

Chapter 5 Scenarios and Framework of Industrial Development in the WSB Region

Table 7.5.1 below shows the past trend of gross provincial manufacturing product (GPMP). GPMP in the WSB region was 28.4 billion Baht in 1994 (in constant 1988 prices), or 3.48 per cent of the national total. The development scenarios set out in this Study present future perspectives for manufacturing industries in the WSB region. The period of industrial development planning will be divided into three phases corresponding to the planning periods of the National Economic and Social Development Plan: 1997-2001 (the Eighth Plan), 2002-2006 (the Ninth Plan), and 2007-2011 (the Tenth Plan).

Table 7.5.1 Gross Provincial Manufacturing Production (GPMP)

(million Baht in constant 1988 prices)	1989	1990	1991	1992	1993	1994
WSB region	13,810	14,084	16,209	24,220	25,167	28,425
year-on-year growth rate (%)	-	2.0	15.1	49.4	3.9	12.9
Bangkok	223,020	254,392	274,673	280,069	291,185	303,214
year-on-year growth rate (%)	-	14.1	8.0	2.0	4.0	4.1
Bangkok Metropolitan Region (BMR)	351,512	408,775	447,283	478,979	512,998	542,391
year-on-year growth rate (%)	-	16.3	9.4	7.1	7.1	5.7
Whole Kingdom	467,632	540,940	603,512	671,783	746,877	815,857
year-on-year growth rate (%)	-	15.7	11.6	11.3	11.2	9.2

(million Baht in current prices)	1989	1990	1991	1992	1993	1994
WSB region	14,865	15,455	18,796	26,323	28,021	32,451
year-on-year growth rate (%)	-	4.0	21.6	40.1	6.5	15.8
Bangkok	233,799	278,935	316,223	320,594	343,779	368,927
year-on-year growth rate (%)	-	19.3	13.4	1.4	7.2	7.3
Bangkok Metropolitan Region (BMR)	373,735	451,776	517,113	554,648	612,359	666,812
year-on-year growth rate (%)	-	20.9	14.5	7.3	10.4	8.9
Whole Kingdom	496,714	594,014	707,910	779,092	893,343	1,014,951
year-on-year growth rate (%)	-	19.6	19.2	10.1	14.7	13.6

[Regional % Shares of the Kingdom Total] (constant price base)	1989	1990	1991	1992	1993	1994
WSB region	2.95%	2.60%	2.69%	3.61%	3.37%	3.48%
Bangkok	47.69%	47.03%	45.51%	41.69%	38.99%	37.17%
Bangkok Metropolitan Region (BMR)	75.17%	75.57%	74.11%	71.30%	68.69%	66.48%

Note: BMR = Bangkok, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, and Samut Sakhon
Source: NESDB

This Study has presented three alternative scenarios, with the Moderate Growth Scenario selected as the most likely in due consideration of the region's prospects and consistency with the overall development vision for the region, as well as in consideration of environmental impacts and relevant infrastructure development.

Based on the Moderate Scenario, the development framework for industrial development was reviewed, including the requirements for water, electricity, and transport to support an increase in industrial production.

5.1 Definition of the Three Scenarios

The three alternative development scenarios have different growth rates up to 2011, and they can be summarized as follows:

Case 1 (Base-Line or Trend Scenario)

The base-line or trend scenario basically corresponds to Case 1 of the macroeconomic development scenario of this Master Plan Study, in which the annual average growth rate of GDP in the industrial sector in the WSB is expected to be 8.8 per cent from 1994 to 2011. This growth rate was set by extrapolating the trend (1981-94) annual growth rates for the industrial sector, which includes mining and quarrying, manufacturing, construction, and electricity and water supply. For the manufacturing subsector, the same 8.8 per cent growth rate was adopted in this scenario.

Case 2 (Sustainable Growth Scenario)

The Sustainable Growth Scenario was set to attain moderate and sustainable growth at a higher rate than that of Case 1, by incorporating the following development efforts led by the strategies established in Chapter 4:

- Accelerated inducement of new industries in line with the region's gateway/transshipment hub functions, import processing, and subregional linkages with Myanmar;
- Accelerated industrial spillover from the BMR coupled with industrial estate development in the region;
- Extension of a steel complex at Bang Saphan, including crude steel manufacturing up to the capacity of 6 million tons, together with downstream and related industries;
- Development of a new free trade area conducive to an influx of investments;
- Promotion of rural industrial development such as formation of agro-industrial communities and "barn factories," and
- Promotion of industrial modernization, industrial clustering, and intersectoral integration by means of establishing the relevant policy measures to increase productivity.

Case 3 (High Growth Scenario)

The High Growth Scenario will target higher growth than that of Case 2 by inducing downstream gas industries (petrochemical complex and chemical fertilizer) using natural gas to be imported from Myanmar.

5.2 Growth and Structure of the Three Scenarios

GPMP in the WSB region will grow from 32.45 billion Baht in 1994 to 136 billion Baht in 2011 at an annual average rate of 8.8 per cent in Case 1, to 209 billion Baht in 2011 at an annual growth rate of 11.6 per cent in Case 2, or to 295 billion Baht at an annual growth rate of 13.9 per cent in Case 3.

Correspondingly, manufacturing employment will increase from 234,794 workers in 1994 to 433,728 workers (Case 1), 535,110 workers (Case 2), or 717,758 workers (Case 3) in 2011. The incremental workers from 1994 to 2011 would be 198,934 (Case 1), 300,316 (Case 2), or 682,964 (Case 3); these estimates of incremental workers can be translated into base workers for the purpose of land demand forecasting, considering that incremental workers in the modern sector accounted for 31.9 per cent of total manufacturing workers in 1994.

These growth rates will be attained through an increase in the GPMP of existing manufacturing industries, as well as through new industries to be located in the WSB region under various strategic development efforts including industrial estate development. The main subsectors of strategic development are also summarized in the Table 7.5.2. The following considerations have been incorporated:

STEP 1: Growth of the existing manufacturing industries

If GPMP of the existing industries collectively grows at a rate of over 8.8 per cent up to 2011, there would be no need for new industries or new factories in Case 1. Accordingly, the growth rates in this case have been established based on the results of the Industrial Questionnaire Survey by the Study Team (IQS/ST). As the growth rates estimated by the respondents of this survey vary among the respondent manufacturers and subsectors, growth rates in a subsector were calculated on a weighted average basis.

Table 7.5.2 Manufacturing Development Framework in the WSB by Scenario

Target year: 2011	Case 1	Case 2	Case 3
Character of the Case	•Base-line/Trend	•Sustainable growth	• High growth
GPMP (in 1994 constant price) • annual average growth rate/1995-2011	136 billion Baht 8.8%	209 billion Baht 11.6%	295 billion Baht 13.9%
(1) Manufacturing employment (persons)	433,728	535,110	717,758
1-1 Existing industries as of the end of 1994	284,978	284,978	284,978
1-2 New industries	148,750	250,132	432,780
(2) Modern sector ratio (1994: 31.9%)	54.3%	57.5%	61.7%
(3) Base workers for factory site demand Moder sector [(1-2) * (2)]	80,719	143,773	241,959
(4) Parameter for factory site demand	107 workers/ha 757 ha	77 workers/ha 1,877 ha	92 workers/ha 2,980 ha
(5) Factory site demand (3) / (4)	(4,732 rai)	(12,094 rai)	(18,038 rai)
(6) Gross land demand (5) / 80%	946 ha (5,914 rai)	2,346 ha (14,464 rai)	3,725 ha (23,281 rai)
(7) Area of planned land development (gross land)	1,157 ha (7,231 rai)	(Kanchaburi 109 ha, Ratchaburi 208 ha, Petchaburi 240 ha, Bang Saphan 600 ha)	
(8) Additional land demand (6) - (7)	-211 ha (-1,317 rai)	1,189 ha (7,288 rai)	2,568 ha (16,050 rai)
Factors/strategies considered by scenario	• based on the Industrial Questionnaire Survey by the Study Team		
• Growth of the existing industries			
• Acceleration of inducement of new industries in relation to: - gateway/transshipment hub functions - import processing - subregional linkages with Myanmar		• import processing food, wood inds. • motor vehicle parts • electrical/electronic	• import processing food, wood inds. • motor vehicle parts • electrical/electronic
• Acceleration of industrial spillover from the BMR coupled with industrial estate development in the region		• spillover food, construction materials	• more spillover food, construction materials and metal
• Extension of a steel mill complex at Bang Saphan		• crude steel base 6 million tons/year • downstream and related industries, etc. (steel mill complex)	• crude steel base 6 million tons/year • downstream and related industries, etc. (steel mill complex)
• Development of "new free trade area" conducive to an influx of investments		• export industries electronics, leather goods, motor parts • port-oriented metal/chemicals, etc.	• export industries electronics, leather goods, motor parts • port-oriented metal/chemicals, etc.
• Promotion of rural industrial development such as formation of agro-industrial community/community based development and barn factory		• food, other industries • mechanical parts	• food, other industries • mechanical parts
• Promotion of industrial modernization, industrial clustering and intersectoral integration through establishing relevant policy measures conducive to a higher productivity		• agro-processing • furniture • pottery • ship building & repairing • metal processing	• agro-processing • furniture • pottery • ship building & repairing • metal processing
• Inducement of downstream gas industries (petrochemical complex and chemical fertilizer) using natural gas to be imported from Myanmar			• ethylene base 600,000 tons/year • chemical fertilizer 1 million tons/year

Source: Study Team

STEP 2: Increase in labor productivity

According to a report by the Thailand Development Research Institute (TDRI), manufacturing labor productivity corresponds to 51 per cent of the increase in gross manufacturing domestic product (GMDP). Based on this estimate by TDRI, labor productivity (GPMP per worker) has been assumed to increase annually at 50 per cent of the increase in GPMP up to 2011.

STEP 3: New industries/new factories in Case 1

Based on past data as shown in Table 7.5.3, subsectoral changes in the GPMP structure of the WSB region have been presumed as summarized below.

- decreasing shares of the food, beverage, and tobacco industry corresponding to relatively high growth of other subsectors;
- increasing shares of the textiles, paper and paper products, and non-metallic mineral products subsectors;
- emergence of basic metal industry, i.e., steel complex; and
- less impact of subsectors other than the above on structural changes in GPMP in the WSB region.

Case 1 (base line or trend scenario) should reflect the overall past trend. In addition, the following recent development have been taken into account:

- A large home electrical appliance maker expressed its wish to locate a new factory in the WSB region. The machinery and equipment industry, which comprises general machinery, electrical and electronic equipment, transport equipment, and precision instruments, will be among the main new industries, especially in the Upper WSB, and will be located in industrial estates.
- Local demand-oriented industries, which comprise bakery products, dairy products, wood products, furniture, and fabricated metal products, will locate new factories in line with macroeconomic growth and increases in income.
- Relocation or industrial spillover from the BMR will become relatively active, especially in the Upper WSB.
- Land-intensive industries will locate factories in the region; these industries will include fabricated metal product, casting, and construction materials.
- Water-intensive industries producing beverages, paper (pulp), dyes, and some chemicals will locate their factories in the Upper WSB.

Table 7.5.3 Structural Changes in the Manufacturing Industries of the WSB Region

TSIC (million Baht in constant 1988 prices)	1981	1982	1983	1984	1985	1986	1987
Total	6,413	8,185	7,409	8,308	8,142	9,340	9,906
311-4 Food, Beverage and Tobacco	4,392	6,051	5,078	5,764	5,734	6,467	6,718
321 Textiles	146	154	183	193	344	427	470
322 Wearing Apparel	3	3	3	2	3	3	3
331-2 Wood, Wood Products and Furniture	283	314	239	248	253	249	252
323-4 Leather, Leather Products and Footwear	12	11	15	16	16	19	28
341 Paper and Paper Products	857	846	898	963	724	823	917
342 Printing and Publishing	7	9	8	9	9	9	10
351-4 Chemical and Petroleum Products	42	43	48	47	43	69	74
355-6 Rubber and Plastic Products	39	46	68	68	87	117	135
361-9 Non-Metallic Mineral Products	330	372	399	441	409	476	488
371-2 Basic Metal Products	0	0	0	0	0	0	0
381 Fabricated Metal Products	17	18	23	23	25	34	35
382-5 Machinery and Equipment	53	42	70	52	47	51	59
390 Other Manufacturing Industries	232	276	372	484	448	596	717
(% Shares of the Total)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
311-4 Food, Beverage and Tobacco	68.48	73.93	68.54	69.37	70.43	69.23	67.82
321 Textiles	2.28	1.88	2.54	2.32	4.22	4.58	4.74
322 Wearing Apparel	0.05	0.04	0.04	0.03	0.03	0.04	0.03
331-2 Wood, Wood Products and Furniture	4.42	3.83	3.22	2.99	3.11	2.66	2.55
323-4 Leather, Leather Products and Footwear	0.19	0.14	0.20	0.20	0.19	0.21	0.29
341 Paper and Paper Products	13.36	10.33	12.12	11.60	8.90	8.81	9.26
342 Printing and Publishing	0.11	0.11	0.11	0.10	0.11	0.10	0.10
351-4 Chemical and Petroleum Products	0.65	0.53	0.65	0.57	0.53	0.74	0.74
355-6 Rubber and Plastic Products	0.61	0.56	0.92	0.81	1.06	1.26	1.36
361-9 Non-Metallic Mineral Products	5.15	4.55	5.38	5.30	5.03	5.10	4.93
371-2 Basic Metal Products	0.00	0.00	0.00	0.00	0.00	0.00	0.00
381 Fabricated Metal Products	0.26	0.22	0.31	0.27	0.31	0.36	0.35
382-5 Machinery and Equipment	0.83	0.51	0.95	0.63	0.57	0.54	0.59
390 Other Manufacturing Industries	3.61	3.37	5.02	5.82	5.51	6.38	7.24
TSIC (million Baht in 1988 constant price)	1988	1989	1990	1991	1992	1993	1994
Total	11,275	13,810	14,084	16,209	24,220	25,167	28,425
311-4 Food, Beverage and Tobacco	7,212	8,931	8,377	9,661	11,824	11,253	12,457
321 Textiles	784	1,162	1,106	1,163	3,388	3,308	3,598
322 Wearing Apparel	3	3	4	4	5	4	5
331-2 Wood, Wood Products and Furniture	271	369	483	415	432	381	419
323-4 Leather, Leather Products and Footwear	37	43	54	59	62	70	81
341 Paper and Paper Products	949	1,174	1,443	1,685	3,830	4,582	5,409
342 Printing and Publishing	11	14	15	17	19	22	24
351-4 Chemical and Petroleum Products	99	111	123	133	151	60	70
355-6 Rubber and Plastic Products	149	159	190	219	646	760	772
361-9 Non-Metallic Mineral Products	623	803	964	1,059	1,692	2,119	2,398
371-2 Basic Metal Products	0	0	3	139	172	200	242
381 Fabricated Metal Products	33	40	47	65	81	103	124
382-5 Machinery and Equipment	72	83	96	111	128	158	185
390 Other Manufacturing Industries	1,032	919	1,179	1,480	1,790	2,146	2,642
(% Shares of the Total)	100.00	100.00	100.00	100.00	100.00	100.00	100.00
311-4 Food, Beverage and Tobacco	63.96	64.67	59.48	59.60	48.82	44.71	43.82
321 Textiles	6.96	8.41	7.85	7.17	13.93	13.14	12.66
322 Wearing Apparel	0.03	0.02	0.03	0.03	0.02	0.02	0.02
331-2 Wood, Wood Products and Furniture	2.40	2.67	3.43	2.56	1.78	1.51	1.47
323-4 Leather, Leather Products and Footwear	0.33	0.31	0.38	0.36	0.26	0.28	0.29
341 Paper and Paper Products	8.42	8.50	10.25	10.39	15.81	18.21	19.03
342 Printing and Publishing	0.10	0.10	0.11	0.10	0.08	0.09	0.08
351-4 Chemical and Petroleum Products	0.88	0.80	0.88	0.82	0.62	0.24	0.25
355-6 Rubber and Plastic Products	1.32	1.15	1.35	1.35	2.67	3.02	2.72
361-9 Non-Metallic Mineral Products	5.52	5.82	6.84	6.53	6.98	8.42	8.43
371-2 Basic Metal Products	0.00	0.00	0.02	0.86	0.71	0.79	0.85
381 Fabricated Metal Products	0.30	0.29	0.33	0.40	0.34	0.41	0.43
382-5 Machinery and Equipment	0.64	0.60	0.68	0.68	0.53	0.63	0.65
390 Other Manufacturing Industries	9.16	6.65	8.37	9.13	7.39	8.53	9.29

Source: NESDB

STEP 4: New industries/ factories in Cases 2 and 3

New industries in Cases 2 and 3, some of which are shown in Table 7.5.2, have been selected in light of various factors/strategies by scenario, and locational characteristics of the industries, focusing on regional comparative advantages of the WSB region (e.g., seaport, airport, and free trade area) and their growth potentials.

Special projects have been included in Cases 2 and 3. In Case 2, a steel complex, downstream-related industries, and other industries to be located in the Bang Saphan area including an industrial estate as shown in Table 7.5.4, would generate a total of 53.3 to 75.5 billion Baht of GPMP in 2011 (refer to the JICA-sponsored Feasibility Study on Bang Saphan Industrial Estate). Likewise, a petrochemical complex and a chemical fertilizer factory in Case 3 would produce an additional 14.1 billion Baht of GPMP.

Table 7.5.4 GPMP of Special Projects in Case 2 and 3 (2011)

Unit: (million Baht in constant 1994 prices)	Bang Saphan		Petrochemicals & Fertilizer
	Minimum Case	Maximum Case	
TSIC Total	53,394	75,469	14,106
311-4 Food, Beverage and Tobacco	681	1,042	
321 Textiles	154	154	
322 Wearing Apparel			
323-4 Leather, Leather Products and Footwear			
331-2 Wood, Wood Products and Furniture	180	317	
341 Paper and Paper Products	72	246	
342 Printing and Publishing			
351-4 Chemical and Petroleum Products	3,698	4,763	14,106
355-6 Rubber and Plastic Products			
361-9 Non-Metallic Mineral Products	1,792	3,081	
371-2 Basic Metal Products	43,146	59,223	
381 Fabricated Metal Products			
382-5 Machinery and Equipment	3,671	6,643	
390 Other Manufacturing Industries			

Source: Bang Saphan (Feasibility Study on Bang Saphan Industrial Estate(JICA/IEAT))
Petrochemicals and fertilizer--Study Team

Meanwhile, Tables 7.5.5 to 7.5.9 present detailed data/information on the development frameworks by scenario; i.e., Table 7.5.5 indicates manufacturing GPP by development scenario, Table 7.5.6 indicates manufacturing employment by development scenario, and Tables 7.5.7 to 7.5.9 illustrate the WSB's manufacturing development framework (Cases 1 to 3).

Table 7.5.5

Manufacturing GPP by Development Scenario

Unit: (million Baht in constant in 1994 constant prices)	Gross Provincial Manufacturing Product				Growth Rate/Year		
	Y 1994	Y 2011			Case 1	Case 2	Case 3
		Case 1	Case 2	Case 3			
TSIC Total	32,451	136,098	208,535	294,959	8.8%	11.6%	13.9%
311-4 Food, Beverage and Tobacco	14,837	45,449	56,599	69,375	6.8%	8.2%	9.5%
321 Textiles	3,382	14,768	14,922	14,922	9.1%	9.1%	9.1%
322 Wearing Apparel	7	24	24	29	7.5%	7.5%	8.7%
323-4 Leather, Leather Products and Footwear	120	551	551	778	9.4%	9.4%	11.6%
331-2 Wood, Wood Products and Furniture	735	2,414	3,980	3,759	7.2%	10.4%	10.1%
341 Paper and Paper Products	5,665	19,508	19,580	21,736	7.5%	7.6%	8.2%
342 Printing and Publishing	27	161	161	161	11.1%	11.1%	11.1%
351-4 Chemical and Petroleum Products	67	1,448	5,146	21,371	19.8%	29.1%	40.4%
355-6 Rubber and Plastic Products	921	5,131	5,131	5,953	10.6%	10.6%	11.6%
361-9 Non-Metallic Mineral Products	2,923	11,650	14,651	18,358	8.5%	9.9%	11.4%
371-2 Basic Metal Products	279	4,670	47,816	68,903	18.0%	35.3%	38.3%
381 Fabricated Metal Products	143	1,739	2,949	8,999	15.8%	19.5%	27.6%
382-5 Machinery and Equipment	218	17,998	25,151	44,882	29.8%	32.2%	38.8%
390 Other Manufacturing Industries	3,123	10,587	11,874	15,733	7.4%	8.2%	10.0%

	% Shares of Total (composition)				Changes in Shares from 1994		
	1,994	2011			Case 1	Case 2	Case 3
		Case 1	Case 2	Case 3			
Total	100.0	100.0	100.0	100.0			
311-4 Food, Beverage and Tobacco	45.7	33.4	27.1	23.5	-12.3	-18.6	-22.2
321 Textiles	10.4	10.9	7.2	5.1	0.4	-3.3	-5.4
322 Wearing Apparel	0.0	0.0	0.0	0.0			
323-4 Leather, leather Products and Footwear	0.4	0.4	0.3	0.3	0.0	-0.1	-0.1
331-2 Wood, Wood Products and Furniture	2.3	1.8	1.9	1.3	-0.5	-0.4	-1.0
341 Paper and Paper Products	17.5	14.3	9.4	7.4	-3.1	-8.1	-10.1
342 Printing and Publishing	0.1	0.1	0.1	0.1	0.0		
351-4 Chemical and Petroleum Products	0.2	1.1	2.5	7.2	0.9	2.3	7.0
355-6 Rubber and Plastic Products	2.8	3.8	2.5	2.0	0.9	-0.4	-0.8
361-9 Non-Metallic Mineral Products	9.0	8.6	7.0	6.2	-0.4	-2.0	-2.8
371-2 Basic Metal Products	0.9	3.4	22.9	23.4	2.6	22.1	22.5
381 Fabricated Metal Products	0.4	1.3	1.4	3.1	0.8	1.0	2.6
382-5 Machinery and Equipment	0.7	13.2	12.1	15.2	12.6	11.4	14.5
390 Other Manufacturing Industries	9.6	7.8	5.7	5.3	-1.8	-3.9	-4.3

Source: Study Team

5.3 Optimum Development Scenario

Three scenarios/frameworks for manufacturing development have been comparatively evaluated. Conclusively, Case 2 is the best in consideration of its possibility, consistency with the development vision for the WSB, and impacts on the environment and relevant infrastructure development.

Table 7.5.6 Manufacturing Employment by Development Scenario

Unit: persons	Manufacturing Employment (persons)				Growth Rate/Year (1995-2011)		
	1994	2011			Case 1	Case 2	Case 3
TSIC Total	234,794	433,728	535,110	717,758	3.7%	5.0%	6.8%
311-4 Food, Beverage and Tobacco	152,692	228,971	268,095	326,168	2.4%	3.4%	4.6%
321 Textiles	11,491	28,114	28,499	28,499	5.4%	5.5%	5.5%
322 Wearing Apparel	278	368	368	400	1.7%	1.7%	2.2%
323-4 Leather, Leather Products and Footwear	555	1,203	1,203	1,698	4.7%	4.7%	6.8%
331-2 Wood, Wood Products and Furniture	10,301	15,997	26,375	24,911	2.6%	5.7%	5.3%
341 Paper and Paper Products	2,412	11,388	11,583	17,410	9.6%	9.7%	12.3%
342 Printing and Publishing	593	1,536	1,536	1,536	5.8%	5.8%	5.8%
351-4 Chemical and Products	1,172	5,297	12,403	43,581	9.3%	14.9%	23.7%
355-6 Rubber and Plastic Products	9,594	25,288	25,288	29,340	5.9%	5.9%	6.8%
361-9 Non-Metallic Mineral Products	14,116	28,272	37,177	48,177	4.2%	5.9%	7.5%
371-2 Basic Metal Products	729	4,898	19,625	27,112	11.9%	21.4%	23.7%
381 Fabricated Metal Products	2,577	8,199	11,888	30,333	7.0%	9.4%	15.6%
382-5 Machinery and Equipment	9,314	42,968	55,742	90,975	9.4%	11.1%	14.3%
390 Other Manufacturing Industries	18,970	31,229	35,328	47,618	3.0%	3.7%	5.6%

Unit: persons	% Shares of Total (composition)				Incremental Employment from 1994		
	1994	2011			Case 1	Case 2	Case 3
TSIC Total	100.0	100.0	100.0	100.0	198,934	300,316	482,964
311-4 Food, Beverage and Tobacco	65.0	52.8	50.1	45.4	76,279	115,403	173,476
321 Textiles	4.9	6.5	5.3	4.0	16,623	17,008	17,008
322 Wearing Apparel	0.1	0.1	0.1	0.1	90	90	122
323-4 Leather, Leather Products and Footwear	0.2	0.3	0.2	0.2	648	648	1,143
331-2 Wood, Wood Products and Furniture	4.4	3.7	4.9	3.5	5,696	16,074	14,610
341 Paper and Paper Products	1.0	2.6	2.2	2.4	8,976	9,171	14,998
342 Printing and Publishing	0.3	0.4	0.3	0.2	943	943	943
351-4 Chemical and Products	0.5	1.2	2.3	6.1	4,125	11,231	42,409
355-6 Rubber and Plastic Products	4.1	5.8	4.7	4.1	15,694	15,694	19,746
361-9 Non-Metallic Mineral Products	6.0	6.5	6.9	6.7	14,156	23,061	34,061
371-2 Basic Metal Products	0.3	1.1	3.7	3.8	4,169	18,896	26,383
381 Fabricated Metal Products	1.1	1.9	2.2	4.2	5,622	9,311	27,756
382-5 Machinery and Equipment	4.0	9.9	10.4	12.7	33,654	46,428	81,661
390 Other Manufacturing Industries	8.1	7.2	6.6	6.6	12,259	16,358	28,648

Source: Study Team

• Possibilities

Case 1 is the easiest case for attaining average annual industrial growth of 8.8 per cent. The Eighth Plan (1997-2011) has a target of 8.0 per cent growth of national GDP while Thailand Vision 2020 envisages 7.0 per cent growth of the Thai economy from 2011 to 2020.

Table 7.5.7 Manufacturing Development Framework in the WSB (Case 1)

Unit: (million Baht in constant 1994 prices)	1994	2011			Growth Rate/Year		% Shares	
		Existing	New	Total	Existing	Total	1994	2011
TSIC Total	32,451	88,332	47,766	136,098	6.1%	8.8%	100.0	100.0
311-4 Food, Beverage and Tobacco	14,837	34,007	11,442	45,449	5.0%	6.8%	45.7	33.4
321 Textiles	3,382	9,867	4,901	14,768	6.5%	9.1%	10.4	10.9
322 Wearing Apparel	7	19	5	24	6.0%	7.5%	0.0	0.0
323-4 Leather, Leather Products and Footwear	120	324	227	551	6.0%	9.4%	0.4	0.4
331-2 Wood, Wood Products and Furniture	735	1,386	1,028	2,414	3.8%	7.2%	2.3	1.8
341 Paper and Paper Products	5,665	16,526	2,982	19,508	6.5%	7.5%	17.5	14.3
342 Printing and Publishing	27	137	24	161	10.0%	11.1%	0.1	0.1
351-4 Chemical and Petroleum Product	67	394	1,054	1,448	11.0%	19.8%	0.2	1.1
355-6 Rubber and Plastic Products	921	4,309	822	5,131	9.5%	10.6%	2.8	3.8
361-9 Non-Metallic Mineral Products	2,923	9,232	2,418	11,650	7.0%	8.5%	9.0	8.6
371-2 Basic Metal Products	279	3,000	1,670	4,670	15.0%	18.0%	0.9	3.4
381 Fabricated Metal Products	143	529	1,210	1,739	8.0%	15.8%	0.4	1.3
382-5 Machinery and Equipment	218	588	17,410	17,998	6.0%	29.6%	0.7	13.2
390 Other Manufacturing Industries	3,123	8,014	2,573	10,587	5.7%	7.4%	9.6	7.8

Unit: (million Baht in constant 1994 prices)	(1) Employment		(2) GPMP/Worker		(3) Growth Rate/Year		% Shares of Employment	
	1994	2011	1994	2011	(1)	(2)	1994	2011
TSIC Total	234,794	433,728	138.2	313.8	3.7%	4.9%	100.0	100.0
311-4 Food, Beverage and Tobacco	152,692	228,971	97.2	198.5	2.4%	4.3%	65.0	52.8
321 Textiles	11,491	28,114	294.3	525.3	5.4%	3.5%	4.9	6.5
322 Wearing Apparel	278	368	25.2	65.2	1.7%	5.8%	0.1	0.1
323-4 Leather, Leather Products and Footwear	555	1,203	216.2	458.0	4.7%	4.5%	0.2	0.3
331-2 Wood, Wood Products and Furniture	10,301	15,997	71.4	150.9	2.6%	4.5%	4.4	3.7
341 Paper and Paper Products	2,412	11,388	2,348.7	1,713.0	9.6%	-1.8%	1.0	2.6
342 Printing and Publishing	593	1,536	45.5	104.8	5.6%	5.0%	0.3	0.4
351-4 Chemical and Petroleum Product	1,172	5,297	57.2	273.4	9.3%	9.6%	0.5	1.2
355-6 Rubber and Plastic Products	9,594	25,288	96.0	202.9	5.9%	4.5%	4.1	5.8
361-9 Non-Metallic Mineral Products	14,116	28,272	207.1	412.1	4.2%	4.1%	6.0	6.5
371-2 Basic Metal Products	729	4,898	382.7	953.5	11.9%	5.5%	0.3	1.1
381 Fabricated Metal Products	2,577	8,199	55.5	212.1	7.0%	8.2%	1.1	1.9
382-5 Machinery and Equipment	9,314	42,968	23.4	418.9	9.4%	18.5%	4.0	9.9
390 Other Manufacturing Industries	18,970	31,229	164.6	339.0	3.0%	4.3%	8.1	7.2

Source: Study Team

Considering these national growth rates, the role of the manufacturing sector in leading the Thai economy, and the growth of manufacturing GPP in the WSB at a rate more rapid than that of the country, 8.8 per cent growth of the manufacturing industry is deemed feasible.

Case 2 has also been evaluated to be feasible, mainly because a steel complex together with downstream and related industries would be promoted in the WSB region by the private initiative of an industrial group.

Table 7.5.8 Manufacturing Development Framework in the WSB (Case 2)

Unit: (million Baht in constant 1994 prices)	1994	2011			Growth Rate/Year		% Shares	
		Existing	New	Total	Existing	Total	1994	2011
TSIC Total	32,451	88,332	120,203	208,535	8.1%	11.6%	100.0	100.0
311-4 Food, Beverage and Tobacco	14,837	34,007	22,592	56,599	5.0%	8.2%	45.7	27.1
321 Textiles	3,382	9,867	5,055	14,922	6.5%	9.1%	10.4	7.2
322 Wearing Apparel	7	19	5	24	6.0%	7.5%	0.0	0.0
323-4 Leather, Leather Products and Footwear	120	324	227	551	6.0%	9.4%	0.4	0.3
331-2 Wood, Wood Products and Furniture	735	1,386	2,594	3,980	3.8%	10.4%	2.3	1.9
341 Paper and Paper Products	5,665	16,526	3,054	19,580	6.5%	7.6%	17.5	9.4
342 Printing and Publishing	27	137	24	161	10.0%	11.1%	0.1	0.1
351-4 Chemical and Petroleum Product	67	394	4,752	5,146	11.0%	29.1%	0.2	2.5
355-6 Rubber and Plastic Products	921	4,309	822	5,131	9.5%	10.6%	2.8	2.5
361-9 Non-Metallic Mineral Products	2,923	9,232	5,419	14,651	7.0%	9.9%	9.0	7.0
371-2 Basic Metal Products	279	3,000	44,816	47,816	15.0%	35.3%	0.9	22.9
381 Fabricated Metal Products	143	529	2,420	2,949	8.0%	19.5%	0.4	1.4
382-5 Machinery and Equipment	218	588	24,563	25,151	6.0%	32.2%	0.7	12.1
390 Other Manufacturing Industries	3,123	8,014	3,860	11,874	5.7%	8.2%	9.6	5.7

Unit: (million Baht in constant 1994 prices)	(1) Employment		(2) GPMP/Worker		(3) Growth Rate/Year		% Shares of Employment	
	1994	2011	1994	2011	(1)	(2)	1994	2011
TSIC Total	234,794	535,110	138.2	389.7	5.0%	6.3%	100.0	100.0
311-4 Food, Beverage and Tobacco	152,692	268,095	97.2	211.1	3.4%	4.7%	65.0	50.1
321 Textiles	11,491	28,499	294.3	523.6	5.5%	3.4%	4.9	5.3
322 Wearing Apparel	278	368	25.2	65.2	1.7%	5.8%	0.1	0.1
323-4 Leather, Leather Products and Footwear	555	1,203	216.2	458.0	4.7%	4.5%	0.2	0.2
331-2 Wood, Wood Products and Furniture	10,301	26,375	71.4	150.9	5.7%	4.5%	4.4	4.9
341 Paper and Paper Products	2,412	11,583	2,348.7	1,690.4	9.7%	-1.9%	1.0	2.2
342 Printing and Publishing	593	1,536	45.5	104.8	5.8%	5.0%	0.3	0.3
351-4 Chemical and Petroleum Product	1,172	12,403	57.2	414.9	14.9%	12.4%	0.5	2.3
355-6 Rubber and Plastic Products	9,594	25,288	96.0	202.9	5.9%	4.5%	4.1	4.7
361-9 Non-Metallic Mineral Products	14,116	37,177	207.1	394.1	5.9%	3.9%	6.0	6.9
371-2 Basic Metal Products	729	19,625	382.7	2,436.5	21.4%	11.5%	0.3	3.7
381 Fabricated Metal Products	2,577	11,888	55.5	248.1	9.4%	9.2%	1.1	2.2
382-5 Machinery and Equipment	9,314	55,742	23.4	451.2	11.1%	19.0%	4.0	10.4
390 Other Manufacturing Industries	18,970	35,328	164.6	336.1	3.7%	4.3%	8.1	6.6

Source: Study Team

Further, Case 2 is attainable and reasonable from a macroeconomic point of view. As shown in Table 7.5.8, the total employment in the region's manufacturing sector is forecast to reach around 535,000 workers in 2011. The macroeconomic projections in the Study Report-Volume 3 indicated that employment in the WSB industrial sector, including mining and quarrying, construction, and electricity and water supply other than manufacturing, would reach approximately 802,000 in 2011 under the Moderate Development Scenario. The manufacturing employment forecast would account for an estimated 69 per cent of the industrial employment in the region. GPMP/value added per worker in the WSB manufacturing sector is expected to grow from 138,000 Baht in 1994 to 380,000 Baht in

2011, with an average growth rate of around 6.1 per cent per annum. Judging from the above assessment of employment, value added, and labor productivity in the manufacturing sector, Case 2 may be considered attainable and a reasonable framework on which to base regional planning.

Table 7.5.9 Manufacturing Development Framework in the WSB (Case 3)

Unit: (million Baht in constant 1994 prices)	1994	2011			Growth Rate/Year		% Shares	
		Existing	New	Total	Existing	Total	1994	2011
TSIC Total	32,451	88,332	206,627	294,959	6.1%	13.9%	100.0	100.0
311-4 Food, Beverage and Tobacco	14,837	34,007	35,368	69,375	5.0%	9.5%	45.7	23.5
321 Textiles	3,382	9,867	5,055	14,922	6.5%	9.1%	10.4	5.1
322 Wearing Apparel	7	19	10	29	6.0%	8.7%	0.0	0.0
323-4 Leather, Leather Products and Footwear	120	324	454	778	6.0%	11.6%	0.4	0.3
331-2 Wood, Wood Products and Furniture	735	1,386	2,373	3,759	3.8%	10.1%	2.3	1.3
341 Paper and Paper Products	5,665	16,526	5,210	21,736	6.5%	8.2%	17.5	7.4
342 Printing and Publishing	27	137	24	161	10.0%	11.1%	0.1	0.1
351-4 Chemical and Petroleum Product	67	394	20,977	21,371	11.0%	40.4%	0.2	7.2
355-6 Rubber and Plastic Products	921	4,309	1,644	5,953	9.5%	11.6%	2.8	2.0
361-9 Non-Metallic Mineral Products	2,923	9,232	9,126	18,358	7.0%	11.4%	9.0	6.2
371-2 Basic Metal Products	279	3,000	65,903	68,903	15.0%	38.3%	0.9	23.4
381 Fabricated Metal Products	143	529	8,470	8,999	8.0%	27.6%	0.4	3.1
382-5 Machinery and Equipment	218	588	44,294	44,882	6.0%	38.8%	0.7	15.2
390 Other Manufacturing Industries	3,123	8,014	7,719	15,733	5.7%	10.0%	9.6	5.3

Unit: (million Baht in constant 1994 prices)	(1) Employment		(2) GPMP/Worker		(3) Growth Rate/Year		% Shares of Employment	
	1994	2011	1994	2011	(1)	(2)	1994	2011
TSIC Total	234,794	717,758	138.2	410.9	6.8%	6.6%	100.0	100.0
311-4 Food, Beverage and Tobacco	152,692	326,168	97.2	212.7	4.6%	4.7%	65.0	45.4
321 Textiles	11,491	28,499	294.3	523.6	5.5%	3.4%	4.9	4.0
322 Wearing Apparel	278	400	25.2	72.5	2.2%	6.4%	0.1	0.1
323-4 Leather, Leather Products and Footwear	555	1,698	216.2	458.2	6.8%	4.5%	0.2	0.2
331-2 Wood, Wood Products and Furniture	10,301	24,911	71.4	150.9	5.3%	4.5%	4.4	3.5
341 Paper and Paper Products	2,412	17,410	2,348.7	1,248.5	12.3%	-3.6%	1.0	2.4
342 Printing and Publishing	593	1,536	45.5	104.8	5.8%	5.0%	0.3	0.2
351-4 Chemical and Petroleum Product	1,172	43,581	57.2	490.4	23.7%	13.5%	0.5	6.1
355-6 Rubber and Plastic Products	9,594	29,340	96.0	202.9	6.8%	4.5%	4.1	4.1
361-9 Non-Metallic Mineral Products	14,116	48,177	207.1	381.1	7.5%	3.7%	6.0	6.7
371-2 Basic Metal Products	729	27,112	382.7	2,541.4	23.7%	11.8%	0.3	3.8
381 Fabricated Metal Products	2,577	30,333	55.5	296.7	15.6%	10.4%	1.1	4.2
382-5 Machinery and Equipment	9,314	90,975	23.4	493.3	14.3%	19.6%	4.0	12.7
390 Other Manufacturing Industries	18,970	47,618	164.6	330.4	5.6%	4.2%	8.1	6.6

Source: Study Team

Case 3 is less feasible, mainly because utilization of natural gas imported from Myanmar as raw material for manufacturing industries appears to be economically less attractive. (Refer to Appendix I)

- **Consistency with the WSB's development vision**

Cases 2 and 3 reflect strategies and development efforts conducive to the development vision of the WSB (Gateway 21 or ISO 2011 [integration through segmentation and open-ports] and a world-class quality zone).

- **Impacts on environment and relevant infrastructure development**

Case 3 will require around 718,000 workers with a larger development effect in terms of employment generation. With this number of manufacturing workers, the total population of the region would exceed 3.3 million in 2011. Assuming that one worker would support 1.5 other family members, the manufacturing population would reach 1.79 million, which would represent 54 per cent of the total regional population. Therefore, this case is too heavy industry-oriented and may be less realistic.

Further, Case 3 would require development of additional industrial land with a total area of some 2,568 hectares or 16,050 rai, while Case 2 would require 1,189 hectares likewise excluding a total 1,157 hectares of already planned land development as shown in Table 7.5.2. This land demand has been estimated based on the required number of incremental workers in the modern sector mainly comprising cottage/household manufacturing, of which the demand for land is in general minimal. The additional development of 2,568 hectares or 16,050 rai in Case 3 may not be desirable from the viewpoint of possible negative impacts on agricultural land and the natural environment.

Furthermore, downstream gas industries in Case 3 would inevitably require costly infrastructure development. In fact, there are regional advantages and disadvantages for the WSB region to attract such industries around the power plant site in Ratchaburi, as follows:

- **Advantages**
 - 1) good access to the raw material/natural gas pipelined from Myanmar to Ratchaburi,
 - 2) proximity to the power plant,
 - 3) relatively cheap land price,
 - 4) availability of water, and
 - 5) easier access to large markets such as the BMR and Myanmar.
- **Disadvantages**
 - 1) distance to and from seaport for export/import,
 - 2) longer access to domestic market except for Bangkok, and
 - 3) huge investment costs for infrastructure development.

The most serious disadvantage of downstream gas industries in Ratchaburi is their high cost; if the petrochemicals and fertilizers industry must bear this cost, their competitiveness in the market will be weakened too much.

On the other hand, Case 2 is considered reasonable. The number of manufacturing workers in 2011 in this case would be around 535,000. Again if one worker supports 1.5 other family members, the manufacturing population would be 1.34 million, which would account for 41 per cent of the total regional population, a reasonable share.

In terms of land demand, Case 2 would require additional industrial estates with a total area of about 1,189 hectares or 7,288 rai. This size of land development is likely within the development capacity of the WSB region.

In conclusion, through the above comparative assessment, the Case 2 scenario is considered the optimum among the three scenarios.

5.4 Development Framework by Phase and by Province

Among the three industrial development scenarios presented in the previous section, Case 2 was considered the optimum one. Based on Case 2, this section will indicate development framework by phase and by province, including land demand by the modern sector.

(1) Development Framework by Phase

Gross provincial manufacturing product (GPMP)

Table 7.5.10 shows GPMP in the WSB region by the end year of each phase. The total GPMP will grow at an annual average rate of 14.1 per cent from 1994 to 2001, 9.8 per cent between 2001 and 2006, and 9.8 per cent in 2006-2011.

The large growth of Phase I (1997-2011) is due mainly to the first expansion of the Bang Saphan project including a steel mill complex and relevant industrial development. The GPMP of basic metal products is expected to increase at a rapid rate, accounting for 13.1 per cent of the total GPMP in 2011. The machinery and equipment industry will also grow rapidly to account for 10.2 per cent of the total GPMP.

Table 7.5.10 Gross Provincial Manufacturing Product (GPMP) in The WSB by Year

1. Manufacturing Total

(in constant 1994 prices)		GPMP (million Baht)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
TSIC	Total	32,451	81,871	130,763	208,535	100.0	100.0	100.0	100.0
311-4	Food, Beverage and Tobacco	14,837	28,243	39,583	56,599	45.7	34.5	30.3	27.1
321	Textiles	3,382	6,890	10,469	14,922	10.4	8.4	8.0	7.2
322	Wearing Apparel	7	13	17	24	0.0	0.0	0.0	0.0
323-4	Leather, leather Products and Footwear	120	257	393	551	0.4	0.3	0.3	0.3
331-2	Wood, Wood Products and Furniture	735	1,838	2,685	3,980	2.3	2.2	2.1	1.9
341	Paper and Paper Products	5,665	9,798	13,553	19,580	17.5	12.0	10.4	9.4
342	Printing and Publishing	27	61	99	161	0.1	0.1	0.1	0.1
351-4	Chemical and Petroleum Products	67	722	1,132	5,146	0.2	0.9	0.9	2.5
355-6	Rubber and Plastic Products	921	2,013	3,285	5,131	2.8	2.5	2.5	2.5
361-9	Non-Metallic Mineral Products	2,923	6,033	9,070	14,651	9.0	7.4	6.9	7.0
371-2	Basic Metal Products	279	10,735	26,232	47,816	0.9	13.1	20.1	22.9
381	Fabricated Metal Products	143	1,052	1,973	2,949	0.4	1.3	1.5	1.4
382-5	Machinery and Equipment	218	8,325	13,625	25,151	0.7	10.2	10.4	12.1
390	Other Manufacturing Industries	3,123	5,891	8,647	11,874	9.6	7.2	6.6	5.7

2. Existing Industries

(in constant 1994 prices)		GPMP (million Baht)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
TSIC	Total	32,451	48,627	65,318	88,332	100.0	100.0	100.0	100.0
311-4	Food, Beverage and Tobacco	14,837	20,877	26,645	34,007	45.7	42.9	40.8	38.5
321	Textiles	3,382	5,256	7,202	9,867	10.4	10.8	11.0	11.2
322	Wearing Apparel	7	11	14	19	0.0	0.0	0.0	0.0
323-4	Leather, leather Products and Footwear	120	181	242	324	0.4	0.4	0.4	0.4
331-2	Wood, Wood Products and Furniture	735	955	1,150	1,386	2.3	2.0	1.8	1.6
341	Paper and Paper Products	5,665	8,804	12,062	16,526	17.5	18.1	18.5	18.7
342	Printing and Publishing	27	53	85	137	0.1	0.1	0.1	0.2
351-4	Chemical and Petroleum Products	67	139	234	394	0.2	0.3	0.4	0.4
355-6	Rubber and Plastic Products	921	1,739	2,737	4,309	2.8	3.6	4.2	4.9
361-9	Non-Metallic Mineral Products	2,923	4,693	6,582	9,232	9.0	9.7	10.1	10.5
371-2	Basic Metal Products	279	742	1,492	3,000	0.9	1.5	2.3	3.4
381	Fabricated Metal Products	143	245	360	529	0.4	0.5	0.6	0.6
382-5	Machinery and Equipment	218	328	439	588	0.7	0.7	0.7	0.7
390	Other Manufacturing Industries	3,123	4,604	6,074	8,014	9.6	9.5	9.3	9.1

3. New Industries

(in constant 1994 prices)		GPMP (million Baht)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
TSIC	Total		33,244	65,445	120,203		100.0	100.0	100.0
311-4	Food, Beverage and Tobacco		7,366	12,938	22,592		22.2	19.8	18.8
321	Textiles		1,634	3,267	5,055		4.9	5.0	4.2
322	Wearing Apparel		2	3	5		0.0	0.0	0.0
323-4	Leather, leather Products and Footwear		76	151	227		0.2	0.2	0.2
331-2	Wood, Wood Products and Furniture		883	1,535	2,594		2.7	2.3	2.2
341	Paper and Paper Products		994	1,491	3,054		3.0	2.3	2.5
342	Printing and Publishing		8	14	24		0.0	0.0	0.0
351-4	Chemical and Petroleum Products		583	898	4,752		1.8	1.4	4.0
355-6	Rubber and Plastic Products		274	548	822		0.8	0.8	0.7
361-9	Non-Metallic Mineral Products		1,340	2,488	5,419		4.0	3.8	4.5
371-2	Basic Metal Products		9,993	24,740	44,816		30.1	37.8	37.3
381	Fabricated Metal Products		807	1,613	2,420		2.4	2.5	2.0
382-5	Machinery and Equipment		7,997	13,186	24,563		24.1	20.1	20.4
390	Other Manufacturing Industries		1,287	2,573	3,860		3.9	3.9	3.2

Note: "Existing industries" were industries/factories located as of the end of 1994.

Source: Study Team

During Phases II (2001-2006) and III (2006-2011), the basic metal industry as well as the machinery and equipment industry will be main sectors leading to the growth of GPMP, the former will constitute around 37 per cent of the total GPMP produced by the new industries/factories to be established during the above phases, while the latter will account for around 20 per cent of the total. In addition to these industries, the food, beverage and tobacco industry will also be active, accounting for around 19 per cent of the total "new" GPMP in the WSB region.

Manufacturing employment

The growth of GPMP will require an additional input of employment and therefore the number of workers will increase depending on the degree of GPMP growth and the labor productivity of each subsector. Workers in the food, beverage, and tobacco industry in the WSB region will continue to be dominant in number, with a forecast 209,664 in 2001, 234,788 in 2006, and 268,095 in 2011; however, the shares of these workers as a percentage of total manufacturing workers is expected to decrease from 65.0 per cent in 1994 to 50.1 per cent in 2011 as shown in Table 7.5.11. The machinery and equipment industry will be the second largest employer up to 2011, contributing to 17.0-18.5 per cent of the total workers to be employed by the new industries.

Modern sector and non-modern sector

New industries to be established up to 2011 will need factory sites, a main component of land demand. However, there are a sizable number of cottage/household manufacturing enterprises, most of which were not officially registered. These enterprises comprise what could be called the "non-modern sector," which are not typically counted in forecasting industrial land demand, but which are very important in terms not only of absorbing many workers, but also of promoting community-based rural development.

In 1994, there were 159,759 workers (68 per cent) in the WSB manufacturing non-modern sector and 75,035 (32 per cent) in the modern sector. The proportion employed in the modern sector is likely to increase due to the movement of industries to the region from the BMR and other regions. Also, the difference between the non-modern sector and the modern sector is likely to become increasingly less, since enterprise in the non-modern sector will grow, and then will be counted in the modern sector.

Table 7.5.11

Manufacturing Employment in the WSB by Year

1. Manufacturing Total

TSIC	Total	Employment (persons)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
		234,794	372,211	410,455	535,110	100.0	100.0	100.0	100.0
311-4	Food, Beverage and Tobacco	152,692	209,664	234,788	268,095	65.0	56.3	53.3	50.1
321	Textiles	11,491	19,463	24,605	28,499	4.9	5.2	5.6	5.3
322	Wearing Apparel	278	322	332	368	0.1	0.1	0.1	0.1
323-4	Leather, leather Products and Footwear	555	872	1,069	1,203	0.2	0.2	0.2	0.2
331-2	Wood, Wood Products and Furniture	10,301	18,909	22,171	26,375	4.4	5.1	5.0	4.9
341	Paper and Paper Products	2,412	6,925	8,050	11,583	1.0	1.9	1.8	2.2
342	Printing and Publishing	593	912	1,182	1,536	0.3	0.2	0.3	0.3
351-4	Chemical and Petroleum Products	1,172	3,534	4,572	12,403	0.5	0.9	1.0	2.3
355-6	Rubber and Plastic Products	9,594	15,401	20,178	25,288	4.1	4.1	4.6	4.7
361-9	Non-Metallic Mineral Products	14,116	22,829	27,942	37,177	6.0	6.1	6.3	6.9
371-2	Basic Metal Products	729	6,936	13,248	19,625	0.3	1.9	3.0	3.7
381	Fabricated Metal Products	2,577	7,066	9,954	11,888	1.1	1.9	2.3	2.2
382-5	Machinery and Equipment	9,314	32,459	40,399	55,742	4.0	8.7	9.2	10.4
390	Other Manufacturing Industries	18,970	26,919	31,965	35,328	8.1	7.2	7.3	6.6

2. Existing Industries

TSIC	Total	Employment (persons)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
		234,794	252,405	267,410	284,978	100.0	100.0	100.0	100.0
311-4	Food, Beverage and Tobacco	152,692	157,681	161,485	165,404	65.0	62.5	60.4	58.0
321	Textiles	11,491	13,120	14,427	15,861	4.9	5.2	5.4	5.6
322	Wearing Apparel	278	302	308	336	0.1	0.1	0.1	0.1
323-4	Leather, leather Products and Footwear	555	614	658	707	0.2	0.2	0.2	0.2
331-2	Wood, Wood Products and Furniture	10,301	9,825	9,496	9,185	4.4	3.9	3.6	3.2
341	Paper and Paper Products	2,412	2,754	3,028	3,329	1.0	1.1	1.1	1.2
342	Printing and Publishing	593	849	1,093	1,414	0.3	0.3	0.4	0.5
351-4	Chemical and Petroleum Products	1,172	1,794	2,422	3,272	0.5	0.7	0.9	1.1
355-6	Rubber and Plastic Products	9,594	13,305	16,812	21,237	4.1	5.3	6.3	7.5
361-9	Non-Metallic Mineral Products	14,116	16,654	18,741	21,097	6.0	6.6	7.0	7.4
371-2	Basic Metal Products	729	1,426	2,301	3,712	0.3	0.6	0.9	1.3
381	Fabricated Metal Products	2,577	3,245	3,826	4,510	1.1	1.3	1.4	1.6
382-5	Machinery and Equipment	9,314	10,282	11,058	11,879	4.0	4.1	4.1	4.2
390	Other Manufacturing Industries	18,970	20,554	21,755	23,035	8.1	8.1	8.1	8.1

3. New Industries

TSIC	Total	Employment (persons)				% Shares			
		1994	2001	2006	2011	1994	2001	2006	2011
			119,806	173,045	250,132		100.0	100.0	100.0
311-4	Food, Beverage and Tobacco		51,983	73,303	102,691		43.4	42.4	41.1
321	Textiles		6,343	10,178	12,638		5.3	5.9	5.1
322	Wearing Apparel		20	24	32		0.0	0.0	0.0
323-4	Leather, leather Products and Footwear		258	411	496		0.2	0.2	0.2
331-2	Wood, Wood Products and Furniture		9,084	12,675	17,190		7.6	7.3	6.9
341	Paper and Paper Products		4,171	5,022	8,254		3.5	2.9	3.3
342	Printing and Publishing		63	89	122		0.1	0.1	0.0
351-4	Chemical and Petroleum Products		1,740	2,150	9,131		1.5	1.2	3.7
355-6	Rubber and Plastic Products		2,096	3,366	4,051		1.7	1.9	1.6
361-9	Non-Metallic Mineral Products		6,175	9,201	16,080		5.2	5.3	6.4
371-2	Basic Metal Products		5,510	10,947	15,913		4.6	6.3	6.4
381	Fabricated Metal Products		3,821	6,128	7,378		3.2	3.5	2.9
382-5	Machinery and Equipment		22,177	29,341	43,861		18.5	17.0	17.5
390	Other Manufacturing Industries		6,365	10,210	12,293		5.3	5.9	4.9

Note: "Existing Industries" were industries/factories located as of the end of 1994.

Source: Study Team

Table 7.5.12 shows the number of workers in new industries in both the modern and non-modern sector, estimated based on data in 1994 and from the above considerations. The number of modern sector workers in manufacturing is forecast to total 61,861 in 2001, 93,034 in 2006, and 143,773 in 2011, corresponding to 51.6 per cent, 53.8 per cent, and 57.5 per cent of the total number of workers.

By subsector, the modern sector ratio will be highest in industries producing chemical/petroleum products, basic metal products, and machinery and equipment. On the other hand, the non-modern sector will continue to be dominant in the food, beverage and tobacco industry, accounting for around 66 per cent of the total workers up to 2011.

All the industries/factories to be located in Bang Saphan (refer to the JICA-sponsored Feasibility Study on Bang Saphan Industrial Estate) have been classified into the modern sector because of their location within the industrial estate.

In terms of gross provincial manufacturing product (GPMP), the modern sector ratio would be higher than that for workers, since the sector mostly comprises capital-intensive or mechanized large industries/factories. The Industrial Survey (1992 data) of the National Statistical Office (NSO) found that subsectoral labor productivity (value added per worker) of establishments with more than 20 workers was almost double that of establishments with less than 19 workers (manufacturing total basis). Table 7.5.13 shows GPMP by the modern and non-modern sectors, which were estimated considering the differences found in the 1992 Industrial Survey.

(2) Demand for Industrial Land Demand (modern sector)

Table 7.5.14 estimates demand of the new industries in the modern sector for factory sites up to 2011. The total site demand was forecast to be 1,877 hectares (11,730 rai) up to 2011; i.e., 1,259 hectares (7,878 rai) for new industries in areas other than the Bang Saphan area (BSA), and 618 hectares (3,862 rai) for the BSA (refer to the Feasibility Study on Bang Saphan Industrial Estate by JICA and IEAT). By phase, the total site demand will be 709 hectares (4,429 rai) in Phase I (including demand in 1995-96), 463 hectares (2,895 rai) in Phase II (2002-2006), and 705 hectares (4,406 rai) in Phase III (2007-2011).

Table 7.5.12 WSB Manufacturing Employment in "New Industries"
(Modern Sector and Non-Modern Sector)

1. Year 2001

(Unit: persons)	Total	Non-Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	119,806	57,945	61,861	4,770	57,091	51.6%
311-4 Food, Beverage and Tobacco	51,983	38,875	13,108	150	12,958	25.2%
321 Textiles	6,343	3,045	3,298		3,298	52.0%
322 Wearing Apparel	20	20				-
323-4 Leather, leather Products and Footwear	258		258		258	100.0%
331-2 Wood, Wood Products and Furniture	9,084	4,427	4,657	230	4,427	51.3%
341 Paper and Paper Products	4,171	1,460	2,711		2,711	65.0%
342 Printing and Publishing	63	63				-
351-4 Chemical and Petroleum Products	1,740		1,740	90	1,650	100.0%
355-6 Rubber and Plastic Products	2,096	1,677	419		419	20.0%
361-9 Non-Metallic Mineral Products	6,175	3,159	3,016	100	2,916	48.8%
371-2 Basic Metal Products	5,510		5,510	3,335	2,175	100.0%
381 Fabricated Metal Products	3,821	761	3,057		3,057	80.0%
382-5 Machinery and Equipment	22,177		22,177	865	21,312	100.0%
390 Other Manufacturing Industries	6,365	4,455	1,910		1,910	30.0%

2. Year 2006

(Unit: persons)	Total	Non-Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	173,045	80,011	93,034	8,835	84,199	53.8%
311-4 Food, Beverage and Tobacco	73,303	52,913	20,390	320	20,070	27.8%
321 Textiles	10,178	4,580	5,598		5,598	55.0%
322 Wearing Apparel	24	24				-
323-4 Leather, leather Products and Footwear	411		411		411	100.0%
331-2 Wood, Wood Products and Furniture	12,675	6,222	6,453	230	6,223	50.9%
341 Paper and Paper Products	5,022	1,758	3,264		3,264	65.0%
342 Printing and Publishing	89	89				-
351-4 Chemical and Petroleum Products	2,150		2,150	190	1,960	100.0%
355-6 Rubber and Plastic Products	3,366	2,693	673		673	20.0%
361-9 Non-Metallic Mineral Products	9,201	4,380	4,821	440	4,381	52.4%
371-2 Basic Metal Products	10,947		10,947	5,795	5,152	100.0%
381 Fabricated Metal Products	6,128	1,226	4,902		4,902	80.0%
382-5 Machinery and Equipment	29,341		29,341	1,860	27,481	100.0%
390 Other Manufacturing Industries	10,210	6,126	4,084		4,084	40.0%

3. Year 2011

(Unit: persons)	Total	Non-Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	250,132	106,359	143,773	16,613	127,160	57.5%
311-4 Food, Beverage and Tobacco	102,691	71,163	31,528	1,030	30,498	30.7%
321 Textiles	12,638	5,503	7,135	410	6,725	56.5%
322 Wearing Apparel	32	32				-
323-4 Leather, leather Products and Footwear	496		496		496	100.0%
331-2 Wood, Wood Products and Furniture	17,190	8,410	8,780	370	8,410	51.1%
341 Paper and Paper Products	8,251	2,836	5,418	150	5,268	65.6%
342 Printing and Publishing	122	122				-
351-4 Chemical and Petroleum Products	9,131		9,131	1,800	7,331	100.0%
355-6 Rubber and Plastic Products	4,051	3,241	810		810	20.0%
361-9 Non-Metallic Mineral Products	16,080	7,430	8,650	1,220	7,430	53.8%
371-2 Basic Metal Products	15,913		15,913	9,573	6,340	100.0%
381 Fabricated Metal Products	7,378	1,476	5,902		5,902	80.0%
382-5 Machinery and Equipment	43,863		43,863	2,060	41,803	100.0%
390 Other Manufacturing Industries	12,293	6,146	6,147		6,147	50.0%

Note: "Non-Modern" sector comprises cottage/household manufacturing, most of which are not officially registered.

Source: Study Team

**Table 7.5.13 Gross Provincial Manufacturing Product (GPMP)
of "New Industries" in the WSB (Modern Sector and Non-Modern Sector)**

1. Year 2001

2001 (million Baht in constant 1994 prices)	Total	Non- Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	33,242	7,533	25,709	10,972	14,737	77.3%
311-4 Food, Beverage and Tobacco	7,366	5,022	2,341	62	2,282	31.8%
321 Textiles	1,634	360	1,274		1,274	78.0%
322 Wearing Apparel	2	2				-
323-4 Leather, leather Products and Footwear	76		76		76	100.0%
331-2 Wood, Wood Products and Furniture	883	302	581	78	503	65.8%
341 Paper and Paper Products	994	186	808		808	81.3%
342 Printing and Publishing	6	6				-
351-4 Chemical and Petroleum Products	583		583	232	351	100.0%
355-6 Rubber and Plastic Products	274	206	68		68	24.8%
361-9 Non-Metallic Mineral Products	1,340	484	856	131	725	63.9%
371-2 Basic Metal Products	9,993		9,993	9,436	557	100.0%
381 Fabricated Metal Products	807	161	646		646	80.0%
382-5 Machinery and Equipment	7,997		7,997	1,033	6,964	100.0%
390 Other Manufacturing Industries	1,287	804	483		483	37.5%

2. Year 2006

(million Baht in constant 1994 prices)	Total	Non- Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	65,448	12,488	52,960	27,519	25,441	80.9%
311-4 Food, Beverage and Tobacco	12,938	8,388	4,550	156	4,394	35.2%
321 Textiles	3,267	572	2,695		2,695	82.5%
322 Wearing Apparel	3	3				-
323-4 Leather, leather Products and Footwear	151		151		151	100.0%
331-2 Wood, Wood Products and Furniture	1,535	528	1,007	127	880	65.6%
341 Paper and Paper Products	1,491	280	1,211		1,211	81.2%
342 Printing and Publishing	17	17				-
351-4 Chemical and Petroleum Products	898		898	195	703	100.0%
355-6 Rubber and Plastic Products	543	411	137		137	25.0%
361-9 Non-Metallic Mineral Products	2,488	680	1,808	674	1,134	72.7%
371-2 Basic Metal Products	24,740		24,740	23,627	1,113	100.0%
381 Fabricated Metal Products	1,613	323	1,290		1,290	80.0%
382-5 Machinery and Equipment	13,186		13,186	2,740	10,446	100.0%
390 Other Manufacturing Industries	2,573	1,286	1,287		1,287	50.0%

3. Year 2011

(million Baht in constant 1994 prices)	Total	Non- Modern	Modern Sector			Modern Ratio
			total	Bang Saphan	Other	
TSIC Total	120,203	19,953	100,250	53,394	46,856	83.4%
311-4 Food, Beverage and Tobacco	22,592	13,694	8,898	681	8,217	39.4%
321 Textiles	5,055	858	4,197	154	4,043	83.0%
322 Wearing Apparel	5	5				-
323-4 Leather, leather Products and Footwear	227		227		227	100.0%
331-2 Wood, Wood Products and Furniture	2,594	905	1,689	180	1,509	65.1%
341 Paper and Paper Products	3,054	559	2,495	72	2,423	81.7%
342 Printing and Publishing	24	24				-
351-4 Chemical and Petroleum Products	4,752		4,752	3,698	1,054	100.0%
355-6 Rubber and Plastic Products	822	617	205		205	24.9%
361-9 Non-Metallic Mineral Products	5,419	1,360	4,059	1,792	2,267	74.9%
371-2 Basic Metal Products	44,816		44,816	43,146	1,670	100.0%
381 Fabricated Metal Products	2,420	484	1,936		1,936	80.0%
382-5 Machinery and Equipment	24,563		24,563	3,671	20,892	100.0%
390 Other Manufacturing Industries	3,860	1,447	2,413		2,413	62.5%

Note: "Non-Modern" sector comprises cottage/household manufacturing, most of which are not officially registered.

Source: Study Team

Table 7.5.14

Demand for Factory Sites in the WSB
(New Industries in the Modern Sector)

TSIC	Total	(a) Modern Sector Employment (persons) (except Bang Saphan)			(b) Work- ers /ha	(c=a/b) Land Demand (ha)		
		2001	2006	2011		2001	2006	2011
		57,091	84,199	127,160		559.8	819.0	1,259.0
311-4	Food, Beverage and Tobacco	12,958	20,070	30,498	180	72.0	111.5	169.4
321	Textiles	3,293	5,598	6,725	100	33.0	56.0	67.3
322	Wearing Apparel							
323-4	Leather, leather Products and Footwear	258	411	496	150	1.7	2.7	3.3
331-2	Wood, Wood Products and Furniture	4,427	6,223	8,410	70	63.2	88.9	120.1
341	Paper and Paper Products	2,711	3,264	5,268	75	36.1	43.5	70.2
342	Printing and Publishing							
351-4	Chemical and Petroleum Products	1,650	1,960	7,331	60	27.5	32.7	122.2
355-6	Rubber and Plastic Products	419	673	810	60	7.0	11.2	13.5
361-9	Non-Metallic Mineral Products	2,916	4,381	7,430	50	58.3	87.6	148.6
371-2	Basic Metal Products	2,175	5,152	6,340	100	21.8	51.5	63.4
381	Fabricated Metal Products	3,057	4,902	5,902	60	51.0	81.7	98.4
382-5	Machinery and Equipment	21,312	27,481	41,803	120	177.6	229.0	348.4
390	Other Manufacturing Industries	1,910	4,084	6,147	180	10.6	22.7	34.2
		(d) Bang Saphan Land Demand (ha)				(e) Total (c+d) Land Demand (ha)		
		2001	2006	2011		2001	2006	2011
TSIC	Total	148.90	352.80	617.85		708.70	1,171.80	1,876.85
311-4	Food, Beverage and Tobacco	2.40	6.55	40.55		74.40	118.05	209.95
321	Textiles			14.30		33.00	56.00	81.60
322	Wearing Apparel							
323-4	Leather, leather Products and Footwear					1.70	2.70	3.30
331-2	Wood, Wood Products and Furniture	7.35	7.35	14.20		70.55	96.25	134.30
341	Paper and Paper Products			2.05		36.10	43.50	72.25
342	Printing and Publishing							
351-4	Chemical and Petroleum Products	5.00	17.60	67.60		32.50	50.30	159.80
355-6	Rubber and Plastic Products					7.00	11.20	13.50
361-9	Non-Metallic Mineral Products	4.50	46.90	60.90		62.80	134.50	209.50
371-2	Basic Metal Products	111.50	200.20	338.05		133.30	251.70	401.45
381	Fabricated Metal Products					51.00	81.70	98.40
382-5	Machinery and Equipment	18.15	74.20	80.20		195.75	303.20	428.60
390	Other Manufacturing Industries					10.60	22.70	34.20

Note: Site area of Bang Saphan (refer to the Feasibility Study on Bang Saphan Industrial Estate.)

Source: Study Team

Estimation of factory site demand was based on a parameter indicating workers in the new industries per site area (i.e., workers per hectare). The parameter varies among manufacturing subsectors; it is high in labor-intensive industries producing food products, leather products, and other manufacturing industries and lower in land-intensive industries such as the manufacturing of non-metallic products.

Gross land demand

The industrial land estimated in Table 7.5.14 is the demand for factory sites. In the case of industrial estates, land to accommodate factories includes not only factory site area, but also areas for internal roads, green belts, public space for utilities, and other public land use.

The aggregated factory site area averaged 77 per cent of the gross area of industrial estates (IEs) developed solely by the Industrial Estate Authority of Thailand (IEAT) from 1982 to 1995. The Board of Investment (BOI) grants incentives to industrial estate /zone projects of private developers if the factory site ratio is less than 75 per cent. On the other hand, all factories will not be located within industrial estates (IEs). Considering these factors, and assuming that 20 per cent of all factories will locate outside of IEs, gross land demand up to 2011 would be as follows:

(Total land demand up to 2011, excluding the Bang Saphan Industrial Estate)

1) Demand for factory site		1,259 (ha)
2) Factory site area / the gross land area of		75 (%)
3) Factory location ratio outside IEs		20 (%)
4) Total land demand	(IEs)	$1,259 * (1 - 0.2) / 0.75 = 1,343$
	(outside)	$1,259 * 0.2 = 252$ (ha)
	Total	1,595 (ha)
5) Total factory site area / gross land	(1 / 4)	$1,259$ (ha) / $1,595$ (ha) = 79 (%)

(3) Factory Site Demand by Province

The next concern relates to the location of new industries in each WSB province. Table 7.5.15 forecast factory site demand by subsector and by province from 1995 to 2011 excluding that of Bang Saphan area (BSA) in Prachuap Khirikhan province. Ratchaburi province is forecast to receive the largest site area, 363.9 hectares, or 28.9 per cent of the total site demand in the WSB region, followed by Petchaburi with 299.1 hectares (23.8 per cent) and Chumphon with 285.3 hectares (22.7 per cent). Samut Songkhram province will absorb only 65.7 hectares (6.2 per cent), following 79.6 hectares in Prachuap Khirikhan (excluding the BSA).

In terms of factory site area by province and subsector, the machinery and equipment industry will account for the largest share in Kanchanaburi, Ratchaburi, Samut Songkhram, and Chumphon due mainly to the comparatively large demand in these areas and the footloose locational characteristics of this industry. The results shown in Table 7.5.15 were obtained with the methodology explained below.

Table 7.5.15

**Factory Site Demand in the WSB Province (1995-2011)
excluding Bang Saphan Area in Prachuap Khirikhan**

		Factory Site Demand (ha)						
		Total	Kan.	Rac.	Son.	Pet.	Khl.	Chu.
TSIC	Total	1,259.0	165.4	363.9	65.7	299.1	79.6	283.3
	(Provincial Shares)	100.0%	13.1%	28.9%	5.2%	23.8%	6.3%	22.7%
311-4	Food, Beverage and Tobacco	169.4	23.7	39.0	5.1	32.2	26.3	43.2
321	Textiles	67.3	7.4	24.2	2.0	17.5	4.0	12.1
322	Wearing Apparel							
323-4	Leather, leather Products and Footwear	3.3	0.7	0.5	0.2	0.3		1.5
331-2	Wood, Wood Products and Furniture	120.1	21.0	34.2	7.2	24.0	7.2	26.4
341	Paper and Paper Products	70.2	12.6	21.1	1.4	16.1	1.1	17.9
342	Printing and Publishing							
351-4	Chemical and Petroleum Products	122.2	23.2	37.9		33.0		28.1
355-6	Rubber and Plastic Products	13.5	1.4	2.9	0.7	4.9	0.1	3.6
361-9	Non-Metallic Mineral Products	148.6	17.8	40.1	7.4	38.6	11.9	32.7
371-2	Basic Metal Products	63.4	8.2	15.5	2.5	20.3	4.8	12.0
381	Fabricated Metal Products	98.4	11.3	28.0	8.2	25.6	4.5	20.8
382-5	Machinery and Equipment	348.4	34.8	113.2	26.1	78.4	17.4	78.4
390	Other Manufacturing Industries	34.2	3.1	7.2	4.8	8.2	2.4	8.6
		Shares by Subsector (%)						
		Total	Kan.	Rac.	Son.	Pet.	Khl.	Chu.
TSIC	Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
311-4	Food, Beverage and Tobacco	13.5	14.3	10.7	7.7	10.8	33.0	15.1
321	Textiles	5.3	4.5	6.7	3.1	5.8	5.1	4.2
322	Wearing Apparel							
323-4	Leather, leather Products and Footwear	0.3	0.4	0.1	0.4	0.1		0.5
331-2	Wood, Wood Products and Furniture	9.5	12.7	9.4	11.0	8.0	9.1	9.3
341	Paper and Paper Products	5.6	7.6	5.8	2.1	5.4	1.3	6.3
342	Printing and Publishing							
351-4	Chemical and Petroleum Products	9.7	14.0	10.4		11.0		9.9
355-6	Rubber and Plastic Products	1.1	0.8	0.8	1.0	1.6	0.1	1.3
361-9	Non-Metallic Mineral Products	11.8	10.8	11.0	11.3	12.9	14.9	11.5
371-2	Basic Metal Products	5.0	5.0	4.3	3.9	6.8	6.0	4.2
381	Fabricated Metal Products	7.8	6.8	7.7	12.4	8.6	5.7	7.3
382-5	Machinery and Equipment	27.7	21.1	31.1	39.8	26.2	21.9	27.5
390	Other Manufacturing Industries	2.7	1.9	2.0	7.3	2.7	3.0	3.0

Source: Study Team

Method to allocate factory site demand to provinces

Factory site demand by province was calculated by a numerical method. Locational factors by subsector and their provincial shares for factory site allocation were set to estimate factory site demand by province through the formula shown in Table 7.5.16.

Locational factors and their provincial shares for allocation should reflect industrial locational characteristics, potential/strategic positioning of each province for industrial development, and balanced development among provinces as summarized below:

Table 7.5.16 Method for Allocation of Factory Site Demand to Provinces

TSIC	G/S	LR	LP	AP	Note
311-4 Food, Beverage and Tobacco	0.3	0.4		0.3	* Locational Factors (LF)
321 Textiles	0.3	0.4*		0.3	G/S: Gateway/spillover functions
322 Wearing Apparel					including availability of seaport
323-4 Leather, leather Products and Footwear	0.5			0.5	and airport
331-2 Wood, Wood Products and Furniture	0.3	0.1	0.4	0.2	LR: Local resource including water
341 Paper and Paper Products	0.2	0.5*		0.3	resource
342 Printing and Publishing					* = oriented to water resources
351-4 Chemical and Petroleum Products	0.2	0.5*		0.3	LP: Land potential for land-intensive
355-6 Rubber and Plastic Products	0.4	0.1	0.1	0.4	industries
361-9 Non-Metallic Mineral Products	0.2	0.2	0.4	0.2	AP: Agglomeration potential
371-2 Basic Metal Products	0.4	0.1*	0.3	0.2	including existing agglomeration
381 Fabricated Metal Products	0.4		0.3	0.3	and future potential
382-5 Machinery and Equipment	0.5			0.5	* LC's structure by subsector is set by
390 Other Manufacturing Industries	0.5	0.1		0.4	considering its locational characteristics

Method to allocate factory site demand to province

(Example of wood, wood products and furniture) In case of Kanchanaburi (Calculation) (Locational factor * Share of Kanchanaburi) $G/S: 0.3 * 0.20 = 0.060$ $LR: 0.1 * 0.35 = 0.035$ $LP: 0.4 * 0.10 = 0.040$ $PA: 0.2 * 0.20 = 0.040$ a) Aggregated share = 0.175 b) Factory site demand total in the WSB 120.1 ha c) Factory site area allocated for Kanchanaburi $a * b = 120.1 * 0.175 = 21.0$ (ha)	Provincial shares for allocation (PSA) Kan. Rac. Son. Pet. Khi. Chu.																												
	<table border="1"> <tr> <td>G/S</td> <td>0.3</td> <td>0.2</td> <td>0.4</td> <td>0.1</td> <td>0.3</td> </tr> <tr> <td>LR</td> <td>0.1</td> <td>0.35</td> <td>0.15</td> <td>0.10</td> <td>0.20</td> <td>0.20</td> </tr> <tr> <td>LP</td> <td>0.4</td> <td>0.10</td> <td>0.25</td> <td>0.10</td> <td>0.30</td> <td>0.05</td> <td>0.20</td> </tr> <tr> <td>AP</td> <td>0.2</td> <td>0.20</td> <td>0.25</td> <td>0.10</td> <td>0.10</td> <td>0.20</td> <td>0.15</td> </tr> </table>	G/S	0.3	0.2	0.4	0.1	0.3	LR	0.1	0.35	0.15	0.10	0.20	0.20	LP	0.4	0.10	0.25	0.10	0.30	0.05	0.20	AP	0.2	0.20	0.25	0.10	0.10	0.20
G/S	0.3	0.2	0.4	0.1	0.3																								
LR	0.1	0.35	0.15	0.10	0.20	0.20																							
LP	0.4	0.10	0.25	0.10	0.30	0.05	0.20																						
AP	0.2	0.20	0.25	0.10	0.10	0.20	0.15																						

Locational factors

- 1) A "gateway/spillover" factor reflects the WSB industrial development strategies, i.e., its regional and subregional gateway functions, as well as the potential for industrial spillover from the BMR. This factor includes industrial locational orientation not only for roads/arteries, but also for availability of/access to a seaport and airport.
- 2) A local resource factor matches industrial needs with the provincial supply conditions in terms of raw materials and water resources.
- 3) A land potential factor is used to allocate the factory site demand of land-intensive industries.
- 4) An agglomeration potential factor includes existing industrial agglomeration and future potential. This factor reflects not only inter-industry linkages such as division of work, but also a "merit of agglomeration," which directs industrial location in general and the BOI zoning for investment incentives.
- 5) By subsector, these four factors have been broken down and distributed according to locational characteristics so as to total a score of 1.0 points; however, some factors are

not always used. In the case of the food, beverage and tobacco industry, for example, the land potential factor is not used since it is not a land-intensive industry. On the other hand, the local resource factor is accorded higher points (0.5) considering its resource-based character. The remaining 0.5 points is divided and allocated 0.3 points to the gateway/spillover factor considering the potential for import processing of food, and 0.2 points for the agglomeration potential.

Provincial shares for the allocation

1) Gateway/spillover factor

The gateway/spillover factor gives higher shares to the Upper WSB provinces (Kanchanaburi, Ratchaburi, Samut Songkhram, and Khao Yoi-Petchaburi), one of the gateways in the WSB region along with the Lower WSB region (Prachuap Khirikhan and Chumphon province). In principle, the Upper WSB is given a total 70 per cent, while the Lower WSB is allocated a total of 30 per cent. Based on this allocation, provincial shares have been allocated considering the potential/positioning of each province for industrial location. For example, Ratchaburi province is generally given the highest share among the four provinces of the Upper WSB followed by Petchaburi. Chumphon province is also expected to receive a higher share than Prachuap Khirikhan as shown in Table 7.5.17.

2) Local resource factor

Provincial shares of local resource factors were set based on resource potential in the provinces. In terms of water resources, higher shares were allocated to the Upper WSB provinces. Shares for agro-industrial resources for the food industry were distributed based on the endowment of each province (refer to Table 7.2.3 for potentials and regional comparative advantages of the WSB region).

3) Land potential factor

The land potential factor incorporates not only ongoing and planned industrial estate (IE) development, but also land development in the future. The former comprises Kanchanaburi IE with a gross area of 109 hectares (681 rai), Mahachay IE with the 208 hectares (1,300 rai) in Ratchaburi, and Khao Yoi IE with 240 hectares (1500 rai) in Petchaburi. IEs will be also developed in Chumphon and Samut Songkhram, the latter on the vast abandoned shrimp field. Accordingly, 10 per cent of factory site allocation was distributed to Samut Songkhram, while 10 per cent was distributed to Kanchanaburi, 25 per cent to Ratchaburi, 5 per cent to Prachuap Khirikhan, and 20 per cent to Chumphon.

Table 7.5.17

Provincial Shares for Factory Site Allocation
by Subsector and by Province

TSIC	Gateway/Spillover (G/S)						Local Resource (LR)					
	Kan.	Rac.	Son.	Pet.	Khi.	Chu.	Kan.	Rac.	Son.	Pet.	Khi.	Chu.
311-4 Food, Beverage and Tobacco	0.05	0.3	0.1	0.15		0.4	0.2	0.2	0.05	0.1	0.2	0.25
321 Textiles		0.5	0.2	0.1		0.2	0.2	0.3		0.2		0.3
322 Wearing Apparel												
323-4 Leather, leather Products and Footwear		0.4	0.2	0.1		0.3						
331-2 Wood, Wood Products and Furniture	0.2	0.4		0.1		0.3	0.35	0.15		0.1	0.2	0.2
341 Paper and Paper Products		0.3	0.2	0.2		0.3	0.2	0.3		0.2		0.3
342 Printing and Publishing												
351-4 Chemical and Petroleum Products	0.1	0.5		0.3		0.1	0.3	0.3		0.1		0.3
355-6 Rubber and Plastic Products		0.5	0.1	0.3		0.1	0.1	0.3		0.1		0.5
361-9 Non-Metallic Mineral Products		0.4	0.1	0.3		0.2	0.2	0.3		0.1	0.1	0.3
371-2 Basic Metal Products		0.3	0.2	0.3		0.2	0.2	0.3		0.2		0.3
381 Fabricated Metal Products	0.1	0.3	0.1	0.2		0.3						
382-5 Machinery and Equipment	0.15	0.3	0.1	0.15		0.3						
390 Other Manufacturing Industries	0.1	0.3	0.2	0.2		0.2	0.2			0.2		0.3

TSIC	Land Potential (LP)						Agglomeration Potential (AP)					
	Kan.	Rac.	Son.	Pet.	Khi.	Chu.	Kan.	Rac.	Son.	Pet.	Khi.	Chu.
311-4 Food, Beverage and Tobacco	0.1	0.3	0.1	0.3		0.18	0.10	0.25	0.05	0.20	0.25	0.15
321 Textiles	0.1	0.3	0.1	0.3		0.18		0.80		0.10	0.10	
322 Wearing Apparel	0.1	0.3	0.1	0.3		0.18						
323-4 Leather, leather Products and Footwear	0.1	0.3	0.1	0.3		0.18	0.40					0.60
331-2 Wood, Wood Products and Furniture	0.1	0.3	0.1	0.3		0.18	0.20	0.25	0.10	0.10	0.20	0.15
341 Paper and Paper Products	0.1	0.3	0.1	0.3		0.18	0.20	0.60		0.15		0.05
342 Printing and Publishing												
351-4 Chemical and Petroleum Products	0.1	0.3	0.1	0.3		0.18	0.10	0.80				0.10
355-6 Rubber and Plastic Products	0.1	0.3	0.1	0.3		0.18	0.05	0.20	0.25	0.10		0.40
361-9 Non-Metallic Mineral Products	0.1	0.3	0.1	0.3		0.18	0.05	0.55		0.25	0.05	0.10
371-2 Basic Metal Products	0.1	0.3	0.1	0.3		0.18	0.10	0.30		0.40	0.20	
381 Fabricated Metal Products	0.1	0.3	0.1	0.3		0.18	0.15	0.45	0.05	0.15	0.10	0.10
382-5 Machinery and Equipment	0.1	0.3	0.1	0.3		0.18	0.15	0.45	0.05	0.10	0.10	0.15
390 Other Manufacturing Industries	0.1	0.3	0.1	0.3		0.18	0.05	0.25	0.20	0.10	0.10	0.30

Source: Study Team

4) Agglomeration potential factor

Provincial shares of the agglomeration potential factor were distributed by applying two considerations. The first consideration was the existing industrial agglomeration represented by the number of workers as indicated in the Industrial Statistics for 1994 (refer to Table 7.1.8). The second consideration was BOI zoning; Zone 2 for the three provinces of Kanchanaburi, Ratchaburi, and Samut Songkhram, and Zone 3 for Petchaburi, Prachuap Khirikhan, and Chumphon.

Zone 3 investors can enjoy an eight-year exemption from corporate income tax, one year more than that of Zone 2 investors in industrial estates or promoted industrial zones. In addition, the BOI designates the categories of industry that can enjoy incentives to be located in Zone 3 as shown in Table 7.5.18. In this context, Khao Yoi in Petchaburi province is accorded the advantage of Zone 3, neighboring to Ratchaburi province of Zone 2. One industrial estate is being developed in Khao Yoi.

Some of the shares to be allocated to Ratchaburi were distributed to Petchaburi province for this reason.

Table 7.5.18 Manufacturing Subsectors to be located in Zone 3 for the BOI Incentives

TISC	Zone 3 Subsectors	TISC	Zone 3 Subsectors
31112	Meat canning	36200	Glass products
31131	Canned fruit & vegetables		(industrial glass, etc.)
31139	Canned & processed fruit and Veg.	36999	Fire protection material or heat insulators
31141	Canned fish	37110	Steel structures
31149	Canned & processed fish, etc.	37110	Steel tubes or pipes
31151	Animal/vegetable fats/oils		(butt-weld processes/IE)
31152	Margarine	37110	Coated steel sheets or coils, excluding
31169	Modified starch		electro-galvanized steel sheets or coils
31190	Cocoa/chocolate	37110	Steel wire rods, steel wire, etc.
31213	Monosodium glutamate monohydrate		(smelting furnaces/IE)
31219	Other food products	37110	Steel round bars or deformed bars
31220	Animal feeds		(smelting furnaces/IE)
31340	Soft drinks	38291	Household appliances
32113	Yarn spinning	38292	Air conditioners
32115	Weaving or knitting	38320	• Televisions
32119	Yarn spinning	38320	• Video cassette recorders and players
32120	Household textiles or textile products	38320	• Radios
32150	Fishing nets	38320	• Car radios
32190	Weaving or knitting	38320	• Radio-tape recorders and players
32201	Ggarments	38320	• Audio systems
32202	Ggarments	38320	• Compact disc players
32209	Ggarments	38320	• Digital audio tape players
32209	Labels	38330	Electrical appliances or housewares
33201	Rubber wood furniture	38391	Insulated wires and cables
33201	Other furniture	38393	Electric lamps
34111	Paper		(energy-saving electric lamps)
34190	Articles made of fiber, pulp, paper, or paperboard	38440	Motor-cycles
35111	L-Lysine from tapioca	39090	Sand paper
35111	basic chemicals	39090	Wax paper
35111	Industrial gases	39090	Sanitary napkins
35111	Oxide compounds	39090	Toys made of other materials than plastics
35111	Inorganic acids	39090	Zippers
35111	Inorganic bases	39090	gloves except rubber gloves
35111	Salt		(leather gloves)
35299	Pesticides, herbicides, fungicides or insecticides	39090	Socks or stockings
35609	Plastic toys	39090	Artificial flowers, trees, etc.
		39090	stationery/educational equipment or parts

Note: Industry within parenthesis can get the BOI incentives even if located in Zone 2.

Source: Board of Investment

(4) Development Framework of the New Industries by Province and Subdivision

Employment and gross provincial manufacturing product (GPMP) of the new industries, which will be located from 1995 to 2001, have been estimated assuming that they will correspond to the factory site demand allocated to WSB provinces by subsector and aggregated as shown in Table 7.5.19. In addition to the allocation by province, an allocation

by industrial estate (IE) was undertaken for the strategically important Ban Pong IE in Ratchaburi and Samut Songkhram Free Trade Area (FTA); refer to Table 7.5.20.

**Table 7.5.19 Development Framework of the New Industries (1995-2011)
by Province/by Subdivision and Total Demand for Factory Site**

	Factory Site (ha)	Workers (persons)	GPMP (mill. Baht)	% Shares		
				Factory Site	Workers	GPMP
(by Province)						
Total	1,876.85	143,773	100,250	100.0%	100.0%	100.0%
1. Kanchanaburi	165.40	16,143	5,585	8.8%	11.2%	5.6%
2. Ratchaburi	363.90	36,052	13,777	19.4%	25.1%	13.7%
3. Ban Pong	120.00	12,167	5,030	6.4%	8.5%	5.0%
4. Other Ratchaburi	243.90	23,885	8,747	13.0%	16.6%	8.7%
5. Samut Songkhram	65.70	6,915	2,780	3.5%	4.8%	2.8%
6. Free Trade Area	40.00	4,550	1,994	2.1%	3.2%	2.0%
7. Other Songkhram	25.70	2,365	786	1.4%	1.6%	0.8%
8. Petchaburi	299.10	29,133	10,760	15.9%	20.3%	10.7%
9. Khao-Yoi	180.00	17,500	6,500	9.6%	12.2%	6.5%
10. Other Petchaburi	119.10	11,633	4,260	6.3%	8.1%	4.2%
11. Prachuap KhiriKhan	697.45	26,193	56,647	37.2%	18.2%	56.5%
12. Bang Saphan	617.85	16,613	53,394	32.9%	11.6%	53.3%
13. Other Khirikhan	79.60	9,580	3,253	4.2%	6.7%	3.2%
14. Chumphon	285.30	29,336	10,701	15.2%	20.4%	10.7%
(by Subarea)						
Total	1,876.85	143,773	100,250	100.0%	100.0%	100.0%
Upper WSB (1+2+5+9)	775.00	76,610	28,642	41.3%	53.3%	28.6%
Central WSB (10+13)	198.70	21,214	7,513	10.6%	14.8%	7.5%
Lower WSB (12+14)	903.15	45,949	64,095	48.1%	32.0%	63.9%
Factory site demand of existing industries/factories	80.00					
Total factory site demand	1,956.85					

Note: GPMP = gross provincial manufacturing product in constant 1994 prices

Ban Pong and S. Songkhram FTA (refer to Table 7.5.20)

Khao Yoi = around 60 percent of Petchaburi total

Bang Saphan (based on the Feasibility Study On the Bang Saphan Industrial Estate (JICA/IEAT))

Free Trade Area will be developed also in the Bang Saphan IE and Pathiu-Chumphon.

*Existing industries/factories were located as of the end of 1994.

Source: Study Team

In terms of factory site area to be developed to 2011, the Upper WSB will absorb sizable new industrial locations along with the Lower WSB; the main location will be the Bang Saphan area (BSA) including the Bang Saphan IE. The Central WSB, which consists of areas in Petchaburi other than Khao Yoi and areas in Prachuap Khirikhan other than the BSA, will have little in the way of new industrial location, due mainly to the area's excellent natural resources and the well-known resort areas of Cha Am and Hua Hin; therefore, most of this area should be preserved for the development of tourism and the proposed Science City. (refer to Volume 5.)

**Table 7.5.20 Development Framework of the New Industries (up to 2011)
for the Ban Pong Industrial Estate and Samut Songkhram Free Trade Area**

TSIC	Total	Bang Pong			S. Songkhram FTA		
		Factory Site (ha)	Workers (persons)	GPMP (mill. Baht)	Factory Site (ha)	Workers (persons)	GPMP (mill. Baht)
		120.0	12,167	5,030	40.0	4,550	1,944
311-4	Food, Beverage and Tobacco	10.0	1,800	485	3.0	540	146
321	Textiles	10.0	999	601	2.0	200	120
322	Wearing Apparel						
323-4	Leather, leather Products and Footwear				0.2	30	14
331-2	Wood, Wood Products and Furniture	15.0	1,050	188	3.8	265	48
341	Paper and Paper Products	10.0	750	345	1.0	75	35
342	Printing and Publishing						
351-4	Chemical and Petroleum Products	5.0	300	43			
355-6	Rubber and Plastic Products	5.0	300	76			
361-9	Non-Metallic Mineral Products	5.0	250	76	4.0	200	61
371-2	Basic Metal Products						
381	Fabricated Metal Products	10.0	600	197	2.0	120	39
382-5	Machinery and Equipment	48.0	5,759	2,878	20.0	2,400	1,199
390	Other Manufacturing Industries	2.0	359	141	4.0	719	282

Note: GPMP = gross provincial manufacturing product in constant 1994 prices

Source: Study Team

(5) Total demand for factory site

Regarding the existing industries the WSB region as of the end of 1994, land demand issues are likely to emerge when the number of workers increases to more than 1.4 times the number in 1994. The number of incremental workers required to reach a total 1.4 times greater than in 1994 is about 16,600, which implies 80 hectares of factory site demand, considering that the modern sector will account for around half of the total number of incremental workers.

Including this 80 hectares, manufacturing development in the WSB will require around 1,960 hectares for factory sites up to 2011. (Table 7.5.19)

(6) Additional considerations regarding the development framework

Impact of motorization on land demand

Manufacturing development in the WSB will require around 1,960 hectares of factory sites, and about 2,500 hectares of gross land up to 2011, including a total of 1,157 hectares for ongoing and planned industrial estate development. This estimation is based on a parameter of workers per hectare of factory site area. The parameter is high for labor-intensive industries/factories, particularly for those adopting two- or three-shift operations, and low in land-intensive industries with sizable stock space mainly for raw materials.

While most factory workers now commute by motorcycle, they may commute by car in the future, as do many Bangkok office workers at present. If so, car parking space on the factory site will be required probably three times more than what would be needed for motorcycle commuters; in such a case, the area demanded for factory sites would be a little greater than that estimated by this Study.

Demand for water

Demand for industrial water is estimated to be around 100,000 m³ per day, based on the demand for new factory sites up to 2011 (1,259 ha). In addition, since the Bang Saphan area will require about 200,000 m³ per day (60 million m³/year), demand for industrial water will total around 300,000 m³ per day.

Chapter 6 Industrial Development Plan in the WSB Region

This Chapter will put forward an industrial development plan for the WSB region up to 2011 consistent with strategies set out in Chapter 4, and based on scenario/framework of Case 2 presented in Chapter 5. Since Appendix II complies Project Profiles that provide detailed information on specific projects/programs for the industrial development of the WSB, this Chapter will only briefly touch on these projects/programs.

6.1 Regional and Subregional Linkages in 2011

According to the Case 2 scenario, gross provincial manufacturing product (GPMP) in the WSB region will grow at an annual average rate of 11.6 per cent up to 2011, from 32.5 billion Baht (in constant 1994 prices) in 1994 to 208.5 billion Baht in 2011. The growth rate by development phase will be 14.1 per cent in Phase I (1997-2001), 9.8 per cent in Phase II (2002-2006), and 9.8 per cent in Phase III (2007-2011). In terms of land development, a total 1,877 hectares of factory site will absorb new industries to produce value-added of 120.2 billion Baht including 250,100 new jobs in 2011.

This relatively high growth of manufacturing industry in the WSB region will be realized by transforming the region so that it may play a new role by providing regional and subregional linkages within the globalizing economy, while mobilizing the region's comparative advantages and potentials for industrial development to the fullest extent.

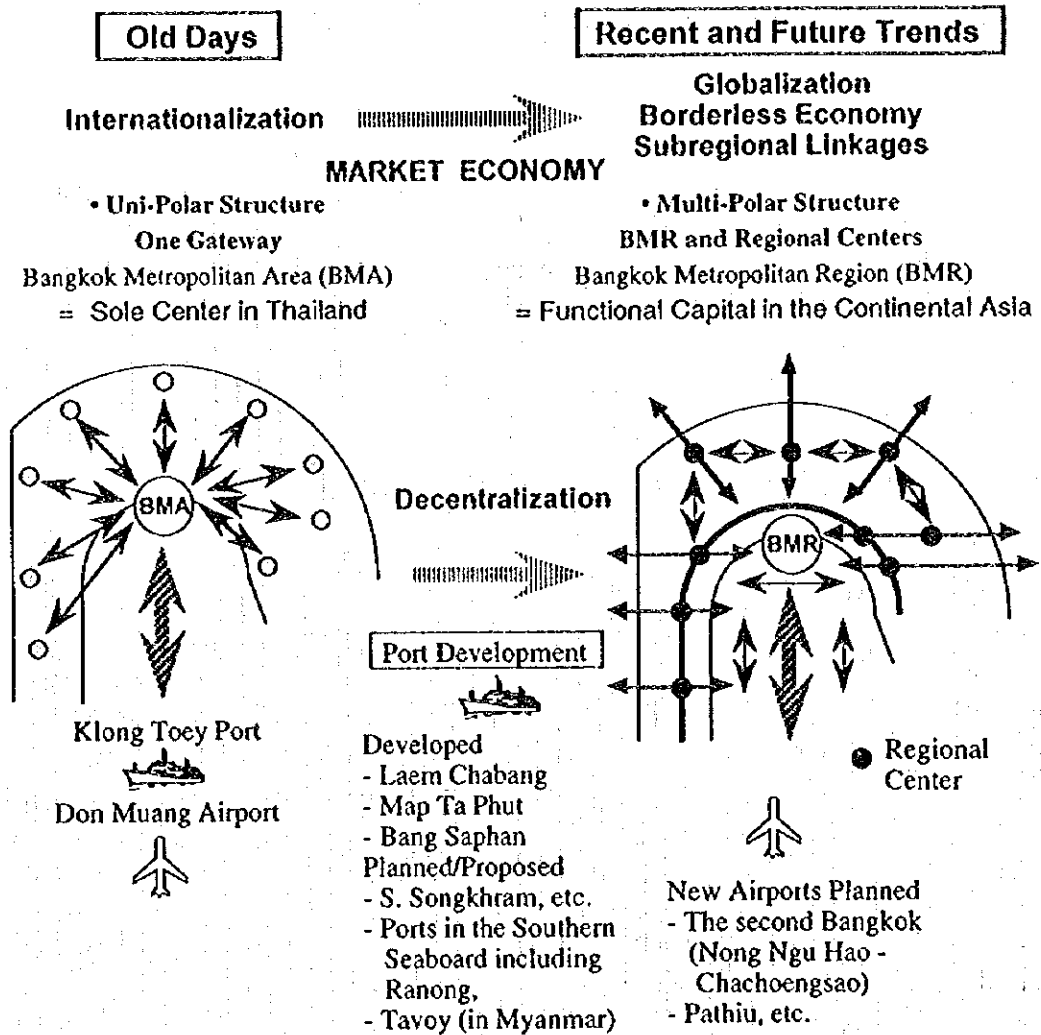
Structural change from unipolar to multipolar structure

The "Gateway 21" vision for the WSB region is set out in Chapter 3, along with "ISO 2011" implying integration through segmentation and open-ports toward the year 2011. The region will play a "Global Gateway" role for Thailand with two hubs (the Upper WSB and Lower WSB) through structural change in regional and subregional linkages.

Previously, especially before Leam Chabang port was developed, and to an extent even today, commodity flows in Thailand were mostly focused on the Bangkok Metropolitan Area (BMA); nearly all freight went to and came from the BMA, with the BMA as the sole center in Thailand. This unipolar structure has also been strongly affected by the centralized government system lacking local autonomous governments. (Figure 7.6.1)

Figure 7.6.1

Structural Change in Regional Linkages: Multipolar Structure



However, the commodity flow pattern has been in the process of transformation since Laem Chabang port opened, followed by Map Ta Phut port, both in the Eastern Seaboard (ESB) region. Supported by these ports and related estate developments, the ESB has grown rapidly, with consequent strong impact in the transformation of commodity flow pattern.

The commodity flow pattern will be further diversified in line with the progress of the country's market economy, which has been increasingly globalizing as part of a borderless international economy. Thailand has already opened several gateways to neighboring countries, such as the Nong Khai bridge to Lao PDR. A new deep-sea port has recently been opened at Bang Saphan in Prachuap Khirikhan province of the WSB region, and it will be developed so as to handle not only steel-related but also general commercial cargo.

Decentralization is one of the focal points of the 8th Plan. Many development projects to improve infrastructure in provincial areas will accelerate diversification of the commodity flow, as well as decentralization of factory location, capital/investment, human settlement, information, and so on. BOI zonal investment incentives will promote industrial spillover from the Bangkok Metropolitan Region (BMR), which consists of the BMA and five other provinces in its vicinity.

All of these changes will help generate a multipolar structure with regional centers and regional and subregional linkages in Thailand. In this context, the BMR will emerge as the "Functional Capital" for continental Southeast Asia, while its factories and industry-and trade-related functions relocate to provincial areas.

The WSB region: gateway cum twin hub alternative to Malacca route

The WSB region is positioned in a strategic location in the country's emerging multi-polar structure to provide a gateway with twin hubs essential for Thailand's sustainable growth within the globalizing economy; an upper hub will center on Ban Pong in Ratchaburi province, with a lower hub in Bang Saphan and Chumphon. (Figure 7.6.2)

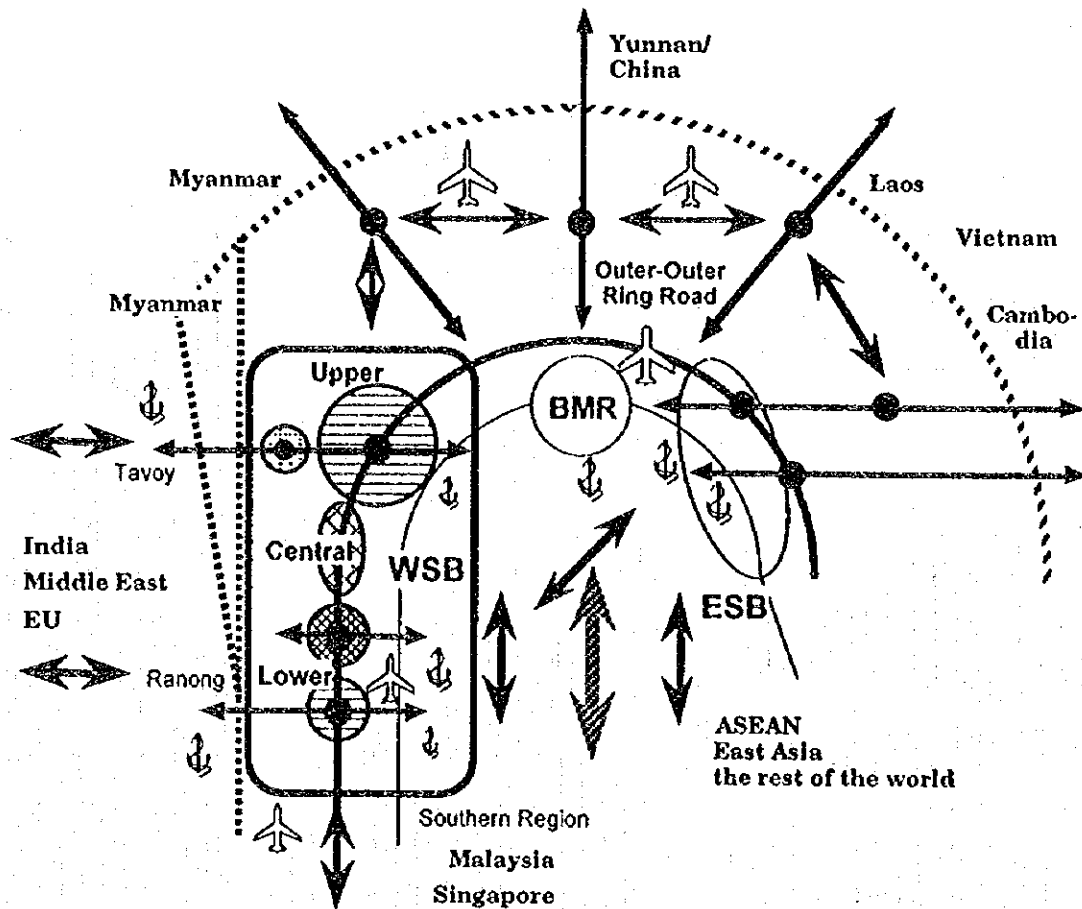
The WSB's strategic gateway location is unique. It could provide a short cut in ocean transportation from/to Thailand to/from India, the Middle East, the EU, and other western destinations without a detour via the Strait of Malacca, if deep-sea ports are developed at Tavoy in Myanmar, located about 250 km from Bangkok, and/or in the vicinity of Ranong in the Southern region of Thailand facing the Andaman Sea. Land transportation is also available between Thailand and other subregions including neighboring countries. The WSB region could become a global hub in Thailand, although relevant international (diplomatic) arrangements will be required for realization of this vision.

6.2 Development Perspectives by Subarea

Based on the fundamental role envisaged for the WSB region, i.e., global hub in terms of regional and subregional linkages of Thailand, an industrial development zoning scheme could be derived from relevant functions, potentials, and advantages by subarea, also considering harmonization with the natural environment.

As mentioned in Chapter 4, core formation/industrial clustering is effective and essential for advancing an area development approach for development of the region. In this context, each subarea will have at least one industrial/research core. (Figure 7.6.3)

Figure 7.6.2 WSB Region: Gateway cum Twin Hub Alternative to Malacca Route

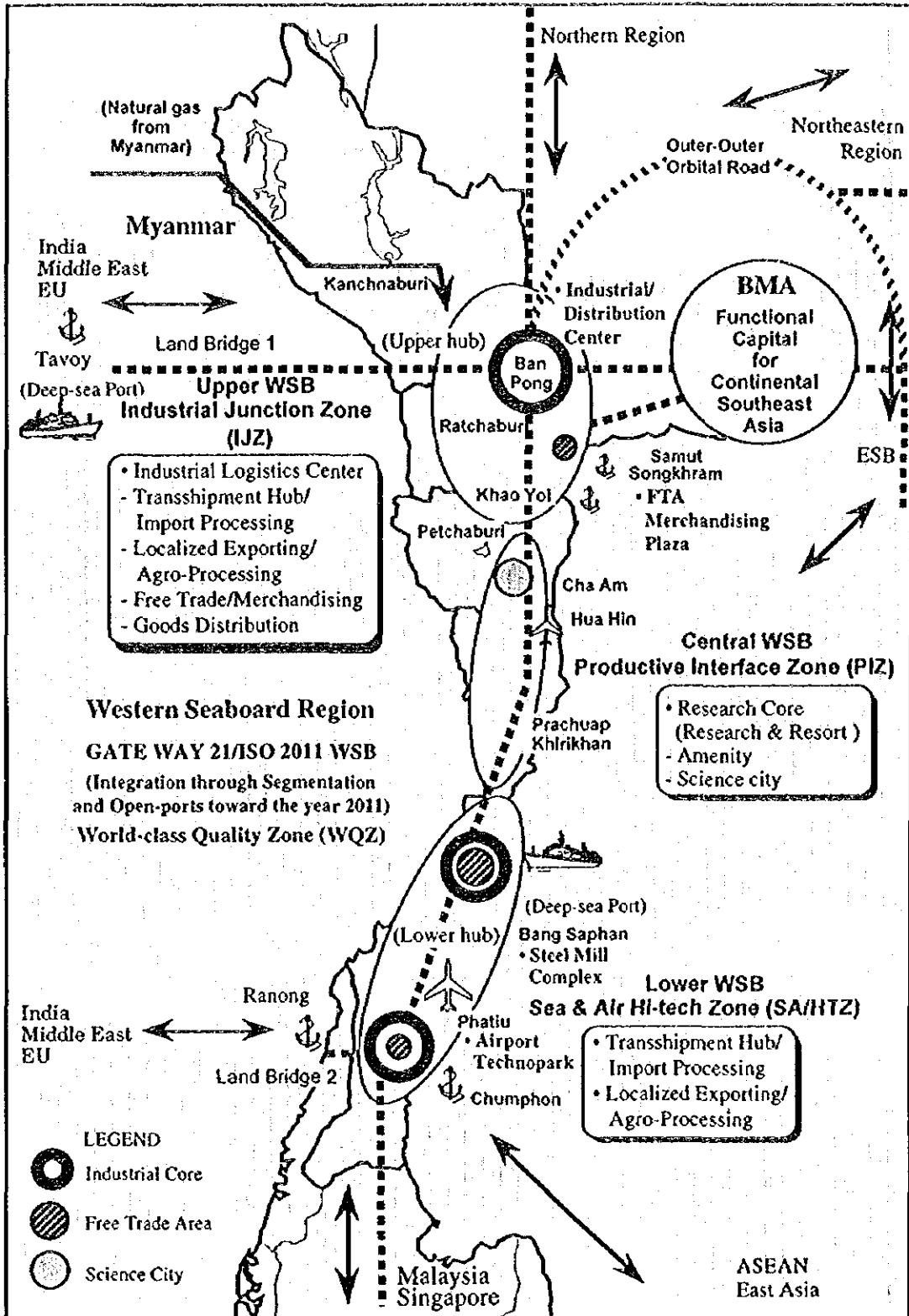


(1) The Upper WSB: Industrial Junction Zone with Industrial Logistics Center

The Upper WSB consists of the provinces of Kanchanaburi, Ratchaburi, and Samut Songkhram, and Khao Yoi in Petchaburi province. This subarea will be an industrial core with substantial potential for linking the WSB with other regions and subregions, e.g., by receiving industrial spillover from the BMR, and serving as an import processing area mainly linked with Myanmar as a whole and Tavoy to be developed as an industrial zone with deep-sea port. In this context, the concept of an "Industrial Junction" may attract many new industries that are oriented toward global gateway functions, and will form an industrial complex in the "Industrial Logistics Center" (ILC) to be extended over areas of Ban Pong in Ratchaburi province and Samut Songkhram.

Figure 7.6.3

Zoning in Subareas for Industrial Development of the WSB



The ILC is a new concept of development activity integrating functions of production, physical distribution, and consumption (depending on the site) to be developed in a compound area on a single site. Ban Pong is a logical place to develop an industrial core and distribution function, since Ban Pong is located at the crossroads of north-south and east-west arteries, and it is also close to the lower part of Myanmar as well as to the BMR.

In addition, Ban Pong's crossroads location is more attractive and easily accessible to other regions in terms of time distance since it will allow bypassing of the BMR after the proposed outer-outer orbital road is developed. The network of the State Railway of Thailand is also available in Ban Pong, encompassing north-south connections (e.g., Northern-Southern region links in Thailand, links to Malaysia) and east-west links (to the BMR and Kanchanaburi). Ban Pong could be said to be a bi-modal transport center.

Samut Songkhram is situated 67 km from the center of Bangkok, and it has a vast area of abandoned shrimp fields that could relatively easily be converted into industrial and urban use. Accordingly, Samut Songkhram is viable for a "Free Trade Area/FTA Merchandising Plaza," encompassing a business center, amusement facilities, convention halls, hotels, light processing factories, or warehouses; also high-class residential facilities (condominium) will be developed. The Samut Songkram FTA will play the role of a sub-business center supplementing the primary business center function of Bangkok, with the FTA also serving a primary wholesaling function serving border provinces in Thailand.

(2) Central WSB: Productive Interface Zone with Science City

The Central WSB consists of areas of Petchaburi province other than Khao Yoi, and the upper part of Prachuap Khirikhan province.

Industrialization conducive to the development of sizable factory sites is undesirable and unrealistic in the Central WSB with its excellent national parks and resort areas including Cha Am in Petchaburi and Hua Hin in Prachuap Khirikhan province. However, such resources could be well mobilized so as to support industrial production activities, and to provide workers with amenity. A "research and resort" center is the answer, and therefore a "Science City" with "research core" will be developed in the Central WSB.

As such, the Central WSB will function as a "Productive Interface Zone" (PIZ) not only to mediate between the Upper and Lower WSB, but also region-wise by integrating industrial production and relevant R&D activities, while inducing high productivity.

(3) Lower WSB: Sea & Air Hi-tech Zone

The Lower WSB will also serve as a global hub in the region with this lower hub to be center on two "industrial cores," Bang Saphan with the deepest seaport in Thailand in Prachuap Khirikhan province, and Chumphon province with a subregional airport to be developed. Optimum combined use of sea and air transport will attract an influx of investments in high-tech areas. The steel mill complex under development will adopt state-of-the-art production technology. Airport-oriented electronics industries will be located around Pathiu airport and will also benefit from upgraded land transport to and from Malaysia.

These industrial cores will serve as Free Trade Areas, with Bang Saphan focused on industrial free trading, and Chumphon oriented not only to industrial trade among airport/export-oriented industries, but also to trade in agricultural products.

6.3 *Prospective Industries by Subarea*

The three subareas of the WSB region, as mentioned above, have different development potentials and perspectives that will attract new investment in manufacturing and related functions.

(1) Upper WSB

Table 7.6.1 shows prospective industries in the Upper WSB. Local resource-based/oriented industries such as canned/processed fruit and vegetables will continue to be the main industries in the subarea; however, some sugar refiners will relocate their factories to the Northeastern region, a new sugarcane producing center of Thailand.

Sizable investments will center on import-processing including wood processing and furniture industries, stimulated by the expansion of subregional linkages mainly with Myanmar. Thai companies will also actively invest in Myanmar, focusing on procurement of industrial resources such as wood and agricultural products, and on labor-intensive industries. In this context, semi-finished products may be processed into final products in the Upper WSB, mainly centering on made-up textiles, leather goods, and jewelry.

Table 7.6.1 Prospective Industries in the Upper WSB up to 2011

Categories of Industry		Industry Type (Products)
1. Local Resource-based	Exporting	<ul style="list-style-type: none"> • Canned/Processed fruit and vegetables • Canned/Processed Fish, etc. • Pottery • Structural Clay Products
	Big Market-orientd	<ul style="list-style-type: none"> • Slaughtering & Meat Products • Dairy Products including Milk
2. Local Resource-orientd	Big Market-orientd	<ul style="list-style-type: none"> • Breweries • Soft Drinks & Carbonated Waters
3. Import-Processing/ Subregional Linkages including "Distribution- Processing"	Wood-related	<ul style="list-style-type: none"> • Sawmills & Other Wood Mills • Furniture, Fixtures and Floorings
	Other Subregional Linkages	<ul style="list-style-type: none"> • Food Processing • Other Made-Up Textiles • Products of Leather & the like • Fertilizers • Jewelry & Related Articles • Sporting & Athletic Goods
4. Gateway-orientd and Spillover from the BMR including big market- oriented	Textile Complex	<ul style="list-style-type: none"> • Spinning, Weaving and Finishing, etc. • Textile Bleaching, Dyeing, Printing and Finishing
	Motor Vehicle-related	<ul style="list-style-type: none"> • Motor Vehicles/Parts • Engine Parts, Transmissions, Brakes, Steering, etc. • Car Radios • Electric Power Vehicle
	Electrical/Electronic	<ul style="list-style-type: none"> • Computer Components • Telecommunication/Data-communication Equipment • Facsimile Machines • Videodisc/Videotex Systems • Audio/Compact Disc • Home Electronics • Electrical Appliances & Housewares • Testing, Measuring and Analyzing Equipment • Power Supplies for Electronics Uses
	Others	<ul style="list-style-type: none"> • Paints, Varnishes and Lacquers • Drugs & Medicine • Soap, Perfume and Cosmetics • Plastic Products excluding Industrial Use • Glass & Glass Products • Metal Furniture & Fixture • Structural Metal Products • Fabricated Metal Products • Other Construction Materials
5. Satellite Industries	Genral	<ul style="list-style-type: none"> • Rubber Products • Plastic Products
	Electrical/Electronic	<ul style="list-style-type: none"> • Electronic Parts/Opto-Electronic Devices • Switches/Keyboards/Relays • Magnetic Components • Connectors • Printed Circuit Boards • Flat, Shielded, Coaxial or Signal Cables • Electronic Tubes • Insulated Wires and Cables • Electronic Subassemblies
6. Supporting Industries including Agriculture- related	Genral	<ul style="list-style-type: none"> • Wooden & Cane Containers • Pulp, Paper and Paperboard/box • Synthetic Resins and Industrial Plastics
	Machinery related	<ul style="list-style-type: none"> • Mold and Die • Steel and Other Metal Casting/Forging • Surface Treatment/Machining/Stamping • Heat Treatment
	Others	<ul style="list-style-type: none"> • Agricultural Machinery & Equipment • Wood & Metal Working Machinery • Cutlery, Hand Tools, etc. • Metal Containers • Repair, Maintenance and Refurbishing of Containers

Industrial spillover from the BMR will be accelerated in response to the planned motorway or outer-outer orbital road development. Industries oriented to the subarea's gateway functions will locate factories in industrial estates and Ban Pong Industrial/Distribution Center (BPIDC), the latter of which will be developed in the crossroads area. Electrical/electronic industries producing finished products such as multi-media equipment will be "core industries" that will form industrial clusters linked with satellite and supporting industries as shown in Table 7.6.1 and Figure 7.6.4. Motor vehicle industries will also be viable through production linkages with Ayutthaya and the BMR, both of which are main motor assembly centers. Sizable agglomerations of motor vehicle industries including bus body building will be an important factor attracting investment in motor parts and components.

A textile complex will be formed mainly as a result of relocation from the BMR, particularly from Samut Prakhan, where industries such as dyeing have faced severe environmental problems. The Upper WSB, with its abundant water supply, will provide a good production environment for such industries to be located in an industrial estate with water treatment facilities.

Supporting industries, especially machinery-related industries, have been strategically promoted by the Government without any limitation on zonal location to obtain BOI incentives. The Upper WSB will provide for such industries with a good location, including reliable electrical power supply (as the region is a national power supply center) and abundant water, as well as its gateway functions when the WSB is linked to Ayutthaya, the BMR, and foreign countries including Myanmar.

In conclusion, industrial clusters centering on agro-processing, motor vehicle, textiles, and electrical/electronic assembly including industries supporting these core industries, will be formed in the Upper WSB. These clusters with inter-industry linkages will diversify the industrial structure of the Upper WSB leading to greater value added. The Upper WSB, the "Industrial Junction Zone," will develop as a subregional industrial and foreign trade center in Thailand, and will generate the next generation of industries in the country.

(2) Central WSB

The Central WSB, a "Productive Interface Zone," will serve as a research and development core as well as a tourism center, and will therefore have no industrial estate development. New industrial location or investment will be minimal, and progress centering on local demand oriented industries producing food, construction materials, and wood processing

incorporated to attract and organize researchers and R&D institutes, helping to create a productive and interface zone in the Central WSB.

(3) Lower WSB

The Lower WSB will be an industrial center with two "Free Trade Areas" in Bang Saphan, Prachuap Khirikhan province, and Pathiu, Chumphon province.

Industrial complexes will be formed in Bang Saphan as shown in Table 7.6.2, comprising food processing, wood processing, carbonate 1 (C1)-based chemicals, and steel production industries. These complexes will utilize Thailand's deepest seaport, thereby minimizing transportation cost, and materializing inter/intra-industry linkages.

Airport-oriented industries will locate their factories in an industrial estate to be developed around Pathiu airport, which will emerge as a subregional airport. Airports, particularly international airports, are crucial for industrial development. According to data on international trade compiled by the Customs Department, air freight accounted for 24.4 per cent of the country's total export value and 29.5 per cent of its total import value in 1994. Airport-oriented industry, with a high ratio of air freight (on a value basis), comprise mostly "gram industries" and "kilogram industries."

Gram industries include precious metal/goods, fur skins or leather products, pharmaceuticals, special transactions (e.g., consigned works of electronics) and precision instruments, i.e., items with a high value per weight and therefore with a transport cost that is minimal in relation to total value/cost. Kilogram industries, such as electrical or electronic equipment, wearing apparel, some high-quality textiles and ceramics, organic chemicals and toys, are also users of air transport. All of these industries are candidates for locating factories in industrial estates or areas around airports. Prospective industries in the Lower WSB will be mainly those manufacturing electronics and precision instruments (as shown in Table 7.6.2) in consideration of the Lower WSB's gateway functions and linkages with Malaysia, where advanced electronics industries are already agglomerated.

As such, the Upper WSB will be a "Sea & Air Hi-tech Zone" through optimum combined use of sea and air transport, which will attract an influx of investments in high-tech areas.

Table 7.6.2

Prospective Industries in the Lower WSB up to 2011

Categories of Industry		Industry Type (Products)
1. Local Resource-based	Exporting	<ul style="list-style-type: none"> • Canned/Processed Fruit and Vegetables • Canned/Processed Fish, etc.
	Domestic	<ul style="list-style-type: none"> • Palm Oil Refinery • Dairy Products
2. Import-Processing and Deep-sea Port-oriented	Food Complex	<ul style="list-style-type: none"> • Vegetable & Animal Oils and Fats • Flour/Starch • Prepared Animal Feeds • Other Food Processing
	Wood Complex	<ul style="list-style-type: none"> • Sawmills & Other Wood Mills • Wooden & Cane Containers • Furniture, Fixtures and Floorings
	Chemical Complex	<ul style="list-style-type: none"> • Basic Industrial Chemicals • Fertilizers & Pesticides • Synthetic Resins & Plastics • Other Organic Chemicals
	Steel Complex	<ul style="list-style-type: none"> • Hot/Cold Rolled Steel Sheets or Coils • Steel Structures • Steel Tubes or Pipes • Coated Steel Sheets or Coils • Steel wire Rods, Steel Wire, etc. • Steel Round Bars or Deformed Bars • Steel Plates
	Heavy Machinery	<ul style="list-style-type: none"> • Boilers • Engine/Turbins, etc. • Air Compressors • Conveyers, Loading/Unloading Equipment • Chemical Plants, etc. • Batteries • Steel Shipbuilding and Repair
3. Gateway and Airport-oriented	Electronics	<ul style="list-style-type: none"> • Quartz Crystals • Electronic Subassemblies • Micro-Motors • Electrical Musical Equipment • Electronic Toys/Electronic Games • Medical Electronic Equipment • Lenses or Spectacles or Parts • Electronic Cameras/Watches/Clocks • Electronic Parts
	Others	<ul style="list-style-type: none"> • Drugs & Medicine • Mechanical Parts
4. Other Industries		<ul style="list-style-type: none"> • Textile Spinning, etc. • Rubber Products • Plastic Products • Structural Metal Products • Fabricated Metal Products • Construction Materials

Note: Industries to be located in Bang Saphan (refer to the Feasibility Study on Bang Saphan Industrial Estate: JICA/IEAT)

6.4 Development Projects and Support Measures

Projects/programs and policy measures for the industrial development of the WSB should be carried out through the development strategies set out in Chapter 4 so as to effectively materialize the development perspectives and introduce the prospective industries mentioned before. At the same time, step-by-step progress is realistic and desirable for well planned development with the internal mechanism of regional growth, summarized in Figure 7.6.5.

Figure 7.6.5

Industrial Development Phasing/Mechanism in the WSB Region

PHASE I (1997-2001)

Localization



- Partly rapid growth
- GPMP 81.9 billion Baht in 2001/growth rate 14.13 %/year (1995-2001)
- Employment 372,200 in 2001
- New industries (1995-2001)
 - Employment 118,800
 - Modern sector 57,900
- Factory site demand 709 hectares (4,430 rai)

Area Segmentation/ Identity Formation

- Pinpoint development
- Identification of area's characteristics, development resources, and advantages through differentiation
- Agro-Industrialization
- Highlight: Bang Saphan Development

PHASE II (2002-2006)

Globalization



- Overall high growth
- GPMP 130.8 billion Baht in 2006/growth rate 9.82 %/year (2002-2006)
- Employment 440,500 in 2006
- New industries (1995-2006)
 - Employment 173,000
 - Modern sector 93,000
- Factory site demand 1,172 hectares (7,324 rai)

Core Formation

- Area development/ industrial core
- Urban-Industrialization
- Industrial clustering synchronized with urbanization
- Governance
- Decentralization

PHASE III (2007-2011)

**Glocalization
Global/Local
Integration**

- Sustainable growth
- GPMP 208.5 billion Baht in 2011/growth rate 9.82 %/year (2007-2011)
- Employment 535,100 in 2011
- New Industries (1995-2011)
 - Employment 250,100
 - Modern sector 106,400
- Factory site demand 1,877 hectares (11,730 rai)

Regional Integration

- Industrial complex
- Rural industrialization
- rural-urban integration
- Networking development
- Governance
- More decentralization

Note: "New industries" mean factories to be established from 1995 to 2011.

Industrial development in the WSB region will be programmed on the basis of the projects/programs outlined below. (Table 7.6.3)

Phase I (1997-2001)

Phase I will be a period for segmentation, a preparatory stage for the core formation to occur during Phase II. Phase I will focus on the individual regional and industrial characteristics of areas, and it will utilize their comparative advantages to effectively advance the industrial development of the WSB region. During this phase, local and indigenous resources will be

fully mobilized, and agro-industrialization will be promoted along with the introduction of new industries. As such, efforts will be concentrated on localization and pinpoint area development. Subregional linkages with Myanmar will progress gradually in line with development of a deep-sea and industrial zone in Tavoy.

Table 7.6.3 Projects/Programs and Policy Measures for the Industrial Development of the WSB

	Phase I (1997-2001)	Phase II (2002-2006)	Phase III (2007-2011)
Development Stage	Segmentation (Localization)	Core Formation (Globalization)	Regional Integration (Glocalization)
Industrialization	• Agro-industrialization	• Urban-industrialization Industrial clustering	• Rural-industrialization Industrial complex
Development Pattern	Pinpoint development	Area development	Networking development
Economic Growth	Partly rapid growth	Overall higher growth	Sustainable growth
Governance		Decentralization	More decentralization
Industrial Development Projects/Programs by Phase			
Regional/Area Development Strategy-related and Institutional-related (including "Free Trade Area"/FTA)	(1) Industrial Land Development (* New development, # Industrial core)		
	<ul style="list-style-type: none"> • Kanchanaburi Industrial Estate (IE: 109 ha) • Mahachay IE/Ratchaburi (208 ha) • Khao Yoi IE/Pechaburi (240 ha) • S. Songkhram/FTA Merchandising Plaza * (65 ha excluding areas other facilities) • Bang Saphan IE (FTA) * # (618 ha) • Chumphon/Airport Technopark (FTA) * # (100-150 ha) • Ratchaburi, Ban Pong Industrial/Distribution Center # (120 ha) • Other IEs * • SMEs Industrial estate * 		
	(2) Agro-Industrial Community Model/Community-based Development		
	<ul style="list-style-type: none"> • Rural industrial development projects • One product-one village project • Barn factory program 		
Quality & Productivity Development Strategy-related and Entrepreneur-related	(3) Quality/Productivity Enhancement		
	<ul style="list-style-type: none"> • Specific industry modernization program • Local specialty product development program integrated with tourism • Factory park program • Productive manpower development program 		
	(4) Industrial R&D Promotion		
	<ul style="list-style-type: none"> • Regional R&D and testing center • Integrated incubation system • WSB techno-consortium • Applied research core (as a component of Science City) 		
Other	(5) Investment Promotion		
	<ul style="list-style-type: none"> • Tavoy development consortium • Special deduction of electricity tariffs in the national power supply center • New investment promotion 		

Note: Area of industrial estate = gross area including factory site and areas for other facilities

1) Industrial land development

Development of four industrial estates (IEs) including the Bang Saphan IE will progress, amounting to a total area of 1,157 hectares (7,231 rai) of gross land including factory site

and areas for other facilities. During this Phase, new industrial locations will center on these IEs.

Free Trade Area (FTA) project

Free Trade Areas are planned in the Upper and Lower WSB, utilizing the gateway functions of these two subareas. Particularly, the objective is to channel sizable investments into the FTAs by allowing "free" international and domestic trade before the AFTA and WTO agreements become fully effective in the early years of the 21st century. As a new institutional arrangement with an independent customs domain, it will be possible in the FTAs to trade and store goods free from the ordinary customs laws. These FTAs will be managed by autonomous bodies with independent authorities. In this context, the FTAs could function as experimental areas spearheading the drive toward future decentralization.

2) Rural-industrial community model/community-based development

The agro-industrial community model project would be promoted in some districts (amphoes) with active participation of villagers and support from the **Rural Industrial Development Project** of the Ministry of Industry. Villagers will find indigenous resources suitable for manufacturing and develop markets in cooperation with traders, concerned government agencies, and NGOs. Handicrafts, food processing, and herbal medicine are among the possibilities to be considered. Villagers will be guided to establish cooperatives or villagers' corporations, with shares to be held by the villagers themselves. Thus, community-based/rural industrialization will be initiated and move forward. The development of the **one product-one village** concept will proceed by village and will be carried out through market and product segmentation among villages. Many products of unique specialty will be produced. "**Barn factory**" will generate second job opportunities by utilizing barn space, while contributing to the formation of industrial linkages with new industries to be located in the WSB region.

3) Quality/productivity enhancement

The results of the Industrial Questionnaire Survey conducted by the Study Team (IQS/ST) indicated that modernization of the production process and manpower development with the objective of production expansion with higher value added are major strategies currently pursued by the region's manufacturers. By subsector, modernization is more critical in sugar refining, palm oil refining, wood products including furniture, and shipbuilding and repair industries, while manpower development is more crucial in motor vehicle industries (mostly composed of bus body assembly) and the other machinery and equipment subsector. (Figure 7.6.6)

Figure 7.6.6 Basic Growth Strategy of (Existing) WSB Manufacturers

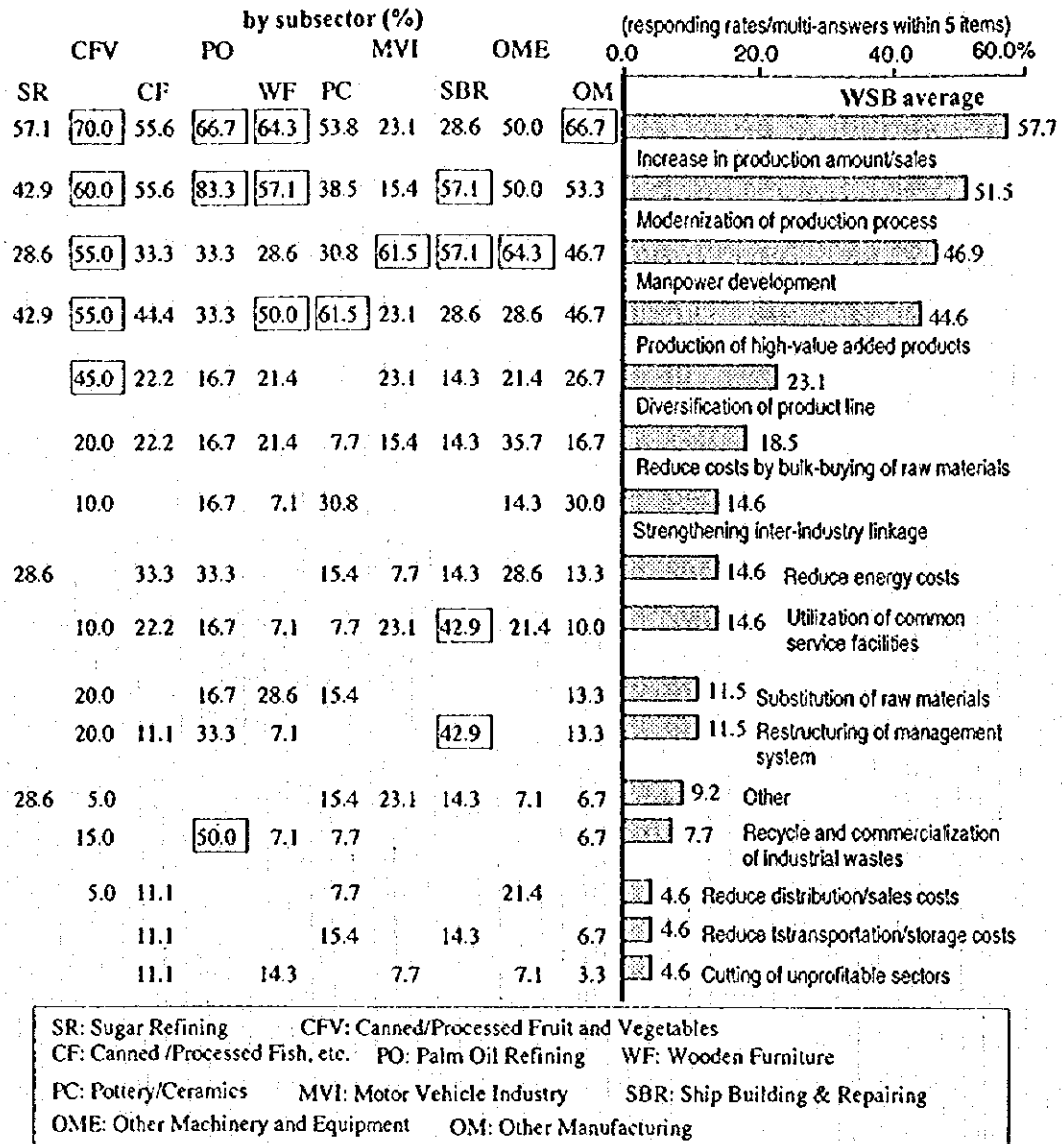
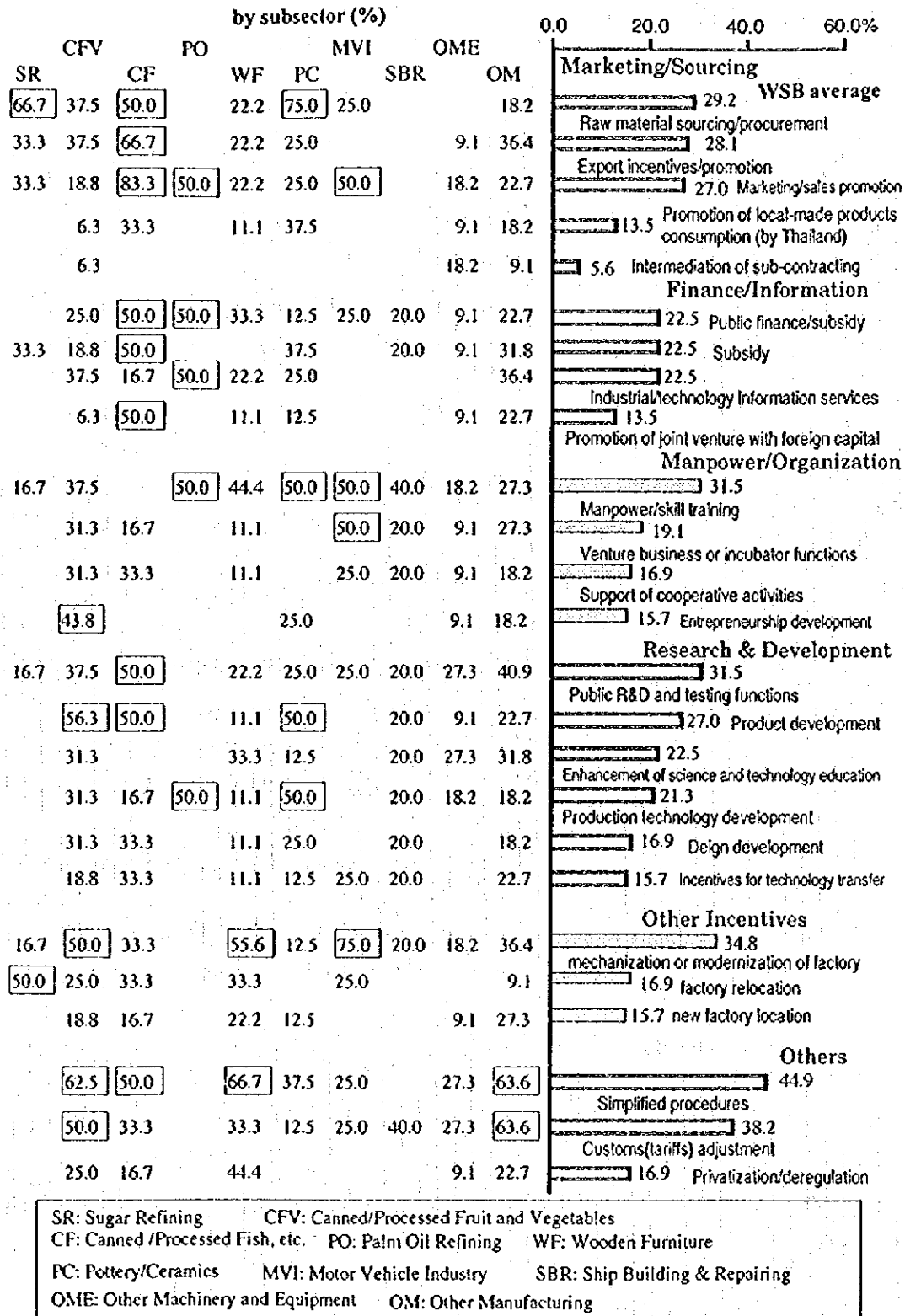


Figure 7.6.7 illustrates government policy measures to be strengthened judging from the IQS/ST; manufacturers currently existing in the WSB region have put forward many policy proposals. Marketing and manpower/skill development are expected to receive support from such policy measures.

The WSB manufacturers also emphasized strengthening policy measures for public R&D and testing functions including assistance in production technology development. Furthermore, they urged that incentives for mechanization and modernization be strengthened.

Figure 7.6.7 Government Policy Measures to be Strengthened



Source: Industrial Questionnaire Survey by the Study Team (IQS/ST)

In response to the stated needs of WSB manufacturers, a project package of quality/productivity enhancement has been formulated; it aims mainly to strengthen their competitiveness or productivity of the region's manufacturers within the globalizing economy.

A **specific industry modernization program** will be developed and will consolidate the foundation of regional industries through a modernization plan of grouped manufacturers or cooperatives, with support by concessional loans and compensation for the disposal of obsolete facilities.

A **local specialty product development program** will develop local resource-based products in line with tourism development. Organized producers and shopkeepers, including first-class hotels, will implement this program in cooperation with concerned government agencies, colleges, and universities in the WSB region. As a component of this program, demonstration sales (e.g., of handicrafts) at studios may contribute to preparatory vocational education.

A **factory park program** will serve to educate students through the opening of factory facilities to visitors, also in relation to the region's national excursion center.

A **productive manpower development program** will strengthen the subsectors' specific skills training through efficient coordination among the existing and proposed public institutes in the WSB region, systematize skills/manpower development through linkages between the public institutes including colleges/universities and manufacturers (e.g., training of core/leader persons who transfer the skills to factory workers), and promote "on-the-job training" through providing incentives to in-house training to efficiently upgrade the skills of workers, minimizing government expenses while meeting the needs of manufacturers.

4) Investment promotion

While BOI zonal incentives have well worked to decentralize industries from the BMR to provincial areas, additional investment promotion measures specific to the WSB region will be necessary to advance area development harmonized with the natural environment.

A **Tavoy development consortium** will be incorporated for development of Tavoy deep-sea port and associated infrastructure including an industrial estate. The Tavoy development will strengthen the WSB's global gateway functions. The Kanchanaburi branch of the Federation of Thai Industries (FTI) is expected to play a leading role in incorporating the consortium with support of the Thai government.

A special deduction of power tariffs in the provinces of the WSB wherein a power plant is or will be located will promote investment in manufacturing industries, particularly power-intensive industries, in compensation for the local burden of serving as a national power supply center in Thailand.

New investment promotion measures will provide specific incentives in the WSB region to promote resource recycling industries and to generate funds to create a high-quality environment.

Phase II (2002-2006)

Phase II will be an epoch-making period for the industrial development of the WSB. Subregional linkages and globalization of industrial activities in the WSB region will progress deeply and substantially. Transactions between the WSB and foreign countries including Myanmar will be more active in terms of the exchange of goods, human resources, capital, and information. Based on the regional and industrial segmentation or characterization of areas for further development, the development of industrial cores synchronized with the region's urbanization will progress in Phase II. Furthermore, industrial clustering will be pursued through structuring industrial core, satellite and supporting industries, and community-based/barn factories.

In other words, industrial core development should be promoted to generate a greater agglomeration of industries with many inter-industry linkages and multiplier effects so as to integrate industrialization and urbanization conducive to the region's further development. Accordingly, industrial development in the WSB region will shift to the area development approach through a pinpoint strategy. During this phase, human empowerment and administrative decentralization from Bangkok are expected to substantially progress.

The development projects and support measures implemented during Phase I will continue to operate, at an enhanced level of effectiveness, and new efforts will be focused on industrial R&D promotion and development of an Industrial/Distribution Center during Phase II outlined below.

1) Industrial land development

New industrial estates will be developed around Ban Pong (Ratchaburi province) and in Chumphon province.

Ban Pong Industrial/Distribution Center (BPIDC)

The BPIDC will be the core project in the Upper WSB, one component of the Industrial Logistics Center (ILC) to fully establish the area's gateway functions. BPIDC will combine in a compound area the following five components: an industrial estate, a distribution center, a truck terminal, an inland clearance depot, and regional R&D and testing center. (Refer to Appendix III)

SMEs industrial estate

Promotion of small and medium enterprises (SMEs) is very important not only to provide a firm foundation for the industrial structure as a whole, but also to modernize the so-called "non-modern sector" which absorbed more than 60 per cent of manufacturing employment in the WSB in 1994. Linked to this effort, an industrial estate for the SMEs will be promoted mostly in urbanized areas; they will provide not only standard and rental factories at low rents, but also some common service facilities that can be operated at reduced costs.

2) Industrial R&D Promotion

In response to the globalizing economy, an industrial R&D promotional package will be designed to strengthen the competitiveness and productivity of manufacturers in the WSB through facilitation of the formation of regional R&D cores by organizing concerned entities.

A regional R&D and testing center will be one of the R&D cores in the WSB region, with the R&D functions relating to the fields of agriculture, manufacturing, construction, and information, which will respond to progress of borderless modern technologies and create new technologies through interdisciplinary R&D.

An integrated incubation system will foster the entrepreneurial qualities of the third generation of Thai industrialists, with functions such as: (i) provision of an open laboratory with R&D facilities; (ii) assistance for production of prototype products; (iii) assistance for market development; and (iv) assistance for the establishment of enterprises producing new products.

A techno-consortium will guide technology development in the WSB region by organizing local manufacturers, as well as R&D staff in colleges, universities, and public institutes.

Phase III (2007-2011)

Phase III will be a period of regional integration for sustainable growth and consolidation for further development of the WSB region. Industrial development in rural and urban areas will take the shape of integrated "rurban" industrialization with inter-industry linkages. This

glocalization in the WSB region will be represented by borderless/free transactions, world-class technology and R&D functions including a Science City, and world-class production centers comprising industrial complexes with strong inter/intra-industrial linkages or agro-industrial linkages formed through greater intersectoral integration. Decentralization in both administration/governance and industries will be fully extended. Accordingly, development efforts will be focused on networking for regional integration of the WSB region.

Development projects and support measures established during Phases I and II will continue with enhanced effectiveness, and new efforts will be focused on networking of industrial R&D activities during Phase III.

An applied research core will be developed as a component of the Science City through networking all concerned manufacturers, R&D laboratories, public institutes for regional R&D, testing centers, Rajabhat Institute, universities, and other agencies. It will provide any and all services for exchange of information on science and technology, and generation of the seeds of new technology and original Thai products. This core will cover such areas as biotechnology, electronics, computer and information technology, and new materials. Conventions inviting the most advanced researchers in the world will be held. This core will be established as a foundation supported by all concerned people and organizations.

6.5 Development Projects and Support Measures by Subarea

Development projects and support measures already proposed will be implemented by subarea as shown in Table 7.6.4.

Industrial land development is in principle planned in consideration of balanced development within the WSB region including factory site demand of new industries and harmonized development with the natural environment, especially in the Central WSB.

An agro-industrial community model (AICM) project will be carried out in all the subareas or provinces in the region, since this project has been conceived to develop rural areas. The quality/productivity enhancement project has almost the same character as that of the AICM, while the proposed "factory park" will be suitable for the Central WSB, which is a national center of excursion.

Table 7.6.4 Development Projects and Support Measures by Subarea

	Upper WSB	Central WSB	Lower WSB
1. New factory site demand up to 2011 (1,876.9 ha)	775.0	198.7	903.2
2. Development Projects/Support Measures			
(1) Industrial Land Development			
(* New development, # Industrial core)			
• Kanchanaburi Industrial Estate (109 ha)	Phase I		
• Mahachay IE/Ratchaburi (208 ha)	Phase I		
• Khao Yoi IE/Pecthaburi (240 ha)	Phase I		
• S. Songkhram/FTA Merchandising Plaza * (100 ha)	Phase I		
• Bang Saphan IE (FTA) * # (618 ha)			Phase I
• Chumphon/Airport Technopark (FTA) * # (100-150 ha)			Phase I
• Ratchaburi, Ban Pong Industrial/Distribution Center # (160 ha)		Phase II	
• Other IEs *	Phase II		Phase II
• SMEs industrial estate *	Phase II		
(2) Rural-Industrial Community Model/Community-based Development			
• Rural industrial development projects	Phase I	Phase I	Phase I
• One product-one village project	Phase I	Phase I	Phase I
• Barn factory program	Phase I	Phase I	Phase I
(3) Quality/Productivity Enhancement			
• Specific industry modernization program	Phase I	Phase I	Phase I
• Local specialty product development program integrated with tourism	Phase I	Phase I	
• Factory park program	Phase I	Phase I	
• Productive manpower development program	Phase I	Phase I	Phase I
(4) Industrial R&D Promotion			
• Regional R&D and testing center	Phase II		
• Integrated incubation system		Phase II	
• WSB techno-consortium		Phase II	
• Applied research core (as a component of Science City)		Phase III	
(5) Investment Promotion			
• Tavoy development consortium	Phase I		
• Special deduction of electricity tariffs in the national power supply center	Phase I		Phase I
• New investment promotion	Phase I	Phase I	Phase I

Note: Phase I (1997-2001), Phase II (2002-2006), Phase III (2007-2011)

Area of industrial estate = gross area including factory site and areas for other facilities

Industrial R&D promotion projects will serve all provinces of the WSB, but they will not be implemented in the Central WSB, where a Science City will be developed (Refer to Volume 5, Chapter 2). A regional R&D testing center will be an exception, since it will be developed as one component of the Industrial/Distribution Center in Ban Pong-Ratchaburi province.

The Tavoy development consortium will be established in Kanchanaburi province because of its proximity to Tavoy and keen efforts undertaken by the Kanchanaburi branch of the Federation of Thai Industries. A special reduction of electricity tariffs will be applicable to

power generation plant areas, and new investment promotion will be carried out throughout the WSB region.

6.6 Action Programs

The Eighth National Social and Economic Development Plan (Eighth Plan) is the first national plan in Thailand formulated with a "bottom-up" approach. This Industrial Development Study has been carried out incorporating public participation as much as possible through a questionnaire survey, interview surveys, workshops specific to proposed projects, and technical seminars.

In translating proposed plans into implementation, further involvement of local people will be essential, for which action programs to be taken up in the 8th Plan period (1997-2001) or Phase I of this Study are outlined below.

- 1) Practical arrangements for new industrial land development will be undertaken. The Bang Saphan Industrial Estate will be developed by joint partnership between private groups and IEAT. Such an arrangement along with the establishment of an autonomous implementation body for the Merchandising Plaza (Samut Songkhram) and Airport Technopark (Chumphon) Free Trade Areas through coordination between and among concerned entities including local authorities, private enterprises, and local people. In addition, the Ban Pong Industrial/Distribution Center (Phase II) project will be further studied at the feasibility level as early as possible, since it is one of the core projects to direct industrial development of the WSB region toward a Global Hub.
- 2) The agro-industrial community model (AICM) project will be supported by the Ministry of Industry (MOI) carrying out the Rural Industrial Development Project from 1996. To date, this project has not been implemented in the WSB region. MOI's Regional Industrial Promotion Center in Suphan Buri, which is one of 11 centers in Thailand, is expected to disseminate the project and encourage local people or small and medium enterprises (SMEs) so that they can participate in the project. MOI's Department of Industrial Promotion (DIP) has a budget for this project (program) amounting to 1.43 billion Baht to be allotted to 480 individual projects from 1997 to 2001, accommodated with a training seminar, mediation activity, consultancy service, product development, provision of machinery and other equipment for production, and other relevant activities. The particularities of local areas will need to be respected in implementing this project to create new

business in rural areas in the WSB region; in this context, the "one product-one village" or "local specialty product" approach emphasized in this Study may be a useful reference. A target will be set for the AICM project in the WSB region, i.e., one project per province per year between 1997 and 2001, a total of 30 projects during the five-year period. For now, efforts should be focused on producing a successful project, which can then be replicated.

- 3) The specific industry modernization program will be accorded first importance among the quality/productivity enhancement projects, since there are a number of manufacturing subsectors in the WSB critically requiring modernization or transformation:

- Mechanization in response to the shortage of unskilled labor, and establishment of food preserving/bacteria control technology for canned/processed fruit and vegetable industry;
- Collective modernization and systematization of production to foster competitiveness for the wood products and furniture industry, including preparation of common service facilities; and
- New business area development accompanied with mechanization for bus body building, and ship building and repair industry, since the former will face a narrowing market due mainly to already commenced operation of original bus assembling factory in Thailand, while the latter will have to switch its product from wooden to steel ships in accordance with forthcoming Government regulations.

As such, organizing manufacturers of these industries to prepare a "modernization plan" will be the first step. The Federation of Thai Industries (FTI) and the Ministry of Industry are expected to lead and coordinate this modernization plan as early as possible.

- 4) Projects/programs regarding industrial R&D promotion are to be materialized during Phase II; however, the regional R&D center project will be studied in advance with the focus on its function, facilities, the equipment to be installed, staffing (e.g., researchers, engineers, and instructors), operation system, and so on.
- 5) Investment promotion measures specific to the WSB region, particularly the proposed special reduction of electricity tariffs, is expected to be put into effect as early as possible with coordination among the concerned agencies including BOI, MOI, and EGAT. A new promotion program for resource recycling industries is expected to obtain BOI incentives.

APPENDIX I

POSSIBILITY OF DOWNSTREAM GAS INDUSTRIES IN THE WSB REGION

Possibility of Downstream Gas Industries in the WSB Region

1. Introduction

(1) Background and Objective of the Preliminary Study

The Petroleum Authority of Thailand (PTT) is undertaking projects to import natural gas from Myanmar and supply it mainly to power plants in Ratchaburi province. In line with the natural gas, this study will investigate a possibility of downstream gas industries in the WSB region.

(2) Scope of the Study

While there has been no proposal to date to use the natural gas from Myanmar as raw materials, it is expected that some proposals would be submitted to PTT. If submitted, the possibility of downstream gas industries could be checked by marketability of the products and by the feasibility of the operation based on the proposals. Without any specific proposals, therefore, the possibility could only be studied focusing on the following items:

1. Outline of Myanmar Natural Gas Projects
2. Outline of Downstream Gas Products
3. Demand and Supply Situations of Downstream Gas Products
4. Possibility of Downstream Gas Industries in WSB Region

2. Outline of Myanmar Natural Gas Project

Myanmar gas projects relating to PTT are outlined in Table A1.1.

Table A1.1 Outline of Myanmar Natural Gas Projects on Gulf of Martaban

	Yadana Gas Field	Yatagon Gas Field
Location	Gulf of Martaban	Gulf of Martaban
Deposits	6-7 trillion cubic feet (CF)	1.5 trillion cubic feet (CF)
Developer (Product Sharing Contractor)	<ul style="list-style-type: none"> • French-Total (36.75%) • US-Unocal (33.25%) • Thai-PTTEP (30.00%) 	<ul style="list-style-type: none"> • US-Texaco (50.00%) • British-Premier Consolidated (30.00%) • Japan-Nippon Oil (20%)
Main Usage	<ul style="list-style-type: none"> • Fuel for power plants in Ratchaburi of Thailand (525 MMCFD) • Raw materials for fertilizer and fuel for power plants in Myanmar 	<ul style="list-style-type: none"> • not fixed but PTT will import 200 MMCFD

The Myanmar Oil and Gas Enterprise (MOGE), which is a national corporation under the Ministry of Energy (MOE), is exclusively in charge of administration for exploration, development, and transportation of natural gas. Foreign companies have participated in the exploration and development of natural gas as subcontractors based on production sharing contracts with MOGE since 1977.

PTT in Thailand already contracted to import 525 million cubic feet per day (MMCFD) of natural gas generated from Yadana Gas Field for 30 years from 1998. The gas price has initially been set at US\$3 per million British Thermal Unit (MMBTU, 1 BTU=1.8 Kcal/kg) at the international border; the price is to be increased according to escalation factors such as inflation rate and the like. It is reported that 125 MMCFD of Yadana gas will be used in Myanmar for fertilizer production and power generation. Reports indicate that the Yadana Gas Field can produce up to 1,000 MMCFD; thus an additional 475 MMCFD from the field appear to be feasible.

PTT also agreed to import 200 MMCFD of Yatagon gas from 1999. The gas price is set at US\$ 3.07/MMBTU at the international border.

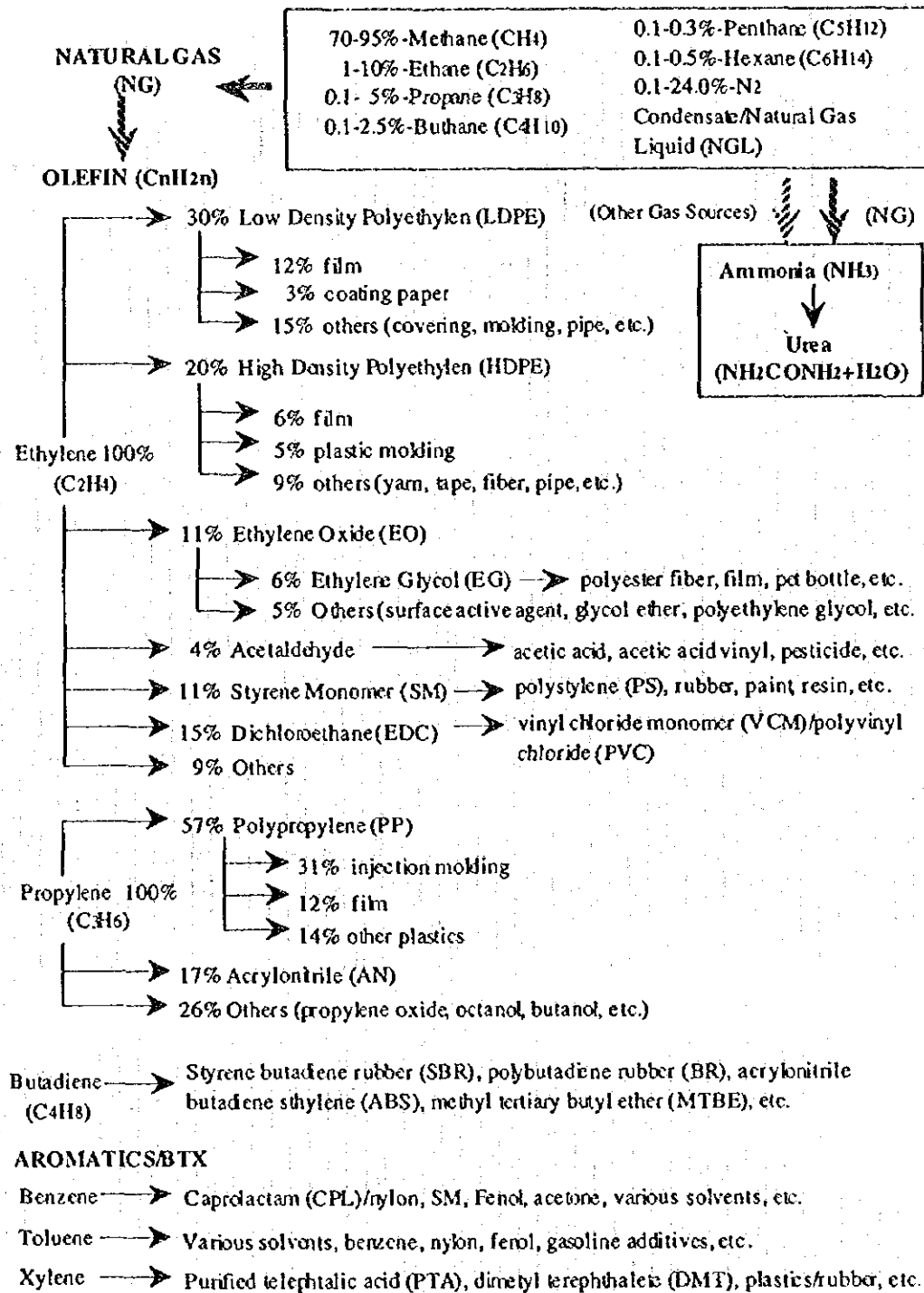
3. Outline of Downstream Gas Products

Natural gas is used mainly for fuel and industrial raw materials. Thailand's consumption of natural gas was 284,994 MMCF in 1993, out of which 264,639 MMCF or 93 per cent of the total was used for electricity generation while 6,237 MMCF or 2.2 per cent of the total were used for petrochemical industries. Liquefied natural gas (LNG) compressed with a high pressure is also used for refrigeration.

Natural gas is composed of hydrocarbons such as methane, ethane, propane, butane, pentane and hexane. Methane is the main component constituting 70-95 per cent of natural gas while ethane constituting 1-10 per cent. These hydrocarbons are used for industrial raw materials with processing through a separation plant or condensate splitting plant. In Thailand, separated ethane and propane are raw materials for olefins such as ethylene and propylene. Ethylene is used for producing polyethylene, ethylene oxide (EO), styrene monomer (SM), dichloroethane (EDC), and the like. Propylene is the raw material for polypropylene (PP), which is also one of the main raw materials for plastics. Condensate or natural gas liquid (NGL) is split to produce LPG, gas oil, and naphtha, the latter of which is another feed for ethylene and propylene. These production processes occur in a "petrochemical complex" wherein processes are vertically and horizontally integrated through a balance of materials and economies of scale in production. (Figure A1.1)

Figure A1.1

Outline of Downstream Gas Products/Petrochemicals



Note: Percent shares are based on the data in Japan (1994).

Ammonia is also one of the downstream gas products synthesized from hydrogen and nitrogen. Hydrogen is produced from methane of natural gas through catalytic reforming. Urea is a chemical compound with ammonia and carbon dioxide.

4. Demand and Supply Situations of Downstream Gas Products

(1) Petrochemicals

Petrochemical industries, especially upstream industries such as those producing olefins (ethylene and propylene) and aromatics (benzene, toluene, and mixed xylene), are heavily capital-intensive industries and therefore domestic production of petrochemicals is an indicator representing a higher level of industrialization.

The first petrochemical complex in Thailand was established by the National Petrochemical Co., Ltd. (NOC) in October 1989. The complex called NPC-1 with capacities 315,000 tons/year of ethylene and 105,000 tons/year of propylene started operation in 1990; however, it did not enter full operation until 1994, as its gas separation plant experienced some initial problems.

Correspond to domestic demand expansion, NPC-2 operated by the Thai Olefins Co., Ltd. (TOC) started operation in 1995 (350,000 tons/year of ethylene and 190,000 tons/year of propylene). The Aromatics (Thailand) Company Ltd. (ATC) will start operation in 1997, with capacities 200,500 tons/year of benzene, 52,000 tons/year of toluene and 15,000 tons/year of Xylene. In addition, NPC-3 is planned to produce 350,000 tons/year of ethylene and 250,000 tons/year of propylene but its implementation is not yet commenced. Two other ethylene centers (TPI and ROC) shown in the following Table will start operation in near future. The five ethylene centers are located at Map Ta Phut in Rayon province and will have a total capacity of more than 2 million tons of ethylene/year. (Table A1.2)

Table A1.2 Present and Future Capacities of Ethylene Centers in Thailand

Ethylene Centers		Capacity (tons/year)	1996	2000	
NPC-1	National Petrochemical Co. (NPC)	401,000	401,000		
NPC-2	Thai Olefins Co. (TOC)	350,000	350,000		
NPC-3	-	350,000		350,000	(targeted in 1999)
TPI	Thai Petrochemical Industry Co. (TPI)	360,000		360,000	(in 1997)
ROC	Rayon Olefins Co. (ROC)	600,000		600,000	(in 1999)
Total		2,061,000	751,000	1,310,000	

The Ministry of International Trade and Industry (MITI) in Japan studied the worldwide demand and supply balance of petrochemicals in 2000 as shown in the following Table. In ASEAN countries, ethylene will be in oversupply although NPC-3 in Thailand was not included in the forecast since it was just in the planning stage. (Table A1.3)

Table A1.3 Forecast Demand and Supply of Petrochemicals in the Asia and the World
(unit: million tons)

	Ethylene by Region								
	1994			2000			Annual Average Growth Rate (1994-2000)		
	(A) Demand	(B) Supply	B-A	(A) Demand	(B) Supply	B-A	Demand	Supply	
Asia Total	14.4	15.3	0.58	20.5	24.5	3.04	6.1%	8.2%	
Korea	3.2	3.6	0.47	3.9	4.1	0.35	3.4%	2.2%	
Taiwan	1.0	1.0	▲ 0.07	2.0	2.4	▲ 0.11	12.2%	15.7%	
China	2.1	2.3	0.08	4.0	4.1	▲ 0.02	11.3%	10.1%	
ASEAN	1.3	1.3	▲ 0.28	3.0	4.6	1.30	15.0%	23.4%	
India	0.7	0.6	0.13	1.5	2.2	0.59	13.5%	24.2%	
Japan	6.1	6.5	0.52	6.2	7.1	1.08	0.3%	1.5%	
Middle East	3.2	3.9	0.73	6.2	7.1	0.57	11.7%	10.5%	
W. Europe	16.8	19.4	2.05	19.3	20.5	0.59	2.3%	0.9%	
N. America	22.3	24.9	1.50	27.0	30.4	2.15	3.2%	3.4%	
World Total	64.8	76.7	5.43	83.3	98.4	6.70	4.3%	4.2%	
	Ethylene Derivatives by Region (Converted to Ethylene Basis)								
	1994			2000			Annual Average Growth Rate (1994-2000)		
	(A) Demand	(B) Supply	B-A	(A) Demand	(B) Supply	B-A	Demand	Supply	
Asia Total	18.4	17.7	▲ 1.43	26.8	25.4	▲ 2.91	6.5%	6.2%	
Korea	2.7	3.8	0.96	4.1	4.6	0.44	7.2%	3.2%	
Taiwan	2.4	1.6	▲ 1.08	3.2	2.9	▲ 0.67	4.9%	10.4%	
China	3.8	2.5	▲ 1.61	7.2	4.6	▲ 2.98	11.2%	10.7%	
ASEAN	2.5	2.0	▲ 0.22	4.1	4.1	▲ 0.22	8.6%	12.7%	
India	0.9	1.0	0.01	1.6	2.0	0.35	10.1%	12.2%	
Japan	5.5	6.9	1.41	6.0	7.0	0.90	1.5%	0.2%	
Middle East	1.3	3.7	2.19	1.8	7.2	4.66	5.6%	11.7%	
W. Europe	17.2	19.6	0.75	20.4	21.5	▲ 0.38	2.9%	1.6%	
N. America	20.3	25.7	4.03	24.1	28.2	2.49	2.9%	1.6%	
World Total	64.8	77.6	7.40	83.3	95.3	4.88	4.3%	3.5%	
	Ethylene Derivatives by Product (Converted to Ethylene Basis) in Asia								
	1994			2000			Annual Average Growth Rate (1994-2000)		
	(A) Demand	(B) Supply	B-A	(A) Demand	(B) Supply	B-A	Demand	Supply	
LDPE	5.5	6.6	▲ 0.50	8.3	8.1	▲ 1.10	7.1%	3.6%	
HDPE	4.4	4.3	▲	6.5	6.2	▲ 0.40	6.7%	6.3%	
EG	3.5	2.4	▲ 1.30	5.3	3.7	▲ 2.20	7.2%	7.5%	
SM	5.4	5.2	▲ 0.60	7.9	8.3	▲ 0.50	6.5%	8.1%	
PVC	6.6	7.0	0.20	9.3	9.0	▲ 0.80	5.9%	4.3%	

Note: Balance between demand and supply was calculated taking operation rates of production facilities into consideration. Demand by region includes exports from the region.

▲ : minus

Source: International Committee for Basic Issues in Petrochemical Industry
(Ministry of International Trade and Industry (MITI) in Japan)

The supply capacity of ethylene derivatives, which consist of low or high density polyethylene (LDPE/HDPE), ethylene glycol (EG), styrene monomer (SM), and dichloroethane (EDC) for vinyl chloride monomer (VCM) and polyvinylchloride (PVC) among others, will be less than the demand in ASEAN countries by 220,000 tons/year (on an ethylene conversion basis). In Asian countries, supply deficiencies will be large in EG (2.2 million tons/year) and PVC (0.80 million tons/year).

Table A1.4 shows future production capacities of selected petrochemicals in Asian countries; for Thailand the data include NPC-3. The table indicates that there is no plan in Thailand to produce EG, acrylonitrile (AN) for synthetic fiber and dimethyl terephthalate (DMT) for polyester fiber. However, it is reported that the NPC-3 complex has a plan to produce EG/EO and AN, among others.

In the meantime, the demand for petrochemicals has expanded rapidly and investments in production facilities are highly active, not only in Thailand and other ASEAN countries, but also in the People's Republic of China and India. Competition will be severe among countries and/or ethylene centers according to progress of the open market economy and deregulation.

(2) Chemical Fertilizers

Thailand entirely depends on imports for chemical/mineral fertilizers, which amounted to around 3 million tons or 13.4 billion Baht in 1994. Mixed or compound fertilizers were 1.79 million tons or accounted for 59.7 per cent of the total imports while urea and ammonium sulfate totaled 0.91 million tons or 30.3 per cent of the total. (Table A1.5)

The 100 per cent dependence on imported fertilizers could be partly attributed to the international price of fertilizer. The chemical fertilizer industry is capital-intensive and late starters in general cannot easily compete in price with the earlier starters. It is not rare to find countries that can import fertilizers cheaper than those produced domestically. Accordingly, there is no fertilizer manufacturer in Thailand to date excluding mixing and compounding.

The National Fertilizer Corporation (NFC) has sought to implement its plan to establish fertilizer production but has faced many difficulties including raising capital and production cost. However, NFC managed at last to commence the plan producing a total of around one million tons of fertilizer at Map Ta Phut in Rayon province.

Table A1.4 Production Capacity of Selected Petrochemicals by Country including Expansion up to around the Year 2000 ('000 tons/year)

	Total	ASEAN	Thailand	Malaysia	Singapore	Indonesia	Philippines	China	Taiwan	Korea	Japan
Total	134,117	28,801	9,785	4,491	4,719	8,772	1,034	23,756	20,876	24,631	36,053
Ethylene	24,119	4,791	2,061	860	965	675	230	5,865	2,365	4,020	7,078
LDPE	3,580	445	215			230		743	240	706	1,446
LLDPE	2,791	500	80	300	120			955	240	464	632
LL/HDPE	3,356	1,950	500	200		1,050	200	340	240	313	513
HDPE	4,777	1,199	729		370	100		604	624	1,330	1,020
EG	3,498	288			110	178		866	875	545	924
PS	5,182	790	335	186	114	96	59	1,141	925	925	1,401
EDC	3,934	458	78			380		860	595	736	1,285
VCM	8,593	1,497	580	400		510	7	1,206	1,440	1,120	3,330
PVC	8,902	2,559	988	685	28	660	198	1,366	1,643	925	2,410
SM	8,504	1,415	600	200	315	300		1,060	870	2,025	3,134
PP	9,536	2,343	925	200	313	565	340	1,507	905	2,200	2,581
AN	1,913							527	371	340	675
ABS	3,629	386	147	160	29	50		532	1,407	490	814
MIBB	2,462	920	55	600	105	160		645	332	403	162
Benzen	7,463	1,043	201	200	360	283		794	758	1,779	3,089
CPL	1,384	70	70					208	280	270	556
P-Xylene	11,434	2,312	622		1,000	690		1,512	1,880	2,950	2,780
PTA	15,326	3,525	1,600	500		1,425		2,431	4,820	2,970	1,580
DMT	729							229		120	380
Metanol	3,005	2,310			660	1,650		365	66		264

Percent Shares (%) to Total by Country

	Total	ASEAN	Thailand	Malaysia	Singapore	Indonesia	Philippines	China	Taiwan	Korea	Japan
Total	100.0%	21.5%	7.3%	3.3%	3.5%	6.5%	0.8%	17.7%	15.6%	18.4%	26.9%
Ethylene	100.0%	19.9%	8.5%	3.6%	4.0%	2.8%	1.0%	24.3%	9.8%	16.7%	29.3%
LDPE	100.0%	12.4%	6.0%		6.4%			20.8%	6.7%	19.7%	40.4%
LLDPE	100.0%	17.9%	2.9%	10.8%	4.3%			34.2%	8.6%	16.6%	22.6%
LL/HDPE	100.0%	58.1%	14.9%	6.0%		31.3%	6.0%	10.1%	7.2%	9.3%	15.3%
HDPE	100.0%	25.1%	15.3%		7.7%	2.1%		12.6%	13.1%	27.8%	21.4%
EG	100.0%	8.2%			3.1%	5.1%		24.8%	25.0%	15.6%	26.4%
PS	100.0%	15.2%	6.5%	3.6%	2.2%	1.9%	1.1%	22.0%	17.8%	17.8%	27.0%
EDC	100.0%	11.6%	2.0%			9.7%		21.9%	15.1%	18.7%	32.7%
VCM	100.0%	17.4%	6.7%	4.7%		5.9%	0.1%	14.0%	16.8%	13.0%	38.8%
PVC	100.0%	28.7%	11.1%	7.7%	0.3%	7.4%	2.2%	15.3%	18.5%	10.4%	27.1%
SM	100.0%	16.6%	7.1%	2.4%	3.7%	3.5%		12.5%	10.2%	23.8%	36.9%
PP	100.0%	24.6%	9.7%	2.1%	3.3%	5.9%	3.6%	15.8%	9.5%	23.1%	27.1%
AN	100.0%							27.6%	19.4%	17.8%	35.3%
ABS	100.0%	10.6%	4.1%	4.4%	0.8%	1.4%		14.7%	38.8%	13.5%	22.4%
MIBB	100.0%	37.4%	2.2%	24.4%	4.3%	6.5%		26.2%	13.5%	16.4%	6.6%
Benzen	100.0%	14.0%	2.7%	2.7%	4.8%	3.8%		10.6%	10.1%	23.8%	41.4%
CPL	100.0%	5.1%	5.1%					15.0%	20.2%	19.5%	40.2%
P-Xylene	100.0%	20.2%	5.4%		8.7%	6.0%		13.2%	16.4%	25.8%	24.3%
PTA	100.0%	23.0%	10.4%	3.3%		9.3%		15.9%	31.4%	19.4%	10.3%
DMT	100.0%							31.5%		16.5%	52.1%
Metanol	100.0%	76.9%			22.0%	54.9%		12.1%	2.2%		8.8%

Source: 1996 Petrochemical Industries in Asia (Heavy and Chemical Industry News Incorporation in Japan)

Table A1.5 Import Trend of Chemical/Mineral Fertilizers in Thailand

	Quantity ('000 tons)			Import Value (Bahu/ton)		
	1992	1993	1994	1992	1993	1994
Total	2,848,915	3,259,038	2,997,672	4,383	4,193	4,480
Urea	473,245	598,593	469,907	4,773	4,019	4,321
Ammonium Sulfate	539,107	510,998	438,838	2,050	2,169	2,304
Ammonium Nitrate	24,835	32,742	34,797	6,798	6,522	6,149
Sodium Nitrate	2,464	3,486	2,449	6,953	7,059	7,700
Double Salts and Mixture of Calcium and Ammonium Nitrate	5,444	8,066	1,449	5,447	4,625	7,542
Superphosphate	4,128	4,751	2,335	5,787	5,466	5,176
Diammonium Phosphate (DAP)	133,980	131,335	86,306	5,949	5,363	6,791
Monoammonium Phosphate, etc.	29,494	11,631	36,298	6,073	5,356	5,545
Potassium Chloride	115,858	111,129	120,728	3,583	3,302	3,484
Potassium Sulfate	20,302	25,090	15,332	5,228	5,125	5,679
Mineral or Chemical Fertilizers containing Nitrogen, Phosphorus and Potassium (NPK compound)	842,542	1,187,840	1,062,550	5,183	4,868	5,239
Mineral or Chemical Fertilizers containing Nitrate and Phosphate (NP)	7,405	21	9,510	4,620	45,714	5,497
Other Mineral or Chemical Fertilizers containing Nitrogen and Phosphorus (NP)	650,111	633,356	717,173	4,592	4,428	4,489

Source: Customs Department

5. Possibility of Downstream Gas Industries in the WSB Region

(1) Viewpoints

The following items could be suitable for investigation of the possibility of natural downstream gas industries in the WSB region:

a) Suitability of Myanmar natural gas for industrial use

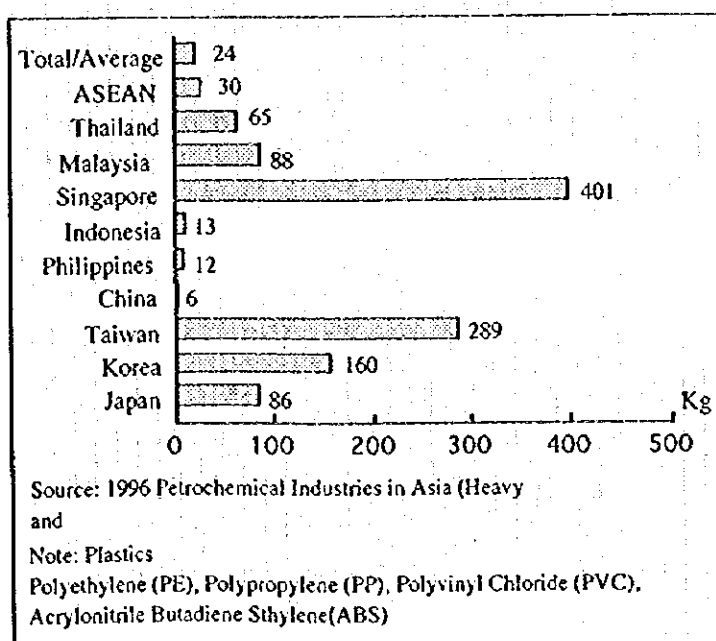
This regards the composition of Myanmar natural gas. Yadana gas includes much nitrogen (N₂), which constitutes 24 per cent of the total volume. As a result, its calorie content is low at 715 BTU/cubic feet (CF), almost 30 per cent less than ordinary gas such as Yatagon gas with 1,000 BTU/CF. This may mean that Yadana gas is more suitable for use as a raw material for chemical fertilizer than as a fuel for a power plant. In addition, if Yadana gas is used for fuel for power plants in Ratchaburi without any treatment, it may bring about air pollution by nitrogen oxide (NO_x). Conclusively, Yadana gas may be used for fertilizer production also taking its rich nitrogen into consideration. PTT has already decided to import Yatagon gas, which could be used for fuel of power plants.

b) Demand and supply situation

In terms of petrochemicals, their demand will expand at a high growth rate as seen previously. The demand in Thailand will grow at about 10 per cent per year over the next ten years led by an expansion of big industrial users such as the motor vehicle and electrical/electronic industries.

Supply capacity of petrochemicals is more critical to investigate than the demand in considering the possibility of WSB downstream gas industries since there are already five petrochemical complexes including those at the planning stage in Thailand. The following figure depicts per capita production capacity of plastics by country and by region around the year 2000. Singapore and Taiwan stand out with 401 kg/person and 289 kg/person, respectively. This means they will be big exporters. Thailand's capacity of 65 kg/person, excluding a proposal/project for petrochemical complex in the Southern region, is 23 kg less than the 88 kg/person of Malaysia, which is almost same as the 86 kg/person of Japan. According to the Investment Opportunities Study-Petrochemicals in Thailand (BOI, July 1995), per capita demand for plastics will reach 39 kg/person in 2000 and 58 kg/person in 2005. As the supply capacity of Thailand will exceed the demand, Thailand would appear to become an exporter of petrochemicals; however, there will be strong competitors such as Taiwan, Singapore and Malaysia, among others.

Figure A1.2 Per Capita Production Capacity of Plastics in Selected Countries (around the year 2000)



As for chemical fertilizers, the present demand is around three million tons. As mentioned earlier, the National Fertilizer Corporation (NFC) is to produce one million tons of nitrogen-phosphate-potassium (NPK) fertilizers, which will substitute for imports. As a result, a total of around two million tons fertilizers may be domestically produced to substitute for the imports.

c) Cost/competitive power of the products

The cost of raw materials is one of the most critical factors for profitable operation both in petrochemical and chemical fertilizer production. The Myanmar natural gas to be imported by PTT is rather expensive, US\$3.00/MMBTU for Yadana and US\$3.07/MMBTU for Yatagon at the border price. Their prices for the users could be US\$3.8/MMBTU and US\$4.00/MMBTU, respectively, including gas pipeline and other costs. Users prices/trading prices of natural gas produced in foreign countries are US\$3.00/MMBTU for Indonesia and US\$3.50/MMBTU for Brunei; users can buy and use natural gas at a price of only US\$0.50/MMBTU in Qatar.

Natural gas is imported under a long-term contract for 20 or 30 years. The gas importers who contracted ten years ago can enjoy a cheaper price even though their price has increased based on contracts permitting the escalation factors for actual pricing. Late starters are disadvantageous at this point unless oil prices increase rapidly. Petroleum oil is also used for the production of petrochemicals and fertilizers. Disadvantages of late starters regarding higher raw gas cost may be offset by cheaper investment cost for production facilities but there is a limitation.

In the case of chemical fertilizer, it is generally felt that economically reasonable production necessitates the raw natural gas price to be less than US\$1.50/MMBTU while Myanmar gas will be around US\$4.00/MMBTU. This cost gap may be too big to be offset by cheaper investment cost.

d) Business circumstance and government policy

Liberalization of investment and trade is a world-wide trend. In June 1994, the Ministry of Industry (Mol) announced new policy guidelines in accordance with agreements of AFTA and the GATT Uruguay Round. These guidelines aimed at liberalizing the market and improving its competitiveness. In response, the Board of Investment (BOI) introduced new policies liberalizing the petrochemical industry as follows:

- Any petrochemical company will be able to expand or invest in the production of any petrochemical product except upstream aromatic products (until May 2003).

However, companies utilizing pyrolysis gas from their olefin units are now able to vertically integrate into the upstream aromatic sector.

- Upstream companies are now permitted to expand or invest in the production of feedstock for their own use, for use in other petrochemical plants, or for exports. However, their byproducts must not be sold, as fuels, on the local market, unless specifically authorized by the National Energy Policy Council.
- Finally, petrochemical products and feedstock should be priced according to world market prices. New plants producing intermediates and/or downstream products should start their operation after January 1, 1997 while new plants producing upstream products like olefins should begin after January 1, 1999.

Following these policy guidelines, there are already five petrochemical complexes, including those in the planning stage. Import tariff rates for petrochemicals are 10 per cent at present (1996) and will be reduced to 0-5 per cent as agreed by AFTA until 1999. Under such an open and free trade regime, the Thai government will not be able to take special support measures for petrochemicals such as downstream of Myanmar natural gas. This is also applicable for chemical fertilizers.

However, it may be an issue that all the five petrochemical complexes and the sole chemical fertilizer plant are concentrated at one point in Map Ta Phut in Rayong province. From the viewpoint of national security, such an extreme concentration should be avoided. The WSB region is a receiving area for decentralization of industries along with the Southern region. In this regard, locational conditions/infrastructure in the WSB region will be critical for a possibility of Myanmar natural downstream gas industries.

e) Locational conditions/infrastructure in the WSB region

Regional advantages and disadvantages of the WSB region to attract Myanmar natural downstream gas industries around the power plant site in Ratchaburi are as follows:

- Advantages
 - 1) good access to the raw material/natural gas pipelined from Myanmar to the power plant site in Ratchaburi,
 - 2) proximity to the power plant,
 - 3) relatively cheap land price,
 - 4) availability of water, and
 - 5) good access to large markets such as Bangkok and Myanmar.

- Disadvantages
 - 1) no industrial estate close to seaport/with waterfront for export
 - 2) limited access to domestic market except Bangkok, and
 - 3) huge investment cost for infrastructure development.

In these comparative considerations, Map Ta Phut is not counted because of placing more emphasis on industrial decentralization and national security. In other words, there is no strong advantage of the WSB region to compete with Map Ta Phut.

The disadvantages of areas around the power plant site in Ratchaburi are conducive to high cost, whether it will be shouldered by the public sector or not. If the downstream gas industries such as petrochemicals and fertilizers shoulder the cost, their competitive power will be weakened too much.

(2) Possibilities and Recommendations

It is not possible for the downstream industries using natural gas from Myanmar to locate in the WSB region, especially around the power plant site in Ratchaburi province as seen so far. A summary of the possibilities from the five viewpoints is shown in Table A1.6.

However, candidate sites for downstream gas industries are not limited to areas around power plant sites. The power plant situated inland was selected probably not taking a possible location of downstream industries into consideration.

There are other candidate sites for the downstream industries if the gas pipeline is extended. According to PTT's plan, it will be extended to Bangkok and the Southern region. On the way to Bangkok, there is a large amount of potential industrial land with a total of 30,000 rai in Samut Songkhram. An oil terminal is planned in Petchaburi province with a total of 300,000 barrels (around 49,000 kl) storage capacity to supply for the Ratchaburi's 1,400 MMW combined cycle (natural gas and oil) power plant. In line with this terminal, land development with a waterfront will be considered. If developed, the land may be one of the candidate sites for the downstream gas industries. (Figure A1.3)

Figure A1.4 illustrates conceptual alternatives for usage of natural gas from Myanmar based on the additional import of 475 MMCFD of Yadana gas, which is not yet contracted, and also taking balance of materials between the gas and products thereof or consumption as a fuel for power plants.

Table A1.6

Summary of Possibilities of Downstream Industries using Natural Gas to be imported from Myanmar

Items for Possibility	Background Data/Information	Petrochemicals	Fertilizer (Ammonia & Urea)
a) Suitability of Myanmar natural gas for industrial use	Yadana gas: • N2-24% • Methane (C1)	not suitable but relatively suitable for methane derivatives	more suitable (not suitable for fuel)
	Yatagon gas: • better than Yadana	suitable	suitable
b) Demand and supply situation	• already 5 ethylene centers • fertilizer demand: 3 million t/y	over supply/ severe competition	more 2 million t/y for import substitution
c) Cost/competitive power of the products	• national border price/user price Yadana: US\$ 3.00/around 4.00 Yatagon: US\$ 3.07/around 4.00	less competitive	less competitive (needed to be less than US\$ 1.50)
d) Business circumstance and government policy	• open and free market policy • deregulation	no protection except aromatics	still protected (state enterprise)
e) Locational condition/infrastructure in the WSB region (Ratchaburi area)	• close to gas-power plant • situated at inland area	needed seaport for export (much cost)	attractive if domestic market-oriented

Note: Gas user price is estimated by the Study Team.

Figure A1.3 Perspectives for Myanmar Natural Gas Distribution

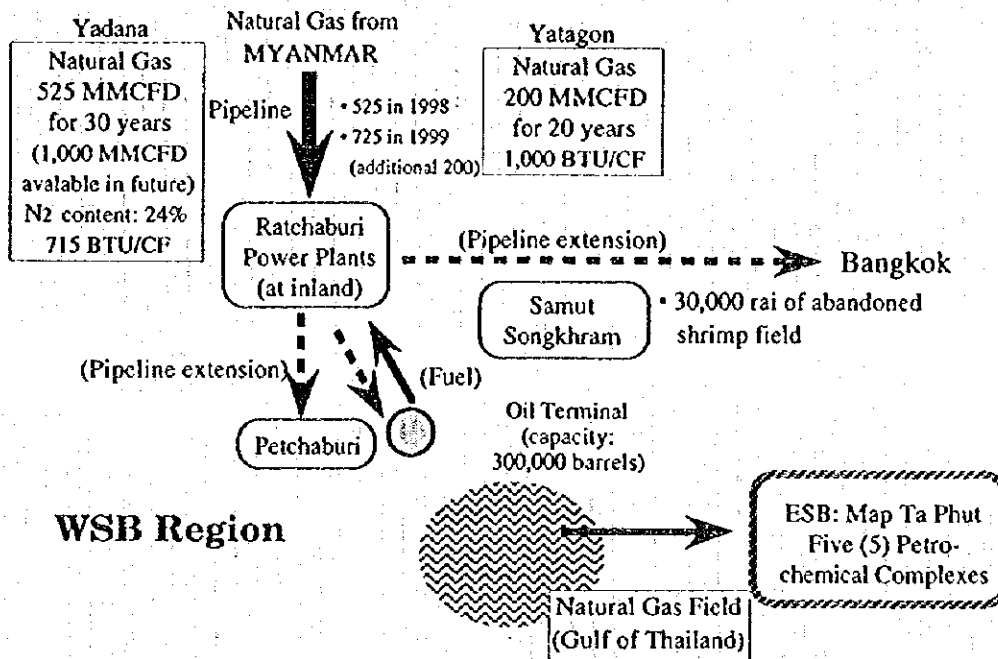
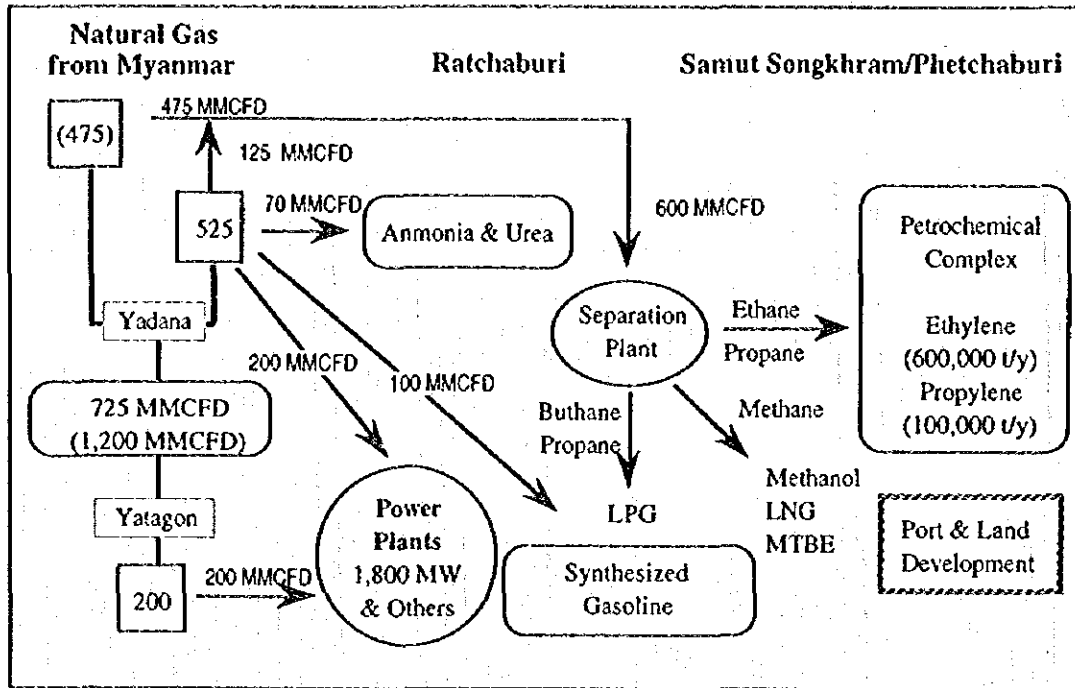


Figure A1.4 Conceptual Alternative for Use of Natural Gas from Myanmar



In order to materialize downstream development in the WSB region, there are several critical preconditions as follows:

- This projects will lack economic feasibility unless a strong development effort is undertaken.
- The Thai Government is expected to designate the project as a national project with strong support measures and to coordinate related agencies and private sector.
- A deeper study should be conducted. The study will comprise such items as identification of optimum sites for the downstream gas industries, their production scale, relevant infrastructure/supporting facility development necessary for competitive operation of the plants or factories, cost analysis in line with who should shoulder and share the cost, and consistency with energy supply plan at national level.