APPENDIX C DEVELOPMENT PLAN OF BANG SAPHAN INDUSTRIAL CITY AND FREE TRADE AREA

C.1 Development Plan of Bang Saphan Industrial City

C.1.1 Background

(1) Existing Urban Facilities in Amphoe Bang Saphan

In Amphoe Bang Saphan, the construction of an industrial estate only without urban facilities will be unsuccessful. Existing social facilities, commercial facilities, and urban facilities in Amphoe Bang Saphan are too poor as shown in the following table to support the large scale industrial development.

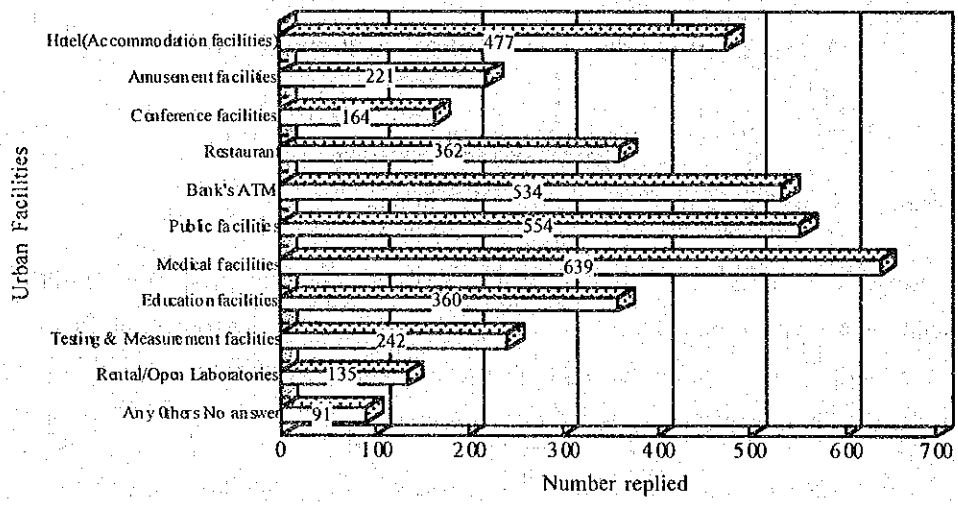
Existing Social & Urban Facilities in Amphoe Bang Saphan as of 1995

Category	Type	Status	Number	Remark
■Education facilities	Primary school	Public	34	
	Primary school	Private	1	
	Extended primary school	Public	8	
	Secondary school	Public	4	
	Secondary school	Private	1	
	Technical college	Public	1	
■Health facilities	Community hospital	Public	1	
	Tambon health center	Public	13	
	Public health station	Public	1	
	Health education center	Public	1	
	Clinic	Public	1	
	Nursery	Public	1	
	Drug store	Private	1	
■Convenience facilities	Post office (Bang Saphan)	Public	1	
	Branch of bank	n.a	n.a	
	Firehouse	n.a	n.a	
	Police station	n.a	n.a	
	Travel agency / etc.	n.a	n.a	
■Social service facilities	Municipality office	Public	1	
	Municipality disposal	Public	1	Waste disposal
	Storage of water	Public	1	Water supply facilities
■Commercial facilities	Market/Plaza	Private	several	
	Daily goods seller	Private	several	
	Restaurant	Private	several	
	Gas /Energy station	Private	several	
	Hotel/Guest house	Private	several	
■Residential facilities	Family type × 2 unit L=20 W = 2F	Private	7 units	Bang Saphan Bar Mill Co., Ltd.
	Single dormitory × 2 Unit	Private		
	Double dormitory × 2 Unit	Private		
■Sports facilities Amenity facilities	Basketball court/Tennis court	Private	several	Bang Saphan Bar Mill Co., Ltd.
■Accommodation facilities	Hotel	Private	some	Western House

Source : The Study Team

(2) Urban Facilities Required by Investors

The Study Team conducted the questionnaire survey to identify the urban functions required by investors. The number of responses was about 3,800 (plural answers).



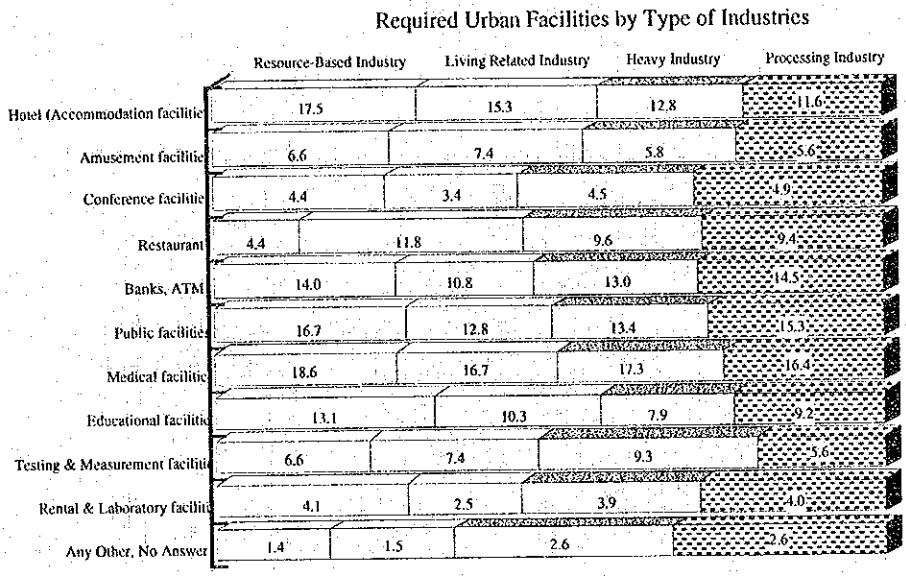
Required Urban Facilities

1) Potential investors required social services such as medical facilities, public facilities, banks, etc. These are the most basic urban facilities and individual enterprises cannot equip them by themselves. There are some hospitals and public facilities in Amphoe Bang Saphan, but they are not sufficient to attract new investors.

2) Accommodation facilities such as hotels are also important for investors who plan the business and production activities. Some enterprises often build these facilities, namely Guest Houses, by themselves.

3) Education facilities and restaurants are also required. Education facilities are classified into two types: One is the facility for skill development of workers and the other is the ordinary education facility for the children of the workers.

The following figure indicates the required urban facilities by four industrial categories.



Required Urban Facilities by Type of Industries

1) Resource-oriented and heavy industries, so called "Foot-Tight industries", tend to locate in rural areas where urban or convenience facilities are insufficient in the vicinity. This is the reason why Accommodation Facilities, Banks, Education Facilities, and Rental and Open Laboratories are required.

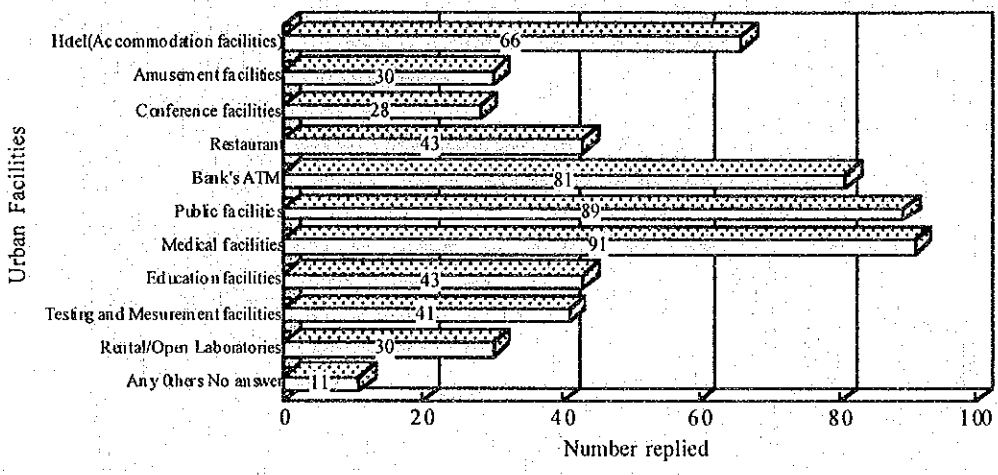
2) Neither living-related industries nor processing industries often choose the site in the vicinity of a city furnished with convenient facilities for production. They are so called "Foot-Loose industries".

For the above-mentioned reason, Amphoe Bang Saphan should be equipped with some urban facilities when the Industrial Estate is developed and companies belonging to the basic industry or resource-oriented industry are established. If these urban facilities are not developed, it is difficult to induce these industrial categories.

22 enterprises had an interest in the Bang Saphan Industrial Estate and 95 enterprises would examine in the future. These 117 companies, called "potential investors", required the urban facilities shown in the following figure. There were 553 plural replies and a company selected 4 -5 facilities on an average.

1) The potential investors required public facilities, medical facilities, banks, etc.

2) Accommodation facilities, testing and analysis facilities, and rental and open laboratory were also required. These are supporting facilities for the production activities.



Required Urban Facilities

These indicate that Bang Saphan needs to be furnished with the supporting facilities for production activities as well as the basic urban facilities. Especially, it is important to construct the facilities which assist small-medium sized enterprise in various scenes.

(3) Urbanization for Industrial Growth

The current situation of industrial activities in Amphoe Bang Saphan is at the initial stage. At the full-operation stage, iron and steel industries will accumulate "technologies". These technologies will constitute the "social infrastructure" in the Bang Saphan area and attract new industries. Technologies, in general, belong to individuals. In other words, the "technological accumulation" means the "accumulation of capable personnel". Then, relevant urbanization should be crucial to attract capable personnel.

In this context, the improvement of urban facilities is a prerequisite to attract capable personnel.

The following table indicates the relationship between urban facilities and the types of human resources.

Priority of Urban Functions and Facilities in the Industrial New Town

Urban Function & Facility Category	Existing in Bang Saphan	1)General Workers	2)High skilled Workers (Engineers & Managers)	3)Skilled Workers	4)Foreign Workers	5)Researchers	6)Visitors
Residential Facilities							
1) High grade residence (One unit type)			◎	◎		◎	
2) Middle class residence	●		◎				
3)Residence (Collective type)		○	○	○	○		
4) Guest House				○		○	◎
5) Hotel(Business & City Hotel)	●						◎
Education Facilities							
1)Business school		○	◎	◎	○		
2)Language school			○	○	◎		
3)International school		○	○	○	◎		
4) Branch of Technical College			○			◎	○
5) Skill Training Center		◎		○	◎		
6) International Technical Training Center				○	◎		
7) Research/Laboratory Center			○			◎	
Supporting Facilities							
1) Testing/Measurement Center			◎	○			
2) Incubation Center/Office			◎	○		◎	
3) Conference Center			○			◎	○
4) International Exhibition Center			○			○	◎
Amusement Facilities		◎	◎	◎	◎	◎	◎
Convenience Facilities		◎	◎	◎	◎	◎	◎
Infrastructures		◎	◎	◎	◎	◎	◎

● = Existing facilities in Amphoe Bang Saphan

◎ = Most important function & facilities desired by workers

○ = Important function & facilities desired by workers

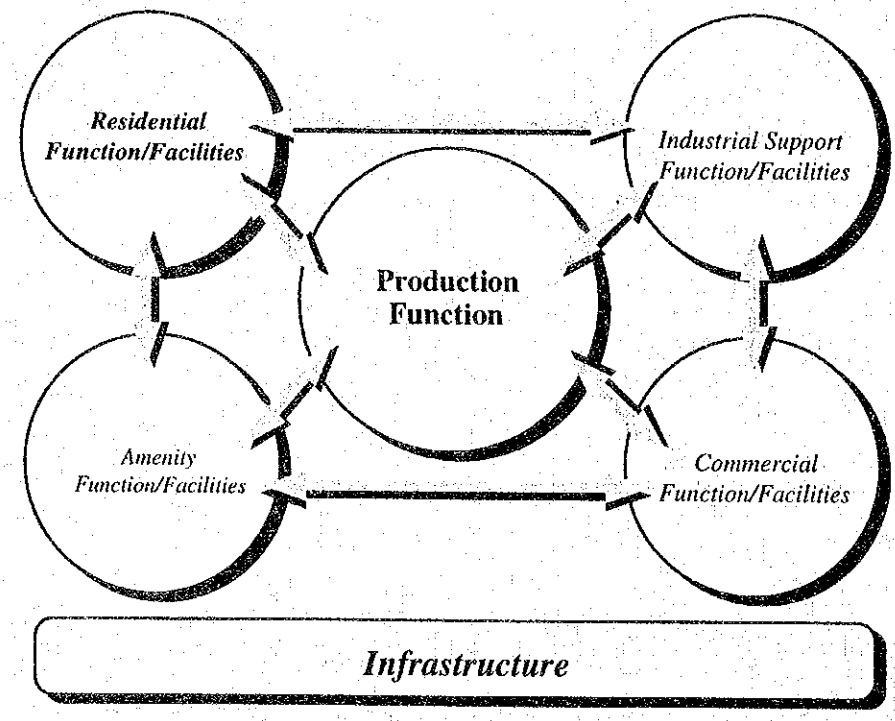
Nothing = not important or no relation

C.1.2 Concept of New Industrial City and Industrial New Town

(1) Concept of New Industrial City

The role of the New Industrial City is as greatly important as that of other infrastructures such as water, electricity, road, etc. For example, most potential investors required urban facilities to be developed in the Bang Saphan Area, as aforementioned. Before discussing of individual facilities, the concept of New Industrial City should be clarified.

The New Industrial City, a highly integrated and well planned city, will have five major functions: i) Production Function, ii) Industrial Supporting Function, iii) Habitation Function, iv) Business & Commercial Function, and v) Amenity Function. From the land use point of view, the New Industrial City will be zoned with a Port Area, Iron and Steel Complex Area, Industrial Estate, Institutions and Education Area, Industrial New Town Area, and Amenity Area. The basic concept of the City is shown in the following figure.



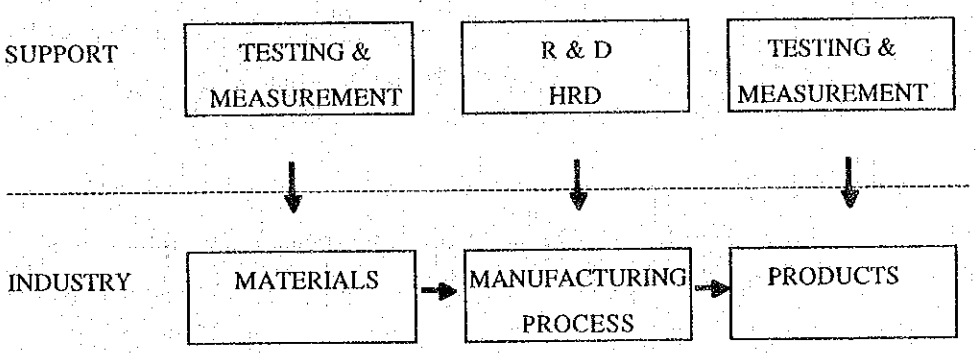
Concept of the New Industrial City

1) Production Function - BSIE and Iron & Steel Complex

The production function is the prime motor of the Industrial New Town. This function will consist of target ten groups of industries including iron and steel industries (refer to Appendix A.2.).

2) Industrial Supporting Function

Research and Development (R&D), Testing & Measurement, and Human Resource Development (HRD) are discussed as the industrial supporting functions. R&D and HRD are classified as the supporting functions of manufacturing process, while Testing & Measurement is important before and after the process. The relation between industrial process and supporting functions is illustrated below.



In case of HRD, aimed at nurturing employees, different facilities should be set up for the target of the trainees such as engineers, skilled workers, etc. As for the education facilities, which are included as one of the HRD facilities, the Technical College will be constructed in order to raise the technical level of workers in the Bang Saphan Area. But other courses of training or education of human resources are not included in that college. Therefore it is recommended that appropriate facilities be established to train or educate engineers as well as skilled and unskilled workers.

It is less realistic to propose the establishment of a university in Bang Saphan. In other words, engineers will be supplied from other region such as BMA. To nurture the skilled and unskilled workers, an ordinary vocational school should be established. The demand for skilled and unskilled workers is expected to increase, but now the demand is small. So the Study Team proposes that a vocational school will be established first using the facilities of the planned

technical college and when the demand is revealed, an independent school shall be considered.

As for R&D and Testing and Measurement, the Study Team proposes to establish a Material Research Center. The Center is outlined below:

Material Research Center

BSIE will be developed to accommodate not only steel-related industries but also other material-based industries such as non ferrous metals, ceramics, rubber, petrochemicals, and so on. Most of the technical standards required will be transferred from the industrially developed partners but Thai companies must obtain their own technical capabilities to modify such manufacturing standards to match the local requirements, such as customer requirements, different raw material sources, and different manufacturing alignments and their operational skill. To conduct those technical development works, there must be a material research laboratory nearby the site. This material research should better start with iron and steel field, the functions of which should be:

(1) Product research:
   * decide manufacturing standards to meet customer requirements.
   * identify root causes of quality fluctuation and develop countermeasures.

(2) Process research:
   * identify operational causes of process fluctuation and develop countermeasures.

(3) Training of operation staffs and key operators:
   * provide basic understanding of overall process and products.
   * provide clear understanding of control indexes and their relations to process stability and product quality.

(4) Assistance in qualification procedures for authorized standards:
   * ex. ISO, JIS, ASTM, API, LR, AB, etc.

Necessary equipment for the initial stage will be

i. Common machinery
ii. Mechanical testers
iii. Corrosion resistance testers
iv. Microscope

v. Spectroscopic analyzers
vi. Chemical analyzer

Instructors may be provided by university faculties or foreign countries.

These research activities shall be gradually expanded into other fields depending upon the requirements from the industry.

3) Habitation Function - Residential Area

Habitation is the main function of the New Industrial City. For the purpose of absorbing the increased population, the Industrial New Town shall be developed.

4) Business & Commercial Function

This function consists of offices, retail sales, wholesales, banking, accommodation facilities, etc. Basically consumer-oriented facilities such as retail sales will be located in the Industrial New Town. Other facilities such as office space, wholesales, banking, and accommodation (e.g. hotel) will be located along the Route 3169. As for retail sales, a certain scale of Shopping Center should be proposed.

5) Amenity Function

The amenity function mainly consists of sport and amusement facilities such as tennis court, athletics fields, stadium, gymnasium, golf course, parks etc. These facilities should be open to visitors as well as to local habitants.

(2) Concept of Industrial New Town

The main function of the Industrial New Town is habitation. Three types of houses are planned. The Town should also have a business and commercial function and an amenity function in order to ensure good living standards for the habitants. For example, traffic facilities such as car park, bus terminal; commercial facilities such as shopping center, restaurant, bank; education facilities such as elementary school, high school, etc. shall be provided.

C.1.3 Frame of the Industrial New Town

The frame conceived by the Study Team for the Industrial New Town is as described below:

(1) Population

The population of the study area is estimated on the following assumptions:

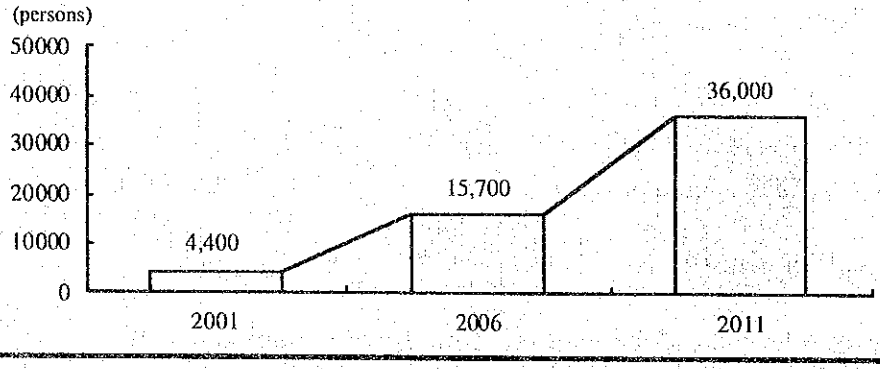
1) The employees of the companies located in the Bang Saphan Industrial Estate will be recruited not only from Bang Saphan District but also from other districts.

2) One family is composed of 3.75 persons.

3) The number of employees in the tertiary sector is estimated by multiplying the number of employees in the manufacturing sector by a certain coefficient.

Labor force demand directly and indirectly induced by the development of the Bang Saphan industrial city is projected as shown in Table C.1.1 and C.1.2. Population grown in conjunction with labor force increase is projected as shown in Table C.2.3 and summarized below.

Estimated population of the Industrial New Town (Years 2001, 2006, 2011)



	2001	2006	2011
Planned population of New Town	4,400(5.5%)	15,700(16%)~ 22,000(22%)	36,000(25%)~ 69,000(43%)
Amphoe Bang Saphan (DTCP estimates)	-	-	137,000
(Study Team estimates)	80,000(100%)	94,000~ 100,000 (100%)	127,000 - 160,000 (100%)

(2) Land Use

Based on the above population, the development areas of the Industrial New Town are assumed as follows.

Planning Factors for the Industrial New Town

All Industrial New Town Area (including Residential Area), Density = 100 people/ha	
◇Residential Area ⇒	65% of Industrial New Town Area, Density = 160 people/ha
◇New Community and Business Space⇒	8% of Industrial New Town, Density = 200 people/ha
◇Road ⇒	17%～20% of Industrial New Town Area
◇Public Space ⇒	3% - 5% of Industrial New Town Area
◇Public Garden Space ⇒	5% of Industrial New Town Area

Based on the population density both in the residential area (100 people/ha) and in commercial area (200 people/ha), the development area of for New Town is estimated at 40 ha in the year 2001, 170 ha in 2006, and 410 ha in 2011 as summarized below.

Population and Development Area

Area	2001	2006	2011
Residential Area/1			
Planned Population (people)	4,400	15,700	36,000
Area (ha)	40.0	150.0	350.0
New Commercial & Business Area/2			
Planned Population (people)	0	3,450	11,000
Area (ha)	0.0	20.0	60.0
Total			
Planned Population (people)	4,400	19,150	47,000
Area (ha)	40.0	170.0	410.0

Note: /1 Refer to Table C.1.4 and C.1.5 for details.
/2 Refer to Table C.1.6 for details.

(3) Types of Residential Facilities

Bungalow Type (High Grade)

Bungalow type house will be supplied to engineers, managers, researchers, etc. The number of bungalow type houses is assumed to be 4% of the total in consideration of the number of prospective number of households. The building ratio is assumed at 20%-25% and the plot ratio at 50%.

Town House Type (Middle Grade)

Town houses are the semi-detached types to be supplied to highly skilled and general workers. The number of those workers is assumed to be 10% of the total number of employees. The building ratio is assumed at 30% and the plot ratio at 60%.

Condominium Type (Collective Building)

This type of house will be mainly supplied to general workers. There are two types of condominium; one is middle building (8-10 stories) and the other is low building (4-6 stories). The average scale of one apartment house is 60 to 70 m^2.

(4) Location of the Industrial New Town

Four sites are proposed for the residential development by DTCP ("City Planning of Bang Saphan Community" as described below).

- Area around the junction of Routes 4 and 3169 (260 ha: 1,200 m × 2,200 m)
- Area between the junction and Municipality Area (center of Amphoe Bang Saphan) along the Route 3169 (220 ha: 1,200 m × 1,800 m)
- Area between the resort area and iron and steel complex (180 ha: 1,500 m × 1,200 m)
- Area to the south of the proposed Industrial Area (120 ha: 1,000 m × 1,200 m)

The necessary facilities for the Industrial New Town are listed in the table below. (For the land use plan of the Industrial New Town, please refer to Figures 5.2 and 5.3 of the Main Text).

【Initial Stage : ~ 2001】

Development Sector	Land Use	Specification & Contents	Area (m2)
Public	☐Road Area	☐ Road w= 6.0m - 16.0m ☐ Green Belt w= 4.0m - 14.0m	66,000
	☐Public Space (Regional Space of Community Area)	☐ Public Facilities (Medical Facilities/Post Office/Education Facilities/etc.)	11,000
	☐Public Garden	☐ Garden/Pond/Refresh Area/etc.	18,000
	☐Traffic Facilities	☐ Car Park/Bus Terminal/etc.	5,000
Private	☐Residential Area	☐ Bungalow/Town House/Collective Building/etc. (Details are give in another table)	260,000
	☐Commercial Area	☐ Shopping Center/Plaza/Restaurant/Book Store/Bank /Flower Shop/Barber/etc. (200 people/ha)	40,000
Total		Industrial New Town Area	400,000

【Final Stage: ~ 2011 ~】

Development Sector	Land Use	Specification & Contents	Area (m2)
Public	☐Road Area	☐ Road w= 6.0m～16.0m	700,000
		☐ Green Belt w= 4.0m～14.0m	123,000
	☐Public Space (Regional Space of Community Area)	☐ Public Facilities(Medical Facilities/Post Office/Education Facilities/etc.)	205,000
	☐Public Garden	☐ Garden/Pond/Refresh Area/etc.	25,000
	☐Traffic Facilities	☐ Car Park/Bus Terminal/etc.	
Private	☐Residential Area	☐ Bungalow/Town House/Collective Building/etc.	2,665,000
	☐Commercial Area	☐ Shopping Center/Plaza/Restaurant/Book Store/Bank /Flower Shop/Barber/etc.(200 people/ha)	382,000
Total		Industrial New Town Area	4,100,000

(4) Methodology of Industrial New Town Development

For smooth development and management of the Industrial New Town, a joint venture company should be established, with equity participation of 70% - 80% by the private sector and 20% - 30% by the public sector.

The Study Team proposes the establishment of the "Bang Saphan New Town & Amenity Co., Ltd." as a management body for the entire Industrial New Town with the following main roles, implement the six specific important activities described below.

【Main Roles】

- land purchase, planning, construction, management and maintenance of the Industrial New Town
- land purchase, planning, construction, and management of related businesses
- leasing of land, facilities, and floors
- coordination and cooperation with other implementing and management bodies

【Main Activities of Project】

1) Construction, management of the Regional Community Center (RCC) and office renting in this RCC.

2) Housing site purchase, planning, construction of various types of houses, selling lots and houses, renting of houses and resettlement.
3) Planning of golf course and sports facilities (outdoor, indoor facilities) including special management function.
4) Hotel site purchase, planning and construction of hotel, including special management function.
5) Shopping Center (SC) site purchase, planning, including special management function.
6) Management and maintenance of the entire Industrial New Town, control of the town landscape.

C.2 Free Trade Area

C.2.1 Background

(1) WTO and AFTA

Based on the GATT Uruguay Round, WTO (World Trade Organization) started. The basic principle of the WTO is to promote the free trade around the World. The WTO includes various countries from least developed countries to advanced countries therefore the treatment of trade conditions has to be complicated. Roughly speaking, the basic policy of the WTO is to keep fair trade under the certain rules and to solve the conflict by the multilateral discussion (avoid solving trade conflict by the bilateral meeting). In WTO agreement, the member countries have to provide the MFN treatment to other member countries without any conditions immediately. Including various development stages WTO allows some exceptions; customs union, free trade zone, general preference treatment tariff and regional economic agreement in the developing countries, tariff wall for the protection of domestic industries in the developing countries, etc. As for the non-tariff barrier, WTO basically prohibits; subsidized export, dumping, etc. To promote free trade is one of the crucial conditions for Thai Economy to continue the sustainable growth.

Among the ASEAN countries the establishment of AFTA were agreed. To achievement of AFTA successfully CEPT(Common Effective Preferential Tariff) scheme were adopted. In CEPT scheme, each country has to reduce the tariff rate of 0 to 5 % till the target year. The tax line adopted by each country is different so it is difficult to argue about tariff reduction evenly among member countries. To solve this issue CEPT requests member countries to draw up the schedule on Fast Track, Normal Track, and Temporary Exclusive List. The number of products listed in Normal Track and Fast Track in each country is summarized as in following table. Tariff rates of products listed in Normal Track list should be reduced within the 0-5 % range until 2008 and these in Fast Track list until 2003. In the Temporary Exclusive list there are 3,322 tax lines in six ASEAN countries. Tariff rate of these shall be reduced within 0-5 % range until 2003. In case of Thailand, 186 items are listed in the list (122 products by the tax lines) and 36 products of the above 186 items are announced as the products in 1996 by MOF. The tariff rate of these 36 products will be 20% in 1996 and will be reduced to 5% in 2003 except 3 products already less than 5%. Along with changing the trade situation the CEPT scheme are accelerated its implementation to 2003. As a result tariff rate of whole manufacturing products will be reduced within 0-5% in 2003.

(2) Current Situation of EPZ in Thailand

In Thailand more than 10 Export Processing Zones are developed by IEAT. Major objectives of EPZ are considered as follows;

- Promotion of foreign direct investment especially in manufacturing sector
- Job creation or expansion of job opportunity
- Accumulation of foreign currency

The available works in EPZ are in general limited to compare to other concept of FTZ, however some of them are liberalized in recent years; for example the deregulation of sales to the domestic market and that of EPZ to EPZ trade. In Thailand, some companies located in EPZ also request to start sales for domestic market because of the rapid economic growth in Thailand. In response to this request, the Thai government liberalized 20% of total products to domestic market. However it is very much complicated to access the domestic market because the companies located in EPZ were provided incentives under condition for export of their products. The example of the procedure to sell the domestic companies is shown as Fig. C.2.1.

Occupancy rate of EPZ are slightly decrease in Thailand. The reason of this decline is not identified whether the location condition of EPZ (i.e. recent developed EPZs are located far from BKK) or the role and function of EPZ itself (i.e. the role or purpose of EPZ in Thailand are already achieved in view of her economic situation). AFTA, mentioned above, is already on schedule and proposals of exception list in Thailand is one of the most liberal, namely less-tax-protected in the countries. Under these conditions, the effectiveness of EPZ becomes smaller than before. Another issue of EPZ is related to the economic or industrial linkage. Firms in EPZ use the labor force and 'imported raw material, intermediate goods, machinery, and technologies' and re-export. Therefore technology transfer to the local companies or usage of parts and intermediate goods produced locally are difficult. The situation of foreign assembler located in GIE is also similar; in the first stage of operation almost of all assemblers imported key parts. But when the local venders were nurtured by the assemblers, local parts took over imported ones (In this case local contents regulations contributed to localization. In EPZ, however, local contents are not applicable generally).

(3) Experience in Other Countries

There are more than 600 FTZ(Free Trade Zone) in the World. Because of the conditions of the development stages or of the purpose of the development the

characters of FTZ are different. Furthermore the name of the 'FTZ' is also different. The taxonomy of the FTZ are illustrated in the Fig. C.2.2.

The origin of the FTZ is considered free port in Europe in 19 century. The organization and systems of FTZ have been proceeding during the period of this hundred years. The EPZ which is one of the forms of the FTZ has been planned as the procedure of economic growth in developing countries.

(a) Foreign Trade Zone in the USA

There are more than 400 FTZ approved in USA. The purposes of the FTZ in USA are to promote the international trade, to expand of export, to strengthen the competitiveness of the domestic industries, and to create job opportunity. FTZ in USA is divided into two types; one is called as General Purpose Zone and the other Special Purpose Zone or Subzone. The latter is counted around 220 and permitted for individual factories. The major tenants in the former counted 180 are trade or/and distribution companies and the special feature is in Exhibition. In the contrary of the purpose products or goods from zone are mainly to the domestic market (These are imports).

The FTZ are composed of four organizations; Foreign Trade Zone Board, Grantee, Operator, and Zone User. The role and competence of each organization are summarized as follows.

Foreign Trade Zone Board: The Board is the decision making organization of the FTZ. It supervises the FTZ and consists of the Secretary of Commerce (Chairman), the Secretary of Treasury, and the Secretary of Department of Defense.

Grantee: The Grantee is the juridical person to be given the authority of the establishment, management, and maintenance of FTZ. In general, the Grantee is to be public bodies such as local government, port authority, etc.

Operator: The Operator is the management and control body of FTZ. There are two forms of Operator; one is the Grantee itself to be Operator and the other is contracted base.

Zone User: The Zone User is the tenant companies.
Available activities in the FTZ and customs works related to the FTZ are provided by the Customs Law and the Rules and Regulations of FTZ(15 CFR Part 400). Basic functions of the FTZ are summarized as follows.

i) It is possible to carry the both foreign and domestic goods in the FTZ without Customs clearance and tariff payment for the purpose of warehousing, exhibition, assemble, manufacturing, etc.

ii) Foreign goods in the FTZ are not objects of taxation and extension of Customs clearance until the shipment to the domestic market (or Customs domain).

iii) It is provided the Customs incentives to 'export' domestic market (or Customs domain) from the FTZ; for example, Inverted Tariff System and Quota Avoidance.

iv) Domestic products carrying in the FTZ are considered as exported.

The advantages of locating in the FTZ are as follows.

i) Contribution to the cash flow of the companies

In the FTZ, foreign goods are stocked without tariff payment. When the foreign goods are needed to assemble, manufacturing, or/and packaging before domestic market, interest of the tariff in the period of works would be saved. In case of the re-export, draw-back is applicable. But, in general, it takes long period of approval to draw-back. In the FTZ, the import and export procedure are simplified. This simplification is also contributing to the improvement of cash flow.

ii) Tax exemption or reduction of the defects, damages, obsolescence, waste, and scrap

iii) Inverted Customs Duty Savings

In case of USA, tariff rate is deferent between materials & parts and final goods. The company selects the lower rate of tariff.

iv) The goods carrying in the FTZ are not required country-of-origin marking.

v) It is possible to transport from FTZ to other FTZs without tariff.

vi) For the exhibition in the FTZ, the goods can import without tariff.

(b) FTZ in Europe

The major purpose of the FTZ in Europe is expansion of trade. The most of them locate behind or vicinity of both air and sea port. They have the role of the gateway to the EU market.

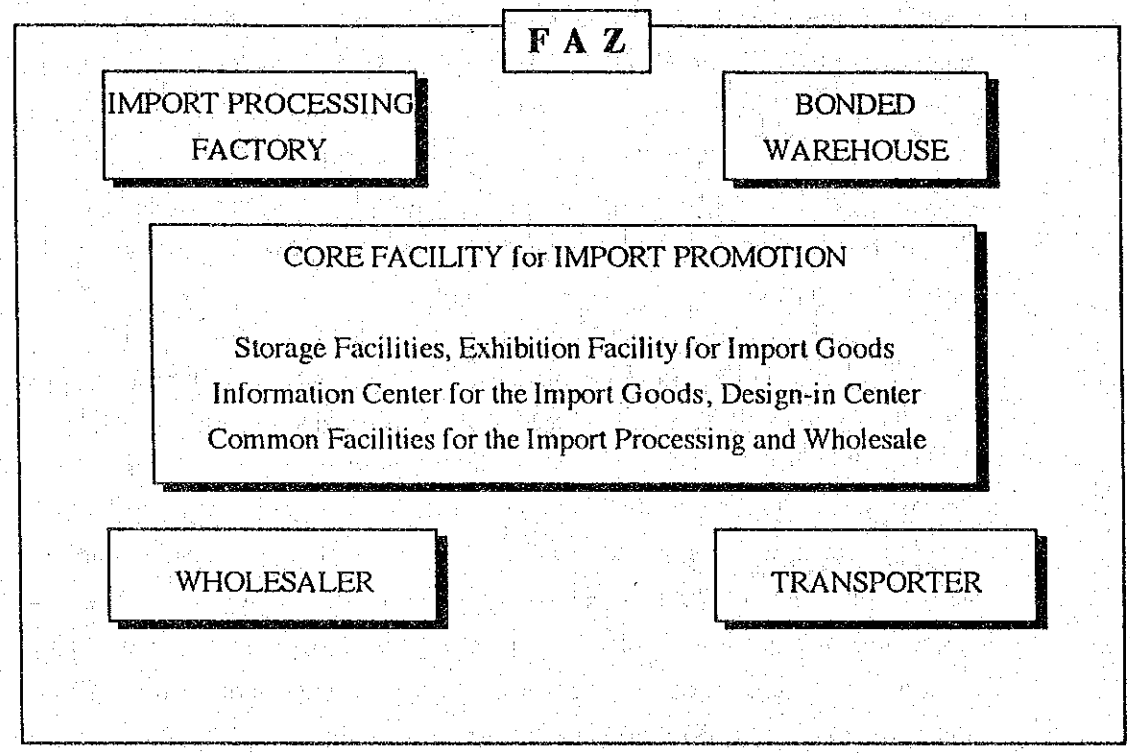
In case of Hamburg(Germany), Hamburg Free Port (Refer to the aforementioned figure) is the part of Hamburg Port Area. The total area of the Free Port is around 1,600 ha isolated by the fence, total length of 30km. The main facilities of the Free Port are the warehousing complex where total area of them are 400ha and the biggest facilities in the World. Services such as washing, repairing, labeling, and repackaging are provided by the warehousing company. There are more than 3,000 trading companies in Hamburg City and they use the services provided by the Free Port. The land of the Free Port are owned by the Hamburg Free City(City-state) to rent the private sector. The Free Port are managed and controlled by the Administration Department of the Free Port under the Ministry of Economy in the city-state. Customs works in the Free Port are also responded by the Department(outside of the Customs Domain of the Federal Customs Office.

Le Havre FTZ in France was established in 1984 under the contract with the Customs Office of France. The advantage of this FTZ are to locate in Le Havre Port area which is the biggest container-treatment deep sea port. This port play the role of the first gate to the Continental Europe from the West. Total area of this FTZ are 190ha composed of warehouse of 100ha and area of transport service companies of 90ha. Authorized warehouses as trade zone provide the various services such as inspection, sampling, washing, repairing, packaging, mixing, etc. The development, advertising, and management of the FTZ are operated by the Port Authority of the Le Havre supervised by the Customs Office. The source of the earnings of the management body are mainly the commission of the using the port facilities and the rent from the tenanted warehousing companies. The investment for the main infrastructure of the FTZ are subsidized by the French Government.

(c) FAZ in Japan

There is only one FTZ in Japan; Okinawa FTZ. But in recent years under the situation of the huge trade surplus the import promotion zone called Foreign Access Zone has been planned by the Government. The initial purpose of the most FTZ has been to promote export(as a result import becomes the major

activities such as FTZ in USA, initially the export promotion was the main purpose), however in case of FAZ in Japan the initial purpose is to promote the import. Therefore the incentives for the companies located in the FAZ are provided to the import related companies. The incentives for the FAZ are divided into two categories; one is providing to the tenanted companies mentioned above and the other is the support for the development and management body (The development and management of the FAZ are carried out by the local tertiary sector - jointly established by the public and private sector). The major incentives are credit guarantee, investment, accelerated depreciation, liberalizing the issue of local bond, exemption of property tax, etc. The concept of the FAZ are shown as following figure.



Concept of FAZ

(d) Free Port Hong Kong and Singapore

Both Hong Kong and Singapore are considered to Free Port with whole territories. All of Hong Kong, around 1,000 s.q.km., is a free port area and the Customs duties are not levied on foreign goods in transit when the goods have entering it expect for certain categories. Furthermore no duties are levied on exports and the goods in transit when the goods have entered duty-free. On the other hand, all of Singapore is not legally free port area but actually it operates as a free port. The Singapore Government developed the free trade zone next to the

are imposed, however, the rate of customs duties and other restrictions are highly liberalized.

The major functions and services available in Hong Kong are summarized below:

- Loading and unloading
- Storing
- Storing, grading, and cleaning
- Distributing locally and reexporting
- Sampling, packing marking, and labeling
- Measuring and weighing of cargoes
- Breaking bulk
- Assembly and manufacturing
- Exhibiting and auctioning

Furthermore banking, insurance and other related services are available.

The major functions and services in FTZ in Singapore are similar to those of Hong Kong

(4) Terminology

The types of Free Trade Zone are defined as Free Port, Foreign Trade Zone, and EPZ in Figure C.2.2. In the case of Japan it is called FAZ focusing on the import promotion. In Thailand, there are two different kinds of FTZ and EPZ: the former are Tax Free Zone (GEMOPOLIS) and Free Trade Zone (defined in the revised draft IEAT Law), and the latter is an ordinary Export Processing Zone. To avoid misleading the Study Team will use 'Free Trade Area (FTA)' as a terminology representing our proposed new concept.

C.2.2 Bang Saphan FTA

Based on the aforementioned background, the Study Team proposes the new concept of the Free Trade Area. The objectives of the FTA are summarized below:

- To prepare for AFTA and WTO.
- To attract not only manufacturers but also traders for both export and import.
- To strengthen competitiveness of domestic market-oriented manufacturers through FTA.
- To contribute to decentralization of business from Bangkok Metropolitan Area.
- To encourage exporting and importing trades.

In order to achieve the objectives, the basic concept of FTA in the Bang Saphan Area is proposed as follows.

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

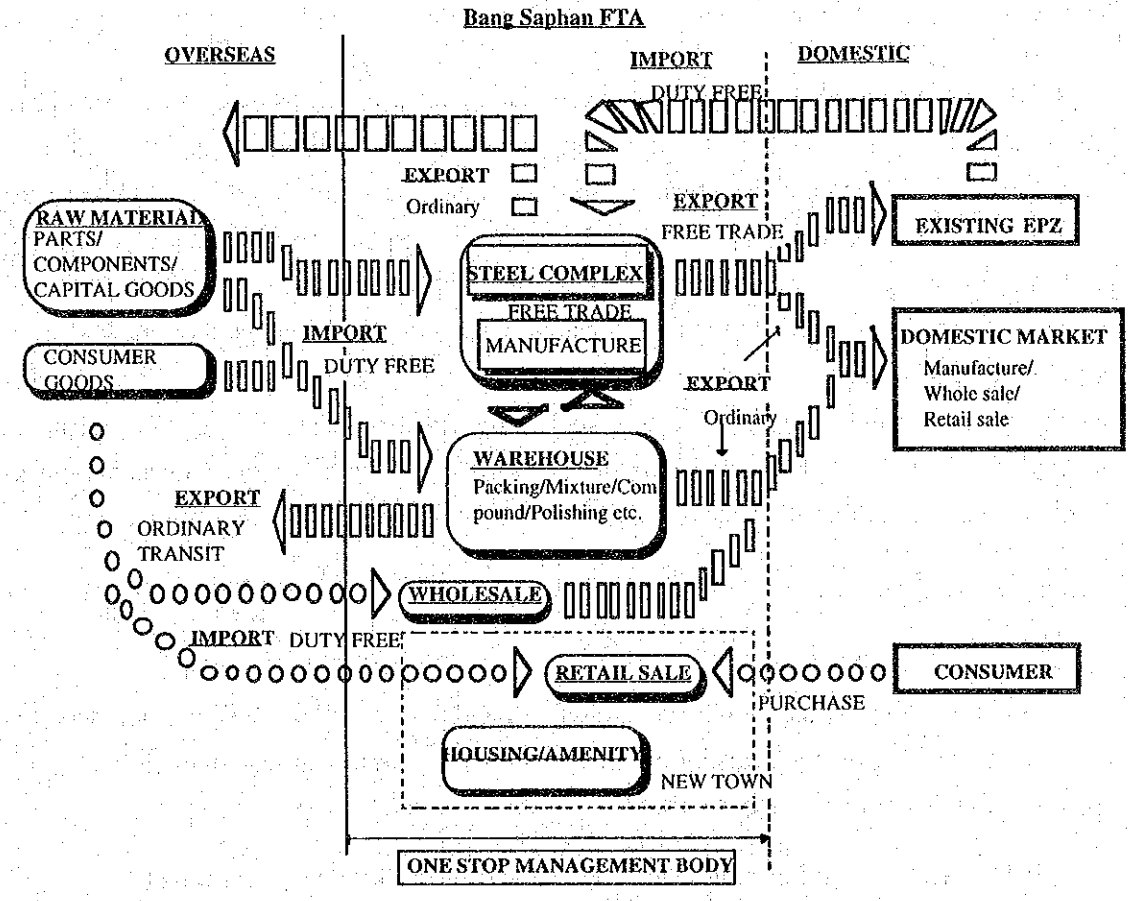
Major functions and facilities are summarized as follows.

Available Works
- Loading/unloading/packaging/labeling
- Warehousing
- Testing/ Measurement
- Repairing/ Washing
- Mixture/ Compound
- Processing/ Assembly
- Manufacturing
- Exhibition
- Sales except retail
- Habitation

Incentives for promotion
- Exemption from business tax
- Accelerated depreciation
- Soft loan
- Subsidiary
- Credit guarantee
- One-stop service

Tariff incentive
- Exemption from Excise duty/ VAT
- Exception of Import approval for IQ goods
- Duty free consumption/ usage in the Area

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



C.2.3 Legal Aspect of FTA

The proposed FTA is a new concept therefore there is no existing law for the FTA. It is preferable to enact the new law for the FTA. But some aspects of FTZ should be covered by the existing law as shown below:

Industrial Estate ---- Modification of New IEAT Law

N.B. : Types of Industries -- Not only the Seven Industries.
No need to specify the development scale for the IE developers.

Warehousing ------ Customs Law

N.B. : Easy application for warehousing license is needed.
Expansion of activities in warehouses is needed.

No law on the 'import processing' activities is identified. If there is actually no law for such activities, new law should be enacted.

- It might be possible to cover the above activities by changing a part of the New IEAT Law and Customs Law like in the case of Gemopolis.

C.2.4 Area of FTA

Most FTZs in the world are isolated, for example, by fences. In the case of the Hamburg Free Port, its area of around 1,600 ha is enclosed by a fence with a total length of 30 km. This isolation is required for security against smuggling, for instance. In case of smuggling, one of the major reasons is prohibitable high rate of tariff. In other words, if the customs duty rate is sufficiently low, the 'business' of smuggling does not occur. Thailand is considered to be under this situation. It indicates that the enclosure of the whole area by a physical way becomes less meaning. In this context the security will be kept by each facility such as warehouse, factory, etc. The Study Team proposes the 'area-designation-method' for FTA. This method is similar to the BoI zoning but the area is limited enough to be managed. In this sense there are three alternatives of the area of FTA as shown below.

Alternative 1: The whole Amphoe Bang Saphan Area except for hilly area will be designated as FTA.

Amphoe Bang Saphan will be zoned as FTA and players in FTA will be "licensed" by the Board of Development & Management of FTA in accordance with the guideline of development or activities in FTA.

Advantage: Administration territory is the same as the local government.
Easy cooperation with governmental activities.
To save the initial investment for security.
To attract new developers for the facilities.

Alternative 2: Similar area of the Industrial New City.

In this case the area-designation-method also is adopted. There is limitation on expansion of new facilities such as the warehousing development area.

Advantage: To save the initial investment for security.
Easy 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.

C.2.5 Advantages of FTA

It is necessary to identify the differences among FTA, FTZ, and EPZ (refer to Figure C.2.3). The most significant difference is that goods manufactured in FTA are allowed to be 'exported' to the domestic market. The companies locating in EPZ are basically required to export one hundred percent of their products (at most 20% of their products are allowed to be exported to the domestic market now). The companies in FTA will be allowed to sell goods and services to the domestic market as well as to export them. The FTZ proposed by MoI (Ministry of Industry) will be allowed to function in a more flexible manner than EPZ, i.e. its activities include trading, exhibition, etc. The purposes of FTZ, however, should be to encourage export. The basic idea of FTZ is considered only to follow the conventional export-oriented policy. In order to attract companies into the areas such as FTZ and EPZ, they provide various incentives. If such incentives are provided to companies on the condition to export, these might be considered as export subsidy which would be forbidden under the WTO scheme.

Under the borderless transaction, to keep or encourage international competitiveness is one of the critical issues for all countries and businesses. In this situation, it must be hard to protect the domestic industries by erecting the tariff barriers as well as non-tariff barriers. While companies strengthen their technology capabilities, materials and/or parts and components should be available with ease and at reasonable prices. The Thai Government has made efforts to do so, but the economic and trade situations should be much more severe than before. The introduction of FTA will be one of the solutions to overcome such difficulties.

Major difference and advantage between FTA and EPZ are shown in the following figure.

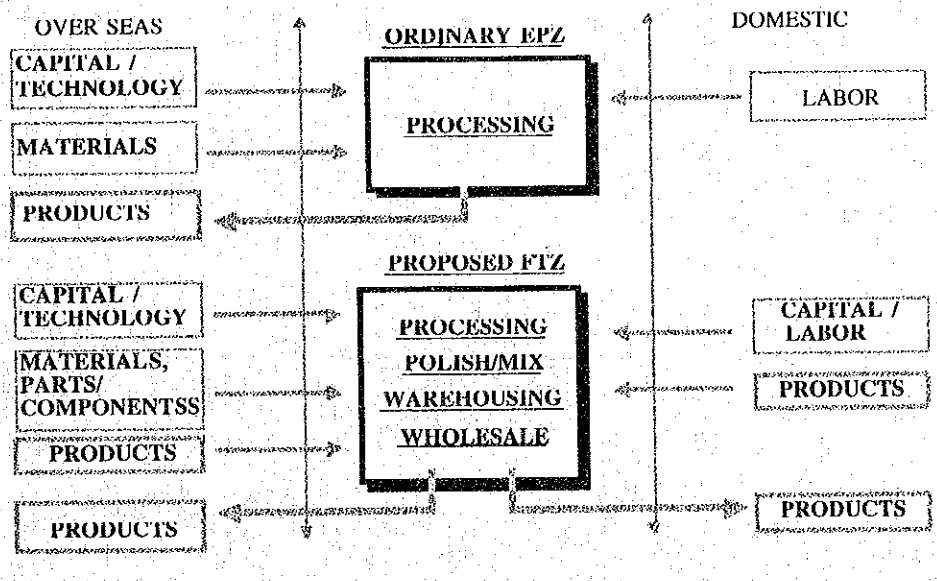


Table C.1.1 Labor Force Demand Induced by Bang Saphan Development

(Scenario 1)

	Cumulative Demand				Increase			
	2000	2004	2010	after 2010	1995-2000	2000-2004	2004-2010	2010-
1 Direct Employee	6,400	10,600	19,100	19,100	6,400	4,200	8,500	0
2 Indirect Employee		5,300	9,300	17,200	0	5,300	4,000	7,900
Total	6,400	15,900	28,400	36,300	6,400	9,500	12,500	7,900

(Scenario 2)

	Cumulative Demand				Increase			
	2000	2004	2010	after 2010	1995-2000	2000-2004	2004-2010	2010-
1 Direct Employee	6,400	14,100	28,300	28,300	6,400	7,700	14,200	0
2 Indirect Employee		5,300	12,800	26,100	0	5,300	7,500	13,300
Total	6,400	19,400	41,100	54,400	6,400	13,000	21,700	13,300

Table C.1.2 Number of Employees Induced by Bang Saphan Development

(cumulative number)

Year			Area (ha)	Direct Employee	Indirect Employee Multiplier Ratio	Indirect Employee Employee	Total Employee	Remarks
1995		Iron/Steel Group	35	560	0.8	0	560	
		General Industry	0	0	1.0	0	0	
		Total	35	560		0	560	
2001		Iron/Steel Group	102	2,400	0.8	0	2,400	
		General Industry	50	2,400	1.0	0	2,400	
		Subtotal	152	4,800		0	4,800	
		Port		1,600	0.6	0	1,600	
		Total	152	6,400		0	6,400	
2006	Scenario 1	Iron/Steel Group	145	2,800	0.8	1,900	4,700	
		General Industry	210	6,000	1.0	2,400	8,400	
		Subtotal	355	8,800		4,300	13,100	
		Power Plant	105	200	0.6	0	200	
		Port		1,600	0.6	1,000	2,600	
		Total	460	10,600		5,300	15,900	
	Scenario 2	Iron/Steel Group	145	2,800	0.8	1,900	4,700	
		General Industry	300	9,500	1.0	2,400	11,900	
		Subtotal	445	12,300		4,300	16,600	
		Power Plant	105	200	0.6	0	200	
		Port		1,600	0.6	1,000	2,600	
		Total	550	14,100		5,300	19,400	
2011	Scenario 1	Iron/Steel Group	260	4,700	0.8	2,200	6,900	
		General Industry	360	11,900	1.0	6,000	17,900	
		Subtotal	620	16,600		8,200	24,800	
		Power Plant	105	200	0.6	100	300	
		Port		2,300	0.6	1,000	3,300	
		Total	725	19,100		9,300	28,400	
	Scenario 2	Iron/Steel Group	260	4,700	0.8	2,200	6,900	
		General Industry	550	20,400	1.0	9,500	29,900	
		Subtotal	810	25,100		11,700	36,800	
		Power Plant	105	200	0.6	100	300	
		Port		3,000	0.6	1,000	4,000	
		Total	915	28,300		12,800	41,100	
after 2011	Scenario 1	Iron/Steel Group	260	4,700	0.8	3,800	8,500	
		General Industry	360	11,900	1.0	11,900	23,800	
		Subtotal	620	16,600		15,700	32,300	
		Power Plant	105	200	0.6	100	300	
		Port		2,300	0.6	1,400	3,700	
		Total	725	19,100		17,200	36,300	
	Scenario 2	Iron/Steel Group	260	4,700	0.8	3,800	8,500	
		General Industry	550	20,400	1.0	20,400	40,800	
		Subtotal	810	25,100		24,200	49,300	
		Power Plant	105	200	0.6	100	300	
		Port		3,000	0.6	1,800	4,800	
		Total	915	28,300		26,100	54,400	

Note: *Port Direct Employee: 0.3 persons/1,000 ton (cargo volume) assumed by Japanese port sample.
** Multiplier effect is assumed based on Master Plan of Laem Chabang Development.
Indirect employee=Direct employee in previous year x Multiplier effect

Table C.1.3 Projection of Population Increase Induced by Bang Saphan Development

(Cumulative number)

Year			Area (ha)	Induced Employee			Induced Population		
				Direct	Indirect	Total	Direct	Indirect	Total
1995		Iron/Steel Group	35	560	0	560	1,000	0	1,000
		General Industry	0	0	0	0	0	0	0
		Total	35	560	0	560	1,000	0	1,000
2001		Iron/Steel Group	102	2,400	450	2,850	4,400	800	5,200
		General Industry	50	2,400	0	2,400	4,400	0	4,400
		Subtotal	152	4,800	450	5,250	8,800	800	9,600
		Port		1,600	0	1,600	2,900	0	2,900
		Total	152	6,400	450	6,850	11,700	800	12,500
2006	Scenario 1	Iron/Steel Group	145	2,800	1,900	4,700	5,100	3,500	8,600
		General Industry	210	6,000	2,400	8,400	10,900	4,400	15,300
		Subtotal	355	8,800	4,300	13,100	16,000	7,900	23,900
		Power Plant	105	200	0	200	400	0	400
		Port		1,600	1,000	2,600	2,900	1,800	4,700
		Total	460	10,600	5,300	15,900	19,300	9,700	29,000
	Scenario 2	Iron/Steel Group	145	2,800	1,900	4,700	5,100	3,500	8,600
		General Industry	300	9,500	2,400	11,900	17,300	4,400	21,700
		Subtotal	445	12,300	4,300	16,600	22,400	7,900	30,300
		Power Plant	105	200	0	200	400	0	400
		Port		1,600	1,000	2,600	2,900	1,800	4,700
		Total	550	14,100	5,300	19,400	25,700	9,700	35,400
2011	Scenario 1	Iron/Steel Group	260	4,700	2,200	6,900	8,500	4,000	12,500
		General Industry	360	11,900	6,000	17,900	21,600	10,900	32,500
		Subtotal	620	16,600	8,200	24,800	30,100	14,900	45,000
		Power Plant	105	200	100	300	400	200	600
		Port		2,300	1,000	3,300	4,200	1,800	6,000
		Total	725	19,100	9,300	28,400	34,700	16,900	51,600
	Scenario 2	Iron/Steel Group	260	4,700	2,200	6,900	8,500	4,000	12,500
		General Industry	550	20,400	9,500	29,900	37,100	17,300	54,400
		Subtotal	810	25,100	11,700	36,800	45,600	21,300	66,900
		Power Plant	105	200	100	300	400	200	600
		Port		3,000	1,000	4,000	5,500	1,800	7,300
		Total	915	28,300	12,800	41,100	51,500	23,300	74,800
after 2011	Scenario 1	Iron/Steel Group	260	4,700	3,800	8,500	8,500	6,900	15,400
		General Industry	360	11,900	11,900	23,800	21,600	21,600	43,200
		Subtotal	620	16,600	15,700	32,300	30,100	28,500	58,600
		Power Plant	105	200	100	300	400	200	600
		Port		2,300	1,400	3,700	4,200	2,500	6,700
		Total	725	19,100	17,200	36,300	34,700	31,200	65,900
	Scenario 2	Iron/Steel Group	260	4,700	3,800	8,500	8,500	6,900	15,400
		General Industry	550	20,400	20,400	40,800	37,100	37,100	74,200
		Subtotal	810	25,100	24,200	49,300	45,600	44,000	89,600
		Power Plant	105	200	100	300	400	200	600
		Port		3,000	1,800	4,800	5,500	3,300	8,800
		Total	915	28,300	26,100	54,400	51,500	47,500	99,000

Note: Induced population = Induced employee / 55 %

Table C.1.4 Demand of New Residential Area

			Number of Employee				Population				Area (ha)			
			-2001	-2006	-2011	2011-	-2001	-2006	-2011	2011-	-2001	-2006	-2011	2011-
Increase	Scenario-1	Existing Residential Area in Bang Saphan	2,550	2,070	3,270	2,550	4,600	3,800	5,900	4,600	180	150	240	180
		New Town in Bang Saphan	2,400	6,220	7,320	3,900	4,400	11,300	13,300	7,100	40	110	130	70
		Bang Saphan Total	4,950	8,290	10,590	6,450	9,000	15,100	19,200	11,700	220	260	370	250
		Residential Area in Other Amphoe	1,450	1,210	1,910	1,450	2,600	2,200	3,500	2,600	100	90	140	100
		Total	6,400	9,500	12,500	7,900	11,600	17,300	22,700	14,300	320	350	510	350
	Scenario-2	Existing Residential Area	2,550	2,070	3,270	2,550	4,600	3,800	5,900	4,600	180	150	240	180
		New Town in Bang Saphan	2,400	9,720	16,520	9,300	4,400	17,700	30,000	16,900	40	180	300	170
		Bang Saphan Total	4,950	11,790	19,790	11,850	9,000	21,500	35,900	21,500	220	330	540	350
		Residential Area in Other Amphoe	1,450	1,210	1,910	1,450	2,600	2,200	3,500	2,600	100	90	140	100
		Total	6,400	13,000	21,700	13,300	11,600	23,700	39,400	24,100	320	420	680	450
Cumulative Number	Scenario-1	Existing Residential Area in Bang Saphan	2,550	4,620	7,890	10,440	4,600	8,400	14,300	18,900	180	330	570	750
		New Town in Bang Saphan	2,400	8,620	15,940	19,840	4,400	15,700	29,000	36,100	40	150	280	350
		Bang Saphan Total	4,950	13,240	23,830	30,280	9,000	24,100	43,300	55,000	220	480	850	1,100
		Residential Area in Other Amphoe	1,450	2,660	4,570	6,020	2,600	4,800	8,300	10,900	100	190	330	430
		Total	4,950	13,240	23,830	30,280	11,600	28,900	51,600	65,900	320	670	1,180	1,530
	Scenario-2	Existing Residential Area	2,550	4,620	7,890	10,440	4,600	8,400	14,300	18,900	180	330	570	750
		New Town in Bang Saphan	2,400	12,120	28,640	37,940	4,400	22,100	52,100	69,000	40	220	520	690
		Bang Saphan Total	4,950	16,740	36,530	48,380	9,000	30,500	66,400	87,900	220	550	1,090	1,440
		Residential Area in Other Amphoe	1,450	2,660	4,570	6,020	2,600	4,800	8,300	10,900	100	190	330	430
		Total	4,950	16,740	36,530	48,380	11,600	35,300	74,700	98,800	320	740	1,420	1,870

Note : /1 Population=employee/55%

/2 Population Density: Existing residential area & other amphoe - 25 persons/ha (4 persons/Rai)

Population Density: New residential area - 100 persons/ha (16 persons/Rai)

Present population (Bang Saphan District) : 65,500 (1995)

Present labor population (Bang Saphan District) : 36,000 (1995), 3,270(2nd sector), 1,280(3rd sector)

Number of Household (Bang Saphan District): 13,476 (1995)

Table C.1.5 Demand and Supply Balance of Labor Force and Distribution by Residential Location

(Scenario 1) (unit:persons)

		Expected Labor Force for BSA [1]				Living in Existing Residential Area in Bang Saphan					Living in New Town in Bang Saphan					Living in Existing Residential Area in other Amphoe				
	Amphoe	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016
	1 Huahin	200	200	300	200	20	40	40	60	40	80	160	160	240	160	0	0	0	0	0
	2 Pranburi	600	500	800	600	20	120	100	160	120	80	480	400	640	480	0	0	0	0	0
	3 Kuiburi	700	600	1,000	700	20	140	120	200	140	80	560	480	800	560	0	0	0	0	0
Supply	4 Muang Prachuap Khiri Khan	1,000	900	1,300	1,000	20	200	180	260	200	80	800	720	1,040	800	0	0	0	0	0
	5 Tabsakae	1,500	1,300	2,000	1,500	30	450	390	600	450	20	300	260	400	300	50	750	650	1,000	750
	6 Bang Saphan	1,300	1,000	1,600	1,300	100	1,300	1,000	1,600	1,300	0	0	0	0	0	0	0	0	0	0
	7 Bang Saphan Noi	1,000	800	1,300	1,000	30	300	240	390	300	0	0	0	0	0	70	700	560	910	700
	Prachuap Khiri Khan Total	6,300	5,300	8,300	6,300		2,550	2,070	3,270	2,550		2,300	2,020	3,120	2,300		1,450	1,210	1,910	1,450
	Other Provinces	100	4,200	4,200	1,600	0	0	0	0	0	100	100	4,200	4,200	1,600	0	0	0	0	0
	Total	6,400	9,500	12,500	7,900		2,550	2,070	3,270	2,550		2,400	6,220	7,320	3,900		1,450	1,210	1,910	1,450
Demand (case 1)		6,400	9,500	12,500	7,900															

(Scenario 2)

		Expected Labor Force for BSA [1]				Living in Existing Residential Area in Bang Saphan					Living in New Town in Bang Saphan					Living in Existing Residential Area in other Amphoe				
	Amphoe	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016	Ratio (%)	1995-2001	2001-2006	2006-2011	2011-2016
	1 Huahin	200	200	300	200	20	40	40	60	40	80	160	160	240	160	0	0	0	0	0
	2 Pranburi	600	500	800	600	20	120	100	160	120	80	480	400	640	480	0	0	0	0	0
	3 Kuiburi	700	600	1,000	700	20	140	120	200	140	80	560	480	800	560	0	0	0	0	0
Supply	4 Muang Prachuap Khiri Khan	1,000	900	1,300	1,000	20	200	180	260	200	80	800	720	1,040	800	0	0	0	0	0
	5 Tabsakae	1,500	1,300	2,000	1,500	30	450	390	600	450	20	300	260	400	300	50	750	650	1,000	750
	6 Bang Saphan	1,300	1,000	1,600	1,300	100	1,300	1,000	1,600	1,300	0	0	0	0	0	0	0	0	0	0
	7 Bang Saphan Noi	1,000	800	1,300	1,000	30	300	240	390	300	0	0	0	0	0	70	700	560	910	700
	Prachuap Khiri Khan Total	6,300	5,300	8,300	6,300		2,550	2,070	3,270	2,550		2,300	2,020	3,120	2,300		1,450	1,210	1,910	1,450
	Other Provinces	100	7,700	13,400	7,000	0	0	0	0	0	100	100	7,700	13,400	7,000	0	0	0	0	0
	Total	6,400	13,000	21,700	13,300		2,550	2,070	3,270	2,550		2,400	9,720	16,520	9,300		1,450	1,210	1,910	1,450
Demand (case 2)		6,400	13,000	21,700	13,300															

Note /1: Assumed according to the present number of labor force and the distance from Bang Saphan.

Table C.1.6 Projection of Business/Commercial Area in Bang Saphan Development

(Number of 3rd Sector Employee) (cumulative number)

	Indirect Employee (Cumulative)				Employee of 3rd Sector			
	~2001	~2006	~2011	after 2011	1995-2001	2001-2006	2006-2011	2010-
1 Scenario-1	0	5,300	9,300	17,200	0	3,450	6,050	11,180
2 Scenario-2	0	5,300	12,800	26,100	0	3,450	8,320	16,970

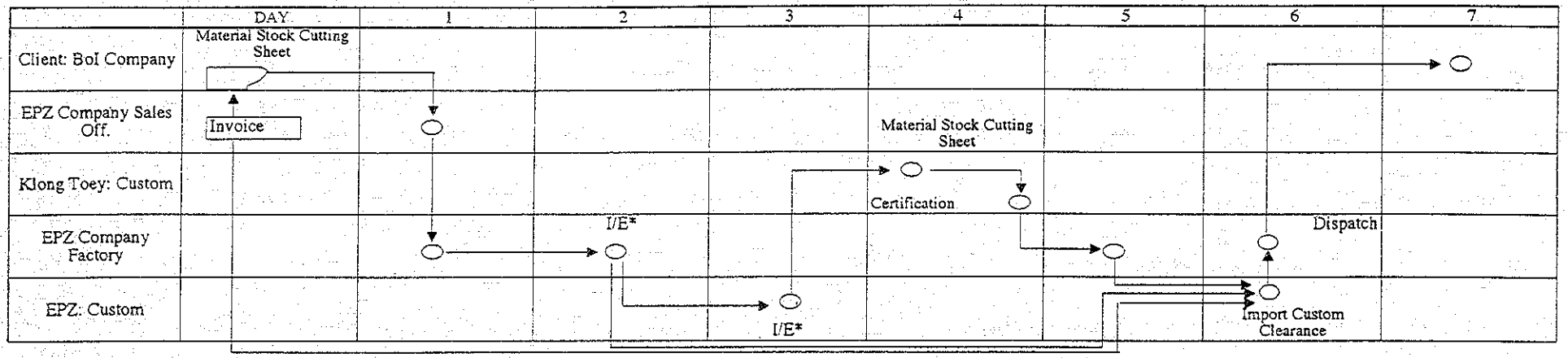
Note: 3rd sector employee is assumed as 65 % of indirect employee based on the statistical data of province.

(Business and Commercial Area)

	Business and commercial Area (ha)			
	~2001	~2006	~2011	after 2011
1 Scenario-1	0	20	30	60
2 Scenario-2	0	20	40	80

Note: Employee density of 200 persons/ha is assumed.

Figure C.2.1 Procedure of Sales from EPZ to Domestic Market



*: Import Entry

Note: This flowchart of documentation and custom clearance is the sample case which is estimated by the interview to EPZ company. In this case, BoI promoted company(Client; locating out of EPZ) orders the products which are produced by the EPZ company (EPZ company means the company which is BoI promoted one and locates in EPZ).It assumes that the Sales office of EPZ company locates in Bangkok and the Factory of that locates in EPZ in Zone 3.
It takes at least 7 days since invoice is submitted. In this case every organization prepares required documents within one day and dispatch them as soon as possible. Otherwise the period of this procedure should be delayed (actually sometimes it takes more than two weeks).

Figure C.2.2 Types of Free Trade Zone (F.T.Z.)

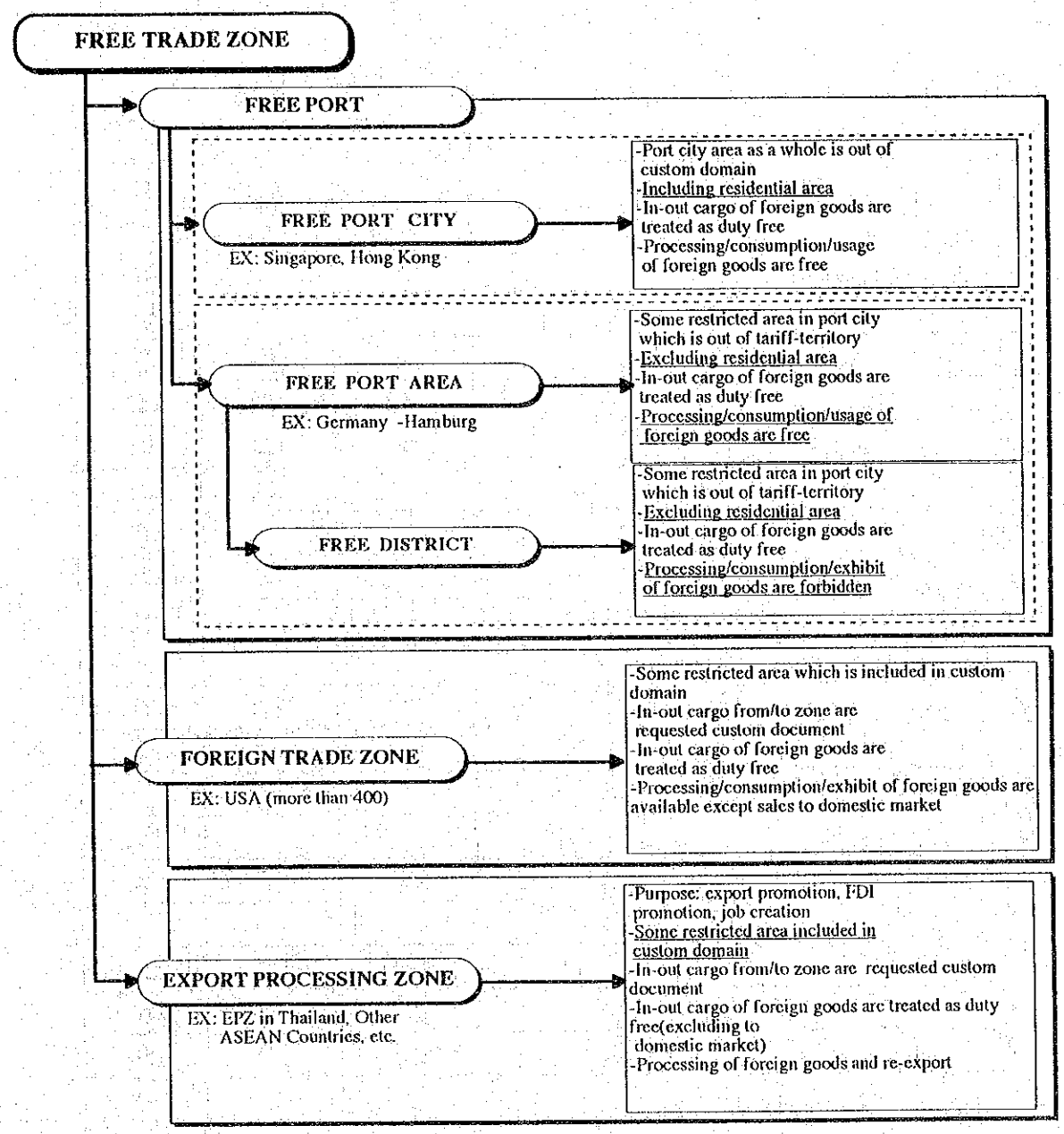


Figure C.2.3 Comparison of EPZ/FTZ

	Existing EPZ	FTZ(MoI)	FTA(New)
Available Works			
Loading / unloading / packaging / labeling		■	■
Warehousing		■	■
Testing / measurement		■	■
Repairing / washing / polishing		■	■
Mixture / compound /		■	■
Processing / assembly	■	■	■
Manufacturing	■	■	■
Exhibition		■	■
Retail sales			■
Sales except retail		■	■
Habitation			■
Incentives for promotion			
Exemption from business tax	■	■	■
Accelerated depreciation			■
Soft loan			■
Credit guarantee			■
One stop service	■	■	■
Tariff incentives			
Exemption from excise duty	■	■	■
Exemption from VAT	■	■	■
Exception of import approval for IQ goods	■		■
Inverted Tariff Material / products			■
Duty free consumption / usage in the Area			
Major Objectives	Attract FDI Export prom.	Attract FDI Export prom.	Trade prom. Strengthen Domestic I.
Shipment to domestic market out of area	up to 20%	up to 20%	no condition

Source: Study Team

APPENDIX D DEVELOPMENT PLAN OF BANG SAPHAN INDUSTRIAL ESTATE

CONTENTS

Tables

Figures

APPENDIX D DEVELOPMENT PLAN OF BANG SAPHAN INDUSTRIAL ESTATE

D.1 Land Use

D.1.1 Land Use Plan

The land use plan of the Bang Saphan industrial estate is elaborated on the basis of the following planning principles.

a. Land use of the Bang Saphan industrial estate should be harmonized with the present land use of the surrounding area. Socially important facilities such as religious and educational facilities will be preserved with their surrounding conditions.

b. A lot of green areas such as park and buffer green will be designated.

c. Factory lot areas is designed to occupy 60 % ~ 75% of the total area in order to receive the BOI privilege.

d. Land use will be planned with consideration of future expansion.

The detailed land use plan of the Bang Saphan industrial estate has been developed and designed as described below.

(1) A main road of 50 m wide has been designed to form the skeleton of the road network. Sub-main roads and collector roads of 30 m wide have been designed to support the main road. Further, a short boulevard of 200 m long has been planned to be constructed in front of the railway station.

(2) Various utilities such as water supply facilities, sewage treatment system, electric facilities, etc. have been designed to be fully equipped in the industrial estate except for the incinerator of solid waste. The incinerator will be built in the area to the east of the estate.

(3) Administrative facilities, service facilities and such amenities as sport facility have been planned to be located at the entrance of the industrial estate and adjacent to the railway station.

The total area of the Bang Saphan industrial estate is 600 ha (3,750 rai) and the land use plan is summarized below. The detailed land use plan is presented in Table D.1.1 and Figure D.1.1.

	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 54.5 ha is inclusive.

D.1.2 Lot Distribution Plan

Industrial Category Configuration

A list of prospective investors to the Bang Saphan industrial estate clarified through the investment demand survey presented in Appendix C is tabulated in Table D.1.2. showing the demands for lot area, water, and labor. The lot distribution plan by category of industry and lot size is elaborated based on the list and summarized in Table D.1.3 and the table below.

	Number of Enterprises			Lot Area (ha)		
	2001	2006	2011	2001	2006	2011
Food	3	5	11	2.5	8.0	49.0
Textile	–	–	3	–	–	12.0
Wood Product	2	2	4	6.0	6.0	11.0
Paper Product	–	–	2	–	–	2.0
C1 Chemical	2	3	10	5.0	15.0	66.0
Ceramic	1	3	5	5.0	50.0	65.0
Steel Products	7	13	14	21.0	71.0	76.0
Machinery	4	8	15	12.5	50.0	78.5
Others	–	1	1	–	0.5	0.5
Total	19	35	65	52.0	200.5	360.0

Note: Steel manufacture (basic metal), and shipbuilding, repairing industry are not inclusive.

Lot Size Distribution

The requirements for lot size indicated by category of industry are summarized below:

Lot Distribution Plan by Lot Size and Category

(Cumulative)

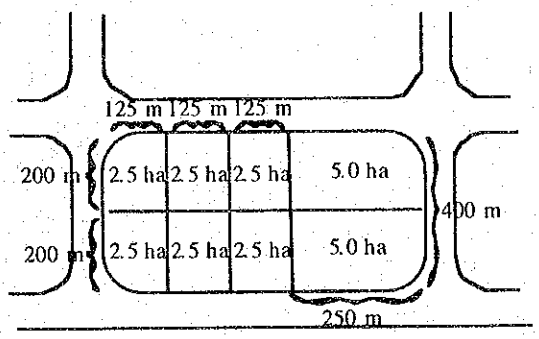
Lot Size	Number of Lots by Industrial Category									
	Food	Textile	Wood	Paper	C1 Chemical	Ceramic	Steel Processing Products	Machinery	Others	Total
Small, less than 1.0 ha	5	2	1	2	1	–	1	1	1	14
Medium 2.5~5 ha	5	–	3	–	6	2	11	12	–	39
Large, bigger than 10 ha	1	1	–	–	3	3	2	2	–	12

Heavy industry such as C1 chemical and ceramic industry will require relatively a bigger area lot and steel product, machinery and wood industry will predominantly need a medium scale lot.

Design of Lot Shape

Seven sizes of prototypic factory lots are proposed as shown in the table below. 2.5 ha and 5 ha lots, the typical sizes in the Bang Saphan industrial estate, have been designed as shown in the figure below.

	Size	No. of Lots	Shape
1	0.5	3	50 m x 100 m
2	1.0	11	100 m x 100 m
3	2.5	13	125 m x 200 m
4	5.0	26	200 m x 250 m
5	10.0	7	250 m x 400 m
6	20.0	4	400 m x 500 m
7	35.0	1	300 m x 1,000 m
	Total	65	



Lot Distribution

In the Bang Saphan industrial estate, the distribution of factory lots is planned in accordance with grouping of industrial types. Steel product and machinery industry which will be equipped with heavy machine tools and require a strong bearing capacity of the ground are designed to be located in the cut area. The surface ground in the cut area is stronger and subsidence of ground by filling materials is minimum.

The distribution of industrial types in the land use plan is presented in Figure D.1.2.

D.1.3 Phase Development Plan

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

Development phasing is summarized below and figured out in Table D.1.4 and Figure D.1.3 and the land use plans of Phase 1 and Phase 2 are presented in Figure D.1.4 and D.1.5 respectively.

	Total Area		Factory Lot Area	
	(ha)	(rai)	(ha)	(rai)
Phase 1	108	608	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.

D.2 Land Grading

D.2.1 Earthworks

Topographically, the land of the Bang Saphan industrial estate site is rather undulated as shown in Figure D.2.1. The highest part of the site is at an elevation of more than 20 m from mean sea level (MSL) and the lowest elevation of 1.2 m is found at the swampy area inundated in the rainy season. Thus the site shall be graded by earthworks with cut and fill. In consideration of the higher cost of the earth borrowed from quarries located outside*, it is recommendable that the cut volume and filling volume shall be balanced inside the site.

* Soil acquired at 10 km away from the industrial estate side will cost 5 times higher than the soil from inside the site.

The following criteria are applied for the design of land grading. The land formation plan of the Bang Saphan industrial estate is presented in Figure D.2.2.

a. Elevation of the land after grading is designed to be higher than 4 m from MSL to avoid flood inundation.

b. Gradient of the factory land is designed to be more than 0.5 % to drain the rain water effectively.

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 by development phase as shown below. The cut and filling area distribution by development phase is presented in Figures D.2.3 ~ D.2.6.

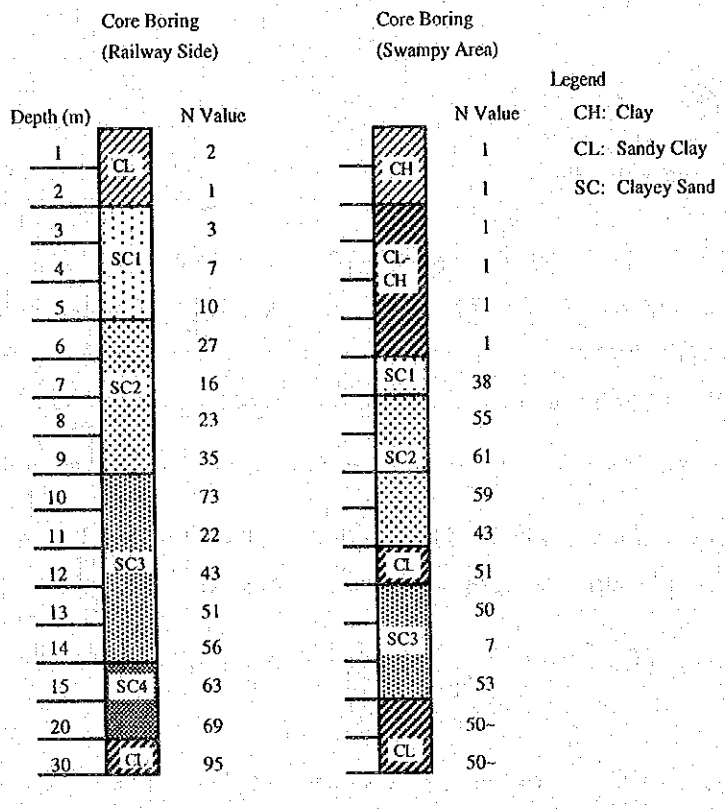
(Unit: million m^3)

	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.

D.2.2 Geological Consideration

Judging from the geological data shown below, which were acquired by the core boring test conducted in the adjacent area, 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 after 8 ~ 10 meters depth 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.



D.2.3 Estimate of Settlement

Two layers observed in the swampy area of the Bang Saphan industrial estate site are deemed to be compressible, composed of Clay (CH) and Sandy Clay (CL) with a thickness of 2 m and 4 m respectively as tabulated below.

	Thickness (m)	Depth (m)
CH	2	0 - 2
CL-CH	4	2 - 6

Consolidation settlement is calculated by the following equation based on the geological conditions shown above.

$$SC = \frac{Cc}{1+Co} \times H \times \log \frac{Pz+dP}{Pz}$$

where,

Sc : Consolidation settlement (cm)

Co : Initial void ratio
H : Thickness of compressible soil
Cc : Compression index
Pz : Effective overburden pressure
dP : Incremental overburden pressure

The maximum consolidation settlement at the lowest elevation in the industrial estate site is estimated at 25 cm on the basis of the following conditions.

Thickness of compressible soil	:	600 cm
Drainage path	:	d=300 cm (600 cm/2)
Unit weight of compressible soil	:	1.95 g/cm^3 (from boring test)
ditto (submerged condition)	:	0.95 g/cm^3 (from boring test)
Unit weight of fill material	:	1.70 g/cm^3 (from boring test)
Initial void ratio (Co)	:	0.46 (from boring test)
Compression index (Cc)	:	0.18 (from boring test)
Depth of groundwater level	:	110 cm from ground surface (from boring test)

Effective overburden pressure (Pz) :

110 cm x 1.95 g/cm^3 + 190 cm x 0.95 g/cm^3 =0.40 g/cm^3

Incremental overburden pressure (dP): at the lowest point

: 280 cm x 1.70 g/cm^3 =0.48 g/cm^3

$$SC=\frac{0.18}{1+0.46} \times 600 \times \log\frac{0.40+0.48}{0.40}$$

$$=\frac{0.18}{1.46} \times 600 \times 0.342$$

$$= 25.3 \text{ cm}$$

D.2.4 Residual Settlement

Expected duration of consolidation is estimated by the following equation:

$$t=\frac{Tv \times d \times d}{Cv}=\frac{300 \times 300 \times Tv}{0.002} = 45{,}000{,}000\ Tv \text{ (sec)}$$

$$= 17.36\ Tv \text{ (month)}$$

where,

t : Time (sec)
Tv : Time factor
Cv : Coefficient of consolidation (0.002 cm^2/sec, from the boring test)
d : Drainage path (max. drainage distance, 300 cm)

In accordance with the above equation, the longest time to complete 90 % consolidation at the lowest elevation in the industrial estate site is estimated at 15 months.

U (%)	Tv	t (months)
10	0.008	0.1
20	0.031	0.5
30	0.071	1.2
40	0.126	2.2
50	0.196	3.4
60	0.287	5.0
70	0.403	7.0
80	0.567	9.8
90	0.848	14.7

As discussed above, consolidation settlement will continue long time though the settlement amount will not be large. Thus, earth filling should be made taking into account a sufficient settlement period before the construction of infrastructure facilities.

D.3 Roads

D.3.1 Highway Network Linked to the Western Seaboard Zone

The existing road networks in the South of Thailand, most of which were developed to serve 2-lane traffic, are being upgraded to 4-lane roads to cope with the growing traffic demand from Bangkok zone to Western and Southern Thailand. The main highway running from north to south is Route No. 4, which starts from Pak Tho through Petchaburi and Prachuap Khiri Khan up to Chumphon. The project area of the Western Seaboard is located along this Route No. 4.

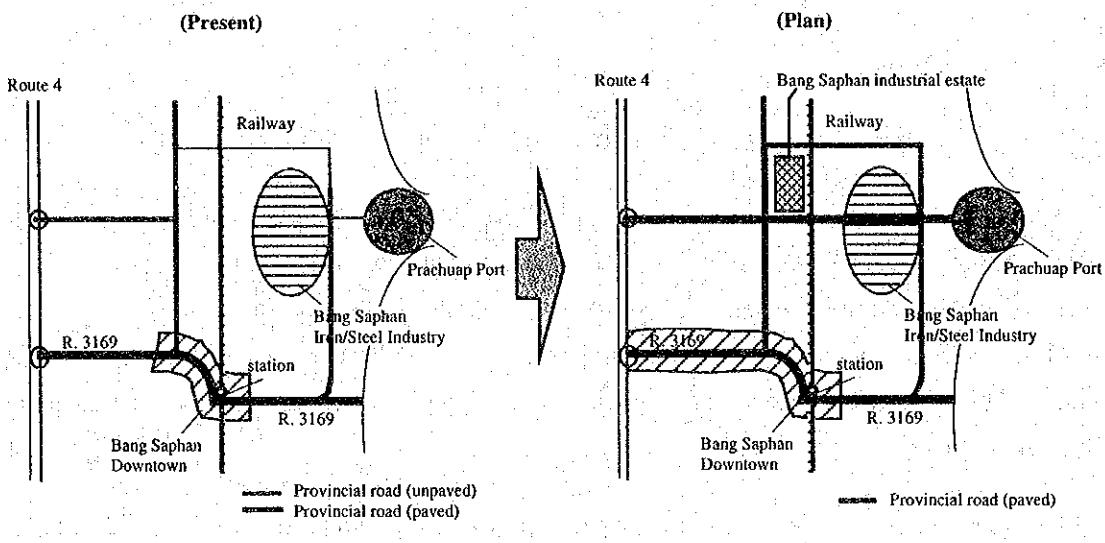
Of the total stretch of 1,201.3 km of the north to south highways, the section of 202.6 km closer to Bangkok zone up to Cha Am has already been upgraded to 4 lanes, another section of 450.1 km beyond Cha Am is being improved to 4 lanes, and the remaining section of 548.6 km is in the designing stage. According to the information of DOH, all the improvement works are expected to be completed by the year 1999.

D.3.2 Roadwork and Railway Networks in the Vicinity of the Project Area

Access to Prachuap Port and Bang Saphan industrial estate is made via Route 3169 from the national highway Route No. 4. Route 3169 with two 2-lane roads is running toward the project area, both of them passing through the local community zone of Bang Saphan city. Route 3169 crosses the national railway near the coastal zone where the Bang Saphan River flows into the cove of Laem Mae Ramphung.

Now the port and iron and steel industrial areas are directly connected to Route 3169 by a 2-lane provincial road.

The existing provincial road running parallel to the national highway No. 3169, is planned to be upgraded to a well-paved road formation. This upgraded provincial road will not run through the Bang Saphan downtown, so this new road will play a key role in access to the port as well as to the Bang Saphan industrial area in the near future.



D.3.3 Traffic volume projection of Bang Saphan Industrial Estate

Three traffic to and from the Bang Saphan industrial estate will be considered as follows:

- Cargo traffic : Import raw materials and export products to and from EPZ will be transported by heavy trucks.
- Business traffic : Passenger car will be dominant for the business traffic to and from EPZ.
- Commuter traffic : Public bus, private bus and passenger car will be utilized from commuter traffic of employee and labors.

Traffic generated from the Bang Saphan industrial estate is estimated at 5,500 PCU (passenger car unit) in the year of 2001 and 29,000 PCU in the year of 2011 as shown below.

Item	2001	2006	2011
1. Cargo traffic			
1) Cargo volume/1 (1000 tons/year)	1,510	3,380	8,050
2) Truck (1)/4/300day x 1.5:trucks/day)	1,900	4,300	10,000
2. Business car			
1) Employee (Direct)	2,400	6,000	11,900
2) Passenger car (1) x 0.04:PCU/day)	100	200	500
3. Commuting car			
1) Bus			
(1) Employee (Direct)	2,400	6,000	11,900
(2) Bus volume ((1)x0.9/40x2 (in & out))	100	300	600
2) Passenger car (Employee x 0.1/1.5 x 2(in & out)	300	800	1,500
4. Total			
1) Truck	1,900	4,300	10,000
2) Bus	100	300	600
3) Passenger car			
- Business	100	200	500
- Commuting	300	800	1,500
Sub-total	400	1,000	2,000
Total	2,400	5,600	12,600
5. PCT converted			
1) Truck (x 2.5)	4,800	10,800	25,000
2) Bus (x 3.0)	300	900	1,800
3) Passenger car	400	1,000	2,000
Total	5,500	12,700	28,800

Note: /1 Projected cargo volume is summarized in Table D.3.1.

Thus the main road in 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 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.

The railway which is projected to have a capacity of approximately 1.1 million tons (0.6 million tons from Bang Saphan industrial estate and 0.5 million tons from iron/steel industry

as shown in Table D.3.1), 15% of truck cargo volume, will not play important role but supporting cargo carrier in the future for Bang Saphan industrial area.

D.3.4 Road Design

Three (3) types of roads have been planned in this study, as follows:

(1) Main road : Main road which passes through the center of industrial estate will be 40 m in width (4 lanes), with wide pedestrian deck on both sides. This is the main service road to factory lots, particularly to large size lots.

(2) Sub-main road : Sub-main road is the access road to small size factory lots. The road width is 30 m (4 lanes) with pedestrian deck on both sides.

(3) Collector road : Collector road is the access road to smallest size factory lot and some section is utilized as the boundary of industrial estate.

At the entrance of the industrial estate, one or two lanes is recommendable to add as the guide lane to cope with the congestion caused by the inflow and outflow traffic. The main road, thus, will be 6 or 8 lane at that point.

The standard section and distribution of each road are shown in Figure D.3.1 and D.3.2.

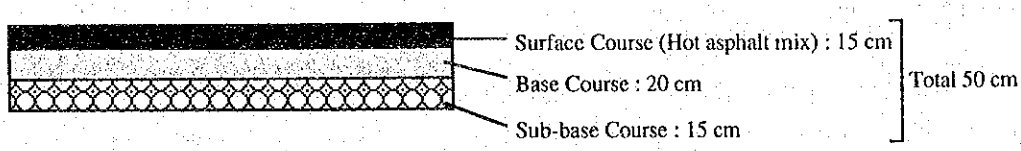
D.3.5 Design Standard

The design standard to be applied for the main road and the subroad is planned as follows:

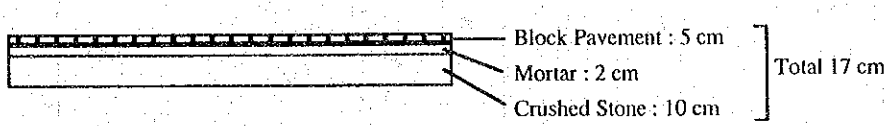
- Design speed : 40 km/hour
- Minimum radius : 60 m
- Minimum corner curve : 12 m (minimum turning radius of heavy truck)

The pavement of carriage way of main road is designed as shown below in consideration of dominant heavy truck and bus in the industrial estate.

Traffic of Truck and Bus	:	app. 10,000 vehicles/day/both direction
Design CBR	:	10
Design Thickness	:	50 cm
Design of Pavement	:	



The pavement structure of side-walk was designed as shown below.



D.4 Water Supply

Preliminary design and cost estimate for water supply facilities of the Bang Saphan industrial estate were carried out on the basis of the land use plan and water demand by lot. Design criteria and standards for the water supply system in Thailand were applied to this Study.

The industrial water demand for the Bang Saphan industrial estate was estimated as shown in Table D.4.1 and summarized below.

Water Demand Projection of Bang Saphan Industrial Estate in 2011

Type of Industry Group	Number of Lots	Total Lot Area (ha)	Water Demand (m^3/d)	(m^3/d/ha)
1. Food	11	49.0	10,560	215
2. Textile	3	12.0	6,050	504
3. Wooden and furniture	4	11.0	390	35
4. Paper and pulp	2	2.0	70	35
5. Chemicals	10	66.0	25,950	393
6. Ceramics	5	65.0	7,400	114
7. Steel processing	14	76.0	7,580	100
8. Machinery	15	78.5	6,320	79
9. Shipbuilding	1	0.5	10	20
10. Reserve lot	2	54.5	5,450	100
TOTAL	67	414.5	69,780	168

Water demand per ha indicates a higher value of 170 m^3/d/ha (25 m^3/d/rai) in comparison with the existing industrial estates developed by IEAT of which water demand is in the range between 40 and 125 m^3/d/ha (7 and 20 m^3/d/rai) as shown in Table D.4.2. Such high value is caused by the target food, textile and chemical industries which share 66% of the total demand.

The water distribution network plan and conceptual layout of the water purification plant in the Bang Saphan industrial estate are designed as shown in Figures D.4.1 and D.4.2 respectively. The result of preliminary flow net calculation is shown in Table D.4.3. Pipes will be laid underground along the roads. The following design criteria were applied in the preliminary design:

(a) Water demand of Bang Saphan industrial estate = 70,000 m^3/d

(b) Water consumption

Daily Maximum Water Consumption (DAWC)
= Daily water demand × (1 + Unaccounted for water)
= 70,000 × (1 + 0.1) = 77,000 m3/d
(Unaccounted for water : 10%)

Hourly Maximum Water Consumption (HMWC)
= DMWC(Industry)/24
= 77,000/24 = 3,200 m3/h

(c) Service reservoir

- Design Capacity	:	HMWC = 3,200 m3
- Drawdown	:	3 to 6 m
- Freeboard	:	more than 30 cm
- Dead water depth	:	more than 15 cm

(d) Distribution network

Design discharge	:	HMWC = 3,200 m3/h (=900 l/s)
Design velocity	:	V < 2.6 m/s
Residual pressure	:	Min. = 15 m, Max. = 60 m
Pipe materials and diameters :		
- Ductile cast iron	:	150 to 700 mm (nominal diameter)
- Steel	:	150 to 700 mm (ditto)

D.5 Sewerage

(1) Present Situation of Bang Saphan Area

Domestic Wastewater

There is no public sewerage system in the Bang Saphan District. Domestic wastewater is discharged into the adjacent river without any treatment or through a cesspool. In the case of big water consumers such as hotels and restaurants, wastewater is treated by septic tank or simple treatment plant. Due to the discharge of wastewater, water quality of the river is being worse.

Industrial Wastewater

Wastewater in the Sahaviriya steel industrial estate is treated by individual treatment plants. In general, industrial wastewater shall be treated by investors' or commune wastewater treatment plants inside industrial estates based on the pollutant pay principle. Effluent from the wastewater treatment plant is discharged into the adjacent river. In some cases, industrial wastewater is discharged without treatment.

(2) Preliminary Design

Design criteria and standards for the wastewater treatment system by IEAT are applied to this Study. The layout of the wastewater collection system and conceptual layout of sewer treatment plant are as shown in Figures D.5.1 and D.5.2 respectively. Effluent from the wastewater treatment plant is discharged to the Khlong Podaeng river, a tributary of the Mae Ramphung river.

The preliminary design was made based on the following design criteria:

(a) Daily max. wastewater (DMWW) = 68,000 m^3/d
(80% of Daily max. water consumption plus 10% as underground water
= 77,000 m^3/d x 0.8 x 1.1)
Daily average wastewater (DAWW) =48,000 m^3/d (70 % of DMWW)
Hourly max. wastewater (HMWW) =102,000 m^3/d (150 % of DMWW)

(b) Design flow for facilities

- Collection pipe : HMWW
- Treatment plant : DMWW

(c) Sewer collection : Separate sewer system with gravity flow
- Pipe materials : Hume/concrete
- Roughness coefficient : 0.015
- Allowable flow velocity : 0.6 - 2.6 m/s
- Minimum size of pipe : 200 mm

(d) Wastewater treatment plant : individual pre-treatment and central treatment

Pre-treatment shall be made by the factories from which the effluent may not satisfy the effluent standard in Thailand.

(e) Central wastewater treatment plant
- Design volume = 68,000 m^3/d
- Quality of influent : Influent Standard of the Ministry of Industry (see Table D.5.1)
- Quality of effluent : Effluent Standard of the Ministry of Industry (see Table D.5.2)
- Treatment method : Activated sludge process (Oxidation Ditch Process or equivalent)

(f) Monitoring system
- Inspection Pond with Fish set by each factory
- Water sampling pit
- Laboratory
- Retention pond with Fish

(g) Pipe materials : Hume/concrete
Roughness coefficient : 0.015

(h) Minimum covering
– For grand surface : 1.1 m to the bottom of pipe
– For premix road : 1.8 m

(i) Minimum size of pipe : 225 mm

(j) Distance between manholes
– Diameter of pipe < 300 mm : less than 40 m
– 300 - 600 : 70 m
– > 600 : 100 m

D.6 Storm Water Drainage

(1) Present Situation of Bang Saphan Area

Storm water is released to the adjacent river through U-shape drains on road sides. There are two main drainage basins, the Bang Saphan Yai river basin and Mae Ramphung river basin, and many small tributaries which run in the plantation area and swamp area near the Bang Saphan Industrial Estate. According to the interview survey on inundation, the lowland area was inundated by flush water in 1995.

Storm water drainage in industrial estates is generally designed for 5-year or 10-year probable rainfall. The probable hourly rainfall intensities by frequency in Prachuap Khiri Khan and Chumphon are as shown below.

Unit : mm/hr

Return Period (year)	Prachuap Khiri Khan	Chumphon
2	42	48
5	60	60
10	72	65
20	84	75

The rainfall intensity curves in Prachuap Khiri Khan and Chumphon are shown in Figure D.6.1.

(2) Preliminary Design

The storm water in the Bang Saphan Industrial Estate will be released to the Khlong Podaeng river, a tributary of the Mae Ramphung river, through the retention pond designed as shown in Figure D.6.2.

The probable hourly rainfall intensities in Prachuap Khiri Khan are adopted for the design of the drainage system as shown below.

10-year Probable Rainfall at Prachuap Khiri Khan

Duration (minutes)	Rainfall Intensity (mm/hr)
10	150
15	130
30	100
60	72
120	42

The plan of drainage system is as shown in Figure D.6.3 and the longitudinal profile of storm water drainage is shown in Figures D.6.4 and D.6.5.

Principal features of the drainage system are as follows:

(a) Drainage Facilities : Storm water drainage, road side ditch and retention pond

(b) Design rainfall : 10-year probable rainfall

(c) Design discharge : by Rational formula (see Table D.6.1)
- Runoff coefficient C = 0.7
- Rainfall intensity $I_{10} = 4051/(t^{0.9}+19.13)$
- Arrival time t = 7 minutes

(d) Storm drain ditch
Material : Concrete or stone masonry
Shape : Trapezoid
Allowable flow velocity : 0.8 ~ 3.0 m/s

(e) Retention pond
Storage volume = 170,000 m3
Area = 16 ha (3 % of gross area, 600 ha)
Depth = 3 m
Water depth = 1.1 m
Flap gate : ø 1m x 6 units

D.7 Electricity

(1) Basic Design Condition and Criteria

Electricity for consumers in the Bang Saphan industrial estate will be fed from on-site substations of PEA at voltage of 22 kV. The internal power supply system is composed of 22 kV distribution lines and a branch switching facility at the service entrance point of each lot.

Either underground or overhead distribution lines will be applied for the project, though, underground distribution method using buried armoring cables is recommendable from the aesthetic viewpoint. The buried depth of 22 kV cables should be not less than 1.2 m under carriageways, and 0.6 m under pedestrian ways. The distribution system will be designed as an open loop system to secure stable power supply. Installation of 22 kV switchgear units is also recommended to tap electricity for factory lots.

The internal distribution system in the industrial estate will be constructed by a joint venture company, however, it is proposed by PEA that it will be responsible for operation and maintenance of the system as well.

In addition to the power supply system, a street lighting system shall also be designed along the main and sub-main roads. Street lights with high-pressure sodium lamps and double-arm steel poles will be constructed on the mediam strip at intervals of 35 m.

(2) Power Demand

The power demand for the Bang Saphan industrial estate is estimated at 19 MW for phase 1, 64 MW for phase 2, and 128 MW for phase 3, as shown below.

	Phase 1 (2001)			Phase 2 (2006)			Phase 3 (2011)		
	ha	MW/ha	MW	ha	MW/ha	MW	ha	MW/ha	MW
1. Factory	52.0	0.3	15.6	200.5	0.3	60.2	414.5	0.3	124.4
2. Industrial estate center	1.8	-	0.2	1.8	-	0.2	1.8	-	0.2
3. Sewage treatment plant	10.0	-	0.9	10.0	-	0.9	10.0	-	0.9
4. Water purification plant.	5.0	-	1.8	5.0	-	1.8	5.0	-	1.8
5. Street lighting	-	-	0.1	-	-	0.2	-	-	0.3
	68.8	-	18.6	217.4	-	63.3	368.8	-	127.6

(3) Power Distribution System

Phase 1

Double circuit 22 kV distribution lines of XLPE steel taped armored cable (3C-240sq mm) will be buried along the pedestrian way of the road from on-site substation-1 to the phase 1 development lot by 2000. 14 sets of 22 kV ring main unit and 1set of tie switch unit will also be installed at the service entrance points and the branch point of the loop line, respectively. These units shall be enclosed in waterproof steel cabinets.

The proposed 22 kV power distribution plan is shown in Figure D.7.1.

Phase 2

Additional six circuits of distribution cable will be laid from the substation-1 to the development area of phase 2 by 2003. 11 sets of 22 kV ring main unit and 3 sets of tie switch unit will be also provided as shown in Figure D.7.2.

Phase 3

Eight circuits of distribution lines will be constructed from the other on-site substation-2 to the phase 3 development area by 2007. 20 sets of ring main units and 4 sets of tie switch unit will be also installed in the industrial estate.

The proposed 22 kV power distribution plan is shown in Figure D.7.3.

D.8 Telecommunications

(1) Basic Design Condition

Telecommunication services for the Bang Saphan industrial estate are available through TOT. The internal telecommunication system of the industrial estate is composed of telephone distribution lines of metallic cable, and pull boxes at the service entrance point of each lot. Cables will be laid in PVC pipes and buried in the ground along pedestrian ways of roads. The buried depth of PVC pipes shall be not less than 1.2 m under carriage ways, and 0.6m under pedestrian ways respectively. Some spare pipes are also recommended to be installed for the future expansion of the telecommunication services.

(2) Telecommunication Demand

The telecommunication demand for the industrial estate is estimated at 276 lines in 2001, 872 lines in 2006, and 1730 lines 2011 as summarized below.

(lines)

	2001	2006	2011
1. Factory	208	804	1660
2. Industry estate center	60	60	60
3. Water purification plant	3	3	3
4. Sewerage treatment plant	3	3	3
5. Power substation	2	2	4
Total	276	872	1,730

Details of telecommunication demand are shown in Table D.8.1.

(3) Telecommunication System

Phase 1

Underground telephone distribution lines will be laid between the remote switching station located in the Industrial Estate Center and the phase 1 development area by 2000. The capacity of the trunk line should be designed considering not only the phase 1 demand but also the phase 2 and phase 3 demands. Pull boxes for subscribers and branch cables should be installed in the phase 1 area. The proposed plan of telecommunication facilities is shown in Figures D.8.1. and D.8.2.

Phase 2

The trunk line should be extended from the phase 1 area to the phase 2 development area by 2003. Pull boxes at each service entrance of subscribers and branch cables from the trunk line should also be constructed in the development area.

The proposed plan of telecommunications is shown in Figures D.8.3. and D.8.4.

Phase 3

The trunk line should be extended from the terminal point of the phase 2 area to the phase 3 area by 2007. Pull boxes and branch cables should also be expanded in the whole area in the phase 3 development stage.

The proposed plan of telecommunications is shown in Figures D.8.5 and D.8.6.

D.9 Other Facilities

D.9.1 Industrial Estate Center

An industrial estate center with operation and maintenance office, business center, etc. will be constructed as the core of the Bang Saphan industrial estate. Facilities necessary for the industrial estate are summarized below.

	Facility	Floor Area (m2)	Site Area (m2)
1.	Administrative O/M office	100	
2.	Promotion Office	100	
3.	Fire Station	150	
4.	Business Center (bank, courier service, etc.) (50 m2 x 10 tenants)	500	
5.	Governmental Office (Customs, Police, etc.)	200	
6.	Telecommunication Center	50	
7.	Amenities (restaurant, clinic, kiosk, nursery, etc.) (40 m2 x 10 tenants)	400	
	Subtotal	1,500	9,000
8.	Sports Facility (ball court, etc.)		3,000
9.	Others (Car parking, Green, etc.)		6,000
	Total		18,000

D.9.2 Park

A park with an area of 19.0 ha (3.2% of the total area) is designed to be created in the industrial park in order to improve the aesthetic attractiveness of the industrial park and the amenities not only for employees but also for investors. Facilities to be installed in the park are presented below :

- Sport facilities : Football court, Sports ground, Tennis courts, Basket ball courts, Athletic park
- Common space : Open field, Green common, Promenade, Pond & Water front park
- Others : Car parking, Supporting utilities

Table D.1.1 Land Use Plan of the Bang Saphan Industrial Estate

	Area (ha)	Area (Rai)	Area (%)	Remarks
1 Factory Lot	360.0	2,250	60.0	
2 Factory Lot (for reserve)	54.5	341	9.1	
3 Road	75.4	471	12.6	
1) Main road (50.0 m)	49.2	307	8.2	L=12,290 m
2) Sub-main road (30 m)	14.1	88	2.4	L=4,680 m
3) Collector road (30 m)	10.1	63	1.7	L=3,370 m
4) Others	2.0	13	0.3	
4 Utilities	26.5	166	4.4	
1) Water purification plant	2.0	13	0.3	
2) Sewage treatment plant	7.0	44	1.2	
3) Electric substation	1.5	9	0.3	2 stations
4) Retention pond	16.0	100	2.7	
5) Drainage canal	8.0	50	1.3	
5 Industrial Estate Center	1.8	11	0.3	
6 Park & Green	26.6	166	4.4	
1) Park	19.0	119	3.2	
2) Multi purpose open space	7.6	48	1.3	
7 Buffer Green	55.2	345	9.2	
Total	600.0	3,750	100.0	

Note: Shipbuilding and repairing factory with the lot area of 6.8 ha is distributed in the port area.

Table D.1.2 List of Prospective Investors and Development Framework of Bang Saphan Industrial Estate

Japanese Industrial Category (No. is Japanese industrial category's number)	Thai Industrial Code	2001 Area (m2)	2001 No. of Employee	2006 Area (m2)	2006 No. of Employee	2011 Area (m2)	2011 No. of Employee
1211 Meat products	311	10,000	50	10,000	50	10,000	50
	31111						
1212 Dairy products	31119	10,000	50	10,000	50	10,000	50
	31121						
1221 Canned seafood and seaweed	31122			5,000	50	5,000	50
1229 Miscellaneous seafood products	31149	5,000	50	5,000	50	5,000	50
1242 Soy source "Sioux" and edible acids	31132			50,000	100	50,000	120
1253 Glucose, starch syrup and high-fructose corn syrup	31211					50,000	80
1263 Wheat flour milling	31163					50,000	70
	31169						
1281 Vegetable oil and fats	31151					50,000	100
1283 Edible oil and fats	31151					50,000	180
1293 Noodles, macaroni and spaghetti	31173					10,000	80
1361 Balanced compound feeds	31120					200,000	200
Manufacture of food group		25,000	150	80,000	300	490,000	1,030
1421 Spinning mills and cotton	32112					100,000	250
1431 Twisting yarns, except bulky yarns	32113					10,000	60
1441 Fabric mills, woven cotton acced spun rayon	32190					10,000	100
Manufacture of textile group						120,000	410
1617 Flooring mills	33190					25,000	100
1619 Sawing and planning mills, n.e.c.	33111					25,000	70
1624 Particleboard	33112	50,000	70	50,000	70	50,000	70
	33113						
1711 Wooden furniture, except Japanese	33201	10,000	160	10,000	160	10,000	160
Manufacture of wooden and furniture group		60,000	230	60,000	230	110,000	400
1841 Office paper products	34190					10,000	90
1851 Sacks for heavy weight shipping	34120					10,000	60
Manufacture of paper and pulp group						20,000	150
2011 Nitrogenous and phosphatic fertilizers	35120					100,000	80
2012 Compound fertilizers	35120					50,000	80
2023 Inorganic pigments	35299					50,000	140
2024 Compressed and liquefied gases	35299					25,000	80
2033 Methane derivatives	35111					200,000	900
2034 Fermentation industry	35299			100,000	70	100,000	70
2121 Lubricating industry	35299	25,000	30	25,000	30	50,000	60
2122 Greases	35299	25,000	60	25,000	60	25,000	60
2210 Industrial plates, bars and rods, pipes and tubes, pipe fittings and	356					50,000	140
2230 Industrial plastic products	356					10,000	90
Manufacture of Petroleum and coal(C_4 chemicals)		50,000	90	150,000	160	660,000	1,700
2512 Processed flat glass	36200					100,000	600
2514 Glass containers	36209					50,000	180
2551 Fire blocks	36910	50,000	100	100,000	170	100,000	170
2559 Miscellaneous clay refectories	36910			50,000	100	50,000	100
2561 Carbonaceous electrodes	36999			350,000	170	350,000	170
Ceramics industry group		50,000	100	500,000	440	650,000	1,220
2631 Steel manufactured, with electric furnaces, including single electric furnaces, and with rolling facilities with rolling factories	371	344,000	400	758,000	650	1,234,000 602,000	2,468
2641 Steel manufacture of hot rolling mill	37110	264,000	655	264,000	655	264,000	655
2642 Steel manufacture of cold rolling mill	37110	213,000	550	213,000	730	264,000	800
2643 Steel manufacture of hot rolling mill(Bar mill)	37110	105,000	300	105,000	300	105,000	300
2652 Galvanized steel sheet(Electrical zinc sheet)	371	88,000	320	88,000	320	88,000	320
2652 Galvanized steel sheet(Fused zinc sheet)	371	8,000	130	10,000	130	18,000	150
Ox Plant							
Steel manufacture (Basic product line by furnace) group		1,011,000	2,355	1,438,000	2,785	2,575,000	4,693
2644 Steel pipes and tubes	371			200,000	150	200,000	180
2646 Cold finished steel bars	371	50,000	250	50,000	250	50,000	250
2648 Wire drawing	371	25,000	75	25,000	75	50,000	150
2659 Coated steel	371			50,000	100	50,000	120
2660 Ferrous metal machine parts and tooling products	371			50,000	90	50,000	110
2661 Iron castings, except cast iron pipes and malleable	371			100,000	200	100,000	300
2662 Malleable iron casting	371			50,000	80	50,000	100
2691 Caussation pipe	371			50,000	80	50,000	100
2692 Iron and steel shearing and slitting	371	25,000	65	25,000	65	25,000	65
2693 Iron and steel scrap preparation for smelting	371	25,000	80	25,000	80	25,000	80
2811 Tin cans and other plated sheet products	371	10,000	110	10,000	110	10,000	110
2841 Fabricated construction-use metal products	371	50,000	100	50,000	100	50,000	100
2842 Fabricated architectural metal products, except structural hardware	371					25,000	100
2843 Fabricated plate work and sheet metal work	371	25,000	185	25,000	185	25,000	185
Steel processing industry(machinery products line)group		210,000	865	710,000	1,565	760,000	1,930
2911 Boilers	382			100,000	470	100,000	470
2912 Steam engines, turbans and water wheels,	382			200,000	800	200,000	800
2972 Air compressors, gas compressors and blowers	38292	25,000	200	25,000	200	25,000	200
2974 Conveyors and conveying equipment	382			25,000	100	25,000	130
2978 Chemical machinery and and its equipment	382			25,000	100	25,000	120
2979 Miscellaneous general industry machinery and equipment	382					25,000	100
2980 Office, service industry and household machines	382	50,000	90	50,000	330	50,000	330
2984 Refrigerators and air conditioning apparatus	382	25,000	370	50,000	800	50,000	800
2989 Miscellaneous office, service industry and household machines		25,000	320	25,000	320	25,000	320
3011 Generators, motors and other rotating electrical machinery	38310					50,000	280
3021 Household electric appliances						50,000	460
3041 Communication equipment(wired)	38320					10,000	70
3091 Storage batteries	38392					50,000	260
3112 Mote vehicle bodies and trailers	38432					50,000	360
3113 Motor vehicle parts and accessories	38434					50,000	180
Steel industry by processing line products group		125,000	980	500,000	3,120	785,000	4,880
3141 Steel shipbuilding and repairing	38411			69,000	140	69,000	140
3142 Hull blocks	38419			5,000	50	5,000	50
Shipbuilding and repairing group				74,000	190	74,000	190
General manufacture(except steel industry)		520,000	2,415	2,074,000	6,005	3,669,000	11,910
Steel industry		1,011,000	2,355	1,438,000	2,785	2,575,000	4,693
Total		1,531,000	4,770	3,512,000	8,790	6,244,000	16,603

Table D.1.3 Lot Distribution Plan by Lot Size and Category

(Cumulative)

Year	Lot Size (ha)	Number of Lot by Industrial Category										Area (ha)
		Food	Textile	Wood	Paper	C1 Chemical	Ceramic	Steel Processing Products	Machinery	Others	Total	
2001	0.5	1									1	0.5
	1	2		1				1			4	4.0
	2.5					2		4	3		9	22.5
	5			1			1	2	1		5	25.0
	10										0	0.0
	20										0	0.0
	35										0	0.0
	Total	3	0	2	0	2	1	7	4	0	19	52.0
2006										1	3	1.5
	0.5	2									4	4.0
	1	2		1				1			10	25.0
	2.5					2		4	4		11	55.0
	5	1		1			1	6	2		4	40.0
	10					1	1	1	1		2	40.0
	20							1	1		1	35.0
	35						1				35	200.5
	Total	5	0	2	0	3	3	13	8	1		
2011										1	3	1.5
	0.5	2									11	11.0
	1	3	2	1	2	1		1	1		13	32.5
	2.5			2		2		4	5		26	130.0
	5	5		1		4	2	7	7		7	70.0
	10		1			2	2	1	1		4	80.0
	20	1				1		1	1		1	35.0
	35						1				65	360.0
	Total	11	3	4	2	10	5	14	15	1		

(Increment by Phase)

Year	Lot Size (ha)	Number of Lot by Industrial Category										Area (ha)
		Food	Textile	Wood	Paper	C1 Chemical	Ceramic	Steel Processing Products	Machinery	Others	Total	
2001	0.5	1									1	0.5
	1	2		1				1			4	4.0
	2.5					2		4	3		9	22.5
	5			1			1	2	1		5	25.0
	10										0	0.0
	20										0	0.0
	35										0	0.0
	Total	3	0	2	0	2	1	7	4	0	19	52.0
2006										1	2	1.0
	0.5	1									0	0.0
	1								1		1	2.5
	2.5							4	1		6	30.0
	5	1									4	40.0
	10					1	1	1	1		2	40.0
	20							1	1		1	35.0
	35						1				16	148.5
	Total	2	0	0	0	1	2	6	4	1		
2011										0	0	0.0
	0.5										6	6.0
	1	1	2		2	1					3	7.5
	2.5	0		2		0			1		15	75.0
	5	4				4	1	1	5		3	30.0
	10		1			1	1				2	40.0
	20	1				1						0.0
	35										29	158.5
	Total	6	3	2	2	7	2	1	6	0		

Table D.1.4 Land Use Plan of the Bang Saphan Industrial Estate by Phase

	Phase 1 (2001)			Phase 2 (2006)			Phase 3 (2011)			Total Area		
	(ha)	(Rai)	(%)	(ha)	(Rai)	(%)	(ha)	(Rai)	(%)	(ha)	(Rai)	(%)
Industrial Estate												
1 Factory Lot	52.0	325	48.0	148.5	928	73.7	159.5	997	55.0	360.0	2,250	60.0
2 Factory Lot (for reserve)	0.0	0	0.0	0.0	0	0.0	54.5	341	18.8	54.5	341	9.1
3 Road	12.6	79	11.6	29.8	186	14.8	33.0	206	11.4	75.4	471	12.6
1) Main road (40.0 m)	10.0	63	9.2	19.4	121	9.6	19.8	124	6.8	49.2	307	8.2
2) Sub-main road (30 m)	1.8	11	1.7	3.1	20	1.5	9.2	57	3.2	14.1	88	2.4
3) Collector road (30 m)	0.8	5	0.7	5.3	33	2.6	4.0	25	1.4	10.1	63	1.7
4) Others	0.0	0	0.0	2.0	13	1.0	0.0	0	0.0	2.0	13	0.3
4 Utilities	37.0	231	34.1	2.0	13	1.0	6.0	38	2.1	45.0	281	7.5
1) Water purification plant	5.0	31	4.6	0.0	0	0.0	0.0	0	0.0	5.0	31	0.8
2) Sewage treatment plant	10.0	63	9.2	0.0	0	0.0	0.0	0	0.0	10.0	63	1.7
3) Electric substation	2.0	13	1.8	0.0	0	0.0	2.0	13	0.7	4.0	25	0.7
4) Retention pond	18.0	113	16.6	0.0	0	0.0	0.0	0	0.0	18.0	113	3.0
5) Drainage canal	2.0	13	1.8	2.0	13	1.0	4.0	25	1.4	8.0	50	1.3
5 Industrial Estate Center	1.8	11	1.7	0.0	0	0.0	0.0	0	0.0	1.8	11	0.3
6 Park & Green	3.0	19	2.8	5.6	35	2.8	18.0	113	6.2	26.6	166	4.4
1) Park	3.0	19	2.8	3.0	19	1.5	13.0	81	4.5	19.0	119	3.2
2) Multi purpose open space	0.0	0	0.0	2.6	16	1.3	5.0	31	1.7	7.6	48	1.3
7 Buffer Green	2.0	13	1.9	15.7	98	7.8	19.0	119	6.6	36.7	230	6.1
Total	108.4	678	100.0	201.6	1,260	100.0	290.0	1,813	100.0	600.0	3,750	100.0

Table D.3.1 Projection of Cargo Demand of Bang Saphan Area

Year		Area (ha)	Cargo Demand (1,000 ton/year)	Port Cargo Volume (1,000 ton/year)					Other Mode Cargo Volume (1,000 ton/year)						
				Inward		Outward	General	Port Cargo	Inward		Outward		Total		
				Bulky	General	General	Total	Total	Truck	Railroad	Truck	Railroad	Truck	Railroad	Total
1995	Iron/Steel Group	35	1,935	0	1,500	300	1,800	1,800	0	0	135	0	135	0	135
	General Industry	0													
	Total	35	1,935	0	1,500	300	1,800	1,800	0	0	135	0	135	0	135
2001	Iron/Steel Group	100	5,630	0	2,900	2,080	4,980	4,980	0	0	520	130	520	130	650
	General Industry	50	1,510	0	340	130	470	470	420	0	620	0	1,040	0	1,040
	Subtotal	150	7,140	0	3,240	2,210	5,450	5,450	420	0	1,140	130	1,560	130	1,690
	Port														
	Total	150	7,140	0	3,240	2,210	5,450	5,450	420	0	1,140	130	1,560	130	1,690
2006	Iron/Steel Group	145	6,900	3,100	1,200	1,950	3,150	6,250	0	0	520	130	520	130	650
	General Industry	200	3,500	0	740	280	1,020	1,020	970	50	1,390	70	2,360	120	2,480
	Subtotal	345	10,400	3,100	1,940	2,230	4,170	7,270	970	50	1,910	200	2,880	250	3,130
	Power Plant	105	4,400	4,400				4,400							
	Port														
	Total	450	14,800	7,500	1,940	2,230	4,170	11,670	970	50	1,910	200	2,880	250	3,130
2011	Iron/Steel Group	260	15,900	9,300	1,080	3,080	4,080	13,380	0	0	1,960	560	1,960	560	2,520
	General Industry	415	9,730	1,080	1,860	780	2,640	3,720	1,730	190	3,680	410	5,410	600	6,010
	Subtotal	675	25,630	10,380	2,860	3,860	6,720	17,100	1,730	190	5,640	970	7,370	1,160	8,530
	Power Plant	105	4,400	4,400				4,400							
	Port														
	Total	780	30,030	14,780	2,860	3,860	6,720	21,500	1,730	190	5,640	970	7,370	1,160	8,530

Table D.4.1 Water Demand Projection of Bang Saphan Industrial Estate

Japanese Industrial Category (No. is Japanese industrial category's number)	Thai Industrial Code	2001 Area (m2)	2001 Water (m3/day)	2006 Area (m2)	2006 Water (m3/day)	2011 Area (m2)	2011 Water (m3/day)
1211 Meat products	311	10,000	150	10,000	150	10,000	150
	31111						
1212 Dairy products	31119	10,000	380	10,000	380	10,000	380
	31121						
1221 Canned seafood and seaweed	31122			5,000	230	5,000	230
1229 Miscellaneous seafood products	31149	5,000	100	5,000	100	5,000	100
1242 Soy source "Sioux" and edible acids	31132			50,000	700	50,000	700
1253 Glucose, starch syrup and high-fructose corn syrup	31211					50,000	5,500
1263 Wheat flour milling	31163					50,000	100
	31169						
1281 Vegetable oil and fats	31151					50,000	1,800
1283 Edible oil and fats	31151					50,000	900
1293 Noodles, macaroni and spaghetti	31173					10,000	150
1361 Balanced compound feeds	31120					200,000	550
Manufacture of food group		25,000	630	80,000	1,560	490,000	10,560
1421 Spinning mills and cotton	32112					100,000	4,500
1431 Twisting yarns, except bulky yarns	32113					10,000	250
1441 Fabric mills, woven cotton aened spun rayon	32190					10,000	1,300
Manufacture of textile group						120,000	6,050
1617 Flooring mills	33190					25,000	160
1619 Sawing and planning mills, n.e.c.	33111					25,000	40
1624 Particleboard	33112	50,000	130	50,000	130	50,000	130
	33113						
1711 Wooden furniture, except Japanese	33201	10,000	60	10,000	60	10,000	60
Manufacture of wooden and furniture group		60,000	190	60,000	190	110,000	390
1841 Office paper products	34190					10,000	30
1851 Sacks for heavy weight shipping	34120					10,000	40
Manufacture of paper and pulp group						20,000	70
2011 Nitrogenous and phosphatic fertilizers	35120					100,000	4,500
2012 Compound fertilizers	35120					50,000	3,700
2023 Inorganic pigments	35299					50,000	7,000
2024 Compressed and liquefied gases	35299					25,000	1,000
2033 Methane derivatives	35111					200,000	2,700
2034 Fermentation industry	35299			100,000	5,500	100,000	5,500
2121 Lubricating industry	35299	25,000	350	25,000	350	50,000	700
2122 Greases	35299	25,000	45	25,000	45	25,000	45
2210 Industrial plates, bars and rods, pipes and tubes, pipe fittings and	356					50,000	650
2230 Industrial plastic products	356					10,000	150
Manufacture of Petroleum and coal(C, chemicals)		50,000	395	150,000	5,895	660,000	25,945
2512 Processed flat glass	36200					100,000	1,850
2514 Glass containers	36200					50,000	400
2551 Fire blocks	36910	50,000	80	100,000	150	100,000	150
2559 Miscellaneous clay refectories	36910			50,000	1,000	50,000	1,000
2561 Carbonaceous electrodes	36999			350,000	4,000	350,000	4,000
Ceramics industry group		50,000	80	500,000	5,150	650,000	7,400
2644 Steel pipes and tubes	371			200,000	1,300	200,000	1,300
2646 Cold finished steel bars	371	50,000	40	50,000	40	50,000	40
2648 Wire drawing	371	25,000	350	25,000	350	50,000	650
2650 Coated steel	371			50,000	750	50,000	750
2660 Ferrous metal machine parts and tooling products	371			50,000	400	50,000	400
2661 Iron castings, except cast iron pipes and malleable	371			100,000	2,700	100,000	2,700
2662 Malleable iron casting	371			50,000	650	50,000	650
2694 Causation pipe	371			50,000	500	50,000	500
2692 Iron and steel shearing and slitting	371	25,000	50	25,000	50	25,000	50
2693 Iron and steel scrap preparation for smelting	371	25,000	50	25,000	50	25,000	50
2811 Tin cans and other plated sheet products	371	10,000	130	10,000	130	10,000	130
2841 Fabricated construction-use metal products	371	50,000	80	50,000	80	50,000	80
2842 Fabricated architectural metal products, except structural hardware	371					25,000	170
2843 Fabricated plate work and sheet metal work	371	25,000	115	25,000	115	25,000	115
Steel processing industry(machinery products-line)group		210,000	815	710,000	7,115	760,000	7,585
2911 Boilers	382			100,000	180	100,000	180
2912 Steam engines, turbans and water wheels,	382			200,000	3,200	200,000	3,200
2972 Air compressors, gas compressors and blowers	38292	25,000	35	25,000	35	25,000	35
2974 Conveyors and conveying equipment	382			25,000	50	25,000	50
2978 Chemical machinery and and its equipment	382			25,000	100	25,000	100
2979 Miscellaneous general industry machinery and equipment	382					25,000	180
2980 Office, service industry and household machines	382	50,000	90	50,000	370	50,000	370
2984 Refrigerators and air conditioning apparatus	382	25,000	160	50,000	300	50,000	300
2989 Miscellaneous office, service industry and household machines		25,000	240	25,000	240	25,000	240
3011 Generators, motors and other rotating electrical machinery	38310					50,000	150
3021 Household electric appliances						50,000	450
3041 Commundation equipment (wired)	38320					10,000	25
3091 Storage batteries	38392					50,000	450
3112 Mote vehicle bodies and trailers	38432					50,000	410
3113 Moter vehicle parts and accessories	38434					50,000	180
Steel industry by processing line products group		125,000	525	500,000	4,475	785,000	6,320
3142 Hull blocks	38419			5,000	10	5,000	10
Shipbuilding and repairing group				5,000	10	5,000	10
Reserve lot						545,000	5,450
Reserve lot						545,000	5,450
General manufacture(except steel industry)		520,000	2,635	2,005,000	24,395	4,145,000	69,780

Table D.4.2 Water Supply of Industrial Estate in Thailand

No.	Name of I.E.	Province	Water Supply (m3/d)	Unit Supply (m3/d/rai)	Water Charge (US$/m3)	Waste Water (m3/d)	Charge (US$/m3)	Area (rai)	(ha)
1	Northern Region	Lamphun							
2	Pichit								
3	Udon Thani								
4	Saraburi		22,000	20		17,600		1,500	240
5	Nong Khae			7		N/A			
6	Hi-Tech		20,000	12	0.32	16,800	0.32	2,150	344
7	Saharattananakorn		13,440	7	0.28	21,000		2,050	328
8	Bangpa-In			12	0.28	6,000	0.28		
9	Welligrow		30,000	7	0.4	7,200			
10	Gateway City			7	0.36	6,000			
11	Bangpakong			7	0.4	11,300		4,515	722
12	Chonburi			8	0.36	8,400	0.102		
13	Map Ta Phut			10					
14	Eastern			10	0.36	12,000	0.102		
15	Padaeng								
16	Laem Chabang		27,000	19.28571429				1,400	acres
17	Gemopolis		N/A	N/A					
18	Ladkrabang								
19	Bangchan								
20	Bangphlee								
21	Bangpoo								
22	Samut Sakhon			45	0.3	21,000			
23	Songkhla								

Source : IEAT

Table D.4.3 Preliminary Hydraulic Calculation of Flow Net

C=	100							
Flow Net 1								
Line	Dia. (mm)	A (m2)	L (m)	Q (l/s)	V (m/s)	I	h (m)	h/Q
FI	300	0.071	630	-39.1	0.553	0.001833	-1.1549279	0.02956048
IH	400	0.126	280	81.3	0.647	0.001752	0.4905985	0.00603814
HG	300	0.071	640	55.0	0.777	0.003448	2.2064725	0.04015419
GF	200	0.031	280	-24.4	0.776	0.005511	-1.5431026	0.06331976
							-0.0009595	0.13907256
Flow Net 2								
JC	600	0.283	235	-334.3	1.182	0.003339	-0.7846848	0.00234704
CD	400	0.126	1,260	81.4	0.648	0.001759	2.2167589	0.02722288
DI	450	0.159	410	123.1	0.774	0.002132	0.8739554	0.0070984
IF	300	0.071	630	39.1	0.553	0.001833	1.1549279	0.02956048
FG	200	0.031	280	24.4	0.776	0.005511	1.5431026	0.06331976
GN	200	0.031	1,040	-13.0	0.413	0.001716	-1.785003	0.13751949
NL	400	0.126	140	-122.7	0.976	0.003758	-0.5261212	0.00428857
LM	150	0.018	180	-6.8	0.387	0.002128	-0.3829626	0.05598869
MJ	150	0.018	440	-11.1	0.630	0.00525	-2.3100037	0.2073612
							-3.051E-05	0.5347065
Flow Net 3								
AE	600	0.283	1,240	265.1	0.938	0.002173	2.6946771	0.01016399
ED	500	0.196	440	184.1	0.938	0.002688	1.1829181	0.00642471
DC	400	0.126	1,260	-81.4	0.648	0.001759	-2.2167589	0.02722288
CB	700	0.385	280	-468.4	1.217	0.002943	-0.8240798	0.00175924
BA	700	0.385	160	-638.9	1.660	0.005229	-0.8365922	0.00130947
							0.0001642	0.04688029
Flow Net 4								
BC	700	0.385	280	468.4	1.217	0.002943	0.8240798	0.00175924
CJ	600	0.283	235	334.3	1.182	0.003339	0.7846848	0.00234704
JK	600	0.283	180	323.2	1.143	0.003136	0.5644759	0.00174658
KP	450	0.159	1,200	182.7	1.148	0.004425	5.3099733	0.02907185
PQ	200	0.031	280	7.5	0.237	0.000615	0.1723165	0.02309873
QB	300	0.071	1,620	-65.2	0.922	0.004726	-7.6554715	0.11750532
							5.873E-05	0.17552874
Flow Net 5								
KL	400	0.126	440	140.5	1.118	0.004834	2.1267587	0.01513276
LN	400	0.126	140	122.7	0.976	0.003758	0.5261212	0.00428857
NO	400	0.126	1,200	91.8	0.731	0.002197	2.6359267	0.0287138
OP	150	0.018	580	0.8	0.044	3.73E-05	0.0216127	0.02806846
PK	450	0.159	1,200	-182.7	1.148	0.004425	-5.3099733	0.02907185
							0.0004461	0.10527544
Flow Net 6								
KJ	600	0.283	180	-323.2	1.143	0.003136	-0.5644759	0.00174658
JM	150	0.018	440	11.1	0.630	0.00525	2.3100037	0.2073612
ML	150	0.018	180	6.8	0.387	0.002128	0.3829626	0.05598869
LK	400	0.126	440	-140.5	1.118	0.004834	-2.1267587	0.01513276
							0.0017318	0.28022923

Table D.5.1 Quality Standard of Influent into Sewage Treatment Plant

1.	Average BOD_5	<=	500	mg/l
2.	Average Suspended Solids	<=	200	mg/l
3.	pH	5.0-9.0		
4.	Temperature	<=	45℃	
5.	Sulphide as hydrogen sulphide	<=	5	mg/l
6.	Cyanide as hydrogen cyanide	<=	2	mg/l
7.	Oil and Grease	<=	10	mg/l
8.	Tar	<=	10	mg/l
9.	Formaldehyde	<=	2	mg/l
10.	Phenol and Cresols	<=	1	mg/l
11.	Free Chlorine	<=	5	mg/l
12.	Insecticide	none		
13.	Radioactive compound	none		
14.	Fluoride (F)	<=	5	mg/l
15.	Free Ammonia	<=	5	mg/l
16.	Total ammonia Nitrogen as N	<=	50	mg/l
17.	Mercury and Mercury Compound	<=	0.005	mg/l
18.	Soluble Iron and Manganese	<=	10	mg/l
19.	Chromium, Arsenic, Silver, Selenium, Lead, Nickel, Barium, Copper, Cadmium Total or Each	<=	1	mg/l
20.	Other materials that should not discharge into the waste water pipeline - High viscosity material - Settleable solids that cause pipe clogging - Calcium Carbide Sludge			
21.	Synthetic Detergent	<=	30	mg/l
22.	Chloride (cl) as Chlorine	<=	2,000	mg/l

Table D.5.2 Standard of Treated Water of Ministry of Industry (1985)

Parameter	Allowable Concentration
1. pH	Between 5.0 and 9.0
2. BOD_5	20 ~ 60 mg/l
3. Permanganate	60 mg/l
4. Dissolved Solids	
- Discharge into Water Course:	2,000 ml/l or more but not exceeding 5,000 mg/l depending upon discharging point
- Discharge into sea or estuaries (Salinity higher than 2,000 mg/l)	5,000 mg/l higher than dissolved solids content in sea or estuary water
5. Sulfide as H_2S	1.0 mg/l
6. Cyanide as HCN	0.2 mg/l
7. Heavy metals:	
-Zinc	5.0 mg/l
- Chromium	0.5 mg/l
- Arsenic	0.25 mg/l
- Copper	1.0 mg/l
- Mercury	0.005 mg/l
- Cadmium	0.03 mg/l
- Barium	1.0 mg/l
- Selenium	0.02 mg/l
- Lead	0.2 mg/l
- Nickel	0.2 mg/l
- Manganese	5.0 mg/l
8. Tar	Nil
9. Oil & Grease	5.0 mg/l (Except for crude oil refinery and lubricant blending plant : less than 15 mg/l)
10. Formaldehyde	1.0 mg/l
11. Phenols & Cresols	1.0 mg/l
12. Free chlorine	1.0 mg/l
13. Insecticides and radio-active substance	Nil

Table D.6.1 Flow Calculation of Storm Water Drainage

Pipe No.	A (ha)	Length (m)	Accu.	C	ti (min)	I (mm/h)	Q (m3/s)	B (m)	Ho (m)	A (m2)	R (m)	ha (m)	i (o/oo)	n	Q'	.8<v<3	To (min)
1-1	50	1620	1620	0.7	15	133	12.9	2	1.6	5	0.80	0.3	2.389008	0.015	12.9	2.8	7.7103
Connect to 5-1																	
2-1	30	1240	1240	0.7	14	136	7.9	2	1.2	3	0.66	0.3	2.296462	0.015	7.9	2.4	6.7942
Connect to 8-1																	
3-1	17	590	590	0.7	11	146	4.8	1.4	1.3	2.3	0.55	0.3	2.2472	0.015	4.8	2.1	3.6997
3-2	102.5	1000	1590	0.7	14	136	27.0	6	1.4	9	1.02	0.3	1.8883	0.015	26.9	2.9	7.2166
3-3	269.5	640	2230	0.7	17	127	66.5	8	2.5	22	1.65	0.3	1.0638	0.015	66.4	3.0	9.7826
3-4	293	640	2870	0.7	20	119	68.0	8	2.7	23	1.71	0.3	0.9671	0.015	67.9	3.0	12.932
3-5	377	620	3490	0.7	23	113	82.6	10	2.6	27	1.78	0.3	0.9671	0.015	82.5	3.0	15.294
Connect to 8-3																	
4-1	61.5	1200	1200	0.5	13	139	11.9	2.4	1.6	4.5	0.79	0.3	2.197802	0.015	11.9	2.7	6.01
Connect to 3-2																	
4-2	20.5	570	570	0.7	11	146	5.8	2	1.4	3	0.67	0.3	1.276495	0.015	5.8	1.8	4.1872
Connect to 6-1																	
5-1	102	1210	1210	0.5	13	139	19.7	4	1.6	7	0.97	0.3	1.778199	0.015	19.7	2.8	5.8475
Connect to 3-4																	
5-2	11	630	630	0.7	11	146	3.1	1.3	1.0	2	0.46	0.3	2.609263	0.015	3.1	2.0	4.1425
5-3	11	630	630	0.7	11	146	3.1	1.3	1.0	2	0.46	0.3	2.609263	0.015	3.1	2.0	4.1425
Connect to 6-3																	
6-1	116	1200	1200	0.7	15	133	29.9	6	2.2	14	1.36	0.3	0.69	0.015	30.7	2.1	7.4465
6-2	127	300	1500	0.7	14	136	33.5	6	2.3	15	1.41	0.3	0.69	0.015	33.5	2.2	9.0773
6-3	165	750	2250	0.7	20	119	38.3	6	2.5	17	1.50	0.3	0.69	0.015	38.4	2.3	13.099
6-4	180	660	2910	0.7	24	111	38.7	6	2.5	17	1.50	0.3	0.69	0.015	38.7	2.3	16.914
7-1	39.5	1750	1750	0.7	15	133	10.2	4	1.3	6	0.84	0.3	0.34	0.015	6.2	1.1	21.216
Connect to 6-2																	
7-2	30	1550	1550	0.7	26	107	6.2	3	1.6	6	0.87	0.3	0.34	0.015	6.2	1.1	18.38
8-1	30	900	1690	0.7	15	133	7.7	2	1.2	3	0.60	0.3	3.662132	0.015	7.7	2.9	7.8089
8-2	323	200	3070	0.7	21	117	73.5	10	2.8	30	1.90	0.3	0.81	0.015	87.5	2.9	14.073
8-2	407	200	3690	0.7	24	111	87.6	10	2.8	30	1.90	0.3	0.81	0.015	87.5	2.9	16.915
9-1	33	1200	1200	0.7	13	139	8.9	2	1.5	3	0.69	0.3	0.52935	0.015	4.1	1.2	13.369
10-1	11.5	400	400	0.7	9	154	3.4	2	1.0	2	0.55	0.3	0.52935	0.015	2.3	1.0	5.155
10-2	19	600	600	0.7	10	150	5.5	2	1.0	2	0.55	0.3	2.434112	0.015	5.0	2.2	3.6059