

BEIP

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)
BANGKOK METROPOLITAN ADMINISTRATION(BMA)
THE GOVERNMENT OF THE KINGDOM OF THAILAND

**THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA**

FINAL REPORT
VOLUME 2: MASTER PLAN

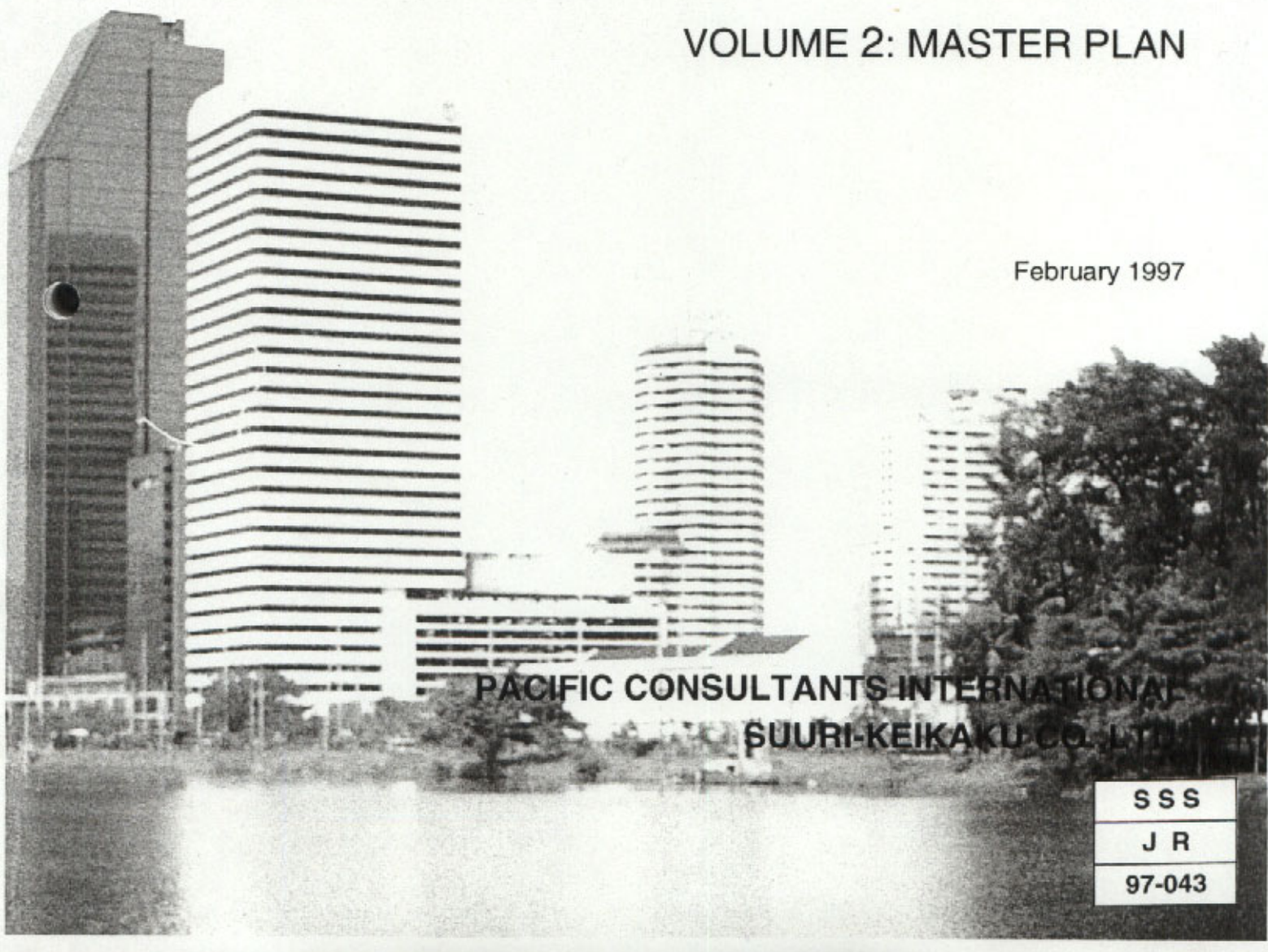
February 1997

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SUURI-KEIKAKU CO., LTD.**

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The exchange rates applied in this Study are:

US\$ 1.00	=	Baht 25.42
US\$ 1.00	=	Japanese Yen 110.65
Baht 1.00	=	Japanese Yen 4.35

(as of September 1996)

Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct "The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area" and entrusted the Study to the Japan International Cooperation Agency (JICA).

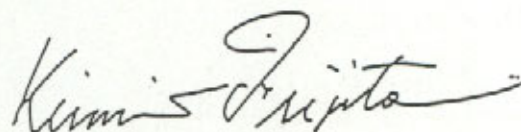
JICA sent to the Kingdom of Thailand a study team headed by Dr. Katsuhide NAGAYAMA, Pacific Consultants International, and composed of members of Pacific Consultants International, and Suuri-Keikaku Co.,Ltd., four times between August 1995 and December 1996.

The team held discussions with the officials concerned of the Government of the Kingdom of Thailand and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Kingdom of Thailand for their close cooperation extended to the team.

February 1997



Kimio Fujita
President

Japan International Cooperation Agency

February 1997

Mr. Kimio FUJITA

President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Sir,

We are pleased to formally submit herewith the final report of "The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area".


This report compiles the results of the Study which was undertaken in the Kingdom of Thailand from August 1995 through December 1996 by the Study Team, organized jointly by Pacific Consultants International and Suuri-Keikaku Co., Ltd.

We owed a lot to many people for the accomplishment of the Study. First, we would like to express our sincere gratitude and appreciation to all those extended their kind assistance and cooperation to the Study Team, in particular, relevant officials of Bangkok Metropolitan Administration, the Thai counterpart agency.

We acknowledge all the officials of your agency, the JICA Advisory Committee, Embassy of Japan in Thailand and Ministry of Foreign Affairs.

We wish the report would be able to contribute really to appropriate policies and measures for the Bangkok environmental improvement to be formed by the Thai Government.

Very truly yours,


Dr. Katsuhide NAGAYAMA

Team Leader,
The Study Team for the Study on
Urban Environmental Improvement
Program in Bangkok Metropolitan
Area

Abstract

This Study proposes a new urban growth system and social rules for forming adequate social capitals and appropriate uses of environmental resources, seeking sustainable development of the Bangkok Metropolis with the ultimate goal of up-grading people's quality of life.

The Study recommends that Bangkok Metropolitan Administration (BMA) and relevant national agencies make integrated efforts to:

- 1) re-structure the physical urban structure towards a multi-polar metropolitan system instead of the present one-center system, by emphasizing "Mass transit-driven Urbanization";*
- 2) institutionalize urban planning-related systems effective for "Urban Growth Management" to materialize adequate land use;*
- 3) realize strategic projects/programs based on the following 6 planning polices:*
 - Sustainable resource utilization of vulnerable environment;*
 - Flood-free urbanization;*
 - Environment-initiative transportation system;*
 - Fresh and clean air;*
 - Water-friendly Eco-city; and*
 - Quality of Living*
- 4) Strengthen the implementability and financial absorptive capacity of BMA, improving the basis of local taxation and encouraging participation of people, communities and the business sector based on a bottom-up approach.*

THE STUDY ON URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM IN BANGKOK METROPOLITAN AREA

Study Period: August 1995 - February 1997

Counterpart Agency: Bangkok Metropolitan Administration

Outline of the Study

1 Background

Thailand has been enjoying a rapid economic growth at more or less 10% p.a. since 1987, in which the Bangkok economy does and will continuously strengthen its centric and higher urban functions rather than industrial function. More information-based and more value-added types of business with international linkages will be expanded.

Despite a long-standing "Decentralization Policy", Bangkok is still accepting rural-to-urban migrants at a significant rate and will grow to be one of the largest Mega-cities over the world with more than 10 million population in 2011. The expected economical development will eventually up-lift the per capita income level to be US\$13,000 in 2011, compared to US\$5,600 at present as of 1995.

Under this favorable circumstances, however, the city suffers from urban environmental problems such as traffic congestion and air pollution. As being economically affluent on one hand, people will become more environment-conscious and more cultural identity-oriented on the other hand. Environmental improvement will be a further critical policy issue on both short- and long-term perspective.

2 Objective

The objective of the Study is to formulate a comprehensive master plan for the urban environmental improvement of Bangkok Metropolitan Area with the target year of 2011. This Study proposes a new urban growth system and social rules for forming adequate social capitals and appropriate utilization of the environmental resources, seeking sustainable development of the Bangkok Metropolis with the ultimate goal of up-grading people's quality of life.

3 Outline of the Program

3.1 Development Framework

Table 1 Socioeconomic Framework of BMA

	1995	2001	2006	2011	Increase 1995-2011	Avg. Growth Rate p.a. 1995-2011
Socioeconomic						
Population (,000)	8,126	9,044	9,761	10,496	2,370	1.6 %
GPP-BMA (Bill. Baht at 1988 const. Price)	1,149	1,823	2,557	3,422	2,273	7.1 %
Urbanization						
Urbanized Ratio (% as of BMA total area)	34.3	38.4	45.6	56.1	-	-
Population density (prs/ha)	150	149	136	119	-	-
Motorization						
No. of Vehicles registered (,000)	1,911	2,773	3,406	4,065	2,154	4.8 %
Vehicle Ownership per Household	0.94	1.20	1.32	1.42	-	-

3.2 Restructuring of the Bangkok Metropolis

1) From One-center to Multi-polar Urban System

Metropolitan Subcenters should be developed at five locations in suburban areas within BMA, that will function as commercial/business centers to make job-and-housing balance, thereby releasing the concentration pressure.

2) Urban Regeneration

Part of the central areas, where a number of warehouses and factories are going to be out of date and no longer economically functional, should be re-generated or re-developed. It is necessary to establish a re-generation program with a long-term perspective.

3) Sub-urbanization

Infrastructure-led urbanization should be pursued, by employing institutional tools under well-coordination between urban planning and implementation of infrastructures.

4) Mass-Rapid Transit-Driven Urbanization

Areas easily accessible to stations of the planned MRTs will induce intensive land use. Hence, such mass-transit driven urbanization is effective for management of traffic demands control. Physical urban design of transport facilities and their network systems should be made in such a way that pedestrians and public transport passengers may take advantages in services and amenities with convenient inter-modal transfer systems.

3.3 Planning Concepts for Bangkok Urban Environmental Improvement

1) Pursuance of Sound Urban Environment

Planning of urban environmental improvement pursues four (4) vital elements of human life: *Healthiness*; *Safeness*; *Comfortableness*; and *Convenience*. The city should provide with environmental conditions to assure all the elements.

2) Functioning Urban Metabolism System

The city itself is an organic system, therefore, always changes its land use and functions, in response to requirements of the times and the economy. This is called "Urban Metabolism" with two sub-systems working reciprocally:

- *Anabolism* : the urban system to provide with fresh and clean inputs sufficiently enough to maintain the organic system;
- *Catabolism* : the urban system to treat with emissions and wastes so as to minimize damages otherwise would-be-harmful.

To maintain the urban metabolism, man-made and natural environment should be co-existing. This is a vital planning issue for the environmental improvement.

3) Urban Growth Management

Bangkok needs to establish a urban growth management system. Growth shall be limited within the carrying capacity that the government can control in providing necessary public services to protect the environmental deterioration. The carrying capacity is determined by not only its spatial extent, but also authorities' managerial and economic capabilities.

3.4 Planning Issues, Targets and Macro Measures

1) Planning Issues

Deterioration of "Bangkok environment" has been reaching a critical level, which means that further worsening of the quality of environment will jeopardize the people's lives as well as sustainable socioeconomic growth. The majority of the Bangkok residents has been already aware of that substantial solutions on environmental problems should be prioritized even though they pay some cost for the economic growth ("Environment Awareness Survey for Bangkok People", IDE). To resolve problems of environmental deterioration, an integrated approach is essential and new social rules are needed for using resources of the Metropolis.

Planning issues, in this sense, are identified to be the following six:

- Sustainable Resource Utilization in Vulnerable Environment;
- Flood-free Urbanization;
- Environment-initiative Urban Transport System;
- Creation of "Water-friendly Eco-city";
- Pursuance of "Fresh and Clean Air policy"; and
- Up-grading of Quality of Living Environment.

2) Macro Measures to Achieve the Targets

For the achievement of the targets, the macro measures, including both soft and hard ones, should be pursued at the level of national as well as BMA. Some of them call for business sector's participation or people's strong involvement.

Table 2 Planning Target and Macro Measures for Environmental Improvement

PLANNING ISSUE	TARGET 2011	NUMERICAL TARGET	PROPOSED MACRO MEASURES
PLAN 1: Sustainable Resource Utilization in Vulnerable Environment	Creation of the robust urban environment against the natural disasters.		<ul style="list-style-type: none"> - Pursuance of energy saving and resource recycling policy. - Establishment of social rules and guidelines for stopping land subsidence. - "Green and Water Network" Development.
PLAN 2: Flood-Free Urbanization	Creation of the man-made environment for people to be free from fears and apprehensions of floods.	Keeping the drainage capacity to cope with 5 year rainfall probability.	<ul style="list-style-type: none"> - Formulation of a long-term master plan. - Formulation of a hierarchical drainage system. - Establishment of well-functioning flood control system. - Control of environmental preserved land. - Development of guidelines regarding water retaining.
PLAN 3: Environment - initiative Urban Transport System	Re-structuring of the Bangkok Urban Transport System with a more environment oriented system, or shifting to a public transport based system; and Mitigation of road traffic congestion, providing with alternative urban public transport modes suitable for their purposes and time constraint.	Anyone can reach his/her work place or school within 45-60 minutes; and the share of public transport as a primary mode shall be 70%(excluding walk trips)	<ul style="list-style-type: none"> - Shift to a Mass Transit - driven Urban System - Public Transport Corridor development. - Development of hierarchical road system.
PLAN 4: Pursuance of "Fresh and Clean Air Policy"	Mitigation of air pollution up to a level that people may feel no damage on health.	Ambient air pollution levels in most of Bangkok urban areas shall satisfy the presently regulated "Thai Environment Standard"	<ul style="list-style-type: none"> - Strengthening of environmental administration. - Measures for mobil sources related to urban transport. - Stationary sources managed on voluntary basis.
PLAN 5: Creation of "Water - friendly Eco - city"	Restoration of the Thai water culture in association with improvement of water quality in khlongs.	BOD: less than 15mg/l in major khlongs in the Special Policy Zone (Khlong Water Quality Improvement Promotion Zone)	<ul style="list-style-type: none"> - Water quality improvement and restration of function of the urban khlongs. - Beautification of khlongs and river front area.
PLAN 6: Up-grading of Quality of Living Environment	Materialization of Healthy, Safe, Comfortable and Convenient Environment for all people, with social cares for urban poor, elderly and handicappers.	<p>Solid Waste Management: reduction of per capita generation rate of solid waste by 10%.</p> <p>Water Supply: supply to all residents in urban areas, in association with reduction of the leakage ratio up to less than 20%</p>	<ul style="list-style-type: none"> - Solid waste management for hygienic living environment. - One-more-step solution of slum problem. - Creation of pedestrian-advantageous society. - Attention to the environment for the weak.

4 Programming of Projects/Programs

4.1 A Conceptual Ground for Programming

Projects/programs to materialize the urban environmental improvement plan are categorized into one of four categories characterized as follows:

- I. Public investment for local and sector solution;
- II. Involvement of voluntary private activities;
- III. Institutional system with guidelines, standards and regulations for urban environmental and growth management; and
- IV. Strategic public investment for urban restructure.

In the short-term, intensive efforts should be made to enhance the categories of I and III; and in the medium- to long-term, emphasis should be placed on the categories of II and IV.

4.2 Proposed Projects/Programs for Bangkok Environmental Improvement

For the macro measures to achieve the planning target, 105 projects/programs are recommended as summarized in the list compiled in the end of this report.

5 Basic Rules for the Implementation

5.1 Social Rules for the Implementation

Social rules are required to manage and support the deliberate implementation of the plans, taking into account:

- A decrease of environmental resources shall be compensated with an increase of environmental inputs at the corresponding economic value. Based on this rule, "Polluter-Pay-Principle (PPP)" or "User Charge System" should be justified.
- Any type of development should minimize anticipated negative impacts on the environment, based on another rule that one's gain never results in worsening the other's welfare.
- A preventive approach is less costly than a curative approach in the long-run. Before worsening the environment, effective measures against it should be undertaken.

5.2 Institutional Arrangement for Urban Growth Management

A number of institutional arrangement for urban growth management are necessary to support the administrative power to implement the plans, including:

- **Special Policy Zoning System**, supplementing the current Land Use Zoning System, to indicate policy directions and concrete measures of the environmental improvement in accordance with the zonal attributes;
- Institutionalization of **Parks and Open-space Development Act** which stipulates guidelines of development and preservation of public parks and green areas along khlongs and other valuable open space;
- Rationalization of the current **Floor Area Ratio** (a flat system of 1,000%) to rationalize the intensity of land use reflected by locational and environmental attributes with institutional links with the Urban Planning Act;
- Enhancement of **Environment-related Acts/Regulations** with enforcement power of the responsible authorities;
- Introduction of the regulation of **Traffic Assessment Study** which is obliged to submit the local government together with the application of building permission for a large-scale projects;
- Preparation of **Local Government's Guidelines** for land and subdivision development with deliberate measures for environmental improvement and preservation in a form of Local Government Ordinance.

6 Financing for the Implementation

6.1 Financial Demarcation System

Since environmental problems likely appear at local level, BMA as of the local government has to have a chief responsibility for resolving the problems.

For the implementation of projects, the budgetary autonomy of local government is limited, and most of environmental projects are carried out under the subsidy system where about 60-65% of the total costs come from the central government. Further devolution in the budgetary power for projects/programs should be pursued in such a way that BMA can directly tackle with local environmental problems, improving the existing subsidization system.

6.2 Enhancement of BMA Financial Capability

Financial and implementing capabilities of BMA itself should be further strengthened in order to put the plans into action, through:

- 1) Improvement of the executing system of the current Local Taxation, including:
 - preparation of **Land and Assets Ownership Maps, or Cadastral Maps**;
 - re-evaluation of **Asset Value**; and
 - improvement of **Tax Collection System**.
- 2) Introduction of **PPP or User Charge System** for environmental services;
- 3) Utilization of **External Financial Resources** (soft loans) to initiate urgent infrastructure projects and social capital formation; and
- 4) Development of **Training Programs of Local Government Personnel** particularly for planners, engineers and financial staff.

6.3 Evaluation of BMA's Financial Capability for the Implementation of Environmental Projects/Programs

1) Evaluation of BMA's Financial Capability in the Short-term

During the period of the BMA 5th Development Plan (1996-2001), a number of projects/programs regarding the environmental improvement of Bangkok has been launched by relevant government agencies. Besides the above, adding the cost for all the projects/programs termed "Urgent Actions" proposed by the BEIP Study, which are to be implemented during the same period between 1996 and 2001, the total necessary cost amounts to approximately 283 billion Baht. Of which, those to be implemented by BMA is estimated at 152 billion Baht. Given the current subsidy system from the central government, BMA itself has to share approximately 53.3 billion Baht out of the total of 152 billion Baht.

If BMA succeeded in execution of the enhancement program for financial capability as proposed in the preceding section 6.2, BMA could enlarge its revenue sources through local taxes, thereby, could bear an accumulated budget of about 22.3 billion Baht available for the environmental investment up to the year 2001. Therefore, if BMA implements all the projects/programs proposed by both the 5th Plan and the BEIP Study in schedule, a fund shortage, or a budgetary deficit, will occur at an amount of 31 billion Baht in 2001.

Two ways are conceivable to fulfill this deficit, i.e., 1) to claim a special subsidy allocation to the central government; or 2) to seek some external fund sources in a form of soft loans.

2) Evaluation of BMA's Financial Capability in the Medium- and Long-term

Out of the projects/programs proposed by the BEIP Study, those to be chiefly implemented by BMA will cost approximately 123 billion Baht for the medium-term (2001-2006), and 141 billion Baht for the long-term (2006-2011). Under the current subsidy system from the central government, BMA itself has to share 43 billion Baht in the medium-term (2001-2006), and 49.4 billion Baht in the long-term (2006-2011). On the fund supply side, BMA will bear available budgets for the environmental investment of 49.8 billion Baht for the medium-term, and 75.3 billion Baht for the long-term. As the result, obviously, BMA will be able to be affordable and manageable to implement all the projects/programs proposed by the BEIP Study. In the long-term, the deficit born in the short-time will be fulfilled with the surplus, and the balance will be all clear in 2011. The above discussed are summarized in Table 3.

3) Overall Evaluation of Project Implementability of BMA

Under two premises that the current subsidy system is workable and that BMA implements the proposed program to enhance its budgetary base, BMA is assessed to be financially capable of executing all the projects/programs stipulated by the 5th Plan and the BEIP Study, despite that BMA will suffer from a budget shortage in the short-run.

Therefore, it is critical whether or not BMA will challenge to put forth the Enhancement Program which is included in the list of the proposed projects/programs compiled in this BEIP Study.

Table 3 BMA's Financial Capability of Implementation of the Proposed Projects and Programs for Environmental Improvement

		million baht			
		Urgent Actions	Medium-term	Long-term	Total
		(1997-2001)	Projects /programs (2002-2006)	Projects /programs (2007-2011)	
1) Required Environment Investment Costs, 1997 -2011					
Investment Budget of Environment Projects in BMA Fifth Five-Year Plan		(a)	120,500		120,500
Investment Budget of MWA Five-Year Plan		(b)	114,900		114,900
Total Costs of Projects/Programs of BEIP Study		(c)	47,330	415,450	472,600
- BMA		(d)	31,740	122,730	141,140
- Central government			2,320	4,690	1,860
- State Enterprise			8,680	180,690	216,500
- Private Sector			4,590	107,340	113,100
Total Investment Cost		(a)+(b)+(c)	282,730	415,450	472,600
2) BMA Budget Revenue in Challenging Case					
Estimated BMA Budget Revenue		(e)	115,100	182,300	255,800
3) Require Amount for Environmental Investment of BMA					
Required Amount for Environmental Investment		(f)=(a)+(d)	152,240	122,730	141,140
- Required Investment of BMA		(g)=(f)x35%	53,280	42,960	49,400
- Required Subsidies from Central Government		(h)=(f)x65%	98,960	79,770	91,740
7) Potential Investment Budget of BMA for Environment					
Potential Investment Budget of BMA for Environment		(i)	22,300	49,790	75,320
Required Investment of BMA		(g)	53,280	42,960	49,400
Balance of BMA Budget		(j)=(i)-g)	-30,980	6,830	25,920
Percentage of BMA Total Budget		(j)/(e)	-27%	4%	10%

Source: BEIP Study

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Abbreviation

BEIP	The Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area
BMA	Bangkok Metropolitan Administration
BMR	Bangkok Metropolitan Region
BMTA	Bangkok Mass Transit Authority
BOD	Biological Oxygen Demand
CBD	Central Business District
CO	Carbon Monoxide
DO	Dissolved Oxygen
DOH	Department of Highways, Ministry of Transport and Communications
DTCP	Department of Town and Country Planning
EEC	European Economic Community
ERTC	Environmental Research and Training Center
ETA	Express Transit Authority of Thailand
FAR	Floor Area Ratio
FIRR	Financial Internal Rate of Return
GDP	Gross Domestic Product
GIS	Geographic Information System
GPP	Gross Provincial Product
HBE	Home Based Education Trip
HBO	Home Based Others Trip
HBW	Home Based Work Trip
IDE	Institute of Developing Economies
IPCC	Intergovernmental Panel on Climate Change
JEA	Japan Environmental Agency
JICA	Japan International Cooperation Agency
LTD	Land Transport Department
MOF	Ministry of Finance
MOH	Ministry of Health
MOI	Ministry of Interior
MOID	Ministry of Industry
MOSTE	Ministry of Science, Technology and Environment
MOTC	Ministry of Transport and Communications
MRR	Middle Ring Road

MRTA	Metropolitan Rapid Transit Authority of Thailand
MSL	Mean Sea Level
MWA	Metropolitan Waterworks Authority of Thailand
NEPO	National Energy Policy Office
NESDB	National Economic and Social Development Board
NHA	National Housing Authority
NHB	Non-Home Base Trip
NO	Nitrogen Monoxide
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
NPV	Net Present Value
OCMRT	Office for Commission of Management for Road Transport
OEPP	Office of Environmental Policy and Planning
ORR	Outer Ring Road
PCD	Pollution Control Department
PCU	Passenger Car Unit
PM	Particulate Matter
PM-10	Particulate Matter Smaller than 10 μ
PPP	Polluter-Pay-Principle
PWD	Public Works Department, Ministry of Interior
RID	Royal Irrigation Department
SO ₂	Sulfur Dioxides
SO _x	Sulfur Oxides
SPM	Suspended Particulate Matter
TDRI	Thailand Development Research Institute
TOE	Ton Oil Equivalent
TSP	Total Suspended Particulate
UNEP	United Nation for Environmental Program
UTDM	Urban Transport Database Management Project
VAT	Value Added Tax
WHO	World Health Organization
WMA	Wastewater Management Authority

**PART I: CURRENT URBANIZATION AND
ENVIRONMENTAL RESOURCES**

CHAPTER 1: INTRODUCTION

1.1 Background

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Study on Urban Environmental Improvement Program in Bangkok Metropolitan Area in the Kingdom of Thailand (hereinafter referred to as "the Study", or the BEIP Study), within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation Between the Government of Japan and the Government of the Kingdom of Thailand, signed on November 5, 1981.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for implementation of the technical cooperation programs by the Government of Japan, undertakes the Study in close cooperation with the authorities of the Kingdom of Thailand. Department of Public Works, Bangkok Metropolitan Administration (hereinafter referred to as "BMA") shall act as the counterpart agency to the JICA study team and also as a coordinating body in relation to other relevant organizations for smooth implementation of the Study.

The Study was commenced the Study on 18 August 1995, and its progress was directed by the Steering Committee, chaired by Mr. Bampen JATOORAPREUK, Deputy Permanent Secretary, BMA.

This present report is the Draft Final Report compiling all the findings and recommendations which are subject to comments by the Steering Committee. Based on the official comments, the Study Team will prepare the Final Report as the guidelines useful for policy-building and decision-making for the Bangkok environmental improvement.

1.2 Objectives

The objective of the BEIP Study is to formulate a comprehensive master plan to improve urban environment in the area of Bangkok Metropolitan Administration through facilitating its sound urban growth with landuse control, urban restructuring for decentralization and infrastructure development on the medium- and long-term perspectives, targeting the years 2006 and 2011.

To this end, the Study aims at formulating macro and micro level master plans and policy guidelines for environmental improvement, including both institutional and physical projects/programs.

1.3 Scope of the Study

Planning of the urban environment is a task to depict a blueprint of the total urban system itself. Since all urban activities are part of the environment and elements of the environmental dynamic system, the task shall inherently cover a wide variety of socioeconomic, urban planning and energy issues, otherwise, the Plan would not be completed. However, it is almost impossible to deepen all the discussions under a

limitation of expert inputs and a time constrain. The BEIP study, therefore, focuses on a number of selected issues related to the urban planning and management as follows:

- Physical urban planning issues, including the spatial structure and land use;
- Transport sector issue;
- Air quality issues;
- Water and Water-related issues;
- Living environment-related issues, including solid waste management, housing and noise; and
- Administrative and institutional issues for the implementation of the proposed plan.

1.4 Previously Submitted Reports

The Study Team submitted four (4) sorts of the reports to the Steering Committees up to now: Inception Report in September 1995, Progress Report (1) in January 1996, Interim Report in March 1996 and Progress Report (2) in September 1996. The Interim Report was a milestone of the Study which complies preliminary findings and planning issues derived from field investigation surveys, monitoring surveys for air quality and noise level, a number of transportation-related surveys including a person trip home-interview survey and analyses of the present conditions. And the Progress Report (2) discussed new additional findings and planning implications derived from a number of simulation analyses particularly on 1) Urbanization, 2) Transportation and traffic congestion and 3) Air pollution. These are all significant basic elements for considerations of the comprehensive master plan.

Because of the logical simplicity of planning, this Draft Final Report does not compile all technical materials. Therefore, those who area interested in the detailed data/information are advised to refer to the previously submitted reports.

1.5 Regional Context and Relevance with On-going Studies

The 8th National Plan has just been officially published in October 1996. The basic framework of the regional context which has been depicted in the 8th Plan was reviewed to be incorporated into the planning framework of the BEIP Study.

There are presently on-going studies focusing on the Bangkok Metropolis. All are important inputs and/or implications to the Study. In particular, the Team has established close collaboration with Urban Transport Data-Base Management Project (UTDM) under OCMRT for building of a transport data-base (referred to as "UTDM-BEIP data base").

The Bangkok Plan proposed by MIT and EC Teams provides a number of significant planning inputs for the Study in terms of urban planning aspects in BMA. Moreover, the Metropolitan Subcenter Plan, prepared by the MIT Consultant Team in September 1996, is another input for clarification in the urban environmental context of this Study.

Thus, the BEIP Study was conducted in close coordination with the national policies and other relevant studies.

1.6 Planning Process with GIS Technique

The Study is challenging in application of GIS technique for the data-base building and data/information analyses in such a way that inter- and intra-governmental information transfer and exchange are possible and expandable for a variety of purposes after the BEIP Study. For this purpose, the basic topo-map covering BMA with the scale of 1/75,000 was created, combining the national base maps with the scale of 1/20,000 issued by Royal Thai Survey Department. This newly edited map is accurate and useful enough to be utilized by all related authorities to compile socioeconomic data as well as geographical information.

In this study, the BEIP Team employed the planning approach with the following three kinds of works:

- 1) To assess existing resources and environment problems objectively and scientifically;
- 2) To simulate and project the most-likely states in the future; and
- 3) To employ planner's visions to make proposals of the master plan and projects and/or programs for the environmental improvement, based on the planning implications derived from the above analyses.

It has been proved through the Study that the GIS technique is remarkably capable of undertaking the first and second works.

1.7 Structure of the Report

The Final Report consists of the following separated volumes:

- Volume 1: Executive Summary;
- Volume 2: Master Plan (Chapter 1 through Chapter 15); and
- Volume 3: Sector Plans and Technical Studies (Chapter 1 through Chapter 14)

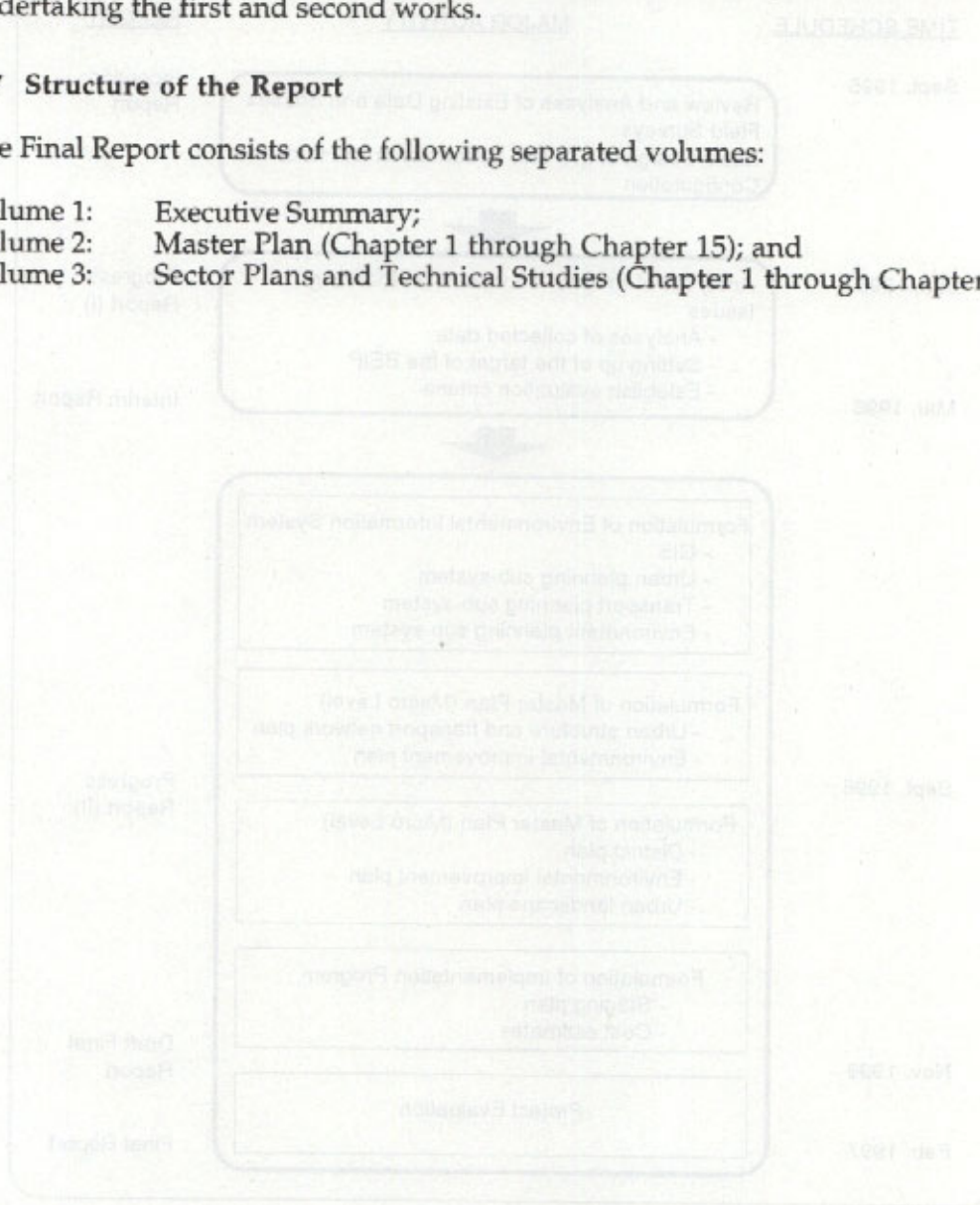


Fig. 1.1 Work Flow and Time Framework of the BEIP Study

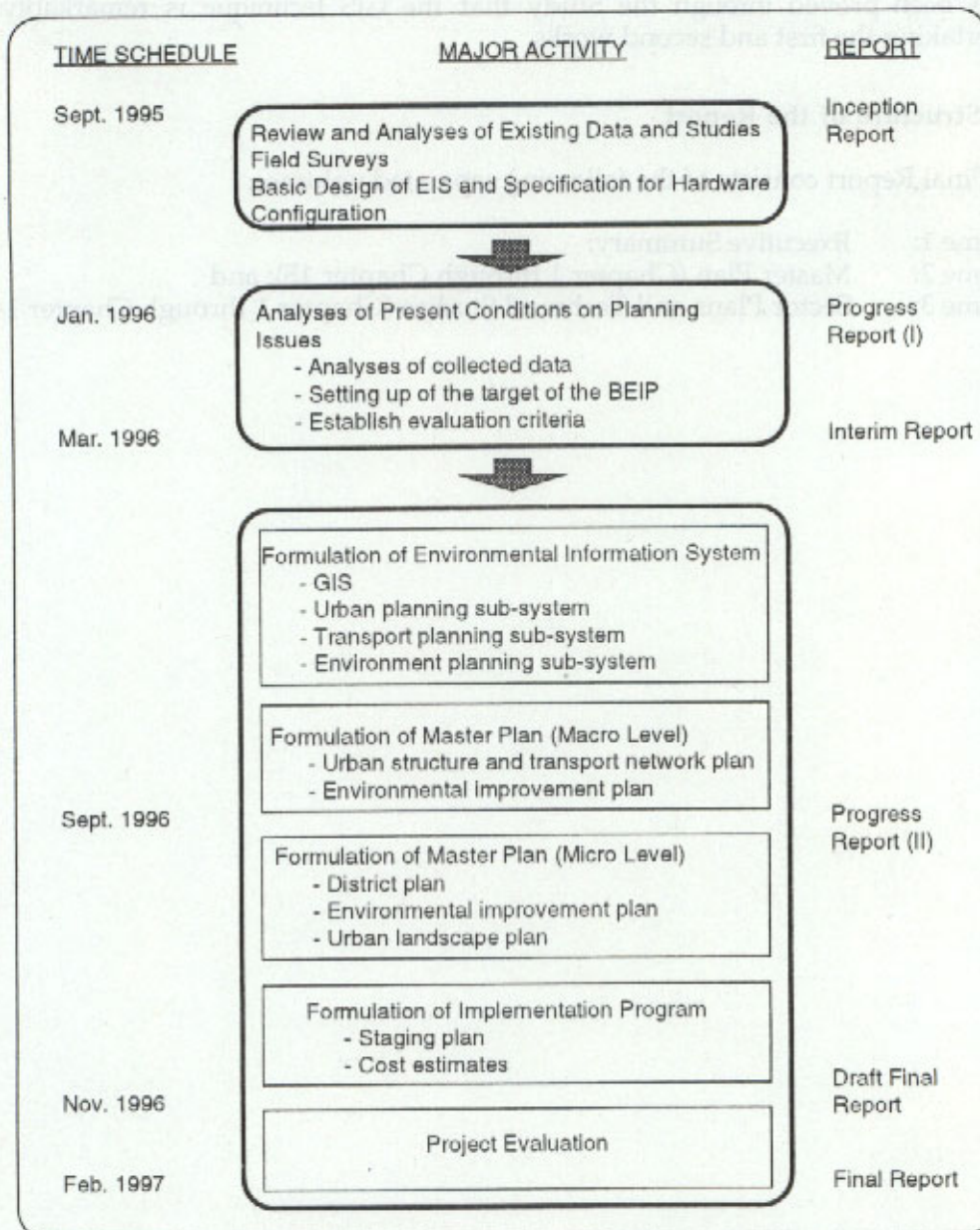


Fig. 1.1 Work Flow and Time Framework of the BEIP Study

CHAPTER 2: SOCIOECONOMIC AND SPATIAL PERSPECTIVES OF THE BANGKOK METROPOLIS

2.1 Current Economic Activities of the Bangkok Metropolis

(1) Economic Growth

Thailand has been continuously enjoying a rapid economic growth since 1987 with about 10 % annual growth rate. In this favorable economic growth, Bangkok has gradually strengthened its main roles in the Thai economy. As seen in Table 2.1, Bangkok has the highest economic growth, compared to BMR and the whole nation, which shows approximately 3 points higher in the GDP annual growth rate. Looking into the sector-wise performance, the construction, banking, insurance and real estate sectors have remarkably grown up, while the growth of the manufacturing sector has no longer predominant in Bangkok, compared to the national average. It implies that Bangkok's economy is gradually sifting from the industry-based economy to a soft and service sector-driven economy.

On the other hand, BMR is more specialized by the growth of the manufacturing sector, which shares approximately 66 % of GPP with a 14 % of annual growth rate, followed by the construction, transportation and communication, and banking, insurance and real estate sectors.

This favorable economic growth has strengthened the fixed capital formation in the Kingdom, of which the private construction sector has contributed greatly to the capital formulation, which shares approximately 36 % of the total capital formulation in 1993 with the highest growth rate of 33 %, as shown in Table 2.2.

(2) Primacy of the Bangkok's Urban Economy and Its Structural Changes

Predominant functions of economic activities of Bangkok have been shifting to the service and finance sectors. The rapid economic growth makes the primacy of Bangkok's urban economy more robust, and at the same time, this is eventually enlarging regional discrepancies in job opportunities, income levels, quality of people's living conditions between Bangkok and other provinces.

Bangkok, in fact, has recently been accumulating more information-oriented and knowledge-based activities. This can be identified from the statistical data of the following aspects:

- Employment;
- Centric Functions of Economic Activities;
- Investment;
- Information and Higher Educational Function; and
- Internationalization.

Employment

In reflection to the expansion of the service and financial sector's value added in Bangkok, administrative and managerial workers are significantly increasing, compared

to those in the other sectors, as shown in Table 2. 3. The requirements of production workers are relatively decreasing in Bangkok in terms of the share structure.

Table 2.1 Recent Economic Growth and BMA's Contribution

Industry	1989		1991		1993		Growth Rate
	No.	Share	No.	Share	No.	Share	
(Thousand Baht)							
Bangkok							
Agriculture	4,475,607	0.68%	4,583,390	0.55%	4,643,612	0.45%	0.93%
Mining and Quarrying	0	0.00%	5,776	0.00%	7,252	0.00%	12.05%
Manufacturing	222,902,553	33.85%	289,107,072	34.74%	357,529,617	34.54%	12.54%
Construction	38,454,143	5.84%	56,139,963	6.75%	74,303,595	7.18%	17.90%
Electricity and Water Supply	13,596,855	2.06%	15,284,119	1.84%	16,733,201	1.62%	5.33%
Transportation and Communication	79,684,125	12.10%	99,300,186	11.93%	118,377,387	11.44%	10.40%
Wholesale and Retail Trade	132,399,529	20.11%	176,738,053	21.24%	198,219,715	19.15%	10.62%
Banking, Insurance and Real Estate	47,491,745	7.21%	70,395,731	8.46%	123,857,303	11.97%	27.08%
Ownership of Dwellings	13,890,960	2.11%	15,338,885	1.84%	17,052,302	1.65%	5.26%
Public Administration and Defence	14,999,189	2.28%	15,033,637	1.81%	17,100,396	1.65%	3.33%
Services	90,621,640	13.76%	90,314,016	10.85%	107,169,551	10.35%	4.28%
GPP	658,516,346	100.00%	832,240,828	100.00%	1,034,993,931	100.00%	11.97%
BMR except Bangkok (Samut Prakan, Nonthaburi, Nakhon Pathom, Phatum Thani, Samut Sakorn)							
Agriculture	20,244,892	9.66%	20,663,342	7.75%	21,792,760	6.64%	1.86%
Mining and Quarrying	424,931	0.20%	325,147	0.12%	456,859	0.14%	1.83%
Manufacturing	128,318,672	61.26%	170,117,540	63.78%	217,550,207	66.24%	14.11%
Construction	7,392,350	3.53%	10,657,550	4.00%	11,822,056	3.60%	12.45%
Electricity and Water Supply	9,996,057	4.77%	12,391,478	4.65%	14,958,670	4.55%	10.60%
Transportation and Communication	5,697,527	2.72%	7,129,351	2.67%	9,422,471	2.87%	13.40%
Wholesale and Retail Trade	16,962,946	8.10%	19,191,293	7.20%	21,151,785	6.44%	5.67%
Banking, Insurance and Real Estate	5,960,582	2.85%	8,389,755	3.15%	9,968,118	3.04%	13.72%
Ownership of Dwellings	3,595,741	1.72%	4,353,470	1.63%	5,175,556	1.58%	9.53%
Public Administration and Defence	2,109,455	1.01%	2,480,162	0.93%	2,658,414	0.81%	5.95%
Services	8,763,845	4.18%	11,031,681	4.14%	13,464,575	4.10%	11.33%
GPP	209,466,998	100.00%	266,730,769	100.00%	328,421,471	100.00%	11.90%
Whole Nation							
Agriculture	276,568,993	15.80%	281,927,977	13.31%	288,760,985	11.68%	1.08%
Mining and Quarrying	28,226,998	1.61%	36,084,998	1.70%	40,589,370	1.64%	6.06%
Manufacturing	467,632,000	26.72%	608,777,992	28.75%	755,488,991	30.56%	12.74%
Construction	95,554,000	5.46%	132,494,000	6.26%	150,735,000	6.10%	12.07%
Electricity and Water Supply	42,259,005	2.41%	51,791,001	2.45%	62,921,774	2.55%	10.46%
Transportation and Communication	128,754,000	7.36%	157,429,013	7.43%	187,240,001	7.57%	9.81%
Wholesale and Retail Trade	296,919,000	16.97%	364,097,000	17.19%	403,953,000	16.34%	8.00%
Banking, Insurance and Real Estate	80,425,962	4.60%	113,842,991	5.38%	182,449,003	7.38%	22.73%
Ownership of Dwellings	58,213,000	3.33%	63,181,000	2.98%	67,660,000	2.74%	3.83%
Public Administration and Defence	57,276,998	3.27%	65,256,000	3.08%	69,688,005	2.82%	5.03%
Services	218,122,000	12.46%	242,700,000	11.46%	262,761,000	10.63%	4.76%
GDP	1,749,951,956	100.00%	2,117,581,972	100.00%	2,472,247,129	100.00%	9.02%

Note: at Constant 1988 prices

Source: National Account Division, NESDB

Table 2.2 Gross Fixed Capital Formation in Thailand

	1986		1992		Growth Rate
	Value	Share	Value	Share	
Construction	126,505	53.01%	569,293	51.12%	31.75%
Private	65,757	27.55%	399,985	35.92%	32.94%
Residential	44,129	(67.11%)	215,777	(53.95%)	26.14%
Non-residential	20,269	(30.82%)	125,564	(31.39%)	32.08%
Other Construction		(0.00%)	45,852	(11.46%)	
New Lands	1,359	(2.07%)	1,444	(0.36%)	-1.74%
Others		(0.00%)	11,348	(2.84%)	
Public	60,748	25.45%	169,308	15.20%	29.13%
Residential	1,756	(2.89%)	6,935	(4.10%)	41.44%
Non-residential	6,510	(10.72%)	32,474	(19.18%)	46.99%
Other Construction	52,482	(86.39%)	129,899	(76.72%)	25.60%
Machinery and Equipment	112,160	46.99%	544,398	48.88%	25.65%
Transport Equipment	38,247	(34.10%)	164,352	(30.19%)	25.04%
Road Motor Vehicles	21,251	(18.95%)	129,888	(23.86%)	25.42%
Other Equipment	16,996	(15.15%)	34,464	(6.33%)	23.65%
Machinery and Other Equipment	73,913	(65.90%)	380,046	(69.81%)	25.92%
Industrial Machinery and Appliances	39,650	(35.35%)	163,271	(29.99%)	14.78%
Office and Other Equipment	34,263	(30.55%)	216,775	(39.82%)	39.58%
Gross Fixed Capital Formation	238,665	100.00%	1,113,691	100.00%	28.59%

Source: Statistical Year Book, 1990,1994

Table 2.3 Labor Requirements by Occupation

Occupation	Bangkok		Whole Nation		Locational Coefficient*2
	No.	Share*1	No.	Share*1	
Year 1991					
0/1 Professional, technical and related workers	7,223	4.73%	16,075	6.38%	0.74
2 Administrative, executive and managerial workers	1,167	0.76%	1,706	0.68%	1.13
3 Clerical and related workers	28,328	18.57%	35,830	14.22%	1.31
4 Sales workers	11,172	7.32%	27,018	10.72%	0.68
5 Service workers	18,762	12.30%	32,911	13.06%	0.94
6 Agriculture, animal husbandary and forest workers, fisherman and hunters	50	0.03%	1,473	0.58%	0.06
7/8/9 Production and related workers, transport equipment operators and laborers	85,858	56.28%	136,965	54.36%	1.04
Total	152,560	100.00%	251,978	100.00%	1.00
Year 1993					
0/1 Professional, technical and related workers	20,606	9.63%	31,045	8.36%	1.15
2 Administrative, executive and managerial workers	4,404	2.06%	5,296	1.43%	1.44
3 Clerical and related workers	54,318	25.38%	74,535	20.08%	1.26
4 Sales workers	24,815	11.60%	38,501	10.37%	1.12
5 Service workers	26,906	12.57%	46,616	12.56%	1.00
6 Agriculture, animal husbandary and forest workers, fisherman and hunters	400	0.19%	1,136	0.31%	0.61
7/8/9 Production and related workers, transport equipment operators and laborers	82,564	38.58%	174,116	46.90%	0.82
Total	214,013	100.00%	371,245	100.00%	1.00

Note: *1 Share to the total No. of labor requirement

*2 Share of Bangkok divided by the share of whole nation.

Source: Thailand Figures 1995-1996

Concentration of Pivotal Urban Functions in the Bangkok Economy

The Bangkok economy seems to be now in a transitional stage shifting towards the next generation. Economic concentration of Bangkok can apparently be observed, but its structure is gradually changing towards more information-based and more value-added type economy. This can be seen in Table 2.4, that is, the shares of BMA are:

- Headquarters of major firms listed in the Stock Market: 88%;
- Commercial banks' loans: 71%;
- Commercial banks' deposits: 61%; and
- Number of business establishments: 47%.

Compared to the Bangkok's GDP share of approximately 50%, these shares are all remarkably high. Concentration of these pivotal urban functions is one of the factors that make the Bangkok economy more competitive in the international market.

Table 2.4 Salient Indicators on Primacy of the Bangkok Economy

	Bangkok		BMR (except BKK)*1		Whole Nation	
	No.	Share*2	No.	Share	No.	Share
No. of Headquarters of Stock Market Firm (Firm)	308	88.00%	32	9.14%	350	100.00%
No. of Commercial Bank Office (Office)	819	28.71%	243	8.52%	2,853	100.00%
Amount of Commercial Bank Deposits (Million Baht)	1,666,442	61.42%	255,353	9.41%	2,713,275	100.00%
Amount of Commercial Bank Loans (Million Baht)	2,350,270	71.11%	168,939	5.11%	3,305,048	100.00%
No. of Business Establishment (Firm)	113,390	47.31%	13,680	5.71%	239,678	100.00%
No. of Service Industries*3 (Firm)	22,678	46.38%	2,059	4.21%	48,901	100.00%

Note: *1 BMR includes Samut Prakan, Patun Thani, Samut Sakhon, Nontaburi and Nakhon Pathom.

*2 Share to the Whole Nation.

*3 Service Industry includes Financing, insurance, real estate, business services and community, social and personal services.

Source: Thailand Figures 1995-1996, Statistical Year Book 1994, Stock Exchange of Thailand Company Profiles

Investment

As described in the preceding subsection, labor requirements for the manufacturing workers are now decreasing in Bangkok, while they are increasing in outside Bangkok. This phenomena can be proved by looking into destinations of BOI investments, as shown in Table 2.5.

Focal areas for investments are shifting from BMR, which is designated as Zone 1 by the BOI's category, to the areas designated as Zones 2 and 3. The investment activities has been slowing down in number, and becomes smaller size in amounts of investment in Bangkok, while the Zones 2 and 3 are expanding the number of projects as well as amounts of investments, being reflected by the BOI policy of "Decentralization". This may imply that investors can no longer recognize Bangkok as a preferable industrial location.

Information and Higher Educational Function

The primacy of Bangkok is also explained by accumulation of the information and higher educational service functions, which are likely to attract a wide variety of businesses activities. Table 2.6 shows that more or less 90 % of computer software and telecommunication firms of Thailand have been concentrated in Bangkok.

Concentration of higher educational functions represents another fact of the primacy of Bangkok. There are 30 of universities and colleges in Bangkok, which is accounted for approximately 68 % of total number of universities and colleges. Looking at the share of the number of students, 86 % of the students enrolled are concentrated in Bangkok in 1992.

However, this figure is smaller than that of 1985. A new notable movement of pushing locations of universities to move out from the central area of Bangkok has emerged, for example:

- Kasetsart University in Nakhon Patom;
- Tamasart University in Patom Thani;
- Bangkok University in Patom Thani
- Mahidol University in Nakhon Patom; and
- Silpakorn University in Nakhon Patom.

Internationalization

The international gateway function of Bangkok is gradually of importance while increasing the importance of the Thai economy in the world market. The interface function between domestic and international economies are rapidly growing up in Bangkok in terms of especially international traffic of peoples and goods, transaction of money and information. In reflection to growing service economy in Bangkok, the amounts of international trade and communications have remarkably expanded during 1989 to 1993, as shown in Table 2.8.

Table 2.8 Computer Software and Telecommunication Firms in Bangkok

Year	Computer Software		Telecommunication	
	Number of Firms	Revenue (Million Baht)	Number of Firms	Revenue (Million Baht)
1989	116	148	110	142
1990	138	171	124	158
1991	152	195	138	174
1992	166	219	152	190
1993	180	243	166	206

Source: Thailand Software Exporters' Forum, Thailand Telecommunication Handbook 1993

Table 2.5 Changes in Investment Activities (BOI Promotional Privileges)

		1992		1993		1994	
		No.	Share	No.	Share	No.	Share
No. of Applications for BOI's Promotional Privileges							
Zone 1	Bangkok	60	13.76%	106	8.51%	100	6.57%
	BMR	98	22.48%	160	12.84%	162	10.64%
	Sub-total	158	36.24%	266	21.35%	262	17.20%
Zone 2		102	23.39%	178	14.29%	266	17.47%
Zone 3		176	40.37%	802	64.37%	995	65.33%
Total		436	100.00%	1,246	100.00%	1,523	100.00%
Amounts of Investment of the Applications							
Zone 1	Bangkok	750	37.17%	268	9.85%	221	3.77%
	BMR	131	6.49%	309	11.36%	250	4.26%
	Sub-total	881	43.66%	577	21.21%	471	8.03%
Zone 2		262	12.98%	585	21.50%	1,095	18.66%
Zone 3		875	43.36%	1,559	57.30%	4,302	73.31%
Total		2,018	100.00%	2,721	100.00%	5,868	100.00%
Amounts of Investment per Application							
Zone 1	Bangkok	12.50		2.53		2.21	
	BMR	1.34		1.93		1.54	
	Sub-total	5.58		2.17		1.80	
Zone 2		2.57		3.29		4.12	
Zone 3		4.97		1.94		4.32	

Note: Zone 1 Bangkok, Samut Prakan, Pathum Thani, Nakhon Pathom and Samut Sakhon
 Zone 2 Samut Songkhram, Rachaburi, Nakhon Nayok, Ang Thong, Ayutthaya,
 Kanchanaburi, Chachengsao, Chon Buri and Saraburi
 Zone 3 Remaining provinces outside Zone 1 and Zone 2

Source: Activity Report 1994, BOI

Table 2.6 Computer Software and Telecommunication Firms in Bangkok

	Bangkok				BMR	Other Provinces	Total
	CBD Zone	Urbanized Zone	Suburban Zone	Total			
Number							
Computer Software	116	149	56	321	18	19	358
Telecommunication	385	310	170	865	54	11	930
Share							
Computer Software	32.40%	41.62%	15.64%	89.66%	5.03%	5.31%	100.00%
Telecommunication	41.40%	33.33%	18.28%	93.01%	5.81%	1.18%	100.00%

Source: Thailand Software Directory 1994/95, Thailand Telecommunication Handbook 1995

Table 2.7 No. of University Students in Bangkok

	1985		1990		1993	
	Number	Share	Number	Share	Number	Share
Universities in Bangkok	695,080	96%	581,252	88%	681,236	86%
Universities outside Bangkok	28,596	4%	80,494	12%	107,107	14%
Total	723,676	100%	661,745	100%	788,342	100%

Note: Universities which has a branch outside Bangkok are included by 50 % in Bangkok and 50% outside Bangkok.

Source: JICA Study Team compiles based on the data from Statistical Year Book, NSO

Table 2.8 Selected Indicators on Internationalization

	Unit	1989	1991	1993	Annual Growth Rate
Foreign Visitors (Whole Nation)	Visitor	4,809,508.0	5,086,899.0	5,760,533.0	4.61%
Foreign Visitors in Bangkok Airport	Visitor	3,637,187.0	3,540,086.0	4,182,104.0	3.55%
Current Transfers (Whole Nation)	Million Baht		7,624.4	7,910.0	1.86%
Amounts of Export (Whole Nation)	Million Baht	515,750.9	725,448.8	940,862.6	16.22%
Amounts of Import (Whole Nation)	Million Baht	658,007.8	959,408.0	1,170,746.4	15.49%
International Air Traffic at Bangkok Airport	Arrivals	6,463,139.0	6,765,538.0	8,362,465.0	6.65%
International Shipping to/from Bangkok Port	1,000 Tonnes	60,086.0	63,620.0	62,964.0	1.18%
International Telephone Outgoing (Whole Nation)	Thousand Calls	17,990.0	32,241.0	47,400.0	27.41%
Postal Service (Whole Nation)	Thousand	92,341.0	107,225.0	121,907.0	7.19%
GDP	Million Baht	1,749,952.0	2,117,582.0	2,472,247.0	9.02%
GPP of Bangkok	Million Baht	658,516.0	832,241.0	1,034,994.0	11.97%

Source: Statistical Year Book Thailand 1994, Thailand Figures 1994-1995 and Transport Statistics Data for 1993

2.2 Social Movements and Living Environment

The primacy of Bangkok has been qualitatively and quantitatively strengthened in reflection to the recent economic growth. Such economic growth inevitably influences the social and living conditions of people of Bangkok. This was viewed from the following aspects:

- Population Increase and Urban Migration;
- Motorization; and
- Modernization of People's Living.

(1) Population Changes

The Bangkok population has been decreasing since 1990, according to the statistics of the population registration of BMA^{*1}, as shown in Table 2.9. The CBD zone of Bangkok has decreased its population at approximately - 2,9 % p.a. during the period between 1988 and 1993, which is the largest decrease compared to the urbanized and suburban zones of Bangkok and BMR.

A drastic population decrease appeared in the CBD zone at approximately - 4.1 %, while the suburban zone and the BMR provinces have increased their population, accommodating some social increases.

Such a phenomena is also observed from a change in migration pattern, as shown in Table 2.10. The CBD zone has more "move-out" than "move-in", however, the urbanized and suburban zones have a more "move-in" tendency. This population growth pattern implies a significant planning implication regarding urbanization and land use of the Bangkok Metropolis.

(2) Motorization

Table 2.11 shows the number of registered vehicles in Bangkok and the Kingdom. Motorization is likely to be proceeding proportionally along with an increase of people's income level. The ownership in terms of the number of registered vehicles per person accounted for 0.28 in Bangkok, which is approximately 4 times bigger than national average. As for the growth rate, however, the whole nation shows a higher growth rate than that in Bangkok during the period between 1989 and 1992.

It is also noted in this table that the number of registered vehicles per GDP in Bangkok slightly decreased in 1993, compared to that in 1989. This trend should be carefully watched to avoid a misleading to future Motorization related to transport planning.

^{*1} As for the accurate figures of present population and its trend in Bangkok, there are several arguments, depending upon different studies and organizations such as NESDB and OCMRT. This analysis is based on the data from Statistical Profile of BMA 1994.

Table 2.9 Population Growth Pattern of Bangkok and BMR

	Population (Person)				Growth Rate (%)	
	1988	1990	1992	1993	Average G.	Social G.****
Bangkok						
CBD Zone*	2,111,460	1,933,683	1,884,952	1,825,044	-2.87%	-4.07%
Urbanised Zone**	1,825,782	1,701,540	1,653,008	1,645,070	-2.06%	-3.26%
Suburban Zone***	1,779,537	1,911,714	2,024,181	2,102,598	3.39%	2.19%
Total	5,716,779	5,546,937	5,562,141	5,572,712	-0.51%	-1.71%
Vicinity Provinces						
Samut Prakan	789,060	854,883	871,806	895,384	2.56%	1.36%
Nonthaburi	596,381	668,760	698,704	717,405	3.76%	2.57%
Nakhon Pathom	630,805	657,182	671,386	710,290	2.40%	1.20%
Phatum Thani	435,409	452,693	484,586	500,086	2.81%	1.61%
Samut Sakorn	340,952	358,155	372,605	373,464	1.84%	0.64%
Total	2,792,607	2,991,673	3,099,087	3,196,629	2.74%	1.54%
BMR Total	8,509,386	8,538,610	8,661,228	8,769,341	0.60%	-0.60%
Whole Nation	54,960,917	56,303,273	57,788,965	58,336,072	1.20%	0.00%

Note: * CBD Zone covers districts within approximately 5 Km radius, including Para Nakorn, Pom Pram, Samphanthawong, Bang Rak, Ratchthewi, Khlong Sun, Patum Wan, Dusit, Bang Kho Laem, Sathon, Bangkok Noi, Bangkok Yai, Thon Buri and Phaya Thai.

** Urbanized Zone covers districts within approximately 10 Km radius, including Bang Sue, Chatuchak, Din Daeng, Huai Khwang, Bang Kapi, Khlong Toei, Yan Nawa, Rat Burana, Chom Thong, Phasi Charoen.

*** Suburban Zone covers districts outside approximately 10 Km radius, including Don Muang, Bang Khen, Lat Phrao, Bang Kun, Suan Luang, Prawet, Para Khanong, Min Buri, Nong Chok, Lat Krabang, Taling Chan, Nong Khaem and Bang Khun Thian.

**** (Average Growth) - (Average Growth of Whole Nation)

Source: Office for Civil-Registration, Department of Local Administration, Ministry of Interior

Table 2.10 Recent Migration Pattern of Bangkok

	1989			1991		
	Move-in	Move-out	Total	Move-in	Move-out	Total
CBD Zone*	232,850	318,340	-85,490	125,078	241,474	-116,396
Urbanised Zone*	147,260	132,175	15,085	140,837	136,592	4,245
Suburban Zone*	300,995	208,673	92,322	214,321	147,595	66,726
Total	681,105	659,188	21,917	480,236	525,661	-45,425

Note: * The division of the districts into the zone is same as Table 2.9.

Source: Office for Civil-Registration, Department of Local Administration, Ministry of Interior

Table 2.11 Changes in No. of Registered Vehicles

	1989		1991		1993		Growth Rate
	No.	Share	No.	Share	No.	Share	
No. of Vehicle Registration (Vehicle)							
Bangkok	1,076,989	45.79%	1,225,229	41.40%	1,551,023	40.38%	9.55%
Whole Nation	2,352,020	100.00%	2,959,634	100.00%	3,841,093	100.00%	13.05%
No. of Motorcycle Registration (Motorcycle)							
Bangkok	644,597	27.41%	887,289	29.98%	1,105,084	28.77%	14.43%
Whole Nation	4,153,000	176.57%	5,521,391	186.56%	7,260,665	189.03%	14.99%
No. of Vehicle per Population (Vehicle/Person)							
Bangkok	0.18		0.22		0.28		10.80%
Whole Nation	0.04		0.05		0.07		11.84%
No. of Vehicle per GDP (Car/Million Baht)							
Bangkok	1.64		1.47		1.50		-2.16%
Whole Nation	1.34		1.40		1.55		3.69%

Note: No. of Vehicle Registration excludes motorcycle.

Source: The Department of Land Transport, Ministry of Transport and Communications

(3) Modernization of People's Living

Consumption Pattern

The increase of income level and inflows of foreign information have influenced the peoples' life style as well as the Motorization. Table 2.12 shows changes in peoples' living conditions represented by the consumption pattern. In accordance with the increase of income level, the share of expenditure for the food and beverages in the total expenditure is decreased, while the shares of transport and communication, apparel and footwear are increased. It is, accordingly, possible for peoples to afford more consumer goods. As the result, ownership of durable consumer goods is increasing, especially electric appliances, as shown in Table 2.13.

Thus, the peoples' consumption pattern seems to be based on a "mass production and mass consumption pattern", resulting in generating more environmental burdens, as seen in advanced countries.

Energy Usage and Utility Services

Modernization of people's way of living is represented by changes in the consumption patterns of energy and utilities. The consumption of water, electricity, petroleum are growing up at considerably higher growth rates than that of GNP per Capita, as shown in Table 2.14, and as illustrated in Fig. 2.1.

This fact implies that Bangkok is running on the energy-consuming economy, which is the same way of other advanced countries. Although modernization cannot be stopped and is desired by all people, the energy-saving approach should be explored to seek a sustainable urban growth while minimizing the environmental deterioration.

Table 2.12 Change of Consumption Patterns of Thai People

	Unit	1986	Share	1992	Share	1992/1986
Average Size of Household	Person	3.8		3.3		
Household socio-economic features						
Average Monthly Income	Bath	6,949.0		16,748.0		2.41
Average Monthly Expenditure	Bath	6,561.9		14,271.7		2.17
Food and Beverages	Bath	2,369.0	36.10%	4,156.0	29.12%	1.75
Alcoholic Beverages and Tobacco Products	Bath	260.0	3.96%	581.0	4.07%	2.23
Apparel and Footware	Bath	300.7	4.58%	769.5	5.39%	2.56
Housing and Household Operation	Bath	1,645.3	25.07%	3,563.5	24.97%	2.17
Medical Care	Bath	166.7	2.54%	404.4	2.83%	2.43
Personal Care	Bath	173.5	2.64%	319.9	2.24%	1.84
Transport and Communication	Bath	638.0	9.72%	2,054.8	14.40%	3.22
Recreation and Reading	Bath	209.3	3.19%	435.1	3.05%	2.08
Education	Bath	161.3	2.46%	324.7	2.28%	2.01
Miscellaneous	Bath	68.8	1.05%	82.3	0.58%	1.20
Non-consumption Ependitures	Bath	569.4	8.68%	1,580.6	11.07%	2.78

Source: Household Socio-economic Survey, NSO, 1986,1992

Table 2.13 Changes in Ownership of Durable Consumer Goods

	1980		1990		Change of Points (90-80)	
	Bangkok	Nation	Bangkok	Nation	Bangkok	Nation
Radio	95.0	95.0	90.7	81.3	-4.30	-13.70
Color TV	80.1	23.4	81.5	46.2	1.40	22.80
Black and White TV			20.4	24.9	-	-
Video			41.9	12.4	-	-
Iron			91.6	54.5	-	-
Electric Rice Cooking			92.7	61.2	-	-
Electric Fan	90.1	32.0	96.1	72.1	6.00	40.10
Sewing Machine			32.6	18.7	-	-
Vacuum Cleaner			16.5	4.2	-	-
Refrigerator	61.0	17.3	74.3	36.0	13.30	18.70
Washing Machine			22.7	6.0	-	-
Air Conditioner	9.6	2.3	20.2	3.7	10.60	1.40
Telephne	22.4	3.8	38.5	8.3	16.10	4.50
Bycycle	19.6	49.0	31.7	57.1	12.10	8.10
Motor Cycle	12.0	20.4	22.3	40.0	10.30	19.60
Motor Car	19.0	7.3	26.8	11.5	7.80	4.20
Motor Boat	1.8	1.8	1.1	1.5	-0.70	-0.30
Water Pump	2.9	9.6	2.5	12.1	-0.40	2.50
Ploughing Machine	1.2	5.5	0.5	9.7	-0.70	4.20
Local farm Truck			0.2	3.0	-	-

Source: Population and Housing Census, 1980, 1990

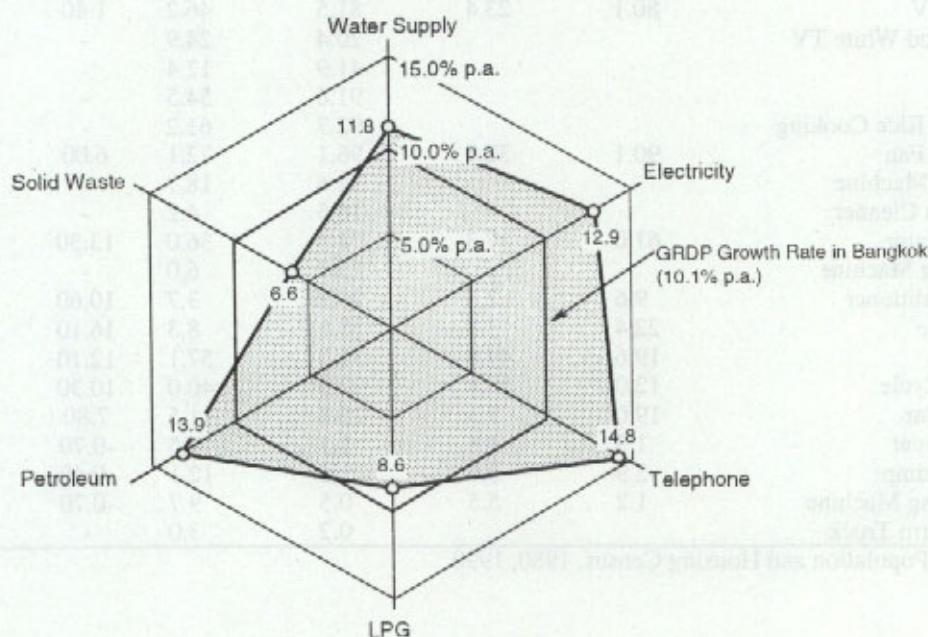
Table 2.14 Consumption of Energy and Utilities in Bangkok

	Unit	1987	1990	1993	Growth Rate (Annual)
Amount					
Water Supply	Million m ³ /Year	470.8	739.2	871.9	10.82%
Electricity*1	gWh	12,464.0	18,285.7	24,468.7	11.90%
Telephone*2	Telephone	622,973.0	820,321.0	1,177,894.0	13.59%
LPG	Million Litter	713.7	873.8	1,112.5	7.68%
Petroleum	Million Litter	6,557.5	10,890.2	13,600.9	12.93%
Solid Waste	Tonnes/day	4,190.1	4,551.8	5,857.9	5.74%
Amount per Person					
Water Supply		80.29	133.26	156.46	11.76%
Electricity	gWh/1,000person	2.13	3.30	4.39	12.85%
Telephone	Telephe/person	0.11	0.15	0.21	14.75%
LPG	Litter/person	121.71	157.53	199.63	8.60%
Petroleum	Litter/person	1,118.29	1,963.28	2,440.62	13.89%
Solid Waste	g/person	714.56	820.60	1,051.17	6.64%
GDP per Capita in BKK	Baht/person	86,009	139,077	185,725	10.12%
Population	Person	5,863,883	5,546,937	5,572,712	-0.85%

Note: *1 including Nontaburi and Samut Prakan

*2 Year 1887 dat is the data in 1988.

Source: Thailand Figures 1995-1996, Statistical Profile of BMA 1997,1990,1993, Statistical Year Book 1990,1994



Notes: Indicating average annual growth rates of per capita consumption during a 1987-1993 period.

Source: Statistical Year Book, BMA

Fig. 2.1 A Comparison of Growth of Energy and Utility Usage

2.3 Urban Structural Changes of the Bangkok Metropolis

(1) Urbanization Process

The urbanization pattern of Bangkok has been analyzed in the Bangkok Plan by the MIT/EU Team. Based on that, the followings can be pointed out:

- Central areas of Bangkok have experienced declines of resident population in recent years;
- Commercial and office centers have expanded along Petchaburi, Rama I, Rama IV, Sukhumvit, Asoke-Ratchadapisek Roads, Victory Monument area and Central Plaza.;
- Suburban residential growth and development are increasingly moving to the eastern and northern corridors;
- Areas within an approximately 10 Km radius from the center of Bangkok, mainly have a vertical extension of development mainly along northern and eastern corridors; and
- Area within an approximately 20 Km radius are being developed with horizontal extension towards all directions. The east bank of Chao Phraya River is predominant.

The historical expansion of urbanized (built-up) area of Bangkok is as seen in Fig. 2.2. Bangkok has expanded mainly to the northern, eastern and southeastern directions. Compared among the urbanized areas in 1971, 1981 and 1991, it is noted that the urban agglomeration in the central area has not been much expanded. Instead of it, urbanization has been taking place along major arterial roads apart from the central area. This pattern is typically called "urban sprawl" in a form of "Ribbon Development". During the past two decades, the increased population was accommodated by these corridor areas.

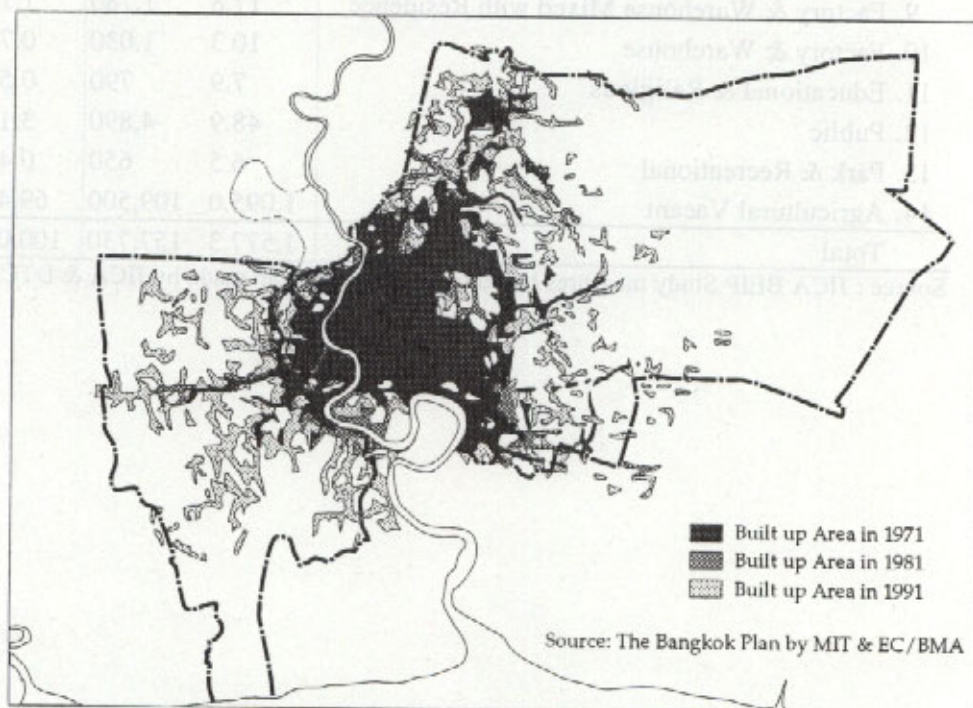


Fig. 2.2 Bangkok Urbanization Process From 1971 to 1991

(2) Land Use Changes and Current Urbanization Area

Urbanized areas of Bangkok was less than 100 sq. km only in the end of the 1950s. In the beginning of the 1970s, urban area was expanded to 200 sq. km, and it became 345 sq. km in 1980. Thus, the urbanized area in Bangkok had been doubling in each decade.

Using the GIS technique, the current land use pattern as of 1993 was examined by the BEIP Study Team. The original source of the information comes from the work done by Department of City Planning, BMA (refer to Chapter 15 for the details).

Based on the examination, the 1993 urbanized area accounted for 482 sq. km, which is equivalent to approximately 30 % of the total BMA area. It became 1.4 times of the 1980 urbanized area. Table 1.15 summarizes the 1993 land use structure, and Fig. 2.3 presents the land use pattern.

Table 2.15 A Summary of Bangkok Land Use in 1993

Type of Land Use	Area		%
	(km ²)	(ha)	
1. Low Density, All Low-rise	306.4	30,640	19.4
2. Low Density, Low-rise partially High-rise	7.4	740	0.5
3. Middle Density, Low-rise	32.5	3,250	2.1
4. Middle Density, Middle-rise	4.2	420	0.3
5. High Density, Low-rise	16.1	1,610	1.0
6. Middle Density, Low & Middle-rise	12.3	1,230	0.8
7. High Density, Middle-rise	10.3	1,030	0.7
8. High Density, High-rise	1.7	170	0.1
9. Factory & Warehouse Mixed with Residence	17.8	1,780	1.1
10. Factory & Warehouse	10.3	1,030	0.7
11. Educational & Religious	7.9	790	0.5
12. Public	48.9	4,890	3.1
13. Park & Recreational	6.5	650	0.4
14. Agricultural Vacant	1,095.0	109,500	69.4
Total	1,577.3	157,730	100.0

Source : JICA BEIP Study measures based on the land use map made by JICA & DTCE

Fig. 2.3

Existing Land Use (1993)

Legend

- Chaopraya River
- High Density Residential Area
- Middle Density Residential Area
- Low Density Residential Area
- Commercial Area
- Industrial Area
- Warehouse Area
- Governmental and Public Facilities
- Open Space/Agriculture Area
- Conservation Area
- Park
- School
- Religion
- Railways
- BMA Boundary
- District Boundary



THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METRO-POLITAN AREA (BEIP)



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



JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Source: Mapping Division, Department of City Planning, BMA
Notes: Based on Aero-Photo Interpretation, taken in 1993

(3) Booming Construction Activities

The recent rapid economic growth of Bangkok has called for a construction boom. As described in the previous section, most of capital formation was stocked in the form of the construction especially by the private sector. Table 2.16 represents such a booming trend between 1987 and 1993 of building construction activities based on the building permission data.

In 1993, a total of 1,342 buildings were permitted. Compared to the number in 1987, it grew to be 4.6 times. The total building area amounted to about 12 million sq. meters in 1993, out of which residential buildings have the largest share, or 62 % with the highest growth rate. On the other hand, the share of commercial buildings increased during 1987 to 1990, but the boom seems to be calm down during the recent period between 1990 to 1993, due to investors' feeling and/or speculation of "Over-supply" in the market.

The same table also indicates that building projects have gradually been enlarged in scale; i.e., the average building area per unit in 1993 became 2 times as large as that in 1988. It is noted that such a tendency can be seen in all types of buildings..

Meanwhile, looking into the locations of building projects in 1993, a notable state can be observed, as shown in Fig. 2.4 and Table 2.17. The most active building construction activities, or 50% of the total, took place in Suburban Zone (defined as the area with a more than 10 km radius from the center of Bangkok), followed by Urbanized Zone (defined as the area with a 5-10 km radius) and CBD Zone (defined as the area with a 5 km radius).

In particular, industrial buildings were almost none in CBD Zone, although commercial and office buildings still are being located in CBD Zone. Larger scale commercial buildings tends to locate in Suburban Zone, rather than CBD and Urbanized Zones.

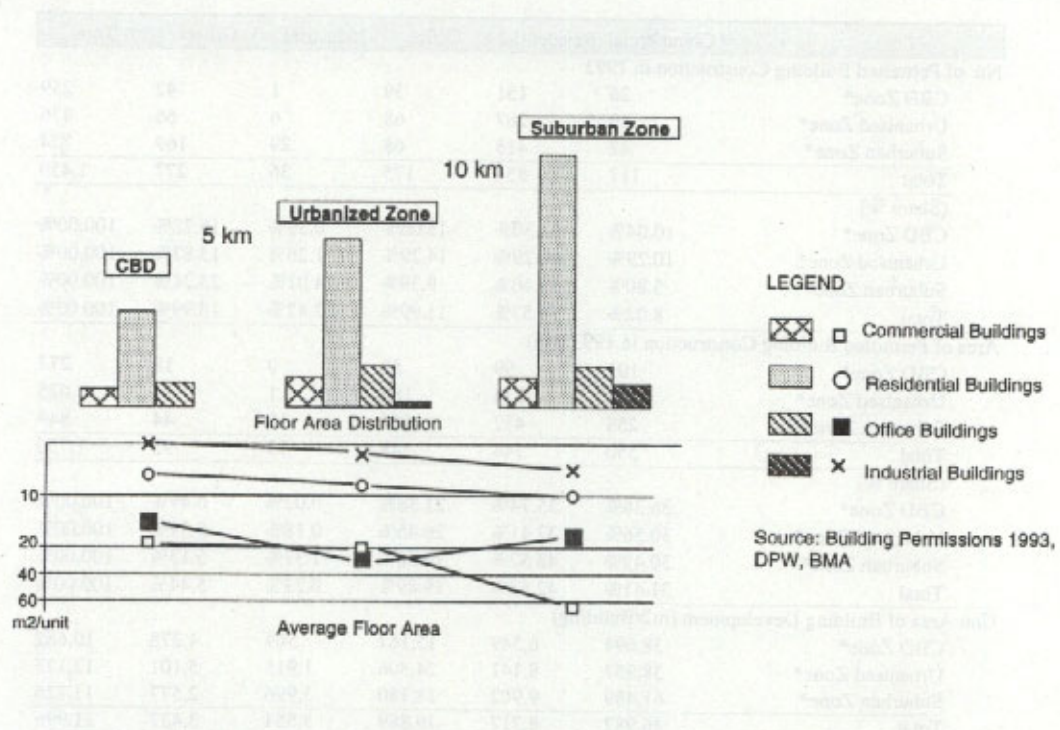


Fig. 2.4 Current Spatial Structure of Building Construction Activities

Table 2.16 Building Construction Activities in Bangkok

	1987		1990		1993		1993/1987
	No. of Permitted Building (No.)	Share	(No.)	Share	(No.)	Share	
Commercial	25	8.50%	114	17.04%	117	8.72%	4.7
Residential	61	20.75%	370	55.31%	854	63.64%	14.0
Office	41	13.95%	162	24.22%	175	13.04%	4.3
Public	55	18.71%	47	7.03%	74	5.51%	1.3
Consumption	17	5.78%	8	1.20%	17	1.27%	1.0
Industrial	52	17.69%	64	9.57%	36	2.68%	0.7
Oil & Gas	67	22.79%	14	2.09%	58	4.32%	0.9
Others	1	0.34%	4	0.60%	128	9.54%	128.0
Total	294	100.00%	669	100.00%	1,342	100.00%	4.6
Area of Permitted Building (Sq.m)							
	(Sq.m)		(Sq.m)		(Sq.m)		
Commercial	475,273	35.25%	3,338,342	31.34%	5,497,498	45.79%	11.6
Residential	270,978	20.10%	3,644,391	34.21%	7,444,503	62.01%	27.5
Office	228,449	16.94%	3,187,238	29.92%	3,480,579	28.99%	15.2
Public	120,177	8.91%	254,735	2.39%	689,224	5.74%	5.7
Consumption	113,809	8.44%	4,860	0.05%	110,868	0.92%	1.0
Industrial	117,853	8.74%	211,852	1.99%	127,951	1.07%	1.1
Oil & Gas	21,496	1.59%	6,863	0.06%	44,217	0.37%	2.1
Others	298	0.02%	5,087	0.05%	107,622	0.90%	361.1
Total	1,348,332	100.00%	10,653,369	100.00%	12,004,964	100.00%	8.9
Area per Building (sq.m/building)							
Commercial	19,010.91		29,283.70		46,987.16		2.5
Residential	4,442.26		9,849.71		8,717.22		2.0
Office	5,571.93		19,674.31		19,889.02		3.6
Public	2,185.04		5,419.90		9,313.84		4.3
Consumption	6,694.63		607.56		6,521.65		1.0
Industrial	2,266.41		3,310.18		3,554.19		1.6
Oil & Gas	320.83		490.25		762.36		2.4
Others	298.00		1,271.72		840.80		2.8
Total	4,586.16		15,924.32		8,945.58		2.0

Source: Department of Public Works, BMA

Table 2.17 Location Characteristics of Building Development in Bangkok by Zone

	Commercial	Residential	Office	Industrial	Others	Total
No. of Permitted Building Construction in 1993						
CBD Zone*	26	151	39	1	42	259
Urbanised Zone*	49	287	68	6	66	476
Suburban Zone*	42	416	68	29	169	724
Total	117	854	175	36	277	1,459
(Share %)						
CBD Zone*	10.04%	58.30%	15.06%	0.39%	16.22%	100.00%
Urbanised Zone*	10.29%	60.29%	14.29%	1.26%	13.87%	100.00%
Suburban Zone*	5.80%	57.46%	9.39%	4.01%	23.34%	100.00%
Total	8.02%	58.53%	11.99%	2.47%	18.99%	100.00%
Area of Permitted Building Construction in 1993 (Ha)						
CBD Zone*	101	99	59	0	18	277
Urbanised Zone*	191	234	165	1	34	625
Suburban Zone*	258	412	124	12	44	849
Total	550	744	348	13	95	1,750
(Share %)						
CBD Zone*	36.36%	35.74%	21.38%	0.02%	6.49%	100.00%
Urbanised Zone*	30.56%	37.41%	26.46%	0.18%	5.39%	100.00%
Suburban Zone*	30.42%	48.52%	14.56%	1.37%	5.13%	100.00%
Total	31.41%	42.53%	19.89%	0.73%	5.44%	100.00%
Unit Area of Building Development (m²/Building)						
CBD Zone*	38,694	6,549	15,167	569	4,278	10,682
Urbanised Zone*	38,957	8,141	24,306	1,915	5,101	13,123
Suburban Zone*	61,489	9,902	18,180	3,996	2,577	11,726
Total	46,987	8,717	19,889	3,554	3,437	11,996

Note: Zonal division is same as that in Table 2.9.

Source: Department of Public Works, BMA

(4) Land Use Intensification with High-rise Buildings in Urbanized Area

Since Bangkok allows construction of buildings with as high as 1,000 % of floor area ratio (FAR) in any area, developers tend to construct high-rise buildings so as to maximize the land economy utmost.

As shown in Table 2.18, approximately 20 % of the buildings were more than 11 stories in both CBD and Urbanized Zones. However, it is noted that out of the total of 1,837 buildings permitted in 1993, 124 were high-rise with more than 20 stories, of which half were located in not CBD, but Urbanized Zone. Thus, the land intensification pressure is expanding outward.

Table 2.18 Distribution of High-rise Building Permissions

	No. of Story				Total	Average No. of Story
	1-4 story	5-10 story	11-20story	> 20 story		
CBD Zone*	33	186	30	30	279	10.1
Urbanised Zone*	73	418	77	61	629	10.0
Suburban Zone*	273	571	52	33	929	7.2
Total	379	1,175	159	124	1,837	8.6
(Share %)						
CBD Zone*	11.83%	66.67%	10.75%	10.75%	100.00%	.
Urbanised Zone*	11.61%	66.45%	12.24%	9.70%	100.00%	
Suburban Zone*	29.39%	61.46%	5.60%	3.55%	100.00%	
Total	20.63%	63.96%	8.66%	6.75%	100.00%	

Note: * The division of the districts into the zone is same as Table 2.9.

Source: Department of Public Works, BMA

(5) Suburbanization Pressures Represented by Land Prices

The construction boom activated the land market, thereby consequently pushing up land prices in Bangkok, particularly in the suburban areas. In this circumstance, the land market tends to be skewed due to land speculation, which makes land procurement for public service facilities and infrastructures more difficult.

Practical information of the market land prices can be hardly obtained. According to the "Land Valuation Price Data" issued by Department of Land, land prices in Bangkok rose by as high as 6 times in the average during the period between 1986 and 1994, as shown in Table 2.19, compared to 1.42 times in the commodity index during the same period. Thus, the land market in Bangkok is not coherent to the real economy.

Looking into the average land prices by zone, the largest rise, or 6.3 times, in land prices occurred in the fringe of the urbanized areas which is encompassed with a 5 to 10 Km radius from the center of Bangkok. It is noted that the land prices in CBD Zone rose at a rather small rate than the average. Thus, the changes in land prices imply strong pressures of suburbanization in the Bangkok Metropolis.

To identify the area characteristics of land prices, the BEIP Team tried to depict rough indifferent contour lines of average land prices, based on the same data. Fig. 2.5 represents the result. The land prices seem to be higher in the East bank area than those in the West bank, or Thonburi Area, and it can be seen that the contour lines are distorted toward the North-East corridors.

Table 2.19 Changes in Land Evaluation Prices in Bangkok

District	Land Evaluation Price*2		Increase
	1986	1992-94	1992-94
1 Pra Nakhon	100,000	300,000	3.00
2 Khlong Toei	24,000	270,000	11.25
3 Klong San	40,000	200,000	5.00
4 Chatuchak	25,000	128,000	5.12
5 Chom Thong	10,000	80,000	8.00
6 Don Muang	8,000	90,000	11.25
7 Dusit	65,000	130,000	2.00
8 Taling Chan	8,800	56,000	6.36
9 Thon Buri	22,000	150,000	6.82
10 Bangkok Noi	25,000	80,000	3.20
11 Bangkok Yai	22,000	120,000	5.45
12 Bang Kapi	16,000	200,000	12.50
13 Bang Khun Thian	5,500	55,000	10.00
14 Bang Khen	8,000	60,000	7.50
15 Bang Kho Laem	20,000	100,000	5.00
16 Bang Sue	15,000	120,000	8.00
17 Bang Phlat	25,000	112,000	4.48
18 Bang Rak	65,000	400,000	6.15
19 Bung Kum	60,000	160,000	2.67
20 Pathum Wan	30,000	290,000	9.67
21 Prawet	15,000	75,000	5.00
22 Pom Prap	30,000	250,000	8.33
23 Phaya Thai	40,000	150,000	3.75
24 Phra Khanong	30,000	250,000	8.33
25 Phasi Charoen	12,000	90,000	7.50
26 Min Buri	1,500	20,000	13.33
27 Yan Nawa	20,000	100,000	5.00
28 Ratchthewi	40,000	200,000	5.00
29 Rat Burana	11,000	80,000	7.27
30 Lat Krabang	1,000	12,000	12.00
31 Lat Phrao	6,000	30,000	5.00
32 Sam Phanthawong	75,000	300,000	4.00
33 Sathon	60,000	280,000	4.67
34 Nong Khaem	4,000	50,000	12.50
35 Nong Chok	500	4,000	8.00
36 Huai Khwang	30,000	180,000	6.00
37 Din Daeng			-
38 Suan Luang			-
Average Land Evaluation Price By Zone			
CBD Zone*3	40,489	178,914	4.42
Urbanised Zone*3	16,320	118,090	7.24
Suburban Zone*3	8,522	54,039	6.34
Total	11,983	72,582	6.06

Note: *1 Sq.Wa is equivalent with 4 sq.m.

*2 The evaluation points along major roads in each districts are selected.

*3 Division of the districts into the zone is same as Table 2.9.

Source: Department of Land, MOI

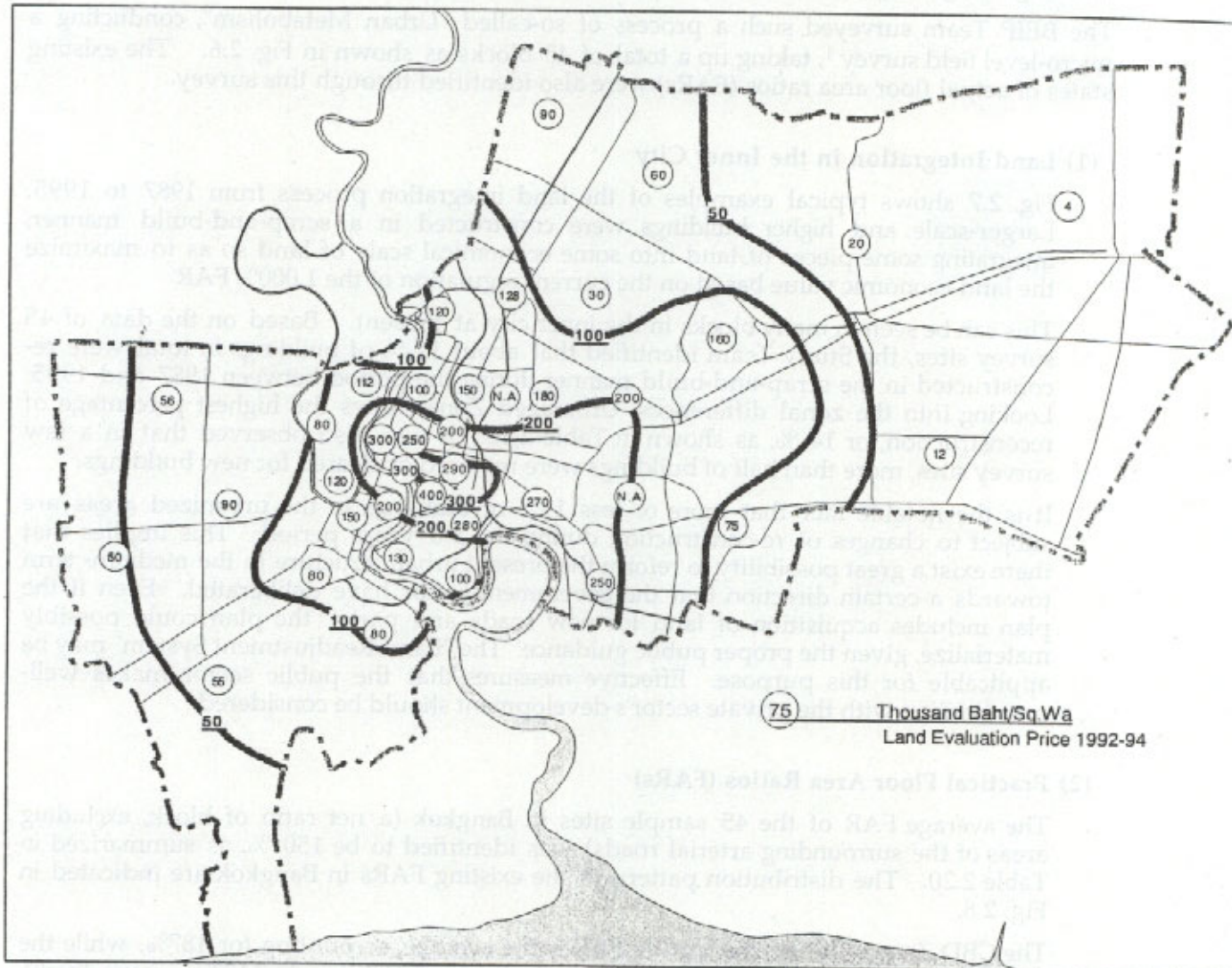


Fig. 2.5 Land Price Indifferent Contour Lines

2.4 A Physical Feature of Urban Metabolism

As discussed in the preceding sections, the vertical extension is rapidly proceeding in CBD and urbanized areas. Such a spatial change is being stimulated by a "land integration process" to provide with wider piece of land for construction of higher and larger-scale building, integrating a few small pieces of land into a larger lot.

The BEIP Team surveyed such a process of so-called "Urban Metabolism", conducting a micro-level field survey¹, taking up a total of 45 blocks as shown in Fig. 2.6. The existing states of actual floor area ratios (FARs) were also identified through this survey.

(1) Land Integration in the Inner City

Fig. 2.7 shows typical examples of the land integration process from 1987 to 1995. Larger-scale and higher buildings were constructed in a scrap-and-build manner, integrating some pieces of land into some economical scale of land so as to maximize the land economic value based on the current regulation of the 1,000% FAR.

This can be seen in many blocks in the inner city at present. Based on the data of 45 survey sites, the Study Team identified that about 11 % of buildings in total were re-constructed in the scrap-and-build manner during the period between 1987 and 1995. Looking into the zonal differences, Urbanized Zone shows the highest percentage of reconstruction, or 14 %, as shown in Table 2.18. It was also observed that in a few survey sites, more than half of buildings were replaced or cleared for new buildings.

It is the notable fact that more or less 14% of buildings in the urbanized areas are subject to changes or re-construction during the 5-8 years period. This implies that there exist a great possibility to reform the present urban structure in the medium-term towards a certain direction that the government sector have deliberated. Even if the plan includes acquisition of land for new roads and parks, the plan could possibly materialize, given the proper public guidance. The "Land Readjustment System" may be applicable for this purpose. Effective measures that the public sector makes well-coordination with the private sector's development should be considered.

(2) Practical Floor Area Ratios (FARs)

The average FAR of the 45 sample sites in Bangkok (a net ratio of block, excluding areas of the surrounding arterial roads) was identified to be 150 %, as summarized in Table 2.20. The distribution pattern of the existing FARs in Bangkok are indicated in Fig. 2.8.

The CBD Zone indicates the highest FAR in the average, accounting for 187%, while the Urbanized and the Suburban Zones indicate 134% and 118%, respectively. Furthermore, the commercial area including office and public buildings presents the highest FAR of 194 %, while the residential area is 84 %. Especially, the areas along Petchaburi, Sukhumvit, Silom Roads in the CBD Zone show the highest FARs. Thus, it should be noted that these figures of FARs at the actual ground are considerably smaller than the currently regulated FAR of 1,000%. Therefore, it must be a vital planning issue whether or not the current regulation of FAR is appropriate from the urban environment point of view. Since high-rise building itself is a great generator of environmental waste as well as traffic demands, it potentially causes environmental problems without sufficient infrastructures to deal with them.

¹ The survey was conducted in a manner that surveyors observe and investigate the lot size, the shape, the size and the number of story of existing each building in the survey site, and record those information on the 1987 topo-map. By this, changes of buildings between 1987 and 1995 can be identified.



Source: JICA Study Team

Fig. 2.6 Locations of Micro Surveys for Building Changes and FARs

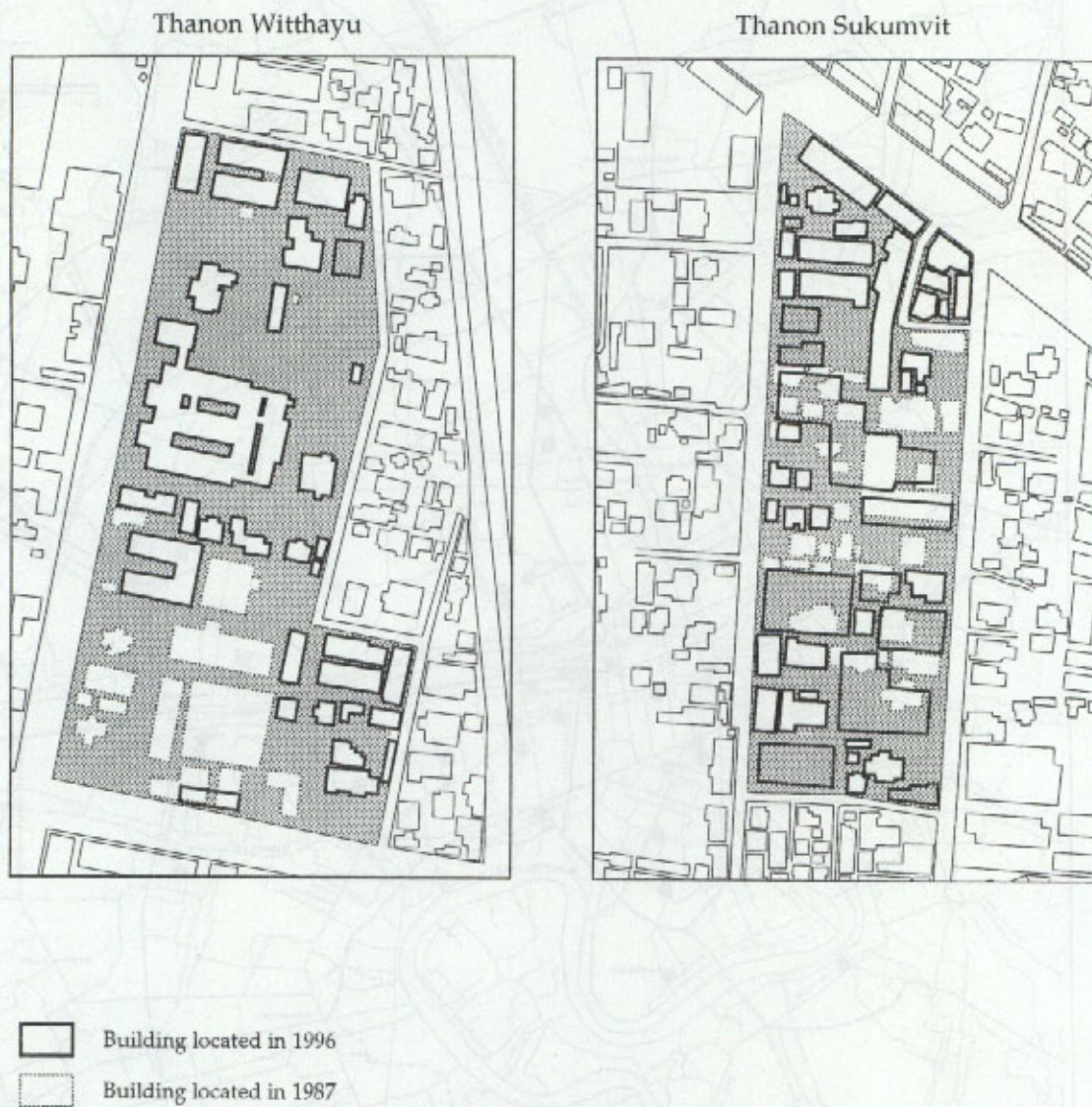


Fig. 2.7 Examples of Land Integration and Urban Metabolism

Table 2.20 Summary of the Results of Building Change and Existing FARs Survey

(1) Occurrence of Building Re-construction by Zone in Bangkok between 1987 and 1995

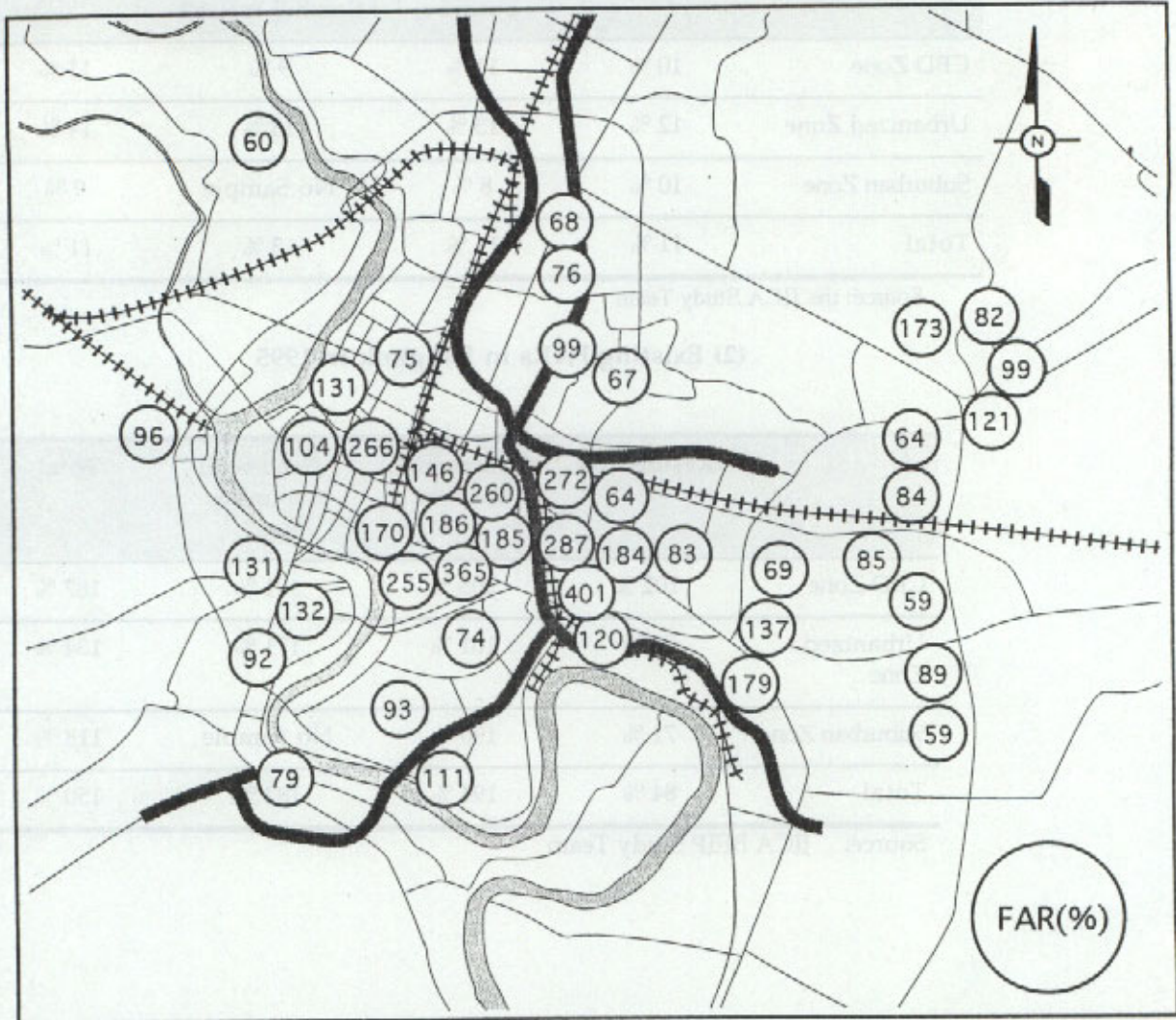
	Residential	Commercial, Business	Mixed with Comm'l & Res'l.	Total
CBD Zone	10 %	11 %	9 %	11 %
Urbanized Zone	12 %	13 %	18 %	14 %
Suburban Zone	10 %	8 %	No Sample	9 %
Total	11 %	11 %	13 %	11 %

Source: the JICA Study Team

(2) Existing FARs in Bangkok in 1995

	Residential	Commercial, Business	Mixed with Comm'l & Res'l.	Total
CBD Zone	102 %	208 %	191 %	187 %
Urbanized Zone	93 %	161 %	171 %	134 %
Suburban Zone	71 %	190 %	No Sample	118 %
Total	84 %	194 %	182 %	150 %

Source: JICA BEIP Study Team



Source : JICA BEIP Study Team

Fig. 2.8 Distribution of FARs in Bangkok in 1995

CHAPTER 3: IDENTIFICATION OF URBAN ENVIRONMENTAL PROBLEMS AND PLANNING IMPLICATIONS

3.1 A General View

To explore the existing conditions of the urban environment in Bangkok, the study team categorized urban environment into four components such as receptacle, urban anabolism, urban function and urban catabolism.

(1) Receptacle

Bangkok can be considered as a receptacle of peoples' activities. Natural conditions and the limited space of the city heavily affect urban activities and characterize the environmental problems. In this sense, Bangkok has unique characteristics in terms of climate and geography. It affects on flood, air pollution and water pollution.

(2) Urban Anabolism (Inputs for Urban Activities)

Urban anabolism means inputs to urban activities such as water, energy and material supplies, since a city can not alive by self-sustenance. Modern technology and financial capabilities can overcome problems related to urban anabolism. However, measures taken with a short-term view sometimes cause larger-term problems.

Problems concerning energy and food supplies are excluded from the study.

(3) Urban Function

Urban function covers activities carried out in Bangkok. Using the inputs, Bangkok carries out activities such as economic activities, urban development, transport and peoples' living.

Since the rapid economic growth from the mid-1980 in Thailand, various economic functions have been concentrated in Bangkok. Expansion of the middle-income group enlarge the domestic market, especially with regard to vehicles, construction and real estate markets. The number of private cars rapidly increased and urban development activities by the private sector such as construction of office and commercial buildings, housing projects and the development of manufacturing facilities accelerated. This resulted in extreme overcrowding in the urban centers and the unexpected expansion of the urbanized areas in the suburban areas, resulting in severe deterioration of the urban and suburban areas and of the natural environment.

(4) Urban Catabolism (Outputs from Urban Activities)

Presently, Bangkok suffers from several urban environmental problems such as air pollution, water pollution of rivers and klongs, difficulty of garbage disposal and traffic noise. These problems appear to be caused by the urban functions.

The meaning of urban catabolism is the management of outputs from the urban functions. The urban environmental problems appear significantly here.

To improve the urban environment, it is necessary to take account not only of the problem of urban catabolism but also of the problems of the receptacle, urban anabolism and the urban function. The urban environmental planning aims at reforming the receptacle in order to balance with nature, through restructuring urban anabolism, the urban function and urban catabolism on the one hand, and mitigating/solving current problems on the other hand. Both measures should be coordinated in the urban environmental plan. In the following sections current urban environmental problems are discussed.

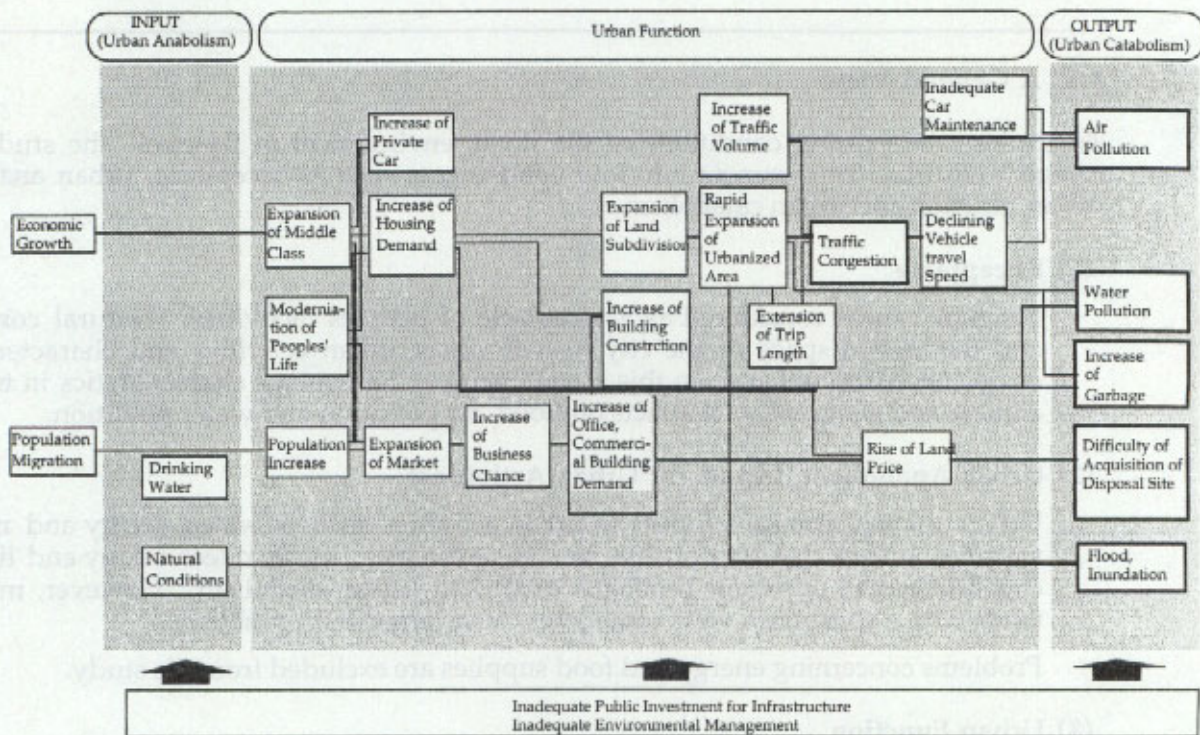


Fig. 3.1 Co-relation of Urban Environmental Problems (A Rough Concept)

3.2 Natural Conditions

(1) Tropical Climate

Bangkok experiences too much precipitation in the monsoon season (more than 300 mm per month) and too little in dry season (less than 10 mm per month). This naturally causes floods in the monsoon season and droughts in the dry season. Moreover, the meteorological data shows that a strongly stable air condition (referred to as the state of G by the Pasquil's stability classification) frequently takes place in the dry season. A stable air condition often results in air pollution staying near the ground surface, thereby resulting in serious ambient air pollution in the dry season. Fig. 3.2 shows the salient characteristics of the climate of Bangkok.

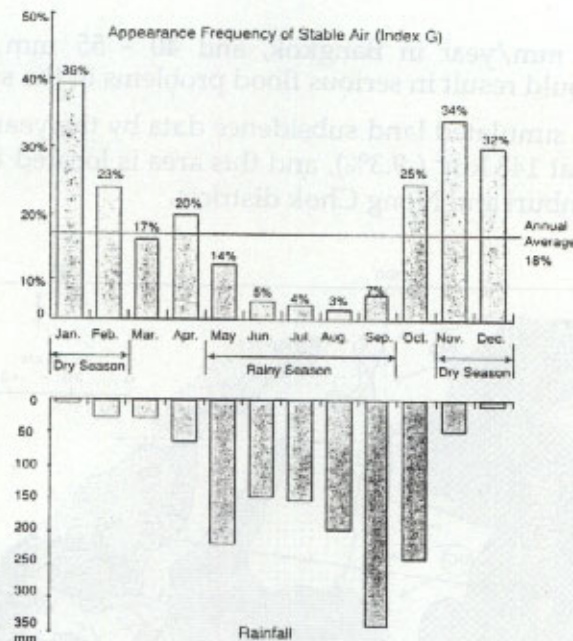


Fig. 3.2 Salient Characteristics of the Tropical Climate of Bangkok

(2) Low Alluvium Plain

The main physiographic features of Thailand are divided into seven regions, namely, the Central Plain, the West Continental Highlands, the North Continental Highland, the Central Highlands, the North Plateau, the Southeast Coast; and Peninsular Thailand.

The Central Plain is a strip of land over 500 Km in length and 100-200 Km in width and this physiographic unit is divided into three areas, namely, the Upper Central Plain, the Nakhon Sawan area and the Lower Central Plain.

The Lower Central Plain covers an area of approximately 53,400 Km² and the length from north to south is roughly 200 Km and the average width is approximately 150 Km. The elevation of this Plain range from 20 m above mean sea level (MSL) at Chai Nat in the northern area, 4 - 5 m at Ayutthaya and 1 - 2 m in Bangkok and its vicinities. The Lower Central Plain is a large and flat lowland which is formed by the fluvial process of the Chao Phraya River, the Mae Klong River, the Tha Chin River and the Bang Pakhong River. These large rivers have been transporting huge volumes of sedimentation for the past several thousands years. Sedimentation takes place mainly at the time of flooding and rivers sometimes freely change the course of channel.

Many abundant river channels can be seen in the lower reach of large rivers in the Lower Central Plain. The geomorphologic map of the Lower Central from the "JICA Study for the Management of Groundwater and Land Subsidence" in 1995 is shown as Fig. 3.3.

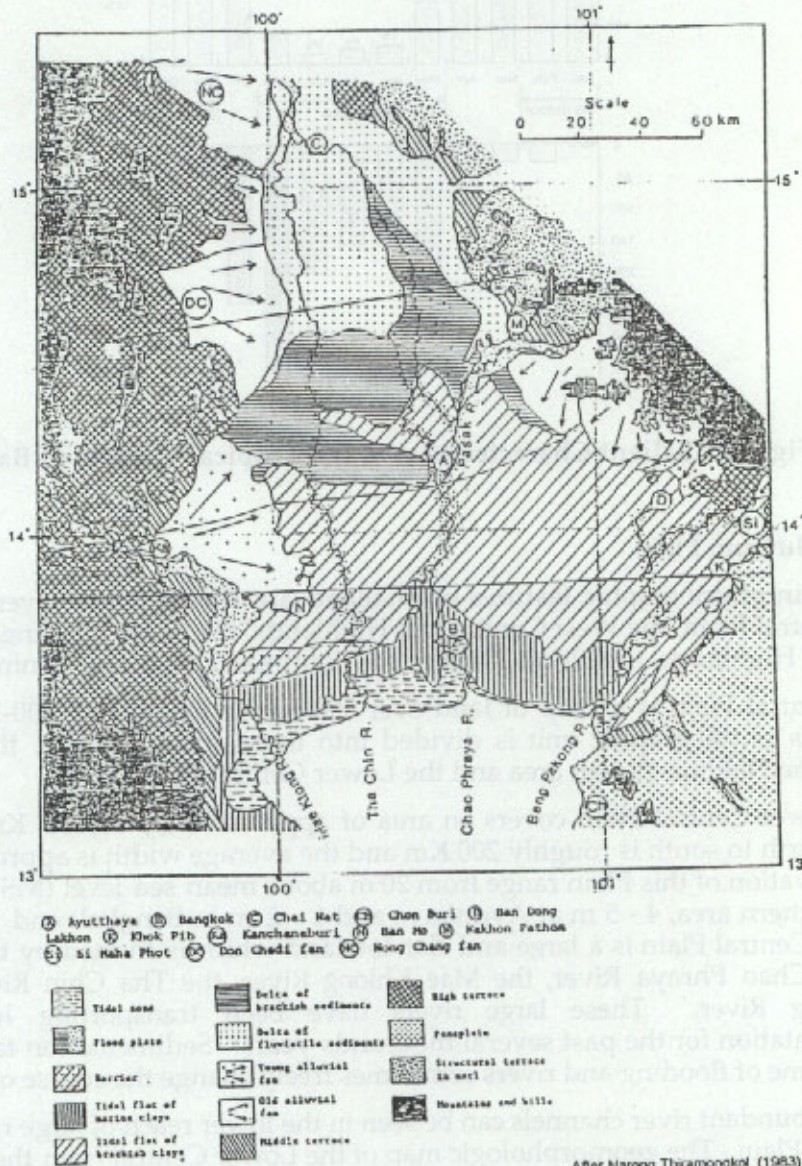
As stated above, Bangkok is located on the low alluvium flat plain of the Chao Phraya River Delta, which belongs to the Lower Central Plain. It is 1 to 2 meters above MSL. Due to these low and flat geographical characteristics, when Bangkok suffers from flooding, it is difficult to drain the water away. It can seriously affect the peoples' life and economy.

(3) Land Subsidence

Rapid urbanization, modernization and industrialization are all demanding more water, however the water supply service can not keep up with the demand. This eventually has increased the groundwater usage, which caused land subsidence. Although land subsidence has now slowed down in the central area of Bangkok as a result of regulation, the suburban areas still receive significant land subsidence, which is

projected at 20 mm/year in Bangkok, and 40 - 55 mm/year in Minburi and Lat Krabang. This could result in serious flood problems in the suburban areas of Bangkok.

According to the simulated land subsidence data by the year 2017, area of less than 50 cm is calculated at 148 km² (9.3%), and this area is located in the north-eastern part of BMA such as Minburi and Nong Chok districts.



Source: the Study for the Management of Groundwater and Land Subsidence, JICA, 1995

Fig. 3.3 Geomorphological Map of the Lower Central Plan

946 km² (60%) of the area is calculated at 50 cm-100 cm of subsidence and 485 km² (31%) of the area is calculated at more than 100 cm of subsidence in the BMA. More than 85% area of the Bangkok Yai, Khlong San, Bangkok Noi, Phasi Charoen, Huai Khwang and Nong Khaem districts are covered by a contour line of subsidence over 100 cm.

Based on the analysis by GIS, it is concluded that Huai Khwang, Khlong Toei, Bangkok Noi and Phra Khanong districts are areas which have a higher potential both of land subsidence and flooding.

Fig 3.4

Problem Areas on Natural Constraints

Legend

- Less than -50 cm
- 50 to -75 cm
- 75 to -100 cm
- 100 to -125 cm
- 125 to -150 cm
- More than -150 cm
- Flooded Area in 1983
- Chaopraya River
- Railways
- BMA Boundary
- District Boundary
- Subdistrict Boundary



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



BANGKOK METROPOLITAN ADMINISTRATION
THE GOVERNMENT OF THE REGION OF THAILAND



JICA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



(4) Floods

Due to the low alluvium plain, Bangkok has traditionally suffered from floods. In particular, Bangkok suffered heavy damages in 1983 and 1995. The Chao Phraya River recorded the highest water level of 2.27 m MSL at the Memorial Bridge in October in 1995, which is higher than in 1983 (2.13 m) when most of the BMA area suffered from heavy flooding for several days. Floods in 1993 recorded higher water level but damages are limited in narrow areas.

According to the GIS analysis, total flooded area from the 1983 flood in BMA is calculated at 424 km² and more than 80 % of districts such as Phra Khanong, Lat Phrao, Suan Luang, and Bang Kapi districts were inundated. 54%-68% of Khlong Toei, Huai Khwang, Jomtong and Prawet districts were inundated. Inundated areas are shown in Fig. 3.4.

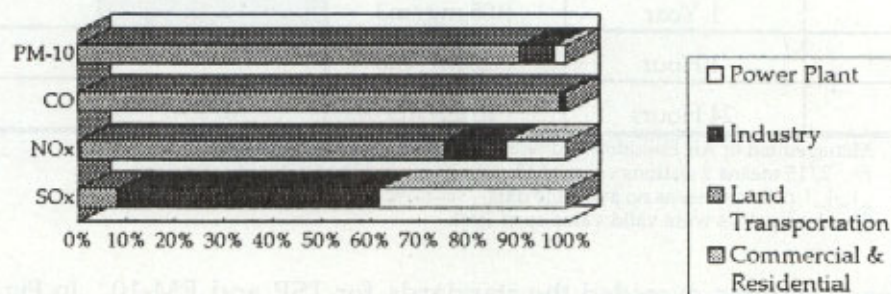
(5) Air Pollution**1) Pollutant Sources and Amounts**

In the BMR, nearly 50% of the consumption of petroleum products in Thailand occurs. Through consumption of petroleum products, large amounts of air pollutants are emitted continuously. The annual amount of these pollutants by sector is estimated in Table 3.1 and Fig. 3.5.

Table 3.1 Air Pollutants Emissions in BMR, by Sector, 1992

Sector	1000 ton/year			
	SO _x	NO _x	CO	PM-10
Power Plant	104	23	2	4
Industry	145	24	7	12
Land Transportation	22	141	686	152
Commercial & residential	0	1	0	0

Source: Power Plant, Industry and Com. & Res. ; Air Pollution Database, 1992, PCD
Land Transportation ; JICA, BEIP Study Team

**Fig. 3.5 Air Pollutants Emissions Ratio by Sector, BMR, 1992**

The emissions from land transportation accounts for a very large portion of NO_x, CO and PM-10. The emissions from vehicles contributes a significant, although not the highest, portion of SO_x.

It is noteworthy that the emissions from land transportation have a direct affect on the concentration of ground level pollutants. In addition, the stable condition of the atmosphere increases the ground level concentration.

2) Monitoring Result of Pollutants

Currently, PCD is monitoring the ambient air condition of the entire nation, with 8 stationary monitoring stations in 1994 (as shown in Fig. 3.6 and 7), and approximately 15 temporary monitoring stations in Bangkok. The Ministry of Health operates 3 stationary monitoring stations in Bangkok under the UNEP-WHO Global Environmental Monitoring System. The Department of Health, BMA, has one stationary monitoring station.

Nevertheless, the ambient air quality standard was formulated to protect the people's health. It is therefore essential to review the results of the monitored ambient air condition with respect to the air quality standard.

Ambient air quality standards and the PCD's monitored ambient air condition results of 1994 are summarized in Table 3.2. This table implies issues listed below.

Table 3.2 Review of the Present Situation of the Atmosphere, 1994

Pollutant	Evaluating Time	Standard Value	Roadside	General Area
CO	1 Hour	50 mg/m ³	0/18	0/4
	8 Hours	20 mg/m ³	2/18	0/4
NO ₂	1 Hour	0.32 mg/m ³	-	-
SO ₂	1 Hour	0.78 mg/m ³	-	-
	24 Hours	0.30 mg/m ³	-	-
	1 Year	0.1 mg/m ³	-	-
TSP	24 Hours	0.33 mg/m ³	12/15	2/4
	1 Year	0.10 mg/m ³	-	3/4
PM-10	24 Hours	0.12 mg/m ³	2/2	-
	1 Year	0.05 mg/m ³	-	-
O ₃	1 Hour	0.20 mg/m ³	-	-
Lead	24 Hours	10 µg/m ³	0/15	0/4

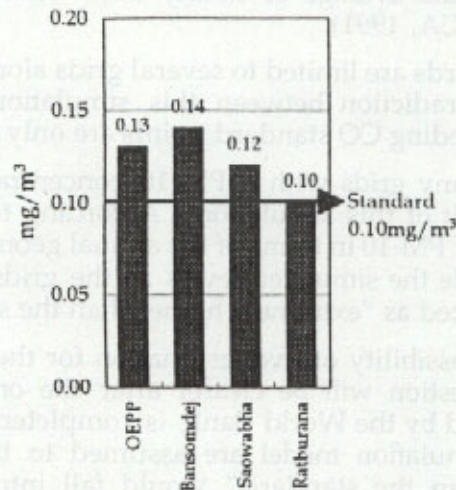
Source : Management of Air Pollution and Noise Pollution in 1993-1994, PCD

Notes : Ex. 2/15 means 2 stations value of 15 stations exceed the air quality standard.

_ _ _ _ column means no available data.

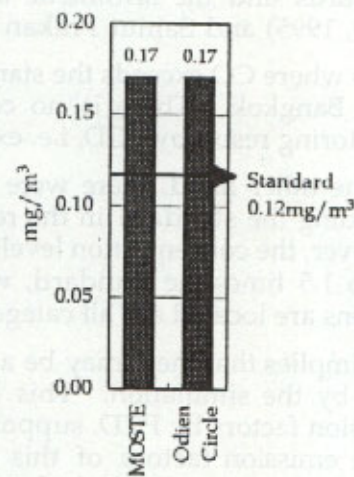
Standard values were valid value as of 1994.

First, many stations exceeded the standards for TSP and PM-10. In Fig. 3.6 and 3.7, TSP and PM-10 numerical data are graphed. Briefly, PM-10 indicates suspended dusts below 10 micron diameter and TSP indicates whole suspended dusts. For the health of the people of Bangkok, the mitigation of this high concentration of TSP and PM-10 is an urgent issue.



Source: Management of Air Pollution and Noise Pollution in 1993 - 1994, PCD

Fig. 3.6 TSP, One Year Average 1994, General Stations



Source: Same as Fig. 3.6

Fig. 3.7 PM-10, Max. of 24 Hr Ave. 1994, Roadside Stations

It is said that PM-10 consists of two portions. One is of natural origin such as the fine matters of soil or sea-salt particulates, and the other is human activity origin matter. For human activity origin PM-10, particulate matters from vehicle exhaust pipe and stationary source stacks might be typical. PM-10 is inhalable and affects human health.

TSP consists of PM-10 and other coarse particles, exceeding 10 microns in diameter. It might be supposed that construction activities on and around roads, and vehicles traveling on dusty roads, are major sources of the coarse portion of TSP. In addition to scattered dust from vehicle tires, body and truck beds might belong to the coarse portion and worsen the TSP concentration.

Integrated abatement measures of the above-mentioned sources should be implemented urgently, not only for PM-10 but also for TSP.

Second, mitigating the level of CO is another target. One hour values are under the standard, however the roadside 8 hours average exceeds the standard at some roadside stations. Vehicles are thought to be the cause, and vehicle traffic is expected to increase in the future. Regulations with regard to CO from vehicles may be necessary.

Third, there are many loopholes for reviewing the current atmospheric pollution. The monitoring activity is not sufficient. SO₂ and NO₂ were not monitored in 1994. PCD has already started monitoring SO₂ and NO₂ at several stations. This activity should be strengthened to monitor not only the residential areas, but also roadside areas. These areas should be monitored as many inhabitants earn their living at roadside areas in Bangkok. In addition, PCD started monitoring O₃. If these monitoring data are reviewed analytically, the significant characteristics of pollution in Bangkok could be understood.

3) Method of Current Air Pollution Simulation

To review the present condition, the simulation analysis of air pollutants is introduced. SO_x, NO_x, CO and PM-10 emissions from vehicles, which are believed to be the major source of pollution, are examined, and their ground level concentrations are simulated.

The concentration distribution patterns simulated by the model are shown below. The ranking for each air pollutant is determined by statistical analyses between the standards and the arithmetic annual average of hourly data measured in Bangkok (PCD, 1995) and Samut Prakan (JICA, 1991).

Grids where CO exceeds the standards are limited to several grids along major roads in inner Bangkok. There is no contradiction between this simulation result and the monitoring result by PCD, i.e. exceeding CO standard points are only 2 out of 18.

On the other hand, there were many grids with a PM-10 concentration "extremely" exceeding the standard in the result of this simulation. According to the PCD data, however, the concentration levels of PM-10 in terms of the annual geometric means were 1.3 to 1.5 times the standard, while the simulated levels at the grids where the PCD stations are located are all categorized as "extremely higher than the standard".

This implies that there may be a possibility of over-estimation for the emission factors used by the simulation. This question will be clearer after the on-going review of emission factors by PCD, supported by the World Bank, is completed. However, even if the emission factors of this simulation model are assumed to be half, the grids evaluated at "extremely higher than the standard" would fall into the category of "higher than the standard" which would still significantly exceed the standard. The grids are spread over the area of Bangkok.

For NO₂, the area "higher than the standard" is widely spread. Thus, most Nox are believed to originate from vehicles.

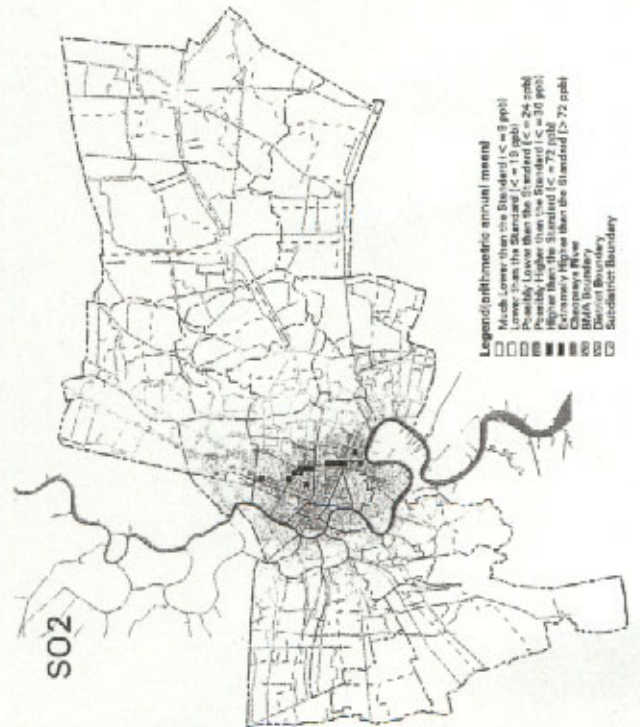
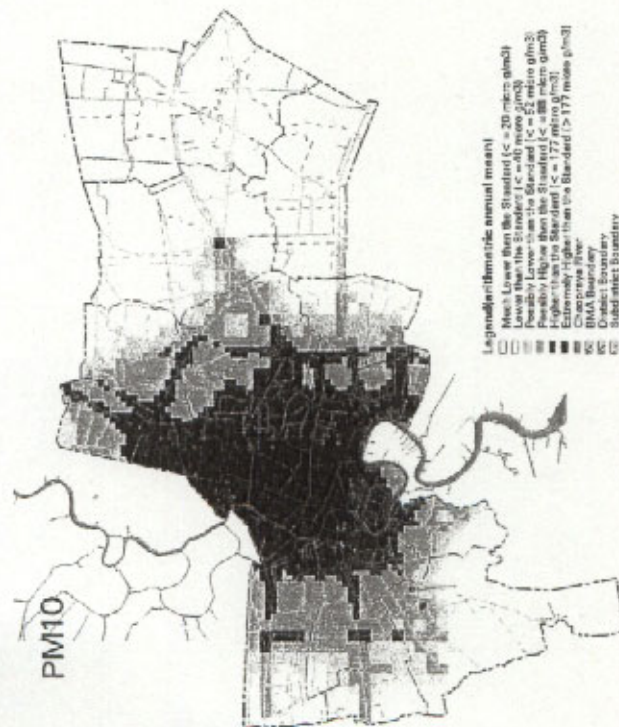
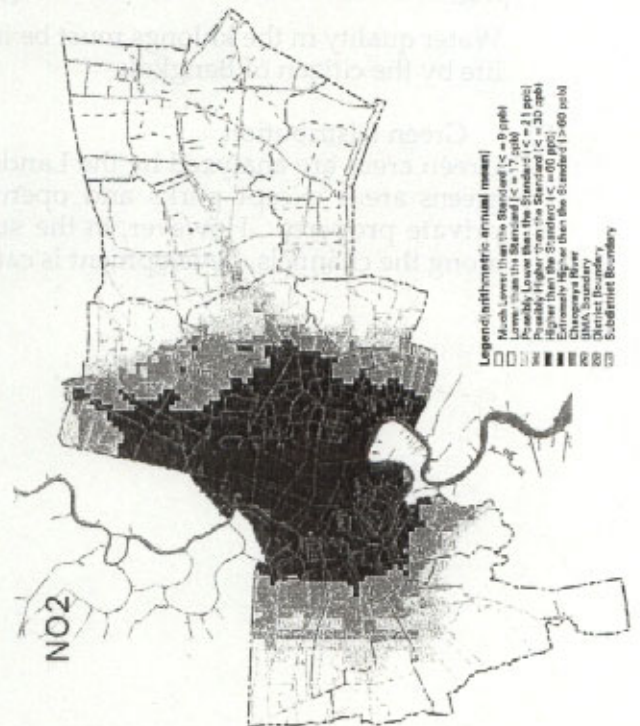
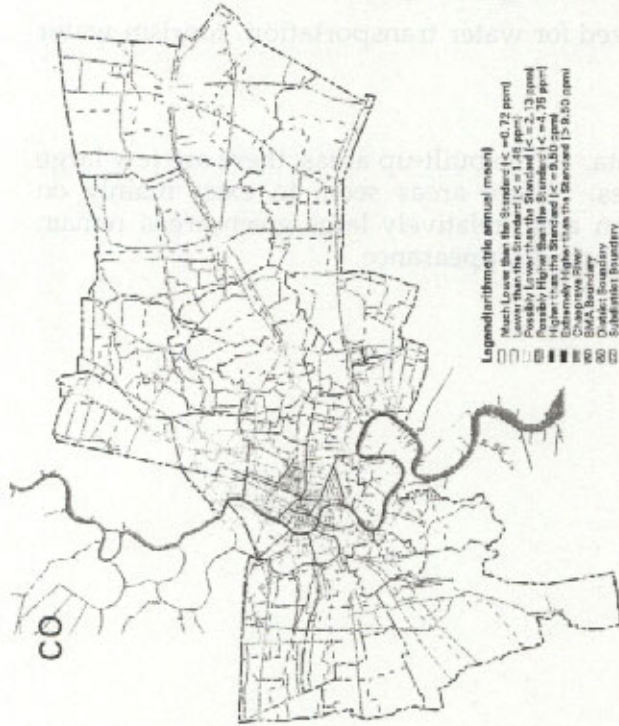
For SO₂, the simulation, which considers only vehicle sources, implies that all regions except 8 km₂ are "lower than the standard". However, in the simulation shown in Fig. 3.8 that includes effects of some power plants, "possibly higher than the standard" and "higher than the standard" zones appear significantly. Influence of power plants might therefore be an important factor for this pollutant.

Substantial monitoring of NO₂ and SO₂ has started recently. Hence, comparison of results between the monitoring and the simulation is not possible at the present time.

Air Pollution Simulation

Case 1

Present Vehicle Emission Factor
 Present Road Network
 Present Mass Transit Network
 Present Transport Demand



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BANGKOK METROPOLITAN ADMINISTRATION (BMA)
 THE GOVERNMENT OF THAILAND



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(6) Water Quality

The contaminated Khlong water areas extends considerably in the BMA area, from the Khlong Lad Phrao to Khlong Phra Khanong line to the west of the Bangkok side and from the Khlong Bangkok Yai to Chom Thong and Rat Burana Districts line to the east of the Thonburi side, which shows progressively contaminated water of 20 to 40 mg/lit in BOD and 0 to 2 mg/lit in DO. Aquatic life along the city khlongs has almost disappeared in the central part of the city.

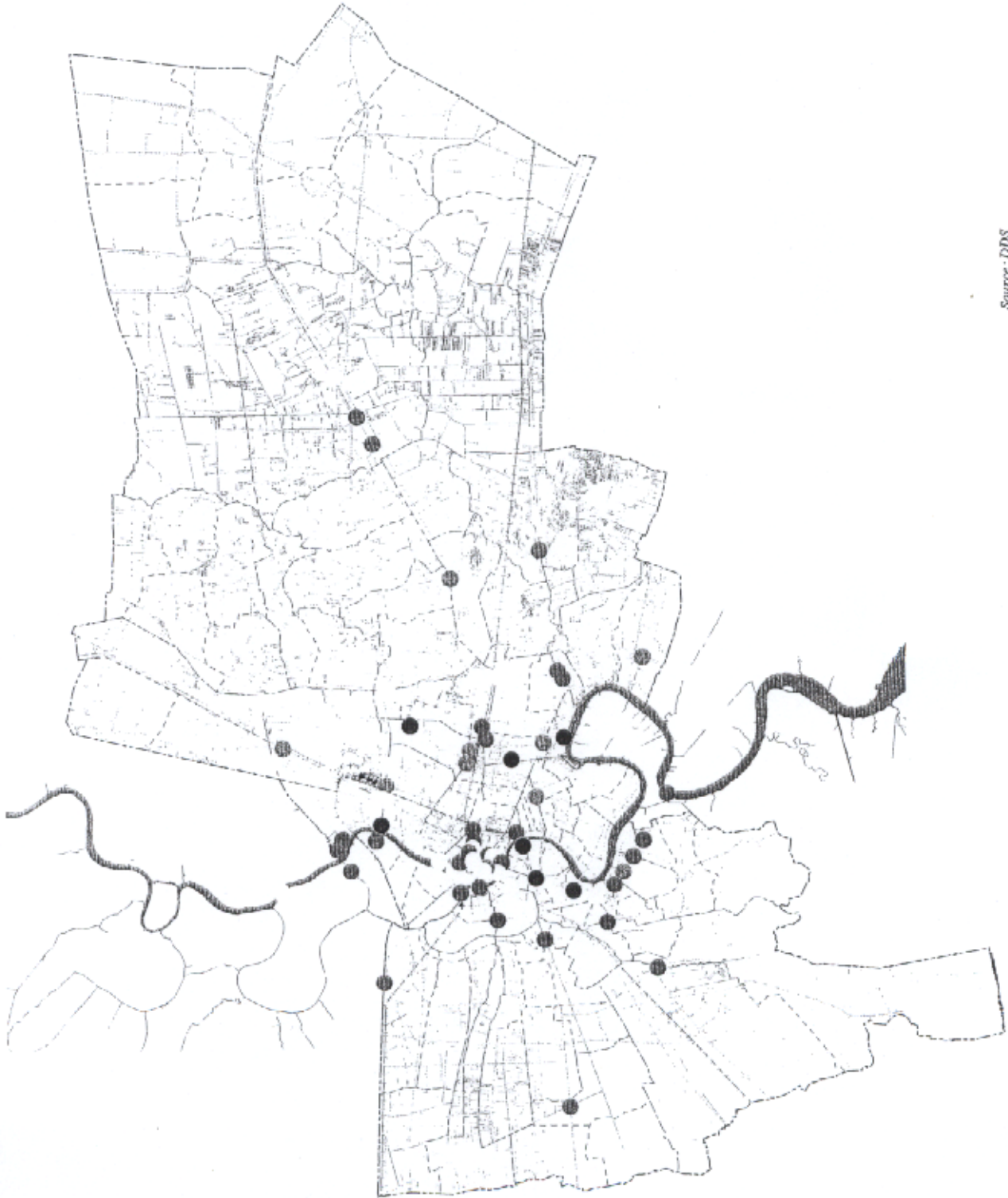
Water contamination in the recent years shows signs of slight improvement in the khlong water. On the contrary, the water quality in the Chao Phraya River shows 3 to 4 mg/lit in BOD off shore of the Khlong Phra Khanong estuary.

Water quality in the khlongs must be improved for water transportation, tourism water life by the citizen of Bangkok.

(7) Green Distribution

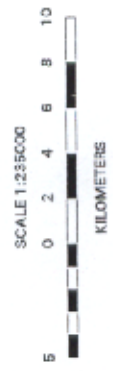
Green areas are analyzed by the Landsat data. In the built-up areas, there are few large greens areas except parks and open spaces. Green areas seem to exist mainly on private property. However, in the suburban area, relatively large green areas remain along the channels, development is causing their disappearance.

Water Quality (Contaminated Area)



Legend

- Klong Water Contaminated Area
- Chao Phraya River
- River/Klong
- Rail
- Road
- BMA Boundary
- District Boundary
- Subdistrict Boundary
- More than 40 mg/l
- 30 to 39 mg/l
- 20 to 29 mg/l
- Less than 20 mg/l



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Source: DDS

Green Coverage (Except for Cultivated Land, Interpreted from Landsat TM Data)

Legend

-  Build-up Area
-  Vegetated Area
-  Park
-  Chaopraya River
-  BMA Boundary
-  District Boundary
-  Subdistrict Boundary



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3.3 Urban Transport

(1) Person Trip Production and Pattern in BMA

A total of 21.3 million person trips are made by 11.5 million people on a typical day in the BMR. A trip production rate of BMR in gross terms (production rate divided by the total population) is estimated at 1.86¹. Approximately 82 % of these trips have either their origins or destinations within BMA (hereafter termed "BMA related trips"). In addition, more than 90 % of these trips have both the starting- and ending-point within BMA (termed "Intra-BMA Trips"). Inbound- and outbound-trips to/from BMA are quite small, estimated at approximately 8.8 % of the BMR total trips. It seems reasonable to suppose that BMA is a relatively closed area in terms of the daily travel of the people.

Accordingly, it should be kept in mind that traffic problems in Bangkok are simply caused by the social and economic activities of Bangkok, and not from those living outside BMA. Bangkokians are thus suffered from the problems caused by themselves. The following question could be raised: should the problem be solved within Bangkok, or through utilization of resources outside Bangkok, or both?

Table 3.3 Person Trip Production by Mode, by Purpose (linked trips)

a) INTRA BMA MORNING TRIPS (6:00 - 10:00AM)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	232,714 9.93%	366,676 23.20%	209,157 11.22%	56,997 5.40%	865,545 12.65%	12.6%
M/C	437,021 18.65%	147,317 9.32%	512,830 27.51%	239,479 22.67%	1,336,647 19.53%	19.5%
Car	556,931 23.77%	155,050 9.81%	607,681 32.59%	698,919 66.16%	2,018,581 29.49%	29.5%
PT	1,116,732 47.65%	911,275 57.66%	534,794 28.68%	60,997 5.77%	2,623,798 38.33%	38.3%
Total	2,343,398 34.24%	1,580,318 23.09%	1,864,462 27.24%	1,056,393 15.43%	6,844,570 100.00%	100.0%

Source: BEIP/UTDM Home Interview Survey

b) FROM BMA TO OUTSIDE TRIP (MORNING)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	2,157 1.33%	723 1.27%	0 0.00%	0 0.00%	2,879 0.83%	0.8%
M/C	23,295 14.38%	2,051 3.61%	2,216 4.09%	13,401 17.94%	40,963 11.78%	11.8%
Car	53,054 32.74%	10,591 18.67%	29,750 54.91%	51,845 69.42%	145,239 41.78%	41.8%
PT	83,534 51.55%	43,373 76.44%	22,211 41.00%	9,439 12.64%	158,556 45.61%	45.6%
Total	162,040 46.61%	56,738 16.32%	54,177 15.58%	74,685 21.48%	347,637 100.00%	100.0%

Source: BEIP/UTDM Home Interview Survey

¹ According to the Study on Medium- to Long- term Improvement / Management Plan of Road and Road Transport in Bangkok by JICA, the trip production rate is estimated at 2.22 in gross terms (rate against the population consisting of those age 6 and above).

c) FROM OUTSIDE TO BMA TRIP (MORNING)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0 0.00%	0.0%
M/C	33,567 19.65%	3,315 4.76%	7,508 10.80%	3,784 10.64%	48,174 13.94%	13.9%
Car	65,281 38.22%	11,558 16.61%	44,699 64.31%	29,026 81.58%	150,564 43.58%	43.6%
PT	71,955 42.13%	54,727 78.63%	17,300 24.89%	2,768 7.78%	146,750 42.48%	42.5%
Total	170,803 49.44%	69,600 20.15%	69,507 20.12%	35,578 10.30%	345,489 100.00%	100.0%

Source: BEIP/UTDM Home Interview Survey

d) MORNING TRIP WHICH HAS ITS ORIGIN OR DESTINATION IN BMA

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	234,871 8.78%	367,399 21.53%	209,157 10.52%	56,997 4.89%	868,424 11.52%	11.5%
M/C	493,883 18.45%	152,683 8.95%	522,554 26.28%	256,664 22.00%	1,425,785 18.92%	18.9%
Car	675,266 25.23%	177,199 10.38%	682,130 34.31%	779,790 66.84%	2,314,384 30.70%	30.7%
PT	1,272,221 47.54%	1,009,375 59.14%	574,305 28.89%	73,204 6.27%	2,929,104 38.86%	38.9%
Total	2,676,241 35.50%	1,706,656 22.64%	1,988,146 26.38%	1,166,656 15.48%	7,537,696 100.00%	100.0%

Source: BEIP/UTDM Home Interview Survey

e) INTRA-BMA TRIPS (ALL DAY)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	631,539 10.9%	766,952 21.6%	481,135 11.9%	112,775 5.2%	1,992,401 12.8%	12.8%
M/C	1,056,735 18.24%	299,310 8.42%	981,123 24.28%	450,581 20.93%	2,787,749 17.94%	17.9%
Car	1,297,121 22.4%	303,490 8.5%	1,301,277 32.2%	1,268,848 58.9%	4,170,736 26.8%	26.8%
PT	2,809,052 48.5%	2,183,071 61.4%	1,276,633 31.6%	320,680 14.9%	6,589,436 42.4%	42.4%
Total	5,794,447 37.3%	3,552,823 22.9%	4,040,168 26.0%	2,152,884 13.9%	15,540,322 100.0%	100.0%

Source: BEIP/UTDM Home Interview Survey

f) FROM BMA TO OUTSIDE TRIP (ALL DAY)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	2,157 0.5%	877 0.6%	3,019 1.7%	461 0.2%	6,514 0.7%	0.7%
M/C	58,412 13.7%	5,675 3.7%	16,177 8.9%	16,263 8.7%	96,528 10.2%	10.2%
Car	148,440 34.8%	22,664 14.8%	103,835 56.9%	132,164 71.0%	407,103 43.0%	43.0%
PT	217,136 51.0%	123,521 80.9%	59,360 32.5%	37,334 20.0%	437,351 46.2%	46.2%
Total	426,145 45.0%	152,738 16.1%	182,391 19.2%	186,222 19.7%	947,496 100.0%	100.0%

Source: BEIP/UTDM Home Interview Survey

g) FROM OUTSIDE TO BMA (ALL DAY)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	2,157 0.5%	723 0.5%	3,019 1.4%	461 0.3%	6,359 0.7%	0.7%
M/C	64,398 14.9%	5,759 3.8%	19,630 9.2%	11,163 7.9%	100,950 10.7%	10.7%
Car	150,735 34.8%	24,575 16.0%	133,737 62.8%	105,872 74.7%	414,919 44.1%	44.1%
PT	215,927 49.8%	122,128 79.7%	56,439 26.5%	24,308 17.1%	418,802 44.5%	44.5%
Total	433,217 46.0%	153,185 16.3%	212,825 22.6%	141,804 15.1%	941,030 100.0%	100.0%

Source: BEIP/UTDM Home Interview Survey

h) WHOLE BMR (ALL DAY)

Mode	Purpose-Persons				TOTAL	%
	HBW	HBE	HBO	NHB		
Walk	752,663 9.3%	942,036 20.1%	538,722 9.7%	134,798 4.5%	2,368,219 11.1%	11.1%
M/C	1,644,751 20.3%	425,571 9.1%	1,431,913 25.9%	635,305 21.1%	4,137,540 19.4%	19.4%
Car	1,923,772 23.7%	431,060 9.2%	1,987,093 35.9%	1,835,642 61.1%	6,177,567 28.9%	28.9%
PT	3,784,851 46.7%	2,894,348 61.7%	1,576,403 28.5%	400,522 13.3%	8,656,125 40.6%	40.6%
Total	8,106,037 38.0%	4,693,016 22.0%	5,534,132 25.9%	3,006,266 14.1%	21,339,451 100.0%	100.0%

Source: BEIP/UTDM Home Interview Survey

Morning (starting between 6:00 - 10:00 AM) person trips according to four main purposes and by mode are presented in Table 3.3 a) - d) and daily trips in the same form are presented in Table 3.3 e) - g). Table 3.3 h) shows daily person trips of BMR.

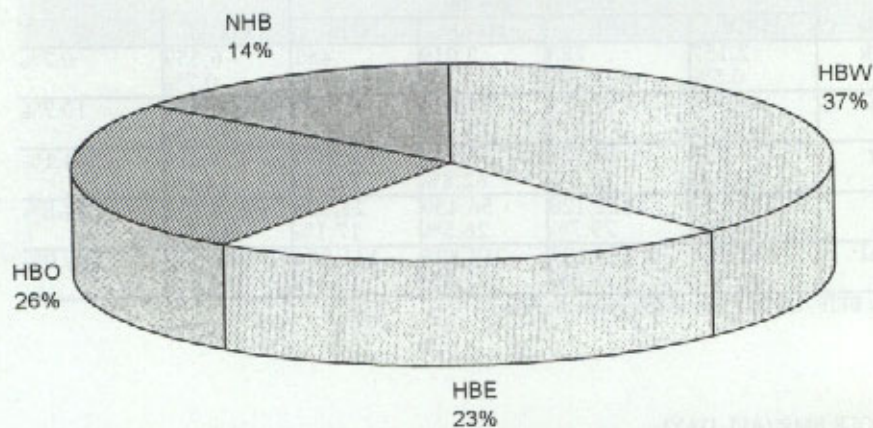
From Table 3.3 e), it is found that Daily Home-Based Work (HBW) trips are the dominant (37.3%), followed by Home-Based Education (HBE) trips (22.9%). A combination of these two types of trips equals approximately 60 % of the total daily trips.

The transport mode for daily intra-BMA trips is predominantly private transport, accounting for approximately 45% of the total (including 27% for private cars and 18% for motorcycles), followed by the public transport mode (42%).

The representative mode for HBW is the public transport mode, accounting for approximately 49% of the total HBW trips. However, approximately 40 % of HBW trips are made by private transport mode.

The mode for HBE is mainly dominated by the public transport mode, estimated at approximately 61% of the total HBE trips. The private transport users for this trip is not so significant.

Non-Home Based trips, which seem to consist chiefly of business trips, are mainly made by private cars (60 % of the total trips are that purpose). This implies that business trips are predominantly undertaken where there is no effective or quality public transport.



Source: BEIP/UTDM Home Interview Survey

Fig. 3.11 Journey Purpose of BMA Intra Trips

(2) Person Trip Length by Mode of Transport

The trip lengths of HBW and HWE trips are indicators for identifying the extent of the commuting area. Table 3.4 shows the average linked-trip distances by purpose and by representative mode for travel.

According to the UTDM travel speed survey, the average a.m. peak travel speed for cars within the Middle Ring Road was 15 km/h and 11 km/h for buses.

The estimated average trip lengths are around 10 km except the private vehicle trips for the HBW purpose. If a 10 km trip is made within 30 to 45 minutes (this time period seems to be a reasonable commuting time), the average travel speed would be increased to 13 to 20 km/h for a typical commute in Bangkok.

From the difference between the observed travel speed and a preferred travel speed of a typical commute, a target transport policy can be set forth with an increase of 2 to 9 km/h within the Middle Road System. In addition, road segments where average speeds are less than 20 km are identified as focal segments of the road system to be improved in Bangkok.

It is important to note that the private vehicle trips of HBW are rather long, at an average of approximately 15 km. The most likely explanation for this is that people with cars prefer to live in suburban areas where there are less effective public transport services. Recently, housing development in the suburbs of Bangkok is rapidly expanding, thus a significant increase of long distance HBW trips is easily anticipated in the near future.

Within this context, it is a debatable point whether it is still necessary to accelerate the radial-type road construction which would be beneficial especially to those who select the suburbs for their area of residence, or whether a ring-type arterial road at the fringe of the existing built-up area and/or secondary systems which will be beneficial for cargo and business trips should be accorded high priority for development. Housing development, which has less impact onto the existing system, should be discussed further.

Table 3.4 Average Trip Distance by Mode by BMA Residents

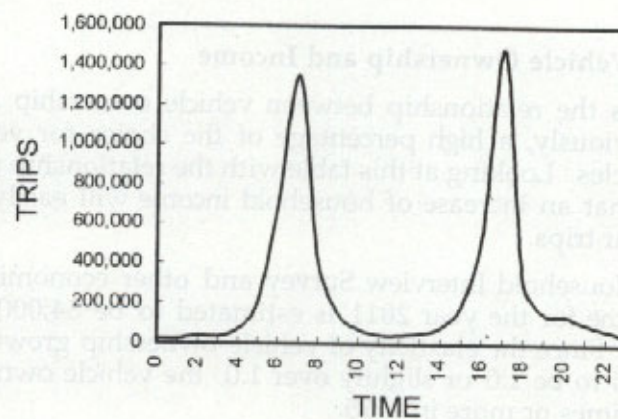
MODE	HBW	HBE	HBO	NHB
MC	11.5 km	7.7 km	6.1 km	9.7 km
CAR	15.2 km	10.5 km	9.1 km	9.7 km
Public Transport	11.5 km	9.6 km	8.4 km	13.0 km
Average	12.4 km	9.1 km	7.9 km	9.7 km

Source: BEIP/UTDM Home Interview Survey

(3) Time of Travel

Through analyses of the BEIP/UTDM Home Interview Survey, it is found that a predominant proportion (40 %) of HBW trips start during the period 6:00 a.m. to 10:00 a.m. This clearly explains the traffic congestion which is usually observed between 7:00 am and 9:00 on many of the major road segments.

A transport policy should focus on this transport demand and should seek measures to accommodate this demand from a short-term point of view.



Source: BEIP/UTDM Home Interview Survey

Fig. 3.12 Travel Starting Time of HBW Trip in BMA**(4) Travel Mode and Journey Purpose in the Morning Peak Hour**

Approximately 30% of the morning trips made between 6:00 am and 10:00 am are vehicular trips, which is estimated to be 2.3 million trips a day. According to the UTDM survey, the vehicle occupancy rate for a car ranges 1.22 to 1.48. Based on these figures, it is calculated that 390,000 - 475,000 private vehicles are started during one hour of the morning. If this figure is multiplied by 10m (space for vehicles), demand for the road system in a morning hour is calculated at 1950 km - 2375 km (two-lanes), which can be as much as 103 to 126 % of the major arterial system within BMA in terms of length (1880 = 2*990 km by OCMRT's classification).

If the present situation of job locations and transport services is given, this excessive demand should be re-allocated to a different time period in order to release the excessive dependency on the road system. For example, a staggered commuting hours system needs to be seriously discussed by each private company and

the modal shift of the use of private vehicles for HBW and HBE (approximately 11% of the total morning trips) to use of public transport should be encouraged. If all the HBW and HBE trips made by private car are shifted to the public transport system, approximately 38% of the total car trip demand can be removed from the road segments. However, there will still remain a 1209 km - 1,473 km (two-lanes) demand on the road system against the existing arterial road system in the peak hour.

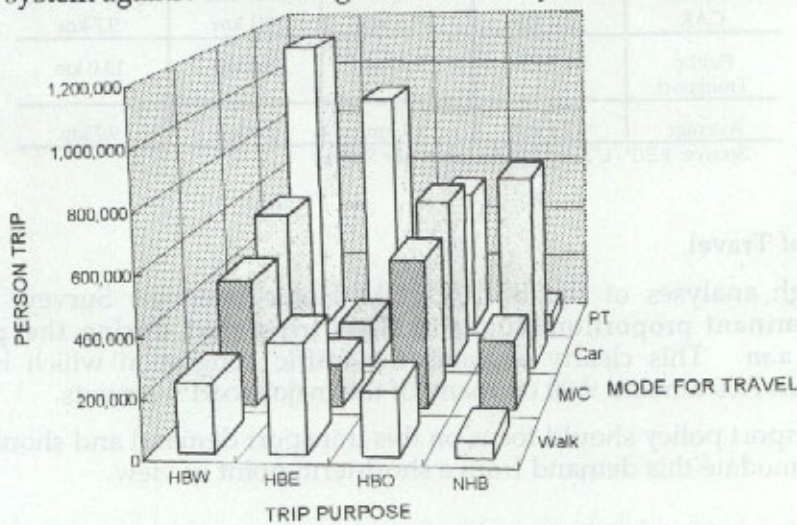


Fig. 3.13 Linked Intra BMA Trip by Mode and by Purpose

(5) Mode Choice, Vehicle Ownership and Income

Table 3.3 shows the relationship between vehicle ownership and choice of mode for transport. Obviously, a high percentage of the choice for vehicles is observed in a household vehicles. Looking at this table with the relationship presented in Fig. 3.14, it is safe to say that an increase of household income will easily lead to an increase of private vehicular trips.

Based on the Household Interview Survey and other economic indicators, an average household income for the year 2011 is estimated to be 34,000 baht / month in 1995 constant prices. Since the elasticity of vehicle ownership growth rate to income growth rate has proved to be 1.0 or slightly over 1.0, the vehicle ownership will undoubtedly increase at 1.6 times or more in 1995.

Table 3.5 Vehicle Ownership and Choice of Mode

VEHICLE OWNERSHIP	WALK	PRIVATE VEHICLE MC	CAR	PUBLIC TRANSPORT
NONE	21.3%	6.5%	2.2%	69.9%
MC	21.7%	42.1%	2.1%	34.1%
1 CAR	18.7%	9.7%	41.9%	29.8%
2+CAR	14.0%	5.9%	62.7%	17.3%

NOTE: VEHICLE OWNERSHIP

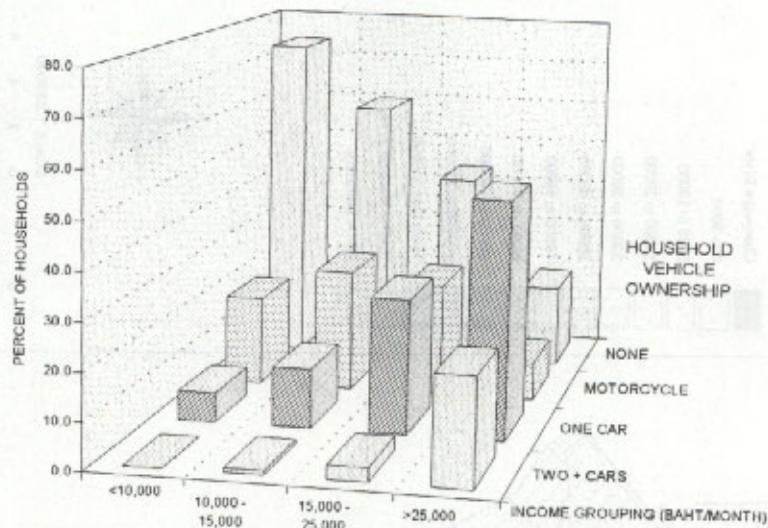
NONE : NO PRIVATE VEHICLE AVAILABLE

MC : AT LEAST ONE MOTOR CYCLE

1 CAR : ONE CAR AND POSSIBLY A MOTORCYCLE

2+CAR : TWO OR MORE CAR AND POSSIBLY A MOTORCYCLE

CAR INCLUDES VANS, SEDANS OR SIMILAR VEHICLES.



Source : BEIP / UTM Home Interview Survey

Fig. 3.14 Vehicle Ownership and Household Income

(6) Trip Generation and Attraction Density in BMA

Fig. 3.15 shows the total trip production density (all day - all purpose person trip divided by area) and Fig. 3.6 shows the total trip attraction density. The former indicates the residential areas, the latter indicates those in attraction centers such as business and commercial center and large industrial estates.

In the production density map, several high production zones can be found at Ratchathewi, Pathumwan, Bang Rak, Khlong Toei (North of Sukhumvit Rd.), Phaya Thai, and Part of Bang Sue. These trip production centers have a high population density as well.

The location of these high production zones are limited to within a radius of about 5 km from the Democracy Monument.

Attraction zones can be found at Phra Nakhon, Pom Prap Sattruphai, the old town of Samphanthawon, Bang Rak, Pathumwan and Ratchathewi. These are located in the areas east of Chao Phraya River and west of the Chalem Mahanakhon Expressway. Other notable attraction zones are observed at Din Daeng, Chatuchak, Minburi and Khlong Toei (along the Sukhumvit Rd.).

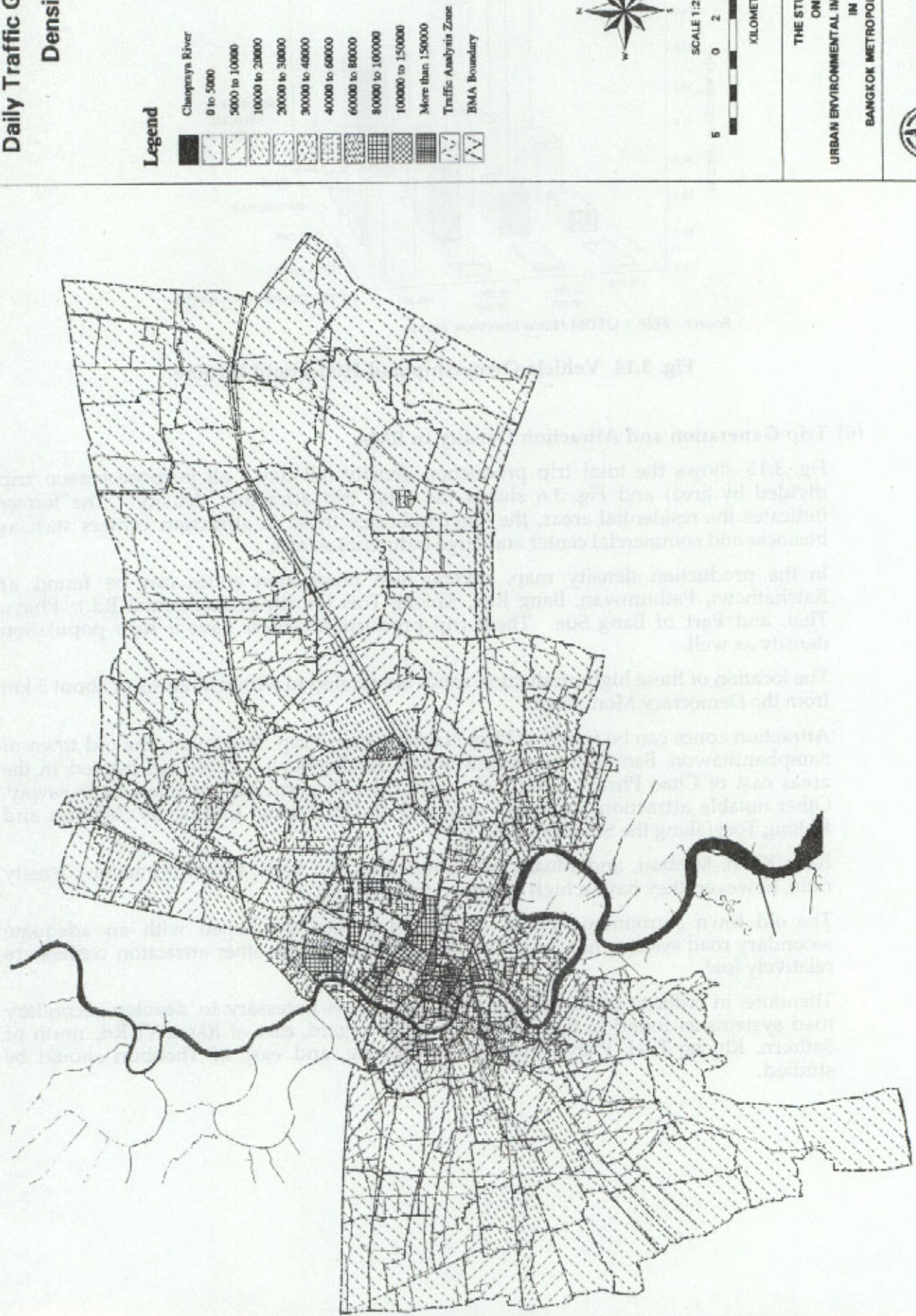
Bang Khen, Minburi, and Muang Nontaburi does not have a high attraction density ratio, however, they have a high attraction trip volume.

The old town surrounding Phara Nakhon has been developed with an adequate secondary road system, however, the road densities of the other attraction centers are relatively low.

Therefore, in order to create quality urban areas it is necessary to develop secondary road systems as found in the old town. In this regard, east of Rama VI Rd, north of Sathorn, Khlong Toei, Phaya Thai, Huai Khwang, and east of Thonburi should be studied.

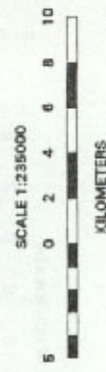
Fig. 3.15

Daily Traffic Generation Density



Legend

- Chao Phraya River
- 0 to 5000
- 5000 to 10000
- 10000 to 20000
- 20000 to 30000
- 30000 to 40000
- 40000 to 60000
- 60000 to 80000
- 80000 to 100000
- 100000 to 150000
- More than 150000
- Traffic Analysis Zone
- BMA Boundary



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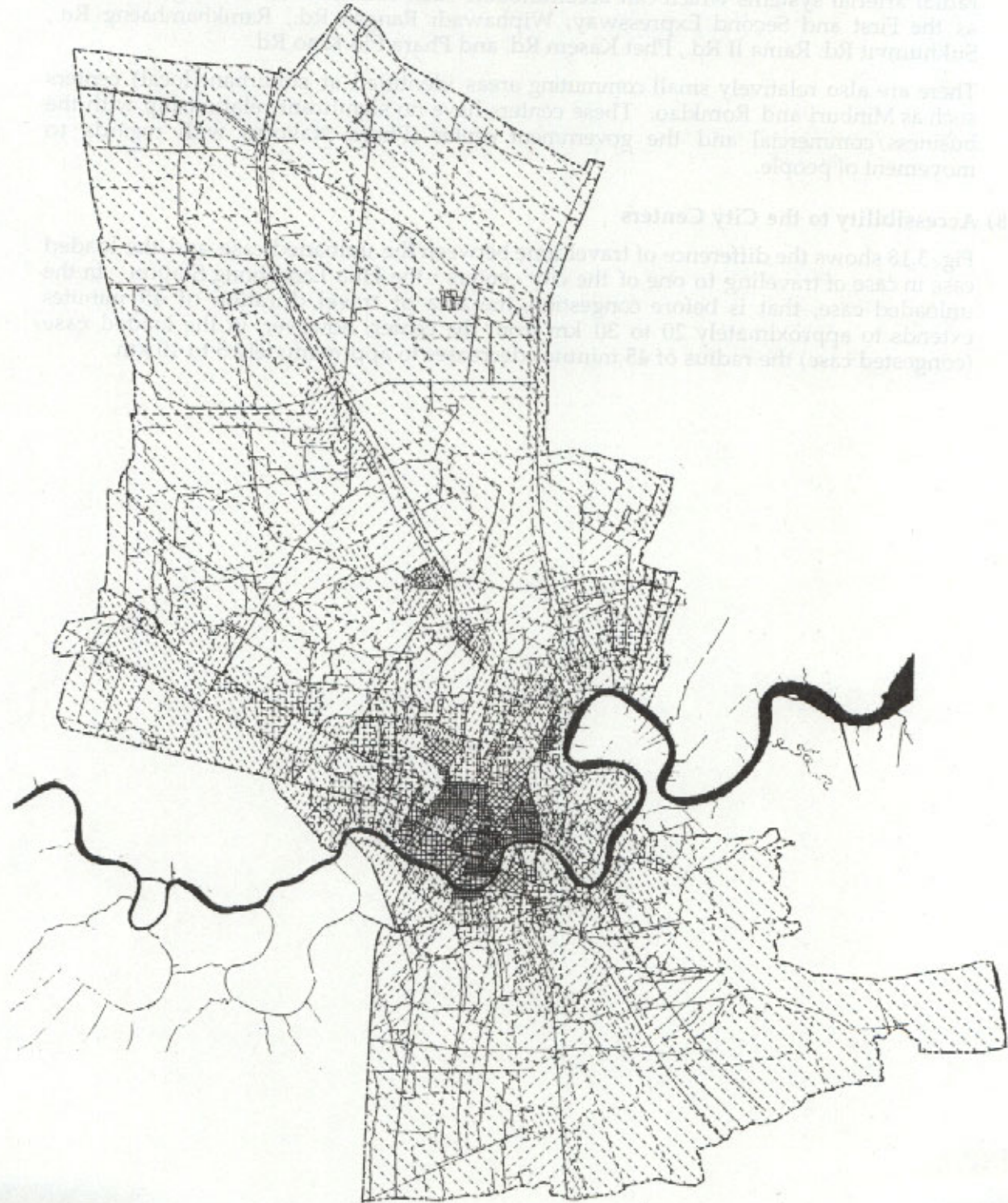
BANGKOK METROPOLITAN ADMINISTRATION
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Fig. 3.16

Daily Traffic Attraction Density



Legend

- Chao Phraya River
- 0 to 5000
- 5000 to 10000
- 10000 to 20000
- 20000 to 30000
- 30000 to 40000
- 40000 to 60000
- 60000 to 80000
- 80000 to 100000
- 100000 to 150000
- More than 150000
- Traffic Analysis Zone
- BMA Boundary



SCALE 1:2395000
 0 2 4 6 8 10
 KILOMETERS

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(7) Trip Attraction Centers and Trip Patterns

Computing the "Daytime - Nighttime Population Ratio Distribution" as shown in Fig. 3.16 and Fig. 3.17, which indicates the area distribution of trip attraction density, several relatively major attraction centers can be observed in Bangkok. In Fig. 3.7, the major attraction trips (70 % of the top major attraction trips) entering each attraction center are plotted. Through these diagrams, major commuting attraction centers are identified.

The Silom area, the World Trade Center, and such places known as business/commercial centers have relatively large commuting areas. These commuting areas are extended notably northward with a radius of approximately 20 km. There are several radial arterial systems which can accommodate such extended commuting areas such as the First and Second Expressway, Wiphawadi Rangsit Rd., Ramkhamhaeng Rd., Sukhumvit Rd. Rama II Rd., Phet Kasem Rd. and Phara Pin Klao Rd.

There are also relatively small commuting areas identified at suburban (local) centers such as Minburi and Romklao. These centers have no significant relationship with the business/commercial and the government center (Phara Nakorn) with regards to movement of people.

(8) Accessibility to the City Centers

Fig. 3.18 shows the difference of travel time between the unloaded case and the loaded case in case of traveling to one of the city centers : the Hua Lamphong Station. In the unloaded case, that is before congestion, the area of travel duration of 45 minutes extends to approximately 20 to 30 km from the center, however, in the loaded case (congested case) the radius of 45 minutes decreases to approximately 5 to 10 km.

Center Analysis

Legend

-  Chao Phraya River
-  Rank 1
-  Rank 2
-  Rank 3
-  Rank 4
-  BMA Boundary
-  District Boundary
-  Subdistrict Boundary



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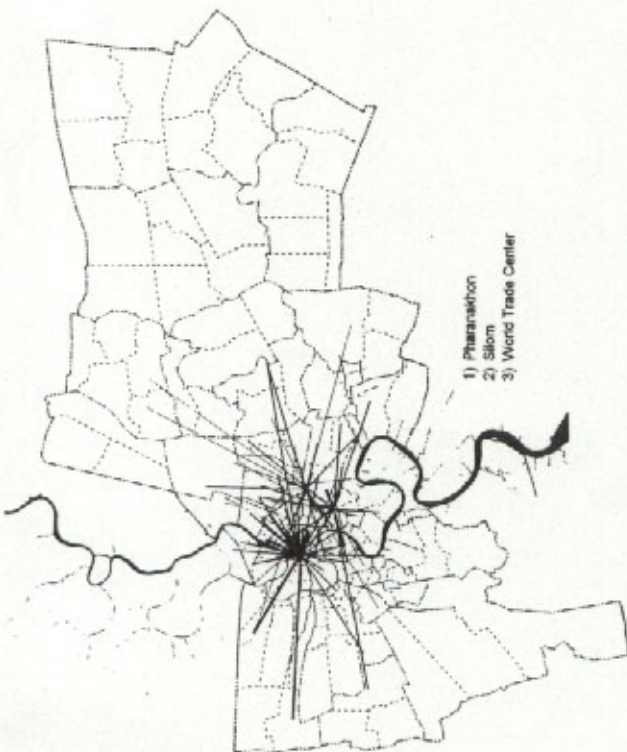
MAHABDI METROPOLITAN ADMINISTRATION (BMA)
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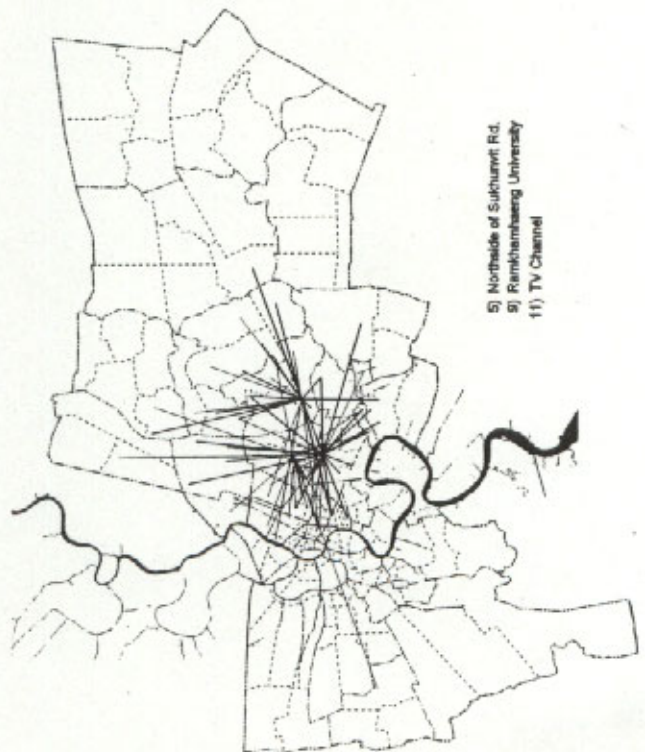
JICA
JAPAN INTERNATIONAL COOPERATION AGENCY

ACCESSIBILITY TO ATTRACTION CENTERS		
Centers	Average Distance of Attraction Trips	Accessibility Index
1) Phanarajon	10.8	1.73
2) Silom	9.3	2.14
3) World Trade Center	11.0	1.82
4) Khlong Toey	10.5	1.86
5) Northside of Sukhumvit Rd.	12.3	1.61
6) Chatuchak	18.9	1.57
7) Kasetsart University	10.8	1.80
8) Don Muang Airport	17.3	1.71
9) Ramkhamhaeng University	14.6	1.77
10) Bangkok Oil Refinery	8.8	2.16
11) TV Channel	12.4	1.51
12) Minburi	10.1	1.57
13) Romklao Industrial Estate	17.0	1.23

NOTE: Accessibility Index = Travel Time of Loaded / Travel Time of Unloaded Road



- 1) Phanarajon
- 2) Silom
- 3) World Trade Center

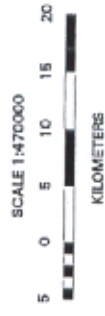


- 5) Northside of Sukhumvit Rd.
- 6) Chatuchak
- 7) Kasetsart University
- 8) Don Muang Airport
- 9) Ramkhamhaeng University
- 10) Bangkok Oil Refinery
- 11) TV Channel



- 4) Khlong Toey
- 5) Northside of Sukhumvit Rd.
- 6) Chatuchak
- 7) Kasetsart University
- 8) Don Muang Airport
- 9) Ramkhamhaeng University
- 10) Bangkok Oil Refinery
- 11) TV Channel
- 12) Minburi
- 13) Romklao Industrial Estate

Transport Accessibility



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(9) Level of Congestion

Road congestion levels were simulated with the present road network, which is approximately 1,700 km long in the BMA area, including though-passable "Soi" as well as major roads.

The simulation result indicated that approximately 29%, or 500 km of roads are facing serious traffic congestion in the morning peak hours. Those congested roads are distributed within the 10 km radius areas from the Bangkok central area. Thus, all commuters whose work places are located in the central area cannot escape the severe traffic congestion every day.

Table 3.6 Level of Congestion of BMA Road System in the Morning Peak Hour

Level of Congestion	Share
1. Saturated	13.2 %
2. Heavily Congested	15.7 %
3. Congested	9.4 %
4. Acceptable	12.6 %
5. Under Capacity	49.1 %
Total Simulated Road	1732 km

Source : BEIP simulation result (CASE 1)

(10) Major Transport Corridor







Certain trip characteristics of 5 major transport corridors which form a radial pattern of the Bangkok Metropolis, were examined, as shown in Fig. 3.20 and Table 3.7. The following are major findings from this analysis:

- Many of the longest car trips appear on Phahon Yothin Rd. running along the northern corridor and Lat Phrao Rd. which is used for in-flow trips from the eastern area. However, bus trips using the same roads have relatively short trip lengths.
- These two major roads are well-known to be heavily congested roads. One of the reasons is the fact that many considerably long car trips are mixed with short trips. Therefore, provision of mass transportation systems in the northern and eastern corridors to absorb these long car trips may bring about an effective solution with regard to the present heavy traffic congestion.
- Looking at the trip length distribution of other corridors, most of the car trips fall within the range of 10-20 km.

Fig. 3-19

Level of Road Traffic Congestion (case 1)

Legend

-  Provincial Boundary
-  Saturated
-  Heavily Congested
-  Congested
-  Acceptable
-  Under Capacity



SCALE 1:250000
0 2 4 6 8 10
KILOMETERS

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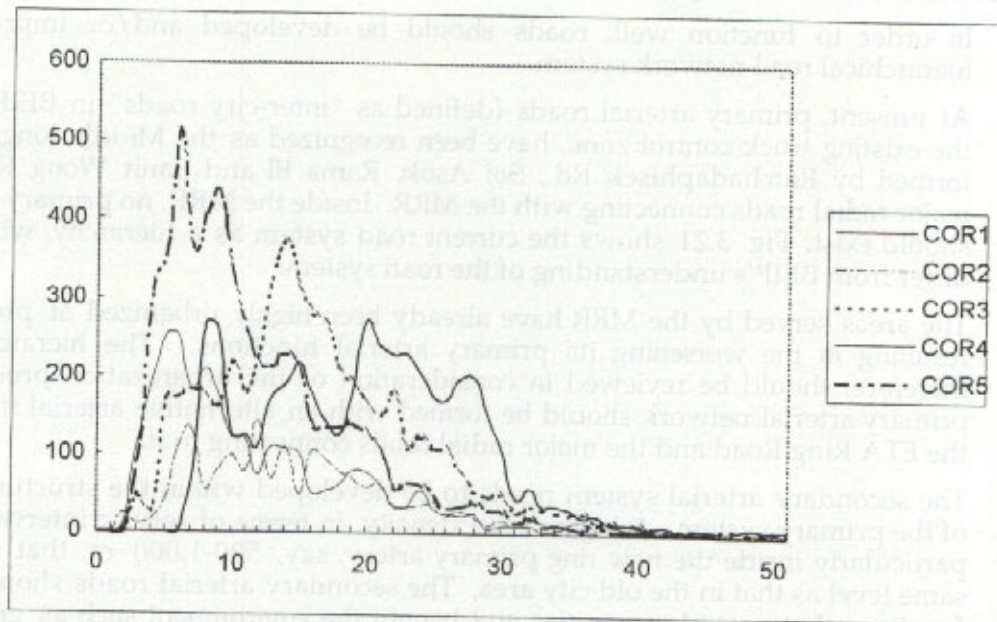


Fig. 3.20 Frequency of Vehicle Trips (PCU) by Distances

Table 3.7 PCU Trips crossing through the Major Corridor by Trip Length in Morning Peak Hour

	COR 1		COR 2		COR 3		COR 4		COR 5	
0-5 km	-	0.0%	47	1.5%	73	1.8%	309	7.9%	402	8.1%
5-10 km	597	18.6%	418	13.2%	867	21.0%	1,078	27.6%	2,084	41.9%
10-15 km	720	22.5%	502	15.8%	1,317	32.0%	534	13.7%	1,244	25.0%
15-20 km	85	2.7%	841	26.5%	397	9.6%	1,258	32.2%	348	7.0%
20-25 km	1,172	36.6%	229	7.2%	727	17.6%	266	6.8%	428	8.6%
25-30 km	135	4.2%	894	28.2%	123	3.0%	400	10.2%	110	2.2%
30-35 km	291	9.1%	66	2.1%	179	4.3%	34	0.9%	95	1.9%
35-	205	6.4%	174	5.5%	438	10.6%	30	0.8%	267	5.4%
TOTAL	3,205	100.0%	3,171	100.0%	4,121	100.0%	3,909	100.0%	4,978	100.0%
AVG TRIP LENGTH	19.6 km		15.4 km		16.2 km		11.5 km		11.9 km	

NOTE: NUMBER OF TRIPS ARE SIMULATED INBOUND (ONE-WAY) VEHICULAR TRIPS IN PCU.

COR1 : PHAHON YOTHIN CORRIDOR NEAR RAM INTHRA RD.

COR2 : LAT PHRAO CORRIDOR

COR3 : RAMA IV CORRIDOR

COR4 : PINKLAO CORRIDOR (PHRA PIN KLAO BRIDGE)

COR5 : THONBURI CORRIDOR (CHAO TAKSIN BRIDGE)

(11) Hierarchical Road System

In order to function well, roads should be developed and/or improved with a hierarchical road network system.

At present, primary arterial roads (defined as "inter-city roads" in BEIP), in view of the existing truck control zone, have been recognized as the Middle Ring Road (MRR) formed by Ratchadaphisek Rd., Soi Asok, Rama III and Sanit Wong Rd. and some major radial roads connecting with the MRR. Inside the MRR, no primary arterial roads should exist. Fig. 3.21 shows the current road system as a hierarchy, which, however, differ from BEIP's understanding of the road system.

The areas served by the MRR have already been highly urbanized at present, thereby resulting in the worsening its primary arterial functions. The hierarchical system, therefore, should be reviewed in consideration of the urbanization process. A new primary arterial network should be formed with an alternative arterial ring road along the ETA Ring Road and the major radial roads connecting to it.

The secondary arterial system needs to be developed within the structural framework of the primary system. A higher road density, in terms of service intervals, is required particularly inside the new ring primary artery, say, 500-1,000 m, that is, almost the same level as that in the old city area. The secondary arterial roads should have urban functions that provide amenities and benefit the environment such as green and open spaces, symbolic monuments and comfortable pedestrian paths as well as inter-modal facilities among public transportation modes.

3.4 Urban Utility and Sanitary Services

(1) Water Supply

Most of the residents in Bangkok obtain water from the Chao Phraya River through the MWA water supply system and through small-scale groundwater supply systems in the suburban area. In the dry season, the river flow decreases to a minimum flow 100 cm which causes of a raw water intake problem due to the flow rate, and causes sea-water intrusion. The master plan of MWA formulated for 2017 plans to withdraw approximately 60 cm of raw water from the Chao Phraya River to utilize the river water to the maximum extent so as to keep the maintenance flow in the lower stream reaches.

Eighty (80) units of deep wells owned by MWA have a yielding capacity at 240,000 cm³/day and the deep wells owned by the private sectors are estimated to yield more or less one million cubic meters per day. These deep wells cause the land subsidence problem in urban areas.

Raw water is well-treated within the drinking water quality standards. However, turbid water from taps and water contamination in negative pressure zones, low distribution pressure, water leakage, etc. are matters for concern with regard to improvement of the water distribution system in order to provide safe and sufficient water constantly to the entire service area.

(2) Drainage and Sewerage

The Si Phraya Waste Water Treatment Plant started operation at the end of 1995 with the inflow rate of 8,000 m³/day approximately. The plant is planned to treat up to 30,000 m³/day of waste water after completion of sewage collection and interceptor mains. In addition, the on-going six sewage projects plan to treat 972,000 m³/day of waste water which is about one third of the sewage amount to be generated in 2011. These sewage projects tend to be delayed with regard to developing initial practical sewage treatment facilities for Bangkok. Meanwhile, waste water is running into the khlongs and the rivers every day which contribute to the water pollution problem.

Fig. 3.21
1995 Road Network

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LEGEND

- Primary Arterial Road
- Secondary Arterial Road
- Tollway

NOTE : Road classification follows
TPPP definition



The master plan prepared by PCD in 1993 formulates the projects of 24 sewage zones for Bangkok that can treat up to 2.7 million m³/day of waste water or appropriately 80 % of the sewage amount to be generated in 2011. Urban growth in the recent years and the future will change the amount and sources of waste water generation which will necessitate a review of the sewage master plan in coordination with the General Plan of Bangkok.

(3) Solid Waste

Solid waste collected from residential areas and business activities amounted to approximately 6,500 tons daily in 1995. Currently, the compost plant in On Nut treats 1,000 tons of solid waste, producing 300 tons of compost, and rejecting approximately 700 tons every day. However, most of the solid waste is disposed by sanitary landfill sites located in Nakhon Phatom and in Lat Krabang under contracts with the private waste management companies.

The existing landfill sites are filled with a large amount of garbage and there is no space available to receive more solid waste any more. BMA must acquire own landfill sites urgently. As basic rule of the society, possible sources of pollution such as waste water and/or solid waste must be treated at the place of generation.

Reduction of the solid waste volume for disposal can prolong the life of landfill sites. Incineration of solid waste is the most effective method for realizing reduction of solid waste volume as the waste is reduced to the minimum, and the ashes can be effectively disposed of. Existing incineration plant projects should be completed as soon as possible to save Bangkok from environmental deterioration.

The per capita solid waste generation rate per day increased annually from 657 grams in 1990 to 805 grams in 1995, that is, 4 to 5 % annually. At this rate, per capita solid waste generation will reach 1.5 kg per capita per day in 2011. The solid waste generation rate can be reduced through recycling and with the participation of communities, enterprises, and the authorities concerned.

3.5 Residential Environment

(1) Green Areas and Open Spaces

According to the existing land use analysis, parks occupy only 10 Km² or 0.6 % of the total area. This is equivalent to 1.25 m² of available park space for each person. This figure is much lower compared to other large cities in the world (for example, Tokyo has 4 m²/person of parks). In terms of the spatial distribution, the central area has relatively large area of parks and open spaces, while other areas have smaller areas of parks and open spaces. As for public parks, Bangkok has only 26 major public parks.

With regard to open spaces, approximately 30 % of the total area of Bangkok is built-up. The built-up areas spread along major transport corridors, resulting little open spaces remaining in the central area. Suburban areas have wider open spaces, nevertheless, residential and industrial development is rapidly occurring.

(2) Accessibility to Public Community Services

Table 3.8 shows some urban community facilities such as a library and youth center. With regard to the library, it is implied that recent urbanization is not concomitant with adequate consideration for urban amenities. Suburban areas still have large areas with less accessibility to hospitals.

Table 3.8 Availability of Selected Community Services by District

	Libraries	Parks (sq.m)			Youth Center	Park per Person (sq.m/person)	
		Public Park	Open Space	Play Ground			
Pra Nakhon	1	36,800	158,382	240	195,422	2	2.13
Khlong Toei					0		0.00
Klong San	1		892		892		0.01
Chatuchak		304,000	94,916		398,916		2.17
Chom Thong	1				0		0.00
Don Muang					0		0.00
Dusit			49,860	80	49,940	1	0.28
Taling Chan	1			420	420	1	0.00
Thon Buri			77,720	280	78,000	1	0.34
Bangkok Noi			51,300	160	51,460	2	0.29
Bangkok Yai	1		100	40	140	1	0.00
Bang Kapi		560,000			560,000		2.41
Bang Khun Thian					0	1	0.00
Bang Khen	1			320	320	1	0.00
Bang Kho Laem					0		0.00
Bang Sue			1,200		1,200	1	0.01
Bang Phlat					0		0.00
Bang Rak			1,056	40	1,096	1	0.01
Bung Kum					0		0.00
Pathum Wan	2	576,000	3,100	3,600	582,700	3	4.72
Prawet	1				0	1	0.00
Pom Prap			4,100	120	4,220	1	0.05
Phaya Thai	1		680		680		0.00
Phra Khanong		800,000	1,300	940	802,240	3	3.99
Phasi Charoen	1				0		0.00
Min Buri					0	1	0.00
Yan Nawa			3,612	300	3,912	1	0.04
Ratchthewi			25,571		25,571		0.23
Rat Burana		101,280			101,280	1	0.61
Lat Krabang		80,000			80,000	1	1.04
Lat Phrao	1				0		0.00
Sam Phanthawong			1,950		1,950		0.04
Sathon					0		0.00
Nong Khaem					0	1	0.00
Nong Chok		56,800			56,800		0.89
Huai Khwang			34,597	560	35,157	1	0.14
Din Daeng					0		
Suan Luang					0		
Bangkok Total	12	2,514,880	510,335	7,100	3,032,315	26	0.55

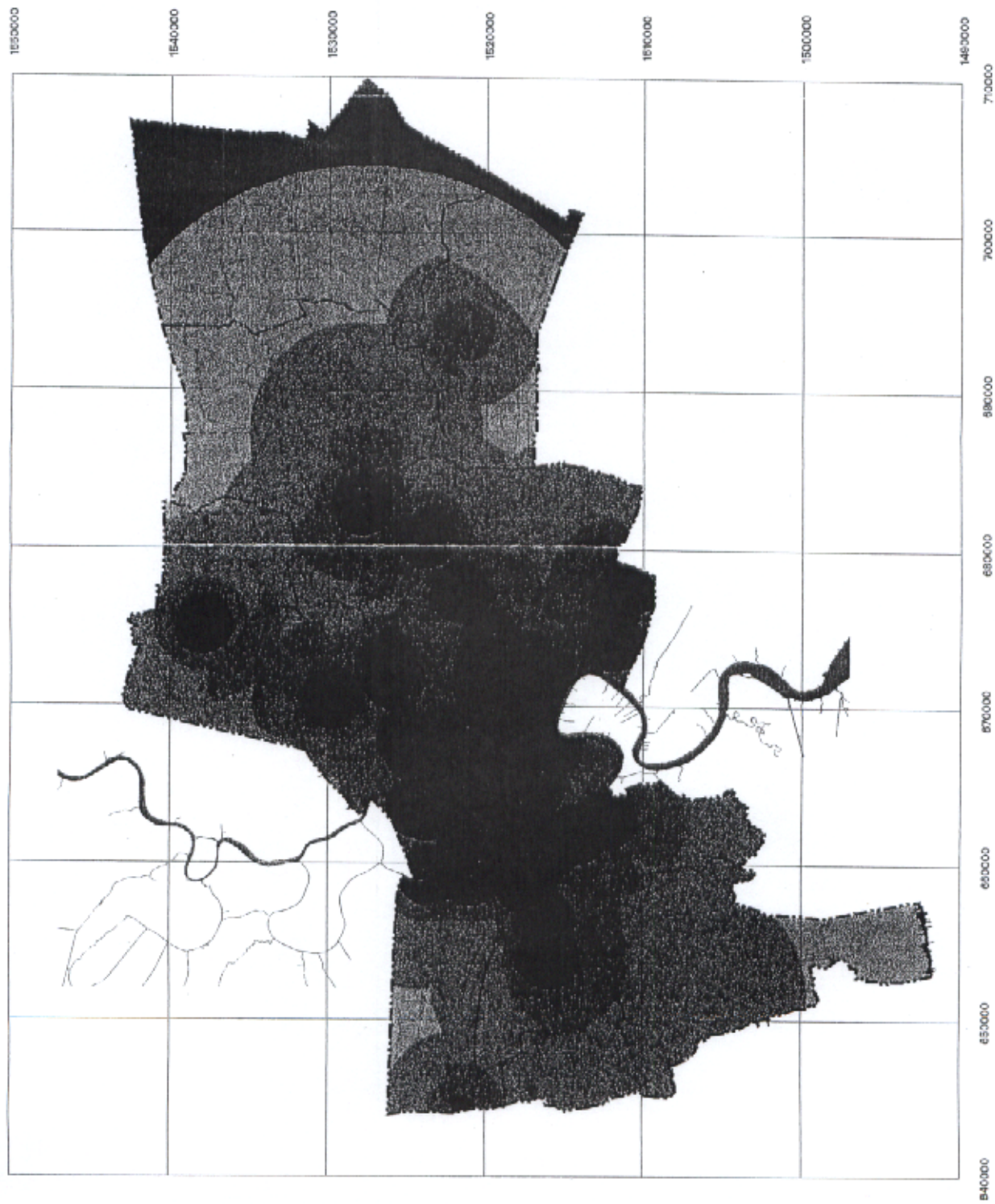
Source: Statistical Profile of BMA, 1993

(3) Accessibility to Shopping Centers

Convenience is a large factor for land potential as well as accessibility and natural conditions. Proximity to the commercial facilities such as department stores and shopping centers is a typical indicator in terms of convenience. Fig. 3.22 shows accessibility to commercial areas. The areas with suitable accessibility are spread along major arterial roads, but newly developed suburban areas such as Bang Kapi, Bung Kum and Prawet districts does not have sufficient accessibility to commercial areas.

Fig. 3.22

Accessibility to Commercial Areas



Legend

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



SCALE 1:275000



KILOMETERS
UTM Zone 47

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3.6 An Overall Assessment (Comprehensive Environmental Problem Maps)

(1) Methodology for the Environmental Assessment

The Study Team has started to collect existing data regarding the urban environment, focusing especially on urban development, urban transport, air pollution, water pollution and solid waste. To supplement the data collected, the Study Team conducted field surveys such as the FAR Survey, the Home Interview Survey, the Special Generation Survey, the Water Quality Test and the Ambient Air Quality Test. Simulations are carried out to calibrate existing conditions for urbanized areas, traffic and air pollution. These data are then integrated into GIS system to identify environmental problem areas by overlaying several analyzed and simulated data. The flow chart of the analyses is shown in Fig. 3.23.

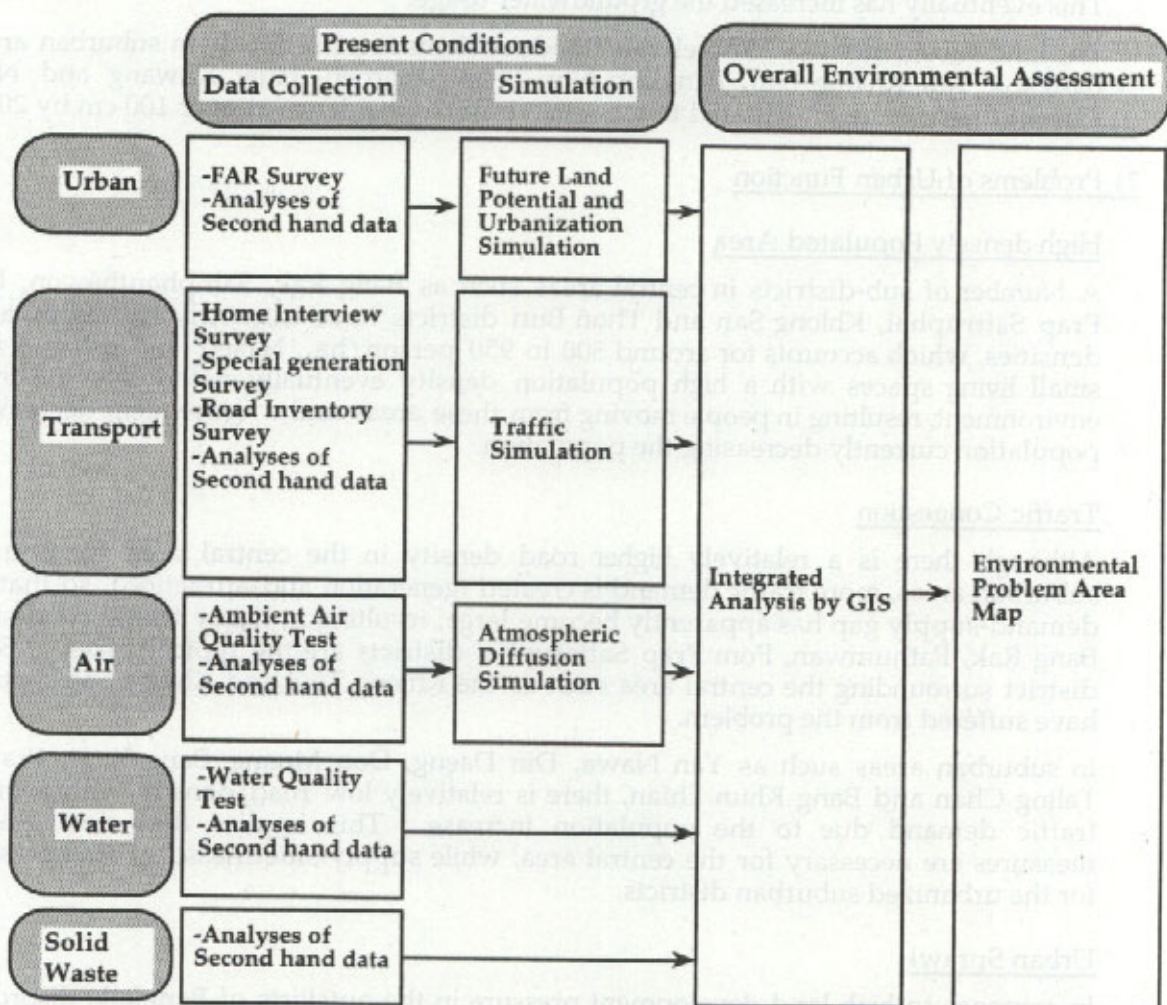


Fig. 3.23 Overall Flow of Urban Environmental Assessment

(2) Identification of Urban Environmental Problems

1) Problems on Natural Condition

Flood

Flooding is the most serious problem caused by natural conditions in Bangkok. It heavily depends on natural vulnerability. Once Bangkok suffers from floods, it is difficult to drain water away due to the low alluvium flat plane of the Chao Phraya River Delta. The low land in Phra Khanong, Lat Phrao, Suan Luang, Bang Kapi, Khlong Toei, Huai Khwang, Jomtong and Prawet districts as well as the areas along the Chao Phraya River and outside King's dike are identified as serious inundation problem areas.

Land Subsidence

Rapid urbanization, modernization and industrialization are all demanding more water, however the adequate water supply service can not keep up with the demand. This eventually has increased the groundwater usage.

The land subsidence would accelerate flood problems more seriously in suburban areas. Bangkok Yai, Khlong San, Bangkok Noi, Phasi Charoen, Huai Khwang and Nong Khaem districts are anticipated to face severe land subsidence at over 100 cm by 2017.

2) Problems of Urban Function

High densely Populated Area

A Number of sub-districts in central areas such as Bang Rak, Samphanthawon, Pom Prap Sattaruphai, Khlong San and Thon Buri districts have extremely high population densities, which accounts for around 800 to 950 person/ha. Mixed land use and very small living spaces with a high population density eventually deteriorate the living environment, resulting in people moving from these areas and a consequent decrease in population currently decreasing the population.

Traffic Congestion

Although there is a relatively higher road density in the central area than in the suburban areas, more traffic demand is created (generation and attraction), so that the demand-supply gap has apparently become large, resulting in heavy traffic congestion. Bang Rak, Pathumwan, Pom Prap Sattaruphai districts are the typical cases. Some district surrounding the central area such as the Khlong Toei and Khlong San districts have suffered from the problem.

In suburban areas such as Yan Nawa, Din Daeng, Don Muang, Bang Kapi, Prawet, Taling Chan and Bang Khun Thian, there is relatively low road density with a higher traffic demand due to the population increase. This implies that demand-side measures are necessary for the central area, while supply-side measures are necessary for the urbanized suburban districts.

Urban Sprawl

In response to high land development pressure in the outskirts of Bangkok, disorderly urbanization or urban sprawl is rapidly taking place. It is mainly observed in the Bang Khen, Bang Kapi, Suan Luang, Minburi, Taling Chan, Rat Burana, Phasi Charoen and Bang Khun Thian districts. This generates low-standard living environmental areas without sufficient infrastructure and will consequently necessitate excessive public investment afterwards. To avoid such urban sprawl, it is necessary to control land development projects in these areas.

Declining Traditional Stocks and Green Areas in the Inner City

Major landmarks representing the traditional Thai urban landscape such as the khlong network, wooden two story shop houses and Thai traditional architecture, have been replaced by roads and modern buildings. Only the Ratanakosin area maintains the invaluable traditional urban landscape. Green areas and open spaces are also disappearing and only 10 Km² or 0.6 % of the total area remains. This is equivalent to 1.25 m² per person. In the built-up areas, there are few large green areas. Green areas are scattered and can be found mostly on private property.

3) Environmental Loads caused by Urban Activities

Air Pollution

Most of the built-up areas suffer from air pollution. Among the pollutants, the most critical situation is the concentrations of TSP, followed by NO₂. Concentrations of CO and SO₂ are also problematic but are relatively less serious than TSP and NO₂. Dust from construction sites is considered to be one of the major sources of TSP together with vehicle emission gas.

Water Pollution

Due to the delay of development of sewerage systems in Bangkok, waste water is running into the khlongs and rivers, resulting in water pollution problems. Aquatic life along the khlongs is threatened in the central part of the city. Khlong contaminated water areas extend to a considerably wider area, from the Khlong Lad Phrao to the Khlong Phra Khanong line to the west on the Bangkok side and from Khlong Bangkok Yai to Chom Thong and Rat Burana Districts line to the east on the Thon Buri side.

However, such water contamination is slightly being improved in some khlongs in recent years because of efforts on inducing of introducing dilution water.

Solid Waste

At the rate of the current increase, per capita solid waste generation rate will reach at 1.5 kg per capita per day in 2011. This will create more serious problems for solid waste management.

As for the solid waste collection, the area with insufficient garbage collection capacity will increase in the suburban areas. As for disposal, it is an urgent issue to make available long-life final disposal sites within the BMA jurisdiction. Since environmentally-sound solid waste disposal is strongly required, BMA must make much effort to reduce the waste volume by encouraging recycling and by introducing more intermediate treatment facilities.

(3) Distribution Pattern of Urban Environmental Problems/ Difficulties

Urban environmental problems are spread over Bangkok. Air pollution, water pollution, traffic congestion and high-population density can be found in the central area. On the other hand, in the suburban areas, flooding, land subsidence, water pollution, the overload of solid waste collection and urban sprawl are serious urban environmental problems. Table 3.9 and Fig. 3.24 show the conceptual distribution of urban environmental problems.

Table 3.9 Distribution of Urban Environmental Problems

	Input (Urban Anabolism)		Urban Function			Output (Urban Catabolism)		
	Natural Conditions	Water Supply	Current Urban Activities	Housing and Quality of Living	Traffic and Transport	Air Pollution	Water Pollution	Garbage
Central Area	Chao Praya Riverside at Thonburi side is dangerous in terms of inundation.	Water supply covers whole area.	Land integration for commercial and business buildings Mixed with population increased and decreased areas	High densely inhabited.	Although road density is relatively high, roads are very congested with much traffic demand.	TSP and NOx are not satisfied by Thai environmental standard in most area.	Less problem at this moment.	Less problem
Surrounding Area of Central Area	Suburban residential area is dangerous in terms of inundation in case heavy rain.	Water supply covers whole area.	Land integration for both commercial and residential buildings. Mixed with population increased and decreased areas	High densely inhabited. Parks and greens are not adequately provided.	Low roads density causes traffic congestion and unsatisfied accessibility of large vehicle like emergency car.	TSP and NOx are not satisfied by Thai environmental standard in most area.	Khlong water is polluted without sewerage system.	Less problem
Urbanized Suburban Residential Area	Suburban residential area is dangerous in terms of inundation in case heavy rain.	Water supply covers almost whole area.	Expansion of residential areas Population is increased.	Parks and greens are not adequately provided.	Certain areas receive more time loss from traffic congestion. There are several low road density areas.	Less Problem at this moment	Khlong water is polluted without sewerage. It would be getting worse with rapid population growth.	Since population is rapidly increased, collection capacity is not meet with garbage generation.
Suburban Area to be Urbanized	Outside areas of King's dike are not protected from flood.	Extension plan of water supply has prepared, accordingly, timing of project is a key issue. Use of well water is a one factor of ground subsidence.	Land subdivision development Population is increased.	Urban facilities such as commercial facilities, school, hospital are not adequately provided.	Less problem at this moment.	Less Problem at this moment	Khlong water will be deteriorated since population is now increasing without sewerage.	Less problem

Urban Environmental Problems Map

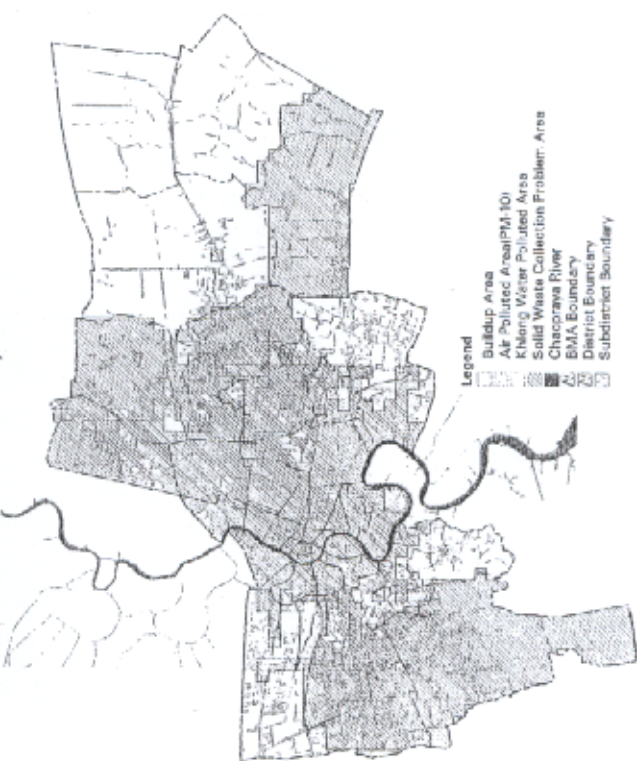
Problem Areas on Living Environment



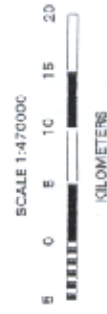
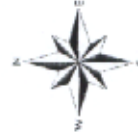
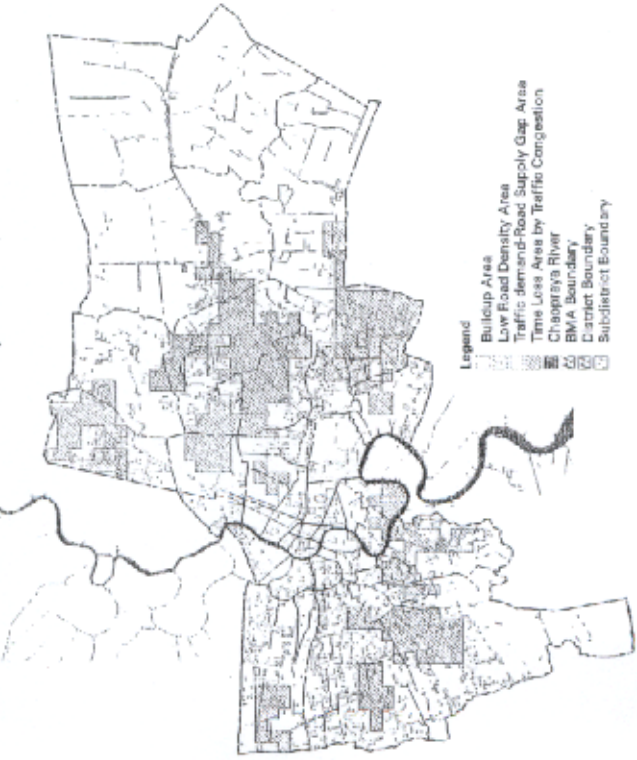
Problem Areas on Natural Conditions



Problem Areas on Air Quality and Solid Waste



Problem Areas on Urban Transport



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**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.

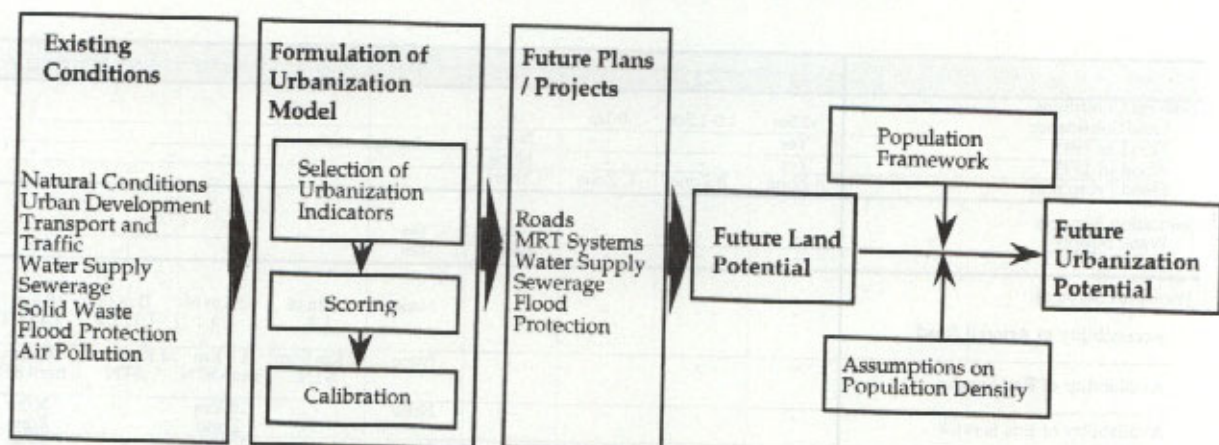


Fig. 4.1 Flowchart for Urban Land Development Potential Analyses

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

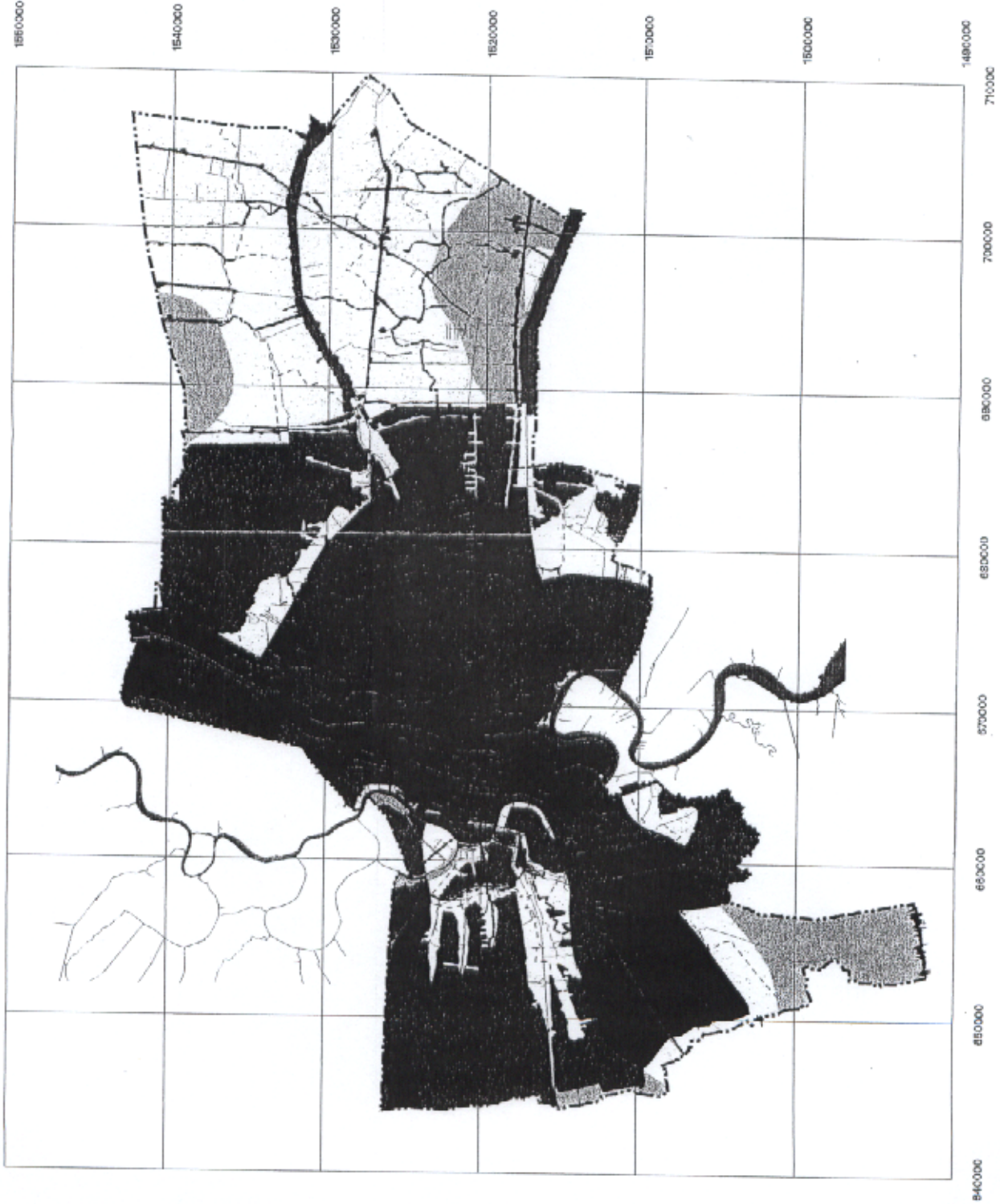
(2) Scoring System

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					1	2	3	4	5
	-3	-2	-1	0						
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	

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



SCALE 1:275000
0 2 4 6 8 10
KILOMETERS

UTM Zone 47

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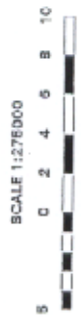
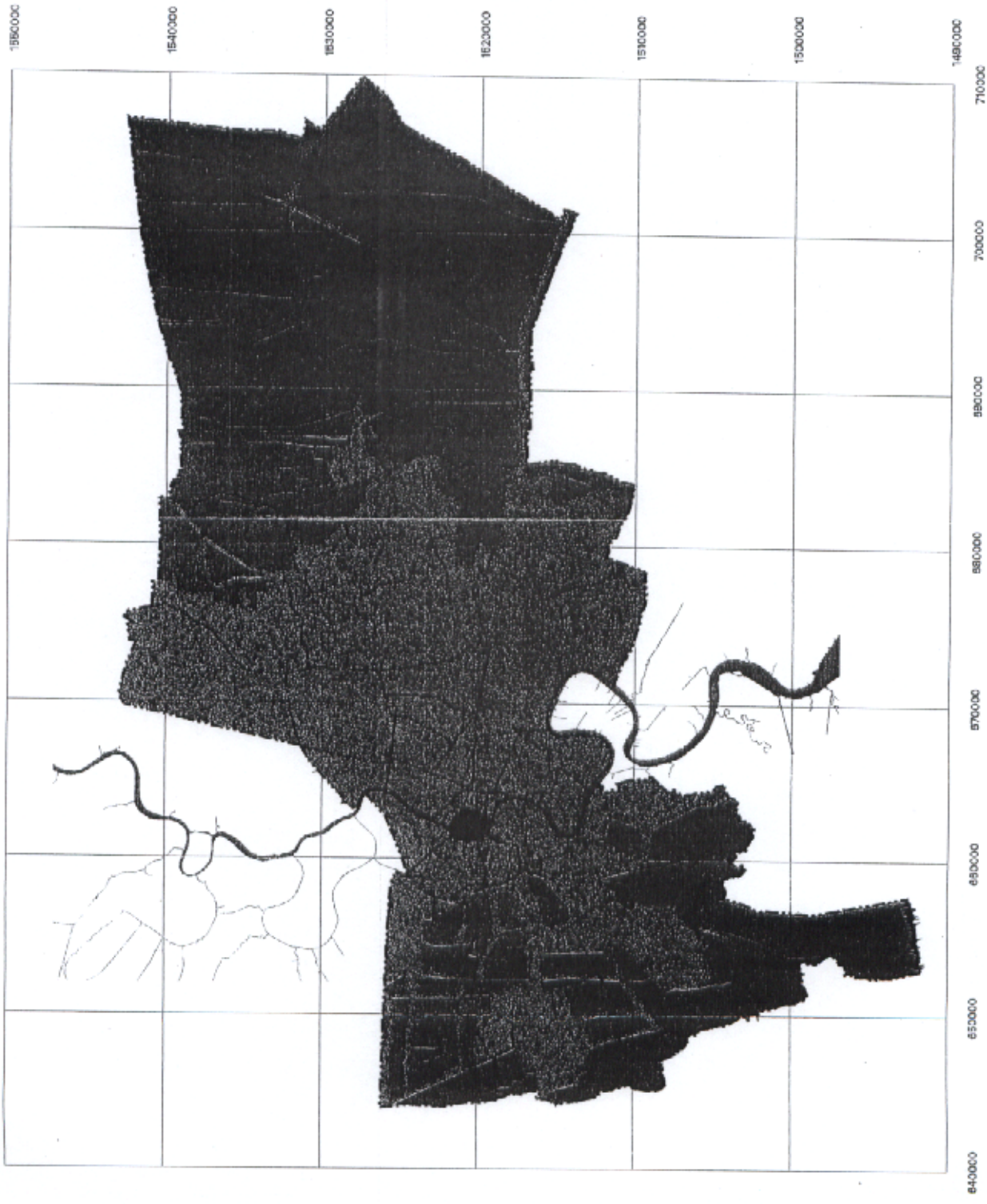


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Land Potential Evaluation Sanitation Services

Legend

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



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Fig. 4.4

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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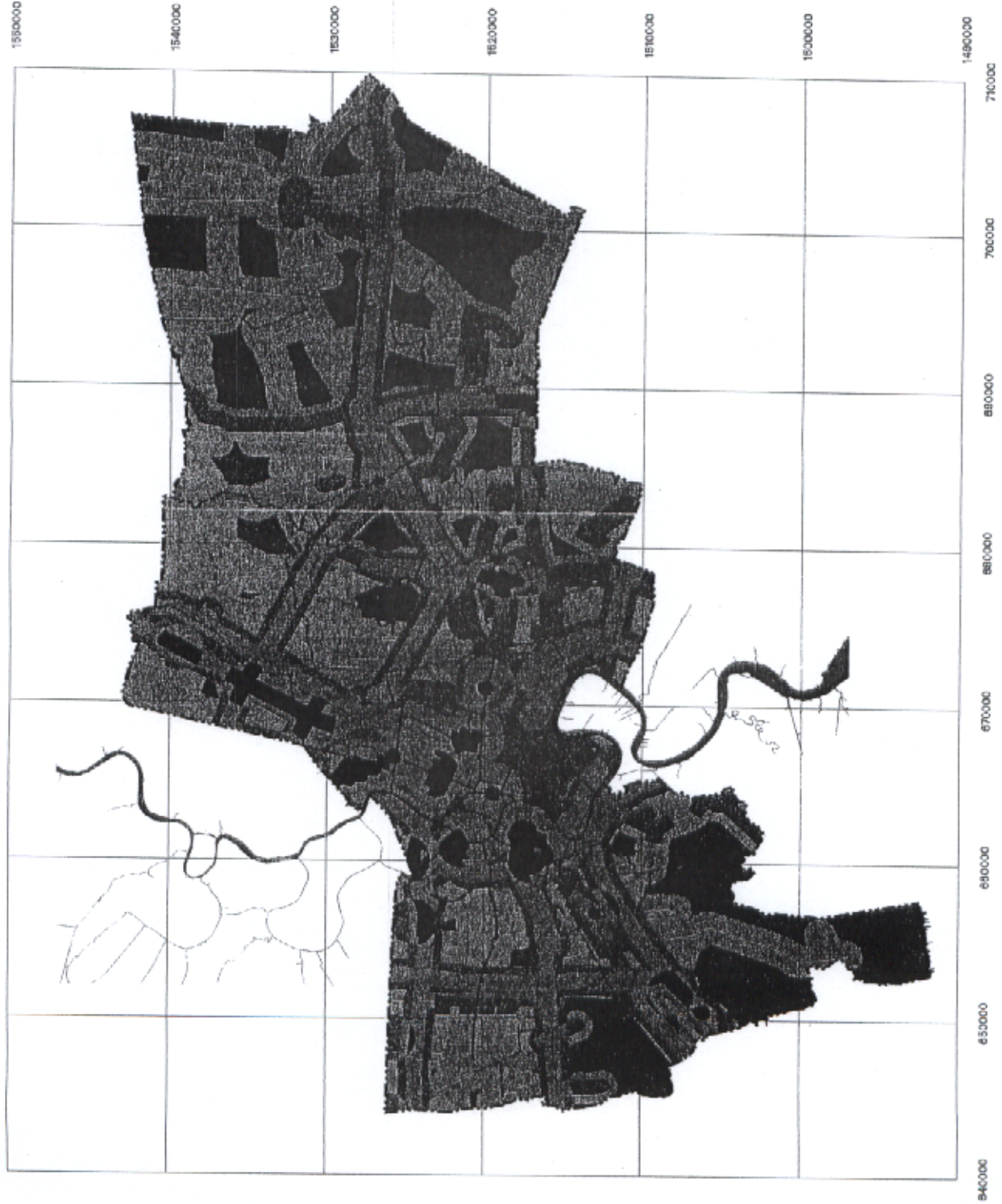
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Land Potential Evaluation Urban Services

Legend

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



SCALE 1:278000



KILOMETERS
UTM Zone 47

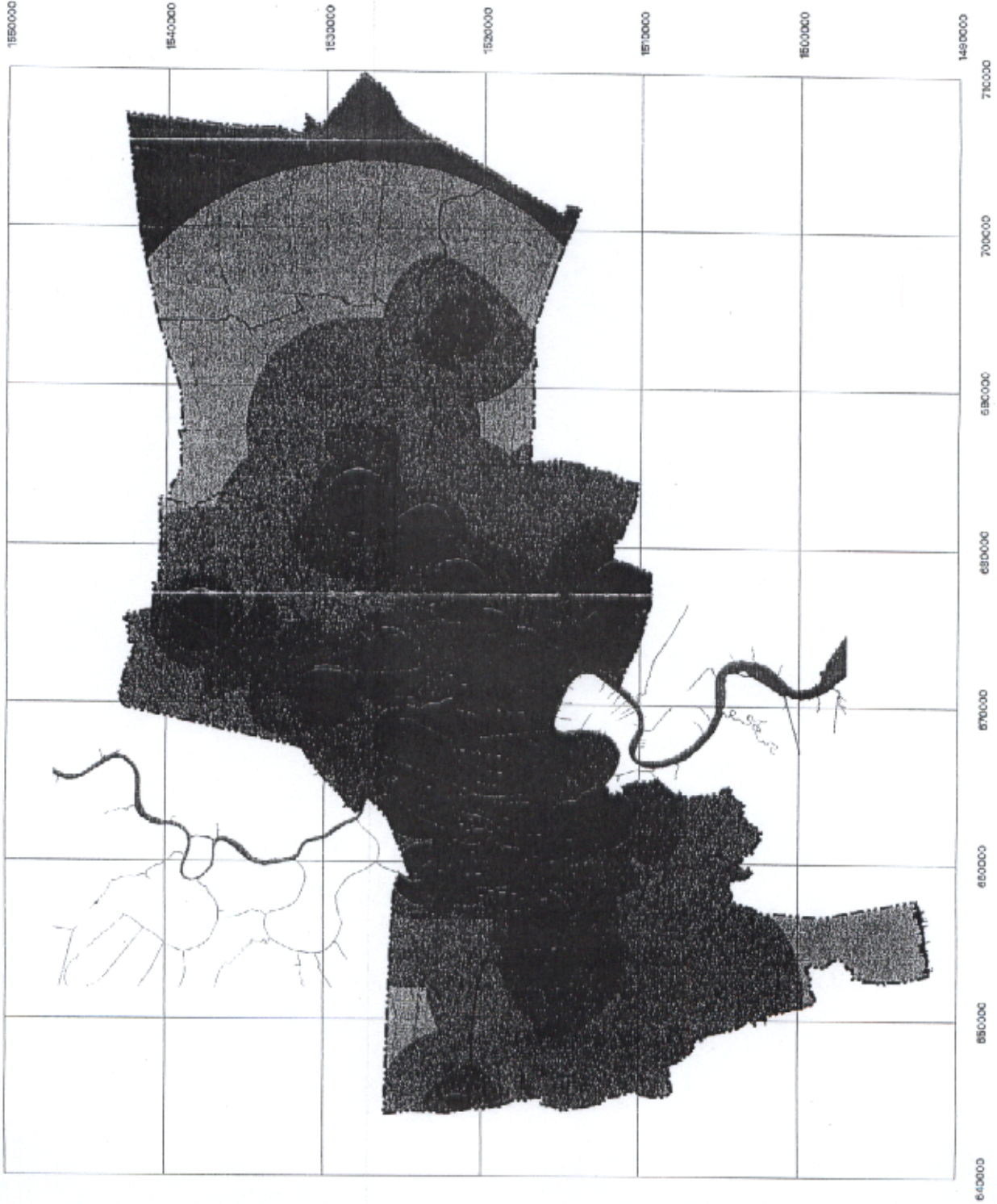
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(3) Simulated Urbanized Area

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 Km², Maha Phuttharam is 0.65 Km², and Thung Phaya Thai is 2.51 Km². 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

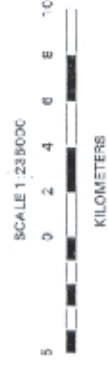
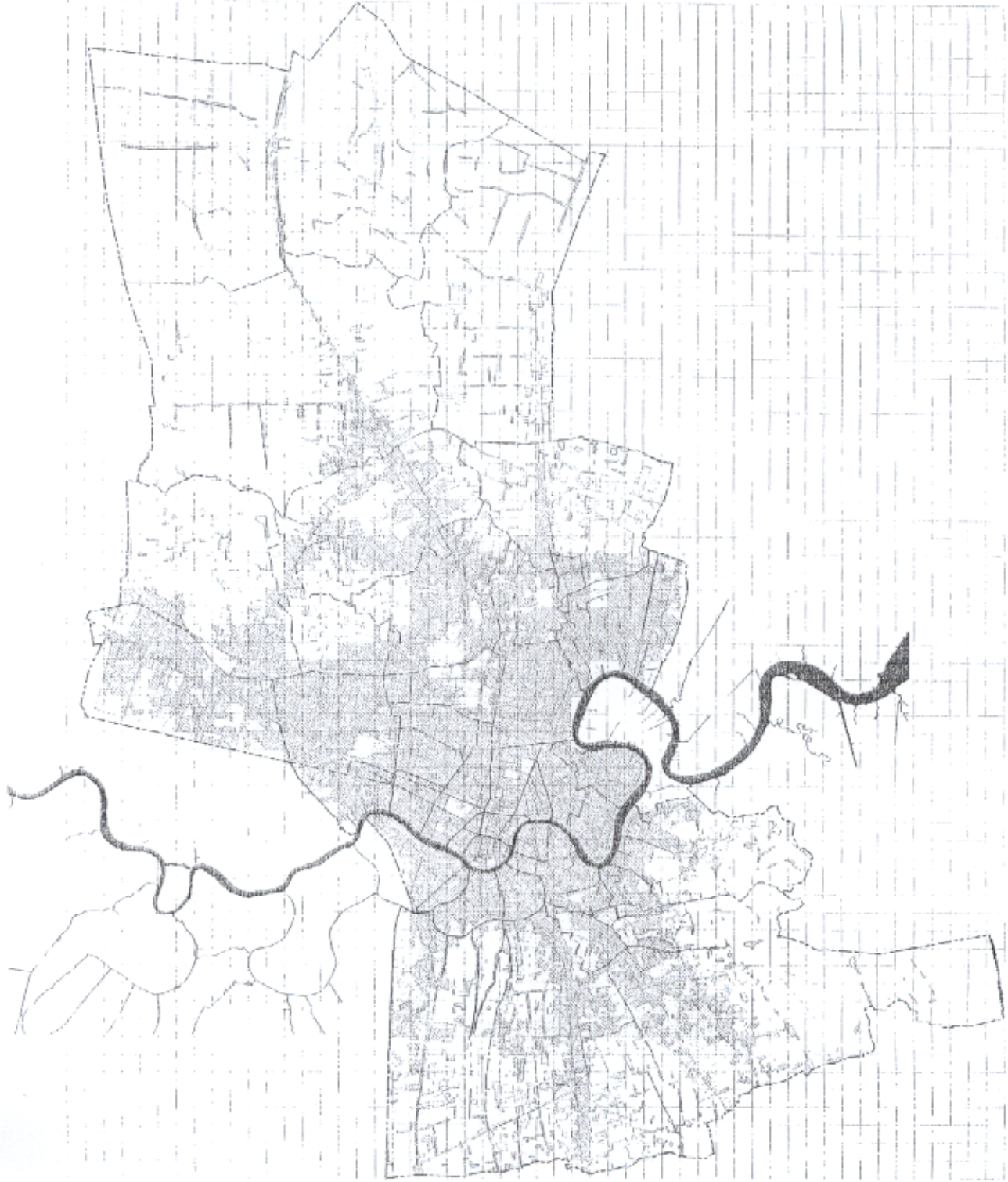
In this group, the population density shows the average level of the population density of Bangkok entirely, which is 148 person/ha in the built-up areas. Accessibility to urban facilities in this group is relatively low at this moment, while future urbanization potential seems to be high in several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

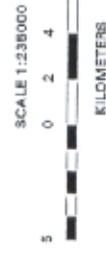
Future urbanization simulation shows approximately the necessary spaces for future population increase. In comparison to the future urbanized areas and land use plan of the 1992 General Plan or The Bangkok Plan by MIT, larger areas have been designated to be urbanized as residential areas. This may result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



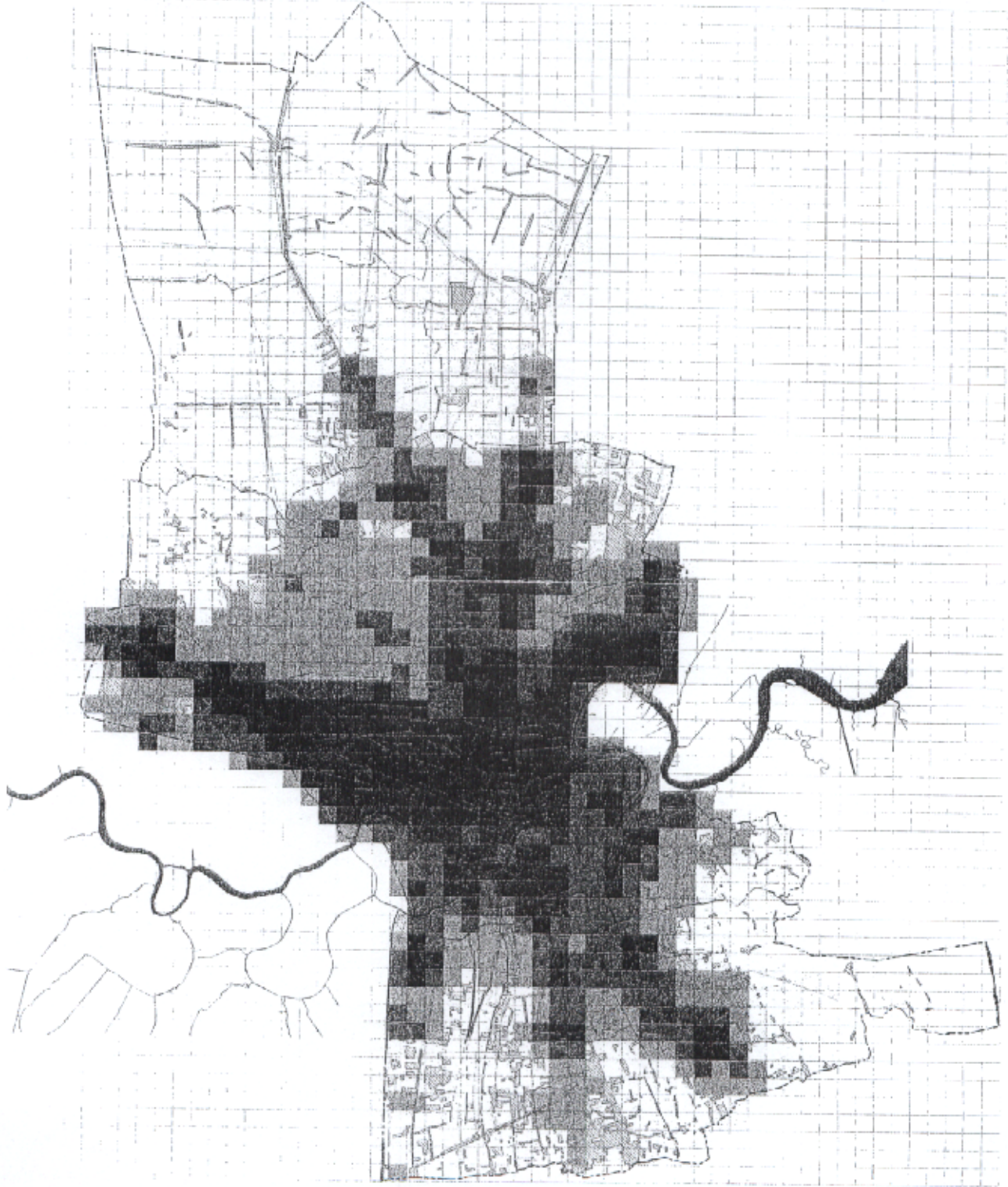
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



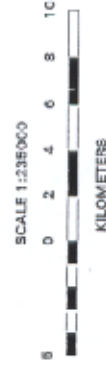
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Future Land Use Simulation Trend Based Policy Free Case-1

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 Prakan.

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

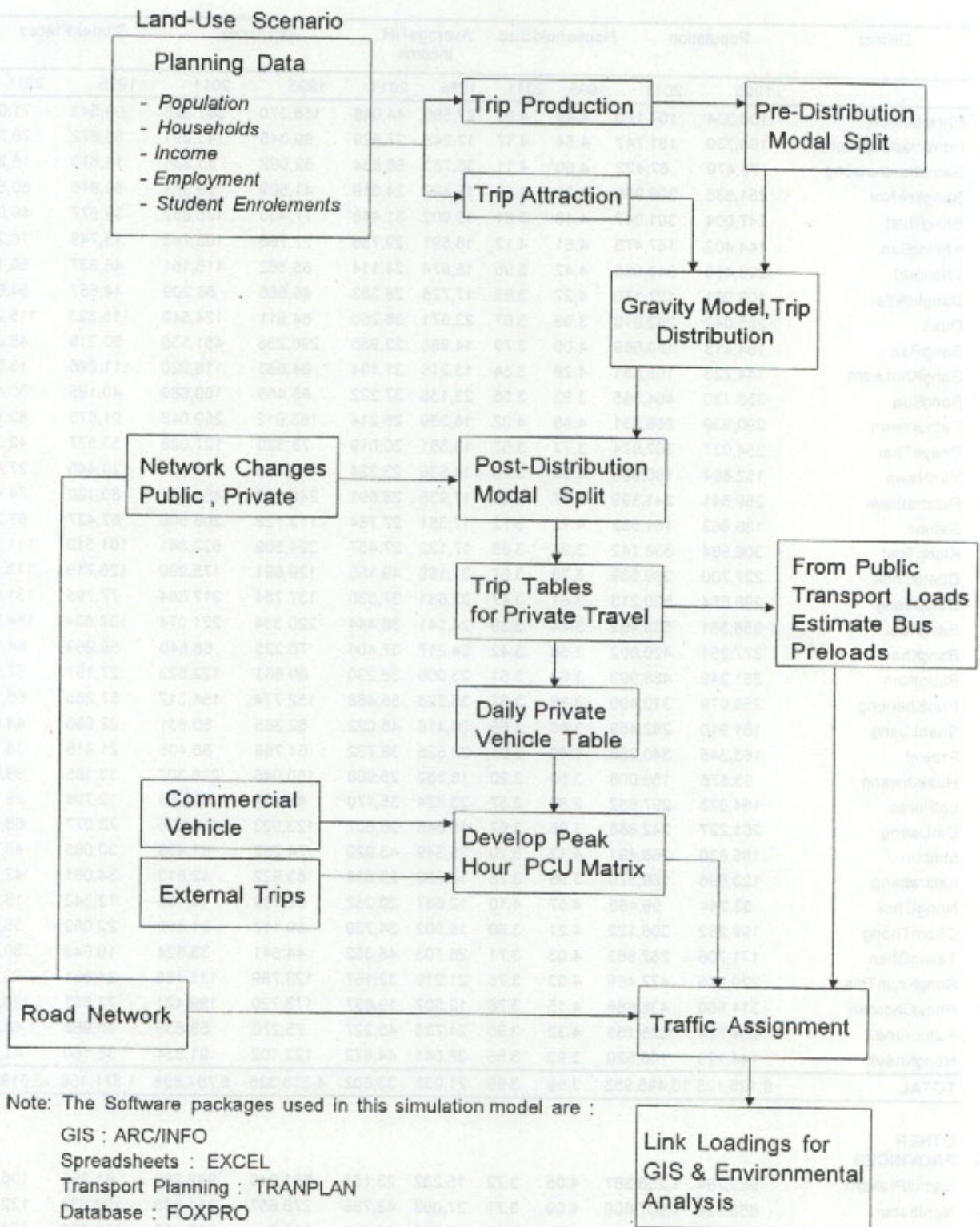


Fig. 5.1 Traffic Demand Forecasting Procedure

Table 5.2 Summary of Demographic Data

District	Population		Household Size		Average HH Income		Job Places		Studen Places	
	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	188,481	4.28	3.84	13,215	21,134	84,683	116,020	11,246	13,052
BangSue	338,730	404,385	3.93	3.58	23,138	37,222	85,456	109,689	40,196	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	308,564	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
DonMueang	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	123,896	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	438,888	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
PathunThani	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
SamuSakhon	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

Year	BMA		BMR	
	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

Income Group	Home Based Work		HomeBasedEducation		HomeBasedOthers		NonHomeBased	
	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

Income Group	Home Based Work		HomeBasedEducation		HomeBasedOthers		NonHomeBased	
	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:

$$A_j = a + b \times LV_j$$

where, A_j is the attractions from zone j

LV_j 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

TripPurpose	LandUseVariable	a	b	Correlation Coefficient
HBW	TotalEmployment	0	1.546	0.93
HBE	TotalStudentPlaces	0	1.936	0.97
HBO	TertiaryEmployment	3620	1.261	0.55
NHB	TertiaryEmployment	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)

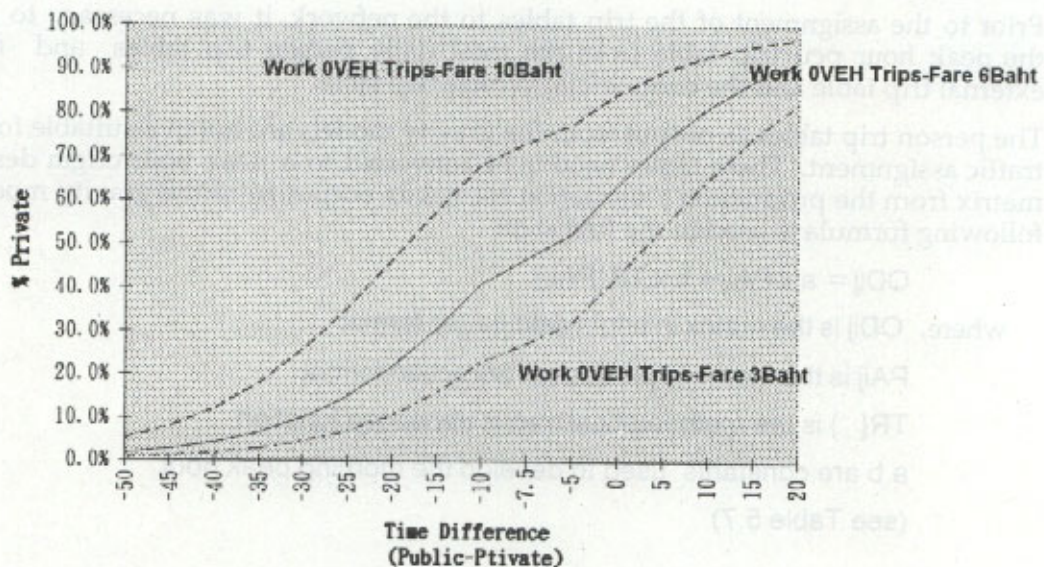
ΔC is the Travel Cost Difference (Public-Private in minutes)

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	-

Modal Split to Private



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:

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

where

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

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

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

$MS\{\text{Base}\}_{ij}$ 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:

$$OD_{ij} = a \times PA_{ij} + b \times TR\{PA_{ij}\}$$

where, OD_{ij} is the matrix in origin destination format

PA_{ij} 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

Factor	Trip Purpose			
	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	PCU	Trip Purpose Occupancy Factor			
	Factor	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:

$$GC_{ij} = a \cdot T_{ij} + b \cdot D_{ij} + c \cdot A_{ij}$$

where, GC_{ij} is defined as generalized cost in equivalent minutes

T_{ij} is the travel time

D_{ij} is the distance

A_{ij} 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.

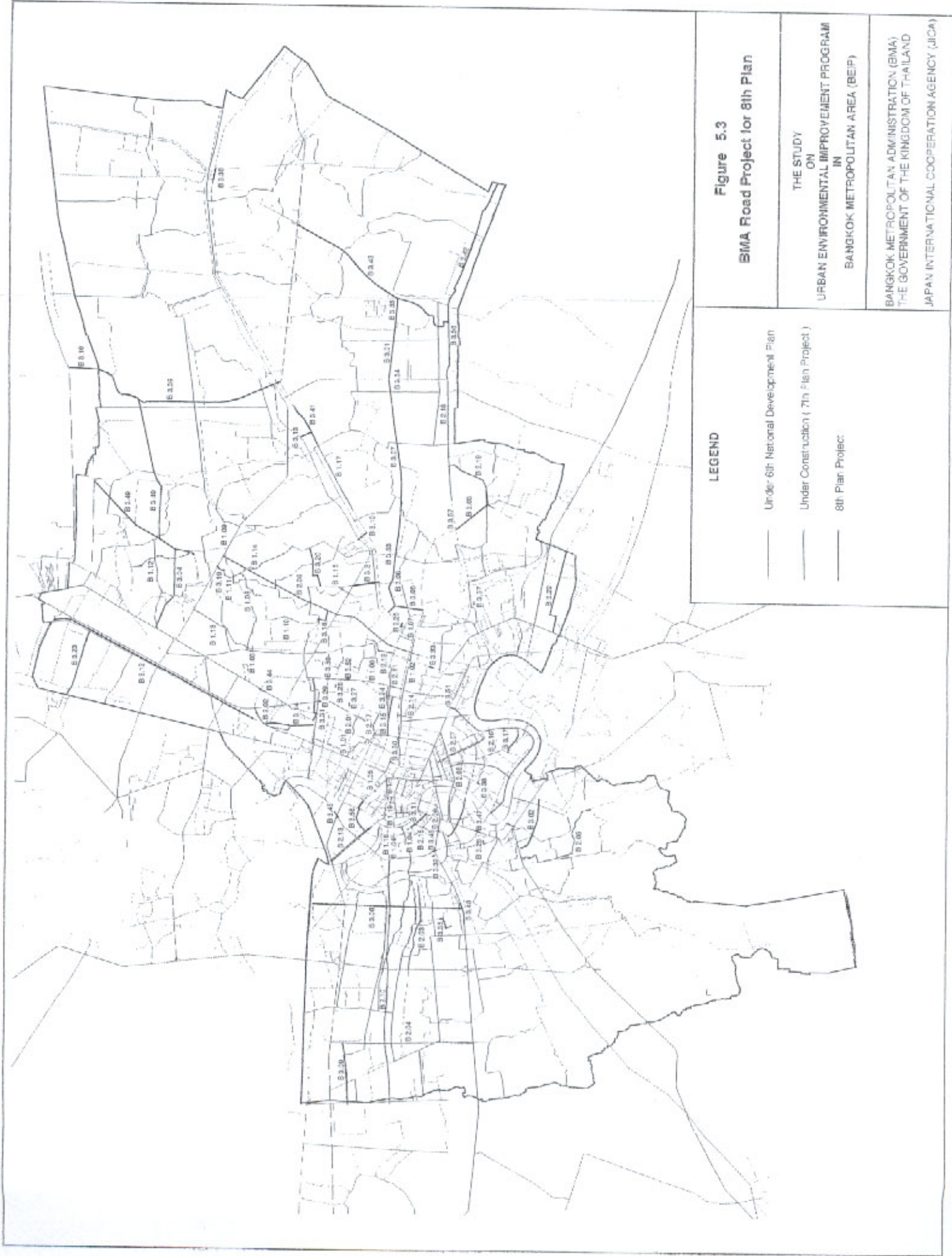


Figure 5.3

BMA Road Project for 8th Plan

LEGEND

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

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)



Figure 5.4
DOH Road Project for 8th Plan

THE STUDY
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 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
 Project Code
 Project at intersection



Figure 5.5
PWD Road Project for 8th Plan

LEGEND

———— PWD Road Project

THE STUDY
 OR
 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)

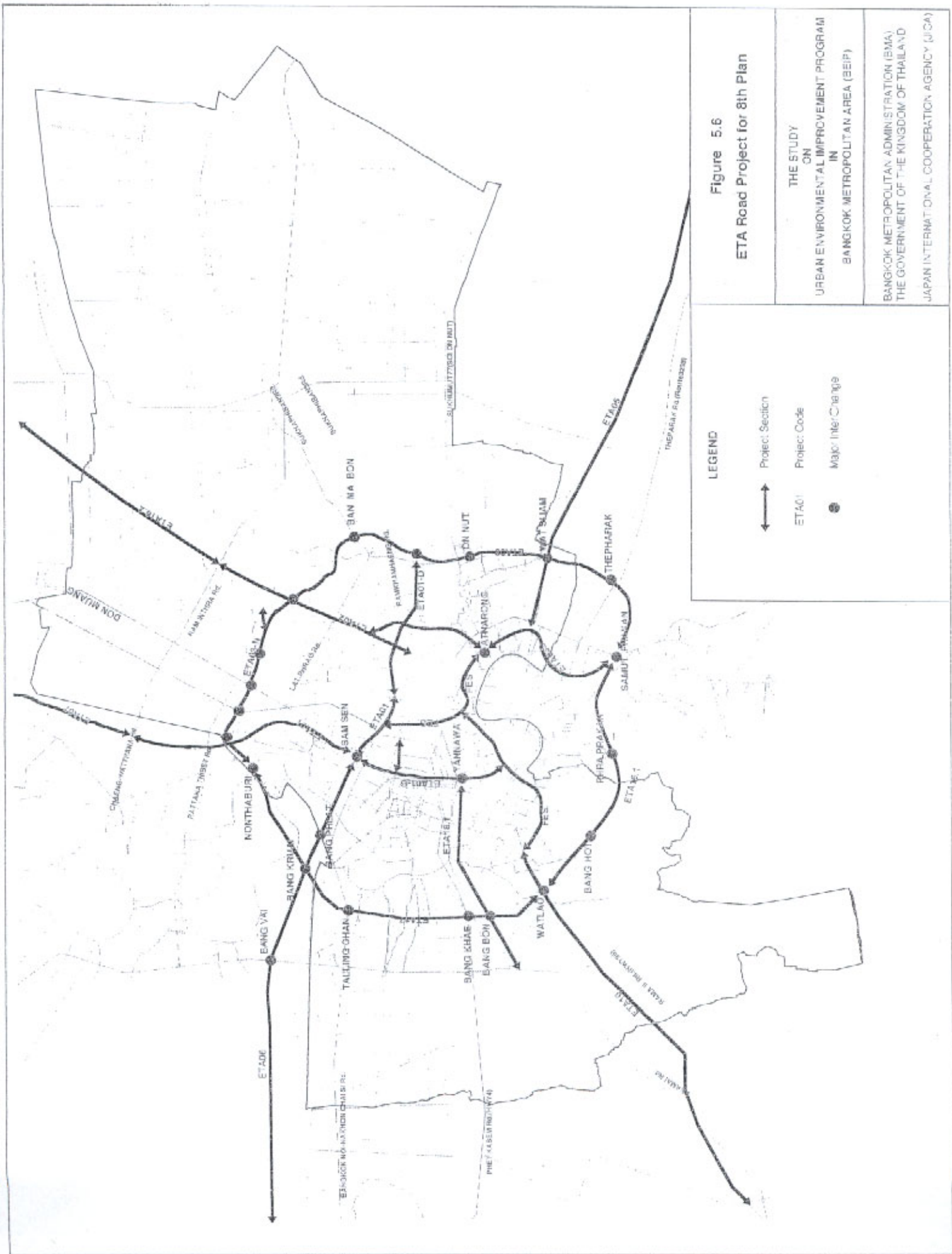


Figure 5.6

ETA Road Project for 8th Plan

LEGEND

- ↔ Project Section
- Major Interchange
- ETA001 Project Code
- Major Interchange

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)



Figure 5.7
MRT Master Plan

- LEGEND**
- BERTS (Happawell)
 - BTSC (Tanyon)
 - MRTA BLUE
 - MRTA ORANGE
 - MRTA PURPLE
 - Transfer Location

THE STUDY
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THE GOVERNMENT OF THE KINGDOM OF THAILAND
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)



Figure 5.8

Proposed Road Projects for 5th Plan

ON

THE STUDY

IN

URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM

BANGKOK METROPOLITAN AREA (BEPI)

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 Type	Standard Lane	Length (km)	Cost (mil Baht)	7th plan (mil Baht)	8th 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	Phuthamonthon 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 - RAMAIII (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	8	4.00	537	446	91
BMA	2.09	13	EKKAMAI - RAM INTRA RD. (including 6 contracts)	New Road	8	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	BAM's Code #	OCMRT Code #	Project Name	Proposed Standard Type	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	3.80	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	674
BMA	3.07	08	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	1,085
BMA	3.08	10	AGSA RD. (PHUTTHAMONTHON SAI 3 - PHUTTHAMONTHON SAI 4)	New Road	6-8	3.80	853	458	487
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	1.80	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	0.60	410	295	115
BMA	3.14	126	NEW KAMPANGPETCH 2 RD.	New Road	6-8	3.00	245	77	188
BMA	3.15	124	LIAB BLING MAKKASAN FROM SRI AYUDDHAYA ROAD TO ASOKE-DIN DAENG ROAD including Ratchaprarop Flyover	New Road	4	3.00	998	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 Nivel 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 Bulding 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 Songkiao Rd.	Improving					
BMA	3.28	none	Connection road , Ratchadaphisek Rd. - Suthisan Vinitchai Rd.	Improving					
BMA	3.29	none	Connection road , Viphawadi Rangsit Rd. - Ratchadaphisek Rd.	Improving					
BMA	3.30	none	Connection road , Rama 8 Rd. - Phetchburi Rd.	Improving					
BMA	3.31	none	Connection road , Suthisan 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 , Ibsarapab 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 road , Liab Waree rd. - Sungka Suntasuk 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 Standard Type	Lane	Length (km)	Cost	7th plan (1000 B)	8th plan (1000 B)
BMA	3.40	44	DISTRIBUTOR RD. IMPROVEMENT, Rattanakosin Sompooj Road - Nimit Mai Road	Improving	4	9.20	1,770	10	1,780
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 POLAMANE'S ENTRANCE TO BMA BOUNDARY	Widening	8	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 Mahal Sawan Intersection.	Underpass	3		560	236	324
BMA	3.48	122	FLYOVER CROSSING INTERSECTIONS (PHETKASEM ROAD- PHUTAMONTOL SAI 1 - SUKHAPHIBAN SAI 1)	Flyover	4		691	11	680
BMA	3.49	138	SAIMA RD. IMPROVEMENT	Widening	4	6.57	0	21	160
BMA	3.50	103	Constructing flyover for Ratchadaphisek - Suthisan 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 Khan 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 (1998)

Other Committed Projects listed by TPPP

Agency	BAM's Code #	OCMRT Code #	Project Name	Proposed Type	Standard 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	8	0.60	336	19	317
BMA	none	28	SUKHAPHIBAN 3 RD. IMPROVEMENT	Widening	6	6.90	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	188	111
BMA	none	98	b AREA TRAFFIC CONTROL, Phase2 226 Intersections	ATC			428	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 Type	Standard 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	4	0.50	150	0	150
BMA	none	50	Liab 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	Paholyothin 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	Indrapitak 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, Suthisan, Sukhumvit, and Sathorn				850	0	850
BMA	none	158	Improvement in selected superblocks				2,500	0	2,500
BMA	none	157	Road improvement on Ramkamhaeng Rd. (from Ramkamhaeng Rd. to Sri Wana Intersection)				142	0	142
BMA	none	158	Road improvement in Liab Bung National Housing Authority				170	0	170
BMA	none	159	Chalermlok Bridge Expansion				18	0	18
BMA	none	180	23 bottlenecks improvement				218	0	218
BMA	none	181	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	285	
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	1,298	
DOH	09	67	37	Interchange at Outer Ring Road (West) and Highway 346	0.5		4	421	
DOH	10	28,29	346	Phaihum Thanl - 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.346 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 Liab Khlong Poyas rd	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 - Cao Rai - Pakkred	13.4	4	6	761	
DOH	23	11,12	302	Kasesart - Cao Rai Section 2 Rd.	5.3	4	8	658	
DOH	24	72		Kasesart section - Sukhaphiban 1	9.2		8	1,800	
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 Plee HWY				2,000	
DOH	32	24	3310	Highway No.4 - Phuttamonthon	11	2	4	200	
DOH	33	none	4	Flyover at Bam Npi			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 - Samul 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	178	
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	8			200	
DOH	none	33	338	Phuthamonthon Sai 2 - Nakorn Chai Si	26			3,200	
DOH	none	36	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 Pral) 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 KMB 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 Rangsil				330	
DOH	none	50	31	Connect Don Muang Tollway to SES				300	
DOH	none	53	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-Phrasow-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 Divided	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 (1983-1999)	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 for 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 Southern 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**

LEVELCASE	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 (km)	38.3% (863)	14.9 (354)	9.3 (219)	81.2 (1406)	58.5 (1389)	46.2 (1100)	33.2 (789)	52.4 (1246)	40.7 (965)	40.8 (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.

CHAPTER 6: SIMULATION ANALYSES OF AIR POLLUTION BY MOBILE SOURCE

6.1 Objective of the Analysis

In order to review the present condition and evaluate the effects of policies in the future, simulation analysis of air pollutants is introduced. Simulated policy options are related only to vehicles because air pollution is mainly caused by vehicles.

The targets of "BEIP Simulation Model for Air Pollution" are as follows:

- Simulated air pollutants are SO₂, NO_x, NO₂, PM-10 and CO;
- Pollutant sources are motor vehicles, thermal power plants, and household; and
- Target area of concentration calculation is BMA.

6.2 Methodology

First, emissions from vehicle and power plants, which are supposed to be major sources of pollution, and the emissions from households are estimated. Their ground level concentrations are computed by the "BEIP Simulation Model for Air Pollution". Simulated cases are listed in Section 6.4 and the BEIP Simulation Model for Air Pollution is described in Section 6.5.

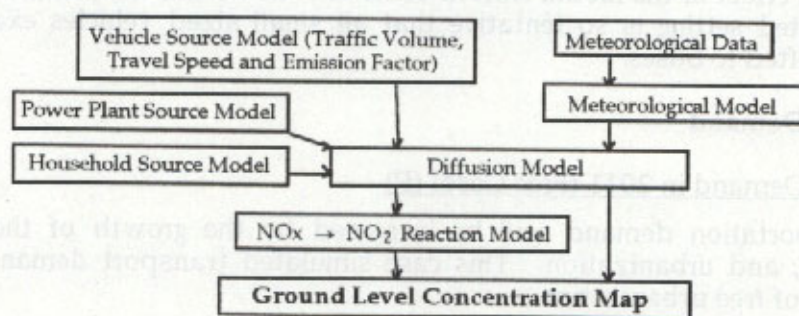


Fig. 6.1 Flow Chart of Simulation Model

6.3 Policy Options for Air Pollution Mitigation

Air pollution from vehicles will be mitigated by the following three conditions:

- Reduction of pollutant emission per vehicle;

- Change of traffic volume and travel speed by improvement of transport network; and
- Change of transportation demand reflecting urban structure development.

(1) Emission per Vehicle

1) Current Vehicle Emission (C)¹

The emission factors of the "Air Emission Database of Vehicles and Industry in Bangkok Metropolitan Region 1992: PCD MOSTE" were applied for the current condition

2) Future Vehicle Emission under Planned Policies (P)

The emission factors were estimated to simulate the following two policies;

- Almost all the vehicles would meet the New Vehicle Regulation because all new vehicles will have to meet the strong regulations after January 1999, as in European countries (PCD, 1996); and
- Sulfur content of high speed diesel oil is considered to be 0.05% in 2011.

3) Replacement by Low-Emission Bus (A)

To consider further improvement of emission, another case is simulated that average of emission factor of bus is decreased to be half. It may be actualized by some policies, e.g., some of the bus routes are replaced by tram or trolley bus system, and the other routes are operated by CNG bus.

(2) Transport Network

Following 3 cases have already been described in Chapter 5.

- Current Transport Network (C)
- Road Construction of the 8th National Plan (P)
- Implementation of the Mass Transit Master Plan (P)

The other simulated case is Extreme Modal Shift (A). The aim of this case is to obtain a numerical effect of the modal shift in order to consider further control of air pollution. The simulated setting is so tentative that all small sized vehicles except taxis and samplers shifted to buses.

(3) Transport Demand

1) Transport Demand in 2011 (Free Case) (P)

The transportation demand will be increased by the growth of the economy and population, and urbanization. This case simulated transport demand change under conditions of free urbanization.

2) Transport Demand in 2011 under Sub Center Development (B)

The effect of transportation demand change under Sub Center Development, proposed by this BEIP Study Team, was evaluated in this case.

¹ Conditions of the current situation are marked as (C), conditions of future probable situations as (P), BEIP recommendations as (B), and other additional future conditions as (A).

6.4 Combination of Cases

Nine (9) cases of combination were simulated as shown in Table 6.1. The purpose of each case is:

- Case 1 : to simulate current air pollution;
- Case 2 - Case 4: to evaluate future probable policies;
- Case 5 - Case 7: to recognize the effect of the transport demand difference; and
- Case 7 - Case 9: to understand the importance of additional future policies.

Table 6.1 Simulated Cases

	Case								
	1	2	3	4	5	6	7	8	9
*	* C)	P)	P)	P)	P)	P)	B)	A)	A)
C) Current Vehicle Emission	○	-	○	○	-	-	-	-	-
P) Future Vehicle Emission	-	○	-	-	○	○	○	○	○
A) Low-Emission Bus	-	-	-	-	-	-	-	-	○
C) Current Road Network	○	○	-	-	-	-	-	-	-
P) Road Construction of the 8th National Plan	-	-	○	○	○	○	○	○	○
P) Implementation of the MRT	-	-	-	○	○	○	○	○	○
A) Extreme Modal Shift	-	-	-	-	-	-	-	○	-
C) Current Transport Demand	○	○	○	○	○	-	-	-	-
P) Transport Demand in 2011 (Free Case)	-	-	-	-	-	○	-	-	-
B) In 2011 under Sub Center Development Case	-	-	-	-	-	-	○	○	○

Note: see footnote in the previous page

6.5 Applied Simulation Model

(1) Emission Model

Emissions from vehicles were estimated by using emission factors, traffic volume and travel speed of each traffic links. The emission factors applied for estimation are quoted from the "Air Emission Database of Vehicles and Industry in Bangkok Metropolitan Region 1992: PCD MOSTE." Emission factors under future conditions were estimated by the BEIP Study Team. The road network, travel speed and traffic volume data by 9 vehicle types were provided from the outcomes of the analysis of the traffic planning sector of the BEIP Study Team.

The emission data of the power plants were mainly obtained from the "Air Emission Database of Vehicles and Industry in Bangkok Metropolitan Region 1992: PCD MOSTE."

Emissions from households were estimated by the amount of fuel consumption and the emission factor. Both are quoted from the "Air Emission Database of Vehicles and Industry in Bangkok Metropolitan Region 1992: PCD MOSTE." The emission distribution was based on population distribution data estimated by this BEIP Study Team.

(2) The BEIP Simulation Model for Air Pollution

The BEIP Simulation Model for Air Pollution was a simulation model modified to emulate the situation of Bangkok, as the BEIP Study Team developed it by checking the simulation results with the actual ambient monitoring results.

The simulation procedure is shown in Fig. 6.2.

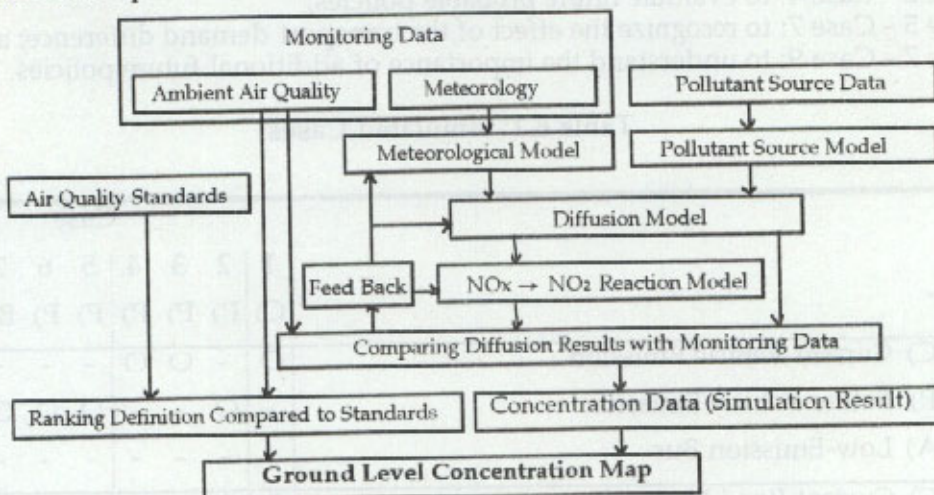


Fig. 6.2 Flow Chart of Diffusion Simulation

The outline of the model is as follows:

- Meteorological data observed at ONEB Station in 1988 by JICA;
- CONCAWE Equation (CONCAWE, 1966) and Briggs Equation (Briggs, 1969) for the height of the plume rise;
- Gaussian Plume Equation and Gaussian Puff Equation for the dispersion model; and
- Monitoring results of CO were used for model improvement.

The Scatter Diagram of estimated and actual CO concentration (annual) is shown in Fig. 6.3. The model is considered to have sufficient reproducibility as the gradient of regression line is near to 1.0 and the coefficient of correlation is more than 0.9.

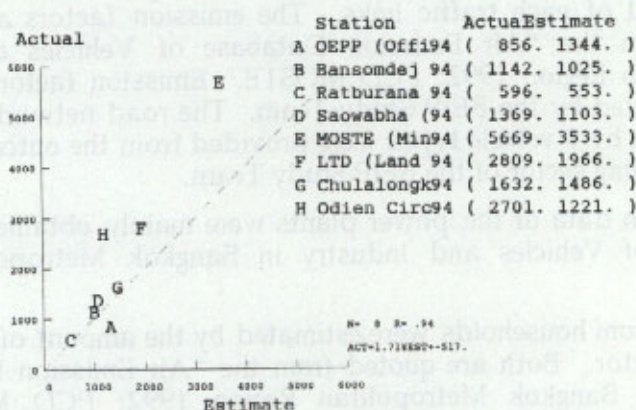


Fig. 6.3 Scatter Diagram Comparing the Simulation Result (Estimate) and the Monitoring Result in 1994 (Actual) (CO, ppb)

To compare the concentration of grid cells with standards, Table 6.2 was prepared by statistical analysis of existing ambient monitoring data.

Table 6.2 Ranking of the Annual Arithmetic Average of Air Pollutant Concentration, compared to the Ambient Air Standards

	PM-10 ($\mu\text{g}/\text{m}^3$)	CO (ppb)	SO ₂ (ppb)	NO ₂ (ppb)
Much Lower than the Standard	≤ 20	≤ 722	≤ 9	≤ 9
Lower than the Standard	≤ 40	≤ 1445	≤ 19	≤ 17
Possibly Lower than the Standard	≤ 52	≤ 2131	≤ 24	≤ 21
Possibly Higher than the Standard	≤ 88	≤ 4748	≤ 36	≤ 30
Higher than the Standard	≤ 177	≤ 9496	≤ 72	≤ 60
Extremely Higher than the Standard	$177 <$	$9496 <$	$72 <$	$60 <$

Source: BEIP Study Team

6.6 Interpretation of the Result of the Model Simulation

Pollutant emissions of all cases are shown in Table 6.3.

Table 6.3 Emissions from Vehicles and Area of Each Ranking by Case

Case Settings:		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
		(C)	(P)	(P)	(P)	(P)	(P)	(B)	(A)	(A)
(C)	Current Vehicle Emission	0	0	0	0	0	0	0	0	0
(P)	Future Vehicle Emission	0	0	0	0	0	0	0	0	0
(A)	Low-Emission Bus	-	-	-	-	-	-	-	-	0
(C)	Current Road Network	0	0	0	0	0	0	0	0	0
(P)	Road Construction of 8th National Plan	-	-	0	0	0	0	0	0	0
(P)	Implementation of the MRT	-	-	-	0	-	-	-	0	0
(A)	Extreme Modal Shift	-	-	-	-	-	-	-	0	-
(C)	Current Transport Demand	0	0	0	0	0	-	-	-	-
(P)	Transport Demand in 2011 (Free Case)	-	-	-	-	-	0	-	-	-
(B)	In 2011 under Sub Center Development Case	-	-	-	-	-	-	0	0	0

Emission from Vehicle (BMR, ton/y):

Case:	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
SPM	206,920	33,353	204,062	179,492	33,918	87,870	78,325	32,069	77,644
CO	934,101	233,741	870,281	705,268	172,370	718,508	607,239	497,118	592,454
SO _x	29,696	4,031	27,182	24,101	3,514	8,918	8,034	5,767	7,307
NO _x	192,396	75,123	155,684	138,844	53,961	153,462	137,412	133,703	110,750

Concentration (Annual Average): Area of Each Rank (km²):

Pollutant	Rank	Concentration	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9
PM-10 (micro g/m ³)	1	<=20	395.50	1,413.75	415.00	466.25	1,373.50	777.75	853.50	1,334.50	855.50
	2	<=40	444.50	217.00	404.00	441.50	258.50	432.75	437.25	298.00	437.25
	3	<=52	145.00	41.50	163.75	168.25	46.50	158.50	144.00	52.25	144.50
	4	<=88	324.00	32.50	339.25	343.00	28.25	228.75	198.00	23.00	196.00
	5	<=177	263.00	3.25	291.25	237.75	1.25	104.75	72.25	0.25	71.75
	6	177<	136.00	0.00	94.75	51.25	0.00	5.50	3.00	0.00	3.00
CO (ppb)	1	<=722	1,551.75	1,705.25	1,598.00	1,658.75	1,708.00	1,629.50	1,660.50	1,689.25	1,661.25
	2	<=1445	134.50	2.75	102.25	48.25	0.00	69.75	44.75	17.25	44.00
	3	<=2131	17.50	0.00	6.00	1.00	0.00	7.50	2.25	1.50	2.25
	4	<=4748	4.25	0.00	1.75	0.00	0.00	1.25	0.50	0.00	0.50
	5	<=9496	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	9496<	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SO ₂ (ppb)	1	<=9	1,275.25	1,509.25	1,312.50	1,354.75	1,523.25	1,473.75	1,481.25	1,501.50	1,483.25
	2	<=19	287.75	190.75	302.50	287.25	176.50	220.75	214.75	196.75	213.25
	3	<=24	93.25	8.00	77.75	60.25	8.25	13.50	12.00	9.75	11.50
	4	<=36	48.25	0.00	15.25	5.75	0.00	0.00	0.00	0.00	0.00
	5	<=72	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6	72<	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NO ₂ (ppb)	1	<=9	485.50	1,148.50	656.75	786.50	1,499.00	715.75	829.25	832.00	905.00
	2	<=17	455.50	347.00	508.75	532.75	207.75	492.50	499.50	510.25	502.50
	3	<=21	144.50	82.75	171.75	156.00	1.25	171.25	140.00	129.50	121.25
	4	<=30	241.25	102.50	218.00	161.25	0.00	194.50	165.00	162.25	136.00
	5	<=60	283.75	27.25	152.25	71.50	0.00	133.50	74.25	74.00	43.25
	6	60<	97.50	0.00	0.50	0.00	0.00	0.50	0.00	0.00	0.00

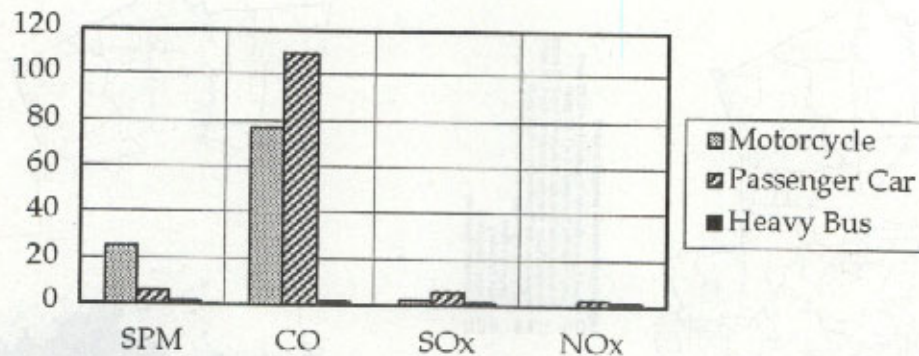
Source: JICA Study Team

Note: Rank 1: Much Lower than the Standard
Rank 2: Lower than the Standard
Rank 3: Possibly Lower than the Standard
Rank 4: Possibly Higher than the Standard
Rank 5: Higher than the Standard
Rank 6: Extremely Higher than the Standard

(1) Simulation Results of Current Air Pollution (C) (Case 1)

1) Emission per Distance per Passenger

Emission per Distance per Passenger (hereinafter, Unit Pollutant Emission, g/km/person) was computed by the BEIP Study Team, shown Fig. 6.4. Buses show the lowest emissions of SO_x, CO and SPM and the second lowest for NO_x after motorcycles. The low emissions result for buses reflects their occupancy rate.



Source: BEIP Study Team

Fig. 6.4 Ratio of Unit Pollutant Emission (bus emission per passenger = 1.0)

2) Concentration Distribution of Air Pollutants

The concentration distribution of air pollutants is shown in Fig. 6.5.

The "Higher than the Standard" area of PM-10 covers the BMA widely, thus not contradicting the monitoring results that indicate that the majority of monitoring stations exceed the standard.

There is no area where the CO concentration is "Higher than the Standard" or "Extremely Higher than the Standard". The "Possibly Higher than the Standard" area is limited along some major roads. There is no contradiction between this simulation result and the monitoring result by PCD, i.e., exceeding CO standard points are only 2 out of 18.

The "Higher than the Standard" area of SO₂ is limited to some major roads. The influence of power plants is an important factor in SO₂ air pollution. Since all the grid cells are "Possibly Lower than the Standard" or "Lower than the Standard", only air pollutants from motor vehicles are simulated.

"Higher than the Standard" covers a wide area in the NO₂ map.

3) Top 20 Grid Cells of High Concentration:

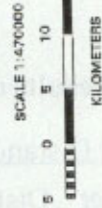
The area of the top 20 grid cells of concentration includes the areas along the expressways and part of the built-up area. Most of the areas are in the Ratchathewi district, on the First Stage Expressway from Din Daeng to Khlong Toei, and on the Second Stage Expressway from Din Daeng to Samsen. Expressways with many lanes and heavy traffic could be the reason of high concentration in the urbanized area.

Fig. 6.5

Air Pollution Simulation

Case 1

- Present Vehicle Emission Factor
- Present Road Network
- Present Mass Transit Network
- Present Transport Demand



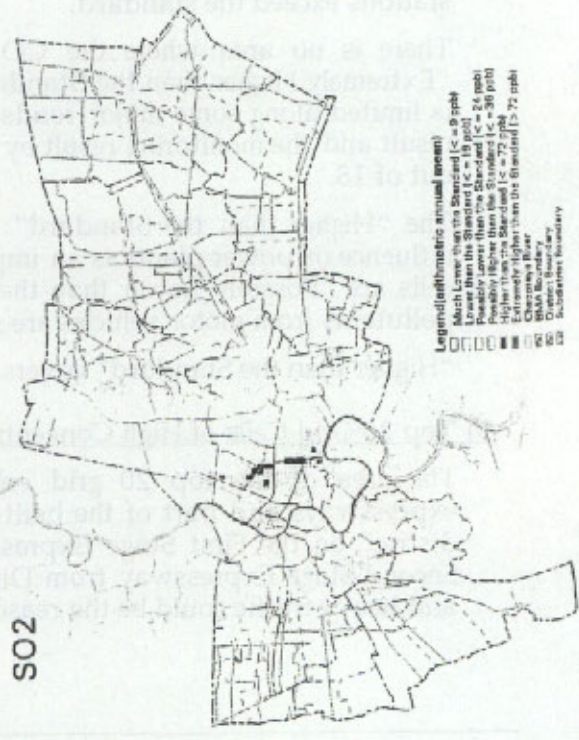
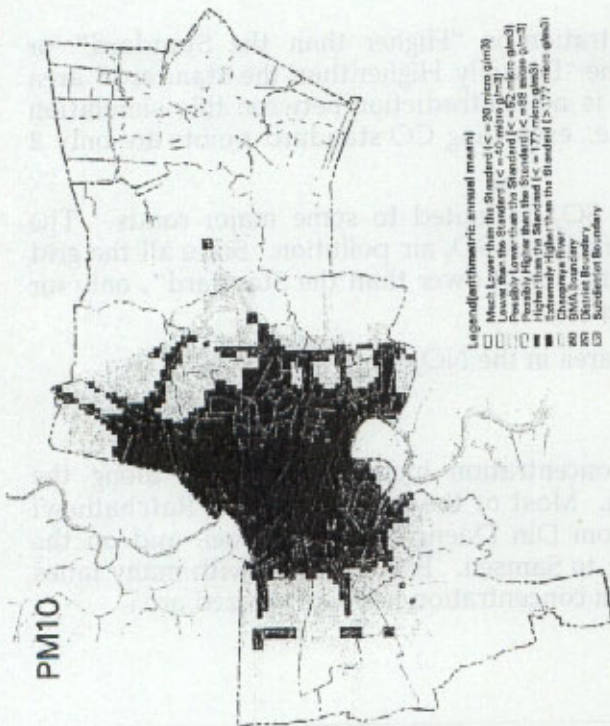
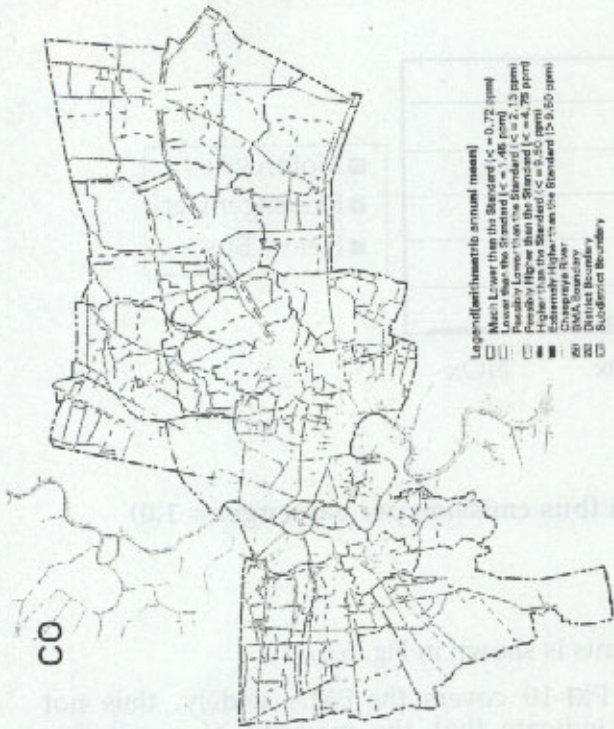
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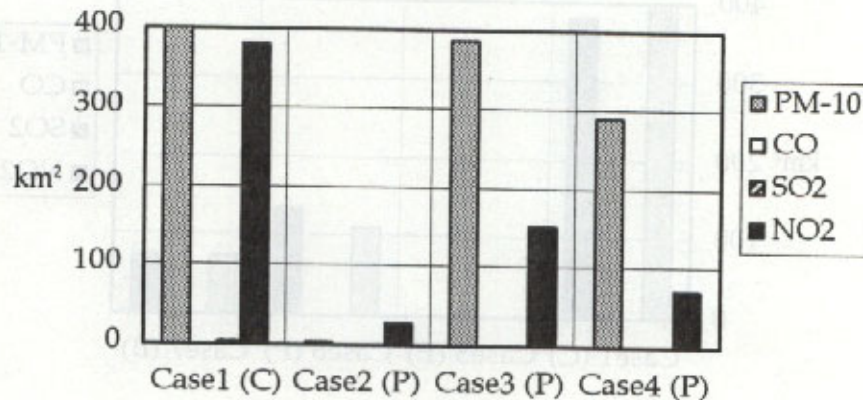


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(2) Comparison of Future Probable Policies (P) (Case 2 -- Case 4)

According to the simulation results of Case 2 to Case 4 as shown in Fig. 6.6, exhaust gas regulations are much most effective. Air pollution in Bangkok would be almost acceptable if the exhaust gas regulations were implemented already, as shown in Case 2. Both New and In-Use Vehicle Regulations are indispensable.



Source: BEIP Study Team

Fig. 6.6 Area of "Higher than the Standard" and "Extremely Higher than the Standard" of Case 1 to Case 4 (km²)

The second effective policy is implementation of the Mass Transit Master Plan. (Case 4). Road construction of the 8th National Plan is not so effective for the PM-10 problem, although it is effective for NO₂ air pollution (Case 3).

1) Recommendations for Future Vehicle Emission (P)

New regulations can be actualized as the vehicle manufacturers have already developed vehicles meeting the EC regulations. However, actualization of in-use regulations seems to be difficult.

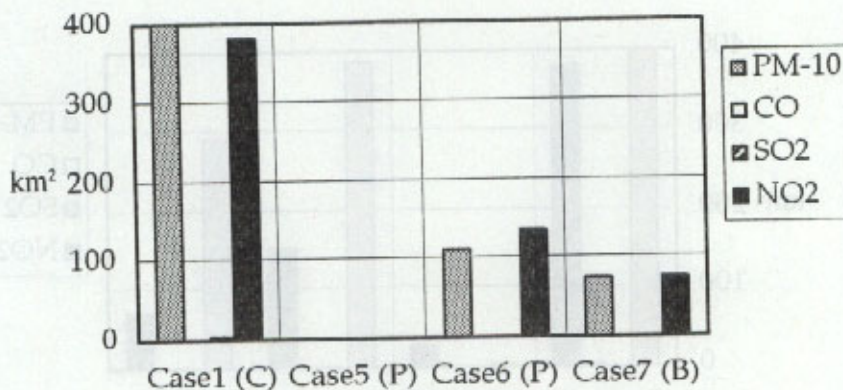
The inspection system, which may include the only major existing regulations for in-use vehicles, has already been applied to all buses. However, the inspection system is apparently not as there are many buses that do not meet the In-Use Vehicle Regulations, although all vehicles would have passed the inspection several months before. For example, 3,291 buses were fined for violating the standards in 1995 (Bangkok Post, Apr. 29, 1996) although the number of the registered bus was only 24,364 at Dec. 31, 1995 (LTD, 1996). The problem might be that many vehicles are inappropriately maintained even they passes periodical inspection.

A daily maintenance program should be strengthened first. An exhaust gas checking program should be applied more frequently than the checking which is carried out under the existing inspection system, and the fine system should be strengthened.

(3) Effect of Transport Demand Change (Case 5 -- Case 7)

Most of the points in Bangkok would not be rated as "Higher than the Standard" nor "Extremely Higher than the Standard" if all the policies already discussed were implemented by this time (Case 5, shown in Fig. 6.7 and Fig. 6.8). However, Case 6, shown in Fig. 6.7 and Fig. 6.9, shows that even if all these policies were introduced, the situation in Bangkok would not sufficiently improved by the 2011. The increase of the

transport demand would cancel the effect of mitigation policies. There will still be over-standard areas even under the sub center development (Case 7, shown in Fig. 6.7 and Fig. 6.10), proposed by this BEIP Study Team. Further policies for controlling air pollution are required.



Source: BEIP Study Team

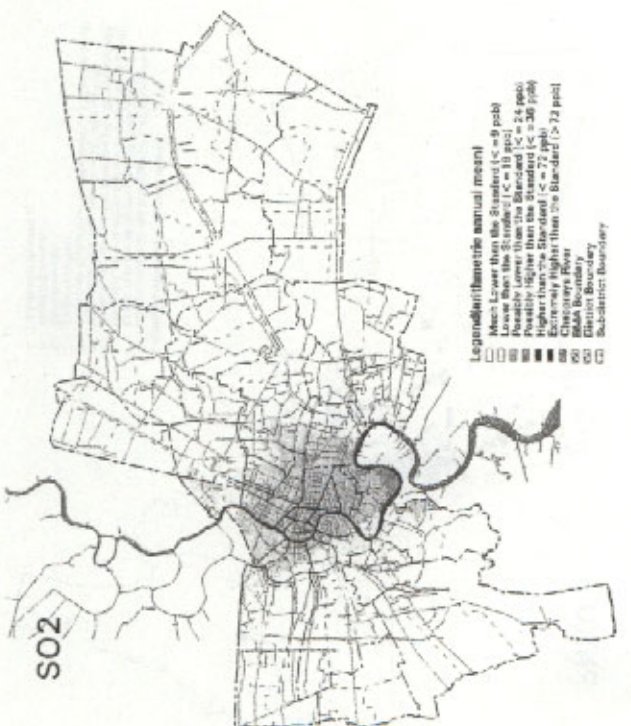
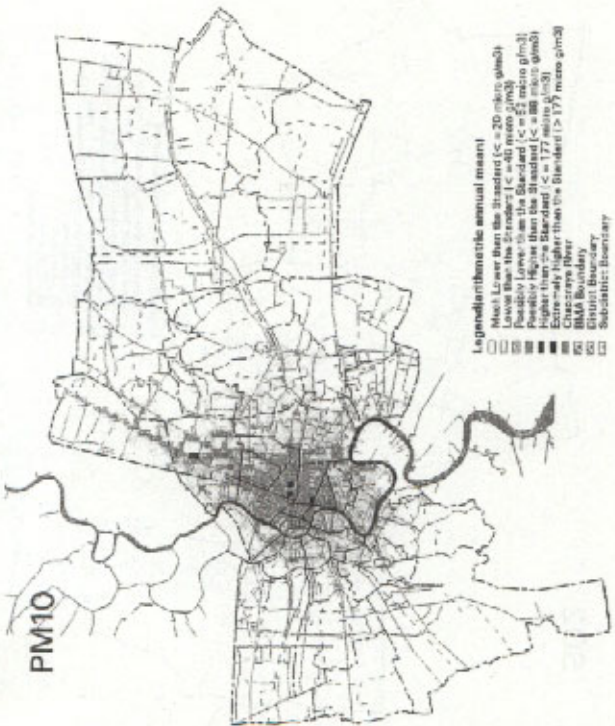
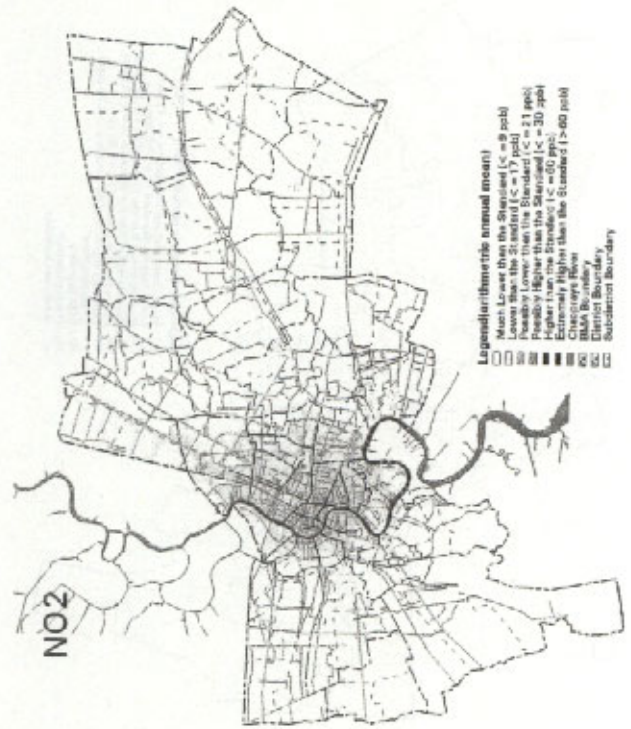
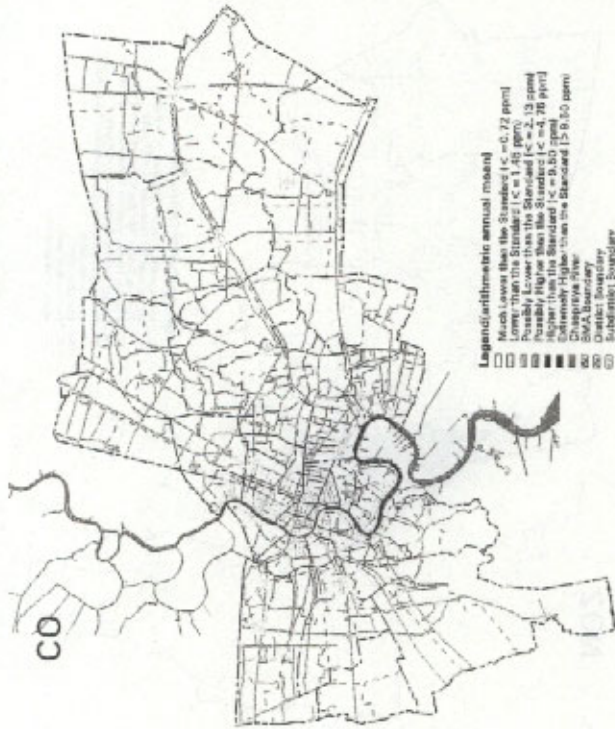
Fig. 6.7 Area of "Higher than the Standard" and "Extremely Higher than the Standard" of Case 1 and Case 5 to Case 7 (km²)

Fig. 6.8


Air Pollution Simulation

Case 5

Future Vehicle Emission Factor
 Future Road Network
 Future Mass Transit Network
 Present Transport Demand



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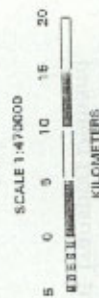

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Fig. 6.9

Air Pollution Simulation

Case 6

- Future Vehicle Emission Factor
- Future Road Network
- Future Mass Transit Network
- Future Transport Demand



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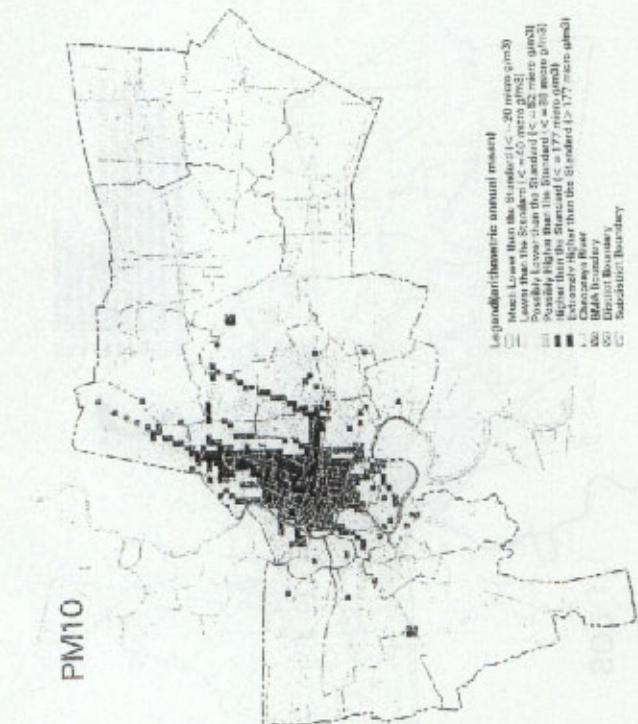
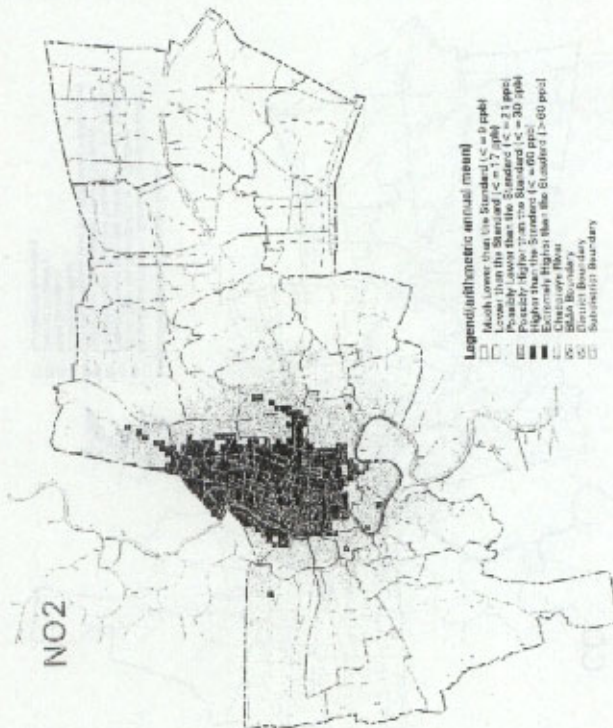
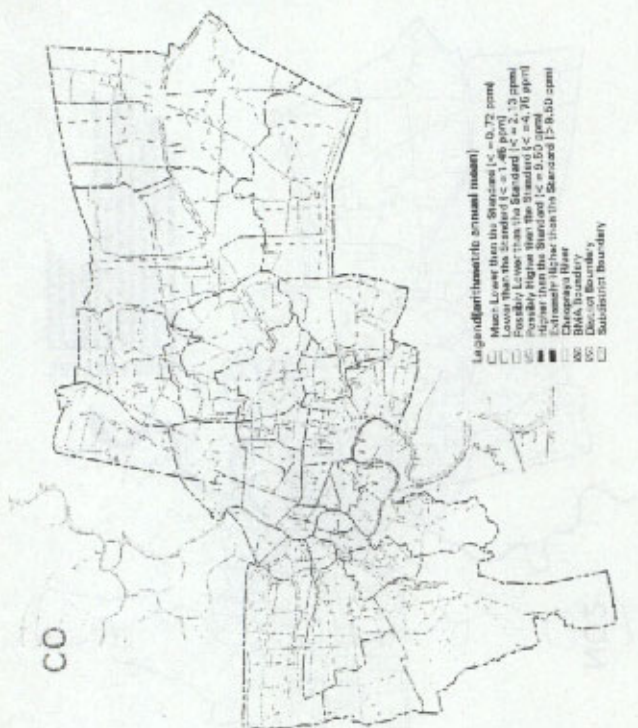
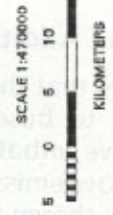


Fig. 6.10

Air Pollution Simulation

Case 7

Future Vehicle Emission Factor
 Future Road Network
 Future Mass Transit Network
 Future Transport Demand with
 Sub Center Development



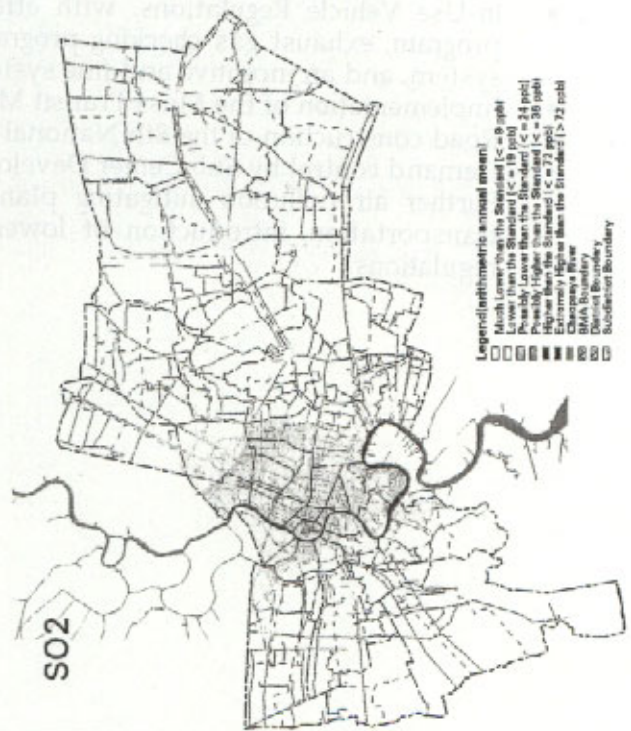
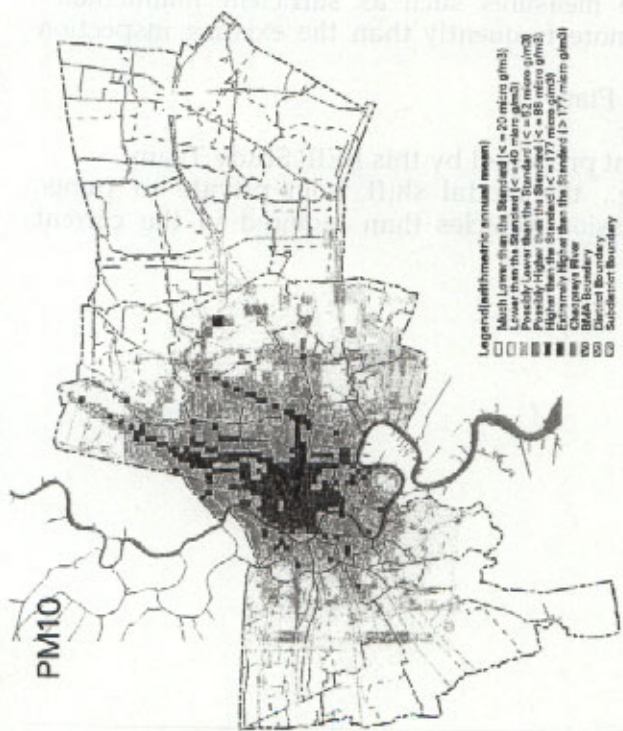
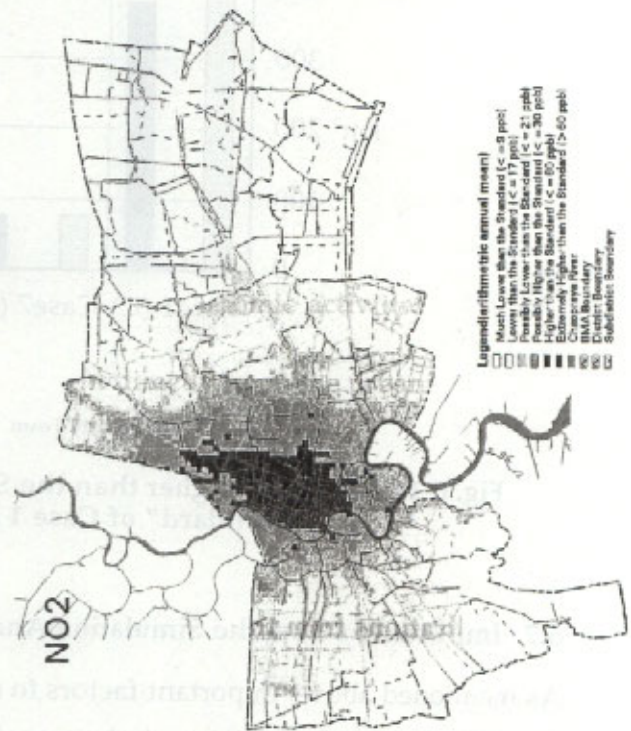
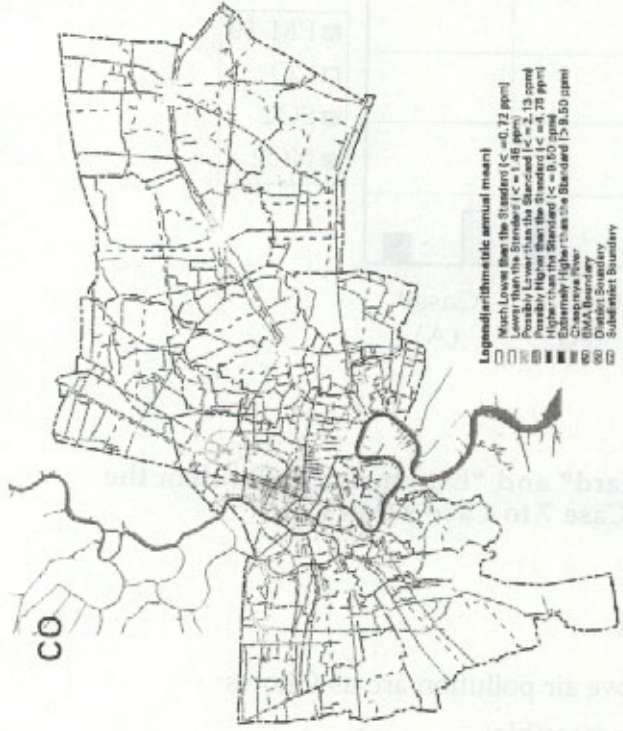
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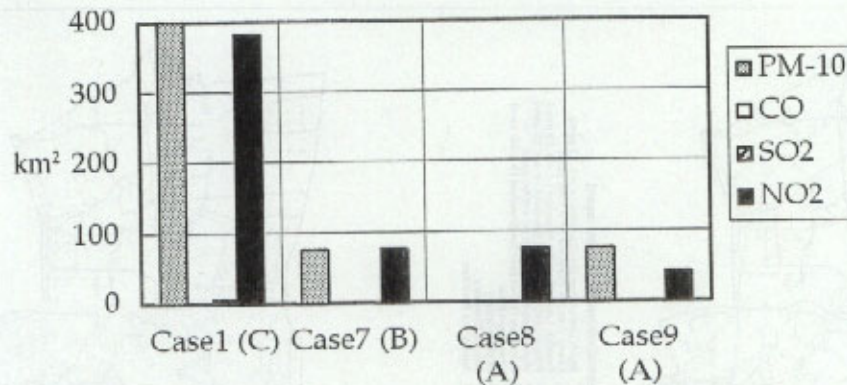


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(4) Importance of Additional Future Policies (Case 7 -- Case 9)

Case 8 shows that the PM-10 problem of Case 7 could be mainly solved by the Extreme Modal Shift to buses as shown in Fig. 6.11, although this shift requires a strong administrative initiative and a change of transport network. Case 9 shows that an increase of low-emission buses, such as the CNG type could be effective for pollution mitigation as shown in Fig. 6.11.



Source: BEIP Study Team

Fig. 6.11 Area of "Higher than the Standard" and "Extremely Higher than the Standard" of Case 1 and Case 7 to Case 9 (km²)

6.7 Implications from the Simulation Analysis

As mentioned above, important factors to improve air pollution are as follows:

- New Vehicle Regulations, starting as soon as possible;
- In-Use Vehicle Regulations, with effective measures such as sufficient maintenance program, exhaust gas checking programs more frequently than the existing inspection system, and an incentive and fine system;
- Implementation of the Mass Transit Master Plan;
- Road construction of the 8th National Plan;
- Demand control by Sub Center Development proposed by this BEIP Study Team;
- Further air pollution mitigating plans, e.g., the modal shift from private to public transportation, introduction of lower emission vehicles than required in the current regulations.

CHAPTER 7: A SUMMARY OF FINDINGS FROM THE SIMULATION ANALYSES

7.1 Environmental Problem Linkages

As demonstrated by the simulation analyses in the preceding sections, all the sector problems are mutually linked with each other, as shown in Fig. 7.1. Since the origin of environmental pollutant loads in the city as a whole come from residents, all the environmental planning arguments are attributed to two aspects: 1) Bangkok urbanization pattern represented by population and land use; and 2) people's living behaviors.

Demands for traffic generation/attraction depend on the urbanization pattern, and affected by people's quality of living and potentials of the socioeconomic activities. This directly affects air quality conditions.

Planning of public service facilities is also dependent directly upon the urbanization pattern, and the existing master plans should be reviewed and revised, if necessary, based on the human settlement patterns.

Thus, outputs from the simulation are inputs for another sector analysis. The simulation analyses are based on such a problem linkage.

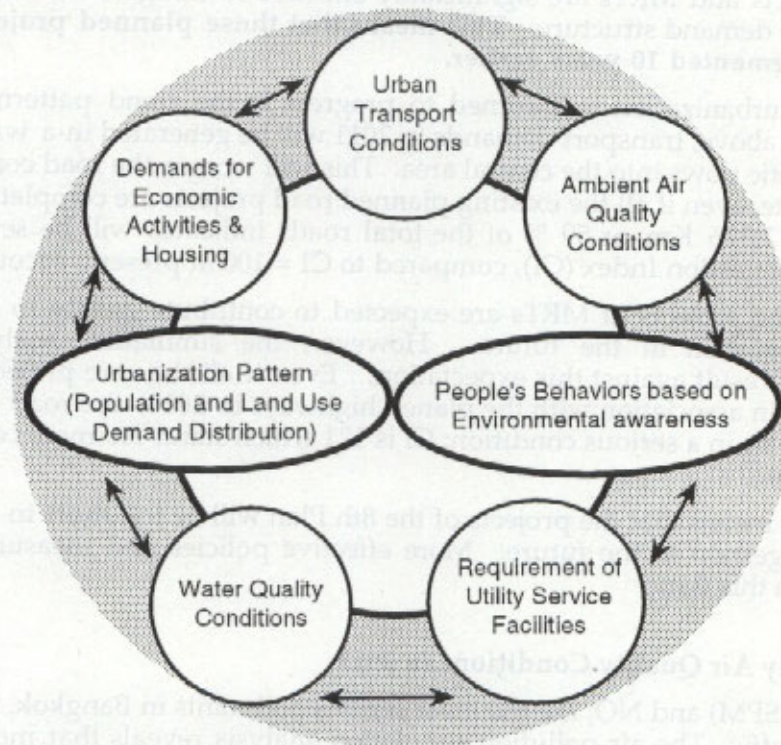


Fig. 7.1 A Linkage Structure among Urban Environmental Problems

7.2 Implications from Simulation of Most-likely Cases

A strong policy is necessary to shift the current movement of development towards the balanced urban growth while minimizing the further environmental deterioration in Bangkok. This is implied from the results of the simulation analysis on the most-likely case.

(1) Most-likely Urbanization in 2011

A total of 343 sq. km will be additionally demanded for the land areas for future urbanization to accommodate additional 2.37 million people up to 2011. Without additional policies to effectively manage land use, the further urbanization will take place mostly in a form of "Ribbon Development" along selected seven corridors with a radial pattern, and areas between the corridors will be gradually occupied for residential use without adequate infrastructures.

Since urbanization is likely to be led significantly by road transport infrastructures, the existing plans of highways will stimulate urbanization pressures along the highways, thereby offsetting the regional benefits. This pattern will worsen the current environmental state.

(2) Most-likely Road Transport Conditions in 2011

At present, as of 1995, out of the total road length of 1,732 km within BMA, 663 km, or 38%, are assessed to be heavily congested in morning peak hours.

Given a hypothetical assumption that the road projects committed for the 8th National Plan with additional 664 km, including ETA expressways, DOH and BMA roads were provided at present, the heavily congested roads would be reduced to half, or 354 Km. Furthermore, given an additional assumption of the completion of MRT systems, the length of heavily congested roads would come down to 219 km. Thus, the planned road projects and MRTs are significantly effective to mitigate the road congestion on the present demand structure. **This means that those planned projects should have been implemented 10 years earlier.**

As far as urbanization is assumed to progress in the trend pattern up to 2011 as mentioned above, transport demands in 2011 will be generated in a way to concentrate further traffic flows into the central area. This will worsen the road congestion than the current state, even if all the existing planned road projects are completed, that is, 1,389 Km out of 2,376 Km, or 59 % of the total roads indicates will be severely congested, and the Congestion Index (CI), compared to CI = 100 at present, accounts for 152.

The on-going projects of MRTs are expected to contribute greatly to mitigation of the traffic congestion in the future. However, the simulation analyses indicates a pessimistic result against this expectation. Even if all the core projects of MRTs were completed in association with the planned highways in 2011, the road traffic congestion would still be in a serious condition: CI is 121 which stand for more congested than the present state.

This result means that the projects of the 8th Plan will be too short to mitigate the road traffic congestion in the future. More effective policies and measures are needed to tackle with this issue.

(3) Most-likely Air Quality Conditions in 2011

PM-10 (or SPM) and NO₂ are the most serious pollutants in Bangkok, which are caused by road traffic. The air pollution simulation analysis reveals that most of the built-up areas are covered with the air with significantly higher concentration of PM-10 and NO₂ than the Thai environmental standard. This assessed to be a serious condition.

The level of air pollutant loads are determined by three factors: 1) average travel speed; 2) traffic volume, especially heavy vehicles; and 3) emission factors. Without any policy to tackle with these factors, the state of air quality in Bangkok will obviously be worsen and broaden, along with extending traffic congestion areas.

7.3 Implications from the Policy Input Cases

(1) Guided Urbanization

As far as the current spontaneous urbanization, or urban sprawl, is allowed, the pressures of urban environmental pollution would not be released and be further concentrated in the central areas. An orderly urban land use system should be pursued by growth management policies with definite guidelines for environment-oriented urbanization.

For this purpose, the simulation analyses implies that one third of land development demands additionally occurring in the future should be guided to areas in subcenter zones where deliberate development with adequate environmental infrastructures, discussed in Sections 9.4 and 24.1.

(2) Effectiveness of Transport Polices

As discussed in Chapter 5, in addition to the transport projects committed by the 8th Plan, four polices/strategies are employed for the simulation analyses to identify the effectiveness on road traffic congestion:

- Bus Priority;
- Road Capacity Increase;
- Area Restraint
- Subcenter Development

In terms of Congestion Index (CI), the most effective strategy is assessed to be "Bus Priority Policy", followed by "Area Restraint" and "Subcenter Development". The bus priority policy and the area restraint policy may be materialized with institutional arrangement plus minor additional investment on the infrastructures. On the other hand, "Subcenter Development" needs a strong initiative of the government sector and requires a massive investment for long time.

It should be noted that "Road Capacity Increase" would not contribute to mitigation of traffic congestion in the city as a whole, because more roads result in more traffic flows into the central areas.

An important implication derived from the above is that in order to improve the road traffic conditions, a policy mix placing high priority on the following are indispensable:

- 1) Bus transport system in association with MRTs;
- 2) Area control in the central area; and
- 3) Subcenter development to disperse the traffic generation/attraction structure.

(3) Effectiveness of Air Pollution Control Policy Mix

The simulation analysis also provides a planning implication that without a considerably sever policy mix, the air pollution cannot be mitigated to be under the designated standard level in terms of PM-10 and NO₂.

The simulation analysis reveals that given the urban re-structuring policy strengthened by a shift to the public transport-oriented system as well as "Subcenter Development" the air pollutant diffusion pattern in 2011 would be significantly changed. Despite that in the central area there will still exist a number of areas with higher concentration of

PM-10 and NO₂ than the standard, the air condition of Bangkok will be improved as a whole.

Therefore, it can be said that the following policy mix will be effective to mitigate air pollution caused by road traffic.

- 1) Travel speed up on road traffic in the inner city;
- 2) Significant shift of passengers from road transport to MRTs; and
- 3) Strong vehicle emission regulation policy (as the European standard).

The first and second factors all depend greatly on the urban structure and the transport system.

(3) Effectiveness of Air Pollution Control Policy Mix

The simulation analysis also provides a planning implication that without a considerably severe policy mix, the air pollution cannot be mitigated to be under the designated standard level in terms of PM-10 and NO₂.

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It should be noted that "Road Capacity Increase" would not contribute to mitigation of traffic congestion in the city as a whole, because more roads result in more traffic flows into the central area.

An important implication derived from the above is that in order to improve the overall conditions, a policy mix placing high priority on the following are indispensable:

- 1) Bus transport system in association with MRTs;
- 2) Area control in the central area; and
- 3) Subcenter development to disperse the traffic generation/attraction structure.

- Subcenter Development
- Area Restrain
- Road Capacity Increase
- Bus Priority

As discussed in Chapter 5, in addition to the transport projects committed by the BRT Plan, four policy strategies are employed for the simulation analysis to identify the effectiveness on road traffic congestion.

(2) Effectiveness of Transport Policies

For this purpose, the simulation analysis implies that one third of land development demands additionally occurring in the future should be placed in areas in suburban areas where deliberate development with adequate environmental management is discussed in Sections 9.1 and 24.1.

As far as the current spontaneous migration of urban sprawl and the pressure of urban environmental pollution would not be relaxed and be contained in the central area. An orderly urban land use system should be pursued by growth management policies with definite guidelines for environmental-friendly interaction.

- 1) Travel speed up on road traffic in the inner city;
- 2) Significant shift of passengers from road transport to MRTs; and
- 3) Strong vehicle emission regulation policy (as the European standard).

The first and second factors all depend greatly on the urban structure and the transport system.

Therefore, it can be said that the following policy mix will be effective to mitigate air pollution caused by road traffic.

PM-10 and NO₂ than the standard, the air condition of Bangkok will be improved as a whole.

**PART III: MASTER PLAN OF URBAN ENVIRONMENTAL
IMPROVEMENT**

CHAPTER 8: POLICY DIRECTIONS AND A SCENARIO OF URBAN GROWTH

8.1 Economic Growth with Environmental Preservation

Once Bangkok has already cleared a hurdle against the self-sustainable economic growth, it has now confronted with another crucial paradigm to seek an environmentally sustainable economic growth. A question is no longer of selection of which policy should be emphasized, the economic growth or the environmental preservation. The issue is to formulate a balanced system between both, based on a recognition that the economy must be part of the environmental system. In this regard, several arguments are viewed, prior to discussions of planning.

(1) Urban Economic Activities and Energy Consumption

Energy consumption, particularly use of fossil fuels, in economic activities, is a significant source of the environmental deterioration. Economic growth has always been putting pressure on environment of the city, however, environmental pollution of the city does not always increase at the same rate with the economic growth, looking into the other countries.

Fig. 8.1 compares the growth rates of the final energy consumption in relation with the level of GDP per capita in major countries over the world. It is generally observed, in fact, that along with the growth of per capita GDP, energy consumption per capita accordingly increased, and that the energy consumption per unit GDP is higher in lower income countries than higher income countries. For instance, while the per capita GDP of Japan is higher than that of Thailand by 15 times in 1993, the final energy consumption per capita of Japan was 5 times as large as that of Thailand. Consequently, it was 2.55 and 0.50 ton oil equivalent (TOE) per unit GDP in Thailand and Japan respectively.

Moreover, looking into city solid waste generation in comparison with major world cities, the garbage generation per person per day in Bangkok amounts to approximately 800 grams at present, which is the similar level to that in London, as shown in Fig. 8.2. It may be said that Bangkok is now the first class city in terms of garbage generation and energy consumption.

It is undoubted that the energy-consuming economy will be losing its international competitiveness in the near future, because the social costs will have to be paid by the economy itself. Therefore, Bangkok needs to formulate anyhow the more energy-saving economic system to maintain both environmental and economic sustainability with more emphasis than other cities in advanced countries.

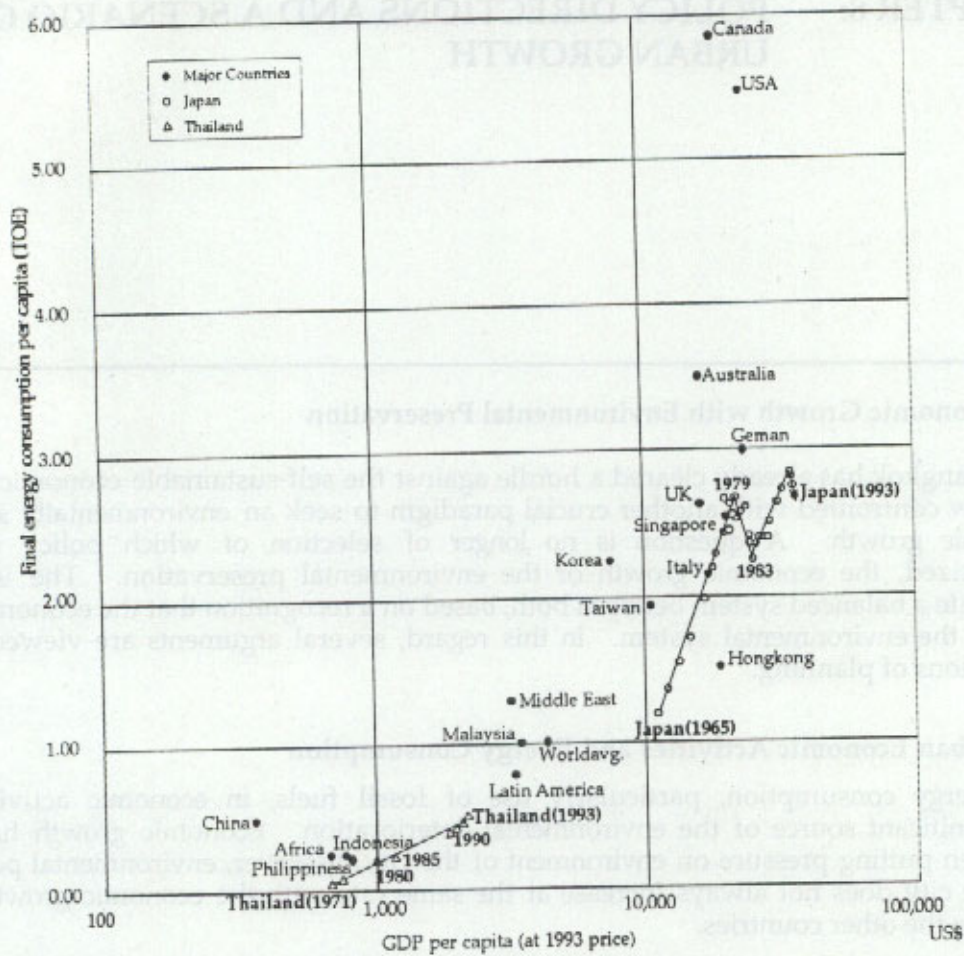


Fig. 8.1 Correlation between Per Capita Final Energy Consumption and Per Capita GDP Growth

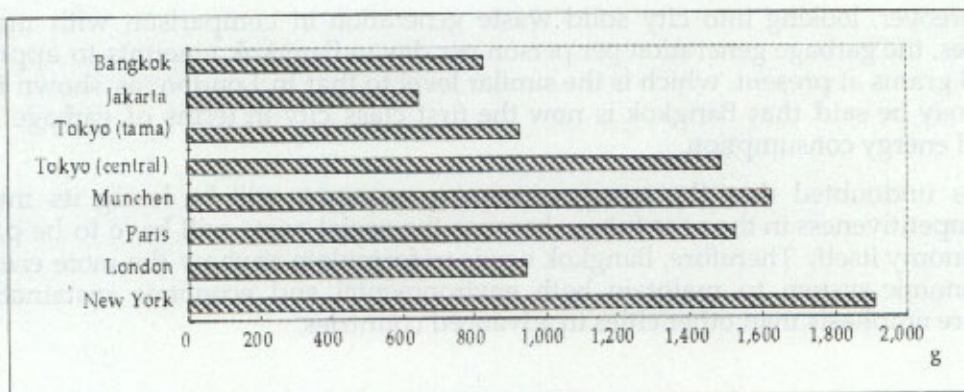


Fig. 8.2 Comparison of Per Capita Garbage Generation

(2) People's Awareness: More Economic Growth or Environmental Preservation

Nowadays, the majority of Bangkok people have already recognized the importance of environmental preservation at the cost of slow-down of the economic growth. This was identified by the Interview Survey on Environmental Awareness to a total of 3,000 Thai people, of which 1,000 are in Bangkok, conducted by Institute of Developing Economies (Japan) in September to December 1994. A Summary of the results are as shown in Table 8.1, and the following are suggestive findings from the survey:

- 59% of Bangkok people have an opinion that environmental protection is more important than economic growth, while 25% select economic development rather than environmental protection;
- Out of prevailing environmental problems, Bangkok people consider that the most serious is "Air Pollution (44%)", followed by "Deforestation (28%)" and "Water Pollution (14%)";
- 41 % of Bangkok people recognize "Deterioration of the Environment" as the most serious social problem, followed by "Rife Corruption and Bribery" (25%); and
- The majority of Bangkok people, or 69%, feel significant apprehension on health and life by the environmental deterioration.

It can be said, based on the survey results, that the environmental improvement must be now the most concern among Bangkok people.

Table 8.1 A Summary of Environmental Awareness Interview Survey

	%
1. People's Awareness regarding Urban Environment:	
Environment VS. Economic Growth	
"Which do you think more important "Economic Growth or Environment"	
1) Environment	59
2) Economic Growth	25
3) Both	16
2. Most Serious Environmental Problems in Bangkok	
1) Air Pollution	44
2) Deforestation	28
3) Water Pollution	14
4) Garbage	6
5) Food	3
6) Drought	2
7) Noise Pollution	2
3. Most Serious Problems in Thai	
1) Natural/Environmental Deterioration	41
2) Rife Corruption and Bribery	25
3) Too Big Gap between the Rich and the Poor	14
4) Lack of Respect for the Superious and the Elderly People	7
5) People are Less Religious	7
6) Good Family Background is an Advantage for Job Opportunity	7

Source: Environmental Awareness Survey, September - December 1994, IDE

(4) Policy Framework of the 8th National Economic and Social Development Plan

National Plan and Environmental Legislation

During the initial stage of the economic growth in Thailand, degradation of environmental quality was not considered as a critical constraint against sustainable development. The national government executed the environmental legislation with a rather small scale. Consequently, the environmental quality had not been functionally managed in urban areas and in tourist spots to exceed the people's acceptable level.

Results of the Sixth National Plan (1987-1991) brought about the economic growth with a respectable degree of stability, security and a generally better standard of living of the people. However, such high economic growth had led the Thai society to the distortion in the economic development in association with the environmental quality degradation.

The Seventh National Plan (1992-1996) formulated definite policies on environmental development to improve the situation of public nuisances for better quality of life. And, at present, a number of the environment-related projects are currently being implemented.

In 1992, the Government established a new ministry, Ministry of Science, Technology and Environment (MOSTE), reorganizing the existing governmental agencies and offices to execute the revised act, Enhancement and Conservation of the National Environmental Quality Act-1992 (called "the Environmental Act"). Pollution Control Department (PCD), MOSTE, takes principal roles for environmental projects/programs though it is required to have well coordination and close cooperation among other relevant implementing agencies of environmental projects. The current legislative framework consists of the following acts:

<u>Environment-Related Acts</u>	<u>Enacted Year</u>
• National Environmental Act (Enhanced)	1992
• Public Health Act	1992
• Public Cleansing and Orderliness Act	1992
• Factory Act	1992
• Agricultural Land Use Act	1975
• Royal Thai Irrigation Act	1975
• Land Development Act	1983
• City Planning Act	1975
• Industrial Estate Act	1979
• Toxic Substance Act	1992
• Ground Water Act	1977
• BMA Act	

Table 8.2 summarizes the major aspects regulated by the environmental quality acts.

Past Performance of Environmental Policies

In the Seventh National Plan (1992-1996), the main objectives of development had been articulated: 1) Maintain economic growth with sustainability and stability; 2) Distribution of income and decentralization; and 3) Development of human resources, upgrading quality of life, environment and natural resources management.

Base on the Plan, six sewage projects in Bangkok, started, but only one, Sipraya Waste Water Treatment Plant, has been completed at present. The Khlong water quality improvement project in the central area in BMA, of which the construction work started in 1993, made the less than 20 % work performance during the last 2 years.

For the smooth implementation of environmental projects such as solid waste incineration projects, the mutual trustworthy relation is needed among the executing agency and neighboring communities of the project site, as represented by the Chiang Mai project. Involvement of activities of NGOs and/or communities from the early stage is essential, otherwise, the project implementation is subject to delay.

Meanwhile, the air quality monitoring work executed successfully with 18 stations in the whole country, including 8 stations in Bangkok to monitor the real time air quality. However, few practical measures have been undertaken based on the monitored data.

Due to the delay of environmental development projects in the Seventh National Plan, the environmental quality in air, in water, in solid waste, etc. have not been improved yet.

Environmental Policy of the Eighth National Plan

The Eighth National plan (1996-2001) was recently released in public. The Plan includes a number of policy requirements for rational management of natural resources, priority accorded to the environmental protection and conservation, and restoration of natural resources on the basis of sustainable and balanced development between economic growth and human life. Measures for materialization of the Plan are summarized as follows.

- 1) Establishment of Community Participation: by decentralizing the implementation of environmental development to the provinces and to the local communities;
- 2) Cooperation for Development: with environmental legislation for development based on a "polluter-pay-principle" applied to project owners and beneficiaries by using economic tools to ensure feasibility of the project; and
- 3) Encouragement of Scientific and Technical Development: by development of human resources, support of clean technology, and support of private sectors for green products.

(5) Policy Framework of the 5th Bangkok Development Plan

The main environmental policy of the Fifth BMA Plan (1996-2001) has just been formulated, aiming to achieve the policy targets as follows:

- Investment on construction of environmental infrastructures and continuous expansion works;
- Human resources development on both BMA and publics through information and participation on environmental problems;
- Beneficiaries side management based on the polluters pay principle;
- Rational management of urban development harmonized with environmental conservation; and
- Promotion for privatization in environmental development.

All the policies are assessed to be on the right way. The Plan includes a list of projects/programs for implementation with five categories during the period of Fifth BMA Plan: 1) development of overall environmental conditions; 2) drainage and flood protection; 3) waste water treatment; 4) solid waste and hazardous wastes management; and 5) air and noise pollution abatement. Table 8.3 shows a draft of the projects/programs to be stipulated in the Plan.

Table 8.2 Environmental Legislative Framework in Thailand

Acts	Regulated Categories	Stipulated Items/ Aspects
The National Environmental Quality Act	<ul style="list-style-type: none"> • Empowered Authority and Duties of National Environment Board; • National Environmental Funds; • Environmental Protection • Environmental Quality Standards • Environmental Quality Management Planning • Conservation and Environmentally Protected Area; • Environmental Impact Assessment • Pollution Control Committee; • Emission or Effluent Standards 	<ul style="list-style-type: none"> • Pollution Control Area; • Air and Noise Pollution; • Water Pollution; • Other Pollution and Hazardous Waste; • Monitoring, Inspection and Control; and • Service Fee and Penalty; • Pollution Control, including: • Inducement Measures; • Civil Liability
Air Quality Standards	<ul style="list-style-type: none"> • National Ambient Air Quality Standards • Industrial Emission Standards • Motor Vehicle Emission Standards • Boat, Ship, & Vessel Emission Standards 	
Noise Quality Standards	<ul style="list-style-type: none"> • Community Noise Standards • Noise Emission Standards • Motor Vehicle Standards • Noise Standard in Workplace by Ministry of Interior and Ministry of Industry 	<ul style="list-style-type: none"> • Boat, Ship & Vessel Noise Standards.
Water Quality Standards	<ul style="list-style-type: none"> • Drinking Water Standards • Industrial Effluent Standards • Effluent Water Standards • Coastal Water Quality Standards • Surface Water Quality Standards • Building Effluent Standards • Coastal Water Quality Standards • Chao Phraya River Water Quality Standards • Tha Chin River Water Quality Standards • Bangkok, Nakorn Nayor, Prachinburi River Water Quality Standards • MaeKlong River Water Quality Standards 	<ul style="list-style-type: none"> • Bottled Drinking Water Quality • Regulation of Industrial Pollution Control Facilities; • Industrial Effluent Guideline for Discharging into Eastern Seaboard Coastal Area (Map Tha Phut Area); • Water Characteristic Discharged into Deep Wells • Classification of Coastal Water • Area Classification for the West Coast of Phuket Island
Solid Waste, Night Soil and Hazardous Waste Stan	<ul style="list-style-type: none"> • General Solid Waste and Night Soil Management • Solid Waste, Night Soil and Hazardous Waste Management for Factories • Solid Waste Management for Multistory or Large Buildings 	<ul style="list-style-type: none"> • Solid Waste and Night Soil Collection Fee • Solid Waste or Unusable Material • Expired or Unusable Solvents • Solid Waste or Unusable Material from Specified Industries • List of Chemical Waste by Ministry of Industry
Toxic Substance Legislation	<ul style="list-style-type: none"> • Toxic Substance Limits in Food • Atmospheric Chemical Standards in the Workplace 	<ul style="list-style-type: none"> • Banned and/or Restricted chemicals under the Toxic Act
Nuisance Abatement	<ul style="list-style-type: none"> • General Nuisance Abatement • Industrial Nuisance Abatement 	

Table 8.3 Environment-related Measures in the Fifth Bangkok Development Plan (1996-2001)

Sector	Major Strategies/Programs
1 Development of Overall Environmental Conditions	<ul style="list-style-type: none"> • Increase green area by planting at unused land in BMA Area • Improvement and restoration of Klongs for effective use • To organize seminar and training for BMA administration staff for understanding of environmental development • Coordination and cooperation with other sectors for environmental conservation
2 Drainage and Flood Protection	<ul style="list-style-type: none"> • Preservation and development of vacant land for retardation of floodwater runoff • Improvement and construction of polder systems in BMA Area, especially in Tonburi and eastern suburbs • Survey and data collection on sub-drainage systems for linking with the main drainage system • Promote support from the government for procurement of retardation area
3 Waste Water Treatment	<ul style="list-style-type: none"> • Completion of on-going projects including leachate treatment plant • Environmental legislation for controlling discharge from buildings • Enhancement of the capability of discharge investigation • Promotion of private sectors for Waste Water management • Improvement of water quality in Klongs • Public campaign to combat water pollution for water quality improvement
4 Solid Waste and Hazardous Waste Management	<ul style="list-style-type: none"> • Continuation of existing systems on collection and disposal • Improvement of solid waste treatment plants at On Nut and at Nong Khaem for integrated development • Provision of equipment to increase efficiency in collection, transfer and sanitary landfill • Enhancement for separation of hospital waste from general waste • Promotion of private sectors for solid waste management • Introduction of appropriate service charge and regulations • Staff training for solid waste management
5 Air and Noise Pollution Abatement	<ul style="list-style-type: none"> • Introduction of stringent standards for control of air and noise pollution • Establishment of the centers for coordination and cooperation with other sectors • Public relations on environmental problems

Source: BMA

8.2 A Vision of New Bangkok 2011

Viewing the future, Bangkok will have to confront with a number of changes to be required by the times in its economy and society. Some of conceivable changes are prospected to get future insights into the Bangkok environment as follows:

(1) Knowledge-based international hub city

Thailand has been enjoying a rapid economic growth at more or less 10% p.a. since 1987, in which the Bangkok economy does and will continuously strengthen its centric and higher urban functions rather than industrial function. More information-based and more value-added types of business with international linkages will be expanded. Appreciating this favorable trend, Bangkok is expected to shift towards "Knowledge-based international hub city" of the Southeast Asia, having the urban environment as good as corresponding to such a reputable city.

(2) A Mega-city with more than 10 million Population

Bangkok is still accepting rural-to-urban migrants at a significant rate, despite a long-standing "Decentralization Policy". Although this increasing trend will cease in the long-run along with the economic growth in regional areas, however, Bangkok will grow to be one of the largest Mega-cities over the world with more than 10 million population in 2011.

(3) Environment-conscious Society

The expected economical development will eventually up-lift the per capita income level to be US\$13,000 in 2011, compared to US\$5,600 at present as of 1995. As being economically affluent on one hand, people will become more environment-conscious and more cultural identity-oriented on the other hand. Environmental improvement will be a further critical policy issue.

(4) Mass Transit-driven Urbanization

The current energy-consuming structure of the urban transport system will be enforced to be shifted towards an "Energy-saving City" to manage the more efficient and internationally competitive urban economy. To this end, Urban Re-structuring will be a key issue for urban planning, based on "Mass Transit-driven Urbanization". And, the society will call for people's awareness of importance of efficient resource utilization and recycling in process of modernization and up-grading of their living environment.

(5) Public Benefit-oriented Society under Urban Growth Management

"Urban Metabolism" will apparently be more activated in land use, affected by a structural change in demands at real estate and housing markets. The inner urban area will be pressured to be re-generated due to land economization, and suburban areas will be further developed to accommodate increasing land demands. Growth Management System, therefore, will be strictly required to materialize orderly urbanization symbiotic with the environment.

"Laissez-faire" must be a principle of the free economy, and should not be narrowed by anyone. However, under the circumstances that available resources are strictly limited in use and that one's gain is likely to result in worsening the other's welfare, this principle may be somewhat restricted or controlled by the authority. Urban development is the case. Free transactions of land and buildings under the free market is now producing more diseconomies, thereby eventually offsetting the otherwise

would-be-gained economic benefits in the society. Hence, the more Public Benefit-oriented Society needs to be pursued in planning of urban environment improvement.

8.3 Planning Disciplines for Urban Environmental Planning

As proved in many other cities, only technical solutions are sometimes not effective and rather likely to produce another problems. Planning of the urban environment is a task to depict a blueprint of the total urban system itself. Because all urban activities are part of the environment and elements of the environmental dynamic system, the task calls for a sophisticated discipline to incorporate all factors into the total urban system which assures people's quality of living. The following considerations were a basis of the planning.

(1) Pursuance of Sound Urban Environment

Planning of environmental improvement pursues four (4) vital elements of human life, i.e., people's healthy, safe, comfortable and convenient lives.

Healthiness: Clean water, clean air and nutritious foods are substantial and good sleep, proper exercise and hygienic metabolism are essential to maintain people's healthy lives.

Safeness: Being free from any fear and danger on one's individual life should be assured in safe transport, social and food security and no natural disaster.

Comfortableness: People feel comfortable when they live in their inherent socio-culture with the indigenous natural environment.

Convenience: Smooth and efficient access to urban services, work places and schools should be first provided for people within their living spheres.

(2) Sustainable Growth with Economy and Environment

Three principles basically need to be employed for realization of a sustainable economic growth while maintaining the quality of the urban environment:

- An economic principle is needed to be employed to materialize a sustainable development system, that is, a decrease of environmental resource by one unit of economic value shall be compensated with an increase of environmental input by the corresponding value through the economic mechanism. The **polluter-pay-principle** may be justifiable in this sense. Social costs for the environmental improvement should be compensated by the economy itself.
- The manner (or **social rules**) for usage of limited environmental resources is also a focal argument on the community ground. Any type of development should minimize anticipated negative impacts on the environment based on another principle that one's gain never results in worsening the other's welfare.
- Urban development management needs to be systematized, based on a faith that a preventive approach is less costly than a curative or remedial approach in the long-run. Before worsening the environment, effective measures against it should be undertaken. The sooner, the better.

(3) Functioning Urban Metabolism System

The city itself is of an organic system. The city always changes its land use and functions, in response to requirements of the times and the economy. This may be called "Urban Metabolism".

To maintain the well-functioning metabolism, two sub-systems must work reciprocally: "Anabolism" and "Catabolism".

- **Anabolism:** the city always requires fresh and clean inputs sufficiently enough to maintain the organic system such as water, air and foods.
- **Catabolism:** the city produces as same volume of excrement such as waste water, solid waste and air emissions as inputs which need to be treated, otherwise it would damage the capability of the urban function itself.

Symbiosis of the man-made environment and the natural environment, as illustrated in Fig. 8.3, is a key planning concept.

(4) Urban Growth Management

Every organism inherently knows its limit of growth. The limit is determined as a level that it can manage itself. Alike, the Bangkok Megalopolis needs a urban growth management system. The growth shall be managed within the carrying capacity that the government can manage in providing necessary public services to protect the environment. The carrying capacity is determined by the authorities' managerial and economic capabilities.

More important is development of institutional systems effective for urban growth management as planning administrative tools and/or power. This is one of focal issues in this Study.

(5) A Tripartite Approach for Implementation of Environmental Programs

Without integrated efforts of three parties of the government, economic and social sectors, a sustainable implementation system could not be built to improve the urban environment, as conceptually illustrated in Fig. 8.4. The public benefit-oriented society lies on the ground of reciprocal relations among the three parties whose roles, duties and rights be just performed.

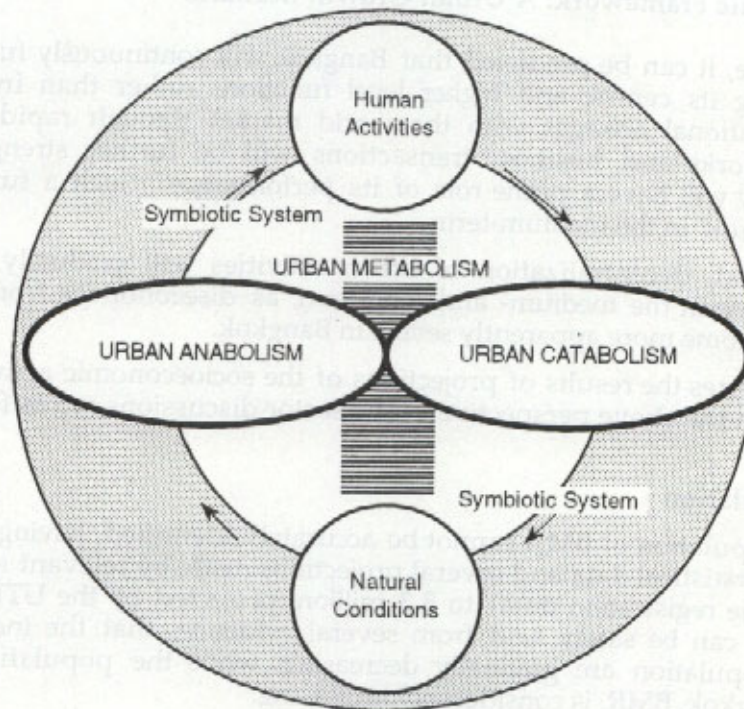


Fig. 8.3 A Concept of Urban Metabolism and Environmental Symbiosis

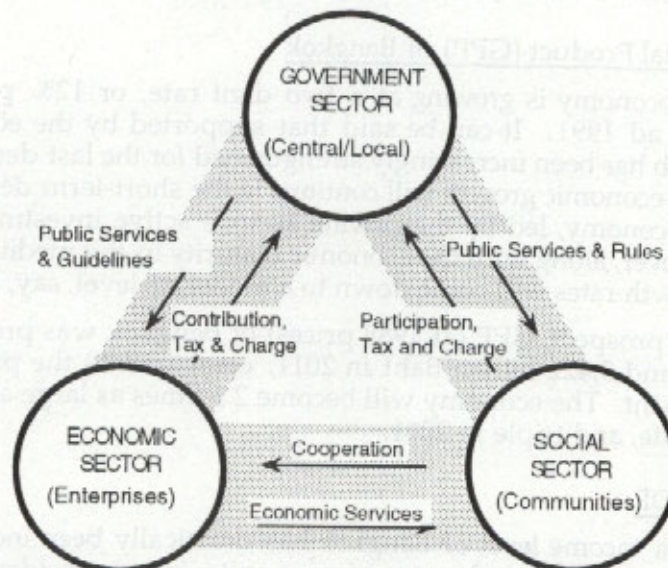


Fig. 8.4 Tripartite Approach Required for Environmental Improvement

8.4. Socioeconomic Framework: A Urban Growth Scenario

Viewing the future, it can be predicted that Bangkok will continuously function as a prime city, strengthening its centric and higher level functions rather than industrial function. Moreover, international linkages with the world market through rapid development of information networks and business transactions will be further strengthened, and the Bangkok economy will have a prime role of its performance. Such a functional shift will make "New Bangkok" in the medium-term.

On the other hand, decentralization of urban activities will gradually proceed over its surrounding regions in the medium- and long-term, as diseconomies from the economy of agglomeration become more apparently severe in Bangkok.

Table 8.4 summarizes the results of projections of the socioeconomic activities in the future till 2011, based on the above perspectives. The sector discussions are as follows:

(1) Urban Population

The 1995 Population of BMA cannot be accurately identified, having a great difference among the statistical data and several projections made by relevant studies: 5.6 million (based on the registration data) to 8.3 million (projected by the UTDM project team). However, it can be safely said from several evidences that the increase rates of the Bangkok population are gradually decreasing, while the population in the regions outside Bangkok, BMR, is considerably increasing.

The pressure of population increase will be gradually released in Bangkok in the long-term. Instead, a more strong pressure will appear on urban restructuring aiming at more efficient and comfortable urbanization. In the year 2010, the Bangkok population will reach around 10 million, compared to the 1995 population of approximately 8.0 million. This projection was made in coordination with the UTDM Project team, based on the a most-likely case study.

Thus, the urban physical and spatial framework to accommodate this 10 million population should be functionally structured toward the target year 2011.

(2) Projections of the Economy and Household Income

Gross Provincial Product (GPP) of Bangkok

The Bangkok economy is growing at a two digit rate, or 12% p.a., during the period between 1989 ad 1991. It can be said that supported by the economic foundation of Bangkok which has been increasingly strengthened for the last decade, such a favorable momentum of economic growth will continue in the short-term despite some fluctuation of the world economy, led by the private sector's active investment onto new business sectors. However, along with the economic maturity in the medium- and long-term, the economic growth rates will come down to a moderate level, say, 8 - 6 % p.a.,

Based on this prospect, GPP (at 1988 prices) of Bangkok was projected at 2,557 billion Baht in 2006 and 3,422 billion Baht in 2011, compared to the projected 1995 figure of 1,149 billion Baht. The economy will become 2.5 times as large as that at present in the nest one decade, and triple in 2011.

Per Capita GDP

The per capita income level of Bangkok has drastically been increasing at 8-10 % p.a. for recent years. The growth rates of per capita income is identical to the difference between growth rates of the economy and the population. Eventually, the per capita income (at 1988 prices) will account for approximately 261 thousand Baht (or equivalent to US\$ 10,400) in 2006 and 326 thousand Baht (or equivalent to US\$ 13,000) in 2011.

Average Monthly Household Income

The BEIP team conducted the Home Interview Transport Survey with a total of 4,000 families over BMR in 1995. Adding to the same survey by the UTDM team with 4,000 families, we have the 8,000 families' transport data base, which can provide with a number of social attributes of families in BMR. From the data base, the average monthly household income in 1995 can be identified to be 21,032 Baht. Taking into account the growth rate of per capita GDP and a decreasing trend of household size, the average monthly household income will be approximately 33,802 Baht in 2011 at a 3.0% p.a. growth rate between 1995 and 2011.

(3) Urbanization and Land Use

The above movements as seen in the Bangkok economy will encourage a "Urban Metabolism", which will encourage physical changes in the urban land use pattern, affecting the demand structure of the real estate market such as commercial, office floor and housing markets. Industrial facilities locating in the inner areas will be rationally enforced to be relocated towards suburban areas.

The present urbanized area as of 1995 is projected at approximately 541 sq. km, or 34.3% of the total BMA area. Future demands for land use are determined by several dynamic factors: 1) increases in number of households; 2) up-grading of housing requirements; 2) demands for the would-be-rebuilt houses/buildings; 3) regeneration of the high density areas in the inner city; 4) manners of housing development; 5) provision of infrastructures and so on.

The BEIP team projected the future demands for urban land use based on a urbanization simulation analyses, as discussed in Chapter 4, taking into account selected factors out of the above. As the result, the urbanized area will account for 884 sq. km in 2011, or increase by 343 sq. km in coming 16 years from 1995 till 2011.

The urbanization ratio, in terms of percentage of urbanized area to the total, will be 56% in 2011, compared to 34% at present. It is assessed that Bangkok will reach a limit in its carrying capacity to accommodate the anticipated urbanization by 2011, taking into account the necessary open space to manage water.

Looking into changes in the population densities in urbanized areas, a gradually decreasing trend will appear, that is, about 150 persons/ha in 1995 and about 12 persons/ha in 2011. This implies a more horizontally spreading urbanization pattern. This comes from a reason that along with the development of infrastructures such as MRTs and highways, the urban potential areas will be gradually expanded in the future.

(4) Motorization

As of 1993, the number of all types of registered vehicles, except motorcycle, accounts for about 1.55 million, or 0.2 vehicle per capita. The number of registered motorcycles was 1.1 million in the same year.

It has broadly been proved that the car ownership grow proportionally in correlation with the economic growth. In fact, the car ownership elasticity of GPP in BMA is computed at 1.1 between 1991 and 1993, and 0.77, between 1989 and 1991, reflected by predominant increases since 1991. In fact, motorization in Bangkok has recently been full-blown, due to up-lifting of income levels in association with reduction of the tax.

As for the future prospect, two cases are conceivable:

Case 1: If the supply side provision can keep up with the demand in the future, in other words, if the traffic congestion and other external factors cannot become any constraint against vehicle ownership, the number of vehicles would increase elasticity (at the elasticity of 1.0 to 1.1) with the economic growth in the future. In this case,

approximately 4.5 million vehicles, except motorcycles, will be registered in 2006, and 6.1 million in 2011.

Case 2: If some strategies and measures effectively can restrain the vehicle ownership by providing a well-functioning mass-transit systems as an alternative transport means, and if demand control measures for car usage and through the taxation be effective, the number of vehicles will increase at a diminishing growth curve. In this case, approximately 3.4 million vehicles, except motorcycles, will be registered in 2006, and 4.1 million in 2011.

The difference between the two cases is as large as about 2 million in 2011. Case 1 might be the most-likely case under no policy intervention, but it will make more difficult to release the road traffic congestion. On the contrary, should Case B be materialized, the traffic burden on roads would be released. For the planning framework of the BEIP, Case 2 is applied with coherence with the proposed transport planning concept.

Meanwhile, the numbers of motorcycles are assumed to be 2.36 million in 2006 and 2.73 million in 2011. The growth rate is thought to be gradually decreasing in the future.

Table 8.4 Planning Framework for Future Development in BMA

	1995	2001	2006	2011	Increase 1995-2011	Avg. Growth Rate 1995-2011 (% p.a.)
Socioeconomic						
Population ('000)	8,126	9,044	9,761	10,496	2,370	1.6
No. of Households ('000)	2,037	2,316	2,578	2,870	833	2.2
Household Size	3.99	3.91	3.79	3.66	-	-
No. of Jobs ('000)	4,338	4,757	5,222	5,681	1,265	1.7
GPP-BMA (Bill. Baht at 1988 const. Price)	1,149	1,823	2,557	3,422	2,273	7.1
Per Capita Income -BMA ('000 Baht at 1988 const. Price)	141.4	201.6	261.2	326.0	184.9	5.4
Average Monthly Household Income-BMA (Baht/month at 1995 Price)	21,032	25,128	30,021	33,802	12,770	3.0
Urbanization						
Urbanized Land Area (Km ²)	541	606	719	884	343	3.1
Urbanization Ratio (% as of BMA total area)	34.3	38.4	45.6	56.1	-	-
Population Density (prs/ha)	150	149	136	119	-	-
Motorization						
No. of Vehicles Registered ('000 in BMA)	1,911	2,773	3,406	4,065	2,154	4.8
No. of Motorcycles Registered ('000 in BMA)	1,335	1,936	2,355	2,730	1,395	4.6
Vehicle Ownership per Households in BMA (excl. Motorcycle)	0.94	1.20	1.32	1.42	-	-

Source: The JICA-BEIP Study Team

8.5 Impacts on Environmental Pollutant Loads

The population growth and economic development will eventually bring out significant impacts on the urban environment and bear massive demands for public services and investments. In order to identify the magnitude of the environmental loads of BMA as a whole in the future, the demands for solid waste, water and waste water, which depend directly on the population and economy, were projected. The summary is tabulated in Table 8.5. The detailed arguments on these aspects are made in the respective sector study in Chapters 3 through 8 of Volume 3.

(1) Solid Waste Generation

Per Capita Generation

Detailed data for solid generation is not available, but the statistical records of amounts of collected solid waste are available. Nonetheless, based on an assumption of the service coverage of collection of 75%, a total of about 8,800 ton/day is assumed to be generated in BMA as a whole at present in 1995. The per capita generation amount, therefore, can be computed at 1,083 g/day.

Meanwhile, looking into the time series data of collection amounts, the amounts are growing at 7-8% p.a. and a simple regression function can be derived from the data. Using the same propensity of the regression model, the generation amounts can be estimated in the future, and eventually the annual changes in per capita amount can also be projected. This analysis yields a theoretical scenario that per capita generation amount will grow at 2.2 % p.a. and as the result the per capita generation in 2011 will be 1,540 g/day, or about 1.5 times as large as that at present.

As a planning issue, however, this upward trend of solid waste generation should be controlled with extending an aggressive campaign for "Reduction of Solid Waste" focusing particularly on enterprises. A great effect can be expected on enterprises rather than residents. Then, it was targeted that the per capita generation amount shall be reduced by 15% of the theoretical amount, and stay at the level of 1,308 g/day in 2011.

Total Amount of Solid Waste Generation

A simple method was tentatively applied to project the total amount of solid waste generation in BMA, which is the product of multiplying the population by the per capita generation. A total of about 13,700 ton/day will be generated as the demand for disposal in 2011. In 2006, it will account for 12,300 ton/day with an increase of 3,500 ton/day during next one decade.

(2) Water Demand

Per Capita Water Demand

It is normally understood that the per capita water demand tends to increase along with upgrading of people's quality of living, however, the level of per capita water consumption of Bangkok people, which is projected to be 480 lt./day in 1995, is deemed to be at a saturated level. By promoting an active campaign for "Save Water", and foreseeing a more water-saving economy of Bangkok, the amount will be able to decrease. Based on this perspective, it was assumed to be 440 lt./day as a target in 2011.

Total Water Demand

At present, as of 1995, the total water demand in BMA is projected at approximately 3.9 million cubic meter per day (MCD). The future water demands were projected,

multiplying the per capita water demand by the population, at 4.43 MCD in 2006 and 4.62 MCD in 2011. The additional demand up to 2006 from now will be 0.53 MCD.

(3) Sewage Amount To Be Treated

The potential amount of sewage to be treated is basically identical to the amount of water supply. However, because of some technical and engineering reasons, it should be computed by multiplying an empirical coefficient of reduction. As the result, the total amounts will be 4.25 MCD in 2006 and 4.43 MCD in 2011.

Table 8.5 Tentative Projection of Demands for Solid Waste, Water and Sewage

	1990	1991	1993	1995	2001	2006	2011
Solid Waste Generation							
Per Capita Generation: Planned (g/d)	-	-	-	1,083	1,191	1,257	1,308
Total Generation (ton/day)	6,847	7,211	7,978	8,800	10,774	12,306	13,730
Per Capita Generation: Regressed (g/d)	940	969	1026	1,083	1,254	1,396	1,539
Reduction Target				0.0%	5.0%	10.0%	15.0%
WATER DEMAND							
Per Capia Demand (LPD)	-	-	-	480	465	452	440
Total Demand (MCD)	-	-	-	3.90	4.20	4.43	4.62
WASTE WATER							
Potential Sewege Amount (MCD)	-	-	-	3.74	4.03	4.25	4.43

Source: the JICA-BEIP Study

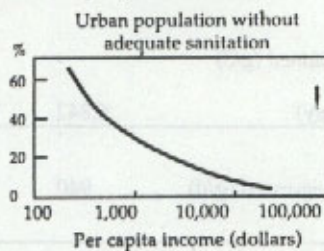
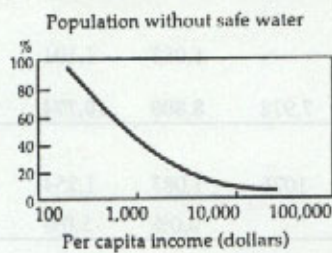
Box: Incidence of Environmental Problems along with Economic Growth

Environmental Indicator at Different Country Income Level

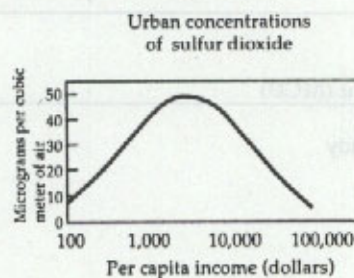
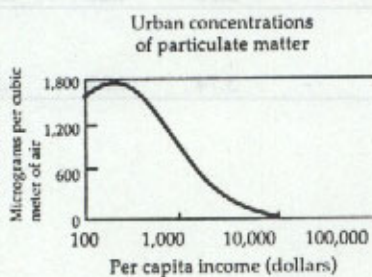
The World Bank Report analyzed the relation between economic activities and environmental problems. Three patterns emerged as follows:

- Pattern 1: Some problems may improve with income growth (water, sanitation)
- Pattern 2: Some problems may worsen but eventually improve with economic growth (PM, SO_x)
- Pattern 3: Some problems may continuously worsen with income growth (waste, CO₂)

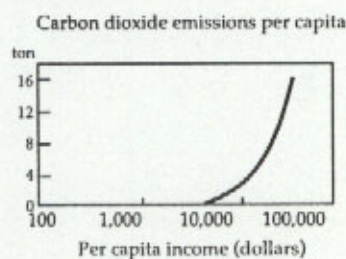
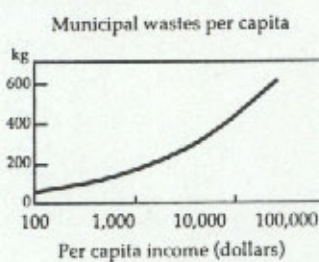
Pattem 1: Increased income provides the resources for public services.



Pattem 2: Some problems improve when country introduces right policies to ensure the input of the additional resources to environmental improvement.



Pattem 3: Some problems worsen as income increases.



Note: Estimates are based on cross-country regression analysis of data from the 1980s.
 a. Emissions are from fossil fuels.
 Sources: Shafik and Bandyopadhyay, background paper, World Bank data.

Source: World Development Report 1992

CHAPTER 9: A VISION OF SPATIAL FRAMEWORK

9.1 A Regional Spatial Framework

(1) A General View

It is a long-standing issue how to release the excessive concentration of Bangkok Metropolis. Since diseconomies of scale/agglomeration have merged in several forms of traffic congestion and environmental deterioration since one decade ago, any policy paper and/or any plan have addressed the necessity of "decentralization of urban economies" for the substantial solution of this problem. A urban structure reform of Bangkok Metropolis, therefore, has broadly been recognized among relevant authorities. People know that "now" is no longer the time to think, but the time to put into action.

Planning directions of the environmental improvement in Bangkok are eventually derived from this argument, simply because the environmental problems in Bangkok are attributed mostly to the congestion in association with inadequate urban land use and a shortage in infrastructures to support the huge economic agglomeration.

(2) A General Spatial Framework in the Extended BMR depicted by NESDB

The key word is "decentralization", "re-allocation" or "re-distribution" of economic resources over the area. The spatial framework for this argument is not limited to BMR, but a wider extent encompassing vast areas within a 200 km radius from the center of Bangkok, which is recognized as an extent to integrate potential economic activities and resources influenced by the Bangkok economy.

The Thai Government has long pursued the decentralization policy, fostering several regional growth poles other than Bangkok in the spatial framework with a 100-200 Km radius from the center of Bangkok. The first comprehensive blueprint titled the Chao Phraya Multipolis Structure Plan was studied by NESDB in 1994. This plan envisaged a macro-spatial structure to foster three regional sub-government centers in the eastern, western and northern wings centered on Bangkok.

Recently, NESDB has depicted the regional spatial framework for extended Bangkok Region for the 8th National Plan. This follows the same basic concepts raised by the Chao Phraya Multipolis Structure Plan, as shown in Fig. 9.1.

In this context, high priority development is proposed to be the Airtran Corridor (Bangkok-Chachoengsao) to accommodate 940,000 additional population (by 2010) and economic growth to be driven by the SBIA. This corridor includes development of three new centers:

- **Lat Krabang Center** (with a target population of 180,000) for knowledge activities requiring close access to the SBIA;
- **NHA New Town** (with a target population of 250,000) for housing for direct and indirect aviation-related workers of the SBIA; and
- **Chachoengsao West Complex** (with a target population of 400,000) for a regional center with manufacturing headquarters and a R & D center.

Equally, the other two growth centers are highlighted as high priority development:

- the ESB Core, centered on Chonburi; and
- the Greater Suraburi Industrial Core (GSIC).

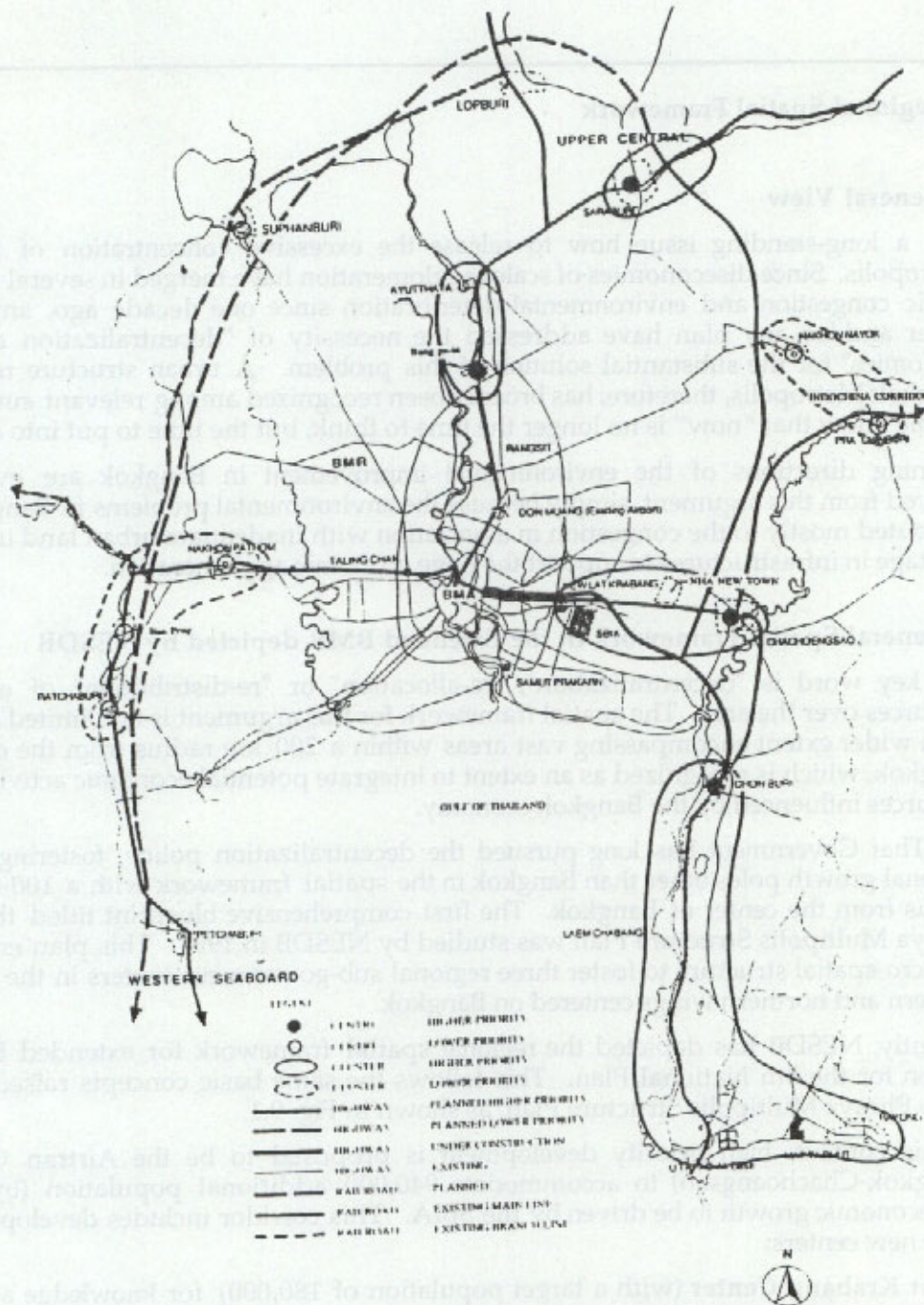


Fig. 9.1 A General Spatial Framework of the Extended BMR (NESDB)

(3) Regional Spatial Structure for the Greater Bangkok Metropolis (Proposed)

Based on the above spatial framework proposed by NESDB and long-standing planning discussions on decentralization schemes, the BEIP team envisages a regional spatial structure for the Greater Bangkok Metropolis as shown in Fig. 9.2.

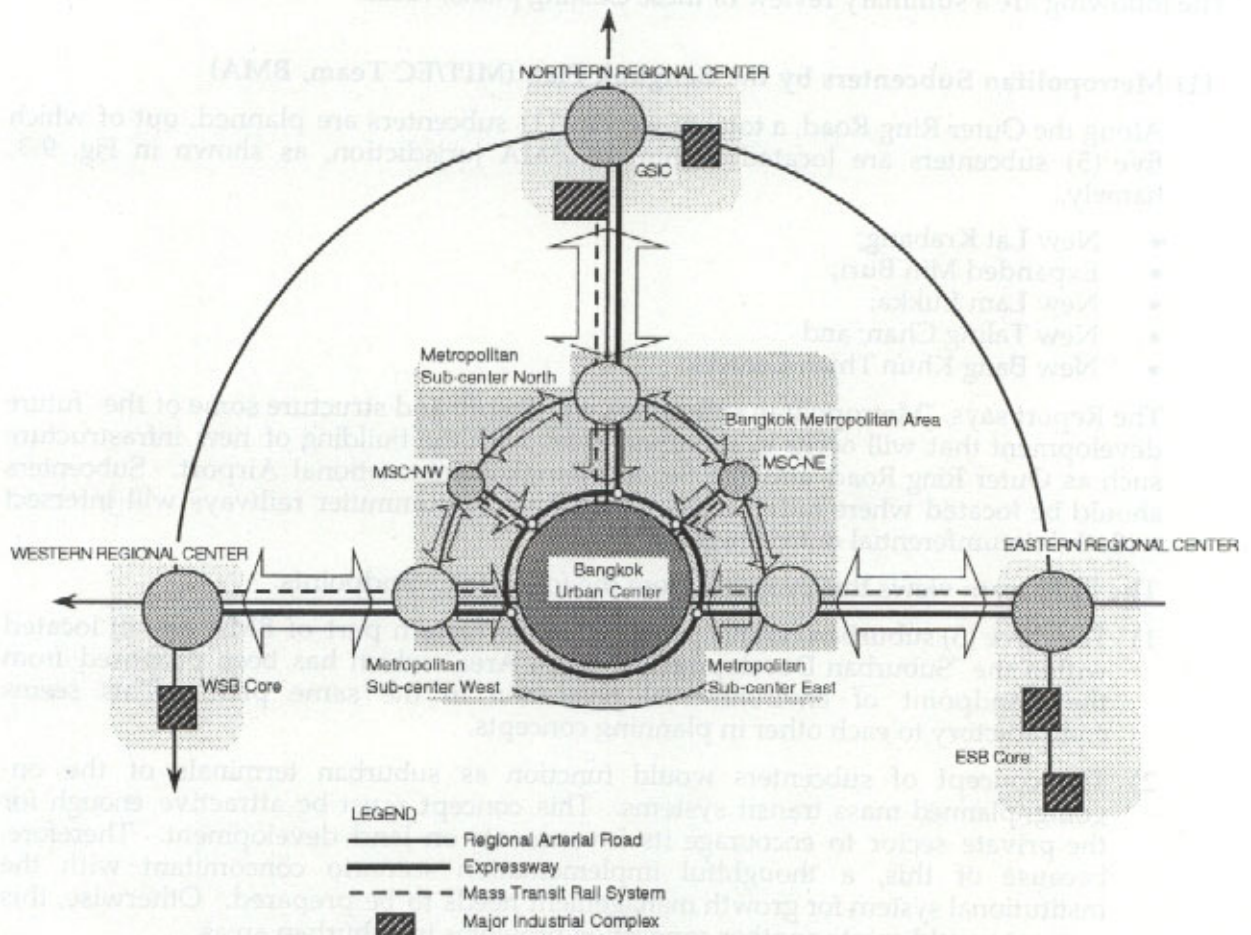


Fig. 9.2 A Conceptual Regional Structure for the Greater Bangkok Metropolis

9.2 Existing Physical Plans for Decentralization Policy

In the line with the decentralization policy, new urban settlement centers are being planned and/or conceptually depicted by different organizations. The basic planning concepts underlying all the plans are similar but locations, spatial settings and functions are different, depending on organizations concerned without planning coordination.

Since all the schemes have been neither fixed nor committed yet, the BEIP team cannot assess all the ideas/plans for the basic spatial framework of the planning. However, the BEP team strongly endorse the plan to shift the Bangkok urban structure towards a multi-polar system, planning coordination among and collective effort with both the central and local governments are absolutely needed immediately, otherwise potential economic resources of both the public and private sectors could not be integrated towards an appropriate direction, thereby resulting in bearing huge economic losses.

The following are a summary review of these existing plans/ideas.

(1) Metropolitan Subcenters by the Bangkok Plan (MIT/EC Team, BMA)

Along the Outer Ring Road, a total of eleven (11) subcenters are planned, out of which five (5) subcenters are located within the BMA jurisdiction, as shown in Fig. 9.3, namely,:

- New Lat Krabang;
- Expanded Min Buri;
- New Lam Lukka;
- New Taling Chan; and
- New Bang Khun Thian Centers.

The Report says, "Metropolitan subcenters will absorb and structure some of the future development that will occur in suburban areas with the building of new infrastructure such as Outer Ring Road and the Second Bangkok International Airport. Subcenters should be located where radial mass transit lines or commuter railways will intersect with the circumferential outer ring road".

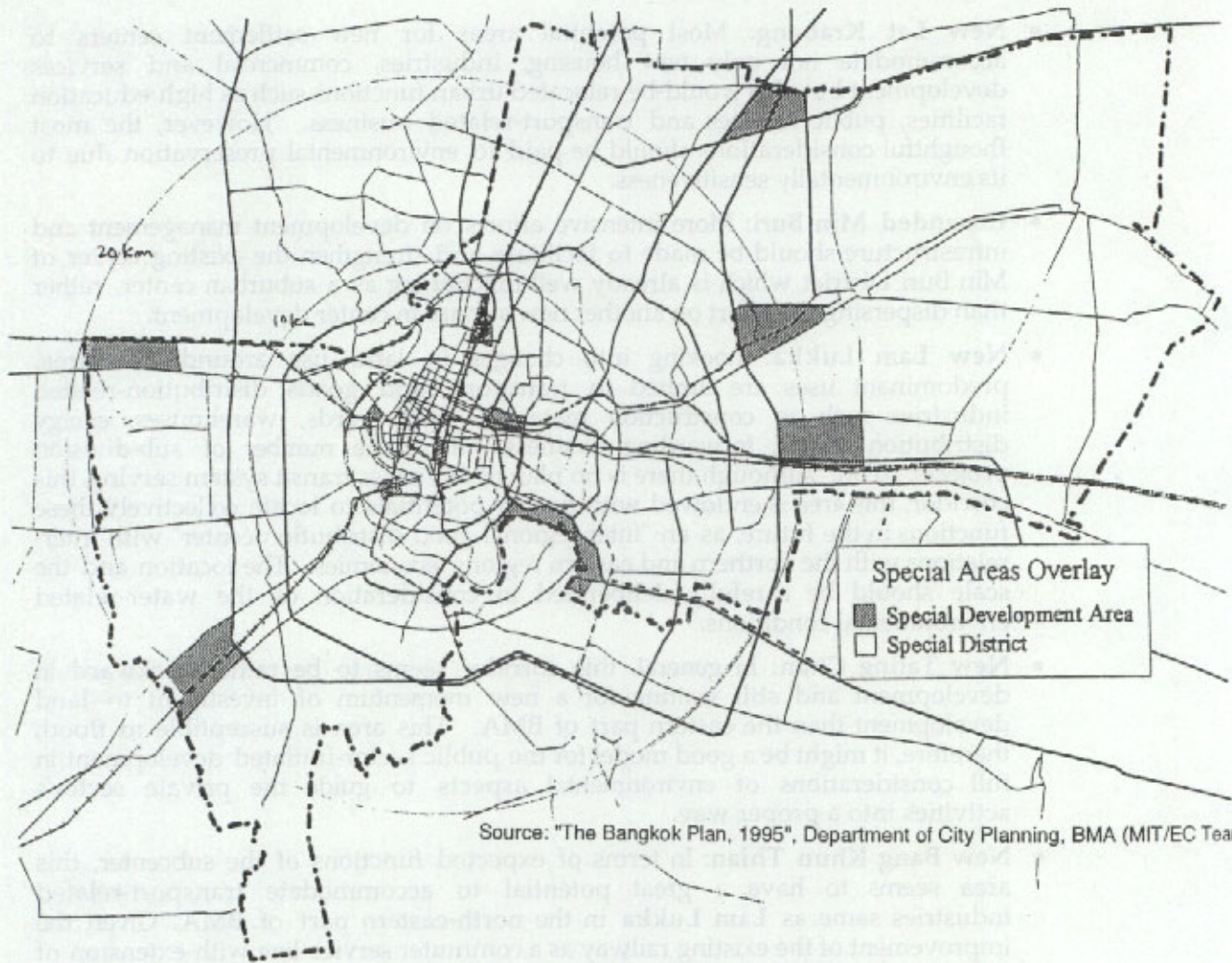
The BEIP team views this proposal from the following standpoints:

- 1) The three (3) suburban centers proposed in the eastern part of BMA are all located within the "Suburban Development Control Area" which has been proposed from the standpoint of environmental protection in the same plan. This seems contradictory to each other in planning concepts.
- 2) The concept of subcenters would function as suburban terminals of the on-going/planned mass transit systems. This concept must be attractive enough for the private sector to encourage its investments on land development. Therefore, because of this, a thoughtful implementation scenario concomitant with the institutional system for growth management needs to be prepared. Otherwise, this concept would create another congestion problems in suburban areas.
- 3) The suburban center concept should be integrated with a restructuring and relocation scheme in the inner city in planning, taking into account the implementation. Otherwise, the public meanings of suburban center projects would be half lost. This integrated concept is not addressed in the Bangkok Plan.
- 4) Outer Ring Road will function as a key trunk road supporting industrial and commercial activities in not only Bangkok but also BMR. This arterial road is expected to make inter-regional cargo traffic flows more smooth and efficient without passing through the inner city. To this end, large-scale commercial development alongside or facing the road should be restrained in order to avoid congestion at/around intersections caused by mixed traffic with short-distance

trips and long-whole industrial trips. Therefore, subcenter development adjacent to intersections with other arterial roads should be avoided.

- 5) The BEIP team holds the following impressions on the proposed subcenters throughout the site observations:
- **New Lat Krabang:** Most potential areas for new settlement centers to accommodate not only new housing, industries, commercial and services development but also would-be-relocated urban functions such as high education facilities, public services and transport-related business. However, the most thoughtful considerations should be paid to environmental preservation due to its environmentally sensitiveness.
 - **Expanded Min Buri:** More intensive efforts on development management and infrastructure should be made to facilitate and strengthen the existing center of Min Buri District which is already well-functioning as a suburban center, rather than dispersing the effort on another new suburban center development.
 - **New Lam Lukka:** Looking into changes in land use around this area, predominant uses are limited to transport- and goods distribution-related industries such as construction materials stock yards, warehouses, energy distribution center, forwarding business, and some number of sub-division projects, so on. Although there is no plan of any mass transit system serving this corridor, this area is endowed with further potentials to locate collectively these functions in the future, as an "inter-regional good distribution center" with inter-relations with the northern and eastern regions' economies. The location and the scale should be carefully deliberated in consideration of the water-related environmental conditions.
 - **New Taling Chan:** In general, this corridor seems to be rather backward in development and still waiting for a new momentum of investment to land development than the eastern part of BMA. This area is susceptible to flood, therefore, it might be a good model for the public sector-initiated development in full considerations of environmental aspects to guide the private sector's activities into a proper way.
 - **New Bang Khun Thian:** In terms of expected functions of the subcenter, this area seems to have a great potential to accommodate transport-related industries same as **Lam Lukka** in the north-eastern part of BMA. Given the improvement of the existing railway as a commuter service line with extension of the Hopewell-SRT System (Red Line) in association with the extension of the MRTA System (Blue Line), this corridor will be undoubtedly a new focal area for urbanization in the long-term. Since the ribbon development has progressed in this corridor, the problem is how to realize it.

**Fig. 9.3 Subcenters Development Concept Proposed by the Bangkok Plan
(Proposed by MIT/EC Team)**



Source: "The Bangkok Plan, 1995", Department of City Planning, BMA (MIT/EC Team)

(2) New Town Development (NHA)

In compliance with housing supplies for low- and middle-income households' demands, NHA has its own plans/programs for housing supply in various forms such as slum improvement; public housing provision, urban renewal project and new town projects. The new town project is rather newly conceptualized.

The Ban Plee Newtown in Samut Prakran Province is the first project being on-going. The Ban Plee Newtown covering a total area of 715 ha, of which 267 ha was completed in 1988 for the first phase, and the remaining 448 ha, being constructed for the second phase toward the completion in 1999. This newtown is planned to grow up as a self-contained community with a 130,000 population, providing job-opportunities in industrial and commercial facilities. Environmental measures for flood protection, drainage system, road network system and public utilities and open space are well taken into account in its plan and design as a publicly initiated-large scale project.

NHA is seeking potential and suitable areas in/outside BMA for several newtown projects each of which has a land area of more than 100 ha. Five (5) areas, in each of which a few newtown projects are to be initiated during the 8th Plan period, have been designated as shown in Fig. 9.4.

It is noted that NHA is considering two (2) types of newtown: semi-self contained and self-contained. The newtowns in the major three corridors in the eastern, western and northern bounds are planned to be self-contained, and the other two locating in-between the three corridors, semi-self contained. Among them, the highest priority is given to the Chachoengsao area.

(3) New City Projects Proposed by DTCP

DTCP recently presented a concept paper titled "City Planning as A Method to Solve Traffic Problem" (September 1996), demonstrating DTCP's strategies for new city projects (or satellite towns) which would be developed within a radius of not more than 100 km from Bangkok or reachable within a traveling time of 1 hour. The satellite towns will accommodate 100,000 to 150,000 population to be moved from Bangkok and the vicinities with at least 100 sq. km.

In the line with this concept, DTCP focuses on three sites as follows:

- **Phra Intaraja New City:** locating in Phra Nakhon Si Ayuthaya Province, the north of Bangkok, and expected to function as a hub to coordinate the economic expansions of Bangkok Metropolis with North and Northwest Regions with a special function of "communication center" as well as offices, business and residences.
- **Lad Loumkaeo New City:** locating in Pathum Thani Province, the west of Bangkok Metropolis, at the position to link with Western and Southern Regions, with emphasis on accommodating governmental agencies, universities and institutions and pollution-free facilities.
- **Suwintawong New City:** locating in Chachoengsao Province, the east of Bangkok Metropolis, to accommodate the economic expansion concerted with air and sea transportation as an industrial city with commerce and technology combined.

The locations of the three focal areas are as shown in the same figure of Fig. 9.4. DTCP discusses measures to put the plans into reality, and it proposes to apply "Land Readjustment System"¹ to this end.

This satellite town concept seems related partially to the MIT proposed subcenters concept on the one hand, and follows partially the MRSP concept as reviewed in the

¹ The Land Readjustment Act has currently been passed by Ministry of Interia on September 11, 1995, and the approval from the Cabinet is being sought.

preceding section on the other hand. That is, **Phra Intaraja** and **Lad Loumkaeo** are identical to the MIT proposed subcenters along the Outer Ring Road, and **Suwintawong** is not. However, it seems that the DTCP plan itself is unique with little relevance to those plans.

DTCP, in addition to the above three centers, is studying other three satellite towns just outside BMA: **Bang Bua Thong**, **Samutsakhon** and **Bang Plee**.

(4) Railway-oriented Urban Development Proposed by the JICA Study

The JICA Study titled "An Improvement Plan for Railway Transport In and Around the Bangkok Metropolis in Consideration of Urban Development (IPRT)" was recently submitted to NESDB and SRT, in August 1995. IPRT proposed a unique and rational urban development concept, highlighting the urban development stimulated by railway and/or mass transit system in the greater metropolitan area with a 200 km radius from the center of Bangkok as shown in Fig. 9.5. This concept is basically in the line with the NESDB policy that the major three corridors should be further encouraged for decentralization of Bangkok, but more unique ideas for urban development have been included in the plan. These are:

- Four Sub-urban Centers in Railway Corridors in Chachoengsao, Nakhon Pathom, Ayuthaya and Samut Sakhon
- Rail-oriented Urban Development to accommodate 1.7 million population in 2010
- Area-wise Urban Development in Railway Corridors with a variety of urban development cum major railway stations

In the Eastern Rail Corridor, there are two large scale development: **Aero-based City** to develop housing and commercial, business establishments around the Second Bangkok International Airport, which is similar to the DTCP's plan of **Suwintawong New City**; and **Eastern Bangkok Park City** to designate new residential area with high quality housing, allowing residents to commute conveniently to/from both Bangkok and ESB.

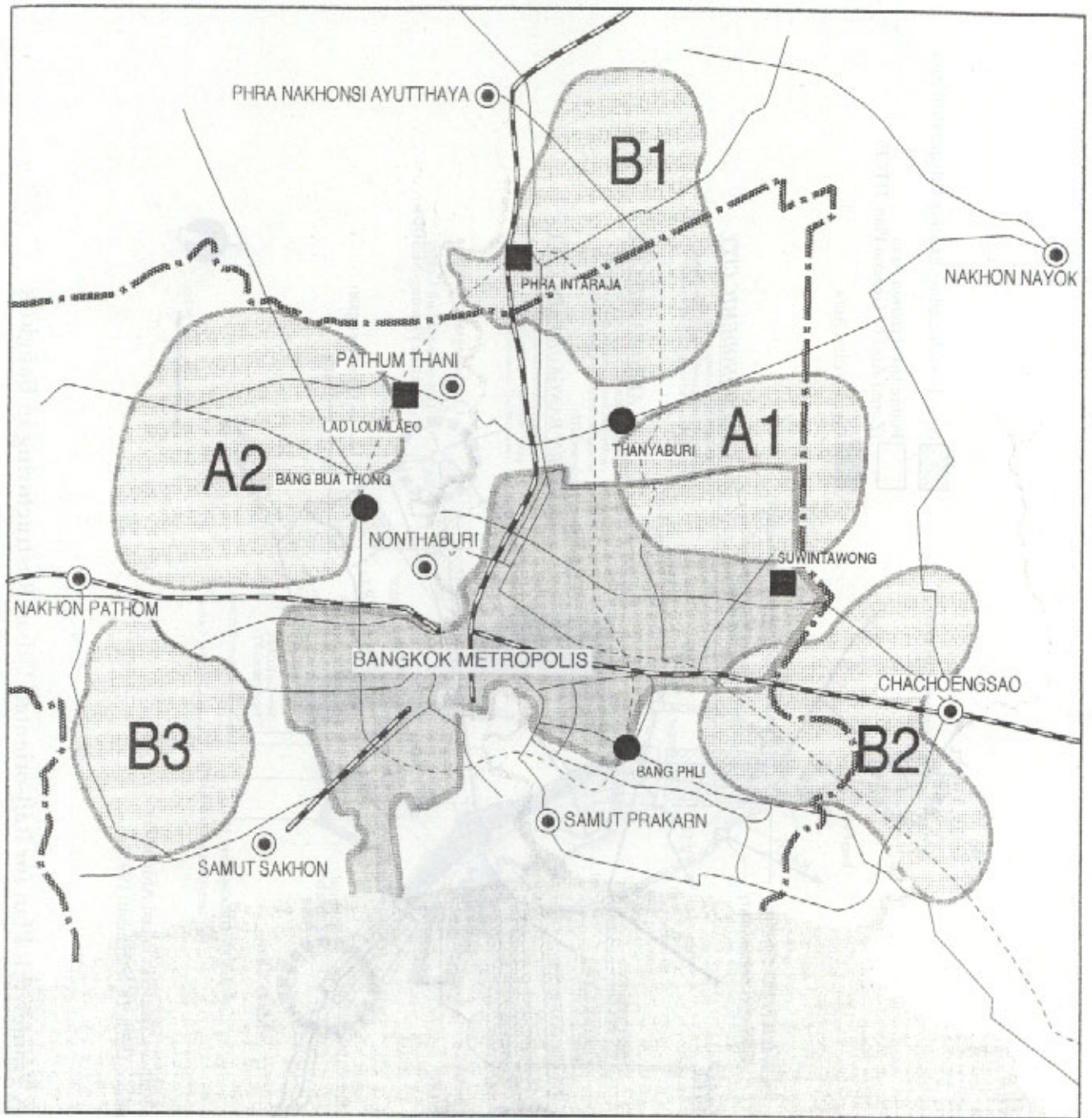
In the northern corridor, **Techonodemic City** was proposed, where housing and business establishments, colleges/universities and R & D laboratories are to be encouraged to locate.

In the western side, proposed are **Western Bangkok Garden City** as intensive quality housing area and **Pier City** including the existing Maha Chai urban areas in front of the Gulf of Thailand.

For materialization of this concept, IPRT recommends the improvement of the Eastern Line of SRT for a modern commuter line, including construction of six (6) new stations and construction of a new airport access line (a 7.0 km feeder line from Lat Krabang Station) in association with the improvement of the inter-city line between Bangkok and Map Ta Phut through Chachoengsao. This program is estimated to cost about 13 billion Bahts², comprised of 1) double tracking; 2) electrification; 3) modernization signaling; 4) level-crossing improvement; 5) improvement of stations and 6) procurement of rolling stock and electric cars.

In fact it has been recognized that a massive volume of traffic demands generated from the Bangkok economic activities can no longer be supported only by roads, and that a drastically structural change in urbanization based on railway/mass transit systems is critically required. The BEIP Team strongly endorses these proposals presented in IPRT.

² The evaluation of this huge scale investment project concludes that the project is feasible from the economic point of view, or EIRR is computed at 16.3%, and that the project will be financially viable, or FIRR is over 7%, if the external free funds may cover 60 % of the initial investment.



LEGEND :

DTCP Proposal New Cities

- Most recently proposed new city development
- Previously proposed and / or under-considering location of satellite town / new city development

NHA Proposal New Towns

- Area "A" : Suitable Location For Semi-self Contained New Town & Self-contained New Towns
- Area "B" : Suitable Location for self-contained New Town

Source : "City Planning As A Method to Solve Traffic Problem, 1995", Department of City & Country Planning (DTCP), and National Housing Authority (NHA)

Fig. 9.4 Proposed New Cities and New Towns by NHA and DTCP

9.3 Restructuring of Spatial Structure of the Bangkok Metropolis

Based on the review of all the existing plans and discussions, the BEIP team proposes a scheme of restructuring the spatial structure of the Bangkok Metropolis towards a sustainable urban growth.

(1) A Conceptual Spatial Structure of BMA

With the one-center urbanization system, the mega-urban agglomeration with more than 10 million population can no longer efficiently work as a functional unit. Urban restructuring to shift the one-center system to a multi-polar system gradually becomes a vital issue as diseconomies are apparently emerging.

A conceptual structure with a multi-polar system is proposed, instead of the current one-center system, as conceptually illustrated on Fig. 9.6. The following considerations are underlying this proposal:

As the life-line of the Bangkok economy, an efficient goods distribution structure needs to be developed, while facilitating inter-regional economic relations. Cargo traffic flows should be functionally treated with less impacts on passenger traffic. For this purpose, truck terminals and distribution facilities needs to be developed in urbanized fringe areas where are suitable for inter-connection with the inner distribution and the regional linkages. Those are to be located in, at least, three locations along the eastern, western and northern corridors;

Road traffic concentration should be dispersed in association with keeping the job-housing balance outside the central area. For this purpose, as proved by the simulation analyses in Chapter 5, creation of new job opportunities needs to be placed in newly developed subcenter areas.

(2) Urban Regeneration:

The central areas, although they are endowed with a relatively high road density and well-infrastructures, have nowadays faced a difficulty in that there exist many buildings and land uses which are no longer economically functional because they are going out of date, or facing diseconomies from traffic congestion. These are awaiting for regeneration, redevelopment and/or renewal.

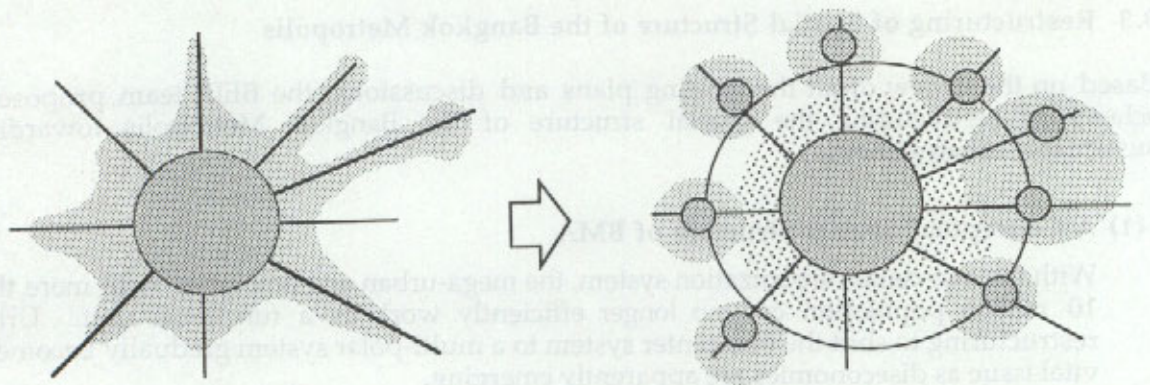
(3) Sub-urbanization:

Urban sprawl has rapidly been proceeding along several major corridors in various forms: individual, shop-housing types, sub-division development, so on without an adequate landuse management system. Eventually, provision of infrastructures and public services cannot catch up with the demands. A more deliberated manner is necessary for orderly sub-urbanization.

(4) Mass-Rapid Transit-Driven Urbanization

As widely recognized, the most effective way to facilitate the urban re-structuring towards a multi-polar system, instead of the present one-center system, is to deliberately utilize the economic and urban functions of mass-rapid transit systems (MRTs).

Areas, easily accessible to major stations of the planned MRTs, may be of newly high valued land, thereby enlarging economic potentials for housing, light industrial commercial and business development. Since stations of MRTs are significant traffic generators, such mass-transit driven urbanization is effective for management of traffic demands. Inter-modal transfer systems, including bus services as feeder transportation, should be improved.



Urban Sprawl without Growth Management

Multi-polar Metropolitan Structure

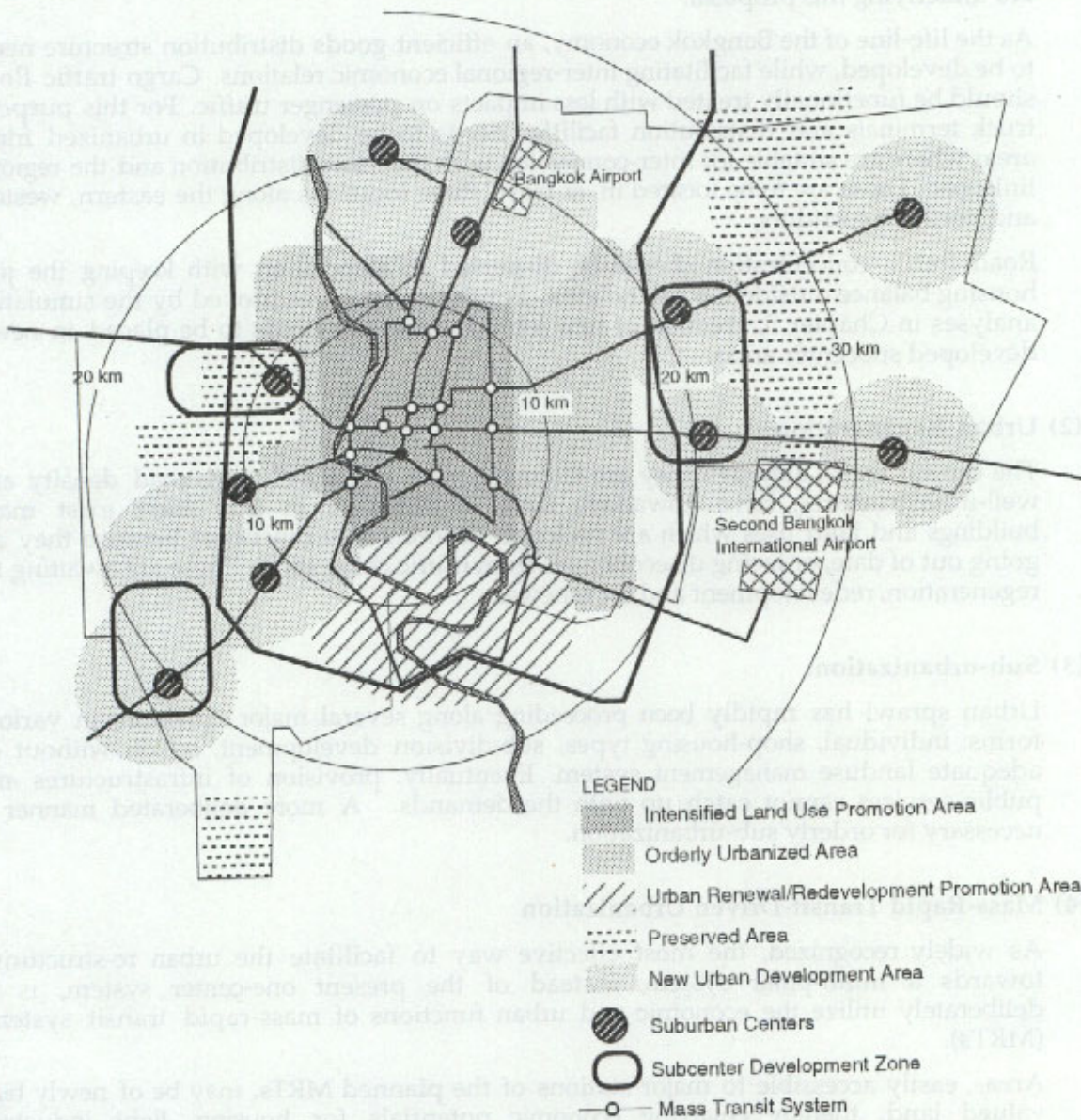


Fig. 9.6 A Concept of BMA Restructuring Spatial Framework (Proposed)

9.4 Planning Strategies for Metropolitan Subcenter Development

As a tool to materialize the long-standing decentralization policy, the BEIP team strongly endorses the metropolitan subcenter development to release environmental loads of the Bangkok Metropolis. However, the proposal by the Team stands on a bit different planning concept from the previously proposed ones as viewed in the preceding section.

Important is the planning concept of "Subcenter Development" that does not necessarily stand for only development of a core of "Business Center", but includes the area-wise urban development centered on the core. Accordingly, it may be rather called "Subcenter Zone Development".

(1) Rationales of Subcenter Zone Development

Sub-center development should be facilitated, because of three reasons:

- 1) Excessive traffic concentration into the central business areas is causing a great economic loss on the Bangkok Economy as a whole, therefore dispersal of traffic demands should be encouraged. As proved in the simulation analyses in Chapter 5, the policy is significantly effective to mitigate road traffic congestion.
- 2) The 10 million urban agglomeration can no longer be efficiently formed by the one-center system in view of the limits of spatial capacity and provision of necessary infrastructures while maintaining a sound urban environmental system.
- 3) Development of subcenters shall provide the space to meet new land demands for urban service facilities to be additionally developed, could-be-relocated and/or moved facilities/activities from the central areas where a pressure for regeneration is emerging for encouraging more efficient urban land use.
- 4) As a model of publicly-initiated and infrastructure-led suburban development, an institutional system for the implementation of orderly area-wise development shall be explored through the subcenter development.

(2) Urban Planning Requirements on Subcenter Zone Development

As a model of environmentally sound suburban development, the plan should first take into account a "Balance of Water and Land", in other words, land development with sufficient water management systems.

In addition to this, the subcenter zone development shall be planned with the following five (5) functions:

- 1) To provide a wide range of job-places (for low to high income groups)
- 2) To accommodate a wide range of business and urban functions required for the Bangkok economy toward the new generation such as:
 - Information-based and related industries, high educational facilities and R&D functions (for a knowledge center);
 - Warehouses, small- and medium scale light industries, goods distribution and cargo transport-related facilities which are to be relocated or newly established;
 - Resort for "New Business Incubator";
 - Support or related facilities to adjacent large-scale projects (such as SBIA); and
 - Government offices/service facilities to be relocated (preferable as a trigger).
- 3) To contribute to substantial or partial solutions of current urban environmental problems in Bangkok such as difficulties in land acquisition for :
 - Solid waste management system; and

- Flood prevention, environmental green and recreation;
 - To provide a wide range of urban services for its surrounding communities to form a self-sufficient sub-economic zone centered on the sub-center function.
- 4) To become an intermodal transport terminal with highly served public transport systems.

(3) Criteria for Selection of Suitable Location for Subcenter Zone Development

Development of the subcenter zones should be located in areas with the following conditions:

- 1) Less natural constraints of the environment, i.e., areas to be preserved for flood control should be avoided;
- 2) Along the planned mass-transit corridor;
- 3) Within 40-60 min. time-distance by mass-transit system to/from the existing Bangkok urban center;
- 4) High accessibility and easy mobility by road transport to/from the surrounding communities (existing and future) as well as major traffic generators;
- 5) Comparatively low urbanization ratio (less than 30%, not necessarily vacant land);
- 6) Presently low service levels of community facilities; and
- 7) Preferably with public land as much available as possible.

(4) Proposed Three Locations

Analyzing the whole land with the above conditions within the BMA jurisdiction using the GIS technique, the BEIP team identified three suitable areas as shown in Fig. 9.7 (the process of the analysis is discussed in Section 12.3). These are: Minburi/Lat Krabang; Taling Chan; and Bang Khun Thian.

Minburi/Lat Krabang Zone (6,700 ha)

As proposed in the Bangkok Plan and other plans, Lat Krabang is assessed to be a focal area with great urban potentials to be influenced by the new transport facilities such as the Red Line MRT, Bangkok-Chonburi Highway and the Second Bangkok International Airport. And, Minburi is already functioning as a subcenter in the northeastern suburban area attracting many housing subdivision projects. Provided with the extended Orange Line, Minburi will be another focal area for development.

This subcenter zone encompasses the considerably vast area combining these two potential centers between Outer Ring Road and the King's Dike.

Taling Chan Zone (4,800 ha)

Having the existing SRT Southern Line, the extended Red Line MRT and Outer Ring Road, Taling Chan area will undoubtedly be a further significant area for urban land development in the Thonburi side. Since the areas are environmentally sensitive against floods, without a public-initiated orderly development scheme in consideration of environmental preservation measures, this area would bear another environmental problems. The zone extends towards East-West along the Southern Line.

Bang Khun Thian Zone (3,899 ha)

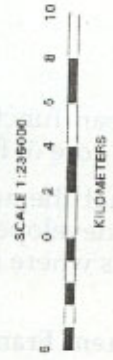
As a gateway to the southern Thai economy, a number of industries and transport service facilities are now located in Bang Khun Thian area. Having the extended Red Line MRT and Outer Ring Road, this area will have another potential to attract a

Fig. 9.7

Proposed Locations of
Development of Three
Subcenter Zones

Legend

- Current Buildup Area
- ▨ Park
- ▩ Urbanized Area in 2001
- ▧ Urbanized Area in 2006
- ▦ Urbanized Area in 2011
- ▥ Existing Road (Class 1, 2)
- ▤ Existing Road (Class 3)
- ▣ Existing Expressway
- ▢ MRT Systems
- MRT Systems Expansion
- Expressway in 2000
- ▟ Improvement of Existing Road (DOH)
- ▞ New Road in 2000 (DOH)
- ▝ Improvement of Existing Road (BMA)
- ▜ New Road in 2000 (BMA)
- ▛ Improvement of Existing Road (PWD)
- ▚ New Road in 2000 (PWD)
- ▙ BMA Boundary
- ▘ District Boundary
- ▗ Chaopraya River



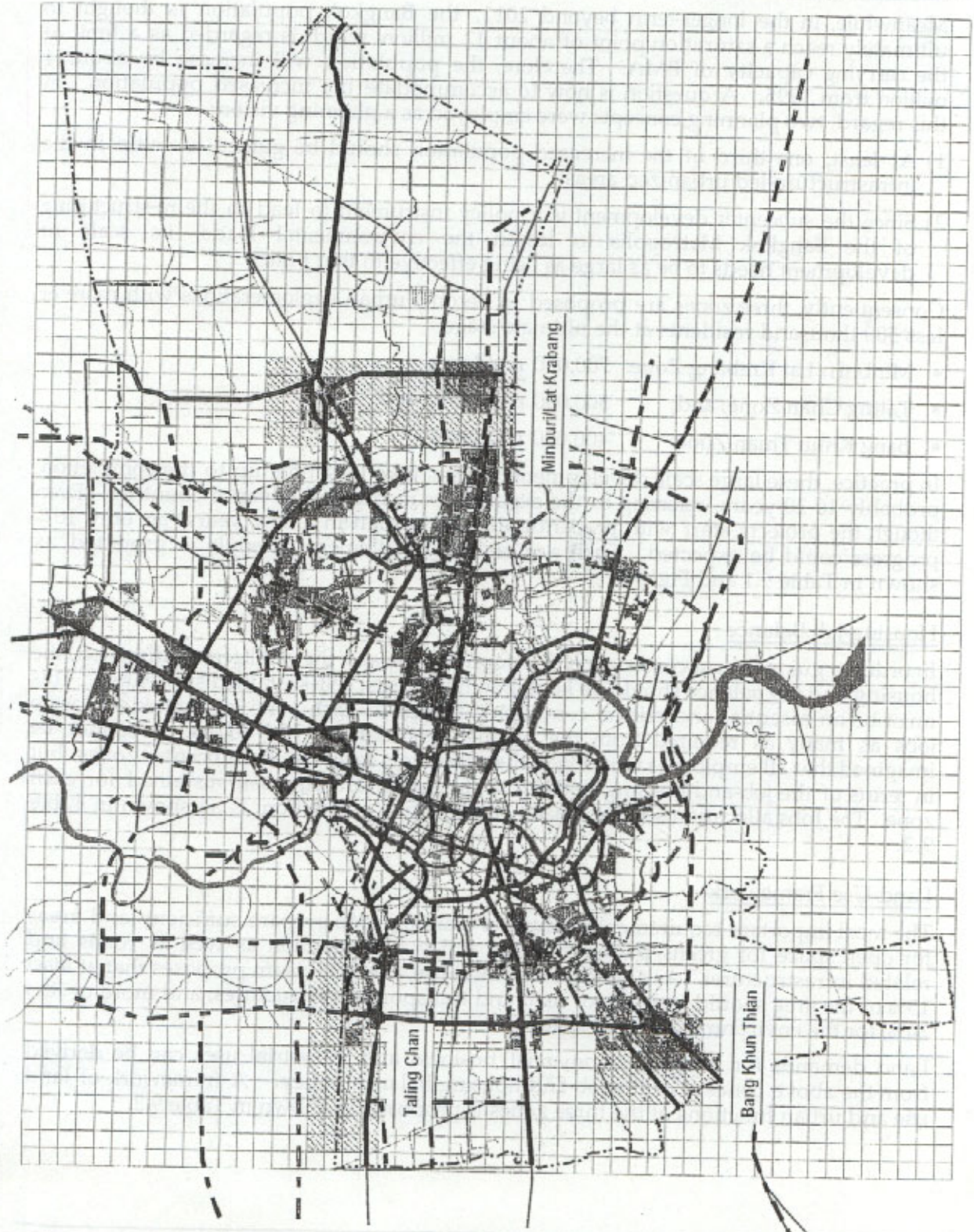
THE STUDY
ON
URBAN ENVIRONMENTAL IMPROVEMENT PROGRAM
IN
BANGKOK METROPOLITAN AREA (BEIP)



BANGKOK METROPOLITAN ADMINISTRATION
THE GOVERNMENT OF THE KINGDOM OF THAILAND



JICA
JAPAN INTERNATIONAL COOPERATION AGENCY



variety of urban functions as a suitable place for would-be-relocated facilities. This area will be a core of further development in the Tonburi side.

It is noted that the areas of the above zones are determined as the "Urban Planning Areas" to be developed under the subcenter development policy. These include existing built-up areas where need to be improved as part of the subcenter zones.

(5) A Development Framework of Subcenters

Scale of the Development

Meanwhile, in the longer-term beyond 2011, the Bangkok population is thought to ultimately reach a saturation point of about 12 million, which is regarded as a limit of the carrying capacity of BMA. Therefore, the population will increase by about 4 million from 1995. A question is how to accommodate the increased population. In this regard, two planning concepts were employed as a planning vision:

- 1) At least, one third of the increased population should be guided to settle in the infrastructure-led urbanized areas;
- 2) Since the subcenter development is a policy instrument to lead to the re-structuring of the Bangkok Metropolis to lessen the environmental loads, its scale of development needs to be as large as being effective to that policy.

Consequently, three zones are proposed to become urban agglomerations with more or less 500 thousand residents at the ultimate stage:

- Minburi/Lat Krabang Zone: 700,000 residents;
- Taling Chan Zone; and: 500,000 residents; and
- Bang Khun Thian Zone: 400,000 residents.

In practice, these large scale development projects take long time up to the completion, probably 10-20 years, referring to the experiences in cities of advance countries. Even though the projects start with preparing the action plan in a few years, an only 10% progress could be expected. Such a most-likely settlement schedule is projected as shown in Table 9.1 and Fig. 9.8.

Housing-Job Balance

In order to guide the subcenter zone development toward the deliberated direction, the housing and job balance should be kept, in other words, self-sustained subcenters. This must be an essential and critical condition. Therefore, each zone is planned to locate jobs as many as required from the planned population. Of course, it cannot be imagined that all employees working in the subcenters reside in the subcenter zones, but in terms of the job-and-housing balance it should be of being self-sustained for each zone. The Jobs allocation scheme, based on the above perception, is as shown in Table 9.2.

Land Use Framework

The most important requirement in physical planning is to prepare sufficient land areas for open space for greens, parks, drainage and water retention as well as roads and related infrastructures. As a guideline of land use, the BEIP team proposes that at least 15% of the area should be used for road and transport infrastructures, and more or less 20%, for the environmental open space.

Land demands for housing, commercial/business and industrial uses can be derived from the above concept of the job-and-housing balance policy. A framework of land use and urban functions of the three zones is proposed as shown in Table 9.2.

Table 9.1 Population Settlement Schedule of Three Subcenter Zones (Proposed)

		(Thousand)				
		1995	2001	2006	2011	Long-term Target
BMA Population		8,126.0	9,044.0	9,761.0	10,496.0	12,000.0
Population in Existing Built Up Area		8,126.0	8,332.7	8,509.0	8,689.0	9,000.0
Population in Future Expanded Built-up Areas			365.8	750.5	1,114.5	1,650.0
Population in Subcenter Zones		284.5	345.5	501.5	692.5	1,350.0
Minburi/Lat Krabang	Existing Population	125.0	125.0	125.0	125.0	125.0
	Future Expanded Built-up Area in Subcenter Zone		7.0	59.5	93.5	93.5
	Newly Developed Subcenter Zone				61.5	481.5
	Total	125.0	132.0	184.5	280.0	700.0
Talong Chan	Existing Population	77.0	77.0	77.0	77.0	77.0
	Future Expanded Built-up Area in Subcenter Zone		18.0	43.0	58.5	58.5
	Newly Developed Subcenter Zone				14.5	114.5
	Total	77.0	95.0	120.0	150.0	250.0
Bang Khun Thian	Existing Population	82.5	82.5	82.5	82.5	82.5
	Future Expanded Built-up Area in Subcenter Zone		36.0	114.5	145.0	145.0
	Newly Developed Subcenter Zone				35.0	172.5
	Total	82.5	118.5	197.0	262.5	400.0

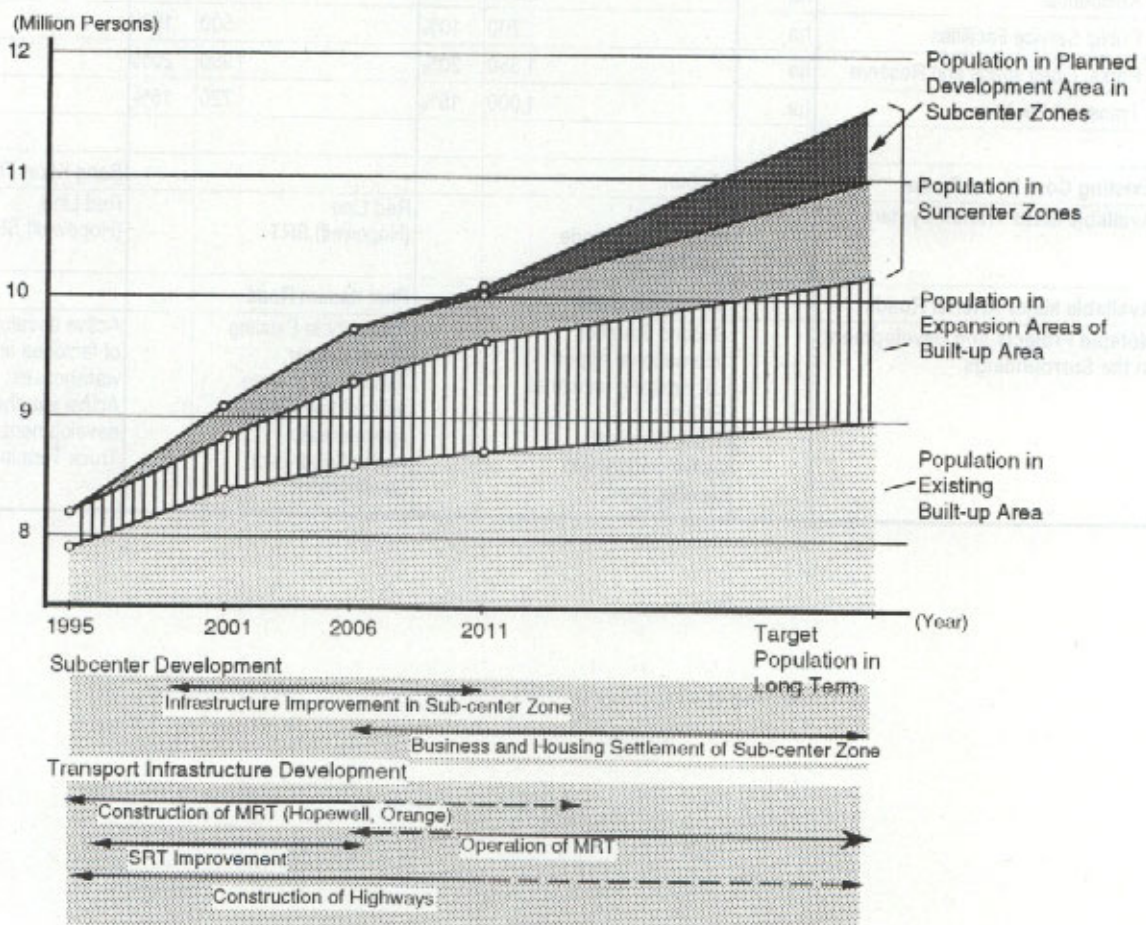


Fig. 9.7 Long-term Future Population Allocation in 2011 and Over

Table 9.2 Development Framework for Three Subcenter Zones Development

	Unit	Minburi/Lat Krabang		Taling Chan		Bang Khun Thian	
Major Subcenter Functions To Be Enhanced		Business, Light Industry, Higher Educational and Government Facilities, R & D and Information, Cargo Distribution, Commercial and Residence		Business, Commercial, Higher Educational and Government Facilities, and Residence		Production and Light Industry, Cargo Distribution, Commercial and Residence	
Target Population	000	700		500		400	
Planned Population in 2011	000	280		150		260	
Target Employment	000	420		300		240	
Planned Employment in 2011	000	84		45		78	
Area of Subcenter Zone	ha	6,700	100%	4,800	100%	3,800	100%
Existing Built-up Area	ha	1,130	17%	700	15%	750	20%
Future Expansion of Built-up Area	ha	850	13%	660	14%	1,480	39%
Planned Development Area	ha	4,720	70%	1,040	22%	1,570	41%
Land Use Composition							
Commercial & Business	ha	350	5%	240	5%	200	5%
Production/industry	ha	350	5%	100	2%	200	5%
Residential	ha	2,950	44%	2,280	48%	1,900	50%
Public Service Facilities	ha	700	10%	500	10%	300	8%
Parks, Open space and Reserve	ha	1,350	20%	960	20%	630	17%
Transport Facilities	ha	1,000	15%	720	15%	570	15%
Existing Core Local Center		Minburi		-		Bang Khun Thian	
Available Mass Transit System		Red Line (Hopewell), Orange (MRTA), SRT		Red Line (Hopewell), SRT		Red Line (Hopewell), SRT	
Available Major Arterial Roads		Outer Ring Road,		Phet Kasem Road			
Notable Projects and Development in the Surroundings		Second Bangkok International Airport; Lat Krabang Industrial Estates; Truck Terminal; Active Subdivision Development;		Proximity to Existing Urban Center; Availability of large agricultural and open space areas; Active Subdivision development		Active development of factories and warehouses; Active subdivision development; Truck Terminal	

(6) Physical Planning of Subcenter Zone Development

Physical planning work for the subcenter zone development are recommended to be conducted as soon as possible. The existing study titled "Metropolitan Subcenter Planning" (October 1996) conducted by the MIT Consultant Team provides with several significant insights into the projects. In this BEIP Study, several planning concepts are demonstrated in Micro Studies in Chapter 24.

(7) Key Elements for the Implementation

Development of the subcenter zone requires to establish a specially unique system for the implementation, including some institutional arrangement. The following are strongly recommended for actions to the implementation:

- 1) Government (or the public sector) initiative in planning with well-coordination among relevant planning organizations such as BMA, NESDB, OCMRT, DTCP, NHA, MOSTE and so on;
- 2) Legal designation of "Subcenter Development Zone" as a policy zone under the Urban Planning Act;
- 3) Private sector's participation in planning the implementation scheme (the key may be involvement of operators/investors of mass-transit systems);
- 4) Establishment of a chiefly responsible entity (in a form of public-private JV) for the implementation;
- 5) Establishment of a land pre-purchase system and a land pooling system by the government sector;
- 6) Pursuance of alternative land development systems, mobilizing feasible ideas of "Land Readjustment System" and "Land Trust System" proposed by the MIT Consultant Team; and
- 7) A well-coordination system for development priority of infrastructures among relevant authorities such as BMA, DOH, ETA, MRTA, BMTA and so on.

CHAPTER 10: POLICY, TARGET AND MACRO-MEASURES FOR URBAN ENVIRONMENTAL IMPROVEMENT

10.1 Planning Issues, Targets and Macro Measures

(1) Planning Issues

Deterioration of "Bangkok environment" has been reaching a critical level, which means that further worsening of the quality of environment will jeopardize the people's lives as well as a sustainable socioeconomic growth. The majority of the Bangkok residents has been already aware of that substantial solutions on environmental problems should be prioritized even though they pay some cost for the economic growth as discussed in Section 8.1.

A fragmented remedial approach will no longer be effective to resolve problems of environmental deterioration, but an integrated approach is essential. New social rules are needed for using resources of the Metropolis, which are unique, intrinsic and compatible to the Thai socio-culture.

Planning issues, based on the above recognition together with findings through the assessment of the present states, are identified to be the following six (6):

- 1) Creation of social rules for "Sustainable Resource Utilization of the Vulnerable Environment";
- 2) Challenge for "Flood-free Urbanization"
- 3) Formulation of "Environment-initiative Transport System"
- 4) Pursuance of "Fresh-and-Clean Air Policy";
- 5) Creation of "Water-friendly Eco-city"; and
- 6) Up-grading of "Quality of Living Environment"

These issues are mutually related in the structure of urban metabolism, as illustrated on Fig. 10.1. Therefore, one solution is influential to another solution, at the same time, one problem is worsen another.

(2) Planning Target 2011

Planning targets for urban environmental improvement are set forth in accordance with the identified planning issues, aiming at the year 2011, as summarized in Table 10.1. The proposed targets are both descriptive and numerical, based on the visions derived from the following three:

Analyses of the most-likely future perspective, based on assessment of present environmental attributes, potentials and constraints;

Attainability, taking into account the performance of past and on-going projects and polices directed by the central government and BMA; and

A vision of planners on what Bangkok should or could be developed and improved to be like.

(3) Macro Measures to Achieve the Targets

Macro measures to achieve the targets are recommended as summarized in Table 10.1. These are derived from the results of simulation analyses and planning considerations based on the assessment of the present situation. The measures, including both soft and hard ones, should be pursued by the national level as well as BMA. And, some of them call for business sector's participation or people's strong involvement.

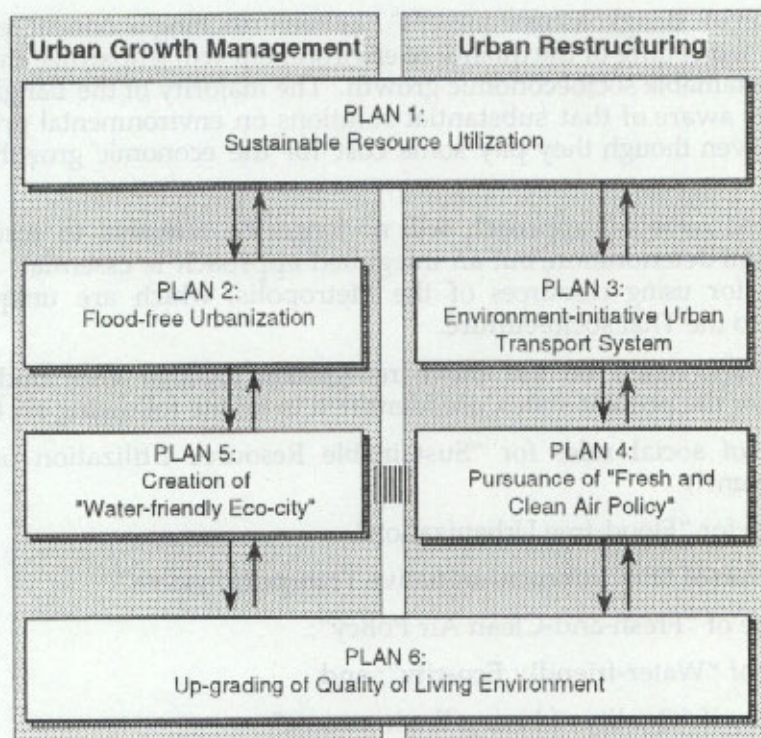


Fig. 10.1 Structure of Planning Issues

Table 10.1 (1/3) Planning Targets and Macro Measures for Bangkok Environmental Improvement

PLANNING ISSUE	TARGET 2011	NUMERICAL TARGET	PROPOSED MACRO MEASURES TO ACHIEVE THE TARGET
<p>PLAN 1: Sustainable Resource Utilization in Vulnerable Environment</p>	<p>Creation of the robust urban environment against the natural disasters.</p>	<p>None</p>	<ul style="list-style-type: none"> • Pursue Energy-saving and Resources-recycling policy; • Undertake the measures for stopping land subsidence based on recommendations by the JICA Study (1992-96); • Develop "Green and Water Network" (in association with road improvement, public parks and Khlong beautification projects/program).
<p>PLAN 2: Flood-free Urbanization</p>	<p>Creation of the man-made environment for people to be free from fears and apprehensions of floods</p>	<p>Keeping the drainage capacity to cope with 5 year rainfall probability</p>	<ul style="list-style-type: none"> • Formulate a Long-term Master Plan and Action Plans for flood protection systems in a view of Lower Chao Phraya area in coordination among relevant agencies; • Formulate a Flood Mitigation Action Plan for the West Bank Area (Thonburi Side); • Institutionalize a Flood Plain Management System for the entire urban areas, including provision of retention ponds and control of land use in preserved areas as retention areas; • Facilitate coordinating work among the central and local authorities to functionalize District Storm-water Drain System in the entire system of Bangkok.
<p>PLAN 3: Environment-initiative Urban Transport System</p>	<p>Re-structuring of the Bangkok Urban Transport System with a more environment-oriented system, or shifting to a public transport-based system; and Mitigation of road traffic congestion, providing with alternative urban public transport modes by which people may select means suitable for their purposes and time constraint.</p>	<p>Anyone can reach his/her work place or school within 45-60 minutes; and The modal share of public transportation shall be more than 50 % (as of all modes including walking trips), compared to 42% at present.</p>	<p>Transport Demand Control:</p> <ul style="list-style-type: none"> • Straighten Urban Growth Management measures for traffic demands control; • Designate a policy zone of "Public Transit Advantage Zone" in part of CBD, where public transport services are intensively improved and in-flow of the private vehicles is controlled with institutional schemes; • Introduction of "Traffic Assessment Study" for permission of large-scale projects <p>Public Transport System Development:</p> <ul style="list-style-type: none"> • Facilitation of on-going Mass Transit Systems Projects based on the OCRT Master Plan • Reroute bus service network/routes in the total public transport system; • Improve waterway transport systems on major khlongs; • Develop intermodal facilities/stations to transfer between "MRT-Bus", "bus-waterway" and "MRT-waterway", in association with taxi and other para-transit systems; • Improvement of pedestrian facilities; <p>Road Transport Development:</p> <ul style="list-style-type: none"> • Made further efforts to construct more arterial and collector roads, reviewing the priority scheme under well-coordination among relevant organizations of DOH, BMA and ETA; • Develop tertiary/local road network in association with urban renewal and new urban development projects; • Accelerate the construction of the Ring Expressway System given the highest priority; • Improve the traffic control system, based on technical and analytical implications, including functionalization of the vested ATCS.

Table 10.1 (2/3) Planning Targets and Macro Measures for Bangkok Environmental Improvement

PLANNING ISSUE	TARGET 2011	NUMERICAL TARGET	PROPOSED MACRO-MEASURES TO ACHIEVE THE TARGET
<p>PLAN 4: Pursuance of "Fresh and Clean Air Policy"</p>	<p>Mitigation of air pollution up to a level that people may feel no damage on health</p>	<p>Ambient air pollution levels in most of Bangkok urban areas shall satisfy the presently regulated "Thai Environmental Standard": CO: 9 ppm (8 hrs. avg.) NO_x: 0.17 ppm (1 hr. avg.) SO₂: 0.3 ppm (1 hr. avg.) TSP: 0.1 mg/m³ (1 year avg.) PM10: 0.12 mg/m³ (24 hrs. avg.) O₃: 0.1 ppm (1 hr. avg.)</p>	<p>Environmental Administration:</p> <ul style="list-style-type: none"> Enhance monitoring and analytical technique of environmental administrators; Review the current environmental standards and formulate policies and strategies to achieve the standards; Promote "public awareness" of air pollution to enlighten driving manners and promote environmental concerns to constructors for mitigating pollutant emission from construction sites; Strengthen voluntary environmental management in the business sector through introduction of "ISO 14000". <p>Measures for Mobile Sources:</p> <p>All measures for mitigation of traffic congestion is simultaneously effective to mitigation of air pollution. On this background, the sectoral measures are to:</p> <ul style="list-style-type: none"> Enhance control measures for "vehicle emission" with introduction of new vehicle regulation and inspection/maintenance systems; Promote replacement to Low-pollution Buses and Trucks by both public and private operators with provision of institutional incentives; Introduction of Quality Fuel: diesel oil with less sulfur contents and lower particulate matter (PM) emission (to be refined with lower distillation temperature); Promote R & D of less pollution vehicles; Improve the road structure with buffer greens, particularly for arterial heavy traffic roads; Explore effective traffic management to increase the average vehicle travel speed; <p>Measures for Stationary Sources:</p> <ul style="list-style-type: none"> Monitor regularly emissions of potential stationary sources; Guide and introduce technologies for appropriate combustion management as well as installation of environmental protection equipment so as to save energy as well as mitigate air pollution; Promote fuel conversion to less pollution fuel like LPG and/or LNG; Provide an incentive scheme for factories to undertaken these measures against air pollution.

Table 10.1 (3/3) Planning Targets and Macro Measures for Bangkok Environmental Improvement

PLANNING ISSUE	TARGET 2011	NUMERICAL TARGET	PROPOSED MACRO-MEASURES TO ACHIEVE THE TARGET
<p>PLAN 5: Creation of "Water-friendly Eco-city"</p>	<p>Restoration of the Thai water culture in association with improvement of water quality in khlongs</p>	<p>BOD: less than 15 mg/liter in major khlongs in the special policy zone (Khlong Water Quality Improvement Promotion Zone)</p>	<ul style="list-style-type: none"> • Designate a policy zone for "Khlong Water Quality Improvement Promotion Zone" in the central areas where special efforts should be intensively made with the highest priority; • Review the existing Sewage Master Plan, based on recommendations by the BEIP Study; • Facilitate the implementation on-going sewage projects under well- coordination among BMA, PCD and the newly established Waste Water Management Authority (WMA); • Further encourage the implementation of the on-going "Khlong Water Quality Improvement Project" in East Bank, and expand the project in West Bank (Thonburi area) as proposed by the BEIP Study; • Create "Green-cum-Water Network System" along major khlongs, implementing the expanded "Beautification Programs"; • Promote Public Campaigns for "Clean, Green, Khlong"
<p>PLAN 6: Up-grading of Quality of Living Environment</p>	<p>Materialization of Healthy, Safe, Comfortable and Convenient Environment for all people, with social cares for the urban poor, elderly and handicappers</p>	<p>Solid Waste Management: Reduction of Per Capita Generation Rate of Solid Waste: by 10%</p> <p>Water Supply: Supply to all residents in urban areas, in association with reduction of the leakage ratio up to less than 20%</p>	<p>Solid Waste Management:</p> <ul style="list-style-type: none"> • Formulate a Long-term Master Plan for Solid Waste Management for BMA; • Facilitate on-going Solid Waste Treatment Projects as urgent projects; • Acquire and prepare the land for final disposal on the long-term perspective within the BMA jurisdiction; • Promote community organization activities for people to participate in reducing, recycling and separation collection; <p>Water Supply:</p> <ul style="list-style-type: none"> • Review the existing Master Plan of Water Supply, taking into account the current and future urbanization process, and formulate "Rehabilitation Action Plans" of existing distribution systems; • Facilitate water supply and rehabilitation projects based on the reviewed Master Plan and Action Plans; • Strengthen the operation, maintenance and management system for distribution facilities and subscribers (GIS technique etc.) <p>Housing and Community Development:</p> <ul style="list-style-type: none"> • Facilitate provision of low and middle income housing by both HNA and the private sector; • Make further efforts for tackling slum problems with a comprehensive approach, including financial support institutions; • Creation of pedestrian-advantageous environment

10.2 Plan 1: Sustainable Resource Utilization of the Vulnerable Environment

It is an absolute fact that the capital city of Bangkok locates with environmentally vulnerable conditions. No one can change it unless the city moves somewhere else. Planning should start with recognizing the fact.

(1) Recognition of Environmental Vulnerability of Bangkok

Tropical Climate Severe for Human Environment:

It has too much precipitation in monsoon season (more than 300 mm per month) and too little in dry season (less than 10 mm per month). This naturally causes floods in monsoon season and droughts in dry season. In addition, a strongly stable condition of the air usually happens particularly in dry season, which tends to accumulate air pollutants on the surface due to less air circulation, thereby easily resulting in more serious air pollution.

Low Alluvium Plain Susceptible to Natural Disasters:

It has a geographical and geological constraint that the Bangkok metropolis locates in the low alluvium flat plain of the Chao Phraya River Delta (1 to 2 meter MSL). Because of this, once it suffers from a flood, water is difficult to be drained out and retain for a long time, thereby being likely to cause more serious damages on people's lives and the economy. In addition, land subsidence easily takes place in areas where voluminous underground water is being drawn up.

Moreover, it is predicted that along with proceeding of "Global Warming", the sea level will rise by 50 cm in coming 100 years on the average. If we believe in this statement, it can be said that after 300 years, most of Bangkok will sink under the sea, unless any measure will be undertaken.

Energy-consuming Modernization:

Compared to other countries, Thai is rapidly shifting to an energy-consuming country in terms of volume of oil consumption per unit GDP. Urban concrete jungle covered with buildings and paved roads, as a result of modernization, is energy-consuming, and the city is heating as much as the inside of buildings is cooling. This is weakening the restoration power of the natural environment. The modernization cannot be stopped, but an energy-saving and energy-recycling systems need to be introduced to the process of modernization and urbanization.

Water and Greens Vulnerable to Environmental Changes:

The tropical climate is capable of growing affluent greens. Bangkok used to be covered with a plenty of water and greens. Water and greens are the natural gifts to moderate the serious climatic conditions, and the most effective tools to mitigate the environmental pollution¹.

Water is necessary to improve the quality of water, and greens are necessary to clean the air. The Thai culture is based on such an exquisite and delicate natural system with water and greens. However, trees growing in the tropical climate are inherently

¹ "An Investigation on the Distribution of Air Temperature and the Effect of Open Space on Mitigating Server Climate in Bangkok, Thailand" (Nath Pichakum and Yorikazu Maruta, 1995) presents the result of simulation analysis using isotherm maps of Bangkok. Two interesting discussions are: 1) the difference of air temperature between built-up area and open space areas is identified to be 3.0 °C at 3:00 PM; and 2) when green coverage increases by 10%, air temperature reduces by 0.43-0.55 °C.

vulnerable to an environmental change and weak in survival power. Because of this, intensive efforts should be made to preserve water and green.

(2) Directions of Macro-measures

The Thai culture is based on an exquisite and delicate natural system with water and greens. Planning, therefore, should focus on:

- Restoration and rehabilitation of "Green and Water Network System";
- Establishment of social rules and guidelines for stopping the land subsidence and protecting the living environment from floods;
- Pursuance of Resource-recycling system and guiding to Energy-saving urban economic development.

10.3 Plan 2: Flood-free Urbanization

Taking into account the environmental vulnerability of Bangkok as mentioned above, the most important urban planning issue must be first on how to manage water wisely and how to realize flood-free urbanization. This issue is fundamental for sustainable socioeconomic development. Bangkok should be free from any fear of flood, otherwise people's safe and comfortable living as well as continuous investments on the economy could not materialize. Bangkok should be restructured to be the most "Comfortable City of Asia". In this regard, the following are proposed:

(1) Long-term Master Plan

Substantial flood protection systems and the action programs should be formulated on long-term perspectives. This may include some large-scale projects (century projects) to release Bangkok from the chronic problem.

(2) Formation of A Hierarchical Drainage Network System

The drainage system, same as the road network, should be functionally networked with a hierarchical system, i.e.,

- 1) the primary may be Chao Phraya River;
- 2) the secondary system comprised of major water by-paths, diversion canals and major khlongs, connecting directly the primary; and
- 3) the tertiary system constituted with khlongs and local drainage canals, linking with the secondary system. Such a functionally systematic integration of existing khlongs and drainage system is a vital planning issue.

A conceptual scheme of this hierarchical drainage network system is proposed as illustrated on Fig. 10.2.

(3) Establishment of Well-functioning Water Management System:

Rehabilitation and improvement of existing drainage facilities should be further strengthened with establishment of the well-organized maintenance and management system under coordination between relevant agencies.

(4) Control of Environmentally Preserved Land

It is rational that urbanization should be encouraged in suitable land areas where a well-functioning drainage system has been developed in the entire system, while it should be restricted in the others areas where no drainage systems have been

developed. Priority for urbanization, therefore, needs to be coherent with development of such a system.

In this regard, areas where are assessed to be preserved from the environmental standpoints need to be strictly controlled. Two types of land areas exist for this purpose:

- the area between the so-called King's Dike (flood wall) and the middle flood wall in the eastern part of BMA, and
- the coastal transition area facing the Gulf of Thailand.

(5) Guidelines for Water Retaining Capacity;

Land development and construction activities in urbanization control areas should institutionally be guided to the direction that water retaining capacity of land after projects must not be less than the status quo.

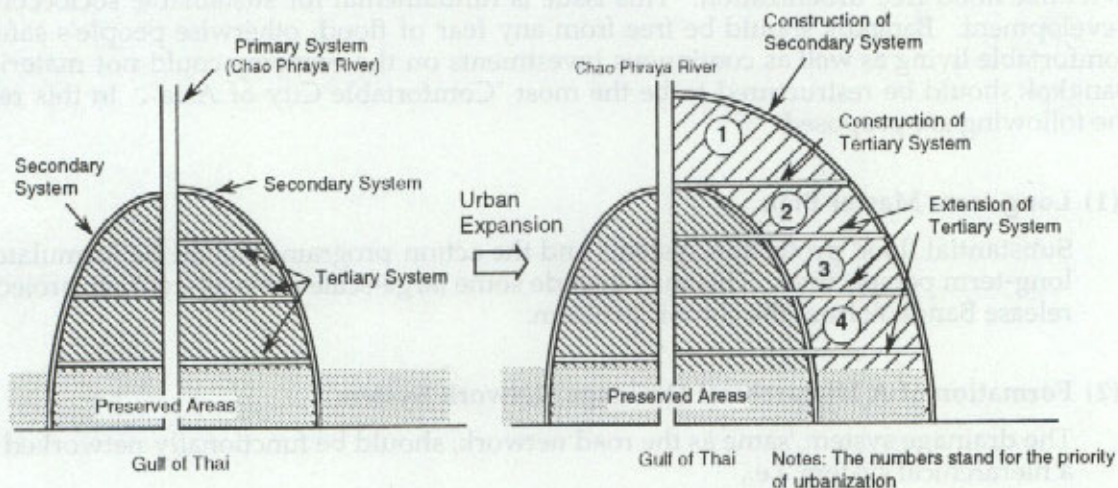


Fig. 10.2 A Hierarchical Drainage System for the Bangkok Metropolis

10.4 Plan 3: Environment-initiative Transport System

Environmental problems of Bangkok are attributed mainly to excessive concentration of economic activities and centric urban functions into the Bangkok Metropolis. This observation must have been broadly accepted. However, "concentration" does not necessarily stand for "congestion". Concentration is thought to be a result of pursuing some rationales of the economy to be more competitive and more efficient under the economy of scale. On the other hand, "congestion" takes place when adequate and sufficient provision of infrastructure and public services cannot meet demands for economic activities. Thus, congestion is stemmed from a failure in urban management or mal-structure of the urban spatial system.

It will be a central issue of the Study how to release the traffic congestion in the Bangkok Metropolis. This cannot be resolved with a sector approach, but needs an integrated approach to urban re-structuring of Bangkok.

(1) A Planning Concept of "Traffic Calmed City"

It needs to be recognized that we will be no longer able to enjoy Bangkok urban economic growth and urban life based on "Car-oriented Society" having been created for last two decades. In this society, mobility of cars is given the highest priority rather than mobility of people. This will eventually lead to a more serious environmental problem as well as fatal losses by further economic growth. Thus, there exist a vicious cycle in the "Car-oriented Society".

A challenge is now to redirect such a unorganized energy-consuming system with a vicious circle towards a new transport vision presented here, where people and transport urban infrastructure development can coexist for betterment of the whole community. The urban structure and transport infrastructure need to be developed together to achieve an environmental / ecological balance. This vision is also consistent with city development philosophies that are currently being pursued in other major cities, represented by "Eco-city" Development.

This implies that planning of transport infrastructure should be aimed at improving the mobility and transport access of people rather than those of motor vehicles, which is termed "Traffic Calming". To this end, it is necessary to change from a motorized private vehicle-advantageous society to a public transport-orientated society. Public transport systems which have less impact on urban ecology should be given the highest priority under the limited resources available to spend on transport infrastructure.

(2) A Shift from Road Transport-based Urban System to a Mass Transit-driven Urban System

There is no room to discuss further the necessity of a shift from the road transport-based to a mass transit-driven urban system in the Bangkok Metropolis. In this regard, the Study is standing on the same ground that several relevant agencies and a number of studies have long discussed for more than one decade. The Study Team also strongly endorses the following strategies some of which have been raised in previous studies:

- to guide intensive urbanization onto selected Metropolitan **Subcenters** where will be structured with MRT systems;
- to develop **inter-modal transfer** terminals/facilities with pedestrians, buses, waterways and MRTs;
- to develop "**park-and-ride**" facilities to encourage a modal shift from individual cars to MRTs;

- to improve the "pedestrian environment" especially in the Public Transport Advantageous Zone" and "Public Transport Corridors".

(2) Public Transport Corridor Development

Special policy emphasis should be placed on development of "Public Transport Corridors", combined with MRTs and buses, using radial arterial/secondary roads. Seven (7) corridors with traffic advantages to MRT and bus are proposed as discussed in Chapter 16.

(3) Formation of An Integrated Urban Transport Systems

A mega city with 10 million population needs a highly functional comprehensive urban transport systems. The system should be structured with the following planning criteria:

Public Transport Systems:

- MRTs or rail-systems provide with services to meet oriented mass traffic demands;
- The inner city needs to be all covered with public transport systems combined with several forms of transportation modes such as MRT, bus and waterway;
- Urbanized areas are all served with any public transportation;

Hierarchical Road Transport System:

A hierarchical road network system should be developed with special emphasis on the following:

- Middle Ring Expressways given a higher priority rather than radial expressways;
- Inter-regional arterial road network linked with Outer Ring Road and Middle Ring Expressways (Ring-and-Radar Pattern);
- Further development of "Secondary and Tertiary" roads in both built-up areas in association with Urban Renewal and Land Readjustment Projects;
- Infrastructure-led suburbanization, guided by institutional tools like guidelines for the private sector's development activities;
- Coordination in planning among relevant organizations to avoid duplicated efforts and funds;
- Area Traffic Control Systems should be explored, based on analytical bases; and
- The vested Area Traffic Control System (ATCS) should be made more functional with necessary institutional arrangement and human resource development to operate the system.

Intermodal System:

- Intermodal facilities should be developed to ease transfer activities and to encourage people to use public transportation; and
- Pedestrians-advantageous environment is created.

(4) Interrelations between Urban Development and Environment-initiative Transport System Development

Regeneration of the Inner City, or Old Bangkok

Relocation of out-of-date facilities in the inner areas should be facilitated. Especially, cargo traffic generators such as factories, warehouses and transport-related service

facilities which are no longer necessarily located in the inner areas should be encouraged to move to some selected suburban places where are more efficient in transport activities. To this end, the government sector needs to assume several responsibilities to:

- designate the relocation promotion areas and, at the same time, the areas to intensively and deliberately accommodate the relocated facilities;
- prepare well-developed land areas (in a form of industrial estates or truck terminals) for would-be-relocated facilities; and
- prepare an incentive scheme including tax incentives, provision of low-interest finance and technical advising services.

Based on the preliminary observation by the Study Team, Ratburana, Bang Kho Laem, Yanawa and Khlong Toey Districts are deemed to be focal areas for relocation.

The government sector also needs to intervene in usage of even private land available after the relocation. More public space for especially roads and open space is absolutely necessary in the inner city areas to improve the urban environment.

For this purpose, a new institution for land use and land transaction is needed to be enacted in order to justify such government interventions. The institution should stipulate an effective incentive scheme on the private-to-public land transaction.

Facilitation of Secondary and Tertiary Roads Development in Built-up Areas

Land acquisition for development of secondary and tertiary roads needs to be eased by empowerment of institutional tools of the Urban Planing Act to be linked with the Building Code.

The Urban Planing Act needs to definitely stipulate the legal designation system of "urban planning roads" including rules of landlords' contribution and land purchase by the public sector when existing buildings are demolished and re-built. More concretely, this system is as follows: when the landlord intends to change the land use or rebuild the building, if a part of the land has been legally designated as a Urban Planning Road, the landowner must contribute the part of land for the road construction or may claim the responsible authority to purchase the part of land at rational prices. The landowner may receive some tax incentives in compensation for doing so.

This system is not of acute treatment for public land acquisition, but workable in the long-term, since more or less 15% of the land use is likely to be changed in Bangkok for one decade, as discussed in Section 2.4.

This system is popular, not special, in developed countries to acquire public land for roads and infrastructures.

Infrastructure-led Suburbanization

To release the pressure of urban congestion, the deliberate suburbanization must be a key. In this regard, three (3) main issues should be tackled from the urban planning points of view:

- Sub-division Development;
- Ribbon Development; and
- Supper-block Problem.

Sub-division development is actively going on with less considerations of environmental impacts by sewage and drainage. It is surprisingly observed that those projects are taking place rather intensively in the zone designated to be environmentally preserved by the 1992 Bangkok General Plan, particularly in the eastern part of the Bangkok Metropolis. In many cases, there exist some drainage and sewerage systems but within the sub-division project areas, and no-treated sewage is being discharge directly to

khlongs or open ditches along roads. And, no adequate road network systems linking with public roads outside the subdivision area are observed.

Secondly, typical **ribbon development** apparently seen in suburban areas should be controlled as much as possible, because of the following three reasons:

- Benefits from the public investment on roads are distributed to only a limited number of residents along the road side;
- Road traffic capacity is likely to be reduced by allowing random access traffic;
- It makes more difficult to build an area-wise network system due to occupation of roadside space.

The problem would be worsen in the structure that many low level-roads (soi) are connected directly with an arterial road without a hierarchical road network structure.

In order to avoid such ribbon development, a hierarchical road network system related to land development needs to be applied as a basic urbanization model which could facilitate more effective area-wise urbanization system, involving the private sector's participation, as conceptually illustrated on Fig. 10.4. The land readjustment scheme is one of them.

Thirdly, supper-block problems which are typically observed in areas with a strong suburbanization pressure, are characterized by the same attributes as the problems on sub-division development. This issue has also been discussed in-depth in the Bangkok Plan (MIT/EC Teams).

The focal planning arguments on this matter are how to provide more secondary and tertiary roads and how to structure an adequate road network in total. Thus, the problem is mostly of the supply side.

Since the private sector's activities are inherently myopic and profit-oriented, it is the government sector's responsibility to provide clear-cut guidelines with enforcement power as an ordinance to direct the private sector's development toward a public benefits-oriented way. District governments have its chief responsibility.

Based on the above considerations, the BEIP Study proposed a Bangkok transport structure which can meet the future urbanization in 2011 and beyond 2011. The detailed discussions are made in Chapter 2 of Volume 3.

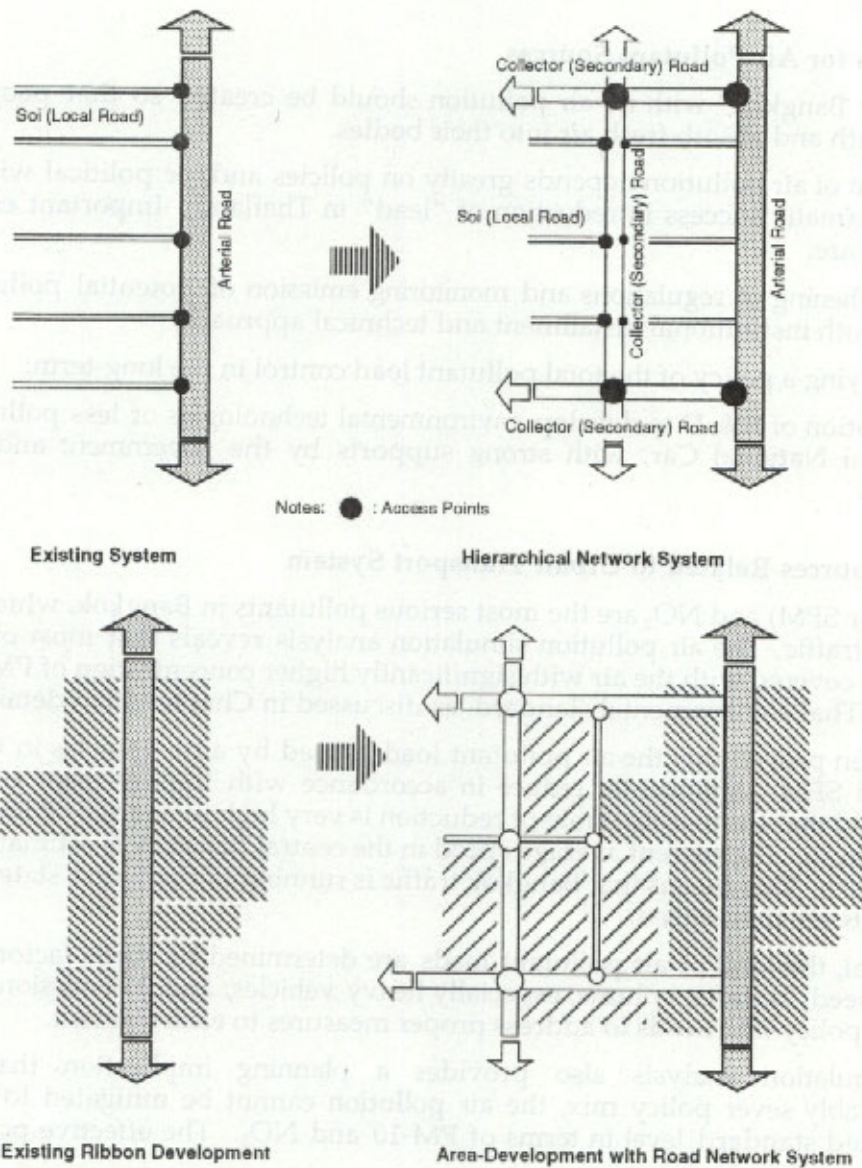


Fig. 10.3 A Conceptual Scheme for Area-wide Urban Development

10.5 Plan 4: Fresh-and-Clean Air Policy

(1) Measures for Air Pollutant Sources

"Healthy Bangkok" with no air pollution should be created so that people can take deep breath and absorb fresh air into their bodies.

Mitigation of air pollution depends greatly on policies and/or political will, as proved by the dramatic success in reduction of "lead" in Thailand. Important environmental measures are:

- strengthening of regulations and monitoring emission of potential pollutant sources with both institutional installment and technical approach;
- employing a policy of the total pollutant load control in the long-term;
- promotion of R & D to develop environmental technologies of less pollution vehicles as Thai National Car, with strong supports by the government and the private sector.

(2) Mobil Sources Related to Urban Transport System

PM-10 (or SPM) and NO₂ are the most serious pollutants in Bangkok, which are caused by road traffic. The air pollution simulation analysis reveals that most of the built-up areas are covered with the air with significantly higher concentration of PM-10 and NO₂ than the Thai environmental standard, as discussed in Chapter 18 in detail.

It has been proved that the air pollutant load caused by auto-vehicles in terms of CO₂, NO₂ and SPM, significantly reduce in accordance with improvement of the average speed, and that the marginal rate of reduction is very high in a range of low speed, say, 0 to 20 km/h. The current average speed in the central Bangkok is estimated at more or less 5 km/h. This means that Bangkok traffic is running in the worst state that emitted pollutants are maximized.

In general, the level of air pollutant loads are determined by three factors: 1) average travel speed; 2) traffic volume, especially heavy vehicles; and 3) emission factors. The optimal policy-mix needs to address proper measures to each element.

The simulation analysis also provides a planning implication that without a considerably sever policy mix, the air pollution cannot be mitigated to be under the designated standard level in terms of PM-10 and NO₂. The effective policy-mix calls for:

- Travel speed up on road traffic in the inner city;
- Significant shift of passengers from road transport to MRTs; and
- Strong vehicle emission regulation policy (as the European standard).

The state of air quality depends greatly on the urban structure and the transport system. The simulation analysis, again, reveals that given the urban re-structuring policy strengthened by a shift to the public transport-oriented system as well as subcenter development as proposed in the BEIP Study, the air pollutant diffusion pattern in 2011 would be significantly changed, as analyzed in Chapters 6 and 18. Despite that in the central area there will still exist a number of areas with higher concentration of PM-10 and NO₂ than the standard, the air condition of Bangkok will be improved as a whole.

(3) Stationary Sources Managed on Voluntary Basis

Stationary pollutant sources should be properly monitored and instructed for technical improvement by the authorities. More important is the voluntary activities for

environmental protection by the private sector itself, such as ISO14000, management of combustion and emission.

10.6 Plan 5: Water-friendly Eco-city

(1) Appreciation of the Thai Water Culture

The planning concept of "Water-friendly Eco-city" is derived from appreciation of the historical water system which the Thai socio-culture has been deeply rooted in. Thai people are traditionally well-knowledgeable of how to get along with water, and their living culture was based on such a respect on "water". Let us remind it again and restore the water-culture.

(2) Restoration of Khlongs

Currently, water quality of Khlongs are getting worse and the problem areas are expanding along with urbanization, as discussed in Section 3.2. In order to improve the water quality, sewage treatment systems need to be facilitated together with technical measures such as flash-water management and aeration.

Functions of khlongs should be restored again in a view of creating "urban ecology" in which people's living systems are integrated with the natural environment.

- **Drainage System:** The most important function of khlongs is for drainage canals for flood protection. This function should be maintained properly and strengthened.
- **Waterways for Public Transportation:** Some of major khlongs are being used as an alternative public transportation meeting commuting and daily traffic demands².
- **Open Space, Greens and Community Amenities:** Water is functioning as community links assorted with greens and open space. Thai people have already developed an outstanding urban design to form a comfortable combination with streets, khlongs and greens.

(3) Beautification of Khlongs and River Front Areas

Water is an effective element of urban amenity and brings out a "Taste of Bangkok", thereby attracting international tourists. Thai landscape design concept should be applied for the beautification program along selected khlongs and Chao Phraya River.

The beautification program needs to be concomitant with sewerage system and housing development.

² For crossing the east-west corridor, it takes 55 minutes by boat from the pier near Wat Saket to the Bangkok Pier in Khlong Saen Saep (17 Km). The average speed is 20 km/h, even in peak hours. By car, it takes more than 2 hours in peak hours.

10.7 Plan 6: Quality of Living Environment

(1) Hygienic Living Environment

Solid waste management is the most vital issue for BMA, including the following measures:

- Promote social awareness for correct recognition of current problems on solid waste;
- Facilitate people's participation in the improvement with an community approach;
- Establish a sustainable system for solid waste management with the coherent system, including collection, transportation, intermediate treatment, and final disposal; and
- Explore a **recycling system**, encouraging participation of communities and the business sector, and support recycling industries.

(2) One-more-step Solution of Slum Problems:

Housing issues are broad and various, and call for a wide variety of social development approach. The "slum problems", reviewing the previous and on-going NHA's attempts and projects/programs, should be further tackled. The financial institutions to support their "self-help solution" should be explored.

(3) Pedestrian-advantageous Society

In the urban transportation network system, "walking" is the most important transport mode, which shares 29% of the total person-trips. In order to encourage people to utilize public transportation such bus and mass transit system, "walking" should be also encouraged. More pedestrian-advantageous urban environment should be formed in Bangkok.

(4) Environment for the Weak

More attention should be paid to the weak such children, handicappers, women and elders in urban design and uses of public service facilities. This is regard as an indicator for the social maturity. Bangkok should never stand behind the maturity, rather go ahead in the world in environment for the weak.

CHAPTER 11: PROGRAMMING OF PROJECTS/PROGRAMS

11.1 Concepts on Project Formation

In order to materialize the above-mentioned 6 plans, the BEIP team propose a number of projects and programs. The following area the basic considerations for the project formation process.

(1) Three types of Projects/Programs

Projects/programs are, in general, classified into three categories representing policies in terms of objectives, target beneficiaries, natures of investment and required approach to implement, as shown in Table 11.1.

Minimum: Projects/programs to provide an "environmental minimum" condition for all people equally and equitably, particular emphasis on the poor and the weak with a bottom-up approach;

Basic: Projects/programs to meet present and future demands to fulfill the gap between supplies and demands, thereby moving environmental diseconomies in the society with an economically and financially feasible approach; and

Strategic: Projects/programs to change the urban structure and/or the socioeconomic balance between demands and supplies toward a future vision of development/growth for people of the next generation with a top-down approach based on future visions.

The BEIP proposed all the three types of projects/programs on the long-term perspectives. Although the time horizons that they are aiming at are deferent, preparatory actions should be initiated urgently.

(2) A Conceptual Frame for Programming

Characteristics of projects/programs are considered in a conceptual frame with two axes: the axis of implementing bodies and the axis of policy approach, as illustrated on Fig. 11.1. In this coordinates, projects/programs are situated as one of four categories characterized as follows:

I: Public investment for local and sector solution;

II: Involvement of voluntary private activities;

III: Institutional system with guidelines, standards and regulations for urban environmental and growth management; and

IV: Strategic public investment for urban restructure.

All the four (4) types of projects/programs are substantially needed to implement in an integrated manner. However, in the short-term, intensive efforts should be made to

enhance the categories of I and III; and in the medium- to long-term, emphasis should be placed on the categories of II and IV.

Table 11.1 Three Types of Projects/Programs

	Minimum	Basic	Strategic
1. Objective	To provide with the Environmentally Minimum Conditions	To meet present and future demands	To change the urban structure and the balance between demands and supplies
2. Target Beneficiaries	All people with special focus on the poor and the weak	Users as direct beneficiaries	People of the next generation
3. Natures of Investment	Equitable, equal or balanced allocation	Prioritized sector allocation	Enhanced strategic allocation
4. Required Approach	Bottom-up social approach with strong participation of communities	Economically and financially feasible approach	Top-down approach based on future visions
5. Action	Actions should be initiated urgently, and continuously undertaken for the long-term	Feasibility and engineering studies should be undertaken urgently, aiming at the medium-term completion.	Master plan studies should be undertaken urgently, aiming at the medium-and long-term completion.

Source: The BEIP Study Team

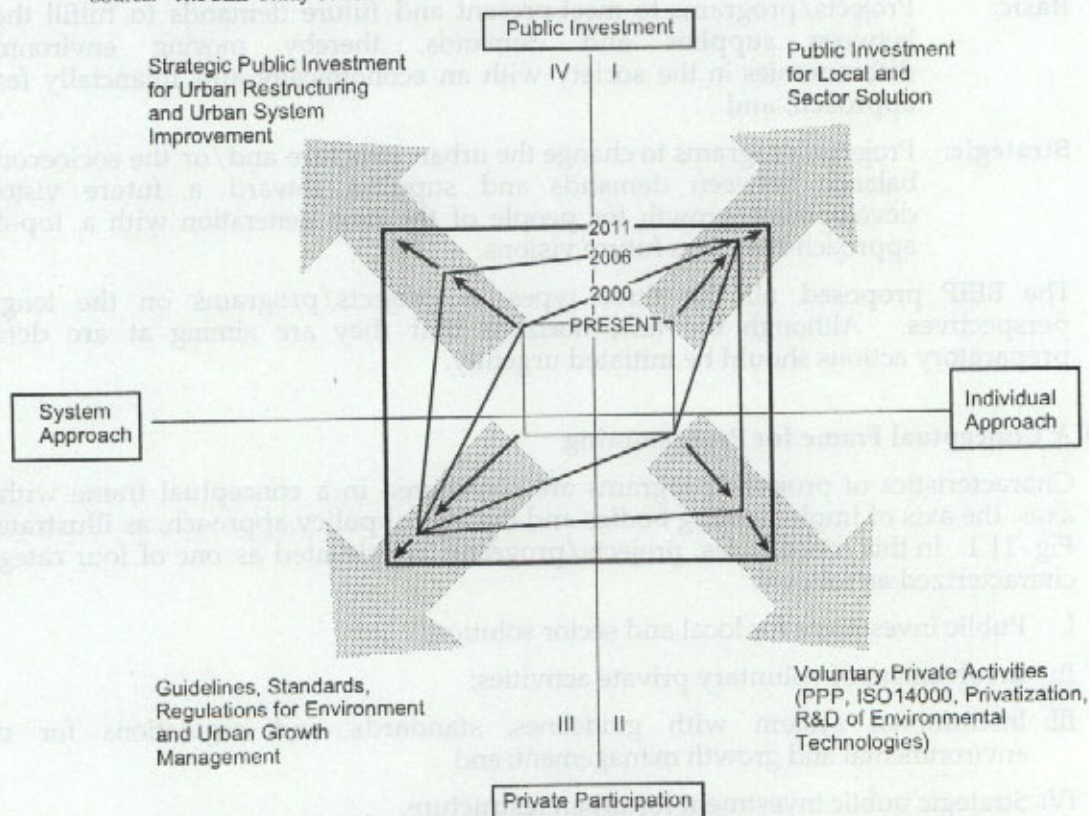


Fig. 11.1 A Conceptual Framework for Projects/Programs Identification and Priority

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (1/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Others	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million baht)		
						Total Cost	BMA	Central Government
Plan 1: Sustainable Resource Utilization								
Urgent Actions								
RU11: Formulation of Institutional Program for Land Subsidence Protection Projects (based on the JICA Study, 1992-95)	B	M	BMA	MOSTE				
RU12: Establishment of Guidelines for Land Development and Environmental Preservation (related to UR12)	B	M	BMA	MOSTE /MOI				
RU13: Public Campaign for Promotion of People's Awareness of Energy-saving	D	M	MOSTE	MOI	II	90	90	
Medium-term Projects/programs								
RU21: Development of "Solid Waste Recycling Center" plus Encouragement of Recycling Industries" (related to SW21)	B, C	B	BMA	MOSTE	I			
RU22: Development of "Green and Water Network" along Major Khlongs (related to WE24)	B, C	B	BMA		II	4,390	4,390	
RU23: R & D Support Program for Environmental and Energy-saving Technologies (related to AR24)	D	S	MOSTE		I			
Long-term Projects/Programs								
RU31: Implementation of Projects/Programs for "Energy-saving" and "Environmental Preservation" (based on RU23)	B, D	B	MOSTE	MOI	I			
Plan 2: Flood-free Urbanization								
Urgent Actions								
FL11: Long-term Master Plan Study for Flood Control in Lower Chao Phraya River Basin (scheduled to be supported by JICA)	A	M	BMA	RID				
FL12: Improvement, Rehabilitation and Enhancement of Existing Flood Protection Facilities (Dike, Water Gates, Pumping Stations and Drainage Systems)	C	M	BMA	MOI/RID		310	310	
FL13: Flood Plain Management Project for the Eastern Bank Area (Thonburi Side)	C	M	BMA	MOI		880	880	
FL14: Implementation of Projects for BMA 5th Five-year Plan	C	B	BMA			23,630	23,630	
Medium-term Projects/programs								
FL21: Implementation of Phase I Projects for Flood Protection System/Facilities Development (based on FL11)	C	B	BMA	RID/MOI		310	310	

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (2/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Others	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million Baht)			
						Total Cost	BMA	Central Government	State Enterprise Private
FL22: Implementation of the Extended Flood Plain Management Project for the Eastern Bank Area (following-up FL13)	C	B	BMA	MOI		880			
Long-term Projects/Programs									
FL31: Implementation of Phase II Projects for Flood Protection System/Facilities Development (based on FL11)	C	B	BMA	RID/MOI		880			
Plan 3: Environment-initiative Urban Transport (Eco-transport) System									
Urgent Actions									
ET11 Pedestrian Environment Improvement Plan	A	M	BMA	MOTC		60			
ET12 Eco-Street Development Plan	A	B	BMA			40			
ET13 Water Transport Revitalization Program	A	B	MOTC /BMA			40	40		
ET14 Public Transport Integration Plan	A	M	OCMRT /BMA	BMTA		60		60	
ET15 Master Plan and Feasibility Study on Public Transport Terminals and Inter-Modal Facilities	A	B	OCMRT /BMA	MOTC /BMTA		60		60	
ET16 Feasibility study and Engineering Study on Major Secondary Road	A	B	BMA			140			
ET17 Area Road Pricing plan	A	B	OCMRT	BMA /MOTC		60		60	
ET18 Review of Primary Road System	A	B	OCMRT	MOTC /ETA		20		20	
ET19 Implementation of Projects for BMA 5th Five-year Plan	C	B	BMA			54,400			
Medium-term Projects/programs									
ET24 Pedestrian Environment Improvement Phase 1 (based on ET11)	C	M	BMA		II	3,910			
ET25 Eco-Street Development Phase 1 (based on ET12)	C	B	BMA	MOTC	II	680			
ET26 Water Transport Revitalization Phase 1 (based on ET13)	C	M	MOTC /BMA		II	840	840		
ET27 Public Transport Integration Phase 1 (based on ET14)	C	M	BMTA	MOTC	II	100		100	
ET28 Public Transport Terminals and Inter-Modal Facilities Development (based on ET15)	C	B	MOTC /BMTA /BMA	MOTC OCMRT	II	7,480	2,490	100 2,500	
ET29 Implementation of Major Secondary Road Projects (based on ET16)	C	B	BMA			2,450			

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (3/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Other	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million baht)			
						Total Cost	BMA	Central Government	State Enterprise
ET30 Implementation of Area Road Pricing Project (based on ET17)	C	B	BMA	MOTC /OCMRT		300			
ET31 Formulation of Transport Master Plan for 9th National Development Plan	A	M	OCMRT	NESDB		60	60		
ET32 Proceed Implementation of Extended Mass Transit System Projects (71.4km)	C	S	MRTA	MOTC /BMA	I	42,080		29,290	12,790
Long-term Projects/Programs									
ET33 Pedestrian Environment Improvement Phase 2 (based on ET11)	C	M	BMA		II	1,360	1,360		
ET34 Eco-Street Development Phase 2 (based on ET12)	C	B	BMA	MOTC	II	1,560	1,560		
ET35 Water Transport Revitalization Phase 2 (based on ET13)	C	M	MOTC	BMA	II	1,550	1,550	100	
ET36 Public Transport Integration Phase 2 (based on ET14)	C	M	OCMRT	BMTA		100		220	
ET37 Public Transport Terminals and Inter-Modal Facilities Development (based on ET15)	C	B	MOTC /BMTA /BMA	OCMRT		640	210		
ET38 Implementation of Major Secondary Road Projects (based on ET16)	C	B	BMA			32,390	32,390		
ET39 Formulation of Transport Master Plan for 10th National Development Plan	A	M	OCMRT	NESDB		100	100		
ET40 Proceed Implementation of Mass Transit System Projects (63.6km)	C	S	MRTA	MOTC /BMA	I	37,400		26,520	10,880
Plan 4: Pursuance of "Fresh and Clean Air Policy"									
Urgent Actions									
AR11: Environmental Administration Enhancement Program, including:	B, D	M	MOSTE	BMA		130			
• Extension of Monitoring Stations and Equipment for Meteorology and Ambient Air Quality;									
• Establishment of Epidemiological Surveillance System; and									
• Training and Technology Transfer of Analytical Technique.									
AR12: Establishment of Air Pollutants Protection Guidelines for Private Activities, including:	B	M	MOSTE	BMA	I				
• Construction Site Management and Truck Cleaning; and									
• Combustion Management and Emission Control for Factories.									

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (4/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Others	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Responsible Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million Baht)			
						Total Cost	BMA	Central Government	State Enterprise Private
AR13: Improvement of Vehicle Inspection and Maintenance System Program, including <ul style="list-style-type: none"> Standardization and Technical Guidelines of Emission Inspection; Training and Qualification System for Inspectors /Mechanics; Public Relation of the System, and Institution Building, and so on. 	B, D	M	MOTC	MOSTE /BMA	I	600	600		
AR14: Implementation of "Fresh and Clean Air Program for Public Bus", including: <ul style="list-style-type: none"> Checking System of Maintenance and Exhaust Gas; and Low-Pollution Bus Replacement (Introduction of CNG Bus, ect.) Program. 	B, D	B	BMTA	MOTC /BMA	II	9,350	940	8,410	
AR15: Public Campaign for Promotion of People's Awareness of Vehicle Maintenance and Dust Reduction by Construction	D	M	MOSTE /BMA	MOTC	II	60	60		
AR16: Establishment of Transportation Research Center (in coordination with ERTC), including <ul style="list-style-type: none"> Study for environmentally sound transportation policies; Research for low-emission-vehicles and transportation technology suitable for South East Asia 	B, D	S	MOTC	MOSTE /MOI		90	90		
AR17: Study of Action Plans for "Comprehensive Urban Traffic Pollution Management"	A	M	MOSTE /MOTC	BMA	II	40	40		
AR18: Implementation of Projects for BMA 5th Five-year Plan	C	M	BMA	MOSTE	II	240	240		
AR21: Implementation of the Extended Environmental Administration Enhancement Program (following-up AR11)	C, D	M	MOSTE		II	70	70		
AR22: Enhancement of Voluntary Activities by the Private Sector, including: <ul style="list-style-type: none"> Introduction of Voluntary Environment Management System; Promotion of Private Laboratory and Monitoring Activities; Establishment of Public Qualification System for Environmental Engineers/Managers; and Introduction of ISO14000 System. 	B	B	MOSTE	NESDB /MOID	I	60	60		

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (5/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev D: Other	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million baht)				
						Total Cost	BMA	Central Government	State Enterprise	Private
AR23: Implementation of the Extended Vehicle Inspection and Maintenance System Improvement Program (following-up AR13)	C	M	MOTC	MOSTE	I	170		90		80
AR24: Implementation of "Energy-saving Policy", including: • Incentive Provision for Shifting to Cleaner Energy/Fuel; and • Institutional Support for Fuel Efficiency Improvement.	B	S	MOSTE	NESDB /MOF /MOID	I	60		60		
AR25: R & D Support Program for Less Pollutant Vehicle Production (Hybrid Electric Vehicle etc.)	A	S	MOSTE		I	5,100		1,020		4,080
Plan 5: Creation of Water-friendly Eco-city										
Sewerage System Development										
Urgent Actions										
SS11: Review of the Existing Sewerage Master Plan in Priority, Facility Sites, Systems, Engineering Design and Implementation Scheme	A	M	BMA	WMA/ MOSTE		20	20			
SS12: Feasibility Study on Priority Sewerage System Projects, Committed in the BMA 5th Five Year Strategic Plan (based on SS11)	A	M	BMA	WMA/ MOSTE		40	40			
SS13: Procurement of Sewerage Treatment Facility Construction Sites for the Priority Project (related to SS12)	C	B	BMA	WMA/ MOSTE	II	22,870	22,870			
SS14: Promotion of Public Campaign for Saving Water and Reducing Water Pollutants	D	M	BMA	WMA/ MOSTE		90	90			
SS15: Implementation Project for BMA 5th Five-year Plan	C	B	BMA	WMA/ MOSTE		18,300	18,300			
Medium-term Projects/programs										
SS21: Implementation of the Priority Projects (based on SS11-13)	C	B	BMA	WMA/ MOSTE	II	50,020	50,020			
SS22: Feasibility Study on Second Priority (Phase II) Sewerage System Projects (based on SS11)	A	B	BMA	WMA/ MOSTE		40	40			
SS23: System Management and Maintenance Capability Enhancement Project (related to UFR22)	B	B	BMA	WMA/ MOSTE	II	590	590			
Long-term Projects/Programs										
SS31: Implementation of Second Priority (Phase II) Sewerage System Projects (based on SS22)	C	B	BMA	WMA/ MOSTE	II	46,890	46,890			
SS32: Implementation of Extended Project for Sewerage System Development	C	B	BMA	WMA/ MOSTE	II	1,070	1,070			

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (6/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Others	Prioritization Criteria M: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million Baht)			
						Total Cost	BMA	Central Government	Slab Enterprises Private
River and Khlong Water Improvement									
Urgent Actions									
WE11: Extension of the on-going Khlong Beautification Program in the Eastern Bank Area	C	M	BMA		II	200	200		
WE12: Feasibility Study for Khlong Waterway and Boat Piers Improvement Project (related to ET13)	A	M	BMA	MOTC		30	30		
WE13: Formulation of "Khlong Water Beautification Program" in Thonburi Area	A	M	BMA	MOSTE/ MOTC		30	30		
WE14: Master Plan Study for Chao Phraya River Water Front Regeneration Project	A	M	BMA	MOSTE /MOTC /MOI		30	30		
WE15: Promotion of Public Campaign for "Clean, Green, Khlongs"	D	M	BMA	MOSTE	II	90	90		
Medium-term Projects/Programs									
WE21: Implementation of Khlong Waterway and Boat Piers Improvement Project (based on WE12)	C	M	BMA	MOTC	II	530	530		
WE22: Implementation of "Khlong Water Beautification Program" in Thonburi Area" (based on WE13)	C	M	BMA	MOSTE /MOTC	II	200	200		
WE23: Implementation of Phase I Project for Chao Phraya River Water Front Regeneration (based on WE14)	C	S	BMA	MOSTE /MOTC /MOI	I	980	490		490
WE24: "Green and Water Network" Project along Major Khlongs	C	B	BMA	MOI	II	780	780		
Long-term Projects/Programs									
WE31: Implementation of the Extended Phase II Projects for Chao Phraya River Water Front Regeneration (following-up WE23)	C	S	BMA	MOI	I	980	490		490
Plan 6: Up-grading of Quality of Living Environment									
Solid Waste Management									
Urgent Actions									
SW11: Master Plan, Feasibility and Engineering Study for Final Disposal Sites/Facilities Development in Bangkok	A	M	BMA			60	60		
SW12: Feasibility and Engineering Study on Intermediate Solid Waste Treatment Facilities and Long-term System Development (including Improvement of Collection and Transport Systems)	A	M	BMA			40	40		

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (7/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Other	Prioritization Criteria M: Minimum B: Basic S: Straight	Implementing Body	Hosted Agency	Private Participation I: Major II: Supporting	Cost and Allocation (million baht)				
						Total Cost	BMA	Capital Government	Subsidiary Enterprise	Private
SW13: Bangkok Incineration Plant Development Project (based on a review of the existing BOT/Turn-key program)	C	B	BMA	MOSTE	II	9,180	4,590			4,590
SW14: Public Campaign for Promotion of People's Awareness for Solid Waste Reduction and Community Collection System	D	M	MOSTE	BMA	II	90		90		
SW15: Implementation of Projects for BMA Fifth Five-year Plan • Facilities Development • Disposal contract • Medium-term Projects/programs	C	B	BMA	BMA	II	23,930	23,930			
SW21: Development of "Solid Waste Recycling Center" and Encouragement of Recycling Industries	C	B	BMA	MOID	I	4,750	2,380			2,370
SW22: Implementation of Final Disposal Site/Facility Development Project (based on SW11)	C	M	BMA	MOSTE	II	5,430	5,430			
SW23: Implementation of Intermediate Waste Treatment System Development (following-up SW12)	C	B	BMA	MOSTE	II	980	980			
SW24: Extended Project of Incineration Plant Development (linked with SW13)	C	B	BMA	MOSTE	I	27,550	13,780			13,770
Long-term Projects/Programs						5,430	5,430			
SW31: Implementation of Extended Projects of Solid Waste Intermediate and Final Disposal Facilities Development (linked with SW21-23)	C	B	BMA	MOSTE	II					
Water Supply System										
Urgent Actions										
WS11: Feasibility Study for Improvement and Rehabilitation of Existing Water Supply Facilities and Subscriber Management System	A	M	MWA	BMA	II	60			60	
WS12: Review of the Existing Long-term Master Plan of Water Supply System Development	A	M	MWA	BMA	II	30			30	
WS13: Implementation of Projects for MWA 5th Five-year Plan	C	B	MWA	BMA		114,900			114,900	
Medium-term Projects/programs										
WS21: Implementation of Improvement/Rehabilitation of Water Supply System (based on WS11 and WS12)	C	M	MWA	BMA		58,620			58,620	
WS22: Development of Computerized Management and Maintenance Systems for Water Supply Facilities and Subscribers	C	S	MWA	BMA		780			780	

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (8/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev D: Others	Prioritization O: Ours M: Medium B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million Baht)				
						Total Cost	BMA	Central Government	State Enterprise	Private
Long-term Projects/Programs										
WS31: Implementation of Extended Water Resource Development and Supply System Development (based on WS12)	C	M	MWA	BMA		87,930			87,930	
Housing and Community Development										
Urgent Actions										
HC11: Feasibility and Engineering Study of the NHA Five-Year Program for Provision of Low and Middle Income Households (related to UR11)	A	B	NHA	BMA	II	40			40	
HC12: Feasibility Study for Slum Resettlement and Up-grading Programs with Enhancement of Financial Support Programs	A	M	NHA	BMA	II	40			40	
HC13: Public Campaign for Promotion of Community Participation in Solving Environmental Problems (related to SW14)	D	M	NHA	BMA	II	40			40	
HC14: Master Plan and Action Programs Study for Metropolitan Sub-center Development	A	M	BMA	NESDB /MOI /NHA		60			60	
Medium-term Project/Programs										
HC21: Implementation of the NHA Five-Year Program for Provision of Low and Middle Income Households (based on HC11)	C	B	NHA	BMA		15,630			15,630	
HC22: Implementation of Slum Resettlement and Up-grading Programs with Enhancement of Financial Support Programs (based on HC12)	C	M	NHA	BMA /MOF /NESDB /MOI	I	39,080			19,540	19,540
HC23: Support Program for Development of Community Parks, Environmental Green and Pedestrian Facilities (following-up HC13)	C	B	BMA		II	3,910		3,910		
HC24: Implementation of Redevelopment Projects of NHA Housing Areas (given to priority to Din Daeng Project)	C	B	NHA	BMA	I	19,540			7,820	7,810
HC25: Implementation of Infrastructure Projects of Sub-center Zone Development (based on HC14)	B, C	S	BMA /NHA	NESDB /MOI /MOTC, etc.	I	116,030		23,210	46,410	46,410

Table 11.2 Proposed Projects/Program for Bangkok Environmental Improvement (9/9)

Title of Projects/Programs	Type of Project A: Development Study B: Institutional Building C: Infrastructure Dev. D: Others	Prioritization Criteria W: Minimum B: Basic S: Strategic	Implementing Body	Related Agencies	Private Participation I: Major II: Supporting	Cost and Allocation (million baht)					
						Total Cost	BMA	Central Government	Staff Enterprise	Private	
Long-term Projects/Programs HC31: Implementation of Infrastructure Projects of Extended Sub-center Zone Development (based on HC14)	C	S	BMA /NHA	NESDB /MOI /MOTC, etc.	I	254,320	50,860		101,730	101,730	
Special Projects/Programs for Urban Planning and Institutional Enhancement											
Urgent Actions											
UR11: Formulation and Empowerment of Local Environmental Plans and Guidelines by District	A	M	MOSTE			40		40			
UR12: Strategic Study for Urban Management System and Financial Enhancement Programs of BMA	A	M	BMA	MOSTE		70	70				
UR13: Establishment of "Bangkok Information & System Development Center (BISDC)" in BMA	C, D	B	BMA	MOI /MOF		780	780				
UR14: Development of Large Scale Topographical and Cadastral Maps for Urban Planning and Tax Assessment Administration (linked with UR12 and UR13)	C, D	B	BMA			1,370	1,370				
Medium-term Projects/programs											
UR21: Computerization of Local Tax Administration in BMA (based on UR14 and UR15)	B, C	M	BMA			290	290				
UR22: Establishment of "Environmental Engineering & Technology Center (EETC)" in BMA, for Staff Training and R&D Promotion	C, D	B	BMA		II	780	760				

**PART IV: MANAGEMENT AND FINANCING
 FOR THE IMPLEMENTATION**

CHAPTER 12: POLICY ZONING PLAN FOR URBAN ENVIRONMENTAL IMPROVEMENT

12.1 Urban Development Strategies

(1) Review of Urban Problems in Bangkok

The urban environmental problems currently occurred in Bangkok are assessed in Chapter 3. It is concluded that the urban environmental problems are spread over all of Bangkok and differs by area.

In the central areas, flood problems along the Chao Phraya River, air pollution, high densely inhabit are crucial. Concentration of economic activities, population with inadequate infrastructure is an issue for urban environmental improvement. To this end, more land utilization and infrastructure provisions should be taken into consideration.

In the built-up areas, water pollution, traffic congestion and inadequate greens and urban amenity are pointed out as the urban environmental problems. The environmental infrastructure provisions can not catch up the rapid urbanization, resulting in causing environmental problems. It is necessary to promote infrastructure provisions to up-grade urban environment.

In the suburban areas, urban sprawl along major development corridors is a problem. It creates inadequate living environment and negatively affects to urban environment such as water pollution, uncollected solid waste and traffic congestion. Therefore, it is necessary to direct urbanization to appropriate directions through appropriately managing private development.

(2) Urban Development Policies

It is necessary to establish the following three directions of urban development policies:

- Improvement of land use efficiency in the built-up areas;
- Management of urbanization in the suburban areas; and
- Development of sub-centers for creating multi-polar urban structure.

For the above policies, much efforts on land use control, infrastructure and facilities provision, change of urban functions and urban redevelopment should be made. Policy Zones indicate necessary measures to be taken for certain areas in order to realize such urban development policies. Based on the policies, certain focal points of the planning directions are emphasized in accordance with local characteristics of the current environmental problems as shown in Table 12.2.

Table 12.1 Issues on Urban Planing

	Central Area	Surrounding Area of Central Area	Urbanized Suburban Residential Area	Suburban Area to be Urbanized
Bangkok Peoples at Present	<ul style="list-style-type: none"> •Revitalization of Buildup Area •Improvement of Urban Amenity 	<ul style="list-style-type: none"> •Provision of Roads •Improvement of Urban Amenity 	<ul style="list-style-type: none"> •Provision of Roads •Provision of Sewerage •Prevention from Inundation 	<ul style="list-style-type: none"> •Provision of Transport Facilities •Provision of Sewerage •Prevention from Inundation
Bangkok Peoples in future	<ul style="list-style-type: none"> •Intensified Land Use •Improvement of Accessibility 	<ul style="list-style-type: none"> •Provision of Appropriate Public Transport System •Improvement of Urban Amenity 	<ul style="list-style-type: none"> •Prevention of Sprawl Development •Provision of Public Transport System •Creation of Urban Amenity 	<ul style="list-style-type: none"> •Prevention of Sprawl Development •Guiding Urbanization to Appropriate Direction with Public Transport System •Maintaining Greens and Flood Prone Area
Thai Economy	<ul style="list-style-type: none"> •Lessening Diseconomy caused by Traffic Congestion •Maintaining/strengthening Hab Function of Economy in Thailand and South East Area 	-	-	Sub-center Development

Table 12.2 Application of Urban Development Policy by Area

Urban development Polices	Urbanized Area		Non-Urbanized Area
	Central	Suburban	
Improvement of Land Use Efficiency	Regeneration of Function	Environmental Infrastructure Improvement	
	Land Use Intensification		
Management of Urbanization		Guiding Urbanization with Infrastructure Provisions	Control of Urbanization Preservation of Nature
		Environmental Infrastructure Improvement	
Development of Sub-center			Development of Sub-center Zones

(3) Instrument of Urban Growth Management: Three Approach

With regard to the above urban development policies, various kinds of projects could possibly be employed. They are conceptually divided into three types, including the individual approach, the area approach and the system approach. The individual approach aims mainly at tackling the problem on site. The area approach aims mainly at tackling the problem by taking into accounts the view of a certain collective area. The system approach aims mainly at tackling the problems on the macro level such as the changing spatial structure and institutional re-arrangement.

Urban growth management should select the best combination from the above three approaches for urban environmental improvement in terms of balancing functional benefits and negative environmental impacts.

Table 12.3 shows a conceptual classification for possible programs and projects for urban environmental improvement using each approach.

Table 12.3 Conceptual Classification of Possible Programs and Projects by Three Approaches

	Problems	Problems Identified	Planning Direction			
			Individual Approach	Area Approach	System Approach	
Urban Anabolism Management	Problems on Natural Conditions	Flood	Rise foundation at respective site	Restriction of urbanization at possible area	Construction of Flood way outside King's dike	
		Land Subsidence	Piling to support building/house	Restriction of urbanization at the area without water supply	Restriction of ground water use Expansion of water supply area	
Urban Growth Management & Provision of High Quality Social Capitals	Problems on Urban Planning	Low Living Environment	-	Urban redevelopment project	Supporting reconstruction of houses by public sector	
		Disorderly Development	Supervising/guiding individual developers	Restriction of urbanization at the area	Strengthening of permission system (increase of criteria, rise of permission criteria)	
		Deterioration of Inner City	-	Redevelopment project	Relocation program	
		Land Speculation	-	Designating the area to supervising land trade	Loan Control	
		Lack of Parks	Land purchase Compulsory land acquisition Utilization of public land	Urban redevelopment project	Obligation of park provision for large scale land development	
	Problems on Low level of Accessibility and Traffic Congestion in Roads	Low road Density by Super Block	Land purchase Compulsory land acquisition Utilization of public land	urban development project (redevelopment, land readjustment etc.)	Obligation of land provision to public use for large scale land development	
		Centralized Urban Structure without Sufficient Radial Transport System	Staggered commuting	Area traffic control	Relocation of urban function Sub-center development	
		High Percentage of Vehicle Use for commuting	Vehicle use control	Area control	Introduction of MRT systems	
		Problems on Air Pollution	Mobile Source	Improvement of vehicle engine to reduce emission factor	Increase vehicle speed Reduce vehicle volume	Strengthening of environmental standard
			Stationary Source	Improvement of efficiency of combustion in factories	Relocation of factories	Strengthening of environmental standard
Urban Catabolism Management	Dust from Construction Site	Strengthening of regulation on construction	-	-		
	Problems on Water Pollution	Increase of waste water into Khlong	Saving water use by people	Provision of sewerage system	Controlling urbanization into appropriate direction	
	Problems on Garbage	Increase of garbage generation	Reducing garbage generation by peoples Recycling	-	Encouraging Recycling	
		Over capacity of Collection Vehicle	Increase of collection vehicle	-	-	
		Difficulty of acquiring Final Disposal Site	-	-	Introduction of incineration plant	
Type of Actions Needed			Individual infrastructure project Procurement/acquisition, strengthening of regulations Enlightenment activities	Policy zoning system Area improvement project	New institutional arrangement Large infrastructure development	

12.2 Policy Zoning

(1) Concept of "Policy Zoning System"

1) Objectives of Policy Zoning

Since the type of urban environmental problems differ by area, urban development policies as well as the approach to be employed will obviously differ by the area. To identify areas with necessary actions to be taken, the policy zoning system is proposed with the following practical objectives:

- To stipulate appropriate directions of development and implement by "zone"; concomitant with land use zoning;
- To implicate project/programs, institutional and legal frameworks, and financial and budgetary back-up to realize the planned directions; and
- To provide an advantageous tool for "growth management and control" in the urban planning administration in coordination with the relevant authorities.

2) Land Use Zoning vs. Policy Zoning

Land use zoning generally aims at indicating the appropriate land usage pattern, permissible activities and permissible types and sizes of buildings. However, it does not show the necessary actions to be taken for realizing such land use nor for solving/mitigating existing problems. On the other hand, the policy zoning system indicates necessary actions to realize urban development policies as well as urban environmental improvement policies. Therefore it is considered that policy zoning is a type of supplemental zoning system to the land use zoning system.

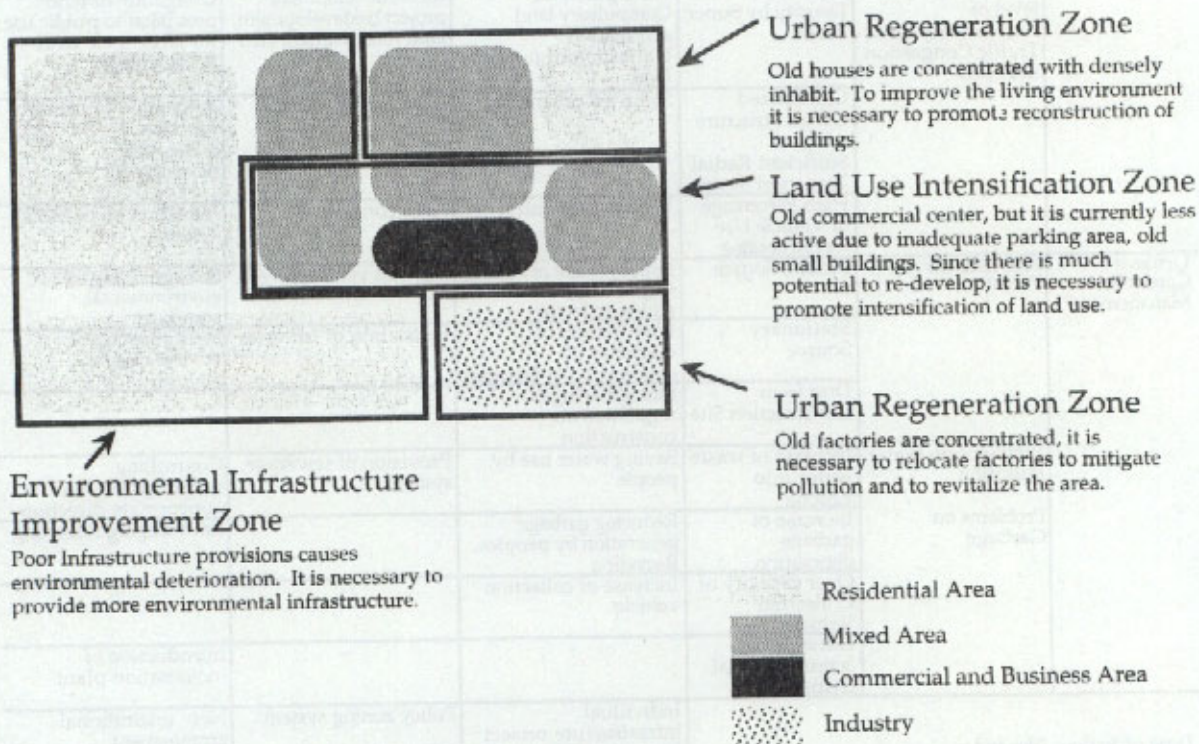


Fig. 12.1 Land Use Zoning and Policy Zoning

(2) Concept of Policy Zoning System

Following the urban development policies as well as the existing urban environmental problems, which were analyzed in Chapter 3, the following policy zoning concepts are employed;

1) Improvement of Land Use Efficiency in the Built-up Area

Replacement of Urban Functions

Industries with less functions located in the central areas and with less productivity compared to land prices should be replaced. The remaining spaces should be used for both new businesses and for provision of public facilities. The public sector should encourage the relocation scheme.

Maximization of land Productivity

The areas with improving land potential should be intensively utilized with higher buildings to create more open spaces and public spaces. The public sector should encourage private development by providing incentives.

Provision of Infrastructure and Facilities

The area with a low living environment should be improved by public investment.

Handing Down Historical Urban Stocks to The Next Generation

The old town view and historical landscape should be conserved as Thai cultural assets. The current view of towns should be maintained by regulations and incentives.

2) Urbanization Control Policy and Measures

Leading Planned Urbanization and Avoiding Urban Sprawl

The area to be urbanized should focus on providing infrastructure in order to direct private development. The other areas should be controlled with regard to private development. Furthermore, it is necessary to specially supervise land transaction and development to avoid land speculation for the area with higher land development potential out of the outer ring roads.

Preservation of Areas for Disaster Prevention and Natural Preservation

The areas used currently for disaster prevention and natural conservation should not basically be permitted any development to maintain present land use.

3) Sub-center Development for Multi-polar Urban Structure

The area for new sub-centers should be designated. The sub-centers should be developed by coordinated efforts of the public and private sectors. The areas for the core area of the sub-center zones and the relatively lower land development potential areas should be developed by the public sector. On the other hand, the areas with higher land development potential should be developed by the private sector with a certain degree of public control.

The above mentioned concept is summarized in Table 12.4.

Table 12.4 Policy Zoning Concept

Natural Conditions	Infrastructure Conditions	Living Environment	Urbanized Area		Non-Urbanized Area
			Central Area	Suburban Area	
×	×	×	Provision of Infrastructure	Provision of Infrastructure Purification of Khlong Water	Preservation Control of Urbanization
△	△	×	Regeneration of Urban Function	Provision of Parks Purification of Khlong Water	
○	○	○	Land Use Intensification Public Transport Use Promotion Maintenance of Scenery	Maintenance of Scenery	Planned Urbanization Sub-center Development

- × Unsuitable Condition
 △ Average
 ○ Suitable Condition

(3) Proposal of "Policy Zones"

1) Set-up of Policy Zones

Based on the above concept, the following 7 policy zones and 5 special development zones are categorized to realize the policy zoning system concept:

- Historical Conservation Zone;
- Urban Regeneration Zone;
- Land Use Intensification Zone;
- Infrastructure Improvement Zone;
- Infrastructure-led Urbanization Zone;
- Controlled Urbanization Zone;
- Preservation Zone;
- Special Development Zone:
 - Public Transit Advantageous Zone;
 - New Sub-center Development Zone;
 - Khlong Water Quality Improvement Promotion Zone;
 - Land Development/Transaction Supervision Zone;
 - Park and Open Space Zone; and
 - Special Scenic Zone.

2) Criteria for designating Policy Zones

Table 12.5 shows detailed criteria to designate each policy zone. Based on the results of the urban environmental assessment as well as the land potential and urbanization analysis, several indicators are selected to designate the each policy zone.

Table 12.5 Criteria for Designating Policy Zones

Zone	Criteria for Designation
1 Historical Conservation Zone	<ul style="list-style-type: none"> Rathanakosin Area;
2 Urban Regeneration Zone	<ul style="list-style-type: none"> Extended District recommended by the Bangkok Plan. Chao Phraya river side area with mixed land use of warehouses, factories, etc. which are no longer functioning well; Part of the Khlong Toei Port Area where integrated development is required; Part of CBD where infrastructures have been developed but the land uses are highly congested with mixed functions; Part of CBD where urban redevelopment is assessed to be necessary from the disaster prevention point of view.
3 Land Use Intensification Zone	<ul style="list-style-type: none"> Intensified land use is required to maximize the location advantages and land economy; Mass-transit terminal areas; Business areas with comparatively high road density and
4 Environmental Infrastructure Improvement Zone	<ul style="list-style-type: none"> Part of built-up areas with poor infrastructures and poor environmental conditions: low road density, too high population density, less services of green and park, low service of water supply and sewerage, fears of land subsidence and occasional floods, Part of built-up area with so-called super block problems
5 Infrastructure-led Urbanization Promotion Zone	<ul style="list-style-type: none"> Area where urban land use should be promoted to accommodate increasing population and land use demands; Areas with a high urbanization potential and a comparatively low built-up ratio at present where the urbanization pressure is thought to be high; Areas with poor infrastructures and public facilities Area where disorderly subdivision development is anticipated without provision of advanced infrastructure.
6 Controlled Urbanization Zone	<ul style="list-style-type: none"> Areas with low urbanization potential and serious natural constraints ; Areas where active urbanization needs to be controlled from the environmental point of view even though high urbanization potentials are observed; Areas along rivers and Klongs necessary for flood prevention and environmental purposes.
7 Preservation Zone	<ul style="list-style-type: none"> Areas with considerably low urbanization potential and to be conserved from the environmental viewpoint; Areas to be reserved on a long-term perspective.
8 Special Development Zone 8.1 Public Transit Advantage Zone	<ul style="list-style-type: none"> Part of CBD with intensive services by mass-transit systems are to be provided (covered with 800 m walking distance from stations of MRTs); and Part of CBD with extremely high traffic generation and/or attraction, and functionally accessible by alternative public transportation.
8.2 New Sub-center Development Zone	<ul style="list-style-type: none"> Locations proposed by the Bangkok Plan, or Another areas where are assessed to be suitable for publicly initiated sub-center development from the environmental view point.
8.3 Khlong Water Quality Improvement Promotion Zone	<ul style="list-style-type: none"> Central urbanized areas both side of Chao Phraya River, encompassed with Khlong Lad Phrao in the eastern side and Khlong Bangkok Yai in the western side.
8.4 Land Transaction/Development Supervision Zone	<ul style="list-style-type: none"> Non-built-up area at present with higher land development potential; and Within controlled urbanization area.
8.5 Park and Open Space Zone	<ul style="list-style-type: none"> Existing large-scale parks and open space; Community parks to be planned; Green areas to be conserved.
8.6 Special Scenic Zone	<ul style="list-style-type: none"> Area with historical, cultural and tourism assets Special area where landscaping should be improved Part of Chao Phraya River side areas to be scenically preserved

(4) Designation of Policy Zones

Based on existing data and simulation data regarding urban planning, transport planning and environmental planning, the policy zones are designated, as shown in Fig. 12.2

(5) Necessary Measures for Policy Zones

To realize urban development and environmental improvement policies, necessary institutional measures are indicated by the policy in Table 12.6. Most of the necessary measures are based on private participation in urban development. The public sector needs to strengthen the regulatory measures as well as create new urban development schemes, which are discussed in the next chapter regarding an institutional plan for urban growth management.

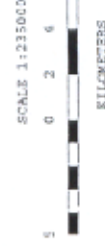
Policy Zone	Necessary Measures
Urban Core	<ul style="list-style-type: none"> Strengthen the regulatory measures to control the land use and building height. Improve the public transportation system to reduce traffic congestion. Strengthen the environmental protection measures to improve air quality.
Urban Fringe	<ul style="list-style-type: none"> Encourage private participation in urban development. Strengthen the regulatory measures to control the land use and building height. Improve the public transportation system to reduce traffic congestion.
Suburban Area	<ul style="list-style-type: none"> Encourage private participation in urban development. Strengthen the regulatory measures to control the land use and building height. Improve the public transportation system to reduce traffic congestion.
Rural Area	<ul style="list-style-type: none"> Encourage private participation in urban development. Strengthen the regulatory measures to control the land use and building height. Improve the public transportation system to reduce traffic congestion.

Fig. 12.2

Policy Zoning

Legend

- Historic Conservation Zone
- Urban Regeneration Zone
- Land Use Intensity Zone
- Environmental Infrastructure Improvement Zone
- Infrastructure Land Urbanization Zone
- Controlled Urbanization Zone
- Preservation Zone
- New Subcenter Development Zone
- Along Water Improvement Promotion Zone
- Land Scaping Scene Zone
- Land Development / Transaction Supervisor Zone
- Park / Open Space Promotion Zone
- Public Transport Priority Zone
- Existing Road (Class 1, 2)
- Existing Road (Class 3)
- Existing Egressway
- MRT Systems
- MRT Systems Extension
- Expressway in 2000
- Improvement of Existing Road (DOH)
- New Road in 2000 (DCH)
- Improvement of Existing Road (BMA)
- New Road in 2000 (BMA)
- Improvement of Existing Road (PWD)
- New Road in 2000 (PWD)
- BMA Boundary
- District Boundary
- Chao Praya River



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



BANGKOK METROPOLITAN ADMINISTRATION (BMA)
THE GOVERNMENT OF THAILAND



JICA
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

Table 12.6 Necessary Measures for Policy Zones

Policy Zone	Designation of Special Zone	Planning Objectives	Proposed Measures				
			Public			Others	Private
			Incentives	Regulation	Others		
Provision of Infrastructure	Institutional Incentives	Regulation	Others	Private			
Historical Conservation Zone		To conserve old Chinese town scape, building reconstruction, signboard, change of building use should be controlled in certain degree.	<ul style="list-style-type: none"> • Provision of Street Furniture • Street Beautification 	<ul style="list-style-type: none"> • Subsidy for old building owners • Subsidy for building repairs 	<ul style="list-style-type: none"> • Signboard regulation • Regulation on reconstruction of old buildings • Regulation on change of building use 		Encouraging tourists arrival
Urban Regeneration Zone	Special Scenic Zone	Present environment and facilities, which are less significant with certain historical value, should be utilized as tourism and recreational use to revitalize areas.	<ul style="list-style-type: none"> • Construction of park • Provision of Street Furniture • Street Beautification 				Reuse of old factories, warehouses Encouraging tourists arrival
	Ordinal Zone	Certain production and distribution industries and governmental facilities should be relocated mainly to sub-center zones and regional centers to locate more significant facilities and generate lands for provision of environmental and amenity facilities.	<ul style="list-style-type: none"> • Provision of estate for relocation in sub-center zones 	<ul style="list-style-type: none"> • Tax reduction for relocated firms • Special Depreciation for relocated firms 	<ul style="list-style-type: none"> • Additional environmental standard 		Redevelopment of site to introduce higher productive land use
Land Use Intensification Zone	Public Transport Priority Zone	Public facilities around MRT stations such as station plaza and bus terminal should be developed by the public sector. Provision of pedestrian facilities and area traffic control should be taken into account for encouraging public transport use.	<ul style="list-style-type: none"> • Provision of station plaza, bus terminal and pedestrian facilities 	<ul style="list-style-type: none"> • FAR Bonus 	<ul style="list-style-type: none"> • Area traffic control • Regulation for providing public spaces from the private development site 		Redevelopment projects
	Ordinal Zone	Private redevelopment project should be encouraged with guiding development by coordinating regulations and incentives. Public urban facilities such as park, roads and water treatment facilities should be provided by utilizing public own lands.	<ul style="list-style-type: none"> • Construct public facilities on lands provided from private developers 	<ul style="list-style-type: none"> • FAR Bonus 	<ul style="list-style-type: none"> • Area traffic control • Regulation for providing public spaces from the private development site 		<ul style="list-style-type: none"> • Provision of public spaces from redevelopment projects
Environmental Infrastructure Improvement Zone	Khlong Water Quality Improvement Promotion Zone	Khlong water purification should be encouraged. Waste water from households should be lessen its environmental loads.	<ul style="list-style-type: none"> • Construction of sewerage system • Introduction of dilution water • Dragging khlong 		<ul style="list-style-type: none"> • Sewerage user charge 	<ul style="list-style-type: none"> • Promotion of peoples' awareness by public relations, education 	<ul style="list-style-type: none"> • Cooperation for reducing environmental loads
	Park and Open Space Promotion Zone	Parks should be provided by utilizing public lands. Small parks and green path should be generated through private development projects.	<ul style="list-style-type: none"> • Construction of large parks on available public own lands • Construction of parks on land provided from private developers 	<ul style="list-style-type: none"> • FAR Bonus 	<ul style="list-style-type: none"> • Regulation for providing public spaces from the private development site 		<ul style="list-style-type: none"> • Provision of public spaces through redevelopment project

Table 12.6 Necessary Measures for Policy Zones (Continued-2)

Policy Zone	Designation of Special Zone	Planning Objectives	Proposed Measures				
			Public			Private	
			Incentives	Regulation	Others		
Provision of Infrastructure	Institutional Incentives						
Environmental Infrastructure Improvement Zone	Ordinal Zone	Living environment should be improved by providing roads, water supply and sewerage.	<ul style="list-style-type: none"> • Construction of major infrastructure • Construction of infrastructure on lands from private development 		<ul style="list-style-type: none"> • Regulation for providing public spaces from the private development site • Redevelopment project (land readjustment project etc.) • Designation of urban planning project area which public sector has priority to negotiate land transaction 	<ul style="list-style-type: none"> • Preparation of redevelopment plan 	<ul style="list-style-type: none"> • Provision of public spaces through redevelopment project
Infrastructure Led Urbanization Zone		Urbanization movement should be directed by providing infrastructure and land use regulations.	<ul style="list-style-type: none"> • Provision of major infrastructure 		<ul style="list-style-type: none"> • Strengthening permission procedure for building permission and land subdivision permission to ensure provision of environmental infrastructure by private developers 		<ul style="list-style-type: none"> • Provision of infrastructure in/ around project site
Controlled Urbanization Zone	Land Transaction/ Development Supervision Zone	Regulations should be introduced to pay a special attention on avoiding sprawl development and discrepancy from land use plan. Building permission and subdivision certificate should be more severely managed.			<ul style="list-style-type: none"> • Strengthening permission procedure of building permission and land subdivision 		
	Ordinal Zone	Urbanization should be restrained.			<ul style="list-style-type: none"> • Restructuring land subdivision committee to emphasize land use plan 		
Preservation Zone		Existing land use should be preserved.			<ul style="list-style-type: none"> • Restructuring land subdivision committee to emphasize land use plan 		

Table 12.6 Necessary Measures for Policy Zones (Continued-3)

Policy Zone	Designation of Special Zone	Planning Objectives	Proposed Measures				
			Public		Extra	Private	
			Incentives	Regulation			
Provision of Infrastructure	Institutional Incentives						
New Sub-center Development Zone	Existing Build up Area	Living environment should be improved by providing infrastructure. Public spaces should be generated through reconstruction of residential areas.	•Provision of Main Infrastructure	•FAR Bonus • Tax Reduction	•Formulation of Special standard for Sub-center zones		• Implementation of redevelopment project with sub-center standard •Provision of public spaces
	Future Expansion Area	Sub-center standard for infrastructure, building should be developed for upgrading private development.	•Provision of Main Infrastructure		•Formulation of Special standard for Sub-center zones •Regulation on providing public spaces/urban planning cooperation fund from private development site		• Implementation of land subdivision project with sub-center standard
	Planned Development Area	Infrastructure and public facilities should be developed by public sector.	•Provision of infrastructure, urban facilities and lands for industries	Tax reduction for relocated firms Special Depreciation for relocated firms	•Special legislation on land acquisition		

CHAPTER 13: INSTITUTIONS FOR URBAN GROWTH MANAGEMENT

13.1 Issues regarding Institutional Improvement for Urban Growth Management

(1) Introduction

Bangkok needs to continuously implement various programs and projects to improve the urban environment, that is not only the programs and projects proposed by this study, but also other programs and projects may be required in accordance with future changes. For this purpose, it is important issue to strengthen the capability of Thai government to revise/modify the programs and projects, to formulate new projects and programs, and to implement the projects, as well as to formulate the programs and projects in this study.

Furthermore, urban growth management is indispensable to realize balanced development between with economic efficiency and environmental sustainability. For this purpose, the study team proposed the policy zoning system indicate necessary measures for urbanization control and urban restructuring. To realize the policy zones, it is necessary to not only provide infrastructure and public facilities, but also control/guide private development into appropriate directions.

In this regard, this chapter proposes institutions related to urban development control as a part of urban growth management measures.

(2) Institutional Problems

As for urban growth management, provision of infrastructure, promotion of urban redevelopment, and private development control are basic necessities. To implement this, the public sector may need to improve capability for environmental management which could divided into the following 7 elements:

- Planning Data Management;
- Master Plan Formulation;
- Land Development Control;
- Land Use Control;
- Building Control;
- Land Acquisition for Infrastructure and Public Facilities Development; and
- Construction of Infrastructure and Public Facilities.

Current institution are reviewed from these points of view as follows:

1) Planning Data Management

Basic data is indispensable for formulating appropriate policies, regulations and development plans. However, some basic data such as land subdivision, land use, building and inventory of infrastructure are not available. Information on flooding and land subsidence are collected and compiled using different format and base map, which, as a result, prevents effective use of such information. Accordingly, detailed analyses using sound scientific data can not be appropriately carried out.

2) Master Plan Formulation

Urban and regional development master plans are formulated by planning authorities such as the City Planning department of BMA, DTCP and NESDB. The District Plan, which formulates micro-level plans for each district, is now being prepared for each district by BMA. The problem is that a structure plan covering the Bangkok Metropolitan Region (BMR) is not formulated, even though a rough spatial framework is planned in "Chao Phraya Multi-Polis Study" by NESDB. From the planning point of view, the development direction of Bangkok depends greatly on the spatial framework of BMR, so that the appropriate positioning of Bangkok in BMR should be discussed in detail.

3) Land Development Control

Land subdivision development is controlled by the Land Subdivision Control Act. It clearly regulates the procedure and development standard. However, many land subdivision projects occur and cause urban sprawl development in conservation areas in Bangkok. The problem is that the Act applies to projects with more than 9 houses. Smaller-scale land subdivision projects with less than 9 houses are out of its control. This should be reviewed.

4) Land Use Control

A land use plan is formulated in the General Plan. To realize the land use plan, the Town and Country Planning Act includes an article that stipulates permissible type of building use by land use. However, the Act also allows exceptional cases, which set a maximum percentage of area for different types of buildings, resulting in allowing different types of building construction. The reason why building development seems to be carried out free of control by the government depends mostly on this exceptional allowance as well as on existing buildings with different uses.

To realize the land use plan, linkage between the land use and the building control should be more strengthened.

5) Building Control

Building development is controlled by the Building Code. Structure, Shape and consistency with the land use plan are checked for building permission. For building capacity, 1000 % of FAR (Floor Area Ratio) permitted and maximum building height is regulated at less than 2 times of the length from public roads in Bangkok. However, the building coverage ratio is not adapted.

With the existing regulations, large building development can possibly be located in any place, and can be mixed with existing low-story buildings. This causes excess load on the infrastructure especially for roads, resulting in added loads of traffic generation.

6) Land Acquisition for Infrastructure and Public Facilities Development

For the projects to realize urban infrastructure and facilities, land acquisition is a critical problem due to high land prices. It is one of the main reasons for the delay of infrastructure and public facilities projects. At present, purchasing necessary land or compulsory acquisition are the only methods available for the public sector. Since the public sector can afford for the land to be within the maximum of land valuation prices, it is very difficult for the public sector to negotiate land purchase with land owner. On the other hand, compulsory acquisition allows purely public purpose only with complicated and long procedure. It is therefore necessary to introduce new methods for land acquisition to accelerate the implementation of projects.

7) Construction of Infrastructure and Public Facilities

The Thai government has accumulated much experience with managing infrastructure and public facilities construction. Technically there are no problems. For the

construction of infrastructure and public facilities, the largest problem is project finance. The projects and programs have to be implemented with very limited public investment. On the one hand, it is necessary to expand the financial sources both from the public sector and the private sector. On the other hand, private participation in urban development is promoted to lessen public investment.

(3) Potentials and Seeds for Urban Environmental Improvement

Instead of institutional problems, there are three notable new situations that can be pointed out as potentials and seeds for urban environmental improvement:

- Economic Growth;
- Growth of Private Sector; and
- Peoples' Awareness.

1) Economic Growth

As described in Chapter 2, the Thai economy generally but especially Bangkok's economy has grown up very rapidly. It contributes to an increase of tax revenue and peoples' affordability as described in Chapter 15. It has positive impacts on the implementation of the projects/programs.

2) Growth of Private Sector

In consonance with economic growth, the private sector has grown rapidly. This results in the private sector being more affordable and responsible to society. In particular, private firms are financially strengthened to bear social costs. For example, the central areas were redeveloped by private developers with a total area of more than 1% a year. A good opportunity is provided to generate public open spaces by combination with private development. In other cases, certain oil refinery firms grew with an environmentally good image associated with their products. These facts imply that either voluntary or compulsory private participation in urban environmental improvement projects/programs is a key element for urban environmental improvement in terms of enlarging investment, land acquisition, reduction of emission and change of production and production process.

3) Peoples' Awareness

Awareness regarding the environment is rising. According to a survey conducted by IDE, 41 % of people of Bangkok recognize that natural and environmental deterioration are the most serious problems for Thai society, as shown in Chapter 3. Air pollution is considered to be the most serious problem by the people of Bangkok, followed by deforestation and water pollution. Peoples awareness strongly affects the implementation of urban growth management policies, programs and projects. The participation of private firms' in environmental activities is going to accelerate in response to consumer awareness.

(4) Planning Issues

Considering the current institutional problems and potentials, the Study Team identified the 4 following planning issues to improve institutions for urban growth management:

- Improvement of Information System for Planning;
- Acceleration of Public Land Acquisition;
- Strengthening of Regulatory Functions and Incentives for Private Participation in Urban Development; and
- Enlargement of Financial Sources for Urban Environmental Improvement Projects/Programs.

1) Improvement of Information System for Planning

In the projects and programs described in Chapter 10 and 11, the necessity of various master plans including revision of existing plans and studies are pointed out. However, basic data for planning is not sufficiently collected and compiled, resulting in huge costs and time required for planning. In addition, since the necessary data are kept in different offices, it takes a long time for data collection. It is necessary to improve the accessibility to the information for planning. Efforts at collecting and compiling basic data through monitoring and regular data exchange among related agencies are indispensable.

2) Acceleration of Public Land Acquisition

For the projects to realize urban infrastructure and facilities, the land acquisition method should be more varied, as the present land acquisition method is limited.

3) Strengthening of Regulatory Functions and Incentives against Private Development

Since the Thai society does not wish for government intervention in private activities, regulatory measures to control private development activities. There are not sufficient measures to realize urban development policies and urban plans, as regulatory measures are not attached to city planning administration. For example, there are few regulations effectively guiding land use. Building capacity control is not functioned due to adapting 1000 % of FAR to whole BMA. Without effective control, free private development causes a capacity gap between building and infrastructure in the central area, and urban sprawl in suburban areas, resulting in increased public investment. It is indispensable to strengthen the regulatory functions for private development.

With regard to the urban development, private building redevelopment in the central area and land subdivision development in suburban area are very active. If public spaces are provided through very active development, certain urban environmental improvement projects are much accelerated without land acquisition. The public sector provides certain incentives to private developers such as building capacity bonuses, additional height of buildings, different use of building instead of providing certain portions of land on site by the private developer. The public sector utilizes the land for public facilities such as footpaths and parks.

For this end, the public sector should prepare a set menu of regulatory measures and incentive measures to promote private participation in urban development, environmental technology development, privatization of infrastructure provision.

4) Enlargement of Financial Sources for Urban Environmental Improvement Projects/Programs

Related to private participation, the public sector should make efforts to enlarge financial sources for programs and projects. An appropriate fee level for public services, use of external resources and so on should be the key for enlarging financial sources for public investment.

13.2 Improvement of Information System

(1) Necessary Information

1) Topographical Map

The up-dated topographical maps covering BMA are not sufficiently prepared. The map covering the central area of Bangkok has been developed with a 1:4000 scale in 1987, but the map covering the suburban areas was developed in the late 1970's with 1:50000 and 1:20000 scales. It is necessary to up-date the topographical maps in accordance with rapid urbanization.

2) Spatial Data

Urbanization and development activities in Bangkok are occurring so rapidly that basic data for planning and policy making are not functionally prepared, in particular the data for spatial analyses. There is a great need to periodically collect data and store one place in order to secure data accessibility.

3) Infrastructure Inventory

Inventories of infrastructure such as roads and water supply are not prepared. They should be developed with a computerized system in order to provide valuable information, not only for planning, but also for the daily maintenance and operation of the infrastructure.

4) Socio-economic data

Socio-economic data are relatively well prepared. There are relatively few problems regarding this data.

(2) Information System Improvement Programs

The following programs on information system improvement are proposed:

1) Mapping

The topographical map covering the central area of Bangkok, approximately the current built-up area, should be prepared with a 1:2000 or 1:2500 scale. As for the other areas, a topographical map with a 1:5000 or 1:10000 scale should be developed. Detailed discussions can be found in Chapter 28.

2) System Information Center

A system information center should be developed in BMA with the following functions:

- Systematic training for the GIS operation;
- Application system development; and
- Data generation and information production.

Detailed discussion can be found in Chapter 28.

3) Infrastructure Inventories

To facilitate maintenance and operation work, the following inventories with a computerized system should be developed:

- Road inventory; and
- Water supply facilities inventory.

(3) Institutional Consideration

To facilitate mapping and road inventories, privatization is essential in order to secure a task force. However, access to the mapping work in Thailand is currently strictly limited for the private sector for national security reasons. The Royal Survey Department accordingly almost monopolizes mapping information. Considering that satellites will have a 1 m resolution within several years, it seems to be less significant for the government to monopolize mapping business for reasons of national security. Therefore, it is recommended that it should be more flexible for the private sector to enter the mapping business.

13.3 Acceleration of Public Land Acquisition

As for implementing the urban infrastructure and facilities development project of the "General Plan", the land acquisition system should be more diversified, since the present land acquisition method is less effective for facilitating public-initiative projects. Therefore, the following measures should be explored:

- Introduction of a Priority Negotiation System for the public sector
- Contribution of land from private development projects
- Land readjustment program

(1) Introduction of A Priority Negotiation System for Public Sector

1) Concept

It is proposed that the planning authority should justify urban facilities and infrastructure projects and give the right can negotiate land purchase with the land owner with highest priority. It is also proposed that in the designated areas, only urban infrastructure and urban facilities justified in the General Plan can be constructed. Other construction activities including the rehabilitation of existing building are strictly prohibited.

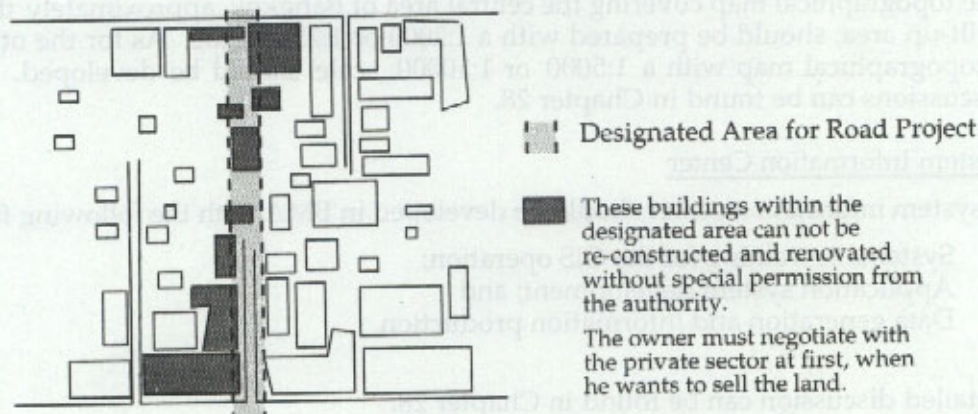


Fig. 13.1 Concept of Priority Negotiation System

2) Necessary Institutions

To realize the above concept, the following measures should be enforced:

- Identification of urban planning project;
- Designation of an urban planning project area;
- Provision of priority negotiation right to public sector; and
- Activities to be prohibited in the designated area.

Identification of An Urban Planning Project

At Present, the transport infrastructure and communication infrastructures are justified in the BMA's General Plan, but other infrastructures are not justified. In order to provide and smoothly implement the infrastructure projects, the General Plan and sector development plans should be coordinated. The infrastructure to be implemented should be justified by the General Plan.

For this purpose, section 17 of the Town Planning Act should stipulate in more detail types of infrastructure which can be justified in the General Plan, or the necessary BMA ordinance should be formulated to justify it. The projects justified by the General Plan are identified as the urban planning project.

Designation of An Urban Planning Project Area

For implementing the urban planning projects, two land acquisition methods are available such as purchasing and compulsory acquisition. To implement the urban planning projects with land purchasing, necessary land for the projects should be designated as the urban planning project area.

Provision of Priority Negotiation Right to the Public Sector

As for the designated urban planning project area, priority negotiating rights should be legally provided to the public sector. The landowner can not sell the land designated as the urban planning project area, unless the public sector gives up the urban planning project.

Activities to be Prohibited in the Designated Area

The following should be prohibited in the urban planning project area:

- New structure construction which has different purposes from the urban planning project;
- Changing the existing land form;
- Reconstruction of existing buildings; and
- Rehabilitation/renovation of existing building.

(2) Contribution of Land from Private Development Projects

1) Concept

Since private developers need to take responsibility for the society, it is necessary to encourage their cooperation in terms of urban development. It is advantageous for the public sector because the public sector does not need to purchase all land necessitated for implementing infrastructure projects.

Since building development by private developers in built-up areas is very active, it is a good opportunity for the public sector to obtain land, if appropriate development management can be done by the public sector. For this purpose, a new system is proposed in which the private developers voluntarily provide certain portion of land in their project sites to public sector. The public sector can give incentives to encourage private contributions. With the provided land, the public sector can implement public facilities projects. This method may be effective for small projects such as small parks, schools, footpaths, bus stops.

2) Necessary Institutions

To implement this new land acquisition system, the public sector needs to strengthen regulatory measures and give incentives to the private urban development project in order to guide the private developer's behavior.

Regulatory Measures

The following regulations should be reviewed in order to control free building development activities by private developers:

- Floor Area Ratio
- Set-back
- Building Height

- Building Coverage Ratio (new introduction)

Incentives

On the basis of more strict regulations in terms of building capacity, incentive measures can be effective to guide private development. Building capacity bonuses can be given to private developer who contribute land. Detailed discussions are made in the following section.

(3) Land Readjustment Program

A land readjustment program has been examined to be introduced in Thailand in several years, in a close cooperation with the Japanese government. The land readjustment program is known to be a useful program for comprehensively developing the area in terms of adjusting land form, providing public facilities such as parks and roads by contribution. The study and pilot projects have been already implemented, and a detailed technical scheme on the land adjustment program has been already determined. It is now in the legislative process. Accordingly, in order to promote the land readjustment project, it is important to improve supportive regulations and institutions at this stage. The following institutions should be reviewed for this purpose:

- Land valuation method;
- Micro level urban development plan (district plan);
- Regulations to keep existing land use and building; and
- Tax exemption for the program.

13.4 Strengthening of Regulatory Functions and Incentives against Private Development

(1) Concept

The principle is that:

- Urban development must not be permitted without appropriate planning; and
- Private development should not be carried out without adequate public facilities and infrastructure.

From these points of view, it is insufficient to manage private development in terms of the relation between policies applied in the General Plan and permission for development such as building permission and land subdivision permission.

As for urban development, especially for urban regeneration, land use intensification and environmental infrastructure provisions, it is necessary to accelerate urban redevelopment and infrastructure development. However, there is a limit to the public budget.

It is therefore necessary to utilize private urban development projects for improving the urban environment, since private development is very active and financially capable of contributing to urban development. To utilize the private sector, it is necessary to strengthen the general regulatory measures to manage private development activities, including land use, and building and land development. Incentives for participation in the urban development by the public sector should be also created. Both measures should be simultaneously undertaken in order to change private behavior. To this end, the following points are made:

- Revision of existing policies;
- Revision of existing regulations;

- Introduction of a new scheme
- Sub-center development scheme; and
- Introduction of new BMA ordinances.

(2) Revision of Existing Policies

The following policy should be enforced in order to prevent disorderly urbanization:

1) Control of Infrastructure Provisions in Controlled urbanization and Preservation Zones

According to the land development potential analysis described in Chapter 4, it is clearly implied that infrastructure provisions lead to land development potential. To control urbanization as well as to preserve existing land use in the suburban area, it is necessary to restrain infrastructure provisions in those area. Further, to restrain groundwater usage, housing development without public water supply should be discouraged.

To this end, priority of infrastructure provisions of both roads and water supply in the controlled urbanization and preservation zones should be reviewed.

(3) Revision of Existing Regulations

The following regulations should be reviewed to facilitate management of private development by the public sector:

- Rationalization of regulations on the building capacity
- Revision between building use and land use
- Review of the effectiveness of the "10 % allowance system"
- Review of the current land subdivision permission system
- Review of parking space obligations in the public transport priority zone

1) Rationalization of Regulations on the Building Capacity

Floor Area Ratio

According to the FAR survey conducted by the BEIP Study Team, it is estimated that the average FAR in Bangkok is approximately 150 %. Since a building can construct up to 1000 % of FAR, the current FAR regulation does not control building capacity well. It is necessary to review the FAR regulation. In this sense, MIT's "The Bangkok Plan" proposed FAR by land use and location, which is divided into 5 level, that is 1000%, 600 %, 400 %, 200 % and 100 %. It provides a good basis to discuss an improved FAR system for Bangkok.

Building Height

Regulations regarding the height of buildings is a measure to manage building capacity. The maximum building height is twice the distance between the building site and public road. This regulation allows for extremely high-rise buildings. It is therefore necessary to introduce other regulations to regulate building height. Regulating the absolute height is an example.

2) Revision between Building Use and Land Use

The current City Planning Act stipulates permissible types of building by land use, however, it is too vague regarding buildings that are not permitted and is therefore difficult to apply as a criteria for building permission. These vague references regarding prohibited buildings in the City Planning Act should be more clearly set out. In this sense, MIT's proposal could lead to further discussions regarding this matter.

3) Review of the Effectiveness of the "10 % Allowance System"

The current City Planning Act includes an exceptional article regarding permissible buildings in land use. It allows for different types of building from the proposed building with a limit of 10 % or 5 % to the total area. It gives any building construction legal status. Together with existing building, this exceptional regulation makes people feel that Bangkok is free for building construction in any land use zone. It is therefore recommended that this exceptional regulation should be reviewed.

4) Review of the Current Land Subdivision Permission System

According to the field investigation and Landsat data analysis conducted by the BEIP Study team, many land subdivision development projects can be seen in conservation areas, especially in the Minburi, Lat Krabang, Taling Chan and Bang Khun Thian districts. The land subdivision development projects which include more than 9 houses need to be permission from the Department of Lands, but projects with less than 9 houses are not regulated. This results in urban sprawl. Therefore, the current land subdivision permission system should be reviewed with a view to applying to smaller-scale projects.

5) Review of Parking Space Requirement in the Public Transport Priority Zone

Car parking space is required for large scale buildings at present. Since public car parking lots have not been appropriately provided in the central districts, such a requirement has been effective for supplying car parks in the central district. However, it generates excessive this may deter use of mass rapid transit in the future. To encourage use of public transport in order to mitigate current traffic congestion, this regulation should be reviewed.

(4) Introduction of A New Scheme

To promote urban redevelopment and restructuring, the public sector needs to prepare systematic urban development project scheme. In accordance with the policy zoning system, the following three schemes are proposed:

- Relocation scheme for urban regeneration zone;
- Public Building relocation/intensification scheme; and
- FAR bonus scheme

1) Relocation Scheme for Urban Regeneration Zone

Concept of Relocation Scheme

Less significant establishments or industries should be relocated from the central area to the suburban areas. The site in the central area can be effectively utilized for introducing new business, public spaces supplying infrastructure and facilities for the area. To this end, a relocation scheme is proposed. The contents of the scheme are as follows:

Target of Industries to be Relocated

- Target establishments are large factories, warehouses/storage facilities, wholesalers along the Chao Phraya River
- Old low-story mixed-use building

Regulatory Measures to discourage staying at the current site

- Periodical revision of the rate for the House and Building Tax
- Additional Environmental Standards for waste water discharge and gas emissions

Incentives Measures to Encourage Relocation

- Preparation of appropriate estates in the sub-centers
- Reduction of House and Building Tax for certain duration

- Special depreciation
- Public finance with low interest rates and a long grace period
- Subsidies

2) Public Building Relocation/ Intensification Scheme

Concept of Public Building Relocation

As well as the encouragement of the relocation of the private sector, unnecessary establishments located in the central area including public sector buildings also need to be relocated. In the case of reconstruction of old public offices, some offices should be combined with larger buildings to generate open land, because it is possible to utilize this open land for public services. In this sense, BMA's effort to establish an inventory of public land is highly acceptable. The BEIP Study Team therefore recommend that this valuable effort should be completed as soon as possible. Based on this inventory, the public building relocation and intensification programs should be developed.

Candidates for Relocation

The following establishments of the public sector are preliminarily for relocation:

- Higher education and research institutes;
- Staff training and laboratories;
- Factories, and warehouses; and
- Others establishments with limited public interaction.

Usage of Remained Land

With open land created by relocation or intensification, the public service facilities justified in the General Plan should be developed. In addition to utilizing the land for public services, it is possible to utilize as a seed land for exchange with private land.

3) FAR Bonus Scheme

To increase public spaces in the central area, the FAR bonus system is proposed. If a private development project provides spaces for public areas such as parks, sidewalks and footpaths, the public sector gives a certain degree of the FAR bonus. This system is popular to increase open spaces in built-up areas especially in developed countries, and is proposed by MIT's Bangkok Plan, too. The maximum bonus is the difference of the building capacity between the building capacity can be obtained without contribution of land and the building capacity that can be obtained with contribution of land. The concept of the FAR Bonus scheme is illustrated in Fig. 13.2.

This system can be implemented after completion of the rationalization of the FAR system.

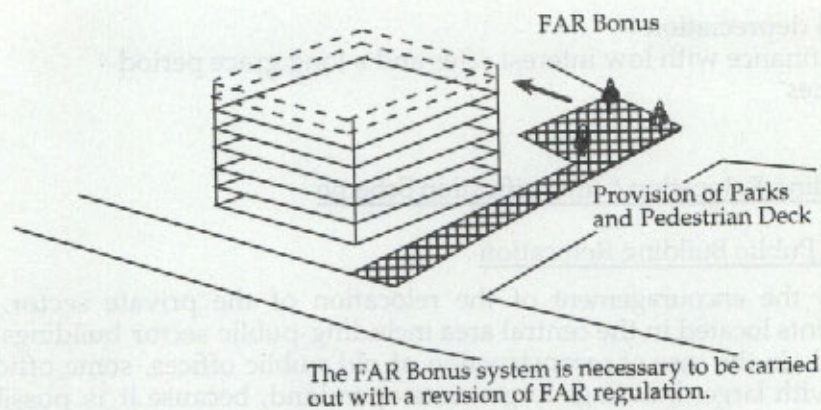


Fig. 13.2 Concept of Building Capacity Bonus

(5) Sub-center Development Scheme

1) Concept of Sub-center Development Method

Sub-center development needs a huge amount of investment. It is nearly impossible to depend only on public investment for the development. Since the sub-center development is one of the major efforts to reform the urban structure of Bangkok, it needs to diversify the sources of investment. Thus, the sub-center development should be developed with private participation.

It is proposed therefore that the sub-center area is divided into 3 areas in terms of development methods such as:

- Area 1: Current built-up area;
- Area 2: The area to be urbanized with higher land development potential; and
- Area 3: Planned development area.

Area 1: Current Built-up Area

The current built-up areas in the sub-center zone should improve their urban environment to satisfy the sub-center standard. For this purpose, the land readjustment program can be applied to these areas.

Area 2: The Area to be Urbanized with Higher Land Development Potential

Some areas in the sub-center zones are evaluated as higher land development potential areas. Such areas seem to be developed even if they are not designated to the sub-center zone due to their higher land development potential. Therefore, it is necessary to give intensive guidance to private development in order to satisfy a sub-center standard.

Area 3: Planned Development Area

This area has relatively lower land development potential with larger non built-up spaces. The public sector should take the lead in developing this area through land acquisition and provision of necessary infrastructure and core facilities.

2) Necessary Measures for Sub-center Development

To materialize the development method proposed above, necessary measures by type of area in the sub-center zone are indicated in Table 13.1.

Table 13.1 Proposed Measures for Sub-center Development

Designation of Special Zone	Planning Directions	Proposed Measures			
		Public			Private
		Incentives		Regulation	
		Provision of Infrastructure	Institutional Incentives		
Area 1: Existing Build up Area	Living environment should be improved by providing infrastructure. Public spaces should be generated through reconstruction of residential areas.	•Infrastructure: Roads, Sewerage, Water Supply, Solid Waste	•FAR Bonus •Tax Reduction	•Special Building and Environment Standards for Sub-center zones	•Implementation of Redevelopment Project with Sub-center Standards •Provision of Public Spaces
Area 2: Future Expansion Area	Sub-center standard for infrastructure, building should be developed for upgrading private development.	•Infrastructure: Roads, Sewerage, Water Supply, Solid Waste		•Special Development and Environmental Standards for Sub-center zones •Development Guidelines	•Implementation of Land Subdivision Project with Sub-center Standard •Provision of Infrastructure
Area 3: Planned Development Area	Infrastructure and public facilities should be developed by public sector.	•Infrastructure: Roads, Water Supply, Sewerage, Electricity etc. •Facilities: Rail Station, Station Plaza, School, Hall etc. •Estates for: Business buildings, Relocated Industries and Warehouses	Tax Reduction for Relocated Firms Special Depreciation for Relocated Firms	•Special Legislation on Land Acquisition •Consideration of Land Trust	

3) Land Acquisition

Areas 1 and 2 are developed by the private sector, so that land acquisition is not a problem at all. It is, however, a key issue for area 3, which is a core of the sub-center zones, that land acquisition should be smoothly and quickly carried out. There are conceptually two methods for land acquisition to be applied for area 3, that is:

- Acquisition from current land owners; and
- Lease from current owners.

Acquisition Method

This method is that the public sector obtains the necessary land from the current land owners through purchase or compulsory acquisition. Since the sub-center needs to be comprehensively developed in order to retain higher environmental standards, land acquisition should be done for not only infrastructure and public facilities, but also residential areas. As for land purchasing, it is necessary to apply the proposed designation of urban planning project area system to avoid land speculation. As for compulsory acquisition, it is necessary to review the applicable project, as current regulations on the compulsory acquisition are strictly. Therefore, with regard to these two methods, it may be necessary to establish a new supportive act to obtain large-scale land only for the sub-center development.

Non-Acquisition Method

If the current land owners remain, the public sector obtains only a use right. Many methods like Land Lease and Land Trust are developed at present especially for redevelopment projects. The advantage is that the public sector does not need to buy

land and suffer from land acquisition. However, it also has disadvantages in that the public sector should return the land if a land owner disagrees with extending the contract. Allocation of rent of the land will also be a complicated problem.

There are various kinds of land acquisition methods possible for sub-center development. To select the applicable land acquisition method, a detailed study should be carried out with regard to the following:

- Land owner's acceptance;
- Comparative financial advantage;
- Reliability as a public project;
- Difficulty in terms of the Thai legislative system; and
- Procedural difficulty for implementation.

4) Sub-center Development Guideline

Since it is proposed that sub-center areas should be developed with private participation, special guidelines for development and environmental for the sub-center area should be prepared in order to create an improved urban environment. For this purpose, development guidelines should be prepared to show minimum standards regarding buildings and lands, which should be followed by the private developers. A detailed discussion is made in the next section.

(6) Introduction of New BMA Ordinance

1) Traffic Assessment Study

Necessity of A Traffic Assessment Study

Building construction generates new traffic production. High-rise buildings can be constructed in any places up to 1000 % of FAR with some exceptional areas in the central area of Bangkok. This creates pressure on infrastructure, resulting in less road space in the central area. It is said that building development should be balanced to provision of infrastructure in the central area. Furthermore, some building construction activities negatively affects road traffic such as disturbing the smooth traffic flow by occupying road spaces and increasing the number of vehicles. It is necessary to mitigate negative impacts from building construction activities.

It is therefore proposed that a traffic assessment system be introduced to substitute the current building permission system. The traffic assessment aims at compelling mitigation measures of negative impacts on traffic flow for private developers. It should cover both construction and operation periods.

Proposed Scheme

The proposed scheme of the traffic study is shown in Fig. 13.3. Private developers carry out the study including the proposal of mitigation measures, and the public sector is responsible for evaluating the mitigation measures and requesting change of building capacity or improving mitigation measures, if necessary, as follows:

- A developer carries out the traffic assessment study;
- Submission of traffic assessment study to authorities;
- Public sector evaluates the project from the traffic impact point of view;
- If there is much problem with traffic, the public sector requests that the project size be reduced;
- Private developers can select either reduction of the project size or provision of urban development cooperate funds; and
- The private sector implements the project with mitigation measures in the construction stage.

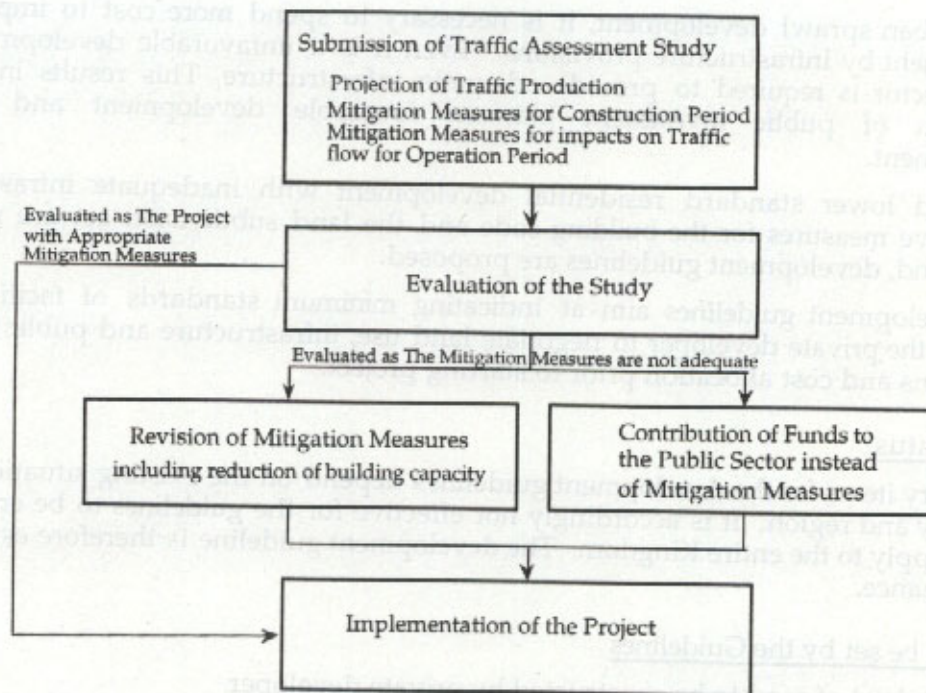


Fig. 13.3 Proposed Process of the Traffic Assessment Study

Target Project

- Large-scale residential development
- Large-scale commercial buildings such as hotels, department stores, commercial complexes
- Large-scale office buildings
- Factories in the built-up area

Items to be included in Traffic Assessment Study

- Summary of the development project
- Traffic production caused by construction and operation periods
- Proposed mitigation measures in accordance with the traffic production

Legal Status

Since this issue occurs in Bangkok, it is not necessary to apply whole nation at this moment. It is accordingly to propose that regulation should be set forth by BMA Ordinance.

Responsible Authority

It is proposed that the Police Department and BMA be co-responsible for this scheme.

2) Development Guideline

Concept

In general, the public sector is responsible for developing infrastructure and public facilities. However, limited amounts of public investment can not cover the necessary infrastructure and public facilities provisions due to very rapid urbanization. Further,

as for urban sprawl development, it is necessary to spend more cost to improve its environment by infrastructure provisions. Even it is a unfavorable development, the public sector is required to provide adequate infrastructure. This results in uneven allocation of public investment between favorable development and sprawl development.

To avoid lower standard residential development with inadequate infrastructure, supportive measures for the building code and the land subdivision act are required. To this end, development guidelines are proposed.

The development guidelines aim at indicating minimum standards of facilities and obliging the private developer to negotiate land use, infrastructure and public facilities provisions and cost allocation prior to starting project.

Legal Status

Necessary items for the development guidelines depend on the existing situation of the area, city and region. It is accordingly not effective for the guidelines to be enacted as law to apply to the entire Kingdom. The development guideline is therefore established by ordinance.

Items to be set by the Guidelines

- Standard of road to be constructed by private developer
- Standard of sewerage to be constructed by private developer
- Standard of water supply facilities to be constructed by private developer
- Necessary space for park
- Urban development cooperation funds instead of provision of the above facilities

3) Landscape Ordinance

Concept

Bangkok has already prepared the ordinance for historical conservation. It stipulates the prohibited use of buildings and maximum height of buildings in certain districts. The ordinance also regulates the size of signboards in the designated historical conservation areas. It prepares regulatory measures adequately to conserve buildings and landscape in the historical conservation areas. Many activities are carried out in the most historical buildings and the designated areas, and the most of buildings are owned by the peoples. Thus, conservation should be carried out by owners with maintaining their daily activities. From this point of view, it may required to include supportive measures which give owners motivation to conserve their historical buildings and landscape.

Institutional Incentives by Ordinance

- Financial incentives such as reduction of the House and Building Tax
- Subsidy to maintain, repair designated old buildings
- Implement special infrastructure development such as sidewalk improvement projects with provisions for specially designed street furniture
- Promotion of tourism and commercial use of old buildings

13.5 Enlargement of Financial Sources for Urban Environmental Improvement Projects/Programs

To enlarge the financial sources for implementing urban environmental improvement projects and programs, the following options could possibly be encouraged:

- Encouragement of private participation;
- Revision of Tax;
- Revision of the fee level of public services;

- Restructuring Administrative Organization to reduce recurrent costs;
- Utilization of external resources;
- Change to effective allocation of public investment budget; and
- Increase of subsidies from central government.

Among the options described above, the options regarding private participation, revision of tax, external resources and increase of subsidies are discussed in detail in Chapter 14 and 15. The other options are not discussed in this study, as they are political matters.

13.6 Organizational Improvement Programs

Responsible organizations have been established with jurisdiction for tasks. Although implementation of certain policies need consistency and coordination of related agencies, coordination among planning authorities, and coordination between planning and administration authorities are not satisfactory. In particular, coordination/ linkage should be strengthened as follows:

- Coordination among planning authorities;
- Linkage between urban planning and building permission; and
- Linkage between urban planning and land subdivision permission.

(1) Coordination among Planning Authorities

Spatial development planning related to BMA is mainly developed by three agencies, that is City Planning Department of BMA, the Department of Town and Country Planning (DTCP) and the National Economic and Social Development Board (NESDB). Although these agencies maintain a certain level of communication and discussion on occasion, it is difficult to understand the consistency of planning from their outputs. For example, the relationship among MIT's sub-center, NESDB's regional center, DTCP's satellite city and NHA's new town are uncertain in terms of mutual relation and allocation of function. Since it is obvious that the functions and spatial development direction of BMA need to be justified in the wider area of BMR or further, all plans needs to be explored as such. To this end, planning authorities need to set up collaboration studies for this matter.

(2) Linkage between Urban Planning and Building Permission

The City Planning Department is responsible for planning, and the Department of Public Works is responsible for building permission. Since building development seems to be permitted with little consideration of urban development policy, it is necessary to strengthen linkage between the City Planning Department and the Department of Public Works in BMA in order to reflect the urban development policy for the building permission.

(3) Linkage between Urban Planning and Land Subdivision Permission

At present BMA has no right to manage any land subdivision development project in Bangkok due to its current institutional arrangements. According to the Land Subdivision Control Act, BMA can not be a member of the land subdivision committee even for projects in the BMA jurisdiction. Since BMA is now responsible for administrating the Bangkok Metropolis as a local autonomous body, it is natural that BMA should become a member of the committee for the project in the Bangkok Metropolis in order to strongly reflect the urban development policy with the land subdivision permission.

CHAPTER 14: SOCIAL SYSTEM FOR THE IMPLEMENTATION

14.1 Integrated Efforts for Urban Environmental Management and Implementation

Bangkok, as the capital of Thai spirit and economy and the international hub city of the South-east Asia, can no longer ignore the environmental contamination. Air pollution and traffic congestion are disadvantages for Bangkok to be a center of economy in the region. Thus, Thailand needs to make more offers to move these diseconomies, accelerating financial investment for the environmental sector.

It is generally assumed that the required environment expenditures would share 2 - 3 percent of country's GDP. The required amount seems to be huge compared with the size of the budget of local government. The solution to the environmental problems will require a cost-sharing system and partnership among government, private sector and community. Government must take leading role to move the state in the right directions.

(1) Roles of National and Local Governments

There are two principle approaches to the environment management; the regulatory instrument (or command-and-control) and economic instruments. In Thailand, the regulatory approach are predominantly adopted by the measures of monitoring and enforcement systems, while there can be found a few example of adopting economic instruments.

The regulatory and economic instruments are used by the national and local levels of governments.

At the national level, governments should be responsible for policy making of pollution control. Their main functions are:

- establishing and enforcing standards and monitoring program;
- establishing the programs of economic instruments;
- carrying out research and technical development programs;
- establishing the national fund allocation system and providing financial assistance programs to the lower level of governments; and
- providing training programs in environmental management.

On the other hand, the major roles of local governments are:

- providing the services for the operation and maintenance of municipal waste;
- establishing and implementing pollution charge, permit and license systems as economic instruments; and
- establishing zoning and subdivision regulations for land and water use control.

The state enterprises have been established to provide the services of the environmental sector such as transportation, housing and water supply under the Ministry of Interior and the relevant ministry by the national government (refer to Figure 14.1). Wastewater Management Authority has been established in July 1995 under the Ministry of Interior, however, the operation and management system have not yet definitely been decided.

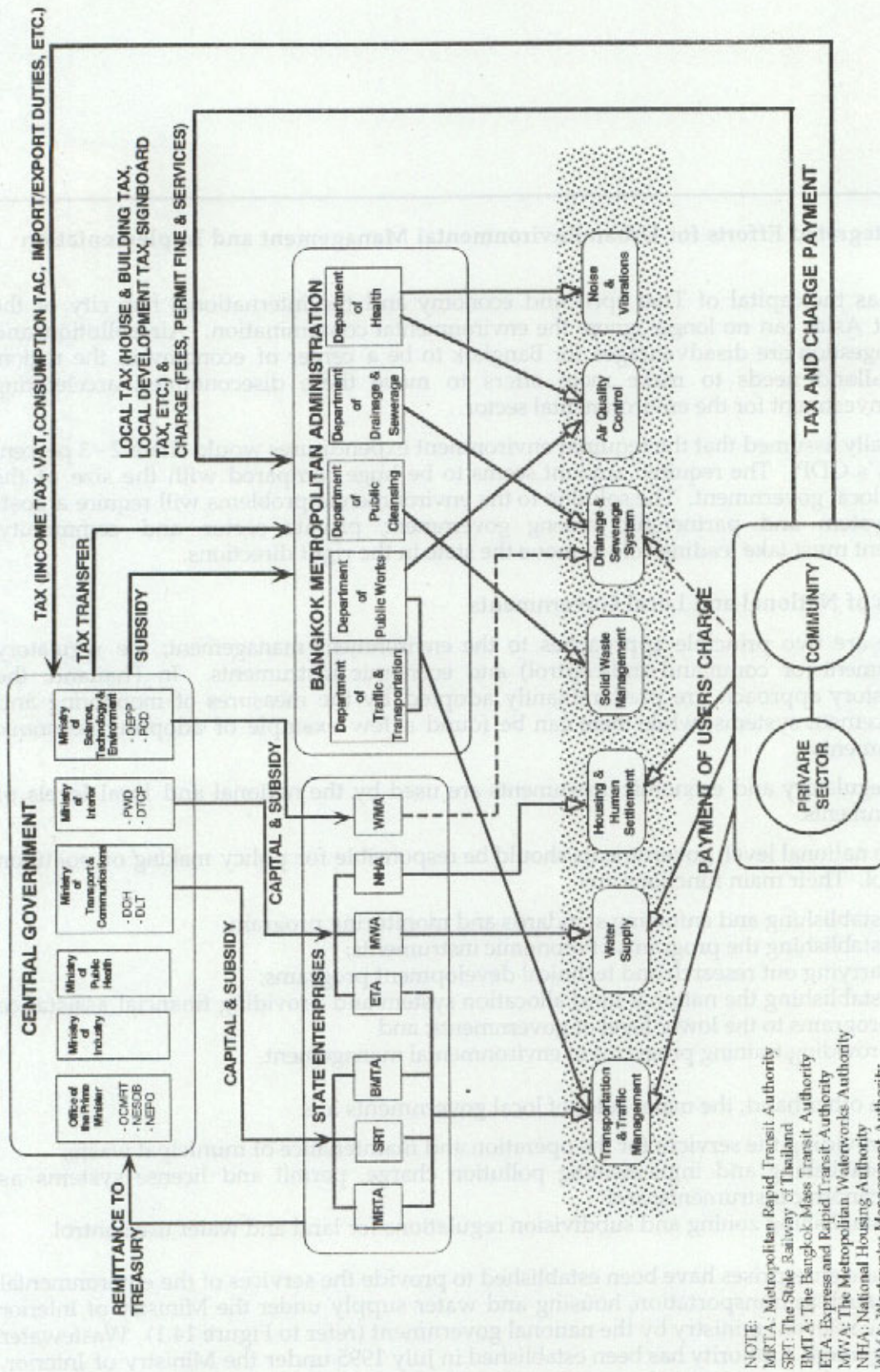


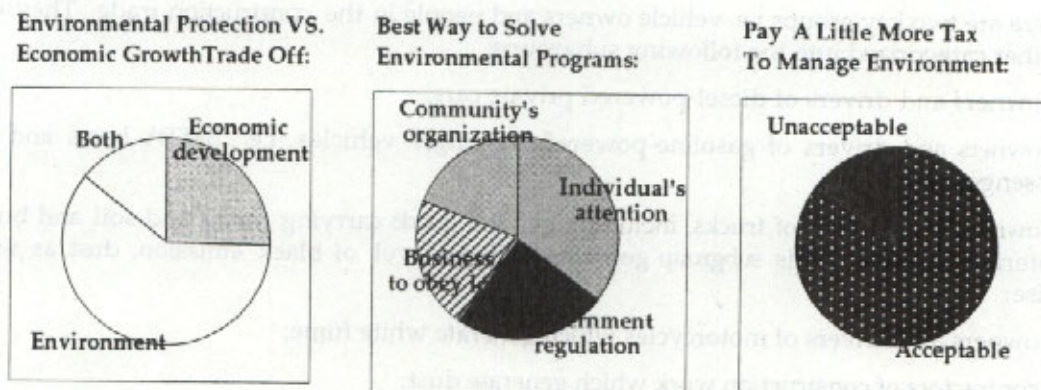
Figure 14.1: Environment Related Organization and Environmental Cost Payments

The solid waste treatment is directly managed by Department of Public Cleansing and the district offices of BMA.

(2) Social Change for Urban Environmental Development

There is an increasing awareness of the community that the environment protection should be given higher priority than economic growth. According to the Environmental Awareness Survey by IDE, the majority of the people in Bangkok responded that:

- environment preservation is more important than economic development for their lives;
- the involvement of individuals is important, as well as government, in the environment management; and
- it is acceptable to pay a little more tax to manage the environment.



Source: Environmental Awareness Survey, IDE

Fig. 14.2: Community's Awareness of Environment in BMA

(3) People's Participation by Community-based Approach

The involvement of community is an urgent and indispensable need, as well as that of private sector, in the environment projects such as water supply, solid waste management and wastewater management.

Regarding to the improvement of air pollution public participation is also essential because a significant reduction is expected from the change in public behavior and the increased the emission can be reduced to some extent by the awareness of the owners and drivers of vehicles, and contractors and owners of projects (refer to Box). It would be acceptable for polluters to pay those additional expenses by themselves in order to share social costs.

Major activities expected in each sector are shown in Table 14.1.

Table 14.1: Activities in Community Participation

Sector	Activities
Sewerage System	• Ditch Cleansing
Solid Waste Management	• Segregated Garbage Collection
	• Group Garbage Collection
	• Curve-side Collection
	• Supporting Activities to Recycling
Housing & Human Settlement	• Sweeping & Mowing Lawn in Park

National Campaign to induce public participation in reducing dust and air pollution

The purpose of the campaign is reduction of dust from black and white emission and dust from construction and other activities. A significant reduction is expected from the changes in public behavior and the increased care on the part of the public as regards dust reduction.

The project aims to achieve:

- to get across relevant information to the target groups at least once a day in the first six months of campaign, and once every two days in the latter six months;
- to induce public participation in reducing the level of dust and air pollution in Bangkok by at least 50%.

Target Groups

There are two key groups i.e. vehicle owners and people in the construction trade. They can be further categorized into the following subgroups:

- owners and drivers of diesel-powered private cars;
- owners and drivers of gasoline-powered passenger vehicles i.e. BMTA buses and other passenger cars;
- owners and drivers of trucks, including general goods carrying trucks and soil and building materials carriers. This subgroup generate highest level of black emission, dust as well as noise;
- owners and drivers of motorcycles which generate white fume;
- contractors of construction work which generate dust;
- owners of building projects;
- providers of mechanical maintenance and repairs such as owners and mechanics of car-repair services, petrol stations and spare-parts dealers; and students and general public.

Activities

The strategy calls for a campaign that will eventually create three social products namely:

- changes in attitude and perception among the people;
- changes in behavior, leading to the right practice and participation; and
- occurrence of a mechanism or equipment that support public participation in the long term.

The planned activities can be categorized as follows:

Disseminating Information

Educating the public is the key in inducing changes in perception and attitude. Activities will include the production of materials for use in all media i.e. TV, radio, newspaper, magazine, pamphlet, poster and more. Contents of the messages will include the cause and effect of dust pollution as well as ways to solve problems.

Encouraging Public Participation

Along with increasing awareness of the problem, we should also reinforce our campaign with activities that will encourage action. A system of reward/punishment should be employed to encourage positive behavior.

Supporting Participation

There are many forms of participation. For example, people can report to authorities of violations they come across; they pay more attention to their own engines, trucks, or work sites.

(4) ISO 14000

Presently, organizations of all kinds including private companies are increasingly concerned to achieve and demonstrate sound environmental performance, especially in Europe, USA and Japan. Private companies have independently begun to undertake environmental 'review' or 'audits' to assess their environmental performance of their activities.

In 1996, International Organization for Standardization (ISO) have been introduced as an important international standards in terms of environmental management system and environmental audits. Particularly, "ISO14000 series" is one of the newest, which represent the international standards.

"ISO14000 series" specifies the following elements:

- standard for the report of the environmental management scheme for a factory and the amount of the emission
- standard for "Eco-label"
- standard for "Life Cycle Assessment" which evaluates the environmental impacts of the goods at each production stage
- method for environmental auditing of the above elements.

The ISO14000 is designated to enable a company to maximize its benefits and to minimize its adverse effects. In the case of adverse effects, emphasis are placed on prevention, rather than on detection after occurrence. This concept is one of the main streams of business and environmental management in many countries.

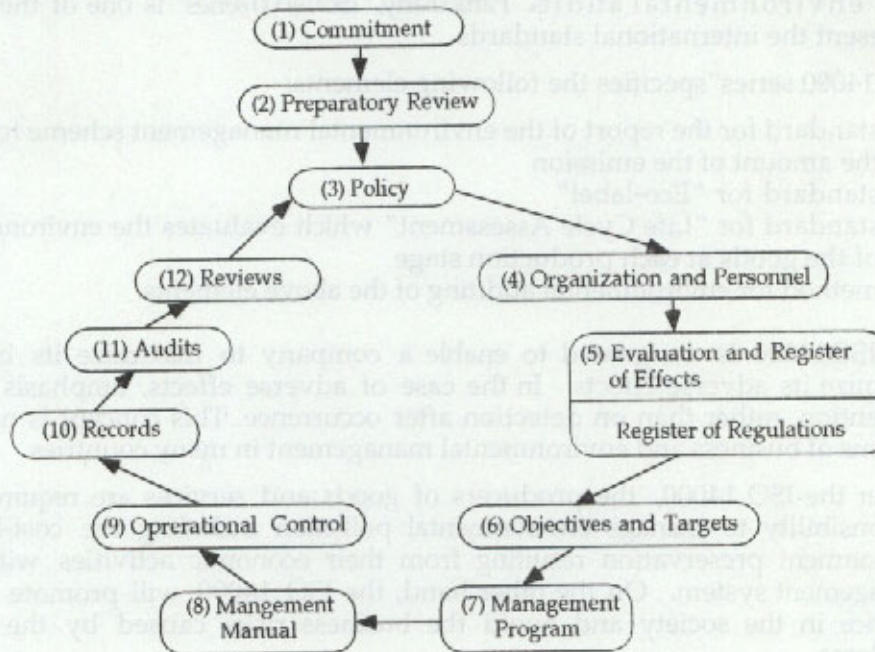
Under the ISO 14000, the producers of goods and services are required to have the responsibility to manage environmental pollution including the cost-burden of the environment preservation resulting from their economic activities within their own management system. On the other hand, the ISO 14000 will promote the company's reliance in the society and avoid the business risks caused by the environmental problems.

In Thailand, the introduction of the ISO 14000 will be required from the global point of environmental preservation in the near future.

Furthermore, based on the standards, each national and local levels of governments will be able to support the environmental management system and the certification schemes of company performing industrial activities within the government, and promote "Environmental-Oriented City".

Schematic Diagram of Environmental Management System

The success of the system depends on the commitment from all levels, especially from the highest levels of management



Source: The European Communities "Council Regulation (EEC), No. 1836/93/ 29 June 1993 - B57750"

14.2 Polluter-Pay-Principle and Economic Instruments

(1) Environmental Expenditure

According to the OECD report the total pollutant abatement and control expenditures have been estimated to amount to between 0.8 % and 1.5 % of GDP in OECD countries as shown in Table 14.2. The share of public sector is greater than that of private expenditure in the most countries.

On the other hand, the World Bank has examined the necessary environment improvement costs for selected sectors in developing countries. According to the study, the additional costs of the required investment are estimated to amount to 1.4 % of the aggregated GDPs in developing countries in 2000 and the overall incremental costs in the range of 2 - 3 percent of GDP are estimated to be appropriate and sufficient with allowance.

Table 14.2: Pollutant Abatement and Control (PAC) Expenditure in OECD Countries, mid 1980s

	PAC expenditure as percentage of GDP			PAC expenditure as percentage of total national investment		
	Public	Private	Total	Public	Private	Total
Canada	0.89	0.36	1.25		1.52	
USA	0.60	0.86	1.46	1.14	1.62	2.76
Japan	1.17	0.08	1.25	2.87	0.28	3.15
Finland	0.52	0.64	1.16	1.06	1.12	2.18
France	0.56	0.33	0.89	0.83	0.46	1.29
Germany	0.78	0.74	1.52	1.54	1.54	3.08
Italy	0.13			0.24		
Netherlands	0.95	0.30	1.25		0.85	
Norway	0.54	0.27	0.81	0.85	0.44	1.29
Sweden	0.66	0.27	0.93	1.10	0.73	1.83
UK	0.62	0.62	1.24			

Source: The State of Environment Indicator, OECD 1991

The environmental costs will be added to the price of goods and services through market mechanism, and therefore ultimately paid by the consumers; namely, they are paying the environmental costs directly through users charges or indirectly through costs of goods and services, and taxes. However, the prices of goods and services are not affected by the total environmental costs. The large amount of environmental costs, which should essentially be born by producer and/or consumer, are transferred to the rest of the economy as "external diseconomy". In German the cost of external diseconomy, because of the environment pollution, is estimated to amount to 5 - 10 percent of GDP.

It should be noted that the required investment costs for environment improvement are extraordinary high in Bangkok, because of:

- the rapid growth of economy has accelerated the increase of discharges of the city;
- the infrastructure services could not catch up the economic growth; and
- frequent communication all over the world made increase people's eagerness to higher standard of life and thereby the discharges of the city have increased faster than its economic growth.

(2) Basic Concept: How to Share the Burden

The Polluter Pays Principle (PPP) is the basic concept to share the cost of environment, approved by OECD countries in 1972, aims that "the polluters should bear the full costs of pollution-reduction measures decided upon by public authorities to ensure that the environment is in an acceptable state."

The economic instruments are the principle approach as well as the regulatory enforcement for the environment preservation and control. User charge, effluent charge and subsidies such as grant, soft loan and tax incentive are adopted as major economic instruments to realize the PPP for environmental improvement in which some will discourage polluting activities and others encourage less polluting activities. The application of the PPP requires the private sector and community to have the responsibility of polluters to pay the costs of environmental damage caused by their activities. Moreover, the polluters can determine the most cost-effective measure for

achieving the acceptable levels of pollution and thereby the environmental costs of the society will be reduced.

In recent years many countries have used a variety of economic instruments. The major economic instruments and its advantages are presented in Table 14.3 according to the OECD's classification.

Table 14.3: Economic Instruments of Environmental Control by OECD's Classification

Type of economic instrument	Advantages	
Charges:	to discourage polluting activities to provide financial assistance to achieve reduction in pollution	Effluent charge User charges Product charges Administrative charges Tax differentiation
Subsidies	to encourage less polluting behavior	Grant Soft loan Tax allowance
Deposit-refund	to encourage re-use and/or more environmentally friendly disposal	for example, beverage container
Market creation arrangements	to encourage more efficient and cost-effective use of emission permits	Marketable or tradable permits
Financial enforcement incentives	to provide additional financial inducement to comply with existing environmental regulations	Non-compliance fees Performance bonds

Source: OECD

When properly implemented, the economic instruments provide several advantages such as to:

- reduce pollution while promoting cost-effectiveness;
- enhance the technology for the pollution control by private sector; and
- reduce the financial requirement of the government or provide the government with revenue for the environment investment

In order to implement economic instruments successfully, regulatory approach should not be ignored, namely, standard needs to be appropriately prepared and monitoring and enforcement system should effectively be implemented.

Among the economic instruments charge, including user charge, emission fee, and effluent fee, should be examined to introduce currently.

Economic Instruments in Thailand

In Thailand, some types of economic instruments are in use, as follows:

User Charges

The User Charge system is the most common type of economic instrument and introduced to municipal water supply and solid waste management in Bangkok. The details are described in the next section.

Tax differentiation

Excise tax is levied on the consumption of gasoline. The following table shows the "Tax Differentiation" among the types of gasoline which is designed to encourage the unleaded gasoline.

Excise Tax Differentiation of Unleaded Gasoline

Kind of Gasoline	Excise Tax (baht per liter)
Premium Gasoline	3.355 baht
Regular Gasoline	3.355 baht
Unleaded Gasoline	2.585 baht

Source: NEPO

Environmental Fund

The National Government has established an Environment Fund, authorized under the NEQA/1992, which will promote the investment of pollution control by local municipalities and private industries and encourage to minimize the waste.

The initial capital of five million baht was contributed to the fund by the government. To the supplement of the initial capital, the following sources are expected;

- service fees and penalties collected under the provision of the NEQA/1992;
- funds and properties from available sources both from domestic and foreign, and from public and private; and
- interest and operating revenue of the Fund.

Fund can be provided for the priority projects for the implementation of provincial action plans as;

- grants to government agencies or local administrations for the investment for central wastewater treatment or waste disposal facilities; and
- loans to local administrations or state enterprises for pollution control facilities.

(3) User Charge System: Affordability vs. Willingness-to-Pay

The users' charge system is commonly adopted for the sanitary services such as water supply, solid waste and wastewater management under the PPP. For the introduction of the users' charge system to sanitary services, the affordability of household to pay the users' charge is serious argument. It has been estimated by several international agencies that the limits of percentage to pay against the disposal household income may be:

- Water supply 4%
- Solid waste treatment 2%
- Waste water treatment 1%

Affordable Level of User's Charge in Bangkok

Based on the above figures, the affordable maximum levels of user's charges for low income group in Bangkok (per household per month) can be computed as follows:

- For water supply: B.100;
- For solid waste treatment: B.50; and
- For waste water treatment: B.25,

where, the minimum household income is assumed to be B.3,120 (= B.156[*min. wage rate*] x 20 days); the average dispersal income ratio, 80% of the total income; one incomer a household.

The present tariff schedules for water supply and solid waste treatment have been examined from the above context as shown in Table 14.6 and solved that the minimum charges are regulated in the range of the affordability as calculated above.

Table 14.4: Present Tariff and Minimum User Charge for Sanitary Services in Bangkok

Service	State Enterprise	Tariff	Tariff conditions	Average monthly charge	Consumption per month
Water supply	MWA	Baht 4.00/M ³	up to 30M ³ per month	Baht 120.00 per household	30M ³ (200 liter x 5 persons x 30 days)
Garbage collection	BMA	Baht 40.00 per month (new tariff)	up to 20 liter per day	Baht 40.00 per household	180 liter (6 liter per day) (0.4 Kg x 5 persons = 2 Kg per day Garbage: 2 Kg amounts to 6 liter.)
Wastewater treatment	WMA	under review			

Willingness-to-Pay

However, on the other hand, another critical argument should be raised to implement the PPP: People's Willingness to Pay. Since the family managed at the minimum wage rate is already at a subsistence level, it is still questionable whether or not the family will pay the calculated charges.

The tariff schedule needs to be examined carefully to be justifiable on the social and economic ground. Moreover, some polluters may choose to pollute if the charge is not set at an appropriate level.

Users' Charges the State Enterprises

As shown in Figure 14.1, each State Enterprise is collecting the users charges for the services of transportation, sanitary and housing. The operating incomes collected by the State Enterprises are calculated in Table 14.7. The total operating revenues from the users for transportation, sanitary and housing services amounted to 22,973 million baht per year, which was approximately 1.7 % of total GPP in BMA, although the income of the SRT included the charges collected from the services outside of Bangkok.

Table 14.5: Financial Condition of State Enterprises

	Transportation				Sanitary		Housing
	State Railway of Thailand (SRT)	Bangkok Mass Transit Authority (BMTA)	Express and Rapid Transit Authority Thailand (ETA)	Metropolitan Rapid Transit Authority (MRTA)	Metropolitan Waterworks Authority (MWA)	Wastewater Management Authority (WMA)	National Housing Authority (NHA)
Fiscal Year	1994	1994	1995	1994	1994		1993
Finance (thousand baht)							
Capital by the Government	12,438,340	8,298,015	15,536,812	326,717	7,337,737		993,634
Operating revenue	7,524,023	5,633,163	1,749,116	0	6,618,898		1,372,156
Operating expenditure	7,289,294	6,757,034	1,435,556	0	3,709,204		664,098
Other income (loss)	423,850	227,847	145,894	32,744	-778,698		-297,173
Net Profit/Loss	658,579	-896,024	459,454	32,744	2,130,996		410,885
Remittance to the Treasury					603,500		23,206
Government Subsidies		341,466	388,740				

Source: SRT, BMTA, ETA, MRTA, MWA, WMA and NHA

CHAPTER 15: FINANCING FOR IMPLEMENTATION OF ENVIRONMENTAL PROJECTS/PROGRAMS

15.1 Financial Structure of BMA

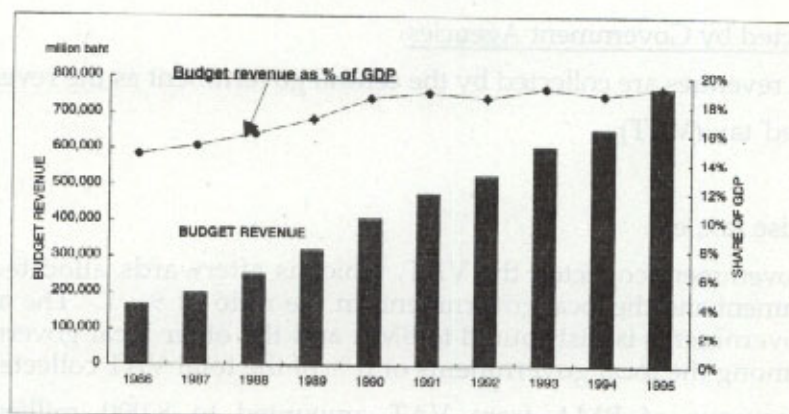
(1) Budget Revenue

1) Budget Revenue of Kingdom and BMA

Thailand has been enjoying a rapid economic growth at about 10 % of annual real growth rate during the last decade. Figure 15.1 shows the actual budget revenue of the central government and its share in the GDP at current price. The budget revenue increased at 4.3 times from 1986 to 1995 and its share of GDP, still, increased from 14.6 % in 1986 to 19.2 % in 1995. Thus, the central government gained the revenue, corresponding to the GDP growth.

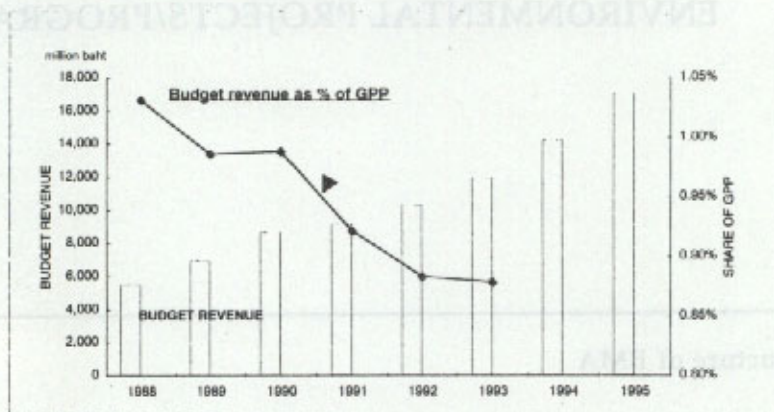
On the other hand, the real Gross Provincial Product (GPP) of BMA grew at a higher rate than that of the Kingdom during the same period. Figure 15.2 shows the budget revenue of BMA and its share in the GPP of BMA. The share of budget revenue extraordinary small, approximately 1 % of GPP. The growth of revenue of BMA was lower than that of GPP. Accordingly the share of budget revenue declined to 0.9 % of GPP in 1993.

In the fiscal year 1995, from October 1994 to September 1995, the budget revenue of the Kingdom amounted to 715,000 million baht, of which 572,000 million baht or 80 % of the total revenue was levied in Bangkok. On the other hand it was 17,000 million baht that BMA collected as the budget revenue in 1995. BMA has set the budget revenue of 1996 at 20,400 million baht.



Source: Statistics of BMA & Statistical Yearbook, Thailand

Fig. 15.1: Budget Revenue of Kingdom and Share of GDP



Source: Statistics of BMA & Statistical Yearbook, Thailand

Fig. 15.2: Budget Revenue of BMA and Share of GDP

2) Revenue of BMA

The source of budget of BMA is classified into two categories as follows:

- the revenue collected by BMA, and
- the revenue collected by other agencies

Revenue collected by BMA

In 1995, BMA collected the revenue of 3,383 million baht as the local tax, such as house and building tax, land development tax and signboard tax.

In addition to the local tax, BMA collected the revenue amounting to 1,652 million baht from the rental fee from BMA assets and fee, fine and service charges from miscellaneous activities. Though the contribution is very small, the users charges, such as collection fee of solid waste and night-soil, and car parking fee are included in the revenue (refer to Table 15.1).

The property-related tax is usually a major revenue in the local government. In Bangkok the share of the property-related tax is, however, very small in the taxation system, which was 18 % of the total budget revenue in 1995.

Revenue collected by Government Agencies

The following revenues are collected by the central government as the revenue of BMA:

- Value added tax (VAT)
- Vehicle tax
- Import-excise tax, etc.

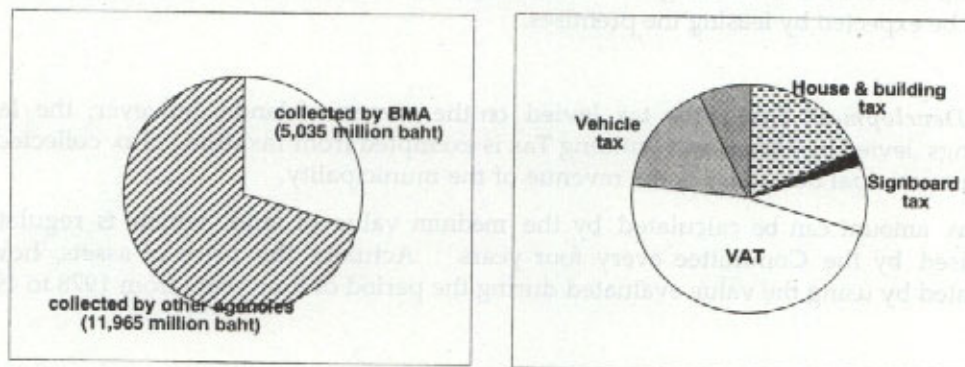
The central government collected the VAT, which is afterwards allocated between the central government and the local governments in the ratio of 9 : 1. The allocated VAT to the local governments is distributed to BMA and the other local governments. BMA shares 60 % among the local governments or 6 % of the total VAT collected.

In 1995 the revenue of BMA from VAT amounted to 8,000 million baht which contributed to 47 % of the revenue of BMA. Vehicle tax was 2,745 million or 16 % of the total revenue.

Table 15.1: Budget Revenue of BMA, 1995

Revenue item	Revenue (million baht)	Share
Tax collected by BMA		
Local development tax	120	0.7%
House & building tax	2,940	17.3%
Signboard tax	318	1.9%
Other tax	5	0.0%
Sub-total	3,383	19.9%
Tax collected by other government agencies		
VAT	8,000	47.1%
Vehicle Tax	2,745	16.1%
Import excise tax	370	2.2%
Consumption tax	850	5.0%
Sub-total	11,965	70.4%
Fees, charges of permits & services and fines	444	2.6%
Income from property	1,020	6.0%
Income from business & public utilities	33	0.2%
Miscellaneous income	155	0.9%
	17,000	100.0%

Source: Department of Finance, BMA



Source: Statistics of BMA & Statistical Yearbook, Thailand

Fig. 15.3: Budget Revenue of BMA by Revenue Item, 1995

Tax of BMA

Value Added Tax: was introduced instead of Business and Municipal Tax in 1992. The VAT is collected by the central government and allocated to the central government and the local governments under the provision of Administration Bangkok Metropolis Act (No. 2) B.E. 2534 and the act relating to Allocation of Value Added Tax to Local Administration B.E. 2534. The rate of allocation complies with the Ministerial Regulation under the act. As the new Ministerial Regulation has not been promulgated at present, the former rate is applied as follows:

$7\% \times 90\% = 6.3\%$ to central government

$7\% \times 10\% = 0.7\%$ to local governments

of which

$0.7\% \times 60\% = 0.42\%$ to BMA

$0.7\% \times 40\% = 0.28\%$ to other local governments

Vehicle Tax: contains the tax and registration fee for motor car and wheeled vehicle levied under the provision of Land Transport Act B.E. 2522 and Motor Car Act B.E. 2522. Ministry of Transport and Communications is responsible to collect vehicle tax and fee including the management of registration of motor car.

House and Building Tax: was originally levied:

- on buildings or other structures and land appurtenant thereto
- on land not appurtenant to buildings or other structures

However, it was amended as follows:

- building and other structures, inhabited by the owners or occupied by their agents not for the purpose of warehouses and industries, shall be exempted from taxation.
- land without buildings and structures shall be exempted from taxation.

The rate of house and building tax is calculated at a rate of 12.5 % of annual income which would be expected by leasing the premises.

Local Development Tax: is the tax levied on the owners of lands, however, the land with buildings levied by House and Building Tax is exempted from taxation. Tax collected on land within municipal boundary is the revenue of the municipality.

The tax amount can be calculated by the medium value of land, which is regulated to be appraised by the Committee every four years. Actually the price of assets, however, is calculated by using the value evaluated during the period of four years from 1978 to 1981.

Signboard Tax: is levied on owners of signboard depending on the condition, size and category of signboard.

The schedule of signboard tax is classified into:

- Signboard with only Thai letters;
- Signboard with the mixture of Thai letters, marks and foreign letters; and
- Signboard without Thai letters.

(2) Budget Expenditures

The budget of BMA increased by about 2.0 times, exactly 198 %, from 8,600 million baht in 1990 to 17,000 million baht in 1995, including the current expenditure and investment expenditure are shown in Table 15.2. The share of each expenditure by sector has been constant except the expenditure for the general administration. Changes in the allocation of expenditure by sector are:

- the expenditure of the general administration increased by 2.87 times from 1990 to 1995 and its share of the total expenditure correspondingly increased from 16 % in to 23 %;
- the expenditure of "public works and traffic" has been constant at about 25 % and its growth rate was 192 % from 1990 to 1995, and;
- the remaining sectors such as drainage and waste water treatment, cleansing services and city orderliness operation, public health, social services and development and education decreased their share

By the expanding expenditure of general administration, BMA is forced to reduce the expenditure of other sectors.

Table 15. 2: Budget Expenditure of BMA by Sector (1990 - 1995)

Fiscal year	Public works & traffic	General administration	Drainage & waste water treatment	Cleansing service & city orderliness operation	Public health	Social service & development	Education	Total
Expenditure (million baht)								
1990	2,397	1,374	1,449	1,221	1,170	532	459	8,600
1991	2,370	1,741	1,316	1,466	1,299	498	449	9,140
1992	2,306	2,124	1,432	2,040	1,311	517	527	10,256
1993	3,056	2,365	1,497	1,886	1,759	685	593	11,840
1994	3,529	2,671	2,103	2,117	2,114	903	732	14,170
1995	4,597	3,947	2,332	2,261	2,174	888	802	17,000
Share								
1990	28%	16%	17%	14%	14%	6%	5%	100%
1991	26%	19%	14%	16%	14%	5%	5%	100%
1992	22%	21%	14%	20%	13%	5%	5%	100%
1993	26%	20%	13%	16%	15%	6%	5%	100%
1994	25%	19%	15%	15%	15%	6%	5%	100%
1995	27%	23%	14%	13%	13%	5%	5%	100%
Growth (1990 =100)								
1990	100%	100%	100%	100%	100%	100%	100%	100%
1991	99%	127%	91%	120%	111%	94%	98%	106%
1992	96%	155%	99%	167%	112%	97%	115%	119%
1993	127%	172%	103%	154%	150%	129%	129%	138%
1994	147%	194%	145%	173%	181%	170%	160%	165%
1995	192%	287%	161%	185%	186%	167%	175%	198%

Source: Statistic Profile of BMA, Department of Policy and Planning

(3) Investment Budget and National Subsidies

The investment budget of BMA classified into the following five categories:

- Environment
- Landuse, traffic & infrastructure
- Human resource & social development
- Management & policy planning
- Finance

BMA allocated 2,397 and 2,853 million baht for the investment budget from their own budget in 1994 and 1995 respectively, which amounted to 17 % of the total budget. In addition to the own budget, BMA received the subsidy from the central government for development budgets (Table 15.3).

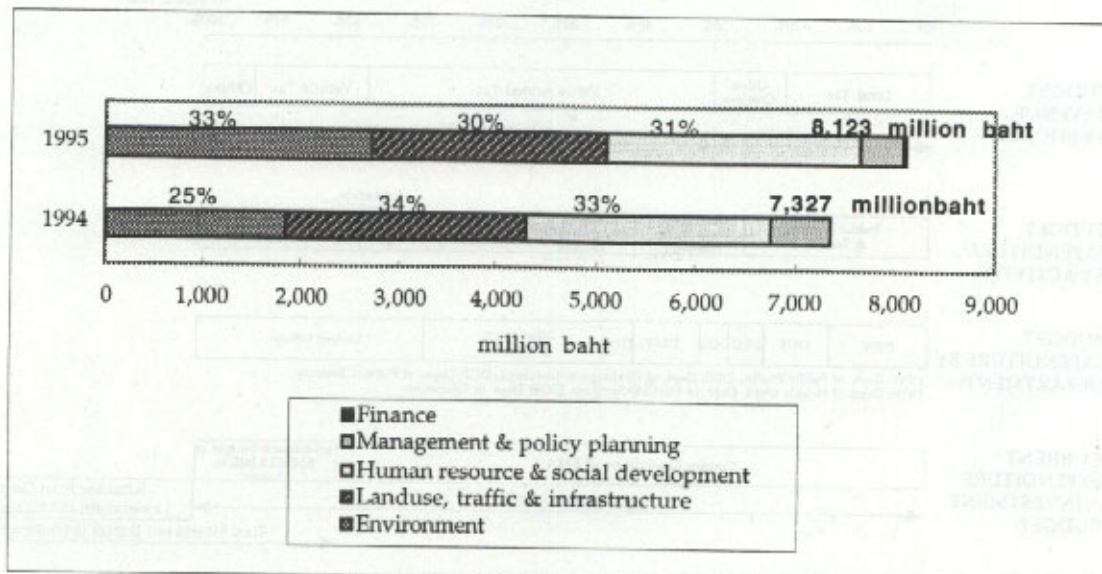
Adding the subsidies, total investment budget amounted to 7,327 and 8,123 million baht in 1994 and 1995 respectively, or 1,000 baht per person per year.

As the allocation of investment by category concerns, the share of environment sector increased both in the own budget and the subsidy in 1995. Accordingly the share of environment increased from 25 % in 1994 to 33 % in 1995 (Figure 15.4).

Table 15.3: Investment Budget of BMA and Subsidies from Central Government by Sector, Fiscal Year 1994 and 1995

Category	million baht								
	BMA Budget			Government Subsidy			Total Investment Budget		
	1994	1995	Total	1994	1995	Total	1994	1995	Total
Environment	585	973	1,558	1,232	1,716	2,949	1,818	2,689	4,507
Landuse, traffic & infrastructure	844	1,109	1,952	1,640	1,300	2,940	2,483	2,408	4,892
Human resource & social development	370	289	659	2,057	2,255	4,312	2,427	2,544	4,971
Management & policy planning	598	430	1,028	0	0	0	598	430	1,028
Finance		53	53		0	0	0	53	53
Total	2,397	2,853	5,250	4,929	5,271	10,200	7,327	8,123	15,450
Share of Investment Budget by Category									
Environment	24%	34%	30%	25%	33%	29%	25%	33%	29%
Landuse, traffic & infrastructure	35%	39%	37%	33%	25%	29%	34%	30%	32%
Human resource & social development	15%	10%	13%	42%	43%	42%	33%	31%	32%
Management & policy planning	25%	15%	20%	0%	0%	0%	8%	5%	7%
Finance	0%	2%	1%	0%	0%	0%	0%	1%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%
Share of BMA Budget and Central Government Subsidy by Category									
Environment	32%	36%	35%	68%	64%	65%	100%	100%	100%
Landuse, traffic & infrastructure	34%	46%	40%	66%	54%	60%	100%	100%	100%
Human resource & social development	15%	11%	13%	85%	89%	87%	100%	100%	100%
Management & policy planning	100%	100%	100%	0%	0%	0%	100%	100%	100%
Finance		100%	100%		0%	0%	100%	100%	100%
Total	33%	35%	34%	67%	65%	66%	100%	100%	100%

Source: Statistics of BMA, 2536 and 2537



Source: Statistics, Department and Policy Planning, BMA

Fig. 15.4: Total Investment Budget of BMA by Sector including Subsidies from Central Government, Fiscal Year 1994 and 1995

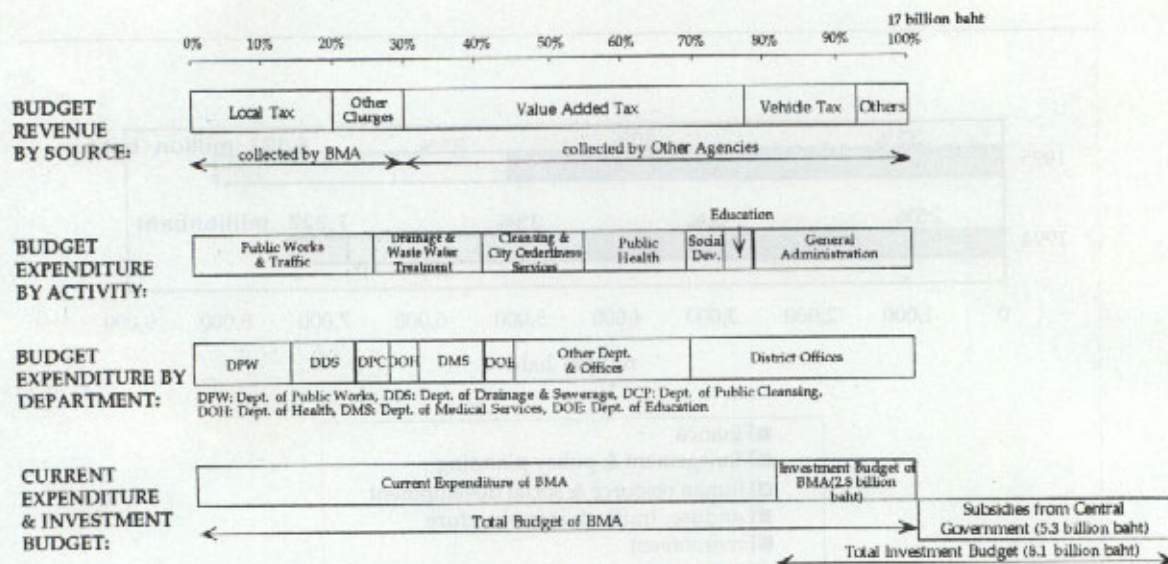
The subsidy from the central government rather concentrates in the investment for the human resource and social development.

The approximate share between the own budget and the subsidy by investment category is currently:

	BMA : National Government
• Environment	35 : 65
• Landuse, traffic & infrastructure	40 : 60
• Human resource & social development	15 : 85
• Management & policy planning	100 : 0
• Finance	100 : 0

Consequently, BMA and the central government share the budget of investment in BMA by 35 % and 65 % respectively.

Figure 15.5 shows the budget structure of BMA in 1995 in terms of the revenue source, the expenditure allocation by sector and by department, and the investment budget including the subsidies from national government.



Source: Statistics of BMA 2536 and 2537, Department of Policy and Planning, BMA

Fig. 15.5: Budget Structure of BMA, Fiscal Year 1995

(4) Issue on Financial Structure of BMA

A large amount of financial resources is required for BMA to invest in order to address the impacts of the discharges in the city resulting from rapid economic growth. BMA is, however, facing the following issues to be improved for the sound and effective financial management.

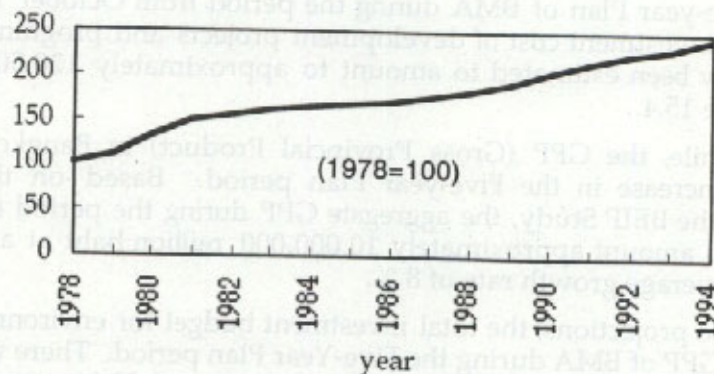
- Less Reflection to Increasing Asset Value;
- Poor Taxation Management;
- Dependency of BMA Budget to the Central Government;
- Insufficient Application of the Polluter-Pay-Principle; and
- lack of the External Financial Source

Less Reflection of Increasing Asset Value

- As the share of the property-related tax is very small in the taxation system in Thailand, the collected revenue hardly reflects the increased value of assets during the rapid growth of the economy even during the rapid growth of the economy in Bangkok.

Poor Taxation Management

- The revenue of BMA budget increased at a lower rate than the economic growth of BMA, probably because of the insufficient management system of tax collection.
- The lack of land-ownership map makes BMA difficult to legitimately collect house and building tax and land development tax.
- The value evaluation of assets for the taxation, that is regulated to be assessed every four years, has not been implemented during more than last ten years. BMA collects the tax by using the estimate of assets evaluated during the four years between 1978 and 1981. The following figure, for example, shows the index of the consumer price increase from 1978. The consumer price has increased by 2.4 times from 1978 to 1994.



Source: Statistic Year Book, Thailand

Figure 15.6: Consumer Price Index, 1978 = 100 (1978 - 1994)

Dependency of BMA Budget on the Central Government

- The percentage of BMA financial revenue is about 1 % of GPP of BMA.
- As the share of current expenditure in BMA budget amounts to almost more than 80 % of the total expenditure and therefore BMA can allocate less than 20 % for the investment budget.
- The investment budget of BMA heavily depends on the subsidy. More than 60 % of the financial source for investment is subsidized by the central government in 1995.

Insufficient Application of the Polluter Pays Principle

- BMA applies the PPP for solid waste management. In 1995, BMA collected 53.5 million baht as the service fee for the collection service of garbage. However the amount collected was less than 20 % that should-be-collected under the present tariff. Although the new tariff has been proposed, it has not yet enforced.

Lack of the External Financial Source

- BMA hardly absorbs external financial resources such as ODAs directly under the present regulation for local administration in Thailand, despite that BMA seeks those funds for investment onto social capital formation particularly for environmental improvement project.

15.2 Financial Capability of BMA for Environmental Improvement

(1) The Five-Year Strategic Plan and Financial Capability

In the Fifth five-year Plan of BMA during the period from October 1996 to September 2001, the total investment cost of development projects and programs for environment has preliminary been estimated to amount to approximately 120,500 million baht as shown in Table 15.4.

In the meanwhile, the GPP (Gross Provincial Product) in Bangkok Metropolis will continuously increase in the Five-year Plan period. Based on the socio-economic framework of the BEIP Study, the aggregate GPP during the period from 1997 to 2001 is estimated to amount approximately 10,000,000 million baht at a constant price of 1993 with an average growth rate of 8 %.

Adopting those projections, the total investment budget for environment will share 1.2 % of the total GPP of BMA during the Five-Year Plan period. There will be a significant deficit of budget under the present revenue structure of BMA, since the total budget revenue of the BMA was less than 1 % of GPP in 1995, of which the allocation to the investment budget was approximately 17 %.

Table 15.4: Investment Budget of Environment Sector in Fifth Five-Year Strategic Plan of BMA

	Total Budget		Fiscal Year					
	Investment	Operation	Total budget	million baht				
				1997	1998	1999	2000	2001
CATEGORY 1								
I Sewerage System	17,627	690	18,316	1,267	3,756	4,957	5,889	2,447
II Solid Waste Management	17,677	6,263	23,939	4,871	5,680	5,464	4,519	3,405
III Drainage and Flood Protection	23,637	0	23,637	3,022	5,307	5,238	5,088	4,982
IV Environmental Health	72	166	237	106	37	37	22	36
Sub-total	59,012	7,118	66,130	9,266	14,780	15,696	15,518	10,870
CATEGORY 2								
I Road & Highway	52,942	71	53,013	26,923	11,490	6,070	5,045	3,485
II Traffic and Transportation	1,058	303	1,361	1,058	93	94	57	59
Sub-total	54,000	373	54,373	27,981	11,583	6,164	5,102	3,543
Total	113,012	7,491	120,503	37,247	26,363	21,860	20,620	14,414

Source: BMA

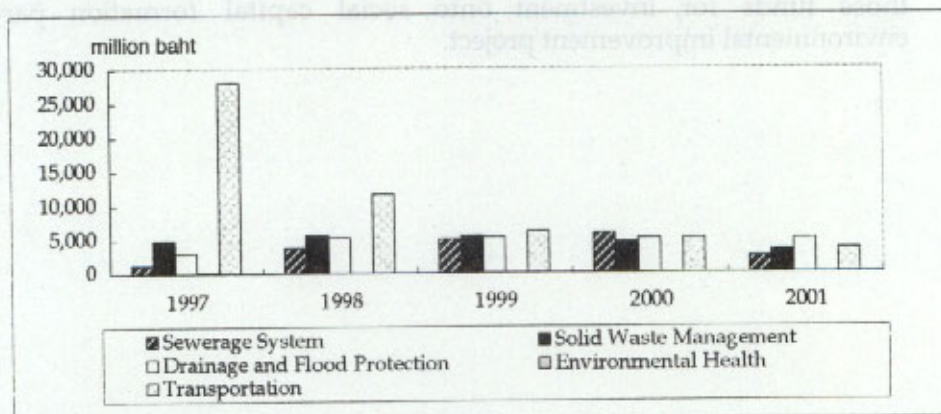


Fig. 15.7: Investment Budget of Environment Sector in Fifth Five-Year Strategic Plan of BMA

(2) Budgetary Demands for Proposed Projects/Programs of BEIP Study

The BEIP Study recommended the projects/programs for the environmental improvement in the Bangkok Metropolis up to the target year of 2011 (refer to Chapter 11). The cost estimates for those projects/programs are prepared in Table 15.5.

An amount of 935,380 million baht has been estimated for the projects/programs up to 2011, of which 47,330 million baht for the Urgent Actions (1997-2001), 415,450 million baht for the Medium-term Projects/programs (2002-2006) and 472,600 million baht for the Long-term Project/programs (2007-2011). As the costs for the projects listed in the Fifth Five-Year Plan of BMA are excluded in the estimates, the share of the Urgent Action period is very small.

Though the total investment amount seems to be enormous, it not so huge compared with the size of Bangkok economy. Problem is the priority of investment, cost/effectiveness of investment and the demarcation of the roles among public and private sectors.

Table 15.5: Cost Estimates for Projects/Programs of BEIP Study by Implementing Term and Agency (1997 - 2011)

	Total		Cost and Allocation (million baht)				
			BMA	Central Govern-	State Enter-	Private	
Urgent Actions (1997 - 2001)	47,330	5.1%	31,740	10.7%	2,320	8,680	4,590
Medium-term Projects/programs (2002 - 2006)	415,450	44.4%	122,730	41.5%	4,690	180,690	107,340
Long-term Projects/programs (2007 - 2011)	472,600	50.5%	141,140	47.7%	1,860	216,500	113,100
Total Cost of Projects/Programs	935,380	100.0%	295,610	100.0%	8,870	405,870	225,030

Source: BEIP Study

(3) Demarcation of Cost Burden for Environment Investment among BMA and Other Agencies

Adding the costs for the projects in the Fifth Five-Year Plan of BMA (refer to Table 15.4) and for the water supply system of the Five-Year Plan of MWA, the total investment costs of the environment sector are estimated to amount to 1,170,780 million baht up to 2011 in Bangkok as shown in Table 15.6 and 15.7. It will share 2.6 % of the aggregated GPP of Bangkok during the corresponding period.

Table 15.6: Environmental Investment Costs and GPP in Bangkok

		million baht			
		Short-term (1997-2001)	Medium-term (2002-2006)	Long-term (2007-2011)	Total
1) Required Environment Investment Costs					
BMA Fifth Five-Year Plan	(a)	120,500			120,500
Investment Budget of MWA Five-Year Plan		114,900			114,900
Total Costs of Projects/Programs of BEIP Study	(b)	47,330	415,450	472,600	935,380
- BMA	(c)	31,740	122,730	141,140	295,610
- Central government		2,320	4,690	1,860	8,870
- State Enterprise		8,680	180,690	216,500	405,870
- Private Sector		4,590	107,340	113,100	225,030
Total Investment Cost	(d)	282,730	415,450	472,600	1,170,780
2) Required Investment Costs of BMA	(a)+(c)	152,240	122,730	141,140	416,110
3) Estimated GPP of BMA in Socio-economic Framework of BEIP Study					
Aggregated GPP (1993 price)	(e)	10,362,000	14,786,000	20,138,000	45,286,000
Increased GDP	(f)	2,187,000	6,611,000	11,963,000	20,761,000
4) Share of Environmental Investment Cost of GPP					
Total Environment Costs as Percentage of GPP	(d)/(e)	2.7%	2.8%	2.3%	2.6%
Total Environment Costs as Percentage of Increased GPP	(d)/(f)	12.9%	6.3%	4.0%	5.6%

Source: BEIP Study

Table 15.7: Environment Investment Costs in Bangkok including Projects/Programs of BEIP Study, Fifth Five-Year Plan of BMA and Five-Year Plan of MWA by Plan and Implementing Term (1/2)

	Cost and allocation (million baht)				
	Total Cost	BMA	Central Government	State Enterprise	Private
Plan 1: Sustainable Resource Utilization					
BMA 5th Five-year Plan (1997 - 2001)	0	0	0	0	0
Urgent Actions (1997 - 2001)	0	0	0	0	0
Medium-term Projects/programs (2002 - 2006)	90	0	90	0	0
Long-term Projects/programs (2007 - 2011)	4,390	4,390	0	0	0
Sub-total	4,480	4,390	90	0	0
Plan 2: Flood-free Urbanization					
- Flood Control					
BMA 5th Five-year Plan (1997 - 2001)	23,630	23,630	0	0	0
Urgent Actions (1997 - 2001)	1,190	1,190	0	0	0
Medium-term Projects/programs (2002 - 2006)	1,190	1,190	0	0	0
Long-term Projects/programs (2007 - 2011)	880	880	0	0	0
Sub-total	26,890	26,890	0	0	0
Plan 3: Environment-initiative Urban Transport (Eco-transport) System					
- Highway & Transportation					
BMA 5th Five-year Plan (1997 - 2001)	54,400	54,400	0	0	0
Urgent Actions (1997 - 2001)	480	240	240	0	0
Medium-term Projects/programs (2002 - 2006)	57,900	9,830	3,390	31,890	12,790
Long-term Projects/programs (2007 - 2011)	75,100	35,520	1,860	26,840	10,880
Sub-total	187,880	99,990	5,490	58,730	23,670
Plan 4: Pursuance of "Fresh and Clean Air Policy"					
- Air					
BMA 5th Five-year Plan (1997 - 2001)	240	240	0	0	0
Urgent Actions (1997 - 2001)	10,270	0	1,860	8,410	0
Medium-term Projects/programs (2002 - 2006)	5,460	0	1,300	0	4,160
Long-term Projects/programs (2007 - 2011)	0	0	0	0	0
Sub-total	15,970	240	3,160	8,410	4,160
Plan 5: Creation of Water-friendly Eco-city					
- Sewerage System					
BMA 5th Five-year Plan (1997 - 2001)	18,300	18,300	0	0	0
Urgent Actions (1997 - 2001)	23,020	23,020	0	0	0
Medium-term Projects/programs (2002 - 2006)	50,650	50,650	0	0	0
Long-term Projects/programs (2007 - 2011)	47,960	47,960	0	0	0
Sub-total	139,930	139,930	0	0	0
- Waterways					
BMA 5th Five-year Plan (1997 - 2001)	0	0	0	0	0
Urgent Actions (1997 - 2001)	380	380	0	0	0
Medium-term Projects/programs (2002 - 2006)	2,490	2,000	0	0	490
Long-term Projects/programs (2007 - 2011)	980	490	0	0	490
Sub-total	3,850	2,870	0	0	980

Table 15.7: Environment Investment Costs in Bangkok including Projects/Programs of BEIP Study, Fifth Five-Year Plan of BMA and Five-Year Plan of MWA by Plan and Implementing Term (2/2)

	Cost and allocation (million baht)				
	Total Cost	BMA	Central Government	State Enterprise	Private
Plan 6: Up-grading of Quality of Living Environment					
- Solid Waste Management					
BMA 5th Five-year Plan (1997 - 2001)	23,930	23,930	0	0	0
Urgent Actions (1997 - 2001)	9,370	4,690	90	0	4,590
Medium-term Projects/ programs (2002 - 2006)	38,710	22,570	0	0	16,140
Long-term Projects/ programs (2007 - 2011)	5,430	5,430	0	0	0
Sub-total	77,440	56,620	90	0	20,730
- Water Supply System					
BMA 5th Five-year Plan (1997 - 2001)	114,900	0	0	114,900	0
Urgent Actions (1997 - 2001)	90	0	0	90	0
Medium-term Projects/ programs (2002 - 2006)	59,400	0	0	59,400	0
Long-term Projects/ programs (2007 - 2011)	87,930	0	0	87,930	0
Sub-total	262,320	0	0	262,320	0
- Housing & Community Development					
BMA 5th Five-year Plan (1997 - 2001)	0	0	0	0	0
Urgent Actions (1997 - 2001)	180	0	0	180	0
Medium-term Projects/ programs (2002 - 2006)	194,190	31,030	0	89,400	73,760
Long-term Projects/ programs (2007 - 2011)	254,320	50,860	0	101,730	101,730
Sub-total	448,690	81,890	0	191,310	175,490
Special Special Projects/Programs					
BMA 5th Five-year Plan (1997 - 2001)	0	0	0	0	0
Urgent Actions (1997 - 2001)	2,260	2,220	40	0	0
Medium-term Projects/ programs (2002 - 2006)	1,070	1,070	0	0	0
Long-term Projects/ programs (2007 - 2011)	0	0	0	0	0
Sub-total	3,330	3,290	40	0	0
Total					
BMA 5th Five-year Plan (1997 - 2001)	235,400	120,500	0	114,900	0
Urgent Actions (1997 - 2001)	47,240	31,740	2,230	8,680	4,590
Medium-term Projects/ programs (2002 - 2006)	411,150	118,340	4,780	180,690	107,340
Long-term Projects/ programs (2007 - 2011)	476,990	145,530	1,860	216,500	113,100
Total	1,170,780	416,110	8,870	520,770	225,030

Source: BEIP Study

Considering the financial demarcation among the central and local governments and the private sector, the required investment of BMA amounts to 416,110 million baht or 36 % of the total, of which 295,610 million baht is the costs of proposed projects/programs listed in the BEIP Study and 120,500 million baht is the budget in the Fifth Plan of BMA.

Under the assumption that BMA would be subsidized at a rate of 65 % of total investment costs from the central government, BMA has to share the cost of 145,640 million baht over fifteen years up to 2011; 53,280 million baht, 42,960 million baht and 49,400 million baht for 1997-2001, 2002-2006 and 2007-2011, respectively as shown in Table 15.8.

Table 15.8: Required Investment Costs of BMA and Subsidies from Central Government (1997 - 2011)

		million baht			
		Urgent Actions (1997-2001)	Medium- term Projects /programs (2002-2006)	Long-term Projects /programs (2007-2011)	Total
Required Amount for Environmental Investment		152,240	122,730	141,140	416,110
- Required Investment of BMA	35%	53,280	42,960	49,400	145,640
- Required Subsidies from Central Government	65%	98,960	79,770	91,740	270,470

Source: BEIP Study

In the short-term, BMA will need the intensive budget allocation for infrastructure development such as solid waste, sewerage system, flood control and highways. At the same time, the institutional schemes for the new standards and regulations need to be prepared in order to enhance the private participation and maximize cost/effectiveness of investment in the long-term. Thereby, housing and community development such as Sub-center development should be started by the latter half of the Plan.

Provided that BMA will implement the projects/programs amounting to 416,110 million baht or 36 % of total environment cost as mentioned above, the remaining costs of 754,670 million baht have to be shared by national government, state enterprises and private sector. The major projects/programs required for each organization to implement are:

- The national government, besides providing the subsidies to BMA implementing projects, needs to be responsible for the investments of the programs related to policy making and research and technical development;
- "Mass Rapid System" for Environment-initiative Urban Transport has mainly to be invested by MRTA and private sector supported by MOTC and BMA.
- Regarding the "Sub-center Zone Development", it is necessary that BMA will strategically develop a part of infrastructure, however, NHA and private sector will have the major responsibility to implement the development; and
- MWA will implement the projects in its Five-Year Plan, 1997-2001, and will be required a further investments for the improvement/rehabilitation of the existing water supply system and development of the extended water resources in medium and long-term.

15.3 Measures to Strengthen Financial Capability of BMA

(1) Improvement Financial and Budgetary Institutions

In Thailand, the national budget revenue amounts to almost 20 % of the country's GDP, while the budget revenue of BMA is approximately 1 % of its GPP. Moreover 70 % of the revenue of BMA is a transferred tax from national government. The budgetary autonomy of BMA is very limited. On the other hand, the environment improvement is an urgent need for BMA.

According to the Fifth Plan of BMA and the BEIP Study, the total required environmental investment has been estimated to amount to 1,170,780 million baht over fifteen years from 1997 to 2011 in Bangkok. The amount is not unreasonably high compared with GPP of BMA. Its share of GPP is estimated at 2.6 %. The World Bank, for example, has reported that the environment projects would require the additional investment costs amounting to 2-3 % of the aggregated GDP in the developing countries in 2000 excluding the investment of highway and transportation sectors.

Although BMA's autonomy is very limited, BMA has to share the investment costs. It is required that BMA will itself strengthen the financial capability under the present taxation regulation and budgetary system. The Strategic Study for Financial Enhancement Program of BMA is proposed including:

- Improvement of Current Local Taxation System with the preparation of Land and Assets Ownership Map (Cadastral Map), Re-evaluation of Asset Value and Improvement of Tax Collection System;
- Implementation of the PPP for Solid Waste Management; and
- Utilization of External Financial Sources

(2) Potential Burden of the Environmental Costs in BMA

The future structure of the budget revenue and expenditure of BMA and its capability to burden the costs for the environmental improvement in Bangkok were projected in two cases, based on several assumptions.

1) "Status quo - Case" reflecting the future growth of economy in the socio-economic framework under the assumptions:

- the revenue of BMA will correspondingly increase and keep the same share of GPP;
- the expenditure will be allocated under the present budget structure and system; and
- the central government will subsidize the same portion (65 %) of the investment budget of BMA

Over fifteen years during from 1997 to 2011, the shortage of investment budget is estimated to accumulate to 87,900 million baht. Particularly, in the short-term, the deficit will be 39 % of the total budget revenue.

2) "Challenging - Case" enhancing the financial capability of BMA to enable to burden the environmental costs under the assumptions:

- the local tax revenue collected by BMA may increase twofold up to the target year of 2011 with an introduction of the effective system of tax management;
- the PPP will efficiently be applied to the solid waste management;
- the increased revenue resulting from the financial improvement will be strategically and intensively allocated to the environment investment;
- the central government will subsidize the same portion (65 %) of the investment budget of BMA; and

- the external finance resource will be utilized if necessary

Table 15.9 shows the required investment costs of environment sector, and the investment budget of BMA in "Challenging Case".

In the Short-term (1997-2001), total costs for the environment improvement is 282,730 million baht, of which the costs for the projects/programs that BMA is responsible to implement amount to 152,240 million. Given the subsidies of 98,960 million baht from central government, BMA itself needs the investment budget of 53,280 million baht.

On the other hand, if BMA could improve the tax collection system and would intensively allocate the incremental revenue to the environmental investment, the available resource is estimated at 22,300 million baht over five years.

Consequently, a significant deficit of 30,980 million baht would emerge in the investment budget, sharing 27 % of total BMA revenue.

In the Medium and Long-term (2002-2011), the balance is expected to improve gradually by the increase of tax revenue to be able to burden the costs for proposed projects/programs up to 2011. In the year of 2011, the accumulated deficit is estimated to decrease to 1,770 million baht or 0.3 % of total BMA budget revenue. The deficit born in the short term will be fulfilled with the surplus in 2011.

In the meantime, in order to finance the shortage for the initial investment of projects/programs, the external financial resources or the special subsidies from the central government would be necessary.

**Table 15.9: BMA Budget and Required Environmental Investment
-Challenging Case-**

		million baht			
		Urgent Actions	Medium-term Projects /programs	Long-term Projects /programs	Total
		(1997-2001)	(2002-2006)	(2007-2011)	
1) BMA Budget Revenue in Challenging Case					
Estimated BMA Budget Revenue	(a)	115,100	182,300	255,800	553,200
Percentage of GDP		1.1%	1.2%	1.3%	1.2%
2) Source of Investment Budget of BMA					
Investment Budget of BMA	(b)	28,100	58,070	86,600	172,770
BMA	(b)/(a)	24.4%	31.9%	33.9%	31.2%
Investment Budget of Environment Sector	(c)	22,300	49,790	75,320	147,410
Budget	(c)/(b)	79%	86%	87%	85%
3) Require Amount for Environmental Investment of BMA					
Required Amount for Environmental Investment	(d)	152,240	122,730	141,140	416,110
- Required Investment of BMA	(e)-(d)x35%	53,280	42,960	49,400	145,640
- Required Subsidies from Central Government	(f)=(d)x65%	98,960	79,770	91,740	270,470
4) Balance between BMA Budget and Required Investment					
BMA Budget of Environment Investment	(c)	22,300	49,790	75,320	147,410
Required Investment of BMA	(e)	53,280	42,960	49,400	145,640
Balance of BMA Budget	(g)-(c)-(e)	-30,980	6,830	25,920	1,770
Percentage of BMA Total Budget Revenue	(g)/(a)	- 27%	4%	10%	0%

Source: BEIP Study

As shown in Figure 15.8 and 15.9, BMA's financial structure will change and the prospective improvement in the "Challenging-Case" is summarized as follows:

- BMA could receive about 45 % of the budget revenue from own revenue such as local tax and charges instead of 30 % in 1995;

- share of the BMA's budget revenue of GPP will increase from 1.0 % in 1995 to 1.3 % in 2011; and
- the investment budget will increase from 17 % to 34 % of total expenditure and more than 85 % of the investment budget could be allocated to environment sector in 2011

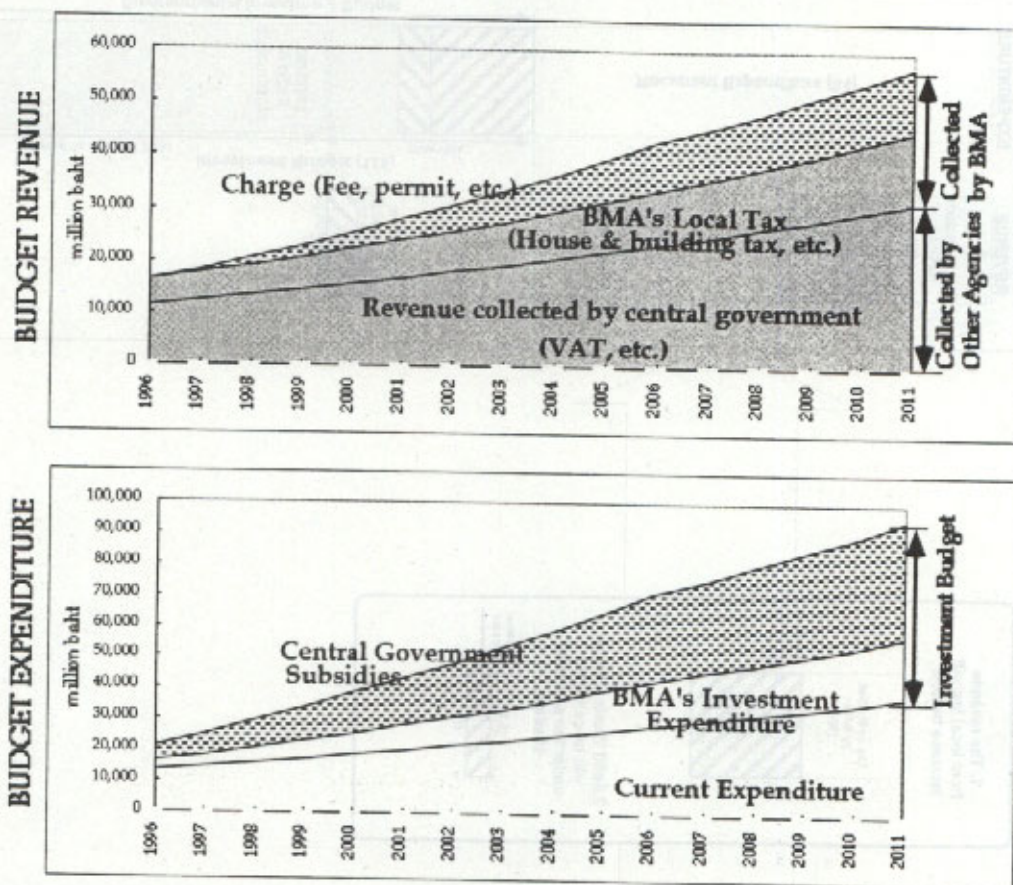


Fig. 15.8: Estimated Budget Revenue and Expenditure in Challenging Case

(3) Absorbed Capacity of External Resources

Absorbed capacity of the borrower is usually evaluated by using the index of "Debt Service Ratio (DSR)". It is generally accepted that the DSR of 20 % is the maximum limit of borrowing capacity for the financially sound management of public administrative bodies.

As BMA has not incurred any loans at present, the borrowing capacity of BMA is accordingly estimated at 13,000 million baht per annum or 65,000 million baht over 5 years during the Short-term between 1997 and 2001, assuming that the available loan conditions are as follows:

- repayment period; 20 years including grace period of 5 years; and
- interest rate; 8 % per annum

In the projection of "Challenging-Case", the deficit of the environment budget has been estimated at 30,980 million baht in the short-term. Provided BMA could borrow the external loan under the same condition above, DSR of BMA will be less than 10 % during the Medium-term which is sufficiently in the safety range of DSR.

A legislative framework is necessary to be developed for BMA to directly access to the external fund sources, and the absorptive capability of BMA needs to be strengthened to this end.

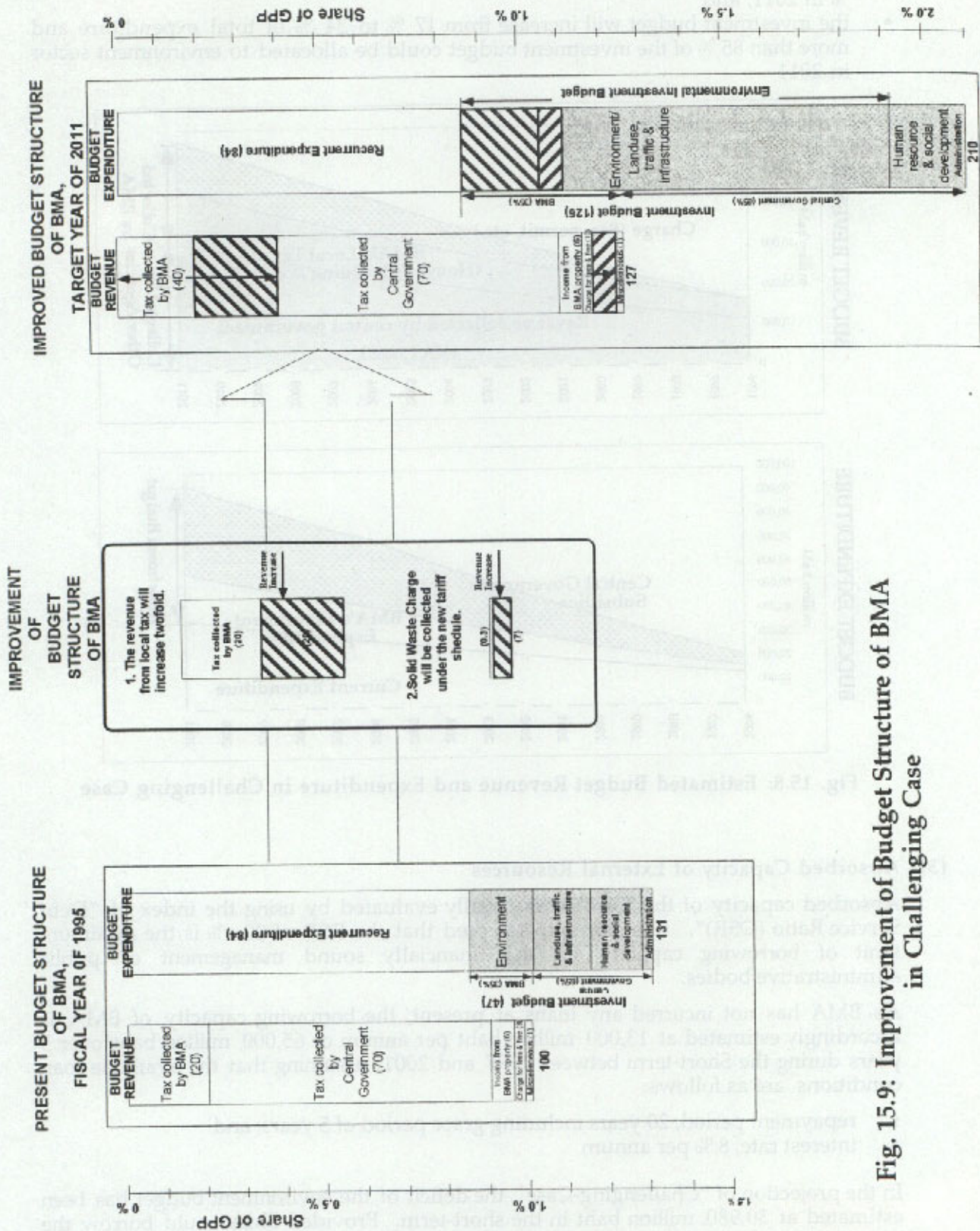


Fig. 15.9: Improvement of Budget Structure of BMA in Challenging Case

(4) Proposed Project (Cadastral Information System Project)

Cadastral Information System Project is proposed for BMA to manage taxation system efficiently. The components of the project will be:

- preparation of land-ownership map (Cadastral Map) ;
- re-evaluation of assets by using the Cadastral Map; and
- improvement of tax collection system by using the Cadastral Map.

The conceptual flowchart of the development of the Cadastral Map for tax assessment is prepared in Figure 15.10.

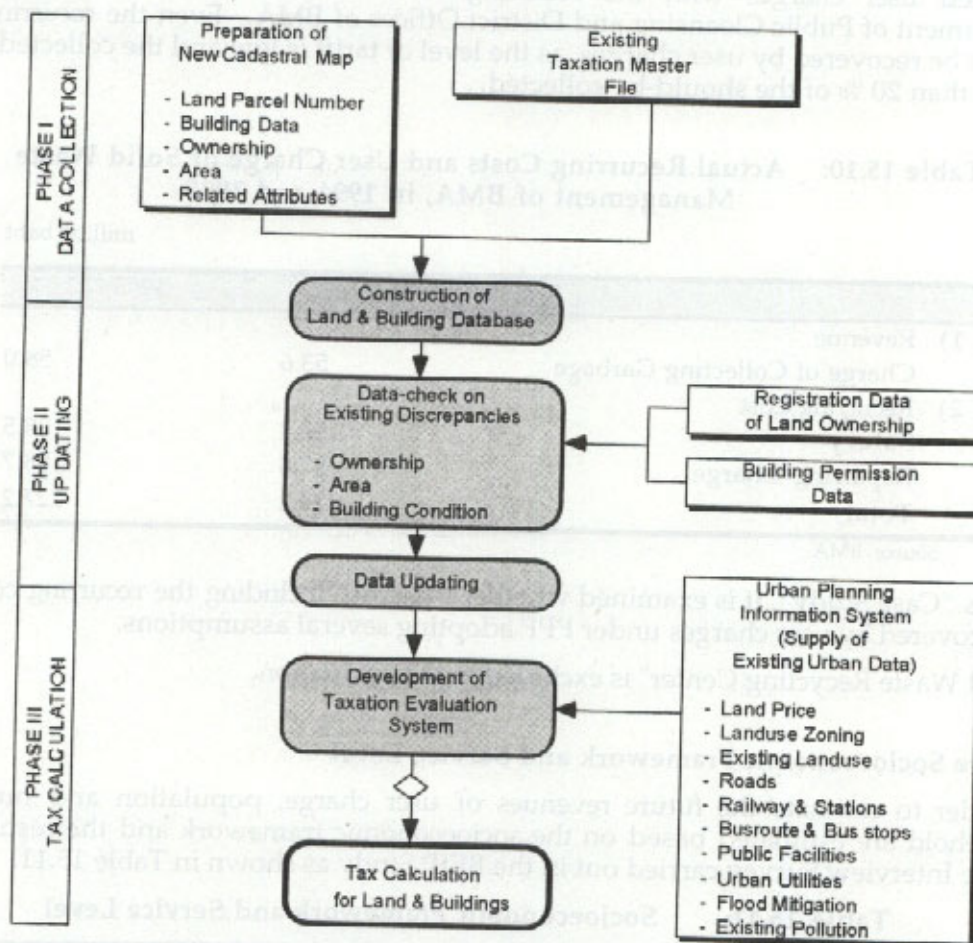


Fig. 15.10: Flowchart of the Development of Cadastral Map for Tax Assessment

15.4 Financial Evaluation of the Proposed Solid Waste Management Project: A Case Study

(1) Investment Costs and Revenue of Solid Waste Management of BMA

In Bangkok, the proposed investment costs of solid waste management is estimated at 77,440 million baht up to 2011, of which 23,930 million baht and 53,510 million baht are listed in the Fifth Plan of BMA and the proposed projects/programs of BEIP, respectively. It shares 6.6 % of the total environmental investment costs. Particularly in the short-term, 1997-2001, its share increases to 11.8 %.

On the other hand, the Polluter-Pay-Principle (PPP) has been introduced in solid waste management and the user charge are collected by BMA. Table 15.10 compares the collected user charges with the recurring costs of solid waste management in Department of Public Cleansing and District Offices of BMA. Even the recurring costs cannot be recovered by user charges, as the level of tariff is low and the collected charge is less than 20 % of the should-be-collected.

Table 15.10: Actual Recurring Costs and User Charge of Solid Waste Management of BMA, in 1994 and 1995

	million baht	
	1994	1995
1) Revenue		
Charge of Collecting Garbage	53.6	58.0
2) Recurring Cost		
Salary	138.4	138.5
Repairing Charge	87.8	88.7
Total	226.2	227.2

Source: BMA

In this "Case Study", it is examined whether the costs including the recurring costs can be recovered by user charges under PPP adopting several assumptions.

"Solid Waste Recycling Center" is excluded in the evaluation.

(2) Future Socioeconomic Framework and Service Level

In order to estimate the future revenues of user charge, population and number of household are estimated based on the socioeconomic framework and the result of the Home Interview Survey carried out in the BEIP Study as shown in Table 15.11.

Table 15.11: Socioeconomic Framework and Service Level

	Present 1995	Urgent Action 2001	Medium Term Plan 2006	Long Term Plan 2011
Number of Family Member (persons)	3.99	3.86	3.76	3.66
Number of Household (1,000)	2,037	2,341	2,596	2,870
Services-coverage-ratio	85%	90%	95%	95%
Charge-collecting-ratio	less than 20%	70%	80%	80%

Source: BEIP Study

In the evaluation the service level and charge-collection level are estimated to increase as the following assumptions:

- Currently the garbage collecting services are provided to approximately 85 % of the household and this ratio will increase to 90 % in 2001 and 95 % in 2006,
- The collected revenue is less than 20 % of should-be-collected amount at present. In the future it will be improved to collect 70 % and 80 % of the billing amounts in 2001 and 2006.

(3) General Assumptions

In order to evaluate financial viability, the following assumptions have been made:

- Project Life: 15 years up to 2016 based on the life period of facilities;
- Project Revenue and Cost are estimated by using market prices in September 1996 and evaluated by Thai Baht;
- Foreign Exchange Rate (as of September 30, 1996):
 US \$ 1.00 = Baht 25.42
 US \$ 1.00 = Japanese Yen 110.65
 Baht 1.00 = Japanese Yen 4.35
- A discount rate of 8 % is used considering the interest rate of available external loan;
- Inflation is not taken into account both in revenue and expenditure projections;
- Salvage Value (Undepreciated Value) is assumed to be a negative cost in the final year of the project life

(4) Costs

The costs of the following projects/programs are included in the evaluation:

Investment Costs in the Fifth Five-Year Plan of BMA (1997 - 2001)

- Incineration Plant 1 (1,350 t/day x 2)
- Nong Khaem Compost Plant (1,000 t/day)
- Other Projects
- Garbage Disposal Contract/on-going (3,500 t/day)
- Future Garbage Disposal contract 1 (6,500 t/day)

Investment Costs of the Projects/Programs proposed by BEIP Study (1997 - 2011)

- Bangkok Incineration Plant 2 (2,000 t/day)
- Bangkok Incineration Plant 3 (1,350 t/day)
- Bangkok Incineration Plant 4 (1,000 t/day)
- Tonburi Incineration Plant 2 (1,000 t/day)
- Procurement of Disposal Site
 -Ning Chok (3,200 t/day)
 -Ban Khuntien (3,500 t/day)
- Future Disposal Contract 2 (5,000 t/day)
- Future Disposal Contract 3 (5,000 t/day)

Operation and Maintenance Costs

- Salary and repairing charges of collection vehicles are estimated based on the actual expenditure of Department of Public Cleansing and the District Offices of BMA from Fiscal Year 1991 to 1995. Namely, an annual growth rate is estimated at 3 %.

- The operation & maintenance costs of additional facilities are included in each investment costs.

Table 15.12 shows the investment costs and operation and maintenance costs of solid waste management of BMA by implementation term up to 2011. Land equitation cost is not included.

Table 15.12: Costs of Solid Waste Management of BMA (1997 - 2011)

	million baht				Reference 1)
	Urgent Action 1997-2001	Medium Term Plan 2002-2006	Long Term Plan 2007-2011	Total	
	1) Facility Development				
BMA 5th Five-year Plan	17,890	2,350	2,350	22,590	SW15
Incineration Plant	8,250	24,300	3,000	35,550	SW13, 24
Procurement of Disposal Site	0	3,950	3,900	7,850	SW11,12, 22, 23, 31
Disposal Contract	0	1,400	1,400	2,800	SW11,12, 22, 23, 31
Sub-total	26,140	32,000	10,650	68,790	
2) Recurrent Expenditure of BMA	1,279	1,483	1,719	4,481	

Source: BMA Fifth Five-Year Plan and BEIP Study

Note 1): Proposed Plan in projects/programs (refer to Chapter 11)

(5) Revenue

The revenues for the residential services are estimated by using the new tariff schedule, which is under the process of introduction in BMA (refer to Table 15.13) and the future tariff is projected to increase in accordance with the growth of income level as estimated in the socioeconomic framework as shown in Table 15.14.

Table 15.13: New Tariff Schedule of Garbage Collection

	Monthly rate
1) Less than 500 liter per day	
Less than 20 liter per day	Baht 40.0
Each 20 liter per day over 20 liter	Baht 40.0
2) Over 500 liter per day	
Less than one cubic meter per day	Baht 2,000.0
Each one cubic meter per day over one cubic meter	Baht 2,000.0

Source: BMA

Table 15.14: Tariff Schedule of Solid Waste Collection

	Present 1995	Urgent Action 2001	Medium Term Plan 2006	Long Term Plan 2011
1) Basic Monthly Tariff Schedule of Solid Waste Collection (baht per month)	12	51	66	82
2) Real growth rate of per capita GPP in Bangkok		6.1 % (1997-2001)	5.3 % (2002-2006)	4.5 % (2007-2011)

Source: BMA and BEIP Study

The amount of garbage from business sector is almost equivalent to the residential garbage in Bangkok according to the previous study; "Study on Bangkok Solid Waste Management", by JICA in 1991. In principle, the waste from the business such as industrial and commercial enterprises should fully be paid by polluters. In the evaluation, therefore, a half of the costs including the recurring expenditure to be recovered by business sector.

(6) Evaluation

1) Financing Plan

Other than user charge revenues, project costs of solid waste management is usually financed by:

- Budget expenditure of municipality or local government collected from tax and other charges;
- Subsidies from central government; and
- "Soft" loans at subsidized rates;

In the evaluation, the cash-flow of the projects/programs are examined in accordance with the following three steps:

- firstly, it is examined whether the user charges will be able to recover the costs including capital investment and recurring costs;
- secondly, an appropriate portion of the capital costs will be subsidized to recover the costs; and
- finally, the external loan is introduced to fulfill the deficit of cash-flow of the capital investment

2) Financial Evaluation

Cash-flow Statement I

The cash-flow of the revenues and costs are calculated as shown in Table 15.15. FIRR (Financial Internal Rate of Return) to the projects/program is estimated at 0.40 % and NPV (Net Present Value) is calculated to be -15,684 million baht using a discount rate of 8 %. It is approved that the costs of solid waste management including the capital investment and operation and maintenance can not be recovered by user charges considering the opportunity cost of capital.

Cash-flow Statement II

Assuming that a half of the capital cost will be subsidized, FIRR increases to 12.12 % and NPV is estimated to be 4,598 million baht as shown in Table 15.16. The result of calculation shows that it would be possible to manage solid waste service if BMA could seek some external fund source under the subsidized loan condition.

Cash-flow Statement III

In the cash-flow statement III, the external loan is applied for 40 % of the capital costs under the following loan conditions:

- repayment period of principal loan; 20 years including grace period of 5 years, and
- interest rate; 8 % per annum.

As the shortage of capital costs is financed by the soft loan, the increased user charge will recover the recurring expenditure and the principal repayments of loan in the latter part of the project period as shown in Table 15.17. Thereby, the accumulative cash-flow continuously shows surplus during the whole project period (refer to Figure 15.11).

It is noted that BMA need to recover the solid waste management costs by user charges as much as possible though the efforts:

- to apply new tariff schedule urgently and revise it timely in accordance with the growth of income level of household,
- to require the business sector to recover the full costs of their wastes under the PPP application, and
- to increase charge-collecting rate of the billings though the introduction of efficient management system of fee-collecting

(7) Further Study

The further study is required to implement in the proposed development studies of projects/programs of the BEIP focusing on:

- Institutional strengthening of BMA for solid waste management;
- Preparation for regulatory framework;
- Pricing, cost recovery and financing;
- Charge collecting system;
- Community participation; and
- Private sector participation

Table 15.16: Cashflow Statement II : with Subsidies

NPV (Discount Rate: 8 %):	4,598 million baht																				FIRR: 12.12%
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	
I Cash-inflow																					
1) User Charges	1,189	1,403	1,647	1,926	2,243	2,509	2,804	3,132	3,494	3,884	4,138	4,408	4,697	5,004	5,351	5,592	5,844	6,107	6,382	6,669	
2) Subsidies	2,700	2,530	2,530	2,530	2,530	2,775	2,775	2,775	2,775	2,775	330	530	530	530	530	5,592	5,844	6,107	6,382	6,669	
Total	3,889	3,933	4,177	4,456	4,773	5,284	5,579	5,907	6,269	6,659	4,468	4,938	5,227	5,534	5,881	5,592	5,844	6,107	6,382	6,669	
II Cash-outflow																					
1) Costs including Recurring Expenditure	5,741	5,408	5,416	5,423	5,431	6,679	6,688	6,696	6,705	6,714	2,454	2,464	2,474	2,484	2,494	2,145	2,157	2,168	2,180	-5,274	
III Net Cash-flow	-1,852	-1,475	-1,238	-967	-658	-1,395	-1,108	-790	-436	-55	2,214	2,475	2,753	3,050	3,387	3,447	3,687	3,939	4,201	11,943	

Table 15.17: Cashflow Statement III: with Subsidies and External Loan

	million baht																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
I Cash-inflow																				
1) User Charges	1,189	1,403	1,647	1,926	2,243	2,509	2,804	3,132	3,494	3,884	4,138	4,408	4,697	5,004	5,351	5,592	5,844	6,107	6,382	6,669
2) Subsidies	2,700	2,530	2,530	2,530	2,530	2,775	2,775	2,775	2,775	2,775	330	530	530	530	530	5,592	5,844	6,107	6,382	6,669
3) External Loan	2,160	2,024	2,024	2,024	2,024	2,219	2,220	2,220	2,220	2,220	424	424	424	424	424	2,145	2,157	2,168	2,180	-5,274
Total	6,049	5,957	6,201	6,480	6,797	7,504	7,799	8,127	8,489	8,879	5,092	5,362	5,651	5,958	6,305	6,305	6,305	6,305	6,305	6,305
II Cash-outflow																				
1) Costs including Recurring Expenditure	5,741	5,408	5,416	5,423	5,431	6,679	6,688	6,696	6,705	6,714	2,454	2,464	2,474	2,484	2,494	2,145	2,157	2,168	2,180	-5,274
2) Principal Repayment	173	335	497	659	820	978	1,124	1,259	1,384	1,498	1,456	1,403	1,337	1,260	1,171	1,046	919	789	657	523
3) Interest Payment	5,914	5,743	5,912	6,082	6,252	7,914	8,203	8,482	8,751	9,009	4,854	4,959	5,051	5,133	5,202	4,756	4,668	4,578	4,487	-3,074
Total	135	214	289	368	545	-409	-404	-365	-261	-129	238	404	599	825	1,103	836	1,176	1,528	1,896	9,742
III Net Cash-flow	135	214	289	368	545	-409	-404	-365	-261	-129	238	404	599	825	1,103	836	1,176	1,528	1,896	9,742
2) Accumulated	135	349	638	1,036	1,582	1,172	769	413	152	22	260	664	1,253	2,088	3,191	4,027	5,203	6,731	8,626	18,368

Table 15.18: Loan Schedule

	million baht																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
I Loan																				
1) Loan	2,160	2,024	2,024	2,024	2,024	2,220	2,220	2,220	2,220	2,220	424	424	424	424	424	1,565	1,593	1,621	1,649	1,678
2) Repayment	2,160	4,184	6,208	8,232	10,256	12,219	14,048	15,741	17,300	18,723	18,203	17,535	16,718	15,754	14,641	13,077	11,484	9,863	8,213	6,535
3) Balance																				
II Interest																				
1) Interest Payment	173	335	497	659	820	978	1,124	1,259	1,384	1,498	1,456	1,403	1,337	1,260	1,171	1,046	919	789	657	523

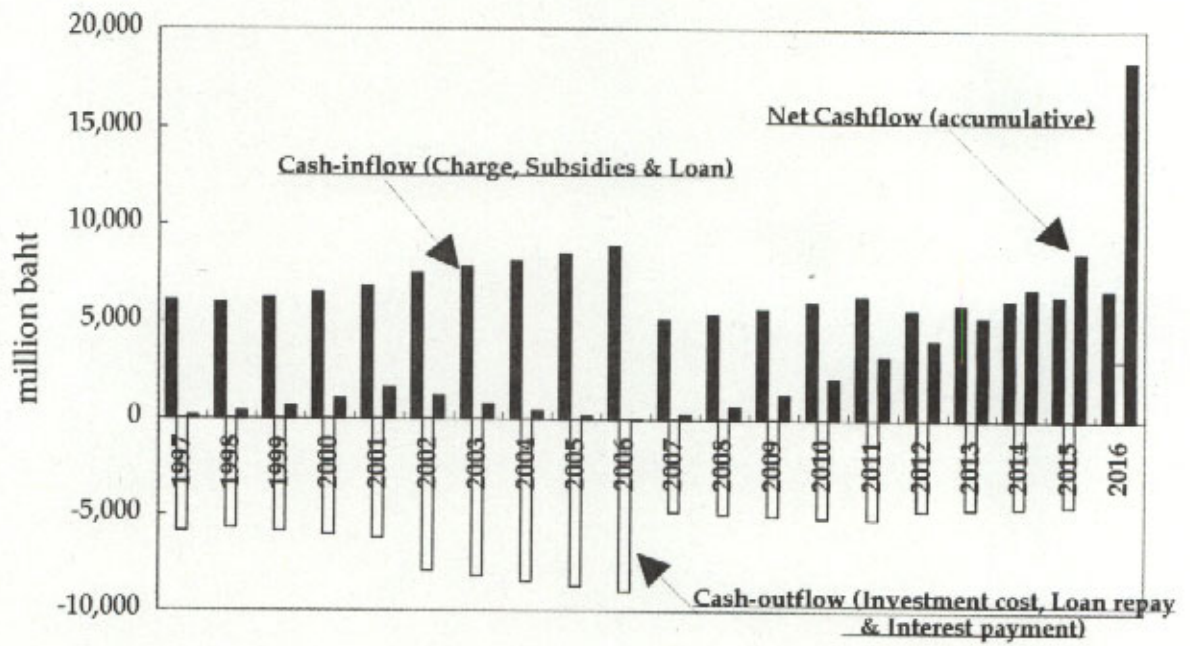


Fig. 15.11: Cash-flow with Subsidies and External Loan

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