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والنقل البحرى

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ROADS AND BRIDGES AUTHORITY

دراسة الجدوى لمشروع طريق القاهرة - أسيوط

CAIRO-ASSUIT HIGHWAY FEASIBILITY STUDY

FINAL REPORT

Appendix Volume 7

EVALUATIONS

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

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FORWARD

This seventh volume of appendices presents the evaluations of investment projects. Separate appendices cover the economic, the financial and the social and environmental evaluations. A review is also made of the organization of RBA.

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Appendix 7A

ECONOMIC EVALUATION

The task of the economic evaluation was to assess the economic value to the Nation of each investment considered by the Study. This was done by comparing the costs of construction and maintenance for each investment with the economic benefits expected to be brought about by the investment.

The two main types of investment considered were i) building a completely new road between Cairo and Assuit in the desert just outside the existing agricultural lands on the west bank of the Nile, and ii) improving the existing West Bank Highway by building bypasses and widening. A third case was also examined namely, an improved program of highway pavement overlaying. These three sets of investments were defined in the Expressway, Improved and Overlay Networks as described in Appendix 6A. In addition, various intermediate networks were evaluated for staging and sensitivity assessments.

Approach to the Economic Evaluation

The economic evaluation was, in fact, a series of individual evaluations. Each evaluation was always the comparison of two alternative transport networks, quantifying the economic advantages of one transport network over the other. Individual investments in a network were not evaluated separately; rather all the investments in each network were treated as a single and complete package.

One network in an evaluation was always taken as the base case against which the other network, the test case, was compared. Generally, the test case represented the network containing an investment, or an increase in investment, which led to economic benefits when compared to the base case. The task of the evaluation was to reveal whether the size of the benefits justified the cost of the investment.

With more than two test networks to be evaluated, each was evaluated against the base case in a separate evaluation. Depending on the results, some pairs of test networks were then evaluated, designating one as the base case for that evaluation, and the other (generally the one with the greater investment costs) as the test case.

Thus the economic evaluation process produced a series of results, each representing the comparison of a pair of networks. These results were then combined with other findings of the Study to make the final judgements on investments in the Cairo-Assuit Corridor.

Costs Considered - The principal cost associated with each investment (as represented by each test network) was the cost of construction. These could be staged, either by constructing sections of route at different times, or by building a reduced highway initially, and then adding to it later (eg extra lanes, grade separated interchanges, or pavement strengthening by overlaying in later years).

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Other costs considered included maintenance costs and the costs of pavement overlaying on the rest of the highway network in the Cairo-Assuit corridor.

Benefits Considered - The three types of benefit considered in the economic evaluation were the savings in vehicle operating costs, passenger time, and traffic accidents. Development benefits, that is to say, the benefits from opening up regions for new growth, were included in the economic evaluation, not explicitly in terms of locations of new factories and cities, but implicitly in the valuation of generated traffic benefits. Other benefits for which quantification in economic terms is more controversial, in particular environmental and social benefits, were considered in a qualitative manner and are discussed in Appendix 7C.

Of the three types of benefit considered, both vehicle operating cost savings and passenger time savings were calculated by computer, using results generated by the Traffic Model described in Appendix 6B. Indeed, the Traffic Model was designed expressly so that the computation of these benefits could be an automatic operation following forecasts of traffic for the two networks being compared. These two sets of benefits were generally referred to as the "model" benefits. Benefits from savings in traffic accidents were estimated manually based on traffic forecasts.

Project Life - The evaluations had to consider a reasonable lifetime for the projects evaluated, and 25 years was selected for this Study. Assuming an earliest year of opening for a new highway project of 1990, the first forecast year of the Study, a project lifetime from 1990 to 2014 was assumed. Since construction costs are incurred in the years prior to opening, the complete analysis period considered by the Study ran from 1987 to 2014, a period of 28 years.

It was necessary to estimate costs and benefits for each year of this analysis period to build up a complete record over the project life. Project costs could be estimated year by year with reasonable certainty. Project benefits, on the other hand, were estimated in detail for just two years, 1990 and 2000, the years for which traffic forecasts were made. Benefits for other years were obtained by interpolation and extrapolation.

Selection of a Base Case Network

As discussed above, the economic evaluation consisted of a series of evaluations of pairs of networks, with one designated as the base case and the other as the test case. For the initial evaluations, all the different test networks were compared against a common base network for each forecast year. Selection of this base network was critical since it affected the size of economic benefits generated.

There were essentially two choices of base network, the Committed Network and the Overlay Network. These networks were identical in configuration of the road system, but the Overlay Network assumed an improved program of pavement overlaying which would lead to better highway surfaces and therefore to reduced vehicle operating costs. As noted in

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Appendix 3B, this policy is one of timing of investments rather than increased quantity of investment.

Choosing the Committed Network as the base network for the evaluations would have guaranteed high project benefits from savings in vehicle operating costs. This is because all the new projects considered by the Study were designed with strong road pavements adequate to take the high axle loads in the corridor, and consequently were assumed to have a good surface and low vehicle operating costs. The Committed Network on the other hand, assumed the current policy of overlaying which delays pavement overlays until the pavement shows signs of obvious distress. Hence although pavements are good for a few years after overlaying, over the life of the overlay the average pavement surface is at best only fair.

Thus most of the benefits observed by comparing the test networks with the Committed Network would be due to savings in operating cost which had little to do with the investment under consideration, and which therefore would have led to an overestimation of the value of the investments in the test network.

It was decided, therefore, to use the 1990 and 2000 Overlay Networks as the base case for economic evaluations. Effectively, this discards real benefits which may in reality accrue to the a project since there is no guarantee that the overlay policy recommended by the Study will be implemented. However, these benefits cannot be used to justify major new investments in highways when they can be obtained simply by change in policy.

Calculation of Model Benefits

This section describes the calculation of vehicle operating cost savings and passenger time savings which were both undertaken by computer. Computation of benefits were made separately for the years 1990 and 2000

The overall objective of the economic evaluation was to identify changes in consumption of economic resources; that is to say, the real cost to the Nation involved in consuming fuel, buying and wearing out vehicles, using up time of drivers and passengers etc. Resource costs were measured by economic costs from which all subsidies, taxes and duties, which do not reflect true resource consumption, were eliminated. The derivation of economic resource costs is described in Appendix 5E. Model benefits were simply the vehicle operating and time cost savings obtained in the test case when compared with the the base case.

For evaluation purposes, traffic was considered as divided into two parts; normal traffic which was the traffic associated with the base case, and generated traffic which was the increase in traffic obtained in the test case (test volumes less base volumes).

For normal traffic, the estimation of benefits was straightforward, since it was known what the vehicle would be doing both with and without the new facility included in the test case (e.g.expressway, bypasses).

Without the new facility it would be driving on a road with high economic operating costs, and with the facility, it would be driving on a road with low economic operating costs. Hence normal traffic benefits could be estimated simply by multiplying the volume of normal traffic by the change in economic costs between the test and base networks.

The estimation of generated traffic benefits was a little more complicated.

Treatment of Generated Traffic - For normal traffic, the situation in both the test network and the base network was known completely. In the case of generated traffic, however, it was known only what traffic would be doing after the facility opens -- driving along it. It was not known precisely what the newly generated traveller or user of transport would be doing without the new facility, but it was possible to surmise.

In the case of a business man, he could be sitting in an office reluctant to travel to Assuit more than once a month; after the road is improved, he may make the journey once a week. In the case of a merchant with goods to sell, he could be selling his production in other parts of Egypt; after the road improvement, he sees a reduction in transport costs in the corridor and therefore produces more and sends more into Upper Egypt for sale at a lower cost than before. In the case of a taxi and bus passenger, they could be indulging in some local social or business activity; after the road in improved it becomes more attractive to replace or supplement this local activity by similar activities involving travel into Upper Egypt.

It is perhaps unwise to go too far in attributing a rationale to individual transport decisions, but it is possible to affirm confidently that generated traffic brought about by a new transport facility would come about through a myriad of small decisions to be more active in Upper Egypt, all associated with a reduction in transport costs in that corridor, and all resulting in a displacement of some previous activity or use of materials in favor of travel and transport in Upper Egypt.

Valuation of Displaced Activities - In order to get a "without project" cost for evaluating generated traffic, it was necessary to place a value on those activities which would be displaced in favor of newly generated travel in the corridor.

For evaluation purposes, it would have been impracticable to identify and cost these displaced activities one-by-one due to their likely great diversity. Therefore an approximation was required. The procedure adopted in this Study, as in most others, was to value the activity at the financial cost of transport when the decision is made to use the new road; that is to say, when the previous activity is displaced. Generally this meant considering tariffs for passenger and goods traffic, and the perceived financial costs of vehicle operation for private cars.

This "without project" activity would not be of equal value for all generated traffic. Imagine the financial transport costs associated with the test network reducing slowly from the level associated with the base

case to the final level associated with the test case. The initial small reduction in costs would generate a few vehicles, as the cost difference got bigger additional traffic would be generated, and for the last reduction in cost to reach the test case cost level some final vehicles would be generated.

Clearly, the switch from the previous activity to generated travel would take place over a range of price levels determined by users of transport weighing the relative importance of the previous activity against the new opportunites to travel in the corridor. In other words, the valuation of displaced activities could range from relatively high (at about the financial cost of transport associated with the base case) to relatively low (approaching the financial cost of transport associated with test cast). Overall, it was assumed that the value of activities displaced by generated traffic was the average of the financial cost of transport in the base and test cases.

Generated Travel Benefits - For each zone pair, the "without project" costs of generated travel were obtained by averaging the perceived financial costs of transport on the two networks being evaluated, while the "with project" costs were valued at the economic resource cost of the travel generated. Generated travel benefit was simply the difference between the before and after cost.

It may seem that an error is made by estimating benefits from a comparison of financial perceived costs on the one hand and economic resource costs on the other. There is no error. The essential point is that the financial perceived costs of the before case are only a proxy for the value of the other quite unidentifiable activities which have been displaced by generated travel. Since nothing is known about these activities, their detailed cost composition is also unknown. It can only be assumed that they have the average National level of taxation/subsidy, in which case they correspond to economic costs as defined for this Study.

An analogy can be made with a reluctant student being encouraged to work for his exams by the promise of a hi-fi system if he passes. If the size of present has been judged correctly, the student will give up his former activities in favor of study. In this case, the value of the hi-fi would be a good proxy for the value to the student of the activities which he gives up. It does not matter how the cost of the hi-fi breaks down into economic costs, local taxes and customs duties. It is the total market value which serves as the proxy for the value of the activities displaced by study. Similarly, it is the cost of travel as perceived by the user which is used to value activities displaced by generated travel, and the composition of the costs in this instance is of no concern.

Formulae for Calculating Model Benefits

All of the above discussion of model benefits can be summarized in a simple formula, based on Consumer Surplus Theory, for estimating combined benefits of normal and generated traffic:

$$\text{Benefits} = \underbrace{Q*EC}_{(1)} + \underbrace{1/2\ (Q' - Q)*(PC + PC')}_{(2)} - \underbrace{Q'*EC'}_{(3)}$$

where
- Q = Traffic volume
- EC = Economic vehicle operating costs
- PC = Perceived Financial veh op costs

} base case

- Q' =
- EC' =
- PC' =

} as above, but for test case

This equation is evaluated separately for each zone-to-zone pair and for each vehicle type, and the results summed to obtain total benefits.

The three numbered elements making up the equation for benefits can be identified as follows:

(1) Q*EC = Cost of normal traffic in the base case

(2) 1/2(Q' - Q)*(PC + PC') = cost of previous activities displaced by generated travel

(3) Q'*EC' = Cost of both normal and generated travel in the test case

Items (1) and (2) represent the "without project" costs: travel on the base case road system for normal traffic and the cost of other activities later to be displaced by generated travel.

Item (3) represents the "with project" cost for both normal and generated travel.

No Generated Travel - If there is no generated travel, item (2) of the above formula disappears, and the formula reduces to:

$$\text{Benefits} = Q*(EC - EC')$$

That is to say, benefits are the volume of traffic times the difference in costs. The term involving perceived financial operating costs disappears since there is no generated travel to evaluate.

Financial and Economic Costs Equal - In this case, the formula reduces to the classic form of:

$$\text{Benefits} = 1/2(Q + Q')*(C - C')$$

Since the economic and financial costs of time (passengers and cargo) are usually reckoned to be equal, this formula is usually employed to evaluate the benefits due to time savings. This is discussed later.

Computation of Benefits

Computation of benefits was complicated by the diversion procedure used to obtain the traffic forecasts. Each zone-to-zone movement was split between at least two routes, the existing highway and the new East Bank Desert Highway, each route with its own distinct costs and times. In all networks with the Expressway included, movements were split between three paths, the Expressway itself representing the third route possibility.

In order to cope with multi-diversions in the base and test cases, the main benefit formula was broken down into parts and each part computed separately, as follows:

$$\text{Benefits} = \underbrace{Q*EC}_{(1)} + \underbrace{1/2(Q' - Q)*(PC + PC')}_{(2)} - \underbrace{Q'*EC'}_{(3)}$$

(1) Q*EC represents the base traffic times the base economic transport cost. Hence the product of volume and economic cost was estimated for each diversion path, and the results summed over all paths.

(2) 1/2(Q' - Q)*(PC + PC') was more of a problem as it was not possible simply to sum two or three products as in (1) above. Moreover, the generated and normal traffic have got tangled up with each other. For example, there would be some generated traffic on the Expressway (perhaps most) but there would also be some on the existing roads following the relieving of the existing roads by the Expressway. Realising that a precise definition was not possible, the following choices of parameters was made:

i) Total volume in base case (sum of all paths) -- Q

ii) Total volume in test case (sum of all paths) -- Q'

iii) Average financial cost in base case (weighted average of all paths) -- FC

iv) Minimum financial cost in test case (minimum of all paths) — FC'

Taking the minimum costs in both iii) and iv) above would certainly under-estimate benefits, but taking the weighted average in both cases could overestimate generated traffic benefits. The selection above was a compromise.

(3) Q'EC' represents the test traffic times the test economic transport

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cost. This was computed as in (1) above.

Benefits from Time Savings

As noted earlier, the classic form of the consumer surplus benefit equation could be used, as follows:

$$\text{Benefits} = 1/2(Q + Q')*(C - C') \quad \text{(summed for each zone pair and vehicle type)}$$

where Q = Traffic volume } base case
C = Time cost }

Q' = } as above but for
C' = } test case

The modelling process did not give time costs as such (in contrast to vehicle operating costs which were given directly). The output was zone to zone travel time, but this was converted to a cost by applying a cost per vehicle, based on occupancy (passengers or tons) and a unit value of time per person or ton (see Appendix 5E).

Q and Q' were easily identified by summing volumes along each available diversion path between the zone pair. The time element of C and C' (to be factored by the time cost per vehicle) was found by taking an average of the time along each available diversion path, weighted by the traffic volume using that path.

Costs

All costs of construction, maintenance and overlaying are discussed in Appendix Volume 3 and 4. They are summarized in this section for ease of reference in the evaluations, breaking down costs only to the detail necessary to separate cost components occurring in different years. In all cases, economic costs are given, which are on average between one quarter and one third higher than financial costs. The costs for the Expressway and Improved Networks are additional costs to those estimated to implement the Committed/Overlay Network.

Committed/Overlay Network Costs - The economic evaluation was concerned with possible investments in the Cairo-Assuit Corridor additional to those already committed. The costs of implementing the Committed Network, which contains all such projects identified in the corridor, had no affect on the evaluation results and therefore these costs are not discussed here.

As discussed above, the point of reference (or base case) for the evaluations of each test network was not the Committed Network but rather the Overlay Network. This had the same configuration as the Committed Network (see Appendix 6A) but assumed an improved pavement overlay policy in the corridor. As with the Committed Network, the costs of implementing the Overlay Network, which in this case were low, did not affect the evaluation and are not discussed further here. See Appendix 3B for a

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discussion of overlaying costs.

Expressway Network Costs - Expressway Network costs are summarized in Table 7A-1.

The main costs are those associated with the construction of the new Cairo-Assuit Highway. Construction costs of the main highway were estimated to rather more than double from LE 118.2 million to LE 240.0 million with 4-lane construction, which additionally assumed grade-separated interchanges at the intersections with the Fayoum Desert Road and the Beni Suef-Fayoum Road. Costs of the access roads increased from LE 36.9 to LE 84.7 million, due entirely to the addition of grade-separated interchanges at all access points to the new road.

The new highway would intersect with the Fayoum Desert Road at its northern terminus, but the Fayoum Road would intersect with the Cairo Ring Road just a few kilometers further to the North. The presence of the new Cairo-Assuit Highway would put additional traffic pressure on the Ring Road intersection. In the initial at-grade configuration of this intersection, no additional cost would be involved, but when the intersection is later improved to a grade-separated design, an additional slip road would be required. The cost of this additional slip road was estimated at LE 4.9 million.

The design and cost of the pavement for the new highway and access roads took into account the high axle loadings associated with truck traffic in the corridor, although expecting these to be reduced to no more than 50 percent above legal limits. Therefore, strengthening overlays in the years after contruction should not need to be more than the 5 cms assumed here. Never-the-less, the costs are substantial at LE 33.7 and LE 49.8 for 2-lane and 4-lane construction respectively.

The additional costs of routine road maintenance associated with the new highway of between LE 0.36 and 0.57 million per year were more than offset by the reduction in overlay costs elsewhere in the road system estimated at LE 0.46 million per year in 1990 and LE 0.79 million per year by 2000. This reduction was attributable to heavy traffic being diverted to the new highway.

Improved Network Costs - The costs of the Improved Network are shown in Table 7A-2.

The principal costs are associated with the construction of 2-lane bypasses round 14 towns in the corridor by 1990 (LE 31.6 million), and widening of the both the existing West Bank Highway (LE 97.7 million) and the bypasses (LE 29.3 million) to 4-lane standard by 2000. The widening costs for the bypasses assumed a 25 percent addition to the cost difference between 2-lane and 4-lane construction.

Strengthening overlay costs were estimated at LE 4.9, 7.9 and 11.8 million respectively for 2-lane and 4-lane bypasses and the additional carriageway added during widening. Costs included one tack coat, a 5cm surface covering both pavement and shoulders, and a seal coat.

Table 7A-1

EXPRESSWAY NETWORK COSTS
(Economic costs, LE millions, 1985/1986)

ITEM	2-LANE	4-LANE
New Cairo-Assuit Highway construction:		
Main highway (1)	118.2	240.0
Access roads (1)	36.9	84.7
Additional cost for Cairo Ring Road grade-separated I/C (2)	4.9	4.9
5cm overlay (3)	33.7	49.8
Additional annual maintenance	0.36	0.57
Additional annual pavement overlay costs elsewhere in network (4)		
1990	-0.46	-0.46
2000	-0.79	-0.79

(1) Assumes at-grade interchanges for 2-lane construction and grade-separated interchanges for 4-lane.
(2) Cost of additional slip road at intersection of Fayoum Desert Road with Cairo Ring Road when this is grade-separated (assumed necessary by the year 2000).
(3) Assumes one tack coat, surfacing to cover pavement and shoulder, and a seal coat (new highway plus access roads).
(4) In fact a reduction in costs of overlaying due to heavy traffic being diverted to the new highway.

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Table 7A-2

IMPROVED NETWORK COSTS
(Economic Costs, LE millions, 1985/1986)

ITEM	COST
2-lane bypass construction	31.6
Widening bypasses to 4-lane (1)	29.3
Widening remainder of existing West Bank Highway to 4-lane	97.7
5cm Overlay (2):	
2-lane bypasses	4.9
4-lane bypasses	7.9
Additional carriageway added during widening	11.8
Additional annual maintenance:	
Bypasses	0.01
Widening (including bypasses)	0.16
Additional annual pavement overlay costs elsewhere in network:	
1990	-0.29
2000 (3)	-0.49

(1) Assumes 25 percent added to cost difference between 2-lane and 4-lane construction.
(2) Assumes one tack coat, surfacing to cover pavement and shoulder, and a seal coat.
(3) In fact a reduction in costs of overlaying due to heavy traffic being concentrated on the existing highway which by 2000 would have the strongest pavement in the corridor.

Additional annual routine maintenance costs were negligible for the bypasses and added only LE 0.16 million per year in the case of widening.

It was estimated that there would be a saving in annual overlay costs elsewhere in the network since heavy traffic would concentrate on the existing highway which by 2000 would have the strongest pavement in the corridor. Savings were estimated at LE 0.29 and 0.49 million for 1990 and 2000 respectively.

Estimated Model Benefits

Model benefits, that is to say the savings in vehicle operating costs and passenger time as computed by the Traffic Model, were estimated in two sets, the first for the main test networks and other for the sensitivity and staging tests completed for various versions of the Expressway Network. Each are discussed below.

Main Test Network Benefits

The model benefits for the main test networks are summarized in Table 7A-3. Both the Improved and the Expressway Network benefits were calculated relative to the Overlay Network, which represented the standard base case for the Study evaluations. However an evaluation of the Overlay Network against the Committed Network is also included Table 7A-3 to indicate the magnitude of the vehicle operating cost savings associated with the improved pavement overlay policy assumed in the Overlay Network.

In all cases, daily vehicle operating cost and passenger time benefits are displayed by vehicle type. Most vehicle operating cost benefits are associated with the three truck types and most time savings are associated, not surprisingly, with the five passenger vehicles.

Daily benefits were converted to annual benefits making two adjustments in the process, one for private cars and the other for trucks.

Benefit Adjustment for Private Cars - Passenger time savings and vehicle operating cost savings are normally maintained separately for evaluation purposes. This is because vehicle operating cost savings are more tangible, representing measurable consumption of resources such as fuel and tires. Passenger time savings, on the other hand, are more subjective, and values of time associated with passenger time savings can be disputed.

However, in the special case of private cars (Car work and Car other in Table 7A-3), an adjustment was made to the vehicle operating cost savings to add an element of passenger time saving. This was because vehicle routings in the Traffic Model were determined on the basis of perceived financial costs, which for private cars included a valuation of time savings for driver and passenger. It would therefore be inconsistent to first determine routings taking account of time savings, and then disallow the time savings in the establishment of economic benefits. In fact, the inclusion of time savings in route choice for private cars is

Table 7A-3

MODEL BENEFITS FOR MAIN TEST NETWORKS
(LE 1985/1986)

VEHICLE TYPE	1990 EVALUATION: Overlay vs Committed	1990 EVALUATION: Improve (1) vs Overlay	1990 EVALUATION: Expressway (2) vs Overlay	2000 EVALUATION: Overlay vs Committed	2000 EVALUATION: Improve (3) vs Overlay	2000 EVALUATION: Expressway (2) vs Overlay
Vehicle Operating Cost (VOC) Benefits (LE per day)						
Car work	2,165	(560)	(2,693)	5,414	(11,029)	(11,501)
Car other	1,320	(554)	(1,917)	3,685	(10,821)	(11,493)
Taxi car	12,636	(1,772)	1,638	19,885	6,378	7,278
Taxi van	8,999	(1,344)	(426)	20,692	4,609	1,170
Pickup	17,536	(3,227)	(807)	34,082	9,769	2,732
Bus	5,625	(798)	1,576	10,961	8,584	5,214
Truck single	9,043	(2,940)	5,948	17,104	22,001	15,996
Truck comb	13,988	(662)	16,619	27,272	45,345	44,826
Truck artic	5,788	(355)	9,725	9,752	21,695	22,724
Total VOC bens	77,100	(12,212)	29,663	148,847	96,531	72,656
Passenger Time Benefits (LE per day)						
Car work	377	249	2,372	(44)	19,323	19,952
Car other	143	125	860	77	8,309	7,041
Taxi car	744	374	4,424	310	26,577	25,718
Taxi van	711	541	2,548	(72)	46,742	27,700
Pickup	0	0	0	0	0	0
Bus	382	189	2,115	(186)	13,712	15,171
Truck single	4	4	26	4	166	151
Truck comb	8	8	62	6	307	322
Truck artic	3	3	22	7	101	106
Total time bens	2,372	1,493	12,429	97	115,338	96,161
Annual Benefits (LE millions)						
VOC benefits mod (4)	28.14	-4.32	12.01	54.33	42.31	34.86
Remaining time benefits	0.87	0.41	3.36	0.04	35.02	26.76
Total	29.01	-3.91	15.36	54.36	77.33	61.62
Annual benefits adjusted for truck load controls (LE millions) (5)						
Addit truck benefits	2.04	-0.17	2.56	3.82	6.68	6.57
Total VOC benefits	30.18	-4.49	14.56	58.14	48.99	41.43
Remaining time benefits	0.87	0.41	3.36	0.04	35.02	26.76
Total	31.04	-4.08	17.92	58.18	84.01	68.19

(1) 2-lane bypasses for 14 towns on existing West Bank Highway.

(2) 4-lane.

(3) Widening of existing West Bank Highway to 4-lane, including 1990 bypasses

(4) Negative VOC benefits offset by positive time benefits (when available) for private cars, for which time was used to select route.

(5) Single truck benefits*1.07 and other truck benefits*1.25, associated with axle loads reduced to no more than 50% overloaded.

the reason why, on a pure vehicle operating cost basis, the private car benefits were mostly negative.

Therefore, negative private car operating cost benefits were cancelled by adding positive time benefits (when available). Any surplus time benefits remaining were retained as time benefits.

Benefit Adjustment for Trucks - Subsequent to the Traffic Model tests, an analysis was made of truck axle load policy.

Trucks in the Cairo-Assuit Corridor were observed in the February 1986 Truck Weighing Survey to be very heavily overloaded with axle loads in excess of twice the legal axle load. With the planned commencement of a regular program of truck weighings in the corridor, using equipment obtained by the Roads and Bridges Authority, it was expected that the excessively high truck loads would be eliminated. However, the Study made a conservative assumption that only the grossly overloaded trucks would be brought under control, and that axle loads as high as 50 percent above legal limits would still persist. This was because many trucks were found to be licensed to carry more than the legal axle loads, and it could prove difficult for the Authorities to reduce loadings to below licensed truck weights.

Even the elimination of the grossly overloaded trucks would produce a significant increase in trucks in the corridor, since the same load must now be carried by two trucks in place of one. Allowing for the fact that axle load control would inevitably lead to tariff increases which would curtail growth in demand for truck traffic, an increase of 7 percent in single trucks and 25 percent in combination and articulated trucks was estimated.

Assuming axle controls would be implemented by 1990, model estimated benefits for trucks were therefore increased by the percentages above (7 percent and 25 percent) to allow for the increase in trucks caused by enforcing lower axle loads. This was a conservative estimate since it allowed only for the benefits accruing to the additional trucks assuming conditions in the base case to be unchanged. In fact, an increase in trucks would also increase congestion which would have the effect of increasing benefits for all vehicles.

Although it can be argued that the new axle load policy might be ineffective, so that this adjustment increased project benefits unreasonably, it can also be pointed out that the project evaluations presented here assumed two changes in policy -- an improved overlay policy, and a reduced axle load policy. The first had the effect of reducing project benefits (by assuming better quality road surfaces than existing) and the other has the effect of increasing project benefits by increasing the number of trucks to take advantage of new highways.

Both policies require planning and determination to carry them through, and if one can succeed, there is no reason why the other should not succeed as well. Conversely, both could fail. In either case, the impact on the justification of new projects would to some extent be cancelled. Therefore it is argued that the evaluation process in general

did not overestimated benefits by this adjustment for trucks.

Discussion of the Main Test Model Benefits - The Expressway Network, which assumes a new 4-lane highway from Cairo to Assuit, showed positive benefits in both 1990 and 2000. Most benefits in 1990 were due to vehicle operating cost savings (LE 14.6 compared with LE 3.4 for time savings), but by 2000, time benefits increased significantly reaching nearly LE 27 million compared with LE 41 million for vehicle operating cost savings. This rapid increase in time benefits was due to the expected development of highway congestion in the period 1990 to 2000, brought about by a forecast doubling of traffic volumes.

The Improved Network showed negative benefits for 1990, due to the increase in route length associated with the 14 bypasses around the towns on the existing West Bank Highway. By 2000, with widening of the entire existing highway to 4-lane, benefits exceeded those of the Expressway Network for both vehicle operating cost savings and time savings (LE 49.0 and 35.0 respectively).

The vehicle operating costs benefits of the Overlay Network compared with the Committed Network were substantial, exceeding the benefits of both the Expressway and Improved Networks (compared with Overlay). This emphasises the the fact that considerable benefits can be obtained by providing good pavement surfaces on existing roads. However, it must be emphasised that a full evaluation of the costs and benefits of an improved overlay policy was not possible within the confines of this Study. Little information was available on existing pavement condition and structure, and the Study budget permitted only 20 borings along about 500 kilometers of highway (existing east and west bank). A full evaluation would require many more borings, as well as deflection and other measurements. The estimates presented here are an indication, no more, of the scale of benefit available.

Sensitivity and Staging Test Benefits

The model benefits estimated for the sensitivity and staging test networks are summarized in Table 7A-4. They all refer to versions of the Expressway Network. The same adjustments for private car benefits and truck benefits were made as for the main test networks.

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

Sensitivity Tests - Two sensitivity tests were undertaken for the 4-lane expressway, one assuming low economic growth between 1990 and 2000 (4 percent per year) and the other assuming high growth (8 percent per year), these compared with 6 percent per year assumed in the main test. In addition, the low sensitivity test assumed that the 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).

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Table 7A-4

MODEL BENEFITS FOR SENSITIVITY AND STAGING TESTS
(LE 1985/1986)

	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
Vehicle Operating Cost (VOC) Benefits												
Car work	(15,801)	(7,469)	(24,615)	(15,801)	(11,398)	(9,040)	(12,125)	(2,482)	(2,693)	(2,339)	(42)	(125)
Car other	(11,483)	(5,082)	(17,833)	(11,483)	(6,487)	(4,403)	(10,162)	(2,630)	(1,917)	(1,771)	(353)	(171)
Taxi car	7,278	4,184	11,105	7,278	3,328	(642)	6,406	2,168	1,638	1,428	1,169	474
Taxi van	1,170	270	2,567	1,170	(363)	(2,032)	1,262	778	(426)	(460)	(16)	(358)
Pickup	2,732	21	6,279	2,732	(1,642)	(5,969)	2,070	1,462	(807)	(852)	799	562
Bus	5,214	4,318	6,478	5,214	2,014	(1,074)	4,428	3,342	1,576	1,314	952	(66)
Truck single	15,996	13,292	20,253	15,996	6,128	(2,362)	14,314	11,023	5,948	5,767	3,6[illegible]	(1)
Truck comb	44,826	38,345	52,799	44,826	17,341	(4,822)	31,081	24,788	16,619	12,555	2,3[illegible]	(1,933)
Truck artic	22,724	17,798	24,946	22,724	7,855	(2,893)	14,988	12,956	9,725	7,208	4,074	(644)
Total VOC bens	72,656	65,677	81,979	72,656	16,776	(33,237)	52,262	51,397	29,663	22,850	12,681	(2,313)
Passenger Time Benefits												
Car work	19,952	8,592	35,319	19,952	13,211	8,702	16,233	835	2,372	1,7[illegible]	(21)	(97)
Car other	7,041	3,073	11,759	7,041	3,654	1,779	6,190	1,218	860	616	87	(45)
Taxi car	25,718	12,655	39,184	25,718	14,507	6,049	22,680	2,088	4,424	3,426	532	(356)
Taxi van	27,700	12,336	41,181	27,700	12,213	1,864	25,868	8,602	2,548	2,142	336	(275)
Pickup	0	0	0	0	0	0	0	0	0	0	0	0
Bus	15,171	6,173	22,028	15,171	9,507	5,170	13,404	1,444	2,115	1,428	296	40
Truck single	151	69	245	151	71	13	133	43	26	21	2	0
Truck comb	322	147	547	322	134	0	260	86	62	45	19	0
Truck artic	106	50	178	106	45	2	88	26	22	15	8	1
Total time bens	96,161	43,095	150,441	96,161	53,342	23,579	84,856	14,342	12,429	9,749	1,219	(732)
Annual Benefits												
VOC bens mod (1)	34.86	27.82	43.20	34.86	11.62	-8.31	25.76	19.51	12.01	9.24	6.49	-0.84
Rem time bens	26.76	11.88	41.63	26.76	13.98	4.78	24.29	4.49	3.36	2.66	0.41	-0.27
Total	61.62	39.70	84.83	61.62	25.59	-3.53	50.05	23.99	15.36	11.90	6.90	-1.11
Annual benefits adjusted for truck load controls (2)												
Addit trk bens	6.57	5.46	7.61	6.57	2.46	-0.76	4.57	3.73	2.56	1.95	1.14	-0.24
Tot VOC mod	41.43	33.28	50.81	41.43	14.07	-9.07	30.33	23.24	14.56	11.19	7.63	-1.08
Rem time bens	26.76	11.88	41.63	26.76	13.98	4.78	24.29	4.49	3.36	2.66	0.41	-0.27
Total	68.19	45.16	92.44	68.19	28.05	-4.29	54.62	27.72	17.92	13.85	8.04	-1.35

NOTE: All benefits computed relative to Overlay Network for appropriate year.

(1) Negative VOC benefits offset by positive time benefits (when available) for private cars, for which time was used to select route.

(2) Single truck benefits*1.07 and other truck benefits*1.25, associated with axle loads reduced to no more than 50% overloaded.

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Vehicle operating cost benefits for the Low and High Sensitivity tests were LE 33 and 51 million respectively, compared with LE 41 million for the main test. This mirrors the change in vehicle kilometers in the two cases with approximately a 20 percent decline for the Low Sensitivity and a 20 percent rise for the High Sensitivity.

The changes in time benefits for the two tests were much greater, with over a 50 percent drop for the Low Sensitivity and a similar rise for High Sensitivity. This reflects the degree of congestion expected in the Cairo-Assuit corridor by the year 2000 with the disproportionate changes in time costs with volume changes indicating unstable traffic conditions.

2000 Expressway Staging Tests - In addition to the main test, two staging tests were undertaken for a 4-lane expressway, both assuming construction starting from Giza. The first considered the new highway terminating at Minia, while the second terminated the highway at Beni Suef.

The Minia alternative showed sharply reduced benefits from the main test, with vehicle operating cost benefits cut to nearly one third and time benefits reduced by a half. The Beni Suef alternative indicated even worse results with a net disbenefit in vehicle operating cost savings and only a slight time benefit. It was concluded that partial networks starting from Giza showed little chance of feasibility.

Observing that on traffic grounds, a 4-lane expressway appeared not to be justified by the year 2000, alternative 2-lane networks were devised. These should be considered as a staging of the full expressway, with construction and design permitting later expansion when traffic increased. The test on a full length 2-lane highway highway indicated a reduction in vehicle operating cost benefits of about 25 percent compared with the 4-lane alternative, from LE 41 million to LE 30 million. However, there was only a slight reduction in time benefits from LE 27 to 24 million.

A further 2-lane staging test was undertaken, this time with the road commencing in Assuit and reaching to Beni Suef (ie omitting the Giza-Beni Suef section). Although this showed reductions in vehicle operating cost benefits from the full length highway, the reduction was much less than 4-lane Giza to Beni Suef test discussed above. However, time benefits were much reduced. The Assuit to Beni Suef staging test showed benefits of LE 23 and 4.5 million respectively for vehicle operating costs and time savings.

1990 Expressway Staging Tests - The evaluation of the full length 2-lane highway showed a similar relationship to the 4-lane results as displayed for 2000, with vehicle operating cost benefits down by about 25 percent to LE 11 million. Time benefits, which were not so significant at 1990 were reduced slightly to LE 2.7 million. The Beni Suef to Assuit staging network showed vehicle operating cost benefits reduced to LE 7.6 million, and time cut to only LE 0.5 million, a similar result to 2000.

A further test was made of a 2-lane highway for 1990, this time considering construction from Assuit to Minia only. The results indicate negative benefits.

Conclusions on Model Benefits

It was concluded that the two major types of projects considered by the Study -- the new Cairo-Assuit Highway and improvements to the existing highway -- both showed strong benefits by the year 2000 and were both serious candidates for consideration.

The tests on the Expressway Network indicated that a full length highway from Giza to Assuit had significantly more benefits than partial highways covering only part of the corridor. Only the partial alternative from Beni Suef to Assuit showed reasonable level of benefits. In particular, short lengths of Expressway starting either from Giza or Assuit had negative benefits. Finally, results showed that the reduction in benefits for a 2-lane highway compared with a 4-lane highway were not great.

Traffic Accident Benefits

The determination of road accident rates and costs is detailed in Appendix 2C. The rates estimated for use in the evaluation process were considered valid but were not derived from a firm Egyptian data base. To avoid an overestimation of benefits, the following assumptions were applied:

1 Accidents involving only minor personal injury or property damage were disregarded.

2. Each fatal accident was assumed to result in one death.

Accident rates were estimated per million vehicle-kilometers. The computer traffic model produced average daily traffic for each zonal movement in passenger car units (PCU). Thus, the first step of this evaluation converted PCU average daily traffic per network link to average daily vehicle traffic. Average daily vehicle traffic multiplied by length of the link, in kilometers, yielded daily vehicle-kilometers per link, and multiplying this by 365 produced annual link vehicle kilometers. Annual vehicle-kilometers were then converted to millions of vehicle kilometers and the results summed for end of the following link categories:

1. 2-lane desert roads.

2. 2-lane urban/rural roads (i.e. most sections of the existing and existing East and West Bank Highways and of the new highway access roads).

3. 4-lane highways.

These summations were then applied to the appropriate accident rates

to produce fatalities and serious injury accidents per year. These figures multiplied by the appropriate cost per accident and summed produced the total cost of accidents for each alternative highway network, for each of the forecast years, 1990 and 2000. The results are depicted in Table 7A-5 for the number of accidents, and 7A-6 for accident costs.

The Committed/Overlay Network was designated the base case. Accident benefits were computed by subtracting the accident costs of the alternative network from accident costs of the base case. The results are also shown in Table 7A-6.

With the exception of the Improved Network, the potential for accident reduction and benefits of the alternative infrastructure investments appears trivial. This result is to be expected in that there is very little variation between alternatives in the year 2000 traffic forecasts for the existing West Bank Highway. Until this road is improved, it will continue to have a high fatality and serious injury accident rate.

Cost Benefit Evaluation

The cost/benefit evaluation brought together all the estimates of costs and benefits for each year and arrayed them in a time series, interpolating and extrapolating cost and benefit values where necessary. Cost and benefit values were then discounted to a common year, 1986, using the Study selected discount rate of 12 percent, and a set of economic indicators were calculated to show project feasibility. These were as follows:

Internal Rate of Return (IRR)	- an IRR above the discount rate of 12 percent indicates project feasiblity.
Net Present Value (NPV)	- a positive NPV indicates project feasibility.
Benefit/Cost Ratio (B/C Ratio)	- a B/C ratio greater than 1.0 indicates project feasibility.

A fourth economic indicator was also considered, that of First Year Rate of Return (FYRR). This is the ratio of benefits in the opening year to the single year cost of construction of the project, and should equal or exceed the Study discount rate for full economic feasibility. Single year cost of construction is the year-by-year costs of construction brought forward to the year of project opening by applying the Study discount rate of 12 percent.

In fact, FYRR was not calculated, but instead the level of annual benefits required to achieve the minimum FYRR was estimated. This gave a good guide to the optimum year of project opening.

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Table 7A-5

ESTIMATED ANNUAL TRAFFIC ACCIDENTS BY NETWORK

NETWORK	1990			2000		
	Fatal	Injury	Total	Fatal	Injury	Total
Committed/Overlay	355	1703	2058	611	2958	3569
Improved	375	1792	2167	72	1179	1251
Expressway (4-lane)	332	1614	1946	551	2730	3281
Expressway (2-lane)	337	1633	1970	570	2973	3543
Expressway (2-lane) (Beni-Suef to Assuit only)	368	1817	2815	1106	3217	4232

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Table 7A-6

ACCIDENT COSTS AND BENEFITS
(LE Million)

ROAD CLASS	COMMITTED 1990	COMMITTED 2000	IMPROVED 1990	IMPROVED 2000	EXPRESS 4 LANE 1990	EXPRESS 4 LANE 2000	EXPRESS 2 LANE 1990	EXPRESS 2 LANE 2000	EXPRESS BS-Ass, 2-lane(1) 1990	EXPRESS BS-Ass, 2-lane(1) 2000
Accident Costs										
Existing Desert	1.3	2.3	1.3	2.2	0.9	1.7	1.0	1.8	1.2	2.6
Existing non-desert	6.2	10.6	6.9	1.9	5.7	9.4	5.8	9.6	6.3	10.6
New Highway					0.3	0.6	0.7	1.3	0.3	0.6
Access Roads					0.1	0.3	0.1	0.2	0.0	0.1
Total	7.5	12.9	7.8	4.1	7.0	12.0	7.6	12.9	7.8	13.9
Accident Benefits(2)										
Existing Desert	0.0	0.0	0.0	0.1	0.4	0.6	0.3	0.5	0.1	-0.3
Existing non-desert	0.0	0.0	-0.3	8.7	0.5	1.2	0.4	1.0	-0.1	0.0
New Highway	0.0	0.0	0.0	0.0	-0.3	-0.6	-0.7	-1.3	-0.3	-0.6
Access Roads	0.0	0.0	0.0	0.0	-0.1	-0.3	-0.1	-0.2	-0.0	-0.1
Total	0.0	0.0	-0.3	8.8	0.5	0.9	-0.1	0.0	-0.3	-1.0

Source: Consultant

(1) Construction from Beni Suef to Assuit only.
(2) Cost reduction compared with Committed.

An inspection of the model and accident benefits led to some network alternatives being discarded. The remaining evaluations were completed:

1. New Cairo-Assuit Highway (4-lane) - Base assumptions
2. - Low sensitiviy
3. - High sensitivity
4. New Cairo-Assuit Highway (2-lane) - Base assumptions
5. - Low sensitiviy
6. - High sensitivity
7. New Cairo-Assuit Highway (2-lane)
   Beni Suef to Minia only - Base assumptions
8. Improvement of the Existing Cairo Assuit Highway
   (Bypasses by 1990, widening by 2000)

All of these evaluations assumed the Overlay Network as the base case and therefore indicate project feasibilility after completion of all currently committed projects, and after the implementation of an improved pavement overlaying policy. The high sensitivity evaluations assumed benefits associated with higher growth rates in the Corridor. Low sensitivity assumed benefits from lower growth rates, and also that construction costs would be 20 percent higher. In all cases benefits after the last forecast year 2000 were assumed to grow at half the estimated rate of growth in the period 1990-2000.

One further evaluation was then undertaken (9) comparing a new 4-lane Cairo-Assuit Highway with a 2-lane highway base case in the high sensitivity case.

The results of the evaluations are summarized in Table 7A-7. Since time benefits assume large values in many networks by the year 2000, two main cases were evaluated, one assuming full time cost savings, and the second assuming that only one third of the time savings were applicable.

Of the two main Expressway Networks, the 4-lane highway succeeded in meeting the evaluation criteria in only one of the six cases presented -- high sensitivity and assuming the full value of passenger time savings, although coming close for high sensitivity with just one third of the time benefits included. On the other hand, the 2-lane highway failed only in the two cases for low sensitivity, in this case coming close with full time savings included.

The apparent case for the 4-lane highway under high sensitivity fails when considering evaluation 9. This showed that the additional investments required to build 4-lane instead of 2-lane would not produce sufficient additional benefits to justify them. These results indicated quite firmly from the purely economic viewpoint that if a new Cairo-Assuit Highway is to be built, it should be initially to 2-lane standard and not 4-lane. These conclusions were supported by the traffic evaluation which indicated no need of a 4-lane highway in the first stage.

Table 7A-7

SUMMARY OF THE ECONOMIC EVALUATION

NETWORK	FULL TIME SAVINGS			1/3RD TIME SAVINGS		
	IRR	NPV(1)	B/C	IRR	NPV(1)	B/C
Expressway vs Overlay						
1. 4-lane, base assumption	11.9%	-2.9	0.99	9.5%	-61.9	0.77
2. 4-lane, low sens	7.3%	-126.4	0.61	5.7%	-157.7	0.51
3. 4-lane, high sens	14.1%	+65.4	1.24	11.3%	-19.7	0.93
4. 2-lane, base assumptions	16.8%	+76.3	1.59	13.7%	+24.1	1.18
5. 2-lane, low sens	11.4%	-8.2	0.95	9.3%	-35.7	0.77
6. 2-lane, high sens	19.2%	+131.9	2.02	15.6%	+56.2	1.43
7. 2-lane, BS-Assuit only	12.5%	+5.4	1.05	11.6%	-3.9	0.96
8. Improve vs Overlay	21.9%	+140.7	2.83	18.5%	+81.7	2.06
9. New Cairo-Assuit Highway, 4-lane vs 2-lane, high sensitivity	6.4%	-66.9	0.51	5.3%	-76.1	0.45

(1) NPV valued in LE millions.

The single staging test for the new highway, evaluating a construction from Beni Suef to Assuit only, indicated feasibility only if full time savings were counted. However, it only just failed with one third of the time savings included. Since this was the best performing staged contruction alternative, it was concluded that none of the staging options which omitted sections of the route were particularly satisfactory. Clearly, the complete highway would produce more benefits than the sum of its parts. This is almost certainly because the each section of the route channels traffic on to the other sections, which would increase the number of vehicles gaining benefit and also increase the benefit for each individual vehicle.

The network with the best economic performance was the Improved Network. Even counting just one third of time benefits, the network achieved an IRR of 18.5%, and NPV of LE 81.7 million and a B/C ratio of 2.06.

Detailed evaluation results for each network are presented in Annex 7A-1 to this Appendix. The results for the 2-lane Expressway Network (base assumption) and the Improved Network are discussed below, in terms of the projects they contain.

New 2-lane Highway - Table 7A-8 presents the detailed economic evaluation for a new 2-lane highway from Cairo to Assuit. Construction was assumed to take place over a three year period from 1987 to 1989 (Government fiscal years indicating the period from mid-1987 to mid-1990), but with the access roads being completed in the year of main project opening. Since access roads were forecast to carry relatively light traffic and were based on existing roads, this was not an unreasonable assumption. It was assumed that any new construction needed to link access roads with the main highway would be completed in the main three year construction period.

The pavement design assumed that an additional 5cm overlay would be required after 10 years, and this was programmed for 1999, with a further 5cm overlay in 2009. It was assumed that the interchange with the Cairo Ring Road would be grade-separated in the year 2000, and that this would require an additional slip road to carry the traffic to the new Cairo-Assuit Highway.

Additional highway maintenance of LE 0.36 million a year was assumed, but it was calculated that an increasing quantity of pavement overlaying in other parts of the corridor would be avoided by heavy vehicles diverting to the new highway.

Project benefits mainly came from savings in vehicle operating costs, but passenger time savings were significant as well. As noted earlier, these were reduced to one third of the calculated value in one of the sets of evaluation parameters presented to demonstrate that they were not essential at the full rate for economic feasibility.

Table 7A-8

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (2-LANE)
BASE ASSUMPTIONS
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	45.6			45.6				0.0	-45.6	-45.6
1988	45.6			45.6				0.0	-45.6	-45.6
1989	45.6			45.6				0.0	-45.6	-45.6
1990 (1)	18.5	0.36	-0.46	18.4	11.2	2.7	-0.10	13.8	-4.5	-6.3
1991		0.36	-0.49	-0.1	12.4	3.4	-0.08	15.7	15.8	13.5
1992		0.36	-0.51	-0.2	13.7	4.2	-0.06	17.8	17.9	15.2
1993		0.36	-0.54	-0.2	15.1	5.2	-0.05	20.3	20.4	17.0
1994		0.36	-0.57	-0.2	16.7	6.5	-0.04	23.1	23.4	19.0
1995		0.36	-0.60	-0.2	18.4	8.1	-0.03	26.5	26.7	21.3
1996		0.36	-0.64	-0.3	20.3	10.1	-0.03	30.4	30.7	24.0
1997		0.36	-0.67	-0.3	22.5	12.6	-0.02	35.0	35.3	27.0
1998		0.36	-0.71	-0.3	24.8	15.7	-0.02	40.5	40.8	30.4
1999 (2,3)	38.6	0.36	-0.75	38.2	27.4	19.5	-0.01	46.9	8.7	-4.3
2000		0.36	-0.79	-0.4	30.3	24.3	.0	54.6	55.0	38.8
2001		0.36	-0.81	-0.5	31.8	25.5	.0	57.3	57.8	40.5
2002		0.36	-0.83	-0.5	33.4	26.8	.0	60.2	60.7	42.8
2003		0.36	-0.86	-0.5	35.1	28.1	.0	63.2	63.7	44.9
2004		0.36	-0.88	-0.5	36.8	29.5	.0	66.4	66.9	47.2
2005		0.36	-0.91	-0.5	38.7	31.0	.0	69.7	70.2	49.5
2006		0.36	-0.93	-0.6	40.6	32.6	.0	73.2	73.7	52.0
2007		0.36	-0.96	-0.6	42.6	34.2	.0	76.8	77.4	54.6
2008		0.36	-0.98	-0.6	44.8	35.9	.0	80.7	81.3	57.4
2009 (3)	33.7	0.36	1.01	33.0	47.0	37.7	.0	84.7	51.6	26.5
2010		0.36	-1.04	-0.7	49.4	39.6	.0	88.9	89.6	63.2
2011		0.36	-1.07	-0.7	51.8	41.6	.0	93.4	94.1	66.4
2012		0.36	-1.10	-0.7	54.4	43.6	.0	98.1	98.8	69.7
2013		0.36	-1.13	-0.8	57.1	45.8	.0	103.0	103.7	73.2
2014 (4)	-11.4	0.36	-1.16	-12.2	60.0	48.1	.0	108.1	120.3	88.2
Totals -	216.0	9.00	-20.40	204.6	836.4	612.3	-0.52	1448.1	1243.5	822.3
Discounted -	132.0	2.01	-3.69	130.3	128.5	78.3	-0.2	206.6	76.3	24.1

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	172.1	182.9
Req opening year benefits (incl cost savings)	20.7	21.9

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	16.8%	13.7%
Benefit/Cost Ratio	1.59	1.18
Net Present Value	76.3	24.1 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

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Accident savings were negligible, if not negative. This was mainly because traffic would be diverted from the 4-lane Cairo-Aiyat section of the existing highway, where accident rates could be expected to be lower than on the new 2-lane highway presented here. Accident savings were significant only for the new 4-lane highway presented in the Annex 7A-1 to this appendix.

The economic indicators of IRR, NPV and B/C Ratio were discussed above together with the results for the other network evaluations, and it was noted that they indidicate project feasibility. However, it is also important to take account of the fourth economic parameter established in this section, that of FYRR. This was approached by first estimating the single year construction cost, and then estimating the opening year benefits required to achieve the minimum FYRR.

The single year construction cost was estimated at LE 172.1 million for a 3-year construction period (as displayed in the table) or LE 182.9 for a 4-year construction period. Hence in order to achieve a FYRR equal to the Study discount rate of 12 percent, opening year benefits of LE 20.7 or 21.9 million respectively would be required. Inspection of the net cost/benefit stream indicated that this could be achieved in the early to mid-1990s.

This indicated a likely starting date for construction as 1990, rather than 1987 assumed in the evaluation. Assuming that international funding would be required to finance the project, with the checks and controls that this necessarily implies, a 1990 start date for construction was considered realistic, if not optimistic. Table 7A-9 shows a revision of the evaluation with the start of construction put back three years to 1990, and assuming a 4-year construction period. The economic parameters for this more realistic option show an IRR of 16.8 percent, an NPV of LE 47.7 million and a B/C ratio of 1.55, all including only one third of time savings.

Improvements to the Existing Highway - Table 7A-10 presents the evaluation of the main alternative to the new Cairo-Assuit Highway; improvement of the existing West Bank Highway.

It was assumed that improvements would start with the construction of 14 bypasses around the major towns and cities along the route which lack such a bypass (the great majority). This construction was scheduled for the period 1987-1989 (which financial period ends in mid-1990). Construction would then commence on widening those sections of the road which are not divided highway; essentially the entire route between Aiyat and Assuit. This work was assumed to last until the Year 2000, allowing for significant difficulties in acquiring land for right-of-way.

Maintenance costs would build up steadily as road widening progressed. So also would the savings in pavement overlaying on other roads in the corridor, as traffic increasingly diverted to the improved West Bank route.

Table 7A-9

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (2-LANE)
FOUR YEAR CONSTRUCTION STARTING 1990
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BENEFIT STREAM: Full Time Savings	One third time Savings
1990	34.2			34.2				0.0	-34.2	-34.2
1991	34.2			34.2				0.0	-34.2	-34.2
1992	34.2			34.2				0.0	-34.2	-34.2
1993	34.2			34.2				0.0	-34.2	-34.2
1994 (1)	18.5	0.36	-0.57	18.2	16.7	6.5	-0.04	23.2	4.9	0.6
1995		0.36	-0.60	-0.2	18.4	8.1	-0.03	26.5	26.8	21.4
1996		0.36	-0.64	-0.3	20.4	10.1	-0.03	30.4	30.7	24.0
1997		0.36	-0.67	-0.3	22.5	12.6	-0.02	35.1	35.4	27.0
1998		0.36	-0.71	-0.3	24.9	15.7	-0.02	40.5	40.9	30.4
1999		0.36	-0.75	-0.4	27.5	19.5	-0.01	47.0	47.3	34.2
2000		0.36	-0.79	-0.4	30.3	24.3	.0	54.6	55.0	38.8
2001		0.36	-0.81	-0.5	31.8	25.5	.0	57.3	57.8	40.8
2002		0.36	-0.83	-0.5	33.4	26.8	.0	60.2	60.7	42.9
2003 (2,3)	38.6	0.36	-0.86	38.1	35.1	28.1	.0	63.2	25.1	6.2
2004		0.36	-0.88	-0.5	36.8	29.5	.0	66.4	66.9	47.2
2005		0.36	-0.91	-0.5	38.7	31.0	.0	69.7	70.2	49.5
2006		0.36	-0.93	-0.6	40.6	32.6	.0	73.2	73.7	52.0
2007		0.36	-0.96	-0.6	42.6	34.2	.0	76.8	77.4	54.6
2008		0.36	-0.98	-0.6	44.8	35.9	.0	80.7	81.3	57.4
2009		0.36	-1.01	-0.7	47.0	37.7	.0	84.7	85.3	60.2
2010		0.36	-1.04	-0.7	49.4	39.6	.0	88.9	89.6	63.2
2011		0.36	-1.07	-0.7	51.8	41.6	.0	93.4	94.1	66.4
2012		0.36	-1.10	-0.7	54.4	43.6	.0	98.1	98.8	69.7
2013 (3)	33.7	0.36	-1.13	32.9	57.1	45.8	.0	103.0	70.0	39.5
2014		0.36	-1.16	-0.8	60.0	48.1	.0	108.1	108.9	76.6
2015		0.36	-1.19	-0.8	63.0	50.5	.0	113.5	114.3	80.7
2016		0.36	-1.22	-0.9	66.1	53.0	.0	119.2	120.0	84.7
2017		0.36	-1.26	-0.9	69.4	55.7	.0	125.1	126.0	88.9
2018 (4)	-11.4	0.36	-1.16	-12.2	60.0	48.1	.0	108.1	120.3	88.2
Totals -	216.0	9.0	-23.2	201.8	1042.8	804.1	-0.2	1846.7	1644.9	1105.8
Discounted -	86.2	1.28	-2.77	86.7	108.9	76.8	-0.1	185.6	98.9	47.7

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	172.1	182.9
Req opening year benefits (incl cost savings)	20.7	21.9

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	20.8%	17.8%
Benefit/Cost Ratio	2.14	1.55
Net Present Value	98.9	47.7 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

Table 7A-10

EVALUATION OF THE IMPROVEMENTS TO THE EXISTING CAIRO-ASSUIT HIGHWAY
BYPASSES BY 1990, ALL 4-LANE BY 2000
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	10.5			10.5				0.0	-10.5	-10.5
1988	10.5			10.5				0.0	-10.5	-10.5
1989	10.5			10.5				0.0	-10.5	-10.5
1990	12.7	0.01	-0.29	12.4	.0	0.4	0.01	0.4	-12.0	-12.3
1991	12.7	0.01	-0.31	12.4	.0	0.6	0.02	0.7	-11.7	-12.2
1992	12.7	0.02	-0.32	12.4	0.1	1.0	0.04	1.1	-11.3	-12.0
1993	12.7	0.02	-0.34	12.4	0.1	1.5	0.08	1.7	-10.6	-11.7
1994	12.7	0.03	-0.36	12.4	0.3	2.4	0.15	2.8	-9.5	-11.1
1995	12.7	0.04	-0.38	12.4	0.7	3.7	0.30	4.7	-7.6	-10.1
1996	12.7	0.05	-0.40	12.4	1.6	5.9	0.58	8.1	-4.3	-8.2
1997	12.7	0.07	-0.42	12.4	3.8	9.2	1.15	14.1	1.8	-4.3
1998	12.7	0.09	-0.44	12.4	9.0	14.3	2.27	25.5	13.2	3.6
1999 (1)	17.6	0.12	-0.46	17.3	20.9	22.4	4.47	47.8	30.5	15.6
2000		0.16	-0.49	-0.3	49.0	35.0	8.8	92.8	93.1	69.8
2001		0.17	-0.50	-0.3	51.5	36.8	9.2	97.4	97.8	73.3
2002		0.18	-0.52	-0.3	54.0	38.6	9.7	102.3	102.7	76.9
2003		0.19	-0.53	-0.3	56.7	40.5	10.2	107.4	107.8	80.9
2004		0.19	-0.54	-0.4	59.6	42.5	10.7	112.8	113.1	84.9
2005		0.20	-0.56	-0.4	62.5	44.7	11.2	118.4	118.8	89.0
2006		0.21	-0.57	-0.4	65.7	46.9	11.8	124.4	124.7	93.5
2007		0.23	-0.59	-0.4	68.9	49.2	12.4	130.6	130.9	98.1
2008		0.24	-0.61	-0.4	72.4	51.7	13.0	137.1	137.5	103.0
2009 (2)	19.7	0.25	-0.62	19.3	76.0	54.3	13.7	144.0	124.6	89.4
2010		0.26	-0.64	-0.4	79.8	57.0	14.3	151.2	151.5	113.5
2011		0.27	-0.66	-0.4	83.8	59.9	15.1	158.7	159.1	119.2
2012		0.29	-0.67	-0.4	88.0	62.9	15.8	166.7	167.0	125.1
2013		0.30	-0.69	-0.4	92.4	66.0	16.6	175.0	175.4	131.4
2014 (3)	-9.2	0.32	-0.71	-9.6	97.0	69.3	17.4	183.7	193.3	147.1
Totals -	174.0	3.92	-12.62	165.3	1093.9	816.6	198.95	2109.5	1944.2	1399.8
Discounted -	78.6	0.47	-2.30	76.7	108.7	88.5	20.2	217.4	140.7	81.2

Discount Rate 12%

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	21.9%	19.5%
Benefit/Cost Ratio	2.83	2.06
Net Present Value	140.7	81.7 million LE

(1) Includes cost of 5 cm overlay on bypasses.
(2) 5cm overlay on all new construction
(3) Residual value @ 5 percent of total construction.

Benefits were estimated to build up slowly in the opening years, mainly because the bypasses on their own in the early 1990s would generate few benefits (since they add length to a road which was expected to be no more congested in 1990 than in the Study Base Year 1985/86). In fact, economic benefits were estimated as negative, but they were set to zero in this evaluation on the basis that there would be sufficient benefits within the bypass towns to at least off-set the negative benefits for traffic passing through. Benefits for the Improved Network were expected to build up over the construction period of widening, since each section of widening would be a complete and useable while other sections were still in construction.

Vehicle operating cost savings were nearly equalled by passenger time savings due to the traffic congestion likely to prevail with no new highway construction in the corridor. Traffic accident savings were likely to be considerable with completion of the safer 4-lane highway.

The economic indicators showed a good rate of return on this project to improve the existing highway. For this evaluation, a First Year Rate of Return (FYRR) was not estimated since the project would really be a series of connected smaller projects which would need to be evaluated separately to establish individual FYRRs.

Further Consideration of Benefits

Some further analyses of model benefits (vehicle operating cost and passenger time savings) are presented here for the two main alternative projects to emerge from the evaluation process: construction of a new 2-lane highway to Assuit, or improvement of the existing West Bank Highway by adding bypasses and widening. The three further aspects discussed here are:

i) Size of benefits

ii) Geographical Distribution of benefits

iii) Foreign Exchange considerations

Size of Benefits

Benefits were divided into large, small and negative benefits. Small benefits were defined as being less than the values given in Table 7A-11 below. The small operating cost benefit was defined as roughly 5 percent of free-flow economic operating cost at 50 kph assuming Base Year average journey lengths. The small time benefit was about 7 percent of average base year journey times. The term "small benefit" has no precise meaning; it was used simply to identify journey benefits which verge on the level of being unnoticeable.

Table 7A-11

IDENTIFICATION OF SMALL BENEFITS

VEHICLE TYPE	OPERATING COST SAVING	TIME SAVING
1. Car work	LE 0.20	5 minutes
2. Car other	0.20	5
3. Taxi car	0.30	5
4. Taxi van	0.40	5
5. Pickup	0.40	5
6. Bus	0.80	5
7. Truck single	0.80	5
8. Truck comb	3.00	10
9. Truck artic	3.00	10

Expressway Network - Table 7A-12 shows the model benefits for the 2000 2-lane Expressway Network classified into three groups, large, small and negative. The great majority of positive benefits were classified as large for both vehicle operating cost savings and passenger time savings. However, negative benefits for vehicle operating cost savings were significant at LE [illegible] per day, compared with the total of positive benefits at about LE 95,000 per day.

Most of these negative benefits were associated with private car travel and, as discussed previously in this Appendix, this was partly because the Traffic Model route choice for private cars was influenced by travel time savings, which attracted vehicles to the new highway despite overall increase in vehicle operating costs. These were mostly offset by time savings for Car Work class, although not for Car Other.

A further cause of negative vehicle operating cost benefits for private cars were that drivers were assumed not to perceive all their operating cost, considering fuel, oil and tire costs only. This can lead to negative benefits for generated travel, as well as contributing to the negative benefits derived from choice of routes which, when economic resource costs are taken into account, prove to be more costly.

Finally, negative benefits were also a byproduct of the route selection process in the Traffic Model which divided traffic between competing routes in accordance to relative costs on the two routes. This process inevitably put some traffic on the more expensive route, especially when costs of the two alternatives were similar. This mirrored real life where drivers select routes based on more than just the vehicle operating costs involved, or with an imperfect knowledge of the alternative route costs. However, negative benefits produced in this manner were generally small and were outweighed by the much greater positive benefits.

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Table 7A-12

2000 EXPRESSWAY NETWORK (2-LANE) MODEL BENEFITS
(LE thousands per day, 1985/1986)

VEHICLE TYPE	LARGE BENEFITS Inter	Exter	Thru	Total	SMALL BENEFITS Inter	Exter	Thru	Total	NEGATIVE BENEFITS Inter	Exter	Thru	Total	TOTAL BENEFITS Inter	Exter	Thru	Total	PERCENTAGES	
Vehicle Operating Cost Benefits																		
Car work	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	-3.9	-8.0	-0.4	-12.3	-3.9	-7.8	-0.4	-12.1	-23%	
Car other	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.1	-3.7	-6.0	-0.7	-10.3	-3.6	-5.9	-0.6	-10.2	-19%	
Taxi car	0.5	4.5	1.5	6.5	0.4	0.2	0.0	0.6	-0.1	-0.6	-0.0	-0.7	0.8	4.1	1.5	6.4	12%	
Taxi van	0.2	0.3	0.1	0.7	1.7	0.4	0.0	2.1	-0.5	-1.0	0.0	-1.5	1.4	-0.3	0.1	1.3	2%	
Pickup	1.1	3.0	2.1	6.2	1.2	0.5	0.0	1.7	-1.0	-4.9	0.0	-5.8	1.3	-1.4	2.1	2.1	4%	
Bus	0.8	2.7	2.0	5.4	0.2	0.2	0.0	0.4	-0.4	-1.0	0.0	-1.4	0.5	1.9	2.0	4.4	8%	
Truck single	1.6	8.5	6.5	16.6	0.8	0.5	0.0	1.3	-1.1	-2.4	-0.2	-3.6	1.3	6.6	6.3	14.3	27%	
Truck comb	3.3	16.3	14.9	34.6	0.3	0.4	0.0	0.8	-0.7	-2.5	-1.1	-4.3	3.0	14.2	13.9	31.1	59%	
Truck artic	1.0	9.0	7.1	17.1	0.2	0.1	0.0	0.4	-0.3	-1.8	-0.4	-2.5	0.9	7.4	6.7	15.0	29%	
TOTAL VEHICLES	8.6	44.5	34.3	87.3	4.9	2.5	0.0	7.5	-11.7	-28.1	-2.7	-42.5	1.8	18.9	31.6	52.3	100%	34%
	10%	51%	39%	100%	66%	34%	1%	100%	27%	66%	6%	100%	3%	36%	60%	100%		
				167%				14%				-81%				100%		
Time Cost Benefits																		
Car work	5.2	10.5	0.7	16.3	0.2	0.0	0.0	0.3	-0.2	-0.2	0.0	-0.4	5.3	10.3	0.7	16.2	19%	
Car other	2.3	3.5	0.5	6.2	0.1	0.0	0.0	0.1	-0.1	-0.1	0.0	-0.1	2.3	3.4	0.5	6.2	7%	
Taxi car	5.8	14.6	2.5	22.9	0.1	0.1	0.0	0.2	-0.0	-0.4	-0.0	-0.4	5.9	14.3	2.5	22.7	27%	
Taxi van	15.5	9.7	0.4	25.6	0.8	0.1	0.0	0.9	-0.1	-0.4	0.0	-0.6	16.2	9.3	0.4	25.9	30%	
Pickup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
Bus	3.2	8.5	1.8	13.4	0.1	0.1	0.0	0.1	-0.1	-0.1	0.0	-0.2	3.2	8.4	1.8	13.4	16%	
Truck single	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	0.0	0.1	0.0	0.1	0%	
Truck comb	0.0	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.0	0.1	0.1	0.3	0%	
Truck artic	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0%	
TOTAL VEHICLES	32.0	46.9	6.1	85.0	1.3	0.2	0.0	1.6	-0.4	-1.3	-0.0	-1.7	32.8	45.9	6.1	84.9	100%	62%
	38%	55%	7%	100%	85%	15%	0%	100%	26%	74%	0%	100%	39%	54%	7%	100%		
				100%				2%				-2%				100%		
Total Benefits																		
Car work	5.2	10.5	0.7	16.4	0.3	0.2	0.0	0.4	-4.1	-8.2	-0.4	-12.7	1.4	2.5	0.2	4.1	3%	
Car other	2.3	3.5	0.5	6.3	0.1	0.1	0.0	0.2	-3.7	-6.1	-0.7	-10.5	-1.4	-2.5	-0.1	-4.0	-3%	
Taxi car	6.3	19.1	4.0	29.5	0.5	0.2	0.0	0.7	-0.1	-1.0	-0.0	-1.1	6.7	18.3	4.0	29.1	21%	
Taxi van	15.7	10.0	0.5	26.2	2.5	0.5	0.0	2.9	-0.7	-1.4	0.0	-2.1	17.5	9.0	0.5	27.1	20%	
Pickup	1.1	3.0	2.1	6.2	1.2	0.5	0.0	1.7	-1.0	-4.9	0.0	-5.8	1.3	-1.4	2.1	2.1	2%	
Bus	3.9	11.2	3.8	18.9	0.3	0.3	0.0	0.6	-0.5	-1.1	0.0	-1.6	3.7	10.3	3.8	17.8	13%	
Truck single	1.7	8.6	6.5	16.7	0.8	0.5	0.0	1.3	-1.1	-2.4	-0.2	-3.6	1.4	6.7	6.4	14.4	11%	
Truck comb	3.4	16.5	15.0	34.9	0.3	0.4	0.0	0.8	-0.7	-2.5	-1.1	-4.3	3.0	14.4	14.0	31.3	23%	
Truck artic	1.0	9.1	7.1	17.2	0.2	0.1	0.0	0.4	-0.3	-1.8	-0.4	-2.5	0.9	7.4	6.8	15.1	11%	
TOTAL VEHICLES	40.5	91.4	40.4	172.3	6.2	2.7	0.0	9.0	-12.1	-29.4	-2.7	-44.2	34.6	64.8	37.7	137.1	100%	100%
	24%	53%	23%	100%	69%	30%	0%	100%	27%	66%	6%	100%	25%	47%	27%	100%		
				126%				7%				-32%				100%		

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Improved Network - Table 7A-13 shows the distribution of benefits by size for the 2000 Improved Network, containing bypasses and widening of the existing West Bank Highway.

The proportion of negative benefits was much lower than for the Expressway Network, and the proportion of benefits for non-truck traffic was also significantly higher. Small benefits remained low compared with other positive benefits, but made up a greater proportion than for the Expressway Network. This indicates a greater range of benefits than for the Expressway.

Geographical Distribution of Benefits

Table 7A-14 shows the geographical distribution of vehicle operating cost benefits in the Cairo-Assuit Corridor for the 2000 Expressway (2-lane) and 2000 Improved Networks.

Expressway Network - The striking feature of the Expressway results is that few benefits (3.4 percent) accrued to internal movements in the corridor. Such benefits as did accrue to this traffic arose from the longer distance inter-Governorate movements, and from the slight relief in congestion in the main corridor brought about by the new highway. This strikingly demonstrates that the main benefit of the new highway would be to long distance traffic moving to, from, and through the corridor.

Benefits for movements in the northern part of the corridor between Beni Suef and Cairo were mostly negative, although movements between Giza (mainly Badrashin, Aiyat and Saff) and Beni Suef gained advantage from the relief given to most congested portions of the existing highway.

Benefits to external traffic made up 43.7 percent of the total, with the highest benefits to the southernmost towns, in particular, Assuit.

Through traffic gained the greatest benefit amounting to 60.4 percent of the total.

Improved Network - Apart from the increased quantity of benefits (LE 97,000 per day compared with LE 52,000 per day on the Expressway Network), there was a major change in the distribution of benefits for the Improved Network.

Internal traffic benefits totalled 25.4 percent, with most occuring in Minia and Assuit Governorates. The proportion of external benefits also went up from the Expressway Network levels to 43.7 percent of the total, and this represented over a doubling of the volume external benefits. This could be explained by the more direct route provided by the improved existing road to origins and destinations in the corridor, compared with the Expressway Network.

Through traffic, which would appear to have most to gain from a completely new highway, suffered little diminution of benefits on the Improved Network, reducing from LE 32,000 to 30,000 per day. As a percentage, the overall share reduced to 30.9 percent because other benefits increased so sharply.

Table 7A-13

2000 IMPROVED NETWORK (BYPASSES AND WIDENING) MODEL BENEFITS
(LE thousands per day, 1985/1986)

VEHICLE TYPE	LARGE BENEFITS				SMALL BENEFITS				NEGATIVE BENEFITS				TOTAL BENEFITS				PERCENTAGES	
	Inter	Exter	Thru	Total	Inter	Exter	Thru	Total	Inter	Exter	Thru	Total	Inter	Exter	Thru	Total		
Vehicle Operating Cost Benefits																		
Car work	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	-6.7	-3.9	-0.5	-11.1	-6.7	-3.8	-0.5	-11.0	-11%	
Car other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-6.4	-3.8	-0.7	-10.9	-6.4	-3.8	-0.7	-10.8	-11%	
Taxi car	2.0	3.2	0.8	6.0	0.2	0.3	0.0	0.5	-0.0	-0.1	-0.0	-0.1	2.2	3.4	0.8	6.4	7%	
Taxi van	2.4	0.2	0.0	2.6	1.9	0.4	0.0	2.3	-0.3	-0.1	0.0	-0.4	4.1	0.5	0.0	4.6	5%	
Pickup	3.6	2.5	1.1	7.1	1.6	1.3	0.0	2.9	-0.2	-0.1	0.0	-0.3	5.0	3.7	1.1	9.8	10%	
Bus	3.3	3.5	1.7	8.5	0.1	0.1	0.0	0.1	-0.0	-0.1	0.0	-0.1	3.4	3.5	1.7	8.6	9%	
Truck single	7.7	8.2	4.8	20.6	1.4	0.2	0.0	1.6	-0.1	-0.2	0.0	-0.2	9.0	8.2	4.8	22.0	23%	
Truck comb	9.7	20.3	15.9	45.9	0.2	0.1	0.0	0.3	-0.0	-0.2	-0.7	-0.9	10.0	20.2	15.2	45.3	47%	
Truck artic	3.8	10.4	7.5	21.7	0.2	0.1	0.0	0.3	-0.0	-0.2	-0.0	-0.3	4.0	10.2	7.5	21.7	22%	
TOTAL VEHICLES	32.6	48.3	31.7	112.6	5.6	2.5	0.0	8.1	-13.7	-8.6	-1.8	-24.2	24.5	42.2	29.8	96.5	100%	46%
	29%	43%	28%	100%	70%	30%	0%	100%	57%	36%	8%	100%	25%	44%	31%	100%		
				117%				8%				-25%				100%		
Time Cost Benefits																		
Car work	11.5	6.9	0.8	19.2	0.2	0.1	0.0	0.3	-0.0	-0.2	0.0	-0.2	11.8	6.8	0.8	19.3	17%	
Car other	4.9	2.8	0.6	8.4	0.1	0.0	0.0	0.1	-0.0	-0.1	0.0	-0.1	5.0	2.8	0.6	8.4	7%	
Taxi car	11.0	12.4	3.3	26.8	0.1	0.1	0.0	0.2	-0.0	-0.4	0.0	-0.4	11.2	12.1	3.3	26.6	23%	
Taxi van	40.6	5.2	0.6	46.4	0.7	0.2	0.0	0.9	0.0	-0.4	0.0	-0.4	41.3	5.0	0.6	46.8	41%	
Pickup	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
Bus	6.2	5.2	2.2	13.6	0.1	0.1	0.0	0.2	0.0	-0.1	0.0	-0.1	6.3	5.2	2.2	13.7	12%	
Truck single	0.1	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	-0.0	0.0	-0.0	0.1	0.1	0.0	0.2	0%	
Truck comb	0.1	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	-0.0	-0.0	-0.0	0.1	0.1	0.1	0.3	0%	
Truck artic	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0%	
TOTAL VEHICLES	74.4	32.9	7.7	115.0	1.2	0.5	0.0	1.7	-0.0	-1.3	-0.0	-1.3	75.6	32.1	7.7	115.3	100%	54%
	65%	29%	7%	100%	70%	30%	0%	100%	1%	99%	0%	100%	66%	28%	7%	100%		
				100%				1%				-1%				100%		
Total Benefits																		
Car work	11.6	7.0	0.8	19.3	0.2	0.1	0.0	0.3	-6.8	-4.1	-0.5	-11.4	5.0	3.0	0.3	8.3	4%	
Car other	4.9	2.9	0.6	8.4	0.1	0.0	0.0	0.1	-6.4	-3.9	-0.7	-11.0	-1.4	-1.0	-0.1	-2.5	-1%	
Taxi car	13.0	15.7	4.1	32.8	0.3	0.4	0.0	0.7	-0.0	-0.5	-0.0	-0.5	13.3	15.5	4.1	33.0	16%	
Taxi van	43.0	5.4	0.6	49.0	2.6	0.6	0.0	3.2	-0.3	-0.5	0.0	-0.8	45.4	5.4	0.6	51.4	24%	
Pickup	3.6	2.5	1.1	7.1	1.6	1.3	0.0	2.9	-0.2	-0.1	0.0	-0.3	5.0	3.7	1.1	9.8	5%	
Bus	9.5	8.7	3.9	22.2	0.1	0.2	0.0	0.4	-0.0	-0.2	0.0	-0.2	9.7	8.7	3.9	22.3	11%	
Truck single	7.7	8.3	4.8	20.8	1.4	0.2	0.0	1.6	-0.1	-0.2	0.0	-0.2	9.1	8.3	4.8	22.2	10%	
Truck comb	9.8	20.4	16.0	46.2	0.2	0.1	0.0	0.3	-0.0	-0.2	-0.7	-0.9	10.0	20.3	15.3	45.7	22%	
Truck artic	3.8	10.5	7.5	21.8	0.2	0.1	0.0	0.3	-0.0	-0.2	-0.0	-0.3	4.0	10.3	7.5	21.8	10%	
TOTAL VEHICLES	107.1	81.2	39.3	227.6	6.8	3.0	0.0	9.8	-13.7	-9.9	-1.9	-25.5	100.2	74.2	37.5	211.9	100%	100%
	47%	36%	17%	100%	70%	30%	0%	100%	54%	39%	7%	100%	47%	35%	18%	100%		
				107%				5%				-12%				100%		

Table 7A-14

GEOGRAPHICAL DISTRIBUTION OF VEHICLE OPERATING
COST BENEFITS IN THE CAIRO-ASSUIT CORRIDOR
(LE thousands per day, 1985/1986)

STARTING FROM	GOING TO: The North	Giza	Fayoum	Beni Suef	Minia	Assuit	The South	TOTAL
2000 Expressway Network (2-lane)								
The North (1)	(1)	(660)	(7,639)	(233)	7,251	10,223	16,023	24,964
Giza (in corr)	(583)	260	(62)	250	70	15	147	97
Fayoum	(7,402)	(62)	(564)	(218)	303	933	376	(6,634)
Beni Suef	(260)	315	(241)	1,094	(279)	376	(224)	781
Minia	6,525	28	295	(258)	25	154	300	7,069
Assuit (in corr)	10,649	9	753	381	51	(1,850)	35	10,028
The South (2)	15,548	131	409	(191)	126	(62)	2	15,963
TOTAL	24,476	21	(7,049)	825	7,547	9,789	16,659	52,268
Total internal	1,778	3.4%						
Total external	18,918	36.2%						
Total through	31,572	60.4%						
	52,268	100.0%						
2000 Improve Network (bypasses and widening)								
The North (1)	(1)	(140)	140	3,689	7,766	7,980	15,667	35,101
Giza (in corr)	(142)	29	133	123	216	14	245	619
Fayoum	197	137	76	143	141	529	296	1,519
Beni Suef	3,585	196	195	1,964	1,129	1,416	142	8,627
Minia	7,309	264	138	1,062	8,200	2,486	935	20,394
Assuit (in corr)	8,472	8	513	1,408	2,296	1,716	118	14,531
The South (2)	14,158	202	329	(13)	921	141	3	15,741
TOTAL	33,578	696	1,524	8,376	20,669	14,282	17,406	96,531
Total internal	24,532	25.4%						
Total external	42,172	43.7%						
Total through	29,827	30.9%						
	96,531	100.0%						

(1) Cairo, Giza outside the corridor, and Northern Egypt

(2) Upper Egypt including Assuit outside the corridor, New Valley and Red Sea

It was concluded that the Improved Network shows a better spread of benefits than the Expressway Network. Benefits to traffic moving entirely within the corridor were increased greatly, external benefits were also increased, but at the same time, through traffic benefits were scarcely changed.

Foreign Exchange

A separate evaluation of vehicle operating cost benefits was made for the 4-lane Expressway Network, considering just the foreign exchange component of costs. The results showed a vehicle operating cost benefit (unmodified for private cars of trucks) of LE 4,300 per day, 6 percent of the total of LE 72,700 per day when measured in economic resource costs. If the results for private cars (which were obscured by the use of time in route finding and which had a large generated traffic component which was impossible to quantify in foreign exchange terms) are excluded, the foreign exchange component rises to LE 14,600 per day, 15 percent of the economic resource valuation of LE 100,000.

The foreign exchange component of benefits was not particularly high, mainly because fuel is produced nationally, and because there is a high local content in the production and assembly of vehicles. As indicated in Appendix 4D, the foreign exchange component of construction costs was estimated at between 27 and 30 percent of economic resource costs. It was concluded that in terms of the foreign exchange component alone, the evaluation was not favorable, indicating that cost in foreign exchange of constructing the new highway would not be justified by the savings in foreign exchange in reduced operating costs.

Conclusions of the Economic Evaluation

It was concluded that both the two main projects evaluated -- improving the existing West Bank Highway or building a new highway from Cairo to Assuit -- would both produce significant economic benefits.

For the new highway, the evaluation supported the traffic analysis in concluding that a 4-lane highway would not be justified for the first stage of construction. An opening date in the mid-1990s could be justified, and this would fit well with a possible program of foreign funding for design and construction. Sensitivity tests indicated that under conditions of lower traffic growth, either due to slower economic performance or through transfer of traffic (particularly freight) to other modes, full feasibility would be delayed, but it is considered that a good economic case has been made for a new Cairo-Assuit Highway for construction at some time in the 1990s.

On economic grounds, the improvements to the existing highway appeared to give even better results than the new highway; more benefits would be produced for lower investment. Also, the benefits would be more evenly distributed to the different traffic elements and so would have more immediate input on the lives of those living in the corridor. In contrast, the new highway would mainly benefit long distance traffic, with little advantage to local traffic.

Table 7A-1.1

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (4-LANE)
BASE ASSUMPTIONS
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	94.1			94.1				0.0	-94.1	-94.1
1988	94.1			94.1				0.0	-94.1	-94.1
1989	94.1			94.1				0.0	-94.1	-94.1
1990 (1)	42.4	0.57	-0.46	42.5	14.6	3.4	0.40	18.4	-24.1	-26.3
1991		0.57	-0.49	0.1	16.2	4.2	0.42	20.8	20.7	17.9
1992		0.57	-0.51	0.1	18.0	5.1	0.45	23.6	23.5	20.1
1993		0.57	-0.54	.0	20.0	6.3	0.47	26.7	26.7	22.5
1994		0.57	-0.57	.0	22.2	7.8	0.50	30.4	30.4	25.2
1995		0.57	-0.60	.0	24.6	9.5	0.53	34.7	34.7	28.3
1996		0.57	-0.64	-0.1	27.3	11.7	0.56	39.6	39.6	31.8
1997		0.57	-0.67	-0.1	30.3	14.4	0.59	45.3	45.4	35.8
1998		0.57	-0.71	-0.1	33.6	17.7	0.63	52.0	52.1	40.3
1999 (2,3)	54.7	0.57	-0.75	54.5	37.3	21.8	0.66	59.8	5.2	-9.3
2000		0.57	-0.79	-0.2	41.4	26.8	0.7	68.9	69.1	51.3
2001		0.57	-0.81	-0.2	43.5	28.1	0.7	72.3	72.6	53.8
2002		0.57	-0.83	-0.3	45.6	29.5	0.7	75.9	76.2	56.5
2003		0.57	-0.86	-0.3	47.9	31.0	0.8	79.7	80.0	59.3
2004		0.57	-0.88	-0.3	50.3	32.6	0.8	83.7	84.0	62.3
2005		0.57	-0.91	-0.3	52.8	34.2	0.8	87.8	88.2	65.4
2006		0.57	-0.93	-0.4	55.5	35.9	0.8	92.2	92.6	68.6
2007		0.57	-0.96	-0.4	58.3	37.7	0.9	96.8	97.2	72.1
2008		0.57	-0.98	-0.4	61.2	39.6	0.9	101.6	102.1	75.7
2009 (3)	49.8	0.57	-1.01	49.4	64.2	41.6	0.9	106.7	57.3	29.6
2010		0.57	-1.04	-0.5	67.4	43.7	0.9	112.0	112.5	83.4
2011		0.57	-1.07	-0.5	70.8	45.8	1.0	117.6	118.1	87.5
2012		0.57	-1.10	-0.5	74.3	48.1	1.0	123.5	124.0	91.9
2013		0.57	-1.13	-0.6	78.1	50.5	1.0	129.6	130.2	96.4
2014 (4)	-21.5	0.57	-1.16	-22.0	82.0	53.1	1.0	136.1	158.1	122.7
Totals -	407.7	14.25	-20.40	401.6	1137.3	680.3	18.12	1835.8	1434.2	980.6
Discounted -	268.3	3.18	-3.69	267.8	173.2	86.5	3.3	264.9	-2.9	-61.9

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	355.7	377.8
Req opening year benefits (incl cost savings)	42.7	45.3

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	11.9%	9.5%
Benefit/Cost Ratio	0.99	0.77
Net Present Value	-2.9	-61.9 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

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Table 7A-1.2

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (4-LANE)
LOW SENSITIVITY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BENEFIT: Full Time Savings	One third Time Savings
1987	112.9			112.9				0.0	-112.9	-112.9
1988	112.9			112.9				0.0	-112.9	-112.9
1989	112.9			112.9				0.0	-112.9	-112.9
1990 (1)	50.8	0.68	-0.35	51.2	14.6	3.4	0.40	18.4	-32.8	-35.0
1991		0.68	-0.37	0.3	15.9	3.9	0.42	20.1	19.8	17.3
1992		0.68	-0.40	0.3	17.2	4.4	0.45	22.0	21.7	18.8
1993		0.68	-0.42	0.3	18.7	5.0	0.47	24.1	23.9	20.6
1994		0.68	-0.45	0.2	20.3	5.6	0.50	26.4	26.2	22.4
1995		0.68	-0.48	0.2	22.0	6.4	0.53	28.9	28.7	24.5
1996		0.68	-0.51	0.2	23.9	7.2	0.56	31.7	31.5	27.7
1997		0.68	-0.54	0.1	26.0	8.2	0.59	34.8	34.6	29.2
1998		0.68	-0.57	0.1	28.2	9.3	0.63	38.1	38.0	31.8
1999 (2,3)	65.6	0.68	-0.61	65.7	30.7	10.5	0.66	41.8	-23.9	-30.9
2000		0.68	-0.61	.0	33.3	11.9	0.7	45.9	45.9	37.9
2001		0.68	-0.67	.0	34.7	12.5	0.7	47.9	47.9	39.6
2002		0.68	-0.69	.0	36.2	13.1	0.7	50.1	50.1	41.3
2003		0.68	-0.71	.0	37.8	13.8	0.8	52.3	52.3	43.2
2004		0.68	-0.74	-0.1	39.4	14.5	0.8	54.7	54.7	45.1
2005		0.68	-0.76	-0.1	41.1	15.2	0.8	57.1	57.2	47.0
2006		0.68	-0.78	-0.1	42.9	15.9	0.8	59.6	59.7	49.1
2007		0.68	-0.81	-0.1	44.7	16.7	0.9	62.3	62.4	51.3
2008		0.68	-0.84	-0.2	46.6	17.6	0.9	65.1	65.2	53.5
2009 (3)	59.8	0.68	-0.86	59.6	48.6	18.5	0.9	68.0	8.4	-3.9
2010		0.68	-0.89	-0.2	50.7	19.4	0.9	71.0	71.2	58.3
2011		0.68	-0.92	-0.2	52.9	20.4	1.0	74.2	74.4	60.9
2012		0.68	-0.95	-0.3	55.2	21.4	1.0	77.5	77.6	63.5
2013		0.68	-0.98	-0.3	57.5	22.4	1.0	81.0	81.3	66.3
2014 (4)	-25.8	0.68	-1.01	-26.1	60.0	23.6	1.0	84.6	110.7	95.0
Totals -	489.3	17.10	-16.96	489.4	829.3	320.5	18.12	1237.9	748.4	534.8
Discounted -	321.9	3.82	-2.98	322.8	146.1	47.0	3.3	196.4	-126.4	-157.7

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	426.8	453.4
Req opening year benefits (incl cost savings)	51.2	54.4

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	7.3%	5.7%
Benefit/Cost Ratio	0.61	0.51
Net Present Value	-126.4	-157.7 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

Table 7A-1.3

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (4-LANE)
HIGH SENSITIVITY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	94.1			94.1				0.0	-94.1	-94.1
1988	94.1			94.1				0.0	-94.1	-94.1
1989	94.1			94.1				0.0	-94.1	-94.1
1990 (1)	42.4	0.57	-0.46	42.5	14.6	3.4	0.40	18.4	-24.1	-26.3
1991		0.57	-0.49	0.1	16.5	4.4	0.44	21.3	21.3	18.4
1992		0.57	-0.51	0.1	18.7	5.6	0.49	24.8	24.8	21.0
1993		0.57	-0.54	.0	21.2	7.2	0.54	29.0	28.9	24.1
1994		0.57	-0.57	.0	24.0	9.3	0.60	33.9	33.9	27.7
1995		0.57	-0.60	.0	27.2	11.9	0.66	39.8	39.8	31.9
1996		0.57	-0.64	-0.1	30.9	15.3	0.73	46.9	46.9	36.7
1997		0.57	-0.67	-0.1	34.9	19.6	0.81	55.4	55.5	42.4
1998		0.57	-0.71	-0.1	39.6	25.2	0.90	65.7	65.8	49.0
1999 (2,3)	54.7	0.57	-0.75	54.5	44.8	32.4	0.99	78.2	23.7	2.1
2000		0.57	-0.79	-0.2	50.8	41.6	1.1	93.5	93.7	66.0
2001		0.57	-0.81	-0.2	53.3	43.7	1.2	98.2	98.4	69.3
2002		0.57	-0.85	-0.3	56.0	45.9	1.2	103.1	103.3	72.8
2003		0.57	-0.86	-0.3	58.8	48.2	1.3	108.2	108.5	76.4
2004		0.57	-0.88	-0.3	61.7	50.6	1.3	113.6	114.0	80.3
2005		0.57	-0.91	-0.3	64.8	53.1	1.4	119.3	119.7	84.3
2006		0.57	-0.93	-0.4	68.1	55.7	1.5	125.3	125.7	88.5
2007		0.57	-0.96	-0.4	71.5	58.5	1.5	131.6	132.0	92.9
2008		0.57	-0.98	-0.4	75.1	61.5	1.6	138.1	138.6	97.6
2009 (3)	49.8	0.57	-1.01	49.4	78.8	64.5	1.7	145.0	95.7	52.7
2010		0.57	-1.04	-0.5	82.7	67.8	1.8	152.3	152.8	107.0
2011		0.57	-1.07	-0.5	86.9	71.2	1.9	159.9	160.4	113.0
2012		0.57	-1.10	-0.5	91.2	74.7	2.0	167.9	168.4	118.6
2013		0.57	-1.13	-0.6	95.8	78.4	2.1	176.3	176.9	124.6
2014 (4)	-21.5	0.57	-1.16	-22.0	100.6	82.4	2.2	185.1	207.2	152.3
Totals -	407.7	14.25	-20.40	401.6	1366.8	1031.9	30.31	2431.0	2029.4	1341.5
Discounted -	268.3	3.18	-3.69	267.8	200.9	127.7	4.6	333.2	65.4	-19.7

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	355.7	377.8
Req opening year benefits (incl cost savings)	42.7	45.3

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	14.1%	11.3%
Benefit/Cost Ratio	1.24	0.93
Net Present Value	65.4	-19.7 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

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Table 7A-1.4

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (2-LANE)
LOW SENSITIVITY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	54.7			54.7				0.0	-54.7	-54.7
1988	54.7			54.7				0.0	-54.7	-54.7
1989	54.7			54.7				0.0	-54.7	-54.7
1990 (1)	22.1	0.43	-0.46	22.1	11.2	2.7	-0.10	13.8	-8.3	-10.1
1991		0.43	-0.49	-0.1	12.1	3.1	-0.08	15.1	15.2	13.1
1992		0.43	-0.51	-0.1	13.1	3.6	-0.06	16.6	16.7	14.3
1993		0.43	-0.54	-0.1	14.1	4.1	-0.05	18.2	18.3	15.6
1994		0.43	-0.57	-0.1	15.3	4.7	-0.04	19.9	20.1	17.0
1995		0.43	-0.60	-0.2	16.5	5.4	-0.03	21.9	22.1	18.5
1996		0.43	-0.64	-0.2	17.9	6.2	-0.03	24.0	24.2	20.1
1997		0.43	-0.67	-0.2	19.3	7.1	-0.02	26.4	26.6	21.9
1998		0.43	-0.71	-0.3	20.9	8.2	-0.02	29.0	29.3	23.8
1999 (2,3)	46.3	0.43	-0.75	46.0	22.5	9.4	-0.01	31.9	-14.1	-20.3
2000		0.43	-0.79	-0.4	24.4	10.8	.0	35.2	35.5	28.3
2001		0.43	-0.81	-0.4	25.4	11.3	.0	36.7	37.1	29.5
2002		0.43	-0.83	-0.4	26.4	11.9	.0	38.3	38.7	30.7
2003		0.43	-0.86	-0.4	27.4	12.5	.0	39.9	40.4	32.0
2004		0.43	-0.88	-0.4	28.6	13.1	.0	41.7	42.1	33.4
2005		0.43	-0.91	-0.5	29.7	13.8	.0	43.5	44.0	34.8
2006		0.43	-0.93	-0.5	30.9	14.5	.0	45.4	45.9	36.2
2007		0.43	-0.96	-0.5	32.7	15.2	.0	47.3	47.9	37.7
2008		0.43	-0.98	-0.6	33.5	15.9	.0	49.4	50.0	39.3
2009 (3)	40.4	0.43	-1.01	39.9	34.8	16.7	.0	51.6	11.7	0.5
2010		0.43	-1.04	-0.6	36.2	17.6	.0	53.8	54.4	42.7
2011		0.43	-1.07	-0.6	37.7	18.5	.0	56.1	56.8	44.5
2012		0.43	-1.10	-0.7	39.2	19.4	.0	58.6	59.3	46.3
2013		0.43	-1.13	-0.7	40.8	20.3	.0	61.1	61.8	48.3
2014 (4)	-13.6	0.43	-1.16	-14.4	42.4	21.4	.0	63.8	78.2	63.9
Totals -	259.2	10.60	-20.40	249.6	652.5	287.3	-0.52	939.2	689.6	498.1
Discounted -	158.4	2.41	-3.69	157.1	107.9	41.2	-0.2	148.9	-8.2	-35.7

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	208.6	219.4
Req opening year benefits (incl cost savings)	24.8	26.3

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	11.4%	9.3%
Benefit/Cost Ratio	0.95	0.77
Net Present Value	-8.2	-35.7 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening, excluding remaining access road costs.

Table 7A-1.5

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (2-LANE)
HIGH SENSITIVITY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	45.6			45.6				0.0	-45.6	-45.6
1988	45.6			45.6				0.0	-45.6	-45.6
1989	45.6			45.6				0.0	-45.6	-45.6
1990 (1)	18.5	0.36	-0.46	18.4	11.2	2.7	-0.10	13.8	-4.5	-6.3
1991		0.36	-0.49	-0.1	12.6	3.5	-0.08	16.1	16.2	13.8
1992		0.36	-0.51	-0.2	14.2	4.6	-0.06	18.7	18.9	15.9
1993		0.36	-0.54	-0.2	16.1	6.0	-0.05	22.0	22.1	18.2
1994		0.36	-0.57	-0.2	18.1	7.8	-0.04	25.8	26.0	20.9
1995		0.36	-0.60	-0.2	20.4	10.1	-0.03	30.5	30.7	24.0
1996		0.36	-0.64	-0.3	23.0	13.1	-0.03	36.1	36.4	27.6
1997		0.36	-0.67	-0.3	25.9	17.1	-0.02	43.0	43.3	31.9
1998		0.36	-0.71	-0.3	29.2	22.3	-0.02	51.5	51.8	37.0
1999 (2,3)	38.6	0.36	-0.75	38.2	33.0	29.0	-0.01	61.9	23.7	4.4
2000		0.36	-0.79	-0.4	37.2	37.7	.0	74.9	75.3	50.2
2001		0.36	-0.81	-0.5	39.0	39.6	.0	78.6	79.1	52.7
2002		0.36	-0.83	-0.5	41.0	41.6	.0	82.6	83.0	55.3
2003		0.36	-0.86	-0.5	43.0	43.7	.0	86.7	87.2	58.1
2004		0.36	-0.88	-0.5	45.2	45.8	.0	91.0	91.6	61.0
2005		0.36	-0.91	-0.5	47.5	48.1	.0	95.6	96.1	64.0
2006		0.36	-0.93	-0.6	49.8	50.5	.0	100.4	100.9	67.2
2007		0.36	-0.96	-0.6	52.3	53.1	.0	105.4	106.0	70.6
2008		0.36	-0.98	-0.6	54.9	55.7	.0	110.7	111.3	74.1
2009 (3)	33.7	0.36	-1.01	33.0	57.7	58.5	.0	116.2	83.1	44.1
2010		0.36	-1.04	-0.7	60.6	61.4	.0	122.0	122.7	81.7
2011		0.36	-1.07	-0.7	63.6	64.5	.0	128.1	128.8	85.8
2012		0.36	-1.10	-0.7	66.8	67.7	.0	134.5	135.2	90.1
2013		0.36	-1.13	-0.8	70.1	71.1	.0	141.2	142.0	94.6
2014 (4)	-11.4	0.36	-1.16	-12.2	73.6	74.7	.0	148.3	160.5	110.7
Totals -	216.0	9.00	-20.40	204.6	1006.1	930.0	-0.52	1935.6	1730.9	1110.9
Discounted -	132.0	2.01	-3.69	130.3	148.8	113.6	-0.2	262.2	131.9	56.2

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	172.1	182.9
Req opening year benefits (incl cost savings)	20.7	21.9

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	19.2%	15.6%
Benefit/Cost Ratio	2.01	1.43
Net Present Value	131.9	56.2 million LE

(1) 50 percent of access roads completed after main project opening.
(2) Additional costs of interchange with Cairo Ring Road.
(3) Cost of 5 cm overlay.
(4) Residual value @ 5 percent of total construction.
(5) In year of opening, excluding remaining access road costs.

Table 7A-1.6

EVALUATION OF THE CAIRO-ASSUIT HIGHWAY (2-LANE)
BENI SUEF TO ASSUIT ONLY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	34.7			34.7				0.0	-34.7	-34.7
1988	34.7			34.7				0.0	-34.7	-34.7
1989	34.7			34.7				0.0	-34.7	-34.7
1990 (1)	16.5	0.27	-0.40	16.3	7.6	0.4	-0.30	7.7	-8.6	-8.9
1991		0.27	-0.42	-0.2	8.5	0.5	-0.34	8.7	8.8	8.5
1992		0.27	-0.45	-0.2	9.5	0.6	-0.38	9.8	9.9	9.5
1993		0.27	-0.47	-0.2	10.6	0.8	-0.43	11.0	11.2	10.7
1994		0.27	-0.50	-0.2	11.9	1.1	-0.49	12.4	12.7	12.0
1995		0.27	-0.53	-0.3	13.3	1.3	-0.55	14.1	14.3	13.4
1996		0.27	-0.56	-0.3	14.8	1.7	-0.62	15.9	16.2	15.1
1997		0.27	-0.59	-0.3	16.6	2.2	-0.70	18.1	18.4	16.9
1998		0.27	-0.63	-0.4	18.6	2.8	-0.79	20.5	20.9	19.1
1999 (2)	26.4	0.27	-0.66	26.0	20.8	3.9	-0.89	23.4	-2.6	-5.0
2000		0.27	-0.70	-0.4	23.2	4.5	-1.0	26.7	27.1	24.1
2001		0.27	-0.72	-0.5	24.4	4.7	-1.1	28.0	28.5	25.3
2002		0.27	-0.74	-0.5	25.6	5.0	-1.1	29.4	29.9	26.6
2003		0.27	-0.76	-0.5	26.9	5.2	-1.2	30.9	31.4	27.9
2004		0.27	-0.78	-0.5	28.2	5.5	-1.2	32.5	33.0	29.3
2005		0.27	-0.81	-0.5	29.6	5.7	-1.3	34.1	34.6	30.8
2006		0.27	-0.83	-0.6	31.1	6.0	-1.3	35.8	36.3	32.3
2007		0.27	-0.85	-0.6	32.6	6.3	-1.4	37.6	38.2	33.9
2008		0.27	-0.88	-0.6	34.3	6.6	-1.5	39.4	40.1	35.6
2009 (2)	26.4	0.27	-0.90	25.8	36.0	7.0	-1.6	41.4	15.7	11.0
2010		0.27	-0.93	-0.7	37.8	7.3	-1.6	43.5	44.2	39.3
2011		0.27	-0.96	-0.7	39.7	7.7	-1.7	45.7	46.4	41.2
2012		0.27	-0.98	-0.7	41.7	8.1	-1.8	47.9	48.7	43.3
2013		0.27	-1.01	-0.7	43.7	8.5	-1.9	50.3	51.1	45.4
2014 (3)	-8.7	0.27	-1.04	-9.4	45.9	8.9	-2.0	52.9	62.3	56.4
Totals -	164.6	6.75	-18.12	153.3	632.8	112.1	-27.05	717.8	564.5	489.8
Discounted -	101.4	1.51	-3.26	99.6	95.0	14.0	-4.0	105.0	5.4	-3.9

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (4)	131.1	139.2
Req opening year benefits (incl cost savings)	15.7	16.7

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	12.5%	11.6%
Benefit/Cost Ratio	1.05	0.96
Net Present Value	5.4	-3.9 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Cost of 5 cm overlay.

(3) Residual value @ 5 percent of total construction.

(4) In year of opening, excluding remaining access road costs.

Table 7A-1.7

EVALUATION OF NEW CAIRO-ASSUIT HIGHWAY (4-LANE VS 2-LANE)
HIGH SENSITIVITY
(millions of LE, 1985/86)

YEAR	PROJECT COSTS: Construction	Addition Maint	Addition Overlays	Total Costs	PROJECT BENEFITS: Vehicle Op Cost Savings	Passenger Time Savings	Reduced Traffic Accidents	Total Savings	NET COST/BEN STREAM: Full Time Savings	One third time savings
1987	48.6			48.6				0.0	-48.6	-48.6
1988	48.6			48.6				0.0	-48.6	-48.6
1989	48.6			48.6				0.0	-48.6	-48.6
1990 (1)	23.9	0.21	.00	24.1	3.4	0.7	0.5	4.6	-19.5	-20.0
1991		0.21	.00	0.2	3.9	0.8	0.5	5.3	5.1	4.5
1992		0.21	.00	0.2	4.5	1.0	0.6	6.1	5.8	5.2
1993		0.21	.00	0.2	5.2	1.2	0.6	7.0	6.7	6.0
1994		0.21	.00	0.2	5.9	1.4	0.7	8.0	7.8	6.9
1995		0.21	.00	0.2	6.8	1.7	0.7	9.2	9.0	7.9
1996		0.21	.00	0.2	7.8	2.0	0.8	10.6	10.4	9.1
1997		0.21	.00	0.2	9.0	2.3	0.9	12.2	12.0	10.4
1998		0.21	.00	0.2	10.3	2.6	0.9	14.0	13.8	12.0
1999 (2)	16.1	0.21	.00	16.3	11.8	3.3	1.0	16.1	-0.2	-2.4
2000		0.21	.00	0.2	13.6	3.9	1.1	18.6	18.4	15.9
2001		0.21	.00	0.2	14.3	4.1	1.1	19.5	19.3	16.8
2002		0.21	.00	0.2	15.0	4.3	1.2	20.5	20.3	17.4
2003		0.21	.00	0.2	15.7	4.5	1.2	21.5	21.3	18.3
2004		0.21	.00	0.2	16.5	4.7	1.3	22.6	22.4	19.2
2005		0.21	.00	0.2	17.4	5.0	1.3	23.7	23.5	20.2
2006		0.21	.00	0.2	18.2	5.2	1.4	24.9	24.6	21.2
2007		0.21	.00	0.2	19.1	5.5	1.5	26.1	25.9	22.2
2008		0.21	.00	0.2	20.1	5.8	1.5	27.4	27.2	23.3
2009 (2)	16.1	0.21	.00	16.3	21.1	6.1	1.6	28.7	12.4	8.4
2010		0.21	.00	0.2	22.2	6.4	1.6	30.1	29.9	25.7
2011		0.21	.00	0.2	23.3	6.7	1.7	31.6	31.4	27.0
2012		0.21	.00	0.2	24.4	7.0	1.8	33.2	33.0	28.3
2013		0.21	.00	0.2	25.6	7.4	1.9	34.9	34.6	29.7
2014 (4)	-10.1	0.21	.00	-9.9	26.9	7.7	1.9	36.6	46.5	41.3
Totals -	191.7	5.25	0.03	197.0	362.1	101.2	29.5	492.8	295.8	228.3
Discounted -	136.3	1.17	0.01	137.5	51.9	13.8	4.9	70.5	-66.9	-76.1

Discount Rate 12%

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (4)	183.5	195.0
Req opening year benefits (incl cost savings)	22.0	23.4

	ASSUMPTION ON TIME SAVINGS: Full	1/3rd
Internal Rate of Return	6.4%	5.3%
Benefit/Cost Ratio	0.51	0.45
Net Present Value	-66.9	-76.1 million LE

(1) 50 percent of access roads completed after main project opening.

(2) Cost of 5 cm overlay.

(3) Residual value @ 5 percent of total construction.

(4) In year of opening, excluding remaining access road costs.

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Appendix 7B

EVALUATION OF TOLLS ON THE NEW CAIRO-ASSUIT

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Appendix 7B

EVALUATION OF TOLLS ON THE NEW CAIRO-ASSUIT HIGHWAY

It was estimated that the new Cairo-Assuit highway would cost over LE 150 million to construct for a single 2-lane carriageway with at-grade intersections. Since the highway was envisaged to be a high quality road with limited access, the possibilities for financing, or at least offsetting, construction costs from toll revenues was considered. The results are presented in this appendix. The location of the proposed new highway is shown in Figure 7B-1.

Alternative Toll Systems

All toll systems require traffic to stop at toll booths and pay a fee for using the highway. The two main alternatives are barrier systems and closed systems.

Barrier Toll Systems - A barrier system places toll booths across the highway at intervals. Anyone using a section of the highway equipped with toll booths has to pass through this barrier, and has to pay the toll. This system has the advantage of simplicity, but does have some operating disadvantages. If barriers are placed on all sections of the highway between access roads, significant delays and inconvenience would be experienced by long distance drivers, the very drivers who should be encouraged to use the new highway. On the new Cairo Assuit Highway, there would be 13 sections between Cairo and Assuit, averaging 26 kilometers each.

If toll barriers are located only on selected links, some drivers would inevitably divert off the new highway to avoid these locations, especially as the toll charged would have to be higher in order to cover sections without toll barriers.

The only toll road in Egypt, the Cairo-Alexandria Highway, uses a toll barrier system. However, with only one intermediate access point along some 200 kilometers of road, all drivers have to pass through either the northern or southern terminus of the highway. Hence toll collection coverage can be complete with just two barrier toll stations.

Closed Toll Systems - A closed toll system effectively seals off the tolled highway by placing barriers on all access roads. Once having entered the highway, drivers do not pass another toll barrier until they exit the highway. Hence traffic is not delayed along the route, and the process of paying and checking tickets is encountered at only the entry and exit points.

A system of ticketing is required if tolls are to be adjusted according to the length of highway used. With a total length of nearly 350 kilometers, this would be necessary on the Cairo-Assuit highway. A ticket system could be quite complex with 14 points of entry and exit along the route. For a 2-lane highway, such a ticketing system would have to be

sufficiently sophisticated to prevent drivers meeting along the route and swapping tickets.

High volume toll roads in the Western World increasingly rely on computer controlled automatic equipment for issueing tickets and estimating tolls based on entry and exit points. This would not be appropriate for the first stage of the Cairo-Assuit Highway.

Layout of toll barriers on access roads would be simple in the case of access roads terminating at the new highway in a T-junction (the majority of cases on the Cairo-Assuit Highway). The northern and southern entrances could also be covered without difficulty by toll barriers across the highway. More problems would be faced at the three 4-way interchanges, especially with the at-grade intersections envisaged for first stage construction.

Toll Systems Evaluated - Three toll systems were evaluated in detail, as follows:

i) Complete Barrier System

ii) Limited Barrier System

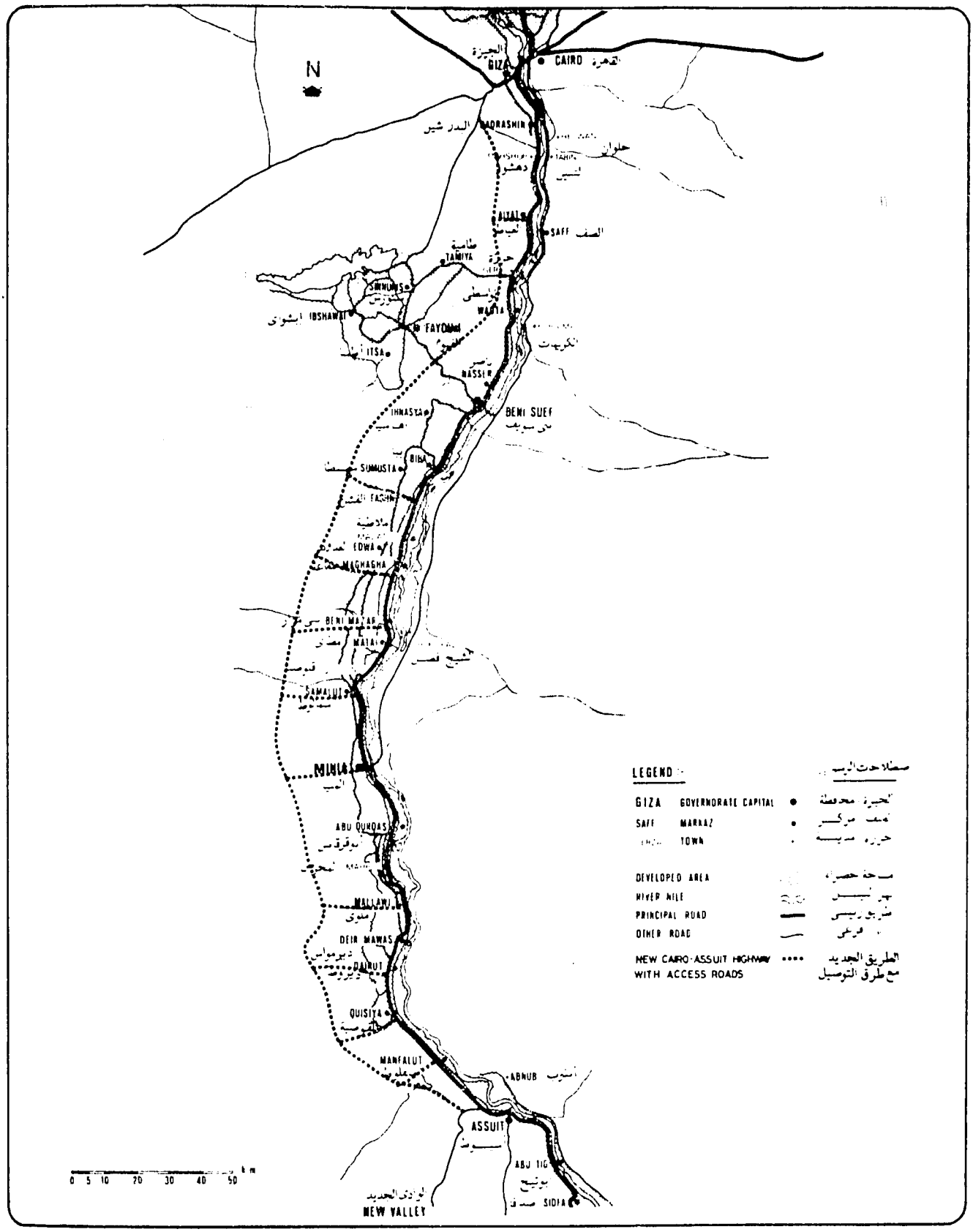
iii) Closed System

The Limited Barrier System envisaged three barriers, each located on a section of the highway between Govenorate capitals. Exact locations would have to be decided based on maximum inconvenience for traffic to bypass the toll barriers; probably at some point midway between Governorate capitals.

Toll System Costs

Construction and equipment costs were estimated at about LE 200,000 per toll booth. For the barrier system, and for the traffic volumes forecast, only one booth would be required for each direction, with two per direction only for the higher traffic sections between Cairo and Beni Suef.

For the closed system, two booths were allowed for each access road terminating in the new highway. Two pairs of booths were allowed, one on each side of the new highway, for the 4-leg intersections at Gerza, Beni Suef and Mallawi. Barrier toll booths were assumed for the northern and southern termini.



Cairo – Assuit Highway Feasibility Study

LOCATION OF THE NEW CAIRO-ASSUIT HIGHWAY

Wilbur Smith and Associates
Egyptian Consultants Consortium

7B-1

Toll booth construction and equipment costs are summarized in Table 7B-1 below.

Table 7B-1

COSTS OF TOLL BOOTH CONSTRUCTION AND EQUIPMENT
(LE millions, 1985/86)

ALTERNATIVE	NUMBER OF TOLL BOOTHS	ESTIMATED COSTS	ANNUAL MAINTENANCE
Complete Barrier	32	6.4	0.11
Limited Barrier	8	1.6	0.03
Closed System	36	7.2	0.13

Annual maintenance was estimated assuming equipment represented about 35 percent of the cost, and allowing 5 percent of initial cost for maintenance per year.

Operating staff for the toll booths was estimated at 8 persons per booth, allowing four shifts to cover 24-hour operations, and for relief at weekends. Allowing a salary of LE 150 per month, staffing costs would be LE 13,500 per year per toll booth. In addition, staff would be required for supervision, accounting and transport for each toll station, located in the nearest town. A staff of 10 was allowed, with a total salary cost of LE 15,000 per year, and an annual office operating budget of LE 15,000. Finally, a central staff would be required, probably located in Cairo, to administer the toll system. A staff of 20 were allowed with a total salary cost of LE 50,000 per year, and an annual office operating budget of LE 50,000. Staff and administration costs for each toll system are summarized in Table 7B-2 below.

Table 7B-2

ANNUAL COSTS OF TOLL STATION STAFFING AND ADMINISTRATION
(LE thousands, 1985/86)

ALTERNATIVE	NUMBER OF TOLL BOOTHS	NUMBER OF LOCATIONS	TOTAL COST
Complete Barrier	32	13	920
Limited Barrier	8	4	330
Closed System	36	14	1,000

Toll Revenues

Alternative toll rates were assumed by vehicle type as set out in Table 7B-3.

Table 7B-3

ALTERNATIVE TOLL LEVELS TESTED
(milliemes per veh-km, 1985/86)

ALTERNATIVE	PRIVATE CAR AND TAXI	BUS AND PICKUP	SINGLE TRUCK	MULTI-UNIT TRUCK
Current (1)	5	10	15	25
Low	10	20	30	50
Medium	20	40	60	100
High	50	100	150	250
Very high	75	150	225	375

(1) Rate charged in 1986 on the Alexandria Desert Highway.

The range from Current to Very High represents approximately from 5 to 75 percent of free-flow vehicle operating costs in each case. Under these assumptions, the charge for a private car travelling from Cairo to Assuit would range from about LE 2 under Current tolls to LE 26 under the Very High tolls. The charge for a multi-unit truck would range from LE 9 to LE 130.

Imposition of tolls on users of the new highway would deter some potential users and thus reduce traffic volumes below those forecast without tolls. The amount of traffic reduction would depend on the level of tolls. The Computer Traffic Model (see Appendix 6B) was used to estimate traffic using the new highway under different assumptions on toll rates.

The impact of tolls on traffic volumes is summarized in Table 7B-4 showing total vehicle-kilometers using the new highway.

As indicated in the table, not all toll cases were tested in detail so that results for some toll levels were interpolated from other results. In all cases, the model test assumed a complete barrier system in operation so that all vehicles would be charged the full toll amount, calculated for each section of highway based on the per vehicle-kilometer rates in Table 7B-3.

With the higher toll rates, forecast traffic decreased, with the Very High tolls reducing traffic to just 30 percent of the no-toll case. Some of the traffic lost from the new highway would transfer back to the existing road, while other traffic would be de-generated; that is to say, the imposition of tolls would slow traffic growth rates in the corridor.

Table 7B-4

FORECAST TRAFFIC AT ALTERNATIVE TOLL LEVELS
(thousands of veh-km per day)

ALTERNATIVE	CAR WRK	CAR OTH	TAXI CAR	TAXI VAN	PCK -UP	BUS	TRK SIN	TRK COM	TRK ART	TOTAL
1990 Forecasts										
No tolls	72	66	195	28	203	51	146	91	39	890
Medium	45	26	140	22	134	40	98	74	33	610
2000 Forecasts										
No tolls	200	176	320	82	406	102	280	171	67	1,804
Current (1)	187	147	296	78	364	96	252	161	64	1,645
Low (1)	174	122	274	75	327	91	227	151	61	1,501
Medium	152	85	235	67	263	81	183	133	55	1,255
High	94	29	159	49	144	61	109	92	42	779
Very high	68	13	106	37	90	46	70	70	35	535

(1) Estimated from results of model tests at other toll levels

Although traffic would decrease with progressively higher tolls, total toll revenues were estimated to increase with each toll increase. Toll revenues for each case are set out in Table 7B-5.

Table 7B-5

ESTIMATED ANNUAL TOLL REVENUES
(LE millions, 1985/86)

ALTERNATIVE	1990	2000
Current		7.0
Low		12.9
Medium	11.9	21.8
High		35.2
Very high		37.6

The toll revenues presented in Table 7B-5 were estimated on the assumption that full revenues would be collected, which should be the case with the complete barrier and closed toll systems. With the limited barrier system, some traffic could be expected to deliberately evade the toll booths by selecting a different place to enter and leave the new highway, while other traffic (estimated to be a small proportion) would not pass a toll barrier for the sections of the route they use. It could be assumed that at least 20 percent of the potential revenues would be lost, and perhaps up to 50 percent.

Highway Construction Costs

The toll evaluation was concerned with comparing net toll revenues (total revenues less costs of toll operations) with the costs of building and maintaining the highway. Costs of construction and maintenance are presented in Table 7B-6. Similar assumptions on construction, maintenance and overlaying were made to those discussed in Appendix 7A. For this evaluation, financial costs were used, as opposed to economic resource costs used for the economic evaluation.

Only those costs directly associated with the construction of the new highway were included in the evaluation. Hence savings in pavement overlaying elsewhere in the road system were excluded, and maintenance costs were the total costs of maintaining the new highway and the access roads, and were not offset by any savings in maintenance costs due to the new highway elsewhere in the road system. The additional slip road at the planned grade-separated Cairo Ring Road interchange with the Fayoum Desert Road was included since this was directly attributable to the additional traffic passing through the interchange for the new highway.

Table 7B-6

FINANCIAL CONSTRUCTION COSTS FOR THE
NEW CAIRO-ASSUIT HIGHWAY (2-LANE)
(LE millions, 1985/86)

ITEM	ESTIMATED COST
Construction:	
Main highway	88.6
Access roads	28.6
Cairo Ring Road:	
additional slip	3.7
5cm overlay	24.5
Annual maintenance	0.34

Toll Evaluation

The evaluation of tolls brought together the estimates of costs and revenues, and arrayed them in a project lifetime table. Costs and revenues were interpolated and extrapolated as necessary to obtain values for each year. Various economic parameters were calculated in a similar manner to the economic evaluation reported in Appendix 7A. As in the economic evaluation, the year of opening was assumed initially for the first traffic forecast year of the Study 1990, although this was an unrealistically early date. The evaluation results were then used to judge a suitable opening year.

One fundamental difference between the economic and the financial evaluations was in the discount rate selected. For the economic evaluation, the opportunity cost of capital at 12 percent was used, a value determined completely independently of commercial interest rates as a minimum acceptable economic return on an investment (see Appendix 5A).

For the financial evaluation, a financial interest rate was required which reflected the real cost of borrowing money to finance investments. As noted in Appendix 5A, commercial interest rates of between 10 and 20 percent contain a major element to cover expected inflation. Since the project evaluation disregards inflation in calculations of future costs and benefits, the interest rate used for a financial evaluation had also to eliminate the inflation element. A pure rate of interest, stripped of inflation, is normally taken as about 3-4 percent. In other words, a return on an investment should be sufficient to cover the devaluation of the currency due to inflation, and give a return of 3-4 percent on top of that.

Specifically for a toll evaluation, use of a pure financial interest rate assumes that both costs and revenues rise with inflation so that the inflationary element cancels out and can be ignored. In practice, while costs tend to rise inexorably, revenues tend to lag since toll roads are in the public sector, and Government, unwilling to add to inflation, will often delay toll increases required to restore the erosion of revenues by inflation. For this reason, the interest rate chosen for this evaluation was 6 percent; above the pure inflation-free interest rate, but still well below a commercial interest rate.

Evaluation Results - The revenues for the Closed system and the Complete Barrier system were identical, and the cost estimates were also very similar. Therefore of the two, only the Closed System (slightly the more costly of the two) was evaluated in detail. The results are shown in Table 7B-7, considering a year of opening of 1990 and a 25-year project life.

The results appeared very promising with an Internal Rate of Return (IRR) of 10.3 percent, a Benefit/Cost (B/C) ratio of 1.47 and a Net Present Value (NPV) of LE 68.7 million. Moreover, net revenues were estimated to reach the level debt service required to pay off capital and interest by the early 1990s. These results indicate that the road could be completely financed from toll revenues over the 25 year life of the project, with a substantial surplus.

Table 7B-8 shows a similar evaluation but this time assuming that tolls were raised from the "medium" to the "high" level over the period from 1990 to 2000. In other words, toll rates would be increased to cover both inflation and also a real increase in rates. As noted earlier, traffic would decrease but toll revenues overall would increase under this assumption. Accordingly the economic parameters for this alternative were 14.7 percent IRR, 2.29 B/C Ratio and LE 189 million NPV. However, this implied toll rates ten times higher in real terms than the existing rates charged on the Cairo-Alexandria Desert Road.

The Limited Barrier toll system would be less costly to implement and run but, as discussed earlier, would suffer a shortfall in revenue compared with the Closed System and the Complete Barrier System. A slight fall in revenues to, say, 80 percent would not be very serious, but a revenue loss of 50 percent, as shown in Table 7B-9, would reduce revenues to below the point of full financial feasibility, although still making a substantial contribution to project costs.

Sensitivity Evaluation - Returning to the medium toll level with the Closed Toll system, Table 7B-10 shows the results of a sensitivity test assuming revenues reduced by 20 percent and all costs, including highway construction and implementing and operating the toll system, increased by 20 percent. The results indicate that revenues would fall only fractionally below those required for full financial feasibility.

Table 7B-7

FINANCIAL EVALUATION OF THE 2-LANE CAIRO-ASSUIT HIGHWAY
CLOSED TOLL SYSTEM, MEDIUM TOLLS
(LE millions, 1985/86)

YEAR	PROJECT COSTS: Construction	Highway Maint	Toll Booths(1)	Toll Opertns	Total Costs	PROJECT REVENUES	NET COST/ REVENUE STREAM
1987	34.3				34.3	0.0	-34.3
1988	34.3				34.3	0.0	-34.3
1989	34.3		7.2		41.5	0.0	-41.5
1990	14.3	0.34	0.13	1.00	15.8	11.4	-4.4
1991		0.34	0.13	1.00	1.5	12.2	10.7
1992		0.34	0.13	1.00	1.5	13.0	11.5
1993		0.34	0.13	1.00	1.5	13.8	12.4
1994		0.34	0.13	1.00	1.5	14.8	13.3
1995		0.34	0.13	1.00	1.5	15.8	14.3
1996		0.34	0.13	1.00	1.5	16.8	15.4
1997		0.34	0.13	1.00	1.5	17.9	16.5
1998		0.34	0.13	1.00	1.5	19.1	17.7
1999 (2,3)	28.2	0.34	0.13	1.00	29.7	20.4	-9.2
2000		0.34	0.13	1.00	1.5	21.8	20.3
2001		0.34	0.13	1.00	1.5	22.5	21.1
2002		0.34	0.13	1.00	1.5	23.3	21.8
2003		0.34	0.13	1.00	1.5	24.1	22.6
2004		0.34	0.13	1.00	1.5	24.9	23.4
2005		0.34	0.13	1.00	1.5	25.7	24.2
2006		0.34	0.13	1.00	1.5	26.6	25.1
2007		0.34	0.13	1.00	1.5	27.5	26.0
2008		0.34	0.13	1.00	1.5	28.4	26.9
2009 (3)	24.5	0.34	7.33	2.00	34.2	29.3	-4.8
2010		0.34	0.26	2.00	2.6	30.3	27.7
2011		0.34	0.26	2.00	2.6	31.3	28.7
2012		0.34	0.26	2.00	2.6	32.4	29.8
2013		0.34	0.26	2.00	2.6	33.5	30.9
2014 (4)	-8.5	0.34	0.26	2.00	-5.9	34.6	40.5
Totals -	161.4	8.50	18.30	31.00	219.2	571.3	352.1
Discounted -	121.0	3.65	9.47	12.10	146.2	214.9	68.7

6% Interest Rate

	CONSTRUCTION PERIOD: 3 years	4 years		
Single year construc cost (5)	115.7	159.1	Internal Rate of Ret	10.3%
Level debt service required	9.1	12.4	Benefit/Cost Ratio	1.47
			Net Present Value LE	68.7 million

(1) Including construction and maintenance

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening

Table 7B-8

FINANCIAL EVALUATION OF THE 2-LANE CAIRO-ASSUIT HIGHWAY
CLOSED TOLL SYSTEM, HIGH TOLLS
(LE millions, 1985/86)

YEAR	PROJECT COSTS: Construction	Highway Maint	Toll Booths(1)	Toll Opertns	Total Costs	PROJECT REVENUES	NET COST/ REVENUE STREAM
1987	34.3				34.3	0.0	-34.3
1988	34.3				34.3	0.0	-34.3
1989	34.3		7.2		41.5	0.0	-41.5
1990	14.3	0.34	0.13	1.00	15.8	11.4	-4.4
1991		0.34	0.13	1.00	1.5	12.8	11.3
1992		0.34	0.13	1.00	1.5	14.3	12.8
1993		0.34	0.13	1.00	1.5	16.0	14.5
1994		0.34	0.13	1.00	1.5	17.9	16.4
1995		0.34	0.13	1.00	1.5	20.0	18.6
1996		0.34	0.13	1.00	1.5	22.4	21.0
1997		0.34	0.13	1.00	1.5	25.1	23.6
1998		0.34	0.13	1.00	1.5	28.1	26.6
1999 (2,3)	28.2	0.34	0.13	1.00	29.7	31.4	1.8
2000		0.34	0.13	1.00	1.5	35.2	33.7
2001		0.34	0.13	1.00	1.5	37.0	35.5
2002		0.34	0.13	1.00	1.5	38.8	37.3
2003		0.34	0.13	1.00	1.5	40.7	39.3
2004		0.34	0.13	1.00	1.5	42.8	41.3
2005		0.34	0.13	1.00	1.5	44.9	43.5
2006		0.34	0.13	1.00	1.5	47.2	45.7
2007		0.34	0.13	1.00	1.5	49.5	48.1
2008		0.34	0.13	1.00	1.5	52.0	50.5
2009 (3)	24.5	0.34	7.33	2.00	34.2	54.6	20.4
2010		0.34	0.26	2.00	2.6	57.3	54.7
2011		0.34	0.26	2.00	2.6	60.2	57.6
2012		0.34	0.26	2.00	2.6	63.2	60.6
2013		0.34	0.26	2.00	2.6	66.4	63.8
2014 (4)	-8.5	0.34	0.26	2.00	-5.9	69.7	75.6
Totals -	161.4	8.50	18.30	31.00	219.2	959.0	739.8
Discounted -	121.0	3.65	9.47	12.10	146.2	335.5	189.3

6% Interest Rate

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	115.7	159.1
Level debt service required	9.1	12.4

Internal Rate of Ret	14.7%
Benefit/Cost Ratio	2.29
Net Present Value LE	189.3 million

(1) Including construction and maintenance

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening

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Table 7B-9

FINANCIAL EVALUATION OF THE 2-LANE CAIRO-ASSUIT HIGHWAY
LIMITED BARRIER TOLL SYSTEM, MEDIUM TOLLS, 50% REVENUES
(LE millions, 1985/86)

YEAR	PROJECT COSTS: Construction	Highway Maint	Toll Booths(1)	Toll Opertns	Total Costs	PROJECT REVENUES	NET COST/REVENUE STREAM
1987	34.3				34.3	0.0	-34.3
1988	34.3				34.3	0.0	-34.3
1989	34.3		1.6		35.9	0.0	-35.9
1990	14.3	0.34	0.03	0.33	15.0	5.7	-9.3
1991		0.34	0.03	0.33	0.7	6.1	5.4
1992		0.34	0.03	0.33	0.7	6.5	5.8
1993		0.34	0.03	0.33	0.7	6.9	6.2
1994		0.34	0.03	0.33	0.7	7.4	6.7
1995		0.34	0.03	0.33	0.7	7.9	7.2
1996		0.34	0.03	0.33	0.7	8.4	7.7
1997		0.34	0.03	0.33	0.7	9.0	8.3
1998		0.34	0.03	0.33	0.7	9.6	8.9
1999 (2,3)	28.2	0.34	0.03	0.33	28.9	10.2	-18.7
2000		0.34	0.03	0.33	0.7	10.9	10.2
2001		0.34	0.03	0.33	0.7	11.3	10.6
2002		0.34	0.03	0.33	0.7	11.6	10.9
2003		0.34	0.03	0.33	0.7	12.0	11.3
2004		0.34	0.03	0.33	0.7	12.4	11.7
2005		0.34	0.03	0.33	0.7	12.9	12.2
2006		0.34	0.03	0.33	0.7	13.3	12.6
2007		0.34	0.03	0.33	0.7	13.7	13.0
2008		0.34	0.03	0.33	0.7	14.2	13.5
2009 (3)	24.5	0.34	1.63	0.66	27.1	14.7	-12.5
2010		0.34	0.06	0.66	1.1	15.2	14.1
2011		0.34	0.06	0.66	1.1	15.7	14.6
2012		0.34	0.06	0.66	1.1	16.2	15.1
2013		0.34	0.06	0.66	1.1	16.7	15.7
2014 (4)	-8.5	0.34	0.06	0.66	-7.4	17.3	24.7
Totals -	161.4	8.50	4.10	10.23	184.2	285.6	101.4
Discounted -	121.0	3.65	2.12	3.99	130.7	107.4	-23.3

6% Interest Rate

	CONSTRUCTION PERIOD 3 years	4 years
Single year construc cost (5)	115.7	159.1
Level debt service required	9.1	12.4

Internal Rate of Ret	4.1%
Benefit/Cost Ratio	0.82
Net Present Value LE	-23.3 million

(1) Including construction and maintenance

(2) Additional costs of interchange with Cairo Ring Road.

(3) Cost of 5 cm overlay.

(4) Residual value @ 5 percent of total construction.

(5) In year of opening

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Table 7B-10

FINANCIAL EVALUATION OF THE 2-LANE CAIRO-ASSUIT HIGHWAY
SENSITIVITY TEST, CLOSED TOLL SYSTEM, MEDIUM TOLLS
(LE millions, 1985/86)

YEAR	PROJECT COSTS: Construction	Highway Maint	Toll Booths(1)	Toll Opertns	Total Costs	PROJECT REVENUES	NET COST/ REVENUE SURPLUS
1987	41.2				41.2	0.0	-41.2
1988	41.2				41.2	0.0	-41.2
1989	41.2		8.6		49.8	0.0	-49.8
1990	17.2	0.41	0.16	1.20	18.9	9.1	-9.8
1991		0.41	0.16	1.20	1.8	9.7	8.0
1992		0.41	0.16	1.20	1.8	10.4	8.6
1993		0.41	0.16	1.20	1.8	11.1	9.3
1994		0.41	0.16	1.20	1.8	11.8	10.1
1995		0.41	0.16	1.20	1.8	12.6	10.9
1996		0.41	0.16	1.20	1.8	13.5	11.7
1997		0.41	0.16	1.20	1.8	14.4	12.6
1998		0.41	0.16	1.20	1.8	15.3	13.6
1999 (2,3)	28.9	0.41	0.16	1.20	30.7	16.3	-14.4
2000		0.41	0.16	1.20	1.8	17.4	15.7
2001		0.41	0.16	1.20	1.8	18.0	16.3
2002		0.41	0.16	1.20	1.8	18.6	16.9
2003		0.41	0.16	1.20	1.8	19.3	17.5
2004		0.41	0.16	1.20	1.8	19.9	18.1
2005		0.41	0.16	1.20	1.8	20.6	18.8
2006		0.41	0.16	1.20	1.8	21.3	19.5
2007		0.41	0.16	1.20	1.8	22.0	20.2
2008		0.41	0.16	1.20	1.8	22.7	20.9
2009 (3)	29.4	0.41	8.80	2.40	41.0	23.5	-17.5
2010		0.41	0.31	2.40	3.1	24.2	21.1
2011		0.41	0.31	2.40	3.1	25.1	21.9
2012		0.41	0.31	2.40	3.1	25.9	22.8
2013		0.41	0.31	2.40	3.1	26.8	23.6
2014 (4)	-9.9	0.41	0.31	2.40	-6.8	27.7	34.5
Totals -	189.0	10.20	21.96	37.20	258.4	457.0	198.6
Discounted -	142.9	4.38	11.36	14.52	173.2	171.9	-1.3

6% Interest Rate

	CONSTRUCTION PERIOD: 3 years	4 years
Single year construc cost (5)	138.9	190.9
Level debt service required	10.9	14.9

Internal Rate of Ret	5.9%
Benefit/Cost Ratio	0.99
Net Present Value LE	-1.3 mill

(1) Including construction and maintenance
(2) Additional costs of interchange with Cairo Ring Road.
(3) Cost of 5 cm overlay.
(4) Residual value @ 5 percent of total construction.
(5) In year of opening

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Other Considerations

This section deals with a number of other aspects associated with implementing a toll system on the new Cairo-Assuit Highway.

Impact on Economic Benefits - Imposition of tolls modifies driver behaviour and deters some drivers from using the new road. They remain on the existing roads, not only losing economic benefits themselves, but also imposing economic dis-benefits on others by contributing to congestion. To identify this situation more closely, the economic benefits associated with the new Cairo-Assuit Highway were re-assessed for each toll alternative evaluated. The results are illustrated in Figure 7B-2 for the Year 2000 traffic forecasts.

Toll revenues were forecast to increase fairly uniformly with each toll increase, but started to level off approaching the Very High toll level. Economic benefits (counting only one third of time benefits -- see Appendix 7A) dropped slowly at first with tolls up to the Medium level, but then dropped sharply at the High and Very High levels. Thus it was concluded that tolls up to the Medium level (about 4 times current levels on the Alexandria Desert Road) would result in an acceptable reduction in economic benefit (just under 13 percent) but higher toll levels would have a serious impact.

Driver Response - Traffic using the new highway for each toll alternative was estimated using the Traffic Model. This took into account the operating costs of vehicles as affected by travel speed and congestion, and also the cost of tolls. The Model assumed rational route choice based on a desire to minimize the total cost of transport. Full knowledge of costs was assumed for the main benefit and revenue producing commercial trucks. On these assumptions, the new highway was expected to generate high toll revenues since even with the imposition of tolls, overall transport costs for many movements were still expected to be lower using the new highway compared with using the existing roads.

However, there is little evidence on just how drivers would react to toll levels discussed in this Appendix. The Medium tolls represent rates four times the toll on the Alexandria Desert Road in 1986. It is possible that such levels would be resisted and that a higher proportion of traffic would continue to use the existing roads, despite resulting overall higher costs of operation.

It would be possible to obtain some idea of the effect of tolls on route choice by making a detailed survey of traffic between Cairo and Alexandria. This has the choice of a relatively lightly trafficked, but tolled, Desert Road or the much more congested Agricultural Road. Comparisons of traffic counts would not be sufficient since the Agricultural Road serves many other major cities in the Delta, but an origin/destination interview survey should produce interesting results. This could be an excellent University project, and should certainly be part of any further studies of the financing of the Cairo-Assuit Highway.

Private Financing - Given the apparently high rates of return for a toll system, what are the possibilities for private construction and operation of the new highway?

Apart from the lack of any previous experience with private highway construction in Egypt, there are likely to be a number of other obstacles to attracting private finance. Most are associated with the sheer uncertainty of the findings reported here. Likely driver response to what by todays terms are high tolls is unknown, as discussed above. Most of the revenues would be derived from truck traffic, and these could be affected by Government investments in, or subsidies of, rail and waterway transport. Sharp changes in inflation and interest rates could make timely imposition of adequate toll increases impossible. Also, private financing companies might suspect that political opposition to toll increases would affect their freedom to run the road as a commercial operation.

The LE 150 million required to finance the new highway is a substantial investment, and would probably be considered high risk. Typically, investors would want to see a revenue return in the first year of operation equal to the level debt service required to fully finance the highway over a 10 to 15 year period, calculated using current commercial interest rates.

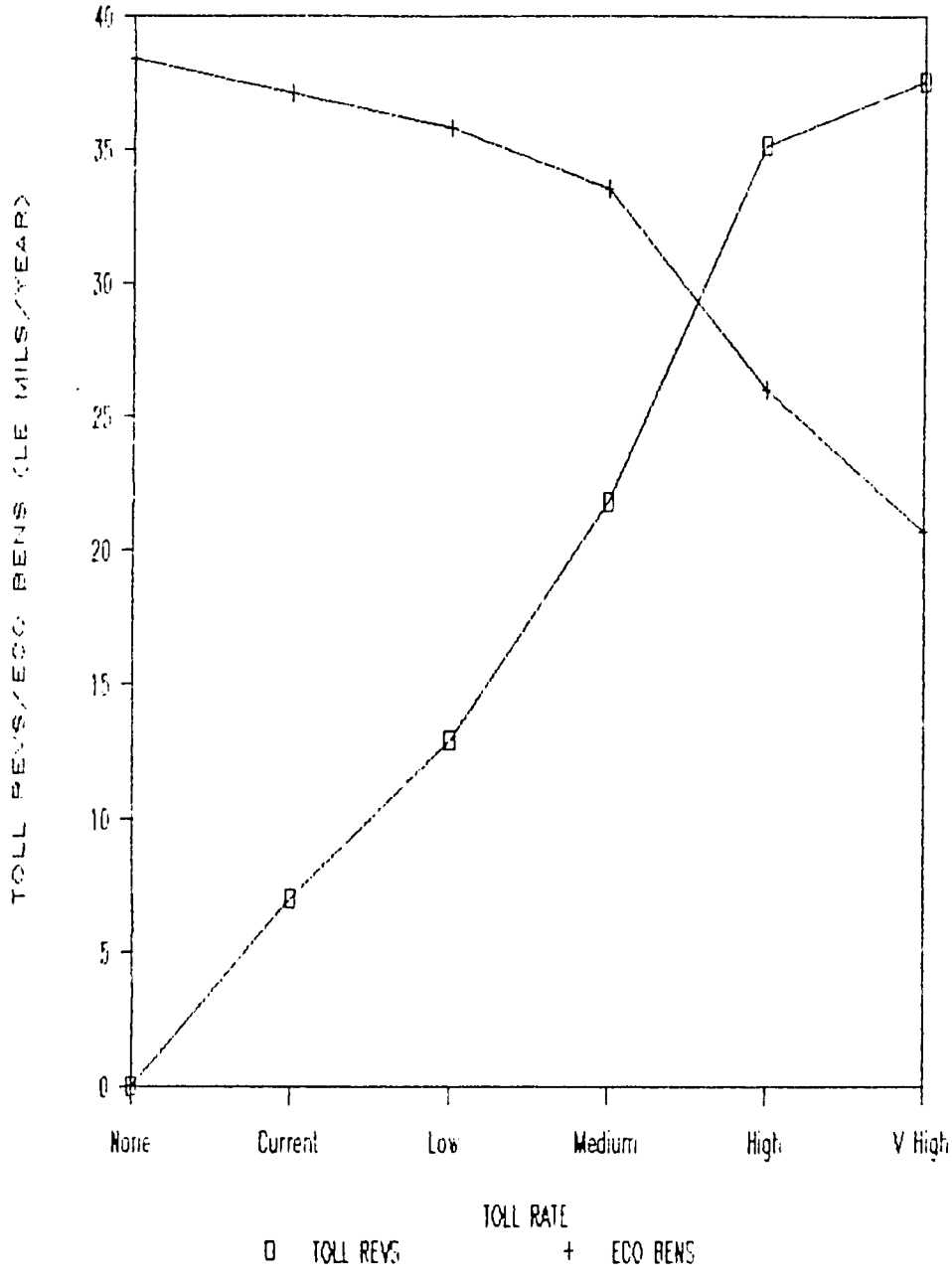
Table 7B-11 indicates how a financing company might view the results of this toll evaluation, based on the Closed Toll system for medium toll levels. Table 7B-11 assumes a realistic opening date of 1995, a 4-year construction period, a 15 year payback period, an interest rate of 12 percent, and an inflation rate of 8 percent.

Table 7B-11

HIGHWAY FINANCING ESTIMATES
(LE millions, 1995 values)

	BASE ASSUMPTION	SENSITIVITY
Single year construction cost in 1995	275	330
Level debt service required, 15 years	40	48
Estimated revenues 1995	29	24

The results indicate a shortfall in revenues over level debt service required for the base assumption, and much worse results with the sensitivity test results. The results are poor seen from the viewpoint of the financing company, essentially because of the uncertainty caused by inflation. This raises the level debt service, essentially requiring initial revenues at a sufficiently high level to offset the later erosion in revenue values by inflation. A private financing company would probably be unwilling to rely on promises of toll increases.



Cairo – Assuit Highway Feasibility Study

Wilbur Smith and Associates
Egyptian Consultants Consortium

ECONOMIC BENEFITS AND TOLL REVENUES
AT DIFFERENT TOLL LEVELS

Figure 7 B - 2

Security - Whatever system of toll collection is envisaged, problems of security for toll collection stations must also be considered. Toll stations would be required to operate 24 hours per day and most would be in isolated locations. Security problems would be most severe with a closed toll system, with toll booths on lightly trafficked access roads. Revenue take at such stations could reach as high as LE 2-3,000 per day.

Safety - Barrier toll systems have the disadvantage of reduced safety with high speed traffic being brought to a complete halt before passing the barrier. This would be critical at night and in times of poor visibility during the winter fogs and summer sandstorms experienced in the Cairo-Assuit Corridor.

Conclusions on the Toll Evaluation

The financial evaluation indicated that tolls could make a substantial contribution to the costs of constructing and maintaining a new Cairo-Assuit Highway, and it is possible, with tolls at a sufficiently high level, that the new highway could be completely financed from tolls. However, the estimates of revenues are theoretical, and more information on driver behaviour in the face of high tolls would be required before a final conclusion was reached. The high risk and uncertainty appears to make private financing of the highway unlikely, but this is a prospect which deserves fuller investigation.

A closed toll system with toll booths on access roads appears to be the best alternative, since toll collection could be complete without the safety hazards and delays associated with barrier tolls located on the road itself. A medium toll level at about four times the 1986 tolls charged on the Alexandria Desert Road gave high revenues with little loss of economic benefits and would appear to be a suitable toll level to aim at.

Appendix 7C

ENVIRONMENTAL AND SOCIAL ASSESSMENT

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Appendix 7C

ENVIRONMENTAL AND SOCIAL ASSESSMENT

This Appendix reports the results of a preliminary assessment of environmental and social impacts of the various route alternatives. A full assessment was not intended at this stage. The purpose of this analysis was to identify significant environmental effects and social issues which would be examined in more detail as appropriate if a full scale assessment were deemed necessary at a later time. In effect, the findings of this analysis were to be used as one factor in determination of overall project feasibility, in a manner consistent with the feasibility level of study. Nevertheless, for purposes of clarity, the same general approach has been followed as for a full scale assessment.

Data Collection

Information was first obtained on current environmental standards and requirements by research of published materials and by interviews with government and university officials who were active in either regulatory roles or in environmental research and study. Background research on sociological factors and social issues, as developed for preliminary route identification, was reviewed and verified. Data for description of baseline environmental conditions was accumulated from available published sources and interviews.

Field trips were made along the major existing roads of the Study corridor in the Nile Valley from Cairo to Assuit, the connection between Fayoum and the Alexandria desert route, newly constructed or improved segments on the east side of the Nile, new bridge connections at Beni Suef and Minia, and improved segments on the west of the Nile near the desert fringe. In addition, the alignment for the new Cairo-Assuit Highway was followed in all segments that were reasonably accessible via tracks and where the line of that route crossed existing roadways. The purpose of these trips was to make field observations of existing conditions as well as to determine the perception of future benefits and issues held by persons living along the Study corridor.

Methodology

The objective of this evaluation was to quantify, as far as was possible, the impact of the different highway investments on social and environmental conditions in the Cairo-Assuit corridor.

Seven principal areas of interest were identified for the evaluation, as follows:

Water Quality
Air Quality
Noise
Land Resources
Ecology
Historic, Cultural, and Aesthetic Resources
Social Impact

The principal measure used for assessing each aspect was traffic volume, and these were established from the Study traffic forecasting process for each investment alternative considered. This evaluation concentrated on the Year 2000 traffic forecasts.

Alternatives Evaluated - Traffic forecasts were prepared for several alternative future situations in the Cairo-Assuit corridor. For each situation, a computer coded description of the roads in the corridor was prepared, containing all the existing principal routes together with the road improvements or new roads included in the investment under consideration.

The Study examined three principal alternatives which were as follows:

i) Complete the new roads and road improvements in construction at the time of the Study, or which were firmly committed for completion before 1990. This represented a null alternative against which the alternative investments investigated by this Study could be compared. This was identified as the Committed Network.

ii) Improve the existing West Bank Highway from Cairo to Assuit by building bypasses round 14 of the principal towns along the route, and widening the entire road to 4-lane standard. This alternative was identified as the Improved Network.

iii) Build a completely new highway from Cairo to Assuit in the desert on the fringe of the existing agricultural area. This alternative was identified as the Expressway Network, although this did not necessarily mean that an expressway standard highway would be built in the initial stages.

Traffic Forecasts - Discussions of traffic volumes in environmental and social assessments are generally given in terms of average daily traffic (ADT) rather than passenger car units (PCU) because most environmental threshold values are expressed in ADT. In order to give a summary impression of the traffic volume impacts anticipated by the alternate routes, Table 7C-1 gives a summary of traffic volumes for major segments. It can be seen that current traffic volumes on the main existing route along the west bank range from about 9,700 vehicles per day at the

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Table 7C-1

FORECAST TRAFFIC VOLUMES
(vehicles per day)

	NEW HIGHWAY	EXISTING HIGHWAYS West Bank	EXISTING HIGHWAYS East Bank
Cairo-Beni Suef			
1985/1986	0	9,700	400
Committed 2000	0	12,700	8,200
Improved 2000	0	14,900	7,400
Expressway 2000	10,000	10,900	4,600
Beni Suef-Minia			
1985/1986	0	5,500	0
Committed 2000	0	7,400	4,600
Improved 2000	0	8,400	4,000
Expressway 2000	4,600	5,900	2,100
Minia-Assuit			
1985/1986	0	5,300	0
Committed 2000	0	10,700	0
Improved 2000	0	11,100	0
Expressway 2000	3,700	7,700	0

NOTE 1: All Traffic volumes crossing Governorate boundaries
NOTE 2: Vehicles per day estimated by dividing PCU forecasts by 2.0

Cairo end of the corridor down to about 5,300 vehicles per day at the Assuit end of the corridor. The data in Table 7C-1 are for sample links considered to be representative of traffic flows in major segments of the networks.

As indicated by the Committed Network, traffic on the existing West Bank Highway is expected to grow by the year 2000 to about 12,700 at the Cairo end, and 10,700 at the Assuit end, if no alternate routes are built or major improvements made. If the new desert highway is built, it is expected to carry about 10,000 vehicles per day at the Cairo end and about 3,700 vehicles per day at the Assuit end. With construction of the new road, traffic volumes would be lowered on the existing West Bank Highway by about 1,800 vehicles per day at the Cairo end and about 3,000 vehicles per day at the Assuit end. Total traffic carried by the new road plus the existing West Bank route in the year 2000 would be about 20,900 at the Cairo end as compared to about 12,700 on the existing route alone. The large difference is because a substantial proportion of the new road traffic is attracted from the existing East Bank Highway, which drops from a forecast of 8,200 vehicles per day on the Committed Network to 4,600 vehicles per day with the new road. At the Assuit end, approximately 11,400 vehicles per day would move on the expressway plus existing route as compared to about 10,700 on the existing route alone.

Environmental And Social Setting

General environmental and social features are discussed here for purposes of general orientation, with more specific discussions given below in association with the respective environmental factors.

Environmental Setting

Across an east-west axis, the Study area can be divided into three distinct physical provinces, the Western Desert, the Nile Valley, and the Eastern Desert. These can be considered as only two distinct environmental provinces for analysis purposes, since both desert areas have quite similar characteristics within the Study corridor.

The Nile Valley is a narrow fertile plain of alluvial soil, varying from 2 km to 25 km wide. This narrow ribbon contains almost all of the urban development and agricultural economy of Upper Egypt, although industrial sites and some new urban development are beginning to occur in the desert fringe outside of the Valley. The east bank valley is generally narrow, and the west bank valley is variable but generally wider than the east bank. Since the west bank contains more agricultural land, the transport network and urban development have historically occured more intensively on the west bank. A lateral branch of the Nile, converted in ancient times to a canal, the Bahr Youssef, flows parallel to the Nile on the west from Assuit to Fayoum.

The Western Desert is the eastern fringe of the Great Sahara. Along most of the study corridor, there are no high cliffs at the edge of the Nile Valley on the west side, with the exception of short lengths of cliffs near Assuit. The absence of cliffs makes extension of development,

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and reclamation of desert land, generally easier on the west bank than on the east bank. Much of the Western Desert fringe is composed of the weathered remains of unconsolidated limestone deposits, with rolling hills of mixed rock, gravel and sand. Approximately 40% of the Western Desert area is dunes, but these are prevalent in the Study corridor generally only in the Minia to Assuit segment.

The Eastern Desert begins with a series of sandstone, limestone and granite cliffs parallel to the Nile at a distance of several hundred meters to several kilometers from the Nile. The desert is nominally flat and rocky beyond the cliffs and slopes eventually up to a chain of mountains between the Nile and the Red Sea.

There is somewhat more variation in environmental characteristics along the north-south axis of the study corridor. Cairo, at the north end, lies at the apex of the Nile delta, though none of the delta would be considered a part of the Study area. The fertile, irrigated valley of the Fayoum Depression lies at the western edge of the corridor, northwest of Beni Suef. There is a gradual gradient in rainfall amounts and temperature from north to south. Cairo receives about 32 mm of average annual rainfall, Minia receives about 5 mm, and Assuit less than 5 mm. Cairo's temperature ranges from daytime highs of 23 to 33 degrees centigrade to nighttime lows of 11 to 20 degrees. At Assuit, daytime highs range from 27 to 35 degrees with nighttime lows of 10 to 21 degrees.

Prevailing winds at Cairo are northerly and northwesterly, with approximately 130 days per year when maximum daily wind velocity exceeds 25 kilometers per hour. Prevailing winds at Assuit are northwesterly to westerly, also having maximum daily wind velocity in excess of 25 kilometers per hour for approximately 130 days per year.

For purposes of contrast, comparisons have been made generally between the northern segment of the corridor between Cairo and Beni Suef and the southern segment between Minia and Assuit. There is some gradient in overall development intensity along the corridor. The Cairo-Beni Suef area is intensely developed with urban settlements, towns and villages. The southern end of the corridor betwen Minia and Assuit has a more rural character, with smaller towns and less roadside urbanization.

Throughout the length of the corridor, the most sensitive environmental impacts include agricultural land, urban settlements, the Nile River, the canals and irrigation system and archaeological, historic and cultural features.

Impact Assessments

Preliminary impact assessments are given below for major environmental attributes including water, air, land, noise, ecology, and cultural, plus an assessement of social impact. For each attribute, a discussion is given for each of the major route alternatives as described above.

Water Quality

Consideration of water as an environmental attribute in the Study corridor is related principally to maintenance of water quality in the Nile and in canals, and the maintenance of hydraulic capacity in irrigation channels.

Standards of Water Quality - The principal reference source for water quality standards is law number 48 of 1982 as put into effect by Minesterial Order number 8 of 1983 by the Ministry of Irrigation. A summary of the parameters adopted in this Law is given in Table 7C-2.

Baseline Conditions - Surface runoff is the principal means of transport of contaminants from the highway network to surface water. The effectiveness of runoff in transporting contaminants to water is a product of conditions of rainfall, soil permeability and ground surface characteristics such as slope.

Rainfall in the corridor is very low, ranging from 32 mm per year at Cairo down to less than 5 mm per year at Assuit. Evaporation potential is high, ranging from about 2 or 3 mm per day at Cairo up to approximately 10 mm per day at Assuit. Soils are generally sandy, with low organic content and high permeability. Natural streams, other than the Nile, are virtually nonexistant. Only intermittent wadi streams are present and these rarely flow. Therefore surface runoff is of almost no significance. Contamination of surface water from highway related activity would have to take place as direct spills or be transported by air.

Water quality in the Nile River south of Cairo is generally good. Bacteriological contamination is marginal, generally at levels of total Coliform bacteria of less than 1000/100 ml. (Even though there is no Coliform standard for the Nile, by comparison, the Coliform standard for irrigation water is 5,000/100 ml.) One reason for the good biological quality of the Nile is the large dilution factor, which is generally more than 1,000 to 1 for most drain and canal outlets. Of course, pollution is higher at the drain outlets, but the high dilution and other natural factors quickly disperse the contaminants.

Water quality in the main canals, which are used as local sources of domestic water supply, is not nearly so good. As noted above, the standard which should not be exceeded is total coliform bacteria of 1,000/100 ml. Samples taken in the Ibrahimiya Canal in 1985 as a part of the USAID sponsored Provincial Cities Development Project showed total Coliform counts of from 7,000 to 17,000/100 ml. Counts by the same project at Minia showed Coliform contamination in the Canal of 7,900 to 9,200/100 ml.

Little specific information is available on non-biological contamination in the Nile and canals, although total dissolved solids generally approximate less than 200 mg/l. (Again, for comparison, although there is no standard for the Nile, the standard for irrigation water is 650 mg/l.) Very little in the way of pesticides or nutrients from fertilizer seems to reach the river.

Table 7C-2

SUMMARY OF WATER QUALITY STANDARDS OF LAW 48 OF 1982

PARAMETER mg/l UNLESS SPECIFIED	NILE AND CANALS	DRAINS REUSED IN IRRIGATION
Color (Degrees)	100	100
Temperature rise above ambient (degrees)	5	5
pH (units)	7-8.5	7-8.5
BOD 5	6	10
COD, Dichromate	10	15
COD, permanganate	10	6
Dissolved oxygen (not less than)	5	5
Total dissolved solids	-	650
Suspended solids	-	500
Sulphates	200	-
Phosphate, organic	-	1
Nitrate	45	45
Phenol	0.02	0.02
Fluoride	0.5	-
Mercury	0.001	0.001
Lead	0.05	-
Cadmium	0.01	0.01
Chronium	0.05	0.01
Copper	1	1
Iron	1	1
Manganese	0.5	-
Zinc	1	1
Cyanide	0.05	0.1
Detergents	0.5	0.5
Nitrogen	1	-
Ammonia	0.5	0.5
Total Alkalinity	20-15	50-200
Turbidity (units)	-	50
Cyanate	0.1	-
E.coli (/100 ml)	-	5,000

Measurements of non-biological contaminants made at Beni Suef and Minia by the Nile River Environmental Center in 1974 showed that none of the Law 48 standards were violated. Although large quantities of fertilizer and some pesticide is used, concentrations of nitrates, phosphates and chemicals derived from pesticides were very low. As noted above this is probably a result of lack of rainfall and runoff to transport the materials to the River.

The Aswan High Dam has regulated the flow of water in the Nile so that there is no flooding and minimal seasonal variation. There is enough water for year round irrigation. Ground water in the aquifer under the Nile Valley is in hydraulic contact with the surface water in the Nile. Hydrology of the irrigation system is, however, much more delicate. While pumps are being used much more frequently, most irrigation still depends on gravity flow. In 1982, it was estimated by a study of socio-economic aspects of the North Saiid Region (containing Minia Governorate) that about 90% of the cultivated land in Minia Governorate was irrigated by gravity flow. The irrigation system has been refined over thousands of years of use to take advantage of very small slope gradients to transport water to large areas of cultivated land. The hydraulics of this sytem are, therefore, subject to disturbance by any development which interrupts or changes the pattern of flow, as could be done by highway development.

Sensitive Areas or Receptors of Water Quality Impacts - Receptors which are most sensitive to environmental impact are the Nile River itself for maintenance of water quality and the smaller field irrigation channels for maintenance of hydrology. Water quality in the canals is already poor, and hydrology of the River and main canals would not be affected by highway related activities.

Expected Conditions with the Committed Network - The highest comparative risk of adverse impact on water resources from continued reliance on the existing highway is the risk of direct spills of toxic substances into the Ibrahimiya Canal, which is used as a source of domestic water supply. Toxic substances most likely to be spilled would be industrial chemicals or pesticides. Spills of fertilizer into the canal would add nutrients, but nutrient levels in the canal are already high. Some spills will also probably occur into irrigation waters. The spills would generally be most likely to occur as the results of vehicle accidents. Since the existing highway carries all traffic through the towns along the West Bank, reliance on this road also has the highest risk of exposing humans directly to spills of toxic substances.

It would at first appear that the existing highway might have a lower risk of petroleum product spills because of petroleum tanker trucks being diverted to the new highway. However, a pipeline is now being constructed along the corridor. When completed, most long distance movement of petroleum products will be via the pipeline, while local distribution, generally outwards from Governorate capitals, will still be done via the local road network. Thus, no significant diversion of petroleum movement to the new highway would occur, and risk of exposure to spills on the existing road would be about the same with or without the new highway.

Water Quality Impacts of the Improved Alternative - This alternative reduce the hazard of spills. The Improved Alternative would divert traffic around the towns, which are high accident areas,and would take trucks away from the banks of the Ibrahimiya Canal, and also away from the urban population.

On the other hand, the Improved Alternative has a potential for disturbing the hydrology of the smaller channels of the irrigation system. New by-pass routes would often run diagonal to the prevailing drainage pattern. This effect could be avoided but it would require careful and sensitive study of the drainage system or else would require an increased investment in irrigation pumps. The widening actions of this alternative produces an even higher risk of disturbing small irrigation channels because these typically run parallel to the main road along much of its length, and widening could require realignment of these channels.

Water Quality Impacts of the Expressway Alternative - This alternative would likely have beneficial impacts rather than adverse impacts with respect to water. It would reduce the risk of spills into the Canal and the risk of human exposure to spills by diverting some of the traffic carrying toxic or hazardous substances away from the Canal and away from urban settlements. Much of the volume of toxic and hazardous material is carried by heavy trucks which would be attracted over to the new highway. The new highway would not have any effect on hydrology of the irrigation system.

Construction Effects - There would probably not be much significant difference in water resource impacts from construction of the Impoved versus the Expressway alternative. Construction of the Improved Alternative may create some sedimentation in canals and irrigation channels as a result of earthwork, as well as minor spillage of asphalt or other materials into waterways.

Comparison of Alternatives, Water Quality Impacts - There would probably be little differential effect on water quality among the alternatives, but what advantages there are appear to accrue to the Expressway Network. The new road would have a beneficial impact in reducing the risk of toxic or hazardous material spillage into waterways and in areas of human contact. However, consequences seem marginal, because lack of runoff transport means that spills would have to be directly into a waterway to produce any significant result. While the Improved Alternative would enjoy some of this beneficial effect also, it would produce a potential for disturbance of irrigation hydrology, thus the positive and negative aspects of the Improved Alternative cancel out to some extent.

Air Quality

Unlike water and some other waste transport systems, air cannot be reprocessed in any practical manner and thus air pollution must be controlled at its source. Operation of vehicles on the highway network is one such source.

Standards of Air Quality - At the present time, there are no uniform national air quality standards in effect. There is, however, an awareness of the problem of air pollution in urban areas, especially Cairo. At the present time, no effective measures have been instituted to control air pollution emissions from industrial sources around Cairo. Evidence of the perception of an acute air pollution problem is, however, given by the announced intention of the Environmental Affairs Agency of the Ministry of Cabinet Affairs to begin measuring pollutants emitted from vehicle exhaust systems and to institute operating standards for exhaust systems as a part of the vehicle licensing process.

In the absence of regulatory standards, there are certain generally accepted air quality measures which can be used to aid in judging ambient air quality. These are presented in Table 7C-3. The reasons for attempting to limit the substances listed in the table are as follows:

1. Particulate matter: Causes respiratory disorder and eye irritation. Results in economic loss from surface material damage.
2. Sulfur oxides: Associated with respiratory disease, forms corrosive compounds, causes plant damage.
3. Hydrocarbons: Combine with oxygen and nitrogen oxides to form photochemical oxidants.
4. Nitrogen oxides: Associated with respiratory disease and forms photochemical oxidants.
5. Carbon monoxide: Reduces oxygen carrying capacity of blood, reducing mental acuity, and increasing burden on pulmonary system.
6. Lead: Retards development of mental processes of children, affects mental acuity of adults.

Various general sources produce different proportions of pollutants in the air, and the transportation system does not produce significant amounts of all air pollutants. Industrial sources (such as cement plants) produce most of the particulates and a large share of the carbon monoxide. Fuel combustion from non-transportation sources produces most of the sulfur oxides and about half of the nitrogen oxides. What is produced by the transportation system is most of the carbon monoxide, most of the hydrocarbons, and about half of the nitrogen oxides.

Baseline Conditions of Air Quality - The discussion above gives an outline of the pollutant factors which may affect air quality. However, a critical element in the overall impact of these pollutants is the means by which they are transported from their source to the areas which suffer the impact. The transport mechanism for air pollution is the local climatic system. If local climatic conditions give a good diffusion of pollutants (for example, blowing away by the wind), then the effects of the pollutants are lessened. Important factors are winds, temperature differentials, and topography. Stable or stagnant air masses trap pollution, as do topographic depressions.

Table 7C-3

JUDGEMENTAL STANDARDS FOR USE IN EVALUATING AIR QUALITY

POLLUTANT	LEVEL OF QUALITY		
	Good	Moderate	Poor
1. Particulates, ug/m^3 24 hr ann geo mean	50	150	300
2. Sulfur Oxides, ppm 24 hr ann arith mean	0.05	0.12	0.25
3. Hydrocarbons, ppm 3hr av ann concentration	0.1	0.2	0.3
4. Nitrogen Oxides, ppm av ann concentration	0.25	0.05	0.10
5. Carbon Monoxide, ppm Continuous exposure	5	15	30
6. Lead, ug/m^3 3mo ann arth mean	1.5	NE	NE

Notes:

ug/m^3 : micrograms per cubic meter
ppm : parts per million
NE : not established

Source: Consultant

Several conditions in Upper Egypt provide a good mixing and dispersion quality to air. In the northern sector of the study corridor, generally from Cairo to Beni Suef, winds are northerly and northwesterly, with approximately 130 days per year when maximum daily velocity exceeds 25 kilometers per hour. Maximum wind velocity and occurence are about the same in the southern sector of the corridor, but wind directions gradually shift to northwesterly and westerly. These are considered reasonably strong winds for dispersion.

Another factor which can lessen air pollution is convection currents caused by day and night temperature differentials. Air pollutants are trapped in a blanket of cool air at night. This is why air pollution is usually most highly visible in early morning. If there is a significant rise in temperature during the day, this air layer warms and rises, carrying away the pollutants. The presence of a large day/night temperature differential in Egypt provides good convection current mixing. The differential in Cairo is about 12 or 13 degrees Centigrade and the differential in Assuit is about 14 to 17 degrees.

Topography also plays a role. Natural depressions or "bowls" can trap stagnant air and allow pollution to build up. Such depressions do not exist in the study corridor. The depth of the Nile Valley is insignificant in proportion to the flat expanses of adjacent desert, and the Valley of course is open at both ends. The Fayoum Depression likewise is not of sufficient depth to create inversions, except to a slight degree.These combined sources of air movement in the local climate thus lead to a high dispersion factor, which does a reasonably good job of "sweeping away" the air pollution.

There are, however, localized conditions in the corridor in which day to day air pollution is rather acute. The industrial area south of Cairo is one such location. During the night, the northerly but fairly low velocity winds funnel pollutants southward into the narrowing Nile Valley. In that area, emissions from electric generating plants, cement plants, steel mills, and countless small brickworks are added to create a pall which can be seen almost every morning and lasting well into the day. The air receives particulate matter from cement and steel mills, sulfur and nitrogen oxides from fuel burning, carbon monoxide from vehicles and industry, hydrocarbons, nitrogen oxides and lead from vehicles. Air quality overall in this district would have to be rated as poor. Particulates probably exceed 600 micrograms per cubic meter and hydrocarbons probably exceed 0.4 ppm daily. Other pollutant factors are probably no better than moderate.

Particulate concentration downwind from the cement plant at Assuit probably exceeds 200 micrograms per cubic meter on a daily basis when the plant is operating at present, and operational output at this plant is expected to triple. There are other spot sources which produce heavy smoke from petroleum burning. Throughout the Nile Valley, small brickworks produce heavy smoke on a spot basis. However, only in the immediate vicinity of the Cairo urban complex does there appear to be any chronic air pollution problem of widespread significance.

Sensitive Areas or Receptors of Air Quality Impacts - Receptors which are most sensitive to the environmental impact of air quality are the human population concentrations susceptible to continuous exposure. Thus, in the study corridor, sensitive areas are the urban areas along the various route alignments.

Expected Conditions with the Committed Network - Significant factors which determine the "production" side of air quality impacts are the volumes of vehicles moving on a highway and the operating characteristics of those vehicles. On the "reception" side of the impact equation, in this particular corridor, are urban population concentrations. These three factors are discussed below for each route alternative. Using figures from Table 7C-1, the expected increase in traffic volumes on the West Bank highway are:

	1985/80	2000	INCREASE
Cairo-Beni Suef	9,700	12,700	3,000
Beni Suef-Minia	5,500	7,400	1,900
Minia - Assuit	5,300	10,700	5,400

The operating characteristics of vehicles are the second factor of consideration. Most pollution from vehicle operation occurs during acceleration and deceleration. Emissions are lowest while idling and slightly higher while cruising. However, emissions are roughly one and one-half to over five times higher during acceleration and deceleration, depending on vehicle type and what factors are measured. Thus, the correlation between pollution emission and speed change cycles is very high. There are therfore, similar correlations between pollution and congestion (or volume/capacity ratios) and comparative vehicle operating speeds over given distances. A number of refinements could be done in a full scale assessment, but operating speeds over the alternative routes has been taken here as an indicator.

Average vehicle operating speed along the West Bank Highway in 1985, for light vehicles, was 61 kph. For the Committed network in 2000, the projected journey speed is 44 kph. Thus, the West Bank route, without further improvement would experience about a 28 percent reduction in operating speed, reflecting a significantly higher level of congestion and thus higher emission of air pollutants.

On the "receptor" side of the equation, only about 47 percent of the length of the West Bank route was through "open country" in 1985, meaning that 53 percent of the length was through city, town or village segments. About 15 percent was through urban or heavy village settlements. It is obvious that the degree of urbanization will increase along the route by the year 2000.

Therefore, the existing West Bank Highway in 2000 is expected to carry increased volumes of traffic of up to 5,400 vehicles per day, at significantly increased rates of congestion meaning much higher pollutant emissions through areas of high population concentration.

Air Quality Impacts of the Improved Alternative - Increase in traffic volumes with the Improved Network is projected to be as follows:

	1985/86	2000	INCREASE
Cairo-Beni Suef	9,700	14,900	5,200
Beni Suef-Minia	5,500	8,400	2,900
Minia-Assuit	5,300	11,100	5,800

For the Improved Alternative, the projected average speed 70 kph compared with 61 kph in Base Year and 44 kph estiamted for the Committed Network. Thus, the Improved Alternative would have a higher operating speed than is currently experienced along the West Bank road, resulting in a slight decrease in air pollution per vehicle. A benefit of the Improved Alternative per vehicle would be the decreased direct exposure of the human population living alongside the road. The Improved route would pass through agricultural land around the perimeter of 14 towns as a result of by-pass construction, instead of through the town centers. The impact of vehicle exhaust air pollutants diminishes quickly with distance, particularly in the case of carbon monoxide and lead. Diversion of traffic to the by-passes would result in less intimate exposure of the human population to air pollutants from vehicles.

Therefore, it could be concluded that the Improved Alternative would result in a modest air quality advantage over the unimproved highway, partly by allowing more efficient vehicle operation, but more by removing the pollutant source away from the exposed population.

Air Quality Impacts of the Expressway Alternative - The Expressway Alternative gives the following traffic volumes:

	1985/86	2000	INCREASE
Existing West Bank Highway			
Cairo-Beni Suef	9,700	10,900	1,200
Beni Suef-Minia	5,500	5,900	400
Minia-Assuit	5,300	7,700	2,400
New Desert Highway			
Cairo-Beni Suef	0	10,000	10,000
Beni Suef-Minia	0	4,600	4,600
Minia-Assuit	0	3,700	3,700

The projected operating speed on the new highway is of 89 kph. On the West Bank route, if the Expressway is built, a journey speed of 54 kph is projected.

Overall, therefore, the Expressway alternative would produce higher total volumes of traffic, running at higher (less polluting) operating speeds. However, consideration of the receptor side of the environmental system suggests that significant impacts would occur only on the West Bank route rather than on the combination of both routes. The reason is that, since the Expressway route is through the desert for almost its entire length, there is almost no human population along the route to receive impacts. Even though some settlement would occur along the Expressway route, by the year 2000 this settlement would still be very small as compared to the heavy urbanization along the West Bank route. Therefore, the significant comparison is the difference in conditions along the West Bank route with and without the expressway, rather than the combined system from 1985 to 2000.

If the new desert highway is built, there would be less traffic on the existing West Bank highway than without the new road, as follows:

	Without Exp.	With Exp.	Difference
West Bank			
Cairo-Beni Suef	12,700	10,900	(1,800)
Beni Suef-Minia	7,400	5,900	(1,500)
Minia-Assuit	10,700	7,700	(3,000)

Average operating speed on the West Bank route without the new desert highway is projected to be 44 kph, compared with 54 kph with. The urbanization factor should also be noted here. Construction of the desert highway would open additional desert land for development. This would relieve some of the urbanization pressure on the existing development areas along the West Bank route, and probably result in less urbanization along the West Bank route than would have occurred without the Expressway.

The net result along the West Bank route would be reduced traffic volume, operating at higher, less polluting speeds, with less exposure of urban population to adverse impacts. The net result along the Expressway would be a substantial volume of new traffic (3,700 to 10,000 on major segments), but this traffic would operate efficiently with little congestion, which minimizes pollutant emissions. More importantly, there would be very little exposure of human population.

Construction Impacts - Construction impacts on air quality from either of the alternatives would be minimal. There would be some construction equipment pollutant emissions and some dust resulting from the Improved alternative. The Expressway Alternative would probably produce significant quantities of blowing dust, but almost no population would be exposed to this.

Comparison of Alternatives, Air Quality Impacts - Even though there are comparative differences among alternatives as discussed above, the question should be asked at this point as to whether any of the air quality impacts are in fact significant in terms of overall scale. As a general rule, a change in traffic volume on an existing highway of about 500 vehicles per hour or about 10,000 vehicles per day is taken as a

threshold value for justifying an analysis of the impact of that change. For a new highway such as the Expressway route, the volume taken as significant to justify analysis is about 800 vehicles per hour or about 20,000 vehicles per day. The Committed Network and Improved Alternatives result in traffic volume increases not exceeding approximately 6,000 vehicles per day, and the Expressway route gives a maximum increase of about 10,000 vehicles per day. Thus, while there are relative differences among the various alternatives, all of the alternatives yield only about half of the traffic volumes generally considered as necessary to produce significant air quality impacts. Therefore, all of the air quality impacts, whether positive or negative, could be considered as marginal.

For purposes of summarization, the following comparative differences can be identified:

1. The Committed network will produce lower operating speeds, more congestion and more pollutant emissions. Since it runs along a more urbanized route than the other two alternatives, it exposes a greater population.

2. The Improved Alternative has a slight benefit, not because of production of less emission but because of moving certains segments of the roadway away from exposed population.

3. The Expressway route has a clear advantage because it produces less pollutant emission, gives very low population exposure, and reduces exposure along the exsiting West Bank Highway.

In view of the overall scale of vehicle operations, it could be concluded that the Expressway Network yields marginally higher beneficial impacts than the Improved Alternative. Both alternatives give an improvement of air quality over the Committed Network, but would produce a marginal deterioration in air quality compared with current conditions.

Noise

While noise can be commonly agreed to be "annoying", the specific effects of noise on individuals varys with conditions and is somewhat subjective. Among effects which can be identified are physiological effects such as reduced hearing ability, psychological effects such as stress and anxiety, and interefence with communications. These effects result in individual attempts at adaptation, interference with work and social tasks, reduced efficiency, and alterations in social behaviour.

Individuals do adapt to the ambient noise level around them. Even though a person becomes accustomed to the surrounding noise level, this process of adaption in itself is stressful. Nevertheless, when analyzing noise impacts, the indicator of impact is taken to be changes in the ambient noise level.

Noise Effect Standards - Regulatory measures concerning noise are usually not directly imposed on highway users. They are put into effect to some extent by regulations requiring noise suppression on vehicles. Therefore, no government regulations or standards are expected. However, good highway design practice does call for observance of standards which help lessen noise effects.

In order to help evaluate design impacts on the noise environment, it helps to know something about how noise is produced and how it is perceived. Noise is measured in decibels, (db) a measurement which takes into account sound pressure (loudness), frequency, and other physical characteristics. The human ear does not perceive noise accurately, but instead hears some parts of the noise spectrum selectively. To give a measure of noise which corresponds to human noise perception, weighting is given to certain parts of the sound spectrum to give an "A weighted" measure, or "dB(A)".

Ambient noise is the "background" or prevailing noise level at any given place. The ambient noise level is the level that people adapt to, or easily learn to ignore. Ambient noise in the desert may approach zero decibels, but most environments in which humans live have ambient levels of 30 to 80 dB(A). Noise levels exceeding about 50 dB(A) will disturb or annoy most people. Impulse noise, which means a high noise level for a short duration, such as a truck horn, is more disturbing than sustained noise. Noise sources which are "line sources", such as heavy streams of traffic, reduce in noise level by about 3dB(A) per doubling of distance. Thus, the noise of a truck horn measured at 90 dB(A) at 20 meters distant from the truck would reduce to 87 dB(A) at 40 meters. Automobile noise increases with speed, while truck noise is higher at low speeds. A diesel tractor-trailer produces approximately 30 times as much noise as a car. Therefore, a key element in noise evaluation is truck traffic operating in semi-congested conditions. The addition of truck horns as an impulse noise source is also particularly important.

Design targets for exterior noise level control which are generally accepted are given below:

1.	Rural open spaces	60dB(A)
2.	Areas with residences, schools, hotels, mosques, institutions	70dB(A)
3.	Other urban developed areas such as commercial	75dB(A)

These are dB(A) values which should not be exceeded more than 10 percent of the time (usually expressed as L10)

Sensitive Areas and Receptors of Noise Effects - The human population are the receptors of noise impact, therefore urban areas, towns and villages are the sensitive areas.

Baseline Conditions - There are no ambient noise level measurements available, but field observations were made in order to obtain subjective judgements of noise. Ambient noise in rural areas along the West Bank

highway seems quite low, probably in the range of L10dB(A) 60-65 under typical conditions. This accounts for about 47 percent of the existing route. However, with increasing development and congestion, noise levels go up quickly, and this is particularly true in larger villages and urban areas, accounting for about 15% of the route length. In these areas ambient noise levels along the highway probably reach into the L10dB(A) 75-80 range, with frequent instantaneous levels of 90dB or over due to truck horns. This can only be considered as a "noise" polluted" environment.

Expected Noise Conditions with the Committed Network - Critical elements in a comparative evaluation of noise effects are, on the production side, changes in volumes of truck traffic and operating speed, and on the reception side, the perceived effect of those changes. With respect to changes in volumes of truck traffic, reductions in the average daily volumes of heavier trucks (singles, combined and articulated) on the West Bank Route would be as follows:

	1985/86	2000	DIFFERENCE
Cairo-Beni Suef	2100	2000	(100)
Beni Suef-Minia	1500	1500	- 0 -
Minia-Assuit	1600	3200	1600

The small differences on the northern and central segments are due to trucks changing over to the East Bank Route, but Minia to Assuit truck traffic would increase by 1600 vehicles per day.

As noted above, operating speeds along the West Bank route, under the Committed network, would decrease from an average of 61 kph in 1985/86 to an average of 44 kph.

Daily truck volumes of 1600 vehicles in 1985 probably produced peak hour volumes of 120 or more. That volume of truck traffic operating under semi-congested conditions would probably produce noise of approximately 60 dB(A), which would be in addition to noise produced by other vehicle types (cars and busses) and would not include noise from horn blowing.

Because of little change in volumes from Cairo to Minia, the noise contribution from trucks on the West Bank route under the Committed network would not be significant. However, between Minia and Assuit, truck traffic was forecast to increase to 3,200 per day, which would probably produce well over 200 per hour, or at least 100 per hour additional. This increase would boost truck noise contribution to nearly 70 dB(A), or an increase of perhaps 8 to 10 dB(A).

The question at this point is the perception of that noise increase on the receptor side of the system. In other words, would humans perceive this increase as significant? Increases or decreases of less than 5dB(A) in ambient noise level are generally perceived as only a slight changes. Changes of from 5 to 15 dB(A) are perceived as significant changes. Changes of more than 15 dB(A) are severe or very significant.

Thus it appears that the Committed network implies little noise change from 1985 from Cairo to Minia, but a severe adverse impact (plus 8 to 10 dB(A)) from Minia to Assuit. This noise impact calculation is the result of truck operation alone, and to this could be added car noise plus horn blowing. Since congestion levels would increase, an additional increase in noise from horn blowing would be expected.

Noise Effects of The Improved Alternative - About the same truck traffic volumes would be carried on the Improved Alternative as on the Committed network. On the production side, the noise levels would be the same. However, a positive benefit would accrue from displacing the source of noise away from the receptor population, as would happen when trucks were routed around urban centers on by-passes. For example, if only half the trucks chose to follow the by-passes, a reduction of probably 6 or 8 dB(A) in noise level would occur, with additional improvements because of less congestion, less hour blowing, and less automobiles in the urban centers. On this basis, the Improved Alternative could be rated as having a significant noise effect reduction.

Noise Effects of The Expressway Alternative - Truck traffic volumes along the new desert highway in 2000 are projected to range from around 1300 per day from Minia to Assuit up to 2300 per day from Cairo to Beni Suef. This volume of truck traffic would probably produce 55 to 60 dB(A) at peak hours, with total noise production from all vehicles probably yielding levels of 60 to 65 dB(A) at peak hours. However, because of very small population along the route, and presumably with set-back regulations which would keep development away from the highway, the noise impact would be insignificant.

What bears analysis is the effect of the Expressway Alternative on the West Bank route. The effect on truck traffic volumes would be as follows:

	Without New Highway	With New Highway	DIFFERENCE
Cairo-Beni Suef	2000	1500	(500)
Beni Suef-Minia	1500	1000	(500)
Minia-Assuit	3200	2000	(1200)

The reduction in noise along the existing route by these decreases in truck traffic would be approximately as follows:

Cairo-Beni Suef	less than 5dB(A)
Beni Suef-Minia	about 5dB(A)
Minia-Assuit	about 8dB(A)

Reductions in addition to that from truck operating noise would accrue from reductions in automobile noise and horn blowing. Therefore, it could be concluded that the Expressway Alternative would have significant

benefits by reducing noise on the West Bank route. While the noise reduction between Cairo and Beni Suef may be marginal, reduction between Beni Suef and Minia would be significant and reduction between Minia and Assuit would be very significant.

Construction Impacts - There would probably be insignificant noise impact from Improved Alternative construction caused by construction vehicle operation and other noises, but virtually no noise impact from construction of the new desert highway.

Comparison of Alternatives, Noise Effects - The conclusions concerning the environmental effects of changes in noise which are discussed above may be summarized as follows:

	IMPROVED	EXPRESSWAY
Cairo - Beni Suef	significant positive	-
Beni Suef - Minia	significant positive	significant positive
Minia - Assuit	significant positive	very significant positive

Land Resources

The only land resource impact of any apparent significance connected with the Study's alternatives is the conversion of agricultural land to highway right-of-way. The economic impact of the acquisition of agricultural land for highway use is taken into account in the economic evaluation of feasibility through consideration of land cost. In Egypt, however, there are nonquantifiable social and environmental costs attached to the taking of agricultural land. The value of agricultural land in the Egyptian economy is well known. A very small proportion of the total land area is arable. All of the cultivated land in the study area must be irrigated to make it productive. All the cultivated land is used very intensively. While additional land can be brought under cultivation by desert reclamation, this process is slow and difficult, so for all practical purposes, agricultural land must be considered as a highly productive, renewable, but not expandable resource.

Of course, transportation is a vital activity, and land converted from agricultural use to transportation has not lost its utility, but has been converted from a productive resource to a support resource. Nevertheless, any conversion of agricultural land to highway use will be judged to be a negative impact. This subsection deals primarily with the comparative amounts of agricultural land resource conversion. The comparative impacts in terms of land quantity can be multiplied by the social impacts discussed in a following subsection.

Agricultural Conversion Regulations - The conversion of agricultural land to non-agricultural use is controlled by law. Most regulations relating to conversion of agricultural land are found in Law 53 of 1966, Law 59 of 1973, Law 59 of 1978 and Law 3 of 1982. The combined effect of these laws is that conversion of agricultural land is permitted within town and city boundaries only upon approval of a special permit, and conversion outside of town boundaries is prohibited. These restrictions can be superceded by expropriation of land for certain public works projects, including roads. These laws have only limited effectiveness as unapproved conversions occur with some frequency.

Land Resources Requirements of The Committed Network - No conversion of agricultural land would be required.

Land Resources Requirements of The Improved Alternative - Almost all of the length of the by-pass construction routes would be through agricultural land. It is estimated that about 3 million square meters, of agricultural land would be required. Widening would require a further 3.2 million sq meters, making 6.2 million square meters for this Alternative.

Land Resources Requirements of The Expressway Alternative - The new desert itself only traverses agricultural land where it crosses a narrow strip at its junction with the road between Fayoum and Beni Suef; requiring about 50 thousand square meters of land. There are, however, 11 access roads connecting the new road with other existing roads, principally with the West Bank route. As much as possible, these access roads utilize existing roadway alignments. Straightening, improving and making minor access connections along these routes to bring them up to acceptable engineering standards would probably require about 1.3 million square meter of agricultural land.

Comparison of Alternatives, Land Resources Requirements - The figures above give a clear comparison. The Improved Alternative has what can be considered as a significant agricultural land requirement of 6.2 million square meters. The Expressway Alternative would require only about 20 percent of this area, which would be a major advantage.

Ecology

Only minor effects of any kind are expected on ecology from any of the alternatives. There are apparently no species of plant or animal life that require protection and no sensitive habitats.

One consideration may be the need for conservation of roadside trees and tree lines which extend through fields. The trees are places of refuge from the sun for local inhabitants, farm workers and animals. Shady places under roadside trees are the location of many social and work activities. The Improved Alternative may require the removal of a number of trees for widening of the road in rural areas and for bypasses.

Spills of toxic materials might affect fish in the Canal. On the other hand, spills of nutrients such as fertilizers may benefit aquatic life.

Historic, Cultural, and Aesthetic Resources

Specific impacts of the highway on historic resources are evaluated as a part of the archeological assessement. There are no effects from the Committed network or the Improved Alternative. The new desert highway passes near ancient sites at Tuna El Gebel. However, it does not appear that the highway will have any direct effect on the site. In fact, there will probably be a positive benefit gained by improving accessibility and possibly stimulating tourism, thus prompting an interest in futher improvement and refinement of the site.

Cultural resources will not be directly affected by any of the alternatives. There will be no taking of culturally related structures. Some indirect effects may accrue from various alternatives such as noise effects on mosques or entertainment sites.

No specific aesthetic effects have been identified other than that the possibility of removal of trees under the widening alternative may have some negative aesthetic effect.

Social Impacts

Social impacts which are associated with highway development in most instances are concerned with disruption caused by relocation of families and economic enterprises, the effect of improvements on accident rates and changes in accessibility of socio-cultural facilities such as education, health and religious institutions. Field interviews revealed additonal considerations such as the sensitive issue of conversion of agricultural land and furtherance of national objectives relating to rural-urban migration.

Relocation - Fortunately, the potential social impacts of relocation are avoided effectively by all of the route alternatives. The by-passes have been given preliminary alignments which avoid structures almost entirely. It is possible that the widening of some road segments could require removal of a few structures at critical locations, but no extensive relocation is required. The desert route avoids all structures.

Perceived or Anticipated Social Benefits - Interviews were conducted with various officials in the Governorates along the route to determine those benefits which were anticipated from various alternatives and which benefits seemed to have most social value.

The result which was expected or perceived as most important was the opening of new land for development by the desert route. Thus, the developmental benefits were generally perceived as more important than the traffic service benefits. The second most desired benefit appeared to be acccident reduction, a possibility which was frequently mentioned. The most sensitive negative issue was the necessity for taking of agricultural land, principally in connection with by-pass construction. Problems of traffic congestion and travel time did not seem to generate much concern.

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These responses are considered in order to help judge whether the implementation of various alternatives may fulfill expectations of social value. Probably the taking of agricultural land would set off sensitive issues as expected. Probably the widest difference between expectations of benefit and likely benefits is the developmental aspect of the desert road. The expectation is that the desert road will improve economic opportunity and open land to settlement and agricultural reclamation. It is true that the road would probably have this benefit to some measurable degree. However, expectations of this benefit seem unrealistically high. Experience has shown, for example, that the desert road to Alexandria has stimulated only minimal developement. Also, the road would be only one component in a required system of infrastructure, and significant additional investment would be required in addition to the road to stimulate economic growth. Nevertheless, it is true that outlets are needed for expansion of settlements outside of agricultural lands and the desert route would help provide the accessibility and transport component necessary to open new lands.

Agricultural Lands - As discussed above under the Land Resources topic, the conversion of agricultural land to non-agricultural uses is agreed by public policy as well as local sentiment to be an action which must be avoided and discouraged. Even though this is based largely on economics, there are also social factors involved which must be recognized. There is a high level of social sentiment in local areas against land conversion, and local public officials are likely to put up substantial opposition to any but the most minor or highly justified takings.

In the local agricultural society, there is a great deal of prestige attached to ownership of land. Also, complex patterns of ownership brought on by inheritance and joint ownership makes the severance of parcels a matter of great dispute when it must occur. This is particularly true if the severance is diagonal to drainage patterns or if it results in small remainder parcels which are either difficult or uneconomic to tend agriculturally.

The degree of impact is generally as discussed under the Land Resource topic, but these attendant social issues multiply that impact.

Developmental Benefits - As discussed above, there is an expectation that certain developmental benefits would accrue to construction of a new desert highway route. It is also noted that the scale and immediacy of those benefits may not be as expected. However, with that caution in mind, it is appropriate to note the types of developmental impacts which may occur.

There is strong demographic tend toward migration from the rural areas of Upper Egypt into the large urban centers, particularly Cairo and Alexandria. At the urban end, this results in a strain on the urban centers ability to provide jobs, housing and infrastructure. At the rural end it results in a draining away of labor force and the younger more educated and capable components of the local population. Another factor

ecouraging this trend is a lack of urban expansion land in the rural areas.

A social aspect which comes into play is the social stress to which rural migrants are subjected in urban areas. The rural migrants have come from a stable and traditional society and are suddenly exposed to social conflict with new urban groups which may have conflicting lifestyles, habits and social values. To these conditions can often be added the disillusionment of not finding the economic rewards which were expected to be found in the city.

Thus great value is placed, both socially and by public policy, upon finding any available means to provide economic opportunity and urban expansion land in the rural areas. The only locational alternative is to provide these factors in the desert fringe near the agricultural lands. The desert highway is seen by many as a vital component in opening this fringe area to productive use.

Some potentials which are expected to be realized include urban settlement, reclamation of desert land for agricultural use, expansion of industrial and agro-industrial sites and improving tourism by better accessibility of historic and tourism sites.

To the extent that these developmental potentials can be realized, the reduction of rural-urban migration and the improvement of economic opportunity in Upper Egypt would be in furtherance of national policy. This policy holds that reduction of the economic and developmental disparity among the various regions of the Country is a long term goal. The policy also holds a similar reduction between the urban and rural disparities of the country to be an important objective. Thus, to the extent that a new desert route would divert migration from Upper Egypt into the Cities, this road would contribute to national policy goals. The danger appears to be in attributing too much potential to the highway alone, as the highway must ultimately be viewed as only one component in an overall strategy of economic development and infrastructure improvement.

Accessibility of Social and Cultural Facilities - An overall social benefit which is expected from most highway improvement projects is the increase in accessibility of social and cultural facilities. One purpose of transportation improvements in the corridor by any of the alternatives is the improvement in accessibility to the population of social and cultural facilities. This includes schools and training facilities of all types, hospitals, clinics and health facilities, religious and cultural facilities, social welfare centers and institutions of all kinds.

The Improved Alternative would facilitate travel to social and cultural facilities to some degree. The principal advantage of either the Improved Alternative or the new desert highway would probably be in facilitating use of existing highways for local traffic needs by diverting through traffic. Removing a substantial proportion of truck traffic and through traffic from the center of the urban settlements would allow better circulation of local traffic. The existing West Bank route now

serves a dual purpose as a local traffic artery as well as a through service facility. It mixes heavy, long distance traffic with local work and social trips. Allowing portions of the West Bank route through urban centers to serve as a better local traffic artery would facilitate access to social and cultural facilities and make social trips more convenient and safe.

Summary of Social Impacts - Fortunately, there are no reloation impacts expected from any alternatives. Social benefits may be derived from the desert route as a result of developmental benefits. This would arise from the opening of non-agricultural desert fringe to better access. However, these benefits must be recognized as only a part of what must be a broader program of economic development.

CONCLUSIONS

Overall conclusions derived from the analysis of impacts are outlined as follows.

Water Quality

Overall - All water quality impacts may be considered as marginal to insignificant because lack of runoff transport means that almost no pollutants will be transported to water bodies except through direct accidental spills. The following must be seen within that context.

Committed - The Committed network produces has the highest risk of adverse water quality impact because of highest probability of direct spills.

Improved - This alternative has risks which balance out. Probability of direct spills is lower than with the Committed network, but there is an offsetting possibility of disturbance to hydrology in the irrigation system.

Expressway - Risks of adverse water quality impacts are insignificant.

Air Quality

Overall - All air quality impacts may be considered as marginal because of the relatively low traffic volumes. The following should be considered within that context.

Committed - Because of higher congestion, the Committed network produces higher rates of air pollution emissions than the two alternatives and exposes a larger population.

Improved - This alternative is slightly better than the Committed network, not because of lower emission rates but because of removal of traffic away from the population.

Expressway - This alternative produces the lowest rate of pollution and has a very low population exposure.

Noise

Overall - There is a potential for significant levels of either adverse or beneficial impact with respect to noise because of the high existing ambient noise level along the West Bank route and the potential for improvement.

Committed - The Committed network shows impact because of increased noise levels resultant from increased traffic volume and congestion and high population exposure.

Improved - This alternative would produce a significant positive benefit because of removal of noise source away from population exposure.

Expressway - This alternative would produce a very significant positive benefit by lowering of traffic volumes on the existing West Bank route and removing the noise source away from population.

Land Resources

Overall - Land resource considerations are of high overall importance because any activity, such as acquisition of highway right-of-way, which requires conversion of agricultural land to non-agricultural use is a critical issue.

Committed - No taking of agricultural land is required.

Improved - A significant adverse impact would result because taking of 1,104 feddans of agricultural land is required.

Expressway - A moderate adverse impact would be produced by this alternative because the taking of about 269 feddans of agricultural land is required in connection with improvement of access roads.

Ecological, Historic, Cultural and Aesthetic Resources

Overall - No apparent significant impacts, either positive or negative were identified with respects to these resources.

Social Impacts

Overall - There is potential for significant overall impact, positive and negative, in relationship to accident occurance, agricultural land conversion, developmental benefits, and accessibility of social and cultural facilities.

Committed - Continued reliance on the Committed network would produce adverse social impacts resulting from higher accident rates.

Improved - This alternative would produce a moderately better accident rate experience than the Committed network, but would generate significant social disbenefits due to taking of agricultural land. Some improvement in accessiblity of social and cultural facilities would occur.

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Expressway - Moderate social disbenefits would result from taking of agricultural land. Some expectation of social benefit accrues to this alternative due to developmental advantages of opening desert fringe land to productive use. However, the expectation may exceed actual benefit unless additional investment in infrastructure accompanies road construction. Some improvement in accessibility of social and cultural facilities would occur as a result of improving local traffic capabilites of the existing roadway network.

General Conclusion

The Expressway Alternative offers a higher level of positive environmental and social benefits and a lower incidence of adverse impacts than the Improvement Alternative. Evaluation of the Committed Network demonstrate increasingly significant adverse impacts over time compared with Base Year 1985/86.

Appendix 7D

ROADS AND BRIDGES AUTHORITY
POLICY AND ADMINISTRATION

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Appendix 7D

ROADS AND BRIDGES AUTHORITY
POLICY AND ADMINISTRATION

This appendix assesses the capacity of the Roads and Bridges Authority (RBA) to implement the proposed highway infrastructure project. Administrative, management and financial policies are reviewed and the organizational structure of the Authority is described. Potential implementation difficulties are identified and discussed.

Transport Policy

Transport policy guidelines appear in the Five Year Plan for Economic and Social Development, 1982/83 - 1986/87 (December 1982). Strategies, or policies affecting highway transport are:

1. Preserving existing productive assets by regular maintenance and renovation.
2. Coordination between different transportation means and network.
3. Expanding T&C (Transport & Communications) capacities by additional units of all types.
4. Improving transportation services structure in favor of the less-expensive rail and river transportation.

These general guidelines are further emphasized by the following sector objectives:

1. Concentration on electrical passenger transportation inside cities. Better utilization of existing capacities, proper maintenance and replacement policies.
2. Increasing the share of railroad and river cargo transportaion, from 12.6% in 1981/82 to 19% of the total in 86/87, and from 12.6% to 13% respectively.
3. Expanding storage capacities especially in Alexandria and Cairo, and construction and pavement of roads (East Nile, and the Egyptian-Sudanese highway).

The following policy statements have been issued by RBA :

1. Maintenance policy, July 1985.
2. RBA Maintenance Plan, 1985-1990.
3. Five Year Plan (1982/83 - 1986/87).

As set forth in the current Five Year Plan, National policy appears directed toward expanding the rail and water share of passenger and cargo internal transport vis a vis highways. The East Nile and the Sudanese highways are mentioned as priority road construction projects for RBA. However, within the highway sector, the major emphasis is on the improvement and maintenance of the existing network. RBA internal policies support the national objectives.

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Organizational Responsibility

Several organizations have responsibility for the construction, improvement and maintenance of the highway infrastructure. At the National level, two ministries are involved: The Ministry for Reconstruction is assigned the planning and construction of roads in areas of economic and/or social importance. Within the Ministry of Transportation, the RBA is responsible for the planning, construction and maintenance of highways. Governorates also plan, construct and maintain regional and local (urban) roads. In practice, this division does not appear to create serious problems. However, there seems to be no clear division of responsibilities between RBA and the governorates. The existing road classification system contributes to this problem as it is based on both functional and traffic volume characteristics.

Finance

The current Five Year Plan budget for the inter-city road network appears in Table 7D-1. The amount allocated to RBA is LE 200 million, 47.6 percent of the total. The amount originally requested by RBA for the period was on the order of LE 350 million. Table 7D-2 presents the current RBA Five Year Plan by project type. The emphasis on road rehabilitation is apparent in that 60 percent of the total budget is allocated to this activity. 1985/86 expenditure is estimated at LE 46 million in 1985 prices and the 1986/87 expenditure is planned at LE 48 million. Current expectations, however, anticipate an austerity budget on the order of LE 41.4 million.

Road construction and rehabilitation is carried out under contract to RBA by the public construction companies and by private contractors. Routine maintenance is carried out by the direct labor organizations of the RBA in 8 district offices. The amount allocated to routine maintenance for 1985/86 was LE 2.5 million.

The RBA has no past experience in the use of private financial participation for financing the construction or rehabilitation of highways. The Ministry of Transportation and its subdivision, the RBA, are not legally authorized to issue bonds or incur obligations beyond the amounts stipulated by the annual and supplementary financial budget allocations. As the RBA contracts with public companies for highway construction and private construction companies lack the financial resources requisite for a project of the magnitude of a Cairo-Assuit highway, use of supplier or contractor credits is not a probable financial alternative. A combination of public and private financing does occur in other areas of social overhead investment such as housing development, supplier credits for passenger and cargo transport equipment, petroleum, private quay facilities and industrial areas. However, there is no precedent for application of this joint financing concept to a major intercity highway project. Discussions with RBA officials indicate such a proposal would encounter severe political resistance.

Table 7D-1

FIVE YEAR PLAN BUDGET 1982/83 - 1986/87
INTERCITY ROADS
(1983 LE million)

Organization	LE
Roads and Bridges Authority	200
Ministry of Reconstruction	80
Ministry of Local Administration	140
Total	420

Source : Roads and Bridges Authority.

Table 7D-2

RBA FIVE YEAR PLAN, 1982/83 - 1986/87

PROJECT TYPE	LE (Thousand)	%
I- Replacement & Renewal Projects		
- Consolidation of embankments	120	(-)
- Investment in paving equipment	10,600	(5%)
Subtotal	10,720	(5%)
II- Rehabilitation Projects		
- Widening & strengthening of main roads	65,164	(33%)
- Construction of divided highways	46,336	(23%)
- Renewal & strengthening of bridges	7,300	(4%)
Subtotal	118,800	(60%)
III-Completion & Extension Projects		
- Construction & pavement of main roads	32,000	(16%)
- Construction of bridges	20,800	(10%)
- Other Activities (building, traffic safety, etc.)	17,680	(9%)
Subtotal	70,480	(35%)
Total	200,000	(100%)

Organization and Manpower

The organizational structure of the RBA is presented in Figure 7D-1. The eight district offices are responsible for routine maintenance of the 10,304 km intercity road network. The district offices execute this task with force account labor units. RBA headquarters contracts the execution of road construction and rehabilitation using both the public and private construction companies. As the objective of this review and analysis is to assess the capacity of RBA to implement the proposed Cairo-Assuit infrastructure project, district capabilities for routine maintenance are not of direct interest and have been covered by the World Bank assisted Egypt Highway Maintenance Project (Reference 14).

Table 7D-3 shows RBA headquarters personnel.

Table 7D-3

PERSONNEL
RBA HEADQUARTERS AND TRAINING CENTER

CATEGORY	NUMBER
Engineering	295
Administrative	452
Artisans	513
Laborers	236
Total	1496

Source: Roads and Bridges Authority.

The manpower assigned to RBA Headquarters was 1496 persons in 1985, or about 20 percent of the RBA total employment. Both ENTS (Reference 1) and the Highway Maintenance Project define a shortage of qualified, experienced engineers and technicians at the headquarters and district levels as a major manpower deficiency. The Highway Maintenance Project recommends the addition of the following to the RBA existing engineering and technician staff:

Headquarters:
- Central Laboratory - 6 junior civil engineers.
- Geometric Design - 6 junior civil engineers.
- Training - 6 experienced civil engineers.
- Bridges - 25 junior civil engineers.
- Technicians: - 9

District:
- Engineers - 84
- Technicians - 185

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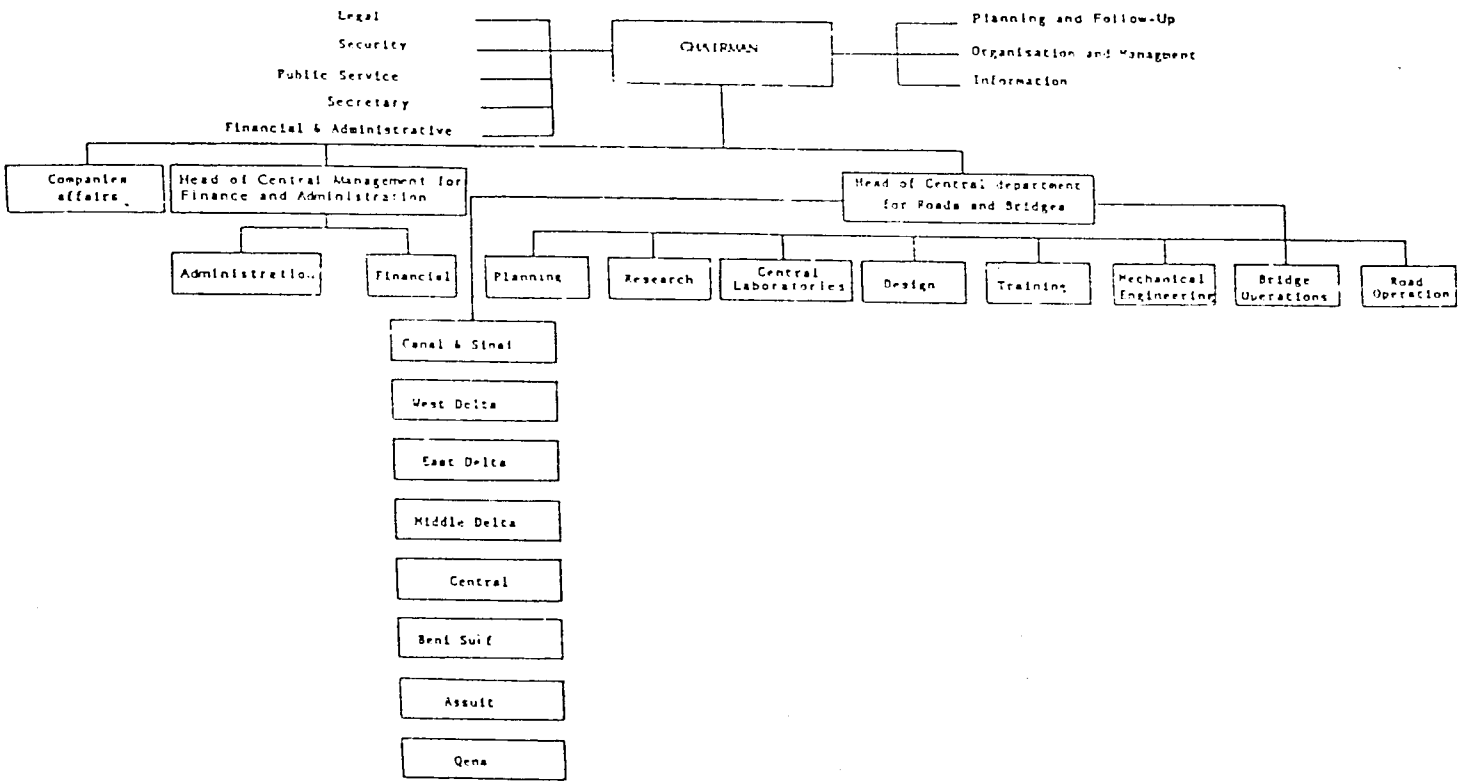

SOURCE: Egypt Highway Maintenance Project: Upgrading The Training Centre

Cairo – Assuit Highway Feasibility Study

THE ORGANIZATIONAL STRUCTURE OF RBA

Wilbur Smith & Associates
Egyptian Consultants Consortium

Figure 7D-1

The RBA current pay structure does not approach the market rate and has been quoted as the main contributing factor for retention and recruitment problems. Government policy is unlikely to change in this respect. Discussions with RBA officials disclosed that the deficiencies are viewed as temporary in that a list of qualified applicants for about 40 percent of the identified engineering vacancies is currently awaiting final approval for immediate employment.

RBA Implementation Capacity

The amount of road construction and rehabilitation completed annually through the RBA appears to be a function mainly of the amount of funds available. The 1975-79 Five Year Plan contained a target of 600 kms. per year but analysis indicates this goal was not attained. The 1980-84 Plan targeted about 500 km per year. Actual production including feeder roads for the period 1970/80 - 1982/83 was about 415 kms. per year. Production for the period 1983/84 -1985/86 is estimated in the range of 400-500 kms annually. After discounting for inflation, road construction companies appear to have increased output at 34-38 percent annually for the last five years. Considerable flexibility exists within the RBA and the road construction industry. For example, when a supplementary budget provided funds, the second carriageway of the Cairo-Alexandria Toll Road (about 200 kms) was designed and tendered by the RBA in about one year. Using four companies, construction was completed in three years.

Strict construction and rehabilitation project supervision would alleviate many of the deficiencies noted by the above mentioned studies. As supervision is provided from the district engineering staff, increased district engineering staff and improved capabilities, as recommended by the Egypt Highway Maintenance Project, would be an important factor in the successful implementation of a Cairo-Assuit highway improvement project. Lack of access to foreign exchange necessary for acquiring construction equipment could also be a constraint to the expansion capabilities of construction companies. Adequate funding, including foreign exchange, thus remains the primary constraint to the successful implementation of a Cairo-Assuit highway improvement project.

Summary

The organizational structure of the RBA is assessed as satisfactory and poses no serious problem to project implementation. Under the World Bank assisted Egypt Highway Maintenance Project, personnel and equipment deficiencies at the headquarters and district levels of RBA have been identified and are being corrected. Recent RBA performance indicates a capacity for construction and rehabilitation in the neighborhood of 400-500 kms annually. Considerable flexibility exists in that the Cairo-Alexandria second carriageway toll road (200kms) was designed and constructed over a four year period when funding was made available. Recourse to private funding sources for the financing of intercity highway projects is not within the experience or legal authority of the RBA. Such a proposal, in the opinion of RBA, would be rejected by the Ministry of Transportation and higher political authority.

Professional, technical and labor manpower is available to support an annual increase in production on the order of 34-38 percent for the public and private construction companies. Foreign exchange requisite for the purchase of construction equipment and parts is in short supply and could constrain production increases by the public and private companies. Given adequate funding, including foreign exchange, there are no constraints to the successful implementation of a Cairo-Assuit highway project by the RBA.