11.3.5 Overall Construction Schedule

Overall construction schedule for 11 sub-projects is prepared taking into account urgent sub-projects for the donor basin and disbursement schedule of the construction cost as shown in Table 11.3.5.

Table 11.3.5 Overall Construction Schedule

Construction Divisions	1	2	3	4	5	6	7	8	9	10	11
1. Kok-Tak Canal											
2. Tak-Ing Canal											
3. Kok-Ing No.2 Tunnel											
4. Ing Canal & Ing Weir											
5. Ing-Yot Canal											
6. Ing-Yot No.2 Tunnel, Division 1											
7. Ing-Yot No.2 Tunnel, Division 2 & 3											
8. Ing-Yot No.2 Tunnel, Division 4 & 5											
9. Ing-Yot No.2 Tunnel, Division 6 & 7											
10. Ing-Yot No.2 Tunnel 8, Division 8 & 9											
11. Yao Dam & River Training											

11.4 Project Cost Estimation

11.4.1 Summary of Project Cost

The whole Project cost is consisting of the costs for ① Kok-Ing-Nan Water Diversion Project, ② Associate Irrigation Project, ③ Environmental Impact Mitigation, ④ Existing Beneficial Area in Lower Nan and Delta and ⑤ New Beneficial Area in Lower Nan and summarized as follows;

And the cost is estimated by 35 Baht/U.S.$.

Table 11.4.1 Summary of Project Cost

(Unit Million Baht)

Items	A Plan			B Plan			Remark
	F.C	L.C	Total	F.C	L.C	Total	
(1) Kok-Ing-Nan Project	31,416	11,970	43,386	31,416	11,970	43,386	Refer to Table 11.4.1.(1)
(2) Associate Irrigation Project	2,500	1,313	3,813	2,500	1,313	3,813	Refer to Table 11.4.1.(2)
(3) Environmental Impact Mitigation	380	420	800	380	420	800	- do -
(4) Existing Beneficial Area in Lower Nan & Delta	-	944	944	-	944	944	- do -
(5) New Beneficial Area in Lower Nan	7,000	3,620	10,620	0	0	0	- do -
Total	41,296	18,267	59,563	34,296	14,647	48,943	

Remark; A plan includes the development of new beneficial area in the lower Nan (with new beneficial area), while B plan is without new beneficial area.

(1) Kok-Ing-Nan Project Cost

The Kok-Ing-Nan Project cost is summarized as follows;

Table 11.4.1.(1) Summary of Kok-Ing-Nan Project Cost

Items	Amount (Million Baht)		
	F.C	L.C	Total
(1) Construction Cost	24,987	7,232	32,219
(2) Engineering Cost	1,539	1,565	3,104
(3) Administration Cost	0	645	645
(4) O/M Equipment	166	0	166
(5) Total (1)~(4)	26,692	9,442	36,134
(6) Total with Contingency ((5)×110%)	29,361	10,386	39,747
(7) Total with Tax ((6)×107%)	31,416	11,113	42,529
(8) Land Acquisition	0	857	857
(9) Project Cost Total ((7)+(8))	31,416	11,970	43,386

(2) Other Costs Related to the Kok-Ing-Nan Project

The other costs for Associate Irrigation, Environmental Impact Mitigation, Existing Beneficial Area and New Beneficial Area which are related to the Kok-Ing-Nan Project are estimated preliminary as shown in Table 11.4.1.(2)

Table 11.4.1.(2) Other Costs related to Kok-Ing-Nan Project

Remark	Unit	Quantity	Unit Price (Baht)			Amount (Million Baht)		
			F.C	L.C	Total	F.C	L.C	Total
1. Associate Irrigation Project								
(1) Irrigation System in New Area								
Kok-Ing Beneficial Area	Rai	200,000	10,000	5,000	15,000	2,000	1,000	3,000
Upper Nan Beneficial Area	Rai	50,000	10,000	5,000	15,000	500	250	750
Sub-total	Rai	250,000				2,500	1,250	3,750
(2) Land Consolidation for Perenial Crops								
Kok-Ing Beneficial Area	Rai	25,000	-	2,000	2,000	-	50	50
Upper Nan Beneficial Area	Rai	6,500	-	2,000	2,000	-	13	13
Sub-total	Rai	31,500				-	63	63
Total						2,500	1,313	3,813
2. Environmental Impact Mitigation								
(1) Reforestation Conter	Place	3	-	-	-	90	60	150
(2) Diversified Crop Conter	Place	3	-	-	-	30	30	60
(3) Eco-Tourism Area	Place	2	-	-	-	150	150	300
(4) Hatchery Facility	Place	4	-	-	-	50	50	100
(5) Animal Dispensary	Place	2	-	-	-	60	30	90
(6) Resettlement	L.S	-	-	-	-	-	100	100
Total						380	420	800
3. Existing Beneficial Area in Lower Nan & Delta								
Land Consolidation in Delta	Rai	377,000	-	2,000	2,000	-	754	754
- do - in Lower Nan	Rai	95,000	-	2,000	2,000	-	190	190
Total	Rai	472,000				-	944	944
4. New Beneficial Area in Lower Nan								
New Irrigation System	Rai	700,000	10,000	5,000	15,000	7,000	3,500	10,500
Land Consolidation	Rai	60,000	-	2,000	2,000	-	120	120
Total	Rai	760,000				7,000	3,620	10,620

11.4.2 Kok-Ing-Nan Project Cost

(1) Construction Cost

The construction works will be carried out on the contract basis under the international tender because the construction is composed of the large scale, complicated and difficult works such as the diversion weir and canals to release the large discharge capacity of 175 cu.m/sec, tunnel with the large diameter of 11.0 m and long distance of more than 50 km and the dam with the large outlet discharge capacity of 200 cu.m/sec.

The construction works also will be carried out by the following 11 construction diversions taking into account the kinds of works, scale of works, construction cost, etc.

Kok-Ing Diversion Canal

1) Kok intake, Kok canal and Kok-Ing No.1 tunnel
2) Tak canal
3) Kok-Ing No.2 tunnel
4) Ing canal and Ing weir

Ing-Yot Diversion Canal and Tunnel

5) Ing-Yot canal including Ing-Yot No.1 tunnel
6) Ing-Yot culvert and Ing-Yot No.2 tunnel, Division 1
7) Ing-Yot No.2 tunnel, Division 2 and 3
8) Ing-Yot No.2 tunnel, Division 4 and 5
9) Ing-Yot No.2 tunnel, Division 6 and 7
10) Ing-Yot No.2 tunnel, Division 8 and 9

Yao River

11) Yao Dam and Yao River Training

(a) Estimation of Unit Rate for the Works

Although the unit rate for the works is estimated by Thai side study, it is very difficult to review it due to lack of back data for the cost estimation. JICA Team accordingly has studied the unit rate for the works preparing the basic rate for labor, construction materials and hiring cost of construction equipment for the works and comparing with the rate estimated by Thai side study.

The unit rate for tunnel construction is studied more carefully through classifying into tunnel types based on the geological conditions along the tunnel route, because the direct construction cost of tunnel which is about 22,000 million Baht in the Project will occupy as much as 70% of the total construction cost and give the large influence to the Project cost and economy. The unit rate also is divided into the foreign and local currency in order to judge the foreign and local currency portion of the construction cost.

(b) Estimation of Construction Cost

The construction cost for the Project is estimated based on the Bill of Quantity for 11 construction divisions as shown in the supporting report and summarized in Table 11.4.2.(1)

The total construction cost of the Project is 32,219 million Baht consisting of the foreign currency of 24,987 million Baht and the local currency of 7,232 million Baht.

Table 11.4.2.(1) Construction Cost

(1,000Baht)

Item	Unit	Project Cost × 1,000Baht			Remarks
		F.C.	L.C.	Total	
B,Q-1 Construction Cost of Kok Intake, Kok Canal & Kok-Ing No.1 Tunnel					
(1) Kok Intake	L.S.	219,445	99,265	318,710	
(2) Kok Open Canal	L.S.	390,282	179,577	569,859	
(3) Kok-Ing No.1 Tunnel	L.S.	827,178	234,790	1,061,968	
(4) Main O/M Office	L.S.	205,590	82,583	288,173	
Sub-Total ("(1)"+~+"(4)")		1,642,000	596,000	2,238,000	× 1,000Baht
B,Q-2 Construction Cost of Tak Canal					
(1) Tak Open Canal	L.S.	215,212	78,749	293,961	
(2) Tak Culvert Canal	L.S.	1,412,302	344,944	1,757,246	
Sub-Total ("(1)"+"(2)")		1,628,000	424,000	2,052,000	× 1,000Baht
B,Q-3 Construction Cost of Kok-Ing No.2 Tunnel					
(1) Kok-Ing No.2 Tunnel	L.S.	1,414,000	388,000	1,802,000	
Sub-Total		1,414,000	388,000	1,802,000	× 1,000Baht
B,Q-4 Construction Cost of Ing Canal & Ing Weir/Intake					
(1) Ing Open Canal	L.S.	623,834	242,894	866,728	
(2) Ing Culvert Canal	L.S.	246,877	67,967	314,844	
(3) Ing Weir	L.S.	273,904	79,767	353,671	
(4) Ing Intake	L.S.	277,992	121,150	399,142	
Sub-Total ("(1)"+~+"(4)")		1,423,000	512,000	1,935,000	× 1,000Baht
B,Q-5 Construction Cost of Ing-Yot Canal & Ing-Yot No.1 Tunnel					
(1) Ing-Yot Open Canal	L.S.	65,564	15,921	81,485	
(2) Ing-Yot Culvert Canal (1)	L.S.	1,434,946	342,254	1,777,200	
(3) Ing-Yot No.1 Tunnel	L.S.	594,877	163,114	757,991	
Sub-Total ("(1)"+~+"(3)")		2,095,000	521,000	2,616,000	× 1,000Baht
B,Q-6 Construction Cost of Ing-Yot Culvert & Ing-Yot No.2 Tunnel Div.1					
(1) Ing-Yot Culvert Canal (2)	L.S.	1,434,946	342,254	1,777,200	
(2) Ing-Yot No.2 Tunnel Division 1	L.S.	1,270,858	358,392	1,629,250	
Sub-Total ("(1)"+"(2)")		2,706,000	701,000	3,407,000	× 1,000Baht
B,Q-7 Construction Cost of Ing-Yot No.2 Tunnel Div.2 & Div.3					
(1) Ing-Yot No.2 Tunnel Division 2	L.S.	1,389,592	393,885	1,783,477	
(2) Ing-Yot No.2 Tunnel Division 3	L.S.	1,599,635	438,305	2,037,940	
Sub-Total ("(1)"+"(2)")		2,989,000	832,000	3,821,000	× 1,000Baht
B,Q-8 Construction Cost of Ing-Yot No.2 Tunnel Div.4 & Div.5					
(1) Ing-Yot No.2 Tunnel Division 4	L.S.	1,940,864	503,636	2,444,500	
(2) Ing-Yot No.2 Tunnel Division 5	L.S.	1,801,914	465,103	2,267,017	
Sub-Total ("(1)"+"(2)")		3,743,000	969,000	4,712,000	× 1,000Baht
B,Q-9 Construction Cost of Ing-Yot No.2 Tunnel Div.6 & Div.7					
(1) Ing-Yot No.2 Tunnel Division 6	L.S.	1,837,916	481,022	2,318,938	
(2) Ing-Yot No.2 Tunnel Division 7	L.S.	1,704,036	441,895	2,145,931	
Sub-Total ("(1)"+"(2)")		3,542,000	923,000	4,465,000	× 1,000Baht
B,Q-10 Construction Cost of Ing-Yot No.2 Tunnel Div.8 & Div.9					
(1) Ing-Yot No.2 Tunnel Division 8	L.S.	1,357,340	377,450	1,734,790	
(2) Ing-Yot No.2 Tunnel Division 9	L.S.	1,272,688	359,035	1,631,723	
Sub-Total ("(1)"+"(2)")		2,630,000	736,000	3,366,000	× 1,000Baht
B,Q-11 Construction Cost of Yao Dam & Yot and Yao River Training					
(1) River Diversion Works	L.S.	72,574	35,001	107,575	
(2) Intake Works	L.S.	91,716	41,281	132,997	
(3) Outlet Works	L.S.	67,179	27,584	94,763	
(4) Coffer Dam	L.S.	26,029	15,202	41,231	
(5) Main Dam	L.S.	126,737	44,219	170,956	
(6) Spillway	L.S.	378,078	125,898	503,976	
(7) Control House Yard	L.S.	30,324	16,367	46,691	
(8) Yot River Training	L.S.	90,307	17,516	107,823	
(9) Flood Protection Dike	L.S.	96,247	31,030	127,277	
(10) River Improvement	L.S.	195,603	276,177	471,780	
Sub-Total ("(1)"+~+"(10)")		1,175,000	630,000	1,805,000	× 1,000Baht
Total ("B,Q-1"+ ~ +"B,Q-11")		24,987,000	7,232,000	32,219,000	without Tax

(2) Other Cost

The Project cost is composed of the construction cost and the other costs such as the engineering cost, administration cost, land acquisition cost and O/M equipment. These costs are estimated as follows;

(a) Engineering Cost

The engineering cost is composed of the engineering fee for the detailed design and construction supervision and the expenses for topographical and geological survey in the detailed design stages. These costs are estimated as shown in Table 11.4.2.(2)-2,3 and summarized as follows.

Table 11.4.2.(2)-1 Engineering Cost

Item	Cost (Million Baht)		
	F/C	L/C	Total
1. Detailed Design Stage			
Engineering Fee	205	169	374
Topographical Survey Cost	-	30	30
Geological Investigation Cost	100	55	155
Sub-total	305	254	559
2. Construction Supervision Stage			
Engineering Fee	1,234	1,311	2,545
Total	1,539	1,565	3,104

(b) Administration Cost

The administration cost is the expenses of government for the implementation of the Project such as the site office, supervision expenses for the Consultant and Contractor, inspection expenses for the monthly payment, management cost for the site maintenance during construction, etc. Since the KIN Project is the huge project requiring construction cost of 32,219 million Baht, the administration cost is estimated at 645 million Baht which is equivalent to 2% of the construction cost.

(c) O/M Equipment

The O/M works for the water diversion in the project will not have difficult items. The major maintenance of the Project facility is consisting of the following items;

- Sediment removal by dredging boat at the approach canal in the Kok intake and at the Ing reservoir
- Road maintenance along the open canal
- Periodical painting and repairing for gate and valves
- Maintenance for the control house, office and residential quarters

These maintenance works will be carried out by employing the contractors in Chiang Rai province except the sediment removal works which will be carried out by the force account.

The O/M equipment, therefore will be consisting of mostly vehicles and their costs are estimated at 166 million Baht (Foreign currency)

(d) Land Acquisition and Compensation Cost

The land acquisition and compensation cost is estimated based on the area and unit rate of area to be lost by the Project implementation.

The cost is estimated at 857 million Baht by Thai side and its detail is as shown in the supporting report.

(e) Physical Contingency

The Physical contingency of 10% is applied for the above construction and other costs except the land acquisition cost.

(f) Tax

Tax of 7% is applied for the above construction and other costs including the physical contingency cost.

Table 11.4.2.(2)-2 Summary of Engineering Cost

Item	F.C.			L.C.			Total Amount (Million Baht)		
	Remuneration	Actual Cost	Total	Remuneration	Actual Cost	Total	Remuneration	Actual Cost	Total
1 Detailed Design									
(1) Engineering Fee	180	25	205	123	46	169	303	71	374
Sub-Total	180	25	205	123	46	169	303	71	374
2 Construction Supervision									
(1) Intake, Weir & Diversion Canal	169	18	187	273	175	448	442	193	635
(2) Kok-Ing No.1 & No.2 Tunnel	139	11	150	57	47	104	196	58	254
(3) Yao Dam & River Training	66	6	72	59	42	101	125	48	173
(4) Ing-Yot No.2 Tunnel,No.1~No.9 Div.	764	61	825	331	327	658	1,095	388	1,483
Sub-Total	1,138	96	1,234	720	591	1,311	1,858	687	2,545
Total	1,318	121	1,439	843	637	1,480	2,161	758	2,919

In addition to the above engineering fee, the following geological and topographical survey costs are required for the detailed design.

(Million Baht)

Item	F.C.	L.C.	Total
1 Geological Survey Works	100	55	155
2 Topographical Survey Works	-	30	30
Total	100	85	185

Table 11.4.2.(2)-3 Engineering Fee for Detailed Design

1.1 Remuneration (36 monthes)

Unit 1,000Baht

Staff	Foreign Currency							Local Currency							Total (1,000Baht)
1. Project Manager	1,000	×	1	Per×	36	×M=	36,000							-	36,000
2. Sub-Manager							-	250	×	1	Per×	36	×M=	9,000	9,000
3. Civil Eng (S)	800	×	2	Per×	30	×M=	48,000	200	×	4	Per×	30	×M=	24,000	72,000
4. Tunnel Eng (S)	800	×	2	Per×	30	×M=	48,000	200	×	2	Per×	30	×M=	12,000	60,000
5. Dam Eng (S)	800	×	1	Per×	20	×M=	16,000	200	×	1	Per×	30	×M=	6,000	22,000
6. Canal Eng (S)							-	180	×	4	Per×	30	×M=	21,600	21,600
7. Geologist (S)	800	×	1	Per×	16	×M=	12,800	180	×	1	Per×	20	×M=	3,600	16,400
8. Soil Mechanist (S)							-	180	×	1	Per×	10	×M=	1,800	1,800
9. Building Eng (S)							-	180	×	2	Per×	15	×M=	5,400	5,400
10. Gate Eng (S)	800	×	1	Per×	8	×M=	6,400	200	×	1	Per×	6	×M=	1,200	7,600
11. Electrical Eng (S)								200	×	1	Per×	12	×M=	2,400	2,400
12. Telemetering (S)	800	×	1	Per×	4	×M=	3,200	200	×	1	Per×	6	×M=	1,200	4,400
13. Cost Estimator (S)	800	×	1	Per×	6	×M=	4,800	180	×	1	Per×	10	×M=	1,800	6,600
14. Spec Writer (S)	800	×	1	Per×	6	×M=	4,800	200	×	2	Per×	10	×M=	4,000	8,800
15. Tender Document (S)								200	×	2	Per×	6	×M=	2,400	2,400
16. Junior Civil Eng (J)								60	×	15	Per×	30	×M=	27,000	27,000
Sub-Total					(M=	216	) **180,000**					(M=	942	) **123,400**	**303,400**

1.2 Actual Expenses

Unit 1,000Baht

Item	Foreign Currency						Local Currency							Total (1,000Baht)
1 Per Diem at Thai	50	/M	×	216	×M=	10,800								10,800
2 Per Diem at Site						-	20	/M	×		200	M=	4,000	4,000
3 Hotel Charge (B.K.)	60	/M	×	130	×M=	7,800								7,800
4 Hotel Charge (Site)	30	/M	×	86	×M=	2,580	30	/M	×		200	M=	6,000	8,580
5 Air Fee	90	/M	×	30	Times=	2,700								2,700
6 Air Fee (to Site)						-	4	/Times		×	900		3,600	3,600
7 Communication	20	/M	×	36	×M=	720	10	/M	×		36	M=	360	1,080
8 Car Rental at B.K.						-	45	/M×	3	×	36	M=	4,860	4,860
9 Car Rental at Site						-	40	/M×	8	×	12	M=	3,840	3,840
10 Office Rental at B.K.						-	200	/M	×		36	M=	7,200	7,200
11 Office Rent at Site						-	50	/M	×		12	M=	600	600
12 Technician						-	30	/M×	6	×	30	M=	5,400	5,400
13 Office Worker						-	20	/M×	8	×	30	M=	4,800	4,800
14 Report						-							5,000	5,000
15 Others						-							340	340
Sub-Total						**24,600**							**46,000**	**70,600**

Unit 1,000Baht

Total	**204,600**	**169,400**	**374,000**

Table 11.4.2.(2)-4 Summary of Cost Estimate for Geological Survey Works

Type of Works	Unit	Amount (Baht)
1 Geological Investigation (Shallow Drilling, Weir, Intake and Diversion Canal)		
1.1. Mobilization and Demobilization	LS.	1,140,000
1.2. Boring works	LS.	5,672,500
1.3. In-situ test	LS.	4,759,000
1.4. Laboratory test (physical test)	LS.	68,000
1.5. Reporting	LS.	100,000
Sub total ("1.1."+~+"1.5.")		11,739,500
2 Geological Investigation (Shallow and Deep Drilling, Kok-Ing and Ing-Yot Tunnel)		
2.1. Mobilization and Demobilization	LS.	9,820,000
2.2. Boring works	LS.	47,818,000
2.3. In-situ test	LS.	6,520,000
2.4. Laboratory test (rock test)	LS.	699,400
2.5. Reporting	LS.	700,000
Sub total ("2.1."+~+"2.5.")		65,557,400
3 Geological Investigation (Yao Flood Control Dam and Yao River Training)		
3.1. Mobilization and Demobilization	LS.	2,220,000
3.2. Boring works	LS.	8,308,000
3.3. In-situ test	LS.	4,170,000
3.4. Test pitting and laboratory test	LS.	2,854,000
3.5. Reporting	LS.	500,000
Sub total ("3.1."+~+"3.5.")		18,052,000
4 Electromagnetic Survey (TEM, TDEM)		
4.1. Rental charge	LS.	4,654,500
4.2. Labor charge	LS.	3,062,200
4.3. Engineer for observation of TEM&TDEM	LS.	16,459,400
4.4. Equipment for measurment	LS.	791,200
4.5. Transportation chage (International and domestic)	LS.	818,100
4.6. Depreciation costs of Equipment (including repair & maintenance)		5,206,700
4.7. Reporting (including analysis)	LS.	2,083,400
Sub total ("4.1."+~+"4.7.")		33,075,500
5 Seismic Survey (Refraction Survey)		
5.1. Seismic survey (refraction survey)	LS.	400,000
5.2. Reporting	LS.	10,000
Sub total ("5.1."+"5.2.")		410,000
6 **Sub total ("1"+~+"5")**		128,834,400
7 **Miscellaneous ("6"×20%)**	20%	25,766,900
8 **Sub total ("6"+"7")**		**155,000,000**
9 **Tax ("8" × 7%)**	7%	**11,000,000**
10 **Total ("8"+"9")**	Baht	**166,000,000**

Table 11.4.2.(2)-5 Cost of O&M Equipment

(Foreign Currency)

No.	Item	Number of Equipment					Unit Rrice	Initial Cost	Remark
		Chiang Rai	Kok Area	Ing Area	Yao Area	Total	(1,000 Baht)	(1,000 Baht)	
1	Truck 2t with Crane 2t	2	-	-	-	2	850	1,700	
2	Lift Truck H=8~9m (for Tunnel Maintenance)	3	-	-	-	3	1,170	3,510	with 8×Light
3	Water Tank Lorry 5.0 m3	1	-	-	-	1	1,450	1,450	
4	Sand Pump ϕ 100 H=25m	-	2	2	2	6	100	600	
5	Sand Pump ϕ 150 H=20m	-	2	2	2	6	130	780	
6	Dredging Boat 500PS	-	1	1	-	2	70,460	140,920	at Kok Intake, Ing Weir
7	Motor Boat	-	1	1	1	3	1,180	3,540	
8	Station Wagon	3	1	1	1	6	830	4,980	
9	Double Cab Truck 1ton	2	-	-	-	2	330	660	
10	Micro Bus	2	-	-	-	2	520	1,040	
11	Motor Cycle	14	4	4	4	26	70	1,820	
12	Movable Telephone	8	2	2	2	14	10	140	
13	Others	-	-	-	-	L.S.	3%	4,830	
14	Subtotal	35	13	13	12	73		166,000	
15	Taxes						7%	12,000	
16	Total (Subtotal+Taxes)							178,000	(1,000 Baht)

Table 11.4.2.(2)-6 Summary of Land Acquisition and Compensation Cost

Local Currency

No.	Location	Compensation Cost (Baht)
L-1	Kok-Ing Diversion Route	478,800,000
L-2	Ing-Yot Tunnel Inlet Diversion Route	128,400,000
L-3	Mae Loy River Improvement	2,400,000
L-4	Diversion Ing Weir Area	6,000,000
L-5	Nam Yao Reservoir Development and Resettlement	8,400,000
L-6	Nam Yao River Training Area	27,600,000
L-7	Ing-Yot No.2 Tunnel Adit No.7 Area	8,400,000
L-8	Ing-Yot No.2 Tunnel Muck at Adit No.3,5,9 Area	121,200,000
L-9	Access Road Area	2,400,000
L-10	Canal Area from Outlet of Ing-Yot Tunnel	15,600,000
L-11	Land Allocation Cost for Nam Yao Reservoir Development	21,600,000
L-12	Land Allocation Cost at Ban Pro for Nam Yao River Improvement	21,600,000
L-13	Land Allocation Cost at Wang Phang for Nam Yao River Improvement	14,400,000
Total		857,000,000

11.4.3 Other Costs Related to Kok-Ing-Nan Project

The other costs related to Kok-Ing-Nan Project as mentioned in Table 11.4.1.(2) are estimated taking into account the following concept.

(1) Associate Irrigation Project Cost

- The Associate irrigation project in the Kok-Ing basin is consisting of the irrigation facilities such as irrigation main and lateral canals connecting to the Kok-Ing diversion canal, new weirs crossing the Ing river and small scale pumping stations along the river and canal. Namely, the project cost does not include the water sources cost but only covers the cost for water distribution facility in the beneficial area.
- The Associate project cost in the lower Nan basin is consisting of mainly floating pump and canal system in the beneficial area. The irrigation water released from the Yao dam in the dry season will be lifted by floating pump and conveyed to the beneficial area by canal system.
- The proposed beneficial area is presently placed at the wet season paddy area under rainfed. The proposed perennial area to be used for fruit and fish pond will be converted from the existing paddy area and will require the land consolidation cost to convert the farm area.

(2) Environmental Impact Mitigation Cost

The surrounding area along the water diversion route of the Project is mostly formed with flat farmland along the river, forest land at high mountain and hilly area and bush and grass land at low hilly area. The environmental impact to the area by the Project implementation is very limited at the area along the open canal because the water diversion route consists of mainly culvert and tunnel passing through underground. The environmental impact mitigation cost for the construction works such as treatment of spoil banks, poluted drainage water, safety measures, etc is included in the construction cost in each Project facility. However, the following mitigation works will be proposed for conservation of water shead and improvement of human life in the Project area. These works will be provided by the governmental agencies concerned and managed in cooperation with the peoples living in the area.

- Three reforestation centers at Amphoe Chiang Kham, Thoeng and King Amphoe Song Khwae by RFD for purpose of forest conservation.
- Three diversified crop centers at Amphoe Phaya Meng Rai, Thoeng and King Amphoe Soeng Khwae by DOE for purpose of research and extension of crop diversification program.
- Two Eco-tourism facilities at the national park area in the Ing-Lao basin and the reserved forest area 1 near the tunnel outlet in the Yao basin by RFD.
- Four hatchery facility at the Kok, lower Ing, and Yao basins by DOF in order to expand the fish culture in the Project area.
- Two animal dispensaries at the lower Ing and Ing-Lao basin by DOL for the purpose of cattle breading at the plateau area along the tunnel route in the Ing-Lao basin.
- Resettlement of houses, which is very scarce in the Project area, if required in future.

(3) Existing Beneficial Area in Lower Nan and Delta

The perennial area of 377,000 rai in the Delta and 95,000 rai in the lower Nan will be

developed by the diversion water of the Project. The perennial area is consisting of the area of sugar cane, fruit and fish pond and will be converted from the existing paddy area. Some land consolidation works will be required for the area conversion from paddy to other crops.

(4) New Beneficial Area in the Lower Nan

In the lower Nan basin, the large irrigation projects of Phitsanulok (2) and pumping irrigation project by DEDP will be newly proposed to use the diversion water of the Project. Those beneficial area is presently under rainfed and will require the irrigation canal and pumping system to use the diversion water. The irrigation main canal in the Phitsanulok (2) will be started at the existing Naresuan barrage and located at the left bank of the lower Nan river, while a number of pumping stations are installed along the Nan and Phichit river.

CHAPTER 12.

PROJECT IMPLEMENTATION PLAN

CHAPTER 12 PROJECT IMPLEMENTATION PROGRAM

12.1 Method of Implementation

(1) Implementation Agency

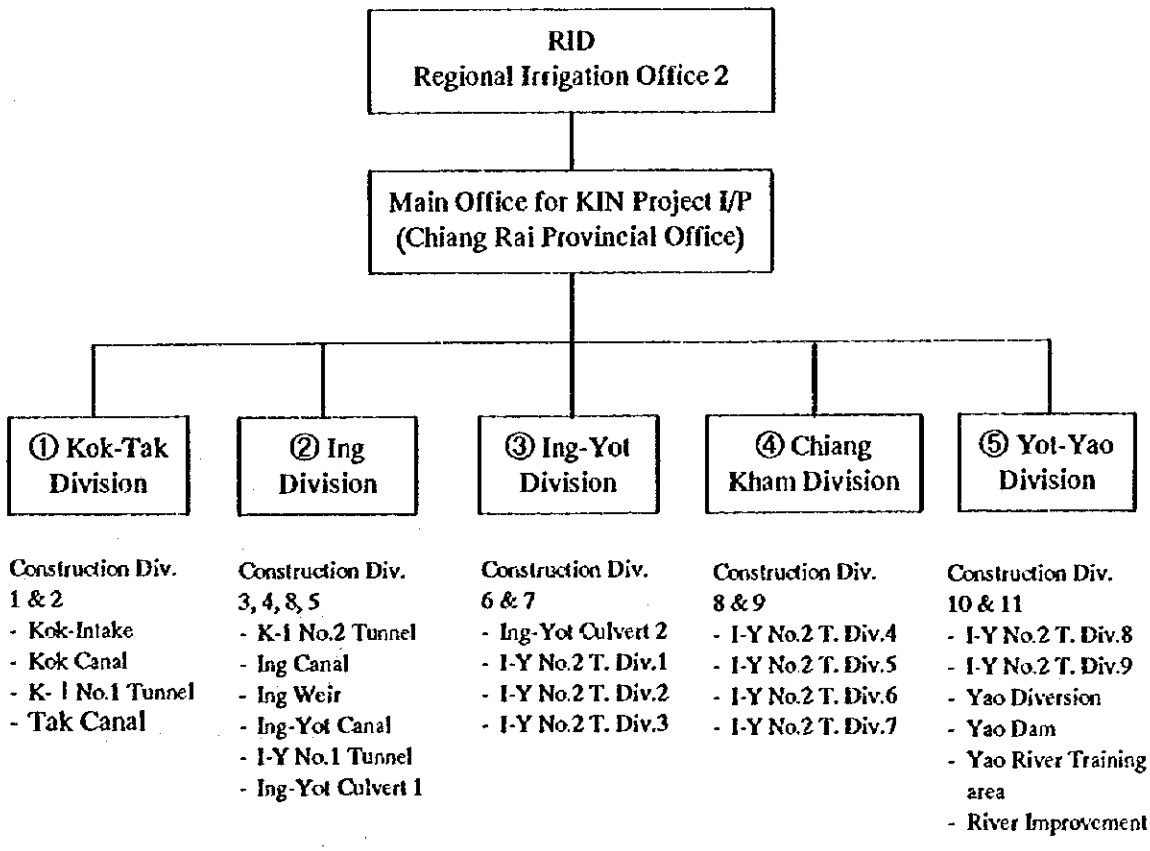
The Royal Irrigation Department (RID) of the Ministry of Agriculture and Cooperative will be the responsible agency for implementation of the project as well as for coordination with the other government agencies concerned.

In order to promote the project implementation, the National Committee for the Project has been set up, while the Regional Irrigation Office 2 has also been nominated by RID to manage the public relation activities for the Project. After completion of the project implementation, the Regional Operation and Management Group will take charge of the O&M of the project facilities.

(2) Project Office Organization for Implementation

The project office for implementation will consist of the proposed O&M headquarters and five (5) Site Diversions to cover the construction works of the diversion canal from the Kok intake to the Yao river training area and shown in Figure 12.1.1.

Figure 12.1.1 Organization Chart of Project office for Implementation



(3) Project Office Organization for O/M

The RID shall set up the O&M organization at the Project site before completion of the Project. The organization will consist of an O&M headquarters and three (3) branch offices to manage the diversion canal system from the Kok intake to the Yao flood control dam.

The headquarters will be provided at the compound of the existing Chaing Rai Provincial Irrigation Office and manage the whole Project area and the following three branch offices.

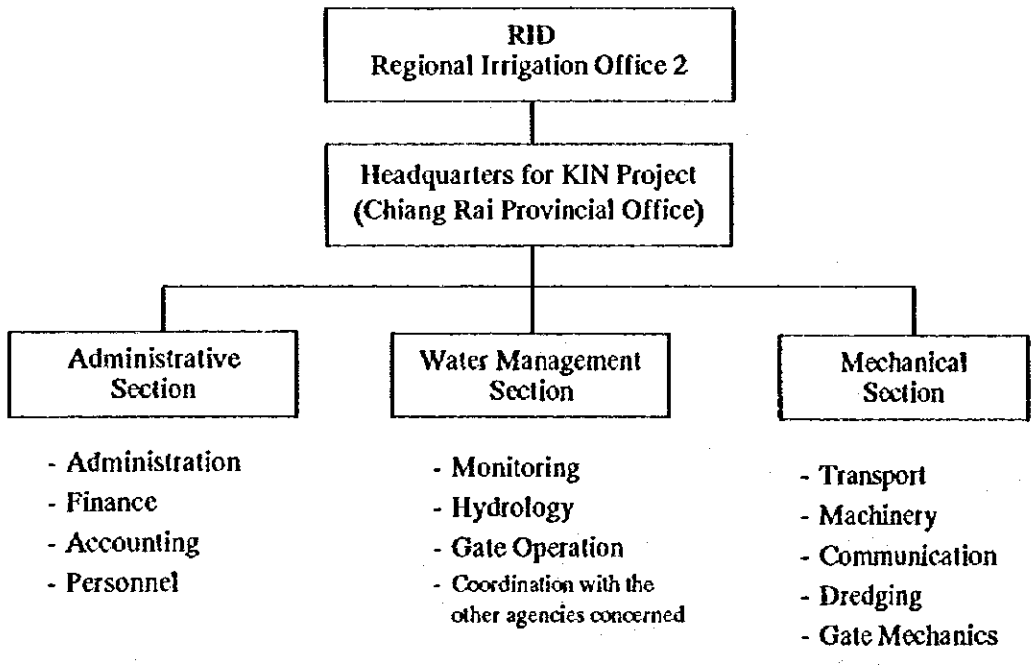
- Kok Branch Office at Kok-Intake site
- Ing Branch Office at Ing-Weir/Intake site
- Yao Branch Office at Yao-Flood Control Dam site

The functions of and the areas covered by each office are as follows;

- Headquarters : Overall O&M, water management and coordination with other agencies concerned.
- Kok Branch Office : Actual O&M works for the diversion canal system from the Kok intake to the Tak canal.
- Ing Branch Office : Actual O&M works for the diversion canal system from the Ing-Weir/Intake to the Ing-Yot canal.
- Yao Branch Office : Actual O&M works for the Yao-Flood Control Dam and the area along the Yao river.

The organization chart for the O&M of the Project is as presented in Figure 12.1.2.

Figure 12.1.2 Organization Chart for Operation and Maintenance of the Project



12.2 Implementation Schedule

Various irrigated agricultural projects and mitigation measures for environmental impact in the Project area shall be implemented in parallel with the Project in order to realize the smooth and successful implementation of the Project, because the Project area where the water diversion route is located is the remote rural area in the country and is the donor basin to supply the water to the Chao Phraya basin.

Accordingly, the implementation schedule for the Project is prepared as shown in Table 12.2.1 taking into account the following conditions of not only the Kok-Ing-Nan Project but also the other related projects and works.

12.2.1 Kok-Ing-Nan Project

(1) Implementation Procedures

- Feasibility study of the Project is completed at the end of the year 2542 (September 1999).
- Review of environmental impact assessment by the National Environmental Board (NEB), approval of the Project implementation by the Cabinet and budget arrangement for the Project will require two and half years. Namely it is expected that the Project implementation will be commenced at 2545 (2002).

(2) Detailed Design Works

The detailed design work is consisting of topo-survey, geological survey, detailed design, land acquisition, etc and will require two to four years depending on the work component.

- The work for the diversion canal from Kok intake to Tak basin will be completed within a short period of two years because topo-survey and geological survey are mostly finished and design component is simple.
- The work for Kok-Ing No.2 tunnel, the canal crossing the Ing basin and the Ing weir will require the period of two and half years because the geological survey through tunnel route, survey for water diversion points to the associate project area in the Ing basin, and survey for land acquisition for the area along Ing canal route and Ing weir site are not completed and will require slightly longer period than those in the diversion canal route from Kok to Tak.
- The work for Ing-Yot diversion canal consisting of culvert with excavation depth of more than 20 m and Ing-Yot No.2 tunnel will require careful geological survey with the survey period of more than one year. The work period of three and half years accordingly, will be required.
- The working period for the Yao dam and river training will require two and half years.

(3) Construction Period

The construction period for diversion canal, weir and dam will be four years but that in Ing-Yot No.2 tunnel will require a longer period of 7 years as explained in 11.3 "Construction Plan".

Table 12.1 Implementation Schedule of Kok-Ing-Nan Project and Others

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
	2542	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
1. Completion of Project F/S	→																	
2. Acquisition of the Environmental Compliance Certificate (ECC) and Project Approval by Cabinet	←- - -	- - -	- - -	→														
3. Project Implementation (After ECC and approval by cabinet)																		
(1) Kok Intake, Canal & Kok-Ing No.1 Tunnel				D/D		Construction												
(2) Tak Open and Culvert Canal				D/D		Construction												
(3) Kok-Ing No.2 Tunnel				D/D			Construction											
(4) Ing Canal & Ing Weir				D/D			Construction											
(5) Ing-Yot Canal, Ing-Yot No.1 Tunnel & No.2 Div.1 Tunnel						D/D				Construction								
(6) Ing-Yot No.2 Tunnel, Div.6~9				D/D					Construction									
(7) Ing-Yot No.2 Tunnel, Div.2~5					D/D				Construction									
(8) Yao Dam & River Training				D/D			Construction											
(9) O/M Office & Equipment																		
(10) Water Operation										Kok-Ing Canal						Tunnel		
4. Associated Project																		
(1) Irrigation Project in Kok & Tak Basin		PRA & IEE		F/S & EIA		D/D	Construction											
(2) Irrigation Project in Lower Ing Basin		PRA & IEE		F/S & EIA		D/D	Construction											
(3) Irrigation Project in Upper Nan Basin		PRA & IEE		F/S & EIA		D/D	Construction											
5. Environmental Impact Mitigation					F/S						D/D and Construction							
6. Improvement of Sirikit Reservoir Operation																		
7. Development of Existing Beneficial Area in Lower Nan & Delta											Land Construction							
8. Development of New Beneficial Area in Lower Nan													Irrigation System					
9. Irrigation Project in Kok-Ing Upper Basin and Upper Nan Basin																		
(1) F/S Completion Project by Thai Side		D/D			Construction													
(2) Medium & Small Scale Projects								F/S, D/D & Construction										

(4) Water Operation

When the construction of Kok-Ing diversion canal system is to be completed, the water operation to divert the Kok water through the Kok-Ing canal system, regulate the Kok water and the Ing river water at the Ing weir and use of the Kok and Ing water for the associate irrigation projects in the Kok and the lower Ing basins will be carried out. The associate projects will also be completed and use the above water in the beneficial area.

12.2.2 Other Projects and Works related to Kok-Ing-Nan Project

(1) Associate Irrigation Projects

As mentioned in the above, the associate irrigation projects in the Kok and Ing lower basins will be implemented in early stage in parallel with the implementation of the Kok-Ing diversion canal system in order to accelerate the irrigated and diversified agriculture in the associate project area.

(2) Environmental Impact Mitigation Works

The environmental impact mitigation works will be implemented by various governmental agencies concerned such as R.F.D, D.O.E, D.O.F, DOL, etc in MOAC in order to preserve the watershed in the Project area and improve the living standard for peoples in the area. The works will be carried out in parallel with the construction of Project facilities.

(3) Improvement of Existing Sirikit Reservoir Operation

In accordance with the water resources development for irrigation in the upper and lower Nan basin in future, the available dry season water in the lower Nan and the Chai Nat barrage will largely decrease. The improvement of the existing Sirikit reservoir operation to increase the dry season outflow will be carried out under the new reservoir operation rule. The operation activities to improve the reservoir outflow will be carried out gradually during the period of 6 years from 2547 (2004) to 2553 (2010).

(4) Development of Existing Beneficial Area in Lower Nan and Delta

The existing irrigated agricultural areas at the Phitsanulok (1) and pumping irrigation in the lower Nan basin and 25 large projects in the Delta have a complete irrigation system and will not require additional irrigation system for use of the additional dry season water to be diverted by the Project. However, for the perennial crop area such as sugar cane, fruit and fish pond to use additional water needs to be converted from the existing paddy area. Accordingly, some land consolidation works for the perennial crop area will be required. Since the additional dry season water of about 640 MCM will be supplied by the improvement of the Sirikit reservoir operation before completion of the whole Kok-Ing-Nan Project facilities, the consolidation works at the perennial area shall be carried out together with the improvement activity of the reservoir operation.

(5) Development of New Beneficial Area in Lower Nan Basin

The new beneficial area of 700,000 rai will be developed by the Phitsanulok (2) project and new pumping projects of DEDP. Since those projects can not be developed without the Kok-Ing-Nan Project, the implementation of those projects will be made before completion of the Ing-Yot No.2 tunnel works.

(6) Irrigation Project in Kok-Ing Upper Basin and Upper Nan Basin

A number of medium and small irrigation projects are identified by the inventory survey in the basins. Although these many projects have no direct relation to the Kok-Ing-Nan Project, it is desirable to implement in parallel with the Kok-Ing-Nan Project because the associate project areas will be developed by the Project while those beneficial areas in the upper basin will be left without development. Thai side has already carried out the feasibility study for three medium scale projects, which will be implemented in earlier stage.

12.3 Annual Disbursement Schedule

The annual disbursement schedule for the Project cost is prepared as shown in Table 12.3-1 to 12.3-5 based on the implementation schedule in Table 12.2.1.

The largest disbursement amount per annum is 8,180 million Baht, of which the local cost is about 2,230 million Baht in the year of 2554. This disbursement will not cause difficulty to RID taking into account the fact that RID has about 26,000 million Baht construction budget annually at present.

12.4 Annual Operation and Maintenance Cost

(1) Kok-Ing-Nan Project

The annual operation and maintenance cost is estimated at 128 million Baht as shown in Table 12.4.1.

(2) Associate Project in Kok-Ing-Upper Nan Basin and New Project in Lower Nan Basin

The associate projects in the Kok-Ing basin and upper Nan as well as the new project in the lower Nan will require the operation and maintenance cost for their irrigation canals and pumping system. The cost is estimated at 1.5% of the project cost as follows;

- Associate Project 3,813 million Baht×0.015 =57.2 million Baht
- New Project in Lower Nan 10,500 million Baht×0.015 =157.5 million Baht

(3) Total Operation and Maintenance Cost

The total operation and maintenance cost with and without new irrigation project in the lower Nan basin is as follows;

Item	With New Project	Without New Project
Kok-Ing-Nan Project	128.0	128.0
Associate Project	57.2	57.2
New Project in Lower Nan	157.5	-
Total	342.7	185.2

(4) Starting Year of Operation and Maintenance Cost

The starting Year of operation and maintenance cost is as follows;

- Kok-Ing-Nan Project, The year of 2557 (2014) after completion of the whole construction works
- Associate Projects, The year of 2552 (2009) after completion of the associate project works
- New Projects in Lower Nan, The year of 2557 (2015) after completion of the new project works.

12.5 Replacement Cost for O/M Equipment and Mechanical Part

The Initial cost for the O/M equipment and mechanical part is estimated at 358.6 million Baht as shown in Table 12.4.2.

The replacement cost for the equipment and mechanical part is estimated as follows based on the replacement term.

Unit 10^3 Bhat

Term	Replacement Cost
Each 5 years	10,600
Each 10 years	10,600+10,000 = 20,600
Each 25 years	10,600+10,000+197,000 = 217,600

12.6 Annual Fund Requirement for Project Cost

The annual fund requirement for the Project cost is estimated based on the disbursement schedule and the price escalation rate of 1.0% for the foreign currency portion and 5.0% for the local currency portion taking into account the low price escalation after the economic crisis in Thailand and Asia including Japan.

The total fund requirement for the Project cost with and without the new irrigation project in the lower Nan basin is estimated as shown in Table 12.3.1 and summarized as follows;

Unit Million Baht

Item	F.C	L.C	Total
With New Project in Lower Nan	45,744	29,952	75,696
Without New Project in Lower Nan	37,773	23,099	60,872

Table 12.3.1 Disbursement Schedule and Annual Fund Requirement of Kok-Ing Nan Project and Others

(1) With New Beneficial Area in Lower Nan Basin

Unit Million Baht

			Disbursement Schedule									Annual Fund Requirement				
			Kok-Ing-Nan Project			Other Cost			Total			Price Escalation Rate		Annual Fund		
			F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C 1.0%	L.C 5.0%	F.C	L.C	Total
1	2542	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2543	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2544	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2545	2002	48	61	109	0	0	0	48	61	109	1.03	1.16	49	71	120
5	2546	2003	102	380	482	180	100	280	282	480	762	1.04	1.22	293	586	879
6	2547	2004	709	666	1,375	180	100	280	889	766	1,655	1.05	1.28	933	980	1,913
7	2548	2005	1,989	1,183	3,172	540	380	920	2,529	1,563	4,092	1.06	1.34	2,681	2,094	4,775
8	2549	2006	3,073	1,336	4,409	540	380	920	3,613	1,716	5,329	1.07	1.41	3,866	2,420	6,286
9	2550	2007	3,908	1,540	5,448	590	430	1,020	4,498	1,970	6,468	1.08	1.48	4,858	2,916	7,774
10	2551	2008	3,857	1,425	5,282	570	423	993	4,427	1,848	6,275	1.09	1.55	4,825	2,864	7,689
11	2552	2009	3,741	1,133	4,874	570	420	990	4,311	1,553	5,864	1.10	1.63	4,742	2,531	7,273
12	2553	2010	4,297	1,281	5,578	570	420	990	4,867	1,701	6,568	1.12	1.71	5,451	2,909	8,360
13	2554	2011	4,297	1,281	5,578	1,650	950	2,600	5,947	2,231	8,178	1.13	1.80	6,720	4,016	10,736
14	2555	2012	3,662	1,085	4,747	1,650	950	2,600	5,312	2,035	7,347	1.14	1.89	6,056	3,846	9,902
15	2556	2013	1,733	599	2,332	1,650	950	2,600	3,383	1,549	4,932	1.15	1.98	3,890	3,067	6,957
16	2557	2014	0	0	0	1,190	794	1,984	1,190	794	1,984	1.16	2.08	1,380	1,652	3,032
Total			31,416	11,970	43,386	9,880	6,297	16,177	41,296	18,267	59,563	-	-	45,744	29,952	75,696

Table 12.3.1 Disbursement Schedule and Annual Fund Requirement of Kok-Ing Nan Project and Others

(2) Without New Beneficial Area in Lower Nan Basin

Unit Million Baht

			Disbursement Schedule									Annual Fund Requirement				
			Kok-Ing-Nan Project			Other Cost			Total			Price Escalation Rate		Annual Fund		
			F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C 1.0%	L.C 5.0%	F.C	L.C	Total
1	2542	1999	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	2543	2000	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	2544	2001	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2545	2002	48	61	109	0	0	0	48	61	109	1.03	1.16	49	71	120
5	2546	2003	102	380	482	180	100	280	282	480	762	1.04	1.22	293	586	879
6	2547	2004	709	666	1,375	180	100	280	889	766	1,655	1.05	1.28	933	980	1,913
7	2548	2005	1,989	1,183	3,172	540	380	920	2,529	1,563	4,092	1.06	1.34	2,681	2,094	4,775
8	2549	2006	3,073	1,336	4,409	540	380	920	3,613	1,716	5,329	1.07	1.41	3,866	2,420	6,286
9	2550	2007	3,908	1,540	5,448	590	430	1,020	4,498	1,970	6,468	1.08	1.48	4,858	2,916	7,774
10	2551	2008	3,857	1,425	5,282	570	423	993	4,427	1,848	6,275	1.09	1.55	4,825	2,864	7,689
11	2552	2009	3,741	1,133	4,874	50	150	200	3,791	1,283	5,074	1.10	1.63	4,170	2,091	6,261
12	2553	2010	4,297	1,281	5,578	50	150	200	4,347	1,431	5,778	1.12	1.71	4,869	2,447	7,316
13	2554	2011	4,297	1,281	5,578	50	150	200	4,347	1,431	5,778	1.13	1.80	4,912	2,576	7,488
14	2555	2012	3,662	1,085	4,747	50	150	200	3,712	1,235	4,947	1.14	1.89	4,232	2,334	6,566
15	2556	2013	1,733	599	2,332	50	150	200	1,783	749	2,532	1.15	1.98	2,050	1,483	3,533
16	2557	2014	0	0	0	30	114	144	30	114	144	1.16	2.08	35	237	272
Total			31,416	11,970	43,386	2,880	2,677	5,557	34,296	14,647	48,943	-	-	37,773	23,099	60,872

Table 12.3.2 Disbursement Schedule for Kok-Ing-Nan Project Cost

(Million Baht)

Year in Order			1. Construciton Cost			2. Engineering Cost			3. Administration Cost			4. O/M Equipment			5. Sub-Total		
			F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
1	2002	2545	-	-	-	41	42	83	-	10	10	-	-	-	41	52	93
2	2003	2546	-	-	-	86	60	146	-	20	20	-	-	-	86	80	166
3	2004	2547	491	161	652	112	132	244	-	30	30	-	-	-	603	323	926
4	2005	2548	1,563	539	2,102	127	159	286	-	65	65	-	-	-	1,690	763	2,453
5	2006	2549	2,413	827	3,240	198	243	441	-	65	65	-	-	-	2,611	1,135	3,746
6	2007	2550	3,108	996	4,104	212	247	459	-	65	65	-	-	-	3,320	1,308	4,628
7	2008	2551	2,974	899	3,873	213	247	460	-	65	65	90	-	90	3,277	1,211	4,488
8	2009	2552	3,068	811	3,879	110	87	197	-	65	65	-	-	-	3,178	963	4,141
9	2010	2553	3,541	936	4,477	110	87	197	-	65	65	-	-	-	3,651	1,088	4,739
10	2011	2554	3,541	936	4,477	110	87	197	-	65	65	-	-	-	3,651	1,088	4,739
11	2012	2555	2,925	770	3,695	110	87	197	-	65	65	76	-	76	3,111	922	4,033
12	2013	2556	1,363	357	1,720	110	87	197	-	65	65	-	-	-	1,473	509	1,982
Total			24,987	7,232	32,219	1,539	1,565	3,104	-	645	645	166	-	166	26,692	9,442	36,134

Year in Order			6. Total with Contingency ("5"×110%)			7. Total with Tax ("6"×107%)			8. Land Acquisition			9. Project Cost Total ("7"+"8")		
			F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
1	2002	2545	45	57	102	48	61	109	-	-	-	48	61	109
2	2003	2546	95	88	183	102	94	196	-	286	286	102	380	482
3	2004	2547	663	355	1,018	709	380	1,089	-	286	286	709	666	1,375
4	2005	2548	1,859	839	2,698	1,989	898	2,887	-	285	285	1,989	1,183	3,172
5	2006	2549	2,872	1,249	4,121	3,073	1,336	4,409	-	-	-	3,073	1,336	4,409
6	2007	2550	3,652	1,439	5,091	3,908	1,540	5,448	-	-	-	3,908	1,540	5,448
7	2008	2551	3,605	1,332	4,937	3,857	1,425	5,282	-	-	-	3,857	1,425	5,282
8	2009	2552	3,496	1,059	4,555	3,741	1,133	4,874	-	-	-	3,741	1,133	4,874
9	2010	2553	4,016	1,197	5,213	4,297	1,281	5,578	-	-	-	4,297	1,281	5,578
10	2011	2554	4,016	1,197	5,213	4,297	1,281	5,578	-	-	-	4,297	1,281	5,578
11	2012	2555	3,422	1,014	4,436	3,662	1,085	4,747	-	-	-	3,662	1,085	4,747
12	2013	2556	1,620	560	2,180	1,733	599	2,332	-	-	-	1,733	599	2,332
Total			29,361	10,386	39,747	31,416	11,113	42,529	-	-	-	**31,416**	**11,970**	**43,386**

Table 12.3.3 Disbursement Schedule for Construction Cost

(Million Baht)

Item	Construction Cost (Million Baht)			2004 2547			2005 2548			2006 2549			2007 2550		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1 Kok Intake, Canal & Kok-Ing No.1 Tunnel	1,642	596	2,238	328	119	447	493	179	672	493	179	672	328	119	447
2 Tak Open Canal & Culvert Canal	1,628	424	2,052	163	42	205	326	85	411	407	106	513	488	127	615
3 Kok-Ing No.2 Tunnel	1,414	388	1,802	-	-	-	283	78	361	424	116	540	424	116	540
4 Ing Canal & Ing Weir	1,423	512	1,935	-	-	-	285	102	387	427	154	581	427	154	581
5 Ing-Yot Canal & Ing-Yot No.1 Tunnel	2,095	521	2,616	-	-	-	-	-	-	-	-	-	-	-	-
6 Ing-Yot Culvert & Ing-Yot No.2 Tunnel Div.1	2,706	701	3,407	-	-	-	-	-	-	-	-	-	135	35	170
7 Ing-Yot No.2 Tunnel, Div.2 & 3	2,989	832	3,821	-	-	-	-	-	-	-	-	-	149	42	191
8 Ing-Yot No.2 Tunnel, Div.4 & 5	3,743	969	4,712	-	-	-	-	-	-	-	-	-	187	48	235
9 Ing-Yot No.2 Tunnel, Div.6 & 7	3,542	923	4,465	-	-	-	-	-	-	177	46	223	354	92	446
10 Ing-Yot No.2 Tunnel, Div.8 & 9	2,630	736	3,366	-	-	-	-	-	-	132	37	169	263	74	337
11 Yao Dam & River Training	1,175	630	1,805	-	-	-	176	95	271	353	189	542	353	189	542
Total	24,987	7,232	32,219	491	161	652	1,563	539	2,102	2,413	827	3,240	3,108	996	4,104

Item	2008 2551			2009 2552			2010 2553			2011 2554			2012 2555			2013 2556		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1 Kok Intake, Canal & Kok-Ing No.1 Tunnel	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Tak Open Canal & Culvert Canal	244	64	308	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 Kok-Ing No.2 Tunnel	283	78	361	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4 Ing Canal & Ing Weir	284	102	386	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 Ing-Yot Canal & Ing-Yot No.1 Tunnel	-	-	-	419	104	523	419	104	523	419	104	523	419	104	523	419	105	524
6 Ing-Yot Culvert & Ing-Yot No.2 Tunnel Div.1	271	70	341	406	105	511	541	140	681	541	140	681	541	140	681	271	71	342
7 Ing-Yot No.2 Tunnel, Div.2 & 3	299	83	382	448	125	573	598	166	764	598	166	764	598	166	764	299	84	383
8 Ing-Yot No.2 Tunnel, Div.4 & 5	374	97	471	561	145	706	749	194	943	749	194	943	749	194	943	374	97	471
9 Ing-Yot No.2 Tunnel, Div.6 & 7	531	138	669	708	185	893	708	185	893	708	185	893	356	92	448	-	-	-
10 Ing-Yot No.2 Tunnel, Div.8 & 9	395	110	505	526	147	673	526	147	673	526	147	673	262	74	336	-	-	-
11 Yao Dam & River Training	293	157	450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	2,974	899	3,873	3,068	811	3,879	3,541	936	4,477	3,541	936	4,477	2,925	770	3,695	1,363	357	1,720

Table 12.3.4 Disbursement Schedule for Engineering Cost

Item	Total Amount (Million Baht)			2002 2545			2003 2546			2004 2547			2005 2548			2006 2549			2007 2550		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1 Detailed Design																					
(1) Engineering Fee	205	169	374	31	25	56	41	34	75	51	42	93	41	34	75	41	34	75			
(2) Geological & Topo-Survey Works	100	85	185	10	17	27	45	26	71	45	42	87	-	-	-	-	-	-			
Sub-Total	305	254	559	41	42	83	86	60	146	96	84	180	41	34	75	41	34	75			
2 Construction Supervision																					
(1) Diversion Canal	187	448	635	-	-	-	-	-	-	16	48	64	50	100	150	40	100	140	40	100	140
(2) Kok-Ing No.1 & No.2 Tunnel	150	104	254	-	-	-	-	-	-	-	-	-	30	20	50	40	28	68	40	28	68
(3) Yao Dam & River Training	72	101	173	-	-	-	-	-	-	-	-	-	6	5	11	22	32	54	22	32	54
(4) Ing-Yot No.2 Tunnel,No.1~No.9 Div.	825	658	1,483	-	-	-	-	-	-	-	-	-	-	-	-	55	49	104	110	87	197
Sub-Total	1,234	1,311	2,545	-	-	-	-	-	-	16	48	64	86	125	211	157	209	366	212	247	459
Total	1,539	1,565	3,104	41	42	83	86	60	146	112	132	244	127	159	286	198	243	441	212	247	459

Item	2008 2551			2009 2552			2010 2553			2011 2554			2012 2555			2013 2556		
	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total	F.C.	L.C.	Total
1 Detailed Design																		
(1) Engineering Fee																		
(2) Geological & Topo-Survey Works																		
Sub-Total	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2 Construction Supervision																		
(1) Diversion Canal	41	100	141	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(2) Kok-Ing No.1 & No.2 Tunnel	40	28	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(3) Yao Dam & River Training	22	32	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(4) Ing-Yot No.2 Tunnel,No.1~No.9 Div.	110	87	197	110	87	197	110	87	197	110	87	197	110	87	197	110	87	197
Sub-Total	213	247	460	110	87	197	110	87	197	110	87	197	110	87	197	110	87	197
Total	213	247	460	110	87	197	110	87	197	110	87	197	110	87	197	110	87	197

Table 12.3.5 Disbursement Schedule for Other Costs related to Kok-Ing-Nan Project

Unit Million Baht

Year	Associated Project			Environmental Impact Mitigation			Existing Beneficial Area in Lower Nan & Delta			New Beneficial Area in Lower Nan			Total		
	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total	F.C	L.C	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	180	100	280	0	0	0	0	0	0	0	0	0	180 (180)	100 (100)	280 (280)
6	180	100	280	0	0	0	0	0	0	0	0	0	180 (180)	100 (100)	280 (280)
7	540	280	820	0	0	0	0	100	100	0	0	0	540 (540)	380 (380)	920 (920)
8	540	280	820	0	0	0	0	100	100	0	0	0	540 (540)	380 (380)	920 (920)
9	540	280	820	50	50	100	0	100	100	0	0	0	590 (590)	430 (430)	1,020 (1,020)
10	520	273	793	50	50	100	0	100	100	0	0	0	570 (570)	423 (423)	993 (993)
11	0	0	0	50	50	100	0	100	100	520	270	790	570 (50)	420 (150)	990 (200)
12	0	0	0	50	50	100	0	100	100	520	270	790	570 (50)	420 (150)	990 (200)
13	0	0	0	50	50	100	0	100	100	1,600	800	2,400	1,650 (50)	950 (150)	2,600 (200)
14	0	0	0	50	50	100	0	100	100	1,600	800	2,400	1,650 (50)	950 (150)	2,600 (200)
15	0	0	0	50	50	100	0	100	100	1,600	800	2,400	1,650 (50)	950 (150)	2,600 (200)
16	0	0	0	30	70	100	0	44	44	1,160	680	1,840	1,190 (30)	794 (114)	1,984 (144)
Total	2,500	1,313	3,813	380	420	800	0	944	944	7,000	3,620	10,620	9,880 (2,880)	6,297 (2,677)	16,177 (5,557)

Remarks; The value in parenthesis shows the cost without New Beneficial Area in Lower Nan.

Table 12.4.1 Annual Operation and Maintenance Cost for Kok-Ing-Nan Project

1. O&M Staff Salaries

No	Staff	Chiang Rai Head Office	Kok Intake & Canal Office	Ing Weir Office	Yao Pan Office	Required Number	Annual Rate (Baht)	Annual Amount (1,000Baht)	Remark
1	Project Manager	1	0	0	0	1	356,000	356	
2	Sub Manager	1	1	1	1	4	172,000	688	
3	Hydrologist	1	0	0	0	1	93,000	93	
4	Gate Operator	0	1	1	1	3	106,000	318	
5	above Assistant	0	1	1	1	3	92,000	276	
6	Civil Engineer	1	1	1	1	4	93,000	372	
7	Mechanical Engineer	2	0	0	0	2	145,000	290	
8	Electrical Engineer	2	0	0	0	2	106,000	212	
9	Water Operation Monitor	1	1	1	1	4	92,000	368	
10	above Assistant	2	0	0	0	2	85,000	170	
11	Equipment Manager	1	0	0	0	1	105,000	105	
12	above Assistant	1	0	0	0	1	92,000	92	
13	Truck Driver	3	0	0	0	3	105,000	315	
14	Driver	5	1	1	1	8	92,000	736	
15	Administrator	2	1	1	1	5	132,000	660	
16	Account	1	1	1	1	4	198,000	792	
17	Store Keeper	3	0	0	0	3	145,000	435	
18	Typist	3	1	1	1	6	79,000	474	
19	Technician	7	3	3	3	16	92,000	1,472	
20	Gate Keeper	1	1	1	1	4	66,000	264	
	Total	38	13	13	13	77		8,488	x1,000Baht/year

2. Labor Wages

200 M/M× 180 Baht/day × 22 days/month = 792 ×1,000Baht/year

3. O/M Cost : including O/M office expenses and equipment is attached to the facilities.

(1) Canal (Open, Syphone & Culvert)	0.7%	×	9,414 × M Baht =	66,000
(2) Tunnel	0.15%	×	23,129 × M Baht =	35,000
(3) Dam	0.5%	×	1,175 × M Baht =	6,000
(4) River Training	1.5%	×	756 × M Baht =	11,000
Sub-Total ×1,000Baht/year			(34,474 × M Baht) (with Tax)	118,000

4. Annual Operation & Mentenance Cost

Total = "1"+"2"+"3" = 128,000 ×1,000Baht/year

Table 12.4.2 Replacement Cost of Mechanical Parts and O&M Equipment

Unit Rate(1,000Baht)

No.	Item	Total Number	Unit Rrice (1,000 Baht)	Initial Cost (1,000 Baht)	Interval of Replacement time (year)	Replacement Cost at one time (1,000Baht)	Remark (Maintenance Cost)
1	Truck 2t with Crane 2t	2	900	1,800	10	7,200	"Initial Cost"×(50years/10 - 1)
2	Lift Truck H=8~9m (for Tunnel Maintenance)	3	1,200	3,600	10	14,400	"Initial Cost"×(50years/10 - 1)
3	Water Tank Lorry 5.0 m3	1	1,400	1,400	5	12,600	"Initial Cost"×(50years/5 - 1)
4	Sand Pump ϕ 100 H=25m	6	100	600	5	5,400	"Initial Cost"×(50years/5 - 1)
5	Sand Pump ϕ 150 H=20m	6	100	600	5	5,400	"Initial Cost"×(50years/5 - 1)
6	Dredging Boat 500PS	2	70,500	141,000	0	-	Entrust to Dredging Company
7	Motor Boat	3	1,200	3,600	10	14,400	"Initial Cost"×(50years/10 - 1)
8	Station Wagon	6	800	4,800	5	43,200	"Initial Cost"×(50years/5 - 1)
9	Double Cab Truck 1ton	2	300	600	5	5,400	"Initial Cost"×(50years/5 - 1)
10	Micro Bus	2	500	1,000	10	4,000	"Initial Cost"×(50years/10 - 1)
11	Motor Cycle	26	100	2,600	5	23,400	"Initial Cost"×(50years/5 - 1)
12	Valve, Gate, Stoplog and Trashrack.. etc.	L.S.	L.S.	197,000	25	197,000	"Initial Cost"×(50years/25 - 1)
13	**Subtotal**	**59**		**358,600**		**333,000**	**×1,000Baht**
14	**Taxes**		**7%**			**24,000**	
15	**Total (Subtotal+Taxes)**					**357,000**	**×1,000Baht**

CHAPTER 13.

PROJECT EVALUATION

CHAPTER 13 PROJECT EVALUATION

13.1 Economic and Financial Evaluation

Economic evaluation aims at assessment of the Project in terms of contribution to the national economy, while financial evaluation is carried out to estimate the profitability of individual household economies after project implementation. On the basis of project benefit and cost comparison for the two cases of (1) future without project (hereinafter called FW/O), and (2) future with project (hereinafter called FW), the economic viability of the project is examined in terms of the three criteria of Net Present Value (NPV), Benefit/Cost Ratio (B/C Ratio), and Economic Internal Rate of Return (EIRR). Financial evaluation focused on farm income analysis in the benefit area, recovery of the Project cost, indirect ripple impacts of the Project, and formulation of a financing plan.

13.1.1 Basic Evaluation Criteria

(1) Interpretation of Future Without Project Case

For the FW/O case, evaluation is in terms of future prices; however, it is assumed that the present farming system including unit yield and farming techniques will remain unchanged over the future.

(2) Project Life

Project life is set at 60 years considering the utility life of the proposed water diversion facilities, including the full 10 year construction period (2004 - 2013).

(3) Project Benefit and Cost

Under financial evaluation, project benefit and cost are expressed in terms of market prices (financial prices). Economic evaluation is in terms of border prices (economic prices) with elimination of transfer payment and application of conversion factors.

(4) Inputs and Outputs

1) Traded Goods

Economic prices of traded goods such as agricultural products and fertilizer are based on 2008 international market prices (1998 constant prices). As a result, inflation is not considered for evaluation. The justification for adopting 2008 prices (1998 constant prices) for FOB/CIF prices is based on the facts that (i) project completion is planned for 2013, with project benefit to begin emerging after 2014; however, calculation of FOB/CIF prices for 2014 would exceed the World Bank's estimation horizon (the

latest World Bank data contains estimated values for FOB/CIF up to 2010), and such values would be considered unreliable given the numerous uncertain factors intervening in international trade; (ii) in line with World Bank policy, the maximum period for meaningful long-term forecast of future FOB/CIF prices is considered to be 10 years; and (iii) applying 2008 international market prices is consistent with methodology adopted by the Thai team.

Farmgate prices of agricultural products and fertilizer are based on FOB/CIF prices and take into account tariffs, port handling charges, and marketing cost including transport/handling costs, after which tariffs and taxes are then eliminated and the necessary conversion factor applied (see the Supporting Report for details). Conversion factors for agricultural commodities and inputs are summarized in Table 13-1.

Table 13-1 Summary of Conversion Factors for Agricultural Commodities and Inputs

Commodities	Unit	Financial Price	Conversion Factor	Economic Price
Rice/Paddy	Baht/kg	4.2	1.10	4.6
Sugarcane	Baht/kg	0.828 – 0.838	1.26	1.041 – 1.051
Mungbeans	Baht/kg	10.3 – 10.5	1.06	10.9 – 11.0
Soybeans	Baht/kg	13.6 – 13.7	1.03	14.0 – 14.1
Sweet Corn	Baht/kg	5.3 – 5.4	1.04	5.5 – 5.6
Water Melon	Baht/kg	7.3 – 7.4	1.07	7.8 – 7.9
Vegetables	Baht/kg	5.0 – 5.2	1.06	5.3 – 5.4
Mango	Baht/kg	19.4	1.13	22.0
Fish	Baht/kg	15,150	1.08	16,327

Inputs and Others	Conversion Factor
Standard Conversion Factor (SCF)	0.92
Consumption Goods	0.95
Capital Goods	0.84
Electricity	0.90
Transportation	0.87
Skilled Labour	0.92
Unskilled Labour	0.55
Marketing Margin	0.79
Seeds/Seedlings/Flingerlings	0.94
Agro-chemicals	0.88
Land Preparation	0.95
Fishery Feed	0.94

Source: 1) "Shadow Prices for Economic Appraisal of Project in Thailand", World Bank.
2) Estimates based on OAE data.

2) Non-traded Goods

In the case of non-traded goods, domestic market prices have been applied for financial prices. On the other hand, in the case of economic prices the composition of non-traded goods has been broken down into traded component, non-traded component,

labour and transfer payment. In the case of the traded, non-traded, and labour components, border price, standard conversion factor (SCF), and shadow wage rate (SWR) are applied, respectively.

(5) Capital

The World Bank's estimated value of 12% for Thailand is applied as the opportunity cost of capital.

(6) Foreign Exchange

The official exchange rate, as of 1998 of US$ 1 = Baht 36.45 is adopted under both financial and economic evaluation.

(7) Labour

The nominal wage rate is applied under financial evaluation. Under economic evaluation, the SWR for unskilled labour is estimated at 0.55 (see the Supporting Report for details). In the case of the SWR for skilled labour, on the other hand, a labour conversion factor of 0.92 is applied.

13.1.2 Total Project Cost

The Project consists of (i) Kok-Ing-Nan Water Diversion Project, (ii) Associate Irrigation Projects, (iii) environmental impact mitigation measures, (iv) land consolidation in the existing irrigation areas in the Lower Nan Basin (Phitsanulok Irrigation Project (Stage 1) and existing DEDP Pumping Schemes) and the Chao Phraya Delta, and (v) new irrigation projects in the Lower Nan Basin (Phitsanulok Irrigation Project (Stage 2) and new DEDP Pumping Schemes).

Total project cost comprises the Project cost, the replacement cost of operation and maintenance equipment, and the annual operation and maintenance cost.

(1) Project Cost

In order to convert costs for individual construction work items (financial prices) into economic prices, transfer payment was eliminated and conversion factors applied as shown in Table 13-2 (see the Supporting Report for details). The salvage value of the facilities was not included in the calculation of the Project cost.

Table 13-2 Breakdown of Project Cost

Item	Financial Cost (1,000 Baht)	Conversion Factor	Economic Cost (1,000 Baht)
1. Kok-Ing-Nan Project			
(1) Direct Construction Cost	32,219,000	0.97	31,252,430
(2) Engineering Fee	3,104,000	0.92	2,855,680
(3) Administration Cost	645,000	0.92	593,400
(4) O & M Equipment	166,000	0.84	139,440
(5) Contingency	3,613,000	0.92	3,323,960
(6) Taxes	2,782,000	0	0
(7) Land Acquisition	857,000	0.92	799,440
Sub-total	43,386,000	-	38,953,350
2. Associate Irrigation Projects	3,813,000	0.91	3,469,830
3. Environmental Impact Mitigation Works	800,000	0.89	712,000
4. Land Consolidation Cost for the Existing Irrigation Areas in the Lower Nan Basin and the Chao Phraya Delta	944,000	0.85	802,400
5. New Irrigation Projects in the Lower Nan Basin	10,620,000	0.91	9,664,200
Total	59,563,000	-	53,601,780

Note: The above conversion factors of 0.92 and 0.84 imply SCF and capital goods, respectively.

The Project cost (economic terms) without the new irrigation projects in the Lower Nan Basin has been estimated at 43,938 million Baht which were computed by deducting 53,602 million Baht of the Project cost from 9,664 million Baht for the new irrigation projects in the Lower Nan Basin.

(2) Annual Operation and Maintenance Cost

O&M cost (financial prices) is converted to economic prices applying an SCF of 0.92 as shown in Tabe 13-3.

Table 13-3 Annual Operation and Maintenance Cost

Item	Financial O&M Cost (1,000 Baht)	Economic O&M Cost with New Irrigation Projects (1,000 Baht)	Economic O&M Cost without New Irrigation Projects (1,000 Baht)
1. Kok-Ing-Nan Project	128,000	117,760	117,760
2. Associate Irrigation Projects	57,200	52,624	52,624
3. New Irrigation Projects in Lower Nan Basin	157,500	144,900	0
Total	342,700	315,384	170,384

(3) Replacement Cost of Operation and Maintenance Equipment

O&M replacement cost (financial prices) is converted to economic prices applying a capital goods conversion factor of 0.84 as shown in Table 13-4.

Table 13-4 O&M Replacement Cost

Term	Financial Replacement Cost (1,000 Baht)	Economic Replacement Cost (1,000 Baht)
Every 5 Years	10,600	8,904
Every 10 Years	20,600	17,304
Every 25 Years	217,600	182,784

13.1.3 Project Benefit

The benefits to be generated by the Project are diverse, including external economic benefits (secondary benefits); however, three types of quantifiable benefit, i.e. water supply for domestic, industrial and livestock uses, hydropower generation, and agriculture including aquaculture, were computed as the benefit under the Project. Additionally, the project would contribute to flood damage reduction in crop production, housing and infrastructures through increased control capacity of the Sirikit reservoir during flooding; however, this benefit which is deemed difficult to quantify is excluded from the evaluation due to inadequacy of available data and information.

(1) Water Supply for Domestic, Industrial and Livestock Uses

The benefit of additional water supply for domestic, industrial and livestock uses, which was valued at the opportunity cost for producing the same quantity of water by a groundwater source, has been estimated according to three different water demand growths as shown in Table 13-5.

Table 13-5 Water Supply by Different Water Demands

Case	Year 2006 – 2015 (MCM)	Year 2016 – (MCM)
1. High Growth	276	1,103
2. Normal Growth	206	825
3. Low Growth	145	578

Economic benefit calculation is based on 4.79 Baht/m^3 for the minimum groundwater charge (3.5 Baht/m^3 for groundwater utilization fee, which is imposed by the Department of Mineral Resources of the Ministry of Industry, are additionally charged only for beneficiaries within the service area) and 30% water conveyance losses.

Annual economic benefits for year 2016 onwards have been calculated at 3,698.4 million Baht for the high growth case, 2,766.2 million Baht for the normal growth case, and 1,938 million Baht for the low growth case (see the Supporting Report for details).

(2) Hydropower generation

Benefits attributable to the additional hydropower generation produced by the newly available discharge of 2,000 MCM comprise the annual average electric energy produced by this increase in available water, and prevention of carbon dioxide emissions.

For the valuation of these benefits, the former was calculated in terms of the opportunity cost for producing the same electric energy by a different source, i.e. the cost of buying the same electric energy from the private sector (1.12 Baht/kWh assuming that the water volume required for generating 1kWh is 5.8 m^3 and power generation losses including transmission losses are set at 15% (see the Supporting Report for details).

With full awareness of the fact that the commitments to reduce CO_2 emissions made at the 1992 Roi Conference in view of the worldwide global warning due to greenhouse gases suggest that power utilities, and international financing agencies should include the external costs for a least-cost power system associated with CO_2 emissions into the economic and financial analyses of power projects, the latter was valued in terms of the cost of prevention of CO_2 emissions which would otherwise result from the use of thermal plants. The approximate value of CO_2 emissions per MWh dispatched to the grid for a gas fired power plant was estimated to be 0.43t/MWh. For the thermal alternative of the Sirikit power plant with newly-produced energy of 293.1GWh/year, this results in an emission of some 126,000t of CO_2 annually.

Annual economic benefit has been estimated at 405.5 million Baht, comprising 328.3 million Baht (additional power generation) and 77.2 million Baht (reduction of carbon dioxide emissions) (see the Supporting Report for details).

(3) Agriculture

For agricultural development, the benefit from increased production of agricultural products was calculated in terms of the net incremental value in the dry season on the basis of comparison of the FW/O and FW cases in the relevant benefit area. Of the newly available water of 2,810 MCM, the remaining water after deducting the water volume used for water supply for domestic, industrial and livestock uses is allocated for this purpose. Financial prices were converted into economic terms by adopting crop-wise conversion factors (see the Supporting Report for details).

Achievement of target yields under the Project for dry season paddy, sugarcane, other field crops such as maize, mungbeans, soybeans, etc., vegetables, fruit trees such as mango, and fish is assumed to be 80% in the first year of cultivation possible in the benefit area, and 90% and 100%, respectively, in the second and third years.

Although the benefit from increased production of agricultural products is calculated in terms of the net incremental value based on comparison of the FW/O and FW cases (see the Supporting Report for details), it should be noted that for derivation of the net incremental value the loss value of wet season paddy production was taken into account on the assumption that the existing wet season paddy field will be converted to land for fish culture, as well as the cultivation of sugarcane and fruit trees with advancement in crop diversification in the benefit area under the FW case (see the

Supporting Report for details).

1) Agricultural Benefit in Chao Phraya Delta

Agricultural benefit in the Chao Phraya Delta varies with available irrigation water and cropped areas for the proposed diversified agriculture in accordance with the above three water supply cases. It is also influenced by whether the new irrigation projects in the Lower Nan Basin are to be included in this Project.

The relationship between irrigation water availability and economic agricultural benefit at full development is summarized in Table 13-6.

Table 13-6 Economic Agricultural Benefit in Chao Phraya Delta

Case	Water Availability (MCM)	Incremental Cropped Area (1,000 rai)	Agricultural Benefit (1,000 Baht)
With New Irrigation Projects in Lower Nan Basin	991.9	691.3	6,091,933
	1,192.0	799.5	6,320,993
	1,369.6	895.5	6,524,225
Without New Irrigation Projects in Lower Nan Basin	1,603.7	1,040.0	6,830,131
	1,803.8	1,180.4	7,127,358
	1,981.5	1,305.1	7,391,348

2) Agricultural Benefits in Other Irrigation Projects

Annual economic agricultural benefits at full development in other irrigation projects are summarized in Table 13-7.

Table 13-7 Economic Agricultural Benefits in Other Irrigation Projects

Project	Water Availability (MCM)	Incremental Cropped Area (1,000 rai)	Agricultural Benefit (1,000 Baht)
1. Associate Irrigation Projects	156.8	157.0	1,071,175
2. Phitsanulok Irrigation Project (Stage 1) and Existing DEDP Pumping Scheme	103.3	15.3	1,582,366
	181.2	57.4	1,671,282
	250.5	94.9	1,750,482
3. Phitsanulok Irrigation Project (Stage 2) and New DEDP Pumping Scheme	611.8	360.5	1,854,339

13.1.4 Scenarios for Project Evaluation

The relationship between scenarios for project evaluation and water allocation is summarized in Table 13-8. Plan A indicates agricultural development in the Chao Phraya Delta, Phitsanulok Irrigation Project (Stages 1 and 2), Existing and New DEDP Pumping Schemes and Associate Irrigation Projects, while the Phitsanulok Irrigation Project (Stage 2) and New DEDP

Pumping Scheme are excluded from the above benefit areas in case of Plan B.

Table 13-8 Scenarios for Project Evaluation

Scenario	Water Availability (MCM)	Power Generation (MCM)	Water Supply (MCM)	Agriculture (MCM)
Plan A-1	2,810	2,000	1,103[1] (276)[2]	1,707[3] (991.9)[4]
A-2	2,810	2,000	825 (206)	1,985 (1,192.0)
A-3	2,810	2,000	578 (145)	2,232 (1,369.6)
Plan B-1	2,810	2,000	1,103 (276)	1,707 (1,603.7)
B-2	2,810	2,000	825 (206)	1,985 (1,803.8)
B-3	2,810	2,000	578 (145)	2,232 (1,981.5)

Note: 1) Figure indicates water supply for 2016 onwards.
2) Figure in parentheses shows water supply for the period 2006 – 2015.
3) Figure indicates water consumption for agricultural use.
4) Figure in parentheses shows water consumption in the Chao Phraya Delta.

13.1.5 Indicators of Project Economic Viability

Based on the above six scenarios, the economic project benefit at full development has been estimated as shown in Table 13-9 (see the Supporting Report for details).

Table 13-9 Scenario-wise Economic Project Benefit

Scenario	Power Generation (1,000 Baht)	Water Supply (1,000 Baht)	Agriculture (1,000 Baht)	Total (1,000 Baht)
Plan A-1	405,500	3,698,400	10,599,813	14,703,713
	(2.8)	(25.1)	(72.1)	(100.0)
A-2	405,500	2,766,200	10,917,789	14,089,489
	(2.9)	(19.6)	(77.5)	(100.0)
A-3	405,500	1,938,000	11,200,221	13,543,721
	(3.0)	(14.3)	(82.7)	(100.0)
Plan B-1	405,500	3,698,400	9,483,672	13,587,572
	(3.0)	(27.2)	(69.8)	(100.0)
B-2	405,500	2,766,200	9,869,815	13,041,515
	(3.1)	(21.2)	(75.7)	(100.0)
B-3	405,500	1,938,000	10,213,005	12,556,505
	(3.2)	(15.4)	(81.4)	(100.0)

Note: Figures in parentheses show comparison with total as 100.

In terms of the 3 criteria in the previous section 13.2.1, economic viability indicators are summarized in Table 13-10 (see the Supporting Report for details).

Table 13-10 Summary of Economic Viability Indicators

Scenario	NPV (1,000 Baht) (12% discount rate)	B/C Ratio (12% discount rate)	EIRR (%)
Plan A-1	7,198,010	1.32	14.4
A-2	6,134,314	1.27	14.1
A-3	5,190,846	1.23	13.8
B-1	8,421,146	1.43	15.0
B-2	7,494,162	1.38	14.7
B-3	6,672,766	1.34	14.5

The above result shows that this project is economically viable, with even greater benefit when indirect ripple impact of the project is considered.

13.1.6 Sensitivity Analysis

The following cases were assumed in analyzing the impact of economic uncertainty on the economic viability indicators of the project.

Case ①: Total project cost increases by 10% due to increased prices for construction materials, equipment and labour.

Case ②: Total project benefit drops by 10% due to difficulty in achieving target yields, and other negative factors.

Case ③: Combination of cases ① and ②

Results of sensitivity analysis on the basis of the above 3 cases are summarized in Table 13-11 (see the Supporting Report for details).

Table 13-11 Summary of Sensitivity Analysis

Scenario	Case ①	Case ②	Case ③
Plan A-1	13.5	13.4	12.6
A-2	13.2	13.1	12.3
A-3	12.9	12.8	12.0
B-1	14.2	14.1	13.3
B-2	13.9	13.8	13.0
B-3	13.6	13.6	12.7

Although project economic viability is more sensitive to decrease in project benefit rather than increase in project cost, no significant negative effect on economic justifiability is anticipated.

13.1.7 Farm Income Analysis

Farm income analysis estimates the incremental benefits arising from farming activities as a result of project implementation. The impact of implementation on the farm incomes of households in the benefit area will be considerable with a shift either (i) from seasonally irrigated agriculture (which presently suffers from unavailability of irrigation water during the dry months) or (ii) from rainfed agriculture, to year-round irrigated agriculture with crop diversification in line with national agriculture policy. Based on Plan A-2 (moderately diversified case) the project impact on income distribution type of land ownership, i.e. owner cultivator and owner-cum-tenant cultivator, has been quantified. This analysis is subject to the assumption that a tenancy obligation of 20% of total agricultural production is applied for owner-cum-tenant cultivators.

With project implementation, average annual net farm household incomes from which household expenses are subtracted will increase considerably as shown in Table 13-12 (see the Supporting Report for details).

Table 13-12 Summary of Net Farm Household Income

Benefit Area/Tenurial Form	Net Income FW/O (Baht/year)	Net Income FW (Baht/year)	Net Increment (Baht/year)
1. Chao Phraya Delta (31.6 rai)			
- Owner	42,000	103,000	61,000
- Owner-cum-Tenant	21,200	75,700	54,500
2. Phitsanulok Irrigation Project (Stage 1) (31.9 rai)			
- Owner	43,500	118,700	75,200
- Owner-cum-Tenant	24,700	90,900	66,200
3. Existing DEDP Pumping Scheme (16.1 rai)			
- Owner	18,000	58,900	40,900
- Owner-cum-Tenant	8,500	44,400	35,900
4. Phitsanulok Irrigation Project (Stage 2) (31.9 rai)			
- Owner	6,400	139,000	132,600
- Owner-cum-Tenant	600	110,400	109,800
5. New DEDP Pumping Scheme (16.1 rai)			
- Owner	5,000	71,800	66,800
- Owner-cum-Tenant	2,000	57,400	55,400
6. Associate Irrigation Projects (15.5 rai)			
- Owner	10,600	107,900	97,300
- Owner-cum-Tenant	7,600	89,800	82,200

The increase of net farm household income is acute especially in newly developed areas such as the Kok, Ing and Upper Nan Basins and the Lower Nan Basin, thereby leading to a high degree of poverty alleviation.

13.1.8 Raw Water Cost and Cost Recovery

Farm income analysis shows that project investments generate a large increase in farm income for all sizes of farmers irrespective of type of land ownership. To assess the financial capability to pay for water charges corresponding to full project cost, the raw water cost at the Sirikit reservoir has been estimated based on the different loan conditions as shown in Table 13-13 (see the Supporting Report for details).

Table 13-13 Raw Water Cost

(Unit: Baht/m^3)

Loan Condition	2,810 MCM	2,000 MCM
Annual Interest Rate: 5%		
(1) Repayment Period: 25 years	1.2	1.6
(2) Repayment Period: 50 years	0.9	1.3

Note: 1) Calculation is based on the construction cost of the Kok-Ing-Nan Water Diversion Project, its O & M cost, and the construction cost of the environmental impact mitigation works.
2) The repayment period of the O&M cost is assumed to be one year.

Assuming unit water charges of 1.3 Baht/m^3 (half of which will be subsidized by the Thai Government), these are accordingly estimated at 16 - 47% of the net income increment for owner cultivators, and at 19 - 53% for owner-cum-tenant cultivators (see the Supporting Report for details). Therefore, the farmer's capability to pay for water charges would be high enough to cover the project cost, and the charges are concluded to pose no heavy burden to their farm economies.

13.1.9 Financing Plan

The financing plan for Plan A has been formulated on the assumption that the entire foreign currency component of the Project including the engineering component will be financed by OECF, and the local currency component by local commercial banks. OECF will extend a loan to the Bank of Thailand (Central Bank) which will on-lend the funds to RID. The loan will be repaid by RID in Baht with the exchange risk borne by RID. OECF provides finance at 2.2% interest with a 7 year grace period and 18 year repayment period, and a commitment fee rated at 0.1% of the total loan amount as summarized in Table 13-14.

Table 13-14 Loan Conditions

Financial Source	Borrower	Interest Rate (%)	Commitment Fee (%)	Grace Period (years)	Loan Period (years)
OECF	Central Bank on-lending to RID	2.2	0.1	7	25
Local Commercial Bank	RID	11.0	-	-	13

Annual repayment for this Project amounts to 8,057.1 million Baht during the period of 2009 – 2014 comprising 3,619.68 million Baht for the foreign currency component, and 4,437.42 million Baht for the local currency component, and to 3,619.68 million Baht for 2015 onwards (see the Supporting Report for details).

13.1.10 Indirect Ripple Impact

In addition to the direct benefit from the Project as a result of the increased production of agricultural products, power generation, and water supply, the following indirect ripple impact based on Plan A-2 would occur.

(1) Forward Related Impact

With the increased production of agricultural products, agricultural inputs such as fertilizer and agro-chemical consumption will also increase, which will in turn stimulate industries related to the production and marketing of these items and thereby generate increased employment opportunities. Estimated annual retail margin increase for agricultural inputs sales in the benefit area is indicated in Table 13-15 (see the Supporting Report for details).

Table 13-15 Forward Related Impact

Agricultural Inputs Sales	Benefit Area	Incremental Retail Margin (1,000 Baht)
Chemical Fertilizer	1. Chao Phraya Delta	23,646
	2. Phitsanulok Irrigation Project (Stage 1) and Existing DEDP Pumping Scheme	5,457
	3. Phitsanulok Irrigation Project (Stage 2) and New DEDP Pumping Scheme	9,647
	4. Associate Irrigation Projects	2,519
	Sub-total	41,269
Agro-chemicals	1. Chao Phraya Delta	38,740
	2. Phitsanulok Irrigation Project (Stage 1) and Existing DEDP Pumping Scheme	10,128
	3. Phitsanulok Irrigation Project (Stage 2) and New DEDP Pumping Scheme	13,407
	4. Associate Irrigation Projects	4,080
	Sub-total	66,355

Total	1. Chao Phraya Delta	62,386
	2. Phitsanulok Irrigation Project (Stage 1) and Existing DEDP Pumping Scheme	15,585
	3. Phitsanulok Irrigation Project (Stage 2) and New DEDP Pumping Scheme	23,054
	4. Associate Irrigation Projects	6,599
	Total	107,624

(2) Backward Related Impact

Increased production of agricultural products will be expected to induce an annual income increase for local collectors and milters.

(3) Generation of Employment Opportunities

Project implementation will generate an estimated 2,649,800 man-days of employment comprising 2,638,600 man-days during the overall construction period, and 11,200 man-days annually during the farming period at full development (see the Supporting Report for details).

(4) Enhanced Standard of Living

Increased farm income will improve farmer standards of living, also increase farmer purchasing power, and further stimulate commercial activity in the benefit area. This will also contribute to rectifying the gap in living standards between urban and rural areas.

(5) Generation of Value Added

With project implementation, a considerable portion of the project cost will be directed at the procurement of locally produced construction materials. Also, large scale employment of local labour during the construction period will increase the purchasing power of these workers. Accordingly, production activities will be stimulated in the construction materials and consumer goods sectors, leading ultimately to generation of new value added for produced items.

13.1.11 Other Benefits

High economic viability as shown in the raw water cost of 1.3 Baht/m^3 and EIRR of 13.8 – 15.0% for six alternative plans has been guaranteed as a result of economic and financial evaluation. In addition to the above, the Project will bring about multifarious benefits as described below.

(1) Kok, Ing and Upper Nan Basins

- Flood mitigation in the Lower Ing Basin by diverting 175 m^3/sec of water under the Project.
- Acceleration of diversified agriculture with assurance of stable water supply in the dry season.
- Preservation of aquatic ecology and expansion of fish production in the river and wet land by the dry season water supply.
- Development of agro- and eco-tourism in the area along the water diversion canal route.
- Promotion of agricultural products trade to China, Myanmar and Laos via the Mekong river.

(2) Sirikit Dam

- Increased flood control capacity in the reservoir from 4,000 MCM to 6,500 MCM by minimizing the existing carry-over capacity for the next dry year, resulting in no more flood outflow at the Sirikit dam to the downstream river.

(3) Nan Basin

- Expansion of water resources development for irrigated agriculture in tributary basins where development has long been suspended due to reduction in water resources induced by large water use in the Chao Phraya Delta area.
- Large flood mitigation in the Lower Nan Basin and Chao Phraya Delta area through implementation of new water resources development for large and medium scale dams on the basin tributaries, and resultant enhanced peak flood control in the tributaries through a number of reservoir.
- Sustainable conservation for aquatic ecology in the Nan river with assurance of sufficient dry season water supply.
- Improvement of water management in the dry season with respect to river flow, reservoir operation, irrigation canal system, etc.

(4) Chao Phraya Delta

- Promotion of successful diversified agriculture and agro-industry with assurance of irrigation water supply in the dry season.
- Export expansion of diversified raw and processed agricultural products.
- Job creation and income generation with advancement in diversified agricultural and agro-industry.

- Expansion of urban and industrial development by the dry season water supply.

- Improvement of the existing groundwater status (currently facing problems including depleted quantity, decreased water level and worsening pollution) as a result of surface water utilization instead of over-pumping of groundwater in the dry season.

Consideration of the above indirect ripple impact and other benefits indicates a considerable overall socio-economic profitability to emerge under the Project.

CHAPTER 14.

CONCLUSION AND RECOMMENDATION

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(1) The irrigated agriculture in the upper Chao Phraya basin tends to expand, reducing the flow of the Chao Phraya river at Chainat from where water is diverted and distributed to the existing large-scale irrigation projects in the delta. Water demand in the delta also tends to increase because of agricultural, urban and industrial development. If these tendencies continue as they are, water resources especially in dry season will become short seriously in future. (Under the current water resources development policy as well as agricultural development policy including crop diversification program, about 4,000 MCM of water will be deficient in dry season in future.) Probable shortage of water in future would be far beyond of saving by means of effective operation and management of water, however, it is an urgent necessity to consider the comprehensive measures of water resources management aiming at sustainable development of limited water resources.

(2) In case that decision is made to take actions to mitigate the chronic shortage of water prevailing over the Chao Phraya basin during dry season, water diversion as studied by the F/S can be considered as one of effective measures from engineering point of view. Possible actions inclusive of improvement of operation rules of the existing storage, such as some 640 MCM of additional dry season release from the Sirikit reservoir proposed by the F/S, should however be taken to cope with the immediate needs of dry season water. A series of water balance scenarios within a possible range are shown in this report for further consideration of appropriate actions by the Thai side. About 8,000 MCM of the water resources in the Kok and Ing basins are very valuable for the peoples living in the basin, however most of them are released unused to the Mekong river at present. On the basis of the maximum development of the potential water resources in eventual future, the JICA Study estimated the volume of water to be reserved in the basins and in turn available water for diversion. However, to lead the implementation of the proposed project into success, it is necessary to continue the public relation activities with full information regarding the EIA and other studies including participatory rural appraisal etc, aiming to arrive at the common consent and understanding among the residents in the donor basins.

(3) In view of the magnitude of influence that might be caused by the water diversion, public relation activities should be executed not only in the Kok, Ing and upper Nan basins but also in the direct beneficiary areas in the lower Nan and Chao Phraya delta, and further at the national level. Water allocation and operation in the Chao Phraya seem to be done well making the use of its scale merit, however, the risk of water shortage even in wet season in future should be fully recognized by all concerned.

(4) In view of a critical condition of balance between demand and supply of water, "Water Resources Management" in the Chao Phraya basin is of quite importance. It is therefore necessary to establish a responsible organization to take charge of this (Strengthening of National Water Resources Committee, Establishment of Basin Authority, etc.).

(5) For the sustainable development of water resources and rationalization of water use, it is recommended to collect water charge from water users. In the case of the water diversion, it is desirable to allocate a part of the collected charge for development of the Kok and Ing basins.

(6) The JICA environmental technical assistance study was carried out focusing on review of RID's EIA study and supplemental study in due consideration of watershed conservation and sustainable rural development. Regarding EIA as it ought to be, RID is recommended to refer the conclusion and recommendation of the JICA environmental technical assistance study for future consultation with OEPP.