

### 12.3.2 Case Study on Dong Nai River Basin

This case study on Dong Nai river basin is intended mainly to understand the general environmental background in connection with the hydropower projects in the basin. Due to available existing data and informations were quite limited especially for those of the river basin as a whole, not every environmental subject could be covered under the study. However, the following descriptions are provided based on the best available current data and information.

Dong Nai river is the largest one in south Viet Nam, except the Mekong river basin. Dong Nai river flow into the sea near My Tho in the south of Ho Chi Minh City.

The catchment area of the river is about 24,770 km<sup>2</sup> at Bien Hoa. Below Bien Hoa, catchment area of Dong Nai river can not be defined accurately as the river has a delta which is also formed by downstreams of other rivers, such as Saigon river and Van Co Dong river. There are two main tributaries of Dong Nai river, those are La Nga river and Be river.

As the Dong Nai river basin is large, the topography varies quite widely. The part of the basin on the east of Di Linh is a hilly plateau with elevation ranging from EL 1,000m to EL 1,400m. The central and northern part of the river basin, e.g. the area around Bao Loc and Gia Nghia, is also a hilly plateau, but with elevation ranging between EL 600m and EL 1,000m. The central southern part of the basin, e.g. the area around the confluence of Dong Nai and La Nga rivers, is a low hill plateau with elevation ranging from EL 50m to EL 125m. The western part, which belongs to Be river basin, is a low hill plateau with elevation ranging from EL 10m to EL 200m ( See Figure 12.2-2 ).

#### (1) Hydropower Projects in Dong Nai river basin

There are three existing hydropower plants under operation, two under construction and other many projects under planning. Details of them are listed below.

##### (a) Three hydropower plants under operation

- Da Nhim hydropower plant : 160 MW
- Ankroet hydropower plant : 3 MW
- Tri An hydropower plant : 400 MW
- Thac Mo hydropower plant : 150 MW

##### (b) Two hydropower projects under construction

- Ham Thuan - Da Mi hydropower project : 472 MW  
(expected commissioning date : Jan. 2000)

(c) The hydropower projects under study

- The hydropower projects of Dong Nai river  
(Dai Ninh, Dong Nai 1 to 8)
- The hydropower projects of La Nga river  
(Bao Loc, La Nga 3)
- The hydropower projects of Be river  
(Cau Don 1 to 3, Phuoc Hoa)

Figure 12.3-5 shows the locations of the above projects. Projects layout maps of some of them under study are given in the case study report (see Reference (24)). Tables 12.3-18 and 12.3-19 show some main features of the above projects.

(2) Nature environmental data

(a) Meteorological condition

The meteorological data are recorded by the meteo-stations located at Dalat, Bao Loc, Tri An and Thac Mo. Tables 12.3-20(a), 12.3-20(b) and 12.3-20(c) show the ambient temperature, humidity and rainfall data of the river basin, respectively.

(b) Hydrological characteristics

The following tables are provided to show some of the hydrological data of the river basin:

Table 12.3-21	Salient Features of Runoff Gauging Stations
Table 12.3-22	Water Quality Data of La Nga River
Table 12.3-23	Water Quality Data of Tri An Reservoir

Detailed runoff data are given in the case study report (Reference (24)). Figure 12.3-6 shows the location map of the runoff gauging stations established in the Dong Nai river basin.

(3) Socio-economic environmental data

(a) Population

The Dong Nai river basin is situated in the area of Lam Dong, Dong Nai and Song Be provinces. Some data of population are shown as Table 12.3-24.

The population of ethnic people are as below.

- In Lam Dong province : 159,527 persons (1992)
- In Dong Nai province : 167,459 persons (1992)
- In Song Be province : no data available

**(b) River and lake utilizations**

The following show some present situation of water utilization of the river and the lakes in this region, besides the power generation by the hydropower projects.

**1) Drinking water supply**

At present, there are two water supply systems which receive water from Dong Nai river. Those are as below.

**a) Dalat water supply system:**

The water treatment plant is located at the side of Donkai reservoir, which has a capacity of 25,000 m<sup>3</sup>/day.

**b) Thu Duc water supply system:**

This system supplies water for Ho Chi Minh city and Bien Hoa province. The Total capacity is 500,000 m<sup>3</sup>/day. The water is supplied by Hoa An pumping station which is located at downstream of Tri An power plant.

**2) Irrigation**

There are two main irrigation projects in Dong Nai river basin. Those are shown below.

**a) Da Nhim hydropower plant irrigation project:**

The water released from the power house flows via Ong river to Cai river where it is picked up by diversion weir for the irrigation of 12,800 ha of land in the Phan Rang area.

**b) Saigon river irrigation project:**

Other name is called Dau Tieng irrigation project. The main characteristics of the project is as below.

• River	:	Saigon
• Construction period	:	1981 to 1988
• Dau Tieng reservoir		
Cathment area	:	2,700 km <sup>2</sup>
Reservoir capacity	:	1.5 billion m <sup>3</sup>
• Irrigation area	:	172,000 ha

**c) Other uses**

Dong Nai river is also utilized for waterway transportation, but it is only in the main river, downstream of Tri An hydropower project. Fishery is being developed only in the reservoirs of Tri An and Da Nhim.

**(c) National parks**

There are two national parks in the Dong Nai river basin as below.

**1) Nam Cat Tien National Park**

This national park is located at up stream of Tri An reservoir, south of Cat Tien district, Lam Dong and Dong Nai provinces. The area is 60,000 ha.

**2) Bui Gia Map National Park**

This park is located at up stream of Thac Mo reservoir, Bu Dang district, Song Be province. Its area is 30,000 ha.

Table 12.3-1 Meteorological Data of Various Locations along Da River

## CLIMATIC CONDITIONS

Meteorological Station	T/year(°C)			Mean Evapo. mm/year	Rain-fall (mm/year)	Rainy days day/year	Sun-shine days /year	Mean humid. year (%)
	Year	Tmax	Tmin					
1	2	3	4	5	6	7	8	9
I. LAI CHAU								
1. Tam Duong	19.2	33.6	-0.4	955.6	2621.7	175.7	1977.9	83
2. Muong Te	22.5	41.1	3.9	666.4	2439.0	159.3	1897.6	84
3. Sin Ho	15.9	30.7	-4.5	668.9	2734.0	178.3	1858.6	85
4. Lai Chau	22.9	42.5	3.4	895.6	2054.0	144.1	1835.8	82
5. Tua Chua	19.2	34.2	1.3	985.1	1891.7	150.6	1949.1	82
6. Tuan Giao	21.0	36.8	-0.6	806.8	1612.7	142.8	1869.9	84
7. Pha Din	17.5	31.5	-1.2	895.0	1817.8	161.9	2014.9	83
8. Dien Bien	21.8	38.6	-0.4	889.6	1583.1	132.1	2002.5	83
II. SON LA								
1. Quynh Nhai	22.9	40.8	2.1	806.9	1703.0	126.6	1744.5	84
2. Son La	20.9	38.0	-0.8	881.4	1408.0	125.3	1986.6	81
3. Co Noi	20.5	37.9	-4.7	1000.1	1319.5	131.3	2102.1	80
4. Phu Yen	22.8	41.8	-0.9	1084.6	1536.6	127.5	1708.0	81
5. Bac Yen	20.4	37.2	2.5	940.0	1627.6	144.0	1921.0	82
6. Song Ma	22.4	41.7	-0.8	872.0	1185.4	118.2	1896.4	82
7. Yen Chau	22.6	41.1	-1.5	1096.3	1211.0	114.0	1931.5	79
8. Moc Chau	18.5	35.0	-1.5	895.7	1589.0	179.0	1805.0	85
III. LAO CAI								
1. Than Uyen	20.8	37.3	-2.8	997.5	2012.0	163.0	1884.7	82
IV. HOA BINH								
1. Hoa Binh	23.3	41.2	1.9	762.6	1901.0	146.0	1620.9	84
2. Mai Chau	23.0	41.0	1.9	910.1	1833.4	130.1	1555.6	82
V. YEN BAI								
1. Mu Cang Chai	18.7	34.1	-2.0	1051.7	1802.0	157.0	1965.3	79

Table 12.3-1 Meteorological Data of Various Locations along Da River  
( continued )

Meteorological Station	Wind velocity (m/s)	Wind direc	Typhoon (day)	Fine - rain (day)	Frost (day)	Fog (day)
	10	11	12	13	14	15
I. LAI CHAU						
1. Tam Duong	1.8	SW	46.4	1.7	2.1	18.2
2. Muong Te	0.5	NH	47.7	5.3	.	90.9
3. Sin Ho	1.2	NW	61.0	12.8	11.9	60.0
4. Lai Chau	0.8	NH	70.3	16.4	.	41.1
5. Tua Chua	0.9	NH	27.2	0.3	1.3	1.7
6. Tuan Giao	0.7	NH	56.0	2.3	.	106.1
7. Pha Din	2.9	SW	58.7	8.4	0.3	82.2
8. Dien Bien	0.9	W	68.0	16.3	0.4	99.4
II. SON LA						
1. Quynh Nhai	1.1		51.0	5.8	.	53.7
2. Son La	1.2		68.4	8.6	2.6	40.4
3. Co Noi	1.6		70.0	2.3	2.9	39.1
4. Phu Yen	1.6		57.0	5.2	0.7	21.9
5. Bac Yen	2.9		66.3	3.9	1.7	76.5
6. Song Ma	1.2		72.9	2.0	0.4	63.5
7. Yen Chau	1.4		47.7	0.9	0.6	98.0
8. Moc Chau	1.2		70.0	59.8	5.1	95.0
III. LAO CAI						
1. Than Uyen	1.4	E	63.0	1.8	1.3	43.0
IV. HOA BINH						
1. Hoa Binh	1.0	N	77.0	22.7	0.9	13.9
2. Mai Chau	1.2	NH	82.8	11.7	1.0	24.5
V. YEN BAI						
1. Mu Cang Chai	2.4	NH	65.6	2.6	2.9	9.3

Table 12.3-2 Area and Growing Stock of Various Forests (1994)  
( Da river and Ma river basins )

North-West Vietnam

S : hectare.  
Unit : M : cb.m.  
N : 1,000 culm.

FOREST TYPE	S — M	Total	Da river Catchment	Ma river Catchment	Remarks
I. WOODYFOREST	S	351,063	285,745	65,318	
	M	17,114,413	14,354,363	2,760,050	
1. Natural woodyforest	S	330,418	266,577	63,841	
	M	16,688,331	13,966,577	2,721,754	
- Rich forest	S	18,751	13,651	5,100	
	M	2,380,718	1,553,225	827,493	
- Medium forest	S	63,944	54,351	9,593	
	M	5,688,643	4,897,288	791,355	
- Poor forest	S	91,452	79,245	12,207	
	M	4,348,605	3,821,330	527,275	
- Young forest	S	104,279	80,124	24,155	
	M	2,134,137	1,999,206	134,931	
- Mixed forest	S	2,584	2,584		
	M	87,046	87,046		
- Rocky forest	S	49,408	36,622	12,786	
	M	2,049,182	1,608,482	440,700	
2. Forest Plantation	S	20,645	19,168	1,477	
	M	426,082	387,786	38,296	
II. Bambo forest	S	37,589	25,546	12,043	
	N	264,503	204,288	60,215	

Table 12.3-3 Area and Growing Stock of Various Forests (1994)  
( Five provinces in Da river catchment )

Da river catchment.  
Year : 1994.

S : hectare.  
Unit : M : cb.m.  
N : 1,000 culm.

FOREST TYPE	S — M	Total	Lai chau	Son la	Remarks
I. WOODYFOREST	S — M	285,745 14,354,363	157,932 7,440,742	70,480 4,163,376	
1. Natural woodyforest	S — M	266,577 13,966,577	155,324 7,361,980	67,962 4,139,551	
- Rich forest	S — M	13,651 1,553,225	3,215 392,280	8,891 986,790	
- Medium forest	S — M	54,351 4,897,288	37,398 2,999,041	8,376 760,907	
- Poor forest	S — M	79,245 3,821,330	43,058 1,800,536	25,683 1,331,589	
- Young forest	S — M	80,124 1,999,206	55,678 1,469,178	12,290 323,209	
- Mixed forest	S — M	2,584 87,046	2,381 78,573		
- Rocky forest	S — M	36,622 1,608,492	13,594 622,372	12,722 737,056	
2. Forest Plantation	S — M	19,168 387,786	2,608 78,762	2,518 23,825	
II. Bambo forest	S — N	25,546 204,288	6,876 55,008	16,256 130,048	

Surveyor : Nguyen Minh Hung



Table 12.3-3 Area and Growing Stock of Various Forests (1994)  
( Five provinces in Da river catchment ) ( continued )

Da river catchment.  
Year : 1994 (continue).

S : hectare.  
Unit : M : cb.m.

N : 1,000 culm.

FOREST TYPE	S — M	Lao cai	Yen bai	Hoa binh	Remarks
I. WOODYFOREST	S — M	15,081 845,712	7,987 762,950	34,265 1,141,581	
1. Natural woodyforest	S — M	14,065 822,167	4,460 552,150	24,766 1,090,727	
- Rich forest	S — M			1,545 174,155	
- Medium forest	S — M	3,134 451,311	3,113 498,080	2,330 187,949	
- Poor forest	S — M	5,576 340,125	521 41,680	4,407 307,398	
- Young forest	S — M	5,310 28,346	826 12,390	6,020 166,083	
- Mixed forest	S — M	45 2,385		158 6,088	
- Rocky forest	S — M			10,306 249,054	
2. Forest Plantation	S — M	1,016 23,545	3,527 210,800	9,499 50,854	
II. Bambo forest	S — N	15 40		2,399 19,192	

**Table 12.3-4 Population Data of the Provinces along Da River Basin**

Provinces	Population (x 10 <sup>3</sup> )		% compared between 1979 and 1989
	1/10/1979	1/4/1989	
Total	2,996.7	3,990.3	133.2
1. Lai Chau	316.1	437.8	185.5
2. Son La	482.3	681.8	141.4
3. Hoang Lien Son	771.5	1,031.9	133.8
4. Ha Son Binh	1,426.8	1,838.8	128.9

Source: Previous population census  
(General Department of Statistics)

**Table 12.3-5 Area and Population Data of the Provinces along Da River (1992)**

Provinces	Area (sq. km)	Population in 1992 (x 10 <sup>3</sup> )	Average Population Density (/km <sup>2</sup> )	Number of Districts
Total	50,812.5	3,075.7	60.6	40
1. Lai Chau	17,139.7	485.7	28.3	7
2. Son La	14,210.0	753.4	53.0	9
3. Lao Cai	8,049.5	517.7	64.3	8
4. Yen Bai	6,801.5	621.4	91.4	7
5. Hoa Binh	4,611.8	697.5	151.2	9

Source: "Economy and Finance of Viet Nam, 1986 - 1992"  
by General Statistical Office, 1994

Table 12.3-6 Population of Ethnic Groups  
(Da and Ma River Basin, August 1994)

Unit : People.

ITEM	TOTAL	LAI CHAU	SON LA	LAO CAI	YEN BAI	HOA BINH
A.No.of household	227,475	73,307	117,578	10,526	4,176	21,888
B.No. of people	1,464,250	476,760	766,773	68,240	30,602	121,875
C.No. of labour	564,866	160,856	315,489	21,111	11,900	55,510
D.Eth.composition						
1) Thai	634,813	165,305	419,405	40,770	6,080	3,253
2) Kinh	269,472	92,238	137,995	12,330	3,585	23,324
3) HMông	233,650	121,177	83,058	8,478	20,937	
4) Mường	138,841	161	59,520			79,160
5) Dao	46,567	34,780	1,365	2,933		7,489
6) Khơ mu	24,050	11,516	11,096	1,438		
7) Ha nhi	11,598	11,598				
8) Sinh mun	10,113		11,113			
9) Tay	9,431	1,477				7,954
10) Giay	8,330	8,330				
11) La hu	6,089	6,089				
12) Xa	4,958		4,958			
13) Lự	4,196	4,196				
14) Lao	3,605	2,282		1,323		
15) Hoa	2,637	2,637				
16) Mang	2,583	2,583				
17) Khang	2,434	2,434				
18) Puộc	2,414		2,414			
19) Công	1,232	1,232				
20) Si la	547	547				
21) Lô lô	511	511				
22) Thô	66	66				
23) others	46,113	7,601	36,849	968		695

Surveyor : Nguyen Minh Hung  
Date : 25 / 8 / 1994.

Table 12.3-7 Population of Ethnic Groups  
(5 Provinces in Da river Catchment, August 1994)

5 Provinces in Da river catchment (1994)

Unit : People.

ITEM	TOTAL	LAI CHAU	SON LA	LAO CAI	YEN BAI	HOA BINH
A.No.of household	177,657	47,115	93,952	10,526	4,176	21,888
B.No. of people	1,124,520	305,285	598,518	68,240	30,602	121,875
C.No. of labour	419,513	87,853	243,139	21,111	11,900	55,510
D.Eth.composition						
1) Thai	446,510	79,546	316,861	40,770	6,080	3,253
2) Kinh	206,282	43,724	123,319	12,330	3,585	23,324
3) H'Mông	175,550	95,802	50,333	8,478	20,937	
4) Mường	137,240	161	57,919			79,160
5) Dao	46,567	34,780	1,365	2,933		7,489
6) Khơ mú	11,995	6,202	4,355	1,438		
7) Hà n'hi	11,598	11,598				
8) Sinh mun	5,601		5,601			
9) Tay	9,431	1,477				7,954
10) Giáy	8,330	8,330				
11) La hủ	6,089	6,089				
12) Xá	4,958		4,958			
13) Lự	4,196	4,196				
14) Lào	3,605	2,282		1,323		
15) Hoa	2,637	2,637				
16) Máng	2,583	2,583				
17) Khang	2,434	2,434				
18) Puộc	2,414		2,414			
19) Công	1,232	1,232				
20) Si la	547	547				
21) Lô lô	511	511				
22) Thô	66	66				
23) others	34,144	1,088	31,393	968		695

Surveyor : Nguyen Minh Hung

Date : 25 / 8 / 1994.

Table 12.3-8 Population of Ethnic Groups  
(The Provinces of Hoa Binh Hydropower Project Area, Sept. 1994)

Provinces of Hoabinh hydro-power (1994).

Unit : People.

ITEM	TOTAL	SON LA	HOA BINH	REMARKS
A.No.of household	91,334	69,446	21,888	
B.No. of people	551,148	429,273	121,875	
C.No. of labour	237,872	182,362	55,510	
D.Eth.composition				
1) Thai	187,767	184,514	3,253	
2) Kinh	139,992	116,668	23,324	
3) HMông	35,104	35,104		
4) Mường	137,079	57,919	79,160	
5) Dao	8,854	1,365	7,489	
6) Khơ mu	64	64		
7) Hà nhi				
8) Sinh mun	5,601	5,601		
9) Tay	7,954		7,954	
10) Giay				
11) La hu				
12) Xa				
13) Lự				
14) Lao				
15) Hoa				
16) Mang				
17) Kháng				
18) Puộc	2,414	2,414		
19) Công				
20) Si la				
21) Lô lô				
22) Thô				
23) others	26,319	25,624	695	

Surveyor : Nguyen Minh Hung

Date : 8 / 9 / 1994.

Table 12.3-9 Population of Ethnic Groups  
(The Provinces of Son La Hydropower Project Area, . 1994)

Provinces of Sonla hydro-power (1994).

Unit : People.

ITEM	TOTAL	LAI CHAU	SON LA	LAO CAI	YEN BAI	REMARKS
A.No.of household	86,323	47,115	24,506	10,526	4,176	
B.No. of people	573,372	305,285	169,245	68,240	30,602	
C.No. of labour	181,641	87,853	60,777	21,111	11,900	
D.Eth.composition						
1) Thai	258,743	79,546	132,347	40,770	6,080	
2) Kinh	66,290	43,724	6,651	12,330	3,585	
3) H'Mông	140,446	95,802	15,229	8,478	20,937	
4) Mường	161	161				
5) Dao	37,713	34,780		2,933		
6) Khơ mu	11,931	6,202	4,291	1,438		
7) Ha nhi	11,598	11,598				
8) Sinh mun						
9) Tay	1,477	1,477				
10) Giay	8,330	8,330				
11) La hu	6,089	6,089				
12) Xa	4,958		4,958			
13) Lự	4,196	4,196				
14) Lao	3,605	2,282		1,323		
15) Hoa	2,637	2,637				
16) Mang	2,583	2,583				
17) Khang	2,434	2,434				
18) Puộc						
19) Công	1,232	1,232				
20) Si la	547	547				
21) Lô lô	511	511				
22) Thô	66	66				
23) others	7,825	1,088	5,769	968		

Surveyor : Nguyen Minh Hung  
Date : 8 / 9 / 1994.

Table 12.3-10 Agriculture Production in 1993

*Da river catchment (North - West Vietnam).*

ITEM	UNIT	LAI CHAU	SON LA	LAO CAI	YEN BAI	HOA BINH
<b>I. CULTIVATION</b>						
<b>1. Food crops</b>						
1) Rice	Ton.	93,513	79,200	10,586	3,703	71,407
2) Maize	Ton.	31,880	24,453	1,187	822	5,590
3) Taro	Ton.	3,812	1,090	26		1,631
4) Cassava	Ton.	29,962	133,383	4,230	984	56,877
<b>2. Cash crops</b>						
1) Soya bean	Ton.	1,386	3,785		36	385
2) Ground-nut	Ton.	703		88		265
3) Sesame	Ton.	54	366		15	
4) Sugar-cane	Ton.	18,067	11,560	840		34,772
5) Cotton plant	Ton.	607	740	99	17	
6) Beans	Ton.	799	396		60	
7) Ora. Tangerine	Ton.			660		
<b>3. Perennial plant</b>						
1) Tea	Ton.	2,385	4,030	15	215	
2) Coffee	Ton.	135	25			
3) Aleur. Montana	Ton.	350				
<b>4. Herbs</b>						
	Ton.	227				
<b>II. HUSBANDRY</b>						
1) Buffalo	Head	94,363	90,229	16,455	5,776	33,790
2) Cow	Head	14,541	79,000	1,774	4,838	10,626
3) Horse	Head	34,293		4,090	3,179	
4) Goat	Head	18,434		1,500	1,114	
5) Pig	Head	156,576	270,000	17,632	9,789	95,456
6) Poultry	Head	796,550	1,992,000	210,520	62,640	437,760
<b>III. FISH REARING</b>						
1) Water body	Ha	400	750	400		650
2) Productivity	Ton.	400	550	60		500

Surveyor : Nguyen Minh Hung

Date : 12 / 9 / 1994.

Table 12.3-11 Forestry Production in 1993

*Da river catchment (North - West Vietnam).*

ITEM	UNIT	LAI CHAU	SƠN LA	LÀO CAI	YÊN BAI	HOÀ BÌNH
1. Forest establishm.						
- Afforestation	Ha	1,298	901	200	305	780
- Tending	Ha	3,500	2,750	850	2,270	3,200
- Regeneration	Ha	45,000	34,700	1,500	1,800	15,800
- Forest garden	Ha	332	450	150	200	650
2. Logging						
- Round wood	M3	125,000	98,100		5,500	7,850
- Fine wood	1,000ster	1,250	1,350	1,200	1,470	120
- Bamboo (Tre)	1,000culm	3,500	2,750			500
- Bamboo (nua)	1,000culm	2,750	1,800			1,200
- Aleurites montana	Ton.	50	25			
- Herbs	Ton.	37	20			
3. Wood processing						
- Sawn wood	cb.m.	2,120	4,500		1,000	1,200
- Furniture	cb.m.	500	780		150	200
4. Land allocation	Ha	9,800	15,850	20,100	20,056	9,309

Surveor : Nuyen Mih Hung  
Date : 14/9/1994.



Table 12.3-12 Area Distribution by Land Use (1994)  
(Da and Ma river Catchments)

5 Provinces in North - West Vietnam.

Unit : Hectare

Item	Total	Da river catchment	Ma river catchment	Remarks
<b>TOTAL LAND</b>	<b>3,509,690</b>	<b>2,633,790</b>	<b>875,900</b>	
<b>I. FORESTED LAND</b>	<b>388,652</b>	<b>311,291</b>	<b>77,361</b>	
1. Natural forest	368,007	292,123	75,884	
1.1. On Earthy mountaine	318,599	255,501	63,098	
- Rich forest (IIIA3)	18,751	13,651	5,100	
- Medium forest (IIIA2)	63,944	54,351	9,593	
- Poor forest (IIIA1)	91,452	79,245	12,207	
- Young forest (IIA, IIB)	104,279	80,124	24,155	
- Mixed forest	2,584	2,584		
- Bamboo forest	37,589	25,546	12,043	
1.2. On rocky mountaine	49,408	36,622	12,786	
2. Plantation	20,645	19,168	1,477	
- Pinus	4,581	4,346	235	
- Aleurites montana Wils	4,166	2,924	1,242	
- M. glauca and Chuklasia	1,121	1,121		
- Other trees	10,777	10,777		
<b>II. NON-FOREST LAND</b>	<b>2,520,131</b>	<b>1,897,630</b>	<b>622,501</b>	
- Grass (IA)	1,123,395	801,778	321,617	
- Shrub (IB)	800,392	580,315	220,077	
- Scattered trees and Bamboo (IC)	596,344	515,537	80,807	
<b>III. AGRICULTURE LAND</b>	<b>335,873</b>	<b>204,652</b>	<b>131,221</b>	
- Water-rice field	49,365	30,840	18,525	
+ 1 crop field	24,513	15,088	9,425	
+ 2 crop field	24,852	15,752	9,100	
- Subsidy crop				
- Cash crop	11,022	11,022		
- Swidden	213,336	100,640	112,696	
- Grazing land	62,150	62,150		
+ Meadow	58,525	58,525		
+ Water bodies	3,625	3,625		
<b>IV. OTHER LAND</b>	<b>265,034</b>	<b>220,217</b>	<b>44,817</b>	
- Residential area	34,499	30,879	7,620	
- Special use land (road..)	4,245	2,504	1,741	
- Water body (lake, river.)	29,509	27,916	1,593	
- Other land	192,781	158,918	33,863	

Surveyor : Nguyen Minh Hung  
Date : 24 / 8 / 1994.

Table 12.3-13 Area Distribution by Land Use (1994)  
(5 Provinces Along Da river Basin)

Da river catchment

Unit : Hectare

Item	Total	Lai chau	Son La	Remarks
<b>TOTAL LAND</b>	<b>2,633,790</b>	<b>1,336,200</b>	<b>915,500</b>	
<b>I. FORESTED LAND.</b>	<b>311,291</b>	<b>164,808</b>	<b>86,736</b>	
1. Natural forest	292,123	162,200	84,218	
1.1. On Earthy mountaine	255,501	148,606	71,496	
- Rich forest (IIIA3)	13,651	3,215	8,891	
- Medium forest (IIIA2)	54,351	37,398	8,376	
- Poor forest (IIIA1)	79,245	43,058	25,683	
- Young forest (IIA, IIB)	80,124	55,678	12,290	
- Mixed forest	2,584	2,381		
- Bamboo forest	25,546	6,876	16,256	
1.2. On rocky mountaine	36,622	13,594	12,722	
2. Plantation	19,168	2,608	2,518	
- Pinus	4,346	56	102	
- Aleurites montana Wils	2,924	2,283	169	
- M. glauca and chuklasia	1,121	87	419	
- other trees	10,777	182	1,828	
<b>II. NON-FOREST LAND</b>	<b>1,897,630</b>	<b>1,048,329</b>	<b>605,440</b>	
- Grass (IA)	801,778	382,942	263,664	
- Shrub (IB)	580,315	211,210	318,906	
- Scattered trees and Bamboo (IC)	515,537	454,168	22,870	
<b>III. AGRICULTURE LAND</b>	<b>204,652</b>	<b>68,409</b>	<b>90,210</b>	
- Water-rice field	30,840	8,545	11,585	
+ 1 crop field	15,088	3,845	5,213	
+ 2 crop field	15,752	4,700	6,372	
- Subsidy crop				
- Cash crop	11,022	4,475	4,130	
- Swidden	100,640	37,774	47,785	
- Grazing land	62,150	17,615	26,710	
+ Meadow	58,525	17,535	23,915	
+ Water bodies	3,625	80	2,795	
<b>IV. OTHER LAND</b>	<b>220,217</b>	<b>54,654</b>	<b>133,114</b>	
- Residential area	30,879	6,241	14,573	
- Special use land (road..)	2,504	957	975	
- Water body (lake, river.)	27,916	7,659	10,712	
- Other land	158,918	39,797	106,854	

Surveyor : Nguyen Minh Hung  
Date : 24 / 8 / 1994.

Table 12.3-13 Area Distribution by Land Use (1994)  
(5 Provinces along Da river Basin) (continued)

Da river catchment (continue)

Unit : Hectare

Item	Lao cai	Yen bai	Hoa binh	Remarks
<b>TOTAL LAND</b>	<b>157,660</b>	<b>89,230</b>	<b>135,200</b>	
<b>I. FORESTED LAND.</b>	<b>15,096</b>	<b>7,987</b>	<b>36,664</b>	
1. Natural forest	14,080	4,460	27,165	
1.1. On Earthy mountaine	14,080	4,460	16,859	
- Rich forest (IIIA3)			1,545	
- Medium forest (IIIA2)	3,134	3,113	2,330	
- Poor forest (IIIA1)	5,576	521	4,407	
- Young forest (IIA, IIB)	5,310	826	6,020	
- Mixed forest	45		158	
- Bamboo forest	15		2,399	
1.2. On rocky mountaine			10,306	
2. Plantation	1,016	3,527	9,499	
- Pinus	268	3,527	393	
- Aleurites montana Wils	452		20	
- M. glauca and chuklasia			615	
- other trees	296		8,471	
<b>II. NON-FOREST LAND</b>	<b>113,325</b>	<b>70,642</b>	<b>59,894</b>	
- Grass (IA)	73,444	49,838	31,890	
- Shrub (IB)	18,728	17,106	14,356	
- Scattered trees and Bamboo (IC)	21,153	3,698	13,648	
<b>III. AGRICULTURE LAND</b>	<b>24,520</b>	<b>7,950</b>	<b>13,563</b>	
- Water-rice field	2,830	1,070	6,810	
+ 1 crop field	1,620	450	3,960	
+ 2 crop field	1,210	620	2,850	
- Subsidy crop				
- Cash crop	2,095	180	142	
- Swidden	6,335	2,435	6,311	
- Grazing land	13,260	4,265	300	
+ Meadow	12,810	4,265		
+ Water bodies	450		300	
<b>IV. OTHER LAND</b>	<b>4,719</b>	<b>2,651</b>	<b>25,079</b>	
- Residential area	1,887	1,663	6,515	
- Special use land (road..)	247	64	261	
- Water body (lake, river.)	737	99	8,709	
- Other land	1,848	825	9,594	

Surveyor : Nguyen Minh Hung

Date : 24 / 8 / 1994.

Table 12.3-14 List of Nature Reserves Da River Basin (Northwest SRV)

NAME	LOCATION	AREA (ha)	MAIN FUNCTIONS
1. Muong Nhe National Park	Muong Te and Muong Lay Districts (Lai Chau)	396,170	- Reseach study - Genetic conservation + Fauna : Elephant, Gaus Pheacock .. + Flora : Po mu Thong tre
2. Sop Cop Nature Reserve	Song Ma district (Son La)	20,000	- Reseach study - Genetic conservation + Fauna : Gaus, Bear, Gibbon + Flora : Po Mu, Lat hoa
3. Xuan Nha Nature Reserve	Moc Chau District (Son La)	38,060	- Reseach study - Genetic conservation + Fauna : Gaus, Bear, Gibbon ... + Flora : Po Mu, Nghien Thong tre, Lat hoa
4. Hangkia-Pako Nature Reserve	Mai Chau district (Hoa Binh)	7,091	- Reseach study - Genetic conservation + Fauna : Gibbon, Bear + Flora : Thong Pako Lat hoa ...
5. Hoang Lien Son Nature Reserve	Phong Tho District (Lai Chau) Than Uyen District (Lao Cai)	30,000	- Reseach study - Genetic conservation + Fauna : Gibbon, Bear, + Flora : Po Mu, Thong Hoang Dan

Table 12.3-15 Number of Villages to be Submerged by Son La Hydropower Project

No	Province, district	Flooded reservoir level		
		+ 220 m	+ 240 m	+ 260 m
I	Lai Chau province :	51	64	86
1	Lai Chau district's capital	14	14	14
	(among that Quarter of capital	3	3	3
2	Muong Lay district	8	16	23
3	Sin Ho district	18	23	32
4	Tua Chua district	4	4	4
5	Tuan Giao district	4	4	2
6	Muong Te district	4	4	7
7	Phong Tho district	4	4	1
II	Son La province	132	133	147
1	Muong La district	57	58	67
2	Quynh Nhai district	40	40	41
3	Thuan Chau district	35	35	39
	<i>Total :</i>	183	197	233

Hiện trạng và dự báo dân số cần di chuyển khỏi vùng hồ Thủy điện Sơn La  
(Tương ứng với các cột ngập nước của hồ nước)

**Table 12.3-16 Existing Conditions and Forecast on the Population Move from Sơn La Reservoir Area (Equal to Flooded Water Level of Reservoir)**

Unit: number of persons

Số TT No	Huyện District	Cột ngập 220 m Flood level 220 m				Cột ngập 240 m Flood level 240 m				Cột ngập 260 m Flood level 260 m			
		Hiện trạng 1990 Existing condition 1990	Dự báo Forecast		Hiện trạng 1990 Existing condition 1990	Dự báo Forecast		Hiện trạng 1990 Existing condition 1990	Dự báo Forecast	Hiện trạng 1990 Existing condition 1990	Dự báo Forecast		Dự báo Forecast
			Năm 2000 Year 2000	Năm 2010 Year 2010		Năm 2000 Year 2000	Năm 2010 Year 2010				Năm 2000 Year 2000	Năm 2010 Year 2010	
1	2	3	4	5	6	7	8	9	10	11			
I.	Tỉnh Lai Châu												
1	Lai Chau Province Thị xã Lai Châu (Lai Chau province capital)	14500	18200	22500	18600	23400	28600	20840	26000	32000			
2	Tủa chùa	2100	2600	3200	2100	2600	3200	2100	2600	3200			
3	Mường Lay	2052	2700	3500	5134	6600	8600	10267	13000	16700			
4	Phong thổ	-	-	-	-	-	-	200	260	310			
5	Sìn Hồ	4500	6200	8000	5800	8000	10400	10550	14560	18900			
6	Tuần Giáo	-	-	-	-	-	-	390	540	700			
7	Mường Tè	1092	1470	1870	1092	1470	1870	1505	2000	2540			
	Cộng : (người)	24320	31170	39170	32730	42100	52970	45850	58960	74350			

Hiện trạng và dự báo dân số cần di chuyển khỏi vùng hồ Thủy điện Sơn La  
(*Tương ứng với các cột ngập nước của hồ nước*)

Table 12.3-16 Existing Conditions and Forecast on the Population Move  
from Sơn La Reservoir Area  
(Equal to Flooded Water Level of Reservoir)

Tiếp theo (Continued)

Unit: number of persons

1	2	3	4	5	6	7	8	9	10	11
II	Tỉnh Sơn La									
	Sơn La province									
1	Mường La	22432	31400	42000	24712	34500	46300	28117	39300	42700
2	Quỳnh Nhai	16632	23200	31200	16737	23400	31400	17202	24000	32200
3	Thuận Châu	14510	19400	25000	15134	20300	26000	15358	20600	26300
	Cộng : (người)	53580	74000	98200	56583	78200	103700	60680	83900	111200
	Total : (Person)									
	Cố 2 Tỉnh : (người)	77900	105170	137300	89310	120300	156670	106530	142860	185550
	Total of 2 province (Person)									

Số hộ cần di chuyển khỏi vùng hồ thủy điện Sơn La.  
 Table 12.3-17 Households should need to move from Sơn La Reservoir

Unit: number of households

TT No	Huyện, thị xã District, province capital	Cốt ngập + 215 ÷ 220 m Flood level + 215 ÷ 220 m			Cốt ngập + 260 ÷ 265 m Flood level + 260 ÷ 265 m		
		Năm 1990 Year 1990	Năm 2000 Year 2000	Năm 2010 Year 2010	Năm 1990 Year 1990	Năm 2000 Year 2000	Năm 2010 Year 2010
I.	Tỉnh Lai Châu						
1	Lai Chau province	2916	3640	5000	4168	5200	7100
2	Thị xã Lai Châu	353	450	640	1700	2240	3040
3	(Lai Chau's Capital)	328	419	533	328	419	533
4	Mường Lay	-	-	-	30	42	52
5	Tà Chua	703	1000	1330	1650	2350	3150
6	Phong Thổ	-	-	-	56	87	116
7	Sìn Hồ	170	237	312	235	322	425
	Tuần Giáo						
	Mường Tè						
	Cộng :	4470	5746	7815	8167	10660	14416
	Total :						
II.	Tỉnh Sơn La						
1	Son La province	3505	5065	7000	4395	6340	8785
2	Mường La	2600	3740	5200	2690	3870	5365
3	Quỳnh Nhai	2270	3235	4170	2400	3320	4385
	Thuận Châu						
	Cộng :	8375	12040	16370	9485	13530	18535
	Total :						
	Tổng cộng 2 Tỉnh :	12845	17786	24185	17652	24190	32951



Table 12.3-18 Existing and Under Construction Hydropower Projects

	Project	Unit	DA NHIM	TRI AN	THAC MO	HAM THUAN DA MI
A	RESERVOIR					
1	Catchment area	Km2	775	15400	2200	1360
2	Capacity	million m3	165	2767	1410	782
3	Water surface area	Km2	9.7	323.4	103	31.5
4	Annual run-off	m3/s	23	551	85.7	52.3
B	POWER GENERATION					
1	Installed capacity	MW	160	400	150	472
2	Annual energy generation	GWh	1026	1760	660	1598.2
3	Commissioning date		1963	1988	Nov-94	1999

Source :

- F/S Report Ham Thuan Da Mi Project
- Da Nhim , Tri An , Thac Mo document

Table 12.3-19 The Hydropower Projects under Study  
(Dong Nai River Basin)

	UNIT	DAI NINH	DONG NAI 1	DONG NAI 2	DONG NAI 3	DONG NAI 4	DONG NAI 5	DONG NAI 6	DONG NAI 7	DONG NAI 8	CAU DON 1	CAU DON 2
I												
- River												
RESERVOIR												
1	Km2											
- Topo		1977	3640	3790	4260	4390	6190	6750	9590	9830	2520	3930
- Actual		1202	1663	1813	2283	2413	4213	4773	7613	7853	2520	3930
2	million m3	160	1142	185	500	120	200	250	140	180	50	80
3	Km2	13.3	27.3	13	32.7	5.3	8.4	19	41.4	27.8	11.2	23.7
4	million m3	1213	1700	1849	2316	2445	4233	4789	7610	7849	3462	4817
II												
POWER GENERATION												
1	MW	380	181	46	165	107	94	90	26	53	68	59
2	GW/h	1738	409	219	581	570	498	464	152	304	239	252

Source : MASTER PLANT STUDY EPDC/93  
ON DONG NAI RIVER

Table 12.3-20(a) Meteorological Data of Dong Nai River Basin  
(Ambient Temperature)

1 - Ambient temperature (oC) :

a - LAM DONG region :

Station :		DALAT												Date :	1964-1974 , 1976-1983											
No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean												
1	Average	15.7	16.9	17.9	18.9	19.2	19.0	18.6	18.5	18.3	18.1	17.1	16.3	17.9												
2	Max	17.6	19.3	18.9	20.2	20.0	19.7	19.2	19.0	18.8	19.0	18.0	17.3	18.9												
3	Min	14.3	15.7	16.8	18.0	18.1	18.4	18.0	17.4	18.0	17.4	16.0	15.3	17.0												

b - SONG BE region :

Station :		THAC MO										Date :		1993	
No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean	
1	Average	22.9	23.0	25.7	26.6	26.4	26.1	25.2	24.3	24.5	24.3	24.4	23.2	24.7	
2	Max	32.7	34.0	35.3	34.5	35.6	34.3	32.7	31.5	39.8	32.6	32.8	32.1	39.8	
3	Min	11.4	12.3	15.0	18.9	20.2	21.2	20.0	20.9	21.2	19.0	17.0	14.1	11.4	

c - DONG NAI region :

Station :		TRI/AN				Date : 1990.0								
No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
1	Average	25.9	27.0	28.0	30.0	29.1	26.8	27.1	26.5	26.9	26.6	26.1	26.0	27.2
2	Max	30.2	30.5	31.4	35.2	32.2	30.0	32.0	30.7	30.2	29.3	29.7	32.0	35.2
3	Min	21.4	22.4	24.7	25.4	25.2	23.5	23.7	23.8	24.2	24.6	21.9	21.9	21.4

Table 12.3-20(b) Meteorological Data of Dong Nai River Basin  
(Humidity)

2 - Humidity (%) :

a - LAM DONG region :

Date : 1964-1974, 1976-1983

Station : DALAT

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
1	Average	79	76	75	82	86	89	89	90	90	77	75	73	82
2	Max													100
3	Min	74	73	65	73	81	87	88	88	89	17	26	35	66

b - SONG BE region :

Date : 1993

Station : THAC MO

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
1	Average	73	69	70	76	80	83	88	89	89	87	81	77	80
2	Max	94	95	94	95	95	98	98	97	97	98	98	98	98
3	Min	33	24	26	33	43	51	57	57	58	50	45	43	24

c - DONG NAI region :

Date : 1990

Station : TRI AN

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean
1	Average	69	67	68	70	77	88	88	90	88	87	86	76	80
2	Max	91	94	94	96	97	98	98	99	98	99	99	96	99
3	Min	41	39	38	37	41	59	62	65	61	59	49	50	37

Table 12.3-20(c) Meteorological Data of Dong Nai River Basin  
(Rainfall)

3 - Rainfall (mm) :

a - LAM DONG region :

Station :		BAO LOC										Date :					1933 - 1974				
No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YEARLY							
1	Sum	64.0	48.0	120.8	175.0	230.6	280.9	422.8	428.3	402.0	325.5	172.7	87.9	2758.5							

Station : DALAT

Date : 1952-1974

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YEARLY
1	Sum	3.7	8.8	45.6	167.2	216.2	233.0	214.3	270.7	291.4	266.1	75.6	24.9	1817.5

b - SONG BE region :

Station : THAC MO

Date : 1993

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YEARLY
1	Max	10.6	0.0	60.7	50.8	50.5	63.4	51.1	77.5	68.6	55.4	21.9	42.3	77.5
2	Sum	11.1	0.0	110.6	127.8	259.1	385.6	379.6	404.4	416.8	397.9	44.5	49.7	2587.1

c - DONG NAI region :

Station : TRI AN

Date : 1990

No	Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	YEARLY
1	Max	40.0	4.4	15.0	1.2	64.1	46.8	77.0	108.0	56.0	205.0	68.0	1.3	205.0
2	Sum	40.0	4.4	31.5	2.7	221.8	330.6	289.0	484.7	351.8	491.2	184.6	1.3	2433.6

Table 12.3-21 Salient feature of Gauging Stations Located at  
Dong Nai River Basin

Name	River	Catchment Area (km <sup>2</sup> )	Period	Annual Runoff (10 <sup>6</sup> m <sup>3</sup> )	Specific Discharge (m <sup>3</sup> /sec/100km <sup>2</sup> )	Remarks
Dran	Danhim, Dong Nai	775	1949-1991	23	2.81	
Thanh Binh	Camly, Dong Nai	286	1980-1989	9	3.06	
Dai Ninh*	Da Queyon, Dong Nai	1,933	-	-	-	
Ta Lai	Dong Nai	10,170	1979-1989	331	3.09	
Cay Gao (Tri An)	Dong Nai	14,800	1978-1989	551	3.53	
Dai Nga	La Nga	374	1979-1990	18	4.52	
Ham Thuan	La Nga	1,287	1977-1991	54	4.02	
Tra Bao	La Nga	2,110	1977-1990	82	3.70	
Phuoc Long	Be	2,200	1977-1990	104	4.57	
Phuoc Hoa	Be	5,760	1976-1991	227	3.81	

\*) Runoff data is not available

**Table 12.3-22 Water Quality before and after Constitution of the Tri An Reservoir (in 1985 and 1988)**

**ORGANIC ANALYSIS**

Measurement point	Water quality : mg/l				
	Date	OD	SO <sub>2</sub>	NO <sub>3</sub>	PO <sub>4</sub>
Centre of reservoir	June 85	7.6	0.015	0.9	0.035
	June 88	5.2-3.7	0.01	0.25	0.004
	Nov 85	7.2	0	0.45	0.04
	Nov 88	5.6-2.2	0.05	Tache	0
Tail water of power station	June 85	8	0.18	0.6	0
	June 88	5.2	0.01	0.2	0.04
	Nov 85				
	Nov 88	6.1	0.06	Tache	0
Hoa An City supply water pumping station	June 85	7	0.18	0.6	0
	June 88	3.7	0.01	0.5	0.85
	Nov 85	7.8	0	0.3	0.02
	Nov 88	6.5	0.05	Tache	0.06

Source : Ham Thuan F/S - PIDC2

**WATER AQUALITY CHEMICAL ANALYSIS**

**TRI AN RESERVOIR**

No		Before : mg/l			After : mg/l		
		Reservoir	Tail water	Hoa An	Reservoir	Tail water	Hoa An
1	Ca++	1.9	2.4	2.88	1.44	1.3	1.45
2	SiO <sub>2</sub>	20.5	20	20.5	12	12.7	16.2
3	SO <sub>4</sub>	3.4	3.4	3.4	0.72	0.78	0.9
4	Fe ( Total )	3.32	2.08	2.08	1.2	0.72	1.8

Source : Ham Thuan F/S Study PIDC2

**MICROBIOLOGICAL ANALYSIS**

**TRI AN RESERVOIR**

	Coliform/100	Ecoli/100 ml	Coliform /100	Ecoli/100 ml
Reservoir	150	150	93	93
Tail water	2400	1100	93	93
Hoa An	1000	460	460	1100

Source : Ham Thuan F/S Study

Table 12.3-23 Water Quality of La Nga River

CHEMICAL ANALYSIS

No		LA NGA (down stream)		HAM THUAN 1987				TRI AN Nov 84
		May 83	Sept 85	Sept	Oct	Nov	Dec	
1	Ambient temperature Co	27-31	28-30					
2	Water temperature Co	30-32	28-29					
3	Purity	70-76	15-Oct					
4	PH	7.5-8	6.9-7	6.5	7.3	5.1	8.6	7.3
5	Total hardness	0.78-1.4	1.68-1.95		0.16	0.22		
6	HCO3	24.4-28	24.4-27	27.4	21.4	21.4	24.4	26.8
7	O2	6.36-7.36	7.12-7.84					8.2
8	CO2	1.76	3.52-4.4					3
9	Total organic carbon	2.4-4	11.8-12.4	2.2	20	1.8	2.4	
10	NH4	0-0.15	0	0.08	0.05	0.08	0.05	Tache
11	PO4	0.15-0.35	0.10-0.15					0.65
12	SiO2	12-13	15-15.5	4	4.5	13.5	7	13
13	Ca++	32-48	6-Apr		2	0.8	4.9	3.6
14	Mg++	2.89-4	1.45-1.92					
15	Fe+ ( Total)	0.05-0.15	0.35-0.4	0.35	0.16	0.12	0.18	1.96
16	Cl-	14.2-21.3	14.2-17.7	5	15	3.2	4.5	Tache
17	SO4			1.2	1.4	1.6	0.8	3
18	Na + K			16	8.3	6.5	8.3	10.35

Source : Ham Thuan F/S Study

MICROBIOLOGICAL ANALYSIS  
LA NGA RIVER

No	Date	June 85	Nov 85
1	Coliform MNP/100 ML	460 x 10	240 x 10
2	Ecoli MNP/100 ML	93 x 10	43 x 10

+ Sediment of La Nga river

The sediment is measured at La Nga, Phu Dien and Dai Nga station for up stream and all the basin of La Nga river.

		DAI NGA station	LA NGA station	HAM THUAM Site
1	Period	1987-1989	1985-1991	1985-1991
2	Suspended solid ( g/m3)	15.5 ~ 25.5		25.6 ~ 63.8
3	Annual average		42.9	42.9

The sediment value at Ham Thuan site is based on the data of La Nga and Phu Dien station.



**Table 12.3-24    Population Data of Concerned Provinces**

No.	Province	Area (km <sup>2</sup> )	Population (x 10 <sup>3</sup> persons)
1.	Lam Dong	10,172.6	722.3 (1992)
2.	Dong Nai	5,864.5	1,721.6 (1992)
3.	Song Be	9,545.8	1,057.4 (1992)

CAC PHƯƠNG AN CÔNG TRÌNH TRÊN SÔNG ĐÀ  
SCHEME OF HYDROPOWER PROJECTS ON DA RIVER

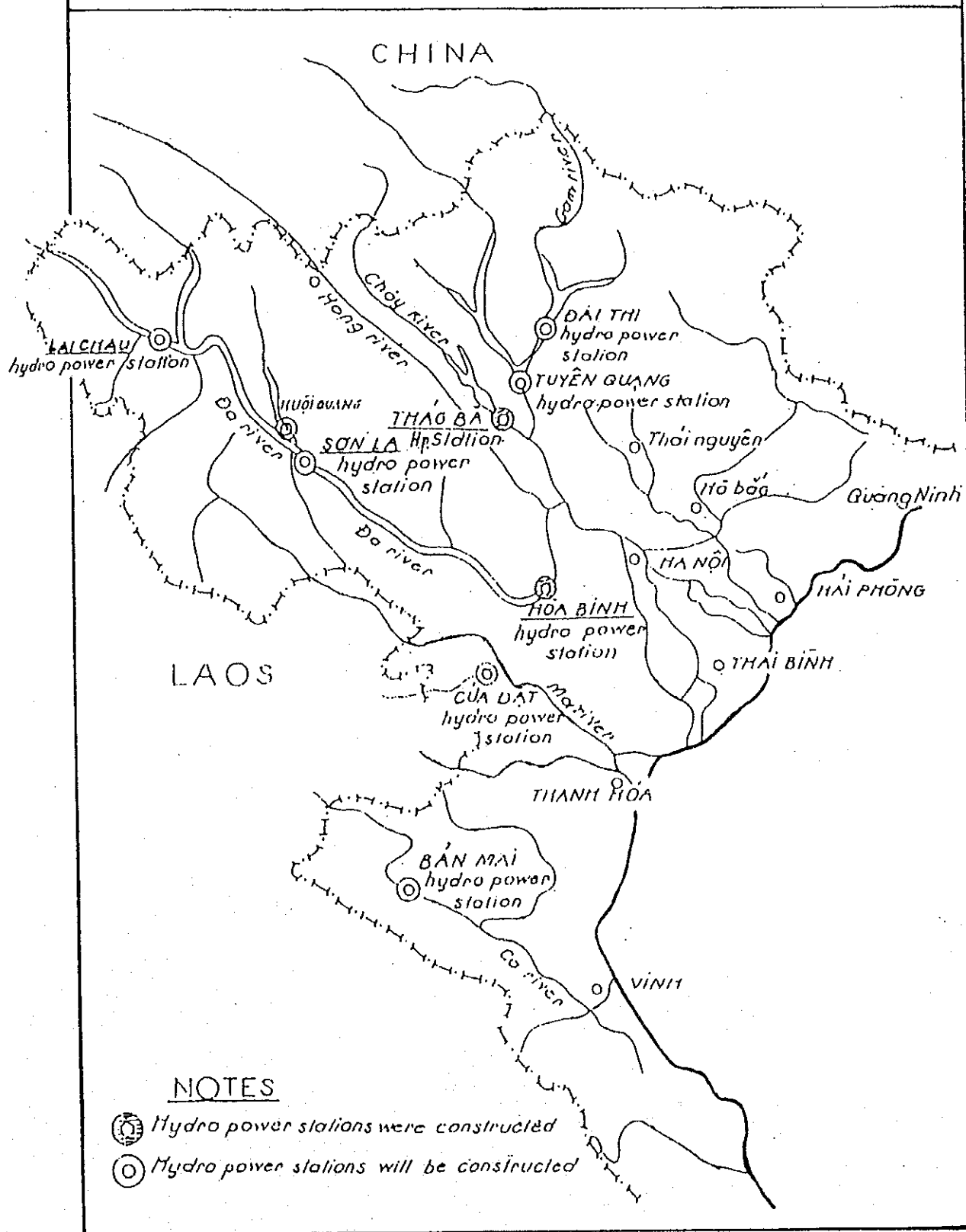
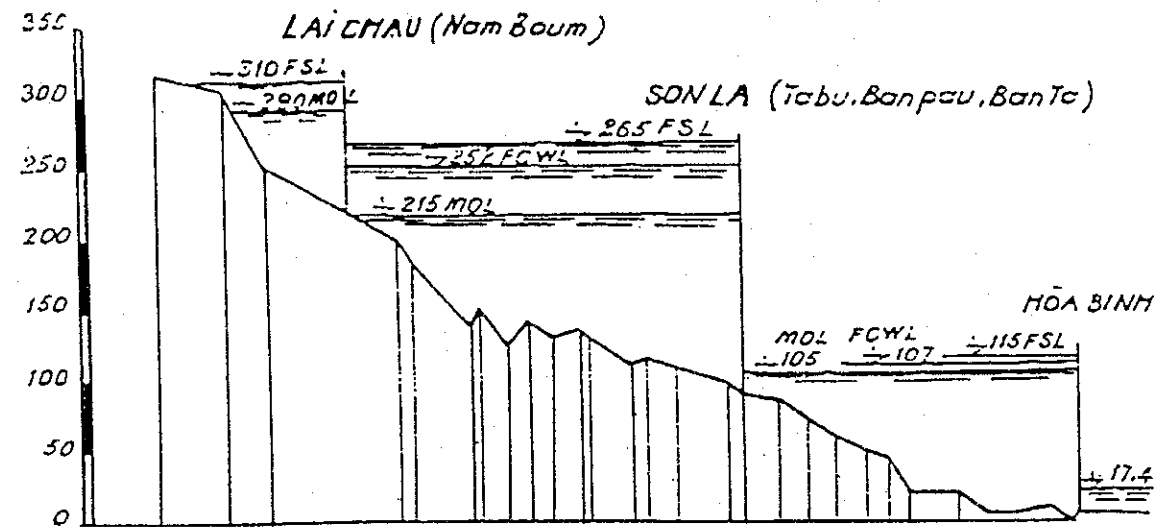


Figure 12.3-1 The Scheme of Hydropower Projects in Da River

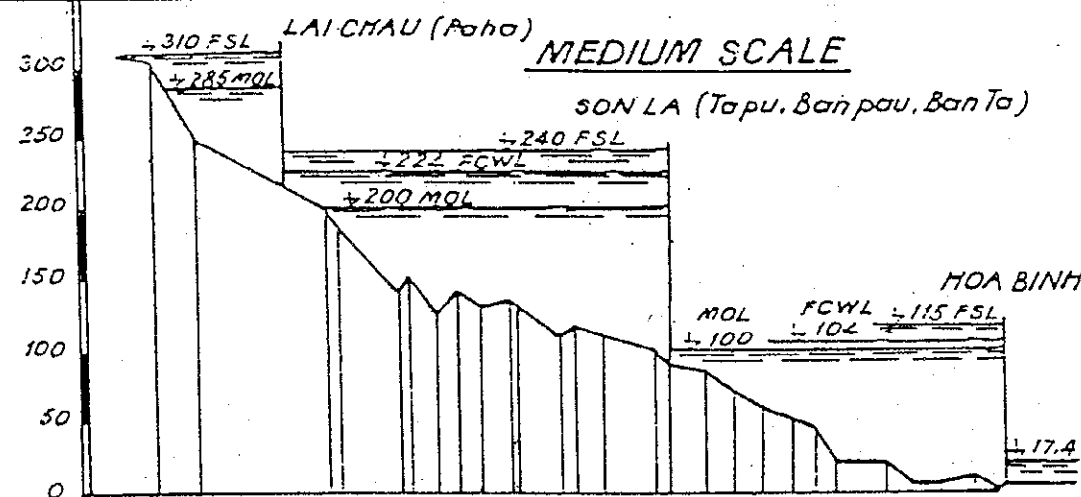




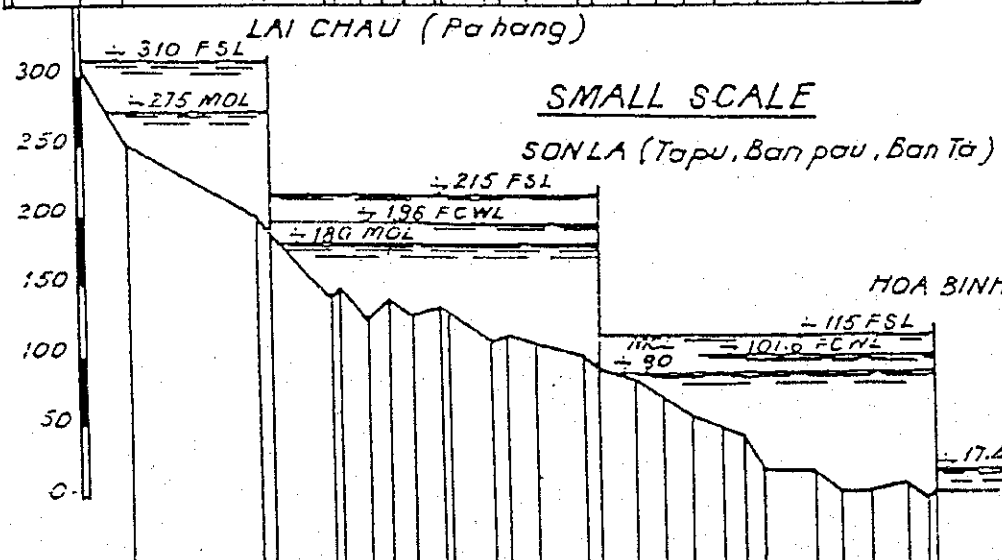
# LARGE SCALE



# MEDIUM SCALE



# SMALL SCALE



ELEVATION (m)	250.0	185.0	150.0	142.3	130.0	112.3	112.8	91.00	83.20	71.00	62.00	49.87	49.50	17.86	17.80	5.88	4.95	10.11	5.62
DISTANCE (km)	24	77.5	40	60	47.5	36.5	32.5	45.0	41.5	32.5	34.0								
Acc. DISTANCE (km)	24.0	101.5	141.5	201.5	249.0	285.5	320.0	365.0	406.5	438.0	473.0								

# THE MAJOR VECTORS OF THE WORKS ON THE DA RIVER

No	MAJOR VECTORS	Unit	LARGE SCALE			MEDIUM SCALE			SMALL SCALE		
			H.binh	S. La	L.chau	H.binh	S. La	L.chau	H.binh	S. La	L.chau
1	Basin area	Km <sup>2</sup>	517.00	45730	22260	51700	45730	22250	51700	45730	226100
2	Annual discharge	m <sup>3</sup> /s	1780	1560	733	1790	1560	754	1780	1560	846
3	Annual water amount	10 <sup>6</sup> m <sup>3</sup>	56.13	49.16	23.11	56.13	49.15	23.65	56.13	49.15	26.29
4	FSL	m	115	265	310	115	240	310	115	215	310
5	MOL	-	105	215	290	100	200	285	90	160	275
6	Flood control water level	-	107	252	-	104	224	-	101.6	196	-
7	Total volume	10 <sup>6</sup> m <sup>3</sup>	9250	30750	500	9450	19663	845	9450	11620	3700
8	Useful volume	-	1850	19162	320	2816	11799	576	4361	7412	2203
9	Flood control volume	-	1500	5500	0	2000	5000	0	2500	4500	0
10	Area of water surface FSL	Km <sup>2</sup>	198	508	20	198	379	31.4	198	275	80.8
11	Area of water surface MOL	Km <sup>2</sup>	175	213.5	12	164	217.6	17	144.7	152.2	41.5
12	Max discharge (through turbine)	m <sup>3</sup> /s	2400	3055	672	2400	2680	816	2400	3177	1120
13	Max water head	m	99	157	55	99	136	68	99	113	121
14	Min water head	-	84	101.5	35	81	87	43	74	65	61
15	Calculation water head	-	88	129	50	85	110	55	88	83	96
16	Firm capacity	MW	925	1502	67	622	1081	102	723	668	264
17	Installed capacity	-	1920	3500	300	1920	2880	400	1920	2400	960
18	Annual energy	10 <sup>6</sup> KWh	11.176	14,522	4539	10,132	11,795	2,184	8,996	9,297	4,505
19	Firm energy	-	8,103	13,557	2,547	7,201	9,469	0,894	6,333	5,851	2,312
20	Time of using of installed capacity	h	5,820	4034	5130	5,777	4095	5460	4685	3873	4692

# QUANTITY OF MAJOR WORK

No	WORK ITEM	Unit	LARGE SCALE			MEDIUM SCALE			SMALL SCALE		
			S. La	L. chau	Total	S. La	L. chau	Total	S. La	L. chau	Total
1	Rock and soil excavation	10 <sup>3</sup> m <sup>3</sup>	50452.0	10,667.0	61,129.0	42,236.0	7656.0	49992.0	37,547.0	22236.0	59783.0
	Soil excavation	"	3414.0	1720.0	5134.0	7850.0	1694.0	9544.0	7915.0	8644.0	16559.0
	Rock excavation	"	39963.0	8592.0	48555.0	33455.0	5865.0	39320.0	28845.0	13,242.0	42087.0
	Underground rock excavation	"	1085.0	355.0	1440.0	991.0	97.0	1088.0	787.0	350.0	1137.0
2	Rock and soil embankment	10 <sup>3</sup> m <sup>3</sup>	49874.0	3149.0	53023.0	34640.0	6187.0	40827.0	22176.0	20456.0	42632.0
	Rock embankment	"	43,250.0	2575.0	45825.0	29780.0	5270.0	35050.0	19160.0	16953.0	36113.0
	Earth core embankment	"	398.0	278.0	676.0	2724.0	430.0	3154.0	1546.0	1902.0	3448.0
	Sand and gravel embankment	"	2644.0	296.0	2940.0	2136.0	487.0	2623.0	1470.0	1601.0	3071.0
3	Concrete	10 <sup>3</sup> m <sup>3</sup>	3161.0	564.0	3725.0	3075.0	827.0	3902.0	1928.0	1274.0	3202.0
	Open concrete	"	2781.0	443.0	3224.0	2715.0	792.0	3507.0	1658.0	1155.0	2813.0
	Underground concrete	"	380.0	121.0	501.0	360.0	35.0	395.0	270.0	119.0	389.0
4	Injection	10 <sup>3</sup> m	254.0	62.0	316.0	246.0	45.0	291.0	205.0	114.0	319.0
5	Equipment	T	67578.0	13705.0	81283.0	58086.0	17046.0	75132.0	56789.0	25636.0	82425.0
	Metal work	"	30820	8543.0	39363.0	29760.0	10789.0	40549.0	28330.0	16454	44784.0
	Hydraulic machinery	"	25938.0	3900.0	29838.0	18808.0	4570.0	23378.0	20150.0	7732.0	27882.0
	Power equipment	"	11120.0	1262.0	12382.0	9518.0	1527.0	11045.0	5317.0	2450.0	7767.0

Figure 12.3-2 The Three Groups of Alternatives of Hydropower Projects along Da River









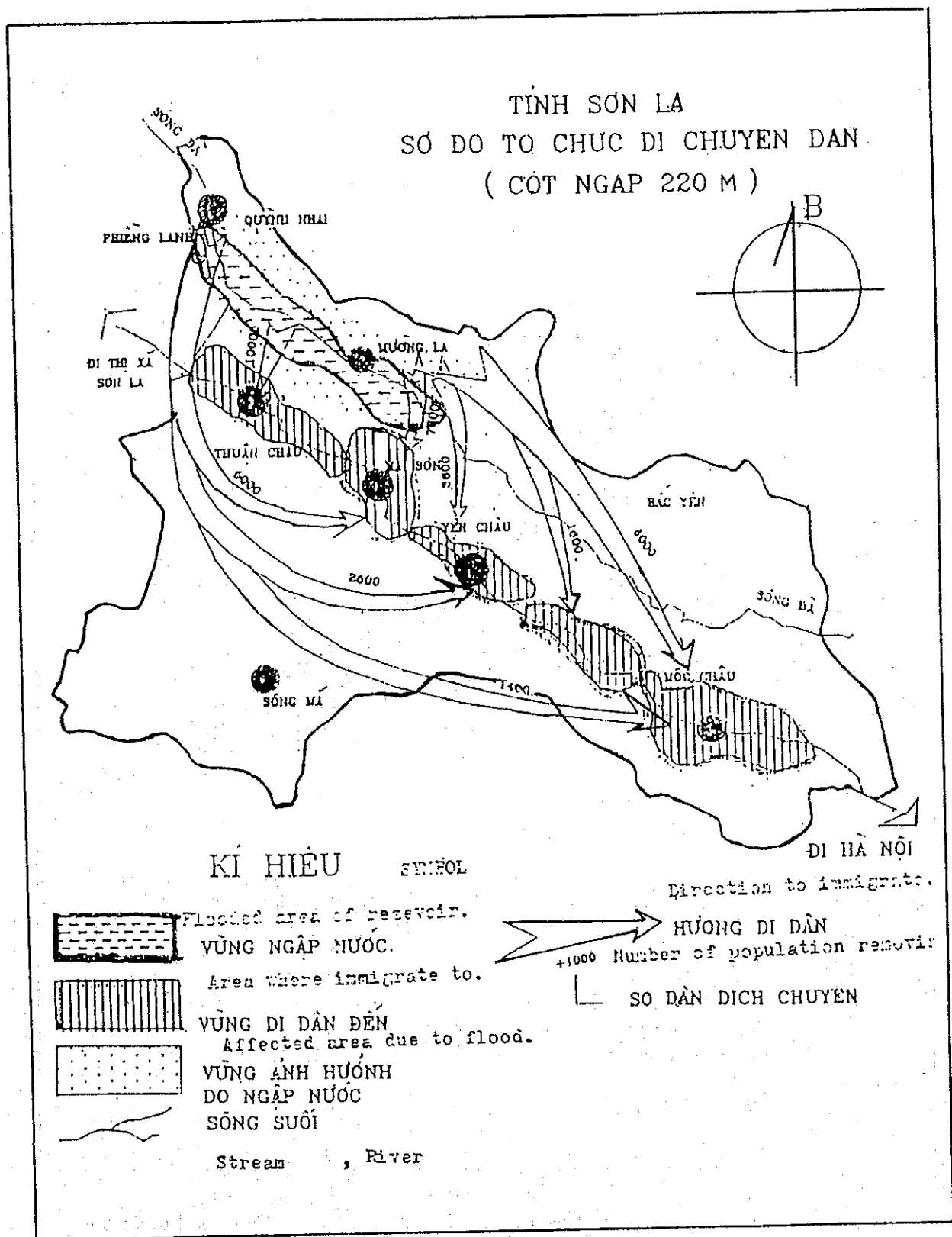


Figure 12.3-3(a) Resettlement Locations Plan in Son La Province  
( In case of Flood Level : + 220m )

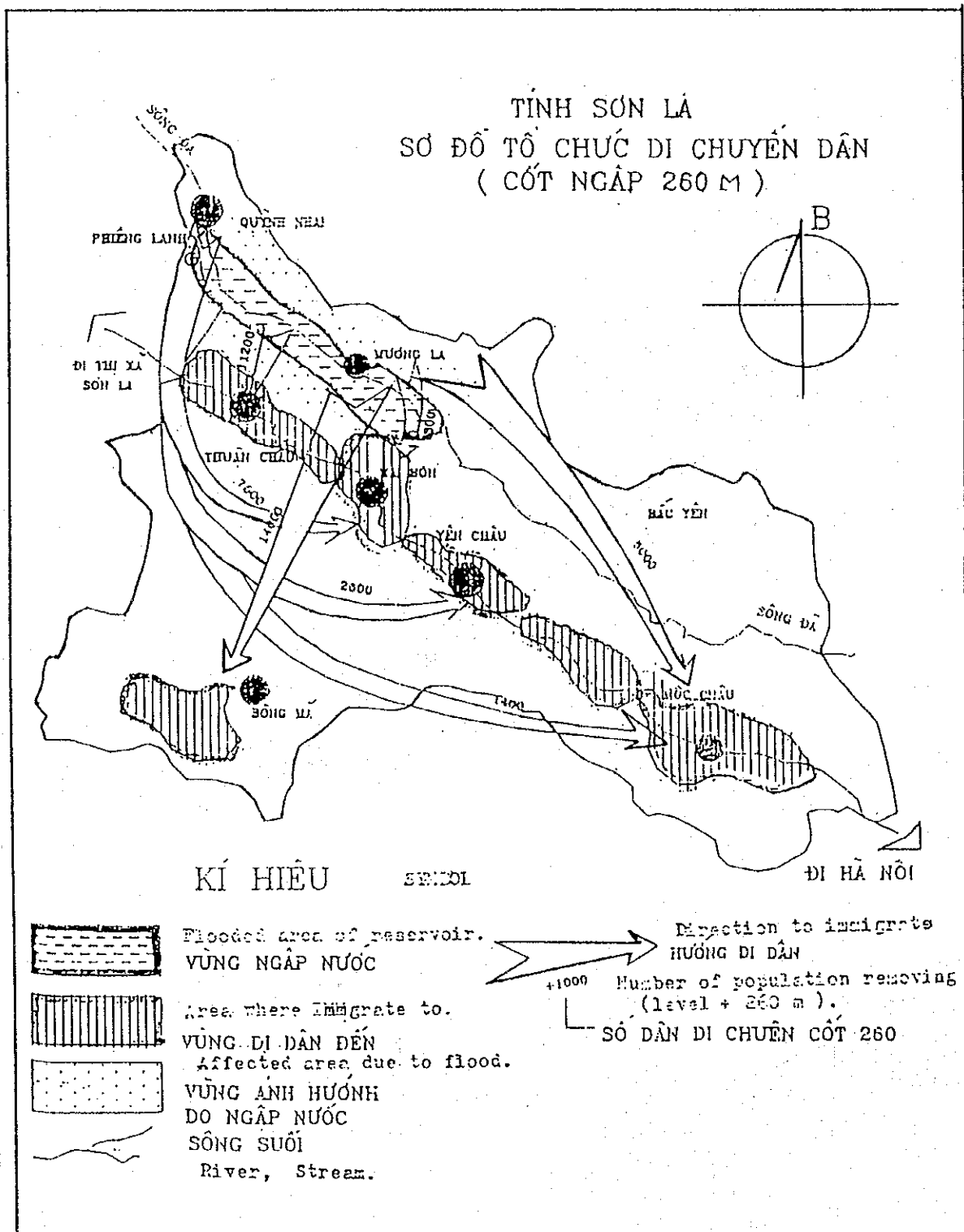


Figure 12.3-3(b) Resettlement Locations Plan in Son La Province  
( In case of Flood Level : + 260m )

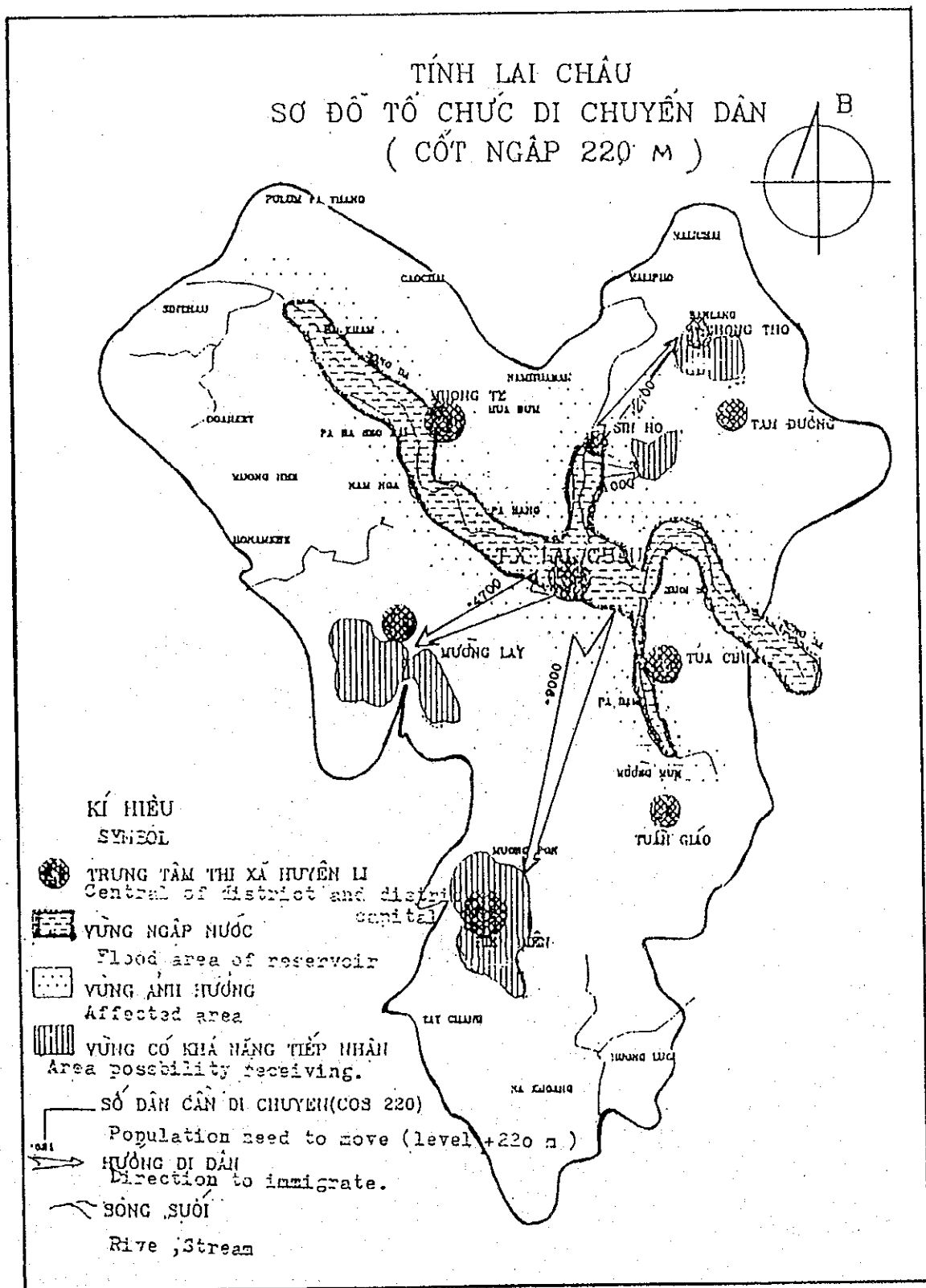
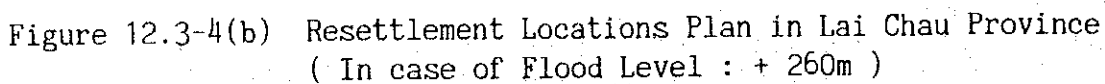
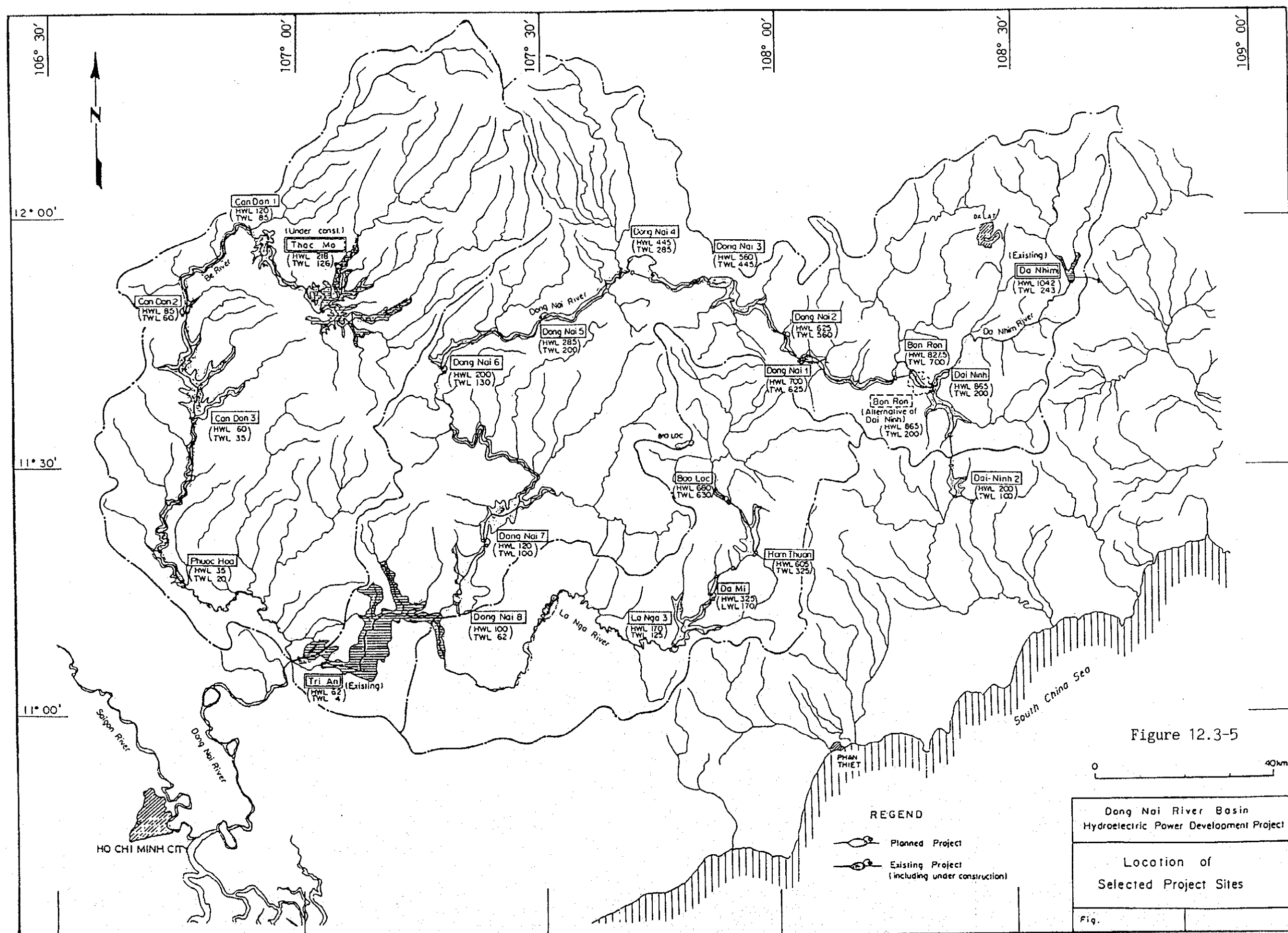


Figure 12.3-4(a) Resettlement Locations Plan in Lai Chau Province  
( In case of Flood Level : + 220m )













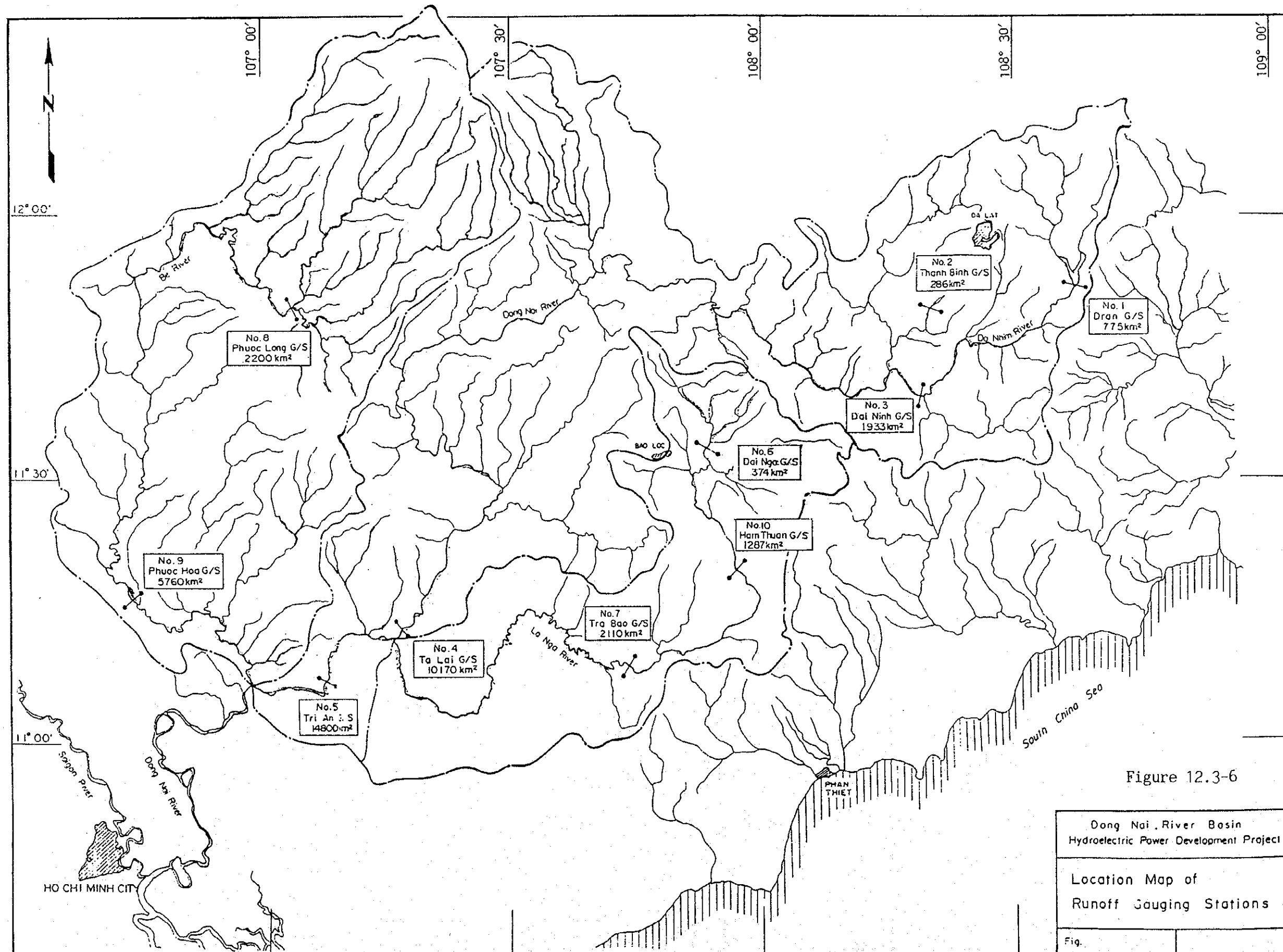


Figure 12.3-6







## 12.4 Present Situation of Environmental Considerations under Thermal Power Projects

To understand the present situation of environmental considerations under thermal power projects in the country, a couple of case studies were performed under the cooperation of a Viet Nam consultant and IEV. From point of view of environmental consideration, coal-fired thermal power plants will be the essential ones for review of their current status. Therefore, the following two operating coal-fired thermal power plants were selected for the case study:

- |     |  |   |        |
|-----|--|---|--------|
| (1) | Pha Lai Thermal Power Plant            | : | 440 MW |
|     | (started full power operation in 1987) |   |        |
| (2) | Ninh Binh Thermal Power Plant          | : | 100 MW |
|     | (started full power operation in 1977) |   |        |

The study results were compiled into the report for each power plant. It is found that the contents of the reports are quite detailed, which have almost covered what are needed for an environmental baseline study. If full scale EIAs would be carried out for these plants in future, such as for the case of Pha Lai extension project, the data and informations obtained under the case studies should be useful and valuable for implementing the EIAs.

In the following, some key results of the case studies are described. For details, please refer to the original reports (References (25) and (26)).

### 12.4.1 Case Study on Pha Lai Thermal Power Plant

It is understood that Pha Lai thermal power plant is the largest and most significant thermal power plant in Viet Nam. In the period from 1983 to 1989, the plant took an important role of power supply in northern power system where was usually faced with electric power shortage. Therefore, other problems such as plant's efficiency, environmental protection, and providing social infrastructure benefit to local society were not seriously taken into consideration. EIA was not carried out carefully for the plant construction and operation. No environmental monitoring system was equipped and therefore the effectiveness of the installed electrostatic precipitators could have not been evaluated to date.

On the other hand, the plant operating performance has been gradually degraded due to lack of key spare parts, not only for the parts of major plant systems such as boilers and operating control system, but also for the environmental protection systems such as the electrostatic precipitators, chemical neutralization system and oil polluted waste water treatment system. Since Hoa Binh Hydropower Plant was put into operation in 1989, the output of Pha Lai thermal power plant was continuously decreased. Although the emissions have been alleviated due to the output decrease, various problems are still existing. Considering the coming extension project of Pha Lai thermal power plant, substantial overhaul and improvement of the existing plant system and related EIA study will become key issues of Pha Lai thermal power plant.

From the above point of view, the case study carried out this time provided various valuable data and information which should become the data base for improving this existing plant as well as for its extension project in future.

#### (1) Main plant specifications and operating data

Pha Lai thermal power plant started its construction in 1980. Its first unit was put into operation in 1983 and the last unit in 1987. The plant design and equipment supply were conducted by former USSR. The main specifications of the plant are as below:

- Plant capacity : 110MW/unit x 4 units = 440 MW
- Boilers : 8 sets, natural circulation
- Turbines : 4 sets
- Generators : 4 sets
- Electrostatic precipitator : 8 sets (one set per boiler),  
4 electro-fields for one set
- Annual electricity generation : 2,860 GWh  
(plant factor 74%)
- Nominal coal consumption : 1,128 x10<sup>6</sup> tons  
(7,000 kcal/kg)
- Annual quantity of ash : 498,095 tons

For more detailed plant specifications, see Reference (25). The coal is delivered from Hong Gai, Cam Pha, Mao Khe and Vang Danh areas. The characteristics of the coal is as below :

C = 55%	V = 5.5% (content of volatile matter)	
H = 2.6%	Q = 5,050 kcal/kg (low calorific value)	
O = 2.5%	Ash deformation temperature	T1 = 1,350°C
S = 0.4%	Ash hemispheric temperature	T2 = 1,450°C
Water = 9%	Ash fluidization temperature	T3 = 1,500°C
Ash = 30%		

Fuel oil is used for starting up and maintaining combustion during low load operation. Table 12.4-1 shows the coal analysis data in 1989 and 1990. Table 12.4-2 shows some of the operating data of the plant during 1986 to 1993.

Some main plant operating issues are summarized below :

- Boiler efficiency is about 80% to 81% (design value is 89%)
- Use of more fuel oil to achieve flame stability
- The feedwater treatment system is in bad condition which leads to long-term issue of boiler tube damage.
- Sometimes only two out of four ESPs are operating due to lack of spare parts. It is estimated that the amount of fly ash being emitted currently is about 3 kg/sec.
- Lack of plant waste water treatment

Some photographs (Figures 12.4-1 to 12.4-6) of the plant area and its related facilities are attached for reference. Table 12.4-3 shows some main design parameters of Pha Lai thermal power plant Extension Project.

## (2) Natural environment of the plant site area and its vicinity

### (a) Plant site location

Pha lai thermal power plant is located at about 70 km north-east of Hanoi, in Chi Linh district, Hai Hung Province. The site is in the bank of Thai Binh River and at the confluence of six rivers, i.e. Cau, Thuong, Duong, Luc Nam, Kinh Thay and Thai Binh rivers.

Hai Hung is a large province with an area of 2,555 km<sup>2</sup> and 2.56 million population. Laying in the center of northern Viet Nam, Hai Hung province shares borders with Ha Bac and Quang Ninh provinces in the north, Thai Binh province in the south, Hai Phong city in the east, Hanoi capital and Hatay province in the west.

Hai Hung has a plain topography, except Chi Linh and Kim Mon are mountainous land in the altitude of about 1,000 m. Soil is alluvium and with high fertility. This province has agriculture land up to 67.2% of its total area, and is one of a granary of the northern plain.

Hai Hung province also has a lot of lakes and ponds, which contribute not only for cultivative irrigation but also for aquatic product breeding. In Chi Linh district, there are two lakes which are Ben Tam (403 ha) and Nhan Hue (44 ha). Da Trach Marsh in Hai Hung province is a famous historical place.

**(b) Meteorological and hydrological characteristics of Pha Lai Thermal Power Plant site area**

**1) Temperature**

- Annual average temperature : 23.5°C
- Average temperature in January : 16.6°C
- Average temperature in July : 29°C
- Temperature range in dry cold season : 17°C to 21°C  
(November to March)
- Temperature range in wet hot season : 23.5°C to 29°C  
(April to October)

For details, see Table 12.4-4 and Table 12.4-5.

**2) Humidity and rainfall : see Table 12.4-4 and Table 12.4-5.**

**3) Wind direction and velocity**

**a) From March to August, south-eastern wind is significant. Its frequency is as below :**

- March : 45% to 55%
- April : 60% to 70%
- May : 60% to 70%
- June : 35% to 45%
- July : 50% to 60%
- August : 40% to 50%

**b) From November to January, north-eastern wind is significant. Its frequency is as below:**

- November : 30% to 40%
- December : 40% to 50%
- January : 35% to 45%

**c) Wind velocity**

- South-eastern wind average velocity: 3 to 4.5 m/sec
- North-eastern wind average velocity: 4 to 4.5 m/sec

### (c) Characteristics of surface water

Water for Pha Lai thermal power plant is taken from Thai Binh river. The river is about 98 km long and its watershed is about 13,000 km<sup>2</sup>. It is influenced by tide. Some data of the river water at the inlet of Pha Lai thermal power plant are as below.

- Average temperature (in past years) : 24°C
- Maximum temperature (in August 1967) : 35.2°C
- Minimum temperature (in January 1961) : 5.5°C
- Average content of suspended solid
  - In dry season : 20 to 30g/m<sup>3</sup>
  - In rainy season : up to 1,000g/m<sup>3</sup>
- Average river water flow rate : 252 m<sup>3</sup>/sec

The following two tables show some water quality data of Cau river, which is one of the rivers flowing nearby Pha Lai town and join with Thai Binh river:

Table 12.4-6 Analysis results of Cau River water at 6 km upstream of Thai Nguyen city

Table 12.4-7 Analysis results of Cau River water at 500 m downstream of Luuxa scouring sluice

### (d) Forest distribution in the vicinity of Pha Lai Thermal Power Plant

The forests distributed in the vicinity of Pha Lai thermal power plant include those of the midland and mountainous area of Hai Hung, Ha Bac and Quang Ninh provinces. Different kinds of the forests and their area sizes are shown by the attached Table 12.4-8 The forest of this area is called as Chi Linh forest.

### (e) The fauna and flora inhabit the area of the Chi Linh forest

#### 1) Terrestrial spined animals

The terrestrial spined animals found in this area are as below:

- Amphibia consists of 14 species      5 families      1 order
- Reptilia consists of 24 species      9 families      2 orders
- Aves consists of 72 species      31 families      15 orders
- Mammalia consists of 29 species      21 families      8 orders

In total, there are 139 species, 66 families and 26 orders.

#### 2) Terrestrial spineless animals

Most of the terrestrial spineless animals are insects. There are many kinds of species found in the forest as listed below:

- *Coleoptera* : 88 species in 9 orders
- *Lepidoptera* : 33 species in 3 orders
- *Odorata* : 5 species
- *Hemiptera* : 13 species in 3 orders
- *Homoptera* : 9 species in 3 orders
- *Orthoptera* : 7 species in 3 orders
- *Manioptera* : 1 species



- *Blathoptera* : 1 species
- *Hymenoptera* : 10 species in 4 orders
- *Diptera* : 75 species in 4 orders
- *Isoptera* : 39 species in 4 orders

### 3) Aquatic flora

Floating flora is the main aquatic plant in this area. There are 30 species in 6 phylums of algae found as listed below.

- *Diatomae* : 11 species
- *Chlorophyta* : 7 species
- *Cyanophyta* : 6 species
- *Euglenophyta* : 3 species
- *Pyrrophyta* : 1 species
- *Santhophyta* : 2 species

### 4) Aquatic fauna

There are various fishes, molluses, crabs and shrimps in this area, which are available as food.

## (3) Initial study on environmental impact caused by waste water of Pha Lai Thermal Power Plant

In 1990, IEV carried out a study on potential environmental impacts to be caused by the waste water from ash and slag disposal. The potential impacts on surface water quality, soil and vegetals were studied by taking samples and making analysis based on Vietnamese Standards TCVN2652-78 and TCVN4556-88.

Discharge water samples from discharge canal, surface water and well water samples from the surrounding area, also soil samples from the Binh Giang rice field were taken and analyzed. Figures 12.4-7 and 12.4-8 show the locations of the sampling points.

The results of the sample analyses are shown in the following attached tables:

Table 12.4-9	Results of Water Quality Analysis in Pha Lai Thermal Power Plant Site Area (April 1990)
Table 12.4-10	Results of Water Quality Analysis in Pha Lai Thermal Power Plant Site Area (November 1990)
Table 12.4-11	The Contents of Chemical Elements in Discharge Water
Table 12.4-12	The Contents of Chemical Elements in Discharge Water and Vegetables
Table 12.4-13	The Contents of Chemical Elements in Sludge
Table 12.4-14	Average Quantity of Micro Organism in Water and Soil
Table 12.4-15	Average Quantity of Micro Organism in Soil and Sediments

Some main findings obtained from the various sample analysis results are summarized as below :

- (a) Analysis of Thai Binh river water showed that there were no phenol, H<sub>2</sub>S, Cu, Pb, Cr and As contained in the river water, while the values of suspended solid and transparency were high and exceeding sanitary standard.

- (b) In the samples of Khelang ash disposal and at the end of discharge canal, there appeared contents of Cr, Cd, As and also H<sub>2</sub>S. Especially, the contents of suspended solid was very high and its high turbidity was clearly noticed. Therefore, further monitoring will be needed to follow the content of such unwelcome elements.
- (c) Well water quality
  - 1) Well water near Khelang dyke : The pH index was very low (acid character), and dissolved oxygen trended forward to lower level.
  - 2) Well water near Pha Lai town and discharging canal : The contents of SS, Fe, Pb and Mn were tending to increase.
- (d) Chemical elements in vegetable samples : Cu, Pb and Cd were found in most of the samples. As was also found in a few samples.

It is understood that this study is an important and valuable part of environmental monitoring. Some findings such as having Cd and other metal elements found in samples of discharge canal and vegetables would need further study in future to clarify their potential sources.

#### (4) Socio-economic environment of the plant site area and its vicinity

The area within 30 km radius of Pha Lai thermal power plant covers Dong Trieu district of Quang Ninh province; Chi Linh, Kim Mon and Nam Sach districts of Hai Hung province; and Yen Dong, Luc Nam, Lang Giang, Gia Luong and Que Vo districts of Ha Bac province.

The socio-economic data base of the three provinces together with their concerned districts are summarized and shown in the attached Table 12.4-16 to Table 12.4-18. Population data of ethnic groups are also shown in the Table 12.4-19 to Table 12.4-21.

In the following, some detailed socio-economic data of Chi Linh district (Hai Hung province) and Gia Luong district (Ha Bac province) are provided.

##### (a) Socio-economic environment of Chi Linh district

Chi Linh district, in which the Pha lai thermal power plant is located, is located in the north-east of Hai Hung province. The northern part of the district is a continued hills area with average height of 50m to 60m. In the south, it is surrounded by Thai Binh and Kinh Thai rivers. There are dykes for flood protection for about 20 km.

Some data of the district are shown below :

- Population (in 1986) : 129,800 people  
(including 2,136 people of 8 ethnic groups)
- Current annual GDP growth rate : 2% to 2.1%
- Portions of labour forces :
  - a) agriculture : 61.6%
  - b) non-agriculture : 38.4%
- There are 23 state and 18 local organizations and enterprises, including Pha Lai power plant and a medical glass enterprise.

Table 12.4-22 shows some more detailed data of the district, including economic development target of this area up to the year 1995.

## (b) Socio-economic environment of Gia Luong district

Gia Luong district is a plain area and surrounded by three rivers. Some socio-economic data are shown below :

• Population (in 1991)	:	192,486 people
• Sown and cultivative area	:	23,831 ha
• Food production per capita (in 1991)	:	286 kg/person/year
• Total length of dykes	:	about 55 km

Table 12.4-23 shows detailed socio-economic data of the district, including the targets up to the year 2,000. Table 12.4-24 shows the names, locations and productivity of the industrial and handicraft enterprises in Gia Luong district.

### 12.4.2 Case Study on Ninh Binh Thermal Power Plant

Ninh Binh thermal power plant is located in Ninh Binh Town, which is the capital of Ninh Binh province, and at about 100 km south of Hanoi. Right after start of the plant construction in 1971, the site had been hardly damaged by bombs and rockets launched from air attacks. After the Paris Agreement in 1973 (ceasing fire in Viet Nam War), the plant construction was started again. The final unit was put into operation in 1976.

During the years 1977 to 1979, operating hours reached about 6,500 hrs per year, while during the years 1980 to 1983 the plant operation reached about 6,000 hrs per year. However, after 1983, the plant operating hours has been gradually reduced due to the difficulty of spare parts supply and other factors. Table 12.4-25 shows the operating data from the year 1981 to 1993.

In consideration of the war at that time, this plant was built in the way that it could withstand an aerial attack. That is why the plant is located closely to the foot of Canh Dieu mountain. The boilers are in constricted area 7 m underground, and the chimney is also built closely to the foot of the mountain. See attached Figure 12.4-9 for the layout. The stack height is 80 m, while the height of the mountain is 96m to 102m.

As a result, the whole area of the plant site is fall within the wind shadow of the neighboring mountain. Fly ash and exhaust gases emitted from the stack almost could not diffuse so far as desired, and thereby the emissions fall directly within the plant site area and also in Ninh Binh Town.

To understand the actual situation of the air pollutions, an aerodynamic model test was performed and the ambient air quality was measured in Nov. 1992. Results of the test and measurement are summarized in later section. To improve the micro-atmospheric condition and reduce the extent of the air pollution in the site and town areas, raising the stack height to 120 m and other measures are being studied.

For details, see the document of Reference (26).

#### (1) Main plant specifications

• Installed plant capacity	:	25 MW/unit x 4 units = 100 MW
• Boilers	:	4 sets
• Turbines	:	4 sets
• Generators	:	4 sets
• Dust collectors	:	double dust separations, cyclone type (wet scrubber)
• Stack height	:	80 m

Coal used for the plant is fine coal No.5 and No.6, which has the characteristic as shown below:

• C = 55.5%	V (volatile matter)	= 5.5%
• H = 2.6%	Q (Heat value)	= 5,050 kcal/kg
• O = 2.5%	ash	= 30%
• N = 0.5%	Ash characteristic temperature:	$\left\{ \begin{array}{l} T1 = 1,350^{\circ}\text{C} \\ T2 = 1,450^{\circ}\text{C} \\ T3 \geq 1,500^{\circ}\text{C} \end{array} \right.$
• S = 0.4%		
• water = 9.0%		

Cooling water for condensers is taken from nearby river (Day river) and discharged to the river through canal.

## (2) Natural environment of the plant site and its vicinity

### (a) Plant site location

Ninh Binh thermal power plant is located at Ninh Binh Town, at the latitude  $20^{\circ} 15' \text{N}$  and longitude  $106^{\circ} \text{E}$ . North side is Day river and south side is Tam Diep mountains, which separate three provinces, i.e. Nam Ha, Ninh Binh and Thanh Hoa provinces.

Day river is a branch of Hong river and joins with other branch of Hong river called Namdinh river, and flows into the sea. Besides limestone mountains (lower than 300 m), the area between the river branches is a low-lying land which is always flooded.

About 6 km west of Ninh Binh town is the Hoa Lu mountain range. The area was an ancient capital (968 to 1010 year). There are many grottos and springs in this area, which constitutes a famous tourism zone.

### (b) Meteorological and hydrological conditions

#### 1) Temperature and humidity

Average temperature in winter fluctuates between  $19^{\circ}\text{C}$  to  $22^{\circ}\text{C}$ . Lowest temperature observed is  $6^{\circ}\text{C}$  to  $7^{\circ}\text{C}$ . Average temperature in summer fluctuates between  $25^{\circ}\text{C}$  to  $28^{\circ}\text{C}$ . Highest temperature is about  $35^{\circ}\text{C}$  to  $36^{\circ}\text{C}$ . See Tables 12.4-26 and A12.4-27 for monthly average temperature and humidity.

#### 2) Wind

Wind direction and speed are as below :

a)	In winter	:	Northern wind	:	40%
			N-W wind	:	30%
			N-E wind	:	30%
			Average wind speed	:	2 to 2.5 m/sec.

b)	In summer	:	Frequent directions are S-E, S and S-W.
			Average wind speed is 2 to 3 m/sec.

3)	Rainfall	:	see Table 12.4-28
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#### 4) Hydrology

The flow rates of Day river and Van river depend on the rainfall in the watershed. The lowest flow observed at Ninh Binh hydro-gauging station is 55 m<sup>3</sup>/sec and the biggest flow observed at the same station is 2,750 m<sup>3</sup>/sec.

In October 1993, water quality was analyzed in and around Ninh Binh town. See Figure 12.4-10 for the locations of the sampling points. See the document of Reference (26) for the detailed water quality data obtained.

#### (c) Forest distribution in the region

The forest covered area of Ninh Binh province is about 8.4%, which is relatively higher than that of the whole Hong river delta (3.4%). Table 12.4-29 shows the forest areas of the provinces within Hong river delta, including Hanoi. Table 12.4-30 shows the areas of natural forest and uncovered land/bare hill lands.

#### (d) National park

There is a national park called Cuc Phuong National Park. The park is located 120 km south-west of Hanoi, in the territory of three provinces of Ninh Binh, Hoa Binh and Thanh Hoa. Total area is 22,000 ha, 50% of it is laying in Ninh Binh province.

Remarkable features of the park are :

- Rich with vegetal species
- Area with many rare and endemic species
- Area having high value for geology and paleontology
- Area having high value of culture, history and landscape

#### (e) Flora and Fauna

Cuc Phuong area retains a noticeable proterozoic forest laying in valleys and limestone mountains. The forest belongs to typical wet tropical ever-green forest, which can be distinguished into five floors, i.e. three wood floors, one shrub floor and one fernery floor. In the forest, 1,880 species, 887 genus and 221 families have been found, which shares 24.6% of species, 43.6% of genus and 68.9% of families of the whole country, respectively.

There are a abundant fauna in the Cuc Phuong area. There are 255 species of spined animals identified as listed Table 12.4-31 However, the amount of the animals has been continuously reduced to date. Tiger, peacock and so on have not been found recently.

#### (3) A study on air pollution in and around the plant site area

A wind flow pattern test using 1 to 1,000 scale model was carried out to see wind flow shadow creating by Canh Dieu mountain. Attached Figure 12.4-11 shows two of the pictures taken, which clarified the wind shadow phenomena caused by the mountain. It is clear that, when southern or S-E wind blows, fly ash and exhaust gases from the plant stack will fall down quickly into the plant site and town areas.

In addition to the model test, ambient air quality was also measured in November 1992 in the areas. Figure 12.4-12 shows the locations of the sampling points. Dust, CO<sub>2</sub>, CO and SO<sub>2</sub> were measured. For detailed data obtained, see the document of Reference (26).

Some results are shown below :

**(a) Dust**

In the distances of 10 m to 1,300 m from the plant stack, concentrations of dust were determined as 0.62 to 8.06 mg/m<sup>3</sup>. It is noted that permissible dust concentration in residential area is 0.5 mg/m<sup>3</sup>. Therefore, the average actual value exceeds 8 to 10 times of the limit.

**(b) SO<sub>2</sub>**

Measured data	:	0.09 to 1.09 mg/m <sup>3</sup>
Permissible concentration	:	0.5 mg/m <sup>3</sup> (instant)

**(c) CO**

Measured data	:	4.63 to 12.57 mg/m <sup>3</sup>
Permissible concentration	:	3 mg/m <sup>3</sup> (instant)

**(d) NO<sub>2</sub>** : Maximum permissible instant concentration is 0.085 mg/m<sup>3</sup>.  
Measured NO concentrations are higher than the standard from 2 to 3 times.

As already mentioned, several measures are being considered to improve the situation, including raising the stack height to 120 m.

**(4) Socio-economic environment of the plant site area and its vicinity**

Taking a radius of 30 km with the center at Ninh Binh town (i.e. at the power plant), the covered area includes two provinces of Ninh Binh and Nam Ha. Before 1991, these two provinces used to be combined as one province called Ha Nam Ninh province. Ha Nam Ninh province is a fertile region located at southern part of the Northern Plain.

The power plant is located at Ninh Binh town, which is the capital of Ninh Binh province. The capital city of Nam Ha province is called Nam Dinh City, which is the third biggest city after Hanoi and Hai Phong in the northern part of Viet Nam.

Some socio-economic data of the two provinces are summarized in attached Table 12.4-32. As shown by the data, agriculture is the main economic sector of the both provinces. The annual production value of agriculture is about twice of that of industry. For more details, see the document of Reference (26).

Table 12.4-33 shows the population of ethnic groups living in the former Ha Nam Ninh province as a whole.

Table 12.4-1 The Average Contents of Coal Supplied to Pha Lai Thermal Power Plant in 1989

Constituent	W	A	S	O	C	H	N	Q kcal/kg
Content (%)	7.038	31.9	0.739	2.545	56.972	2.229	0.04	5013

The average contents of coal supplied to Phalai in 1990

Month \ Contents	W %	A %	S %	N %	O %	C %	H %	Q Kcal/kg
1	5.918	28.624	0.805	0.04	2.798	58.422	2.538	5284.5
2	6.16	25.379	0.848	0.04	2.641	61.682	2.525	5567
3	6.16	27.084	0.814	0.04	2.84	59.55	2.519	5185.25
4	10.63	24.11	0.8	0.04	2.086	60.62	2.311	5186
5	8.79	27.11	1.041	0.04	2.656	57.86	2.459	4994
6	7.76	29.32	0.981	0.026	1.73	58.58	2.186	4808
7	8.238	29.21	1.031	0.024	2.274	56.515	2.313	4763
8	9.372	31.04	0.996	0.024	2.051	55.33	2.186	4582

Table 12.4-2 Operating Result of Pha Lai Thermal Power Plant

Year	Electricity MWh	Coal consumption Ton	FO consumption Ton	Low heat value Kcal/kg
1986	1,895,700	1,249,620	12,429	4,896
1987	2,275,700	1,447,532	20,121	4,895
1988	1,548,600	1,576,913	19,332	5,000
1989	2,668,900	1,302,156	10,049	4,952
1990	1,492,800	967,620	4,748	4,909
1991	1,004,208	642,697	5,434	5,119
1992	616,128	396,010	7,315	5,054
1993	396,928	249,877	3,687	5,257



**Table 12.4-3** Main design Parameters of Pha lai Extension Project  
( 2 x 300 Mw )

No.	Indicators	Unit	Value
1	Installed capacity	MW	600
2	Capability	MW	1200
3	Number and Capacity of unit	MW	2x300
4	Electric generation	GWh	3,600
5	Electric selfuse (5%)	GWh	0,180
6	For sale generation	GWh	3,420
7	Nominal coal consumption	g/kWh	362,23
8	Rate of net output	g/kWh	502,22
9	Natural coal consumption Rate of net output	T/year	1717,2x10 <sup>3</sup>
10	Natural Coal consumption	%	92
11	Boiler's efficiency (Gross)	%	42,95
12	Turbine's efficiency	%	98,5
13	Transmission's efficiency	%	38,92
14	Plant's efficiency (Gross)		50,09
	Occupied Area:		
	- Boiler and Turbine house	ha	5,2
	- Coal yard, coal unloading Port, conveyer	ha	5,7
	- Ash disposal	ha	40
15	Inlet water canal (up grading and widening	m	70
16	New Discharge water canal	m	3540
17	Cooling water flow	m <sup>3</sup> /s	42,33
18	Water flow for Residents and Fire pump	m <sup>3</sup> /h	40
19	Inner Road	m	1600
20	Construction and Installation time	month	54
21	Weight of installed equipment	T	45.000
22	Volume of concretes	m <sup>3</sup>	60.000
23	Substation for construction and Installation	MVA	6,30

Table 12.4-4 Hydro - Meteorological Data of Phalai Power Station Area

Station	Province	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	Average
I. Average Temperature °C														
Bac Giang	Ha Bac	12,7	14,3	20,1	23,2	28,3	29,6	28,7	29,0	26,9	25,0	19,6	18,8	23,0
Bai Chay	Quang Ninh	13,2	14,0	19,3	23,1	28,0	29,3	28,7	28,4	27,0	25,2	20,6	19,0	22,9
Hai Duong	Hai Hung	13,1	14,3	19,9	23,2	28,4	29,6	29,0	29,0	26,9	25,3	19,9	19,2	23,9
II. Rainfall mm														
Bac Giang	Ha Bac	46,6	5,0	17,0	62,8	96,2	144,0	257,6	151,0	100,3	141,4	13,5	63,4	1099
Bai Chay	Quang Ninh	61,3	4,9	15,7	56,9	261,1	131,3	287,8	268,6	136,5	150,9	3,5	49,3	1428
Hai Duong	Hai Hung	61,5	26,0	15,7	49,5	106,4	176,5	616,1	124,8	277,8	27,6	26,8	51,5	1560
III. Average Humidity %														
Bac Giang	Ha Bac	81	72	79	85	79	78	81	80	79	82	72	82	80
Bai Chay	Quang Ninh	83	76	83	88	84	82	84	84	78	83	71	82	81
Hai Duong	Hai Hung	86	77	84	90	83	83	84	85	84	85	77	84	83
IV. Sunshine Hours Hr:														
Bac Giang	Ha Bac	26,8	53,1	90,5	39,7	258,8	236,3	174,3	200,9	212,4	217,0	168,3	170,1	1848,2
Bai Chay	Quang Ninh	40,1	49,9	99,0	39,3	250,7	226,5	174,8	194,0	220,8	194,8	181,0	180,0	1850,9
Hai Duong	Hai Hung	22,1	46,4	74,3	231,0	247,7	220,7	167,2	183,9	180,3	186,3	156,9	161,4	1878,2

Table 12.4-5 Climate Characteristics Observed at Chi Linh Station  
( Average values past several years )

N°	Climate Items	Months												
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
1	Air Temperature °C	16,6	17,2	19,8	23,4	27	28,7	29	28,5	27,3	24,6	1,3	18	23,5
2	Wind speed at the altitude 10m (m/s)	2,7	2,7	2,4	2,7	2,9	2,6	2,8	8,3	2,4	2,3	2,5	2,6	2,6
3	Relative humidity	80	84	89	88	84	83	82	85	85	83	81	80	84
4	Air pressure	1019	1017	1014	1011	1007	1002	1002	1004	1008	1014	1017	1019	1010
5	Land surface Evaporation	32	23	32	40	80	111	103	96	96	88	63	56	820
6	Rain fall (mm)	35	25	42	89	204	229	233	283	231	140	44	20	1575
7	Water surface evaporation	80	60	54	64	95	97	108	83	82	99	96	89	2007
8	Total sunny radiation Kcal/cm <sup>2</sup>	11,7	14,5	15,3	13,9	10,7	8,6	8,5	9,2	8,5	9,6	9,8	9,9	150
														Total

Table 12.4-6 Analysis Results of Cau River water 6 km upstream of Thai nguyen city

N°	Analysis Indexes	Maximum permissible concentration	Contents of water			
			3/1976	6/1976	11/1976	12/1976
1	PH	5 - 7,8	7,8	8,2	7,1	6,1
2	Colour index	No	No	No	No	No
3	Purity	pure	pure	Light opaque	pure	Light opaque
4	Solid content	5	135	52	5	15
5	DO	4	4,8	7,32	5,98	5,8
6	BOD <sub>5</sub>	3 - 6	0,69	0,57	5,6	-
7	Organic Matter	2 - 5	3,04	1,52	3,87	1,6
8	Total hardness	12°	4°03	4°48	-	-
9	Alkalinity	-	70	103	2,2	0,7
10	Cl	1	-	6	-	-
11	Fe	0,3	-	0,8	Trait	Trait

Table 12.4-7 Analysis results of cau river water 500m downstream of Luuxa scouring sluice

N°	Analysis indexes	Maximum permissible concentration	Contest of water			
			6/1976	10/1976	11/1976	12/1976
1	PH	6 - 7,8	7,8	7,69	7,8	7,9
2	Purity	Pure	impure	Light impure	impure	Light impure
3	Solid content	5	200	5	400	15
4	DO	4	-	-	-	2,38
5	BOD <sub>5</sub>	3 - 6	34,1	10,06	3,8	-
6	Alkalinity	-	109	300	40	-
7	NH <sub>4</sub>	3	-	15	9	2
8	Sulphur	0	-	-	7,4	-
9	Organic matter	2 - 6	32	9,8	7,36	0,95
10	Phenol	0,001	-	-	0,7	-
11	Aphanur	0,1	-	-	-	-

**Table 12.4-8 Forest Lands Distributed in the Vicinity of  
Pha Lai T.P. Station**

Unit:ha

Kinds of land and forest	Quang Ninh province	Hai Hung province	Ha Bac province
Total	386,820	11,738	149,187
I. Natural forest	133,317	2,390	50,811
1. Productive-Commercial forest	110,076	1,257	41,585
a. Forest with special products			
b. Breeder forest			
c. Timber exploitable and other products	110,076	1,257	41,585
+ Broad leaved timber forest	92,183	1,257	40,920
+ Rich forest	1,254		
+ Medium forest	24,122	8	27
+ Poor forest	22,818	194	4,212
+ Recoved forest	43,989	1,055	15,309
- Acerose leared wood forest			21,372
- Mangrove and aluminous forest			
- Bamboo forest	16,050		93
- Mixed forest	1,843		572
+ Wood and bamboo forest	1,843		572
+ Broad leaved and acerose forest			
2. Protective forest	17,741	1133	9,226
a. Water shed conservation forest	15,262	1133	9,226
b. Wavy blockade forest	2,479		
c. Windy blockade forest			
3. Special used forest	5,500		
II. Uncovered land and bare hills	253,503	9348	98,376
Exploitable land	208,839	8716	98,376

**Table 12.4.9 Results of Water Analysis in Pha Lai T.P. Plant Site Area**  
( April 1990 )

Indexes	Thaibinh river	Khelang Ash Disposal	At the canal from Kelang Disposal	At the end of discharge canal	Water well near Kelang canal	Water well near cooling water discharge	Kinhbay river Sample M7	Kinhbay river Sample M8	Kinhbay river Sample M9	Binhgiang pond	Water well near Binhgiang pond	Water at Ricefield far from Phalai discharge canal
1	2	3	4	5	6	7	8	9	10	11	12	13
pH	8.01 +	7.77 +	7.81 +	7.76 +	2.52 -	6.23 +	7.15 +	7.82 +	7.81 +	5.44 -	5.64 -	7.19 +
Colour index	30 -	light opaque	light opaque	40 -	10 -	45 -	50 -	40 -	40 -	70 -	70 -	40 -
Purity (sneller)	12 -	opaque	opaque	opaque	15 -	18 +	3 -	8 -	7 -	opaque	opaque	5 -
Suspended solid	95 -	170 -	130 -	205 -	100 -	130 -	155 -	115 -	125 -	170 -	120 -	110 -
Total solid	340 +	590 +	610 +	380 +	292 +	250 +	330 +	280 +	305 +	510 +	380 +	273 +
Oxydation	1.6 +	1.06 +	1.36 +	1.36 +	1.20 +	1.63 +	1.63 +	1.28 +	1.2 +	5.92 +	5.92 +	9.2
Total hardness	4.42 +	.93 +	4.62 +	4.76 +	0.9 +	3.64 +	3.7 +	4.42 +	4.46 +	0.56 +	1.01 +	6.16
Alkalinity	75 +	80 +	72.5 +	70 +	by ester	50 +	47.5 +	80 +	80 +	35 +	15 -	110
Disolved oxygen	6.84 +	9.74 +	6.12 +	10.15 +	5.21 +	1.62 -	6.03 +	7.24 +	6.03 +	7.85 +	3.24 -	5.21
BOD <sub>5</sub>	0.41 +	1.22 +	0.47 +	2.91 +	0.34 +	0.81 +	0.41 +	4.0 -	0.41 +	0.41 +	1.21 +	1.56
Si	0.39 +	0.15 +	0.46 +	0.39 +	0.39 +	0.39 +	0.26 +	0.39 +	0.52 +	0.35 +	0.33 +	0.13
HCO <sub>3</sub>	91.5 +	97.5 +	80.45 +	85.4 +	0 +	61.0 +	57.95 +	100.65 +	100.65 +	42.7 +	18.3 +	134.3
Cl	9.0 +	9.0 +	12.0 +	12.0 +	111 +	20.4 +	16.8 +	18 +	10.8 +	51.0 +	51.0 +	10.8
SO <sub>4</sub>	0 +	176.94 +	221 +	0 +	0 +	0 +	0 +	0 +	0 + 0	126 +	85 +	0
NO <sub>2</sub>	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	2.5 +	0 +	0 +	0.05
NO <sub>3</sub>	2.5 +	0.5 +	2.5 +	1.5 +	1.45 +	1.0 +	2.5 +	2.0 +	0 +	2.5 +	2.0 +	3.0
PO <sub>4</sub>	0 +	0.25 +	0.25 +	0.25 +	0 +	0 +	0 +	0 +	2.83 +	0 +	0.25 +	0
Na + K	4.18 +	87.12 +	109.14 +	0.37 +	54.32 +	5.86 +	0.2 +	13.3 +	25.6 +	103.52 +	10.67 +	6.79
Ca	2.0 +	25.6 +	27.2 +	26.8 +	26.4 +	2.4 +	20.0 +	20.0 +	4.56 +	24.4 +	2.4 +	4.0
Mg	4.8 +	4.8 +	1.56 +	4.56 +	2.4 +	3.6 +	3.84 +	4.8 +	0.25 +	0.96 +	1.92 +	9.12
Fe	0.21 +	0.35 +	0.52 +	0.45 +	0.32 +	0.7 +	1.89 -	0.11 +	0.2 +	1.86 +	1.82 -	0.49
Al	0.35 +	0.9 +	0.9 +	0.94 +	0.35 +	0.1 +	0.35 +	0 +	0 +	0 +	0.5 -	0.425
Mn	0 +	0 +	0 +	0 +	0 +	0 +	0 +	5.0 +	0 +	0 +	0 +	0
NH <sub>4</sub>	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0
Cr	0 +	0.01 +	0.01 +	0.01 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0
As	0 +	0.15 +	0.1 +	0.06 +	0.015 +	0 +	0 +	0 +	0 +	2.001 +	0.003 +	0
Pb	0 +	0 +	0 +	0 +	0.01 +	0 +	0 +	0.03 +	0 +	0.05 +	0.1 -	0
H <sub>2</sub> S	0 +	0.05 +	0 +	0 +	0.085 +	0 +	0.085 -	0 +	0 +	0 +	0 +	0.01
Phenol	0 +	2 -	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0

Table 12.4-10 Results of Water Analysis in Pha Lai T.P. Plant Site Area  
( November: 1990 )

Indexes	Thaibinh River	Khehang Ash Disposal	At the canal from Khehang Disposal	Water well near Canal from Khehang Ash Disposal	Water well 10m far from Phalai Discharge canal	After Anbai culvert at Khehang River Sample M7	Kinhthay River M8	Kinhthay River M9	At settler of Ash Disposal	Binhgiang pond	At drinking water well near Binhgiang Pond
1	2	3	4	5	6	7	8	9	10	11	12
pH	7,55 +	7,83 +	7,88 +	4,26 -	5,79 +	7,2 +	7,92 +	7,89 +	4,76 -	5,09 -	4,27 -
Colour index	45 -	45 -	45 -	70 -	60 -	60 -	30 -	45 -	50 -	70 -	50 -
Purity	8 -	3 -	2 -	2800 -	yellow Red	3,5 -	4 -	10 -	7 -	1,5 -	7,5 -
Suspended Solid	100 -	1340 -	2930 -	80 -	160 -	180 -	160 -	200 -	160 -	120 -	30 -
Total solid	190 +	1500 -	128 -	130 +	360 +	152 +	420 +	300 +	200 +	154 +	62 +
Oxydation	2,95 +	1,52 +	4,31 +	1,44 +	1,92 +	2,72 +	2,4 +	2,08 +	4,56 +	8,8 +	1,76 +
Total hardness	3,13 +	4,25 +	65 +	0,61 +	4,36 +	2,01 +	4,25 +	4,25 +	0,39 +	0,72 +	0,44 +
Total Alkalining	30 +	55 +	6,43 +	5 +	52,5 +	27,5 +	75 +	80 +	5,0 +	5,0 +	7,5 +
Dissolved oxygen	4,46 +	6,84 +	0,4 +	3,65 +	2,43 +	7,24 +	7,65 +	8,1 +	6,43 +	6,03 +	5,82 +
BOD <sub>5</sub>	0,81 +	0,41 +	0,39 +	3,05 +	0,4 +	3,59 +	3,19 +	2,07 +	0,4 +	0,41 +	0,75 +
Silic	0,26 +	0,325 +	79,3 +	0,26 +	0,39 +	0,195 +	0,46 +	0,33 +	0,195 +	0,19 -	0,195 +
HCO <sub>3</sub>	61 +	87,1 +	10,2 +	6,1 +	64,05 +	33,55 +	91,5 +	97,6 +	6,1 +	6,1 +	9,15 +
Cl	9,6 +	10,2 +		27,6 +	40,3 +	13,2 +	10,8 +	10,2 +	19,0 +	13,2 +	12,0 +
SO <sub>4</sub>	0 +	96 +	93,0 +	0 +	0 +	25,0 +	0 +	0 +	50,0 +	50,0 +	0 +
NO <sub>2</sub>	0,2 +	0,05 +	0 +	0 +	0,05 +	0,3 +	0,1 +	0,07 +	0 +	0 +	0,05 +
NO <sub>3</sub>	1,5 +	1,25 +	0,5 +	2,0 +	2,0 +	1,25 +	1,25 +	1,25 +	1,5 +	1,25 +	1,25 +
PO <sub>4</sub>	0 +	0,5 +	0,5 +	0 +	0 +	0,2 +	0 +	0,2 +	0 +	0 +	0,2 +
Na+K	3,37 +	6,72 +	2,98 +	12,2 +	11,7 +	3,05 +	15,48 +	9,36 +	0,37 +	0,65 +	6,88 +
Ca	16,0 +	24,0 +	24 +	0,8 +	24 +	9,2 +	20,8 +	20 +	0,96 +	2,0 +	2,0 +
Mg	3,84 +	3,84 +	4,08 +	2,16 +	4,32 +	3,12 +	5,76 +	6,24 +	1,1 +	1,92 +	0,72 +
Fe	0,31 +	0,65 +	0,94 +	0,07 +	1,715 -	0,52 +	0,7 +	0,85 +	0,36 +	1,2 -	0,28 +
Al	0,2 +	1,18 -	0,88 +	0,42 -	0,20 +	0,65 -	0,12 +	0 +	0,36 +	1,12 -	0,66 +
Mn	0,24 +	0,25 -	0,24 +	0,24 +	0,15 +	0,3 -	0,34 -	0,3 +	0,32 +	0,152 +	0,148 +
NH <sub>4</sub>	0 +	0 +	0 +	0 +	1,0 +	0 +	0 +	0 +	0 +	0,250 +	0,5 +
Cr	0 +	0,05 +	0,05 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +
As	0 +	0,25 -	0,1 -	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +
Pb	0 +	0 -	0 +	0 +	0,30 +	0 +	0 +	0 +	0 +	0,012 +	0 +
H <sub>2</sub> S	0 +	0 -	0 +	0 +	0 +	0,05 +	0,05 +	0,01 +	0,05 +	0,02 +	0 +
Phenol	0 +	0 -	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +	0 +



**Table 12.4-11** The contents of chemical elements in discharge water

Sample	Ind- ex	pH	Hum- mus	%  			mgr./l			mgr./100gr. °C equivalent						ppm					
				Cl <sup>-</sup>	SO <sup>2-</sup> <sub>4</sub>	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Ca <sup>2+</sup>	M <sup>2+</sup>	Fe <sup>3+</sup>	Al <sup>3+</sup>	HCO <sub>3</sub>	CO <sup>2-</sup> <sub>3</sub>	Cu	Pb	Mn	Cd	As	Hg	Zn
Khe Lang	1 <sup>st</sup> stage	6,82		0,385		56,35	21,63		26,00	18,21	2,39	2,92	0,55	0,0	0,00	0,00	0,28	0,00	0,00	0,00	
	2 <sup>nd</sup> stage	5,40		0,210		58,27	23,10		18,48	9,88	5,18	4,12		0,014	0,00	0,41	0,00	0,00	0,00		
	Aver.	6,11		0,300		57,31	22,37		22,24	11,55	3,79	3,52		0,007	0,00	0,35	0,00	0,00	0,00		
Binh Giang	1 <sup>st</sup> stage	5,21		0,421		54,18	19,00		12,28	2,22	3,19	4,81	0,38	0,0	0,012	0,00	0,088	0,00	0,00	0,00	
	2 <sup>nd</sup> stage	5,55		0,515		62,17	12,78		16,28	3,21	2,68	3,29		0,041	0,00	0,067	0,00	0,00	0,00		
	Aver.	5,38		0,508		58,18	15,89		14,14	2,72	2,94	4,05		0,027	0,00	0,077	0,00	0,00	0,00		

Table 12.4-12 The contents of Chemical Elements in Discharge Water and Vegetables

( The second stage )

Unit: mg/l

	Type of sample	Cu	Pb	Mn	Cd	As	Hg
1	Discharge (PPm) water	0,01	0,015	0,000	0,001	0,000	0,002
2	After water hyacinth growing	0,01	0,000	0,049	0,000	0,000	0,000
3	After pistia growing	0,00	0,004	0,041	0,002	0,00	0,000
4	After azolla growing	0,00	0,008	0,00	0,00	0,00	0,000
5	After fish raising	0,00	0,010	0,000	0,00	0,00	0,000
6	Fish sample	0,510	0,00	3,29	0,64	0,00	0,000
7	Water hyacinth sample	0,097	0,127	<u>1,99</u>	0,181	0,00	0,000
8	Pistia sample	0,357	0,113	5,50	0,105	0,00	0,000
9	Azolla sample	0,163	0,155	0,988	0,112	0,00	0,000

The content of chemical elements in vegetable

( The second stage )

No. of sample	Types of sample	Location	Cu	Pb	Mn	Cd	As	Hg
2	Batata	Thach Thuy	0,193	0,248	1,19	0,30	1,00	
3	Bean		0,090	0,140	1,81	0,21	0,00	
4	Tomato		0,178	0,140	1,17	0,18	0,00	
5	Kohlrabi		0,103	0,105	0,97	0,27	0,00	
Average			0,141	0,158	1,29	0,24	0,25	
6	Bataba	Binh Giang	0,193	0,00	4,02	0,27	2,00	
7	Bataba		0,23	0,14	2,83	0,20	0,00	
Average			0,21	0,07	3,43	0,24	1,00	

**Table 12.4-13** The contents of chemical elements in sludge

Sample	In- dex	PH	Hum- mus	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup> %	To- tal N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Fe <sup>3+</sup>	Al <sup>3+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub> <sup>2-</sup>	Cu	Pb	Mn	Cd	As	Hg	Zn
		KCl	%	%			mg/100gr equivalent		l/100gr equivalent	mg/100gr equivalent	mg/100gr equivalent			mg/100gr equivalent				ppm			
Sludge in Khe Lang lake		7,46	1,61	0,002	0,14	3,92	16,81	3,51	0,63	0,51	34,93	0,00	1,08	0,42	1,20	0,24	0,84	0,00	11,51	0,18	3,11
Sludge at the in let of discharge canal	NH11	6,41	3,09	0,003	0,12	3,92	8,48	8,33	2,13	0,37	52,41	0,69	1,56	0,52	2,10	0,44	3,23	0,00	15,25	0,084	4,84
Sludge in the outlet of canal	NH22	5,72	3,48	0,003	0,13	5,29	11,21	7,16	3,63	0,39	55,89	0,14	1,22	0,47	1,51	0,00	6,88	0,00	18,00	0,078	2,28
Sludge in Binh Giang lake		3,56	2,14	0,002	0,11	6,38	6,74	9,24	0,42	0,12	72,14	18,27	0,86	0,09	2,24	0,16	2,38	0,00	9,87	0,098	1,59

Table 12.4-14 Average Quantity of Micro-Organism in Water and Soil

No.	Sampling location	Bacteria $\times 10^3$ cell/grof soil	Coliform $\times 10^3$ cell/grof soil	Micro fungus $\times 10^4$ cell/grof soil
1	Distance 50m far from canal	19,82	4,98	7,34
2	From distance	34,27	6,44	7,65
3	Distance 500m far from canal	36,51	5,25	16,44
4	Average in Khe Lang area	30,20	5,57	23,81
5	Average in Binh Giang area	12,63	13,92	9,51
6	Sown soil of cereals in Khe Lang	37,03	17,52	19,87
7	Sown soil of cereals in Binh Giang	28,52	6,19	17,74

Table 12.4-15 Average Quantity of Micro-Organism in Soil and Sediments

No. sample	Location	Bacteria $\times 10^3$ cells/grof soil	Coliform $\times 10^3$ cells/grof soil	Micro fungus $\times 10^4$ cells/grof soil
NH <sub>1</sub>	District	35,41	5,52	23,12
NH <sub>21</sub>	Field	36,55	5,87	20,44
NH <sub>20</sub>	Phao Son	32,78	6,31	29,64
NH <sub>19</sub>	Thach Thuy	29,8	6,73	23,04
NH <sub>18</sub>	Phao Son-Thach Thuy Riel	34,42	5,93	24,12
NH <sub>17</sub>	Field	32,5	5,41	21,78
B		33,52	6,08	22,36
NH <sub>24</sub>	District	29,72	5,28	21,57
NH <sub>25</sub>	Lake	27,46	6,48	26,11
NH <sub>28</sub>	Near Binh Giang lake	21,22	7,23	25,02
Average	Near Binh Giang lake	26,33	6,33	25,23

**Table 12.4-16 Socio-Economic Situation of Quang Ninh Province**

		Area			Population (10 <sup>3</sup> people)		GDP (at 1989 value) in millions Dong					Gross production of paddy equivalence (ton)	Number of commune
		Natural area km2	Agricl. area ha	Rice Cult.area ha	Total	Rural population	Total	Breaking down					
								Industry	Agricul- tural	Fishery	Forestry		
	Total	593,800	56,317	27,597	847.3	482.9	253773.4	69501.9	139283.5	20473.5	24514.8	120,161	176
1	Hongai townlet	12,300	663	99	134.2	6.6	25048.1	18,700	1671.4	4374.5	294.2	261	19
2	Cam Pha town let	48,600	762	434	131.9	22.7	17638.2	12,000	1949.9	2683.2	1005.1	1,013	16
3	Uong Bi district	24,500	2,197	1,434	82.7	33.2	13109.0	6,500	5432.3	-	1176.7	5,031	9
4	Binh Lieu district	47,900	10,214	1,451	20.8	17.9	19620.4	2,500	15061.2	-	2059.2	8,288	8
5	Quang Lien district	72,200	7,484	4,564	64.9	59.3	29108.9	3,700	18524.6	2030.4	4853.9	20,266	24
6	Hai Ninh district	52,000	3,473	2,383	35.3	31.3	14759.1	2,300	8635.5	3161.7	661.9	9,366	14
7	Tien Yen district	61,700	7,588	1,780	36.5	30.3	23348.6	2,000	18673.9	1081.3	1593.4	8,393	11
8	Ba Che district	60,500	3,033	638	16.1	12.9	13840.6	3,500	7521.5	-	2819.1	1,607	8
9	Dong Trieu district	40,200	8,405	6,830	130.9	93.0	32954.2	4901.9	26753.1	-	1299.2	28,976	21
10	Yen Hung district	31,100	8,116	5,15	113.8	105.4	36177.2	7,900	24335.3	3721.3	220.6	25,590	18
11	Hoanh Bo district	91,100	3,285	2,060	47.9	41.4	19770.7	3,000	8078.4	3421.2	5271.1	6,915	14
12	Cam Pha district	51,700	1,097	773	32.3	28.9	8406.8	2,500	2646.4	-	3260.4	3,455	14

Table 12.4-17 : Socio-Economic Situation of Hai Hung Province

		Area			Population (10 <sup>3</sup> people)		GDP (at 1989 value) in millions Dong				Gross production of paddy equivale- nce	Number of commune
		Natural area km2	Agric. area ha	Rice Cult.area ha	Total	Rural population	Total	Breaking down				
								Industry	Agricult- ural	Fishery	Forestry	
	Total	2551,7	160,969	2527708	2556.2	2377.2	876.026	215.600	581.689		78.737	422
1	Hai Duong District	34,7	1,816	113,238	116.3	79.5	19.677	13.320	6.357			13
2	Hung Yen town let	18	1,082	36,362	36.5	26.5	12.020	10.000	2.000			6
3	Chi Linh district	296,3	9,760	143,024	104.0	130.8	49.919	7.562	26.500		15.857	20
4	Nam Thanh district	287,9	18,594	276,444	279.8	266.9	106.351	19.431	76.200		10.720	49
5	Kim Mon district	277,2	15,468	265,524	268.1	256.3	105.006	20.430	64.260		20.316	45
6	Cam Binh district	214,5	14,798	209,443	211.5	198.2	83.390	20.120	63.370		75,413	37
7	Tu Loc district	292,3	19,583	293,732	297.3	282.9	120.285	23.973	78.102		18,210	51
8	Ninh Thanh district	258,5	17,949	259,191	261.9	249.7	110.468	20.624	76.210		13,634	47
9	My Van district	221,6	16,252	251,219	253.8	241.4	64,790	21,320	43,470		90,616	39
10	Chau Giang district	203,9	14,117	249,384	252.0	235.2	57,840	21,240	36,600		72,190	39
11	Kim Thi district	242,4	17,256	230,942	233.7	220.9	96,580	21,450	75,130		86,985	41
12	Phu Tien district	204,4	14,214	199,205	201.3	188.9	39,120	16,110	23,010		11,310	35
	State	-	-	-	-	-	-	-	480			1,218

**Table 12.4-18** Socio-Economic Situation of Ha Bac Province

		Area			Population (10 <sup>3</sup> people)		GDP (at 1989 value) in millions Dong					Gross production of paddy equivale- nce (ton)	Number of commune
		Natural area km2	Agricl. area ha	Rice Cult.area ha	Total	Rural population	Total	Breaking down					
								Industry	Agricul- tural	Fishery	Forestry		
	Total	461,458	164,891	131,071	2196.6	-	590.164	75.756	479.300	-	35.108	493,698	326
1	Bac Giang townlet	3,050	714	217	36.5	30.8	23,270	17,970	5,300	-	-	5,091	9
2	Bac Ninh townlet	2,650	716	559	65.7	27.8	18,380	13,580	4,800	-	-	4,498	9
3	Luc Ngan district	101,150	15,546	9,432	150.0	145.0	21089.8	789.8	16,300	-	4.000	16,780	28
4	Luc Nam district	59,860	16,931	12,692	169.0	163.7	47992.4	2692.4	40,300	-	5.000	40,789	25
5	Son Dong district	84,620	8,039	3,128	55.7	55.3	14272.7	571.7	6,700	-	7.000	6,649	19
6	Yen The district	28,850	7,777	4,330	80.9	76.0	30,247	2647.0	20,600	-	7.000	21,193	16
7	Hiep Hoa district	20,160	13,473	11,452	185.2	179.8	46275.5	2575.5	40,700	-	3.000	41,823	25
8	Langgiang district	24,930	13,262	10,208	173.8	169.1	41,888	1380.0	37,400	-	3.108	39,276	22
9	Tan Yen district	20,380	10,933	9,216	144.8	143.2	39815.7	815.7	36,000	-	3.000	37,227	22
10	Viet Yen district	17,130	10,741	9,944	144.3	142.6	37987.6	2387.6	32,600	-	3.000	32,473	17
11	Yen Dung district	21,540	12,761	11,427	152.1	150.3	40,649	2749.0	37,900	-	-	38,667	23

Table 12.4-19 Population by ethnic group and sex

Quang Ninh Province

Number of persons

Ethnic group	Total	Male	Female	Sex ratio (Percentage)
Total	812905	410267	402638	101.89
01. Kinh	725421	365638	359783	101.63
02. Tay	23130	11533	11597	99.45
03. Thai	41	27	14	192.86
04. Hoa	3567	1757	1810	97.07
05. Kho Me	24	13	11	118.18
06. Muong	129	71	58	122.41
07. Nung	221	120	101	118.81
08. H'mong	8	3	5	60.00
09. Dao	36177	18673	17504	106.68
10. Gia-rai	2	-	2	0.00
11. E-de	6	3	3	100.00
13. Xo Dang	1	-	1	0.00
14. San chay (Cao lan-San Chi)	9003	4581	4422	103.60
15. Co Ho	1	1	-	-
17. San diu	14691	7602	7089	107.24
18. H're	9	5	4	125.00
23. Tho	37	19	18	105.56
25. Co Tu	3	1	2	50.00
34. Ha Nhi	1	1	-	-
36. Lao	1	-	1	0.00
46. Pu Peo	1	1	-	-
49. Others	2	1	1	100.00
50. Foreigners	5	3	2	150.00
Not Stated	424	214	210	101.90



Table 12.4-20 Population by ethnic group and sex

Hai Hung Province

Number of persons

Ethnic group	Total	Male	Female	Sex ratio (Percentage)
<b>Total</b>	<b>2445586</b>	<b>1148304</b>	<b>1297282</b>	<b>88.52</b>
01. Kinh	2441202	1146100	1295102	88.49
02. Tay	781	373	408	91.42
03. Thai	69	27	42	64.29
04. Hoa	1188	655	533	122.89
05. Kho Me	27	13	14	92.86
06. Muong	126	42	84	50.00
07. Nung	175	87	88	98.86
08. H'mong	42	19	23	82.61
09. Dao	35	11	24	45.83
10. Gia-rai	6	3	3	100.00
11. E-de	10	4	6	66.67
12. Bana	6	5	1	500.00
13. Xo Dang	1	-	1	0.00
14. San chay (Cao lan - San Chi)	60	33	27	122.22
17. San diu	1265	676	589	114.77
18. H're	5	4	1	400.00
19. M'ngong	3	1	2	50.00
20. Ra-glai	4	-	4	0.00
22. Bru- Van Kieu	4	2	2	100.00
23. Tho	53	28	25	112.00
24. Giay	4	1	3	33.33
25. Co Tu	1	-	1	0.00
30. Ta Oi	4	3	1	300.00
31. Cho ro	2	1	1	100.00
34. Ha Nhi	1	-	1	0.00
36. Lao	1	-	1	0.00
49. Others	2	-	2	0.00
Not Stated	509	216	293	73.72

Table 12.4-21 Population by ethnic group and sex

Ha Bac Province

Number of persons

Ethnic group	Total	Male	Female	Sex ratio (Percentage)
<b>Total</b>	<b>2064439</b>	<b>985009</b>	<b>1079430</b>	<b>91.25</b>
01. Kinh	1931166	918291	1012875	90.66
02. Tay	26268	13119	13149	99.77
03. Thai	67	40	27	148.15
04. Hoa	14049	7254	6795	106.75
05. Kho Me	31	18	13	138.46
06. Muong	196	99	97	102.06
07. Nung	51530	25649	25881	99.10
08. H'mong	53	25	28	89.29
09. Dao	5333	2769	2564	108.00
10. Gia-rai	3	-	3	0.00
11. E-de	17	9	8	112.50
12. Bana	2	1	1	100.00
13. Xo Dang	5	-	5	0.00
14. San chay (Cao lan-San Chi)	18047	8937	9110	98.10
15. Co Ho	1	-	1	0.00
16. Cham	7	-	7	0.00
17. San diu	17060	8522	8538	99.81
18. H're	1	1	-	-
19. Mnong	6	4	2	200.00
20. Ra-glai	2	-	2	0.00
22. Bru- Van Kieu	1	1	-	-
23. Tho	6	3	3	100.00
24. Giay	1	-	1	0.00
28. Kho mu	1	1	-	-
30. Ta Oi	6	4	2	200.00
38. La Hu	1	-	1	0.00
43. Cong	6	4	2	200.00
45. Sila	1	1	-	-
49. Others	33	21	12	175.00
50. Foreigners	9	5	4	125.00
Not Stated	530	231	299	77.26

**Table 12.4-22 The aim of Economic Development of Chi Linh District**  
**Agriculture**

No.	Indicator	1987-1990		1991-1995	
		Area (ha)	Production (ton)	Area (ha)	Production (ton)
1	Land				
1	Agricultural land				
	- Rice cultivation	8,600	30,040	8,620	30,183
	- Industrial plant	2,400	1,440	2,550	1,600
	- Foodstuff crops	1500		1600	
2	Agricultural capable land				
3	Forestry land				
4	Other				
II	Gross production of paddy		35,323		42,235
	Equivalence				
	- Paddy		30,040		35,583
	- Subsidiary crop		5283		6652

Breeding develops in state-run-farm, cooperative and household farms.

Unit: head

No.	Indicators	1987-1990	1991-1995
1	Buffalo	1,000	1,200
2	Ox and Cow	10,050	10,050
3	Pig	45,000	51,000
4	Fowltry	350,000	450,000

**Industry, Minor handicraft-forestry**

No.	Indicators	Unit	1990	1995
I	Gross production	10 <sup>3</sup> Dong	120,000	150,00
II	Main products			
1	Brick	10 <sup>3</sup> pieces	30,000	45,000
2	Slag brick	10 <sup>3</sup> pieces	15,000	30,000
3	Enamelled tibe	"	1,000	1,500
4	Burnt tile	"	1,500	2,200
5	Cement tile	"	400	400
6	Macadam	m <sup>3</sup>	80,000	100,000
7	Yellow sand	"	90,000	120,000
8	Porcelain	10 <sup>3</sup>	2,000	2,500
8	Hook of Plough	10 <sup>3</sup>	15	20
10	Sedgemat	"	15,000	20,000
11	Bucket	"	20	25

**Table 12.4-23**      **Some Socio-Economic Indicators of Gia Luong District**  
( Ha Bac Province )

No	Indicator	Đơn vị	1991	1995	2000
I	<b>Population and Labour Force:</b>				
1	Population	person	192.486	205.700	223.000
2	Growth Rate of Population	%	2,0	1,7	1,7
3	Number of Doctors and Nurses	person	107	110	120
4	Number of pupils	"	36,834	30,400	38,250
5	Number of Hospital beds	bed	305	380	480
II.	<b>Agricultural Production:</b>				
1	Gross Production	106 đồng	54,000	68,500	77,000
2	Area of sown land	ha	24,852	24,960	25,000
3	Gross Production in paddy equivalence	ton	54.831	63,146	91.446
4	Gross Production of Agr. per. capita	kg/pers	285 (draught 1991)	404	405
5	Gross Production of Major crops				
	- Rice	ton	47,220	70,980	77,280
	- Maize	"	2,915	6,000	7,500
	- Batata	"	9,583	12,000	13,000
	- Potato	"	3,670	6,498	6,949
6	Breeding				
	- Pig (Thousand heads)	head	30,637	50,000	52,000
	- Bufaloes (Thousand heads)	head	5,487	5,500	5,800
	- Cattle (Thousand heads)	head	7,162	8,500	9,000
	- pork	ton	3,048	3,100	3,200
	- Asow	head	5,600	6,000	
	- Boar	head	100	100	
	- Commercial average weight of Pig	kg/head	66	70	
	- Heas	10 <sup>3</sup> head	900	1,100	
	- Ducks	10 <sup>3</sup> head	150	165	
	- Production of Fishes	ton	660	800	
7	Food trees				
	- Chilli	ton	180	200	
	- Garlic	ton	1,750	1,750	
	- Some kinds of bean	"	160	280	
	- Soy bean	ton	420	600	
	- Sesame	ton	12	12	
	- Sugar cane		525	525	
II.	<b>Local Industry</b>				
1	- Industrial GDP	1000 d	2,400,000	3,380,000	3,600,000
2	- Investment	"	1,733,000	5100,000	6,500,000
					The price of 4th quarter 1994
III.	<b>Commercial service:</b>				
1	- Value of export	1000 USD	2,403	2,470	3,006

**Table 12.4-24 Industrial and Handcraft Enterprises in Gia Luong District ( Ha Bac Province )**

No	Name of Enterprise	Location	Productivity
<b>Section I</b>			
<b>a. North western Area</b>			
1	Woolen Carpet cooperative	Lang Ngam	3000 m <sup>2</sup> /year
2	Dongcuu woolen Carpet cooperative	Dong Cuu	2000 m <sup>2</sup> /year
3	Rice mill	8 communes	3 ton/day
4	8 brick kilns	8 communes	(1,200,000 brick pieces /year and 500,000 piece of Tile/year of each)
5	8 farming tool repair coop.	8 communes	
6	Worm silk cooperative	Song Giang	
<b>b. Central Area</b>			
1	Agro - Mechanical Enterprise	Phá Lang	Mechanical Repair
2	Brewery		60,000 l/year
3	Limestone, Brick and Tile Enterprise	Dong Binh, X lai	2,800,000 brick pieces /year + 1,400,000 pieces of Tile /year
4	Hai Phong Mechanical workshop	Thuc, Pha Lang	Repairing tractors
5	Hop Thanh - Dai Bai cooperative	Dai bai	Bronze-Aluminum casting 300T/year
6	Dong Binh Mechanical cooperative	Dong Binh	Mechanical Repair
7	Binh Minh Mosquito Netweaving cooperative	Binh Dinh	10,000 m/year
8	Mechanical cooperative	Thuc	Bronze-Aluminum Casting 20 ton/year
9	Mechanical cooperative	Quang Phu	Bronze-Aluminum Casting 50 ton/year
10	7 Rice Mills	7 communes	3 ton/day for each
11	Food Processing Enterprise		
12	2 Brick Enterprise	2 communes	1,200,000 brick pieces 500,000 Tile pieces/year for each
<b>Section II</b>			
1	Mechanical cooperative	Trang Kenh	Mechanical Repair
2	Mechanical cooperative	Lam Thao	Mechanical Repair
3	Mosquito Netweaving cooperative	Cao duc	15,000 m/year
4	12 Rice Mill	12 communes	3 ton/day for each
5	10 Brick Enterprise	10 communes	1,286,000 brick piece/year + 60,000 Tile piece/year for each
6	Jute and Maize arcca carpet cooperative	Cao duc	12,500m <sup>2</sup> /year of Maize arcca carpet/year 3250m <sup>2</sup> of jute carpet

Table 12.4-25 Plant Operating Data of Ninh Binh T.P. Station  
( from 1981 to 1993 )

Year	Elect. Generation (MWh)	Auxiliary power ratio (%)	Utilization factor	Coal consumption (ton)	Oil consumption (ton)	LHV of Coal (Kcal/kg)
1981	540,000(*)					
1982	576,000(*)					
1983	574,000(*)					
1984	475,000(*)					
1985	379,000(*)					
1986	312,167	14.73	0.52	349103	6208	4896
1987	345,828	13.82	0.58	350639	4319	4895
1988	345,427	13.74	0.58	351980	5808	5000
1989	316,108	14.60	0.53	326396	2451	4952
1990	268,013	14.53	0.45	258845	460	4909
1991	256,579	15.08	0.43	265135	293	5119
1992	182,155	16.29	0.30	202944	395	5064
1993	188,779	16.74	0.31	203700	288	5257
1994	240,000 (**)	15.70(**)				

Note: (\*) Rounded figures  
(\*\*) Forecasted figures

**Table 12.4-26** Average air temperature observed at Ninh Binh Station

Months °C	Jan.	Feb.	March	April	May	Jun	July	August	Sept.	Oct.	Nov.	Dec.
Average temperature	13,4	14,2	19,6	23,0	28,1	29,6	29,2	29,0	27,0	25,4	20,1	19,5

**Table 12.4-27** Average Relative air humidity observed at Ninh Binh Station

Months Humidity	Jan.	Feb.	March	April	May	Jun	July	August	Sept.	Oct.	Nov.	Dec.
%	86	80	87	91	82	81	82	84	84	86	81	87

**Table 12.4-28** Average Rainfall observed at Ninh Binh Station

Months Rainfall	Jan.	Feb.	March	April	May	Jun	July	August	Sept.	Oct.	Nov.	Dec.
mm	54	12	14	51	78	118	278	307	306	309	15	71

**Table 12.4-29** *Forest covered distribution in the Red River Delta*

Provinces	Natural Area (ha)	Forest covered Area (ha)	Of which		Covered Ratio (%)
			Natural (ha)	Planting (ha)	
Red River Delta as the whole	1,251,662	42,765	22,718	20,047	3.4
- Hanoi	92,056	1,990	-	1,990	2.1
- Haiphong	150,350	8,623	7,123	1,500	5.7
- Haihung	255,139	5,006	2,390	2,616	2.0
- Thaibinh	150,877	2,174	-	2,174	1.4
- Namha	249,199	3,450	-	3,450	1.3
- Ninhbinh	138,755	11,696	11,275	421	8.4
- Hatay	215,286	9,826	1,930	7,896	4.6

**Table 12.4-30** *Areas of Natural Forestry, uncovered lands and bare hills in the Red River Delta*

Unit: hectare

Provinces	Natural forestry	Uncovered Lands and bare hills	Total
Red river delta as the whole	22,718	90,936	113,654
Ha Noi	-	2,074	2,074
Hai Phong	7,123	14,828	21,951
Hai Hung	2,390	9,348	11,738
Thai Binh	-	12,042	12,042
Nam Ha	-	21,756	21,756
Ninh Binh	11,275	23,226	34,501
Ha Tay	1,930	7,662	9,592



Table 12.4-31 Some Socio-economic Data of Ninh Binh  
and Nam Ha Provinces

Items	Ninh Binh province	Nam Ha province
1. Area ( km <sup>2</sup> )	1,386.8	2,418.6
2. Population (x 1,000 pers.)	802.5	2,484
3. Gross production of the industry ( million dong\$ at the price of 1989 )	85,571	271,421
4. Gross production of the agriculture (million dong\$ at the price of 1989 )	159,815	530,521
5. Production of some typical products		
a) Rice (x1,000 tons)	189.4	721.3
b) Pig (x1,000 heads)	160.7	535.7
6. Agriculture land (x1,000 ha)		
a) Total	64.1	157.9
b) Cultivated land	55.1	143.2

Source: "Economy and Finance of Vietnam, 1986 - 1992 ",  
by General Statistical Office, Hanoi, 1994

Table 12.4-32 *Population by ethnic group and sex*

Ha Nam Ninh Province

Number of persons

	Ethnic group	Total	Male	Female	Sex ratio (Percentage)
	Total	3.156.931	1.495.156	1.661.775	89,97
01	Kinh (Viet)	3.142.473	1.488.088	1.654.385	89,95
02	Tay	398	200	198	101,01
03	Thai	93	57	36	158,33
04	Hoa (Han)	418	232	186	124,73
05	Kho me	11	5	6	83,33
06	Muong	12.844	6.248	6.596	94,72
07	Nung	133	74	59	125,42
08	H'mong (Meo)	30	13	17	76,47
09	Dao	22	9	13	69,23
10	Giarai	2	1	1	100,00
11	Ede	13	7	6	116,67
13	Xodang	2	1	1	100,00
14	Sanchay (Cao Lan-San Chi)	12	5	7	71,43
15	Co Ho	1	1	-	....
17	San Diu	5	1	4	25,00
19	Mnong	4	2	2	100,00
20	Raglai	4	1	3	33,33
23	Tho	21	7	14	50,00
24	Giay	4	2	2	100,00
30	Taoi	3	3	-	...
34	Hanhi	4	3	1	300,00
36	Lao	1	-	1	0,00
37	Lachi	1	1	-	....
49	Others	6	3	3	100,00
50	Foreigners	3	1	2	50,00
	Noi Stated	423	191	232	82,33

**Table 12.4-33 Identified Spined Animals**

Class	Order	Family	Species
Mammal	1	25	64
Aves	16	45	137
Reptile	3	12	36
Amphibian	1	5	17
Fish	1	1	1
Total	22	85	255



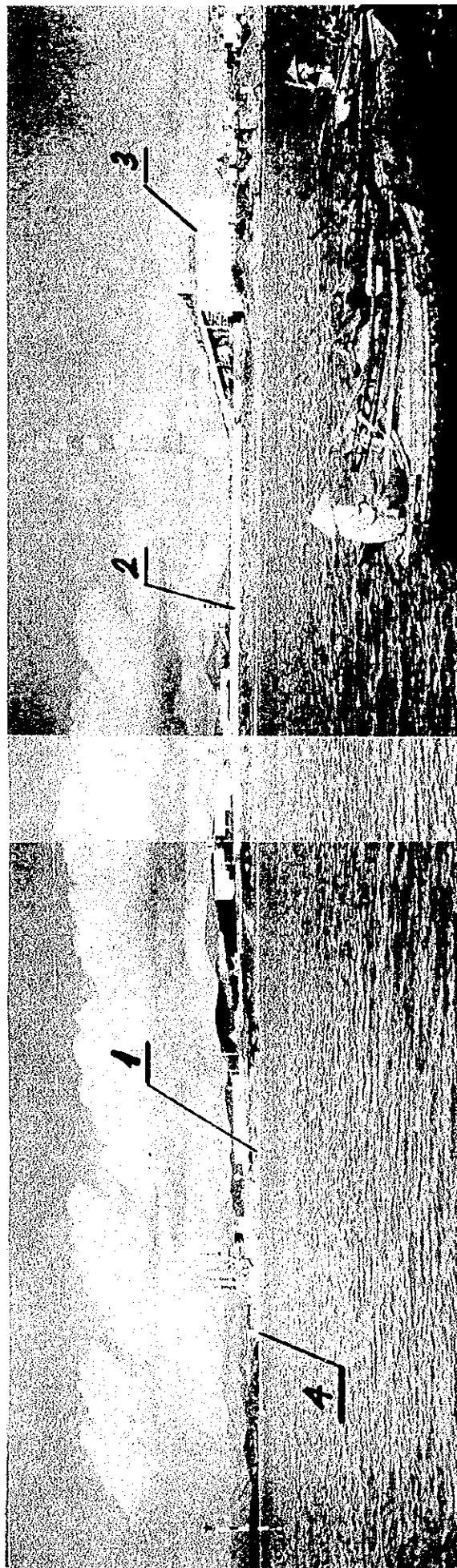


Figure 12.4 -1 A View of Thai Binh River Bank

View of Thai Binh river bank

1. Heavy equipment unloading port
2. Site for new cooling water pump station
3. Existing cooling water pump station
4. Fuel oil receiving pump station



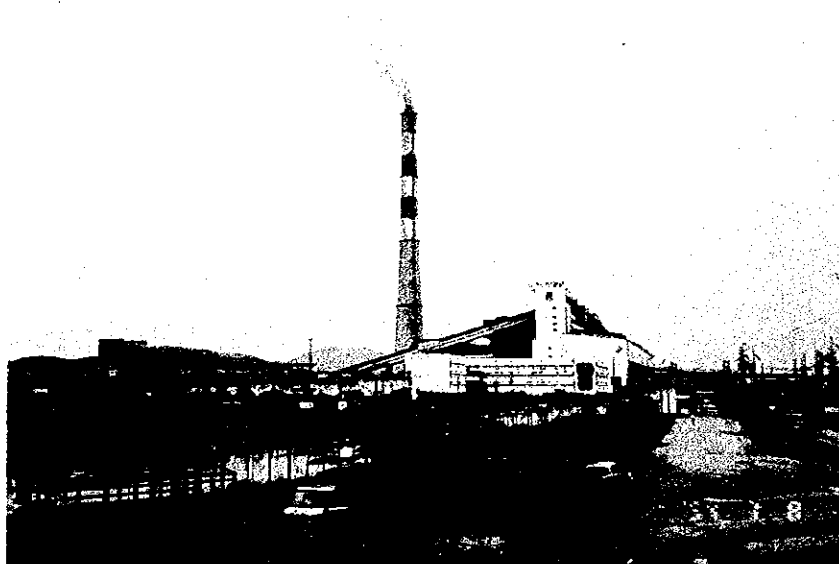


Figure 12.4. -2(a) A View of Pha Lai Thermal Power Station

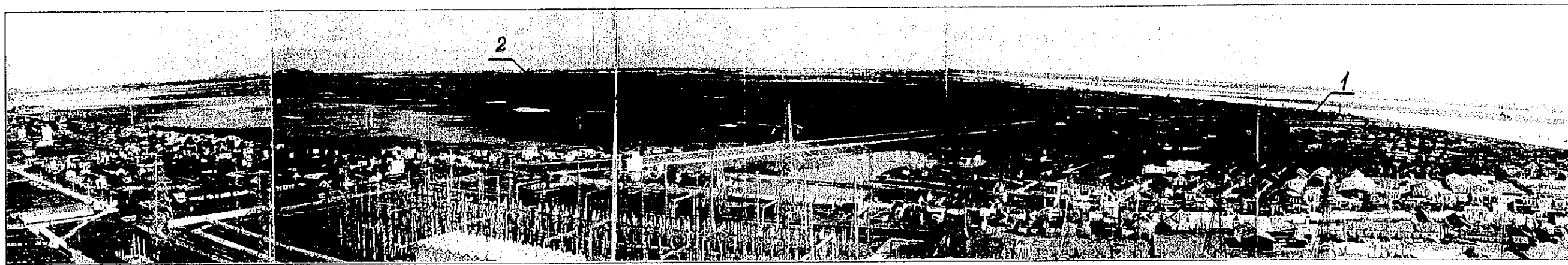


Figure 12.4 -2(b) A View of Ash Disposal Site  
of Pha lai T.P. Station









Bird eyes view of discharge water (Phao Tan - An Bai) canal

- 1. Phao Tan canal
- 2. An Bai canal

Figure 12.4. -3 A Bird's-eye View of Discharge Water Canals

- 1. Phao Tan canal
- 2. An Bai canal







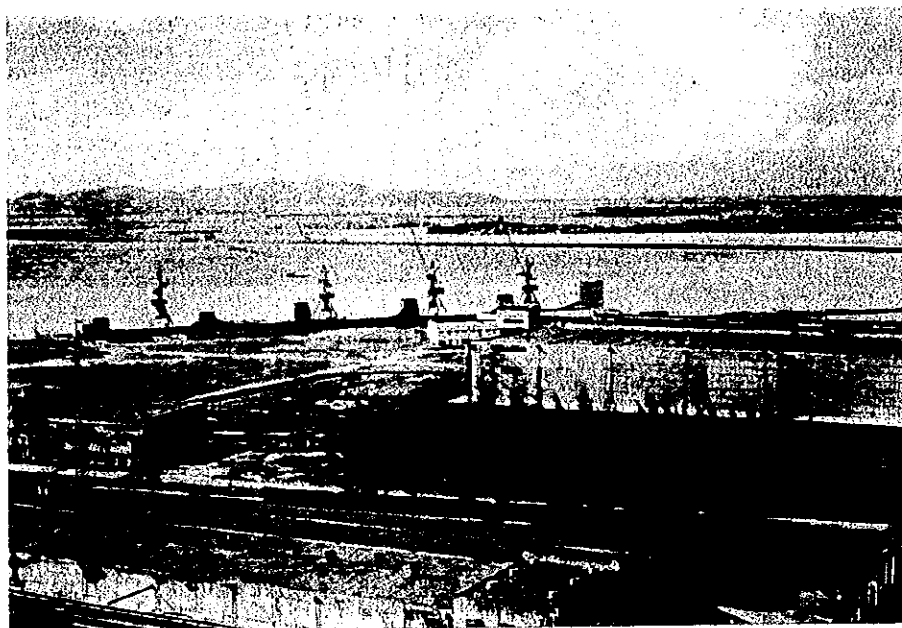


Figure 12.4.-4 A View of Coal Unloading Port and Coal Strage Site

View of Coal Unloading river port and Coal Storage

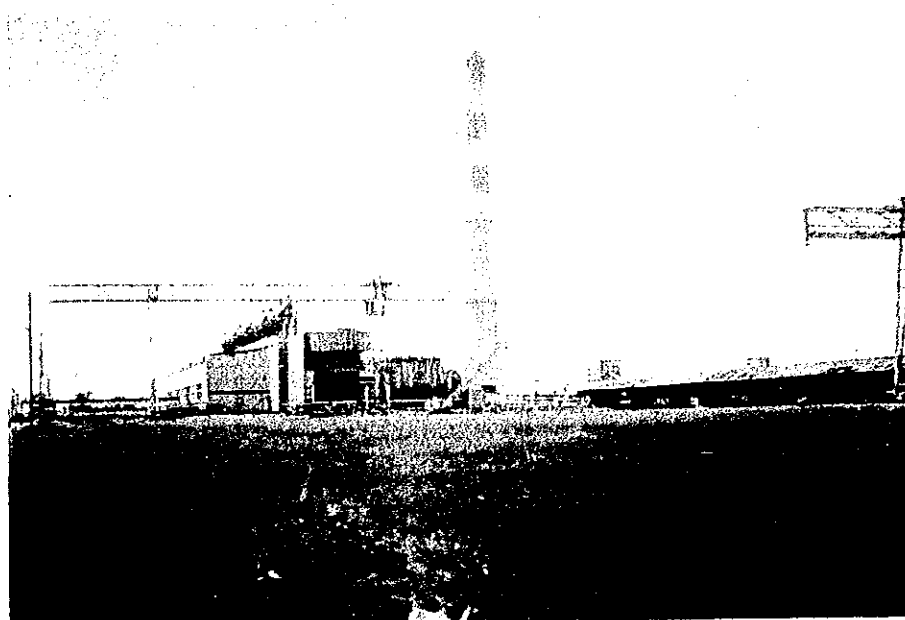


Figure 12.4 -5 A View of the Site of Pha Lai T.P. Extention

View of Floor for Extension



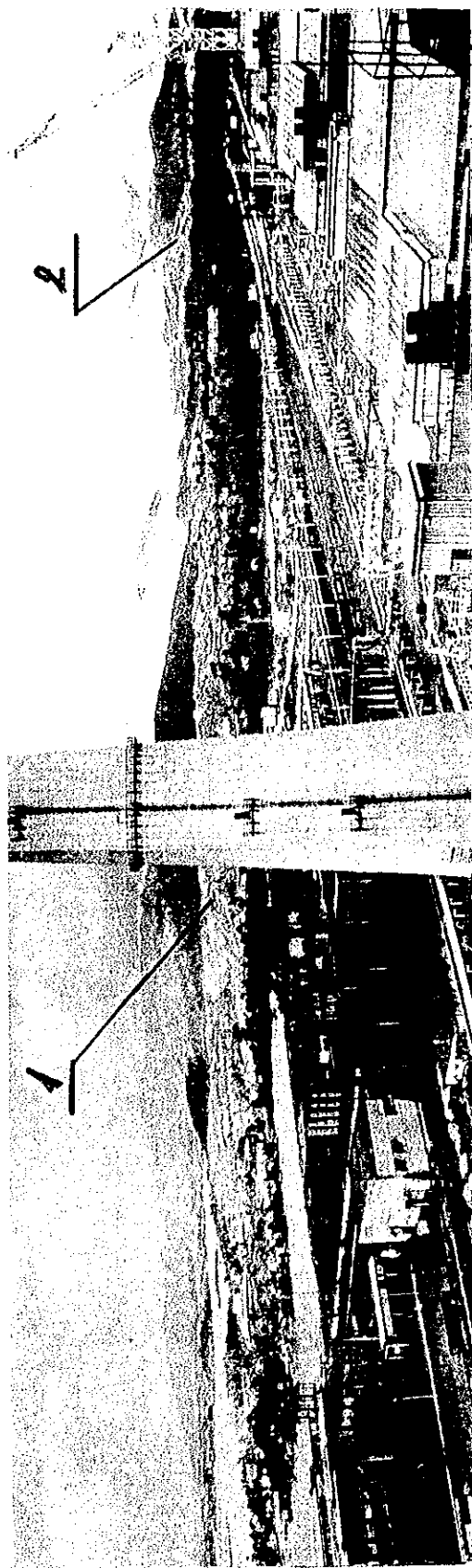


Figure 12.4 -6 A View of Ash Disposal Sites of Pha lai Power Plant

View of Ash disposals (Khe Lang and Binh Giang)

1. Khe Lang Ash disposal
2. Binh Giang Ash disposal





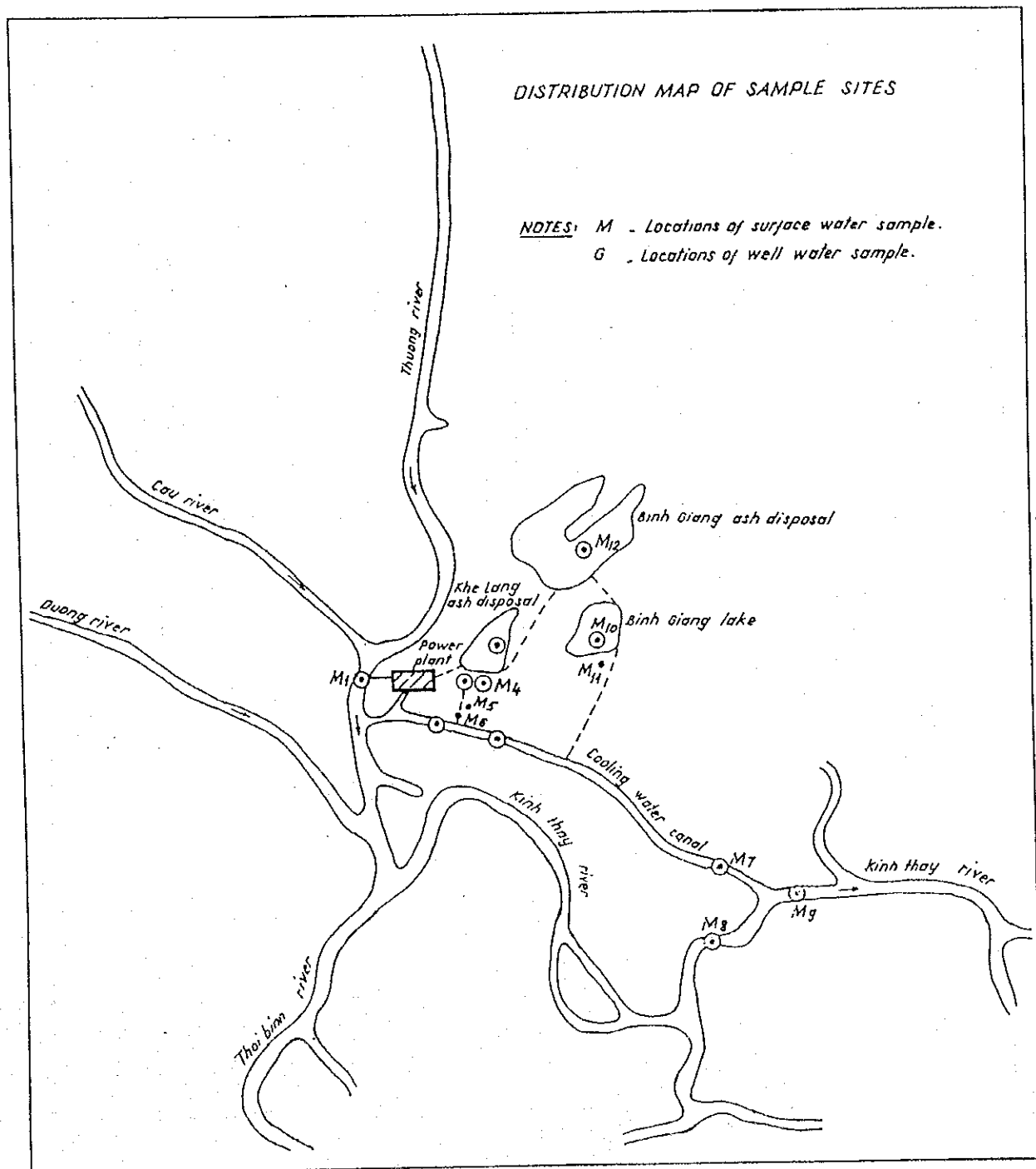


Figure 12.4 -7 The Sampling Locations of Surface Water and Well Water around Pha Lai T.P. Site

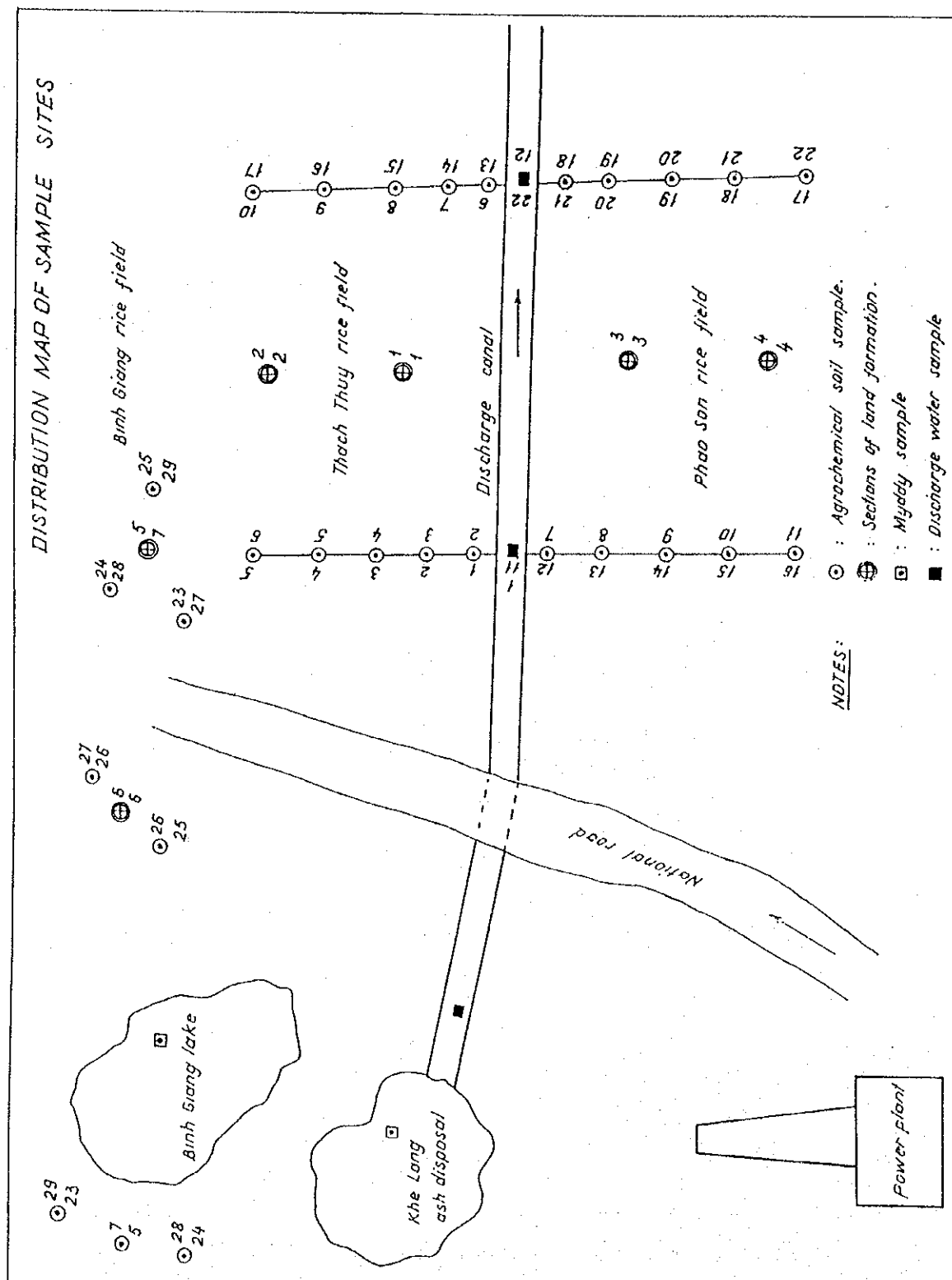


Figure 12.4 -8 The Sampling Locations of Discharge Water, Soil and Others along Discharge Canal of Ash Disposal Site



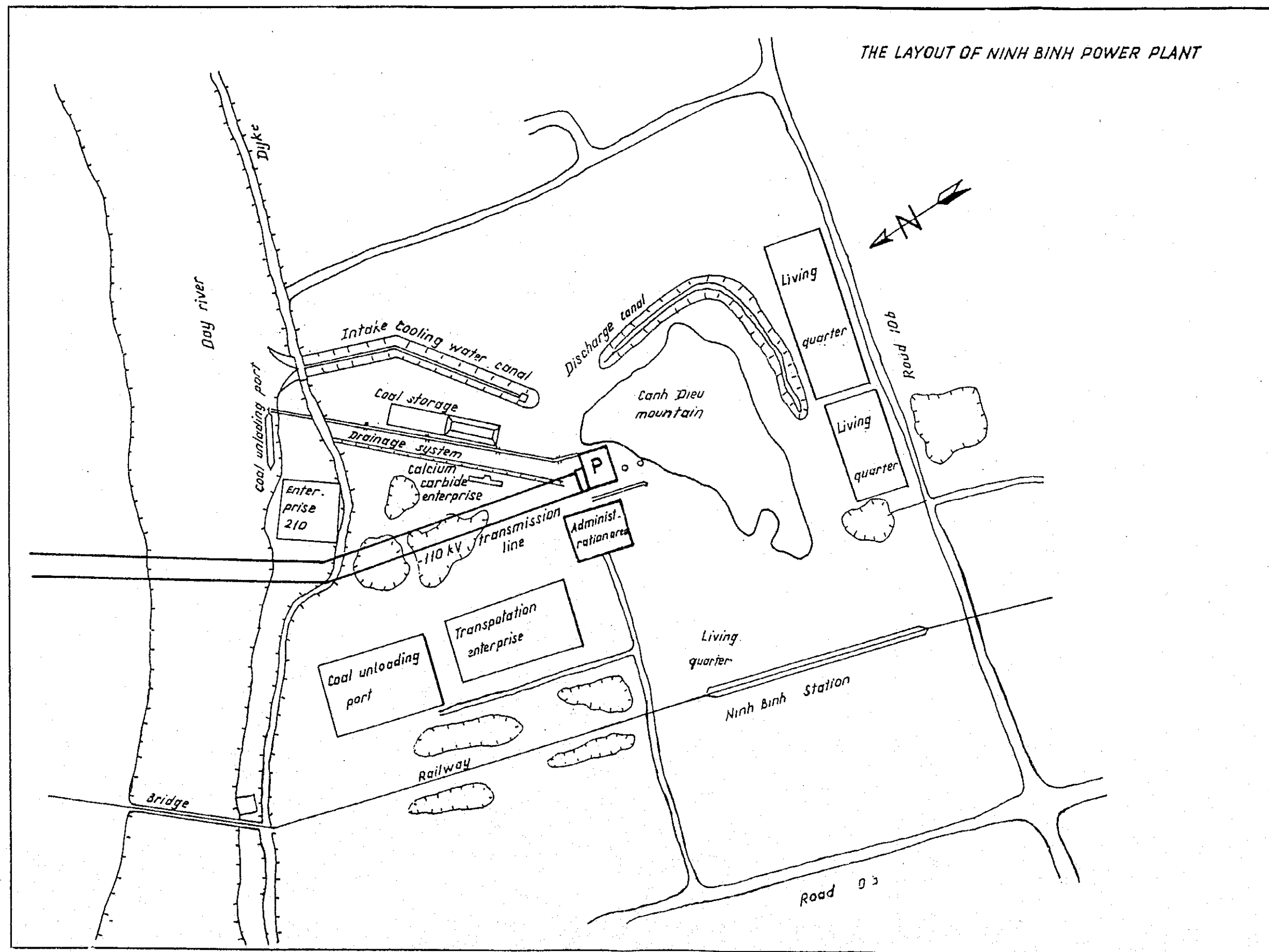


Figure 12.4-9 The Layout of Ninh Binh T.P. Station





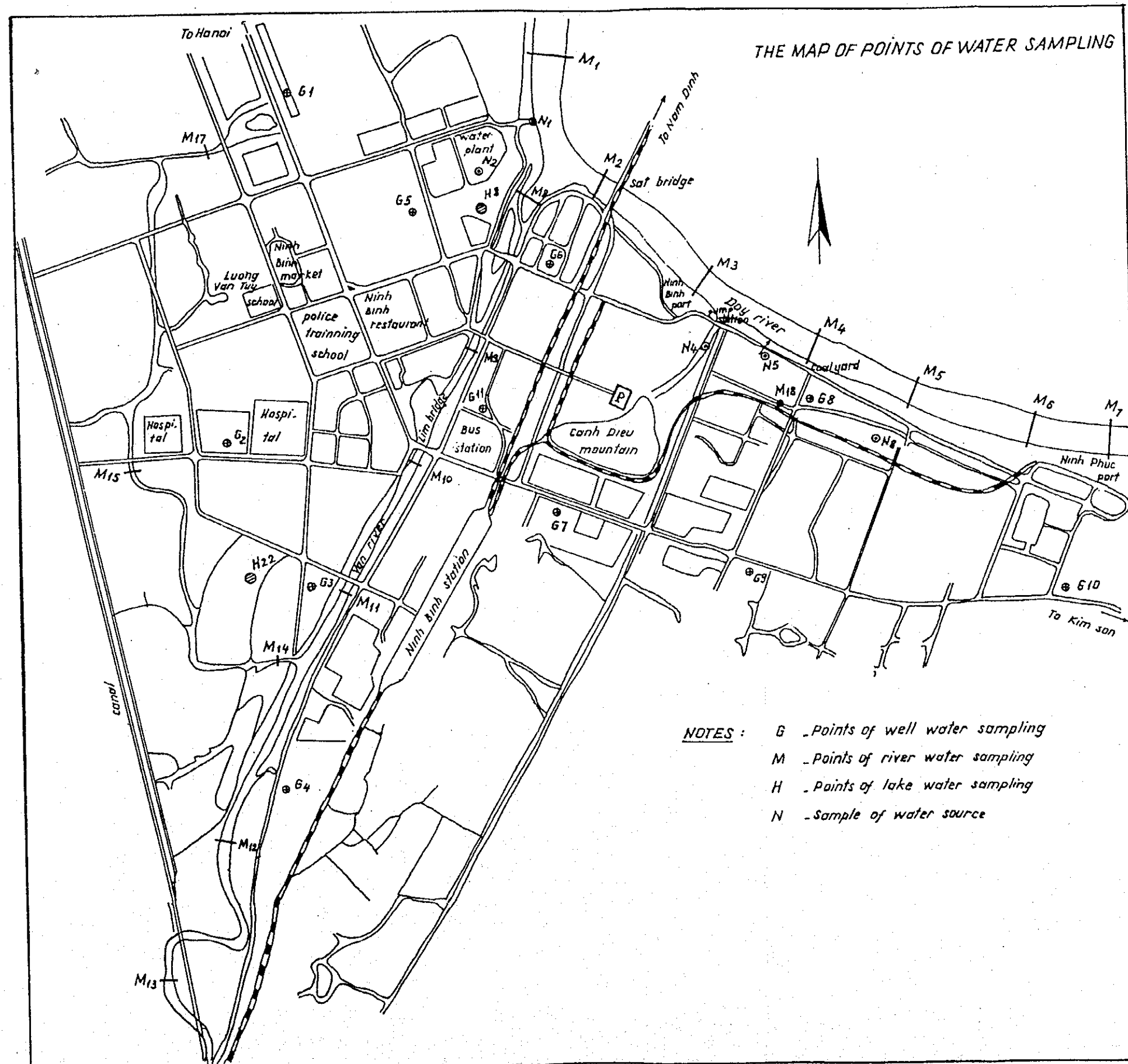


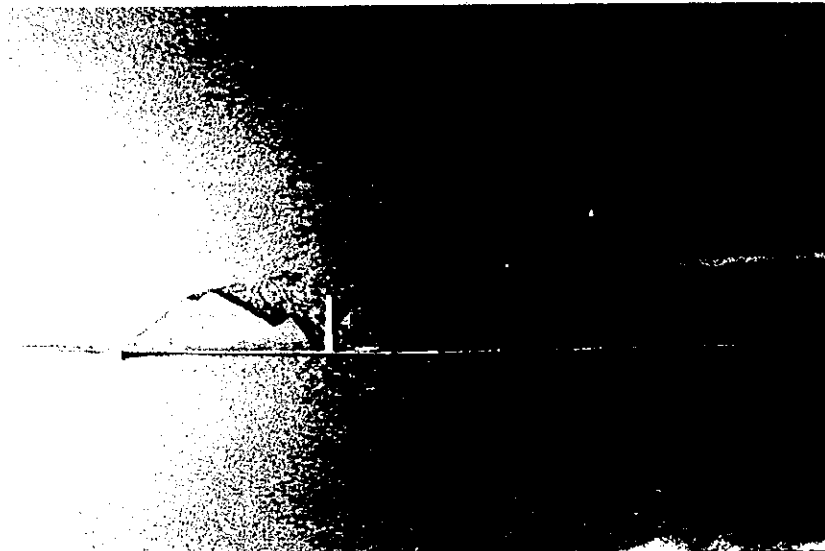
Figure 12.4-10 The Location Map of Water Sampling Points



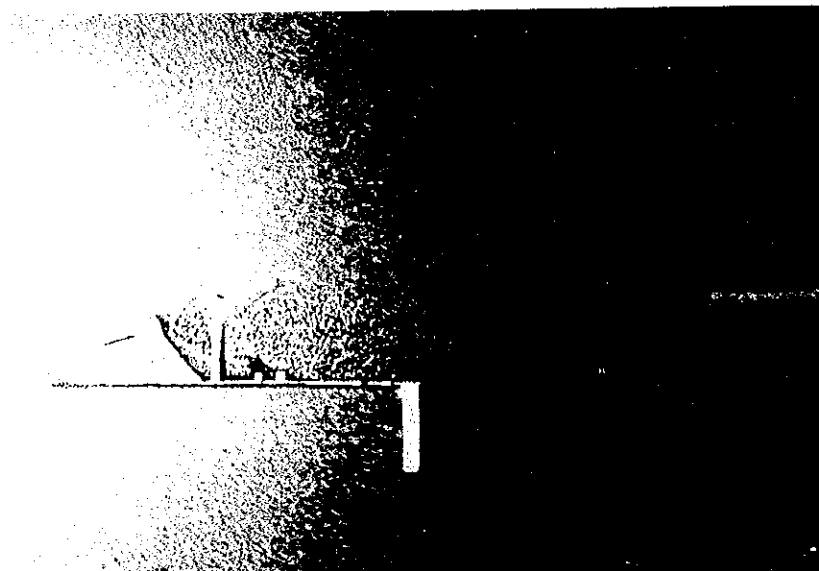








(a) Picture 1. Aerodynamic shadow formed while the southern wind flows though Canh Dieu Mountain (Vertical section) - Model



(b) Picture 3. Aerodynamic shadow formed while the S-E wind flows though Canh Dieu Mountain (Vertical section) - Model

Figure 12.4-11 Model Test on Wind Flow through Canh Dieu Mountain and Ninh Binh T.P. Plant





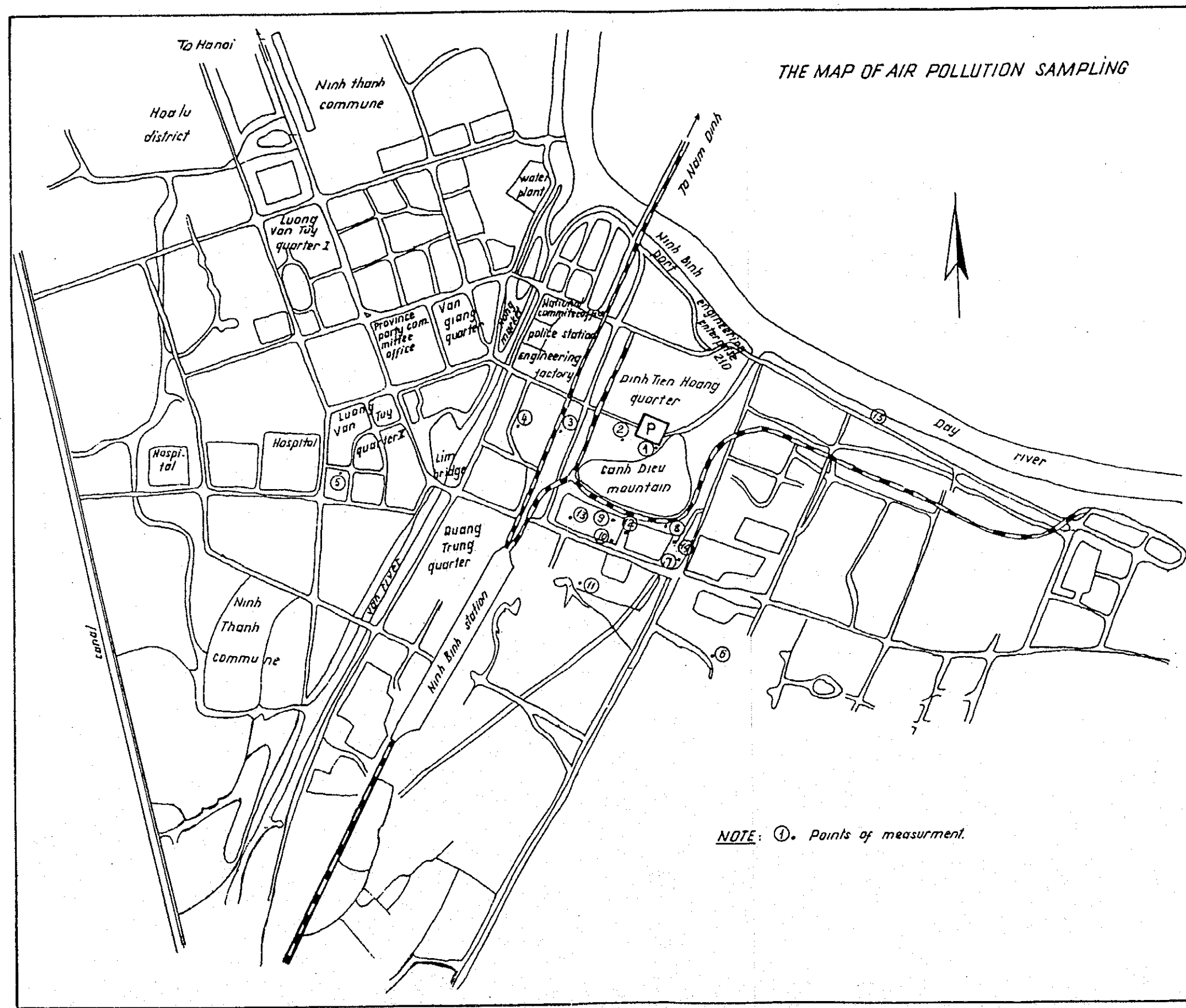


Figure 12.4-12 The Location Map of Air Pollution Sampling Points









## 12.5 Comments for Enhancement of Environmental Protection in Future

The survey has reviewed and studied the present situation of environmental protection activities being implemented in the country from various aspects, including such items as below.

- Environmental policy, laws and institutional framework
- Environmental regulations of local governments
- Roles of central and local governments
- Present situation of nature and socio-economic environments of the country
- Review of environmental considerations having been applied to hydropower and thermal power projects

Details of the review results are described in the previous sections. In summary, some impressive points of the results are itemized as below.

- National Environmental Protection Law (the Law) was issued and became effective in January 1994. MOSTE was established in September 1993, and NEA was formed within the Ministry to be responsible for the environmental protection activities of the whole country.  
The Law has clarified the national environmental policy and philosophy, and basic regulatory requirements for environmental protections.
- Temporary guideline for EIA of techno-economic projects was prepared, in which detailed EIA requirements are provided. The decree regarding protected forest plants and animals was issued, in which the rare and precious plants and animals are listed, and specific forest areas have been identified for protection.
- Provisional environmental criteria was issued and defined permissible environmental limits of various effluents discharged from industrial and other activities.
- Most of local authorities have already established Environmental Committees to carry out environmental protection activities on the level of local areas. Especially, Hanoi and Ho Chi Minh cities and some provinces have issued their own environmental regulations. Hanoi and Ho Chi Minh cities have already started environmental monitorings and licensing activity for new project establishments.
- Through a couple of brief environmental case studies made on Da River and Dong Nai River basins, and also on coal-fired thermal power plants, it is impressed that the organizations in charge are all capable to carry out such studies, and various data are existing. This will mean that EIAs can be implemented by pertinent domestic organizations under some guidance from outside consultants.

On the other hand, there were also some findings which would need some improvements or development, so that more effective environmental protection activities can be implemented and achieved. The following sections identified the findings and provided some recommendations for considerations by pertinent organizations of the country.

It is believed that the bases of environmental protection plan of the country have already been established. With these bases, making some more improvements, obtaining more experiences and also having financial support from certain sources should be able to lead to meaningful implementation of the national environmental protection plan.

## **12.5.1 Environmental Policy and Regulations**

### **(1) Environmental regulations**

It is known that the temporary guideline for EIA of techno-economic projects became formal and effective in October 1994. As every one knows, there are now many on-going development project plans in the country. To have timely environmental considerations taken by the plans, it is essential that the EIA guideline will be complied with by the project planners and/or investors.

It is also recommended that environmental regulations and EIA requirements of local authorities will be established as soon as possible, if not yet been issued. Regulations of local authorities can be more specific and detailed to fit their specific local conditions.

### **(2) Review and licensing procedures of an EIA**

The EIA guideline defined the projects which are subject to review by MOSTE. However, the review and licensing processes have not been clarified. Also that the organization of having the authority of approval or denial of an EIA has not been clearly expressed. Moreover, it seems not clear that how a project plan be treated if its EIA report deemed not satisfactory from viewpoint of environmental considerations. The involvement of the public in the process of review of an EIA report should also be considered.

Through discussions with concerned MOSTE personnel, it was advised that the licensing process has not yet been clearly established at this moment. However, the process should be identical to both of domestic and foreign funded projects.

For reference, the licensing procedure of an EIA in Japan is shown by Figure 12.5-1.

### **(3) Enhancement of environmental monitoring activity**

Generally speaking, local governments should be responsible for environmental monitoring to check out environmental quality of their local areas. This will mean that local governments will have authority to regulate any techno-economic project activity within their regions to comply with the environmental requirements. In order to comply with such local government requirements, each techno-economic establishment shall also carry out environmental monitoring by itself to assure that its activities will not violate the regulations.

From the above point of view, establishment of environmental monitoring programs by both local governments and industrial operators/owners is essential for environmental protections. It was found that only a few local governments, such as Hanoi and Ho Chi Minh cities, have such program and started their necessary monitoring activities. To establish analysis laboratories or make use of such facility operated by specific organizations or universities will be needed for the activities. It appears that foreign financial support and technical assistance would be required to enhance environmental monitoring activities.

It should be noted that environmental monitoring program is an important element of establishing such industrial facilities as those listed by the EIA guideline, which will need full-scale EIAs.

## 12.5.2 Environmental Impact Assessment

In order to understand the situation of implementing EIAs in the country, every effort was made to collect a certain EIA report currently prepared for recent development project(s), such as those for Yaly hydropower project or Hoa Binh hydropower plant. However, it is regretted that there were no complete EIA report(s), especially in English version, available for review. A few informations were obtained through meeting discussions. A couple of case studies performed also provided some aspects of implementing an EIA. With these in mind, this section will describe only what are deemed appropriate and what informations would be recommendable to Viet Nam side.

### (1) Defining detailed scope of work of an EIA

It was our impression that defining a detailed scope of work of an EIA of a certain project may be a key issue for project owners or planners. Financial allocation for carrying out an EIA may also be related. Basically, it is first required to comply with the Viet Nam's EIA guidelines and then to incorporate the requirements set force by foreign or international project funding organizations. To reflect the latter requirements, it is essential to collect those information or consult with pertinent organization or consultants before setting up a scope of work. It is regretted that not every ODA funding country or international funding organization has prepared clear and detailed guidelines for the purpose of borrower's use. If this would be the case, to make use of consulting organizations should be able to resolve such problem. In the following separate items, some information on Japanese and World Bank guidelines are described briefly for reference.

### (2) Environmental assessment guidelines of Japan

There are two ODA funding organizations in Japan. One is the Japan International Cooperation Agency (JICA) and the other is The Overseas Economic Cooperation Fund, Japan (OECF). JICA has issued a series of EIA guidelines to cover each area of development project, such as those in terms of harbor, airport, highway, railway, river work, waste treatment, sewerage, groundwater development, water supply, regional development, tourism, transportation, urban transportation, agriculture, forestry and dam construction projects, respectively. It is regretted that English versions of them are not yet available now. On the other hand, OECF prepared an overall guideline to cover key points of concerns for each area of development. It is noted that JICA guidelines are prepared mainly for the purpose of being used by the experts of the ODA project teams, while that of OECF is prepared for considerations by the borrowers.

#### (a) Environmental assessment guidelines of JICA

Within a project cycle, JICA is usually involved in the first half of the cycle, that is from Preliminary Study (P/S) stage to the Feasibility Study (F/S) stage. The latter stage can be separated again into Master Plan (M/P) stage and the F/Sy stage. At the P/S stage, JICA requires to implement "Preliminary Environmental Study" to make screening and judgment of whether Environmental Impact Study (i.e. Environmental Impact Assessment) would be required or not. And if it is judged that EIA will be needed, then it is required to make decision on main aspects of the EIA study. At the M/S stage, it is required to implement an "Initial Environmental Examination (IEE)" to identify various environmental factors to be examined and also the possible main negative impacts together with their causes. In this stage of study, mitigation measures must be studied to see whether those possible negative impacts could be avoided or mitigated.

If it is judged by the study results of an IEE that possible negative impacts can be avoided or mitigated by incorporating mitigation measures, then a full-scale EIA study will be implemented at the stage of the F/S. If it is judged at the stage of P/S that a full-scale EIA will not be necessary, then an IEE which is equivalent to a so called "partial EIA" will be sufficient at the stage of F/S.

Table 12.5-1 shows the checklist to be used for scoping during P/S stage, and Table 12.5-2 shows the study items to be covered by a full scale EIA during F/S. These tables are used for the case of dam construction projects. The contents of the checklist and EIA study items will be different for other cases.

#### **(b) Environmental assessment guidelines of the OECF**

In 1989, OECF issued its first version of "OECF Environmental Guidelines". In its first chapter, it is mentioned that these guidelines cover those environmental items which should be considered by the Borrowers at the stages of project planning and preparation, that is, before making a loan request. OECF will review the Borrower's environmental findings and the environmental protection measures taken by the Borrower. In the second chapter of the guidelines, the checklists are provided for sixteen sectors selected. Attached Table 12.5-3 and Table 12.5-4 are the checklists to be used for hydropower and thermal power projects, respectively.

#### **(3) Environmental guidelines of the World Bank**

The World Bank issued an Operational Directive on Environmental Assessment (OD 4.00, Annex A) in October 1989, which mandates an environmental assessment for all projects that may have significant impact on the environment. The Directive requires the Bank staff to screen and categorize all its prospective loans (Category A to D) for potential adverse environmental impacts at the time of project identification. In October 1991, OD 4.00 Annex A was replaced by OD 4.01. The key points of the OD 4.01 are as below.

- Introduced a new system for classifying projects according to the nature and extent of their environmental impact. OD 4.00 Annex A categorized projects/components into four categories, i.e. Category A to D, while OD 4.01 simplified them into three categories, i.e. Category A through C. The original Category D, which will not require environmental assessment, was deleted and combined with Category B and C. Table 12.5-5 shows the projects and components of each category defined. (The table is excerpted from the Bank's "Environmental Assessment Sourcebook UPDATE" dated April 1993.) In summary:

Category A: A full EA is required.

Category B: Although a full EA is not required, some environmental analysis is required.

Category C: No EA or other environmental analysis is required.

- Provided more specific instructions to Bank staff on public consultation and disclosure of information.
- Recommended that the "Environmental Assessment Sourcebook" be used for guidance throughout the environmental assessment process.