2.3 Cargo Movements

2.3.1 Commodity Flows and Directions

In order to determine the major origins and destinations for commodities to the GBA, surveys were made and reviewed in this report. The results, presented in the paragraphs below indicate that approximately 80% of all commodities originating from the GBA go to the Central Region and that about 80% of all commodities destined for the GBA originate in the Central Region.

(1) Type of Goods Transported

The cross sectional survey data collected during this report for the type of commodities carried by the inbound trucks for GBA is ranked by commodity in Table 2-19 and by commodity for each major inbound direction to the GBA in Table 2-20.

According to these tables, almost 50 percent of inbound commodity consists of construction materials and this flow is especially strong in the eastern and southern directions.

Table 2-19 Surveyed Inbound Commodity Composition Ratio

Type of Commodity	Number of Vehicles	Percentage (%)
Construction Materials	1,093	55.0
Farm Products	231	11.6
Manufactured Goods	118	5.9
Fishery Products	106	5.3
Sugar	101	5.1
Rice	70	3.5
Forestry	41	2.1
Livestock	25	1.3
Minerals	16	0.8
Others	38	1.9
Unclear	149	7.5
Total	1,988	100.0

Table 2-20 Surveyed Commodity Ranking by Direction

Ranking	Rangsit (N)	Chonburi (E)	Srisamran (S)	Ekachai (SW)
1	Corn (18.8)	Laterite (43.9)	Sand (48.5)	Gravel (18.3)
2	Stone (15.3)	Fish (9.7)	Stone (27.8)	Fish (13.0)
3	Rice (12.0)	Sand (7.9)	Sugar (4.8)	Sugar (8.7)
4	Soil (2.9)	Sugar (6.8)	Rice (1.5)	Soil (7.0)
5	Steel (2.9)	Gravel (5.3)	Soil (1.2)	Vegetables (6.7)
6	Lime (2.7)	Piling (4.7)	Lime (1.0)	Sand (5.0)
7	Cattle (2.1)	Wood (3.9)	Paper (1.0)	Charcoal (3.3)
8	Vegetables (1.9)	Cassava (2.1)	Pigs (1.0)	Coconut (3.0)
9	Rice Bran (1.6)	Canned Food (1.8)	Laterite (0.6)	Lemon (2.7)
10	Cement, Bottles Beans, (1.4) Charcoal	Bottles (1.1)	Tiles (0.5)	Bamboo (2.7)
1-10 Total (%)	(61.4)	(87.4)	(87.9)	(70.4)

(2) Origin and Destinations

The cross sectional survey results gathered during this report were analyzed for establishment of O-D matrices in this study. The summary results of origins shown in Tables 2-21 and 2-22 indicate that about 80 percent of inbound heavy trucks have their origins in the Central Region. These survey results were used as a basis of the establishment of cargo attraction factors described in the Chapter 3.

Table 2-21 Summary of Origin by Region

Originating Region	Number of Trucks	%
Central	1,601	(80.6)
North-Eastern	128	(6.4)
Northern	96	(4.8)
Southern	13	(0.7)
Unclear	150	(7.5)
Total	1,988	(100.0)

Table 2-22 Rank Order of Origins

Rank	Origin	%	Region
1	Ratchaburi	(32.4)	C
2	Chonburi	(21.4)	C
3	Saraburi	(8.2)	C
4	Rayong	(4.6)	C
5	Chantaburi	(2.0)	C
6	Nakhon Pathom	(1.8)	C
7	Nakhon Rachasima	(1.6)	NE
8	Pathum Thani	(1.2)	C
9	Nakhon Sawan	(1.1)	N
Total		(74.2%)	

Based on the O-D results of the DLT survey, the inbound and outbound traffic volumes for the GBA by directions which are summarized in Table 2-23, the inbound traffic volume comprises the major portion of 77.5% of the total, and outbound traffic the balance (22.5%). The summary of O-D survey results for inbound and outbound cargo volumes by commodity type are shown in Table 2-24. In the same table the number of trucks surveyed is also mentioned.

Table 2-23 Inbound and Outbound Cargo Flows, 1976

(1,000 ton/year)

	Central			Northern	Northeastern	Southern	Total
	Central	Western	Eastern				
From GBA	580 (23.3)	1,096 (12.8)	413 (26.7)	834 (37.0)	1,169 (30.2)	256 (92.8)	4,348 (22.5)
To GBA	1,905 (76.7)	7,455 (87.2)	1,131 (73.3)	1,422 (63.0)	2,700 (69.8)	342 (57.2)	14,955 (77.5)
Total	2,485(100.0)	8,551(100.0)	1,544(100.0)	2,256(100.0)	3,869(100.0)	598(100.0)	19,303(100.0)
(%)	(12.9)	(44.3)	(8.0)	(11.7)	(20.0)	(3.1)	(100.0)

Source: DLT O-D Survey Results, 1976.

The composition ratio of each commodity is very similar with the survey results of this study. The majority of inbound cargoes are construction materials and outbound cargo is mainly manufactured goods which are well suited for handling at the truck terminals.

Table 2-24 Inbound and Outbound GBA Cargo Flows, 1976

(tons/year)

Type of Commodity	From GBA	To GBA	Total	To GBA O-D Field Survey Results (%)
Rice	123,171.8 (2.8)	1,307,855.0 (8.7)	1,431,026.8 (7.4)	(3.5)
Sugar	10,395.6 (0.2)	1,143,653.6 (7.6)	1,154,049.2 (6.0)	(5.1)
Farm Products	135,428.7 (3.1)	2,813,804.4 (18.8)	2,949,233.1 (15.3)	(11.6)
Forestry	54,285.8 (1.2)	901,267.9 (6.0)	955,553.7 (5.0)	(2.1)
Construction Materials	501,735.5 (11.5)	6,696,376.0 (44.9)	7,198,111.5 (37.4)	(55.0)
Manufactured Goods	1,610,188.2 (37.0)	831,432.7 (5.6)	2,441,620.9 (12.6)	(5.9)
Livestock	27,044.3 (0.6)	401,948.8 (2.7)	428,993.1 (2.2)	(1.3)
Minerals	764.8 (0.2)	70,740.4 (0.4)	71,505.2 (0.3)	(0.8)
Others	1,885,557.0 (43.4)	787,477.9 (5.3)	2,673,034.9 (13.8)	(9.4)
Total	4,348,571.7 (100.0)	14,954,556.7 (100.0)	19,303,128.4 (100.0)	(100.0)
Number of Trucks	575,443	1,564,102	2,139,545	1,988
Tons per Truck	7.6	9.6	9.0	-

Source: DLT

Based on the study report of "Distribution of Origins and Destinations in Bangkok of Long Distance Trucks by A.I.T., which was conducted at Rangsit, Nong Mai Daeng, Sri Sam Ran and Cha Choeng Sao by interviews, the following O-D matrix was established.

Table 2-25 O-D Matrix by A.I.T., 1979

(veh/day)

O \ D	GBA	Central	South	North	North-east	Sub-total	Total
GBA	493	8,844	327	559	958	11,181	20,580
Central	7,722	4,031	2	-	365	12,120	25,605
South	148	85	-	-	-	233	562
North	721	-	-	-	-	721	1,280
Northeast	315	525	-	-	13	853	2,189
Sub-total	9,399	13,485	329	559	1,336	25,108	50,216

The survey results indicate that about 80 percent of inbound trucks for GBA have their origins in the Central Region which is the same conclusion conducted in this studv. This matrix also indicates that about 80 percent of outbound trucks from GBA have their destinations in the Central Region. Actually, the zoning of the O-D table established in this study is divided into 99 zones; therefore, based on this O-D matrix, the O-D matrix for through truck traffic was established to the zones in this study as in Table 2-26.

Table 2-26 O-D Matrix of GBA Through-Traffic

(No. of trucks more than 6-wheels/day)

O \ D	Zone No.	72	73	74	75	78	Total
Zone No.	Region	CN	CE	CS	CW	S	
72	CN	-	277	484	57	0	818
73	CE	111	-	36	0	2	149
74	CS	52	42	-	0	0	94
75	CW	48	71	0	-	0	119
78	S	0	85	0	0	-	85
Total		211	475	520	57	2	1,265

These through truck trips would definitely not use the truck terminal. However, to make the forecasting more accurate, this through traffic was assigned on the road network.

According to the study report of "Transport Management Information System "(TMIS), the inbound and outbound GBA cargo volume by type of commodity and by mode are summarized in Table 2-27. Since the surveyed year for the modal split is not the same, all of the cargo volumes by mode in this study were adjusted to the basic year 1977 of this study based on the past trend of cargo volumes for each mode.

Table 2-28 shows the adjusted modal split by direction. About 60 percent of cargoes are handled by truck for both inbound and outbound traffic; for inbound cargo movement, water transport also handles about 35 percent whereas for outbound traffic, railway transport handles about 30 percent.

2.3.2 Mixed Cargo Trucking Operation

- A Large gap exists between transportation demands for inbound and outbound goods. Since GBA is a heavy importer of low-value large-volume truck products and exporter of high-value smaller-volume manufactured goods. The total capacity of outbound trucking service from the GBA has therefore a constant and large surplus producing a buyers market for trucking service.

- Mixed cargo transportation mainly originates from the commercial areas in Central Bangkok, and serves to transfer goods from wholesalers in these areas to distributers in the provinces.

- Since consumption demand in Thailand is relatively small, the normal scale of individual distribution transaction is also small. The volume of an average individual freight consignment is therefore also small.

- Since the operators of both trading and trucking business are both heavily concentrated in the commercial areas of Central Bangkok, freight collection is generally operated on an individual basis, either delivered by the consigner to the transport operator or collected by the operator on order.

- Trucking business is generally operated with fixed destinations and freight collection is operated accordingly.

- Freight forewarders apparantly handle a substantial share of the transport on mixed cargo. The practice of charging freight on piece meal basis while employing truckers for hauling operation on trip lump-sum payment basis is commonly practiced since it is cheaper to hire trucking service on demand than maintain personnel and equipment for private operation in a buyers market.

  This explains the fact that mixed cargo trucks operating on long distance routes from Bangkok are commonly over-loaded while numerous inbound trucks leave the GBA empty.

Table 2-27 Inbound and Outbound Cargo Volumes GBA by Mode

(1000 ton/year)

	Mode / Commodity	(1976) DLT. (Trucks Only)	Transport Management Information System by A.I.T. Truck (1975)	Rail (1976)	Water (1976)	Total (%)
Inbound to GBA	Rice	1,308	1,463	232	1,585	3,280 (11.1)
	Sugar	1,144	1,889	27	-	1,916 (6.5)
	Other Farm Products	2,814	3,635	211	1,669	5,515 (18.8)
	Forestry	901	1,120	250	114	1,484 (5.1)
	Construction Materials	6,696	6,459	646	7,894	14,999 (51.2)
	Manufactured Goods	831	746	34	30	810 (2.8)
	Minerals	70	41	621	88	750 (2.6)
	Others	1,189	322	49	193	564 (1.9)
	Total	14,953	15,675	2,070	11,573	29,318 (100.0)
Outbound from GBA	Rice	123	163	61	20	244 (4.5)
	Sugar	10	23	15	-	38 (0.7)
	Other Farm Products	135	206	31	33	270 (5.0)
	Forestry	54	50	2	75	127 (2.4)
	Construction Materials	501	288	29	25	342 (6.3)
	Manufactured Goods	1,610	842	995	338	2,175 (40.4)
	Minerals	1	6	22	21	49 (0.9)
	Others	1,912	1,523	606	16	2,145 (39.8)
	Total	4,346	3,101	1,761	528	5,390 (100.0)

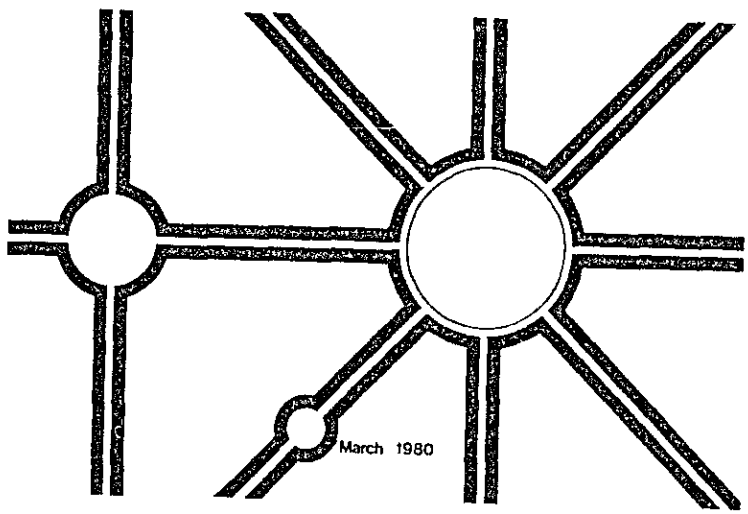
Source: TMIS

Table 2-28 Adjusted Inbound and Outbound Cargo Volumes, 1977

(1000 ton/year)

Direction / Mode	Truck	Rail	Water	Total
Inbound to GBA	23,513	2,401	13,656	39,572
(%)	(59.4)	(6.1)	(34.5)	(100.0)
Outbound from GBA	4,652	2,043	633	7,317
(%)	(63.6)	(27.9)	(8.5)	(100.0)
Total	28,165	4,444	14,289	46,889
	(60.1)	(9.5)	(30.4)	(100.0)

CHAPTER 3 FORECASTS OF TRAFFIC DEMAND



Chapter 3 FORECASTS OF TRAFFIC DEMAND

3.1 General

For the purpose of obtaining the fundamental parameters for terminal planning and examining the effect of the establishment of the terminal, both cargo and passenger traffic are examined since both contribute to the congested road situation.

The effects of trucks on traffic flow and road capacity is by no means small when one considers that trucks are slower, less maneuverable and larger than passenger cars. If the passenger car equivalents (P.C.E.) of trucks is taken into account, it is estimated that registered trucks totalled about 40% of registered passenger car units (P.C.U.) in 1976 as shown in the table below.

Vehicle type	P.C.E.	Bangkok-Thouburi Veh. Rehistration	Total P.C.U.	
Passenger car	1.0	220,550	220,550	
4-wheel truck	1.3	39,842	51,794	40%
6-wheel truck	1.5	17,194	25,791	
10-wheel truck	3.0	3,511	10,533	

Source: DLT., 1976

The first phase of coping with the effects of truck traffic in Thailand has been to restrict truck movements in Bangkok during peak morning and evening hours. Whereas this solution has a beneficial impact on other vehicle flows, it obviously does not contribute to the development of the trucking industry which has a valuable contribution to make to freight transport and distribution, and the promotion of business welfare.

Examination of the feasibility of establishing truck terminals will move in the directions of both reducing traffic congestion and promoting the economic distribution network.

The accurate forecasting of demand which is the basis of terminal planning is the subject of this chapter.

3.2 Commodity Traffic O-D Matrices

3.2.1 Traffic Forecasting Methodology

The work flow of the traffic forecasting procedure is shown in Fig. 3-1 and described below.

(1) The various types of commodities constituting the existing cargo flow were determined and the various statistical data gathered was grouped by zone.

(2) The influence area and its zones were determined.

(3) The framework of the control total cargo flow for the GBA based on the "Fourth Five-Year Plan" and "GBA Master Plan, 2000" was determined.

(4) The production and consumption of each commodity by zone were estimated.

(5) The generated and attracted cargo flow for each commodity by zone were estimated.

(6) Cargo O-D matrices based on the distribution model, modal split model, etc. were established.

(7) The control total of cargo flow using the screen-line check method was revised.

(8) Cargo O-D matrices were finalized.

(9) A coefficient of truck terminal utilization for each type of commodity was determined.

(10) The composition of truck types and average truck loading ratio was determined.

(11) Truck O-D matrices were established.

(12) Traffic (including trucks, passenger cars and buses) was assigned according to the truck O-D matrices on the road network.

(13) The number of trucks using the truck terminals for either collection or delivery was estimated.

(14) The total network vehicle-kms, and vehicle-hours were determined for use later in determining project benefits.

3.2.2 Definition of the Study Area

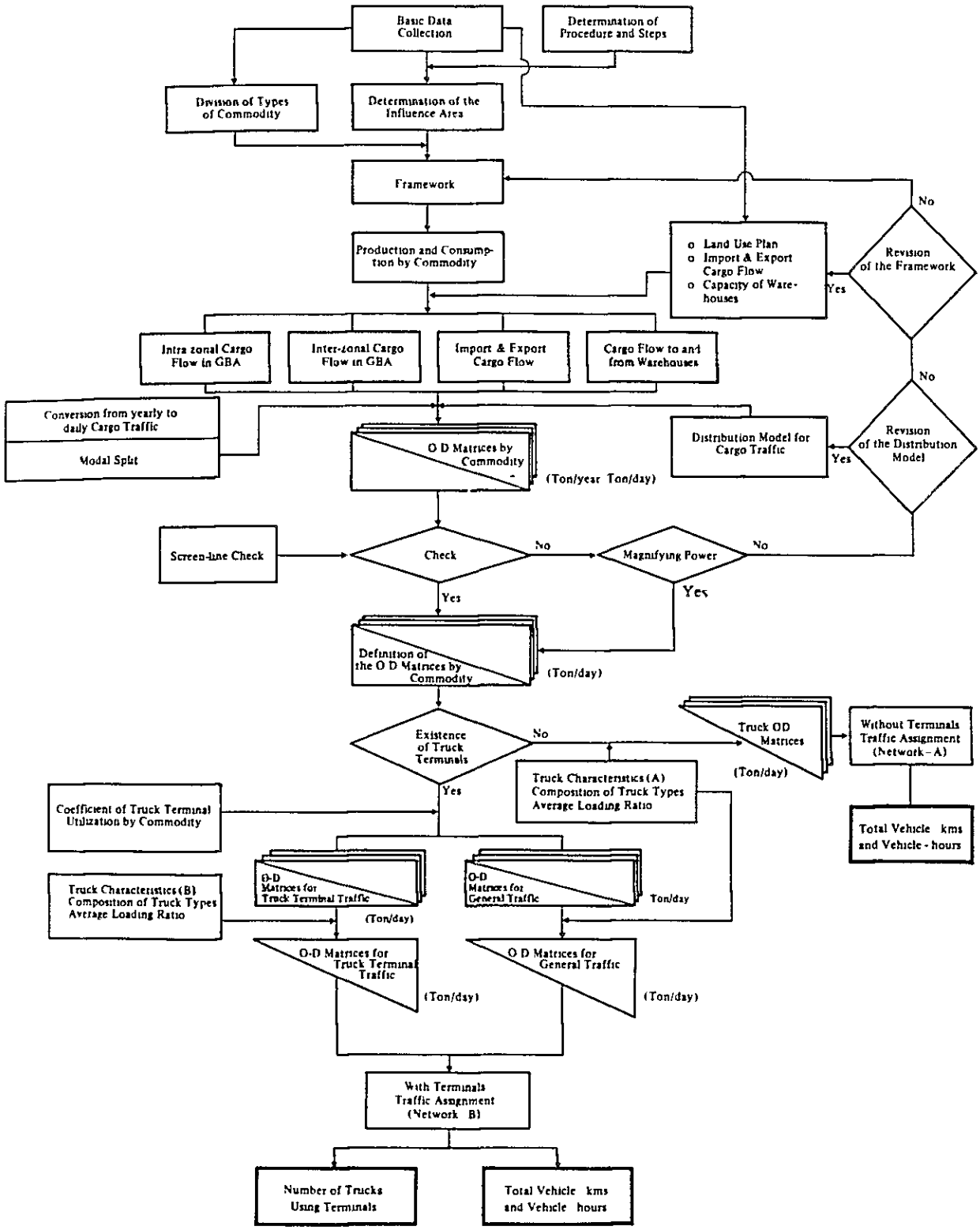
Since the major function of the truck terminals would be as a node of freight flow between the GBA and its surroundings, the boundary of the study area was defined as the GBA boundary.

In order to simulate cargo flows between major facilities of cargo handling such as truck terminals, warehouses and ports with a high degree of accuracy it was decided to subdivide the GBA into small zones. From this viewpoint, the zone division inside of GBA was primarily based on the smallest administrative units called "Tambon".

Since the area outside the GBA contributes to the traffic flows in the GBA by serving the markets (production, consumption, distribution, import and export) located there, it too was studied as a part of the zone of influence of the project. However, larger units of study were used. In the case of the central region outside the GBA, the Changwat was taken as the zone size. For other areas outside the Central region, the Region was adopted as the zone size.

The zoning arrangements were slightly adjusted so that the origins and destinations of cargo flow could be closely defined geographically and

Fig. 3–1 METHOD OF FORECASTING TRUCK TERMINAL TRAFFIC



so that the many factors associated with vehicle trips, such as employment, population, etc., could be spatially quantified.

The results of the definition of the study area are as follows:

	Area Name	Basis of Zone Division	Number of Zones
Main Study Area	GBA	Tambon	71
Area of Influence	Central Region outside GBA	Changwat	4
	Other Regions	Region	3
Total			78

The zoning map of the GBA and the regions outside the GBA are shown in Figs. 3-2, 3-3, respectively, and the Central Zone code by Amphoe is presented in Table 3-1.

The various existing and future indicators by zone established in the comprehensive study for Bangkok Suburban Transportation Project were considered in this study.

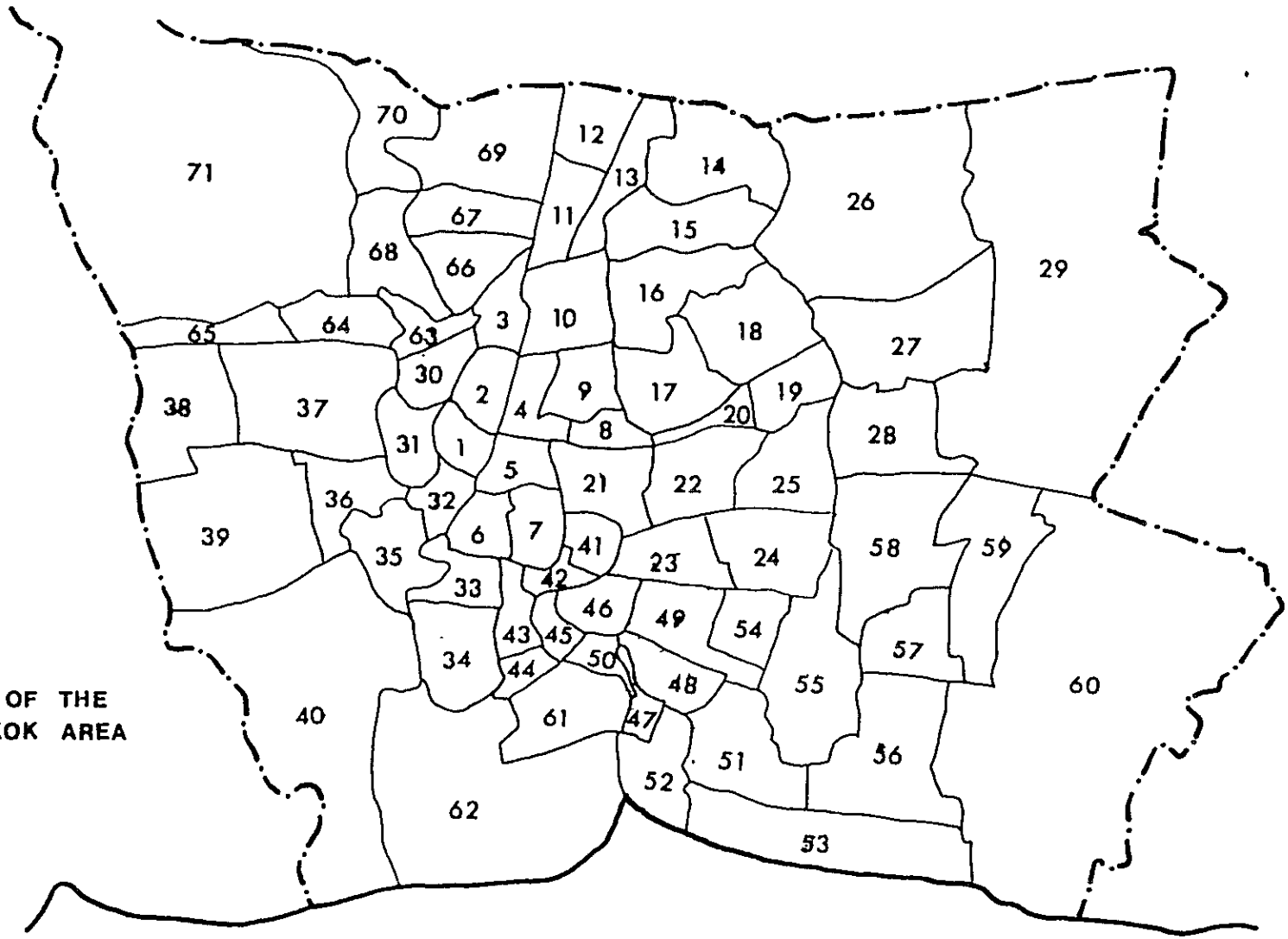


Fig. 3-2
ZONE DIVISION OF THE GREATER BANGKOK AREA

Fig. 3–3 ZONE DIVISION OUTSIDE GREATER BANGKOK AREA

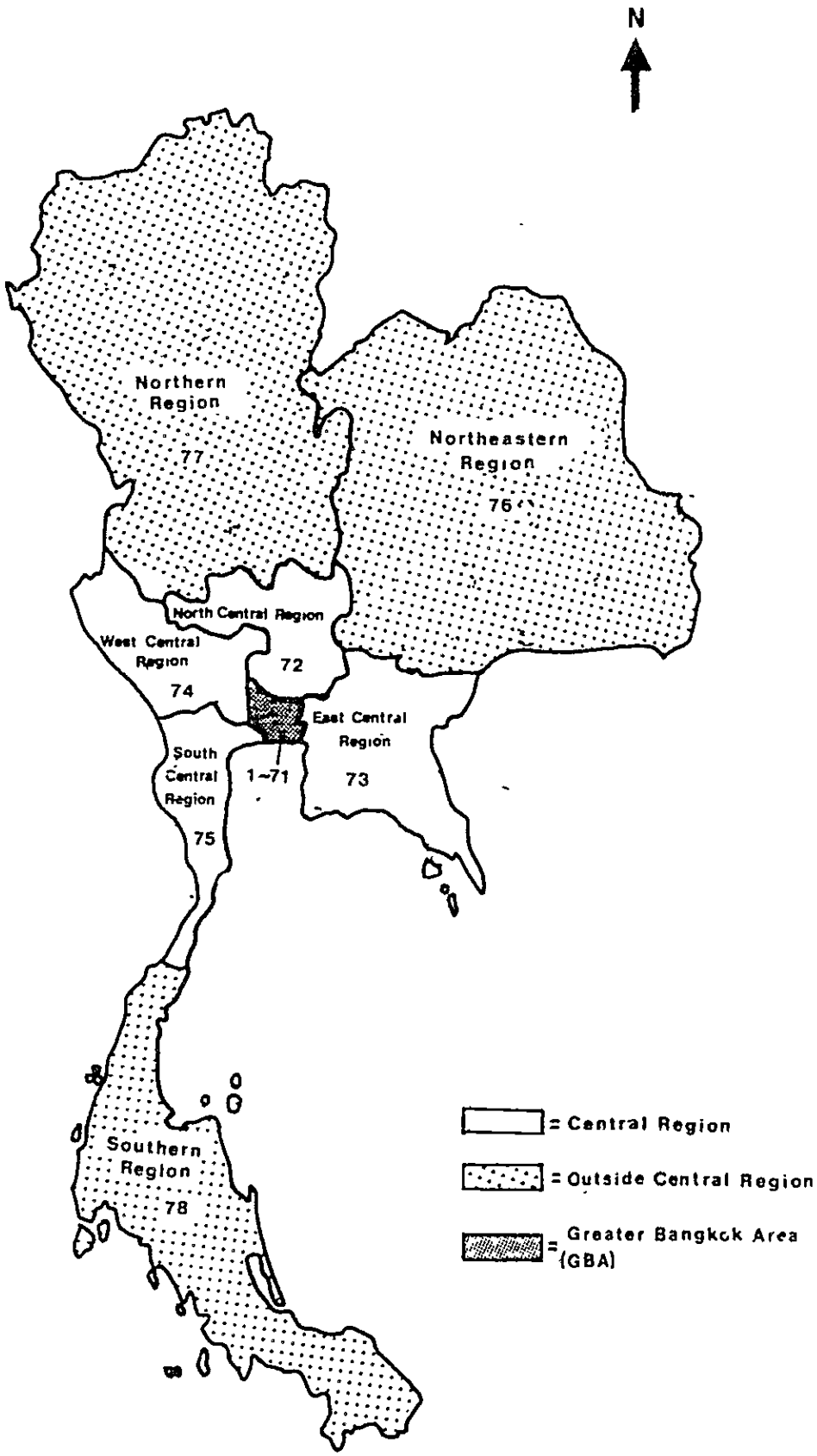


Table 3-1 Central Zone Code Table

Greater Bangkok Area: Zones 1 ∿ 71
Central Region : Zones 1 ∿ 75
Northeast Region : Zone 76
North Region: Zone 77
South Region: Zone 78

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
1.	Phra Nakhon	Phra Nakhon	Phra Nakhon	Bang Khun Prom Ban Pan Tom Wat Sam Phra Ya Chana Song Khram Talat Yod Wat Bawonniwet Sao Ching Cha San Chao Po Sue Wat Rachabopit Samranrat Pra Borom Maha Rachawang Wang Burapa
			Pom Prap	Pom Prap Thep Sirin Mahanak Ban Bat Somanat
			Sam Phan Tawong	Songwat Sam Phan Tawong Talat Noi
2.	Dusit		Dusit	Dusit Wachira Phayaban Suan Chitrada Siyaek Mahanak Thanon Nakhorn Chaisri
3.	Bang Sue		Dusit	Bang Sue
4.	Phayathai		Phayathai	Samsen Nai Thanon Phetchaburi Thung Phayathai Makkasan Thanon Phayathai
5.	Pathumwan		Pathumwan	Rong Muang Wang Mai Pathumwan Suan Lumpini
			Bang rak	Maha Phuttaram Siphraya Suriwong Bang rak Silom

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
6.	Yannawa	Phra Nakhon	Yannawa	Yannawa Wat Phraya Khrai Bang Kolaem Thung Wat Don Bang Khlo
7.	Bang Pong Pang		Yannawa	Thung Mahamek Bang Pong Pang Chongnonsi
8.	Bang Kapi		Huai Khwang	Bang Kapi
9.	Samsen		Bang Kapi Huai Khwang	Samsen Nok Huai Khwang Ding Daeng
10.	Lat Yao		Bang Khen	Lat Yao
11.	Thung Song Hong		Bang Khen	Song Hong
12.	Thung Si Kan		Bang Khen	Si Kan
13.	Talat Bang Khen		Bang Khen	Talat Bang Khen
14.	Khlong Thanon		Bang Khen	Khlong Thanon Sai Mai O Ngoen
15.	Thareng		Bang Khen	Anusawari Thareng
16.	Lat Phrao		Bang Kapi	Lat Phrao Charakhe Bua
17.	Khlong Chan		Bang Kapi	Khlong Chan Wang Thong Lang
18.	Khlong Kum		Bang Kapi	Khlong Kum Kanna Yao
19.	Saphan Sung		Bang Kapi	Saphan Sung
20.	Huamak		Bang Kapi	Huamak
21.	Phra Khanong		Phra Khanong	Phra Khanong Khlong Tan Khlong Toei
22.	Suan Luang		Phra Khanong	Suan Luang
23.	Bang Na		Phra Khanong	Bang Na Bang Chak

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
24.	Nong Bon	Phra Nakhon	Phra Khanong	Nong Bon Dok Mai
25.	Prawet		Phra Khanong	Prawet
26.	Bang Chan		Minburi	Bang Chan Sai Kong Din Sai Kong Din Tai Samwa Tawan Ok Samwa Tawan Tok
27.	Minburi		Minburi	Minburi Saen Saep
28.	Lat Krabang		Lat Krabang	Lat Krabang Khlong Song Tonnun Khlong Sam Prawet
29.	Nong Chok		Nong Chok	Kra Thum Rai Nong Chok Khlong Sip Khlong Sip Song Kok Faet Khu Fang Nua Lam Phak Chi Lam Toi Ting
			Lat Krabang	Lam Pla Tiu Tap Yao Khum Thong
30.	Bang O	Thonburi	Bangkok Noi	Bang Yi Khan Bang Phlat Bang Bamru Bang O
31.	Siriraj		Bangkok Noi	Sirirat Ban Chang Lo Bang Khunnon Bang Khun Sri
			Bangkok Yai	Wat Arun Wat Tha Phra
32.	Thonburi		Khlong San	Somdet Chao Phraya Khlong San Bang Lampu Lang Khlong Ton Sai
			Thonburi	Wat Kanyani Hiranruchi Bang Yi Rua Bukhalo Talat Phlu

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
33.	Rat Burana	Thonburi	Rat Burana	Rat Burana Bang Pakok
34.	Thung Khru		Rat Burana	Bang Mot Thung Khru
35.	Bang Khun Tian		Bang Khun Tian	Chom Thong Bang Khun Tian Bang Mot Bang Kho
36.	Phasi Charoen		Phasi Charoen	Bang Wa Bang Duan Bang Chak Bang Waek Khlong Khwang Pak Khlong Khu Ha Sawan
37.	Taling Chan		Taling Chan	Taling Chan Chim Phli Bang Phrom Bang Ramat Bang Chuak Nang
38.	Sala Tham Masop		Taling Chan	Thawi Watana Sala Tham Masop
39.	Nong Khaem		Phasi Charoen	Bang Khae Bang Khae Nua Bang Phai
			Nong Khaem	Lak Song Nong Khaem Nong Khang Phlu
40.	Bang Bon		Bang Khun Tian	Bang Bon Ta Kham Samae Dam
41.	Bang Ko Bua	Samut Prakan	Pra Pa Daeng	Bang Ko Bua Bang Ka Chao Bang Nam Phung
42.	Bang Yo		Pra Pa Daeng	Song Khanong Bang Yo Bang Krasop
43.	Bang Talat		Pra Pa Daeng	Bang Pung Bang Khru

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
44.	Bang Chak	Samut Prakan	Pra Pa Daeng	Bang Chak
45.	Bang Ya Phraek		Pra Pa Daeng	Bang Ya Phraek Bang Hua Sua
46.	Samrong Tai		Pra Pa Daeng	Samrong Tai
47.	Samut Prakan		Samut Prakan	Pak Nam
48.	Bang Muang		Samut Prakan	Bang Muang
49.	Samrong Nua		Samut Prakan	Sam Rong Nua
50.	Bang Duan		Samut Prakan	Bang Duan Bang Prong
51.	Phraek Sa		Samut Prakan	Phraek Sa
52.	Thai Ban		Samut Prakan	Thai Ban
53.	Bang Pumai		Samut Prakan	Bang Pumai Bang Pu
54.	Bang Kaeo		Bang Phli	Bang Kaeo
55.	Bang Phli Yai		Bang Phli	Bang Phli Yai
56.	Bang Pla		Bang Phli	Bang Pla
57.	Bang Chalong		Bang Phli	Bang Chalong
58.	Racha Thewa		Bang Phli	Racha Thewa Nong Pru
59.	Srisa Charakhe		Bang Phli	Srisa Charakhe Noi Srisa Charakhe Yai
60.	Bang Bo		Bang Phli	Bang Sao Thong
			Bang Bo	Khlong Dan Bang Bo Bang Priang Ban Rakat Preng Khlong Suan Niyom Yatra Bang Phli Noi
61.	Bang Pakok		Samut Prakhan	Nai Khlong Bang Plakot Pak Khlong Bang Plakot
62.	Laem Fa Pha		Samut Prakhan	Laem Fa Pha Naglua

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
63.	Wat Chalo	Nonthaburi	Bang Kruai	Wat Chalo Bang Kruai Bang Sithong
64.	Bang Khanun		Bang Kruai	Bang Khanun Bang Khun Kong Bang Khu Wiang Mana Sawat
65.	Bang Kruai		Bang Kruai	Sala Klang Plai Bang
66.	Nonthaburi		Nonthaburi	Bang Khen Talat Khuan
67.	Bang Kraso		Nonthaburi	Bang Kraso Tha Sai
68.	Bang Krang		Nonthaburi	Bang Krang Bang Phai Bang Si Muang Sai Ma Bang Rak Noi
69.	Pak Kret		Pak Kret	Bang Talat Pak Kret Ban Mai Bang Put Ko Kret
70.	Om Kret		Pak Kret	Om Kret Bang Phlap Khlong Khoi Ta It Bang Ta Nai Khlong Phra Udom
71.	Bang Bua Thong		Bang Bua Thong	Bang Bua Thong Bang Rak Yai Lampho Bang Ku Rat Lahan
			Bang Yai	Bang Muang Bang Mae Nang Bang Len Sao Thong Hin Bang Yai Ban Mai
			Sai Noi	Sai Noi Rat Niyom Nong Prao Ngai Sai Yai Khun Sri

Central Region Outside the Greater Bangkok Area

Zone Number	Name of Zone	Changwat	Amphoe	Tambon
72.	Ayuthaya (North Central Region)	Pathum Thani Phra Nakhon Sri Ayuthaya Saraburi Nakhan Nayok Suphanburi Lopburi Singburi Chai Nat		
73.	Chonburi (East Central Region)	Chonburi Chachoengsao Prachinburi Rayong Chanthaburi Trat		
74.	Nakhon Pathom (West Central Region)	Suphanburi Ang Thong Nakhon Pathom Kanchanaburi		
75.	Samut Sakhon (South Central Region)	Samut Sakhon Ratchaburi Samut Songkhram Phetchaburi Prachuap Khiri Khan		

3.2.3 Establishment of Cargo O-D Matrices

(1) Estimation of production and consumption, and imported and exported cargo volumes

The growth of the transport demand differs with the kind of commodity: for example, although agricultural products show steady growth, manufactured products bring higher growth for transportation demand.

Consequently, in this study the future changes in transportation demand for major commodities were estimated based on the future economic plans and the analyses of the present economic activities in production, consumption, export and import of each major commodity.

(2) Estimation of the present production, consumption, export and import volumes by region and major commodities.

In order to analyze the present volumes of production, consumption, export and import, appropriate zoning of Thailand and major commodity groups must be determined based on traffic planning zones and the availability of statistical data in particular.

a) Regional division

The traffic planning zones shown in Fig. 3-3 were determined based on the transport network and also on the data available, from which the present and future cargo flows can be estimated.

Statistical measures adopted in Thailand generally classify Thailand into regions as follows:

- Northern Region: 16 Changwats,
- Northeastern Region: 16 Changwats,
- Southern Region: 14 Changwats and
- Central Region: 25 Changwats.

Taking account of the future landuse plan for the Greater Bangkok Area (GBA), this area was separated from the Central Region.

Further study efforts were made to delineate the different characteristics of the sub-regions of the Central Region. However, within the limitation of the data and the coverage of future plans, it was not possible to apply to this production and consumption analysis to every traffic planning zone. Therefore, the results derived from production and consumption analyses chiefly depict the cargo flows between the GBA and other regions. Directional analysis was made according to the O-D survey results conducted in this study and also other reliable sources.

b) Selection of commodity items

Wider selection of commodities for production and consumption analyses makes it possible to estimate more accurate cargo flows only if such data are obtainable consistently even in smaller zones or regions. However, the number of commodities and the size of zone trade-off within the limits of the available data. After an inventory analysis of the data and its availability for a specific statistical year and regional coverage, the following commodities were selected. (Note: The commodity categories listed below are used throughout this report.)

i) Agricultural Products:

1. Rice (Paddy)
2. Sugarcane
3. Maize
4. Cassava
5. Soyabean
6. Mungbean
7. Rubber
8. Kenaf
9. Cotton

ii) Livestock:

1. Buffalo
2. Cattle
3. Swine
4. Chicken
5. Duck

iii) Forest Products:

1. Teak
2. "Yang"
3. Other timber

iv) Fishery Products:

1. Marine fish
2. Freshwater fish

v) Mineral Products:

1. Tin
2. Tungsten
3. Lead
4. Antimony
5. Iron
6. Manganese
7. Gypsum
8. Fluorite
9. Lignite
10. Marl

vi) Manufactured Products:

1. Sugar and Molasses
2. Other processed foods (including monosodium glutamate, condensed milk, evaporated milk, wheat flour, rice bran oil and butter)
3. Beverages (including brewery products, soda, water and bottled drinking water)
4. Cement
5. Iron and steel
6. Printing and writing paper
7. Woods and wood products
8. Petroleum products
9. Textile products
10. Fertilizer

c) Production of the selected commodities by region

Regional agricultural production data were mainly cited from the "Agricultural Statistics of Thailand". Regional production data for manufactured products were not available; however, data was obtainable for Thailand as a whole as shown in Table 3-2.

Table 3-2 Production of Selected Commodities in Thailand, 1979

(Unit: 1000 tons)

Commodities	Production	Commodities	Production
1. Rice (Paddy x 0.7)	8,635	13. Mineral products	1,782
2. Sugarcane	18,941	14. Sugar & molasses	2,546
3. Maize	1,624	15. Other processed foods	201
4. Cassava	12,372	16. Beverages	275
5. Soyabean	96	17. Cement	5,083
6. Mungbean	207	18. Iron & steel	190
7. Rubber: raw rubber	411	19. Printing & writing paper	300
processed rubber	411	20. Woods & wood products	1,954
8. Kenaf	246	21. Petroleum products	5,365
9. Cotton	91	22. Textile products	469
10. Livestock	927	23. Fertilizer	144
11. Forest products	2,004		
12. Fishery products	2,190	Total	66,464

The method used to find the regional production volume for each selected manufactured product is described below:

Sugar & molasses: Production place of sugar and molasses was assumed to be the same as that of sugarcane. The productivity per ton of sugarcane in Thailand is about 134 kg or 13.4% for sugar & molasses. Applying this rate to regional sugarcane production the sugar & molasses production volume was estimated for each region.

Other processed foods: The whole production volume was distributed to each region in proportion to the value added to the processed foods for the regional manufacturing industry.

Beverages: The whole production volume was distributed to each region in proportion to the value added to the beverage products of the respective region.

Cement: The whole production volume was distributed to each region in proportion to the value added to the non-metalic mineral products of the respective region.

Iron & steel: It was found in a JETRO report that the majority of iron & steel products are produced in GBA.

Printing & Writing paper:	The whole production volume was distributed to each region in proportion to the value added to printing and writing paper products.
Woods and wood products:	The whole production volume was distributed to each region in proportion to the value added to the woods and wood products of the manufacturing industry.
Petroleum products (Petroleum refining & coal):	The whole production volume was distributed to each region in proportion to the value added to petroleum refining and coal products.
Textile products:	The whole production volume was distributed to each region in proportion to the value added to textile products.
Fertilizer:	The whole production volume was distributed to each region in proportion to the value added to chemicals and chemical products.

The social and economic distribution factors employed for estimating regional production volume are summarized in Table 3-3. The data were primarily derived from the "Gross Regional Product, 1977" issued by the NESDB.

The regional production volume was thus estimated for the selected commodities and tabulated in Table 3-4.

d) Consumption, export and import volumes of the selected commodities

Agricultural products and also manufactured products do not necessarily move directly to the final consumption places. These volumes are diverted to intermediate places such as wholesalers, retailers warehouses, manufacturers and so forth. Such intermediate diversion was examined in the traffic distribution phase, and the results were checked by the screen line survey and then adjusted to reflect the actual commodity flows.

Destinations of the selected commodities, either final consumers or intermediate manufacturers, differ primarily depending on the nature of the commodity. Therefore, the commodity consuming place and its volume was estimated by examining the nature of each commodity and selecting its major consumer group.

Table 3-3 Social and Economic Indicators by Region, 1977

(unit: million Bht. unless otherwise specified)

Social & Economic Distribution Factors	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand Total
Population (x1000)	5,303	8,364	13,667	9,354	15,574	5,444	44,039
V.A.[1] to crops	2,955	23,832	26,787	18,400	18,879	10,450	74,516
V.A. to livestock	218	4,607	4,825	2,968	4,388	1,848	14,029
No. slaughtered: Cattle (heads)	54,025	80,726	134,751	50,719	111,404	46,402	383,904
Buffalo	47,563	46,451	94,014	2,680	14,726	4,381	115,801
Swine	553,440	1,197,208	1,750,648	282,928	341,127	335,319	2,710,022
V.A. to forest products	-	1,224	1,224	2,231	1,445	1,450	6,350
V.A. to fishery products	712	4,235	4,947	388	1,226	4,302	10,863
V.A. to mining & quarrying	12	2,398	2,410	730	284	3,789	7,213
V.A. to manufacturing ind.	36,538	21,506	58,044	4,713	4,499	4,033	71,289
V.A. to beverages	3,312	1,920	5,232	467	874	259	6,832
V.A. to processed foods	6,887	3,993	10,880	1,933	2,021	1,372	16,206
V.A. to rubber & rubber products	417	241	658	202	1	543	1,404
V.A. to Basic metallic products	833	634	1,143	-	-	410	1,553
V.A. to non-metallic products	2,250	1,712	3,086	278	2	327	3,693
V.A. to textile products	3,080	1,785	4,865	295	449	16	5,625
V.A. to woods and cork	798	463	1,261	227	446	278	2,212
V.A. to wearing apparel & made-up textile	2,965	1,718	4,683	151	98	107	5,039
V.A. to chemicals & chemical products	2,584	1,497	4,081	119	70	97	4,367
V.A. to paper & paper products	188	110	298	2	-	-	300
V.A. to petroleum refining & coal	3,732	-	6,167	11	-	-	6,178
V.A. to construction ind.	9,635	3,171	12,806	2,673	3,955	2,429	21,863
V.A. to electricity & water supply	1,337	574	1,911	1,727	236	148	4,022

Note: V.A. stands for "value added."
Source:"Gross Regional Product, 1977", NESDB

Table 3-4 Production in 1977

(unit: 1,000 ton/year)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	171	2,640	2,811	2,484	2,477	863	8,635
2. Sugarcane	-	15,399	15,399	2,355	1,187	-	18,941
3. Maize	-	284	284	917	395	28	1,624
4. Cassava	-	5,077	5,077	445	6,737	113	12,372
5. Soyabean	-	15	15	78	3	-	96
6. Mungbean	-	48	48	154	5	-	207
7. Rubber: raw rubber	-	9	9	-	-	402	411
processed rubber	122	71	193	59	-	159	411
8. Kenaf	-	1	1	1	244	-	246
9. Cotton	-	28	28	36	27	-	91
10. Livestock	16	347	363	204	233	127	927
11. Forest products	-	190	190	603	839	372	2,004
12. Fishery products	154	829	983	17	54	1,136	2,190
13. Mineral products	4	727	731	650	-	401	1,782
14. Sugar & molasses	-	2,070	2,070	317	159	-	2,546
15. Other processed foods	85	50	135	24	25	17	201
16. Beverages	133	78	211	19	35	10	275
17. Cement	2,726	1,581	4,307	318	2	456	5,083
18. Iron & Steel	190	-	190	-	-	-	190
19. Printing & writing paper	188	110	298	2	-	-	300
20. Woods & wood products	706	408	1,114	201	393	246	1,954
21. Petroleum products (refinery)	5,355	-	5,355	10	-	-	5,365
22. Textile products	257	149	406	25	37	1	469
23. Fertilizer	85	50	135	4	2	3	144
Total	10,192	30,161	40,353	8,923	12,854	4,334	66,464

First of all, the total consumption volume of each commodity in Thailand was derived by deducting the net export volume from the total production volume as shown in Table 3-5.

Export and import volumes of the selected commodities were mainly taken from the "Agricultural Statistics of Thailand" and the "Foreign Trade Statistics of Thailand". The origin of an export commodity was estimated by distributing the total export volume to each region in proportion to the surplus of regional production and consumption of the commodity. The destination of an import commodity was similarly estimated.

In order to begin with the regional distribution of each commodity exported and imported, it is necessary to estimate the regional consumption volume for each selected commodity.

Eventually, the total consumption volume of a commodity in Thailand was distributed to each regions based on the social and economic indicators shown in Table 3-3, and the method explained as follows:

1. Rice: Distributed proportionally to the respective regional population

2. Sugarcane: Assumed that the produced sugarcane is processed to sugar and molasses within the same production area.

3. Maize: Distributed proportionally to the regional amount of value added to the livestock industry.

4. Cassava: 20% distributed proportionally to the regional population and 80% proportionally to the regional amount of value added to the livestock industry.

5. Soyabean: Distributed proportionally to the regional population

6. Mungbean: Same as above.

7. Rubber: Assumed that all raw rubber produced is processed in Thailand to intermediate goods and exported for further manufacturing abroad, so that the regional consumption of raw rubber is estimated proportional to the regional amount of value added to the manufacturing of rubber and rubber products.

8. Kenaf: Distributed proportionally to the regional amount of value added to the textile industry.

9. Cotton: Same as above

10. Livestock: Distributed proportionally to the number of animals slaughtered by region.

11. Forest Products: 50% distributed proportionally to the regional amount of value added to the manufacturing of wood and cork and 50% proportionally to that of value added to the construction industry.

12. Fishery Products: 50% distributed proportionally to the regional amount of value added to animal husbandy and the other 50% distributed by the weighted population, namely 40, 16, 8 and 32 for C. Region, N. Region, N.E. Region and S. Region respectively.

13. Mineral Products: The metallic minerals were distributed proportionally to the regional amount of value added to the basic metal industry, and the non-metalic minerals are distributed proportionally to that of value added to the non-metallic industry.

14. Sugar & molasses: 50% distributed proportionally to the regional population and the other 50% proportionally to the regional amount of value added to the processed foods.

15. Other processed foods: Distributed proportionally to the gross regional product.

16. Beverages: Same as above.

17. Cement: Distributed proportionally to the regional amount of value added to the construction industry.

18. Iron & steel: 50% distributed porportionally to the regional amount of value added to the construction industry and the other 50% proportionally to the manufacturing industry.

19. Printing & writing paper: Distributed proportionally to the gross regional product.

20. Woods & wood products: 20% distributed proportionally to the regional population and 80% proportionally to the value added to the construction industry.

21. Petroleum products: 50%, 30%, and 20% each distributed proportionally to the regional amount of value added to the transportation/communications, electricity/water supply and manufacturing industry respectively.

22. Textile products: Distributed proportionally to the regional amount of value added to the manufacturing of wearing apparel and made-up textile goods.

23. Fertilizer: Distributed proportionally to the regional amount of value added to the crops production.

According to the above method of estimation for the regional consumption volume and the social and economic indicators estimated in Table 3-3 , the volumes of consumption, export and import were obtained for each of the selected commodities by region as summarized in Tables 3-6 and 3-7.

(2) Future social and economic development

For the estimation of future demand of commodity flows, social and economic development plans, either on national or regional levels, have to be considered and incorporated into the prediction of future production and consumption volumes by commodity.

"The Fourth National Economic and Social Development Plan, 1977 - 1981" and the "Greater Bangkok Plan 2000" are the most indicative of the national and regional development plans, and their frameworks have been applied to several recent studies such as "Bangkok Transportation Study", "First Stage Mass Transit System in Bangkok", "Feasibility Study for Outer Bangkok Ring Road" and so forth. By making use of the above study results, the following future framework of social and economic development was determined.

a) Population projection

Population projection for the GBA was estimated based on the study results of "First Stage Mass Transit System in Bangkok" and "The Comprehensive Study for Bangkok Suburban Transportation Project." Regarding regions other than the GBA, respective population growth rates are projected in the Fourth National Plan during the 1977/1981 period. The average annual growth rates for this period in Central Region, Northern Region, Northeastern Region and Southern Region are 2.62%, 1.97%, 2.24%, and 2.00% respectively. Making reference to the above mentioned reports and the Fourth National Plan, the future regional populations were estimated as shown in Table 3-8.

Table 3-5 Production Consumption, Export and Import Volumes by Commodity, Thailand, 1977

(unit: 1000 ton)

Commodities	Production	Export	Import	Consumption
1. Rice (Paddy x 0.7)	8,635	2,897	-	5,738
2. Sugarcane	18,941	-	-	18,941
3. Maize	1,624	1,544	-	80
4. Cassava	12,372	3,954	-	8,418
5. Soyabean	96	12	4	88
6. Mungbean	207	71	-	136
7. Rubber: raw rubber	411	-	-	411
processed rubber	411	402	-	9
8. Kenaf	246	79	-	167
9. Cotton	91	3	91	179
10. Livestock	927	-	-	927
11. Forest products	2,004	50	-	1,954
12. Fishery products	2,190	165	-	2,025
13. Mineral products	1,782	190	-	1,592
14. Sugar & molasses	2,546	1,700	-	846
15. Other processed foods	201	3	10	208
16. Beverages	275	-	-	275
17. Cement	5,083	296	-	4,787
18. Iron & Steel	190	-	810	1,000
19. Printing & writing paper	300	-	84	384
20. Woods & wood products	1,954	61	238	2,131
21. Petroleum products	5,365	-	-	5,365
22. Textile products	469	24	48	493
23. Fertilizer	144	-	886	1,030
Total	66,464	11,451	2,171	57,184

Table 3-6 Consumption in 1977

(unit: 1000 ton/yr.)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	691	1,090	1,781	1,219	2,029	709	5,738
2. Sugarcane	-	15,399	15,399	2,355	1,187	-	18,941
3. Maize	1	26	27	17	25	11	80
4. Cassava	308	2,531	2,839	1,782	2,702	1,095	8,418
5. Soyabean	12	17	29	17	31	11	88
6. Mungbean	16	26	42	29	48	17	136
7. Rubber: raw rubber	122	71	193	59	-	159	411
processed rubber	5	2	7	1	-	1	9
8. Kenaf	92	52	144	9	14	-	167
9. Cotton	98	57	155	9	15	-	179
10. Livestock	184	348	532	110	177	108	927
11. Forest products	784	347	1,131	219	372	232	1,954
12. Fishery products	228	672	900	368	447	310	2,025
13. Mineral products	836	485	1,321	112	1	158	1,592
14. Sugar & molasses	231	185	416	140	202	80	846
15. Other processed foods	72	50	122	31	29	26	208
16. Beverages	95	67	162	40	38	35	275
17. Cement	2,109	695	2,804	585	866	532	4,787
18. Iron & Steel	477	223	700	94	122	84	1,000
19. Printing & writing paper	133	92	225	56	54	49	384
20. Woods & wood products	802	329	1,132	298	459	243	2,131
21. Petroleum products	2,226	1,266	3,492	1,030	424	419	5,365
22. Textile products	290	168	458	15	10	10	493
23. Fertilizer	41	330	371	254	261	144	1,030
Total	9,853	24,528	34,381	8,849	9,513	4,447	57,184

Table 3-7 Export & Import, 1977

Export/Import (unit: 1000 ton/yr.)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	-	1,314/-	1,314/-	1,072/-	380/-	131/-	2,897/-
2. Sugarcane	-	-	-	-	-	-	-
3. Maize	-	260/-	260/-	898/-	369/-	17/-	1,544/-
4. Cassava	-	1,898/-	1,898/-	-	2,056/-	-	3,954/-
5. Soyabean	-/4	1/-	1/4	11/-	-	-	12/4
6. Mungbean	-	16/-	16/-	55/-	-	-	71/-
7. Rubber	117/-	69/-	186/-	58/-	-	158/-	402/-
8. Kenaf	-	-	-	-	79/-	-	79/-
9. Cotton	-/71	-/20	-/91	2/-	1/-	-	3/91
10. Livestock	-	-	-	-	-	-	-
11. Forest products	-	-	-	19/-	24/-	7/-	50/-
12. Fishery products	14/-	48/-	62/-	-	-	103/-	165/-
13. Mineral products	-	67/-	67/-	95/-	-	28/-	190/-
14. Sugar & molasses	-	1,556/-	1,556/-	144/-	-	-	1,700/-
15. Other processed foods	2/-	1/2	3/2	-/3	-/2	-/3	3/10
16. Beverages	-	-	-	-	-	-	-
17. Cement	129/-	167/-	296/-		-	-	296/-
18. Iron & Steel	-/331	-/204	-/535	-/86	-/112	-/77	-/810
19. Printing & writing paper	-	-/3	-/3	-/28	-/28	-/25	-/84
20. Woods & wood products	35/135	25/19	60/154	-/50	-/34	1/-	61/238
21. Petroleum products 1]	-	-	-	-	-	-	-
22. Textile products	-/28	-/17	-/45	5/-	19/-	-/3	24/48
23. Fertilizer	-/4	-/266	-/270	-/237	-/246	-/133	-/886
Total: Export/Import	297/573	5,422/531	5,719/1,104	2,359/404	2,928/422	445/241	11,451/2,171

Note: 1] Petroleum imports of 7,758 million tons are not included since refined products have more regional significance.

Table 3-8 Regional Population Projection

(Unit: 1,000 persons)

	1973	1977	Av. annual growth rate 1973/1977 (%)	The 4th Plan 1977/1981 (%)	Estimated growth rate 1977/2000 (%)	Estimated population 2000
GBA	4,679	5,560	4.41	-	2.63	10,110 [1]
C. Region outside GBA	8,249	8,910	1.92	-	2.18	14,620
C. Region	12,928	14,470	2.86	2.62	2.36	24,730 [1]
N. Region	8,309	9,107	2,32	1.97	2.05	14,535
N.E. Region	13,625	15,163	2.71	2.24	2.32	25,718
S. Region	4,802	5,300	2.50	2.00	2.08	8,517
Thailand	39,664	44,040	2.65	2.27	2.25	73,500 (73,614) [2]

Note: 1 derived from the "Comprehensive Study for Bangkok Suburban Transportation Project" JICA, 1979.

2 quoted from the "Quarterly Bulletin of Statistics, National Statistical Office, Dec., 1978", estimated by NESDB.

b) Gross Domestic Product (GDP)

According to the Fourth National Plan the target average annual growth rate between 1977 and 1981 is expected to be 7% in real terms. The actual growth rates in 1977, 1978 and 1979 are estimated by NESDB to be 6.2%, 8.7% and 7.5% respectively at 1972 prices. The achievement of Thai economy in the last three years will secure achievement of the economic development targeted GDP growth. Therefore, 7% average annual growth was taken in this study during the period of 1977/1981.

For the estimation of GDP growth for the subsequent years, recent transportation study reports were referred to and consequently it was assumed as follows:

Year 1977 - 1981	7% per annum
1981 - 1991	6% per annum
1991 - 2000	5% per annum

From the viewpoint of the industrial origin of GDP, each industrial development has been anticipated in the Fourth National Plan as shown in the table below. Taking these growth rates as tentative up to the year 2000, an adjustment was made to coincide with the previously estimated GDP in 1985 and 2000. The result is summarized in Table 3-9.

Table 3-9 Estimated Future GDP by Industrial Origin at 1972 Prices

(Unit: million Baht)

Industrial origin	1977	4th National Plan annual growth (%)	1985	2000
Agriculture:	63,742	5%	90,349	141,310
Crops	46,029	-	63,950	94,160
Livestock	8,214	-	11,588	17,522
Fishery	5,918	-	10,099	22,981
Forestry	3,581	-	4,712	6,647
Mining & Quarrying	3,365	3.2%	4,153	5,012
Manufacturing	47,082	9.6%	94,042	279,827
Construction	12,733	3.0%	15,474	18,138
Electricity & Water Supply	4,022	4.0%	5,280	7,155
Transportation & Communication	14,287	6.9%	23,375	47,843
Others	88,892	7.2%	154,765	353,308
Gross Domestic Product	234,123	7.0%	387,438	852,593

c) Production Targets of Major Commodities

Based on the Fourth National Plan, the production target of the major commodities in volume are as shown in Table 3-10.

The future growth rate of GDP, assumed previously, run downward from 7% in 1977 to 5% in 2000. Taking this into consideration the production growth rates from 1981 to 2000 was assumed to slow down also.

In the Fourth National Plan, however, some of the targeted growth rates are quite high, for example, cotton's production is expected to grow at 28.6% per annum. It is not conceivable that such a high annual growth rate for cotton will continue over 20 years. These higher growth rates were, therefore, adjusted as shown in Table 3-10.

Consequently, the average annual increase in the total production of the major commodities was estimated to be 5.6%, 4.9% and 4.3% for the periods of 1977/1981, 1981/1991 and 1991/2000 respectively as presented in Table 3-10.

d) Consumption, Export and Import of the Selected Commodities

Future production volumes of the selected commodities have been estimated previously, so that if one of the volumes of consumption, export or import is determined, the others can be derived based on the production volume.

Making reference to the Fourth National Plan, the target growth rates for export commodities were found during the

Table 3-10 Production Target by Commodity

(unit: 1000 ton)

Goods	Year	4th Plan Av. Annual Increase(%)	Year		
	1977		1981	1991	2000
Rice	8,635	2.3	9,457	10,808	11,191
Sugarcane	18,941	7.2	25,014	45,641	72,004
Maize	1,624	9.8	2,360	5,472	10,711
Cassava	12,372	3.2	14,033	17,505	19,612
Soyabean	96	8.3	132	267	462
Mungbean	207	8.9	291	621	1,129
Rubber	411	3.4	470	598	682
Kenaf	246	3.3	280	353	399
Cotton	91	28.6 1]	249	948	1,765
Livestock	927	8.9	1,304	2,785	5,062
Forest Products	2,004	1.3	2,110	2,186	2,072
Fishery Products	2,190	3.4	2,503	3,183	3,629
Mineral Products	1,782	3.4	2,037	2,588	2,953
Sugar & Molasses	2,546	7.5	3,377	6,162	9,721
Processed foods	201	9.6 2]	290	660	1,271
Beverages	275	9.6 2]	397	904	1,741
Cement	5,083	7.0	6,663	11,932	18,510
Iron & Steel	190	10.5	283	699	1,449
Paper & Pulp	300	19.5 3]	612	1,095	1,700
Woods & wood products	1,954	4.0 4]	2,286	3,081	3,700
Petroleum Products	5,365	7.0 5]	7,032	12,593	19,536
Textile Products	469	10.4	697	1,707	3,509
Fertilizer	144	9.6 2]	208	474	913
Total	66,053	-	82,085	132,262	193,721
Average annual growth(%)		5.6	4.9	4.3	

Note 1] Assumed to increase at 14.3% p.a. from 1981 to 1991 and 7.15% p.a. from 1991 to 2000.

2] Assumed to be the same growth rate as the total manufacturing industry of the 4th Plan.

3] Assumed to increase at 6% p.a. from 1981 to 1991 and 5% p.a. from 1991 to 2000.

4] Only includes plywood production.

5] Assumed to increase at the same rate as the Gross Domestic Product.

planning period 1977/1981 as shown in Table 3-10. At the same time, taking account of the slower economic growth rates as assumed in the previous item b), the growth rate in export up to the year 2000 was assumed to be somewhat lower than that of the Fourth National Plan as shown in Table 3-10.

Regarding the future import volume, there are as equivalent information available as for export volume. Therefore, in some cases, the unit consumption volume was derived from the existing consummed volume and then applied to the future population for estimating the future consumption volume. Consequently, the surplus of consumption or the production which was estimated previously in Table 3-5 is the import volume or export volume respectively.

In like manner, the future consumption, export and import volumes of the selected commodities were estimated. The basic data and assumptions used in this estimation are summarized in Table 3-11.

e) Regional Share of Economic Growth

The method of calculating the regional distribution is quite similar to the case used in the analysis of the existing regional production consumption, export and import volumes mentioned in item (1) of section 3.1.1. The only difference between the two is that the data and information about the present social and economic situation in Thailand are available somewhat in greater detail than for the future. The most useful data, however, are the "Gross Provincial Product, 1977 - 1981" by NESDB, which shows the gross provincial product by industrial origin from 1977 to 1981. These economic growth factors in each province (Changwat) were, therefore, utilized to estimate the future provincial product of the respective industry by extrapolation. The resulting provincial value added in the year 2000 was consolidated to find the regional value for each of the industries and its regional percentage share was calculated as shown in Table 3-12.

Table 3-11 Basic Data and Assumptions Used for Future Consumption or Export Volumes in Thailand, 2000

Selected Commodities	Consumption	Export	Description of basic data and assumptions
1. Rice	x	x	Per capita consumption volume was assumed to be the same as present
2. Sugarcane		x	Sugarcane other than sugar or molasses is not exported
3. Maize		x	Growth rate was found 6.4% p.a. in the 4th Plan and assumed to be 5.4% p.a. and 4.4% p.a. for 1981/1991 and 1991/2000 periods respectively
4. Cassava		x	Growth rate was found 1.4% p.a. in the 4th Plan and assumed to be 0.5% and 0% p.a. for 1981/1991 and 1991/2000 periods respectively
5. Soyabean		x	Growth rate was found 7.5% p.a. in the 4th Plan and assumed to be 6.5% and 5.5% p.a. for 1981/1991 and 1991/2000 periods respectively
6. Mungbean		x	Growth rate was found 3.7% p.a. in the 4th Plan and assumed to be 2.7% and 1.8% p.a. for 1981/1991 and 1991/2000 periods respectively
7. Rubber (processed)	x		The assumed growth rate of the export derived from the 4th Plan exceeds the estimated production volume, so that the future growth rate of the manufacturing industry was applied to the existing consumption volume
8. Kenaf	x		Similar results occurred as above when applying the 4th Plan for future export, so that the future growth rate in population was used to estimate the future consumption volume
9. Cotton	x		The future growth rate of the manufacturing industry was used to estimate the future consumption of raw cotton
10. Livestock		x	Growth rate was found 6.8% p.a. in the 4th Plan and assumed to be 5.8% and 4.8% p.a. for 1981/1991 and 1991/2000 periods
11. Forest products		x	Assumed that such a forest product as a teak is not exported in future but used for domestic industries
12. Fishery products		x	From the past growth trend in exports, 3.5% p.a. was taken to estimate the future export volume

Continued.....

Selected Commodities	Consumption	Export	Description of basic data and assumptions
13. Minerals		x	The weighted average growth rate of the export of several minerals was derived from the 4th Plan to be 4.4% p.a. and assumed to be 3.4% and 1.5% p.a. for 1981/1991 and 1991/2000 periods respectively
14. Sugar & Molasses		x	The growth rate of 4.5% p.a. was taken from the 4th Plan and assumed to be 3.5% and 2.5% p.a. for 1981/1991 and 1991/2000 periods respectively
15. Other processed foods	x		The future consumption volume was estimated by using the same growth rate as the GDP
16. Beverages		x	Assumed no export
17. Cement		x	Growth rate was found in the 4th Plan to be 7.5% p.a. and assumed to be 6.5% and 5.5% p.a. for 1981/1991 and 1991/2000 periods respectively.
18. Iron & Steel	x		Assumed that 50% of the existing consumption grows proportionally to manufacturing industry and the other 50% grows proportionally to construction industry
19. Printing & Writing paper	x		The future consumption volume is assumed to be proportional to the growth of Gross Regional Products
20. Woods & wood products	x		Assumed that 20% of the existing consumption grows proportionally to the population and the other 80% proportionally to the construction industry
21. Petroleum products	x		Taking the existing share of consumption among industries, that is 50% for transport, 30% for electricity and 20% for manufacturing, the future consumption volume was estimated by using the future growth rates of these industries to the respective share of consumption
22. Textile products	x		The future consumption volume was assumed to grow proportionally to the GDP
23. Fertilizer	x		The future consumption volume was assumed to grow proportionally to the crop production

Following the above assumptions, the future volumes of consumption, export and import of the selected commodities were estimated based on the future social and economic growth factors in Table 3-3 and also the future production in Table 3-10. The results are summarized in Table 3-12.

Table 3-12 Estimated Future Volumes of Production, Consumption Export and Import of Commodities in Thailand, 2000

(unit: 1000 ton)

Commodities	Production	Consumption	Export	Import
1. Rice (Paddy x 0.7)	11,191	9,578	1,613	-
2. Sugarcane	72,004	72,004	-	-
3. Maize	10,711	5,778	4,933	-
4. Cassava	19,612	15,218	4,394	-
5. Soyabean	462	430	32	-
6. Mungbean	1,129	1,003	126	-
7. Rubber: raw rubber	682	682		
processed rubber	682	53	629	-
8. Kenaf	399	279	120	-
9. Cotton	1,765	1,064	701	-
10. Livestock	5,062	4,968	94	-
11. Forest products	2,072	2,072	-	-
12. Fishery products	3,628	3,264	364	-
13. Mineral products	2,953	2,592	361	-
14. Sugar & molasses	9,721	6,149	3,572	-
15. Other processed foods	1,271	758	513	-
16. Beverages	1,741	1,741	-	-
17. Cement	18,510	17,309	1,201	-
18. Iron & Steel	1,449	3,684	-	2,235
19. Printing & writing paper	1,700	1,398	302	-
20. Woods & wood products	3,700	3,141	559	-
21. Petroleum products	19,536	19,536	-	-
22. Textile products	3,509	2,214	1,295	-
23. Fertilizer	913	2,107	-	1,194
Total	194,402	177,022	20,809	3,429

The regional distribution of the above national amounts will provide the basis for estimating the future cargo flows.

Table 3-13 Percentage Share of Regional Product by Industrial Origin, 2000

(Unit: %)

Industrial origin	GBA	C.Region outside GBA	Central Region	Northern Region	North-eastern Region	Southern Region	Thailand Total
Agriculture:							
Crops	3.7	43.2	46.9	20.2	20.2	12.7	100.0
Livestock	1.0	29.6	30.6	13.7	40.3	15.4	100.0
Fishery	1.9	38.8	40.7	5.9	10.6	42.8	100.0
Forestry	-	32.9	32.9	31.2	21.8	14.1	100.0
Mining & Quarrying	-	19.7	19.7	9.5	14.7	56.6	100.0
Manufacturing	68.0	22.1	90.1	5.0	2.4	2.5	100.0
Construction	39.8	13.9	53.7	7.4	26.0	12.9	100.0
Electricity & Water Supply	34.9	16.3	51.2	42.1	3.6	3.1	100.0
Gross Regional Product	39.3	20.3	59.6	12.9	11.9	15.6	100.0
Population	13.7	19.9	33.6	19.8	35.0	11.6	100.0

The estimation of regional production and consumption volumes were based on the above regional share of population, agricultural and industrial production and also the present pattern of the regional production and consumption volumes which were estimated in the previous Table 3-4, 6. The method used for this estimation is described as shown below.

Table 3-14 Description of the Distribution Method for Regions

Commodities	Application for:	Description of the regional distribution method
1. Rice	Production	The existing pattern of regional production is used to distribute the whole rice production to each of the regions
	Consumption	The unit consumption volume per capita in 1977 is applied to the future regional population
2. Sugarcane	Production	The existing pattern of regional production is applied
	Consumption	It is assumed that the sugarcane produced in a region is processed to sugar and molasses in the same region
3. Maize	Production	The existing pattern of regional production is applied
	Consumption	The regional share of livestock industry is applied
4. Cassava	Production	The existing pattern of regional production is applied
	Consumption	The existing pattern of regional consumption is applied
5. Soyabean	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is distributed proportionally to the regional population
6. Mungbean	Production	Same as above
	Consumption	
7. Rubber	Production	The existing pattern of regional production is applied
	Consumption	Proportionally to the regional manufacturing industry the whole consumption volume is distributed to each region
8. Kenaf	Production	The existing patterns of regional production and consumption are applied
	Consumption	
9. Cotton	Production	Same as above
	Consumption	
10. Livestock	Production	Proportionally distributed to the regions by the share of regional production of livestock industry
	Consumption	The existing pattern of regional consumption is applied
11. Forestry	Production	The existing pattern of regional production is applied
	Consumption	50% of the whole consumption is distributed by the existing pattern of regional consumption and the other 50% by the regional share of the construction industry
12. Fishery products	Production	Proportionally to the share of regional production of fishing industry the whole production volume is distributed
	Consumption	Proportional distribution by regional population

Continued.....

Commodities	Application for:	Description of the regional distribution method
13. Minerals	Production	The existing patterns of regional production and consumption are applied
	Consumption	
14. Sugar & Molasses	Production	Sugar is assumed to be produced in the same region as the sugarcane with the productivity of 13.4% of the sugarcane production
	Consumption	50% of the whole consumption is proportionally distributed by regional population and the remaining 50% by the existing pattern of regional production of processed foods
15. Processed foods	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is distributed proportionally to the gross regional products
16. Beverages	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is distributed proportionally to the gross regional products
17. Cement	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is distributed proportionally to the regional share of the construction industry
18. Iron & Steel	Production	The existing pattern of regional production is applied
	Consumption	50% of the whole consumption is proportionally distributed by the regional share of the manufacturing industry and the remaining 50% by that of the construction industry
19. Printing & Writing paper	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is distributed proportionally to the gross regional products
20. Woods & Wood products	Production	The existing pattern of regional production is applied
	Consumption	80% of the whole consumption is proportionally distributed by the regional share of the construction industry and the remaining 20% by the regional population
21. Petroleum products	Production	The existing pattern of regional production is applied
	Consumption	50% of the whole consumption is proportionally distributed by the regional share of the Transport and communications industry, 30% by the electricity and water supply industry and 20% by the manufacturing industry

Continued.....

Commodities	Application for:	Description of the regional distribution method
22. Textile	Production	The existing patterns of regional production and consumption are applied
	Consumption	
23. Fertilizer	Production	The existing pattern of regional production is applied
	Consumption	The whole consumption volume is proportionally distributed by the regional share of the agricultural crop production

The export and import volumes by region were determined by apportioning the respective volume of Thailand to regions proportionally to the size of difference between the regional production and consumption volume.

The regional production, consumption, export and import volumes for the year 2000 were calculated accordingly and the results are shown in Tables 3-15, 3-16 and 3-17.

Table 3-15 Production in 2000

(unit: 1000 ton/yr.)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	221	3,421	3,642	3,221	3,210	1,118	11,191
2. Sugarcane	-	58,539	58,539	8,953	4,512	-	72,004
3. Maize	-	1,873	1,873	6,048	2,605	185	10,711
4. Cassava	-	8,049	8,049	705	10,679	179	19,612
5. Soyabean	-	72	72	376	14	-	462
6. Mungbean	-	261	261	841	27	-	1,129
7. Rubber: raw rubber	-	15	15	-	-	667	682
: processed rubber	202	119	321	98	-	263	682
8. Kenaf	-	2	2	2	395	-	399
9. Cotton	-	544	544	697	524	-	1,765
10. Livestock	51	1,499	1,550	695	2,040	777	5,062
11. Forest products	-	197	197	623	867	385	2,072
12. Fishery products	67	1,404	1,471	215	385	1,557	3,628
13. Mineral products	7	1,205	1,212	1,076	-	665	2,953
14. Sugar & molasses	-	7,904	7,904	1,210	607	-	9,721
15. Other processed foods	537	317	854	152	158	107	1,271
16. Beverages	841	495	1,336	120	222	63	1,741
17. Cement	9,927	5,757	15,684	1,158	7	1,661	18,510
18. Iron & Steel	1,449	-	1,449	-	-	-	1,449
19. Printing & writing paper	1,066	623	1,689	11	-	-	1,700
20. Woods & wood products	1,336	773	2,109	381	744	466	3,700
21. Petroleum products (refinery)	19,500	-	19,500	36	-	-	19,536
22. Textile products	1,924	1,114	3,038	187	277	7	3,509
23. Fertilizer	539	317	856	25	13	19	913
Total	37,667	94,500	132,167	26,830	27,286	8,119	194,402

Table 3-16 Consumption in 2000

(unit: 1000 ton)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	1,318	1,905	3,223	1,894	3,351	1,110	9,578
2. Sugarcane	-	58,539	58,539	8,953	4,512	-	72,004
3. Maize	58	1,710	1,768	794	2,329	887	5,778
4. Cassava	557	4,576	5,133	3,221	4,884	1,980	15,218
5. Soyabean	59	85	144	85	151	50	430
6. Mungbean	138	199	337	198	352	116	1,003
7. Rubber: raw rubber	202	119	321	98	-	263	682
processed rubber	38	11	49	2	1	1	53
8. Kenaf	155	86	241	15	23	-	279
9. Cotton	583	339	922	53	89	-	1,064
10. Livestock	986	1,865	2,851	590	948	579	4,968
11. Forest products	787	360	1,147	183	478	264	2,072
12. Fishery products	449	649	1,098	645	1,142	379	3,264
13. Mineral products	1,361	789	2,150	182	2	258	2,592
14. Sugar & molasses	1,731	1,366	3,097	971	1,463	618	6,149
15. Other processed foods	298	154	452	98	90	118	758
16. Beverages	684	354	1,038	224	208	271	1,741
17. Cement	6,893	2,394	9,287	1,287	4,495	2,240	17,309
18. Iron & Steel	2,306	753	3,059	201	257	167	3,684
19. Printing & writing paper	549	284	833	180	167	218	1,398
20. Woods & wood products	1,067	476	1,543	322	880	396	3,141
21. Petroleum products (refinery)	8,087	4,651	12,738	4,072	942	1,784	19,536
22. Textile products	1,303	754	2,057	66	44	47	2,214
23. Fertilizer	78	909	987	427	426	267	2,107
Total	29,687	83,327	113,014	24,761	27,234	12,013	177,022

Table 3-17 Export & Import, 2000

Export/Import (Unit: 1,000 ton)

Commodities	GBA	Central Reg. outside GBA	Central Region	Northern Region	Northeastern Region	Southern Region	Thailand
1. Rice (Paddy x 0.7)	-	868/-	868/-	741/-	-	4/-	1,613/-
2. Sugarcane	-	-	-	-	-	-	-
3. Maize	-	890/-	890/-	3,841/-	202/-	-	4,933/-
4. Cassava	-	2,186/-	2,186/-	-	2,208/-	-	4,394/-
5. Soyabean	-	4/-	4/-	28/-	-	-	32/-
6. Mungbean	-	28/-	28/-	98/-	-	-	126/-
7. Rubber (processed)	164/-	108/-	272/-	96/-	-	261/-	629/-
8. Kenaf	-	-	-	-	120/-	-	120/-
9. Cotton	-	115/-	115/-	350/-	236/-	-	701/-
10. Livestock	-	-	-	7/-	74/-	13/-	94/-
11. Forest products	-	-	-	-	-	-	-
12. Fishery products	31/-	106/-	137/-	-	-	227/-	364/-
13. Mineral products	-	127/-	127/-	181/-	-	53/-	361/-
14. Sugar & molasses	-	3,450/-	3,450/-	122/-	-	-	3,572/-
15. Other processed foods	234/-	159/-	393/-	53/-	67/-	-	513/-
16. Beverages	-	-	-	-	-	-	-
17. Cement	564/-	637/-	1,201/-	-	-	-	1,201/-
18. Iron & Steel	-/857	-/753	-/1,610	-/201	-/257	-/167	-/2,235
19. Printing & writing paper	182/-	120/-	302/-	-		-	302/-
20. Woods & wood products	203/-	259/-	462/-	44/-	-	53/-	559/-
21. Petroleum products [1]	-	-	-	-	-	-	-
22. Textile products	603/-	349/-	952/-	117/-	226/-	-	1,295/-
23. Fertilizer	-	-/427	-/427	-/290	-/298	-/179	-/1,194
Total: Export/Import	1,981/857	9,406/1,180	11,387/2,037	5,678/491	3,133/555	611/346	20,809/3,429

Note: 1] Petroleum imports not included since refined products have more regional significance.

(3) Generated and Attracted Cargo Traffic

The method of converting produced and consumed cargo volumes by zone into generated and attracted cargo traffic is as follows:

In general, cargo flows result from the difference between produced and consumed cargo in a zone. However, it is universally recognized that actual cargo flow will be greater than this quantified difference since even in a zone which has exactly the same amount of production and consumption of goods, the generated and attracted cargo flows into and out of the zone are considerable.

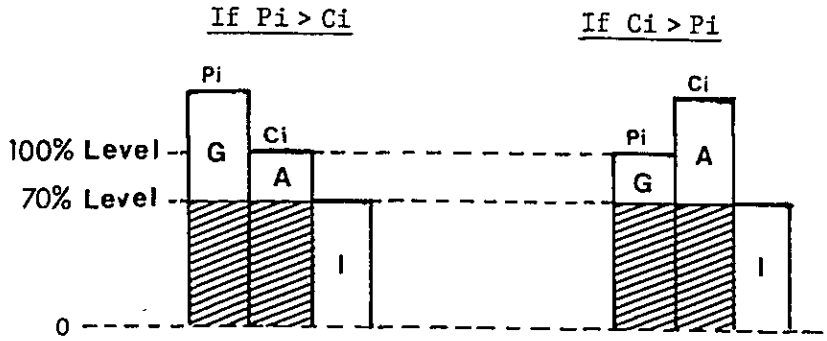
It is very hard to confirm the actual ratio of generated and attracted cargo volumes by quantitative analysis, because the elements which have an influence on the cargo flows consists of many factors such as type of commodity, modal split for cargo traffic, etc.

Nonetheless, the Origin and Destination Survey has established the internal trip rate as 30 percent and the external trip rate as 70% by difference. Using this trip rate, the following formulas were applied to estimate the generated and attracted cargo flows for each zone.

Zonal Condition	Intra-zonal Cargo Volume	Attracted Cargo Volume	Generated Volume
If production > consumption (Pi > Ci)	Ci x 0.7	Ci x 0.3	(Pi - Ci) + Ci x 0.3
If consumption > production (Ci > Pi)	Pi x 0.7	(Ci - Pi) + Pi x 0.3	Pi x 0.3

Where Pi = Produced cargo volumes in Zone-i
Ci = Consumed cargo volumes in Zone-i

The estimation of intra-zonal, generated and attracted traffic is conceptually summarized in the following figure:



G : Generated cargo volume

A : Attracted cargo volume

I : Intra-zonal cargo volume

(4) Modal Split for Cargo Traffic

Modal split models can be applied to the transport model in one of two ways. First, by relating the number of trip ends in a zone to trip origin characteristics, thereby introducing the modal split before trip distribution. Alternatively models of modal split can be incorporated after the distribution phase. In this study, the previous method is preferred for the reasons mentioned below.

a) Existing Situation

According to the survey results of TMIS (Transport Management Information System) for the Ministry of Communications, the modal percentages of cargo flow by commodity and direction (inbound and outbound) are shown in Table 3-18 and summarized by Region in Table 3-19 below.

Table 3-19 Summary of Modal Split, 1976

(Unit: %)

Direction	Region	By Transport Mode			By Region
		Truck	Rail	Water	
Inbound to GBA	Central	39.6	3.8	37.1	80.5
	North	4.4	2.1	2.4	8.9
	Northeast	8.6	0.6	-	9.2
	South	0.8	0.6	-	1.4
	Sub-Total	53.5	7.1	39.5	100.0
Outbound from GBA	Central	26.1	3.5	9.6	39.2
	North	11.5	12.5	0.2	24.2
	Northeast	17.7	8.6	-	26.3
	South	2.3	8.0	-	10.3
	Sub-Total	57.6	32.6	9.8	100.0
Total	Inbound Outbound	54.1	11.0	34.9	-

Source: TMIS

Fig. 3-14 illustrates the results of modal split based on Table 3-19 data. According to this data, the following comments regarding cargo traffic flow can be made.

1. Approximately 50% of both inbound and outbound cargo enters and leaves the GBA by trucks.

2. The major transport modes of inbound cargo consists of truck and waterway but for outbound cargo mainly consists of truck and railway.

3. The diversion rate of railway is affected by the distance from GBA. The diversion rate increases in the following regional order: Central, Northeast, North and South.

4. The diversion rate of waterway is only large for inbound and outbound cargo flows between the GBA and the Central Region and inbound flows from the North Region.

   Future use of waterways depends on the natural conditions of the Chaophraya River.

5. The diversion rate of trucks is largest for the Central Region for both inbound and outbound cargo flows.

6. Trend of Modal Split

   Although past records of cargo transport by mode are limited and of unequal levels of detail, the data which is available is presented in the following Tables 3-20 and 3-21.

Table 3-18 Transport Modal Split of Selected Major Commodities, 1976

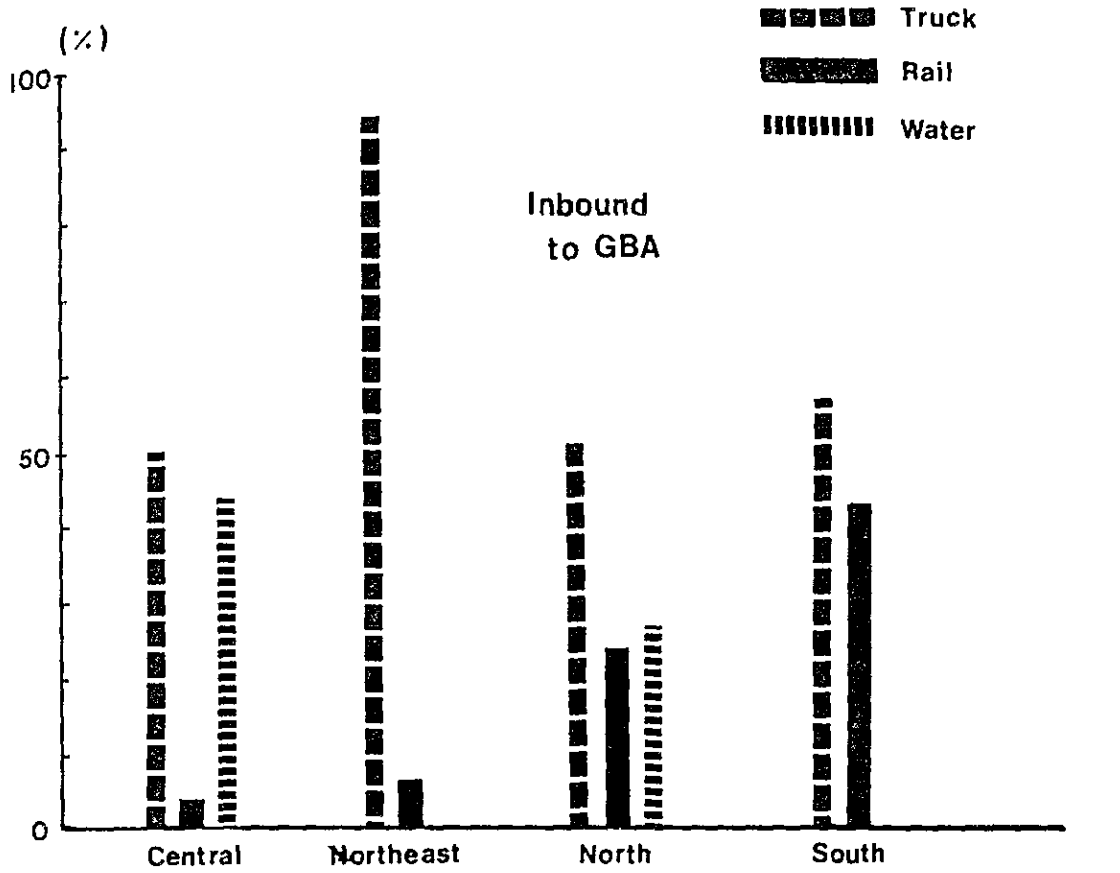
		Inbound			Outbound		
		Truck	Rail	Water	Truck	Rail	Water
Central Region	Rice	42.5	0.0	57.5	99.2	0.0	0.8
	Maize	18.3	0.0	81.7	22.2	0.0	77.8
	Tapioca	85.3	-	14.7	78.8	0.0	21.2
	Other Farm Prod.	78.4	0.6	21.0	79.0	0.0	21.0
	Sub-Total	56.0	0.2	43.8	77.1	0.0	22.9
	Sugar	100.0	-	-	100.0	-	-
	Forest Prod.	88.2	-	11.8	56.1	-	43.9
	Const. Mat.	30.0	-	70.0	80.1	1.2	18.7
	Man. Goods	96.7	-	3.3	68.1	-	31.9
	Other Goods	46.4	1.9	51.7	92.8	4.6	2.6
	Average	49.2	4.7	46.1	66.5	9.0	24.5
North Region	Rice	35.8	12.9	51.3	100.0	0.0	0.0
	Maize	33.9	10.8	55.3	-	-	100.0
	Tapioca	97.8	-	2.2			
	Other Farm Prod.	89.9	7.9	2.2	94.6	3.6	1.8
	Sub-Total	53.7	9.5	36.8	93.2	3.6	3.2
	Sugar	70.3	29.7	-	100.0	-	-
	Forest Prod.	95.5	-	4.5	97.0	-	3.0
	Const. Mat.	60.1	-	39.9	73.5	26.5	-
	Man. Goods	82.2	17.6	0.2	93.5	6.0	0.5
	Other Goods	90.3	9.7	-	64.2	35.5	0.3
	Average	50.0	23.5	26.5	47.6	51.6	0.8

Continued.....

Table 3-18 Cont'd

		Inbound			Outbound		
		Truck	Rail	Water	Truck	Rail	Water
Northeast Region	Rice	77.0	23.0	0.0	53.7	0.0	46.3
	Maize	92.6	7.4	0.0	100.0	-	-
	Tapioca	100.0	-	-	100.0	-	-
	Other Farm Prod.	93.9	-	-	98.3	1.7	-
	Sub-Total	95.7	4.3	-	98.6	1.4	
	Sugar	100.0	-	-	100.0	-	-
	Forest Prod.	100.0	-	-	100.0	-	-
	Const. Mat.	100.0	-	-	87.9	12.1	-
	Man. Goods	100.0	-	-	99.4	0.6	-
	Other Goods	77.2	22.8	-	82.6	17.4	-
	Average	93.5	6.5	-	67.2	32.8	-
South Region	Rice	-	-	-	18.7	81.3	0.0
	Maize	-	-	-	-	100.0	-
	Tapioca	-	-	-	-	-	-
	Other Farm Prod.	68.1	31.9	-	13.9	86.1	-
	Sub-Total	68.1	31.9		12.7	87.3	-
	Sugar	-	-	-	17.1	82.9	-
	Forest Prod.	78.4	21.6	-	80.8	19.2	-
	Const. Mat.	33.3	66.7	-	22.0	78.0	-
	Man. Goods	69.8	30.2	-	29.5	70.5	-
	Other Goods	49.4	50.6	-	26.4	73.6	-
	Average	57.0	43.0	-	22.3	77.7	-

Fig. 3-4 TRANSPORT MODAL SPLIT BY REGION AND DIRECTION



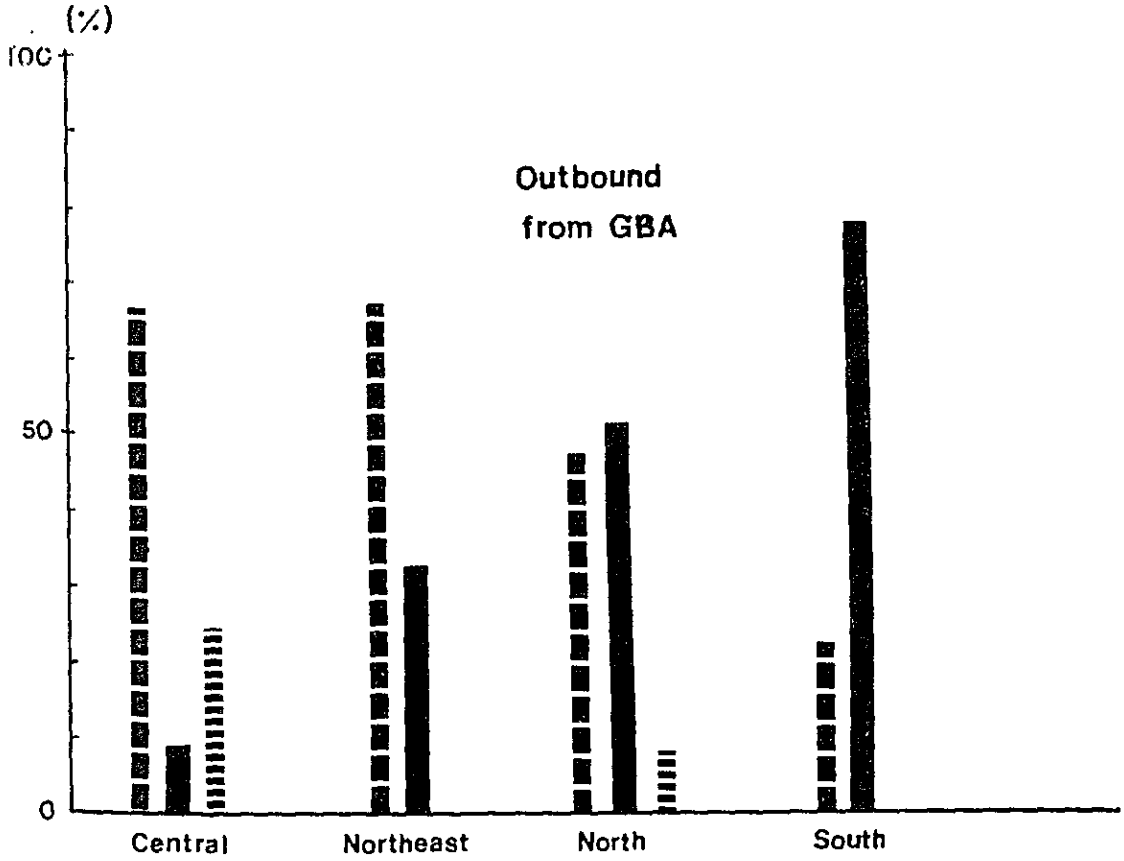


Table 3-20 Annual Commodity Volumes Carried by Railway, 1972 - 1978.

	Annual Tonnage (1000 tons)			Ton-Kilometers (1000 Kms)		
	1972	1978	Average Annual Growth Rate (%)	1972	1978	Average Annual Growth Rate (%)
Rice Products	454	347	-4.3	264,309	272,924	0.5
Sugar	13	89	37.8	7,656	24,538	21.4
Other Farm Products	316	293	-1.3	177,891	278,519	7.8
Forestry	311	333	1.1	185,239	186,509	0.1
Fishery	37	52	5.8	25,632	34,426	5.0
Construction Materials	971	1,674	9.5	325,406	368,255	2.1
Manufactured Goods	193	226	2.7	94,038	146,194	7.6
Livestock	19	50	17.5	7,792	16,364	13.2
Minerals	808	975	3.2	179,748	215,405	3.1
Petroleum Products	1,465	1,430	-0.4	783,462	708,465	-1.7
Others	401	692	9.5	191,644	488,827	16.9
Total	4,988	6,161	3.6	2,242,817	2,740,926	3.4

Source: Marketing Department, SRT

Tonnage and Ton-Kms carried by railway and by year is summarized as follows:

Table 3-21 Total Annual Commodity Volume Carried by Railway, 1972 - 1978

	Annual Tonnage		Ton-Kilometers		Average Trip Length (Kms)
	(1000 tons)	Index	(1000 Kms)	Index	
1972	4,988	100.0	2,242,817	100.0	450
73	4,703	94.3	2,069,737	92.2	440
74	4,835	96.9	2,296,353	102.4	475
75	4,819	96.6	2,353,264	104.9	488
76	5,156	103.4	2,504,584	111.7	486
77	6,142	123.1	2,911,995	129.8	474
78	6,161	123.5	2,740,926	122.2	445

Source: Marketing Department, SRT

Tonnage handled at Bangkok Port by year is summarized as follows:

Table 3-22 Total Annual Tonnage Handled at Bangkok Port, 1972 - 1978.

(Unit: 1000 tons)

Year	Inbound	Outbound	Total	Growth Rate
1972	4,485	7,796	12,281	100.0
73	4,863	6,827	11,690	95.2
74	4,244	8,772	13,016	106.0
75	3,902	8,732	12,634	102.9
76	4,792	11,020	15,812	128.8
77	6,198	12,525	18,723	152.5
78	7,463	13,025	20,488	166.8

Source: Statistical Section, Port Authority.

The number of vans and trucks registered and the corresponding cross-sectional truck traffic volumes on the boundary of GBA are summarized in Table 3-23.

Table 3-23 Growth of Registered Trucks, 1972 - 1977

Year	Number of Vehicle Registered	Index	Cross-Sectional Truck Volume 1] (Veh/day)	Index
1972	147,498	100.0	14,490 2]	100.0
73	172,073	116.7	15,980 2]	110.0
74	224,119	151.9	21,025	145.0
75	224,142	152.0	20,380	141.0
76	276,879	187.7	22,774	157.0
77	-	-	30,512	211.0

Source: Police Department, Department of Highways.

Note 1] Total of light, heavy and trucks over 2 axles.

2] Excludes traffic volumes on Thonburi-Pak Tho Highway.

Based on this data, the trend for each transport mode is summarized below:

1. The total cargo traffic volume for all modes increased steadily during the period 1972 to 1977/8.

2. Cargo transportation by truck increased most rapidly followed by waterway and then by railway.

3. Therefore, the trend of the occupancy ratio for each mode to the total cargo flow is summarized as follows:

   - The share of trucks will increase
   - The share of waterway will remain approximately constant
   - The share of railways will decline.

c) Future Trend of Modal Split

Based on the statistical data for each mode and the many factors which will have some relationship with cargo movement such as transportation distance, transportation frequency required and transportation cost, etc., correlation and multiple regression analyses (forward selection) were made; however, the results did not prove to be significant because of the scattered nature of the data. Therefore, in this study, the future modal split was determined in accordance with the existing modal split data and the past growth trends of transport modes. The results are summarized in Table 3-24 and described below.

1. The share of cargo transported by truck will increase in all directions and for all commodities.

2. The cargoes which do not use a certain mode of transportation now are assumed to continue to have no use of that mode in the future.

3. The transported volumes by railway and waterway will increase, but their share of total cargo movement will decrease.

4. Even for medium and long distance transport, the share of trucks will increase.

(5) Establishment of the Present O-D Matrices

The basic year of establishment of O-D matrices was fixed as 1976 since this is the year for which the latest data is complete and available. The work flow for the establishment of O-D matrices is shown in Fig. 3-5 and described in detail in the following sections.

Table 3-24 Transport Modal Split of Selected Major Commodities, 2000

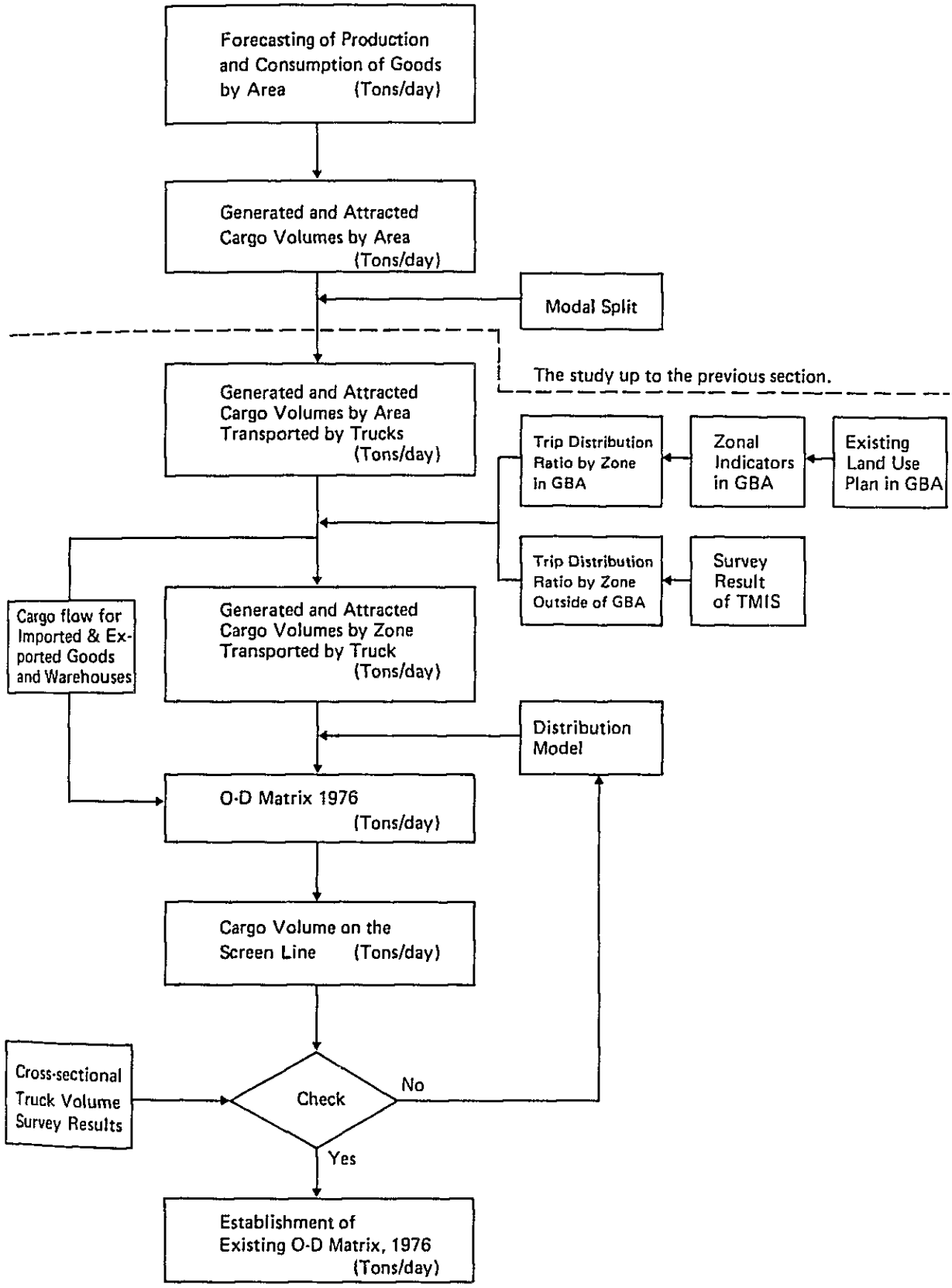
		Inbound			Outbound		
		Truck	Rail	Water	Truck	Rail	Water
Central Region	Rice	70.0	-	30.0	100.0	-	0.0
	Maize	18.3	-	81.7	22.2	-	77.8
	Tapioca	85.3	-	14.7	78.8	-	21.2
	Other Farm Prod.	78.4	0.6	21.0	79.0	-	21.0
	Sub-Total	70.0		30.0	90.0		10.0
	Sugar	100.0	-	-	100.0	-	
	Forest Prod.	95.0	-	5.0	80.0	-	20.0
	Const. Mat.	50.0	-	50.0	90.0	-	10.0
	Man. Goods	100.0	-	-	80.0	-	20.0
	Other Goods	70.0	1.0	29.0	95.0	4.0	1.0
North Region	Rice	60.0	5.0	35.0	100.0	-	0.0
	Maize	33.9	10.8	55.3	-	-	100.0
	Tapioca	97.8	-	2.2	-	-	-
	Other Farm Prod.	89.9	7.9	2.2	94.6	3.6	1.8
	Sub-Total	75.0	5.0	20.0	100.0	-	-
	Sugar	80.0	20.0	-	100.0	-	-
	Forest Prod.	100.0	-	-	100.0	-	-
	Const. Mat.	80.0	-	20.0	90.0	10.0	-
	Man. Goods	90.0	10.0	-	100.0	-	-
	Other Goods	95.0	5.0	-	80.0	20.0	-

Continued.....

Table 3-24 Cont'd

		Inbound			Outbound		
		Truck	Rail	Water	Truck	Rail	Water
Northeast Region	Rice	85.0	15.0	-	70.0	-	30.0
	Maize	-	7.4	-	100.0	-	-
	Tapioca	100.0	-	-	100.0	-	-
	Other Farm Prod.	93.9	6.1	-	98.3	1.7	-
	Sub-Total	100.0			100.0		
	Sugar	100.0	-	-	100.0	-	-
	Forest Prod.	100.0	-	-	100.0	-	-
	Const. Mat.	100.0	-	-	95.0	5.0	-
	Man. Goods	100.0	-	-	100.0	-	-
	Other Goods	90.0	10.0	-	95.0	5.0	-
South Region	Rice	-	-	-	-	-	-
	Maize	-	-	-	50.0	50.0	-
	Tapioca	-	-	-	-	-	-
	Other Farm Prod.			-	13.9	86.1	-
	Sub-Total	80.0	20.0		50.0	50.0	
	Sugar	-	-	-	17.1	82.9	-
	Forest Prod.	90.0	10.0	-	95.0	5.0	-
	Const. Mat.	60.0	40.0	-	50.0	50.0	-
	Man. Goods	80.0	20.0	-	50.0	50.0	-
	Other Goods	60.0	40.0	-	50.0	50.0	-

Fig. 3–5 WORK FLOW FOR ESTABLISHMENT OF EXISTING O-D MATRIX



a) Trip distribution ratio by zone in GBA

Based on the O-D survey results of cargo traffic conducted, in this study, attracted cargo volumes by zones in GBA were analysed. Zonal growth indicators covering land use factors and demographic factors were also examined. The list of zonal indicators is shown below:

Zonal Indicators:

Land Use Factors	x_1 : Mixed use low density area x_2 : Mixed use high density area x_3 : Institutional area x_4 : Industrial area x_5 : Agricultural area x_6 : Other areas
Demographic Factors	x_7 : Residential population x_8 : Economically active population sector-I x_9 : Economically active population sector-II x_{10}: Economically active population sector-III x_{11}: Workers at work places sector-II x_{12}: Workers at work places sector-III x_{13}: Traffic-relevant students

The data for these zonal indicators for 1977 was taken from "The Comprehensive Study for Bangkok Suburban Transportation Project" and is shown in Table 3-25 and 3-26.

This data is based on the Department of Town and Country Planning Office Land Use Plan in 1976.

Using this data and the O-D survey results, correlational analysis and multiple regression analysis using the forward selection method were performed. However, since land use multiple coefficient results were not significant (r = less than 0.6) and the sample size of trucks surveyed was small, no useful distribution model could be established. Consequently, using the zonal demographic indicators, which had a high correlation ratio, the zonal generated and attracted cargo volumes were calculated.

The demographic zonal indicators used in this analysis to distribute total cargo volumes in the GBA for both producion and consumption are summarized in Table 3-27 .

Table 3-25 Land Use Zonal Data, 1977

(Unit: Ha)

Zone No.	Name of Zone	Mixed Use Low Dinsity	Mixed Use High Density	Insti-tutional	Industrial	Agri-cultural	Others	Total
1	Phra Nakhon	23	409	223	59	-	454	1,168
2	Dusit	217	81	545	41	-	241	1,125
3	Bang Su	594	91	22	75	105	451	1,338
4	Phayathai	725	383	444	119	-	55	1,726
5	Pathumwan	192	472	269	13	-	265	1,211
6	Yannawa	266	303	75	131	328	249	1,352
7	Bang Pong Pang	580	128	102	103	276	309	1,498
8	Bang Kapi	363	50	3	14	94	72	596
9	Samsen	1,056	114	30	23	279	180	1,682
10	Lat Yao	2,077	115	397	395	-	408	3,392
11	Thung Song Hong	417	-	214	8	840	216	1,695
12	Thung Si Kan	378	5	42	3	1,516	116	2,060
13	Talat Bang Khen	498	12	291	453	-	358	1,612
14	Khlong Thanon	734	31	388	-	3,113	469	4,735
15	Thareng	1,209	13	406	16	743	913	3,300
16	Lat Phrao	1,419	-	22	9	1,917	-	3,367
17	Khlong Chan	1,514	52	17	33	1,442	-	3,058
18	Khlong Kum	847	16	3	75	3,059	116	4,116
19	Saphan Sung	114	-	-	-	1,473	-	1,587
20	Huamak	289	31	45	30	1,015	97	1,507
21	Phra Khanong	1,597	545	84	194	98	451	2,969
22	Suan Luang	578	36	3	11	1,549	82	2,259
23	Bang Na	1,147	94	1 105	220	1,254	150	2,970
24	Nong Bon	441	8	5	5	2,807	-	3,266
25	Prawet	555	-	-	106	2,968	208	3,837
26	Bang Chan	828	-	-	2	11,293	-	12,123
27	Minburi	513	9	17	36	5,651	2	6,228
28	Lat Krabang	444	19	17	8	3,700	95	4,283
29	Nong Chok	20	-	-	-	32,261	-	32,281
30	Bang O	816	150	22	13	222	206	1,429
31	Sirirat	380	419	120	28	385	325	1,657
32	Thonburi	264	434	73	87	16	582	1,456
33	Rat Burana	431	45	28	220	689	106	1,519
34	Thung Khru	219	5	20	2	2,848	19	3,113
35	Bang Khun Tian	439	94	16	72	1,491	81	2,193
36	Phasi Charoen	450	27	13	62	1,313	66	1,931
37	Taling Chan	366	6	5	6	4,807	-	5,190
38	Sala Than Masop	81	-	-	-	3,514	-	3,595
39	Nong Khaem	1,062	28	86	-	7,444	-	8,620
40	Bang Bon	242	-	-	41	12,273	-	12,556
	Bangkok Metropolis	24,385	4,225	4,152	2,713	112,783	7,342	155,600
41	Bang Ko Bua	77	-	3	28	745	209	1,062
42	Bang Yo	70	-	13	48	584	212	927
43	Bang Talat	128	77	22	144	267	293	931
44	Bang Chak	84	6	6	147	548	58	849
45	Bang Ya Phraek	62	19	9	84	650	175	999
46	Samrong Tai	133	14	3	403	497	63	1,113
47	Samut Prakan	-	86	65	36	445	320	952
48	Bang Muang	330	-	8	13	1,031	266	1,648
49	Samrong Nua	937	28	6	50	848	90	1,959
50	Bang Duan	116	-	5	2	423	273	819
51	Phraek Sa	336	-	-	2	4,020	-	4,358
52	Thai Ban	333	-	5	123	1,241	41	1,743
53	Bang Pumai	419	8	23	123	2,545	2,266	5,384
54	Bang Kaeo	102	-	-	2	2,477	-	2,581
55	Bang Phli Yai	445	3	3	3	4,363	-	4,817
56	Bang Pla	283	-	-	-	3,094	2,419	5,796
57	Bang Chalong	89	-	-	25	3,013	-	3,127
58	Racha Thewa	401	-	-	-	5,374	85	5,860
59	Srisa Charakhe	-	-	-	14	5,311	-	5,325
60	Bang Bo	169	9	-	5	28,777	-	28,960
61	Bang Pakok	150	5	16	103	2,263	138	2,675
62	Laem Fa Pha	155	-	219	6	11,135	-	11,515
	Samut Prakan	4,819	255	406	1,361	79,651	6,908	93,400
63	Wat Chalo	166	3	11	23	1,114	51	1,368
64	Bang Khanum	102	-	2	-	2,004	-	2,108
65	Bang Kruai	47	-	-	-	2,137	-	2,184
66	Nonthaburi	651	45	230	27	818	93	1,864
67	Bang Kraso	917	13	75	56	1,137	59	2,257
68	Bang Krang	148	8	6	2	3,066	84	3,314
69	Pak Kret	502	12	134	105	4,306	250	5,309
70	On Kret	98	8	11	-	3,933	131	4,181
71	Bang Bua Thong	622	2	-	6	44,385	-	45,015
	Nonthaburi	3,253	91	469	219	62,900	668	67,600
	Greater Bangkok Area	32,457	4,571	5,027	4,293	255,334	14,918	316,600

Source: The Comprehensive Study for Bangkok Suburban Transportation Project.

Table 3-26 Demographic Zonal Data, 1977

(Unit: 1,000 Persons)

Zone No.	Name of Zone	Residential Population	Gross Population Density (Persons/Ha)	Economically Active Population			Workers at Work Places		Traffic Relevant Students
				Sector I	Sector II	Sector III	Sector II	Sector III	
1	Phra Nakhon	406.9	548.4	-	32.8	65.4	21.8	83.9	16.7
2	Dusit	284.6	253.0	-	22.9	45.7	11.1	76.9	11.7
3	Bang Su	146.1	109.2	0.1	11.8	23.5	9.8	16.7	6.0
4	Phayathai	547.2	317.0	-	44.0	87.9	28.3	110.3	22.5
5	Pathumwan	349.9	288.9	-	28.2	56.2	19.1	91.9	14.4
6	Yannava	257.7	130.6	0.2	20.7	41.4	20.2	44.2	10.6
7	Bang Pong Pang	110.6	73.8	0.2	8.9	17.8	11.5	19.4	4.5
8	Bang Kapi	24.6	24.2	0.1	2.0	4.0	2.4	6.2	1.0
9	Samsen	93.7	55.7	0.2	7.5	15.1	6.0	16.5	3.8
10	Lat Yao	142.6	42.0	-	11.5	22.9	29.1	22.8	5.8
11	Thung Song Hong	14.4	8.5	0.5	1.2	2.3	8.9	2.9	0.6
12	Thung Si Kan	26.2	12.7	1.0	2.1	4.2	1.0	2.2	1.1
13	Talat Bang Khen	42.5	26.4	-	3.4	6.8	6.6	6.3	1.7
14	Khlong Thanon	79.9	16.9	2.0	6.4	12.8	2.6	11.1	3.3
15	Thareng	36.5	11.1	0.5	2.9	5.9	2.1	2.3	1.5
16	Lat Phrao	33.7	10.0	1.2	2.7	5.4	1.3	2.0	1.4
17	Khlong Chan	69.7	22.8	0.9	5.6	11.2	4.7	8.9	2.9
18	Khlong Kum	32.9	8.0	2.0	2.6	5.3	5.5	3.2	1.3
19	Saphan Sung	9.0	5.7	0.9	0.7	1.4	0.2	0.4	0.4
20	Huamak	21.7	14.4	0.7	1.7	3.5	2.9	4.7	0.9
21	Phra Khanong	259.2	87.3	0.1	20.9	41.7	28.9	68.8	10.6
22	Suan Luang	50.0	22.1	1.0	4.0	8.0	2.5	6.1	2.1
23	Bang Na	119.5	40.2	0.8	9.6	19.2	17.8	16.6	4.9
24	Nong Bon	20.9	6.4	1.8	1.7	3.4	1.0	1.9	0.9
25	Prawet	24.8	6.5	1.9	2.0	4.0	6.8	1.2	1.0
26	Bang Chan	22.7	1.9	7.2	1.8	3.7	0.7	1.1	0.9
27	Minburi	25.7	4.1	3.6	2.1	4.1	2.9	2.4	1.1
28	Lat Krabang	20.7	4.8	2.4	1.7	3.3	1.4	5.1	0.9
29	Nong Chok	65.2	2.0	20.7	5.2	10.5	1.6	3.2	2.7
30	Bang O	126.4	88.5	0.1	10.2	20.3	7.0	21.6	5.2
31	Sirirat	341.9	206.3	0.2	27.5	54.9	18.6	60.5	14.0
32	Thonburi	390.4	268.1	-	31.4	62.7	23.6	64.0	16.0
33	Rat Burana	75.1	49.4	0.4	6.0	12.1	15.7	8.5	3.1
34	Thung Khru	23.3	7.5	1.8	1.9	3.8	0.8	1.9	1.0
35	Bang Khun Tian	123.4	56.3	1.0	9.9	19.8	9.2	15.8	5.1
36	Phasi Charoen	99.2	51.4	0.8	8.0	15.9	6.6	7.7	4.1
37	Taling Chan	47.0	9.1	3.1	3.8	7.6	1.7	3.0	1.9
38	Sala Than Masop	13.2	3.7	2.2	1.1	2.1	0.3	0.7	0.5
39	Nong Khaem	100.1	11.6	4.8	8.1	16.1	3.1	8.7	4.1
40	Bang Bon	59.9	9.8	7.9	4.8	9.6	3.9	3.0	2.5
	Bangkok Metropolis	4,739.0	30.5	72.3	381.3	761.5	341.2	837.6	194.7
41	Bang Ko Bua	15.2	14.3	0.5	1.2	2.4	2.0	0.8	0.6
42	Bang Yo	14.0	15.1	0.4	1.1	2.2	3.1	0.8	0.6
43	Bang Talat	40.9	43.9	0.2	3.3	6.6	11.3	10.2	1.7
44	Bang Chak	8.9	10.5	0.4	0.7	1.4	9.0	1.1	0.4
45	Bang Ya Phraek	16.5	16.5	0.4	1.3	2.7	5.7	2.8	0.7
46	Samrong Tai	29.7	26.7	0.3	2.4	4.8	24.8	2.9	1.2
47	Samut Prakan	48.4	50.8	0.3	4.0	7.8	5.0	12.0	2.0
48	Bang Muang	23.9	14.5	0.7	1.9	3.8	1.4	1.3	1.0
49	Samrong Nua	32.8	16.7	0.5	2.6	5.3	4.3	4.5	1.3
50	Bang Duan	11.1	13.6	0.3	0.9	1.8	0.4	0.7	0.4
51	Phraek Sa	6.6	1.5	2.6	0.5	1.1	0.3	0.3	0.3
52	Thai Ban	19.0	10.9	0.8	1.5	3.0	7.8	1.0	0.8
53	Bang Pumai	15.6	2.9	1.6	1.3	2.5	7.8	1.8	0.6
54	Bang Kaeo	8.5	3.3	1.6	0.7	1.4	0.3	0.4	0.3
55	Bang Phli Yai	13.8	2.9	2.8	1.1	2.2	0.6	1.0	0.6
56	Bang Pla	9.9	1.7	2.0	0.8	1.6	0.2	0.5	0.4
57	Bang Chalong	8.0	2.6	1.9	0.7	1.3	1.7	0.4	0.3
58	Racha Thewa	11.1	1.9	3.4	0.9	1.8	0.3	0.6	0.5
59	Srisa Charakhe	8.8	1.7	3.4	0.7	1.4	1.0	0.4	0.4
60	Bang Bo	72.5	2.5	18.4	5.9	11.6	2.3	4.6	3.0
61	Bang Pakok	22.8	8.5	1.5	1.8	3.7	6.8	1.8	0.9
62	Laem Fa Pha	27.6	2.4	7.1	2.2	4.4	1.1	3.6	1.1
	Samut Prakan	465.6	5.0	51.1	37.5	74.8	97.2	53.5	19.1
63	Wat Chalo	22.6	16.5	0.7	1.8	3.6	2.1	1.5	0.9
64	Bang Khanum	18.6	8.8	1.3	1.5	3.0	0.5	0.9	0.8
65	Bang Kruai	7.3	3.3	1.4	0.6	1.2	0.2	0.4	0.3
66	Nonthaburi	74.1	39.8	0.5	6.0	11.9	4.4	10.8	3.1
67	Bang Kraso	44.8	19.8	0.7	3.6	7.2	4.7	4.3	1.8
68	Bang Krang	29.5	8.9	2.0	2.4	4.7	1.0	2.4	1.2
69	Pak Kret	37.6	7.1	2.8	3.0	6.0	2.3	4.4	1.5
70	Om Kret	22.2	5.3	2.5	1.8	3.6	0.8	2.0	0.9
71	Bang Bua Thong	98.7	2.2	28.4	7.9	15.9	2.9	5.2	4.1
	Nonthaburi	355.4	5.3	40.3	28.6	57.1	23.9	31.9	14.6
	Greater Bangkok Area	5,560.0	17.6	163.7	447.4	893.4	462.3	923.0	228.4

Source: The Comprehensive Study for Bangkok Suburban Transportation Project.

Table 3-27 GBA Zonal Indicators Used for the Commodity Distribution Model

	Production	Consumption
Rice Products	X_8	$X_7 + 1/10\ (X_{11} + X_{12})$
Sugar	Zero production (only Import & Export)	$X_7 + X_9$
Other Farm Products	X_8	$X_7 + X_9$
Forestry	Zero production (only Import & Export)	$X_{11} + X_{12}$
Fishery	"	$1/2\ X_7 + X_{11} + X_{12}$
Construction Materials	"	$X_{11} + X_{12}$
Manufactured Goods	X_{11}	$X_7 + X_{11} + X_{12}$
Livestock	$1/10\ X_7 + X_{11}$	$X_{11} + 1/2\ X_{12}$
Minerals	Zero production	$X_{11} + 1/2\ X_{12}$
Petroleum Products	X_{11}	$X_7 + X_{11} + X_{12}$
Others	$1/10\ X_7 + X_{11} + X_{12}$	$1/4\ X_7 + X_{11} + X_{12}$

b) Trip distribution ratio for zones outside the GBA

Using the survey results of TMIS, the commodity flows into and out of the GBA were adjusted to the zones in this study. The compiled results are shown in Table 3-28.

c) Establishment of present O-D matrix and revision

i) Distribution Model

In a metropolitan area like Bangkok, where increasing growth and development can be anticipated in the foreseeable future, the traffic flow pattern can also be expected to change rapidly. The planned changes of road influstructure such as First Stage Expressway, Outer Ring Road, Middle Ring Road and also the improvement of existing trunk highways will certainly exert a major change in the traffic flow pattern. Based on these considerations, the "gravity model" was chosen in this study for establishment of O-D matrices. The parameters of the model were determined from the analysis of the present O-D matrix as follows.

The general formula of the "gravity model" is shown below:

$$Tij = Ti \times Tj \times \frac{k}{Dij^n}$$

Table 3-28 Commodity Trip Distribution Ratio for Zones Outside of the GBA

Inbound To GBA

(%)

Commodity \ Zone	Zone No.72 (NC)	Zone No.73 (EC)	Zone No.74 (WC)	Zone No.75 (SC)	Zone No.76 (NE)	Zone No.77 (N)	Zone No.78 (S)	Total
Rice	23.2	14.2	6.5	34.6	6.6	4.9	-	100.0
Sugar	1.7	7.9	10.8	2.9	26.1	50.6	-	100.0
Other Farm Products	7.1	17.4	26.4	8.5	15.8	21.2	3.6	100.0
Forestry	17.6	8.6	19.2	25.8	8.3	18.2	2.3	100.0
Fishery	-	-	-	-	-	-	-	-
Construction Materials	13.3	22.0	17.3	21.2	12.1	8.6	5.5	100.0
Manufactured Goods	17.5	6.8	18.4	18.0	8.1	25.7	5.5	100.0
Livestock	6.7	7.6	22.0	6.1	16.4	34.0	7.2	100.0
Minerals	-	-	-	81.6	3.7	-	14.7	100.0
Petroleum Products	17.5	6.8	18.4	18.0	8.1	25.7	5.5	100.0
Others	10.0	13.0	13.0	12.1	16.9	24.9	10.1	100.0

Outbound From GBA

(%)

Commodity \ Zone	Zone No.72 (NC)	Zone No.73 (EC)	Zone No.74 (WC)	Zone No.75 (SC)	Zone No.76 (NE)	Zone No.77 (N)	Zone No.78 (S)	Total
Rice	19.8	8.4	3.9	20.7	3.3	9.8	34.1	100.0
Sugar	1.1	4.9	6.7	1.8	11.4	31.5	42.6	100.0
Other Farm Products	6.4	15.7	24.0	7.7	11.4	10.7	24.1	100.0
Forestry	19.7	9.6	21.5	28.9	5.8	12.9	1.6	100.0
Fishery	12.6	-	-	6.2	-	40.7	40.5	100.0
Construction Materials	9.0	14.8	11.6	14.3	17.7	17.5	15.1	100.0
Manufactured Goods	21.3	8.3	22.5	21.9	6.9	6.5	12.6	100.0
Livestock	3.8	4.2	12.3	3.4	25.8	35.4	15.1	100.0
Minerals	-	-	-	55.5	7.0	-	37.5	100.0
Petroleum Products	21.3	8.3	22.5	21.9	6.9	6.5	12.6	100.0
Others	5.6	7.2	7.2	6.7	26.5	25.7	21.1	100.0

where Tij : Distribution trip volume between zone i and j

Ti : Generated (attracted) trip volume of zone i

Tj : Generated (attracted) trip volume of zone j

n and k : Coefficients

Dij : Required travel time between zone i and j

Parameters from the previous O-D matrices are as follows:

n : 1.283

k : 0.28051×10^{-4}

Using these parameters, the present O-D matrix was established and the O-D matrices were compiled as computer output in a separate book.

ii) Revision of Present O-D matrices

In general, established O-D trips based on commodity consumption and production is lower than the actual number of O-D trips for the following reasons.

- It is impossible to obtain trip data for every type of commodity. For instance, in the case of agricultural products, only the statistical data for rice, maize, cassava, soybean, mungbean and kenaf is available; the data for various other agricultural product is not.

- Truck cargo does not always travel directly from the production origin to the destination for consumption. Intermediate destinations for processing or re-direction are possible.

A long study period to make a complete survey and analysis of cargo movement is necessary to obtain high data accuracy, and even for this feasibility study, a supplementary survey of the commodity distribution routes is desireable.

Nonetheless, based on the data available, the inbound and outbound cargo volumes estimated from commodity production and consumption were compared with the control total survey results from TMIS in order to determine the expansion ratio for each type of commodity shown as follows:

Table 3-29 Commodity Flow Comparison

(Unit: 1000 tons/year)

	Previously Estimated Total		Control Total from TMIS Survey		Expansion Ratio[1]	
	Inbount	Outbound	Inbound	Outbound	Inbound	Outbound
1. Rice	3,337	51	4,334	339	1.3	6.6
2. Sugar	1,931	0	1,931	52	1.0	-
3. Other farm products	2,527	20	7,667	384	3.0	19.2
4. Forestry	1,084	315	2,105	166	1.9	0.5
5. Construction materials	1,144	1,709	19,753	495	17.2	0.3
6. Manufac-tured goods	1,385	5,039	1,972	5,822	1.4	1.2
7. Livestock	175	4	402	34	2.3	8.5
8. Mineral	995	1	886	59	0.9	59.0
Total	12,578	7,139	39,050	7,351	3.1	1.0

Note: 1 Expansion Ratio = TMIS control total ÷ Previously estimated amount

The level of accuracy of the estimated commodity volumes is 42.5% of control total, calculated as follows:

Level of Accuracy = Total estimated inbound and outbound cargo volume/control total volume
= (12,578 + 7,139)/(39,050 + 7,351)
= 42.5%

Based on revised O-D matrices, the revised total generated and attracted cargo volumes for each zones are shown in Table 3-30.

(5) Establishment of Future O-D Matrices

a) Methodology

The same method of present O-D matrix establishment was used for the establishment of the future O-D metrices. The work items are summarized as follows:

Step 1. Forecasting of future production and consumption. (Refer to previous section)

Step 2. Estimation of future generated and attracted cargo volumes.

Step 3. Adjustment of generated and attracted cargo volumes using the expansion ratio.

Table 3-30 Generated and Attracted Total Commodity by Zone, 1977
(Unit: tons/day)

Zone No.	Name of Zone	1977
1	Phra Nakhon	2,991.6
2	Dusit	1,523.5
3	Bang Su	1,345.4
4	Phayathai	3,883.6
5	Pathumwan	2,621.0
6	Yannawa	2,772.9
7	Bang Pong Pang	1,579.1
8	Bang Kapi	329.9
9	Samsen	824.7
10	Lat Yao	3,991.7
11	Thung Song Hong	1,224.1
12	Thung Mi Kan	144.2
13	Talat Bang Khen	905.4
14	Khlong Thanon	370.7
15	Thareng	291.6
16	Lat Phrao	186.7
17	Khlong Chan	651.1
18	Khlong Kum	768.2
19	Saphan Sung	33.7
20	Ruamak	402.6
21	Phra Khanong	7,487.8
22	Suan Luang	350.0
23	Bang Na	2,447.2
24	Nong Bon	149.6
25	Prawet	945.8
26	Bang Chan	145.7
27	Minburi	422.7
28	Lat Krabang	208.6
29	Nong Chok	362.4
30	Bang O	961.3
31	Sirirat	2,553.8
32	Thonburi	3,238.4
33	Rat Burana	2,156.3
34	Thung Khru	122.2
35	Bang Khun Tian	1,269.2
36	Phasi Charoen	911.1
37	Taling Chan	254.7
38	Sala Than Masop	56.4
39	Nong Khaem	458.7
40	Bang Bon	589.6
41	Bang Ko Rua	277.8
42	Bang Yo	428.0
43	Bang Talat	1,551.4
44	Bang Chak	1,237.2
45	Bang Ya Phraek	784.6
46	Samrong Tai	3,403.4
47	Samut Prakan	688.0
48	Bang Muang	196.9
49	Samrong Nua	593.3
50	Bang Duan	57.0
51	Phraek Sa	59.1
52	Thai Ban	1,075.3
53	Bang Pumai	1,080.8
54	Bang Kaeo	52.2
55	Bang Phli Yai	101.7
56	Bang Pla	41.3
57	Bang Chalong	246.3
58	Racha Thewa	64.6
59	Srisa Charakhe	160.6
60	Bang Bo	442.6
61	Bang Pakok	943.1
62	Laem Fa Pha	199.9
63	Wat Chalo	292.9
64	Bang Khanum	77.6
65	Bang Kruai	37.1
66	Nonthaburi	607.2
67	Bang Kraso	649.6
68	Bang Krang	151.1
69	Pak Kret	334.9
70	Om Kret	127.1
71	Bang Bua Thong	594.0
	Greater Bangkok Area	68,489.8

Step 4. Forecasting of future control total of generated and attracted cargo volumes of the GBA.

Step 5. Revision of future control total.

In this study, the target year of estimation was defined as the year 2000, and the annual volumes were caluculated using the growth rate of the economic indicators.

b) Establishment of the control total for generated and attracted cargo volumes of the GBA

The Gross Regional Product (GRP) for the GBA and the Gross Domestic Product (GDP) for Thailand in the NESDA fourth 5-Year Plan (1977 - 1981) were compared with the daily cargo tons inbound and outbound from the GBA as follows:

Item \ Year	1972	1973	1974	1975	1976	1977	1985	2000
GBA GRP(X_1)	56,785	62,845	67,464	72,162	79,053	85,441	145,585	335,224
Thailand GDP (X_2)	162,071	180,146	189,191	203,751	220,450	234,123	387,438	852,593
Daily Traffic (Y) (Ton)	40,378	44,323	59,088	59,355	64,310	91,711	-	-

Based on this statistical data, the following regression formulas were developed showing a high correlation of Daily Traffic with both GBA GRP and GDP for Thailand.

Formula No. 1 $Y = 1{,}625\ X_1 - 54{,}904.792$ $(r = 0.940)$

Formula No. 2 $Y = 0.632\ X_2 - 65{,}457.605$ $(r = 0.923)$

Formula No. 3 $\log Y = -4.248 + 1.860 \log X_1$ $(r = 0.956)$ $(t = 6.515,\ n = 4)$

where;

X_1 : Gross Regional Product of GBA (million Baht at 1972 Const. Prices)

X_2 : Gross Domestic Product of Thailand (")

Y : Daily Traffic (ton)

This analysis demonstrates the high degree of correlation between daily cargo volume and the economic indicators examined in this study. The control totals for 1985 and 2000 were calculated on the basis of the regression formulas mentioned above with results as follows:

Table 3-31 Project Control Totals

(Unit: tons/day)

Model		Formula No. 1	Formula No. 2	Formula No. 3
Average Annual Increase 1972 - 77		17.8%	17.8%	17.8%
Estimated Daily Traffic 1/	1985	181,671	179,403	225,497
	2000	489,834	473,381	1,063,462
Average Annual Increase	1977-85	8.9%	8.7%	11.9%
	1985-2000	6.8%	6.7%	10.9%

Note: 1/ Based on the 1977 traffic volume of 91,711 tons

Since these results indicate the GBA control total for trucks and in tons/day, it is necessary to convert them to cover all transport modes and yearly traffic volumes. In this study, using the following formule was used to convert daily into yearly cargo volumes for all modes of transport.

$$Y = D \times \frac{100}{70} \times 300$$

where;

Y: Yearly inbound and outbound cargo volume and out of the GBA by all transport modes.

D: Daily cargo volume into and out of GBA carried by truck

$\frac{100}{70}$: Expansion ratio to all modes of transport from trucks

300: Potential workdays (day/year) based on the following assumptions:

Sundays	52 days/year
National holidays	15 days/year
Total holidays	67 days/year

Therefore, Potential workdays =
365 - 67 = 298 ≒ 300 days/year

In accordance with this formula, the control totals for the GBA were calculated as follows:

(Unit: 1000 tons/year)

Model \ Year	1977	1985	2000
Formula No. 1	39,300	77,860	209,930
Formula No. 2	39,300	76,890	202,880
Formula No. 3	39,300	96,640	455,770

c) Determination of the control total

The estimated control total based on the future projection of commodity production and consumption (described previous section), and on the same procedure used in the establishment of present O-D matrices, is 52.8 million tons/year. By applying the same expansion ratio by commodity as before, the revised control total in the year 2000 is as follows:

	1000 tons/year
Control total calculated by commodity production and consumption:	52,834
Revised control total using the present expansion ratio:	91,758
Control total calculated by the Model No. 1	209,930
Control total calculated by the Model No. 2	202,880
Control total calculated by the Model No. 3	445,770

Comparing these figures and considering the economic indicators which were applied for establishing these formula, the control total using model No. 1 was adopted.

Consequently, using this control total, the inbound and outbound cargo flows into and out of GBA by commodity are summarized in the following Table 3-32.

e) Establishment of future O-D matrices

Applying the same procedure which established in the process of establishing the present O-D matrix, the future O-D matrices for the year 2000 were established.

For the purpose of examining the generated and attracted commodity flows by zones, the same method as present O-D matrix establishment was used. Table 3-33 shows the various types of future demographic data base examined together with the future landuse map for the year 2000 by DTCP. These figures were developed in the previous study, "The Comprehensive Study for Bangkok Suburban Transportation Project". Based on this table, the zonal generated and attracted cargo volumes were estimated by type of commodity. Table 3-34 summarizes the results for total commodity volumes by zone.

Using the "gravity model method", the future O-D matrices in the year 2000 were established for each type of commodity. The O-D matrices are presented separately from the main text as an appendix.

Table 3-32 Estimated Commodity Flows by Type of Traffic, 2000

(Unit: 1000 tons/year)

Type of Commodity	Intra-zonal-Traffic	Inter-zonal Traffic			Import & Export Traffic			Total		
		Outbound	Inbound	Total	Export	Import	Total	Inbound	Outbound	Total
1. Rice	505	1,004	3,457	4,461	4,782	-	4,782	8,239	1,004	9,243
2. Sugar	-	556	3,960	4,516	8,173	-	8,173	12,133	556	12,689
3. Other farm products	-	2,251	10,759	13,010	34,193	-	34,193	44,952	2,251	47,203
4. Forestry	2,671	709	4,918	5,627	2,248	-	2,248	7,166	709	7,875
5. Fishery	364	1,020	-	1,020	-	-	-	0	1,020	1,020
6. Construction materials	49,692	1,834	74,991	76,825	14,217	401	14,618	89,208	2,235	91,443
7. Manufactured products	5,784	7,578	2,844	10,422	3,164	2,999	6,163	6,008	10,577	16,585
8. Livestock	197	293	4,992	5,285	426	-	426	5,418	293	5,711
9. Minerals	11	270	2,761	3,031	627	-	627	3,388	270	3,658
10. Petroleum products	5,048	13,931	572	14,503	-	-		572	13,931	14,503
TOTAL	64,272	29,446	109,254	138,700	67,830	3,400	71,230	177,083	32,847	209,930

Table 3-33 Future Demographic Data Base, 2000

(Unit: 1,000 Persons)

Zone No.	Name of Zone	Resi-dential Popula-tion	Gross Population Density (Persons/Ha)	Economically Active Population			Workers at Work Places		Traffic Relevant Students
				Sector I	Sector II	Sector III	Sector II	Sector III	
1	Phra Nakhon	273.0	233.7	-	29.2	55.0	20.2	68.4	35.8
2	Dusit	325.4	289.2	-	34.8	65.6	21.4	85.1	42.7
3	Bang Su	136.9	102.3	-	14.6	27.6	9.6	12.3	18.0
4	Phayathai	705.5	408.7	-	75.4	142.2	58.0	174.3	92 7
5	Pathumwan	395.3	326.4	-	42.2	79.7	31.7	105.8	51.9
6	Yannawa	492.4	364.2	-	52.6	99.2	32.5	68.3	64.7
7	Bang Pong Pang	247.6	165.3	-	26.4	49.9	18.6	46.5	32.5
8	Bang Kapi	28.7	48.2	-	3.1	5.8	6.7	25.3	3 8
9	Samsen	416.4	247.6	-	44.5	83.9	37.5	102.5	54 6
10	Lat Yao	497.2	146.6	-	53.1	100.2	54.3	130.4	65.3
11	Thung Song Hong	47.5	28.0	-	5.1	9.6	2.6	8.5	6.2
12	Thung Si Kan	42.9	20.8	0.2	4.6	8.6	2.4	3.8	5.6
13	Talat Bang Khen	78.6	48.8	0.1	8.4	15.8	9.6	18.1	10.3
14	Khlong Thanon	131.3	27.7	0.9	14.0	26.5	12.7	38.8	17.2
15	Thareng	119.2	36.1	0.3	12.7	24.0	6.5	19.8	15 6
16	Lat Phrao	107.7	32.0	0.9	11.5	21.7	8.9	23.2	14.1
17	Khlong Chan	191.4	62.6	-	20.4	38.6	16.0	41.6	25 1
18	Khlong Kum	321.0	78.0	-	34.3	64.7	30.5	74.3	42.1
19	Saphan Sung	30.3	19.1	-	3.2	6.1	1.7	2.7	4.0
20	Huamak	53.3	35.4	-	5.7	10.7	2.9	6.4	7.0
21	Phra Khanong	285.2	96.1	-	30.5	57.5	50.5	103.9	37.4
22	Suan Luang	95.5	42.3	-	10.2	19.2	5.2	8.5	12.5
23	Bang Na	175.4	59.1	-	18.7	35.3	35.4	36.2	23.0
24	Nong Bon	153.4	47.0	-	16.4	30.9	12.9	33.7	20.1
25	Prawet	49.3	12.8	-	5.3	9.9	2.7	4.4	6 5
26	Bang Chan	36.5	3.0	3.4	3.9	7.4	2.0	3.3	4.8
27	Minburi	282.4	45.3	1.1	30.2	56.9	29.8	66.6	37.0
28	Lat Krabang	167.3	39.1	0.9	17.9	33.7	13.3	30.7	21.9
29	Nong Chok	100.5	3.1	9.0	10.7	20.3	39.6	9.0	13.2
30	Bang O	215.6	150.8	-	23.0	43.4	13.1	51.3	28.3
31	Sirirat	520.5	314.1	-	55.6	104.9	40.6	101.6	68.3
32	Thonburi	361.3	248.1	-	38.6	72.8	33.5	93.3	47 4
33	Rat Burana	146.0	96.1	-	15.6	29.4	11.3	27.8	19.2
34	Thung Khru	59.8	19.2	-	6.4	12.0	4.2	10.0	7.8
35	Bang Khun Tian	309.8	141.3	0.1	33.1	62.4	21.7	48.4	40.6
36	Phasi Charoen	154.8	80.2	0.1	16.5	31.2	8.7	14.9	20.3
37	Taling Chan	55.9	10.8	1.2	6.0	11.3	3.1	5.0	7.3
38	Sala Than Masop	27.6	7.7	1.1	2.9	5.6	1.5	2.5	3.6
39	Nong Khaem	159.3	18.5	2.0	17.0	32.1	10.4	21.8	20 9
40	Bang Bon	58.2	4.6	3.3	6.2	11.7	3.2	5.2	7.6
	Bangkok Metropolis	8,055.9	51.8	24.6	860.5	1,623.3	733.0	1,734.2	1,056.9
41	Bang Ko Bua	21.7	20.4	-	2.3	4.4	1.2	1.9	2.8
42	Bang Yo	42.0	45.3	-	4.5	8.5	3.2	7.7	5.5
43	Bang Talat	173.3	186.1	-	18.6	34.9	26.2	42.3	22.7
44	Bang Chak	19.0	22.4	-	2.0	3.8	21.1	1.7	2 5
45	Bang Ya Phraek	74.2	74.3	-	7.9	15.0	19.8	15.9	9.7
46	Samrong Tai	61.1	54.9	-	6.5	12.3	48.7	5.5	8.0
47	Samut Prakan	218.4	229.4	-	23.4	43.4	19.9	54.7	28.7
48	Bang Muang	68.0	41.3	-	7.3	13.7	5.5	12.2	8.9
49	Samrong Nua	98.3	50.2	-	10.5	19.8	16.1	19.0	12.9
50	Bang Duan	15.1	18.4	-	1.6	3.0	2.5	1.6	2.0
51	Phraek Sa	93.1	21.4	-	9.9	18.8	11.6	8.3	12.2
52	Thai Ban	37.0	21.2	-	4.0	7.5	33.9	3.3	4.9
53	Bang Pumai	35.3	6.6	0.5	3.8	7.1	42.0	3.2	4.6
54	Bang Kaeo	53.4	20.7	0.2	5.7	10.8	3.2	6.0	7 0
55	Bang Phli Yai	13.2	2.7	1.4	1.4	2.7	0.7	1.2	1.7
56	Bang Pla	12.6	2.2	1.7	1.3	2.5	0.7	1.1	1.7
57	Bang Chalong	8.8	2.8	0.9	0.9	1.8	0.8	0.8	1.2
58	Racha Thewa	89.7	15.3	0.8	9.6	18.1	31.7	13.0	11.8
59	Srisa Charakhe	14.7	2.8	1.5	1.6	3.0	0.8	1.3	1.9
60	Bang Bo	99.8	3.4	8.6	10.7	20.1	5.5	8.9	13.1
61	Bang Pakok	53.3	19.9	-	5.7	10.7	25.7	4.8	7.0
62	Laem Fa Pha	31.3	2.7	3.3	3.3	6.3	1.7	2.8	4.1
	Samut Prakan	1,333.3	14.3	18.9	142.5	268.7	322.5	217.2	174.9
63	Wat Chalo	31.1	22.7	-	3.3	6.3	3.4	2.8	4.1
64	Bang Khanum	26.8	12.7	0.5	2.9	5.4	1.5	2.4	3.5
65	Bang Kruai	7.4	3.4	0.7	0.8	1.5	0.4	0.7	1.0
66	Nonthaburi	116.9	62.7	-	12.5	23.6	9.7	34.8	15.3
67	Bang Kraso	297.0	131.6	-	31.7	59.8	25.1	68.4	39.0
68	Bang Krang	44.7	13.5	0.4	4.8	9.0	2.5	4.0	5.9
69	Pak Kret	117.2	22.1	0.4	12.5	23.6	8.0	23.3	15.4
70	Om Kret	10.0	2.4	1.2	1.1	2.0	0.5	0.9	1.3
71	Bang Bua Thong	69.7	1.5	13.3	7.4	14.0	3.8	6.2	9.1
	Nonthaburi	720.8	10.7	16.5	77.0	145.2	54.9	143.5	94.6
	Greater Bangkok Area	10,110.0	31.9	60.0	1,080.0	2,037.2	1,110.4	2,094.9	1,326.4

Source: The Comprehensive Study for Bangkok Suburban Transportation Project

Table 3-34 Generated and Attracted Total Commodity by Zone, 2000

Zone No.	Name of Zone	1977	2000	2000/1977
1	Phra Nakhon	2,991.6	4,352.6	1.45
2	Dusit	1,523.5	4,613.5	3.03
3	Bang Su	1,345.4	2,069.0	1.54
4	Phayathai	3,883.6	12,492.1	3.22
5	Pathumwan	2,621.0	6,828.2	2.61
6	Yannawa	2,772.9	7,006.4	2.53
7	Bang Pong Pang	1,579.1	4,007.5	2.54
8	Bang Kapi	329.9	1,439.5	4.36
9	Samsen	824.7	8,074.0	9.79
10	Lat Yao	3,991.7	11,684.2	2.93
11	Thung Song Hong	1,224.1	561.0	0.46
12	Thung Si Kan	144.2	552.5	3.83
13	Talat Bang Khen	905.4	2,082.4	2.30
14	Khlong Thanon	370.7	2,889.6	7.79
15	Thareng	291.6	1,454.6	4.99
16	Lat Phrao	186.7	2,072.7	11.10
17	Khlong Chan	651.1	3,445.7	5.29
18	Khlong Kum	768.2	6,565.5	8.55
19	Saphan Sung	33.7	366.8	10.88
20	Huamak	402.6	625.8	1.55
21	Phra Khanong	7,487.8	19,867.8	2.65
22	Suan Luang	350.0	1,122.1	3.21
23	Bang Na	2,447.2	7,607.1	3.11
24	Nong Bon	149.6	2,778.0	18.57
25	Prawet	945.8	582.6	0.62
26	Bang Chan	145.7	1,020.5	7.00
27	Minburi	422.7	6,603.2	15.62
28	Lat Krabang	208.6	3,020.7	14.48
29	Nong Chok	362.4	10,062.2	27.77
30	Bang O	961.3	2,825.3	2.94
31	Sirirat	2,553.8	8,746.5	3.42
32	Thonburi	3,238.4	7,212.4	2.23
33	Rat Burana	2,156.3	2,434.5	1.13
34	Thung Khru	122.2	905.2	7.41
35	Bang Khun Tian	1,269.2	4,694.2	3.70
36	Phasi Charoen	911.1	1,894.5	2.08
37	Taling Chan	254.7	876.8	3.44
38	Sala Than Masop	56.4	514.2	9.12
39	Nong Khaem	458.7	2,588.6	5.64
40	Bang Bon	589.6	1,262.2	2.14
41	Bang Ko Bua	277.8	258.9	0.93
42	Bang Yo	428.0	689.4	1.61
43	Bang Talat	1,551.4	5,633.5	3.63
44	Bang Chak	1,237.2	4,528.8	3.66
45	Bang Ya Phraek	784.6	4,253.2	5.42
46	Samrong Tai	3,403.4	10,452.9	3.07
47	Samut Prakan	688.0	4,284.2	6.23
48	Bang Muang	196.9	1,184.6	6.02
49	Samrong Nua	593.3	3,460.9	5.83
50	Bang Duan	57.0	537.4	9.43
51	Phraek Sa	59.1	2,495.0	42.22
52	Thai Ban	1,075.3	7,275.7	6.77
53	Bang Pumai	1,080.8	9,100.3	8.42
54	Bang Kaeo	52.2	724.8	13.89
55	Bang Phli Yai	101.7	393.6	3.87
56	Bang Pla	41.3	445.5	10.79
57	Bang Chalong	246.3	328.1	1.33
58	Racha Thewa	64.6	694.6	10.75
59	Srisa Charakhe	160.6	432.5	2.69
60	Bang Bo	442.6	2,676.4	6.05
61	Bang Pakok	943.1	5,518.1	5.85
62	Laem Fa Pha	199.9	938.5	4.69
63	Wat Chalo	292.9	731.6	2.50
64	Bang Khanum	77.6	410.3	5.29
65	Bang Kruai	37.1	207.6	5.60
66	Nonthaburi	607.2	2,089.1	3.44
67	Bang Kraso	649.6	5,405.5	8.32
68	Bang Krang	151.1	608.7	4.03
69	Pak Kret	334.9	1,793.6	5.36
70	Om Kret	127.1	315.8	2.48
71	Bang Bua Thong	594.0	3,123.9	5.26
	Greater Bangkok Area	68,489.8	250,795.2	3.66

Source: The Comprehensive Study for Bangkok Suburban Transportation Project

3.3 Forecast of Future Person-Trips

The detailed person-trip analyses made in the previous study entitled "The Comprehensive Study for Bangkok Suburban Transportation Project", were also used in this study.

For the purpose of analysing the influence of passenger traffic (presented in terms of passenger cars and buses) for the establishment of truck terminals, the passenger car and bus O-D matrices were assigned at the same time along with the truck O-D matrix. The detailed forecasting method has already been mentioned in this report, and therefore, in this section, only outline of the forecasting method and a summary results are described.

3.3.1 Outline of Forecasting Method

The greatest demand period for the transport network causing the most congestion is during peak hours. For the purpose of determining the policy of terminal facilities, future traffic demand in the peak period will be forecast as a key factor.

In the Bangkok area, the congested conditions of the existing traffic demand and the growth of future urbanization, make consideration of the demand in the peak period all the more necessary. For the forecasting of future traffic demand in the GBA, future person-trip demand in the peak hours are examined along with future truck traffic demand in the same period. The methodological flow chart for estimation of future traffic volume is as shown in Fig. 3-6.

The basic concept used for the forecast of future traffic volumes is summarized as follows:

(1) Establishment of the future Person-Trip (P.T.) O-D matrix

(2) According to the passenger car ownership, P.T. O-D matrices are divided into two groups:

   a) P.T. O-D matrix for car-owning passengers

   b) P.T. O-D matrix for non-car-owning passengers.

(3) Establishment of the considerable mass transit network.

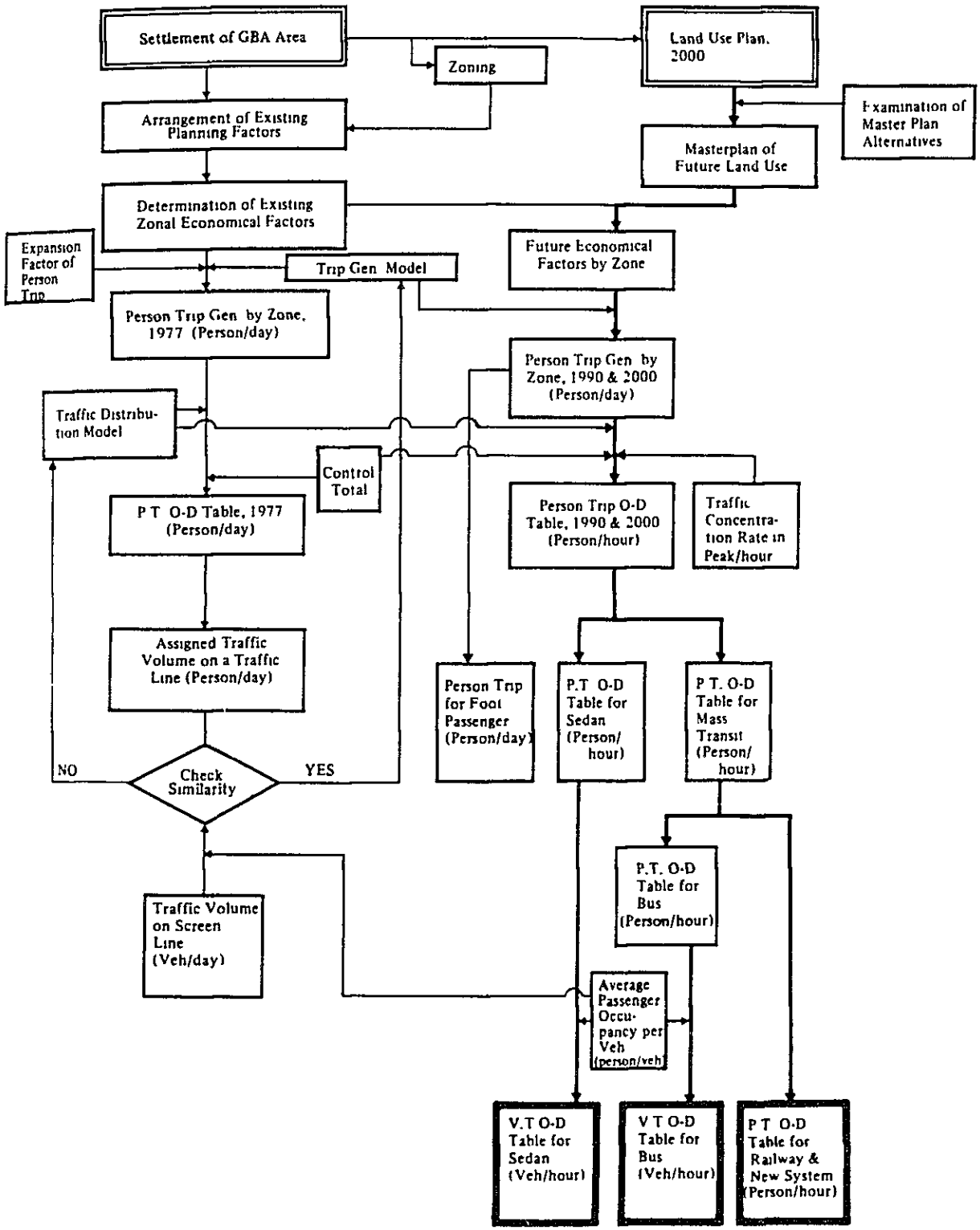
(4) Using the modal split model to divide P.T. O-D Table for Mass Transit and P.T. O-D Table for Sedan.

(5) P.T. O-D Table for Mass Transit are divided into P.T. O-D Table for Mass Transit System, Railway and Bus.

(6) P.T. O-D Table for Sedan and Bus are converted to Vehicle Trip O-D Table using passenger occupancy rate.

Fig. 3-6 WORK FLOW FOR ESTIMATION OF FUTURE TRAFFIC VOLUME

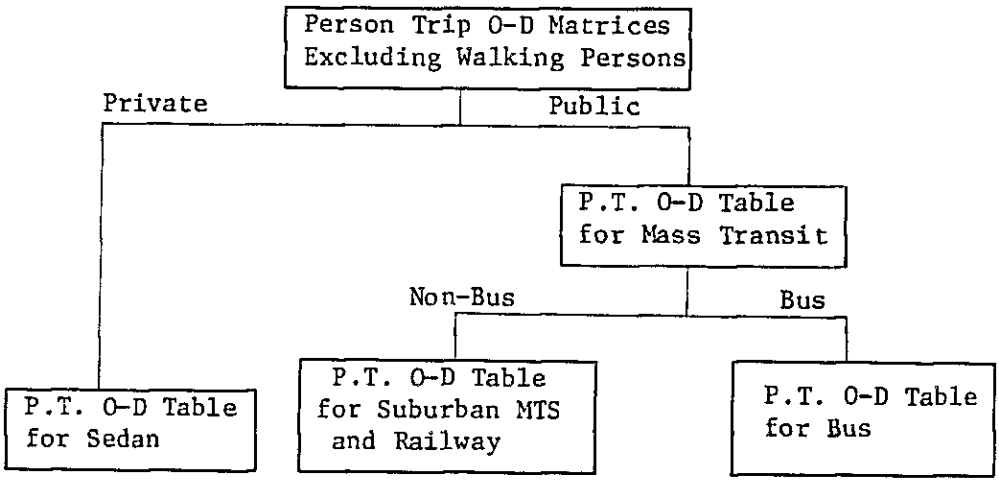
Note : Gen. : Generated and Attracted
P.T. : Person Trip
V.T. : Vehicle Trip
O-D : Origin and Destination
⟵ : Main Stream of Flow Chart



3.3.2 Establishment of O-D Matrices

Based on the future land use plan in the year 2000, generated and attracted person-trips were estimated as Table 3-35. Based on the established O-D matrix of all person-trips, O-D matrices for sedan and bus were established using the following procedure.

Fig. 3-7 WORK FLOW DIAGRAM FOR TRANSPORT MODE DIVISION



Consequently, the Person-Trips and Vehicle Trip-ends adopted in this study based on the established O-D matrices are summarized below.

Vehicle Trip-Ends (Veh./Hr.)

Sedan	249,006
Bus	20,262
Total	269,268

Person-Trips on MTS (including SRT) (Trips/Hr.) : 253,566

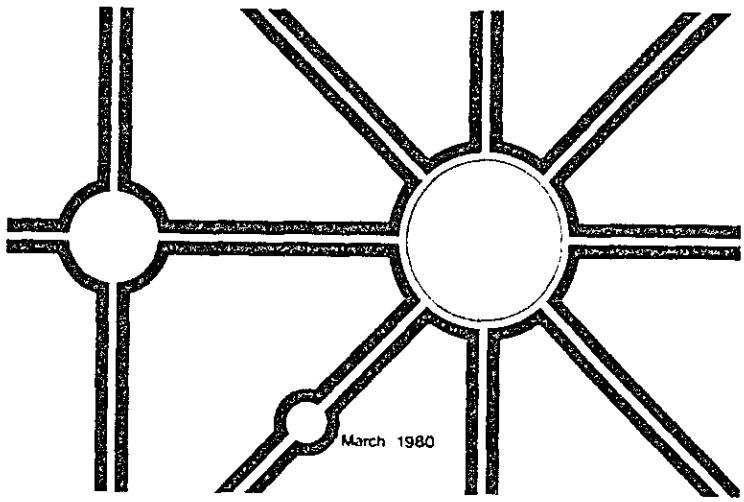
Table 3-35 Generated and Attracted Person-Trips, 2000

(Unit: 1,000 persons/Hr.)

Zone No.	Name of Zone	Generated	Attracted	Zone No.	Name of Zone	Generated	Attracted
1	Phra Nakhon	22.6	23.8	41	Bang Ko Bua	2.2	1.2
2	Dusit	27.0	28.6	42	Bang Yo	3.8	3.1
3	Bang Su	13.5	8.2	43	Bang Talat	14.3	18.3
4	Phayathai	58.7	62.5	44	Bang Chak	1.6	6.0
5	Pathumwan	26.4	37.0	45	Bang Ya Phraek	6.1	9.5
6	Yannawa	46.4	32.9	46	Samrong Tai	5.0	14.4
7	Bang Pong Pang	21.8	18.8	47	Samut Prakan	18.1	20.0
8	Bang Kapi	2.2	8.5	48	Bang Muang	6.0	5.1
9	Samsen	34.6	37.7	49	Samrong Nua	8.3	9.5
10	Lat Yao	41.2	49.6	50	Bang Duan	1.3	1.1
11	Thung Song Hong	4.4	3.4	51	Phraek Sa	8.6	6.4
12	Thung Si Kan	4.4	2.5	52	Thai Ban	3.0	9.9
13	Talat Bang Khen	6.5	6.1	53	Bang Pumai	2.9	12.0
14	Khlong Thanon	10.8	13.7	54	Bang Kaeo	5.1	3.2
15	Thareng	11.1	8.4	55	Bang Pli Yai	2.3	0.8
16	Lat Phrao	9.1	8.7	56	Bang Pla	2.3	0.8
17	Khlong Chan	16.1	15.8	57	Bang Chalong	0.9	0.7
18	Khlong Kum	26.7	28.2	58	Racha Thewa	7.5	12.0
19	Saphan Sung	3.0	1.8	59	Srisa Charakhe	1.6	0.9
20	Huamak	5.1	3.2	60	Bang Bo	10.1	5.7
21	Phra Khanong	23.7	41.1	61	Bang Pakok	4.5	8.2
22	Suan Luang	9.6	5.5	62	Laem Fa Pha	3.1	1.8
23	Bang Na	14.5	7.4	Sub-total	Samut Prakan	118.6	150.6
24	Nong Bon	13.0	12.6	63	Wat Chalo	2.9	2.0
25	Prawet	4.9	2.9	64	Bang Khanum	2.8	1.6
26	Bang Chan	3.7	2.1	65	Bang Kruai	0.8	0.8
27	Minburi	23.5	25.8	66	Nonthaburi	9.7	12.0
28	Lat Krabang	14.6	12.6	67	Bang Kraso	24.5	25.1
29	Nong Chok	8.5	13.1	68	Bang Krang	4.6	2.7
30	Bang O	18.0	19.0	69	Pak Kret	10.3	8.9
31	Sirirat	45.2	40.3	70	Om Kret	1.0	0.6
32	Thonburi	30.0	34.1	71	Bang Bua Thong	6.9	3.9
33	Rat Burana	12.7	11.2	Sub-total	Nonthaburi	63.5	57.6
34	Thung Khru	5.4	4.2	Total	Greater Bangkok Area	874.1	888.7
35	Bang Khun Tian	28.4	21.7				
36	Phasi Charoen	15.4	9.1				
37	Taling Chan	5.6	3.1				
38	Sala Than Masop	2.8	1.6				
39	Nong Khaem	15.1	10.5				
40	Bang Bon	5.8	3.2				
Sub-total	Bangkok Metropolis	692	680.5				

Source: The Comprehensive Study for Bangkok Suburban Transportation Project

CHAPTER 4 TRUCK TERMINAL STUDY



Chapter 4 TRUCK TERMINAL STUDY

4.1 Functions and Characteristics of GBA Truck Terminals

GBA truck terminals are designed to establish 4 base facilities: North, East, West and Central. The four base facilities have main terminal functions. (see Section 1.1.3)

The location of the facilities are designed to benefit city traffic, coordination with the city development plan, modernize management for physical distribution operators and benefit users.

4.1.1 Functions of Each Truck Terminal

(1) Central Truck Terminal

The GBA is a source of origin for less-than-truckload (LTL) cargoes centered in specific areas where illegal parking of large-sized trucks and loading and unloading operations of individual trucks is done in the streets.

Truckers locate their bases of operation in the central area because the trucks of small-sized trucking enterprises are gathered there under control of freight forwarders whom they must rely on.

The Central truck terminal is proposed as a centrally integrated physical distribution base to handle about 50% of the total volumes of all truck terminals.

It is expected that physical distribution enterprises will join the terminal easily, since the main facilities will centralize functions of administration for operators joining the terminal.

Consequently, the terminal will have comprehensive facilities containing truck platforms administrative building, parking area, garage, storage places, filling station, maintenance, checking and washing areas. A systematic operational liaison with the other three terminals will be maintained.

(2) Eastern Truck Terminal

This main terminal is located at the key eastern traffic point of about 20 km from the center of the GBA.

Functions of the facilities are mainly pickup and delivery services for LTL cargo within a 10 km radius. A container yard (including CFS) is to be located in the terminal complex as an auxiliary facility to connect systematically with the deep-sea port of Sattahip.

(3) Northern Truck Terminal

This main terminal is to be established at the key northern traffic point about 28 km from the center of the GBA. The functions of the facilities are also mainly pickup and delivery services for LTL cargo within a 10 km radius. The terminal will function to meet the expansion of the city and its development.

Demand for transport services of agricultural prodcuts and timber products destined for the GBA is high, and so, storage warehouses and silo are needed at this terminal complex.

Cargo storage for wholesalers in the GBA can transfer into the warehouses of the terminal and sales services apart from physical distribution will be possible.

(4) Western Truck Terminal

This main terminal is to be established at the key western traffic point of about 12 km from the center of the GBA. The functions of the facilities are also mainly pickup and delivery services for LTL cargo within the Thonburi area within a 10 km radius. The terminal facilities will also function to meet future expansion of the GBA and especially areas close to the Chao Phraya River which are presently experiencing traffic congestion due to insufficient numbers of bridges, etc. The facilities in this terminal will meet such traffic conditions and still provide smooth pickup and delivery services in Thonburi.

The western terminal is designed to meet the increasing demand for vegetables and fruits in the GBA and the need for an efficient distribution system. It is designed to be equipped with the same facilities as the northern terminal.

4.1.2 Common Assumptions for Truck Terminals

(1) The GBA occupies an area 25 km in radius from the center and tends to expand towards the north and east.

In view of the city structure and its physical distribution system and for efficient pickup and delivery service for LTL cargo, pickup and delivery service within a 13 km radius has been designed to have 2 turnarounds per day at each of the four terminals (assuming an 8-hour working day)

(2) Plan of Operation by Destination for Line-Haul Trucks

All 4 truck terminals will have their own territory for pick-up and delivery services. Line-haul trucks by destination will operate at each terminal.

Accordingly, single transfer system of operation towards

destination will be made. The practice will be adopted by operators taking responsibility to stay within their own territory.

However, on starting terminal operation, it will be possible to coordinate trucking operations by destination among the terminals. This is one of the basic premises of the plan.

(3) Plan for utilization of trucking terminal

The platforms will be leased for use to operators in lots. It is presumed that operation on the platform (loading, unloading, transshipment, sorting and temporary storage by destination) is to be done jointly among operators.

However, responsibility for cargo handling must be clearly defined, especially, to prevent cargo accidents and losses.

4.2 Truck Terminal Demand Forecast

In this section the cargo volume generated and attracted by the terminal are forecast based on the established O-D matrices.

4.2.1 Alternative for Truck Terminal Locations

(1) Number of Terminals and Locations

For reasons to be described below, five terminal locations were considered as follows:

List of Possible Terminal Locations

Symbol	Location	Name of Terminals	Distance from City Center (km)
N	Northern part of GBA	Rangsit	28
E	Eastern part of GBA	Bang Na	21
W	Western part of GBA	Bang Kae	12.5
C	Central part of GBA	Yannawa	6.5
N'	North part of GBA, closer to the city center	Bang Khaen	17.5

The rough locations of the possible truck terminals are shown in the Fig. 4-1.

(2) Alternative for Truck Terminal Locations

For the purpose of the truck traffic volume estimation, eight alternative combinations of truck terminal locations and territories served were evaluated. The terminal locations are shown in Table 4-1, and the approximate zones for collection and delivery of freight for each truck terminal are indi indicated in Fig. 4-2.

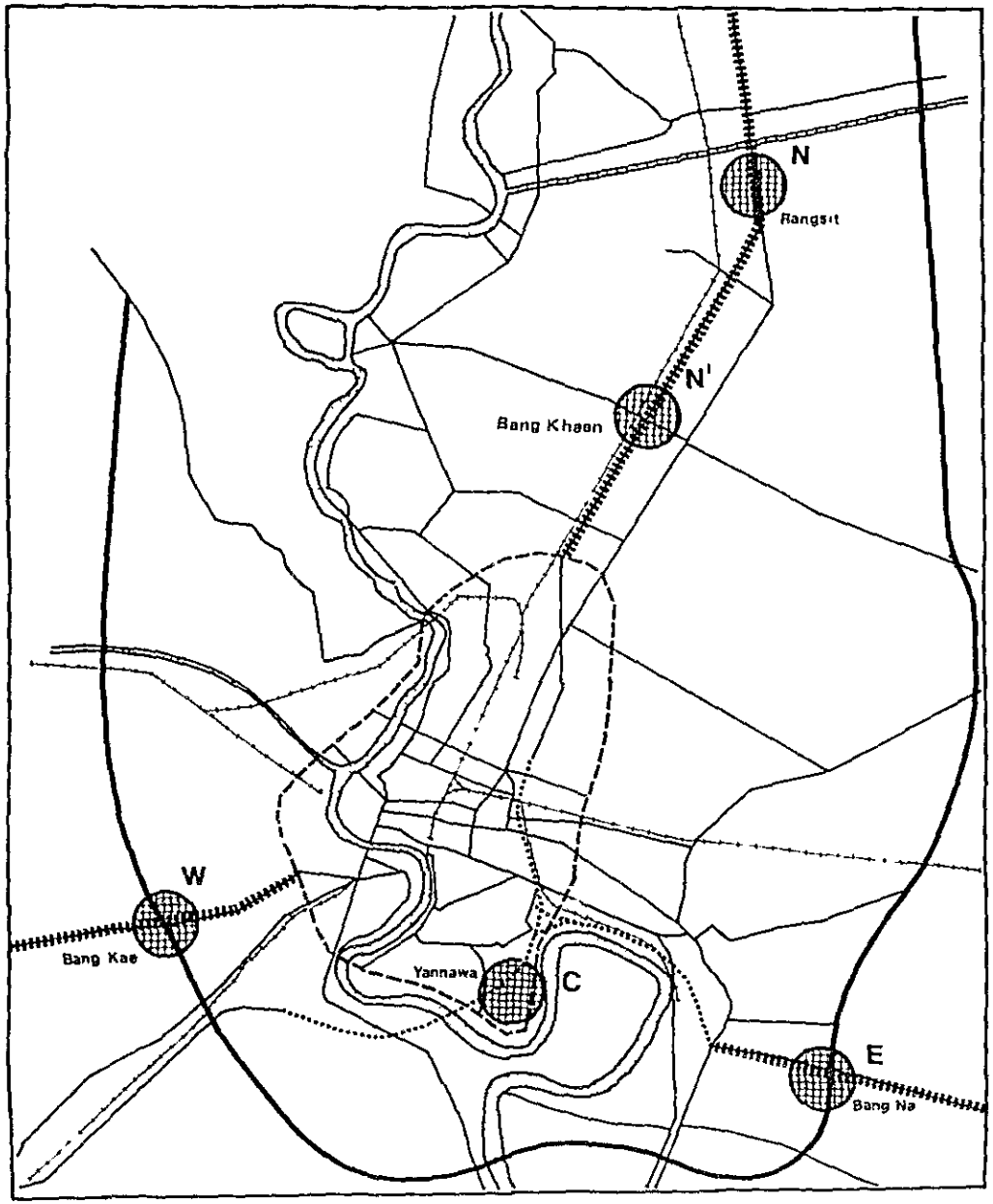


Fig. 4-1 TRUCK TERMINAL LOCATIONS

LEGEND:

- Existing Road
- Trunk Road
- Existing Railway
- Outer Ring Road
- Middle Ring Road
- Expressway
- Proposed Truck Terminal Site (Radius ≒ 2 km)

Table 4-1 Terminal Alternatives Examined

Alternative	Terminal Combinations					Truck Route Territory
	N	E	W	C	N'	
1						-
2	N					Same as Alt. 3 N+C
		E				Same as Alt. 3 E
			W			Same as Alt. 3 W
3	N					Zones 3, 10-20, 26-27, 29, 66-67, 69
		E				Zones 22-25, 28, 45-60
			W			Zones 30-44, 61-65, 68, 70-71
				C		Zones 1-2, 4-9, 21
4	N					Same as Alt. 3 N plus Zones 2,4,8-9
		E				Same as Alt. 3 E
			W			Same as Alt. 3 W
					N'	Zones 1, 5-7, 21
5		E				Same as Alt. 3 E
			W			Same as Alt. 3 W
					N'	Same as Alt. N+C
6		E				Same as Alt. 3 E
			W			Same as Alt. 3 W
				C		Same as Alt. 3 C
					N'	Same as Alt. 3 N
7				C		Total GBA
8				C		Zones 2-4,8-20,26-27,29,63-71
					N'	Zones 1,5-7,21-25,28,30-62

These alternatives were selected for the following reasons:

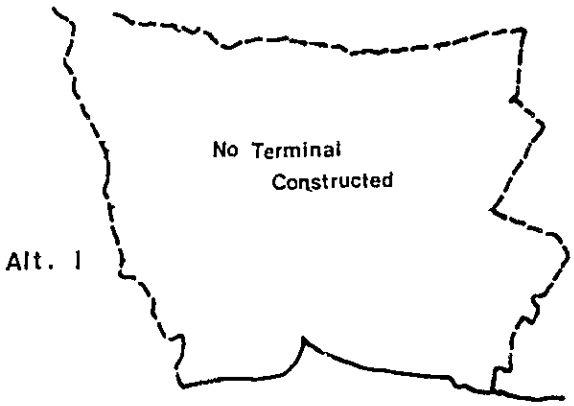
Alt. 1 Null case: No terminals constructed

Alt. 2 In this case, the locations were chosen for the purpose of meeting the cargo flow demand to and from Bangkok in each major direction along the three major trunk highways; Consequently, three truck terminals were considered. This alternative was also recommended by the SEATAC Study.

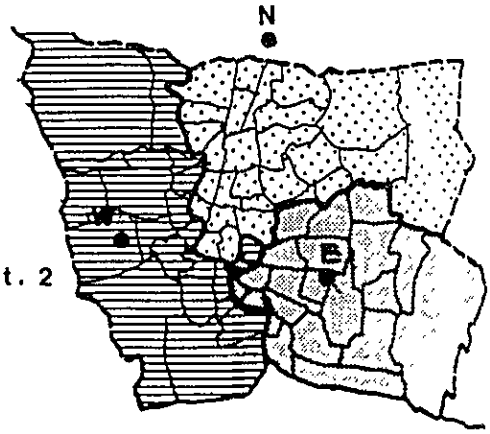
Alt. 3 According to the land use plan for the year 2000, the centralization of the Greater Bangkok Area will continue. To meet the future freight demand into and out of the central area, the additional truck terminal-C was considered.

Alt. 4 This case is a rough alternative combination of terminal locations from Alt. 3. Some of the central truck terminal-C territory would be covered by terminal N which would cover most of the northern area, but some of the central area would still be covered by terminal N' which, although in the north, is closer to the central area than terminal-N.

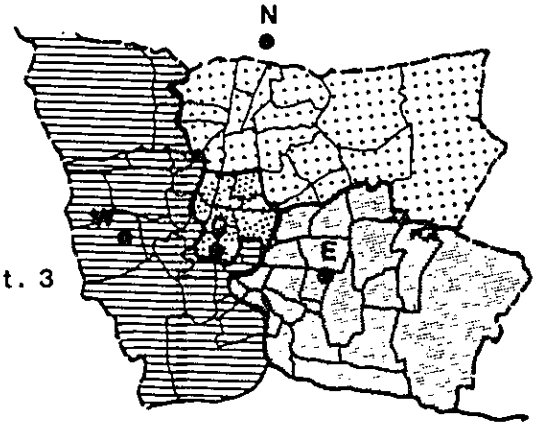
Fig. 4–2 TERRITORIES COVERED BY ALTERNATIVE TRUCK TERMINAL CASES



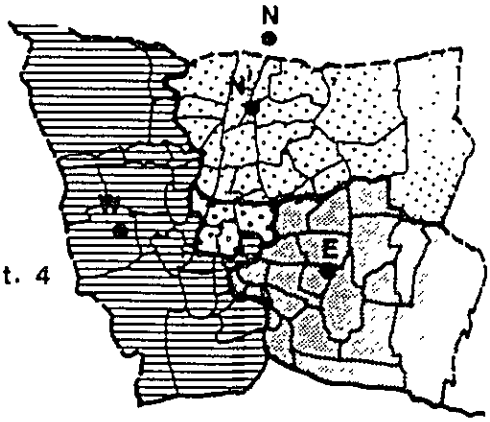
Alt. 1



Alt. 2

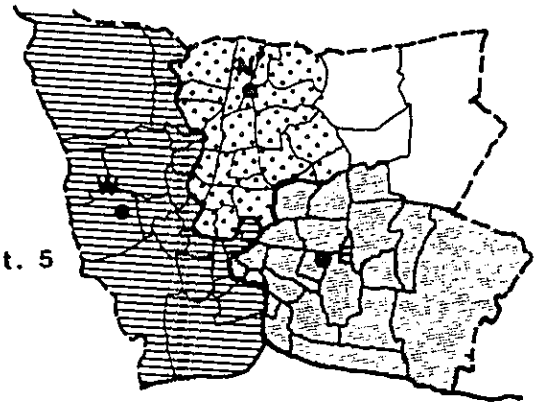


Alt. 3

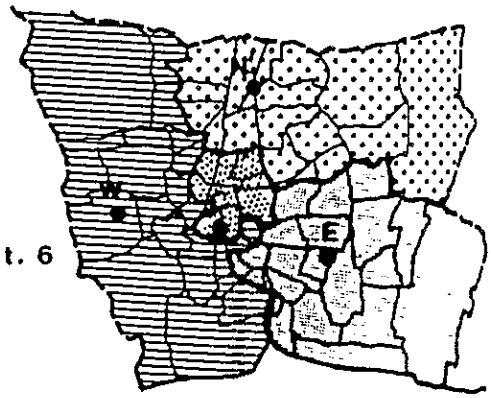


Alt. 4

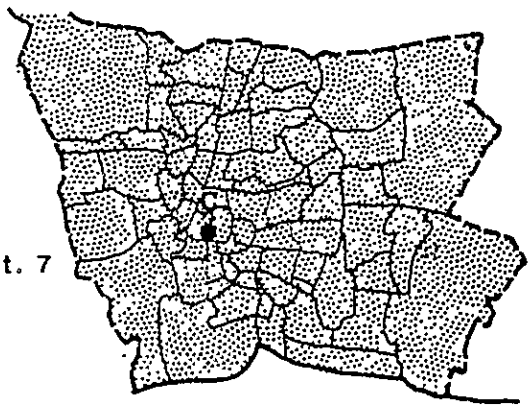
(Note; Territory for Terminal–N' is the Central Zone indicated above



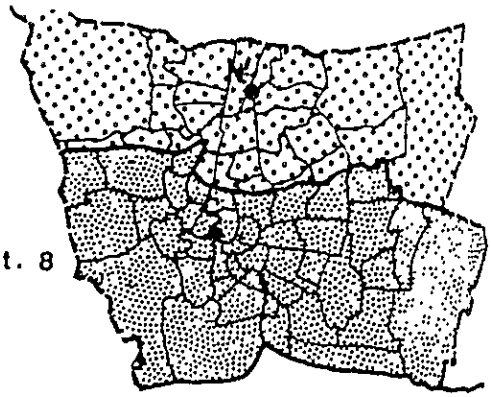
Alt. 5



Alt. 6



Alt. 7



Alt. 8

Alt. 5 This is an alternative combination of terminal locations of Alt. 2. Since there is some disagreement concerning the location of terminal-N as it is believed to be too far from the center of Bangkok, the alternative location N' was considered.

Alt. 6 This is an alternative combination of terminal locations from Alt. 3 also examining the affect of the northern terminal-N' closer to the central area.

Alt. 7 To consider the possibility of providing only one terminal to meet the future cargo flow demand, this alternative was considered. Since the future demand will mostly be concentrated in the central area, truck terminal location C was examined alone. This alternative has also been proposed by E.T.A.

Alt. 8 This is an alternative combination of truck terminal to consider the possibility of providing only two terminals. In view of the future road network and future landuse plan, the north and central regions of the GBA will experience the heaviest demand and so the territory was divided north/south and terminals C and N' were considered.

Other alternative combinations for truck terminal locations are possible, but the main cargo flows from and to the GBA will be along the existing truck highways which extend in three directions (Northward, Eastward and Westward) and to and from the central area of Bangkok which will continue to be the main origin and destination of cargo flows until the government succeeds to decentralize the landuse pattern. The eight alternative combinations for truck terminal location were chosen to test the alternative future cargo flow patterns mentioned above.

4.2.2 Determination of Suitable Cargoes for the Truck Terminal Complex

(1) General

The main functions of the truck terminal complex, from the view point of traffic forecasting, is for transshipment, warehousing and open storage. The parking area for the truck terminal users and public parking area for heavy trucks which have restricted entry into the GBA will be considered separately.

The sources of information for the determination of commodity suitability are based on the SEATAC study results, the Suan Luang survey results, statistical data of Japanese truck terminals and commodity composition ratios obtained during the course of this study.

In order to determine the use ratio of the truck terminal complex, the following considerations and assumptions were made:

- For consumption goods inside the GBA, rice, sugar, other agricultural product, construction materials and manufactured products were considered as constituting the inbound cargo flow. In the outbound cargo flow, only a part of the manufactured products flow will be considered to use the warehouses.

- The actual ratio of commodities which have a tendency to be handled by public line-haul truckers was also considered.

- In principle, intra-zonal cargo which will not use the truck terminal since trip-ends are widely scattered, was not considered.

- Although some of imported and exported cargo flows must make use of warehouses, they were not considered for use of the warehouses planned in the truck terminal complex since warehouses are already conveniently located in Bangkok, Samut Prakan, Ayutthaya and almost all located along the Chao Phraya River.

(2) Determination of the use ratio of the truck terminals by commodity.

a) Inbound traffic

Based on the above considerations, commodity suitability and the use ratio by commodity for truck terminals was determined as follows:

i) Rice: Not suitable

ii) Sugar: Not suitable

iii) Other agricultural products: Not suitable

iv) Forestry products: Among the forestry products, charcoal will make considerable use of the truck terminals. According to the O-D survey results conducted in this study, the composition ratio of charcoal is 17 percent of the total forestry products. It was assumed that 25 percent of this total would be handled by truck terminals. Consequently 4.3 percent was adopted as the amount that would be handled at the truck terminals.

v) Construction Materials:

Based on the O-D survey results conducted in this study, the detailed inbound flow of construction materials is summarized as follows:

Table 4-2 Inbound Construction Materials Carried by Truck, 1979

Type of Commodity	Number of Trucks surveyed (Veh.)	Composition Ratio (%)	Suitability	Suitable Facilities
Sand	350	32.6	No	
Laterite	281	26.3	No	
Store	237	22.2	No	
Gravel	88	8.2	No	
Soil	46	4.3	No	
Piling	32	3.0	Yes	Terminal
Steel	17	1.6	Yes	Terminal
Cement	7	0.7	Yes	Warehouse 1
Brick	5	0.5	Yes	Warehouse 1
Rock	3	0.3	No	
Tile	3	0.3	Yes	Warehouse 1
Total	1,069	100.0		

(Note: 1 Refer to the section of Warehouses)

Using this table, it was assumed that 50 % of the suitable commodities will use the truck terminal. Consequently, the use ratio of truck terminal for construction materials was calculated as follows:

Use Ratio = 4.6 x 0.5 = 2.3%

vi) Manufactured goods:

Manufactured goods are usually considered suitable for truck terminal handling because they consist of mixed types of cargo. The various types of manufactured goods inbound to the GBA were compiled from the O-D survey results conducted in this study.

Using the same method as construction materials, the use ratio of truck terminals for manufactured goods was determined as shown in Table 4-3.

Accordingly, to Table 4-3, the total percentage of highly suitable commodities was 46.8% and the total percentage of medium suitable commodities was 24.3%. The use ratios for high and medium suitability commodities was assumed to be 80% and 50% respectively.

Consequently, the total use ratio of manufactured goods for truck terminals was caluculated at 50% as follows:

Percentage of highly suitable commodities: 46.8%

Percentage of medium suitable commodities: 24.3

Use ratio of truck terminals = 46.8 x 0.8 + 24.3 x 0.5 = 50.0%

Table 4-3 Inbound Manufactured Goods and Other Goods Carried by Truck, 1979

Type of Commodity	Number of Trucks Surveyed (Veh.)	Composition Ratio (%)	Suitability for Truck Terminal	Suitability for Warehouse & Open Storage
Manufactured Goods				
Paper	18	13.0	No	Medium
Bottles	16	11.6	High	"
Flour	13	9.5	High	"
Canned Food	11	8.0	Medium	"
Rice Bran	10	7.3	No	High
Noodle	6	4.3	High	Medium
Salt	5	3.6	"	"
Tyres	5	3.6	"	"
Ice	4	2.9	Medium	"
Cloth	44	2.9	High	"
Wood Piling	4	2.9	No	High
Rubber	3	2.2	No	Medium
Jars	3	2.2	High	"
Matches	2	1.4	No	No
Leather	2	1.4	"	"
Bowls	2	1.4	"	"
Animal Food	2	1.4	"	"
Food	2	1.4	"	"
Pipes	2	1.4	Medium	"
Tanks	2	1.4	"	"
Mats	2	1.4	High	"
Syrup	1	0.7	Medium	"
Bottled Ice	1	0.7	"	"
Manure	1	0.7	"	"
Water	1	0.7	"	"
Barbed Wire	1	0.7	No	"
Others				
Reels	3	2.2	Medium	Medium
Egg	2	1.4	No	"
Scrapped Iron	2	1.4	High	High
Gunny Sacks	2	1.4	Medium	Medium
Kerosine Cans	2	1.4	"	No
Gas	1	0.7	No	No
Miscellaneous	1	0.7	High	High
Mosaic Tile	1	0.7	Medium	Medium
Bone	1	0.7	Medium	No
Silk Leaves	1	0.7	Medium	Medium
Total	139	100.0		

Source: Field Survey Result

vii) Livestock: Not suitable

viii) Minerals: Not suitable

b) Outbound traffic

i) Rice: Not suitable

ii) Sugar: Not suitable

iii) Other agricultural products: Not suitable

iv) Forestry: Not suitable

v) Construction materials: Not suitable

vi) Manufactured Products:

The only data available for the outbound flow of manufactured products from GBA by truck are the survey results of the Department of Land Transport. These survey results are summarized as follows:

Table 4-4 Outbound Flow of Manufactured Products from the GBA by Trunk, 1976

Type of Commodity	Composition Ratio (%)
Appliances (Electric)	51.5
Fuel Lubricants	32.0
Fertilizer	6.0
Soft Drinks & Tabacco	5.9
Knitted Materials	2.4
Grocery & Canned Food	1.6
Raw Rubber, Vegetables Oils	0.3
Jute	0.3
TOTAL	100.0

The majority of outbound manufactured products are transported as mixed cargo, and therefore, the potentiality for using the truck terminals is very high. According to the survey results at Japanese truck terminals, the composition ratio of manufactured products handled was more than 90%. Accordingly, in this study, the use ratio of truck terminals for outbound manufactured goods was assumed as 80%.

vii) Livestock: Not suitable

viii) Minerals: Not suitable.

(3) Determination of use ratio of warehouses (including the use ratio of open storage areas)

Present warehouse conditons in GBA are summarized as follows:

- Private warehouses for raw materials and manufactured goods are easily constructed because they are easy to organize if land is available. In addition, the minimum economic level of cargo flow and the requirement for specialized knowledge is small.

- Since the cost of labour is low, most cargoes are handled manually. The automation and systematic operation of warehouses is rare.

Based on these conditions, it is assumed that the import and export cargoes will use the established and planned warehouses, but that the inbound cargo for consumption in the GBA will use the warehouses to be established in the truck terminal complex.

The basic considerations for future warehouse usage are summarized by type of commodity as follows:

a) Rice

The majority of warehouses for rice are located along the Chao Phraya River and their total capacity is approximately 730 thousand tons. The Thai government intends to expand warehouse capacity by 50 thousand tons. This would raise the total rice warehouse capacity to 780 thousand tons.

Comparing the future demand of rice consumption and the capacity of warehouses in GBA, 80% of the surplus portion is assumed will be handled at the warehouses in the truck terminal complex. Consequently, 28.7% of inbound rice flow would be handled at the truck terminal warehouses.

b) Sugar

The private warehouse which constructed by the major sugar enterprises play a main role in the sugar commodity flow. The present capacity of sugar warehouses is 189 thousand tons in Bangkok and 588 thousand tons in Samut Prakan. It can be foreseen that the future demand will exceed the future capacity even after consideration for expansion of these facilities in the future. Therefore, examining the future demand and future capacity, it was assumed 20% of cargo flow would be handled at the warehouses in the truck terminal complex.

c) Other agricultural products

The present warehouse capacity for this commodity is 560 thousand tons and warehouses are mainly concentrated in the GBA. The silo capacity in Samut Prakan is 653 thousand tons. Recently, the warehouses for the export of maize were constructed in Ayutthaya with a total capacity of 300 thousand tons. The main purpose for constructing the warehouses in Ayutthaya is for direct export from Ayutthaya using the Chao Phraya River.

Additionally, the Chonburi area has warehouses for tapioca export with a capacity of 50 thousand tons. The total capacity of warehouses for tapioca is 640 thousand tons.

Consequently, in this study, 20% of the inbound cargo of other agricultural products is assumed would be handled at the warehouses in the proposed truck terminal complex.

d) Forestry: Not Suitable

e) Construction materials

Based on the O-D survey result and suitability analysis in the previous section, the use ratio of warehouses by this group of commodities was assumed as 0.7%.

f) Manufactured goods

Using the same O-D survey results and the suitability analysis in the previous section, the warehouse use ratio for outbound and inbound cargo flows were assumed as 2.5% and 3.1% respectively.

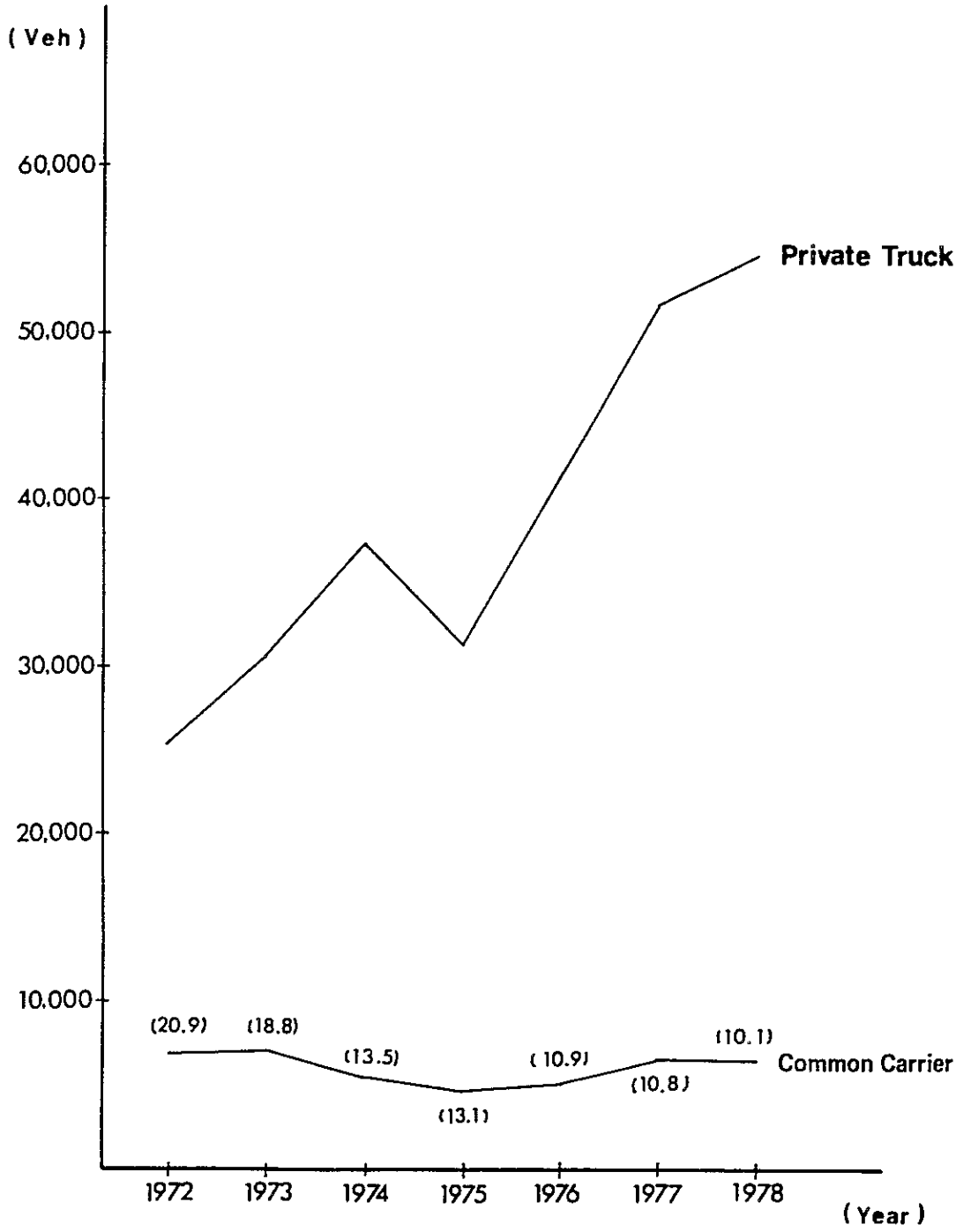
(4) Line-haul truck composition ratio

The growth trend for the number of registered trucks in Bangkok is shown in Fig. 4-3. According to this figure, it is mentioned that the total number of trucks registered has increased, but percentage composition of common carriers has shown a tendency to decrease.

For Japan, the composition ratio of tonnage carried by common carrier line-haul trucks in 1978 was 4% of all of the common carrier tonnage. However, the ton-kms carried by common carrier line-haul trucks against that carried by all common carriers and by all trucks was 28% and 16% respectively. The composition ratio of ton-kms carried by line-haul trucks showed a yearly increase, especially after the construction of truck terminals.

Based on the above data for line-haul trucks and the potential for the growth of common carrier line-haul trucks in Thailand, it was assumed that 20% of commodities which are suitable for

Fig. 4-3 GROWTH OF REGISTERED TRUCKS IN BANGKOK



Note: ( ) = Public Truck Percentage of Total Vehicles in Each Year.

truck terminals would be handled by line-haul vehicles.

Consequently, the commodity amount to be handled at the proposed terminals was calculated based on the following formula.

$$TTi = Ti \times CR \times LR$$

where, TTi: Cargo tonnage to be handled at the proposed terminal
Ti: Cargo tonnage which are suitable for truck terminals
CR: Truck terminal use ratio by commodity
LR: Common carrier line-haul truck composition ratio

4.2.3 Establishment of O-D Matrices for Truck Terminals

(1) Cargo transportation system

Future O-D matrices were established in Section 3.2. However, these O-D matrices are basic freight O-D matrices without truck terminals. With the construction of truck terminals, the cargo transportation system will change remarkably.

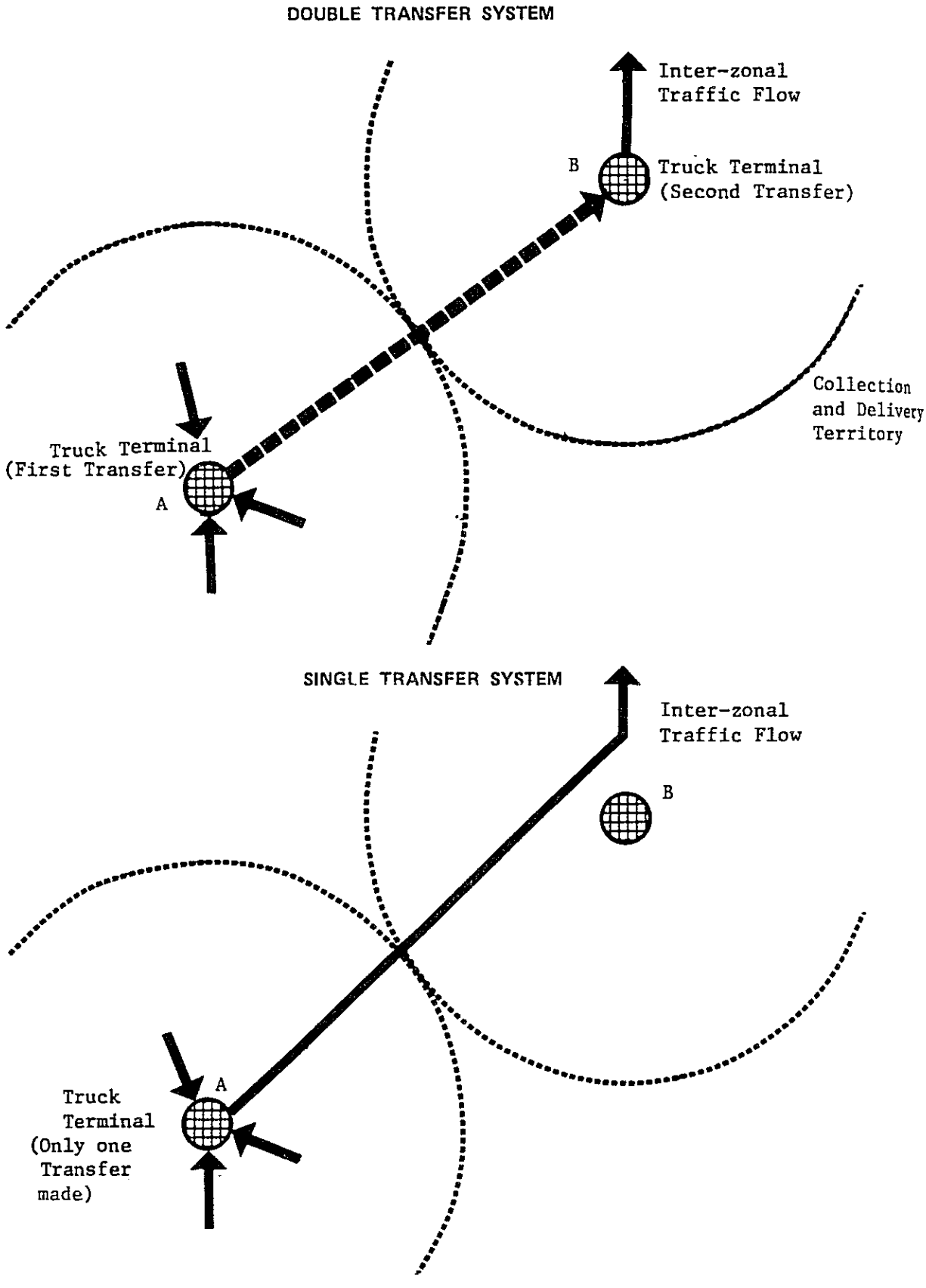
There are two basic concepts for a truck terminal system as shown in Fig. 4-4 a double transfer system and a single transfer system. The appropriateness of the transfer system depends on the amount of cargo within the territory of a terminal. If the cargo flow in a certain direction, such as the northbound cargo which is illustrated, is small, the effect of having two collection and consolidation terminals is greater; hence, the double transfer system is more appropriate. Conversely, if the cargo flow is large, the single transfer system is more appropriate.

It should be noted that evaluation between the eight alternatives and territories combinations of terminal location was based on the double transfer system as it was initially believed that the future demand in each zone would be small. Although the size of future demand proved larger than anticipated, the basis of evaluation between the eight alternatives still remains the double transfer system. A separate evaluation of the transfer system was made by examining alternative-33 which is the single transfer case for alternative-3 and by examining alternative-55 which is the single transfer case for alternative-5. The results of all the evaluations are presented later in Section 4.2.4.

(2) Establishment of O-D matrices for the alternative combinations of terminal locations and territories.

Using the computer, cargo O-D matrices for each type of commodity and each alternative cargo were established. The work items to establish O-D matrices for the truck terminals are described below.

Fig. 4-4 TRUCK TERMINAL TRANSFER SYSTEM ALTERNATIVES
(OUTBOUND FREIGHT FLOWS ILLUSTRATED)



- The location of the five alternative terminal construction sites was determined.

- The collection and delivery territory for each terminal was determined based on the zone map. (See Fig. 4-2.)

- Based on the truck terminals use ratio and the public line-haul truck ratio, the cargo volume for truck-terminals was estimated.

- The truck terminal transfer system (Double or Single transfer system) was considered.

- Based on the transfer system, the freight volume to be handled at each truck terminal was estimated by computer.

- Future O-D matrices were established.

Using the established O-D matrices, the relative cargo volumes to be handled at the proposed terminals were estimated as shown in Table 4-5 for each alternative. Since the total freight volume into and out of the GBA was the same for all of the alternatives, the difference in cargo tonnages can be attributed directly to the cargo transport system.

Table 4-5 Distribution of Cargo Volumes for Truck Terminal Alternatives, 2000

(Unit: %)

Transfer System	Terminal / Alternative	N	E	W	C	N'	Total
Double	1						
	2	52.4	14.1	33.5			100.0
	3	29.3	12.5	29.7	28.5		100.0
	4	37.5	12.6	29.0		20.9	100.0
	5		14.1	33.5		52.4	100.0
	6		12.5	29.7	28.5	29.3	100.0
	7				100.0		100.0
	8				55.8	44.2	100.0
Single	33	16.9	15.8	15.2	52.1		100.0
	55		15.7	15.2		69.1	100.0

A detailed comparison was made between alternatives 3 and 33 to determine the effect of the type of transfer system.

The results are shown in Table 4-6. According to this comparison, the following conclusions are drawn.

Table 4-6 Estimated Cargo Flow for Each Terminal in Alternatives 3 and 33

Alt. No. 3 (Double Transfer System)

Unit: (Ton/day)

Terminal Number	Intercity		Collection & Delivery		Transfer		Total		
	Generated	Attracted	Generated	Attracted	Generated	Attracted	Generated	Attracted	Total
N	2,705.1	2,459.4	749.4	1,210.9	2,758.0	2,542.2	6,212.7	6,212.7	21,425.4
E	570.7	449.2	461.7	1,369.3	1,627.4	841.3	2,659.8	2,659.8	5,319.6
W	3,488.3	1,910.1	670.1	1,088.1	2,130.7	3,292.3	6,289.1	6,289.1	12,578.2
C	0.0	0.0	2,937.4	3,097.8	3,097.9	2,937.4	6,035.3	6,035.3	12,070.6
Total	6,764 1	4,818.7	4,818.6	6,764.1	9,614.0	9,613.8	21,196.9	21,196.9	42,393.8
	11,582.8								

Alt. No. 33 (Single Transfer System)

Terminal Number	Intercity		Collection & Delivery		Transfer		Total		
	Generated	Attracted	Generated	Attracted	Generated	Attracted	Generated	Attracted	Total
N	1,210.9	749.4	749.4	1,210.9	–	–	1,960.3	1,960.3	3,920.6
E	1,369.3	461.7	461.7	1,369.3	–	–	1,831.0	1,831.0	3,662.0
W	1,086.1	670.1	670.1	1,086.1	–	–	1,756.2	1,756.2	3,512.4
C	3,097.8	2,937.4	2,937.4	3,097.8	–	–	6,035.2	6,035.2	12,070.4
Total	6,764.1	4,818.6	4,818.6	6,764.1	–	–	11,582.7	11,582.7	23,165.4
	11,582.7								

- Intercity freight volume is some in both cases: 11,583 tons/day.

- The total handling freight volume for the double transfer system (Alt. 3) is about 1.8 times that of the single transfer system (Alt. 33): (21,196.9 ÷ 11,582.7 ≒ 1.83)

- In the case of double transfer system, transfer volume consists of about 45% of total volume handled.

- Therefore, it is recommended that the truck terminal transfer system should be operated as a single transfer system.

The estimated cargo volumes for the warehouses in alternative-33 are summarized by commodities in Table 4-7.

Table 4-7 Estimated Cargo Volumes for Truck Terminal Warehouse, year 2000, (Alt. 33)

(Unit: tons/day)

Type of Commodity		Terminal				
		N	E	W	Total	(%)
Agricultural Products	Rice	86.6	66.6	313.4	466.6	(18.8)
	Sugar	440.0	40.0	20.0	500.0	(20.5)
	Others	746.6	173.4	200.0	1,120.0	(45.0)
Construction Materials	Cement	53.8	20.0	40.0	113.8	(4.6)
	Brick	31.9	12.0	24.0	67.9	(2.7)
	Piling	20.9	8.0	16.0	44.9	(1.8)
	Sub-Total	106.6	40.0	80.0	226.6	(9.1)
Manufactured Products		80.0	20.0	73.4	173.4	(7.0)
Total		1,459.8	340.0	686.8	2,486.6	(100.0)

The central terminal-C was not considered for warehouses for the reasons mentioned below:

a) The "C" Terminal is locating in the central area, near the CBD (Central Business District) where any more concentration of traffic should be avoided.

b) Furthermore, it will not be easy to acquire large parcel of land in the planned site area.

c) In the central area of the GBA, the existing warehouses are already located along the Chaophraya river and they have expansion plans for their facilities in future. Therefore, terminal-C traffic can make use of these facilities.

Based on these considerations, in this study, it was recommended to establish terminal-C without warehouses.

In order to determine the scale of truck terminal facilities required for each year in the future, cargo volumes were estimated for the truck terminals by each year assuming all of the planned platforms are constructed. Based on the Table 4-6 and on the formula No. 1 established in Chapter 3.2.3 the estimated control volumes are as follows:

Year	Tons/day	% of Year 2000
1977	91,711	18.7
1985	181,671	37.1
2000	489,834	100.0

Using these control totals, the freight volumes for each year were calculated. However, during the period from 1980 to 1989, the rate of the urbanization in the territories of truck terminal-N, E and W will not be as considerable as in the territory of Terminal-C. Therefore, it was assumed that 80% of the estimated freight volume growth would occur for terminal-N, E and W during the period 1980 to 1989.

The result of calculation are shown in Table 4-8. This table was established based on the economical indicators forecast in Chapter 3.

(3) Establishment of truck O-D matrices

For the purpose of examining the economic benefit produced by truck terminal construction, the established freight O-D matrices were converted to truck O-D matrices. Three types of truck were categorized: namely four-wheel truck (light trucks), six-wheel trucks (medium trucks) and ten-wheel trucks and over (heavy trucks).

Based on the cross-sectional traffic count survey results on the boundary of GBA by DOH, the number of each type of truck

and the trend of composition ratio are shown in Fig. 4-5. According to this figure and the following growth trends, the truck composition ratio and average loading factor were determined.

- The light truck composition ratio for intra-zonal traffic within the GBA will increase.
- The heavy truck composition ratio for inter-zonal traffic will increase especially for ten-wheel trucks and over.
- The truck composition and loading ratio of inter-zonal truck trips which are not suitable for the truck terminals will not be affected by the existence of the truck terminal.

- The average loading ratio for intra-zonal truck trips will not change in future.

- The loading ratio of inter-zonal trucks which is not suitable for the truck terminals will increase slightly.

- The loading ratio for trucks originating from the truck terminals is assumed as 95% for bulk cargo and 80% for mixed cargo respectively.

- It was assumed that inbound general cargo trucks which use the truck terminal will have no change in the truck composition ratio and loading ratio at the truck terminal.

- It was also assumed that the majority of inbound mixed cargo trucks which use the truck terminal will transship to smaller trucks at the truck terminal.

- For outbound trucks, it was assumed that only mixed cargo trucks would use the truck terminal and that the majority of cargo collection and delivery trucks would be light trucks.

Based on these considerations, the truck composition ratio and average load (ton/veh) were projected for the year 2000 for both general cargo (not mixed) and mixed cargo. The results are shown in Table 4-9.

4.2.4 Traffic Assignment for Evaluation of Truck Terminal Effects

(1) Road network for traffic assignment

In accordance with the future land use plan in the year 2000, provided by Department of Town and Country Planning (DTCP), the future road network was established. The basic road network is shown in Fig.4-6. All nodes were numbered as well as all segments between nodes (link numbers) for the purpose of computer simultation runs. Proposed truck terminals were also given the as following node numbers.

Symbol	Name of Terminal	Node Number
N	Rangsit	501
E	Bang Na	502
W	Bang Kae	503
C	Yannawa	504
N'	Bang Khaen	505

(2) Method of assignment

The purpose of the traffic assignment is to simulate route choice and to analyse the effect of the construction of truck terminals. Of the various traffic assignment models, the method based on traffic capacity limitation (the Q-V method) was chosen for the reasons mentioned below.

Table 4-8 Estimated Cargo Volume by Year

(Alternative 33)

(Ton/day)

Year \ Terminal	Estimated Cargo Volume				
	North	East	West	Central	Total
1980	410	380	367	1,583	2,740
81	446	414	400	1,725	2,985
82	483	449	433	1,867	3,232
83	520	483	466	2,010	3,479
84	557	517	499	2,152	3,725
85	594	551	532	2,294	3,971
86	661	614	592	2,553	4,420
87	728	676	652	2,813	4,869
88	794	738	712	3,072	5,316
89	862	800	773	3,331	5,766
90	1,161	1,078	1,041	3,590	6,870
91	1,245	1,156	1,116	3,850	7,367
92	1,329	1,234	1,191	4,109	7,863
93	1,412	1,311	1,266	4,368	8,357
94	1,496	1,389	1,341	4,627	8,853
95	1,580	1,467	1,416	4,887	9,350
96	1,664	1,545	1,491	5,146	9,846
97	1,748	1,623	1,567	5,405	10,343
98	1,831	1,700	1,642	5,664	10,837
99	1,915	1,778	1,717	5,924	11,334
2000	1,999	1,856	1,792	6,183	11,830
01	2,083	1,934	1,867	6,442	12,326
02	2,167	2,012	1,942	6,702	12,823
03	2,250	2,089	2,017	6,961	13,317
04	2,334	2,167	2,093	7,220	13,814
05	2,418	2,245	2,168	7,479	14,310
06	2,460	2,284	2,206	7,609	14,559
07	2,502	2,323	2,243	7,738	14,806
08	2,544	2,362	2,281	7,868	15,055

Note: Assumes all terminal facility are constructed from the beginning.

Fig 4-5 INBOUND AND OUTBOUND TRUCK VOLUME ON BOUNDARY OF GBA

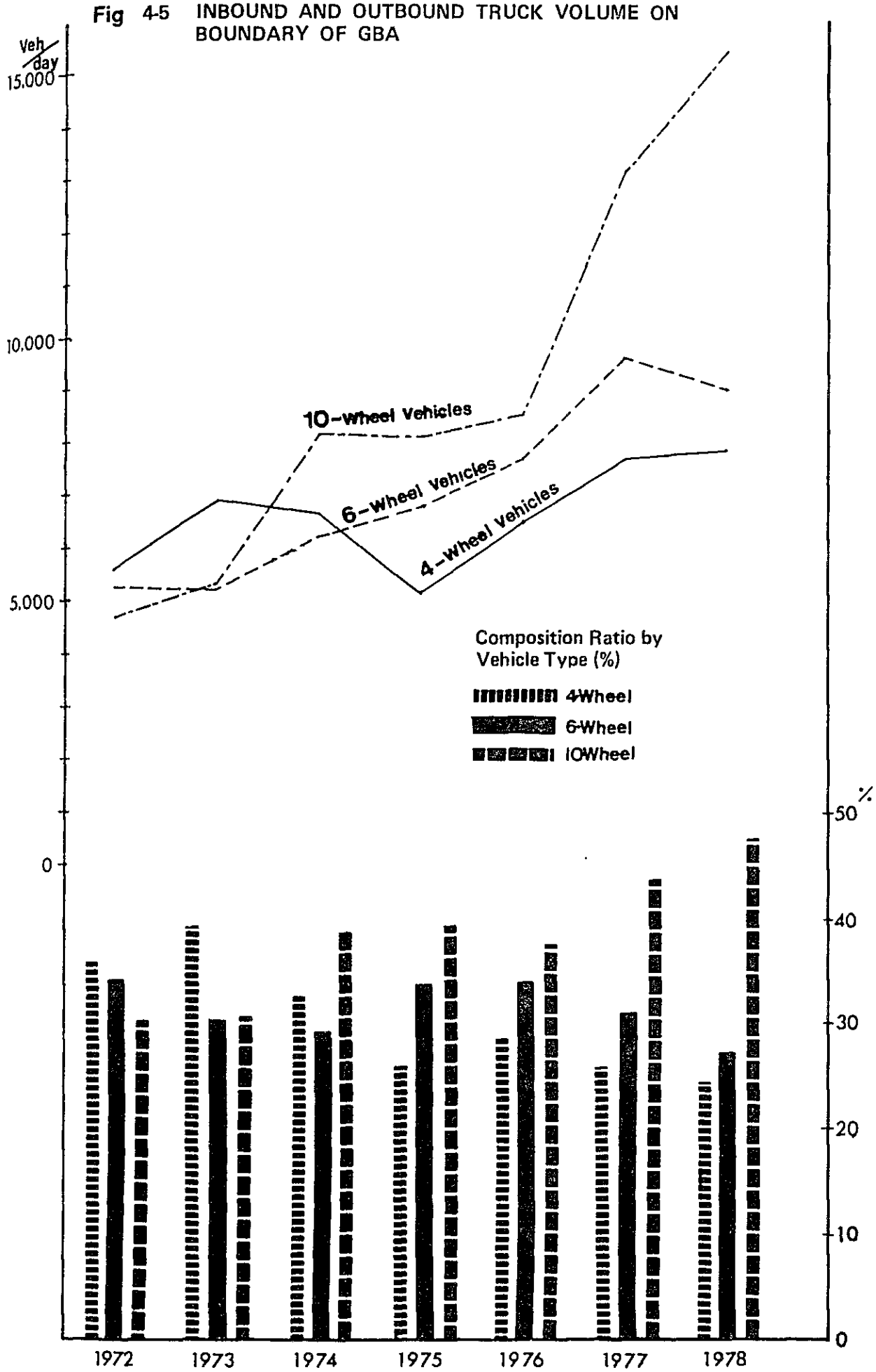


Table 4-9 Truck Composition Ratio and Average Load

General Cargo (Including Mixed only for 1977)

Year	Direction		4-Wheel Truck		6-Wheel Truck		10-Wheel Truck	
			(%)	ton/veh.	(%)	ton/veh.	(%)	ton/veh.
1977	Intra-Zonal		(35.3)	0.9	(46.7)	2.6	(18.0)	6.2
	Inter-Zonal	Outbound	(7.5)	0.3	(24.9)	0.8	(67.6)	1.6
		Inbound	(8.1)	1.6	(24.7)	3.9	(67.2)	7.8
2000	Intra-Zonal		(50.7)	0.9	(27.5)	2.6	(21.8)	6.2
	Inter-Zonal	Outbound	(0.8)	0.4	(6.4)	1.5	(92.8)	2.5
		Inbound	(1.1)	1.6	(5.5)	4.0	(93.4)	8.0
	Through Traffic		-	-	(10.0)	-	(90.0)	-
	Related T.T. Trip	In → T.T.	-	-	-	-	-	-
		T.T.→In	-	-	(2.6)	4.5	(97.4)	9.0
		Out →T.T.	-	-	(2.6)	4.5	(97.4)	9.0
		T.T.→Out	-	-	(2.6)	4.8	(97.4)	9.5
		T.T.→T.T.	-	-	(2.6)	4.8	(97.4)	9.5

Mixed Cargo

Year	Direction		4-Wheel Truck		6-Wheel Truck		10-Wheel Truck	
			(%)	ton/veh.	(%)	ton/veh.	(%)	ton/veh.
2000	Intra-Zonal		(50.7)	0.9	(27.5)	2.6	(21.8)	6.2
	Inter-Zonal	Outbound	(1.1)	1.4	(5.5)	3.6	(93.4)	7.2
		Inbound	(1.4)	1.1	(7.1)	2.7	(91.5)	4.1
	Through Traffic		-	-	(10.0)	-	(90.0)	-
	Related T.T. Trip	In → T.T.	(61.5)	1.4	(38.5)	3.5	-	-
		T.T.→In	(61.5)	1.6	(38.5)	4.0	-	-
		Out →T.T.	-	-	(3.4)	3.0	(96.6)	4.5
		T.T.→Out	-	-	(2.6)	4.0	(97.4)	8.0
		T.T.→T.T.	(61.5)	1.6	(38.5)	4.0	-	-

(Note: T.T. = Truck Terminal)

Fig. 4–6 BANGKOK TTP[1/] ESTIMATED TRAFFIC VOLUME (ALTERNATIVE–33)

● Proposed Terminal

Note : 1/ TTP = Truck Terminal Project

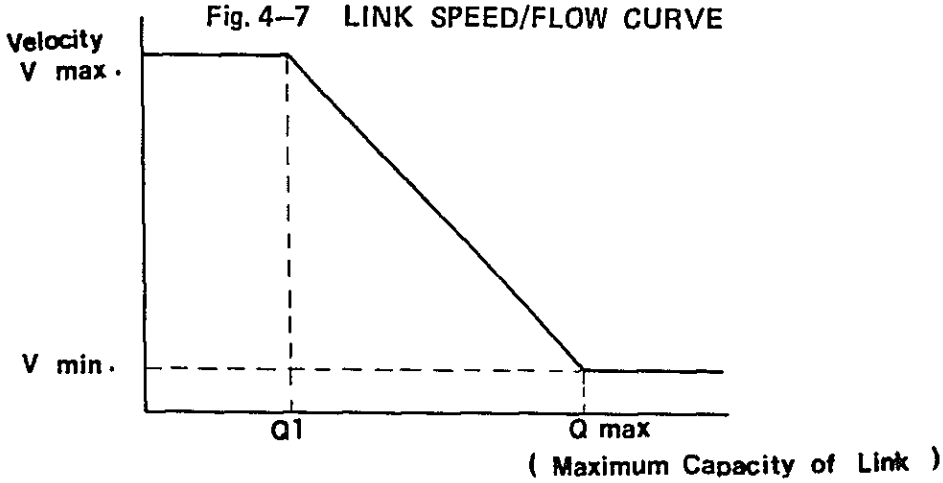
Unit : Vehicle/day

- In order to evaluate the effect of the construction of terminals, on the road network congestion, not only truck but also simultation of passenger cars and buses are necessary.

- Since there are many planning roads in the GBA, many alternative routes have to be compared at the same time.

The conceptual method of Q-V is as shown in the Fig. 4-7 that is, travel speed is determined according to the condition of road congestion and it is assumed that the traveller will select the route which minimizes his perceived cost of travel.

Fig. 4-7 LINK SPEED/FLOW CURVE



The traffic capacity limitation conditions of the Bangkok road network were divided into 14 different categories according to the nature of the road as shown in Table 4-10.

(3) Evaluation of Traffic Assignment Results

For the purpose of evaluating traffic assignment results, two cases have been calculated: the first case is where the area of influence is only the GBA and the second case is where the area of influence is Thailand. The reasons for these two cases were made is as follows:

a) The benefits of the truck terminal project will accrue to the whole nation, and so the whole of Thailand must be taken as the area of influence; however,

b) By only focusing on Thailand, one will get a distorted view of the difference between the alternatives since the part of the road network outside the GBA is obviously much larger than the part inside the GBA.

The results of traffic assignment are presented in Tables 4-10 and 4-11 . The results from these tables were summarized and again presented in Table 4-12 for vehicle-hours and in Table 4-13 for vehicle-kilometers. Based on these summary table, the following conclusions were reached.

1) Although the size of the GBA road network in terms of vehicle-hours is only about 14% of the total Thailand road network (see column A and B), the savings in vehicle-hours on the GBA account for about 60% of the savings for Thailand or 6000 veh-hrs/day (see column C and D).

   The savings from construction of the terminals is defined as the difference between each alternative and the null case (the case in which no terminal is constructed: alternative-1).

2) By comparison with all the other alternatives, alternative-3 is most recommendable as producing the largest veh-hr. savings within the GBA. By comparison between comparable single and double transfer system alternatives, the single system is more recommendable. Hence, alternative-33 is most highly recommended.

3) In a similar way, although the size of the GBA road network in terms of vehicle-kilometers is small (only about 15% of the total Thailand road network as shown in column A/B of Table 4-11), the savings in vehicle-kms in the GBA account for about 90% of the savings for Thailand or 200,000 veh-km/day (see column C/D). The savings is again defined by the difference between each alternative and the null case (alternative-1).

4) By comparison with all the alternatives, alternative-3 is again the most recommendable for producing the largest veh-kms savings within the GBA. By comparison between comparable single and double transfer system alternatives, the single system is still more recommendable. Hence, alternative-33 is recommended for adoption as the best combination of truck terminals for the GBA and Thailand.

Table 4-10 Traffic Capacity Limitation of Roads in Q-V Traffic Assignment

Model No.	Type of Road	Location	No. of Lanes	FREE FLOWING		CONGESTED FLOW	
				V max. (km/hr.)	Ql (Veh./day)	V min. (km/hr.)	Q max (Veh./day)
1	Ordinary Road	Urban Area	2	30	1,000	5	7,300
2			4	35	7,000	10	35,200
3			6	40	10,500	20	52,800
4		Suburban Area	2	45	1,300	10	8,500
5			4	50	8,500	15	42,400
6			6	55	16,000	20	63,600
7	Town Planning Road (Improved)	Urban Area	2	40	1,400	10	9,400
8			4	50	8,300	20	42,100
9			6	50	12,500	20	61,800
10		Suburban Area	2	50	1,400	10	9,400
11			4	60	10,000	20	50,000
12			6	60	18,800	20	75,000
13	Expressway	Urban Area	6	60	22,500	20	90,000
14		Suburban Area	6	60	30,600	20	102,000

Table 4-11 Summary of Vehicle-Hours Traffic Assignment Results

(Unit: veh-hrs/day)

Alt. (Terminals)	A GBA Traffic Network	B Total Thailand Traffic Network	A/B GBA Percentage(%)	C Time Savings within GBA	Rank of Alt.	D Time Savings within Thailand	C/D GBA Percentage(%)
1. (Null case)	107,134	767,339	14.0	-	-		
2. (NEW)	103,128	761,532	13.5	-4,005	(2)	-5,807	69.0
3. (NEWC)	102,881	761,090	13.5	-4,253	(1)	-6,249	68.1
4. (NEWN')	103,128	761,320	13.5	-4,005	(2)	-6,019	66.5
5. (EWN')	103,183	761,074	13.6	-3,951	(7)	-6,265	63.1
6. (EWCN')	103,167	760,895	13.6	-3,967	(6)	-6,444	61.6
7. (C)	103,124	760,574	13.6	-4,010	(4)	-6,765	59.3
8. (CN')	103,125	760,782	13.6	-4,010	(4)	-6,557	61.1
33. (NEWC)	102,661	758,188	12.4	-4,473		-9,151	48.9
55. (EWN')	103,034	760,349	13.6	-4,101		-6,990	58.7

Table 4-12 Summary of Vehicle-Kms Traffic Assignment Results

(Unit: veh-kms/day)

Alt. (Terminals)	A GBA Traffic Network	B Total Thailand Traffic Network	A/B GBA Percentage(%)	C Distance Savings within GBA	Rank of Alt.	D Distance Savings Within Thailand	C/D GBA Percentage(%)
1. (Null case)	5,309,629	34,308,259	15.0	-		-	
2. (NEW)	5,111,722	34,108,323	15.0	-197,907	(4)	-199,936	99.0
3. (NEWC)	5,102,786	34,092,697	15.0	-206,843	(1)	-215,562	99.0
4. (NEWN)	5,111,722	34,100,894	15.0	-197,907	(4)	-207,365	95.4
5. (NEW')	5,114,585	34,092,269	15.0	-195,044	(7)	-215,990	90.3
6. (EWCN')	5,113,075	34,085,803	15.0	-196,554	(6)	-222,456	88.4
7. (C)	5,111,395	34,074,707	15.0	-198,234	(3)	-233,552	84.9
8. (CN')	5,111,294	34,082,036	15.0	-198,335	(2)	-226,223	87.7
33. (NEWC)	5,100,266	33,992,191	14.4	-209,363		-316,068	66.2
55 (EWN')	5,111,116	33,992,191	15.0	-198,513		-316,068	62.8

Table 4-13 Traffic Assignment Results for Thailand, 2000

1. Vehicle-Hours

(Unit: veh-hrs)

Alt. / Veh.	1 Null case	2 NEW	3 NEWC	4 NEWN'	5 EWN'	6 EWCN'	7 C	8 CN'	33 NEWC	55 EWN'
4-wheel truck	60,197	64,803	64,480	64,639	64,399	64,282	63,680	64,020	61,258	60,163
6-wheel truck	30,429	30,400	30,322	30,359	30,306	30.277	30,155	30,226	29,569	29,408
10-wheel truck	193,592	183,092	183,081	183,085	183,132	183,127	183,504	183,301	184,123	184.279
Sub-Total	284,218	278,295	277,883	270,083	277,837	277,686	277,339	277,547	274.950	273.850
Sedan	428,789	428,925	428,923	428,925	428,925	428,925	428,923	428,923	428,992	431.783
Bus	54.332	54,312	54,284	54,312	54,312	54,284	54,312	54,312	54,246	54,716
Sub-Total	483,121	483,237	483,207	483,237	483,237	483,209	483,235	483,235	483,238	486,499
Total	767,339	761,532	761,090	761,320	761,074	760,895	760,574	760,782	758,188	760,349

2. Vehicle-Kilometers

(Unit: veh-kms)

Alt. / Veh.	1 Null case	2 NEW	3 NEWC	4 NEWN'	5 EWN'	6 EWCN'	7 C	8 CN'	33 NEWC	55 EWN'
4-wheel truck	2,106,887	2,268,121	2,256,800	2,262,368	2,253,967	2,249,859	2,228,793	2,240,703	2,144,029	2,105,709
6-wheel truck	1,065,006	1,064,012	1,061,278	1,062,579	1,060,710	1,059,703	1,055,411	1,057,923	1,034,907	1,024,293
10-wheel truck	6,774,719	6,408,218	6,407,818	6,407,975	6,409,620	6,409,440	6,422,625	6,415,932	6,444,312	6,449,769
Sub-Total	9,946,612	9,740,551	9,725,896	9,732,922	9,724,297	9,719,002	9,706,829	9,714,158	9,623,248	9,584,771
Sedan	22,297,035	22,304,109	22,304,015	22,304,109	22,304,109	22,304,015	22,304,015	22,304,015	22,307,582	22,307,676
Bus	2,064,612	2,063,863	2,062,786	2,063,863	2,063,863	2,062,786	2,063,863	2,063,863	2,061,361	2,061,847
Sub-Total	24,361,647	24,367,972	24,366,801	24,367,972	24,367,972	24,366,801	24,367,878	24,368,878	24,368,943	24,369,523
Total	34,308,259	34,108,323	34,092,697	34,100,894	34,092,269	34,085,803	34,074,707	34,082,036	33,992,191	33,954,294

Table 4-14 Traffic Assignment Results for GBA, 2000

1. Vehicle-Hours

(Unit: Veh-hrs)

Alt. / Veh.	1 Null case	2 NEW	3 NEWC	4 NEWN'	5 EWN'	6 EWCN'	7 C	8 CN'	33 NEWC	55 EWN'
4-wheel truck	3,917	3,696	3,640	3,696	3,698	3,698	3,696	3,696	3,640	3,696
6-wheel truck	8,657	8,275	8,208	8,275	8,278	8,278	8,275	8,275	8,033	8,263
10-wheel truck	79,378	76,113	75,995	76,113	76,146	76,146	76,109	76,109	75,947	76,092
Sub-Total	91,952	88,084	87,843	88,084	88,122	88,122	88,080	88,080	87,620	88,051
Sedan	13,617	13,503	13,501	13,503	13,494	13,503	13,503	13,503	13,501	13,503
Bus	1,565	1,541	1,538	1,541	1,567	1,542	1,541	1,542	1,540	1,480
Sub-Total	15,182	15,044	15,039	15,044	15,061	15,045	15,044	15,042	15,040	14,983
Total	107,134	103,128	102,882	103,128	103,183	103,167	103,124	103,125	102,661	103,034

2. Vehicle-Kilometers

	1 Null case	2 NEW	3 NEWC	4 NEWN'	5 EWN'	6 EWCN'	7 C	8 CN'	33 NEWC	55 EWN'
4-wheel truck	199,656	188,058	185,139	188,058	188,149	188,149	188,043	188,043	185,130	188,043
6-wheel truck	442,485	422,196	418,696	422,196	422,306	422,306	422,175	422,177	418,230	421,556
10-wheel truck	3,890,124	3,724,104	3,721,699	3,724,104	3,725,256	3,725,256	3,723,813	3,723,813	3,719,645	3,723,233
Sub-Total	4,532,265	4,334,358	4,325,525	4,334,358	4,335,711,	4,335,711	4,334,031	4,334,033	4,323,005	4,332,832
Sedan	704,690	704,690	704,690	704,690	704,690	704,690	704,690	704,690	704,690	704,690
Bus	72,674	72,674	72,571	72,674	74,184	72,674	72,674	72,571	72,571	73,594
Sub-Total	777,364	777,364	777,261	777,364	778,874	777,364	777,364	777,261	777,261	778,284
Total	5,309,629	5,111,722	5,102,786	5,111,722	5,114,585	5,113,075	5,111,395	5,111,294	5,100,266	5,111,116

4.3 Terminal Location Considerations

In selecting suitable site locations for the truck terminals, the following criteria were examined.

- Contribution to the decongestion of Bangkok traffic
- Avoidance of land use conflicts
- Accessibility to the road network and terminal users
- Accessibility to other modes of transport without causing conflict with them
- Availability of land

(1) Decongestion Criteria

In the First Revision of the Greater Bangkok Plan in 1971, the Dept. of Town and Country Planning catalogued the major causes of traffic congestion at that time as follows:

- Incomplete road network missing many links
- Insufficient by-passes of the intra-city road system
- Insufficient road capacity for the traffic volume
- Inconsistent road width and inadequate surfacing
- Insufficient number of bridges crossing the Chao Phraya River
- Insufficient city parking areas such that public roadways are blocked for private parking and loading/unloading of cargoes
- Distribution of land use not related to the road network

Almost a decade has passed since the DTCP assessment of traffic conditions was made and many road projects have been planned, executed or are in the process of execution. Consequently, the future road network will include a multi-functional and interconnected system of wide 6-lane highways and 4-lane trunk roads providing access into, out of and through Bangkok. Among the projects, the following are noteworthy:

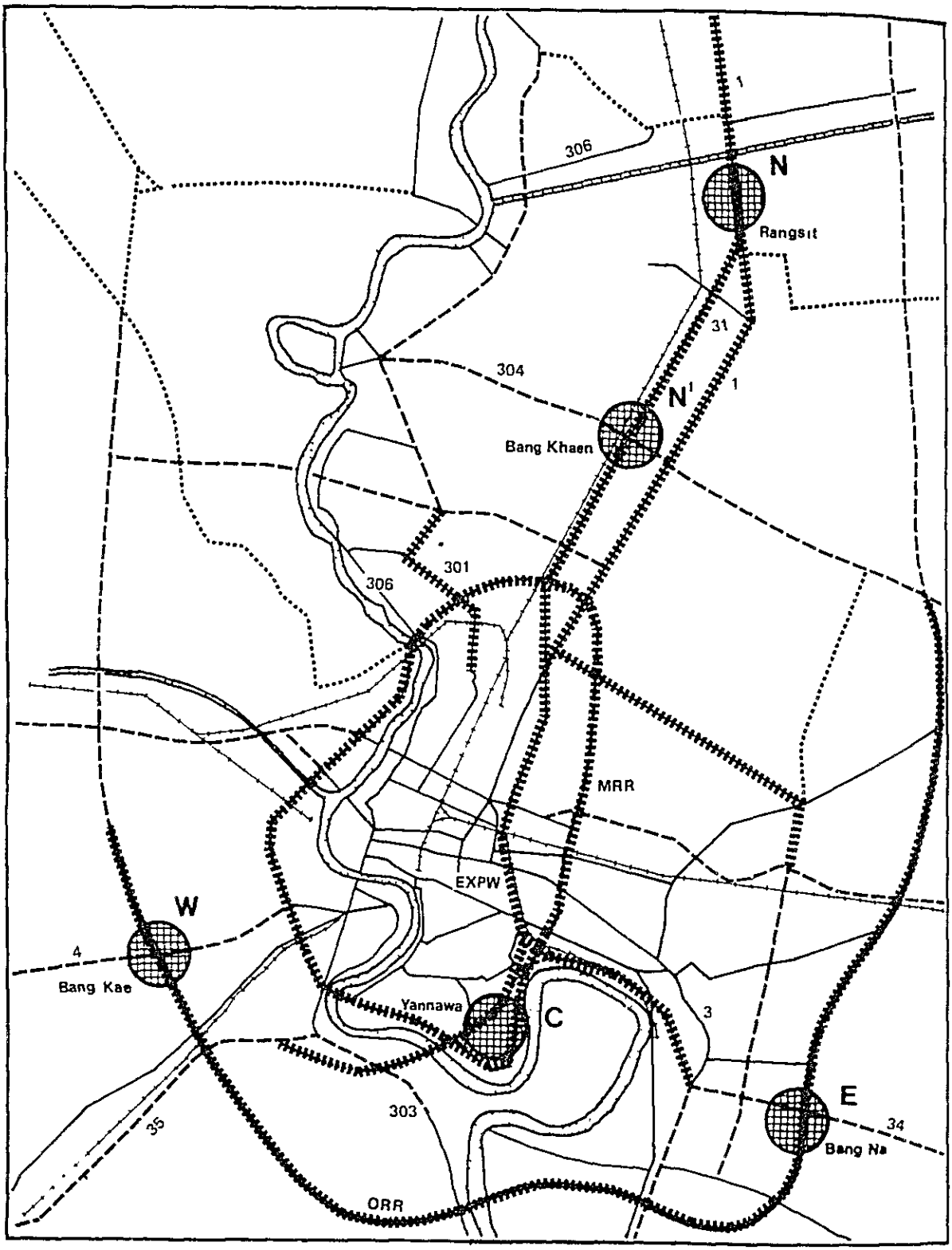
1. Outer Ring Road (ORR) - a major 6-lane by-pass with a U-shape starting south in the near Bang Bua Thong, passing through Phra Pradaeng and Samut Prakan and then heading north again to Bang Pa-in.

2. Middle Ring Road (MRR) - a circular 6-lane route allowing passage around Bangkok, 5-10 km from the city center.

3. First Stage Expressway (EXPW) - central 6-lane by-pass routes from Dao Kanong and Samrong to the Din Daeng area.

In addition to the above mentioned roadways which are shown together with other existing and future routes in Fig. 4-8 , the First Stage Urban Mass Transit and Suburban Mass Transit Systems have been planned. The Mass Transit System will remove many vehicle-trips and help as a traffic decongestant. However, after the completion of all planned roads and the First Stage MTS, the total road network still will experience near-congestion or over-

Fig. 4–8 FUTURE ROAD NETWORK OF BANGKOK



LEGEND

- 6-Lane Roadway
- 4-Lane Roadway
- 2-Lane Roadway
- Existing Road
- Railroad

Proposed Truck Terminal Location

congestion, and especially on the radial roads outside the central business district (CBD) as shown below:

Average Congestion Ratio for Peak Hours, 2000

Congested Road Section		Average Congestion Ratio*
The total road network in GBA		0.82
On radial roads in the Greater Bangkok Area	Total	0.95
	Inside CBD**	1.38
	Outside CBD	0.84
At the boundary of the CBD outside the Middle Ring Road	Total	1.14
	East Side	1.30

Source: The Comprehensive Study for the Suburban Mass Transit Project

Note: * Congestion Ratio = Forecast Traffic Volume/Maximum Road Capacity

** Central Business District is defined by High Density Mixed Land Use

Since the difference between areas inside the CBD and outside is almost 40%, the truck terminal should be located outside the CBD since truck terminals do attract a great deal of vehicle traffic. Consequently, the high density mixed land use area of the central zone as shown in Fig. 4-9 has been excluded from consideration for truck terminal sites.

(2) Land Use Criteria

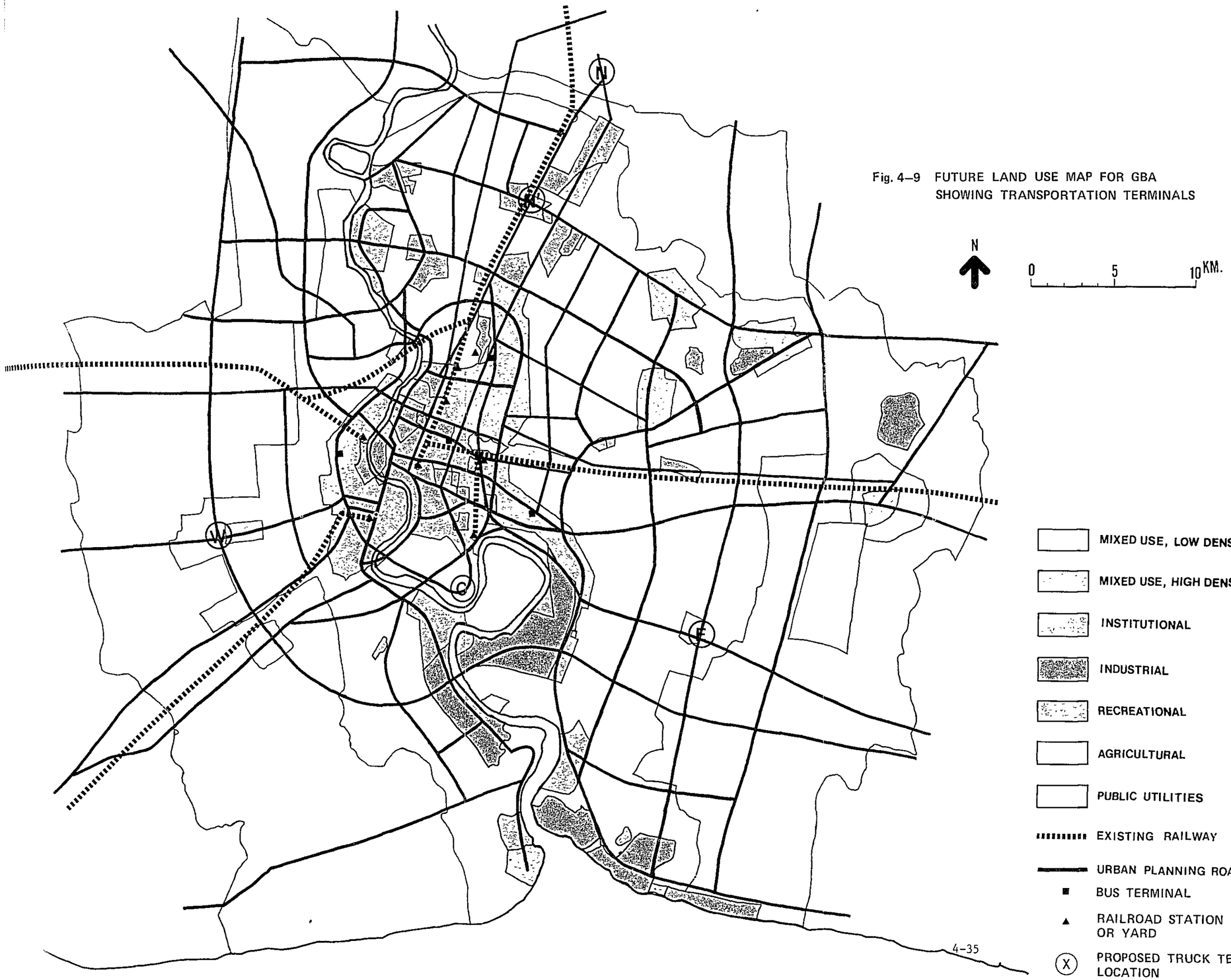
In order to avoid conflict with the land use areas defined in the DTCP's Greater Bangkok Plan 2000 (see Fig. 4-9), truck terminal site location should avoid areas designated for specific land uses such as industrial, institutional and high density mixed use. Consequently, attention for site location was focused on areas designated as low density mixed use.

(3) Accessibility Criteria

The major users of a truck terminal are outbound inter-city truckers whose O-D ranges are large. Without a truck terminal, their less-than-truckload (LTL) mixed cargoes are not only unprofitable from a trucking industry point of view, but also represent a loss to the national economy since an empty truck takes up public road space and causes, wear on the road surface just as a loaded truck.

Intra-city truckers are unlikely to use a truck terminal for transfer and consolidation even for LTL cargoes since O-D distances are short and hence petrol and other operating overheads do not consume such a large percentage of profits.

Fig. 4–9 FUTURE LAND USE MAP FOR GBA
SHOWING TRANSPORTATION TERMINALS



Inbound inter-city truckers will not profit as much from truck terminals since they will have expended the major portion of overheads by the time they reach the terminals. Nonetheless, it must be noted that provincial truck terminals which are strategically located would greatly improve the efficiency and profitability of inbound LTL mixed cargo truckers in the same way that truck terminals in the GBA will do.

From the viewpoint of outbound inter-city truckers, the terminal locations should be near or on major provincial exit routes from Bangkok which are as follows:

Major Truck Roads for the GBA

West/South - Route 4
East - Route 34
North/Northeast - Route 1 (alternately, Route 31)

From the viewpoint of the road network, accessibility is defined in terms of the major 6-lane roadways which include the following: Outer Ring Road, Middle Ring Road, First Stage Expressway and Routes 1 and 31.

From the viewpoint of other transport, accessibility to airports and sea ports is desirable since both are major originating nodes for the trucking industry. On the other hand, too close a proximity represents a conflict. The major present and future ports and access routes are outlined as follows:

Type of Port		Name	Road Access to GBA
Airport	Present	Don Muang	Route 31
	Future	Nong Ngu Hao	Route 303
Sea Port	Present	Klong Toei	Expressway
	Future	Sattahip and Laem Chabong	Route 34

Consideration of access to railway terminals is problematic since the major railway cargo terminals (Klong Toei, Thonburi and Bang Sue) are all located within the high density mixed-use area of the CBD. Nonetheless, by eliminating the CBD from consideration, conflict with a major form of traffic, passenger traffic, is also eliminated since all major City Bus and Railroad Stations are located within the CBD as shown in Fig. 4-9.

Intermodel transfer is a possibility which is discussed in Section 5.9; however, since the major Junctions of truck terminals are for road transport, location near and with access to major roads is considered to be the overriding determinant of terminal location.

In conclusion, the following terminal locations are recommended primarily from the access point of view although the locations also meet the decongestion and land use criteria mentioned before.

Summary of Terminal Site Accessibility

Terminal	Location	Terminal User Access	6-Lane Road Network Access	Present Port Access
North	Rt. 1	Rt. 1	Rt. 1	Rt.31 (Don Muang)
East	Rt. 34	Rt. 34	Outer Ring Road	RT.34 (Sattahip/ Laem Chabang)
West	Rt. 4	Rt. 4	Outer Ring Road	-
Central	Between Expressway/ MRR	Expressway	Expressway	Expressway (Klong Toei)
Alt. North	Rt. 31	Rt. 31	Rt. 31	Rt.31 (Don Muang)

(4) Availability of Land

Although the terminal locations selected above are in low density land use areas, land availability can only be confirmed by actual negotiation. The prices of land are examined in Chapter 5, however, it is recommended that the government initiate zoning restrictions and land acquisition at the earliest possible date in order to keep land values from becoming inflated and to prevent the large land parcels required for truck terminals from disappearing from the market.