

CHAPTER 6
ASSOCIATED PROJECT IN KOK, ING AND UPPER NAN BASIN



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6.1 Identification of Associated Project Area

The average income in Chiang Rai province is reported at 16,900 Bahts, indicating a lower value compared to 24,700 Bahts in Chiang Mai province, 18,900 Bahts as an average in the northern region and 32,000 Bahts in the whole country. The wet season paddy cultivation is the main occupation for the people in the area. Besides, vegetables and orchard are grown and swine, fowl and cattle are also raised in the area. Natural water resources fisheries, harvest fish pond and fish culture are prevailing especially in Ing river basin.

Of the total drainage area of the Kok river, 10,900 sq.km covering eight districts and 2 sub-districts, about 5,520 sq.km are occupied by the forest land of which 5,090 sq.km or 92% are classified into the National Forest Reserve. Of the plain area of 1,630 sq.km, 1,322 sq.km are the agricultural land which are composed of 890 sq.km of paddy fields, 375 sq.km of upland crop areas and some 55 sq.km of fruit tree land. In the Ing river basin, in total 29 National Forest Reserves are occupying 4,096 sq.km or 55% of the drainage area of 7,400 sq.km. Within the basin, the potential irrigable area of 1,055 sq.km occupies 14.3% of the basin area. In the upper Nan basin above the Sirikit dam, the forest area amounts to 4,800 sq.km, accounting for 42% of the total watershed area of 11,500 sq.km while the agricultural and settlement area are only 1,400 sq.km occupying 12% of the basin area.

The Kok basin covers Fang, Mae Ai districts and Chai Prakarn sub-district of Chiang Mai province and Muang, Chiang Saen, Mae Chan, Mae suai, Wiang Pa Pao, Wiang Chai, Wiang Chiang Khung, Mae Fa Luang and Mae Lao districts of Chiang Rai province. The main economic crops in the basin are rice particularly glutinous rice, corn, soybean, vegetables and fruit trees which are consisting of mango, litchi, longan and tea. Common vegetables such as garlic, shallot, chili, ginger and various leafy vegetables and soybean are mainly grown on lowlands in dry season after rice harvested. Corn is mostly grown on uplands in wet season.

The Ing basin covers Chiang khong, Thoeng, Khun Tan, Phan, Pa Daet, Phaya Mengrai and a part of Muang and Wiang Chai districts of Chiang Rai province and Muang, Mae Chai, Dok Kham Tai, Chun, Chiang Khan of Phayao province. Major economic crops are glutinous and non

glutinous rice, corn, peanut, soybean, mungbean, fruit trees and vegetables.

The upper Nan basin covers the most part of Nan province except Ban luang district. In the basin, the present agriculture in both upland and lowland is almost similar as experienced in the Kok and Ing basins but there is a high ratio of planted land area of fruit trees and perennial crops than the other crops. Most important crops are rice, corn, mungbean, peanut, soybean, cotton, fruit trees, perennial crops and vegetables.

In the basins, the livestock including cattle, buffalo, pig, chicken and duck is mainly raised for household consumption and separate income in addition to crop production. In the area, cattle and buffalo are fed by natural food because most farmers do not have their own grass lands, pigs are raised by small farmers and in commercial farms and poultry including chicken and duck are raised both broiler and layer with natural feed for commercial purposes. There are a few poultry farms in these basins.

The rural infrastructures at provincial level is composed of electricity, road and piped water supply system. The collected data shows that electricity is distributed for 95 to 98% of the total households in the basins. There are roads connecting to the district offices covering about 96 to 99 % of the total numbers of villages. The households in the Kok river basin have been furnished with the least percentage of piped water supply system covering about 12% of the total households, while 34% are consolidated in the Ing basin and 32% in the Nan basin. Regarding the water sources for domestic supply in forms of wells and underground water sources, it is found that 92,000 units are utilized in the Kok river basin while 76,000 units and 23,000 units are being utilized in the Ing and upper Nan river basins. The domestic water supply is insufficient covering 62 % of households in the Kok river basin, 59% in the Ing basin, and 54% in the upper Nan basin.

The proposed Kok-Ing-Nan water diversion project will effect to a great extent the regional development in the Kok, Ing and upper Nan basins as well as the lower Nan basin and the Chao Phraya delta areas where the irrigated agriculture is the main industry. A great extension of irrigated agriculture is expected by the proposed project especially in dry season.

All public information gathered from Chiangrai, Phayao and Nan provinces may be summed up to the common requests, namely strengthening and adding up the water sources along the diversion channel in their provinces to a full water potential and improving the Sirikit

reservoir operation for storing and releasing more water in dry season.

6.2 Concept for Development of Associated Project

(1) Associated Projects Proposed by the Thai-side Study

The associated water resources development projects proposed by the Thai-side Study are the Nong Luang Improvement Project and the Chai Sombat Weir Improvement Project in the Kok river basin, The Community Irrigation Project and the Nong Leng Sai Rehabilitation Project in the Ing river basin, and the Nam Samun Reservoir Project and the Nam Kwang Reservoir Project in the upper Nan basin. Brief explanation of the said projects is as follows;

(a) Nong Luang Improvement Project

The Nong Luang swamp is located between Muang and Wiang Chai districts, Chiang Rai province. Formerly, the Nong Luang is a natural swamp with its water surface area of 12,400 rai, however later in the year 1973, only 9,190 rai was left with the storage water of about 15 MCM. The average annual inflow is reported at 63 MCM. The proposed rehabilitation works consist of (i) improvement of the existing regulator and weirs, (ii) dredging work in the swamp in combination of polder dikes construction to gain more water not less than 50 MCM from the Kok-Ing-Nan diversion channel and (iii) supplying water to nearby areas of about 50,000 rai (at present, only 5,700 rai can be grown in dry season). Besides, in wet season, the Nong Luang is expected to store more water and in turn to alleviate annual flood damage in the downstream areas. In addition construction of potential reservoir projects in various tributaries flowing into the Nong Luang is also recommended.

(b) Chai Sombat Weir Improvement Project

The existing Chai Sombat weir is located at Tambol Tha sai, Muang districts, Chiangrai province constructed in 1983 with a concrete dam of 2.70 m high and 50 m long. The weir is distributing waters for the people's irrigation area of 35,000 rai in

wet season and 10,000 rai in dry season. Improvement of all structures and systems are recommended.

(c) Community Irrigation Projects

The project consists of 17 existing local weirs along the upper Ing river stretching for about 35 km between the Kwan Phayao and Ban Hard Tan, Tambol Huay Kaew and irrigating about 30,600 rai. The replacement and merging of some old weirs with new permanent weirs at suitable sites and improvement of the old distribution system including dredging work of Ing river itself are proposed.

(d) Nong Leng Sai Rehabilitation Project

The Nong Leng Sai is a natural swamp located near Mae Chai district, Phayao province covering an area of 6,000 rai at a distance about 25 km upstream of Kwan Phayao. The rehabilitation works comprising of two structural modifications, raising weir crest from EL 397.50 to 399.00 m,MSL and replacement of the old weir by a new sluice gate of 4 x 2 m approximately are proposed. According to the proposal, the capacity of the Nong Leng Sai will be increased from 4.8 MCM to 15.3 MCM which will provide an additional water of 6.9 MCM for dry season cultivation.

(e) Nam Samun Reservoir Project

The Nam Samun Project is located in Muang district, Nan province with a drainage area of 180 sq.km. The earth dam of 27 m high and 420 m long is projected with a reservoir capacity of 13.5 MCM and irrigation area of 12,000 rai.

(f) Nam Kwang Reservoir Project

The Nam Kwang Reservoir Project is located in Pua district, Nan province, with a drainage area of 89 sq.km and the average annual inflow of 27.7 MCM. The dam of 35 m high and 400 m long is proposed with a reservoir capacity of 7 MCM, which would cover the irrigation area of 5,500 rai.

(2) Additional Proposal in Due Consideration of People's Request

As a conceptual planning phase, the following water resources development projects will be recommended for further study;

(a) Diversion from Mae Lao to Upper Ing Project (Mae Lao scheme)

This proposed development plan intends to increase the irrigation areas in Mae Lao and the upper Ing river basins initially proposed by Electro-Watt-Columbus in 1972. Since the upper Mae Lao river has a considerable amount of annual yield estimated at about 774 MCM, a small scale transbasin water diversion plan to convey water from Mae Lao river through a 130 km long diversion canal of 35 cu.m/sec capacity will be effective to supply water into the head of the Ing river. The diversion canal will be able to command an area of approximately 181,250 rai (29,000 ha), however this diversion plan would be possible only if it is built in conjunction with the construction of Mae Pun Luang and Mae Suai reservoirs. Under this proposal, the completed Mae Tam reservoir and a 8 to 12 km stretch of the Mae Lao canal is combined resulting the proposed irrigable area of about 50,000 rai or 8,000 ha in Dok Kham Tai district.

(b) Mae Lao Rehabilitation Project

The large scale Mae Lao irrigation project was completed in 1963. The main structure is the Mae Lao weir of 2.5 m high and 30.5 m long. The left and right intake canals have a 5.2 cu.m/sec and 13.4 cu.m/sec commanding 166,000 rai of beneficial area in Muang , Mae Chai and Phan districts of Chiang Rai and Phayao provinces. The irrigation system is effective mainly for supplemental water in wet season and the irrigable area in dry season is recorded at only 10,000 rai as usual. The project rehabilitation work is at present under study for the purpose of increasing project efficiency and for providing adequate irrigation canal section to carry diversion water as needed in future.

(c) Chai Sombat Weir Improvement Project

Such rehabilitation works for the irrigable area of 35,000 rai should be studied and implemented because of the water management of this system has been run by farmers for a long time. The only main improvement work is limited to headwork, intake structure and main canal. This type of scheme would encourage the people's farming activity which in turn strengthen regional economy.

(d) Mae Kok Hydropower Project

Being located on the border of Thailand and Myanmar, the main project features will include the catchment area of 2,980 sq.km and the average annual inflow of 2,230 MCM. The concrete dam of 125 m height and 495 m long is planned with a gross storage capacity of 4,650 MCM. The project feasibility should be proceeded and implemented as soon as possible in order to maximize the full benefits to all water uses in Kok, Ing and upper Nan basins as well as for the proposed Kok-Ing-Nan water diversion project, since this project would regulate annual flows of the main Kok river presenting a special effect especially in dry season.

(e) Nong Luang Improvement Project

In addition to the proposed rehabilitation works to extend irrigation area from 5,700 to 50,000 rai and to store water not less than 50 MCM as previously mentioned, the supplemental water can be diverted from the proposed Kok-Ing diversion channel.

With the proposed Kok-Ing-Nan Water Diversion Project, more opportunity to obtain surplus water from the Kok river to fill up the channel storage in both existing and proposed weirs along Ing river in dry season whether by gravity or pumping system as suitable for the potential irrigation areas is expected.

(f) Nong Leng Sai Improvement Project

In combination with the improvement programs as proposed by the Local

Study, more emphasis should be paid to the water diversion from Upper Mae Lao basin to Nong Leng Sai, from which waters are distributed through the Kwan Phayao (Phayao lake) to irrigable areas along the upper Ing river. The diversion project from Mae Lao to upper Ing, the Mae Lao rehabilitation project and the Nong Leng Sai rehabilitation project should therefore be combined into one feasibility study.

(3) Associated Irrigation Projects related to the Kok-Ing Diversion Scheme

The following associated project areas to be irrigated by the water from the proposed Kok-Ing-Nan diversion channel are identified on the 1/50,000 scale map for further studies.

- (a) Nong Luang Irrigation Project 2,000 ha (12,500 rai)
Waters are pumped up from the proposed Kok-Ing diversion channel into the Nong Luang swamp from where about 2,000 ha of cropland are irrigated under gravity system.
- (b) Nong Leng Sai Irrigation Project 3,000 ha (18,750 rai)
Waters are diverted transbasin from the Lao river into the Nong Leng Sai swamp to irrigate about 3,000 ha of cropland extending along the upper Ing river mainly downstream of Kwan Phayao.
- (c) Upper Ing Irrigation Project 12,000 ha (75,000 rai)
Waters received from the proposed Kok-Ing diversion channel will be conveyed through a feeder canal and finally pumped up into a regulation pond to be distributed in the cropland of about 12,000 ha, extending along the upper and middle Ing river between Thoeng and Khao Ing Rod.
- (d) Lower Ing Irrigation Project 5,000 ha (31,250 rai)
Waters are diverted at the regulating pond located near the Kok-Ing tunnel outlet and distributed by gravity to irrigate about 5,000 ha of cropland located downstream of Thoeng.

- (c) Pak Ing Irrigation Project 8,000 ha (50,000 rai)

A rubber dam is constructed across the Ing river near the river mouth and a pumping station is installed to irrigate about 8,000 ha of cropland in the lower Ing river basin.

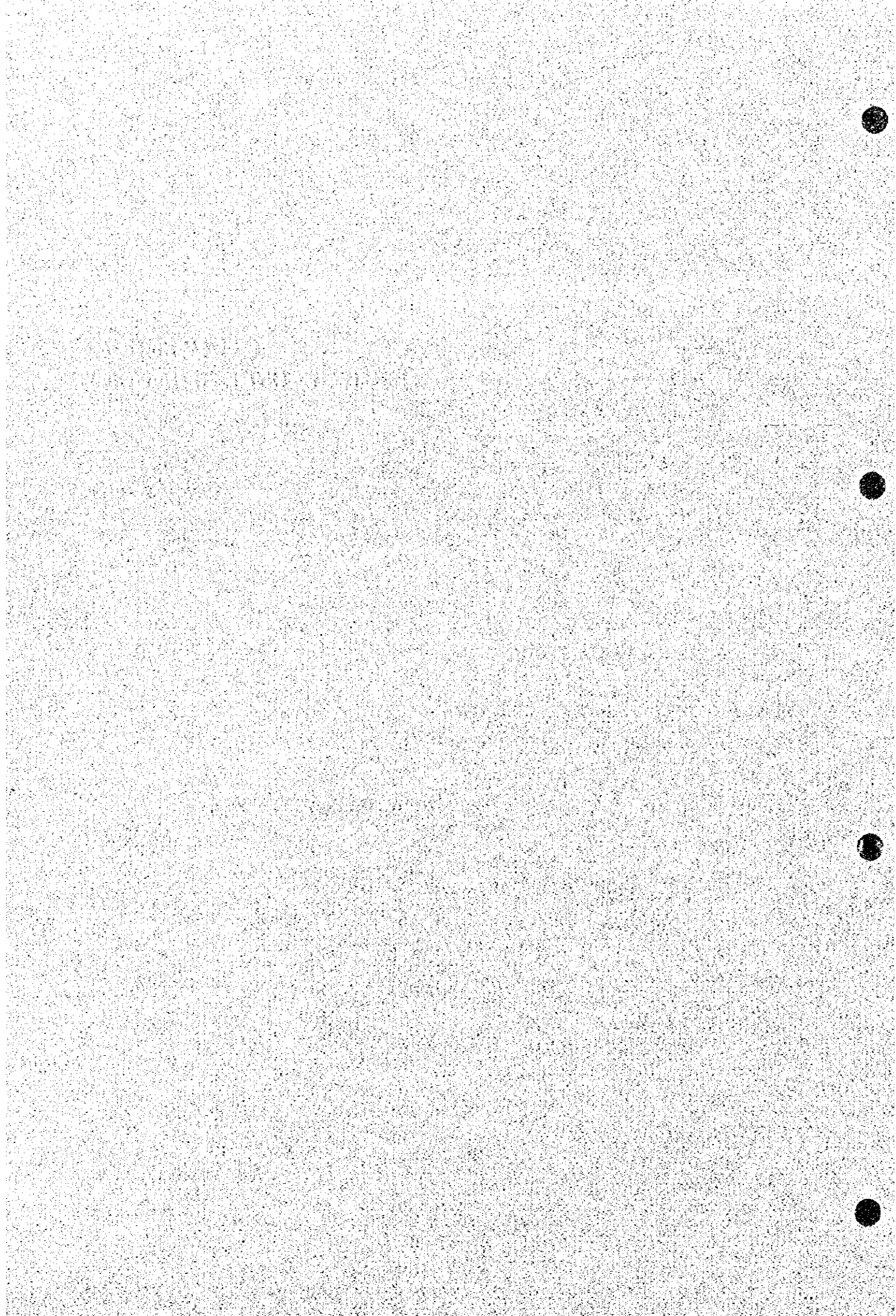
In addition to the above, the Inland Fishery Project would be identified in the Ing river basin, covering the water surface areas of about 2,000 ha (12,500 rai)

(4) Associated Irrigation Project related to Yao Flood Control Dam

The Yao Flood Control dam proposed by the Kok-Ing-Nan water diversion project with a gross storage capacity of 35 MCM will have two functions, flood control and irrigation. Of the total storage capacity, some 27 MCM will be allotted to flood control and the remaining part for irrigation. The irrigable area of about 2,000 ha or 12,500 rai may be distributed along the Yao and upper Nan rivers, including the Tha Wang Pha area situated around the confluence of the Yao with the Nan river.

The associated irrigation project areas above mentioned are as shown in the Database Map. The feasibility studies for these associated projects should however be carried out by RID in order to promote implementation of the proposed Kok-Ing-Nan water diversion project through participation of rural inhabitant living in the associated project area.

CHAPTER 7
PROJECT COST ESTIMATION



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Although the project cost is estimated by Thai side study, it is very difficult to review it due to lack of back data for quantity and unit rate for the construction works. JICA Team, accordingly has studied approximately the project cost based on preliminarily assumed quantity and rate for the construction works.

The cost estimation for tunnel construction however employed more careful study through classifying into tunnel types based on the geological condition along the tunnel route and setting up the rate based on each tunnel type, because the tunnel construction cost will share as much as 60% of the total construction cost. Particulars involved in the cost estimation by JICA Team is as follows ;

The project cost for each project facility is estimated as shown in Table 7.1. There are two plans for irrigation beneficial area, one is for the existing irrigation area and other for the new Phitsanulok area in addition to existing area.

(a) Kok Diversion Dam

The cost for new diversion dam was estimated at 288 million Baht by Thai side study which is mostly same construction cost needed for the existing Chiang Rai Weir. The new Kok diversion dam to be constructed at the downstream of the said existing weir will require higher cost of 426 million Baht than that of the existing one because of increased design flood capacity by the Lao flood and construction method to enable the river diversion.

(b) Open and Culvert Canal in Kok-Ing Diversion Canal

- Quantity for excavation, fill and concrete is approximately estimated by cu.m/m based on the canal profile.
- The following rate is applied for the civil works taking into account excavation with deep depth, drainage during construction, transportation of earth material from borrow area and to spoil bank, concrete placing with equipment, etc.

Earth Excavation	50 Baht/cu.m.
Rock Excavation	160 Baht/cu.m.
Fill with Transportation	100 Baht/cu.m.
Plain Concrete	1,300 Baht/cu.m.
Reinforced Concrete	1,700 Baht/cu.m.

Canal Lining Concrete	1,950 Baht/cu.m.
Reinforced Bar	15,000 Baht/ton
Formworks	450 Baht/sq.m.

The rates are mostly referred from the Bill of Quantity of Bang-Pakong Diversion Dam project which was recently contracted by RID, and Mac Wong Dam project which was studied by RID for OECF Loan in 1993.

- The construction cost for Nong Luang reservoir and regulating pond at the outlet of Kok-Ing tunnel was also estimated in the Kok-Ing diversion canal.
- Estimated construction cost for the above items is as shown in Table 7.2.

(c) Tunnel in Kok-Ing Diversion Canal

Tunnel in Kok-Ing tunnel route for the discharge of 125 cu.m/sec is placed at the poor geological condition and requires a little higher cost than that in the Ing-Yot tunnel.

The tunnel construction cost is estimated with the following manner,

- Estimation of basic rate per linear meter for tunnel with the items classified into excavation, shotcreting, rock bolting, steel supporting, sheeting, reinforced bar, etc. based on different tunnel type of B, C1, C2, D1, D2, E1 and E2 as shown in the attached table.
- Tunnel length for type B, C1, C2, D1, D2, E1 and E2 is estimated based on the geological condition along the tunnel route.
- Tunnel cost per linear meter for the different type is estimated by the above basic rate and tunnel length.
- The costs for associated works, depreciation cost for tunnel equipment and temporary works are estimated separately.

(d) Ing-Yot Tunnel

The construction cost for the Ing-Yot tunnel with the discharge of 175 cu.m/sec is estimated by the same manner as mentioned in the above (c), though the cost of Ing-Yot tunnel includes the cost for inclined shaft.

(e) **Ing Diversion Dam, Yao Flood Control Dam and River Training**

The construction cost for both dams is estimated by the following method.

- Quantity is estimated by the layout plan of dam.
 - Rate mentioned in the above (b) is in principle adopted for estimation.
- (f) Engineering fee, administrative fee, O/M equipment cost, etc. are estimated by percentage of the construction cost.
- (g) Estimated construction cost and other costs are shown in the attached Bill of Quantity.

Table 7.1 Summary of Project Cost

Item	Unit	Plan A and B			Plan C			Remark
		Q'ty	Rate Baht/m	Amount Million B	Q'ty	Rate Baht/m	Amount Million B	
1. Construction Cost								
(1) Diversion Dam & Canal between Kok and Ing	L.S			8,500			8,500	Table 7.2
(2) Ing Diversion Dam	L.S			354			354	Table 7.3
(3) Lao Diversion Canal	L.S			3,588			3,588	Table 7.4
(4) Ing-Yot Diversion Tunnel	L.S			20,604			20,604	Table 7.5
(5) Yot Flood Control Dam	L.S			182			182	Table 7.6
(6) Yao River Training	L.S			400			400	Table 7.7
(7) Irrigation Project in Kok-Ing Basin	ha	32,000	50,000	1,600	32,000	50,000	1,600	
(8) Irrigation Project of Phitsanulok Stage II	ha				120,000	50,000	6,000	
(9) O/M office, Quarters & Facility	L.S			170			170	
Subtotal				35,398			41,398	
2. Contingency				5,310			6,210	15 % of subtotal of 1
3. Total (1 + 2)				40,708			47,608	
4. Others								
(1) Engineering Fee				3,257			3,809	8 % of subtotal of 3
(2) Administrative Fee				2,035			2,380	5 % of subtotal of 3
(3) Land Acquisition	L.S			1,000			1,200	Table 7.8
(4) O/M Equipment	L.S			106			124	0.3 % of subtotal of 3
(5) Environmental Mitigation	L.S			500			500	
Total				6,898			8,013	
Grand Total (3+4)				47,606			55,621	
				round 47,600			round 55,600	

Table 7.2 Comparative Table of Construction Cost of Diversion Dam & Canal between Kok and Ing

Item	Unit	A Route			A-R Route			B Route			B-J Route			B-P Route		
		Q'ty	Rate Bht/m	Amount Million B	Q'ty	Rate Bht/m	Amount Million B	Q'ty	Rate Bht/m	Amount Million B	Q'ty	Rate Bht/m	Amount Million B	Q'ty	Rate Bht/m	Amount Million B
1 Kok Diversion Dam																
New Diversion Dam	L-S	1		426	1		426	1		50	1		50	1		50
Emergency Spillway	L-S									110	1		110	1		110
Intake Works	L-S									536			536			160
Sub total																
2 Open Canal in Kok Basin	m	13,746	37,390	513	15,112	41,780	631	14,063	51,480	723	18,589	43,040	800	23,507	48,290	1,135
3 Culvert in Kok Basin	m	1,050	178,660	187	3,011	188,900	568	17,994	209,140	3,763	1,861	177,860	330	3,856	171,520	661
4 Nong Luan Reservoir																
Folder Dike	m	10,000	6,000	60	10,000	6,000	60	10,000	6,000	60	10,000	6,000	60	10,000	6,000	60
Small Pump Station	L-S	-	-	90	-	-	90	-	-	90	-	-	90	-	-	-
Gate at Outlet	L-S	-	-	10	-	-	10	-	-	10	-	-	10	-	-	-
Sub total																
5 Large Pump Station																
Pump Station	L-S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,500
Gate at Outlet	L-S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
Sub total																1,600
6 Regulating Pond at Tunnel Outlet																
Folder Dike	m	2,000	6,000	12	2,000	6,000	12	2,000	6,000	12	2,000	6,000	12	2,000	6,000	12
Small Pump Station	L-S	-	-	38	-	-	38	-	-	38	-	-	38	-	-	38
Gate at Outlet	L-S	-	-	70	-	-	70	-	-	70	-	-	70	-	-	70
Sub total																
7 Tunnel																
No.1 Tunnel	m	5,800	539,000	3,126	3,114	557,000	1,734	-	-	-	3,114	557,000	1,734	-	-	-
No.2 Tunnel	m	7,240	462,000	3,344	7,775	467,000	3,630	5,506	527,000	2,901	7,775	467,000	3,630	4,200	500,000	2,100
Sub total																
8 Open Canal in Ing Basin	m	21,750	42,420	922	21,750	42,420	922	21,750	42,420	922	21,750	42,420	922	21,750	42,420	922
Total				8,908			8,301			8,749			7,856			6,756

Note : (1) The rate of open canal, culvert and tunnel is shown of the Supporting Report.

(2) Although the construction cost is different by the alternative routes as shown in the above figure, the total cost of diversion dam and canal between Kok and Ing is approximately estimated at 8 500 million Baht taking into account the average construction cost for alternative routes.

Table 7.3 Construction Cost of Ing Diversion Dam

Item	Unit	Quantity	Rate	Amount (Thousand Baht)	Remark
1 River diversion (Common Ex.)					
Subtotal	cu.m	250,000	50	12,500	
2 Weir Construction					
Common Ex.	cu.m	350,000	50	17,500	
Weathered Rock Ex.	cu.m	8,000	160	1,280	
Embankment	cu.m	55,000	100	5,500	
Riprap (Use of Tunnel Muck)	cu.m	25,000	50	1,250	
Reinforced Concrete	cu.m	12,000	1,700	20,400	
Reinforced Bar	ton	1,500	15,000	22,500	
Formworks	sq.m	8,000	450	3,600	
Radial Gate (10 mw x 7 mh)	L.S	0	0	40,000	
Rubber Dam (40 mw x 5 mh)	L.S	0	0	3,000	
P.C. Pile (600 mm dia)	m	6,500	1,500	9,750	
Subtotal				124,780	
3 Intake					
Common Ex.	cu.m	50,000	50	2,500	
Embankment	cu.m	20,000	100	2,000	
Riprap (Use of Tunnel Muck)	cu.m	10,000	50	500	
Reinforced Concrete	cu.m	4,500	1,700	7,650	
Reinforced Bar	ton	450	15,000	6,750	
Formwork	sq.m	4,000	450	1,800	
P.C. Pile (600 dia)	m.	18,000	1,500	27,000	
Gate (10 mw x 9 wh)	L.S			35,000	
Subtotal				83,200	
4 Polder Dike					
Embankment	cu.m	1,000,000	100	100,000	
Riprap (use of Tunnel Muck)	sq.m	150,000	50	7,500	
Road pavement	m	20,000	500	10,000	
Subtotal				117,500	
Total				337,980	
5 Temporary Works (5%)					
Total				16,899	
Grand Total			about	354,879 354,000	

Table 7.4 Construction Cost of Lao Diversion Canal

Item	Unit	Quantity	Rate (B)	Amount (Thousand Baht)	Remark
1 Open Canal and Syphon					
Concrete Canal No.3 Type (Cut)	m	1,130	43,500	49,155	
Syphon	m	100	280,000	28,000	
Crossing Structure (30% of Canal and Syphon)	L.S			23,100	
Subtotal				100,255	
2 Culvert	m	10,310	284,300	2,931,133	
3 Lao River Improvement	m	1,300	5,400	7,020	
4 Tunnel	m	1,000	550,000	550,000	
Total			about	3,588,408 3,588,000	

Table 7.4.C Backup Data of Rate/m of Lao Diversion Canal

Item	Unit	Rate	Q'ty	Amount 1,000 Baht	Remark
1 Concrete Canal in Ing Basin (No.3 Type)					
No.3 Type			H = 7.19 m		
Excavation	cu.m	50	300	15.0	
Fill	cu.m	40	19	0.8	
Spoil Bank	cu.m	30	275	8.3	
Lining Concrete	cu.m	1,950	7	14.0	
Formwork	sq.m	100	14	1.4	
Others				4.0	
Total				43.5	
2 Culvert			H = 24.60 m		
Excavation	cu.m	50	1,086	54.3	
Backfill	cu.m	50	1,004	50.2	
Spoil Bank	cu.m	30	129	3.9	
Reins. Concrete	cu.m	1,700	45	75.8	
Reinforcing Bar	ton	15,000	4	66.8	
Formwork	m	6,000	1	7.5	
Others				25.8	
Total				284.3	

Table 7.5 Construction Cost for Ing - Yot Diversion Tunnel

(B)

Q = 175.00 m³/sec

Item	Unit	Quantity	Rate	Amount (Thousand Baht)
1. Main Tunnel				
1.1 Tunnel Excavation	m	50,875		7,540,113
1.2 Tunnel Lining	m	50,875		2,745,945
Subtotal				10,286,058
2. Inclined Adit				
2.1 Inclined Adit Excavation	m	17,381	143,247	2,489,776
2.2 Inclined Adit Lining	m	17,381	40,455	703,148
Subtotal				3,192,924
3. Associated Works				
3.1 Access Road to Inclined Adit	places	9	55,420	498,780
3.2 Permanent Drainage Works	lms.	1		190,354
3.3 Portals Works	places	9	3,240	29,160
3.4 Vertical Anchor Method	places	9	16,000	144,000
3.5 Environmental Protection Works	lms.	1		411,104
Subtotal				1,273,398
4. Depreciation for Machinery	places	16	159,832	2,557,316
Subtotal				2,557,316
5. Temporary Works for Construction				
5.1 Temporary Portals Facilities	lms.	1		6,020
5.2 Temporary Air Supply Facilities	lms.	1		507,451
5.3 Temporary Water Supply Facilities	lms.	1		168,442
5.4 Temporary Drainage Facilities	lms.	1		349,779
5.5 Temporary Ventilation Facilities	lms.	1		375,042
5.6 Temporary Power Facilities	lms.	1		347,522
5.7 Water Pollution Countermeasures		9	16,166	145,494
5.8 Assembling and Dismantling Works	faces	16	1,193	19,089
5.9 Plant Facilities	faces	16	1,436	22,969
5.10 Inclined Adit Facilities	places	7	22,222	155,554
5.11 Temporary Houses for Compressor, Magazine		1		25,418
5.12 Maintenance for Temporary Works	month	78.0	5,778	450,684
5.13 Basic Power Rates and Land Rent	lms.	1		478,733
5.14 Safety Measures and Others	lms.	1		242,493
Subtotal				3,294,692
Total (1+2+3+4+5)				20,604,388
Total Construction Cost for Diversion Tunnel			(Rounded)	20,604,000
		(404,000 Bht/m)	

Table 7.6 Construction Cost of Yao Flood Control Dam

Item	Unit	Quantity	Rate	Amount (Thousand Baht)	Remark
1 Dam Construction					
Weathered Rock Excavation	cu.m	45,000	160	7,200	
Embankment	cu.m	4,000	100	400	
Mass Concrete in Dam Body	cu.m	65,000	1,300	84,500	
Formworks	sq.m	25,000	450	11,250	
Consolidation Grouting	m	800	3,000	2,400	
Curtain Grouting	m	2,500	5,000	12,500	
Gate	ton	170	120,000	20,400	
Subtotal				138,650	
2 Spillway					
Reinforced Concrete	cu.m	10,000	1,700	17,000	
Reinforced Bar	ton	950	15,000	14,250	
Formwork	sq.m	9,000	450	4,050	
Subtotal				35,300	
Total				173,950	
3 Temporary Works (5%)					
Total				8,698	
Grand Total			about	182,648 182,000	

Table 7.7 Construction Cost of Yao River Training

Item	Unit	Quantity	Rate	Amount	Remark
1 Dike					
Excavation	cu.m	34,835	25	870,875	
Compacted Earthfill	cu.m	227,370	83	18,871,710	
Compacted Latelite	cu.m	9,015	300	2,704,500	
Grassing	sq.m	113,210	20	2,264,200	
Land Acquisition	rai	465	20,000	9,300,000	
Subtotal				34,011,285	
2 Appurtenant Structures					
Conduit	No.	34	120,000	4,080,000	
Regulator	No.	15	850,000	12,750,000	
Subtotal				16,830,000	
3 River Training					
Rock Excavation	cu.m	191,650	80	15,332,000	
Common Excavation	cu.m	447,190	46	20,570,740	
Riprap	cu.m	31,940	300	9,582,000	
Gabion	cu.m	19,165	600	11,499,000	
Bridge	m	140	110,000	15,400,000	
Subtotal				72,383,740	
Total				123,225,025	
Grand Total		123,225,025	3.23 about	398,016,831 400	42km/13km=3.23 Million Baht

Note ; The total length (about 42 km) of the Yao River has to be entirely protected by riprap and/or gabion in stead of partial river training recommended by TEAM (river training length is about 13km, as mentioned in Table 6.4.9-9 of TEAM Report).

Table 7.8 Cost of Land Acquisition

Item	Unit	Quantity	Rate	Amount (Million Baht)	Remark
1 Kok-Ing Diversion Canal	Rai	5,600	150,000	840	45km x 0.2km / 0.16
2 Ing Diversion Dam	Rai	800	100,000	80	
3 Lao Diversion Canal	Rai	100	100,000	10	
4 Yao Flood Control Dam	Rai	100	100,000	10	
5 Yao River Training	Rai	400	100,000	40	
6 Irrigation Project in Kok-Ing Basin	Rai	200	100,000	20	
7 Irrigation Project of Phitsanulok Stage	Rai	880	250,000	220	
Total of Plan A and B (1+2+3+4+5+6)				1,000	
Total of Plan C (1+2+3+4+5+7)				1,200	

CHAPTER 8
IMPLEMENTATION PROGRAM



CHAPTER 8 IMPLEMENTATION PROGRAM

8.1 Disbursement Schedule

The project will be planned to be implemented in 8 years period taking the net construction period of 6.5 years for the Ing-Yot into consideration. The construction of the Kok-Ing diversion dam and canal will take place first in order to contribute grade up rural inhabitant's living standard in the Kok and Ing basins which would be influenced by the proposed project, by means of providing the Kok river water for irrigation and other uses in irrigable areas to be newly developed, in the Kok and Ing basins. Construction of remaining works such as Ing diversion dam, Ing-Yot tunnel, Yao river training, etc will be commenced 1.5 to 2 years afterwards. Accordingly, the annual amount of the project disbursement will be 6,000 to 7,000 million Baht on an average and 8,000 million Baht in the peak year.

8.2 Implementing Agency and Its Budget

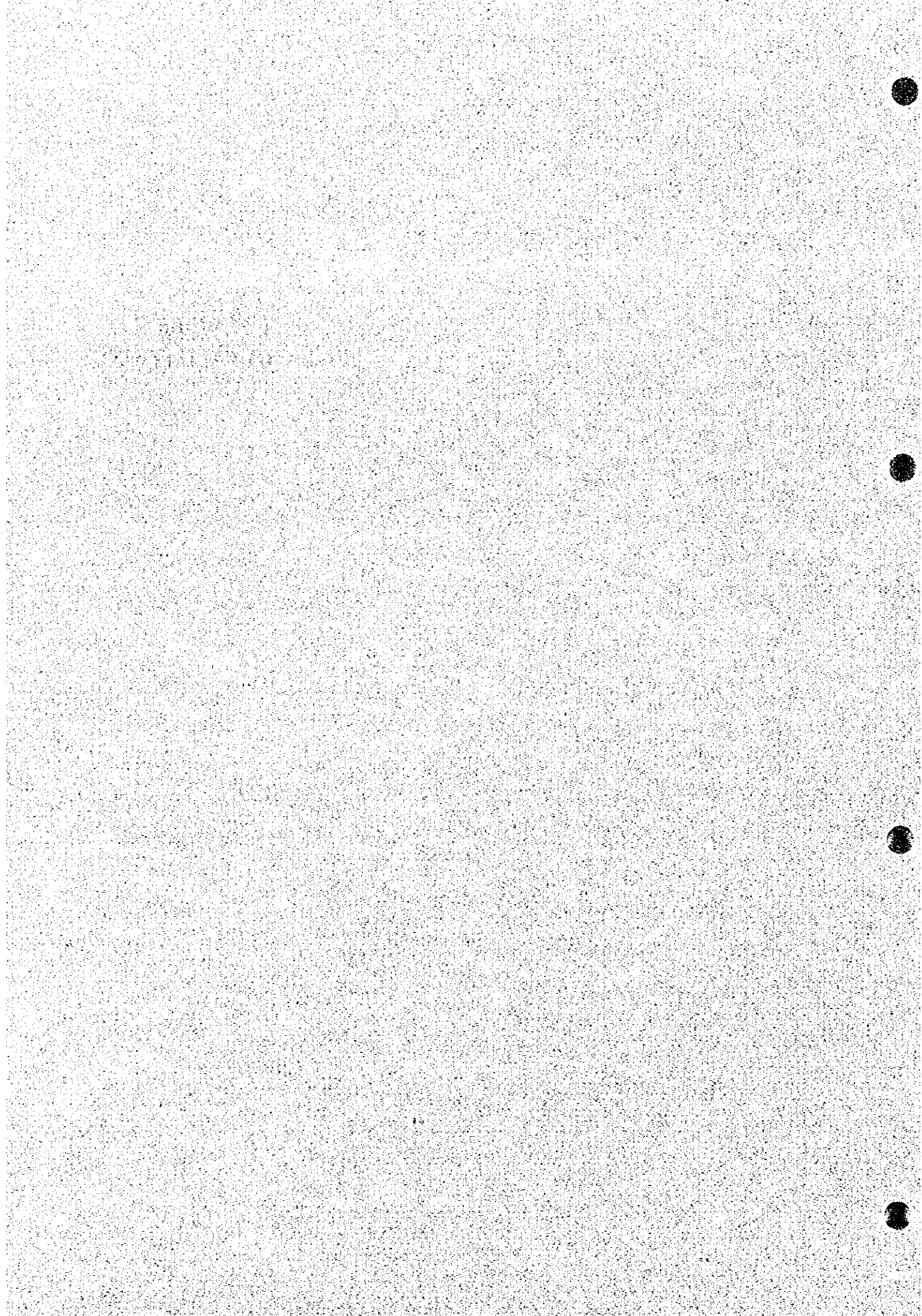
The implementing agency of the project is RID which is the largest agency to implement water resources and irrigated agricultural development projects in Thailand holding employee of more than 50,000. The annual budget allocated is 43,700 million Baht in 1997, of which 25,800 million Baht is the budget for project implementation excluding the foreign aid amount. The average project disbursement amount of 6,000 to 7,000 million Baht could therefore be provided without any budget constraints in the 21 century. The budget allocation could be more easy for RID if foreign credit became available through international financing agencies.

8.3 Implementation of Project in 8th National Development Plan

In accordance with the implementation list of water resources development projects in the 8th National Economic and Social Development Plan submitted by RID and approved by NESDB, the proposed Kok- Ing-Nan water diversion project is nominated as the project to be commenced in 2000 after consideration of a period needed for feasibility study.



CHAPTER 9
PROJECT EVALUATION



CHAPTER 9 PROJECT EVALUATION

9.1 Incremental Benefit of the Project

The beneficial areas and water use plans for the developed water by the proposed diversion project are planned tentatively as explained previously in the paragraph 4.7 taking into account the present water shortage condition, the future economic growth and the possibility to distribute water under gravity system. The incremental benefit by the proposed project is then estimated on the basis of these water use plans as summarized below;

(1) Incremental Benefit for Agriculture

(a) Increment of Irrigated Agricultural Area

To utilize effectively about 1,800 MCM of water to be released during dry season from the Sirikit reservoir for agricultural purpose, three alternative plans of water use for the lower Nan and Chao Phraya delta areas of either existing or newly developed and one plan for the project area are established as follows;

- The plan A is set up for irrigation of second crops without dry season paddy in the existing Phitsanulok project area and the existing Chao Phraya delta area taking into account the promotion of the crop diversification program as well as high and quick return of the project benefit since the areas have already developed with irrigation systems and consolidated farmlands together with skilled farmers.
- The plan B is set up so as to irrigate dry season crops including paddy in the same areas as proposed for the plan A.
- The plan C includes the development of the Phitsanulok Stage II area lying on the left bank of the Nan river in addition to the existing areas of the Phitsanulok and Chao Phraya delta areas taking into account the balanced development of the Phitsanulok area.
- The water use plan for the project area in the Kok and Ing river basins is set up for irrigation of second crops without dry season paddy.

The proposed cropping pattern, irrigable area and water requirement by water use plan are summarized as below;

Crops	Plan A		Plan B		Plan C		Project Area	
	Area 10 ³ ha	Water Demand MCM	Area 10 ³ ha	Water Demand MCM	Area 10 ³ ha	Water Demand MCM	Area 10 ³ ha	Water Demand MCM
Wet Paddy	-	-	-	-	120	240	-	-
Dry Paddy	-	-	91	910	37	370	-	-
Dry Maize	70	280	35	140	46	184	10	40
Dry Soybean	60	300	30	150	39	195	6	30
Dry Peanut	20	80	9	36	13	52	6	24
Sugarcane	40	280	20	140	26	182	-	-
Orchard	40	440	20	220	26	286	6	66
Vegetable	10	60	4	24	8	48	2	12
Fish	30	360	15	180	20	240	2	24
Total	270	1,800	224	1,800	335	1,797	32	196

(b) Unit Economic Benefit of Crops and Fishery

The per ha economic benefit of crop and fish is assumed based on the financial benefit as shown in Table 2.3.

Crop/Fish	Yield/ha (ton/ha)	Economic Price (Baht/ton)	Economic Gross Value per ha (Baht/ha)	Economic Input Cost per ha (Baht/ha)	Economic Net Value per ha (Baht/ha)
	A	B	C=AxB	D	E=C-D
Wet Paddy	1.8*	4,000	7,200	1,860*	5,340
Dry Paddy	4.5	4,300	19,350	9,320	10,030
Maize	3.5	3,000	10,500	6,195	4,305
Soybean	2.0	8,300	16,600	7,624	8,976
Peanut	1.8	11,400	20,520	9,410	11,110
Sugarcane	43.3	460	19,918	12,078	7,840
Orchard	5.0	16,500	82,500	37,120	45,380
Vegetable	10.0	9,100	91,000	33,600	57,400
Fish	4.0	27,000	108,000	47,250	60,750

Note: *The benefit of wet season paddy is estimated by difference of with project (irrigation) and without project (rainfed).

(c) Incremental Economic Net Benefit

The agricultural net benefit is brought mostly from the benefit of second crops to be newly cultivated under irrigation in dry season with the developed water by the proposed water diversion project. There is almost no benefit from second crops in dry season in the existing rainfed area since cultivation of second crops is extremely limited because of lack of irrigation water supply. The incremental economic net benefit is therefore estimated only for with project condition applying the above cropped area (A) and the economic price (B). The estimated values for three alternative plans of A, B and C are given in Table 9.1.

(2) Incremental Benefit in Municipal and Industrial Water Supply

The municipal and industrial water of 1,200 MCM per year can be supplied by the project to the lower Nan and Chao Phraya delta area. The benefit of water supply is estimated as below;

$$4.79 \text{ Baht/m}^3 \times 1,200 \text{ MCM/year} \times 0.7 = 4,024 \text{ million Baht}$$

where, 4.79 Baht is opportunity cost of urban water and 0.7 is loss factor of water supply

(3) Incremental Benefit in Hydro-Power Generation

The benefit from hydro-power generation at the Sirikit power plant by additional water through the proposed project is estimated as follows;

$$2,000 \text{ MCM} \times 1\text{KWh}/5.8\text{m}^3 \times 1.12 \times 0.85 = 328 \text{ million Baht}$$

where, 1Kwh/5.8m³ means that 5.8m³ of water is consumed to produce 1Kwh of power energy, 1.12 Baht/Kwh is the opportunity cost of electricity, and 0.85 is the transmission loss coefficient

(4) Total Incremental Benefit

The total benefit is then summarized as below;

Table 9.1 Agricultural Incremental Benefit (Economic)

(1) Agricultural Increment Net Benefit (Economic) in Nan & Chao Phraya Basin

Crop/Fish	Net Benefit per ha Baht/ha	Plan A		Plan B		Plan C	
		Area 10 ³ ha	Net Benefit 10 ⁶ Baht	Area 10 ³ ha	Net Benefit 10 ⁶ Baht	Area 10 ³ ha	Net Benefit 10 ⁶ Baht
Wet Paddy	5,340	-	-	-	-	120	641
Dry Paddy	10,030	-	-	91	913	37	371
Maize	4,305	70	301	35	151	46	198
Soybean	8,976	60	539	30	269	39	350
Peaanut	11,110	20	222	9	100	13	144
Sugarcane	7,840	40	314	20	157	26	204
Orchard	45,380	40	1,815	20	908	26	1,180
Vegetable	57,400	10	574	4	230	8	459
Fish	60,750	30	1,823	15	911	20	1,215
Total		270	5,588	224	3,639	335	4,762

(2) Agricultural Increment Net Benefit (Economic) in Project Area

Crop/Fish	Net Benefit/ha Baht/ha	Area 10 ³ ha	Net Benefit 10 ⁶ Baht
Maize	4,305	10	43
Soybean	8,976	6	54
Peanut	11,110	6	67
Orchard	45,380	6	272
Vegetable	57,400	2	115
Fish	60,750	2	122
Total		32	673

(3) Total Incremental Benefit

Basin	Incremental Benefit in 10 ⁶ Baht		
	Plan A	Plan B	Plan C
Nan & Chao Phraya Area	5,588	3,639	4,762
Project Area	673	673	673
Total	6,261	4,312	5,435

(Unit: million Baht)

Incremental Benefit	Plan A	Plan B	Plan C
Agriculture	6,261	4,312	5,435
Water Supply	4,024	4,024	4,024
Hydro-Power	328	328	328
Total	10,613	8,664	9,787

9.2 Economic Investment Cost

The economic investment costs for plans A, B and C are estimated based on the financial project cost as given below;

(Unit: million Baht)

Item	Conversion Factor	Plans A and B		Plan C	
		Financial	Economic	Financial	Economic
1. Construction Cost	0.85	40,708	34,602	47,608	40,467
2. Engineering Fee	0.85	3,257	2,769	3,809	3,238
3. Administration Fee	0.94	2,035	1,913	2,380	2,237
4. Land Acquisition	0.94	1,000	940	1,200	1,128
5. O/M Equipment	0.85	106	90	124	105
6. Environmental Impact Mitigation	0.49	500	245	500	245
Total		47,606	40,558	55,621	47,420

9.3 Economic Evaluation

The result of economic evaluation based on the above economic benefit and investment cost is summarized as follows;

Item	Plan A	Plan B	Plan C
EIRR (%)	15.1	13.2	12.7
B/C	1.38	1.13	1.08

If additional supply of about 1,000 MCM of water become available in dry season to be

possibly provided from the Kok hydro-power dam being studied, the project economy will be further upgraded assuming the EIRR of exceeding 15%.

9.4 Necessity and Viability of Kok-Ing-Nan Water Diversion Project

Necessity and viability of the proposed Kok-Ing-Nan water diversion project is judged to be high as supported by the following reasons;

(1) Necessity of Additional Water to Support Economic Development in the Chao Phraya Basin

The agricultural and socio-economic development in 21 century in the Chao Phraya basin, especially in the delta area holding a large irrigated farmland of 1.2 million ha, expanded urban area involving the Bangkok Metropolis with dense population of exceeding 10 million and developed industrial zone achieving successful growth will be stagnant because the area will face the critical water shortage problem due to limited water resources and increased water demand in dry season. It is inevitably necessary to introduce additional water to the Chao Phraya basin to solve water shortage problem and to achieve sustainable development of the area in 21 century.

(2) Necessity and Advantage of Kok-Ing-Nan Water Diversion Project

The Thai Government has studied numbers of water resources development projects in the Chao Phraya river basin since the early 1980s intending to implement feasible projects toward 21 century. The total volume of water resources to be developed in future by large and medium scale storage dam projects are however limited to less than 4,000 MCM in the whole Chao Phraya basin, and they will be consumed mostly for supplemental irrigation of wet season paddy in the tributary sub-basins where dams are constructed, meaning that there is no allowance at all to supply excess water in dry season to the Chao Phraya delta area.

The Thai Government has studied as well a number of alternative plans of transbasin water diversion from the Salavin and Mekong rivers to the Chao Phraya basin since the 1980s. All of such plans except the Kok-Ing-Nan water diversion project have, however,

been judged to be not or less viable for project implementation due to difficulty of diverting water from international rivers which needs water agreement among riparian countries, long distance tunnel and high pumping head which require high construction and operation costs, no availability of suitable construction site of large scale dam/reservoir to regulate the bulk amount of wet season runoff as well as large environmental impact such as peoples resettlement to be induced by dam construction, etc.

Only the Kok-Ing-Nan water diversion project among many alternative plans is advantageous and viable for project implementation since the project is technically and economically viable and would bring less environmental impact as compared to the other transbasin water diversion projects ever studied.

(3) Technical and Economic Viability of the Project

- All of the project facilities, except tunnel structure which has a large sectional area of 73 sq.m and a long length of 50 km, could be easily implemented employing the past experiences accumulated by RID.
- The proposed project is judged to be economically feasible with EIRR of some 13%. The project economy will be further improved showing the EIRR value of exceeding 15%, when additional water diversion of 1,000 MCM is introduced in dry season from the Kok hydro-power dam to be constructed by BOT on the Kok river near the national border with Myanmar.

(4) Firm Intention of Thai Government for Project Implementation

The Thai Government has recognized with full details of water shortage problem especially in the Chao Phraya delta area that the national socio-economic and agricultural development would be largely restricted by this problem in coming 21 century. Therefore the Thai Government has a firm intention to implement the Kok-Ing-Nan water diversion project in near future, and has performed already the following activities;

- In accordance with the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin, the Thai Government issued the Official

Notice to commence the Feasibility Study on the Kok-Ing-Nan Water Diversion Project to the Mekong Joint Committee where notification was greatly appreciated by three riparian countries, Lao PDR, Cambodia and Vietnam.

- The Government provided the budget of 150 million Baht for the feasibility study of the proposed project, which is presently undergoing by RID employing the local consultants JV for the purpose to cooperate with the JICA studies.
- The Government has listed up already the Kok-Ing-Nan water diversion project in the implementation program of water resources development in the 8th National Economic and Social Development Plan (1997-2001) in which the proposed project is given with high priority and planned to be commenced in the year 2000.

(5) Implementation Capability of RID

RID is the largest agency in Thailand for implementation of water resources development projects. Having sufficient capability such as staff, budget, experience etc, RID is considered as the proper agency for smooth and successful implementation of the proposed Kok-Ing-Nan water diversion project.

(6) Environmental Impact due to Project Implementation

There exist impacts to be induced by the project implementation on the natural environment, farmland acquisition, living environment of rural inhabitant, etc. These environmental impacts could however be solved when proper measures are taken for mitigation of such impacts, since the environmental impacts to be possibly caused by implementation of the proposed project seem not so severe in scale and nature as compared with the resettlement problem in the large reservoir area. In addition, the irrigated agricultural development projects will be implemented in association with the proposed water diversion project in order to expedite the progress of rural development in the Kok, Ing and upper Nan basins and to prompt the participation of rural inhabitant in the project.