

FIGURES

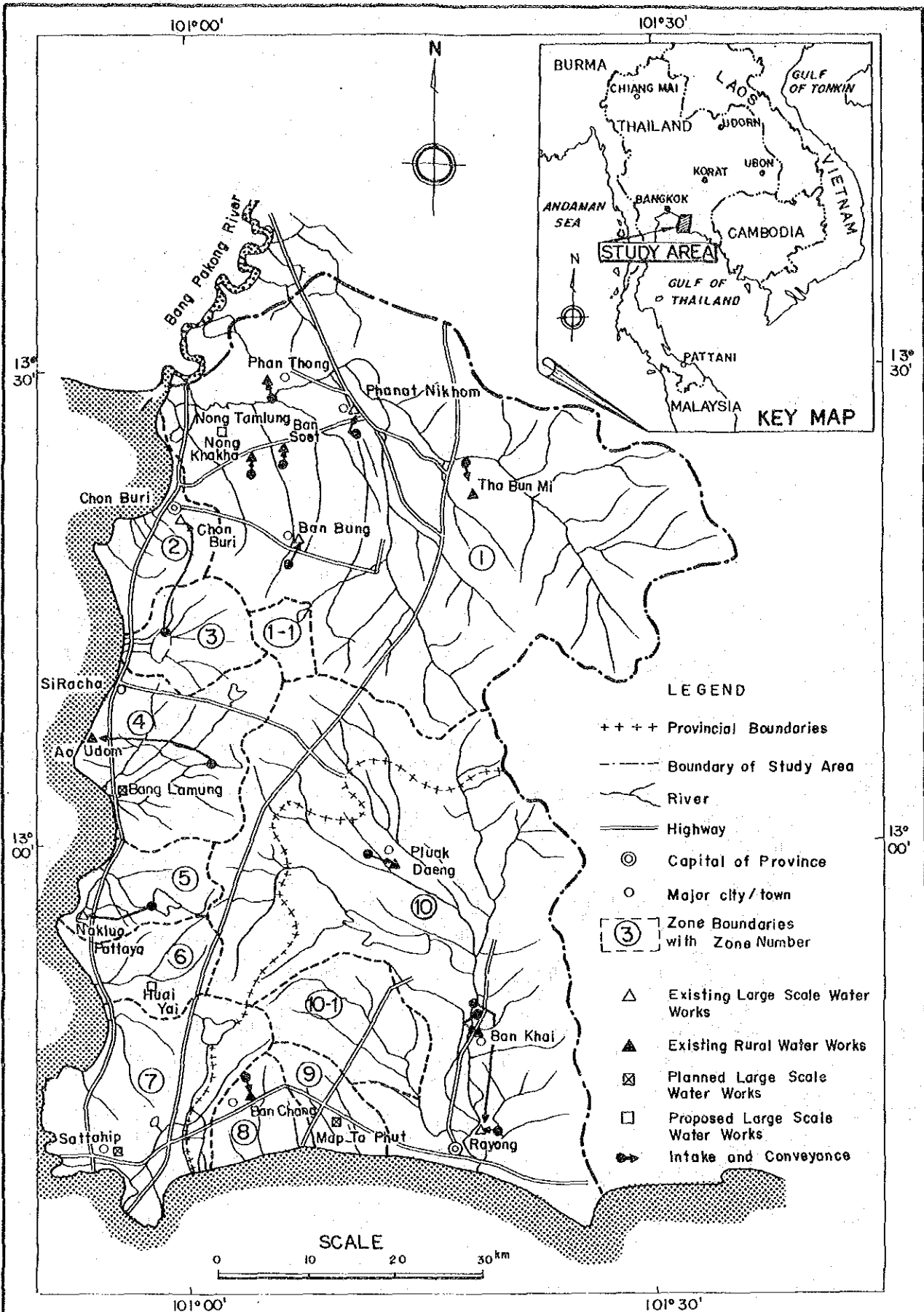


Fig. 1 Location Map of Water Works in the Study Area

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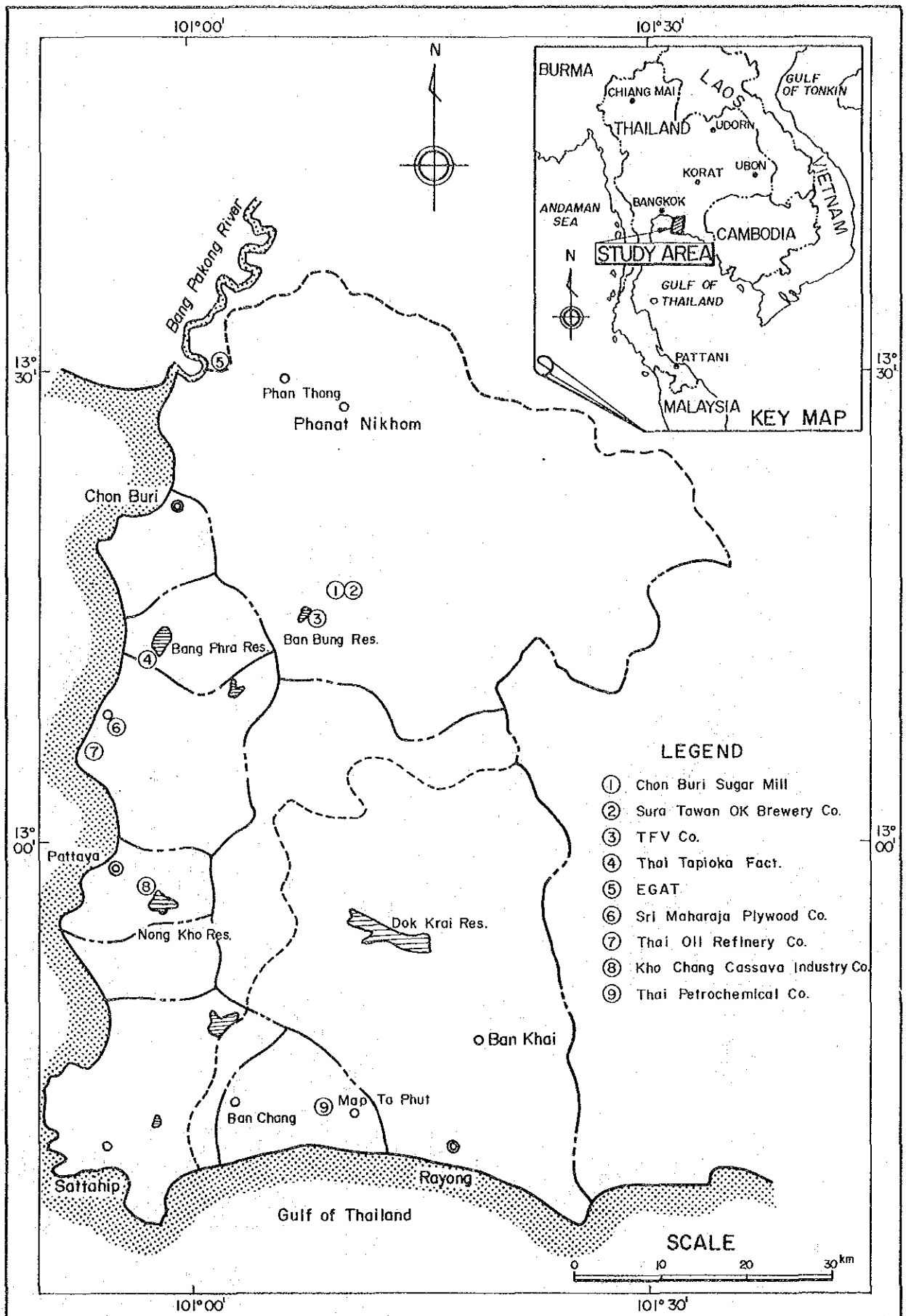
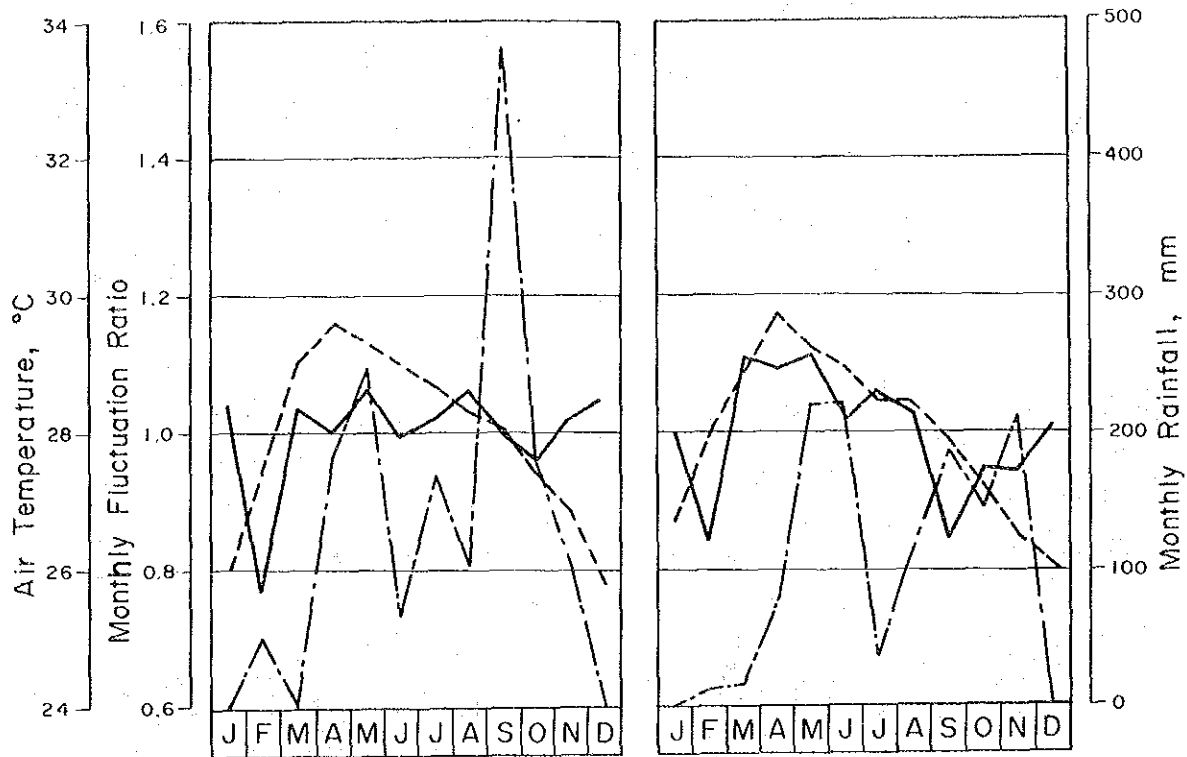


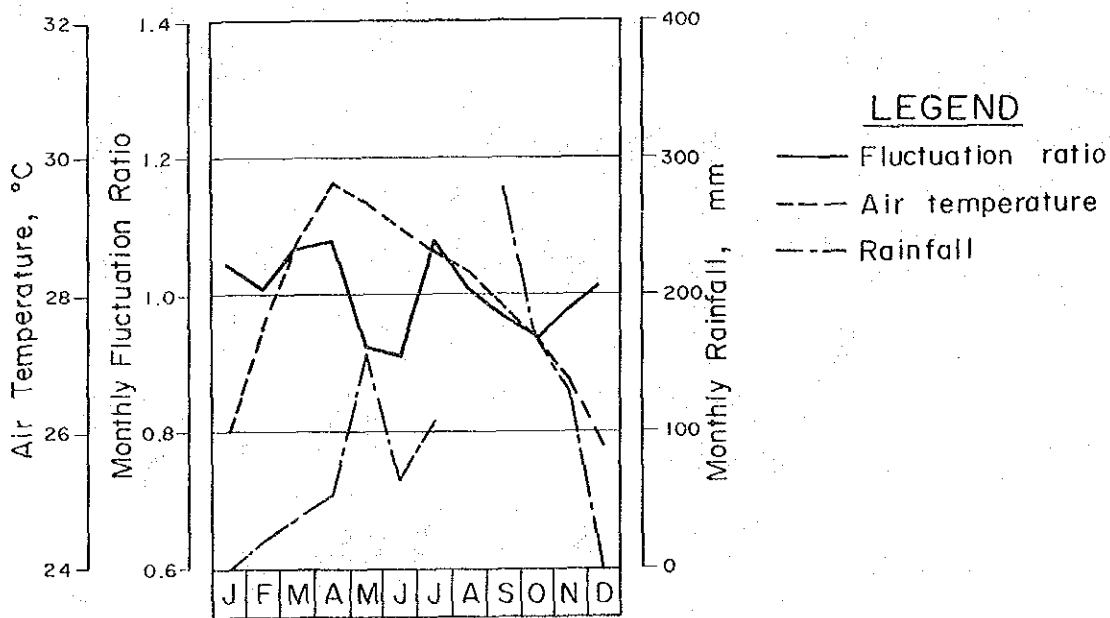
Fig. 2 Location Map of Private Water Users

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Chon Buri Water Works

Rayong Water Works



Ban Bung Water Works

Fig. 3 Relationship between Fluctuation Ratio, Air Temperature and Rainfall

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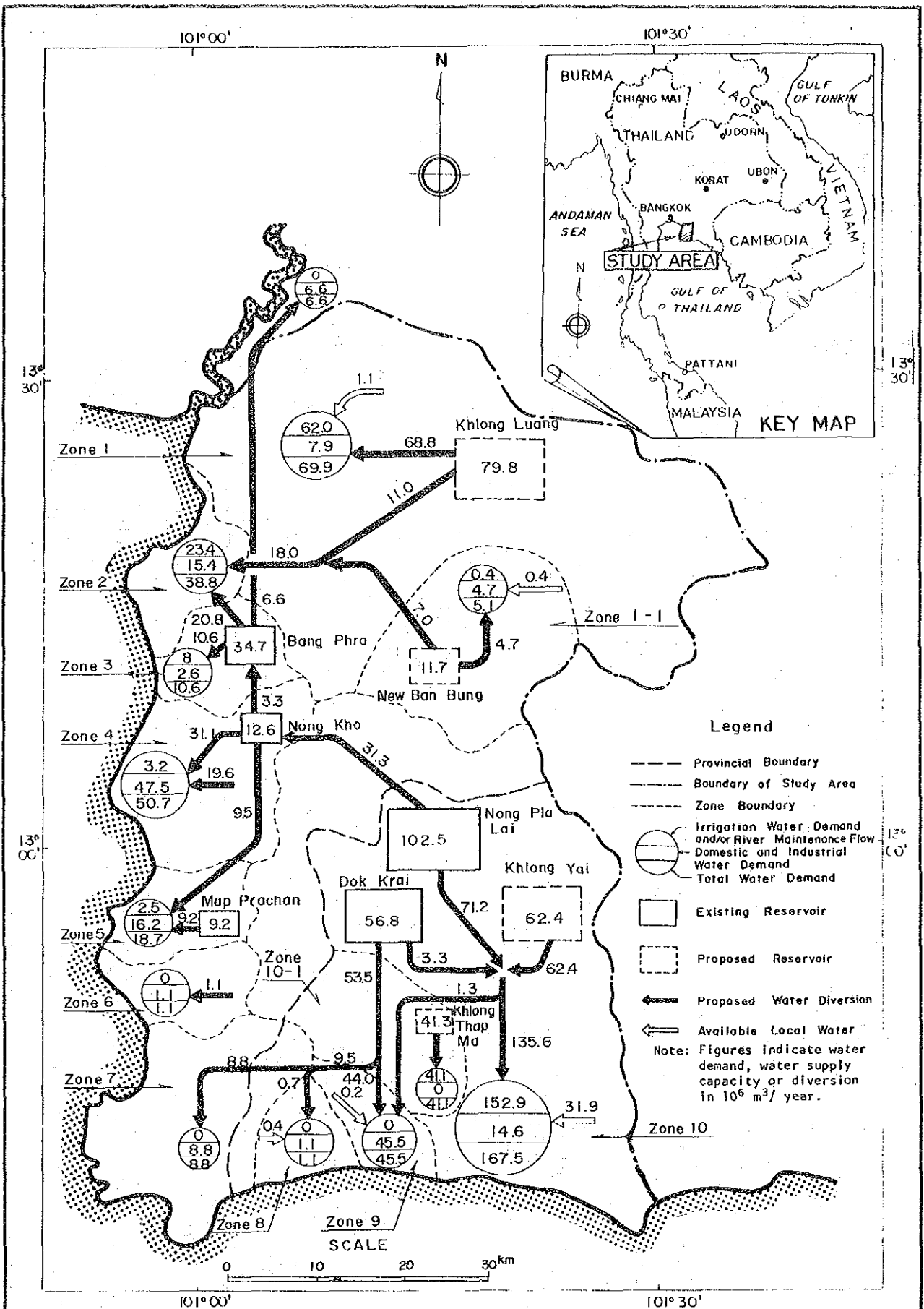


Fig. 4 Water Supply Plan in 2001, Alternative I

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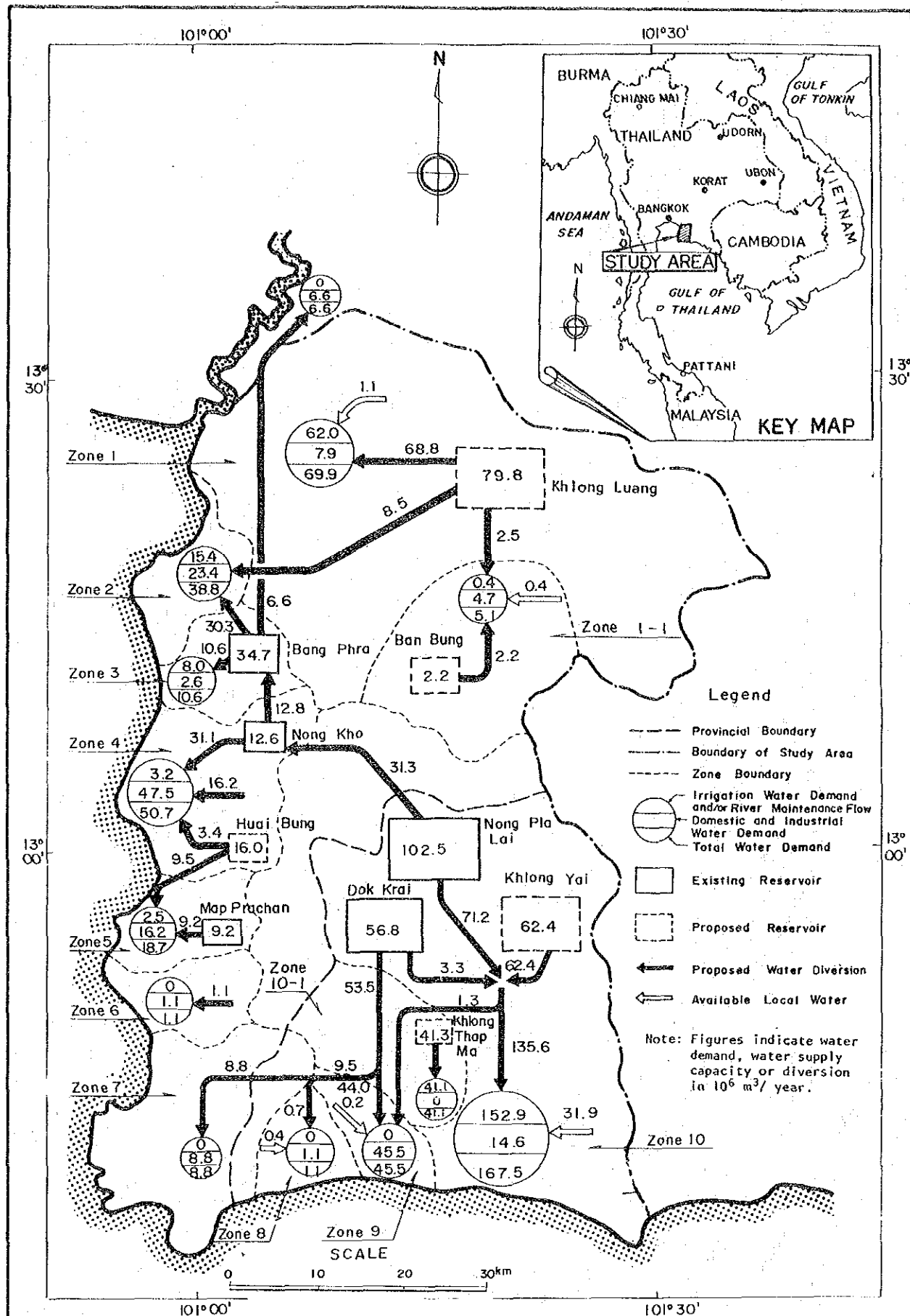


Fig. 5 Water Supply Plan in 2001, Alternative II

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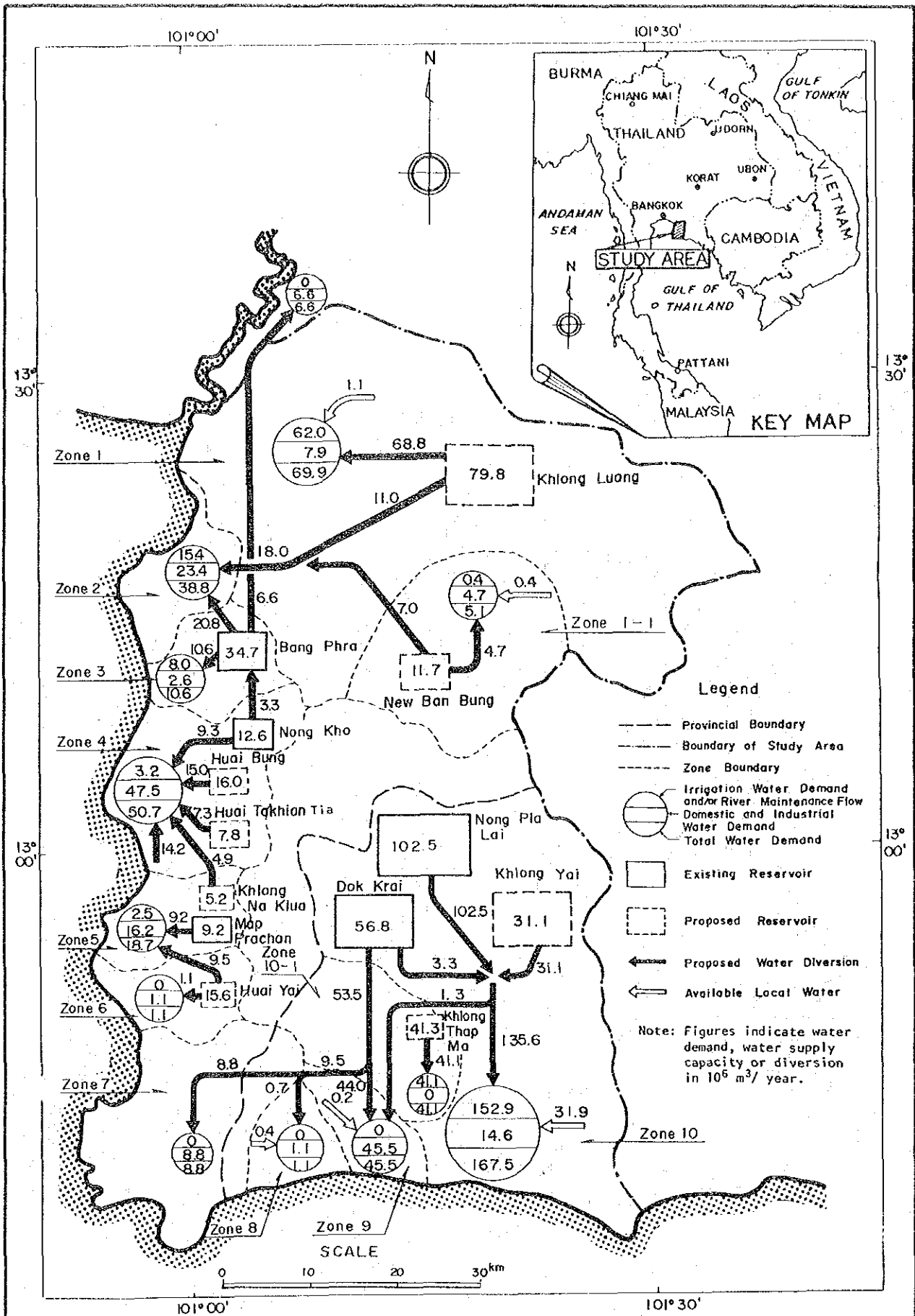


Fig. 6 Water Supply Plan in 2001, Alternative III

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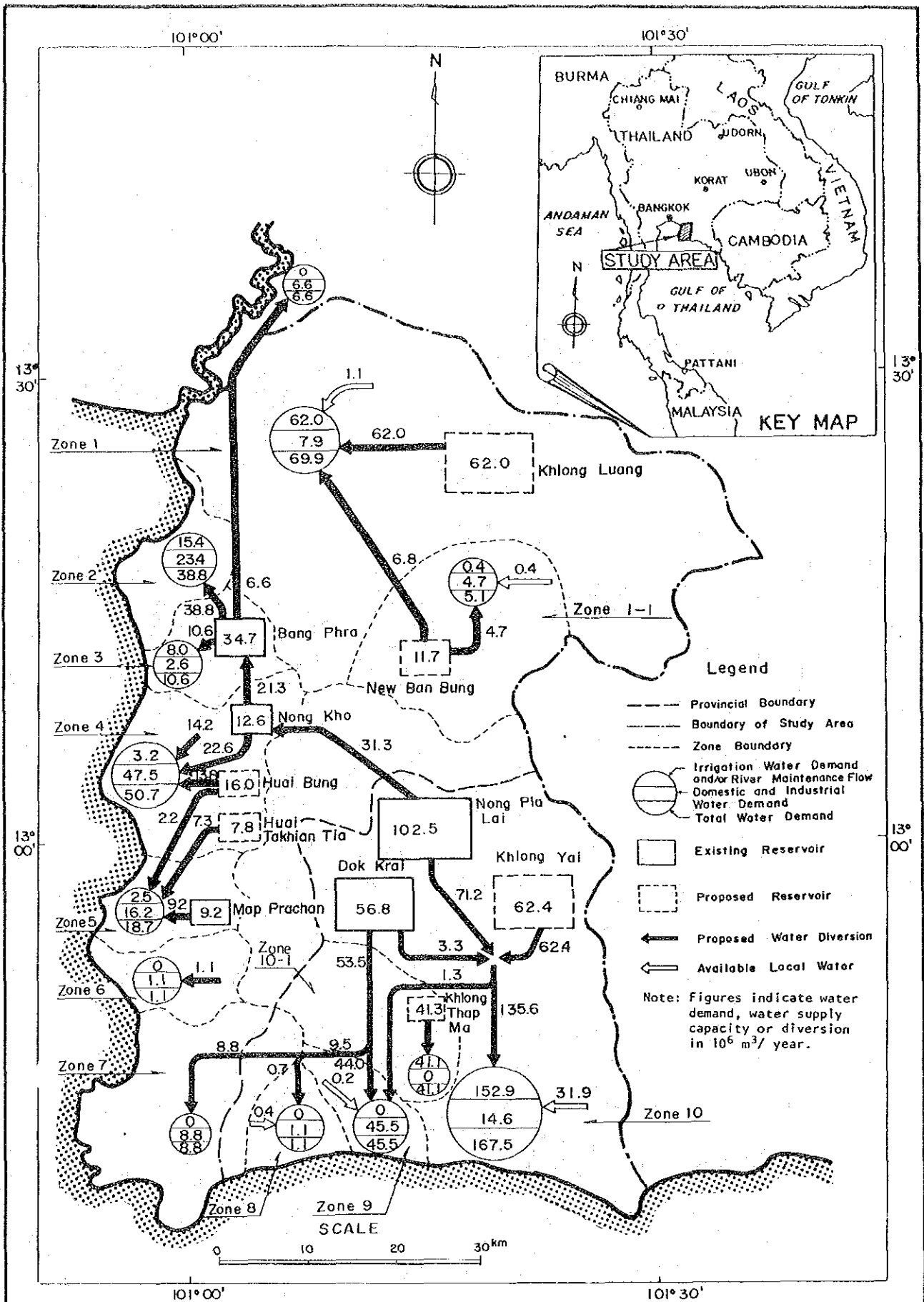
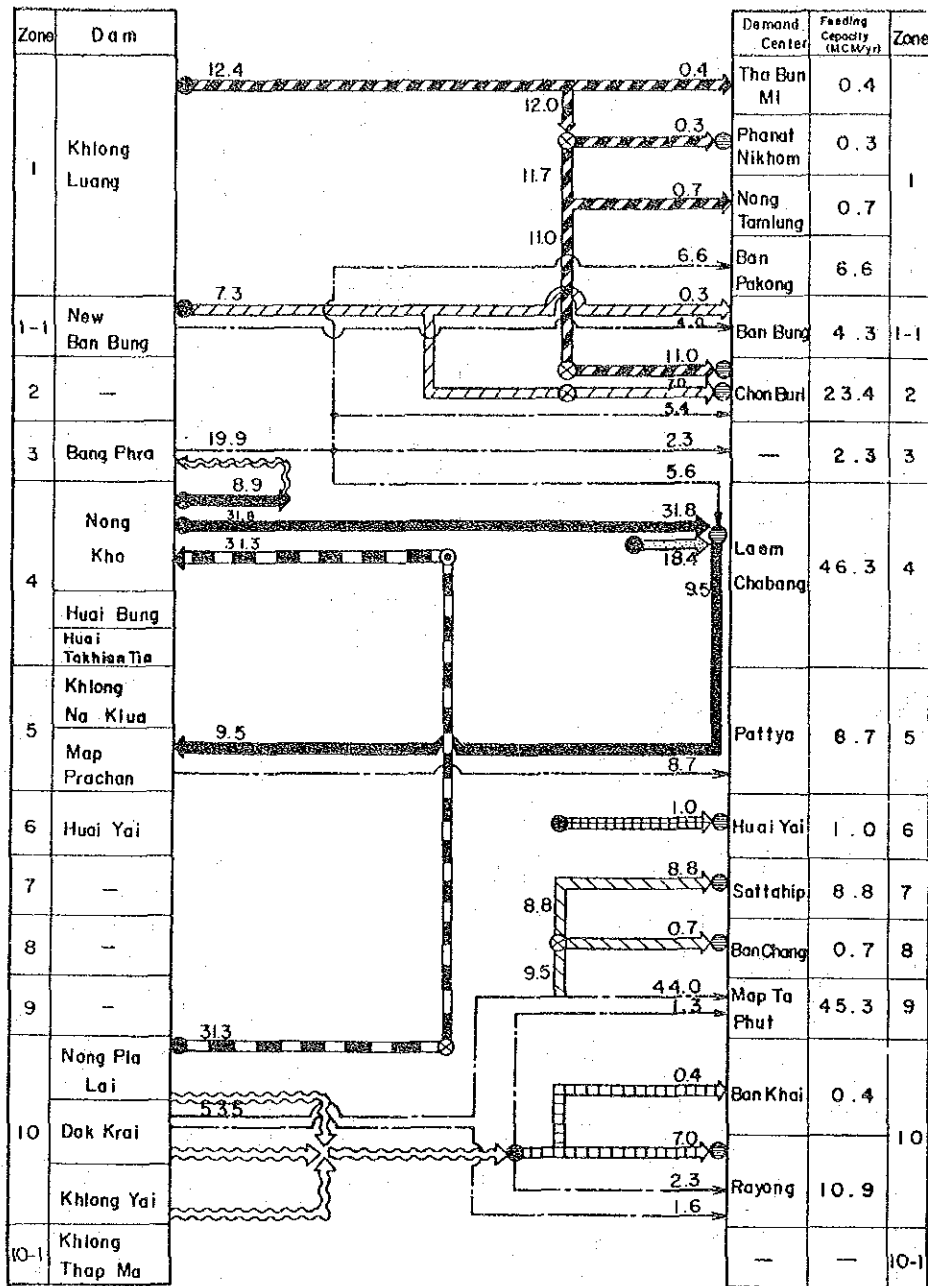


Fig. 7 Water Supply Plan in 2001, Alternative IV

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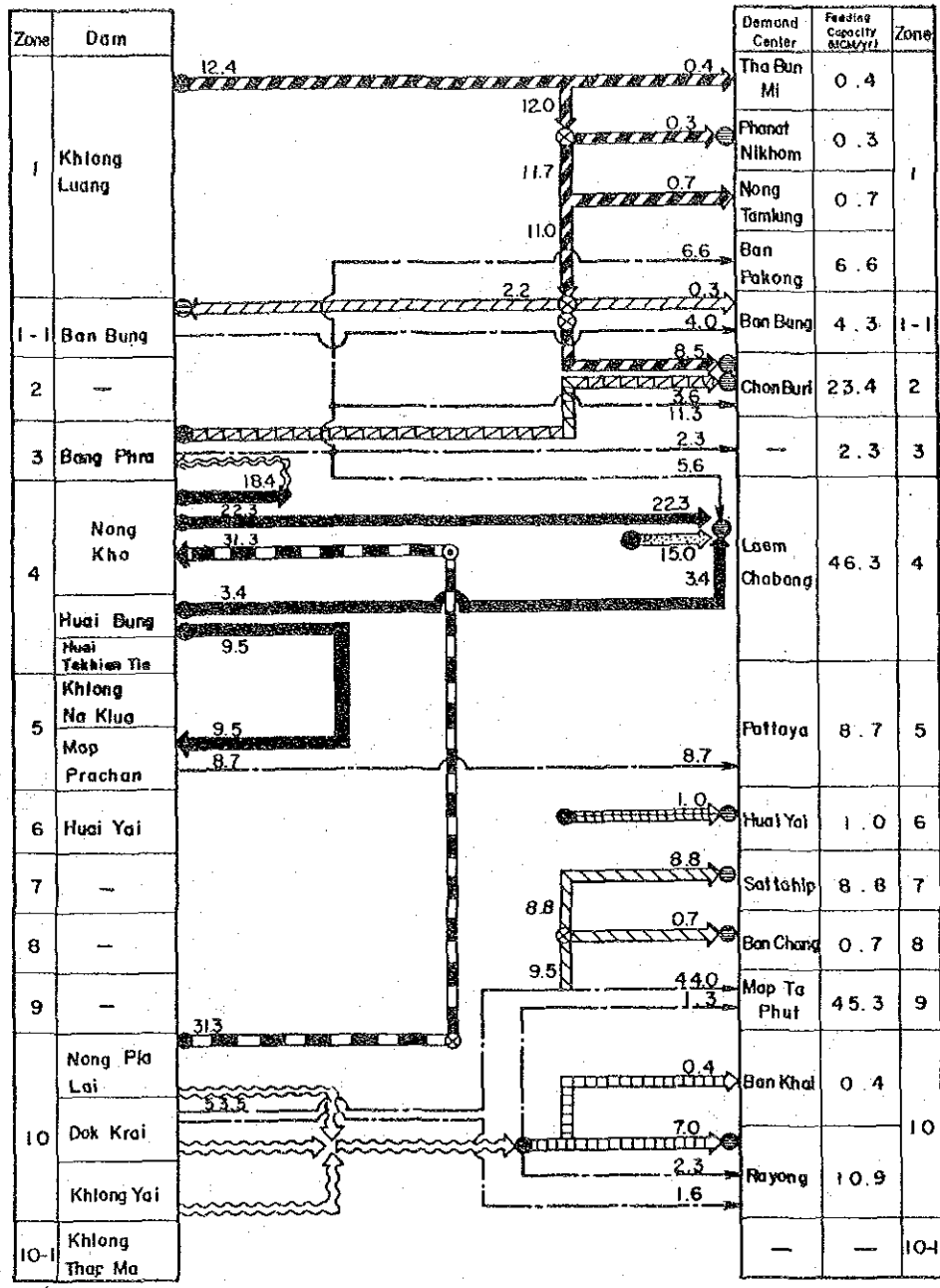
Note : Figures indicate feeding capacity in $10^6\text{m}^3/\text{year}$.

LEGEND

- Khlong Luang Pipeline System
- Ban Bung Pipeline System
- Nong Kho Pipeline System
- Nong Pla Lai Pipeline System
- Bang Lamung Pipeline System
- Huai Yai Pipeline System
- Ban Khai Pipeline System
- Dak Krai Pipeline System
- Existing Pipeline
- Natural Stream
- Intake
- Raw Water Basin
- Boosting Pump
- Head Tank or Junction Well

Fig. 8 Water Conveyance Diagram for Alternative I

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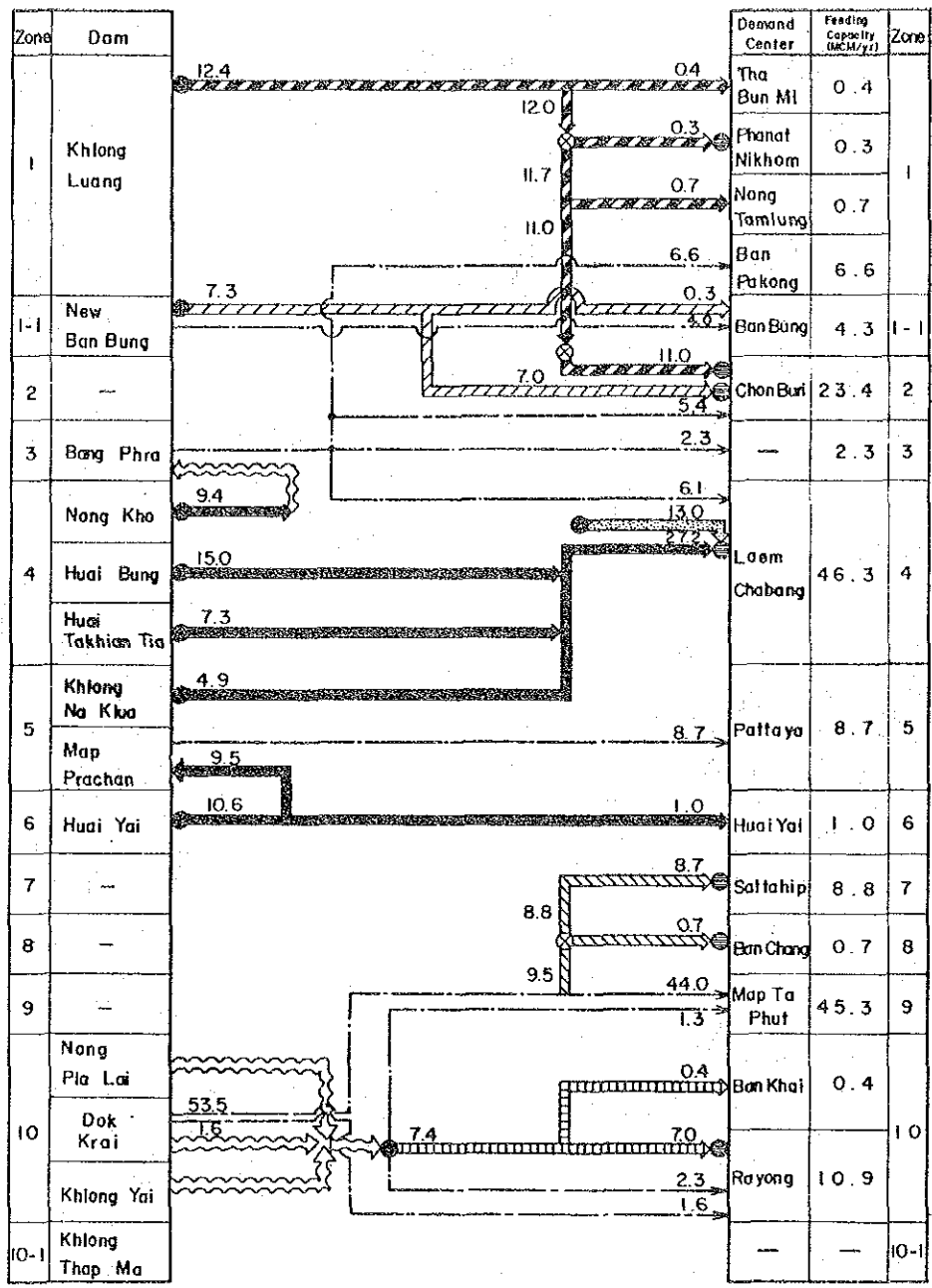
Note : Figures indicate feeding capacity in 10⁶m³/year.

LEGEND

- Khlong Luang Pipeline System
- Ban Bung Pipeline System
- Nong Kho Pipeline System
- Nong Pla Lai Pipeline System
- Bang Lamung Pipeline System
- Huai Yai Pipeline System
- Ban Khai Pipeline System
- Dok Krai Pipeline System
- Existing Pipeline
- Natural Stream
- Intake
- Raw Water Basin
- Boosting Pump
- Head Tank or Junction Well

Fig. 9 Water Conveyance Diagram for Alternative II

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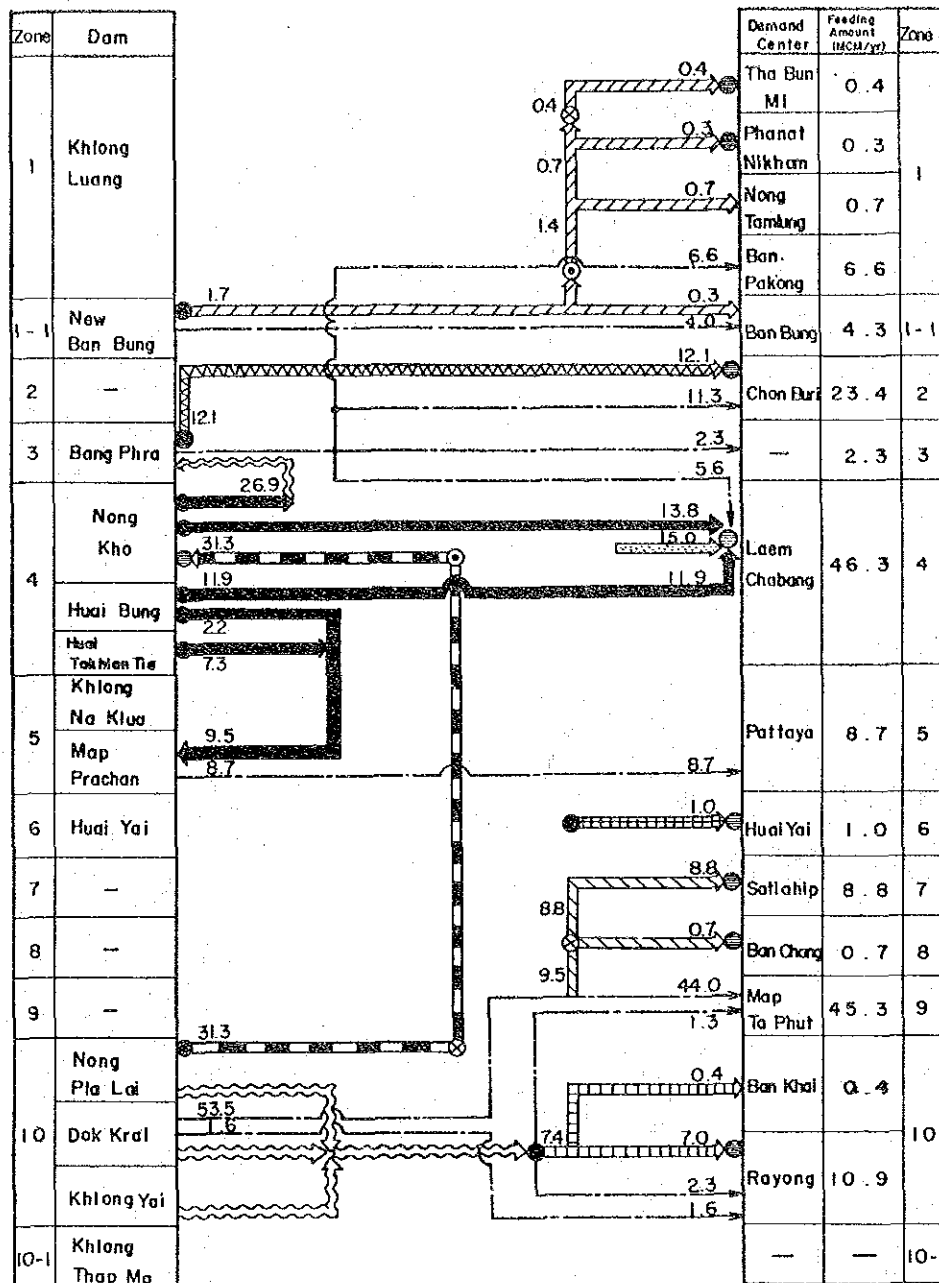


Note : Figures indicate feeding capacity in 10⁶m³/year.

LEGEND

- Khlong Luang Pipeline System
- Ban Bung Pipeline System
- Nong Kho Pipeline System
- Nong Pla Lai Pipeline System
- Bang Lamung Pipeline System
- Huai Yai Pipeline System
- Ban Khai Pipeline System
- Dok Krai Pipeline System
- Existing Pipeline
- Natural Stream
- Intake
- Raw Water Basin
- Boosting Pump
- Head Tank or Junction Well

Fig. 10 Water Conveyance Diagram for Alternative III



Note : Figures indicate feeding capacity in $10^6 m^3/year$.

LEGEND

- Khlong Luang Pipeline System
- Ban Bung Pipeline System
- Nong Kho Pipeline System
- Nong Pla Lai Pipeline System
- Bang Lamung Pipeline System
- Huai Yai Pipeline System
- Ban Khai Pipeline System
- Dok Kral Pipeline System
- Existing Pipeline
- Natural Stream
- Intake
- Raw Water Basin
- Boosting Pump
- Head Tank or Junction Well

Fig. 11 Water Conveyance Diagram for Alternative IV

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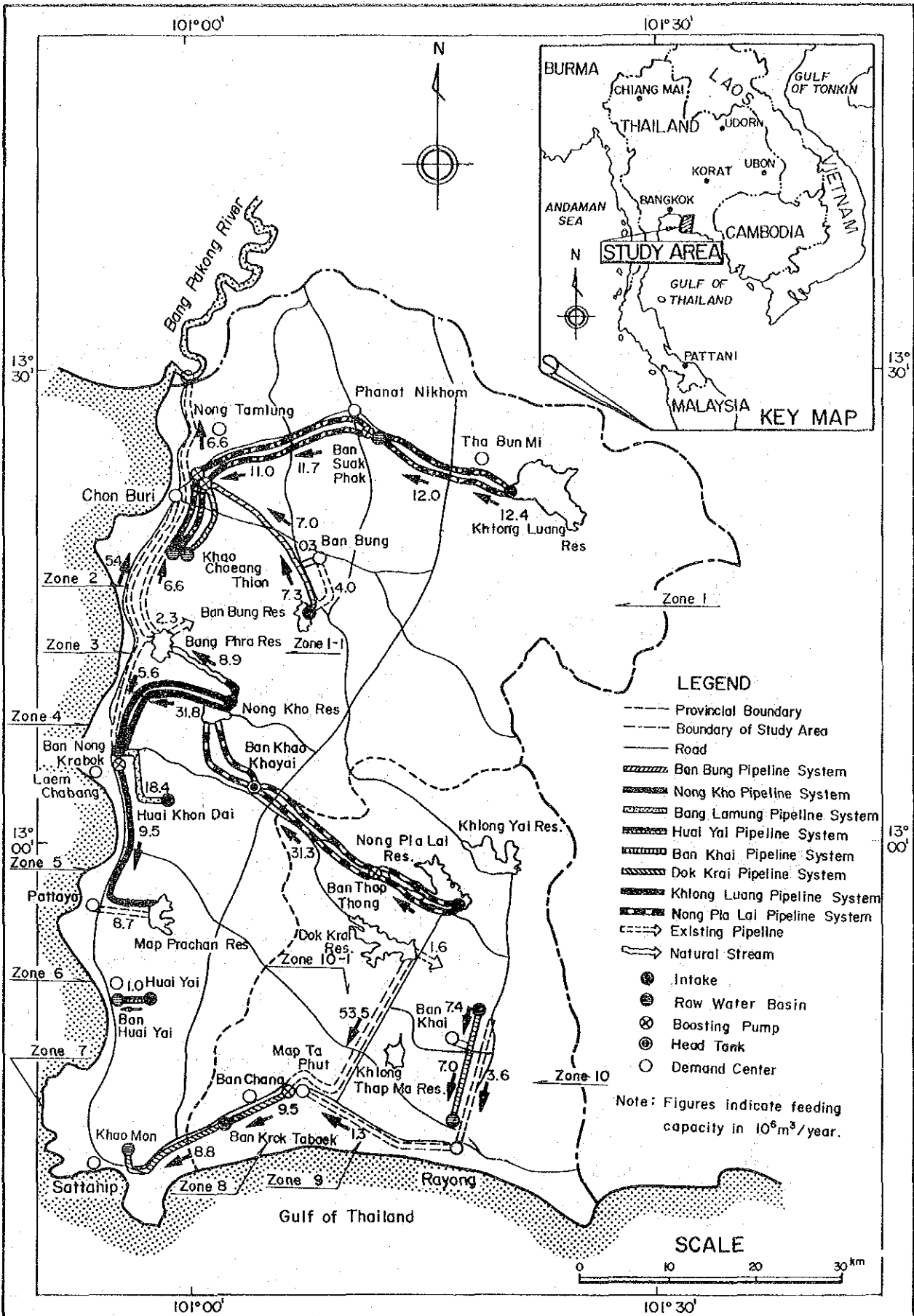


Fig. 12 Preliminary Layout of Water Conveyance System in 2001, Alternative I

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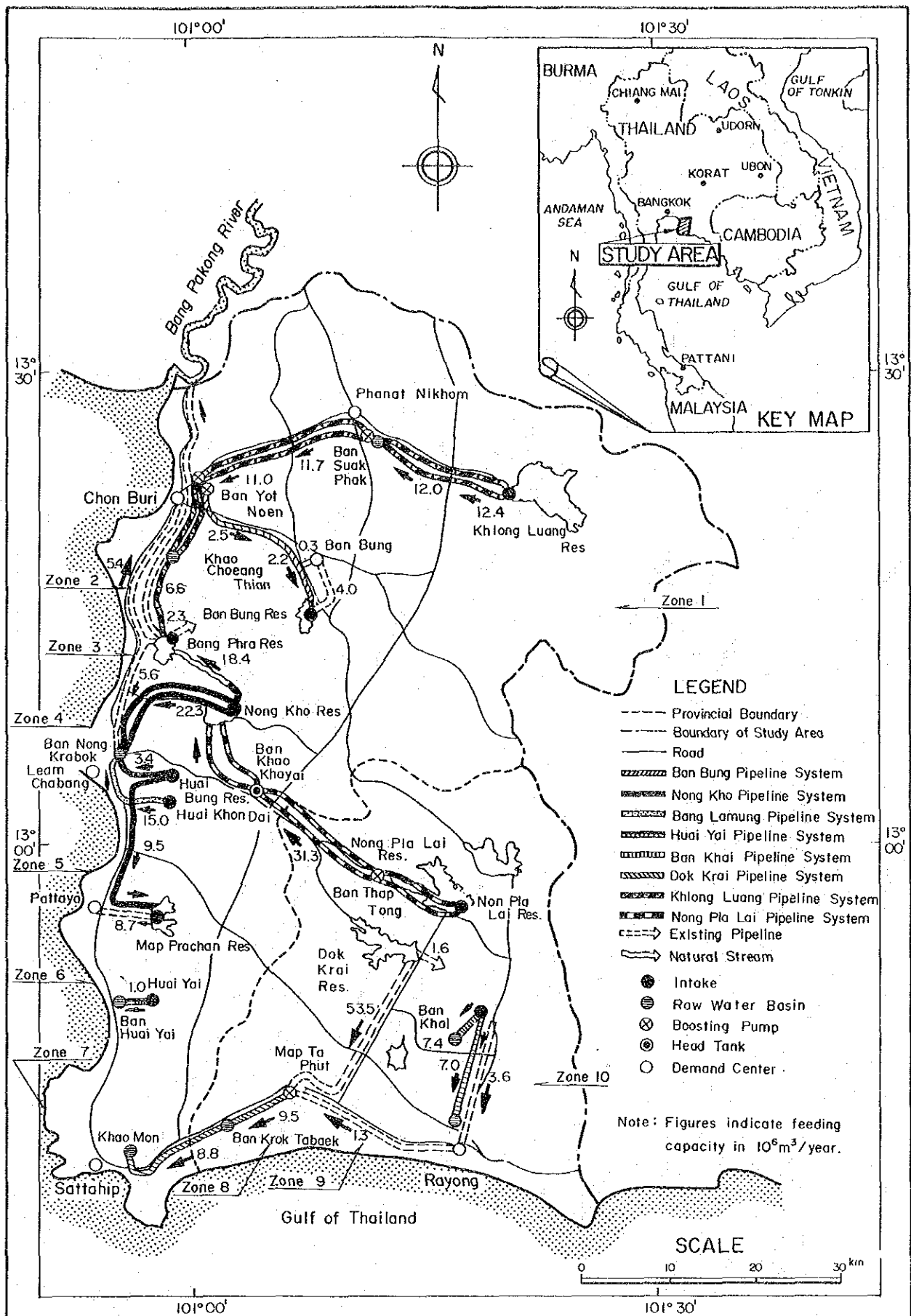


Fig. 13 Preliminary Layout of Water Conveyance System in 2001, Alternative II

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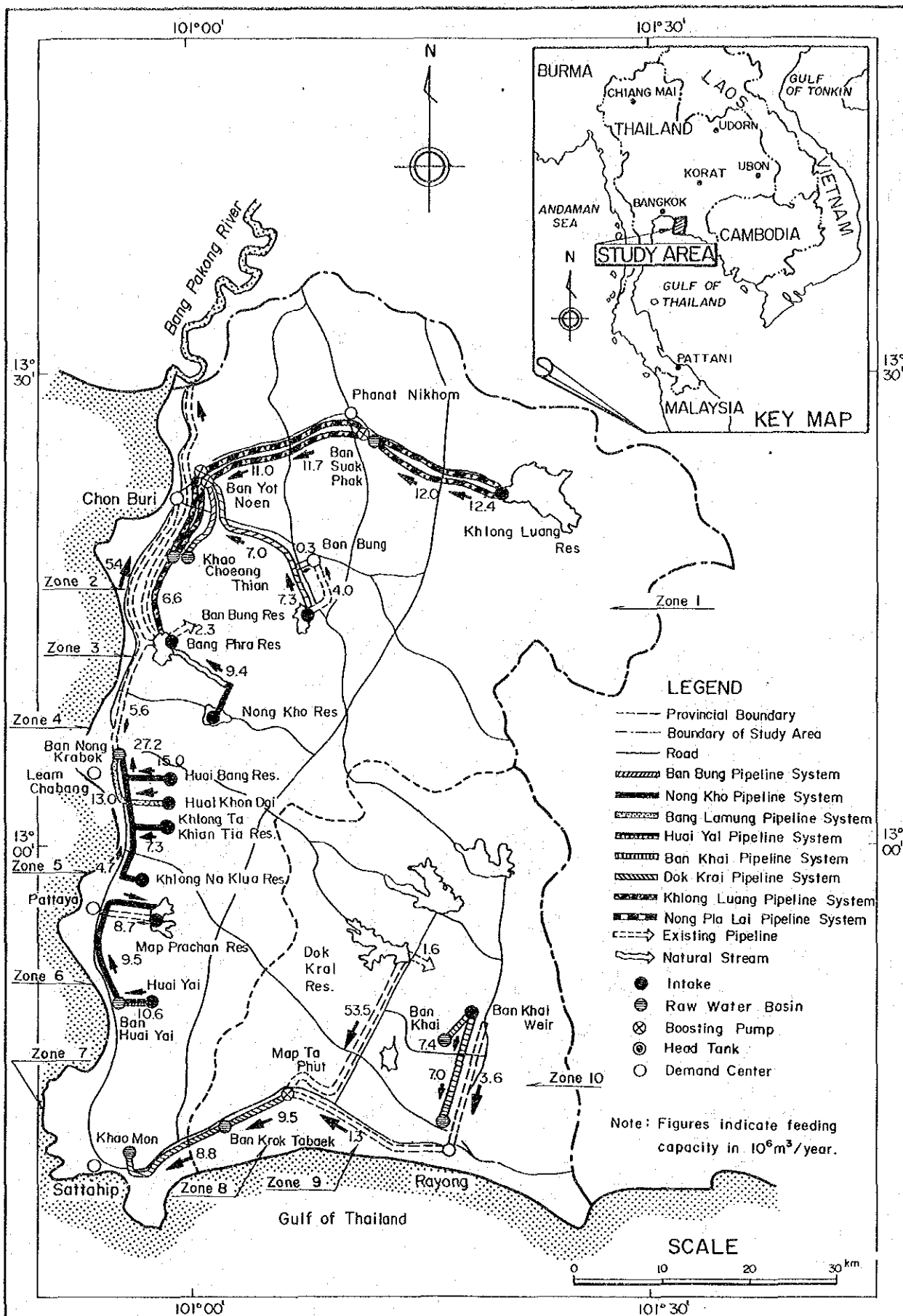


Fig. 14 Preliminary Layout of Water Conveyance System in 2001, Alternative III.

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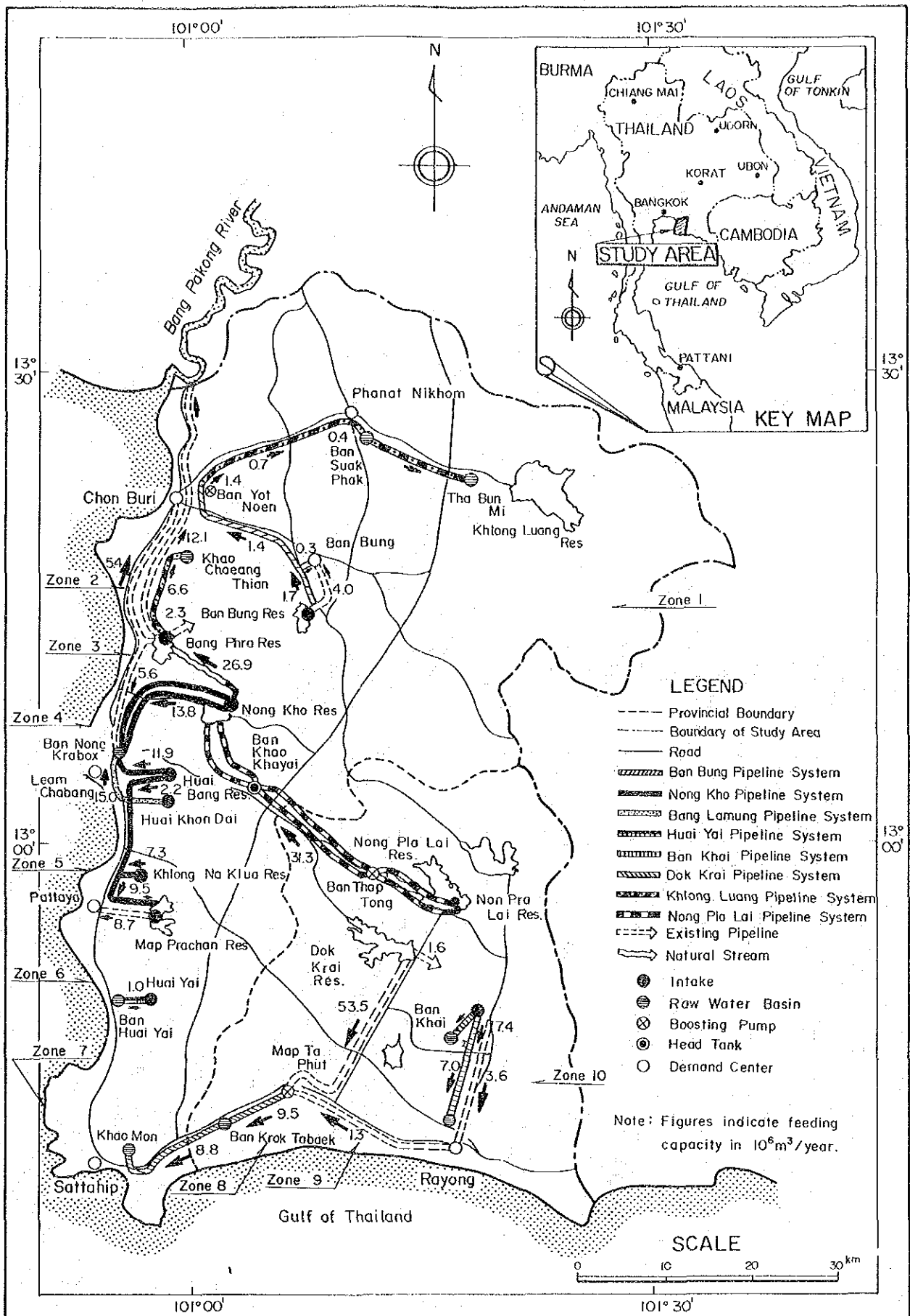


Fig. 15 Preliminary Layout of Water Conveyance System in 2001, Alternative IV

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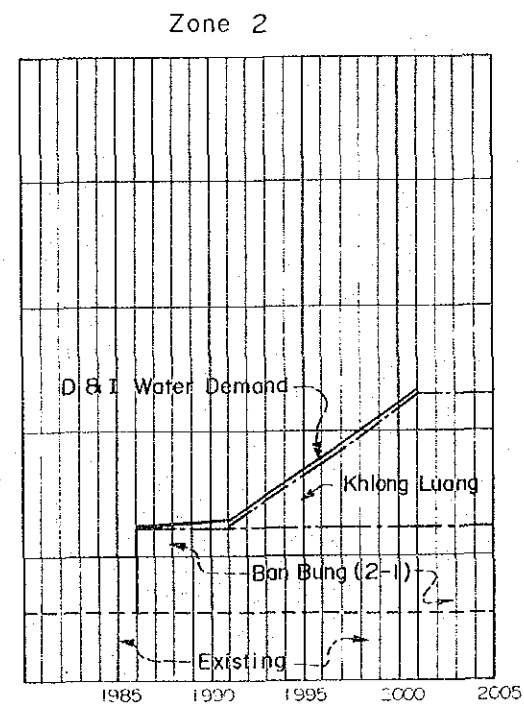
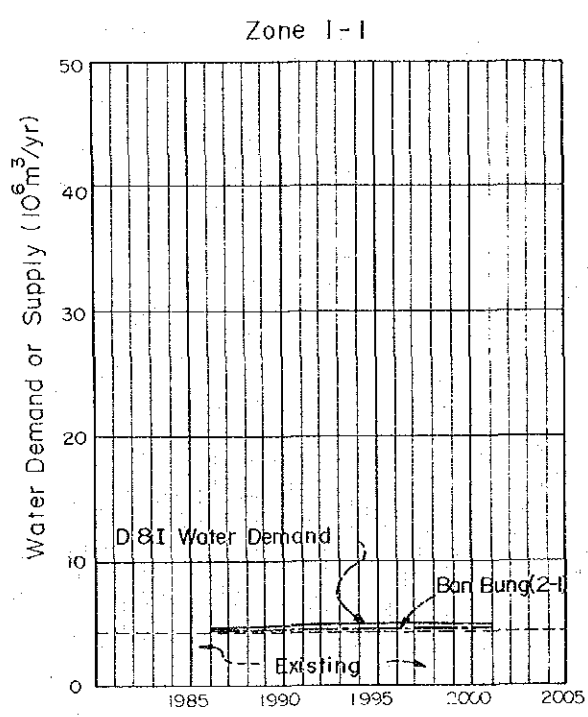
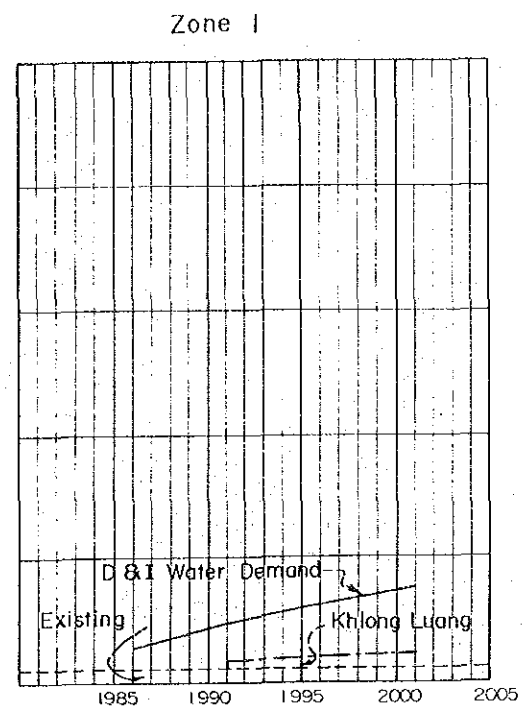
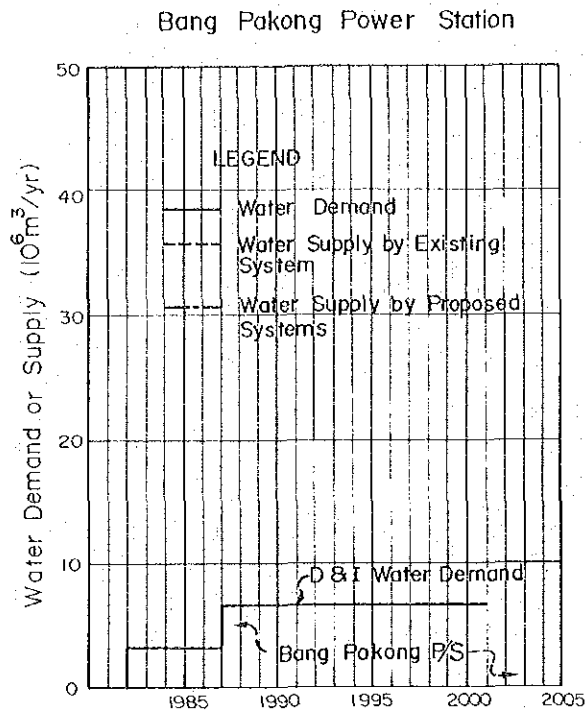


Fig. 16 D & I Water Demand and Supply Balance by Zone (1/3)

KINGDOM OF THAILAND
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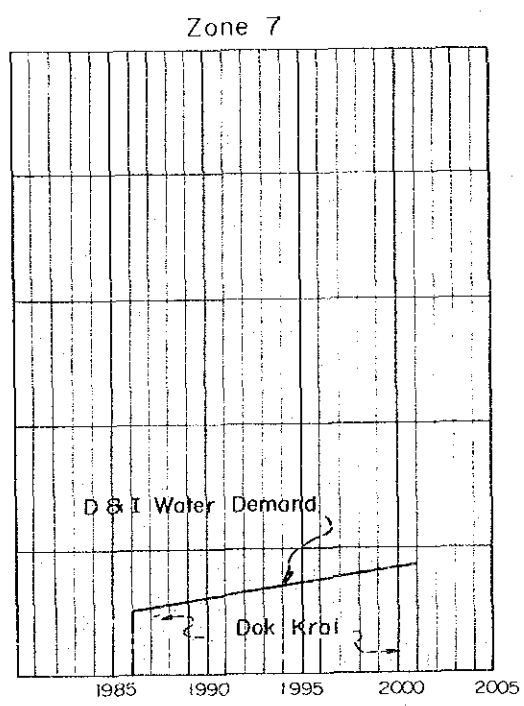
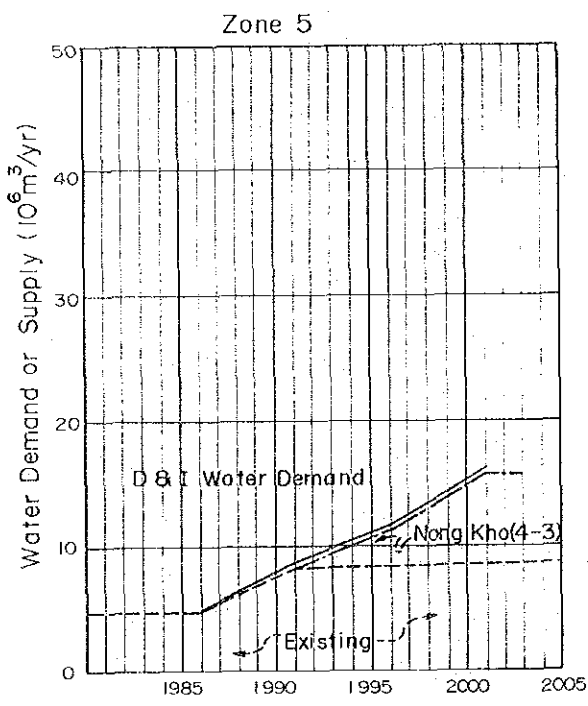
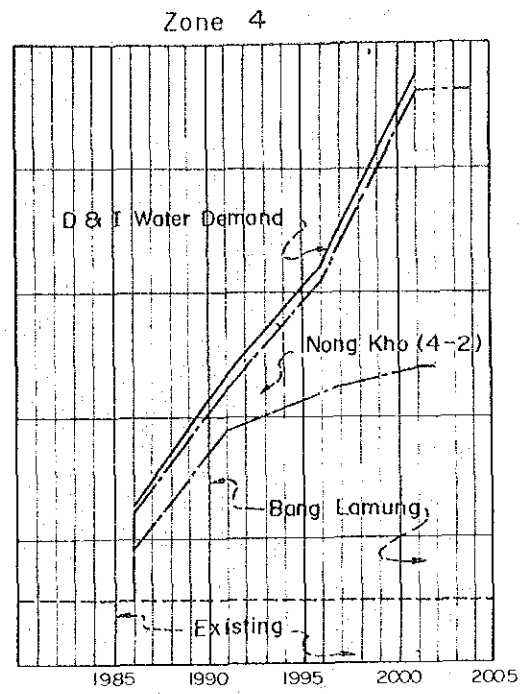
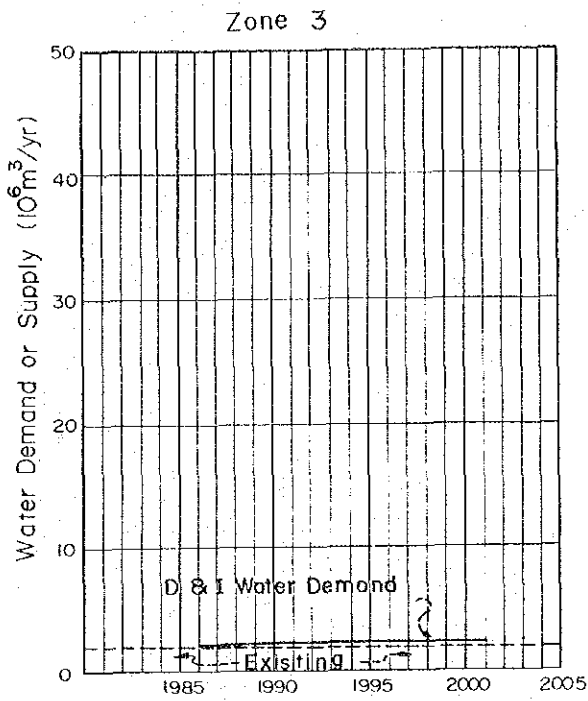


Fig. 16 D & I Water Demand and Supply Balance by Zone (2/3)

KINGDOM OF THAILAND
 THE EAST COAST WATER RESOURCES
 DEVELOPMENT PROJECT PHASE II
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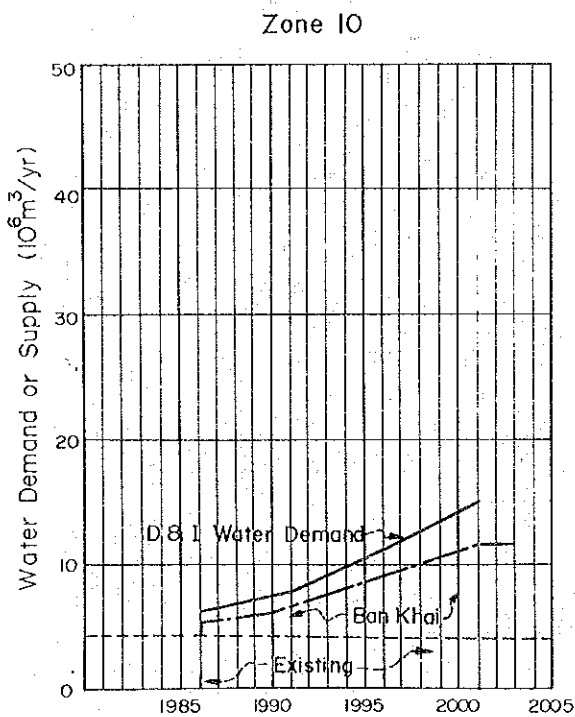
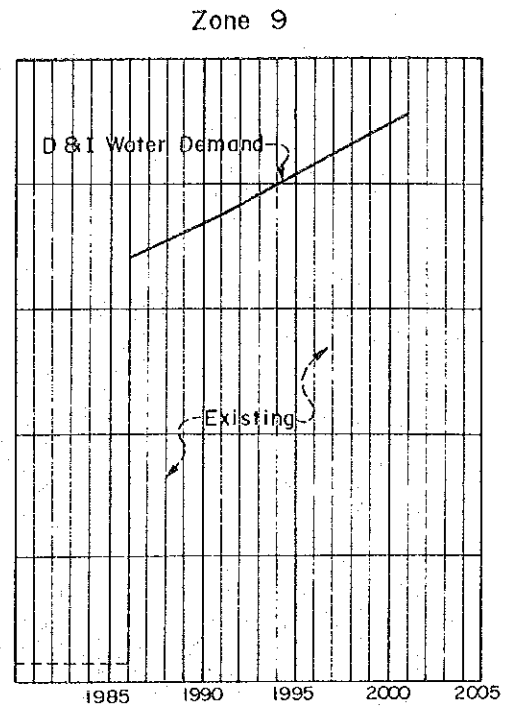
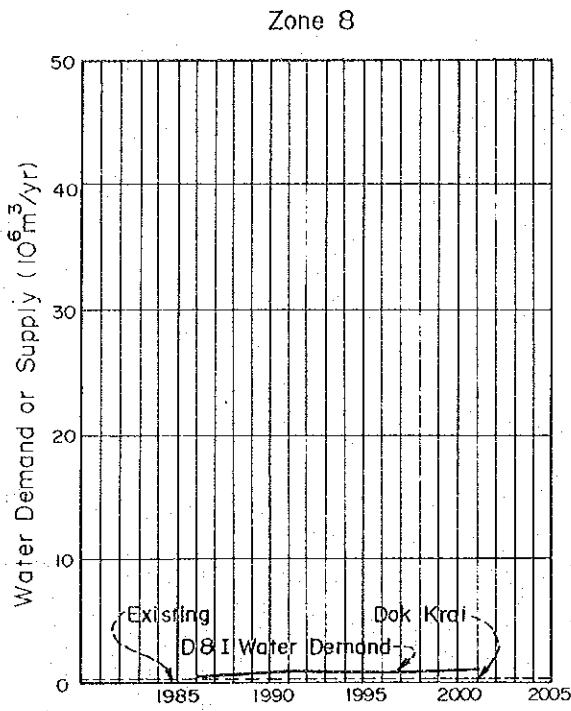


Fig. 16 D & I Water Demand and Supply Balance by Zone (3/3)

KINGDOM OF THAILAND
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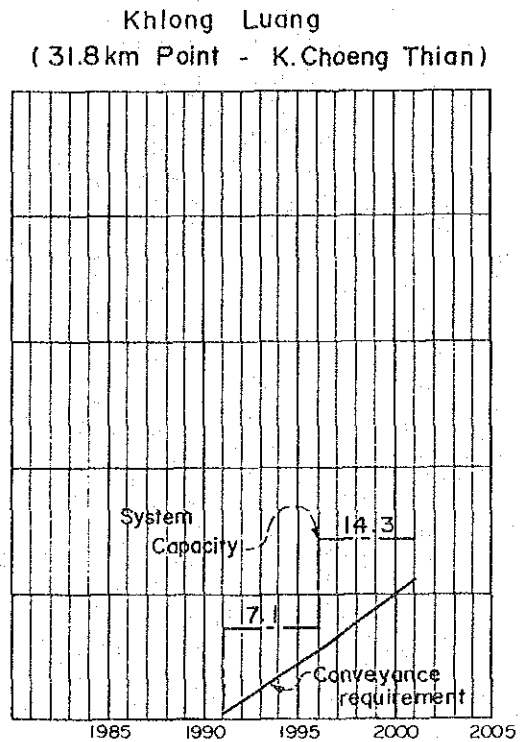
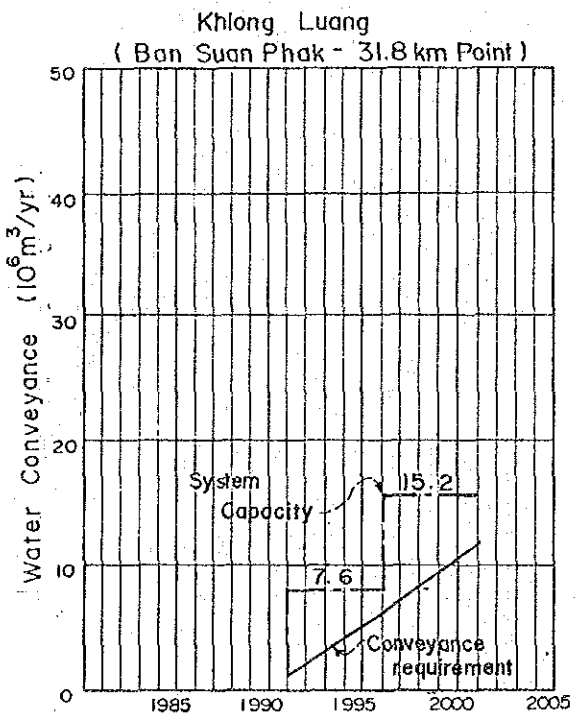
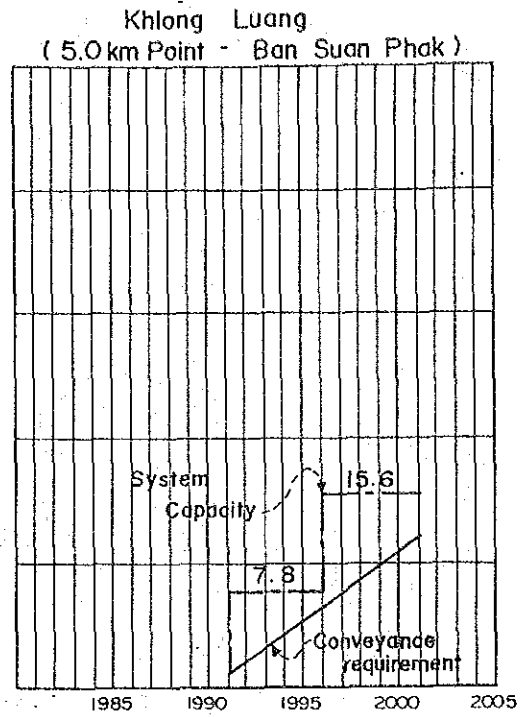
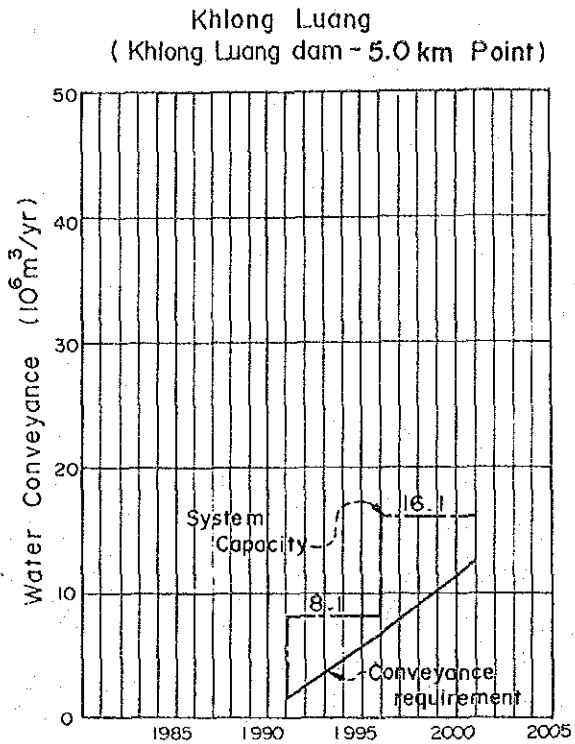


Fig. 17 Water Conveyance System Development Plan (1/4)

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DEVELOPMENT PROJECT PHASE II
JAPAN INTERNATIONAL COOPERATION AGENCY

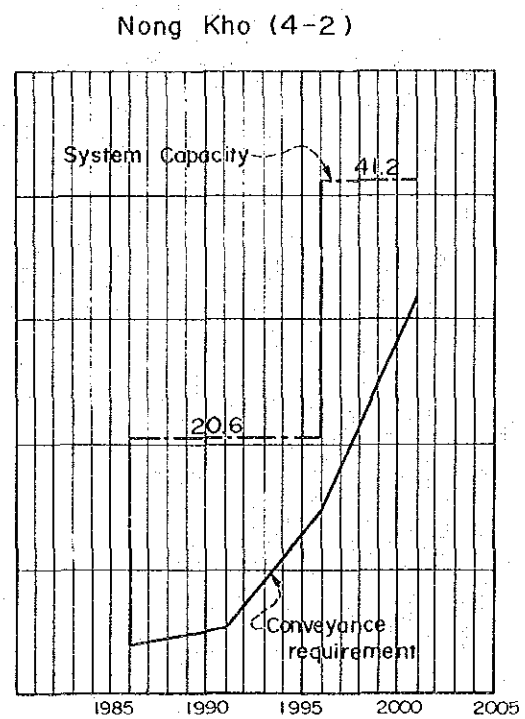
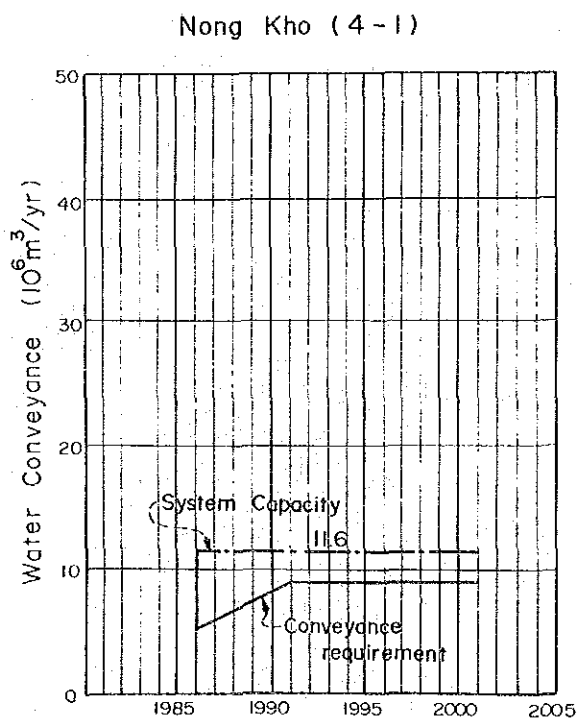
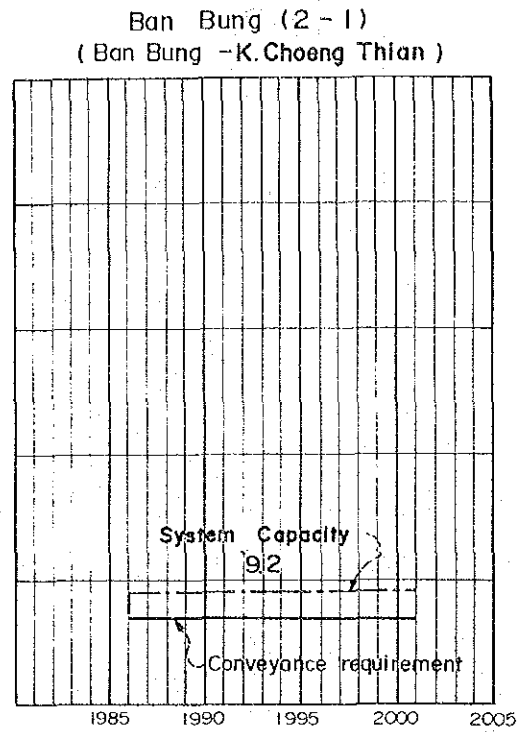
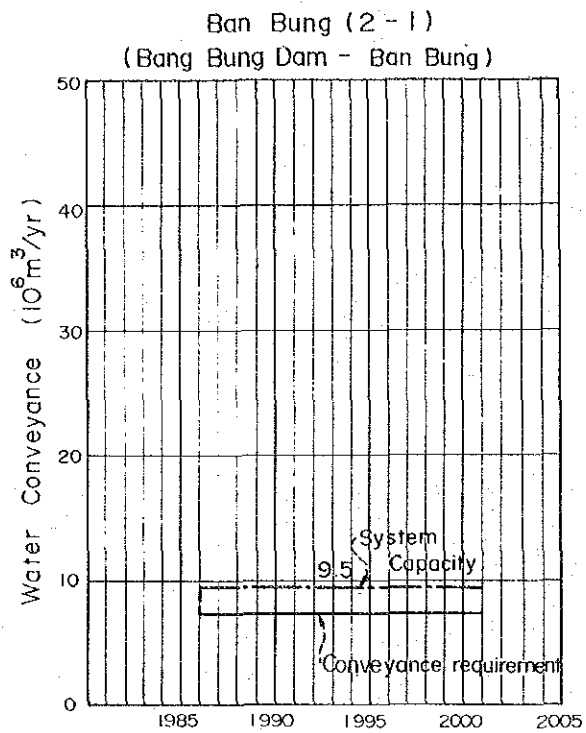


Fig. 17 Water Conveyance System Development Plan (2/4)

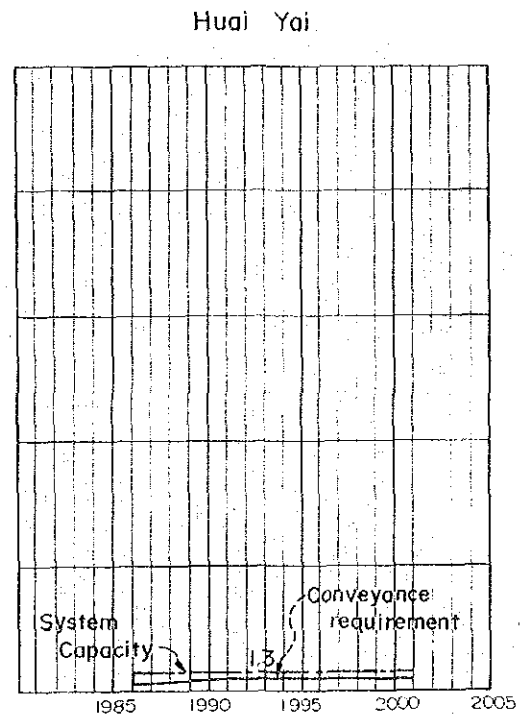
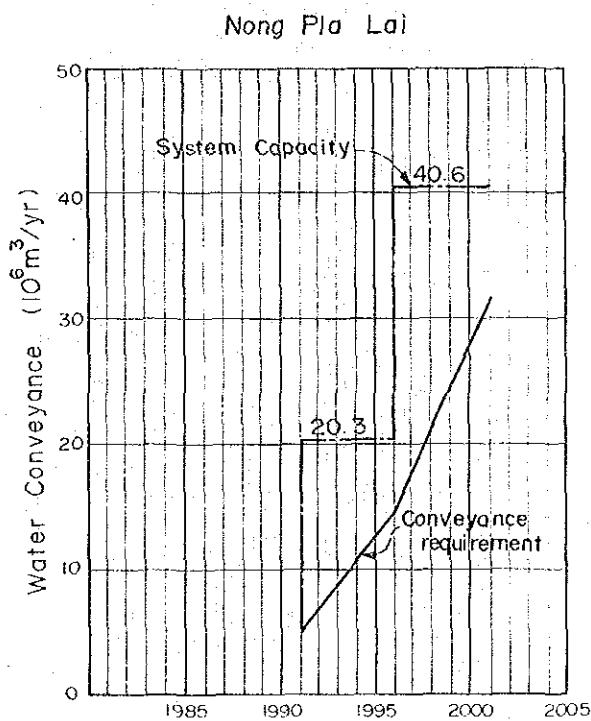
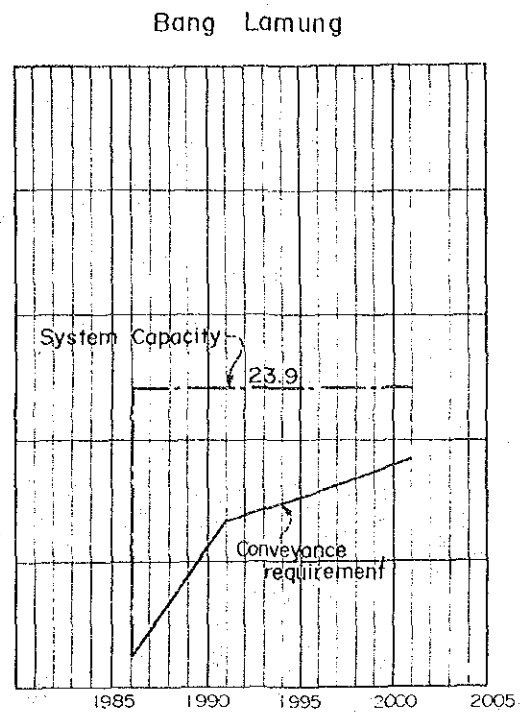
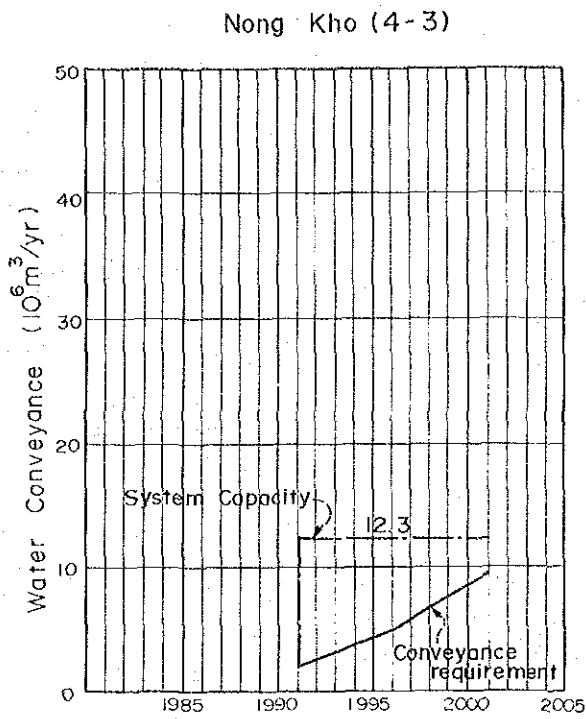
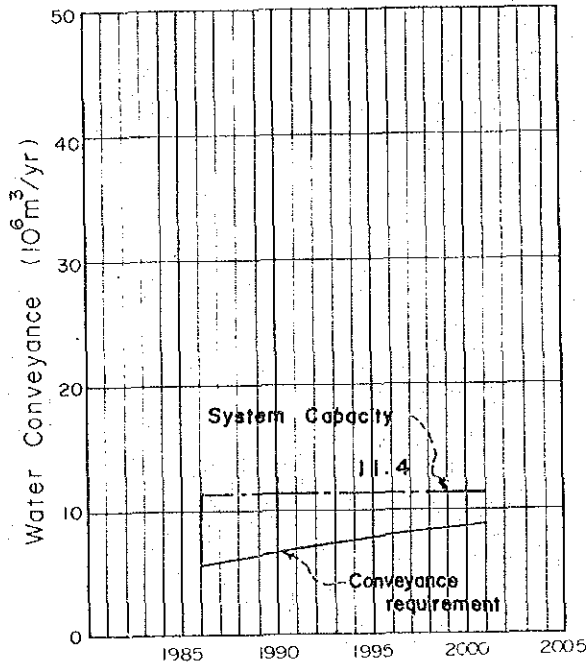
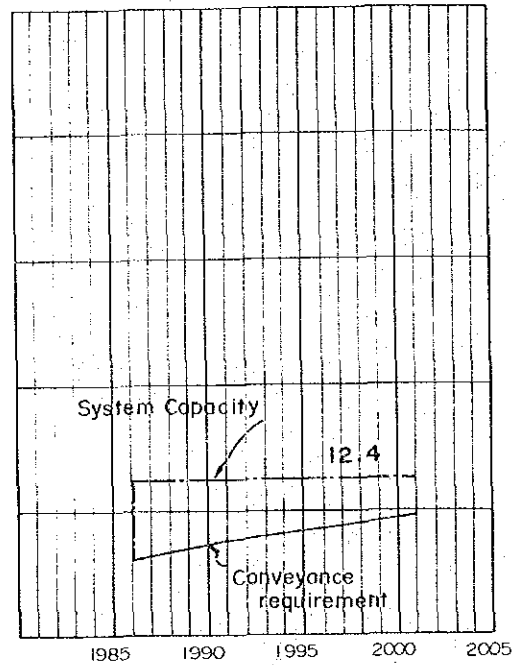


Fig. 17 Water Conveyance System Development Plan (3/4)

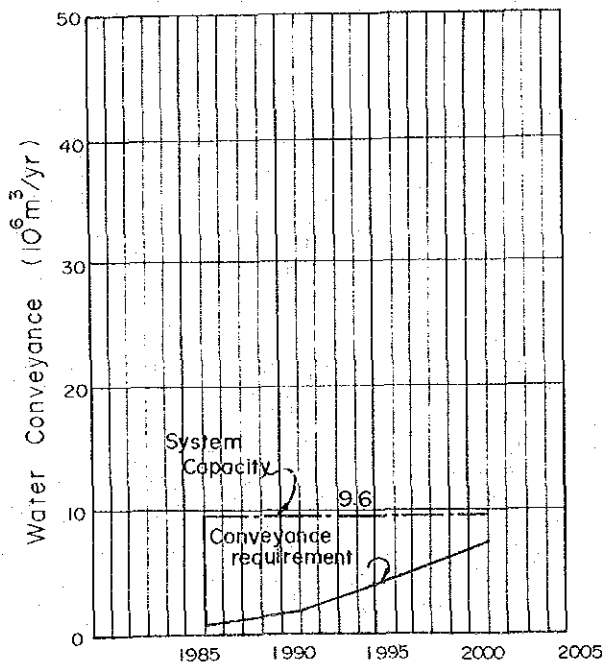
Dok Krai
(Ban Chang - Sattahip)



Dok Krai
(Map Ta Phut - Ban Chang)



Ban Khai
(Ban Khai Intake - Ban Khai)



Ban Khai
(Ban Khai - Rayong)

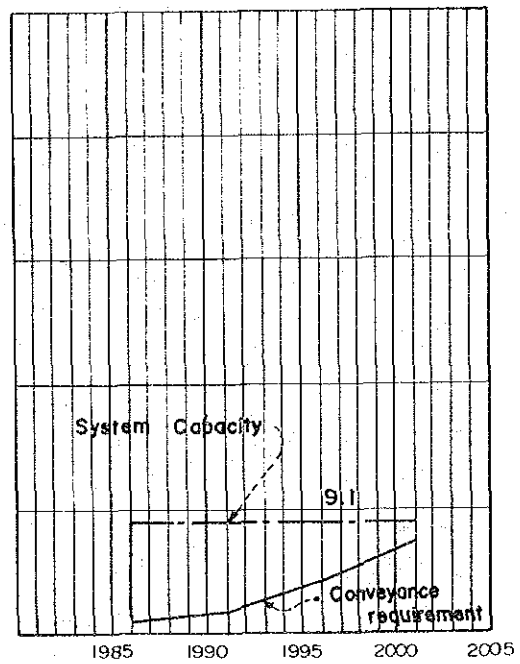


Fig. 17 Water Conveyance System
Development Plan (4/4)

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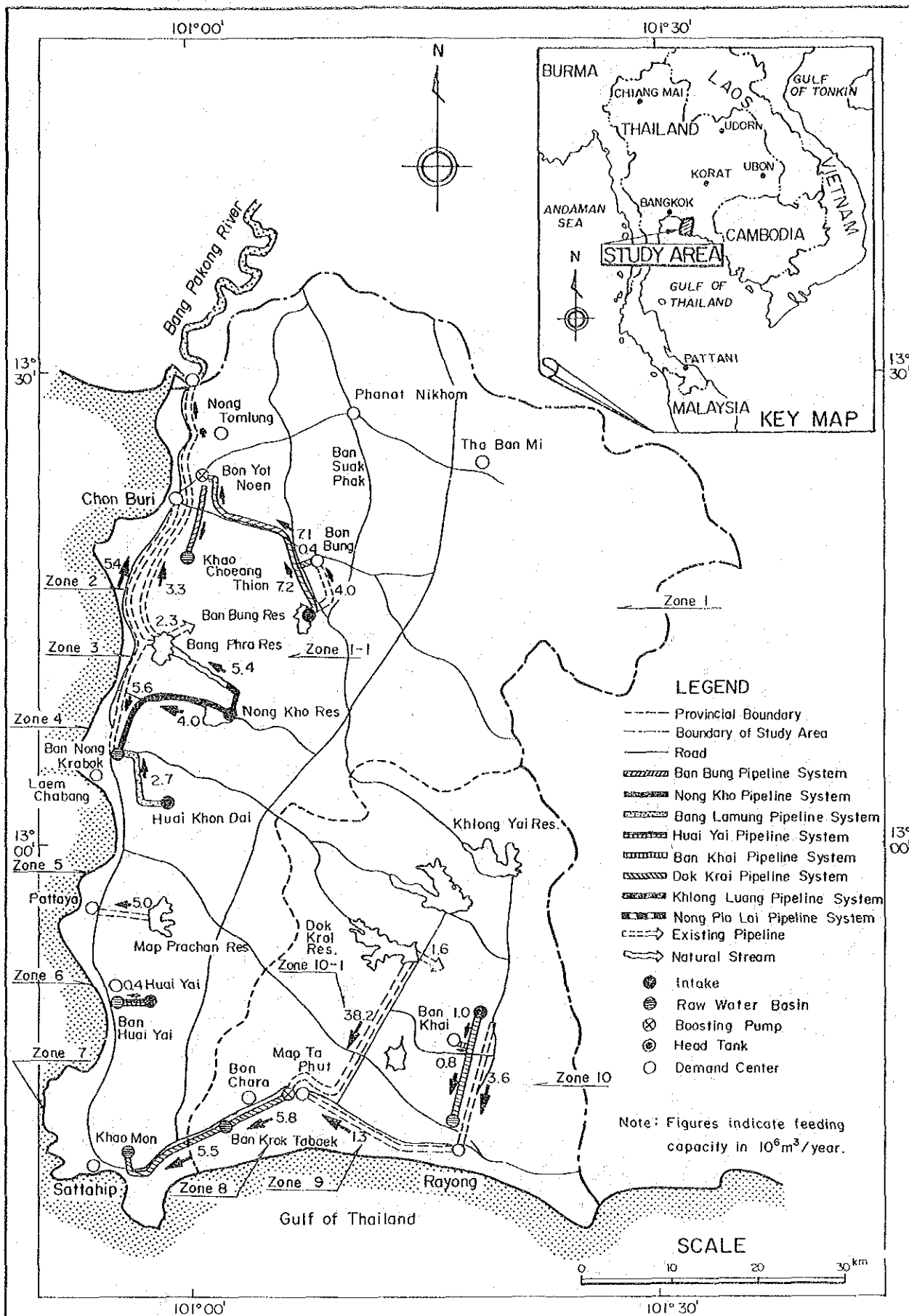


Fig. 18 General Layout of Proposed Development Plan for 1986

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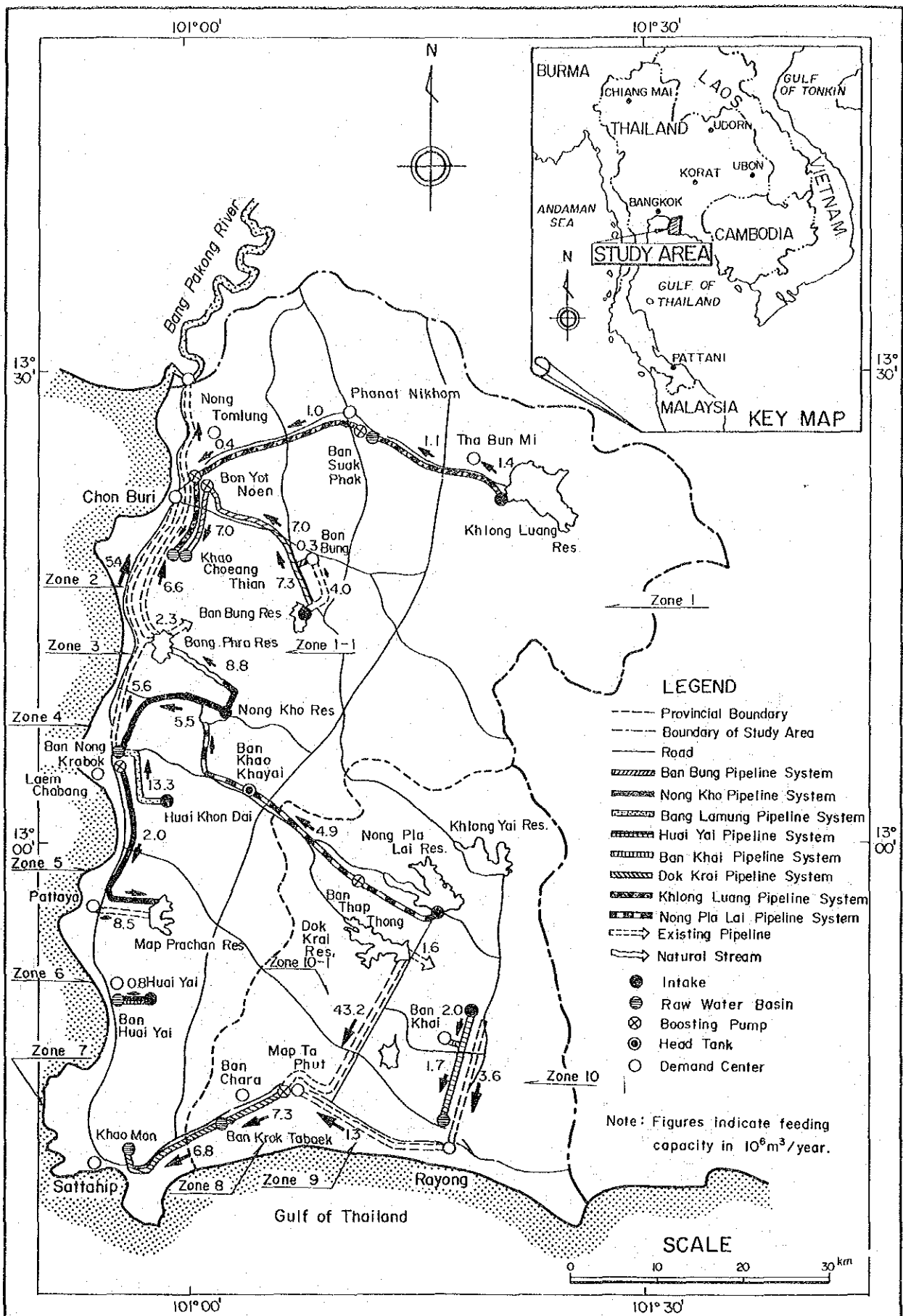


Fig. 19 General Layout of Proposed Development Plan for 1991

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 THE EAST COAST WATER RESOURCES
 DEVELOPMENT PROJECT PHASE II
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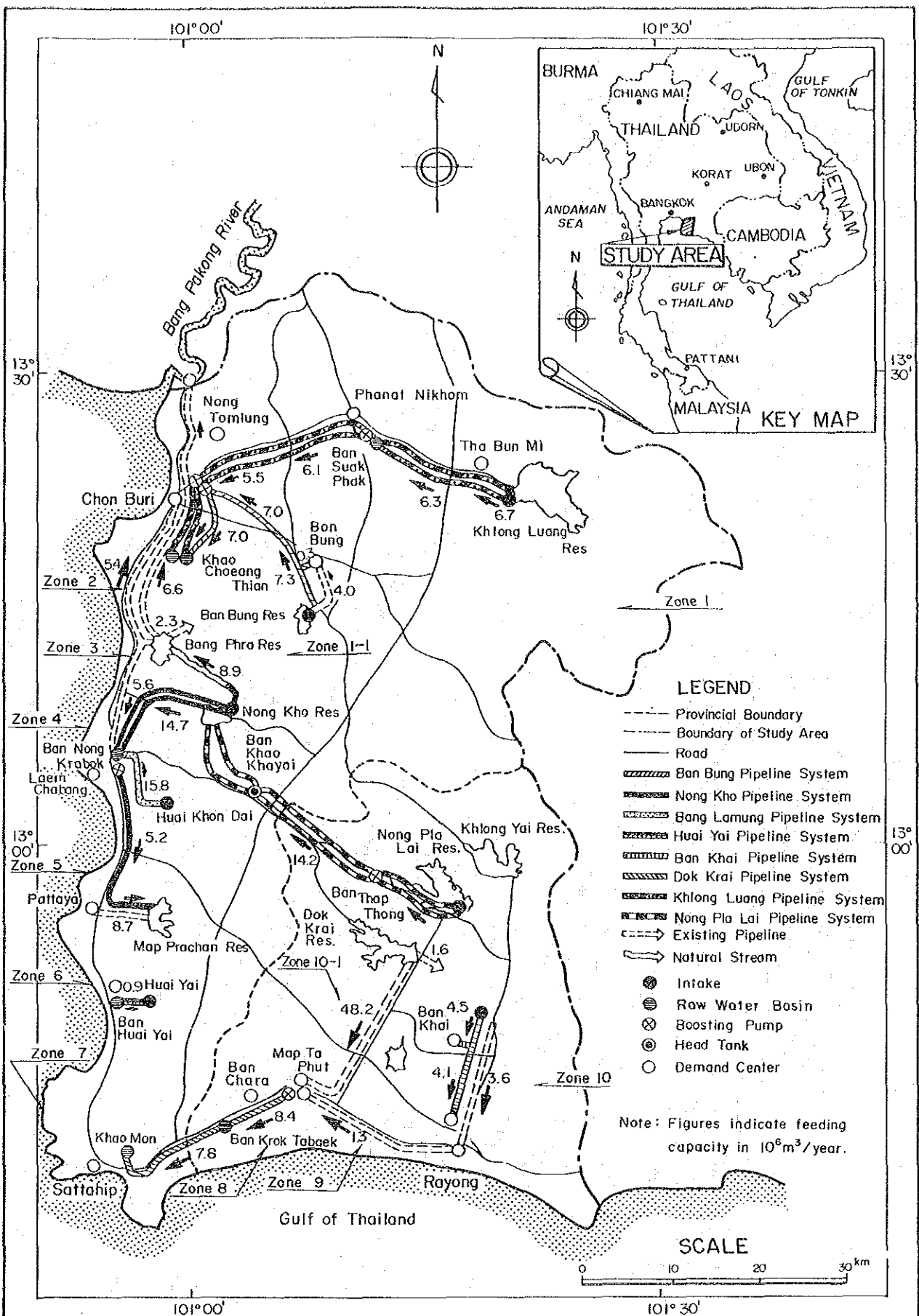


Fig. 20 General Layout of Proposed Development Plan for 1996

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 THE EAST COAST WATER RESOURCES
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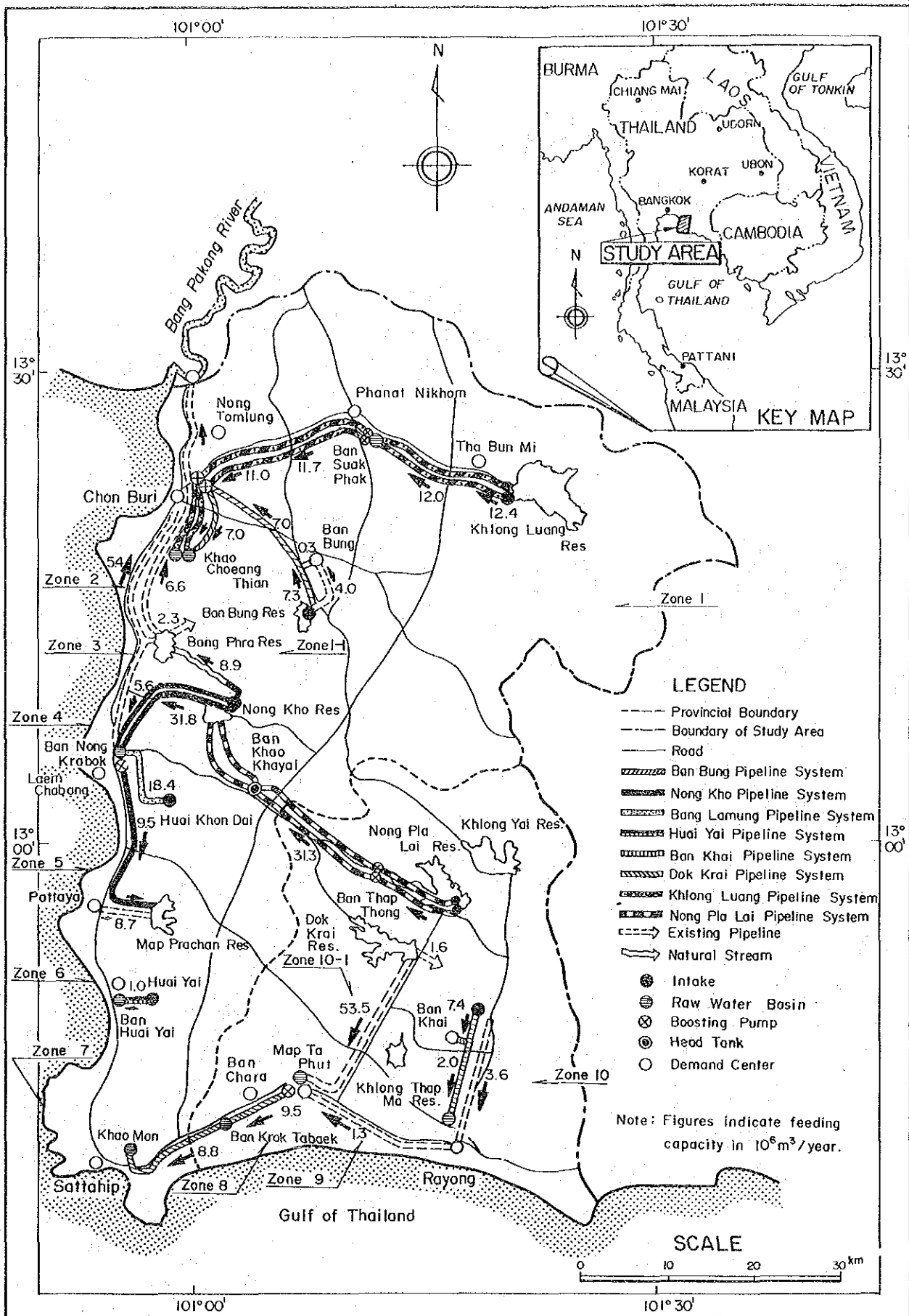


Fig. 21 General Layout of Proposed Development Plan for 2001

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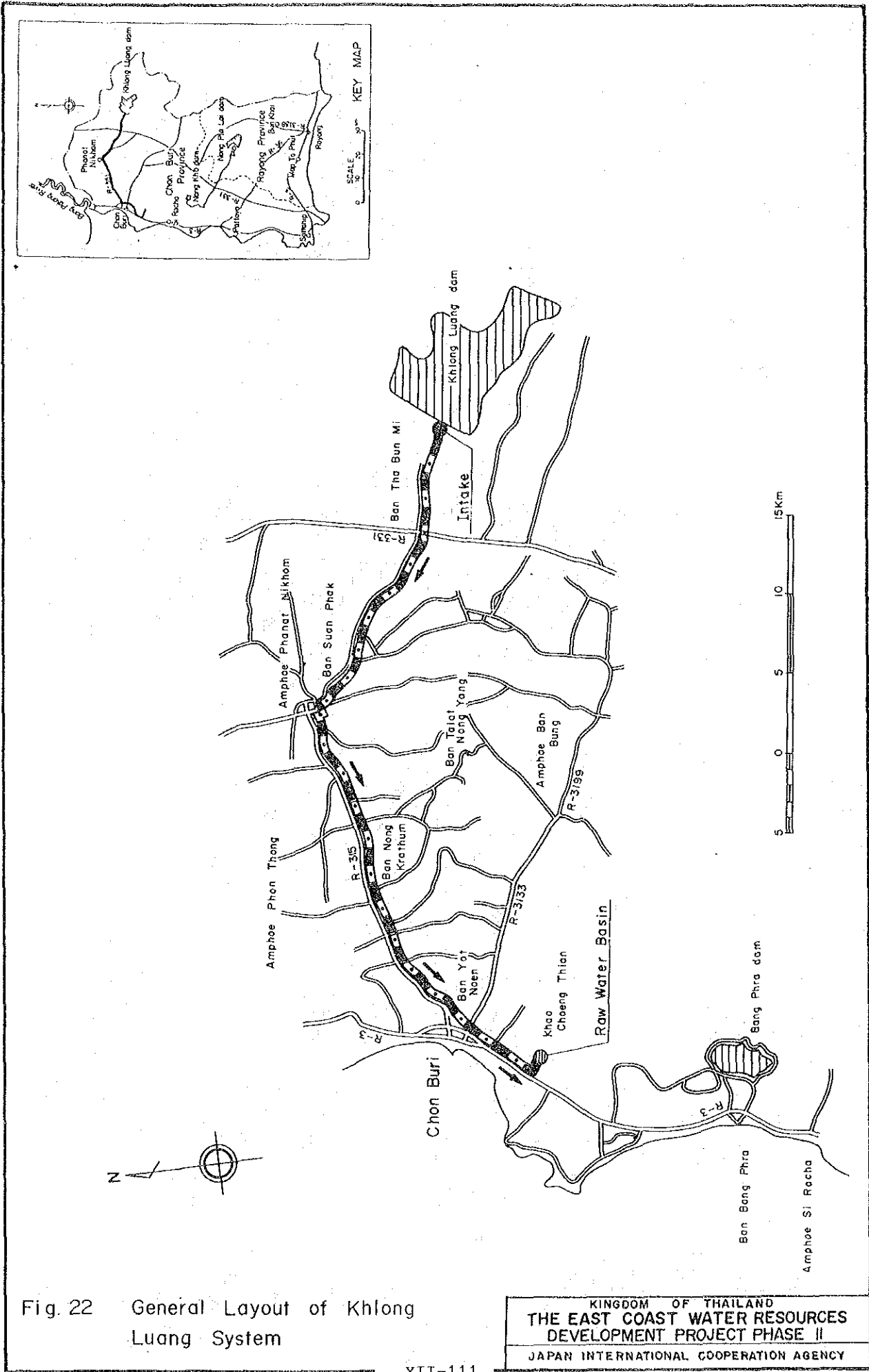
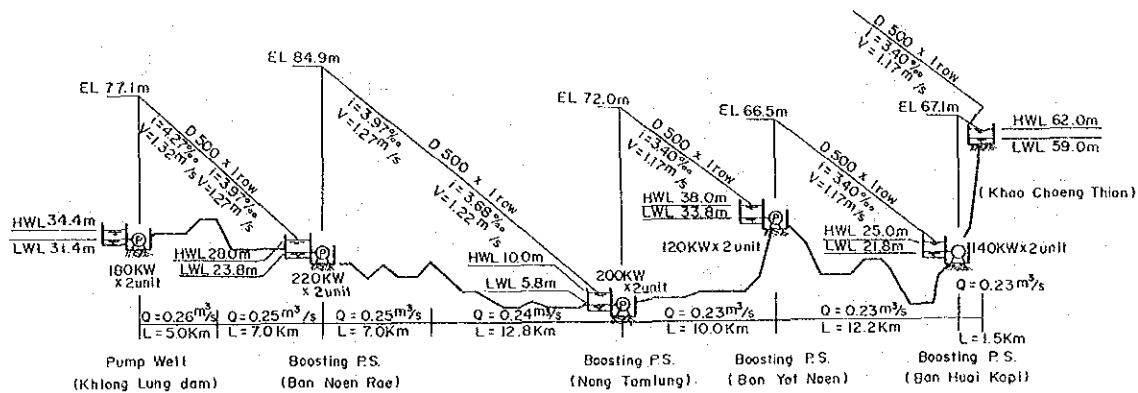
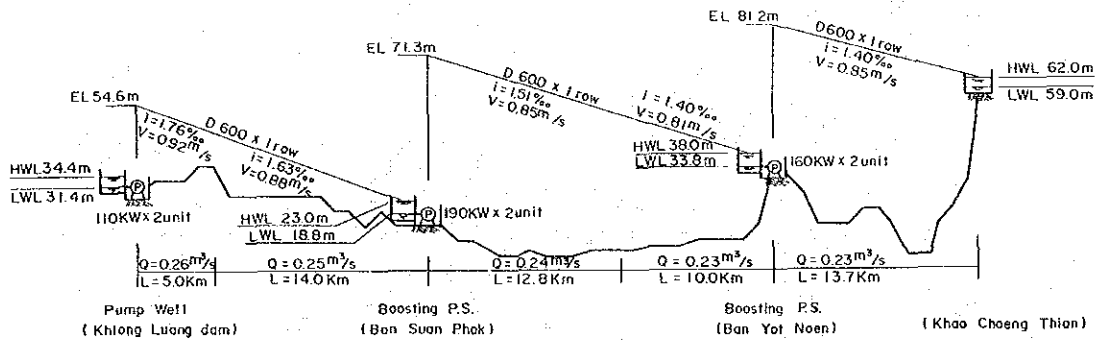


Fig. 22 General Layout of Khlong Luang System

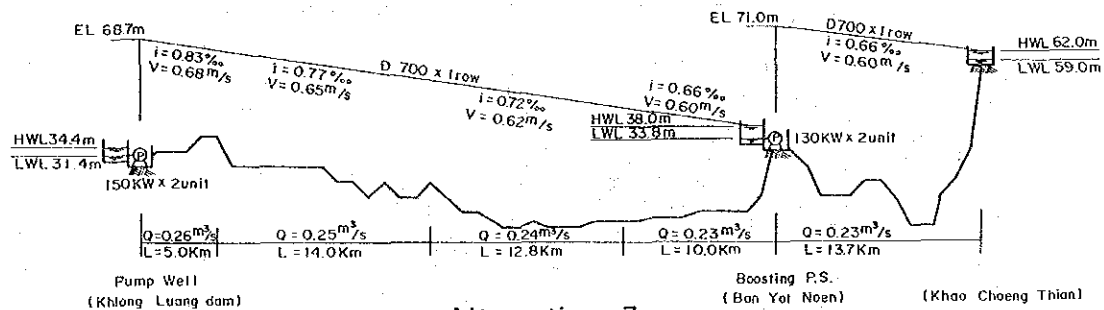
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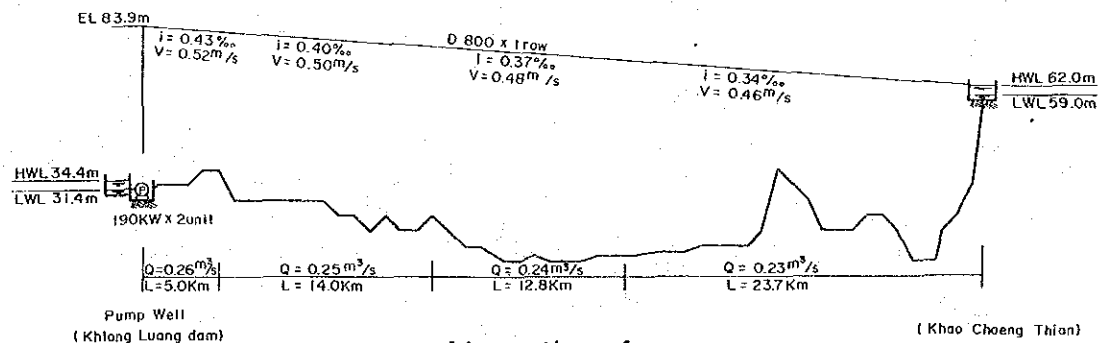
Alternative 1



Alternative 2



Alternative 3



Alternative 4

Fig. 23 Hydraulic Designs of Four Alternatives, Khlong Luang System

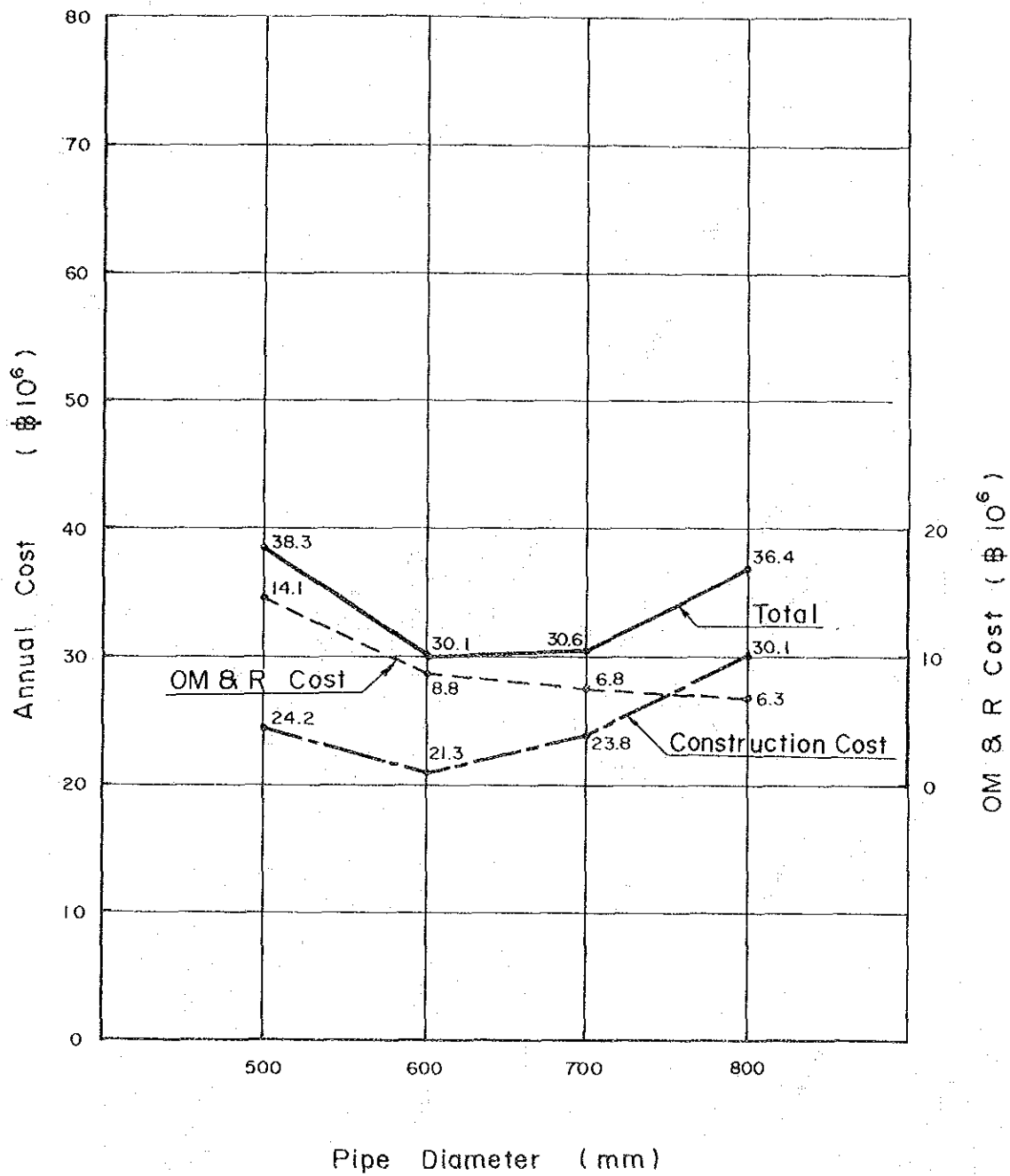


Fig. 24 Relations between Annual Costs and Pipe Diameters, Khlong Luang System

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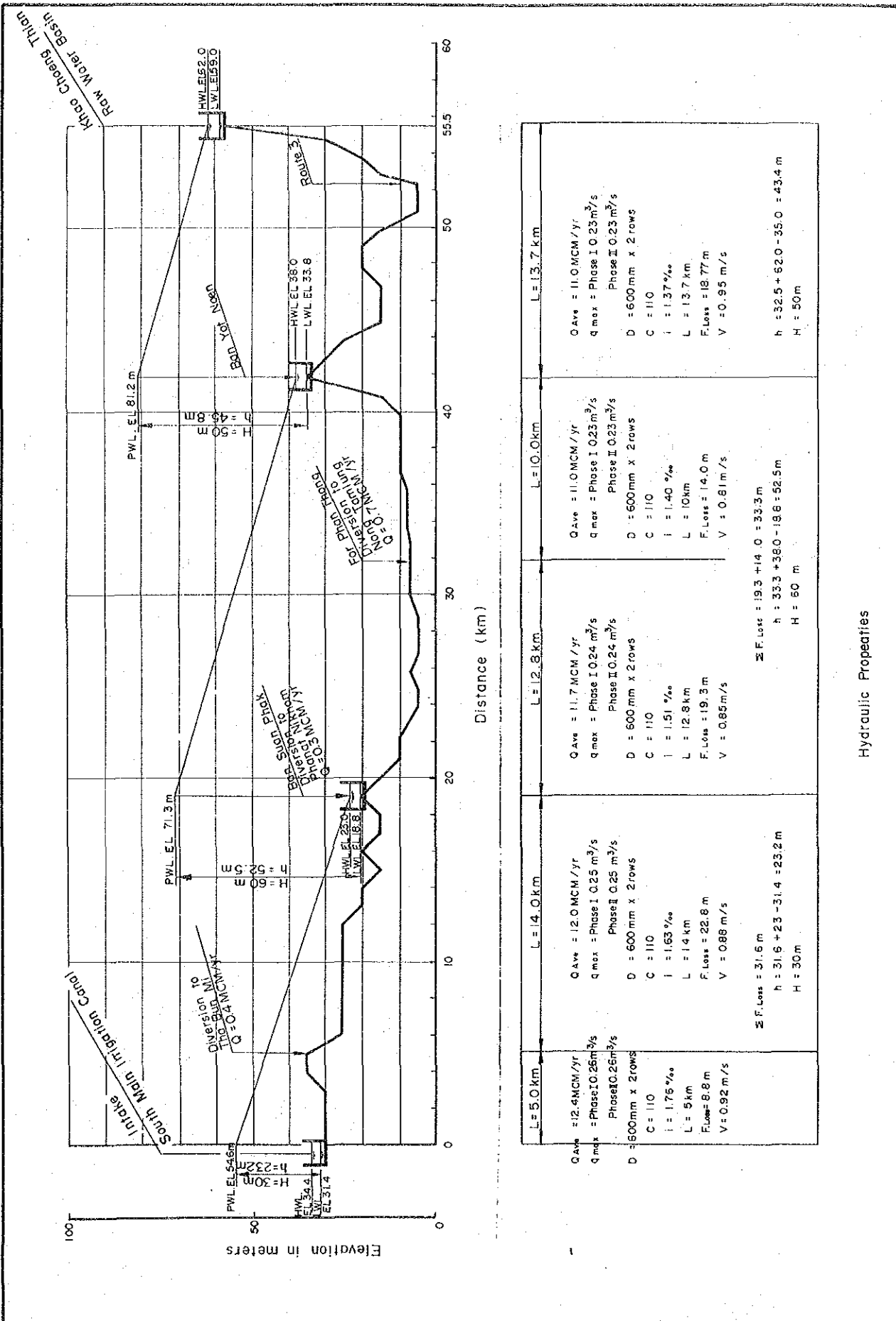


Fig. 25 Hydraulic Design of Proposed Plan, Khlong Luang System

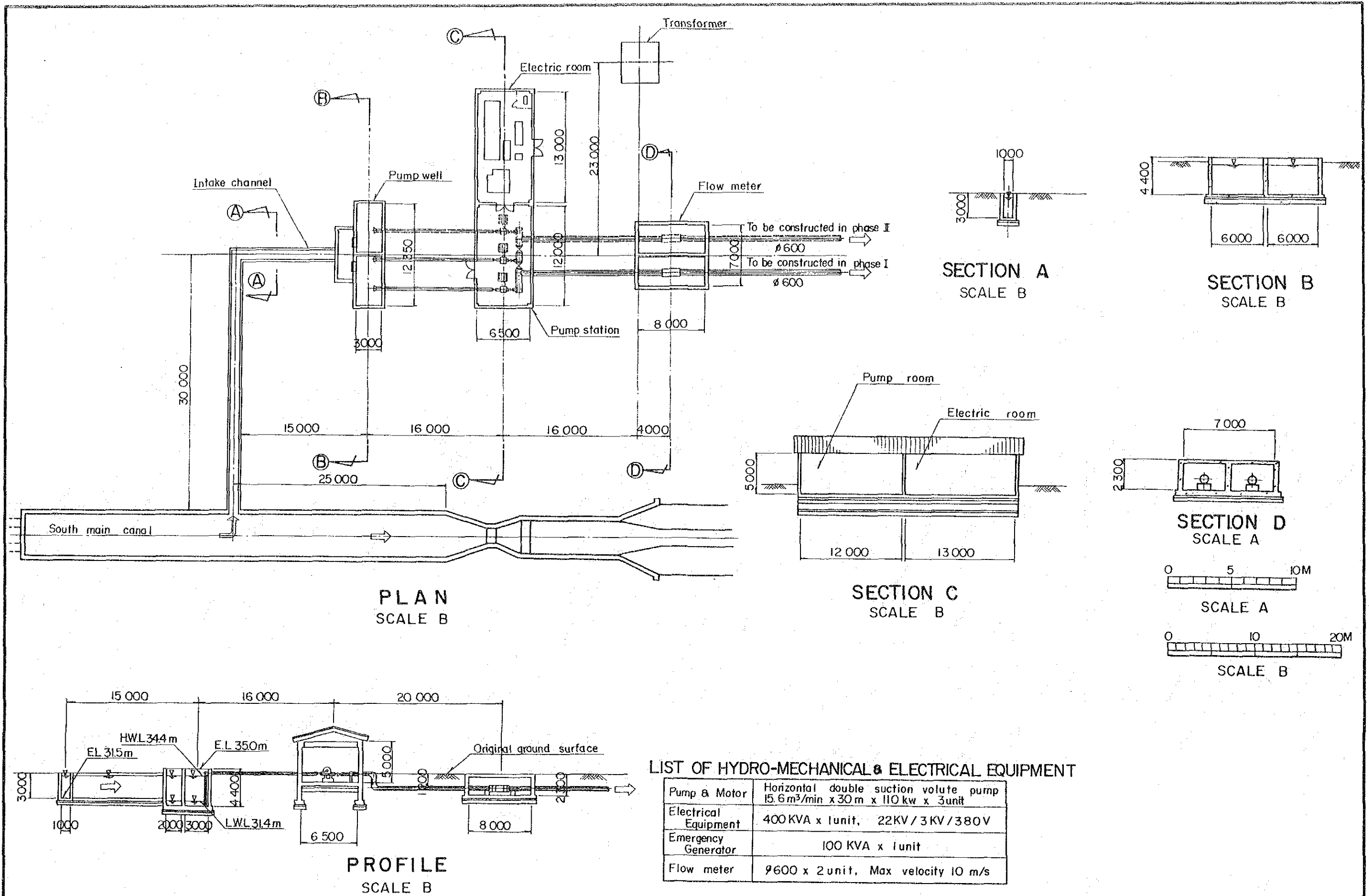


Fig. 26 Khlong Luang System, Intake

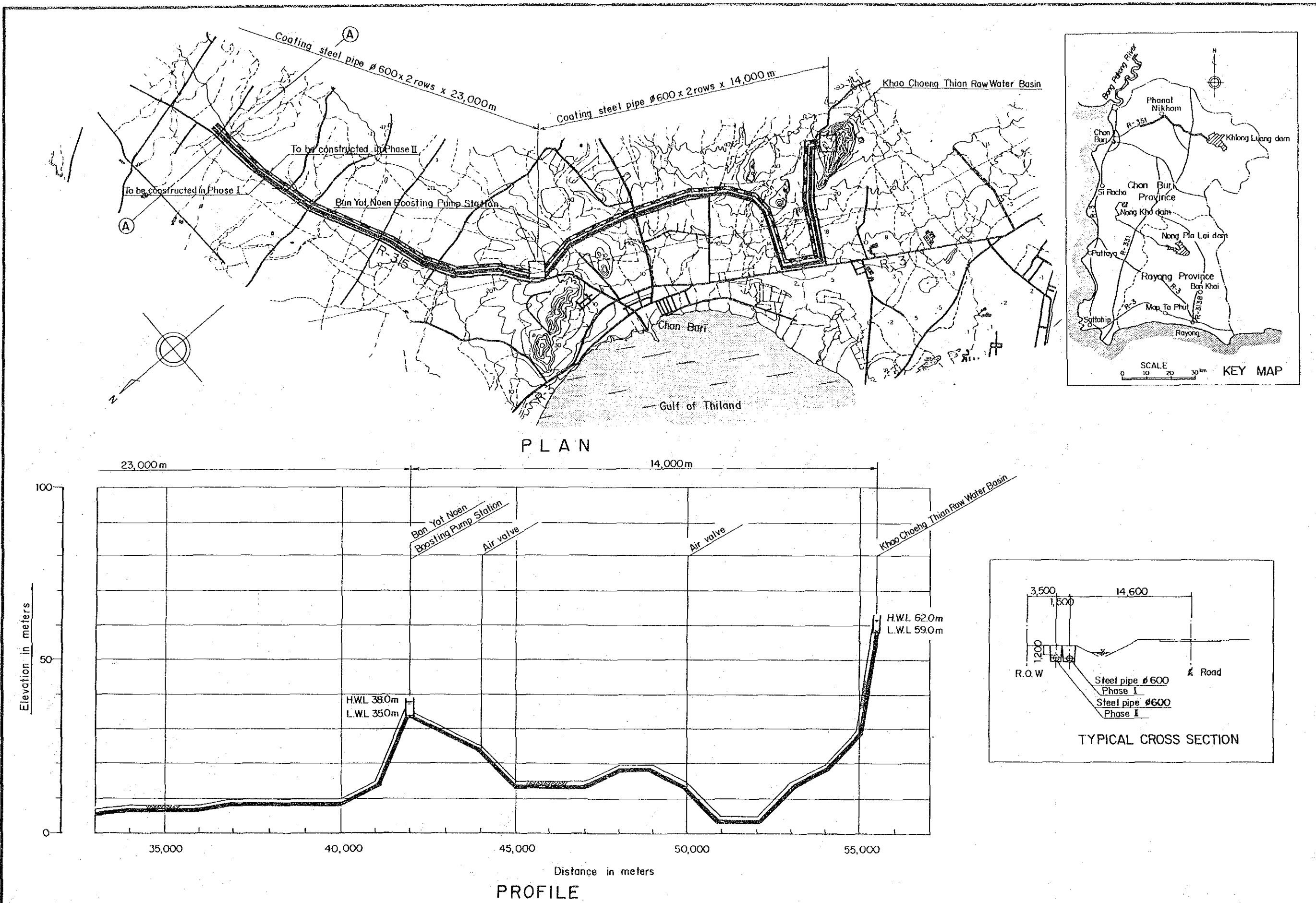
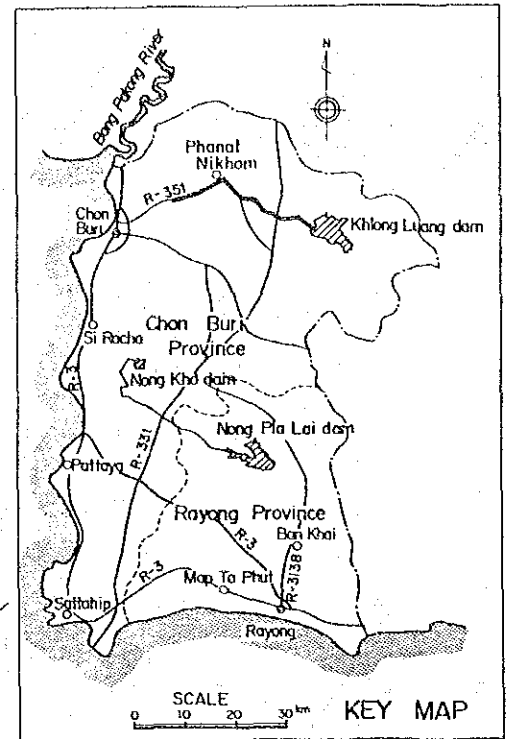
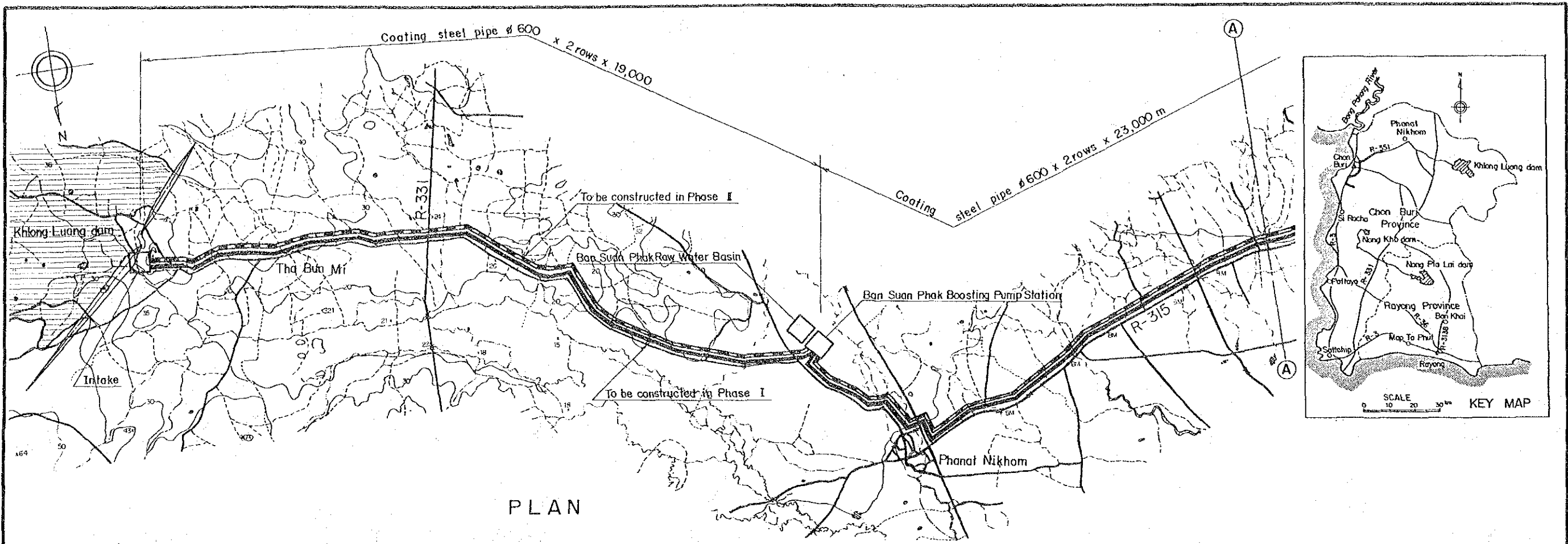
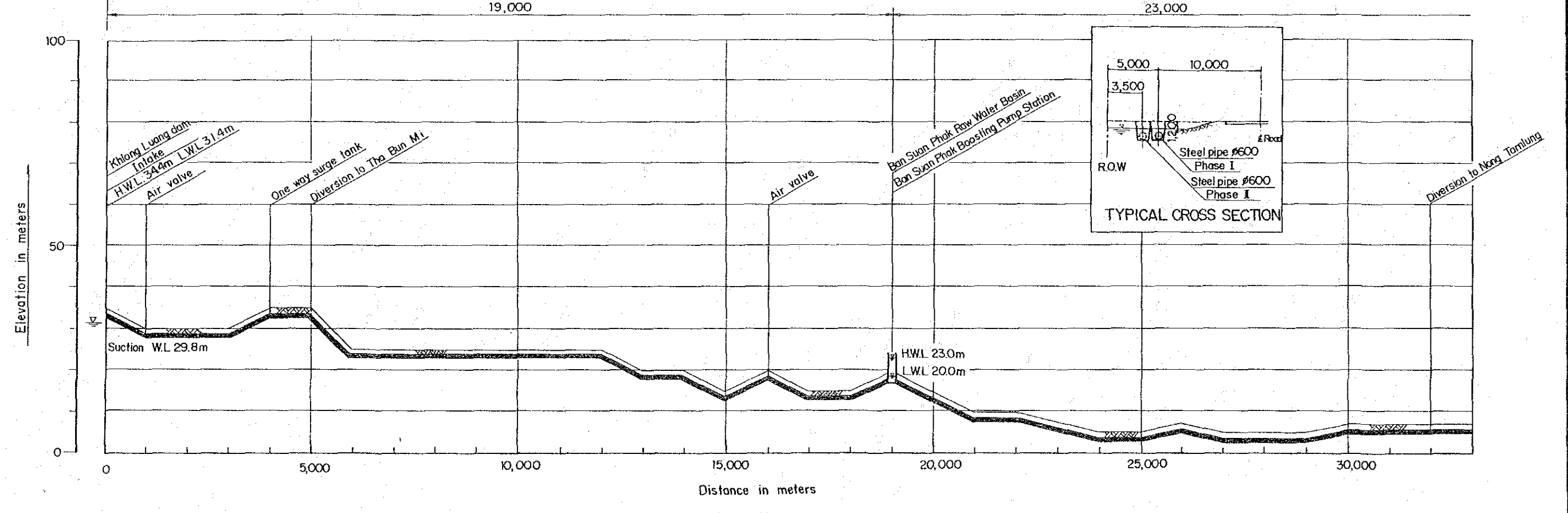


Fig. 27 Khlong Luang System,
Plan and Profile of Pipeline (1/2)



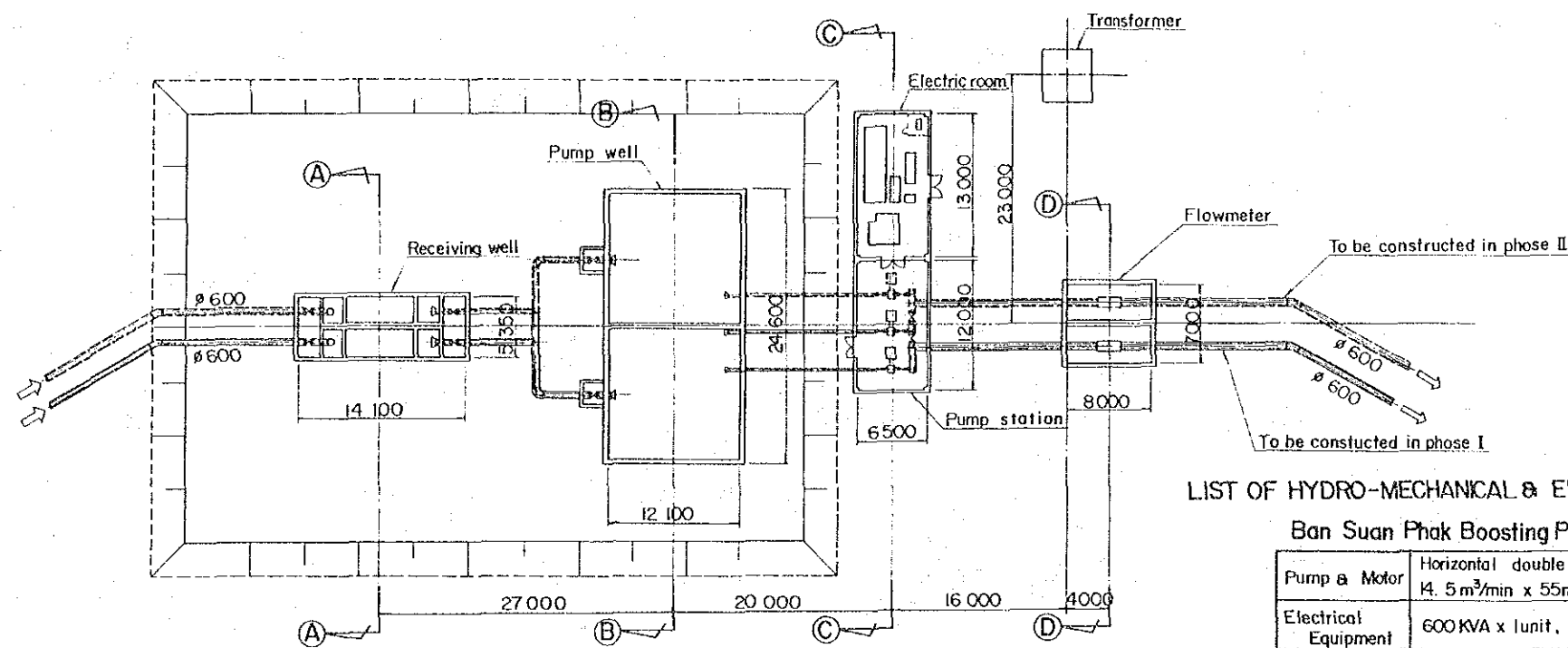


PLAN



PROFILE

Fig. 27 Khlong Luang System,
Plan and Profile of Pipeline (2/2)



BOOSTING PUMP STATION PLAN
SCALE B

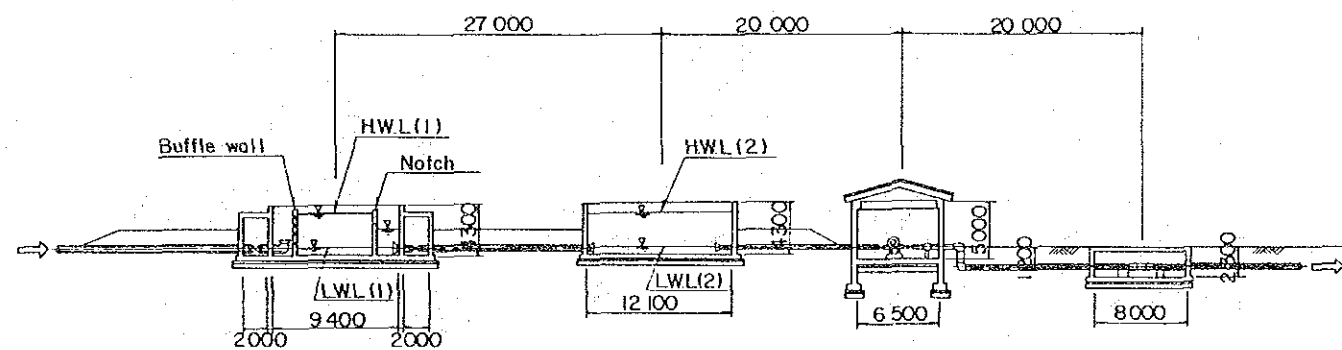
LIST OF HYDRO-MECHANICAL & ELECTRICAL EQUIPMENT

Ban Suan Phak Boosting Pump Station

Pump & Motor	Horizontal double suction volute pump 14.5 m ³ /min x 55m x 190kw x 3 unit
Electrical Equipment	600 KVA x 1unit, 22KV / 3KV / 380V
Emergency Generator	100 KVA x 1unit
Flow meter	φ 600 x 2 unit, Max velocity 10 m/s

Ban Yot Noen Boosting Pump Station

Pump & Motor	Horizontal double suction volute pump 13.6 m ³ /min x 50m x 160kw x 3 unit
Electrical Equipment	500 KVA x 1unit, 22KV / 3KV / 380V
Emergency Generator	100KVA x 1unit
Flow meter	φ 600 x 2unit, Max velocity 10 m/s

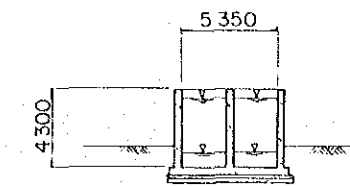


BOOSTING PUMP STATION PROFILE
SCALE B

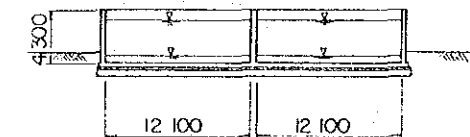
TABLE OF WATER LEVELS

Station	Receiving well		Pump well	
	HWL (1) (EL.m)	LWL (1) (EL.m)	HWL (2) (EL.m)	LWL (2) (EL.m)
Ban Suan Phak	23.0	20.0	21.8	18.8
Ban Yot Noen	38.0	35.0	36.8	33.8

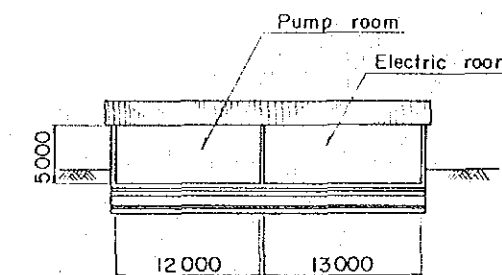
Note: (1) Ban Suan Phak B/s
(2) Ban Yot Noen B/s



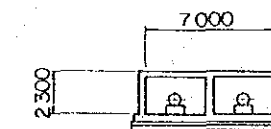
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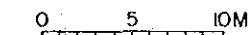
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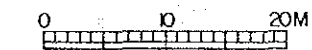
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SECTION D
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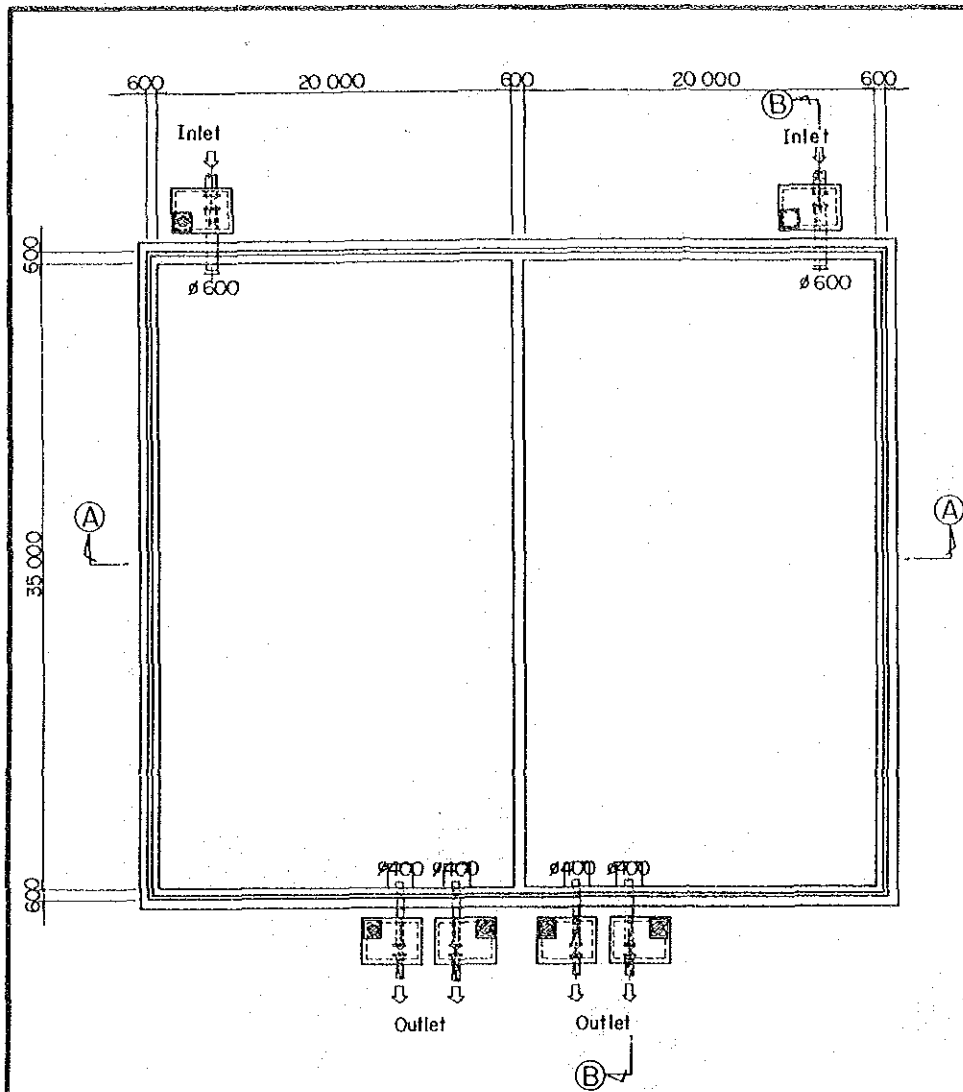


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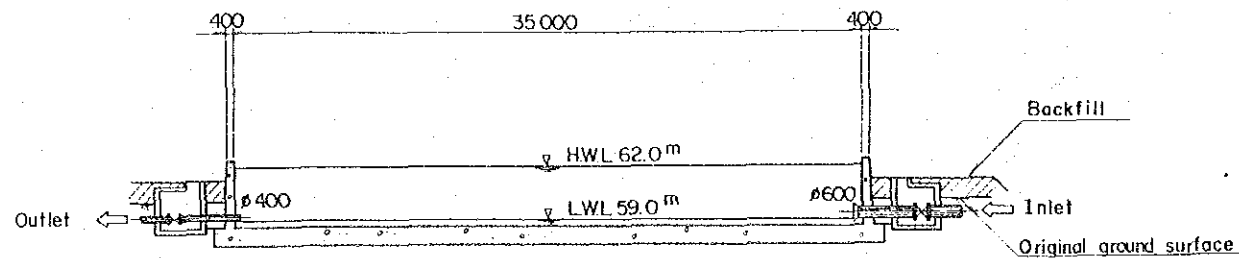


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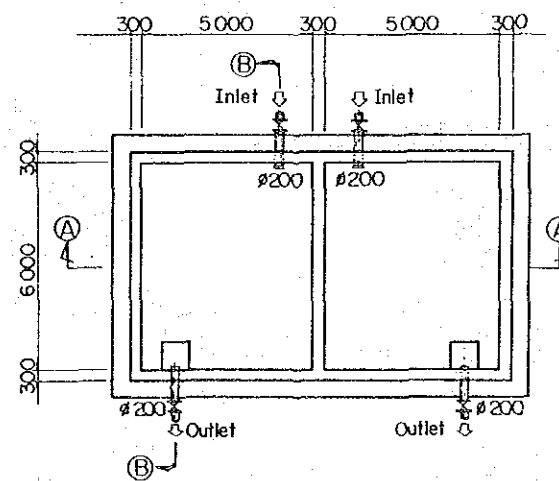
Fig. 28 Khlong Luang System,
Boosting Pump Station



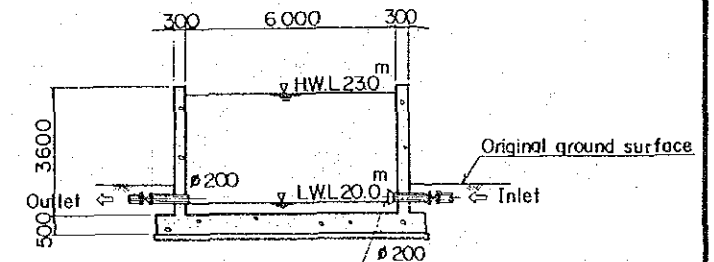
KHAO CHOENG THIAN RAW WATER BASIN PLAN
SCALE B



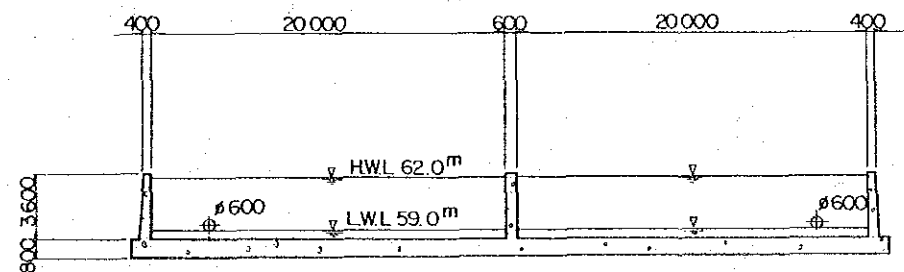
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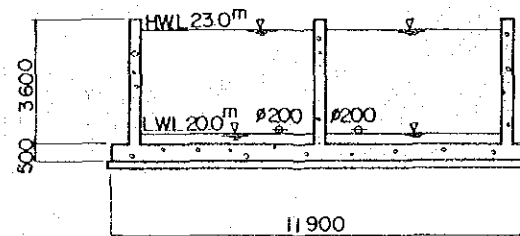
BAN SUAN PHAK RAW WATER BASIN PLAN
SCALE A



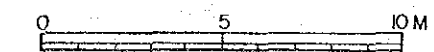
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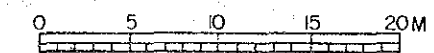
KHAO CHOENG THIAN RAW WATER BASIN SECTION A
SCALE B



BAN SUAN PHAK RAW WATER BASIN SECTION A
SCALE A

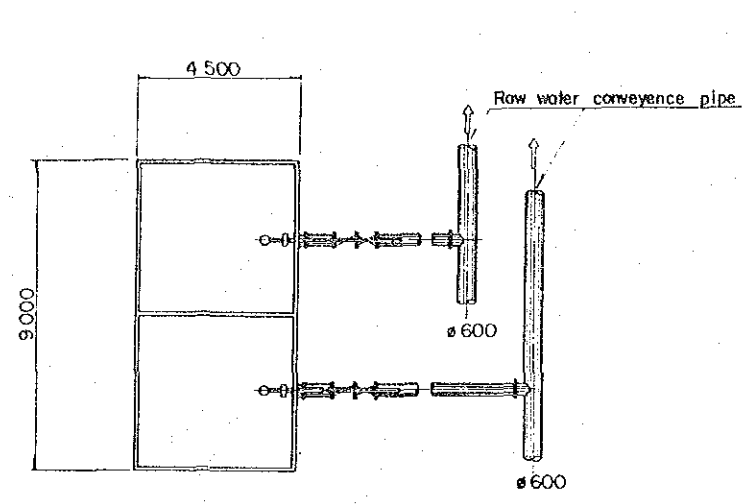


SCALE A

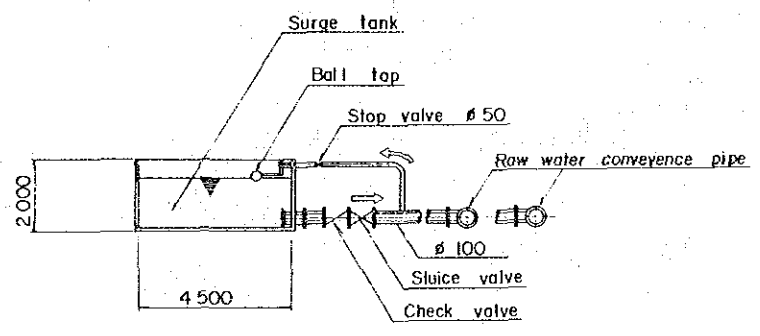


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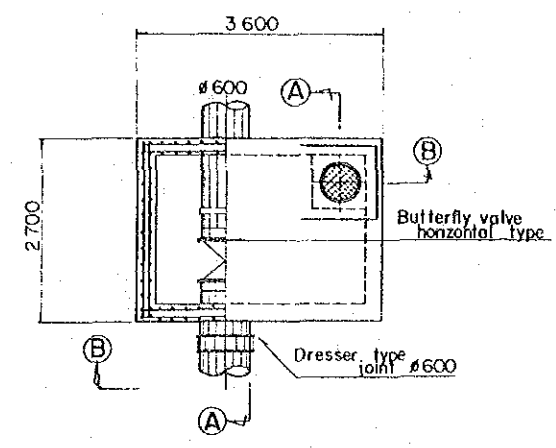
Fig. 29 Khlong Luang System,
Raw Water Basin



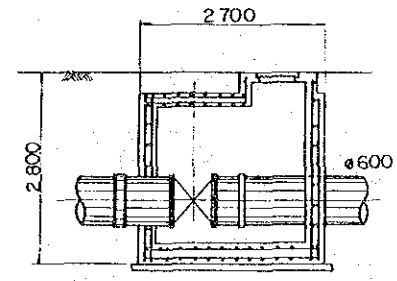
SURGE TANK PLAN
SCALE B



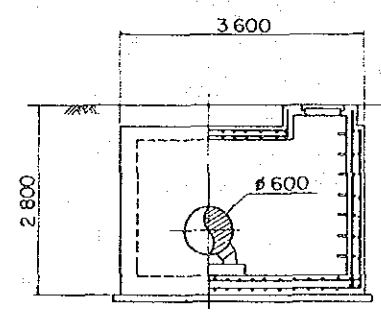
SURGE TANK SECTION
SCALE B



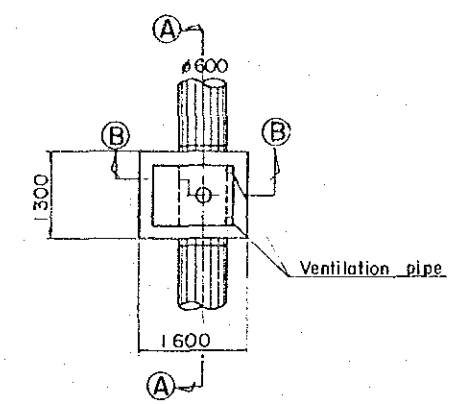
BUTTERFLY VALVE PLAN
SCALE A



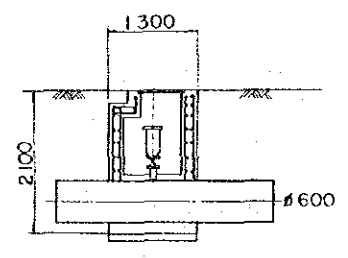
BUTTERFLY VALVE SECTION A
SCALE A



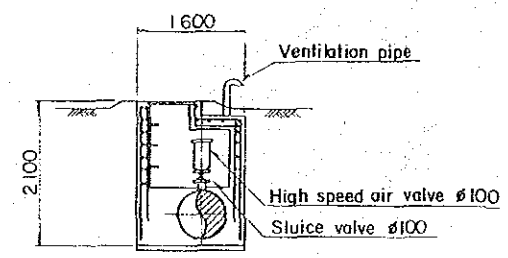
BUTTERFLY VALVE SECTION B
SCALE A



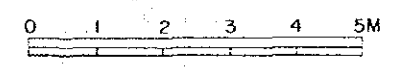
AIR VALVE PLAN
SCALE A



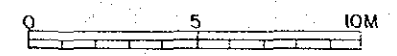
AIR VALVE SECTION A
SCALE A



AIR VALVE SECTION B
SCALE A



SCALE A



SCALE B

Fig. 30

Khlong Luang System,
Appurtenant Facilities

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THE EAST COAST WATER RESOURCES
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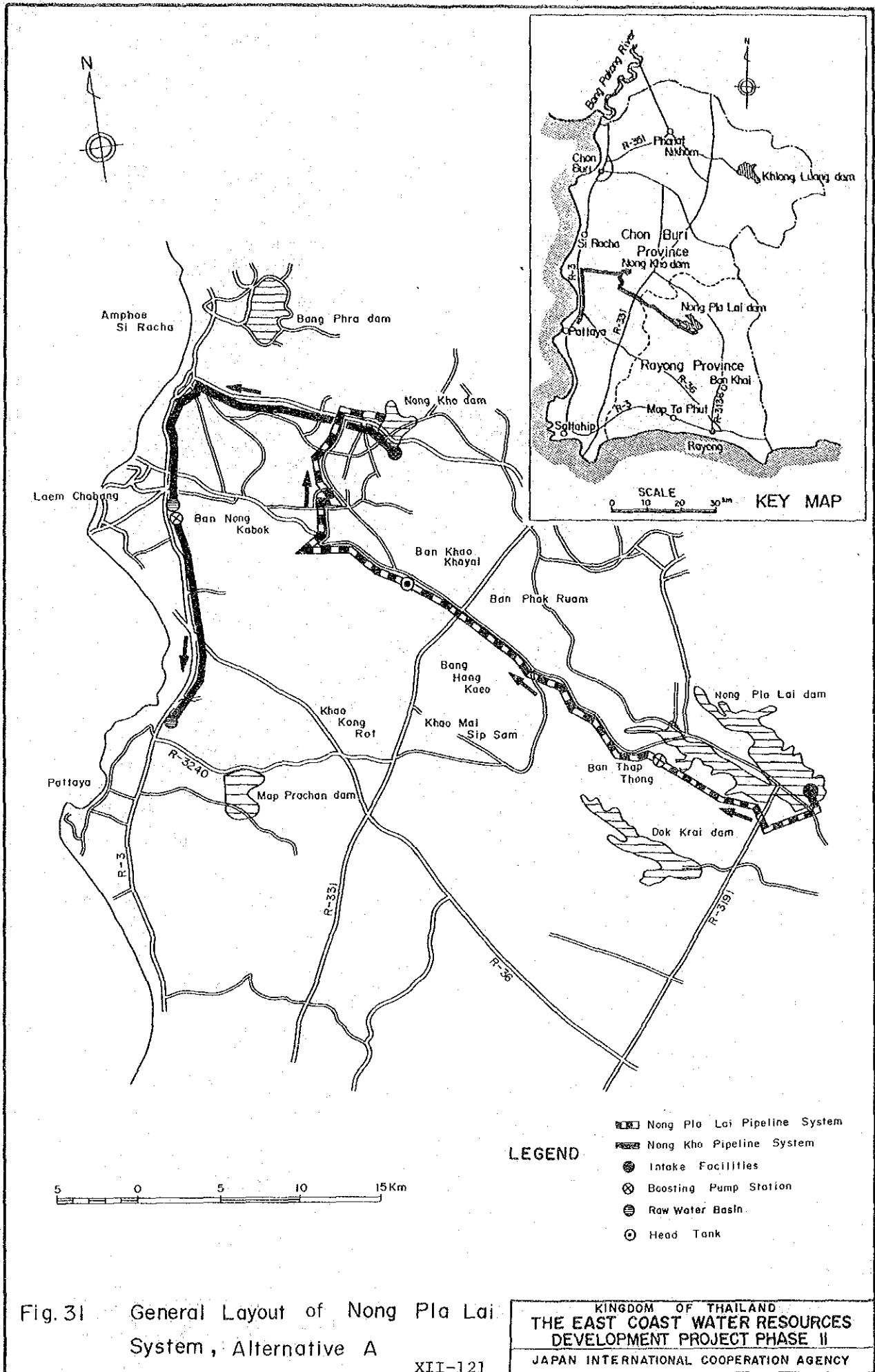
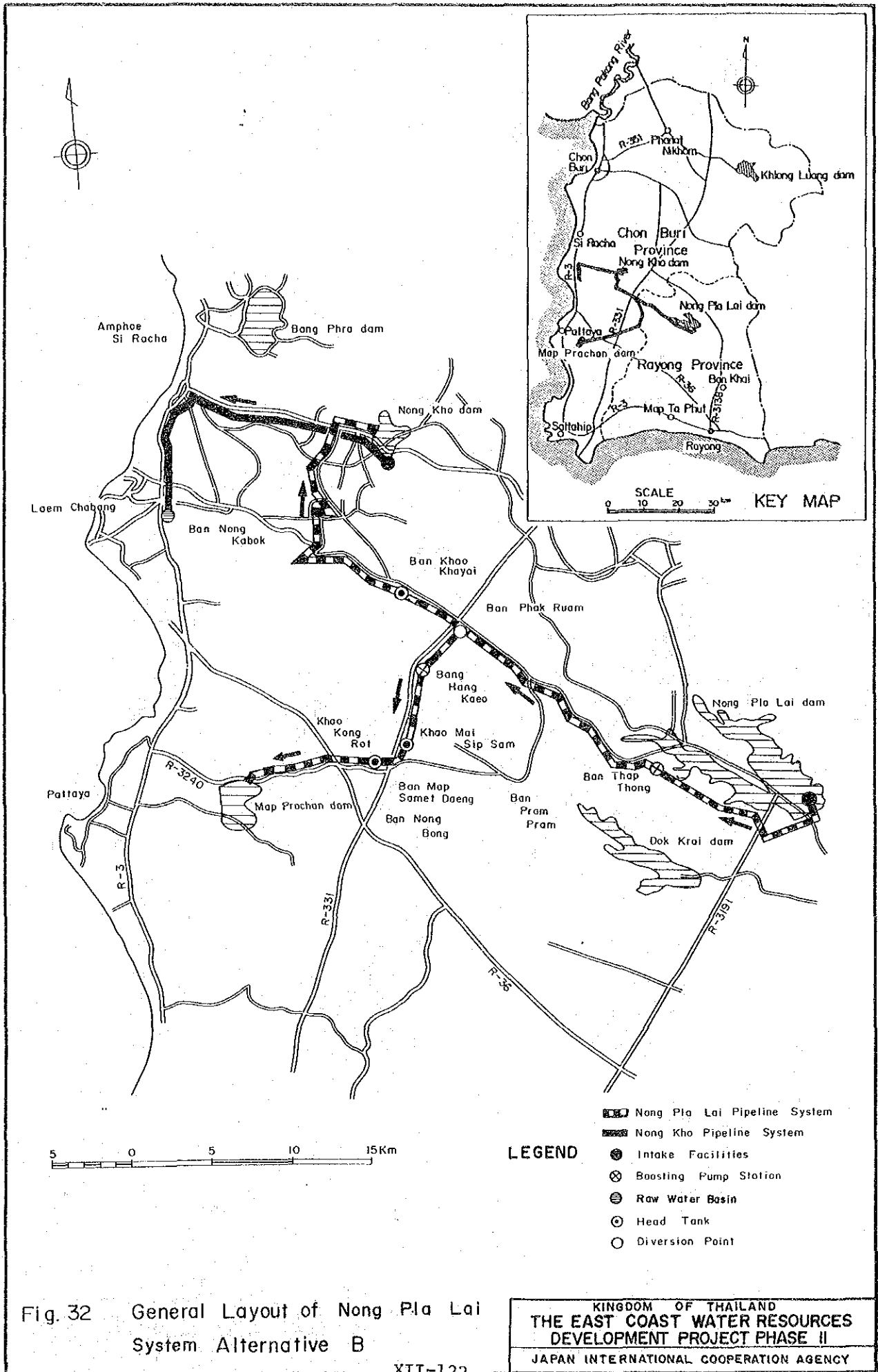


Fig. 31 General Layout of Nong Pla Lai System, Alternative A



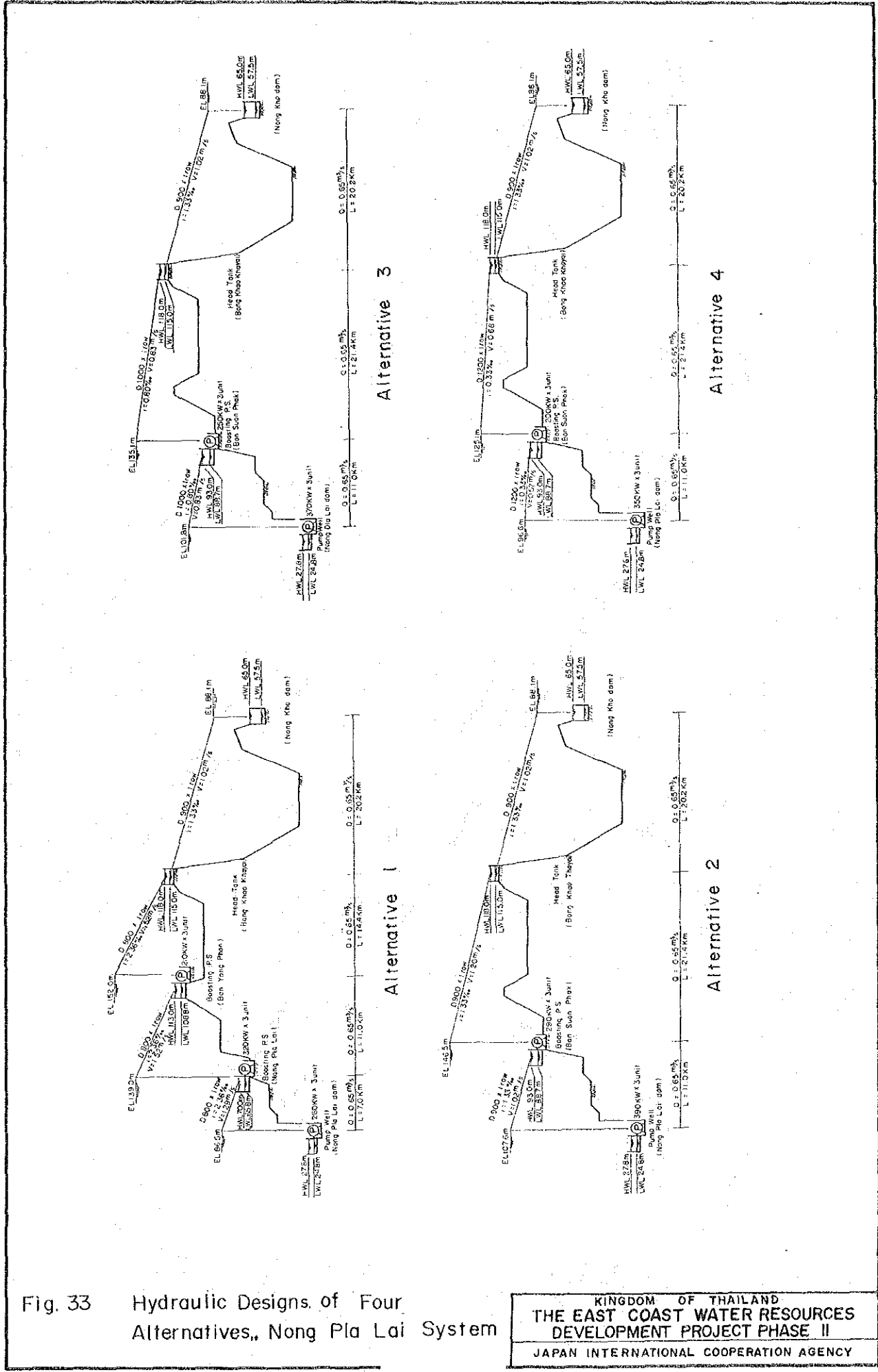


Fig. 33 Hydraulic Designs of Four Alternatives, Nong Pla Lai System

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 DEVELOPMENT PROJECT PHASE II
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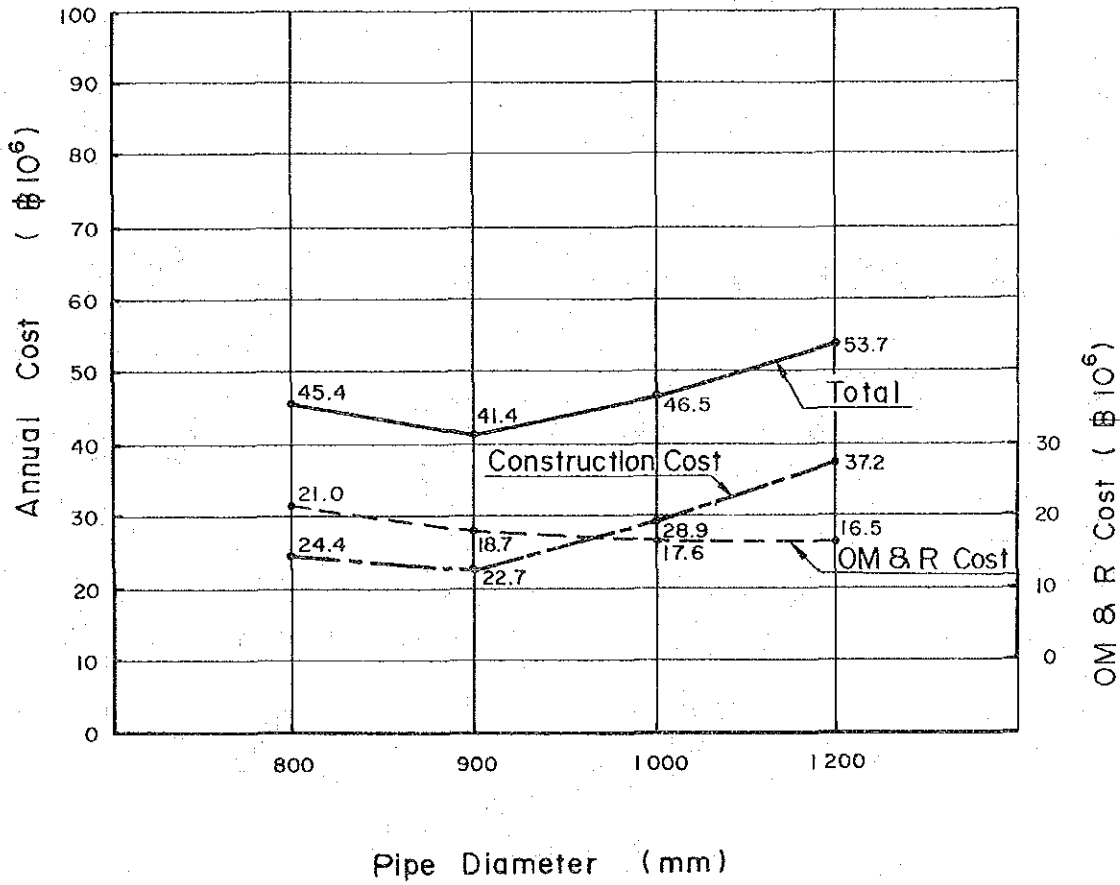
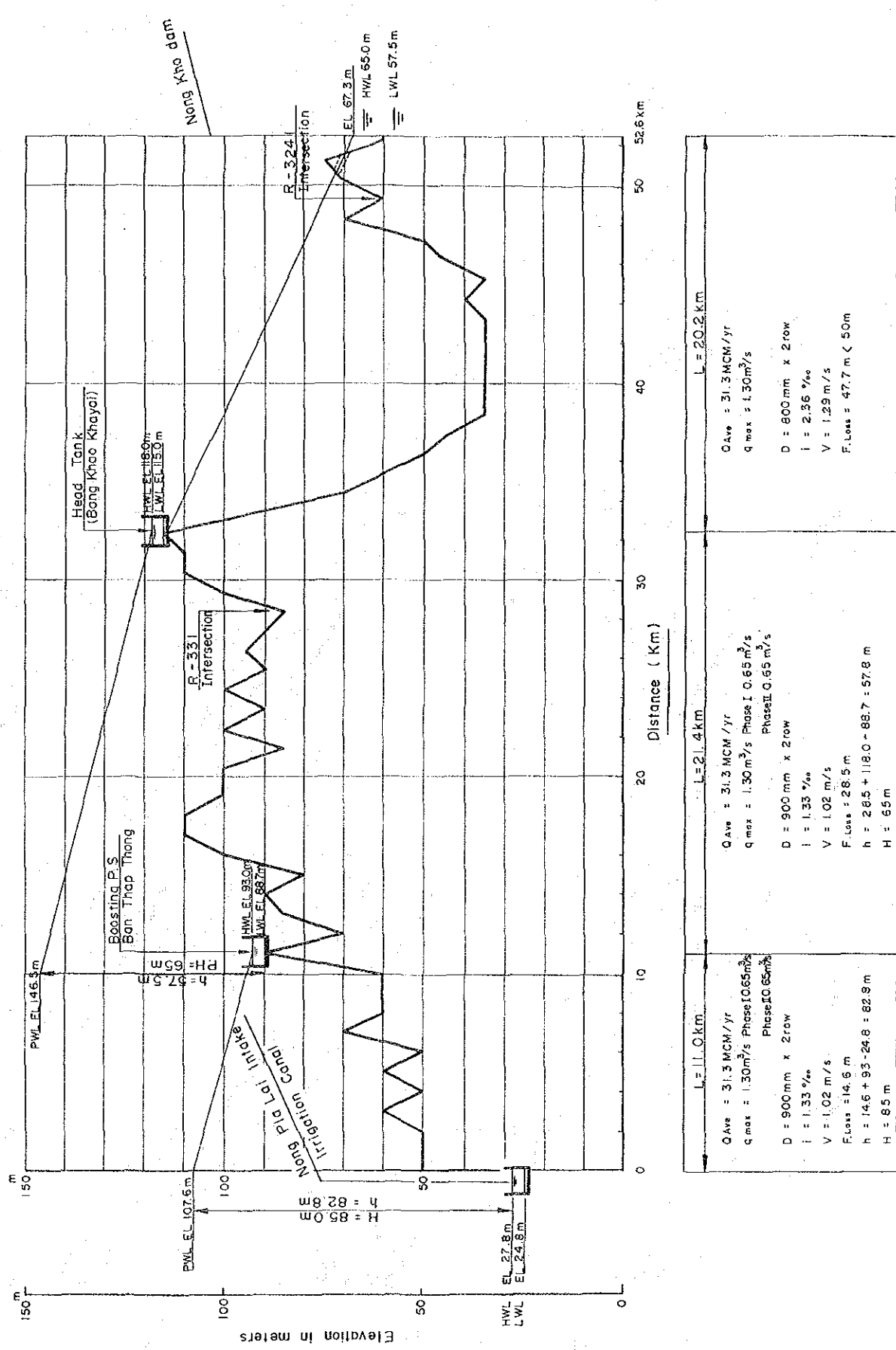


Fig.34 Relations between Annual Costs and Pipe Diameters, Nong Pla Lai System

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 THE EAST COAST WATER RESOURCES
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Distance (Km)	Hydraulic Properties
0 - 10	<p>L = 11.0 km</p> <p>Q_{Ave} = 31.3 MCM/yr q_{max} = 1.30 m³/s Phase I 0.65 m³/s Phase II 0.65 m³/s</p> <p>D = 900 mm x 2 row i = 1.33 ‰ V = 1.02 m/s F_{Loss} = 14.6 m h = 14.6 + 93 - 24.8 = 82.8 m H = 85 m</p>
10 - 30	<p>L = 21.4 km</p> <p>Q_{Ave} = 31.3 MCM/yr q_{max} = 1.30 m³/s Phase I 0.65 m³/s Phase II 0.65 m³/s</p> <p>D = 900 mm x 2 row i = 1.33 ‰ V = 1.02 m/s F_{Loss} = 28.5 m h = 28.5 + 118.0 - 88.7 = 57.8 m H = 65 m</p>
30 - 52.6	<p>L = 20.2 km</p> <p>Q_{Ave} = 31.3 MCM/yr q_{max} = 1.30 m³/s</p> <p>D = 800 mm x 2 row i = 2.36 ‰ V = 1.29 m/s F_{Loss} = 47.7 m < 50 m</p>

Fig. 35 Hydraulic Design of Proposed Plan, Nong Pla Lai System

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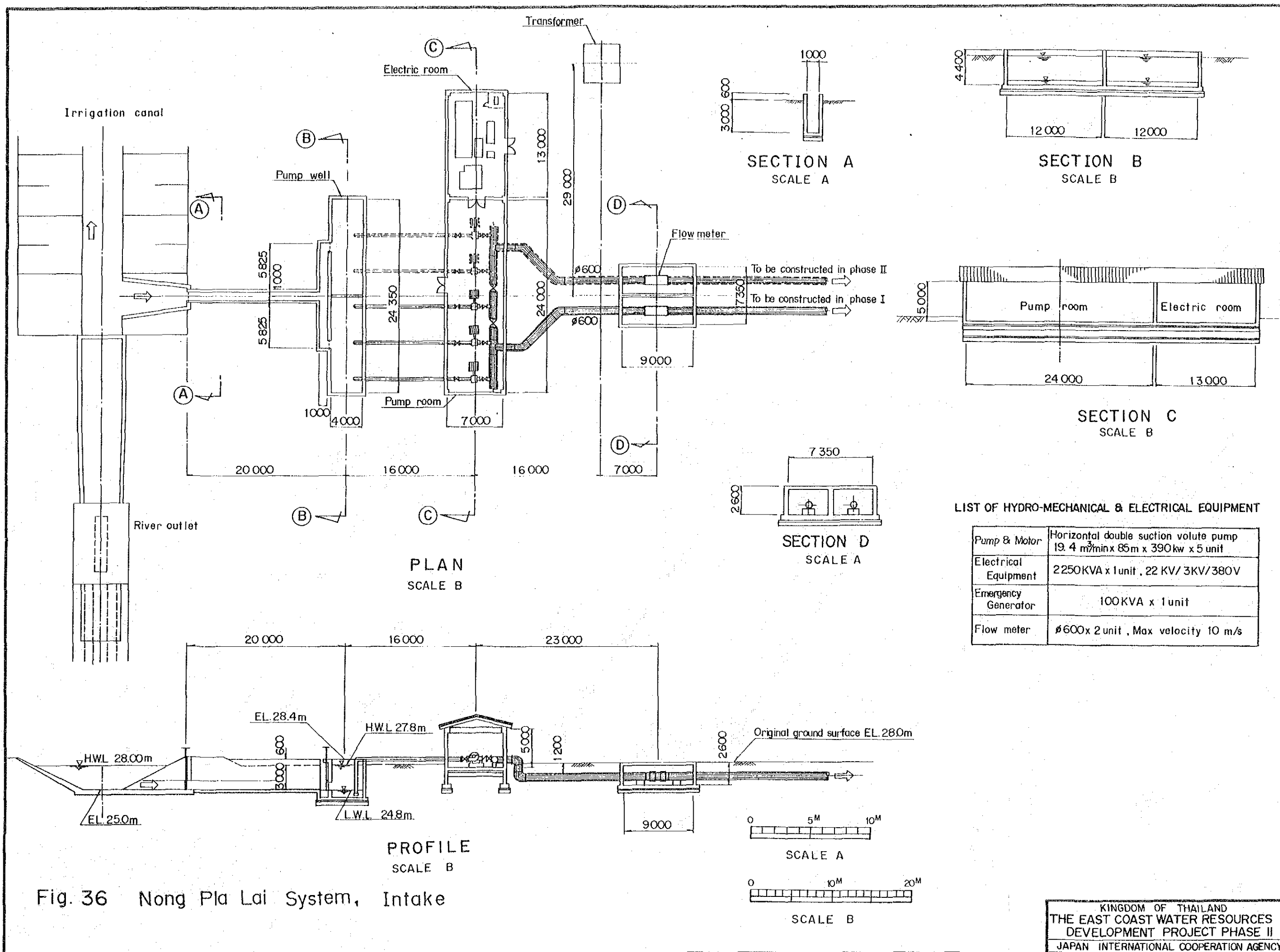


Fig. 36 Nong Pla Lai System, Intake

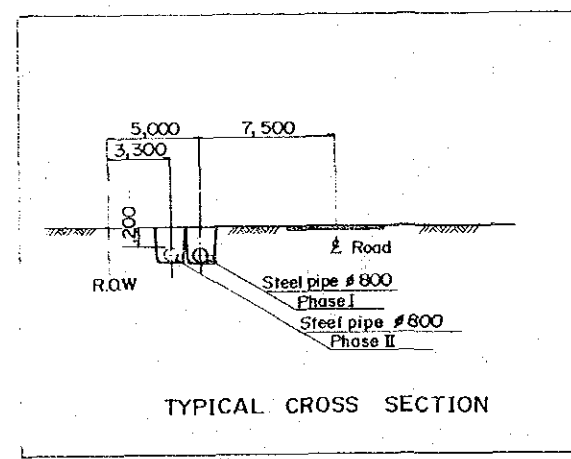
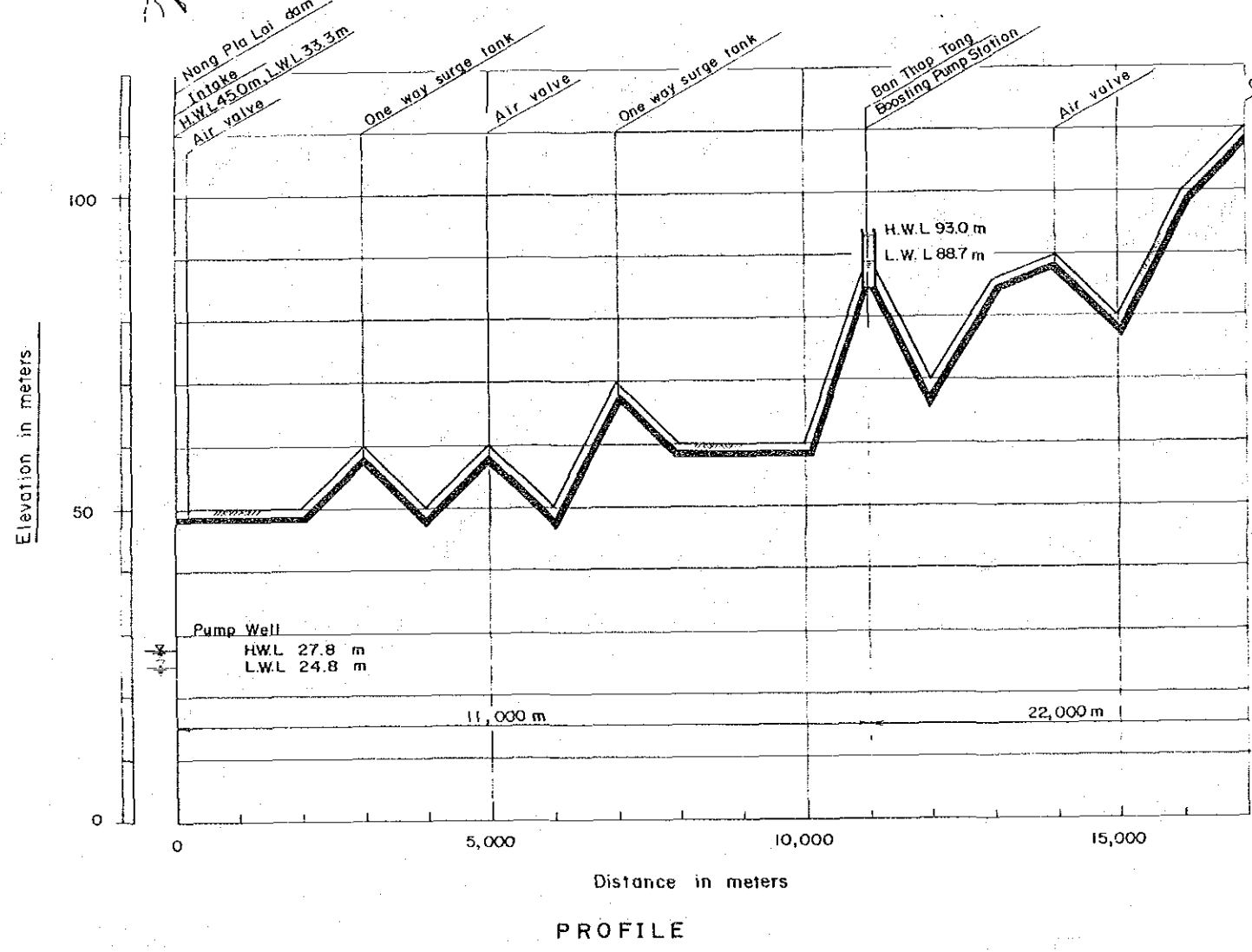
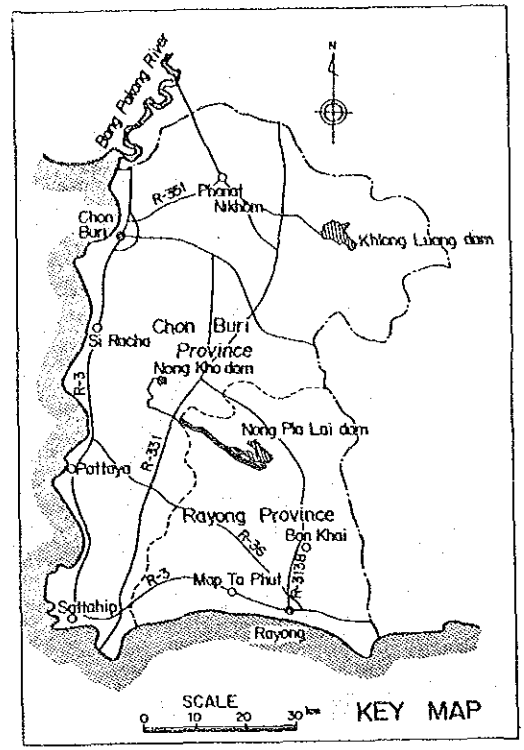
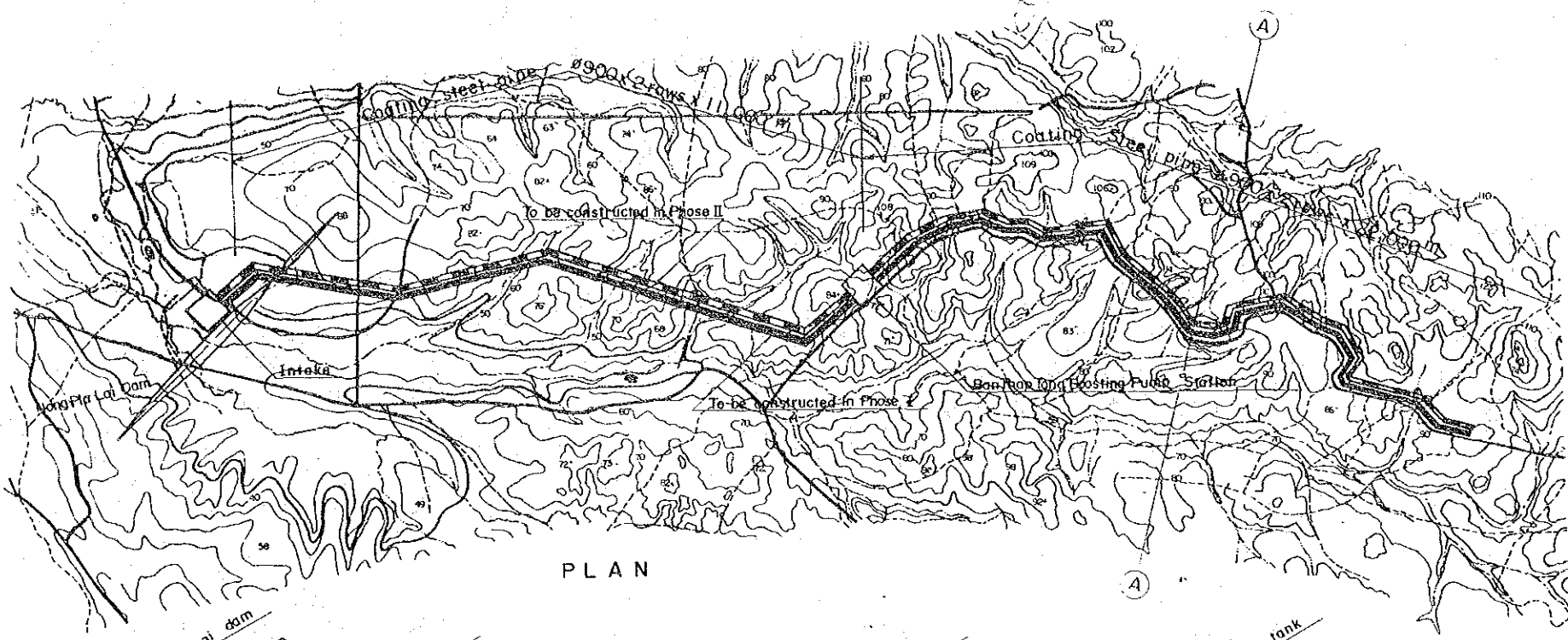


Fig. 37 Nong Pla Lai System, Plan and Profile of Pipeline (1/2)

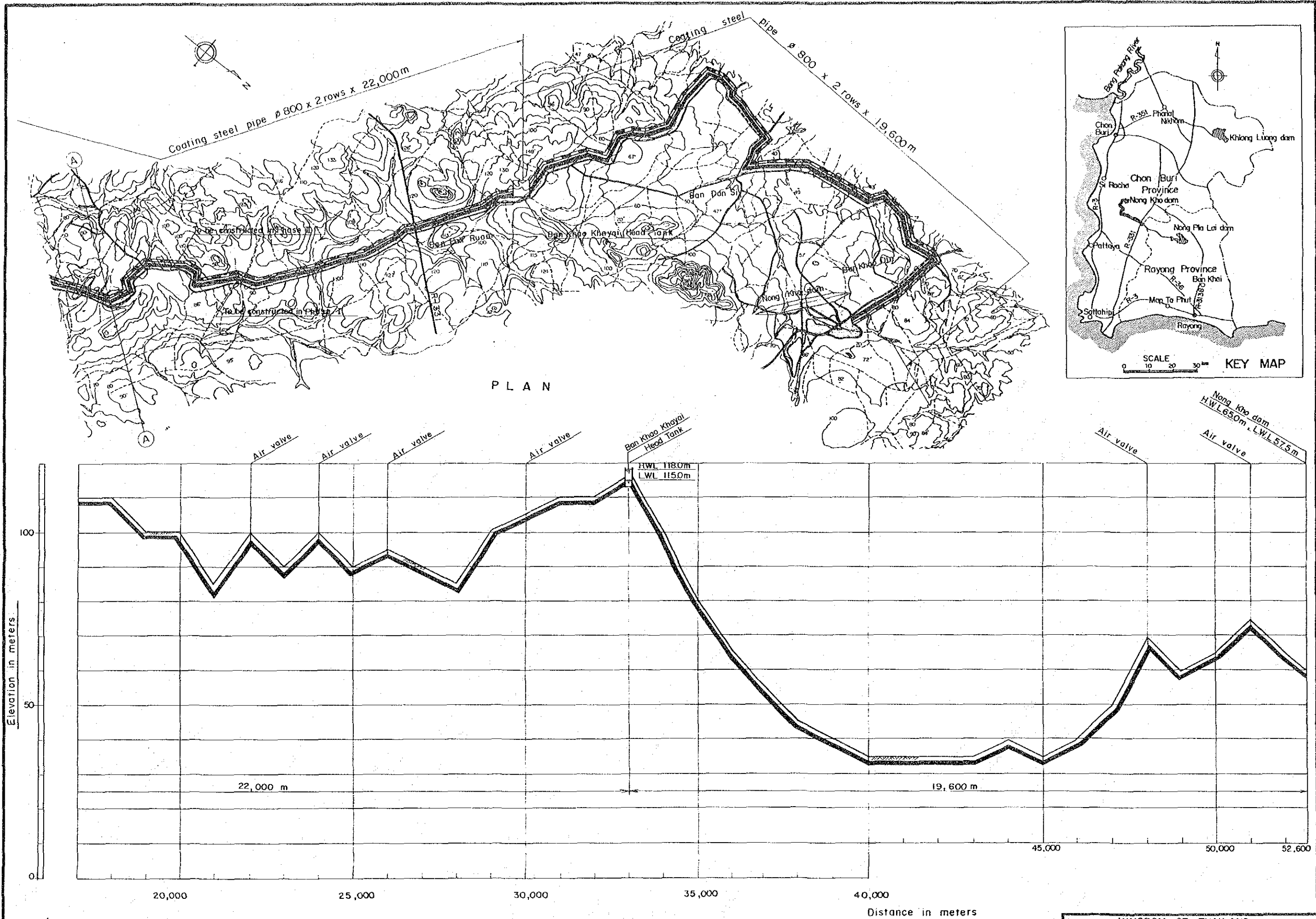
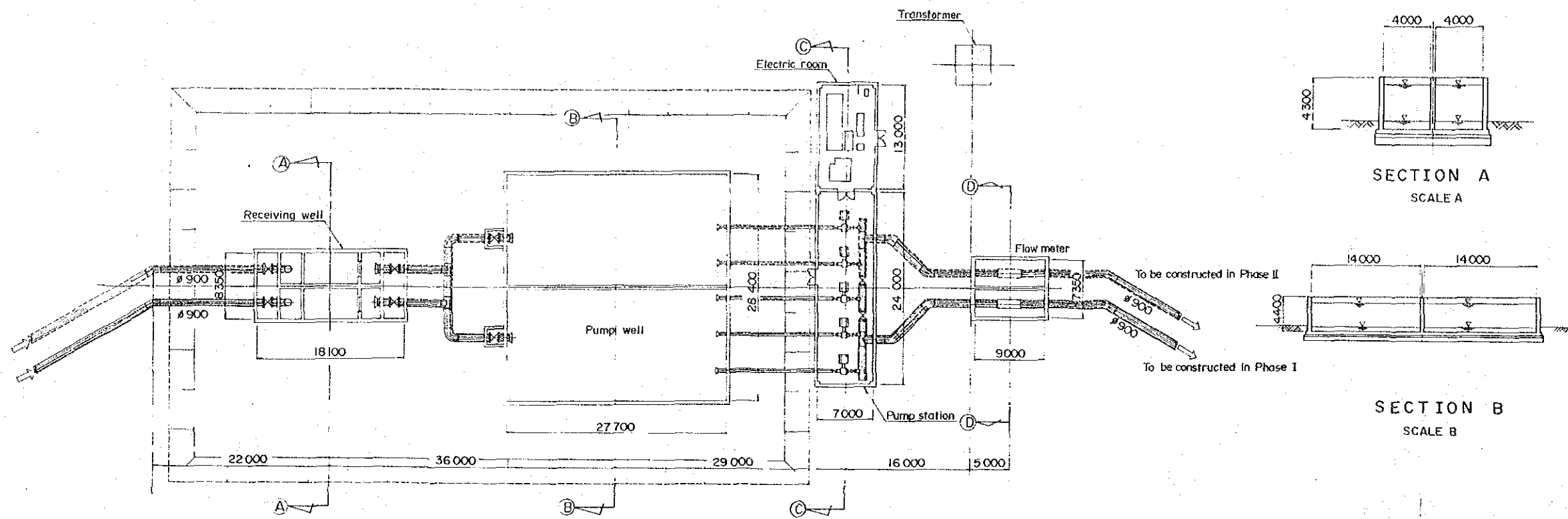


Fig. 37 Nong Pla Lai System, Plan and Profile of Pipeline (2/2) PROFILE

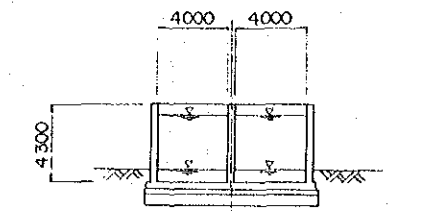
KINGDOM OF THAILAND
 THE EAST COAST WATER RESOURCES
 DEVELOPMENT PROJECT PHASE II
 JAPAN INTERNATIONAL COOPERATION AGENCY



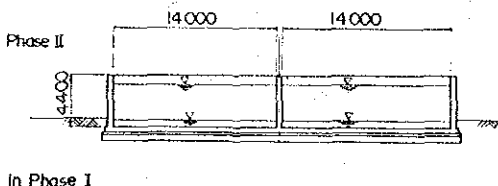
PLAN
SCALE B

LIST OF HYDRO-MECHAICAL & ELECTRICAL EQUIPMENT

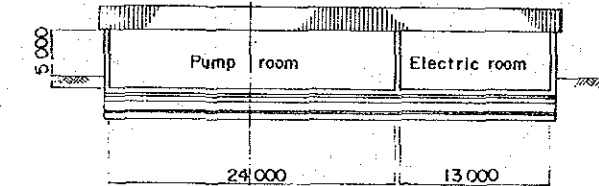
Pump & Motor	Horizontal double suction volute pump 19.4 m ³ /min x 65m x 290kw x 5unit
Electrical Equipment	1,700 KVA x 1unit, 22KV/3KV/380V
Emergency Generator	100 KVA x 1 unit
Flow meter	∅ 900 x 2unit, Max velocity 10m/s



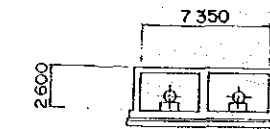
SECTION A
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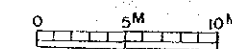
SECTION B
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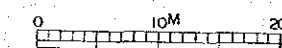
SECTION C
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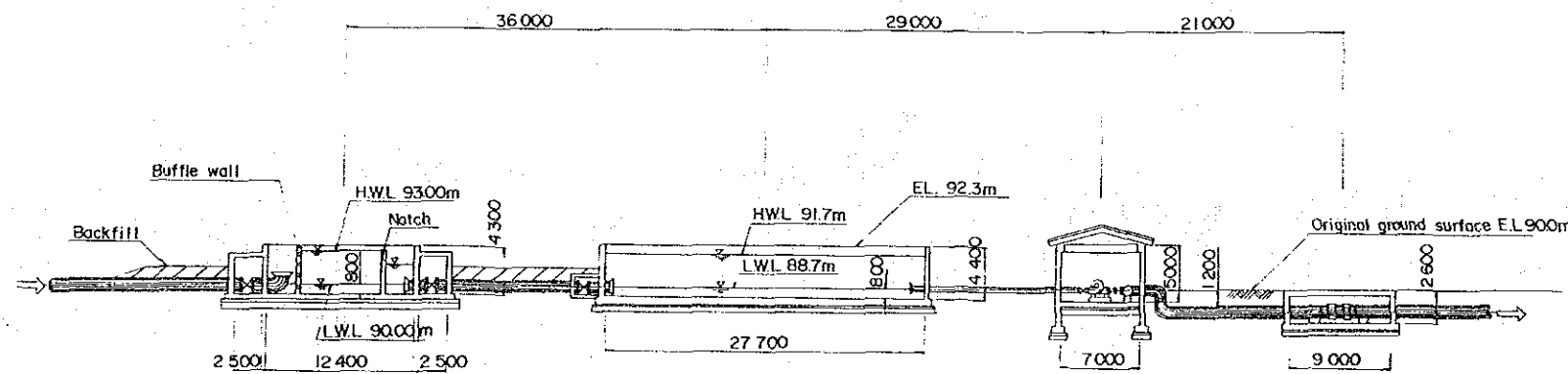
SECTION D
SCALE A



SCALE A

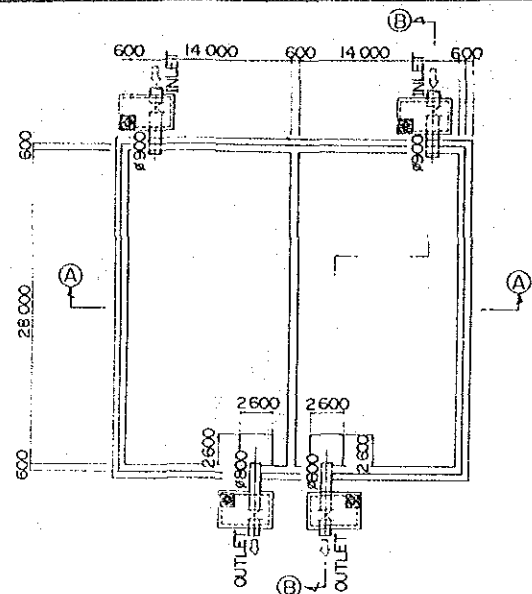


SCALE B

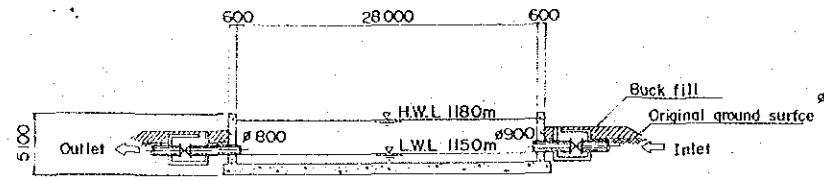


PROFILE
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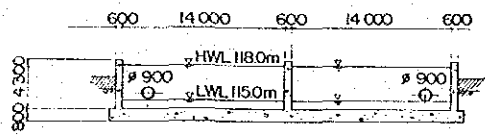
Fig. 38 Nong Pla Lai System, Boosting Pump Station



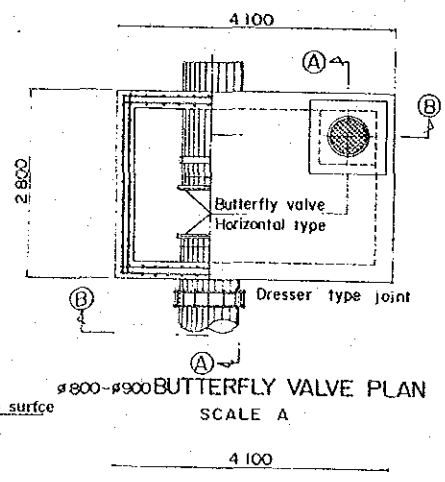
HEAD TANK PLAN
SCALE B



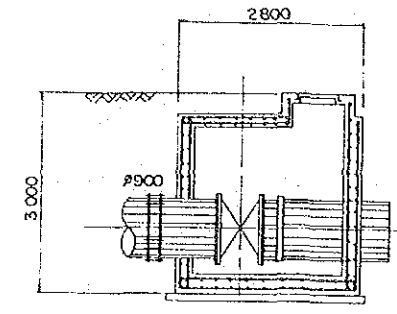
HEAD TANK SECTION B
SCALE B



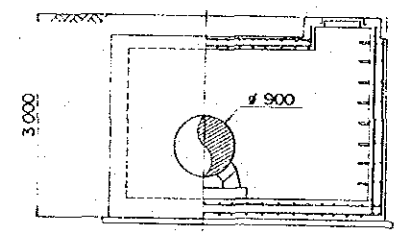
HEAD TANK SECTION-A
SCALE B



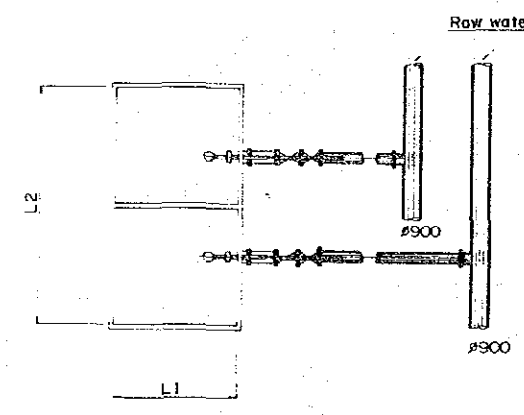
#800-#900 BUTTERFLY VALVE PLAN
SCALE A



#800-#900 BUTTERFLY VALVE SECTION-B
SCALE A



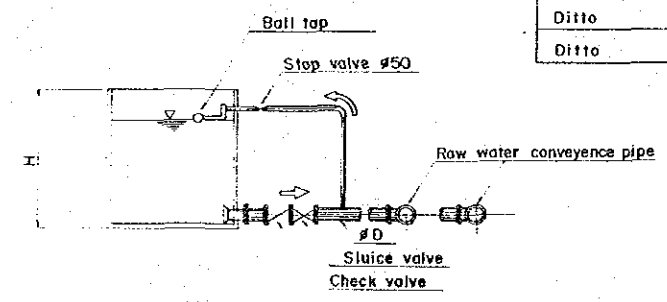
#800-#900 BUTTERFLY VALVE SECTION-B
SCALE A



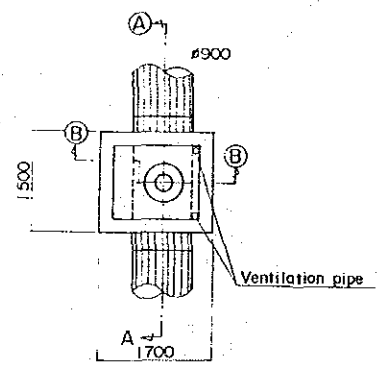
SURGE TANK PLAN

DIMENSIONS OF SURGE TANK

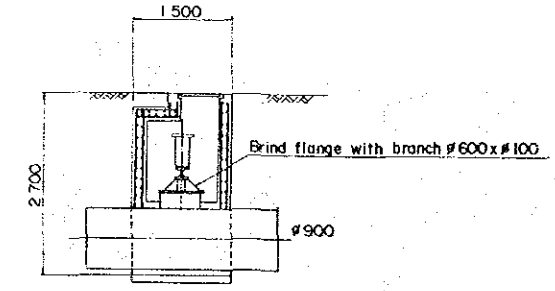
Systems	Site	Volume (m ³)	Dimensions (m)			
			L1	L2	H	φ D
Nong Pla Lai dam	3 km from intake pump	16.0	3000	6000	900	80
Ditto	7 km from intake pump	4.0	2000	4000	600	80
Ditto	17 km from intake pump	60.0	3500	7000	2500	100



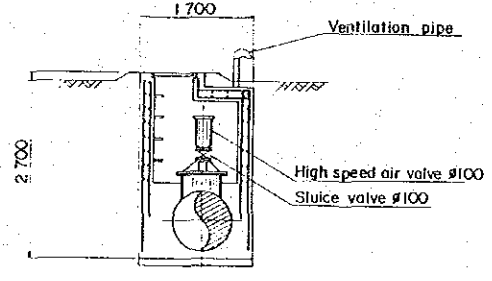
SURGE TANK SECTION



#800-#900 AIR VALVE PLAN
SCALE A



#800-#900 AIR VALVE SECTION-A
SCALE A



#800-#900 AIR VALVE SECTION-B
SCALE A

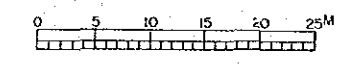
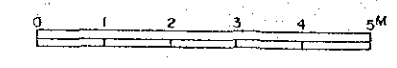
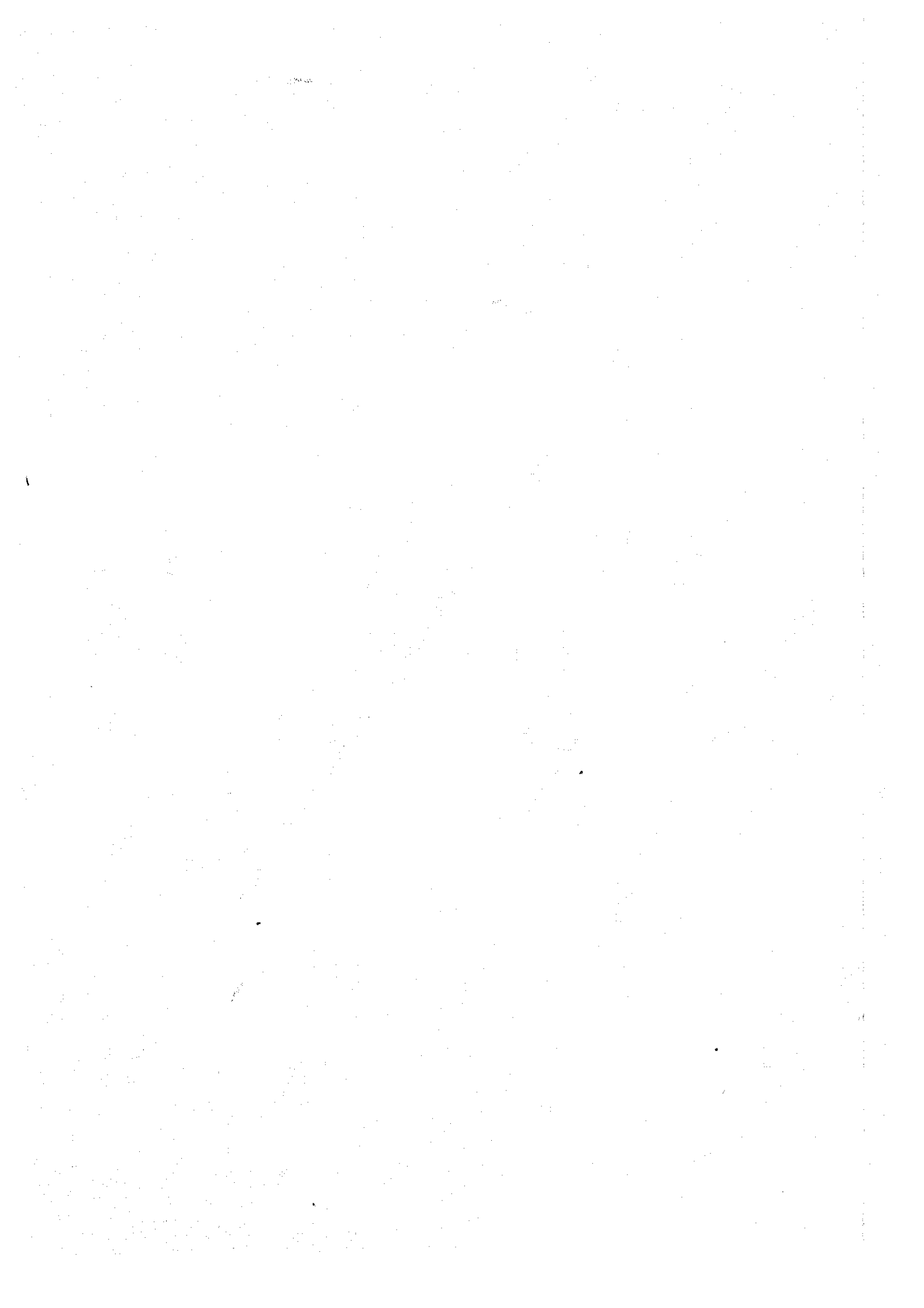


Fig. 39 Nong Pla Lai System, Head Tank and Appurtenant Facilities



Item	Descriptions	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
I Intake	(Khlong Luang dam)	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9	3 6 9
Intake & Pump Well	Conc : 246 m ³						8							
Pump & Elect Station	Floor Area : 163m ²						8							
Erection Works	Phase I : 110 kw x 2 unit Phase II : 110 kw x 1 unit						4							4
II Pipeline	(Khlong Luang dam ~ Khae, Chooang, Thian)						30							
Installation	Phase I : φ 600 x 56 km Phase II : φ 600 x 56 km						30							
III Booster P/S (1)	(Ben Suan Phok)													
Receiving & Pump Well	Conc : 484 m ³						8							
Pump & Elect Station	Floor Area : 163m ²						8							
Erection Works	Phase I : 190kw x 2 unit Phase II : 190kw x 1 unit						4							4
IV Booster P/S (2)	(Ben Yet Neen)													
Receiving & Pump Well	Conc : 484 m ³						8							
Pump & Elect Station	Floor Area : 163m ²						8							
Erection Works	Phase I : 160kw x 2 unit Phase II : 160kw x 1 unit						4							4
V Raw Water Basin	(Ben Suan Phok & Khae Chooang Thian)													
Raw Water Basin (1)	Conc : 94m ³							12						
Raw Water Basin (2)	Conc : 1739m ³							12						

Fig. 40 Construction Time Schedule of Khlong Luang System

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 DEVELOPMENT PROJECT PHASE II
 JAPAN INTERNATIONAL COOPERATION AGENCY

Item	Descriptions	1984		1985		1986		1987		1988		1989		1990		1991		1992		1993		1994		1995		1996			
		3	6	9	3	6	9	3	6	9	3	6	9	3	6	9	3	6	9	3	6	9	3	6	9	3	6	9	
I Intake	(Nong Pla Lai dam)																												
	Intake Pump Well Conc. 417 m ³													8															
	Pump & Elect. Station Floor Area 259 m ²													8															
	Erection Works Phase I: 390kw x 3 unit													4															
	" Phase II: 390kw x 2 unit																											7	
II Pipeline	(Nong Pla Lai 2km ~ Nong Pla Lai 200-200m)																												
	Installation Phase I: φ 800 33km																												
	" Phase II: φ 800 29km																												
	" Phase II: φ 800 29km																												
III Booster P/S	(Ban Thap Thong)																												
	Receiving Well & Pump Well Conc. 920 m ³																												
	Pump & Elect. Station Floor Area 259 m ²																												
	Erection Works Phase I: 290kw x 3 unit																												
	" Phase II: 290kw x 2 unit																												
IV Head Tank	Conc. 1,120 m ³																												

Fig. 41 Construction Time Schedule of Nong Pla Lai System

**SECTORAL REPORT XIII
FLOOD MITIGATION ENGINEERING**

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1. INTRODUCTION

The study on the flood mitigation engineering aims at formulating a flood mitigation plan in the Study Area in consideration of the proposed Khlong Luang, Khlong Yai and Khlong Thap Ma dams. The study covers (1) present conditions of rivers, (2) flood damages, and (3) formulation of preliminary flood mitigation plan.

The present river conditions are clarified, firstly, in order to provide basic data for the formulation of flood mitigation plan. This includes general features of river and its basin, flood mitigation facilities, and channel capacity of the existing river channels.

Secondly, flood damages in the past are estimated based on the interview surveys on fields. The flood damage survey will be used for the estimation of flood mitigation benefit of the proposed dams and river improvement projects.

Then, alternative flood mitigation schemes in consideration of proposed dams are set up and examined technically and economically. Finally, basic flood mitigation plans of the Khlong Luang and Rayong river are formulated at preliminary level.

The Study Area encompasses Chon Buri and Rayong Provinces excluding the Prasae river basin. For the convenience of the study, the Study Area is divided into three, i.e., Khlong Luang river basin, Rayong river basin, and coastal area which includes a large number of small rivers. Location of the Study Area is shown in Fig. 1.

2. PRESENT CONDITIONS OF RIVERS

2.1 Khlong Luang River

2.1.1 River System

The Khlong Luang river originates in Mt. Khao Ang Kraden (El. 338 m) and flows northwestwards. In the downstream alluvial plain, the main stream is divided into several creeks forming a braided channel network. Finally it empties into the Bang Pakong river. Total length of the river is about 85 km.

From the right, the Khlong Bung Duan and Khlong Wang Rakam rivers which originate in Mt. Khao Chang Khaep (El. 246 m) join to the main stream. On the other hand, it has also tributaries on the left such as the Huai Yang, Khlong Muang and Khlong Soet rivers which have their origins in the southern mountains.

In the lower deltaic area, the main stream is hardly distinguishable owing to its braided courses. It seems that the Khlong Nong Hua Mu, Khlong Hua Sakae and Khlong Phan Thong rivers and the Phan Thong drainage canal drain the most of flow to the Bang Pakong river. During flood time, the Phan Thong drainage canal seems to be main stream.

Total drainage area of the Khlong Luang river is 1,970 km², of which 40% or 750 km², is the flat alluvial plain. The basin belongs to the Chachoengsao Province and the Chon Buri Province, most of which are located in Chon Buri Province except a part of the habitual inundation area in the lower reaches.

The width of channels is narrow and the meandering is remarkable. Some small weirs have been constructed in the streams for the purpose of irrigation. The cultivated land along the rivers have suffered from inundations by the overflow of runoff. In the downstream area, its slope is gentle and ground elevation is low. Moreover, the area is influenced by the tides and backwater of the Bang Pakong river. Hence, flooding occurs every year and inundation continues for long time.