JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

INDUSTRIAL ESTATE AUTHORITY OF THAILAND
MINISTRY OF INDUSTRY

FEASIBILITY STUDY ON BANG SAPHAN INDUSTRIAL ESTATE IN THE KINGDOM OF THAILAND

FINAL REPORT

(Summary)

January 1997

NIPPON KOEI CO., LTD.

JAPAN INDUSTRIAL LOCATION CENTER

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Preface

In response to request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct the Feasibility Study on Bang Saphan Industrial Estate in the Kingdom of Thailand and the study was implemented by the Japan International Cooperation Agency (JICA).

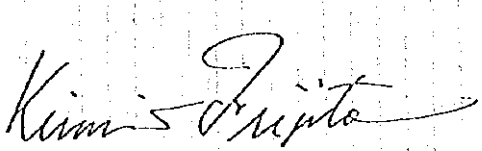
JICA sent a study team, led by Mr. Hajima Koizumi of Nippon Koei Co., Ltd. and organized by Japan Industrial Location Center, to the Kingdom of Thailand three times from November 1995 to November 1996.

The team held discussion with the officials of the Government of the Kingdom of Thailand, and conducted related field surveys. After returning to Japan, the team conducted further studies and complied the final results in this report.

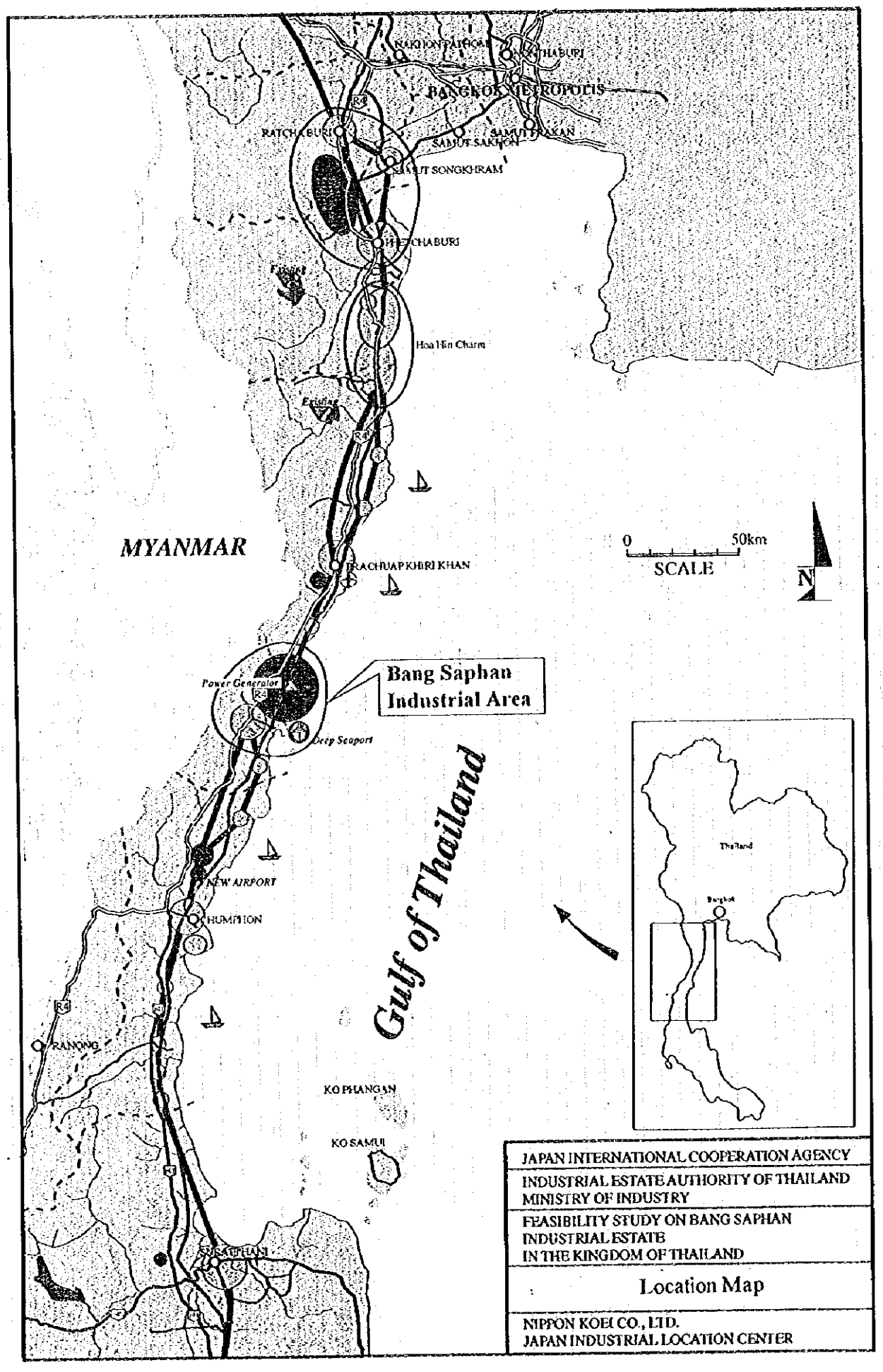
I hope this report will contribute to the promotion of the plan and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation throughout the study.

January, 1997



Kimio Fujita
President
Japan International Cooperation Agency



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Location Map
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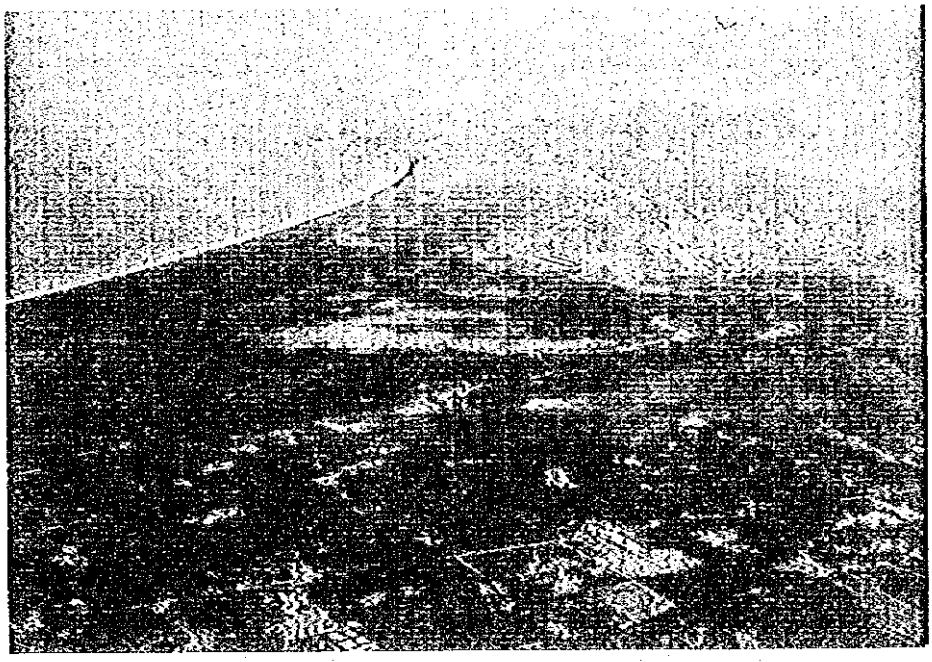
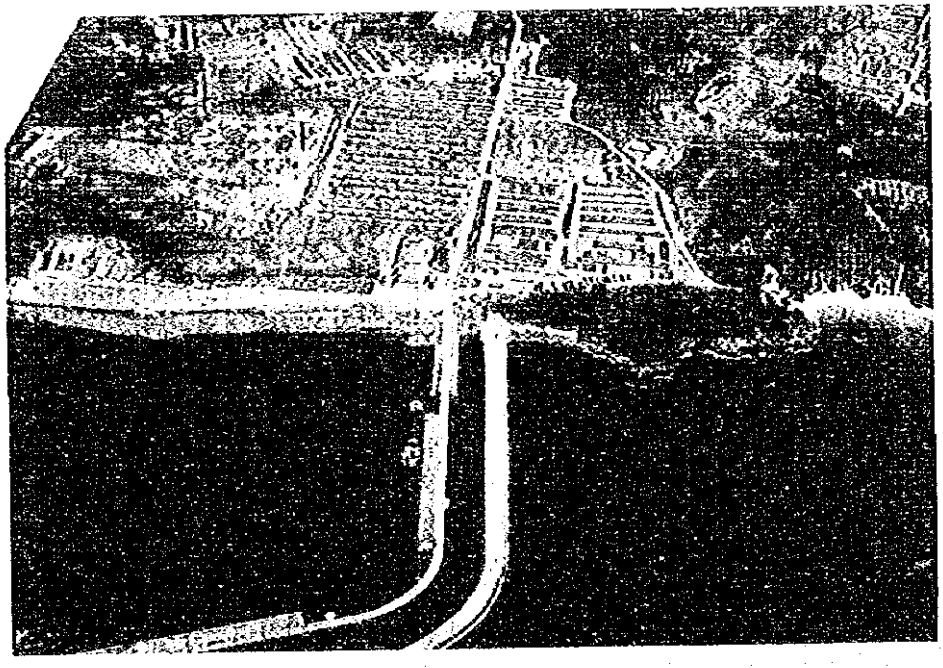


Aerial View of the Project Area (February 1996)



Prachuap Port (February 1996)

Feasibility Study on Bang Saphan Industrial Estate
(Final Report)

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List of Acronyms

AFTA	ASEAN Free Trade Agreement
BMA	Bangkok Metropolitan Authority/Area
BOI	Board of Investment
BSIE	Bang Saphan Industrial Estate
DOH	Department of Highways
DTCP	Department of Town and Country Planning
EGAT	Electricity Generating Authority of Thailand
EPZ	Export Processing Zone
ESB	Eastern Seaboard
FTA	Free Trade Area
FTZ	Free Trade Zone
GIE	General Industrial Estate
IEAT	Industrial Estate Authority of Thailand
IPP	Independent Power Producer
JICA	Japan International Cooperation Agency
MCM	million cubic meter(s)
MOI	Ministry of Industry
NESDB	National Economic and Social Development Board
PCU	passenger car unit
PEA	Provincial Electricity Authority
RID	Royal Irrigation Department
TOT	Telephone Organization of Thailand
WSB	Western Seaboard

Exchange Rate
US$1 = Baht 25
in July 1996

1. Background and Objective of the Study

Thailand is enjoying drastic economic expansion and enlarging the manufacturing industry in recent years. However, such industrial production enlargement depends on the growth of processing and assembling industry which imports and processes semi products and assembles final products. It can be said that upstream industry producing industrial materials, on the other hand, is premature in Thailand. For instance, iron and steel industry, one of major material industries, covers only 17% of the amount of consumption in Thailand and the remainder is imported presently.

For the purpose of realizing an advanced industrial structure supported by an integrated production process, principles for enhancement of the material industry were established by the Government and large-scale development of iron and steel industry has commenced in the Bang Saphan area from 1993 on the private sector initiative.

Against this background, the Government of Thailand (GOT) requested the Government of Japan to provide technical cooperation concerning the feasibility study on the Bang Saphan industrial estate. This feasibility study aims to examine the development possibility of the "Bang Saphan industrial estate" which is expected to be contributive to the establishment of a material industry complex in the Bang Saphan area with the cooperation of the iron/steel industry initiated by the private sector.

2. Execution of the Study

The Study has been executed by the consortium of Consultants retained by Japan International Cooperation Agency (JICA), an official agency in charge of the technical cooperation program. The consortium is composed of the following consulting firms:

Nippon Koei Co., Ltd. (Lead firm)
Japan Industrial Location Center

On the Thailand side, a Steering Committee was formed to coordinate, review and supervise the Study. The Committee, headed by Vice-Governor of IEAT, is composed of the representatives from NESDB, MOI, DTCP, BOI, DTEC, RID, DOH, PEA, Office of Environmental Policy and Planning, and Thai Industrial Estate Association.

The Study was initiated in November 1995 and the Final Report was submitted in January 1997.

3. Overview of Western Seaboard and Prachuap Khiri Khan Province

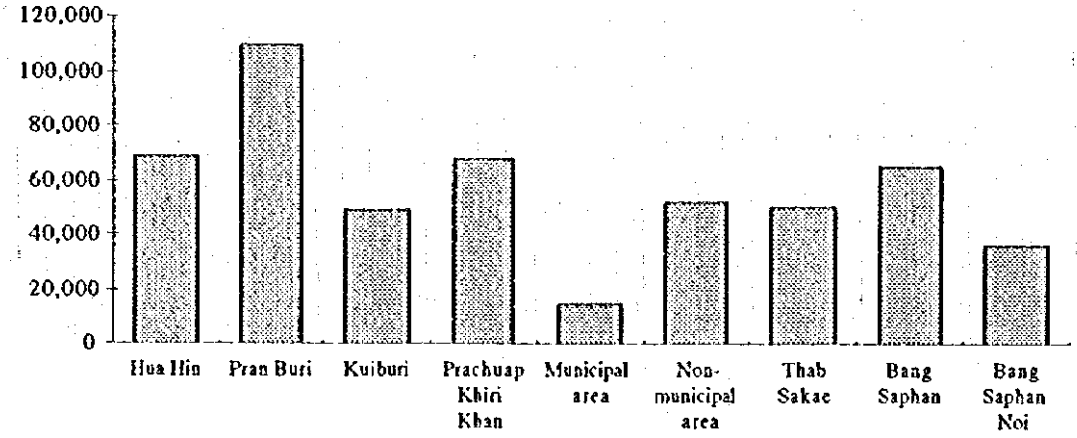
Population

The Western Seaboard composed of six provinces had a population of 2.9 million in 1994 representing 5.2% of the population of the Kingdom. The region's population increase of approximately 154,000 during 1989 ~ 1992, at an annual growth rate of 1.5%, was a little larger than the national average of 1.1% per annum.

The population of Prachuap Khiri Khan province, located in the center of the Western Seaboard, was 441,930 in 1994 and increased by approximately 22,000 during the last 5 years, at an annual growth rate of 1.0%.

Prachuap Khiri Khan province is composed of six districts (Amphoe) and one municipality (City). The most populated district is Pran Buri with 110,144 inhabitants in 1995, an increase of 7.8% from 1994. Hua Hin, Prachuap Khiri Khan and Bang Saphan had the next largest population of 69,350, 68,404 and 65,115 respectively in 1995.

Population by District in Prachuap Khiri Khan Province

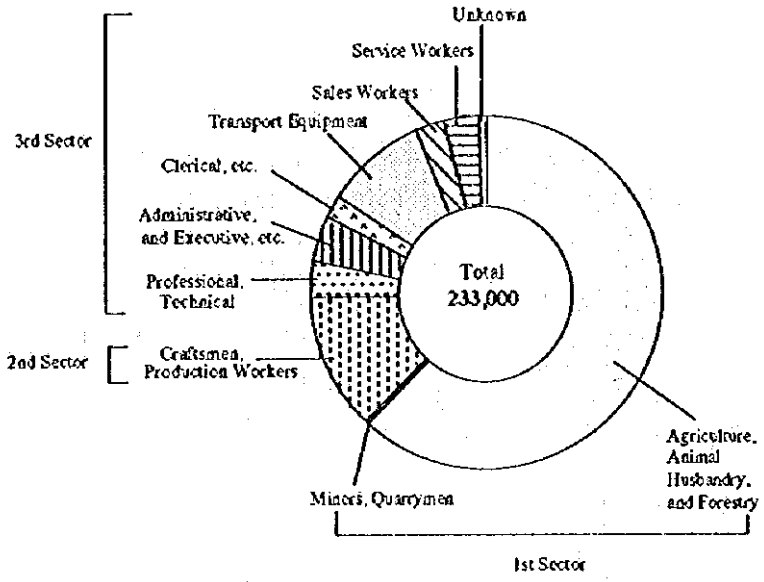


Source: Statistical Report and Investment Plan of Prachuap Khiri Khan Province

Labor Force

Prachuap Khiri Khan has a labor force of approximately 233,000, or 0.76% of the national labor force. The labor force configuration by category of industry is 62% for the agricultural industry, 13% for the manufacturing industry, and 25% for the commercial and other industries. From these figures it can be said that the main industry of Prachuap Khiri Khan province is agriculture.

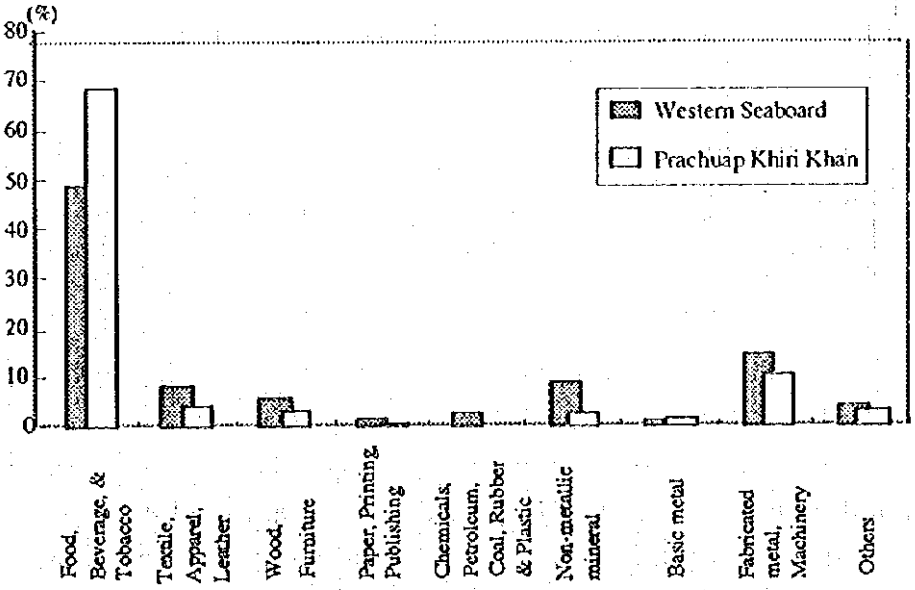
Labor Force of Prachuap Khiri Khan Province (1990)



Source: Statistical Report of Prachuap Khiri Khan Province and Labor Force Survey (1993)

Manufacturing Industry

In the manufacturing industry of Prachuap Khiri Khan Province, a total number of 459 registered establishments were in operation and employed 13,641 workers in 1994. Major manufacturing subsectors are food manufacturing (152 establishments and 9,640 employees; canning and preserving of fruit and vegetables factories are large both in investment and number of employees) occupying approximately 70 % of total employee of the manufacturing industry which is remarkably higher than the food industry of the Western Seaboard as shown below.



Industrial Structure by Number of Employee in 1994

Industrial Estate

The GOT recognized the important role of industrial estates for the industrial promotion and embarked on a program of creating industrial estates from the 1970s. IEAT developed the Bang Plee industrial estate, Lat Krabang industrial estate in the Bangkok suburb, and Laem Chabang and Map Tha Phut industrial complexes on the Eastern Seaboard to cope with the drastically increasing investment demand of foreign entrepreneurs. In the 1990s, private development of industrial estates was encouraged and supported by the government and many joint-venture developments by IEAT and private companies have since been made. Presently 96 industrial estates are developed and approximately 60% of land was occupied as shown below.

The numbers of developed and planned industrial estates in Thailand are listed below.

Industrial Estates by Region in Thailand

Region	No. of I.E.	Total		Vacant Area		Area Occupied	
		ha	rai	ha	rai	ha	rai
Central	32	6,518	40,738	1,759	10,994	4,766	29,789
Eastern	25	7,794	48,715	3,296	20,601	4,498	28,114
Northern	13	1,091	6,818	566	3,536	525	3,282
North eastern	12	2,613	16,329	1,268	7,924	1,345	8,405
Western	3	557	3,481	557	3,481	0	0
Southern	11	138	864	129	804	10	60
Total	96	18,711	116,945	7,575	47,340	11,144	69,650

Note: 1 rai = 1,600 m²

Source: Tabulated based on the data from IEAT.

The present stock of industrial estates is analyzed in comparison with the investment demand as shown below.

Demand-Supply Balance of Industrial Estates in Thailand

(1)	Annual Demand (1989-1995 average)	18,179 rai	(2,909 ha)
(2)	Stock of industrial estates	47,340 rai	(7,575 ha)
(3)	Industrial estates under planning	60,000 rai	(9,600 ha)
(4)	Expected years to be sold out (Stock+planned IE)	5.9 years ((47,340+60,000)/18,179=5.9)	

The present stock of industrial estates in Thailand is estimated at approximately 100,000 rai (16,000 ha) and all industrial estates will be occupied by investors after only 5.9 years. In the case the investment demand shrinks to half of the present figure, the existing and planned industrial estates would need a period of approximately 10 years to be fully occupied. It means that all the industrial estates including the planned ones will be filled by

the year 2005. It also means that the demand and supply balance of industrial estates in Thailand will still be tight even if the investment demand will decrease.

Role of the Western Seaboard and Bang Saphan

Industrial development axes in Thailand can be conceived as shown in Figure 1, judging from the development situation of industrial estates:

a.	Relocation axes from Bangkok Metropolis	:	Eastern Seaboard, Saraburi
b.	Northeastern axes	:	Khon Kaen, Nakohn Ratchasima, Ubon Rachathani
c.	Northern axes	:	Nakhon Sawan, Phitsanuluk, Chiang Mai, Chiang Rai
d.	Southern axes	:	Surat Tani, Song Khla, Hat Yai

Four industrial development axes, in the east, northeast, north and south, will be encouraged to promote well-balanced national development. However, there is long undeveloped coastal area of the Western Seaboard in the south axes. It is important that the industrial area of the Western Seaboard be developed in order to link the Bangkok Metropolis and the Southern Seaboard to the border of Malaysia.

Industrialization of the Western Seaboard which is located next to the Central Area will be contributive to the decentralization of the over-populated capital area. Further, the development of industrial area in the hinterland of the deep sea port in Bang Saphan will be important for the effective utilization of deep shore which is finite in the Gulf of Thailand as shown in Figure 2.

Figure 3 presents the prospective linkage between the Bang Saphan area and industrial areas developed in Thailand and neighboring countries.

Advantages of Bang Saphan Area in the Development of Industry

The Bang Saphan area is evaluated as the suitable location for the development of manufacturing industry considering that 1) the construction of deep sea port is rather easier, 2) cheaper land cost is available, 3) the giant iron/steel industry is presently operating, etc. The most advantageous point is that the Bang Saphan area is comprehensively planned by the Western Seaboard Regional Development Master Plan and the official support concerning the advantageous incentives for investment promotion and development of the supporting infrastructure will be available. Advantages of Bang Saphan area in the development of industry is summarized in Table 1.

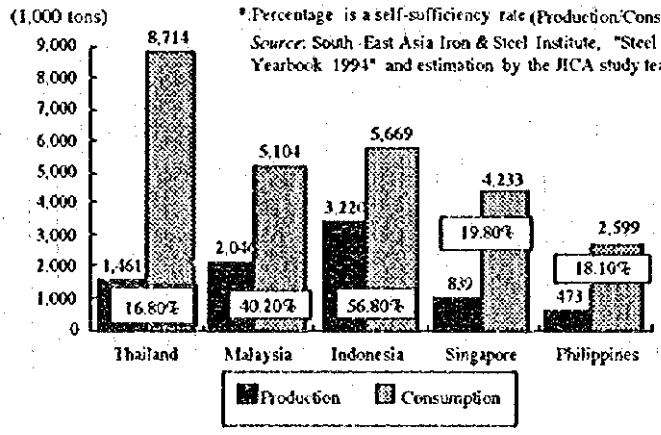
4. Development Direction of Steel Industry in Bang Saphan

Present Status of Steel Industry in Thailand

The Thai steel industry has experienced constant growth in terms of both consumption and production, underpinned by steady economic growth.

However, one of the characteristics of the Thai steel industry is the lowest self sufficiency in steel products. Particularly, it is notable that Thailand has the lowest self-sufficiency rate in terms of crude steel, as shown below, although it has a relatively large economy and is in an advanced stage of economic development among the ASEAN countries. This is the result of the underdevelopment of the upstream steel industry, namely iron and steel making. Establishment of iron and steel making facilities requires a large amount of capital, and the fact that Thailand has no state-owned integrated steel mills is largely responsible for this low rate of self-sufficiency in crude steel, while other ASEAN countries such as Indonesia and Malaysia have .

Production and Consumption of Crude Steel in ASEAN Countries (1994)



Comparison Study of Promoting Measures in Asia

In many Asian countries governments have played an important role in promoting the growth of the steel industry by establishing state-owned companies or giving many incentives and protection. Government ownership of the steel industry is found in Korea, Taiwan, Malaysia, and Indonesia, and also at the early stage of the industry's formation in Japan. In those countries, there were direct or indirect financial supports by the government, because the steel industry requires a huge amount of capital. There have also been various tax benefits, support for infrastructure and protection from imports. There is also a global trend of privatization of state-owned steel firms on a worldwide basis to

promote efficiency and to reduce government obligations. On the other hand, in Thailand the scale of measures taken was relatively small, especially with no direct injection of capital to core steel producers.

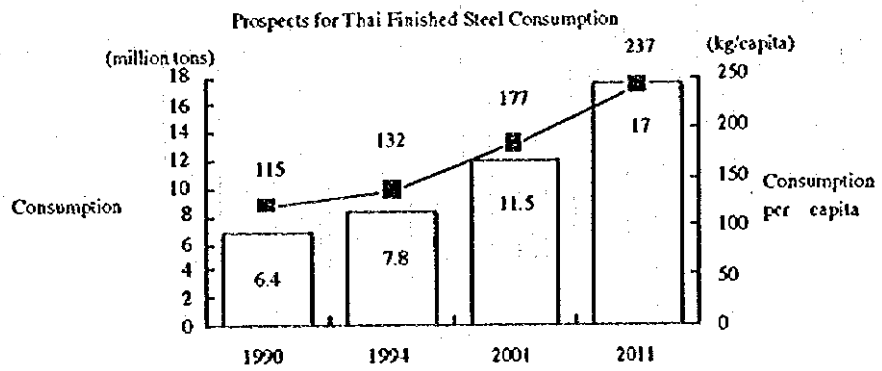
While there is no rationale for introducing subsidies and direct promoting measures under this global environment, introduction of indirect measures including a preparation of basic infrastructure such as port facilities, roads, railways, electricity and water supply, should be considered to nurture the steel industry and to establish a steel-based industrial complex in a remote area. This area is away from the Bangkok Metropolitan area and has to bear a lot of inconveniences due to such isolation, while having a perfect conformity to the government policy of "Decentralization".

	Government Ownership	Financial Support	Support for Infrastructure Development	Tax Benefits	Import Restriction
Japan	+-	+-	+-	+-	+-
Korea	++	++	++	++	++
Taiwan	++	++	++	++	++
Indonesia	++	++	++	++	++
Malaysia	++	++	++	++	++
Thailand	--	--	--	++	++

++: Exists both in the past and now, +-: Exists only in the past, --: Does not exist

Future Steel Industry in Thailand

Based on the economic growth, it is forecast that finished steel consumption in Thailand would reach 11.5 million tonnes in 2001 and 17 million tonnes in 2011. This means that every individual in Thailand consumes 237 kilograms of steel every year, or in other words Thailand consumes 26 grams of steel to produce one US dollar of GDP, which is a world standard level compared to its assumed per capita GDP of US$9,000.



Taking into account the fact that Thailand has a low self-sufficiency rate of steel products and steel consumption is expected to grow at a steady rate, many are planning to

construct steel mills in Thailand. Simple accumulation of reported capacities of these projects suggests that production capacity increases of 12 to 13 million tonnes of iron and steel are in consideration. It is assumed that production capacities would be in a direction to increase the country's self-sufficiency in steel products. The Study Team sees much possibility for Thailand to increase its self-sufficiency rate of finished steel to around 90 per cent by the year 2011.

Prospective Development of Steel Industry in Bang Saphan Area

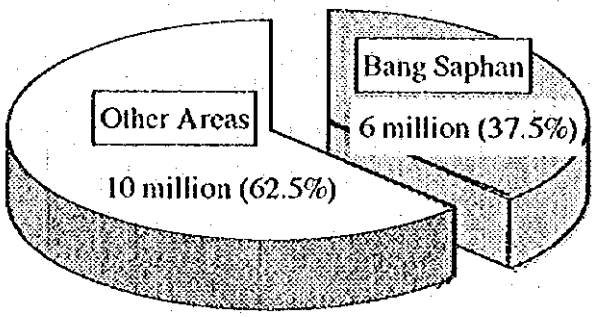
The following facilities have been installed or are under construction in Bang Saphan.

Hot Strip Mill	2.4 million tonnes/yr (Mt/y)	in operation
Electrogalvanizing	0.135 Mt/y	in operation
Bar Mill	0.72 Mt/y	in operation
Cold Strip Mill	1.0 Mt/y	under construction

At the moment, the complex does not have upstream production facilities which provide semi-products such as slabs for hot strip mill and billets for bar mill. Therefore, these feedstocks are imported. However, procurement of a big amount of slabs (2.5 million tonnes per annum) is not always easy and will be more difficult.

Considering that Thailand could expect a constant increase in steel consumption and that the Bang Saphan area has an established base for the steel complex with a deep sea port, it would be quite reasonable to expand its capacity including iron and steel making in accordance with the plan of the Sahaviriya group, which is almost one third of the estimated crude steel consumption in Thailand.

Importance of Bang Saphan in Crude Steel Production in Thailand (2011)



5. Investment Demand in Bang Saphan Industrial Estate

Results of Investment Demand Survey

Industrial investment demand was estimated from the viewpoint of macroeconomic projection and microscopic consideration, based on the results of demand questionnaire survey.

Macroeconomic Projection

For the Western Seaboard (WSB) including the Bang Saphan Area, NESDB conducted the projection of the regional economy with cooperation of the JICA Study Team (WSB Team) for the target years of 2001, 2006, and 2011 as shown below.

Estimate of GRP of Industrial Sector in WSB in 2001, 2006, and 2011

Unit: million Baht, %

					Annual Growth Rate		
	1994	2001	2006	2011	95-01	02-06	07-11
Low Case	48,985	88,403	134,776	205,474	8.8	8.8	8.8
Middle Case	48,985	122,575	197,408	296,833	14.0	10.0	8.5
High Case	48,985	122,575	246,541	434,490	14.0	15.0	12.0

Source: Western Seaboard Regional Development Master Plan Study, Interim Report, Volume 3

Based on these estimates, the Study Team projects the GPP (Gross Provincial Product) of industrial origin in Prachuap Khiri Khan taking the Middle Case and High Case in WSB estimates.

GPP Manufacturing Sector in Prachuap Khiri Khan in 2001, 2006, and 2011

Unit: million Baht, %

					Annual Growth Rate		
	1994*	2001	2006	2011	95-01	02-06	07-11
Scenario 1	6,661	18,162	37,400	67,314	18.2	15.5	12.5
Scenario 2	6,661	18,162	42,485	87,182	18.2	18.5	15.5

Note: *Figures for 1994 are actual. In 2001, the estimates of both scenario 1 and 2 are the same.
Source: The Study Team estimates.

Assuring that manufacturing products in Bang Saphan will increase drastically and account for 60-90% of GPP as shown in the table below, the value added derived from the Bang Saphan area (including the manufacturers in the Bang Saphan industrial estate and Iron and Steel Complex) was estimated. In the estimation, configuration of the manufacturing sub-sectors identified in the subsequent section is considered.

Percentage of GPP in Bang Saphan Area against Total GPP

%

	2001	2006	2011
Scenario 1	60	74	80
Scenario 2	60	78	87

The value-added and development area for industrial use in the Bang Saphan area are set as follows:

(Scenario 1 ~ Scenario 2)

Year	Value-added (mill. Baht)	Area (ha.)
2001	10,973	150
2006	27,519 ~ 33,169	350 ~ 450
2011	53,394 ~ 75,469	620 ~ 810

Source: The Study Team Estimates.

Results of Questionnaire Survey and Interview Survey

(Demand in 2001)

The Study Team identified that 10 companies might invest in the Bang Saphan Industrial Estate by 2001, according to the interview survey. The average site demand per company is around 36 rai and the total area demand by 2001 was estimated at 360 rai or 57.6 hectares as shown below.

Type of industry	Need of Land area	Major product	The reason of interest							The requirement to I.E				
			1	2	3	4	5	6	7	1	2	3	4	5
Chemical	60 rai	Pharmaceutical bulk	O		O	O	O			O	O		O	
Chemical	150 rai	PX, PTA	O		O				O	O	O			
Chemical	5 rai	PVC, PP, ABS, PE	O		O		O			O			O	
Furniture	5 rai	Wooden furniture	O					O		O				
Machinery	30 rai	Pump	O	O						O	O	O		
Auto Parts	20 rai	Bearings	O							O	O	O		
Electrical Machinery	10 rai	Electrical equipment	O	O		O				O	O	O		
Machinery	20 rai	Hoist	O	O	O					O		O		
Iron & Steel	20 rai	Steel Service	O	O										O
Fabricated metal	40 rai	Steel Structure	O	O	O					O		O		
Total	360 rai	(57.6ha)	-	-	-	-	-	-	-	-	-	-	-	-

1= Beside Deep seaport
2= Near iron & steel industry
3= In FTA
4= In Zone 3
5= In industrial estate
6= Raw materials can be got from near area
7= Sufficient land space

1= Good city life
2= Easy access Eastern Seaboard
3= Stable supply of raw materials
4= Land price
5= Nearby customers

(Demand in 2011)

Based on the results of questionnaire survey conducted by the Study Team and the expansion coefficient, which is equivalent to the reciprocal of the sampling ratio, the total number of prospective investors was estimated at approximately 180 and 830 respectively as shown below.

	No of Samples	Total Number	Expansion Coefficient	Replied Number		Expanded Number	
	a)	b) *	1/a)*b)	Yes	Possibly	Yes	Possibly
Taiwan	1,000	12,242	12.24	1	11	12	135
South Korea	500	3,926	7.85	4	39	31	306
USA	1,000	5,205	5.21	3	36	16	188
Japan	2,389	29,047	12.16	7	14	85	170
Subtotal	4,889	50,420		15	100	144	799
Thailand	2,888	7,999	2.77	12	11	33	30
Total	7,777	58,419		27	111	177	829

Source: * Taiwan: 1991 Taiwan-Fukien Census Report of Commerce and Service Industry, Republic of China
Korea: Korea Business Consultancy
USA: Dun & Bradstreet Directory
Japan: 1991 Establishment Census of Japan
Thailand: 1992 Industrial Survey

This number of prospective companies was confirmed by the certainty of investment utilizing the confirmation ratio shown below. The confirmation rate was acquired on the basis of the result of interview survey conducted in Thailand and Japan.

	Thailand	Other Countries
Yes	25.0 %	34.3 %
Possibly	36.4 %	5.5 %

Source: The Study Team estimates

The Study Team estimated two cases; one is the high case composed of companies replying 'yes' and 'possibly', the other is the low case composed of companies replying 'yes' only. Thai companies in the category of 'possibly' were also added to the low case in consideration of the certainty for investment demand identified in the interview survey.

70-115 companies are expected to locate in the Bang Saphan industrial estate by 2011 as shown in the following table.

	Thailand	Other Countries	Total
Low Case	20 companies	50 companies	70 companies
High Case	20 companies	95 companies	115 companies

Assuming the average area per factory is 50,000 m^2, the demand of land area by 2011 was estimated at 350 ha (2,188 rai) and 575 ha (3,594 rai), for the low and high case respectively.

	Companies	Land Area
Low Case	70 companies	350 ha (2,200 rai)
High Case	115 companies	575 ha (3,600 rai)

Source: The Study Team estimates.

Industrial Development Demand in the Bang Saphan Industrial Estate

In the estimates by the macroscopic approach, existing and future expanding iron and steel industries were included. On the other hand, the estimates by the microscopic approach excluded the iron and steel industries. The land area in the macroscopic approach after subtraction of the iron and steel industries was projected at 48 ha and 348 ~ 538 ha for 2001 and 2011 respectively. Those calculated from the microscopic approach are 58 ha by 2001 and 350 ~ 575 ha by 2011. The difference between two approaches is 10 ha in 2001 and 2 ~ 37 ha in 2011 and it can be said that the results of macro estimate and micro estimate almost coincide. Therefore, estimates of macroscopic approach is adopted as the industrial development demand in Bang Saphan industrial area.

Promising Industrial Categories for the Bang Saphan Industrial Estate

Selection of Port-Oriented Industries

The Study Team selected the target industries from the viewpoint of industrial location theory by matching two factors; one is the location condition in the Bang Saphan district, and the other is the location factors of industrial categories.

The major advantage of location condition in the Bang Saphan industrial estate is availability of a deep seaport. The industries which use large vessels to carry raw materials in and products out are suitable in Bang Saphan.

Seventy types of industry were selected as the first prospective categories of port-oriented industries.

Policy-Oriented Industries

The next approach is examination of the industrial categories based on the Government Industrial Promotion Program. The selection of industries was conducted, based on the List of Activities Eligible for Investment Promotion by BOI (the BOI List).

The selection was made by eliminating industries with the following corresponding conditions:

- Categories provided by BOI incentives without condition anywhere
- Categories provided by BOI incentives in Zone '2 or 3'.

Selection of Resource-Oriented Industries

Industries using agricultural products which are the major industries in Prachuap Khiri Khan province are thought to be prospective industries; Canning of fruit and seafood, coir fiber, coconut furniture.

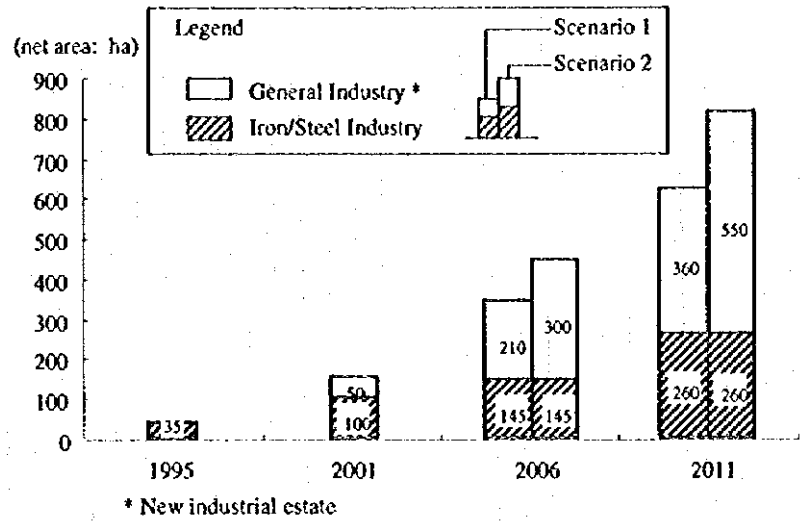
The target industries or the promising industrial categories selected through the above approach, which will be basic input for the planning of the Bang Saphan industrial estate, are tabulated in Table 2.

6. Development Concept of Bang Saphan Area

Setup of Development Framework

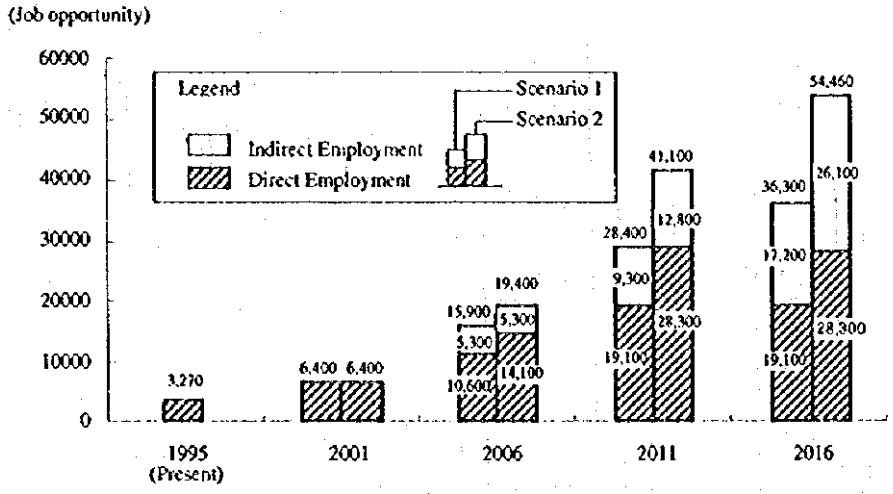
Demand of Industrial Area

As discussed in Chapter 5, demand for industrial area in Bang Saphan is assumed to be 150 ha and 620 ha (scenario-1) or 810 ha (scenario-2) in the years of 2001 and 2011 as summarized in the figure below.



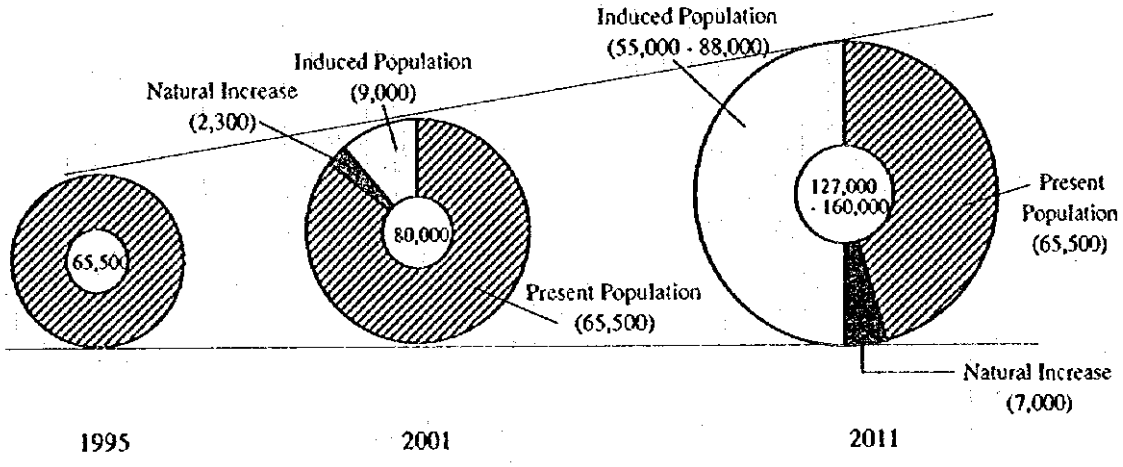
Setup of Population and Number of Employees

Direct and indirect employment opportunities will be induced by the Bang Saphan industrial area and relevant port and power plant development as illustrated below.



Estimate of Employment Demand of the Bang Saphan Area

The population increase induced by the Bang Saphan industrial area and relevant project development is estimated based on the projected number of employees. A 55,000 or 88,000 population will come and reside in Bang Saphan District, raising the total residential population to an estimated 127,000 ~ 160,000.



Estimate of Population Increase in Bang Saphan District

Land Use Concept of the Bang Saphan Area

Available land in Bang Saphan District is rather limited due to the mountainous area and green reserve designated by the Royal Forest Department. The supporting amenities and new residential area will be distributed in the neighboring area of Bang Saphan town and the corridor along the route 3169.

Conceptual land use plans of the Bang Saphan area by development alternatives scenario 1 and scenario 2 have been formulated and evaluated by comparative method. It has been concluded that scenario 1 is more suitable for the Bang Saphan area where the potential of infrastructure development is rather limited to some extent.

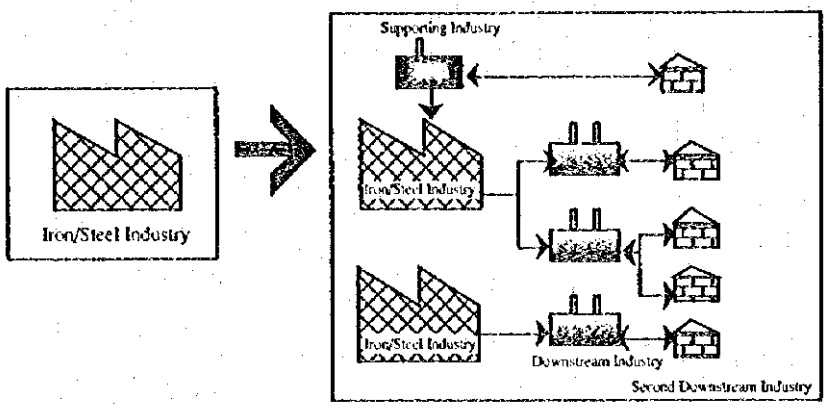
Scenario 1 presented in Figure 4 is, therefore, proposed to be adopted for the development of the Bang Saphan industrial city paying due attention to the sufficient industrial area for future expansion.

Prospective Development of the Bang Saphan Area

The development of the Bang Saphan area, in which a gigantic iron and steel industry is being developed by the private sector initiative, shall aim to accomplish the comprehensive targets proposed below.

Development of Iron and Steel Industrial Complex

Utilizing the present iron and steel industry, an industrial complex composed of the steel downstream industries such as metal and machinery industries and supporting and relevant industries shall be developed in the Bang Saphan area.

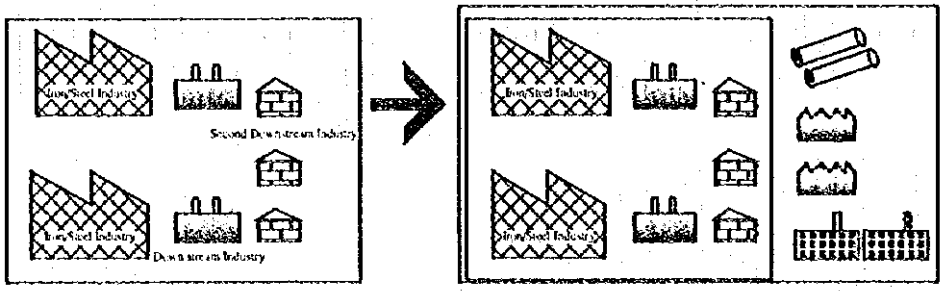


Present Industrial Structure (Mono-industry)

Future Industry in Bang Saphan (Comprehensive Industry)

Development of Comprehensive Industry

The development of a comprehensive category of industry including petro-chemical industry, food industry and construction material industry, etc., is desirable for sustainable prosperity of the Bang Saphan area. Experiences in Japan and other industrialized countries shows that an industrial area which is developed by a single industry, is too weak to endure economic stagnation or to respond to changes in demand.



Monopolized Category of Industry

Comprehensive Category of Industry

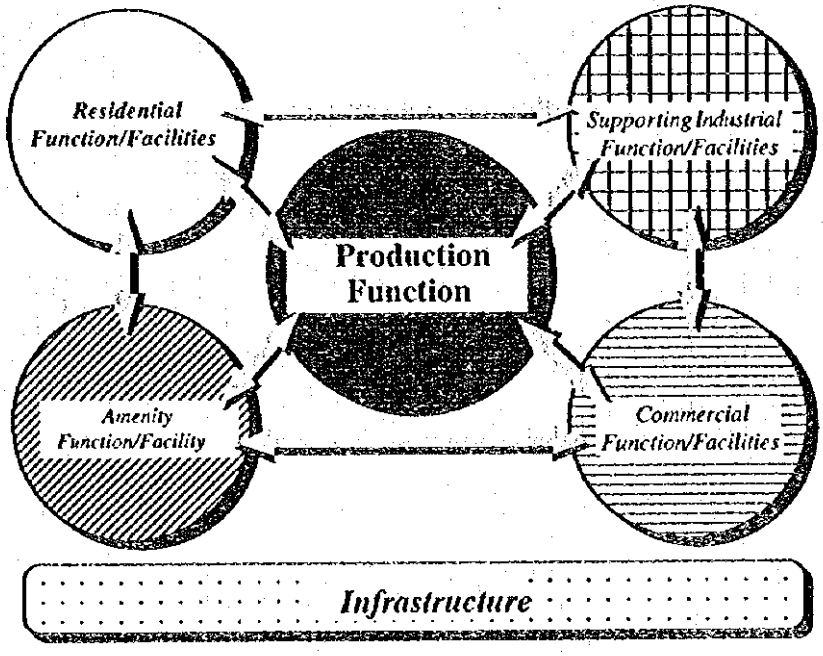
Industrial Development Centered on a Deep Sea Port

The most advantageous characteristic of the Bang Saphan area is the existence of a deep sea port. The port's future maximum water depth of 20 m, which could not be developed in other places in the Gulf of Thailand, is suitable for large vessels for the transportation of iron ore and coal. So the port shall play an important role in the development of Bang Saphan area, particularly in attracting investors.

Development of Industrial City

Bang Saphan is approximately 400 km from Bangkok and existing living conditions and supporting social facilities are insufficient for the workers of factories.

In order to supplement the weak points of Bang Saphan, a self-contained industrial city including housing, amenities, commercial and business facilities, etc. as show in the following schematic diagram, is necessary.



Introduction of Free Trade Area (FTA)

Considering the disadvantageous location of Bang Saphan, which is located 400 km from Bangkok metropolis where major economic activities are concentrated, remarkable investment incentives should be given to the Bang Saphan area. A Free Trade Area, where manufacturing and cargo transactions are managed with exemption of tax and procedure, would be the best solution to invite investors to the Bang Saphan area.

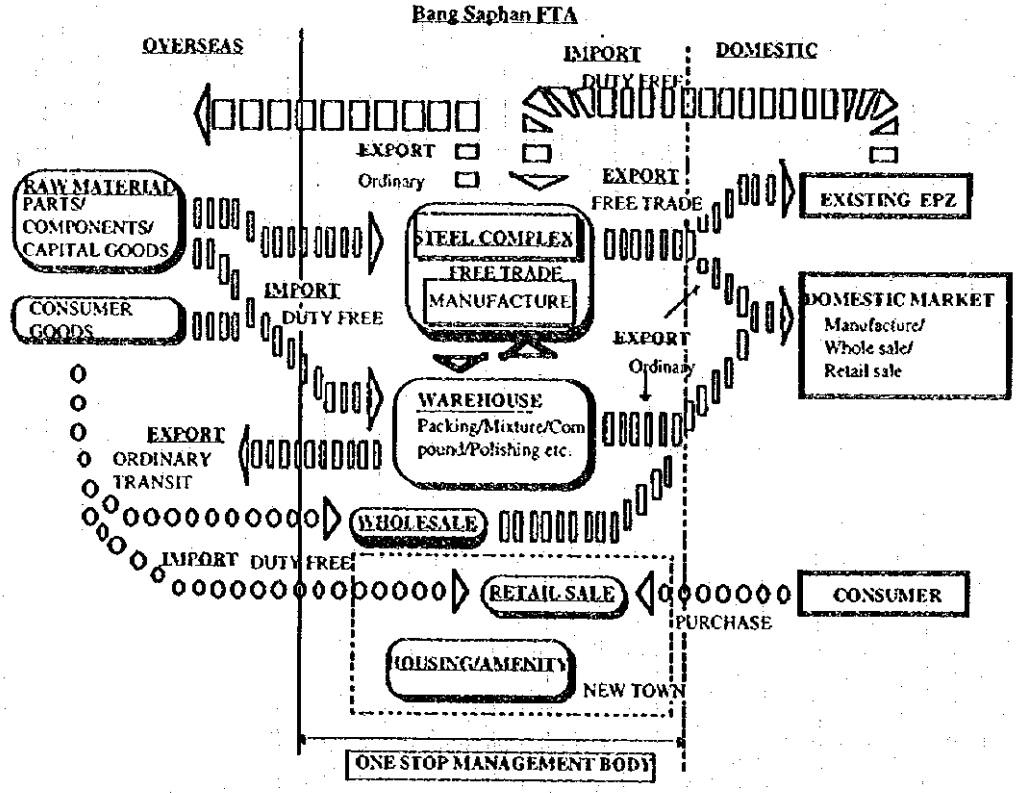
The Study Team proposes a new concept for the FTA. The objectives of the FTA are summarized below:

- To anticipate AFTA and WTO.
- To attract not only manufacturers but also traders for both export and import.
- To strengthen competitiveness of domestic market-oriented manufactures.
- To contribute to decentralization of businesses from the Bangkok Metropolitan Area.
- To encourage trades in export and import.

In order to achieve the above objectives, the basic concept of FTA to be created in the Bang Saphan area is proposed as follows.

- Import duties must be exempted for the importers operating in the FTA.
- The companies shall be allowed to 'export' to domestic market in ordinary 'import' procedure. In other words, '20% sales constraint to domestic market' rule applied for the existing EPZ must be lift.
- Besides the manufacturing activity, other activities such as packaging, labeling, compound, polishing, testing, measurement, warehousing, and wholesale must be allowed for both re-export and 'export' to the domestic market.
- The whole area of the FTA is under the customs domain.
- One organization must govern the FTA, from construction to operation and management.

The concept of FTA in Bang Saphan is illustrated in the following figure.



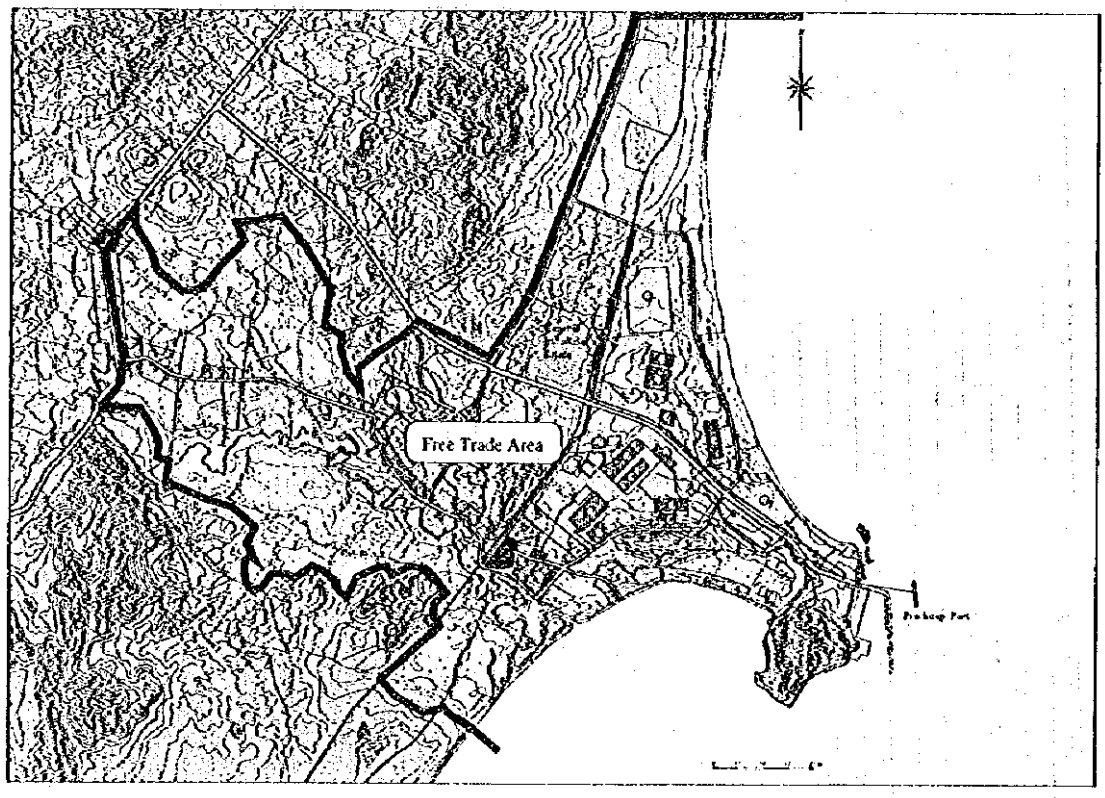
Area of the FTA

The Study Team proposes the 'area-designation-method' for the FTA area. This method is similar to the BOI zoning but the area is limited enough to be managed. In this sense there are two alternative areas for the FTA; one is the area including the said Industrial City and the other is the area of Amphoe Bang Saphan except for the mountainous or hilly area.

Alternative 1: Whole Area of Bang Saphan except for hilly area will be designated as FTA.

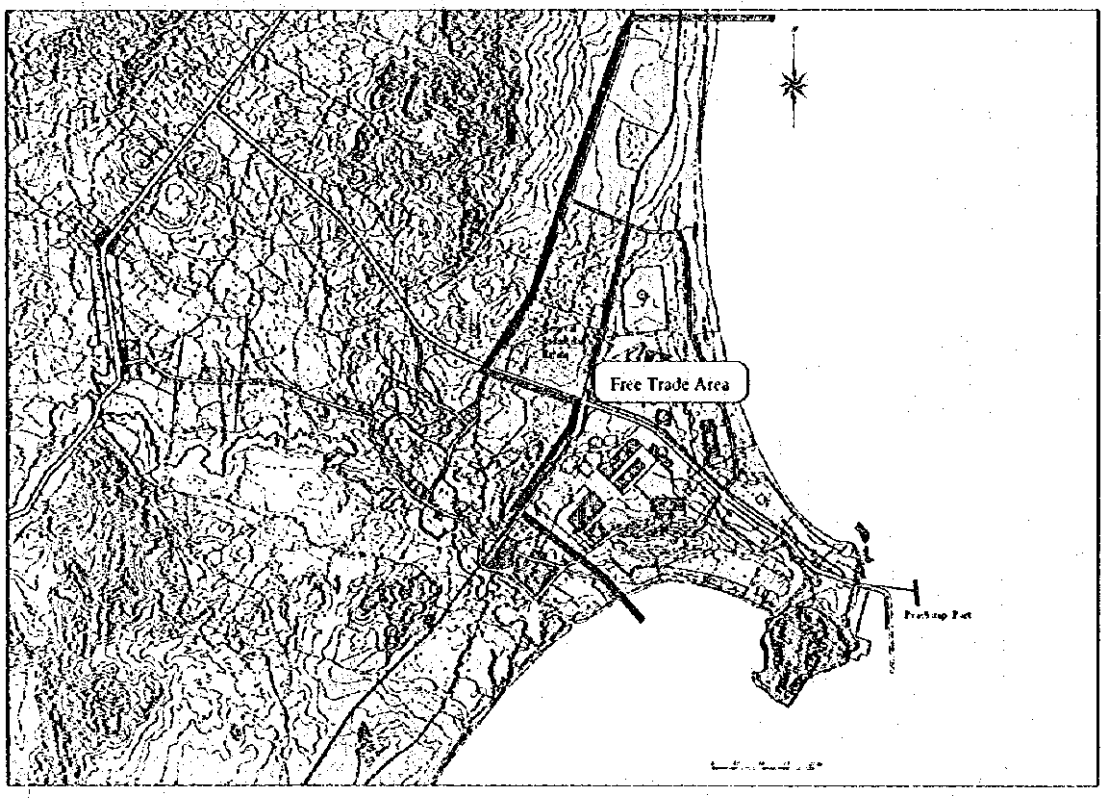
Advantage: Administration boundary is the same as local government.
Easy cooperation with governmental activities.
Vast land for future expansion.
Easy participation by new developers for facilities.

Alternative 2: Similar area of Bang Saphan Industrial City as shown below.
Advantage: Easy operation and management of the whole area.



Alternative 3: Bang Saphan industrial estate, iron/steel industry and port area are designated as the FTA.

Advantage: Area designation will be easy and quickly made on the basis of the IEAT law and FTZ law newly enacted.



The Study Team recommends the Alternative 1 in consideration of easy participation of new developers in the FTA for the long term perspective, and the Alternative 3 for the realistic designation in the short term development.

7. Development Plan of Bang Saphan Industrial Estate

Land Use Plan

Location and Area of the Site

The Bang Saphan industrial estate is proposed to be located to the west of the Sahaviriya iron/steel industrial site as shown in Figure 5 in consideration of road access to the Prachuap port and route 4, and land availability. The total site area is approximately 600 ha (3,750 rai) covering plantations on hilly areas and ricefields in lower swampy areas.

Land Use Plan

The land use plan of the Bang Saphan industrial estate is summarized below and presented in Figure 6.

	Area		(%)
	(ha)	(rai)	
Factory lot *	414.5	2,590	69.1
Road & utility	101.9	640	17.0
Green area	81.8	510	13.6
Others	1.8	10	0.3
Total	600.0	3,750	100.0

* Future expansion area of factory lots of 54.5 ha is inclusive.

Plan of Phased Development

The Bang Saphan industrial estate is proposed to be developed in three phases as summarized below. The detailed development schedule is explained in Chapter 8.

	Total Area		Factory Lot Area	
	(ha)	(rai)	(ha)	(rai)
Phase 1	108	680	52	330
Phase 2	202	1,260	149	930
Phase 3	290	1,810	159 *	990
Total	600	3,750	360	2,250

Note: * Reserve area of 54.5 ha is not inclusive.

Land Grading

Earth works

Topographically, the land of the Bang Saphan industrial estate site is rather undulated as shown in Figure 7. Thus the site shall be graded by cut and fill. Considering the higher cost of earth borrowed from quarries located outside the areas, it is recommendable that the cut volume and filling volume inside the site be balanced.

The earthworks volume is estimated at 4.0 million m^3 for the total development area. Cut and filling balance is designed to be kept in each development phase as shown below.

(Unit: million m^3)

	Phase 1	Phase 2	Phase 3	Total
Cut Volume:	1.28	1.38	1.40	4.06
Filling Volume:	1.35	1.27	1.04	3.66

Note: Some soil shall be brought from outside for phase 1.

Geological Consideration

Judging from the geological data acquired by the core boring test conducted in the area adjacent to the Bang Saphan industrial estate site, N value of more than 10 appears at 5 ~ 6 meters below the surface and stiff sand with N value of more than 40 follows at 8 ~ 10 meters from the surface. It means that the surface soil is rather weak, however, stiff soil appears at a shallow depth and short pile foundation will be sufficient to support the buildings and structures.

Roads

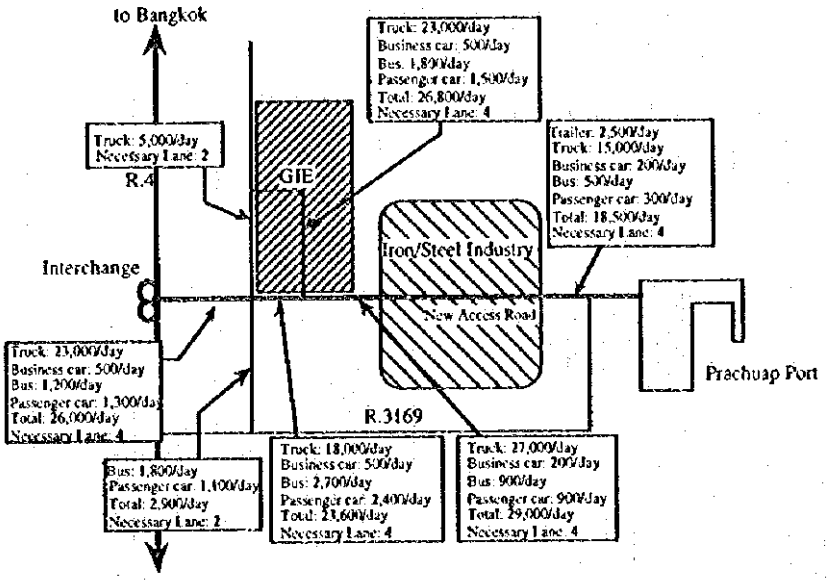
Internal Road

The main road in the Bang Saphan industrial estate will have approximately 29,000 PCU per day as the design traffic volume and four (4) lanes will be necessary in 2011 assuming that the traffic capacity of one lane is approximately 10,000 PCU per day. Two lanes will be enough to cope with 5,500 PCU in 2001 and 13,000 PCU in 2006.

External Road

A new access road connecting Route 4 with the Bang Saphan industrial estate, the iron/steel industry and Prachuap port should be developed urgently considering that the

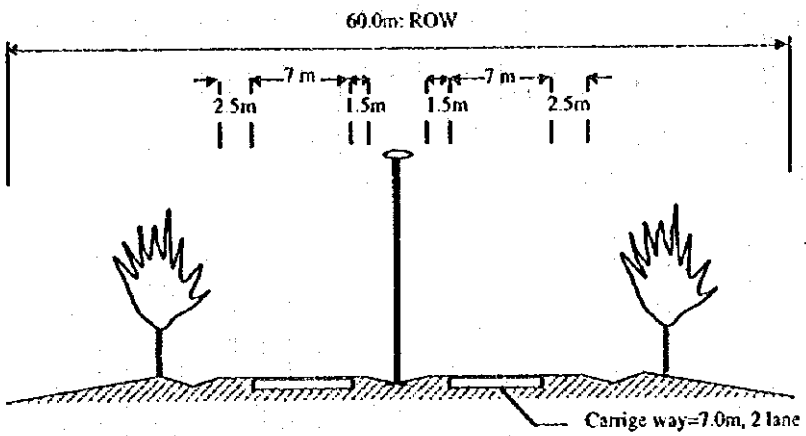
heavy traffic to/from the industrial area and port has been increasing drastically. Traffic on the new access road is estimated at approximately 10,000 PCU and 30,000 PCU per day in 2001 and 2011 as illustrated below.



Traffic Demand and Necessary Lane for Access Road

The access road section is designed to have 4 lanes in 2011 with approximately 16 km in length as shown below paying due attention to the pavement design considering the heavy vehicle traffic generated from the port and iron/steel factories. In the preliminary development phase, a 2-lane carriageway will be sufficient.

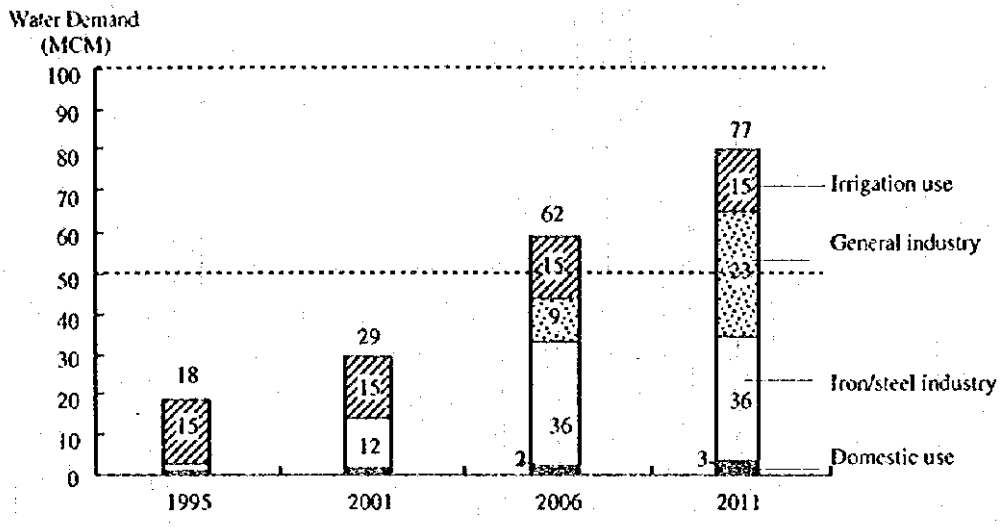
Access Road between R.4 to Port : 4 lanes
Right of Way : 60.0 meters (in 2011)



Water Supply

Water Demand

Total water demand of the Bang Saphan area is summarized in the figure below. 77 MCM of water will be required annually.

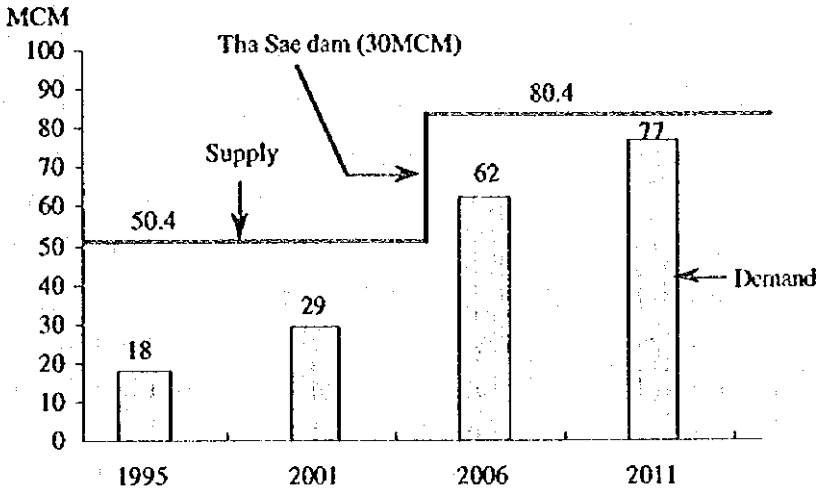


Water Resources

RID proposed the development of the Tha Sae dam project, which will supply 30 million m^3 of industrial water per annum to the Bang Saphan industrial estate. The project is waiting for approval of the Cabinet. If the Tha Sae dam project is approved in 1997 or 1998, it will be commenced immediately and completed around the year 2003 or 2004.

The Bang Saphan river will also constitute a main water resource because of its proximity to the Bang Saphan industrial city. The mininum and average annual runoffs recorded by RID during 1980 ~ 1989 near the weir were 59.5 million m^3 (MCM) per year (1.88 m^3/sec as average flow) in 1980 and 147 MCM per year (4.68 m^3/sec) in 1989.

Assuming that 85 % of the runoff of the Bang Saphan river can be practically exploited, the balance between demand and supply water resources mentioned above can be calculated as shown in the figure below.



As shown in the above figure, if the water resources in the Bang Saphan river basin are adequately developed and a water conveyance pipeline from the Tha Sae dam is constructed, water will be sufficiently available for the development of Bang Saphan industrial city.

If the Tha Sae dam project is not completed, a shortage of 15 MCM of water is projected to occur in 2006 and 30 MCM in 2011. An Alternative plan to divert the Tha Sae river basin to the Bang Saphan river basin would be substitutional in case of the cancellation of the Tha Sae dam project.

Development Plan of Water Supply System

(Strategy of Water Resource Development)

A development strategy of water supply system for the Bang Saphan industrial city is preliminarily proposed below for the purpose of securing sufficient water in average drought years.

Step - (1) Upgrade and expand the existing water intake system located in the Bang Saphan river to meet the water demand in 2001

Step - (2) Develop the Tha Sae dam and conveyance pipeline

Step - (3) Study the development possibilities of other reservoirs in the Bang Saphan river basin and develop the economically viable reservoirs

An integrated water supply system to meet the water demand of the Bang Saphan area is illustrated in Figure 8.

(Water Conveyance from Tha Sae Dam)

According to RID's plans, the Tha Sae dam will supply 30 MCM of industrial water to the Bang Saphan area. The conveyance pipeline from Tha Sae dam to Bang Saphan over a distance of 72 km is required to send 30 MCM per year (1.0 m^3 /sec). Two pipelines have been preliminarily designed in consideration of the convenience of maintenance work. Two sets of 750 mm diameter steel pipe, which will be buried under ground in the right of way of Route 4 and a pump station are designed. The development cost of the pipeline is estimated at approximately Baht 1,700 million.

(Water Distribution System in Bang Saphan Industrial Estate)

The water distribution network plan and conceptual layout of the water purification plant in the Bang Saphan industrial estate are designed as shown in Figure 9.

Sewerage

The volume of wastewater is estimated at 68,000 m^3/day which is adopted for the design of sewer and sewage treatment plant. Oxidation Ditch Process is adopted as the treatment process of the sewage treatment plant. The layout of wastewater collection system and conceptual layout of the sewage treatment plant are designed as shown in Figure 10.

Storm Water Drainage

Storm rain water in the Bang Saphan industrial estate will be discharged to the Khlong Podaeng river, a tributary of the Mae Ramphung river, through the retention pond designed to retard the flood discharge. The plan of drainage system is designed as shown in Figure 11.

Electricity

The total power demand in the Bang Saphan area is estimated to be approximately 1,900 MW in 2011 as shown below.

(MW)

	1995	2001	2006	2011
1. Iron/Steel Group	84	359	1,746	1,746
2. Industry Estate	-	19	64	128
3. Port	-	3	6	9
4. Existing Residence	10	15	16	20
5. New Residence	-	1	3	7
Total	94	397	1,835	1,910

Up to the end of 2001, electric power for the Bang Saphan area will be fed from the existing Bang Saphan substation of EGAT, which is located 22 km northwest of the estate and connected with the 230 kV national grid. By the end of 2001, a new 500 kV substation connected with the new 500 kV national power grid will be constructed near the Bang Saphan substation*. In addition, by 2003, a new IPP power plant with a 500 kV substation is expected to be constructed in the Bang Saphan area, therefore from the year 2003, power could be supplied in sufficient quantity to the Bang Saphan industrial city. A schematic diagram of the power supply system is shown in Figure 12.

Note*: It is recommended that the development schedule of the new 500 kV substation and transmission line shall be arranged to meet the increase of the electric demand in Bang Saphan area.

The two 115 kV transmission lines and two substations in the Bang Saphan industrial estate will be constructed by PEA at its own cost in accordance with PEA's standards, under the condition that necessary land for the substation in the estate be provided to PEA free of charge.

A 22 kV distribution system should be constructed in the estate, to feed power from the new 115/22 kV substation to factory lots, industrial estate center, water purification and sewage treatment plant. The underground distribution system using buried armored cables is recommendable from an aesthetic viewpoint. 22 kV switchgear units are also recommended to be installed in factory lots to tap electricity.

Telecommunications

There is an existing Bang Saphan Remote Switching Station of TOT which is located 9 km southwest of the project site. The present switching capacity of the Bang Saphan Remote Switching Station is 600 lines, and TOT plans to expand it to 1,000 lines by October 1998.

The total telecommunications demand in the Bang Saphan industrial city is estimated at approximately 16,000 lines in 2011 as shown below.

(lines)

	2001	2006	2011
1. Iron/Steel Group	220	540	540
2. General Industry	280	870	1,730
3. Power Plant	-	20	20
4. Port	20	30	50
5. Existing Residence	7,460	8,060	9,720
6. New Residence	440	1,570	3,610
Total	8,420	11,090	15,670

It is proposed that by 2001 a new Remote Switching (RS) station be installed in the Bang Saphan industrial estate for exclusive use of the estate. In order to link the RS station to the national and international telecommunication network, an optical fiber cable should be laid between the RS station in the industrial estate and the existing Bang Saphan RS station. The new RS station in the Bang Saphan industrial estate and the optical fiber cable will be constructed by TOT at its own cost.

A schematic diagram of telecommunications system is shown in Figure 13.

Metallic cable telephone lines will also be constructed between the planned switching station in the Industrial Estate Center and each distribution pull box installed in the factory lot. Cables sealed with PVC pipes will be buried in the ground.

Port

Existing Prachuap Port

To run the steel factory of Sahaviriya, the Prachuap port was developed by the Sahaviriya group in 1994. Steel materials (steel slabs) are imported mostly from Japan and steel products are shipped out from the port. The port consists of two berths; the main berth has a total quay length of 450 m and the secondary berth 245 m. The water depth along the quayside is 15.0 m below MSL in the main berth and 10.0 m below MSL in the secondary berth, which means that the main berth can accommodate vessels of up to 45,000 DWT class and the secondary berth up to 7,000 DWT class, in full loaded condition.

Cargo Traffic Demand in Future

On the basis of the cargo demand forecast related to the Bang Saphan industrial development, approximately 23 million tons of seaborne cargoes in Prachuap Port are projected for 2011 as shown below.

Prachuap Port Cargo Demand

(Unit: 1,000 tons)

	1995	2001	2006 1/	2011
Steel Related General Cargo	1,800	4,980	3,150	4,080
Industrial Estate General Cargo	–	470	1,020	2,640
Locally Based General Cargo	500	805	1,030	1,310
General Cargo Total	2,300	6,255	5,200	8,030
Bulk Cargo Total	–	–	7,500	14,780
Grand Total	2,300	6,255	12,700	22,810

Note: 1/ Steel-related general cargo will decrease in 2006 because iron making will start and import of slabs will be stopped.

Berth Demand in Future

In 1995, 2.3 million tons of cargoes were handled by the Prachuap Port, while its available berth length totaled 695 m, which means that the berth productivity was 3,300 tons/m/year. Simply applying the current berth productivity to the future cargo demand, the berth length requirement for the shipment of general cargoes in the year 2001, 2006 and 2011 could be estimated as follows:

Berth Requirement for General Cargo Shipment

		2001	2006	2011
(1)	Steel Cargo and General Cargo (1,000 tons)	6,255	5,200	8,030
(2)	Required Berth Length (m)	1,895	1,940	2,430
(3)	Required Berth Expansion ** (m)	1,200	1,245	1,735

** (3) = (2) - 695 m (present berth length)

Port Expansion Plan

(General Cargo Berth Zone)

To meet the above berth demands, a possible port expansion plan has been prepared as shown in Figure 14. According to this plan, the existing breakwater will be expanded southward with a slight skew to the sea side, and along the existing N-S shoreline, a stretch of land about 200 m wide will be reclaimed and its southern water front will serve as a general cargo berths zone. To the south of the ESE reclaimed land area, a commercial dock could be developed.

(Mineral Bulk Berth Zone)

In addition to the general cargo berths, bulk berths should also be developed to unload 7.5 million tons of bulk cargo in 2006 and 14.8 million tons in 2011. Unlike general cargoes, mineral bulk will be transported by large bulk carriers, most likely in the size of 60,000 - 140,000 DWT. In the case Cape-Size bulk carriers (140,000 DWT) call in the Prachuap Port, an about 1.2 km long trestle would be required to link the mineral cargo berth with a 19 m water depth to the shore conveyor system.

Development Cost

Internal Cost

The development cost of the Bang Saphan industrial estate with a total area of 600 ha is estimated at Baht 2,770 million or US$ 111 million as shown below.

Development Cost of Bang Saphan Industrial Estate (Internal Cost for 600 ha)

	million Baht	$ million equivalent	Unit Cost 1/ 1,000 Baht/rai	Unit Cost 1/ $/m²
1. Construction Cost	2,250	90	870	22
2. Engineering Cost	270	11	100	3
3. Physical Contingency	250	10	100	2
4. Total	2,770	111	1,070	27

Note: 1/ Per net factory area (total area is 414.5 ha including reserve factory area)
2/ Land acquisition cost for the industrial estate and price contingency are excluded.

The cost by the development phase is also estimated as shown below.

Cost by Development Phase of Bang Saphan Industrial Estate

	million Baht	$ million equivalent
Phase 1	610	24
Phase 2	890	36
Phase 3	1,270	51
Total	2,770	111

Note: 1/ Land acquisition cost for the industrial estate and price contingency are excluded.

External Cost

In addition to the internal cost of the Bang Saphan industrial estate, the following estimated external infrastructure cost will be required: Baht 11.6 billion or US$ 463 million for overall external infrastructure, including Baht 3.3 billion or US$ 132 million (approximately 30 % of the total cost) for the Bang Saphan industrial estate, and the remainder for the iron/steel industry, urban area, and port development project.

Development Cost of External Infrastructure

		Overall Cost		Cost for BSIE	
		(Baht million)	(US$ million)	(Baht million)	(US$ million)
I	Water supply facilities	3,260	130	1,440	58
II	Road	1,170	47	890	36
III	Port	6,100	244	610	24
IV	Electric facilities	290	12	290	12
V	Telecommunication facilities	20	1	20	1
VI	Others	750	30	20	1
	Total	11,590	464	3,270	132

Note: Water supply facilities: Pipeline between the Tha Sae dam to BS, etc.
Road: Access road, interchange, etc.
Port: General cargo berth, bulk cargo berth of the Prachuap port
Electric facilities: Transmission line, etc.
Telecommunication facilities: Trunk line cable, etc.
Others: Hazardous waste treatment

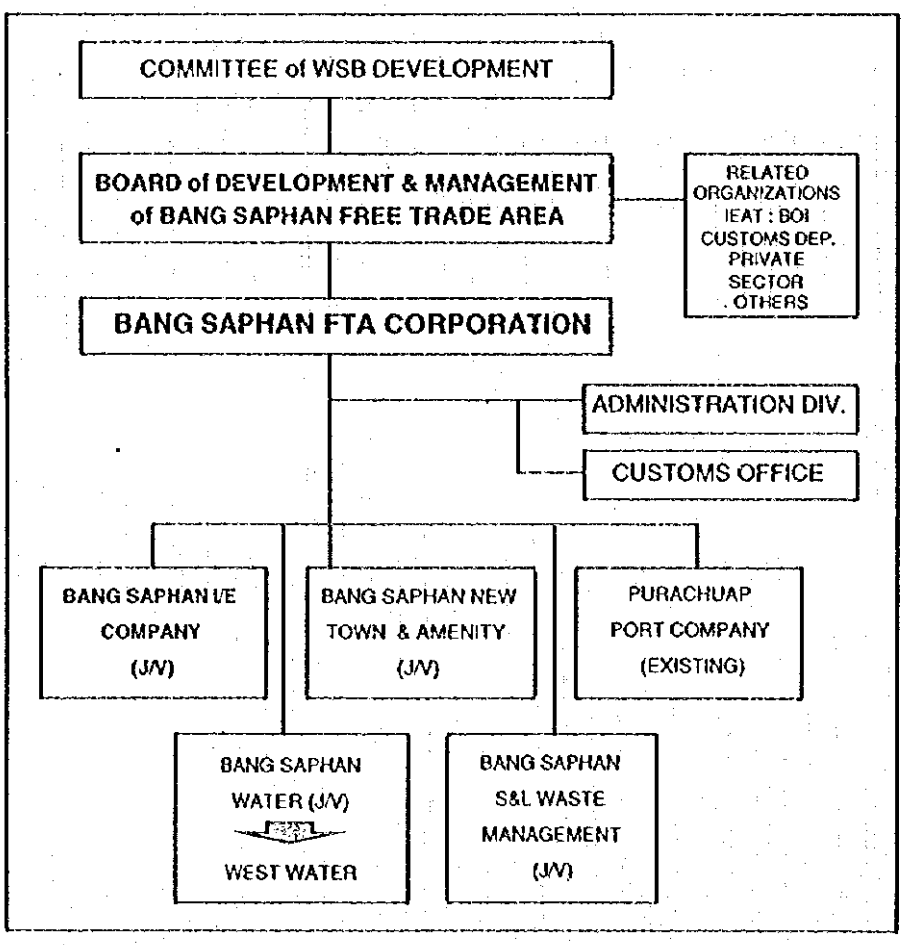
8. Implementation Method of the Bang Saphan Industrial Estate

Setting of the Implementation Method

Integrated Development Organization for the Bang Saphan Area

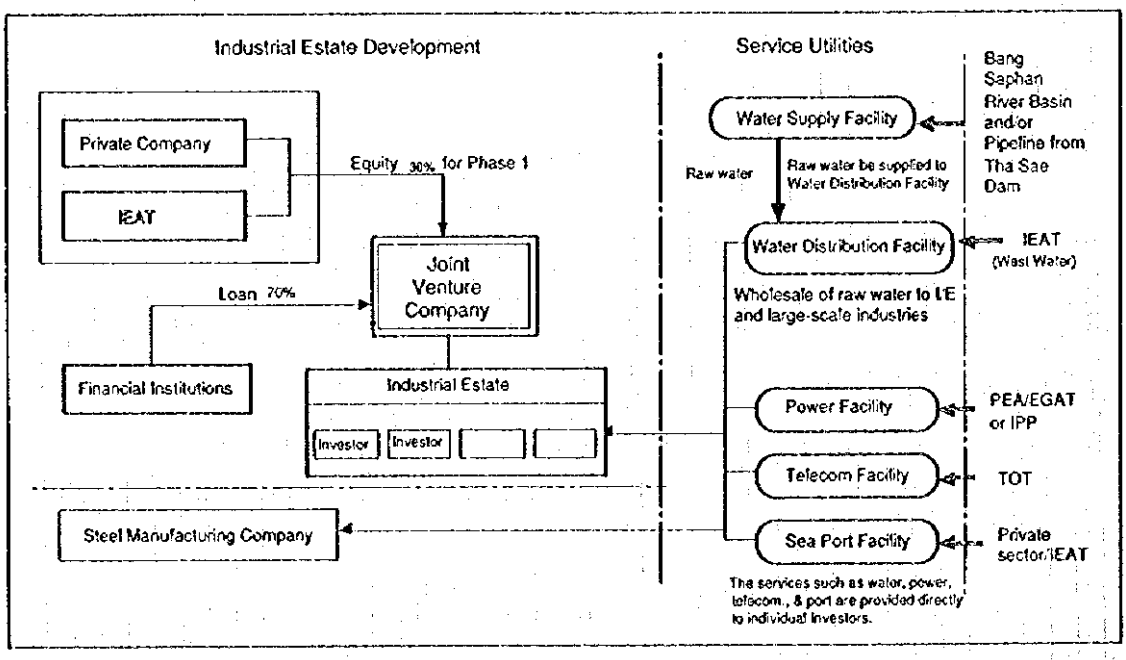
The Board of Development & Management of Bang Saphan FREE TRADE AREA (FTA) is recommended to be established to administer the economic development of the designated Bang Saphan area. The Board will be managed in accordance with the policy set out by the Committee of Western Seaboard (WSB) Development under NESDB.

The Board should consist of representatives not only from governmental authorities such as BOI, IEAT, Customs Department, etc., but also from private sectors such as industrial developers, financial institutions, manufacturing firms, etc. Under the Board, an executing organization, so-called the "Bang Saphan FTA Corporation" shall be set up to administer and manage the activities undertaken by several companies in cooperation with and with assistance from the Customs Office. The Integrated Development Organization is schematically presented below.



Industrial Estate

A "Joint Venture" ("JV") of a private company and IEAT is proposed to be established in order to implement the development of the "Bang Saphan Industrial Estate". The equity proportion and the form of equity contribution of each party will be determined by the parties concerned. But it should be noted that the private company will play the main role in the project in terms of not only financing but also operation & management. The project formation is schematically presented below.



The positive involvement of the public sector in this project will be really conforming to the envisaged strategy of IEAT towards the coming 21st century. According to that strategy, IEAT will no longer act simply as regulator of the industrial estate development in which IEAT plays a role in the promotion and partial operation, but IEAT's functions might include those of an organizer, coordinator, assistant, and partner. To succeed, IEAT will need to change its orientation and acquire new skills. In this sense, the Bang Saphan I/E will be a challenging project for IEAT. Furthermore, this is a good opportunity to keep a leading edge in the industrial development in Thailand.

Water Supply Facilities

In the initial stage of the Bang Saphan Industrial estate development, IEAT is advised to play an important and responsible role in supplying water to the project site in consideration of the emergent and integrated development of water supply facilities,

especially of pipeline development project from Tha Sae dam to Bang Saphan. After the project is recognized to progress satisfactorily, the management structure should be shifted from the public sector to the private sector because of the governmental privatization policy. Finally the "West Water" (provisionally named) is recommended to be established for supplying water to the Western Seaboard area. The equity participation of the Government agencies (IEAT) in the West Water will contribute to a continuous management of water resources and to the proper and efficient development in concordance with the national development policy.

Other Facilities

Organizations to be listed for the development and management of the industrial estate and external infrastructure are summarized in Table 3.

Development Schedule

The Bang Saphan industrial estate is proposed to be developed in three phases in accordance with the investment demand increment.

The construction schedule of the Bang Saphan industrial estate is planned as shown below in consideration of the period of investor promotion and construction schedule of external infrastructure.

- Implementation year of Phase 1 (610 rai or 108 ha): end of 2000
- Implementation year of Phase 2 (1,260 rai or 202 ha): end of 2003
- Implementation year of Phase 3 (1,810 rai or 290 ha): end of 2007

A detailed implementation schedule of the Bang Saphan industrial estate and external infrastructure is summarized in Figure 15.

9. Preliminary Environmental Impact Study

Environmental Impact Assessment

EIA

In Thailand, environmental impact assessment (EIA) for industrial projects is prescribed by the "Enhancement and Conservation of National Environmental Quality Act" enacted in 1978. Accordingly, the industrial estate, which is planned to be newly constructed, shall also be subject to an EIA before its implementation.

It takes more than one year to carry out full-scale EIA. Therefore, in this study, the potential environmental impact in the Bang Saphan area was studied preliminarily utilizing readily available data and information. In the Bang Saphan area, in addition to the environmental impact caused by the activity of the industrial estate, those of the iron/steel industry and the thermal power plant cannot be disregarded. Hence, the environmental impacts assessed in this study cover also those of the iron/steel industry and the thermal plant.

Air Pollution

The ambient ground level concentration of effluent gas from stacks can be calculated and predicted by using the smoke plume-puff formulae. In this study the ambient concentration of stationary sources in the Bang Saphan area including the iron industry and the thermal power plant was forecast using computer program based on significant air pollution indices of SO_2, NO_2 and TSP.

Maximum Ground Level Concentration in Bang Saphan Area

	Maximum Ground Level Concentration	Ambient Concentration (Reference)*	Air Quality Standards		
			1-hr average value	24-hr average value	1-yr average value
SO_2	0.034	0.003	-	0.30	0.10
NO_2	0.012	0.017	0.32	-	-
TSP	0.008	0.096	-	0.33	0.10

Note: * Data measured during March 12 to 15, 1995, in the Bang Saphan area

The result of calculation shows that the concentrations of SO_2, NO_x and TSP will all be within the ambient air quality standard of Thailand in the year of 2011 when the factories in the Bang Saphan area, which are factories in the industrial estate, the iron/steel making mills and thermal power plant, are in operation.

Water Pollution

Wastewater generated by the industrial estate should be treated by a central wastewater treatment facility to be installed in the industrial estate. Treated wastewater in the central treatment facility should meet the industrial effluent standards provided by the Ministry of Industry (MOI). Wastewater generated by the iron/steel making industry should also be treated by the treatment facility installed in the site.

Wastewater will be discharged into a receiving water body after being treated by the central wastewater treatment facility. In rivers, dilution and advection of pollutants proceed with the linear flow of water downstream. In this study, it is assumed that the treated wastewater is discharged into the Mae Ramphung river and mixed completely. Hence, concentrations of pollutants are determined by flow rate of the river water, and can be simply expressed by the following equation:

$$\text{Pollutant Concentration } C_2 = (C_0q_0 + C_1q_1 + C_2q_2) / (q_0 + q_1 + q_2)$$

Where, C_0 : Average concentration of a given pollutant in river water (mg/l), q_0 : Flow rate of river water, C_1 , C_2: Concentration of the pollutant in wastewater flowing into the river (mg/l) (BOD = 20 mg/l, SS = 30 mg/l) , q_1, q_2 : Flow rate of wastewater (m^3/day).

The following table shows the forecast of pollutants concentration in the Mae Ramphung river in connection with BOD and SS when treated wastewater from the industrial estate and the iron/steel making industry is discharged into the river.

Forecast of Pollutants Concentration in Mae Ramphung River

	Concentration to be forecast	Background Concentration *
BOD_5 (mg/l)	8.2	2 - 6
SS (mg/l)	17.5	3 - 22

* : Data at Klong Mae Ramphung, 1994 - 1996

A BOD of 8 ppm is still admissible considering that toxic waste will be completely removed in the wastewater treatment facility, however, further degradation of the river water should be avoided and higher grade treatment of wastewater shall be considered after 2011.

Solid Waste

Industrial wastes are generally divided into two categories, general wastes and hazardous wastes. The following table shows the summary estimate of general wastes and hazardous wastes to be generated in the Bang Saphan industrial estate.

Estimate of Industrial Solid Wastes Generated in Bang Saphan Area

(Unit : ton/yr.)

Type of Industry	General Waste	Hazardous Waste	Total
Food	1,377	243	1,620
Textile	387	68	456
Wooden and furniture	316	56	371
Paper and pulp	57	10	68
Chemicals	1,836	324	2,160
Ceramics	1,865	329	2,194
Steel processing	2,235	394	2,629
Machinery	2,080	367	2,447
Shipbuilding	29	5	34
Industrial estate total	10,181	1,797	11,978
Iron/Steel Industry	90,000		150,000
	* 60,000		
Thermal power plant	480,000 (Ash)		480,000

* Although the sludge generated from the pickling and plating process will contain Ferrite, Aluminum, Zinc, etc., heavy metal will not be contained. Therefore, the sludge will be recycled efficiently.

For the treatment and disposal of general wastes, landfill and incineration are proposed. Refractories from the iron/steel industry will be treated in the sanitary landfill and general wastes from the industrial estate will be treated by an incinerator. Ash produced by IPP coal-fired power plant is proposed to be processed for manufacturing of ash blocks/modules. It is further proposed that ash blocks/modules be utilized as artificial reefs for the promotion of environmental rehabilitation of coastal fisheries in the central and lower Western Seaboard.

A hazardous waste treatment facility should be constructed adjacent to the industrial estate for the treatment and disposal of hazardous wastes generated by the Bang Saphan industrial estate. MOI has the responsibility for treatment and disposal of hazardous wastes and has the guideline to implement industrial waste treatment centers. MOI has already established a new company, the General Environmental Conservation (GENCO), by joint investment with the private sector for constructing treatment centers. Considering these precedent examples, the facilities for treatment and disposal of hazardous wastes should be constructed and managed by a joint venture of the government and the private sector.

Social Environment Impacts in the Bang Saphan Area

(Relocation of Social Facilities)

In the proposed site of the industrial estate, social facilities including two primary schools and one temple have been identified. The two primary schools namely Wat Na Pak Kang Primary School and Thum Khaonoi Primary School, reportedly had 122 and 106 students respectively in 1995. The temple is called Wat Na Pak

Kang. Considering that the temple is a religious asset respected by local people and community, it is recommended to preserve Wat Na Pak Kang as it is at present. On the other hand, the two primary schools should be relocated to the outside for providing more amenities and safety for pupils.

(Relocation of Local Residents)

Approximately 120 establishments have been identified in the site, as of 1995. In the event the industrial estate is developed, the local residents currently living in the site are to be relocated to the outside of the site. Although the relocated residents will be fully compensated by the J/V company established for the development of the industrial estate, supporting measures such as priority for employment in the construction works of the estate for getting on-the-job training, etc. shall be taken to facilitate the process of relocation.

Monitoring Plan

Monitoring of Air Pollution

Monitoring stations must be able to grasp the level of air pollution and the pattern of its changes over the entire area. Its covering range must be determined in the light of meteorological conditions, topographical features, and the distribution of pollution sources in the area. Upon determining the location of monitoring stations in areas crowded with pollution sources, such as industrial zones, it is considered that one monitoring station should cover an area of about 3 km in radius. And a broader area of about 5 to 10 km in radius should be covered for residential and other less polluted areas in general.

Generally, for the purpose of investigating pollution caused by industrial activities, main items to be monitored are SO_2, NO_x and TSP. Other particular pollutants (such as hydrocarbons, HCl, CO, etc.) will be added occasionally.

Monitoring of Water Pollution

In the same manner as in the case of monitoring air pollution, a water pollution monitoring station should be installed in the Bang Saphan area. Since wastewater generated by factories will be discharged into rivers after being treated, it will have an effect on the receiving environment. Therefore, water quality should be monitored for both the effluent water and the receiving environment. Monitoring of effluent water, this means in-factory sampling, should be undertaken both before and after the wastewater treatment process.

10. Evaluation of Development of the Bang Saphan Industrial Estate

Economic Viability

Method of Economic Analysis

Economic analysis of the industrial estate development is to be made in terms of EIRR, where the industrial output (production) to be generated by the potential industries located in the industrial estate is regarded as main benefits of the Project. EIRR is determined as a discount rate that equalizes the present value of the streams of costs and benefits over the project life (30 years), where the effect of the industrial estate development is evaluated in terms of value-added generated by the potential industries in the industrial estate.

Value-added Generated by Investors in Bang Saphan Industrial Estate

	2001	2006	2011
Baht million per annum	5,600	18,700	34,200
(US$ million per annum)	220	750	1,370

Results of Economic Analysis

In the case the cost of external infrastructure is totally charged to the capital cost of the industrial estate development, EIRR is calculated at 51 %. If only the cost of external infrastructure attributable to the industrial estate development which is estimated at 3,270 million Baht, or roughly to 30% of the total external infrastructure cost of 11,575 million Baht, is taken into account, EIRR would be 68%.

EIRR: 51% (Covering total external infrastructure cost)
68% (Covering external infrastructure cost for BSIE)

Financial Viability

Method of Financial Analysis

Financial evaluation is to be made from two aspects, one for assessing the project as being wholly financed from the developer's own fund (no debt financing), and the other for assessing the project from the investor's viewpoint where the return on equity is highlighted, incorporating debt, interest, repayment, etc.

The former is evaluated in terms of "Return on Investment" (ROI) based on the cashflow streams of revenues and expenses/costs. The latter is evaluated in terms of "Return on Equity" (ROE), that is, the profitability of the equity capital.

Preconditions and Assumptions

- Land valuation:
  The land acquisition cost is estimated at Baht 0.4 million/rai or 10 US$/m2.
- Lot sales to investors:
  The sale price estimated at 50 US $/m^2 for example, equal to 2.0 million Baht/rai in 2000, is assumed to be inflated at 5.0 % per annum.
- Capital contribution of the private company and IEAT:
  The capital structure is assumed as follows.

  1. Ratio of equity : 30% of the project cost for Phase 1

     Note: The cost of subsequent phase development is supposed to be raised by debt finance and internal fund.

  2. Capital contribution (Provisional)
     Private sectors: 80% of the equity; IEAT: 20% of the equity

Result of the Viability Analysis

ROI and ROE are estimated at 13.6 % and 16.4 % respectively.

ROI : 13.6 %
ROE : 16.4 %

Sensitivity analysis showing the appropriate lot sale price under the condition of adequate ROE is made in addition as summarized below.

	Lot Sale Price	
	US$/m^2	million Baht/rai
1) Land price of 600,000 Baht/rai:	56	2.2
2) Land price of 200,000 Baht/rai:	44	1.8
3) VAT is imposed (in case the proposed concept "FTA" is not adopted):	51	2.0
4) 10% decrease in construction cost:	47	1.9
5) Combination of 2) and 4):	41	1.6

Evaluation of the Project

An appropriate Rate of Return on Investment (ROI) can be compared with the opportunity cost ranging from 10% to 15% in Thailand, and an appropriate Rate of Return on Equity capital (ROE) could be assumed to be from 14% to 17% in Thailand.

The project could be sufficiently viable in terms of ROI of 13.6% and also in terms of ROE of 16.4% at the sale price of 50 US$/m^2. The sale price of 50 US$/m^2 appears to be competitive in comparison with the lot sale price prevailing in the Eastern Seaboard and other Asian countries.

From the economic viewpoint, the project could also be sufficiently viable judging from the fact that EIRR is higher than the opportunity cost, say 10 - 15% in Thailand.

11. Recommendation

The Bang Saphan industrial estate is one of the determining projects which constitute the key for the success of development of the Bang Saphan area. This study aims to clarify the feasibility of the development of the Bang Saphan industrial estate and leads to the conclusions and recommendations as summarized below.

The development of the Bang Saphan area, where the Bang Saphan industrial estate is planned as the core project, is anticipated for the following four reasons.

(1) The Western Seaboard, which is expected to be contributive to the decentralization of the over-populated capital area and the formation of a corridor to/from Myanmar and Southwest Asia under the perspective of the new era of open trade policy and expansion of Baht economic area, shall be developed urgently. For the development of the Western Seaboard, successful development of the Bang Saphan area, one of the key projects in the Western Seaboard development plan, is indispensable.

(2) The industrial structure of Thailand, characterized by the processing and assembling industry and consumer goods industry presently, is starting to transform into a structure of integrated industry by the introduction of upstream material industry. The iron/steel industry already has started operation in the Bang Saphan area, and the creation of an iron-related industrial complex is foreseeable by means of upgrading and expansion of the iron/steel industry and the establishment of downstream industry as well as supporting and relevant industries in the Bang Saphan industrial estate.

(3) The shallow shore line along the Gulf of Thailand is unsuitable for the construction of a deep sea port which is required for the material-based heavy industry. Bang Saphan as well as Map Tha Phut and Laem Chabang is one of the precious locations suitable for deep sea port construction in Thailand. This important and so called "finite port resource" should be effectively utilized through the expansion of port facilities and the development of industrial activities in the hinterland of the port.

(4) Since Thai economy including industries is taking off, it is required to set up the new concept for Free Trade. The regime of Free Trade Area (FTA) is recommended to be introduced to respond to the recent situations such as the changes in domestic economy and international movements of AFTA and WTO. The objectives of FTA recommended by the Study Team are not only to contribute to export promotion by

attracting foreign direct investment but also to strengthen the competitiveness of the domestic industries through the expansion of trade. Bang Saphan is the right place to adopt FTA for trial.

The Bang Saphan industrial estate is viable on both economic and financial points of view, in case the following conditions are satisfied.

(1) External infrastructure including water supply, electric power supply, transportation and telecommunications, fundamental for the industrial activities, should be developed and managed on the public sector initiative. As for water supply facilities, especially, the Tha Sae dam planned by R/D should be realized urgently and a water conveyance pipeline of approximately 70 km from the Tha Sae dam to the Bang Saphan area is to be installed by the public sector, for instance IEAT.

Conveyed water will be distributed not only to the industrial estate but also the iron/steel industry as well as to the new town and port area after purification. According to IEAT, the Government has decided to conduct the feasibility study of external infrastructure of water and electric supply facilities, which should be carried out as an urgent project.

(2) It is recommendable that the Bang Saphan area inclusive of the Bang Saphan industrial estate be designated as a free trade area. Advantages of such a designation are as follows:

- Providing strong incentives for promotion of the investment in the Bang Saphan industrial estate which is disadvantageous due to its remote location from Bangkok,
- Viability of the Bang Saphan industrial estate project will be enhanced by the application of tax reduction and exemption in addition to the ordinary incentives.

(3) To strengthen the competitiveness of the Bang Saphan industrial estate, a possible reduction of the development cost should be considered. The Bang Saphan industrial estate development project is proven to be viable both economically and financially under the condition of a lot sale price of 50 US$/m^2. However, the sale price should be low enough to overcome competitors. Land acquisition cost, for instance, could be minimized by the endeavor of the J/V company for the Bang Saphan industrial estate development.

Although, the development of the Bang Saphan industrial estate shall be principally initiated by the private sector, the public sector, by initiating the development of external infrastructure, shall participate in the industrial estate project to collaborate and integrate with the Western Seaboard development.

(1) For this context, a Board of Development and Management of the Bang Saphan Free Trade Area shall be set up with the participation of relevant governmental bodies and representatives from the private sector. Under the Board, a Free Trade Area Corporation and several J/V companies shall be established to take charge of the development of the industrial estate, external infrastructure and urban development. The industrial estate J/V company will be composed of IEAT and partners from the private sector. As for the external infrastructure, it is recommendable that IEAT participates in J/V companies to keep integration among the projects.

(2) The development fund for the industrial estate will be raised from the equity participation from the private and public sectors as well as from loans from the financial market. On the other hand, some external infrastructure projects of which the return is expected to be low and requires a long term, will need governmental resources. Soft ODA loans will be contributive to the procurement of governmental budget for the stable accomplishment of the project.

Due consideration should be paid to the environmental conservation to cope with the environmental impact caused by the development of the Bang Saphan industrial estate.

There will be some degree of air pollution and water contamination by industrial activities, but it is considered that the environmental degradation will be little according to the environmental standard. Therefore, the result of projection together with the monitoring method to be taken shall be informed and explained to be residents of Bang Saphan.

As for the relocation of residents living in the industrial estate site, the private industrial estate development company will be in charge. However, it is recommended that IEAT and participants to the industrial estate company assist the private company for smooth negotiation, especially for the relocation of educational and social facilities.

Environmental Impact Assessment defined by the law shall be made in advance of the implementation of the industrial estate by referring to the results of this study report.

Tables

Table 1 Advantages of Bang Saphan Area in the Development of Industry

1	Deep Sea Port of Prachuap Port	- Prachuap Port is the deepest port in Thailand which allows accommodation of the gigantic vessels with bulk cargo and suitable for the heavy and chemical industries which require amount of cargo transportation.
2	Virgin Area with Lower Land Price	- Vast industrial land will be available by the lower price for the investors.
3	Directed and Supported by the Governmental Development Policy and Strategy	- Bang Saphan area will gradually be developed in accordance with the integrated regional plan of Western Seaboard Development Plan and Bang Saphan Industrial Development Plan formulated by the cooperation of Japanese technical assistance. - Infrastructure such as water supply, electric supply, road network, etc. will be developed by the official initiative.
4	Free Trade Zone Concept	- Free trade zone concept will be applied in the Bang Saphan industrial area in order to accelerate the promotion of investment. Enterprises could enjoy free production and trading activity with tax exemption and reduction including the VAT exemption.
5	Presence of Giant Iron/Steel Industry	- An Integrated industrial complex will be developed in the Bang Saphan area where the Sahaviriya group has developed the giant iron/steel factories and a new industrial estate has being developed. The downstream industry and supporting industry as well as relevant industries will be recommended to be establish in the industrial complex.
6	Linkage with Eastern Seaboard and Myanmar and Andaman Sea	- Easy access to other industrial regions in Thailand and abroad from Bang Saphan area will be accomplished by the marine and road transportation. Liner service including Ro/Ro ship is already begun to Eastern Seaboard from Bang Saphan area.

Table 2 Selection of Industrial Groups in the Bang Saphan Industrial Estate

1	2	3	4	JSIC	TSIC	Japanese Industry
				Manufacture of Food Group		
○				1211	311	Meat Products
○				1212	311	Dairy Products
○				1219	311	Miscellaneous Livestock Products
○	○			1222	31141	Canned seafood and seaweed
○				1229	31149	Miscellaneous seafood products
○			△	1242	31132	Soy sauce "syoyu" and edible amino acids
	○			1253	31211	Glucose, starch syrup and high-fructose corn syrup
	○			1263	31169	Wheat flour milling
○	○			1281	312	Vegetable oil and fats
	○			1283	312	Edible oil and fats
○				1293	31173	Noodle, macaroni and spaghetti
○	○			2021	35120	Compound fertilizers
				Manufacture of Textile Group		
		●		1421	32113	Spinning mills and cotton
		●		1431	32119	Twisting yarns, except bulky yarns
		●		1441	32115	Fabric mills,woven cotton and spun rayon
				Manufacture of Petroleum and Coal(C1 Chemicals) Group		
○		●		2011	35400	Nitrogenous and phosphatic fertilizers
○	○	●		2012	35120	Compound fertilizers
○		●		2023	35210	Inorganic pigments
○	○	●		2024	35111	Compressed and liquefied gases
○	○	●	△	2031	35111	Basic petrochemicals, including derivatives produced from an integrated process
○	○	●	△	2032	35111	Alphabetic intermediates, including alphabetic solvent
○	○	●		2033	35111	Methane derivatives
○	○	●		2034	35299	Fermentation industry
	○	●	△	2061	35220	Medical material preparations
○	○	●		2121	35299	Lubricating oils
○		●		2122	35299	Greases
		●		2311	35510	Tire and tubes for automobiles
		●		2333	35591	Mechanical rubber products
		●		2393	35591	Rubber sheets
				Manufacture of Wooden and Furniture Group		
○		●		1617	33112	Flooring mills
○		●		1619	33111	Sawing and planning mills,n.e.c.
○	○	●		1624	33113	Particle board
		●	△	1711	33201	Wooden furniture, except Japanese
				Manufacture of paper and pulp group		
○	○	●		1821	34111	Paper
○	○	●		1822	34111	Paperboard
○		●		1832	34120	Corrugated paper
○		●		1841	34190	Office paper products

1	2	3	4	JSIC	TSIC	Japanese Industry
				Steel processing industry group (Machinery product-line)		
○	○		△	2644	371	Steel pipes and tubes
○				2646	371	Cold finished steel bars
○	○		△	2648	371	Wire drawing
○				2653	371	Coated steel pipes
○				2654	371	Coated steel wire
○	○		△	2661	371	Iron casting, except cast iron pipes and malleable iron castings
○			△	2662	371	Malleable iron castings
○	○		△	2663	371	Steel castings
○			△	2664	371	Secondary forgings
○	○		△	2692	371	Iron and steel shearing and slitting
○			△	2693	371	Iron and steel scrap preparation for smelting
○			△	2694	371	Cast iron pipe
○	○		△	2841	371	Fabricated construction-use metal products
○				2842	371	Fabricated architectural metal products,except structural hardware
○	○		△	2843	371	Fabricated plate work and sheet metal work
				Ceramics industry group		
○	○			2512	36200	Processed flat glass
○	○			2514	36200	Glass containers
○				2551	36910	Fire blicks
○	○			2559	36999	Miscellaneous clay refractories
○	○			2561	36999	Carbonaceous electrodes
				Processing and Assembly industrial group		
○	○	●		2911	38299	Boilers
○	○	●		2912	38240	Steam engines, turbines and water wheels
○		●	△	2971	38240	Pumps and pumping equipment
○	○	●		2972	38292	Air compressors, gas compressors and blowers
○	○	●		2974	38240	Coveyers and conveying equipment
○		●		2977	38240	Oil hydraulic equipment
○	○	●		2978	38240	Chemical machinery and its equipment
○	○	●	△	2979	38299	Miscellaneous general industry machinery and equipment
		●		2981	38250	Office machines
		●		2982	38250	Miscellaneous office,service industry and household machines
○		●		2983	38292	Refrigerators and air conditioning apparatus
○		●		3011	38240	Generators, motors and other rotating electrical machinery
○		●		3012	38240	Power and distribution transformers, except electronic appliances transformers
		●	△	3021	38330	Household electric appliances
		●		3042	38320	Radio communication equipment
		●		3091	38392	Storage batteries
		●		3112	Shipbuilding	Motor vehicle bodies and trailers
		●	△	3113	Shipbuilding	Motor vehicle parts and accessories
				Shipbuilding and repairs		
○	○			3141	38411	Steel shipbuilding and repairing
○	○			3142	38419	Hull blocks

Note;

○ Regional resources based industrial category

○ Port-oriented industrial category

● Policy-oriented industrial category

△ Industrial category selected from result of demand survey

Table 3 Implementation Organization for Infrastructure of the Bang Saphan Industrial Estate

	F/S	E/S	Construction	Maintenance /Operation	Remarks
1 Water Supply System					
1) Reservoir(Tha Sae)	RID	RID	RID	RID	
2) Reservoir(Bang Saphan River)	RID	RID	RID	RID	
3) Pipeline(Tha Sae~Bang Saphan)	IEAT/PWA	IEAT/PWA	IEAT/WW	IEAT/WW	
4) Pipeline(Bang Saphan Reservoir ~ Bang Saphan)	IEAT/PWA	IEAT/PWA	IEAT/WW	IEAT/WW	
5) Purification Plant	-	IE Co.	IE Co.	IE Co.	
6) Distribution Facility	-	IE Co.	IE Co.	IE Co.	
2 Port					
1) Jetty for Ore/Coal	PP Co.	PP Co.	PP Co.	PP Co.	
2) General Cargo Berth	PP Co.	PP Co.	PP Co.	PP Co.	Governmental assistance is recommendable for the construction.
3) Back Up Area (Container Deposit, General Cargo Warehouse, etc.)	PP Co.	PP Co.	PP Co.	PP Co.	
3 Road					
1) Access Road to IE (R4 ~ IE)	DOH	DOH	DOH	DOH	
2) Access Road to Port (IE~Port)	DOH	DOH	DOH	DOH	
3) Road inside IE	IE Co.	IE Co.	IE Co.	IE Co.	
4) Community Road in Bang Saphan Town (R. 3169)	-	DOH (1996)	DOH (1997~1998)	DOH	will be improved by 1998
5) Community Road in Bang Saphan Town (Provincial Road)	-	PKK Province	PKK Province	PKK Province	
4 Electric Supply					
1) IPP	Private	Private	Private	Private	
2) 500 kV transmission line	EGAT	EGAT	EGAT	EGAT	
3) Expansion of Bang Saphan SS	EGAT	EGAT	EGAT	EGAT	
4) Development of New SS	EGAT	EGAT	EGAT	EGAT	
5) 115 kV TL (BS SS ~ IE)	PEA	PEA	PEA	PEA	
6) 115 kV TL (New SS ~ IE)	PEA	PEA	PEA	PEA	
7) SS in IE	PEA	PEA	PEA	PEA	
8) Distribution line in IE	IE Co.	IE Co.	IE Co.	IE Co.	
5 Telecommunications					
1) Switching station in IE	TOT	TOT	TOT	TOT	
2) Optical cable from SS of IE to Bang Saphan SS	TOT	TOT	TOT	TOT	
3) Distribution line in IE	IE Co.	IE Co.	IE Co.	IE Co.	
6 Solid Waste Disposal					
1) Hazardous Waste Disposal	MOI/Private	MOI/Private	MOI/Private	Private	
2) Incinerator for General Waste	IE Co.	IE Co.	IE Co.	IE Co.	

RID : Royal Irrigation Department
PWA : Provincial Waterworks Authority
WW : Western Water Resources Development and Management Co., Ltd.
IE Co. : Industrial Estate Company (Assumption)
DOH : Department of Highway
PKK : Prachuap Khiri Khan
PPCo. : Prachuap Port Company
EGAT : Electricity Generating Authority of Thailand
PEA : Provincial Electricity Authority
MOI : Ministry of Industry
TOT : Telephone Organization of Thailand