

- **High Level Development**

To create a modern CBD featuring quality environment and adequate urban space with excellent landscaping suitable for international cities such as Bangkok.

- **Integrated Development**

Many major urban center facilities/industries shall be collectively accommodated and be physically well integrated in the study area.

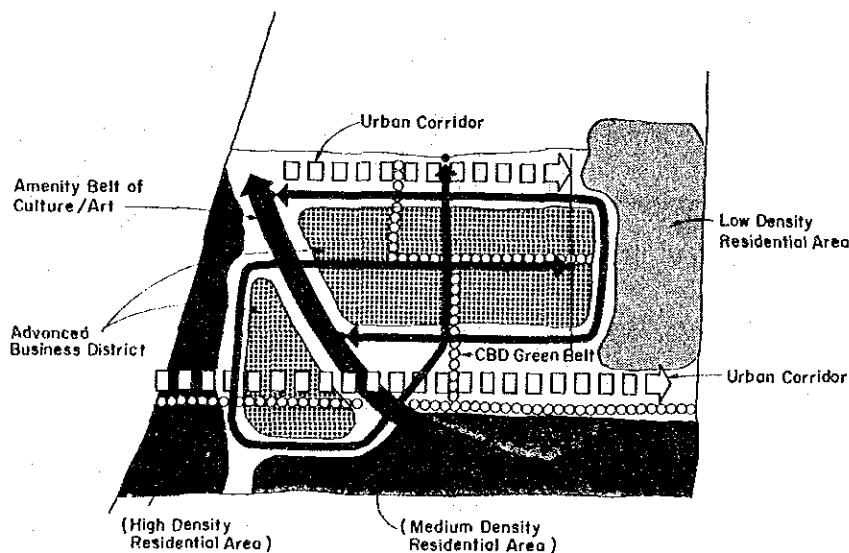
- **Area Management System Development**

An area management system designed to manage utility services in the new CBD shall be developed, that will manage water works, electricity, solid waste, security and information regarding utility operations and management. This will also include state-of-the-art communication and information processing systems.

6.3 General Structure and Strategic Development

Before formulating a concept plan, a general structure and strategic development plan in the study area are investigated as follows.

Figure 3.2.27-Structure Pattern for New CBD

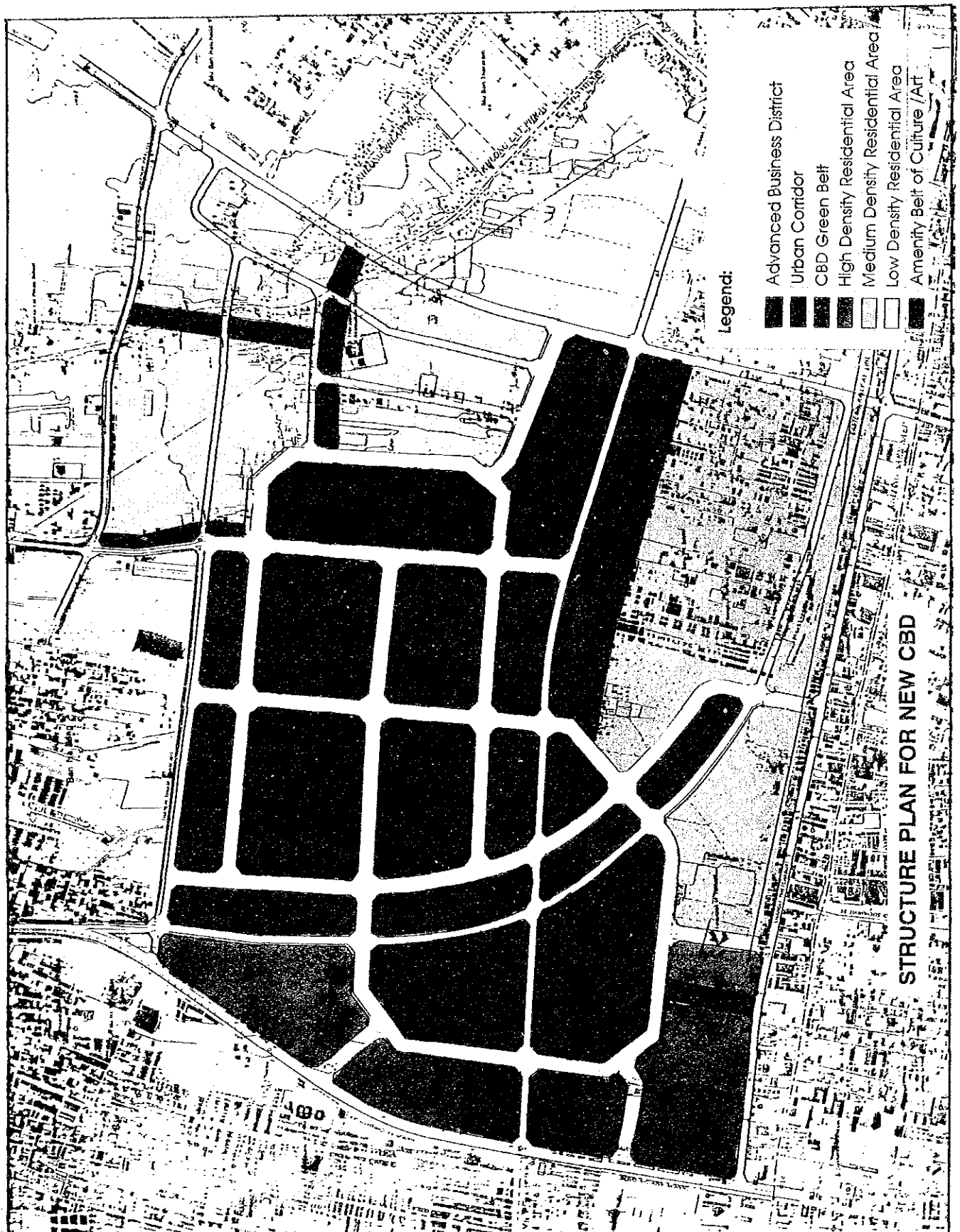


STRUCTURE PATTERN FOR NEW CBD

6.3.1 General Structure

With a purpose to creating an integrated/unified CBD in the study area, the general structure of development is analyzed as described below.

Figure 3.2.28-Structure Plan for New CBD



(1) Green Belt Development

- **Amenity Belt of Culture and Arts**

The State Railway of Thailand (SRT) site is in the form of a crescent stretching from the northwest to southeast at the end of the study area. Designated the "Royal City Avenue", the SRY site is used as a direction for development since development of this project will have shopping arcades.

Accordingly, people shall immigrate in this pattern which is instrumental to unify and integrate the activities in the urban center.

The amenity belt shall be constructed with the major development direction of the SRT site, connecting the rail stations of Hopewell and Lavalin.

Development in this belt includes cultural and business industries, boutiques, galleries, studios, international convention halls, hotels in linkage with the existing Thai Cultural Center, and mass media such as television broadcasting stations.

- **CBD Green Belt**

The CBD green belt is rich in natural resources, landscape, and parks, and shall adjoin the CBD along the existing canals where hotels and condominiums are under construction.

(2) Corridor Developments

Two kinds of development corridors are to structure the urban space in the study area.

- **Inner Corridor**

The study area is divided into districts by arterial roads connecting those districts. The inner corridor shall be established along the road constructed through the middle of each district.

This corridor is designed to accelerate urban development in the study area, not limited to along the arterial roads.

- **Urban Corridor**

Urban corridors under development along the arterial roads encompassing the study area have the development features of a variety of urban facilities such as hotels, condominiums, offices, shops, houses, restaurants, and amusement centers. This development must be carefully accelerated to make the most efficient and effective urban growth corridors.

(3) Advanced Business District Development

Along the inner corridor, an advanced business district shall be developed to

accommodate significant business functions such as international trade, finance, hi-tech industries, and intellectual/information industries such as consultants (law, business, account), software marketing, data base business, mass media, telecommunication, computer industries, marketing, et cetera.

(4) Transport Development

The transportation systems to be developed in the study area consists of three (3) transportation modes of a public transit system represented by the ETA sky train system, a road transport system, and a pedestrian system. (Figure 3.2.29).

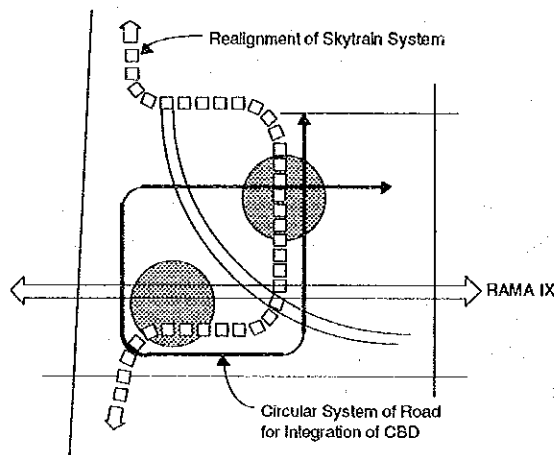
Transport system developments in the study area are of great concern regarding how to determine the unify and integration of the separate districts in order to create one self-contained urban center for the new CBD.

In order to fulfil such purposes, the following measures should be taken.

i. Realignment of skytrain system line

The alignment of the skytrain that was originally designed to run along the Ratchada Pisek Road should be altered to give better access to the planned CBD and to unify the major districts separated by the Rama IX Road and the STR project as shown in Figure 3.2.29.

Figure 3.2.29-Transport Development Pattern



2). Road system

The circular system of arterial roads in the study area is recommended for development to create an independent road system in one CBD district and free the new CBD from the serious road traffic condition of Bangkok.

6.3.2 Strategic Developments

In contrast to the general structure plan aimed at tapping land resources (open land) that stretch

broadly in the study area, strategic developments in specific parts of the study area are examined to maximize the development potential, and provide the most efficient and effective land use.

Three (3) significantly potential areas are identified and shown in **Figure 3.2.30, 3.2.31, 3.2.32 and 3.2.33.**

(1) Urban Axis Development

Open lands with significant potential for urban development in the study area were located in the area along Rama IX Road.

In addition to the purposes described above, this plan tends to seek more efficient and effective land uses in such manners as the CBD's development is strategically focused/concentrated in the area along Rama IX Road.

Accordingly, the area-wise development and a certain width of area along the road, will lead to a creation of an urban axis with highly aggregated urban activities.

Figure 3.2.30- Strategic Development in the Study Area

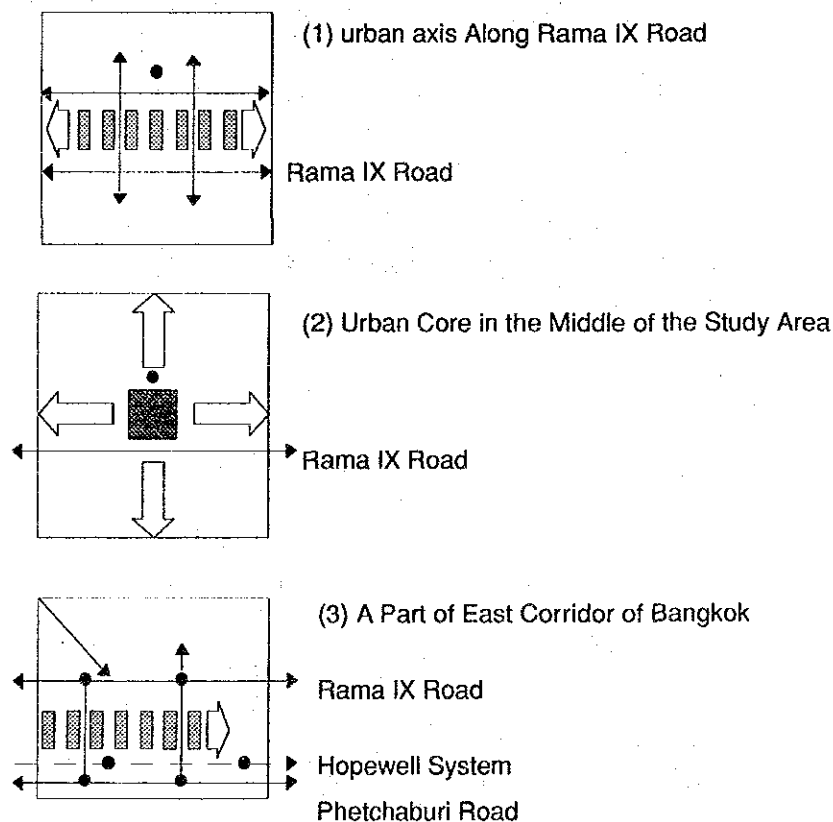


Figure 3.2.31-Urban Axis Development

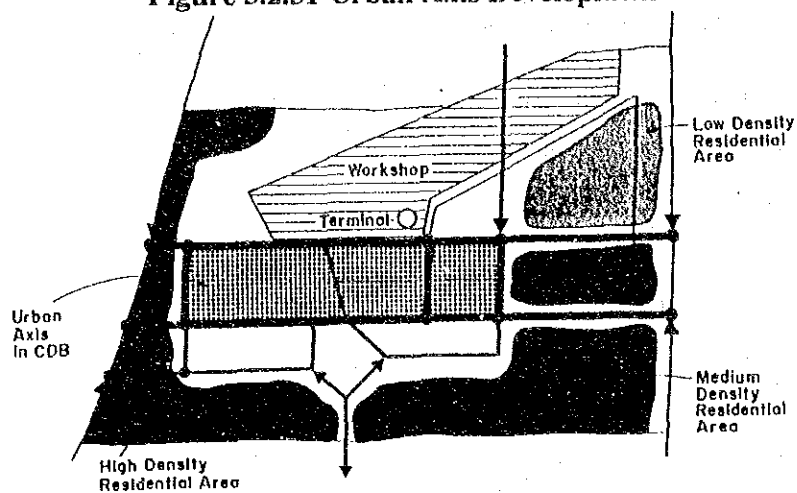


Figure 3.2.32-Urban Core Development

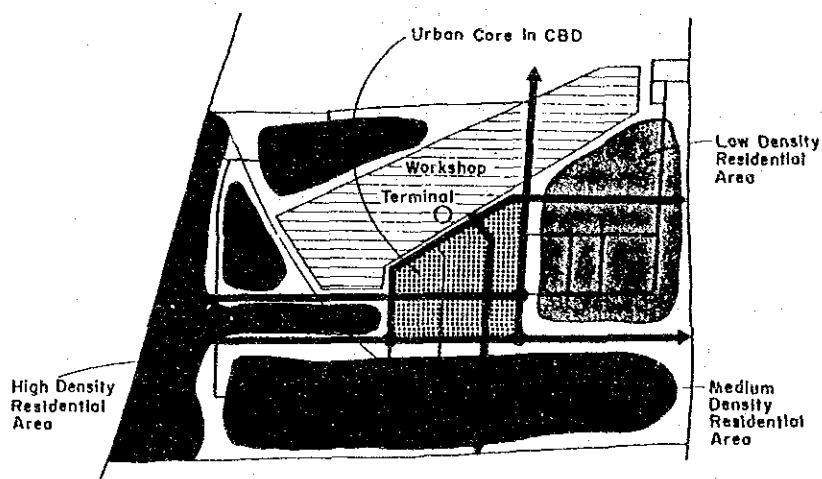
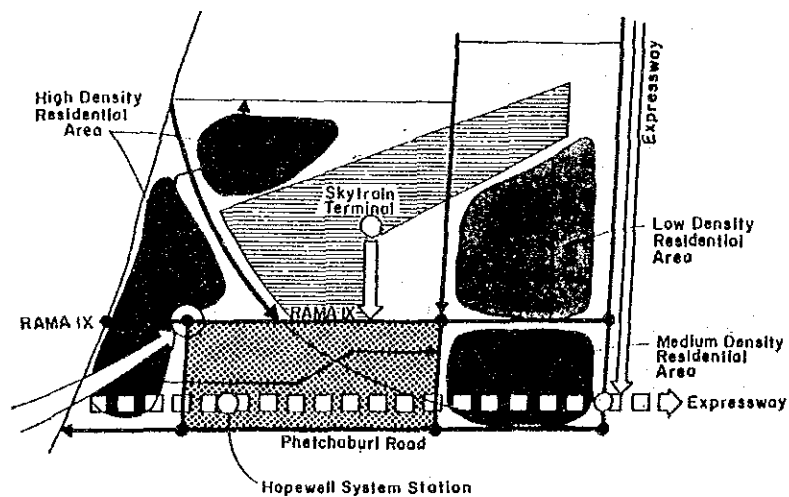


Figure 3.2.33-East Corridor Development



(2) Urban Core Development

This is another way to seek more effective and efficient land uses in the study area.

The area that has a considerable distribution of open lands in the middle of the planning area has great potential for urban development due to locational advantages (such as direct access to the skytrain terminal), if constructed, and access in four (4) directions if roads leading to the arterial road encompassing the planning area are constructed in this project. The CBD development should be strategically focused/ concentrated in the specific areas in such a manner as area-wise urban development in that location creates a very compact/high density urban core.

(3) East Corridor Development

As stated before, the study area is located on the east corridor of Bangkok stretching from the existing CBD toward the east. This corridor is to be reinforced by large scale transport projects such as the Hopewell System and the Second Stage Expressway which will to serve the study area.

In this regard, special attention must be paid to the area between the Petchburi Road and Rama IX Road, that are given direct access to the above-mentioned transportation trunk lines.

Accordingly, it seems reasonable to develop this specific area as a part of the east corridor of Bangkok.

6.4 Concept Plan

6.4.1 Development Framework

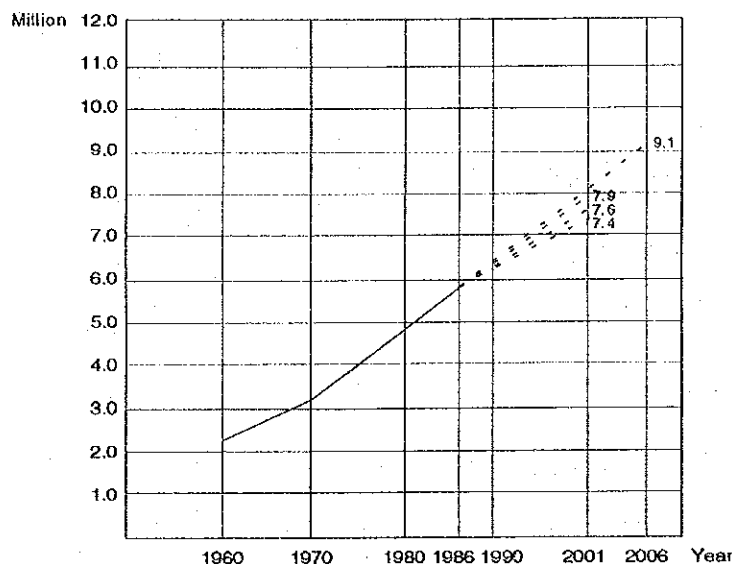
- (1)** The socioeconomic framework of the BMA population projections for the BMA have been documented by different agencies as shown in **Figure 3.2.34**.

The general plan of the BMA now in effect was based on a population of 7.6 million in the year 2001. The plan was formulated based on 1983 socioeconomic data as a bench mark, thus failing to take into account the unexpected rapid growth of Thailand in/around Bangkok.

In this study, the future socioeconomic framework that was projected in the study for the medium to long term improvement/management plan of roads and road transportation in Bangkok (JICA Study), is adopted for this study for the following reasons.

- i) There are not any other projections which take into account the rapid economic growth of the 1980's and 90's in Bangkok.
- ii) The projection was made in consideration of a shift in urban development policy from centralized urban growth to urban growth management by the government.

Figure 3.2.34-Population Projection of BMA



Population Projection

Year 2001	7.4 million	SSES	(Second Stage Expressway System)
	7.6 million	DTCP	(General Plan)
	7.9 million	BMR	(Bangkok Metropolitan Regional Development Proposal)
Year 2006	9.1 million	BMA	(Medium to long term improvement/management plan of road transport)

(1) Socioeconomic framework of the Bangkok Metropolitan Region (BMR)

The socioeconomic framework for the Thai national economy through the year 2006.

- 1) The rapid growth of the national economy, after experiencing a boom in recent years, will gradually subside and the BMR's gross regional product (GRP) will slow. Between the year 2001 and 2006, annual growth will level off at an average rate of 5 percent per year for the country.
- 2) The Sixth Plan period will continue recent high rates of growth. And the growth rate between the present and 1996 will continue at an annual average of 7%, a level comparable to that achieved in 1987.
- 3) Regional development outside the BMR will take time. The success of regional development will, to a great extent, hinge on the successful dispersion of economic activity into local areas; regional growth rates during the Sixth Plan period (1986-1991) will be equal to the average growth rate between 1980 and 1987, and that the growth will rise gradually from this year (1989) through 1996 to achieve an annual growth level of 4 percent. At the start of the 21st century, regional growth will attain a level of 5 percent, comparable to average national growth.
- 4) The BMR will lead the nation's economic growth, maintaining an average

annual growth rate of 11.8percent for the period from the current year to 1996, on the same level as in 1987.

(2) Socioeconomic Projection of the BMA

1) Development Pattern

For the future of the BMR, the following points should be given due consideration from a socioeconomic view point:

- a. The tertiary industry, especially management, finance, government administration, and professional services that are expected to develop along with the internationalization of Thailand and the capital, are likely to be located in the center of Bangkok. Accordingly, the related employment of workers (office workers and white-collar workers) will be concentrated in the CBD.
- b. Of the manufacturing industries, medium- and small-scale enterprises will evolve within Bangkok while the export-oriented industries that are awarded promotional privileges, will be located in the five surrounding provinces and assume a leading role in each province for the development of local economies.
- c. The exploitation of unused land is in no way an easy task because of the minutely, segmented holding rights, lack of accessibility to trunk roads, and various other structural reasons. In addition, many government-owned land lots within the central city or its periphery, will not be readily available for new development.
- d. In comparison to peripheral areas, land prices go up nearer the center of the city. Accordingly, residential development and business locations tend to move away from the center.
- e. Traffic congestion in the central city and its periphery will cause various activities to move away from the center, but at the same time, will somewhat restrict the outward extension of urban belts because of far distances and time-consuming travel between locations and the central city.

In conclusion, the above urbanization trend suggests that the typical urban development for the future of the BMR will be based on the following three patterns.

a. Corridor Development Pattern

Allowing the formation of ribbon-type urban areas, appropriate communication facilities, and other infrastructure will be constructed for more efficient and effective development of the urban corridor.

b. Concentric Pattern

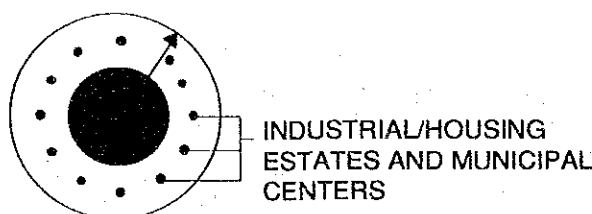
Urban activities will be contained generally within the 30 km. range. In order to build a high-density urban area, this pattern requires effective land-use regulations and the building of an intensive and efficient urban infrastructure.

c. Poly-centric Pattern

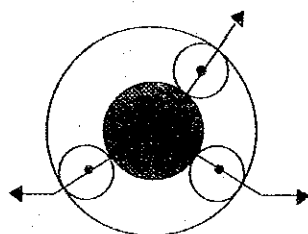
This will organize dispersed development operations into an organic system and construct the infrastructure required to promote the evolution of sub-centers.

Figure 3.2.35-Schematic Urban Development Pattern

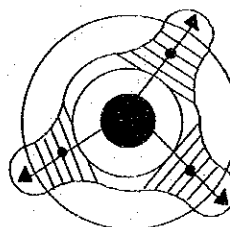
1. Concentric Pattern



2. Poly-centric Pattern



3. Corridor Development Pattern



Source: The Study on Medium to Long Term Improvement Management Plan on Road and Road Transport in Bangkok. Main Report, JICA 1990

2. Projection of Population and Employment

In accordance with the development pattern, population and employment were estimated as follows:

[Population]

Population projections were made based on the following conditions.

- a. The planned population by zone for the year 2001 provided in the general plan for the BMA are utilized as base assumptions.
- b. The population is distributed as heavily as possible in zones located along major trunk roads.

- c. Referring to the general plan for the BMA, a maximum limit of accommodation (or minimum limit for decreasing population zones) is computed for each zone to distribute the population within limits.

[Employment - Tertiary Industry]

The study was made on the location function to explain the current distribution of tertiary industries. Consequently, the following linear expressions were obtained.

$$E_i = 2272.3 \times 1_i + 5132.1 \times 2_i + 13212.5 \times 3_i + 40318.0 \times 4_i + 11937.3 \quad (R = 0.92)$$

where

- E_i : Tertiary industry employment in zone 'i'
 X_{1i} : Tertiary industry locational potential
 (Relative magnitude of surrounding population discounted by distance from zone 'i')
 X_{2i} : Trunk road density (km/km²)
 X_{3i} : Commerce specialization factor (-1 to 2)
 X_{4i} : Special zone dummy variable (e.g., zone "31" having the airport will get 1, and other zones 0.)

The above relationship was applied to the increased portion of employment in tertiary industries to calculate the future value by zone.

The result of the population and employment forecasts are shown in **Table 3.2.8.**

Table 3.2.8-Population and Employment Forecast

	1989	2006	
		Centric	Corridor
Population	5,365,000	9,746,000	9,101,000
Employment of	1,724,000	3,504,000	3,319,000
Tertiary industry			

(3) Bangkok Central Area Population and Employment

In the previously mentioned study, population and employment in the tertiary industries by zone for the years 1989 and 2006 are set forth as shown in **Table 3.2.9.**

The zones shown in the figure represent major business districts in the central area. (**Figure 3.2.36**)

1) Centrality

The centrality of the Zones is derived from indicators such as, differences in the number employed between residences and work place by zone, and the number of

tertiary employment per population by zone.

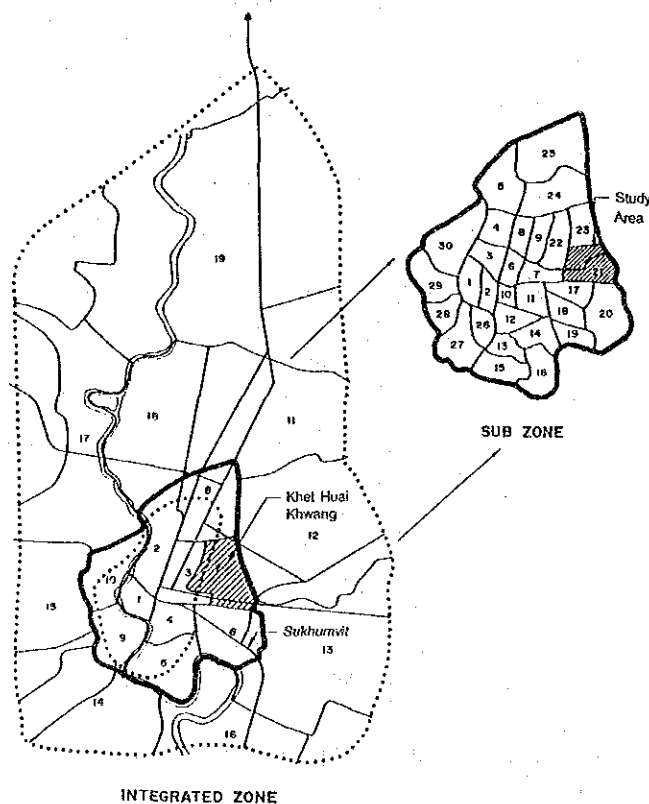
Judging from the indicators in Table 2.6.2, Zone 1 (Phra Nakhon), 4 (Bang Rak), and 6 (Sukhumvit) are identified with high centrality and are followed by Zone 3 and 8.

2) Size of CBD

The size of the CBD is shown in the numbers employed in the of tertiary industries and its share to the total number of Bangkok. It can be roughly estimated that the CBD with a high centrality has a range of 200,000 tertiary employment and more than 10 percent over the total number of the tertiary employment of Bangkok.

During 2006, the size of the CBDs reach over 300,000 of the tertiary employment with some decreasing share of less than 10 percent. This is due to physical limitations and development maturity of the existing CBD. In return, the tertiary industry doubled in the zone adjoining the existing CBD.

Figure 3.2.36-Zones in/around the Central Area of Bangkok



Source: The Study on Medium to Long Term Improvement/Management Plan of Road and Road Transport in Bangkok. Main Report, JICA 1990

Table 3.2.9-Population and Employment of Bangkok Central Area

			1989			2006			Person/ha			Employment/ha			Tertiary employment /Population			Share to BMA of Tertiary employment			
Zone No.	Sub Zone	Area sq. km.	Population	Worker (homebase)	Employment (Marketplace)		Centric Pattern		Corridor Pattern		Population Density		Employment Density		Tertiary employment /Population		Share to BMA of Tertiary employment				
					Total	Tertial	Population	Employment (Tertial)	Population	Employment (Tertial)	1989	2006	1989	2006	1989	2006	1989	2006			
1	1	8.9	322,497	47,392	192,115	282,970	294,910	282,970	287,227	362	318	318	216	331	325	0.599	1.042	1.015	11.1	8.4	8.7
			120,057		115,437	95,729	157,099	95,729	153,985												
2	2	22.2	202,440	81,278	76,678	187,241	137,811	187,241	133,242												
			528,268		115,693	682,244	252,505	554,871	229,954	238	307	250	52	114	104						
3	3	16.7	187,819	73,750	44,714	175,555	84,346	175,555	81,384												
			178,051		45,057	32,307	203,594	76,594	188,094	71,362											
4	4	13.9	162,398	45,753	38,672	303,095	91,566	191,222	71,208												
			399,657		200,551	364,378	320,343	311,390	239	218	218	120	192	186	0.502	0.878	0.854	11.6	9.1	9.4	
5	5	36.8	148,339	43,312	60,635	140,566	113,205	140,566	109,231												
			71,168		28,278	64,658	69,536	85,650	59,536	84,081											
6	6	22.8	90,075	49,293	36,112	77,484	58,288	77,484	58,631												
			90,075		46,188	46,755	39,746	76,792	61,447												
7	7	22.7	345,082	54,511	232,798	297,826	327,711	287,385	319,546	248	212	207	157	236	230	0.675	1.1	1.111	13.5	9.4	9.6
			127,816		56,057	82,973	111,580	80,962													
8	8	32.9	85,211	36,548	68,677	67,660	89,301	67,660	87,759												
			132,055		52,432	108,064	115,596	155,437	108,144	150,825											
9	9	36.8	430,482	54,798	31,892	390,120	119,121	383,203	116,031	117	106	104	22	32	32	0.19	0.305	0.302	4.7	3.4	3.5
			128,297		20,980	110,778	31,077	105,954	29,805												
10	10	22.8	114,438	45,027	28,306	96,361	37,066	93,368	36,641												
			85,573		31,721	19,681	82,806	18,803	82,806	18,289											
11	11	22.8	105,174	40,955	20,669	100,175	32,155	100,175	31,296												
			285,475		138,224	525,311	293,531	633,701	295,344	125	230	280	61	129	130	0.464	0.558	0.452	8	8.4	8.9
12	12	22.7	71,596	21,546	27,649	125,052	95,947	148,787	66,143												
			50,866		30,582	26,997	104,815	56,616	132,608	56,766											
13	13	22.7	58,623	19,152	54,285	39,027	68,874	95,233	67,852												
			106,388		48,509	67,454	210,199	103,094	282,073	104,583											
14	14	22.7	251,239	17,027	55,192	529,114	157,409	397,903	134,218	111	233	175	29	69	59	0.263	0.297	0.237	3.8	4.5	4
			21,474		15,436	76,929	22,499	51,402	15,615												
15	15	32.9	108,656	43,201	46,471	235,446	90,104	138,606	76,209												
			121,109		47,679	15,591	216,739	44,806	207,895	41,403											
16	16	32.9	221,748	37,266	48,306	559,403	208,984	682,345	210,690	67	170	207	30	64	64	0.44	0.373	0.307	5.7	6	6.3
			93,134		50,169	49,356	365,619	116,804	463,044	119,277											
17	17	20.8	522,722	61,110	117,991	640,761	258,005	708,045	255,490	251	309	340	57	124	123	0.225	0.402	0.36	6.8	7.4	7.7
			146,242		36,755	206,767	84,732	234,120	84,693												
18	18	20.8	269,865	125,038	91,464	59,909	247,915	109,285	247,915	105,595											
			106,815		36,513	31,484	185,079	53,988	226,010	65,202											
19	19	23.3	400,156	93,326	102,364	620,266	214,691	473,449	191,308	172	266	203	44	92	82	0.256	0.346	0.404	5.9	6.1	5.8
			251,925		60,181	359,211	123,739	279,926	110,930												
20	20	23.3	148,231	73,895	42,183	281,055	90,952	193,523	80,478												
			5,365		1,724,000	9,746,000	3,503,600	9,101,000	3,314,300												
BMA Total			5,365		2,229,000	1,724,000	9,746,000	3,503,600	9,101,000	3,314,300									100	100	100

(4) Development Framework for the Study Area

Khet Huai Khwang, in which the study area is located, corresponds to Zone 7 in **Table 3.2.9**.

1) Employment in Tertiary Industries and Office Workers in Secondary Industries

According to **Table 3.2.9**, the number employed in the tertiary industries are 66,000 for 1989, and estimated to reach some where in the 130,000 -160,000 range.

The figures are estimated without any development measures. However, it is likely that the new CBD development will increase to the above-estimated numbers of tertiary industrial employment in the Khet Huai Khwang.

It is expected that Khet Huai Khwang will be match the existing CBD Khet with high centrality such as the Sathorn district as a result of the impact of the new CBD development in the study area. Based on the shares of the existing CBD, nine (9) percent of tertiary industry employment in Bangkok is anticipated to accumulate in Khet Huai Khwang, and match the existing CBD. The 9 percent is equivalent to 315,000 persons employed in the tertiary industries.

The number of office workers such as administrative, sales, professional staffs, etc., in the secondary industries in the Bangkok Metropolitan Region were estimated as follow:

The number of office workers in the secondary industries

= total number of employed in the secondary industries of the BMR
(2,164,000*¹, Year 2006)

x ratio of office workers to the total number employed in the secondary industries
(15%)*²

= 324,600

*1 The JICA Study

*2 The result of the 1992 sample survey

Utilizing the same methodology, the estimation of the tertiary industry employment of 32,000 or 10 percent of the projected office workers shall locate in Khet Huai Khwang. Thus, the total number of the employment in the tertiary industry and office workers in the secondary industry amounts to approximately 350,000.

The 350,000 employment is distributed as shown in **Figure 3.2.37**, in the Khet Huai Khwang in such a manner as the density of employment in the tertiary

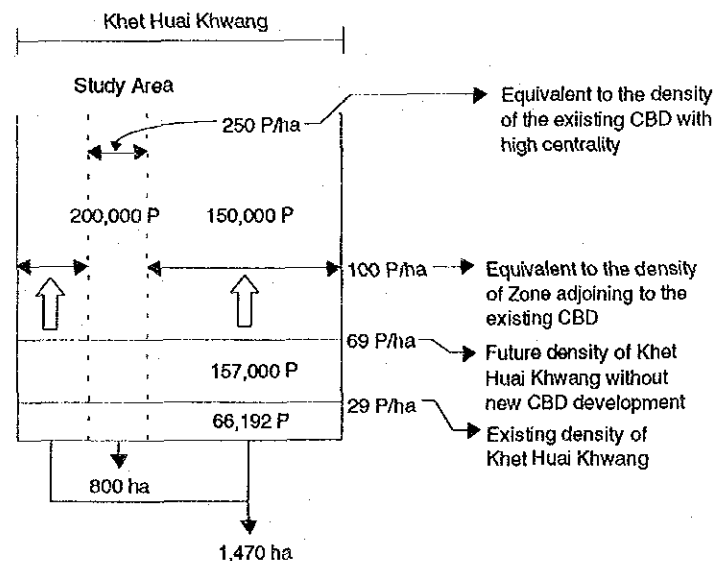
industry of the study area and the rest of the Khet should reach those of the existing CBD with high centrality, that is 250 person/ha, and the zones adjacent to the existing CBD, that is 100 p/ha, respectively.

As such the number of employment in the tertiary industry is set at 200,000 persons.

2) Population

As stated before, the basic development policy is that the study area should be specialized for business activities as one of the CBD's of Bangkok. This implies that there is little room for accommodating housing in the study area. In this study it is recommended that the study area accept the number of population at about 90,000, resulting in the population density equal to the present average population density of Khet Huai Khwang (111 person/ha).

Figure 3.2.37-Growth of Density of Employment in Tertiary Industry in Khet Huai Khang



Source: JICA Study's Estimation

3) Target Year

The target year is set at 2011 because the development framework set above will be materialized in about 20 years.

6.4.2 Concept Plan

(1) Urban Space Structure

The urban structure is worked out in such a manner that strategic developments studied in Chapter 6.3.2 are adjusted and incorporated into the general structure plan set up in Chapter 6.3.1.

Figure 3.2.38-Integration of Strategic Development

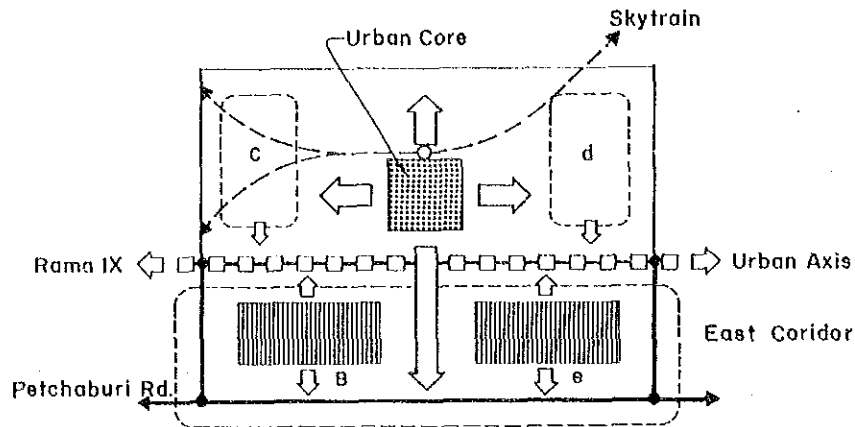
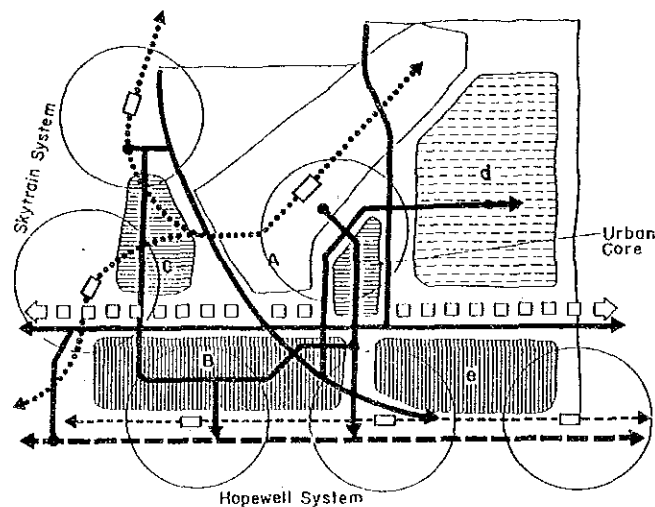


Figure 3.2.39-Urban Space Structure



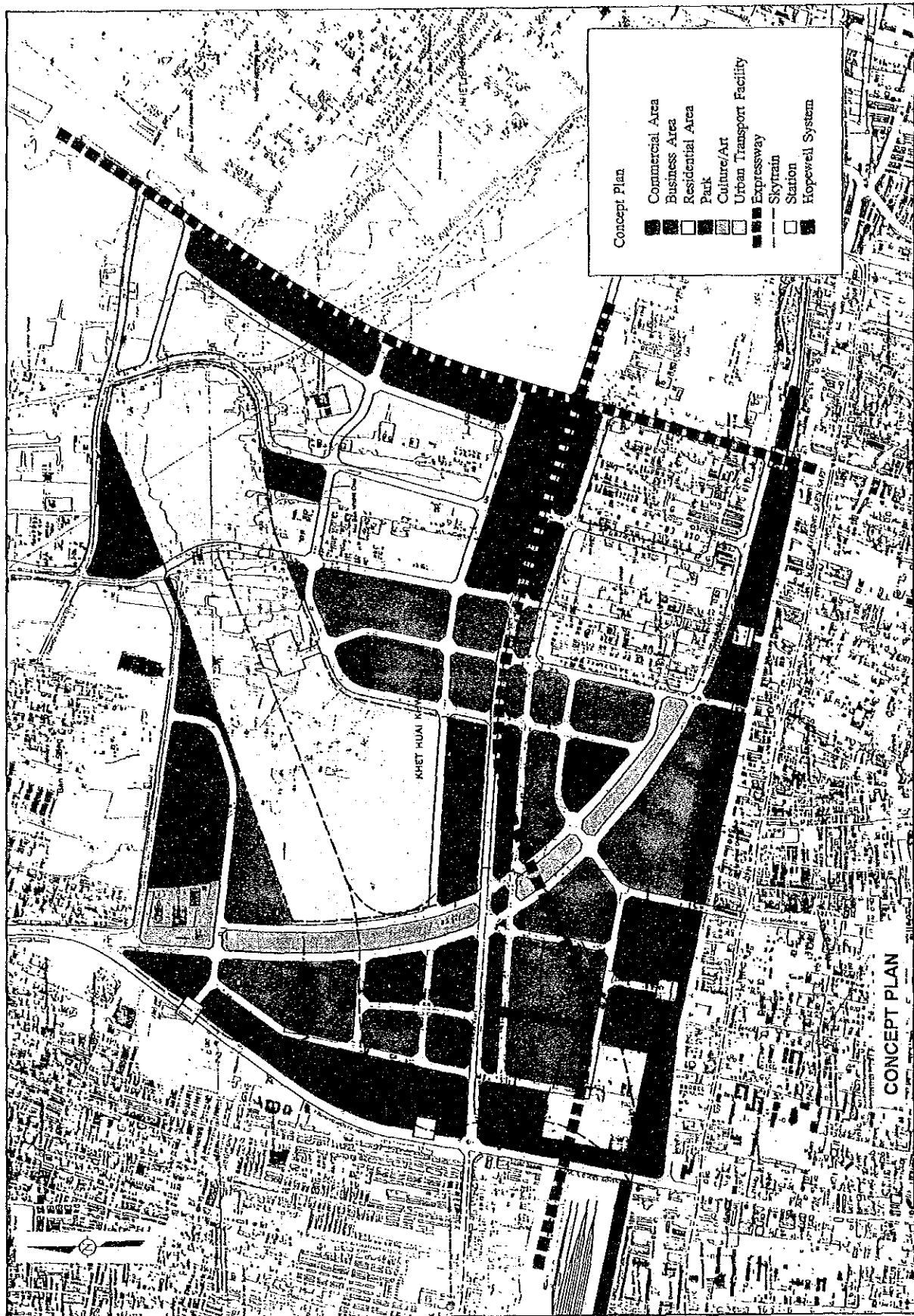
In other words, the structure of urban space is to integrate the major strategic developments - urban axis on the Rama IX, and the urban core in the middle of the study area and east corridor between Petchburi road and Rama IX road as shown in the **Figure 3.2.38**.

Based on the integration of strategic developments as shown above in the framework of general structure plan, the urban structure is set up as follows in **Figure 3.2.39**.

1. Basically, the study area is divided into six districts from A to E as shown in the figure.
2. The districts of A, B, and C form one unified central business district.

District A	:	CBD development in conjunction with skytrain terminal station
District B	:	CBD development as a part of east growth corridor
District C	:	CBD development in conjunction with skytrain stations

Figure 3.2.40-Concept Plan



3. District D and E shall be designated as residential areas that will house office workers of the CBD as developed above.

Urban development and building construction have already started in these district, featuring multiland use such as housing, hospital, offices, condominium, hotels, et cetera.

Accordingly, mixed land use may emerge with residential use becoming prominent.

(2) Land Use Plan

In line with the structure of urban space, the land use plan is mapped out as shown in **Figure 3.2.40**, and considers the following points.

- 1) Due to the significant potential of a multi-functional development including commercial, entertainment facilities, restaurant, offices and hotels, along the arterial roads and urban axis, a commercial area with business offices is designated in this location.
- 2) The areas close to the skytrain stations and the hopewell system are also designated as a commercial area, given the high commercial development potentials in those areas.
- 3) Office business areas are exclusively designated in the districts of A, B, and C.

An urban core area in district A and the area south of Rama IX in district B, are planned for high rise business districts. District A, B, and C are to be unified as a one CBD.

- 4) Construction of dwellings and other structures in district D and E has begun in the form of a soi development as observed in the Bangkok area.

With residential uses such as housing and condominiums, multi-land uses seems to be emerging, represented by the locations of hospital, offices, commercial facilities, schools, etc., along the sois in the districts.

However, in principle, most areas in the districts should be designated as residential to accommodate office workers (white color) of the new CBD developed in the study area.

Consequently, land use area and distribution of the population and employment in the tertiary industry are summarized in **Table 3.2.10**.

Table 3.2.10-Summary of Land Use Area and Distribution of Employment

Land Use Area		Employment in Tertiary Industry	Population	Assumptions		
The Study Area	800 ha	200,000	105,000	Family Size 5 Person x 3,000 families		
Workshop Area	162 ha		15,000			
Development Area	638 ha	100,000		Rate of Usable Land	Floor Area Per Person	Total Floor Area/Land Area
1. Project Area	100 ha			50%	40 m ² /p	800%
Business Office	100 ha (net 50 ha)					
2. The Other Area	538 ha	69,000		60%	30 m ² /p	155%
Commercial and Offices	223 ha (net 134 ha)					
Business Office	83 ha (net 50 ha)	31,000		60%	40 m ² /p	250%
Residential	231 ha (net 139 ha)		90,000	60%	30 m ² /p	200%

(3) Transportation Plan

1) Road System

Basically, the road system in the study area is organized by a grid pattern consisting of the arterial roads encompassing the area.

- Rama IX road is a main access road and is also a direct access road from Petchaburi Road to the urban core; Rama IX Road should be constructed to serve the concentrated traffic on the new CBD. This is important to increase the development potential for the CBD.
- Other important roads within the study area connect the development focus and district. These major roads serve traffic flow in the area with a view to:
 - i. constituting a road network by connecting dead-end sois in the area;
 - ii. opening up untapped lands without access roads; and
 - iii. supplementing arterial roads such as Rama X by keeping the traffic within the area off such arterial roads.

A hierarchical road network comprises the following roads.

- | | | | |
|----|--------------------------|--------------|----------|
| 1. | Expressway | | |
| 2. | Arterial road | 6 or 8 lanes | 25~30 m. |
| 3. | Major road | 4 lanes | 20 m. |
| 4. | Minor street distributor | 4 lanes | 16 m. |
| 5. | Access road | 2 lanes | 12 m. |
| 6. | Soi | 2 lanes | 5~10 m. |

2) Mass Transit (Public Transport) System

As stated before, mass transit systems such as the Skytrain and the Hopewell system are planned to be constructed in/around the study area.

It is apparent that coordination between those systems and a transportation system in the study area should be made especially in the following field.

- a. Location of Station
- b. Terminal facility and access transportation mode and network

(4) Public Utility

1) Drainage

During of rapid urbanization, many paddy fields were reclaimed and converted into residential areas. This results in an increase of the run-off discharge due to decreases in the rain water retention function. In addition, land subsidence caused by ground water draw results in longer times of inundation during the flood season in Bangkok.

The DDS (Department of Drainage and Sewerage) of the BMA, administrates the flood protection/drainage system in Bangkok. The major flood protection measures taken by the DDS are as follows:

- a. To improve khlongs
- b. To upgrade the capacity of downstream drain pump
- c. To keep the rain water retention areas

At present, there are no laws and regulations regarding restrictions to reclamation, nor provisions for a flood regulating pond upon land development. While, the DDS requires a developer to secure as much as 5 percent of the developed land upon land development as a retention area, the DDS does not have the legal authority to force a developer to do so.

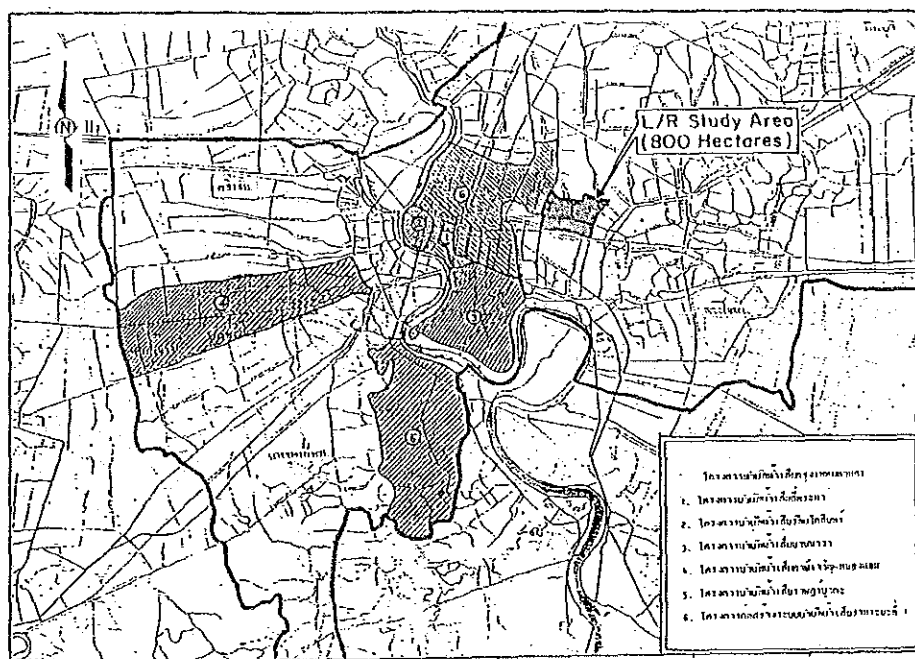
There are 10.6 km long khlongs in the study area. At the east side of the study area along khlong Lat Phrao, an aeration pond for canal water treatment was constructed in 1991. Those low ground flood-prone areas shall be developed as artificial flood regulating ponds with large retention functions, and will be utilized as an urban park by the citizens.

Other unused land in the study area shall be converted for commercial and housing land use by landfills of 0.5 to 1.5 m. As counter-measures against the decrease of the rain water retention capacities due to such landfilling, the following measures are planned:

1. To improve the rain water retention of khlongs
2. To allocate open space along improved khlongs for reinforcing rain water retention that will also be utilized as pedestrian walkways, a park and a green belt as shown in **Figure 3.2.41**.

This study area shall be developed in harmony with the water reservoirs as a place for relaxation and amenities for urban residents, and as much as 5 percent of the land shall be secured as khlong and rain water retention areas for flood protection.

3.2.41-BMA's Sewerage Project



Project	Area(km ²)	Population (x 10 ³)	Wastewater (m ³ /d)	Situation	Project Cost	Finance
① Si Phraya	2.7	120	30,000	WTP: Under Construction (91-93) CS: D/D Finish	450 MB	BMA
② Rattanakosin	4.1	70	40,000	D/D Finish Construction 1992-94	860 MB	Government
③ Yanawa	28.5	485	195,000	D/D 1991-92 Construction 1993-95	2,900 MB	BMA
④ Nong Khaem	42.0	310	106,000	D/D 1991-93 Construction 1993-95	850 MB	BMA
⑤ Lard Burana	41.0	170	60,000	D/D 1991-93 Construction 1993-95	650 MB	BMA
⑥ Lumpini Huay Khwant (Phase 1)	37.0	800	350,000 (2 sites)	Bidding (Turn Key) D/D, Const 1993-93	7,500 MB	Government 25 % BMA 25%
Total	155.3	1,955	776,000 (7 sites)		131,500 MB	

Feb. 1992

WTP : Wastewater Treatment Plant
MB : Million Bahts

D/D : Detailed Design
CS : Collection System

2) Sewerage

The study area is located outside of the BMA's on-going sewerage project. Figure 3.2.41 shows the BMA's sewerage project.

Tables 3.2.11 and 3.2.12 show the standard for discharged water quality regulated by the PWD (Public Works Department) of the MOI. Rank A in Table 2.6.4 shall be applied to the study area in terms of its large-scale development. Rank A requires sewerage treatment facilities with a biological treatment process for satisfying standards.

Figure 3.2.42- Concept of Khlong and Retention System

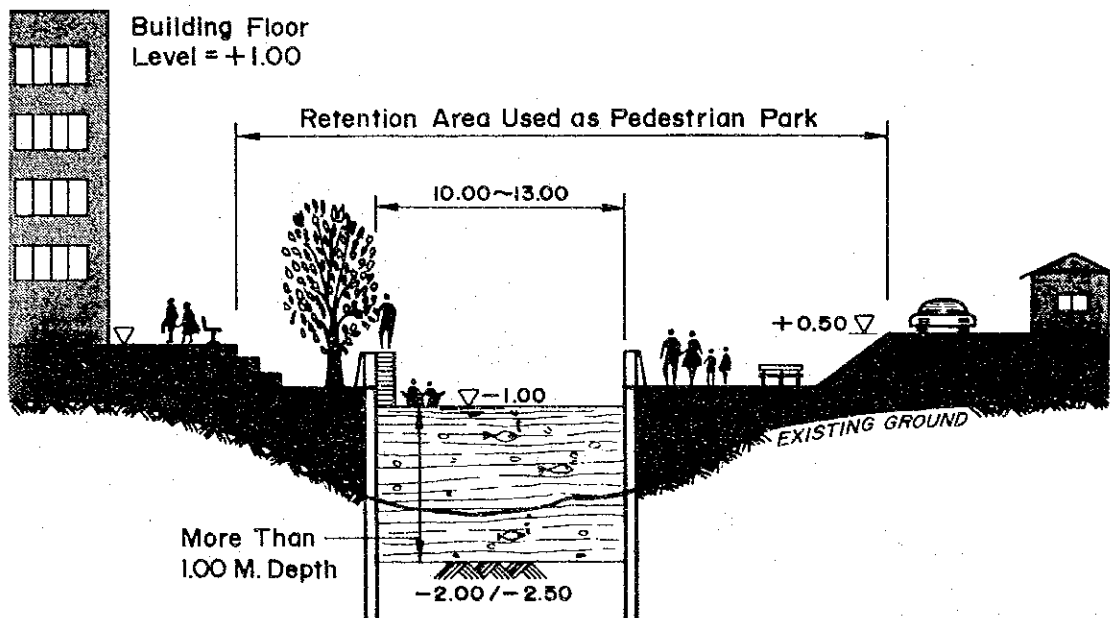


Table 3.2.11-Standard for Discharged Water Quality from Houses

Item	Unit	Rank (Persons)			
		A >2500	B 501-2500	C 101-500	D -100
BOD	mg/l	20	30	60	90
SS	mg/l	30	40	50	60
Set-SS	mg/l	0.5	0.5	0.5	0.5
TDS	mg/l	500	500	500	500
Sulfide	mg/l	1.0	1.0	3.0	4.0
Residual Chlorine	mg/l	0.3	0.3	-	-
TKN	mg/l	-	-	40	40
Org-N	mg/l	10	10	15	15
NH-N	mg/l	-	-	25	25
NO-N	mg/l	-	-	-	-
pH	-	5-9	5-9	5-9	5-9
Oil-Grease	mg/l	20	20	20	20
Colon bacillus	MPN/100 ml	-	-	-	-
Phosphoric acid	mg/dm ³	-	-	-	-

Table 3.2.12-Standard for Discharged Water Quality from Buildings

Type of Building	Scale	Applied Rank	Remark
1. Government office, State company, bank and office building	2,000-10,000 m ²	C	business space only
	10,000-50,000 m ²	B	
	>55,000 m ²	A	
2. Condominium	<100 house	C	
	100-500 house	B	
	>500 house	A	
3. Hotel	60-200 room	B	
	>200 room	A	
4. Hospital	10-30 bed	B	
	>30 bed	A	
5. Massage parlor	>5,000 m ²	B	
6. Supermarket	500-1,000 m ²	D	
	1,001-1,500 m ²	C	
	1501-2,500 m ²	B	
	>2,500 m ²	A	
7. Residential estate	<20 house	D	
	20-100 house	C	
	101-500 house	B	
	>500 house	A	
8. Restaurant	50-100 m ²	D	kitchen space only
	101-500 m ²	C	
	501-2,500 m ²	B	
	>2,500 m ²	A	
9. Department store	5,000-25,000 m ²	B	
	>25,000 m ²	A	
10. School, university, college and research institute	5,000-25,000 m ²	B	
	>25,000 m ²	A	
11. Dormitory	10-50 room	D	
	51-250 room	C	
	>250 room	B	
12. Fishing port	>300 m ²	B	excludes loading, unloading and assorting space

For completion of the total development of the study area, many different development bodies will take part in the total development of the study area and a long development term is expected. For example, because the BMA is not concerned with the development of public sewerage systems within the study area, private enterprises must take the difficult responsibility of developing an integrated sewerage system that covers multiple development areas and manage sewerage disposal in terms of finance and development time schedules.

In this circumstance, each development body shall provide a sewerage system, pipes, and sewerage treatment facilities, district by district in accordance with the development body's development schedule. This system will be turned over to the BMA, becoming integrated into the BMA's sewerage system. The later stages of the study area's development may be covered by the BMA's public sewerage system, if the BMA continues the sewerage project for Bangkok City without interruption.

The MWA's served demand will meet the water demand of the developed study area after the year 2007. However, if the development schedule of the study area is far ahead of the MWA's Master Plan, or many skyscrapers which consume large amounts of water are constructed in the business district, a recycling system for the treated water shall be considered within the business district.

3) Water Supply

Figure 3.2.43 shows the MWA's existing and planned water transmission and major distribution pipelines in the study area. In the study area, the MWA's water distribution pipelines are completed, and it is easy to obtain piped water for new houses and buildings.

In accordance with the MWA's Master Plan formulated in 1990, the water demand of the study area(800 ha) is forecast as follows.

Table 3.2.13-Water Demand in the Study Area

Year	Urbanization (%)	Population (prs.)	Served demand (l/sec)
1997	53	66000	247
2007	79	70000	411
2017	98	71000	541

While, the specific water demand parameters assumed by the MWA in the Master plan are as follows.

Table 3.2.14-Water Demand by MWA Master Plan

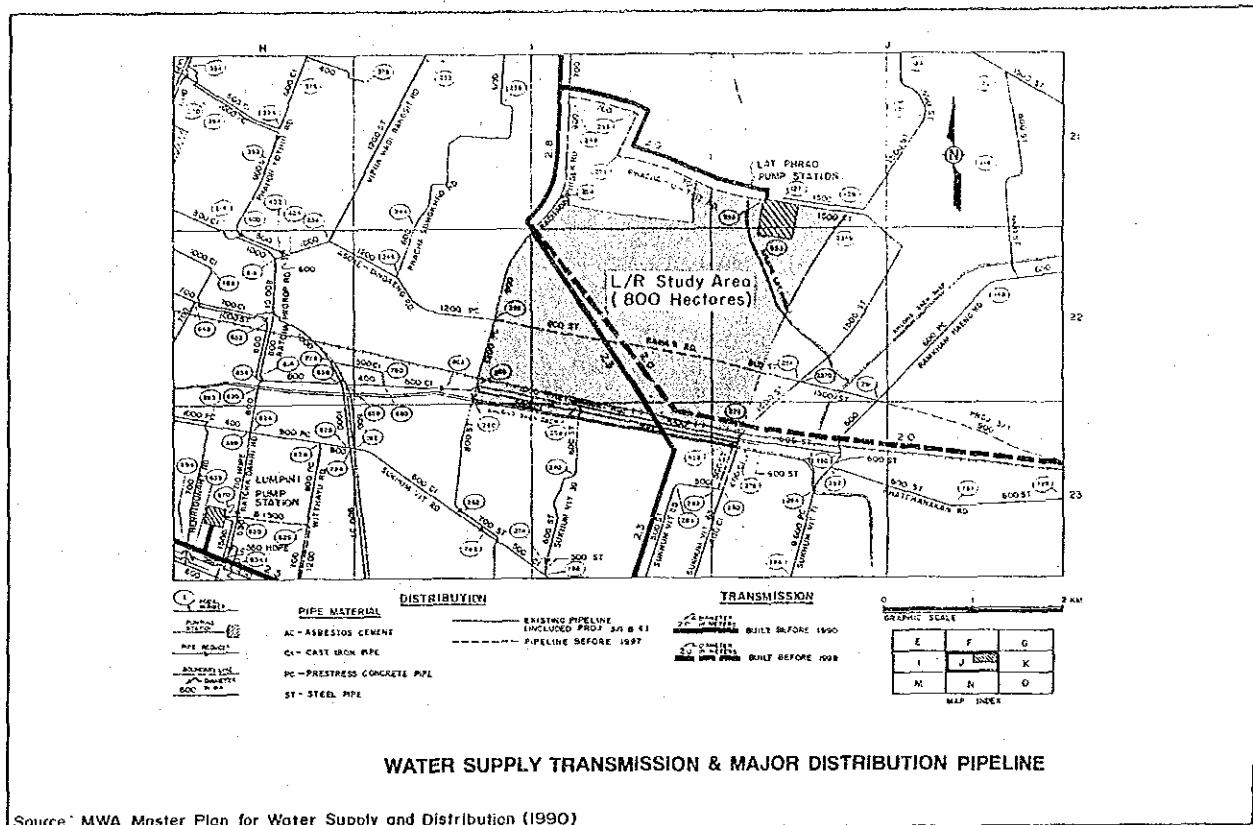
	Year		
	1997	2007	2017
- Residential (m ³ /inhabitant/day)	0.20	0.21	0.22
- Government (m ³ /ha/day)	60	63	65
- Commercial(m ³ /ha/day)	90	100	100
- Industrial(m ³ /ha/day)	40	50	55

In accordance with the above parameters, the planned land use and number of inhabitants, the total water demand of the developed study area is estimated below.

Table 3.2.15-A Total Water Demand

	Land use and population	Water demand (l/s)
Concept Plan	- Residential:90,000 prs	
	- Government/Business:167 ha	450
	- Commercial:67 ha	
	- Workshop:15,000 prs	

Figure 3.2.43-Water Supply Transmission & Major Distribution Pipeline



4) Electricity and Tele Communication Services

Electricity and tele communication services shall be provided by the MEA and the TOT, respectively for the study area development.

5) Garbage Collection Service

Garbage collection services for the study area development are the responsibility of the BMA.

(5) Public Urban Facility

The following urban facilities will be incorporated into the Master Plan of the New CBD.

• Educational Center

Educational centers such as international schools, research laboratories, and kindergartens are considered to be necessary to meet the education needs of Thai Nationals' and other Nationalities' children. This infrastructure would attract more investors to the new CBD.

- **Hospital**

A well equipped hospital or medical center is an important infrastructure that attracts investors and residents to a new CBD. This type of infrastructure should be proposed into the development of the new CBD.

- **Business Complex**

The New CBD is expected to be operated by the private sector. For this reason, a business complex is necessary to attract investors that could gain profits from this investment. The business complex may consist of department stores, supermarkets, and other related facilities, including accommodations.

- **Housing Complex**

In order to minimize commuting time/cost of people who will work in the New CBD, a residential complex should be planned. This complex should consist of high-rise buildings for the purpose of living and/or commercial use.

Within the New CBD, safe, healthy, and pleasant residential environments in which people can live comfortably will be created.

- **Sports Center**

Sports activities are considered important for the relieving of stress and maintaining good health. The New CBD will be equipped with modern facilities for day-to-day leisure and sports activities.

- **Other Facilities**

In this context, other urban facilities include

- communication facilities;
- disaster and fire control facilities;
- government and public office facilities;
- public markets;
- water, electric, gas, sewerage, and other utilities;
- roads, urban transit, parking, transport facilities;
- rivers, canals, and other waterways; and
- parks, green areas, and other public spaces.

6.4.3 Selection of Planning Area

300 ha of planning area as shown in the **Figure 3.2.44** is earmark excluding the following areas where urban development/improvement method/systems other than an L/R system are applied.

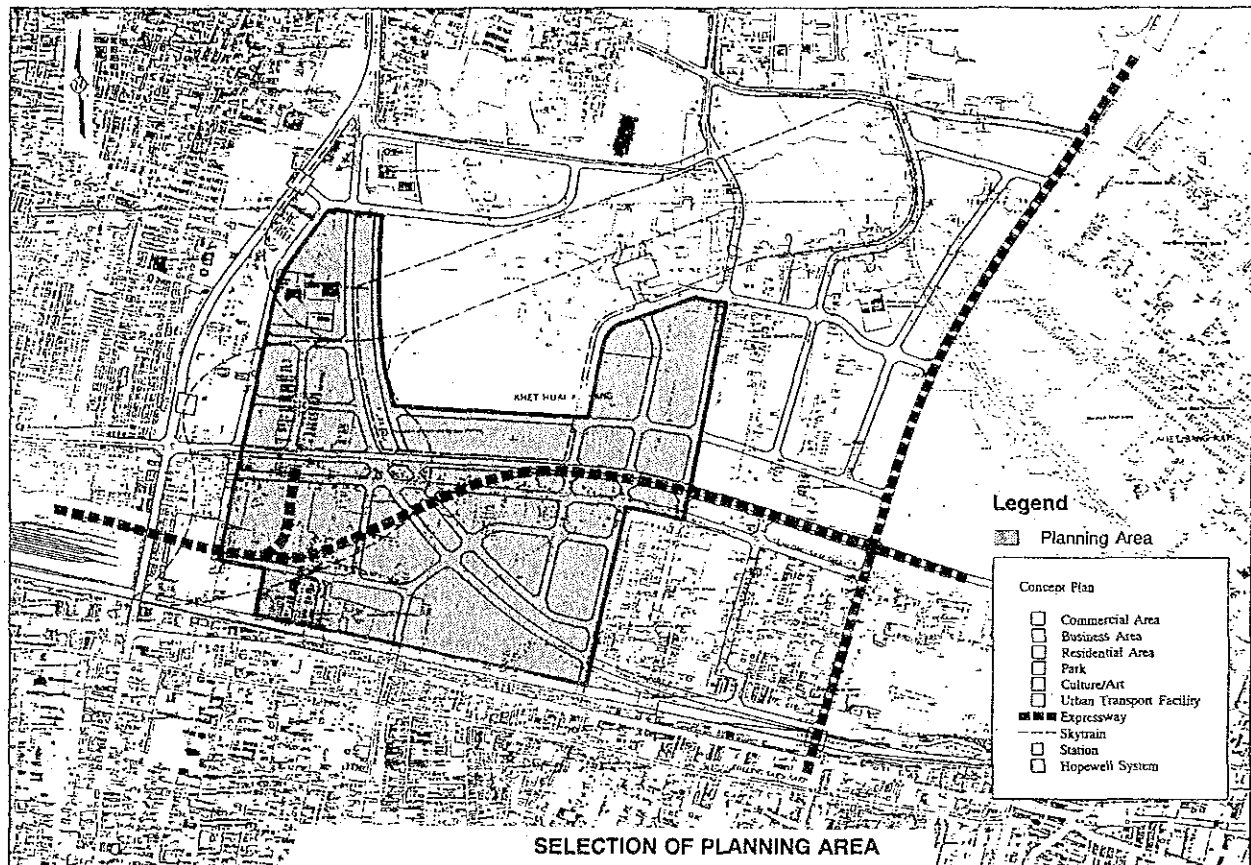
1. Districts of D and E
2. Area along Ratchada Pisek Road

The above listed areas have already been built up to some extent, so that an L/R application seems to be difficult, if not impossible.

Urban development methods, such as the redevelopment or the rehabilitation method, shall be examined in those areas.

The planning area of 300 ha designated is to cover the key development of the new CBD.

Figure 3.2.44-Selection of Planning Area



Part III.
Land Readjustment Project Planning

Volume III.
General L/R Master Plan Study

Volume III: General Land Readjustment Master Plan Study

1. Introduction

In the preceding study, the General Concept Planning Area was designated as the area where urban development should be executed through the application of an L/R system.

Following the general concept plan the General L/R Master Plan is formulated in this volume.

Targeted outputs are;

1. L/R Design
2. L/R Project Analysis
3. Selection of Project Area

It is defined that public facilities and sites are to be planned and designed based on the rules and principles of the L/R system. Their standards of improvement are determined through the L/R Designing.

The L/R project analysis aims at the feasibility of the project through the calculation of lands contribution for providing lands for public facilities and for financing the project.

Finally, the priority project and area covering approximate 100 ha were selected.

In the L/R urban development there are two (2) conflicting interests.

1. To achieve as high a standard of public facilities and environment as possible from the view points of city planning.
2. To lower the project cost as much as possible, which the community must bear under the system of land contribution.

Consequently a major concern in the study is how to balance the two conflicting interests.

2. General Land Readjustment Design

2.1 Existing Conditions of Planning Area

The planning area covers an area of 300 ha. The area includes a grass land to be planned for the workshop of the Skytrain. Therefore, most surveys were conducted in the area as shown in **Figure 3.3.1**. The following sub-sections discuss briefly the existing conditions of the planning area, based on the results of the second site survey.

2.1.1 Social Characteristics

(1) Population and Households

Based on the second site survey, the total number of residential buildings is 857 units, including shop houses (**Table 3.3.1**). Applying an average household size of 5, population was calculated

to be 4,285 inhabitants in 1992, an average of 1,785 inhabitants per km². Population is living mainly in the planning sub-area (zone) 4, followed by sub-areas 1, 3 and 2.

Figure 3.3.1-Planning Area

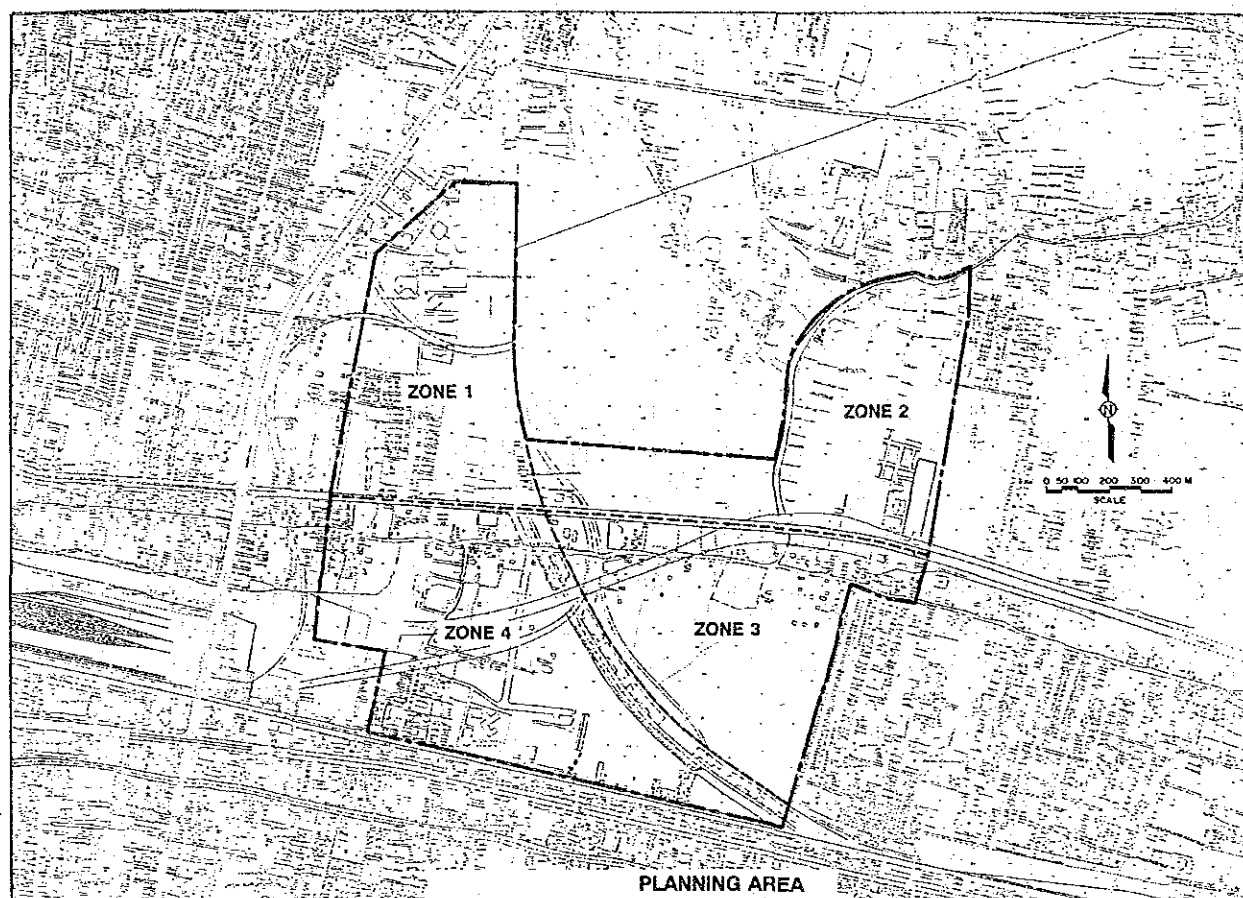


Table 3.3.1-Existing Population and Households

Sub-Area	Number of Population and Households		
	Number of		
	Residential buildings	Household size	Population
1	220	5	1100
2	27	5	135
3	95	5	475
4	515	5	2757
Total	857		4285

(2) Locations and Names of Major Establishments

Major establishments located in the planning area include TV Channels 9 and 11, Government Housing Bank, Rama 9 Hospital, Piyavet Hospital, business centers, Uthai Tharam Temple,

etc., as shown in Figure 3.3.2. Most major establishments are located in the planning sub-area 1.

(3) Current Land Price

Two categories of land price were investigated:

- official land price; and
- market land price

The market land price was found to be approximately 1.6 to 2.1 times the official land price as shown below.

Table 3.3.2-Official Land Price in the Planning Area

Road/Soi/Area	Samples of Land Price	
	Official Price (Baht/sq.wa)	Market Price (Baht/sq.wa)
Rama 9	150,000	280,000-320,000
Soi Thaveemit	120,000	200,000-220,000
New Phetchburi	170,000	310,000
Soi U-Thai Tharam Temple		170,000-200,000
Rama 9 Hospital		210,000

(4) Land Owners and Land Transaction

Land owners and land transactions within the planning area were obtained from Huai Khwang Land Office. The number of land zones and that of land lots are 34, and 2,198, respectively. Approximately 80% of land owners live outside the planning area. The largest plot of land owned by a land owner is approximately 50 rai, while the smallest is approximately 2 sq.wa.

This survey includes the following information:

- Zone/Block and Lot numbers;
- Land use;
- Area;
- Name of land owner;
- Address of land owner;
- Transaction price; and
- Date of land transaction.

The aforementioned information is useful for interviewing the land owners on opinions relating to land readjustment.

2.1.2 Physical Characteristics

(1) Geographic Characteristics

The most updated topographic data within the planning area were surveyed. These include additional roads, soils, buildings, and other geographic information. Major roads includes Rama IX, New Phetchburi. The geographic characteristics of the planning area are depicted in Figure 2.1.2. This map also presents the right-of-way of the ETA Mass Rapid Transit (MRT) and of the Second Stage Expressway System (SES). The Royal City Avenue Project forms a part of the planning area. Other geographic information includes Khlong Sam Sen Nai, Khlong Yommarat and the Eastern Railway. In addition, the ground elevations of the planning were investigated.

(2) Existing Land Use by Classification of Land Category

Land ownership is classified into the following three categories. **(Figure 3.3.3)**

- Public Owned Land for Public Facilities such as roads, rivers and open space.
- Public Owned Land not for Public Facilities such as temples, land belonging to the Bangkok Metropolitan Administration (BMA), the State Railway of Thailand (SRT), royal property office, and other public land.
- Private Owned Land for Private and Public Uses such as private roads, other private land, and private open space.

The area of each aforementioned land category was calculated as shown in **Table 3.3.3**. Land ownership under the category of the unused land occupies the largest amount (47%), followed by residence (12%), and government institution (6%). It should be noted that there is presently no park in the planning area. Arterial roads occupy only 2.2%, whereas the right-of-ways of the SES and MRT form about 8% of the planning area. The Royal City Avenue Project amounts to 5 per cent. Canals, an important public utility, account for 2 per cent.

(3) Classification of Buildings by Use and Construction Type

Building uses are classified into:

- residence;
- education;
- government;
- shop house;
- commerce such as hotels, department stores, etc.;
- hospital;
- factory; and
- religion.

Figure 3.3.2-Major Establishments

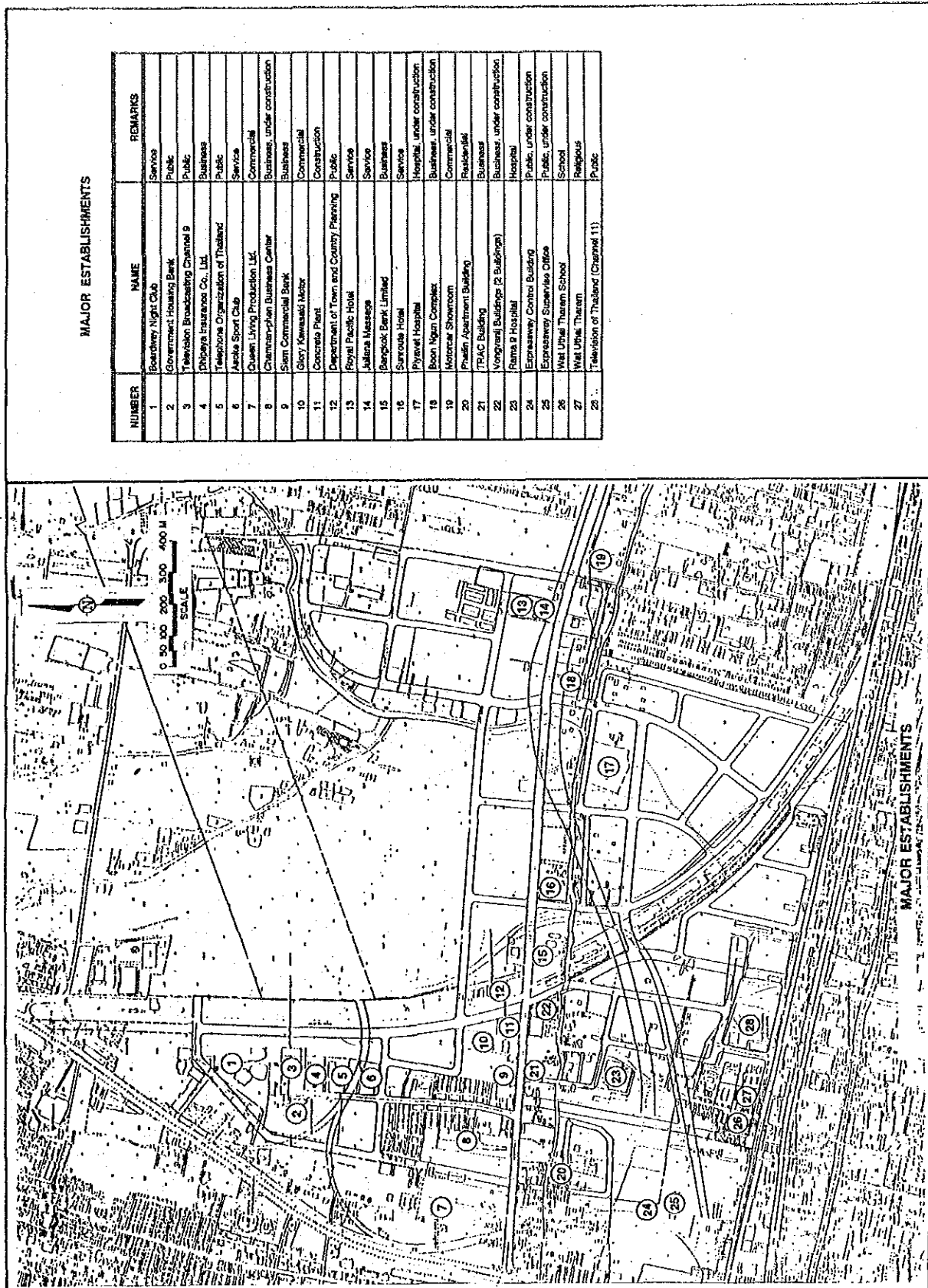


Figure 3.3.3-Land Ownership

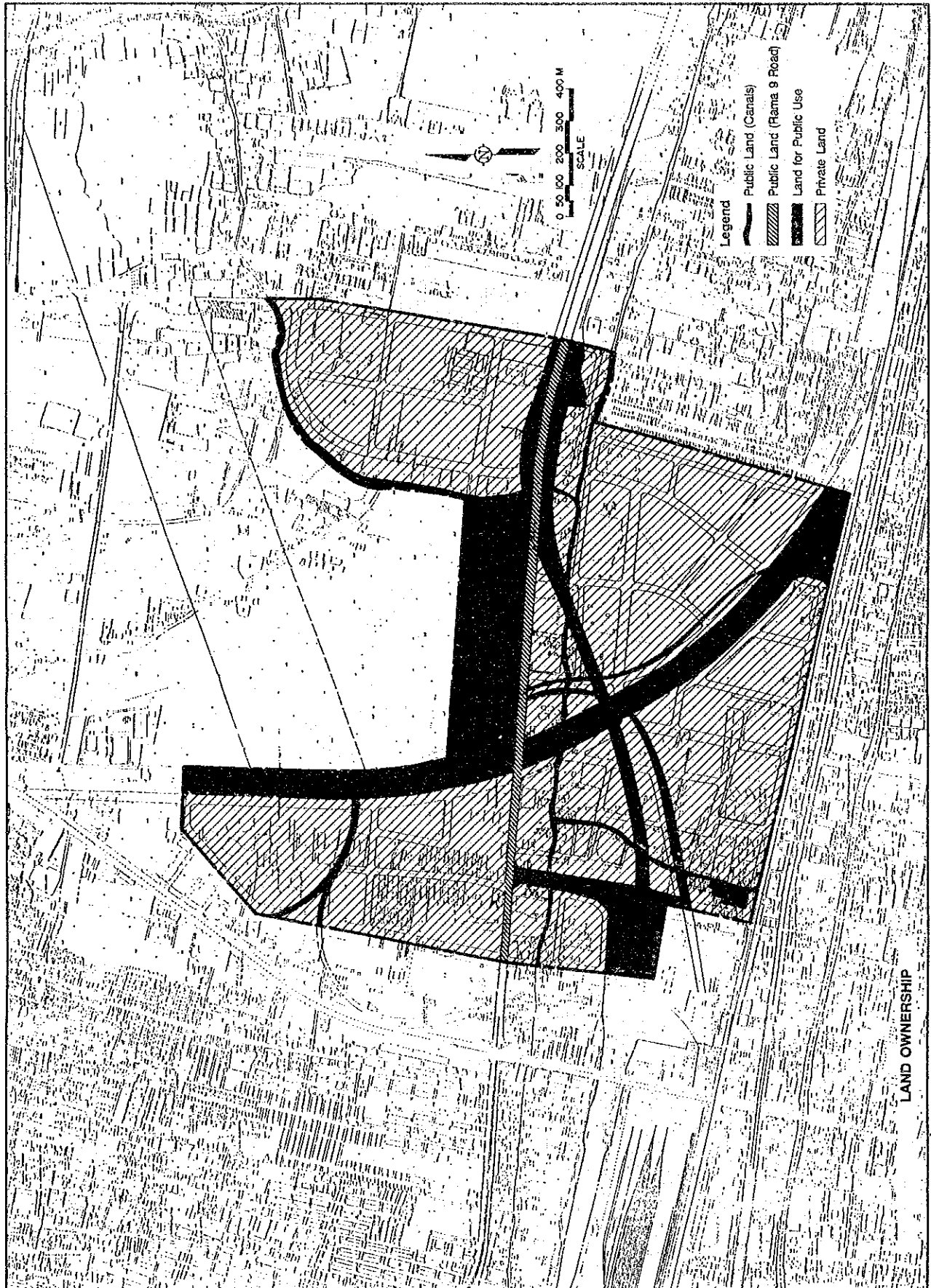


Table 3.3.3-Existing Land Use

	Category	Area (sqm)	Ratio
Public Land	Arterial Road	53,000	2.2%
	Major Road	0	0.0%
	Minor Road	0	0.0%
	Sub Total	53,000	2.2%
	Canal	48,000	2.0%
	Retention Area	0	0.0%
	Park	0	0.0%
	Sub Total	48,000	2.0%
	Total	101,000	4.1%
Land for Public Use	Express Way	144,200	5.9%
	Skytrain Workshop	143,600	5.9%
	Skytrain (MRT)	48,200	2.0%
	Royal City Avenue	115,900	4.7%
	SRT (Government)	92,900	3.8%
	School	7,000	0.3%
	Total	551,800	22.6%
Private Land	Residential	288,000	11.8%
	Commercial	130,000	5.3%
	Private Road	41,000	1.7%
	Government	148,000	6.1%
	Wat	23,000	0.9%
	Agriculture	10,000	0.4%
	Unused Land	1,152,200	47.1%
	Total	1,792,200	73.3%
	Grand Total	2,445,000	100.0%

Construction Types are:

- reinforced concrete;
- wood; and
- mix of reinforced concrete and wood.

Moreover, the following data of each building were indicated:

- number of floors; and
- whether it exists or under-construction.

Table 3.3.4 shows the number of buildings classified by building use and material used. Most buildings are located in the planning sub-area 4. The number of buildings by material used is 221, 332, and 76 for RC, wood and RC+wood, respectively.

Residential buildings account for the highest number, followed by commercial buildings. Religious buildings are located only in the planning sub-area 4. These buildings belong to Uthai Tharam Temple. Government buildings, commercial buildings, and shop houses are mainly located in sub-area 1.

2.2 Development Framework and Land Use Plan

2.2.1 Time Framework of Planning

Time framework of planning is set at three stages of 20 and more years for the Concept Plan, 10 years for the Master Plan, and five years for the Implementation Plan in the sequent courses of the study as follows. (Figure 3.3.4)

- 1) Concept plan of 800 ha area, proposed in the Progress Report represents the development concepts and goals of a new urban center which Bangkok as an international capital should have in 20 or more years.
- 2) Land Readjustment Master Plan of 300 ha area is defined as a physical development plan providing, in the medium term of 10 years, for the urban growth presented in the development concept and goals in the concept plan formulated above.
- 3) Implementation plan/program covering about 100 ha area is a short term plan to implement the Master Plan in around five years by stage.

As shown above, the time span of the Concept Plan is beyond that of the BMA General Plan while the Master Plan and Implementation Plan are placed within the framework of the General Plan.

2.2.2 Development Framework of Land Readjustment Master Plan

The development framework of the L/R master plan is set forth in consideration of 1) development regulations imposed by the BMA General Plan and 2) Socio-economic framework set for the concept plan at the year 2011.

(1) Development Regulation by General Plan of BMA

Medium Density Residential Area (hereinafter referred to as MDRA) is designated through out the planning area in the General Plan. In this land use zoning not less than 10% of MDRA area in zone 2.22 (about 720 ha) can legally be used for land uses other than housing.

It is understandable that the General Plan is designated to manage the urban growth by means of total land volume control for urbanization, more specifically commercial development in the MDR Area.

However, this does not mean that General Plan intends to freeze the commercial development within 10% of the MRD Area.

In the interval of 5 years, the general plan is subject to review/revision so as to accommodate further commercial development, if necessary. In a district where the commercial developments reach the 10% allowance in terms of land in 5 years, the applicant for the commercial development must wait for the revision of general plan to be made every 5 years.

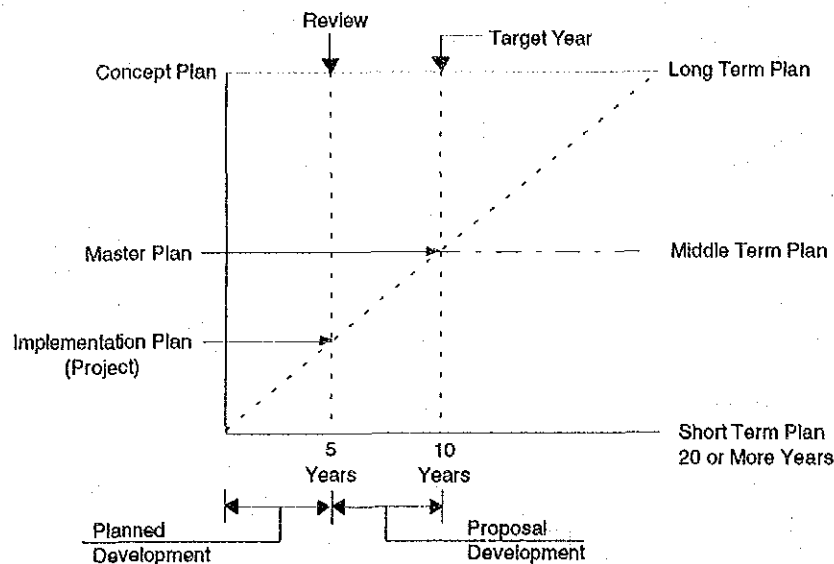
Table 3.3.4-Number of Building Classified by Building Use and Material Used

Sub-Area	Building Use	Material Used			
		RC	Wood	RC + Wood	Total
1	Residence	86	2	0	88
	Education	0	0	0	0
	Government	9	0	1	10
	Shop House	10	0	0	10
	Commercial	32	2	2	36
	Hospital	0	0	0	0
	Factory	2	0	0	2
	Religion	0	0	0	0
	Subtotal	139	4	3	146
2	Residence	7	14	5	26
	Education	0	0	0	0
	Government	0	0	0	0
	Shop House	0	1	0	1
	Commercial	4	0	0	4
	Hospital	0	0	0	0
	Factory	2	0	0	2
	Religion	0	0	0	0
	Subtotal	13	15	5	33
3	Residence	21	59	13	93
	Education	0	0	0	0
	Government	0	0	0	0
	Shop House	0	0	0	0
	Commercial	4	6	1	11
	Hospital	0	0	0	0
	Factory	0	0	0	0
	Religion	0	0	0	0
	Subtotal	25	65	14	104
4	Residence	13	218	38	269
	Education	3	4	0	7
	Government	1	0	0	1
	Shop House	4	0	1	5
	Commercial	6	3	0	9
	Hospital	1	0	0	1
	Factory	1	0	1	2
	Religion	15	22	14	51
	Subtotal	44	247	54	345
	Total	221	331	76	628

As such the general plan is designed to be responsive to urban growth with a great deal of flexibility.

The L/R projects shall be implemented under such flexible framework of the general plan as stated above.

Figures 3.3.4-Time Framework of Planning



According to the time framework set in the preceding section, the planning time for the L/R master plan happens to be almost equivalent to that of the general plan, that is 10 years from now, the year 2001.

This dictates that the L/R master plan must be formulated under the development framework of the general plan, that is 10% regulation. However taking into consideration, the due schedule of review of the general plan within the time framework of 10 years, it may be fair that commercial development projects beyond 10% regulation shall be proposed in the L/R master plan.

It is apparent that the proposed development projects are subject to the revision of general plan in the forthcoming 10 years.

The allowable development land for commercial uses in the planning area under the general plan in force is calculated as follows.

The allowable development land for commercial uses in the planning area

$$= 10\% \text{ of MRD Area (720 ha) } \times 70\% *1$$

$$= 50 \text{ ha}$$

*1 70% of the allowable commercial land in zone 2.22 shall be allocated in the planning area

(2) Socio-economic Framework

Target population and employment of the study area were set at 105,000 and 200,000 respectively at the year 2111 in the Development Concept Plan as presented before. Based on

these figures, the population and employment of the planning area are estimated at 15,000 and 78,000 respectively in the year 2001.

2.2.3 Zoning

Based on the development concept plan set forth and the analysis of urbanization in the districts of the planning area, the Development Zoning is mapped out as shown in the **Figure 3.3.5**.

(1) Planned and Proposed Development

Urban developments in the planning area are divided into two (2) kinds of development, that is planned development and proposed development.

1) Planned Development

Area for planned development includes the areas where the urbanization and urban development are deemed most probable and due judging from the current trend of urbanization in the planning area. Since this developments are in line with the ordinary trends of urbanization, it may be safe to say that the planned development never exceeds the set framework of the general plan (areas for planned developments are less than 50 has.)

2) Proposed Development

It is anticipated that the large scale transport infrastructure projects such as skytrain and Hopewell system will give a great impact on the future land use in the planning area. In this regard it is recommendable that urban development projects are set up based on the potentials tapped by the transport infrastructure projects. However these development projects may be of a great magnitude and dimension in development activities which the general plan failed to provide for. Accordingly the urban development projects are proposed on the ground that the general plan shall be revised to accommodate them.

(2) Zoning

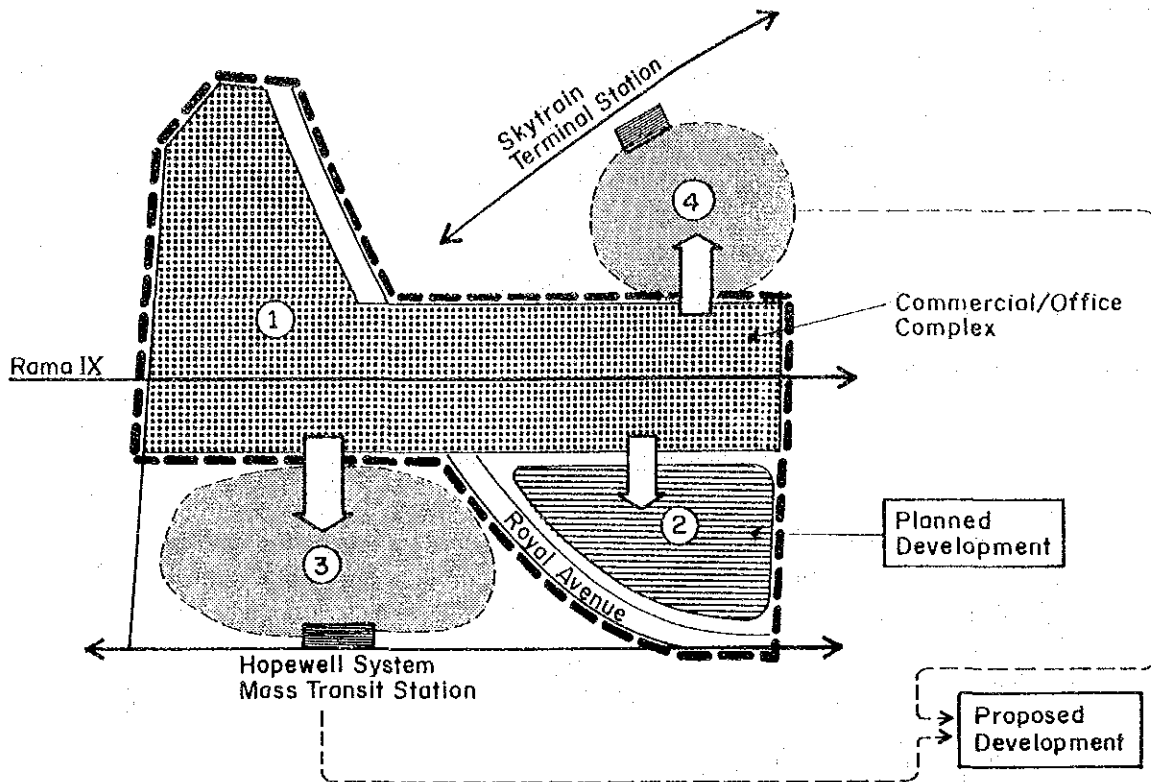
The planning area is to be divided into 4 major zones such as commercial/office complex, three (3) business office districts (I, II, III). (**Figure 3.3.5**)

1) Commercial/office complex

The complex covers areas in progress of urbanization/building up/subdivision in the planning area, centering on the areas along the Rama IX road and Soi Taweemit leading to TV Channel 9. In this area, mixed land use including office, hotels, restaurants, government agencies, condominiums and the like has been emerging. This area will continue to be a major focus of urbanization in the planning area and the building density will continuously increase.

Through the urbanization in this area, commercial development will be prominent due to

Figure 3.3.5-Development Zoning



DEVELOPMENT ZONING

- (a) locational advantage for commercial activities
 - Free from the traffic congestion in the existing CBD
 - Convenience, not far from the existing CBD
- (b) high land price
 - Housing development projects shall become financially less feasible due to the high land price in the area.
 - Nothing but industrial activities such as commercial industries with high economic returns on investment shall be economically allowed to be located in the area because of the high land value.

In conclusion urbanization of this area shall be led by commercial development.

2) Business Office District I

The above mentioned commercial/office complex will not be large enough to meet the future demand of serviced land in the planning area. Accordingly urbanization will infiltrate into the open land in the planning area.

To accommodate the further urbanization, serviced land shall be developed in the three (3) candidate sites as shown in the figure (zone 2, 3, 4). Among the candidate sites, zone 2 flanked by Rama IX Road and Royal City Avenue seems most advantageous in terms of area-wise urban development expanded from the commercial/office complex zone 1.

Consequently, business office district I in the zone 2 is included in planned development project of L/R master plan.

3) Business Office Districts II, III

Business office district II in zone 3 and district III in zone 4 shall be developed in connection of construction with mass transit stations of Hopewell system and a Skytrain terminal station respectively.

However these projects are classified as proposed developments in L/R master plan because the development intensity and magnitude appear to be beyond the regulation of the general plan and details of the transport projects have not been determined for coordination.

2.2.4 Land Use Plan

The land use plan for the L/R Master Plan is worked out in compliance with the regulations imposed on MDR area by the General Plan.

The following development and building activities are permissible as far as the accumulated land area for them is confined less than 10% of MDR area.

1. Large building residential
2. Large building commercial
3. Terraced building for commercial
4. Subdivision for commercial

As for the housing development, subdivision for housing/land, terraced building for residential are unconditionally permissible any where in the MDR area.

In the regulation of General Plan, the large building is interpreted as a building of over 2,000 m² or a building of 15 m high up and GFA of over 1,000 m².

It should be noted that large buildings for commercial use are permissible in the planning area as far as the accumulated land to be developed for them keep less than 10% of MDR area (equivalent to 50 ha as estimated before).

On these premises the land use plan for the L/R master plan is worked out as shown in **Table 3.3.5 and Figure 3.3.6**.

- 1) The areas along the Rama IX Road and Soi Taweemit which are in progress of urbanization at present, should be developed/improved as commercial/business

complex. Thus land use category of commercial area is placed on this area in the land use plan for the L/R master plan.

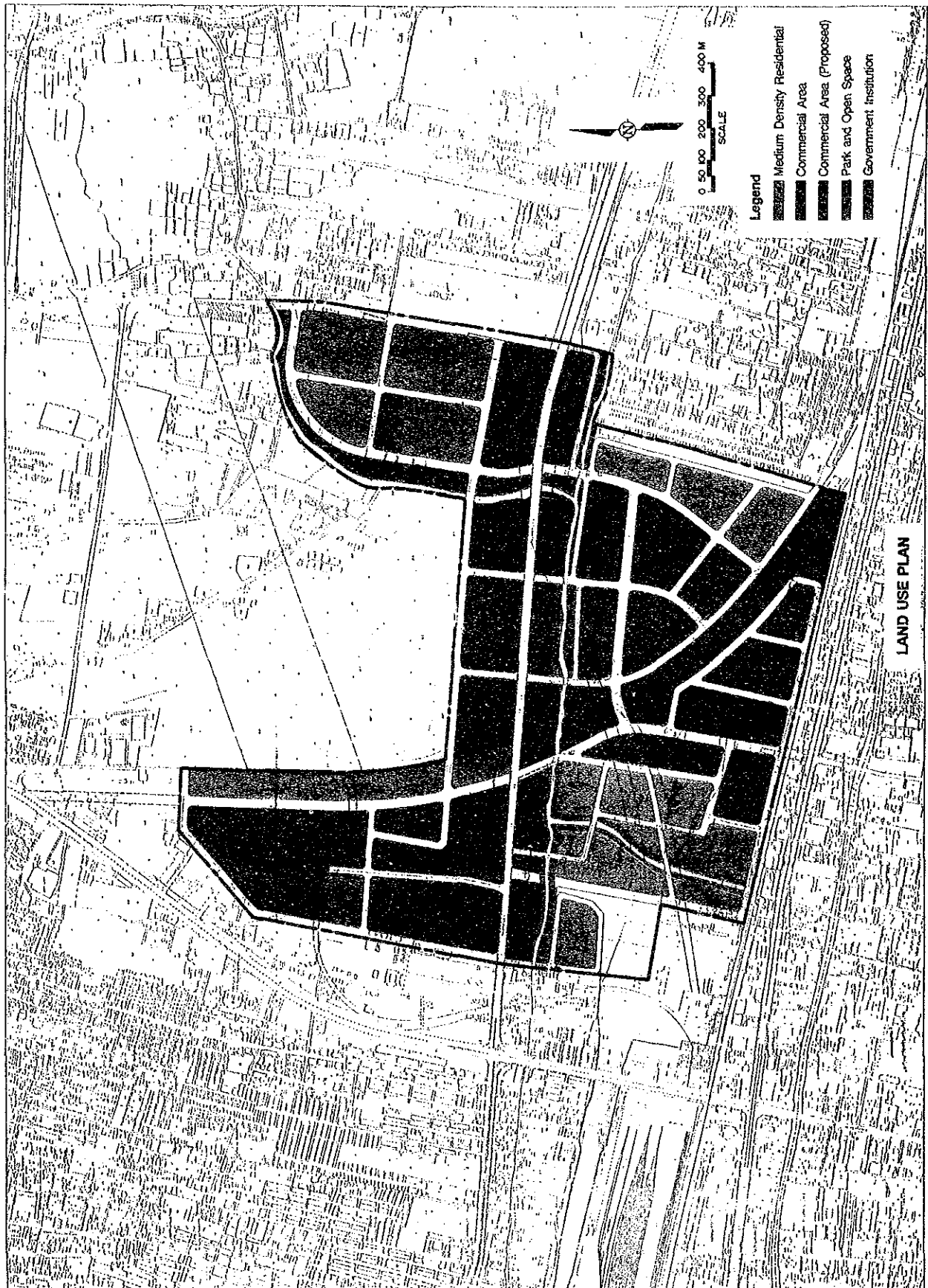
The semi-gross site area for building is calculated at about 60 ha in this area, 50% of which have already built up. Accordingly remaining 50%, 30 ha shall be used for commercial development.

- 2) Business district I shall be developed as an annex to the above-mentioned commercial area to meet further land demand for commercial development. This district falls in land use category of commercial area where 16 ha of semi gross land area is used for commercial purposes. Combined land areas for commercial use in the master plan (30 ha + 16 ha) amount to not more than 50 ha, thus complying the land use regulation of the general plan in force.
- 3) Land areas for none commercial uses of 19, 8 and 29 ha are allotted for open space, government institutes and medium density residential respectively.
- 4) Land use category of commercial areas is proposed to be placed in the business district II since potentials of commercial development associated with Hopewell system project are considered very high and realistic.
- 5) Although the development of business office district III associated with Skytrain terminal station development seems very challenging and ambitious one, the planning and design of the terminal station is still in the air. Therefore it may be safe to put the land use category of medium density residential area as it is in the general plan in force.

Table 3.3.5-Land Use Area

	Area of Site	Site Area for Commercial Use
Planned Development		
Commercial/business complex (along Rama IX Road, and TV 9 Soi)	60 ha	30 ha (60 ha x 50%)
Open Space	19 ha	0
Government Institute	8 ha	0
Medium Density Resident	29 ha	0
Business office district I	16 ha	16 ha
Proposed Development		
Business office district II	16 ha	16 ha
Business office district III	19 ha	16 ha
Medium Density Residential Area (General Plan)	177 ha	78 ha (Semi-gross excluding roads and other transport site)

Figure 3.3.6-Land Use Plan



2.3 General Land Readjustment Design

2.3.1 Basic Policy and Concept of Land Readjustment Design

(1) Pre-condition for General L/R Design in the Master Plan

It is not unusual that L/R design is conducted on the basis of finalization of land use development. In this study planned land use for the master plan is flexible, in other words changeable depending on the selection of development alternatives shown in the preceding section of land use plan.

In this situation it is a pre-condition for L/R general design that all the 300 ha of planning area shall be developed through L/R system including all the three alternatives of development projects.

(2) Basic Policy of General L/R Design

Basic policy of general design is that site and infrastructure are designed so as to create a new central business district as proposed in the concept plan. More specifically

1) Space Design (Block Design)

Spacious urban lands are preferable for the central business activities. Blocks, which are space units of urban area, should be large enough to accommodate large buildings for office commercial and residential.

2) Design Standards of Public Facilities

High design standard of public and infrastructure service shall be required for development of an advanced CBD. In Thailand different planning/design standards of public facilities seem to be applied to urban development projects such as subdivision projects, housing estate developments, and slum upgrading projects by NHA, industrial estate development and so on.

It is desirable to establish unified planning/design standards of public facilities in the official city planning system. And such standard as state above should be applied to the L/R project.

3) System Design

One of the basic purposes of L/R project is to achieve an area-wise integrated development. It is a far cry from aggregation of subdivision projects.

One integrated system of public service covering the planning area of 300 ha (not separately by subdistrict) must be established and designed.

2.3.2 Block Design

The road network divides the planning area into space unit of blocks with different size and shape in which land use and building activities take place. The size and shape of blocks encompassed by the road are designed based on the following factors.

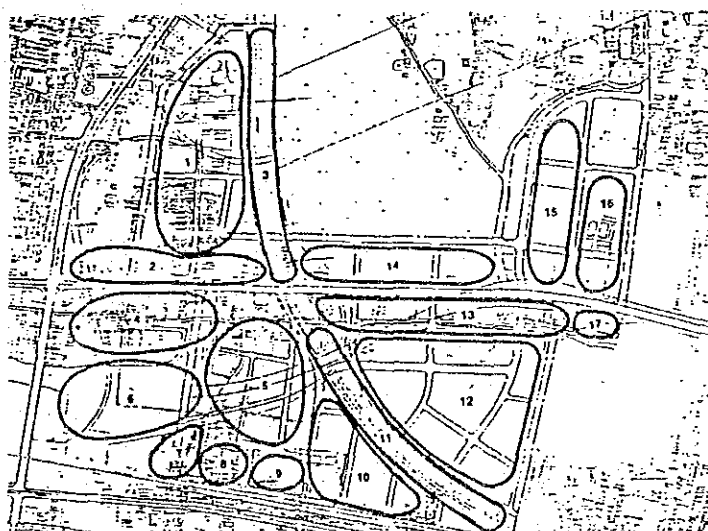
- 1) The size and shape of the existing lots to be replotted into the block

Table 3.3.6 shows the size-range of the existing lots in the planning area. Difference of lots in each district must be taken into consideration for block designing.

Table 3.3.6-Basic Features and Lot Sizes by Zone

Zone No.	Basic Feature	Size of Lots	Remarks
1	Modern area TV 9	-	Modern area TV 9
2	Frequent Congestion	150 ~ 1500 m ²	
3	Grass land	-	Commercial mall
4	Old style houses	300 ~ 1000 m ²	
5	Agriculture field	800 ~ 9000 m ²	Rama IX Hospital
6	Grass land	12000 ~ 10000 m ²	Express way ETA's Central Control Building
7	Old style house	200 ~ 3000 m ²	
8	Wat	-	Wat
9	TV 11	-	TV 11
10	Grass land	7000 ~ 8000 m ²	
11	Commercial mall Construction	-	Commercial mall (Royal City Avenue)
12	Grass land	1500 ~ 15000 m ²	Imperial Piyavate Hospital
13	Scattered building Construction	1000 m ²	Sunroute Hotel
14	Grass land	1000 ~ 20000 m ²	
15	Grass land		
16	New houses	150 ~ 200 m ² 10000 ~ 20000 m ²	
17	Car dealers	10000 ~ 80000 m ²	

Figure 3.3.7-Basic Features and Lot Sizes by Zone



2) The existing buildings on the lots

Block design must be made so as not to impede the existing economic/social activities of the people in the planning area as much as possible.

3) Future land use and building activities

Block design must be geared toward accelerating and accommodating the urban growth proposed in the land use plan. Attention must be paid to land use in designing blocks since the roads have a great impact on land use.

The scale of buildings to be constructed in each land use area as proposed in the preceding chapter is set, ranging from small to large depending upon the land use, as shown in **Table 3.3.7**.

The size of lots to be replotted in the block are determined based on the size of existing lots and scale of buildings to be accommodated in the blocks.

Table 3.3.7-Building Scales and Lot Sizes by Land Use

Category of Land Use	Scale of Building	Size of Lots in the Blocks
Commercial/Business Complex	medium to large	600 ~ 5000 m ²
Medium Density Residential Area	small to medium	400 ~ 600 m ²
Business Office District	large	5000 ~ 10000 m ²

2.3.3 Roads

(1) Traffic Prospect

Traffic volume on major roads in the concept plan area have been increased at a much higher pace than a forecast made a few years ago. In recent years, these roads have persistent traffic congestion.

Considering development in the area as well as surrounding areas, both road development and public transport development are necessary.

(2) Planning Criteria

The following planning criteria are adopted for a road master plan.

- a. Hierarchical structure of inter-district roads and inner-district roads
- b. Spacing of roads suitable to the land use plan
- c. Improvement of north-south access
- d. Smooth connection and networking

- e. Feeder roads to new urbanization
- f. Development of pedestrians' networks
- g. Development of access to public transport

(3) Types of Roads to be designed

To realize a hierarchical structure, the following types of roads are designed. District roads will be designed at the implementation plan stage. (Figures 3.3.8, 3.3.9 and 3.3.10)

a. Expressway

The Second Stage Expressway to Thavimitr Road is under construction by Bangkok Expressway Co. Ltd. which is the project concessionaire of the Expressway and Rapid Transit Authority of Thailand. The section is scheduled to be completed in March 1993.

Construction of the extension to Srinakarin Road is expected to start within a couple of years. The completion will be in 3 years from the start.

The elevated expressway will have ramps in the master plan area. Smooth traffic to the ramps are considered in the road design. Environmental protection from the expressway is also considered.

Typical cross-sections are a 3-lane dual road along both sides of Rama IX Road and a 6-lane single road along other sections in the area.

b. Arterial streets (30 m)

This type of roads are for inter-district traffic. They will open north-south access by connecting Tiam Ruam Mit Road/Pracha Utit Road, Rama IX Road and New Petchburi Road. The arterial streets in the area are:

- i. existing Rama IX Road
- ii. planned road connecting Rachadapisek and New Petchaburi Road
- iii. planned road connecting Thiam Ruam Mit Road/Pracha Utit Road with Rama IX Road and the above No. ii road
- iv. planned road connecting Tiam Ruam Mit Road/Pracha Utit Road with Rama IX Road

These roads will have 6 lanes, a pair of sidewalks and the median.

**Figure 3.3.8-Typical Cross-sections of Rapid Mass Transit Systems,
Expressways and Royal City Avenue**

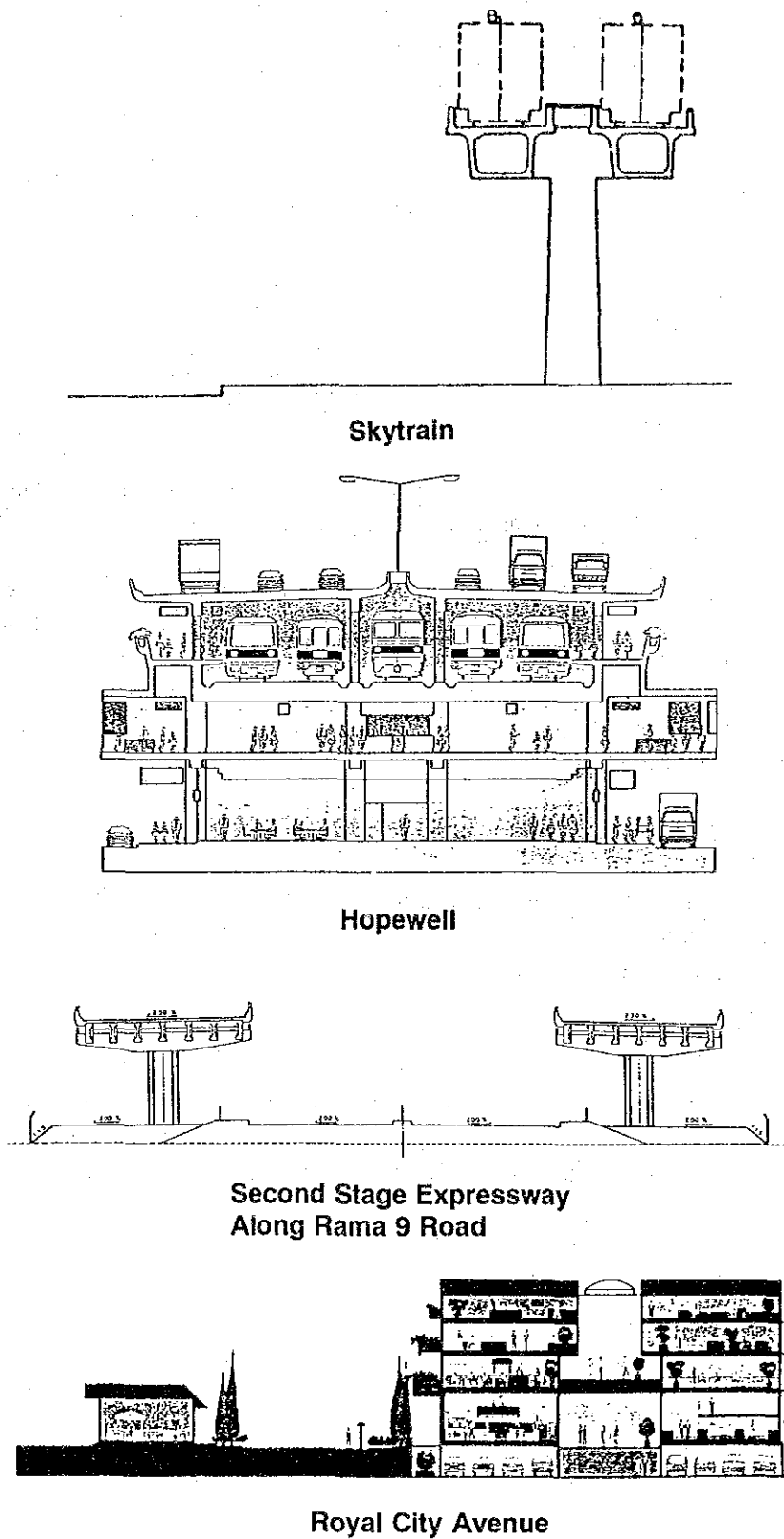
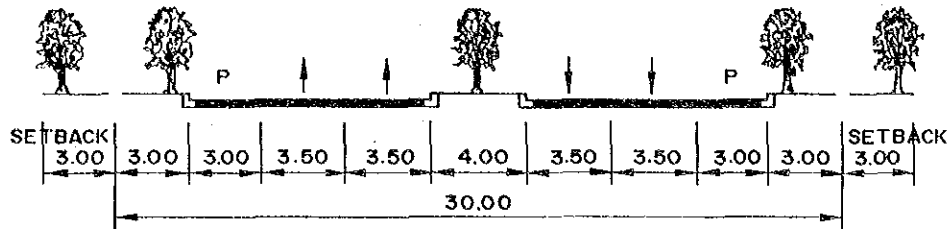
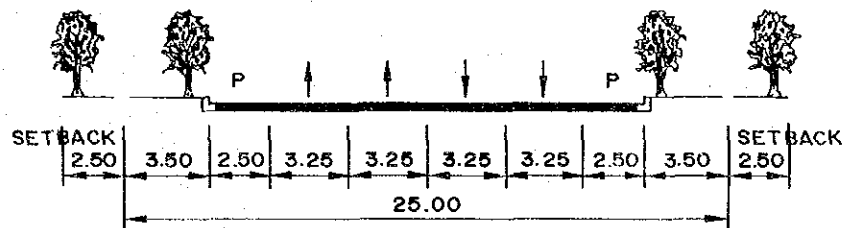


Figure 3.3.9-Standard Cross-sections of Planned Roads

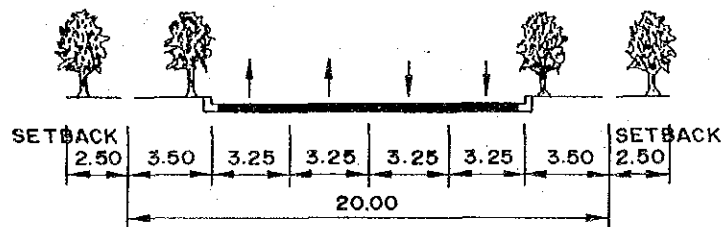
ARTERIAL STREET (WIDTH OF RIGHT OF WAY 30.00 M.)



MAJOR ROADS (WIDTH OF RIGHT OF WAY 25.00 M.)



MAJOR ROADS (WIDTH OF RIGHT OF WAY 20.00 M.)



MINOR STREET DISTRIBUTIVE (WIDTH OF RIGHT OF WAY 16.00 M.)

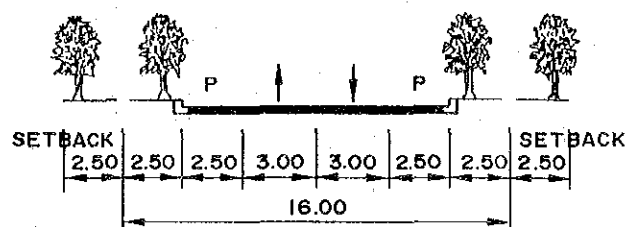
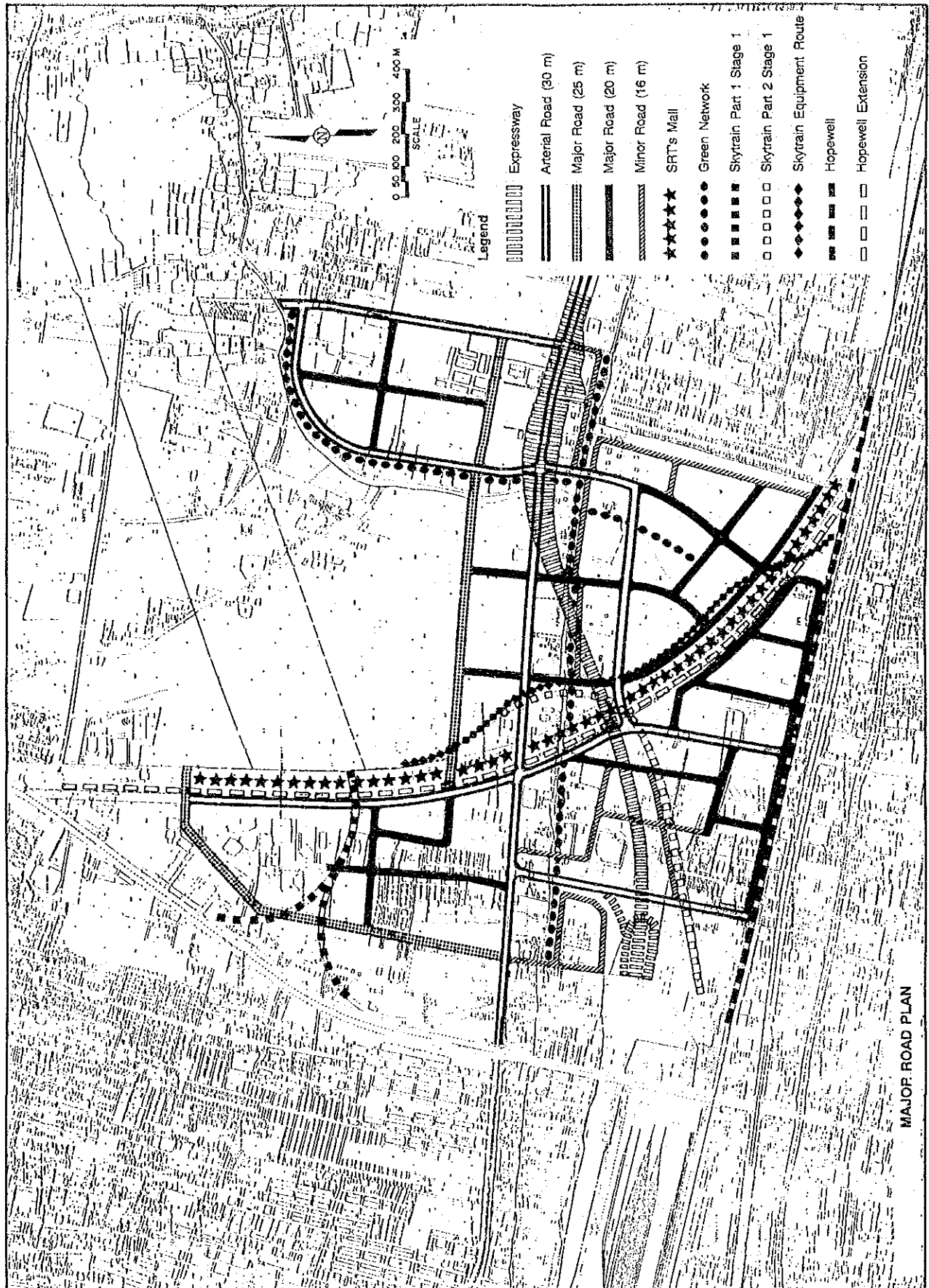


Figure 3.3.10-Major Road Plan



c. Major roads (25 m)

This type of roads are main roads to delineate districts. These roads distribute traffic from the arterial streets to the major roads (20 m).

d. Major roads (20 m)

This type of roads are main roads in each district. These roads distribute traffic from the major roads (25 m) or arterial streets to the inside of each district. The major roads (20 m) together with the major roads (25 m) are spaced approximately at 200 m to 300 m according to future urbanization. By interconnecting major roads to avoid soi patterns, unnecessary traffic flow can be minimized.

e. Minor street distributive (16 m)

This type of roads are also main roads in each district where the land use is not intensified commercial use or where wide roads are impractical.

(4) Green Network

Connecting parks and along canals such as Khlong Yommarat (Huai Khwang) and Khlong Sam Sen Nai, a green network is to be developed for pedestrians.

(5) Access to Public Transport

Smooth traffic flow would not be possible without development and full utilization of public transport especially mass rapid transit systems.

The master plan area will accommodate the following stations.

a. On-going Hopewell Project along the Eastern Line of SRT

- i. station at the end of Sukhumvit Soi 39
- ii. station at Soonvijai Area

b. The SRT has an idea to operate a commuter transit system along the Royal City Avenue and Ratchadapisek Road. The possibility of implementation depends on various currently unknown factors. If it is realized, there will be a possibility of stations in the master plan area.

c. The Skytrain project is now under revision. There is a possibility of a route to Ramkhamhaeng. If the route is through the workshop, there is a possibility of a station close to the north-eastern part of the master plan area.

The on-going Hopewell Project including stations is now at the design stage. Ordinary stations will be on the second floor. Development of the station areas and access to them should be considered in coordination with the project.

Upgrading of bus services is also important. The above stations should have transfer functions to buses and possibly bicycles. In addition to ordinary buses, feeder buses to new urban districts should be introduced. (Figure 3.3.11)

(6) Set Back

For pedestrians convenience and urban environment, setback of buildings facing the planned streets are recommended.

(7) Tree Planting

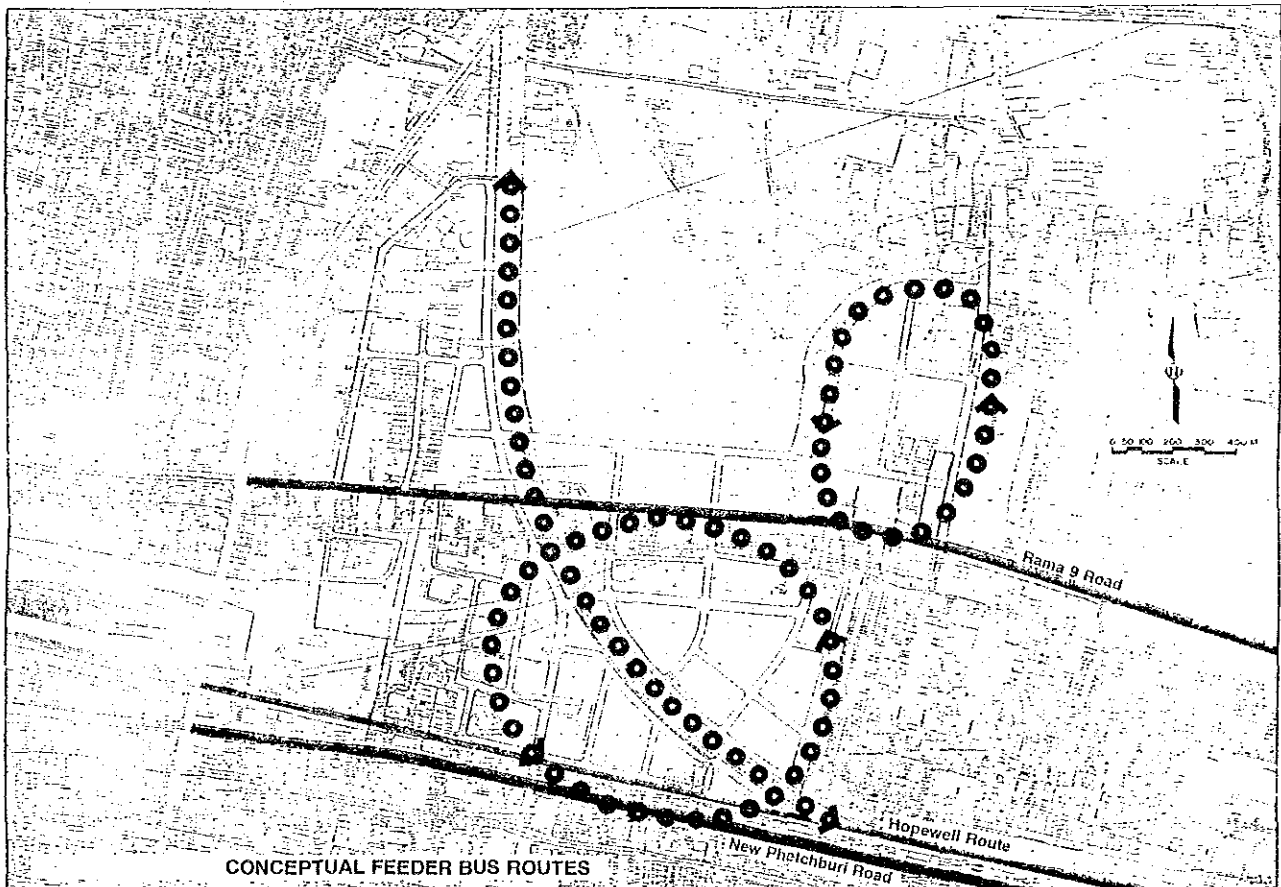
To keep urban environment, major streets should have trees. They provide pedestrians with comfort and so indirectly promote utilization of public transport.

2.3.4 Parks and Open Space

According to the proposed standard in Bangkok General Plan, the following park area should be provided.

- Local recreational park (playground etc.) $2.0 \text{ m}^2/\text{person}$
- Parks, stadiums and other recreational area $4.1 \text{ m}^2/\text{person}$
(district park, sports park, comprehensive park etc.)

Figure 3.3.11-Conceptual Feeder Bus Routes



In the NHA standard, the following park shall be provided.

- Public park for 1,600 families or 8,000 people
- Sports and recreation area for 1,600 families or 8,000 people

Although Land Sub-division Act will not be applicable to the study project, supposing 4 people live in 1 lot of land, the following park should be prepared.

- 800 m² of playground for 200 lots (800 people)
- 16,000 m² of recreational park for 2,000 lots (8,000 p.)

In the master plan, 8.8 ha of parks, green area and recreational area will be provided according to the proposed standard of General Plan.

14,500 people x 6.1 --> 8.8 ha

Considering the characteristics of the master plan as a business/commercial center, emphasis shall be put on neighborhood or district parks rather than on small playlots. There are only 9 parks of BMA, whose area ranges 4 to 80 ha and BMA have difficulty in preparing and maintaining small playlots. Therefore assuming that 1.4 ha of playlots or playgrounds (1 m² per person) is to be prepared in the retention areas by public or in residential areas by developers etc., 7.4 ha of public parks will be planned in the master plan area, which will form about 3% of the total master plan area.

As the master plan area is largely divided into 4 zones by Rama IX Road and SRT sites, parks will be prepared in each zone. The size of one park will be 1 to 5 ha in reference to the guidelines of Land Sub-division Act and the proposed standard of the specific planning division, DTCP.

"Green" network is to be formed in the frame of parks and pedestrian ways distributed according to size and classification of the community, connecting with other open spaces such as water ways, forests, schools, temples etc.

The flood retention area along the canal will be used as park and green area, where pedestrian way, landscaping furniture and playlots will be distributed. The condition of quality of canal water is quite low with bad smelling, however it will be improved in future and water front of the canal can be relaxing and attractive space for citizens because the canal water improvement project and sewerage improvement project are going on. Water front is precious and has special interest as Bangkok was called as "*Oriental Venice*". The green network will be formed with a backbone of the retention area along the canals. Two parks will be located adjoining to the retention green area, one of which will be placed at the crossing of Khlong Kamen and Khlong Huai Khwang, and one will be planned near the entrance of Royal City Avenue where the Express way and Skytrain are to be running and land use limited. The other park will be placed on the opposite side of Royal City Avenue. The space under the express way and the skytrain is proposed to be for public use to enable to use the whole block as park. One park will be located in the center of the north east zone next to the retention area. The other two parks will be planned in the center of the south and north community, one of which will have liaison with the plaza of Royal City Avenue and the north park will function of buffer between

skytrain/business zone and residential area. Under the planned skytrain in the south park will be used car parking. In south west zone, there is a temple having open space and vegetation.

In addition to the above parks, it would be desirable that a symbolic park should be prepared on Rama IX road for the benefit of all Bangkok citizens symbolizing the development of the project. It will be difficult to make this kind of park by contribution that the park would be financed by the government if possible. The suitable place would be a super-block on Rama IX road and apart from the planned express way or skytrain with the area of 5 ha or more. This park will enhance the quality of landscape and amenity of the project area.

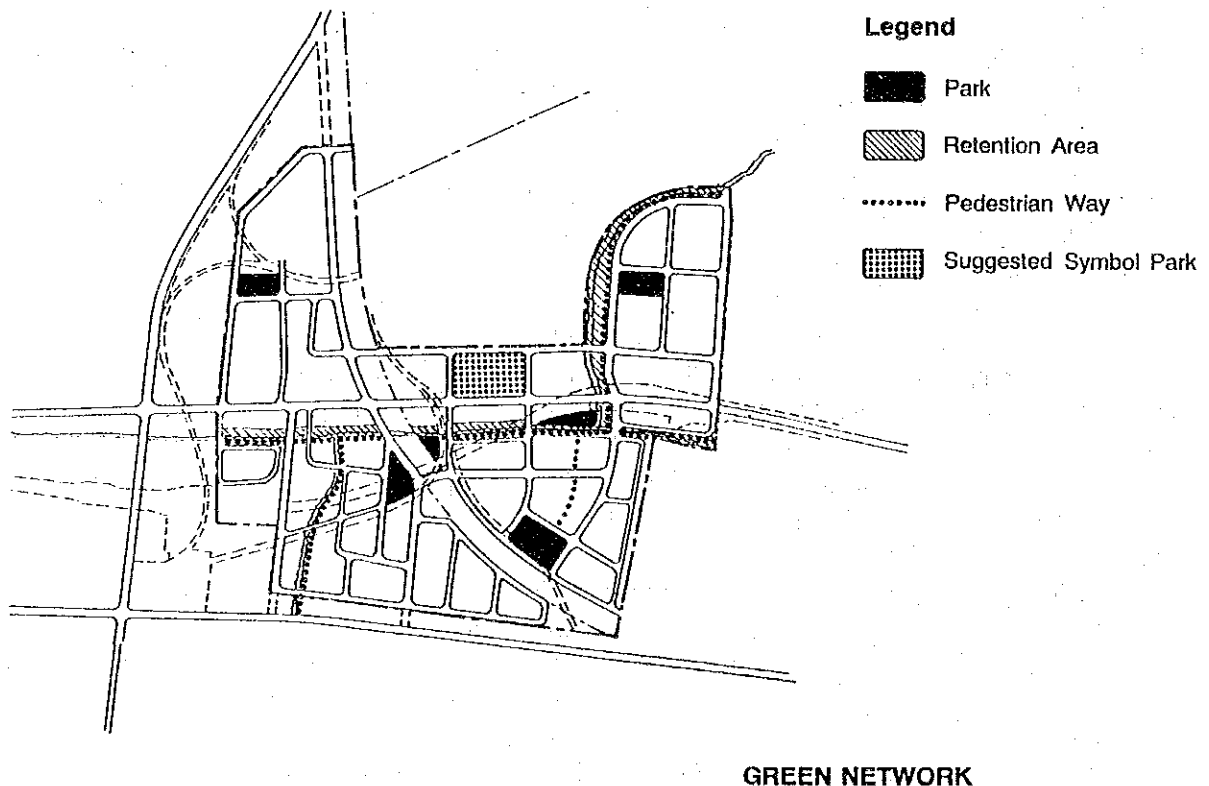
2.3.5 Drainage and Flood Protection System

(1) Outline of Drainage and Flood Protection System

Khlong is indispensable in Bangkok to transfer of rain water and sewage. Khlong Khamen, Khlong Huai Khwang and Khlong Sam Sen Nai are located in the study area. Those khlongs shall be improved, and open space shall be allocated along such improved khlongs for reinforcing rain water retention function as well as amenities for urban residents.

While, a low ground part of the study area shall be reclaimed up to the elevation +1.0 m. for preventing inundation during flooding. A building floor level shall be established on the elevation higher than +1.5 m.

Figure 3.3.12-Green Network



Rain water of the study area shall be collected to the pipes laid under the streets, then it is discharged to the khlongs by gravity. Sewerage system of the study area shall be separated

completely from the drainage system, and accordingly waste water shall never be mixed into drainage and khlongs.

(2) Needs of Rain Water Retention Area

During the progress of urbanization, paddy fields are reclaimed and converted into residential area, resulting in an increase of the run-off discharge due to the decrease of the natural rain water retention function. It results in longer duration of inundation during flooding in Bangkok.

At present, there is no laws and regulations regarding restriction to reclamation of paddy fields nor provision with any flood regulating facilities upon land development in terms of flood protection in urban area.

DDS (Department of Drainage & Sewerage) of BMA administrates drainage and flood protection system in Bangkok. However, it is impossible to prohibit the use of unused land in urban area by reason of its natural flood regulating function without any compensation to the land owners.

While, the JICA study team regarding drainage and flood protection system in easter suburban Bangkok in 1985/1986 recommended DDS that as much as 5% of the urbanizing area should be kept as rain water retention area as one of flood protection measures against rapid urbanization.

From these circumstances, DDS is requesting a land developer to keep a rain water retention area as much as 5% of development land area, though DDS has no legal power to impose developers to do so.

This L/R study observes the DDS's basic policy for flood protection, and keeps a necessary rain water retention area with necessary retention volume as a model of flood protected large-scale land development in urban area.

(3) Hydrological Calculation

This hydrological calculation is to estimate the rain water retention volume required for land development of the study area for retarding the increase of run-off discharge due to the conversion of land use.

1) General Assumption

The study area is located within the Phrakhanong polder system, and the rain water is discharged to Chao Phraya River at Phrakhanong pump station which is located about 7.5 km. downstream from the study area as shown in **Figure 3.3.13**.

To simplify the calculation of the required rain water retention volume, the following assumptions are adopted:

- a. Khlongs and low ground open space located between the study area and the Phrakhanong pump station are regarded as a continuous retarding pond.

- b. The Phrakhanong pump station discharge as much rain water as before land development, even it is after land development.
 - c. Influence of inflow of rain water from outside of the study area is neglected.
- 2) Hydrological Design Criteria
 - i) Design rainfall

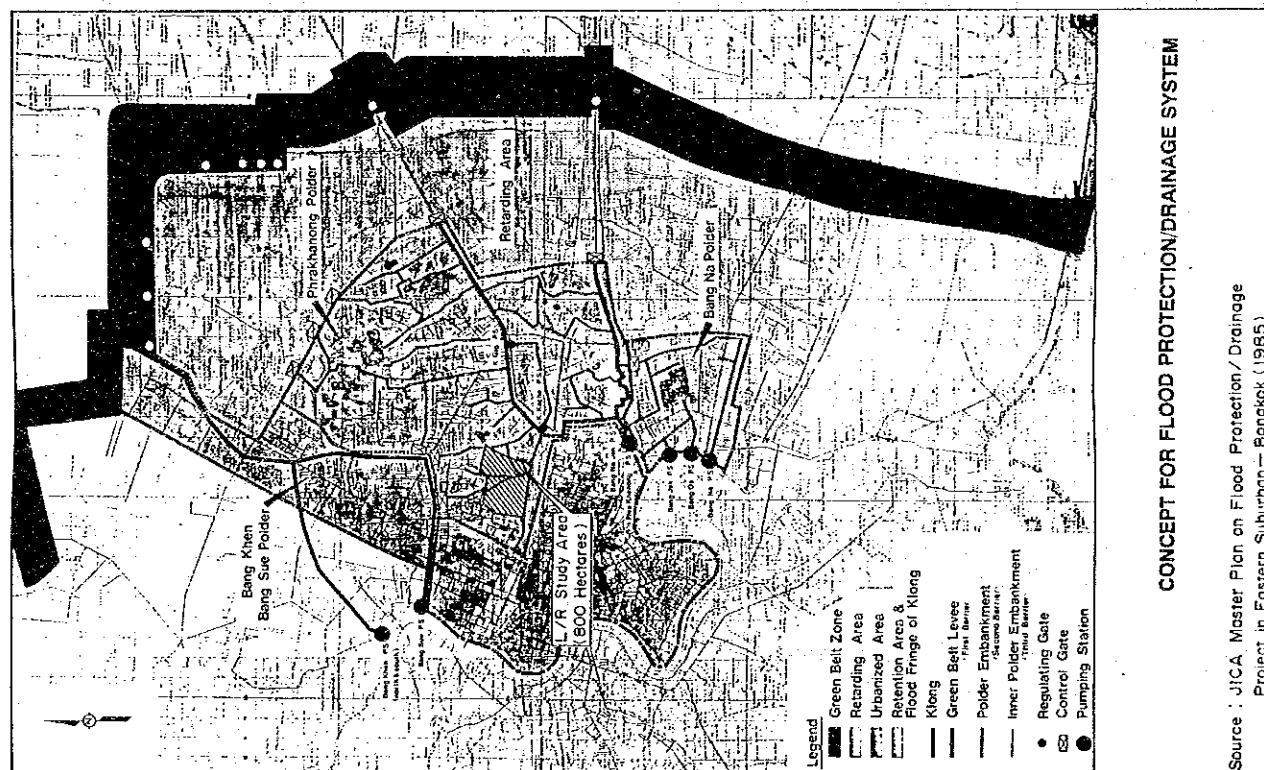
The adopted design rainfall is:

Inside drainage area	-----	2 years frequency I_2	=	$\frac{5690}{t+37}$
Khlongs	-----	5 years frequency I_5	=	$\frac{7600}{t+40}$

Where I: Rainfall intensity (mm./hr.)
 t: Time of concentration (min.)
 $t = T_i + L/V$
 T_i : Time of inflow from ground surface to khlong (min.) $T_i = 10$ min.
 L: Length of khlong (m.)
 V: Average velocity in khlong (m./s.)
 $V = 0.35$ m./s.

Source: Master plan of flood protection/drainage project in easter suburban -Bangkok By JICA in 1985

Figure 3.3.13-Concept for Flood Protection/Drainage System



ii) Run-off Coefficient

The adopted run-off coefficient is:

Table 3.3.8-Run-off Coefficient

Land use	Run-off Coefficient (f)
- Commercial/residential high density	0.75
- Residential medium density	0.50
- Residential low density	0.40
- Institutional	0.40
- Parks/agriculture	0.15
- Industrial	0.70
- Railroad yard	0.35

Source: Master plan of flood protection/drainage project in eastern suburban -Bangkok by JICA in 1985

iii) Formula for Calculation of Required Rain Water Retention Volume

The adopted formula is:

$$V_i = 60 \frac{(R_i - R_c)}{2} \times \frac{t_i \times f \times A}{360}$$

Where V_i = Required rain water retention volume (m^3)
 R_i = Rainfall intensity at time- t_i (mm./hr.)
 R_c = Rainfall intensity which meets to the allowable discharge quantity (Q_c)
 t_i = Any time during rainfall duration (min.)
 A = Drainage area (ha)
 f = Run-off coefficient

Source: Design standard for sewerage facilities by Japan Sewage Works Association

3) Simulation of Required Rain Water Retention Volume

The land use both before and after land development of the study area is simulated in the following three cases:

Table 3.3.9-Land Use and Run-off Coefficient

	Land Use and Run-off Coefficient	
	Before (f_b) Development	After (f_a) Development
Case 1	40% unused land, 30% residential medium density & 30% residential low density $f_b = 0.33$	100 % commercial residential high density $f_a = 0.75$
Case 2	Same as Case 1 $f_b = 0.33$	40% commercial/residential high density & 60% residential medium density $f_a = 0.60$
Case 3	Same as Case 1 $f_b = 0.33$	50% residential medium density & 50% residential low density $f_a = 0.45$

The required rain water retention volume of each case of every 1 km² (100 ha) area is calculated as follows:

- Time of concentration

$$\begin{aligned} t &= T_i + L/V \\ &= 10 + 7500/(0.35 \times 60) \\ &= 367 \text{ min.} \end{aligned}$$

- Rainfall intensity at the above time of concentration

$$\begin{aligned} I_5 &= 7600/(t+40) \\ &= 7600/(367+40) \\ &= 18.7 \text{ mm./hr.} \end{aligned}$$

- Allowable discharge quantity before development

$$\begin{aligned} Q_c &= f_b \times I_5 \times A/360 \\ &= 0.33 \times 18.7 \times 100/360 \\ &= 1.71 \text{ m}^3/\text{sec} \end{aligned}$$

- Rainfall intensity after development which meets to the above allowable discharge quantity (Q_c)

$$R_c = \frac{360 \times Q_c}{f_a \times A} = 6.16 / f_a$$

$$\begin{aligned} \text{Case 1 : } R_c &= 8.2 \text{ mm./hr.} \\ \text{Case 2 : } R_c &= 10.3 \text{ mm./hr.} \\ \text{Case 3 : } R_c &= 13.7 \text{ mm./hr.} \end{aligned}$$

- The required rain water retention volume

$$\begin{aligned} V_i &= 60 \left(R_i - \frac{R_c}{2} \right) \times \frac{T_i \times f_a \times A}{360} \\ &= \left(\frac{7600}{t_i} - \frac{R_c}{2} \right) \times t_i \times f_a \times 16.7 \end{aligned}$$

The required maximum rain water retention volume is 690 m³/ha, 530 m³/ha and 370 m³/ha in the respective cases as calculated above and as shown in **Figure 3.3.14**.

4) Required Rain Water Retention Volume of the Study Area

The average run-off coefficient of the study area (245 ha) after development will be 0.67 as calculated below.

Table 3.3.10-Rain Water Retention Volume

ti		Vi (m ³)		
(hour)	(minutes)	Case 1	Case 2	Case 3
1	60	54,030	42,590	31,180
2	120	65,230	50,920	36,660
3	180	68,640	53,020	37,460
4	240	69,270	52,890	36,600
5	300	68,590	51,710	34,950
6	360	67,180	49,960	32,870
7	420	65,430	47,860	30,530
8	480	63,220	45,520	28,010
10	600	58,430	40,430	22,660
12	720	53,210	34,990	17,040
15	900	44,920	26,470	8,350
18	1080	36,330	17,700	-
24	1440	18,670	-	-

Table 3.3.11-Average Run-off Coefficient in the Study Area

Land Use	Area (ha) A	Run-off Coefficient fa	A x fa
• Business & Commercial district	105	0.75	79
• Medium density residential	60	0.50	30
• Government Institution	10	0.40	4
• Green and open space	15	0.15	2
• Roads	50	0.90	45
• Khlongs	5	1.00	5
Total	245		165

$$\frac{A \times fa}{A} = \frac{165}{245} = 0.67$$

From **Figure 2.1.13** and the above run-off coefficient, a required retention volume is calculated to be 148,000 m³ (605 m³/ha x 245 ha).

(4) Allocation of Retention Area

The water level of Khlongs in Huai Khwang drainage area is maintained by DDS as follows:

While, the flooding water level simulated by the JICA study in 1985/1986 was +0.80 m. in case the Phrakhanong pump capacity is 21 m³/s and +0.50 m. in case of 159 m³/s. The present Phrakhanong pump capacity is 105 m³/s.

From the above water level, the low grand part shall be reclaimed up to the elevation +1.0 m. and the top of the retaining wall of khlongs shall be improved up to +1.0 m. in accordance with the BMA's khlong improvement plan.

Figure 3.3.14-Duration-Retention Volume Curve

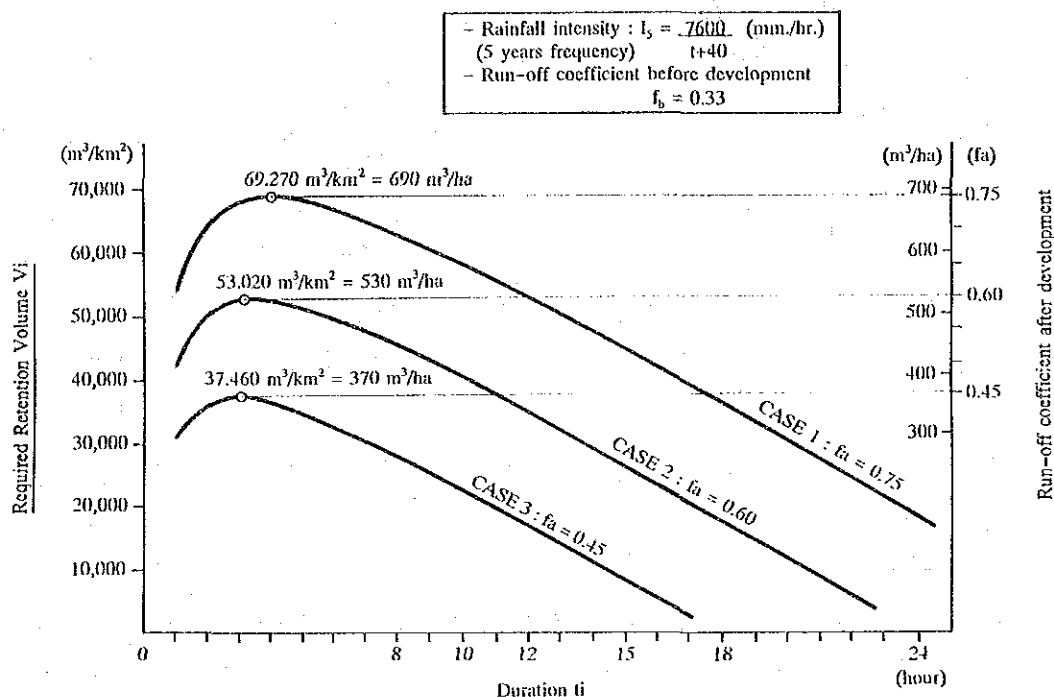


Table 3.3.12-Water Level of Khlong in Huai Khwang

Water Level	Gate at Chao Phraya River	Seasons	Remarks
+ 0.77 m	open	dry	when flushing inside khlongs by river water
- 0.35 m	closed	rainy	maintenance water level at Phrakhanong pump station

Source: The feasibility study on purification of khlong water in Bangkok by JICA in 1990

The open space allocated along khlongs will function as rain water retention area in flooding. Its ground elevation is +0.0 m. to -0.20 m. When it is dry, it will be utilized as pedestrian, park, and playground.

All khlongs in the study area shall be dredged and the both sides shall be protected by concrete-made retaining wall, resulting in reinforcing rain water retention function as shown in Figure 3.3.15. The drainage pipes laid under the streets is also counted as rain water retention space in flooding.

The rain water retention area and its retention volume provided in the study area are summarized as follows: