第 9 章　勧　　告

1. プロジェクトの実施

前章迄の検討結果より，ノンブラライ・サブプロジェクトおよび，バンブン・サブプロジェクトは，技術的に実施可能であり，また内部収益率は各々11.3%および8.2%であり，経済的にも実施可能といえる。

当地区の水不足は逼迫しており，第5次社会・経済開発計画の実施により，工業用水の需要は急激に増大すると考えられる。したがって，上記2つのプロジェクトは，地域開発の促進，公共福祉の向上，ひいては国家経済の発展のために，速やかに実施することが望まれる。

2. 施　工　期　間

上記2つのサブプロジェクト建設のための工期は，対象地域における緊急な水需要を満たすべく，可能な限り短縮した工期となっている。したがって，プロジェクトの実施に必要な諸手続および諸準備作業は遅延なく速やかに行うことが必要となる。

3. ランチャバン地区への水供給

対象地区への導水システムとして，ドククライ～ マブタブッド，マブタブッド～ サタヒップおよびドククライ～ ランチャバンの3ルートが計画された。

このうち，ドククライ～ ランチャバンルートは，建設費が非常に高くなるはかりでなく，ランチャバン周辺地域に水資源開発の可能性があるので，さらに詳細な検討を行う必要がある。

4. 浄化・配水システム

浄化・配水システムは，本プロジェクトの調査対象事項に含まれておらず，今後，地方政府の手により建設が行われることとなっている。

浄化・配水システムを建設し，飲料水の安定供給を計ることは，特に都市用水供給に，欠くことのできない重要なものといえる。したがって，上記の浄化・配水システムの建設は，本プロジェクトの完了時点で，完了させておくことが必要不可欠なものとなる。

5. 家 屋 移 転

本プロジェクトを実施するには，多数の家屋を移転させる必要がある。これに伴う社会問題を回避すべく移転実施に際しては法律や法規に基づいて，慎重に行うべきである。

6. 水 質 汚 濁

将来貯水池や河川の水質汚濁が懸念される場合，法律による規制はもとより必要な設備を設置する等の対策が必要となる。

7. か ん が い

本プロジェクトは，かんがい用水について既得水利権量および現時点で開発対象とされている将来水需要量の部分のみを満足させる計画となっている。ただし，地域開発計画に応じて，稲作のみならず野菜，果樹等の栽培のため，今後さらにばく大なかんがい用水が必要となると考えられ，地域開発計画の一環として，農業開発のためのマスタープランを策定することが望まれる。

8. 水 文 観 測 所

本プロジェクトの円滑な運営とさらに新規の水資源開発の検討のためには，既存の水文観測所の維持管理を充分に行う事はもとより，各ダムサイト上流域に最低1ヶ所の水文観測所を設置する事が望ましい。

9. 維持・管理体制

ダムおよびかんがい施設の維持・管理は現在ＲＩＤが行うこととなっている。しかしながら，パイプラインシステムに関しては，その維持・管理をいづれの機関で行うか決っておらず，早急に決定する必要がある。

また，各ダムによって開発された水を確実に供給するため，プロジェクト完成前に施設の維持・管理規則を作成する必要がある。

10. 補 足 調 査

次段階の調査を円滑に行うためには，下記事項について調査する必要がある。

－計画ダムサイト，計画導水ルート，かんがい地区および河川構造物サイトの地計図

作成。

—計画のダム軸，主要構造物サイト，パイプラインおよびかんがい水路の縦横断測量の実施。

—計画ダムサイトおよび主要構造物建設予定地点の地質調査およびボーリングの実施。ダム建設のための土取場の土質調査および土質試験の実施。パイプラインおよび，かんがい施設建設地点の土質調査および土質試験の実施。

—ダム建設のための築堤材料試験およびコンクリート強度試験の実施。

Table 2-1 Change of Population of Changwat Chon Buri and Rayong

Unit: Person

Changwat Rayong	1976	1977	1978	1979	1980
Rayong Municipality	26,250	26,761	27,060	27,516	37,305
A. Muang Rayong	84,582	87,298	89,521	91,433	83,693
A. Klaeng	98,823	92,449	95,242	97,620	100,484
A. Ban Khai	68,941	69,768	70,526	71,049	71,190
K.A. Pluak Daeng	23,910	24,642	24,842	25,648	25,791
K.A. Ban Chang	27,218	27,289	27,181	27,247	27,594
K.A. Wang Chang	-	10,374	11,469	12,391	12,839
Total	329,724	338,481	345,841	352,904	358,896

Unit: Person

Changwat Chon Buri	1976	1977	1978	1979	1980
Chon Buri Municipality	49,017	49,529	49,855	50,063	50,106
Panat Nikhon M.	13,014	13,130	13,262	13,334	13,411
Tambon Si Racha M.	17,491	18,601	19,773	21,099	21,632
A. Muang Chon Buri	107,454	110,665	114,567	117,384	119,281
A. Panat Nikhon	123,321	126,410	107,000	108,923	110,203
A. Pan Thong	36,739	36,946	37,279	37,779	38,289
A. Ban Bung	76,104	76,284	77,199	77,714	78,262
A. Si Racha	77,993	78,615	80,665	82,062	84,516
A. Ban La Mung	68,870	70,699	43,392	43,925	43,789
A. Sattahip	80,355	80,887	81,963	84,639	85,112
K.A. Ko Si Chang	2,697	2,792	2,815	2,884	2,955
K.A. Nong Yai	16,158	16,674	16,930	17,247	17,386
K.A. Bo Thong	-	-	22,409	23,594	24,779
Muang Pattaya	-	-	29,726	31,777	34,706
Total	669,213	681,232	696,835	712,426	724,427

(Source ; Changwat Registration Office)

Table 2-2 Per Capita Gross Provincial Products in the Eastern Region

Province	Capita in Baht		
	GPP/1972	GPP/1976	Average Growth Rate (Annual)
Chantaburi	3,634	4,140	3.5 %
Chachoengsao	3,395	3,493	0.7 %
Chon Buri	8,049	9,486	4.5 %
Trat	5,097	3,636	-7.2 %
Nakhon Nayok	2,689	3,332	6.0 %
Prachin Buri	2,450	2,820	3.8 %
Rayong	4,869	5,097	1.2 %
Eastern Region Average	4,625	5,145	

Note : GPP-Gross Provincial Products

Source : Dpet. of Town & Country Planning Ministry of Interior

Table 2-3 Gross Provincial Products in Changwat Chon Buri

Unit : Million Baht

Sector	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
Agriculture and Fisheries	1177.4	1384.1	1259.2	1288.7	1322.5	1380.7	1444.9	1517.3	1597.3	1689.1
Mining & Manufacturing	1464.9	1628.4	1792.2	2013.1	2242.8	2458.5	2682.4	2911.6	3148.6	3386.6
Services	2209.7	2355.4	2433.5	2602.1	2783.2	2977.5	3185.6	3409.2	3649.5	3907.2
Total	4852.0	5367.9	5484.9	5903.9	6348.5	6816.7	7312.9	7838.1	8395.4	8982.9

Note: 1972 - 1976 Actual on 1972 Price
1977 - 1981 Projection

Source: Dept. of Town & Country Planning
Ministry of Interior

Table 2-4 Existing Water Supply Systems in Chon Buri & Rayong (1980)

Changwat	Water Supply Location	Service Area	Source of Water	Capacity CM/day	Population	Percentage Water Users	Water Supply Record CM/Year				Fare Baht/CM
							1977	1978	1979	1980	
Chon Buri	Chon Buri	A. Muang A. Si Racha	Bang Phra Res.	48,000	164,300	55.1%	10,858,727	11,478,293	11,610,306	12,033,720	2
	Panut Nikhom	A. Panut Nikhom	Huaysarica	1,440	15,200	44.76%	390,264	414,566	263,677	264,019	2
	Ban Bung	A. Ban Bung	Changnam Luor Huay Mai Fai	480	6,690	39.73%	141.593	105.129	120.603	85,367	2
	Nu Klua	Pattaya	Marpra Chan Res.	1,920 24,000	33,600	17.25%	219.170	302.699	226.975	295,010	2
	Ao Udon	Ao Udon	N.A.	N.A.	N.A.	N.A.	--	195,128	117,849	194,400	2
	Nong Yai	Nong Yai	N.A.	N.A.	N.A.	N.A.	--	13,811	14,734	22,000	3
	Pan Thong	Pan Thong	N.A.	N.A.	N.A.	N.A.	--	55,869	36,716	43,200	3
	Tanbon Mie	Tanbon Mie	N.A.	N.A.	N.A.	N.A.	--	--	30,940	36,000	3
Rayong	Rayong	A. Muang	Bung Tassipete to Fai Ban Khai	6,720	28,900	66.02%	1,297,580	1,548,695	1,337,485	N.A.	2
	Prasae	A. Klang	Klong Plo	2,400	6,340	24.73%	--	--	39,125	155,594	2
	Pluak Daeng	A. Pluak Daeng	N.A.	N.A.	N.A.	N.A.	--	11,614	15,082	14,680	3
	Ban Khai	A. Ban Khai	Irrigation Canal	N.A.	N.A.	N.A.	--	23,873	25,495	27,153	3
	Ban Chang	K.A. Ban Chang	N.A.	N.A.	N.A.	N.A.	--	61,249	51,267	61,883	4
	Ban Khuen	Ban Khuen	N.A.	N.A.	N.A.	N.A.	--	124,637	134,861	142,723	2

Note: N.A. ; Not available
-- ; Before operation of water supply.

Table 2-5 Existing Reservoirs for Water Supply

	Ban Phra	Ban Bung	Map Prachan	Dok Krai	Nong Kho* (Under Construction)
Changwat	Chon Buri	Chon Buri	Chon Buri	Rayong	Chon Buri
River	Huai Skuhrid	Huai Khlong, Yai tributary of Ban Pakong River	Huai Nong	Khlong Dok Krai in the watershed of the Rayong River	Khoong Nong Kho
Year of Completion	1974	1958	1979	1975	1983
Catchment Area (km^2)	130	53	32	291	51
Annual Rainfall (mm)	1,306	1,150	1,258	1,500	1,224
Annual Inflow (MCM)	31.4	13	14	101	16
Water Utilization Capacity (MCM)	(106)	(1.5)	(13)	49	18
Gross Storage Capacity (MCM)	110	1.9	14.8	71	20
Main Purposes & Consumption	Tapioca factory: 0.3 MCM/Y Veneer: 0.1 MCM/Y Oil Refinery: 3.2 MCM/Y	Sugar Refinery: 1.8 MCM/Y	City water: (Pattaya) 8 MCM/Y Irrigation: 80 ha	Irrigation: 4,800 ha	Irrigation and Industrial use

Note : Figure in parenthesis shows estimated capacity.
* Under construction

Table 3-1 Future Population Based on Current Trend

Unit: Person

Changwat Rayong	Future Population			Population Increase	
	1980	1990	2000	1980-1990	1980-2000
Rayong Municipality 1/	37,305	56,629	79,773	19,324	42,468
A. Muang 1/	83,693	90,474	93,065	6,781	9,372
A. Klaeng	100,484	127,383	154,338	26,899	53,854
A. Ban Khai	71,190	77,522	83,524	6,332	12,334
K.A. Pluak Daeng	25,791	30,804	35,676	5,013	9,885
K.A. Ban Chang 1/	27,594	28,264	29,047	670	1,453
K.A. Wang Chang	12,839	21,414	29,834	8,575	16,995
Total	358,896	432,490	505,257	73,594	146,361

Unit: Person

Changwat Chon Buri	Future Population			Population Increase	
	1980	1990	2000	1980-1980	1980-2000
Chon Buri Municipality	50,106	52,897	55,557	2,791	5,451
Panat Nikhon M.	13.411	14,408	15,392	997	1,981
Tambon Si Racha M. 1/	21,632	32,611	43,339	10,979	21,707
A. Muang Chon Buri	119,281	150,115	180,290	30,834	61,009
A. Panat Nikhon	110,203	126,154	142,024	15,951	31,821
A. Pan Thong	38,289	42,069	45,957	3,780	7,668
A. Ban Bung 2/	78,262	83,894	89,555	5,632	11,293
A. Si Racha 1/	84,516	100,426	116,795	15,910	32,279
A. Ban La Mung	43,789	45,824	47,765	2,035	3,976
A. Sattahip	85,112	98,377	111,528	13,265	26,416
K.A. Ko Si Chang	2,955	3,553	4,157	598	1,202
K.A. Nong Yai	17.386	20,486	23,491	3,100	6,105
K.A. Bo Thong	24,779	36,579	48,372	11,800	23,593
Muang Pattaya	34,706	59,380	84,173	24,674	49,467
Total	724,427	866,773	1,008,395	142,346	283,968

1/: Nong Pla Lai Sub-Project

2/: Ban Bung Sub-Project

Table 3-2 Projection of Induced Population and Labor Force by Area (1990)

Unit: Person

Area	Projects	direct workers	indirect workers	induced workers	local workers	1980-1990 net natural growth 4/	expected work force (40%) (50%)	net induced population
Sattahip	Soda Ash 1/	800	400	640	560	13,265		
	Sea port 2/	5,280	1,186	1,056	5,410	335		
	SUB TOTAL	6,080	1,586	1,696	5,970	13,600	5,440 - 6,800	6,784
Laem Chabang	Sea port /3	-	-	-	-	10,979		
	Industrial Estate 2/	7,500	3,750	6,000	5,250	15,910		
	SUB TOTAL	7,500	3,750	6,000	5,250	26,889	10,756 - 13,445	24,000
Rayong	Sponge Iron 1/					335		
	Natural Gas Separation					19,324		
	Petro Chemical	9,464	4,732	7,571	6,625	6,781		
	Chemical Fert.					6,332		
	Industrial Estate	12,500	6,250	10,000	8,750			
	SUB TOTAL	21,964	10,982	10,571	15,375	32,772	13,109 - 16,386	70,284

Note: 1/ 100% operation : 2/ 50% operation : 3/ 0%
4/ Sattahip .. A. Sattahip + 1/2 K.A. Ban Chang, Laem Chabang .. Si Racha M. + A. Si Racha
Rayong-Sattahip.. 1/2 K.A. Ban Chang + Rayong M. + A. Muang + A. Ban Khai
5/ The long term plan of Chonburi states that the labor force is 46% of the population and employment is 16% of the total population. Population & Housing Census-1970 indicates that employment population for Chonburi and Rayong are 41.9%, 43.6% of the population respectively.

Table 3-3 Projection of Induced Population and Labor Force by Area (2000)

Unit: Person

Area	Projects	direct workers	indirect workers	induced workers	local workers	1980-2000 net natural growth	expected work force	net induced population
Sattahip	Soda Ash	800	400	640	560	26,416		
	Sea port	10,560	2,371	2,112	10,819	726		
	SUB TOTAL	11,360	2,771	2,752	11,379	27,142	10,857 - 13,571	11,008
Laem Chabang	Sea port /1	2,112	474	422	2,164	21,707		
	Industrial Estate	15.000	7,500	12,000	10,500	32,279		
	SUB TOTAL	17,112	7,974	12,422	12,664	53,986	21,594 - 26,993	49,688
Rayong	Sponge Iron					726		
	Natural Gas Separation					42,468		
	Petro Chemical	9,464	4,732	7,571	6,625	9,372		
	Chemical Fert.					12,334		
	Industrial Estate	25,000	12,500	20,000	17,500			
	SUB TOTAL	34,464	17,232	27,571	24,125	64,910	25,964 - 32,455	110,284

/1 20% operation

Table 3-4 Water Demand for Industrial Use (Nong Pla Lai Sub-Project)

Unit: MCM/Year

Year	Rayong Area			Sattahip Area			Sub-total		Laem Chabang Area			Total	
	Plant	Demand	Increase Demand	Plant	Demand	Increase Demand	Demand	Increase Demand	Plant	Demand	Increase Demand	Demand	Increase Demand
1984	Gas Separation Petrochemical	7.8	7.8				7.8	7.8				7.8	7.8
1985	Sponge Iron	1.0	8.8				1.0	8.8				1.0	8.8
	Chemical Fertilizer	9.5	18.3	Soda Ash	10.2	10.2	19.7	28.5	Industrial Estate	3.3	3.3	23.0	31.8
1986	Industrial Estate	2.4	20.7	Sattahip Port	2.1	12.3	4.5	33.0				4.5	36.3
1990	Industrial Estate	2.4	23.1	Sattahip Port	1.4	13.7	3.8	36.8	Industrial Estate	3.3	6.6	7.1	43.4
1995									Industrial Estate	3.6	10.2	3.6	47.0
				Sattahip Port	0.6	14.3	0.6	37.4	Laem Chabang Port	1.8	12.0	2.4	49.4
1996				Sattahip Port	1.2	15.5	1.2	38.6	Industrial Estate	3.0	15.0	4.2	53.6
2000	Industrial Estate	4.8	27.9	Sattahip Area	1.7	17.2	6.5	45.1	Laem Chabang Port	1.8	16.8	8.3	61.9

Table 3-5 Water Demand for Industrial and Municipal Use (Nong Pla Lai Sub-Project)

Unit: MCM/Year

Year	Rayong				Sattahip				Sub-Total				Laem Chabang				Total				Year
	Industry	Industry -related municipal	Other municipal	Total	Industry	Industry -related municipal	Other municipal	Total	Industry	Industry -related municipal	Other municipal	Total	Industry	Industry -related municipal	Other municipal	Total	Industry	Industry -related municipal	Other municipal	Total	
1980	-	-	1.5	1.5	-	-	0.3	0.3	-	-	1.8	1.8	-	-	0.3	0.3	-	-	2.1	2.1	1980
1981	-	-	1.8	1.8	-	-	0.6	0.6	-	-	2.4	2.4	-	-	0.5	0.5	-	-	2.9	2.9	1981
1982	-	-	2.1	2.1	-	-	0.9	0.9	-	-	3.0	3.0	-	-	0.7	0.7	-	-	3.7	3.7	1982
1983	-	-	2.4	2.4	-	-	1.1	1.1	-	-	3.5	3.5	-	-	1.0	1.0	-	-	4.5	4.5	1983
1984	7.8	-	2.7	10.5	-	-	1.4	1.4	7.8	-	4.1	11.9	-	-	1.3	1.3	7.8	-	5.4	13.2	1984
1985	18.3	-	3.0	21.3	10.2	0.3	1.7	12.2	28.5	0.3	4.7	33.5	3.3	1.7	1.6	6.6	31.8	2.0	6.3	40.1	1985
1986	20.7	3.7	3.2	27.6	12.3	0.6	2.0	14.9	33.0	4.3	5.2	42.5	3.3	1.7	1.8	6.8	36.3	6.0	7.0	49.3	1986
1987	20.7	3.7	3.5	27.9	12.3	0.6	2.3	15.2	33.0	4.3	5.8	43.1	3.3	1.7	2.1	7.1	36.3	6.0	7.9	50.2	1987
1988	20.7	3.7	3.8	28.2	12.3	0.6	2.5	15.4	33.0	4.3	6.3	43.6	3.3	1.7	2.4	7.4	36.3	6.0	8.7	51.0	1988
1989	20.7	3.7	4.1	28.5	12.3	0.6	2.8	15.7	33.0	4.3	6.9	44.2	3.3	1.7	2.6	7.6	36.3	6.0	9.5	51.8	1989
1990	23.1	8.5	4.4	36.0	13.7	0.8	3.1	17.6	36.8	9.3	7.5	53.6	6.6	3.4	2.9	12.9	43.4	12.7	10.4	66.5	1990
1991	23.1	8.5	4.9	36.5	13.7	0.8	3.3	17.8	36.8	9.3	8.2	54.3	6.6	3.4	3.2	13.2	43.4	12.7	11.4	67.5	1991
1992	23.1	8.5	5.3	36.9	13.7	0.8	3.5	18.0	36.8	9.3	8.8	54.9	6.6	3.4	3.4	13.4	43.4	12.7	12.2	68.3	1992
1993	23.1	8.5	5.8	37.4	13.7	0.8	3.8	18.3	36.8	9.3	9.6	55.7	6.6	3.4	3.7	13.7	43.4	12.7	13.3	69.4	1993
1994	23.1	8.5	6.3	37.9	13.7	0.8	4.0	18.5	36.8	9.3	10.3	56.4	6.6	3.4	3.9	13.9	43.4	12.7	14.2	70.3	1994
1995	23.1	8.5	6.8	38.4	14.3	0.9	4.2	19.4	37.4	9.4	11.0	57.8	12.0	6.0	4.2	22.2	49.4	15.4	15.2	80.0	1995
1996	23.1	8.5	8.0	39.6	15.5	1.2	4.4	21.1	38.6	9.7	12.4	60.7	15.0	7.0	4.5	26.5	53.6	16.7	16.9	87.2	1996
1997	23.1	8.5	9.2	40.8	15.5	1.2	4.6	21.3	38.6	9.7	13.8	62.1	15.0	7.0	4.7	26.7	53.6	16.7	18.5	88.8	1997
1998	23.1	8.5	10.4	42.0	15.5	1.2	4.9	21.6	38.6	9.7	15.3	63.6	15.0	7.0	5.0	27.0	53.6	16.7	20.3	90.6	1998
1999	23.1	8.5	11.6	43.2	15.5	1.2	5.1	21.8	38.6	9.7	16.7	65.0	15.0	7.0	5.2	27.2	53.6	16.7	21.9	92.2	1999
2000	27.9	15.5	12.6	56.0	17.2	1.5	5.3	24.0	45.1	17.0	17.9	80.0	16.8	7.0	5.5	29.3	61.9	24.0	23.4	109.3	2000

Note: Rayong includes Rayong Municipality, Amphoe Muang Rayong, King Amphoe Ban Chang, Amphoe Ban Khai.
Sattahip includes Amphoe Sattahip.
Laem Chabang includes Amphoe Si Racha, Si Racha Municipality.

Table 3-6 Water Demand for Industrial and Municipal Use (Ban Bung Sub-Project)

Unit: MCM

Year	Industry	Municipality	Total
1980	1.8	1.3	3.1
1981	1.8	1.4	3.2
1982	1.8	1.5	3.3
1983	1.8	1.6	3.4
1984	1.8	1.7	3.5
1985	1.8	1.8	3.6
1986	1.8	2.0	3.8
1987	2.0	2.1	4.1
1988	2.3	2.3	4.6
1989	2.6	2.4	5.0
1990	2.9	2.5	5.4
1991	3.0	2.6	5.6
1992	3.2	2.7	5.9
1993	3.4	2.9	6.3
1994	3.6	3.0	6.6
1995	3.8	3.2	7.0
1996	4.0	3.4	7.4
1997	4.2	3.6	7.8
1998	4.4	3.8	8.2
1999	4.6	4.0	8.6
2000	4.8	4.2	9.0

Table 3-7 Water Demand of Nong Pla Lai Irrigation Area (Cropping Intensity 180%)

Unit: MCM

YEAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	6.68	1.13	0.00	12.35	11.59	9.38	9.48	6.63	0.00	0.67	7.16	6.01	71.14
1969	5.33	0.88	0.51	10.33	8.56	5.92	5.72	5.55	0.00	1.45	2.30	6.98	53.59
1970	2.81	0.95	0.27	12.89	8.67	7.19	9.48	5.21	0.00	4.47	8.15	8.79	60.93
1971	4.87	1.01	0.56	14.92	8.26	5.57	6.96	7.40	0.00	4.47	8.84	9.67	72.58
1972	2.85	1.93	0.29	15.83	14.77	3.21	10.46	4.86	0.00	3.47	8.84	6.77	73.34
1973	5.72	0.74	0.29	12.58	10.22	4.72	7.26	5.10	0.00	4.47	7.42	8.77	67.33
1974	2.83	0.91	0.46	14.56	9.49	4.19	0.00	5.87	0.00	1.31	8.84	7.31	55.80
1975	5.10	0.90	0.43	12.80	10.02	6.37	3.53	6.35	0.00	4.47	6.80	8.25	65.09
1976	4.50	0.98	0.61	17.24	6.47	7.21	5.19	6.41	0.00	3.45	8.84	9.68	70.61
1977	5.00	1.18	0.49	5.23	12.70	7.25	6.35	7.14	0.00	1.27	4.70	10.05	61.43
1978	4.90	1.21	0.28	8.21	11.29	6.44	9.54	6.91	0.00	4.47	6.46	9.66	69.41
1979	4.53	1.84	0.25	12.84	14.97	6.26	10.12	7.40	0.00	4.47	8.84	7.13	78.69
1980	4.20	1.76	0.28	10.16	8.12	8.37	6.82	6.10	0.00	4.47	8.04	8.56	66.88

Table 3-8 Water Demand of Thap Ma Irrigation Area (Cropping Intensity 180%)

Unit: MCM

	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	ANNUAL
1968	11.71	1.98	0.00	21.65	20.32	16.45	16.62	11.62	0.00	1.17	12.55	10.70	124.74
1969	9.35	1.54	0.89	18.11	15.01	10.38	10.03	9.73	0.00	2.54	4.03	12.24	93.97
1970	4.93	1.67	0.47	22.08	15.20	12.61	16.62	9.14	0.00	7.84	14.29	15.41	106.84
1971	8.54	1.77	0.98	26.16	14.48	9.76	12.20	12.96	0.00	7.84	15.50	16.96	127.26
1972	5.00	3.38	0.51	27.76	25.90	5.63	18.34	8.52	0.00	6.08	15.50	11.87	128.60
1973	10.03	1.30	0.51	22.06	17.92	8.28	12.73	8.94	0.00	7.84	13.01	15.38	118.06
1974	4.96	1.60	0.81	25.53	16.64	7.35	0.00	10.29	0.00	2.30	15.50	12.82	97.84
1975	8.94	1.58	0.75	22.44	17.57	11.17	6.19	11.13	0.00	7.84	11.92	14.47	114.13
1976	7.89	1.72	1.07	30.23	11.34	12.64	9.10	11.24	0.00	6.05	15.50	16.97	123.81
1977	8.77	2.07	0.86	9.17	22.27	12.71	11.13	12.52	0.00	2.23	8.24	17.62	107.71
1978	8.59	2.12	0.49	14.40	19.80	11.29	16.73	12.12	0.00	7.84	11.33	16.94	121.71
1979	7.94	3.23	0.44	22.51	26.25	10.98	17.74	12.98	0.00	7.84	15.50	12.50	137.98
1980	7.36	3.09	0.49	17.81	14.24	14.68	11.96	10.70	0.00	7.84	14.10	15.01	117.27

Table 3-9 Water Balance of Supply and Demand

Unit: MCM/Year

Year	Nong Pla Lai Sub-Project Area					Ban Bung Sub-Project Area		
	Water Demand			Water Supply	Water Balance	Water Demand	Water Supply	Water Balance
	Ind.&Mun.	Irrigation	Total			Ind.&Mun.		
1980	2.1	-	2.1	-	- 2.1	3.1	(2.3)	- 0.8
81	2.9	-	2.9	-	- 2.9	3.2	(2.3)	- 0.9
82	3.7	-	3.7	-	- 3.7	3.3	(2.3)	- 1.0
83	4.5	-	4.5	-	- 4.5	3.4	(2.3)	- 1.1
/1 84	13.2	-	13.2	22.8	9.6	3.5	(2.3)	- 1.2
85	40.1	-	40.1	22.8	-17.3	3.6	(2.3)	- 1.3
/2 86	49.3	69.4	118.7	149.4	30.7	3.8	9.0	5.2
87	50.2	69.4	119.6	149.4	69.4	4.1	9.0	5.9
88	51.0	69.4	120.4	149.4	29.0	4.6	9.0	5.4
89	51.8	69.4	121.2	149.4	28.2	5.0	9.0	4.0
90	66.5	69.4	135.9	149.4	13.5	5.4	9.0	4.6
91	67.5	69.4	136.9	149.4	12.5	5.6	9.0	4.4
92	68.3	69.4	137.7	149.4	11.7	5.9	9.0	4.1
93	69.4	69.4	138.8	149.4	10.6	6.3	9.0	3.7
94	70.3	69.4	139.7	149.4	9.7	6.6	9.0	3.4
/3 95	80.0	128.1	208.1	230.3	22.2	7.0	9.0	2.0
96	87.2	128.1	215.3	230.3	15.0	7.4	9.0	1.6
97	88.8	128.1	216.9	230.3	13.4	7.8	9.0	1.2
/4 98	90.6	194.7	285.3	296.9	11.6	8.2	9.0	0.8
99	92.2	194.7	286.9	296.9	10.0	8.6	9.0	0.4
2000	109.3	194.7	304.0	296.9	- 7.1	9.0	9.0	0

/1 Completion of Water Transmission System between Dok Krai Dam and Mab Ta Pud.
/2 Completion of Nong Pla Lai Dam and Ban Bung Dam
/3 Completion of Khlong Yai Dam
/4 Completion of Thap Ma Dam

* Figure in parenthesis shows vested right water of the existing Ban Bung.

Table 4-1 Area and Discharge of Turnout in Irrigation Blocks

Block No.	Area (ha)	Turnout No.	Discharge (m^3/sec)	Lateral Canal No.
B-1	92	T-1	0.247	
B-2	86	T-2	0.230	
B-3	21	T-3	0.056	
B-4	20	T-4	0.054	
B-5	218	T-5	0.584	L-1
B-6	87	T-6	0.233	L-2
B-7	125	T-7	0.335	
B-8	166	T-8	0.445	
B-9	92	T-9	0.247	
B-10	122	T-10	0.327	
B-11	163	T-11	0.437	
B-12	115	T-12	0.308	
B-13	63	T-13	0.169	L-3
B-14	30	T-14	0.080	L-4
B-15	185	T-15	0.496	L-5
B-16	150	T-16	0.402	
B-17	148	T-17	0.397	L-6
B-18	83	T-18	0.222	L-7
B-19	137	T-19	0.367	
B-20	116	T-20	0.311	
B-21	749	T-21	2.007	L-8
B-22	68	T-22	0.182	L-9
B-23	194	T-23	0.520	L-10
B-24	165	T-24	0.442	L-11
B-25	260	T-25	0.697	L-12

Note: Refer Fig. 4-7.

Table 6-1 Construction Cost of the Project

Unit : million US$

Item	Grand Total			Nong Pla Lai Sub-Project			Ban Bung Sub-project		
	L.C.	F.C.	Total	L.C	F.C	Total	L.C.	F.C.	Total
1. Direct Construction Cost	44.82	75.74	120.56	40.09	70.15	110.24	4.73	5.59	10.32
Civil Works	37.73	46.81	84.54	33.08	41.50	74.58	4.65	5.31	9.96
Equipment & materials	7.09	28.93	36.02	7.01	28.65	35.66	0.08	0.28	0.36
2. Road Relocation	0.98	1.60	2.58	0.78	1.30	2.08	0.20	0.30	0.50
3. Compensation	11.12	-	11.12	9.86	-	9.86	1.26	-	1.26
4. Engineering Cost	1.59	14.20	15.79	1.45	11.95	13.40	0.14	2.25	2.39
Sub-total (1-4)	58.51	91.54	150.05	52.18	83.40	135.58	6.33	8.14	14.47
5. Contingencies	45.36	41.44	86.80	40.57	37.59	78.16	4.79	3.85	8.64
Physical	7.48	10.75	18.23	6.52	9.52	16.04	0.96	1.23	2.19
Price	37.88	30.69	68.57	34.05	28.07	62.12	3.83	2.62	6.45
6. Interest during Construction	-	4.72	4.72	-	4.24	4.24	-	0.48	0.48
Total Project Cost (1-6)	103.87	137.70	241.57	92.75	125.23	217.98	11.12	12.47	23.59

Table 6-2 Construction Cost of Nong Pla Lai Sub-Project

Unit : million US$

Item	Grand Total			Nong Pla Lai Dam			Water Transmission System: Dok Krai-Mab Ta Pud			Water Transmission System: Mab Ta Pud-Sattahip			Water Transmission System: Dok Krai - Laem Chabang			Irrigation and Drainage System		
	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total
1. Direct Construction Cost	40.09	70.15	110.24	10.78	14.77	25.55	9.31	24.29	33.60	4.80	10.98	15.78	11.04	17.20	28.24	4.16	2.91	7.07
Civil Works	33.08	41.50	74.58	10.55	14.07	24.62	6.17	10.37	16.54	3.51	5.86	9.37	8.69	8.31	17.00	4.16	2.89	7.05
Equipment & materials	7.01	28.65	35.66	0.23	0.70	0.93	3.14	13.92	17.06	1.29	5.12	6.41	2.35	8.89	11.24	-	0.02	0.02
2. Road Relocation	0.78	1.30	2.08	0.78	1.30	2.08	-	-	-	-	-	-	-	-	-	-	-	-
3. Compensation	9.86	-	9.86	9.37	-	9.37	0.04	-	0.04	0.04	-	0.04	-	-	-	0.41	-	0.41
4. Engineering Cost	1.45	11.95	13.40	0.13	3.02	3.15	0.31	2.11	2.42	0.27	1.80	2.07	0.51	3.46	3.97	0.23	1.56	1.79
Sub-total	52.18	83.40	135.58	21.06	19.09	40.15	9.66	26.40	36.06	5.11	12.78	17.89	11.55	20.66	32.21	4.80	4.47	9.27
5. Contingencies	40.57	37.59	78.16	15.64	9.62	25.26	4.12	7.49	11.61	4.47	6.40	10.87	12.10	11.80	23.90	4.24	2.28	6.52
Physical	6.52	9.52	16.04	3.17	2.87	6.04	0.97	2.64	3.61	0.51	1.28	1.79	1.16	2.06	3.22	0.71	0.67	1.38
Price	34.05	28.07	62.12	12.47	6.75	19.22	3.15	4.85	8.00	3.96	5.12	9.08	10.94	9.74	20.68	3.53	1.61	5.14
6. Interest during Construction	-	4.24	4.24	-	1.14	1.14	-	1.05	1.05	-	0.54	0.54	-	1.25	1.25	-	0.26	0.26
Total (1-6)	92.75	125.23	217.98	36.70	29.85	66.55	13.78	34.94	48.72	9.58	19.72	29.30	23.65	33.71	57.36	9.04	7.01	16.05

Table 7-1 Personnel Required for Operation and Maintenance

	Before completion	After completion	Remark
Dok Krai Dam			
Civil Engr.	2	3	Additional to the existing staff
Mechanical Engr.	4	6	
Operation and Monitor	4	6	
Driver	2	2	
Nong Pla Lai Dam			
Chief	-	1	
Asst. Chief	-	2	
Civil Engr.	-	5	
Mechanical Engr.	-	5	
Operation and Monitor	-	10	
Driver	-	2	
Pipeline System			
Chief	1	1	
Asst. Chief	1	2	
Civil Engr.	2	6	
Mechanical Engr.	4	10	
Operation and Monitor	10	20	
Patrol	4	8	
Driver	2	4	
Irrigation System			
Chief	-	1	Additional to the existing staff
Operation and Monitor	-	4	
Driver	-	2	
Ban Bung Dam			
Civil Engr.	-	2	Additional to the existing staff
Mechanical Engr.	-	2	
Operation and Monitor	-	2	
Driver	-	1	

Table 8-1 Annual Disbursement of Economic Project Cost

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Sub-Project													
1. Nong Pla Lai Dam	13.62	21.96	35.58	-	-	1.28	2.19	3.90	3.05	6.24	10.84	2.20	5.88
2. Water Transmission System*	27.55	65.24	92.79	0.21	1.42	7.45	21.29	4.58	14.59	8.42	16.70	6.89	11.24
3. Irrigation and Drainage System	3.26	5.14	8.40	-	-	0.10	0.75	0.24	0.64	1.25	1.63	1.67	2.21
Sub-Total (1-3)	44.43	92.34	136.77	0.21	1.42	8.83	24.23	8.72	18.28	15.91	29.17	10.76	19.24
II. Ban Bung Sub-Project	4.86	9.37	14.23	-	-	0.55	1.81	1.31	1.51	2.25	4.50	0.75	1.55
Total	49.29	101.71	151.00	0.21	1.42	9.38	26.04	10.03	19.79	18.16	33.67	11.51	20.79

NOTE * : This cost covers the pipeline route of Dok Krai - Mab Ta Pud, Mab Ta Pud - Sattahip and Dok Krai - Laem Chabang

Table 8-2 Economic Cost of Land Consolidation of Nong Pla Lai Irrigation Area

Unit in million US$

	Total	1985	1986	1987	1988
1. Base Cost	3.00	0.35	1.00	1.00	0.65
2. Engineering Service	0.12	0.01	0.04	0.04	0.03
3. Compensation	-	-	-	-	-
4. Contingency	0.47	0.04	0.17	0.17	0.09
5. Total	3.59	0.40	1.21	1.21	0.77

Table 8-3 Water Supply and Benefit (Nong Pla Lai Sub-Project)

Year	Water Supply (MCM)	Benefit (1,000 US$)
1984	6.2	1,345
1985	16.7	3,624
1986	22.8	4,948
1987	50.2	10,893
1988	51.0	11,067
1989	51.8	11,241
1990	66.5	14,431
1991	67.5	14,648
1992	68.3	14,821
1993	69.4	15,060
1994	70.3	15,255
1995	80.0	17,360
1996		
1997		
1998		
1999		
2000		
2031	80.0	17,360

Table 8-4 Agricultural Production by Crop

	Production Volume (T/ha)	Economic Price (฿/T)	Production (฿/ha)	Cost (฿/ha)	Net Production (฿/ha)
Without Project					
Wet Season					
Paddy (L.V.)					
Present (1981)	1.44	5,500	7,700	2,278	5,422
Future (1992)	2.00	6,700	13,400	2,639	10,761
With Project (1992)					
Wet Season					
Paddy (H.Y.V.)	4.00	6,700	26,800	7,342	19,458
Dry Season					
Paddy (H.Y.V.)	4.50	6,700	30,150	8,671	21,479
Groundnuts	1.90	13,020	24,738	10,146	14,592

Table 8-5 Agricultural Net Production by Crop
(Cropping Intensity 180%)

	Plant Area (ha)	NP per ha (฿/ha)	Gross Production (1,000฿)
Without Project			
Wet Season			
Paddy (L.V.)			
Present (1981)	3,840	5,422	20,820
Future (1992)	3,840	10,761	41,322
With Project (1992)			
Wet Season			
Paddy (H.Y.V.)	3,650	19,458	71,022
Dry Season			
Paddy (H.Y.V.)	975	21,497	20,960
Groundnuts	1,945	14,592	28,381

Table 8-6 Price Structure of Rice/Paddy at Constant 1981 Prices

	1981		1990	
	Financial	Economic	Financial	Economic
Export price, 5% br,				
FOB Bangkok (US$/ton) /1	510	510	622	622
(B/ton)	10,200	10,200	12,444	12,444
Grade differential (86%) /2	8,770	8,770	10,700	10,700
Rice premium	1,000		1,220	
Export duty	440		540	
Municipal tax	15		18	
Reserve requirement loss	845		1,030	
Exporter's margin /3	440	305	536	370
Wholesaler's margin /3	210	145	256	177
Ex-mill price of rice	5,820	8,320	7,100	10,153
Ex-mill price of paddy	4,190	5,990	5,110	7,310
Tax	90		110	
Miller's margin /4	350	250	430	310
Input price of paddy at mill	3,750	5,740	4,570	7,000
Middleman's margin /3	350	240	430	300
Farm gate price of paddy	3,400	5,500	4,140	6,700

/1 : The World Bank prospect.
/2 : Average of exported white rice excluding parboiled rice over previous five years.
/3 : Conversion factor 0.69 is applied.
/4 : Conversion factor 0.72 is applied.

Table 8-7 Water Supply and Benefit
(Ban Bung)

	Water Supply (MCM)	Benefit (1,000 US$)
1987	1.8	547
88	2.3	699
89	2.7	821
90	3.1	942
91	3.3	1,003
92	3.6	1,094
93	4.0	1,216
94	4.3	1,307
95	4.7	1,429
96	5.1	1,550
97	5.5	1,672
98	5.9	1,794
99	6.3	1,915
2000	6.7	2,037
|	|	|
2031	6.7	2,037

Table 8-8 Sensitivity Analysis of Industrial and Municipal Water for Nong Pla Lai Sub-Project (Economic)

	Construction cost	Delay of Water Demand	IRR (%)
Base case			10.5
Case 1	10% up		9.5
Case 2	20% up		8.7
Case 3		10 years	8.6

Table 8-9 Sensitivity Analysis of Industrial and Municipal Water for Ban Bung Sub-Project (Economic)

	Construction cost	Delay of Water Demand	IRR (%)
Base case			8.2
Case 1	10% up		7.6
Case 2	20% up		7.0
Case 3		10 years	7.0

Table 8-10 Annual Disbursement of Financial Project Cost

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Sub-Project													
1. Nong Pla Lai Dam	36.70	29.85	66.55	-	-	3.42	2.54	10.43	3.83	16.37	14.56	6.48	8.92
2. Water Transmission System*	47.01	88.37	135.38	0.24	1.54	9.84	25.25	7.73	19.36	15.17	24.21	14.03	18.01
3. Irrigation and Drainage System	9.04	7.01	16.05	-	-	0.13	0.87	0.77	0.81	3.54	2.21	4.60	3.12
Sub-Total (1-3)	92.75	125.23	217.98	0.24	1.54	13.39	28.66	18.93	24.00	35.08	40.98	25.11	30.05
II. Ban Bung Sub-Project	11.12	12.47	23.59	-	-	1.02	2.09	2.55	1.92	5.52	6.08	2.03	2.38
Total	103.87	137.70	241.57	0.24	1.54	14.41	30.75	21.48	25.92	40.60	47.06	27.14	32.43

NOTE * : This cost covers the pipeline route of Dok Krai - Mab Ta Pud, Mab Ta Pud - Sattahip and Dok Krai - Laem Chabang

Table 8-11 Income Statement for Industrial and Municipal Use (Nong Pla Lai Sub-Project) (1)

(UNIT: 1000 DOLLAR)

<<< INCOME STATEMENT >>>

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. REVENUE	0.0	0.0	942.4	2538.4	3404.8	7630.4	7752.0	7873.6	10108.0	10260.0
WATER COMSUMPTION (1)	0.0	0.0	6.2	16.7	22.4	50.2	51.0	51.8	66.5	67.5
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	0.0	0.0	140.0	650.0	1040.0	1230.0	7465.8	7475.8	7775.8	7785.8
1) OPERATING & MAINTENANCE	0.0	0.0	140.0	650.0	1040.0	1230.0	1240.0	1250.0	1550.0	1560.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	2862.6	2862.6	2862.6	2862.6
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	2862.6	2862.6	2862.6	2862.6
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	0.0	0.0	802.4	1888.4	2364.8	6400.4	286.2	397.8	2332.2	2474.2

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. REVENUE	10381.6	10548.8	10685.6	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	68.3	69.4	70.3	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	7815.8	7805.8	7813.8	7780.3	7723.2	7637.6	7531.6	7425.6	7319.5	7213.5
1) OPERATING & MAINTENANCE	1590.0	1580.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	2862.6	2862.6	2860.6	2827.0	2770.0	2684.4	2578.3	2472.3	2366.3	2260.3
ON LONG TERM DEPOSIT	2862.6	2862.6	2860.6	2827.0	2770.0	2684.4	2578.3	2472.3	2366.3	2260.3
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	2565.8	2743.0	2871.8	4379.7	4436.8	4522.4	4628.4	4734.4	4840.5	4946.5

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	7107.5	7001.5	6895.5	6789.4	6683.4	6577.4	6471.4	6365.4	6259.3	6153.3
1) OPERATING & MAINTENANCE	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	2154.3	2048.2	1942.2	1836.2	1730.2	1624.1	1518.1	1412.1	1306.1	1200.1
ON LONG TERM DEPOSIT	2154.3	2048.2	1942.2	1836.2	1730.2	1624.1	1518.1	1412.1	1306.1	1200.1
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	5052.5	5158.5	5264.5	5370.6	5476.6	5582.6	5688.6	5794.6	5900.7	6006.7

Table 8-11 Income Statement for Industrial and Municipal Use (Nong Pla Lai Sub-Project) (2)

(UNIT: 1000 DOLLAR)

<<< INCOME STATEMENT >>>

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	6047.3	5941.3	5835.2	5729.2	5623.2	5517.2	5411.2	5305.1	5199.1	5095.1
1) OPERATING & MAINTENANCE	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	1094.0	988.0	882.0	776.0	670.0	563.9	457.9	351.9	245.9	141.8
ON LONG TERM DEPOSIT	1094.0	988.0	882.0	776.0	670.0	563.9	457.9	351.9	245.9	141.8
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	6112.7	6218.7	6324.8	6430.8	6536.8	6642.8	6748.8	6854.9	6960.9	7064.9

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	5022.6	4973.7	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2	4953.2
1) OPERATING & MAINTENANCE	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0	1590.0
2) INTEREST	69.4	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON LONG TERM DEPOSIT	69.4	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3	3363.3
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	7137.4	7186.3	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7	7206.7

Table 8-12 Cash Flow of Nong Pla Lai Sub-Project

Unit : 1000 US$

YEAR	CAPITAL COST	REVENUE	OPE. & TAX	BENEFIT
1982	1752.4	0.0	0.0	0.0
1983	37980.4	0.0	0.0	0.0
1984	33811.6	942.4	140.0	802.4
1985	53986.1	2538.4	650.0	1888.4
1986	37281.4	3404.8	1040.0	2364.8
1987	0.0	7630.4	1230.0	6400.4
1988	0.0	7752.0	1240.0	6512.0
1989	0.0	7873.6	1250.0	6623.6
1990	0.0	10108.0	1550.0	8558.0
1991	0.0	10260.0	1560.0	8700.0
1992	0.0	10381.6	1590.0	8791.6
1993	0.0	10548.8	1580.0	8968.8
1994	0.0	10685.6	1590.0	9095.6
1995	0.0	12160.0	1590.0	10570.0
⋮	⋮	⋮	⋮	⋮
2031	0.0	12160.0	1590.0	10570.0

Table 8-13 Income Statement for Industrial and Municipal Use (Ban Bung Sub-Project) (1)

(UNIT: 1000 DOLLAR)

<<< INCOME STATEMENT >>>

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. REVENUE	0.0	0.0	0.0	0.0	0.0	273.6	349.6	410.4	471.2	501.6
WATER COMSUMPTION (1)	0.0	0.0	0.0	0.0	0.0	1.8	2.3	2.7	3.1	3.3
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	1162.0	1162.0
1) OPERATING & MAINTENANCE	0.0	0.0	0.0	0.0	0.0	100.0	100.0	100.0	100.0	100.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	425.0	425.0
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	425.0	425.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	637.1	637.1
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	0.0	0.0	0.0	0.0	0.0	173.6	249.6	310.4	-690.8	-660.4

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. REVENUE	547.2	608.0	653.6	714.4	775.2	836.0	896.8	957.6	1018.4	1018.4
WATER COMSUMPTION (1)	3.6	4.0	4.3	4.7	5.1	5.5	5.9	6.3	6.7	6.7
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	1162.0	1162.0	1162.0	1158.3	1151.2	1133.9	1112.6	1091.4	1070.1	1048.9
1) OPERATING & MAINTENANCE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2) INTEREST	425.0	425.0	425.0	421.2	414.1	396.8	375.5	354.3	333.0	311.8
ON LONG TERM DEPOSIT	425.0	425.0	425.0	421.2	414.1	396.8	375.5	354.3	333.0	311.8
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	-614.8	-554.0	-508.4	-443.9	-376.0	-297.9	-215.8	-133.8	-51.7	-30.5

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. REVENUE	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (1)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	1027.6	1006.4	985.1	963.9	942.6	921.4	900.1	878.9	857.7	836.4
1) OPERATING & MAINTENANCE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2) INTEREST	290.5	269.3	248.0	226.8	205.6	184.3	163.1	141.8	120.6	99.3
ON LONG TERM DEPOSIT	290.5	269.3	248.0	226.8	205.6	184.3	163.1	141.8	120.6	99.3
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	-9.2	12.0	33.3	54.5	75.8	97.0	118.3	139.5	160.7	182.0

Table 8-13 Income Statement for Industrial and Municipal Use (Ban Bung Sub-Project) (2)

(UNIT: 1000 DOLLAR)

<<< INCOME STATEMENT >>>

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. REVENUE	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (1)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	815.2	793.9	772.7	755.2	741.0	737.1	737.1	737.1	737.1	737.1
1) ORERATING & MAINTENANCE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2) INTEREST	78.1	56.8	35.6	18.1	3.9	0.0	0.0	0.0	0.0	0.0
ON LONG TERM DEPOSIT	78.1	56.8	35.6	18.1	3.9	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	203.2	224.5	245.7	263.2	277.4	281.3	281.3	281.3	281.3	281.3

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. REVENUE	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4	1018.4
WATER COMSUMPTION (1)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1	737.1
1) ORERATING & MAINTENANCE	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1	637.1
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3	281.3

Table 8-14 Cash Flow of Ban Bung Sub-Project

Unit : 1000 US$

YEAR	CAPITAL COST	REVENUE	OPE. & TAX	BENEFIT
1982	0.0	0.0	0.0	0.0
1983	3076.9	0.0	0.0	0.0
1984	4398.3	0.0	0.0	0.0
1985	11413.1	0.0	0.0	0.0
1986	4204.1	0.0	0.0	0.0
1987	0.0	273.6	100.0	173.6
1988	0.0	349.6	100.0	249.6
1989	0.0	410.4	100.0	310.4
1990	0.0	471.2	100.0	371.2
1991	0.0	501.6	100.0	401.6
1992	0.0	547.2	100.0	447.2
1993	0.0	608.0	100.0	508.0
1994	0.0	653.6	100.0	553.6
1995	0.0	714.4	100.0	614.4
1996	0.0	775.2	100.0	675.2
1997	0.0	836.0	100.0	736.0
1998	0.0	896.8	100.0	796.8
1999	0.0	957.6	100.0	857.6
2000	0.0	1018.4	100.0	918.4
|	|	|	|	|
2031	0.0	1018.4	100.0	918.4

Table 8-15 Sensitivity Analysis of Industrial and Municipal Water for Nong Pla Lai Sub-Project (Financial)

	Water tariff (US$/m^3)	Construction cost	Delay of Water Demand	IRR (%)
Base case	0.152			4.9
Case 1-1	0.066			-
1-2	0.130			3.7
1-3	0.218			7.2
Case 2-1		10% up		4.3
2-2		20% up		3.5
Case 3-1			10 years	3.8

Table 8-16 Sensitivity Analysis of Industrial and Municipal Water for Ban Bung Sub-Project (Financial)

	Water tariff (US$/m^3)	Construction cost	Delay of Water Demand	IRR (%)
Base case	0.152			1.8
Case 1-1	0.174			2.3
1-2	0.218			3.3
1-3	0.304			5.4
Case 2-1		10% up		1.4
2-2		20% up		1.0
Case 3-1			10 years	1.2

Table 8-17 Result of Water-Quality Test

Unit: ppm

Item	Location		
	Ban Bung	Nong Pla Lai	Dok Krai
Cadmium	unfound	unfound	unfound
Cyanide	unfound	unfound	unfound
Phosphorus	0.29	0.04	0.03
Chronium	unfound	unfound	unfound
Arsenic	0.001	0.001	0.001

Table 8-18 Mineral Constituent

(Sample, 16 Aug. 1981)

Item		Item	
PH	7.1	Ec x 10^6	100
Ca (ppm)	10	SSP	23
Mg (ppm)	4	SAR	0.4
Na (ppm)	5	RSC	0.01
Fe Total (ppm)	0.1	TS (ppm)	93
Fe Diss (ppm)	0	TDS (ppm)	68
Mn	0	SS (ppm)	25
CO_3	0	Alkalinity as $CaCO_3$ (ppm)	40
HCO_3 (ppm)	49		
Cl (ppm)	8	Total hardness as $CaCO_3$ (ppm)	40
SO_4 (ppm)	2		

PH by glass electrode
Ec x 10^6 = Electrical conductivity Micromhos/cm
RSC = Residual sodium carbonate
SSP = Soluke sodium percentage
SAR = Sodium adsorption ratio
TS = Total solid
TDS = Total dissolved solid
SS = Suspended solid

Table 8-19 Water Analysis at Dok Krai

(Jan. 1979 - Jun. 1981)

Item	Upstream				Downstream			
	Count	Mean	Max.	Min.	Count	Mean	Max.	Min.
PH	25	7.1	7.9	6.4	25	7.1	7.7	6.3
EC×10⁶ at 25°C	27	116	130	100	27	145	410	110
SAR	18	0.5	0.6	0.4	18	0.5	0.9	0.2
SSP	18	28	32	25	18	25	36	7
RSC meq/l	18	0.08	0.25	0	18	0.08	0.32	0
Ca(ppm)	18	10.3	11.9	7.5	18	17.3	60.6	8.7
Mg(ppm)	18	3.2	5.1	1.7	18	3.7	10.7	2.4
Na(ppm)	18	6.9	8.1	6.0	18	7.8	17.3	6.0
K (ppm)	-	-	-	-	-	-	-	-
Fe Total	-	-	-	-	-	-	-	-
Fe Diss.	-	-	-	-	-	-	-	-
CO_3	0	0	0	0	0	0	0	0
HCO_3 (ppm)	18	62	237	42	18	71	257	42
Cl (ppm)	18	7.1	8.2	5.7	18	7.1	8.2	5.7
SO_4 (ppm)	18	1.0	2.9	0	18	6.7	40.3	0
ND_3 (ppm)	-	-	-	-	-	-	-	-
PO_4	-	-	-	-	-	-	-	-
B (ppm)	-	-	-	-	-	-	-	-

Table 8-20 Potable Water Quality Standard (WHO)

Item	Standard	Item	Standard
PH	7.0 - 8.5	Cyanide (CN)	0.01 ppm
Iron (Fe)	0.3 ppm	Lead (Pb)	0.1 ppm
Manganese (Mn)	0.1 ppm	Calcium (Ca)	75 ppm
Copper (Cu)	1.0 ppm	Cl^-	200 ppm
Zinc (Zn)	5.0 ppm	NH_4 - N	0.5 ppm
Fluoride	1.0 ppm	NO_3 - N	40 ppm
Phenols	0.001 ppm	SO_4^-	200 ppm
Arsenic (As)	0.2 ppm		

Table 8-21 Irrigation Water Quality Standard

Item	Standard
PH	6 - 7
COD	below 6 ppm
T-N	below 1 ppm
Ec	500 μu /cm
Cu	below 0.01 ppm
Zn	beow 1 ppm
As	below 0.01 ppm
Mn	below 7 ppm

Table 8-22 Industrial Water Quality Standard

Item / Usage	PH	Evaportion Residuce (ppm)	Turbidity	Fe + Mn (ppm)	Hardness ($CaCO_3$ ppm)
Cooling Water	6 - 8	50 - 200	5 - 20	0.1 - 1.0	30 - 100
Boiler Use	6.5 - 7.5	10 - 100	2 - 6	0.05 - 0.5	10 - 60
Washing	6 - 8	80 - 150	2 - 6	0.1 - 1.0	30 - 50
Processing	6.5 - 7.5	50 - 90	1 - 5	0.2 - 0.3	20 - 80
Material	6.5 - 7.5	50 - 80	1 - 5	0.05 - 1.0	30 - 50
Temperature Control	6.5 - 7.5	50 - 100	3 - 10	0.1 - 0.3	20 - 80

Fig. 2-1 Isohyetal Annual Mean Rainfall Map of Thailand

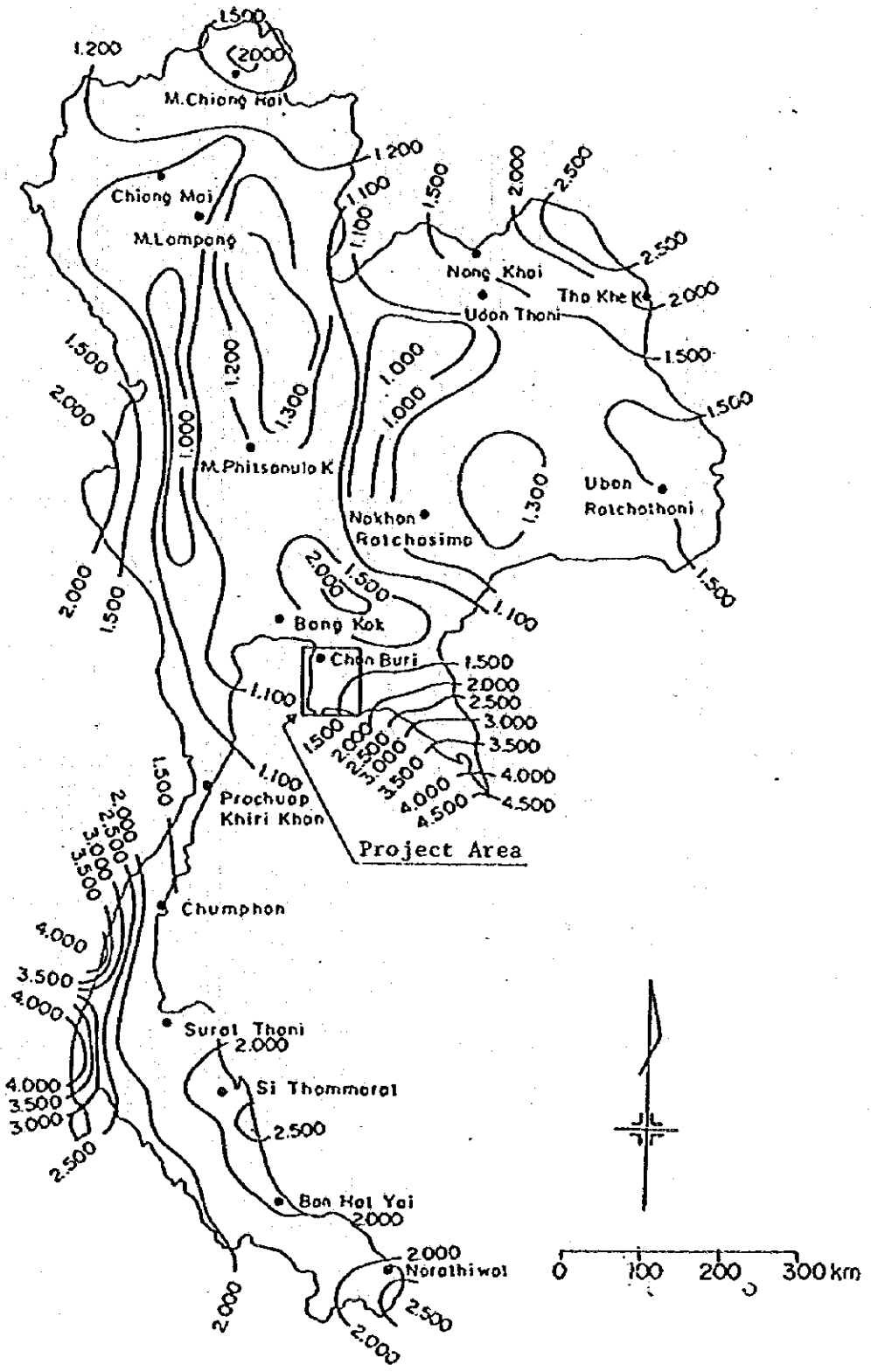


Fig. 2-2 Monthly Mean Rainfall Distribution

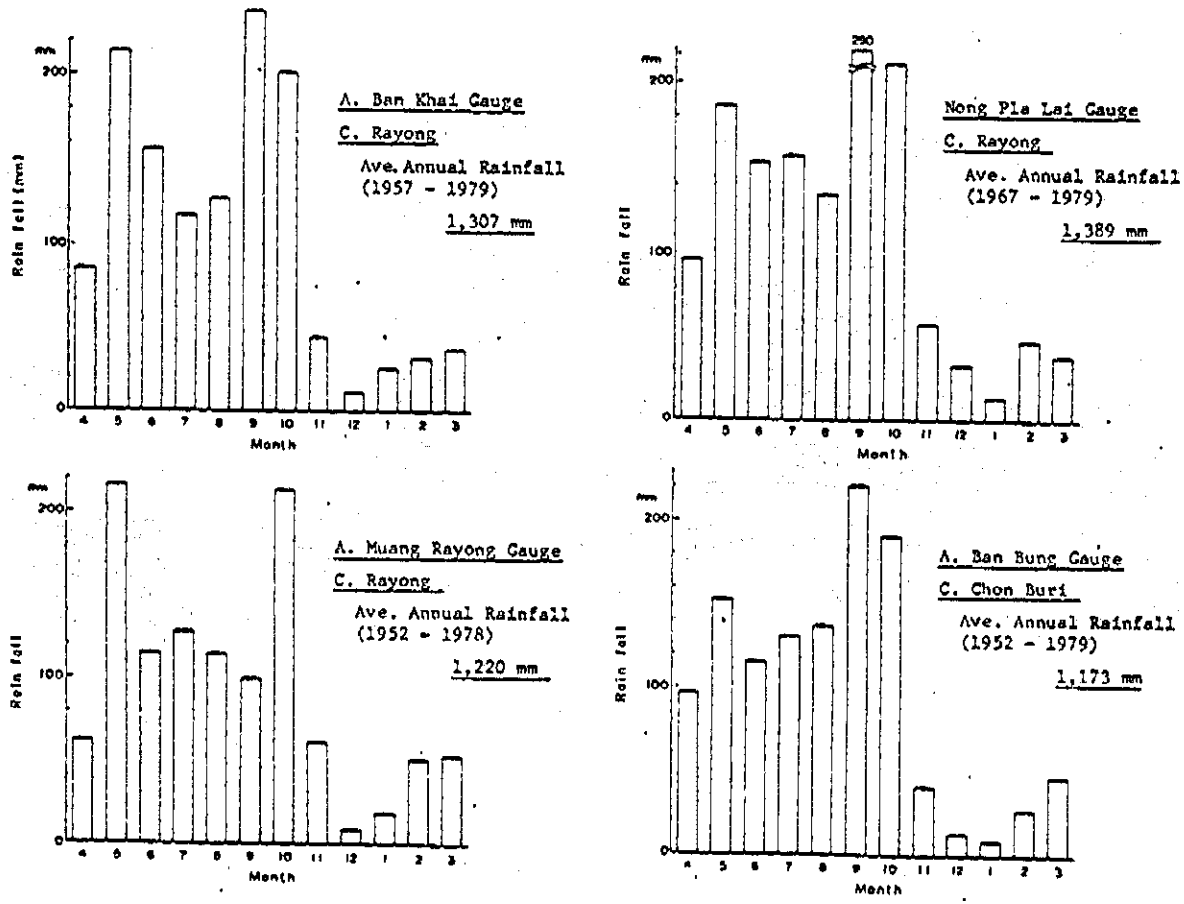


Fig. 2-3 Monthly Mean Evaporation

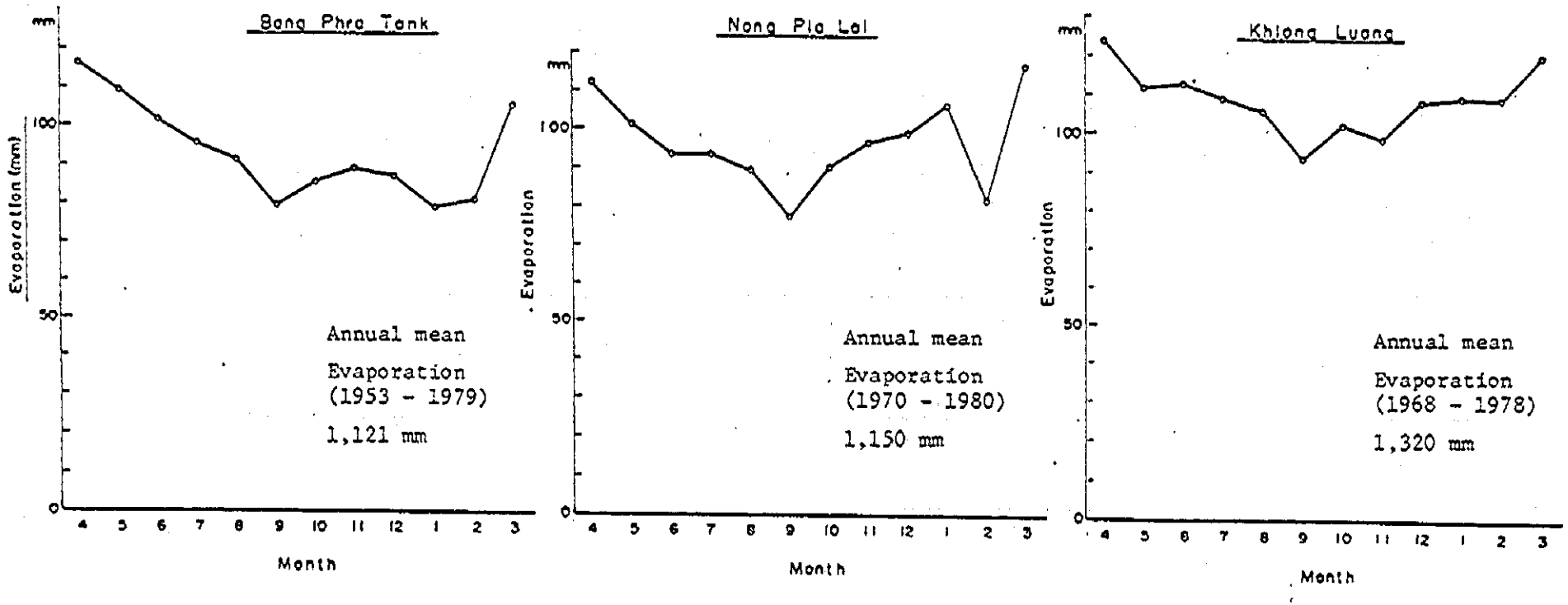


Fig. 2-4 Specific Discharge of Main Flood in Thailand

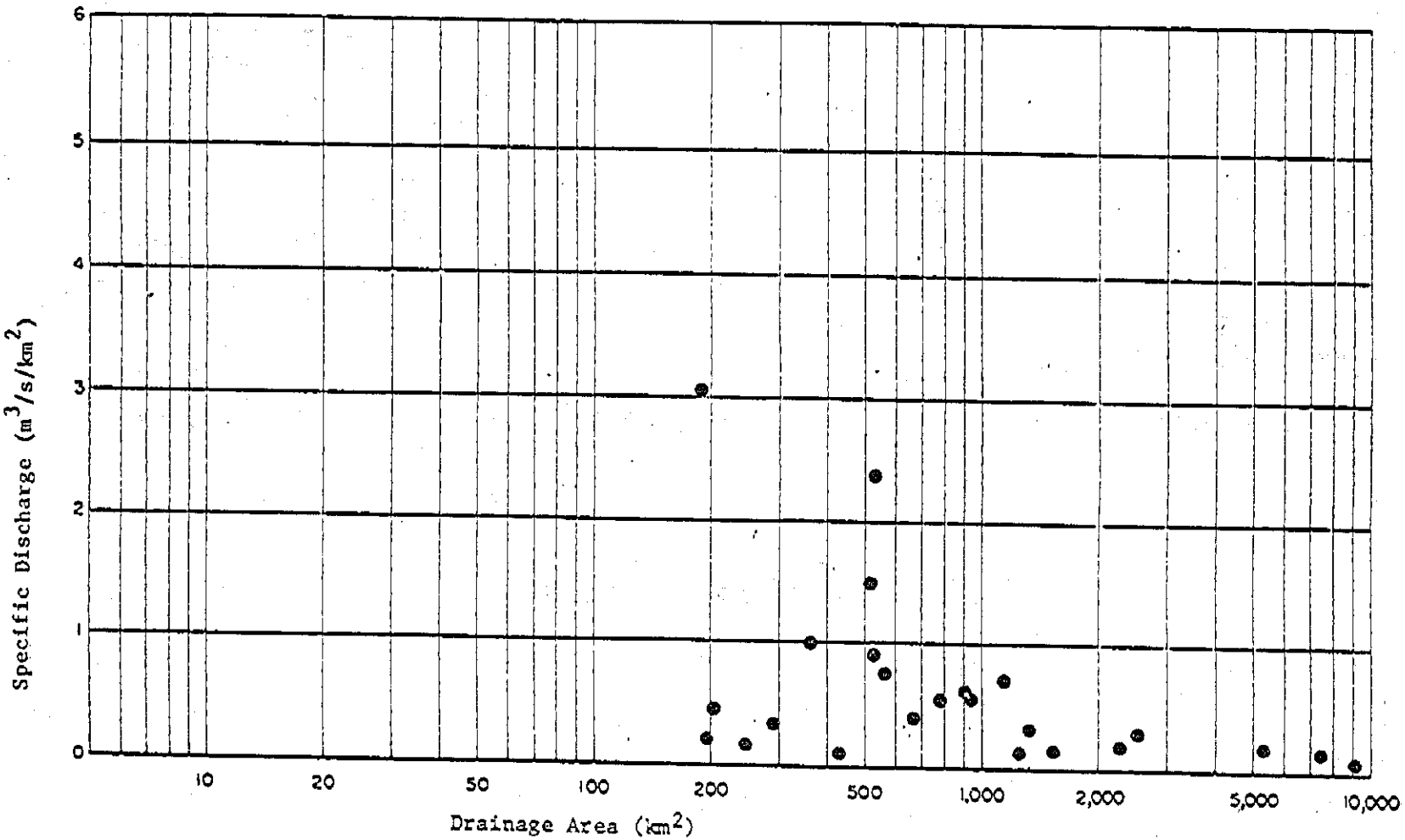


Fig. 2-5 General Map of Rayong River

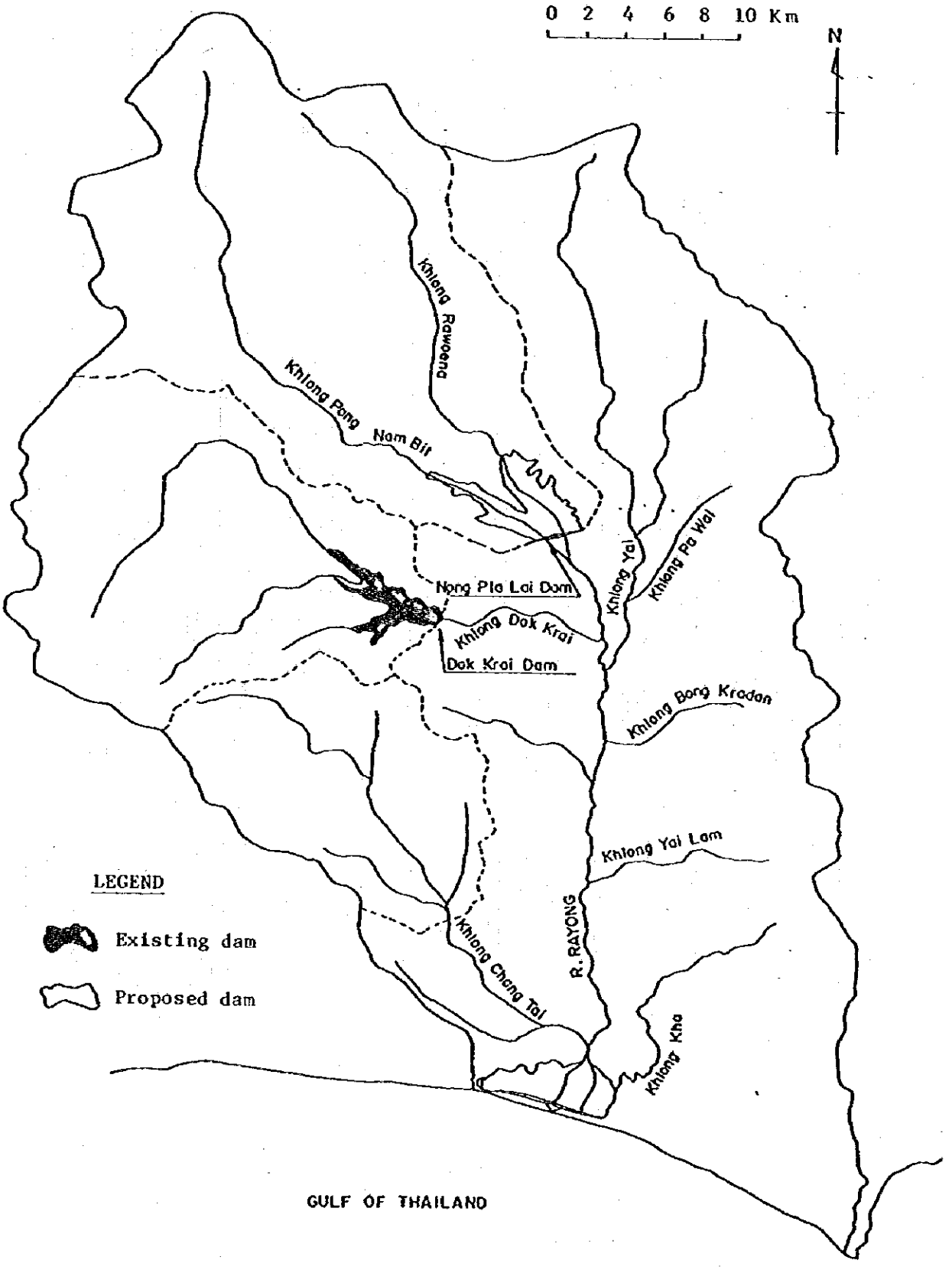


Fig. 2-6 Longitudinal Profile and Stream Flow Capacity (Rayong River)

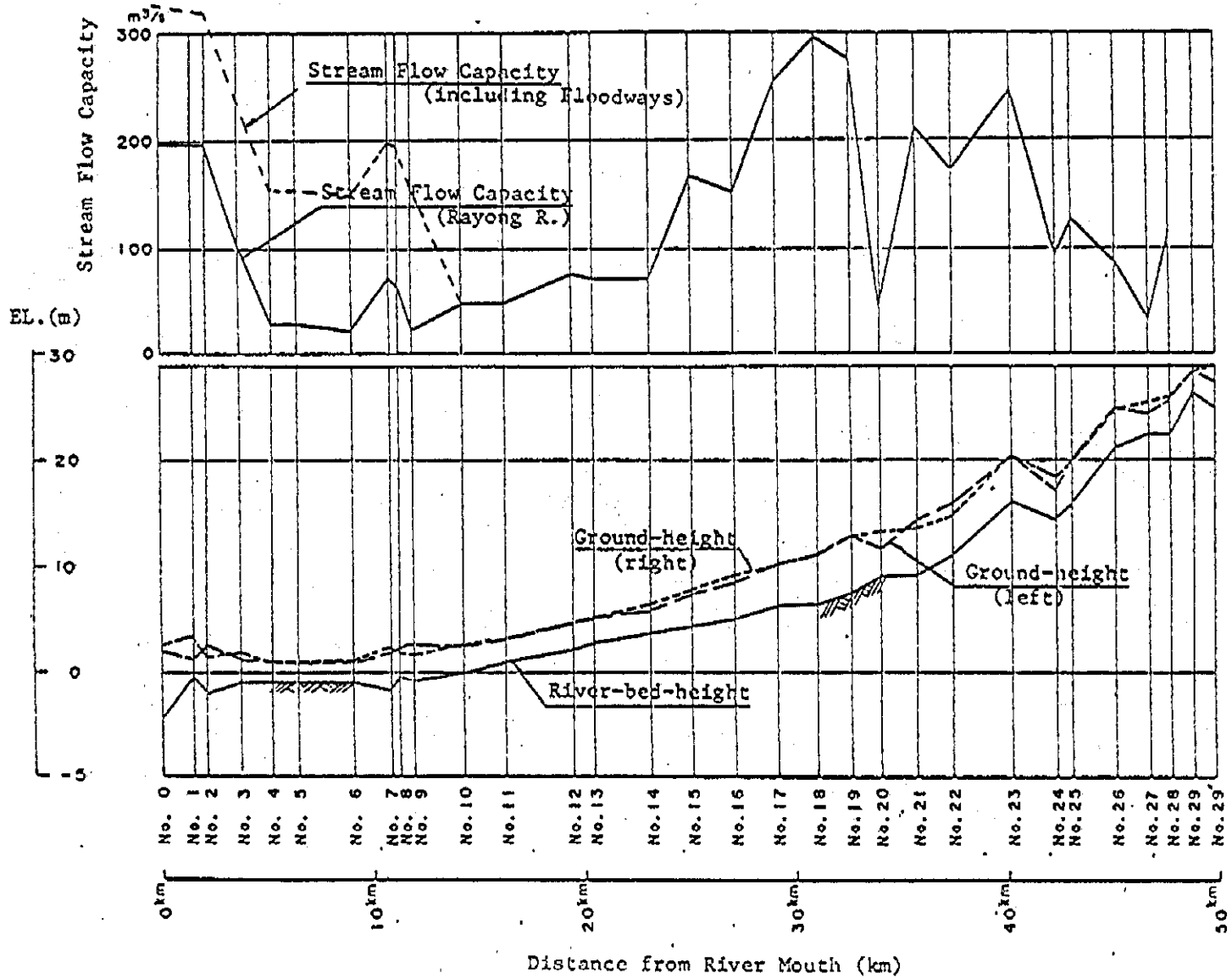


Fig. 2-7 General Map of Ban Bung River

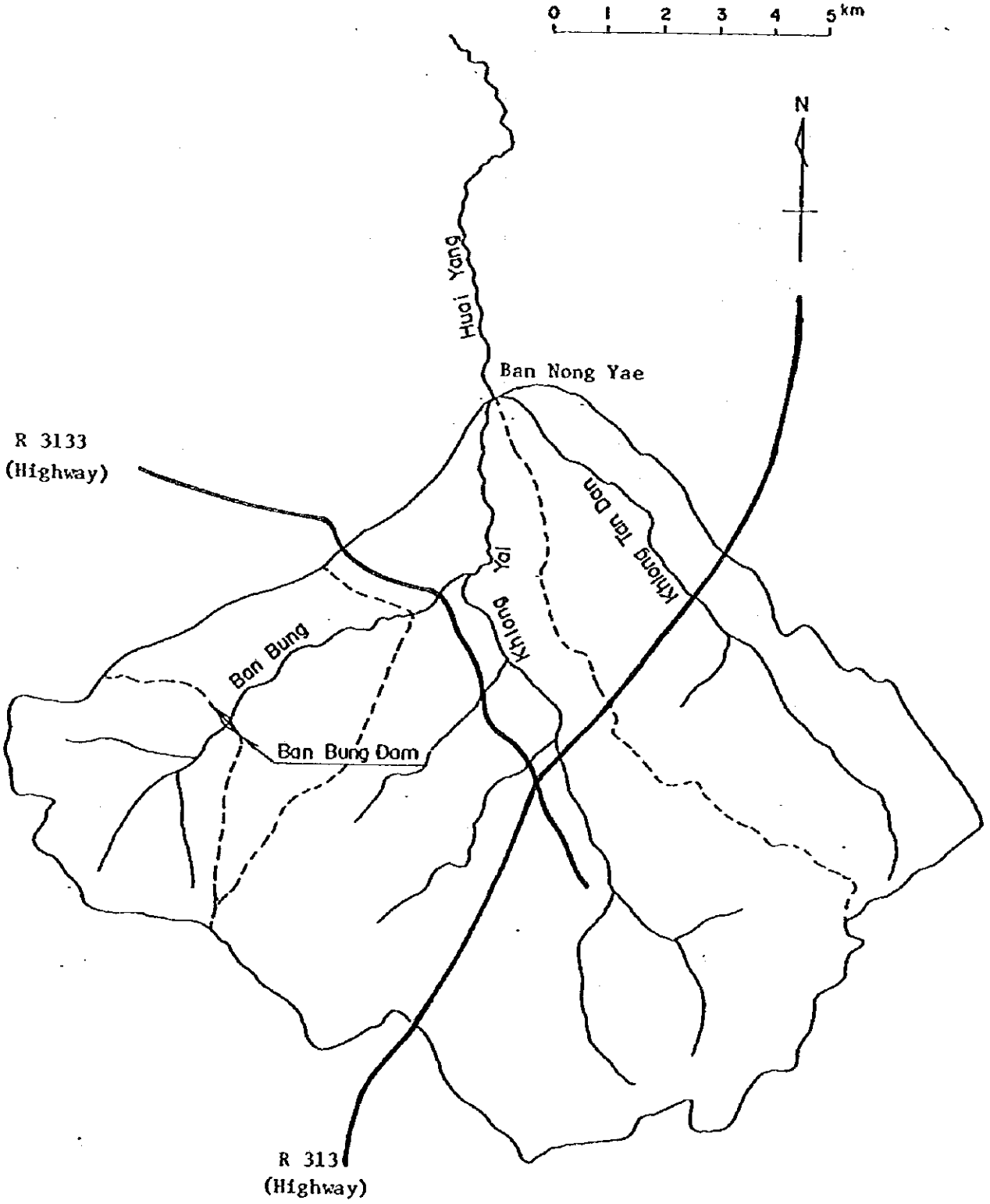


Fig. 2-8 Longitudinal Profile and Stream Flow Capacity (Ban Bung River)

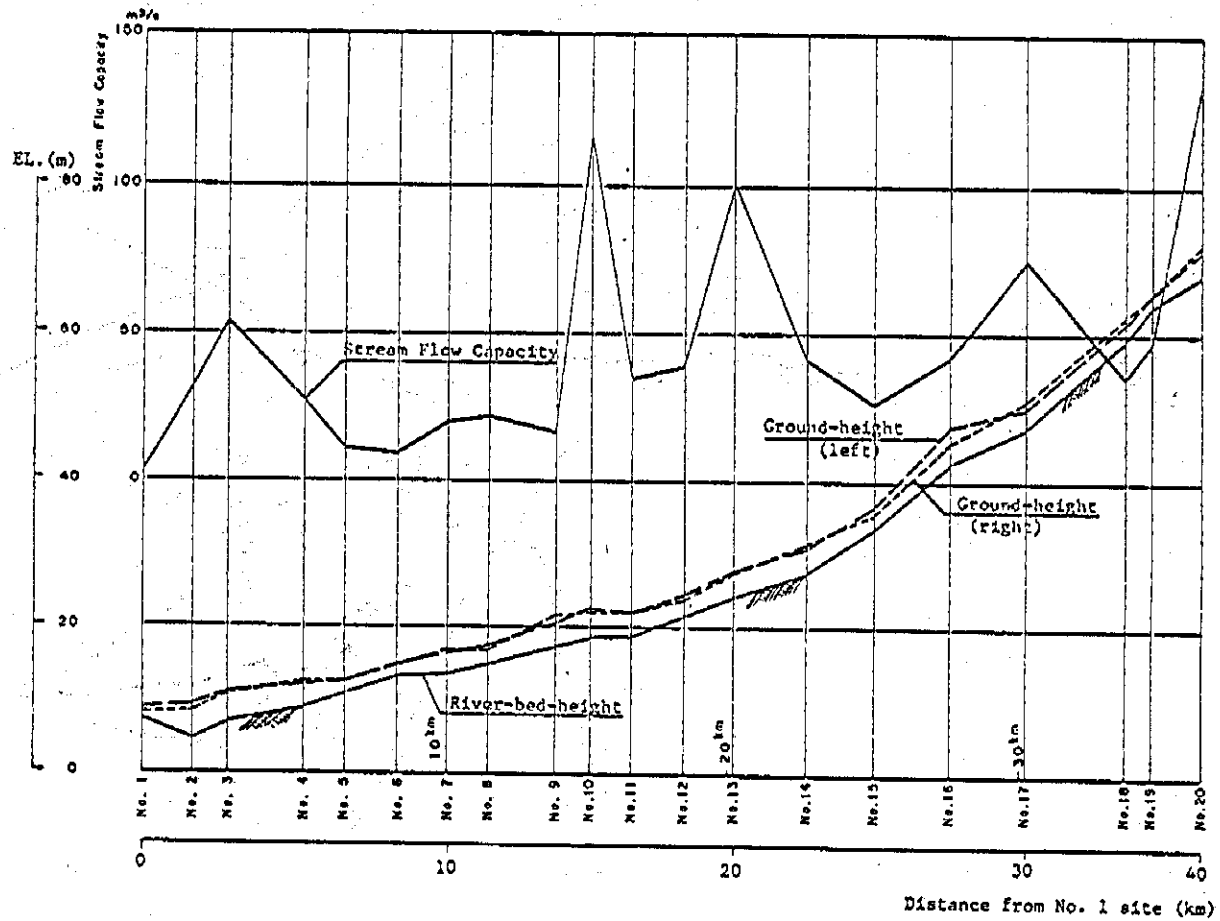


Fig. 2-9 Land Use Map

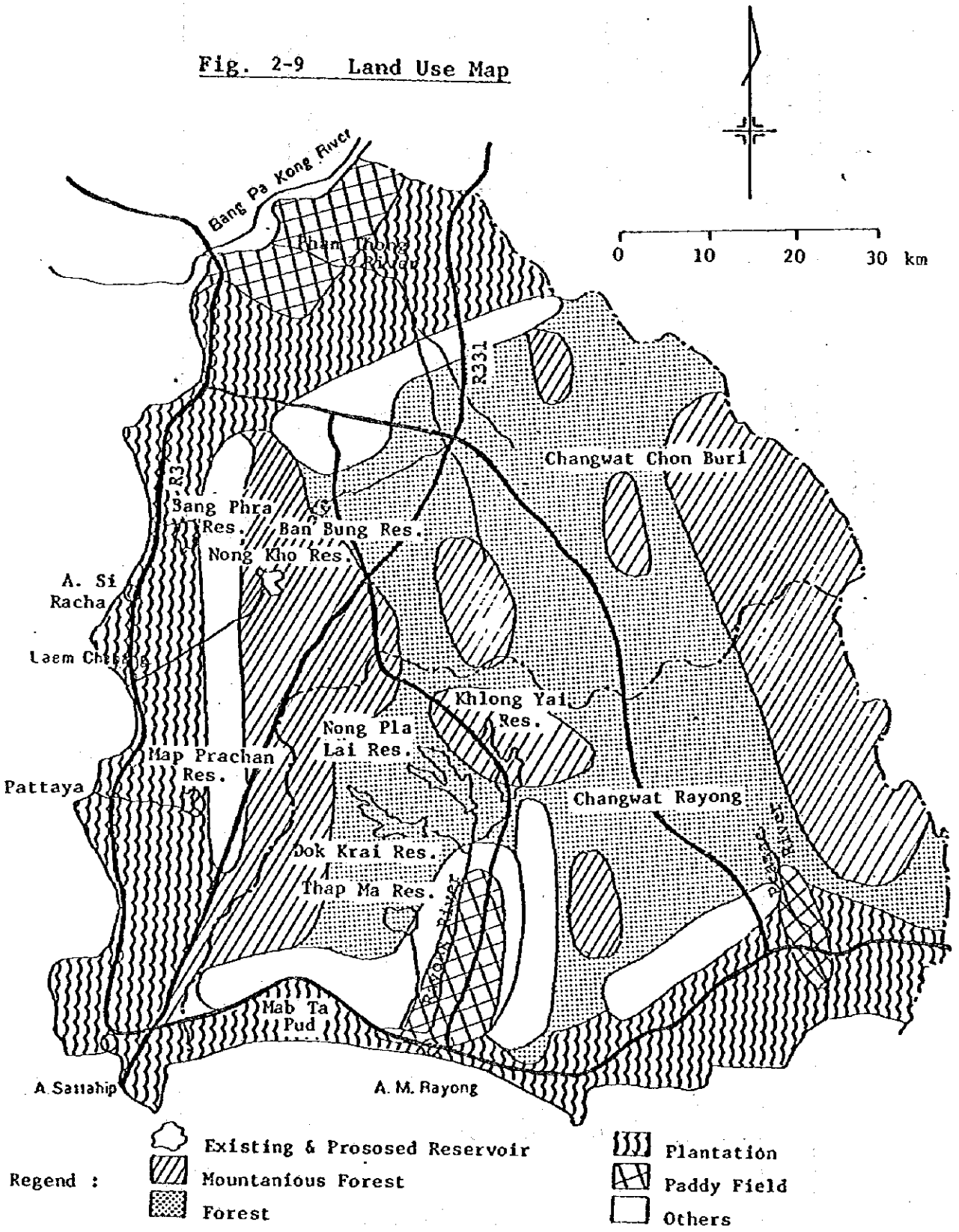


Fig. 3-1 Proposed Cropping Pattern

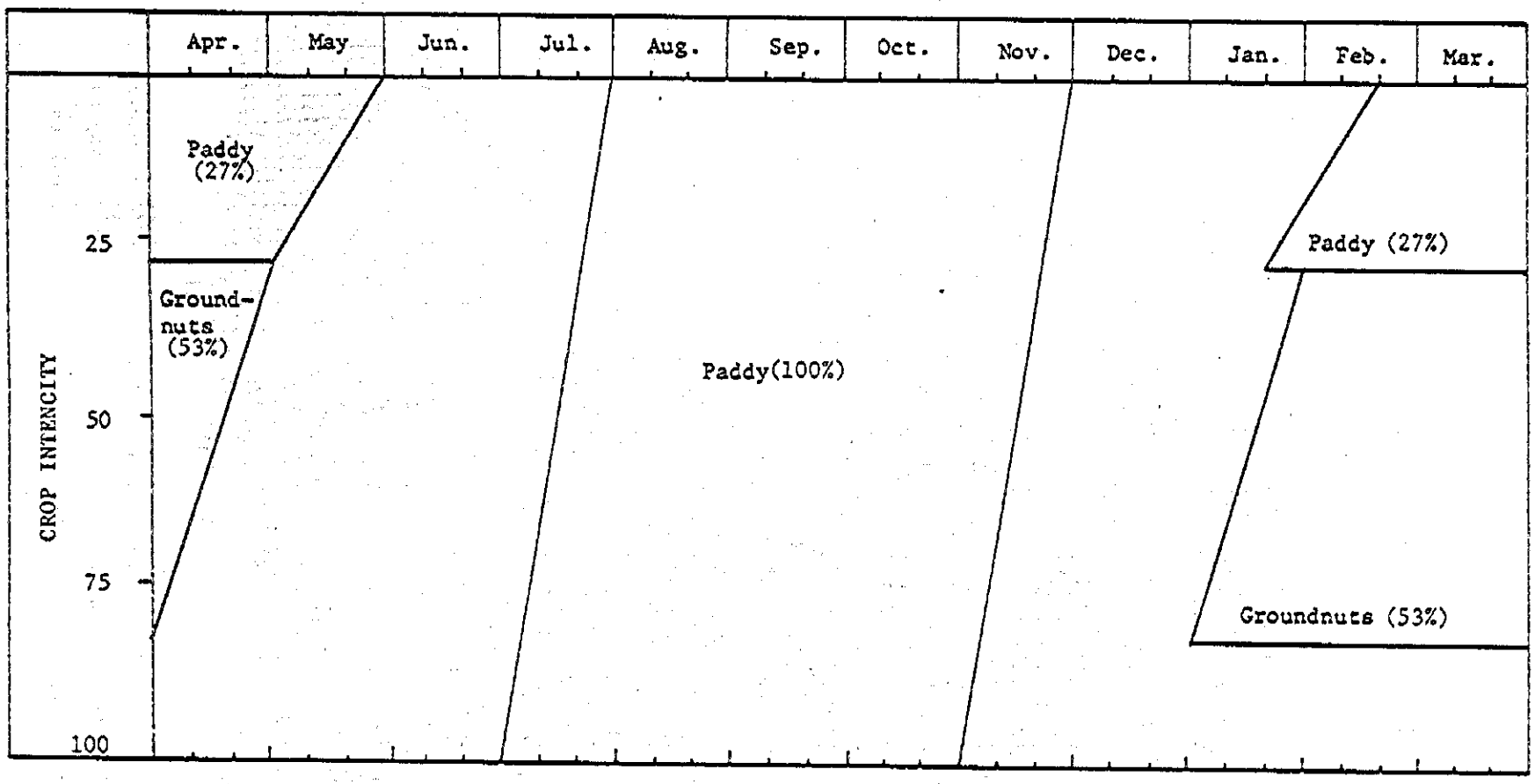


Fig. 3-2 Industrial & Municipal Water Demand

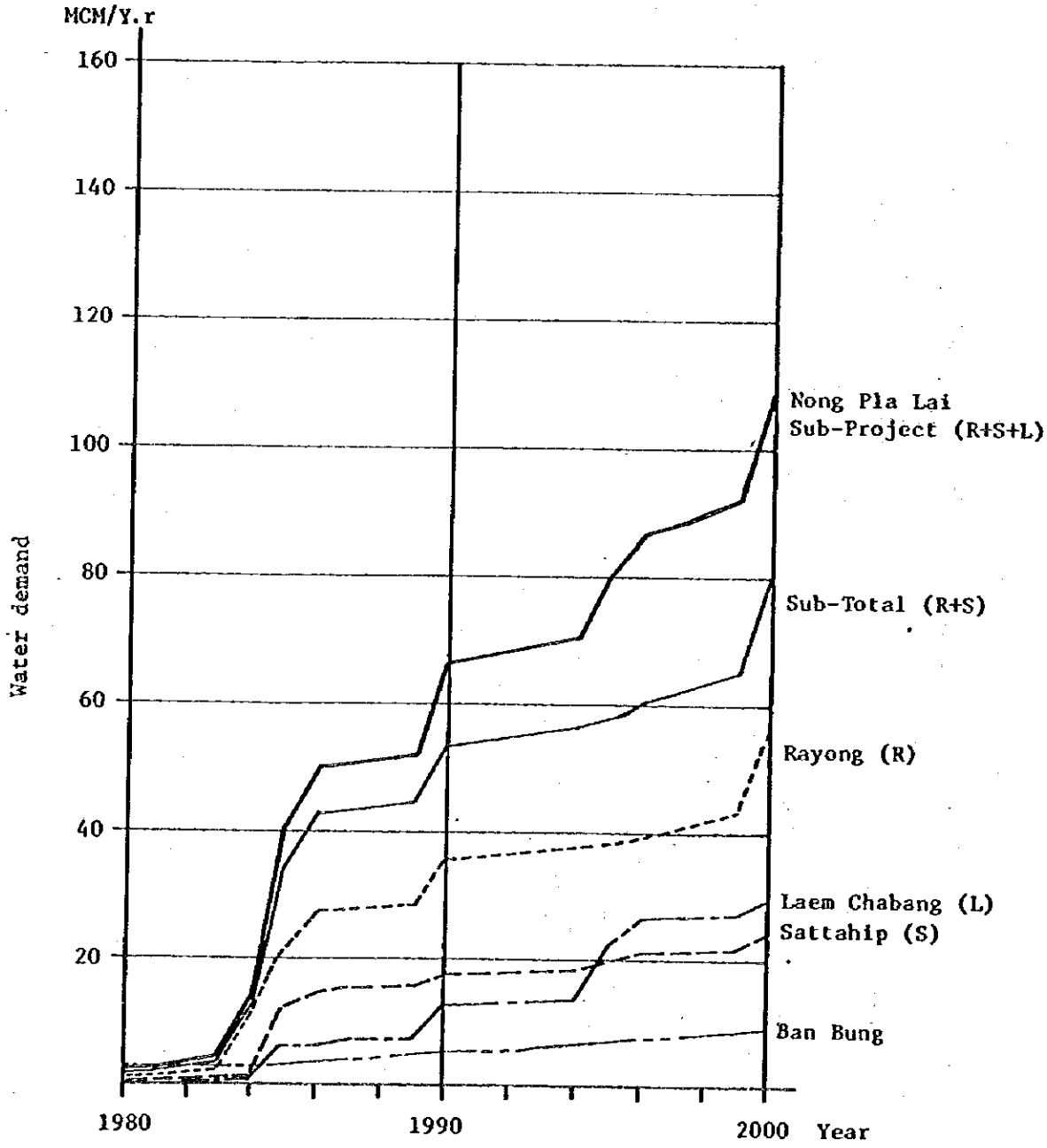


Fig 3-3 Location of Existing and Proposed Reservoir

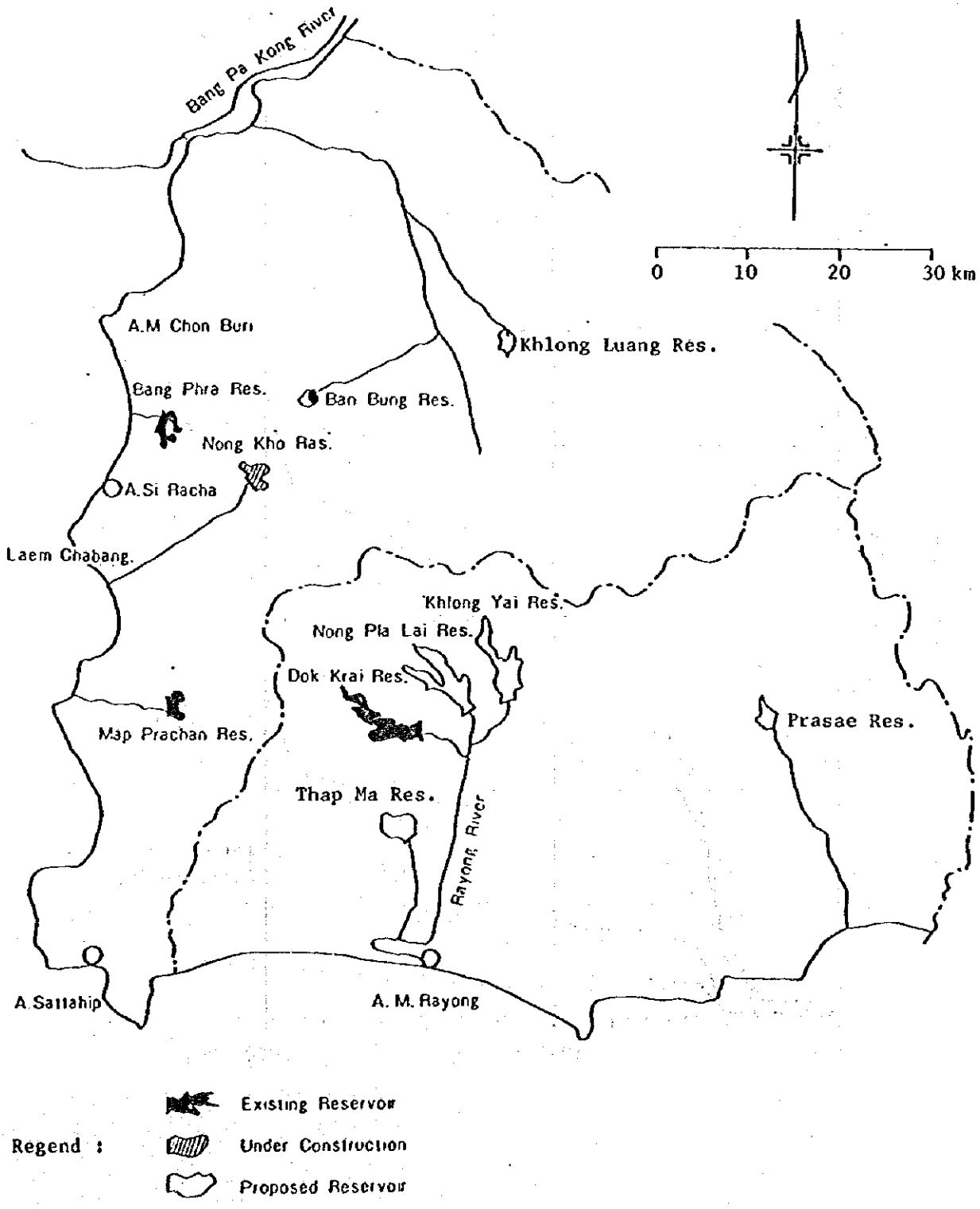


Fig. 3-4 Water Supply and Demand

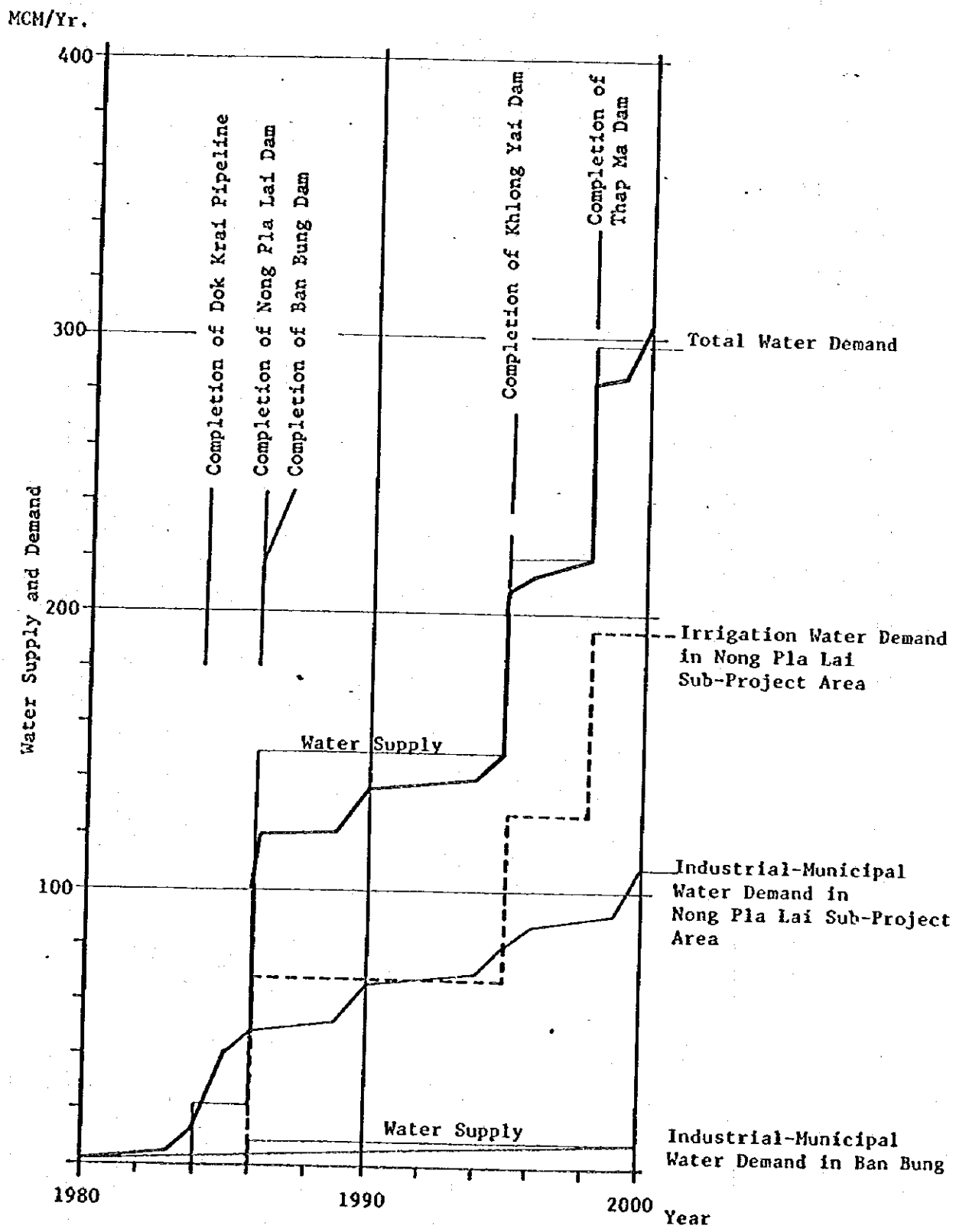


Fig. 4-1 Water Balance in Dok Krai Reservoir (First Stage)

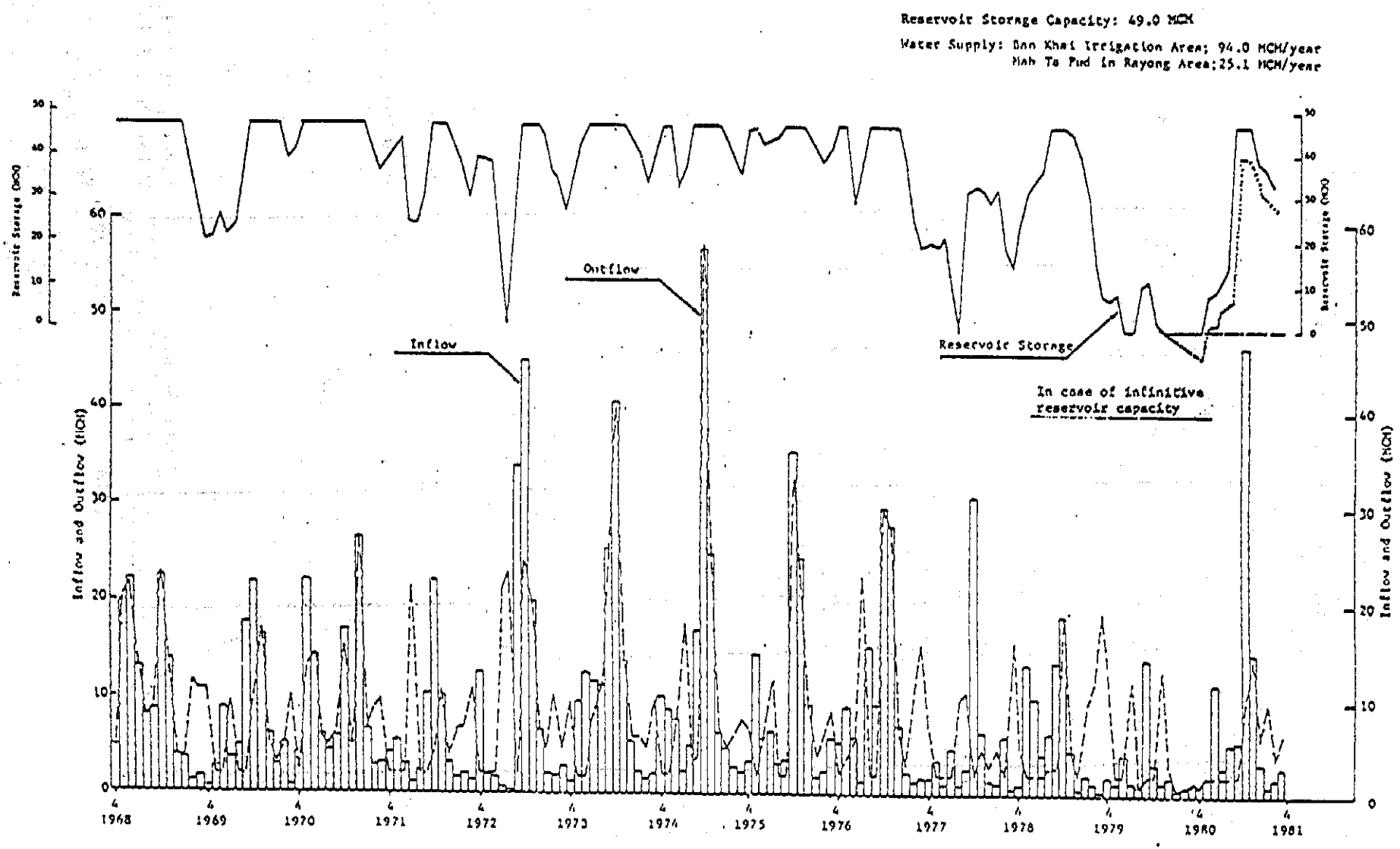


Fig. 4-2 Water Balance in Dok Krai Reservoir (Second Stage)

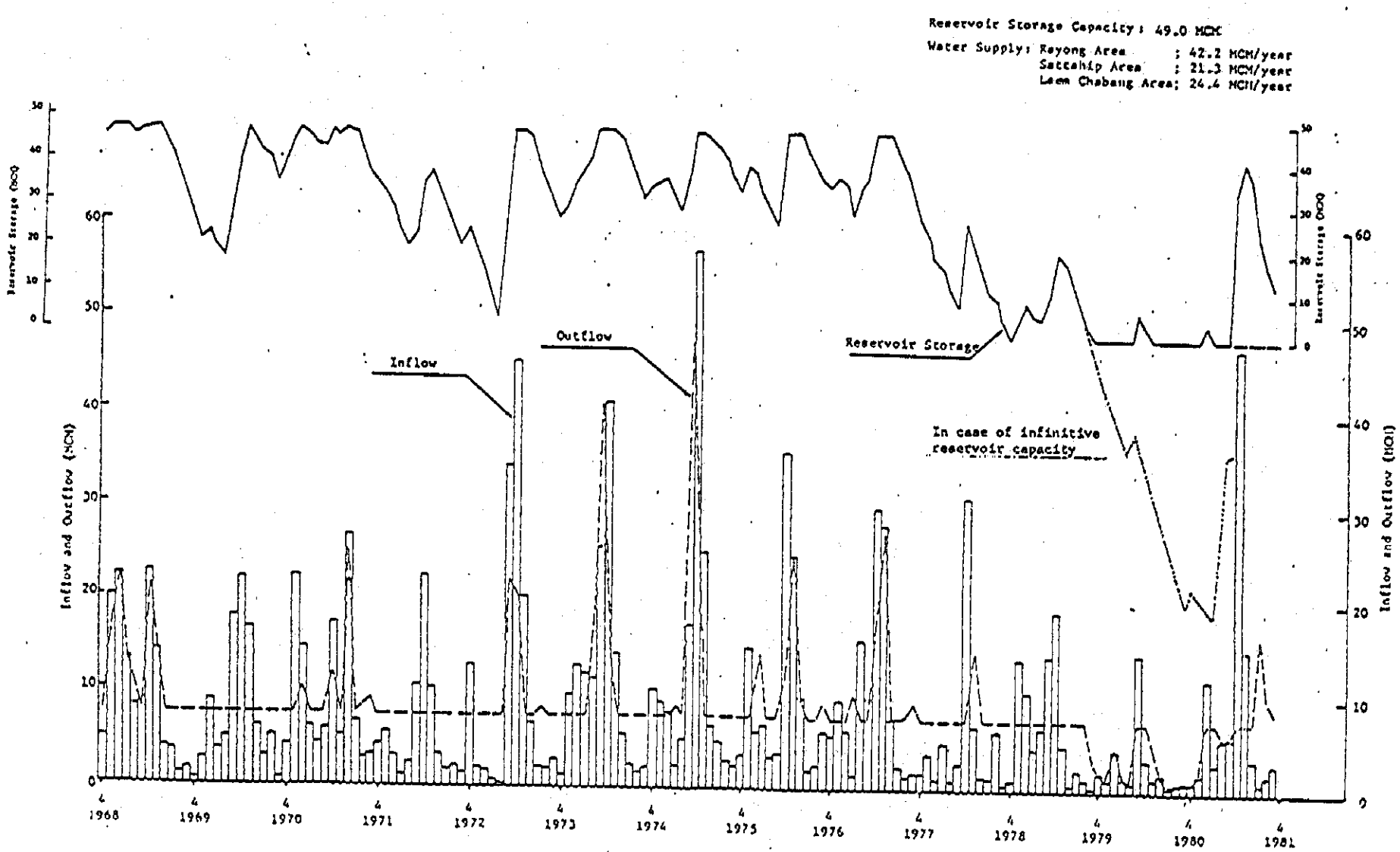


Fig. 4-3 Water Balance in Nong Pla Lai Reservoir

Reservoir Storage Capacity: 144.4 MCM

Water Supply: Ban Khai Irrigation Area ; 94.0 MCM/year
Nong Pla Lai Irrigation Area; 71.5 MCM/year

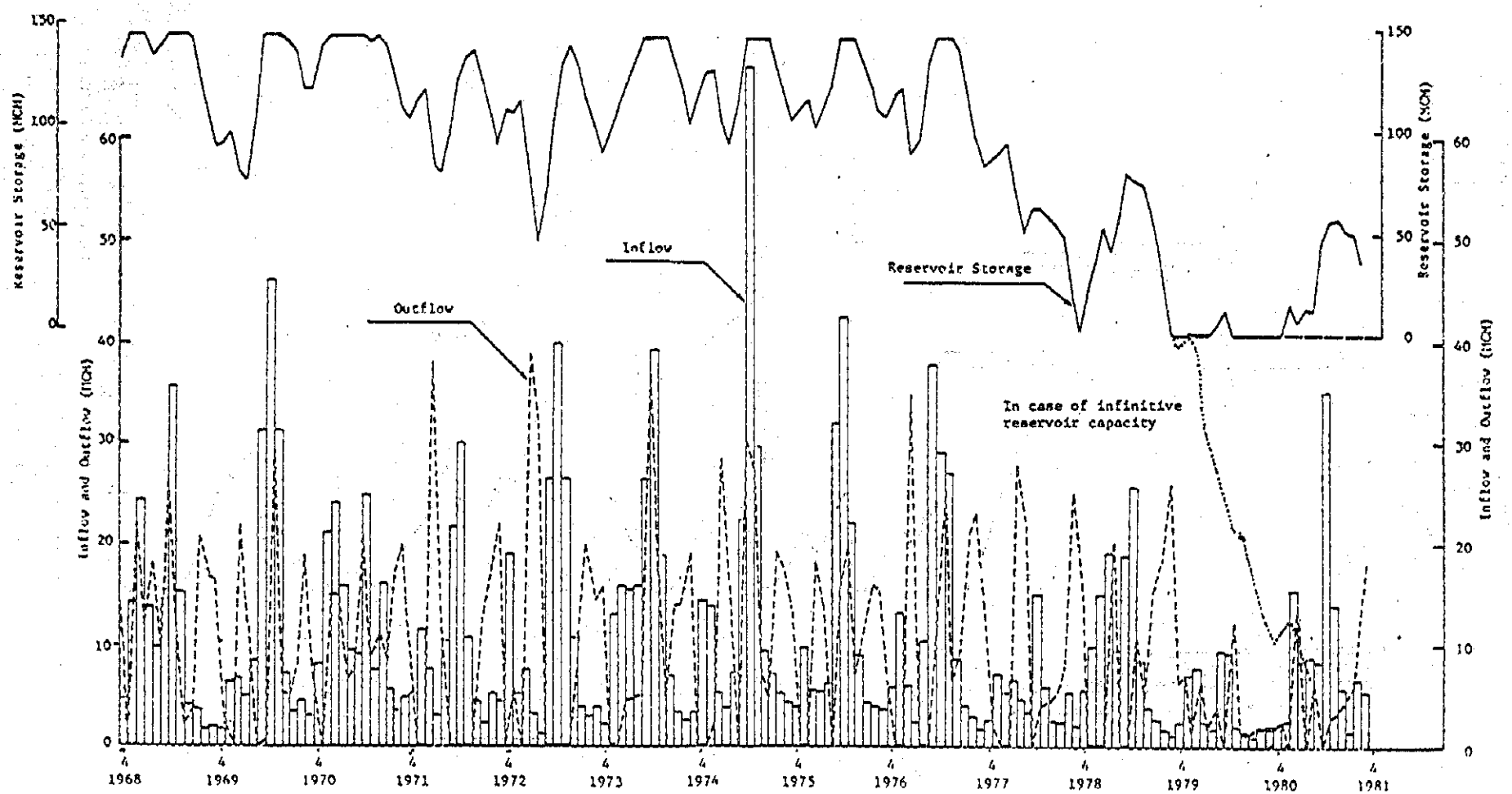
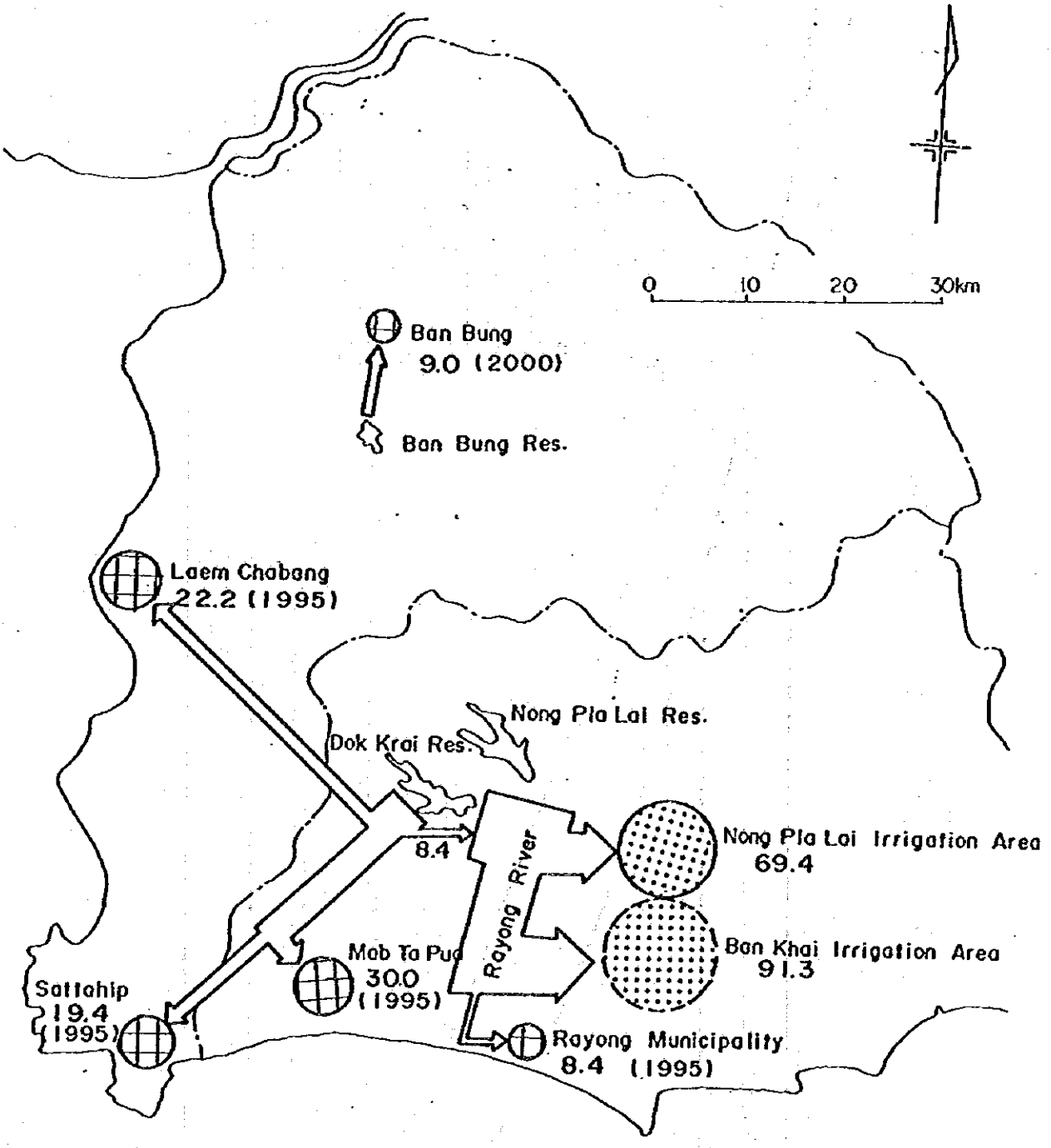


Fig. 4-4 Water Supply by Dok Krai, Nong Pla Lai and Ban Bung Reservoirs

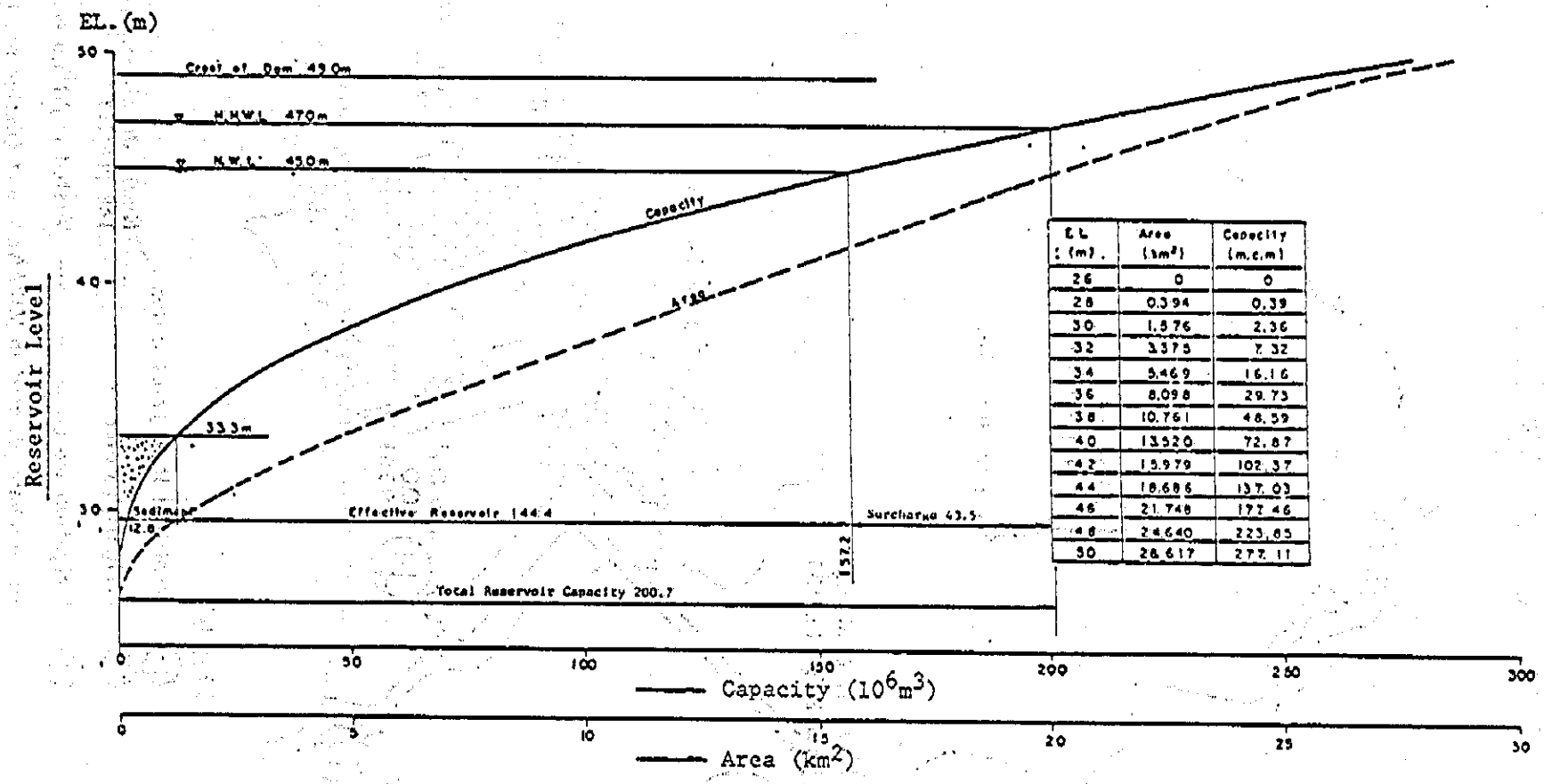


LEGEND

- Municipal-industrial water.
- Irrigation water. — Newly developed water by the project.
- Irrigation water. — Vested right water.

Figure is water demand in MCM/year and (Design Year)

Fig. 4-5 Storage Capacity Curves of Nong Pla Lai Reservoir



EL. (m)	Area (km^2)	Capacity (m.c.m)
26	0	0
28	0.394	0.39
30	1.576	2.36
32	3.375	7.32
34	5.469	16.16
36	8.098	29.73
38	10.761	48.59
40	13.520	72.87
42	15.979	102.37
44	18.686	137.03
46	21.748	177.46
48	24.640	223.65
50	28.617	277.11

Fig. 4-6 General Plan of Water Transmission System

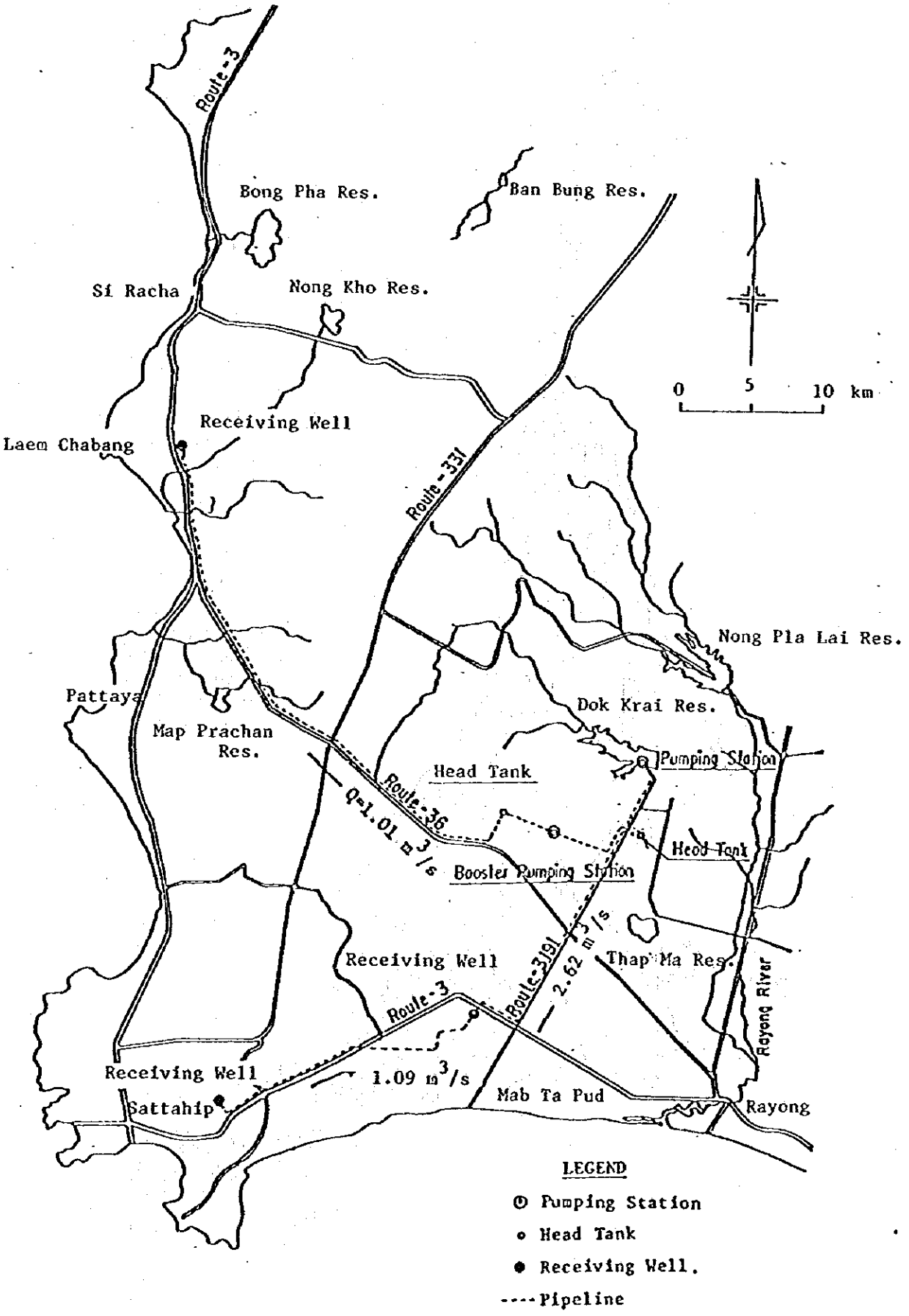


Fig. 4-7 General Plan of Irrigation and Drainage System

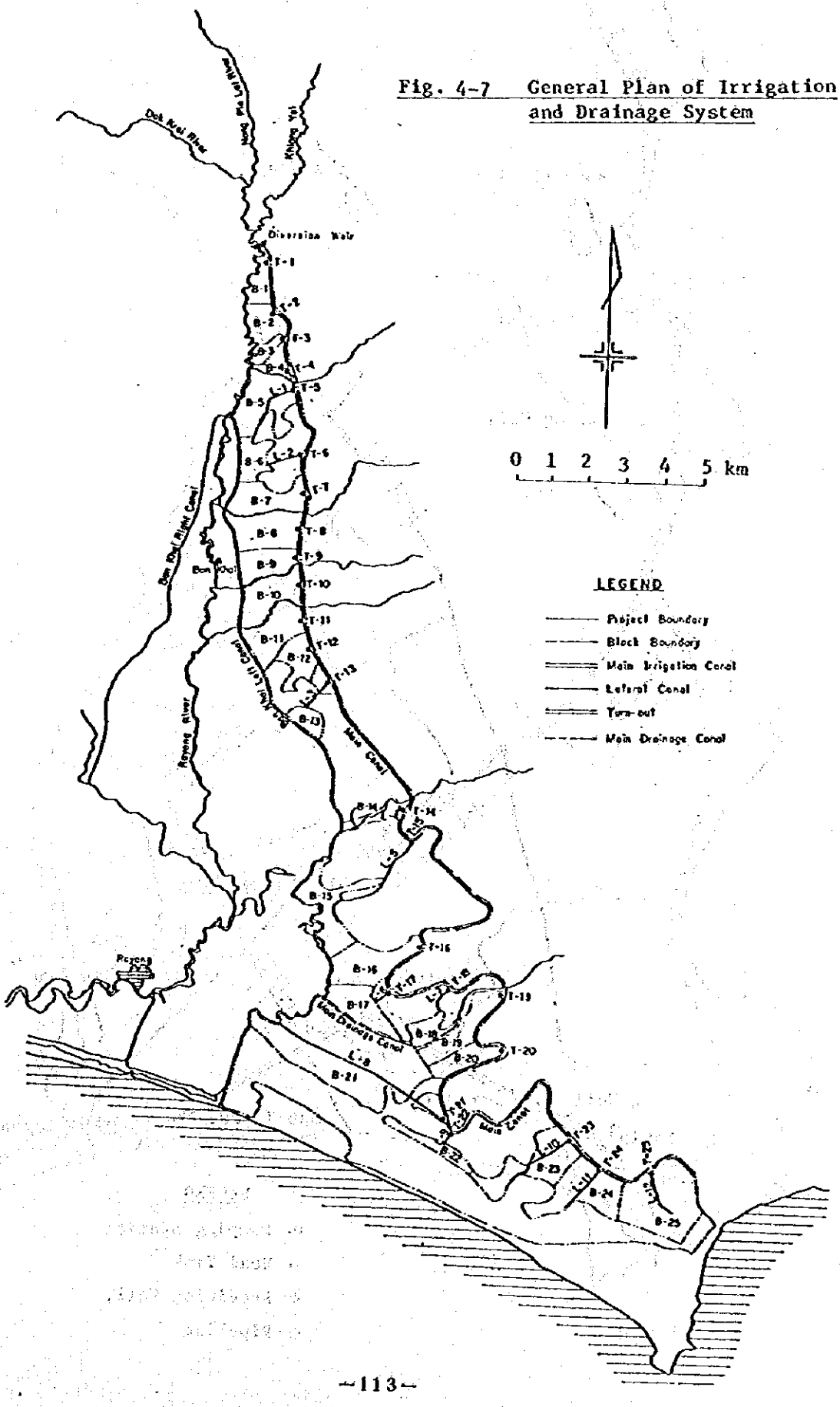


Fig. 4-8 Water Balance in Ban Bung Reservoir

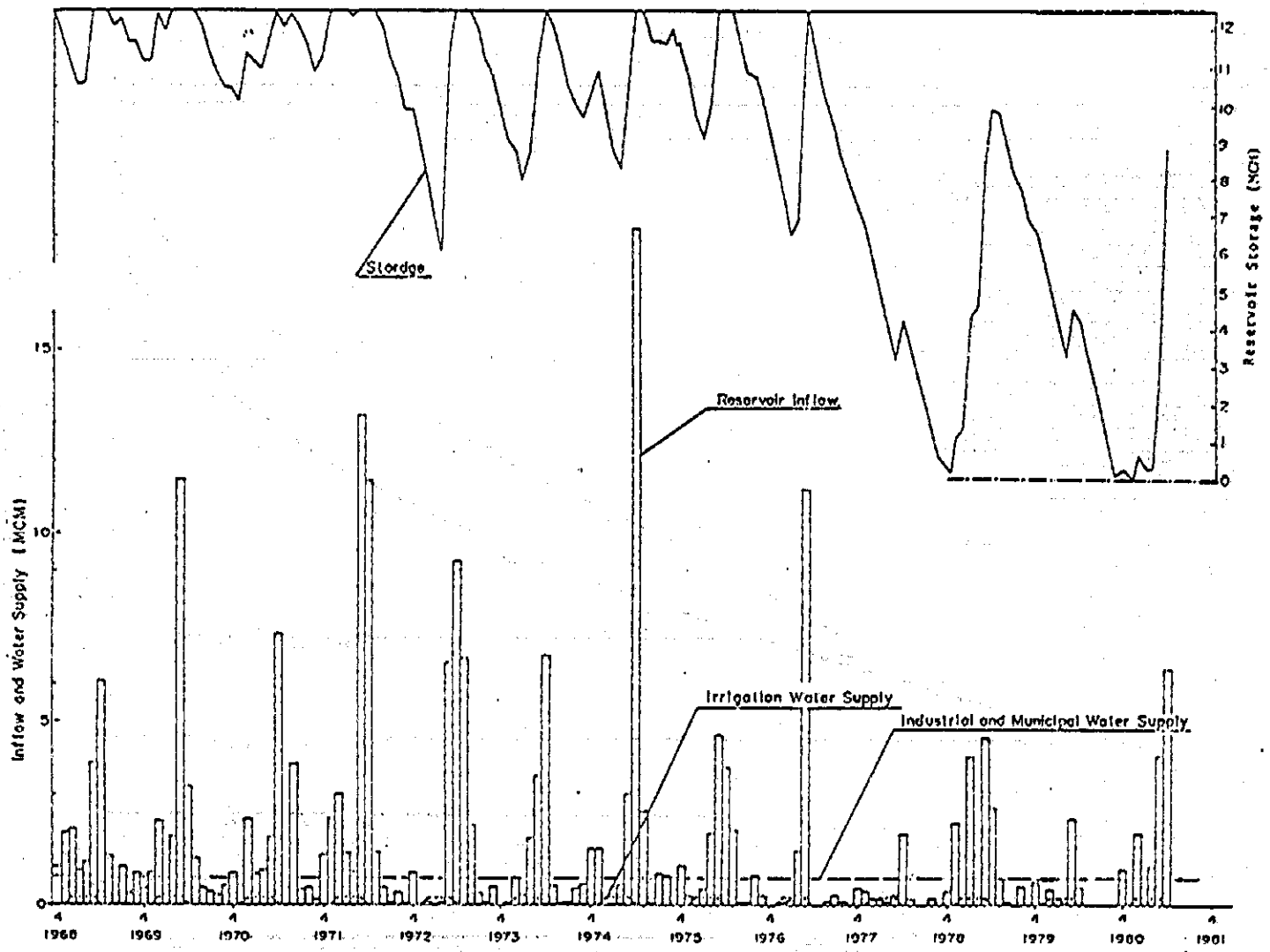
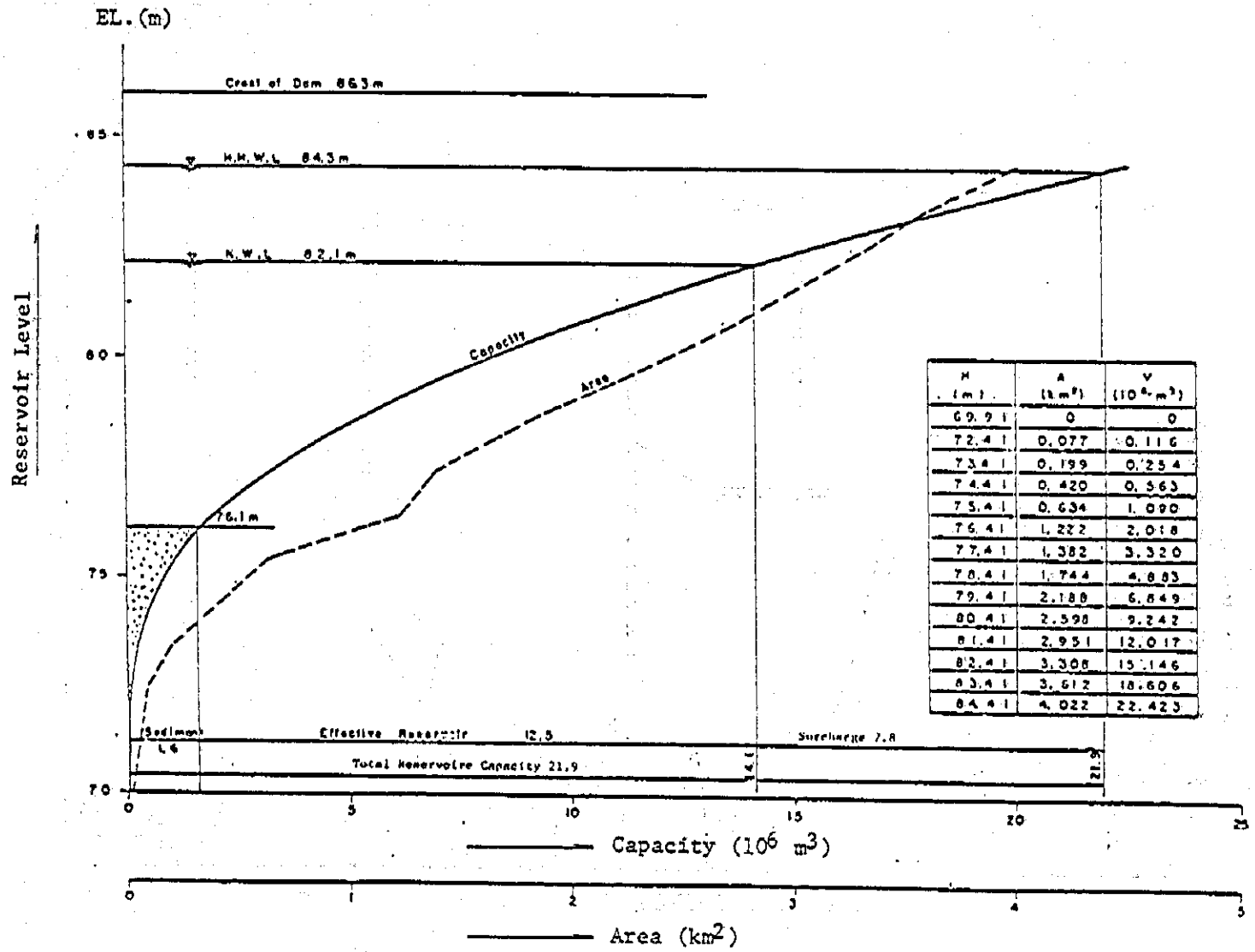


Fig. 4-9 Storage Capacity Curve of Ban Bung Reservoir



H (m)	A (km^2)	V ($10^6 m^3$)
69.91	0	0
72.41	0.077	0.116
73.41	0.199	0.254
74.41	0.420	0.563
75.41	0.634	1.090
76.41	1.222	2.018
77.41	1.382	3.320
78.41	1.744	4.883
79.41	2.188	6.849
80.41	2.598	9.242
81.41	2.951	12.017
82.41	3.308	15.146
83.41	3.612	18.606
84.41	4.022	22.423

Fig. 5-1 Geological Map Of Nong Pla Lai Dam Axis

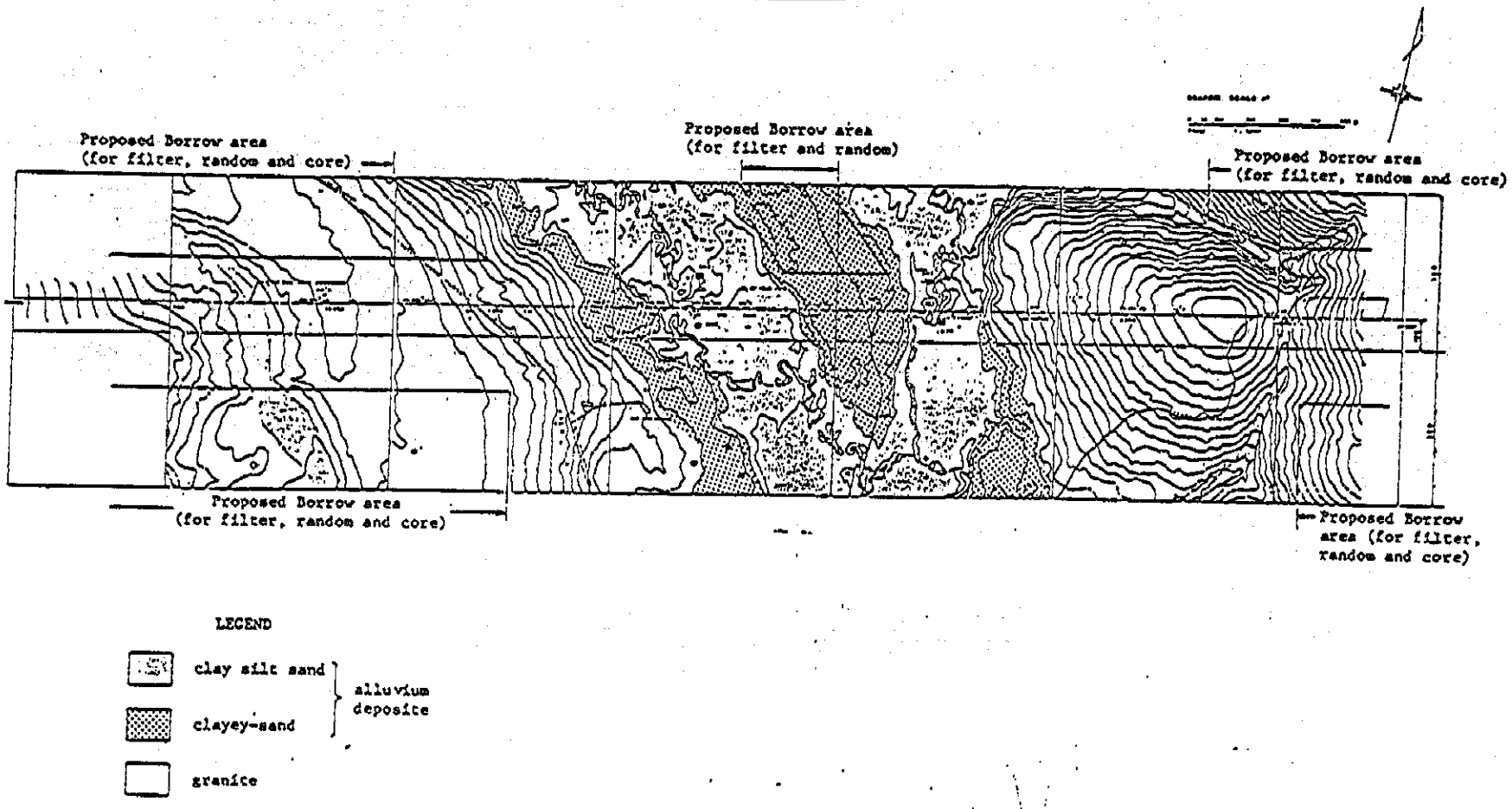


Fig. 5-2 General Plan of Nong Pla Lai Dam

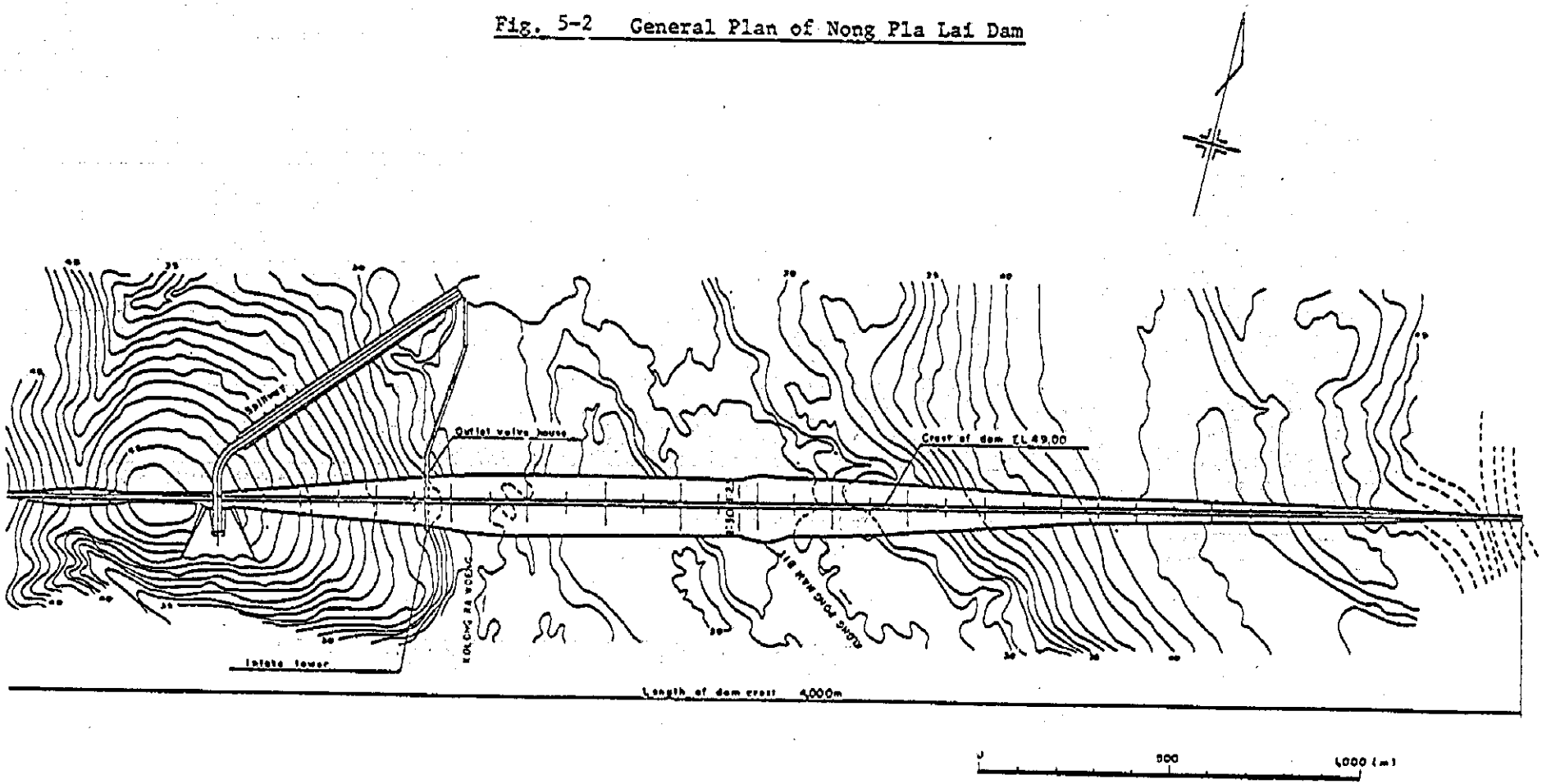


Fig. 5-3 Longitudinal Profile of Nong Pla Lai Dam

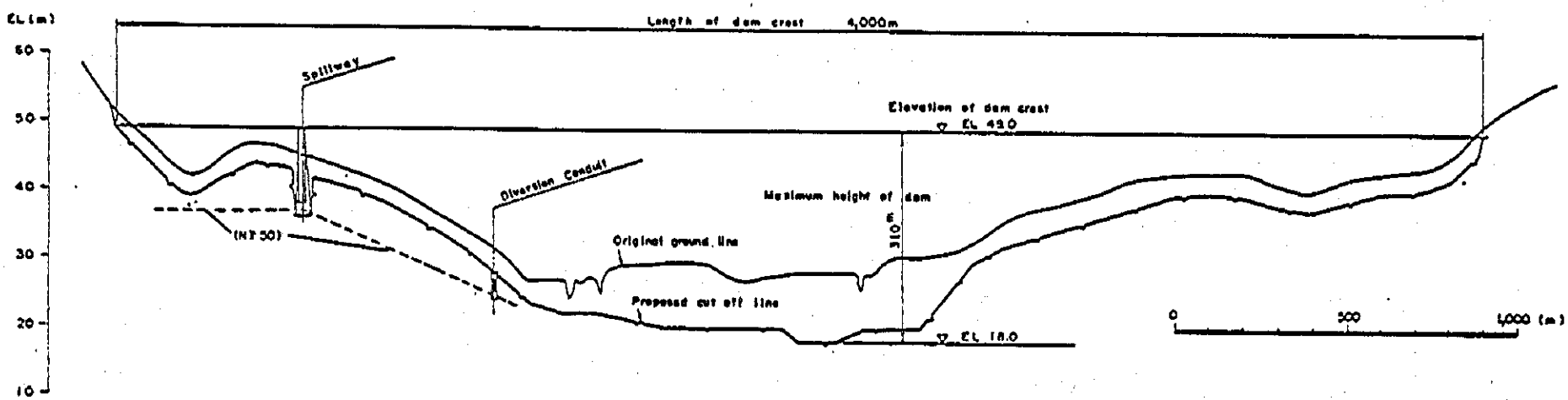


Fig. 5-4 Standard Cross-Section of Nong Pla Lai Dam

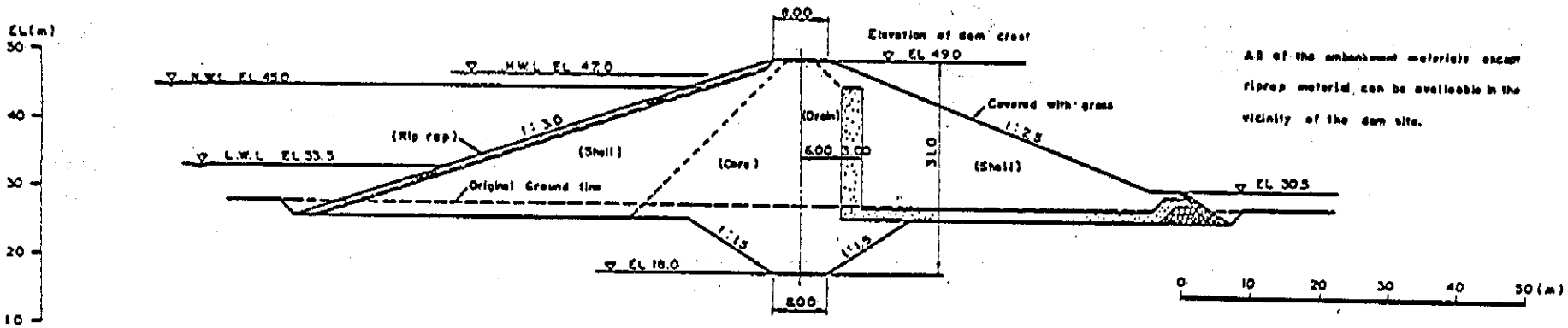


Fig. 5-5 Inflow and Outflow Hydrograph of Design Flood for Spillway

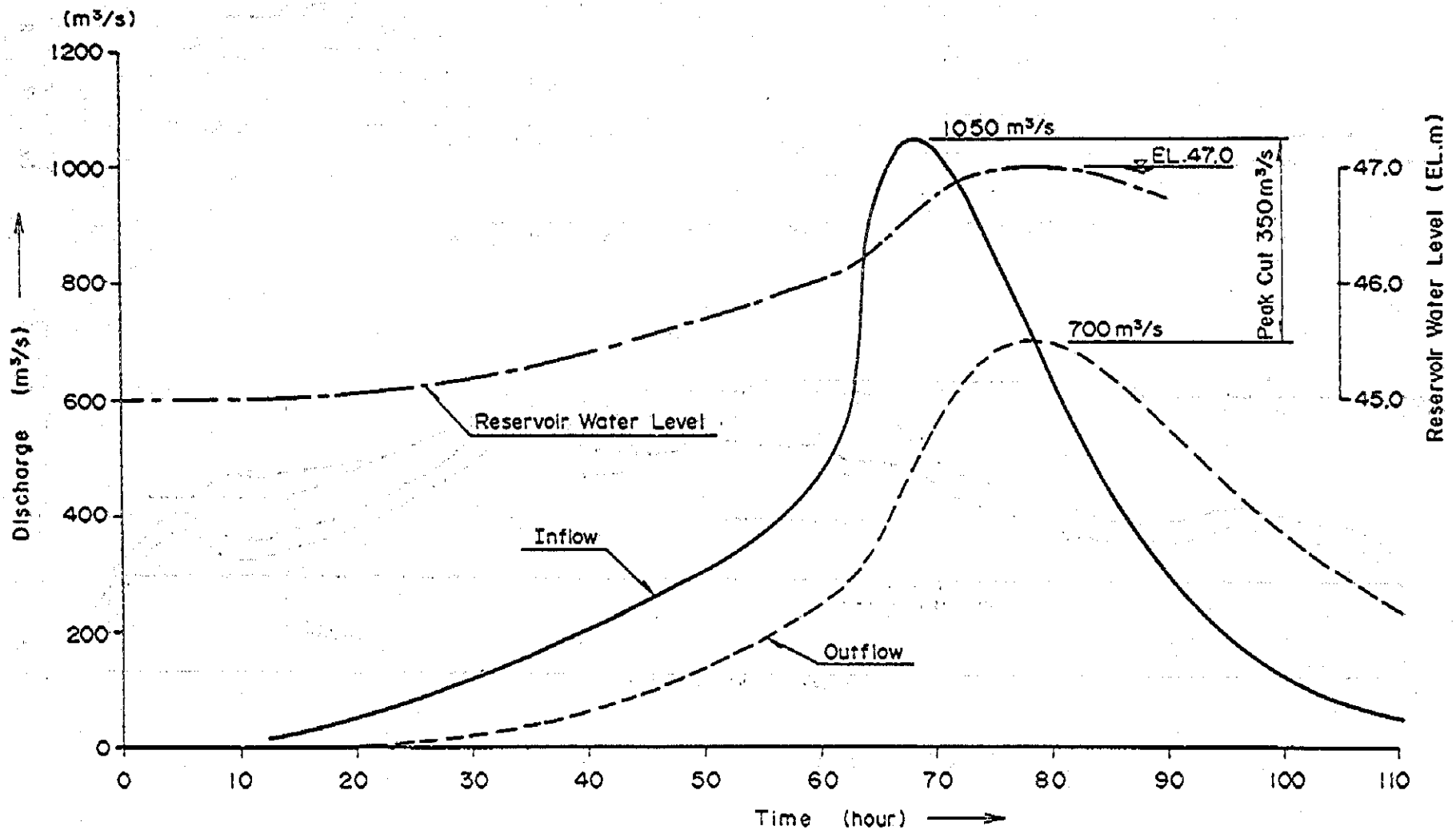


Fig. 5-6 Plan of Spillway of Nong Pla Lai Dam

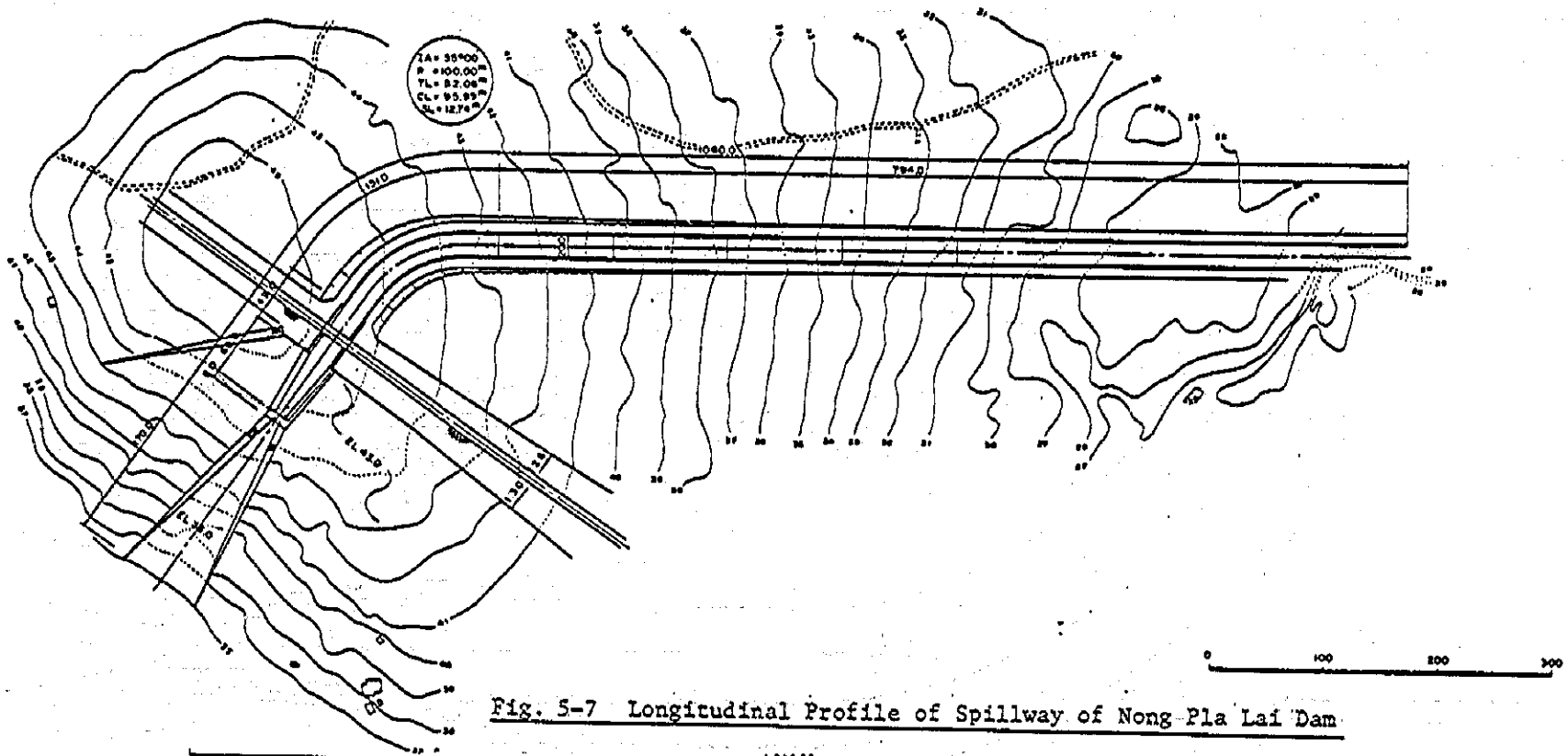


Fig. 5-7 Longitudinal Profile of Spillway of Nong Pla Lai Dam

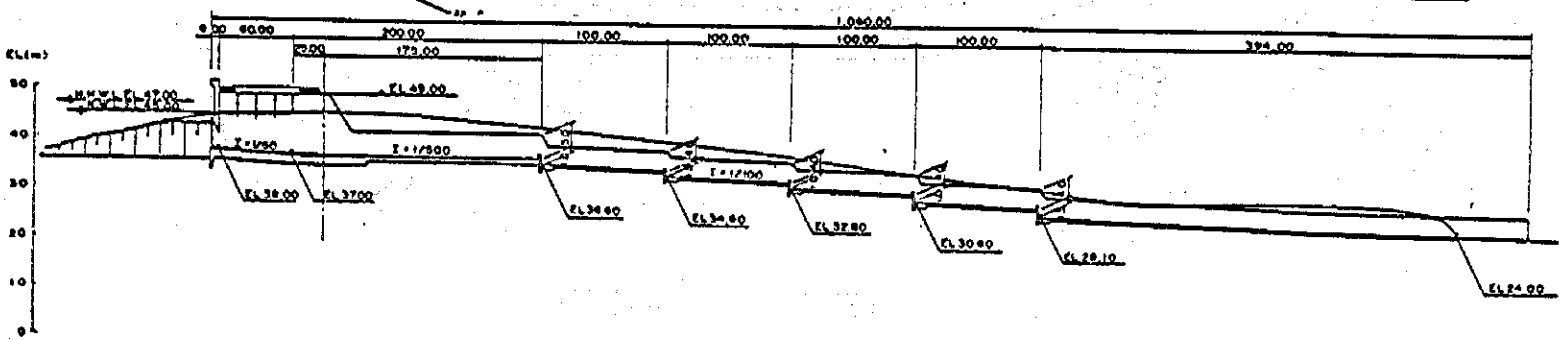


Fig. 5-8 Details of Spillway of Nong Pla Lai Dam

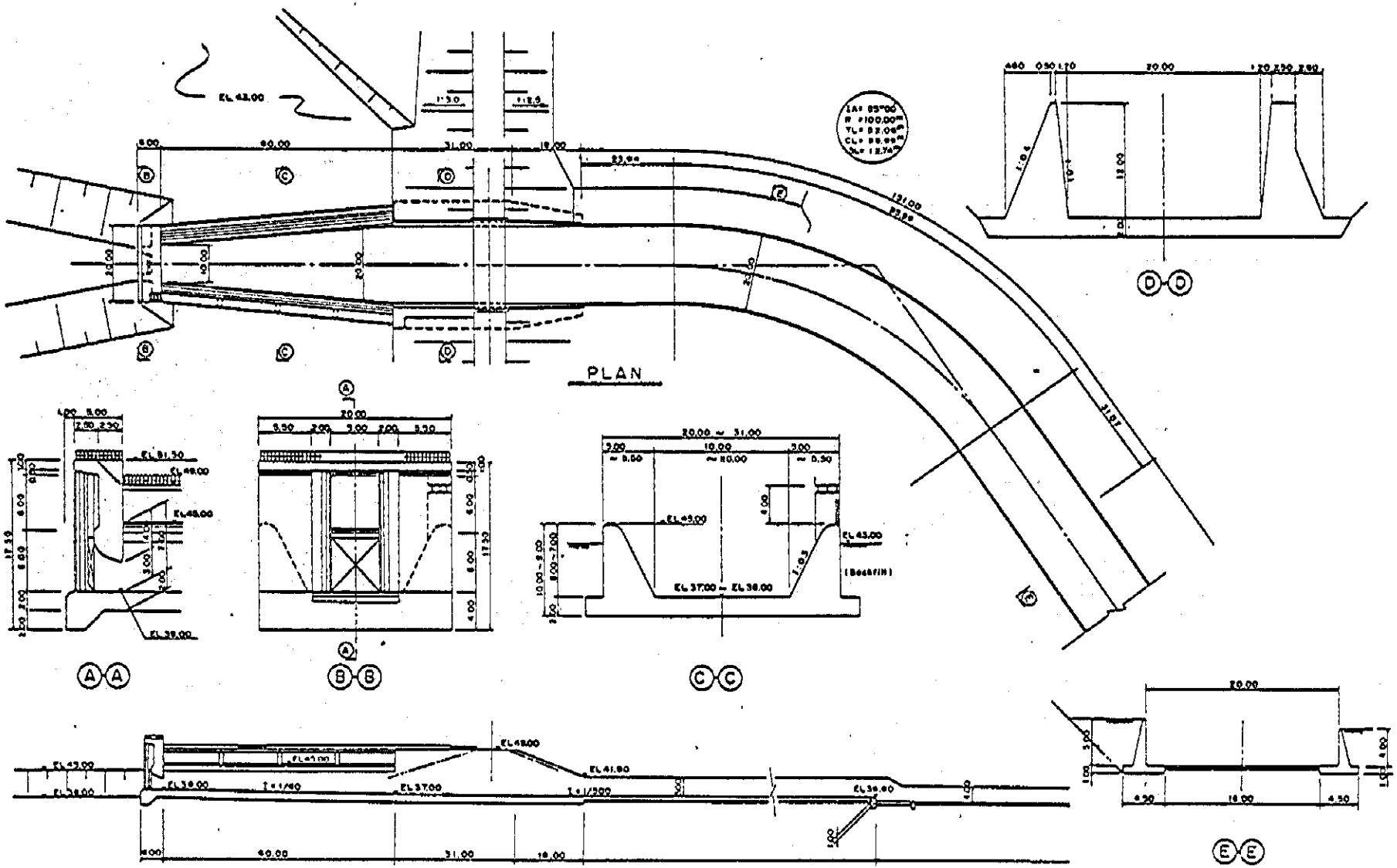


Fig. 5-9 Intake and Outlet Facilities of Nong Pla Lai Dam

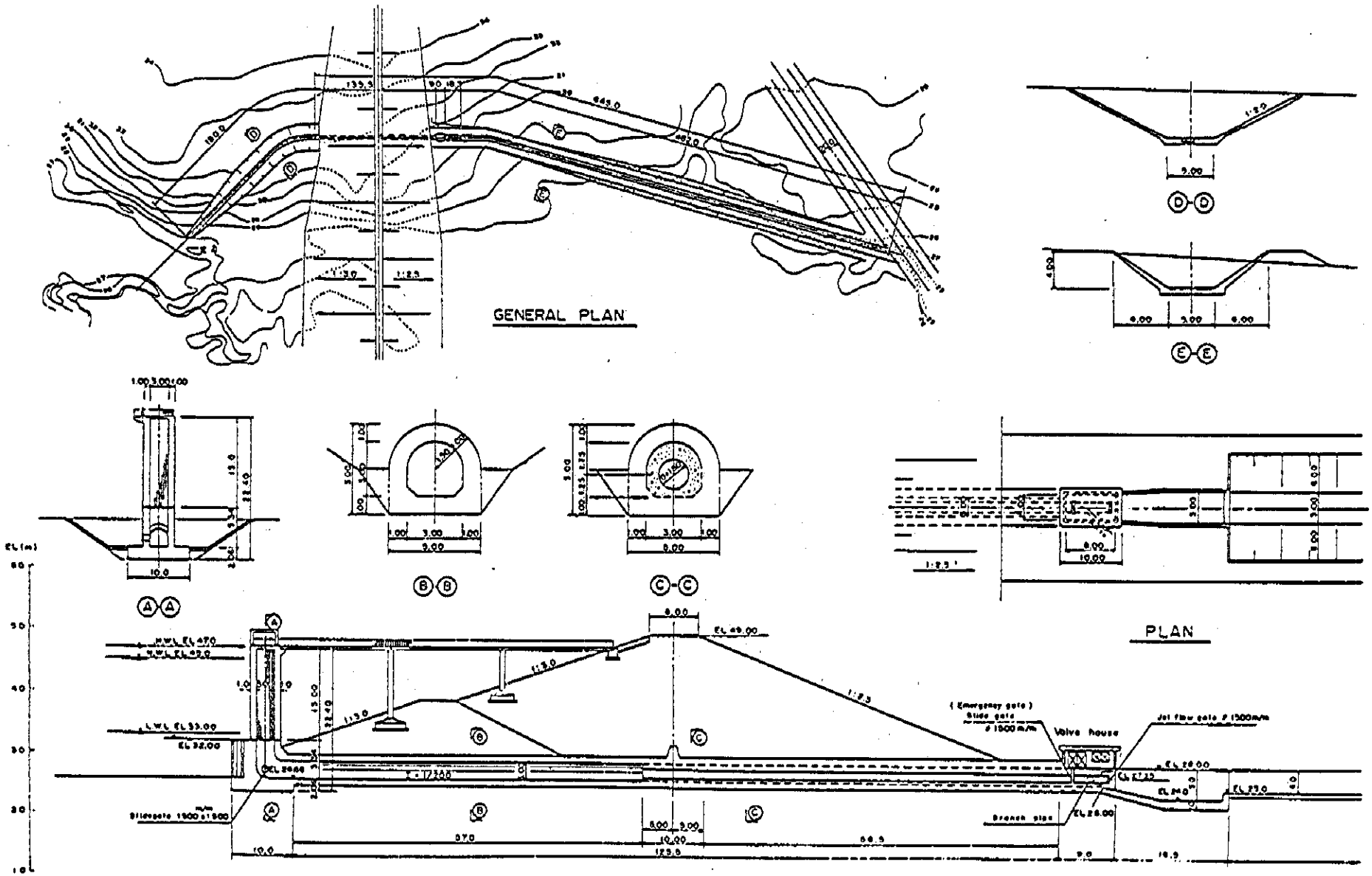


Fig. 5-10 Road Relocation

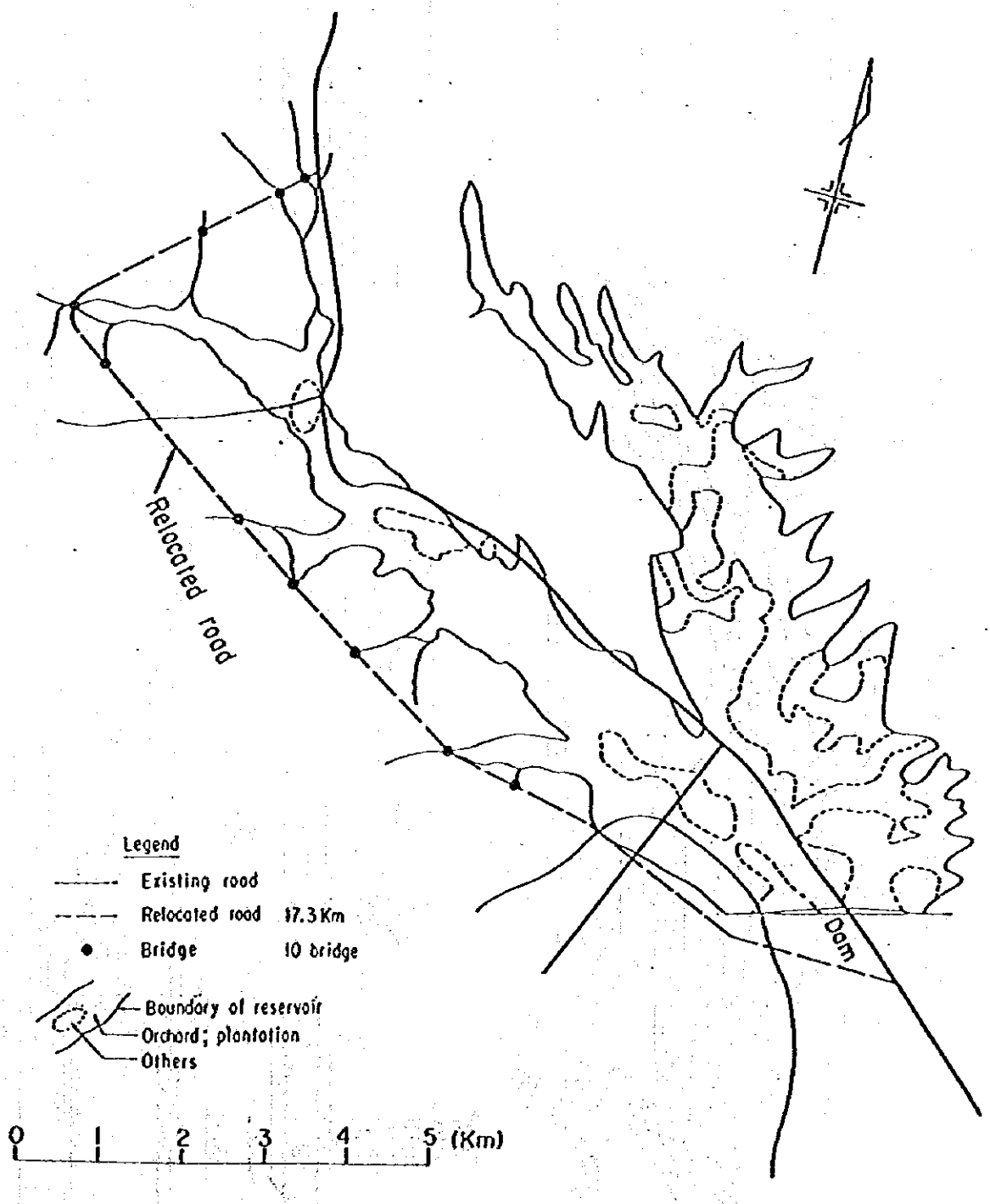


Fig. 5-11 Plan and Longitudinal Profile (Dok Krai Dam to Mab Ta Pud)

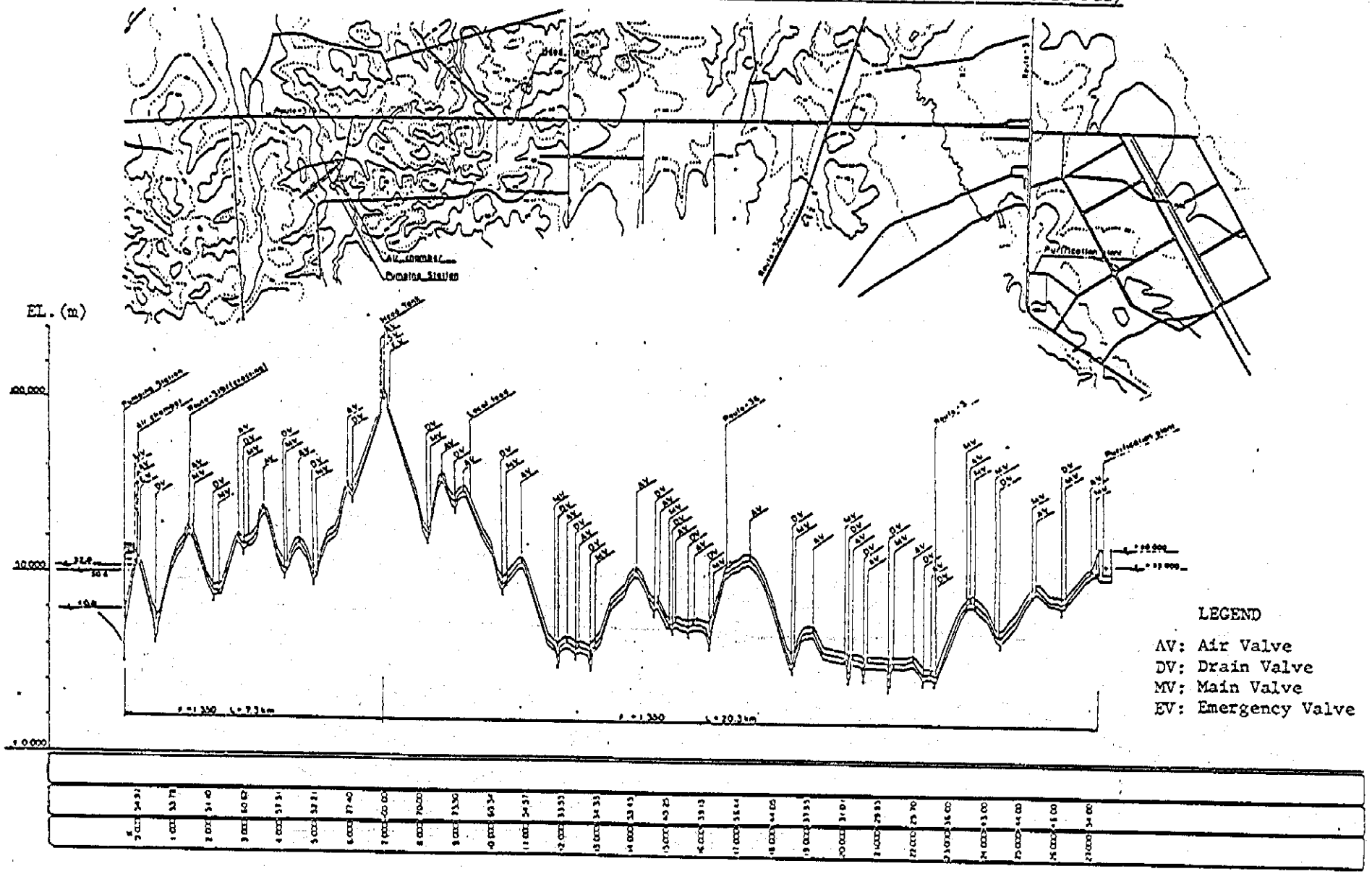


Fig. 5-12 Plan and Longitudinal Profile (Mab Ta Pud to Sattahip)

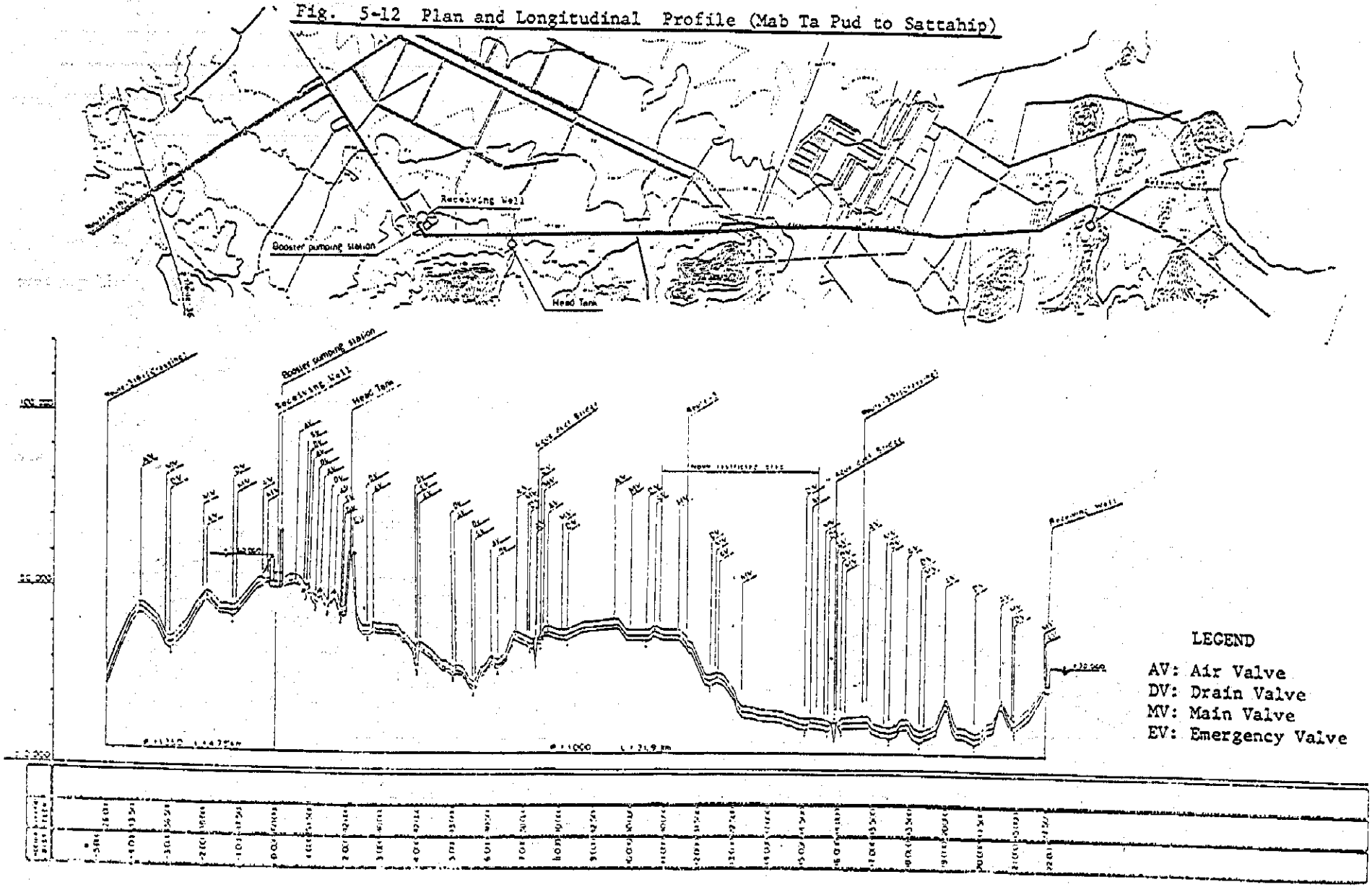


Fig. 5-13 Plan and Longitudinal Profile (Dok Krai Dam to Laem Chabang)

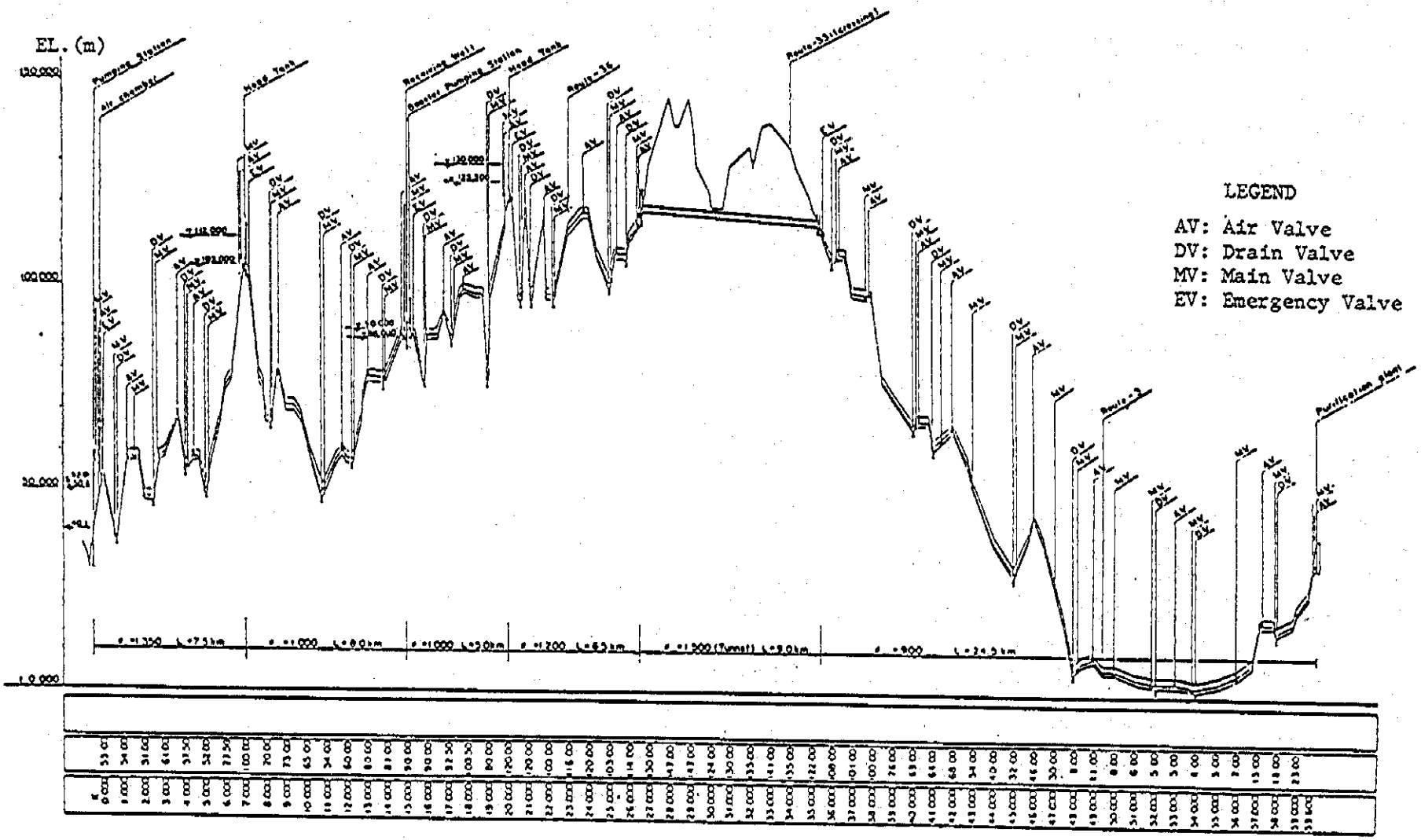


Fig. 5-14 Location Map of Pumping Station and Transmission Pipe

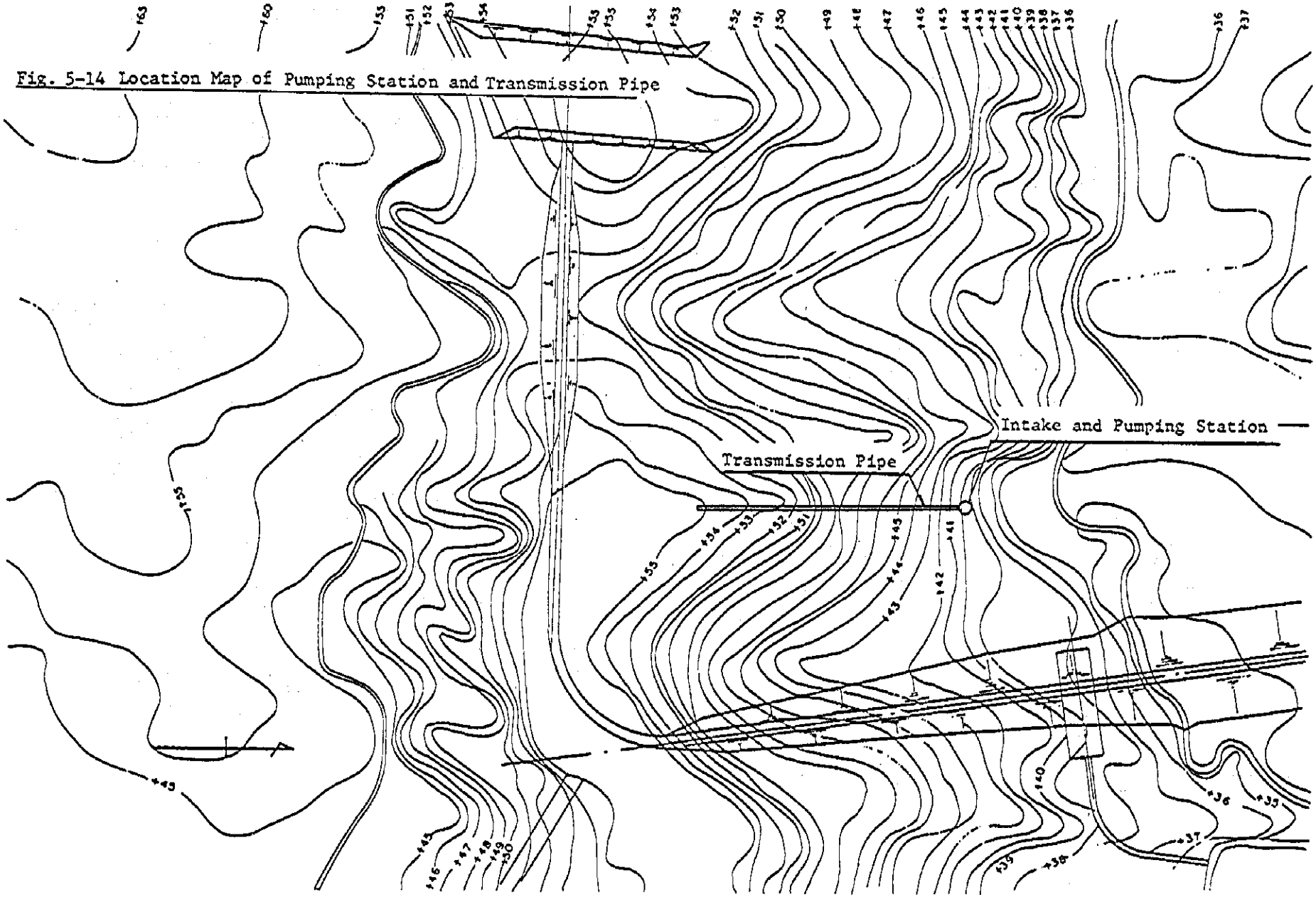


Fig. 5-15 Profile of Pumping Station and Transmission Pipe

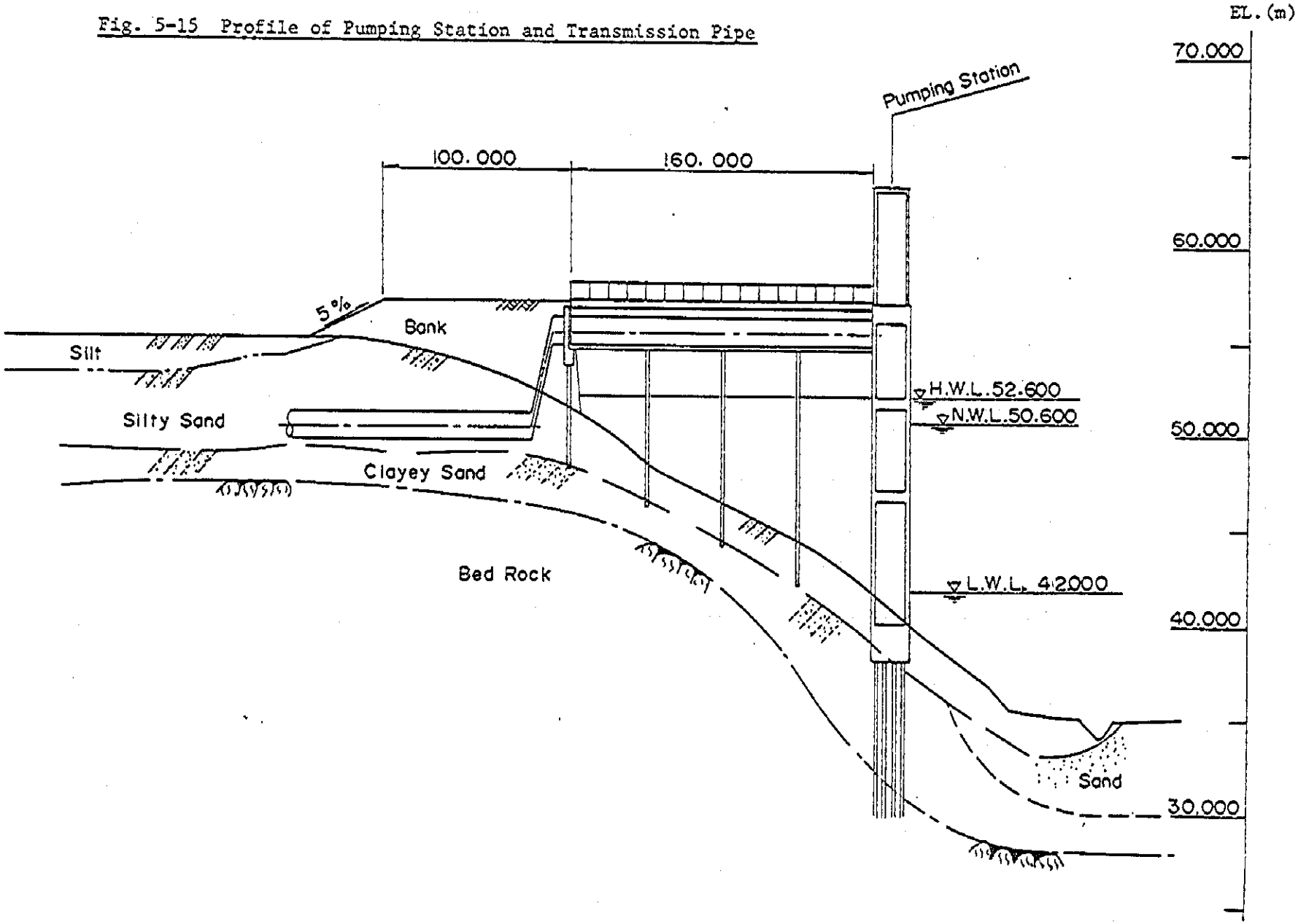


Fig. 5-16 General Plan of Pumping Station

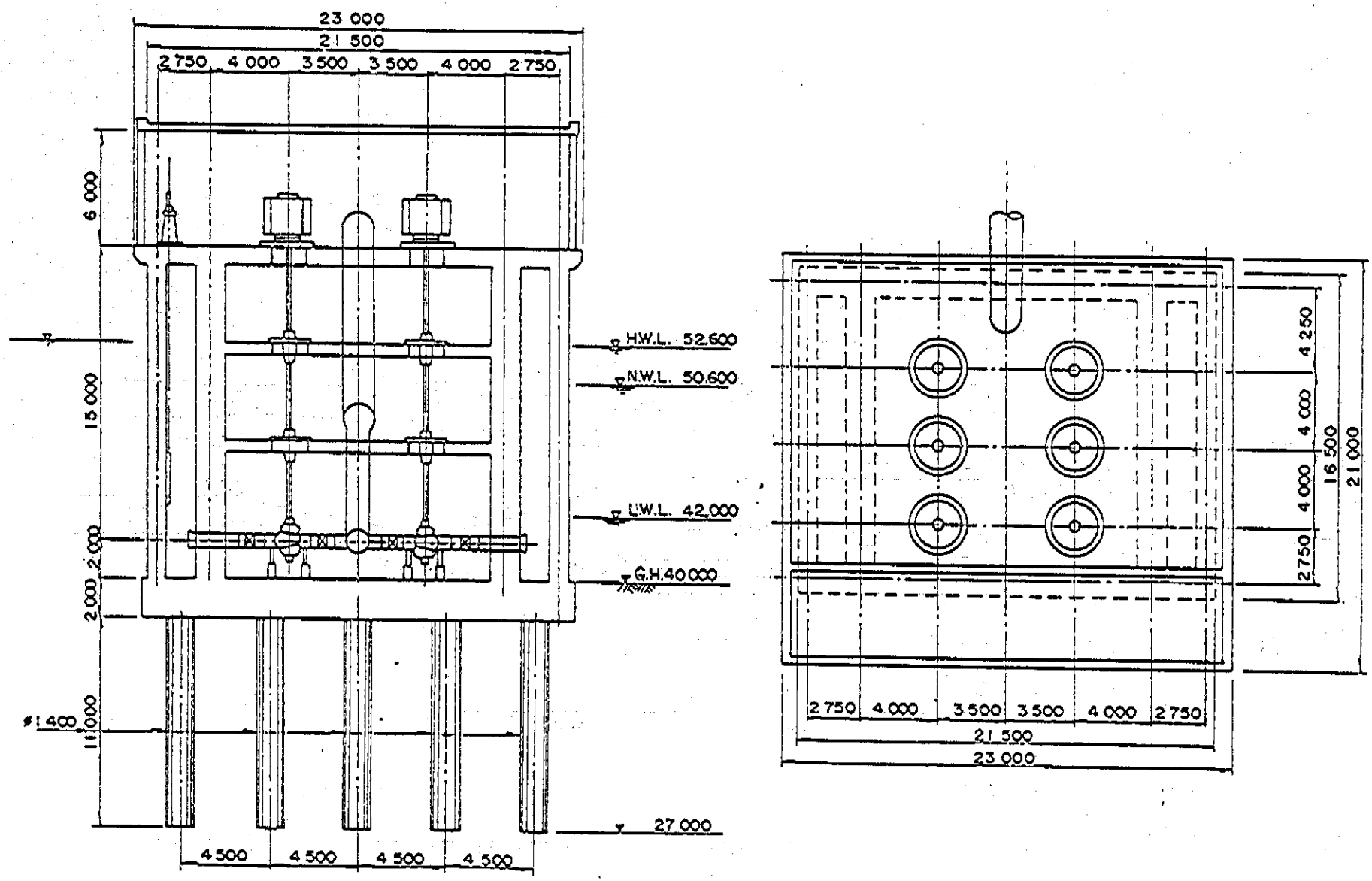


Fig. 5-17 General Plan of Air Chamber

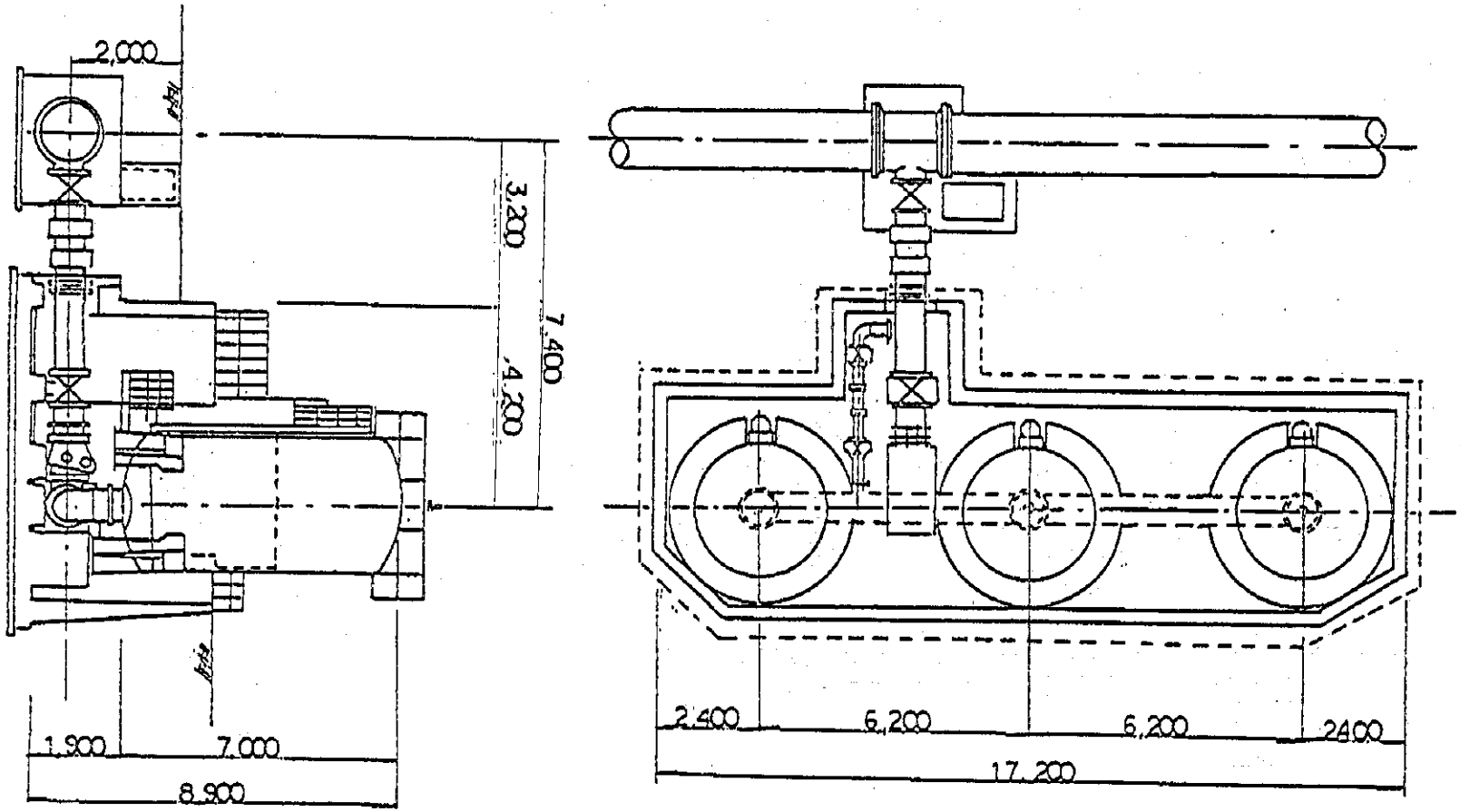


Fig. 5-18 Standard Dimension of Head Tank

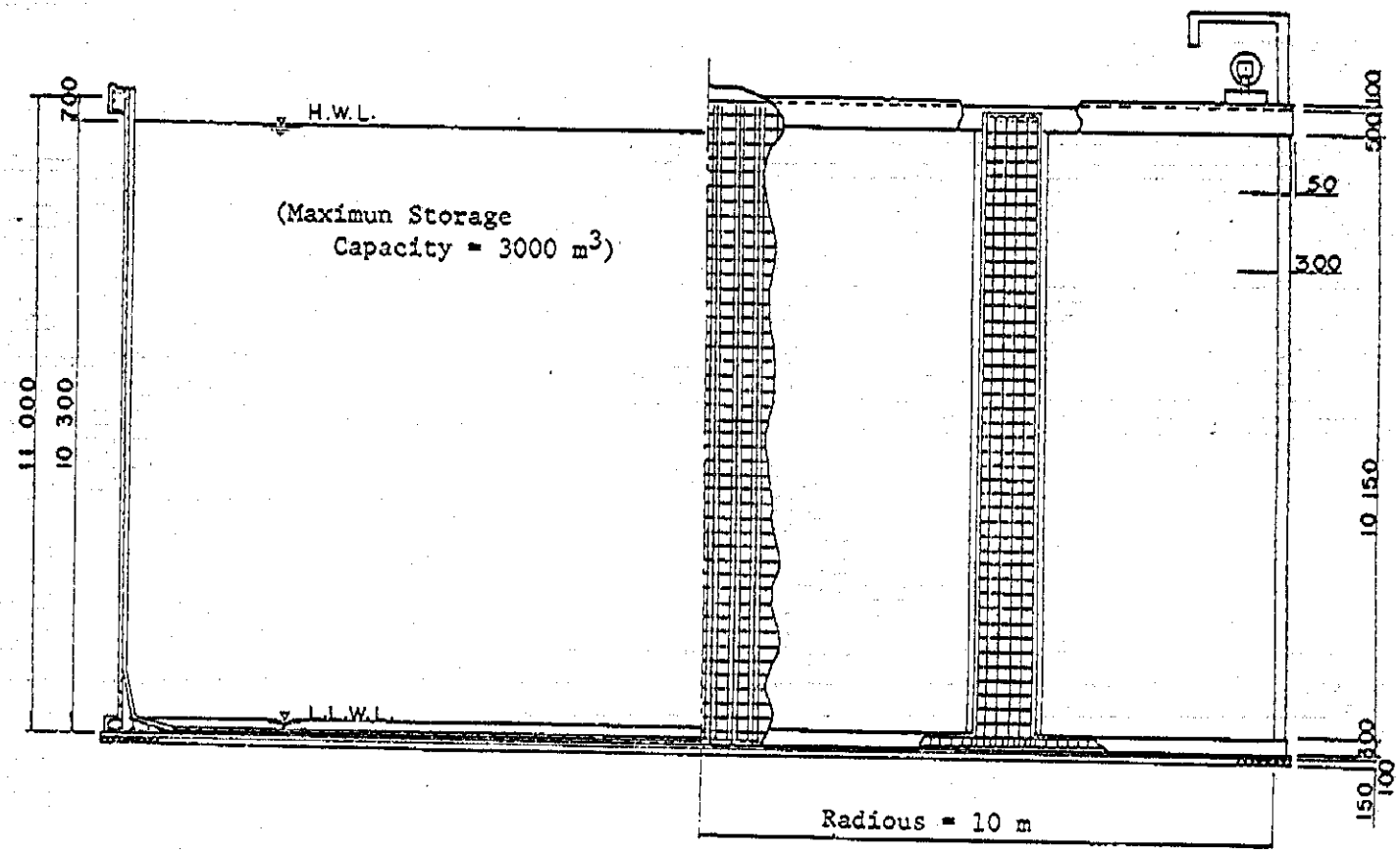
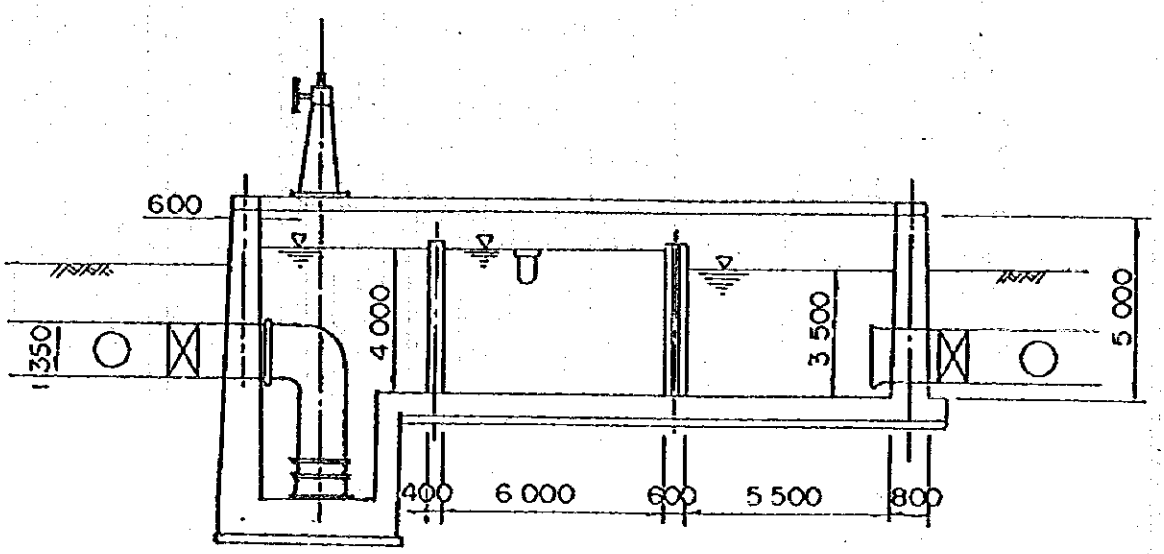


Fig. 5-19 General Plan of Receiving Well



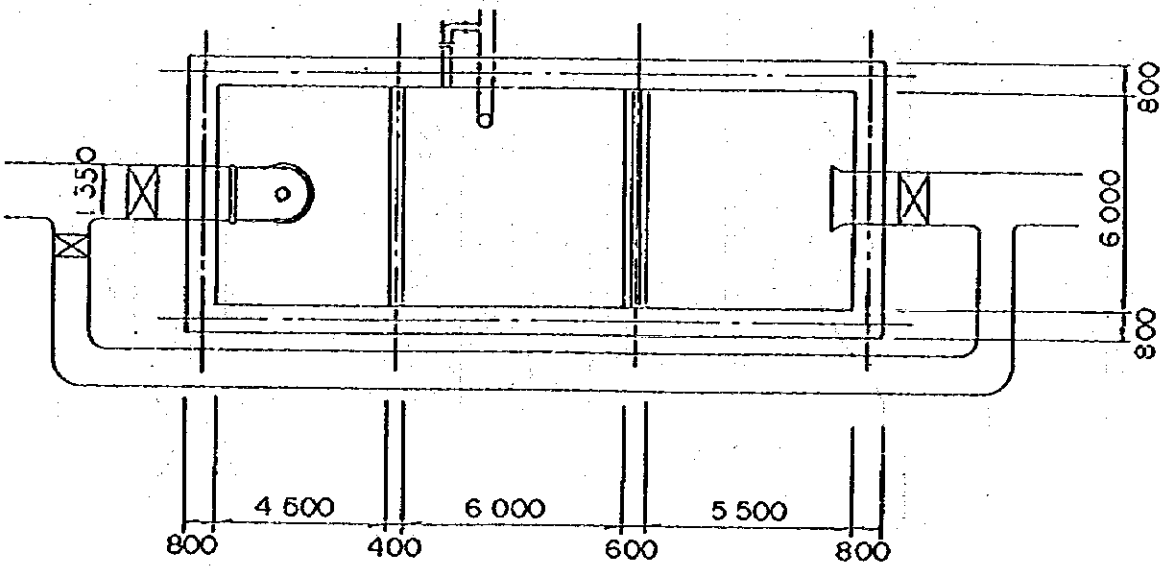
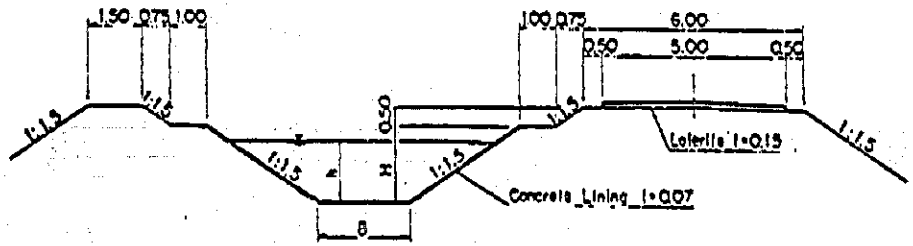
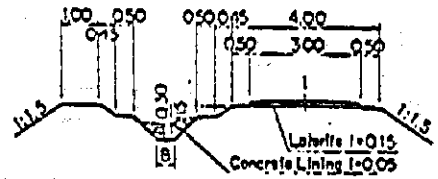


Fig. 5-20 Standard Cross-Section and Dimension of Irrigation and Drainage Canal



Standard Cross-Section of Main Canal



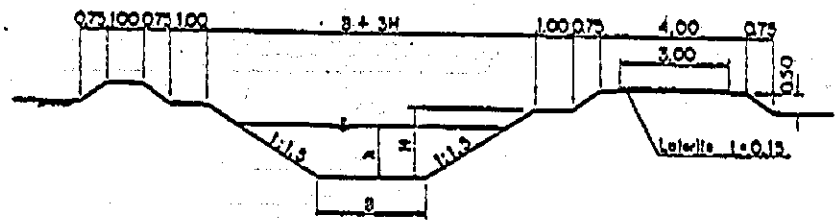
Standard Cross-Section of Lateral Canal

Dimension Table of Main Canal

Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)	H (m)
7.9	9.795	1/5,000	1.75	2.80	2.15
5.9	8.056	1/5,000	1.59	2.60	1.99
20.8	6.123	1/5,000	1.39	2.00	1.79
3.1	3.848	1/5,000	1.23	2.00	1.53
8.5	1.841	1/3,000	0.81	1.60	1.11

Dimension Table of Lateral Canal

Lateral No.	Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)
L-1	1.75	0.584	1/600	0.45	0.50
L-2	0.80	0.233	1/800	0.40	0.40
L-3	1.05	0.169	1/500	0.30	0.40
L-4	0.40	0.060	1/600	0.25	0.30
L-5	3.35	0.496	1/500	0.40	0.50
L-6	0.60	0.397	1/800	0.40	0.50
L-7	1.00	0.222	1/800	0.35	0.40
L-8	5.35	2.007	1/1,200	0.90	1.00
L-9	0.45	0.182	1/800	0.35	0.40
L-10	2.10	0.520	1/800	0.50	0.50
L-11	1.65	0.442	1/800	0.50	0.50
L-12	1.65	0.697	1/600	0.50	0.60



Standard Cross-Section of Drainage Canal

Dimension Table of Drainage Canal

Length (km)	Discharge (m³/sec)	Slope	h (m)	B (m)	H (m)
3.40	14.2	1/700	1.80	4.0	2.20
3.05	20.4	1/1,000	2.05	6.0	2.50

Fig. 5-21 Geological Map of Ban Bung Dam Axis

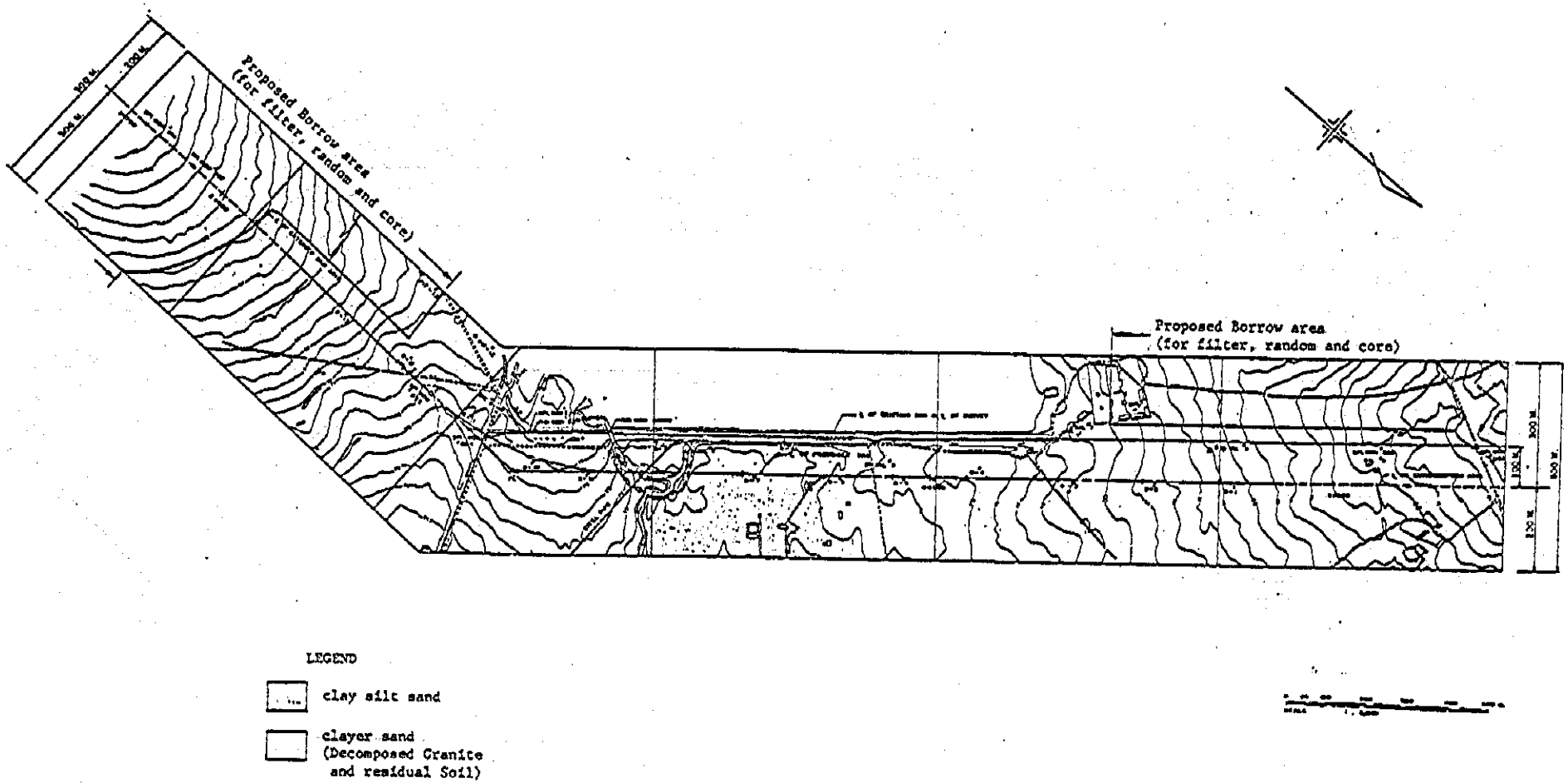


Fig. 5-22 General Plan of Bun Bung Dam

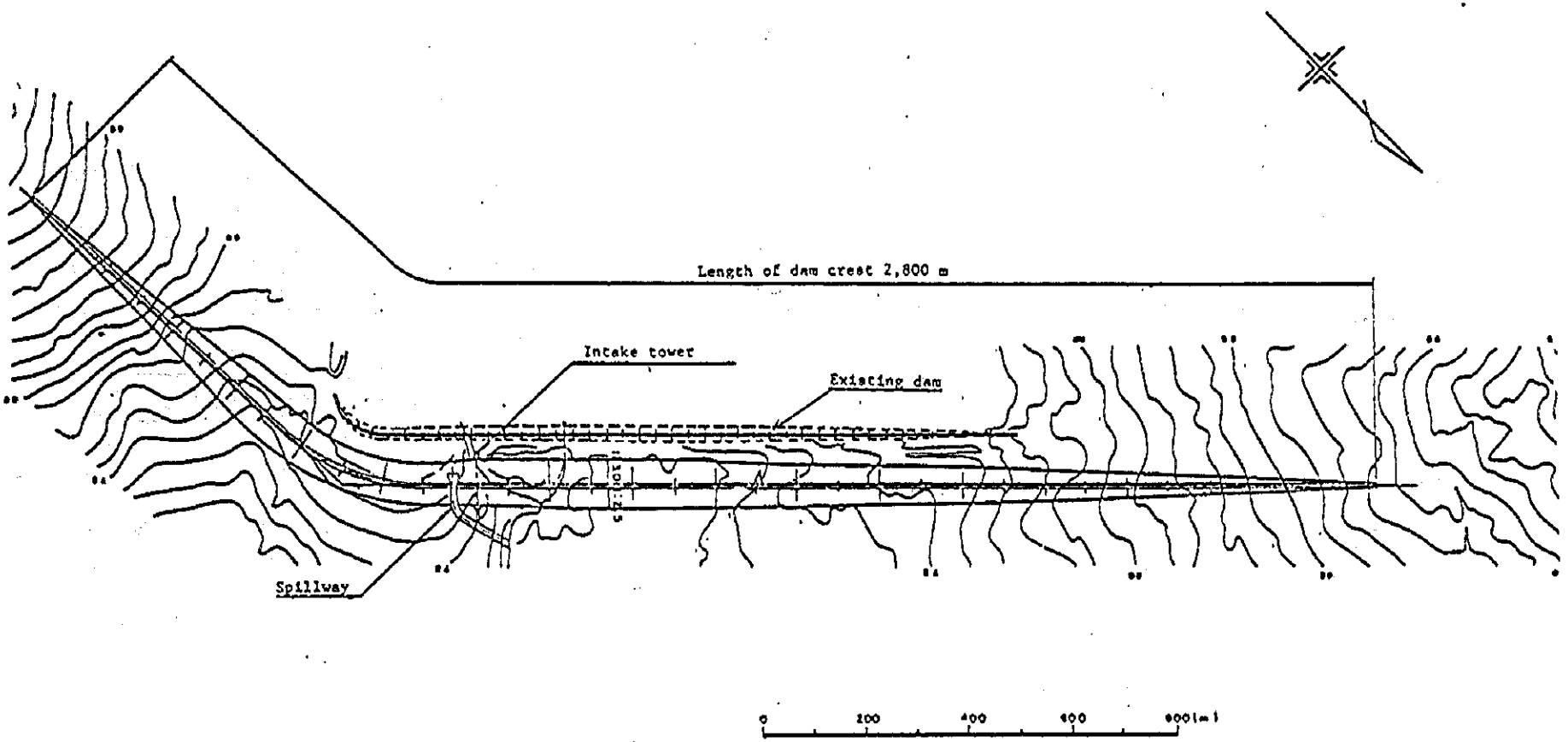
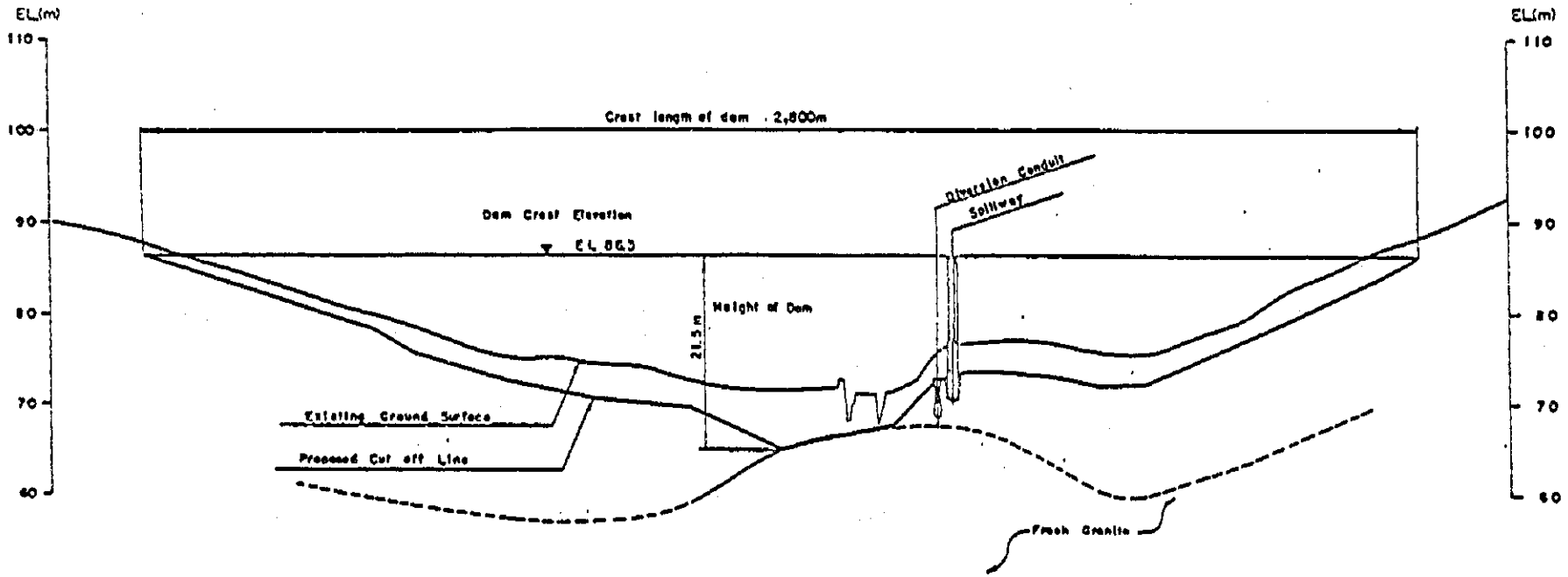


Fig. 5-23 Longitudinal Profile of Ban Bung Dam



CROSS SECTION NO.	ACCUMULATED DISTANCE (m)	ORIGINAL GROUND SURFACE	PROPOSED CUT OFF LINE
0	0	88.1	86.3
1	100	85.8	84.3
2	200	84.6	83.1
3	300	82.9	81.4
4	400	81.5	80.0
5	500	80.0	78.5
6	600	78.5	77.5
7	700	76.7	76.0
8	800	75.3	74.5
9	900	75.2	74.5
10	1,000	74.4	73.5
11	1,100	74.2	73.0
12	1,200	72.5	69.5
13	1,300	71.6	67.5
14	1,400	71.3	65.0
15	1,500	74.8	66.5
16	1,600	71.1	68.0
17	1,700	72.5	70.5
18	1,800	76.7	73.5
19	1,900	77.0	73.5
20	2,000	76.8	73.0
21	2,100	75.6	72.0
22	2,200	75.4	72.0
23	2,300	72.2	74.0
24	2,400	78.8	76.5
25	2,500	82.0	79.0
26	2,600	84.3	81.0
27	2,700	86.5	83.5
28	2,800	88.3	86.3

Fig. 5-24 Standard Cross-Section of Ban Bung Dam

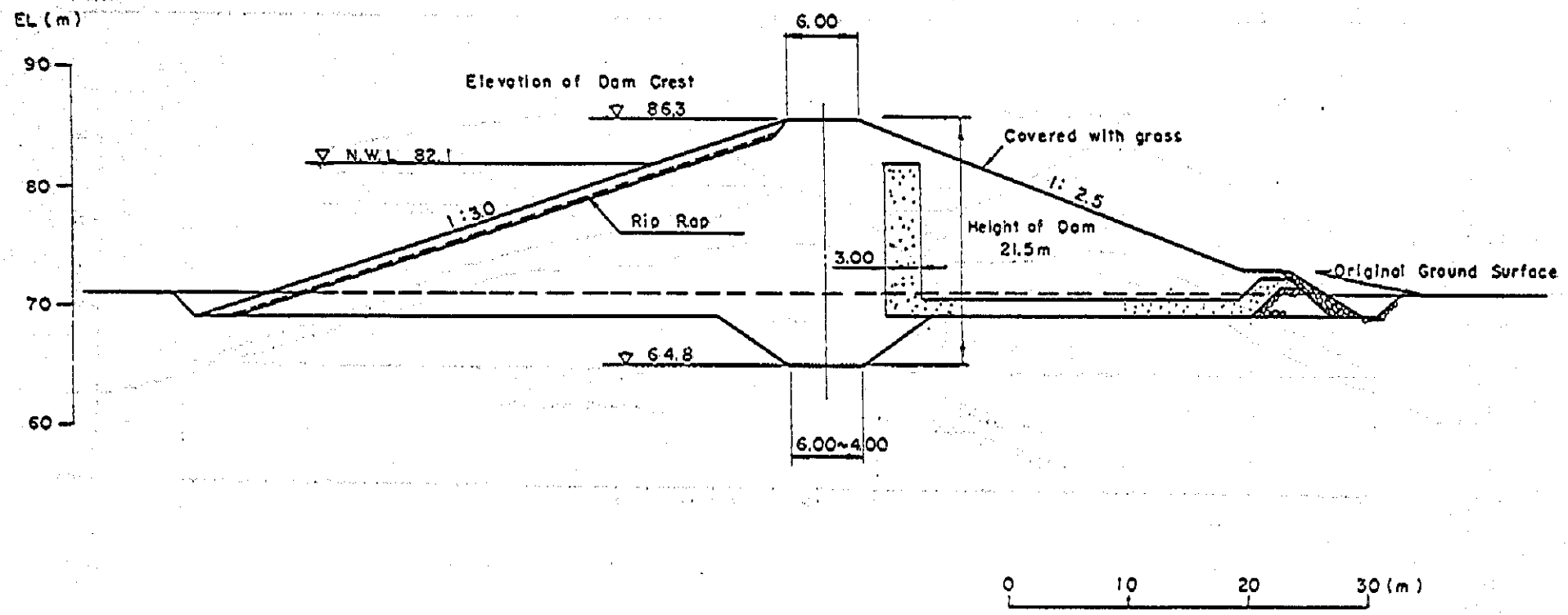


Fig. 5-25 Inflow and Outflow Hydrograph of Design Flood for Spillway

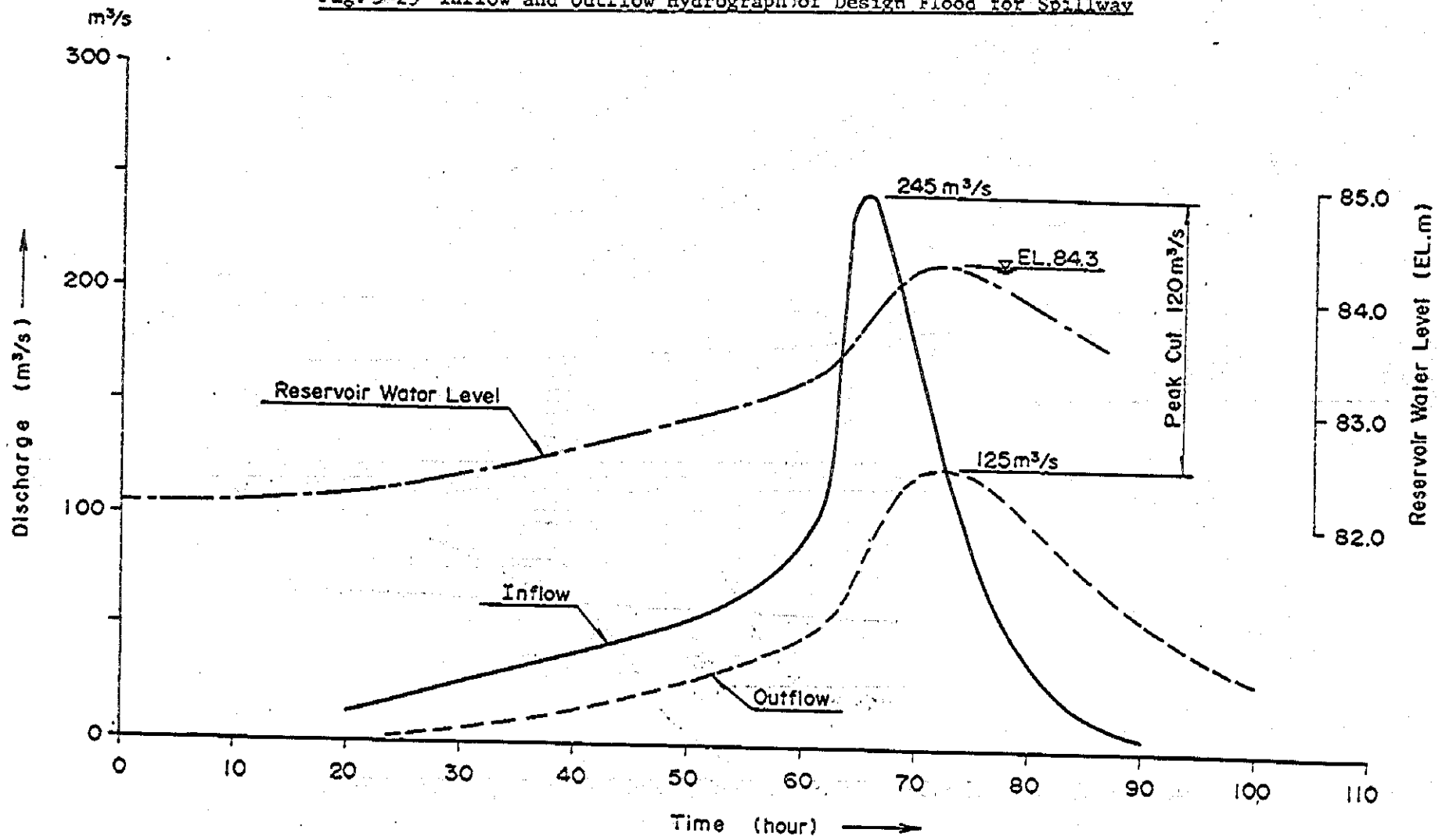


Fig. 5-26 Plan of Spillway, Intake and Outlet Facilities of Ban Bung Dam

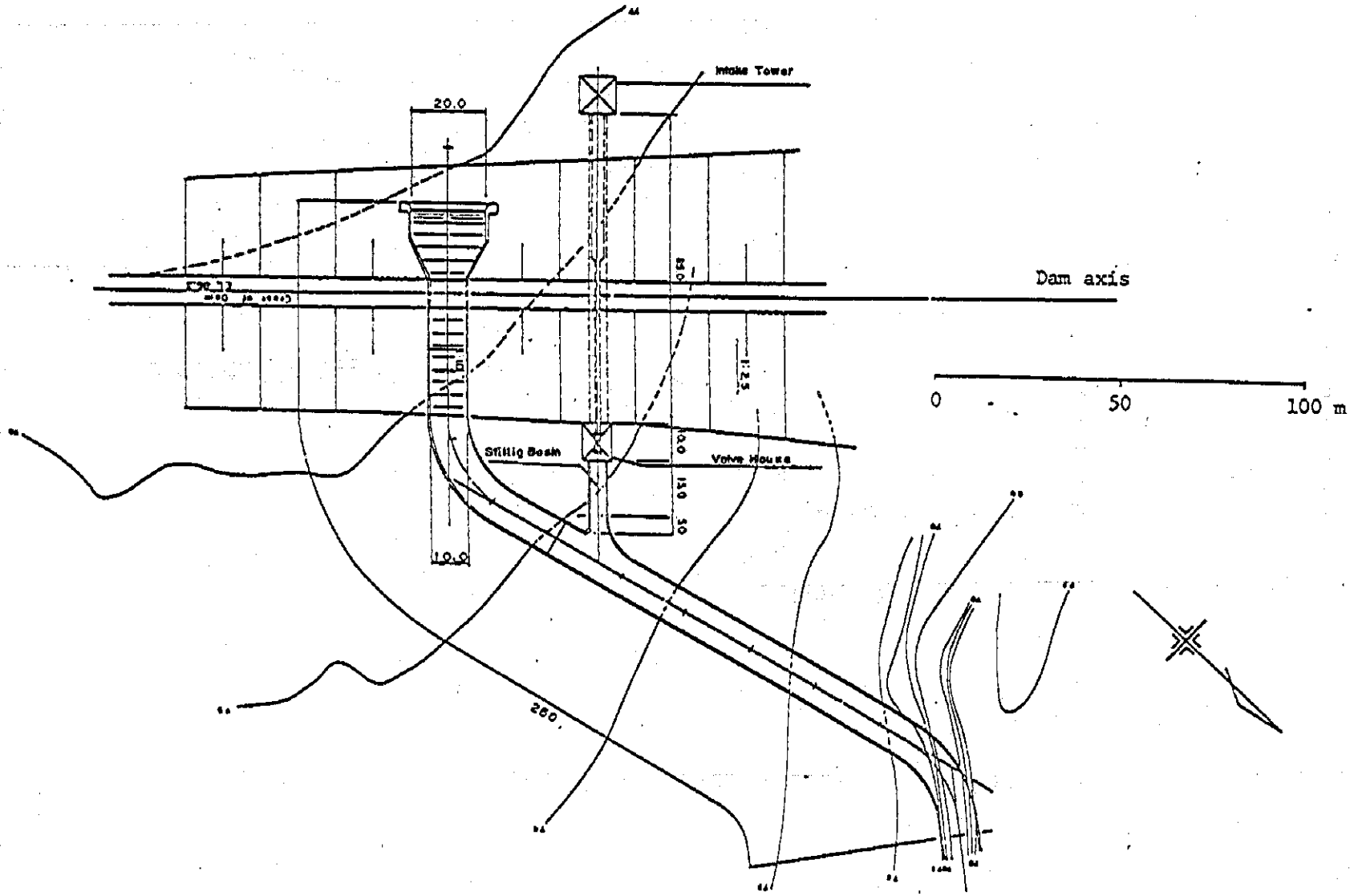


Fig. 5-27 Details of Spillway of Ban Bung Dam

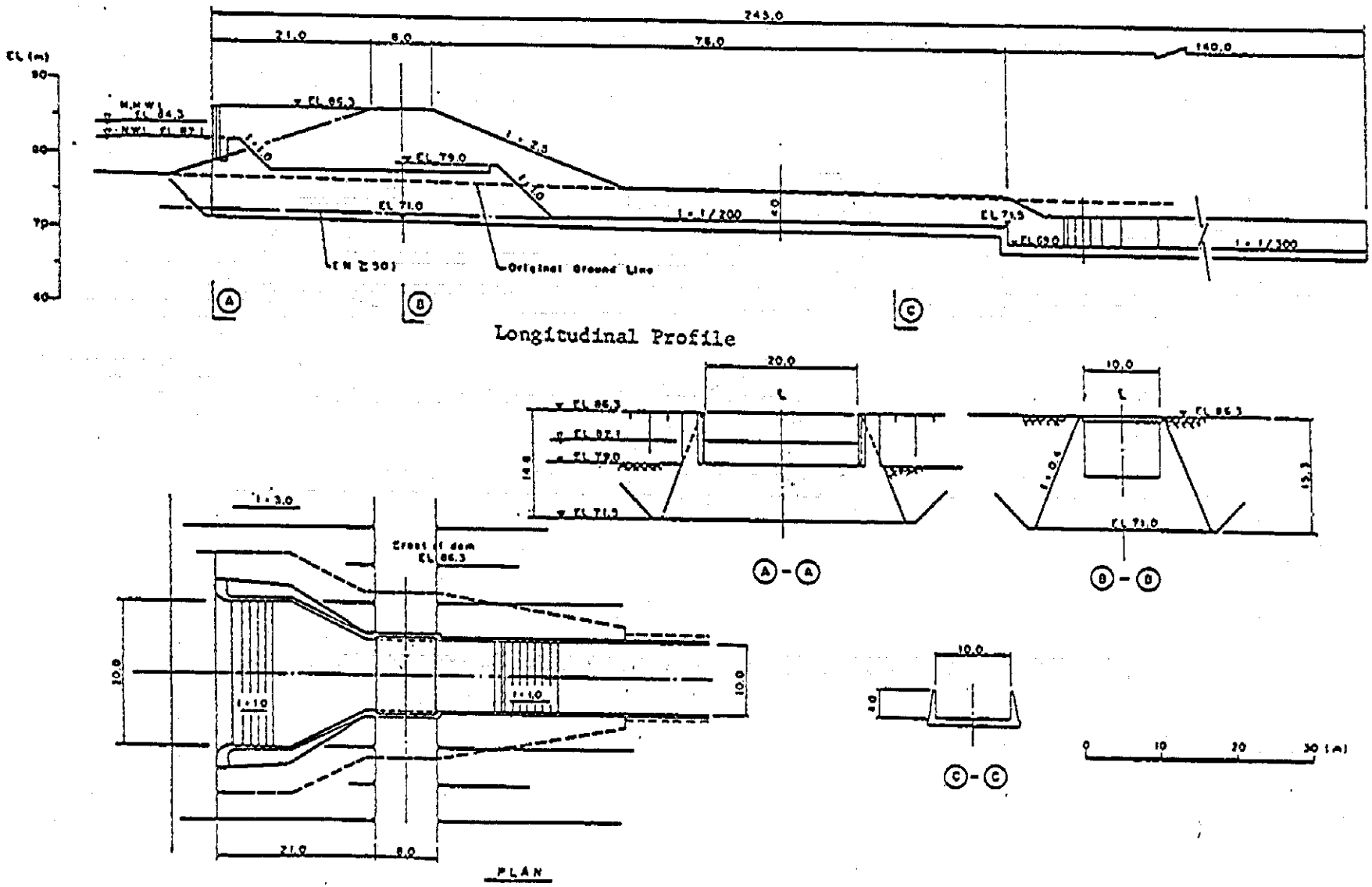


Fig. 5-28 Longitudinal Profile of Intake and Outlet Facilities of Ban Bung Dam

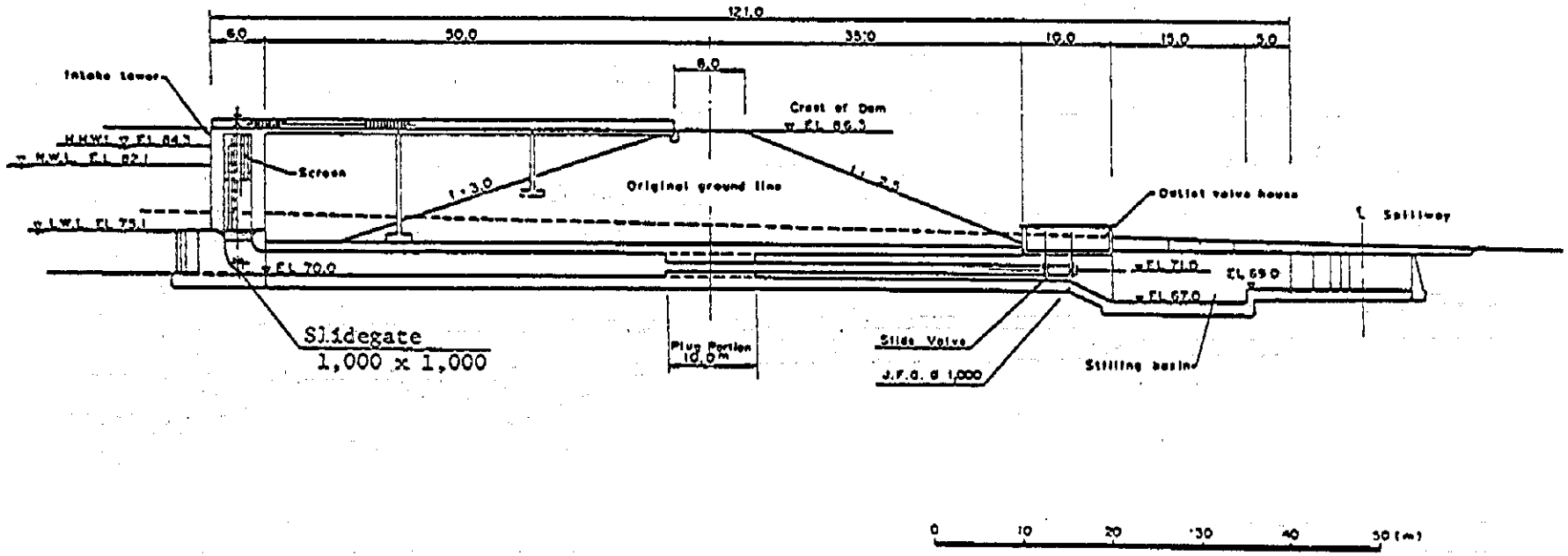
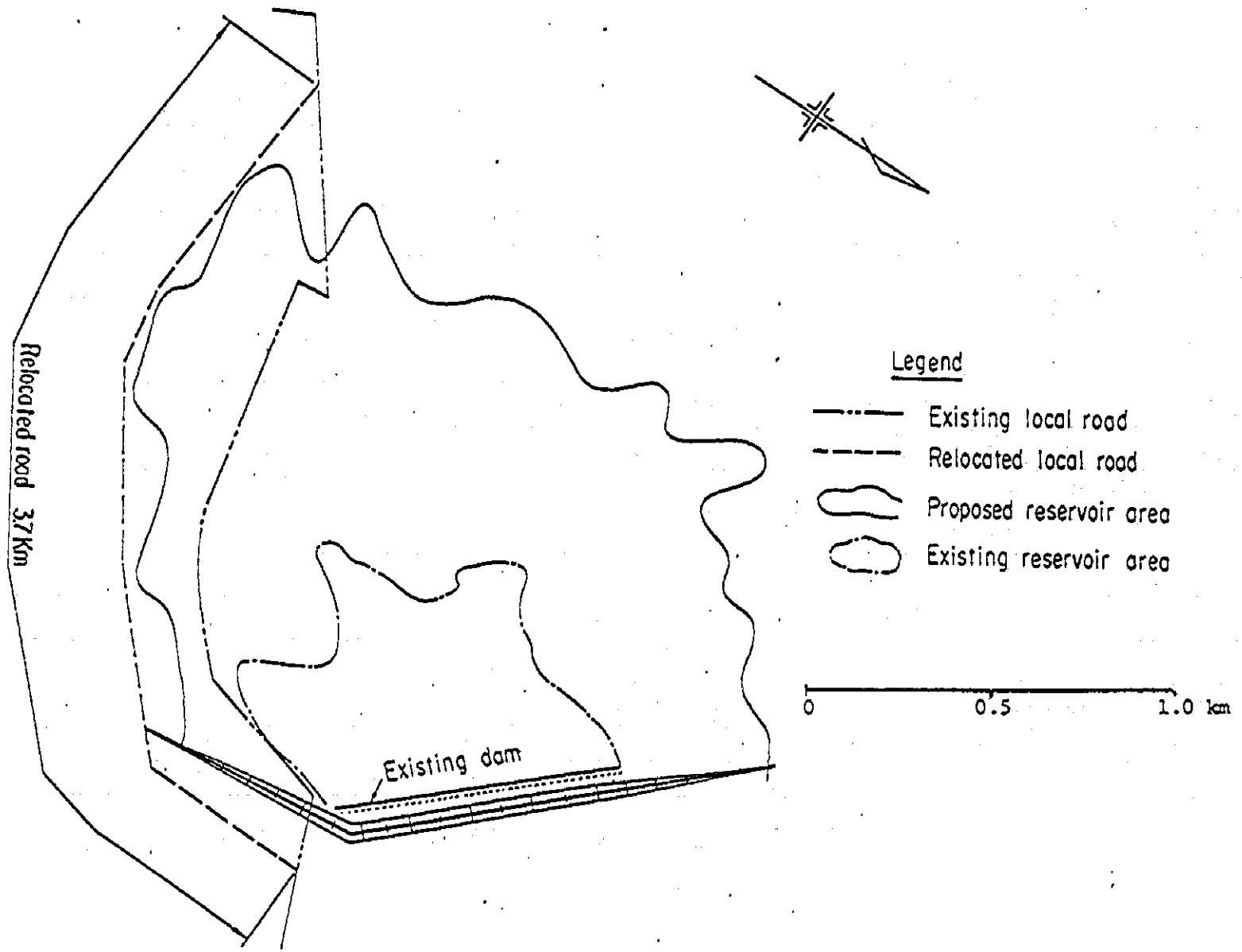
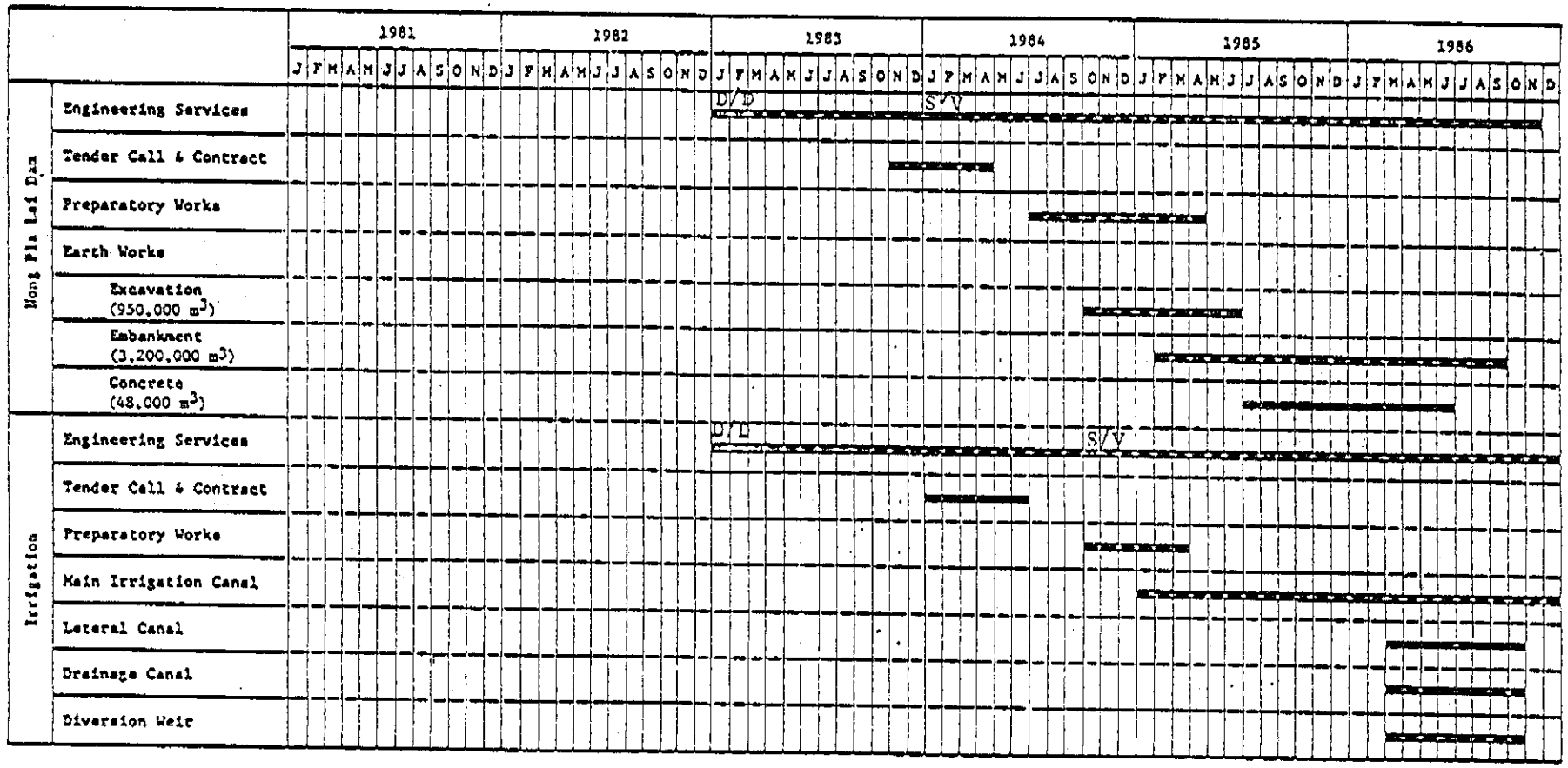


Fig. 5-29 Road Relocation



Nong Pla Lai Dam and Irrigation

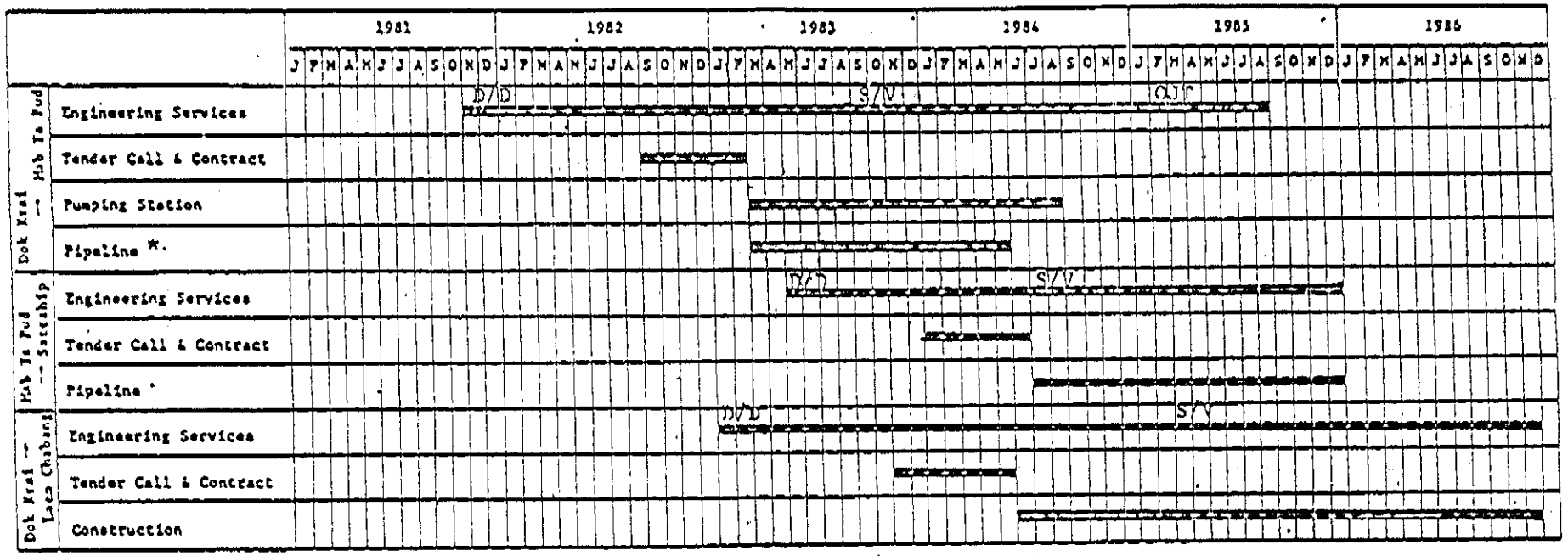
Fig. 6-1 Implementation Schedule of Nong Pla Lai Sub-Project (1)



Legend : D/D: Detailed Design and Preparation of Tender
S/V: Construction Supervision
OJT: On the Job Training

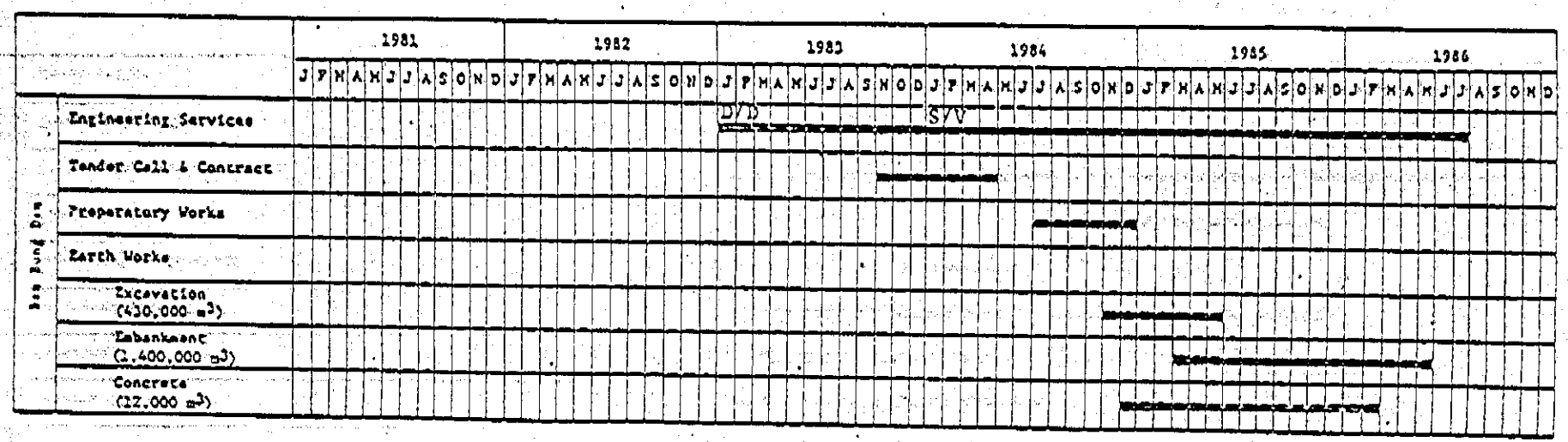
Pipeline

Fig. 6-1 Implementation Schedule of Nong Pla Lai Sub-Project (2)



Legend : D/D:Detailed Design
S/V:Supervision
OJT:On the Job Training

Fig. 6-2 Implementation Schedule of Ban Bung Sub-Project



Legend : D/D:Detailed Design
S/V:Supervision
OJT:On the Job Training

アペンディックス　I

ノンプラライ，サブプロジェクト

（水供給地区：ラヨンおよびサタピップ）

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アペンディックスI　ノンプラライ．サブプロジェクト
（対象地区：ラヨン，サタヒップ地区）

1. 概　　要

本調査において，東部沿岸地域の西暦2000年における水需要，すなわち，ラヨン，サタヒップ，ランチャバン，バンブン各地区の都市・工業用水の水需要およびノンプラライ，タブマ計画かんがい区の水需要を満すため，既存ドククライダムの利用，ノンプラライ，バンブン，クロンヤイ，タブマの新規4ダムの建設を柱とする水資源開発計画が策定された。

この計画の中ではまずノンプラライ・サブプロジェクトから着手し，これにより1995年時点の水需要を満すことが提案されている。

ノンプラライ・サブプロジェクトはダムおよびマブタプッド（ラヨン地区），サタヒップ，ランチャバンの3地区への導水システムより成っている。

しかしながら，ランチャバン地区への送水はコストが高くつき，またこの地区の近傍から取水できる可能性もあることが，検討の課程で確認された。

そこで，このアペンディクスではランチャバン地区への送水をしない計画を検討する。したがって，この計画は，ノンプラライダム，マブタプッド（ラヨン地区），サタヒップへの送水パイプライン，ノンプラライかんがい区より成っている。計画目標年次は2000年とする。

2. 水需要と供給

2.1 水　需　要

都市・工業用水

ラヨン，サタヒップの2000年時点の都市・工業用水の需要は次のように推計される。

（単位×10^6 m^3/年）

	ラヨン地区		サタヒップ地区
	ラヨン市	マブタプッド	サタヒップ
工業用水	6.4	21.5	17.2
工業関連都市用水	3.2	12.3	1.5
一般都市用水	12.6	—	5.3
計	22.2	33.8	24.0

この2地区における1996年から2000年までの水需要の伸びは1995年におけるランチャバンの水需要と同量である。

かんがい

ノンプラライかんがい区3,650haの水需要は，作付率を雨期100%，乾期80%とすると69.4×10⁶ m³/年となる。これは本文で検討した計画と同様である。

2.2 水供給計画

水供給計画はドククライダムの余剰水を利用する第1期とノンプラライダムが加わる第2期に分れる。

第1期

ドククライダム（利水容量49×10⁶ m³）の余剰水を新設される導水システムにより1986年ノンプラライダムが完成するまで，マブタプッドで発生する水需要に供給する。1986年時点でのマブタプッドの水需要は22.8×10⁶ m³/年である。

第2期

ノンプラライダム（利水容量144.4×10⁶ m³/年）が1986年に完成するので，それ以後，ドククライダムを都市・工業専用とし，バンカイかんがい区の既得水利および新規のノンプラライかんがい区の水はノンプラライダムより供給する。

3. 計画策定および概略設計

3.1 ノンプラライダム

ダムの規模その他の諸元は次に示すが，開発規模は本文と同様である。

貯水池

集水面積	426 km²
湛水面積（H.W.L.）	23 km²
洪水時最高水位（H.W.L.）	EL. 47.0 m
常時満水位	EL. 45.0 m
低水位	EL. 33.3 m
総貯水容量	200.7 × 10⁶ m³
サーチャージ	43.5 × 10⁶ m³
利水容量	144.4 × 10⁶ m³
堆砂容量	12.8 × 10⁶ m³

ダ　ム

ダム型式	カットオフトレンチ付アースフィルタイプ
天端高	EL. 49.0 m
ダム高	31.5 m
天端長	4,000 m
法面勾配	上流面　1：3.0
	下流面　1：2.5
堤体積	3.2×10^6 ㎥

余水吐

型式	非常用ゲート付横越流タイプ
放流能力（H.W.L）	700 ㎥/sec
非常用ゲート	ローラーゲート5 m×5 m×1門

取水口，放流管

取水構造	直立式取水塔
かんがい用水放流管	
高圧ゲート	ジェットフローゲート
	φ 1,500㎜ × 1 基
放流能力（L.W.L）	14 ㎥/sec

3.2　導水システム

マブタプッド（ラヨン地区）とサタヒップ地区の都市・工業用水はドククライダムからのパイプラインによって供給する。ラヨン市の都市・工業用水はドククライダムより放流し，既設のバンカイ取水堰の上流に設ける取水堰から取水し，バンカイに設ける受水槽に送る。

導水施設は，ポンプ，パイプライン，受水槽，ヘッドタンク等より成る。ドククライ－マブタプッド・ルートとマブタプッド－サタヒップ・ルートの能力は2000年の需要に対応する。ただしポンプについては，原案からランチャバンルートを除く。（図A－2参照）

一方，ラヨン地区の新規需要に対する導水は河道を通して行われる。

マブタプッドへの供給

施設の諸元を次に示す。関連の設計図等は本文にある計画案と同様である。

1）ドククライポンプ場

ポンプ場型式	コンクリートケーソン　杭基礎
ポンプ型式	立軸渦巻型ポンプ
設計流量	2.62 m^3/sec　（31.44 m^3/min／unit）
ポンプ台数	6台（予備1台を含む）
総揚程	90 m
モーター出力	3,000 kw

2）パイプライン

全長	27.6 km
スチールパイプ	鋼管 φ 1,350 mm，肉厚 11.9 mm

3）ヘッドタンク

位置	ドククライポンプ場より南6 km
容量	3,000 m^3×2基

4）受水設備

位置	国道3号線沿い。バンチャンルクヤ西方
受水槽容量	780 m^3
受水池	21,000 m^3

<u>マブタブッドからサタヒップへの導水</u>

施設の諸元は次の通り，関連設計図は本文にある計画案と同様である。

1）マブタブッド増圧ポンプ場

ポンプ型式	横軸渦巻ポンプ
設計流量	1.09 m^3/sec
ポンプ台数	3台（予備1台を含む）
総揚程	11 m
モーター出力	150 kw

2）パイプライン

設計流量	1.09 m^3/sec
延長	21.9 km
スチールパイプ	鋼管 φ 1,000 mm，肉厚 8.7 mm

3）受水槽

位置	サタヒップ市街より東方約5 km

容　　量　　350㎥

ラヨンへの供給

ドククライダムより放流された水は，河道を流下して，新設取水堰（バンカイ堰上流）にて取水し，こののち約1kmのパイプラインを経由して受水施設に至る。同地で浄水されラヨン市に配水される。

施設の諸元は下に示す。（図A－3　取水堰概要　参照）

1）取水堰

位　　置	既設バンカイ堰直上流
洪水吐水門	20m×2.5m×2門
土砂吐水門	10m×3.0m

2）取水・送水設備

設計流量	1.01㎥/sec
パイプ	コンクリートパイプφ1,500mm
パイプ延長	1.0km

3）受水施設

位　　置	バンカイ
容　　量	300㎥

3.3　かんがいおよび排水システム

かんがいおよび排水システムは本文に述べたノンプラライ地区を対象とする。計画の諸元は本文にある計画案と同様である。

かんがい

かんがい面積	3,650ha	
作付率	雨期100%，	乾期80%
作付体系	雨期：水稲	
	乾期：水稲，落花生	
予想収穫高	水稲：雨期	4.0 t/ha
	乾期	4.5 t/ha
	落花生：乾期	1.9 t/ha
かんがい用水量		69.4 × 10^6㎥/年

頭首工位置	バンノンバウ	
かんがい水路延長	幹線水路（コンクリートライニング）	46.5 km
	支線水路（コンクリートライニング）	20 km

排　水

排水面積	（地区内）	21.3 km²
	（地区外）	14.9 km²
計画排水量		20.4 m³／sec
幹線排水路延長		6.5 km

4. 施工計画および建設費積算

4.1 施工計画

ノンプラライダム，導水システム（ドククライーマブタブッドーサタヒップ），かんがいシステムの施工計画は本文の計画案と同様である。（図A－4参照）　ここでは新しく考えられたラヨン市への送水についてのみ述べる。

建設材料

取水堰等に要するコンクリートは4,100 m³である。

粗骨材，細骨材は国内で入手する。鉄筋（300 t）は外国より入手する。取水堰よりの1 kmの区間コンクリートパイプは国内で入手する。鉄筋（300t），ゲート用鋼材（70 t）は外国より入手する。取水堰よりの1 Kmの区間のコンクリートパイプは国内で入手する。

用地買収

取水堰，パイプライン，受水槽の用地は買収する必要がある。

工　種

ダム，導水システム，かんがいおよび排水システムの建設は図A－4に示す工程に従って行う。

4.2 建設費積算

建設費の合計を下に示す。詳細は表A－1を参照のこと。

単位：US$×10⁶

	外貨	内貨	合計
ダム・貯水池	29.85	36.70	66.55
導水システム	63.73	29.07	92.80
かんがいおよび排水システム	7.01	9.04	16.05
合　計	100.59	74.81	175.40

各目的別の建設費および年度別費用は，経済コスト，財務コストの形で表A－2，A－3に示した。

4.3 維持管理

業務内容

プロジェクトの施設のうち導水システムの他はすべてＲＩＤが維持管理をする。ＲＩＤは同時に全プロジェクトの建設にあたる。導水システムの維持管理に当る組織は未定である。

ドククライダム，ノンプラライダム，導水システムの維持管理に必要とされる人員は本文の表７－１に示してある。またその業務内容はラヨン市への水供給を除き，本文中の計画案と同様である。

ラヨン市への水供給に関する業務を次に示す。

ダム・貯水池の巡視（毎日）

構造物の管理

送配水の管理

水理・水文データの収集，整理

維持管理費

ダムとかんがいおよび排水システムの維持管理費は，US$ 0.50×10⁶ /年と見積られる。導水システムについては年US$ 1.20×10⁶ であるが，この大部分は揚水動力費である。

5. プロジェクト評価

評価の方法は本文に述べた方法と同様である。

5.1 経済評価

経済コストの算出

1) 建設費

経済コストはUS$ 115.13 × 10^6 であるが，その内容は下記の通りである。

（単位US$ × 10^6）

部　門	費　用
ノンプラライダム	35.58
導水システム	67.56
かんがいおよび排水システム	8.40
ほ場整備	3.59
合　計	115.13

この費用の支出の支出計画は表A－2に各施設別に示してある。

2) ダムコストアロケーション

ダムの経済価格を分離費用身替り妥当支出法によって各部門に配分した。

（単位US$ × 10^6）

部　門	負担額
洪水調節	4.91
都市・工業用水	21.35
かんがいおよび排水システム	9.32
合　計	35.58

3) 部門別費用算定（経済価格）

前記の配分費用と専用施設費を合計して部門別費用を求めた。

（単位US$ × 10^6）

部　門	費　用
洪水調節	4.91
都市・工業用水	88.91
かんがいおよび排水システム	21.31
合　計	115.13

4) 維持管理費

ノンプライダム，都市・工業用水，導水システム，かんがいおよび排水施設の年間維持管理費はUS$ 1.50 × 10^6 である。

経済便益の算定

1）直接便益

a．都市・工業用水

都市・工業用水プロジェクトの便益は貨幣価値で見積るのは一般にむずかしいが，ここでは，m^3当り₨5とし，これに年使用水量を乗じて便益とする。表A－4に水量と便益とをまとめてある。これにより，施設が全面運用される2,000年以降の年便は，US$ 17.36×10^6となる。

b．かんがい用水

かんがい用水の供給によって増加した純年間生産額をもって便益とする。

かんがい施設が全面運用となる1993年の便益は₨ 79.04 ×10^6（US$3.44×$10^6$）である。年供給水量を69.4×$10^6$ m^3とするとm^3当り便益は₨ 1.14／m^3（US$ 0.05／m^3）となる。詳細については，本文の表8－4，8－6にまとめてある。

現況純生産額	₨ 41.32×10^6（US $1.80×$10^6$）
かんがい後純生産額	₨120.36×10^6（US$5.23×$10^6$）
増　加　額	₨ 79.04×10^6（US$3.44×$10^6$）

c．洪水調節

洪水制御の便益は，年に₨6.2 × 10^6（US$ 0.27 × 10^6）である。

2）間接便益

本文と同様である。

経済評価

ノンプラライサブプロジェクトおよびその各部門別の内部経済収益率（ＩＲＲ）を上記の便益に基づいて算出すると次のようになる。

部　門	ＩＲＲ(%)
都市・工業用水	11.3
かんがいおよび排水	12.1
洪 水 調 節	3.5
プロジェクト全体	11.2

感度分析

建設費の変動や水需要発生の遅延によりＩＲＲがどう変るかを感度分析した。

1）建設費

建設費が10%あるいは20%増加するとプロジェクトのIRRは1.0%，1.8%落ちて，10.3%，9.3%となる。

2）水需要発生が10年遅れた場合

このプロジェクトの計画目標年次は，2000年であるが，需要発生がこれより10年遅れるとすると便益の発生も遅れ，結果としてIRRは1.1%落ちて10.2%となる。る。

5.2 財務評価

財務評価の条件

タイ国において，ダム建設，水供給，かんがいシステムは，国家予算によりRIDが実施している。

水料金の徴収は都市・工業用水については行われているが，かんがい用水については原則のみであって実際には行われていない。したがって，財務評価は都市・工業用水についてのみ行うこととする。

財務計画

都市・工業用水の資金計画は次のようになっている。

1）所要資金

費用配分の結果によると都市・工業用水部門はノンプラライダム費用の60%を負担することになっているので専用施設である導水システム費と合わせ，US$132.73×$10^6$が必要である。このうち61.5%は外貨，38.5%は内貨である。

単位 US$×$10^6$

	外貨	内貨	合計
ダムの負担金	17.91	22.02	39.93
導水システム費	63.73	29.07	92.80
合計	81.64	51.09	132.73

全プロジェクトの年度別費用は，表A－3に示してある。

2）水料金

都市・工業用水の料金は฿3.5／m^3（US$ 0.152／m^3）とする。（詳細はサポーティングレポート参照）

3）減価償却と維持管理費

償却年数はダムと導水システムの平均をとって37年とする。維持管理費は，2000年の全面運用以降で次のようになる。

（単位 US$ × 10^6）

ダ　　ム	0.18
都市・工業用水	1.20
合　　計	1.38

4）外貨の借款条件

借款条件は次のように想定する。（注）

利　　率	3％
債 還 期 間	30年
据 置 期 間	10年

注：この条件はOECFからの借入を想定した場合である。

財務分析

1）収益計画

表A－6に示す収益計画は前記の所要資金計画，1984年より始まる料金収入に基づいて作成された。1987年は元利償還が始まるので利益は急減するが，その後徐々に増益となる。償還は2023年に終るので2024年からは毎年US$ 8.07 × 10^6 の利益があがる計画である。

2）内部財務収益率

収益計画に基づいて財務ＩＲＲを求めると

財務ＩＲＲ＝5.9％

となる。（表A－6参照）

したがって，ノンプラライダムと導水システムの建設に導入する資金の利率は5.9％以下であることが望ましい。

感度分析

感度分析においては，水料金，建設費，水需要の発生がどのようにＩＲＲと影響するかを調べた。それによると料金設定いかんが，特に大きな影響を持つことが分った。

感度分析の結果は表A－7に示してある。

Table A-1 Construction Cost of Nong Pla Lai Sub-Project

Unit : million US$

Item	Grand Total			Nong Pla Lai Dam			Water Transmission System									Irrigation and Drainage System		
							Dok Krai-Mab Ta Pud			Mab Ta Pud-Sattahip			Ban Khai Head Works					
	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total	L.C.	F.C.	Total
1. Direct Construction Cost	31.97	57.26	89.23	10.78	14.77	25.55	8.93	22.60	31.53	4.80	10.98	15.78	3.30	6.00	9.30	4.16	2.91	7.07
Civil Works	27.25	38.37	65.62	10.55	14.07	24.62	5.96	10.10	16.06	3.51	5.86	9.37	3.07	5.45	8.52	4.16	2.89	7.05
Equipment & materials	4.72	18.89	23.61	0.23	0.70	0.93	2.97	12.50	15.47	1.29	5.12	6.41	0.23	0.55	0.78	-	0.02	0.02
2. Road Relocation	0.78	1.30	2.08	0.78	1.30	2.08	-	-	-	-	-	-	-	-	-	-	-	-
3. Compensation	9.86	-	9.86	9.37	-	9.37	0.04	-	0.04	0.04	-	0.04	-	-	-	0.41	-	0.41
4. Engineering Cost	1.14	9.99	11.13	0.13	3.02	3.15	0.31	2.11	2.42	0.27	1.80	2.07	0.20	1.50	1.70	0.23	1.56	1.79
Sub-total	43.75	68.55	112.30	21.06	19.09	40.15	9.28	24.71	33.99	5.11	12.78	17.89	3.50	7.50	11.00	4.80	4.47	9.27
5. Contingencies	31.06	28.68	59.74	15.64	9.62	15.26	3.91	6.88	10.79	4.47	6.40	10.87	2.80	3.50	6.30	4.24	2.28	6.52
Physical	5.66	8.04	13:70	3.17	2.87	6.04	0.93	2.47	3.40	0.51	1.28	1.79	0.34	0.75	1.09	0.71	0.67	1.38
Price	25.40	20.64	46.04	12.47	6.75	19.22	2.98	4.41	7.39	3.96	5.12	9.08	2.46	2.75	5.21	3.53	1.61	5.14
6. Interest during Construction	-	3.36	3.36	-	1.14	1.14	-	1.01	1.01	-	0.54	0.54	-	0.41	0.41	-	0.26	0.26
Total (1-6)	74.81	100.59	175.40	36.70	29.85	66.55	13.19	32.60	45.79	9.58	19.72	29.30	6.30	11.41	17.71	9.04	7.01	16.05

Table A-2 Annual Disbursement of the Economic Project Cost (Nong Pla Lai Sub-Project)

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Dam													
1. Main Civil Works	6.88	14.07	20.95	-	-	-	-	0.97	1.60	4.08	8.39	1.83	4.08
2. Equipment & materials	0.04	0.70	0.74	-	-	-	-	-	-	-	-	0.04	0.70
3. Road Relocation	0.48	1.30	1.78	-	-	-	-	0.24	0.65	0.24	0.65	-	-
4. Land Acquisition & Compensation	4.31	-	4.31	-	-	1.08	-	2.15	-	1.08	-	-	-
5. Engineering Service	0.13	3.02	3.15	-	-	0.03	1.90	0.03	0.40	0.03	0.39	0.04	0.33
6. Physical Contingencies	1.78	2.87	4.65		-	0.17	0.29	0.51	0.40	0.81	1.41	0.29	0.77
Sub-total (1-6)	13.62	21.96	35.58	-	-	1.28	2.19	3.90	3.05	6.24	10.84	2.20	5.88
Total	35.58			-		3.47		6.95		17.08		8.08	
II. Water Transmission System /1													
1. Main Civil Works	13.36	20.79	34.15	-	-	5.20	8.33	4.28	7.15	3.88	5.31	-	-
2. Equipment & materials	2.74	18.17	20.91	-	-	1.06	7.55	0.88	6.06	0.80	4.56	-	-
3. Land Acquisition & Compensation	-	-	0.08	-	-	0.04	-	0.04	-	-	-	-	-
4. Engineering Service	0.88	5.41	6.29	1.29	0.19	0.25	1.94	0.21	1.33	0.23	0.85		
5. Physical Contingencies	1.70	4.43	6.13	0.13	0.02	0.66	1.78	0.54	1.45	0.48	1.07	-	-
Sub-total (1-5)	18.70	48.80	67.56	1.42	0.21	7.21	19.60	5.95	15.99	5.39	11.79		
Total	67.56			1.63		26.81		21.94		17.18		- -	
III. Irrigation and Drainage System													
1. Main Civil Works	2.61	2.91	5.52	-	-	-	-	0.17	0.19	1.04	1.15	1.40	1.57
2. Land Acquisition & Compensation	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Engineering Service	0.23	1.56	1.79	-	-	0.09	0.65	0.04	0.37	0.05	0.27	0.05	0.27
4. Physical Contingencies (15%)	0.42	0.67	1.09	-	-	0.01	0.10	0.03	0.08	0.16	0.21	0.22	0.28
Sub-total (1-4)	3.26	5.14	8.40	-	-	0.10	0.75	0.24	0.64	1.25	1.63	1.67	2.12
Total	8.40			-		0.85		0.88		2.88		3.79	
Sub-total (I + II + III)	35.58	75.90	111.54	1.42	0.21	8.59	22.54	10.09	19.68	12.88	24.26	3.87	8.00
Grand Total	111.54			1.63		31.13		29.77		37.14		11.87	

/1 : This cost covers the pipeline route (Dok Krai-Mab Ta Pud and Mab Ta Pud-Sattahip) and the Ban Khai Head Works

Table A-3 Annual Disbursement of the Financial Project Cost (Nong Pla Lai Sub-Project)

Unit : million US$

Item	Total			1982		1983		1984		1985		1986	
	L.C.	F.C.	Total	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.	L.C.	F.C.
I. Nong Pla Lai Dam													
1. Main Civil Works	10.55	14.07	24.62	-	-	-	-	1.34	1.60	6.28	8.39	2.93	4.08
2. Equipment & materials	0.23	0.70	0.93	-	-	-	-	-	-	-	-	0.23	0.70
3. Road Relocation	0.78	1.30	2.08	-	-	-	-	0.39	0.65	0.39	0.65	-	-
4. Land Acquisition & Compensation	9.37	-	9.37	-	-	2.34	-	4.69	-	2.34	-	-	-
5. Engineering Service	0.13	3.02	3.15	-	-	0.03	1.90	0.03	0.40	0.03	0.39	0.04	0.33
6. Physical Contingencies	3.17	2.87	6.04	-	-	0.36	0.29	0.97	0.40	1.36	1.41	0.48	0.77
7. Price Contingencies	12.47	6.75	19.22	-	-	0.69	0.32	3.01	0.69	5.97	3.37	2.60	2.37
8. Interest during Construction	-	1.14	1.14	-	-	-	0.03	-	0.09	-	0.35	-	0.67
Sub-Total (1-8)	36.70	29.85	66.55	-	-	3.42	2.54	10.43	3.83	16.37	14.56	6.48	8.92
Total	66.55			-		5.96		14.26		30.93		15.40	
II. Water Transmission System /1													
1. Main Civil Works	12.54	21.41	33.95	-	-	4.84	8.89	4.14	7.15	3.56	5.37	-	-
2. Equipment & materials	4.49	18.17	22.66	-	-	1.73	7.55	1.48	6.06	1.28	4.56	-	-
3. Land Acquisition & Compensation	0.08	-	0.08	-	-	0.04	-	0.04	-	-	-	-	-
4. Engineering Service	0.78	5.41	6.19	0.19	1.29	0.25	1.94	0.21	1.33	0.13	0.85	-	-
5. Physical Contingencies	1.78	4.50	6.28	0.02	0.13	0.69	1.83	0.58	1.46	0.49	1.08	-	-
6. Price Contingencies	9.40	12.28	21.68	0.03	0.10	1.95	3.06	3.25	4.35	4.17	4.77	-	-
7. Interest during Construction	-	1.96	1.96	-	0.02	-	0.31	-	0.87	-	0.76	-	-
Sub-Total (1-7)	29.07	63.73	92.80	0.24	1.54	9.50	23.58	9.70	21.22	9.63	17.39	-	-
Total	92.80			1.78		33.08		30.92		27.02		-	
III. Irrigation and Drainage System													
1. Main Civil Works	4.16	2.91	7.07	-	-	-	-	0.28	0.19	1.66	1.15	2.22	1.57
2. Land Acquisition & Compensation	0.41	-	0.41	-	-	-	-	0.16	-	0.25	-	-	-
3. Engineering Service	0.23	1.56	1.79	-	-	0.09	0.65	0.04	0.37	0.05	0.27	0.05	0.27
4. Physical Contingencies	0.71	0.67	1.38	-	-	0.01	0.10	0.07	0.08	0.29	0.21	0.34	0.28
5. Price Contingencies	3.53	1.61	5.14	-	-	0.03	0.11	0.22	0.14	1.29	0.51	1.99	0.85
6. Interest during Construction	-	0.26	0.26	-	-	-	0.01	-	0.03	-	0.07	-	0.15
Sub-total (1-6)	9.04	7.01	16.05	-	-	0.13	0.87	0.77	0.81	3.54	2.21	4.60	3.12
Total	16.05			-		1.00		1.58		5.75		7.72	
Sub-total (I + II + III)	74.81	100.59	175.40	0.24	1.54	13.05	26.66	20.90	25.86	29.54	34.16	21.08	12.04
Grand Total	175.40			1.78		40.04		46.76		63.70		23.12	

/1 : This cost covers the pipeline route (Dok Krai-Mab Ta Pud and Mab Ta Pud-Sattahip) and the Ban Khai Head Works

Table A-4 Water Supply and Benefit

(Nong Pla Lai Sub-Project)

Year	Water Supply (MCM)	Benefit (1,000 US$)
1984	6.2	1,345
1985	16.7	3,624
1986	22.8	4,948
1987	43.1	9,353
1988	43.6	9,461
1989	44.2	9,591
1990	53.6	11,631
1991	54.3	11,783
1992	54.9	11,913
1993	55.7	12,087
1994	56.4	12,239
1995	57.8	12,543
1996	60.7	13,172
1997	62.1	13,476
1998	63.6	13,801
1999	65.0	14,105
2000	80.0	17,360
|	|	|
2031	80.0	17,360

Table A-5(1) Income Statement for Industrial Municipal Use (Nong Pla Lai Sub-Project)

(UNIT: 1000 DOLLAR)

<<< INCOME STATEMENT >>>

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
1. REVENUE	0.0	0.0	942.4	2538.4	3404.8	6551.2	6627.2	6718.4	8147.2	8253.6
WATER COMSUMPTION (1)	0.0	0.0	6.2	16.7	22.4	43.1	43.6	44.2	53.6	54.3
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	0.0	0.0	130.0	640.0	790.0	980.0	6256.7	6266.7	6426.7	6426.7
1) ORERATING & MAINTENANCE	0.0	0.0	130.0	640.0	790.0	980.0	980.0	990.0	1150.0	1150.0
2) INTEREST	0.0	0.0	0.0	0.0	0.0	0.0	2699.4	2699.4	2699.4	2699.4
ON LONG TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	2699.4	2699.4	2699.4	2699.4
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	0.0	0.0	0.0	0.0	0.0	0.0	2577.2	2577.2	2577.2	2577.2
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	0.0	0.0	812.4	1898.4	2614.8	5571.2	370.5	451.7	1720.5	1826.9

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. REVENUE	8344.8	8466.4	8572.8	8785.6	9226.4	9439.2	9667.2	9956.0	12160.0	12160.0
WATER COMSUMPTION (1)	54.9	55.7	56.4	57.8	60.7	62.1	63.6	65.5	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	52548.3	52548.3	52521.5	51969.2	50961.3	49452.1	47644.3	46846.4	44288.6	42510.8
1) ORERATING & MAINTENANCE	1160.0	1160.0	1170.0	1210.0	1210.0	1220.0	1220.0	2230.0	1480.0	1510.0
2) INTEREST	48811.1	48811.1	48774.2	48182.0	47174.0	45654.8	43847.0	42039.2	40231.4	38423.6
ON LONG TERM DEPOSIT	48811.1	48811.1	48774.2	48182.0	47174.0	45654.8	43847.0	42039.2	40231.4	38423.6
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	-44203.5	-44081.9	-43948.7	-43183.6	-41734.9	-40012.9	-37977.1	-36890.4	-32128.6	-30350.8

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	40703.0	38895.2	37087.3	35279.5	33471.7	31663.9	29856.1	28048.3	26240.4	24432.6
1) ORERATING & MAINTENANCE	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0
2) INTEREST	36615.7	34807.9	33000.1	31192.3	29384.5	27576.7	25768.8	23961.0	22153.2	20345.4
ON LONG TERM DEPOSIT	36615.7	34807.9	33000.1	31192.3	29384.5	27576.7	25768.8	23961.0	22153.2	20345.4
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	-28543.0	-26735.2	-24927.3	-23119.5	-21311.7	-19503.9	-17696.1	-15888.3	-14080.4	-12272.6

Table A-5(2) Income Statement for Industrial and Municipal Use (Nong Pla Lai Sub-Project)

(UNIT: 1000 DOLLAR)

<<< I N C O M E S T A T E M E N T >>>

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	22624.8	20817.0	19009.2	17201.3	15393.5	13585.7	11777.9	9970.1	8162.3	6391.3
1) OPERATING & MAINTENANCE	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0
2) INTEREST	18537.6	16729.7	14921.9	13114.1	11306.3	9498.5	7690.7	5882.8	4075.0	2304.1
ON LONG TERM DEPOSIT	18537.6	16729.7	14921.9	13114.1	11306.3	9498.5	7690.7	5882.8	4075.0	2304.1
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	-10464.8	-8657.0	-6849.2	-5041.3	-3233.5	-1425.7	382.1	2189.9	3997.7	5768.7

	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
1. REVENUE	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0	12160.0
WATER COMSUMPTION (1)	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0	80.0
WATER COMSUMPTION (2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WATER RATE (1)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
WATER RATE (2)	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0	152.0
2. COST	5175.7	4375.9	4087.2	4087.2	4087.2	4087.2	4087.2	4087.2	4087.2	4087.2
1) OPERATING & MAINTENANCE	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0	1510.0
2) INTEREST	1088.5	288.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON LONG TERM DEPOSIT	1088.5	288.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ON SHORT TERM DEPOSIT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3) DEPRECIATION	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2	2577.2
4) OTHERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3. PROFIT	6984.3	7784.1	8072.7	8072.7	8072.7	8072.7	8072.7	8072.7	8072.7	8072.7

Table A-6 Discount Cash Flow for Industrial and Municipal Use
(Nong Pla Lai Sub-Project)

Unit : 1000 US$

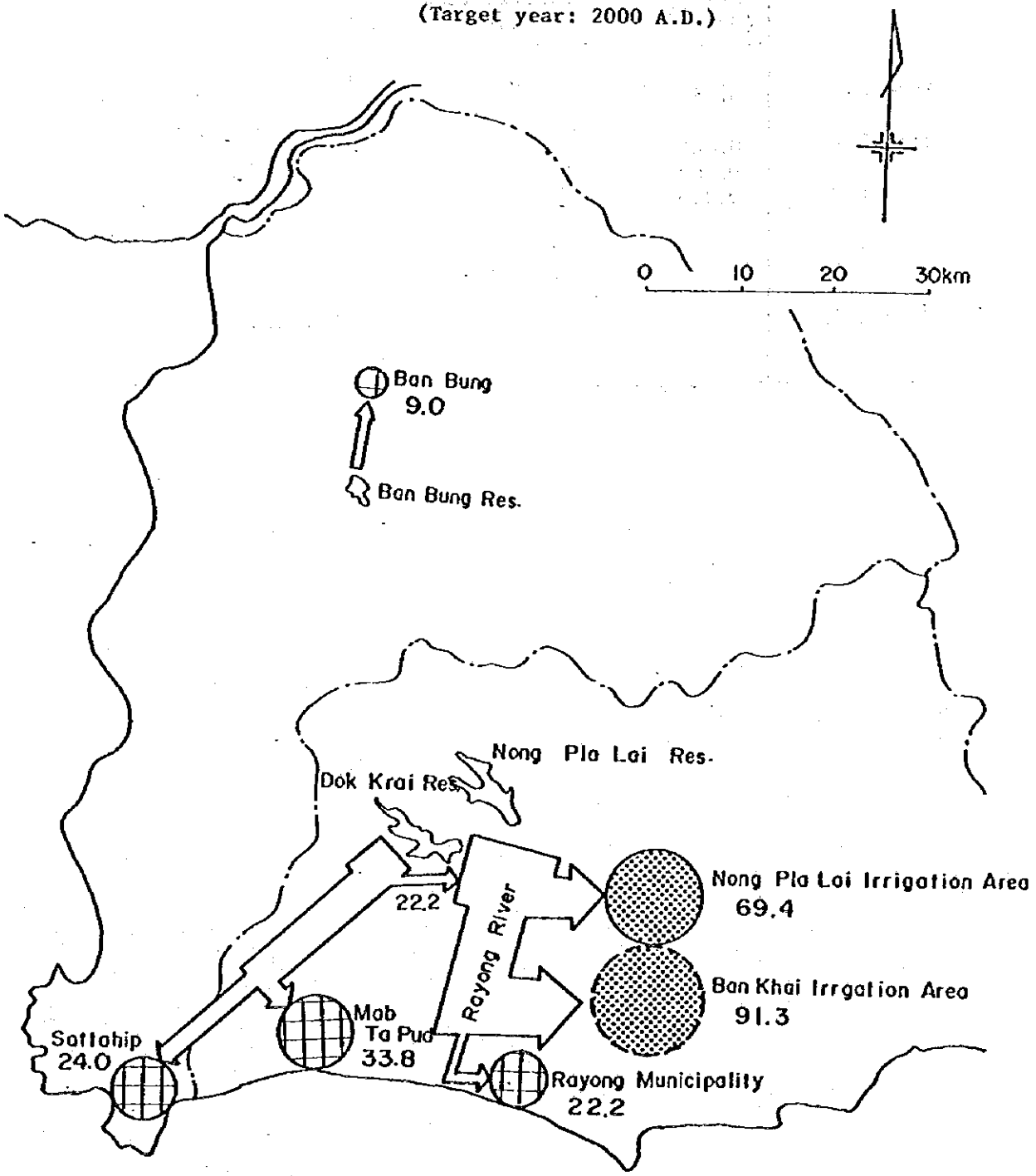
YEAR	CAPITAL COST	REVENUE	OPE. & TAX	BENEFIT
1982	1752.4	0.0	0.0	0.0
1983	36165.5	0.0	0.0	0.0
1984	37157.5	942.4	130.0	812.4
1985	42489.7	2538.4	640.0	1898.4
1986	8836.5	3404.8	790.0	2614.8
1987	0.0	6551.2	980.0	5571.2
1988	0.0	6627.2	980.0	5647.2
1989	0.0	6718.4	990.0	5728.4
1990	0.0	8147.2	1150.0	6997.2
1991	0.0	8253.6	1150.0	7103.6
1992	0.0	8344.8	1160.0	7184.8
1993	0.0	8466.4	1160.0	7306.4
1994	0.0	8752.8	1170.0	7402.8
1995	0.0	8785.6	1210.0	7575.6
1996	0.0	9226.4	1210.0	8016.4
1997	0.0	9439.2	1220.0	8219.2
1998	0.0	9667.2	1220.0	8447.2
1999	0.0	9956.0	2230.0	7726.0
2000	0.0	12160.0	1510.0	10650.0
↓	↓	↓	↓	↓
2031	0.0	12160.0	1510.0	10650.0

Table A-7 Sensitivity Analysis of Industrial and Municipal Water for Nong Pla Lai Sub-Project (Financial)

	Water tariff (US$/$m^3$)	Construction Cost	Delay of Water Demand	IRR (%)
Base Case	0.152			5.9
Case 1-1	0.066			-
1-2	0.109			3.8
1-3	0.200			8.1
Case 2-1		10% up		5.2
2-2		20% up		4.4
Case 3-1			10 years	4.5

Fig. A-1 Water Supply by Dok Krai, Nong Pla Lai and Ban Bung Reservoirs

(Target year: 2000 A.D.)



LEGEND

Municipal-industrial water.

Irrigation water. ---------- Newly developed water by the project.

Irrigation water ------- Vested right water.

Figre is water demand (MCM/Year)

Fig. A-2 General Plan of Ban Khai Head Works

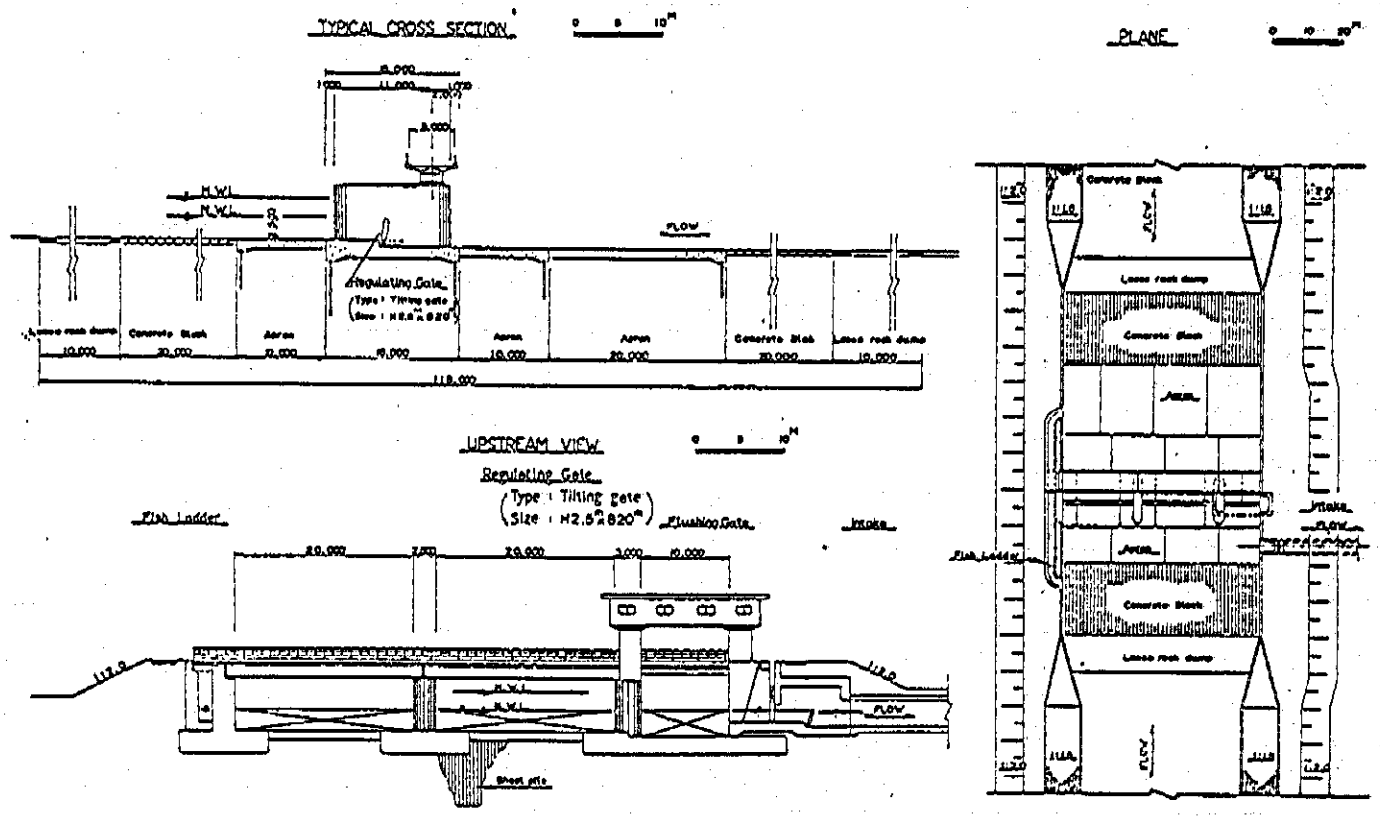
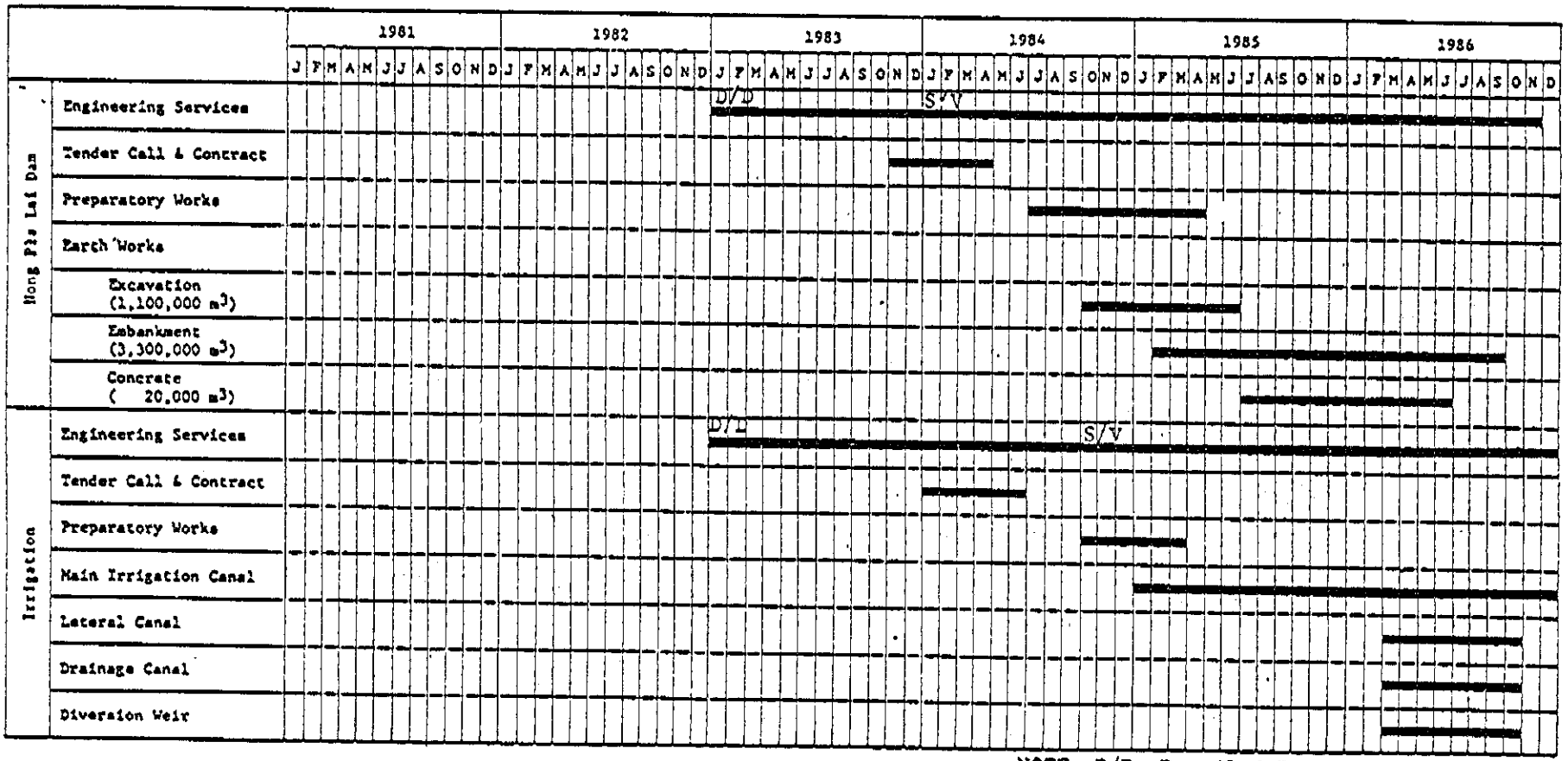


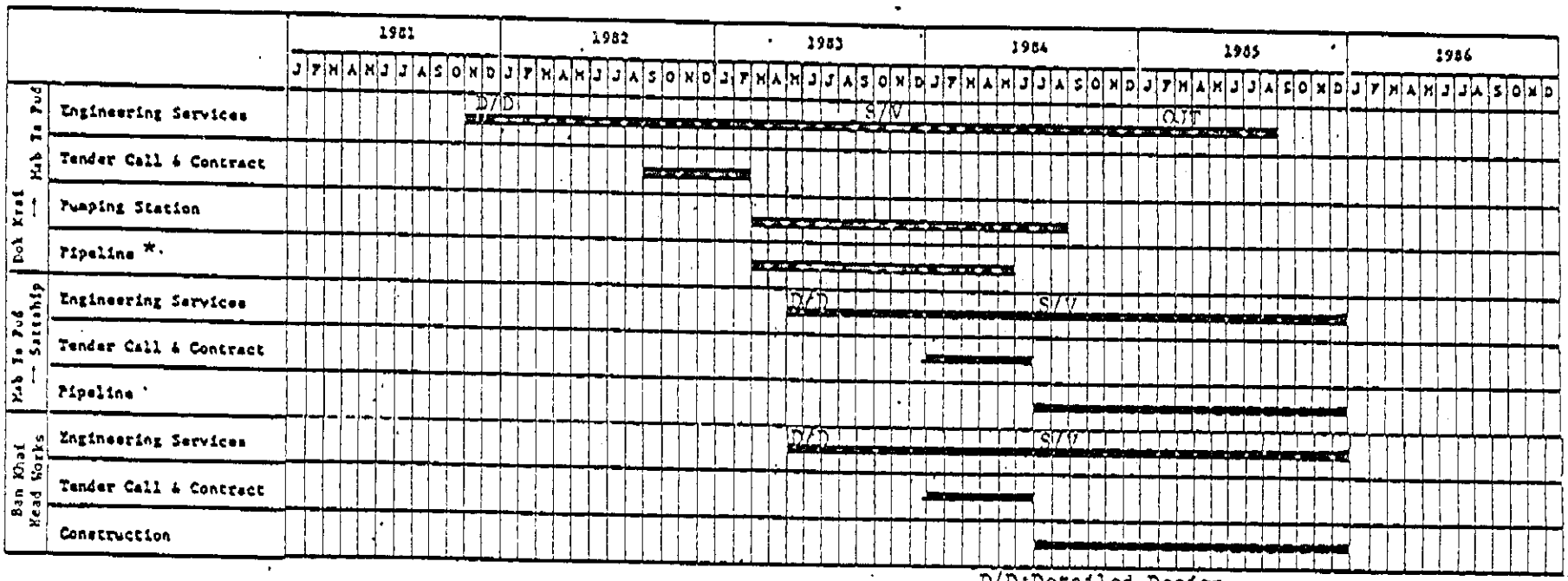
Fig. A-3 Implementation Schedule of Nong Pla Lai Sub-Project (1)



NOTE: D/D: Detailed Design and Preparation of Tender
S/V: Construction Supervision
OJT: On the Job Training

Fig. A-4 Implementation Schedule of Nong Pla Lai Sub-Project (2)

Pipeline



Legend : D/D:Detailed Design
S/V:Supervision
OJT:On the Job Training

アペンディックス　II

1　スコープ　オブ　ワークス

2　議　　事　　録

Scope of Work

for

Feasibility Study on The East Coast Water

Resources Development Project

in

The Kingdom of Thailand

December 11, 1980

K. Hisatake

Keisuke HISATAKE
Team Leader of
Japanese Preliminary Survey Team

Sunthorn Ruangleh

Sunthorn RUANGLEK
Director General
Royal Irrigation Department
Ministry of Agriculture
and Cooperatives

I. Introduction

In response to the request made by the Government of Thailand, the Government of Japan has made the decision to provide a feasibility study on the East Coast Water Resources Development Project (hereinwith referred to as "the Project") in accordance with laws and regulations in force in Japan.

The Japan International Cooperation Agency (JICA) an official agency responsible for implementation of technical cooperation programmes of the Government of Japan, will carry out this Study in close cooperation with Royal Irrigation Department, Ministry of Agriculture and Cooperatives and authorities concerned

II. Objectives of the Study

The objectives of the study are to verify the feasibility of the water resources development project at Nong Pla Lai in Changwat Rayong, and at Ban Bung in Changwat Chonburi.

III. Outline of the Study

The activities to be undertaken by the study team will be divided into two stages;

(1) Field Works in Thailand

(2) Home Office Works in Japan

I. Field Works

(1) To collect and review the relevant existing data and information including;

a. Meteorology and hydrology

b. Topographic map

c. Soil

d. Geology and Geohydrology

e. Irrigation and drainage

f. Agriculture

g. Agricultural and regional economy and institution, etc.

h. Water utilization

To select and delineate the Project Area on the basis of a review of data and information, and a reconnaissance survey.

(3) To carry out Field surveys in the Project Area including the following items;

a. Meteorological and hydrological survey
b. Topographical survey at proposed sites for the major structure
c. Soil survey with digging pits and laboratory analysis
d. Geology and geohydrologic survey
e. Various water requirement surveys
f. Water resource survey
g. Irrigation and drainage survey
h. On-farm development survey
i. Land use survey
j. Socio-economic survey
k. Agricultural survey
l. Regional economic and institutional survey
m. Construction material and cost survey
n. Flood control survey

2. Home Office Works

Based on the results of the field works, the home office works will be carried out by the study of the following items;

(1) the formulation of multi-purpose water resources development plans for the Project Area
(2) the preparation of a Preliminary design for the dam and other structures for the Project
(3) the preparation of a Preliminary design for the irrigation and drainage structure, and other facilities for the agricultural development
(4) the estimation of costs and benefits for the Project

(5) the preparation of an economic evaluation

(6) the preparation of implementation schedule for the project

(7) the study of the effects of flood control

(8) the study of environmental aspect

(9) the study of organization and management for the project

IV. Reports

JICA will prepare and submit the following reports in English to the Government of Thailand:

1. Plan of Operation (30 copies)
   This report will contain the programme for the study with its schedule and will be discussed as soon as possible after the Study team arrives in Thailand.

2. Interim Report (30 copies)
   This report will be submitted within 3 months after the completion of the field survey.

3. Draft Report (30 copies)
   This report will be submitted after the completion of the main home office work.

4. Final Report(150 copies)
   The final report will be submitted within 3 months after receipt of the comments on the draft final report.

V. Undertaking of the Government of Thailand

To facilitate the smooth performance of the field works, the Government of Thailand is requested:

1. to provide the data and information necessary for the study.

2. to provide topographic maps available in the RID and other agencies.

3. to conduct several core borings, including soil tests.

4. to arrange for the quick and smooth customs clearance of the survey equipment and materials which the team members will bring into the field so as to exempt it from taxes and duties imposed by the Government on the goods brought in by the team members into Thailand.

5. to make arrangements for the exemption of income taxes, incurred by the Team during the survey.

6. to request the ministries and other governmental organizations concerned to cooperate with the team in the smooth execution of the survey.

7. to arrange the necessary computer machines and other equipment.

8. to designate the counterpart personnel in the following fields to cooperate with the team in conducting the study effectively:

   1) General Planning
   2) Irrigation & Drainage
   3) Dam Engineering
   4) Land Consolidation
   5) Foundation & Soil Mechanical Engineering
   6) Regional Development Planning
   7) Surveying
   8) Agronomy
   9) Socio-economy
   10) Hydrology
   11) Soil Surveying

   The number of counterpart personnel and their respective assignment periods should be decided by prior consultation by the team with the Thai Authorities concerned at the commencement of the study.

9. to provide office space with furniture for the team.

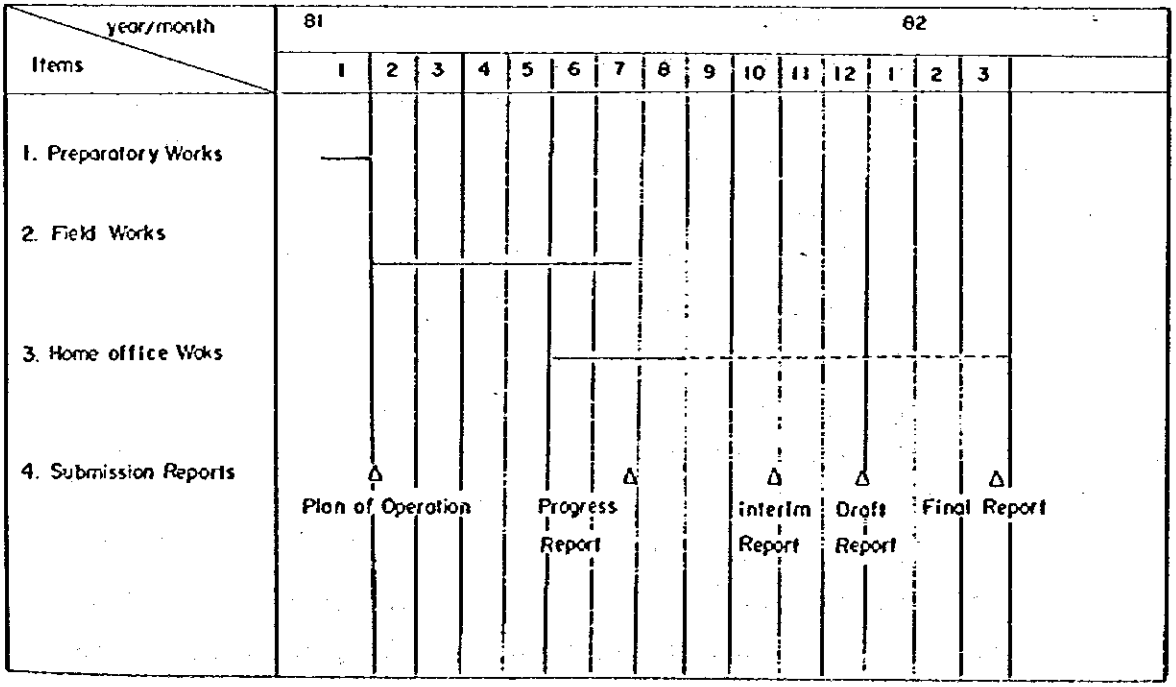
10. to make the necessary arrangements to obtain the permission of the authorities concerned for the team to conduct the survey in the objective areas.

11. Besides the above, to extend close cooperation to the team in every respect for the smooth execution of the study.

VI. Work Schedule

To carry out the study, JICA shall provide the required experts for the survey team in accordance with the work schedule attached.

TENTATIVE WORK SCHEDULE



APPENDIX

Attendance List

1.	Mr. Sunthorn RUANGLEK	Royal Irrigation Department Ministry of Agriculture and Cooperatives
2.	Mr. Boonthai OTAGANONTA	-ditto-
3.	Mr. Boonyok VADHANADHUTI	-ditto-
4.	Mr. Sutin SUSILA	Department of Technical and Economic Cooperation (DTEC)

5. Seven Japanese Preliminary Survey Team headed by Mr. Keisuke HISATAKE

December 11, 1980

MINUTES OF DISCUSSION

In response to the request made by the Government of Thailand, the Government of Japan dispached a preliminary survey team from 30th November 10 13th December 1980, through the Japan International Cooperation Agency (JIAC), to carry out the preliminary survey for the feasibility study on The East Coast Water Resources Development Project in Thailand.

The Team carried out the reconnaisance survey and series of discussion with The Royal Irrigation Department (RID) and authorities concerned during the stay in Thailand.

The main items which were understood by both sides are summerized as follows:

1. Draft "Scope of Work" proposed by the Team was discussed on 2nd, 9th and 11th of December and was reached to the agreement with the RID.

2. The Team was requested to submit the Progress Report including an outline of the Project, rough cost estimates and benefits by the end of July 1981, which will be formed by the feasibility study team.

3. The Team requests the RID for carrying on necessary additional mapping works as follows, before the feasibility study team on duty;

   a. Bush clearing and re-leveling works at Nong Pla Lai and Ban Bung dam axes simulteneously.

   b. Making additional contourlines with one meter intervals on the existing sheets of map, such as
      - Nong Pla Lai Res, sheet No.12910, up to the necessary elevation (49m).
      - Ban Bung Res, sheet No. 10798, up to the necessary elevation (32m).

   The RID admits to carry on the mapping within a short period.

c. Show up the existing main irrigation channels clearly on the sheet No.9612 in the Ban Khai Project area.

4. The Team promises the RID to convey the request on the participation in report preparation with RID's engineers, to the Japanese Government.

11th December 1981

K. Hisatake

Keisuke HISATAKE
Team Leader
of
apanese Preliminary Survey Team

Boonthai Otaganonta

Boonthai OTAGANONTA
Director, Design Division
Royal Irrigation Department
Ministry of Agriculture
and Cooperatives

MINUTES OF DISCUSSIONS

1. In response to the request made by the Government of Thailand, an advisory team (The Team) was dispatched by the Government of Japan from May 28 to June 4, 1981 through the Japan International Cooperation Agency (JICA), to carry out the additional study on the pipe-line system for the industrial and municipal water (the Additional Study) to the Feasibility Study on the East Coast Water Resources Development Project (the Main Study), the Scope of Work for which was signed on December 11, 1980.

The Team carried out a field survey and held a series of discussions on the Additional Study with the Royal Irrigation Department (RID), during their stay in Thailand.

The final meeting between RID and the Team was held on June 3, 1981. A list of attendance in the final meeting is attached as Annex.

2. RID and the Team reached the following agreement and understanding on the framework of the Additional Study.

3. Objective of the Additional Study

The objective of the Additional Study are to formulate the pipeline system from Nong Pla Lai dam and Dok Krai dam and to verify the feasibility of the pipeline system for the Industrial and municipal water, in addition to the Main Study.

4. The AdditionalStudy consists of the followings

4-1. The Additional Study Area

a. Water source: Nong Pla Lai dam, Dok Krai dam.

b. Service area: Map Ta Pud, Sattahip.

4-2. Outline of the Additional Study

a. to collect and review the relevant existing maps, data, information and the study reports concerning the pipeline system in the Additional Study

area for the proper plan formulation.

b. to conduct studies in the aspect of topography and foundation geology.

c. to study the alternative plans for water conveyance including outlet work, pumping station, pipe line, receiving basin etc., based on the topographical, geological and water demand studies, so as to obtain the most adequate concepts for project formulation.

d. to conduct layout and preliminary design for the pipe-line system and the related structures.

e. to conduct studies on construction plan and cost estimation.

5. The Additional Study is to be conducted in accordance with the following tentative schedule.

Field Survey: Middle of July - Middle of August, 1981,

Interim Report: End of October, 1981

Draft Report: End of December, 1981

Final Report: End of March, 1982

6. The additional undertakings by the Government of Thailand are requested as follows:

1) To conduct geological exploration and profile survey along the pipe-line route.

2) To conduct topographic survey at the main structures.

7. This minutes is subject to the approval of the Minister of the Agriculture and Cooperatives, which should be informed to the Government of Japan by June 15, 1981.

June 3, 1981

Keisuke Hisatake

Keisuke HISATAKE
Team Leader
of
Japanese Advisory Team

Sunthorn Ruanglek

Sunthorn Ruanglek
Director General
of
Royal Irrigation Department

Annex

Attendance List

Mr. Sunthorn Ruanglek	Director General Royal Irrigation Department
Mr. Boonthai Otaganonta	Director, Design Division Royal Irrigation Department
Mr. Keisuke Hisatake	Team Leader Japanese Advisory Team
Mr. Norihiro Endo	Member Japanese Advisory Team
Mr. Yukihisa Sakurada	Co-ordinator Japanese Advisory Team
Mr. Takashi Kaneko	JICA, Bangkok Office

THE EAST COAST WATER RESOURCES

DEVELOPMENT PROJECT

MINUTES OF MEETING

held on February 17 & 18, 1981

I. Present:

1.	Boonthai Otaganonta	Royal Irrigation Department
2.	Boonyok Vadhanaphuti	"
3.	Prahas Masamondana	"
4.	K. Hisatake	Head, Advisory Committee
5.	T. Endo	Member, Advisory Committee
6.	M. Yatazawa	Leader, Japanese Survey Team
7.	Y. Ishii	Member, Japanese Survey Team
8.	H. Suganuma	"
9.	F. Nakajima	"
10.	H. Takahashi	"
11.	Y. Nakao	"
12.	K. Ishizuka	"
13.	K. Miyoshi	Japan International Cooperation Agency
14.	Kaneko	"

II. Matters Arising:

At the commencement of the meeting, the members of the Japanese Survey Team (the Team) were welcomed by the Directors of the Royal Irrigation Department (the RID). The followings are the matters taken up for discussion:

1. The Inception Report was submitted by the Team to the RID. The content of the report was appreciated by the RID.

2. As to the request made by the Team concerning the accomodation for office use, the RID has agreed to provide one in the Bangkok Head Office and one each at Rayong and Chon Buri.

3. The counterpart staff to the experts of the Team will be assigned by the RID from time to time as the Team requires.

4. After the review of the available data by the Team, necessary survey work will be conducted by the RID with Team's surveying engineer supervising the procedures in the field and in the office.

5. After the review of the available data by the Team, necessary geologic survey in the proposed dam sites and other relevant locations will be conducted by the RID. The geology and soil engineer of the Team will be at hand to supervise the undertaking.

6. After the review of the available data by the Team, the soil tests required will be conducted by the RID in collaboration with the geology and soil engineer from the Team.

7. The RID will conduct the door-to-door interview required to collect the firsthand information on the actual flood damage, under the supervision of the member of the Team.

8. As to the Team's request for setting up a working group for the coordination among concerned agencies, the RID has agreed to make necessary arrangements.

M. Yatazawa

Masaharu Yatazawa
Team Leader
JICA East Coast Water Reosurces
Development Project

Boonthai Otaganonta

Boonthai Otaganonta
Director
Design Division
Royal Irrigation Department

THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT

Minutes

The Study Team and the Advisory Team from JICA for the purpose of submitting the Progress Report have been dispatched from July 22 to 31, 1981.

They held a series of discussions on the Progress Report. The final meeting with the Royal Irrigation Department (RID), the National Economic and Social Development Board (NESDB) and the National Environment Boad (NEB) was held on July 29, 1981.

The list of attendance in the final meeting is attached as Annex.

The following agreements and understandings reached in the meeting will be taken into the Interim Report.

1. (Water Demand)

In the Study of water supply and demand, the Sattahip Naval Base is not taken into consideration.

2. (Water Allocation)

The allocation of developed water and reservoir capacity among industry and municipality irrigation, and flood control is agreed upon as shown in the Progress Report.

3. (Hydro-Power Generation)

The outlet penstock and foundation of turbine for small scale hydro-power generation will be taken into consideration in the preliminary design of Nong Pla Lai Dam.

4. (Operation of Dok Drai and Nong Pla Lai Dam)

Available water of 89 MCM/year at Dok Krai Reservoir will be utilized mainly for industry and municipality and 119 MCM/year at Nong Pla Lai Reservoir will be utilized mainly for irrigation. The two Reservoirs will be connected with pipe line for combined operation.

5. (Resettlement)

The resettlement for the families which is expected to be submerged will be studied in general. It is considered as an option of compensation.

6. (Operation and Maintenance)

RID takes responsibility of operation and maintenance of dam and irrigation systems. As for the pipe line system, the administrative agency is not yet decided.

7. (Environment)

Environmental impact will be studied,in general, in accordance with the NEB's guideline and one chapter of the Interim Report will be allocated to the impact study. Photoes will be attached to the Report to show the present natural and social conditions.

8. (Pipe Line)

The findings on the pipe line in the Progress Report are only in the reconnaissance stage.

9. (Diameter of Pipe Line)

The proposed diameter of 1,500 mm for Dok Krai-Map Ta Pud route will be reviewed in the further study.

July 30, 1981

Y. Katayama

YUICHI KATAYAMA

Team Leader

JICA Survey Team

East Coast Water Resources

Development Project

Boonthai Otaganonta

BOONTHI OTAGANONTA

Director

Design Division

Royal Irrigation Department

T. Takeuchi

TATSUO TAKEUCHI

Member

JICA Advisory Team

ANNEX ATTENDANCE LIST OF FINAL MEETING

Mr. Boonthai	Otaganonta	Royal Irrigation Department
Mr. Prasarn	Leelasara	"
Mr. Phyool	Chantasiro	"
Dr. Boonyok	Vadhanaphuti	"
Mr. Prasert	Milintaugul	"
Mr. Kamol	Chitarkon	"
Mr. Amphai	Muthitacharoen	"
Mr. Manas	Sanguandikul	National Economic and Social Development Board
Mr. Witit	Rachatatanun	"
Mr. Suroj	Sutthiapha	"
Mr. Chalermsak	Wanichsombat	National Environment Boad
Mr. Yuichi	Katayama	Team Leader, JICA Survey Team
Mr. Yumio	Ishii	Asst. Leader, "
Mr. Hirokazu	Koriki	Member, "
Mr. Yutaka	Nakao	" "
Mr. Tatsud	Takeuchi	Member, JICA Advisory Team
Mr. Tetsuro	Miyasato	" "
Mr. Yukihisa	Sakurada	" "

THE EAST COAST WATER RESOURCES DEVELOPMENT PROJECT

FEASIBILITY STUDY

MINUTES OF DISCUSSIONS

I. Introduction

1. The Study Team/together with the Advisory Team from JICA (The Team) visited Thailand from November 4 to 11, 1981. The Team submitted the Interim Report of the Feasibility Study (the Study) on the Water Resources Development Project (the Project), and held a series of discussions on result of the Study with the officials of the Royal Irrigation Department (R I D) and the National Economic and Social Development Board (NESDB). The list of attendants is attached as Annex I.

2. The followings are certain matters for clarification and further study which were discussed and agreed upon.

II. Water Demand and Supply

3. The Team explained the water demand whose estimation is mainly based on the East Coast Development Plan prepared by the Committee for the Primary Industry Development and Deep Sea Port in the Eastern Seaboard. The Team mentioned the importance of the estimation of water demand which affects directly on the project component, especially to the pipe-line system, its design discharge and construction schedule and asked clarification of the East Coast Development Plan.

4. RID and NESDB clarified the East Coast Development Plan and through the discussion the followings are agreed upon.

1) The Study will be performed based on the water demand as Annex II.

2) The municipal water to the Rayong City and its vicinity will be supplied through the Rayong river, not through the pipe-line system.

3) Industrial and municipal water demand has the first priority and the Project will be designed firstly so as to meet this demand considering the existing storage capasity of the Dok Krai dam and proposed Nong Pla Lai dam.

4) In the Study industrial and municipal water demand for Laem Chabang area is designed so as to be supplied through the pipe-line system from Dok Krai dam.

5) Ban Bung dam will be designed so as to meet the municipal water demand in Ban Bung City and the vested water right of the existing Ban Bung dam.

6) In order to meet the future increase of water demand which the Project can not fully meet, further development of water resources will be essential.

7) NESDB clarified chemical fertilizer plant will be completed in 1984. The water demand will be modefied according this information.

III. Project Design

Nong Pla Lai Dam

5. RID proposed the utilization of dead water storage for the urgent water supply in the period of drought. The Team accepted the proposal. The design of the dam will be modified so as to be installed with an outlet below the low water level.

Pipe-Line System

6. There is no question for the utilization of pipe-line system for the transmission of the industrial and municipal water.

7. The discussion was concentrated on the pipe-line system from Dok Krai Dam to Mab Ta Pud. The Team presented the alternatives of the system which is shown in Annex III. The Team also mentioned the selection among the alternatives has to be performed considering water demand, construction schedule and cost.

8. After the discussion on this matter, single pipe, pipe-line system with steel pipe of 1,350 mm. diameter, shown in Annex III, is clearified as the most preferable plan.

Dok Krai Dam

9. There is no comment on the pumping station which will be constructed by concrete caisson method. RID mentioned there is no possibility of draw-down of reservoir for the construction.

IV. Construction Schedule

10. The Team presented the construction schedule of the Project as shown in the Interim Report. Through the exchange of information and discussion, the schedule, at the Interim Report Stage, were modified considering the required period for selection of consultant and construction contract. The schedule is shown in Annex IV.

11. The Team mentioned the modified schedule is ~~not normal~~ very tight. It is performed considering the other development projects, especially the Natural Gas Separation Plant Project. The Team recommended the closest coordination between the two projects at the further study and construction.

V. Project Cost

12. RID and NESDB raised the question on the project cost, especially on the pipe-line system and asked the Team to clarify the cost estimation.

13. The Team explained the contents of the cost. The both sides had a discussion to find out the best way for the alternative selection considering such fact affecting to the cost as water demand, construction method and schedule etc.

14. The Team tentatively estimated the project cost of the pipe-line system from Dok Krai Dam to Mab Ta Pud according to the project component and the result is attached as Annex V. The cost estimation is still at the interim stage and cost estimation will be finalized in futher study.

15. The unit cost by RID as of February 1981 is applied for cost estimation.

16. The exchange rate-US $ 1.0 = ฿ 23.0 = ¥ 230.0 as of November 1981 is applied for cost estimation.

17. Metal material and its products, cement, oil and fuel, construction and gauging equipment are counted in foreign currency portion. Steel pipe, pump and their related equipment are estimated based on CIF cost from Japan.

VI. Operation and Maintenance

18. The Team requested the clarification of the organization for the operation and maintenance of the pipe-line system. RID mentioned no decision was made yet by the Government of Thailand and NESDB will make the decision to make IEAT or PWWA take the responsibility. The Team recommended earliest decision is required not only for the study but also for the project implementation.

19. The Team proposed the required personnel and RID took it as an suggestion. The ordinary manual operated control and gauging facilities will be adopted in the place of sophisticated electronic facilities.

VII. Project Evaluation

20. The Team explain the tariff in the Project. RID and NESDB agreed the result of the Study. The Team recommend the necessity of further study on the tariff structure.

21. The life time of the facilities by Design Criteria for Water Works by Japan Water Works Association (JWWA) will be applied for economic analysis.

Miscellaneous

22. Japan Industrial Standard (JIS), Design Criteria by JWWA and other related Japanese criteria will be applied to the design.

November 10, 1981

Y. Katayama

YUICHI KATAYAMA
Team Leader,
JICA Study Team
East Coast Water Resources
Development Project.

Boonthai Otaganonta

BOONTHAI OTAGANONTA
Chief Engineer
for Civil Engineering,
Royal Irrigation Department.

Joji Harada

JOJI HARADA
JICA Advisory Team

List of Attendants

Royal Irrigation Department

1. Mr. Boonthai Otaganonta
   Chief Engineer for Civil Engineering

2. Dr. Boonyok Vadhanaphuti
   Director, Project Planning Div.

3. Mr. Chari Tulayanond
   Director, Medium Scale Const. Div.

4. Mr. Shoombhol Chaveesuk
   Director, Design Div.

5. Mr. Osot Charnvej
   Operation and Maintenance Div.

6. Mr. Dhongchart Chullasuk
   Project Planning Div.

7. Mr. Prasert Milintaugul
   Hydrology Div.

8. Mr. Taweechai Mackaman
   Project Planning Div.

9. Mr. Suthep Tingsabhat
   Program and Budget Div.

10. Dr. Katsuhiko Kimura
    Colombo Plan Expert, Project Planning Div.

National Economic and Social Development Board

1. Dr. Savit Bhotiwihak

   Director, Center for Integrated Plan of Operation

2. Mr. Manas Sanguandikul

   Civil Engineer, Center for Integrated Plan of Operation

Japan International Cooperation Agency

Advisory Team

1. Mr. Joji Harada

   Ministry of Construction

2. Mr. Tetsuro Miyasato

   Ministry of Agriculture, Forestry and Fishery

3. Mr. Koichi Miyoshi

   JICA cordinator

Study Team

1. Mr. Yuichi Katayama

   Team Leader,

2. Mr. Yumio Ishii

   Assistant Team Leader.

3. Mr. Hirokazu Koriki

   Agricultural Development Planner

4. Mr. Yutaka Nakao

   Economist

5. Mr. Hisataka Suganuma

   Hydrologist

6. Mr. Fumio Enomoto

   Pipe-line Engineer

The East Coast Water Resources Development Project

Feasibility Study

MINUTES OF DISCUSSIONS

1. The Study Team (the Team) together with the Advisory Team from JICA visited Thailand from December 14 to 20, 1981. The Team submitted the Draft Final Report and Supporting Report with the Appendix of the Feasibility Study (the Study) on the Water Resources Development Project (the Project), and held a series of discussions on the result of the Study with the officials of the Royal Irrigation Department (RID) and the National Economic and Social Development Board (NESDB). The list of attendants is attached as Annex.

2. The Team made the briefing on the result of the Study and RID accepted it as a whole. The followings are comments of RID and certain matters agreed upon.

3. The proposed schedules at the feasibility stage are agreed upon except that of the preparatory works for dams. Since the preparatory work will be conducted by a contractor, this portion of the schedule is to be revised.

4. RID mentioned that RID will make an additional study of the adoption of the construction by force account basis. In this connection, the Team will submit the data and information as soon as possible.

5. The proposed routes of pipelines, adoptation of steel pipe, its diameter and the necessity of imported steel pipe are clarified by the Team and agreed upon by the both parties.

6. As for the possible contamination of reservoir, RID mentioned the sewage treatment. In this connection, the Team agreed upon to

revise the 3rd paragraph of " 11. Environment" and " 15. Reconmendation" of Summary of the Report as follows.

11. Environment

(3rd paragraph)

The present condition of water quality of the reservoirs and the rivers is found to be clean enough for water supply, though there is no sewage treatment system in the catchment areas which is categorized as rural area. But the future development of municipalities and industries in the areas might possibly cause water contamination though not in near future.

15. Recommendation

9) Water Contamination

When the possible water contamination in the reservoirs and rivers may be anticipated, structural counter-measures as well as enforcement of legal regulations will become necessary.

7. The comments of RID on the Draft Final Report which is to be submitted until January 15, 1982 will be studied and compiled into the Fianl Report.

December 18, 1981

Y. Katayama
(YUICHI KATAYAMA)
Team Leader,
JICA Study Team for
East Coast Water Resources
Development Project

(BOONTHAI OTAGANONTA)
Chief Engineer for Civil
Engineering.
Royal Irrigation Department

Keisuke Hisatake
(KEISUKE HISATAKE)
Team Leader
JICA Advisory Team

ANNEX 1 LIST OF PARTICIPANTS

Place : RID Conference Room

Date : Dec. 15, 1981

	NAME		POSITION
1. MR.	BOONTHAI	OTAGANONTA	Chief Engineer for Civil Engineering, RID
2. MR.	SHOOMBHOL	CHAVEESUK	Director of Design Div, RID
3. MR.	PHYOOL	CHANTASIRO	Director Survey Division, RID
4. MR.	DAMRONG	JARASWATHANA	Director of Hydrology Div.
5. MR.	PRASARN	LEELASORN	Director, Soil & Geo. Survey
6. MR.	SUTHEP	TINGSABHAT	Director, Program & Budget Div.
7. MR.	CHAREUK	NONTHATHUM	Director, Large Project Construction Div.
8. MR.	SUHA	THANOMSINGHA	Director of Region Office, RID
9. MR.	PRAKAI	SASTRAVAHA	Large Project Construction Div. RID
10. MR.	KAMOL	CHITARKON	Large Project Construction Div. RID
11. MR.	RUONGRIT	AMMAWAT	Chief Dam Design Branch, RID
12. MR.	JUMROEN	PANITYING	Medium Project Construction Div. RID
13. MR.	CHALERMTHEP	RATANAPRAYOON	O & M Div. RID
14. MR.	PAIROJ	NANONGKAI	Law and Land Div. RID
15. MR.	SUPHON	CHIRAPUNTU	Chief, Soil Eng. Investigation Branch. RID
16. MR.	DHONGCHART	CHULLASUK	Economic Branch, Project & Planning Div. RID
17. MR.	SUTHI	SONGVORAVIT	Chief, Policy Planning Br.,Proj. Planing Div.RID
18. MR.	KATSUHIKO	KIMURA	Colombo Plan Expert, Project Planning Div. RID
19. MR.	SAVIT	PHOTIVIHOK	Secretary,CIPO, NESDB
20. MR.	MANAS	SANGUANDIKUL	CIPO, NESDB
21. MR.	KUMROPLUK	SURASWADI	CIPO, NESDB
22. MR.	HIDEAKI	KONDO	First Secretary, Embassy of Japan
23. MR.	YUICHI	KATAYAMA	Team Leader, JICA Team
24. MR.	YUMIO	ISHII	JICA Team
25. MR.	YUTAKA	NAKAO	JICA Team
26. MR.	KEISUKE	HISATAKE	Advisory Team of JICA
27. MR.	TOSHIHIRO	ENDO	Advisory Team of JICA
28. MR.	KOICHI	MIYOSHI	Coordinator, JICA
29. MR.	TADASHI	NITTA	Coordinator, JICA

ANNEX 2 LIST OF PARTICIPANTS

Place : RID Conference Room
Date : Dec. 16, 1981

	NAME		POSITION
1.	MR. BOONTHAI	OTAGANONTA	Chief Engineer for Civil Engineering, RID
2.	MR. PRAHAS	MASAMONDANA	Chief, Design Section 6th Design Div. RID
3.	MR. PRAKAI	SASTRAVAHA	Large Scale Construction Div. RID
4.	MR. SUWIT	THANOPANUWAT	Civil Engineer, Project Planning Div. RID
5.	MR. SIRIPONG	HUUGSPREUG	Civil Engineer, Section 6th, Design Div. RID
6.	MR. YUICHI	KATAYAMA	JICA Team
7.	MR. YUMIO	ISHII	JICA Team
8.	MR. YUTAKA	NAKAO	JICA Team
9.	MR. FUMIO	ENOMOTO	JICA Team
10.	MR. KEISUKE	HISATAKE	Advisory Team, JICA
11.	MR. TOSHIHIRO	ENDO	Advisory Team, JICA
12.	MR. YUICHI	MISHIMA	Advisory Team, JICA
13.	MR. KOICHI	MIYOSHI	Coordinator, JICA
14.	MR. TADASHI	NITTA	Coordinator, JICA

ANNEX 3 LIST OF PARTICIPANTS

Place : RID Conference Room

Date : Dec. 17, 1981

	NAME		POSITION
1.	MR. BOONTHAI	OTAGANONTA	Chief Engineer for Civil Engineering, RID
2.	MR. PRAHAS	MASAMONDANA	Chief Design Section 6th, Design Div. RID
3.	MR. PRAKAI	SASTRAVAHA	Large Scale Construction Division RID
4.	MR. SUWIT	THANOPANUWAT	Civil Engineer, Project Planning Div. RID
5.	MR. SIRIPONG	HUNGSPREUG	Civil Engineer, Design Div. RID
6.	MR. YUICHI	KATAYAMA	Team Leader, JICA
7.	MR. YUMIO	ISHII	Assist. Team Leader, JICA
8.	MR. YUTAKA	NAKAO	Economist, JICA Team
9.	MR. KEISUKE	HISATAKE	Advisory Team, JICA
10.	MR. TOSHIHIRO	ENDO	Advisory Team, JICA
11.	MR. KOICHI	MIYOSHI	Coordinator, JICA
12.	MR. TADASHI	NITTA	Coordinator, JICA

JICA