THE KINGDOM OF THAILAND
FEASIBILITY STUDY
FOR
SAMUT SAKHON INDUSTRIAL ESTATE PROJECT
FINAL REPORT

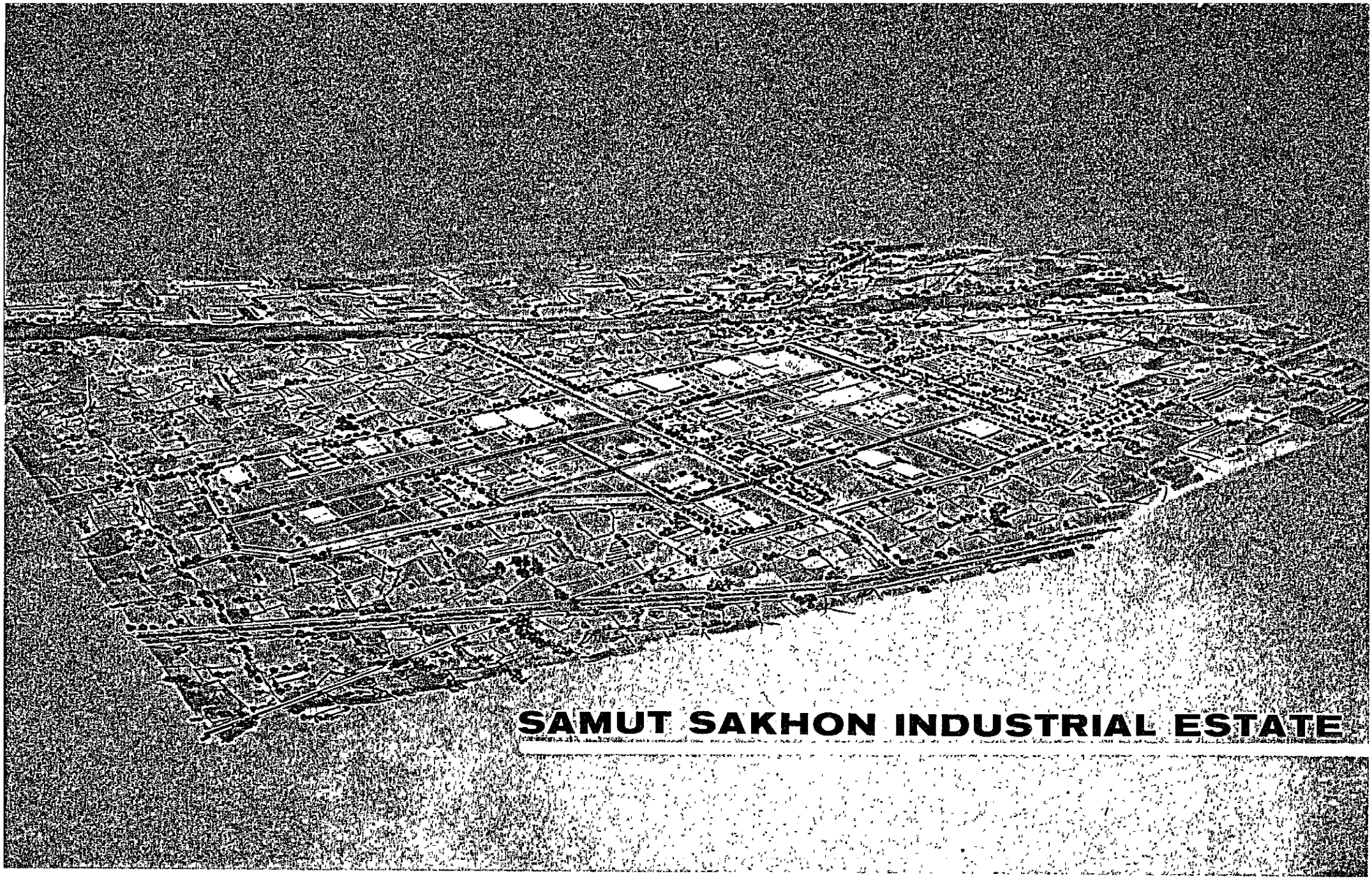
September 1 9 8 0

Japan International Cooperation Agency

THE KINGDOM OF THAILAND
FEASIBILITY STUDY
FOR
SAMUT SAKHON INDUSTRIAL ESTATE PROJECT
FINAL REPORT

September 1 9 8 0

Japan International Cooperation Agency


SAMUT SAKHON INDUSTRIAL ESTATE

PREFACE

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to conduct a feasibility study for the industrial estate project in the Province of Samut Sakhon in Thailand and entrusted its execution to the Japan International Cooperation Agency (JICA). The Agency thereby organized a survey team comprising ten (10) expert members, headed by Mr. Eiji Nishita of the Regional Planning International, Co. which visited Thailand for a field survey during the period of February 4 to March 5, 1980.

The survey team conducted the field survey into full particulars on existing industries, economic trends and local conditions in the Province of Samut Sakhon and the Bangkok Metropolitan Area as well as the site observation of industrial estates around the metropolitan area and assembling of necessary information and data. On the basis of the field survey, the interim report was prepared and presented to the Industrial Estate Authority of Thailand (IEAT) on March 4, 1980. The interim report included the team's recommendation on the suitable site and optimum size for the development of industrial estate, on the basis of which the physical planning should be worked out back in Japan.

After its return home, the survey team immediately set to work on the detailed analysis of information and data obtained during the field survey and proceeded with subsequent works upon receipt of comments on the IEAT's interim report dated April 16, 1980. Three (3) IEAT staff members visiting Japan under the training program were closely consulted at the stage of drafting the report. In order to present the draft final report to the IEAT, the JICA sent again Mr. Eiji Nishita and three (3) members to Thailand from June 30 to July 6, 1980. The final report was prepared after necessary revisions made in accordance with the comments of the IEAT of July 25, as well as taking into accounts additional information and data obtained.

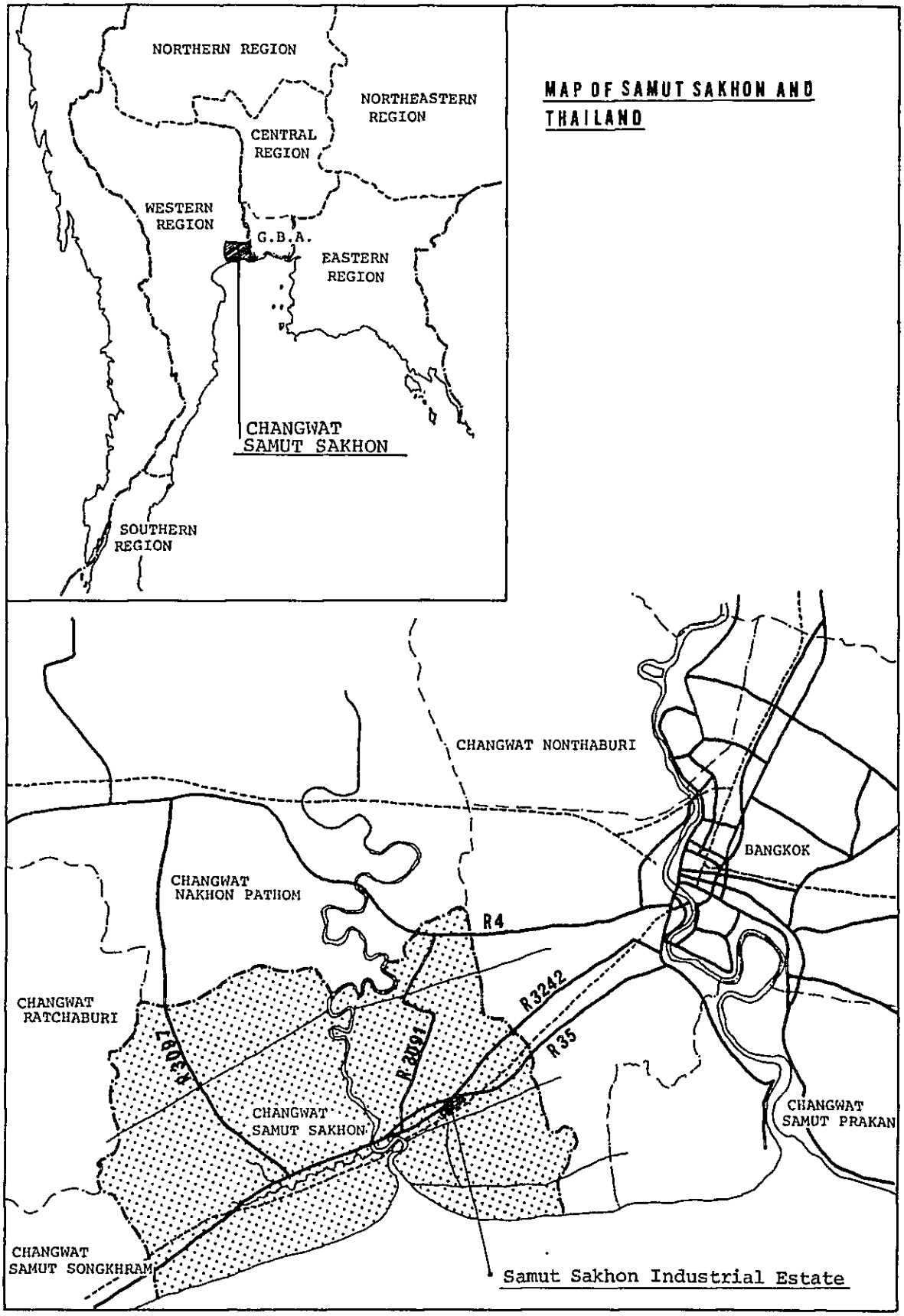
The present report includes the master plan and the preliminary design of the Samut Sakhon Industrial Estate Project, together with study results on the recommendable types of industries to be introduced, the economic and financial analysis of the project and special points of consideration required for the execution of the project.

In presenting this report, it is sincerely hoped that it will contribute further economic development of the Samut Sakhon province and eventually of the Kingdom of Thailand and also to improvement of the social and natural environments within the Bangkok Metropolitan Area, thus helping furtherance of friendship between Thailand and Japan.

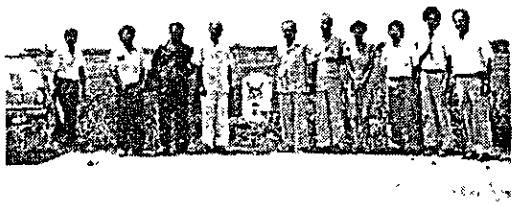
I wish to express our sincere gratitude to the officials concerned of the Government of the Kingdom of Thailand and the Japanese Embassy for their kind assistance rendered to our survey team and to the officials of the Ministry of Foreign Affairs and the Ministry of International Trade and Industry for their thoughtful support for this survey.

Keisuke Arita

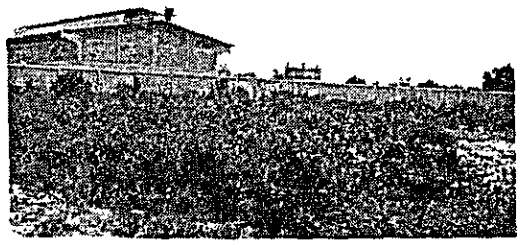
Keisuke Arita
President
Japan International
Cooperation Agency


MAP OF SAMUT SAKHON AND THAILAND
NORTHERN REGION
NORTHEASTERN REGION
CENTRAL REGION
WESTERN REGION
G.B.A.
EASTERN REGION
CHANGWAT SAMUT SAKHON
SOUTHERN REGION
CHANGWAT NONTHABURI
BANGKOK
CHANGWAT NAKHON PATHOM
R4
R3242
R35
R3091
R3087
CHANGWAT RATCHABURI
CHANGWAT SAMUT SAKHON
CHANGWAT SAMUT PRAKAN
CHANGWAT SAMUT SONGKHRAM
Samut Sakhon Industrial Estate

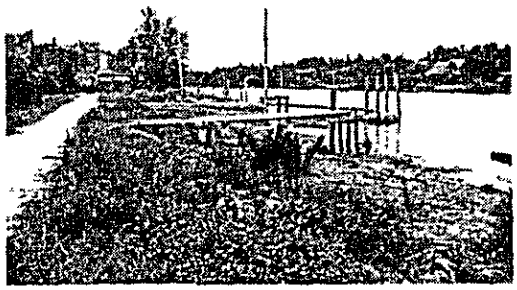
SITE NO. 5



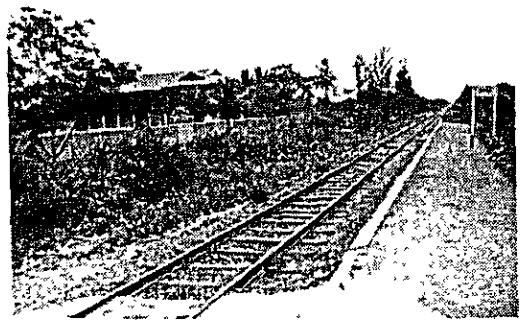
SITE SURVEY



COLD STORAGE



KHLONG MAHA CHAI



RAILWAY (Station)

PHOTOGRAPHIES OF SITE 5

ABBREVIATIONS

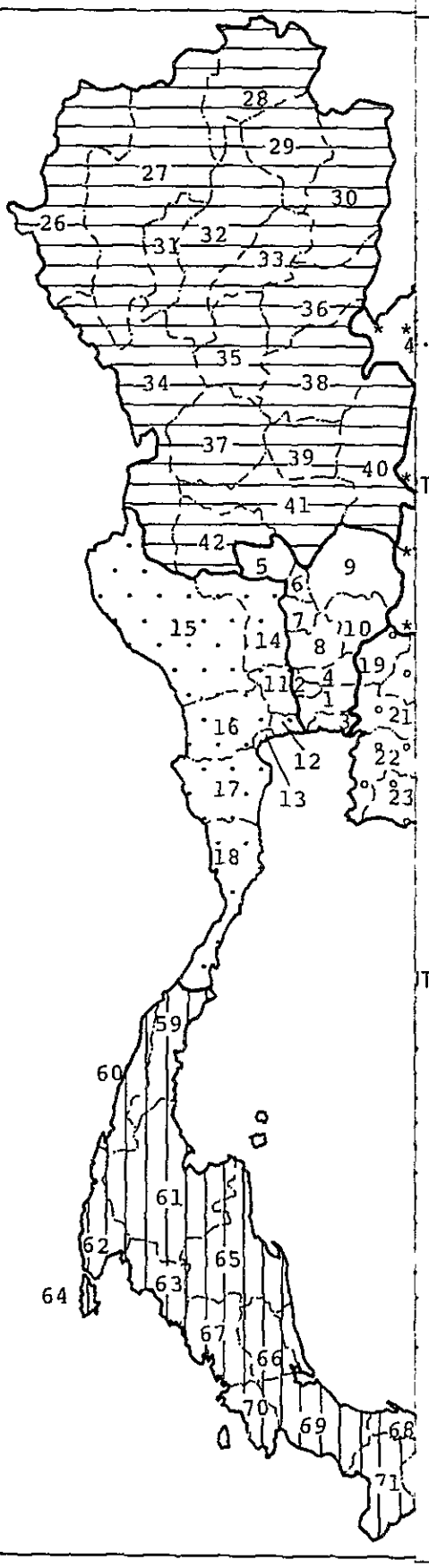
AIT	Asian Institute of Technology
BIC	Business Information Center
BMA	Bangkok Metropolitan Area
	Bangkok Municipal Authority
BOI	Board of Investment
BWFD	Brackish Water Fisheries Division (DF-MOAC)
CMD	Cubic Meters per Day
DC	Department of Customers (MOF)
DF	Department of Fisheries (MOAC)
DH	Department of Health
DMR	Department of Mineral Resources (MOI)
DTCP	Department of Town and Country Planning (MOINT)
DTEC	Department of Technical and Economic Cooperation
ECFA	Engineering Consulting Firms Association, Japan
EED	Environmental Engineering Div. (AIT)
EGAT	Electricity Generating Authority of Thailand
EHD	Environmental Health Division (DH)
EPPD	Economic Project Planning Division (NESDB)
ESCAP	Economic and Social Commission for Asia and the Pacific
FWD	Factory Works Division (MOI)
GBA	Greater Bangkok Area
GWD	Ground Water Division (DMR-MOI)
HD	Highway Department (MOINT)
HSDD	Human Settlements Development Division (AIT)
IBRD	International Bank for Reconstruction and Development
IE	Industrial Estate
IEAT	Industrial Estate Authority of Thailand
IEPD	Industrial Economics and Planning Division (MOI)
IFCT	Industrial Financing Corporation of Thailand
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
LCD	Land Classification Division (LDD-MOAC)
LD	Land Department (MOINT)
LDD	Land Development Department (MOAC)
LDO	Land Development Office (SPG)
LTD	Land Transport Department (MOC)
MOAC	Ministry of Agriculture and Cooperatives
MOC	Ministry of Communications
MOF	Ministry of Finance
MOI	Ministry of Industry
MOINT	Ministry of Interior
MWWA	Metropolitan Water Works Authority
NEB	National Environmental Board
NHA	National Housing Authority
NESDB	National Economic and Social Development Board
NESDP	National Economic and Social Development Plan
NRC	National Research Council
OECF	Overseas Economic Cooperation Fund
OL	Office of Labor (SPG)
OMD	Operation and Maintenance Div. (RID-MOINT)
OPP	Office of Policy and Planning (MOINT)
PAT	Petroleum Authority of Thailand
PEA	Provincial Electricity Authority
PWD	Public Works Department (MOINT)

PWSD	Provincial Water Supply Division (PWD-MOINT)
PWWA	Provincial Water Works Authority
RID	Royal Irrigation Department (MOINT)
RIE	Regional Industrial Estate Program
RPD	Regional Planning Division (NESDB)
RSRT	The Royal State Railway of Thailand
RTN	Royal Thai Navy
SIE	Samut Sakhon Industrial Estate
SIFO	Small Industrial Financing Office
SMO	Samut Sakhon Municipal Office
SPG	Samut Sakhon Provincial Government
SZIE	Satellite Zone Industrial Estate Program
TD	Tariff Division (DC-MOF)
TOT	Telephone Organization of Thailand
TSD	Technical and Statistics Division (DC-MOF)
UAIE	Urban Area Industrial Estate Program
UNDP	United Nations Development Program
UNIDO	United Nations Industrial Development Organization
WOC	Water Operation Center (RID-MOINT)

EQUIVALENTS

US $ 1	= Baht 20.0
Baht 1	= US $ 0.05
1 Rai = 400.0 Wa^2	= 1,600 sq.m
1 Wa^2	= 4.0 sq.m
1 ha	= 6.25 Rai

Changwat	Province
Amphoe	Political subdivision of a province
Tambon	Political subdivision of an amphoe
Khlong	Canal
FY	Fiscal Year = Oct. 1 to Sept. 30 (Thailand)



Metropolitan Area (BMA)
Bangkok Area (GBA)

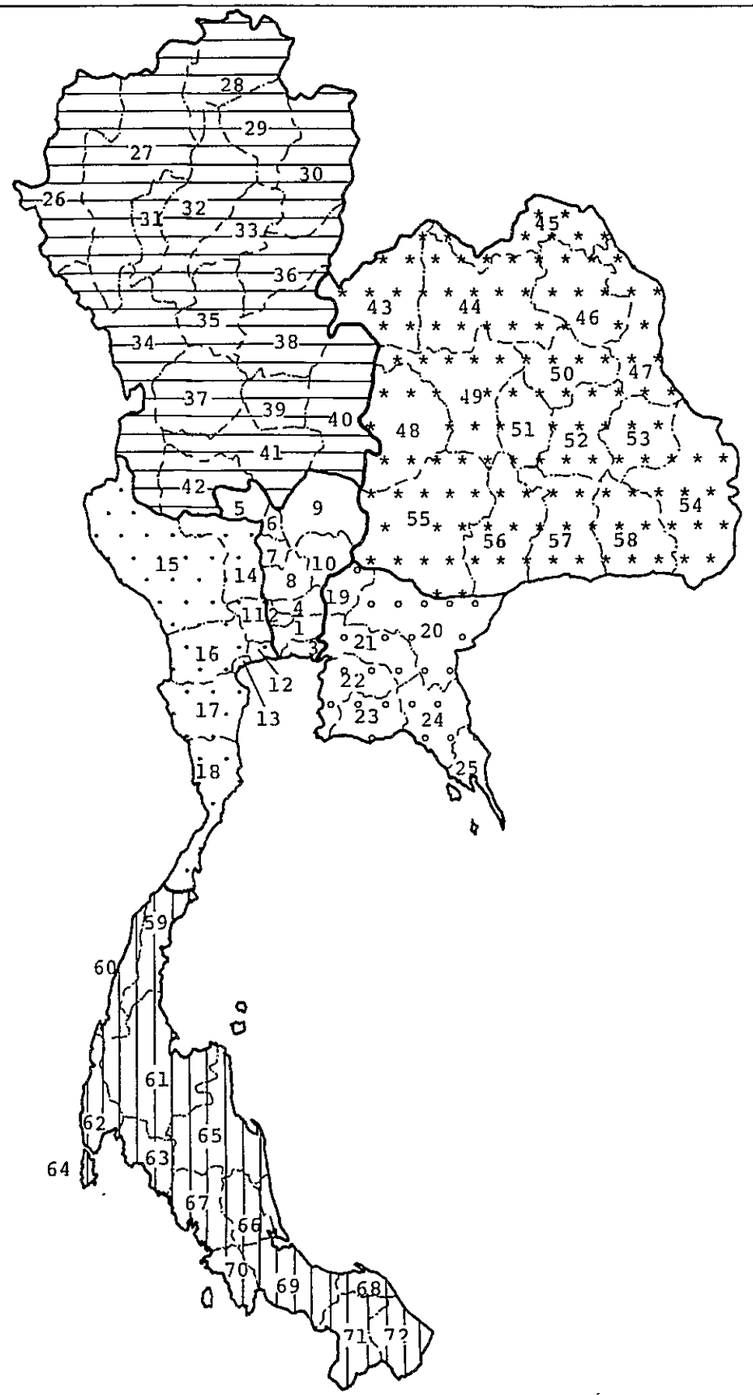
and its Surrounding Area
. 3. 4. 11. 12. 13.)

THEASTERN REGION

Loei
Udon Thani
Nong Khai
Sakhon Nakhon
Nakhon Phanom
Chaiyaphum
Khon Kaen
Kalasin
Maha Sarakham
Roi Et
Yasothon
Ubon Ratchathani
Nakhon Ratchasima (Korat)
Buri Ram
Surin
Si Sa Ket

THERN REGION

Chumphon
Ranong
Surat Thani
Phangnga
Krabi
Phuket
Nakhon Si Thamarat
Phatthalung
Trang
Pattani
Songkhla
Satoon
Yala
Narathiwat



REGIONAL CLASSIFICATION

A. CENTRAL (MIDDLE) REGION

1. Thon Buri, Phra Nakhon
2. Nonthaburi
3. Samut Prakan
4. Pathum Thani
5. Chai Nat
6. Sing Buri
7. Ang Thong
8. Ayutthaya
9. Lop Buri
10. Saraburi

Bangkok Metropolitan Area (BMA)
Greater Bangkok Area (GBA)

Bangkok and its Surrounding Area (1. 2. 3. 4. 11. 12. 13.)

B. WESTERN REGION

11. Nakhon Pathom
12. Samut Sakhon
13. Samut Songkhram
14. Suphan Buri
15. Kanchanaburi
16. Ratchaburi
17. Phetchaburi
18. Prachuap Khiri Khan

C. EASTERN REGION

19. Nakhon Nayok
20. Prachin Buri
21. Chachoengsao
22. Chon Buri
23. Rayong
24. Chanthaburi
25. Trat

D. NORTHERN REGION

26. Mae Hong Son
27. Chiang Mai
28. Chiang Rai
29. Pha Yao
30. Nan
31. Lamphoon
32. Lampang
33. Phrae
34. Tak
35. Sukhothai
36. Uttaradit
37. Kamphaeng Phet
38. Phitsanulok
39. Phichit
40. Phetchabun
41. Nakhon Sawan
42. Uthai Thani

E. NORTHEASTERN REGION

43. Loei
44. Udon Thani
45. Nong Khai
46. Sakhon Nakhon
47. Nakhon Phanom
48. Chaiyaphum
49. Khon Kaen
50. Kalasin
51. Maha Sarakham
52. Roi Et
53. Yasothon
54. Ubon Ratchathani
55. Nakhon Ratchasima (Korat)
56. Buri Ram
57. Surin
58. Si Sa Ket

F. SOUTHERN REGION

59. Chumphon
60. Ranong
61. Surat Thani
62. Phangnga
63. Krabi
64. Phuket
65. Nakhon Si Thamarat
66. Phatthalung
67. Trang
68. Pattani
69. Songkhla
70. Satoon
71. Yala
72. Narathiwat

CONTENTS

PART II. RESULTS OF STUDY

ANNEX

Annex No. Page

Annex No.		Page

Annex No.		Page

FIGURES

Fig. No.

Fig. No.

TABLES

Table No.

Table No.

Table No.

PART I

SUMMARY AND RECOMMENDATION

I. INTRODUCTION

I. INTRODUCTION

A. Objectives of the Survey

This survey is designed to study the feasibility of the Samut Sakhon Industrial Estate project in the Kingdom of Thailand. The report consists of the following chapters:

(1) Background of the Samut Sakhon Industrial Estate
(2) Current Situations of Samut Sakhon Area
(3) Concept of Regional Development
(4) Types of Industries and Size of Industrial Land
(5) Selection and Evaluation of Sites
(6) Land Use Plan
(7) Basic Design
(8) Construction Program and Cost Estimate
(9) Organization and Management
(10) Financial Analysis
(11) Economic Analysis
(12) Environmental Impact Statement

B. Team Composition

The composition of the Survey Team is as follows:

Members of the First Survey Team

Chief	Eiji NISHITA	President Regional Planning International
Member	Yutaka NAKAO	Nomura Research Institute
Member	Shoichi KOBAYASHI	Nomura Research Institute
Member	Kazuhiro KATAYAMA	Regional Planning International
Member	Toshio SATO	Regional Planning International
Member	Iwao NAKAJIMA	Yachiyo Engineering Co., Ltd.
Member	Tetsuo KAWAMURA	Yachiyo Engineering Co., Ltd.
Member	Hiroshi SUMIKAWA	Mitsui Consultants Co., Ltd.
Member	Tsuneyasu FUKASE	Mitsui Consultants Co., Ltd.
Member	Yukio NAKAJIMA	Industry Division Mining & Industrial Planning and Survey Department Japan International Cooperation Agency

Members of the Second Survey Team

Chief	Eiji NISHITA
Member	Yutaka NAKAO
Member	Tetsuo KAWAMURA
Member	Yukio NAKAJIMA

C. Thai Counterparts Teams

The composition of the IEAT counterparts teams is as follows:

1. Planner

   - Mr. Supak Vatanasuti
   - Mr. Suchart Archanatana
   - Mr. Anan Swasdechamedhi

2. Engineer (Civil and Transportation)

   - Mr. Somchai Angkasuvana
   - Mr. Manat Chuenkerdlarp
   - Mr. Saksit Suksumake

3. Economist and Financier

   - Ms. Wantana Nanakul
   - Mr. Somporn Jongprasirt
   - Mr. Manoon Teppitaksak

4. Secretary

   - Ms. Panprapa Jiranakul

5. Advisor

   - Mr. Prateeb Chuntaketta — Director, Technical Project Dept.
   - Mr. Vitoon Nimmansoontorn — Chief. Project Div.
   - Mr. Anan Ahandrik — Act. Chief. Development Div.
   - Mr. J.M. Gajewski — UNIDO Expert

6. Project Coordinator

   - Mr. Chavalit Chokratanachai — Act. Chief. Planning

D. Field Survey

The following is the detailed schedule of the survey team during the field survey.

Itinerary of the First Survey (From Feb. 4 to Mar. 5, 1980)

FEB. 4 (MON.)	1) TG601 Narita → Bangkok (Traveling. Mr. Nishita, Katayama, Kobayashi, Kawamura, Y. Nakajima)
FEB. 5 (TUE.)	1) Japan International Cooperation Agency (JICA) (Greeting and Meeting) 2) Japanese Embassy 3) Department of Technical and Economic Cooperation (DTEC) 4) Industrial Estate Authority of Thailand (IEAT)
FEB. 6 (WED.)	1) IEAT (Team Meeting) 2) JICA 3) Japanese Embassy 4) CX501, CX713 Narita → Bangkok (Traveling. Mr. Nakao, Sato, I. Nakajima, Sumikawa, Fukase)
FEB. 7 (THR.)	1) IEAT (Team Meeting) 2) JICA 3) Japanese Embassy
FEB. 8 (FRI.)	1) Samut Sakhon Provincial Government (SPG) 2) Candidate Sites Survey (Samut Sakhon)
FEB. 11 (MON.)	1) Bang Chan Industrial Estate 2) Lat Krabang Industrial Estate 3) Bang Poo Industrial Estate
FEB. 12 (TUE.)	1) Department of Town and Country Planning (DTCP-MOINT) 2) Office of National Economic and Social Development Board (NESDB) - Regional Planning Division (RPD) 3) Industrial Economics and Planning Division-(MOI) 4) Thai Textile Industry Association 5) Environment Engineer Section--(MOI) 6) Public Works Department (PWD) - Provincial Water Supply Division 7) Royal Irrigation Department (RID) - Hydrological Division 8) Telephone Organization of Thailand (TOT) 9) Japanese Embassy
FEB. 13 (WED.)	1) Board of Investment (BOI) 2) Factory Works Division-(MOI) 3) ESCAP 4) NESDB - Regional Planning Division 5) National Environmental Board (NEB) 6) Provincial Electricity Authority (PEA) 7) Metropolitan Water Works Authority (MWWA) - Technical and Planning Dept.

	8) Provincial Water Works Authority (PWWA) - Technical and Planning Dept. 9) Highway Department (HD) - Planning Division
FEB. 14 (THU.)	1) NESDB - Economic Project Planning Division (EPPD) 2) Office of Policy and Planning (OPP - MOINT) 3) Land Development Department (LDD - MOAC) - Land Classification Division(LCD) 4) National Research Council (NRC) 5) Department of Mineral Resources (DMR) - Ground Water Division(GWD) 6) Electricity Generating Authority of Thailand (EGAT)
FEB. 15 (FRI.)	1) Factory Works Division-(MOI) 2) National Housing Authority (NHA) 3) Asian Institute of Technology (AIT) - Human Settlements Development Div. (HSDD), Environmental Engineering Div. (EED) 4) MWWA
FEB. 16 (SAT.)	1) Hotel (Team Meeting and Collection Data Investigation)
FEB. 17 (SUN.)	1) Hotel (Team Meeting and Preparing Work Report)
FEB. 18 (MON.)	1) Team Meeting 2) Sunny Industry Co., Ltd. - Mr. Nishioka
FEB. 19 (TUE.)	1) Samut Sakhon Provincial Government (SPG) - Governor - Office of Labor (OL) - Land Development Office (LDO) - Extension Office 2) Municipal Waterworks Division-(SMO) 3) Highway Department - Thon Buri Branch Office 4) Provincial Electricity Authority - Samut Sakhon Office 5) Royal Irrigation Department - Krathum Baen Station 6) Field Work - Tha Chin River and khlongs
FEB. 20 (WED.)	1) Department of Fisheries (DF) 2) Department of Town and Country Planning (DTCP) 3) Land Transport Department (LTD) 4) Royal Irrigation Department - Operation and Maintenance Div. (OMD) - Water Operation Center (WOC) 5) Field Work - Tha Chin River and khlongs
FEB. 21 (THU.)	1) Samut Sakhon Provincial Government 2) Samut Sakhon Municipal Office 3) Thai Ohbayashi Co., Ltd. 4) Provincial Water Works Authority - Samut Sakhon Office 5) Field Work - Tha Chin River and khlongs 6) Industrial Survey - Samut Sakhon Area 7) JICA Office

FEB. 22 (FRI.)	1) Department of Fisheries - Brackish Water Fisheries Division (BWFD) 2) Royal Irrigation Department - Hydrological Division 3) Public Works Department - Public Water Supply Division (PWSD) 4) Industrial Survey - Bangkok Area 5) Air line 6) Japanese Embassy 7) JICA Office
FEB. 23 (SAT.)	1) Office Work
FEB. 24 (SUN.)	1) Office Work
FEB. 25 (MON.)	1) Team Meeting 2) Industrial Survey - Bangkok Area
FEB. 26 (TUE.)	1) Industrial Survey - Bangkok Area 2) Environmental Health Division (EHD) - (Department of Health) (DH) 3) Highway Department 4) JETRO
FEB. 27 (WED.)	1) Royal Thai Navy (RTN) - Hydrographic Department 2) Industrial Survey (Bangkok Area) 3) Land Department-(MOINT) 4) Factory Works Division - DIW
FEB. 28 (THU.)	1) Nomura Trading (Thailand) Co., Ltd. 2) Thai Ohbayashi Co., Ltd. 3) Thai Japan Construction Co., Ltd. 4) Department of Customers (DC) - Technical and Statistics Division (TSD) - Tariff Division 5) National Environmental Board (NEB) 6) Industrial Survey - Bangkok Area
FEB. 29 (FRI.)	1) Royal Thai Navy - Hydrographic Department 2) Team Meeting 3) Japanese Embassy 4) JICA Office
MAR. 1 (SAT.)	1) Office Work (Interim Report Preparation)
MAR. 2 (SUN.)	1) Office Work
MAR. 3 (MON.)	1) Office Work
MAR. 4 (TUE.)	1) IEAT (Presentation) 2) JICA Office 3) Japanese Embassy 4) JAL462 Bangkok → Narita (Traveling. Mr. Nakao, Nakajima, Kawamura, Katayama, Sumikawa, Fukase)
MAR. 5 (WED.)	1) JAL718 Bangkok → Narita (Traveling. Mr. Nishita Sato, Kobayashi)

Itinerary of the Second Survey (From June 30 to July 6, 1980)

JUN. 30 (MON.)	1) AZ775 Narita → Bangkok (Traveling. Mr. Nishita, Nakao, Kawamura, Nakajima)
JUL. 1 (TUE.)	1) IEAT 2) DTEC 3) Japanese Embassy 4) JICA Office
JUL. 2 (WED.)	1) IEAT (Meeting)
JUL. 3 (THU.)	1) IEAT (Presentation) 2) OECF 3) Bangkok NOMURA
JUL. 4 (FRI.)	1) Site 5 Survey 2) Japanese Embassy 3) JICA Office
JUL. 5 (SAT.)	1) Laem Chabang
JUL. 6 (SUN.)	1) JAL718 Bangkok → Narita (Traveling. Mr. Nishita, Nakao, Kawamura, Nakajima)

II. SUMMARY AND RECOMMENDATIONS

II. SUMMARY AND RECOMMENDATIONS

A. Outline of the Project

1.	NAME	: SAMUT SAKHON INDUSTRIAL ESTATE PROJECT
2.	SPONSOR	: INDUSTRIAL ESTATE AUTHORITY OF THAILAND (IEAT)
3.	TYPE	: A. Motivation - Dispersal & Promotional B. Location - Semi Urban C. Scale - Nucleus for Satellite City D. Industrial Activities - Composite
4.	SCALE OF DEVELOPMENT	: A. Industrial Area 1,819.7 Rai B. Residential Area 265.0 Rai C. Total 2,084.7 Rai
5.	LOCATION	: Amphoe Muang Samut Sakhon Has easy access to R-35, R-3242, railway and Khlong Maha Chai
6.	TYPE OF THE CANDIDATE INDUSTRIES	: A. Textile and Apparel B. Metal & Machinery C. Foods D. Chemicals E. Rubber F. Wood & Furniture G. Non Metals (Ceramic) H. Paper (Secondary) I. Others (Trans. equipment, Electrical, etc.)
7.	EMPLOYMENT	: Direct workers - approx. 16,500
8.	PLANNED POPULATION AT RESIDENTIAL AREA	: 18,150
9.	REQUIRED WATER SUPPLY	: A. Industrial - 18,000 CMD B. Domestic - 3,700 " C. Total 21,700 "
10.	SOURCE WATER	: Ground water - 8 deep wells
11.	REQUIRED ELECTRICITY	: 64 MW supply by EGAT
12.	TELEPHONE	: PBX 500 circuits
13.	WASTE WATER TREATMENT	: ACTIVATED SLUDGE SYSTEM (Common Facility) Level : BOD & SS - 20 PPM Toxic substance and heavy pollutants shall be pretreated by the individual factories prior to discharge into sewer system
14.	FLOOD CONTROL	: Dike & Pump System

15.	CONSTRUCTION PERIOD	: Approx. 4 years
16.	INAUGURATION	: 1985
17.	TOTAL INVESTMENT REQUIRED	: Baht 699 Million (1980 price)
18.	PLANNED LAND PRICE	: 420,000 Baht/Rai (1980 price)
19.	FINANCIAL ANALYSIS	: IRR - 10.3%
20.	ECONOMIC ANALYSIS	: IRR - 23.2%

B. Conclusion

This project is one of those six (6) industrial estate development projects now being proposed under the 4th National Economic and Social Development Plan. It aims at mitigation of pollution and dense-population problems becoming conspicuous in Bangkok in the recent years, promotion of the nationwide industrialization and encouragement of regional development (by construction of new satellite towns).

Initially, the Government of Thailand had intended to characterize this project as an industrial estate for pollution industries, which might be capable of receiving the existing pollution industries within the BMA for relocation. However, in view of the facts that the project area of Samut Sakhon is neighbored to the BMA, with the capacity of natural environment not superior to that of the BMA and that the image as a new industrial estate may be damaged if it is allotted solely to those pollution industries, it was mutually agreed that those incoming industries would not necessarily be limited to the pollution industries, after consultation with the IEAT officials.

Needless to mention, however, it is most probable that the greater majority of industrial activities may be accompanied, more or less, by pollution problems though such pollution may be varied by type or density. Here is one of significant meanings involved in development of industrial estate which is designed to concentrate such industrial activities into the space properly arranged with the pollution control facilities engineered at a high level and allow utilize these facilities with less economic burden by cost sharing among all industries within the estate and effectuate better pollution control under a closed circuit monitoring system.

It is fully assured as the result of this survey that the proposed project is of great significance for the nation's socio-economic development and is feasible financially as well as technically. Although it may be physically impossible that the industrial estate will be completed within the predetermined period of 1977 - 1981 under the current Plan, it is recommended that the Government of Thailand will follow its procedural steps toward final decision to implement this project for earlier realization.

C. Background of the Samut Sakhon Industrial Estate

S-01 Since the early 1960's, when the First NESDP was launched, the Thai economy has grown at a remarkably rapid pace, at an annual rate of 7.6% during 1960 to 1978 -- a growth rate rarely matched by other developing countries. Playing the role of a "locomotive" in such a rapid economic advance was the agriculture and the manufacturing industries, whose growth rates during this period averaged 4.9% and 10.8% a year, respectively. Looking ahead, however, one cannot help seeing a looming spector overshadowing the future of agriculture. A recent survey conducted by IBRD points to a low growth rate of agriculture in the 1980's, dashing the hope of a repeat performance of the past vigorous growth. In view of the fact that a large pool of latent underemployment in primary sector has accelerated the migration from rural areas to Bangkok and that the blunted growth in export of agricultural products has worsened the nation's balance-of-payments, it will be more and more necessary to shift industrial structure to the secondary and tertiary industries. Manufacturing industry will have increasingly important role in the 1980's.

S-02 The Thai government has been promoting industrialization and economic development through the execution of Fourth National, Economic and Social Development Plans (NESDP). The most prominent feature of governmental policies on industrialization lays in the philosophy that the government avoids direct investments in production facilities and devotes its resources to providing infrastructure and monetary incentives. These efforts have paid off as growth of import substitution industries in the 1960's and the growing competitiveness of export-oriented industries in the 1970's. It amply demonstrates the high industrial potentiality of Thailand that the economy grew 11% in real terms in 1978-79 despite of the worldwide stagnation caused by crude price hikes and of the high domestic prime rate.

S-03 Because of excess zeal for the efficiency of investment and economic rationality, however, too many industrial activities have become concentrated in Bangkok and have aggravated environmental pollution, traffic congestion, rises in land prices and other evils that eroded the living standard of those living in Bangkok. Painfully aware of the importance in resolving these problems, the Thai government in its Third and Fourth NESDP actively sought to disperse industries to rural areas in the 1970's. In order to achieve a balanced economic growth in the coming decades, efficient implementation of industrial relocation policies will be indispensable as well as the enlargement of the overall economic pie of Thailand.

S-04 With a view to accelerating industrial and demographic dispersion from Bangkok, the Department of Town and Country Planning-(MOINT) has been recently advocating the development of secondary and satellite cities. In keeping with this proposal, IEAT came up with a plan for the construction of regional industrial estates (RIE) and satellite-zone industrial estates (SZIE) to accommodate the relocating factories and of urban Area industrial estates (UAIE) to provide land and facilities to small and medium size factories which cannot leave Bangkok because of their locational characteristics and financial capabilities. Given the prospects of an increasingly rigorous industrial pollution control by NEB and the Ministry of Industry, the construction of these proposed industrial estates

deserves a high priority in order to achieve well-balanced future economic growth.

S-05 The role to be played by the Samut Sakhon Industrial Estate, which is characterized both as a regional industrial estate and a satellite-zone industrial estate, obviously is not only to contribute to economic development of Thailand but also to accelerate local development in the Samut Sakhon area. The most important is, however, its role in lessening the various burden currently borne by Bangkok, e.g., environmental problems, traffic congestion, increasing price of land, etc. In addition, since there are substantial sprawls caused by the past development in the Samut Sakhon area, the industrial estate is anticipated to be a trigger to implement rational landuse controls and to assist the construction of a satellite city in the area.

D. Current Situations of Samut Sakhon Area

S-06 Changwat Samut Sakhon has a littoral area of 839,867 km^2 and is adjacent to BMA. The Changwat is divided into three Amphoes, and its population is 258,633 persons (as of 1979). Although the population growth rate (1.6 - 1.7% per annum) is low, it has a net gain of social migration, that is, the immigration of the Changwat slightly exceeds emigration. The place of largest accumulation of population is Samut Sakhon City, which is inhabited by 46,380 persons (as of 1980).

S-07 Changwat Samut Sakhon is a plain Changwat with the altitude of around 1 - 2 m above sea level, and Tha Chin River of the width of 200 - 300 m runs in north to south across the center of the Changwat. Furthermore, five rivers and canals are distributed in east and west direction from the Tha Chin, and land use in the Changwat can be classified into three kinds along these canals. That is, the area close to the coastline is mainly used for salt farms and shrimp farms. The area from the center through northern part of the Changwat is used for paddy fields and fields for vegetables, fruit trees and horticulture (57% of the area of the Changwat). The area between them is the area where seawater and fresh water are mixed, and is used for plantation of coconuts or is thicket of assorted trees or wasteland.

S-08 Samut Sakhon is a base for both deep sea and offshore fishery, and the amount of fish catch landed at Samut Sakhon is the largest in Thailand. Many fishing boats which belong to other Changwats also make entry into the ports of Changwat Samut Sakhon, and the share of fisheries in gross production of the Changwat is as high as 33.1% (as of 1978).

S-09 The share of industry in gross production of the Changwat is 8.9% (as of 1978), but locations of factories to the areas along R-4 and R-3091 are conspicuous in the recent years. Although the majority of the factories were mostly of small scales of such as fish meal, canning, fishing boat repair and so forth until the middle of 1960's, main types of industries which are recently located are textile, ceramics such as tiles using locally available raw material, steel, food and chemical.

S-10 The climate is typical monsoon, annual precipitation amounts to 1,500 mm and rainfall concentrates mostly in the rainy season between May and October. The temperature ranges from 25°C to 30°C and April has the highest temperature. In the rainy season, the southwest monsoon wind prevails and the northeast wind in the dry season. The topography is flat and the average altitude is +1.1 m from MSL. Subsoil consists of alluvial clay layer until -20 m from the surface and is very poor. Therefore, the pile foundations will be needed for the factories. Almost all the rivers and Khlongs in Changwat Samut Sakhon are tidal rivers and their hydrologic characteristics correspond to tidal changes. According to the data on tides at the estuary of Tha Chin River, tides are of complex type and the differences between the highest tide and the lowest tide in June and November are about 3.5 m. According to the data compiled by Ministry of Public Health for 1977-1979, DO is 1 ppm and BOD is 1-2 ppm throughout a year. Comparing these figures with the recommendable minimal concentration of DO at the egglaying time of trout, which ranges between 6-7 ppm, DO in the water of Tha Chin River can be said to be low, while other figures such as Chloride, Alkalinity, Total Nitrogen and Phosphate indicate the normal values of the tidal river. Water around Samphran indicated high value of Coliform Bacteria caused by animal excreta. By the report of Tha Chin River Conservation Committee, the present BOD load of water flowing the river originates in the industries in Suphanburi, Nakhon Pathom and Samut Sakhon amounts to 17,362 kg/day. By the survey report of NEB the high concentration of Hg was found in the sediment at the estuary of the river.

S-11 Samut Sakhon and Bangkok is connected by the trunk raods of R-4 and R-35, Mae Klong railway and the 3 Khlongs. R-35 has a plan to be widened from 2 lane road at present to the divided 4 lane road and the enough right of way has been secured. At the Samut Sakhon port, there are facilities for the passenger boats and for the fishing boats which are planned to be improved. However, there is no facilities for the freight.

S-12 Piped water in Samut Sakhon is supplied by Municipal waterworks, PWWA and PWD and has a good quality, but their sources entirely rely on the underground water. The surface water is supplied within BMA by MWWA, but in Samut Sakhon, they will not be supplied within a forseenable future.

S-13 Electricity can be supplied to SIE from the new substation Samut Sakhon-2 which is planned to be constructed by EGAT by Oct. in 1982 around Samut Sakhon. There is 1,000 telephone line between Bangkok and Samut Sakhon and is planned to be expanded to 2,000 by 1981 and 4,000 by 1984. The telephone density is 0.25 per 100 population and is very low.

S-14 In Samut Sakhon, there are a fire station, a government hospital, a junior educational college and a vocational school as public facilities and in the whole Changwat, there are 129 schools. Domestic wastewater is discharged into Tha Chin River untreated for there is no treatment plant, and solid waste is collected and disposed using sanitary trucks by Municipality.

E. Concept of Regional Development

S-15 It is considered that the population of Changwat Samut Sakhon will reach 338,000 persons in 1990 and about 403,500 persons in 2000 as a result of development of SIE.

S-16 Land use and facilities plan of Samut Sakhon City, fairway and port improvement plan, construction of dike and canals to protect the land from penetration of seawater, brackish water farm plan and so forth are currently in progress in Changwat Samut Sakhon, and it is possible to point out the following three points as for positioning of Samut Sakhon area.

i) Base for supplying fresh food to BMA
ii) A satellite city of capital city Bangkok
iii) Gateway to western region from Bangkok

S-17 Positioning of this Changwat as the strategic base (gateway) for development of the western region is important, and consideration should be made so that Samut Sakhon City will not be overdeveloped and large impact of SIE will lead to induce development of the whole western region. Furthermore, the following four points can be raised as the functions to be strengthened in Samut Sakhon area.

i) Strengthening of distribution and processing function with fishing as the nucleus

   - To introduce industries related to fish processing and distribution to SIE -

ii) Strengthening of farm product distribution and processing function

   - To introduce industries related to farm products to SIE -

iii) Strengthening of industrial cargo distribution function and manpower development function

   - To introduce an intermodal transport terminal of railway, truck and water transportation in the vicinity of SIE -

iv) Strengthening of industrial tourism function

S-18 It is considered that linear type along R-35 is desirable as for the direction of development of the town area of Samut Sakhon including development of SIE, due to the relationship with linkage with Bangkok, current situation of traffic network, water-ways, land use and productivity of land.

S-19 The following measures are considered necessary simultaneous with development of the SIE.

i) SIE is a project including construction of a housing estate, but it is considered that an additional relevant population will be generated besides the population to live in the housing area. Such population should be orderly induced to the planned city area of Samut Sakhon as an effort for preventing urban sprawl.

ii) It is recommended to change the source of supply of water to town area of Samut Sakhon and to SIE from ground water to surface water to cope with increasing town population, and it is therefore necessary to cause SIE to be included in the water supply plan of MWWA.

iii) It is recommended from an environmental point of view to construct a sewer system and a treatment plant for Samut Sakhon as early as possible to cope with increasing polluting loads of the town area.

iv) It is necessary to make expansion and new provision of public facilities to cope with rapidly increasing town population, and it is desired that backup in financial aspect is provided by the national government.

F. Types of Industries and Size of Industrial Land

S-20 With the roles of the Samut Sakhon Industrial Estate outlined in S-05 in mind, screening of industries is conducted in the following four stages of procedure.

i) Selecting the types of industries that have substantial future growth potentiality in Thailand.

ii) From this industrial group, selecting those which have better locational potentiality in Bangkok and its surrounding areas.

iii) From such industry group, selecting those which have particularly high locational potentiality in the Samut Sakhon area.

iv) Making the final selection of industries considering the locational characteristics of candidate sites and industrial linkage among the types of industries selected through the foregoing three stages.

S-21 The types of industries thus selected and the proposed land allocation among them are summarized as follows:

Textiles and apparels	30%
Metals and machinery	20
Foods	15
Chemical products	10
Non-metal products	7
Rubber and rubber products	5
Wood and furniture	5
Paper products	3
Others	5
Total	100%

S-22 The land demand for the Samut Sakhon Industrial Estate is estimated in two different ways:

i) Allocation model : Estimates are made from the perspective of nationwide land requirements based on a macro-economic projection, and they are regionally allocated.

ii) Accumulation model : Estimates are made on the basis of land requirements of entrepreneurs achieved through our interview survey.

Further, we estimate the land size of the estate that may become necessary to create enough number of job opportunities to facilitate the functioning of Samut Sakhon as a satellite city. Estimates derived from different approaches are cross-checked in order to finally determine the size of industrial development in Samut Sakhon.

S-23 The analyses on demand side indicate that 1,000 Rai of industrial land is at least necessary from whichever approach to satisfy the potential demand for the Samut Sakhon Industrial Estate and that 5,000 Rai of industrial land may be necessary according to future circumstances. On the other hand, in order to create sufficient number of jobs, the industrial estate will need 1,100 Rai to 1,400 Rai. On these grounds, we came to the conclusion that an optimum size of industrial land is somewhere between 1,000 Rai and 1,500 Rai.

S-24 There are six reasons for limiting the scale of development to a level below the estimated land demand. First, there is a strong possibility that the supply of industrial land will become increasingly tight in the area surrounding Bangkok by 1985. Therefore, the construction of the proposed industrial estate must be expedited, even at the expense of its size, to meet the rapidly growing demand for industrial land. Second, the risks involved in disposing of the developed land must be minimized. Although rule-of-thumb estimate of land demand for this industrial estate is in excess of 2,000 Rai, it is advisable to limit the land development to a size which can be sold out even in a worst case. Third, the limited availability of industrial sites will give IEAT much leverage and latitude in screening of industrial types and individual tenants as well. This size of industrial estate will provide IEAT a better opportunity to realize the basic concept underlying the project. Fourth, environmental issues should be carefully considered. Even if a best attention is paid to the protection of environment by constructing anti-pollution facilities jointly used, the environmental load is bound to increase. In view of the current load which Tha Chin River is bearing, it is ill-advised to enlarge the estate development to more than 2,000 Rai. Fifth, the development of an industrial estate geared to controlling pollution represents the first experience for the IEAT. As such, it carries implicit risks of incurring an unforeseen pollution prone situation. An industrial estate of this size, therefore, will give the IEAT a valuable experience enabling it to promptly meet any unforeseen outcomes. Sixth and last, there is a good chance that the industrial development in the Western Region will be accelerated in the near future because of its proximity to Bangkok. If a larger size of industrial land becomes available in the Samut Sakhon area which is located at the gateway to the Western Region, the industrialization in hinterland might be suppressed even for a while. If it is a case, it will definitely run counter to the governmental policy encouraging dispersion of industrial plants to rural areas.

S-25 During the interviews we conducted on entrepreneurs, we also sounded out the intention of those wishing to locate in SIE as to the use of their present sites. As a result, one half of the respondents plans to use the current site continuously for factories, while the other half wants to sell it when they relocate to SIE. We believe that the ratio achieved through the interview survey is desirable also from the standpoint of socio-economic policy, since the available land is equally used for enlarging the pie of Thai economy and for promoting urban redevelopment by providing sizable vacant land. Since factories already located in the Samut Sakhon area still have room around them, there is no particularly strong land demand arising from them. However, as the environmental control enforced in this area becomes more strict, a growing number of them will seek refuge in the industrial estate where joint anti-pollution facilities are

available. It is also important to prepare for future expansion or development of another estate from early construction stage of the objective industrial estate in order to cope with the large potential demand for relocation within Samut Sakhon as well as that from Bangkok.

G. Selection and Evaluation of Sites

S-26 First of all, two candidate sites, one (B group) facing along R-3901 at Amphoe Krathum Baen and another Punthai No Ra Sin area (C group) were added to seven candidate sites (A group) extracted during the pre-feasibility study, and comparison was made among these groups during this feasibility study. As a result, it was concluded that seven candidate sites selected during the pre-feasibility study are superior to others.

S-27 For making selection out of remaining seven candidate sites, it was decided to select the land of approximately 2,000 Rai as the site for SIE at each candidate site and then to make selection of these lands by means of scoring evaluation method. The main items of evaluations are

i) environmental acceptability,
ii) infrastructure and utility services availability,
iii) land acquisition possibility and development cost, and
iv) compatibility with regional development policy.

Analysis was made with four cases with weight distribution to these items varied.

S-28 As a result, Site 5 was of the first place in three cases and was of the second place in one case. Site 9 was of the first place in one case and was of the second or third place in three cases. The land use and external infrastructure development cost are similar between Site 5 and Site 9, and therefore, it is possible to reduce the candidate sites to two sites, that is, Site 5 and Site 9.

S-29 The points which caused the judgement that Site 9 is superior to Site 5 are

i) ease of drainage of waste water because of larger river width, and

ii) expectation of better quality and quantity of ground water.

Site 5, however, is also close to a river of large width and is located in a more advantageous position for receiving supply of water from MWWA (Metropolitan Water Works Authority) in the future.

S-30 Furthermore, Site 5 provides the following advantages.

i) It faces two national routes, R-35 and R-3242, and is linked with bus lines of frequent services.

ii) It has easy access to a railway. There is a large possibility where the flood control cost could be reduced by the use of the railway track as a part of the dike.

iii) It is located closer to Bangkok which offer more attractiveness to industrial investors.

It was therefore decided to recommended Site 5 as the candidate site for SIE and to carry out the subsequent study.

S-31 For determining Site 5 as the land for SIE,

i) survey of land ownership,

ii) boring survey related to quality and quantity of ground water, and

iii) deliberation with RSRT (the Royal State Railway of Thailand) regarding provision of new railway station(s) and a spur line should be urgently started.

H. Land Use Plan

S-32 The land use plan of SIE shall be planned with the following basic thoughts.

i) To create pleasant working environment

ii) To consider influence to peripheral existing villages and farming

iii) To make double assurance as for countermeasures against disasters

iv) To provide residences close to the place of work

v) Unifization of wastewater treatment system

vi) To enable entry of relevant minor industries

vii) To make subdivision capable of coping with the changes in economic environment

viii) To reduce development cost and to eliminate restricting conditions for sales of land

S-33 The preconditions for the plan are as follows.

i)	Land scale :	Industrial estate 1,820 Rai (of which factory lots 1,254 Rai) Housing area 265 Rai
ii)	Expected types of industry :	Textile, clothing, metal, machinery, food, chemical, rubber, wood, furniture, ceramics, stone, paper, etc.
iii)	Number of employees :	Approx. 16,500 persons
iv)	Water supply and drainage :	(Planned water intake volume) 18,000 cum/day for factories, 3,700 cum/day for houses (Planned discharge volume) 16,000 cum/day from factories, 3,000 cum/day from houses
v)	Electric power :	64 MW
vi)	Housing area :	Residents approx. 18,000 persons
vii)	Traffic:	Generated traffic 4,000 vehicles/day

S-34 Examination of the ideas of land use was made with two plans, that is, a plan designed from the standpoint of arrangement conditions of infrastructure and related facilities (A type) and its modification (B type). Planning was proceeded with the basic thoughts and characteristics of these two plans suitably rearranged.

S-35 Summary of planning conditions are as follows.

i) To locate the housing area in the site located toward Samut Sakhon City, and to preserve good living environment with buffer greens provided between housing area and factory area.

ii) To make layout of the industrial estate in such a manner that factories of large scale are located along the main road (R-3242) and the railway, to keep good image and appearance of the industrial estate.

iii) To construct a dike and ditch around the planned area of the industrial estate as a countermeasure against disasters.

iv) To provide the main center for the industrial estate in the central part, and to provide sub centers at two different places besides the main center.

v) To provide parks and greens in the area adjacent to the main center and also in the block on the east side of the industrial estate, besides the buffer greens.

vi) To locate the wastewater treatment plant along the railway in the central part of the industrial estate, in consideration of expected types of industry, wastewater discharge volume, water quality, destination of drainage.

vii) To cause the access road to make direct linkage with main road R-35.

viii) Discharge waterway connected with the treatment plant shall be made on the part extended straight downwards from the primary road to Khlong Maha Chai to allow future expansion.

S-36 As for the factory lot plan, standard lots were established so that it is possible to cope with the demand for various size of lots desired by the diversified types of industry. The minimum lot is of 3,000 m^2(50 m x 60 m).

S-37 As for layout by the type of industry in the industrial estate, arrangement was made with various conditions in mind such as kind of environmental pollution, working conditions, transportation characteristics and appearance. Standard factories are prepared for businesses of small scales.

S-38 The composition of land use is as follows.

LAND USE PLAN

1. Industrial estate area	Total 291.15 ha	1,819.7 Rai
Factories sites	200.62	1,253.8 (68.9%)
Roads	39.95	249.7 (13.7%)
Parks and Greens	11.80	73.8 (4.1%)
Dike	24.70	154.4 (8.5%)
Utilities	10.78	67.4 (3.7%)
Administration	3.30	20.6 (1.1%)
2. Residential area	Total 42.39 ha	265.0 Rai
Housing (including road)	25.88	161.8 (61.1%)
Roads (Main)	2.31	14.4 (5.4%)
Greens/Recreations	4.78	29.9 (11.3%)
Dike	6.72	42.0 (15.8%)
Shopping center	1.00	6.3 (2.4%)
Primary school/ Kindergarten	1.70	10.6 (4.0%)
3. Total	333.54 ha	2,084.7 Rai

I. Basic Design

S-39 In SIE landfilling was not applied to the flooding in the rainy season. But the pump/dike system was applied as in the Lat Krabang Industrial Estate. Since the subsoil is very poor, the construction of bund needs about three months to secure the sufficiently increased cohesion of the ground accompanying the progress of consolidation.

S-40 The generated traffic by SIE is estimated at about 4,000 veh/day for both directions, and R-35 will provide the connection to BMA. In coping with this traffic demand, the acceleration of the improvement of R-35, the construction of outer belt, the review of Mae Klong Railway and the improvement of inland waterway and unloading facilities are required. Within SIE the asphalt paved roads with the right-of-ways of 40 m, 20 m and 10 m were planned.

S-41 Water demand in SIE is estimated at 21,700 CMD, and water can be supplied from eight deep wells with the depth of 150 m from Nakhon Luang Aquifer via reservoir and elevated water tanks to each enterprise. The salinity of water is expected to be around 200 ppm. Currently, the existing water supply facilities, Tha Chin River, MWWA, and fresh water canals can not supply water to SIE. Subsequently, IEAT should verify the quantity and quality of the underground water by conducting test boring at the earlier stage.

S-42 The industrial wastewater will be discharged to the central treatment plant by keeping the allowable effluent standard which follows the trade effluent standard of MOI under the responsibility

of each factory. The quantity of 19,000 CMD and the quality of 250 ppm for BOD, 200 ppm for COD and 250 ppm for SS are estimated. The central treatment plant is planned to have the secondary treatment system by the activated sludge process with consideration given to the quality of discharge, construction cost, and the situation in Thailand. The quality of discharge water has 20 ppm for BOD and SS by eliminating the rate of 92%.

S-43 IEAT should manage this central treatment plant and highly advanced staff for wastewater treatment, being familiar with the detail production processes of factories, pretreatment systems and the effect to the production should be arranged. The industrial wastewater, pretreatment facilities, influent, effluent and the water in the waterway need to be inspected regularly.

S-44 The total power demand in SIE is estimated at 64 MW. This demand is greater than that of Samut Sakhon. Samut Sakhon-2 substation planned by EGAT has a great possibility to be constructed within SIE. IEAT should contact EGAT promptly in connection with Samut Sakhon-2 substation which is planned to be constructed in 1982. Overhead wiring system of 22 KV are planned for SIE.

S-45 PBX with 500 circuits will be provided for SIE to connect with Samut Sakhon exchange station by cable. Accordingly to the future demand, an exchange station shall be built within SIE to link with BMA directly.

S-46 Solid waste from SIE is estimated to be about 323,800ton/year and is disposed of for sanitary landfill in SIE. Each factory should transport solid waste to the disposal area, and in the residential area NHA should desirably collect in cooperation with Samut Sakhon Municipality.

S-47 The facility installation standard shall be provided to keep unity and beauty of the estate, such as the building restrictions for the factories inducing into SIE. The common facilities should be planned emphasizing discrimination from factories in the estate.

J. Construction Program and Cost Estimate

S-48 Among the development cost of SIE, IEAT and PEA will each bear 50% of the cost for the electricity supply facilities, and also IEAT and TOT each will bear 50% of the cost for the telecommunication system. The cost for major utility facilities in the residential area will be bone by IEAT, while NHA will develop buildings and their appurtenant works independently. The work relating to facilities outside the estate will be carried out by the relevant agencies.

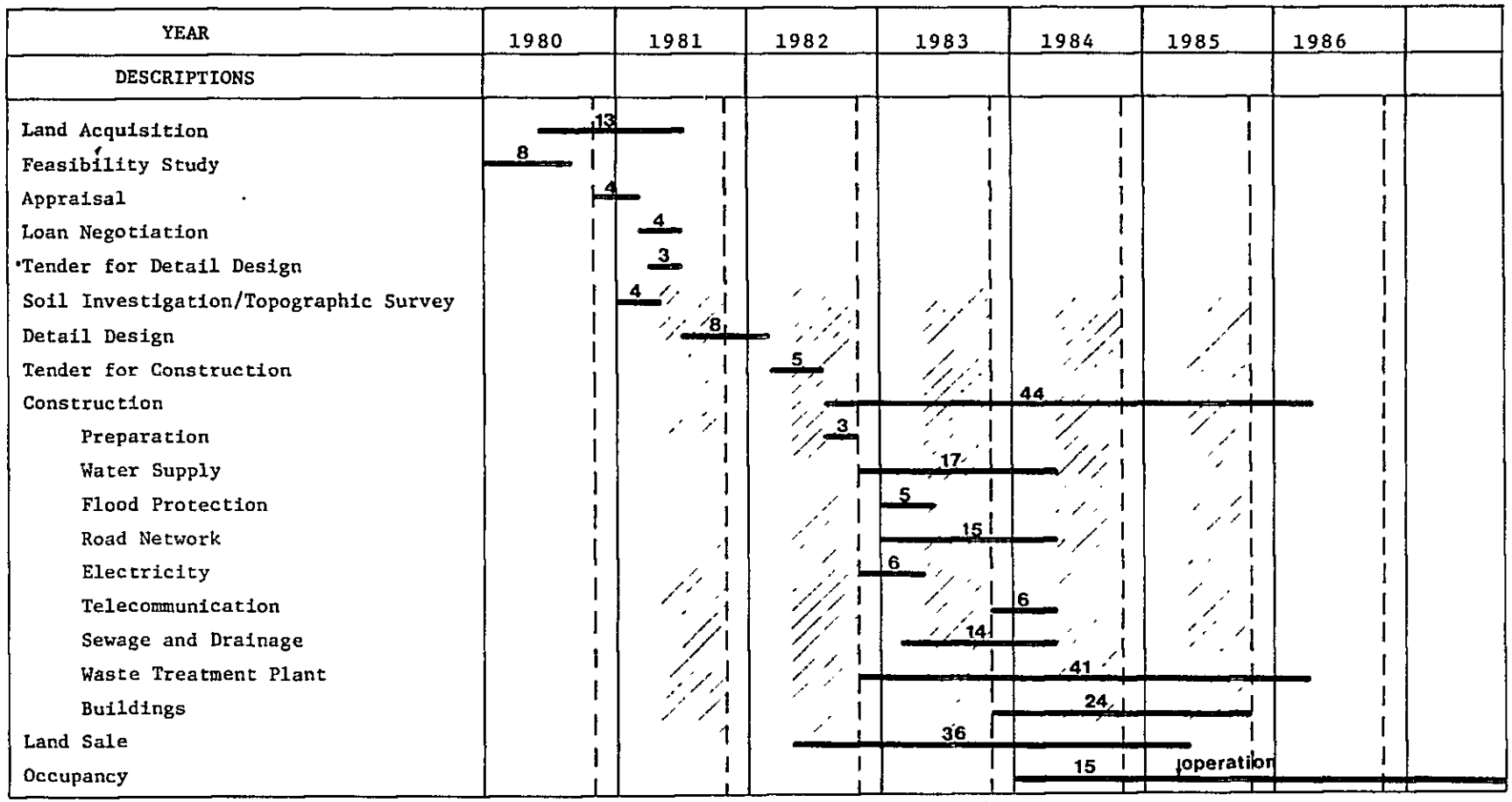
S-49 The total construction cost is estimated as shown in the following table on a 1980 basis. The total cost is Baht 665.470 million and the foreign portion is 41.6% or Baht 276.588 million. The additional costs by the residential area is 11.3% of the total cost (See page 21).

S-50 IEAT will propose commencing acquisition of land in 1980, and the works are scheduled to commence in October 1982 and to complete in 1984, except for buildings and sewage treatment plant, as shown in the following figure.

COST PROJECTION TOTAL

Baht 1,000

	1980	1981	1982	1983	1984	1985	1986	
LAND AQUISITION	43115	0	0	0	0	0	0	43115
LAND DEVELOPMENT			19789	176782	98036	9837	6737	311181
SITE PREPARATION	0	0	2611	0	0	0	0	2611
ROAD	0	0	3872	65037	48271	0	0	117180
DRAINAGE	0	0	0	6201	24228	0	0	30429
WATER SUPPLY	0	0	13306	17684	3782	0	0	34772
POWER SUPPLY	0	0	0	3385	0	0	0	3385
SEWAGE DISPOSAL	0	0	0	31576	19424	9837	6737	67574
TELECOMMUNICATION	0	0	0	990	2331	0	0	3321
FLOOD CONTROL	0	0	0	51909	0	0	0	51909
OTHERS	0	0	0	0	0	0	0	0
BUILDING	0	0	0	24317	38115	23464	0	85896
STANDARD FACTORY BUILDING	0	0	0	21033	30217	10401	0	61651
ADMINISTRATIVE BUILDING	0	0	0	3284	6248	9517	0	19049
COMMERCIAL, ETC.	0	0	0	0	1650	3546	0	5196
ENGINEERING & ARCH. SERVICE	0	20250	8528	2332	2332	550	0	33992
OTHERS	0	0	23920	0	0	0	0	23920
BASE COST	43115	20250	52237	203431	138483	33851	6737	498104
CONTINGENCIES	4311	3473	13001	66929	58235	17413	4003	167366
PHYSICAL	4311	2025	5224	20343	13848	3385	674	49810
PRICE	0	1448	7778	46586	44387	14027	3329	117556
TOTAL FINANCING	47426	23723	65238	270360	196718	51264	10740	665470



—— : calendar year

– – – : fiscal year (from Oct.1 to Sept. 30)

Rainy season : From May to Oct.

Numbers in Months

IMPLEMENTATION SCHEDULE

K. Organization and Management

S-51 In formulating management and administrative organization of SIE, the following points are to be noted.

i) To fully utilize management knowhows accumulated by IEAT

ii) Operations conducted by IEAT headquarters are not to be included in the SIE organization

iii) Surveillance and measuring organization concerning wastewater treatment is to be strengthened.

S-52 In the management and administration of SIE, the following points are to be noted.

i) In selling industrial sites, firms located in SIE are to be selected so that an industrial composition and the ratio of relocated firms will be adequate.

ii) Financial assistance is to be provided to the relocated firms.

iii) To establish a business information center.

L. Financial Analysis

S-53 Construction cost of the SIE amounts to Baht 666 million, adjusted for price increases, with 1980 as the base year. Taking account of the interest payments of Baht 33 million during the construction period, the total amount of funds necessary for this project reaches Baht 699 million. Of the total, the foreign portion accounts for 44.3% and the domestic portion 55.7%.

S-54 The Baht 699 million will be raised with a long-term foreign loan of Baht 310 million (44.3%), the Thai government's contribution of Baht 60 million (8.6%), and internally-generated Baht 329 million (47.1%). It was assumed that the foreign loans should be repaid in 15 years with a 5-year grace at the four different rates of annual interest of 3.5%, 5%, 6.5% and 8%.

S-55 Per-unit revenues from sale and lease of factory and housing lots and facilities in the SIE, together with those from rendering services, have been assumed as follows:

Source of Revenue	Unit	Unit Price
Sale of Factory Lots	1,000 Baht/Rai	420
Housing Lots Sale to NHA	1,000 Baht/Rai	420
Installment Sale of Factory Lots	1,000 Baht/Rai	400
Lease of Factory Lots	1,000 Baht/Rai-year	37.7
Lease of a Standard Factory	1,000 Baht/m^2-year	1.28
Lease of Buildings for Commercial Purpose	1,000 Baht/m^2-year	3.51
Maintenance and Administration	1,000 Baht/Rai-year	2.70
Water Supply and Sewerage	Bath/m^3	7.6

S-56 The area of factory lots to be sold totals 1,254 Rai, including 125 Rai for lease and that of housing lots to be sold to NHA totals 179 Rai. The standard factory for lease covers an area of 12,000 m^2 and the buildings for lease cover 1,200 m^2. The schedule for sale and lease is as follows:

Revenue Source	Unit	1982	1983	1984	1985	1986	Total
Sale of Factory Lots	Rai	46	203	197	102		548
Sale of Housing Site to NHA	Rai	179					179
Sale of Factory Lots on Installment Basis	Rai	180	305	85	11		581
Lease of Factory Lots	Rai			55	55		110
Lease of Standard Factory	m^2				6,000	6,000	12,000
Lease of Commercial Building	m^2				600	600	1,200

S-57 According to a trial calculation of earnings of this project (see Chapter X, 10-36), sizable profits after tax will be posted for four years from 1982 to 1985 during which factory and housing sites will be sold. Then, the balance will dip into the red, but from 1996 onward, it will resume posting a surplus.

S-58 The internal rate of return (IRR) of this project in the 1980 real prices will reach 10.3%, considerably exceeding 8%, a level commonly regarded as the bottom of the IRR for industrial development projects. The cost-benefit ratio and the net present value at a discount rate of 8% will stand at 1.025 and Baht 13,032,000 respectively.

S-59 According to the results of the sensitivity analysis, a 5% decline in the selling prices of factory and housing lots or a 5% rise in the construction costs is the tolerance limit, and a further rise or drop is undesirable.

S-60 Since the financial analysis of this project from all angles shows favorable results, the project can be regarded as worthy of carrying out.

M. Economic Analysis

S-61 The economic cost (direct) of the Project is composed of Baht 497 million for construction of SIE (plant site), Baht 54 million per year (for a 100 percent operation) for operation of SIE, and Baht 2,547 million for plant construction by the enterprises in SIE.

S-62 The economic benefit (direct) of the Project consists of Baht 65 million of benefit resulting from the construction of SIE, Baht 388 million from the plant constructions in SIE, and Baht 1,112 million per year (for a 100 percent operation) from production by the plants in SIE.

S-63 In consideration of these economic cost and benefits, the economic internal rate of return (EIRR) for the 20 years from the base year of 1980 to 1999 is estimated at 23.2 percent. Therefore the Project is highly favorable from the viewpoint of economic analysis, too. It is fully worth executing from the standpoint of national interests of Thailand.

S-64 The indirect economic benefit of the Project comprises a saving of foreign currencies worth about Baht 3,150 million over 20 years, an improvement in the infrastructure of the Samut Sakhon area, including roads, water supply, sewerage, power supply, telephone system and transportation facilities, and a sharp rise in employment opportunity for unskilled workers, thanks to construction works for the infrastructure improvement. With the completion of SIE, the population of the city of Samut Sakhon is expected to increase by nearly 40,000 to attain a two-fold gain. As a result, business opportunities will increase largely in construction, transportation, traing and other industries in the city. About half of the enterprises locating themselves in SIE will be those moving from GBA. So, the urban environment of GBA will be improved, though very locally.

PART II

RESULTS OF STUDY

I. BACKGROUND OF THE SAMUT SAKHON INDUSTRIAL ESTATE

I. BACKGROUND OF THE SAMUT SAKHON INDUSTRIAL ESTATE

A. Economic Development

1. Historical Review

1-01 Since the beginning of the 1960's, when the First NESDP was launched, the Thai economy has expanded at a remarkably rapid pace, at an annual rate of 7.6% during the years from 1960 to 1978 -- a growth rate rarely matched by other developing countries. Because of this high economic growth rate, the real per-capita gross domestic product (GDP) in Thailand also increased at an annual rate of 4.4%, despite the rapid increase in her population. This is only one of many examples reflecting the vigor of the Thai economy.

Table 1-1 GDP GROWTH RATE, 1960-1978
(in constant 1962 prices)

Unit: %

	1960-65	1965-70	1970-78	1960-78
Agriculture	5.2	5.7	3.9	4.9
(Crops)	(4.7)	(4.5)	(3.9)	(4.3)
Manufacturing	11.4	10.3	9.6	10.8
GDP	7.6	8.2	6.4	7.6
GDP per Capita	4.2	4.9	3.7	4.4

Note: Prices are estimated by logarithmic regression with respect to time over the periods shown.

Source: NESDB

1-02 The rapid economic growth of Thailand is attributable to the following three factors: The first factor is the rapid growth of manufacturing sector, which grew at an annual rate of 10.8%. This was achieved largely in the form of a rapid expansion of import substitution mainly in consumer goods. Production of the manufacturing industry which accounted for 13% of the GDP in 1960 increased to 21.3% in 1978. Manufacturing workers also grew from 3.4% of the total work force in 1960 to 5.8% in 1978, and thus the manufacturing industry has played an important role in creating job opportunities. The second factor is the growth of agriculture, forestry and fishery. Somewhat slower though they were than the manufacturing, the growth of primary industrial sector has averaged at about 5% per year during the same period, and this also was far higher than those of other developing countries. It must be noted, however, that the growth of these sectors came not from increases in per-acre productivity but rather from the diversification of crops, increases in truck farming and enlarged acreage of planted areas. As shown in Annex, the per acre productivity remained virtually flat in the 1970's, while the farm acreage almost doubled in 1950-78, supporting the view mentioned above. The third factor relates to the growth of the tertiary industry. The rapid growth of the manufacturing and primary industry provided the strong drives for the growth of the tertiary industry. Tertiary industry grew by 1978 to a level accounting for about 44% of GDP.

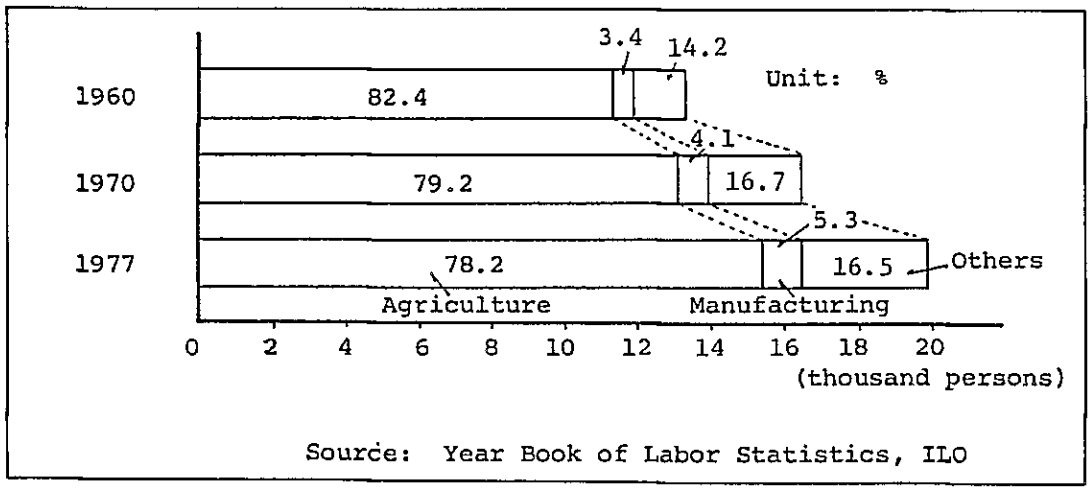


Fig. 1-1 EMPLOYMENT IN TYPE OF INDUSTRY

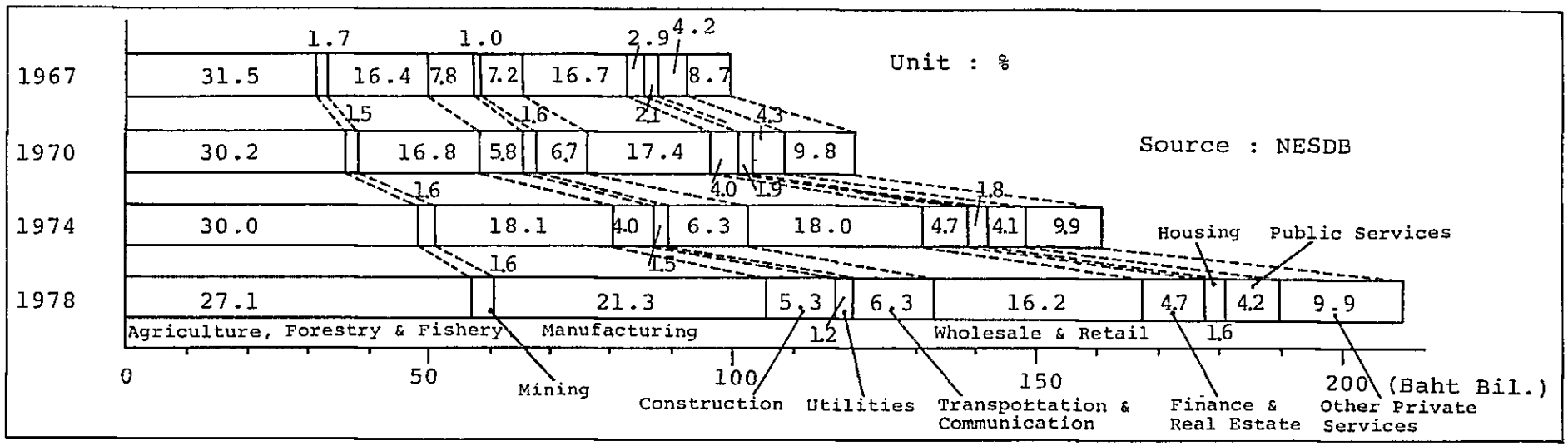


Fig. 1-2 GDP BY TYPE OF INDUSTRY

2. National Economic and Social Development Plan and Industrialization

1-03 Industrialization which had initially generated a strong forward momentum underpinning the rapid economic growth in Thailand traces its root to the Industrial Development Acts enacted in the middle of the 1950s. However, the initial industrialization in the 1950s was largely led by the direct investment of government and failed to trigger the wave of private investment. As a result, the efforts fell short of the original goals. It was after 1960 when the First NESDP was sent in motion that the industrialization drive started to take hold in earnest.

1-04 The first serious attempt at encouraging private investment started with the institution of the Board of Investment in 1959. With the enactment of the Investment Promotion Act of 1962, the industrialization policy of the Thai Government has clearly established a sense of direction in favor of private initiatives toward industrialization. Aware of the poor results of the government-led industrialization policy pursued in the 1950s, the government stated in its announcement of the First NESDP of 1961 as follows: "that in Thailand increased output will be most readily secured through the spontaneous efforts of individual citizens, fostered and assisted by Government, rather than through Government itself entering directly into the field of production". Indeed, the government has made no direct investment in the industrial sector since then and till the Fourth NESDP. It has stuck to the line of policies aimed at developing infrastructures necessary for industrialization and encouragement of private investments.

1-05 Under the First NESDP (1961-66), its major thrusts were directed to encouraging import-substitution. Industries that emerged during this period include automobile assembly, steel, oil refinery, tire and tube, plate glass, paper, pharmaceuticals, construction materials, tin smeltering and cotton spinning and weaving. During the plan the industrial sector grew 10.2% annually, a pace faster than that the original goal had envisaged.

1-06 The emphasis on the import-substitution was continuously carried into the Second NESDP (1967-71). During the first half of the program period, the increased investment by foreign firms and the growing volume of Vietnam-induced orders generated added momentum to the industrialization, but as the years advanced to the second half, the growth momentum levelled off largely because of the decreased volume of Vietnam-induced orders and the limited size of the domestic market. As a result, the growth rate, 9.2%, fell short of the goal, 10.9%.

1-07 Faced with the limited growth potential of the domestic market, the emphasis of the Third NESDP that started in 1972 was shifted from import-substitution to export-oriented products. At the same time, the program was addressed to correcting the all-important question of disparity of income among the population and the uneven development of regional economies. For this purpose, the government adopted corrective measures attructing industrial investment to promotion areas designated in rural regions. Tax and credit incentives were extended to businesses siting in these designated areas. In the meanwhile, Industrial Estate Authority of Thailand established in 1973 1973 began breaking ground for siting industrial parks that are necessary for the distribution of industries. However, at the start, this

program was greeted with a number of formidable problems -- the sharp increase in crude oil prices, the realignment of the international monetary system and the resultant stagnation in the developed countries on international front, and the surging inflation caused largely by international factors, the deterioration of balance-of-payments in foreign currency and the sluggish capital spending of business on domestic front. As a result, the industrial sector barely managed its growth rate at 8.6%, and owing to such circumstances, the nation hardly made any dent on the income disparity and uneven regional development.

1-08 The on-going Fourth NESDP (1977-81) basically inherited the policy goals of the Third Plan and places a special emphasis on eliminating destitution in rural areas and decreasing disparity of economic and social development among regions by developing social overhead capital in rural areas. In terms of priorities, emphasis is placed on export-oriented and job-creating industries. More specifically, they will include the following:

i) Development of agro-manufacturing and the restructuring of industrial production in rural area: Emphases will be placed on such agro-industries, particularly export-oriented and job-creating ones, that are capable of triggering forward momentum of local economic development. In addition, the government is actively seeking to develop steel mills, fertilizer plants, paper pulp mills and oil-related facilities, with the possibility of government's equity participation in such projects.

ii) In developing import-substitution industries, the emphasis will be shifted from consumer goods to industrial goods.

iii) The government will help the industry to expand and diversify their export markets, and special efforts will be devoted to the promotion of export sales.

iv) With a view to dispersing industries to local areas, establishment of industrial estates in those areas will be actively promoted.

1-09 Since 1976, production and private investments in production facilities have been recovering gradually from the stagnation caused by the first oil crisis. Industrial production has increased at an annual rate of 12.7% in 1976-79 and private investment also has recovered the pre-oil-crisis level. The gross domestic products increased at an annual rate of 7.8% during the same period.

1-10 The second-round sharp increases in crude oil prices and the steep rise in interest rates across the world which had been triggered by the political turmoil in Iran took a heavy toll of the Thai economic growth in the form of surging inflation and deteriorating balance-of-payments in foreign currency. Inflation raced at a rate of 13% in 1978-79 and the nation ran a trade deficit of 38 billion baht. In an effort to curb the inflation and shore up the balance-of-payments, the government has been enforcing a restrictive credit policy. As a result, the prime rate has climbed up to about 16% in recent months. However, despite the tight monetary policy, real-term industrial production surged ahead 11% over a year ago in 1979. As pointed out by NESDB, the Ministry of Industry and the Bank of Thailand, although the tight monetary policy enforced since 1978 will continue to bite, and the growth may be somewhat blunted over the short run, the Thai economy is believed to have considerable growth

Table 1-2 OBJECTIVES AND ACTUAL ACHIEVEMENTS IN NATIONAL ECONOMIC AND SOCIAL DEVELOPMENT PLANS

Unit: %

	First (1961-66)		Second (1967-71)		Third (1972-76)		Fourth (1977-81)	
	Objective	Real Achiev.	Objective	Real Achiev.	Objective	Real Achiev.	Objective	Real Achiev.
Agriculture, Forestry	3.3	4.6	4.3	4.1	5.1	3.9	5.0	3.7
Mining	5.3	10.9	6.6	8.1	6.0	0.5	3.2	18.1
Manufacturing	9.3	10.2	10.9	9.2	8.0	8.6	9.6	12.7
Construction	3.9	12.3	11.4	8.4	6.5	4.0	3.0	16.3
Utilities	16.4	18.2	18.0	20.7	15.0	14.4	11.3	11.6
Transportation & Communication	9.3	9.0	11.0	7.5	6.0	8.1	7.4	9.6
Commercial Services	5.5	8.0	8.4	7.7	7.0	4.8	6.3	3.7
Financial Services & Real Estate	5.5	16.6	17.0	14.4	15.0	5.1	8.1	8.7
Housing	5.5	3.7	5.0	4.1	2.5	3.6	4.4	4.7
Public Services	5.5	7.2	12.0	10.0	6.0	6.0	6.5	10.8
Other Private Services	5.5	6.0	9.5	8.8	7.0	8.2	7.8	7.8
GDP	5.5	7.3	8.5	7.2	7.0	6.2	7.0	7.8
Per Capita GDP	3.0	4.8	5.0	4.0	4.5	3.3	4.6	5.2

Note : Objectives and achievements are shown in growth rates.

Source : NESDB

potential over the medium and long term, without another round of sharp runups in crude prices. IBRD projects the growth rate of the Thai economy in its 1978 report at 10.2% for 1980-85 and 10.6% for 1985-90. Its projection lends support to the view stated above. Depending on the progress Thailand will make in its industrialization projects, its economy can maintain the 10% annual growth rate which it had registered during the past 20 years and could possibly exceed 10% growth rate if industrialization programs are smoothly implemented.

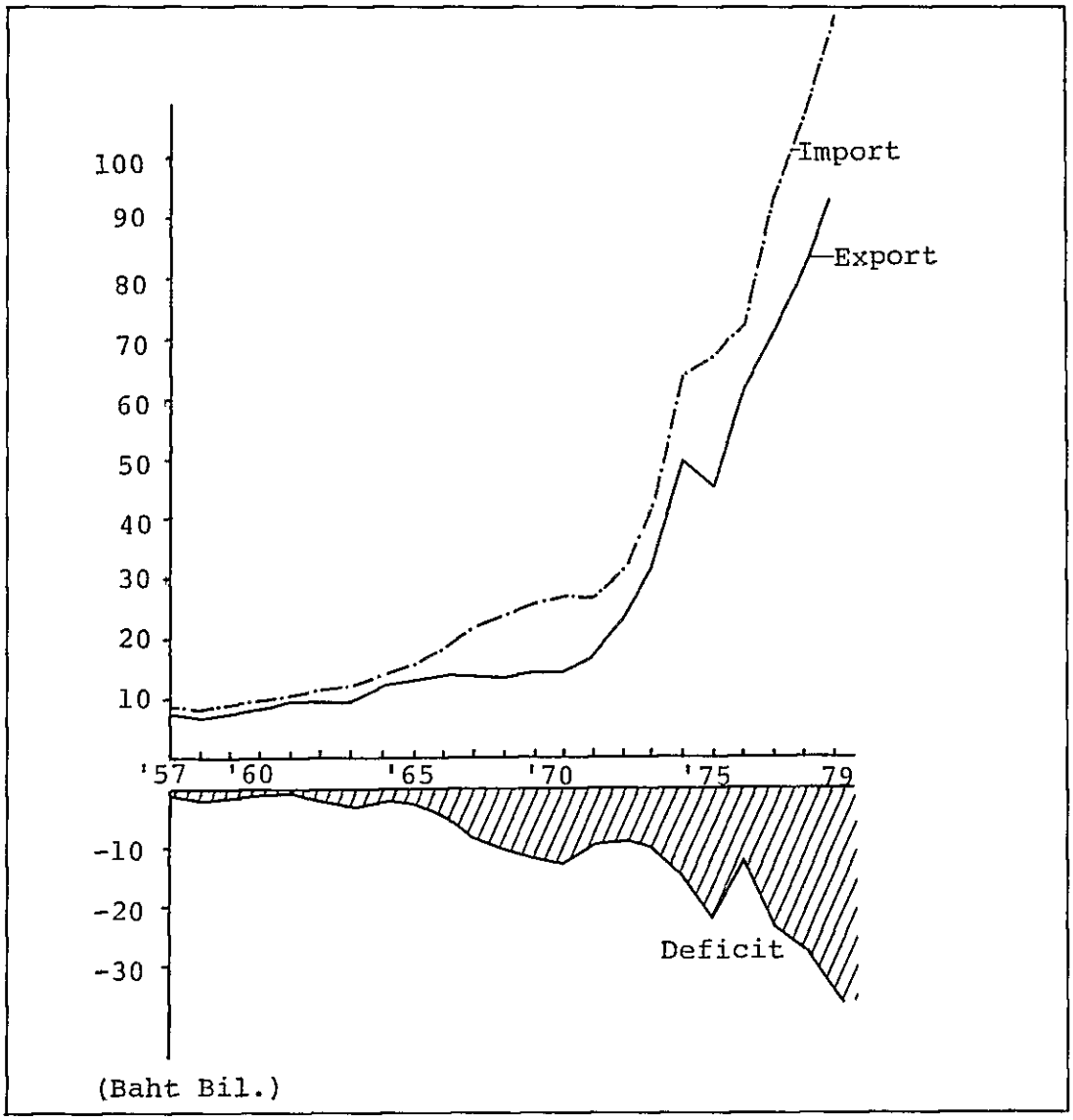
B. Changes in Industrial Structure and Role of Manufacturing Sector

1. Indispensable Structural Changes for Future Growth

1-11 Primary sector, of which relatively high growth rate has duely contributed to the growth of Thai economy, is losing its growth potential. As pointed out by IBRD in its survey report, the development of new farmlands is expected to reach a saturation point early in the 1980s, thus leaving little room for futher expansion in the future. Since the predominant part of the past growth in agricultural production came from increased acreage of farmlands as seen in 1-02, agricultural sector is not expected to achieve a future growth rate as high as in the past. In order to sustain the vitality of the Thai economy, growth in other sectors will be inevitagle.

1-12 Demographic analyses also support the importance of the growth momentum generated by the secondary and tertiary industries. Because of the high birth rates in the 1960s and the 1970s, the working population is expected to increase at an annual rate of 2.9% in the first half of the 1980s and 2.6% in the second half. And this spells a growing need for creating jobs at a rate much faster than in earlier decades. During the past 20 years, although the GDP shares of primary sector has shrunken precipitously from 40% in 1960 to 27.1% in 1978, the percentage of workers in primary sector decreased only about 7%; from 82.4% to 74.7%. The primary sector still holds 1.6 million workers; 0.5 million increase from 1.1 million in 1960. This suggests the strong possibility that the primary sector is already saddled with a considerable number of latent unemployed workers and that the primary sector has virtually little capacity to absorb additional workers. The onus for creating future job opportunities necessarily falls on the lap of the secondary and tertiary industries.

1-13 Import and export structure of Thailand is very similar to those of other developing countries; exporting primary products and importing manufactured products. This structure worked well until 1966 and the balance of payment was not unfavourable. After 1966, however, since the export of primary products leveled off, the balance of payment was continuously aggravarated as shown in Fig. 1-3. The increasing price of crude oil further accelerated the imbalance. As the export of primary products is not expected to increase substantially in the future, it is urgently required to promote other basic industries.



Source : Monthly Bulletin, Bank of Thailand

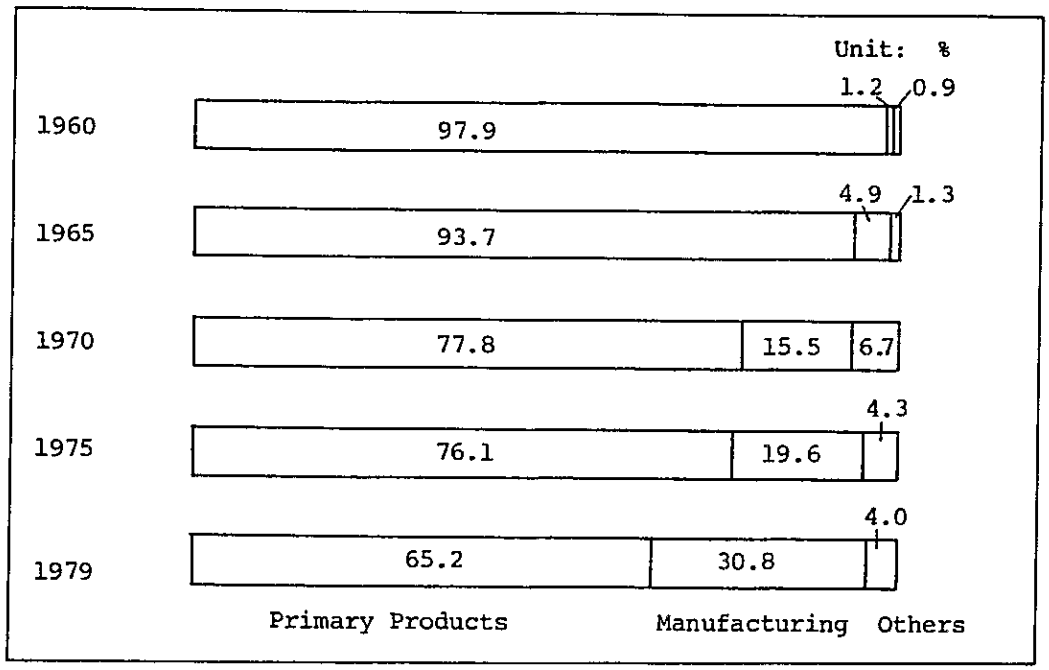
Fig. 1-3 EXPORT, IMPORT AND BALANCE OF TRADE

2. Role of Manufacturing Industry

1-14 Looking ahead over the 1980s, manufacturing industry has increasingly important roles to play for the economic development of Thailand. The single-most important factor justifying this view is, as seen in the above, the fading hope for a rapid growth in agricultural production. Although tertiary sector has shown stable growth in the past and reached to the level of 40% share in GDP in 1978, the future growth of tertiary sector will not be satisfactorily achieved without the increase in manufacturing production. Considering the contribution of manufacturing sector to the past economic growth, improvement in manufacturing productivities and promotion of new promising manufacturing industries will be more and more important for the Thai economy.

1-15 The importance of manufacturing sector is also confirmed in the balance of payment. As shown in Fig. 1-4, the primary products which accounted for 98% of export in 1960 decreased its share to a little over 65% in 1979, while the share of manufactured products

increased from 1.2% to 31% in the same period. Especially after the Fourth NESDP where emphasis in industrial promotion was placed on export oriented one, the share of manufactured products has increased rapidly. The growth in manufacturing sector is necessary in the future to acquire foreign currency.

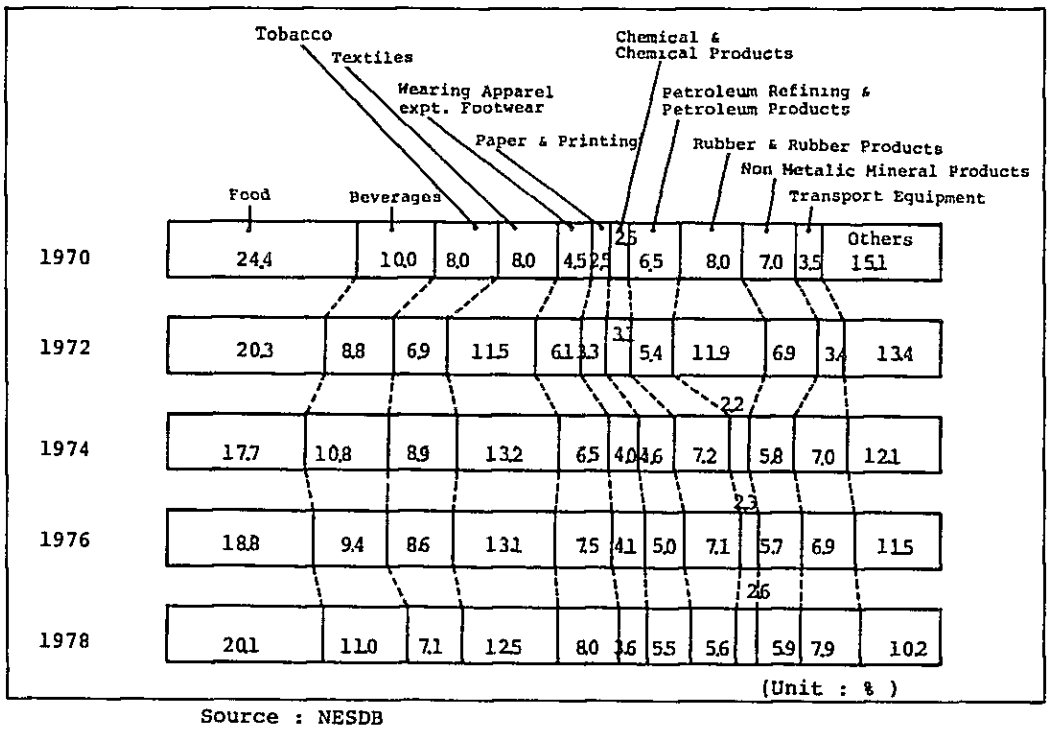


Source: Bank of Thailand

Fig. 1-4 EXPORT STRUCTURE

1-16 In addition, there are many favourable signs for the future growth in manufacturing sector. Signs that bode well for the development of manufacturing industry include the possibility of domestic production of natural gas coming on stream during the years of the Fourth NESDP (1977-81). According to the Petroleum Authority of Thailand, they look to a daily production of 500 MMSCF in 1985, and this quantity corresponds to 58% of Thailand's fuel oil consumption and about 20% of her requirements for oil-based energy. Since the present deposit of natural gas is 40% in excess of the original estimate and the investigation of new gas field will be continued, there is a good possibility of finding further natural gas deposits in the coming years. Large-scale projects designed to harness the natural gas resources, such as steel, fertilizers, petrochemicals and soda ashes, are also expected to become a reality if partially in the 1980s. The development of industry groups, such as cement and pulp, which aim at tapping locally available resources is also expected to get into the full swing the 1980s and the ratio of domestic components that go into other import-substituting products (automobiles and home appliances) will also increase appreciably. Domestic production of intermediate (chemicals) and capital goods (machinery) is expected to make further gains if the performance of the Fourth Plan meets its original schedule.

Further signs that lend support to an optimistic outlook include the steady growth in the export sales of textiles, furniture and processed agricultural and fishery products and the remarkable growth in the production of labor-intensive electrical machine components. The past four NESDP's have contributed to shift the manufacturing structure to more value-added industries. It is more and more important to accelerate this trend by promotion of industrialization centering high value-added industries.



Source : NESDB

Fig. 1-5 STRUCTURAL CHANGES IN MANUFACTURING SECTOR (in 1962 Prices)

3. Incentives for Industrialization

1-17 One of the features of the industrialization policy of Thailand lies, as we have seen in 1-04, in the philosophy that the Thai government refrains from investing directly in production facilities and devotes its resources exclusively to creating infrastructure conductive to encouraging private investment. Under the Fourth NESDP the government seriously considered investing its funds directly in plant construction projects in the field of energy development which requires large sums of capital. However, this is an isolated exception which does not alter the basic stance of the government -- assisting and inducing private investment from the sideline.

1-18 Typical of the incentives extended by the government for encouraging private investment has been those which are made available under the Investment promotion Act. Under this Act, a Board of Investment chaired by the Prime Minister and composed of senior officials drawn from NESDB, Ministry of Industry, Ministry of Finance and the Bank of Thailand was firstly instituted in 1959. The Board studies and decides on types of industries selected for governmental incentives and on the substance of such incentives pursuant to the said Act.

At present, the following six sectors including 64 industry groups are made eligible for government incentives:

i) Agriculture

ii) Mining, smeltering and ceramics

iii) Chemical industry and chemicals

iv) Machinery and electrical products

v) Service industry

vi) Others

Detailed provisions dealing with the eligibility for incentives are set forth and they relate to the minimum scale of investment, export ratio, the minimum equity ratio of local interests and conditions of siting, and so on. To firms eligible for the incentives, the following four pribileges are extended:

i) Exemption of corporate income tax for the initial three to eight years

ii) Exemption of income tax on dividends for a maximum of five years

iii) Total or 50% exemption of import duty and business tax

iv) Exemption of export duty

1-19 In addition, with a view to accelerating local development, the following areas are designated as investment promotion areas and even more advantageous incentives are extended to firms siting in any of the areas.

i) Amphoe Muang Lamphoon and Amphoe Sankamphang

ii) Amphoe Muang Saraburi, Amphoe Kang Kog, Amphoe Muang Nakhon Ratchasima, Amphoe Pathonchai, and Amphoe Pahchong

iii) Amphoe Muang Khon Kaen and Amphoe Ban Phai

iv) Amphoe Muang Songkhla and Amphoe Haad Yai

Further incentives available in the aforementioned areas include the following:

i) Exemption of a maximum of 90% of the business tax leviable on the products or on the sale of such products for a maximum period of five years from the date on which the first income accrued.

ii) One half of the corporate income tax will be exempted for a period of five years immediately following the expiration of the initial period of corporate income tax exemption.

iii) Deduction of an amount double the transportation costs and electricity and water bills from the taxable income.

iv) Deduction of an amount equivalent to 25% of the costs of the construction of infrastructure from the net income of a year. This privilege is effective for such a period less than ten years from the date of which the income first accrued as the Board of Investment may authorize.

4. Industrial Estate Plans and Their Future Outlook

1-20 In addition to the incentives outlined in the foregoing, the government is taking a positives stance to develop industrial estates for creating conditions favorable to the newly siting firms. Ministry of Industry established the first industrial estate in Thailand at Bang Chan in 1973. With a view to spurring the planning and construction of industrial estates, the IEAT was spun off in 1973 from the Ministry of Industry as an independent public agency and was charged with the following responsibilities.

i) To provide the proper planning industrial area for industries by providing complete infrastructures and all necessary facilities for industrial operation and also to further assist industries for a more efficient operation;

ii) To protect and eradicate various pollutions from the operation of the factory with the aid of an effective industrial estates and export processing zones development program;

iii) To control and improve the deteriorating environment caused by the improper factory operation and management.

iv) To prevent the immigration of people from rural area into Bangkok by establishing industrial estates in the proper planning provinces in other regions;

v) To support and stimulate industrial investment in order to increase national employment thus enlarging national per capita income, enhance the standard of living and decrease other social problems;

vi) To support and promote industry, especially the industry which employs the country's raw materials and natural resources; also to change the country's economic framework from depending on the agricultural sector to industrial sector by increasing income from the latter;

vii) To promote both export - oriented and import substitution industry by utilizing the country's raw material and labour and to raise the country's industrial standard by recommending the new production technics and skilled labour.

1-21 Under the on-going Fourth NESDP, six industrial estates given in Table 1-3 are planned. Of these, the Lat Krabang Industrial Estate has made the most progress. The development of the industrial sites on the estate has been nearly completed and more than 90% of the plant site has been sold. However, except the Southern Industrial Estate for which the Asia Development Bank conducted a feasibility study in 1979, no significant progress on other four industrial estates. Preparations are being made rather belatedly for feasibility studies of these industrial estates. Especially the Eastern Industrial Estate planned at Laem Chabang as a heavy and chemical industry complex has been stalled partly because of the change of port location to Sattahip. The industrial estates which have a good prospect of completion in the early 1980's include only the Lat Krabang Industrial Estate, the Southern Industrial Estate, this SIE, and two industrial estates which were not included in the original program and are being developed jointly with private sector, i.e., the Bang Poo Industrial Estate and the Nava Nakorn Industrial Estate.

Table 1-3 THE STATUS AND WORK SCHEDULE OF INDUSTRIAL ESTATE IN THE FOURTH ECONOMIC AND SOCIAL DEVELOPMENT PLAN (1977-81)

No.	Project	Size (Rai)	Construction Period(Year)	Estimated Number of Factory	Estimated Permanent Employment	Estimated Temporary Employment/ Year
1	Lat Krabang Industrial Estate and Export Processing Zone	1,007 Rai of land has been bought at a cost of Baht 25 mil. in Sept., 1976	4(1977-1980)	160-220	7,500-8,500	1,000
2	The Eastern Industrial Estate Project	1,000	4(1978-1981)	90	7,500-8,500	1,000
3	The Southern Industrial Estate Project	1,500	4(1978-1981)	90	7,500-8,500	1,000
4	The Northeastern Industrial Estate Project	1,000	4(1979-1982)	90	7,500-8,000	1,000
5	Heavy-Polluted Industrial Estate Project (Samut Sakhon)	1,500	4(1979-1982)	80	10,000-12,000	1,000
6	The Northern Industrial Estate Project	1,000	4(1980-1983)	90	7,500-8,000	1,000

Source : IEAT

1-22 In an effort to expedite the development of the industrial estates whose construction has lagged behind the original schedule, the IEAT is now drawing up an ambitious development plan for execution in 1982-86. The outline of the planned industrial estates and their development schedules are summarized in Table 1-4.

Table 1-4 INDUSTRIAL ESTATE DEVELOPMENT PLAN (1980-1985)

	Fourth NESDP			Fifth NESDP				
	1979	1980	1981	1982	1983	1984	1985	1986
1. Lat Krabang Ind. Est. & Exp. Proc. Zone	C	C-O	C-O					
2. Lat Krabang Ind. Est. & Exp. Proc. Zone Extension		FS	C	O				
3. Lat Krabang Ind. Est. & Exp. Proc. Zone Phase II		FS	LA	C	C	C-O		
4. Samut Sakhon Ind. Est.	PS	FS	LA	C	C	C-O	C-O	
5. Southern Region Ind. Est.	FS	LA	C	C	C-O			
6. Laem Chabang Ind. Est. & Exp. Proc. Zone or at Sattahip	LA	PS-LA	FS-LA	C	C-O	C-O	C-O	
7. Bang Poo Ind. Est.	C-O	C-O	C-O	C-O	C-O			
8. Bang-Phli Bang-Bo Ind. Est.	(FS LA)	C	C-O	C-O				
9. Rangsit Ind. Est	(LA)	PS FS	C	C-O				
10. Small Scale Ind. Est. in Urban Area (BKK)		PS	FS-LA	LA	C	C-O	C-O	
11. Industrial Estate Around Bangkok								
(1) Bang Bua Tong Ind. Est.	PS	FS	LA	C	C-O			
(2) Pathum Thani Ind. Est.		PS	FS	LA	C	C-O		
12. Feasibility Studies on Regional Development of Ind. Ests.								
(1) North-Eastern Region Ind. Est.	PS	PS	FS	LA	C	C-O		
(2) Northern Ind. Est.		FS	LA	C	C-O			
(3) Western Region Ind. Est.		PS	FS	LA	C	C-O		
(4) Ind. Est. in Central Region			PS	FS	LA	C	C-O	

Legend: PS - Pre-Feasibility Study; FS - Feasibility Study; LA - Land Acquisition; C - Construction; O - Operation; ( ) - Executed by N.H.A.

Source : IEAT

C. Concentration of Industries in BMA

1. Concentration of Industries in BMA

1-23 It is not an exaggeration to say that the industrialization in Thailand started and developed primarily in and around Bangkok. As shown in Table 1-5, while the population of Bangkok in 1978 accounted for only about 10% of the nation's total population, its industrial production accounted for about 36% of the nation's total and 47% in terms of number of factories.

Table 1-5 REGIONAL SHARES IN POPULATION, MANUFACTURING AND GDP IN 1978

Unit: %

	Bangkok	Central	North	Northeast	South
Population Share	10.5	20.7	21.2	35.4	12.3
Share in Manufacturing					
. Production	35.7	45.6	6.6	6.3	5.7
. No. of Factories	47.0	27.0	7.0	12.0	7.0
. Workers	31.7	37.8	9.4	15.8	5.3
GDP Share	28.6	30.5	13.8	14.2	12.9
Per Capita Income 1979 Price	16,339	8,350	3,646	2,369	5,283

Source : NESDB

1-24 Table 1-6 summarizes regional shares in sub-divided manufacturing industries. Particularly in the case of beverages, apparels, furniture, paper products, printing and publishing, chemical products, transportation equipments, and electrical machinery, the share of Bangkok accounts for more than 40%. Add to this those located in the Central Region, the production of these industry groups accounts for more than 85% -- especially, those of furniture and paper products do no less than 99% -- of the national total production. The types of industries of which shares are large in other rural areas such as North, Northeast, East, South, etc., are food, woods & cork and rubber, the types processing local natural resources.

1-25 The heavy concentration of these industries in Bangkok and the Central Region obviously is due to the easier access to the market, skilled labor and managers, capital, and industrial infrastructure that Bangkok and the Central Region offer. More specifically,

i) Bangkok has a higher density of population with higher per-capita income. (The per-capita income of the inhabitants in Bangkok is 2.9 times, and that in the Central Region is 1.5 times of the national average).

ii) Bangkok has a pool of skilled labor and has a ready access to accountants, engineers and managerial personnel, etc.

iii) Banking institutions and government agencies are concentrated in Bangkok, and

iv) Bangkok offers better transportation and communications systems and other infrastructure as well as urban amenities such as educational and recreational facilities.

Therefore, if left to their own devices, industrial location in Bangkok and BMA will continue to increase.

Table 1-6 REGIONAL SHARE IN MANUFACTURING (Based on GDP) BY TYPE OF INDUSTRY

Unit: %

Type of Industry	Bangkok		Central		Bangkok & Central		Others	
	'74	'77	'74	'77	'74	'77	'74	'77
Food	34.8	29.9	36.6	37.3	71.4	67.2	28.6	32.8
Beverages	32.1	34.1	33.8	42.5	65.9	76.6	34.1	23.4
Tobacco & Snuff	45.2	40.0	47.5	49.9	92.7	89.9	7.3	10.1
Textiles	41.1	38.5	43.3	48.0	84.4	86.5	15.6	13.5
Wearing Apparel	40.3	41.4	50.2	51.6	90.5	93.0	9.5	7.0
Wood & Cork	29.5	25.4	31.0	31.6	60.5	57.0	39.5	43.0
Furniture	47.9	43.7	50.5	54.4	98.4	98.1	1.6	1.9
Paper & Paper Products	48.4	44.3	51.0	55.2	99.4	99.5	0.6	0.5
Printing & Publishing	47.6	43.5	50.1	54.1	97.7	97.6	2.3	2.4
Leather & Leather Prod.	46.5	32.6	49.0	40.6	95.5	73.2	4.5	16.8
Rubber & Rubber Prod.	26.6	20.9	28.0	26.0	54.6	46.9	45.4	53.1
Chemical	47.5	41.6	50.0	51.8	97.5	93.4	2.5	6.6
Petroleum	39.6	39.4	60.3	60.4	100.0	99.8	0.0	0.2
Non Metal Products	39.5	37.2	41.6	46.4	81.1	83.6	18.9	16.4
Basic Metal	32.2	32.8	33.9	40.8	66.1	73.6	33.9	26.4
Metal Products	38.0	34.2	40.0	42.6	78.0	76.8	22.0	23.2
Machinery	41.7	39.5	43.9	49.2	85.6	88.7	14.4	11.3
Electric Machinery	44.7	40.2	47.0	50.1	91.7	90.3	8.3	9.7
Transport Equipment	44.4	40.1	46.8	50.0	91.2	90.1	8.8	9.9
Miscellaneous	34.0	19.6	35.8	24.4	69.8	44.0	30.2	56.0
Average	38.9	35.7	43.1	45.6	82.0	74.7	18.0	25.3

Source : JICA Team

2. Diseconomy of Heavy Industrial Concentration to Bangkok

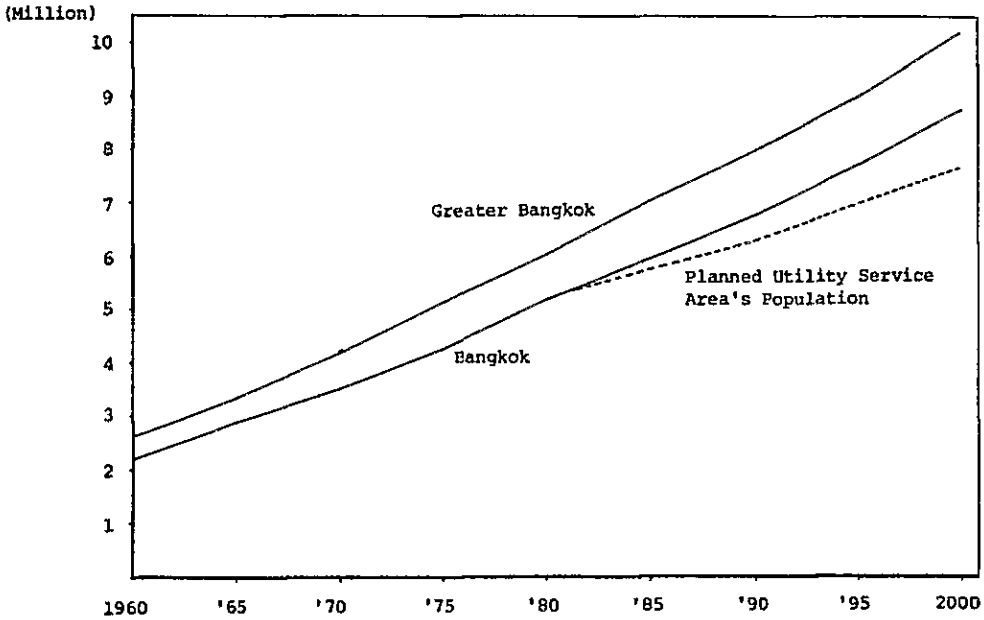
1-26 The concentration of industrial plants in Bangkok lured by the advantageous locational conditions began to give rise to chronic traffic jam and environmental pollution early in the 1960s, and as the years wore on into the 1970s, these problems became aggravated. Pressed for an early alleviation of these problems, the government came up with an industrial relocation measure under the Third NESDP that started in 1972. Under the succedding (and the current) NESDP that started in 1977, the government took a further positive stance on the question of industrial relocation out of BMA. However, the decentralization policy has just started coming out effective. As indicated in Table 1-7, the MOI identified about 300 factories as pollution sources in Bangkok and recognized that further efforts for pollution controls and industrial decentralization are required.

Table 1-7 FACTORIES EMITTING POLLUTION IN BANGKOK AND SAMUT SAKHON

Type of Industry	Bangkok	Samut Sakhon	Total
Textile	146	19	165
Paper	9	3	12
Chromium	116	-	116
Total	271	22	293

Source : Ministry of Industry

1-27 In the meantime, the population of BMA increased by 23.7% or about 833,000 people in 1970-75. According to the estimation by the Department of Town and Country Planning, the population of BMA will swell at this rate to 8,568,000 people by the year 2000, and that of the Greater Bangkok Area which includes Samut Prakan and Nontha Buri will top the 10,100,000 mark by the same year.



Source: Greater Bangkok Plan 2000
Dept. of Town and Country Planning MOINT

Fig. 1-6 POPULATION IN FIVE YEARS AD 1960-2000

1-28 A large amount of investments into utilities and infrastructure will be definitely necessary to accommodate the estimated populations. If it is not possible to make such investments, the currently recognized problems such as pollution and trafic congestion will be more worsened. In this sense as well, the control of population in Bangkok based upon industrial decentralization is indispensable.

D. Decentralization Policy and Role of Samut Sakhon Industrial Estate

1. Decentralization Policy

1-29 Alarmed by such a prospect, the DTCP worked out the following four-point measure summarized in Table 1-8 to curb the inflow of rural population into the MBA and alleviate the problems created by the excessive demographic concentration.

Table 1-8 DECENTRALIZATION PLAN BY TOWN AND COUNTRY PLANNING DEPARTMENT

Development of Secondary Cities	With a view to dispersing population among local areas, encouragements will be given for the development of local cities secondary in importance to Bangkok.	Candidate Cities: Chiang Mai, Lampang, Phitsanulok, Khon Kaen, Nakhon Ratchasima, Ubon Ratchathani, Udon Thani, Chon Buri, Phuket, Songkhla and Haad Yai
Construction of Satellite Cities	With a view to dispersing population from overpopulated Bangkok, the functions that have no compelling reasons to be performed in Bangkok will be moved to outlying cities and towns to attract population away from Bangkok.	Candidate Cities: Nonthaburi, Samut Prakan, Phra Pradaeng, Pathum Thani, Nakhon Pathom, Samut Sakhon, Chon Buri, Phatthaya and Laem Chabang.
Rural Development	With a view to curb the inflow of rural population to urban centers, public facilities and job opportunities in rural communities should be improved.	
Birth Control	The current rate of overall population growth will be curbed by reducing the birth rate from the current 2.5% to 1.5% by the year 2000.	

Note 1: The three cities of Nontha Buri, Samut Prakan and Phra Pradaeng are located within the limits of Greater Bangkok.

Note 2: Chon Buri is chosen also as a secondary city.

Source : Dept of Town and Country Planning

1-30 For accelerating industrial decentralization, IEAT is intending to develop the following three types of industrial estates.

i) Regional Industrial Estate (RIE)

By promoting industrial development in the South, North, Northeastern, and East Regions, this type of IE intends to create substantial job opportunities in the regions and to minimize income disparity between urban and rural areas. RIE mainly provides industrial land to the types of industries processing local natural resources.

ii) Satellite Zone Industrial Estate (SZIE)

Following the basic philosophy of Satellite city that the functions which have no strong reasons to be performed in Bangkok should be dispersed, this industrial estate accommodates the types of industries which are not necessarily located in Bangkok but in the outskirts not far from Bangkok. The candidate industries are those which need a large market in a short distance, skilled labours, information, high quality services.

iii) Urban Area Industrial Estate (UAIE)

This estate is for small and medium size factories which cannot be relocated from Bangkok because of their locational characteristics and financial abilities. The site of UAIE is planned to be comparatively small and to have efficient anti-pollution facilities.

1-31 Along with the implementation of these mesures, the following measures for promoting decentralization are being agreed among the government agencies concerned.

i) New industrial activities within Bangkok, in principle, will not be authorized.

ii) With respect to the industrial plants already sited and operating within Bangkok, vigorous measures will be taken to strengthen the control of pollution, extend guidance for the installation of pollution control equipment and, where necessary, levy surcharges, and in worst cases, order the suspension of operation.

iii) Construction of industrial estates in rural areas and outlying cities will be promoted to accommodate relocating plants as well as active new manufacturing factories.

iv) Tax and credit incentives will be extended to industrial plants newly siting or relocating in rural areas.

There are several evidences that reveal strong will of the government to implement the aforementioned measures. IEAT is taking a positive stance on the development of industrial estate in the surrounding area of Bangkok and rural areas. And under the Investment Promotion Act, the Board of Investment has been maintaining a selective attitude in favour of the factories locating in rural areas and authorizing only the industrial activities of urban-oriented types in Bangkok.

2. Industrial Estate Development Plan in Bangkok and Its Surrounding Area and Their Stage of Materialization

1-32 As discussed in 1-22, including the second stage development plan of the Lat Krabang Industrial Estate, IEAT expects to accomplish

14 industrial estates by 1985. Among then, the industrial estate in Bangkok and its surrounding Area counts nine, while that in rural area does five. Most of industrial estate in the Central Region is planned within the distance of 30 - 50 km from Bangkok and hence constitute satellites around Bangkok.

1-33 Among these, the industrial estates which will be developed solely by IEAT and be ready for appropriation by 1985 are the Lat Krabang I.E. and the Bang Poo I.E. In addition, the Nava Nakorn which is developed with private sector will be available for use. Other industrial estates such as Rungsit, Bang Bua Tong, and Pathum Thani are just on the stage to initiate feasibility studies and have little possibility to provide usable industrial land by 1985 if the past experience with development schedule is any guide. Accordingly they are the industrial estates to meet the demand in the period of 1985 - 90 or further later. As a result, shown in Table 1-9, approximately 5,000 Rai will become available by IEAT in 1980 - 85.

Table 1-9 PLANNED INDUSTRIAL ESTATE AND AVAILABLE LAND BY 1985

Unit : Rai

	Industrial Land	Amount Available 1982-1985
1. Lat Krabang	1st Phase 627 2nd Phase 300	300
2. Bang Poo	3,374	3,000
3. Nava Nakorn	756	300
4. Bang-Phli Bang Bo	396	396
5. Samut Sakhon	1,500	1,500
Total	6,953	5,496

Source : Estimated by JICA Team based on information from IEAT

3. Role of Samut Sakhon Industrial Estate

1-34 The Samut Sakhon Industrial Estate is one of the nine industrial estates planned within 30 - 50 km from Bangkok, and is classified as both RIE and SZIE. Accordingly, it is expected that the Samut Sakhon Industrial Estate contributes to promote the decentralization from Bangkok and to resolve the problems such as pollution and traffic congestions arising from the heavy industrial concentration in the city of Bangkok. This is the most important role of SIE.

1-35 The second task which the industrial estate has to address is to prevent the wanton destruction of environment in Samut Sakhon area that is taking place in the wake of the sprawl of industrial development. If the haphazard development of land now pushed by private companies is left uncontrolled, irreparable damage may be done to the environment in the near future. Therefore, the Samut Sakhon Industrial Estate is expected to play a crucial role to improve environmental conditions by utilizing anti-pollution facilities and by facilitating systematic land use in the area.

1-36 Third, Samut Sakhon is planned to be developed into a satellite city of Bangkok, the Samut Sakhon Industrial Estate is expected to play an important part in developing basic industries for the satellite city. Availability of adequate job opportunities and the prospect of a decent income are the conditions essential to an efficient execution of the satellite city development plan.

1-37 Fourth, it is expected to make due contribution to the economic development of Thailand. The fact that a great majority of manufacturers are still insisting on locating in or around Bangkok suggests that Bangkok and its surrounding area still offer higher locational potentialities despite of several urban problems. Given such conditions in Bangkok and its surrounding areas, a forced dispersion of industrial activities to rural areas would not only run counter to economic rationality but also could dampen the private enthusiasm for investment. Therefore, to strike a well-advised balance between the competing elements of the three tasks mentioned above and the national imperative of economic growth will be the basic role to be played by the Samut Sakhon Industrial Estate.

II. CURRENT SITUATION OF SAMUT SAKHON AREA

II. CURRENT SITUATION OF SAMUT SAKHON AREA

A. Administrative Division of the Changwat

2-01 Changwat Samut Sakhon has a littoral area of 839,867 km^2 and shares a boundary with the BMA. The Changwat is divided into three amphoes, that is, Muang Samut Sakhon (15 tambons, 107 villages total area: 480.126 km^2), Ban Phaeo (11 tambons, 89 villages total area: 239.098 km^2) and Krathum Baen (9 tambons 73 villages total area: 120.643 km^2)(see Fig. 2-1).

2-02 Furthermore, Samut Sakhon City, an area of 5.9 km^2, is located in Amphoe Muang Samut Sakhon, and township system has been adopted in Krathum Baen (Area 2.175 km^2). In addition to the administrative divisions, three sanitary districts, Om Noi (Tambon Om Noi: 7.6 km^2), Ban Phaeo (Tambon Ban Phaeo and a part of Luk Sam) and Luk Har (Tambon Yokrabut, Ron Kae, Nong Song Hong, Non Bue: 96.12 km^2) are present (see Annex 2-1).

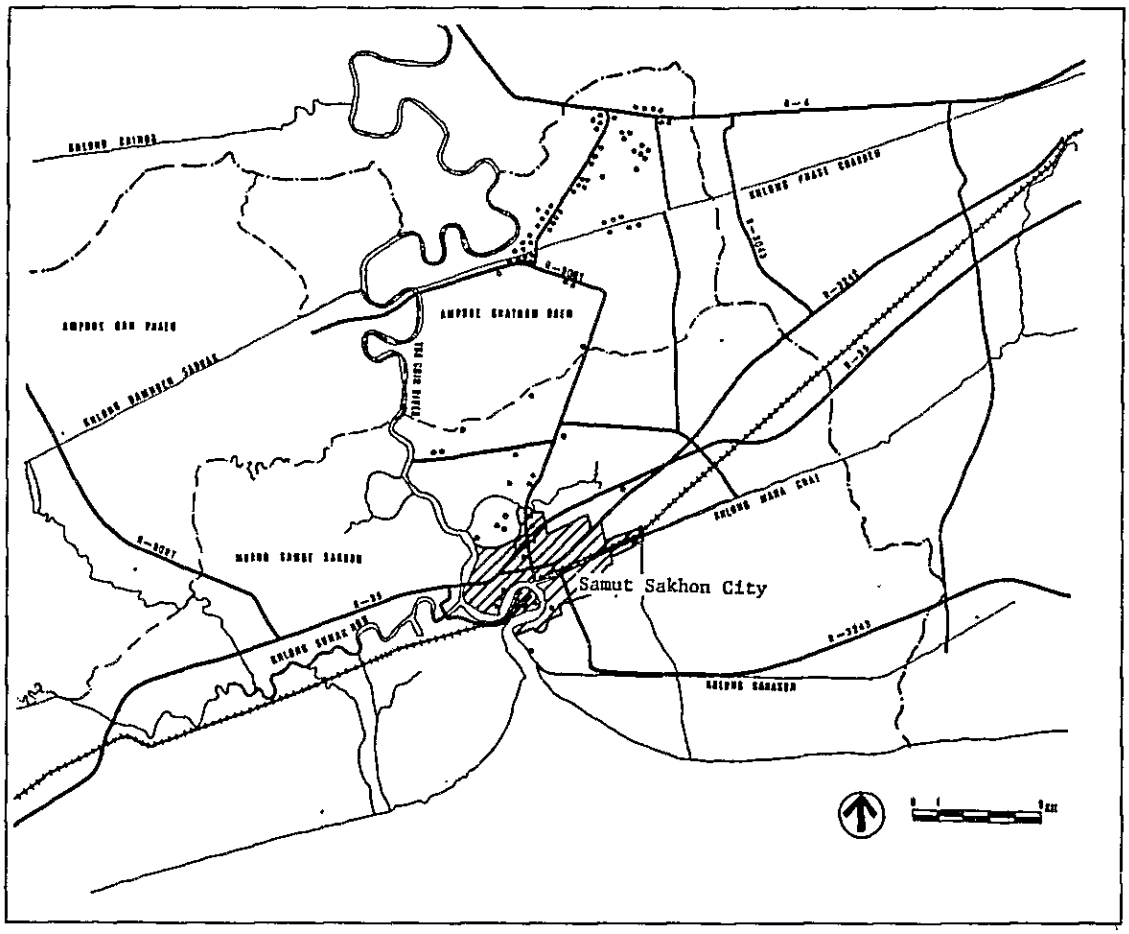


Fig. 2-1 ADMINISTRATIVE DIVISION OF CHANGWAT SAMUT SAKHON

B. Population

1. Population of Changwat Samut Sakhon

2-03 The total population of Changwat Samut Sakhon, as of 1979 is 258,633 persons (Annex 2-2). Compared with the population at the end of 1978, the population increased by 4,119 persons or 1.6% over the previous year. The population increase in the 1978 fiscal year is 4,316 persons (1.7%). Its breakdown is 4,231 persons of natural increase (birth - death) and 85 persons of social increase (inflow - outflow). Consequently, the population flowing into Changwat Samut Sakhon is slightly larger than population outflow. Population growth rate of the Changwat, however, is considerably lower than that of the adjacent BMA, which is increasing at a rate of 4.3% per annum.

Table 2-1 POPULATION OF CHANGWAT SAMUT SAKHON (DECEMBER, 1978)

Area	1978	1979	Increase over Previous Year	Growth Rate over Previous Year (%)
Amphoe Muang Samut Sakhon	79,315	79,257	Δ58	Δ0.1
Amphoe Ban Phaeo	45,275	47,512	2,237	4.9
Amphoe Krathum Baen	73,321	74,141	820	1.1
Samut Sakhon City	45,467	46,522	1,055	2.3
Krathum Baen Town	11,136	11,201	65	0.6
Total population of Changwat Samut Sakhon	254,514	258,633	4,119	1.6

Source : Samut Sakhon Provincial Government

Table 2-2 POPULATION CHANGES IN CHANGWAT SAMUT SAKHON (JANUARY - DECEMBER, 1978)

Increase Factor	Increase (Person)	Ratio to Total Population	Decrease Factor	Decrease (Person)	Ratio to Total Population
Birth	5,479	2.17%	Death	1,248	0.49%
Inflow	10,500	4.15%	Outflow	10,415	4.12%
Total	15,979	6.28%	Total	11,633	4.58%
Population increase (balance): 4,316			Population increasing rate: 1.7% per annum		

Source : Samut Sakhon Provincial Government

2. Population of Samut Sakhon City

2-04 The population of Samut Sakhon City is 46,380 persons as of 1980, with a population density in the city area of 78.6 persons/ha (12.6 persons/Rai). In addition, there seems to be a fishing fleet population of over 10,000 persons without resident registration, because of the fishing port of Samut Sakhon City (Paragraph 2-07).

Table 2-3 CHANGE OF POPULATION OF AMPHOE MUANG SAMUT SAKHON AND SAMUT SAKHON CITY

Year	Municipality Area		Rural Area	
	Population	Increasing Rate (%)	Population	Increasing Rate (%)
1967	34,815	3.26	65,290	1.99
8	35,951	2.05	66,587	2.00
9	36,672	2.62	67,921	1.98
70	37,634	4.15	69,264	2.02
1	39,197	2.00	70,661	2.10
2	39,982	1.87	72,142	1.61
3	40,729	2.69	73,705	1.73
4	41,823	1.75	74,170	1.72
5	42,553	2.75	76,151	2.07
6	43,724	2.75	75,648	Δ0.60

Source : Comprehensive Plan of Changwat Samut Sakhon : DTCP

C. Land Use

1. Land Use in Changwat Samut Sakhon

2-05 The total area of Changwat Samut Sakhon is 839,867 km^2 (525,000 Rai). Approximately 57% of total area of the Changwat is farmlands, and approximately 2/3 of farmlands are paddy fields. Two annual rice crops can be obtained in only 12% of the total paddy field area. The largest area of farmlands is in Amphoe Ban Phaeo. Characteristically there are many orchards in this Amphoe. The ratio of paddy fields is high in Amphoe Krathum Baen (Annex 2-3). Amphoe Muang Samut Sakhon is located in the zone where seawater and fresh water are mixed. Therefore, about one quarter of the total area of this Amphoe is wasteland covered with forests of Tiak and Lamut, and salt farms and shrimp farms of 20,000 Rai are spread over the area located along the coastline.

Table 2-4 AREA OF CHANGWAT SAMUT SAKHON CLASSIFIED BY LAND USE

Total Area 525,000 Rai (839.867 km^2)			Land Use Ratio (%)
Paddy field	1/	190,926 Rai	36.4
Coconut	2/	30,584 Rai	5.8
Fruit tree (excluding coconut)	2/	52,641 Rai	10.0
Vegetable	3/	25,995 Rai	5.0
Farmland total	4/	300,146 Rai	57.2
Aquacultural farm and salt farm	5/	20,000 Rai	3.8
Others	5/	204,854 Rai	39.0

Source : JICA Team

1/ Estimated from 1978/1979 rice field statistics.

2/ 1978/1979 fruit cultivation statistics

3/ Area of vegetable fields surveyed in 1977: Fiscal 1978-79 Changwat Samut Sakhon Agriculture Promotion Plan

4/ Paddy field + coconut + fruit tree + vegetable

5/ Fiscal 1978-79 Changwat Samut Sakhon Agriculture Promotion Plan

6/ Difference between total area and other unclassified items

2. Land Use in Samut Sakhon City

2-06 The current situations of land use in Samut Sakhon City are as shown in Fig. 2-2 and Table 3-4. According to the survey made by DTCP of MOINT, approximately 70% of the city area, excluding rivers and waterways, was occupied by farmlands, while residential area occupied 13.4% and commercial and industrial area occupied 2%, as of 1976.

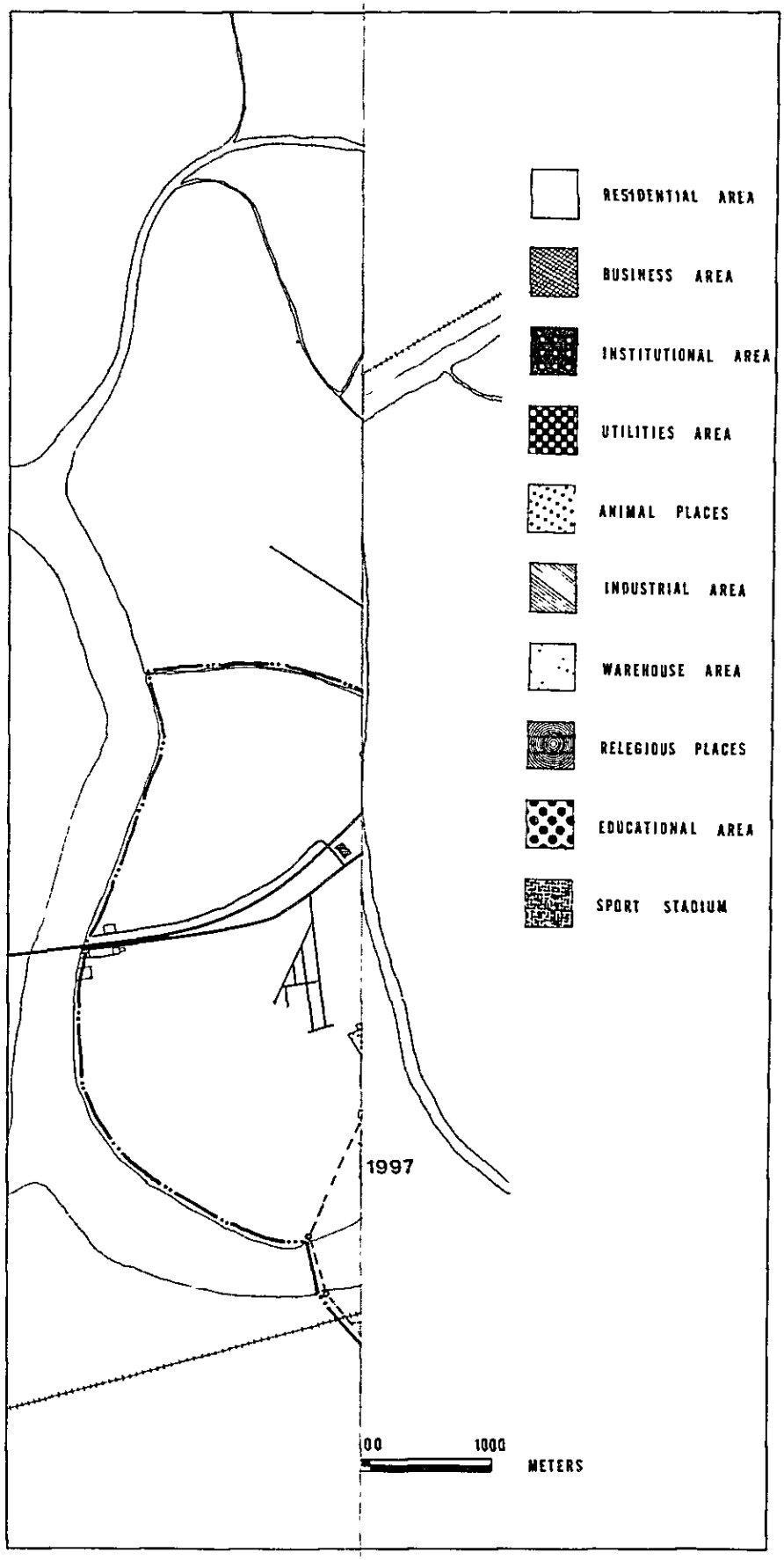

RESIDENTIAL AREA
BUSINESS AREA
INSTITUTIONAL AREA
UTILITIES AREA
ANIMAL PLACES
INDUSTRIAL AREA
WAREHOUSE AREA
RELEGIOUS PLACES
EDUCATIONAL AREA
SPORT STADIUM
1997
00
1000
METERS

Fig. 2-2 EX

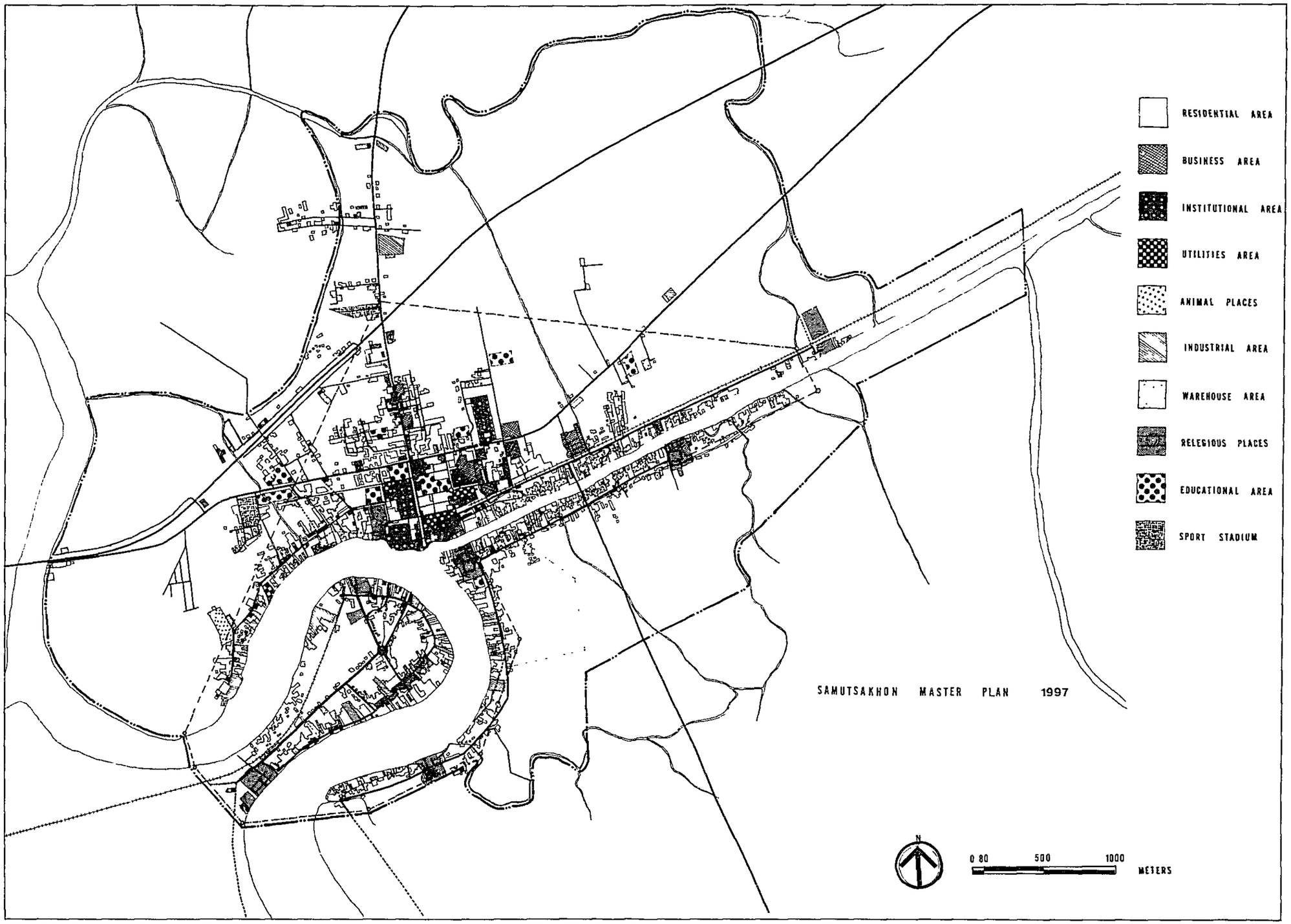


Fig. 2-2 EXISTING LAND USE OF SAMUT SAKHON CITY

D. Industries

1. Main Industries of Changwat Samut Sakhon

2-07 The most representative industry of Changwat Samut Sakhon is fishing. There are 832 registered fishing boats, and the number of fisheries household was 8,456 1/ as of the end of 1978. The share of fisheries sector in the gross products of the Changwat is as much as about 1/3 (33.1%). This can be compared with the shares of fisheries in both the gross regional and national products of the Central Region and of the whole Kingdom, at 3.6% and 2.5% respectively. The unloaded volume of fish catch in fiscal 1978 was 352,392 tons, which is of the first rank in Thailand. The majority (99.2%) of the fish products unloaded in Changwat Samut Sakhon are caught on high seas such as the central and west parts of the Gulf of Thailand and off-shore of Cambodia and Viet Nam. Those caught in the adjacent waters of Samut Sakhon amount to as little as 0.8%. Therefore, Samut Sakhon plays an important role as a regional fishing base. Accordingly, a large number of fishing boats belonging to other Changwats enter the port (2,000 boats per day on the average). The number of unregistered fishing boats staying in the ports of Amphoe Muang Samut Sakhon is about 600; the population of the fishing boat crews without local resident registration is as many as 15,000 (see Annex 2-4 to Annex 2-8).

Table 2-5 SHARE OF GDP AND GRP (%) - 1978

Industry	Samut Sakhon	Central	Thailand
Agriculture	48.8	31.5	27.1
(Fishery)	33.1	3.6	2.5
Manufacturing	8.9	29.8	21.3
Others	42.3	38.7	51.6

Source: NESDB

2-08 Shrimp culture and salt farming are along the coastline of Changwat Samut Sakhon, and paddy field areas are located in the central part of the Changwat. In the area between them, where sea-water and fresh water mix, mangrove, nipa and coconut plantation as well as hatcheries of duck and chicken exist. In general, farming is more prosperous in the inland area not affected by seawater, where there are many orchards, particularly in Amphoe Ban Phaeo. The share of agriculture and stock-farming, excluding fishery, is 15.7% of the gross product of the Changwat. The number of agricultural households in 1978 was 19,556 1/.

2-09 Secondary and tertiary industrial establishments numbered 574 as of 1980, with a total of 31,327 employees. In 1978, the total number of factories in the Changwat was 343. Consequently, the number of commercial and other establishments is about 250. The share of wholesale and retail business is 14.8% and the share of industry is 8.9% of the gross product of the Changwat.

1/ From Changwat Samut Sakhon Development Plan

2. Manufacturing Trade in Changwat Samut Sakhon

2-10 Until the mid 60's, the majority of manufacturing trade was fish meal processing, canning, fishing boat repair and so forth because Samut Sakhon has been developed as a base for fishing, the majority being medium and small scales. Beginning in the mid 60's, however, industrial development in the areas along R-4 and R-3091 took place, as shown in Fig. 2-1, due to the relatively cheap price of land and good accessibility of Samut Sakhon to BMA. At present, 58% of all the factories in the Changwat are concentrated in Amphoe Krathum Baen. (29% in Amphoe Muang Samut Sakhon; 13% in Amphoe Ban Phaeo)

Table 2-6 ENTRY OF FACTORIES (1970 - 79)

Year	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
No. of factories	30	19	70	26	31	35	46	33	30	14

Source : Industrial Office, Municipality of Samut Sakhon (Annex 2-9, 2-10)

2-11 As far as the working population and capitalization are concerned, the textile-clothing industry has an overwhelming share with over one half of the total. Ceramics industry comes next with a share of about 10% because of availability of raw material, and then steel, food and chemical follow. These constitute the important categories of industry in Samut Sakhon.

E. Natural Environment

1. Climate

2-12 The region has a typical monsoon climate. The Bangkok observatory data from 1931 to 1975 shows a monthly mean atmospheric temperature range between 25°C and 30°C with the highest temperature in April. Rainfall is concentrated between May and October, and the maximum monthly precipitation in September amounts to 400 mm. Annual precipitation is approximately 1,500 mm. The Meteorological Department has calculated precipitation per day and per hour by the Gumbel method based on the precipitation records from 1937 to 1965 (see Fig. 2-4 and 2-5). Particularly in summer from March and April, seasonal south-westerly winds, called "tapao winds" blow from sea to land, these winds tend to alleviate the heat. During November through January north-eastern winds, called "wao winds", being cool air from the Chinese continent (see Annex 2-12).

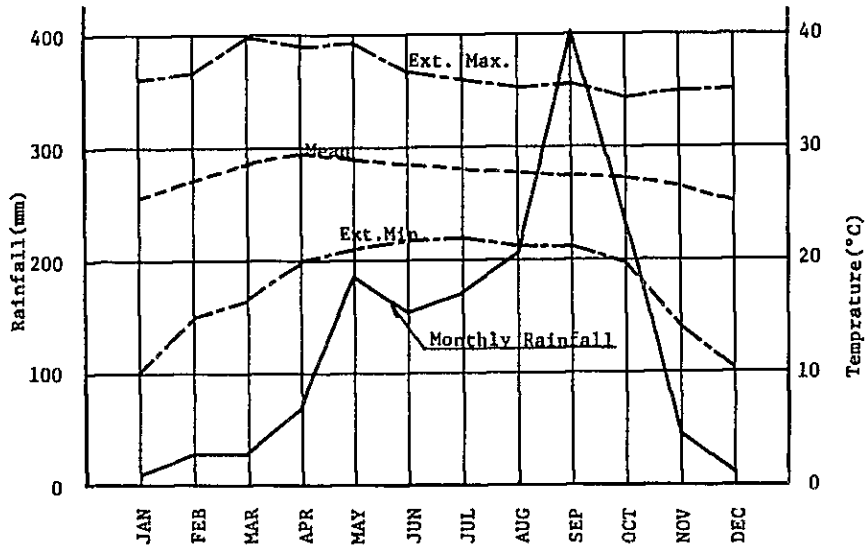


Fig. 2-3 MONTHLY RAINFALL AND TEMPERATURE (1951 - 1975)

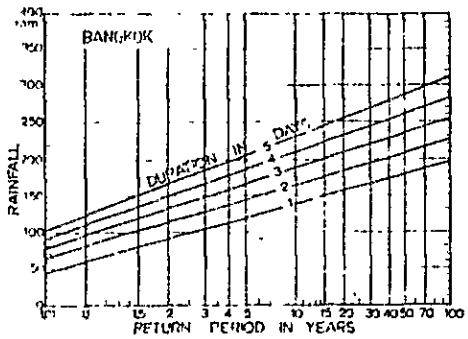


Fig. 2-4
RAINFALL INTENSITY IN DAYS

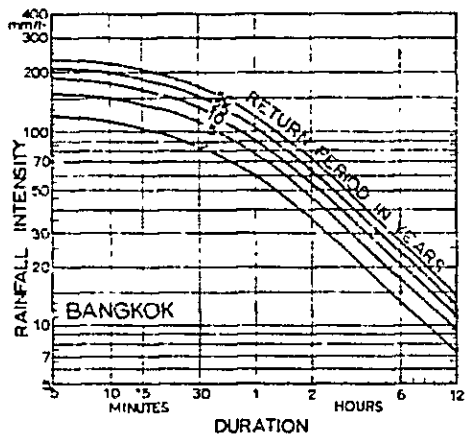


Fig. 2-5
RAINFALL INTENSITY IN HOURS

Source: Rainfall Intensity-Duration-Frequency Curves in Some Stations in Thailand

2. Topography

2-13 The Samut Sakhon region spreads over the mouth of Tha Chin River, a branch of Chao Phraya River, and is included in Chao Phraya Deltaic Plain. Therefore, it has extremely level topography ranging 1.0 m and 2.0 m above sea level. According to construction record R-35, the elevation of the land from the right bank of Chao Phraya to the left bank of Mae Klong averages 1.1 m. The highest and lowest levels of the sea recorded at the mouth of Tha Chin River have been + 1.66 m and - 0.32 m, respectively. The maximum flood level to date is 1.9 m above MSL, recorded in 1970. It seems that the whole area is submerged in the rainy season except for roads and railroads.

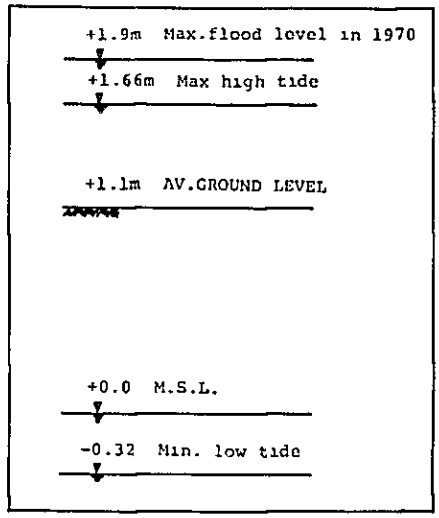


Fig. 2-6 GROUND LEVEL AND WATER LEVELS

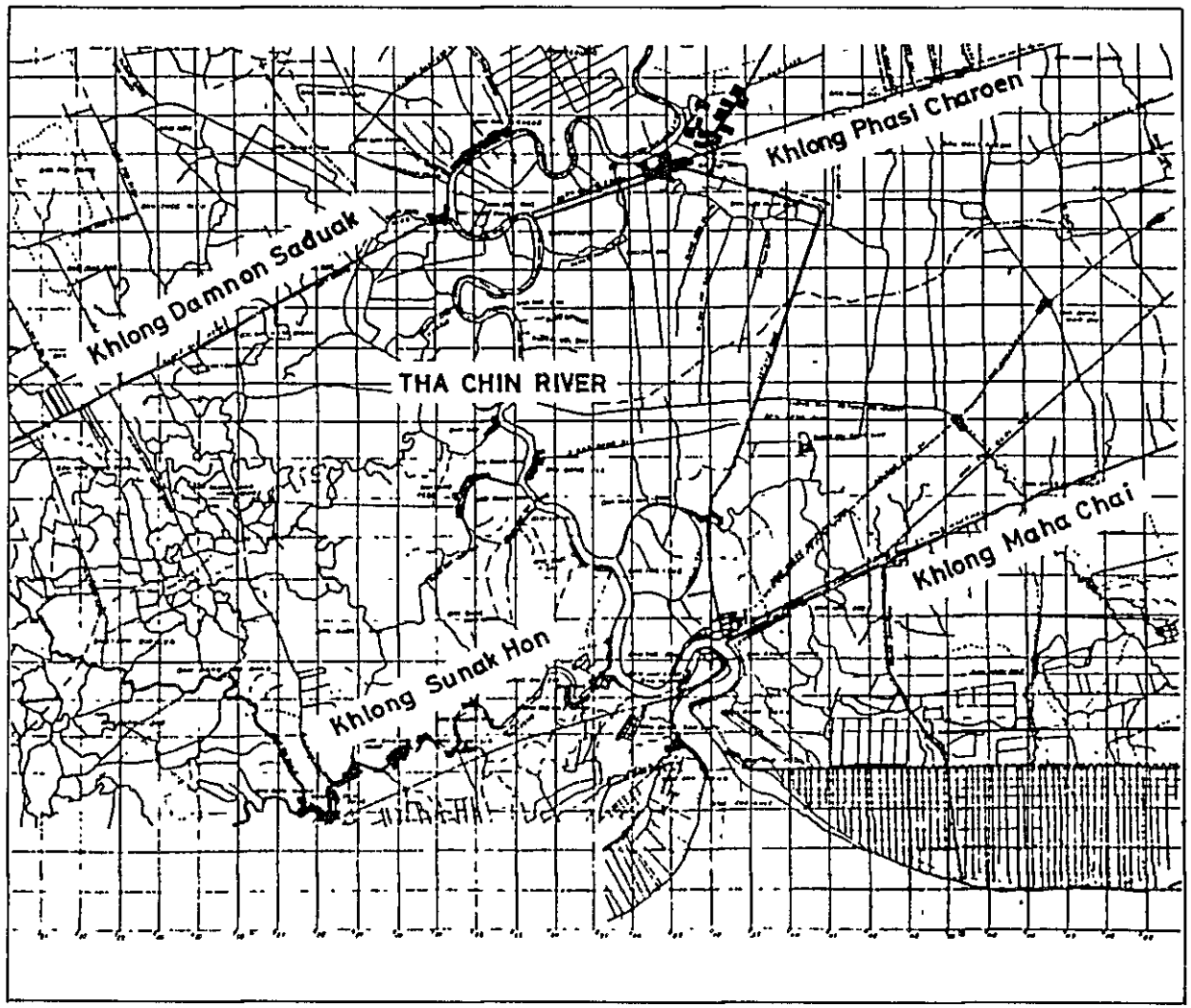
3. Tha Chin River

a. General situation

2-14 As shown in Fig. 2-7, the Tha Chin River issues from Changwat Chai Nat and flows through Changwat Suphan Buri, Changwat Nakhon Pathom, and Changwat Samut Sakhon to the Gulf of Thailand. A tidal river, its width is 200 m to 300 m. It contains salt in Changwat Samut Sakhon and so the use of the river for irrigation or other purposes is greatly limited. This is an untouched river with no bank protection work. Thus, when water rises at high tides, the lowlands, such as the mangrove forest area, becomes inundated and marsh-like, and the river width temporarily increases. According to MOI the discharge of Tha Chin River decreases to 3 m^3/sec in the dry season. The slope of the stream bed is mild and the incoming tidal waves move 50 to 60 km upriver from the mouth.

b. Hydrologic characteristics of Samut Sakhon region

2-15 The most rivers in Changwat Samut Sakhon (except the Khlong Damunoen Saduak, Khlong Phasi Charoen, and Khlongs with embankments), are tidal rivers and are influenced by tidal fluctuations. According to the data on tides obtained from Hydrologic Division of the Royal Thai Navy (Annex 2-13) the type of tides at the mouth of Tha Chin River is regarded as a mixture of diurnal and semidiurnal types. Also, the tide types are roughly classified into March - September and June - December type. There is time lag of 12 hours between March - September tide and June - December tide. In March and September the diurnal inequality of the tide is small, and the difference between the heights of the higher high tide and lower low tide is as small as 1.1 to 1.8 m. Between the high tide and low tide, there also is little difference, at about 1.2 to 1.7 m. On the other hand, in June and December the diurnal inequality of tide is



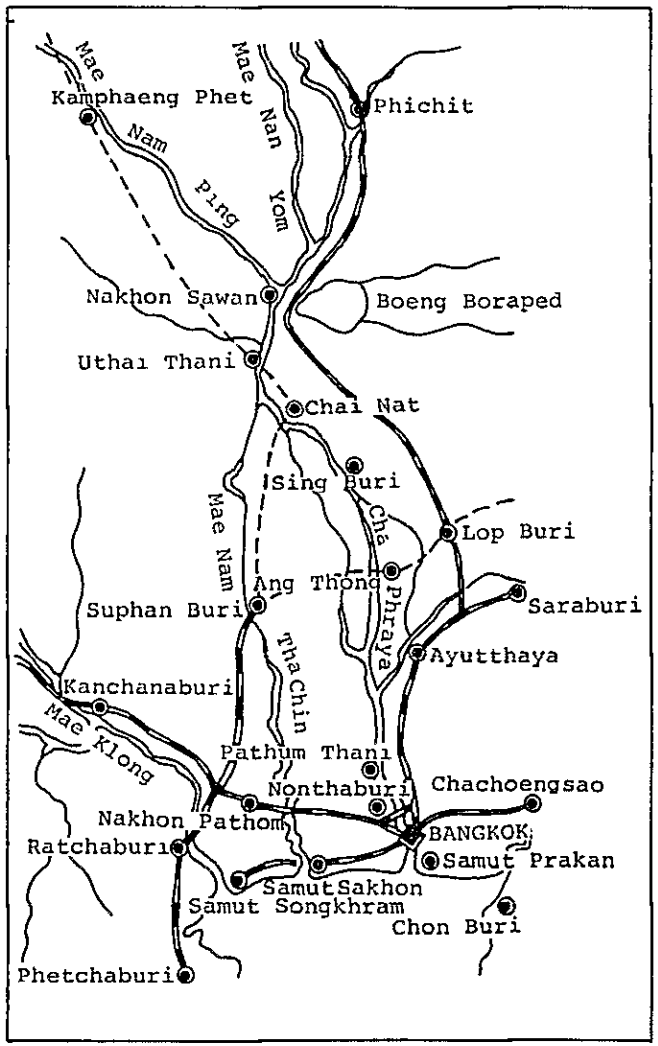


Fig. 2-7 A MAP OF RIVER NETWORK IN THE STUDY AREA

great and the difference between the heights of the higher high tide and lower low tide is 3.4 to 3.6 m, but that the height difference between the high tide and low tide can be as small as 0.3 m. Thus, the range of tides in June and December is relatively large compared to that in March and September.

2-16 Characteristics of the tides mentioned above affect the tidal rivers and canals in Changwat Samut Sakhon and their feeding streams. When the Study Team explored Tha Chin River and other main rivers and canals on February 19, 20, and 21 they observed that the heights of all streams fluctuated, and the streams reversed their direction, during high and low tides. Data for the tides at the mouth of Tha Chin River at that time are given in Annex 2-13 on the basis of the tide table published by Hydrologic Division of the Royal Thai Navy. In this figure, the tide type on the day of the investigation is the same as during March.

c. Quality of water of Tha Chin River

2-17 The number of industrial plants and houses are increasing rapidly. The increasing waste water load on the rivers and canals has increased water pollution and the situation has reached the stage necessitating the investigation of the ability of Tha Chin River to accept pollutants. The Ministry of Public Health investigated the quality of water in the Tha Chin River over a three-year period from 1977 to 1979. The main results are given in Annex 2-14. The quality of water has been described for individual stations up to Nakhon Chaisi (St. 4) which is located 83 km upriver from the mouth.

2-18 1) Water temperature

It was 27.5°C in Samut Sakhon and 28°C in Nakhon Chaisi in February. In June, it ranged between 31°C and 32.5°C. The lowest record was obtained in Samphran. In August, it ranged between 28.5°C and 29.5°C. Nakhon Chaisi showed the lowest temperature. In November, it ranged between 28°C and 29°C. In Samphran it was highest. Of the above four months, June has the highest water temperature. The temperature fluctuation during the course of a year is larger as the observation spot is closer to the mouth of the river.

2-19 2) pH

In February, pH is about 7. In June, it ranges from 6.5 to 7.5. In August, 6.5 to 7.5. In November, 6.5 to 8.5. pH 8.5 is the result of the influence of the sea water.

2-20 3) Dissolved Oxygen (DO)

In February, the value ranged between 1.0 mg/l and 1.7 mg/l. At St. 2 and St. 3 the value was as low as 1.0 mg/l. In June, it ranged between 0.5 mg/l and 2.0 mg/l, with St. 2 showing a low value of 0.5 mg/l. In August, between 0.8 mg/l and 2.8 mg/l. The lowest value was 0.8 mg/l at St. 2. In November, between 0.3 mg/l and 2.5 mg/l. The lowest was 0.3 mg/l at St. 3. According to the above data there are many cases where St. 2 in Krathum Baen district shows the lowest value, but in November St. 3 in Samphran district had the lowest DO count.

2-21 4) Suspended solids (SS)

In February SS concentration ranges widely from 20 mg/l to 760 mg/l, decreasing further upstream. In June, it ranges between 30 mg/l and 170 mg/l, slightly smaller than February. In August, it ranges from 30 mg/l to 430 mg/l. In November, the range is from 14 mg/l to 120 mg/l. The concentration of SS suddenly rises at the station which is close to the mouth of the river, but reason for this has not yet been determined.

2-22 5) Chloride

The results of the Study Team's four surveys indicated the chloride concentration had a similar situation as that of SS. At St. 1 (Samut Sakhon) the concentration ranged from 3,000 mg/l to 7,000 mg/l and above St. 2 (Krathum Baen) it was 100 mg/l. This decreasing tendency was observed only for the surface water of the stream.

2-23 6) Alkalinity

Data have been obtained for only February. At St. 1 (Samut Sakhon) it was 120 mg/l and above St. 2 it was less than 100 mg/l. Effects of sea water are considered to be found here.

2-24 7) Total Nitrogen (TN)

Total nitrogen ranged from 0.7 mg/l to 1.3 mg/l in February with the largest range found at the mouth of the river.

2-25 8) Phosphate (PO_4-P)

0.05 mg/l - 0.1 mg/l in February
0.02 mg/l - 0.34 mg/l in June
0.02 mg/l - 0.14 mg/l in August
0.015 mg/l - 0.35 mg/l in November

2-26 9) Biochemical Oxygen Demand (BOD)

1.0 mg/l - 2.2 mg/l in February
1.2 mg/l - 2.1 mg/l in June
1.0 mg/l - 1.6 mg/l in August
1.0 mg/l - 1.6 mg/l in November

St. 2 in Krathum Baen district showed rather high values constantly in all four surveys.

2-27 10) Coliform bacteria

400 MPN/ml - 8,600 MPN/ml in February
3,500 MPN/ml - 9,200 MPN/ml in June
1,000 MPN/ml - 10,300 MPN/ml in August
1,200 MPN/ml - 8,600 MPN/ml in November

Coliform bacteria do not multiply in rivers and sea water but rather decreases with the passing of time. The speed of such decrease becomes greater in sea water. Water around Samphran where St. 3 is located consistently indicated high values in all four surveys. It is supposed that a large amount of animal excreta occurs in the river in and around Samphran.

2-28 Annex 2-14 shows observation data for DO and BOD obtained from 1977 to 1979, at low and high tides. The figure for low tides at St. 1 shows a similar trend in the three years, that is, DO decreases to lower than 1.0 mg/l in March through July and BOD shows a tendency to increase in October through March. These changes become small the

further upstream the station is, while DO shows an increasing trend. The minimum concentrations of DO at the egg-laying time of trout and in the period when they live in water are shown in Table 2-7, based on the report from The National Environment Board of Thailand (NEB).

Table 2-7 RECOMMENDED MINIMAL ACCEPTABLE AND CONCEPTABLE CONCENTRATIONS OF DISSOLVED OXYGEN IN FRESH WATER, AFTER ENVIRONMENTAL PROTECTION (1973)

Temperature	Oxygen Levels for Complete Saturation	Minimal Levels for Protection of Trout Spawning		Minimal Levels for Protection of Aquatic Life	
°C	ppm	ppm	Saturation %	ppm	Saturation %
36.0	7	6.4	91.4	5.8	82.9
27.5	8	7.1	88.8	5.8	72.5
21.0	9	7.7	85.6	6.2	68.9
16.0	10	8.2	82.0	6.5	65.0
7.7	12	8.9	74.2	6.8	56.7
1.5	14	9.3	66.4	6.8	48.6

2-29 11) Heavy metals, DDT and PCB

Results of the survey carried out by NEB on the quality of water and river beds of four main rivers and the upper Gulf are given in Annex 2-15 page 3. Page 1-2 shows the data on heavy metals found at the mouth of Tha Chin River. It indicates that Cd, Cr, Pb, Zn, and Hg are found both in water and in the sediment and the concentration of Hg in the sediment is especially high. In fact, the concentration has been decreasing in recent years, from 23,400 μg/kg in 1974 to 1,090 μg/kg in 1977. Annex 2-14 shows the distribution of water quality in Tha Chin River, as surveyed during the year of 1978.

d. Tha Chin River, and industrial wastewater

2-30 1) Dissolved oxygen in Tha Chin Rivers

The Technical Section of Industrial Environment Technology Department, Tha Chin River Project of the Tha Chin River Conservation Committee, issued a report on D.O., which listed the average DO values from December, 1978 to May, 1979. In the list there is an obvious correlation between DO values and particular months. To cite one example, in December the value was somewhere between 1.5 - 2.5 mg/l. In January, it fell to 1.0 mg/l and in February there was a further decrease to 0.5 mg/l. At the end of March, it rose to 1.5 mg/l and during April and May, it again decreased to 0.5 mg/l (refer to Annex 2-16). From January to May, 1979, it was reported that the average DO values were 3.6 mg/l at Amphoe Bangplama and 0.8 mg/l at Amphoe Sampran. It is recovered to 2.7 mg/l at Amphoe Krathum Baem. From the above data, we can assume that there must be some condition causing the decline of the DO value in Sampran (see Annex 2-17).

2-31 2) BOD load to Tha Chin River caused by industrial wastewater

Annex 2-18 shows the BOD load in the prefectures of Suphan Buri, Nakhon Pathom and Samut Sakhon. It is noted that three kinds of BOD load values are described therein. From this, it can be seen that the present BOD load of waters flowing into the Tha Chin River originates in three prefectures, totalling 17,362 kg/day, which is equal to the BOD supplied by 2,250,000 people. When this water is treated so as to comply with the Water Treatment Standard of the MOI (BOD 20-60 ppm), the total charge from the three prefectures shall be 5,811 kg/day, reduced to one-third of the existing loads in all three provinces. This volume corresponds to a population of 755,000. Accordingly, it is expected that a reduction in BOD equal to the load from a population of 1,500,000 shall occur, indicating a BOD load almost ten times to the population of Changwat Samut Sakhon. Looking into the situation of Changwat Samut Sakhon, the BOD load of industrial wastewater discharged into Tha Chin River will be equal to a population of 450,000. However, when the water is treated to comply with MOI standards, the BOD load shall be reduced to approximately one quarter of the existing load, which will result in a reduction of quantity equivalent to a population of 340,000. Summarizing, the BOD value in the Tha Chin River, as a result of the inflow of industrial wastewater, has been deteriorated, and it is therefore imperative that the BOD limit of industrial wastewater be strictly observed, in order to restore the water quality of the Tha Chin River to acceptable levels.

2-32 3) Masterplan of Tha Chin River Project

Fig. 2-8 illustrates the plan and time schedule, starting in 1979 and ending in 1981. According to this masterplan, industrial and plant wastewater is to be examined, as well as its relationship to environment conditions of the Tha Chin River. By commencing from the district of Amphoe Sampram, continuing to Changwat Suphan Buri and then Changwat Samut Sakhon, treatment facilities of wastewaters are to be gradually completed in an orderly manner. The overall plan is designed to complete each phase of the project by the end of each corresponding fiscal year, and therefore it is anticipated that the quality of the water shall be improved within a few years.

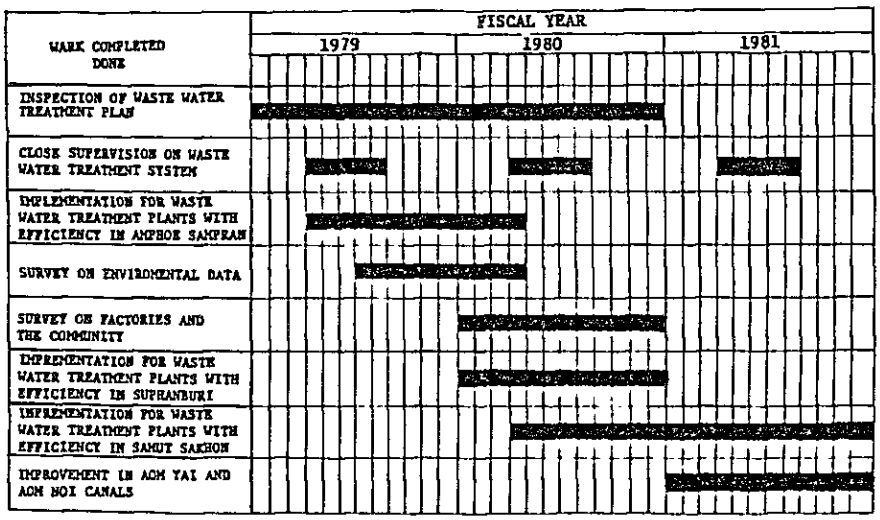


Fig. 2-8 MASTERPLAN OF THE THA CHIN PROJECT

4. Major Rivers and Canals

2-33 i) Khlong Damunoen Saduak

This is located in the north part of Changwat Samut Sakhon and is one of the canals crossed and divided by Tha Chin River. It forms the west side portion of the canal, reaching to Mae Klong River with an overall length of 35 km and width of 40 to 50 meters. At both extremities of Tha Chin and Mae Klong Rivers water gates are installed, to protect against salt water intrusion; the canal itself is used for transportation and agricultural irrigation. Amphoe Ban Phaeo, one of the water markets frequented by many small and medium size boats, is located in this area.

2-34 ii) Khlong Phasi Charoen

This is located in the north part of Changwat Samut Sakhon and forms the east side portion of the canal described in paragraph 2-33. It extends as far as the Chao Phraya River, with an overall length of 27 km and width of 30 to 40 meters. At both extremities of this canal, water gates are installed, to protect against salt water intrusion, the canal itself is used for transportation and agricultural irrigation. This canal extends to adjoining areas and to the capital. Along it are many factories and densely populated areas; the canal is used by many small and medium size vessels.

2-35 iii) Khlong Sunak Hon

This is located to the west of Samut Sakhon city, and links the Tha Chin and Mae Klong rivers. The overall length is 30 km and width 80 to 100 meters. This is a natural tidal-water river, allowing backflow of the sea water through the two rivers. This river is not protected by manmade works against a rise in the water level or flooding and the elevation of land in the area is relatively low. On frequent occasions, the river overflows, inundating wide areas. This river is important to residents, but because of its undeveloped condition, boats seldom frequent this area.

2-36 iv) Khlong Maha Chai

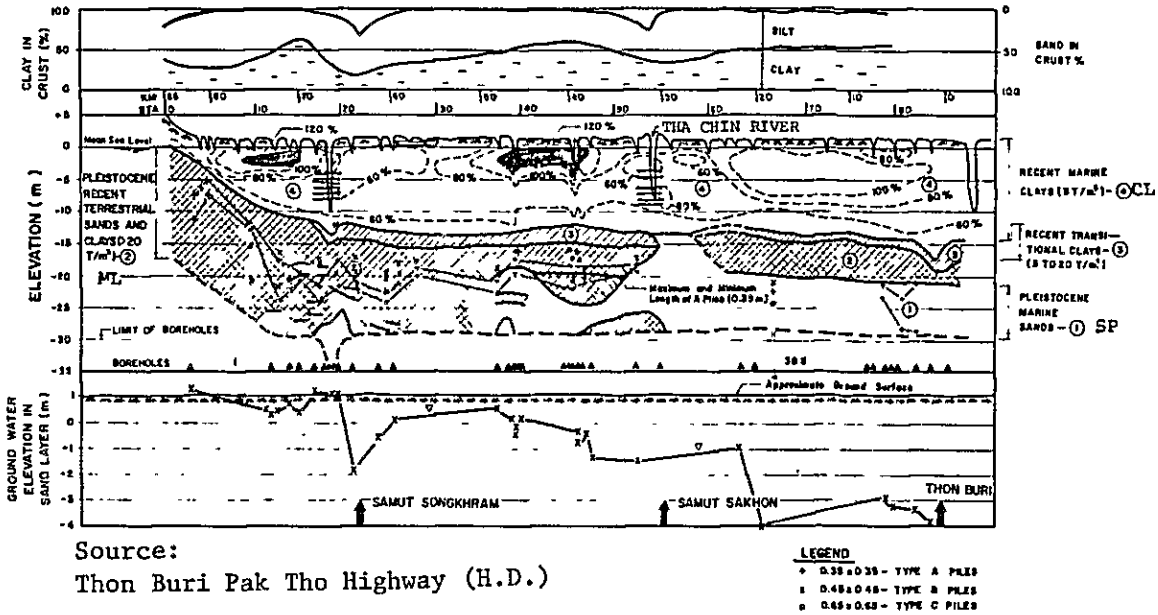
This is a canal linking Tha Chin River with Bang Khun Thian, a suburb of Bangkok, it has an overall length of 30 km and a width of 50 to 100 meters, crossing through the center of Samut Sakhon city. At the junction of this canal with Tha Chin River, a fisherman's wharf as well as a fish market are located. Also, large ocean-going fishing boats, trawlers, barges loaded with heavy cargo and many small and medium size ships often use this canal, which is said to be one of the most busy and important canals. In the eastern suburb of Samut Sakhon there are Nippa forest, salt fields, shrimp breeders and set net fishing is more popular than other areas.

2-37 v) Khlong Sahakon

From the mouth of Tha Chin River, this canal extends to the eastern section, up to as far as Chao Phraya River, and has an overall length of 27 km and width of 10 to 20 meters. Land along this canal is occupied mostly by salt fields, shrimp breeders, fishermen, the team noted that set net fishing is practised at about every 300 meters. . The main use of this canal is for fishing and transportation.
This canal is parallel the sea shore at a distance of 3.0 km, with many canals and trenches connecting to the sea and therefore salt water is quite evident, to a greater extent than in other canals.

5. Soils

2-38 As shown in Fig. 2-9, the soil strata is of 4 types: an alluvial clay layer with a lens-shaped intermediate layers of sand (0 to -12 m); a transitional clay layer (-12 m to - 15 m); a layer of diluvial silty clay (-15 m to -20 m); and a layer of diluvial marine sand (-20 m to -30 m). Each layer is classified into CL, ML and SP; their characteristics as materials for banking and road subgrades are shown in Annex 2-19. While the surface soil is not suitable for road subgrades, it can be used for embankments. At present, the surface soil is already being taken from Samut Sakhon for use in the reclamation of housing land in Bangkok.



Source:
Thon Buri Pak Tho Highway (H.D.)

Fig. 2-9 SOIL PROFILE ALONG R-35

2-39 According to standard penetration tests carried out during the R-35 road construction (the Thon Buri-Pak Tho Highway), the alluvial clay surface layer has a negligible N-value and is prone to severe settlement. As a foundation base, considering the degree of consolidation, the soil is very poor. According to our survey, most factories around Bangkok, including those in Samut Sakhon, have pile foundations. Around Samut Sakhon the piles extend to the diluvial clay layer at around -20 m.

2-40 According to records of the construction of the Samut Sakhon - Samut Songkhram power-transmission lines, the groundwater level is at 0 m to -0.5 m, dropping along both sides of the Tha Chin River to -1.0 m.

2-41 Topsoil can be characterized into Tha Chin soil (coastal deposits) which has a high salt content, and Bangkok soil (river deposits) which has a relatively low salt content. Tha Chin soil areas are covered with bush (mangroves etc.), while Bangkok soil areas are mainly under paddy cultivation.

6. Flora

2-42 In those areas which are not affected by salt in the soil, rice, grapes, tangerines, leafy vegetables, cucumbers, egg-plants, tomatoes, beans, onions, hed fang and fruit such as pudsa pomelo are planted. In those areas affected by salt, or in the rivers and canals which contain sea water, we can observe many plants such as coconut, jark, karaboon, prong, kong kang, samae, faek and so forth. Over recent years, the jark fields have been gradually converted to a coconut plantings and have decreased in area year by year (See Fig. 2-10).

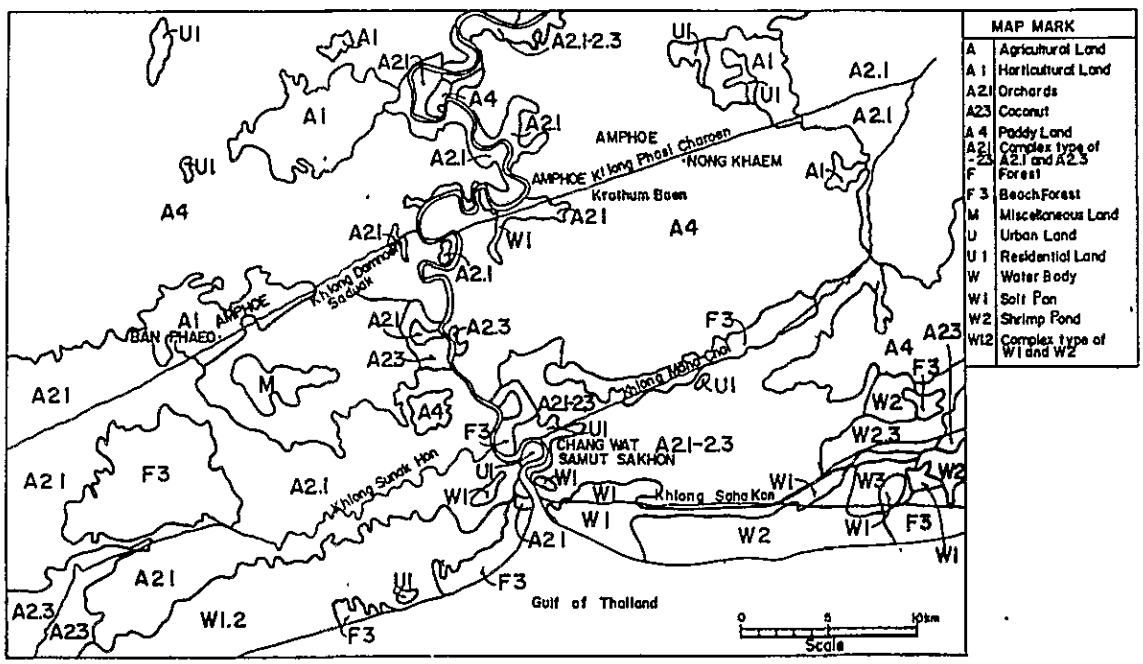


Fig. 2-10 LAND CLASSIFICATION