(2) Alternative-B

This alternative aims at the selection of a better location of the interchange to Mojokerto city for the connection to the road network near the city and services to the planned industrial and housing development areas on the north of the provincial road in Gresik regency.

From the Mojokerto terminus, the route runs easterly to cross the national road and to meet Mojokerto Bypass to which an interchange will be provided. Thereafter, the route turns to the northeast direction and crosses a railway line and the Porong river.

After running through farmland in a northeast direction for 5 km, there are two choices of route location. Alternative-B1 changes direction to the north to cross the Mangetan Canal and the Surabaya river and joins with Alternative-A. The location of the interchange to Krian is the same as for Alternative-A, at 3.5 km north of Krian city. Alternative-B2 aims at bringing the location of the interchange close to Krian city. The route crosses the Mangetan Canal 1 km east of Alternative-B1 and crosses the provincial road 2 km north of Krian city, where the interchange will be planned. The route then runs in a northeast direction through the area between the Surabaya river and an electric power transmission line, crosses the Surabaya river near its sharp bend and joins Alternative-A.

(3) Alternative-C

This alternative aims at avoidance of the crossings with electric power transmission lines (Alternative-B has to cross electric power transmission lines three times while Alternative-C crosses once). The other characteristics of this route alternative are identical to Alternative-B.

After crossing Mojokerto Bypass, the route separates from Alternative-B. It runs easterly for 3 km then turn northerly to cross a railway line and the Porong river 1.7 km downstream from Alternative-B. Thereafter, the route turns to the northeast and passes through farmland on the southeast side of the electric power transmission line, then turns in a northerly direction to cross the national road at 1.2 km west of Krian and reaches the interchange 1.5 km north of Krian city.

In order to avoid the industrial area along the provincial road to the north of the Surabaya river, the route runs northeasterly for about 7 km in the area to the north of the national road, then turns to the north to cross the Surabaya river and joins with Alternative-A.

There is no alternative route which passes the northern locations of Krian Interchange and proceeds to the southern locations of the Junction with the Surabaya-Gempol Toll Road. The northern location of Krian Interchange is focussing on the service to the planned industrial areas in the north of the Surabaya river. For trips between Surabaya and the industrial areas, such a route is not meaningful.

(4) Alternative-D

This alternative aims at a better location of the interchange to Mojokerto city compared with Alternative-A, the shortest route to the Surabaya-Gempol Toll Road and services to the eastern areas of the East Java Province after the extension of the Trans Java Tollway System to the Pasuruan/Probolinggo direction. The interchange to Krian is located in the south of Krian city putting emphasis on the services to the southern area. The effect to the planned industrial and housing areas in Gresik regency is less than the other alternatives. This alternative is also characterized as that which passes through well-developed farmland with the modernized irrigation system.

After separating from Alternative-C and running eastward continuously for 2 km, the route turns to the northeast to cross the Porong river. After crossing the abandoned railway line, the route gradually turns easterly to cross the provincial road at about 3 km south of Krian city, where the interchange to Krian will be planned.

After running 3 km towards the northeast, there are 2 further alternatives depending on the proposed locations of the Junction with the Surabaya-Gempol Toll Road. Alternative-D1 is connected with the Surabaya-Gempol Toll Road 3 km south of Waru IC and Alternative-D2 is connected 3.5 km north of Sidoarjo IC.

Both options of Alternative-D have the possibility to plan an extension of the ramps to connect with the national road (Taman-Sidoarjo-Gempol) depending on the traffic demand.

7.1.10 Screening of Alternative Routes

(1) General

The established route alternatives as described above were compared from the following viewpoints of technical, environmental, socio-economic and transportation aspects.

- Technical Aspects
  - Route length and alignment
  - Scale and difficulty of construction expressed in number of crossing facilities, the length of soft ground areas to be passed, etc.
  - Technical issues related to the location of interchange
  - Construction cost summarizing the above factors
- Environmental Aspects
  - Loss of farmland
  - Displacement of residents and severance of villages and farmland
  - Difficulty of land acquisition
- Socio-economic Aspects
  - Relation with landuse plan
  - Relation with road network
  - Distance between interchanges and major points of traffic generation/attraction (cities of Mojokerto and Krian, areas of planned industrial estate development, etc.)
- Transportation Aspects
  - Convenience for toll road users
  - Traffic flow on toll road (on the Toll Road and also on the Surabaya-Gempol Toll Road in relation to its capacity)

As for the transportation aspects, the detailed examination was made in the process of optimum route selection based on the results of traffic demand forecast, together with the preliminary economic analysis.

(2) Alternative-D

Among the 4 basic alternatives, the characteristics of Alternative-D largely differ from those of the other alternatives as mentioned in the following.

a) Alternative-D connects with the Surabaya-Gempol Toll Road on the south of Waru IC, while the other alternatives connect on the north after crossing the planned Inner Ring Road.

b) Alternative-D is shorter than the other alternatives which implies lower construction cost, though the adverse effects on socio-economic environment will be larger since Alternative-D passes through more developed areas than the others.

c) Slightly meandering horizontal alignment is required for Alternative-A, -B and -C for crossing more roads, rivers/canals and electric power transmission lines and for avoiding the planned new town of Driyorejo and the military area. This results in a small difference in travel distance for long trip users to/from Surabaya city via the route of Alternative-A, -B, or -C and that via the route of Alternative-D.

d) Alternative-D has less effects on new regional development, since the route passes through technical irrigation areas.

e) Alternative-D might bring more burden on the Surabaya-Gempol Toll Road. In case of Alternative-A, -B, and -C, better traffic distribution is expected by connection with the planned Inner Ring Road of Surabaya.

f) Alternative-D has the possibility to extend the ramps of the Junction with the Surabaya-Gempol Toll Road to the national road, the others have not.

Alternative-D has 2 subsidiary alternatives in connection with the location of the Junction with the Surabaya-Gempol Toll Road, Alternative-D1 and -D2, which are compared as shown in Table 7.3. Alternative-D1 has a longer total length and the magnitude of its construction cost is higher than Alternative-D2. There is a 5% difference in total length and about 10% difference in the magnitude of construction cost index between Alternative-D1 and -D2.

For the traffic bound for Surabaya city (considered to share a major part), Alternative-D1 is more advantageous with a 3.1 km shorter travel distance than Alternative-D2, while for the southbound and eastbound traffic, it is less advantageous with a 7.1 km longer travel distance.

The comparison of such advantages and disadvantages between Alternative-D1 and -D2 also needs further examination based on the results of the preliminary traffic demand forecast and preliminary economic analysis.

Based on the above, the Study Team proposed to bring both Alternative-D1 and -D2 to the subsequent stage of comparison.

(3) Comparison between Alternative-A, -B and -C

Alternative-A, -B (-B1 and -B2) and -C are compared as shown in Table 7.3, and inherent advantages and disadvantages for the alternatives are described as follows:

1) Alignment

The total length is similar in the four alternatives. There is no difference in the standard of the horizontal alignment, applying a minimum radius of 2,000 m in Alternative-B1 and 1,300 m in others.

2) Crossings with Existing Roads/Railway Lines/Transmission Lines

Alternative-A has least crossings with such existing facilities as national/ provincial roads, railway lines, large rivers/canals and electric power transmission lines. Alternative-B1 and -B2 are almost identical and have more crossings than Alternative-A. Alternative-C is more advantageous than Alternative-B in reducing the number of crossings of electric power transmission lines.

3) Location of Interchanges

The location of the interchange for Mojokerto city is more advantageous in Alternative-B and -C, nearer to the city center. In case of Alternative-A, the approach of the interchange has to cross the Surabaya river and some improvement of the national road for about 1 km will be required between the interchange and Mojokerto Bypass. Possible requirement of an additional interchange in the south of Mojokerto for the westward extension of the Toll Road is another disadvantage of this alternative.

Table 7.3 Comparison of Route Alternatives

DESCRIPTION	UNIT	ALT.-A	ALT.-B1	ALT.-B2	ALT.-C	ALT.-D1	ALT.-D2
A. GEOMETRIC ASPECTS							
1. Total Length	km	44.7	44.7	44.6	45.3	39.8	37.8
2. Number of Horizontal Curves	each	9	11	12	11	7	8
3. Smallest Radius	m	1,300	2,000	1,300	1,300	2,500	2,500
B. CONSTRUCTION FEATURES							
1. Number of facilities Crossed							
- National/Provincial Highways	each	4	6	7	7	3	3
- Kabupaten Road	each	2	2	1	1	2	2
- Railway Lines	each	1	1	1	1	1	1
- Large Rivers/Canals	each	3	3	3	3	1	1
- Transmission Line	each	7	12	12	8	3	3
2. Construction Works							
- Earth Work Section	km	43.0	42.6	42.5	42.7	39.1	37.1
- Bridge Section	km	1.7	2.1	2.1	2.6	0.7	0.7
Long Span Bridges	Bridge	3	3	3	3	1	1
Total length of Long Span Bridges	m	500	650	650	650	200	200
- Soft Ground Treatment Required	km	7.00	7.00	7.90	11.00	16.20	14.10
3. Construction cost Index	-	100	112	114	117	96	87
C. ENVIRONMENTAL IMPACTS							
1. Densely Inhabited Village Areas Crossed	km	4.8	7.4	8.8	10.9	9.8	8.0
2. Sparsely Inhabited Village Areas Crossed	km	5.7	3.6	2.1	0.0	0.0	0.0
3. Farmland Crossed	km	31.8	31.3	31.3	32.0	30.0	29.0
D. SOCIO-ECONOMIC ASPECTS							
1. Service to Jatis Industrial Estate		Good	Poor	Poor	Poor	Poor	Poor
2. Service to Gresik Industrial Area		Fair	Fair	Fair	Fair	Poor	Poor
3. Service to Krian and its South		Fair	Fair	Good	Good	Good	Good
E. ROAD USER'S SERVICE							
1. Location of Mojokerto IC		Poor	Good	Good	Good	Good	Good
2. Location of Krian IC		Fair	Fair	Good	Good	Fair	Fair
COMPARISON (RANKING)							
GEOMETRY		2	1	2	2		
CONSTRUCTION		1	2	3	4		
ENVIRONMENTAL IMPACTS		1	2	3	4		
SOCIO-ECONOMIC EFFECTS		1	3	2	2		
ROAD USER'S SERVICE		3	2	1	1		
TOTAL RANKING		1	2	3	4		

4) Construction Cost

The magnitude of the construction cost of Alternative-A, including land acquisition and diversion of public facilities, is lower than Alternative-B and -C by 12-17% due to less crossings with existing facilities and shorter length of route through soft ground areas.

5) Environmental Impact

Alternative-A will cause least adverse impact to the existing socio-economic environment as the route passes through less developed area. The length passing through densely inhabited village area is shorter than the others.

6) Effects on Regional Development

Alternative-A has the advantage of easier access to the planned Jetis industrial estate development located to the north of Mojokerto.

The interchange to Krian is located at 3.5 km north of Krian city in Alternative-A and -B1 and at 1.5 km north in Alternative-B2 and -C. The southern location better serves Krian and its southern area. To the industrial development in the north of the provincial road in Gresik regency, the southern and northern locations are similar since access is through the provincial road and the length of access to the interchange is almost equal.

7) Others

Alternative-B and -C will reduce the revenue of the toll bridge on Mojokerto Bypass, which may be compensated by the revenue from the Toll Road.

Based on the above comparison, the Study Team recommended that Alternative-A and Alternative-B1 are the best and the second best routes respectively and are to be included in the comparison in the subsequent stage, together with Alternative-D1 and Alternative-D2.

(4) Conclusion

On 22 October 1990, a joint meeting was held with Bina Marga, Jasa Marga and the Local Government Authorities in Kanwil PU Surabaya, utilizing a working paper "Preliminary Route Study" prepared by the Study Team. The following matters were concluded in the meeting:

1) All the possible route alternatives have been duly examined by the Study Team.

2) Alternative-A shall be omitted from the short-listed alternatives since the northern location of the interchange for Mojokerto city is unsuitable being far from the city center and requiring an additional interchange to the south of the city in future.

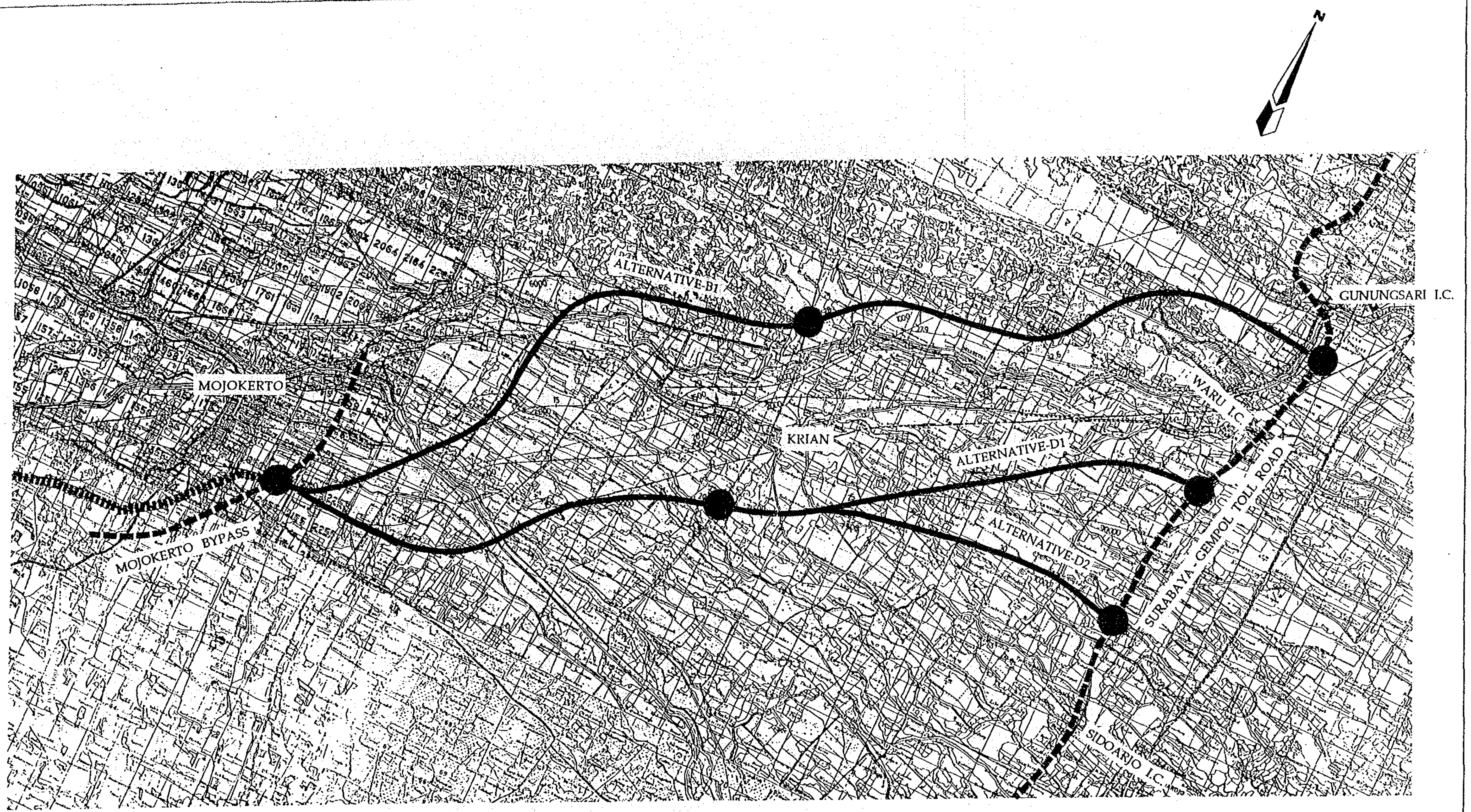
3) Among the 6 possible alternatives, the 3 route alternatives of Alternative-B1 (the alignment of the western part shall be modified so as to minimize the length in Sidoarjo regency), -D1 and -D2 will be carried forward to the next step of detailed comparison to be made based on the results of the preliminary traffic demand forecast and the preliminary economic analysis.

7.2 Selection of the Optimum Route

7.2.1 General

Formation of a consensus amongst the government agencies concerned on the development policies of the Toll Road, in particular, to fix an optimum route of the Toll Road and interchange locations, was indispensable. The start of preliminary design in the subsequent stage of Phase I Work was bound to be a direct continuation of the selection of an optimum route of the Toll Road in the sense that the Study Team would continue to carry out the Study in more detail, in more depth and at more precise scales on all the aspects.

This Section contains the comparison of short-listed route alternatives (i.e. Route Alternative-B1, -D1 and -D2, refer to Fig.7.12) on the following bases, together with the findings and recommendations of the Study Team concerning the selection of an optimum route:



PROPOSED INTERCHANGE

0 5 10 km
SCALE

Alternative-B1	37.1 km
Alternative-D1	30.9 km
Alternative-D2	28.9 km

SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 7.12 Short-Listed Route Alternatives

1) Technical aspects
2) Environmental impact
3) Transportation aspects
4) Economic aspects

In the comparison, the traditional procedure of comparing road-user benefits with costs has been expanded to reflect the needs of non-users and the environment in the Study. The second and the third items in the above provide the outline of fundamental material concerning these additional matters. Although this adds a complexity to the analysis, it was believed that the adoption of this broader approach would provide better procedures for the selection of an optimum route.

7.2.2 Technical Aspects

Technical aspects of each alternative are compared in the form of i) geometric aspects, ii) construction effort and iii) cost for construction and land acquisition and compensation, as shown in Table 7.4.

Table 7.4 Comparison of Technical Aspects

DESCRIPTION	UNIT	ALT-B1	ALT-D1	ALT-D2
A. GEOMETRIC ASPECTS				
1. Total length of the Toll Road	km	37.1	30.9	28.9
(Index)		(1.00)	(0.83)	(0.78)
2. Minimum horizontal curve (Radius)	m	2,000	2,500	2,500
B. CONSTRUCTION EFFORT				
1. Soft ground treatment	km	7.0	16.2	14.1
2. Bridge length	km	2.1	0.7	0.7
C. CONSTRUCTION/ROW ACQUISITION				
1. Construction cost	B.Rp.	223.0	195.4	182.4
(Index)		(1.00)	(0.88)	(0.82)
2. ROW acquisition	B.Rp.	66.7	109.4	95.8
(Index)		(1.00)	(1.64)	(1.44)
3. Total of Construction and ROW	B.Rp.	289.7	304.8	278.2
acquisition (Index)		(1.00)	(1.05)	(0.96)
4. Percent of ROW acquisition cost to the total cost of construction and ROW acquisition	%	23.0	35.9	34.4

Notes : 1. ROW (Right-Of-Way) acquisition cost comprises the cost for land acquisition, building/crops compensation and relocation/protection of existing utilities (i.e. electric power transmission lines).
2. B.Rp. denotes Billion Rupiah in 1990 prices.

Through the study of technical aspects, the Study Team obtained the following findings:

a) All the alternatives are technically feasible and no serious difficulties will be encountered in the construction of the Toll Road (i.e. excluding ROW acquisition).

b) All route alternatives satisfy a 120 km/hr design speed for full stretches.

c) Each route alternative has inherent poor soils problems, expansive clay for Alternative-B1 and soft ground areas for Alternative-D1 and -D2. These poor soils problems can be technically solved (required cost for the treatment of such soils is included in the estimated construction costs) through appropriate geotechnical studies.

d) No serious traffic diversion problem is anticipated during the construction for all alternatives.

e) ROW acquisition costs are unusually high, in Surabaya and Sidoarjo regencies in particular, compared with other toll road development projects in Indonesia.

f) Alternative-D1 and -D2 offer lower construction cost (i.e. excluding ROW acquisition cost) compared with Alternative-B1, due to the short lengths of the Toll Road inherent to these alternatives.

g) In comparison of the total cost of construction cost and ROW acquisition cost, Alternative-D2 is the lowest (minimum initial investment cost), though the differences among the 3 alternatives are not significant.

It is to be noted that the escalation of ROW acquisition cost will be more violent than that of the construction cost in the outskirts of major cities of Indonesia. Particularly, when Alternative-D1 or -D2 are selected as an optimum route, the Government should provide necessary countermeasures to control the ROW acquisition cost.

7.2.3 Environmental Impact

Since there found no preserved forest, important vegetation and wildlife in the Project Area, comparison of natural surroundings is omitted in the Study. Environmental impact is divided into favorable impact and adverse impact. The former is an important factor to decide whether the Project be implemented or not and sometimes the impact is evaluated in the form of indirect benefit of the Project. The latter is concerned with the actual implementation of the Project and this will become a more important factor in case that the Project must be executed urgently. The following describes mainly the adverse impact and its mitigation.

(1) Social Environment

Adverse impact for social environment is comprised of residents displacement and loss of agricultural land. Table 7.5 shows the comparison of alternatives from the viewpoint of social impact.

Table 7.5 Comparison of Social Impact

DESCRIPTION	UNIT	ALT-B1	ALT-D1	ALT-D2
A. RESIDENTS DISPLACEMENT (PARAMETER)				
1. Developed area	km	0.70	-	-
(Equivalent length f=1.0)		(0.70)		
2. Densely inhabited village	km	1.95	6.75	5.60
(Equivalent length f=1.0)		(1.95)	(6.75)	(5.60)
3. Sparsely inhabited village	km	2.50	-	-
(Equivalent length f=0.5)		(1.25)		
4. Total equivalent length	km	3.9	6.75	5.6
5. Index, population displacement	-	1.00	1.73	1.44
B. LOSS OF AGRICULTURAL LAND				
1. Area in Surabaya city	m^2x10^3	126.5	-	-
(equivalent area f = 1.0)		(126.5)		
2. Area in Gresik regency	m^2x10^3	756.2	-	-
(equivalent area f = 1.0)		(756.2)		
3. Area in Sidoarjo regency	m^2x10^3	362.2	1,157.3	1,104.0
(equivalent area f = 2.0)		(724.4)	(2,314.6)	(2,208.0)
4. Area in Mojokerto regency	m^2x10^3	330.2	406.9	406.9
(equivalent area f = 2.0)		(660.4)	(813.8)	(813.8)
5. Total equivalent area	-	2,267.5	3,128.4	3,021.8
6. Index, loss of agr. land		1.00	1.38	1.33

The residents displacement is measured by the length of the Toll Road which passes through the following areas applying length conversion factors (refer to Table 7.5 for total equivalent length and indexes for population displacement):

Designation	Length Conversion Factor (f)
Developed area, housing and industry	1.0
Densely inhabited village area	1.0
Sparsely inhabited village area	0.5

The quantification of loss of agricultural land is based on the ROW acquisition data which is measured by the affected area in thousand square meters. Technical irrigation projects have been completed in Sidoarjo and Mojokerto regencies and the output of crops is quite large compared with the agricultural land in Gresik regency. Therefore the impact due to the loss of agricultural land in these regencies is considered to be strong and the area conversion factor of f=2.0 was applied in the comparison to reflect such situation.

(2) Man-made Environment

Man-made surroundings in the Project Area comprise the following:

a) Irrigation systems
b) Public facilities such as existing road network, railway lines, electric power transmission lines, etc.

For the facilities described in b) above, necessary countermeasures will be taken to a full extent in the construction, therefore no remarkable adverse impact will be resulted.

The Brantas Delta is the one of the most highly developed irrigation areas in the region, and utmost attention must be paid to this situation. Sidoarjo regency occupies the most part of the Brantas Delta. A list of major canals which will be crossed by each alternative route is shown in Table 7.6.

Table 7.6 Existing Major Irrigation Canals to be Crossed by Each Route Alternative

ALTERNATIVE-B1		ALTERNATIVE-D1		ALTERNATIVE-D2	
Irrigation Canal	Area (ha)	Irrigation Canal	Area (ha)	Irrigation Canal	Area (ha)
Kd.Ploso	930	Porong I	417	Porong I	417
		Purboyo I	1,020	Purboyo I	1,020
		Sidomukti	1,053	Sidomukti	1,053
		Kemasan I	1,423	Kemasan I	1,423
		Ketawang	924	Kemasan II	489
		Botokan	421	Ketawang	924
		Dungus	400		
Total Irrigation Area and (Index)	930 (1.00)	Total Irrigation Area and (Index)	5,658 (6.08)	Total Irrigation Area and (Index)	5,326 (5.73)
Number of Canals to be crossed	1	Number of Canals to be crossed	7	Number of Canals to be crossed	6

(3) Physical Environment

Temporary air and water pollution during construction is a major problem in which the Project elements reduce the physical environmental quality. Nuisance and inconvenience during construction should be significantly reduced by the introduction of proper construction management/supervision and adoption of proper construction equipment and methods.

The comparison of route alternatives from the viewpoint of environment impact revealed the following findings:

- It is concluded that <u>Alternative-B1</u> is superior to the other alternatives in every aspect of social, man-made and physical environment.

- The displaced families will be sufficiently compensated and/or resettled to proper areas. The ROW acquisition cost is estimated on the compensation bases.

7.2.4 Transportation Aspects

Based on the results of traffic demand forecast, route alternatives are compared from the viewpoint of traffic demand and impact on regional planning.

(1) Road Network Profile

Alternative-B1 connects with both the Inner and Middle Ring Roads, so that the ring road function is fully utilized for the dispersion of radial traffic to/from Surabaya.

In the case of Alternative-D1, the interchange with the planned Middle Ring Road is located a little remotely from Surabaya compared with Alternative-B1. Therefore, the ring road function is less effective than Alternative-B1 and the radial traffic depends much on the existing Surabaya-Gempol Toll Road and the Surabaya-Malang national road.

Alternative-D2 has no connection with either the planned Inner or Middle Ring Roads. Therefore, Surabaya bound traffic inevitably has to use the Surabaya-Gempol Toll Road.

Consequently, from the road network point of view, Alternative-B1 is preferable to the other alternatives.

(2) Traffic Demand

Table 7.7 shows the forecast traffic demand on the alternative routes in terms of the average cross sectional traffic volume and the number of the Toll Road users.

Table 7.7 Cross Sectional Traffic Volume and Toll Road Users on Alternative Routes

Year	Average Cross Sectional Traffic Volume (Veh./day)			Average Number of Toll Road Users (Veh./day)		
	ALT-B1	ALT-D1	ALT-D2	ALT-B1	ALT-D1	ALT-D2
1995	9,100	10,200	9,300	10,300	11,500	11,200
2005	23,600	26,200	24,200	28,600	28,800	26,600
2015	67,600	69,400	65,300	83,000	75,400	67,200

Note: Number of toll road users is counted as a half of all on and off traffic of the Toll Road.

Alternative-D1 shows the highest average cross sectional traffic volume and it also attracts more traffic than the other alternatives in the early stage of the Toll Road operation. However, the number of the Toll Road users on Alternative-B1 grows faster than those of the other alternatives, and it finally exceeds Alternative-D1 after the year 2005. This is because the traffic volume on the Surabaya-Gempol Toll Road reaches its capacity around the year 2005.

From the traffic demand point of view, it can be said that Alternative-D2 is inferior to the other alternatives.

(3) Impact on Regional Development

The positive impact of the Toll Road is greatly concerned with the possible and potential number of interchanges. In this connection, Alternative-B1 has more potential interchange locations than the others. This is because of the suitable linkage with the future road network and the emerging development along the existing Surabaya-Mojokerto national road as well as the provincial road. Especially, the implementation of a new town development in Driyorejo and the Tandes industrial development can be expedited by the implementation of the Project and the Inner Ring Road development (western part).

Alternative-D1 will enable one interchange, other than Krian IC, to be located at Sukodono where the Toll Road is connected with the planned Middle Ring Road. However, the Middle Ring Road is planned in the long-term and a definite schedule is not established yet.

Alternative-D2 has no potential location to plan an interchange between Krian IC and Surabaya-Gempol Toll Road, since the route does not cross the Inner Ring Road or Middle Ring Road.

Accordingly, Alternative-B1 will most effectively enhance the future development and will encourage the early implementation of ongoing development schemes in the region.

(4) Conclusion

Overview of the issues discussed above will conclude that Alternative-B1 is recommended from the viewpoint of transportation aspects.

7.2.5 Economic Aspects

A preliminary economic analysis was conducted for the comparison of route alternatives.

(1) Basic Assumption for Cost-Benefit Analysis

The analysis followed the conventional discounted cash flow method in determining the economic internal rate of return (EIRR), the net present value (NPV) and the benefit cost ratio (B/C).

In case of "Without" Project, costs such as road maintenance costs on the road network would occur. When such costs are taken into consideration, the net benefit would be increased. Such costs were, however, excluded from the cost-benefit analysis for the sake of a conservative analysis.

The following assumptions for analysis were made :

Project Life	:	25 years after opening of the proposed Toll Road
Prices	:	1990 prices
Residual Value	:	None

(2) Economic Cost-Benefit Analysis

The economic project costs were estimated, tentative implementation time schedule was established and the economic benefits from savings in vehicle operating cost and time cost for the planning years (1995, 2005 & 2015) were calculated. The benefits in the intermediate years were interpolated and those beyond 2015 were estimated as unchanged.

Following the conventional discounted cash flow method, the efficiency measures were calculated and the results are summarized as shown in Table 7.8.

Table 7.8 Summary of Economic Comparison

Description	Alt-B1	Alt-D1	Alt-D2
Economic Internal Rate of Return (EIRR)	24.8 %	20.9%	18.4%
Net Present Value (NPV) at Discount Rate of 15% (M. Rp.)	201,939	127,526	62,953
Benefit Cost Ratio (B/C) at Discounted Rate of 15%	2.03	1.60	1.33

In terms of economic comparison, Alternative-B1 showed the highest efficiency to the project investment out of the alternatives.

7.2.6 The Optimum Route

(1) Summary

Order of priority to be taken up in technical, environmental impact, transportation and economic aspects among the route alternatives is summarized in Table 7.9 (refer to Table 7.10 for comparison of short-listed route alternatives).

Table 7.9 Preferable Priority in Four Major Aspects for Each Route Alternative

MAJOR ASPECTS FOR COMPARISON	ORDER OF PRIORITY TO ADOPT		
	ALT-B1	ALT-D1	ALT-D2
A. Technical Aspect (i.e. Costs)	2	3	1
B. Environmental Impact	1	3	2
C. Transportation Aspects	1	2	3
D. Economic Aspects	1	3	2

(2) Selection of Optimum Route

The Study Team strived to satisfy optimally the needs of road users while maintaining the integrity of the environment in the establishment of each route alternative. However, the preferable priority in four major aspects differentiated as seen in Table 7.9. In the table, item A. Technical Aspect is normally neglected for comparison, since the matters in this item are quantified in the form of cost and benefit and are reflected in item D, Economic Aspects.

As a result of the comparison of the alternatives, it was concluded that Alternative-B1 is superior to the other alternatives in all aspects as listed below:

- Environmental impact
- Transportation aspects
- Economic aspects

The combination of the needs of road users and preservation of environment in many cases of road projects offers conflicting results. However, in the case of Alternative-B1, the inherent social condition along the sub-corridor is compatible with the economic indicators. The priority, as a total evaluation for Alternative-B1, will not be changed even if different weighting factors are adopted for these three elements of environment, transportation and economic aspects, thus the Study Team recommends **Alternative-B1** as the optimum route.

Table 7.10 Comparison of Short-Listed Route Alternatives

ITEM FOR COMPARISON	ROUTE ALTERNATIVE-B1		ROUTE ALTERNATIVE-D1		ROUTE ALTERNATIVE-D2	
	Quantified Figure	Rating/ Index	Quantified Figure	Rating/ Index	Quantified Figure	Rating/ Index
TECHNICAL ASPECTS						
(1) Total Length of the Toll Road	37.1 km	1.0	30.9 km	0.8	28.9 km	0.8
(2) Minimum Horizontal Curve	R = 2,000 m	Good	R = 2,500 m	Good	R = 2,500 m	Good
(3) Soft Ground Treatment	7.0 km	1.0	16.2 km	2.3	14.1 km	2.0
(4) Construction Cost	Rp. 223 Billion	1.0	Rp. 195 Billion	0.9	Rp. 182 Billion	0.8
(5) ROW Acquisition Cost	Rp. 67 Billion	1.0	Rp. 109 Billion	1.6	Rp. 96 Billion	1.4
(6) Total Cost of Construction and ROW	Rp. 290 Billion	1.00	Rp. 304 Billion	1.05	Rp. 278 Billion	0.96
(7) Ease of Construction	Longer hauling distance of fill materials		Troublesome soft ground treatment		Troublesome soft ground treatment	
Priority from Consideration on Technical Aspects (Costs)	2		3		1	
ENVIRONMENTAL IMPACT						
(1) Residents Displacement (weighed Village Crossing Distance)	3.9 km	1.0	6.8 km	1.7	5.6 km	1.4
(2) Loss of Agricultural Land (weighed by Crop Production Output)	2.3 million m2	1.0	3.1 million m2	1.3	3.0 million m2	1.3
(3) Protection/Reconst. of Irrigation Canal	1 location	-	7 locations	-	6 locations	-
Priority from Preservation of Environment	1		3		2	
TRANSPORTATION ASPECTS						
(1) Road Network	- Effective combination with the two ring roads (Inner and Middle) - Lower burden onto SBY-Gempol in volume and distance		- Effects of Middle Ring Road are not sufficient to disperse SBY bound traffic - Compared with Alt-B1, traffic burden onto SBY-Gempol is heavier in volume and distance.		- No connection with the planned ring road - Number of interchange is limited and the traffic burden onto SBY-Gempol is heaviest in volume and distance	
(2) No. of Toll Road Users	- Slightly lower at the Toll Road opening but grows faster than other alternatives.		- Relatively high at opening but it ranks next to Alt-B1 in 2015		- Almost the same as Alt-D1 but it grows at the lowest rate compared with the others	
(3) Influence to Regional Development	- Encourages the emerging development along the provincial road, particularly new town development in Driyorejo and Tandes ind. area through Inner Ring Road.		- Promotes a southward expansion of SBY urban area particularly in Taman, Waru, Gedangan and Sukodono in Kab. Sidoarjo		- Separates the agricultural land of higher productivity and it runs through an area of relatively lower potential to traffic generation	
Priority from Transportation Aspects	1		2		3	
ECONOMIC ASPECTS						
(1) NPV at i = 15 %	Rp. 201.9 Billion	1.00	Rp. 127.5 Billion	0.63	Rp. 63.0 Billion	0.31
(2) B/C Ratio at i = 15 %	2.03	1.00	1.60	0.79	1.33	0.66
(3) EIRR	24.8 %	1.00	20.9 %	0.84	18.4 %	0.74
Priority based on EIRR	1		2		3	
EVALUATION AS A WHOLE AND RECOMMENDATIONS	Though initial cost is not the lowest, Route Alternative-B1 is superior to the other alternatives in the following aspects: - Shorter ROW acquisition period - Preservation of environment - Accessibility to development areas - Avoidance of traffic concentration by Inner/Middle Ring Roads - Economic The Study Team recommends this alternative as the Optimum Route.		Route Alternative-D1 follows the existing national road. Serious residents displacement and loss of agricultural land are anticipated. Traffic overburden to Surabaya-Gempol Toll Road can be mitigated by the widening of the existing toll road. Many small industrial/ housing developments are on-going by individual investors, but Sidoarjo Regency has no future landuse/development plan.		Route Alternative-D2 has the shortest route length and the lowest initial cost. Traffic overburden to Surabaya-Gempol Toll Road can be mitigated by the provision of an access road to the existing national road but this will entail additional construction and ROW acquisition cost. Environmental impact is slightly less compared with Route Alternative-D1 since the route length in Sidoarjo Regency is shorter.	
RECOMMENDED PRIORITY	1		2		3	

Chapter 8

TRAFFIC DEMAND FORECAST

CHAPTER 8

TRAFFIC DEMAND FORECAST

8.1 Present Vehicle OD Matrix

8.1.1 Methodology

In order to obtain the traffic distribution pattern of the vehicle traffic in the Study Area, a roadside OD interview survey was carried out in September 1990. The traffic pattern obtained from the survey, however, is not sufficient enough to fulfill the complete OD matrix. The traffic distribution pattern that was not available from the survey was estimated by updating the results of the 1982 nation-wide traffic OD survey (National OD Survey).

The method of estimating the present 1990 vehicle OD matrix is presented in the flow chart diagram shown in Fig. 8.1 and the main procedure is as follows:

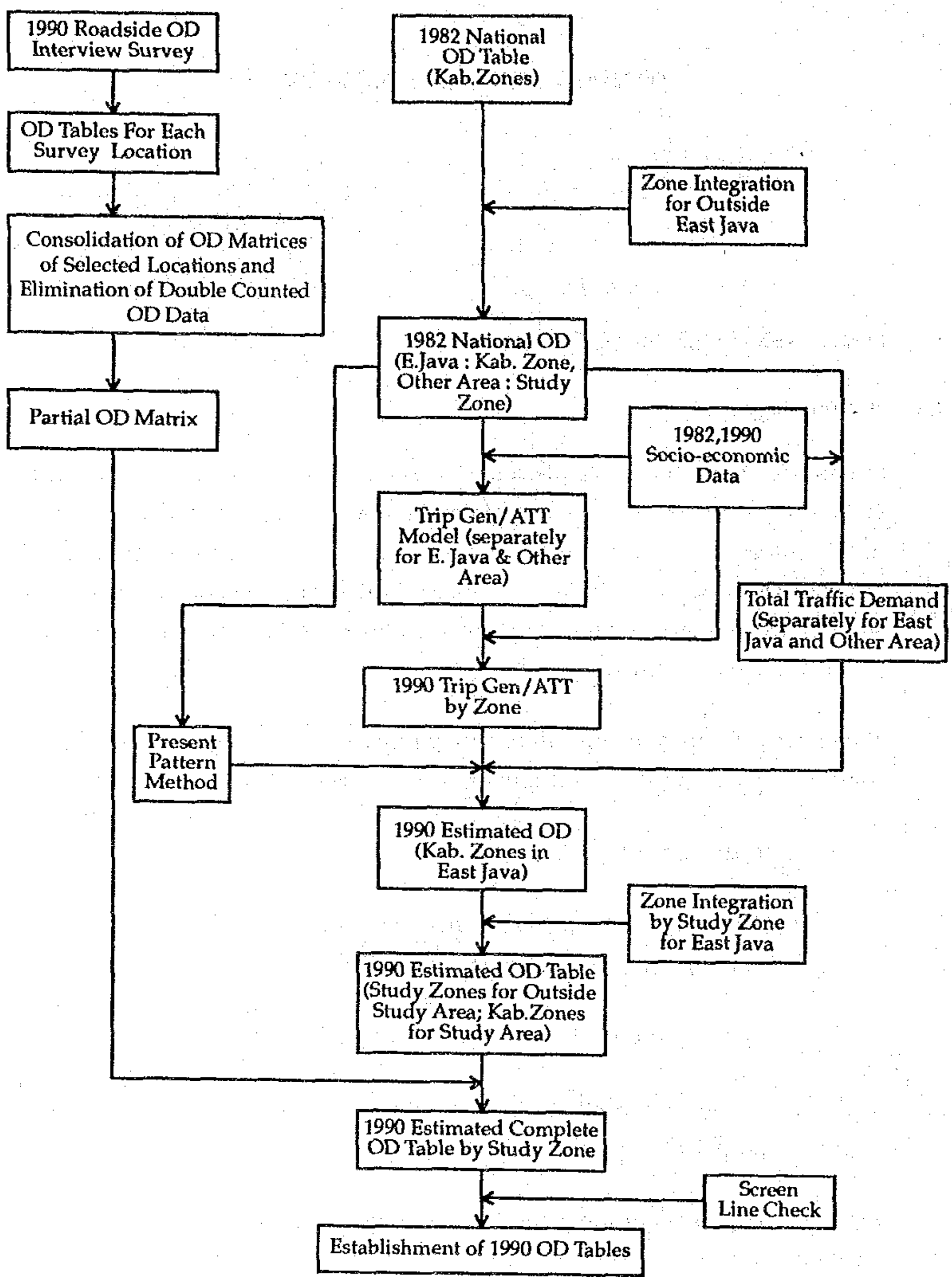
1) Traffic Zone System

2) Estimation of Partial OD matrix, based on the OD information obtained from the 1990 roadside interview survey

3) Updating the 1982 National OD Survey results

4) Consolidation of the updated National OD matrix and the estimated partial OD matrix

Detailed procedure is discussed in the subsequent sections following the previously mentioned methodological flow diagram.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.1 Flow Diagram of Estimating 1990 OD Matrix

8.1.2 Traffic Zone System

There are two different zoning systems. One is the system used for the 1982 National OD Survey and the other is the system applied to the 1990 roadside interview survey.

The former zone system consists of small zones and large zones. A large zone generally coincides with a Kabupaten and it encloses some small zones that are defined as the urban area. Therefore, most of the Kotamadyas are included in the relevant large zones of Kabupatens. The large zones were applied to update the 1982 National OD matrix, and referred to as Kabupaten zones.

The latter zone system is designed particularly to analyze the traffic demand of the Toll Road. Therefore, zones in the direct influence area were designed to be smaller than the area of a Kabupaten and compatible with the estimation of interchange traffic.

As a result, the Kabupatens/Kotamadyas of the Study Area were divided into several zones that consist of Kecamatans. Zone codes and the corresponding administrative regions are listed in Table 8.1 and shown in Fig. 8.2 through Fig. 8.5. The zone defined above is referred to as the study zone.

Table 8.1 Zone Code List

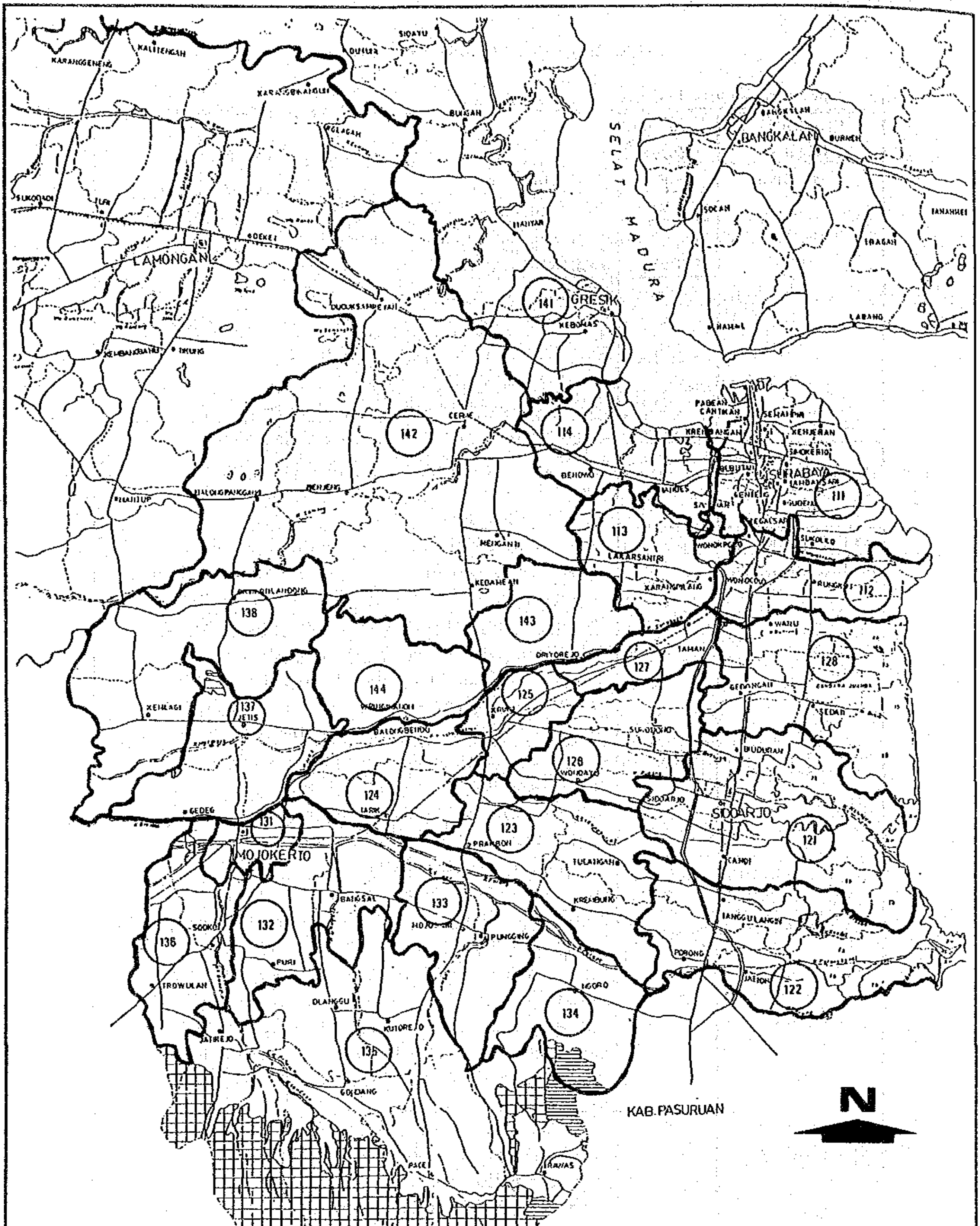
(1) Zone Code in the Study Area

Medium Zone	Kabupaten/ Kotamadya	Small Zone	Kecamatan
110	Kotamadya Surabaya	111	Sawahan, Genteng, Tegalsari, Gubeng, Sukolilo, Kenjeran, Tambaksari, Simokerto, Semampir, Pabeancantian, Krembangan, Bubutan
		112	Wonocolo, Wonokromo, Rungkut
		113	Lakarsantri, Karangpilang
		114	Tandes, Benowo
120	Kabupaten Sidoarjo	121	Sidoarjo, Buduran, Candi
		122	Porong, Tanggulangin, Jabon
		123	Krembung, Tulangan, Prambon
		124	Balongbendo, Tarik
		125	Krian
		126	Wonoayu, Sukodono
		127	Taman
		128	Waru, Gedangan, Sedati
130	Kodya Mojokerto	131	Prajurit Kulon, Magersari
	Kabupaten Mojokerto	132	Bangsal, Puri
		133	Pungging, Mojosari
		134	Ngoro
		135	Jatirejo, Gondang, Pacet, Trawas, Kutorejo, Dlanggu
		136	Trowulan, Sooko
		137	Gedek, Jetis
		138	Kemlagi, Dawarblandong
140	Kabupaten Gresik	141	Kebomas, Gresik, Manyar, Bungah, Sedayu, Dukun, Panceng, Ujungpangkah, Sangkapura, Tambak
		142	Menganti, Kedamean, Balongpanggang, Benjeng, Cerme, Duduk Sampeyan
		143	Driyorejo
		144	Wringinanom

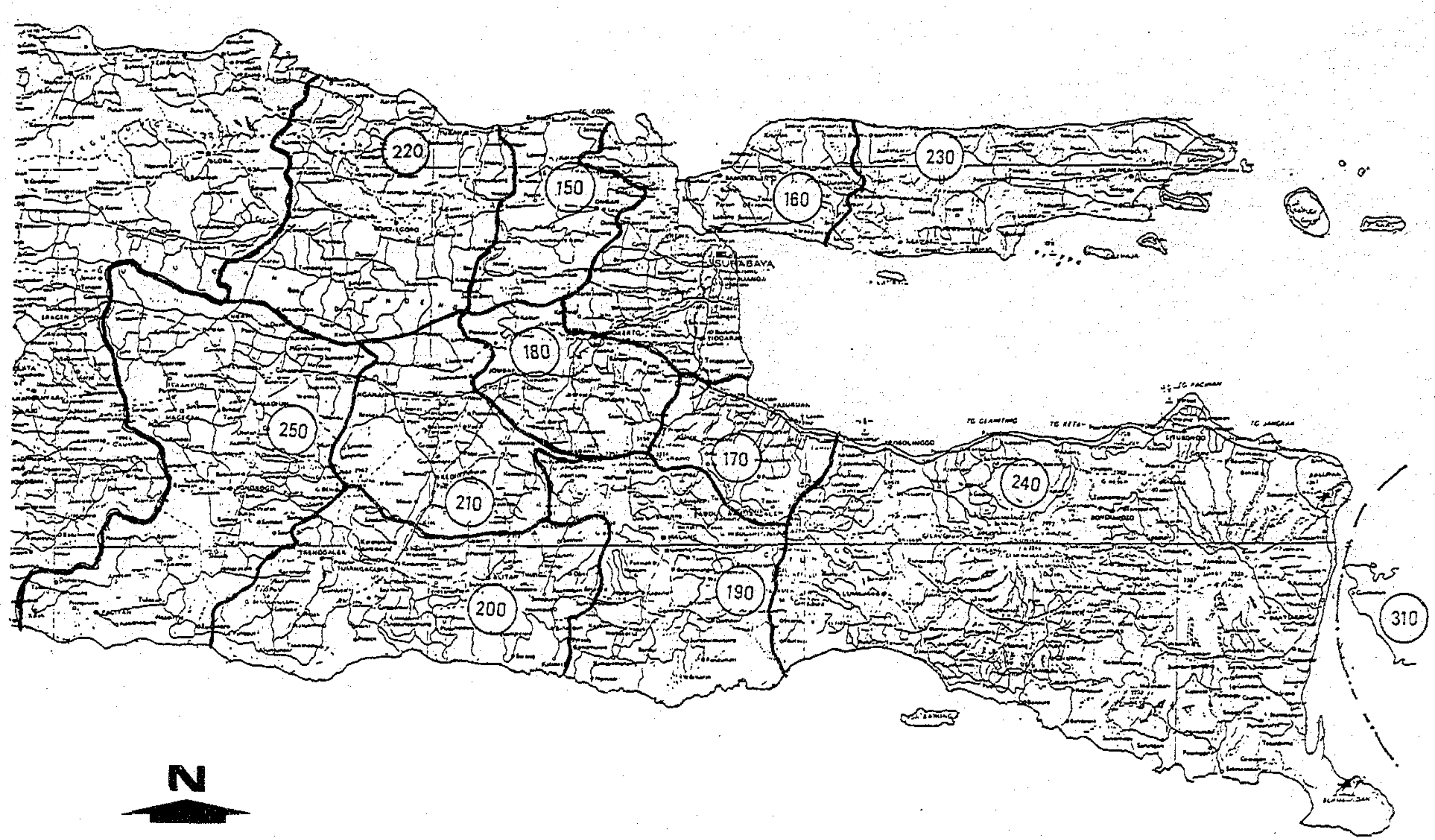
Table 8.1 Zone Code List (Continued)

(2) Zone Code Outside the Study Area

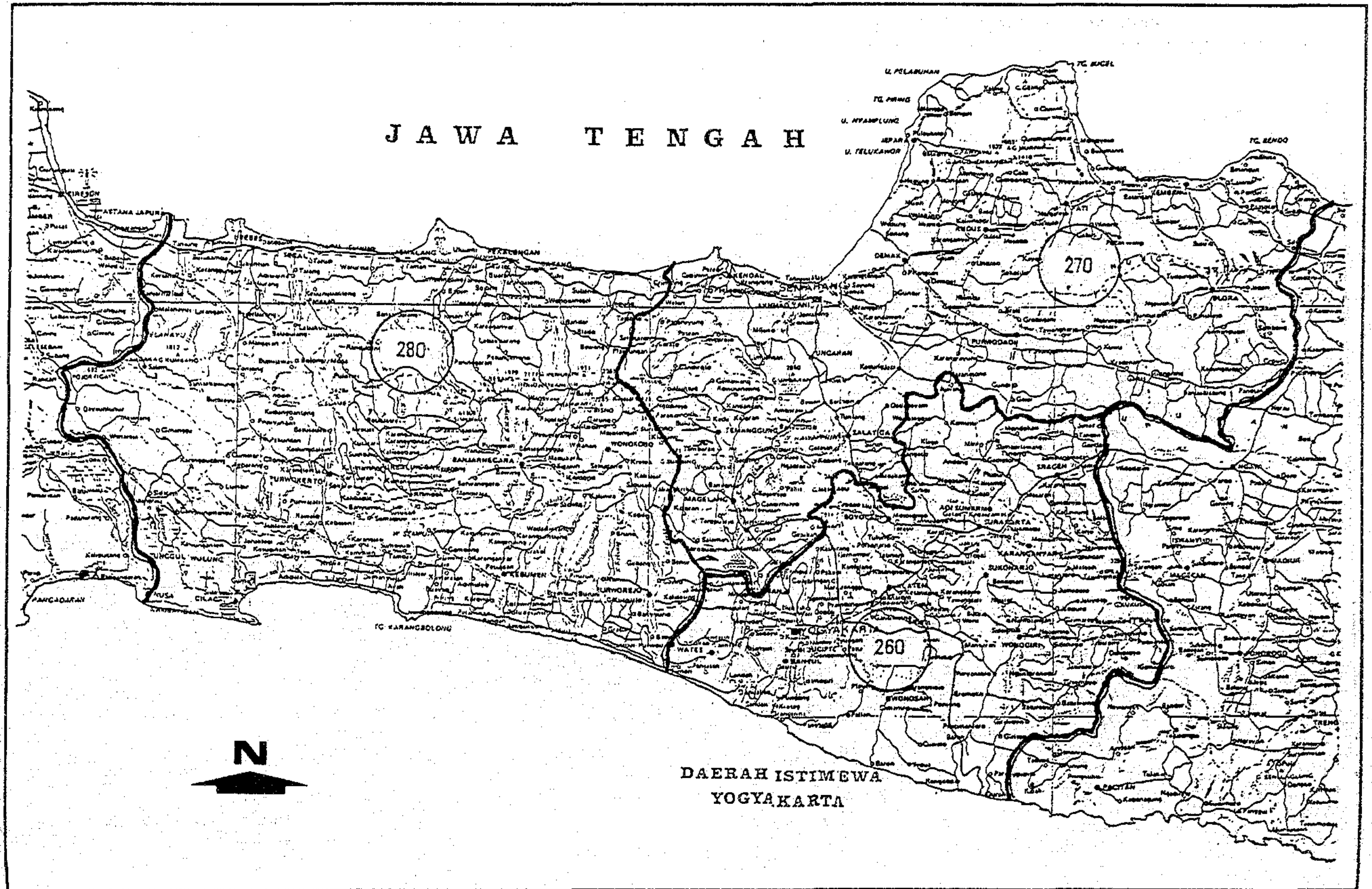
Province/ Island	Medium Zone	Kabupaten/Kotamadya/Province
East Java	150	Kab. Lamongan
	160	Kab. Bangkalan
	170	Kab. Pasuruan, Kodya Pasuruan
	180	Kab. Jombang
	190	Kab. Malang , Kod.Malang
	200	Kab. Blitar, Kab.Trenggalek, Kab.Tulungagung, Kod. Blitar
	210	Kab. Kediri, Kab. Ngnajuk, Kod. Kediri
	220	Kab. Bojonegoro, Kab. Tuban
	230	Kab. Pamekasan, Kab. Sampang, Kab. Sumenep
	240	Kab. Banyuwangi, Kab. Bondowoso, Kab.Jember, Kab. Lumajang, Kab. Probolinggo, Kab. Situbondo
	250	Kab. Madiun, Kab. Magetan, Kab. Ngawi, Kab. Pacitan, Kab. Ponorogo, Kod. Madiun
D.I. Yogyakarta and Central Java	260	DI.Yogyakarta (Kod.Yogyakarta, Kab. Wates, Kab. Wonogiri,Kab. Sleman, Kab. Bantul), Kab. Boyolali, Kab. Gunung Kidul,Kab. Karanganyar, Kab. Klaten, Kab. Kulon Progo, Kab. Sragen, Kab. Sukoharjo, Kod. Surakarta
	270	Kab. Blora, Kab. Demak, Kab. Grobogan, Kab. Jepara, Kab. Kendal, Kab. Kudus, Kab. Magelang, Kab. Pati, Kab. Rembang, Kab. Semarang, Kab. Temanggung, Kab. Ungaran, Kod. Magelang, Kod. Salatiga, Kod. Semarang
	280	Kab. Banjarnegara, Kab. Banyumas, Kab. Batang, Kab. Brebes, Kab. Cilacap, Kab. Kebumen, Kab. Pekalongan, Kab. Pemalang, Kab. Purbalingga, Kab. Purworejo, Kab. Tegal, Kab. Wonosobo, Kod. Pekalongan, Kod. Tegal
DKI Jakarta and West Java	290	DKI. Jakarta (Kod. Jakarta Barat, Kod. Jakarta Pusat, Kod. Jakarta Selatan, Kod. Jakarta Timur, Kod. Jakarta Utara), Kab. Bandung, Kab. Bekasi, Kab. Bogor, Kab. Ciamis, Kab. Cianjur, Kab. Cirebon, Kab.Garut, Kab. Indramayu, Kab. Karawang, Kab. Kuningan, Kab.Lebak, Kab. Majalengka,Kab. Pandeglang, Kab. Purwakarta, Kab. Serang, Kab. Subang, Kab.Sukabumi, Kab. Sumedang, Kab. Tangerang, Kab. Tasikmalaya, Kod. Bandung, Kod. Bogor, Kod. Cirebon.
Sumatra/ Kalimantan/etc.	300	DI. Aceh, Prop. Sumatera Utara, Prop. Sumatera Barat, Prop. Riau, Prop. Jambi, Prop. Sumatera Selatan, Prop. Bengkulu, Prop. Lampung, Prop. Kalimantan Timur, Prop. Kalimantan Selatan, Prop. Kalimantan Tengah, Prop. Kalimantan Barat,
Bali/ Sulawesi/ etc.	310	Prop. Bali, Prop. Nusatenggara Barat, Prop. Nusatenggara Timur, Prop. Irian Jaya, Prop. Maluku, Prop. Sulawesi Utara, Prop. Sulawesi Tengah, Prop. Sulawesi Tenggara, Prop. Sulawesi Selatan, Prop. Timor Timur



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.2 Traffic Zones in the Study Area

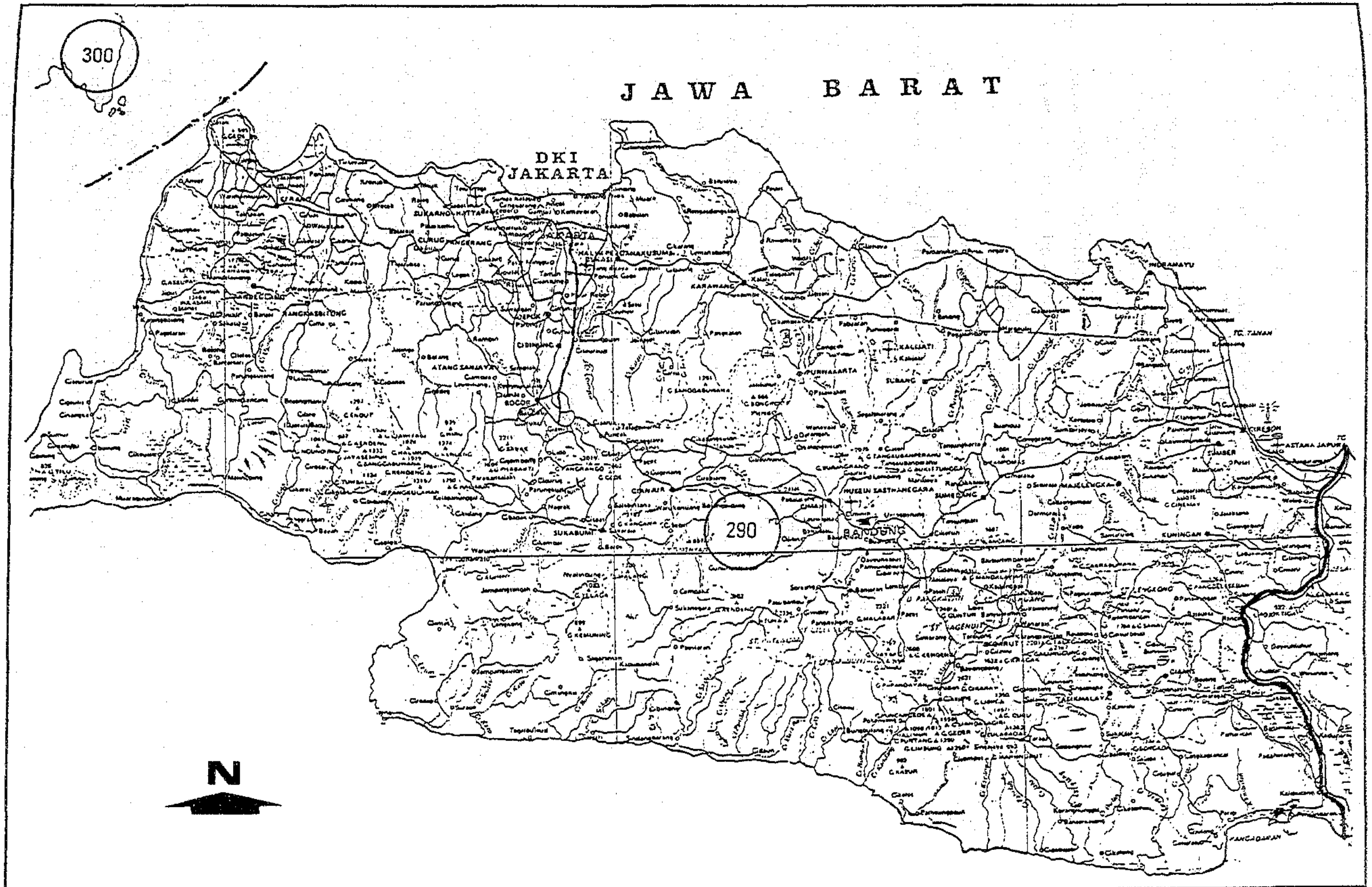


SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.3 Traffic Zones in East Java



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 8.4 Traffic Zones in Central Java and DI Yogyakarta



SURABAYA - MOJOKERTO TOLL ROAD PROJECT | Fig. 8.5 Traffic Zones in DKI Jakarta and West Java

8.1.3 Estimation of Partial OD Matrix

(1) Distribution Pattern of Traffic at the Survey Location

The roadside interview survey was carried out by the random sampling method. Therefore, the traffic count survey was also executed at the same place and time.

After the checking process of the raw data and the coding of OD address zones, the effective sampling rate was calculated from the traffic count result. An adverse figure of the effective sampling rate was used as an expansion factor of the obtained sample OD data.

The expanded OD traffic shows a particular distribution pattern of the traffic passing through the survey location.

(2) Elimination of Double Counted Traffic

Due to the nature of roadside OD survey, double counting of the traffic is unavoidable. In order to eliminate double counted traffic, the survey locations and the traffic distribution patterns derived from the respective survey locations were carefully examined.

Further, the most appropriate survey location was selected to fulfill particular OD pair traffic. In other words, every box of the OD matrix was given a unique reference for the specifically selected survey location(s).

The survey locations cover most but not all of the Study Area, so that the intending OD matrix is not completed but only partially completed by the survey data. All the matrix boxes, particularly outside the Study Area, are not filled in by the 1990 survey data.

8.1.4 Updating the 1982 National OD Matrix

(1) General

The 1982 National OD matrix covers the whole of Indonesia and most of the inter-city traffic flows in Indonesia. In order to supplement the previously estimated 1990 partial OD matrix, the 1982 OD matrix was compiled to match the updating procedure. That is, outside East Java zones were integrated to accord with the study zones and inside East Java zones were compiled by Kabupaten zones. Kotamadya other than Surabaya were absorbed by the surrounding Kabupaten.

Socio-economic data in 1982 and 1990 were either collected or estimated for the Kabupaten zones, based on the existing statistical data. The data include zonal population and GRDP. Vehicle ownership by type was also analyzed to determine the growth of total traffic demand between 1982 and 1990.

(2) Trip Generation and Attraction Model

Based on the 1982 zonal traffic data and 1982 socio-economic data as shown in Table 8.2, a zonal trip generation/attraction model was estimated as shown below:

Passenger Vehicle: $T_i = 0.003 X_1 - 108.3$ (r = 0.961)
(t=18.084) (t=-1.551)

Mini Bus: $T_i = 0.009 X_1 - 1.867 X_2 + 1484.4$ (r = 0.891)
(t=6.825) (t=-2.497) (t=2.776)

Bus: $T_i = 0.001 X_3 - 172.0$ (r = 0.884)
(t=9.839) (t=-3.260)

Pick-up: $T_i = 0.002 X_1 + 56.7$ (r = 0.939)
(t=14.137) (t=1.079)

Truck: $T_i = 0.011 X_1 - 0.005 X_3 + 425.9$ (r = 0.920)
(t=4.502) (t=-2.460) (t=1.698)

where, T_i = Zonal traffic generation/attraction volume per day
X_1 = Secondary + Tertiary Sector of GRDP
(Million Rp. at 1983 constant price)
X_2 = Population (1,000 persons)
X_3 = Total GRDP (Million Rp. at 1983 constant price)

(3) 1990 OD Matrix by Kabupaten Zone

In order to determine the total traffic demand of the 1990 OD matrix, growth rates of vehicle ownership in the 1982-1990 period (refer to Table 4.14 in Chapter 4) were employed. The resulting traffic demand increase between 1982 and 1990 was determined and the controlled increase in total traffic demand in East Java and outside East Java was estimated.

Table 8.2 1982 Zonal Traffic Data and Socio-Economic Data in East Java

Name	1982 National Zone Code	(1) Pass.Car Generated/ Attracted Traffic Volume	(2) Minibus Generated/ Attracted Traffic Volume	(3) Bus Generated/ Attracted Traffic Volume	(4) Pick-up Generated/ Attracted Traffic Volume	(5) Truck Generated/ Attracted Traffic Volume	Estimated 1982 Value (1983 Constant Price) GRDP I (Mil. Rp.) (1)	GRDP II + III (Mil. Rp.) (2)	GRDP Total (Mil. Rp.) (3)	1982 Population (1,000) (4)	1982 Total GRDP per Capita (5)
Kab. PACITAN	4110	87	84	50	79	110	66,187	44,412	110,599	488	226,638
Kab. NGAWI	4120	227	1,279	14	288	666	83,620	102,266	185,886	783	237,403
Kab. MAGETAN	4130	319	747	54	193	654	59,861	138,344	198,205	630	314,611
Kab. PONOROGO	4140	150	1,216	195	258	384	76,900	83,651	160,551	799	200,940
Kab. TRENGGALEK	4150	156	752	340	125	641	43,836	67,076	110,912	578	191,890
Kab. BOJONEGORO	4160	211	464	145	224	599	98,018	107,516	205,534	1,014	202,697
Kab. MADIUN + Kodya. MADIUN	4170	752	2,634	184	558	1,315	90,282	149,403	239,685	798	300,357
Kab. TUBAN	4180	118	151	89	148	407	91,473	129,818	221,290	887	249,482
Kab. NGANJUK	4190	329	1,984	11	194	596	68,036	147,746	215,781	890	242,451
Kab. TULUNGAGUNG	4210	683	605	331	404	953	59,731	158,999	218,730	843	259,467
Kab. KEDIRI + Kodya. KEDIRI	4220	899	2,400	122	616	1,399	128,396	657,564	785,960	1,443	544,671
Kab. BLITAR + Kodya. BLITAR	4230	341	1,029	202	429	532	85,164	151,524	236,687	1,116	212,086
Kab. JOMBANG	4240	670	1,219	28	485	1,005	78,971	178,070	257,042	948	271,141
Kab. LAMONGAN	4250	207	660	56	273	651	202,604	114,481	317,085	1,065	297,732
Kab. MALANG + Kodya. MALANG	4260 + 4270	2,518	4,627	1,044	1,654	2,191	349,886	797,171	1,147,057	2,567	446,847
Kab. MOJOKERTO + Kodya. MOJOKERTO	4280	671	2,931	25	761	2,898	79,024	190,175	269,198	796	338,189
Kab. SIDOARJO	4290	1,159	5,999	43	1,115	1,839	83,599	352,330	435,929	863	505,132
Kab. GRESIK + Kodya. SURABAYA	4310	5,414	10,605	2,106	3,262	9,584	151,308	1,550,061	1,701,369	2,710	627,811
Kab. BANGKALAN	4320	128	1,594	24	312	473	84,590	75,895	160,484	693	231,579
Kab. SAMPANG	4330	165	1,727	6	358	494	79,500	72,030	151,530	607	249,638
Kab. PAMEKASAN	4340	228	1,064	17	263	360	41,353	58,780	100,133	545	183,730
Kab. SUMENEP	4350	168	446	29	166	264	92,589	134,220	226,809	864	262,510
Kab. PASURUAN + Kodya. PASURUAN	4360	860	2,684	82	930	2,405	147,959	268,009	415,968	1,134	366,815
Kab. LUMAJANG	4370	317	495	37	202	542	165,479	145,750	311,228	870	357,734
Kab. PROBOLINGGO + Kodya. PROBOLINGGO	4380	370	927	67	299	1,081	95,885	205,748	301,633	966	312,250
Kab. JEMBER	4390	1,428	723	239	646	1,362	284,236	333,998	618,234	1,877	329,373
Kab. SITUBONDO	4410	240	691	70	199	340	62,774	109,373	172,147	524	328,524
Kab. BONDOWOSO	4420	434	892	50	351	413	72,441	94,410	166,851	617	270,422
Kab. BANYUWANGI	4430	400	250	181	240	723	161,487	268,652	430,140	1,389	309,676
EAST JAVA	TOTAL	19,649	50,879	5,841	15,032	34,881	3,185,188	6,887,472	10,072,659	29,304	343,730

As to zones in East Java, the increase in zonal traffic generation volume from 1982 to 1990 was estimated applying the relevant 1982 and 1990 socio-economic parameters, which are presented in Tables 8.2 and 8.3, to the above model equations, The increase was adjusted to the controlled increase in total traffic demand, and subsequently added to the 1982 zonal traffic.

Zonal traffic generation volumes of passenger vehicles and mini-buses, which are categorized separately for the 1982 OD matrices, were combined and defined as "Passenger Vehicle" for the 1990 and future traffic demand analysis. This is because of limited vehicle ownership data on mini-buses that are likely to be incorporated into the registered vehicle data as either passenger vehicles or buses.

Consequently, the 1990 zonal traffic generation volume was estimated for East Java as shown in Table 8.4.

As to zones outside East Java, growth factors of provincial population during 1982-1990 were used and the resulting zonal traffic generation was adjusted to the previously determined total traffic demand of outside East Java in 1990.

A present pattern method was applied to estimate the distributed traffic, and the 1990 OD matrix was estimated on the 1982 National OD zone basis.

8.1.5 Estimated 1990 OD Matrix

The partial 1990 OD matrix based on the 1990 survey and the estimated 1990 OD based on the 1982 National OD were consolidated to complete the 1990 OD matrix. The resulting 1990 OD matrix is presented by consolidating study zones to the East Java and outside East Java blocks as shown in Table 8.5.

Table 8.3 Estimated Socio-Economic Parameters in East Java, 1990

Name	1982 National Zone Code	Estimated 1990 Value (1983 Constant Price) GRDP I (Mil. Rp.) (1)	GRDP II + III (Mil. Rp.) (2)	GRDP Total (Mil. Rp.) (3)	1990 Population (1,000) (4)	1990 Total GRDP per Capita (5)
Kab. PACITAN	4110	99,273	73,446	172,719	490	352,488
Kab. NGAWI	4120	144,400	173,275	317,675	839	378,635
Kab. MAGETAN	4130	110,365	232,596	342,961	653	525,208
Kab. PONOROGO	4140	166,466	144,030	310,496	813	381,914
Kab. TRENGGALEK	4150	46,049	126,352	172,401	627	274,962
Kab. BOJONEGORO	4160	94,067	183,105	277,172	1,146	241,860
Kab. MADIUN + Kodya. MADIUN	4170	104,088	244,976	349,064	854	408,740
Kab. TUBAN	4180	115,779	198,195	313,974	1,005	312,412
Kab. NGANJUK	4190	89,862	253,745	343,607	993	346,029
Kab. TULUNGAGUNG	4210	93,173	243,253	336,426	898	374,639
Kab. KEDIRI + Kodya. KEDIRI	4220	173,190	1,159,803	1,332,993	1,668	799,156
Kab. BLITAR + Kodya. BLITAR	4230	133,642	259,087	392,729	1,201	327,002
Kab. JOMBANG	4240	120,191	281,747	401,938	1,080	372,165
Kab. LAMONGAN	4250	127,984	204,184	332,168	1,199	277,038
Kab. MALANG + Kodya. MALANG	4260 + 4270	782,675	1,221,585	2,004,260	2,961	676,886
Kab. MOJOKERTO + Kodya. MOJOKERTO	4280	101,804	309,765	411,569	906	454,270
Kab. SIDOARJO	4290	114,235	603,501	717,736	1,094	656,066
Kab. GRESIK + Kodya. SURABAYA	4310	208,313	2,891,936	3,100,249	3,516	881,755
Kab. BANGKALAN	4320	123,124	118,420	241,544	737	327,739
Kab. SAMPANG	4330	107,401	122,793	230,194	673	342,042
Kab. PAMEKASAN	4340	67,103	111,352	178,455	617	289,230
Kab. SUMENEP	4350	111,244	208,831	320,075	945	338,704
Kab. PASURUAN + Kodya. PASURUAN	4360	237,661	503,554	741,215	1,339	553,559
Kab. LUMAJANG	4370	205,636	234,814	440,450	957	460,240
Kab. PROBOLINGGO + Kodya. PROBOLINGGO	4380	202,933	357,395	560,328	1,103	508,004
Kab. JEMBER	4390	421,385	557,469	978,854	2,039	480,066
Kab. SITUBONDO	4410	88,309	195,588	283,897	577	492,023
Kab. BONDOWOSO	4420	89,435	168,355	257,790	665	387,654
Kab. BANYUWANGI	4430	234,287	441,872	676,159	1,611	419,714
EAST JAVA	TOTAL	4,714,074	11,825,024	16,539,098	33,206	498,076

Table 8.4 Estimated 1990 Zonal Trip Generation/Attraction in East Java

Name	1982 National Zone Code	1990 Controlled Zonal Trip Generation/Attraction			
		Pass. Veh.	Bus	Pick-up	Truck
Kab. PACITAN	4110	867	93	279	120
Kab. NGAWI	4120	3,016	106	778	804
Kab. MAGETAN	4130	3,262	155	845	1,007
Kab. PONOROGO	4140	2,775	300	676	287
Kab. TRENGGALEK	4150	2,159	383	536	1,030
Kab. BOJONEGORO	4160	2,009	195	745	1,132
Kab. MADIUN + Kodya. MADIUN	4170	5,491	260	1,217	1,883
Kab. TUBAN	4180	1,480	154	621	733
Kab. NGANJUK	4190	4,493	100	926	1,190
Kab. TULUNGAGUNG	4210	3,123	413	987	1,334
Kab. KEDIRI + Kodya. KEDIRI	4220	14,616	504	4,081	4,545
Kab. BLITAR + Kodya. BLITAR	4230	3,655	311	1,171	987
Kab. JOMBANG	4240	3,903	129	1,199	1,474
Kab. LAMONGAN	4250	2,534	66	891	1,678
Kab. MALANG + Kodya. MALANG	4260 + 4270	15,939	1,642	4,584	2,623
Kab. MOJOKERTO + Kodya. MOJOKERTO	4280	6,085	124	1,586	3,579
Kab. SIDOARJO	4290	12,371	240	2,847	3,366
Kab. GRESIK + Kodya. SURABAYA	4310	45,483	3,082	12,524	18,343
Kab. BANGKALAN	4320	2,588	81	605	543
Kab. SAMPANG	4330	2,873	61	710	680
Kab. PAMEKASAN	4340	2,295	71	625	571
Kab. SUMENEP	4350	2,116	94	680	663
Kab. PASURUAN + Kodya. PASURUAN	4360	8,477	309	2,555	3,493
Kab. LUMAJANG	4370	2,641	127	816	919
Kab. PROBOLINGGO + Kodya. PROBOLINGGO	4380	4,454	248	1,345	1,504
Kab. JEMBER	4390	6,953	491	2,189	2,101
Kab. SITUBONDO	4410	2,820	148	793	780
Kab. BONDOWOSO	4420	2,937	113	862	818
Kab. BANYUWANGI	4430	4,011	353	1,434	1,484
EAST JAVA	TOTAL	175,426	10,353	49,107	59,671

Table 8.5 **Estimated 1990 Block OD Matrix**

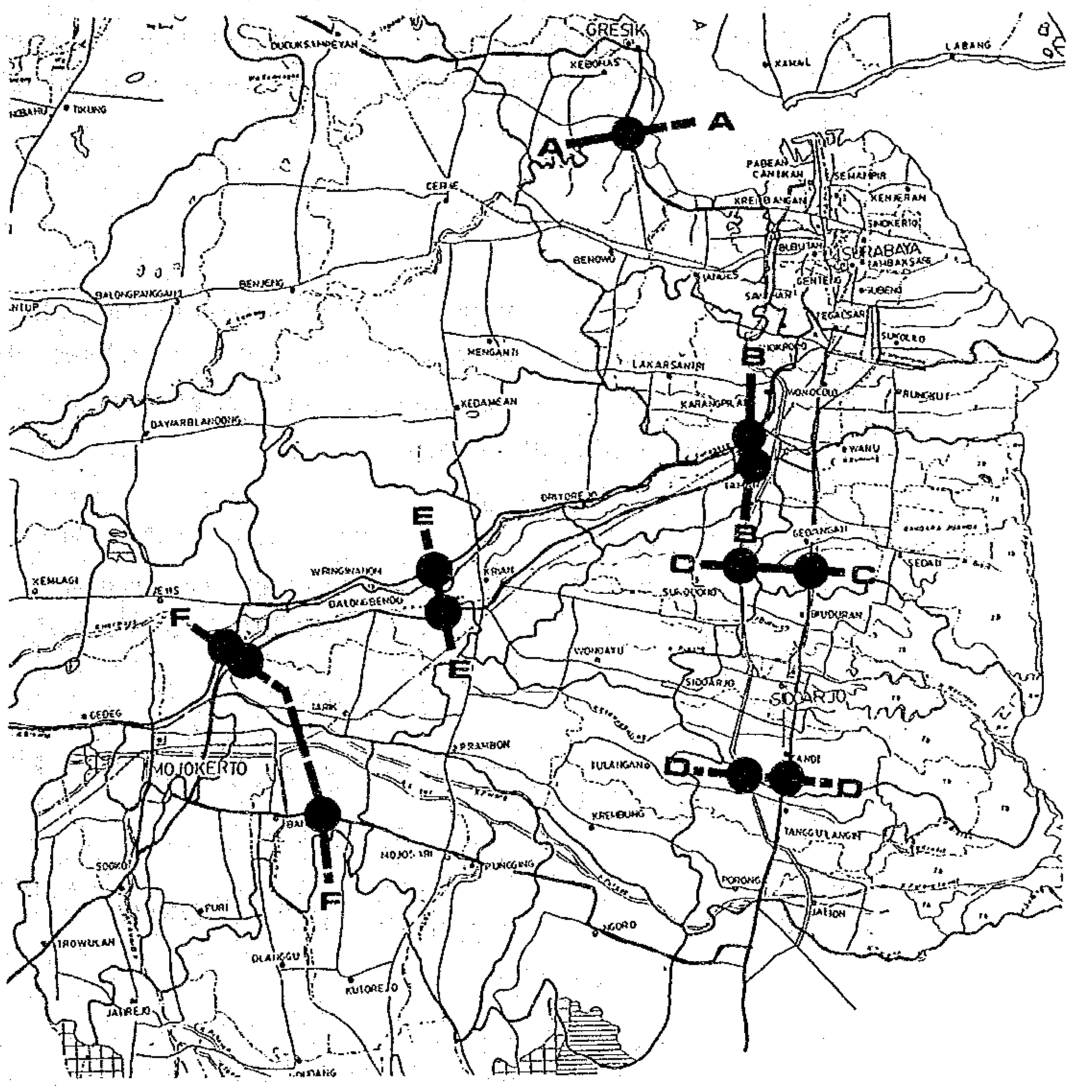
(Unit: veh./day)

		Block (1) East Java (Zone No. 111 ~ 250)	Block (2) Outside East Java (Zone No. 260 ~ 310)	Total
Block (1)	Pass. Veh.	83,663	6,195	89,858
	Bus	6,896	224	7,120
	Pick-up	27,980	1,196	29,176
	Truck	41,357	3,880	45,237
Block (2)	Pass. Veh.	6,195	25,872	32,067
	Bus	224	31,792	32,016
	Pick-up	1,196	6,158	7,354
	Truck	3,880	14,189	18,069
Total	Pass. Veh.	89,858	32,067	121,925
	Bus	7,120	32,016	39,136
	Pick-up	29,176	7,354	36,530
	Truck	45,237	18,069	63,306

The estimated 1990 OD matrix was examined by comparing the traffic volumes on screen lines. The difference between the estimated screen line traffic volumes and the 1990 traffic count survey volumes is found to fall in the magnitude of acceptable accuracy as shown in Table 8.6.

Table 8.6 Comparison of Screen Line Traffic in 1990

Screen Line	(1) Estimated Traffic Volume	(2) Surveyed Traffic Volume	(1)/(2) ((2)=100)
A	17,600	18,000	98
B	33,700	35,900	94
C	41,000	37,500	109
D	33,600	34,700	97
E	17,600	17,900	98
F	24,800	22,100	112



8.2 Toll Road Diversion Model

8.2.1 Methodology

In order to analyze traffic diverted to the Toll Road, the OD interview survey was carried out at every gate of the existing Surabaya-Gempol Toll Road. Information about the toll road user was collected, particularly those of the on- and off-ramp OD data and their actual origin and destination of the travel. A comparison was made between the OD matrix based on the toll road interview survey and the OD matrix estimated previously for 1990.

Factors to explain the traffic diversion include travel time, toll road tariff, travel distance, vehicle operating costs and safety. In this study, a model analysis was made using factors of toll road tariff and travel time saving comparing travel through toll road and non-toll road routes. The procedure for the model analysis is presented in Fig. 8.6.

8.2.2 Estimation of Diversion Formula

A model was estimated with the two independent variables of toll rate and difference between travel times through a toll road route and through a non-toll road route, and with the dependent variable of diversion rate, a percentage of diverted traffic to toll road over the total traffic of a specific OD zone pair.

The model formula was calibrated from the data samples of the selected OD pair zones that include a competitive arterial road route against the existing toll road route. Consequently, parameters of the formula were calibrated as follows:

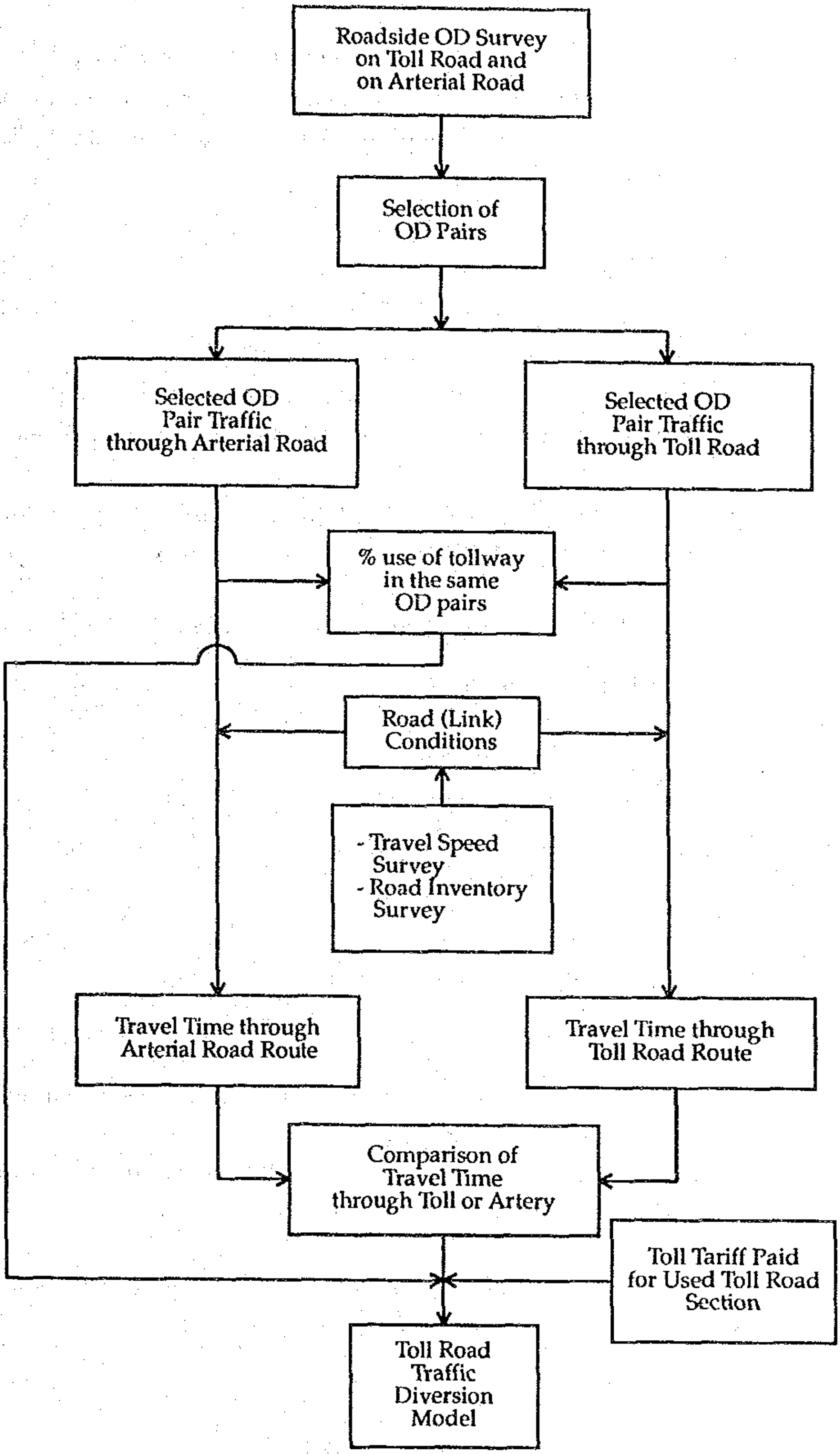
Passenger vehicle : $$p = \frac{100}{1+1.454219 \times 10^{-5} \times T^{2.229036}} \quad (r=0.82)$$

Pick-up : $$p = \frac{90}{1+2.623553 \times 10^{-5} \times T^{2.279117}} \quad (r=0.92)$$

Truck : $$p = \frac{80}{1+3.330657 \times 10^{-5} \times T^{1.741448}} \quad (r=0.83)$$

where, p = Diversion rate (%)

T = Toll/Travel time difference



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.6 Flow Diagram for Toll Road Diversion Model

For buses, the use of toll road is not determined by the preference of a driver but by the operational intention of the bus company. Therefore, the average rate of the existing toll road utilization was derived from the samples obtained from the bus terminal survey.

8.3 Future Road Network

8.3.1 Trunk Road Development Plan

The future road network is required for estimating future traffic volumes on the Toll Road. Accordingly, it was assembled with the following network components:

a) The existing toll road and its access roads; national and provincial roads were assumed to remain as they are for the future.

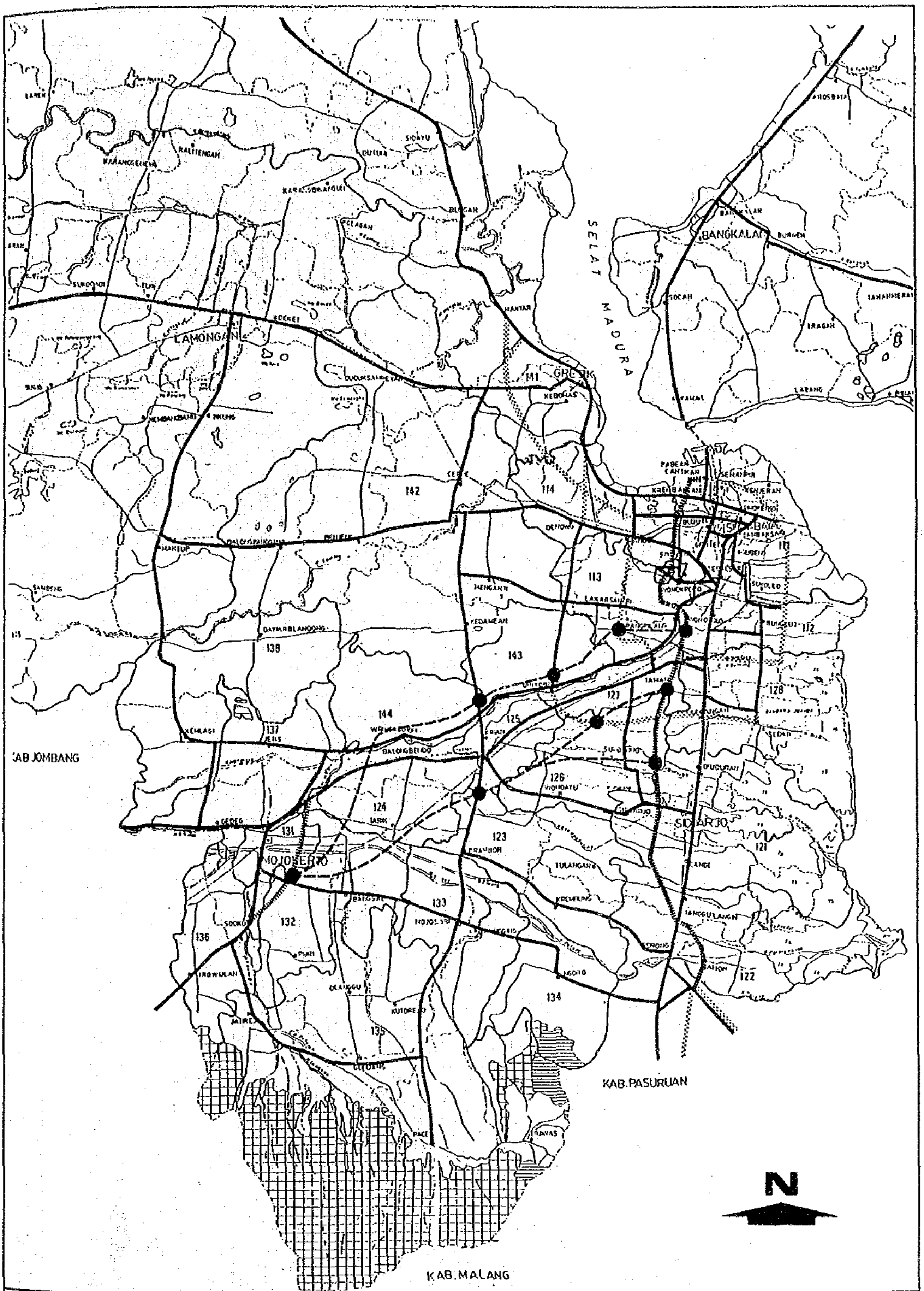
b) The following network components are assumed to exist in the future.

Name of Trunk Road	Year of opening
Gempol - Malang Toll Road	1998
Surabaya - Gresik Toll Road (East)	1994
Surabaya - Gresik Toll Road (West)	1999
Gempol - Pasuruan Toll Road	1999
Inner Ring Road (East)	1999
Inner Ring Road (West)	2004
Middle Ring Road	2009

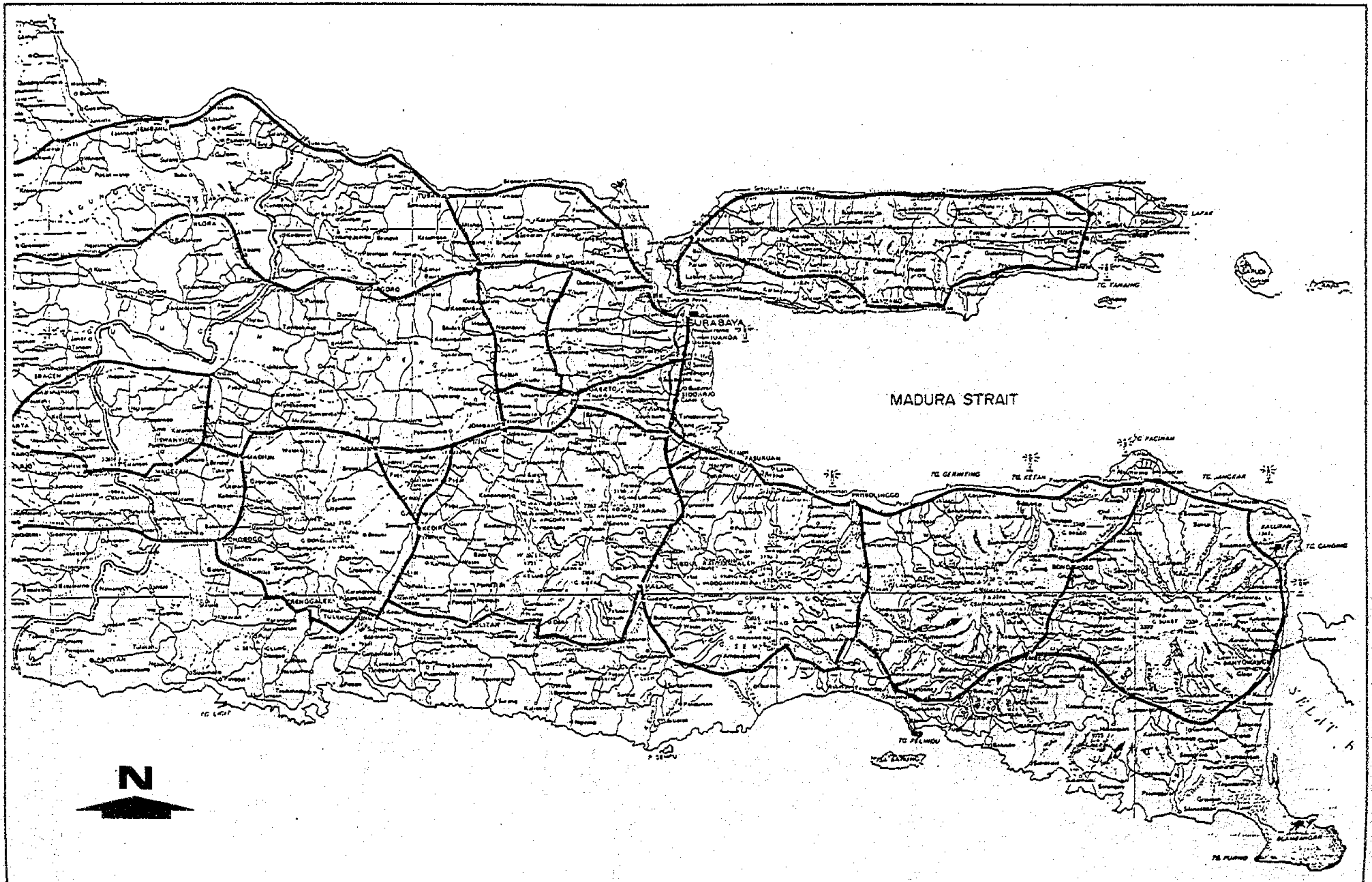
c) Proposed interchanges of the Toll Road are all considered in the network.

d) Major arterial roads in Central and West Java are represented by the relevant selected links.

Based on the above network components, the networks used for the study analysis were assumed as shown in Fig. 8.7 through Fig. 8.10.

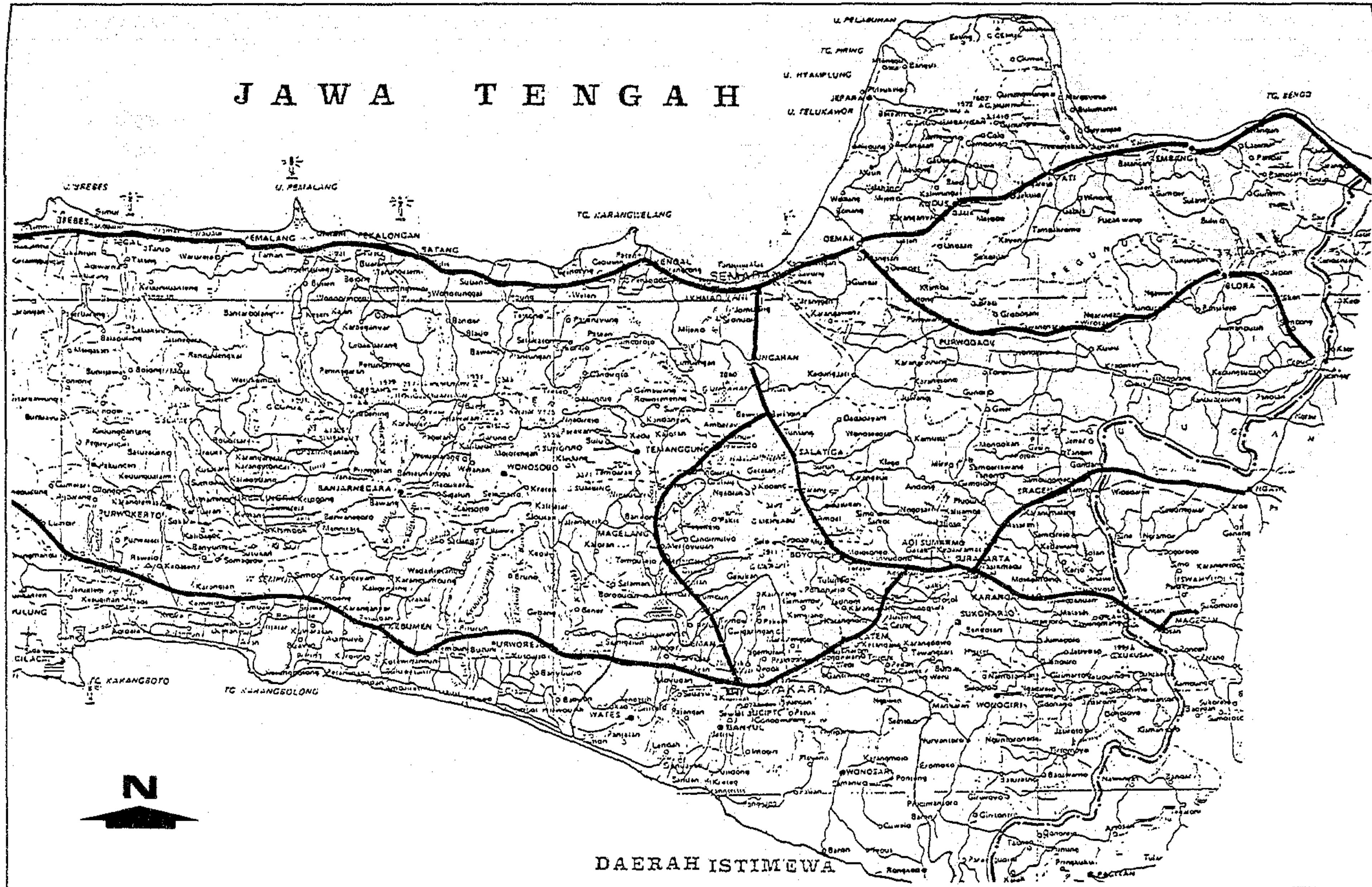


SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.7 Road Network in the Study Area

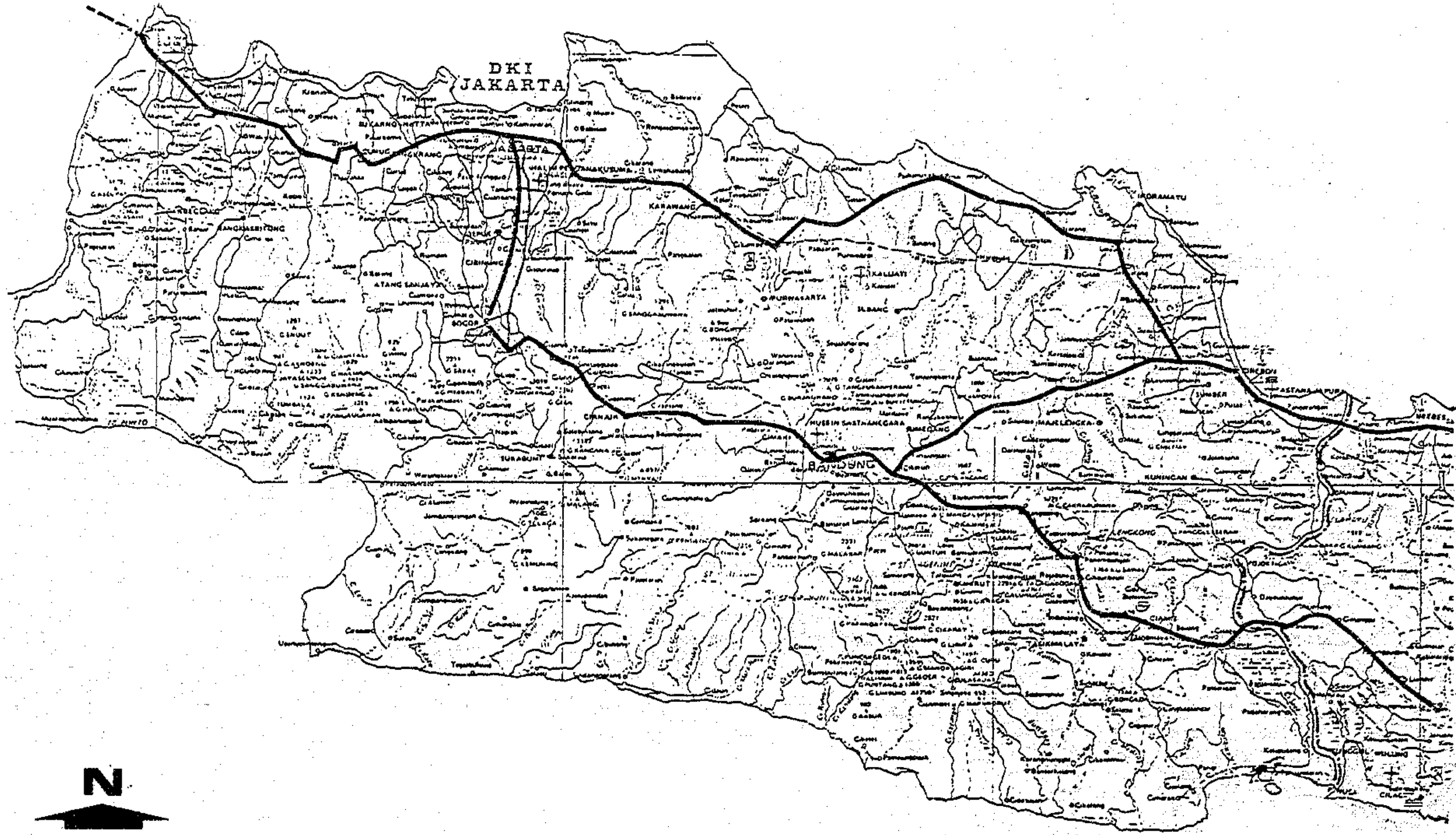


SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 8.8 Road Network in East Java



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.9 Road Network in Central Java and DI Yogyakarta



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 8.10 Road Network in DKI Jakarta and West Java

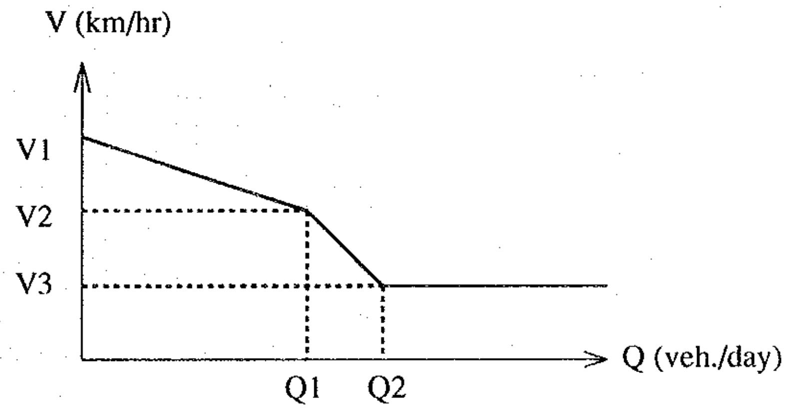
8.3.2 Link Conditions and Q-V Model

Conditions of the road links were determined by referring to the latest road inventory data, the result of travel speed survey and field reconnaissance.

Road links incorporated into the network were classified into 9 categories and the Q-V (quantity and velocity) relationship was determined as shown in Table 8.7.

Table 8.7 Q-V Conditions of Network Links

Road Type	V1	V2	V3	Q1	Q2
1) 6-lane Toll Road (Rural)	100	60	30	72,000	86,400
2) 6-lane Toll Road (Urban)	80	60	30	68,000	81,600
3) 4-lane Toll Road (Rural)	100	60	30	48,000	57,600
4) 4-lane Toll Road (Urban)	80	60	30	45,000	54,000
5) 4-lane Arterial Road	70	40	15	44,000	52,800
6) 2-lane 2-way (Wider lane width)	70	40	15	11,000	13,200
7) 2-lane 2-way (About 6.5 m width)	60	30	15	9,000	10,800
8) 2-lane 2-way (6.0 m width)	40	30	15	8,000	9,600
9) 2-lane 2-way (4-6 m width)	40	25	15	6,000	7,200



8.4 Forecast Future Traffic Demand

8.4.1 Future Vehicle OD Matrix

The future OD matrix was based on the growth factors derived from the future vehicle ownership projections in East Java and Java total (refer to Table 4.14 in Chapter 4).

As a result, the controlled future traffic generation was estimated corresponding to the following OD blocks and shown in Tables 8.8 and 8.9.

Traffic Generation by Zone Block

Block (1) East Java (Zone No. 111 ~ 250)	Block (2) Outside East Java (Zone No. 260 ~ 310)	Total Traffic Generation
M	N	T

Table 8.8 Growth of Total Traffic Generation (T)

(Unit: veh./day)

Type of Veh.	1990	1995	2005	2015
Passenger Vehicle	121,925	174,326	346,066	672,433
(% p.a.)		7.40%	7.10%	6.90%
Bus	39,132	51,718	91,026	161,742
(% p.a.)		5.70%	5.80%	5.90%
Pick-up	36,530	53,617	109,360	216,855
(% p.a.)		8.00%	7.40%	7.10%
Truck	63,306	80,987	136,223	235,336
(% p.a.)		5.00%	5.30%	5.60%
Total	260,893	360,648	682,675	1,286,366
(% p.a.)		6.70%	6.60%	6.50%

Table 8.9 Estimated Future Traffic Generation by Zone Block

(Unit: veh./day)

(1) Passenger Vehicle			
Year	M	N	T
1990	89,858	32,067	121,925
1995	128,878	45,450	174,328
2005	249,676	96,393	346,069
2015	462,700	209,731	672,431
(2) Bus			
Year	M	N	T
1990	7,120	32,016	39,136
1995	9,092	42,626	51,718
2005	14,867	76,158	91,025
2015	24,500	137,240	161,740
(3) Pick-up			
Year	M	N	T
1990	29,176	7,354	36,530
1995	44,596	9,018	53,614
2005	93,044	16,312	109,356
2015	180,384	36,466	216,850
(4) Truck			
Year	M	N	T
1990	45,237	18,069	63,306
1995	57,619	23,368	80,987
2005	94,260	41,966	136,226
2015	156,016	79,319	235,335

In order to estimate the future zonal trip generation/attraction, model equations were calibrated from the established 1990 OD matrix and zonal socio-economic parameters in 1990. The availability of socio-economic data both at present and in the future, and their compatibility with area, confined model parameters to population and GRDP in Kabupaten/Kotamadya in East Java.

Traffic zones smaller than Kabupaten/Kotamadya provide only population parameters, at present as well as in the future. Therefore, the traffic zones were consolidated to Kabupaten as a minimum unit zone and the trip generation model was calibrated using 1990 population and GRDP by Kabupaten estimated in Table 4.15 in Chapter 4. The estimated regression equations for different vehicle types are as follows:

(1) Passenger Vehicle:

$$Y = 4.567 X_1 - 1.905 X_2 + 3.839 X_3 \qquad (r = 0.761)$$
$$(t=2.610) \quad (t=-2.414) \quad (t=2.147)$$

(2) Pick-up:

$$Y = 2.497 X_1 - 0.997 X_2 + 2.436 X_3 \qquad (r = 0.757)$$
$$(t=2.483) \quad (t=-2.198) \quad (t=2.370)$$

(3) Truck:

$$Y = 8.565 X_1 - 3.464 X_2 + 7.418 X_3 \qquad (r = 0.802)$$
$$(t=2.930) \quad (t=-2.628) \quad (t=2.483)$$

(4) Bus: A regression model was not applicable.

where, Y = Trip generation/attraction (veh./day)
X_1 = GRDP (Billion Rp. at 1983 constant prices)
X_2 = Population (x 1,000 persons)
X_3 = Per Capita GRDP (x 1,000 Rp.)

The future socio-economic parameter by Kabupaten has been estimated previously in Table 4.15. Applying this to the above equations, the future increment of the zonal trip generation was derived and it was adjusted to fit the increment of the controlled total demand in future. The adjusted increment volume was then added to the 1990 zonal trip volume to determine future trip generation by zone.

Regarding the zonal trip generation of bus, the zonal bus trip generation was assumed to grow proportionally to the future total demand in the block region.

Trip generation in zones smaller than Kabupaten unit was based on the growth factor of the zonal population in the future. The derived zonal trip volume was then adjusted to the relevant Kabupaten total which was estimated by the regression equation.

Consequently, future zonal trip generation/attraction volumes were estimated for different vehicle types as shown in Tables 8.10 and 8.11.

The present pattern model was employed to estimate the future traffic distribution and the process was repeated to reach the previously determined zonal trip generation/ attraction volumes.

Table 8.10 Estimated Future Zonal Trip Generation/Attraction for Passenger Vehicle and Bus

(unit : veh./day)

ZONE	Passenger Vehicle				Bus			
	1990	1995	2005	2015	1990	1995	2005	2015
111	16,886	22,311	40,227	76,030	489	549	739	1,110
112	3,784	5,233	10,279	20,966	1,606	1,841	2,624	4,245
113	708	1,068	2,501	6,077	0	0	0	0
114	898	1,499	4,285	12,722	0	0	0	0
121	5,300	5,820	6,794	8,523	0	0	0	0
122	1,788	1,945	2,225	2,736	0	0	0	0
123	154	169	194	242	0	0	0	0
124	83	90	103	127	0	0	0	0
125	1,920	2,089	2,389	2,938	0	0	0	0
126	125	138	163	207	0	0	0	0
127	3,901	4,482	5,712	7,830	0	0	0	0
128	2,245	2,361	3,804	5,750	0	0	0	0
131	2,729	4,345	9,229	17,975	0	0	0	0
132	144	201	339	526	0	0	0	0
133	446	645	1,131	1,826	0	0	0	0
134	52	77	132	208	0	0	0	0
135	96	136	222	335	0	0	0	0
136	144	197	318	471	0	0	0	0
137	313	447	769	1,216	0	0	0	0
138	130	193	336	536	0	0	0	0
141	4,351	6,310	12,302	20,947	31	36	52	74
142	784	1,120	2,122	3,504	0	0	0	0
143	244	360	722	1,264	0	0	0	0
144	14	20	38	66	0	0	0	0
150	968	1,908	4,779	9,378	20	27	49	83
160	61	1,144	4,445	9,914	34	264	937	2,027
170	5,954	8,080	14,468	24,945	195	222	299	422
180	3,120	4,307	7,901	13,568	75	86	118	167
190	8,237	11,232	21,505	43,469	956	1,089	1,525	2,436
200	6,402	8,182	13,273	20,920	1,033	1,142	1,442	1,883
210	8,662	12,863	25,442	45,853	325	385	557	831
220	2,157	3,800	9,267	18,917	290	374	643	1,107
230	334	1,279	3,979	7,884	113	235	569	1,041
240	3,843	8,225	20,544	38,947	1,155	1,657	3,010	4,987
250	2,881	6,600	17,735	35,885	793	1,184	2,304	4,089
260	9,103	12,902	27,363	59,537	5,135	6,837	12,215	22,012
270	11,238	15,928	33,781	73,501	4,333	5,769	10,307	18,574
280	6,061	8,591	18,220	39,643	2,576	3,430	6,128	11,043
290	5,557	7,876	16,704	36,345	19,954	26,566	47,463	85,530
300	2	3	6	13	1	1	2	4
310	106	150	318	692	18	24	43	77
TOTAL	121,925	174,326	346,066	672,433	39,132	51,718	91,026	161,742

Table 8.11 Estimated Future Zonal Trip Generation/Attraction for Pick-up and Truck

(unit : veh./day)

ZONE	Pick-up				Truck			
	1990	1995	2005	2015	1990	1995	2005	2015
111	5,213	7,293	14,096	27,579	9,589	10,972	15,281	23,286
112	953	1,395	2,939	6,206	1,920	2,299	3,489	5,738
113	382	610	1,532	3,851	669	874	1,581	3,097
114	405	715	2,195	6,742	1,156	1,671	3,690	8,835
121	1,620	1,807	2,170	2,810	1,557	1,647	1,756	1,993
122	526	581	684	868	636	666	696	774
123	64	71	84	108	164	172	182	205
124	34	38	44	57	84	88	92	103
125	571	631	742	943	814	853	891	992
126	78	87	106	139	79	84	91	104
127	1,545	1,803	2,362	3,345	2,943	3,256	3,791	4,701
128	807	862	1,429	2,230	1,201	1,216	1,791	2,448
131	791	1,487	3,625	7,549	1,466	1,987	3,493	6,073
132	59	80	129	199	153	168	202	245
133	257	356	600	951	548	614	766	971
134	14	19	32	50	219	243	297	369
135	53	71	112	165	135	146	170	201
136	62	83	127	186	332	356	408	474
137	154	210	348	541	302	335	410	509
138	38	53	87	136	88	98	121	153
141	1,093	1,854	4,206	7,680	2,226	2,848	4,656	7,134
142	182	304	671	1,186	196	247	392	583
143	116	200	468	876	314	408	686	1,082
144	7	13	28	48	17	21	35	53
150	581	961	2,138	4,067	736	1,036	1,910	3,248
160	26	470	1,845	4,185	102	447	1,454	3,052
170	1,794	2,644	5,238	9,585	2,790	3,466	5,409	8,454
180	1,068	1,549	3,025	5,412	1,601	1,979	3,073	4,724
190	2,417	3,587	7,666	16,575	1,871	2,821	5,935	12,293
200	1,975	2,673	4,705	7,834	1,957	2,521	4,063	6,278
210	2,958	4,601	9,613	17,948	3,755	5,084	8,892	14,802
220	954	1,605	3,801	7,772	1,466	1,988	3,645	6,443
230	143	518	1,603	3,210	339	639	1,458	2,590
240	1,107	2,794	7,615	15,001	2,092	3,476	7,192	12,503
250	1,129	2,574	6,982	14,354	1,720	2,894	6,259	11,507
260	1,736	2,129	3,851	8,609	4,397	5,686	10,212	19,301
270	2,513	3,082	5,575	12,462	5,331	6,894	12,381	23,401
280	1,635	2,005	3,627	8,108	3,856	4,987	8,956	16,928
290	1,425	1,747	3,160	7,064	4,127	5,337	9,585	18,116
300	2	2	4	9	8	10	18	34
310	43	53	96	215	350	453	814	1,539
TOTAL	36,530	53,617	109,360	216,855	63,306	80,987	136,223	235,336

8.4.2 Estimated Traffic Volume on the Toll Road

The future road traffic volume was estimated by assigning the future OD traffic (matrix) to the future road network. The method used for this project traffic assignment is shown in Fig. 8.11.

A minimum travel time was adopted as a criterion when selecting possible alternative routes for a particular OD pair traffic.

The future OD traffic was divided into 5 steps of 20% of OD traffic and the assigned traffic volume was estimated separately for "via toll road route" and "via non-toll road route".

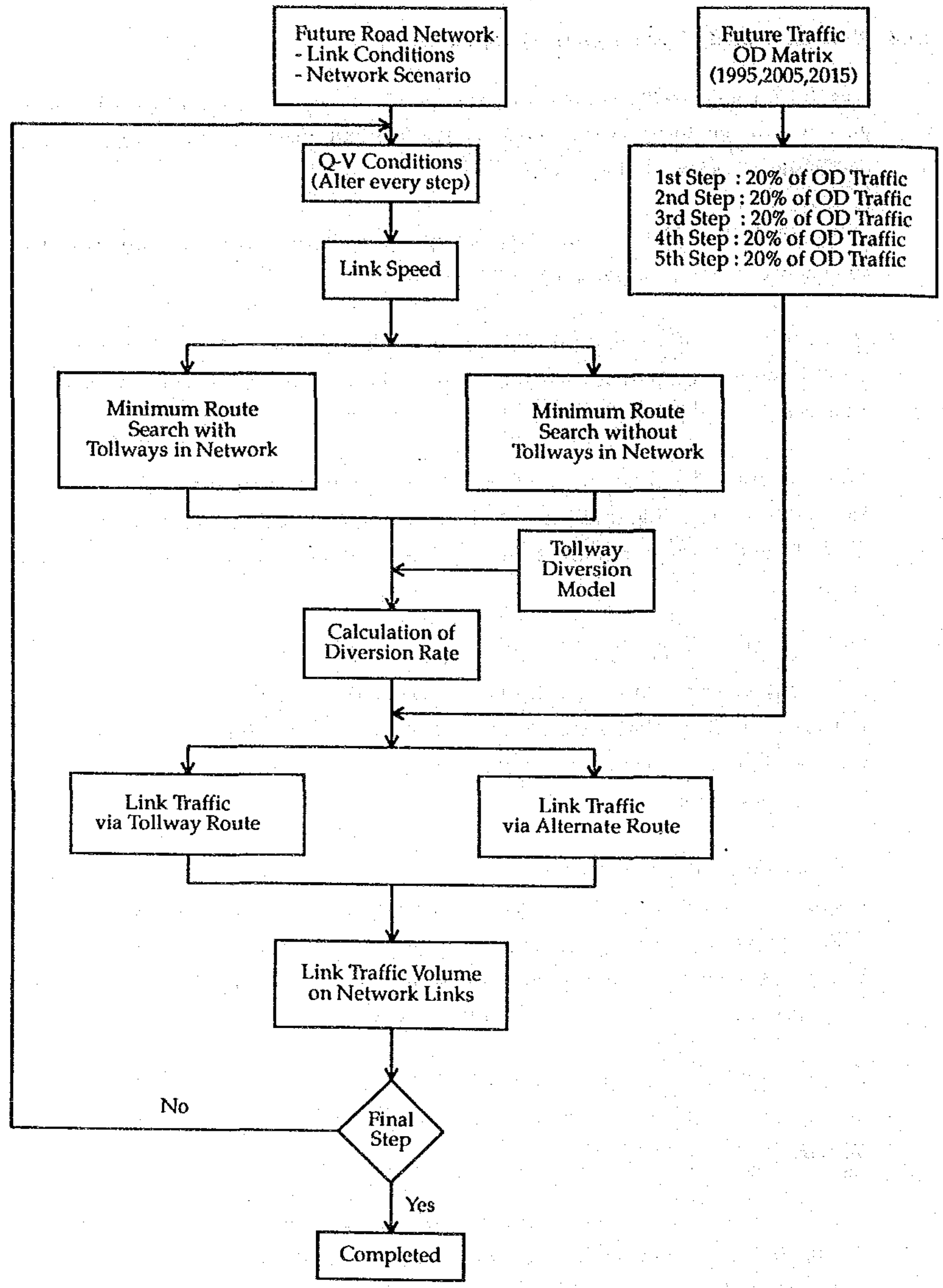
Link conditions (i.e. link speed) of the road network was evaluated after assigning the first 20% OD traffic to the network, and under the altered conditions the second 20% of the OD traffic was assigned to the network based on minimum time travel routings.

The travel time difference between "via toll road" and "via non-toll road" was computed for particular origin-destination traffic under the minimum route search process. The travel distance on the toll road was simultaneously calculated at the route search simulation stage. The distance is used to find the toll to be paid for respective toll roads.

Derived travel time difference and the corresponding toll for using toll roads were the basis used to calculate the rate of traffic diversion to the toll roads. The diversion model applied to the study was estimated as previously mentioned in Section 8.2 and the tariff system was assumed as the same as it is for Surabaya-Gempol Toll Road (distance-proportional tariff system in Waru-Gempol section).

The network scenario was composed of the road network development in the planning years of 1995, 2005 and 2015, and "with" and "without" the Toll Road options.

Numeric results of the traffic assignment present the projected future traffic volumes on the Toll Road and imply effects of the Toll Road that are to be quantified for testing the economic and financial feasibility of the Project.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.11 Flow Diagram for Estimating Future Assigned Traffic Volume

The forecast traffic volume is presented in Fig. 8.12. The forecast average traffic volume on the Toll Road is 12,100 veh./day in 1995, 39,900 veh./day in 2005, and 75,600 veh./day in 2015 and the number of toll road users is 13,700 veh./day in 1995, 50,800 veh./day in 2005 and 107,000 veh./day in 2015 as shown in Table 8.12.

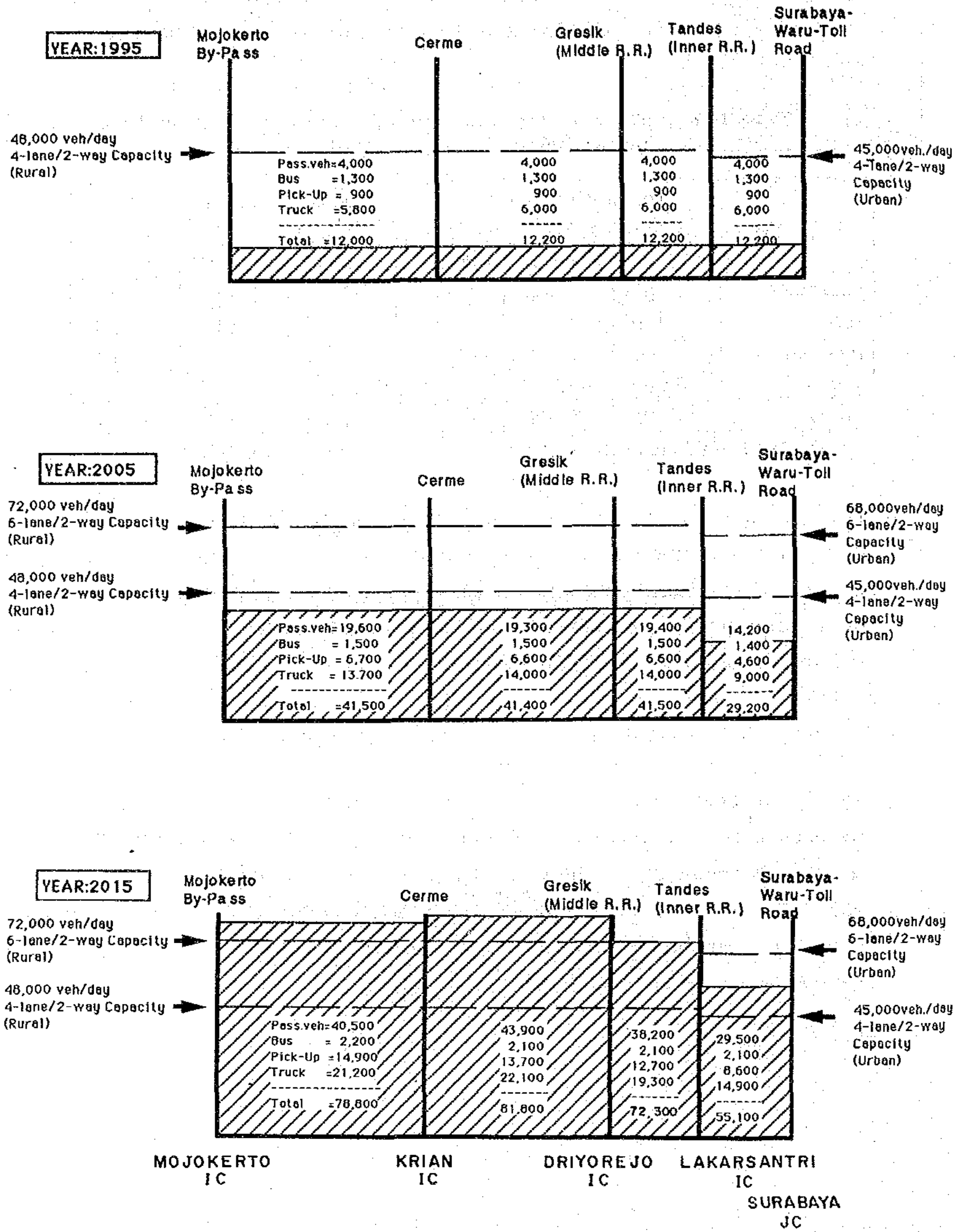
Table 8.12 Average Sectional Traffic Volume and Toll Road Users on the Toll Road

Veh. Type	Average Cross-sectional Traffic Volume (Veh./day)			Average Number of Toll Road Users* (veh./day)		
	1995	2005	2015	1995	2005	2015
Pass. Veh.	4,000	18,800	39,600	4,600	24,600	57,500
Bus	1,300	1,500	2,100	1,300	1,500	2,300
Pick-up	900	6,400	13,600	1,000	7,700	18,500
Truck	5,900	13,200	20,300	6,800	17,000	28,700
Total	12,100	39,900	75,600	13,700	50,800	107,000

Note*: This is half the number of total traffic on and off the Toll Road.

Decreases in the estimated future traffic volumes on the Toll Road are seen between Driyorejo IC and Surabaya JC in Fig. 8.12. It is observed that these decreases are brought about mainly by the shortage of road capacity of the Surabaya-Waru section of the Surabaya-Gempol Toll Road as well as the openings of the Inner Ring Road (i.e. toll free, the presumed opening of the eastern part to be connected with the Toll Road at Lakarsantri IC in 1999 and the western part in 2004) and the Middle Ring Road (i.e. toll free, to be connected with the Toll Road at Driyorejo IC in 2009).

Table 8.13 shows the forecast vehicle-kilometers on the Toll Road and the average travel distance of the Toll Road user. In the beginning of the Toll Road operation, the user travels around 90% of the total length of the Toll Road, 80% in 2005 and 70% in 2015. The traffic volume in 2005 reaches near the capacity of a 4-lane/2-way toll road. It is, therefore, recommended that the Toll Road should be widened to a 6-lane/2-way toll road around the year 2005.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig. 8.12 Estimated Future Traffic Volume on the Toll Road

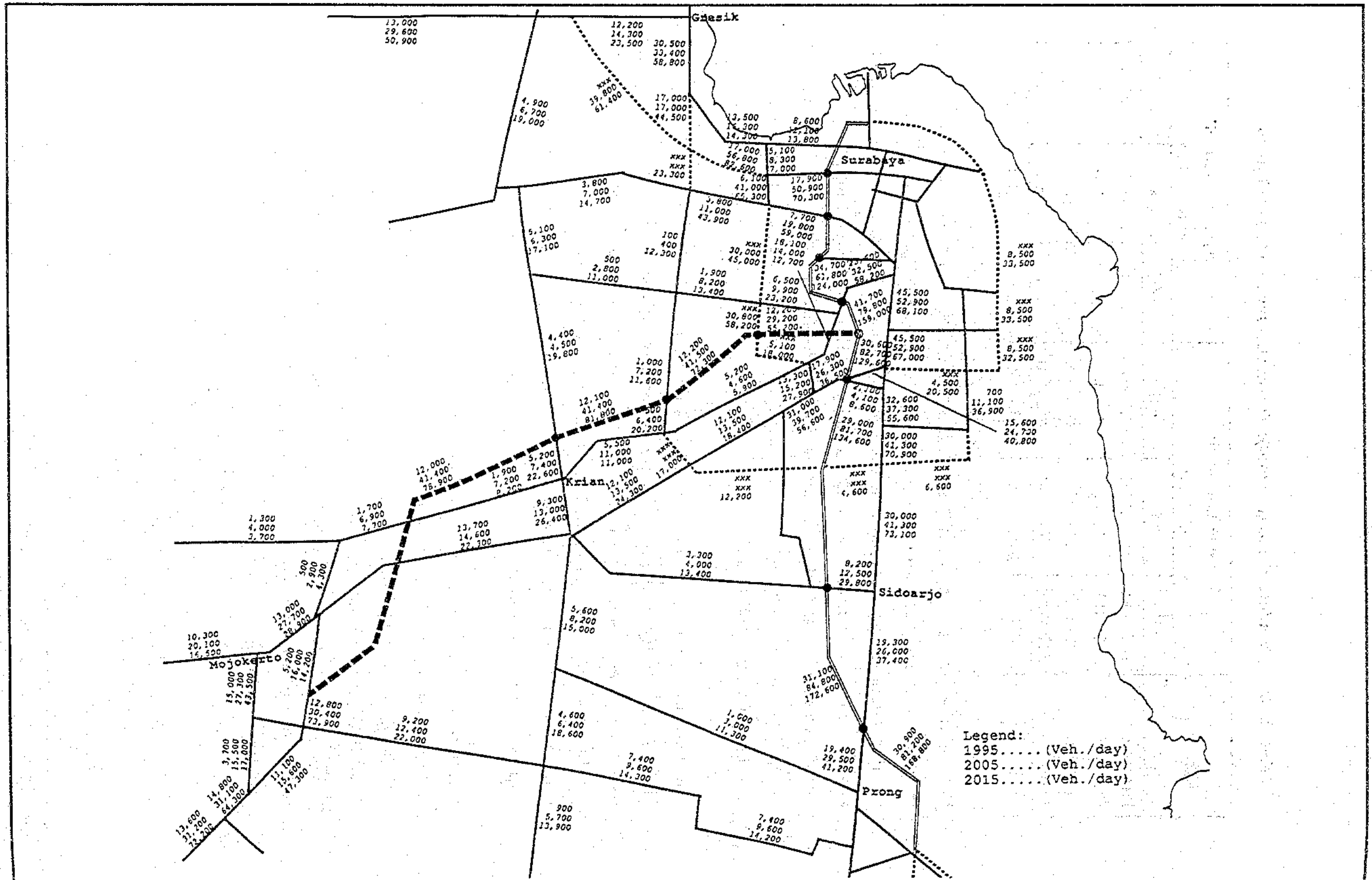
Table 8.13 Vehicle-km and Average Travel Distance on the Toll Road

Veh. Type	Vehicle-km on the Toll Road			Average Travel Distance (km)		
	1995	2005	2015	1995	2005	2015
Pass. Veh.	147,300	692,800	1,457,100	32.0	28.2	25.3
Bus	47,200	53,800	78,900	36.3	35.9	34.3
Pick-up	32,300	236,800	499,200	32.3	30.8	27.0
Truck	217,900	486,600	748,300	32.0	28.6	26.1
Total	444,700	1,470,000	2,783,500	32.5	28.9	26.0

Fig. 8.13 shows estimated future traffic volumes under the "with Toll Road" condition and Fig. 8.14 shows those under the "without Toll Road" condition. The existing 4-lane/2-way Surabaya-Gempol Toll Road is estimated to reach its capacity around the year 1997. The road capacity of the Surabaya-Gempol Toll Road influences on the traffic demand on the Surabaya-Mojokerto Toll Road, particularly in the toll road section between the Inner Ring Road and the Junction with the Surabaya-Gempol Toll Road.

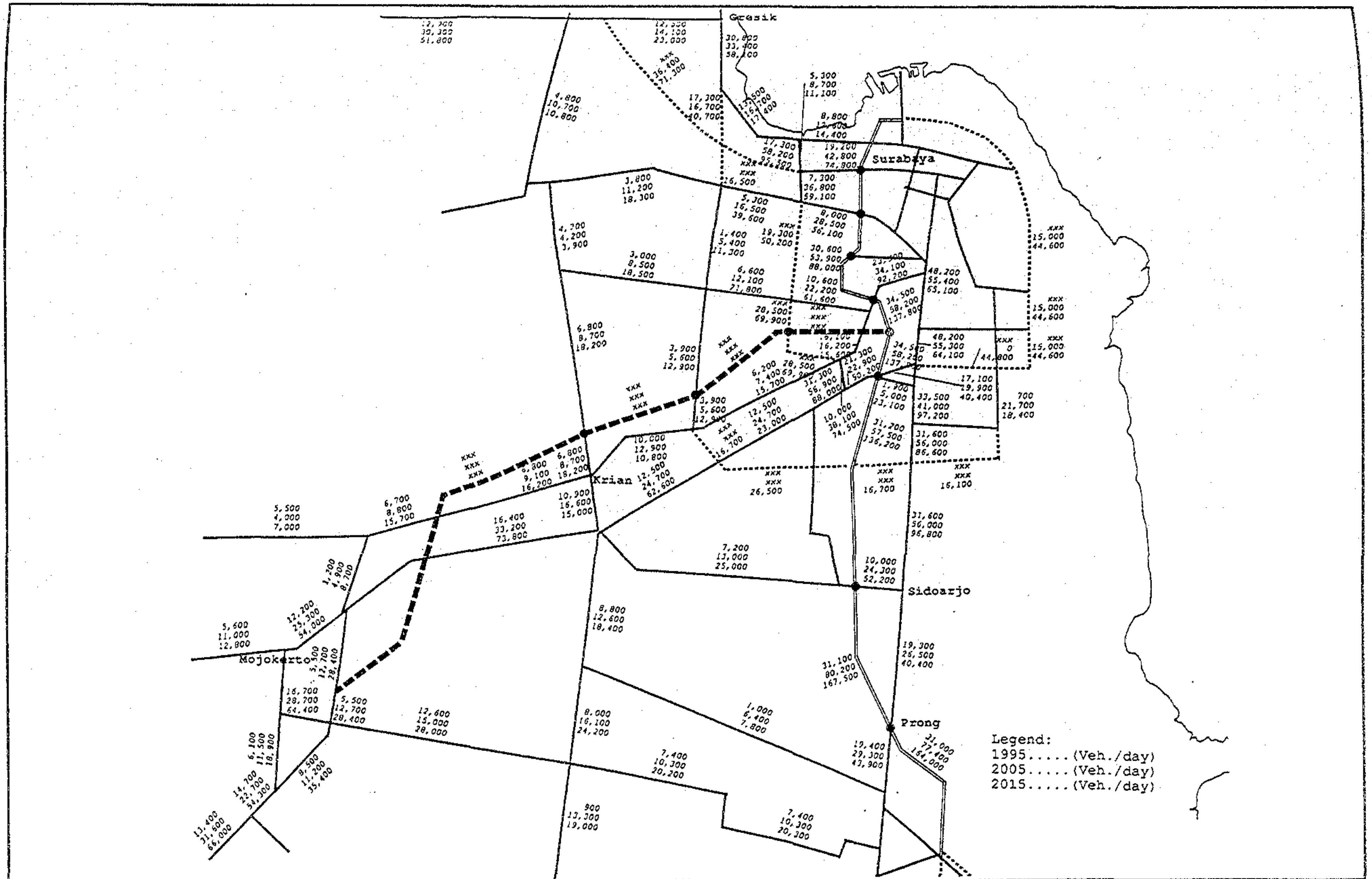
The widening of the Surabaya-Gempol Toll Road to a 6-lane/2-way toll road increases the traffic demand on the project Toll Road. The development of the Inner Ring Road is also influential to the Toll Road traffic demand. A total road capacity for the concentrating Surabaya-bound traffic is not sufficient to fulfill the future traffic demand. The road network development in Surabaya city is a matter of important and urgent issue.

A ring road as well as a radial road development will soon be required to cope with the future demand for the Surabaya-bound inter-city traffic. The Surabaya-Gresik Toll Road is scheduled to start construction soon and the Surabaya-Mojokerto Toll Road is expected to start operation in 1996. The Inner Ring Road development is required thereafter, together with the radial road development inside Surabaya city. Subsequently, the Surabaya-Gempol Toll Road should be widened to strengthen the Surabaya-Gempol corridor.



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 8.13 Estimated Future Traffic Volumes (With Project Condition)



SURABAYA - MOJOKERTO TOLL ROAD PROJECT

Fig. 8.14 Estimated Future Traffic Volumes (Without Project Condition)

Chapter 9

PRELIMINARY ENGINEERING DESIGN

CHAPTER 9

PRELIMINARY ENGINEERING DESIGN

9.1 General

This chapter describes the results of preliminary engineering design prepared for the selected optimum route based on the results of traffic demand forecast, topographic survey (1/5,000 scale topographic map was prepared by the Study Team), geological and soils and materials investigations and hydrological survey, covering the followings:

- Design standards
- Highway capacity and number of lanes
- Preliminary geometric design
- Cross sectional design
- Preliminary design of interchanges
- Preliminary design of bridges and other structures
- Preliminary design of pavement
- Relocation of roads, waterways and irrigation canals
- Toll road supporting facilities
- Length by structural type and major work quantities
- ROW acquisition and utility relocation/protection

9.2 Design Standards

This section discusses the design standards to be applied for the design of the Surabaya-Mojokerto Toll Road .

The design standards are divided into the following five sections:

- Geometric design standard
- Structural design standard
- Pavement design standard
- Drainage design standard
- Design standard of road lighting

The Government's standards are used to a maximum extent where available. The American and Japanese standards are referred to for items not covered in the Government's standards.

9.2.1 Geometric Design Standard

There exist the following two Government's standards related to the design of expressway.

- Standard Specifications for Geometric Design of Expressway and Freeway, No. 13A/1976
- Standard Specifications for Geometric Design of Urban Roads, January 1988

The former standard covers the design of rural expressway, though it is obsolete and is currently used with modifications incorporating the updating in design policies after its publication to meet recent conditions. Its revision is now intended to be issued by the Government. The latter standard covers the design of urban roads including high-standard roads to serve inter-region or inter-city high-speed traffic with full access control.

In addition to the above standards, the standards actually applied to the designs of Jakarta-Merak Toll Road (Tangerang-Merak Section, under construction) and Cikampek-Cirebon Toll Road (feasibility study completed in early 1990) were referred to, since both roads constitute parts of the Trans Java Tollway System.

(1) Geometric Design Standard for Throughway

The recommended geometric design standard for throughway of the Toll Road is shown in Table 9.1. The major points are briefly discussed in the following paragraphs:

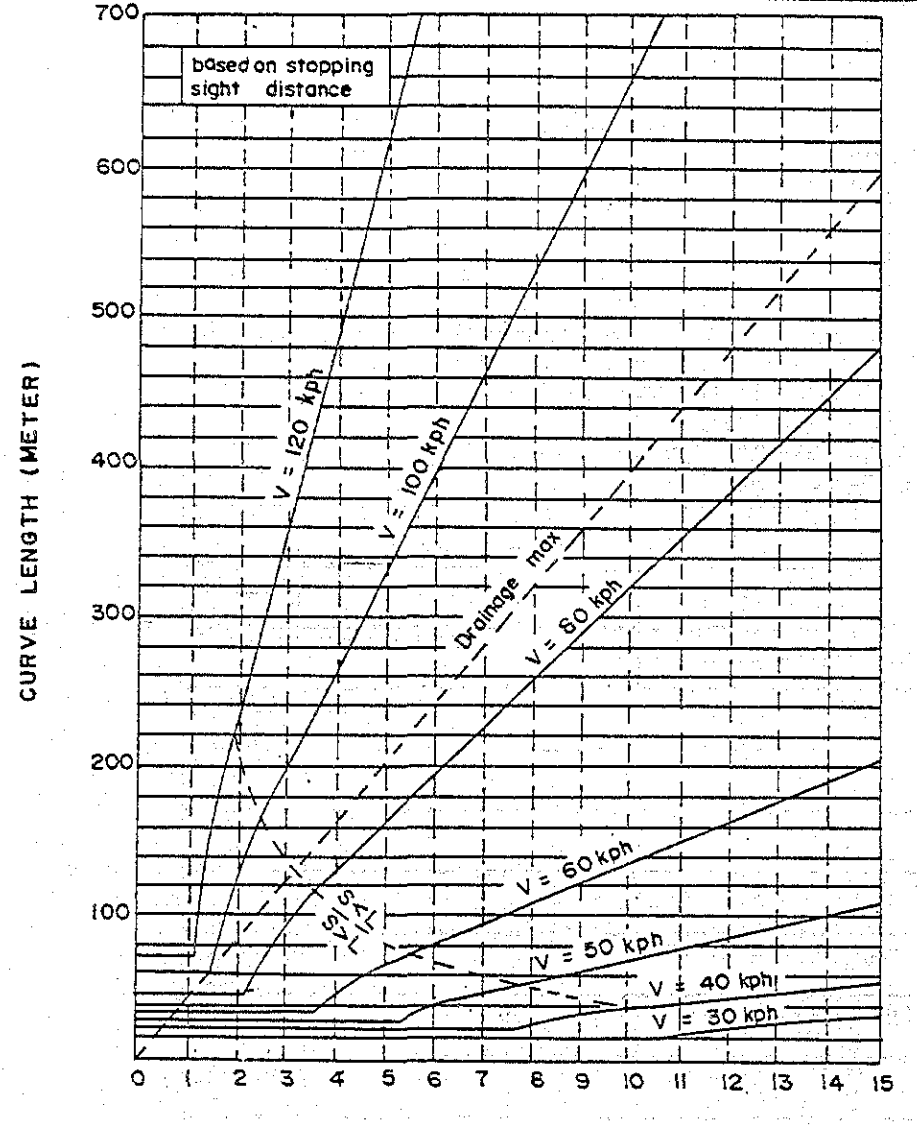
a) Design Speed

Basically, a 120/km design speed is recommended to be applied for the design of the Toll Road, taking into account the role of the Trans Java Tollway System to have high-speed and high-capacity services as a regional toll road. This design speed is the same as those applied for the design of the Jakarta-Merak Toll Road and the Cikampek-Cirebon Toll Road. Favorable terrain conditions in the Project Area also permit high-speed design.

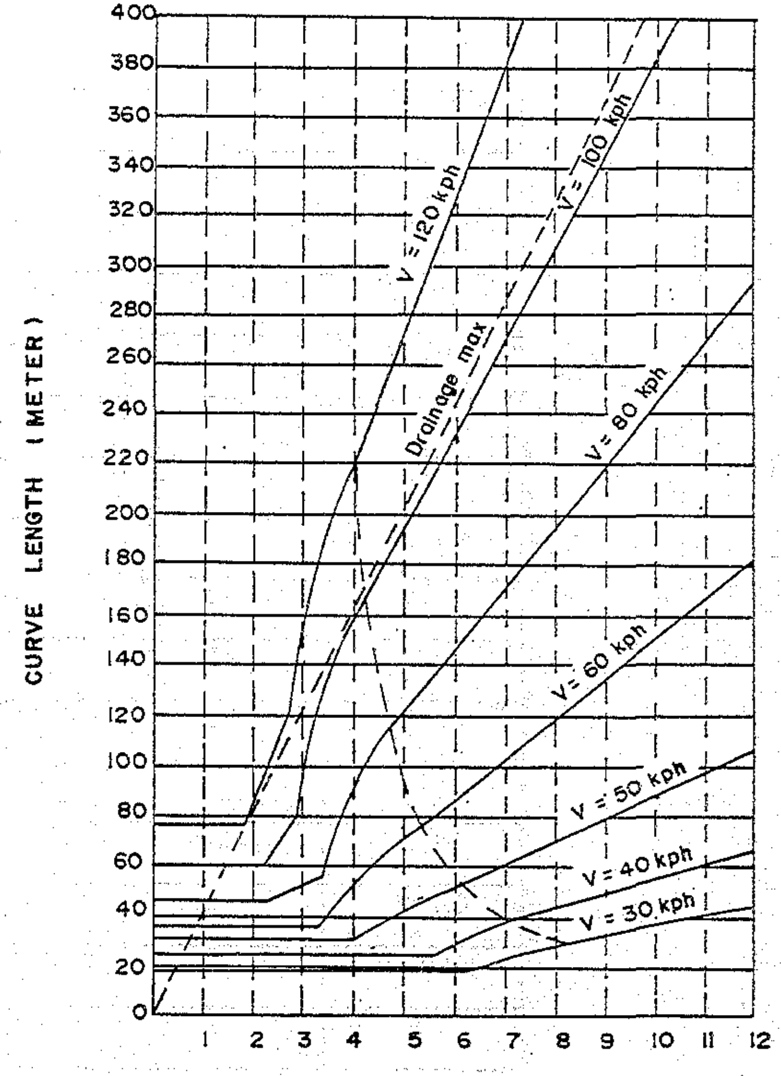
Table 9.1 Geometric Design Standard for Throughway of the Toll Road

ITEM	UNIT	THROUGHWAY GEOMETRIC DESIGN STANDARDS			
Project	-	SURABAYA-MOJOKERTO	JAKARTA-MERAK	CIKAMPEK-CIREBON	STANDARD (1976)
Terrain	-	Flat	Flat	Flat	Flat
Min.R.O.W. Width	m	As designed	As designed	As designed	60 or 70
Design Speed	km/h	120/100	120	120	120/100
Sight Distance	m	225/165	225	225	225/165
Lane Width	m	3.6	3.6	3.6	3.75
Median Width	m	5.5	8.0	5.0	5.5 or 18.0
Inner Shoulder Width	m	1.5	1.5	1.5	1.5
Outer Shoulder Width	m	3.0	3.0	3.0	3.0
Minimum Radii	m	760(570) /460(380)	570	760	760(530)
Minimum Radius not Requiring Transition Curve	m	4,000 /3,000	2,000	-	-
Minimum Radius not Requiring Superelevation	m	7,500 /5,000	7,500	-	-
Maximum Gradient	%	3.0/4.0	3.0	5.0	3.0/4.0
Minimum Vertical Curve Length	m	Fig.-A	Fig.-A	Fig.-A	Fig.-A
Crossfall of Carriageway	%	2.0	2.0	2.0	2.0
Crossfall of Shoulder	%	4.0	4.0	4.0	4.0
Maximum Superelevation	%	7.0(10.0) /9.0(10.0)	10.0	-	7.0(10.0)

Note : ( ) shows absolute minimum values.



LENGTH OF VERTICAL CREST CURVE



LENGTH OF VERTICAL SAG CURVE

SURABAYA - MOJOKERTO TOLL ROAD PROJECT	Fig.-A Minimum Vertical Curve Length

The eastern end of the Toll Road is the junction with the existing Surabaya-Gempol Toll Road. The design speed of the northern part of Surabaya-Gempol Toll Road, north of Waru IC, is 100 km/hr as an urban toll road (120 km/hr for the southern part as a regional toll road). In line with the Surabaya-Gempol Toll Road, it is recommended to apply 100 km/hr design speed for the eastern section of the Toll Road, east of the planned Inner Ring Road, for about 5 km length (as a section of urban toll road). For the remaining sections of the Toll Road, 120 km/hr design speed is applied. Table 9.1 shows the standard for both sections of 120 km/hr and 100 km/hr design speeds.

b) Lane Width

A 3.6 m lane width is recommended following the recent design policy of the Government, which is the same as that applied for the Jakarta-Merak Toll Road and the Cikampek-Cirebon Toll Road, and the Surabaya-Gempol Toll Road as well. A 3.6 m lane width is intended to keep the desirable lateral clearance of 55 cm at each side of a vehicle having a maximum width of 2.5 m.

c) Shoulder Width

A 3.0 m outer shoulder and a 1.5 m inner shoulder are to be adopted based on the 1976 Standard and to meet the standards adopted for the Jakarta-Merak Toll Road and the Cikampek-Cirebon Toll Road.

d) Median Width

The median width is expressed as the dimension between the through-lane edges and includes inner shoulders. The principal functions of a median are:

- To provide freedom from undesirable interference of opposing traffic
- To minimize headlight glare
- To provide open green space
- To provide space for pier construction of grade separation structure

It is recommended to provide a 5.5 m median including 1.5 m inner shoulders and with 2.5 m width raised. A 2.5 m width is generally sufficient for the construction of pier columns of grade separation structure including space for protection with guardrail.

(2) Geometric Design Standard for Interchange Ramps

The recommended geometric design standard for interchange ramps of the Toll Road is shown in Table 9.2, together with the standard of the throughway in the vicinity of ramp terminals. The values in Table 9.2 are based on the Standard Specifications for Geometric Design of Urban Roads, January 1988, except for several items which refer to the Japanese standards and AASHTO standards.

As for the design speed of interchange ramps, AASHTO recommends the followings (refer to "A Policy on Geometric Design of Highway and Streets, 1986").

Ramp Design Speed

- Upper range : 85% of highway design speed
- Middle range : 70% of highway design speed
- Lower range : 50% of highway design speed

Minimum Design Speed by type of ramp

- Loops : 40 km/hr (25 mph)
- Semi-direct connection : 48 km/hr (30 mph)
- Direct connection : 56 km/hr (35 mph)

While, the Japanese Standards specifies the speed as shown below:

Category	Design Speed of Throughways (km/hr)	Design Speed of Interchange Ramps (km/hr)
Junctions	120/120	50-80
	120/100	50-80
	100/100	50-80
Interchanges	120/60	40-60
	120/80	40-50

With reference to the above, a 50 km/hr design speed for the ramps of junction (tollway-to-tollway interchange) and a 40 km/hr design speed for the ramps of interchange (tollway-to-artery interchange) are recommended.