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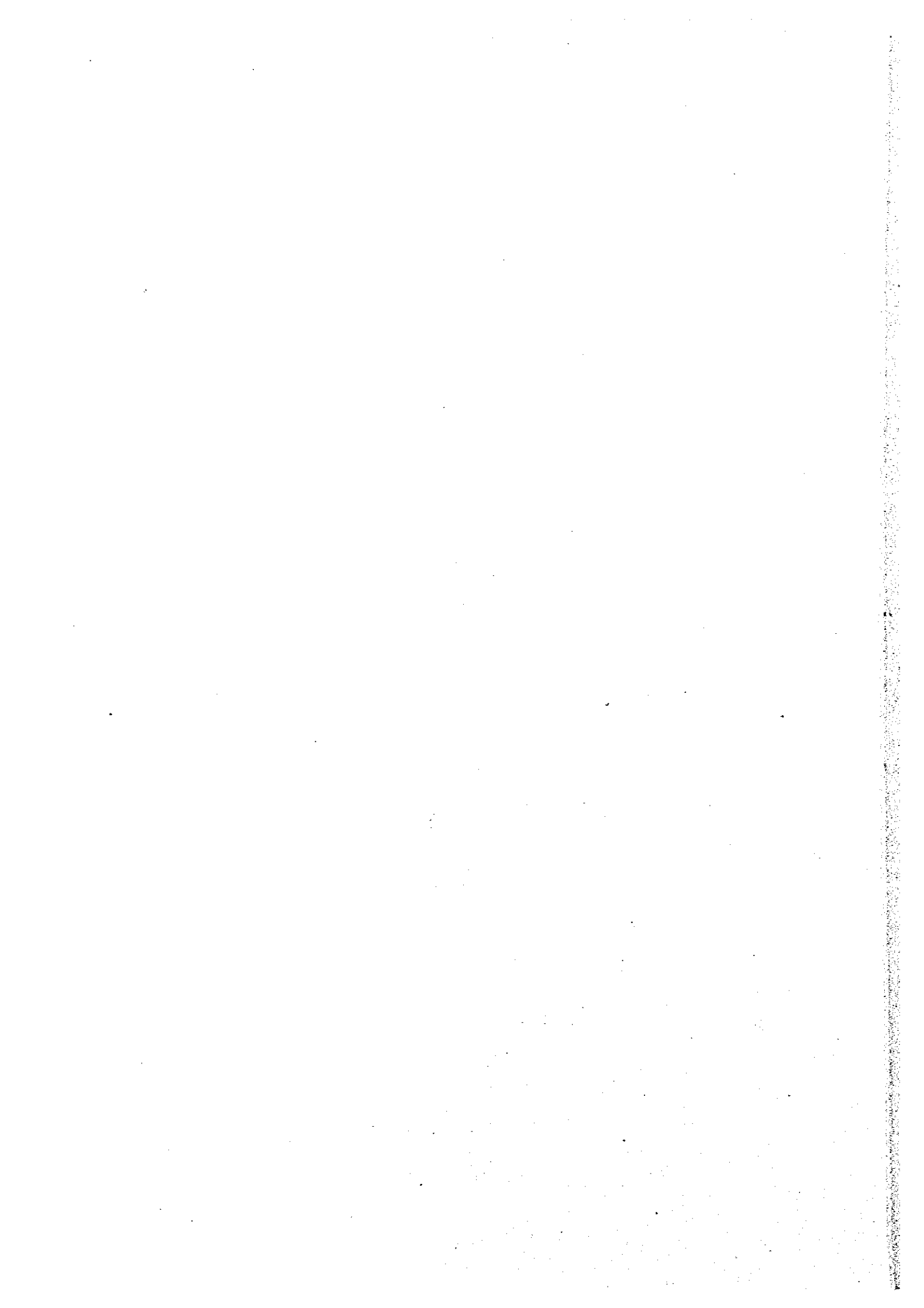
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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ROYAL IRRIGATION DEPARTMENT  
MINISTRY OF AGRICULTURE AND COOPERATIVES  
THE KINGDOM OF THAILAND

**THE STUDY  
ON  
THE KOK-ING-NAN WATER DIVERSION PROJECT  
IN  
THE KINGDOM OF THAILAND**

**FINAL REPORT**

**(Supporting Report to  
Environmental Technical Assistance Study)**

NOVEMBER 1999

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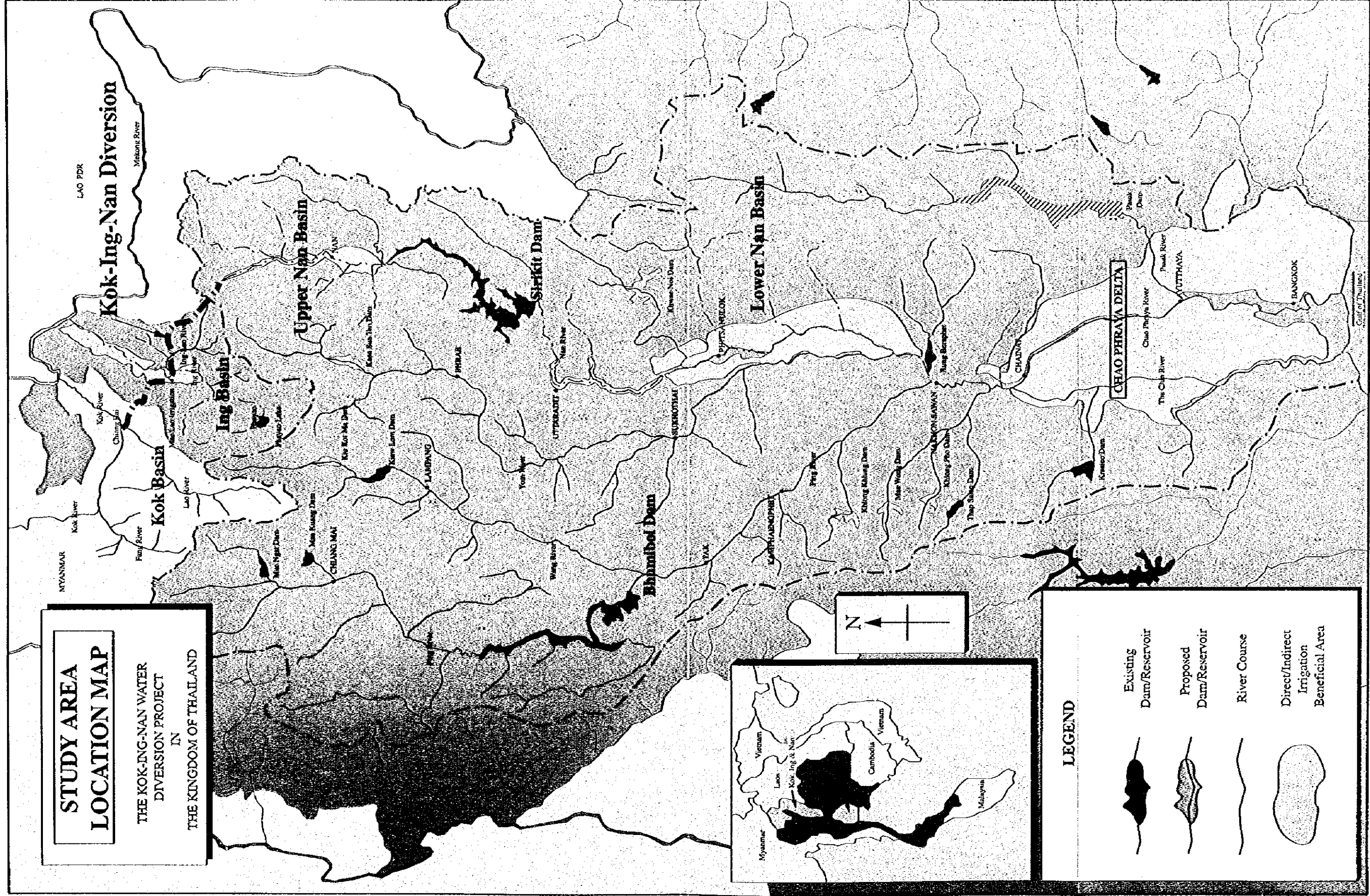


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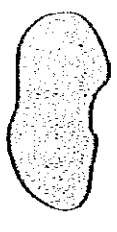


**STUDY AREA  
LOCATION MAP**

THE KOK-ING-NAN WATER  
DIVERSION PROJECT  
IN  
THE KINGDOM OF THAILAND

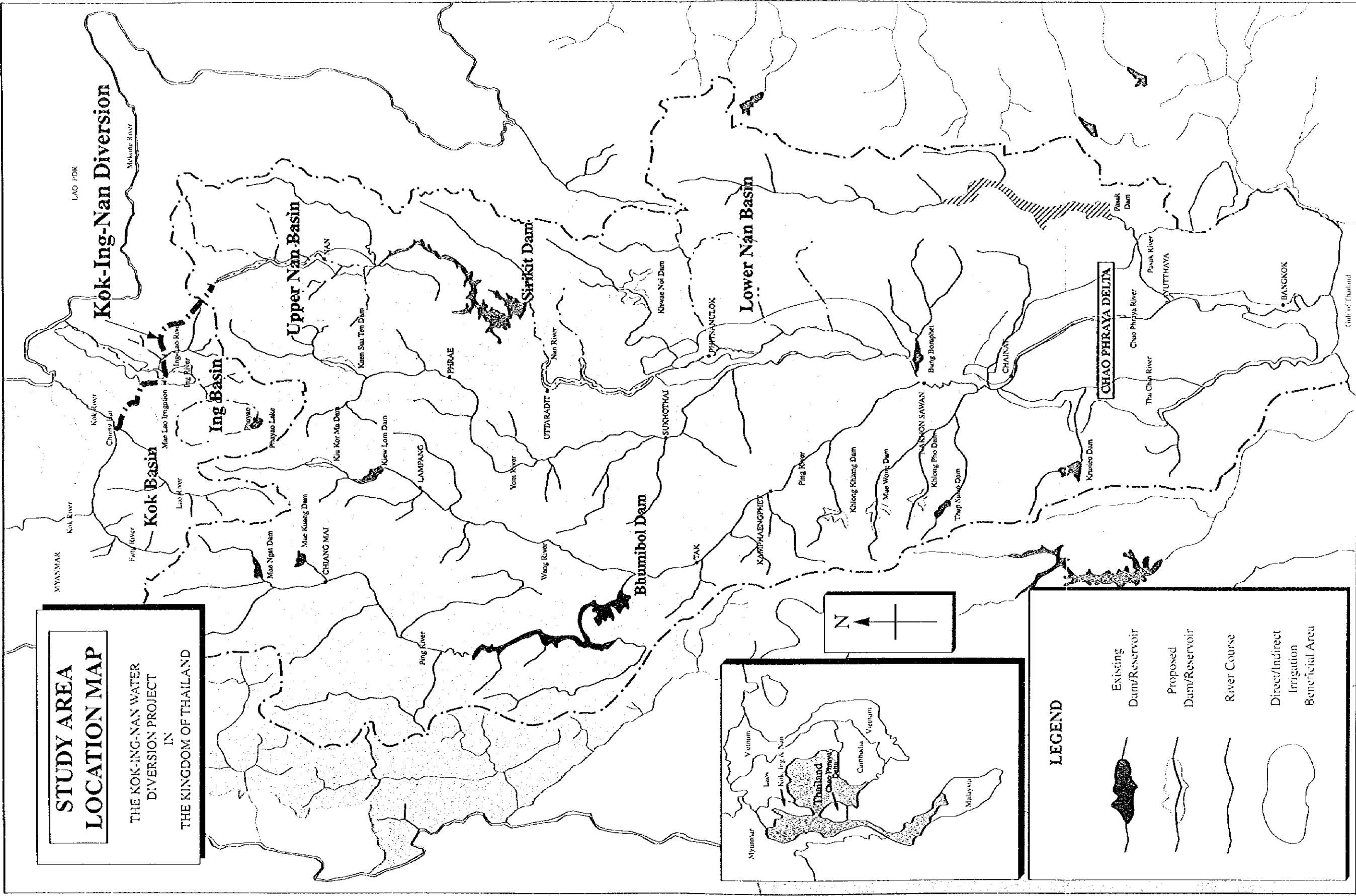


**LEGEND**

-  Existing Dam/Reservoir
-  Proposed Dam/Reservoir
-  River Course
-  Direct/Indirect Irrigation Beneficial Area

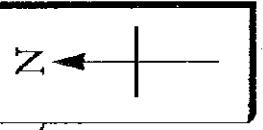
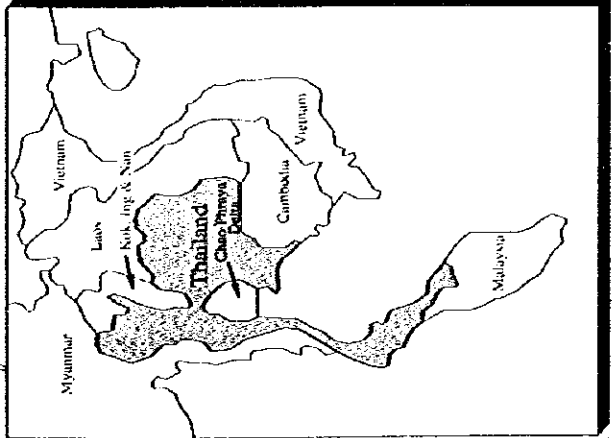
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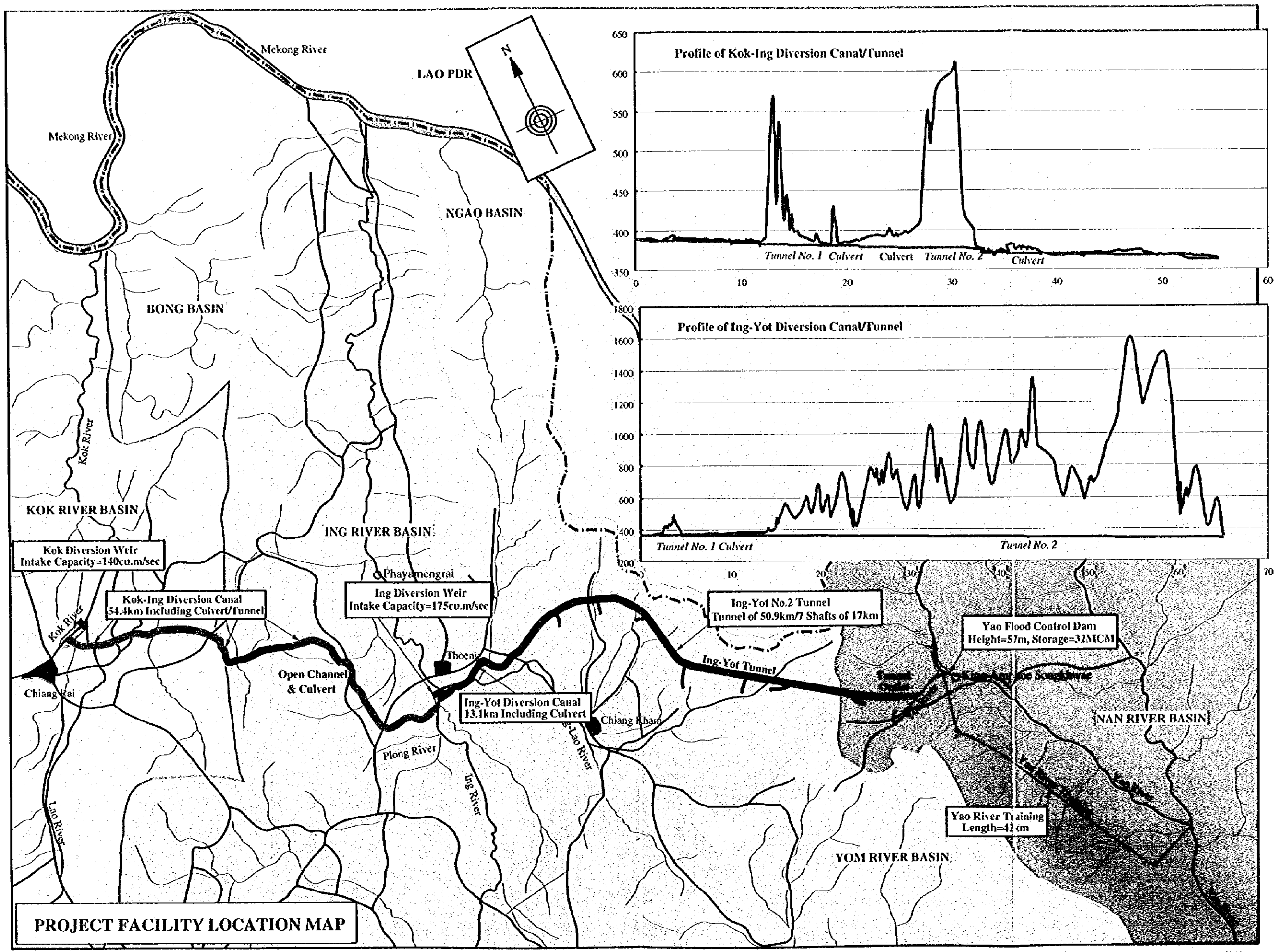


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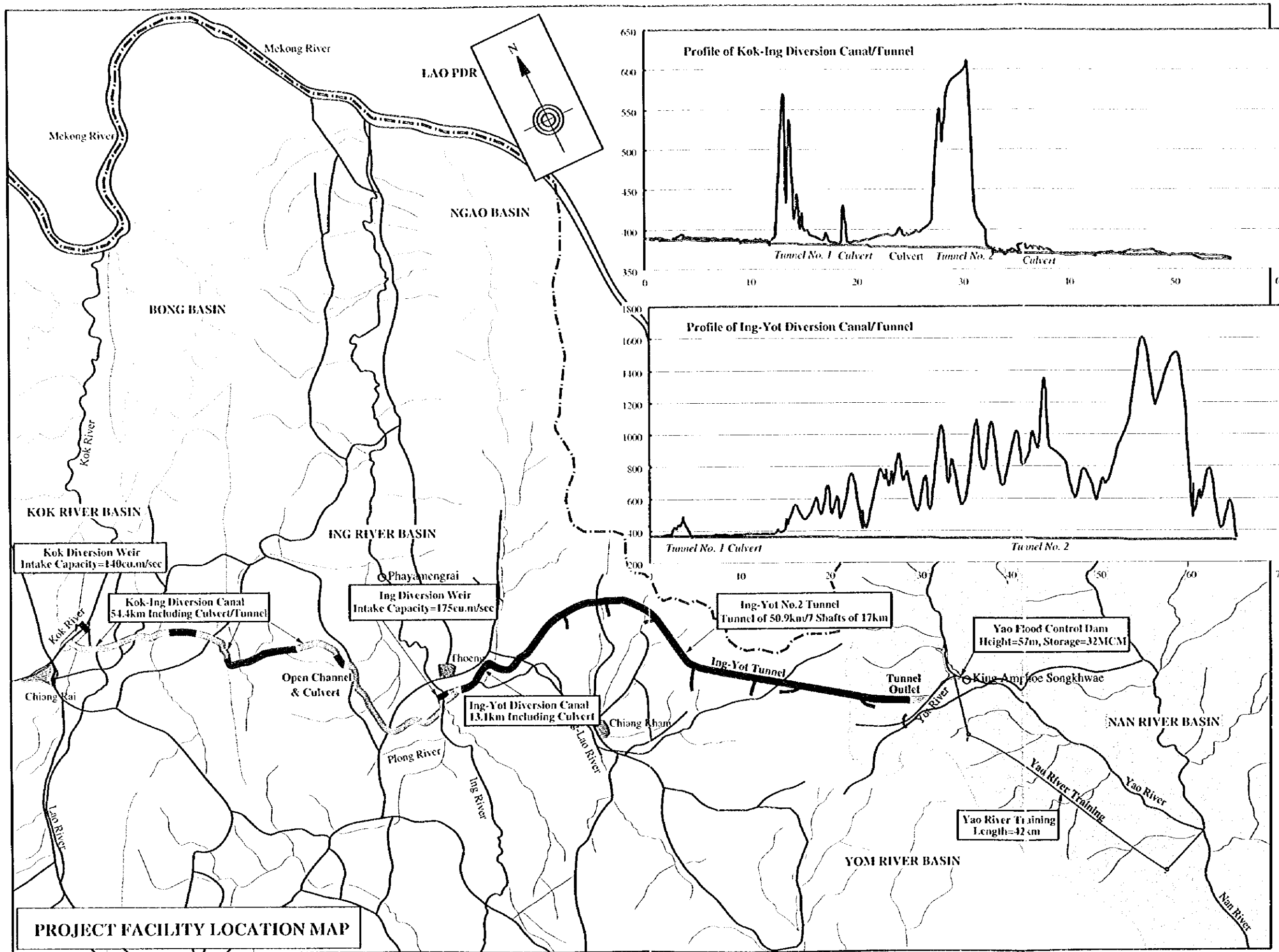
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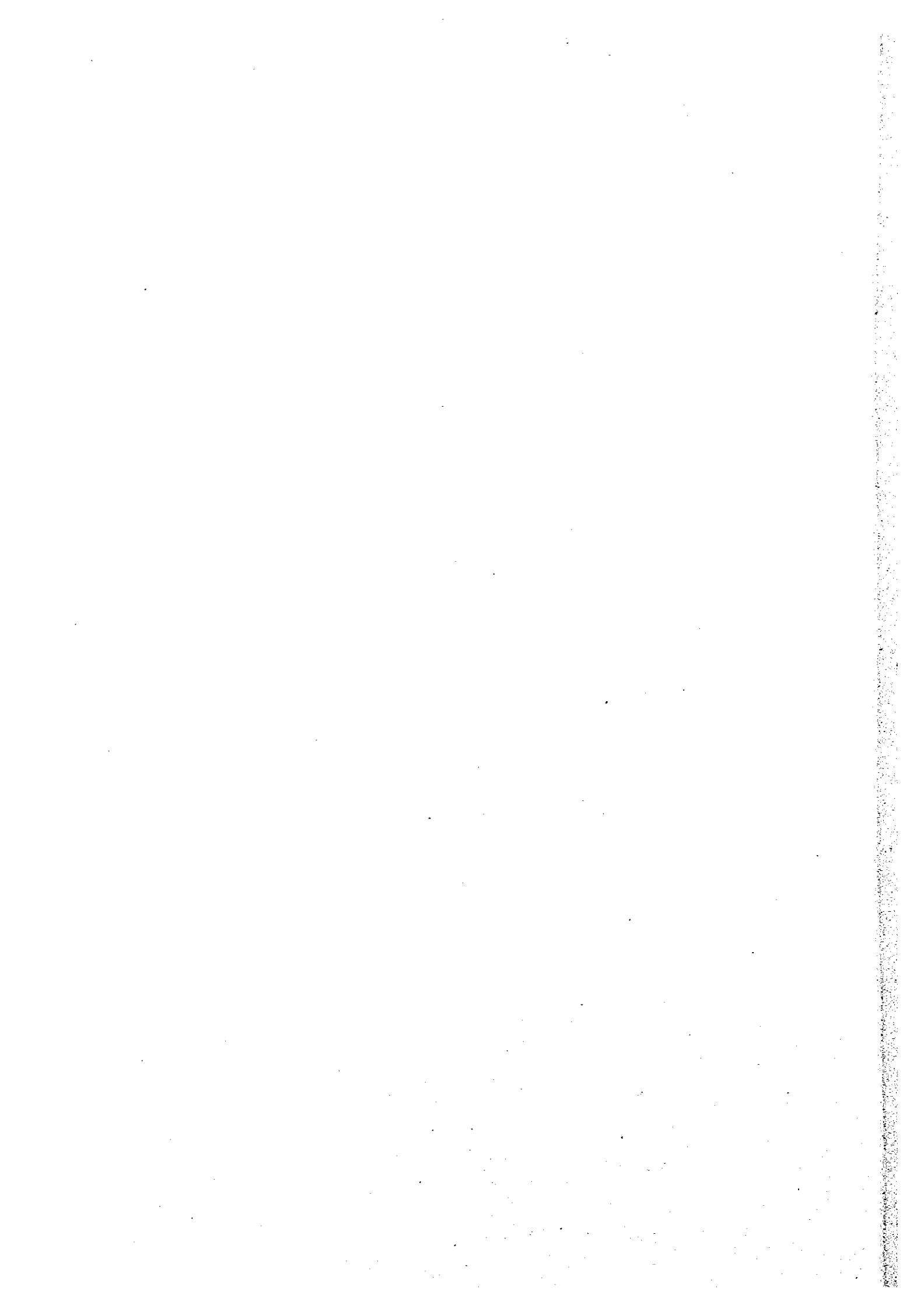


Gift of Thailand









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***1. OVERVIEW OF RID ENVIRONMENTAL IMPACT ASSESSMENT***



## **1 OVERVIEW OF RID ENVIRONMENTAL IMPACT ASSESSMENT**

This chapter comprises a review of the EIA produced for RID by Team J/V, together with the OEPP comments on the IEE produced by JICA.

### **1.1 Introduction and Project Description**

The English version of the Environmental Impact Assessment Draft Final report (referred to hereafter as 'EIA Report') prepared by the group of consultants - Team Consulting Engineers Co., Ltd., Asdecon Corporation Ltd., Sanyu Consultants (Thailand) Ltd., and Panya Consultants Co., Ltd., (referred to hereafter as the "TEAM"), has just been made available to the JICA Study Team in early July 1999. This chapter presents a summary of the EIA Report.

#### **(1) Project Components**

Table 1.1 presents the planned project facilities/ components as part of the Kok-Ing-Nan Water Diversion Project. The EIA Report should be referred to for more detailed design information and figures.

#### **(2) Telemetering system**

Use of Telemetering system is proposed in the KIN project for timely compilation of water flow and rainfall data information of various locations. This will essentially involve the construction of a master station, 13 remote stations and a number of repeater stations in the mountainous areas.

#### **(3) Water resources development along the diversion alignment**

Area of 45,800 rai along 120-km stretch along KIN alignment has potential for irrigated agriculture. This will be by installation of 14 pumping stations at various locations to pump water out of the diversion canal to potential irrigation areas. In Nan watershed, 8 pumping stations will be installed to discharge water into potential cultivable areas totaling 2,627 rai on both banks of the Yao in Song Khwae district and Tha Pha district.

#### **(4) Water distribution**

The average amount of water that can be diverted from Kok basin into Ing basin during June to December is 1,757 MCM/year. Canal and other project facilities in the Kok-Ing section have been designed to have a capacity of 140 m<sup>3</sup>/sec. The average water volume that can be diverted from the Ing basin is 910 MCM/year. Together, 2,196 MCM/year can therefore be diverted into the Nan basin per year during June to December. The Ing-Yot-Nan sections are designed to have a flow capacity of 175 m<sup>3</sup>/sec. The Yao reservoir is designed to have a capacity of 32.8 MCM. Water distribution/balance analysis (with/without KIN Project) is presented to show how the KIN project adds more volume through the Sirikit dam to enable second crop cultivation in the Chao Phrya basin.

#### **(5) Management of the tunnel spoil material**

9 MCM of tunnel muck/spoil material is expected to be dug out as part of the tunnel construction works. 12 locations near the inlet/exit points of tunnels and 7 adits, all of which are mostly deteriorated forest areas have been identified.

**Table 1.1. Planned Project Facilities**

Project facility	Details
Kok Diversion Weir	Use of existing Chiang Rai weir facilitated with eleven spillway gates constructed by DEDP
<b>Kok-Ing Diversion Canal</b>	
(1) Approach Canal	Canal 450 m long, 3 m deep and 150 m wide
(2) Intake structure	Crest length of 100 m facilitated with 6 gates. Intake water level is set at 389 m, MSL
(3) Open canal in Kok basin	Concrete lined canal passing through paddy fields with a length of 12.8 km consisting of 5 siphons, 10 crossing bridges, 20 culvert drains etc.
(4) No. 1 Tunnel	Tunnel 3.0 km long passing through mountain ridge which divides Kok and Tak watersheds
(5) Open canal in Tak basin	Concrete lined canal 3.5 km long passing mainly through paddy field
(6) Culvert/ canal in Tak basin	Some parts of the 6.7 km long canal in paddy fields and foothill area in the Tak basin would require deep excavation exceeding 15 m
(7) No. 2 Tunnel	This 5.5 km long tunnel will pass through mountain ridge between Tak and Ing watersheds
(8) Open canal in Ing basin	Concrete lined canal 22 km long including a culvert section 0.5 km long
<b>Ing Diversion Weir</b>	
(1) Water level at weir	Retention level of 363.5 m; high water level 367 m, MSL
(2) Weir	Rubber dam 100 m long and 3.5 m high
(3) Intake	Concrete structure with a design capacity of 175 cu. M/sec, facilitated with 6 to 8 gates to divert Ing flow into the Ing-Yot tunnel. Flood protection dike with a crest elevation of 367 m will be facilitated.
(4) River training	River course improvement in the upstream reaches to control Kok and Ing water will be required
<b>Lao Diversion Canal</b>	
(1) Open canal	Concrete lined canal 500 m long along the right bank
(2) Culvert	Culvert section 10 km long located along the Lao river to connect Lao open canal and Ing-Yot tunnel. This culvert would require deep excavation of 20 to 25 m.
<b>Yao Ing-Yot Tunnel</b>	A long distance tunnel of about 51 km with a total shaft length of 17 km at 7 different adit locations
<b>Yao reservoir and improvement</b>	Rock fill dam 40 m high, 200 m long with effective capacity of 32 MCM to control flood runoff from the upper Yao watershed in wet season and to supply irrigation water to the beneficial areas along the Yao river in dry season.
<b>Yao River Training</b>	River improvement works including expansion of river width, reinforcement of river bank and bed, installations of weirs and drops to dissipate flow energy, improving existing bridges and adding 5 new bridges; stretching over a distance of about 28 km with design flow capacities of 200 m <sup>3</sup> /sec.
<b>O/M Facilities</b>	O/M facilities include buildings and equipment at proposed Kok and Ing weir sites as well as flood control dam site. Tele-metering system along the water diversion route is to be connected to the operation center at Sirikit reservoir.

**(6) Development of irrigation system in the upper KIN**

34 large, medium and small scale projects totalling about 555,000 rai potential irrigation areas under large and medium scale projects, and 249,000 rai in small scale projects have been identified in the Kok, Ing and Nan (upper part) basins. Among the large and medium scale projects, 15 are under



preliminary study, five are under detailed design stage, one is under construction and 3 are yet to be studied.

**(7) Preservation and development of water sources of KIN basins**

This refers to watershed management strategies and projects planned in the upper KIN. No details of any project are presented.

**(8) Project economic analysis**

The total cost of the project comprising investment, operation and maintenance including environmental operation is 55,578 million Baht. Net present value cost at 12% discount rate is 11,710 million Baht. The ratio of capital, operation and maintenance, and environmental expenses are 96.59%, 2.35% and 1.06% respectively.

**(9) Project Implementation**

The project implementation period (2000-2015) involves four broad works:

- Development of irrigation system in the upper KIN basins. Three potential irrigation projects – the Samun Reservoir Project (Nan Province), Nong Luang Project (Chiang Rai province), Chon Prathan Rat Project (Pha Yao Province) and improvement of 27 public weirs in Ing river are planned.
- KIN Project works;
- Watershed management programs in the KIN catchment areas;
- Works on development and improvement downstream of Sirikit reservoir.

The EIA Report should be referred to for the detailed implementation program.

## **1.2 Present Environmental Conditions**

Table 1.2 presents the scope of the study, methodology adopted, and relevant remarks concerning the study of existing environmental conditions for each parameter. A summary of the results of the existing environmental conditions determined with remarks is presented below.

**(1) Geology**

**(a) Upper Kok Basin**

- Steep slopes, valleys;

**(b) Kok -Ing Basin**

- canal/pipe, tunnel pass through areas where geological characteristics are weathered sediment rock granite hills, and sediment rocks alternatively with volcanic rocks and basalt hill slopes.

**(c) Ing-Nan Basin**

- Initial 2 km of Ing-Yot tunnel passes through area of conglomerate rocks and sandstone which are medium to highly weathered;
- Second section of tunnel 51 km long in length passes through shale rocks, sandstone, tuff rocks, limestone and shale rocks.

**Table 1.2. Study of Existing Environmental Conditions.**

Condition	Scope of Study	Methodology	Remarks
Geology and seismology	Determine geological conditions and earthquake potential along diversion route	Secondary data review, aerial photo interpretation, field geological surveys, geophysical surveys, drillings, pitting and laboratory tests	
Mineral resources	Mining activities and mineral potential of area to determine possible borrow areas	<ul style="list-style-type: none"> <li>• Secondary data review</li> <li>• Field observations</li> </ul>	
Groundwater	Determine any potential groundwater resources that could be along the KIN route	Review of hydrogeological data, field surveys including groundwater sampling (8 wells) twice: <ol style="list-style-type: none"> <li>1. 6-7 April 1996</li> <li>2. 28-29 December, 1996</li> </ol>	Standard Methods used for water quality analysis.
Surface water hydrology and flooding	Determine streams and waterways in the right of way of the KIN route and their characteristics	Hydrological data review (meteorology, rainfall, runoff, diversion water), flooding data and field surveys	
Soil	Determine soil characteristics to determine related impacts on land use and soil erosion and sediment runoff	Secondary data review and field surveys	
Surface water quality	Determine existing baseline conditions: Parameters assessed for are: Calcium, magnesium, Bicarbonate, Carbonate, Alkalinity, Chloride, Sulphate, Nitrate, Phosphate, SS, Dissolved solids, Hardness, Iron, Manganese, BOD, COD, Heavy metal, Insecticide/ Pesticide, (Organochlorines), Faecal coliform, bacteria	Collection of sample <ol style="list-style-type: none"> <li>1. May 27-30, 1996 (Before the rainy season)</li> <li>2. September 4-5, 1996 (In the rainy season)</li> <li>3. February 6-7, 1996 (In the dry season)</li> </ol> Station of sampling 2 Kok Basin 5 Ing Basin 3 Nan Basin	Standard Methods used for water quality analysis.
Erosion and sedimentation	Determine current erosion and sedimentation levels in order to assess impacts due to changed flow regime in rivers as well as changes induced due to construction of project components both temporary and permanent	Compilation of existing data from RID, DEDP, etc. along with field surveys and observations	The rate of bed load is estimated at 30 % of the suspended sediments.

Condition	Scope of Study	Methodology	Remarks
Aquatic fishery and ecology	<ul style="list-style-type: none"> <li>• Fish</li> <li>• Plankton</li> <li>• Benthic organisms</li> <li>• Aquatic plants</li> <li>• Fishing activities</li> </ul> <p>All samples especially fish have been analysed for species type, weighted and counted. Plankton is measured by their capacity in the number of cells per cubic meter. Benthic organisms are estimated by their density per square meter. Aquatic plants studied include those, which grow in water along the riverbanks and close to water resources.</p>	<p>Documents review</p> <p>Field survey</p> <ol style="list-style-type: none"> <li>1. May 26-29, 1996 (In the dry season)</li> <li>2. September 6-9, 1996 (In the wet season)</li> <li>3. February 8-10, 1996 (In the cold season)</li> </ol> <p>Station of sampling Same as "Surface Water Quality"</p> <p>2 Kok Basin 5 Ing Basin 3 Nan Basin</p>	<p>Additional fishery related studies done by JICA study team on fish behavior and migration patterns to determine necessity of structures such as fish ladders and effects of passing through long tunnels at high velocity.</p>
Forestry resources	<p>Determine present conditions of forest vegetation cover and legal status in the project area namely, diversion canal route, tunnel inlet/ outlet and adit locations. Studied items include:</p> <ul style="list-style-type: none"> <li>• Dispersal of forest type</li> <li>• Forest plants community species</li> <li>• Density of species</li> <li>• Important value index</li> <li>• Species diversity</li> <li>• Volume</li> </ul>	<p>Study method</p> <p>Documents review</p> <p>Circular sampling plots</p> <p>Square shape sampling plots</p> <p>Data analysis</p> <p>(a) Ecological data analysis</p> <ul style="list-style-type: none"> <li>• Species frequency</li> <li>• Density</li> <li>• Species dominance</li> <li>• Important value index</li> <li>• Species diversity</li> </ul> <p>(b) Economic data analysis</p> <ul style="list-style-type: none"> <li>• Tree volume</li> </ul>	<p>Construction access road locations do not seem to be adequately covered</p>

Condition	Scope of Study	Methodology	Remarks
Wildlife	Species <ul style="list-style-type: none"> <li>• Amphibians</li> <li>• Reptiles</li> <li>• Birds</li> <li>• Manunals</li> </ul> Density Survey plot <ul style="list-style-type: none"> <li>• 1,000 m long</li> <li>• 200 m wide</li> </ul> 2 seasons Location <ul style="list-style-type: none"> <li>• Kok-Ing</li> </ul> Diversion canal & conduit – 15 locations Diversion tunnel – 4 locations <ul style="list-style-type: none"> <li>• Ing-Nan</li> </ul> Tunnel inlet Tunnel adits (1-7) Tunnel outlet	<ul style="list-style-type: none"> <li>• Wildlife survey</li> <li>• Direct counting</li> <li>• Indirect survey (interviews)</li> <li>• Study of ecological status (food resources, water resources, breeding places, shelters)</li> <li>• Verification of wildlife species</li> <li>• Compilation of wildlife found</li> <li>• Estimation of wildlife density</li> <li>• Classification of wildlife status</li> <li>• Near extinction species</li> <li>• Threatened species</li> <li>• Rare species</li> <li>• Concerned species</li> <li>• Impact Assessment</li> <li>• Wildlife receiving:               <ul style="list-style-type: none"> <li>• Negative impacts</li> <li>• Positive impacts</li> <li>• Capable of adaptation</li> </ul> </li> </ul>	Construction access roads and vicinity are not covered or are covered inadequately
Water Use Irrigation	Determine existing water use and irrigation in KIN area which could be impacted by the ROW of the diversion route	Secondary data review and field surveys done in May 27-29 1996	
Transportation	Determine distances of various project components and construction sites like tunnel inlet and outlet, adits, from existing transportation network Determine necessity of crossing structures across diversion canal Determine needs for road widening and upgrading of proposed access roads as well as construction of new access roads	Secondary data review and field observations	
Compensation and Resettlement	<ul style="list-style-type: none"> <li>• Classification of lands affected</li> <li>• Estimation of compensation of land, building structures and trees affected</li> <li>• Determine new locations of farmlands for compensation</li> </ul>	Primary data – field studies through surveys and interviews Secondary data review  Cost for the development of the relocation areas in Yao dam <ul style="list-style-type: none"> <li>• Improvement of plot area</li> <li>• Public utilities system</li> <li>• Irrigation system, etc.</li> </ul>	Concrete line open canal ROW 150 m. Conduit ROW 200 m.

Condition	Scope of Study	Methodology	Remarks
Socio-economic study	<ul style="list-style-type: none"> <li>Regional Overview</li> <li>Socio-economic condition in project area</li> <li>Opinions towards the project</li> </ul>	<ul style="list-style-type: none"> <li>Secondary data review</li> <li>Interview surveys (3582 samples in the KIN Project area, behind Sirikit dam, and the Chao Phraya Irrigation Project Area</li> </ul>	
Public health and nutrition	<ul style="list-style-type: none"> <li>Life expectancy</li> <li>Population census</li> <li>Cause of illness &amp; death</li> <li>Status of nutrition</li> <li>Public health centre</li> </ul> <p>Due to long construction period as well as extensive complicated construction work, large influx of new construction workers and colonies is a certainty. This is to determine baseline health conditions in project area to take remedial action during construction and operation phase.</p>	<p>Compilation of secondary data</p> <p>Field survey</p> <ul style="list-style-type: none"> <li>Physical examination</li> <li>Stool sample</li> <li>Shellfish sample</li> <li>Fish sample</li> <li>Mosquito sample</li> <li>Community public health</li> </ul>	-
Archaeological and historical sites	Identify sites within project area to assess impacts	<p>Documents review</p> <ul style="list-style-type: none"> <li>Initial field survey</li> <li>Map 1/50,000</li> </ul> <p>Field survey</p> <ul style="list-style-type: none"> <li>Preparation survey</li> <li>Field survey stage</li> <li>Point marking survey (10 km<sup>2</sup>)</li> <li>Interview, etc.</li> </ul>	Avoiding these areas has been a major objective in selecting route and siting of project components.
Aesthetic and tourism	Identify sites to determine impacts and mitigation measures	<p>Documents review</p> <ul style="list-style-type: none"> <li>Summary report from Chiang Rai, Phayao and Nan Provinces</li> <li>Tourism Magazine <i>Aor-Sor-Tor</i></li> <li>Tourism promotion documents by TAT</li> </ul> <p>Field Survey</p>	Avoiding these areas has been a major objective in selecting route and siting of project components.

## (2) Earthquake

- Majority of earthquake incidences (greater than 4 on the Richter scale) occurred more than 200 km from Project area in the last 85 years;
- Earthquake incident in Northern Thailand is not high (less than 4.0 on the Richter Scale).

## (3) Groundwater

- Geo-hydrological conditions – two types of groundwater – within loamy rock area and within cracks;
- 9 categories of aquifers identified in the KIN basin and their characteristic and details are presented;
- Level and direction of flow of groundwater is characterised in each basin;
- Quality of groundwater in general was good in all places sampled.

#### (4) Surface Water Quality

##### (a) Kok River Basin

- High turbidity in wet season
- Low organic pollution
- Kok river is classified under Class 2 of the NEB surface water quality classification (as in Table 1.3)
- High iron content in wet season flow
- Heavy metals and organochlorine not detected

##### (b) Ing River Basin

- Upstream of Nam Mae Loi ranked Class 3 of NEB classification
- Nam Mae Loi ranked Class 3 to 4; organic contamination evident from faecal coliform and BOD values
- Nam Mae Lao and Ing river are similar in characteristic to Kok river. They can be classed under Class 2.

##### (c) Nan River Basin

- Huai Yod – Class 2 surface water quality
- Nam Yao – Class 2 surface water quality
- Nan river – turbidity high in wet season river is ranked under Class 2.

**Table 1.3. NEB Surface water quality classification, Notification of the NEB No. 8, B.E. 2537 (1994), published in the Royal Government Gazette, Vol. 111, Part 16, 24 February B.E. 2537.**

Class	Objectives/Condition & Beneficial Uses
Class 1	Extra clean fresh surface water resources used for: (1) consumption, not necessary pass through water treatment processes, require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
Class 2	Very clean fresh surface water resources used for: (1) consumption which requires ordinary water treatment processes before use (2) aquatic organism of conservation (3) fisheries (4) recreation
Class 3	Medium clean fresh surface water resources used for: (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
Class 4	Fairly clean fresh surface water resources used for: (1) consumption, but requires special water treatment process before using (2) industry
Class 5	The resources which are not in classified in classes 1 to 4 and are used for navigation

#### (5) Erosion and Sedimentation

Sedimentation data from 30 monitoring stations (18 in Kok, 3 in Ing and 9 in Nan) were analysed. The rate of bed load is estimated at 30% of the suspended sediments. The results are summarised in Table 1.4. The overall sedimentation rates were analysed as being 0.0982 mm/year for the Kok and Ing Basin and 0.1049 mm/year for the Nan Basin.

**Table 1.4. Sedimentation data from monitoring stations.**

Location	Quantity of bed load (tonne/year)	Suspended sediments (tonne/year)	Erosion rate (mm/year)
In-take at Kok	139,290	464,300	0.077
Ing at Thoeng Bridge	120,450	401,499	0.077
Outlet of Tunnel	1,583	5,278	0.169
Yao Dam	12,468	41,559	0.115
Sirikit Dam	985,142	-	0.067

**(6) Aquatic Ecology and Fishery**

- A wide variety of fish family and species seen. A total of 20 families and 98 species of fish were identified. Of these fish species, 33 were in Kok basin, 69 in Ing basin and 49 in the Nan basin.
- There is a considerable diversity in plankton species with the highest seen in Nan river.
- Benthic organisms have the highest density in the Nan basin.
- Aquatic plants exhibit 19 species in 15 families. These include two species of floating plants, one species of partially emerging plants, 4 species of submerged plants and 12 species of emergent plants.

**(7) Forest resources**

**(a) Regional Overview**

- Northern Thailand faces most extensive forest encroachment averaging 0.71% per year
- Kok basin has 3 out of 23 national forest reserves in Chiang Mai province and 12 out of 30 national reserve forests in Chiang Rai province. Forest cover decreased continuously and it is estimated at 65%, 53% and 37% respectively of the total province area in Chiang Rai province in 1961, 1973 and 1989.
- Ing basin- There are 29 national reserve forests occupying 55% in the Ing watershed area in Phayao and Chiang Rai provinces. Forest cover decrease in Phayao province due to encroachment during 1976-91 is around 480,000 rai or 20%. Reforestation achieved during 1982-91 was only 10,000 rai.
- Nan basin: has 66 national reserve forests in 6 provinces. Chad Trakan waterfall area having area of about 340,000 rai is a declared national park. Doi Phu Kha of area 731,250 rai is another national park under establishment. There are several wildlife conservation areas – Doi Pha Chang, Phu Miang, Phu Thong – totaling 340,625 rai, Tham Pha Tuh, Phu Soi Dao, and Kang Chet Daeng are other areas.

**(b) Project route and forest classification**

Diversion route runs across 5 national reserve forests:

- Huai Sak and Mae Kok (right bank)
- Khun Huai Ngew, Chiang Khien and Khun Huai Pong
- Doi Ta and Doi Bor Som
- Nam Peuy, Nam Yuan, Nam Lao
- Nam Yao and Nam Suad

Diversion route runs across and underneath conservation forest area for about 60 km, economic forest area (E) for approximately 0.5 km, and forest area suitable for agriculture (A) for approximately 0.5 km.

Adits numbers 4, 5, and 6 are located in the Conservation forest area of Nam Peuy, Nam Yuam and Nam Lao national reserve forest while adit number 7 and tunnel outlet are in the Conservation forest area of Nam Yao and Nam Suad national reserve forest.

About 27 km of Ing-Yot tunnel is located underneath watershed class 1 area. However, headwork area comprising inlet/outlet area, adit locations, diversion canal and conduit route are not located in area classified as Watershed Class 1.

Totally 1062 rai of Forest Conservation Area (C) needs to be acquired for the project facilities. Majority of which is for the adits and spoils material disposal sites along the Ing-Yot tunnel route (797 rai).

(c) Field survey results

*Kok-Ing*

- General: Project area (within assumed Right of Way of project facilities) consists of lowland agricultural area being used for rice farming along diversion canal and conduit route, and highland area where slash and burn (swidden) cultivation is being practiced.
- Inlet and Outlet of Ban Don Mun: dipterocarp forest cover, 30 species of plants/ trees, low tree density, low sapling density, slash and burn cultivation seen, tree species diversity is high;
- Doi Mon Kong Khao: Mixed deciduous forest area around foothills and dipterocarp forests on ridges up to hilltop, low density of trees but tree species diversity is high;
- Sinthorn Farm: Secondary mixed deciduous forest, tree species density is low, area seems to be under transition from abandoned land to primary forest and has significant potential for reforestation;
- Tunnel Inlet/ Outlet near Ban Huai Kang: Land used for agriculture (corn, fruit tree orchards), forest tree cover is only near mountain ridge upto the top approximately 500 m north of tunnel inlet/ outlet; these areas have low tree density and low species diversity, Bamboo (a secondary colony) is found commonly scattered in the area.

*Ing-Yot*

- General: land use near tunnel inlet/ outlet and all 7 adits is being used for agriculture, crop rotation of corn, tapioca, cotton and vegetables like cabbage is widely practiced.
- Adit No. 3: Mixed deciduous forest with extensive bamboo; agricultural land use near inlet where rice and other crops are being cultivated, low tree and sapling density and diversity
- Adit no. 4: agricultural land use with corn, and upland rice, cotton common in steep slope areas, on the upper hills, evergreen forest and dipterocarp forest seen with at least 20 different species
- Tunnel outlet near Ban Pha Lak: slash and burn cultivation area now abandoned, tree species diversity is low, seedling density and diversity high, some seedlings a source of income for local people (*Zanthoxylum alston*)

(8) Wildlife

(a) Kok-Ing route

*Species diversity*

199 species with 13 amphibians, 39 reptiles, 123 birds and 24 mammals; most species found are widely distributed in Thailand also. 11 bird species have high population density, most mammals found are small in size and can adapt to changing environment, three mammal species have high density



#### *Ecological condition*

- Open diversion canal and conduit: almost entire area along and close to the diversion route is used for agriculture; condition of land within 1 sq. km upstream of diversion route is mostly abandoned agricultural use land;
- Inlet of Tunnel 1: area consists of slopes; near foothills and mountains mixed deciduous forests on the lower slopes and dipterocarp forest on steeper slopes are common; wildlife found are few in species and density
- Outlet of Tunnel 1: area consists of high and wide slopes with wide creeks in between or continuous narrow and wide plains; present agriculture land use is corn and cassava cultivation;
- Inlet and Outlet of Tunnel 2: area consists of slope areas on hills or foothills; present land use is for cultivation of corn but the area was probably once covered by mixed deciduous forests; some areas are covered by clusters of bamboo.

#### *Legal status*

Of the 199 species found, 124 species are protected including 15 reptiles, 102 birds and 7 mammals; 1 species of reptiles and one species of mammals is classified under endangered status.

#### (b) Ing-Nan route

##### *Species diversity and population density*

241 species with 20 species of amphibians, 42 species of reptiles, 143 species of birds, and 36 species of mammals are found; 1 species of amphibians, 8 species of reptiles, 14 species of birds, and 5 species of mammals have high population density.

#### *Ecological condition*

- Tunnel inlet: extensive slopes, combination of mixed deciduous and dipterocarp forest, several areas cleared for field crop cultivation; no large mammals are found due to insufficient forest cover.
- Tunnel adits: Topographical features of areas near all adits are slopes on foothills or steep mountains; land has been cleared in both lowland and on upland for shifting cultivation with corn and cotton being common; some adit areas like 5 and 6 have water courses and streams nearby. Wildlife to be found in these areas generally feed in the open especially birds; some medium size mammals are reported to migrate into the project area for feeding purposes; rats, lizards, skinks, snakes and many bird species are common.
- Tunnel outlet: hills, uneven slopes on foothills, vertical slopes on limestone hills and narrow plains between these features characterise the area; plains, hill slopes and foothills are being used for crop cultivation with some abandoned areas and secondary growth of dry evergreen forests on the hills; wild animals in few numbers are reported in the areas with forest habitat including small and medium sized mammals; many species of birds common.

#### *Wildlife legal status*

163 species found are protected including 1 species of amphibians, 17 reptile species, 129 bird species and 16 mammal species; 78 species are not protected. Out of the total 241 species, 1 species is near extinction and 7 are threatened including 3 reptiles, 1 bird species and 3 mammals.

#### (9) Mineral resources

There is concentration of mineral resources in the mountain range west of Chiang Rai province and smaller number in Phayao province. Some mineral deposits are found in the mountain range southeast of Nan province. No mineral mining is carried out in the project area. All mines have been

temporarily closed due to low production. Limestone mining may have potential though this needs assessment. Later in this report, the potential uses of spoil materials including limestone deposits, which result due to tunnelling, are assessed. Again, this would largely depend on the composition of the spoil material.

#### (10) Transportation

##### (a) Land transportation network

Highway nos. 1, 101, 103, 1202, 1021 and 1020 transverse the study area. Annual traffic quantities are low and are mostly bicycles, 4-wheel trucks and private vehicles

##### (b) Project features and road access & condition

- Diversion dam in Kok and Ing watercourses  
Asphalt 2 lane good source condition roads to dam site
- Canal route and diversion channel  
The route crosses highways and minor roads at few points
- Tunnel inlet at Kok-Ing  
Laterite road 5 m wide is 3 km from inlet location to Highway no. 1021
- Adit locations in Ing-Nan
  - No. 1: Inter-village road from Highway no. 1021 ending in a laterite road 3 to 4 m wide. The adit inlet is 6 km from Highway no. 1021.
  - No.2: Access road to adit has laterite surface and is 3 to 4 m wide. It is 15 km from Highway no.1021, a large part of it before the laterite road being Highway No. 1093.
  - No.3: Access road with laterite surface 5 m wide is 500 m from Highway no. 1021.
  - No. 4: Access road with laterite surface (2 km from Highway no. 1021) is narrow (3 to 4 m wide), steep and uneven, with landslides during the wet season.
  - No. 5: From Highway no. 1021, a laterite road 6 km long and 3 to 4 m wide provides access to the adit location. The road is narrow, fairly steep, uneven and is obstructed by Nam Yuam watercourse.
  - No. 6: Access road to adit location from nearest highway no. 1021 is 18 km long, has a laterite surface, is very steep and prone to landslides.
  - No. 7: Main road in Highway no. 1148 leading to Highway no. 1021 over a distance of 45 km. The access road from Highway no. 1148 is 6 km long, 7 m wide, has an asphalt surface leading to Yod village and ending at the adit.
- Tunnel outlet  
Main nearest road is Highway no. 1148, which connects to an asphalt road (laterite 6 months before) passing Ban Pha Lak and leading to the tunnel outlet. Total distance is approximately 7 km.

#### (11) Socio-economic study

Regional overview: In donor basin provinces, 36% of land is agricultural land while in the beneficiary basin, 80% is agricultural land. Land utilisation due to lack of irrigation and cost restrictions is low in donor basins (38% of land used 76 to 90% of time). In the beneficiary basins, land utilisation is high (53% of land being used up to 90 % of time). Farm size in donor basins varies from 0 to 5 rai while in the Chao Phraya basin it is generally around 11 to 20 rai. The donor basin area people also have limited access to piped water (40%). The majorities of people along the KIN project route have their own land (about 12.4 rai per household) and are primarily used for rice farming followed by cash crops.

Results of public campaign meetings done in each sub-district (Tambon) to inform local people of the Kok-Ing-Nan Project by the TEAM J/V group are summarised below:

(a) People Along the Kok-Ing Diversion Route

- Project generally acceptable
- Concerned about mode, amount and timing of compensation for land and their houses or properties.
- People are well receptive to the open diversion canal and the planned outlets for releasing water into their existing Peoples' Irrigation Project areas.
- Many suggestions for the development of the small scale irrigation development projects in the Kok basin.
- They are very sensitive and concerned on the effect of the diversion canal construction on their existing Peoples' Irrigation canal systems. These concerns relate to flood flow, blockage of water to PIS, construction machinery temporary use of their lands and crossing structures across diversion canal. :
- Request for Irrigation development in the Nam Lao.

(b) People Along the Ing-Yot Diversion Route

- People are quite disappointed about the route and planned structures, as they will not be able to access the diverted water because it is mostly carried within the tunnel or the cut and cover conduit. The tunnel and conduit are quite deep below the ground surface.
- People were asked to propose other water resources development in their vicinity areas, be it the small-scale irrigation projects or other kind of development. This was for consideration of alternative supporting projects for their benefit.
- Serious concerns were expressed regarding tunnel spoil material quantity, quality, disposal and effects on their land and water resources.

(c) People in Nam Yao Basin

- In the Nam Yao area, the terrain is hilly and mountainous, except that near the river confluence with the Nam River. The people are very concerned about losing their lands, especially those people in the proposed Nam Yao reservoir area. They requested assistance in finding suitable land for resettlement.
- Many people have got the wrong information that the government is going to charge for water that is taken from the Nam Yao River.
- Some said that the project main purpose is to divert water for electricity generation at the Sirikit Dam.
- Information on the Na. Yao River Improvement, to accommodate the diverted water discharge has been given to these people. Generally, they include:
  - The width of the river at particular reach (at each km.),

- How the river is going to be improved, by dredging, widening and building some retarding weirs,
- How the operation of the Project will be done so that the diversion will be stopped in the event of impending flood in the Nam Yao or Nan River.
- One particular village, i.e., Ban Na Nun #1, whose villagers are very concerned that the additional diverted discharge, will inundate their agricultural lands that used for growing tobacco plant in the dry season.
- Usual concerns about compensation and resettlement were expressed.
- The forestry workers from the DANCED project asked the sediment problem and impact to the existing aquatic plants.
- Some 6 small-scale pumping irrigation projects approx. 2,300 rai in total area, have been conceived for people along the Nam Yao River.

## (12) Compensation and relocation

Cash compensation for land, building structures and standing crops and trees is considered for people affected. Relocation studies in finding suitable new farmlands for affected people were studied with the criteria that these are close to old plots as possible. Results are summarised as follows:

Private land, which needs to be acquired, is 8,506 rai of which 7,236 rai is in use. These lands include 2,899 rai corn fields, 584 rai annual/perennial plants, 544 rai various crop fields, and 554 rai of mixed orchards. Another 507 perennial plant areas are near residential areas. 13 residential/commercial structures including 9 houses, barns and chicken farm are affected. All the above resources are owned by 2,391 households and are valued at around 625 million Baht.

Peoples' needs for procurement of new farmlands (land for land instead of cash compensation) were different in various areas of the KIN project route. Areas where this need is high include the stock piling area of Ban Don Chai, Ban Hua Na, and Ban Yot (47 households), Yao reservoir area (32 households), and Yao River Restoration Area (290 households).

Possible alternative land for a 'land for land' compensation were identified at:

- 100 rai in Phu sang sub district near Ban Hua No tunnel spoil area.
- 174 rai owned by villagers at Ban Yot who are willing to sell;
- 1200rai forestation areas in control of Khun Prik water source management Unit and 1743 rai owned by villagers nearby;
- Yao River Restoration area – 825 rai in Ban Wang Phang areas (Pha Thong sub district, Tha Wang Pa sub district) which are mostly abandoned areas, and 1700 rai in Ban Phaw (Rim sub district, Tha Wang Pha sub-district), and 150 rai owned by villagers of Ban Na Noon and Ban Wang Phang.

## (13) Public health and nutrition

- Public health resources like general hospital, community hospital, health care centres, and community health care centres are found to be present in reasonable numbers in the districts and villages of the project area. Child nutrition is a major problem in the area. Mosquito-borne diseases, particularly malaria, are a major problem.
- Life expectancy: There is an increase in death rate of new born babies since early 1990s;
- Major cause of death in Chiang Kham and Thoeng districts is HIV diseases as per 1995 data
- Status of nutrition is a problem in children;

- Regarding diseases related to water resources development, malaria is a major problem. Encephalitis, Dengue and Elephantiasis which are also mosquito borne, are controllable diseases already. Diseases infected through water and food showed no tendency to decrease as per 1993-95 data.
- A major public health concern is AIDS

(14) Archaeological and historical sites

Eleven sites were determined near the diversion route and facilities- seven in the Kok-Ing basin and four in the Ing-Nan basin that may be affected by the project. These are as follows:

Wat Pa Yang Mon	Wat rad Samak
Buddha Boran Ban Pho Chai	Wat Phra That Phu Sang
Khai Charoen School	Buddha's Footprint O Ban Ton Pheung
Wat Chai Narai	Wat Ban Yod Ordination Hall
Ban Huai Kang Archaeological site	Wat Tham Wi Wek
Wat Phra Borom	

(15) Aesthetics and Tourism

Tourist attractions of significance close to project facilities are as follows:

Tourist Attractions in Kok-Ing	Tourist Attractions in Ing-Nan
Nong Luang	Phu Sang Waterfall
Buddha Boran Ban Pho Chai	Wat Phra That Sob Waen
Phra That Chom Chor	Tham Pha Toob
Wat Thoeng Sao Hin	Wat Nong Bua
Phu Chi Fah	Thai Lue Nong Bua Village
	Phra Borom That Chaer Hang

1.3 Environmental Impacts and Mitigation Measures

A summary of the environmental impacts due to the selected project facilities during project construction and operation stage, assessment of the significance of negative impacts and proposed environmental mitigation measures to minimise negative impacts, for various environmental parameters is presented in Table 1.5.

Table 1.5. Summary of Environmental Impacts and Mitigation Measures

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
<b>Physical Resources</b>			
Geology, Earthquake and Mineral Resources	Weathered Rocks and fault areas present along tunnel route, which could cause rock fall, rock burst and groundwater seepage. Impact from Earthquake low as area classified under low risk (Richter Scale less than 4)	Low as it can be controlled by suitable design and construction methods.	Suitable tunnel construction methods like New Australian Tunnelling Method (NATM), use of widened horseshoe pattern, rock bolting, shotcreting, tunnel lining and safe drilling practices;
Groundwater	Irrigation canals, pipes and tunnel construction areas prone to groundwater seepage through fractures and cracks; Construction period – shallow groundwater aquifers where present could be affected; Operation Period – water-logging possible	Low if adequate measures to drain water are in place; Low	Earthquake resistant design Seepage and Drainage control plan
		Not known; monitoring necessary	Groundwater monitoring

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
Surface Hydrology	<p>Construction Period</p> <p>Kok-Ing Route</p> <ul style="list-style-type: none"> <li>• Diversion canal - Impact on 4 natural waterways for construction of Siphon;</li> <li>• Conduit - impact on 2 natural waterways;</li> </ul> <p>Ing-Nan Route</p> <ul style="list-style-type: none"> <li>• Headwork area Ing River- affected during construction of approach channel and diversion gate;</li> <li>• Conduit - cuts across two waterways</li> <li>• Outlet of Tunnel 2 -300 m from water source</li> <li>• Adits - Adit 5,6, and 7 are close to rivers flowing all year around;</li> <li>• Tunnel Muck disposal areas - all at or near surface water bodies</li> <li>• Yot river - construction of 5 weirs will obstruct flow</li> <li>• Nam Yao reservoir - construction requires temporary river diversion</li> <li>• Nam Yao river training works - will impact natural river flow during construction;</li> </ul>	<p>Low if construction done in dry season only</p> <p>And other mitigation measures proposed are implemented</p>	<p>Construction in dry season only;</p> <p>Preventive methods like adequate provision of drainage and sediment traps to avoid soil runoff especially at tunnel muck disposal areas which are close to water bodies;</p> <p>Provision of alternative drainage infrastructure if natural flow of water body is disrupted temporarily during construction;</p> <p>Construction management by Construction Contractors</p>
Flooding	<p>Operation Period</p> <p>Low or no impacts</p> <p>Flooding potential upstream of diversion point in Kok river, upstream of diversion point in Ing river, and upper part of Nan basin is possible</p>	<p>Low or none</p> <p>Low if mitigation measures proposed are implemented</p>	<p>Monitoring of tunnel muck disposal areas</p> <p>Installation of telemetering system for rainfall and river flow predictions;</p> <p>Control of diversion water in Kok and Ing river not to exceed design levels in rainy season;</p> <p>Improvement works to prevent flooding in upper Nan basin include:</p> <p>Construction of 5 weirs to reduce flow velocity in Huai Tot;</p> <p>Nam Yao river improvement works including construction of 5 weirs to reduce velocity along Nam Yao, enlargement of river width, dredging to increase river depth and necessary infrastructure like bridges and crossing structures across the river and for accessing the river, and</p> <p>Control of water flow diversion using Yao reservoir in case of flood warning in Nan basin</p>
Soil	<p>Loss of area with good soil for agriculture required for constructing head work and component structures in Kok basin (22 rai) and Ing basin (115 rai);</p> <p>Slope stability and soil runoff in canal excavation area and cut/fill area</p> <p>Loss of top soil in areas to be used for storage of tunnel spoil material</p> <p>Soil wash away and runoff contribution to erosion and sedimentation in Nam Yao reservoir area;</p> <p>Fertile soil loss , slope stability of river banks in Nam Yao basin due to dredging and widening of river banks (100 rai land will be disturbed)</p>	<p>Impact low if adequate and fair compensation is provided;</p> <p>Low if adequate mitigation measures adopted;</p>	<p>Limiting area for construction by appropriate siting and design;</p> <p>Careful siting of Project facilities and construction camps;</p> <p>Project construction management including works to be carried out only in dry season;</p> <p>Implementation of re-vegetation strategies wherever applicable with proper storage of topsoil after initial removal for future use;</p> <p>Adequate spoil material disposal site management.</p>

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
Erosion and sedimentation	<p><b>Construction Period</b> Soil erosion would be high in areas with moderate to high slope; soil erosion rates calculated using Universal Soil Loss Equation for existing, without mitigation measures and with mitigation measures indicate soil erosion rates without mitigation to be extremely high and unacceptable while with mitigation measures vary from lower to slightly higher than standard and existing condition. Quantity of sediment load into the river beds was estimated from the catchment erosion rates. Results show that for all situations, the Catchment Erosion Rate (CER) is lower than 0.02 mm/year. Project will not impact sedimentation to any significant level.</p> <p><b>Operation Period</b> Soil erosion negligible, as project area will be rehabilitated. On high slope and rock piling areas landscaping and vegetation and crop cover will be present; adequate storm drainage will be provided.</p>	<p>Impacts severe if mitigation measures are not implemented. Implementation of mitigation measures in many cases improves over existing conditions.</p> <p>Insignificant</p>	<p>Construction management to avoid activities leading to high soil loss and runoff in the wet season; Piling of excavated soil only on construction sites to prevent washout into water bodies; In high slope area, soil and rock is to be piled in terrace form; Retaining wall and drainage channel should be constructed along with diversion canal; Soil cut operations should be for short stretches in minimum time and backfilling should be completed before cutting up next section; After construction and land leveling of the headworks and diversion canals, cover crops should be immediately planted.</p>
Surface water quality	<p>Increase in suspended solids(SS) in surface waters due to soil erosion as a result of construction activities if no mitigation measures are in place</p> <ul style="list-style-type: none"> <li>• Kok Basin - 2.1 to 4.1 mg/l increase in diversion canal areas sections 1 and 4, 1.5 mg/l increase in section 2 of diversion canal</li> <li>• Ing basin impacts (low level) on water bodies due to spoil disposal area from Tunnel 1 and 2 (0.9 to 1.5 mg/l increase in SS),</li> <li>• Ing-Yot section causes an increase of 4.4 mg/l</li> <li>• Tunnel spoil materiel area from adits 1 to 6 causes an increase of 0.4 to 0.9 m/l.</li> <li>• Nan basin - Yao reservoir SS could rise by 20.7 mg/l. Tunnel outlet and improvement area of Yao basin, the SS increase could be 4.2 and 7 mg/l respectively</li> </ul> <p>Impact of wastewater from Construction worker camps - 1000 estimated workers in 8 to 10 camps, 25-30 m<sup>3</sup>/d wastewater possible from these camps.</p>	<p>Negative impacts low if mitigation measures are put in place to control erosion and SS increase in surface waters.</p> <p>Impacts low if adequate sanitation and wastewater treatment facilities are provided at each camp</p>	<p>To reduce impacts of soil erosion Measures mentioned above need to be implemented; Contractors Construction plans should be regularly monitored;</p> <p>Operation period - Proper maintenance of vegetation cover on slopes and canal banks, control of flow rate in diversion canal to control sediment rate Promotion of watershed management and green agriculture practices in the watersheds</p> <p>Camps at least 150 m away from water bodies; Adequate sanitation and wastewater treatment facility at each camp site</p>

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
<b>Ecological Resources</b>			
Aquatic ecology and fishery resources	<b>Construction period</b> <b>Kok-Ing route</b>		<b>Construction Period</b>
	<ul style="list-style-type: none"> <li>Head works on Kok River involving construction of pumping station, water gate and connection to diversion canal will have low impact as construction will occur in dry season only;</li> </ul>	Low	<ul style="list-style-type: none"> <li>Construction in dry season as far as possible to avoid sediment flushing into water bodies;</li> </ul>
	<ul style="list-style-type: none"> <li>Construction of 4 siphons over a period of 19 months will moderately affect aquatic ecological resources. Impact on fishery resources is low due to low production;</li> </ul>	Moderate on aquatic ecology and low on fishery resources	<ul style="list-style-type: none"> <li>Construction of water diversion canal and conduit in segments to shorten construction time and avoid sediment flushing;</li> <li>Provision of sediment retention ponds during construction period where appropriate;</li> </ul>
	<ul style="list-style-type: none"> <li>Conduit, Tunnel inlet area and Tunnel muck disposal area – impacts low or none;</li> </ul>	Low or none	<ul style="list-style-type: none"> <li>Nam Loe rehabilitation should be done in winter and dry season only. Excavated dredge should be stored at least 50 m away from water bodies and dike built around it to prevent sediment wash off;</li> </ul>
	<ul style="list-style-type: none"> <li>Nam Loy improvement – involving dredging and widening of river over 1.4 km will have low impact if construction works are restricted to the dry season.</li> </ul>	Temporary and low if construction is only in dry season	<ul style="list-style-type: none"> <li>Worker construction camps should be at least 150 m away from water bodies;</li> <li>Construction waste like oil and grease should not be allowed into waterways by installing structures like trap ponds;</li> <li>Rehabilitation of Nam Yao should be done in 100-200 m sections.</li> </ul>
	<b>Ing-Yot route</b>		<b>Operation Period</b>
	<ul style="list-style-type: none"> <li>Head works on Ing river – construction of water diversion dam, canal and water gate will have impact due to higher turbidity and disturbance of benthic organisms;</li> </ul>	Low to moderate if controlled by suitable construction management	<b>Kok-Ing Route</b> Control of water gate at Mae Kok inlet and regulation gate at diversion canal;
	<ul style="list-style-type: none"> <li>Diversion Canal – No impact</li> </ul>	Low temporary impacts if done in dry season	<b>Ing-Yot Route</b> Control of water gate at Ing regulation water gate and control of flow rate at diversion canal to keep turbidity levels down downstream
	<ul style="list-style-type: none"> <li>Diversion culvert low level temporary impacts at two river sections – Lao and Ngao rivers during 3-4 months construction period;</li> </ul>		<b>Yao reservoir</b> Watershed conservation activities to preserve and regenerate forests along the banks and management of fishery resources to be developed in the reservoir under Department of Fisheries conservation program
	<ul style="list-style-type: none"> <li>Tunnel inlet/outlet – no impact;</li> <li>Tunnel adit areas and spoil storage areas – 1 to 4 and 7 small water bodies flowing only in wet season – impacts low; 5 and 6 may have significant impacts as they are located close to Nam Yuan river flowing all year;</li> <li>Yao reservoir construction may cause impacts downstream in Yao river due to sediment runoff;</li> <li>Huai Nam Yot and Nam Yoi improvement - Moderate impacts on aquatic life and fishery resources</li> </ul>	Adits 5 and 6 impacts significant – needs careful construction management  Impacts on Yao river;  Impacts moderate with suitable management	
<b>Operation Period</b>			
<ul style="list-style-type: none"> <li>Impacts on aquatic resources and fisheries species diversity in the three basins due to trans-basin water transfer in assessed to have no adverse impacts;</li> <li>Passage of fish in long 52 km Ing-Yot tunnel is determined not to be harmful to the fish resources;</li> <li>Yao reservoir could be a source for increase in fishery resources area;</li> <li>Fish migration problem between the three basins is controlled through construction of appropriate structures as fish ladders.</li> </ul>	Impacts determined to be low  Low  Beneficial impacts  Impacts low		



Resource	Impact Characteristics	Impact Significance	Mitigation Measures
Forest resources	<ul style="list-style-type: none"> <li>Kok Ing route passes through agricultural area mostly with the tunnel section going below National Conservation Forest area. Diversion canal route passes through Roi Sinthorn plantation which is a secondary forest with low species diversity;</li> <li>Ing-Yot tunnel passes under National Conservation Forest area; adits locations are all in agricultural lands;</li> <li>Forest areas are affected by tunnel stock piling area of adits 4,5 and 6 which is unavoidable. These are valued totally at 432,400 baht;</li> <li>Yao reservoir construction will involve loss of 980 m<sup>3</sup> of forest trees valued at 960,912 Baht.</li> </ul>	Impacts low as Conservation forest areas are avoided and minimal loss of secondary forest areas occur;	<p>Implementation of afforestation for any forest resource lost within Conservation forest areas;</p> <p>Control of illegal forest logging and tree cutting during project construction period;</p> <p>Control of use of construction access roads;</p> <p>Tree cutting to be minimal;</p> <p>Promote watershed conservation practices and water conservation projects;</p> <p>Implementation of forest fire protection measures</p>
Wildlife	<ul style="list-style-type: none"> <li>Habitat loss/ fragmentation caused by project facilities of the KIN project lead to high level impact on 4 species whose status is threatened species. These are the Asiatic Black Bear, Asian Wild Dog, Malayan Porcupine and Yellow Tortoise.</li> <li>Medium level impacts are caused on 25 species which include: <ul style="list-style-type: none"> <li>animals which use tree holes for habitats and nestings (1 mammal the Phayre Flying squirrel, 16 bird species);</li> <li>wildlife whose distribution is limited in this area of Thailand (2 reptiles and 3 birds), and</li> <li>3 near threatened species (Burmese Python, Malayan Pangolin, Fishing Cat);</li> </ul> </li> <li>Low level impact is caused on 46 species, which include 7 amphibians, 3 reptiles, 24 birds and 12 mammals.</li> <li>Ing-Yot Tunnel inlet/outlet and vicinity of location of adits and tunnel spoil areas are areas receiving high negative impact due to disturbance of wildlife who may use these areas temporarily and move in/out to nearby forest habitat areas</li> </ul>	Wildlife impacts are assessed and significance determined based on their being threatened species or by loss of habitat (tree holes only) which may be lost by tree cutting; considering other conditions such as adaptability to changed conditions and ability to escape from project areas, wildlife distribution and abundance, it is concluded the impacts are negative but their significance is low level.	Preservation of important wildlife habitats as far as possible; avoiding and keeping tree cutting to a minimum; ban on hunting and poaching of animals, minimising forest area requirements for project facilities like access roads; appropriate siting of construction worker camps far away from important habitats and forest areas; implementation of various sediment and erosion control plans given earlier for preservation of aquatic flora and fauna; re-vegetation and re-plantation where applicable to allow for regeneration of biotic communities and habitats are some of the mitigation measures applicable in all project areas to minimise negative impacts on wildlife.
<b>Human Use Values</b>			
Land use and Agriculture	Main impacts are loss of agricultural land, forests and houses. Loss of agricultural land required for various project facilities will impact agricultural production. Land severance along alignment route will also be a major issue. These issues are discussed later under "Compensation". Operation period - 45,800 rai area along diversion route will have irrigation water available in rainy season;	Impacts to be controlled by provision of adequate and fair compensation for lost land as per governmental regulations	Minimise land required for project facilities construction; Adequate and fair compensation for land acquired; Develop other idle land and Tunnel Spoil area for agricultural use

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
Water use/irrigation	<p>Impacts on existing water use of water sources in the right of way of the KIN project facilities will not be significantly affected, adequate provisions in the form of drainage infrastructure will be provided to ensure the natural flow and direction is maintained in all these water bodies during construction stage.</p> <p>As the water diversion (surplus water) is to occur only in the wet season, existing water use in Kok and Ing basins will be unaffected during project operation.</p> <p>Project benefits in the Chao Phraya basin due to availability of irrigation water.</p>	<p>Impacts low which are controlled by provision of drainage infrastructure across right of way</p>	<p>Provision of adequate temporary drainage infrastructure at the right of way of KIN project facilities during construction stage to ensure existing water bodies and their users are unaffected;</p>
Transportation	<p>Impact of increased traffic due to project construction activities on the transportation network is determined to be low as projected traffic on these roads is low and can easily absorb the traffic flows due to project construction at various locations. Many of the access roads proposed for use to adits, tunnel inlet/outlet locations, river head work locations etc. are used sparingly by local people. Impacts of noise, dust and vehicle exhaust pollution is also assessed to be low due to the rural setting and distance from residential areas of all proposed access roads.</p> <p>Construction of new access roads, bridges and improvement of existing laterite roads due to the KIN project will benefit the rural population of the Kok-Ing-Nan basins by better and speedy transportation of their agricultural products.</p>	<p>Low level impacts</p> <p>Adequate traffic safety and management on all access roads to construction sites to be implemented.</p>	<p>During construction stage, adequate traffic safety is to be ensured by proper traffic planning on all access roads and construction sites. Warning signs, operating hours, access restrictions, speed limit indications and adherence and pollution reduction measures like watering for dust suppression and exhaust emissions control need to be implemented by construction contractors at each construction site. Co-operation and working arrangements with local police and transportation officers of local villages would be done to ensure control of transportation related negative impacts like safety and accidents.</p> <p>Crossing structures like bridges will be constructed on all roads which cross the right of way.</p>
<b>Quality of Life Values</b>			
Compensation	<p>Total private land (including agricultural land used for crops, fruit trees, paddy, plantation cultivation etc.) that needs to be acquired along the KIN route is 8,506 rai. In addition, 13 houses and around 500 fruit trees/ perennial trees within residential areas are also affected. The total number of project affected families are 2,391 and estimated compensation cost is around 625 million Baht</p>	<p>impacts low level if adequate, fair and timely compensation is given to project affected families</p>	<p>Project facilities siting has minimised the necessary land and avoided affected housing areas and prime agricultural areas;</p> <p>Adequate, fair and timely compensation is to be given to project affected families. This process should be decided through public consultations and involvement of project-affected persons and as per Governmental laws and procedures. Compensation could be monetary or land and the choice if available should be left to the project affected family. The aim is to ensure project affected families enjoy a better or at worst the same quality of life which they had before the project.</p>

Resource	Impact Characteristics	Impact Significance	Mitigation Measures
Social and economic issues	Concerns of people living in the Kok-Ing-Nan basin include adequate and timely compensation for land and other resources, land subsidence issues due to tunnel construction, and problem of flooding especially along Nam Yao and Nan river banks. There is also some confusion due to conflicting/ untrue opinion and reports about the project in the media.	Negative impacts need to be controlled through proper public consultations and information provision;	Appropriate public awareness campaign for imparting easy to understand information about the project to people in the KIN basin; arrange public hearings about the project in compliance with the Office of Prime Minister's Regulations;
	Persons losing their land (2,391 households) in general have some area still remaining for cultivation.	Low impacts if adequate and timely compensation is given	Compensation has to be timely as per Governmental laws and procedures.
	Loss of household income (6,700 to 30,000 Baht per annum) due to temporary or permanent loss of agricultural land	Low level if adequate, fair and timely compensation is paid.	Adequate, fair and timely compensation; Preference to project affected persons to income earning opportunities resulting from the KIN project construction
	Development of irrigation through 14 pumps in 45,800 rai area will be beneficial during project operation stage along the KIN route. The benefits of augmenting the Sirikit reservoir for use in the Chaophrya basin for various purposes has been discussed often and is the main reason for implementing this KIN project. The social and economic benefits to the Chao Phrya basin have also been discussed in the main feasibility report.		
Public Health, Nutrition and Safety	Impacts of construction worker camps on existing residential areas and spread of communicable diseases; Public health and safety concerns; Safety concerns with respect to accidents that could occur during transport of materials related to the KIN Project; Dust and other air pollution problems due to transportation Operation period impacts of Malaria and other diseases	Low level if measures are in place	Separation of construction labour force camps from existing housing areas. Proper implementation of health and safety measures by construction contractors (establishment of health service facility, provision of health service, pre-employment examination of workers, Disease surveillance, health insurance for workers etc.); adequate monitoring by implementing agency in co-operation with Ministry of Public Health; Formulation of Construction management plans, environmental and safety management plans by Construction Contractors.
Archaeological and cultural resources	No archaeological resources found along the diversion route. Six temples are found within 1.5 km of the Diversion route;	None	Careful transportation planning near temples in close proximity to project roads. Archaeological relics if found during river dredging and improvement works will be carefully preserved.
Amenity and tourism	Tourism resources are not in close proximity to KIN diversion route. During operation stage, several areas along the diversion route have potential for recreational use development	None	Landscaping of irrigation canal and river rehabilitation works proposed as part of project to increase their value for recreational use.

#### 1.4 Monitoring Programs

Tables 1.6 and 1.7 summarise the proposed monitoring program during project construction and operation stage respectively.

Table 1.6. Summary of construction stage monitoring programme.

Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
1. Physical Resources					
1.1 Geology					
- Hot spring	Monitor the subsurface temperature and impact assessment.	Hot spring at Phu Sang waterfall (Ing-Yod Tunnel).	3 times/year in 2 years of construction period.	300,000 Baht/time	RID
- Stability of tunnel muck at dumping site	Monitor the stability of tunnel muck	Tunnel muck dumping area of Kok-Ing section (2 points) and Ing-Yod section (10 points)	Throughout construction period	Include in construction supervision cost	Consulting firm / RID
1.2 Erosion and Sedimentation					
- Silt decrease drain into waterway	Investigate the construction activities of contractors	Construction area	Throughout construction period	Include in construction supervision cost	Construction supervision firm / RID
- Soil erosion	Investigate soil erosion	Construction area and vicinity waterway	Throughout construction period	Include in construction supervision cost	Construction supervision firm / RID
1.3 Surface Water Quality	Investigated parameters consist of temperature, depth, pH, conductivity, DO, flow, Ca, Mg, SS, HCO <sub>3</sub> <sup>-</sup> , TS, TDS, CO <sub>3</sub> <sup>-</sup> , BOD, alkalinity, COD, Cl, hardness, SO <sub>4</sub> <sup>-</sup> , Fe, Mn, NO <sub>3</sub> <sup>-</sup> , Pb, Cd, Cr, Hg, PO <sub>4</sub> <sup>-</sup> , Organochlorine and Fecal coliform	10 sampling stations located at both upstream and downstream as follows; <ul style="list-style-type: none"> <li>• Station 1 : Kok river, downstream of Chiang Rai weir</li> <li>• Station 2 : Kok river, upstream of Chiang Rai weir</li> <li>• Station 3 : Nam Loi, Ban Mae Loi Luang</li> <li>• Station 4 : Nam Loi-Ing</li> <li>• Station 5 : Nam Ing, Ban Non Somboon</li> <li>• Station 6 : Nam Ing, downstream of Thoeng district</li> <li>• Station 7 : Nam Yod, Ban Pha Lak</li> <li>• Station 8 : Nam Yao, upstream Of Yao dam</li> <li>• Station 9 : Nam Yao, Song Khwae district</li> <li>• Station 10 : Nam Nan, Tha Wang Pha district</li> </ul>	3 times/year with; <ul style="list-style-type: none"> <li>• Station 1-5 in 2003-2007</li> <li>• Station 6 in 2007-2015</li> <li>• Station 7 in 2006-2007</li> <li>• Station 8-10 in 2003-2007</li> </ul>	15,000 Baht/station	Construction supervision firm / RID

Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
2. Biological resources					
2.1 Aquatic Ecology and Fisheries	Investigate fish, plankton, benthos and aquatic plants.	6 designed stations with; <ul style="list-style-type: none"> <li>Station 1 : Kok river, Kok dam site</li> <li>Station 2 : Ing river, Ing dam site</li> <li>Station 3 : Nam Yod at the end of tunnel</li> <li>Station 4 : Nam Yao at 3 km. Upstream of dam</li> <li>Station 5 : Nam Yao at Song Khwae district</li> <li>Station 6 : Nam Nan at Tha Wang Pha district</li> </ul>	2 times/year in rainy and dry season, total 10 years.	100,000 Baht/time	DOF / RID
2.2 Forest Resources	Monitoring and evaluation on forest plantation area, soil erosion prevention including measures for Wild fire prevention (belong to RFD).	Forest plantation area <ul style="list-style-type: none"> <li>within Kok-Ing-Nan diversion project, to area about 7,250 rais, classified as;</li> <li>within Chiang Rai province 1,200 rais</li> <li>within Phayao province 1,160 rais</li> <li>within Nan province 4,950 rais</li> </ul>	Once per year throughout 5 years.	Include in plan for headwater conservation and rehabilitation.	RFD and RID
2.3 Wildlife resources	Investigate on species and abundance of wildlife.	Inlet, outlet of Ing-Yod Tunnel. Adit Yao dam / reservoir. Tunnel muck dumping area.	Twice per year in 2 first year after the completion of project construction and once per year in 3-8 years after the completion of project construction.	150,000 Baht/time	RFD and RID
3. Human use					
3.1 Transportation	Investigate traffic condition with traffic volumes and accident.	Crossing point of road and diversion alignment.	Twice a year	40,000 Baht/time	Contractor

Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
4. Quality of Life					
4.1 Socio-Economic	Interview the available households about 2,400 households at;	Construction area	Twice a year with;		RID
	Kok-Ing section (1,150 HH.)		Kok-Ing section in 2004-2006.	970,000 Baht/time, total 5,820,000 Baht.	
	Ing-Yod section (620 HH.)		Ing-Yod section in 2008-2014.	530,000 Baht/time, total 7,420,000 Baht.	
	Yao reservoir (50 HH.)		Yao reservoir in 2003-2005.	40,000 Baht/time, total 240,000 Baht.	
	Yao improvement (580 HH.)		Yao improvement in 2003-2007.	500,000 Baht/time, total 5,000,000 Baht.	
	Interview attitude and supported need from 2,000 sampling households.	Benefited area	1 time before operation	2,000,000 Baht/time	RID
4.2. Public Health and Nutrition	Investigate sanitary and safety of temporary labour community.	Construction area	Throughout construction period.	Include in construction cost.	Contractors / RID

**Table 1.7. Operation stage monitoring programme.**

<b>Environmental Resources</b>	<b>Monitoring Measures</b>	<b>Locations</b>	<b>Frequency</b>	<b>Budget</b>	<b>Responsible Agency</b>
<b>1. Physical Resources</b>					
<b>1.1 Geology</b>					
Stability of tunnel muck at dumping site.	Investigate stability of tunnel muck.	At tunnel muck dumping area	Once a year, total 5 years	50,000 Baht/time	RID / TAO
1.2 Groundwater Quality	Investigate water level and quality.	Dam site at Chiang Rai and Thoeng weir. Nam Loi and Yod area. Earth - lining canal area.	Twice a year (in rainy and dry season) is 2 first year of operation period.	180,000 Baht/year	RID
1.3 Erosion and Sedimentation	Measure SS. Collect and analysis flow. Investigate erosion at upstream and downstream of Kok-Ing-Nan basin	At Nam Yao before drain into Yao reservoir and discharge from Yao reservoir and Nam Nan at downstream of Yao reservoir	3 times/year for SS measurement. 2 times/year for erosion record	150,000 Baht/time	RID
1.4 Hydrology and Flood Control	Measure flow, water level and rainfall.	15 telemetering stations consist of; <ul style="list-style-type: none"> <li>• Head station (S.1)</li> <li>• Sub-station (S.2-9, S.11-15)</li> <li>• Re-signal station (S.10)</li> </ul>	Once/day throughout year (for water level and rainfall measurement). Measure consecutive 24 hrs. for water level and rainfall. 1 time/month for statistic report for water level, rainfall and runoff.	Include in operation cost	RID

Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
1.5 Surface Water Quality	Measure the same parameters with monitoring measures in construction period.	10 sampling stations as follows; <ul style="list-style-type: none"> <li>• Station 1 : Kok river, downstream of Chiang Rai weir</li> <li>• Station 2 : Kok river, upstream of Chiang Rai weir</li> <li>• Station 3 : Nam Ing, upstream of Ing weir</li> <li>• Station 4 : Nam Ing, Ban Non Somboon</li> <li>• Station 5 : Nam Yod, Ban Pha Lak</li> <li>• Station 6 : Nam Yao, 3 km. Upstream of Yao dam.</li> <li>• Station 7 : Nam Yao, Song Khwae district</li> <li>• Station 8 : Nam Nan, Chiang Klang district</li> <li>• Station 9 : Nam Nan, Tha Wang Pha district</li> <li>• Station 10 : Nam Nan, Muang Nan district</li> </ul>	3 times/year.	10,000 Baht/station	Consulting firm / RID.
<b>2. Biological Resources</b>					
2.1 Aquatic Ecology and Fisheries	Investigate fish, plankton, benthos and aquatic plants.	The same stations with monitoring measures in construction period.	2 times/year (rainy and dry season) throughout year 1-10 of operation period.	10,000 Baht/time	RID / DOF
2.2 Wildlife Resources	Investigate species and abundance of wildlife.	Adit and tunnel muck dumping site.	2 times/year (May and December) in 1-2 first year and 1 times/year (December) in next 3-5 year of operation period.	150,000 Baht/time	RID
<b>3. Human Uses</b>					
3.1 Water Use / Irrigation	Monitor water use demand for agriculture.	Project irrigation area.	3 times/year	20,000 Baht/time.	RID



Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
	Monitor water use demand for water supply and electricity production.	Chiang Rai, Pha Yao and Nan province area	Once a year		
	Monitor problems and water use demand.	Southern Nan basin and Chao Phraya basin.	Once a year in dry season		
<b>4. Quality of Life</b>					
4.1 Socio-Economic	Interview sampling households affected by socio-economic (20% of total households).	Affected areas	<ul style="list-style-type: none"> <li>• Kok-Ing section in 2007-2009 and 2016-2018.</li> <li>• Ing-Yod section in 2016-2018.</li> <li>• Yao reservoir in 2006-2008 and 2016-2018.</li> <li>• Yao improvement in 2016-2018.</li> </ul>	2,007,000 Baht/time	RID
	Interview simple samples about 10% of total households.	Benefited area	Once a year in year 1-5, total 5 times.	1,000,000 Baht/time	RID
4.2 Public Health and Nutrition	Investigate mosquito changing	Project area especially Yao reservoir.	2 last year of construction period and 1-3 first year of operation period.	Include in operation cost.	RID / Department of Communicable Disease Control
	Investigate snail changing	Project area	2 times / 2 years (in rainy and dry season) in 1-6 first year of operation period	Include in operation cost.	RID / Department of Communicable Disease Control
	Analysis epidemiological data	Project area	1 times / 2 years in 4 last year of construction period and 1-2 first year of operation period.	Include in operation	RID / Epidemiology Division.

Environmental Resources	Monitoring Measures	Locations	Frequency	Budget	Responsible Agency
	Analysis community public health.	Project area	1 times / 2 years in 4 last year of construction period and 1-2 first year of operation period.	Include in operation	Department of Health and Provincial Public Health Office.

## 1.5 Public Relations

Keeping in mind the human and social elements, the Royal Irrigation Department (RID) the proponent agency is adopting a transparent open policy in conduct of the EIA of the KIN Project. This is to ensure peoples' participation and inputs in project formulation and implementation right from project inception stage. A public relation or awareness component has consequently been a part of the EIA study process with the objective of presenting the right information to various stakeholders, and to establish participation and acceptance of the KIN Project from various stakeholders. Five major groups namely – Project affected persons in the KIN project area, private groups, NGOs, related governmental agencies and community leader groups were the target groups. The public relation campaign during the conduct of the EIA studies used four main channels of communication. These were interpersonal communications (meetings, focus group discussions, seminars), printed documents, video films and touch screen computers with presentation materials. Six more ways have been added which are establishment of 'Provincial Data Centre' in 1999 at the provincial irrigation office in Chiang Rai, Phayao and Nan, installation of 'Suggestion Box' at city hall office and in the district offices, hire of 'Post Box No. 5 (Bung Thong Lang Bangkok)', establishment of a telephone inquiry line at the central RID office in Bangkok, appointment of KIN provincial committee and participation in various local fairs in the concerned provinces.

## 1.6 OEPP Comments on IEE

Office of Environmental Policy and Planning  
 Soi Pibul Wattana 7, Rama 6 Road  
 Bangkok 10400

22<sup>nd</sup> October 1997

Subject : Kok-Ing-Nan Water Diversion Project  
 To : Director-General, Royal Irrigation Department  
 Ref : RID's letter No. □□ 0318/5165 dated 30 June 1997  
 Enclosure : Opinion towards Kok-Ing-Nan Water Diversion Project

With reference to the above letter wherein RID had sent Study Report on suggestion guideline for developing and Initial Impact on Environment of Kok-Ing-Nan Water Diversion Project by sending an additional complete and perfect document on 25<sup>th</sup> September 1997 to enable Office of Environmental Policy and Planning to express opinion and give suggestion guideline on Kok-Ing-Nan Diversion Project, as already mentioned in details.

Office of Environmental Policy and Planning has considered about the suggestion guideline in developing the Project including initial impact of the said Diversion Project which RID will make a suitability Study including impact to environment of the Project at a later date, and have the following opinion:-

1. In developing the Project, one ought to consider about the impact from Inter-Basins Diversion both in ecological aspect and in beneficial use by the people within such Basin by giving importance and by considering about beneficial use of the people within the existing (old) Basin as first priority.

2. Since Kok-Ing-Nan Diversion Project is a big-scale Project and must involve with nearly every aspect of resources therefore, in implementing various steps of work including the study on environment of the Project, people ought to be allowed to participate in order to avoid conflicts in making use by the people, by implementing regularly throughout the duration of the Project.
3. In making a study on impact to environment of Kok-Ing-Nan diversion Project, scope of study ought to be specified to cover various aspects in accordance with the detail stated in the enclosed document and in case RID has completed preparing the scope of study in order to study the impact to environment of Kok-Ing-Nan Diversion Project, please send it to this office in order to propose it to the Panel of Experts Board for considering the Analytical Report on Impact to Environment in the aspect of Water Source Development Project so that they can give opinion for the benefit in preparing analytical Report on Impact to Environment in the future.

The above is for information and consideration.

Yours respectfully,

(Mr. Chatree Chuay Prasit)  
Deputy Secretary-General and Officer-in-Charge  
for Secretary-General, Office of Environmental Policy and Planning

Analysis on Impact to Environment Division  
Tels. 272-3055, 279-9703  
Fax. 272-3055, 271-3226

Enclosure:

Completion Report  
Opinion towards the Final Report (Initial Study on Impact to Environment)  
Kok-Ing-Nan Water Diversion Project

From consideration made on the suggestion guideline for developing the Project and from studying about the initial impact to environment of Kok-Ing-Nan Diversion Project, Office of Environmental Policy and Planning has an opinion that in studying a bout the impact to environment, scope of study should be specified to cover the following aspects :-

1. In considering about suitability in selecting the Project which there are altogether 3 alternative diversion guidelines, it must also include suitability of environment.
2. General environmental condition, Land Use, beneficial use by the people along the Diversion Route and nearby vicinity in individual area in a precise manner in order to use it for evaluating the impact to environment and for specifying suitable measures towards such impact to environment by making an evaluation on impact and any changes in case there is a Project and there is "no" Project - about cases.
3. Evaluation on value of natural resources within the Project area in order to act as a part in analyzing about cost price of the Project which has different condition in individual area. Therefore, one ought to specify method on evaluation to suit individual area and ought to propose precisely as to whether the beneficial area which has been specified is the "old" (existing) irrigated area or is a "new" irrigated area, to enable the analysis of the Project to reflect the actual cost price.
4. Rate of flow of water in the tunnel in order to bring it for evaluation as to whether or not in pulling the sediment from various Basins together, it will enable an increase in sedimentation within Sirikit Reservoir and what measure does one have in preventing and in remedying the impact which may arise.

5. As regards the study made on fishery, there is no type of fish which is economic fish within individual Basin. In the Report "Fish Biomass" is used similarly to "Standing Crop" or not? Moreover, study has not yet been made as to how much F/C Ratio in individual Basin, which has been surveyed, would be, in order to use it for making a comparison between trend and Sirikit Reservoir which has F/C Ratio, as to whether or not value of F/C Ratio would change after diverting the water.
6. In diverting the water, it will be to pull water from various Basins to dilute together within Sirikit Reservoir which will be to pull young ones of fresh-water animals, young ones of shells which are carriers of various diseases, hence, there might be the following impact :-
  - 6.1 In the aspect of biological varieties, there might be cross-breeding between local fishes within Mekong Basin and fishes from other Basins in Sirikit Reservoir, in this case a new breed will be obtained or else we may obtain mixed-species which is contradictory to measures for protecting biological varieties. Therefore, data should be proposed. At the same time, specify measures for maintaining local fish species in a precise manner.
  - 6.2 There might be epidemic diseases, i.e. parasitic disease in blood (leaf parasites), water-borne disease due to diversion of water from Mekong Basin and other Basins together wherein the Reservoir may have suitability in distributing diseases better than the old place of such disease, therefore, an additional study ought to be made concerning these diseases from water.
  - 6.3 There might be an epidemic of various fresh-water animals, i.e. cherry shells, animals which damage other crops which come with the diversion of water from various Basins.
  - 6.4 There might be a distribution of water weed flora, specifically, Java-weed, water lettuce and various algae in the Reservoir which come from water diversion in the various Basins.
  - 6.5 There might be an accumulation of additional poisonous substance and heavy metals in Sirikit Reservoir.
7. As regards quality of surface water, a study ought to be made on various variables in full in accordance with standard on quality of surface water, such as Alkalinity, Phenols, CN, Zn, Ni, Cu in order to observe the trend on quality of water from commencement of construction up till implementation period.
8. There ought to be a clear study as to how much area it is within Project area, (specifically, vicinity of the mouth of the tunnel and various shaft openings), which passes through important area for preservation, i.e. National Park, preservation forest or Grade IA Basin area. Then, search for guideline to reduce impact to the environment by diverting (shifting) the outlet of the mouth of the tunnel away from the boundary of the said important forest.
9. Analysis should be made and precise data should be submitted on species of trees, animal species, whether fish species found within the Project area are rare species, or they are found in specific place only, or how they are threatened or whether or not they are terrified and whether or not protective measure should be issued to remedy the impact as a special case.
10. Since there are 12 temples and ancient places 500 metres to 1 km away from the Project area, therefore, choice should be made to avoid impact which may be caused to the temples and ancient places so that remains as minimum as possible.