

## **3.2 IEE for the Alternative Route Recommended by JICA Study Team**

The diversion route proposed by JICA Study Team is shown on Figure 3.2.1.

### **3.2.1 Aquatic Ecology**

#### **3.2.1.1 Method of Aquatic ecology**

##### **(1) Site inspection**

From September 19 to October 6 1996, the site inspection was carried out as follows :

Sep. 19 to Sep. 22      Chiang Rai Diversion Weir, Yao River, Nong Luang, Doi Basa,  
Nong Nontakai, Nong Bong Kai, Sokok, Kok River,

Sep. 23 to Sep. 29      Kwan Phayao, Kok River, Kok Diversion Weir, That Chong  
Cho, Phusan Waterfall,  
Huaisuk Reservoir, Ing River, Mepuu Reservoir, Nong Leng Sai

Sep. 30 to Oct. 6      Ban Nongnian Reservoir, Ban Huai Luang, Nan River, Lao  
River, Phra That Chae Heng,  
Ban Wat Phrra, Thart Khao Noi, Sai Khao Swamp, Nan Tuan  
Reservoir, Huai Hat Reservoir, Maung Tud Swamp, King  
Amphoe Song Khae, Amphoe Pua, Amphoe Tha Wang Pha,  
Ban Don Kaeng, Ban Sop Nang, Ban Don Tan, Shirikhit Dam,  
Ban Raum Jit,  
Ban Samachik Pha Thi

##### **(2) Data collection and Interview**

Fishery statistical data and information were obtained at the followings;

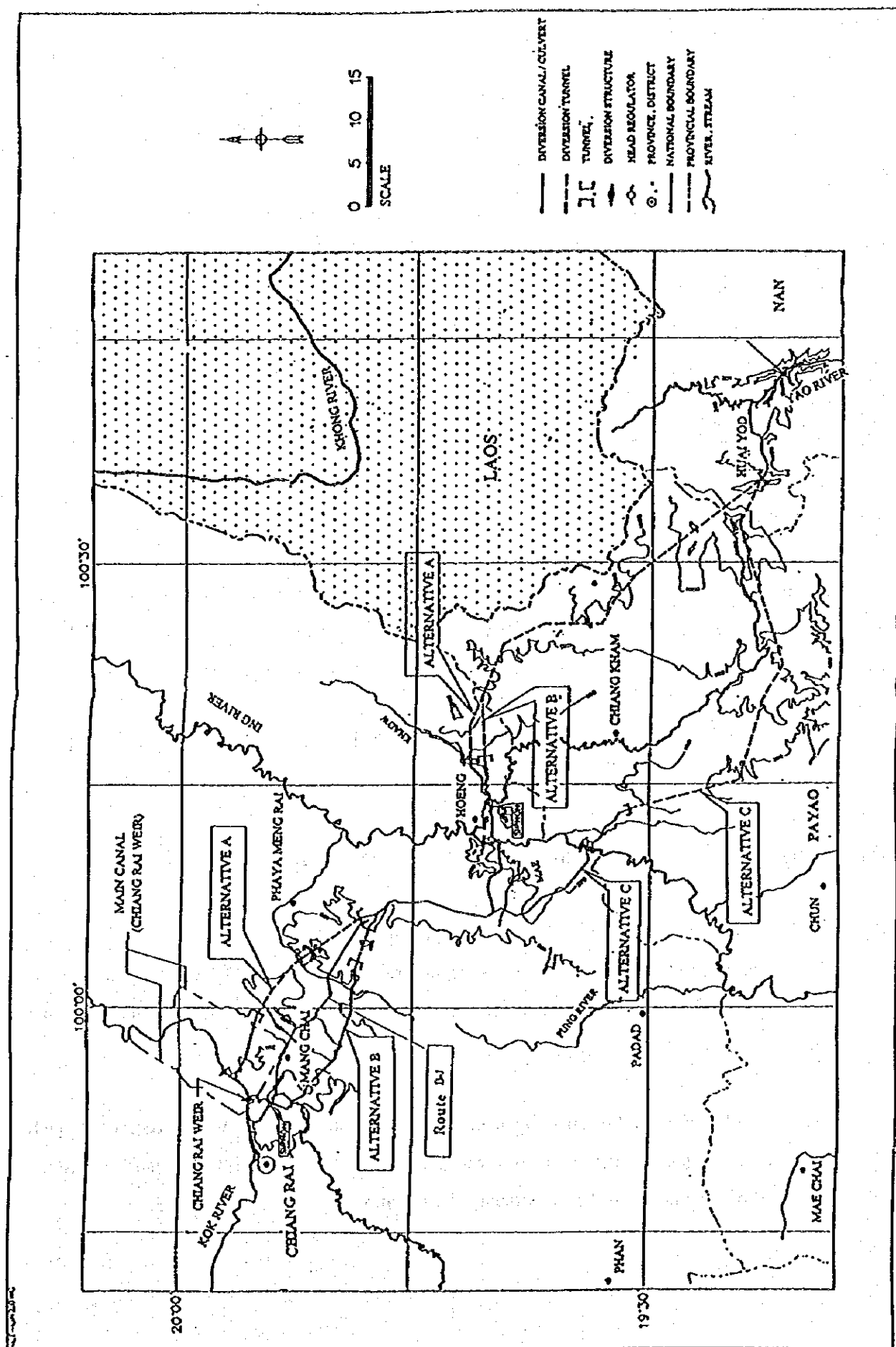
DOF Bangkok Central Office  
DOF Chiang Rai Provincial Office  
DOF Phayao Provincial Office  
DOF Nan Provincial Office

Aquaculture statistical data and information were obtained at the followings;

Chiang Rai Fisheries Experimental Station

## Phayao Fisheries Experimental Station

Interview and discussion about the fishery condition and aquatic ecology were carried out at the above offices.



### 3.2.1.2 Surface water quality

Results of the survey by TEAM J / V and the present trip survey in the project site revealed that the environmental impacts on the water quality and bottom sediment are quite low in terms of aquatic organisms.

The sediment may increase due to the soil dredging during the construction of the open canal, tunnels and dams, but the impacts will be prevented or minimized by improving the construction method and introducing suitable machinery and equipment.

Based on the water diversion plan of the project, the fluctuating of water level after the construction be lower than the seasonal difference in water level between dry and rainy seasons. Furthermore, it is well known that the inflow of silt and acid soil from the land area are caused by the improper land use and / or deforestation.

### 3.2.1.3 Aquatic ecology / Fisheries

The biological resources, especially the abundance and distribution of fishery resources, will eventually decrease or change due to intake of water from Kok and Ing rivers, the water of which will be conveyed through several facilities such as canal, tunnel, etc. to the regulating dam, finally into the Nam river.

However, the impacts on the biological resources will be low after implementing the project, judging from the following reasons.

- (1) Change of flow volume by the diversion plan be lower than present seasonal change.
- (2) Pulling fish into the open canal and tunnel will be a small part of population.  
As majority of the fish population possess the swimming ability against the current, the intake of fish into the facility can be prevented by settling the stagnant space in front of the entrance of the facility.
- (3) Oxygen depletion will not occur in the tunnel because the atmospheric gas can penetrate through the surface of running water as far as slight movement of air exists inside the tunnel, where the oxygen supply be maintained even without solar radiation.

- (4) Significant decrease water temperature will not occur because the inside of the tunnel is surely connected to the outside and because ground water temperature is almost the same as the average atmospheric temperature in the region.

It is noticeable that the impacts on the fishery of capture fishing and aquaculture will be negligible while local industries will be surely accelerated judging from the following reasons:

- (1) Water level fluctuation by the change of flow volume will be smaller than natural seasonal change between the dry and rainy season. It is noted that there are many small scale fish ponds, where the water be utilized from the inundation of the main river.
- (2) Fish population can change their habitat by migrating to suitable environment for them. The fish biomass in the river is only 3 to 7 kg / ha, while that is 2,800 kg / ha in the water body where aquaculture is popular in the regions according to the provincial data and TEAM J / V report.
- (3) Abundance of fish population pulled into the facility will be one third of the total fish biomass at most based on the planning diversion volume from the upper streams. This degree of reduction of biomass can be easily recovered shortly in more proper growing space such as swamp and ditch where they have constant inundation during rainy season to trap some quantity of water.

#### 3.2.1.4 IEE for aquatic ecology

The result of IEE for the surface water quality and the aquatic ecology/fisheries are shown on Tables 3.2.1.1 and 3.2.1.2.

Table 3.2.1.1 INITIAL ENVIRONMENT EXAMINATION: Surface water quality

	Environmental Impact from JICA's Proposed Route	Recommended Mitigation Plan	Magnitude of Impacts				Not Clear
			No Significant Effect	Significant effect			
				Small	Mode-rate	Major	
1 . Kok -diversion dam	<ul style="list-style-type: none"><li>- Water quality near the structure</li><li>- Communities located upstream</li><li>- Water use of communitie</li></ul>		X X X				
2 . Kok-Ing diversion canal	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>	<ul style="list-style-type: none"><li>- Careful soil dredging</li></ul>		X	X		
3 . Ing diversion dam	<ul style="list-style-type: none"><li>- Sediment accumulation on the bottom</li></ul>			X			
4. Ing diversion canal to Ing River Traing	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>	<ul style="list-style-type: none"><li>- Careful soil dredging</li></ul>		X	X		
5 . Ing River Training	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>	<ul style="list-style-type: none"><li>- Careful soil dredging</li></ul>		X	X		
6. Ing-Yod Tunnel	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>	<ul style="list-style-type: none"><li>- Careful soil dredging</li></ul>		X	X		
7. Flood control dam	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>	<ul style="list-style-type: none"><li>- Careful soil dredging</li></ul>		X	X		
8 Yao River Training	<ul style="list-style-type: none"><li>- Obstruction on the natural flow direction</li><li>- Sediments increase during construction period</li></ul>			X			

Table 3.2.1.2 INITIAL ENVIRONMENT EXAMINATION: Aquatic ecology / Fisheries

Environmental Impact from JICA's Proposed Route	Recommended Mitigation Plan	No Significant Effect	Magnitude of Impacts			Not Clear
			Small	Moderate	Major	
1. Kok-diversion dam						
2. Kok-ing diversion canal	<ul style="list-style-type: none"> <li>- Type and abundance of fish flow direction</li> <li>- Abundance of aquatic weed</li> <li>- Abundance of plankton and benthos</li> <li>- Fisheries</li> </ul>	X X X X				
3. Ing diversion dam	<ul style="list-style-type: none"> <li>- Type and abundance of fish flow direction</li> <li>- Abundance of aquatic weed</li> <li>- Abundance of plankton and benthos</li> <li>- Fisheries</li> </ul>	X X X X				
4. Ing diversion canal to Ing-Yod tunnel	<ul style="list-style-type: none"> <li>- Distribution of aquatic organisms</li> <li>- Change of aquatic ecological condition</li> </ul>	X X				
5. Ing River Training	<ul style="list-style-type: none"> <li>- Distribution of aquatic organisms</li> <li>- Change of aquatic ecological condition</li> </ul>		X	X		
6. Ing-Yod Tunnel	<ul style="list-style-type: none"> <li>- Distribution of aquatic organisms</li> <li>- Change of aquatic ecological condition</li> </ul>		X	X		
7. Flood control dam	<ul style="list-style-type: none"> <li>- Distribution of aquatic organisms</li> <li>- Change of aquatic ecological condition</li> </ul>		X	X		
8. Yao River Training	<ul style="list-style-type: none"> <li>- Distribution of aquatic organisms</li> <li>- Change of aquatic ecological condition</li> </ul>		X	X		

### 3.2.2 Forest Resources

#### 3.2.2.1 Forest resources along the JICA route

Forest resources along the diversion route are almost the same as those for Team J/V routes, except the route between Kok River and Ing River, shown at Table 3.1.2.1. However, the forest conditions are not so different from each other.

The national forest reserves along the diversion route are shown on Figures 3.2.2.1 and 3.2.2.2. The watershed classification is shown on Figures 3.2.2.3 and 3.2.2.4.

#### 3.2.2.2 Summary of the JICA route

The tunnel runs underground in the mountain/conservation areas mostly represented by National Forest Reserve (C)/National Park under establishment and designated as "Watershed Classification (1A)" as well. According to the regulation set up by OEPP, no development activities are allowed in the forest areas classified as Watershed Classification (1A). In association with the tunnel construction, tunnel shafts are planned to be located at seven places along the route. In order to avoid the environmental impact, the entrance, exit and all the inlet portions of shafts are located outside of the Watershed Classification (1A).

From the ecological viewpoints of forest conservation, any significantly adverse impacts of the tunnel construction on forest resources may not be expected. There exist some projects planned/implemented in the area designated as Watershed Classification (1A), one of which was that an underground headrace tunnel had been planned, in part, under the designated area (1A) for the "LAMTAKONG Hydroelectric Power Project".

However, the prior permission to proceed to the next study should be obtained through discussion/consultation among RID, RFD and OEPP. In addition, their joint site inspection is highly advised to be carried out at the earliest possible date to clarify the present situation of the inlet and the outlet portions of the tunnel and the shafts, focusing on the forest resources, the watershed conservation, the access road (reinstatement after the operation and/or proper protection measures to prevent illegal logging), impacts of portals on slope stability, social environment of the surrounding villages, etc..



### 3.2.2.3 IEE for JICA Route

The results of IEE for forest resources is shown on Table 3.2.2.1.

### 3.2.2.4 Recommendations for the Subsequent Study

In the tunnel construction, the major issues related to watershed conservation will be the behavior of the groundwater/the surface water which may affect, more or less, the vegetation and forest resources occurring on the surface above the tunnel/shafts. The longitudinal sections of the tunnel/shafts are shown on Database Map. From the watershed conservation aspects, the investigation items are provisionally listed as follows for the impacts likely induced by tunnel construction.

- 1 Clarification of boundary and area along the diversion route and its surroundings  
National Forest Reserves (including National Park under establishment)  
Watershed Classification
- 2 Topographical and geological conditions of the watershed by tributary sub-basin
  - 2-1 Variation in ground elevation with surface slope along the tunnel route
  - 2-2 Transversal section of the mountain along the tunnel route (tunnel and shafts)
  - 2-3 Examination of topographical and geological conditions at the inlet and the outlet of tunnel and shafts from environmental/engineering viewpoints such as ground surface slope, vegetation, depth of overburden layer, stream/river flow conditions near the site
  - 2-4 Identification of fault zone
    - Groundwater variation in wet and dry seasons
    - Stream/river flows conditions in wet and dry seasons, if exists near the site.
  - 2-5 Farmland use ( grassland, field crops, paddy, fruit tree, etc.)
- 3 Forest and vegetation conditions in watershed along the tunnel route
  - Classification of the area by forest type, tree density, vegetation, etc.
  - Tree species and size
  - Principal vegetation in wet and dry seasons
- 4 Watershed management
  - Division of watershed based on watershed boundary
  - Area and landform in watershed

- Headwater conditions such as headwater type(stream/river), tributary density, stream and river gradient, etc.
- Discharge condition in wet and dry seasons
- Present utilization of stream and river flow (particularly water use by hilltribes)

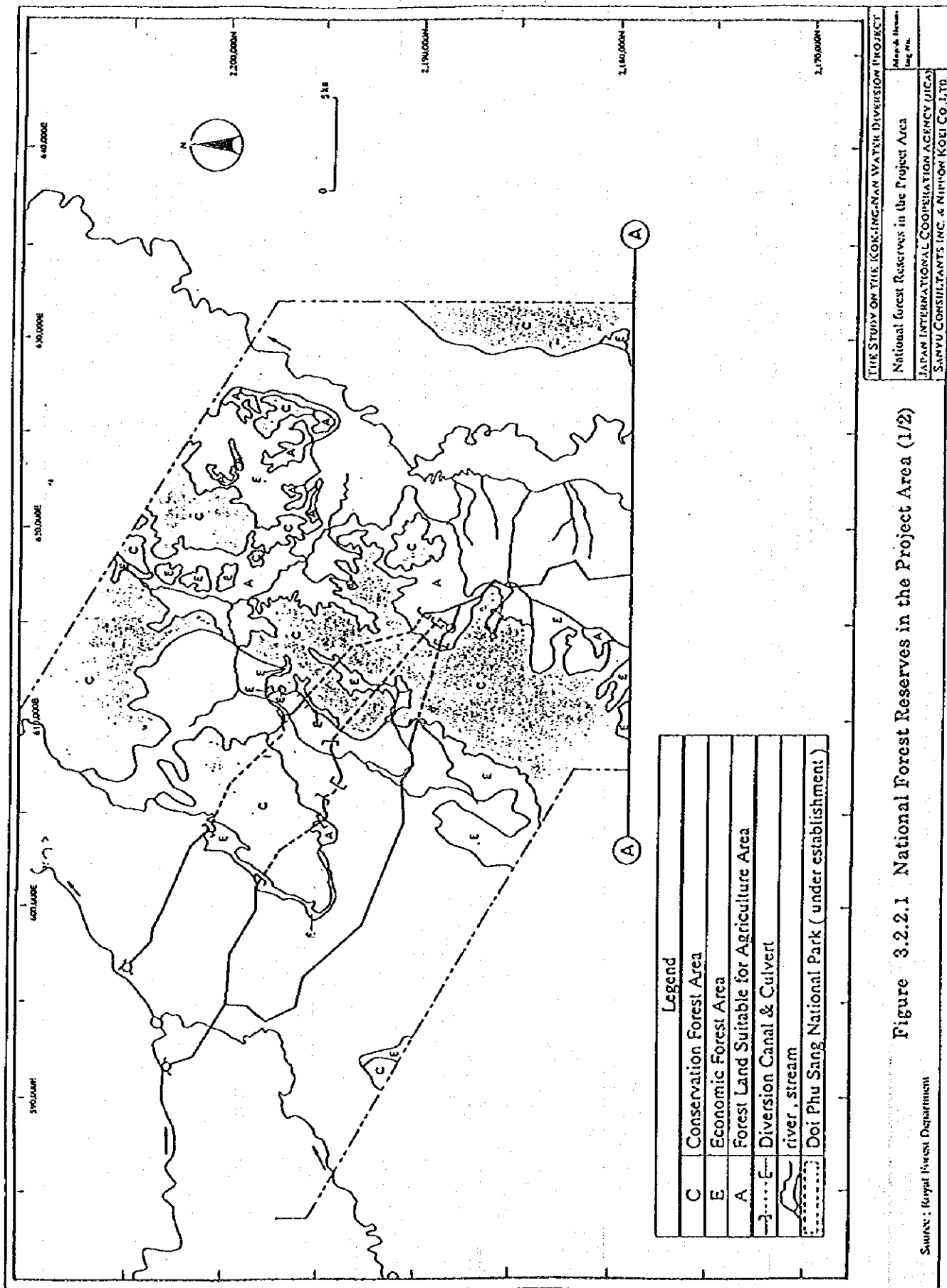
Social study focusing on water use in the watershed

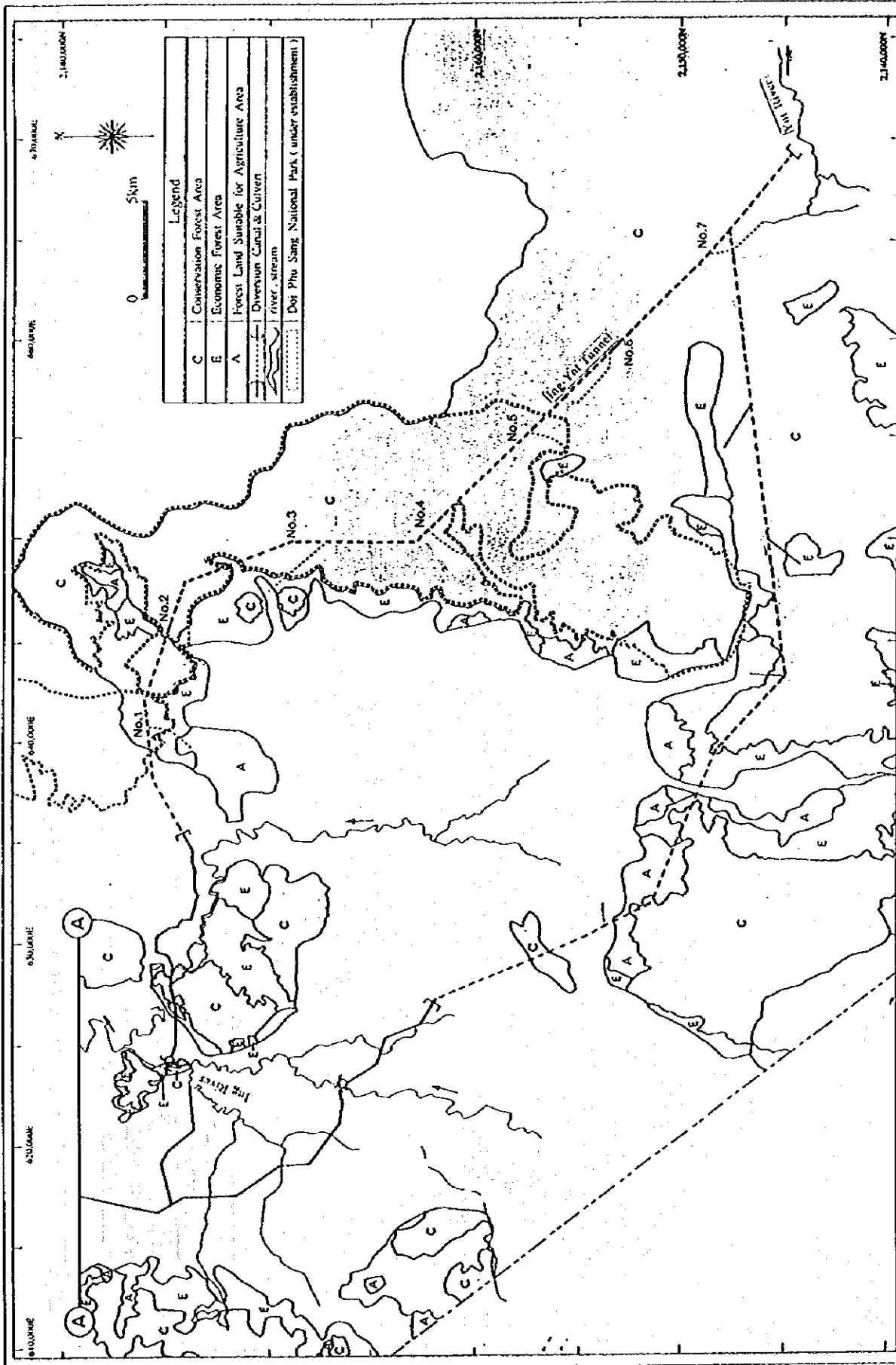
Quality and quantity of water from the viewpoint of public health

- Location of existing ponds and reservoirs
- Location of existing public/private facilities such as road, power line, villages, etc.

Table 3.2.2.1 INITIAL ENVIRONMENTAL EXAMINATION : Forest Resources

Environmental Impact from JICA's Proposed Route					Recommended Mitigation Plan	Magnitude of Impacts			Not Clear
Forest condition	Disturbance to the Forest Reserves	Disturbance of Watershed Class 1 areas	Disturbance to the National Park	No Significant Effect		Significant effect		Major -rate	
						Small	Mode		
1. Kok Diversion Dam	-no forest trees	-no impact	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization	X			
2. Kok - Ing Diversion Canal	-mainly agricultural areas -some degraded forest	-some part under Zone C	-some part under 1A	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization		X		
3. Ing Diversion Dam	-no forest trees - wetland occurs along the meandering	-no impact	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive program for forest conservation -comprehensive utilization		X		
4. Ing Diversion Canal to Ing - Yot Tunnel	-mainly agricultural areas -some degraded forest	-some part under Zone C -some part through Zone C	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization		X		
5. Ing River Training	-none forest	-no impact	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization	X			
6. Ing - Yot Tunnel	-mainly degraded forest -Hill Evergreen forest -some , deforested -some , agricultural areas	-most tunnel under Zone C -some shaft disturb Zone C	-most tunnel under 1A	-most tunnel under Doi Phu Sang N.P. ( under establishment )	-Careful Planning and Mitigation Measures -Comprehensive improvement / utilization -JEE for Phu Sang Waterfall's vegetation		X		X
7. Flood Control Dam	-mainly degraded forest	-in the boundary Zone C	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization			X	
8. Yao River Training	-few trees	-no impact	-no impact	-no impact	-Careful Planning and Mitigation Measures -Comprehensive utilization		X		





THE STUDY ON THE KUMINGAN WATER DIVERSION PROJECT		
NATIONAL FOREST RESERVES IN THE PROJECT AREA (2/2)		
Map & Draw	Fig. No.	Figure 3-4
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)		
SANWU CONSULTANTS INC. & NIPTON KAME CO. LTD.		

Figure 3.2.2.4 Watershed Classification in the Project Area (2/2)

Source: Royal Forest Department



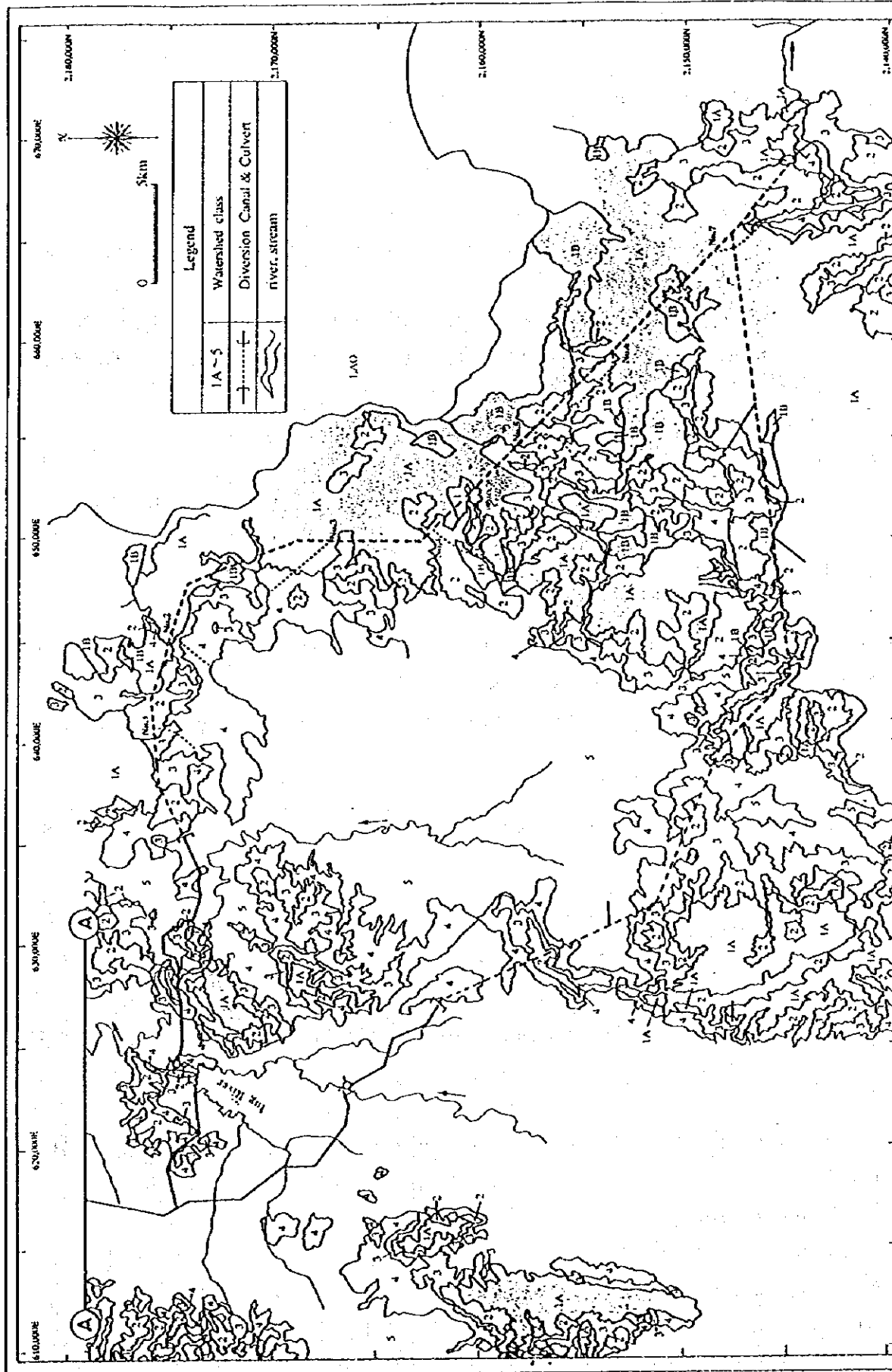


Figure 3.2.2.2 National Forest Reserves in the Project Area (2/2)

THE STUDY ON THE KOK-ING-NAN WATER DIVERSION PROJECT	
WATERSHED CLASSIFICATION IN THE PROJECT AREA (2/2)	Map & Data
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	Map No.
SANSHU CONSULTANTS INC. & NIPPON KORI CO., LTD.	Page 1-10

Source : Office of Environmental Policy and Planning

### 3.2.3 Wildlife

#### 3.2.3.1 Methodology on Wildlife

Data on wildlife were collected by the following method.

- 1) Observation by field survey: 15 September ~ 4 October 1996 in Chiang Rai to Phisanulok
- 2) Hearing with local people
- 3) Collection of information at the local offices of RID and RFD (Chiang Rai, Phayao, Nan)
- 4) Collection of data at national park (Phu Sang ) and wildlife sanctuary (Doi Pha Chan) offices
- 5) Reference of data from IEE Report of TEAM J/V.
- 6) Collection of materials from RID, RFD, and DLD in Bangkok.
- 7) Collection of materials at Kasetsart University and Mahidol University in Bangkok

The IEE Report 5) above was prepared in the following manner.

Data on all types of wildlife collected either by indirect survey or direct sample plot are recorded by wildlife type. Wildlife was divided into 4 groups as reptile, amphibian, bird, and mammal. Each group is characterized by density and status. In case of bird, migration and living characteristic are taken into account.

Wildlife density of each type is classified into high, intermediate and low by applying the following equation.

$$\% \text{ density} = \frac{\text{Number of found animal} \times 100}{\text{Number of survey time}}$$

The derived percentages are classified into 67 - 100 % (high), 34 - 66 % (intermediate) and 1 - 33 % (low).

Status of wildlife are classified into 4 groups following the concept of Humphrey and Bain (1990) as:

- 1) To become extinct,
- 2) To be threatened,
- 3) Rare, and
- 4) Uncertain.

An evaluation by the JICA Study Team was carried out incorporating the following aspects.



- 1) Loss of food source, water source, breeding source, and hiding location
- 2) Disturbance on wildlife route
- 3) Wildlife diversification

### 3.2.3.2 Wildlife Condition in Project Area

The living condition of wildlife found along the alternative routes is summarized in Table 3.2.3.1.

**Table. 3.2.3.1 Wildlife Habitat in Project Area**

Area	Condition
<u>Kok-Ing Area</u> Diversion Canal / Culvert	<u>Background</u> Most plain area. Few sections are slope area Mountain covered with dry dipterocarp forest and cultivation area. Low land covered with grass or small swamp during wet season. <u>Wildlife</u> 4 groups of wildlife (amphibian, reptile, birds and mammal) were found. Most wildlife living in the project area are small and capable to adapt themselves to the disturbance, agricultural and village community area. Majority of them are birds which earn their living on open land such as rice field Big size mammal, Siamese hare ( <i>Alps sequences</i> ) and Common civet ( <i>Paradxurus hermaphroditus</i> ) were found.
The Tunnel Inlet / Outlet	<u>Background</u> Crop cultivation, mostly corn. During dry season, abandoned area is covered with dense weed. Some part remain as mixed deciduous forest. Bamboos are found anywhere. <u>Wildlife</u> 4 groups of wildlife were found. Most wildlife were small size wildlife. Big size mammal: Large Indian civet ( <i>Viverra zibetta</i> ). Bird: Red jungle fowl ( <i>Gallus gallus</i> ), White-rumped shama ( <i>Copsychus malabaricus</i> ), Greater racket tailed drongo ( <i>Dicrurus paradisens</i> ).
<u>Ing-Nan Area</u> Diversion Canal / Culvert	<u>Background</u> Crop cultivation, mostly corn. <u>Wildlife</u> Only small size wildlife
Tunnel Inlet	<u>Background</u> Cropping after crop cultivation, area are left with weeds. <u>Wildlife</u> Small size wildlife with active movement, (bird, rat, lizard, snake) Big mammal; Large Indian Civet ( <i>Viverra zibetha</i> )
Tunnel Outlets	<u>Background</u> Most area is cultivation area. Some parts are fruit orchard area.

	<u>Wildlife</u> A few small size wildlife are found.
Around Vertical Shafts	<u>Background</u> The area was grubbed for cropping with no forest community. Some areas are lychee orchard. <u>Wildlife</u> A few and small size wildlife were found. Medium size mammals; Common barking deer ( <i>Mutiacus muntjak</i> ) Common wild pig. ( <i>Susscrofa</i> )

Agricultural area is mostly rainfed rice fields. Farmers in many areas burn paddy stubbles in dry season, which affects the living area of wildlife and disturbs the ecological system. Survivors are small size wildlife with active movement such as bird, rat, lizard, snake, and some kind of frog.

The diversion tunnel of the Ing-Nan area will go underneath the steep mountain covered with forest community such as mixed deciduous forest. This area has been proposed as the area for Phu Sang National Park in the draft Decree. This area is a valuable place for wildlife living there. The proposed national park will save the wildlife disturbed. Middle size wildlife like deer and wild pig already escaped to forest area in national parks.

### 3.2.3.3 IEE for JICA route

The results of IEE for the wildlife are shown on Table 3.2.3.2, based on the following impacts on wildlife environment.

#### a. Loss of Breeding Source and hiding location

The change in wildlife environment due to the canal construction would be small. Wildlife to be directly influenced would be small ones except birds. Small wildlife has the ability to adapt to changes in the environment. Birds are able to escape from the range of the influence of construction due to their high mobility. Rice field, forest, and marsh belt extending around canal area would serve as breeding source and hiding location for birds.

#### b. Disturbance on food source

Decrease in wild animal's food source due to the canal construction would be small.

The area to be affected by the canal construction is small compared with the agricultural area extending in the project area. Decrease in the food source for small animals would be limited because they are able to depend on grains in the field. Decrease in wetland which is a

food source for the waterfowl would be small. Surface water area of wetland would increase due to the construction of water canal.

c. Disturbance on Wildlife Route

There will be few negative impacts on wildlife route due to the division of areas by the project facilities, because action radius of small animals is short and recovered vegetation after construction would provide them with an appropriate environment.

d. Wildlife diversification

The majority of wildlife would return after the water canal construction is over. The diversity of wildlife in the construction area would decrease. The diversity of wildlife in the whole area, however, would remain almost unchanged since the areas to be affected by canal construction will be limited to narrow strips of land area.

Table 3.2.3.2 INITIAL ENVIRONMENT EXAMINATION: Wildlife Environment

	Environmental Impact from JICA's Proposed Route	Recommended Mitigation Plan	Magnitude of Impacts			
			No Significant Effect	Significant Effect	Not Clear	
					Small	Major
					Rate	
1. Kok - ING - Diversion Canal/Culvert	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversity	1. To preserve the present environment around the diversion route. 2. To designate the wetlands as non-hunting area		X		
2. ING-NAN - Diversion Canal	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversification	1. To preserve the present environment around the diversion route. 2. To plant trees along the bank of the diversion canal.		X		
3. ING- NAN - Tunnel Inlet and Outlet	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversification	1. To restore the environmental deterioration caused by the tunnel construction. 2. To minimize the disturbance of the wildlife route. 3. To provide temporary nests for homeless birds during construction period.		X		
4. ING - NAN - Tunnel Shafts	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversification	1. To restore the environment deterioration caused by the tunnel construction. 2. To minimize the disturbance of wildlife route. 3. To minimize the effect of traffic-noise on wildlife. 4. To provide temporary nests for homeless birds during construction period.		X		
5. Flood Control Dam ( Yot , Yao , Nan )	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversification			X		
6. Yao River Training	1. Losing Bleeding Source and hiding location 2. Disturbance on Food Source 3. Disturbance on Wildlife Route 4. Wildlife diversification			X		

### **3.2.4 Social Environment**

This section describes adverse and positive impacts of implementing the water diversion project. The analysis is divided into two main aspects: economic and social impacts. In addition, an overview of impacts is presented for each of the four alternatives of the project.

#### **(1) Objectives**

The objective of the study is to investigate the impacts of the proposed Kok-Ing-Nan water diversion project on socio-economic conditions in the project area, particularly during construction and operation.

#### **(2) Methodology**

The IEE stage of the study was conducted mainly by gathering statistical data and performing a site survey. The study also considers socio-economic conditions which are expected to change by implementing the project.

#### **(3) Scope of the study**

The socio-economic study covers four alternative plans for water diversion: A, B, C, and the JICA proposed route. Topics for environmental examination have been selected based on JICA guidelines. They include: Compensation and Resettlement, Economic Activities, Transportation, Aesthetic Considerations and Tourism, Archaeological and Historical aspects, and Construction and Operation impacts such as noise and vibration.

### 3.2.4.1 Resettlement and Compensation

#### (1) Introduction

When projects require the acquisition of land or the extraction of resources (e.g., water, minerals, timber, etc.) from territories, people affected should be compensated in kind or in cash at replacement value for the expropriated assets.

Development projects sometimes require the involuntary resettlement of people from areas where they live and work to other locations. Such relocation causes profound economic and cultural disruption to the individuals affected as well as to the social fabric of local communities. Adequate policy and supportive implementation actions are necessary to minimize or reverse the negative effects of compulsory relocation on individuals and on the national economy.

Development policy should avoid or minimize involuntary resettlement because of the social and economic disruption it causes. When forced resettlement is unavoidable and fully justified, development policy should require that a resettlement plan be formulated and financed to ensure that the people displaced are provided opportunities to improve, or at least restore, the standard of living they had before project implementation.

#### (2) Methodology

This study for resettlement and compensation was conducted based on a site survey and a map reading (1/50,000 scale). Basic standards used for estimating the compensation costs of an affected area are follows:

1. Affected area of diversion canal is calculated assuming a right of way of 300 meters.
2. Affected area of conduit is calculated assuming a right of way of 200 meters.
3. Affected area of river dredging is a 100 meter right-of-way.
4. Tunnel has no affected area<sup>1</sup>.

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<sup>1</sup> Tunnel and tunnel shaft portion will be built largely through a National Park. Thus these areas are excluded from the objective of compensation.

### (3) Amounts of land required<sup>2</sup>

The Kok-Ing-Nan water diversion project as planned features a total construction length of approximately 170 kilometers including the tunnel portion and Yao river training. Preliminary estimates suggest that this will require approximately 10,000 rai of land to be acquired for the construction of this project. This amount of land includes that required to construct a regulating dyke at the Ing River, a regulating dam at the Yot River and a river training at the Yao River as well as a tunnel and tunnel shaft portion.

### (4) Type of land involved

#### Kok - Ing Diversion Canal:

The Kok alluvial plain is lying along the Kok river basin with five to seven km. width from the Kok river to mountains or low hill area. The Diversion Canal route is planned to cross this alluvial plain. The Diversion Canal route, as presently planned, is largely comprised of paddy fields, forests, and Orchard fields. Some marshy ground and swamp on the upper stream of the Sakoen river are found in this area. The typical one is Nong Luang marsh. The mountain are lying between the Kok and Ing alluvial plain along the Tak river. Mountain consists of the West and East one. The west mountains consists mostly of lower mountain with elevation of less than 500 meter, while the east one with 500 to 650 meter.

#### Ing Diversion canal to Ing Yot tunnel:

The alluvial plain of the Ing river has a width of 9 km to 11 km. There are small mountains with the elevation of 500 m near the Ing diversion dam. Along the river Lao which is tributary of the Ing river, a wide Chiang Kham basin is formed. There are existing a number of low hills and small mountain between Chiang Kham and Ing alluvial plain. There are high and steep mountain ranges stretching from north to south along the border of Laos. There are also formed low hills and small mountain of ground height 500 m to 600 m on the northern part and the southern part around the Chiang Kham basin.

#### Yao river basin:

This mountain area has an accordance of summit level with ground height of 500 m to 600 m and there are many tributaries distributed dense cutting mountain.

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<sup>2</sup> In planning terms required land refers to that which the project intends to acquire.

(5) Numbers of land users involved and resettlement<sup>3</sup>

Table 3.2.4.1-1 below presents overall estimates of the land and housing requirements of the project and the number of people likely to be affected by the process.

Table 3.2.4.1-1 Overall land and housing required and the number of people affected

Alternative A

Section	Land required (rai)	Affected population		
		By requiring land	By requiring housing	Total
Total	9,975	1,284	332	1,616

\*\* 1 rai = 1,600 square meters

Alternative B

Section	Land required (rai)	Affected population		
		By requiring land	By requiring housing	Total
Total	11,937	2,472	312	2,784

Alternative C

Section	Land required (rai)	Affected population		
		By requiring land	By requiring housing	Total
Total	12,358	2,512	312	2,824

JICA proposed route

Section	Land required (rai)	Affected population		
		By requiring land	By requiring housing	Total
Total	8,997	2,190	312	2,502

(6) Affected province/county and area

The below table presents the estimated affected province/county and area.

<sup>3</sup> In this calculation, the river training at Yao river is not included.



Alternative A

<u>Administrative county / subdistrict</u>		<u>Affected area (rai)</u>
Amphoe	Tambon	
<u>Wiangchai</u>		
	Wiangnua	1,041
	Muangchum	825
	Phangam	293
Amphoe	Tambon	
<u>Phayamengrai</u>		
	Maiya	2,220
<u>Thoeng</u>		
	Ngiu	2,444
<u>Subtotal, Kok-Ing</u>		<u>6,823</u>
<u>Thoeng</u>		
	Wiang	2,090
	Ngao	830
<u>Subtotal, Ing-Yot</u>		<u>2,920</u>
<u>King Amphoe Song Khwae</u>		232
<u>Total</u>		<u>9,975</u>

Alternative B

<u>Administrative county/subdistrict</u>		<u>Affected area (rai)</u>
Amphoe	Tambon	
<u>Muang</u>		
	Robwieng	701
<u>Wiangchai</u>		
	Wiangchai	2,011
	Donsila	1,476
<u>Phayamengrai</u>		
	Maiya	2,109
<u>Thoeng</u>		
	Ngiu	2,444
<u>Sub-total, Kok-Ing</u>		<u>8,741</u>
<u>Thoeng</u>		
	Wiang	2,090

	Ngao	874
<u>Subtotal, Ing-Yot</u>		<u>2,964</u>
<u>King Amphoe Song Khwae</u>		232
<b>Total</b>		<b>11,937</b>

Alternative C

<u>Amphoe</u>	Tambon	
<u>Muang</u>		
	Robwieng	1,001
<u>Wiangchai</u>		
	Wiangchai	2,011
	Donsila	1,476
<u>Phayamengrai</u>		
	Maiya	2,109
<u>Thoeng</u>		
	Ngiu	1,091
	Plong	600
	Nong-raet	1,538
<u>Subtotal, Kok-Ing</u>		<u>9,526</u>
<u>Chiengkum</u>		
	Angthong	2,600
<u>Subtotal, Ing-Yot</u>		<u>2,600</u>
<u>King Amphoe Song Khwae</u>		232
<b>Total</b>		<b>12,358</b>

JICA proposed route

<u>Amphoe</u>	Tambon	
<u>Muang</u>		
	Robwieng	701
<u>Wiangchai</u>		
	Wiangchai	3,500
	Muangchum	1,200
	Pha-ngam	400
<u>Sub-total, Kok-Ing</u>		<u>5,801</u>
<u>Thoeng</u>		

Wiang	2,090
Ngao	874
<u>Subtotal, Ing-Yot</u>	<u>2,964</u>
<u>King Amphoe Song Khwae</u>	232
<b>Total</b>	<b>8,997</b>

#### (7) Compensation Costs

Table 3.2.4.1-2 shows the cost estimate for building and tree crop compensation for each route.  
Table 3.2.4.1-3 shows compensation costs for each alternative diversion route.

**Table 3.2.4.1-2. Estimate of buildings and tree crops compensation<sup>5</sup>**

Alternative Route	Compensation Cost (Million Baht)				
	Kok-Ing	Ing-Yot	Flood control dam	Yot-Nan	Total
<u>Housing<sup>6</sup> Compensation cost</u>					
Alternative A	7.2	-	-	-	7.2
Alternative B	-	-	-	-	-
Alternative C	-	-	-	-	-
JICA proposed route	-	-	-	-	-
<u>Tree crops compensation cost<sup>7</sup></u>					
Alternative A	20.47	4.62			25.09
Alternative B	26.22	4.75			30.97
Alternative C	28.58	3.66			32.24
JICA proposed route	21.10	3.55	5.75	2.1	32.5

Note: Alternative A,B, and C does not consider the affect by the river training.

Compensation costs for each alternative diversion route are summarized as follows.

<sup>5</sup> Contingency 20%

<sup>6</sup> There are about 20 houses found in diversion route A on Ban San Salit Tambon Wiangua Amphoe Wiangchai Changwat Chiangrai.

<sup>7</sup> Rate for tree crops compensation = 2,500 Baht/rai (under an assumption that the affected area is all paddy field)

Table 3.2.4.1-3 Compensation Cost of each route

Alternative Routes	Compensation Cost (Million Baht) <sup>8</sup>			
	Land	Buildings	Tree Crops	Total
<u>Kok-Ing</u>				
Alternative A	732.40	7.2	20.47	760.07
Alternative B	1,234.10	-	26.22	1,260.32
Alternative C	1,253.33	-	28.58	1,281.91
JICA proposed route	886.00	-	26.22	912.30
<u>Ing-Yot</u>				
Alternative A	66.25	-	4.62	70.87
Alternative B	68.92	-	4.75	73.67
Alternative C	29.25	-	3.66	32.91
JICA proposed route	68.92	-	4.75	73.67

#### (8) Resettlement

Involuntary resettlement is one of the most difficult and controversial aspects of development project planning. Resettlement issues range from large-scale displacement to relatively smaller-scale involuntary movement of population. For this project, each route has been planned principally to avoid villages. However, there is the possibility for resettlement at the following area. (The detail of flood control dam and river training at Yao river is not clarified at present. Thus, the following figure is showing the worst case.)

<sup>8</sup> Yot-Nan portion is excluded from the calculation because the official price of the land could not be obtained.

Alternative route	Number of resettlements	Place
Alternative A	20 households	There are about 20 households on Ban San Salit Tambon Wiangnua Amphoe Wiangchai, Changwat Chiangrai.
	312 households	Yot flood control dam Ban Huai Lao, Ban Wang Sao, Ban Sop Phang, Ban Pang Kom, Ban Nam Pan
	1,662 households	Yao river training 13 villages( Song Khwae, Mai Song Khwae, Hang Thung, Pak Puk, Nam Mong, Pang Sa, Wang Phang, Haen Tut Wang Hid, Na Nun, Pu Kha, Sop Yao)
	<b>Total</b>	<b>1,994 household</b>
Alternative B, C & JICA route	312 households	Yot flood control dam Ban Huai Lao, Ban Wang Sao, Ban Sop Phang, Ban Pang Kom, Ban Nam Pan
	1,662 households	Yao river training 13 villages (Song Khwae, Mai Song Khwae, Hang Thung, Pak Puk, Nam Mong, Pang Sa, Wang Phang, Haen, Tut Wang Hid, Na Num, Pu Kha, Sop Yao)
	<b>Total</b>	<b>1,974 households</b>

Approximately 2,000 households, 8,000 peoples, are supposed to resettle involuntarily if project would implement. This figure is so large even though the worst case is considered. If the scale of resettlement is minimized to zero or something, the implementaion of project should not implement from the point of human rights etc.

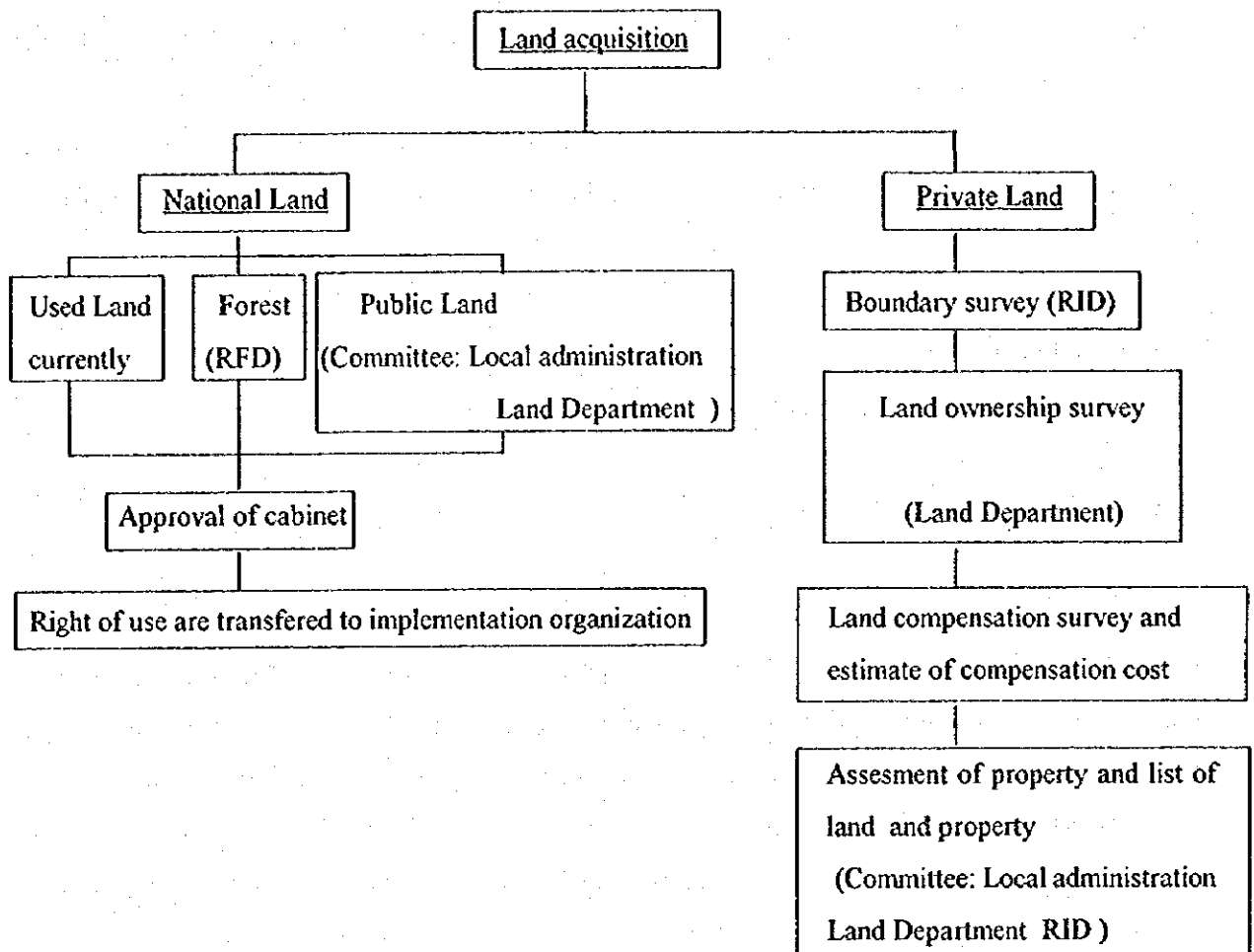
## **(9) Procedures used**

The land acquisition procedure adopted will conform to the laws and practices enshrined in the Law of Thailand as well as all applicable provincial regulations. There may also be local by-laws made by the relevant prefectures, cities, and counties based on the above-mentioned laws and stipulations. The RID are fully acquainted with these laws and obligations. The following general principles are mentioned in this legal framework.

1. Reducing the amount of required land and the affected people to a minimum without jeopardizing project quality.
2. Minimizing the amount of cultivated farmland and urban land acquired.
3. Maintaining the living conditions of the affected people.
4. Paying prompt compensation to all concerned.
5. Using the opportunity of land acquisition to improve the social and economic conditions of the affected peoples.
6. Ensuring that any grievance of the affected peoples are dealt with and that any acceptable problems they encounter are solved.

In case a portion of the project must be located on areas presently occupied by people, compensation must be undertaken. The below chart shows the process of land acquisition determined by the Cabinet in 1957

Chart 1. Process of Land Acquisition



A compensation committee shall be established under MOAC's regulation, in which its responsibility is to survey those properties to be inundated/removed, conduct negotiations, determine proper compensation amounts for each property, and finally make the payment.

Generally, compensation items can be categorized as:

1. Structures (housing, shelter, etc.)
2. Trees/Crops (Type and age are also considered)
3. Land (Privately owned with legal note or public land e.g: forest land)

In former days, only the land with legal occupants could be compensated. However today, for humanitarian reasons, the farmers who occupy public land utilized for cultivation without legal note, shall also obtain payment, under the title "removing cost", but at a smaller amount than given to proper land owners.

As such, the committee can and shall establish a working group to conduct a detailed survey of the properties. Although RID establishes compensation guidelines and general standard amounts to be paid for properties, actual payment shall be determined under negotiation with the affected people by the afore-mentioned committee.

The committee shall be chaired by the concerned provincial governor and the RID official shall be committee secretary. The members shall be comprised of representatives of the following concerned local bodies:

- Provincial Forestry
- Land Department
- Local Administration (district chief)

#### **(10) IEE for each alternative route**

Based on the process described above, the JICA proposed route is better than the other alternatives in terms of the amount of land required and the affected population at present. However, even if which routes are selected, the number of involuntary resettlement at Yao river training is very large according to the outline of current river training plan. Land required is also large between Kok and Ing diversion canal route. Thus the implementation of project should be changed the route or the way of diversion water from the point of human rights and social environment. And the community system along the project route hold the long history and the rights of land or irrigation system are very complicated. It is very difficult to get their approval for changing or occupying their system. Therefore, the implementation of present project plan would bring about a hard objection from local people even if the PR activities start from the early stage.



### 3.2.4.2 Impacts From Construction

Impacts from the construction of the project can be controlled by good scheduling and coordination of activities, due consideration to the sentiments of local communities, observance of good erosion control measures and limitation of night-time activities.

#### Kok-Ing Diversion Canal section (Alternative A, B, C, and the JICA proposed route)

##### (1) Noise and vibration

The annoyance could be significant where construction activities occur for an extended period close to populated areas, such as in the area of Amphoe Thoeng because the project extends over a long distance and construction will continue for a long period. Vibration during construction activities may be caused by heavy truck transportation as well as pile-driving. Limiting truck speed and using vibro hammers should significantly reduce vibration from these sources. Relative noise levels of construction equipment are shown below.

#### EQUIPMENT USE SOUND POWER LEVELS

Equipment	Sound power Level Lwa dB	Activity Equivalent Continuous Sound Pressure Level Laen at 10 m.
Truck	112	85
Concrete pump	109	81
Concrete mixer	108	80
Pneumatic concrete breaker	120	92
Jack hammer	117	89
Tracked excavator	113	87
Dump truck	117	89
Compressor	109	81

Adverse impact of noise and vibration for people is considered to be especially large at alternative B. Alternative A and JICA proposed route is smaller adverse impact than alternative B since both route have a long tunnel than B.

## **(2) Drainage**

Proper precautions to secure natural water courses or drainage ways during the construction process should minimize problems related to drainage. Temporary retention of storm water may be necessary until permanent drainage structures are completed. Stockpiles of construction materials must be stabilized to prevent erosion and clogging of drainage channels.

## **(3) Erosion and Siltation**

Construction activities including land reclamation, grading, and excavation can generate large amounts of dust, while storm water run-off that passes through construction areas may cause sedimentation and turbidity in water quality, though possibly only for short periods. Mitigation measures should be designed and implemented to minimize the effect of construction activities on water quality, especially in the Kok and Ing Rivers.

## **(4) Hazard**

The construction industry has a long history of instituting good safety practices, and many of these safety programs are mandated by law. However, most regulations are oriented to the protection of construction personnel and equipment rather than other persons in the vicinity of construction activity. Because the project alignment is of a linear nature, it is difficult to secure it from all possible intrusions. Local residents will be tempted to walk or drive across or along the construction area including unstabilized earthworks, especially in the area of Nong Luang. And the open canal with deep excavation, depth of more than 10 m, is very dangerous for around people, in particular at route B. Construction should be phased in manageable sections and a program of patrolling, fencing, and warning should be instituted to prevent this behavior. Local residents should be warned of these restrictions and potential dangers. Communication with residents should occur through existing local networks or through other means more appropriate to the respective community along the diversion route.

## **(5) Air Quality**

Dust dispersion in air can be caused by construction activities and the transport of construction material. Land clearing and excavation are two major construction activities that can cause a high level of dust. Truck movement, particularly on inclined roads, can produce a considerable amount of dust. Community or other sensitive areas such as wats or schools located close to construction zones will be

impacted by these activities. Approximately 5 sub-districts in the Kok-Ing sections which are located within 500 meters of the proposed project route may potentially be affected by construction activities. Deep excavation with depth of more than 10 m at alternative B would affect large adverse impact for people. Mitigation measures such as regular sprinkling of exposed earth should help to control dust.

#### (6) Waste

Construction waste, surplus soils, sludge, and domestic waste will be generated in large quantities. ( 18 million cum). Thus, the generation of huge excavation soils will big adverse impact for local people around the project area.

Alternative A: The open canal is constructed mostly with excavation with the depth of 4 m, accordingly, the huge spoil bank of about 2 million cum will be generated.

Alternative B: The deep excavation with depth of more than 10 m is required near the wetland and its excavation volume reaches 3.5 million cum. After passing the wetland, the canal is designed with the culvert structure. This culvert is designed with the length of 13 km. and the deep depth of 25 to 30 m.. Accordingly, the culvert with the top width of 100 m and bottom width of 30 m will generate the huge excavation volume of 18 million cum.

JICA proposed route: JICA proposed route is basically designed to avoid the deep excavation. Thus, the excavation soil is less than alternative A and B. But, the generation of considerable excavation soil are to be considered.

The generation of excavation soil is huge between Kok and Ing section. This problem affects big adverse impact for people around the construction sites. Effective mitigation measures for the excavation soils were not designed at the stage of IEE. Thus, if the effective mitigation measures are not designed, the change of route or diversion way should be conducted from the point of social environment.

#### (7) Split of Communities

Each proposed route pass through the paddy field, near village or established community systems such as "people irrigation" facilities. In addition, the width of canal ranges from 60 m to 100 m. Thus, the construction of the diversion canal will affect big adverse impact on the people along the route even if the bridge was constructed temporarily during a construction period. In particular, alternative B would affect an large adverse impact on the people in the area of Nong Luang and inlet of Kok-Ing tunnel since the canal needs the width and depth than the other route.

Community systems such as "people irrigation" system are establishing extensively in this area from a long time ago. In addition, these facility and irrigation right are owned by individual and also the system is very complex. Thus, it is very difficult to get their consensus before constructing a diversion canal in this area even if a Public Relation activities are conducted from the early stage. The construction of canal in this area causes not only a compensation but also a split of communities. Detail investigation about a life style and community systems of the village along the route should be made throughly to avoid an objection from a local people at the level of EIA.

#### **(8) Economic conditions**

Positive aspects: During the construction period, the residents of the project area will find new job opportunities available during the dry season. The annual income of farming households would increase due to these new employment opportunities. In addition, laborers from other areas are likely to move to the project area, bringing additional commercial occupations and skills to the regional employment and labor pool and increasing overall household incomes.

Negative aspects: During the construction period, the loss of productive land and other changes in the regional economic structure will generate some adverse impacts for households in the project area. The loss of productive land for alternative diversion routes A, B, C, and the JICA proposed route is 9,975, 11,937, 12,358 and 7,997 rais respectively. According to these estimates, about 9,975 to 12,358 rais of farmland must be expropriated for construction of the Kok-Ing section of the water diversion canal. This loss of farmland will affect more than 1,600 families directly and a great number of these households may have to change their economic activities as a result. Job opportunities are limited in this area. Therefore, people affected would receive a great adverse impact by this project.

#### **(9) Social condition**

A large number of new residents will move to and work at the construction sites. This sudden increase of population may create social instability and lead to an increase in problems such as arguing and stealing.

Ing-Nan section including tunnel, diversion dam at Ing (Alternative A, B, C and JICA proposed route)

### **(1) Noise and vibration**

Because the tunnel is long, noise and vibration effects from construction will not be stationary for long durations. However, these effects could be considerable where complex construction sites are close to populated areas (particularly at tunnel shaft No.4). Hilltribe village, Mien (Yao)<sup>1</sup> village, is scattered around the tunnel shaft No 4. Noise and vibration during construction activities should be more paid attention around the tunnel shaft No 4. Noise and vibration during construction activities also may be caused by heavy truck transportation. However, these adverse impacts may be reduced through speed and routing restrictions.

### **(2) Drainage**

During the construction process, proper precautions to secure natural water courses or drainage ways should minimize drainage problems. Temporary retention of storm water may be necessary until permanent drainage structures are completed.

### **(3) Erosion and Siltation**

Construction activities, including excavation, can generate large amounts of dust, while storm water run-off that passes through construction areas may cause sedimentation and turbidity in the water into which it drains. This could induce temporarily poor water quality, typically for short periods of time. Mitigation measures should be designed and implemented to minimize the effect of construction activities on water quality.

### **(4) Waste**

The quantity of rock excavated from tunnel construction is expected to be quite large, approximately 5 to 6 million cubic meters. Due consideration should be paid to selecting a suitable spoil bank in the forest area. This environmental consideration will be required to not only protect the slope of the spoil bank from collapsing, but also so that the spoil bank might be used for cultivation purposes.

Plans

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<sup>1</sup> MIEN (Yao) A desire for PROPRIETY is a driving theme in the Mien culture. There are a dignified people, who prize decorum highly. Whether the endeavor they are engaged in concerns human needs or the realm of unseen forces (including spirits and ancestors) the Mien seek perfection in their orderliness. They desire to avoid open conflict at all costs.

to utilize excavated rock for canal structures or as construction materials such as concrete aggregate and embankment material should be established in the EIA stage.

Alternative A generate huge excavation soil at the route of 1.0 km from the end of open canal to the Lao river to need the deep excavation more than 40 m.

Alternative B and JICA proposed route also generate large excavation soils at the route from the tunnel outlet to the inlet of Ing-Yot tunnel to need the deep excavation of about 20 m.

The amounts of waste in this section are not larger than Kok-Ing section. If the proper measures for dealing with these waste, the route or construction way should be reconsidered carefully.

#### **(5) Split of communities**

The width of canal is also large (60 m - 100 m) in this section. Thus, split of communities in this section would not be avoided, in particular at the route of 1.0 km from the end of open canal to the Lao river and at the route from the tunnel outlet to the inlet of Ing-Yot tunnel.

Communities in this area also hold a long history and established community system. Therefore, split of communities by construction of canal should be considered carefully at the stage of EIA. In particular, the split of communities of hilltribe village should be avoided absolutely.

#### **(5) Economic conditions**

Positive aspects: The residents of the project area will be provided additional employment opportunities, increasing household incomes. Moreover, immigrants from other areas will bring additional occupations and businesses such as restaurants etc. These commercial occupations will help to increase regional incomes eventually.

Transportation condition should also improve due to project construction. The existing road conditions in some areas (particularly near tunnel shaft No.4) are not suitable for the transport of construction materials, and will require improvement prior to project construction.

Negative aspects: During construction period, loss of productive land and other changes in the regional economic structure will occur—principally at the site of the construction site of canal. Their main job is agriculture and also limited of their job opportunities in this area. Thus, loss of productive land would affect large adverse impact for local people in this area. The job opportunities of affected people should be considered carefully at the stage of EIA.

## (6) Social conditions

A large number of new residents will move to and work at the construction sites. This sudden increase of population may create social instability and lead to an increase in problems such as arguing and stealing. In addition, some hilltribe villages (Yao tribe) are scattered around the No. 4 shaft of the tunnel. Consequently, additional attention should be given to impacts on and the needs of these residents. As such, Public Relations activities with NGOs may need to be prepared earlier for this region than the other regions.

### Yot-Yao river section (Alternative A, B, C and the JICA proposed route)

#### (1) Noise and vibration

The annoyance could be significant where construction activities occur close to populated areas, such as in the site of flood control dam and along the Yao river. In particular, river training of Yao river would affect adverse impact for 6,669 peoples along the Yao river. (Adverse affected villages profile are as follows.) Vibration during a construction activity caused by heavy truck transportation would also affect adverse impact for 13 villages, 6,669 peoples along the Yao river.

**The profile of adverse affected villages by Yao river training**

Village	Average Household Income				
	Household	Population	Male	Female	(Baht / Year)
Song Khwae	167	739	363	376	28,970
Mai Song Khwae	37	162	77	85	22,330
Hang Thung	74	398	212	186	35,636
Pak Puk	186	821	400	421	24,345
Nam Mong	125	449	230	219	19,756
Pang Sa	123	525	266	259	13,701
Wang Phang	49	285	137	148	25,498
Haen & Tut	214	952	480	472	21,789
Wang Hid	55	333	149	184	15,673
Na Nun	213	587	273	314	14,487
Pu Kha	197	794	401	393	33,665
Sop Yao	222	624	273	351	29,551
(Total)	1,662	6,669	3,261	3,408	

The outline of flood control dam at Yot river is not clarified at conceptual study stage. Proposed damsite was designed based on the map of 10,000 and 50,000 scale. Therefore, the following figure is showing the worst case by constructing a flood control dam.

**The profile of affected village by constructing a flood control dam**

Village	Household	Population	Male	Female	Household Income (bath / year)
Huai Lao	67	298	164	134	4,509
Wang Sao	77	328	169	159	4,690
Sop Phang	33	154	81	73	4,850
Pang Kom	74	321	161	160	4,700
Nam Pan	61	383	205	178	5,000
Total	312	1,484	780	704	

However, approximately 1,484 peoples would receive adverse impact by implementing this project. Approximately 8,153 peoples would receive large adverse impact only in this area during the construction period.

## **(2) Erosion and Siltation**

Construction activities, including excavation, can generate large amounts of dust, while store water run-off that passes through construction areas may cause sedimentation and turbidity in the water into which it drains. Mitigation measures should be designed and implemented to minimize the effect of construction activities on water quality, in particular in Yao river.

## **(3) Economic condition**

River training in Yao river causes big adverse impact on the local peoples (6,669 peoples) along the Yao river. The outline of river training in Yao river and flood control dam at Yot is not clarified at present. However, huge farm land is required to do river training of Yao river and flood control dam. In addition, job opportunity in this area is limited for agriculture. Thus, local people along Yao river and around flood control dam can not avoid the big adverse impact from river training of Yao river and flood control dam construction.

The economic situation of local people along the Yao river is considerably higher than the other areas in Nan province. Thus, it is very difficult to guarantee the same life standard as before river training.



## **Impacts from operation**

Unlike impacts from construction which are temporary, impacts from operation of the water diversion project will be long-lasting, because the water diversion project will be a permanent fixture in the landscape. During the evaluation of alternative alignments, all routes under consideration were surveyed to identify sensitive sites within 700 m of the proposed routes. These sites include communities, wats, schools, etc. The survey of sensitive sites was used in the evaluation of alternative alignments which resulted in the designation of the selected route.

### **Kok-Ing diversion canal section (Alternative A, B, C, and the JICA proposed route)**

#### **(1) Split of Communities**

The water diversion project passes through cultivated land areas such as paddy fields and orchards. Therefore separation of regional communities by a canal after completion of the project can not be avoided. In particular, between the Nong Luang lake and the Kok-Ing tunnel inlet at alternative B, separation of regional communities by hindrance of regional traffic will occur at the following place.

- between the Nong Luang lake and the Kok-Ing tunnel inlet at alternative B.

This adverse impact could be mitigated by locating and constructing bridges effectively. However, the width of bridge is large, over 100 m at some places. Thus, this adverse impact can not avoid considerably even if the bridge would be constructed.

#### **(2) Landscape**

Change of topography and vegetation by land reclamation would affect adverse impact for local people. Deterioration of aesthetic harmony by the appearance of diversion canal would also affect adverse impact for local people. Valuable scenery, in particular Amphoe Thoeng, would be destroyed or deteriorated by land reclamation, vegetation change and change of topography. The change of landscape may alienate the feeling of inhabitants in this area. However, this adverse impacts could be mitigated considerably by reexamination of the route, project contents, meeting with the inhabitants and provisions of necessary informations.

#### **(2) Economic conditions**

A great number of positive impacts from operation may be considered if the water supply would be provided during a dry season. This would be a particularly relevant benefit for the people around Non Luang.

Ing-Nan section including tunnel, diversion dam at Ing river, flood control dam and river training at Yao river (Alternative A, B, C, and the JICA proposed route)

**(1) Split of communities**

Inconvenience in daily activities of inhabitants due to community split in the area of open canal section would occur even if the bridge would be constructed. The bridge would be constructed based on the opinion of local people.

**(2) Social condition**

The Yao River is currently utilized for washing, irrigation, and recreation spot by nearby residents. However it will not be possible to utilize the river in this manner after the completion of the project. Therefore, the people who used this river for these purposes would be adversely impacted by the operation of the diversion project. However, these adverse impacts could be mitigated by construction of a small water canal close to the existing villages that would enable people to use the water in the same way as before.

**(3) Landscape**

Change of topography and vegetation by river training of Yao river and construction of flood control dam would adverse impact for local people. Valuable scenery in the area would be destroyed or deteriorated by river training and the construction of flood control dam. These change of landscape may alienate the feelings of inhabitants. Adverse impacts for landscape is mitigated by reexamination of the route and project contents and meeting with the inhabitants along the Yao river and provisions of necessary information.

**(4) Hazards (Risk)**

The Yao river is currently utilized for washing, irrigation, and recreation spot by nearly residents. However, it will not be possible to utilize the river in this manner after the completion of the project since

both the volume of a water and velocity of a water increase. Thus, the people who used this river for these purposes would be adversely impacted by the operation of the project. These adverse impacts, however, could be considered to mitigate by construction of a small water canal close to the existing villages that would enable local people to use the water in the same way as before. However, the design of facility should be considered opinion of local people through PR activities.

### **Monitoring Program**

A monitoring program should be established before project construction begins for the purpose of verifying that all environmental objectives are achieved and that mitigation measures are effective.

#### **(1) Construction Monitoring**

To ensure that environmental control measures are effective during construction, a monitoring program should be established to observe the process. The monitoring program need not be complicated or time consuming. It could be conducted by representatives from the implementing organizations, RID, the provincial and local governments as well as persons who live along the route. The main focus of the monitoring should be to ensure that construction noise is not excessive, that most of the construction takes place during the daytime, that water sprinkling and other measures are used effectively to hold down dust, and that construction materials and stormwater sediment do not end up in inappropriate waterways. A noise monitoring program should be established to ensure that control measures are being employed and that night-time activities do not create disturbances in residential areas. Suspended particulate matter in ambient air should be measured regularly at community areas close to the construction activities. Water quality should be monitored at water bodies close to the construction area. These will include the Kok, Ing, Yot, and Yao Rivers as well as drainage channels leading to them from the project.

#### **(2) Operation Monitoring**

A committee will also be formed to monitor the environmental effects of the project after it is placed in operation. It may be advisable for the committee formed in the construction stage to continue its duties in the operation stage as well.

When unexpected situations arise, the committee should propose additional mitigation measures. The committee should then be responsible for verifying the effectiveness of the measures in reducing the negative situation to acceptable levels.

## IEE for the Alternative Routes

The proposed Kok-Ing-Nan water diversion project considered in this study would generally have a big adverse socio-economic impacts. Following big adverse impacts for social and people are considered at each alternative route.

### ◆ Construction waste, excavation soil, surplus soil and domestic waste

For example, huge excavation volume of 18 million cum will be generated at the section of the culvert with the top width of 100 m and bottom width of 30 m of alternative B. It is almost impossible to find a proper measures to deal with huge excavation soils etc. Big adverse impact for society would be caused if this problem did not settle.

### ◆ Split of Communities

Each alternative routes have to pass through the farm land and near villages. In addition, the width of canal ranges from 60 m to 100 m. Thus big adverse impact for society can not avoid by implementing this project even if the bridge was constructed, in particular between Kok and Ing.

In particular, fully consideration for community systems such as "people irrigation" should be made from the early stage of feasibility study. The rights of land and irrigation system such as "people irrigation" are very complex, thus it is almost impossible to get a consensus from all local people related.

### ◆ Hazard

Open canal with deep excavation, depth of more than 10 m, is more dangerous for local people.

### ◆ Yot - Yao river section

Approximately 8,153 peoples would receive adverse impacts anyway only in this area if project would be implemented.

In addition to the above mentioned big adverse impact, usual adverse impact such as noise, vibration, erosion and waste must be fully mitigated. And the influx of labor in the project area may result in the spread of HIV/AIDS.<sup>2</sup> Implementation of the project would affect big adverse impact for social

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<sup>2</sup> Useful research on this issue has been undertaken in several recent related studies. See, e.g., Yothin Sawaengdee and Pimonpan Isarapakdee, *Ethnographic Study of Long-Haul Drivers for Risk of HIV Infection*, study supported by Family Health International under a cooperative agreement with the United States Agency for International Development, conducted at the Institute for Population and Social Research, Mahidol University, Bangkok, May 1991; and David E. Bloom and Joyce V. Lyons (ed.), *Economic Implications of AIDS in Asia*, HIV/AIDS Regional Project, UNDP, New Delhi,

environment judging from the above mentioned points. If the proper measures are not designed for these adverse impacts, project routes or the way of diversion water should be changed.

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1993. Also, in 1993-94 the Yangon office of the United Nations Development Program conducted a *Socioeconomic Study of HIV/AIDS in Shan State* in Myanmar.

### 3.2.4.3 Transportation

#### (1) Introduction

Kok-Ing-Nan water diversion project comprises many activities which would increase traffic volume during construction period in roads related to the project area due to material transportation, workers transportation and excavation soils etc.

The study on transportation comprises field survey and baseline data. The field survey conducted by TEAM and JICA included in investigation on condition of existing roads within the 4 alternatives including JICA proposed route areas, collection of data on type and numbers of vehicles from related government offices to be used as baseline data for initial environmental examination (IEE) of the 4 alternatives including JICA proposed route of water diversion schemes.

#### (2) Result of Preliminary Study

Transportation network: In the project area land transportation network in Chiang Rai and Phayao consists of the following highway:

\*Highway No. 1: From Phayao to Chiang Rai

\*Highway No. 101: Sukhothai - Phrae-Nan

\*Highway No. 103: Nago - Rong Kwang

\*Highway No. 1126: Phan - Pa Daed

\*Highway No. 1202: Phayao - Pa Daed

\*Highway No. 1021: Phayao - Chun - Toeng

\*Highway No. 2020: Chiang Rai - Toeng

The impacts of the project for main road are described as follows:

#### THE MAIN ROAD NEAR OR CROSSING WITH DIVERSION CANALS

Kok-Ing		Ing - Nan		
Alternative A	Alternative B JICA proposed route	Alternative A	Alternative B JICA proposed route	Alternative C
Highway number 1173, 1152, 1174 and 1020	Highway number 1232, 1152, 1174 and 1020	Highway number 1021, 1155 and 1222	Highway number 1021, 1155 and 1222	Highway number 1179

## THE MAIN ROAD WHICH THE DIVERSION TUNNELS WILL PASS BENEATH

Kok-Ing		Ing - Nan		
Alternative A	Alternative B JICA proposed route	Alternative A	Alternative B JICA proposed route	Alternative C
Highway number 1152	—	Highway number 1155, 1222, 1903 1210, 1148 and 1160	Highway number 1021, 1155, 1222, 109, 1210, 1148, and 1160	Highway number 1021, 1179, 1148 and 1160

Diversion Dam area in Kok and Ing: In this area there are 2 main asphalt roads with 2 traffic lanes connected by 2-lane minor lateritic roads in generally rather good condition. Diversion Canals and Diversion Tunnels would scarcely pass across highways, minor roads. Most of them run through agricultural area and parallel along the roads. For tunnel, its entrance would be located far from the traffic route.

According to the traffic data collected by TEAM, the traffic volumes were of low level. The mostly found vehicles were motorcycles, 4 wheel trucks and private car respectively. (Table 3.2.4.3-1)

### (3) IEE for the alternative Route

According to the study, it is found that network of the transportation routes near diversion canal alternative A, B, C, JICA proposed route and tunnels of Ing-Nan section have the same characteristic i.e., there are main road and minor roads linking together, some part of the roads are rough, inconvenience for traveling especially for the access road to regulating dam in Nan province and the access road to shaft portion of tunnel between Ing and Nan.

During construction period, transportation of construction materials and excavation soils must cause adverse impact on surface of roads and traffic condition. In particular, the generation of huge amount of excavation soils between Kok and Ing basin cause serious problem for traffic condition. Thus, the way of transportation of construction material and excavation soils should be further study at the stage of EIA.

Table 3.2.4.3-1 Average annual daily traffic volumes on highway No. 1020, 1721, and 1152

Route No.	Control	Terminal	Year	Car and Taxi	Light Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Total	Heavy Vehicle (%)	Bicycles	Motor Cycle
1020	100	SCT. R. No 1 (Chiang Rai-Pong Klua)	1993	1296	236	133	2716	630	315	5326	20.24	23	2155
			1994	2018	517	118	1331	438	530	4952	21.93	21	2181
			1995	3314	281	145	1681	400	217	6038	12.62	18	2548
	201	Pong Klua - Ban Phlong (Chiang Kam Dist)	1993	558	41	115	992	212	111	2029	21.7	11	446
			1994	426	41	129	1311	219	132	2258	21.25	63	568
			1995	1118	40	119	1076	210	143	2706	17.44	8	594
	202	Chiang Rai Dist Thoeng	1993	395	170	117	2267	315	130	3394	16.55	66	2516
			1994	596	279	212	2477	441	214	4219	20.54	169	3114
			1995	1734	998	338	4001	854	384	8309	18.96	345	4620
	300	Thoeng - Nan Phrae Bridge	1993	414	127	118	1760	299	169	2887	20.29	74	1964
			1994	783	219	173	2288	601	290	4354	24.43	188	2890
			1995	1046	228	181	2953	589	315	5312	20.42	264	3919
	400	Nan Phrae Bridge - Chiang Khong	1993	212	43	79	833	87	36	1290	15.65	135	1436
			1994	206	36	77	853	96	40	1308	16.28	77	1806
			1995	167	38	56	914	115	38	1328	15.73	5	978
1021	100	JCT.R.No. 1 (Mae Dam) - Chun	1993	2546	304	173	3278	451	155	6907	11.27	112	5510
			1994	3134	384	261	2880	462	349	7470	14.95	248	2767
			1995	3566	287	173	2687	728	407	7848	16.66	142	2886
	201	Chun	1993	722	79	80	935	275	74	2165	19.81	67	1113
		Chiang Kham Dist	1994	1103	40	85	496	187	77	1988	17.55	35	1119
			1995	1168	65	99	920	253	206	2711	20.58	38	1244
	202	Phayao Dist by pass Chiang Kham	1993	848	169	156	2222	310	111	3816	15.12	66	3584
			1994	885	156	149	1228	202	118	2738	17.12	159	2796
			1995	716	75	99	2590	322	143	3945	14.29	33	3806
	203	Bypass Chiang Kham	1993	239	44	21	1059	263	112	1738	22.78	70	1558
			1994	301	32	23	1175	296	122	1949	22.62	61	1846
			1995	504	58	41	1260	539	179	2581	29.4	120	2397



Route No.	Control	Terminal	Year	Car and Taxi	Light Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Total	Heavy Vehicle (%)	Bicycles	Motor Cycle
		300 Bypass Chaing Kham-Thoeng	1993	321	115	117	1195	161	103	2012	18.93	89	1055
			1994	217	62	114	1247	135	102	1877	18.7	30	722
			1995	325	82	105	1755	210	131	2608	17.1	102	1292
1152		100 JCT.R.No. 1020	1993										
		(Huai Doi)-Sop Pao	1994	401	143	22	1427	182	123	2298	14.22	67	1330
			1995	427	132	21	1635	172	133	2520	12.93	62	1432
		201 Sop Pao - R.No. 1020	1993										
			1994	448	77	23	1293	232	45	2118	14.16	97	1090
			1995	310	75	24	1553	217	74	2253	13.98	13	1432
		202 To Tung Chao	1993										
			1994	100	76	0	395	19	1	591	3.76	663	950
			1995	178	74	0	527	6	0	785	0.76	774	1163

#### 3.2.4.4 Aesthetic and tourism

##### (1) Introduction

Many projects or project components have a potential impact on aesthetic and tourism. In numerous cases aesthetic and tourism sites coincide with important natural sites. Aesthetic and tourism resources are a part of the resource base, and it is therefore important that development options under consideration are screened for potential impacts on aesthetic and tourism property.

##### (2) Result of Preliminary study

Main aesthetic and tourism sites in Chiang Rai province are as follow:

- \* Monument of King Mengrai the Great
- \* Ku Phra chao Mengrai, \* Namtok Khum Kon Forest Park, \* Haad Chiang Rai
- \* Maenam Kok, \* Hot spa, \* Hilltribe Developments and Welfare Center
- \* Doi Saen Chai, \* Doi Maesalong, \* Doi Tung, \* Pamee Akha Village
- \* Khum-nam Nang-non, \* Tham Pum-Tham Pla, \* Tham Phayanak, \* Tham Pha Chom
- \* Chiang Saen National Museum, \* Chiang Saen Lake, \* Khong River Boat Trip
- \* Baan Haad Klai, \* Baan Haad Bai, \* Doi Pha Tang, \* Phu Chee Fah
- \* Doi luang National park

Festivals

- \* King Mengrai Festival
- \* Lynchee Fair
- \* Chiang Saen Song Kran Festival & National Boat Racing Competition

Most of tourist attractions are of natural type such as Hot spa at Mae Chan, Mae Kok raft tour, and etc. There are also tourist attraction of cultural type such as hill tribe culture at Ban kariat Ruam Mit. Main tourist attraction in Mae Kok watershed area. (Locations are shown in Figure 3.2.4.4-1)

Tourism resources in Phayao province are as follow:

- \* Pho Khum Ngum Muang Status, \* Doi Chom Thong, \* Kwan Phayao,
- \* Champa Thong Waterfall, \* Phu Sang Waterfall,
- \* Thai Lue Tribe of Chiang Kham and Chiang Muan, \* Phayao fishery station,
- \* Analayo Buddhistic Institute and Doi Busarakham, \* Motar Making Village,

\* Cart Making Village, \* Nam pin Waterfall

Tourism resources are classified 2 type; natural and cultural types. Main natural tourist attraction is Kwan Phayao. Tourist attractions of cultural type are Analayo Buddhistic Institute. (Figure 3.2.4.4-1)

Tourism resources in Upper Nan Watershed Area

Upper Nan watershed area cover 2 provinces comprising Nan and Utaradit provinces. The tourism sites in these sites are as follows.

The tourist attractions in Nan are as follows:

\* Phra That Chae Haeng, \* Phra That Khao Noi, \* Wat phu Min, \* Nan National Museum  
\* Wat Suan Tan, \* Phra Chao Thong Thip, \* Wat Chang Kham Woriwihan,  
\* Pha Toob National Park, \* Tham Pha Mong, \* Tham Pha Wiang, \* Sao Din (Hon Chom),  
\* Doi Pha Jik, \* Wat Nong Bua, \* Thung Chang, \* Pua Immigrant Camp, \* Sila Phet Waterfall,  
\* Doi Phukha National Park, \* Boat Racing Festival

The tourist attractions in Utaradit are as follows:

\* Phraya Phichai Dab Huk Monument, \* Wat Phra Fang, \* Luang Pho Phet, \* Phra Thaen Sila At  
\* Wat Phra Yuen Phutthabat Yukhon, \* Phra Boromthat Chedi, \*Muang Lublae  
\* Mae pool Waterfall, \* Sirikit Dam

**(3) IEE for the alternative route and JICA proposed route**

Judging from the location of aesthetic and tourism, direct adverse impact for aesthetic and tourism property is low. However, indirect adverse impact for aesthetic and tourism is supposed to be large. For example, traffic congestion due to construction may produce adverse impact for aesthetic and tourism industry.

Implementation of project does not affect some sites indicated by pre-study report conducted by JICA, such as Khong River Boat Trip, judging from the site investigation and related data. However, the preliminary of Boat Racing Festival in Nan province has the possibility of adverse impact by implementing this project though the main Boat Racing Festival does not receive the adverse impact judging from season that will be held. Thus we need more detail investigation about the preliminary Boat Racing Festival and indirect adverse impact at the level of EIA.

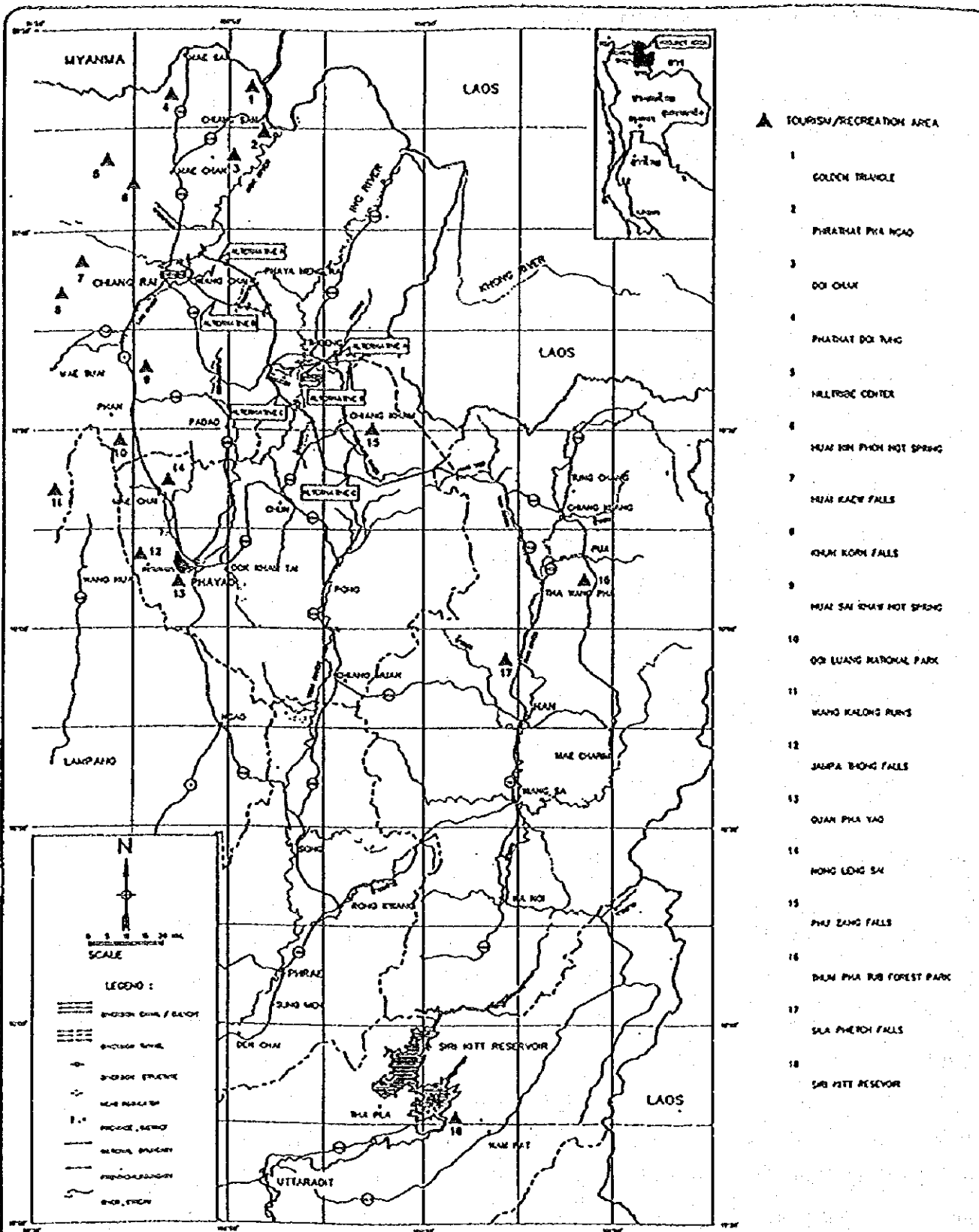


Figure 3.2.4.4 -1 Important Tourism/Recreation Area in Kok-Ing-Nan Basins

### 3.2.4.5 Archaeological and historical aspects

#### (1) Introduction

Many projects or project components have a potential impact on archaeological sites, building complexes, architecture, monumental sculpture, painting, inscriptions, and other physical remains left by previous human inhabitants and considered part of a country's cultural heritage. In many cases cultural property sites coincide with important natural sites. Cultural resources are a part of the resources base, and it is therefore important that development options under consideration are screened for potential impacts on cultural property.

Employed study methodology is as follows:

- Collect data from topographical map scale 1:50,000, related documents and field check.
- List the archaeological and historical site including Wats located not more than 1,000 meters from the project area by sorting into sections namely Kok-Ing section and Ing-Nan section including grouping according to the distance from the diversion alignment i.e., archaeological sites/Wats within 500 meters and archaeological sites/Wats within 501~1,000 meter distance.

#### (2) Results of Preliminary study

##### **Diversion Structure in Kok**

Alternative A: Diversion structure and head regulator are about 4 Km downstream of the existing Chiang Rai Weir. The nearest Wat is Wat Bandai Kaew which is 1 Km away.

Alternative B (and C): Diversion structure is located at 2.5 Km upstream of existing Chiang Rai weir. The nearest Wat and archaeological sites to the head regulator construction site is Wat Pa Yang Mon, 1.3 Km to the Southeast. The Wat is only 500 meters from diversion canal/culvert (Figure 3.2.4.5-1 shows the location of Wat and archaeological sites in the project area).

JICA proposed route: Diversion structure is located at 2.5 Km upstream of existing Chiang Rai weir. The situation is as same as alternative B.

##### **Diversion Structure in Ing**

Alternative A, B or JICA proposed route: Diversion structure is located about 2.5 Km to the south of Amphoe Thoeng. The nearest Wat to the diversion structure is Wat Samakkhi Wanaram, located 1.2 Km to the northwest. The diversion structure in Ing of alternative C is located about 16 Km (distance along stream) to the south of the diversion structure of alternative A, B or JICA proposed route. There is not any Wat or archaeological site in the 1 Km radius of the dam site of the alternative C.

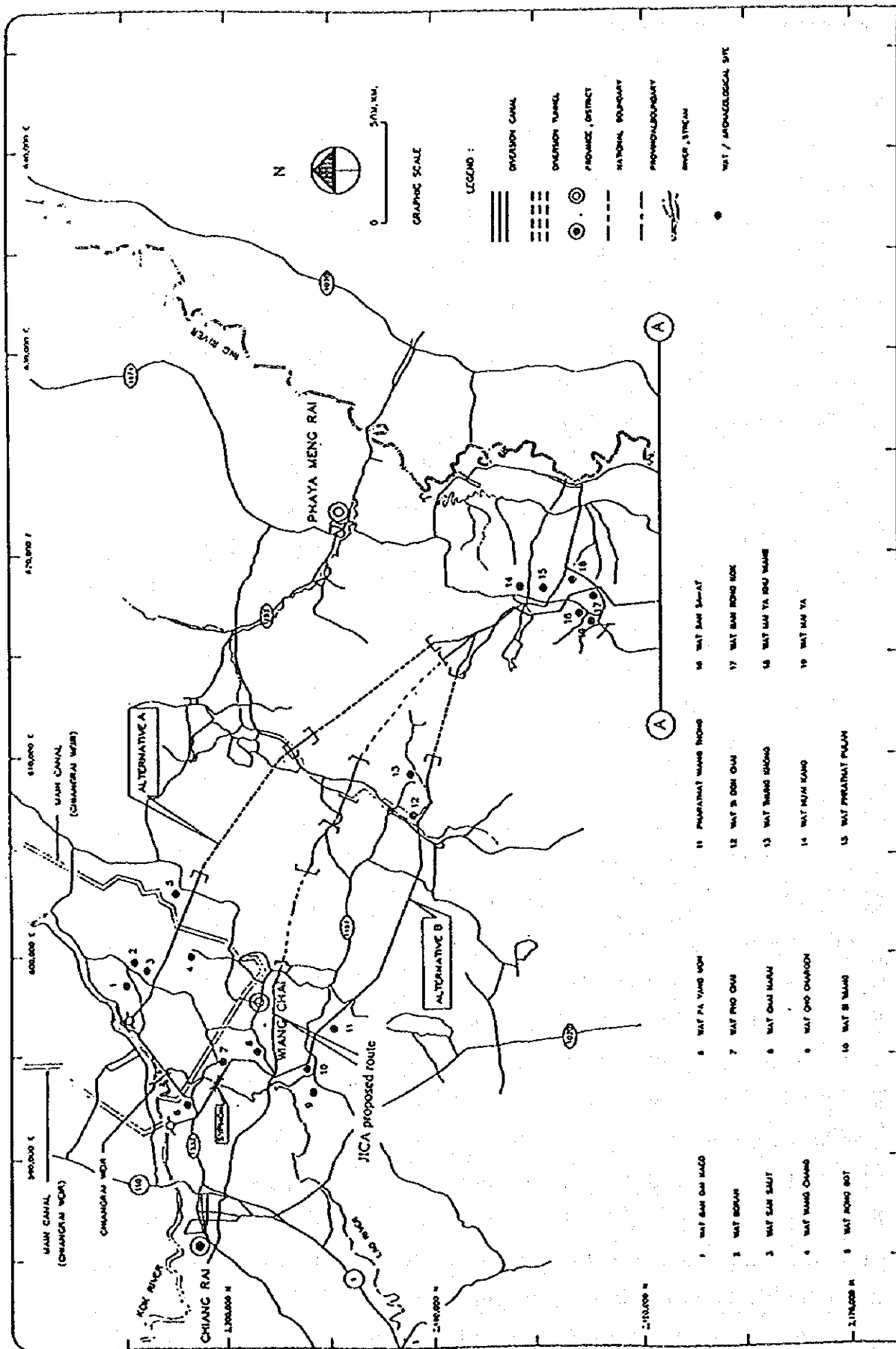


Figure 3.2.4.5-1 Wat/Archaeological Sites along the alternative route of diversion canals and tunnels in the Project area

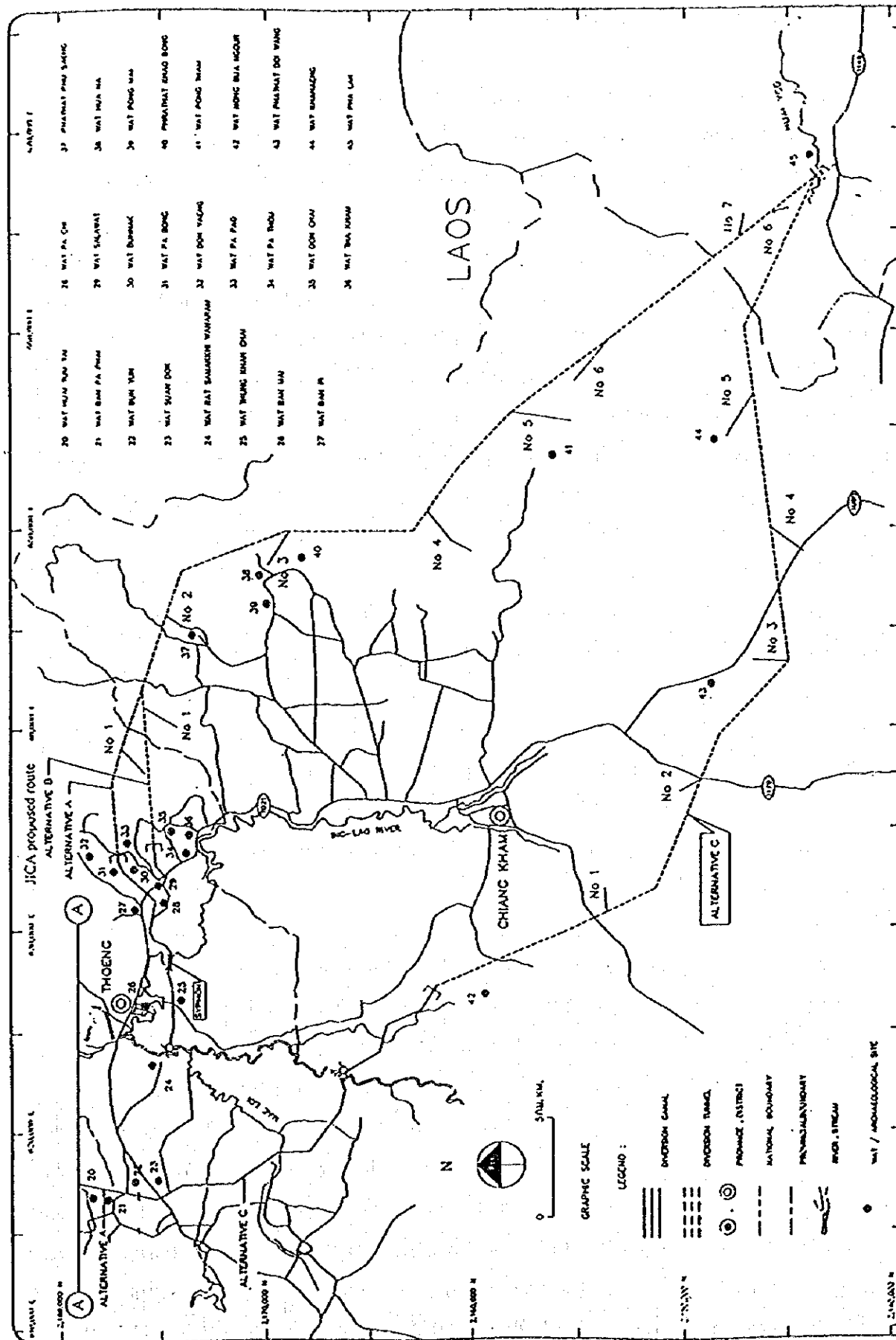


Figure 3.2.4.5-2 Wat/Archaeological Sites along the alternative route of diversion canals and tunnels in the Project area

### (3) Archaeological Sites along Alternative Diversion Route

#### 1) Archaeological Sites along Diversion Canal/Culvert of Kok-Ing Section

a) Alternative A: Diversion canal of Kok-Ing section is 37.3 Km long. Most of the diversion canal passes through plain fields. No archaeological site has been found in the construction site of the diversion canal at the preliminary survey.

There are 12 Wats and archaeological sites within 1 Km distance from the project site, 5 of which namely Wat San Salid, Wat Rong Bot, Wat Ban Rong Kok, Wat Huai Tom Tai and Wat pa Phai are located within 500 meter distance (Details are shown in Table 3.2.4.5-1 and Figure 3.2.4.5-1).

b) Alternative B: Diversion canal and culvert are 52.6 Km long. No archaeological site was found within the construction site to be directly affected from the project development according to the preliminary survey. There, however, 19 Wats within 1 Km radius, 9 of which namely Wat Pa Yang Mon, Wat Pho Chai, Wat Nong Lom, Wat Si Wiang, Wat Phra That Wiang Thong, Wat Thung Khong, Wat Ban Rong Kok, Wat Huai Tom Tai and Wat Ban Phai are located within 500-meter distance.

c) Alternative C: Diversion canal and culvert of Alternative C from Kok to Ban Pa Man (0.5 Km to the south of highway No. 1020) is the same route as Alternative B, then separates towards Ing. There are 22 archaeological sites within 1 Km distance according to the preliminary survey. (Table 3.2.4.5-1, Figure 3.2.4.5-1)

d) JICA proposed route: Diversion canal and culvert are 52.6 Km long. No archaeological site was found within the construction site to be directly affected from the project development according to the preliminary survey. There, however, 15 Wats within 1 Km radius, 7 of which namely Wat Pa yang Mon, Wat Pho Chai, Wat Nong Lom, Wat Thung Khong, Wat Ban Rong Kok, Wat huai Tom Tai and Wat Ban Phai are located within 500 meter distance.

#### 2) Archaeological sites along Diversion Canal/Culvert of Ing-Nan Section

a) Alternative A: Diversion canal and culvert of Ing-Nan section (Yot) can be divided into 2 sections. The first section is the same route as alternative B and JICA proposed route. The second section separates from Alternative B and JICA proposed route from the head regulator in Ing.

Diversion canal/culvert section passes within 100 meter distance from Wat Thung Khan Chai. Another Wat, Wat Ban Phi, is located from 501~1,000 meter distance. There are 3 Wats, namely Wat Pa Bong, Wat Pa Pao and Wat Pa chi, within 500 meter distance for diversion canal/culvert section. There are also other 2 Wats, namely Wat Bunnak and Wat Sala Wat, within 501~1,000 meter distance.

b) Alternative B: There are the same archaeological sites as those of Alternative A section 1 for diversion canal and culvert of alternative B of section 1. There are 2 Wats, namely Wat Sala Wat and Wat Pa Chi, within 500 meter for section 2. Another Wat, namely Wat Pa Ban Phi, is located about 600 meters away.



c) Alternative C: There are 2 Wats, namely Wat Lai Patthand and Wat Bo Noi, within 500~1,000 meter distance.

d) JICA proposed route: The situation is almost the same as alternative B. wat Sala and Wat Pa Chi are located within 500 meter. Another Wat, Wat Pa Ban Phi, is located approximately 600 meters away.

### 3) Archaeological Site near the Inlet and Outlet of Kok-Ing Section

a) Alternative A: According to the prelliminary survey, the nearest 2 Wats, Wat Rong Boat and Wat Pa Bong, are located about 1,500 meters from the inlet and outlet.

b) Alternative B, C and JICA proposed route: The nearest Wat is Wat Thung Khong, located about 1 Km to the northwest of the inlet and outlets.

### 4) Archaeological Sites near the Inlet of Ing-Nan (Yod)

#### a) Inlet portion

Alternative A: Wat Pa Pao is located about 500 meters to the southeast of the inlet portion Wat Pa Bong is about 1 Km to the northwest of the inlet.

Alternative B: The nearest Wat to the inlet are Wat Pa Pao and Wat Bunnak which are 1.3 Km to the north and to the northwest of the inlet respectively.

Alternative C: There is no Wat within 1 Km distance for the inlet of alternative C. The nearest Wat is Wat Nong Bua Nguen, located 2 Km to the south of the inlet.

JICA proposed route: The situation is as same as alternative B. Wat Pa Pao and Wat Bunak are located within 1.5 Km.

#### b) Outlet portion

The outlet of the 4 alternatives is the same area. There is only 1 Wat, namely Wat Pha Lak, located at about 1 Km to the northeast.

### 5) Archaeological sites near Shafts

Alternative A: There is only one archaeological site in the vicinity of the shaft namely Wat Hua Na, located about 1 Km to the northwest of the shaft No. 3. No archaeological site were found within 1 Km radius for other shafts.

Alternative B: No archaeological site were found within 1 Km radius.

Alternative C: There is only Wat Khanaeng located about 1 Km to the north of the shaft No. 5.

JICA proposed route: The situation is as same as alternative B.