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REPUBLIC OF SINGAPORE
PUBLIC WORKS DEPARTMENT
MINISTRY OF NATIONAL DEVELOPMENT

THE FEASIBILITY STUDY
OF
SELECTED EXPRESSWAYS

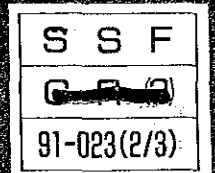
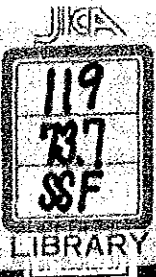
FINAL REPORT
(TEXT)

MARCH 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

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REPUBLIC OF SINGAPORE

**PUBLIC WORKS DEPARTMENT
MINISTRY OF NATIONAL DEVELOPMENT**

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SELECTED EXPRESSWAYS**

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PREFACE

In response to a request from the Government of Republic of Singapore, the Japanese Government decided to conduct a feasibility study of Selected Expressways in Singapore and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Singapore a survey team headed by Mr. Kazuro Yanagida, composed of members from Oriental Consultants Co., Ltd., from May to December 1990.

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

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

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

March 1991



Kensuke Yanagiya
President

Japan International Cooperation Agency

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ABBREVIATIONS

ABBREVIATIONS

1. Agencies and Authorities

PWD	Public Works Department (Ministry of National Department)
MND	Ministry of National Department
URA	Urban Redevelopment Authority
HDB	Housing Development Board
DOS	Department of Statistics
EDB	Economic Development Board
MCI	Ministry of Communication and Information
MOL	Ministry of Labour
MTI	Ministry of Trade and Industry
SIC	Singapore International Chamber of Commerce
MRTC	Mass Rapid Transit Corporation
SBS	Singapore Bus Service
JTC	Jurong Town Corporation
NUS	National University of Singapore
JICA	Japan International Cooperation Agency

2. Other Abbreviations

SS	Singapore Standard
BS	British Standard
AASHTO	American Association of State Highway and Transportation Officials
PIE	Pan-Island Expressway
KLE	Kallang Expressway
PYE	Paya Lebar Expressway
CTE	Central Expressway
BKE	Bukit Timah Expressway
ECP	East Coast Expressway
TPE	Tampines Expressway
MRT	Mass Rapid Transit
LTS	Land Transport Study
IC	Interchange
ROW	Right of way
PL	Private land
SL	State land
RL	Reduced level
VOC	Vehicle operating cost
GDP	Gross domestic product
IRR	Internal rate of return
TP	Truck percentage
PC	Prestressed concrete
STA	Station
Rd.	Road
Ave.	Avenue

CONCLUSION AND RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

1. CONCLUSION

(1) Overview

The Study concluded, after lengthy and in-depth investigations and analyses in Singapore during which time valuable advices were received from the concerned officials of PWD (Public Works Department), that the improvement of PIE (Pan Island Expressway) and constructions of proposed KLE (Kallang Expressway) and PYE (Paya Lebar Expressway) were necessary in due course, that the alternatives selected for each expressway were feasible in every aspects of technical, socio-economy and economics, and that the implementation of such projects would contribute to national development.

(2) PIE

An alternative for at-grade increase of lanes, as a rule, was selected for the improvement of PIE between the PIE/BKE (Bukit Timah Expressway) Interchange and the Aljunied Flyover excluding the interchanges at the PIE/CTE and PIE/Woodsville, which were outside the scope of the Study.

Various alternatives were studied; such as underground, bypass and grade separated routes. The final alternative was found to be more superior in technical and economical aspects over the others.

All the existing structures, except the PIE/Toa Payoh Interchange, were proposed to be retained. New structures were planned to be added at interchanges and main expressway bridges. The flyover at PIE/Toa Payoh Interchange, which had insufficient head room clearance for the main expressway, was proposed to be completely refurbished to manage the existing problems and to cope with proposed improvements.

For the section between the interchanges of PIE/Thomson and PIE/CTE where an early tendering for the improvement works was planned, advices were sought by the PWD officials on the Study Team's proposals finalizing them to be in time for the tendering.

Maps of one in 1,000 and smaller were used. The final alternative was presented on drawings of one in 1,000 at all the interchanges, the stretch of PIE between the interchanges of PIE/CTE and PIE/Thomson; and one in 2,000 at other locations.

(3) KLE

An alternative of viaduct/tunnel structure was selected. The route was proposed to cross over the ECP (East Coast Parkway) and Geylang River by viaduct/bridge; to the Kallang Park by a tunnel of 495m long; to stay semi-depressed under Mountbatten Road, Geylang Road, Sims Avenue and MRT; and to finally climb up to cross over the PIE and to link up with the PYE.

Interchanges were studied at the ECP/KLE for full accesses, at the KLE/Mountbatten/Geylang for the underground major accesses with traffic directions from the city and at the PIE/KLE/PYE for full accesses.

Viaducts were planned to use standardized girders for both economics and aesthetics considerations. The bridge over Geylang River was proposed to be a three span continuous PC (Prestressed Concrete) box girder.

The tunnel would require a longitudinal forced ventilation by

jet fans. The length of the tunnel was proposed to be shortened as much as possible to reduce concentration of contaminated air and the semi-depressed section was utilized more.

A viaduct alternative for the whole length of the KLE remained competitive until the very end of evaluation as it possessed some advantages over the final selected one particularly on traffic safety. The recommendation was based largely on the aesthetic implications of the viaduct structures which, in the local context, might be viewed as unacceptable. The tunnel alternative was planned to pass through the portal with a tight 600m curve on 3% gradient, conditions which were known to be undesirable from the viewpoint of traffic accidents. This point should be looked into again prior to implementation.

The Study was conducted using one in 2,000 maps and smaller. Drawings of one in 2,000 scale were prepared for the final alternative.

(4) PYE

An alternative to make use the green belt of Air Base was selected. The proposed expressway should start from the PIE as an extension of the KLE, pass over the Pelton Canal by a viaduct, stay on the viaduct until the green belt where it should be at-grade. Flyovers were proposed at the crossings of Tampines Road and new Punggol Road.

Interchanges were proposed at Paya Lebar Road for full accesses, Hougang Avenue 3 for only a directional service from the Hougang area, at Tampines Road for full accesses, and at new Punggol Road for full accesses. The PYE/TPE (Tampines Expressway) should be connected as a junction for full directional services.

Viaduct should be standardized though, those over the Pelton Canal were proposed to be supported by three piers to preserve the capacity of the canal as much as possible.

Against the final alternative, there were others studied for different routes at such locations as the Air Base, Defu Avenue and Hougang Avenue and for other ideas of combining structures including a tunnel under the Air Base. The final alternative proved to be the most superior in overall aspect.

The drawings were prepared in a same scale as the KLE.

2. RECOMMENDATION

(1) Rezoning of Land Use at the Crossings of KLE, PYE and PIE

Proposed interchange had services to almost all the directions of three expressways. The roads and structures would be so complicated that some negative impact on the environ would be unavoidable. A change in land use from housings to others was recommended to reduce impact, at least to residents.

(2) Classified Use of Expressways

It was a common understanding to separate grade and role of expressways so that they could contribute more in terms of reduction in travel time and accidents. To keep a higher grade of an expressway, there would need several basics such as avoiding common bus stops and mixed usage with frontage roads, providing enough distance between interchanges, etc. Some of the expressway systems were recommended to be reviewed thoroughly in the light of such understanding prior to implementation.

CHAPTER 1

INTRODUCTION

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CHAPTER 1 INTRODUCTION

1.1 Project Background

In response to the request of the Government of the Republic of Singapore (hereinafter referred to as "the Singapore Government"), the Government of Japan decided to conduct the Feasibility Study of Selected Expressways in Singapore (hereinafter referred to as "the Study").

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, will undertake the Study, in close cooperation with the concerned authorities of Singapore.

The Public Works Department, Ministry of National Development (hereinafter referred to as "PWD") will act as the counterpart agency to the Japanese Study Team (hereinafter referred to as "the Study Team") and also as the coordinating body with other relevant organizations for the smooth implementation of the Study.

Singapore's urban transport system is predominantly road-based and will continue to be so, even when the MRT system is in full operation. Today there are approximately half a million vehicles comprising 226,000 cars, 9,000 buses and 110,000 goods vehicles, together with motorcycles and other forms of transport in Singapore.

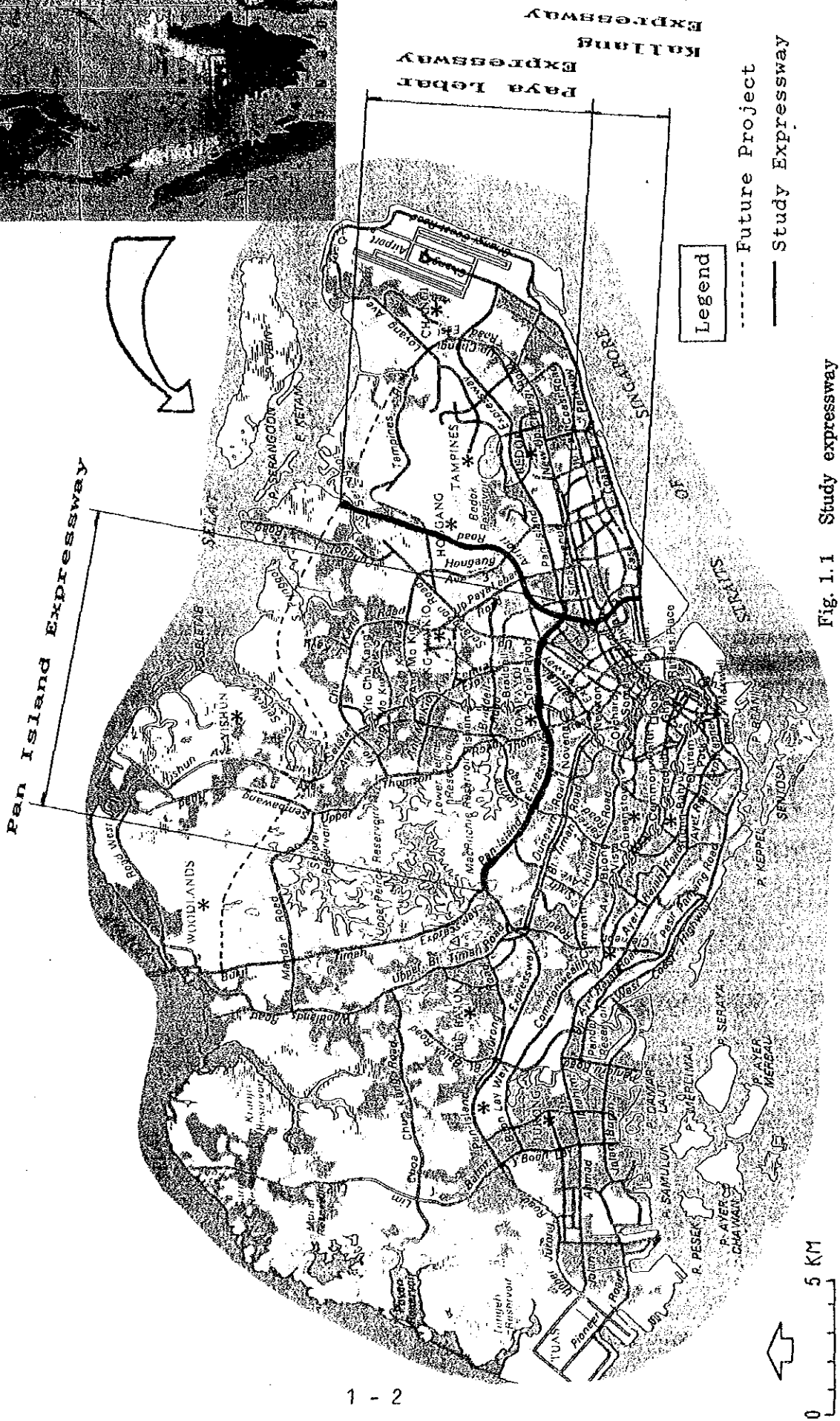
The PWD has planned an expressway network in total of about 150 km to meet the long term needs for better and faster travel on the island. Today, about 100km of the expressway network has been completed. The remainder of the network is due for completion prior to the end of this decade.

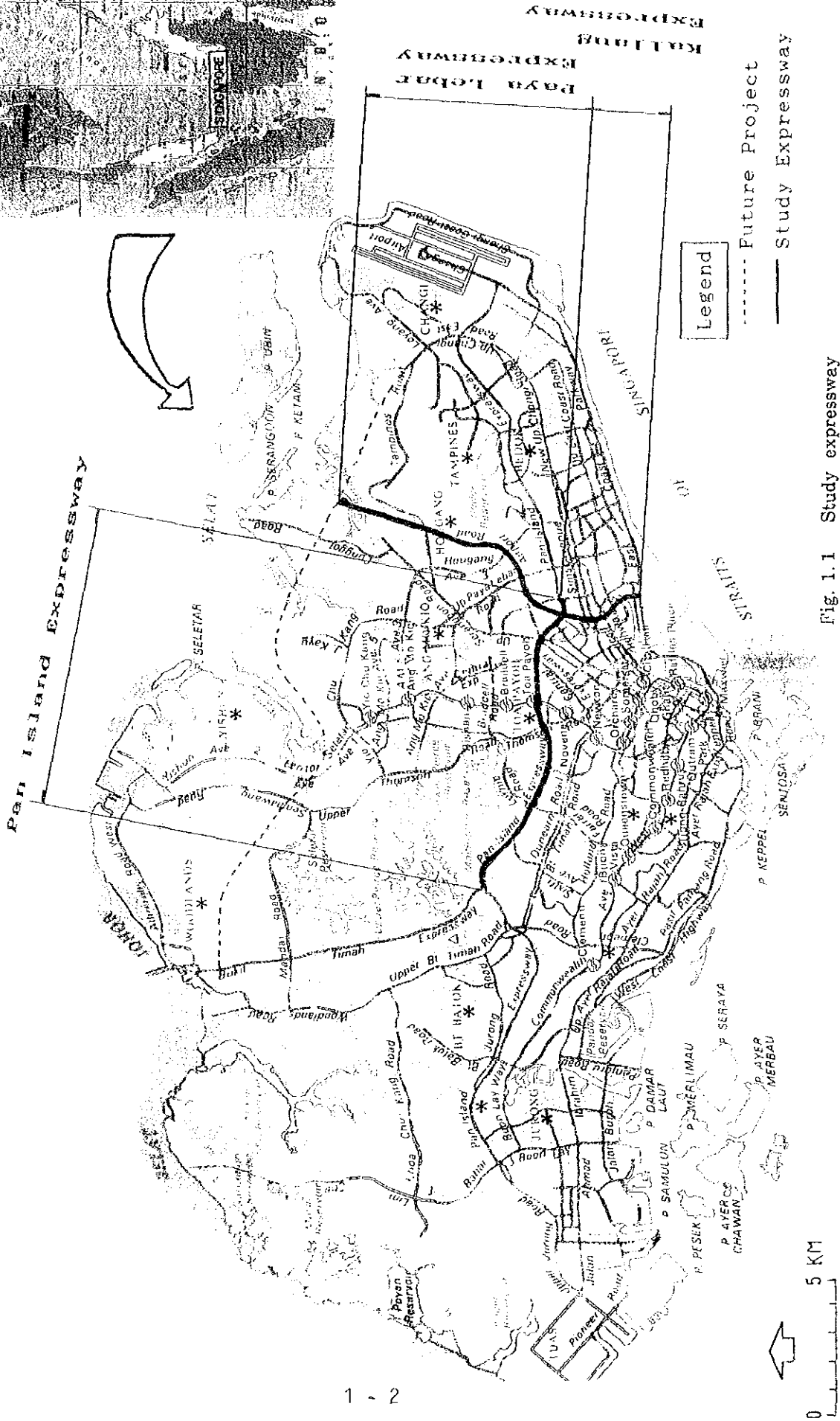
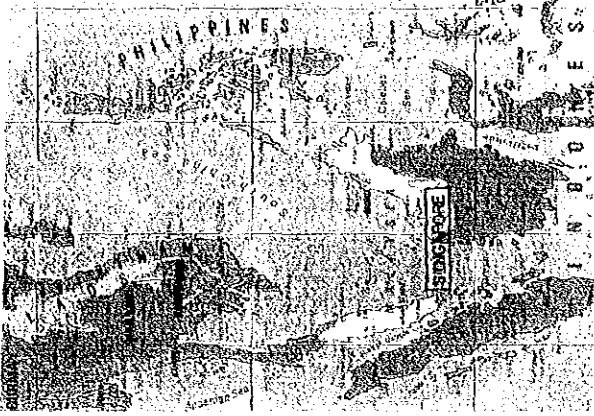
The Kallang Expressway (KLE) forms a part of the expressway network in the eastern sector of the island. Linking the Pan Island Expressway (PIE) with the East Coast Parkway (ECP), it also forms the eastern leg of the Central Area Expressway System (CAES). With the completion of the CTE currently under construction, the KLE will be the only leg of the CAES left to be implemented. (See Fig. 1.1).

The Paya Lebar Expressway (PYE) is the northward extension of the Kallang Expressway from the latter's intersection with the Pan Island Expressway (PIE) to the north-eastern sector of the island. The concept was developed only in 1985, this expressway will serve four new towns to be constructed by the Housing Development Board in the north-east sector in the 1990s and in the early part of the 21st century.

Both expressways are expected to be built in the 1990s to meet projected traffic requirements. Construction of the two expressway projects is expected to be particularly difficult, because of various existing developments and constraints in the vicinity of the expressway routes.

A route location study is proposed to examine and compare the alternative route locations, traffic interchange layouts and methods of construction. The results of the study will enable the PWD to adopt an optimum alignment for the two expressways.





The PIE is the most heavily used expressway in Singapore. It runs from Changi Airport in the east to Jurong in the west. It links six new towns along its route.

The dual 3-lane expressway carries more than 120,000 vehicles per day. The stretch of the expressway between the Woodsville flyover and the Bukit Timah Expressway (BKE) is already operating at or close to its practical capacity during the peak periods. Traffic projections indicate that its existing capacity would be insufficient to meet future traffic volumes. Its level of service is expected to deteriorate further unless measures are taken in the 1990s to increase its capacity.

A study is required to explore different ways of increasing its capacity. The study is likely to include an evaluation of the need to reconstruct some of its key interchanges, and to implement improvements and alterations to others to meet the forecasted increases in traffic volume.

1.2 Study Objectives

The study objective is to conduct the feasibility study of the Kallang Expressway (KLE), Paya Lebar Expressway (PYE) and improvement of the Pan Island Expressway (PIE) between the Bukit Timah Expressway (BKE) and Aljunied Flyover.

The study area will cover the whole length of KLE and PYE and the sections of PIE between BKE and Aljunied Flyover, excluding the interchanges at PIE/CTE (Central Expressway) and PIE/Woodsville, and their vicinities.

1.3 Scope of Work

The Study will cover the following items in order to meet the objectives.

- (1) data collection and analysis
- (2) field survey and analysis
- (3) preliminary design
- (4) cost estimate
- (5) economic evaluation
- (6) implementation schedule

More detailed items are narrated in the next section.

The Study is divided into two phases, viz. Phase 1 and 2. In the Phase 1 study, the Study Team aims to identify the existing and future expected problems on the expressways, to conceive alternative solutions, and to select prospective ones for further studies in the next phase. In the Phase 2 study, the Study Team will examine those selected alternatives more in detail to finalize them for each expressway.

1.4 Study Approach and Execution of the Study

1.4.1 General

A multi-disciplinary team approach was employed for the Study. With this approach, adequate attention to all the various aspects of the Study was ensured. This allowed an opportunity for resolving the various complex issues in a broader manner.

Although the Study Team concentrated their efforts on the execution of the Study, special attention was also given to specific objectives, such as site visits, preparation of various preliminary reports for each Counterpart meeting, as well as attendance at these meeting. Throughout the period of the Study, the Study Team kept close contact with the PWD and care was exercised to secure concurrence at all the stipulated stages.

In the preparation of reports an attempt was made to present the results of the Study as completely and as clearly as possible, including not only results and conclusions, but also the steps taken and the basic assumptions used. This was done to make it possible for those in charge of the implementation to have at their disposal all possible variations during actual development.

1.4.2 Basic Policies of the Study

The target of phase I study is to propose feasible and competitive alternatives and to select the most advantageous alternatives. The Study Team designed their Study approach to meet the following basic policies.

1) Proposal of competitive alternatives

Improvement of an expressway under operation and construction of new expressways have different schemes and points considered, therefore, alternatives should be taken into careful consideration of each expressway's character.

2) Selection of advantageous alternatives

In Singapore the available land area is very limited, therefore, the evaluation of alternatives should be conducted comprehensively with future prospects taken into account as much as possible. Sense of value for improvement or construction of expressways does not always agree, because some items for evaluation are quantitative and it is hard to find and determine the difference between alternatives. Obtaining an evaluation of alternatives means also that taking an objective view of the overall Singapore situation is very important.

1.4.3 Execution of the Study

1) General

The Study Team, dispatched by JICA, will be spending 233 days (from 7 May to 25 December, 1990) in Singapore for the subject study which includes fact finding, data collection, topographic, soils and materials and traffic surveys, etc. as well as for discussions with the officials

of relevant ministries and agencies of the Government.

In planning the efficient execution of the Study, the Study was carried out in two phases under the headings of Phase I and Phase II. These phases were further sub- divided into logical functions as briefly shown in Fig. 1.2.

2) Phase I Study

Phase I essentially consisted the following:-

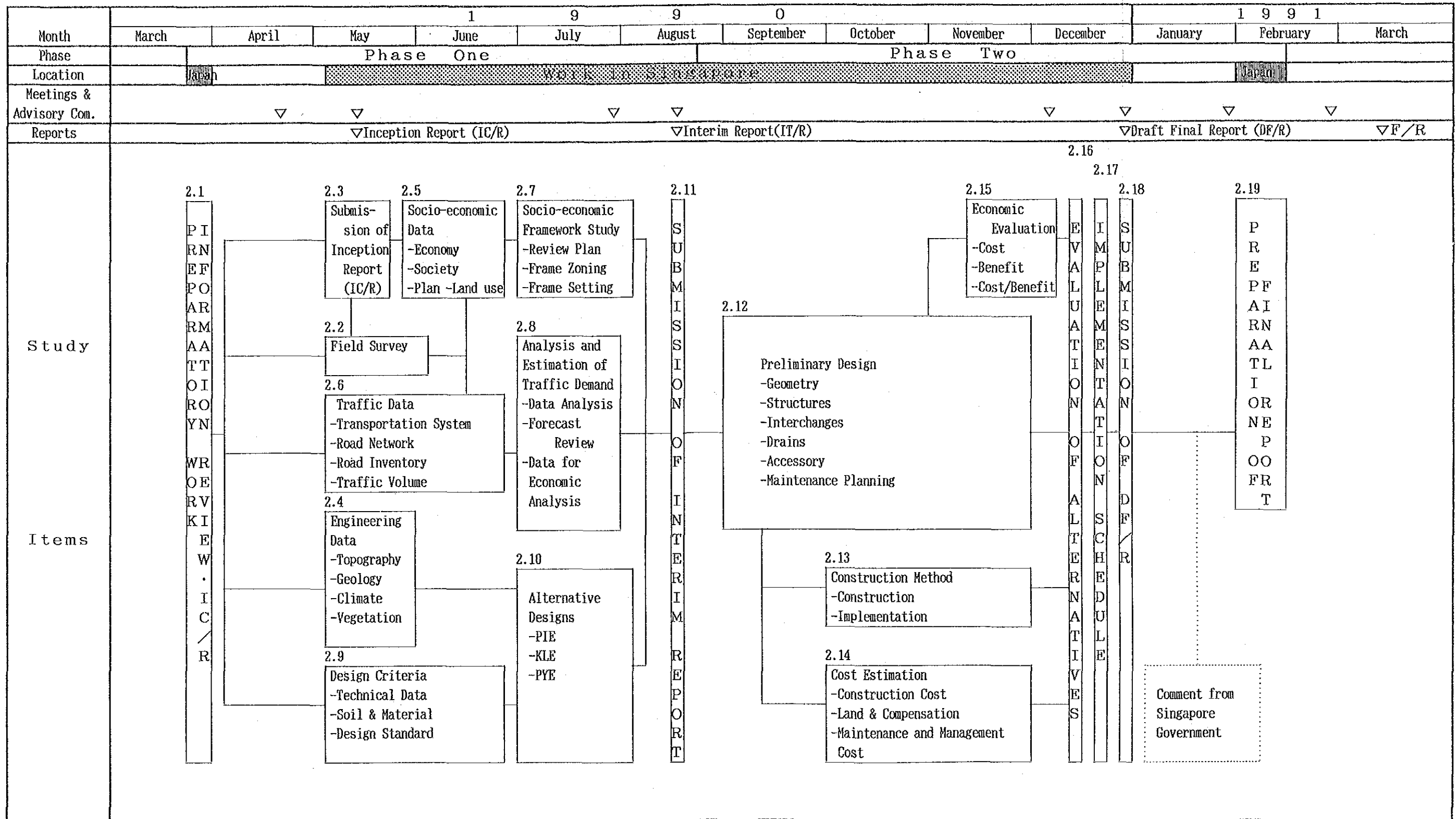
- (a) Collection and Analysis of Data
 - Socioeconomic and land use data;
 - Development plans;
 - Traffic characteristics of transportation systems;
 - Inventory of existing transport facilities;
 - Road network; Traffic volume;
 - Geotechnical and hydrological data;
 - Meteorological data and topographical maps; and
 - Various design standards.
- (b) Socioeconomic Framework Study
 - Conduct interviews; Review Plans;
 - Frame zoning; and
 - Frame setting.
- (c) Traffic Study
 - Traffic survey and analysis; and
 - Estimation of traffic demand.
- (d) Design Criteria Study
 - Examine design standards; and
 - Determine design criteria for alternative evaluation.
- (e) Alternative designs of KLE & PYE and PIE improvement.
 - Design consideration;
 - Selection of alternative; and
 - Scale of design.

3) Phase II Study

Based on the previously determined data, the Study Team will carry out the following tasks listed below for the selected alternatives in the Phase I Study.

- (a) Preliminary design
 - Geometric design
 - Plan for Interchanges
 - Accessory
 - Quantity
 - Plan for structures
 - Drains
 - Maintenance Planning
- (b) Construction planning
 - Construction method
 - Construction period
 - Traffic operation
- (c) Cost estimate
 - Construction cost
 - Maintenance and management cost
 - Land and compensation

Fig. 1.2 Study flow chart



Note: Numbers indicated correspond to those in the main text.

- (d) Economic evaluation
- (e) Evaluation of alternatives
 - Economic aspects
 - Noise and aesthetic aspects
 - Traffic aspects
 - construction aspects
- (f) Implementation schedule

1.5 Conduct of the Study

The Study was carried out by the Study Team comprised of Japanese Consultant staff and PWD staff.

The Advisory Committee of JICA and the Steering Committee of PWD have acted as advisors to the Study Team.

The organisation described above is as shown in Fig. 1.3.

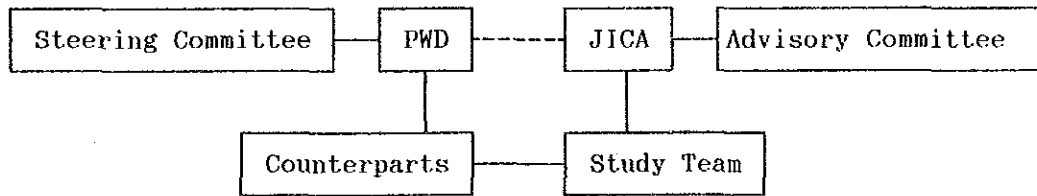


Fig. 1.3 Study organisation chart

The Advisory Committee of JICA comprises three members as follows:-

Mr. MATSUMURA	Tetsuo	Chairman	Ministry of Construction
Mr. NAKANO	Masanori	Member	Ministry of Construction
Mr. FUJISHITA	Kozo	Member	Japan Highway Public Corporation

The Steering Committee of PWD comprises four members as follows:-

Mr. CHUA Koon Hoe	Chairman	Deputy Director General
Mr. WONG Eng Seng	Alternate Chairman	Director
Mr. ONG Ah Tiang	Member	Chief Engineer
Mr. LAM Chuen Fong	Member	1st Assistant Chief Engineer

1.6 Organization of the Project Team

The staff who directly participated in the Study are as follows:

1) Members of the Study Team

Mr. YANAGIDA	Kazurou	Leader
Mr. OHNO	Hirohisa	Deputy Leader/Highway Planning
Mr. OKAMURA	Noashi	Traffic Planning/Analysis
Mr. HOSHINO	Kanji	Urban Planning

Mr. OKITA	Hitoshi	Road/Highway Design
Mr. TANAHASHI	Takamichi	Structure Planning/Design
Mr. KUBOYA	Nobuhiro	Structure Planning/Design
Mr. MIYAZAKI	Yosiki	Construction Planning/Cost Estimate
Mr. KUROSAWA	Yasuhiko	Economic Analysis

2) PWD Counterpart Staff

Mr. Mohinder SINGH	Senior Engineer
Mr. LOOI Teik Soon	Executive Engineer
Mr. TOH Eng Heong	Engineer
Mr. KOH Ser Onn	Engineer

1.7 Report Procedure

This Draft Final Report on the Feasibility Study of the Kallang Expressway, Paya Lebar Expressway and improvement of the Pan Island Expressway (between Bukit Timah Expressway and Aljunied Flyover) consists of the following volumes:

EXECUTIVE SUMMARY		
VOLUME I	:	TEXT
VOLUME II	:	DRAWINGS

At the various stages of the Study, the following reports have been presented by JICA to the PWD:

- Inception Report----- May 1990
- Interim Report----- August 1990
- Draft Final Report----- December 1990

CHAPTER 2

SOCIO-ECONOMIC CHARACTERISTICS

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CHAPTER 2 SOCIO-ECONOMIC CHARACTERISTICS

2.1 Outline of the Concept Plan

A UNDP programme was set up to formulate a long-term strategic development plan, known as the Long Range Concept Plan. This coordinated and integrated development plan involved various proposed and realised projects on land use, expressways, public utilities, MRT, and other infrastructure projects.

The Concept Plan was aimed at the decentralization of urban functions to avoid over-concentration in the city centre. The New Towns proposed in the hinterland of the city were designed to be self-contained urban areas where businesses and commercial activities are carried out in the respective town centres.

In 1985, the Concept Plan (Fig. 2.1) was revised to incorporate the revisions of the Master Plan. The basic planning policies were revised in accordance with the new requirements generated from the rapid and remarkable development of the country over the past 18 years. A second review was done in 1990 by MND as shown in Fig. 2.2.

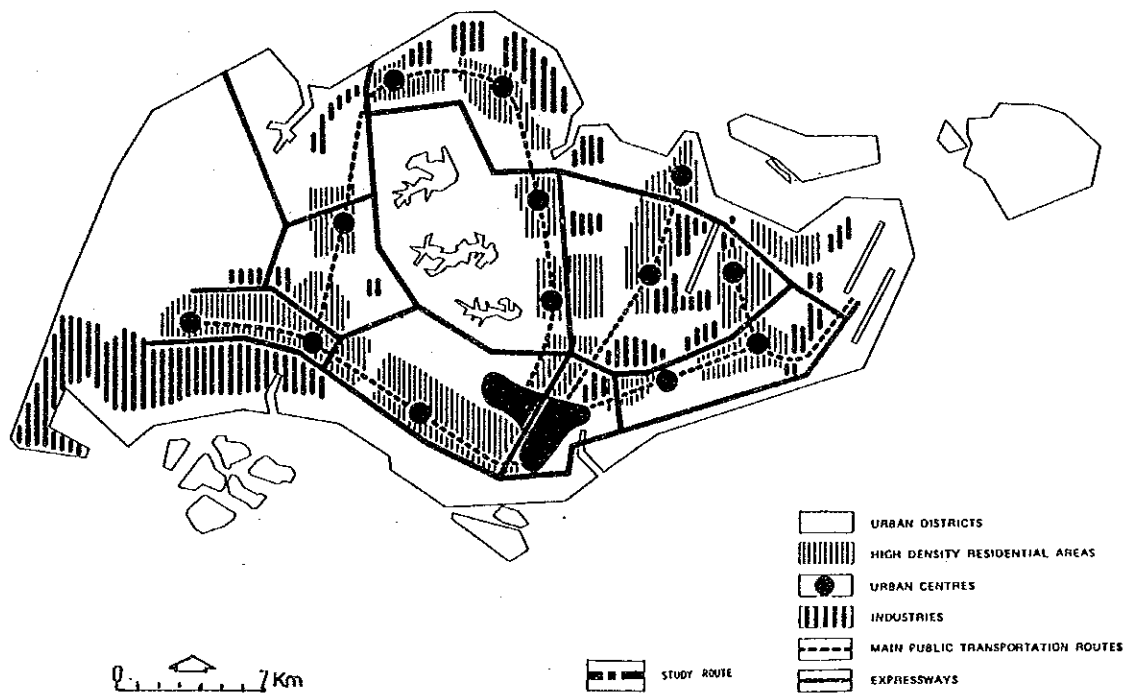


Fig. 2.1 Revised Concept Plan 1985

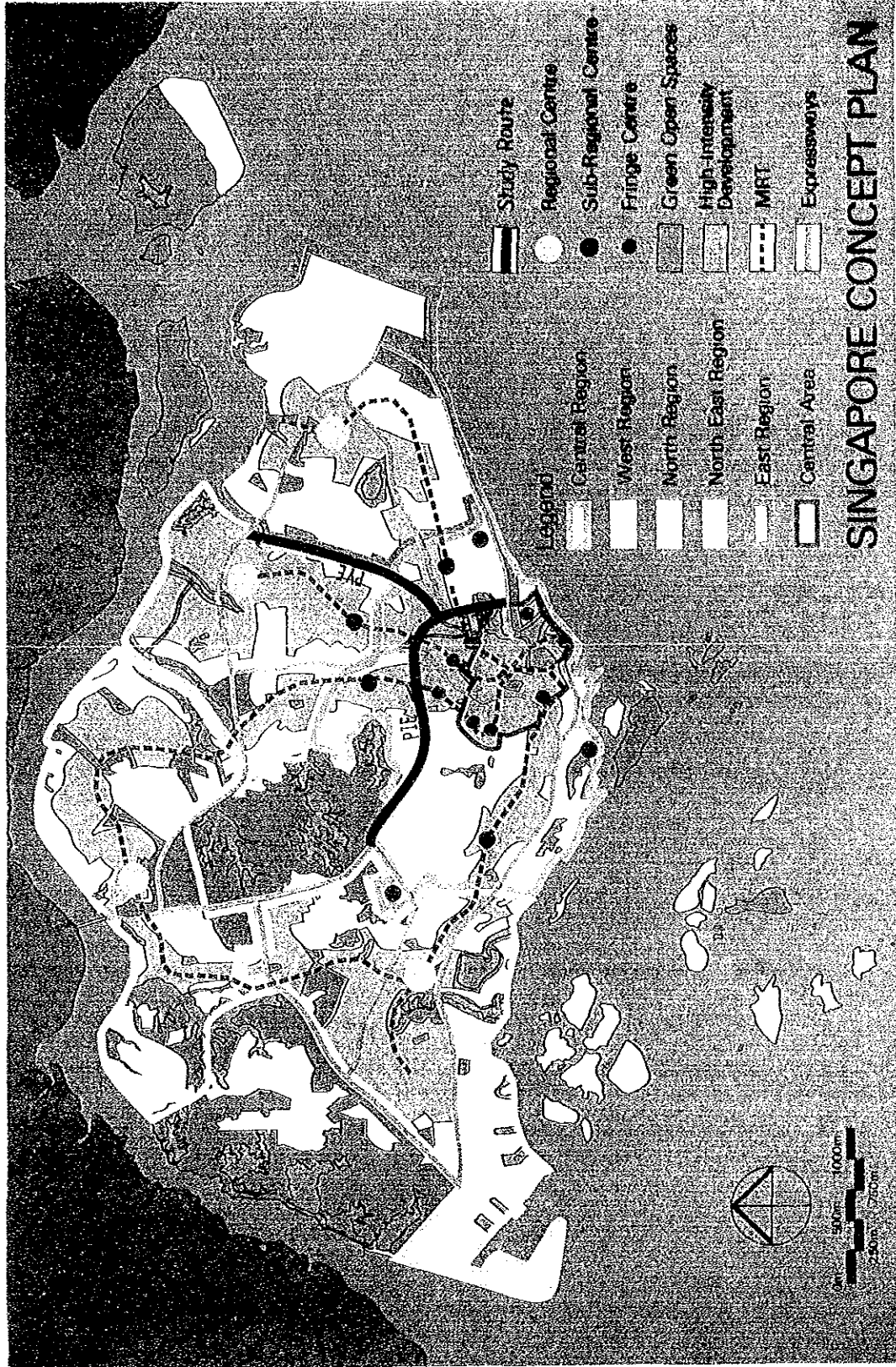


Fig. 2.2 Singapore concept plan for year 1990

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

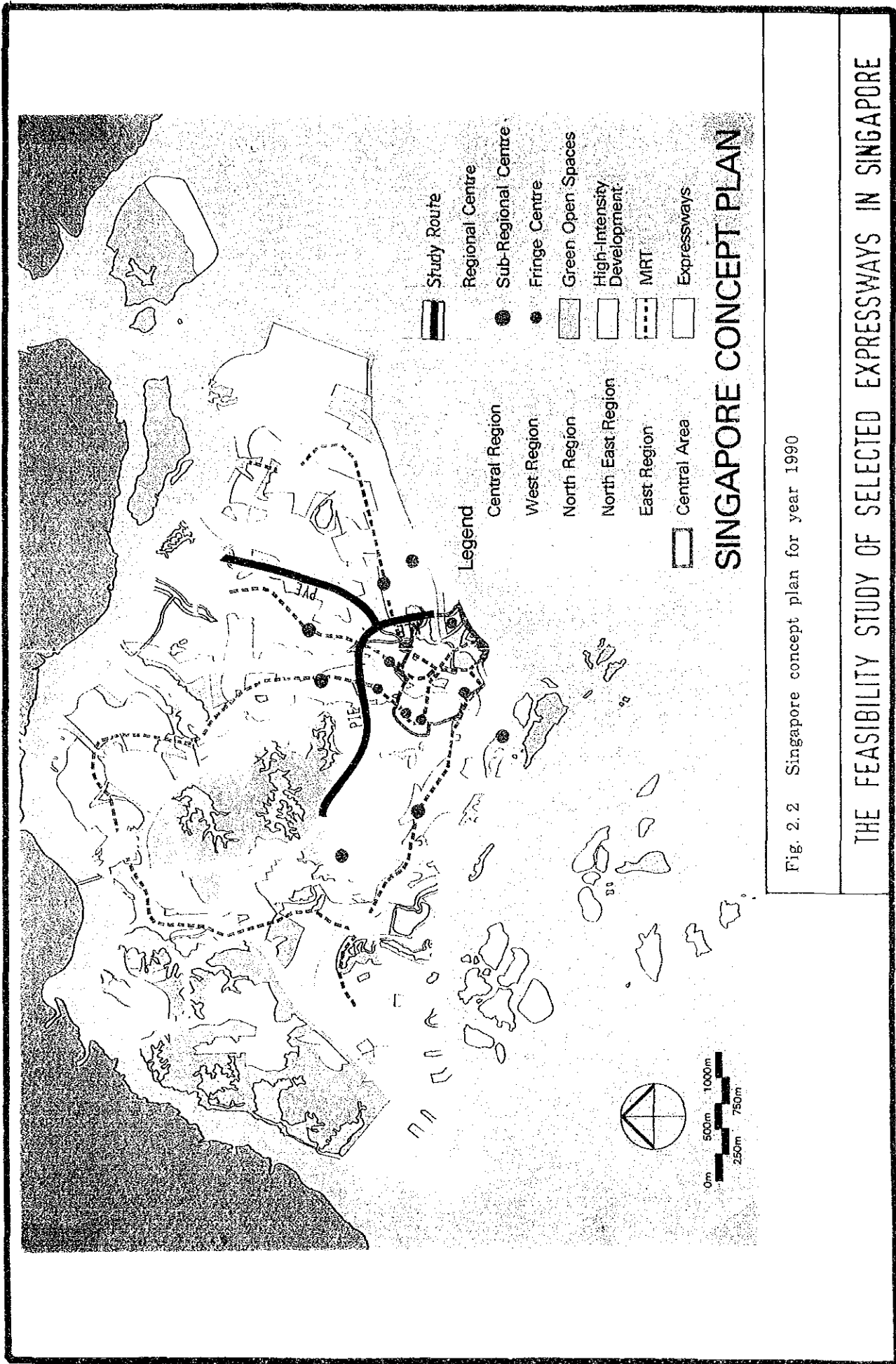


Fig. 2.2 Singapore concept plan for year 1990

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

2.2 Outline of Master Plan

The Master Plan was established as the basic development plan of Singapore and has been reviewed and up-dated periodically in accordance with socio-economic changes arising from the development of the country.

The planning department of MND undertook the 5th review of the Master Plan and will transfer to the local level "Development Plan" which regulates the use of land and development of road.

2.2.1 Housing Development Plan

1) Background

The New Town development is a major part of the national development being undertaken by the Housing Development Board (HDB). HDB has become the biggest supplier of residential units to low and middle income groups and supported community development in Singapore. As a result, 2.3 million people are now housed in HDB flats.

2) HDB New town development

The basic concept of New Town development in Singapore is to optimize the use of limited land and promote decentralization of urban functions from the city centre.

Currently, 20 New Towns have been developed by HDB and are located all over the island, linking each other and with the city centre by expressways or MRT. (Table 2.1 and Fig.2.3).

Table 2.1 New town development by HDB

	Total Land Area (Ha)	Projected Total Dwelling units	Estimated Population
(1)Geylang	1,085	37,300	146,870
(2)Bedok	979	57,100	229,430
(3)Tampines	1,035	65,400	167,860
(4)Pasir Ris	998	36,000	3,770
(5)Serangoon	634	21,000	56,560
(6)Hougang	1,196	41,000	125,120
(7)Kallang/Whampoa	813	57,400	151,370
(8)Toa Payoh	417	44,200	169,430
(9)Bishan	704	22,000	49,400
(10)Ang Mo Kio	742	49,500	209,800
(11)Yishun	919	60,000	191,520
(12)Bukit Panjang	475	30,000	47,830
(13)Choa Chu Kang	466	35,000	17,380
(14)Woodlands	1,244	66,000	96,970
(15)Bukit Merah	854	60,800	246,170
(16)Queenstown	716	40,600	143,180
(17)Clementi	433	25,000	101,970
(18)Jurong East	300	21,000	83,060
(19)Bukit Batok	813	28,000	111,510
(20)Jurong West	918	65,000	147,760

Source: HDB

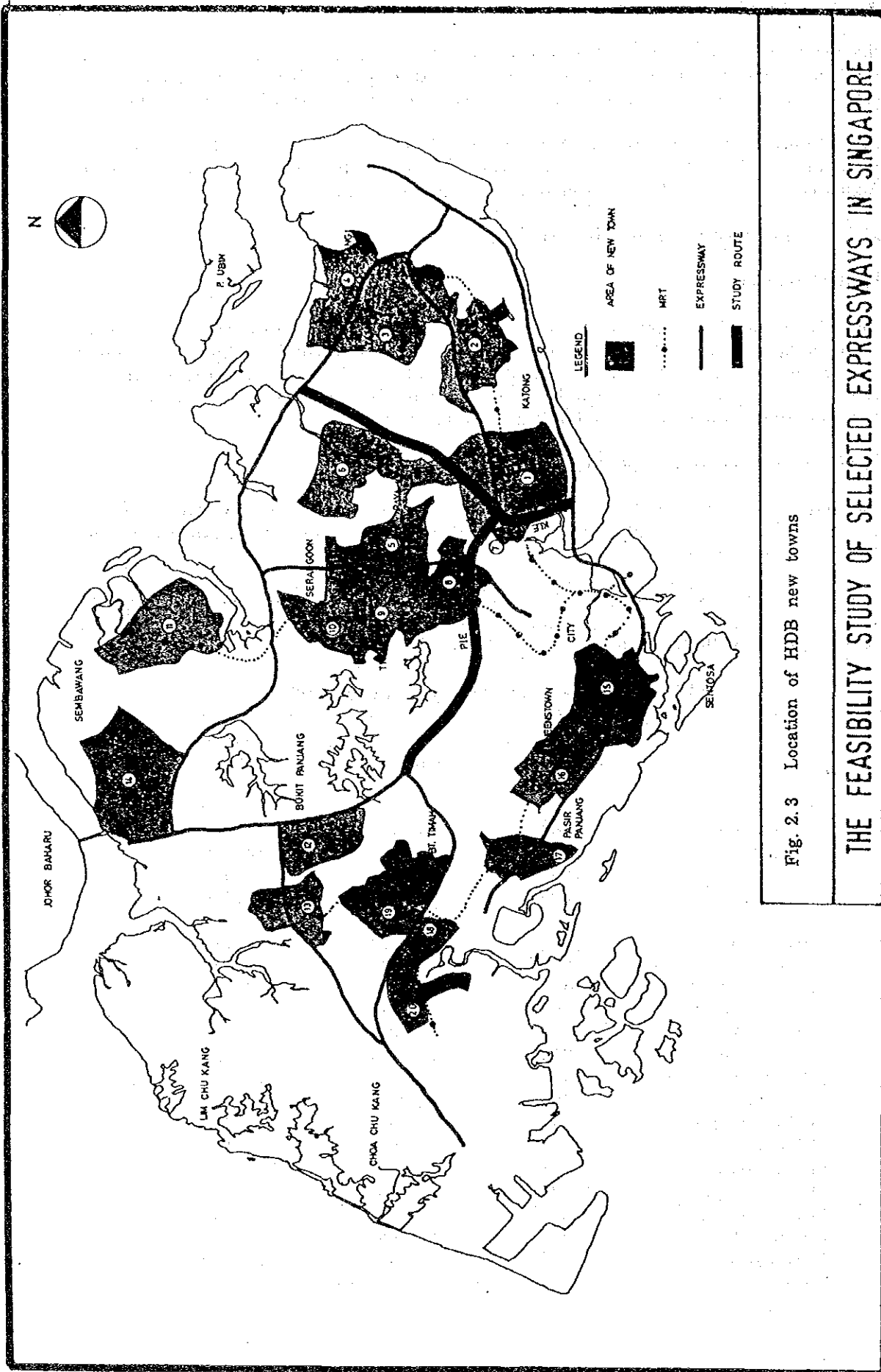


Fig. 2.3 Location of HDB new towns

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

4 New Town development projects are being planned in the north-eastern part of Singapore. Completion of these New Towns is expected to be in 2030. (see Fig. 2.5)

- Seletar New Town	50,000	units	139,250	residents
- Jalan Kayu New Town	25,000	units	68,850	residents
- Kangkar New Town	50,000	units	135,850	residents
- Punggol New Town	55,000	units	149,550	residents
Total	180,000	units	493,500	residents

3) Supply and demand of housing

The total number of residential units supplied by HDB during the fiscal year 1988/1989 was 617,474. This make up a percentage of 53.4% of HDB's property. 4-Room flats form the largest group of units supplied. The demand of flats has been relatively stable in the last five years on the whole.

2.2.2 Industrial Development Plan

1) Background

Reflecting the country's limited land resource and it's history as a free commercial port, tertiary industrial activities form the largest portion of GDP followed by the secondary industries. Primary industries are becoming less prevalent because of the unavailability of land and the rising of production and labour costs. (Table 2.2)

Table 2.2 GDP by industrial sector (unit: million S\$)

Year	Primary	Secondary	Tertiary
1983	330.9	13,251.9	23,150.9
1984	339.7	14,939.3	24,768.9
1985	292.3	13,463.5	25,167.7
1986	244.5	13,410.2	24,500.4
1987	221.5	14,866.0	26,811.0
1988	203.5	17,764.2	31,397.6
1989	190.0	19,385.4	35,734.7

Source: Department of Statistics

2) Establishment of industrial base and JTC development programme

In order to provide a favorable climate for investments in the industrial sector, the Government established the Jurong Town Corporation (JTC) as a statutory board to develop and manage industrial estates in Singapore. The board oversees

- The allocation of industrial land sites,
- The construction and leasing of flatted factory buildings,
- The provision of cargo handling facilities at Jurong Port and
- The provision of engineering and logistics back-up for the Asia Pacific offshore oil industry at the Jurong Marine Base.

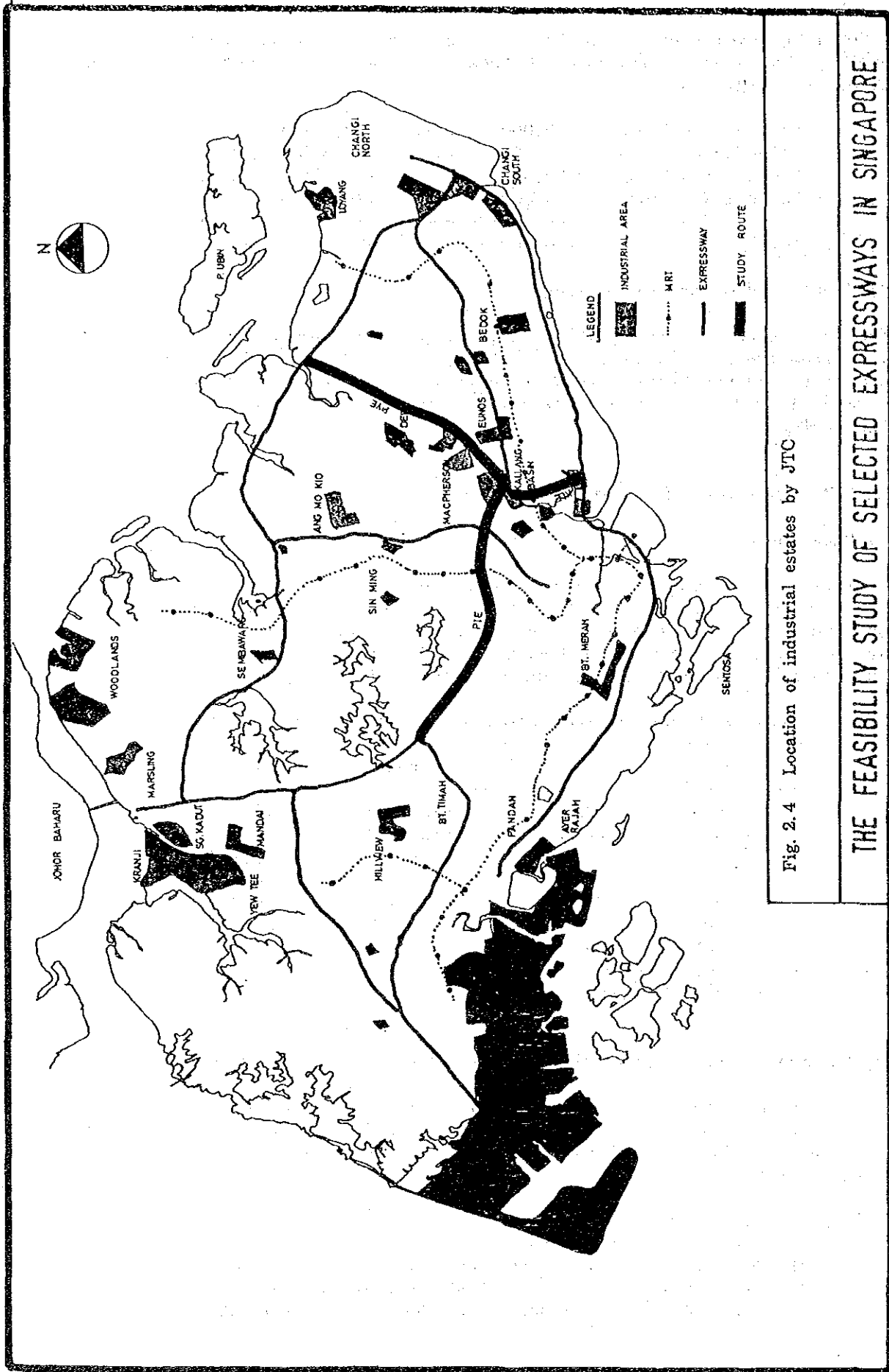


Fig. 2.4 Location of industrial estates by JTC

THE FEASIBILITY STUDY OF SELECTED EXPRESSWAYS IN SINGAPORE

29 industrial estates are currently under its management all over the country of which another 4 are in the planning stage. (Fig. 2.4) They include Clementi West, Jalan Bahar, Paya Lebar and Bishan. The estates will occupy a land area of 198ha and expected to employ 47,250 workers.

3) Jurong Port

Jurong Port is embarking on a 530 million dollar expansion plan to build eight multi-purpose deep-water berths at Pulau Damar laut, an off-shore island. A causeway is expected to link the island with the mainland and this development is anticipated to enhance the competitiveness of JTC industrial estates with other international ports and make Singapore a significant bulk distribution and consolidation centre.

2.2.3 Commercial Development Plan

Commercial business activities have played an important role in the country and consist of businesses from the service sectors. Table 2.3 shows the importance of commercial businesses in the country's GDP.

Table 2.3 Commerce/business activities as a proportion of GDP

	1980	1985	1986	1987	1988	1989
GDP	25.09	38.92	38.65	42.61	49.36	55.31
Commerce/ business	12.67	21.57	20.87	23.96	27.63	31.94
Percentage	(50.5)	(55.4)	(54.0)	(56.2)	(56.0)	(57.8)

Source: Department of Statistics

(unit billion S\$)

The productivity in the commercial sector, which consist of mainly small traders was evaluated to be extremely low during the recession of 1985 and a restructuring of the sector was strongly recommended. With changed shopping patterns and improved transportation systems, traditional shop-houses were redeveloped into high-rise commercial complexes to maximize the use of land and human resource, especially in the city centre. As a result, there was a remarkable change in the commercial activity pattern.

1) Commercial development in the Central Area

Commercial activities are dominated by offices, shops, hotels and restaurants in the central area of which offices occupy the largest floor space. Shops take over the next largest occupancy and consist of large shopping complexes located mainly in the Orchard Area, Scotts Road and North Bridge Road. Investments are actively progressing in this area. Hotels and restaurants form the third largest category as the number of tourists is expected to reach 5.5 million in 1990 and the occupancy rate is expected to be more than 90%.

Currently, development projects are being implemented in the central

area with investments from the private sector. URA has also completed several commercial redevelopment projects all over Singapore in the fiscal year 1988- 1989.

2) Commercial development in the outer City Area

Commercial development in the outer city area are characterized as Town Centres which were established as centres of businesses, commerce, recreation and culture for local communities.

The new town development programme by HDB reflects the Government's decentralization policy to prevent over concentration of population in the city centre. This programme will continuously be taken as an important national policy. 87% of the population now inhabits in the New Towns and these developments are expected to enhance growth in commercial activities outside the city area.

2.2.4 Other Development Plans

1) Mass Rapid Transit

The MRT is being operated as shown in Fig. 2.5. According to the Revised Concept Plan (Fig. 2.1), Yishun and Choa Chu Kang will be connected to form the Ring Circuit with the Northern and North-West lines. The MRT Ring Line Project will link all HDB Town Centres and another MRT line from Raffles Place to Punggol is being planned as a future project.

2) Reclamation project

Reclamation is being undertaken by two organizations namely, HDB and JTC. HDB has already completed projects at East Coast Area (from Benjamin Sheares Bridge to Changi Airport- approximately 14km), Marina City and Pasir Ris and is planning to reclaim the North-Eastern part of the country.

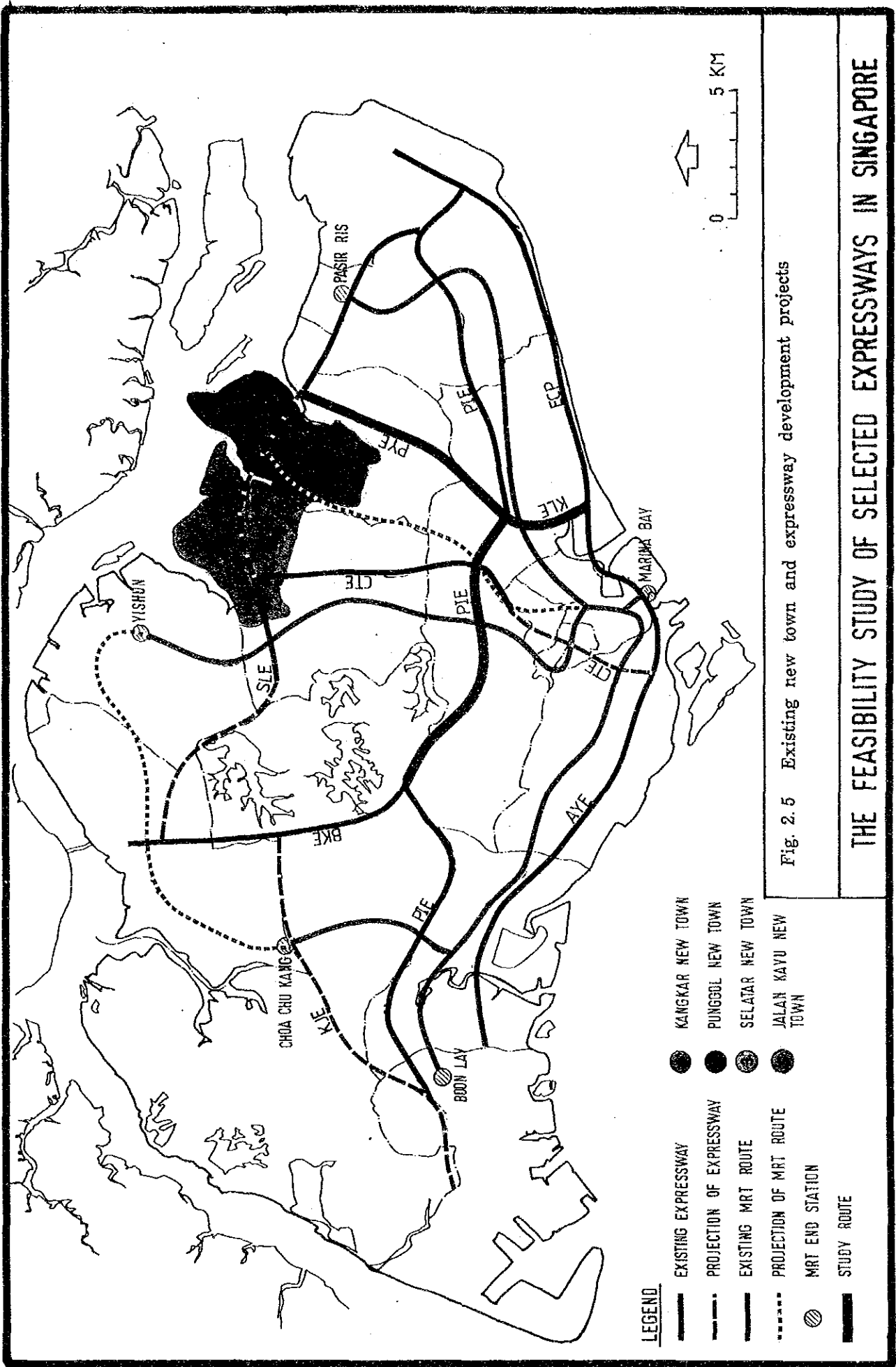
JTC has completed projects in the Southern Islands, Pulau Ayer Merbau and Pulau Merlimau in order to prepare the sites for oil refineries and Petrochemical Complexes.

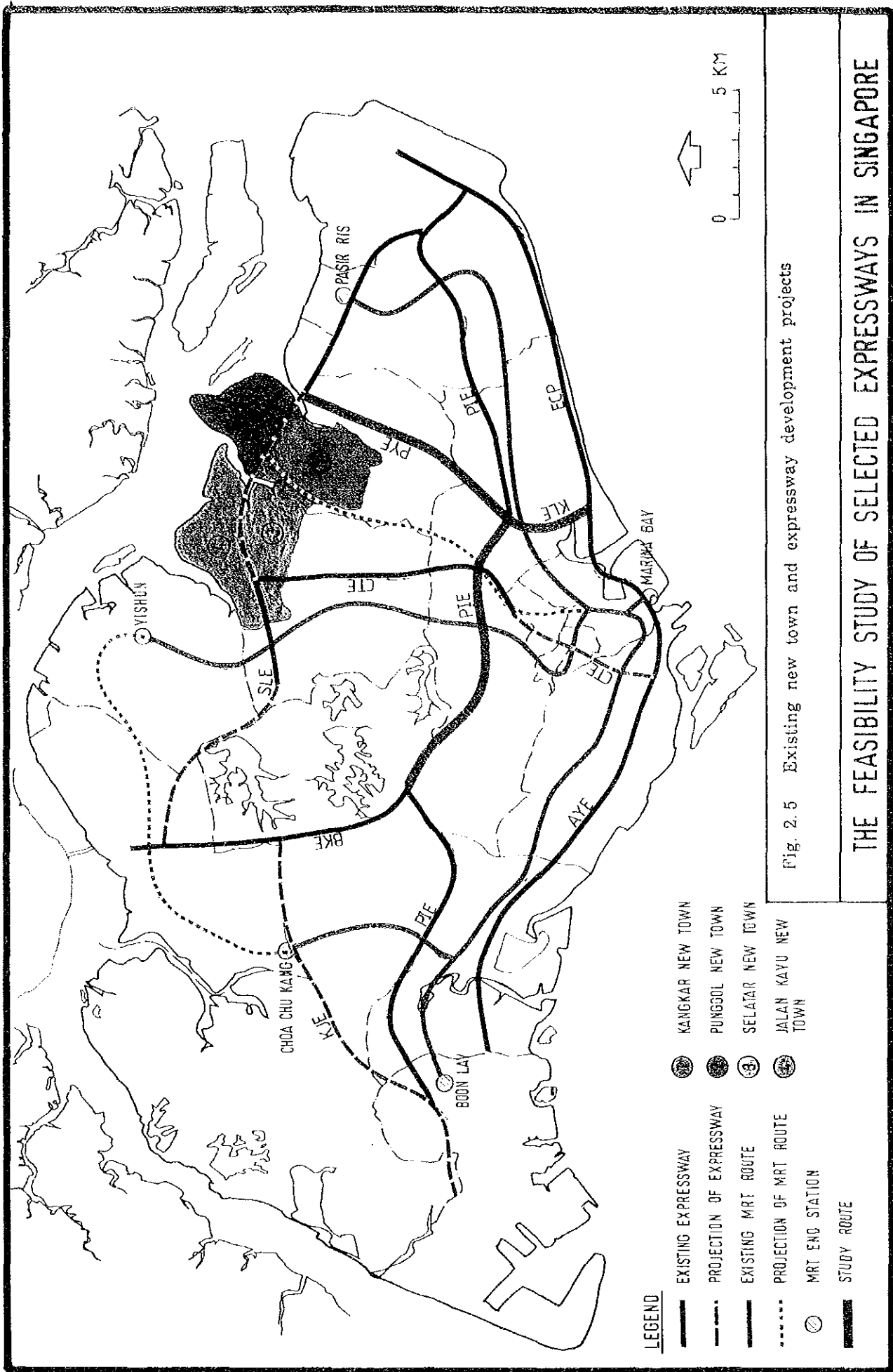
3) Marina City development

Marina City was reclaimed by HDB as a water-front area owned by the Government. URA is now developing this land as one of Singapore's urban areas and will be holding the International Exhibition and Convention Centre (IECC) which will be strategically located in Marina Centre. This proposed exhibition and convention centre is expected to further enhance Singapore's position as an important total business centre.

4) The urban waterfront projects

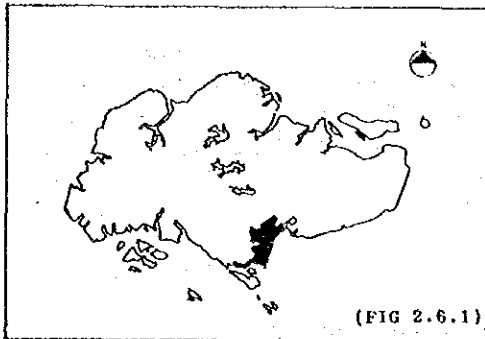
Together with the Singapore River Redevelopment Plan, Marina Bay and the Kallang Basin will be transformed into an exciting area with full recreational activities.



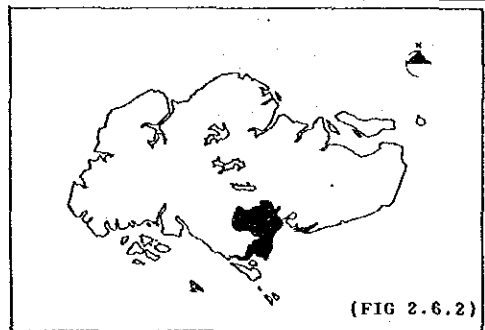


2.3 Historical Change of Urban Area

The island was settled by small villages and fishermen when Raffles first stepped foot on the island in 1819.



Since then, Singapore has attracted migrants from all over in search of a better way of life. Rapid population growth resulted and in 1881 the population was 181,602. (Fig. 2.6.1)



Singapore began to serve as a free port as well as a port for transit trade in the region. The competitive trading activities enhanced its role as a British trade base in Asia and attracted more migration. The census conducted in 1921 showed a population of 418,000. (Fig. 2.6.2)



The population growth rate continued to be more than 5% per annum after the second world war. The reopening of international trade enabled Singapore to play an important role in world trade and economic activity. In 1947, the population of Singapore reached 938,200 and its urban areas were further expanded. (Fig. 2.6.3)



The establishment of modern transportation systems and the active New Town development expanded the urban areas significantly and the population grew to be 2,413,900 by 1980. (Fig. 2.6.4)



The improvement and implementation of The Master Plan resulted in more active development of HDB New Towns and transportation infrastructures. These developments further increased the urbanized areas. (Fig. 2.6.5)

2.4 Socio-Economic Indicators

2.4.1 Population

1) Population of Singapore

The rapid population growth rate resulted in the Government taking drastic measures to control the increase. As a result, population in the age group 0-14 decreased remarkably. Since 1983, the population growth rate has been continuously decreasing with the popularity of higher education and attractive job opportunities for females. This resulted in a change in the Government's policy in 1988.

Table 2.4 provides estimates on the Singapore population from 1980-1989.

Table 2.4 Population of Singapore

Year	Population (thousand)			Population Growth Rate(%)
	Total	Males	Females	
1980	2,413.9	1,231.7	1,182.2	1.2
1981	2,437.1	1,243.2	1,193.9	1.0
1982	2,471.8	1,260.4	1,211.4	1.2
1983	2,502.0	1,275.5	1,226.5	1.1
1984	2,529.1	1,288.7	1,240.4	1.1
1985	2,558.0	1,302.9	1,255.1	1.1
1986	2,586.2	1,316.9	1,269.3	1.0
1987	2,612.8	1,330.2	1,282.6	1.2
1988	2,647.1	1,347.4	1,299.7	1.5
1989	2,685.4	1,366.4	1,319.0	1.3

Source: Department of Statistics

Note: The 1981-1989 figures are estimations based on the 1980 Census.

2) Demographic characteristics of Singapore

The population census is conducted approximately every 10 years. (Table 2.5). The latest census was conducted in June 1990. Based on the censuses,

Table 2.5(1) Population census and demographic characteristics

Period	Total Population	Rate of Population Increase	Sex Ratio (Males per 1,000 Females)
1901	227.6	2.3	2,951
1911	303.3	2.9	2,453
1921	418.3	3.3	2,044
1931	557.7	2.9	1,713
1947	938.2	3.3	1,217
1957	1,445.9	4.4	1,117
1970	2,074.5	2.8	1,049
1980	2,413.9	1.5	1,042

Table 2.5(2) Population census and demographic characteristics

Period	Total Fatality Rate (per 1,000 Females)	Crude Rate of Natural Increase (per 1,000 Population)	Crude Birth Rate	Crude Death Rate	Infant Mortality Rate (per 1,000 Live-births)
1980	1,737	11.9	17.1	5.2	11.7
1981	1,723	12.0	17.3	5.3	10.7
1982	1,706	12.0	17.3	5.2	10.7
1983	1,589	10.9	16.2	5.3	9.4
1984	1,609	11.2	16.4	5.2	8.8
1985	1,619	11.4	16.6	5.2	9.3
1986	1,445	9.9	14.8	5.0	9.4
1987	1,636	11.7	16.7	5.0	7.4
1988	1,980	14.8	20.0	5.2	6.9
1989	1,792	12.5	17.8	5.2	6.6

- (1) The increase in the Chinese female population is especially remarkable. After the Second World War, the sex ratio of males per 1000 females moved to equilibrium i.e. 1,036 in 1989.
- (2) The death rate has been very stable since 1980, within the range of 5.0-5.3 per 1000 population.
- (3) With the improvement in sanitary and hygiene conditions, the infant mortality rate decreased to 6.9 in 1988.

A demographic pyramid showing age and sex distributions, based on the 1980 census is shown in Fig. 2.7.

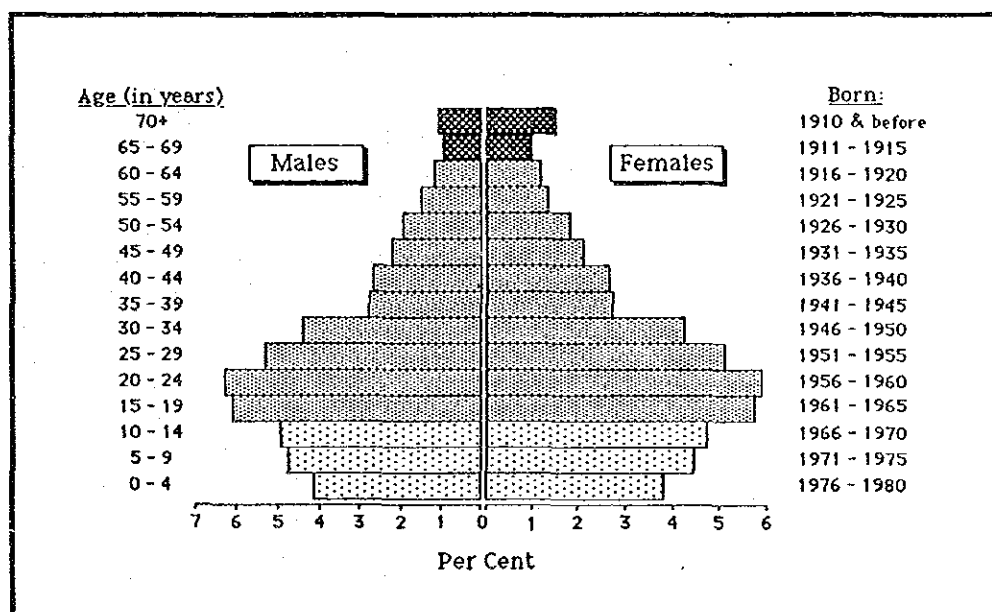


Fig. 2.7 Demographic pyramid, 1980 Census

The pyramid shows that the demographic structure of Singapore is similar in pattern to that of developed countries. However, the structure can be easily change due to the small absolute number of the population of

Singapore i.e. 2.4 million.

2.4.2 Employment

1) General

Employment in the labour market has grown rapidly since 1985 and according to the latest labour Force Survey conducted in 1989, the job market showed high employment and falling unemployment. (Table 2.6)

Table 2.6 Employed persons aged 15 and more

	1983	1984	1985	1986	1987	1988	1989
Male	752.8	748.0	734.3	719.0	739.2	757.0	774.0
Female	414.9	426.8	420.0	430.0	453.7	481.5	503.2
Total	1,167.7	1,174.8	1,154.3	1,149.0	1,192.9	1,238.5	1,277.2
Unem- ployed	38.5	31.2	50.0	79.8	58.8	42.9	28.1

Source: Ministry of Labour (Unit: thousands of persons)

2) Employment structure

The most significant feature of employment in Singapore is the small proportion of employment in the primary industry as such almost all raw materials including foodstuffs are imported. As shown in the employment statistics (Table 2.7), the employment structure of Singapore has not changed since 1989. Tertiary industry has been the major sector of employment.

Table 2.7 Employment in Singapore

	1983	1984	1985	1986	1987	1988	1989
Primary	11.8	8.8	8.1	9.6	10.4	6.2	6.5
(%)	(1.0)	(0.8)	(0.8)	(0.8)	(0.9)	(0.5)	(0.5)
Secondary	410.7	423.9	339.9	390.9	411.0	443.7	461.3
(%)	(35.2)	(36.1)	(34.3)	(34.0)	(34.5)	(35.8)	(36.1)
Tertiary	743.5	739.3	747.8	746.7	769.9	786.8	808.3
(%)	(63.7)	(62.9)	(68.0)	(65.0)	(64.5)	(63.6)	(63.3)
Others	1.6	2.8	2.4	1.8	1.6	1.8	1.2
(%)	(0.1)	(0.2)	(0.2)	(0.2)	(0.1)	(0.1)	(0.1)
Total	1,167.6	1,174.8	1,154.3	1,149.0	1,192.9	1,238.5	1,227.3
(%)	(100)	(100)	(100)	(100)	(100)	(100)	(100)

Source: Ministry of labour (Units: thousands of persons)

2.4.3 Gross Domestic Product

The 10-year Economic Development Plan forecast a real GDP growth rate of 8%-10% for the Eighties. Singapore enjoyed a real GDP growth of 8.5% during the first half of the decade. Extreme rapid economic expansion

resulted in a recession in 1985 and the causes were considered to be the following.

- Fall in petroleum prices
- Decrease in consumption of petroleum prices
- Rapid fall in the U.S economic growth rate and less favorable economic environment in ASEAN countries.
- Loss in competitiveness caused by the rise in the costs and fees for operations, rentals, interest rates, wages, statutory board charges etc.
- Decrease in consumption caused by an extremely high national savings rate.

As a result of continuous efforts by the Government for economic betterment, the economy of Singapore grew more rapidly 9.5% p.a. in 1987, 11.1% p.a. in 1988 and 9.2% p.a. in 1989. During the first quarter of 1990, the GDP was \$13,534 million at 1985 market prices equivalent to 10.1% annual growth rate. The projected GDP growth in 1990 is expected to be 6-8%.

The change in GDP based on 1985 market prices from 1983 to 1989 is shown in Table 2.8.

Table 2.8 Change in GDP, 1983-1989

	1983	1984	1985	1986	1987	1988	1989
GDP	36.54	39.57	38.92	39.64	43.19	48.22	52.68

Source: Department of Statistics (Units: billion S\$)

The growth rate in the manufacturing sector was 18.4% and that of commercial sector was 16.9%. The total amount of consumer expenditure was S\$23,100 million in 1988, 13% more than the previous year's. Similarly, the total amount of retail sales was 25% higher than 1987. Currently, a shortage in manpower is being pointed out as a factor constraining Singapore's international competitiveness.

2.4.4 Land Use

The latest land use survey is the "Comprehensive Land and Building Use Survey", which was carried out in 1981/1982. The results of the survey were included in the "Existing Land Use in 1982"(Fig.2.8) and used as a basis of the Master Plan. (Fig. 2.9)

According to a 1982 survey, the mainland Singapore occupies a land area of 57,400ha whilst the off-shore island occupies 4,770ha. Reclamation works by HDB and JTC in Punggol, the North-Eastern Coast and the southern islands have increased the country's total land area to 62,600ha in 1989.

1) Residential use

Residential use accounts for 15% of total land area in 1982. Further New Town development resulted in the usage of 15,800ha of land in 1989.

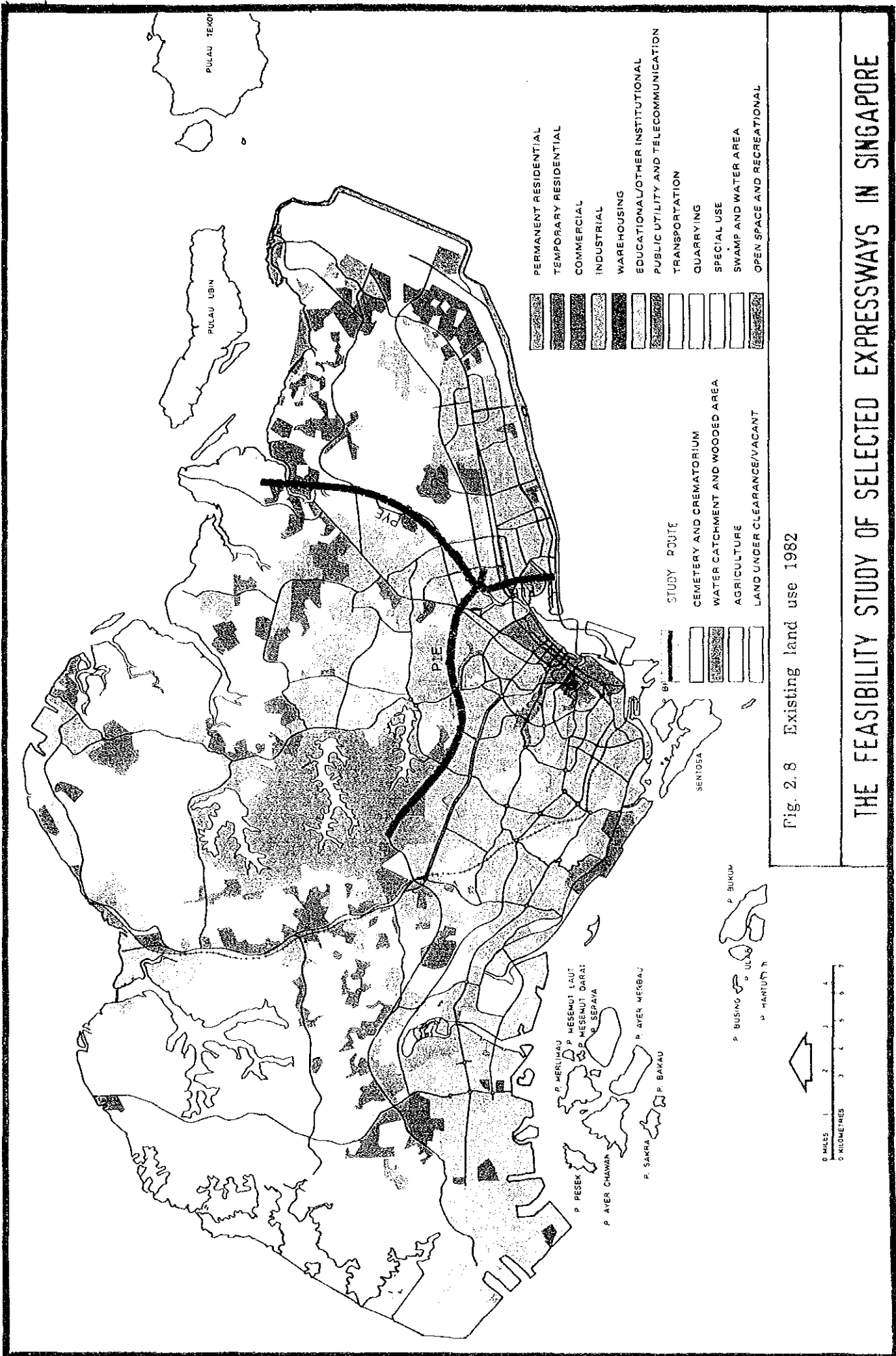


Fig. 2.8 Existing land use 1982

