5. Conceptual Planning of Mine Development

5.1 Mining Area

Open cut mine was planned in the condition that the depth of final floor is 150m below the surface. This depth is a possible mining level, which adjacent open cut mines suggest.

Although the geological structures, correlation of coal seams and coal reserves for mining are still uncertain in detail, whole data at present indicates that three areas (A, B and C) in Ngao basin could be mining candidate areas. Those areas are shown in Figure 5-1.

Key figures such as area, overburden, coal reserves and stripping ratio are shown in Table 5-1. Coal reserves in Table 5-1 are based on the geological assessment of article 2.5.2 in this report.

Table 5-1 Key figures of Area-A, B and C

	Area-A	Area-B	Area-C
Surface Area (㎡)	2,296,000	1,544,000	981,000
Final Bench Are (㎡)	422,000	386,000	78,000
Overburden (1,000m^3)	184,327	135,867	75,882
Coal Reserves (1,000 t)	29,352	15,984	5,313
Stripping Ratio (Bank m^3/t)	6.30	8.50	14.28

Area-A is the most promising area because of the largest coal reserve, the smallest stripping ratio and comparatively low sulfur content.

Therefore, the mining plan was made for Area-A. But, if some limited area with good coal quality is measured in Area-B as a result of further exploration, Area-B also may be able to come up to be hopeful area.

The stripping ratio in Area-A is almost same level as the neighboring coal mines, and

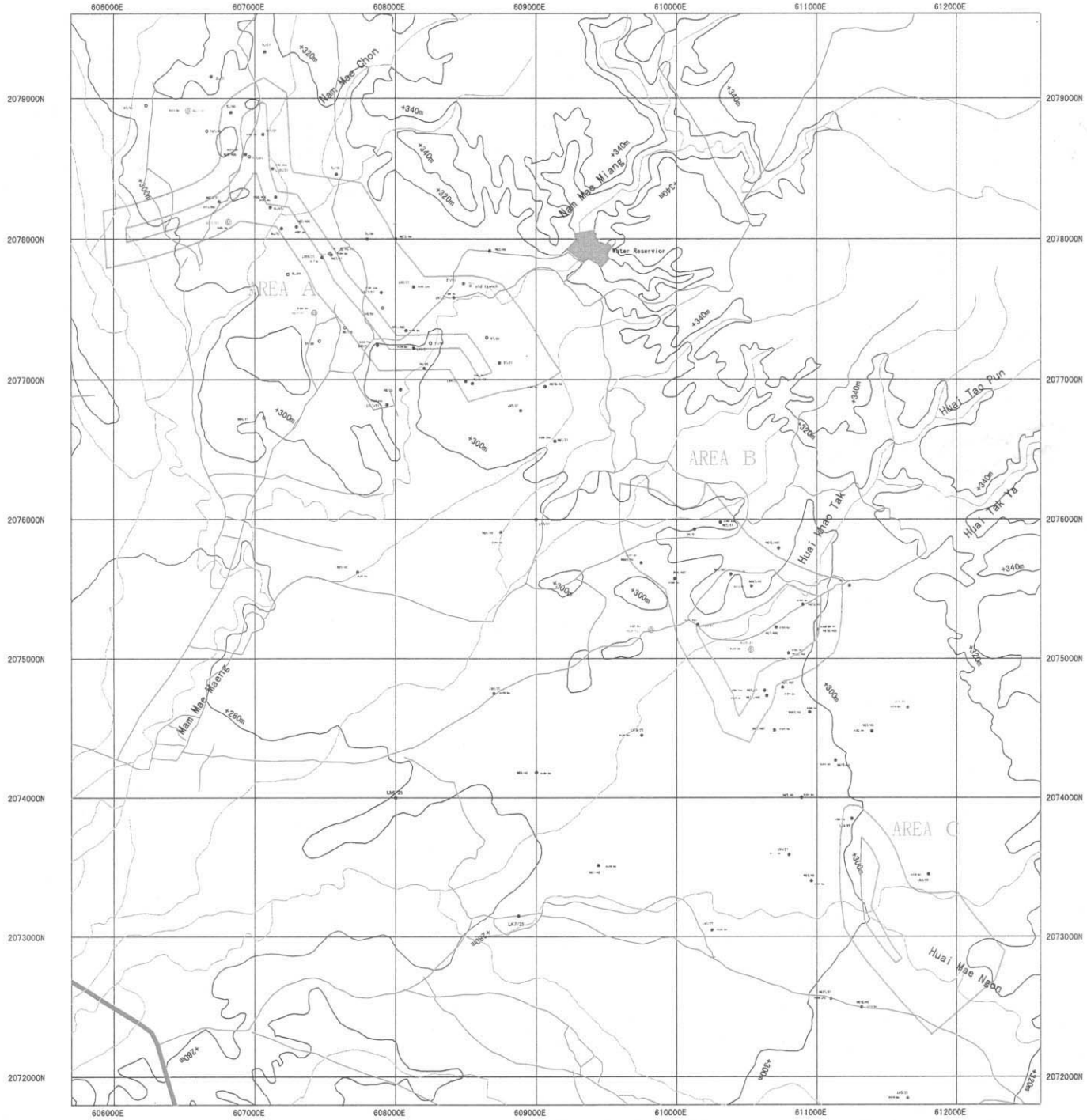


Fig5-1 Mining candidate areas

the coal reserves for mining is comparatively large in Thailand.

In any case, we consider that more detailed exploration about coal seam and coal quality condition are required mainly in Area-A. After that, the most promising area will be selected in Ngao coal basin, and the optimum mining plan will be made.

5.2 Production and Depth of Final Floor

Annual production and final depth of working floor were settled tentatively in 500,000 ton and 150m below the surface respectively.

The inspections were conducted on the five adjacent coal mines in the Study.

Mae Moh mine, the biggest coal mine in Thailand, produces annually around 15 million tons of coal with about 6 bank-m^3/t of average stripping ratio. The final depth of floor is planned at 250m below the surface.

Other four coal mines produce annually around 400,000 to 1,300,000 tons of coal with about 4 to 6.5 bank-m^3/t of average stripping ratio. The final depth of floor is planned at 100m to 220m below the surface in these mines.

5.3 Rock Strength

Compression tests (uni-axial and tri-axial) were conducted on the core samples taken from the drill holes at the depth of around 50 and 100m below the surface, to get information about the workability of heavy machine, stability of bench and dump area, and need for blasting etc.

The tests were carried out by PBC Engineering Co., Ltd in Thailand with ASTM standard procedures.

(1) It is well known that there is a good correlation between uni-axial compression strength and tri-axial one (shear strength). Generally, shear strength shows 1/10 to

2/10 of uni-axial compression strength. The test results show roughly same tendency as those in other rocks.

(2) These rocks have week property for the impact and stress. Therefore, we consider that the shovels are useful for the excavation of these rocks, and blasting is not necessary.

(3) The week property of the rocks exerts a bad influence upon a stability of bench and dump area. Suitable bench angle, moderate high wall slope and afforestation are commonly recommended. Groundwater level should be checked periodically.

Table 5-2 Result of Rock Test

Hole No.	Depth of Sampling (m)	Uni-axial Compression Strength (kg/cm^2)	Tri-axial Compression Strength (kg/cm^2)
NGJ 1/43	26-30	10.6	6.8
	81-84	5.9	0.1
NGJ 2/43	50-56	13.0	0.2
	99-105	15.8	–
NGJ 3/43	42-47	5.0	3.4
	92-95	6.2	7.0
NGJ 4/43	34-40	9.3	0.9
	87-99	6.3	0.5
NGJ 5/43	48-56	2.4	0.7
	90-92	3.2	0.4

ATT : Conducted by PBC Engineering Co., Ltd.

5.4 Water Control and Dewatering Plan

5.4.1 Surface Water

(1) River

Three creeks, of which width is few meters, flow in the Area-A. One creek passes through the center of northern part of the Area-A. This is considered to have an effect on the mining operations. The other creeks pass near the west and south edge of the Area-A. If we start the operations from the northern part of the area, we can avoid these effects on the operation in long term. We should take measures to meet the situation.

The following measures are effective to control the river water.

① To shift the northern creek to the outside of the pit approximately in 2 km.
② To start the mining operations from the north.
③ To check the water level of the creeks periodically, and take the effective measures to prevent the water flow into the pit.

(2) Precipitation

It is relatively less rainfall in northern Thailand. The following table 5-3 shows the daily precipitation records in these ten years at the neighboring C-Coal Mine, which is located approximately 30 km northeast from the Study area.

In these ten years, monthly maximum rainfall is 354 mm, and yearly one is 1,364 mm.

The following table 5-4 shows the comparative precipitation data at C-Coal Mine (1991-2000) and northern observation point 328003 (1977-1997) by the computer section of Climatologic Division in Thailand Meteorological Agency.

Table 5-3 Precipitation Records by C-Coal Mine

	1991		1992		1993		1994		1995		1996		1997		1998		1999		2000	
Mo.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.	mm	D.
1			3	1													11	2		
2			48	2									5	1			3	1	64	4
3					16	3	64	2	40	4			17	2	61	4	6	3	20	1
4			7	2	124	5	10	1	152	9	152	5	125	6	108	7	192	10	112	8
5			10	1	154	8	354	14	96	8	110	10	69	7	210	11	237	15	294	15
6			139	9	32	3	144	7	160	15	139	6	53	10	212	10	110	14	213	13
7	27	8	217	20	112	10	91	6	312	15	20	1	108	12	170	10	137	10	166	9
8	270	18	248	15	205	14	158	14	187	15	169	16	255	16	146	18	123	17	141	12
9	83	9	253	17	270	11	132	8	198	13	315	15	191	18	141	14	287	18	216	17
10	63	10	148	11	102	5	58	3	65	3	95	8	97	9	68	5	189	15	117	9
11	12	2									51	3			61	5	69	7		
12	11	2	186	2											4	1				
To.	466	49	1259	80	1015	59	1011	55	1210	82	1051	64	920	81	1181	85	1364	112	1343	88

Table 5-4 Comparative Precipitation Data at C-Mine and Northern Point C

Factor	C-Coal Mine	Northern Observation Point C
Max Yearly Rainfall	1,364mm (1999)	1,378.1mm (1981)
Max Monthly Rainfall	354mm (May 1994)	394.6mm (July 1981)
Max Mon. Rainfall days	20 days (July 1992)	23days (September 1992)
Max Daily Rainfall	—	133.6mm (July 1978)

Both of the maximum yearly rainfall at C-Coal Mine and the point 328003 are less than the average rainfall of 1,492.4 mm in these 30 years in Bangkok. Then, it is supposed that the yearly rainfall is not so much in Ngao area. And the catchments area for the proposed mining area is relatively narrow.

Following draining measures will be effective.

① To install drain pumps in the reservoir designed in the pit bottom, and pump out gathered water.

② To design more than two benches of different elevation and operate on upper bench in rainy days.

③ To make drain ditches around the mining area to prevent the water to flow into the pit.

5.4.2 Ground Water

Groundwater exerts two negative effects on operations. One is groundwater seepage in pit. It makes the operations difficult and degrades coal quality by the contamination of mud. Another one is the influence for the wall stability. Following data are the result of Permeability test by "falling head method" at water bearing zone in two drill holes in five ones.

Table 5-5 Result of Permeability Test

Hole Number	Elevation SL (m)	Lithology of Perforate Range	Perforatre Interval GL (－m)	Static Water Level GL (－m)	Permeability (cm/sec)
NGJ1/43	316.5	Coal	100~112	28.6	1.06×10^{-6}
NGJ4/43	303.8	Mudstone	51~63	2.6	1.49×10^{-6}

Permeability of 10^{-6} is said to be almost impermeable. Static water level is relatively high in NGJ4/43 hole in consideration of the low elevation, as the hole is located near a creek.

The similar tests had been carried out at four wells around here by Thailand authority, and almost same results were obtained, in which the static water level is GL.－l0.5m～17.8m, and the permeability is $3\sim10\times10^{-6}$.

According to the permeability and condition of neighboring coal mine, we need not to

be so anxious about the water seepage in pit. But, we should take measures to meet the situation.

Following measures will be effective to minimize the bad influences by ground water.

① To pump up the seepage water in pit.

② To plant trees on the berms to increase high wall stability.

③ To install the sensor to watch the movement of wall and establish the emergency evacuation system.

5.5 Operational Criteria

The criteria of operation are as follows.

(1) Production and Bench Depth

- Production : 500,000t/y
- Final depth of floor : 150m below the surface

(2) Bench

- Height : 5m
- Inclination : 55 degree (maximum)
- Road width : 15m
- Road dip : 10 %

(3) High wall

- Bench height : 5m
- Berm width : 2m, and 10m at every 5 steps

(4) Waste dump

- Bench height : 5m
- Bench inclination : 45 degree

- Berm width : 5m
- Overall inclination : 30degree

Surface of waste dump will be planted with grass and trees to prevent collapse.

Figure 5-2 shows conceptual mining.

5.6 Coal Production Cost

5.6.1 Production System

Generally, a coal company in Thailand entrusts a contractor with direct production activities under a contract agreement.

Following to this agreement which is normally revised in every three years, the contractor bears the responsibility for mining and transporting of coal at the designated place, stripping, disposal of waste materials, work shop works, and bench maintenance.

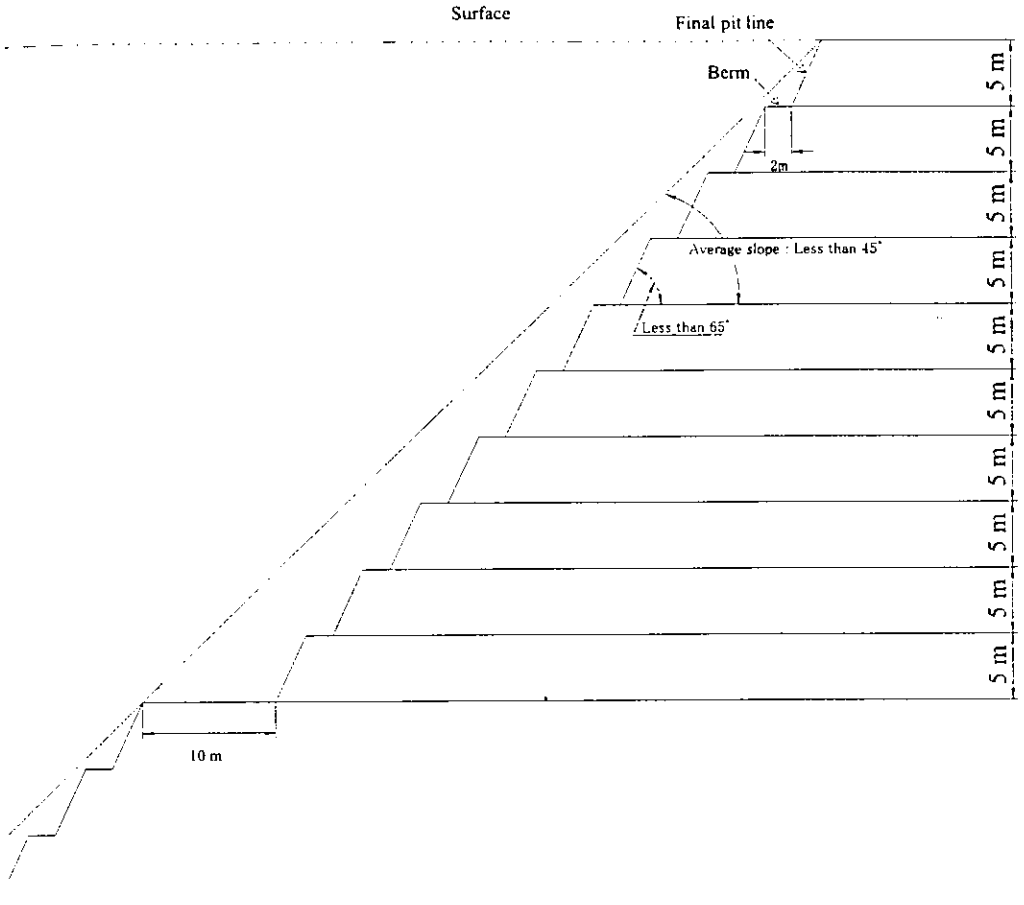
The contractor holds also the responsibility for preparing equipments and spare parts as well as manpower, relating to coal production and waste disposal.

On the other hand, the company designs mining plan, maintains safety at works, controls coal quality, protects environment and keeps friendly relations with local people.

5.6.2. Presumed Condition for Production

- Mining Area : Area-A
- Annual Production : 500,000 ton
- Term of Operation : 20 years
- Minable Reserves Required: 10,000,000 ton
- Average Stripping Ratio : 6.30 Bank m^3／ton-coal
- Coal Preparation : Jig System

Fig5-2 Conceptual mining



Berm width : 2m, and 10m at every 5 steps

5.6.3 Production Cost

Production cost was roughly estimated, based on the investigation data on coal mine, which is located around Lampang city. In case that the cost in Thailand is not clear, it was estimated referring the data in Japan, in consideration of economic index in Thailand.

As a result, the production cost was estimated 315 Bahts/t, which was almost same to that of coal mines around Lampang city.

The breaking down is as the followings.

(1) Mining: 192.0 B/t-coal

(Contractor Fee)

・Coal (28 B/t) : 28 B/t

・Waste (26B/t): 164 B/t($26B/m^3 \times 6.3\ m^3/t = 164$ B/t)

(2) Fuel 2.5 B/t

(3) Electricity 2.5 B/t

(4) Water 0.7 B/t

(5) Running of Jig Plant 20.0 B/t

(6) Administration 26.8 B/t

(7) Investment 30.9 B/t

・Land (6.6 B/t)

・Office (2.1 B/t)

・Residence (2.1 B/t)

・Jig Plant (10.0 B/t)

・Pump & Pipe (5.8 B/t)

・Weighing Machine (0.3 B/t)

・Stationery and Fixture (0.8 B/t)

・Road Pavement (3.0 B/t)

・Shift of River Flow (0.2 B/t)

(8) Royalty	20.0 B/t
(9) Others	19.6 B/t
Total cost of clean coal (1)～(9)	**315.0 B/t**

5.7 Quality and Use of Products

5.7.1 Quality of Products

Based on the present data by eleven (11) drillings, the average quality of raw coal in Area-A is estimated as the following table 5-6. As mentioned in article 2.5.2, this raw coal includes the rock bands less than 30 cm in thickness.

The quality of products is mentioned about two cases. One is the case only by conventional coal preparation (jig plant), and the other is that by the upgrading technique (Low temperature dry distillation process: SGI process) in addition to the former process.

(1) Case by conventional coal preparation

The average Sulfur content in Area-A is 4.27 % (A.R). But, according to the Figure 3-5 (Iso-value contour map on Sulfur contents), relatively low Sulfur content area (less than 3 %, A.R) is seemed to spread over some range in Area-A. Then, we expect to make cleare about 10 million tons of low Sulfur coal reserves (less than 3 %, A.R) in the definite area of Area-A by further exploration. Furthermore, it is considered to remove high Sulfur of thin coal seam in order to keep the low Sulfur content.

We consider that the heating value of coal products can be kept 3,600 kcal/kg (A.R) using selective mining method and washery plant.

Table 5-6 Quality of Raw Coal and Products

Area	Sample	Analysis Basis	Mo. (%)	Ash (%)	Total S (%)	Form of Sulfur		H.V. (kcal/kg)	S/H.V. (per 1000kcal)
						Pyrite	Others		
Area -A	Raw Coal (Ave.)	A.R	30.0	29.0	4.27			2,520	
		Dry	0.0	41.4	6.10	41%	59%	3,495	1.75
	Clean Coal (Asumed)	A.R	30.0	18.0	＜3.0			3,600	
	Bulk Sample	A.R	30.0	13.0	4.27			3,780	
		Dry	0.0	18.6	6.10	41%	59%	5,400	1.13
	Upgraded Coal	A.R	5.0	25.9	3.42			5,800	
		Dry	0.0	27.3	3.60	0%		6,100	0.59

(2) Case by Conventional Coal Preparation and Upgrading Technique

By further exploration, we expect to measure about 10 million tons of coal reserves in the definite area of Area-A, where the quality of clean coal is almost same to the bulk sample. In this case, we will be able to get the following products by applying SGI process to the clean coal.

- Solid Product (Yield: 50 %) : H.V; 5,800 kcal/kg, S; 3.42 (A.R)
- Liquid Product (Yield: 10 %): H.V; 8,100 kcal/kg, S; 4.5 (A.R)
- Sulfur content equivalent to the heating value of domestic coal (4,500 kcal/kg):

  $3.42 \times (4{,}500 \div 5{,}800) = 2.65$ % (A.R)

And then, if we can get the Sulfur content of clean coal less than 5 % (D.B), we will keep the Sulfur content of the upgraded coal less than 3 % (A.R).

5.7.2 Use

The Sulfur content of coal products is estimated around 3 % in both cases as above mentioned. Therefore, the main user for the coal product in Ngao is supposed to be cement industry.

And, we consider that the Sulfur content of coal products is likely kept less than 3 % as above mentioned.

6. Environmental Surveys

The object of this survey (Phase 1) is to collect the data on the environmental policies and the understanding of the present natural and social condition of the Ngao city and the proposed mining area, and to point out the environmental issue relating the mining activities.

The environmental survey (Environmental Impact Assessment (EIA)) in accordance with the environmental relation laws of Thailand must be carried out, in the case that the coal development work in the Ngao coal basin proceeds after the present survey. For the purpose of the preparation of this environmental survey plan based on the Ngao mining plan, the study of previous reports on environmental relation laws of Thailand and the investigation of the mining area and its vicinity are needed.

6.1 National Policy for Mining Industry and Environment Preservation

From the First to the Eight National Economic and Social Development Plan, National Policy guidelines have been formulated to facilitate the development of mineral resources, and the government has promoted and expanded the development of mineral resources. Meanwhile, a number of environmental laws and regulations have been stipulated and enforced since Thailand accepted the action plan of the United Nations Conference on the Human Environment (Stockholm 1972). From the middle 1980's onward, with regard to nationwide environmental concerns, the government has adopted "Green Policy" to preserve and to increase forest reserves. This policy has affected the development of mining industry since the increment of forest reserves induces the depression of land available for mineral exploitation. Mineral industry shows less essence to the national economy whereas the environmental issue received more public attention.

Under these circumstances, any proposed mining project must submit mining plan and EIA report, as tools for operational and environmental planning and management, for approval before commencement of its respective activity.

6.1.1 Environmental Preservation Policy Affecting the Development of Mining Industry

Since the middle of 1980's, the Thai government has adopted a "green" policy to preserve the country's diminishing forests and increase forestland. This policy has unintentionally affected the development of mining industry as it leads to land use conflict. Since May 1985, watershed classification has been declared for all over the country for preservation of water source area and stipulation of appropriate land use. Moreover, under the Seventh National Economic and Social Development Plan, forest preservation policy has been employed. As a result, 40% of the country's area is targeted to be forest reserves of which 25% is classified as conservation forest where all activities are prohibited and 15% is determined as commercial forest in which economic and agricultural activities can be processed under individual permission. Therefore, area available for mining industry, which is naturally confined by geological condition, has become rather limited. With present environmental policy and practice, investment in mineral exploration and development is expected to decline and slow down.

6.1.2 Environmental Policy for Mining Industry

Under the Ministry of Industry, the Department of Mineral Resources (DMR) is responsible for mineral resources exploration and development, administration of mining activities, enforcement of minerals law and mine pollution control. DMR has currently proclaimed some policies to restrain environmental deterioration

caused by mining industry and to integrate conservation and development schemes. Theses policies are as follows:

(a) Environmental Impact Assessment (EIA)
(b) Public Participation
(c) Beneficial Return to Host Communities
(d) Performance and Assurance Bonds
(e) Bank Guarantee

In 1978, DMR has established Environment Section and later, in 1988 promoted to the Division with wider responsibilities and mandates in order to accomplish its commission in environmentally sound manner. The main tasks of the Environmental Division are as follows:

(a) Investigate the environmental impacts from mining activities and seek for suitable and economic solutions
(b) Evaluate application and approve permission for mining lease extension changing mining plan and including new minerals in operating process
(c) Cooperate with the National Environmental Board (NEB) to carry out all tasks concerning environmental issues relating mining industry
(d) Inspect mining activities and monitor associated environmental problems to determine and execute promptly protection and mitigation measures
(e) Verify the complaints on mining induced environmental matters to diminish the problems and conciliate disputing parties
(f) Provide to miners information and advices regarding techniques to encounter environmental degradation conserve healthy surrounding and reclaim mined out land

6.1.3 Mining Laws and Regulations

In Thailand, there are two acts involving mainly mining environmental protection and management.

- The Mineral Act
- The Enhancement and Conservation of National Environmental Quality Act

(1) The Mineral Act

The Mineral Act, B.E. 2510 (1967) has been amended on a number of occasions in 1973, 1979, 1983 and 1985. The Act provides the legal framework permitting the orderly and progressive exploration and exploitation of mineral resources.

The process of acquiring mining license addressed in this act is as follows:

(Acquiring mining license)

Public announcement of the prospected mine area (20 days)

During this period, the local people are allowed to express their opposition including environmental awareness.

Application

Submit a work scheme and plan with attached necessary diagrams to specify mining techniques, types of equipment use, environmental protection and mitigation measures and reclamation plan.

Granting mining permits

Before granting mining permits, all approved submitted documents must be reconsidered in packet by the agencies such as the Royal Irrigation Department, Land Department, Royal Forest Department, Internal Security Operations Command, Office of Environmental Policy and Planning, and Agricultural Land Reform Office.

(During the operation period)

Miners must comply with the approved work schemes and plans and conditions prescribed in the issue of the lease. Moreover, they must conduct the operation in compliance with mining laws and regulations.

For examples:

(a) The mine shall not discharge outside mining area any slime or tailing unless such water does not contain solid matter in excess of the amount prescribed in a Ministerial Regulation.

(b) The mine shall not obstruct, destroy or undertake any work, which may damage the use of highways and waterways.

(c) Any excavated land such as pit, trench or shaft, which is no longer used in mining process, shall be filled up and the mined out area shall be reclaimed.

(2) The Enhancement and Conservation of National Environmental Quality Act

The environmental act having the most significance on the mining industry is the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992). This Act was promulgated on 4th June 1992 and effectively repealed the Environmental Quality Act, B.E. 2518 (1979). The 1992 Act further clarified and improved the environmental process and replaced the Office of National Environmental Board (ONEB) with three new organizations;

(a) The Office of Environmental Policy and Planning (OEPP)

OEPP is responsible for the preparation, review and approval of environmental documents for a range of specified project categories.

(b) The Pollution Control Department (PCD)

PCD is responsible for regulating standards of pollutant levels and investigating environmental violations.

(c) The Department of Environmental Quality Promotion (DEQP)

DEQP is responsible for providing environmental information and assisting point source discharges with advise on technical expertise concerning pollution control.

This 1992 Act covers four main issues relating to mining activities. They are specified as follows:

(a) New proposed mining projects of any size and type must submit EIA reports to the OEPP for approval before implementation.
(b) Mining activities must follow forthcoming and predetermined environmental standards such as the standards for surface water quality, industrial effluent quality and ambient air quality.
(c) The OEPP authorized to designate any natural area as an environmentally protected area or conservation area, which is prohibited for economic utilization including mining.
(d) The Act established an environmental fund for investment in operation of pollution control and waste treatment systems as well as waste disposal facility. This fund can be another source of finance for miners, particularly small to medium size mines, to borrow for improvement of their environmental works.

6.1.4 Environmental Impact Assessment (EIA)

The EIA has been adopted as a tool for managing the environment in relation to mineral resources development since July 1981. It contains a procedure of environmental planning and management. For mining industry, the EIA is part of a prerequisite in the process of granting a mining lease. A proposed mining project

of any size and type must submit EIA report prepared by a competent company, which has been registered with the OEPP. The impact assessment must fully address any aspects relevant to the ambient environment, the possible future implication as well as the effective protection and mitigation measures to prevent and monitor the adverse effects.

Under the Enhancement and Conservation of National Environmental Quality Act 1992, the EIA reports are reviewed and approved by the OEPP under the consideration of the Expert Committee. The Committee is appointed by the National Environmental Board (NEB) and composed of experts from various relevant fields. The Committee of mining project is formed of members specialize in mining engineering, geology, hydrology, soil science, forestry, archeology and environment. The representatives from the DMR and a non-governmental organization (NGO) are also appointed in the Committee.

According to the OEPP's guideline, the process of EIA approval is as follows:

Submit EIA reports

↓

Pre-review by the OEPP (within 15 days)

↓

(acceptable)

↓

Preliminary comments by OEPP

(OEPP proposes to the Expert Committee (within 30 days))

↓

Review by the Expert Committee (within 45 days)

↓

(approval or rejection)

Upon EIA approval, the OEPP under the recommendation of the Expert Committee shall stipulate a set of environmental condition to ensure the safety of personnel and minimize the damage to the public and surrounding as well. The environmental condition is essential material attached with the mining plan and must be followed by the mine operator.

6.1.5 Environmental Policy and its problems

The national environmental policies and legislation for mining industry in Thailand have been modified periodically to satisfy the country's social and economic conditions. Currently, environmental issue gains more attention from the public compared with the mineral resources development. However, the Environmental Division of DME is pointing out the following issues as real problems occurred at present;

- A lack of a land utilization plan for development of mineral resources
- Private mining sectors don't spend sufficient money to the environmental protection due to shortages of company's funds except the Electricity Generating Authority of Thailand (EGAT)
- The relationship among each government offices is not arranged well because of their own different policies.
- Development study is not enough due to the insufficient ability on mine development planning and technology.
- Management on an environmental protection from mining is not enough level.

Therefore, the Environmental Division of DME has concluded that the close collaboration upon integrated planning and management between the government and private sector is urgently acquired to achieve the nation's goal, and that policies

and legislation regarding planning and management of natural resources utilization and conservation in harmonious manner is certainly important for the country's future to obtain its sustainable development and national prosperity.

6.2 Present condition of Amphoe Ngao (Ngao city)

Amphoe Ngao is one of 13 cities (Amphoe) in the Lampang Province, with area of 1,815 km^2 (60 km from north to south and 30km from west to east). It is located 83 km northeast of Lampang town. Town area and farming villages are located in a basin (the Ngao Basin) surrounded by mountains of the 1,000m class. A mountain area occupies 73% of Amphoe Ngao, and a flat area is 22% and rivers and ponds are 5%.

Subtropical monsoon climate covers the area. A rainy season usually continues from April to September. An average annual precipitation is 1,082mm. A lot of small streams are running from the mountain ranges around the basin and join the Ngao River flowing at the center of the Ngao basin from north to south. The drainage system in the Ngao basin is divided into two drainage systems; the Ngao main stream system and the Hua river system. Moreover, the drainage system of the Ngao main stream is also divided into two sub-systems; the northwest area and the southeast area. The surveyed area is located in the southeast area of the Ngao main stream drainage system (Figure 6-1). The Ngao River is a river running out to the basin and joins the river of Mae Nam Chao Phraya, running into the Gulf of Thailand finally. The river system has as much as 67 water reservoir dams and more than 2,500 water-boreholes throughout the basin.

Amphoe Ngao is politically divided into ten (10) districts, and consists of seventy-three (73) villages. A population of Amphoe Ngao is 61,346 (1999) and its households are 15,532. An average population and households per a village is 840 and 212 respectively.

A main industry in Ngao is agriculture.

Farming land: 248 km^2

Families engaged in farming: 12,395 families

Productions:	Rice	(paddy : 58 km^2)
	Corn	(field : 17 km^2)
	Garlic	(field : 8 km^2)
	Garlic	(field : 8 km^2)
	Oranges	(field : 8 km^2)
	Vegetables	(field : 8 km^2)
	Cotton	(cotton field : 4 km^2)

Flat area along the Ngao River and its tributaries are used for rice farming due to good water condition. Some areas are raised two crops a year.

6.3 Present condition around the Proposed Mining Area

The proposed mining area is located in the eastern part of the Ngao basin, 12 km northeast of the town of Ngao. This area is the gentle hill regions in a fringe area of the basin and bounded on the east and northeast by mountains consist of basement rocks. Several tributaries flow from the mountains to the center of the basin and join the Ngao River. In this area, there are two drainage systems (Drainage systems A and B) (Figure 6-2).

The flat area between the exploration area and the Ngao town, within 10 km from the Ngao town, is utilized to a large-scale rice farming. In the hilly area including the exploration area, the irrigated area is used as a rice field and other area is utilized to the small-scale farming field of corn, cotton, upland rice and oranges (Photo 6-1). There is an irrigation dam (a earth-fill-type dam) to the northeast of

the exploration area and irrigation channels are cut toward the rice field (Photo 6-2, 6-3). Some of them are running in the proposed mining area and must be changed their routes in the case of an open cut mining (Photo 6-4).

Watershed Classification in this area is shown in Figure 6-3. This area belongs to Class-4 or Class-5 in which mining activities can be processed (the development of the mine in Class-1A is needed the approval of the cabinet.). As shown in Figure 6-4, mountainous area is classified as the forest preservation under the Forest Act. However, almost of the proposed mining area is classified as commercial forest in which economic and agricultural activities can be processed under individual permission.

The proposed mining area is located in Ban Haeng district, of which population and households were reported 7,055 peoples and 1,729 families in 1999. Ban Haeng district consists of ten villages and its main industry is agriculture (Photo 6-5). According to the current mining plan, the proposed mining area is planned more than 1.5 km apart from the Ban Haeng Nua village. However, the environmental study and monitoring on noise and water pollution occurred from the mining activities will be conducted. One cultivating village of mountainous tribe exists near the planned pit so that the village may be considered to move if the development activities affect it.

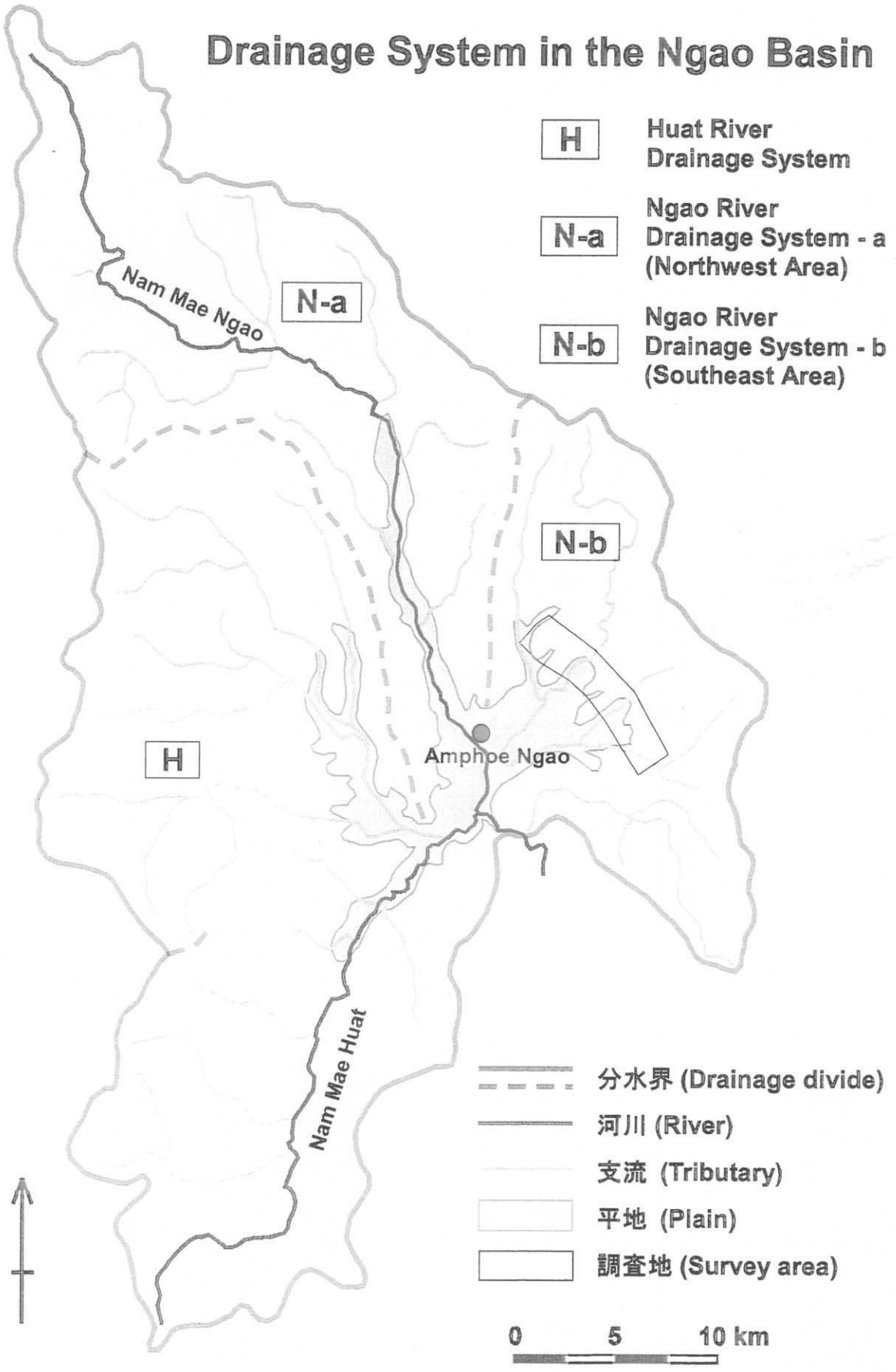

Drainage System in the Ngao Basin
H
Huat River
Drainage System
N-a
Ngao River
Drainage System - a
(Northwest Area)
N-b
Ngao River
Drainage System - b
(Southeast Area)
Nam Mae Ngao
N-a
N-b
H
Amphoe Ngao
Nam Mae Huat
分水界 (Drainage divide)
河川 (River)
支流 (Tributary)
平地 (Plain)
調査地 (Survey area)
0
5
10 km

Figure6－1

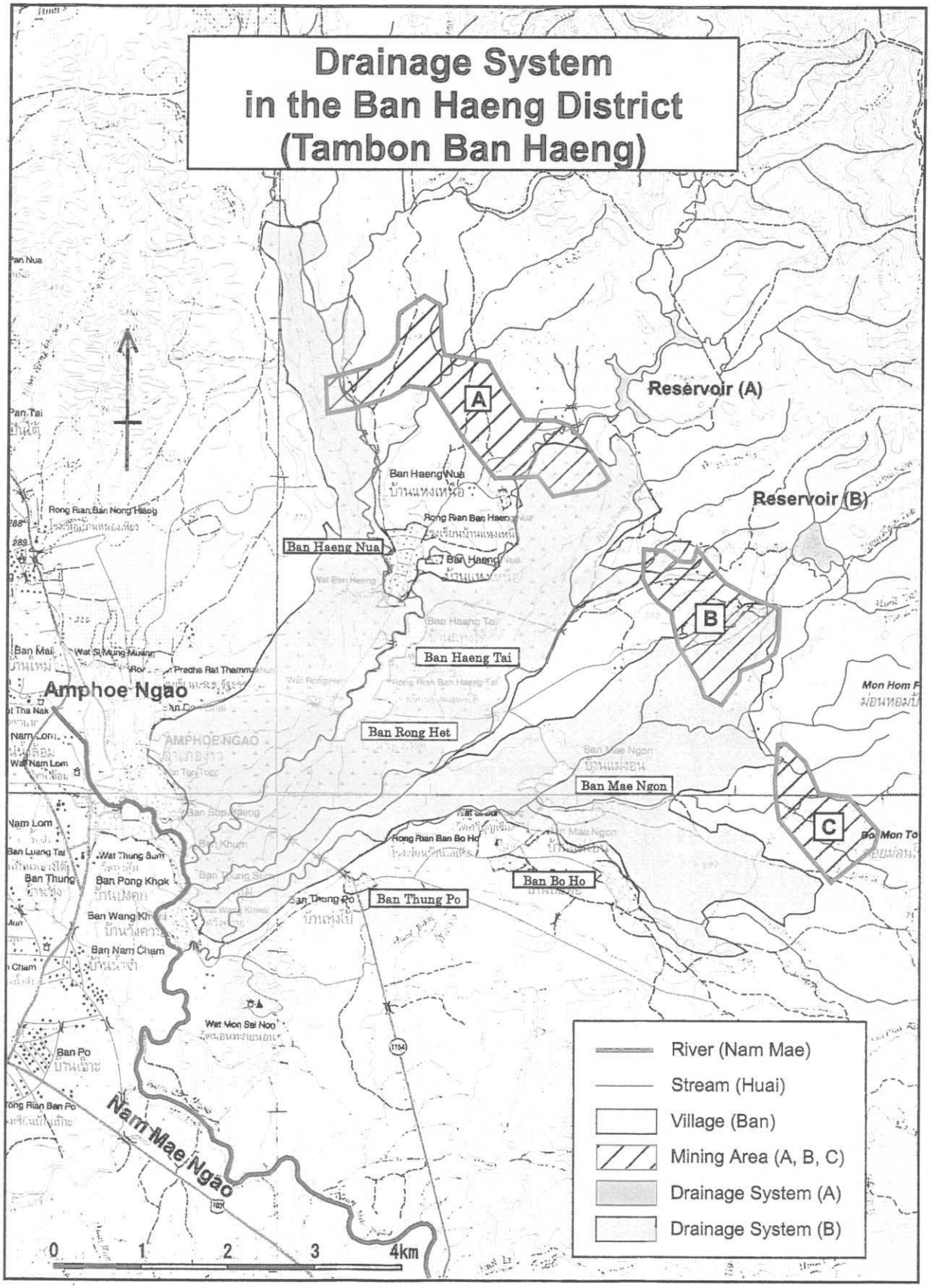

Drainage System
in the Ban Haeng District
(Tambon Ban Haeng)
A
B
C
Reservoir (A)
Reservoir (B)
Ban Haeng Nua
Ban Haeng Tai
Ban Rong Het
Ban Mae Ngon
Ban Bo Ho
Ban Thung Po
Amphoe Ngao
Nam Mae Ngao
Wat Mon Sai Noo
Ban Pong Khok
Ban Nam Cham
Ban Po
River (Nam Mae)
Stream (Huai)
Village (Ban)
Mining Area (A, B, C)
Drainage System (A)
Drainage System (B)
0
1
2
3
4km

Figure6－2