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FINAL REPORT
THE STUDY ON THE DEVELOPMENT PROJECT OF THE INDUSTRIAL PORT ON THE EASTERN SEABOARD IN THE KINGDOM OF THAILAND

NOVEMBER 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

FINAL REPORT
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PREFACE

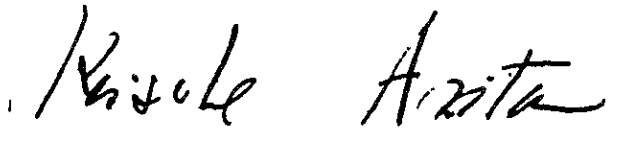
In response to the request of the Royal Thai Government, the Government of Japan decided to conduct a feasibility study on the Project to Develop an Industrial Port on the Eastern Seaboard in Thailand and entrusted the study to the Japan International Cooperation Agency (JICA).

The JICA despatched to Thailand a study team headed by Mr. Kazuo NISHIMURA, Senior Adviser of the Overseas Coastal Area Development Institute of Japan (OCDI). The team made several visits to Thailand in the period from July 1982 to September 1983, conducted a field survey in Map Ta Phut, Bamnet Narong, Prachub Khirikhan etc. and exchanged views with the officials concerned of the relevant organizations. After the team returned to Japan, further studies were made and the present report has been prepared.

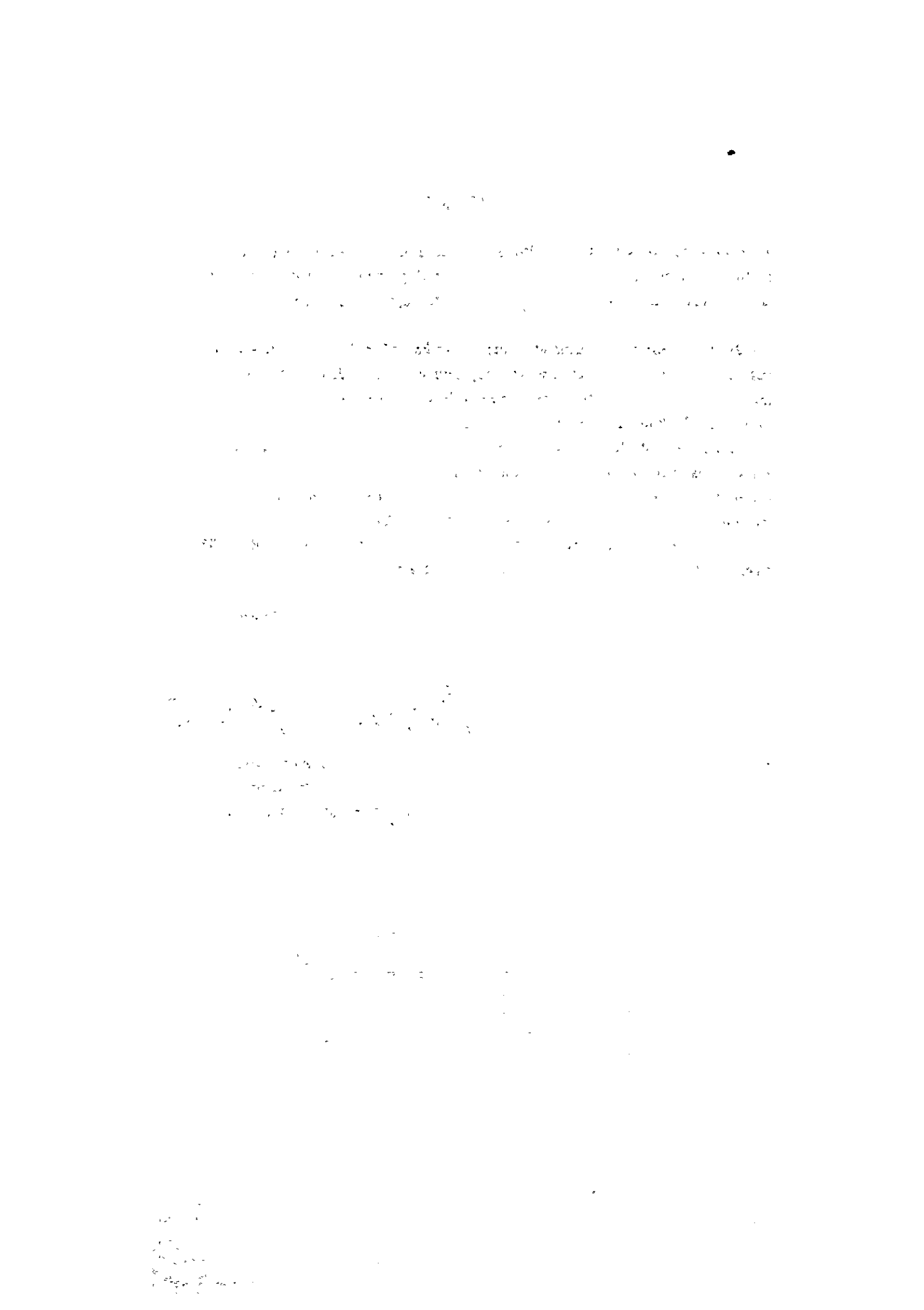
I hope this report will serve for the development of the Eastern Seaboard area and contribute to accelerate industrialization process of the Kingdom of Thailand.

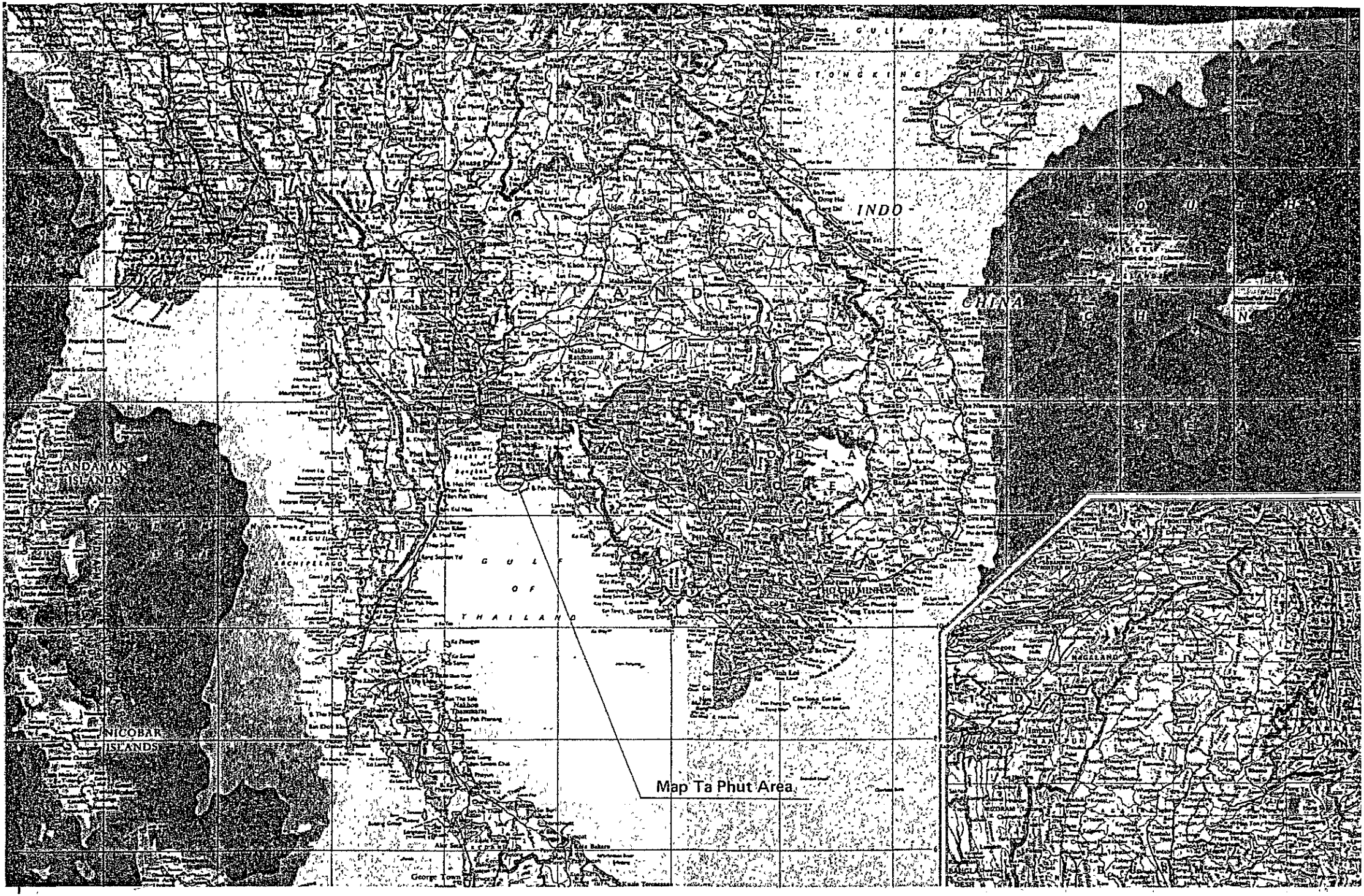
I wish to express my deep appreciation to the officials concerned of the Royal Thai Government for the close cooperation they extended to the team.

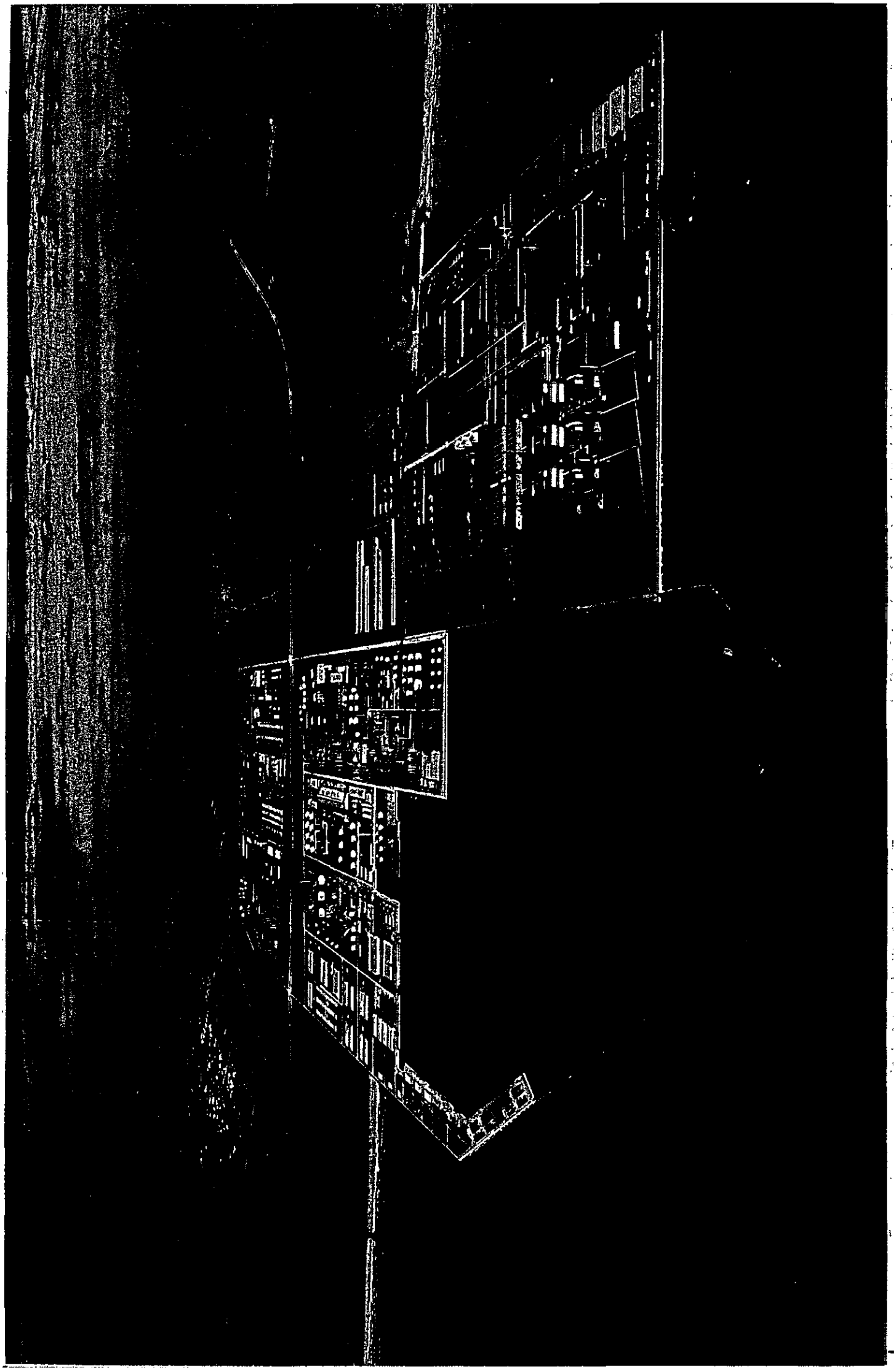
November 1983

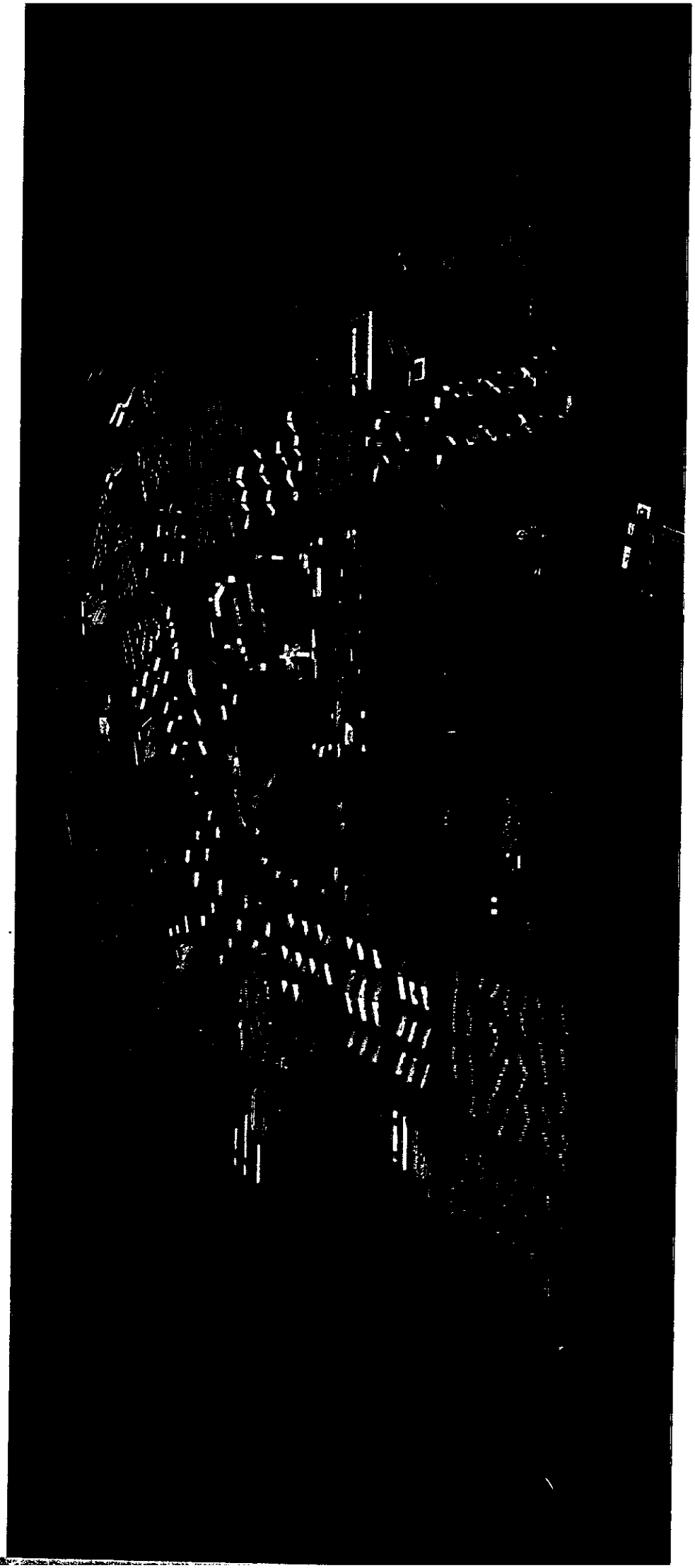


Keisuke Arita
President
Japan International Cooperation Agency




Map Ta Phut Area





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PART II SHORT TERM DEVELOPMENT PLAN

Foreign Exchange Rate is fixed as follows;

1 US$ = 23 Baht

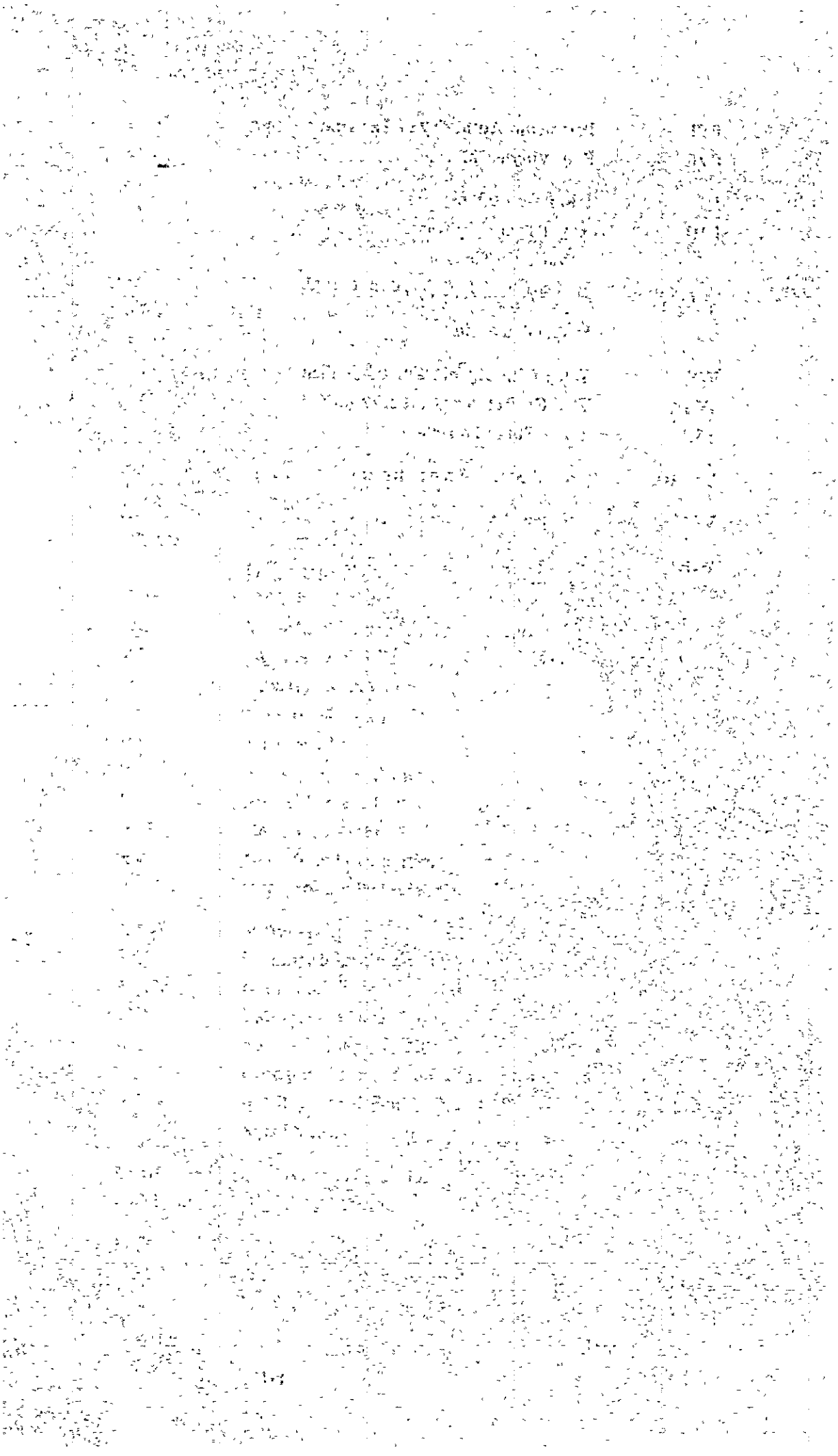
1 Baht = 10.4 Yen

ABBREVIATION

AIT	Asian Institute of Technology
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
B/C Ration	Benefit/Cost Ratio
BOD	Biochemical Oxygen Demand
CAT	Communication Authority of Thailand
CDL	Chart Datum Line
CFC	Conversion Factory for Consumption
CFM	Conversion Factor of Machinery
CIF	Cost, Insurance and Freight
CIPO	Center for Integrated Plan of Operation
DAP	Di-Ammonium Phosphate
DCF	Discounted Cash Flow
DL	Datum Line
DLT	Department of Land Transportation
DOH	Department of Highway
DWT	Dead Weight Tonnage
EG	Ethylen Glycol
EGAT	Electricity Generating Authority of Thailand
EO	Ethylen Oxide
ES	Eastern Seaboard
ESS	Eastern Seaboard Study
ETO	Express Transportation Organization of Thailand
FOB	Free on Board
FRR	Financial Rate of Return
F/S	Feasibility Study
GDP	Gross Domestic Production
GPP	Gross Provincial Production
HDPE	High Density Polyethylene
H.H.W.	Highest High Water
H.W.L.	High Water Level
IEAT	Industrial Estate Authority of Thailand
IFC	International Finance Corporation
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency

LDPE	Low Density Polyethylene
LLW	Lowest Low Water
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LWL	Low Water Level
MAP	Mono-Ammonium Phosphate
MBK	Mah and Boonkrong Co.
MCM	Million Cubic Meter
MEA	Metropolitan Electricity Authority
MEG	Mono-Ethylen Glycol
M.H.H.W.	Mean Higher High Water
MIE	Map Ta Phut Industrial Estate
M.L.L.W	Mean Lower Low Water
MMSCFD	Million Standard Cubic Feet per Day
MOAC	Ministry of Agriculture & Cooperatives
MOC	Ministry of Communication
MOE	Ministry of Education
MOF	Marketing, Organization of Farmers
MOI	Ministry of Interior
MOI	Ministry of Industry
MOP	Muriate of Potash
MSL	Mean Sea Level
MTA	Metric Ton per Annum
MTD	Metric Ton per Day
MTL	Mean Tide Level
MTS	Main Telephone Station
MWWA	Metropolitan Water Works Authority
NEB	National Environmental Board
NEC	National Education Commission
NESDB	National Economic and Social Development Board
NFC	National Fertilizer Corporation
NHA	National Housing Authority
NPK	Nitrogen, Phosphate, Potash (NPK Compound Fertilizer)
NRT	Net Registered Tonnage
NSE	New State Enterprise
OCDI	The Overseas Coastal Development Institute of Japan
O-D Data	Origine and Distination Data
PAT	Port Authority of Thailand
PEA	Provincial Electricity Authority
PP	Pro Palypylene

PTT	Petroleum Authority of Thailand
PVC	Poly Vinyle Chloride
Rai	1 Rai = 1,600 m^2
RID	Royal Thai Irrigation Department
RTG	Royal Thai Government
SRT	State Railway of Thailand
SS	Suspended Solid
TOT	Telephone Organization of Thailand
TORC	Thai Oil Refinery Corporation
TSP	Triple Super Phosphate
USAID	United States Agency for International Development
VCM	Vinyle Chloride Monomer
WHO	World Health Organization



CONCLUSION AND RECOMMENDATION

Conclusion

The implementation of the Fifth Five-Year National Economic and Social Development Plan in Thailand began in October 1981. The development of the Eastern Seaboard is one of its main strategies. The plan includes the establishment of industries utilizing natural gas resorces, aiming to accelerate the region's urban-industrial development as part of its long-term objective of deconcentrating the growth of the Bangkok Metropolitan region. The plan emphasizes the development of energy-related and other gas bases heavy industries, with provision for the improvement of the infrastructures, especially port facilities.

The target years for the Master and the Short Term Plans of this industrial port project are the years 2000 and 1987. Three major industries, i.e. petrochemical, fertilizer, and soda ash, as well as various supporting industries are selected for the Short Term Plan and these three major industries, with doubled capacity, plus an iron and steel complex and downstream industries are assumed in the Master Plan.

Based on the geological conditions, the gas pipeline alignment and land use restrictions, the port site was selected to be between Saket island and the gas pipeline. Among the three alternative for the port's layout, an excavated type, with almost all berths near the shoreline, was selected. The amount of cargo handled in this port is assumed to be 23 million tons annually in the Master Plan and 4 million tons in the Short Term Plan. The total length of required berths for each plan is 5,750 m and 1,750 m respectively.

An area to the northwest of the industrial estate, between Ban Chang and Map Ta Phut, was selected as the new urban area for the workers at the industrial complex.

Considering the allotment of population to the existing towns, the population in the new urban area is estimated at 71,500 for the Master Plan and 18,300 for the Short Term Plan, which respectively require 575 ha and 131 ha.

Water supply, sewerage and treatment of enfluents, drainage, solid waste disposal, roads, and bus service were studied in order to support the industrial and urban activities in this area.

A railway will be constructed as a branch of the Chachoengsao-Sattahip line which is now under construction. There are two alternatives for both the branch point and the railway route. The route parallel to the seashore with the branch point located north of Phu Ta Luang station was finally selected. Its length is 25 km for the Master Plan and 24 km for the Short Term Plan. The annual traffic volume transported by this railway is estimated at 3.7 million tons for the Master Plan and 2 million tons for the Short Term Plan.

The total demand for electricity is estimated at 1,354 MW for the Master Plan and 133.5 MW for the Short Term Plan. The number of lines to be installed is 10,000 for the Master Plan and 3,000 for the Short Term Plan. The number of telex, telegram terminals and other non-telephone service facilities are 44 for the Master Plan and 23 for the Short Term Plan.

The total investment cost for the infrastructure of this project, comprising, the port, the related infrastructures in the urban and industrial complexes, and the railway, is 600 million dollars for the Master Plan and 198 million dollars for the Short Term Plan.

Economic analysis is done only for the Short Term Plan. The total cost in this analysis includes the construction and operations cost for infrastructures in the urban, industrial and port areas, and plant cost in the factories. The total benefit for the project is defined as the

value-added generated by the industries and the reduction of transportation cost for the commercial cargoes, comparing the cost with that in case of using Sattahip Port. The internal rate of return (IRR) is 15.7% and the cost benefit ratio (B/C Ratio) is 1.12, assuming a 14% discount rate, which is the present bank rate of Bank of Thailand.

A financial feasibility study was carried out for the port and industrial estate development necessary under the Short Term Plan.

Assuming that 45% of the initial investment in the port is supplied by the Government as equity and a port tariff 5% higher than that in Khlong Toei Port is adopted, the net operating income will be kept positive during the 27 years after the completion of the port. However, the financial internal rate of return (FIRR) for the this case was estimated as 1.6%, which is lower than the assumed loan interest (3.5%). The F.I.R.R. will increase to 4.5 if a 20% higher port tariff be adopted.

Regarding to the industrial estate project, the following premises were assumed; the industrial plots for the factories will be sold in 1985 and 1986 and the sales price is determined by allowing for a 10% margin over the development cost. The study on the profit/loss status and the debt service ability proved that the financial soundness of this project will be secured. The F.I.R.R was estimated to be 19.8%, which is higher than the averaged interest of the loans, implying the profitability of this project.

The most crucial problem is the delay of the sale of the factory lots, which critically influences the financial soundness and profitability. It is recommended that the development schedule should be determined corresponding to the actual timing of the factory construction.

Production Scale of Industry

(1,000 t/y)

	Short Term Plan	Master Plan	Remarks
Soda Ash Plant	400	800	Same volume of Ammonium Chlorid
Petrochemical Complex	513.2	1,026.4	Ethylene 300
Fertilizer Complex	1,000	2,000	
Iron and Steel Complex	–	5,688	Direct reduction
Down Stream Industry	–	429	
Supporting Industry	166	166	

Land Use Plan in Urban Area

	Master Plan		Short Term Plan	
	Area (ha)	Ratio (%)	Area (ha)	Ratio (%)
Residential Use	245	43	62	47
Commercial Use	69	12	8	7
School	41	7	10	8
Park & Play Ground	72	12	17	13
Road	119	21	31	23
Others	29	5	3	2
Total	575	100	131	100

Scale of Port

	Cargo Volume (1,000t)		Total length of Wharf (Depth of Wharf) (m)		Maximum Size of Calling Vessel (DWT)	
	Master Plan	Short Term Plan	Master Plan	Short Term Plan	Master Plan	Short Term Plan
Industrial Material & Product	20,461.7	2,003.7	1) 4,055 (-6.5 -18)	1) 945 (-6.5 -11)	100,000	20,000
Commercial Cargo	2,523	1,978	2) 1,695 (-6.5 -14)	2) 805 (-6.5 -11)	150,000	20,000
Total	22,984.7	3,981.7	5,750	1,750		

1) : Private wharf 2) : Public wharf

Total Investment Cost of the Infrastructures

(1,000 US$)

	Master Plan	Short Term Plan
Industrial Estate	224,870	43,500
Port Area	234,670	119,640
Urban Area	125,340	21,080
Railway	14,650	13,640
Total	599,530	197,840

Recommendation

(Industrial Development)

1. As there are usually shortages of water in this area, the construction of dams and water courses should be promoted in order not to limit the industrial development.
2. As regard the industrial development in the 2nd Phase, further study is needed. In particular, the possibility of inducementing other industries to locate should be studied, in order to concentrate as many basic industries in the site as possible.

(Harbour Development)

3. The private wharves for the industries should be reviewed in accordance with the actual plans drawn by the industries. The channel and the basin should also be studied again, if necessary.
4. As a new base rock survey will be conducted, some modification of the face line of the marine structures may be needed at the detailed design stage.
5. It is recommended that the Thai Government construct the fundamental facilities beforehand, as inducement to attract industries, because a port is essential to industries which rely heavily on marine transportation.
6. The rock material availability on the islands near the Samaesan fishery harbour should be examined, although these are under the Royal Navy's control. Because the supply of the rock material will be a crucial factor in implementing the port construction within a short period.

(Urban Development)

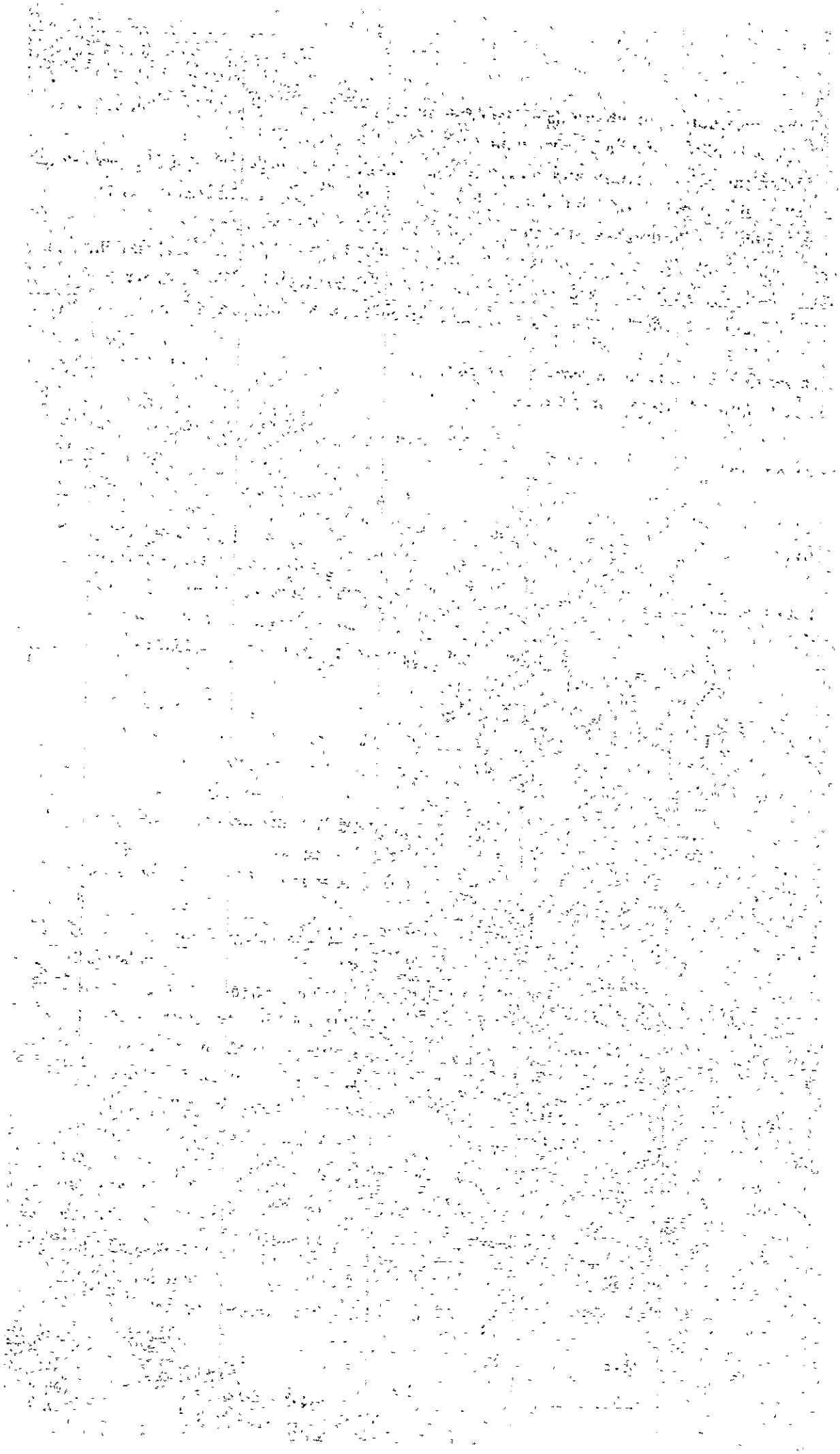
7. As the population of the new urban depends on the kind and the scale of the located industries, the urban development should be reviewed in line with any changes in the industrial development.
8. As the whole development will take a long time, the regulation of land use and the control of land prices are necessary, so as to prevent random development and land speculation.
9. The existing towns (Ban Chang and Map Ta Phut) should be developed to the same level as the new urban area.
10. Policies to induce private sectors to invest in housing and commercial activities should be undertaken.

(Construction, Administration and Operation)

11. The most important condition at the construction stage is that the necessary infrastructures be provided by the time the plants start operation.
12. As the development schedule for the Short Term Plan is extremely tight, the postponement of the target year, if possible, is recommended.
13. Although IEAT has already been appointed as the implementation agency, the reinforcement of its organization and authority, and co-operation among the agencies concerned are needed in order to harmoniously conduct the development, administration and operation of all the infrastructures.
14. The administration of the port is not financially self-supporting as long as the existing tariff rates are adopted. Although it may be possible for Port Authority to raise the rates to some extent, the Central Government should supply funds as equity to cover the expenditures of

the construction of un-profitable facilities such as the breakwater and channel. This fund raising is quite common in other countries.

15. When the sale of factory sites is delayed, the land development cost can not be recovered, the construction work should be syncronized with the plant construction as much as possible so as to minimize the interest costs.
16. In this study the cargo handling at the private wharves is each industry's responsibility, but that at the commercial wharves is assumed to be done by Port Authority workers. The other alternative, that such servies be left to the private sectors, is worth investigating.



SUMMARY

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(1) Industrial Development and Project Identification for the Proposed Industrial Estate

1) Project Identification

In accordance with the discussions made with several Thai authorities responsible for the excution of the Eastern Seaborad Development Program, and also taking fully into account the recent progress in the development activities of the heavy and chemical industrial projects in line with the Fifth National Economic and Social Development Plan (1981 – 1986), the following projects have been identified, as possible projects which would be attracted to the area of the proposed Industrial Estate in Map Ta Phut.

The scale of production for each plants is shown in Table S1-1 and the expected scheme is shown in Fig. S1-1.

(a) Gas Separation Plant
(b) Soda Ash Plant
(c) Petro Chemical Complex
(d) Fertilizer Complex
(e) Iron & Steel Complex
(f) Supporting Industries
(g) Down Stream Industries
(h) Other Industries

2) Technical Requirements for the Identified Projects

On the basis of the nature and characteristics of the identified projects that would be attracted to the area of the proposed Map Ta Phut Industrial Estate, the technical requirements such as raw materials, utilities, land, infrastructure services, number of workers, product distribution, treatment and disposal of waste materials are shown in Table S1-2.

3) Layout of the Industrial Complex

A layout of the industrial complex is shown in Fig. S1-2.

Table S1-1 Scale of Production (in terms of Salable Outputs) for Master Plan

Projects	Final Products	Scale of Production t/y
Soda Ash Plant	Soda Ash	800,000
	Ammonium Chloride	800,000
Petrochemical Complex	LDPE resin	200,000
	HDPE resin	200,000
	Caustic Soda (as 50% NaOH)	206,400
	VCM	160,000
	MEG	100,000
	PP resin	140,000
Fertilizer Complex	Ammonia*1	256,000
	Phosphoric Acid	(50,000)
	Urea	
	DAP/MAP	2,000,000
	NPK-Fertilizer	
Steel & Iron Complex	Hot Steel	946 000
	Hot Coil	2,176,000
	Cold Steel	582,000
	Cold Coil	1,984,000
Down Stream Industry		429 000
Supporting Industrey		166,000

Notes *1 as salable output

Table S1-2 Technical Requirements for Master Plan

		Soda Ash	Petrochem.	Fertilizer	Iron Steel	Downstream	Supporting
1. Main Raw Material							
Salt	T/Y	1,124,400	182,400	-			-
Ammonia	T/Y	256,000	-	-			-
Ethane	T/Y	-	700,000	-			-
Propane	T/Y	-	260,000 *1/	-			-
Natural gas (CH_4 rich)	MMSCFD	18.8 *1/	30 *1/	108 *2/	293 *2/		-
Sulfur	T/Y	-	-	406,600			-
Phosphate rock	T/Y	-	-	1,408,000			-
Muriate of potash	T/Y	-	-	146,800			-
Carbon dioxide	10^6N m^3/Y	265.6	-	-	9,108,000		-
Iron ore pellet	T/Y	-	-	-	1,457,000		-
Scrap	T/Y	-	-	-	467,600		-
Lime (Lime Stone)	T/Y	-	-	-	(888,800)		-
Ferromanganese	T/Y	-	-	-	37,300		-
Ferrosilicon	T/Y	-	-	-	4,600		-
Aluminium	T/Y	-	-	-	13,400		-
Fluorite(calcium fluoride)		-	-	-	10,200		-
Carbonizing Material	T/Y	-	-	-	14,800		-
Supporting ind. inputs		-	-	-		-	191,000
Downstream "		-	-	-		538,000	-
2. Utilities							
Electricity	KW	49,600	145,400	31,400	1,011,000	25,000	3,400
Fresh water	m^3/H	2,300	2,700	2,650	4,500	1,055	50
Portable water	m^3/H	22	40	27	105	38	22
3. Total Manpower Requirement		1,410	2,600	1,800	7,010	2,560	
4. Land Area Requirement	ha	100	410	100	600	120	100
5. Waste Disposal					*4/		
Solid waste	T/Y	288,000	4,000	2,200,000	322,400	-	-
Waste water	m^3/H	810	970	900	4,050	53	3

Notes: *1/ as fuel
*2/ as raw material and fuel
*3/ inclusive those of the 1st phase
*4/ excluding scales, fly ash and fine lime which amount to 2,018,000 MTA in total.

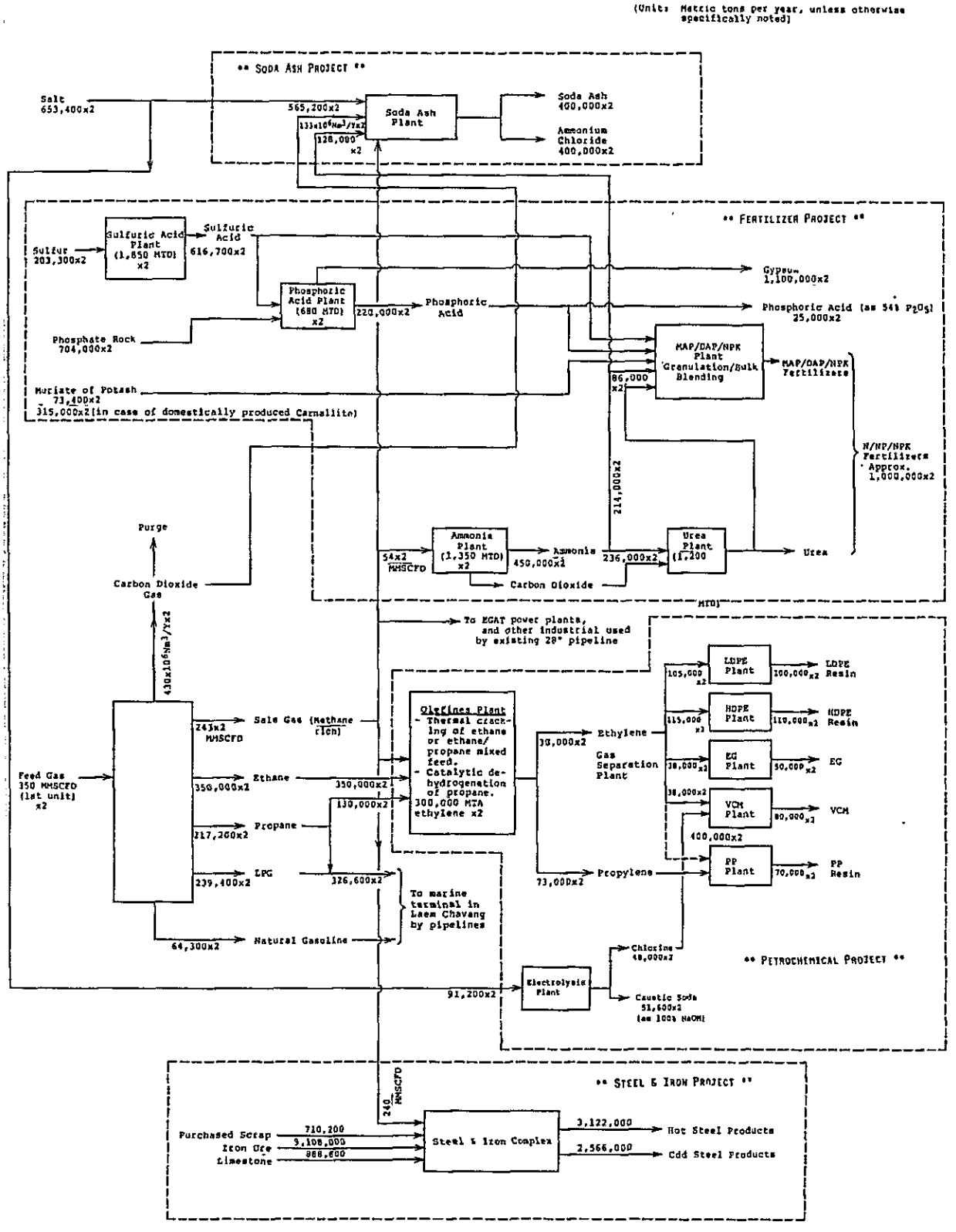
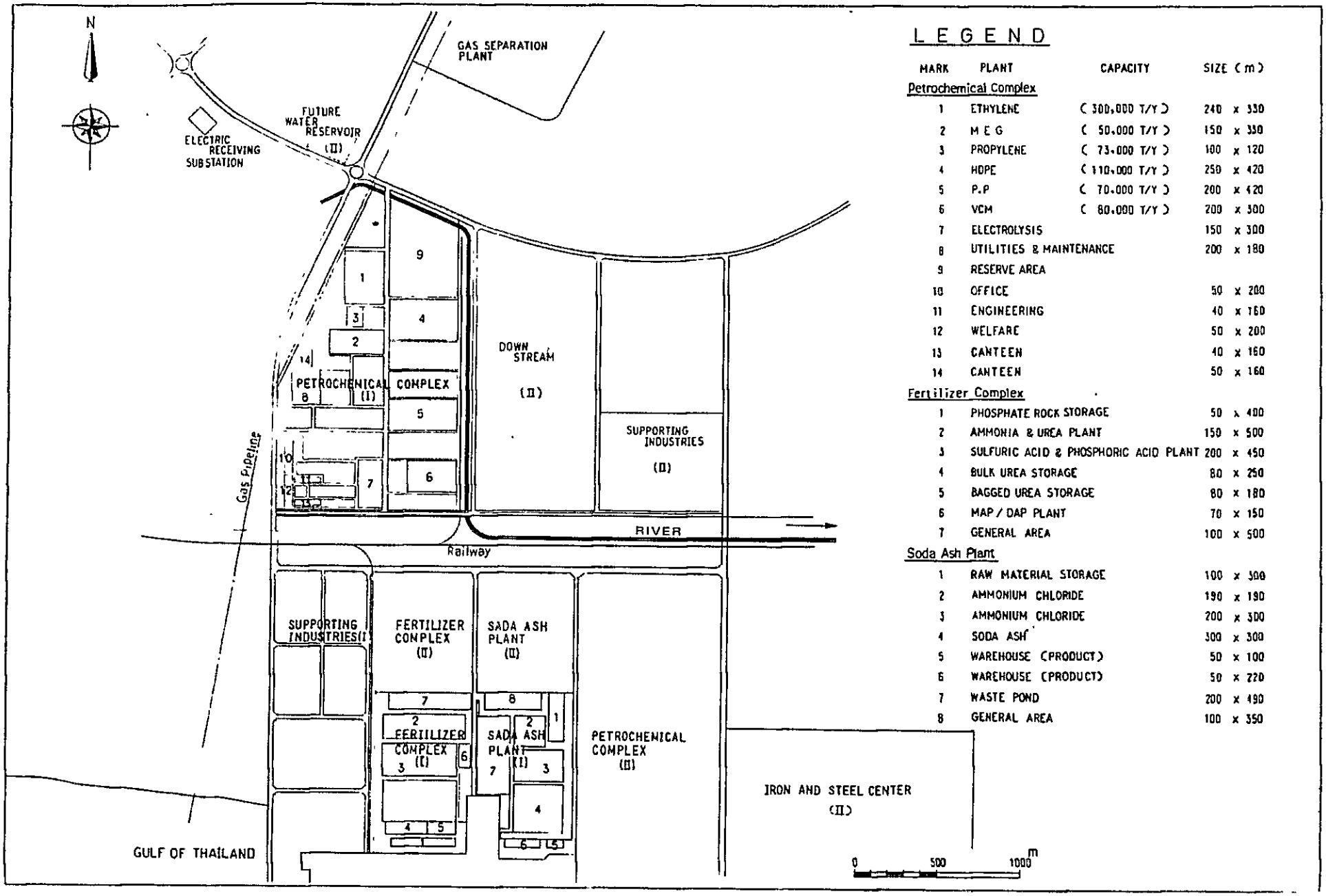


Fig. S1-1 Expected Scheme for Master Plan with the Target Year of 2000



LEGEND

MARK	PLANT	CAPACITY	SIZE (m)
Petrochemical Complex			
1	ETHYLENE	(300,000 T/Y)	240 x 330
2	M E G	(50,000 T/Y)	150 x 330
3	PROPYLENE	(73,000 T/Y)	100 x 120
4	HDPE	(110,000 T/Y)	250 x 420
5	P.P	(70,000 T/Y)	200 x 420
6	VCM	(80,000 T/Y)	200 x 300
7	ELECTROLYSIS		150 x 300
8	UTILITIES & MAINTENANCE		200 x 180
9	RESERVE AREA		
10	OFFICE		50 x 200
11	ENGINEERING		40 x 160
12	WELFARE		50 x 200
13	CANTEEN		40 x 160
14	CANTEEN		50 x 160
Fertilizer Complex			
1	PHOSPHATE ROCK STORAGE		50 x 400
2	AMMONIA & UREA PLANT		150 x 500
3	SULFURIC ACID & PHOSPHORIC ACID PLANT		200 x 450
4	BULK UREA STORAGE		80 x 250
5	BAGGED UREA STORAGE		80 x 180
6	MAP / DAP PLANT		70 x 150
7	GENERAL AREA		100 x 500
Soda Ash Plant			
1	RAW MATERIAL STORAGE		100 x 300
2	AMMONIUM CHLORIDE		190 x 190
3	AMMONIUM CHLORIDE		200 x 300
4	SODA ASH		300 x 300
5	WAREHOUSE (PRODUCT)		50 x 100
6	WAREHOUSE (PRODUCT)		50 x 220
7	WASTE POND		200 x 490
8	GENERAL AREA		100 x 350

(2) Cargo Traffic Forecast

The flow of the cargo handled in the Map Ta Phut area is summarized in Table S2-1 and Fig. S2-1.

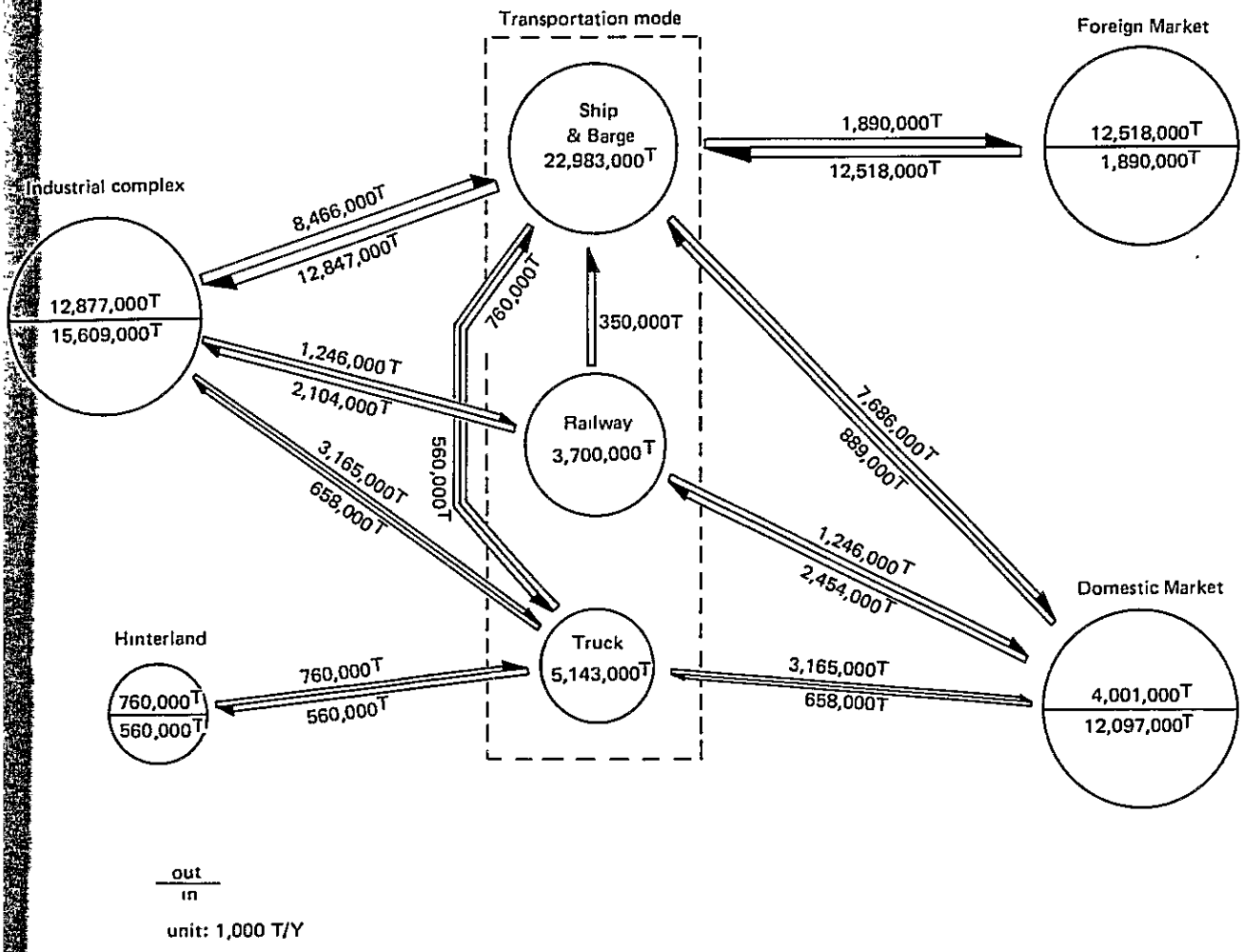


Fig. S2-1 Cargo Flow

Table S2-1 Cargo Traffic Handled at the New Industrial Port

Unit: T/y

Center	Name of Commodities	Cargo Format	Cargo Volume	From Industrial Complex					Into Industrial Complex					
				Ship and Export	Barge outward	Railway	Truck	Destination	Ship and Import	Barge Inward	Railway	Truck	Origin	
1. Fertilizer Center	Urea	Bag	800,000		400,000	120,000	280,000	whole						
	Fertilizer	Bag	1,200,000	300,000	450,000	135,000	315,000	whole						
	Phosphate Acid	Liquid	50,000		40,000	3,000	7,000	W N						
	Sulfer	Bulk	406,600						406,600				Foreign	
	Phosphate Ore	Bulk	1,408,000						1,408,000				Foreign	
	Potash Ore	Bulk	650,000								650,000		North East	
2. Soda Ash Center	Soda Ash	Bag	800,000	480,000	160,000	48,000	112,000	W N						
	Ammonium Chloride	Bag	800,000		400,000	120,000	280,000	whole						
	Rock Salt	Bulk	1,122,000								1,127,000		North East	
3. Petrochemical Center	LDPE	Bag	100,000		20,000	24,000	56,000	W N						
	HDPE	Bag	220,000		22,000	59,400	138,600	W N						
	PP	Bag	140,000		14,000	37,800	88,200	W N						
	MEG	Liquid	100,000		80,000	6,000	14,000	W N						
	VCM	Liquid	160,000		128,000	9,600	22,400	W N						
	Caustic Soda	Liquid	206,400		166,000	12,120	28,280	WN						
	Rock Salt	Bulk	122,400								182,400		North East	
4. Iron & Steel Center	Steel Products	Bulk	5,688,000		4,550,000	341,400	796,600	W N						
	Iron Ore	Bulk	9,108,000						9,108,000					
	Scrap	Bulk	1,457,000						1,457,000					
	Burnt-Lime	Bulk	467,600								140,280	327,320	North	
	Ferro-Manganese	Bulk	37,300						37,300					
	Ferro-Silicon	Bulk	4,600						4,600					
	Aluminum	Bulk	13,400						13,450					
	Flaorite	Bulk	10,200								3,060	7,140	North	
	Carburizing	Bulk	14,800						14,800					
	Fly Ash	Bag	498,000		249,000	74,700	174,300	W N						
	Fine Lime	Bag	25,800		12,900	3,870	9,030	W N						
	Sluge	Bulk	1,280,000		640,000	192,000	448,000	W N						
	Scale	Bulk	214,000		107,000	32,100	74,900	W N						
5. Down & Supporting Industries	Products	Bulk	594,515		246,894	27,123	320,498	W N						
		Bulk	728,763							399,096	6,017	323,856	North	
6. Commercial Center	Potash Ore	Bulk	(350,000)	350,000			from port	Foreign			350,000		North East	
	Tapioca	Bulk	(760,000)	760,000				Foriegn				760,000	East	
	Steel Products	Bulk	70,000				70,000	W & E	70,000				Foreign	
	Cement	Bag	150,000				150,000	W & E		150,000			North	
	Sand	Bulk	340,000				340,000	W & E		340,000			North	
	TOTAL		30,157,378	1,890,000	7,685,794	1,246,113	3,724,808		12,519,700	889,096	2,453,757	1,418,316		

(3) Natural Condition

1) Wind

Overall winds in Thailand are characterized by the northeast and southwest monsoon seasons. The northeast monsoon season is from Mid. Oct. to Mid. Feb., and north and northeast winds prevail. The southeast monsoon season is from Mid May to Mid Oct. and prevailing winds are from the south and west.

A long-term wind survey was carried out at the Sattahip observatory and at U-Tapao airport, near the proposed industrial port site.

Wind data taken every 3 hours from 1963 to 1981 at the Sattahip observatory and analytic data from U-Tapao airport were obtained.

Since the data may have been affected by local topography, the survey team installed a wind recorder on Saket Island and surveyed winds for about 2 months.

Saket Island is located about 2.5km off Map Ta Phut, so the data can be used to estimate wave characteristics without initial adjustment. However, the period of observation on Saket Island was short and long term wind characteristics used for wave estimation, must be obtained using the wind record at the Sattahip observatory.

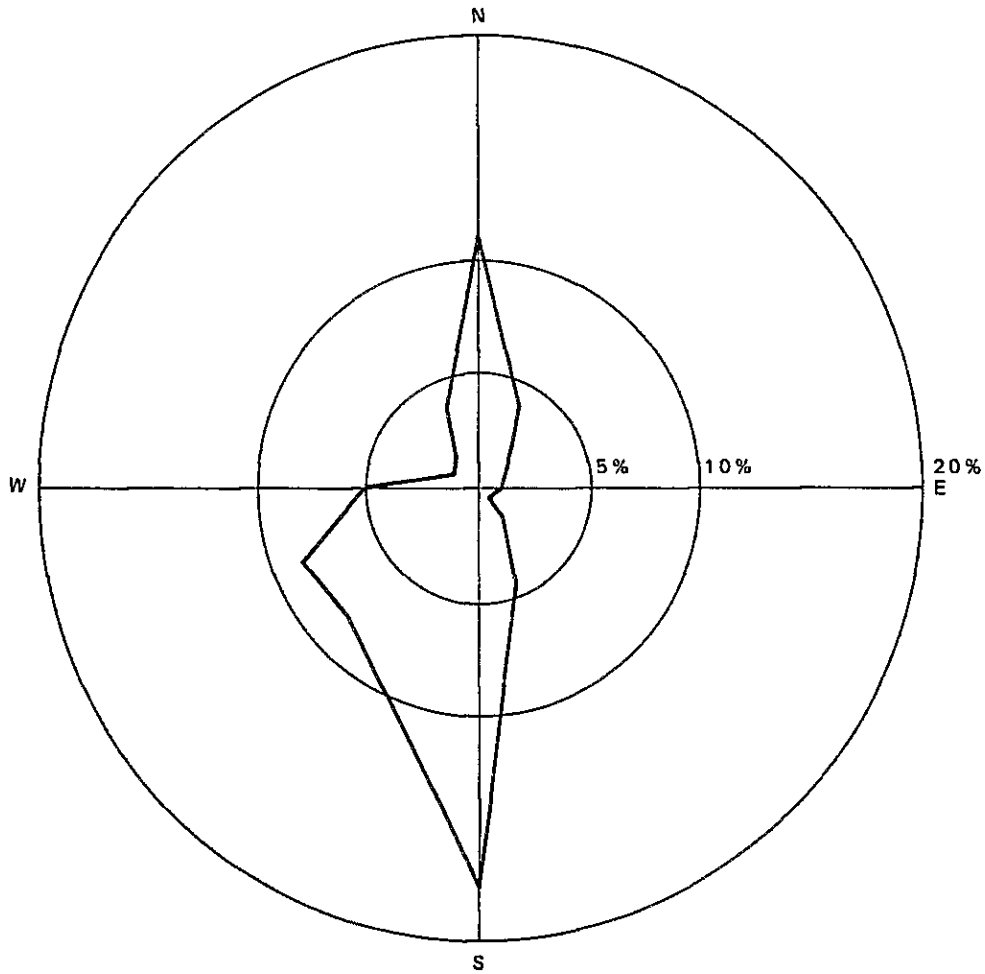


Fig. S3-1 Wind Rose (Annual), Sattahip

2) Topography

Hills, terraces, and low-lands are found around the survey area. Hills include Khao Khrok and Khao Noen Kraprok to the North of the survey area. Those running south to north border the west side of the survey area around Sattahip and the east side around Kaho Yai Da and Laem Ya. Terraces can be seen along mountains, such as Khao Khrok, to an area near the coast.

Terrace surfaces, gradually sloped, are ditched by small rivers and eroded coastal cliffs can be seen where terraces close in on the coast. Coastal cliff elevation varies between 5 and 10m above mean sea level.

Low-lands are widely observed in the basin of the Rayong River.

3) Bathymetry

A sounding survey was carried out using an echo sounder. The survey's results are shown in Fig. S3-2. According to the survey, the gently sloped sea bottom topography with scattered reefs can be seen between U-Tapao airport and Saket Island.

A −6m contour line extends 3.5km off the coast and the average grade is about 1/600. Past the −6m line, there is a sudden dip to about −16m. Farther down, little change in water depth is observed, however, and a very slow grade extends to the center of the gulf almost horizontally.

4) Geology of the Sea

Geologic features of the sea were studied using the results of sonic prospecting.

According to the study, the features are classified into 'A' layer, 'D' layer, and 'G' layer:

(i) 'G' layer

This layer corresponds to weathered granitic rocks on land when compared with the boring results. This layer, then, is equivalent to that with an elastic wave velocity of more than 2.5km/sec. and an N value showning more than 50.

Fig. S3-3 shows a contour line representing the top face of the layer. A valley can be seen approximately in the middle of Saket and the pipeline.

(ii) 'D' layer

It is believed that heavily weathered granitic rocks lie under the lower part. Elastic wave velocity is less than 1.4km/sec. and N value is about 15−50.

(iii) 'A' layer

The N value is 2−12. Comprised mostly of medium and coarse sands, parts contain deposits of shells.

5) Normal waves

Fig. S3-4 shows the average percentage occurrence of significant wave height groups. Relatively rough sea conditions are seen from March to August and the other months show very calm sea. Fig. S3-5 illustrates the average annual percentage occurrence of significant wave height-direction groups. Prevailing wave direction is between South and West-southwest.

6) Storm waves

Wave estimates, employing the SMB method, were done based on wind data from Sattahip for the 19 years from 1963 to 1981.

By the systematic selection and analysis of each year's highest estimated waves, a return period estimation for design waves was analyzed.

The significant wave heights with recurrence intervals of 30 years and 50 years are 3.51m and 3.67m respectively.

Wave direction is S-SW and especially high waves occur in SW and SSW directions.

7) Tide

A tide gauge was installed at Saket Island to obtain tide characteristic and tide levels were observed there for about 1.5 months from the middle of August, 1982.

A final tide diagram was decided upon, however, by using the existing data from Sattahip Port, etc. as reference. In the diagram, the tide level is shown with the Mean Tide Level (Local Mean Level) at Ko Lak Standard and Ko Saket.

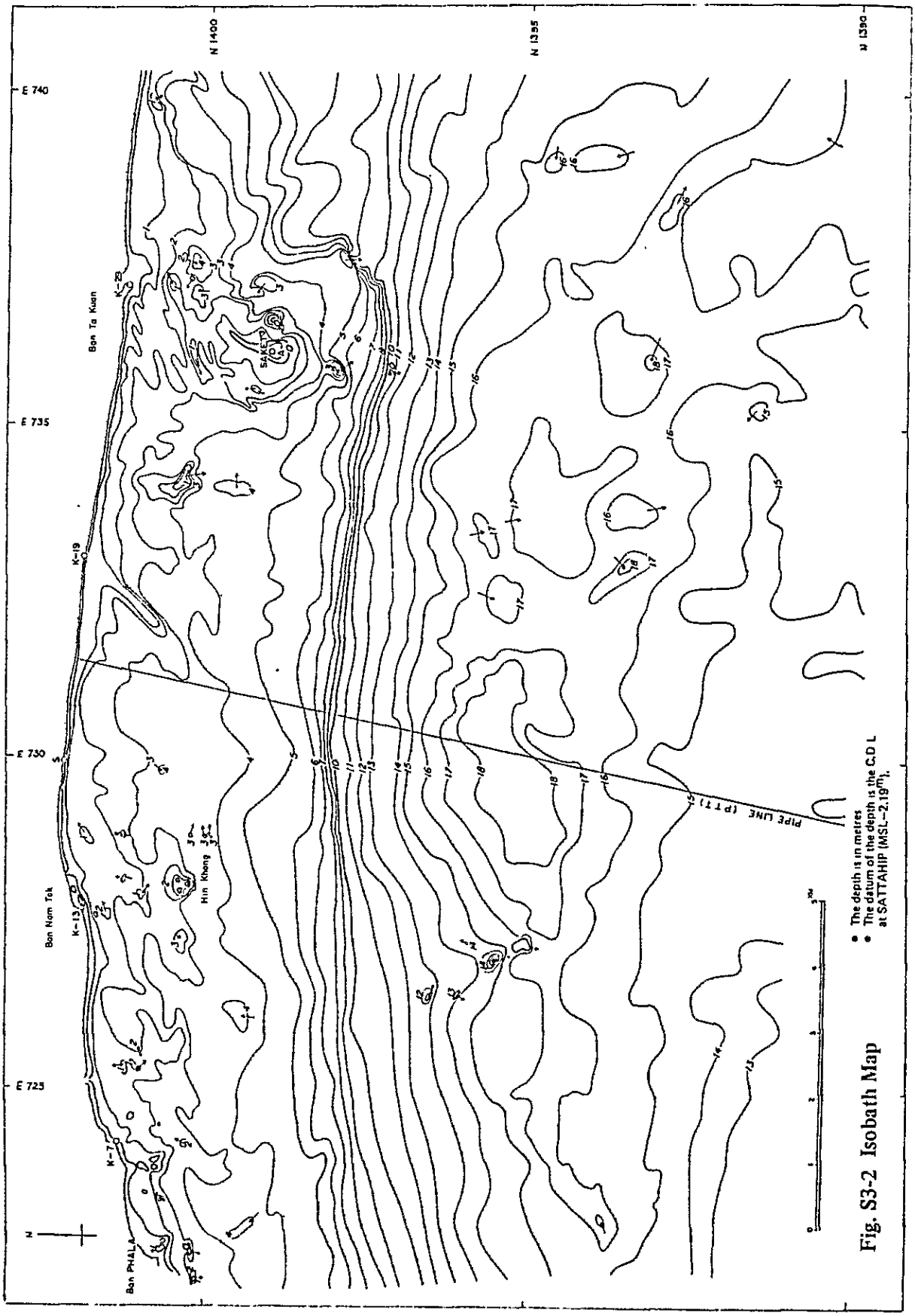


Fig. S3-2 Isobath Map

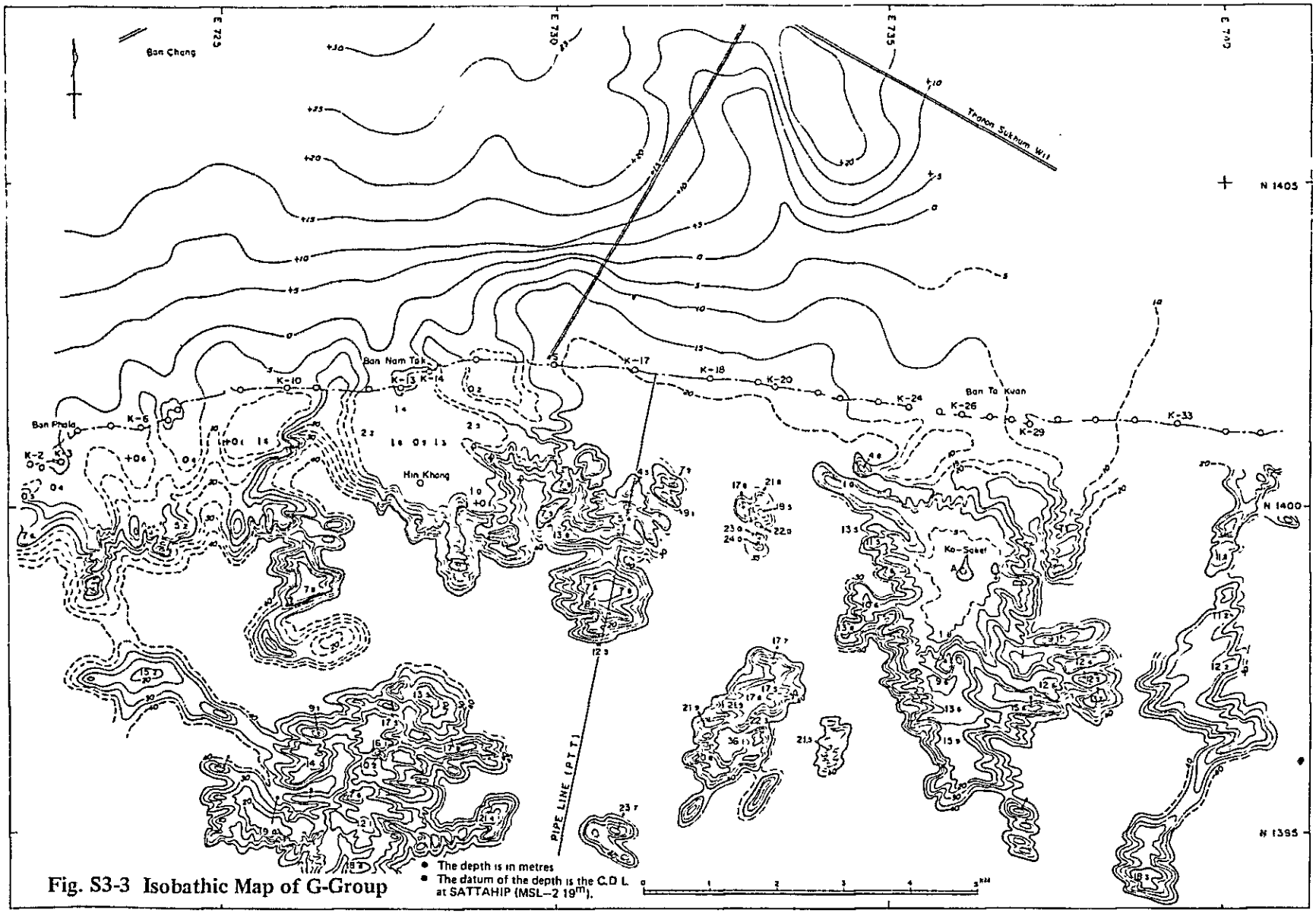


Fig. S3-3 Isobathic Map of G-Group

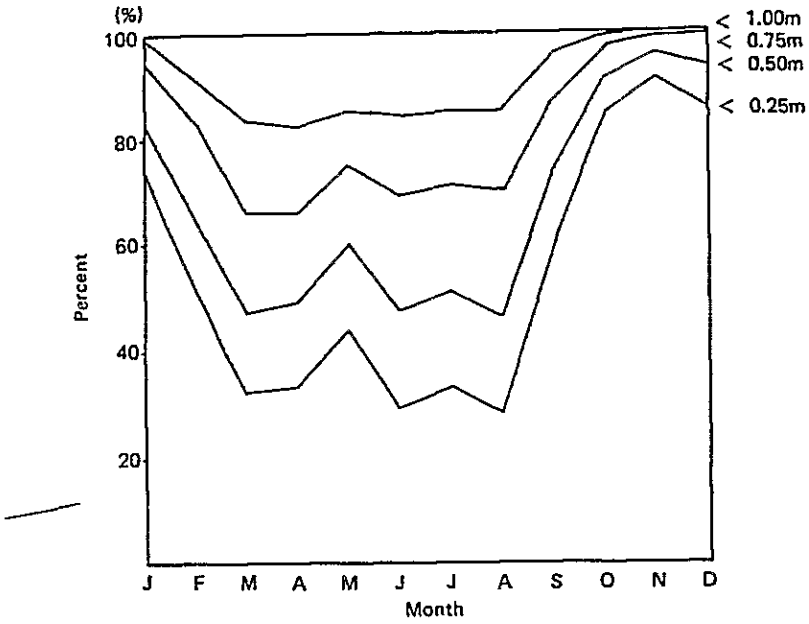


Fig. S3-4 Average Percentage Occurrence of Significant Wage Height Groups

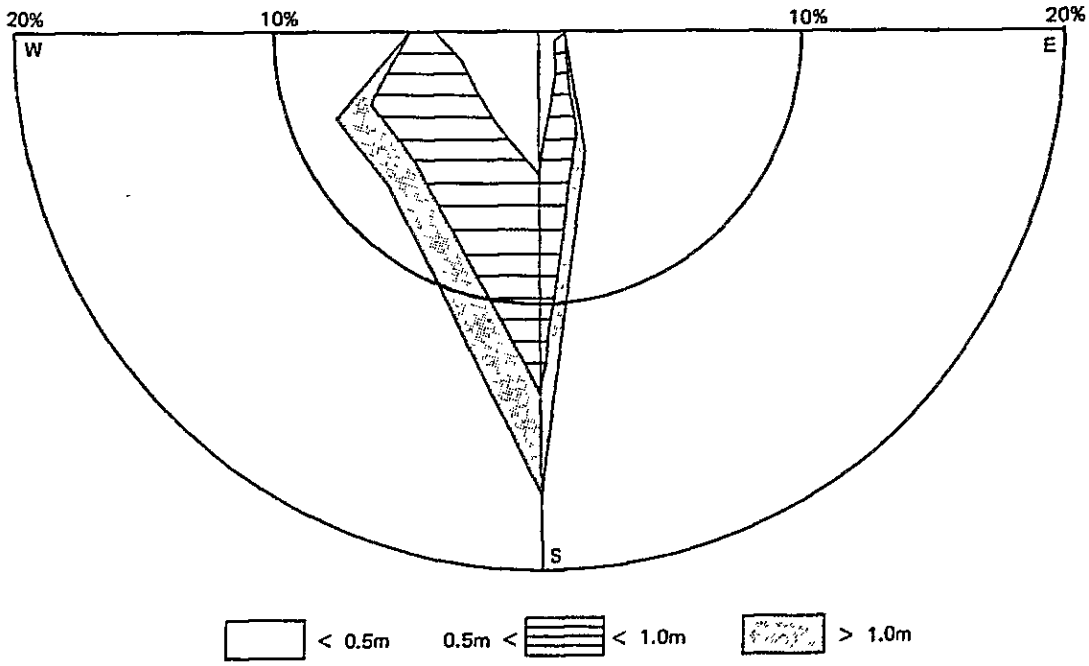


Fig. S3-5 Average Annual Percentage Occurrence of Significant

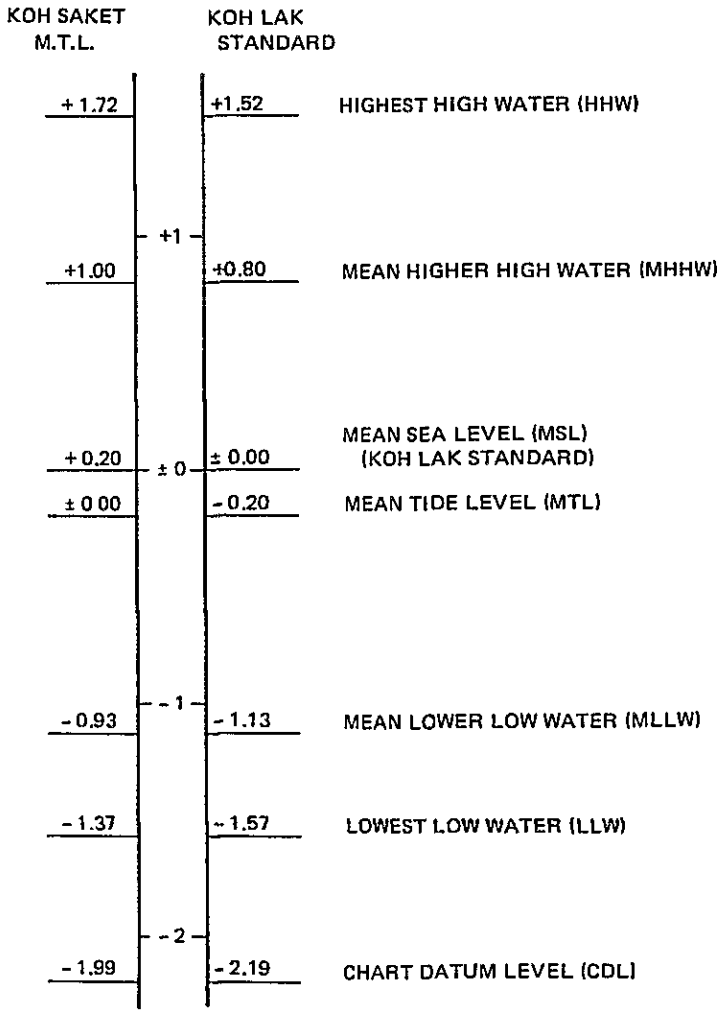


Fig. S3-6 Tidal Diagram at Koh Saket

8) Tidal Current

Maximum current speed during the observation period:

St. A	(2 m below sea level):	34 cm/sec	(direction: 320°)
St. B	(2 m below sea level):	48 cm/sec	(direction: 293°)
St. C	(2 m below sea level):	39 cm/sec	(direction: 218°)
St. D	(2 m below sea level):	48 cm/sec	(direction: 103°)
St. D	(2 m above sea bottom):	31 cm/sec	(direction: 247 – 282°)

A current harmonic analysis was done and a tidal current ellipse prepared based on current observation data.

According to the analysis, tidal constituents K_1, O_1, M_2 and S_2 and prevalent, of which K_1 and M_2 make up a relatively large share.

Additionally, the constant current is very small – less than 4 cm/sec.

The main direction of tidal current is ESE (approx. 100°) – WNE (approx. 280°)

9) Bottom Sediments and Littoral Drift

Data on the median grain size and natural of sea bottom sediments was obtained from sampling the bottom's surface layer.

Except along part of the coastline, the sea bottom is made up of medium and coase grain sand of about 0.4–0.8mm. Median grain size of gravels and shell-maxed gravels found farther of the coast is about 1.0mm.

Farther toward the outer ocean (over 10km from the coast), sediment characteristics begin to vary from place to place. As the percentage of sand decreases, there is an increase in shell-mixed gravels and muddy soil. A study using tracer (fluorescent sand) and sand catchers (sand catching tube and box) was undertaken over a brief period to more effectively record littoral drift.

The main direction of coastal tidal current is WNW-ESE and the maximum current speed is 30–50cm/sec. Prevailing wind and off-coast wave direction during the study was SW. From this, it can be concluded that littoral drift in the study area, during SW monsoon season, partly flows west with the direction of the coastal current and partly moves toward Ko Saket. The bottom sediments are believed to move along with the current.

(4) Port Planning

The cargo to be handled at the port in Master Plan stages is estimated as follows;

Table S4-1 Cargo Handling Volume

(Unit: 1,000 t/y)

	Foreign		Domestic		Total
	Export	Import	Export	Import	
Fertilizer Complex	300	1,814.7	890	–	3,004.7
Soda Ash Plant	480	–	560	–	1,040
Petrochemical Complex	–	–	243	–	243
Iron and Steel Complex	–	10,635	5,559	–	16,194
Public Terminal Area	1,130	70	434	889	2,523
Total	1,890	12,519.7	7,686	889	22,984.7

The necessary No. of berth and the length of the mooring facilities is summarized as follows;

Table S4-2 Requirement of the Mooring Facilities

		Ship Size (DWT)	Quay Depth (m)	Berth Length (m)	Necessary No. of Berth	Total Length (m)	Berth Occupancy rate (%)
Fertilizer	Domestic	3,000	– 6.5	105	5	525	50
	Foreign	60,000	–14.0	280	1	280	46
Soda Ash	Domestic	3,000	– 6.5	105	3	315	54
	Foreign	60,000	–14.0	280	1	280	17
Petrochemical	Domestic (Resin)	3,000	– 6.5	105	1	105	16
	Domestic (Liquid)	3,000	– 6.5	105	1	105	53
Iron and Steel	Domestic	3,000	– 6.5	105	17	1,785	78
	Foreign	100,000	–18.0	330	2	660	53
Public Terminal	Domestic (Bulk, Bag etc.)	3,000	– 6.5	105	12	1,260	–
	Domestic (Liquid)	3,000	– 6.5	105	1	105	54
	Foreign	150,000 60,000	–14.0	330	1	330	24
Total					45	5,750	

1) Breakwater:

A main breakwater will be arranged approximately in the SE direction to shielded berth from SW waves.

2) The maximum shipsize:

The ore carrier for the steel and iron complex is assumed to be 100,000DWT and the maximum size of vessels serving for the fertilizer, soda ash plants and the potash export terminal is assumed to be 60,000DWT. The ship for the tapioca is assumed to be 150,000DWT with the draft of 13m due to the small bulk density of tapioca.

3) Channels:

Channels is to be arranged in SSE direction so as not to expose directly the stern and shipside to the SSW Ware. A channel width of 300m is proposed considering the length of the maximum ship size.

Oceanographic study is carried out to evaluate the calmness in the harbour basin,the shoreline change due to the port construction and amount of the siltation.

According to these results, the probability that the wave hight in the harbour basin exceeds the 0.5m is less than 5% through the year. In west beach of the port site the shoreline advances 100–200m due to the accumulation of the sand. Thus no serious problem or change is anticipated.

The amount of siltation is estimated to be approximately 250,000 m^3 to 450,000 m^3 annualy.

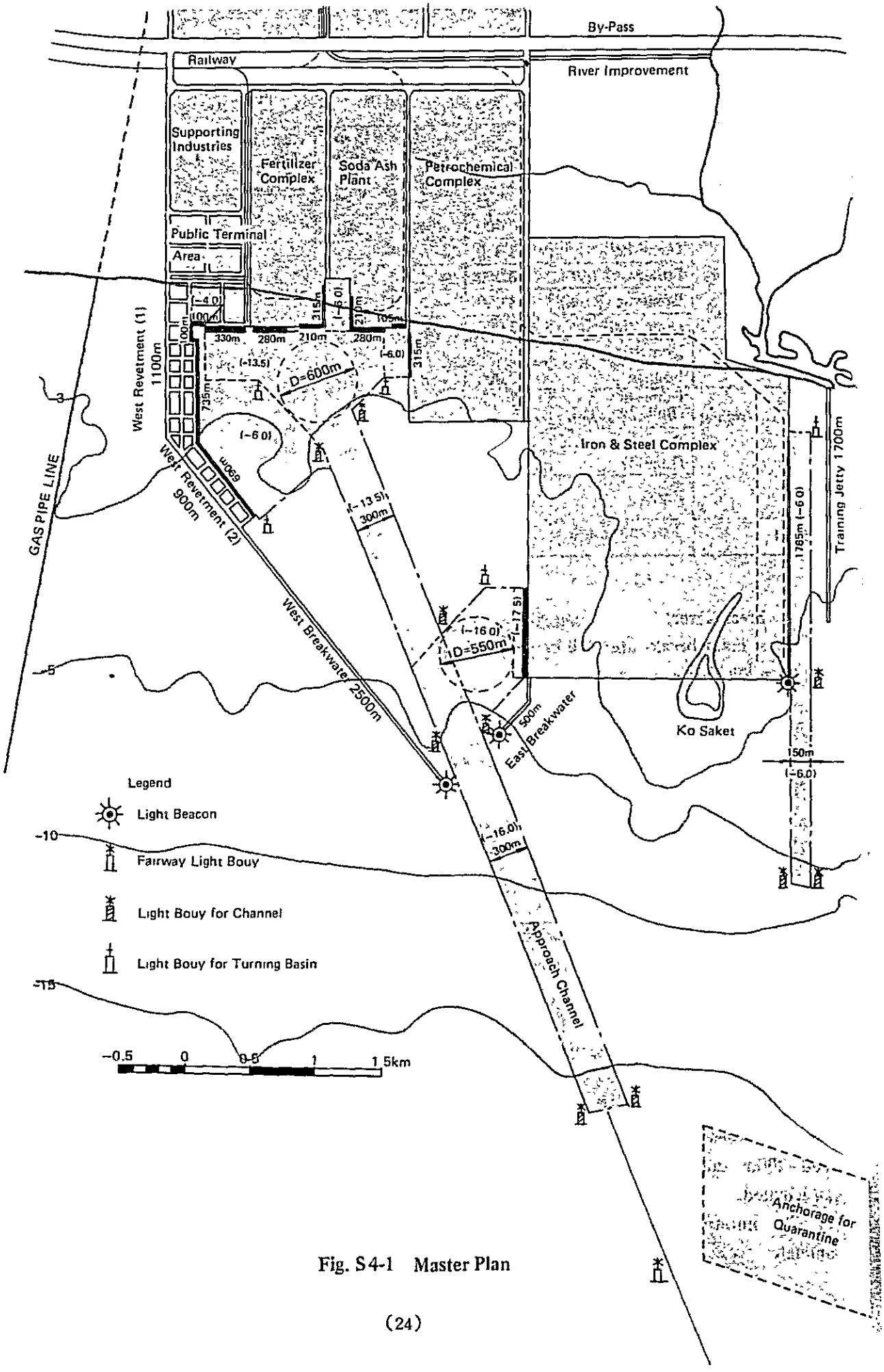


Fig. S4-1 Master Plan

(5) Urban Development Plan

1) Basic Policy

The New Town should be developed to accommodate a total population of some 71,500 for industry employees and other service workers induced by these industries both with their families.

The New Town should be distant from the Industrial Complex as far as possible to secure residential environment and amenity. On the other hand, it should be located at the place where workers can enjoy short distance for commuting to the Industrial Complex.

Growth direction for the existing nearby towns in relation to the New Town development will be considered as follows:

Ban Chang could be re-activated through making full use of existing urban facilities by the migrants induced by the industrial development. Thus, investment on the New Town development could be eliminated to the minimum through such utilization of the existing facilities. On the other hand, a number of inducement of migrants in Map Ta Phut town should be avoided because of possible environmental problems and land speculation.

Buffer zones will be provided between the New Town and the Industrial Complex; and between Map Ta Phut and the Industrial Complex to secure residential environment and amenities. The former buffer zone will be arranged to have a width of about 800m. A 200m width of land will be purchased by IEAT and the land within the remaining width of about 600m should be preserved by regulating the land use. The later buffer zone will be secured with the same width of 200m.

In future, the population in the New Town is anticipated to be far bigger than that in Ban Chang. And the New Town will play an important role as a core in the Map Ta Phut area. So, arterial roads should be arranged as axes of the urban area development to link Ban Chang, the New Town and Map Ta Phut.

2) Target Population

The total population induced by the industrial development is distributed among the New Town and the existing nearby towns with due consideration given to the directions of the future development in the existing towns as described in Table S5-1.

Table S5-1 Anticipated Population in Each Area

1st Phase

	New Town	Ban Chang	Map Ta Phut	Rayong, etc.
Existing Residents (1981) + Natural Growth (until 1987)	–	15,500*	7,800**	–
Population by Induced Industries	13,600	–	–	–
Population by Multiplier Effects	4,700	6,900	3,000	1,630
Total	18,300	22,400	10,800	–

Master Plan

	New Town	Ban Chang	Map Ta Phut	Rayong, etc.
Existing Residents (1981) + Natural Growth (until 2000)	–	20,000*	10,750**	–
Population by Induced Industries	44,700	–	–	–
Population by Multiplier Effects	26,800	11,500	4,050	2,600
Total	71,500	31,500	14,800	–

* Based on the data given by the Town and Country Planning, including natural growth.
14,357 residents (1981) in Ban Chang.

** Based on ESS, including natural growth.
7,400 residents (1981) in Map Ta Phut.

The number of households in the New Town is set up as follows:

Table S5-2 Households in New Town

	Population	No. of Households
1st Phase	18,300	4,360
Master Plan	71,500	17,340

Household size: 4.2 persons for 1st Phase
4.1 persons for Master Plan (Based on ESS)

3) Land Use

The area allotment by land use is as indicated in Table S5-3. Which is settled to meet the anticipated demand for land for respective purposes and Fig. S5-1 shows the proposed land use plan of the New Town.

Table S5-3 Area Allotment by Land Use

	Area (HA)	Ratio (%)
Residential Use (Net)	245	43
Town Center	54	9
Nighborhood Shopping Center	5	1
Community Center	10	2
Secondary School	24	4
Primary School	12 (3)*	2
Kindergarten	5	1
Sub-total	41	7
Central Park	45	8
Neighborhood Park	13	2
Playground	5	1
Pedestrian Way	9	2
River and Mall	21	4
Sub-total	93	16
Road	119	21
Sewage Treatment and Others	8	1
Total	575	100

Gross density; 125 persons/ha (20 persons/rai)

* The figure in ( ) shows the area of the existing facilities which is not included in the total planning area.

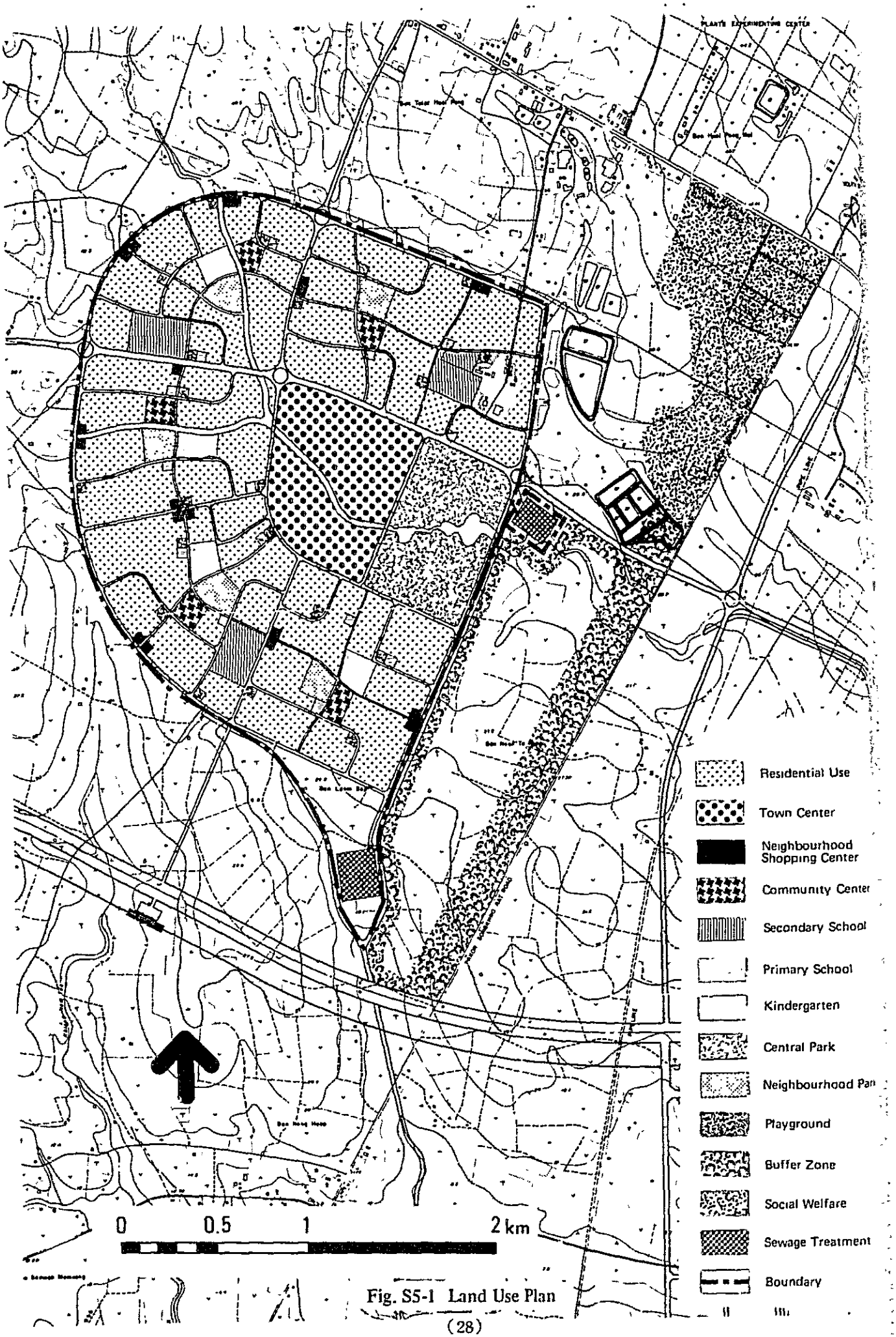


Fig. S5-1 Land Use Plan

Model of typical residential unit is illustrated in Fig. S5-2.

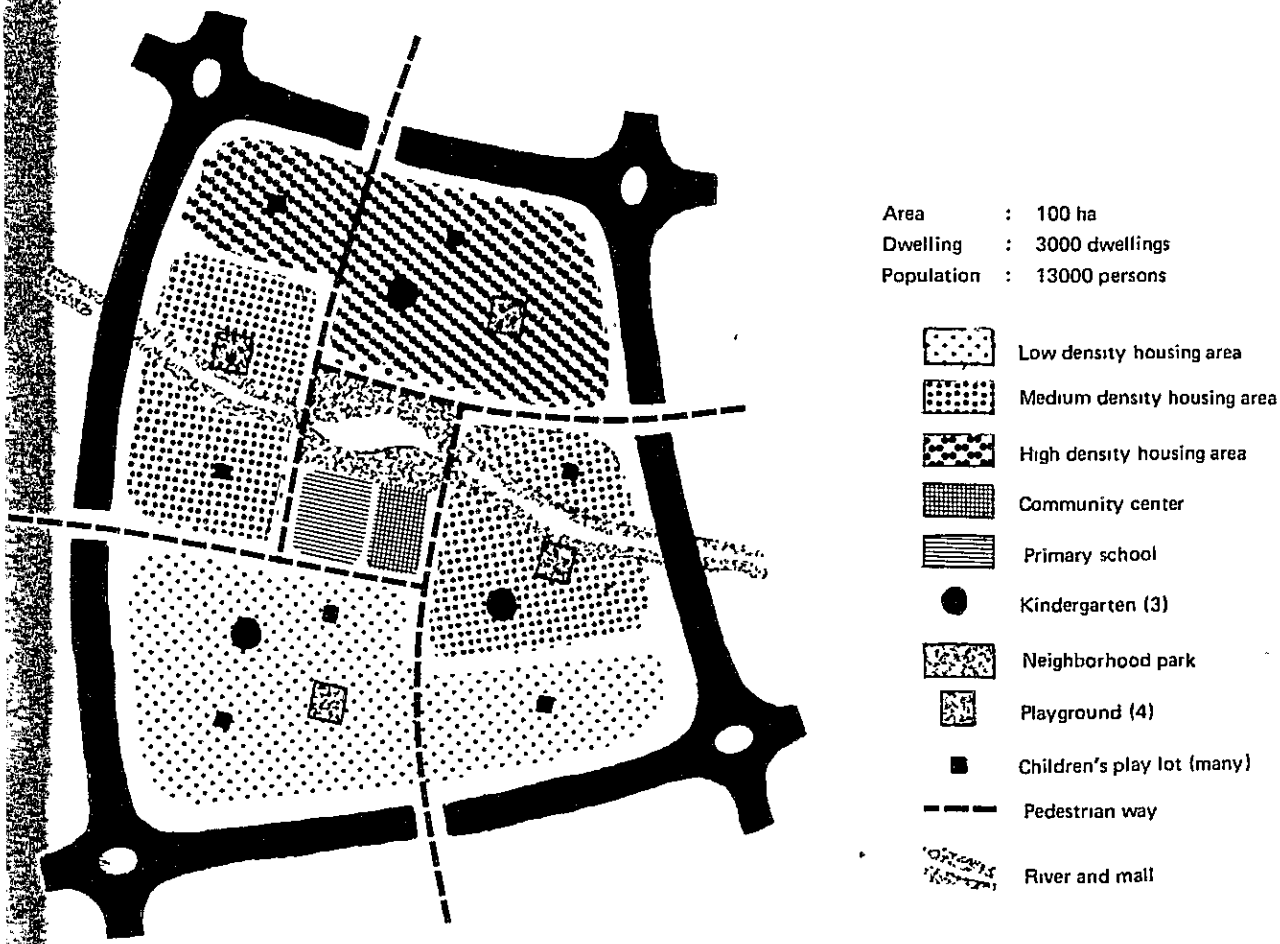


Fig. S5-2 Model of Typical Residential Unit

The types and ratios of housing distribution are shown in Table S5-4.

Table S5-4 Housing Distribution

Type of Housing	Residential Unit Size	Ratio of Housing Distribution
Detached House	400 m^2/plot	10%
Semi-Detached House	180 m^2/plot	20%
Town House	100 m^2/plot	40%
Flat or Row House	80 m^2/plot	30%

(6) Plan for Related Infrastructures

1) Road

The following road network was established, based on the evaluation of the loaded network by car traffic assignment and further more on the basis of qualitative and quantitative analysis of the traffic flow on each road.

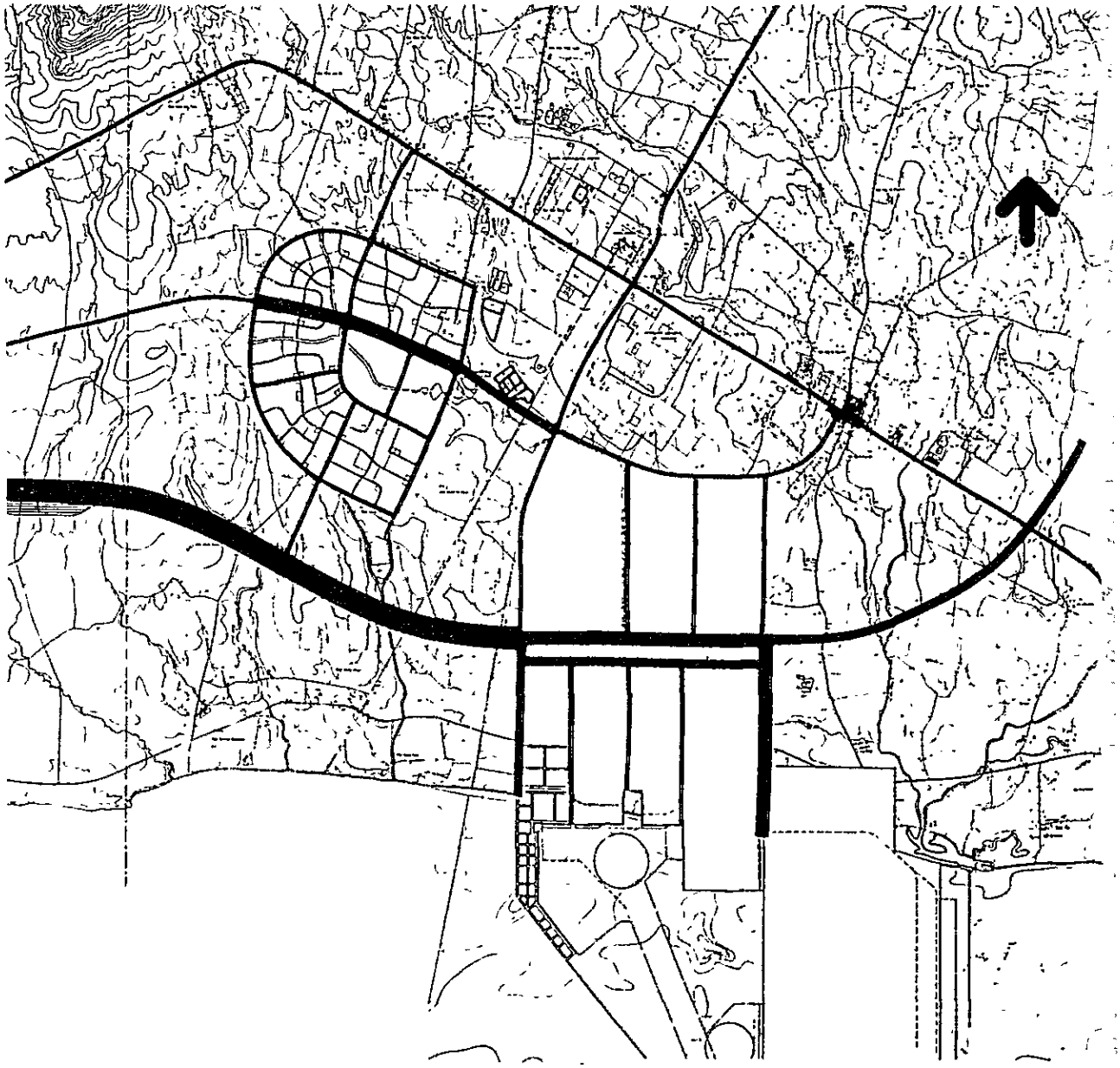


Fig. S6-1 Road Network

2) Railway

Chachoengsao – Sattahip Line will be completed in middle of 1984 by State Railway of Thailand.

One of main reasons for construction of this line is in order to transport the raw material such as rock salt and potash ore which will be used at Map Ta Phut Industrial Complex.

Four alternative plan from the place in vicinity of Ban Phu Ta Luang on Chachoengsao – Sattahip Line to Rayong have already been recommended to the Eastern Seaboard Development Sub-Committee in July 6th 1981. At the first Phase in 1987, the spur from the place in vicinity of Ban Phu Ta Luang to Map Ta Phut Industrial Complex will be constructed for the complex to operate effectively.

In future, the spur will be expanded to Rayong and it will be also used to transport local products.

The traffic forecast is summarized in the following Table S6-1.

Table S6-1 Railway Traffic Forecast

	1st phase		2nd phase	
	From	Into	From	Into
Cargo Volume per year	ton/y 316,860	ton/y 1,653,400	ton/y 1,246,113	ton/y 2,453,757
Cargo Volume per a day	ton/d 868.1	ton/d 4,529.9	ton/d 3,414	ton/d 6,727.7
Number of Cargo Train per day	trains/d 0.87	trains/d 4.6	trains/d 3.7	trains/d 6.7

The two alternative routes for the railway alignment are considered as shown in Fig. S.6-2 and the respective construction cost is estimated. (Table S.6-2)

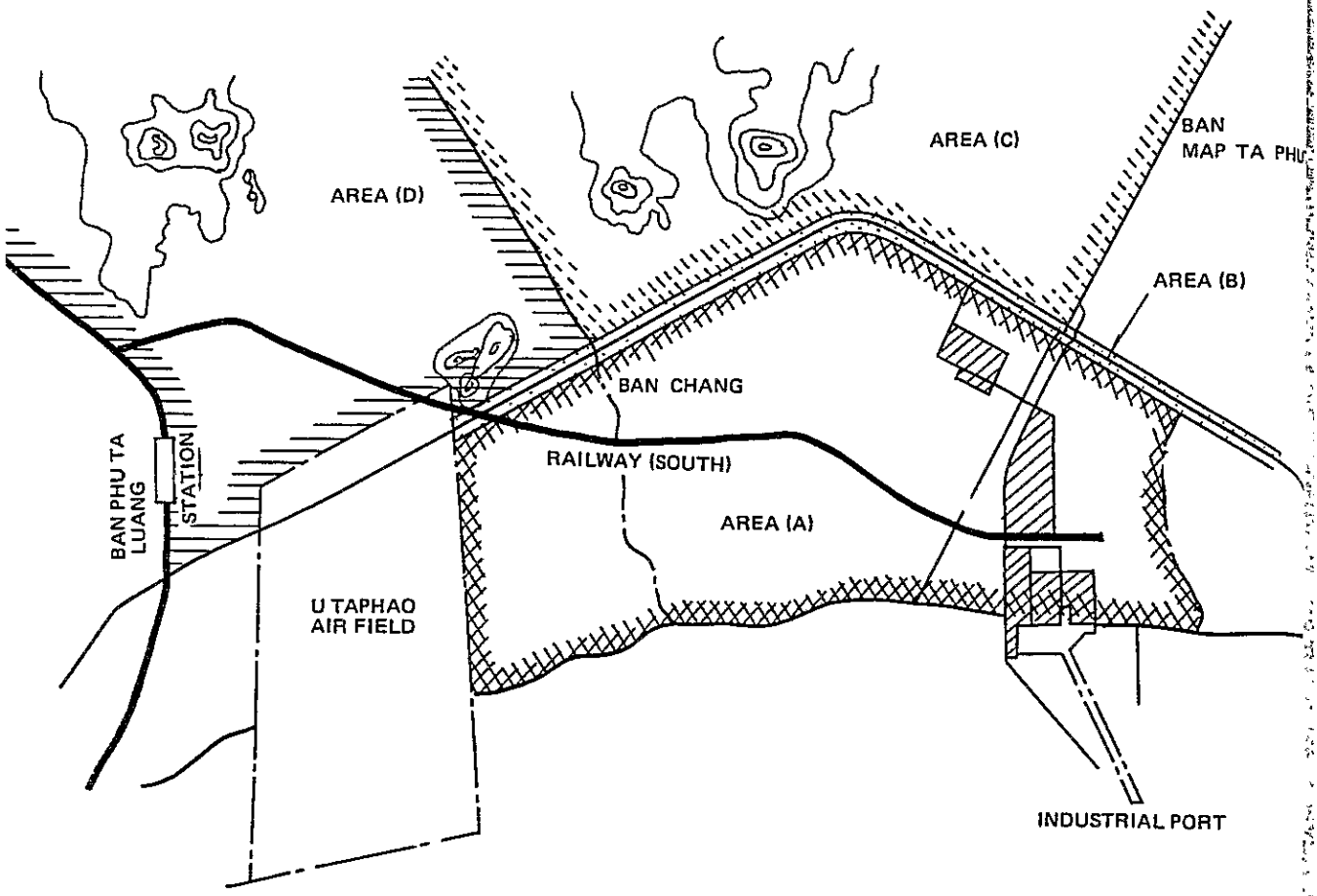


Fig. S6-2 Railway Alignment

Table S6-2 Comparison of Railway Construction Cost

Item	Unit	Alt. 2				Alt. 1				Remarks
		Quantity	Amount (Thousand ₱)			Quantity	Amount (Thousand ₱)			
			Total	Local Currency	Forein Currency		Total	Local Currency	Forein Currency	
1. Land Acquisition		(127.4ha)	(37,250)	(37,250)	(0)	(153.4ha)	(37,000)	(37,000)	(0)	
Within Promalgated Area	ha	79.4	24,810	24,810	0	72.2	23,340	23,340	0	
Outside Promalgated Area	ha	48.0	12,440	12,440	0	81.2	13,660	13,660	0	
2. Trunk Line			(167,200)	(105,010)	(62,190)		(250,250)	(166,240)	(84,010)	
(1) Truck Structure			(82,960)	(63,370)	(19,590)		(151,580)	(117,890)	(33,690)	
Preparatory Work	ha	47.2	944	850	94	60.2	1,204	1,084	120	
Embankment	m^3	662,000	55,740	44,592	11,148	1,402,000	114,658	91,731	22,927	
Sodding	m^2	162,000	2,430	2,430	0	354,000	5,310	5,310	0	
Laterite	m^3	47,200	8,968	5,829	3,139	60,200	11,438	7,435	4,003	
Aggregate Base	m^3	42,500	14,875	9,669	5,206	54,200	18,970	12,330	6,640	
(2) Truck Work			(58,740)	(27,610)	(31,130)		(74,770)	(35,200)	(39,570)	
Concrete Sleeper	Unit	36,350	28,353	21,265	7,088	46,360	36,161	27,121	9,040	
Truck (80 lb)	Ton	1,888	24,544	2,454	22,090	2,408	31,304	3,130	28,174	
Shunt (80 lb)	Set	7	1,120	112	1,008	8	1,280	128	1,152	
Truck Installation	km	23.6	4,720	3,776	994	30.1	6,020	4,816	1,204	
(3) Bridge	Unit	11	25,500	14,030	11,470	10	23,900	13,150	10,750	
3. Marshaling Yard			(21,570)	(12,420)	(9,150)		(78,360)	(57,850)	(20,510)	
(1) Truck Structure			(9,070)	(6,550)	(2,520)		(65,860)	(51,980)	(13,880)	
Preparatory Work	ha	25	500	450	50	25	500	450	50	
Embankment	m^3	88,000	3,520	2,817	703	721,000	60,310	48,247	12,063	
Laterite	m^3	10,000	1,900	1,235	665	10,000	1,900	1,235	665	
Aggregate Base	m^3	9,000	3,150	2,048	1,102	9,000	3,150	2,048	1,102	
(2) Truck Work	m	5,000	12,500	5,870	6,630	5,000	12,500	5,870	6,630	
4. Communication/Signalling	Ls	1	20,000	18,000	2,000	1	20,000	18,000	2,000	
5. Lighting Facilities	Ls	1	3,260	1,880	1,380	1	3,260	1,880	1,380	
6. Maintenance Office	Ls	1	2,900	2,460	440	1	2,900	2,460	440	
Sub-Total			252,180	177,020	75,160		391,770	283,430	108,340	
Investigation/Engineering	Ls	1	28,860	11,500	17,360	10	35,480	14,190	21,290	
Phisical Contingency	Ls	1	32,260	20,980	11,280	15	53,250	36,980	16,270	
Total			313,300	209,500	103,800		480,500	334,600	145,900	
Truck Length	km	23.6	313,300/23.6 = 13,275 ₱/m			30.1	480,500/30.1 = 15,963 ₱/m			

3) Water Supply

(i) Water Demand

Total water demand is shown in Table S.6-3.

(ii) Proposed Water Supply System

Proposed water supply system is shown in Fig. S.6-3.

(iii) Water Supply Scheme

(a) Each complex in the Industrial Area is supplied with raw fresh water for industrial use. It will be treated in some amount at its own treatment facilities properly designed for process and boiler use, while the remainder can be utilized for general services.

(b) Portable water will be supplied to Industrial Area. Port Area and Urban Area by an integrated water supply network after hygienic treatment at a purification facilities.

(iv) Purification Facilities

(a) Location

Water purification facilities will be located west to the Water Receiving Facilities to be constructed near Route 3.

(b) Amount of Water to be purified

Amount of Water to be purified is showed as follows.

	1987	1987–2000 (Expansion)	2000 (Total)
Amount of water	9,200 m^3/day	24,800 m^3/day	34,000 m^3/day

(v) General Plan for Water Supply System

General plan for water supply system is shown in Fig. S.6-4.

Table S6-3 Fresh Water Consumption

Item	Industrial Water						Portable Water				
	Ferti-lizer (m^3/H)	Soda Ash (m^3/H)	Qetro-chem. (m^3/H)	Gas Sep. (m^3/H)	Sup-port ing (m^3/H)	Down Stream (m^3/H)	Iron/ Steel (m^3/H)	Indus-tural Area (m^3/D)	Port Area (m^3/D)	Urban Area (m^3/D)	Total Demand ($\times 10^3$ m^3/y)
1st Phase (1987)											
(1) Industrial Water	1,470	1,280	1,500	220	50	–	–	–	–	–	36,160
(2) Portable Water	*4 (15)	*1 (12)	*1 (25)		*1 (22)			*2 740	*6 456	*2 4,575	*3 2,430
Total											
2nd Phase (2000)											
(1) Industrial Water											
1st phase	1,470	1,280	1,500	220	50	–	–				
2nd phase	*4 1,176	*4 1,024	*4 1,200	220	–	500	*5 4,500				
Sut-botal	2,646	2,304	2,700	440	50	500	4,500				105,120
(2) Portable Water	*1 (27)	*1 (22)	*1 (40)		*1 (22)	*1 (38)	*1 (105)	*2 2,540	*6 576	*2 21,450	*3 8,190
Grand Total											113,310

Notes:
- *1 Maximum hourly requirement.
- *2 Normal daily requirement calculated based on 10 hours/day operation at the maximum hourly requirement.
- *3 Total annual requirement.
- *4 These figures are estimated based on an assumption that 20% of industrial water requirement can be substituted by the use of sea water.
- *5 This figure is estimated based on an assumption that 50% of industrial water requirement can be substituted by the use of sea water.
- *6 Of which, 336m^3/D will be used for the washing purpose.

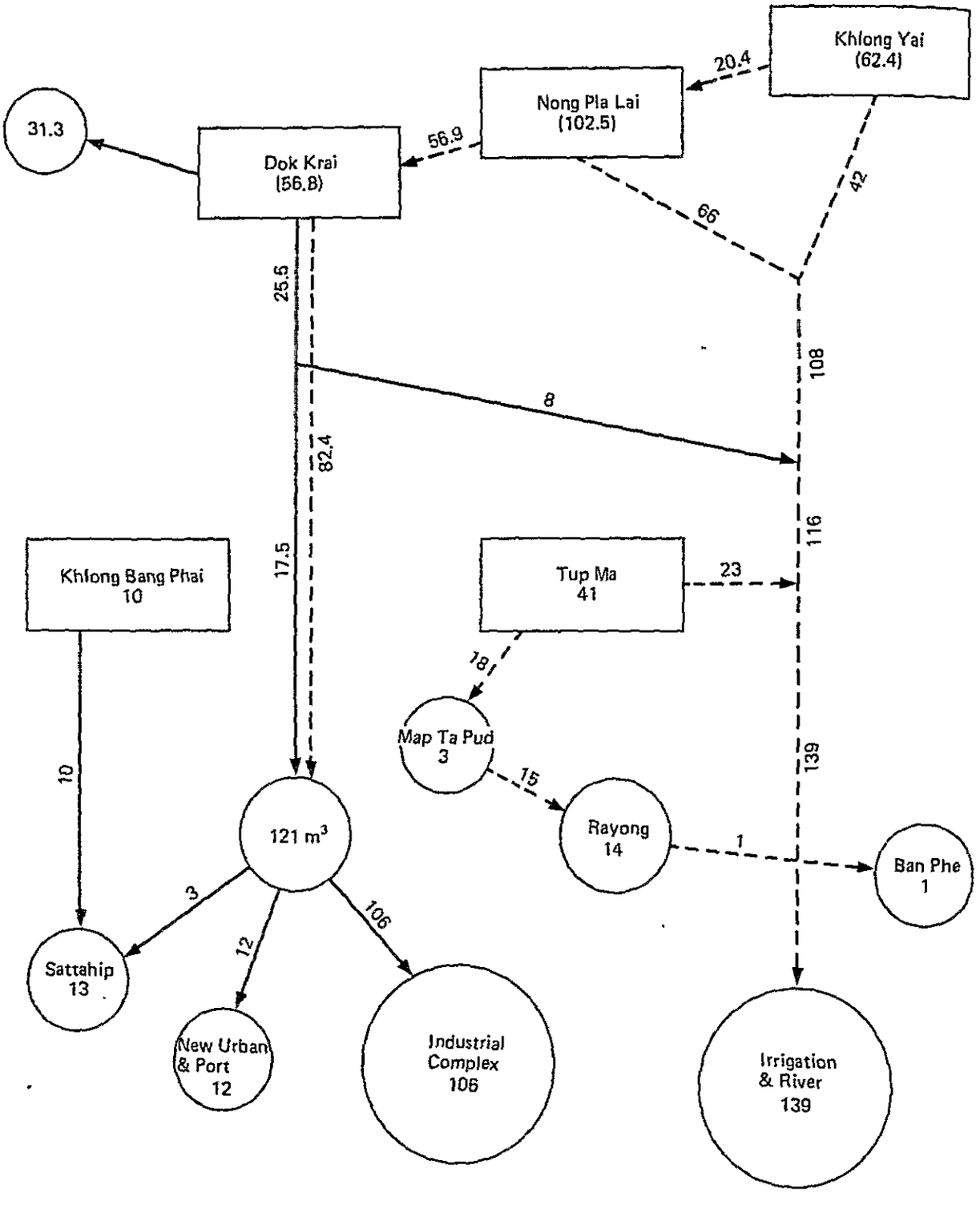


Fig. S6-3 Proposed Water Supply System

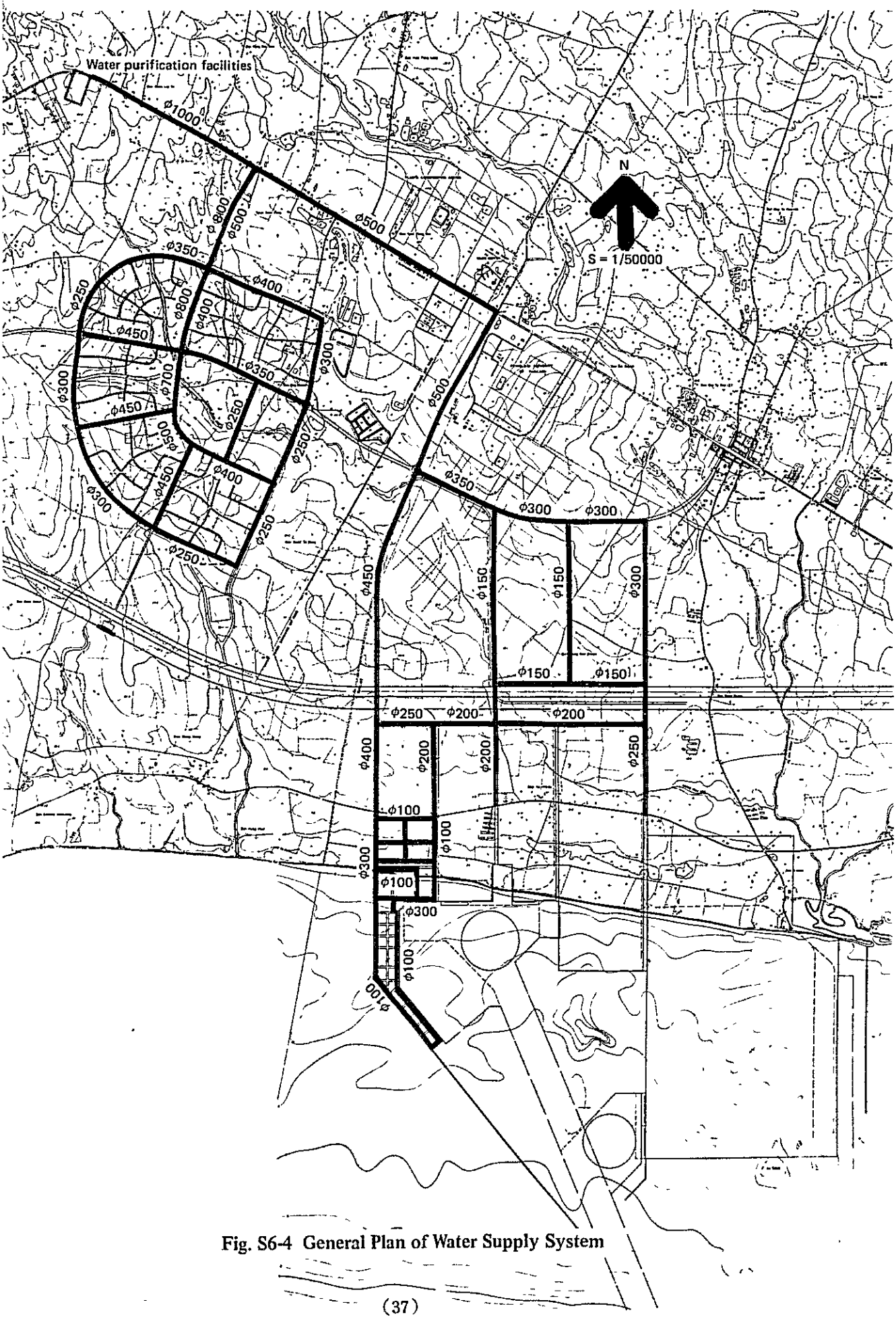


Fig. S6-4 General Plan of Water Supply System

4) Sewerage and Treatment of Effluents

(i) Amount of Sewage

(a) Amount of future domestic sewage effluent in urban area

Items	Unit	1st Phase	2nd Phase	Total
Target population	person	18,300	53,200	71,500
Size of urban area for design of sewage treatment plant	ha	131	444	575
Daily maximum	m^3/d	6,863	19,950	26,813

(b) Amount of future domestic sewage effluent in port area is as follows;

	1st Phase	2nd Phase
Population served (per.)	500.0	1,000.0
Daily maximum (m^3/day)	150.0	300.0

(c) Loads from industrial complex

Sewage from The Industrial Complex consists of the waste water generated in the process plants and the domestic waste water.

Quantity of the sewages discharged to the waste water treatment facilities within the Complex is as follows.

1st Pase	Waste Water (m^3/h)
Soda ash	450 (60 g Nacl/l)
Petrochemical	540 (mixture)
Fertilizer	500 (mixture)
1st & 2nd Phase	
Soda ash	810
Petrochemical	970
Fertilizer	900
Iron and steel	4,050
Total:	8,220

(ii) Planning Policy

Sewage generated from the Port Area, Industrial Complex and Urban Area will be individually treated in each zone.

(iii) Proposed Sewarage System

(a) Industrial complex

The waste water will be treated inside the each plants in accordance with the water quality standard of Thailand. After then, the waste water will be discharged to sea together with the domestic waste water.

(b) Port area

Domestic waste water generated in the Port Area will be collected independently and discharged to sea after biological treatment.

(c) Urban area

Domestic waste water generated in the port area will be collected independentprior to discharge into the river.

(iv) Sewage Treatment Plant

(a) Amount of sewage in urban area

Items	Unit	lst Phase	2nd Phase	Total
Daily maximum include ground water	m^3/d	8,300	24,200	32,500

(b) Amount of sewage in port area

Items	Unit	lst Phase	2nd Phase	Total
Daily maximum	m^3/d	150	150	300

(c) Sewage effluent quality

BOD	20 mg/l
SS	30 mg/l

(v) General Plan of Sewage System in Urban Area

General plan of sewerage system in Urban Area is shown Fig. S.6-5.

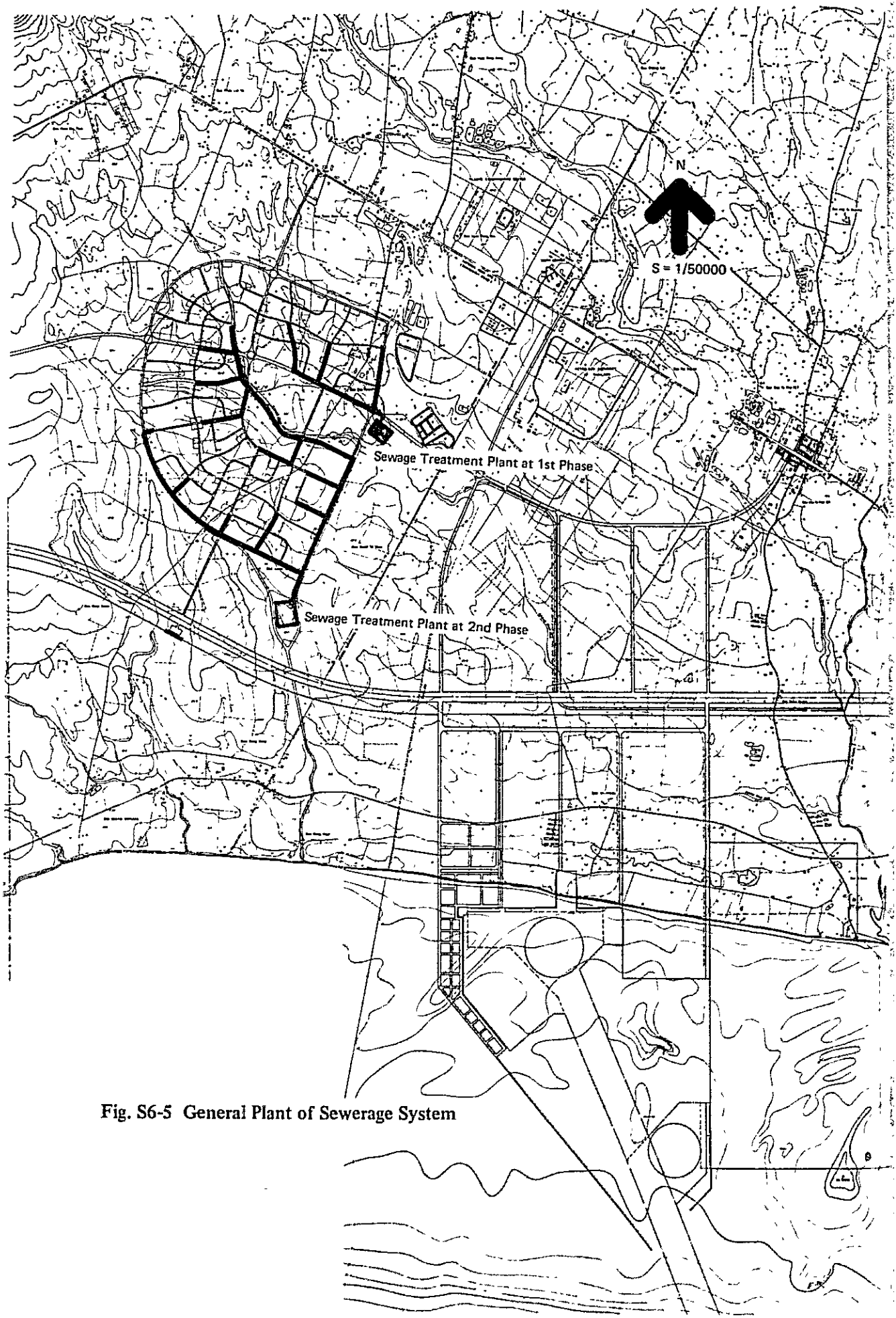


Fig. S6-5 General Plant of Sewerage System

5) Drainage System

(i) Catchment basin: Some substantial changes will be made in the catchment basin for an economical reason. That is, we can reduce the section of this river by this changes.

(ii) Watercourse and river improvement: Watercourse of covered U-type, culverts and trapezoidal shape will be arranged to carry surface water. The existing river will be improved and used for drainage.

(iii) Runoff and section size:

(a) Rainfall intensity Water course 140 mm/hr
River improvement 140 – 55 mm/hr

(b) River Plan is shown in Fig. S.6-6

6) Solid Waster Disposal

(i) Quantities and Characteristics of Solid Waste

(a) Industrial Complex

Various kinds of solid wastes will be generated in, and have to be disposed from the Industrial Complex in accordance with the nature of each complex.
The description and quantities of those refer to the following table.

	1st Phase	1st Phase and 2nd Phase
Soda ash	144,000 t/y ($CaCo_3$, Gypsum)	288,000
Petrochemical	2,000 t/y (Filter cake)	4,000
Fertilizer	1,100,000 t/y (Gypsum)	2,200,000
Iron and steel	–	321,800 (Oxydized iron and others)

(b) Port-related Solid Waste

Bilge

1st Phase: 1,000 t/year (be disposed of by specialized traders)
Master Plan: 6,000 t/year (be processed in certain suitable facilities)

Municipal Solid

They are jointly discussed in Urban Area.

(c) Urban and Port Area

Unit average generation rate

800 g/cap. day

Total volume

1st Phase: (18,300 + 500) persons x 800 g/cap. day = 15.0 t/day

2nd Phase: (71,500 + 1,000) persons x 800 g/cap. day = 58.0 t/day

(ii) Solid Waste Disposal System

(a) Industrial Complexes

Solid wastes to be produced in the industrial complexes are disposed in accordance with the latest technology in consideration of environmental protection and financial feasibility.

The principle of the disposal system plan, as has been practiced in the developed region, is to provide the disposal system in the individual complex of origin of the wastes.

(b) Urban and Port Area

Solid wastes to be generated in Urban Area will be collected and transported to the Landfill Site.

(iii) Operation Plan for Collection and Transport

(a) Urban and Port Area

Collection and transport system

The following collection system is proposed:

	Residential Area	Town Center
Container and collection system	Stationary container with cover	Hauled container system
Frequency	3 times/week	Depends on volume
Truck	Compactor	Container loader

(iv) Disposal Area Study

Urban and Port Area

Three alternative sites were selected for comparative study with a result of site (3) best suited. Fig. S.6-7 shows alternative site locations

Fig. S6-6 River Plan

Fig. S6-7 Alternative Site Locations

7) Power and Telecommunication System

(i) Power system

(a) Electric power supply to the Industrial complexes is carried out with 115 KV transmission line from Rayong No. 3 substation and with 230 KV transmission line from Rayong No. 2 substation. For the 1st phase of the project 115 KV receiving/distribution substation will be built in the Industrial Complexes.

(b) For the Master Plan of the project the 115 KV receiving/distribution substantion will be expanded to a double capacity. Power supply to the iron and steel complex with the 230 KV transmission line will directly be made from Rayong No. 2 substation.

(c) The assumed breakdown of receiving capacity to the plants in the Industrial Complexes is shown as follows:

(Unit: MW)

	1st Phase	Master Plan	Total
Petrochemical	75	75	150
Soda Ash	25	25	50
Fertilizer	16	16	32
Supporting Industries	3.4	–	3.4
Port Area	1.6	1.8	3.4
Marshalling Yard	0.5	0.6	1.1
New Town	12	48	60
Downstream	–	43	43
Iron and Steel	–	1,011	1,011
Total	133.5	1,220.4	1,353.9

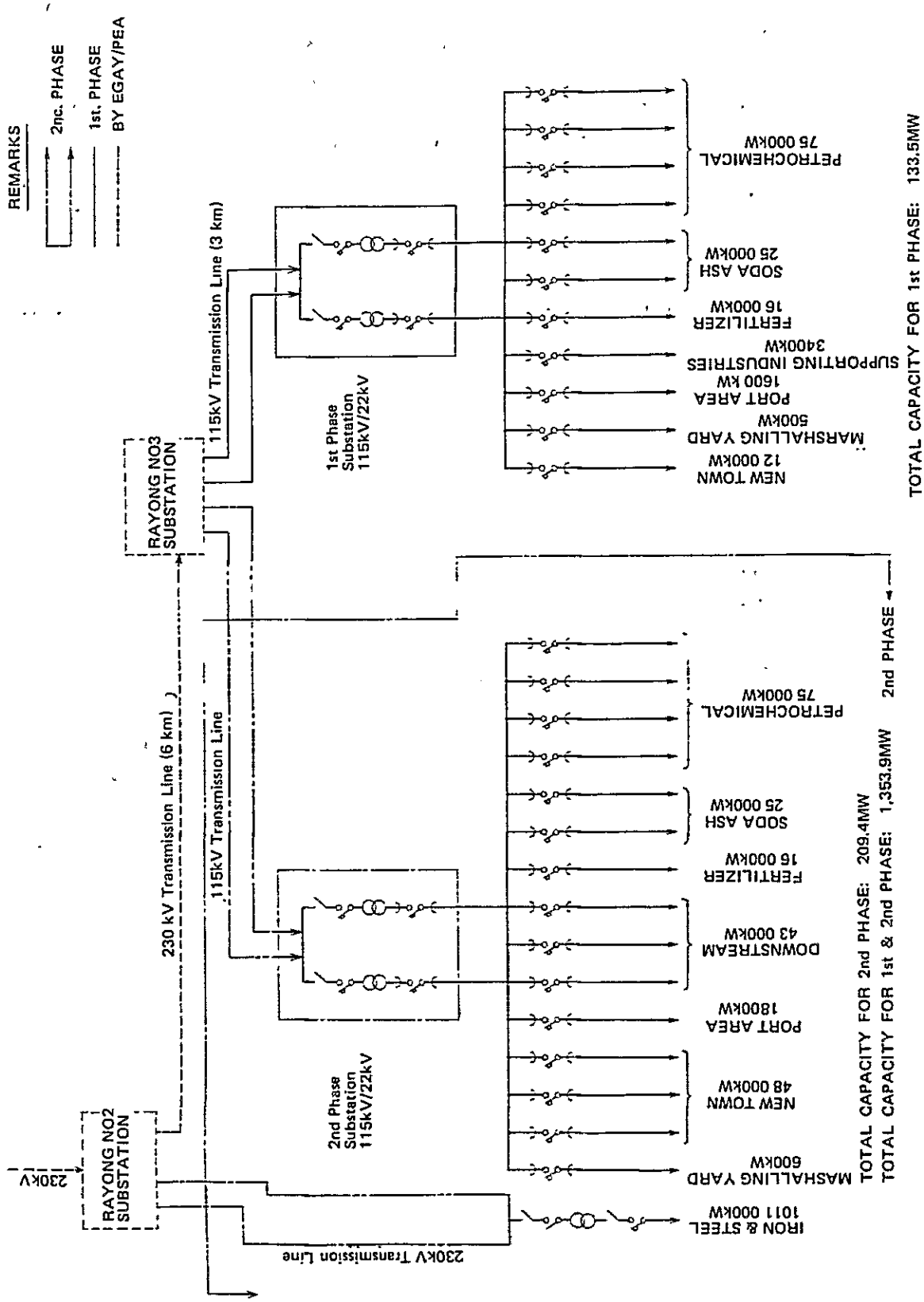


Fig. S6-8 Electric Power Receiving and Distribution System

(ii) Telecommunication System

Total M.T.S and the number of lines installed

(a) Total Main Telephone Station and Public booths are estimated as follows;

	1990	2000
New town area	1,800	6,290
Town center	600	2,170
Industrial complexes	180	540
	(120 + 60)	(355 + 185)
Port and related area	50	150
Other industrial area	170	620
Sub-total	2,800	9,770
Public booth	60	200
Total M.T.S	2,860	9,970
The number of lines installed	3,000	10,000

(b) Number of telex and telegram terminals etc.

The number of telex terminals, telegram terminals and other non-telephone service facilities required in the industrial complexes will be assumed as follows;

	As of 1987			As of 2000		
	Telex	Telegram	Fax. etc.	Telex	Telegram	Fax. etc.
Soda ash	1	–	1	2	–	1
Petrochemical	6	–	2	10	–	5
Fertilizer	1	–	1	2	–	1
Iron	–	–	–	3	–	2
Port & Related area	1	–	–	3	–	1
Other industries	2	–	1	4	–	2
Town Center	4	2	1	4	2	2
Total	15	2	6	28	2	14
Leased circuits		23			44	

(7) Pre-Environmental Assessment

This master plan has the various environmental impacts as shown below.

(i) Quality of Air and Water

(ii) The influence on Tidal current

(iii) The influence on marine biota

(iv) The influence on fishery activities

(v) The influence on noise level of vehicles and plants

(vi) The influence on land scape

(vii) The influence on recreational area

The magnitude of these impacts can not be estimated, because the operating processes of each plant are not decided yet and data concerning existing the environmental quality level within the proposed development area are not available.

Therefore, the level of the environmental impacts will be examined based on the monitoring results from the Kashima Industrial Port which has the same production scale as this master plan These results indicates to satisfy the environmental standard of Japan which is more severe standard than that of Thailand.

But this master plan has the various impacts to some extent on such aspects as the noise level, marine biota, fishery activities, landscape and recreational activities. Therefore, it is still recommended to establish the monitoring system in this area for any unexpected changes. The monitoring items should include air quality, water quality, noise level, vibration and nasty smells etc. The locations of monitoring stations should be within a 10km radius from the discharged points of waste loads depending on the results of a Pasquill's equation analysis.

(8) Cost Estimation

Construction cost of the master plan is shown in Table S8-1. Plant construction cost is excluded from this cost estimation.

Table S8-1 Construction Cost (Master Plan)

Item	Unit	Quantity	Unit Price (฿)	Amount (Thousand ฿)			Total Amount (Thousand US$)
				Total	Local Currency	Foreign Currency	
1. Industrial Complex	Ls	1		5,172,000	2,713,600	2,458,400	224,870
2. Port Area	Ls	1		5,397,400	2,410,500	2,986,900	224,670
3. Urban Area	Ls	1		1,824,300	1,256,800	567,500	79,320
4. Railway	Ls	1		337,000	228,800	108,200	14,650
5. By-pass & Connective Road	Ls	1		1,023,900	701,600	322,300	44,520
6. Buffer Zone	ha	110	312,500	* 34,00	* 34,400	0	1,500
Sub-total				13,789,000	7,345,700	6,443,300	599,530
7. Telecommunication	Ls	1		318,700	76,000	242,700	13,860
8. Housing & Public Facilities	Ls	1		6,321,200	5,706,400	614,800	274,830
Sub-total				6,639,900	5,702,400	857,500	288,690
Total Construction Cost				20,428,900	13,128,100	1,300,800	888,220

* This amount is land acquisition cost. The land price is assumed to be 50,000 ฿/Rai.

(9) Cargo flow in Short Term Development

Corresponding to the industrial activity assumed in the first phase, the cargo transportation volume and its mode was estimated as follows in the table;

Table S9-1 Cargo Flow by All Mode (1st Phase)

Unit: T/Y

Center	Name of Commodities	Cargo Format	Cargo Volume	From Industrial Complex					Into Industrial Complex					Remarks
				Ship and Export	Barge Outward	Railway	Truck	Destination	Ship and Import	Barge Inward	Railway	Truck	Origin	
1. Fertilizer	Urea	Bag	400,000	-	200,000	60,000	140,000	whole						
	Fertilizer	Bag	600,000	-	300,000	90,000	210,000	whole						
	Phosphate Acid	Liquid	25,000	-	20,000	6,000	14,000	W N						
	Sulfer	Bulk	203,300						203,300				Foreign	
	Phosphate Ore	Bulk	704,000						704,000				Foreign	
	Potash ore	Bulk	315,000								315,000		North East	
2. Soda Ash	Soda Ash	Bag	400,000	200,000	100,000	30,000	70,000	W N						
	Ammonium Chloride	Bag	400,000		200,000	60,000	140,000	whole						
	Rock Salt	Bulk	562,200								562,200		North East	
3. Petro-chemical	LDPE	Bag												
	HDPE	Bag	110,000			33,000	77,000	W N						
	PP	Bag	70,000			21,000	49,000	W N						
	MEG	Liquid	50,000		40,000	3,000	7,000	W N						
	VCM	Liquid	80,000		64,000	4,800	11,200	W N						
	Caustic Soda	Liquid	103,200		83,000	6,060	14,140	W N						
	Rock Salt	Bulk	91,700								91,200		North East	
4. Iron & Steel	Steel Products	Bulk												
	Iron Ore	Bulk												
	Scrap	Bulk												
	Burnt-Lime	Bulk												
	Ferro-Manganese	Bulk												
	Ferro-Silicon	Bulk												
	Aluminum	Bulk												
	Fluorite	Bulk												
	Carburizing	Bulk												
	Fly Ash	Bag												
	Fine lime	Bag												
	Slug	Bulk												
	Scale	Bulk												
5. Down & Supporting Industries	Products	Bulk	166,000		27,000	3,000	136,000	W N						
	Raw Materials	Bulk	191,000							42,000	0	149,000	North	
6. Public Terminal	Potash Ore	Bulk	(685,000)	685,000				Foreign			685,000		North East	
	Tapioca	Bulk	(760,000)	760,000				Foreign				760,000	East	
	Steel Products	Bulk	35,000				35,000	W&E	35,000				Foreign	
	Cement	Bag	75,000				75,000	W&E		75,000			North	
	Sant	Bulk	170,000				170,000	W&E		170,000			North	
TOTAL			6,195,900	1,645,000	1,034,000	316,860	1,118,340		942,300	287,000	653,400	909,000		