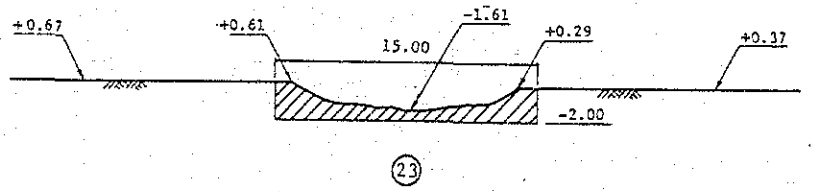

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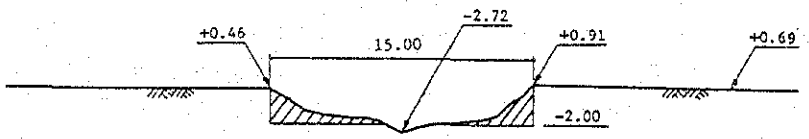

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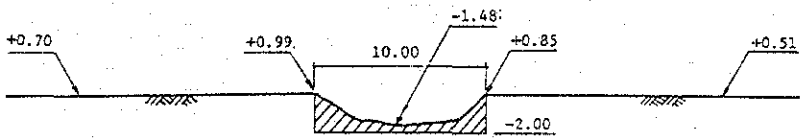

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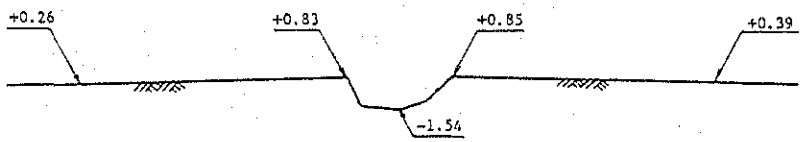


(19)

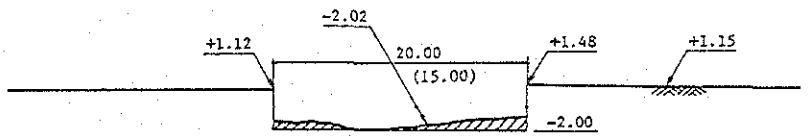
Legend

20 : Section No.

▨ : Excavation Required

+0.37 : Ground Elevation in 1984 (m)

Scale 1 : 800



(24)

Fig. J.27	CROSS SECTION OF DRAIN (BANG NA DRAINAGE AREA : 2)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

APPENDIX K

COST ESTIMATES

APPENDIX K COST ESTIMATES

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Appendix K COST ESTIMATES

1. Project Cost and Operation/Maintenance

The project cost consists of the construction cost of the proposed flood protection and drainage facilities (flood protection barriers, klongs improvement, pumping stations, gates and flood forecasting and warning system), engineering and supervision fees, contingencies and land acquisition costs. The project cost is also classified into foreign currency and local currency portions.
Besides, operation and maintenance costs will be required for the proposed flood protection and drainage facilities.

2. Basis of Project Cost Estimates

2.1 Unit Cost

Information and data on basic costs, including labour and material costs, have been collected from various sources such as DDS, RID, other departments concerned, manufacturers, suppliers of equipment and materials and contractors. All cost obtained from the sources referred to above are expressed in 1984 price levels in Thailand. Using these basic costs, unit construction costs have been developed with due consideration for the suitability of materials and construction methods, including availability of local materials and the ability of the local contractors.
A labour cost is presented in Table k.1. Unit basic construction cost including contractor's profit, overhead, relevant customs tax, surtax and sales tax are presented in Table K.2.

2.2 Unit Construction Cost

Unit costs of flood protection barriers, klong improvements, pumping stations and gates are developed from the labour cost (Table K.1) and basic cost (Table K.2). The developed unit costs are presented form Figs. K.1 to K.8 by the following categories.

Table K.1 Labour Cost

Typr of Labour	Labour Cost per Day (฿)
Unskilled Labour	64
Mason	80 - 85
Bar Bender	85 - 120
Concretor	100 - 140
Asphalter	100 - 130
Carpenter	100 - 180
Painter	120 - 150
Welder	130 - 150
Foreman	180 - 200
Chief Forman	350 - 600
Car Driver	100 - 150
Crane Operator	150 - 180
Boat Crew (low)	90 - 290
" (middle)	120 - 430
" (high)	400

Table K.2 Basic Cost

Item	Description	Unit	Price (¥)
Backfilling	local soil	m^3	130
excavation	manual	m^3	600
"	Backhoe	"	180
"	Clamshell	"	700
Concrete	1 : 2 : 4	"	1300
"	1 : 3 : 5	"	1000
Formwork	wood	m^2	200
Dredging	on Bank	m^3	53
"	on Barge	"	176
Steel Sheet Work	SP IIℓ = 8.0 m	m	2600
"	SP IIIℓ = 15.0 m	m	5800
Driving & Extracting of Steel Sheet Pile	H-Shape	t	2600
Rental Cost	H-Shape	t/day	120
"	SP	"	10
Maintenance Cost for Steel	H-Shape	"	90
"	SP	"	80

(1) Flood Protection Barrier

- Raising the existing road
- New Embankment
- T-shape concrete wall

(2) Klong Improvement (Retaining Wall)

- Concrete sheet pile wall (Type A)
- Anchored sheet pile. Wall with panel (Type B)
- Double row of piles. Wall with panel (Type C)
- Front support-anchored sheet pile. Wall with panel (Type D)

(3) Klong Improvement (Dredging)

- Dredging on bank : 53 Baht per m^3
- Dredging on barge: 176 Baht per m^3

(4) Pumping Station

- Axial flow type
- Mixed flow type

(5) Gate

- Sluice gate

(6) Main Drain Pipe

Cost of main drain pipe excluding lateral drain is estimated by the following unit cost per hectare:

A) Density of main drain pipe which is usually laid under roads, depends on road density.

B) Road density is not high in the Master Plan Area at present. However, almost all the Master Plan Area is expected to be developed as an urbanized area in the year 2000.

C) Consequently, a relatively developed Bang Na drainage area from among the eight drainage areas in the Master Plan Are is selected, representing the developed area in the year 2000 over the Master Plan Area.

D) The road density in Bang Na area based on the aerial photos is estimated to be about 13.5 meter per hectare.

E) An average diameter of main drain pipe is assumed to be 1,500 mm.

F) Hence, cost of main drain pipe is estimated as 190,000 Baht per hectare.

The unit cost usually vary from 250,000 to 350,000. Considering the above-mentioned cost, unit cost is decided to be 200,000 Baht per hectare.

2.3 Land Acquisition Cost

Unit costs for land acquisition are determined from the "TISCO real estate study 1982/83".;

3,000 Baht/m^2	----	Bang Sue drainage area
1,000 Baht/m^2	----	Huay Kwang, Bang Na, Hua Mark and Lat Phrao drainage area
500 Baht/m^2	----	Bang Khen, Klong Chang and Patterna Karn drainage areas.

2.4 Engineering and Supervision Cost

The detailed engineering design and supervision cost are assumed to be 10% of the total construction cost.

2.5 Contingency

Contingencies are assumed to be 17% of the total construction cost plus engineering and supervision costs.

2.6 Operation/Maintenance Cost

Annual operation and maintenance cost is taken as 3% of the total construction cost.

3. Estimated Project Cost

The total project cost including land acquisition and contingencies amounts to 11,000 million Baht as shown in Table K.3 out of which the local currency component is 6,800 million Baht and the foreign currency component is 4,200 million Baht. Tables K.4 through Table K.10 shows the breakdown of construction costs.

4. Operation and Maintenance Cost

248 million Baht will be incurred for operation and maintenance of the proposed facilities every year.

Table K.3 Project Cost

[Unit: million Baht]

Item	Whole Package	Priority Package
Embankment	70.0	
Gate	298.4	
Pumping Station	1,478.8	
Main Klong	356.5	
Sub Klong	1,919.4	
Main Pipe	6,692.0	2,033.0
Flood Forecasting and Warning System	128.9	
Total	10,944.0	6,285.0

Note: Costs shown in this table include land acquisition cost, engineering and supervision fees, contingency, and operation and maintenance cost.

Table K.4 Construction Cost of Embankment and Cofferdam

Drainage Area	Section	Construction Cost (M฿)	Land Aquisition Cost (M฿)
Bang Na	A	54.4	-
Sub-Total		54.4	6.8
Engineering/Supervision Fee		5.4	
Contingency		10.2	
Total		70.0	

Table K.5 Construction Cost of Gate and Cofferdam

Name	No.	Construction Cost (M฿)	Remark
Bang Khen (North)	1	5.9	Bang Kehn Drainage Area
Bang Khen (South)	1	4.1	" " " "
Bang Sue	1	12.5	Bang Sue Drainage Area
Jek	1	3.5	Bang Na Polder
Bang Na Jen	1	3.5	" " "
Bang Oa	1	3.5	" " "
Bang Na	1	5.9	" " "
Phra Khanong	1	12.5	Phra Khanong Polder
Kacha	1	3.5	Hua Mark Drainage Area
Gig	1	3.5	" " " "
Section III	3	8.4	
Section IV	12	33.6	
Section IV	1	12.5	Klong Saen Saep
Section V	12	33.6	
Section V	1	12.5	Klong Phra Khanong
Section VI	10	28.0	
Section VII	9	25.2	
Section VIII	7	19.6	
Sub --Total	65	231.8	
Engineering/supervision Fee		23.4	
Contingency		43.4	
Total		298.4	

Tabel K.6 Construction Cost of Pumping Station

Drainage Area	Construction Cost (M฿)	Name of Pumping Station
Phra - Khanong	425.0	-
Bang Khen	85.0	Bang Khen
Bang Sue	245.0	Bang Sue
Kacha	45.0	Hua Mark (North)
Gig	32.0	Hua Mark (North)
Bang Na Chine	60.0	Bang Na
Jek	45.0	Bang Na
Bang Oa	100.0	Bang Na
Bang Na	112.0	Bang Na
Sub-Total	1,149.0	
Engineering/Supervision Fee	114.9	
Contingency	214.9	
Total	1,478.8	

Table K.7 Construction and Land Acquisition Cost

[Unit: million Baht]

Klong	Section No.	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
Phra Khanong	1	18.2	6.2	24.4	0
	2	9.1	11.3	20.4	0
	3	-	8.8	8.8	0
	4	9.1	3.5	12.6	0
	5	9.1	3.9	13.0	0
	6	-	15.8	15.8	0
	7	-	6.3	6.3	0
	8	-	5.3	5.3	0
	9	-	5.6	5.6	0
	10	-	2.8	2.8	0
K. Tan	11	13.7	7.9	21.6	0
	12	9.1	4.6	13.7	0
	13	-	8.1	8.1	0
	14	9.1	2.8	11.9	0
	15	-	8.8	8.8	0

[Unit: million Baht]

Klong	Section No.	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
K. Saen Saep	16	-	10.6	10.6	0
	17	-	4.2	4.2	0
	18	-	4.2	4.2	0
	19	-	9.2	9.2	0
	20	9.1	4.6	13.7	0
	21	9.1	5.6	14.7	0
	22	-	7.0	7.0	0
	23	-	7.0	7.0	0
	24	9.1	4.2	13.3	0
	25	-	7.0	7.0	0
	26	-	7.0	7.0	0
Sub-Total		104.7	172.3	277.0	0
Engineering/Supervision Fee				27.7	
Contingency				51.8	
Total				356.5	

Table K.8(1) Construction and Lnad Acquisition Cost of Sub-Klong Improvement

1. (Bang Khen and Bang Sue Drainage Areas)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
K. Lat Phrao	1 to 8	-	-	-	-
K. Bang Sue	9	36.4	2.8	39.2	0
	10	36.4	2.8	39.2	0
	11	36.4	5.6	42.0	12.0
	12	36.4	4.6	41.0	0
Bang Sue Drainage Area		145.6	15.8	161.4	12.0
K. Bang Khen	14	-	4.2	4.2	0
	15	-	3.7	3.7	0
	16	-	13.6	13.6	72.0
	17	-	12.0	12.0	48.0
	18	-	9.9	9.9	37.5
K. Prem Prachiakan	20,21	-	-	-	-
Bang Khen Drainage Area		-	43.4	43.4	157.5
Sub-Total		145.6	59.2	204.8	169.5
Engineering/Supervision Fee				20.5	
Contingency				38.3	
Total				433.1	

Table K.8(2) (Klong Chan Drainage Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
N.N	1, 2, 3	-	7.9	7.9	14.4
K. Bang Toei	4, 5	-	-	-	-
K. Bang Chala	7	15.1	0.7	15.8	0
K. Phlu	8	-	1.4	1.4	3.0
Sub-Total		15.1	10.0	25.1	17.4
Engineering/Supervision Fee				2.5	
Contingency				4.7	
Total				49.7	

Table K.8(3) (Lat Phrao Drainage Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
N.N	1	13.9	1.1	15.0	0
K. Lod Plakao	2	-	2.2	2.2	3.6
N.N	3	-	3.5	3.5	6.0
K. Chan	4	43.7	4.2	47.9	4.8
	6,7	29.0	4.0	33.0	5.0
K. Sua Noi	5	18.2	0.9	19.1	0
K. Song Kla Tian	8,9	29.0	1.8	30.8	0
K. Chan	10,11	25.5	2.7	28.2	0
K. Tanang	13,14	-	-	-	-
	15	21.8	1.7	23.5	0
Sub-Total		181.1	22.1	203.2	19.4
Engineering/Supervision Fee				20.3	
Contingency				38.0	
Total				280.9	

Table K.8(4) (Patterna Karn Draingae Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
N.N	1, 2	-	5.4	5.4	8.4
N.N	3	-	2.2	2.2	3.6
N.N	4	-	5.3	5.3	7.5
N.N	6, 7	-	-	-	-
Sub-Total		-	12.9	12.9	19.5
Engineering/Supervision Fee				1.3	
Contingency				2.4	
Total				36.1	

Table K.8(5) (Hua Mark Drainage Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
North					
N.N.	1	13.9	0.8	14.7	0
K. Kacha	2, 3	31.3	1.9	33.2	0
South					
N.N.	1	-	1.7	1.7	1.5
K. Sakae	2	19.7	1.2	20.9	0
	4	12.8	1.0	13.8	0
N.N	3	18.6	1.7	20.3	0
Hua Mark	6	18.2	0.9	19.1	0
Sub-Total		114.5	9.2	123.7	1.5
Engineering/Supervision				12.4	
Contingency				23.1	
Total				160.7	

Table K.8(6) (Huay Khwang Drainage Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
East					
K. Wat Tuk	1	18.4	1.6	20.0	-
K. Wat Tuk	2, 3	-	3.3	3.3	5.1
N.N	5	11.6	3.2	14.8	10.0
K. Plab Pla	6	-	3.0	3.0	4.5
West					
K. Lat Phrao	1, 2	58.2	3.9	62.1	0
	3, 4	-	9.5	9.5	11.0
K. Huay Khwang	6	20.4	2.1	22.5	0
K. Huay Khwang	7, 10	-	10.1	10.1	16.0
N.N	8	-	3.2	3.2	5.4
N.N	9	-	4.6	4.6	6.4
N.N	11	36.4	1.8	38.2	0
K. Sam Saem	12, 13	74.6	3.6	78.2	0
	14	36.4	2.5	38.9	0
Sub-Total		256.0	52.4	308.4	58.4
Engineering/Supervision Fee				30.8	
Contingency				57.7	
Total				455.3	

Table K.8(7) (Bang Na Drainage Area)

[Unit: million Baht]

Klong	Section	Retaining Wall	Excavation	Construction Cost	Land Acquisition Cost
N.N	1	12.7	3.7	16.4	7.0
K. Bang Oa	2, 3	25.5	1.2	26.7	0
K. Bang Jek	5	15.1	1.1	16.2	0
	6	27.3	1.3	28.6	0
	7	12.7	0.6	13.3	0
N.N	9	11.6	0.7	12.3	0
K. Bang Na Jen	10	23.2	1.8	25.0	0
N.N	11	16.2	4.7	20.9	11.2
	12	12.8	0.8	13.6	0
K. Bang Loi	13	11.6	1.6	13.2	2.0
N.N	14	17.4	5.8	23.2	15.0
K. Kelet	15, 16 17, 18	-	-	-	-
	19	-	-	-	-
N.N	19	13.9	4.6	18.5	12.0
K. Bang N	20	41.9	2.0	43.9	0
	21	18.2	1.1	19.3	0
	22, 23	36.4	2.6	39.0	0
	24	-	1.3	1.3	0
N.N	25	11.6	3.8	15.4	10.0
Sub-Total		308.1	38.7	346.8	57.2
Engineering/Supervision Fee				34.7	
Contingency				64.9	
Total				503.6	

Table K.9 Construction Cost of Flood Forcasting/Warning System

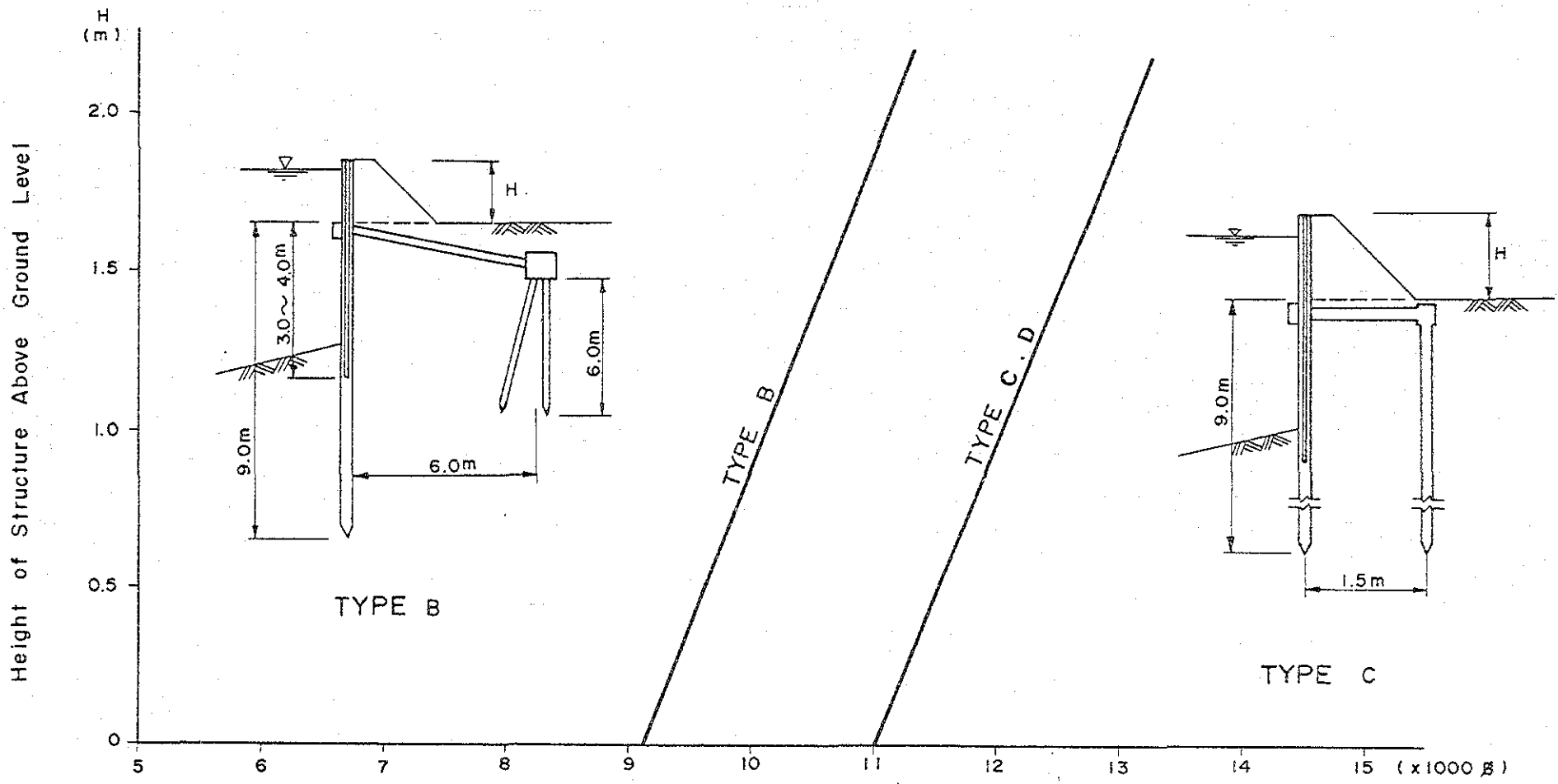
[Unit: million Baht]

Item	Quantity	Cost	Remarks
Master Station Equipments	1 L.S.	50.4	
Remorte Station Equipments	1 L.S.	25.3	
Rain fall measuring (30 s.t.)			
Water level measuring (30 s.t.)			
Observation of P.S (15 s.t.)			
Installation, Superrison and Other Fee	1 L.S.	24.3	
Sub-Total		100.0	
Engineering/Supervision Fee		10.0	
Contingency		18.9	
Total		128.9	

Table K.10 Construction Cost of Main Drain Pipe

[Unit: million Baht]

Drainage Area	Total Package		Priority Package	
	Served Area (km^2)	Construction Cost	Served Area (km^2)	Construction Cost
Bang Khen	29	580	4	80
Bang Sue	35	700	12	240
Klong Chan	24	480	2	40
Lat Phrao	59	1,180	4	80
Patterna Karn	24	480	3	60
Hua Mark	23	460	10	200
Huay Kwang	35	700	24	480
Bang Na	31	620	20	400
Sub-Total	260	5,200	79	1,580
Engineering/Super-ision Fee		520		158
Contingency		972		295
Total		6,692		2,033

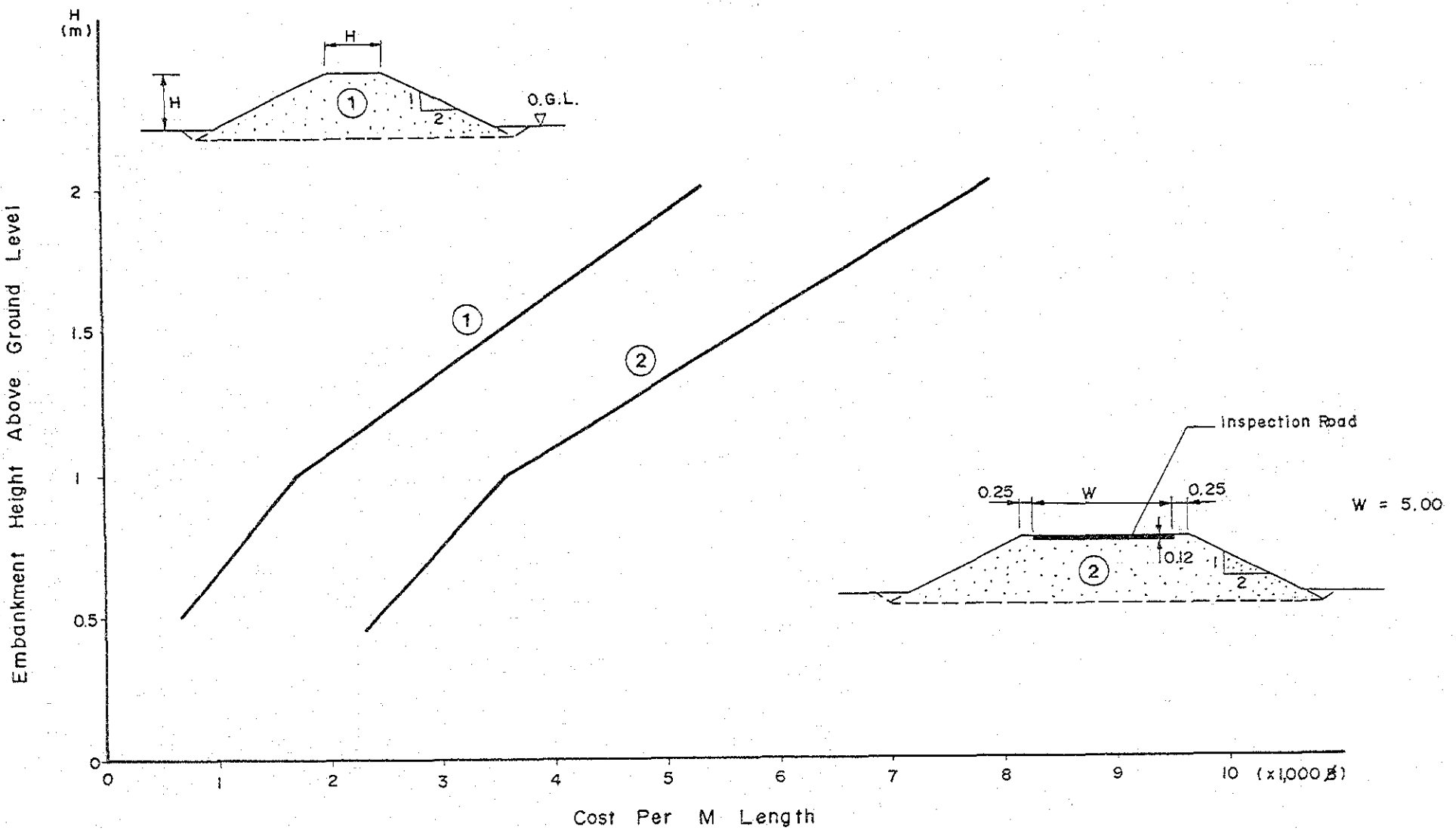


note: Cost of Retaining Wall TYPE A is estimated 5,800 ฿/m

Fig. K.1 COST CURVES FOR RETAINING WALL

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 252BLE 1985A.D



Note : Excluding land aquisition

Fig. K.2 COST CURVES FOR WATER PROTECTION BARRIER (TYPE A)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528 B.E. 1985 A.D.

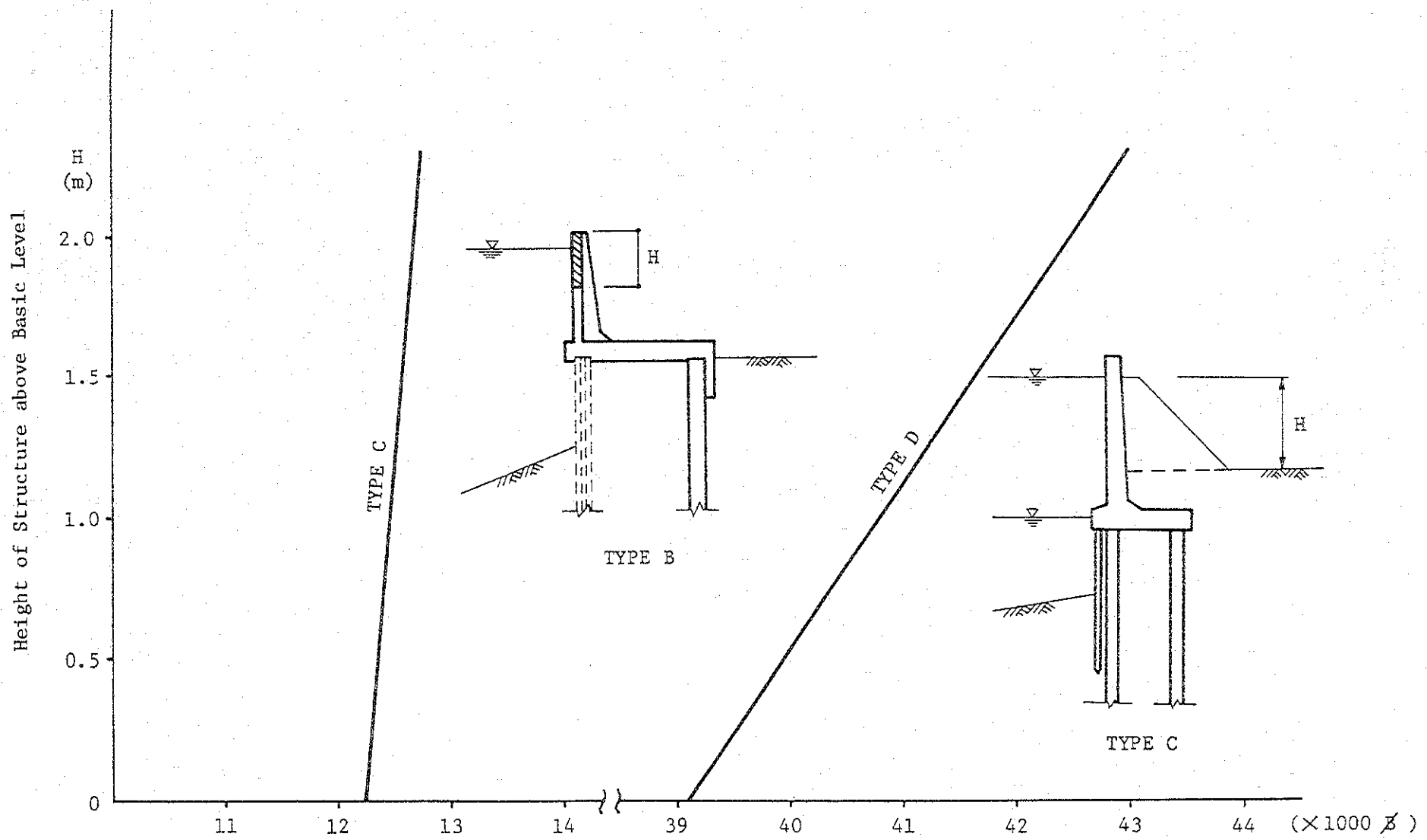


Fig. K.3 COST CURVES FOR WATER PROTECTION BARRIER (TYPE B,C)

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

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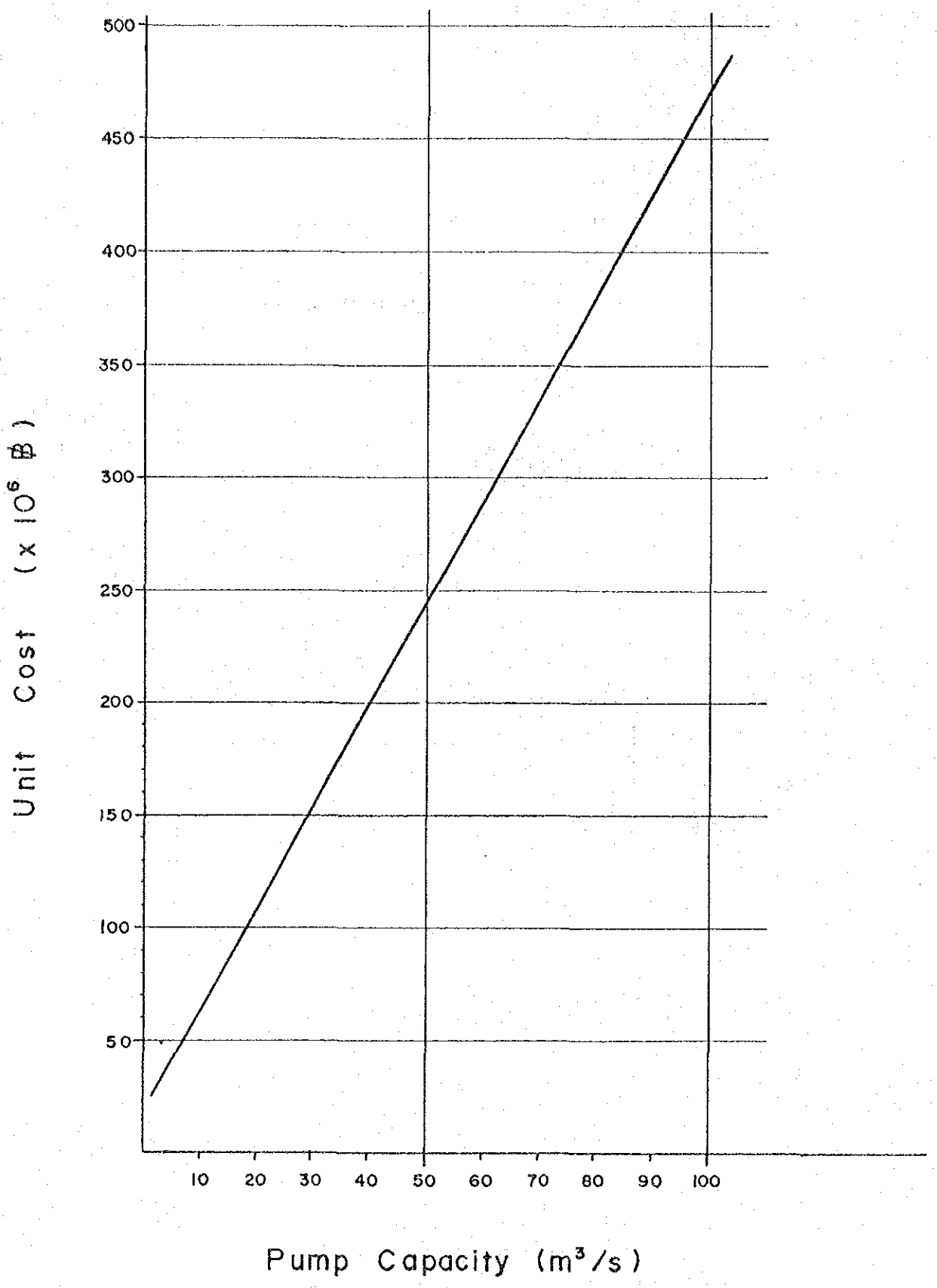
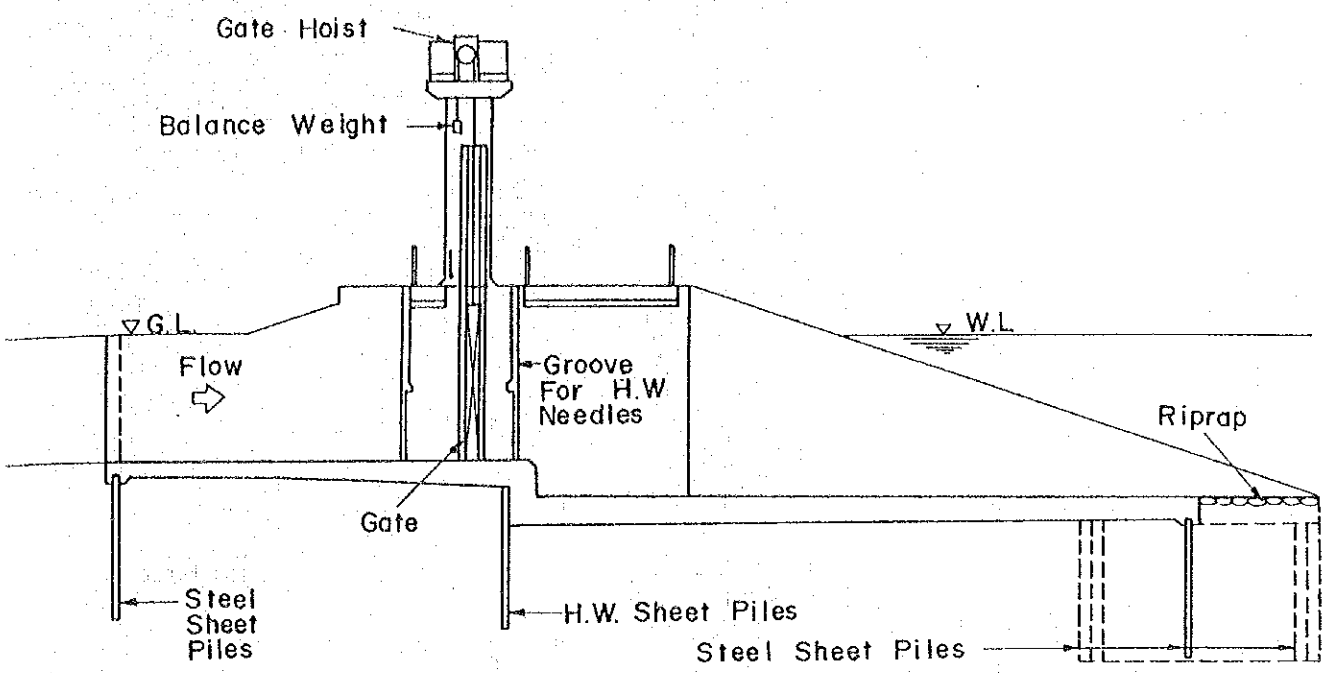


Fig. K.4 COST CURVE FOR PUMPING STATION

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D



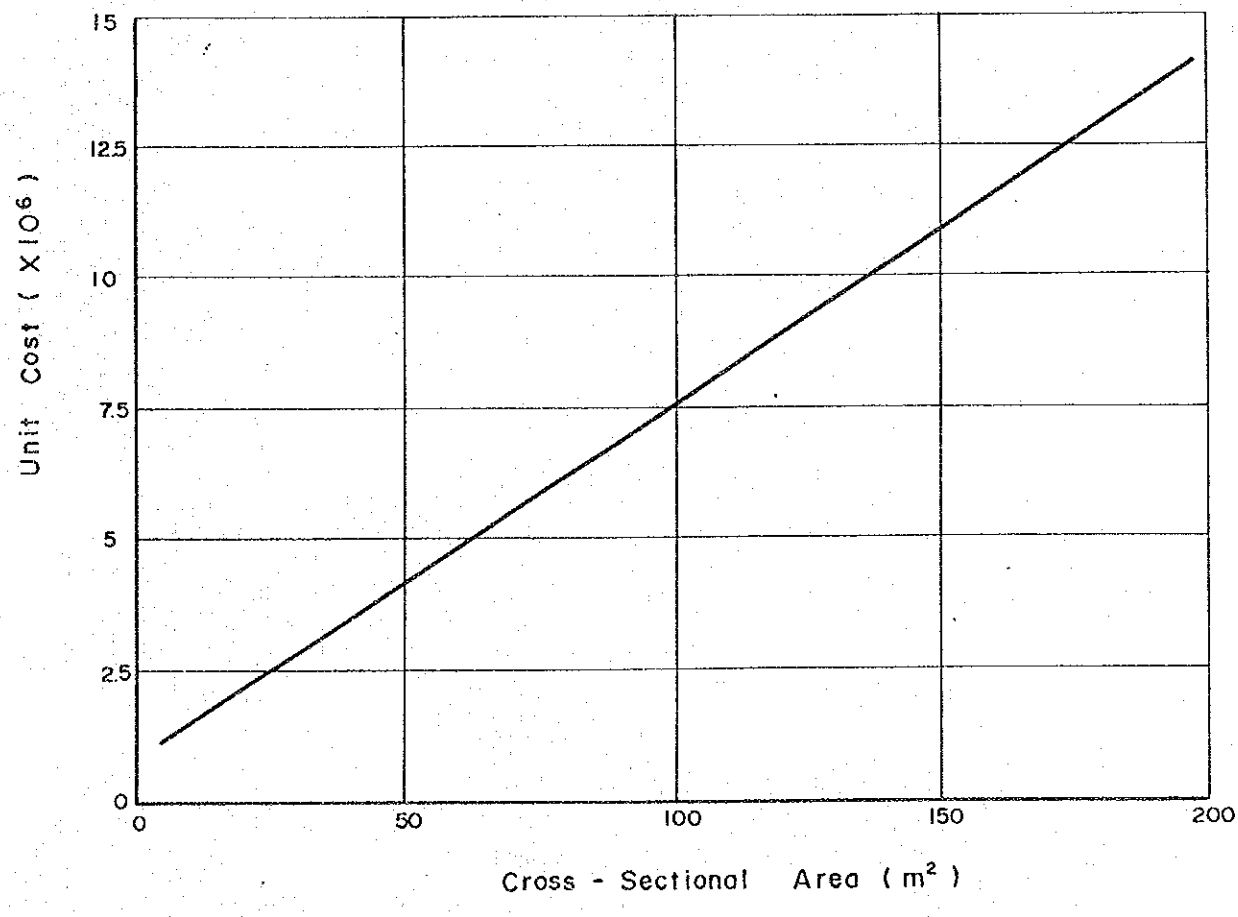


Fig. K.5 COST CURVE FOR GATE

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

APPENDIX L

IMPLEMENTAION PROGRAMME

APPENDIX L IMPLEMENTATION PROGRAMME

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Appendix L IMPLEMENTATION PROGRAMME

1. General

Staged construction planning of the required facilities is recommended due to financial constraints and construction priority. The detailed design and financial procurement and execution of flood plain management are to be implemented in stages. Furthermore, a staged construction schedule will enable distribution of capital expenditure over a period of years and facilitate implementation.

2. Factors for Determination of Implementation Programme

A higher implementation priority should be given to those works that will alleviate the heavier flood damage at lower cost. These include the flood protection barriers and gates because they prevent inflow from the outer areas. The executed urgent measures, following the 1983 flooding, included these works, which have succeeded in alleviating flood damage for the time being.

Nevertheless, the effect of the urgent measures will eventually be offset by continuous urbanization and land subsidence, and result in heavy flooding with increased flood damage in the near future. Therefore, such works as flood preotection barriers and gates will have highest implementation priority.

Pumping stations and improvement of main klongs are also given higher priority since they serve to increase the overall discharge capacity from the Master Plan Areas to the outer area. Flood forecasting and warning system is planned to be implemented at an early stage because the system, in combination with the execution of flood plain management, will facilitate water management over the Master Plan Area.

Furthermore, despite the lowered water level of the main klongs, which resulted from the executed urgent measures, flooding in various small areas occurred in 1984. This situation is expected to be alleviated by improvement of sub-klongs and construction of tertiary drainage facilities, which, however, would constitute a considerable portion of the total project cost. Consequently, such drainage facilities are required to be implemented stage by stage according to area priority. Table L.1 shows the concept of the implementation sequence.

Table L.1 Implementation Order

Item	Implementation Order				
	1	2	3	4	5
1. Feasibility Study & Detailed Design					
2. Flood Protection Barrier					
3. Gate and Cofferdam					
4. Pumping Station					
5. Main Klong					
6. Sub-Klong					
High Priority Area					
Low Priority Area					
7. Main Pipe					
High Priotiy Area					
Low Priority Area					
8. Flood Protection/ Warning System					
9. Flood Plain Management					
Preparation					
Establishment					
Operation & Supervision					

3. Priority of Areas for Tertiary Drainage Facilities

3.1 Existing Flooded Area

The high priority areas may be defined as flooded areas of about 21 km^2 as shown in Fig. I.6. (in Appendix I) observed on 29, September, 1984 and 7, October 1984 when about 91 mm rainfall (design rainfall) occurred.

3.2 Priority of Meshes

The study is made by ranking the meshes for comparison of severity of flood damage. The following factors are considered in order to determine serious flooding areas and priority area:

a. Data of flooding in the past in order to determine serious flooding areas and priority area.
   1) Flood depth in 1983 (Fig. L.1)
   2) Flood duration in 1983 (Fig. L.2)

b. Data of flood damage potential at present (1984)
   1) Population density (Fig. L.3)
   2) Income distribution (Fig. L.4)
   3) Density of commercial employees (Fig. L.5)
   4) Density of industrial employees (Fig. L.6)

c. Data of flood damage potential in 2000
   1) Population density (Fig. L.7)
   2) Density of commercial employees (Fig. L.8)
   3) Density of industrial employees (Fig. L.6)

All figures are obtained from the flood damage survey which is presented in Appendix P. These items are assigned by arbitrary weighting as shown in Table L.2.

Items A, representing physical flooding conditions are assigned between 1 point and 13. Items B (representing flood damage potential at present) are assigned between 2 and 10 points while items C (representing flood damage potential in 2000) are assigned between 1 point and 7 points. A maximum of 30 points is assigned to meshes where physical flooding conditions have been severe and the existing and future flood damage potential is high. For the lowest priority mesh, 3 points are assigned.

Table L.3 and Fig. L.9 present the result of the ratings. As can be seen in Fig. L.9, meshes near Central Bangkok are ranked generally with high points. These high-ranked meshes also correspond to the 1984 flooded areas (Fig. L.10) which occured after the execution of the urgent flood protection measures. Consequently, a drainage system to relieve flooding in these areas should be implemented at an early stage.

Table L.2 Weighting Assignment for Rating Drainage Areas

Item	Weighting	Description
A. Flooding in the Past		
1) Flood Depth in 1983	10	more than 51 cm
	7	25 - 50 cm
	5	5 - 24 cm
	0	less than 5 cm
2) Flood Duration in 1983	3	more than 3.5 months
	2	2.0 - 3.4 months
	1	less than 1.9 months
B. Flood Damage Potential in 1984		
1) Population Density in 1984	3	more than 150 persons/ha
	2	11 - 149
	1	less than 10
2) Income Distribution in 1984	3	more than 10,000 Baht/ household
	2	4,001 - 9,999
	1	less than 4,000
3) Density of Commercial Employees in 1984	2	more than 10 employees/ha
	1	6 - 9
	0	less than 5
4) Density of Industrial Employees in 1984	2	more than 10 employees/ha
	1	6 - 9
	0	less than 5
C. Flood Damage Potential in 2000		
1) Population Density in 2000	3	more than 150 persons/ha
	2	11 - 149
	1	less than 10
2) Density of Commercial Employees in 2000	2	more than 10 employees/ha
	1	6 - 9
	0	less than 5
3) Density of Industrial Employees in 2000	2	more than 10 employees/ha
	1	6 - 9
	0	less than 5

Table L.3 (1) Rank for Implementation by Mesh

Item / Mesh No.	A		B				C			Total	Rank
	1	2	1	2	3	4	1	2	3		
1	5	2	1	2			2			12	Low
2	7	2	2	2			2			15	Medium
3	7	2	2	2			2			15	Medium
4	7	2	1	2			2			14	Low
5	7	2	1	2		2	1		2	17	High
6	10	2	3	1	1	2	3	2	2	26	High
7	7	2	3	2			2			16	Medium
8	7	2	2	2			2			15	Medium
9	7	1	1	2		2	3		2	18	High
10	7	2	3	3	2		3	2		22	High
11	10	3	3	3			2			21	High
12	10	3	2	2			2			19	High
13	7	2	1	1			2			13	Low
14	7	2	2	3			2			16	Medium
15	10	2	1	3			2			18	High
16	10	2	1	2			2			17	High
17	7	3	1	1			2			14	Low
18	7	1	1	3			2			14	Low
19	10	2	3	1	1		2	1		20	High
20	7	3	3	2			2			17	High
21	7	1	3	2			2			15	Medium
22	10	2	1	1			1			15	Medium
23	7	2	1	2			2			14	Low
24	7	2	3	3	1		3	2		21	High
25	5	1	3	2			3			14	Low
26	7	2	2	3			2			16	Medium
27	7	2	2	3			2	1		17	High
28	7	1	2	1	1		2	2		16	Medium
29	5	2	3	1	1		2	2		16	Medium
30	5	1	1	3			2			12	Low
31	5	3	1	3			2			14	Low
32	5	3	3	2			3			16	Medium
33	7	2	3	2	1	1	3	2	1	22	High
34	7	1	3	2	1		2			16	Meidum
35	10	3	2	2		1	2		1	21	High
36	7	2	2	2			2			15	Medium
37	7	3	3	3	2	1	3	2	1	25	High
38	7	1	2	2			2			14	Low
39	5	1	1	2			2			11	Low
40	5	1	2	3			3			14	Low
41	7	2	3	2	2		3	2		21	High
42	5	1	3	3			3	2		17	High
43	7	2	2	2			2	1		16	Medium
44	7	3	2	2			2			16	Medium
45	5	2	3	3			2	1		16	Medium

Note:
- A.1 Flood dpeth in 1983
- A.2 Flood duraiton in 1983
- B.1 Population density in 1983
- B.2 Income disturbution in 1983
- B.3 Density of commercial employees in 1984
- B.4 Density of Industrial employees in 1984
- C.1 Population density in 2000
- C.2 Density or commercial in 2000
- C.3 Density of Industrial employees in 2000

Table L.3 (2) Rank for Implementation by Mesh

Item / Mesh No.	A		B				C			Total	Rank
	1	2	1	2	3	4	1	2	3		
46	5	2	2	2			2			13	Low
47	7	2	2	2			2			15	Medium
48	7	2	1	3			2			15	Medium
49	7	1	2	3			2	1		16	Medium
50	5	1	3	2	2	1	3	2	1	20	High
51	5	1	3	3			3			15	Medium
52	5	1	3	2			2			13	Low
53	7	3	1	2			2			15	Medium
54	7	1	1	2			2			13	Low
55	7	3	2	3			1			16	Medium
56	10	2	1	2			1			16	Medium
57	7	2	1	2			1			13	Low
58	5	2	3	2			3			15	Medium
59	5	2	3	3	1	1	3	2	1	21	High
60	5	2	3	3			3			16	Medium
61	5	1	3	2			3			14	Low
62	7	2	1	2			1			13	Low
63	5	2	1	1			1			10	Low
64	5	3	2	3			2			15	Medium
65	10	2	1	2			2			17	High
66	5	2	1	3			3			14	Low
67	5	2	3	2			3	1		16	Medium
68	7	2	3	2			3			17	High
69	7	2	2	2			2			15	Meidum
70	5	1	1	3			2			12	Low
71	5	1	1	2			2			11	Low
72	7	2	1	2			2			14	Low
73	7	2	1	3			2			15	Medium
74	7	2	3	2			2			16	Medium
75	7	2	1	3			2			15	Medium
76	7	2	1	2			2			14	Low
77	7	2	1	3			2			15	Medium
78	7	1	2	3	1		2	1		17	High
79	7	1	1	2			3			14	Low
80	7	1	1	2			1			12	Low
81	7	1	3	2			2			15	Medium
82	7	1	1	2			2			13	Low
83	5	1	1	2			2			11	Low
84	5	1	1	2			1			9	Low
85	5	1	3	2			2			13	Low
86	5	1	1	2			1			10	Low
87	5	1	1	2			1			10	Low
88	7	2	1	2			2			14	Low

Note:
- A.1 Flood depth in 1983
- A.2 Flood Duration in 1983
- B.1 Population density in 1984
- B.2 Income distribution in 1984
- B.3 Density of commerial employees in 1984
- B.4 Density of industrial employees in 1984
- C.1 Population density in 2000
- C.2 Density of commercial employees in 2000
- C.3 Density of industrial imployees in 2000

3.3 Priority of Drainage Area

In order to alleviate flood damage in a specific mesh, drainage facilities in the specific mesh must be provided and also in the related area, particularly downstream of the specific mesh. Therefore, the priority of a designated drainage area is more important than that of a mesh. Using the priority of a mesh, each drainage area is evaluated as follows:

1) Bang Na (18 points per mesh)
2) Huay Kwang (17 " " ")
3) Hua Mark (17 " " ")
4) Bang Sue (17 " " ")

The above four drainage areas have high priority while the following four drainage areas have medium - low priority:

5) Klong Chan (15)
6) Lat Phrao (14)
7) Patterna Karn (14)
8) Bang Khen (13)

4. Implementation Programme

Prior to the construction work preparatory work for a feasibility study, detailed design and financial procurement must be carried out. The feasibility study and detailed design could be carried out in 1985 and 1986 respectively. As financial procurement can be carried out simultaneously with the detailed design, construction can be started in 1987.

Thailand has a Five-year National Development Plan and this project should be incorporated into this Plan. The Sixth National Development Plan starts in October 1986.

4.1 Alternative I

Table L.4 shows an implementation schedule (alternative I) studied based on the foregoing. The Project is planned to be implemented for completion by the year 2000 in three stages, corresponding to the sixth, seventh and eighth national development plans.

The First Stage aims at prevention of water inflow from the outer area and increase of overall drainage facilities. The first stage works include (see Fig. L.11):

- All embankments and gates at border of Master Plan Area
- All pumping stations (except pumps installed in 1984)
- All main klongs
- Most sub-klongs
- Some tertiary drainage facilities
- Flood forecasting and warning system

The remaining sub-klongs and part of the tertiary drainage facilities are implemented in the second stage, in order to alleviate small-area flooding in high-priority areas; i.e., Bang Na, Hua Mark, Huay Kwang and Bang Sue.

At the Third Stage, tertiary drainage facilities in low-priority areas are implemented. However, it is considered difficult to implement this plan from the viewpoint of financial constraint as this plan requires 3,600 - 3,800 million Baht at each stage.

4.2 Alternative II

Prior to completion of the total project by the year 2015, the priority package is to be completed by the year 2000, aiming at prevention of water inflow from the outer area, increase of overall drainage facilities and alleviation of heavy local flooding (about 80 km^2) at present and in the future. The areas are selected based on high-priority mesh (Fig. L.9). Local flooding in medium-low priority mesh will be combatted at least by 2000, partly by execution of flood plain management. Therefore, priority package (by the year 2015) is the same as the total package; however, priority package (by the year 2000) is different from the total package in terms of provision of tertiary drainage facilities.

Table L.4 Implementation Schedule (Alternative I)

	1985	1986	First Stage (1987-1991)	Second Stage (1992-1996)	Third stage (1997-2000)
1. Feasibility Study					
2. Detailed Design					
3. Embankment					
4. Gate					
5. Pumping Station					
6. Main Klong					
7. Sub-Klong					
High Priority Area					
Low Priority Area					
8. Main Pipe					
High Priority Area(A)					
High Priority Area(B)					
Low Priority Area					
9. Flood Forecasting and Warning System					
Total Project Cost (million Baht)			3,600	3,800	3,600

Implementation schedule by the year 2000 as shown in Table L.6 and Fig. L.12 is planned based on:

1) Embankment along the Chao Phraya River is constructed at the 1st Stage.

2) Required pumps excluding the pumps installed as urgent measures are provided at the 1st stage. The pumps installed as urgent measures are replaced by permanent-type pumps during the 2nd and 3rd stages.

Table L.5 Construction of Pumping Station

(Unit: m^3/sec)

Item \ Stage	1st	2nd	3rd
Outlet Pump			
Phra Khanong	-	90	-
Bang Khen (North & South)	-	-	15
Bang Sue	14	-	36
Jek	-	-	6
Bang Oa	-	-	18
Bang Na	6	-	15
Inner Pump			
Kacha	6	-	-
Gig	3	-	-
Bang Na Chine	9	-	-

Note: = replacement of urgent pump

3) Two gates in Kacha, Gig and Bang Na Chine pumping stations are constructed at the 1st stage while two gates in Bang Na and Bang Sue pumping stations are improved at the 1st stage. The other gates in five pumping stations are reconstructed at the 2nd or 3rd stages.

Four gates in the upstream of Klongs Phra Khanong, Saen Saep, Lam Chala and Tanang are constructed at the 1st Stage for prevention of water inflow from the outer area during rainy season and for flushing during dry season.

At the 2nd and 3rd stages, 26 and 25 gates respectively are constructed, with cofferdams being utilized until the gates are completed.

4) Main klongs (Phra Khanong, Tan and Saen Saep) covering high priority drainage areas are improved at the 1st Stage and the remaining sections at the 2nd Stage.

5) Flood forecasting and warning system are established at the 1st Stage.

6) Improvement of sub-klongs and provision of tertiary drainage facilities are implemented based on:

1st Stage : Facilities to alleviate local flooding in special areas (flooded area in 1984 flood, about 21 km^2)
2nd Stage : Facilities to alleviate local flooding in high-priority dranage areas
3rd Stage : Remaining facilities

The project cost at each stage is:

1st Stage	:	2,560 million Baht
2nd Stage	:	1,830 million Baht
3rd Stage	:	1,890 million Baht
Total	:	6,280 million Baht

The priority package is considered to be practical from the viewpoint of finance and organization, although both priority (alternative II) and alternative I are judged preliminarily feasible.

Table L.6 Implementation Schdule (Alternative II)

	1985	1986	First Stage (1987 - 1991)	Second Stage (1992 - 1996)	Third Stage (1997 - 2000)	Fourth to Sixth (2001 - 2015)
1. Feasibility Study						
2. Detailed Design						
3. Embankment						
4. Gate						
5. Pumping Station						
6. Main Klong						
7. Sub Klong						
High Priority Area						
Low Priority Area						
8. Main Pipe						
High Priority Area (A)						
High Priority Area (B)						
Low Priority Area						
9. Flood Forecasting and Warning System						
Total Project Cost (million Baht)			2,560	1,830	1,890	4,720

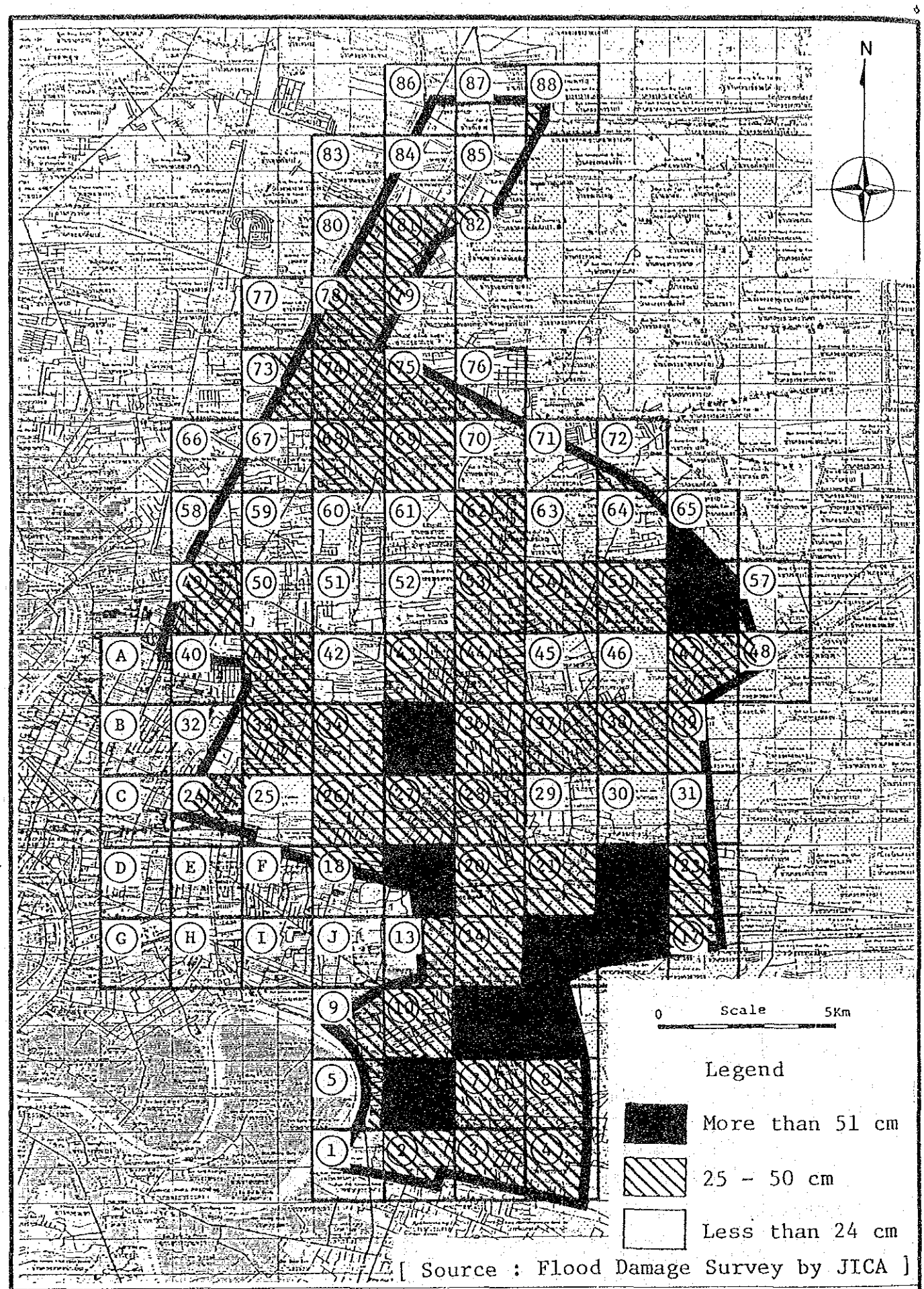

Fig. L.1 FLOOD DEPTH IN MASTER PLAN AREA IN 1983

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D

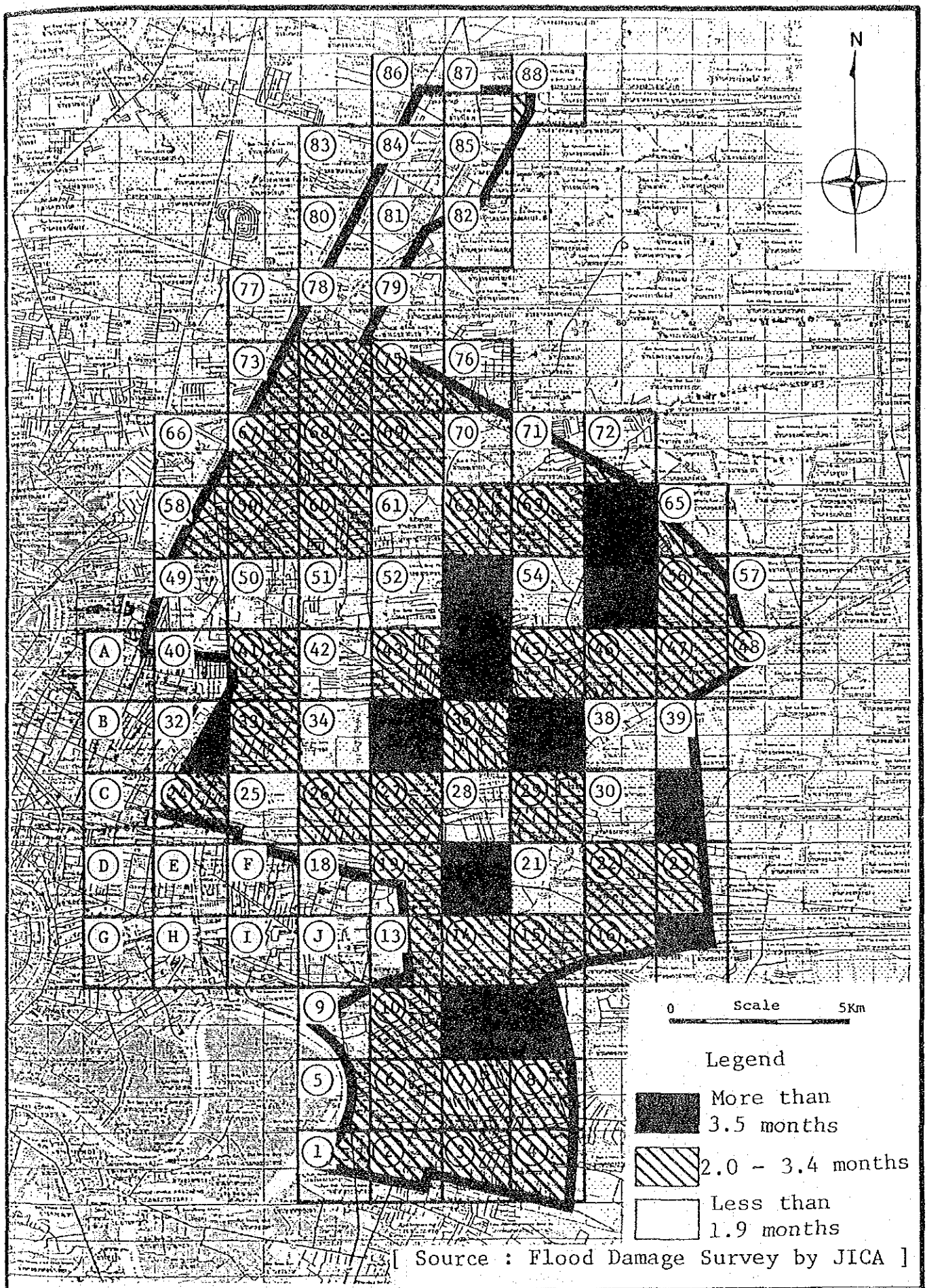

Fig. L.2 FLOOD DURATION IN MASTER PLAN AREA

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D

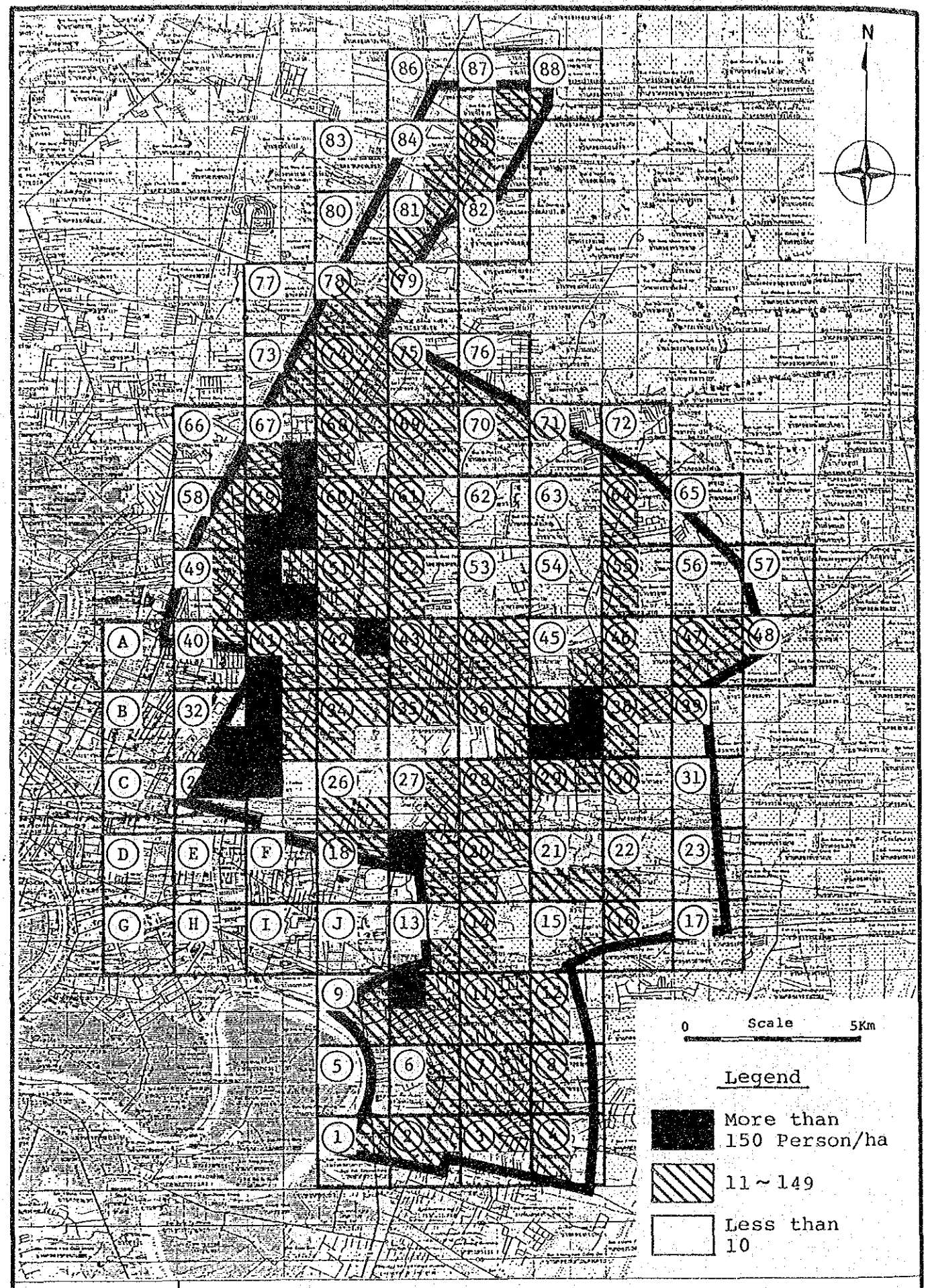

Fig. L.3 POPULATION DISTRIBUTION IN 1983

MASTER PLAN ON FLOOD PROTECTION/DRAINAGE PROJECT IN EASTERN SUBURBAN-BANGKOK

JICA 2528B.E 1985A.D