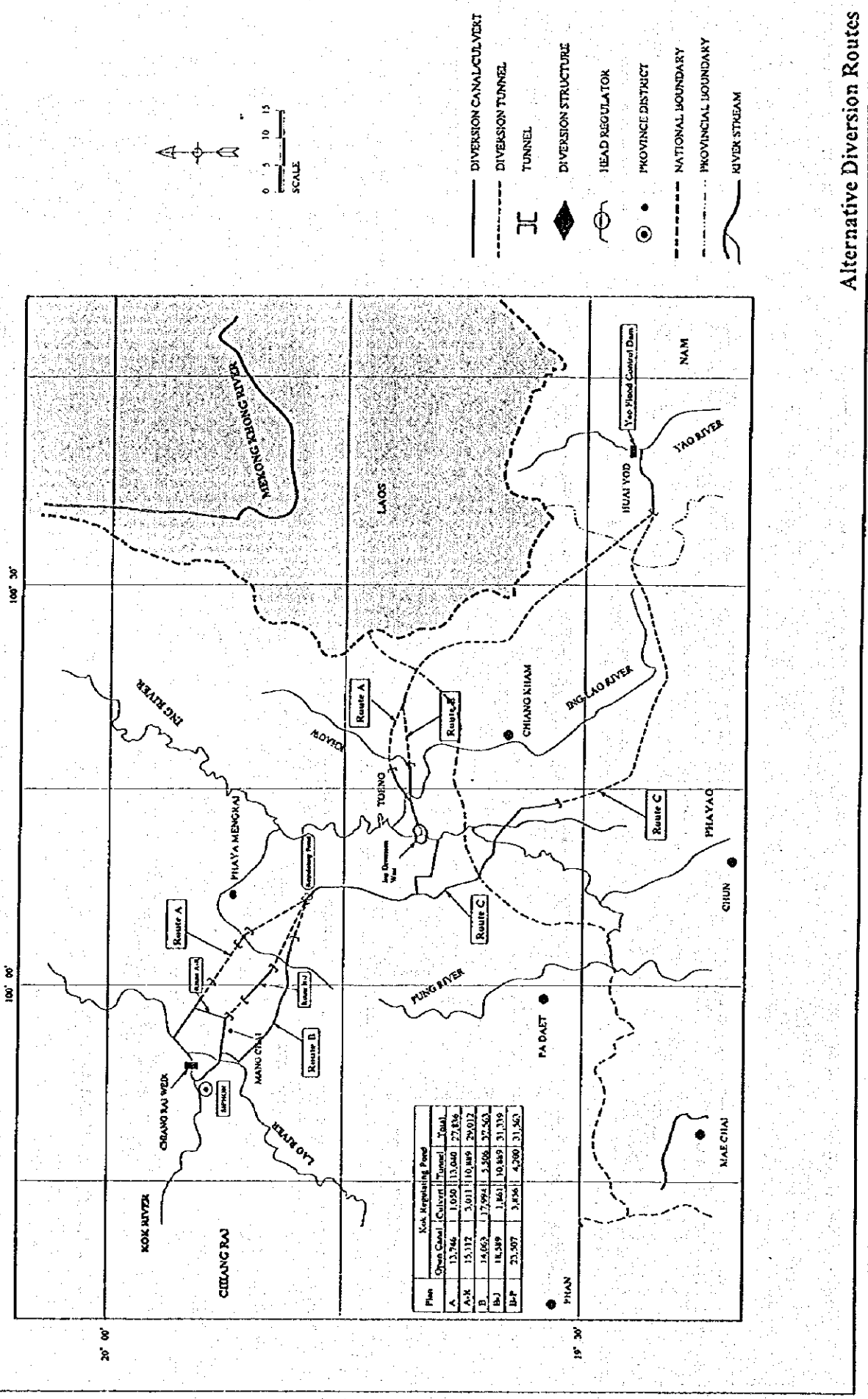


IV. Conclusions and Recommendations

Finally, it will be concluded that the Environmental Impact Assessment (EIA) be indispensable in the next stage of the study, focusing on the above-mentioned issues. The major works for EIA are tentatively presented in Chart-7. In the EIA study, the activities of the public relations in association with social environmental impacts induced by the Project and the proposal of the enhancement/mitigation programs to facilitate rural development under people's participation, both of which are closely related to each other, should be given high priority.

The Kok-Ing-Nan Water Diversion Plan should be really a strategic development plan. Therefore, the Project should be planned and implemented to meet the above development concepts, that is, to maximise the benefit of the people affected/people related and facilitate people's participation in the whole project cycle of planning, implementation, monitoring and evaluation. Furthermore, to secure the sustainable environmental development, the co-operation /collaboration among government agencies concerned and provincial governments will be strongly required.



Alternative Diversion Routes

**Chart — 1 Flow Conditions before and after water Diversion
in Kok & Ing Rivers**

Kok River	Present Situation		Proposed Scheme		Unit : MCM
	Run off	Volume to be used for irrigation development	Available Flow	Diverted Flow	After Project Remaining (Residual) Flow
Proposed Diversion Site	3,800 MCM/year (Wet 2,944) (Dry 851)	1,200 MCM/year	2,600 MCM/year (Wet 2,248) (Dry 358)	100 MCM/year (55%) (125 m ³ /sec)	1,500 MCM/year (Wet 1,210) (Dry MCM)

Ing River	Present Situation		Proposed Scheme		Unit : MCM
	Run off	Volume to be used for irrigation development	Available Flow	Diverted Flow	After Project Remaining (Residual) Flow
Proposed Diversion Site	1,730 MCM/year (Wet 1,588) (Dry 145)	680 MCM/year	1,050 MCM/year (Wet 1,011) (Dry 41)	900 MCM/year (45%)	150 MCM/year (Wet 115 MCM) (Dry 35 MCM)

Yao/Nan Rivers

2,000 MCM/year
(175 m³/sec)

Chart - 2 Influence of Water Diversion on Flow Conditions of Kok, Ing and Mekong Rivers

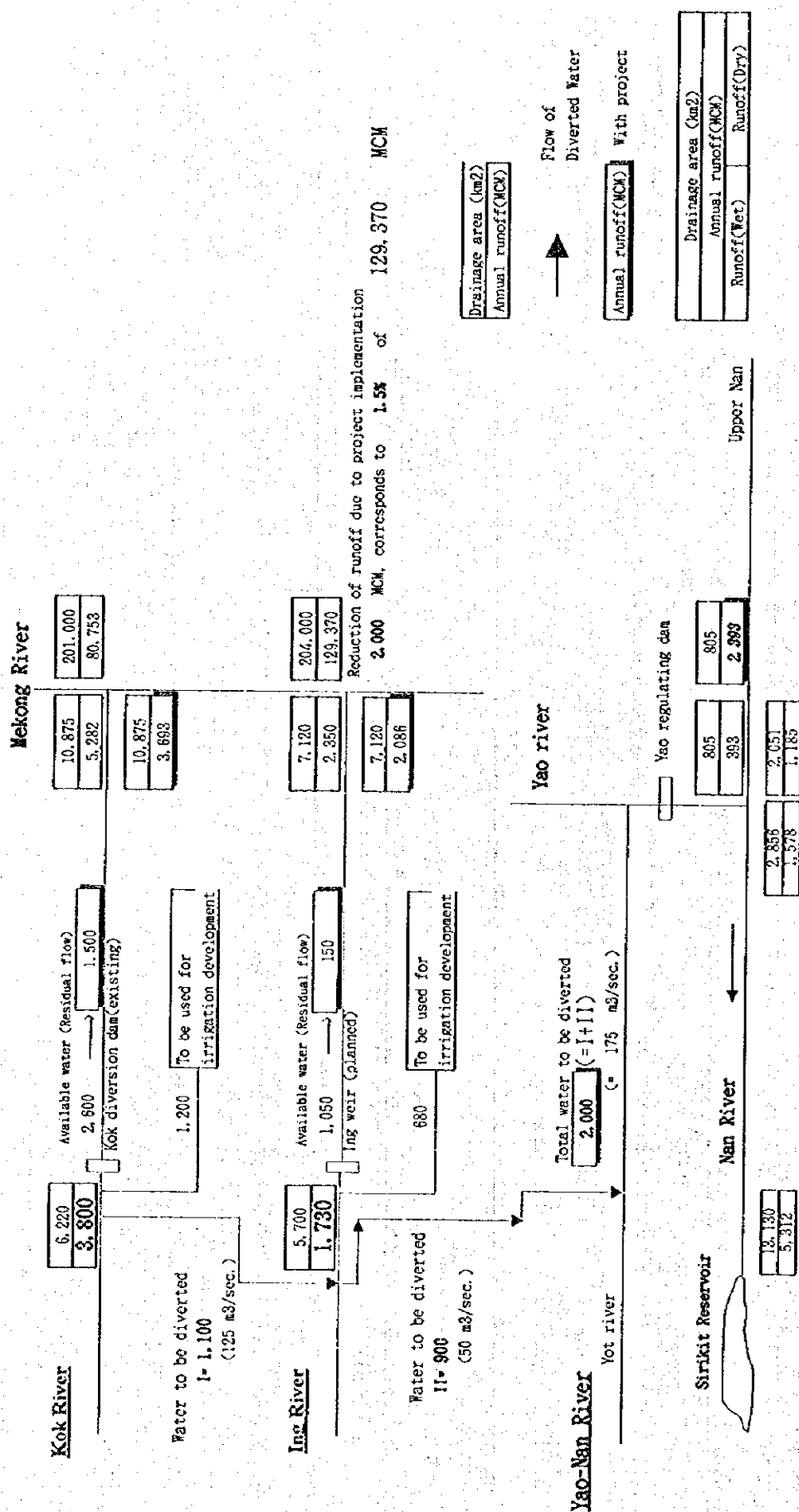


Chart-3 Summary of Initial Environmental Examination

Diversion route/Problems		Further study	Government Agencies Concerned
① Kok Diversion Dam 1-1. Construction of a new diversion dam (A route) - is possible, but the canal inevitably passes through DEDP's project area 1-2. Utilization of the existing diversion dam (B route) - Permission of water use from DEDP. - Operation under RID's control is not possible	Operation under RID's control is possible, but the canal inevitably passes through DEDP's project area	• Confirmation of "People's Irrigation" network • Reconfirmation of the irrigation plan of DEDP	Discussion between RID and DEDP. Discussion among RID, Chiang Rai province and DEDP.
	Utilization of the existing diversion dam (B route) - Permission of water use from DEDP. - Operation under RID's control is not possible		
② Kok Diversion Dam - Ing Diversion 2-1. Land acquisition and Compensation - Due consideration to People's irrigation (A and B routes) - All routes, particularly in B route with a width of 60~100m 2-2. Resettlement - Approximate 20 households will be required for Routes A and (A - B) 2-3. Influence on Wetland - Effective utilization and conservation (Eco-tourism) of Nong Luang Wetland. (B route) 2-4. Tunnel construction and safety measure. - geological situation 2-5. The security of open canal and culvert construction - Excavation depth - 20 to 25 m (B route) in association with culvert construction - Excavation volume - 18 million m ³ (B route) (Treatment of dewatering during construction, disposal of a large amount of excavated soils and safety measures)	Due consideration to People's irrigation (A and B routes) All routes, particularly in B route with a width of 60~100m Approximate 20 households will be required for Routes A and (A - B) Effective utilization and conservation (Eco-tourism) of Nong Luang Wetland. (B route) geological situation Excavation depth - 20 to 25 m (B route) in association with culvert construction Excavation volume - 18 million m ³ (B route) (Treatment of dewatering during construction, disposal of a large amount of excavated soils and safety measures)	• Topographic survey and confirmation of existing canal and its rights • Route selection and detail investigation of current situation of affected villages (land ownership and economic situation etc.) • Detail survey of vegetation and aquatic ecology of Nong Luang and detail survey of economic activities of the surrounding villages. • Detail geological survey. • Re-study of route selection in due consideration if construction method.	• Discussion among Chiang Rai province, RID and village community. • Discussion among Chiang Rai province, RID and affected village community. • Discussion among RID Chiang Rai province, DOF, RFD and village community • Discussion among RID, Chiang Rai province and village community
	Impacts on ecosystem of fluctuation in water level and change in inundation period by construction of weir and dyke - Contribution to alleviation of flood damage in paddy field by construction of weir and dyke - Ing/Yot Tunnel - Ing/Yot Tunnel Safety of open canal construction - Excavation with a depth of 40 m (designed by local consultant) Changed to tunnel (JICA Study Team)	• Environmental impacts on aquatic ecology and wildlife habitat by construction of dyke.	Discussion among RID, RFD and village community (Establishment of development concept by people's participation aiming at construction of dyke and conservation of wetland including eco-tourism)
	Ing - Yot Tunnel 5-1. Tunnel construction and safety - Treatment and effective utilization of excavated rock (6 - 7 million m ³) meter - Adverse effects on neighboring villages caused by passage of truck - Effective utilization of excavated rock and soils in terms of quantity and construction schedule (Construction material for canal/dyke embankment and concrete cyrgates, etc.) 5.2. Inlet/outlet of tunnel, shaft and access road - National Forest Reserve - National Park (under establishment) - Watershed Classification - Reforestation	• Detail survey of social impacts on surrounding community villages during construction • Detail site survey of watershed management and reserved forest regulation in association with an access road from the existing road to tunnel shafts and inlet/outlet of tunnel	Discussion among Chiang Rai, Phayao, RID, and RFD regarding treatment and effective utilization of excavated rock Discussion among RID, RFD, village community and OEPP
	Hilltribe issue 5.3. Consideration for hilltribe (Yao) of shaft No.4 6.1. Flood Control Dam (Yao river) Dam construction - Watershed Classification and National Forest Reserve - Reforestation plan - Alleviation of flood damage in Yao river - Social impacts on 5 villages (312 households) - Effective utilization of reservoir * Irrigation in dry season	Detail study of existing situation about watershed management/reserved forests regulations for forest resources affected by impounding	Discussion among RID, RFD, Yao hilltribes and NGOs Discussion among RID, RFD and Nan province Discussion among RID, DOF, Nan Province, and village community (Study of effective utilization of reservoir)
	Yao River Training 7-1. River training - Impacts on ecosystem of river bank by river training that secure the discharge capacity of river flow (150~200m ³ /sec) - Social impacts on 13 villages (1,662 households) along the river by river training (40 km) * Water supply for fish ponds (River/ponds are used for community villages not only for crop cultivation but also for security of aquaculture which is a main supply source of protein in rural community)	• Detail survey of current socio-economic activities of the affected community villages • Due consideration to ripens aquatic ecology and to socio-economic activities of the affected community villages after river training • Explanation to and public hearings from representatives of the affected community villages about river training	Discussion among RID, village community (chief of villages, chief of women' association, etc.), Nan province and environmental specialist (NGOs inclusive).

Chart - 4 Route conditions from Kok diversion to Ing regulating dike

	A	A-R	B-J	B	B-P (Pump)
Location of intake	New weir 4 km downstream of Existing Diversion Dam	New weir 4 km downstream of Existing Diversion Dam	2 km downstream of Existing Diversion Dam	Intake 2 km downstream of Existing Diversion Dam	Intake 2 km downstream of Existing Diversion Dam
Canal route	Canal passes through the project area of DEDP	Canal passes through the project area of DEDP	Canal doesn't pass through the project area of DEDP	Canal doesn't pass through the project area of DEDP Canal is planned to pass through Nong Luang Wetland	Canal doesn't pass through the project area of DEDP
Natural environment	Fertile paddy field (Likely dominated by people's irrigation)	Fertile paddy field (Likely dominated by people's irrigation)	Paddy field and orchard (Less dominated by people's irrigation)	Paddy field and orchard (Less dominated by people's irrigation)	Paddy field and orchard (Less dominated by people's irrigation)
Social environment	Ban San Salit 20 households affected	Ban San Salit 20 households affected	No household affected ^{2/}	No household affected ^{2/}	No household affected ^{2/}
Geology along tunnel	Canal passes near Ban Wiang Thong	Canal passes near Ban Wiang Thong	Canal passes near Ban Mai Don Kuang	Canal passes 5 km south of Ban Mai Don Kuang	Canal passes 5 km south of Ban Mai Don Kuang
Land area for compensation	Poor	Better than A route	Better than A route	Better than "B-J"	Better than "B-J"
Compensation cost (excl. houses and crops)	6,823 rais	6,823 rais	5,801 rais	8,741 rais	8,741 rais
Unit price for official land compensation	732 M.Baht	732 M.Baht	886 M.Baht	1,234 M.Baht	1,234 M.Baht
	0.04-0.5 M.Baht/rai (1.0-12.5 US\$/m ²)	0.04-0.5 M.Baht/rai (1.0-12.5 US\$/m ²)	0.04-3.0 M.Baht/rai (1.0-75 US\$/m ²)	0.04-3.0 M.Baht/rai (1.0-75 US\$/m ²)	0.04-3.0 M.Baht/rai (1.0-75 US\$/m ²)
Forest condition	Low hill covered mostly with degraded forest but designated as "National forest Reserve (C)"				
Canal Length					
Open canal	13.75	15.11	18.59	14.06	23.51
Culvert	1.05	3.01	1.86	17.99 ^{1/}	3.86
Tunnel	13.04	10.89	10.89	5.51	4.20
Total Length	27.84	29.01	31.34	37.56	31.56
Excavation					
Depth (m)	4			25 - 30	
Volume (m ³)	2 million			18 million	

Remark: ^{1/} Deep excavation with a depth of 25-30 m.

^{2/} No. of household affected will be increase at the time of project implementation due to expansion of urbanization in Chiang Rai.

Chart - 5 Investigation Items for the Impacts induced by Tunnel Construction
(Watershed Management)

- 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.

Chart - 6 Villages to be Affected

The profile of adversely-affected villages by Yao river training

Village	Household	Population	Male	Female	Average Household Income (Bath/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	

(Source: Technical Service and Planning Division, the Community Development Department, Ministry of Interior, December 1992)

The profile of adversely-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	

(Source: Technical Service and Planning Division, the Community Development Department, Ministry of Interior, December 1992)

Chart -7 Major Works for EIA

A. Kok-Ing Diversion Canal Route

1. Confirmation of " People's Irrigation " network system in Chiang Rai and its function
2. Identification and confirmation of households to be relocated and present socio-economic situation of the affected villages
3. Assessment of spoil bank for excavated soils from canal construction in the Kok basin
4. Assessment of borrow area for fill materials to construct diversion canal and dyke in the Ing basin
5. Confirmation of the role and function of the wetland located along the route
6. Examination of the environmental study in association with construction of the existing Diversion Dam under DEDP

B. Ing Diversion Dam

1. Assessment of the impacts on aquatic ecology and wildlife habitat due to fluctuation in water level and change of flood patterns
2. Strengthening of Public Relations activities in the villages affected

C. Ing Diversion Canal

1. Assessment of safety problems in association with deep excavation, in the surrounding villages

D. Ing-Yot Tunnel

1. 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. Forest and vegetation conditions along the tunnel route
 - Existing degraded area shown on the map
 - Classification of the area by forest type, tree density, vegetation, etc.
 - Tree species and size
 - Principal vegetation in wet and dry seasons
3. 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 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.

5. Assessment of disposal area for the excavated rock (6-7 million m³)
6. Assessment of impacts on the neighboring villages due to traffic of construction trucks, such as noise during construction, dust, vibration noise, etc..
7. Assessment of impacts of the construction of access road connected to the existing road on the social activities in the surrounding villages, including safety problems at the inlet/outlet portions of the shafts, illegal logging, etc.
8. Assessment of social impacts on Hill-Tribes (Yao) near the shaft No.4
9. Assessment of the waterfall in Phu Sang National Park under establishment

E. Flood Control Dam

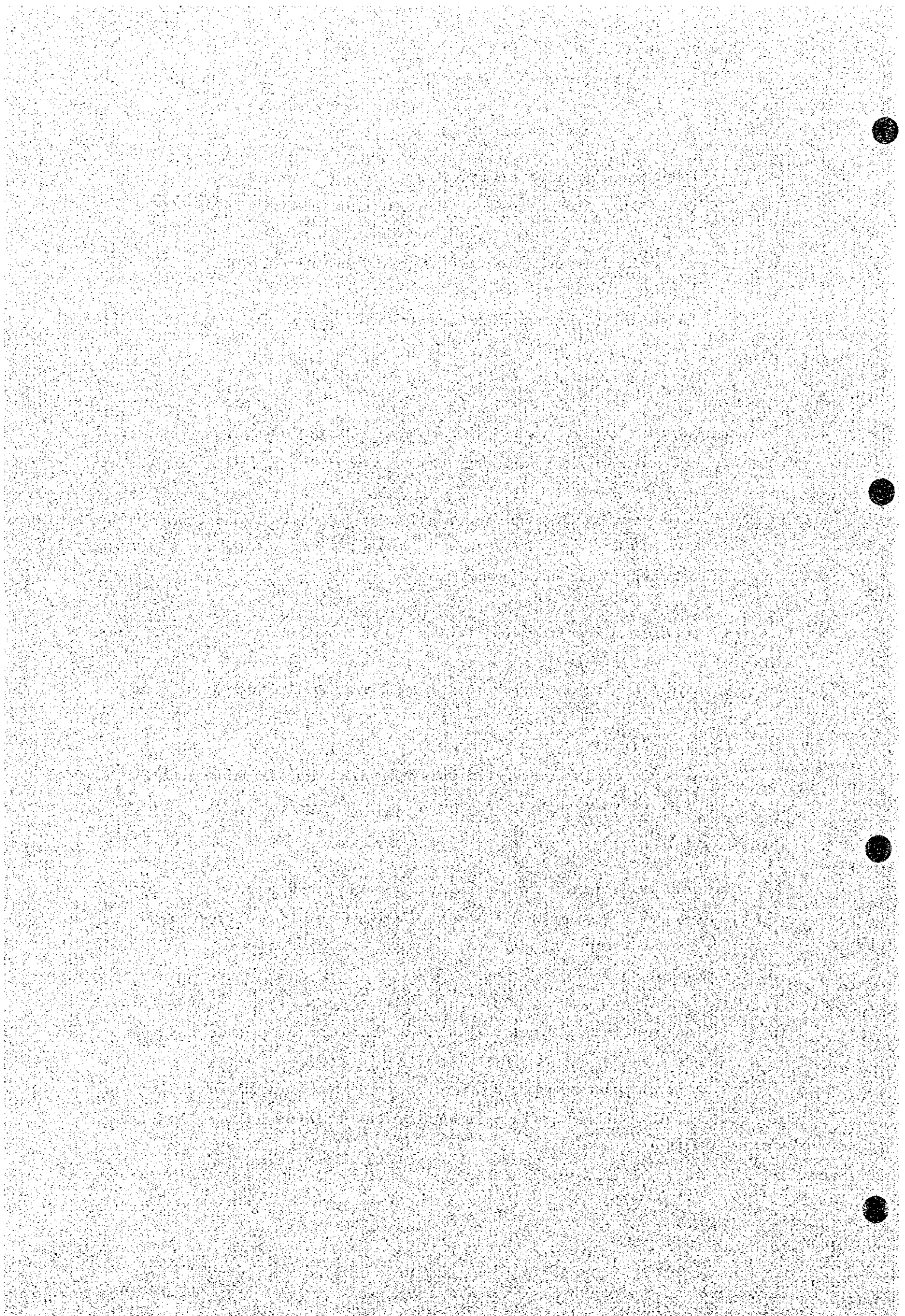
1. Assessment of impacts on forest resources by the dam construction and social impacts on the likely affected villages

F. Yao River Training

1. Assessment of impacts on eco-system of the river bank by river training
2. Assessment of social impacts on riparian villages along the river stream by river training

G. Others

1. Formulation of monitoring plan concerning the impacts on ecosystem in the Mekong River
2. Further survey and analysis to assess the impacts on aquatic ecology from one watershed to other watershed, focusing on fish habitat and populations
3. More comprehensive public health survey, focusing on water-related disease such as malaria, diarrhea, etc., in the riparian Yao river, the Ing Diversion Dam and Nong Luang wetland.



CHAPTER 1 INTRODUCTION

1.1 Background of the Study

The Chao Phraya river basin has a large drainage area of 158,000 sq.km, consisting of the major sub-basins of the Nan, Yom, Wang, Ping, Sakae Krang, Pasak and Delta area and has been playing a vital and important role in the economic development in the country, contributing to the national food security and the export of agricultural products favoured with a fertile farm land area of 5.8 million ha. In the surrounding of Bangkok Metropolitan, being located in the far-lower reach of the basin, significant development of urbanization and industrialization has been made.

Keeping the pace with the rapid and successful economic development in Thailand in the recent years, the water demand for irrigation, domestic, industrial use and others has increased year by year and reaches the large amount of 22,400 MCM in the year of 1993. The agricultural and industrial development in Thailand will be further progressed toward 21st century. As a result, the total water demand in the year of 2006 is estimated to reach the huge amount of 34,200 MCM. Especially, the irrigation water demand in the basin will increase up to 27,100 MCM in the year of 2006 from 16,500 MCM in the year of 1993, because of increasing irrigation water in the dry season as derived from the acceleration of second crops plantation in the basin.

While, the potential water resources in the Chao Phraya basin are limited at about 33,000 MCM, which can't meet the future water demand of 34,200 MCM in the whole basin. Furthermore, the water resources of 33,000 MCM is mostly concentrated in the wet season from June to November, the period of which needs less irrigation water for crop plantation. The water resources are, however, very scarce in the dry season and can't meet satisfactorily the water demand for the secondary crops.

In order to alleviate the constraint of water shortage during the dry season, a number of storage dams to retain surplus runoff available in the wet season and use it in the dry season, have been planned, constructed and operated in the Chao Phraya basin. Bhumibol dam with the active capacity of 9,660 MCM in the Ping river and Sirikit dam with the capacity of 6,660 MCM in the Nan river are the notable dams in Thailand.

The developed water by storage dams in the basin, however, is still not sufficient to meet the water demand for various water users. Water demand in the Chao Phraya basin are summarized as below in accordance with the report of water resources development for 25 basins prepared by NESDB in 1993.

(Unit MCM)

Water Demand	At Present (1993)	In Future (2006)	Rate of growth (%)
Agriculture	16,540	27,130	3.9 %
Domestic/Municipal Water	1,600	2,560	3.7 %
Industry/Tourism	580	850	3.0 %
Environment Balance	3,720	3,670	-
Total	22,440	34,210	3.3 %

On the other hand, the new water resources development in cope with the increasing water demand has been studied by RID and other agencies concerned since 1980. The new water resources development, however, has faced more difficulty in selecting proper dam sites to store the water economically, and in solving environmental problems related to resettlement issues. In addition, the water resources development planned in the sub-basins to use for their own economic activities will induce the water shortage problem for the Lower Chao Phraya delta area where the potential water resources are limited and as well limited in the whole basin.

In order to solve the water shortage problem in the Chao Phraya basin, a number of transbasin projects to divert the water from the Mekong and Salawin rivers to the Chao Phraya basin had been studied by Thai Government since 1980. Those transbasin projects, however, were judged to be less or non-viable for the project implementation, due to difficulty in using the water in the international river, adverse environment impacts for the large reservoir to retain the bulk water in the wet season, etc.. As a result, further study on the transbasin schemes by Thai Government has been canceled or suspended to date.

In 1991, the Royal Irrigation Department (RID) set up a preliminary plan for the transbasin water diversion from the Kok and Ing rivers to the existing Sirikit dam through the Nan river. The plan is consists of two diversion dams at the Kok and Ing rivers to divert their water, a diversion canal with long distance to connect two diversion dams and a diversion tunnel with long distance and large discharge capacity to convey the diverted water to the Nan river and associated facilities. The plan was found to be highly feasible as compared with a number of alternative transbasin plans ever studied with favourable development merits as stated below;

- Water diversion from the rivers situated within Thai territory
- Abundantly available runoff in Kok and Ing rivers
- Effective use of the existing facilities, Sirikit reservoir facing water shortage problem

- Less environmental impacts, if proper mitigation measures be taken under people's participation
- Positive contribution to rural development in the Kok and Ing river basins

In order to further ascertain the soundness and viability of the proposed plan, from technical, economic and environmental aspects, the Royal Irrigation Department (RID), the Ministry of Agriculture and Cooperatives (MOAC) initiated "Feasibility Study and Environmental Impact Study on the Kok-Ing-Nan" Water Diversion Project (Project) from March 1996, which is to be completed at the end of 1997. The RID study is divided into two phases as follows;

Phase I, Conceptual Planning and Initial Environmental Examination (IEE)	1996.3 - 1996.9
Phase II, Feasibility Study and Environmental Impact Assessment (EIA)	1996.10 - 1997.12

1.2 Objective and Scope of the Study

RID requested the Japanese Government to carry out the Feasibility Study under the Technical Cooperation program. In response to the request of RID, Japan International Cooperation Agency dispatched the JICA Study Team on August 1996 to commence the Phase I study to justify the necessity and viability of the project and conduct the initial environmental examination in the project area.

The study will be conducted to review, supplement and strengthen the RID study, in cope with the schedule of the RID study.

The Phase I study (JICA) is to be conducted to examine and justify the necessity and viability of the project, while the Phase II study (JICA) is to be performed only under a condition that the necessity and viability of the project are verified by the Phase I study.

The objectives of the JICA study are as follows;

- (1) To investigate and justify in Phase I study the necessity and viability of the project, which aims to contribute to agricultural and other development in the Kok, Ing and Chao Phraya river basins, through the study for the water resources potentiality, water demand projection, and the various alternative plans and projects ever studied/proposed within the Chao Phraya basin or transbasin projects from the other river basins.

- (2) To conduct a study on Initial Environmental Examination (IEE)
- (3) To carry out Technology of Transfer to the Thai counterpart personnel in the course of the Study.
- (4) To conduct as the Phase II study a Feasibility Study and Environmental Impact Assessment (EIA) only in case that the project be justified to be viable technically, socially and environmentally.

1.3 Project Area for IEE

The study of the Project shall cover (1) the Project area consisting of the Kok, Ing and upper Nan river basins; where the water diversion plan sets up and (2) the Chao Phraya basin consisting of the direct beneficial area of the Nan and Chao Phraya Delta and the indirect beneficial area of the large sub-basins of the Yom, Wang, ping, etc. However, the study for the IEE covers only the Project area.

1.4 Reporting

The following reports have been prepared;

- Summary Report (Part II Initial Environmental Examination)
- Main Report
- Supporting Report
- Database Map

The Supporting Report is compiled based on the environmental study, which constitutes a part of the Phase I Study (RID study).

CHAPTER 2 PROJECT OUTLINES AND PRESENT ENVIRONMENTAL CONDITIONS

2.1 Characteristics of River

The Kok and the Ing basins, being the water sources of the project, spread in the most northern part of Thailand and cover the total drainage area of 18,000 km², divided into 10,900 km² in the Kok river and 7,100 km² in the Ing river.

2.1.1 Kok Basin River

The Kok river, originated in Myanmar on the mountainous area at an elevation of 1,500 m, flows southwards passing through Tha Ton, a town with an elevation of 470 m in the Thai territory located 3 km downstream of the border between Myanmar and Thailand, turns to the east after being joined by its major tributary of the Fang river, towards the city of Chiang Rai with an elevation of 390 m and finally empties into the Mekong river. The other major tributary of the Lao river joins the Kok river about 2 km downstream of the existing diversion dam (DEDP).

Chiang Rai is a mountainous province located at the northern tip of Thailand bordering Myanmar on the north, Laos on the east, Phayao and Lampang on the south and Chiang Mai on the southwest.

The total length of the Kok river is about 285 km, of which 157 km is in the Thai territory. The Kok river after passing through Chiang Rai city flows down to the Mekong river in a meandering course with a gentle gradient of more than 1 to 3,000. The water level of the Mekong river at the mouth of the Kok river has been recorded to fluctuate in a range of 350 m to 360 m.

The lower basin of the Kok river has a flatter slope and wide flood plain area, encountering inundation in a wet season caused by the backwater from the Mekong river. The mean annual rainfall over the Kok river is ranged between 1,000 mm in the south and 1,900 mm in the north. The lower basin, downstream of the existing Kok Diversion Dam, has a mean annual rainfall of 1,600 to 1,900 mm.

The annual average runoff at the proposed intake point, 2 km. upstream of the Kok Diversion Dam, is estimated at 2,889 MCM corresponding to 92 m³/sec., while the average annual run-off of the Kok river basins is 5,280 MCM, of which 80% (4,230 MCM) occur in a rainy season (June to November) at the mouth to the Mekong river.

2.1.2 Ing Basin River

The Ing river originates in the southern plateau with an elevation of 450 to 500 m and flows southwards to the Phayao Lake used for fish culture and irrigation near the Phayao city. After the Phayao Lake accommodated with a regulator which keeps the water level between 391 m and 392 m throughout the year. The Ing river flows northwards to Amphoe Thoeng, where a large tributary of the Lao river with a drainage area of 1,300 km² joins the Ing river.

In the upper basin upstream of Amphoe Thoeng, a flat area with an elevation of 450 to 350 m extends to a width of 6 to 8 km along the river reaches of 70 km. In the lower basin, the Ing river flows northwards with a gentle gradient of more than 1:5,000 in a meandering course over a length of about 300 km and empties into the Mekong river.

The water level of the Mekong river at the mouth of the Ing river has been recorded to fluctuate in a range of 350 m to 340 m. The area in the downstream reaches of about 20 km is inundated in a wet season caused by the backwater from the Mekong river.

The mean annual rainfall over the Ing river is ranged between 1,000 mm in the south and 1,600 mm in the north. The lower basin, downstream of Thoeng, has a mean annual rainfall of 1,600 mm.

The average annual runoff at the Thoeng bridge, 2 km. downstream of the proposed diversion dam, is estimated at 1,890 MCM corresponding to 60 m³/sec., while the average annual runoff of the Ing river basin is 2,350 MCM, of which about 92% (2,162 MCM) occur in a rainy season (June to November) at the mouth to the Mekong river.

2.1.3 Nan River

The Nan basin is divided into two basins by the Sirikit Dam, the upper basin with a drainage area of 13,100 km² and the lower basin with a drainage area of 21,200 km².

The Nan river originates in the high mountain area at an elevation of 1,000 to 1,500 m, bordering with Lao P.D.R. and flows southwards to the Sirikit Dam 100 km downstream of Nan city. The Yao river joins the Nan river at the point 50 km. upstream of Nan city.

The basin is of slender shape, extending over a length of 200 km and to a width of 60 to 70 km, where the topography is characterized by high rainfall and steep slope and farm land occurs rather scarcely and in a limited narrow and flat area.

The average annual runoff in Nan river at Amphoe Muang Nan is estimated at 2,540 MCM corresponding to 80 m³/sec., of which about 81% (2,057MCM) occur in a rainy season (June to November)

The mean annual rainfall over Nan river basin is ranged between 1,100 mm in the south and over 1,600 mm in the north.

2.2 Outline of Kok-Ing Nan Water Diversion Plan

2.2.1 Kok-Ing Water Diversion facility

The facility that intake the water from Kok river and divert the water into Ing river comprises the followings:

(1) Kok diversion Dam

This diversion dam is planned to intake the water (125 m/sec) from Kok river. The plan as envisaged would divert the water from the Kok river possibly at the existing Chiang Rai weir constructed by DEDP near the city of Chiang Rai and the other plan would divert the water from the Kok river at the new weir which is to be constructed downstream of the existing weir. These two alternatives will be studied in detail in the next stage of F/S, together with the diversion route plan.

(2) Kok-Ing diversion route

The water diverted from the Kok river will be conveyed to the proposed diversion damsite on the Ing river near Amphoe Thoeng through a 50 km long diversion channel, consisting of open canal, siphon, culvert and tunnel sections as required by topographic, geographical and present land use conditions. Alternative A and B plans proposed by local consultant TEAM JV, JICA proposed route (B-J plan) and A-R route proposed by RID will be studied in detail, based on the results of topographic and geological surveys under way. In particular, the social environmental survey will be made, focusing on paddy field of Kok basin close to Chiang Rai city and also their irrigation systems administered by "People's Irrigation Association" that hold a history over one hundred years. Thus, a big adverse impact on social environment might be induced from construction of a canal with a width of 50 m to 70 m crossing this area. The outline of facility is shown as below.

Outline of Water Diversion Facility between Kok river and Ing Diversion Tunnel
for Water Diversion Plan

Item	A	A-R	B	B-J
1. Kok diversion dam	New	New	Existing	Existing
2. Diversion route				
Open canal (km)	13.7	15.1	14.0	18.6
Siphon (km)	1.1	2.0	18.0	1.9
Total	14.8	17.1	32.0	20.5
3. Diversion tunnel				
No. 1 tunnel (km)	5.8	4.1	-	3.1
No. 2 tunnel (km)	7.2	7.8	5.5	7.8
Total	13.0	11.9	5.5	10.9

(3) Diversion route between tunnel outlet and Ing diversion dam

The tunnel outlets are located at the same district for any alternative plan, from which open canals are planned to be constructed over a distance of 23.6 km between the tunnel outlets and the Ing diversion dam. This canal crosses the existing paddy field in the Ing river basin and is planned to be constructed of embankment, in most parts, in this section.

2.2.2 Ing diversion dam and Lao diversion canal

(1) Ing diversion dam

Ing diversion dam is planned to regulate the diverted water from the Kok river and the run-off of rainy season in the Ing river, and convey them into Ing-Yot diversion tunnel. This dam is planned to intake water amount of 175 m/sec. However, concerning adjustment amount of flood water, uprising of flood water level due to backwater from the Mekong river, drainage in the upstream Ing river basin, river training of Lao river that flow into diversion dam, and river training of upstream and downstream of the Ing river, the dam design based on the results of topographic survey at the dam site and geological investigation have to be made in the next stage of F/S.

(2) Lao diversion route

The route between the Ing diversion dam and Ing/Yot long tunnel over a distance of 11.8 km is situated at the elevation of 365 m to 380 m, which is higher than the water level, being 361.5 m, in the Ing diversion dam. Thus, the route consists of an open canal(2.4 km), culvert(8.4 km), and tunnel(1.0 km). This diversion route is planned to cross the Lao river by siphon, and thus will require a river training of Lao river.

2.2.3 Long tunnel between Ing and Yot

The long tunnel is planned to run through the mountain in the Ing river basin over a length of 40 km and to come out to the Yot river, which is a tributary of the Yao river. The tunnel is designed to be construct at the elevation of 340 m and 360 m, which is far below the mountain with a surface elevation of 600 m to 1,500 m. Thus, the tunnel requires to be accommodated with 7 shafts with a total length of 17 km.

Of north routes (A& B) and south route studied, the south route C was not adopted due to poor geological condition.

2.2.4 River training at Yao river

The diverted water (175 m³/sec) from the Ing-Yot tunnel which are released into the Yot river, flows down into the Nan river through the Yao river and finally comes to Sirikit dam. The Nan river is large enough to flow a flood with a discharge of more than 2,000 m³/sec, and any significant impacts are not anticipated for the flow capacity even if the water(175 m³/sec) are added. However, the current capacity of the Yao river is 200 m³/sec at the upstream and 400 m³/sec at the downstream. Thus, the Yao river will be damaged by flood if the above diverted flow of 175 m³/sec is added. Therefore, a flood control dam is planned at the upstream of the Yao river for storing a flood discharge at the peak and regulating the water flow to be released under 200 m³/sec, including sideflow. The current maximum discharge of 400 m³/sec will be a design flood in the downstream .

(1) Yao regulating dam

The regulating dam is planned to be constructed at the upstream of the Yao river, with a catchment area of 370 km² and a maximum flood discharge of 200 m³/sec. The dam is to be of concrete type with a storage capacity of 28 MCM, a height of 37 m and a maximum discharge of 250 m³/sec.

(2) River training in Yao river

The river training over a distance of 40 km is planned to flow smoothly the flow (200 - 300 m³/sec) at the upstream and the flow(300 - 400 m³/sec) at the downstream. The river training consisting of the following measurements is to be studied in the next stage of F/S..

- Widening the river
- Reduction of discharge energy by several weirs and drops over a length of the river course in problem.

- Water supply facility for village community
- Rehabilitation and/or replacement of existing road and bridge



