PART II: SIMULATION ANALYSIS AND PLANNING IMPLICATIONS

CHAPTER 4: LAND DEVELOPMENT POTENTIAL AND FUTURE URBANIZATION

4.1 Objectives of the Analysis

The Urban development potential analysis aims to recognize the urbanization process of Bangkok and simulating future land potential and future urbanization direction. From the analysis, future land potential change, future land use of policy free case of future urbanized area, and population allocation are obtained.

4.2 Methodology

An urbanization model is developed with selected indicators for existing conditions of Bangkok, which strongly affect on land utilization. The Study Team scores each indicator, then counted total score by 1 km grid columns covering all of Bangkok. The scoring system changed through the calibration process until the model fit the real built-up area.

The future land potential is simulated by the developed urbanization model with future infrastructure conditions.

Based on the future land potential, the future urbanized area is simulated with a population framework. The assumption implied is that urbanization will occur from the higher-score grid column.

The analysis flow chart is shown in Fig. 4.1.

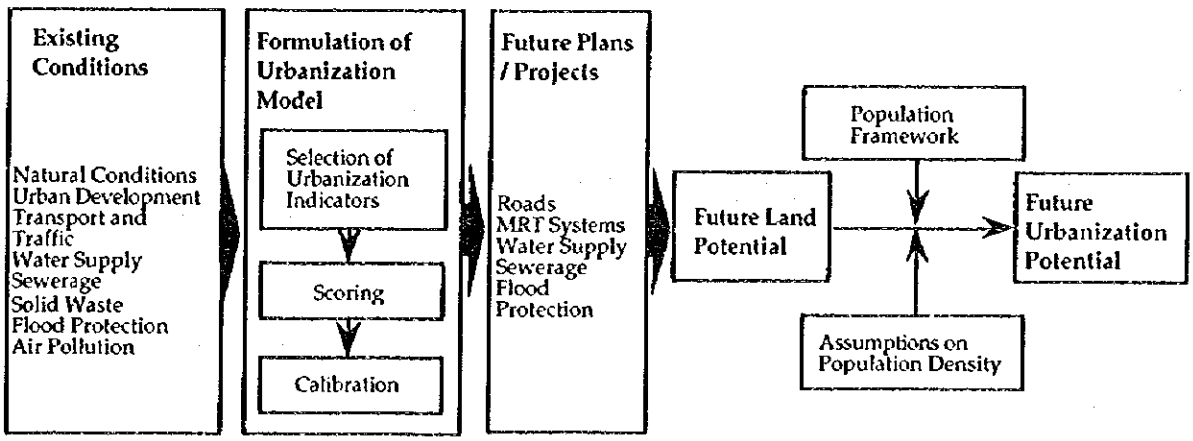


Fig. 4.1 Flowchart for Urban Land Development Potential Analyses

4.3 Urbanization Model

(1) Selected Indicators

To formulate the urbanization model, appropriate indicators have to be selected. In general, urbanization is affected by natural conditions and convenience of living and commuting, which are heavily affected by the level of infrastructure provided. In this sense, indicators related to natural conditions, sanitary services, transport and urban services are selected, as follows:

Natural conditions:
- Land subsidence
- Flood area (1983,1995)
- Flood protection

Sanitation services:
- Water supply
- Sewerage

Transport services:
- Accessibility to arterial roads
- Availability of rail service
- Availability of bus service
- Availability of MRT service (only for the future)

Urban services:
- Time distance from urban center
- Accessibility to hospital
- Accessibility to commercial facilities

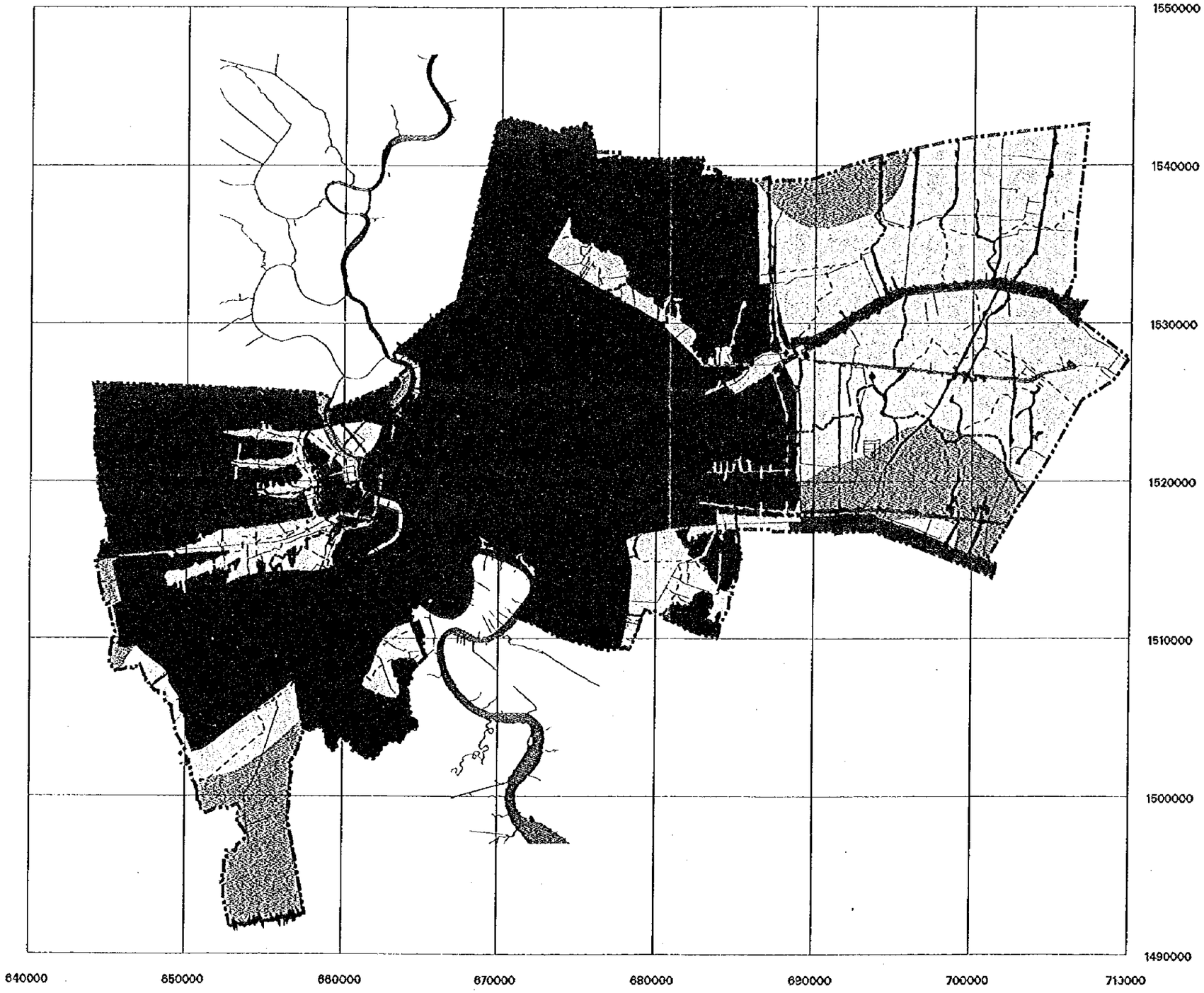
(2) Scoring System

Since the magnitude of the impacts to urbanization differ with the indicators selected, it is necessary to apply appropriate weight to each indicator. The BEIP Study Team conducted many trials in order to explain the current urbanized area of Bangkok, and finally to obtain the scoring System as shown in Table 4.1. Score points are given to all of BMA, applying this scoring system. Fig. 4.2 to 5 show the results of scoring by the categories.

Table 4.1 Indicators for Urbanization Model

	Score								
	-3	-2	-1	0	1	2	3	4	5
Natural Conditions									
Land Subsidence	>1.5m	1.0-1.5m	0-1m	0m	-	-	-	-	-
Flood in 1983	Yes	-	-	None	-	-	-	-	-
Flood in 1995	Yes	-	-	None	-	-	-	-	-
Flood Protection	A Zone	B Zone	C Zone	Others	-	-	-	-	-
Sanitation Services									
Water Supply	-	-	-	None	Yes	-	-	-	-
Sewerage	-	-	-	None	Yes	-	-	-	-
Transport Services									
Accessibility to Arterial Road	-	-	-	-	None	1 Km of L3	0.5Km of L3	1km of L1/L2	0.5 Km of L1/L2
Availability of Rail Service	-	-	-	-	None	2 Km from STN	1.5 Km from STN	1 Km from STN	0.5 Km from STN
Availability of Bus Service	-	-	-	-	None	-	1000m Zone	-	500m Zone
Availability of MRT Service	-	-	-	-	None	-	1000m Zone	-	500m Zone
Urban Services									
Time Distance to Urban Center	-	-	-	-	>75 Min.	60-74	45-59	30-44	<29 Min.
Accessibility to Hospital	-	-	-	-	>5 Km	3-5 Km	2-3 Km	1-2 Km	<1 Km
Accessibility to Commercial Facilities	-	-	-	-	>15 Km	10-15 Km	5-10 Km	2-5 Km	<2 Km

Fig. 4.2



Land Potential Evaluation
Natural Conditions

Legend

- -11 ~ -10
- -9 ~ -8
- -7 ~ -6
- -5 ~ -3
- -2 ~ 0
- Main Road
- BMA Boundary
- District Boundary
- Subdistrict Boundary
- Chaopraya River

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KILOMETERS

UTM Zone 47

THE STUDY
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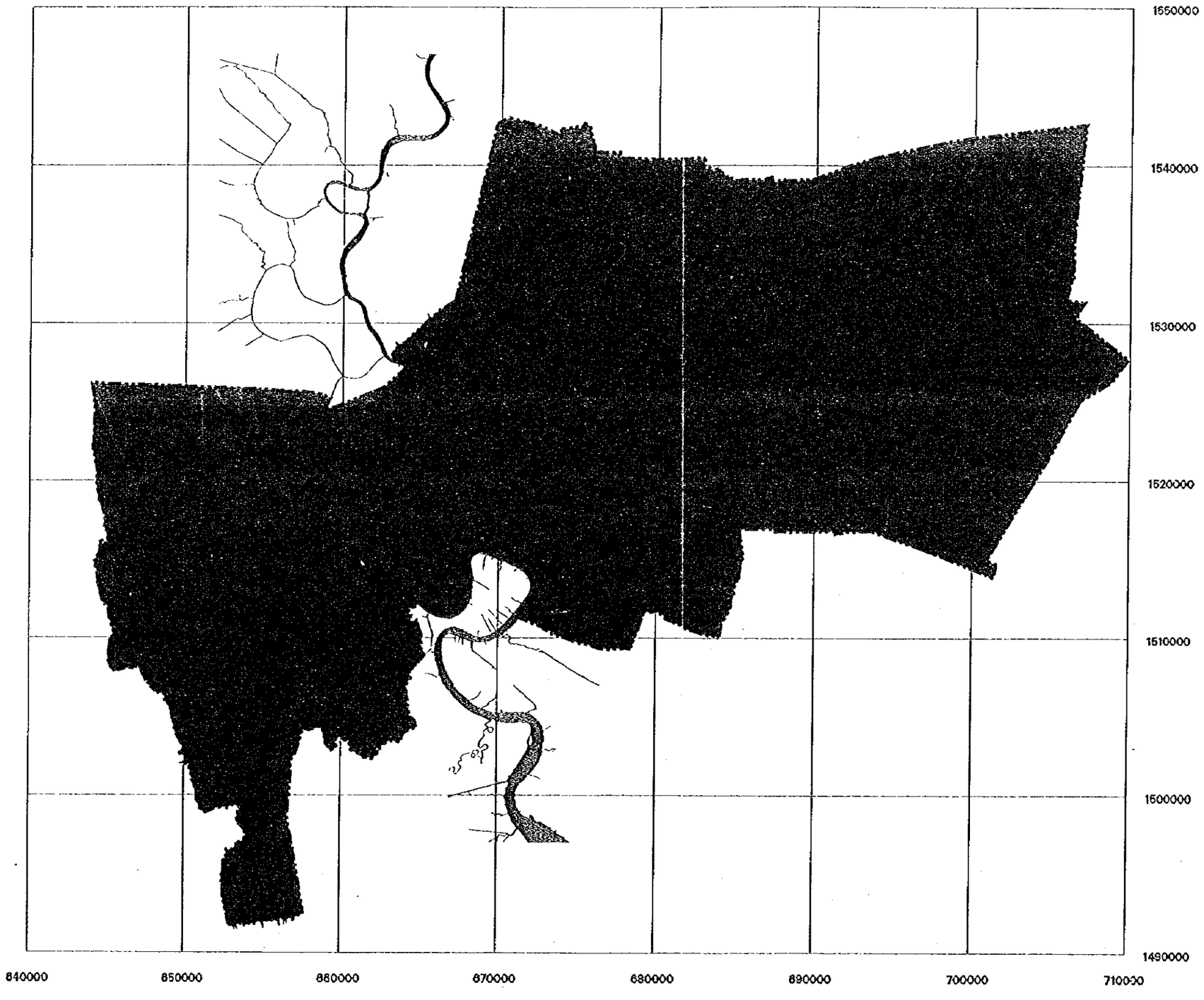
Fig. 4.3



Land Potential Evaluation Sanitation Services

Legend

- 0
- 1
- 2
- Main Road
- BMA Boundary
- District Boundary
- Subdistrict Boundary
- Chaopraya River

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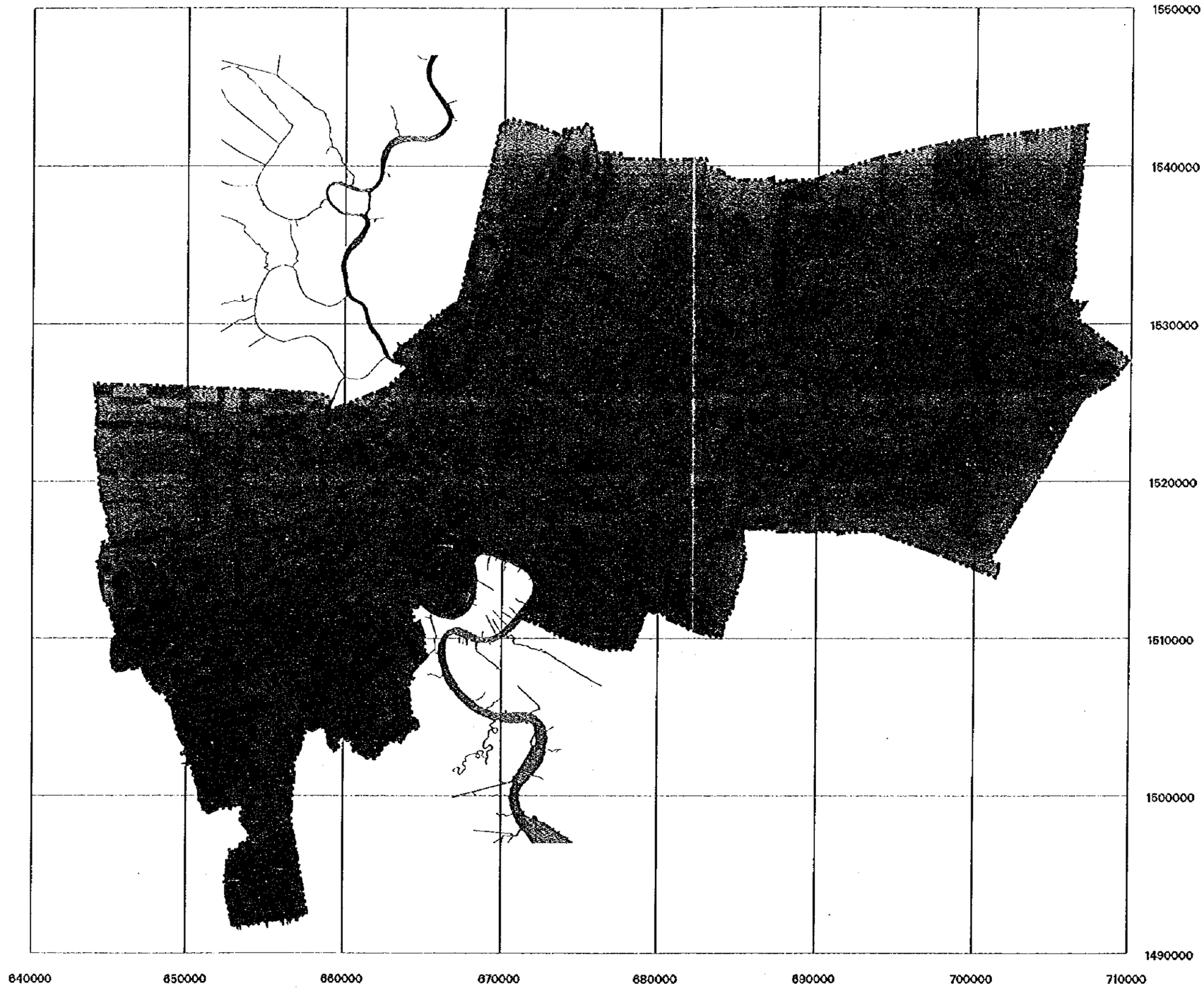

Land Potential Evaluation
Transport Services

Legend

- 1 ~ 3
- 4 ~ 6
- 7 ~ 9
- 10 ~ 12
- 13 ~ 15
- Main Road
- BMA Boundary
- District Boundary
- Subdistrict Boundary
- Chaopraya River

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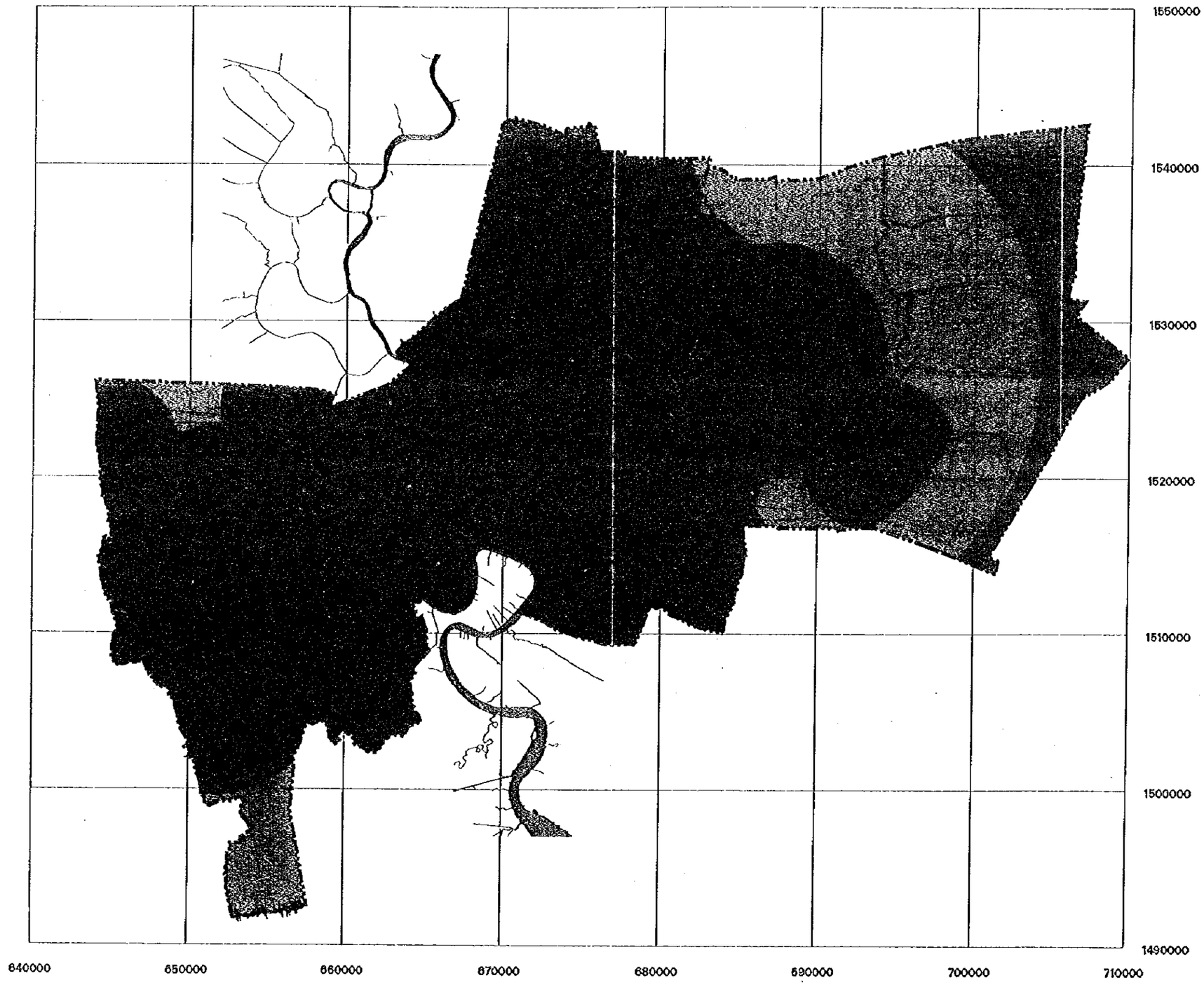

Land Potential Evaluation
Urban Services

Legend

- 1 ~ 2
- 3 ~ 4
- 5 ~ 6
- 7 ~ 8
- 9 ~ 10
- Main Road
- BMA Boundary
- District Boundary
- Subdistrict Boundary
- Chaopraya River

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(3) Simulated Urbanized Area

Fig. 4.6 shows a result of the simulation in 1995. The model successfully explains the real built-up area of Bangkok.

4.4 Distribution of Urban Development Potential

(1) Indicators

The future land potential is simulated by the urbanization model, and the adaptation of the following future expansion plans of infrastructure are taken into consideration:

- Water supply;
- Sewerage;
- Roads; and
- Mass rapid transit.

(2) Results of Analysis

Suburban areas improve the land potential due to the provision of infrastructure. The largest improvements of the land potential are identified in certain areas in the Prawet, Lat Krabang, Minburi, Bang Kapi and Bang Khun Thian Districts. However, the present built-up areas are not improved as there is little infrastructure planned at present.

In detail, the sub-districts can be classified into the following 4 groups in terms of future land potential:

1) Sub-district Group with More Than 90 % of the Built-up Ratio and Limited Open Spaces

This sub-districts group is mainly located in the old urbanized area in Bangkok. In these areas, accessibility to the main road network or commercial center is excellent and basic urban facility services are also excellent.

The average population density in this group is 352 person/ha, which is almost equal to the density of the built-up area of 365 person/ha in Tokyo. However, there are extremely populated areas with more than 900 person/ha of the population density.

Another characteristic of this group is that the area is relatively narrow. For instance, Si Phraya is 0.76 Km^2, Maha Phuttharam is 0.65 Km^2, and Thung Phaya Thai is 2.51 Km^2. Because of the high population density with a limited open space ratio, this group seems to have limited urbanization potential. Therefore, it is necessary to take into account the combination of land intensification and urban redevelopment.

2) Sub-districts Group with 76-89 % of Built-up Ratio

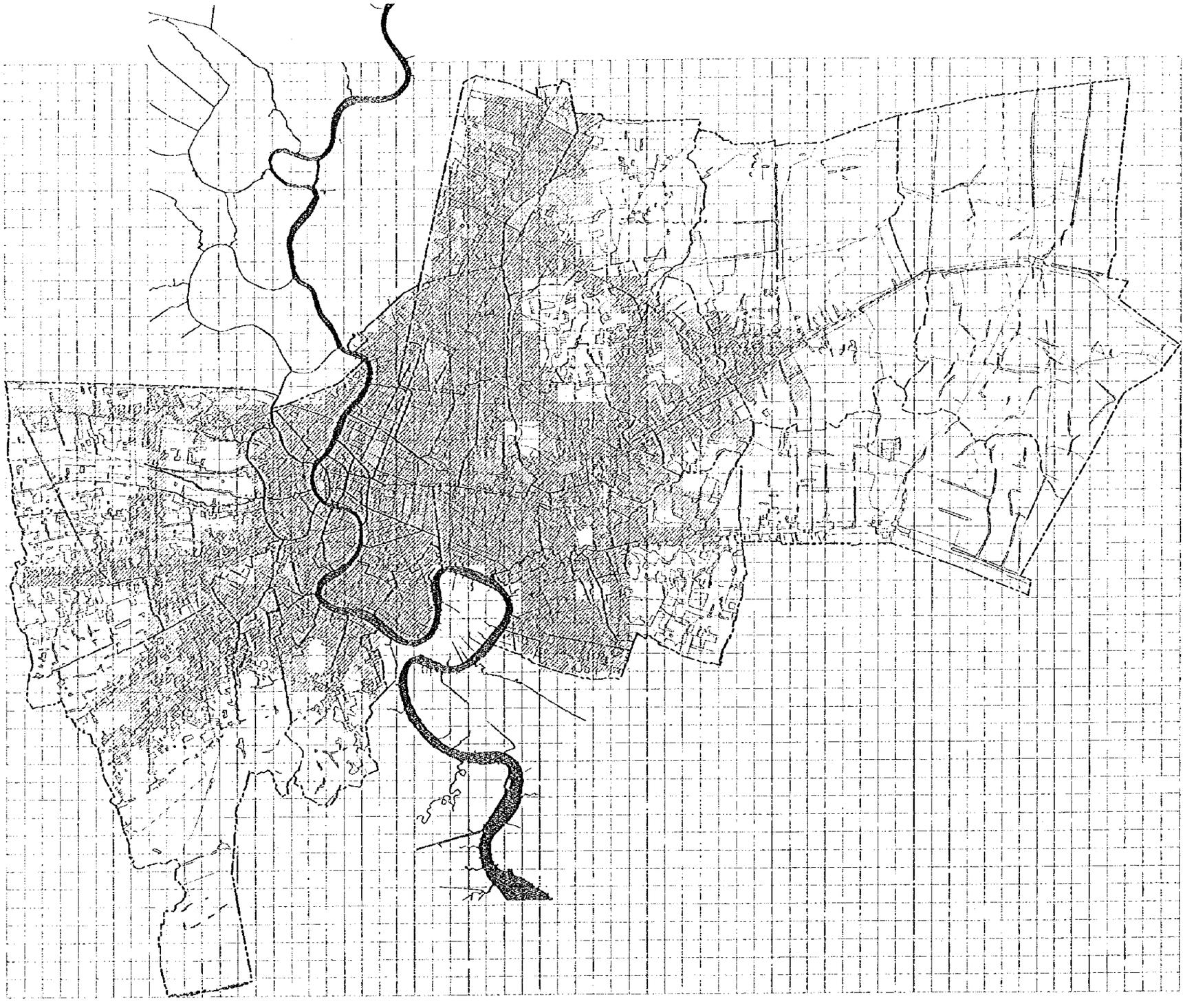
This group is located in almost the same district mentioned above. The basic characteristics of the population density, accessibility to the urban facility services and road network are almost the same. The area of these sub-districts is also very narrow and the future urbanization potential is limited.

3) Sub-districts Group with 51-75 % of Built-up Ratio

In this group, the population density shows the average level of the population density of Bangkok entirely, which is 148 person/ha in the built-up areas. Accessibility to urban facilities in this group is relatively low at this moment, while future urbanization potential seems to be high in several sub-districts such as Hua Mak and Thong Song Hong.

Fig. 4.6

Simulated Urbanized Area (1995)



Legend

- Chaopraya River
- Buildup Area
- Simulated Urbanized Area
- BMA Boundary
- District Boundary
- Subdistrict Boundary

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4) Sub-districts Group with Less Than 50 % of Built-up Ratio and Enough Open Spaces

This group is located in the fringe area of the existing urbanized area. The area of each sub-district is relatively large and the average population density is 146 person/ha in the built-up area and 49 person/ha in total. Accessibility to urban facilities is also relatively low at this moment, however, certain sub-districts such as Chim Phli, Khlong Thanon, Khanna Yao, Saphan Sung, Bang Khae Nua, Minburi and Nong Khang Phlu have higher future land use potential with infrastructure provisions and enough vacant spaces.

The results of the future urbanization potential analysis is shown in Fig. 4.7.

4.5 A Simulated Urbanization Pattern for the Future (Growth Policy -free Case)

Based on the future land potential analysis, a future urbanized area for 2011 is simulated with a population of approximately 10.4 million. To this end, the future population density at newly built-up areas is assumed to be 110 person/ha, which is same level as the present population density at the built-up areas in the suburban districts.

Consequently, urbanization is expected to occur in the same direction as present. Therefore, Don Muang, Minburi, Bang Kapi, Prawet, Phra Khanong, Taling Chan, Phasi Charoen and Bang Khun Thian Districts are expected to be mostly urbanized by 2011.

The result of the simulation seems to show a probable urbanization pattern in the case of policy free which no policies carried out on the urban spatial structure but infrastructures are provided.

The results of the future urbanization simulation is shown in Fig. 4.8.

4.6 Planning Implications

(1) Effects of Infrastructure Provision on Urbanization

It has been shown that the land potential can be improved by developing physical conditions, especially the transport network. It is implied that urbanization can be directed appropriately with infrastructure provisions.

(2) Necessity to Control Land Use

Certain areas in the Minburi, Lat Krabang, Bang Khun Thian Districts are simulated to have rapidly improved their land potential. It is, accordingly, foreseeable that these areas could receive much investment and land development. Therefore, certain measures to control disorderly development and land speculation should be taken into account in these areas.

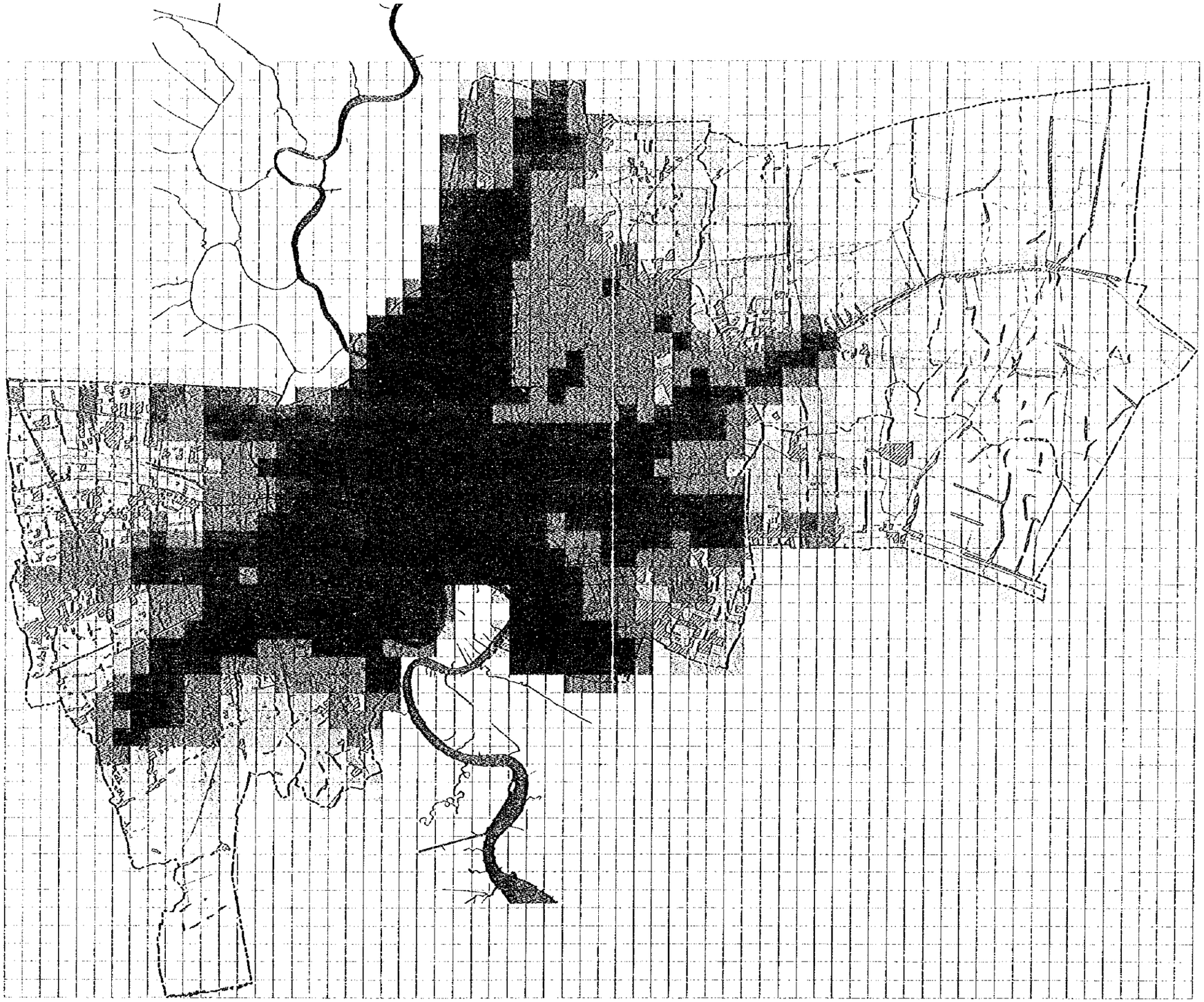
(3) Necessity of Urban Renewal

Certain areas in the central areas are simulated to have a relative decline in their land potential. It is, accordingly, possible to foresee that these areas are developed according to a commercial market basis, resulting in the low utilization of land and in a deteriorating living environment. It is, therefore, necessary to support regenerating/ intensifying existing land use and urban functions by the public sector.

(4) Area to be Urbanized

Future urbanization simulation shows approximately the necessary spaces for future population increase. In comparison to the future urbanized areas and land use plan of the 1992 General Plan or The Bangkok Plan by MIT, larger areas have been designated to be urbanized as residential areas. This may result in disorderly development with the present development control measures. Since their population framework is more or less 10 million, it is not necessity to urbanize such a large area.

Fig. 4.7



Future Urbanization Potential(2011)

Legend

- 1: Highest Potential Area
- 2
- 3
- 4
- 5
- 6
- 7
- 8: Lowest Potential Area
- Build-up Area
- Chaopraya River
- BMA Boundary
- District Boundary
- Subdistrict Boundary

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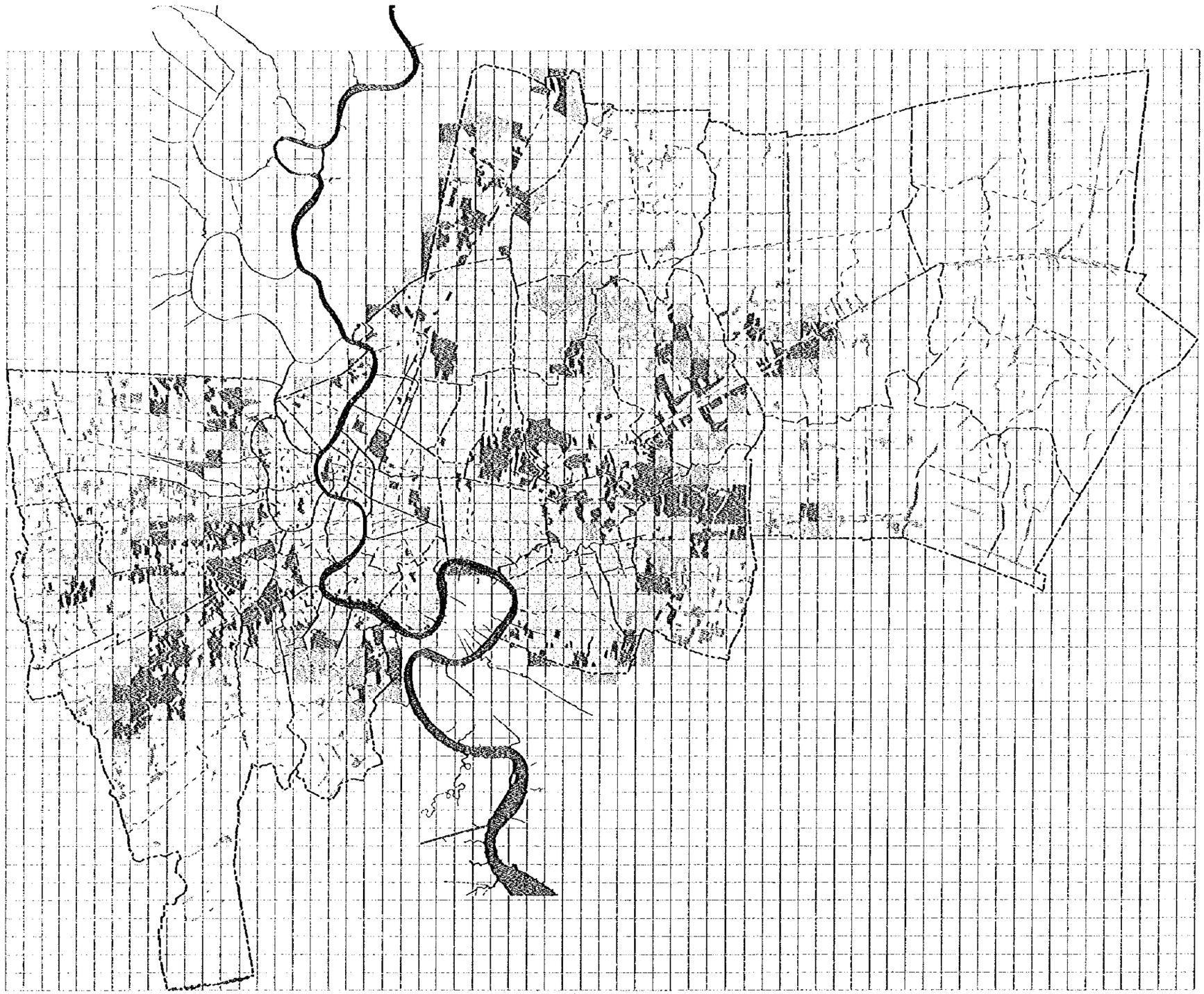
Fig. 4.8



Future Land Use Simulation

Trend Based Policy Free Case-1

Legend

- Build-up Area
- Urbanized Area in 2001
- Urbanized Area in 2006
- Urbanized Area in 2011
- Chaopraya River
- BMA Boundary
- District Boundary
- Subdistrict Boundary

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CHAPTER 5: TRANSPORT SIMULATION ANALYSES

5.1 Objective of the analysis

The objective of the simulation is to test numerically the transport concepts and principles that are seen as the foundation of the "Transport Vision for Bangkok" in Chapter 2 of Volume 3. This simulation cannot be confined to Bangkok but must embrace the whole region that has a major interaction with Bangkok namely the Bangkok Metropolitan Region (BMR). For example, the traffic congestion on Sukumvit Road does not stop abruptly when you cross the BMA boundary, it continues on the other side of the boundary into the adjacent province of Samut Prakhan.

Several transport philosophies are considered in this project and the simulation analysis must be capable of the evaluation of the impact of the different policies and philosophies. In all ten cases are simulated by the Bangkok Urban Model (see Table 5.1). These range from the existing situation to two different demand projections for the Year 2011. They include model runs with and without improved public transport, an increase in local road space and a simulation of area restraint .

Table 5.1 Description of the Ten Simulations

	DEMAND			SUPPLY			SPECIALPOLICY
	1995	TREND 2011	NEW 2011	1995	8th Plan Road Projects	MRT	
CASE1	•			•			
CASE2	•			•	•		
CASE3	•			•	•	•	
CASE4		•		•			
CASE5		•		•	•		
CASE6		•		•	•	•	
CASE7		•		•	•	•	BUSPRIORITY
CASE8		•		•	•	•	ROADCAPACITYINCREASE
CASE9		•		•	•	•	AREARESTRAINT
CASE10			•	•	•	•	SUBCENTERDEVELOPMENT

Notes:

1: The 8th Plan Road Project includes all the major road projects as supplied by agencies .

2. MRT is the mass transit system as defined by CMIP, the mass transit master plan of OCMRT .

The output from the transport also becomes an important input into the analysis by GIS. It also provides the primary input into the environmental air pollution analysis thus providing the vital link between the impact of transport policies on the environment.

5.2 Methodology

(1) Methodology Overview

During BEIP, a transport model, the Bangkok Urban Model was developed for the purpose of testing various transport options. The basic inputs to the transport model were :

- Land Use Planning Data
- Network Characteristics
- Travel Demand Characteristics

Future travel demand is forecast using a four step transport model. The forecasting procedure is described in Figure 5.1 and is discussed in detail in Appendix 1. There are five major steps in the model:

- Trip Generation - Pre Distribution Modal Split
- Trip Distribution
- Modal Split - Post Distribution
- Non Person Trip Table Development
- Traffic Assignment

Prior to the start of the development of the trip generation, estimates for Land Use Data were prepared for 2011 for two land use scenarios , one following the general trend in Bangkok, the other driven by the development of Sub - Centers at Lat Krabang ; Talin Chan and Bang Kungthian. At a global level there is little difference between the two scenarios but the distribution is different at the zonal level. For input into trip generation and attraction, the following land use parameters needed estimation at a zonal level namely :

- Population
- Number of Households
- Household Income
- Employment Places
- Tertiary Employment
- Student Places

A comparison between the major land use parameters in 1995 and 2011 for the trend case is presented in Table 5.2 for each district in the BMA.

(2) Trip Generation

In the Trip Generation step of the model the land use planning data is developed into trips starting and ending in a traffic zone i.e. trip production and attraction respectively. The first stage is to determine the apportioning of households between the four vehicle ownership categories namely :

- No Vehicle
- Motorcycle, at least one (M/C)
- One Car
- Two Car or more than two cars

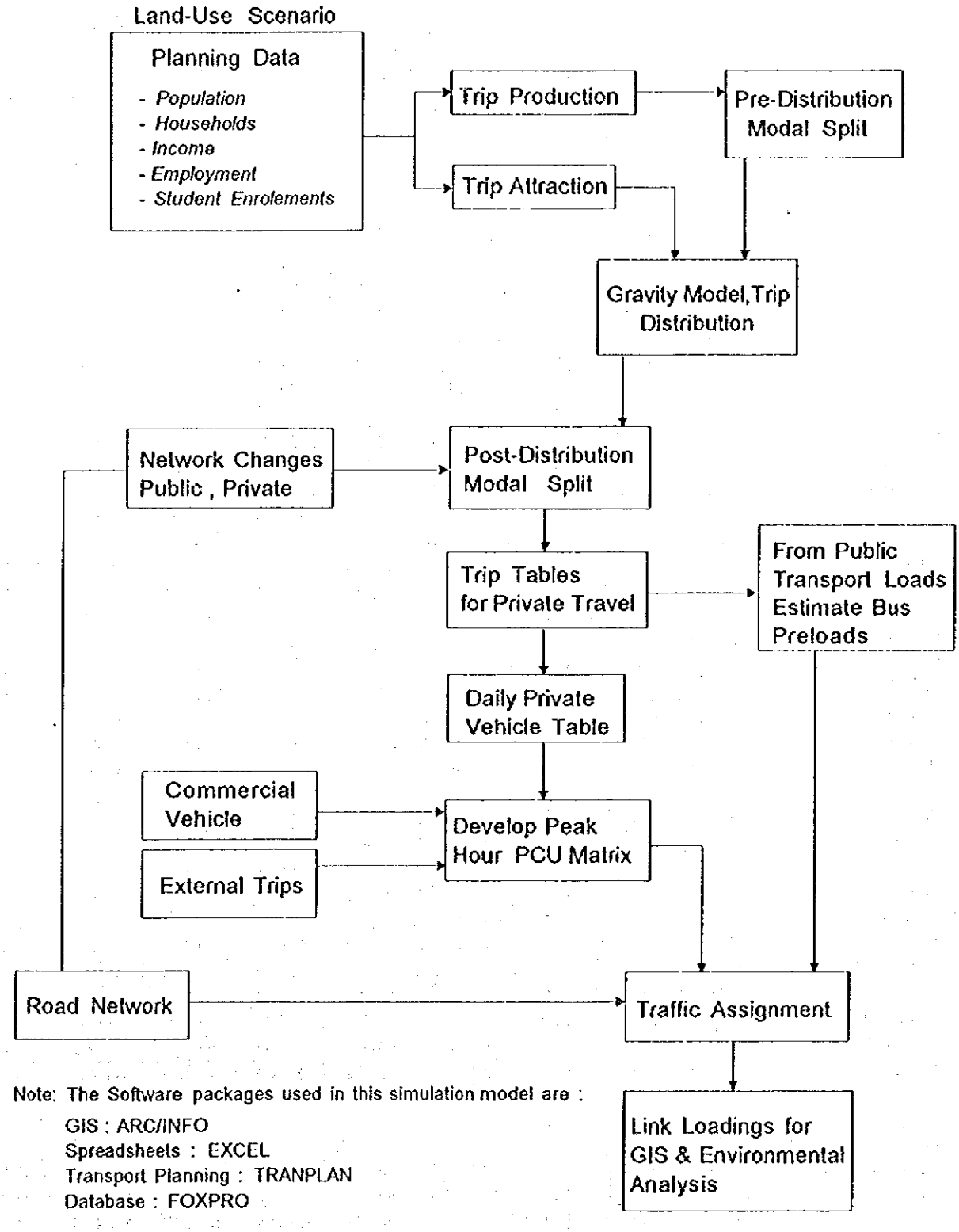


Fig. 5.1 Traffic Demand Forecasting Procedure

Table 5.2 Summary of Demographic Data

District	Population		HouseholdSize		AverageHH Income		JobPlaces		StudenPlaces	
	1995	2011	1995	2011	1995	2011	1995	2011	1995	2011
PhraNakhon	106,334	107,190	4.49	4.02	27,580	44,048	158,370	301,928	69,542	71,075
PomPrapSattruphai	198,739	181,747	4.54	4.17	17,248	27,620	99,345	143,291	30,872	28,215
Samphanthawong	73,479	67,422	4.60	4.11	36,783	58,834	52,092	83,236	16,610	15,241
BangkokNoi	251,535	308,989	4.22	3.90	15,497	24,819	41,509	59,973	50,816	60,519
BangPhlat	247,004	301,047	4.18	3.81	19,902	31,448	77,430	125,852	39,977	49,097
KhlongSan	144,402	167,473	4.61	4.12	18,591	29,736	77,766	105,743	15,749	18,254
Thonburi	296,430	343,068	4.42	3.95	15,074	24,114	85,862	115,151	48,637	56,143
BangkokYai	103,961	127,170	4.27	3.85	17,725	28,353	46,686	66,209	44,657	54,631
Dusit	283,042	282,910	3.99	3.67	22,671	36,260	84,911	124,549	115,323	115,296
BangRak	164,413	150,669	4.09	3.79	14,985	23,955	296,236	451,530	50,219	46,028
BangKhoLeam	144,223	168,481	4.28	3.84	13,215	21,134	84,683	116,020	11,246	13,052
BangSue	338,730	404,365	3.93	3.58	23,138	37,222	85,456	109,689	40,195	50,403
Pathumwan	290,939	266,851	4.48	4.02	16,389	26,214	163,612	259,048	91,673	83,849
PhayaThai	254,027	307,974	3.77	3.57	18,561	30,019	73,320	127,026	33,577	42,367
YanNawa	152,804	180,088	4.08	3.76	14,636	23,324	118,295	175,901	23,445	27,472
Ratchathewi	259,641	241,399	3.77	3.65	17,935	28,591	249,932	454,861	80,120	74,479
Sathon	136,963	161,532	4.12	3.72	17,351	27,764	113,728	206,506	57,427	67,280
KlongToei	306,564	338,142	3.94	3.68	17,122	27,457	394,509	522,341	101,313	111,377
ChatuChak	227,700	269,669	3.78	3.67	31,188	49,156	129,891	175,990	126,719	148,518
DonMuang	298,654	520,213	3.61	3.47	22,681	37,330	137,784	217,654	77,796	131,643
BangKapi	388,381	538,462	3.44	3.39	24,141	36,444	220,334	221,074	132,524	154,555
BangKhen	377,261	420,802	3.58	3.42	24,217	37,406	70,325	68,640	58,269	64,553
BungKum	251,249	488,993	3.62	3.51	23,000	35,230	80,863	122,623	27,197	57,972
PhraKhanong	258,079	310,499	3.86	3.52	35,226	55,468	152,774	154,317	57,285	66,766
SuanLuang	161,910	282,459	3.86	3.55	26,416	45,022	62,365	80,631	22,036	44,631
Prawet	163,345	340,256	4.40	3.91	23,528	38,732	64,788	88,405	21,416	34,126
HuaiKhwang	93,576	156,008	3.50	2.20	16,382	25,908	150,046	228,307	33,165	66,659
LatPhrao	164,073	297,852	3.82	3.57	23,624	35,170	42,007	52,968	12,706	29,715
DinDaeng	261,227	242,888	3.85	3.57	16,546	26,607	123,923	116,320	72,077	66,973
Minburi	185,830	268,491	4.12	3.70	25,349	43,920	74,282	61,498	30,085	45,325
Latkrabang	123,696	160,370	3.96	3.76	14,690	23,638	83,922	42,813	34,061	42,149
NongChok	93,244	95,465	4.57	4.10	12,667	20,262	32,739	16,156	13,342	13,652
ChomThong	199,282	306,122	4.21	3.80	15,502	24,739	69,117	81,862	22,082	35,963
TalingChan	171,706	282,862	4.03	3.71	28,703	48,352	44,541	33,524	19,648	39,696
BangKhunThian	229,975	477,459	4.03	3.75	21,219	32,167	123,789	111,165	34,861	72,670
PhasiCharoen	314,860	438,688	4.15	3.76	12,607	19,697	173,720	199,421	77,663	128,752
Ratburana	264,724	325,158	4.32	3.95	24,738	40,327	75,270	53,839	40,968	48,866
NongKhaem	144,123	166,520	3.92	3.65	28,041	44,872	122,102	91,834	36,160	41,408
TOTAL	8,126,125	10,495,953	3.99	3.66	21,032	33,802	4,338,325	5,767,895	1,871,458	2,319,369
OTHER PROVINCES										
SamutPrakarn	982,794	1,258,387	4.05	3.72	15,232	23,151	661,040	932,209	61,355	106,162
Nonthaburi	668,926	1,007,608	4.09	3.71	27,093	43,788	278,857	341,686	103,033	122,661
PathumThani	584,283	919,464	3.97	3.69	17,733	32,949	363,844	302,407	123,879	164,451
NakhonPathon	721,917	1,071,249	4.19	3.77	15,098	23,722	411,093	555,506	153,107	266,344
SamutSakhon	367,689	473,211	3.92	3.64	12,997	21,323	296,559	430,049	42,793	30,374
GRAND TOTAL	11,451,734	15,225,872	4.01	3.67	20,094	32,452	6,349,718	8,329,752	2,355,625	3,009,360

In the trip generation a cross-classification analysis has been used, and each household has been divided into 4 income groups by 4 Vehicle Ownership Groups. The trip generation rates have been estimated for each of four trip purposes namely :

- Home based Work **(HBW)** :
  Trips between residence and primary work location.
- Home based Educational **(HBE)** :
  Trips between residence and school location.
- Home based Other **(HBO)** :
  Trips between residence and all other locations (shopping, recreational, religious and personal business locations).
- Non-home-based **(NHB)** :
  Trips with neither end at home (for example, a trip between work place and restaurant).

A global comparison between 195 and the trend case for the year 2011 is shown in Table 5.3 and the generation rates are shown in Table 5.4.

Table 5.3 Global Generation Statistics

	BMA		BMR	
Year	1995	2011	1995	2011
Population (x 1,000)	8,126	10,495	11,453	15,227
Households (x 1,000)	2,037	2,870	2,858	4,145
HH Size	3.99	3.66	4.01	3.67
Mechanized Trip per household	6.79	7.80	6.29	6.97
Average HH Income (Bahts / Month)	21,032	33,802	20,081	32,437
Household Vehicle Ownership				
NONE	42.5 %	25.3 %	38.9 %	22.9 %
M/C	21.8 %	12.9 %	23.5 %	15.3 %
1 CAR	29.4 %	44.6 %	31.1 %	45.7 %
2 CAR	6.3%	17.2 %	6.5%	16.1 %

Table 5.4 Trip Generation Rates (1)

Within Bangkok Metropolitan Area

	Home Based Work		Home Based Education		Home Based Others		Non Home Based	
Income Group	Vehicle Ownership	Trips per worker	Vehicle Ownership	Trips per Student	Vehicle Ownership	Trips per person	Vehicle Ownership	Trips per person
1	1,2	1.70	2	2.15	1	0.20	1	0.05
	3,4	1.50	1,3,4	2.06	2	0.33	2	0.15
					3,4	0.44	3,4	0.26
2	1,2	1.80	2	2.20	1	0.21	1	0.07
	3,4	1.50	1,3,4	2.09	2	0.35	2	0.17
					3,4	0.45	3,4	0.27
3	1,2	1.80	2	2.20	1	0.22	1	0.08
	3,4	1.60	1,3,4	2.09	2	0.37	2	0.18
					3,4	0.46	3,4	0.29
4	1,2	1.80	2	2.20	1	0.22	1	0.10
	3,4	1.63	1,3,4	2.09	2	0.37	2	0.18
					3,4	0.46	3,4	0.32

Table 5.4 Trip Generation Rates (2)

Outside Bangkok Metropolitan Area

	Home Based Work		Home Based Education		Home Based Others		Non Home Based	
Income Group	Vehicle Ownership	Trips per worker	Vehicle Ownership	Trips per Student	Vehicle Ownership	Trips per person	Vehicle Ownership	Trips per person
1	1,2	1.30	1,2,3,4	1.67	1	0.07	1	0.02
	3,4	0.85			2	0.15	2	0.05
					3,4	0.25	3,4	0.17
2	1,2	1.37	1,2,3,4	1.70	1	0.09	1	0.03
	3,4	1.00			2	0.16	2	0.06
					3,4	0.27	3,4	0.19
3	1,2	1.43	1,2,3,4	1.70	1	0.10	1	0.04
	3,4	1.10			2	0.18	2	0.09
					3,4	0.27	3,4	0.20
4	1,2	1.49	1,2,3,4	1.70	1	0.12	1	0.05
	3,4	1.43			2	0.18	2	0.10
					3,4	0.28	3,4	0.22

Notes:
(1) Income group definitions (all Baht/month/household)
1-less than10,000;
2-10,000-15,000;
3-15,000-25,000;
4 -more than 25,000
(2) Vehicle Ownership definitions:
1-households with no vehicles;
2 - households owning at least one motorcycle;
3-households owning at least one car;
4-household own at least two cars

(3) Trip Attraction

In trip generation the control total is always the trip generation rather than the attraction. In the science of transport modeling it is believed that greater accuracy can be assumed in the prediction of trips starting from the home, i.e. trip production rather than at the destination end i.e. trip attraction .

The trip attraction equations are developed in the form of a regression equation of the form:

$$Aj = a + b \times LVj$$

where, Aj is the attractions from zone j

LV is a particular land-use variable for zone j

a,b are calibration constants

The trip generation equations are presented in Table 5.5.

Table 5.5 Trip Generation Equations

Trip Purpose	Land Use Variable	a	b	Correlation Coefficient
HBW	Total Employment	0	1.546	0.93
HBE	Total Student Places	0	1.936	0.97
HBO	Tertiary Employment	3620	1.261	0.55
NHB	Tertiary Employment	960	0.791	0.54

From Table 5.5, it is noted that the Correlation Coefficients for HBW and HBE values are extremely high thus confirming the strong correlation between HBW trips and employment, as well as between HBE trips and student places.

However, the regression analyses for HBO trips and NHB trips proved more problematic. These types of trip attractions are typically related to land uses such as commercial activity, retail development and religious institutions. Regretfully, zonal information which quantifies these data (such as square meters of retail/commercial activity, number of restaurant seats, number of theater seats, size of religious institutions) are not available from governmental sources, nor do the resource and temporal constraints of the current study permit development of such a database.

In light of this limitation, a series of regression runs were undertaken to evaluate the statistical relationship of available zonal variables with HBO and NHB trips. It was found that tertiary employment is the most appropriate surrogate indicator; unfortunately, the correlation coefficient is less than hoped for.

To partially compensate for this shortcoming, the generation process was structured to maintain sensitivity toward both observed and empirical levels of demand. In other words, the application of base (1995) and future zonal socio-economic variables resulted in the calculation of a relative rate of growth vis-à-vis observed conditions; that is,

$$T_F = T_B * \frac{T_{RF}}{T_{RB}}$$

where, for each zone,

T_F = Estimated future - year trips
T_B = Base - year trips
T_{RF} = Regression trip estimate derived from future socio-economic variables
T_{RB} = Regression trip estimate derived from base - year socio-economic variables

The final calculated attractions are, as indicated previously, balanced to calculated productions for the BMA and areas outside of the BMA.

(4) Pre-Distribution Modal Split

A pre-distribution modal split approach was adopted in this study for the base year analysis. In future years this was complimented with the modal split diversion curves derived during the SIMR study. The modal split proportion factors were derived for each trip purpose and each vehicle ownership group from the 1995 home interview survey. These proportions are shown in Appendix 1 .

(5) Trip Distribution

The trip distribution models take zonal productions and attractions, and link them to form a trip matrix of zone-to-zone movements. A total of 16 models were built; 12 for private vehicle modes (four purposes by three vehicle availability groups , only one car group) and four for public transport modes (four purposes) .

A gravity model is used to achieve the trip distribution and is expressed as:

$$T_{(i,j)} = \frac{P_i \; A_j \; F_{t(i,j)} K_{(i,j)}}{\sum_{x=1}^{n} A_x F_{t(i,x)} K_{(i,x)}}$$

Where $T_{(i,j)}$ = trips produced in zone i and attracted to zone j

P_i = trips produced in zone i

A_j = trips attracted to zone j

$t_{(i,j)}$ = travel time between zone i and zone j

$F_{t_{(i,j)}}$ = empirically derived travel time factor that expresses the average area-wide effect of spatial separation on trip interchange between zones that are t(i,j) apart

$K_{(i,j)}$ = specific zone-to-zone adjustment factor to allow for the incorporation of spatial/geographic influences upon travel patterns

Distribution functions for each zone pair are prepared using as input public and private vehicle generalized cost skims and the calibrated distribution function. Subsequently, these distribution function values and an observed modal split matrix are applied to zonal trip productions and trip attractions to generate private and public person trip matrices. These two steps are conducted separately for each of the four trip purposes - home-based work, home-based school, home-based other and non-home-based.

(6) Modal Split Post Trip Distribution

The pre-distribution mode splits were sufficient for the base year where the modal choice was not necessarily sensitive to changes in travel times between private and public modes . This was not sufficient to test major changes in either the public or private sector . For this reason modal diversion curves were needed to be produced for this study . The previous logit modal diversion curves of SIMR were reviewed and accepted for BEIP .

The modal distribution curves used take the following format :

$$p = 1/(1 + \exp(a + b \times \Delta T + c \times \Delta C + d \times N))$$

where p is the share of private mode

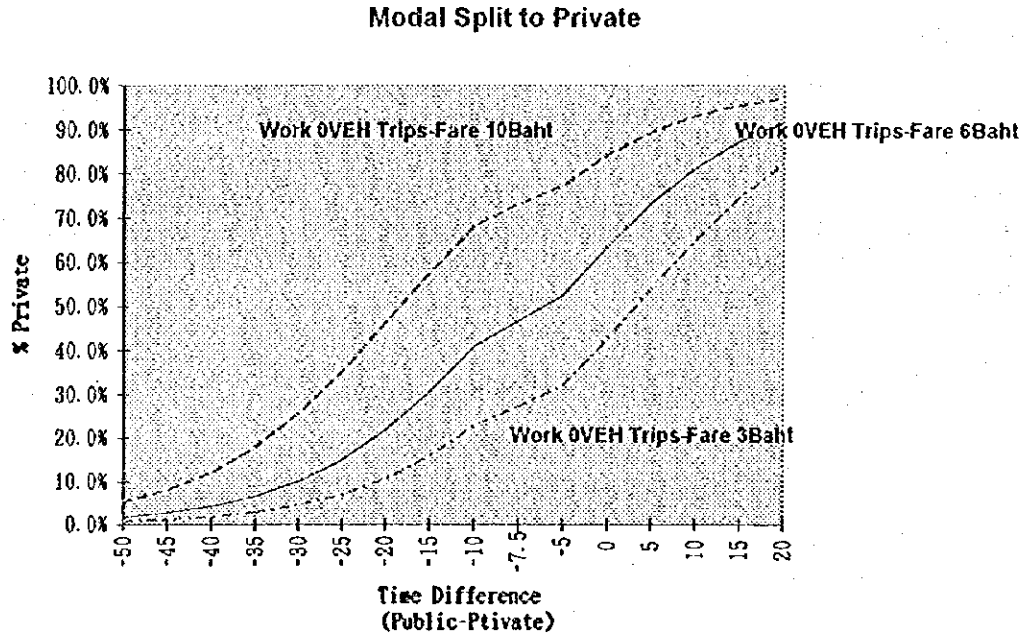
ΔT is the Travel Time Difference(Public-Private in minutes)

ΔC is the Travel Cost Difference(Public-Private in minutes)

N is the number of Interchanges

Table 5.6 Parameters for Modal Split Diversion Curves

HouseholdType	Purpose	a	b	c	d
VehicleAvailable	HBW	-1.689	-0.073	-0.120	-0.215
	HBE	-0.070	-0.162	-0.382	-
	HBO	-2.601	-0.008	-0.169	-0.701
	NHB	-1.103	-0.093	-0.302	-0.254
NoVehicleAvailable	HBW	1.148	-0.092	-0.284	-
	HBE	2.264	-0.056	-0.366	-
	HBO	-1.101	-0.010	-0.165	-
	NHB	1.378	-0.046	-0.114	-



Parameters: Fare difference : Three Fares as shown
No Interchange

Fig. 5.2 Modal Diversion Curve for HBW No Vehicle Available

The parameter values are given in Table 5.6 and examples of the curves themselves are given in Figure 5.2. These modal diversion curves which are logit curves had to be programmed into the transport modeling software package TRANPLAN .

The basic formula was of the following form for each test case:

$$T\{Test\}ij = T\{Base\}ij * [MS\{Test\}ij] / [MS\{Base\}ij]$$

where

T{Test}ij is the resulting number of private person trips for the test case.

T {Base}ij is the resulting number of private person trips for the base i.e. without major network changes.

MS{Test}ij is the modal split of private trips derived from using the private and public transport skims in the formula described above for modal diversion.

MS{Base}ij is the modal split of private trips derived from using the private and public transport skims in the formula described above for modal diversion.

(7) Non-Person Trip Tables

The future external and commercial vehicle trip tables were developed from the base year using the mathematical growth model known as Fratar. A set of expansion factors were developed for each trip type. These assumed growth rates are discussed in Appendix 1.

With commercial vehicles trips the overall growth is 5 % per annum. This compares with a growth rate of 3 % per annum for mechanized trips (public plus private). However in the so-called "do nothing" scenario with no improvements to public transport and continued congestion there was expected to be a growth in private pcu vehicle trips of 5.4 % per annum in the morning peak hour .

It should also be remembered that the controlling number of trips in the peak hour assignment are the private vehicle trips which make up approximately 90% of all peak hour vehicle trips excluding public transport vehicles.

(8) Traffic Assignment

Prior to the assignment of the trip tables to the network, it was necessary to develop the peak hour pcu trip table from the total daily person trip tables and from the external trip table and the commercial vehicle trip table.

The person trip tables as output from the gravity models are not in a suitable format for traffic assignment. These tables need to be converted to a peak hour origin destination matrix from the production / attraction format as output from the gravity model. The following formula is used in the first step:

$$ODij = a \times PAij + b \times TR\{PAij\}$$

where, ODij is the matrix in origin destination format

PAij is the matrix in production attraction format

TR{ } is the mathematical matrix transpose function

a,b are constants used to develop the morning peak hour

(see Table 5.7)

Table 5.7 Peak Hour Factors

	Trip Purpose			
Factor	HBW	HBE	HBO	NHB
a	0.15	0.15	0.04	0.02
b	0.01	0.01	0.04	0.02

This is still in the form of a person trip table , these are then converted to vehicle format with two sets of factors namely :

- Passenger Car Unit (pcu) factor ; and
- Vehicle Occupancy Factor.

These are presented in Table 5.8. The peak factors for goods vehicles and external vehicles are also presented in this table .

Table 5.8 Vehicle Occupancy and PCU factor

Vehicle Type	Peak Hour Factor	PCU Factor	Trip Purpose Occupancy Factor HBW	HBE	HBO	NHB
Car	-	1.00	1.73	2.32	2.08	1.97
Motor Cycle	-	0.25	1.38	1.60	1.22	1.47
Goods Vehicle	0.03	2.30	-	-	-	-
External Vehicle	0.05	-	-	-	-	-

The peak hour trip table for traffic assignment is the addition of the three pcu tables namely person , external and commercial trip tables.

Since route choice, travel time and congestion impacts are important considerations, an equilibrium assignment algorithm is considered appropriate. Equilibrium, in the context of transportation assignments, occurs when no trip can be made by an alternative path without increasing the total travel time of all trips in the network. Equilibrium assignment consists of an iterative series of all-or-nothing traffic assignments with an adjustment of link capacity/speed reflecting congestion encountered in each associated iteration.

The load from each assignment after the first iteration is combined with the previous load in such a way as to minimize the impedance of each trip and thus reducing the number of iterations to find the equilibrium loads. Equilibrium assignment is multi-path because the final loads are a linear combination of the all-or-nothing loads of each iteration. These loads may be assigned to different paths because of the time adjustments after each iteration.

For the BEIP project these assignment paths are based on a generalized cost derived in equivalent minutes for the path between each zone pair and takes the form of:

$$GCij = a*Tij + b*Dij + c*Aij$$

where, GCij is defined as generalized cost in equivalent minutes

Tij is the travel time

Dij is the distance

Aij is the additional cost such as expressway tolls in units of 10 Baht

a,b,c are constants defined as: a = 1.0 , b = 0.76 and c = 6.58

The other parameters input into the road traffic assignment include the pre-load volumes developed in the bus passenger assignments .

5.3 Traffic Demand

By the year 2011, the BMA will grow into a mega-city of around 10.5 million people. During this time period there will also be a growth in the proportion of households with a vehicle available for trip-making. By 2011 only a quarter of households in the BMA will no longer have access to a vehicle. This results in 70% more residents of BMA having access to a private vehicle in comparison with the existing state.

Table 5.9 Household Vehicle Ownership Distribution

TYPE OF OWNERSHIP	1995	2011
NO VEHICLES	42.4%	25.3%
MOTOR CYCLE	21.8%	12.9%
ONE CAR	29.5%	44.6%
TWO OR MORE CAR	6.3%	17.2%
TOTAL	100.0%	100.0%
HOUSEHOLDS IN BMA (THOUSAND)	2,037	2,870
AVERAGE H/H SIZE	3.99	3.66
AVERAGE H/H INCOME (BAHT/MONTH IN 1995 PRICES)	21,032	33,802

Source : BEIP Simulation Model Sept. 1996

This results in an additional demand for a growth of 200% of person trips that have the opportunity of being made by private vehicle mode in the BMA. Residents of BMA will attempt to make these trips by private vehicle mode if there are no improvements in public transport or any other new government initiatives .

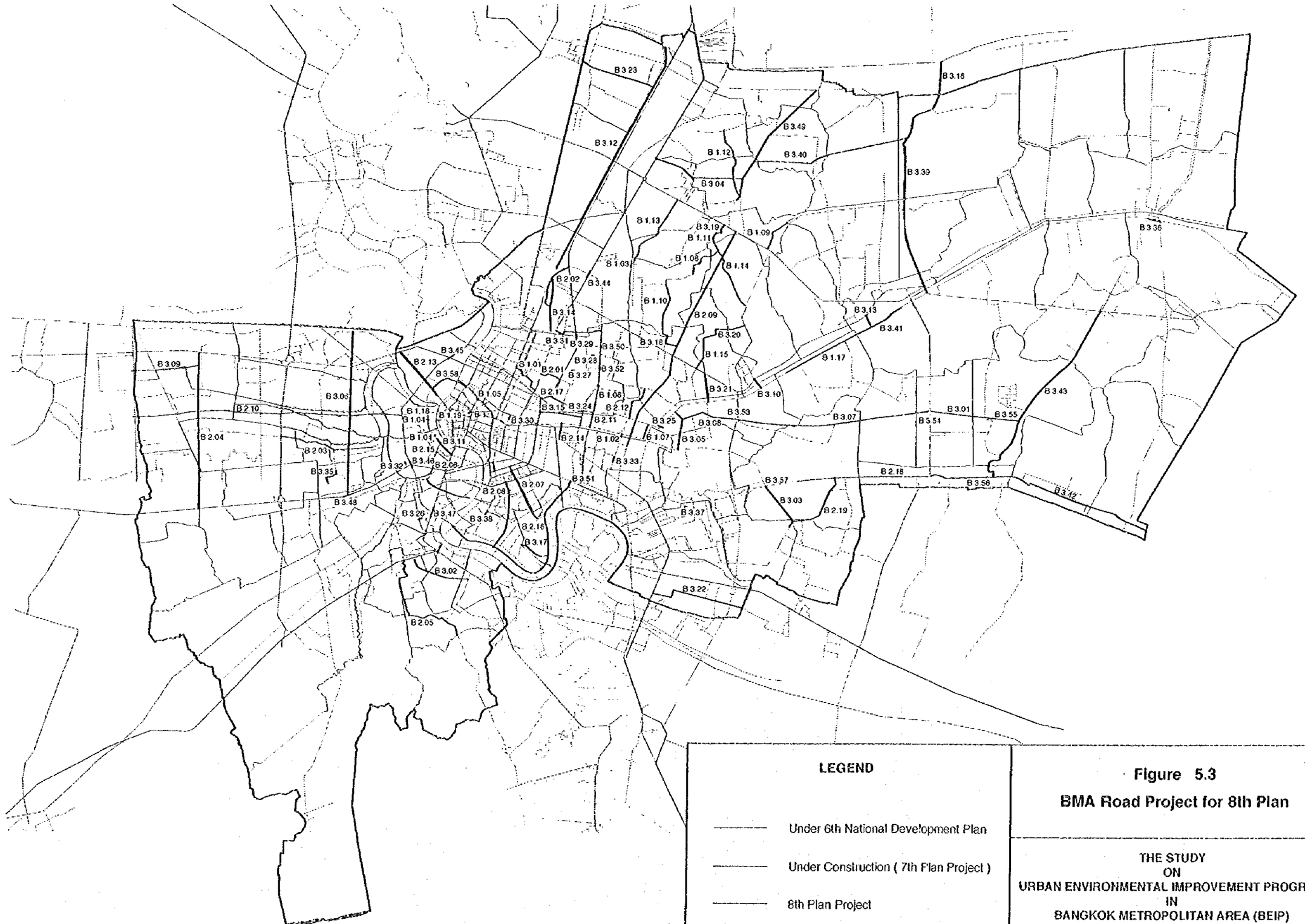
5.4 Traffic Supply

In the 8th National Plan currently under preparation, it is proposed to significantly increase the road space within the BMR (see Table 5.10 - 5.13). (Transport supply is discussed for the whole of the BMR as the BMA transport system is simply an integral part of the BMR.) The planned network is shown in Figure 5.3 - 5.6. The proposal for the plan will result in an increase in the length of the road system by 30%.

For the purpose of the transport simulation, all road projects currently proposed are assumed to be completed by the year 2011.

By this year also the public transport system will have been improved with the implementation of the Mass Transit Master Plan. The proposed Master Plan is shown in Figure 5.7.

In Figure 5.8 all the transport projects for 8th plan are plotted. Several road segments seem to be duplicated in terms of function, however, all the projects are assumed to be completed in the simulation analyses.



LEGEND

- Under 6th National Development Plan
- Under Construction (7th Plan Project)
- 8th Plan Project

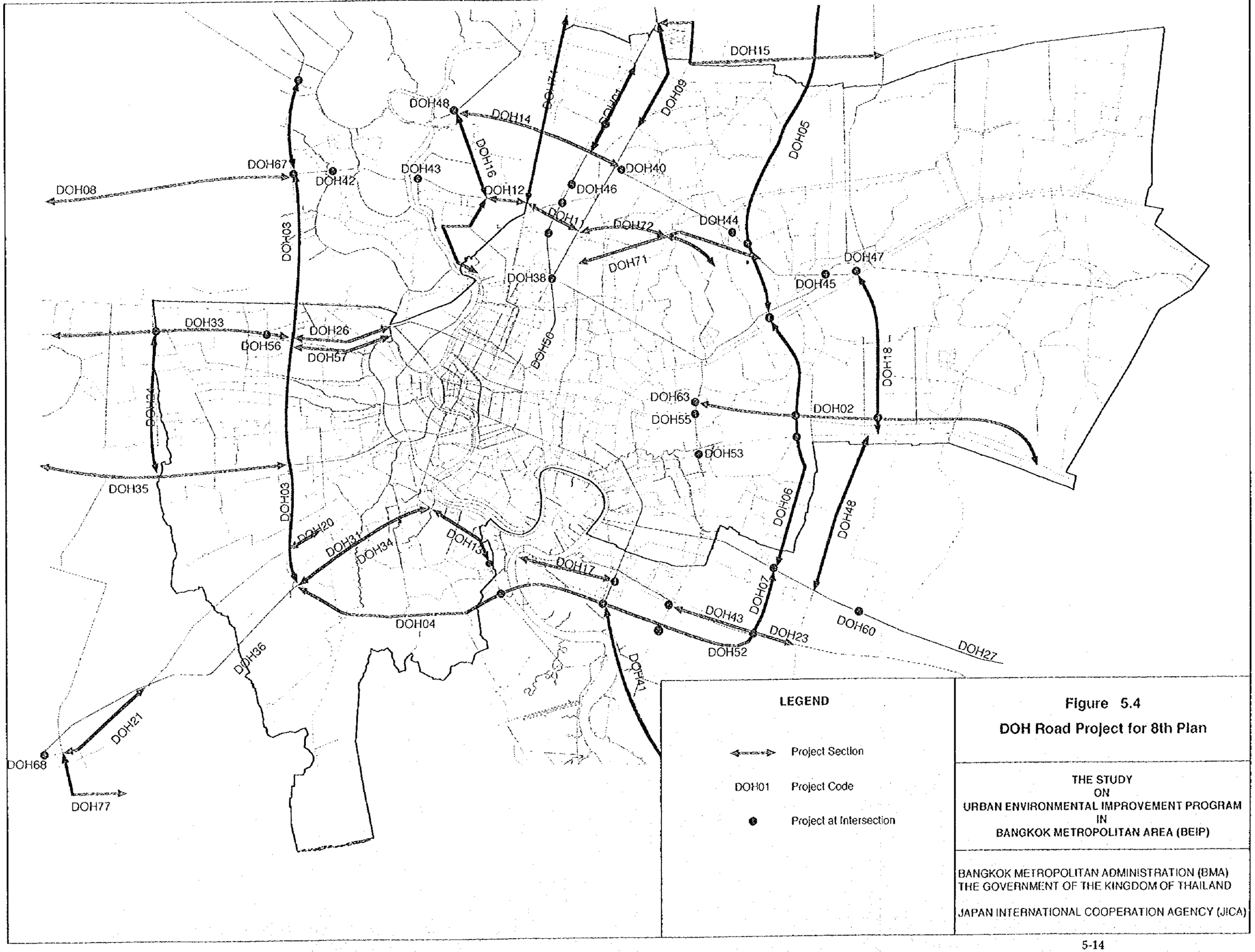
Figure 5.3

BMA Road Project for 8th Plan

THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)

BANGKOK METROPOLITAN ADMINISTRATION (BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



LEGEND

Project Section

DOH01 Project Code

Project at Intersection

Figure 5.4

DOH Road Project for 8th Plan

THE STUDY
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URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
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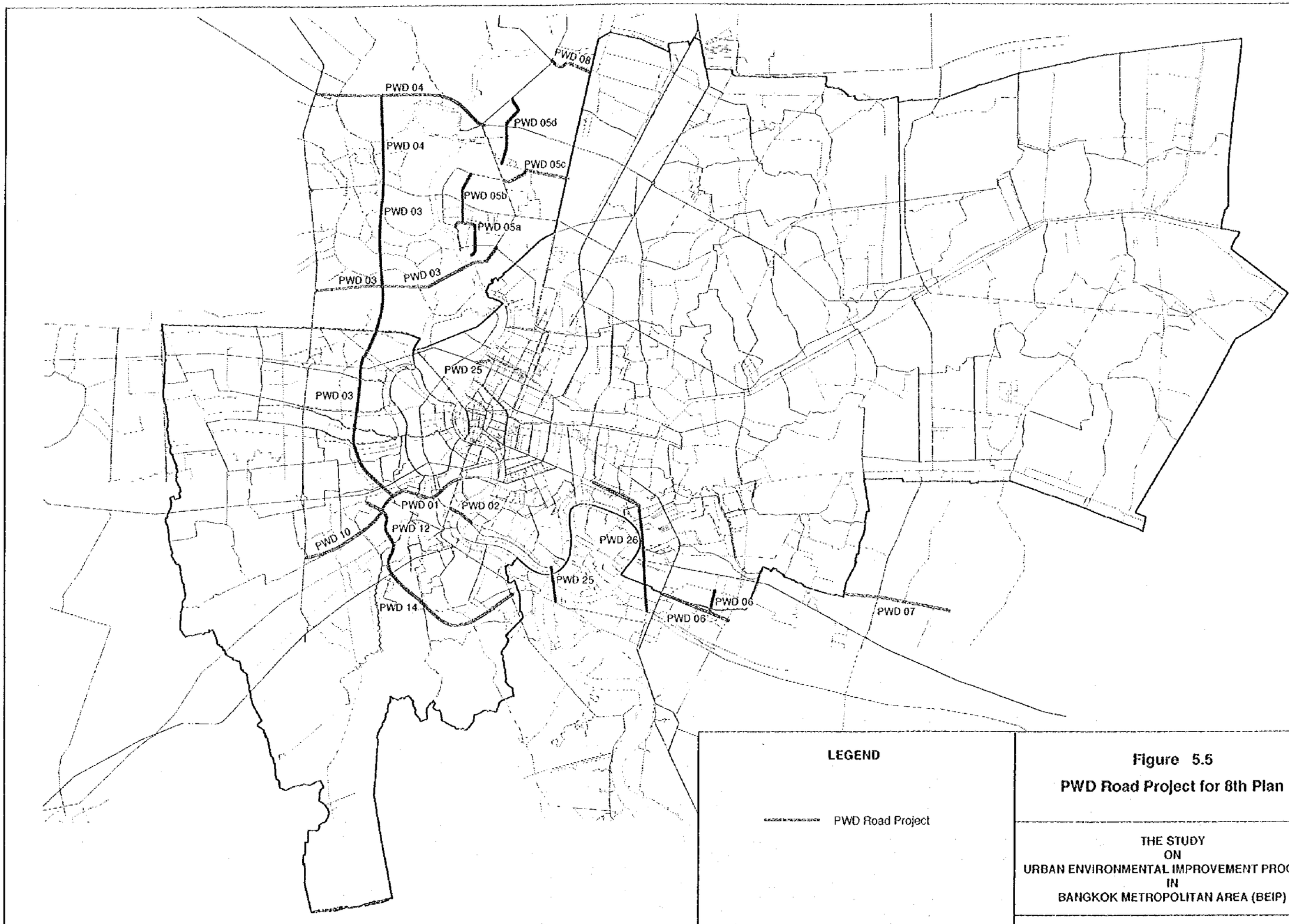

LEGEND

PWD Road Project

Figure 5.5

PWD Road Project for 8th Plan

THE STUDY
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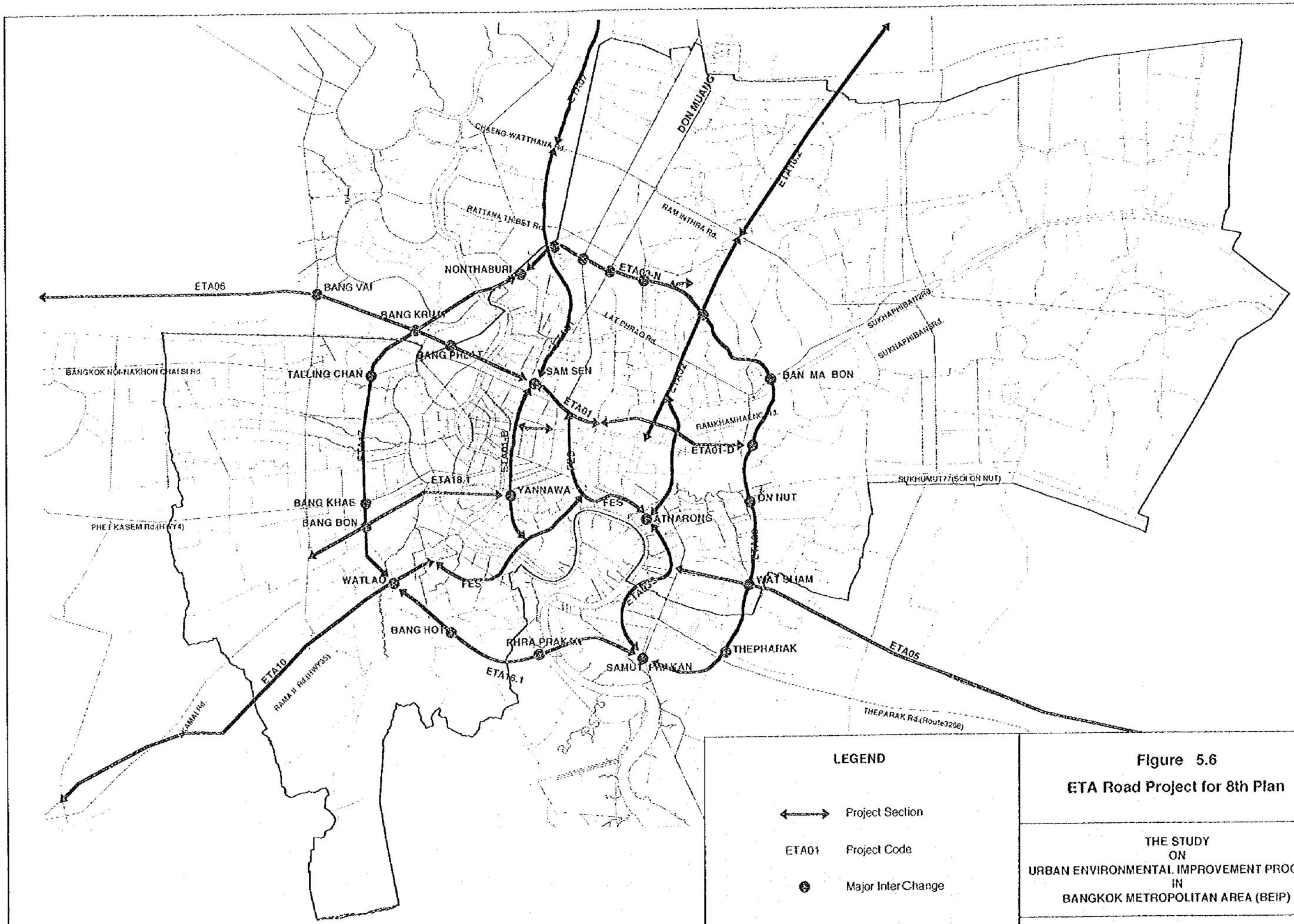

LEGEND

- Project Section
- ETA01 Project Code
- Major Inter Change

Figure 5.6

ETA Road Project for 8th Plan

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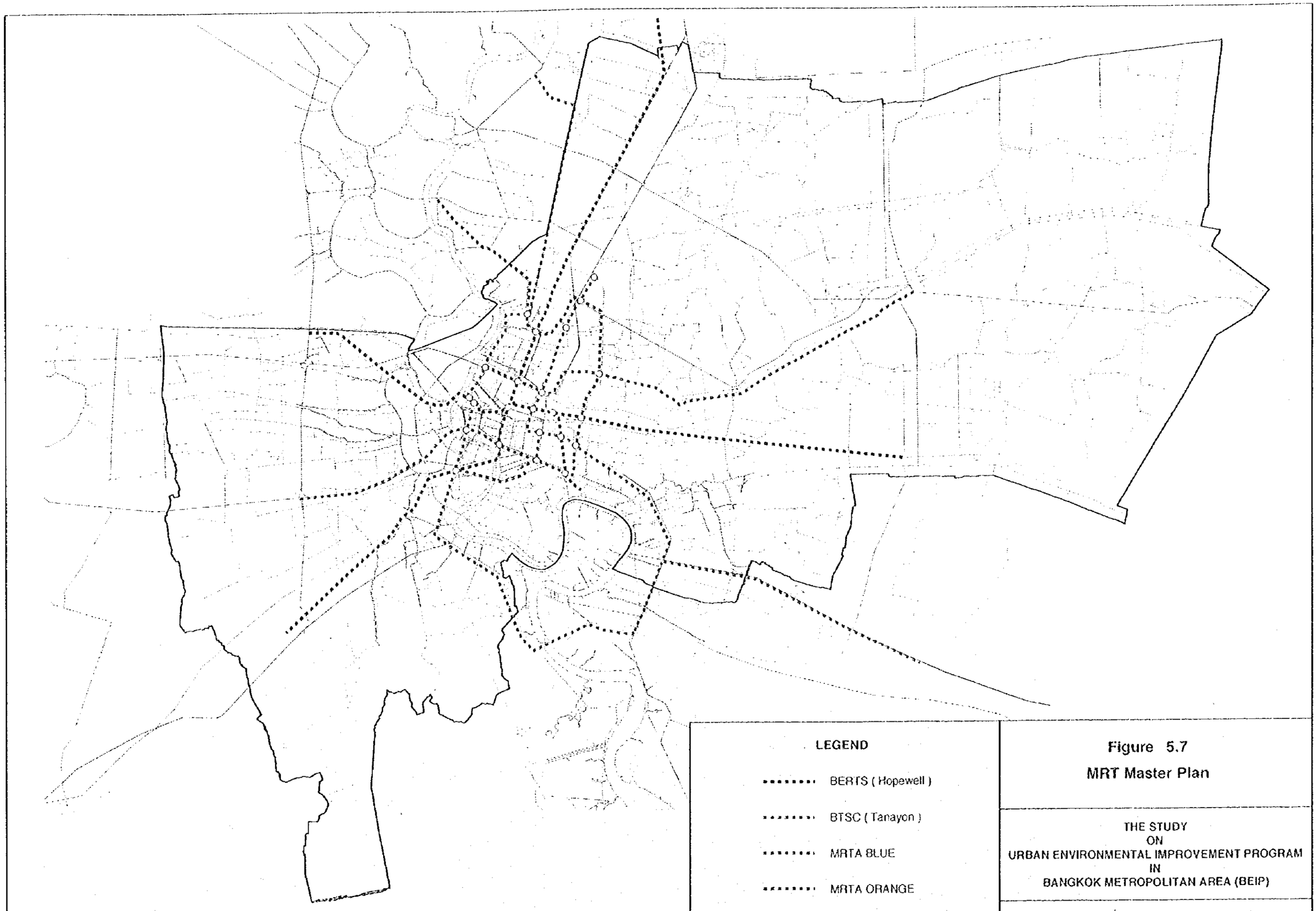

Figure 5.7
MRT Master Plan

THE STUDY
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BANGKOK METROPOLITAN ADMINISTRATION (BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

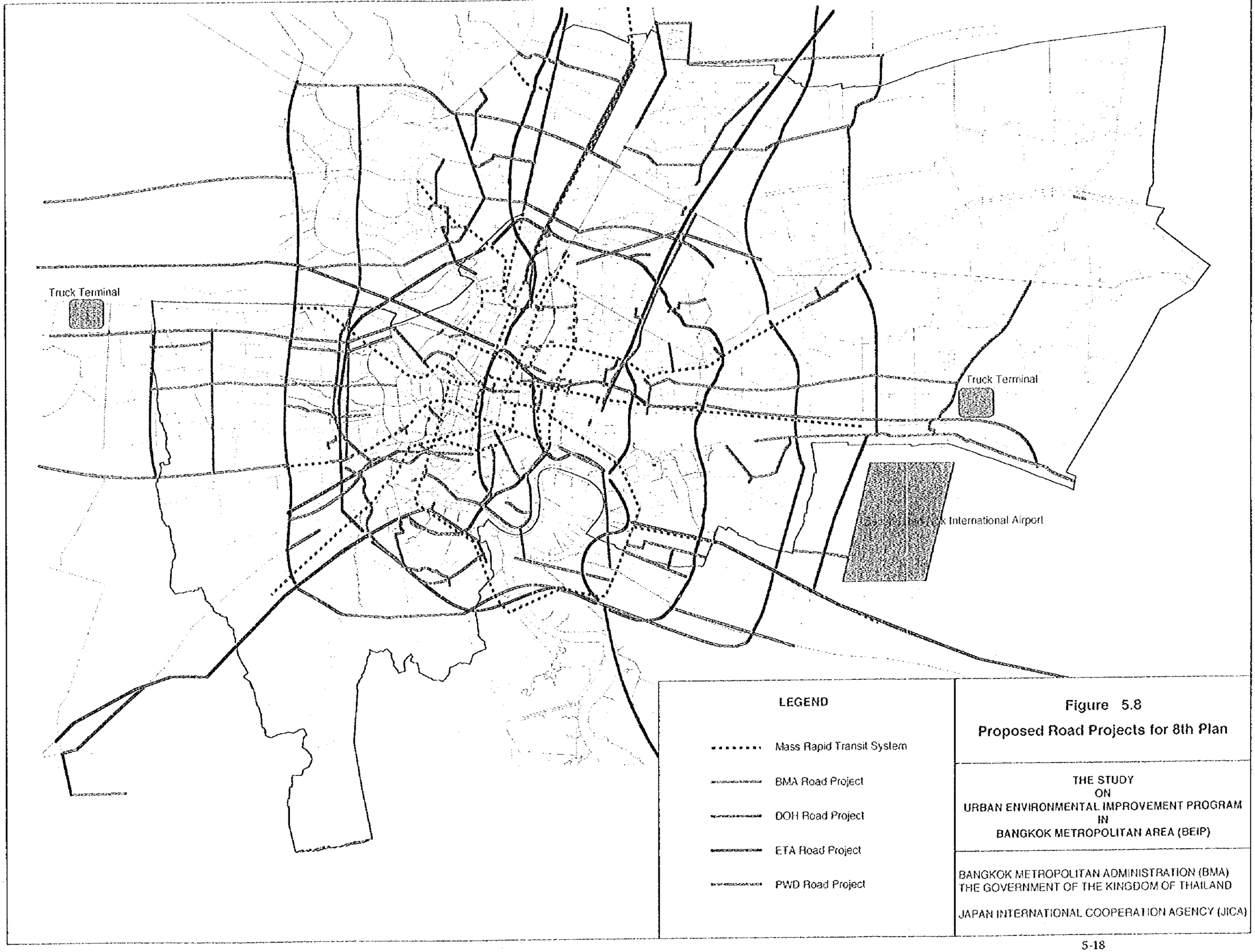

Figure 5.8

Proposed Road Projects for 8th Plan

THE STUDY
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BANGKOK METROPOLITAN ADMINISTRATION (BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Table 5.10 (1) BMA Road Project under 7th Plan

Under Construction Project of the 7th National Plan

Agency	BAM's Code #	OCMRT Code #	Project Name	Proposed Standard Type	Lane	Length (km)	Cost (mil Baht)	7th plan (mil Baht)	6th plan (mil Baht)
BMA	2.01	114	Connecting Paholyothin Rd. and Viphawadi Rd. across military area	New Road	4	1.09	285	0	285
BMA	2.02	115	KAMPAENGPETCH 2 FROM KAMPAENGPETCH RD. TO Ratchada Phisek Intersection	Widening	4	0.00	53		
BMA	2.03	30	Bang Wak Rd. From Wat Tanode to Outer Ring Rd.	Widening	4	5.00	109		
BMA	2.04	12	Phutthamonthon Sai 3 Rd. From Nong Kham Dispose Plant to South Rout Railway	New Road	2	8.70	148	78	70
BMA	2.05	53	Phutthabicha Rd. from Thonburi Rd. to Rama 2 Rd.	Improving	4	5.75	170	65	105
BMA	2.06	54	Improving Naowa Jamnian Bridge, Thonburi - Bangkok Yai.	Bridge	6	0.13	91		
BMA	2.07	02	Liab Khlong Chong Nonsi Rd (SURAWONG RD - RAMA III (CHAO PHRAYA RIVER)	New Road	6	4.50	1,534		
BMA	2.08	03	North-South Rama 6 Rd. from Sathorn Rd. to the road parallel river.	New Road	6	4.00	537	446	91
BMA	2.09	13	EKKAMAI - RAM INTRA RD. (including 6 contracts)	New Road	6	14.00	2,192	1,486	705
BMA	2.10	09	PHRAN NOK - PHUTTHAMONTHON SAI 4 (FROM CHARANSANITWONG RD. TO PHUTTHAMONTHON SAI 4)	New Road	6-8	12.00	4,550	250	4,301
BMA	2.11	19	LIAB KHLONG BANG KAPI RD. (ROAD CONNECTING BETWEEN PHETCHABURI RD. TO RAMA 9 RD. SAI 1)	New Road	4	0.80			
BMA	2.12	none	Constructing connection road , between Pracha U-Tit Rd. and Rama 9 Rd.						
BMA	2.13	128	ELEVATED ROAD FROM PHRA PIN KLAO BRIDGE TO SOUTH BUS STATION	Elevated	4	4.50	1,272	0	1,272
BMA	2.14	125	SUKHUMVIT 3 ROAD IMPROVEMENT (NORTH NANA)	Widening	4	4.50	1,272		
BMA	2.15	117	BRIDGE CROSSING KHLONG BANGKOK YAI (CHAROENPHAT BRIDGE)	Bridge	4		44	0	44
BMA	2.16	27	RAMA 3 RD. IMPROVEMENT	Widening	6	11.05	1,107	385	722
BMA	2.17	90	INTERSECTION IMPROVEMENT AT VIPHAWADI RANGSIT RD./ DIN DAENG RD.(UNDERPASS)	Underpass	2	0.15	406	406	0
BMA	2.18	21	SUKHUMVIT 77 RD. IMPROVEMENT	Widening	6	12.50	327	288	40
BMA	2.19	06	CHALERM PHRA KIAT KING RAMA 9 (SUKHUMVIT 103 RD .KHLONG MAKHAMTHET BRIDGE - SUKHUMVIT 77 RD.)	New Road	4	4.20	150	103	47
BMA	2.20	98	a AREA TRAFFIC CONTROL, Phase1 143 Intersections				227	227	0

Table 5.10 (2) BMA Road Project for 8th Plan

Agency	BAMs Code #	OCMRT Code #		Project Name	Proposed Type	Standard Lane	Length (km)	Cost	7th plan (1000 B)	8th plan (1000 B)
BMA	3.01	52		CHAO KHUN THAHAN RD IMPROVEMENT PHASE 2	Improving	2	5.00	203	203	0
BMA	3.02	130		ROAD UNDER EXPRESSWAY FROM PRACHA U-TIT RD. TO RAMA 2 RD. (with drainage pipe and 7 rc bridges)	New Road	2	3.60	101	0	101
BMA	3.03	44	b	DISTRIBUTOR RD. IMPROVEMENT (EXTENSION ROAD FROM PATTANAKARN TO SUKHUMVIT 103)	New Road	4	2.60	697	245	452
BMA	3.04	44	c	DISTRIBUTOR RD. IMPROVEMENT (PAHONYOTHIN RD. TO RATTANAKOSIN RD.)	New Road	4	6.00	1,208	142	1,066
BMA	3.05	14		RAMKAMHAENG - PHATTANAKAN RD. (VIA SOI THAVORNTHAWATCH 1)	New Road	6	1.70	1,439	734	705
BMA	3.06	11		PHUTTHAMONYHON SAI 1 RD. (PHETKASEM RD.-BMA BOUNDARY)	New Road		9.50	1,370	496	874
BMA	3.07	09		KRUNG THEP KREETHA - ROM KHLAO RD. (SRI NAKARIND RD.-ROM KHLAO RD.)	New Road	6	9.00	2,340	682	1,658
BMA	3.08	15		RAMKAMHAENG - SRINAKARIND RD. (VIA SOI RAMKAMHAENG 24)	New Road	6	3.00	1,809	744	1,065
BMA	3.09	10		AGSA RD. (PHUTTHAMONTHON SAI 3 - PHUTTHAMONTHON SAI 4)	New Road	6-8	3.80	953	456	497
BMA	3.10	106		ROAD CONNECTING BETWEEN SUKHAPHIBAN 2-3 RD.SAI 1	New Road	6	0.60	556	523	33
BMA	3.11	04		ARUN-AMARIN RD (KHLONG MOM-PRRACHATHIPOK RD.)	New Road	4	1.60	158	64	94
BMA	3.12	118		LIAB KHLONG PREM PRACHAKORN (WEST SIDE) FROM RACHADAPHISEK ROAD TO BMA BOUNDARY	New Road	4	17.75	1,720	10	1,710
BMA	3.13	108		ROAD CONNECTING BETWEEN SUKHAPHIBAN 2-3 RD.SAI 3	New Road	6	0.80	410	295	115
BMA	3.14	126		NEW KAMPANGPETCH 2 RD.	New Road	6-8	3.00	245	77	168
BMA	3.15	124		LIAB BUNG MAKKASAN FROM SRI AYUDDHAYA ROAD TO ASOKE-DIN DAENG ROAD including Ratchaprarop Flyover	New Road	4	3.00	958	202	797
BMA	3.16	51	b	NIMITR MAI RD. IMPROVEMENT	Widening	6	2.00	140	28	112
BMA	3.17	16		SATHUPRADIT - RAMA 3 RD.	New Road	6	2.00	640	17	623
BMA	3.18	none		Nak Nivat Rd. phase 1. From Soi Lad Phrao 71 to an intersection at khlong Kra Thiam School.	Improving					
BMA	3.19	none		Lad Phrao 101 Rd., phase 2. From Ram Intra Rd. to Front of Building 44/132	Improving					
BMA	3.20	none		Yoo Yen Rd., phase 2. From Wat Bung Thong Lang to Pho Khaew.	Improving					
BMA	3.21	none		Connection road, Ramkamhaeng Rd. and Lad Phrao Rd.	Improving					
BMA	3.22	44	a	DISTRIBUTOR RD. IMPROVEMENT (SOI LASAL)	Widening		3.40	99	85	14
BMA	3.23	44	d	DISTRIBUTOR RD. IMPROVEMENT (Song Pracha Rd.)	Improving		4.50	421	179	242
BMA	3.24	87		Constructing flyover bridge for intersection at Ratchadaphisek - Rama 9 - Asoke - Dindaeng	Flyover		1.75	425	46	379
BMA	3.25	87		Construction flyover bridge for intersection at Ramkamhaeng - Rama 9 Rd.	Flyover		1.75	425	46	379
BMA	3.26	none		Connection road, Ratchadaphisek Rd. - Jomthong Rd.	Improving					
BMA	3.27	none		Connection road, Viphawadi rangsit Rd. - Pracha Songkdao Rd.	Improving					
BMA	3.28	none		Connection road, Ratchadaphisek Rd. - Sutthisan Vinitchai Rd.	Improving					
BMA	3.29	none		Connection road, Viphawadi Rangsit Rd. - Ratchadaphisek Rd.	Improving					
BMA	3.30	none		Connection road, Rama 6 Rd. - Phetchburi Rd.	Improving					
BMA	3.31	none		Connection road, Sutthisan Vinitchai Rd. - Phahon Yothin rd.	Improving					
BMA	3.32	none		Connection road, Phet Kasem rd. - Charun Sanitwong Rd.	Improving					
BMA	3.33	none		Connection road, Sukhumvit 55 Rd. - Sukhumvit 53 Rd.	Improving					
BMA	3.34	none		Connection road, Itsarapab Rd. - Arun Amarin rd.	Improving					
BMA	3.35	none		Connection road, Phetch Kasem rd. - Liab khlong Bang Wak Rd.	Improving					
BMA	3.36	none		Connection raod, Liab Waree rd. - Sungka Sunlsuk Rd.	Improving					
BMA	3.37	none		Connection road, Sukhumvit Rd. - Sukhumvit 77 Rd.	Improving					
BMA	3.38	none		Connection road, Charoen krung Rd. - Chan Rd.	Improving					
BMA	3.39	51	a	NIMIT MAI RD. IMPROVEMENT	Widening	6	12.00	879	41	839

Agency	BAM's Code #	OCMRT Code #	Project Name	Proposed Type	Standard Lane	Length (km)	Cost	7th plan (1000 B)	8th plan (1000 B)
BMA	3.40	44	DISTRIBUTOR RD. IMPROVEMENT, Rattanakosin Sompoj Road - Nimit Mai Road	Improving	4	9.20	1,770	10	1,760
BMA	3.41	49	Ramkamhaeng rd (Sukhaphiban 3). From Khlong bang Chan to Suwinthawong rd.	Widening	6	4.65	1,168	500	668
BMA	3.42	119	LUANG PHANG ROAD IMPROVEMENT FROM WAT POLAMANEE'S ENTRANCE TO BMA BOUNDARY	Widening	6	7.50	700	120	580
BMA	3.43	120	CHALONG KRUNG ROAD IMPROVEMENT FROM SUKHUMVIT 77 TO SUWINTHAWONG ROAD	Widening	4-6	12.00	975	168	807
BMA	3.44	91	Road under the Ratcha Yothin Intersection.	Underpass	3		560	236	324
BMA	3.45	91	Road under the Bangphlad Intersection.	Underpass	3		560	236	324
BMA	3.46	91	Road under the Tha Phra Intersection.	Underpass	3		560	236	324
BMA	3.47	91	Road under the Mahai Sawan Intersection.	Underpass	3		560	236	324
BMA	3.48	122	FLYOVER CROSSING INTERSECTIONS (PHETKASEM RPAD-PHUTAMONTOL SAI 1 - SUKHAPHIBAN SAI 1)	Flyover	4		691	11	680
BMA	3.49	138	SAIMAI RD IMPROVEMENT	Widening	4	6.57	0	21	160
BMA	3.50	103	Constructing flyover for Ratchadaphisek - Sutthisan Intersection.	Flyover			370	134	236
BMA	3.51	103	Constructing flyover for Ratchadaphisek - Rama 4 - Sunthorn Kosa Rd.	Flyover			370	134	236
BMA	3.52	103	Constructing flyover for Ratchadaphisek - Phracharat Bamphen Rd.	Flyover			370	134	236
BMA	3.53	127	Improving Intersection at Sri nakkarin - Krung Thep Kreetha Rd.	Improving			1,205	5	1,200
BMA	3.54	127	Improving Intersection at Krung Thep Kreetha - Rom klao Rd.	Improving			1,205	5	1,200
BMA	3.55	127	Improving Intersection at Chao Khun Thahan - Chalong Krung Rd.	Improving			1,205	5	1,200
BMA	3.56	127	Improving Intersection at Chalong Krung - Sukhumvit 77 Rd.	Improving			1,205	5	1,200
BMA	3.57	127	Improving Intersection at Sukhumvit 77 - Pattanakarn Rd.	Improving			1,205	5	1,200
BMA	3.58	137	RAMA 8 BRIDGE (ARUN AMARIN-WISUTKASAT)	Bridge	6		4,030	225	3,805

Source : BMA (1996)

Other Committed Projects listed by TPPP

Agency	BAM's Code #	OCMRT Code #	Project Name	Proposed Standard Type	Lane	Length (km)	Cost (1000 B)	7th plan (1000 B)	8th plan (1000 B)
BMA	none	20	NEW RAMA 2 RD (JCT RAMA 2 RD / SUKSAWAT RD. - CHAO PHRAYA RIVER	New Road	6	0.60	336	19	317
BMA	none	29	SUKHAPHIBAN 3 RD. IMPROVEMENT	Widening	6	6.80	1,708	75	1,633
BMA	none	93	Intersection improvement at Rama 4/Kasemrat Rd	Underpass			560	56	504
BMA	none	94	Intersection improvement at Bang Khun Thien Rd /Rama 2 Rd.	Underpass			560	163	397
BMA	none	96	Flyover crossing on Bang Khun Thien Rd.	Flyover			300	189	111
BMA	none	98 b	AREA TRAFFIC CONTROL, Phase2 226 Intersections	ATC			429	5	424
BMA	none	98 c	AREA TRAFFIC CONTROL, Phase3 220 Intersections	ATC			600	5	595
BMA		107	ROAD CONNECTING BETWEEN SUKHAPHIBAN 2-3 RD SAI 2				410	242	168
BMA	none	153	Installation of CCTV				131	0	131
BMA		154	Project to solve traffic problem in Rama 9 road and 3 connecting roads	New Road	4	4.20	170	58	112
						TOTAL	5,204	812	4,392

Other Candidate Projects Listed by TPPP

Agency	BAM's Code #	OCMRT Code #	Project Name	Proposed Standard Type	Lane	Length (km)	Cost (1000 B)	7th plan (1000 B)	8th plan (1000 B)
BMA	none	07	NORTH-SOUTH RD. (SI PHRA RD.- SURAWONG RD.)	New Road	6	0.50	150	0	150
BMA	none	50	Lab Khlong Thaweetana Rd. Improvement			12.00	185	0	185
BMA	none	85	Intersection improvement at Phrachachuen Rd /Phracharat Sai 2 Rd.				150	0	150
BMA	none	139	Viphawadi Rangsit Rd. to Pracharaj Rd. (SPURT No. B40)				380	0	380
BMA	none	140	Pahotyothin Rd. to Rachadaphisek Rd. (SPURT No. B42)				217	0	217
BMA	none	141	Lad Prao Rd. to Din Daeng Rd. (SPURT No. B43)				553	0	553
BMA	none	142	Din Daeng Rd. to Sukhumvit Rd. to Chan Rd. (SPURT No. B45)				998	0	998
BMA	none	143	Sukhumvit 39 Rd. to Rachadaphisek Rd. (SPURT No. B46)				448	0	448
BMA	none	144	Sukhumvit 55 Rd. to Rama 9 Rd. (SPURT No. B48)				261	0	261
BMA	none	145	Wireless Rd. to Rachadaphisek Rd. (SPURT No. B51)				179	0	179
BMA	none	146	Rama 4 Rd. to Sukhumvit 26 Rd. (SPURT No. B53)				78	0	78
BMA	none	147	Rama 4 Rd. to Sukhumvit 42 Rd. (SPURT No. B55)				41	0	41
BMA	none	148	Taksin Rd. to Charoen Nakorn Rd.(SPURT No. B61,62)				186	0	186
BMA	none	149	Indraphitak Rd. to Issaraphab Rd. (SPURT No. B63)				98	0	98
BMA	none	150	Issaraphab Rd. to Charansanitwong Rd. (SPURT No. B64)				157	0	157
BMA	none	151	Taksin Rd. to Rama 2 Rd (SPURT No. B69)				95	0	95
BMA	none	152	Rachadaphisek Rd. to Outer Ring Rd. (SPURT No. B85)				1,135	0	1,135
BMA	none	155	Improvement in 5 superblocks: Thonburi, Bang Plad, Sutthisan, Sukhumvit, and Sathorn				850	0	850
BMA	none	156	Improvement in selected superblocks				2,500	0	2,500
BMA	none	157	Road improvement on Ramkamhaeng Rd. (from Ramkamhaeng Rd. to Sri Wara intersection)				142	0	142
BMA	none	158	Road improvement in Lab Bung National Housing Authority				170	0	170
BMA	none	159	Chalermlok Bridge Expansion				18	0	18
BMA	none	160	23 bottlenecks improvement				218	0	218
BMA	none	161	Road under SES from North-South Rd. to Rama 3				130	0	130

Source: TPPP, Report on Traffic and Transport for the 8th NSEDP (June 1996)

Table 5.11 DOH Road Project for the 8th Plan

DOH Project Around BMA

Agency	DOH Code	OCMRT Code	Route	Project Name	Length (km)	Existing lane	New lane	Cost (mil. Baht)	Remark
DOH	01	none	347	Bang pain - Bang pahan Section 1	34.9		2	734	
DOH	01	none	347	Bang pain - Bang pahan Section 2	0.6			142	
DOH	01	none	347	Bang pain - Bang pahan Section 3				680	
DOH	02	none	347	Bang poon - Bang pain	8.8		4	726	
DOH	03	none	1	Intersection at Wang Noi			4	552	
DOH	04	75	3478	Wang Noi - Thanyaburi - Lam Lukka	24.6		2	265	
DOH	05	05	37	Outer Ring Road (East)	63		4	11,988	Completed
DOH	06	30	347	Highway No.346 (Bang poon) to Outer Ring Road (East)	17	2	4	1,894	
DOH	07	51	37	Interchange at Outer Ring Road (West) and Highway 3111	1		4	570	
DOH	08	none	37	Outer Ring Road (Bang Bua Thong - Highway No.3111)	20		4	1,293	
DOH	09	67	37	Interchange at Outer Ring Road (West) and Highway 346	0.5		4	421	
DOH	10	28,29	346	Phathum Thani - Lad Lumkaen - Bang Len	41.3	2	4	1,500	
DOH	11	62	340	Bangkok - Chainat Part 2, Section 2, Interchange at HW.346				31	
DOH	11	none	340	Bangkok - Chainat Part 2, Section 2, Interchange at HW.345				32	
DOH	11	none	340	Bangkok - Chainat Part 5, Bangbuathong - Supan	5.4	2	4	337	
DOH	12	66	306,346	Flyover on HW.345 and HW.306	0.5		4	90	
DOH	13	39	1	Interchange at Khlong Luang	0.4		4	1,035	
DOH	14	15	305	Rangsit - Nakorn Nayok - Thangaburi	32.3	2	4	1,052	
DOH	15	25	3312	Highway No.1 - Lam Lukka	13	2	4	350	
DOH	16	09	1	End of 6 lane to Highway No.31	3.8	4	6	215	
DOH	17	none	31	Interchange at Don Muang	0.4		3	132	
DOH	18	74		Improve Llab Khlong Poyoa kd	12.5	2	4	1,100	
DOH	19	49	306	HW. No 3100 - HW. No. 347, Section 2, Khlong Rang Sit Bridge				330	
DOH	20	14	304	Lak Si Pakkred	9	4	8	550	
DOH	21	40	1304	Underpass at Lak Si	0.5	4	4	200	
DOH	22	16	306	Rama 6 - Cae Rai - Pakkred	13.4	4	6	761	
DOH	23	11,12	302	Kasesart - Cae Rai Section 2 Rd.	5.3	4	8	658	
DOH	24	72		Kasesart section - Sukhaphiban 1	9.2		8	1,600	
DOH	25	71		Rachadaphisek - Ram Intra	11.5		8	2,500	
DOH	26	38	1	Interchange at Lad Phrao				440	
DOH	27	none	340	Interchange at Bang Yai				339	
DOH	28	08		Bang Yai - Ban Pong	60		4-6	5,200	
DOH	29	56	338	Interchange at HW.338 and Phuttamonthon Sai 2	1.6		4	559	
DOH	30	none	338	Interchange at HW.338 and Phuttamonthon Sai 4	2		4	424	
DOH	31	26	338	Bangkok Noi - Nakorn Chai Si (Taling Chan - Phuttamonthon Sai 2)	12	8	12	1,200	
DOH	31	57	338	Elevated Road from Pin Klao to Nakorn Chai Si: Section Taling Chan Interchange - Chim Plea HWY				2,000	
DOH	32	24	3310	Highway No.4 - Phuttamonthon	11	2	4	200	
DOH	33	none	4	Flyover at Bam Npl			4	180	

DOH Project Around BMA

Agency	DOH Code	OCMRT Code	Route	Project Name	Length (km)	Existing lane	New lane	Cost (mil. Baht)	Remark
DOH	34	35	4	Bangkok - Nakorn Pathom	31.3	2	3	1,157	
DOH	35	03	37	Bang Bua Thong - Bang Khun Thien	35	4	12	5,000	
DOH	36	20	3242	Bang Bon - Highway 340	2	2	4	50	
DOH	37	34	35	Thonburi - Pakthor (Dao Khanong - HW. No.37)	8	4	12	350	
DOH	38	13	303	Dao Khanong - Phra Pradaeng	5.2	4	8	435	Completed
DOH	39	17	3113	Sam Rong - Thahin	6.4	4	6	402	
DOH	40	04	37	Outer Ring Road (South)	13			2,000	
DOH	40	07	37	Outer Ring Road (South)	27.0			2,200	
DOH	41	10	3	Sam Rong - Samut Prakarn	4.7	4	6	424	
DOH	42	23	3268	HW. No. 3344 - Bangphlee	8	2	4	699	
DOH	43	52	3268	Flyover at HW. No. 3344 - HW. No. 3268	0.5		4	250	
DOH	44	53	3344	Flyover at On Nut	0.5		4	180	
DOH	45	55	343	Interchange at HW.No.346 and HW. No 3344	0.5			200	
DOH	46	18	3119	Lad Krabang - Minburi	11	2	4	500	
DOH	47	02	36	Bangkok - Chonburi (Sai Mai)	81.7		8,4	12,754	
DOH	48	22	3256	Bang Phlee - Lad Krabang	10.2	2	4	500	
DOH	49	27	34	Bang Na - Bang Pakorn (Bang Phlee - Bang Woi)	28.8	2	5	3,850	
DOH	50	76	3	Bang Tam Ru - Khlong Dam - Bang Pakorn	35.3	2	2	176	
DOH	none	01	31	Extension of Don Muang Tollway	6			3,000	
DOH	none	21	3242	HW35 - Samut Sakorn Section 1 Samut Sakorn Bang Khun Thien	4			48	
DOH	none	31	35	Rama 2 (Thon Buri - Pak Tho) Section Dao Khanong - Highway 37 (both of frontage roads)	7		6-10	350	
DOH	none	32	4	Nakorn Pathom Bypass	6			200	
DOH	none	33	338	Phutthamonthon Sai 2 - Nakorn Chai Si	26			3,200	
DOH	none	35	35	Rama 2 (Thon Buri - Pak Tho) Section km 9-29	20		6-10	2,100	
DOH	none	37		Flyover crossing railway at Tammasart Univ.	1			120	
DOH	none	41	3	Flyover at intersection of Samrong - Wang Hin (Puchao Saming Prai) and Theparak Rd.				150	
DOH	none	42	302	Interchange at intersection of Highway 302 and Highway 3215				400	
DOH	none	43	302	Interchange at intersection of Highway 302 and Highway 3110				600	
DOH	none	44	304	Flyover at intersection Laksi KM8 to Minburi				80	
DOH	none	45	304	Interchange at intersection of Highway 304 and Highway 3278				500	
DOH	none	46	304	Elevated road from Chaeng Wattana to Ram Intra section Laksi - Laksi Monument				700	
DOH	none	47	304	Interchange at intersection of Highway 304 and Highway 3119				300	
DOH	none	48	304	Flyover at Pak Kret				300	
DOH	none	49	306	HW No.3100 - JCT HW No. 347 Section 2: Bridge crossing Khlong Rangsit				330	
DOH	none	50	31	Connect Don Muang Tollway to SES				300	
DOH	none	63	343	Interchange at KM14+950 Bang Na - Bang Pakong	1			200	
DOH	none	64	346	Pathum Thani - Lad Lum Kaew - Bang Len Section	3			200	
DOH	none	65	346	Flyover at Intersectoin of HW 346 and HW347	1			90	
DOH	none	73	3000	Kra Thum Ban-Phraew-Dam Noen Saduak	50			400	

Source 1 : DOH Mar, 1996
Source 2 : TPPP Report (June 1996)
Note : If costs are not available from the list of DOH, costs listed in the TPPP report are used.
Costs do not include land costs.

Table 5.12 PWD Project for the 8th Plan

Agency	CODE	Project Name	Existing Standard	Proposed Standard	Lane	Length (km)	Cost (mil. Baht)
PWD	01	TAKSIN -PHETKASEM RD (1992-1997)	None	New Road Devided	8	4.5	3,436
PWD	02	NEW KRUNGTHEP BRIDGE (1985-1998)	None	New Bridge	6	3.372	1,968
PWD	03	WAT NAKORN-IN BRIDGE AND CONNECTING ROAD;TIVANON PHETKASEM-RATTANATHIBET (1990-1998)		New Bridge	6	28.95	11,872
PWD	04	PAK KRED BRIDGE & CONNECTING ROAD (1993-1999)	None	New Bridge - 6 lane	6	14.906	5,053
PWD	05 a	DISTIBUTOR ROADS IN NONTABURI (1992-1998)		New Road		3.2	1,215
PWD	05 b	DISTIBUTOR ROADS IN NONTABURI (1992-1998)		New Road		3	1,026
PWD	05 c	DISTIBUTOR ROADS IN NONTABURI (1992-1998)		New Road		10.7	492
PWD	05 d	DISTIBUTOR ROADS IN NONTABURI (1992-1998)		New Road		4.7	2,150
PWD	06	SOI BARING IMPROVEMENT AND ROAD CONNECTING TO SOI LASAL (1993-1996)	2 way -2 lane	Widening	4	4.4	313
PWD	07	WAT KING KAEW - 2000 YEARS RATTANAKOSIN RD. (1993-1998)	None	New Road		16.4	1,837
PWD	08	SRI SAMAN ROAD IMPROVEMENT (1993-1996)	2 way -2 lane	Widening	4	2.4	384
PWD	09	THA NAM NON - RATCHAWITHI - NAKORN CHAISRI RD. (1993-1994)	None	New Road Divided	4	10.0	1,150
PWD	10	TAKSIN PHETKASEM - OUTER RING RD. (1992-1998)		New Road Divided	4	7.7	2,606
PWD	11	ROAD TO PHRA PATHOM JEDI (1993-1994)	2 way -2 lane	Widening to 8 lanes	8	1.0	226
PWD	12	TAKSIN PHETKASEM - RAMA 2 RD. (1993-1999)	None			5.9	2,763
PWD	13	TAKSIN PHETKASEM - CHALERM MAHANAKORN EXPRESSWAY(1994-1998)				5.0	844
PWD	14	RAMA 2 -NAKORN KHUEM KHUN RD. (1994-1998)				7.5	1,266
PWD	25	NEW KRUNG THON BRIDGE	None	New Bridge	4	0.9	1,117
PWD	26	PHRA PRADAENG BRIDGE & KHLONG TOEY to SAMUT PRAKARN ROAD (INDUSTRIAL RING ROAD)			8		15,980

Source : Report on Traffic and Transport fot the 8th NSEDP, OCMRT

Table 5.13 ETA Project for the 8th Plan

Agency	Code		Project name	Proposed Standard	Length (km)	Cost mil. Baht
ETA	01	A,C1	SECOND STAGE EXPRESSWAY PROJECT,SES (1988-1996), Sector A and C1	Elevated - 6 lanes	20.4	
ETA	01	B	SECOND STAGE EXPRESSWAY PROJECT, SES Sector B (1988-1996)	Elevated - 6 lanes	11.4	27,957
ETA	01	D	SECOND STAGE EXPRESSWAY PROJECT, SES (1988-1996), Section D	Elevated - 6 lanes	8	12,152
ETA	02		RAM INDRA-AT NARONG EXPRESSWAY PROJECT,RAE (1991-1996)	Elevated - 6 lanes	19	34,617
ETA	03	N	THIRD STAGE EXPRESSWAY PROJECT (1994-1999), The Northern Route	Elevated - 6 lanes	23	33,599
ETA	03	S	THIRD STAGE EXPRESSWAY PROJECT (1994-1999) The Southen Route	Elevated - 6 lanes	12	15,545
ETA	04		THE IMPROVEMENT OF ON-OFF RAMPS FOR FES(1994-1996)	Elevated - 6 lanes		1,853
ETA	05		BANG NA-BANG PHLI-BANG PAKONG EXPRESSWAY PROJECT (1994-1998)	Elevated - 6 lanes	55	25,193
ETA	06		PHAYATHAI - PHUTTHAMONTHON -NAKORN PATHOM EXPRESSWAY PROJECT : SES EXTENSION	Elevated - 4 lane	14.0	24,276
ETA	07		CHAENG WATTANA-BANG POON- BANG SAI EXPRESSWAY PROJECT: SES-SECTOR C EXTENSION (1995-2000)	Elevated - 6 lanes	34	28,000
ETA	08		SRINAKARIN - BANGNA - SAMUT PRAKARN EXPRESSWAY PROJECT:SES-SECTOR D EXTENSION (1995-1998)	Elevated - 4 lane	18.0	13,269
ETA	09		EXPRESSWAY ABOVE KHLONG SAEN SAEP PROJECT : KHLONG TON-BANG CHAN - MIN BURI (1995-1999)	Elevated - 4 lane	18.0	10,626
ETA	10		DAO KHANONG-BANG KHUN TIEN-SAMUT SAKORN EXPRESSWAY PROJECT (1995-1999)	Elevated -4 lanes	25.7	14,341
ETA	16.1		The Fourth Stage Expressway System, First Phase. Samut Prakarn - Sukkawat -Thonburi-Pakthor.Includes crossing of Chao Phraya River.	Elevated 6- lane	18.0	15,594
ETA	16.2		The Fourth Stage Expressway System, Secound Phase : Ram Inthra - ORR	Elevated 6- lane	6.1	6,910
ETA	17		The Fifth Stage Expressway : Thonburi Pakthor-Petkasem Nonthaburi. Includes crossing of the Chao Phraya River.	Elevated 6- lane	24.0	23,625

5.5 Alternative Cases for The Traffic Model Simulation Analysis

As discussed in Chapter 5.1 ten simulation cases were prepared for the simulation analysis. These ten cases are discussed below :

Case 1: This is the simulation model run for the base case i.e. the existing situation in 1995.

Case 2: This case assumes all of the 8th National Plan road projects were completed in 1995 .

Case 3: This case tests the impact on the transport environment if all the 8th Plan project, as well as mass transit, had been completed in 1995 .

Case 4: In this case it is assumed that there are no improvements between 1995 and 2011 .

Case 5: In this case the 8th National Road Plan is assumed to be completed in 2011 but there is no mass transit .

Case 6 In this case the 8th National Road Plan is assumed to be completed in 2011 with full mass transit .

Case 6 is the base case for the future 2011 analysis on which cases 7 - 10 are built for testing .

Case 7: This case assumes that there is a large degree of bus priority .

Case 8: In this case it is assumed that there is a 20 % increase in road space in addition to the 8th National Plan projects .

Case 9: This is the case that analyses the effect of area restraint on the transport environment .

Case 10: For this case it is assumed that there is a change in the distribution of population and employment away from the trend projections toward a distribution led by sub-center development.

5.6 Interpretation of Results of Model Simulation

(1) Overview

From the analysis of the simulation results, several conclusions can be drawn. These conclusions will assist in the clarification of the thinking behind the Bangkok Transport Vision. The results are presented in Table 5.14 together with a summary of the interpretation in Table 5.15. The ten simulations are shown in Appendix 1.

To analyze the results each link in the road network is given a rank between 1 and 5 for each case. This rank is based on the level of congestion estimated on that link in the morning peak hour and varies from saturated (Rank 1)to a link carrying a low considerably less than its capacity (Rank 5).

The percentage of road length is compared with the base of Case 1. A rank 1 could be described as a two-lane road trying to carry 4,000 vehicles in the peak hour when the capacity is 2000. The same road would be considered as rank 5 if it was carrying less than 1500 vehicles per hour.

Two other parameters are used in the interpretation of the network results. These are the Congestion Index (C.I.) and the modal share to public transport (%PT).

The C.I. is a comparison of the percentage length of road that falls into Rank 1,2&3 roads in comparison to the existing situation in 1995 (Index = 100) . The %PT is simply the percentage of private person trips that will use public transport for each case .

(2) The Simulation Results

In case 1 , the base existing simulation for 1995 showed that there was existing heavy congestion with approximately 55 % of all private trips being made by public transport.

The analysis in case 2 and 3 simulates the existing demand on future networks. If, for example, all the roads of the 8th Plan were actually built and in place, the C.I. , the measure of congestion is significantly lower than the present situation. However, the results that indicate that the transport system shifts toward a car-orientated society with a decrease in the use of public transport. This implies more roads, less public transport users.

Whereas in case 3, where the hypothesis is that mass transit is there in 1995, the C.I. is less because of the extra roads. There is a further decrease as a result of a shift towards public transport .

The analysis then examines the impending effect on the transport system as the city grows towards its anticipated new size by the year 2011.

Table 5.14 Results of Simulation Analysis: Congestion Ranking for Roads within BMA in Morning Peak Hour

LEVEL/CASE	1	2	3	4	5	6	7	8	9	10
SATURATED	13.2%	3.4	1.5	62.2	35.5	23.8	10.1	32.0	16.8	18.2
HEAVILY CONGESTED	15.7%	6.0	3.8	13.2	14.6	13.8	14.1	13.2	14.8	13.3
CONGESTED	9.4%	5.5	4.0	5.8	8.4	8.6	9.0	7.2	9.1	9.3
Sub-Total	38.3%	14.9	9.3	81.2	58.5	46.2	33.2	52.4	40.7	40.8
(km)	(663)	(354)	(219)	(1406)	(1389)	(1100)	(789)	(1246)	(965)	(971)
C.I.	100	39	24	212	152	121	87	137	106	106
ACCEPTABLE	12.6%	10.1	8.0	5.8	10.4	10.3	11.5	9.8	11.9	11.5
UNDER CAPACITY	49.1%	75.0	82.7	13.0	31.1	43.5	55.3	37.8	47.4	47.7
TOTAL	100%	100	100	100	100	100	100	100	100	100
LENGTH (km)	1732	2376	2376	1732	2376	2376	2376	2376	2376	2376

Note C.I. : Congestion Index (Based on Percentage of Congested Roads in 1995=100)

If there is no or little investment in transport infrastructure, the C.I. will more than double between 1995 and 2011. This means that the mobility of people would be significantly restricted (Case 4).

In case 5 , the road network of the 8th plan are added to the road network . This improves the C.I. but it is still above the level of 1995 which means that the mobility of persons in Bangkok will still be less than the current level .

Finally, in case 6 the mass transit is added returning the proportion of public transport users to the level of 1995 with a further reduction in the C.I., although not below the current level in 1995 .

Table 5.15 Major Findings from the Simulation Analysis

CASE	C.I.	% PT	COMMENTS
1	100	55	The Existing Situation
2	39	50	If all the roads of the 8th plan were to built in 1995, the C.I. decreases to 39
3	24	60	If Mass Transit were in place in 1995, the C.I. drops further as the modal share of public transport increases.
4	212	55	The "Do Nothing Case" by 2011 If nothing is done, the C.I increases significantly
5	152	43	The roads of the 8th plan in place by 2011, the C.I. decreases but not below 1995 level. More road construction leads to decrease of public transport (PT) share.
6	121	58	Case 5 with the Mass Transit, C.I decreases but still above 1995 level.
7	87	63	In addition, "BUS PRIORITY" is added, C.I. becomes close to the existing level.
8	137	48	It was assumed more road space could be created at the local street level. This leads to a decrease of public transport (PT) share and increase of C.I.
9	106	61	With central area restraint (the Middle Ring Road in this case), public transport (PT) share and C.I. decreases.
10	106	58	With the sub-center development case, C.I. decreases in comparison with case 6.

Cases 1 to 6 can be summarized as follows:

- Construction of more roads will encourage more cars
- Construction of mass transit will shift some to public transport
- 8th Plan Road Projects and Mass Transit will not decrease the level of congestion prior to 2011
- Construction of all current projects will not improve levels of congestion

In BEIP, there is a vision however to improve the transport environment in Bangkok by improving the public transport system and by encouraging travelers to use public transport in preference to private cars. This will also result in a reduction in levels of air pollution. Cases 7 to 10 quantify the impact of adopting policies which support the BEIP transport vision .

The hypothesis in case 7 is that bus public transport is significantly improved by the creation of bus-ways and dedicated bus lanes with access being restricted to buses and taxis only. There is a change in the priority use of road space. The priority use for road space is to be given to public transport. If this policy is adopted and enforced the C.I. falls below existing 1995 levels. The proportion of travelers using public transport is also increased above 1995 levels.

An alternative policy may be to increase significantly by 20 % with a significant capital investment and land resumption plan. If this was carried out over the whole of BMA the level of C.I. will increase and the proportion of public transport decreases. When more road space is made available, the space cannot meet the expectations of additional travelers. However, in this case it should also be remembered that additional road space to provide better access within, for example, sub-center development is completely different to providing globally new road infrastructure .

Area restraint as a policy is simulated in Case 9. This may take the form of restrictions into the central city including area entry tolls, odd / even number plates, area licensing, significant parking restrictions including off street parking or parking charges. The results of this simulation suggest a fall in the C.I. to a level similar to that of 1995 whilst an increase in public transport usage similar to that in case 7.

The final simulation examines the effect of structural change in the development of the city by the year 2011. In this analysis the growth of employment in the central area is transferred to the sub-centers. Approximately 10 % of the anticipated employment in the central area by 2011 is transferred to the sub-centers. This has a significant effect on the C.I. by shifting that last 10 % of the destinations of the road traffic away from the center towards more local destinations .

The results of Cases 7 to 10 can be summarized as follows:

- The policy emphasizing public transport system development is the most effective to reduce private car use ;
- Area Control Systems are effective in reducing private car use. They, however, cannot be expected to be as effective in releasing traffic congestion; and
- Metropolitan Sub-center Development is remarkably effective for releasing traffic congestion while maintaining the public transport share as a whole.

(3) Transport Vision 2011

In summary, Bangkok needs Mass Transit for 2011, and it also needs a combination of policies to support this as discussed, such as structural change in the city, area restraint and an improvement in bus public transport. These projects and policies should be given higher priority above some, if not all, the 8th Plan projects.

Some 8th. Plan Projects will effect the movement of freight in and around Bangkok such as the Outer Ring Road. These 8th plan projects also need high priority as they will reduce the number of trucks using the road space in Bangkok .

The above will lead Bangkok towards the **BEIP Vision 2011** for transport systems (this is discussed in Chapter 2 of Volume 3).

A set of initiatives have been developed that will lead towards an improved transport system as described in the analysis of the ten cases. These initiatives are consistent with the development of the transport philosophies that are currently being pursued in other major cities such as Tokyo and London. These other major cities do have a viable alternative to the motor vehicle i.e. mass transit, and they give priority use of their road space to public transport i.e. bus and taxi rather than the private motor vehicle.

Table 5.16 Key Strategic Initiatives for the Bangkok Transport Sector 2011

For Vehicle Owners:
1 Reduce need and use of private vehicles in urban life.
2 Promote ridership of public transport systems including buses and MRTs and non-motorized modes.
For Commuters:
3 Improve or develop Inter-modal facilities among those systems.
4 Restrict private vehicle use in CBD where public transport modes are readily available.
For All Residents
5 Create a safe environment for non-motorized mode users, pedestrians and residents.