1.5 Project Evaluation

1.5.1 Economic Evaluation

The major benefit of the Project is the elimination of flood damages to be brought on in the years to come. Those damages are direct damages to properties such as houses, shops and factories, income losses due to closure of commercial and industrial establishments, traffic damages, damages to infrastructure, etc.

Such damages on an annual average basis amounted to Rp. 1,262 million in 1988. They are projected to reach Rp. 7,085 million in the target year of 2010, under without project condition.

The total initial cost for the Project is estimated at Rp. 51,200 million. Those costs are calculated to be Rp. 23,385 million in economic terms. Annual O&M cost in economic terms is also calculated at Rp. 91 million.

In this economic analysis, project life and opportunity cost of capital are assumed to be 50 years and 10% respectively. The cost benefit streams over the project life is shown in the Table 1.4.

The economic efficiency of the Project is evaluated in terms of benefit cost ratio (B/C), net present value (NPV) and economic internal rate of return (EIRR) as follows.

B/C : 2.18
NPV : Rp. 20,822 million
EIRR : 20.0%

1.5.2 Environmental Assessment

No significant adverse effects on environment are anticipated in consideration to the similar projects completed recently.

1.5.3 Recommendation

This project is both technically and economically feasible. No significant adverse environmental impacts are anticipated. Its early implementation is recommended to cope with the increasing flood problems due to the ongoing and future land developments.

Table 1.1 Main Features of Existing Drainage System

River Reaches	Catchment Area (ha)	River Length (km)	River Width (m)	River Gradient
Drainage System A				
Tanjungan R. (a0-a3)	777	3.15	2-5	1:3,000
Drainage System B				
Upper Kamal R. (b1-b2)	464	2.30	3-10	1:2,000
Middle Kamal R. (b2-b5)	590	3.18	10-14	1:3,000
Lower Kamal R. (b5-b6)	184	1.88	14-18	1:3,000
Right Tributary (b7-b3)	152	1.60	3-4	1:3,000
Left Tributary (b8-b2)	247	2.80	4-10	1:3,000
Total	1,637	11.76		
Drainage System C				
Kali Gede R. (c0-c2)	563	3.43	2-4	1:2,000
Kali Bor R. (c2-c4)	0	1.33	4	1:2,000
Total	563	4.76		
Drainage System D				
Upper Saluran Cengkareng (d0-d1)	139	1.65	2-4	1:2,000
Lower saluran Cengkareng (d1-d2)	192	2.88	4-6	1:2,000
Total	331	4.53		
Drainage System E				
Padongkelan R. (e2-e4)	515	1.14	2-5	1:2,000
Total	3,813	25.34		

Table 1.2 Profile and Cross Section of Proposed Channel

Basin	Sub-basin	Channel Section	Channel Gradient	Length (km)	Top width (m)	Bottom Width (m)	Depth (m)
A	A-1	a_0 - a_1	1:3,000	1.10	7.50	5.00	2.50
	A-2 (1)	a_1 - a_2	1:3,000	0.45	9.50	7.00	2.50
	A-4	a_5 - a_4	1:3,000	2.30	7.00	4.50	2.50
	A-2 (2)	a_4 - a_2	1:3,000	1.70	8.50	6.00	2.50
	A-3	a_2 - a_3	1:3,000	1.60	16.00	6.00	2.50
B	B-1	b_0 - b_2	1:1,600	2.98	8.90	6.50	2.40
	B-3, B-4	b_2 - b_4	1:3,000	1.30	18.00	15.60	2.40
	B-5	b_4 - b_5	1:3,000	1.88	18.00	15.60	2.40
	B-6	b_5 - b_6	1:3,000	1.88	25.20	15.60	2.40
C	C-1	c_0 - c_1	1:2,000	1.95	8.20	5.70	2.50
	C-2	c_1 - c_2	1:2,000	1.48	8.20	5.70	2.50
	C-2	c_2 - c_4	1:2,000	1.33	8.50	5.50	3.00
D	D-1	d_0 - d_1	1:2,000	1.65	6.50	4.00	2.50
	D-2	d_1 - d_2	1:2,000	2.88	7.50	5.00	2.50
E		e_0 - e_1	1:2,000	0.75	5.90	3.40	2.50
		e_1 - e_2	1:2,000	1.00	7.00	4.50	2.50
		e_2 - e_3	1:2,000	0.95	8.60	6.10	2.50
		e_3 - e_4	1:2,000	0.10	10.70	8.20	2.50

Table 1.3 Break-down of Project Cost

Item	Cost (million Rp.)						Remarks
	Basin A	Basin B	Basin C	Basin D	Basin E	Total	
I Direct Construction	4,022.7	6,437.1	3,909.1	3,413.1	2,098.2	19,880.2	
Channel Excavation	399.6	824.4	212.4	129.6	123.1	1,689.1	
Embankment	114.4	105.6	85.4	99.8	61.6	466.8	
Revetment	2,852.9	3,919.9	3,267.8	2,741.7	1,696.9	14,479.2	
Bridge Improvement	-	388.0	49.4	163.2	14.1	614.7	
Highway Crossing	264.6	209.0	-	-	-	473.6	
Inspection Road	391.2	990.2	294.1	278.8	172.5	2,126.8	
Sluice gate	-	-	-	-	30.0	30.0	
Others	-	-	-	-	-	-	
II Land Acquisition/ Compensation	5,817.9	10,063.8	4,618.9	3,049.5	3,096.0	26,646.1	
Residential Area	5,580.5	9,458.3	4,288.0	3,049.5	3,096.0	25,472.3	
Green Area	237.4	341.8	-	-	-	579.2	
House Resettlement	-	263.7	330.9	-	-	594.6	
III Engineering Service	402.3	643.7	390.9	341.3	209.8	1,988.0	Ix10%
IV Administration	147.6	247.5	127.9	96.9	77.9	697.8	(I+II) x1.5%
Sub-total	10,390.5	17,392.1	9,046.8	6,900.8	5,481.9	49,212.1	
V Physical Contingency	402.3	643.7	390.9	341.3	209.8	1,988.0	Ix10%
Total	10,792.8	18,035.8	9,437.7	7,242.1	5,691.7	51,200.1	

Table 1.4 Cost Benefit Streams - Cengkareng West Urban Drainage -

No.	Year	Initial Costs (IC)	O/M Costs (OM)	Costs (CS)	Benefits (BF)	Cash Flow (BF - CS)
1	1992	1988	0	1988	0	-1988
2	1993	3215	0	3215	0	-3215
3	1994	5987	44	6031	1364	-4667
4	1995	7391	72	7463	2475	-4988
5	1996	4804	91	4895	3379	-1516
6	1997	0	91	91	3644	3553
7	1998	0	91	91	3909	3818
8	1999	0	91	91	4174	4083
9	2000	0	91	91	4438	4347
10	2001	0	91	91	4703	4612
11	2002	0	91	91	4968	4877
12	2003	0	91	91	5232	5141
13	2004	0	91	91	5497	5406
14	2005	0	91	91	5762	5671
15	2006	0	91	91	6026	5935
16	2007	0	91	91	6291	6200
17	2008	0	91	91	6556	6465
18	2009	0	91	91	6820	6729
19	2010	0	91	91	7085	6994
20	2011	0	91	91	7085	6994
21	2012	0	91	91	7085	6994
22	2013	0	91	91	7085	6994
23	2014	0	91	91	7085	6994
24	2015	0	91	91	7085	6994
25	2016	0	91	91	7085	6994
26	2017	0	91	91	7085	6994
27	2018	0	91	91	7085	6994
28	2019	0	91	91	7085	6994
29	2020	0	91	91	7085	6994
30	2021	0	91	91	7085	6994
31	2022	0	91	91	7085	6994
32	2023	0	91	91	7085	6994
33	2024	0	91	91	7085	6994
34	2025	0	91	91	7085	6994
35	2026	0	91	91	7085	6994
36	2027	0	91	91	7085	6994
37	2028	0	91	91	7085	6994
38	2029	0	91	91	7085	6994
39	2030	0	91	91	7085	6994
40	2031	0	91	91	7085	6994
41	2032	0	91	91	7085	6994
42	2033	0	91	91	7085	6994
43	2034	0	91	91	7085	6994
44	2035	0	91	91	7085	6994
45	2036	0	91	91	7085	6994
46	2037	0	91	91	7085	6994
47	2038	0	91	91	7085	6994
48	2039	0	91	91	7085	6994
49	2040	0	91	91	7085	6994
50	2041	0	91	91	7085	6994

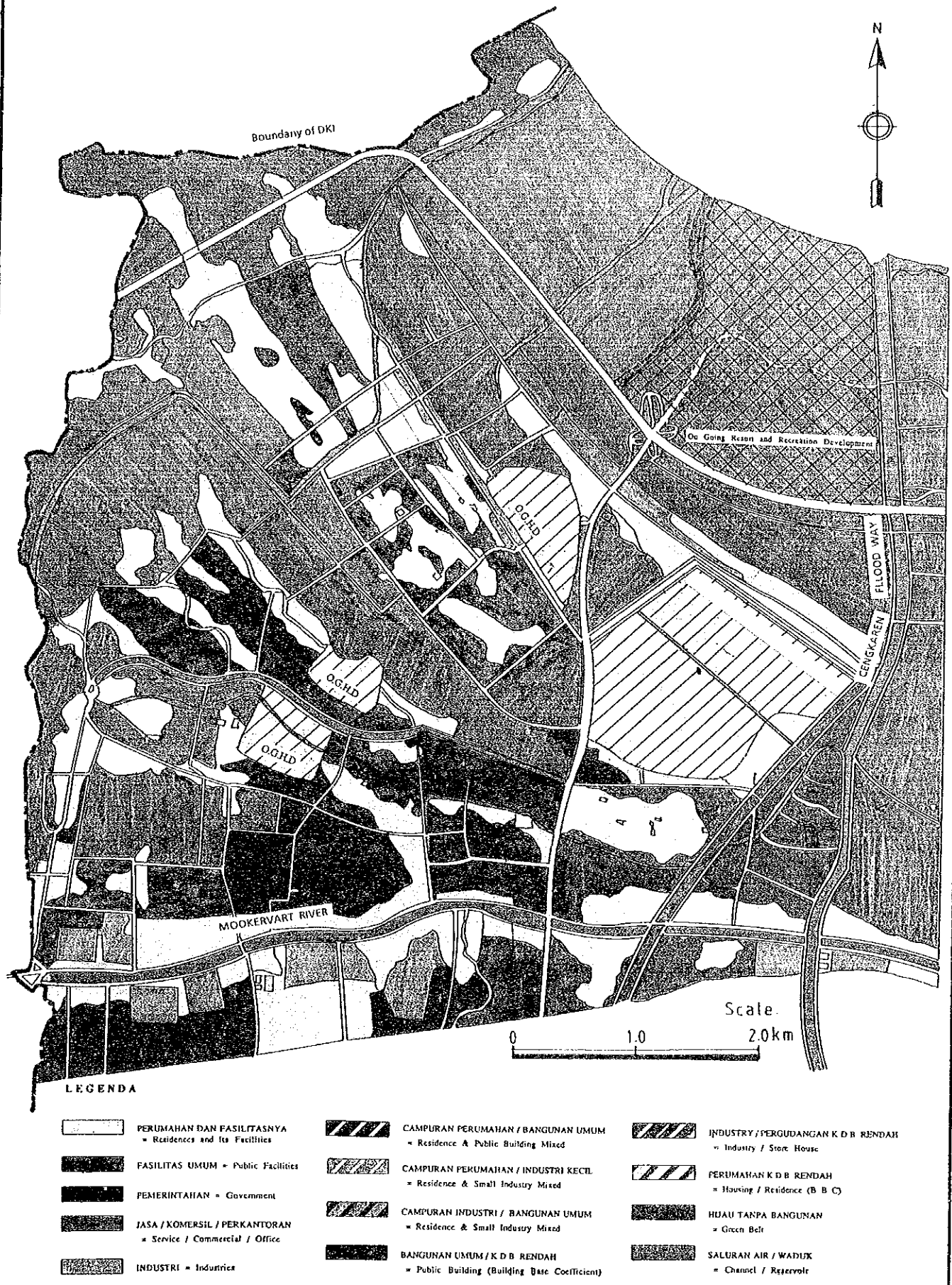


FIG. 1.1 EXISTING LAND USE OF PROJECT AREA(1990)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

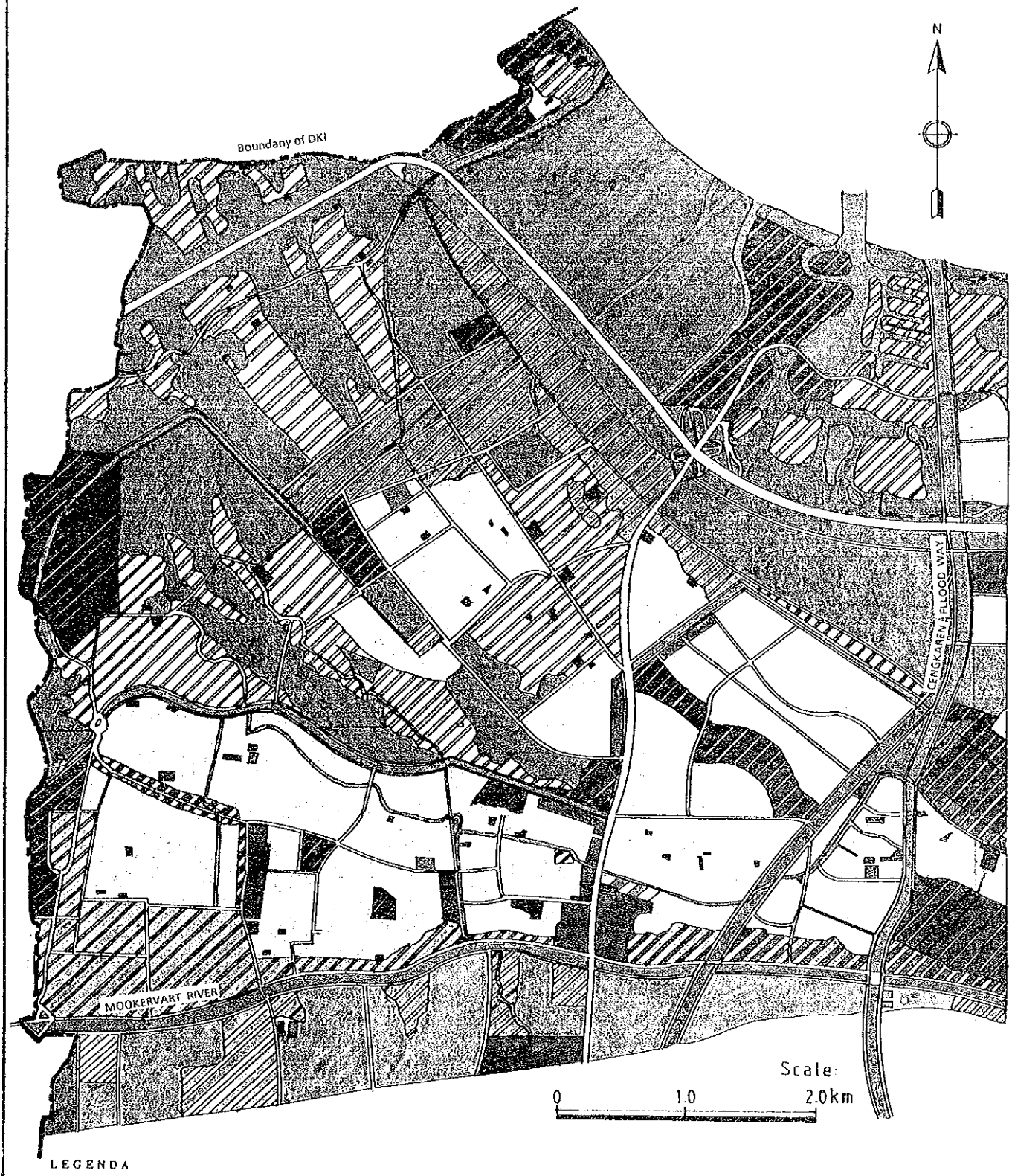


FIG. 1.2 FUTURE LAND USE OF PROJECT AREA (2005)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

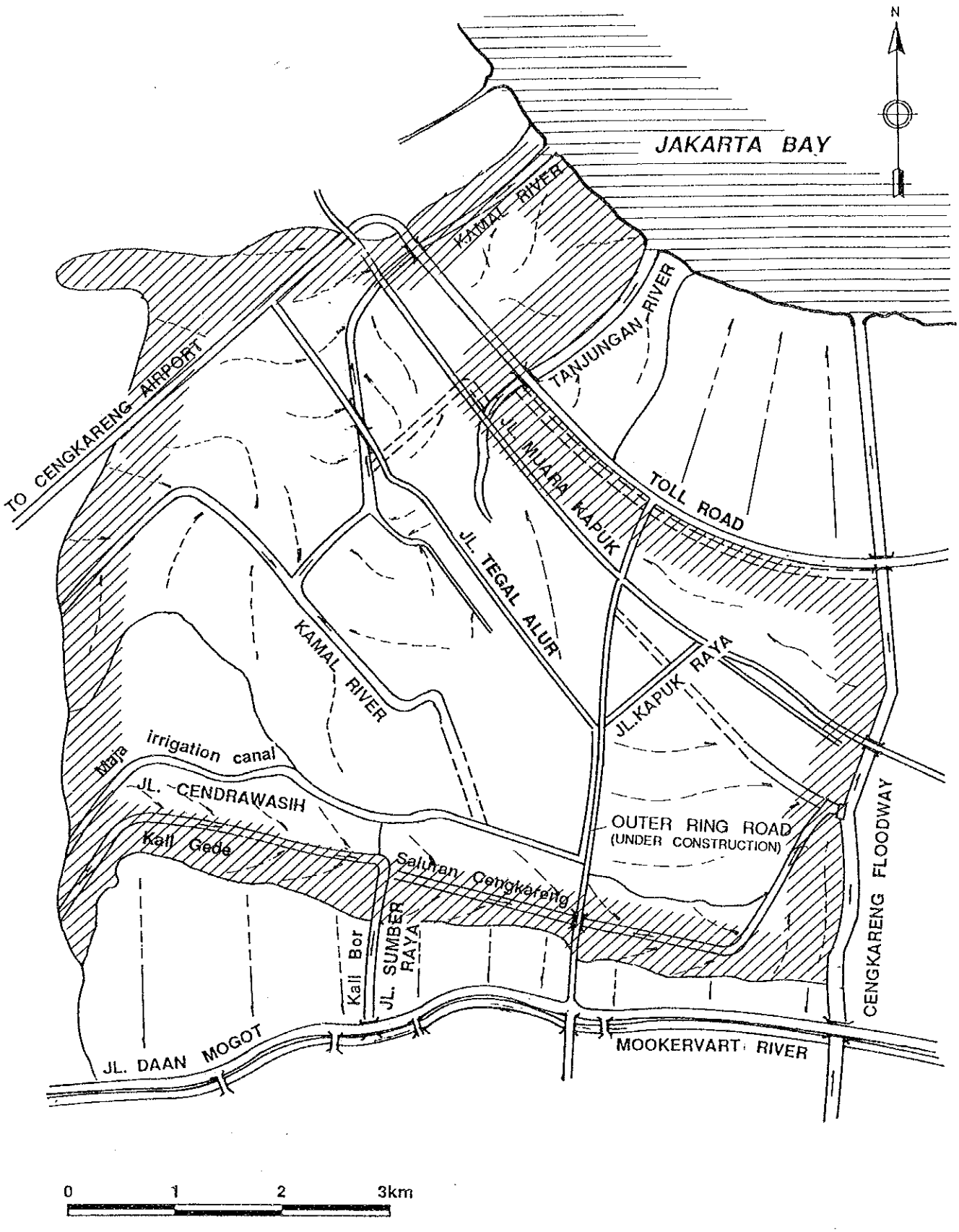
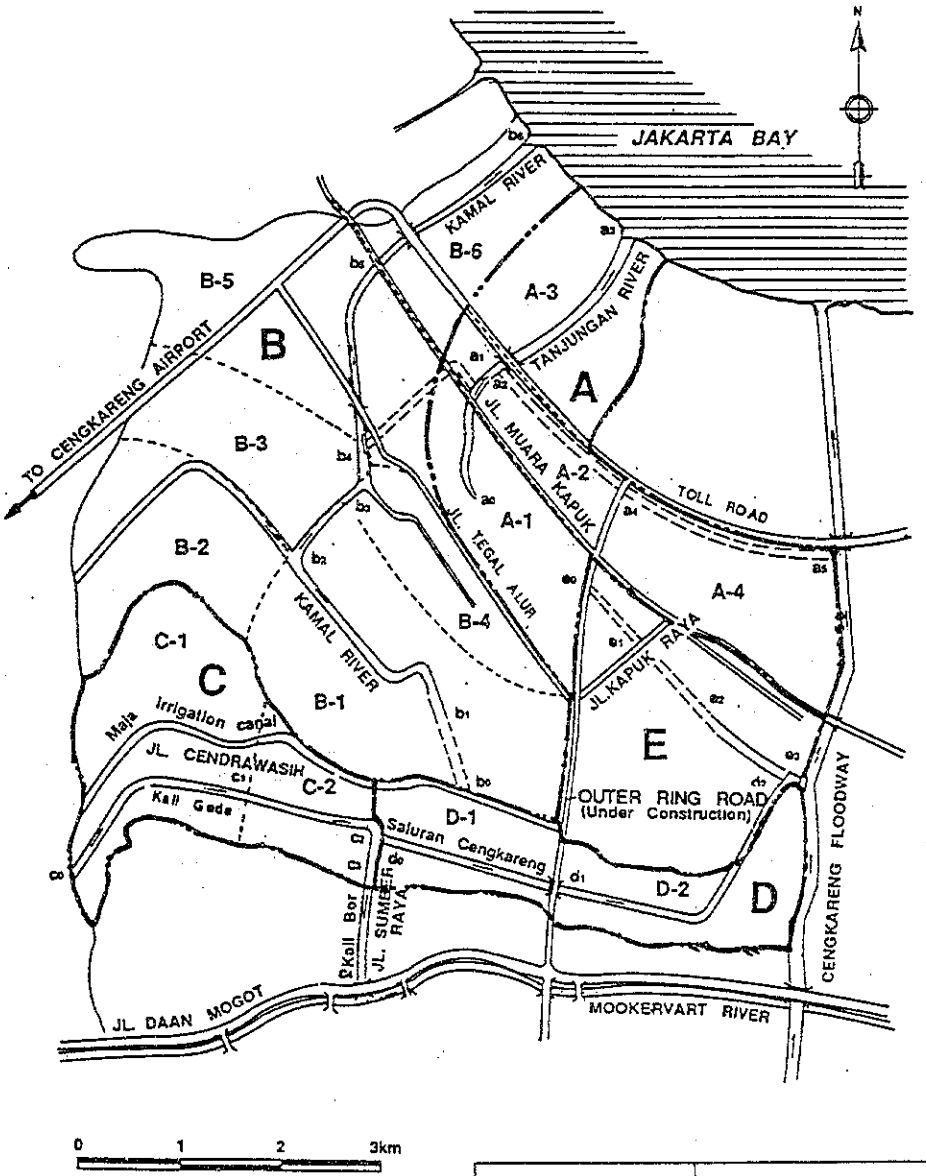


FIG. 1.3 OBJECTIVE DRAINAGE BASIN

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



Length of Drainage Channel

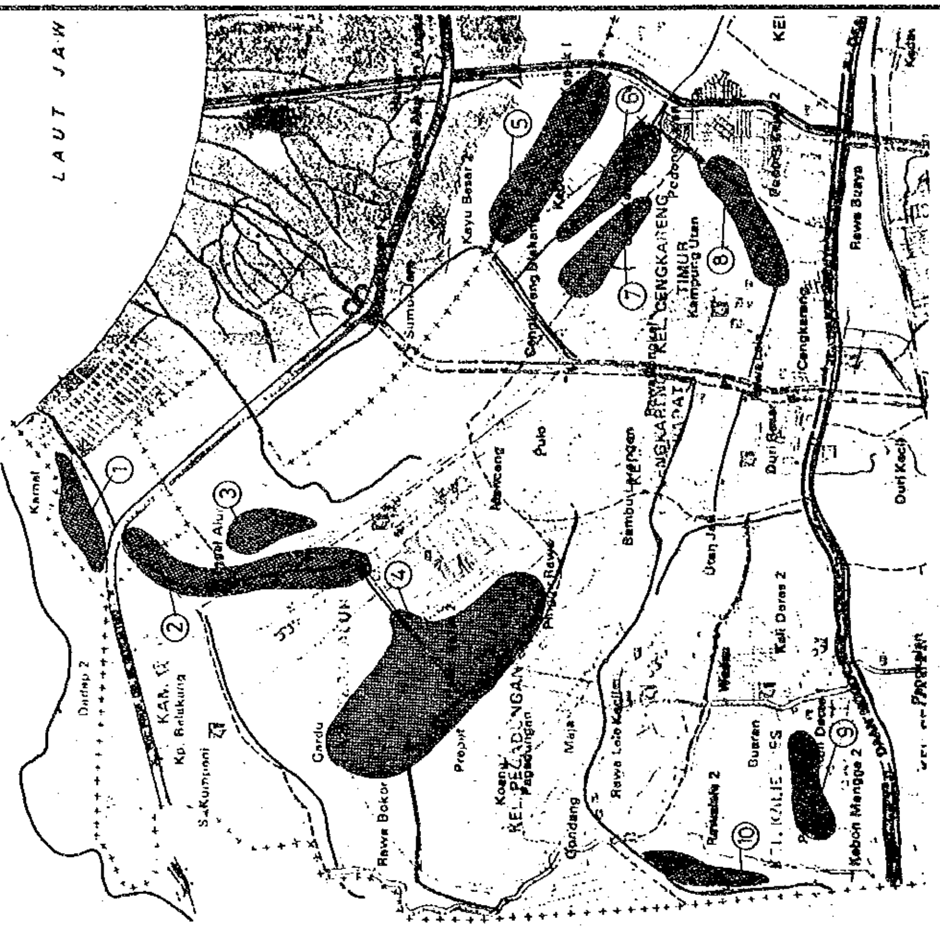
Basin	Route	Length(km) Existing	New Channel
A	a0-a1	1.10	
	a1-a2	0.45	
	a2-a3	1.60	
	a4-a2		1.70
	a5-a4		2.30
	Sub Total	3.15	4.00
B	b0-b1		0.68
	b1-b2	2.30	
	b2-b3	1.00	
	b3-b4	0.30	
	b4-b5	1.88	
	b5-b6	1.88	
	b7-b3	(1.60)	
	b8-b2	(2.80)	
	Sub Total	11.76	0.68
C	C0-C1	1.95	
	C1-C2	1.48	
	C2-C3	0.45	
	C3-C4	0.88	
	Sub Total	4.76	
D	d0-d1	1.65	
	d1-d2	2.88	
	Sub Total	4.53	
E	e0-e1		0.75
	e1-e2		1.00
	e2-e3	0.95	
	e3-e4	0.10	
	Sub Total	1.05	1.75
	Total	20.94	6.43

Catchment Area of Sub Basin

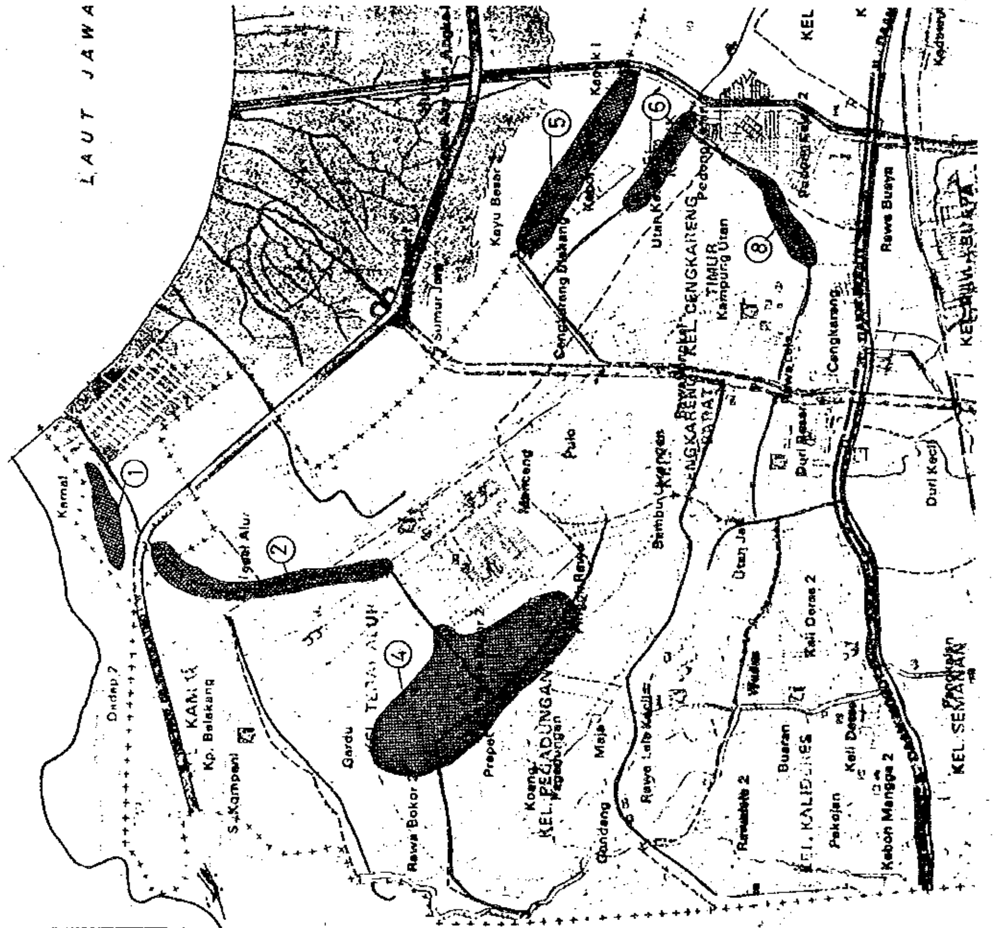
Basin	Sub-basin	Area(km2)
A	A-1	1.9
	A-2	1.41
	A-3	2.11
	A-4	2.35
	Sub Total	7.77
B	B-1	4.64
	B-2	2.47
	B-3	2.18
	B-4	1.52
	B-5	3.72
	B-6	1.84
	Sub Total	16.37
C	C-1	3.32
	C-2	2.31
	Sub Total	5.63
D	D-1	1.39
	D-2	1.92
	Sub Total	3.31
E	Sub Total	5.15
	TOTAL	38.23

FIG. 1.4 EXISTING DRAINAGE SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



	Depth (m)	Area (ha)	Duration
1	0.4	22.5	7 days
2	0.3	66.8	1 day
3	0.5	20.7	1 day
4	0.6	169.5	10 days
5	0.3	62.3	4 days
6	0.5	30.4	1 day
7	0.5	27.3	1 day
8	0.4	33.1	1 day
9	0.5	25.5	1 day
10	0.5	16.2	1 day

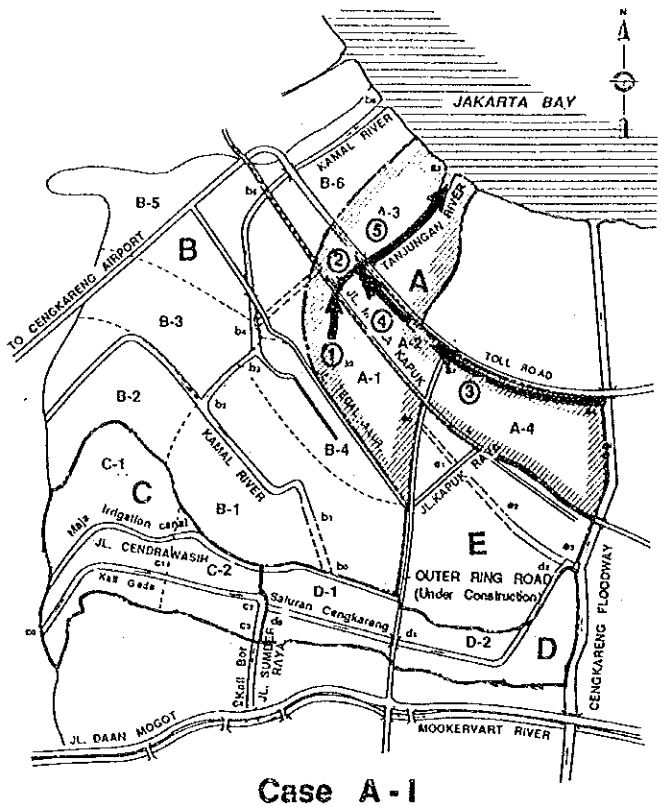


	Depth (m)	Area (ha)	Duration
1	0.3	20.3	2 days
2	0.3	40.5	4 hours
4	0.5	133.6	7 days
5	0.2	44.5	1 day
6	0.2	20.3	1 day
8	0.2	14.2	5 Hours

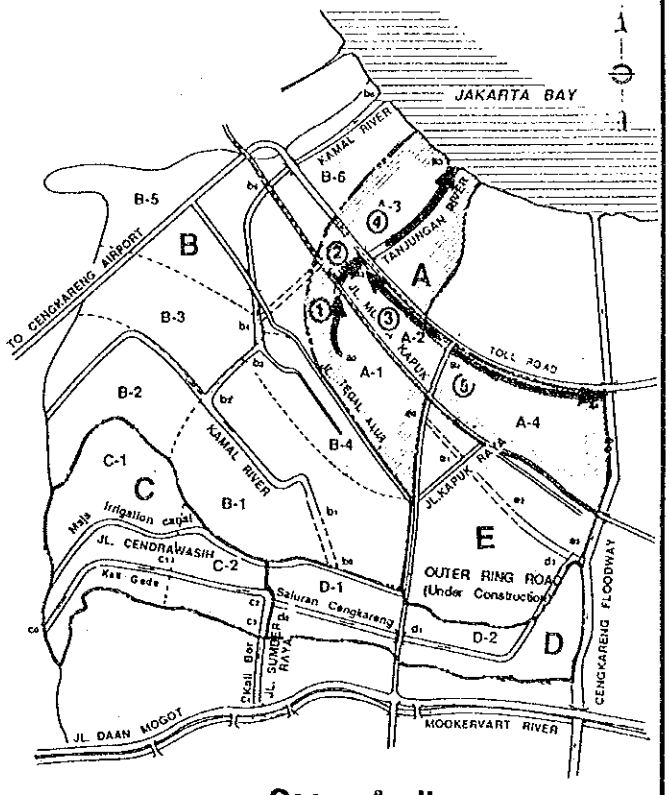
FIG. 1.5 HABITUAL AND POTENTIAL INUNDATION AREA (CENGKARENG WEST URBAN DRAINAGE)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

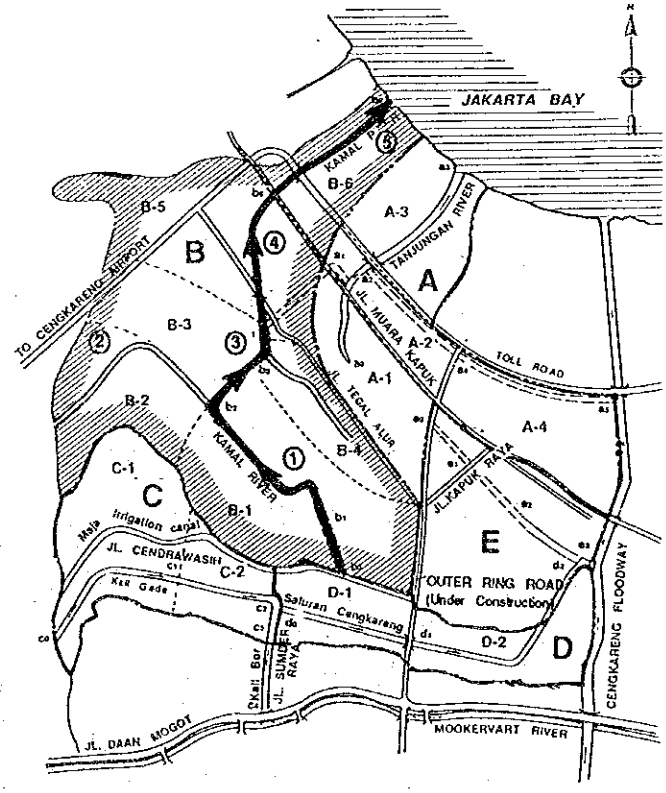
JICA A.D 1991



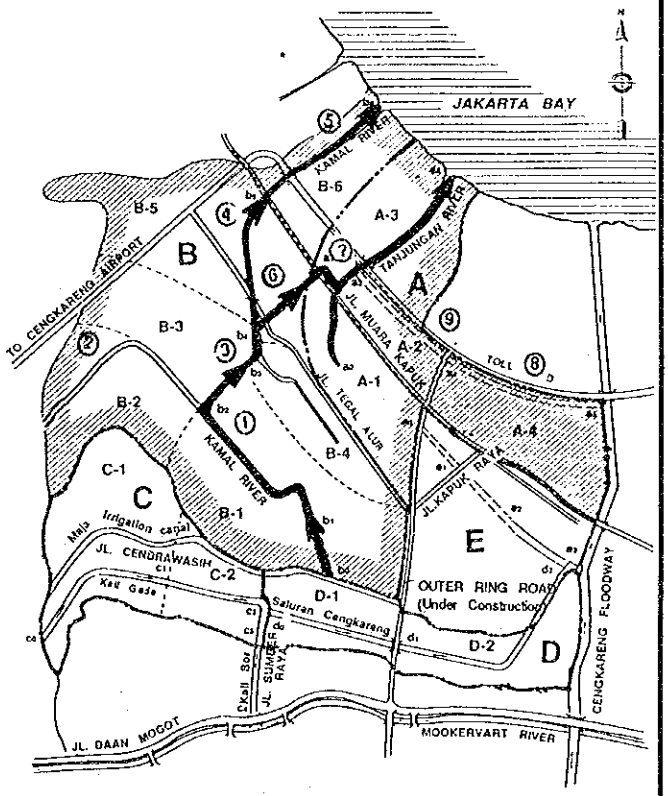
Case A - I



Case A - II



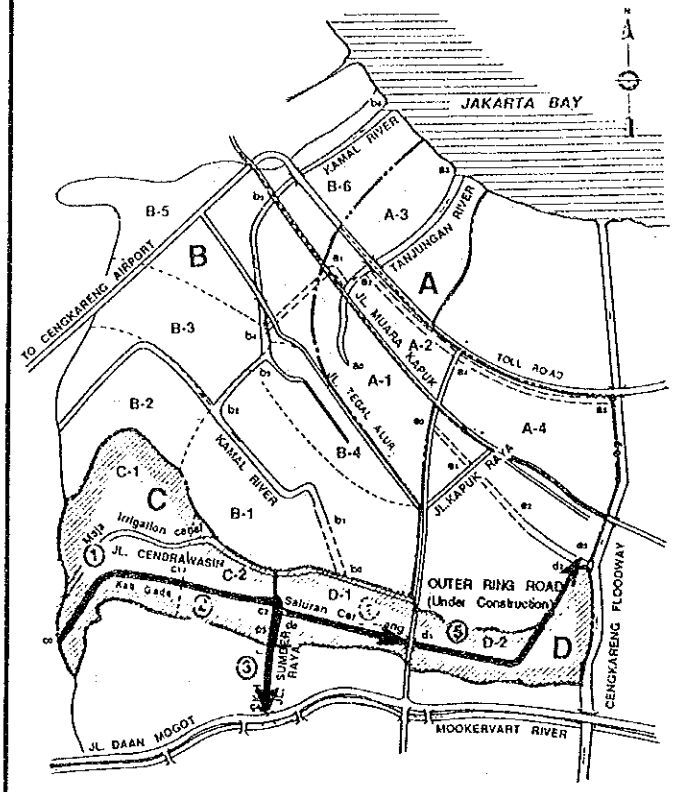
Case B - I



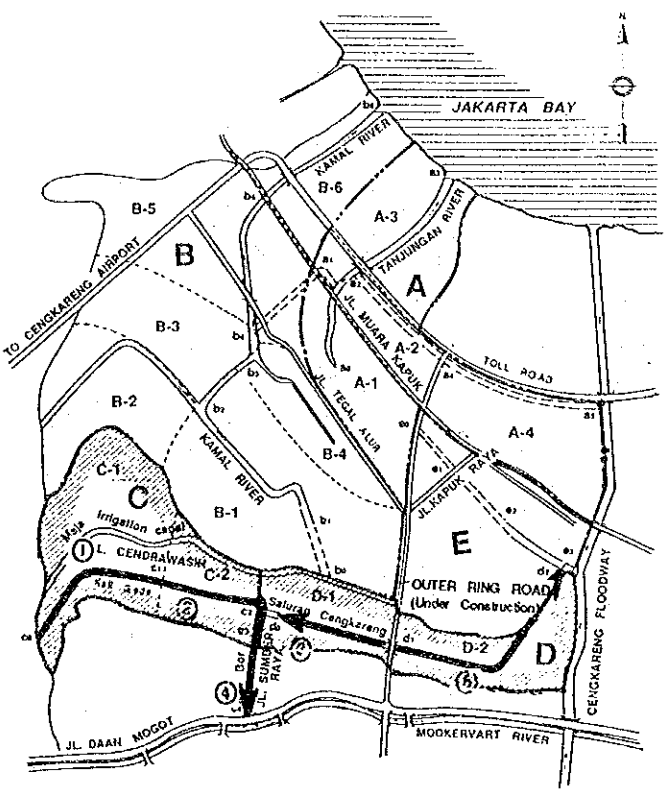
Case B - II

FIG. 1.6 LOCATION OF ALTERNATIVE CHANNEL IMPROVEMENT FOR BASIN A & B

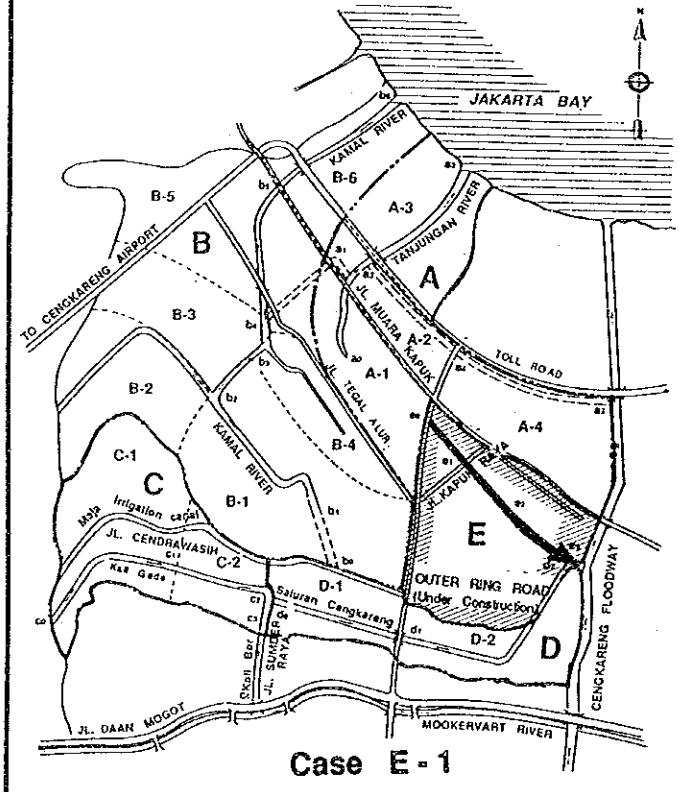
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



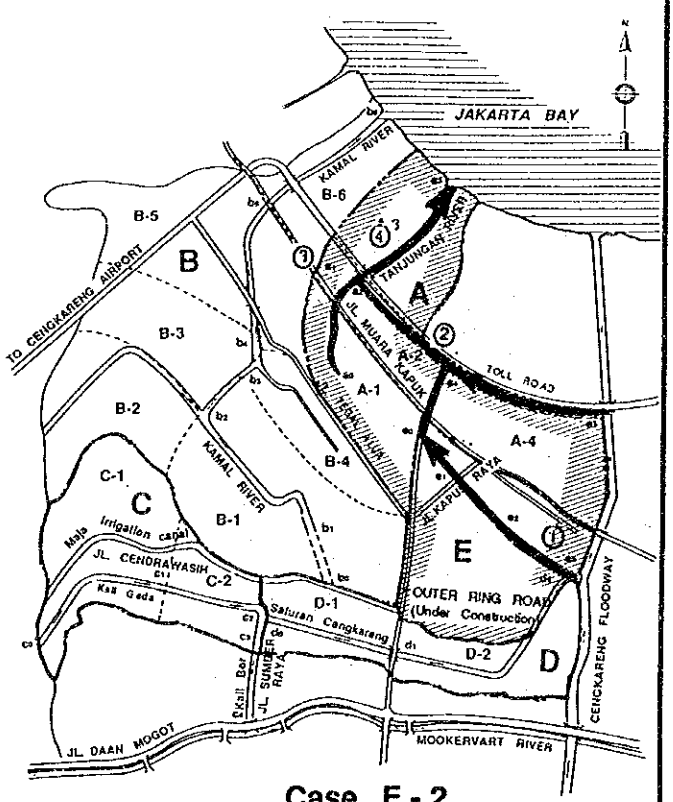
Case C/D - 1



Case C/D - 2



Case E - 1

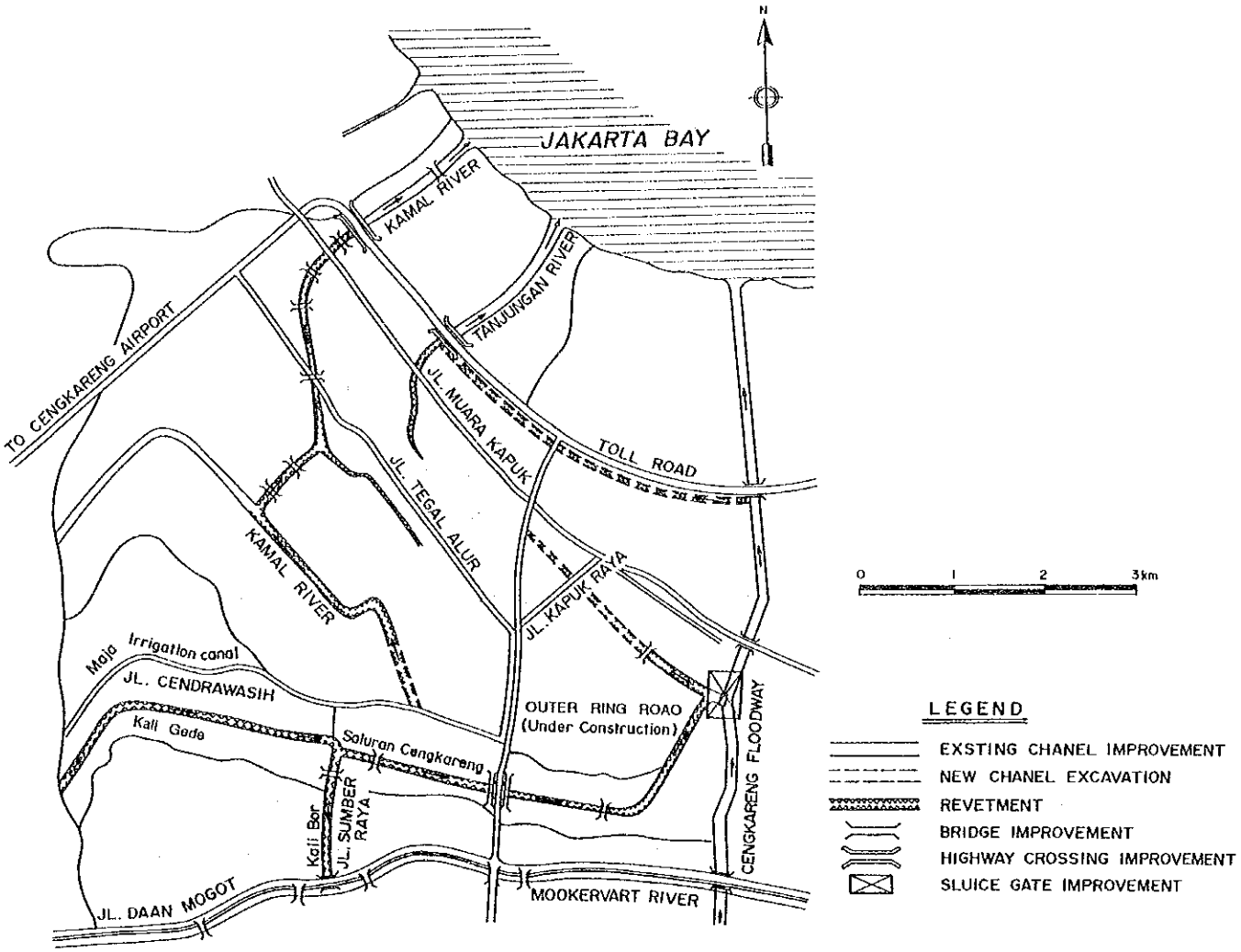


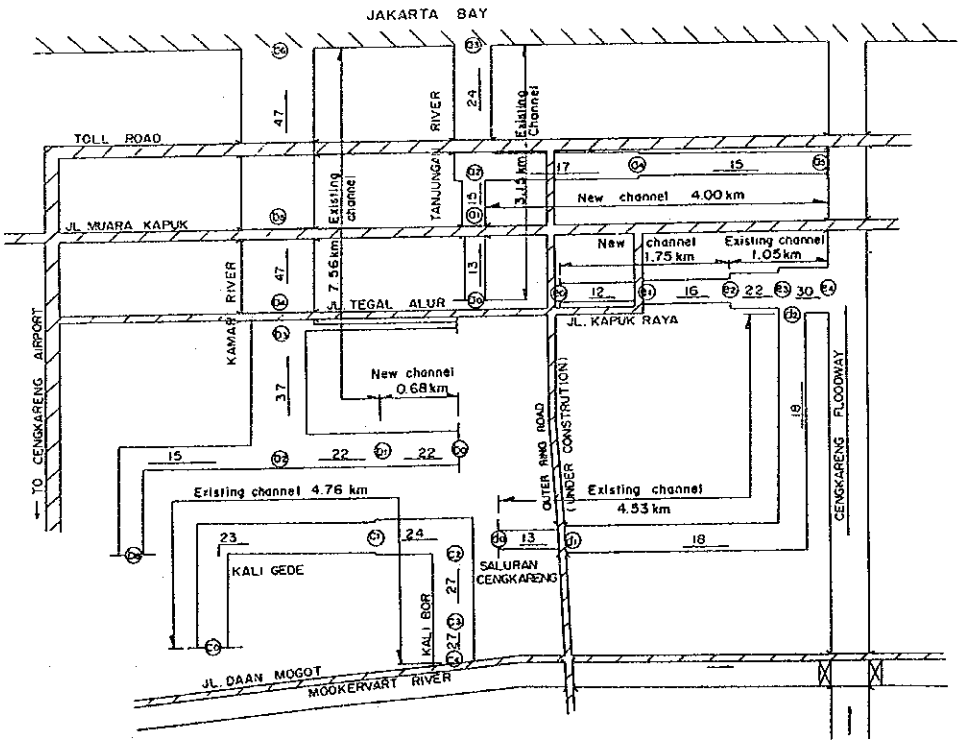
Case E - 2

0 1 2 3km

FIG. 1.7 LOCATION OF ALTERNATIVE CHANNEL IMPROVEMENT FOR BASIN C/D & E

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA





(DESIGN FLOOD DISCHARGE DISTRIBUTION OF PROPOSED CHANNEL)

FIG. 1.8 LOCATION OF PROPOSED CHANNEL IMPROVEMENT

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 2 SEPAK RIVER IMPROVEMENT

2.1 Project Area

(1) General

The Sepak River covers a drainage area of 43.4 km^2 at its downstream end where it joins the Cengkareng Floodway (See Fig. 2.1). The river system is composed of the main Sepak River, and the tributaries of Kembangan, Kreo and Ulujami.

The Sepak River basin is undergoing a rapid urbanization. The population of the basin will increase from 0.466 million in 1988 to 1.109 million in 2010.

The urban land area including residential, commercial & institutional and industrial uses is expected to increase from 3,227 ha or 74% of the total area in 1990 to 3,915 ha or 90% in 2005.

(2) Existing Drainage System

Most part of the Sepak River have already been improved. Improvement of the lowermost reaches with a total length of 3.3 km is on-going. The project includes the following major construction works.

- Channel improvement including excavation, embankment and bank protection : 3.3 km
- Construction of bridge : 2 places
- Construction of drainage culvert : 2 places

While, 1.0 km of the Kreo River, 0.5 km of the Sepak River and 0.6 km of the Kembangan River still remain unimproved.

Location of the on-going and unimproved river sections are shown in Fig. 2.1.

2.2 Floods and Flood Damages

There exist two (2) inundation areas in the Sepak River Basin. The total potential inundation area adds up to 51.5 ha, while a total area of 42.9 ha is habitually inundated. The depth and duration of inundation at times of potential floods work out to 19 to 49 cm and 13 to 22 hours respectively. Whereas, the depth and duration of habitual inundation are 5 to 11 cm and one (1) hour, respectively (Refer to Fig. 2.2).

In this Study, the following damages were estimated in monetary terms.

- Damages to properties including house, shop and factory
- Income losses due to closure of shop and factory
- Damages to traffic
- Damages to infrastructure and others

The total average annual flood damage in 1988 and 2010 are estimated to be Rp. 119 million and Rp. 1,056 million respectively. Its break-down is shown below.

(Unit: million Rp.)

Item		1988	2010
(i)	Damages to Property	93.6	859.2
(ii)	Income Losses	0.3	1.8
(iii)	Traffic Damages	5.2	18.8
(iv)	Damages to Infrastructure & Others	19.8	176.0
	Total	118.9	1,055.8

2.3 Proposed River Improvement

The three (3) unimproved river sections mentioned in the previous Section 2.1 will be improved to meet increasing flood peaks due to the land development. For their location, ref. Fig. 2.1.

(1) Design Flood Discharge

Design flood frequency is determined to be 10-year for the Kreo River, 10-year for the Sepak River and 5-year for the Kembangan River based on the guidelines established by the Government of Indonesia.

The design flood discharge of the objective three (3) river sections are calculated by the Rational Formula. The results are summarized below.

Item	Kreo River	Sepak River	Kembangan River
Catchment Area (km^2)	7.8	17.8	2.4
Design Frequency (year)	10	10	5
Design Rainfall Intensity (mm/hr)	33	31	45
Runoff Coefficient	0.521	0.488	0.625
Design Discharge (m^3/s)	35	70	20
Specific Design Discharge ($m^3/s/km^2$)	4.5	3.9	8.3

(2) Proposed River Profile and Cross Section

The river profiles of the objective three (3) river sections are determined to smoothly connect with the respective upstream and downstream sections which are completed or on-going.

The river banks of the whole objective river sections are protected by revetment of wet masonry type. Inspection road with a side ditch is provided along the river bank.

The length, gradient, width and depth of the proposed rivers are shown below.

River	Length (m)	Gradient	Bottom Width (m)	Top Width (m)	Depth (m)
Kreo	1,000	1/540	7.2	10.1	2.9
Sepak	500	1/667	10.6	13.5	2.9
Kembangan	600	1/540	10.7	12.0	1.3

(3) Proposed Construction Works and Land Acquisition

Major construction works of the proposed river improvement plan are channel excavation, embankment, revetment works, inspection road pavement and side drain works. Those are summarized below.

- Channel excavation : 33,000 m^3
- Embankment : 8,000 m^3
- Revetment works : 4,200 m, 14,500 m^2
- Inspection road pavement : 2,100 m, 6,300 m^2
- Side drain works : 4,200 m

The required land acquisition is 1.7 ha for green area.

The break-down of the construction works and land acquisition by river is shown in Table 2.1.

2.4 Cost Estimate

The project costs were estimated in the same manner of Supporting Report, II-1, Cengkareng West Urban Drainage, Chapter 4.

The total project cost amounts to Rp. 4,835 million at July, 1990 price as given below. Its break-down by construction work and by river is shown in Table 2.2.

(million Rp.)

Item	Cost	Remarks
I. Direct Construction	2,976	
II. Land Acquisition	1,200	
III. Engineering Service	298	I x 10%
IV. Administration	63	(I + II) x 1.5%
V. Physical Contingency	298	I x 10%
Total	4,835	

Table 2.1 Construction Works and Land Acquisition by River

Item	Unit	Kreo	Sepak	Kembangan	Total
Channel Excavation	(m^3)	14,000	5,000	14,000	33,000
Embankment	(m^3)	5,000	2,000	1,000	8,000
Revetment Works	(m)	2,000	1,000	1,200	4,200
	(m^2)	7,800	3,900	2,800	14,500
Inspection Road	(m)	1,000	500	600	2,100
	(m^2)	3,000	1,500	1,800	6,300
Side Drain	(m)	2,000	1,000	1,200	4,200
Land Acquisition	(ha)	0.8	0.4	0.5	1.7

Table 2.2 Break-down of Project Cost

(Unit: million Rp.)

Item	Kreo	Sepak	Kembangan	Total	Remarks
I. Direct Construction	1,498	739	739	2,976	
Channel Excavation	51	18	51	120	
Embankment	22	9	4	35	
Revetment	697	348	247	1,292	
Inspection Road	46	23	28	97	
Side Drain	682	341	409	1,432	
II. Land Acquisition	565	282	353	1,200	
III. Engineering Service	150	74	74	298	I x 10%
IV. Administration	31	15	17	63	(I+II)x1.5%
V. Physical contingency	150	74	74	298	I x 10%
Total	2,394	1,184	1,257	4,835	

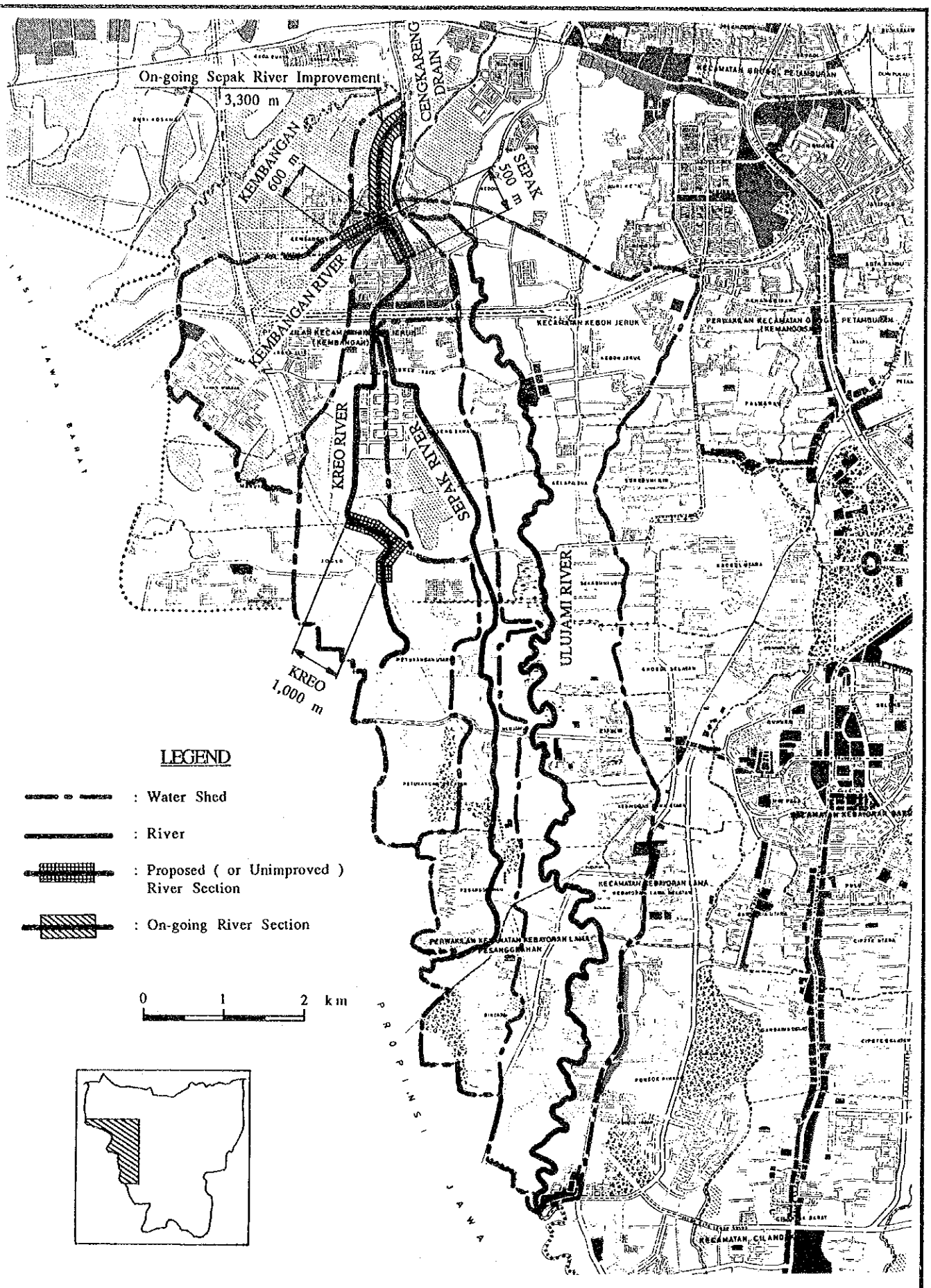
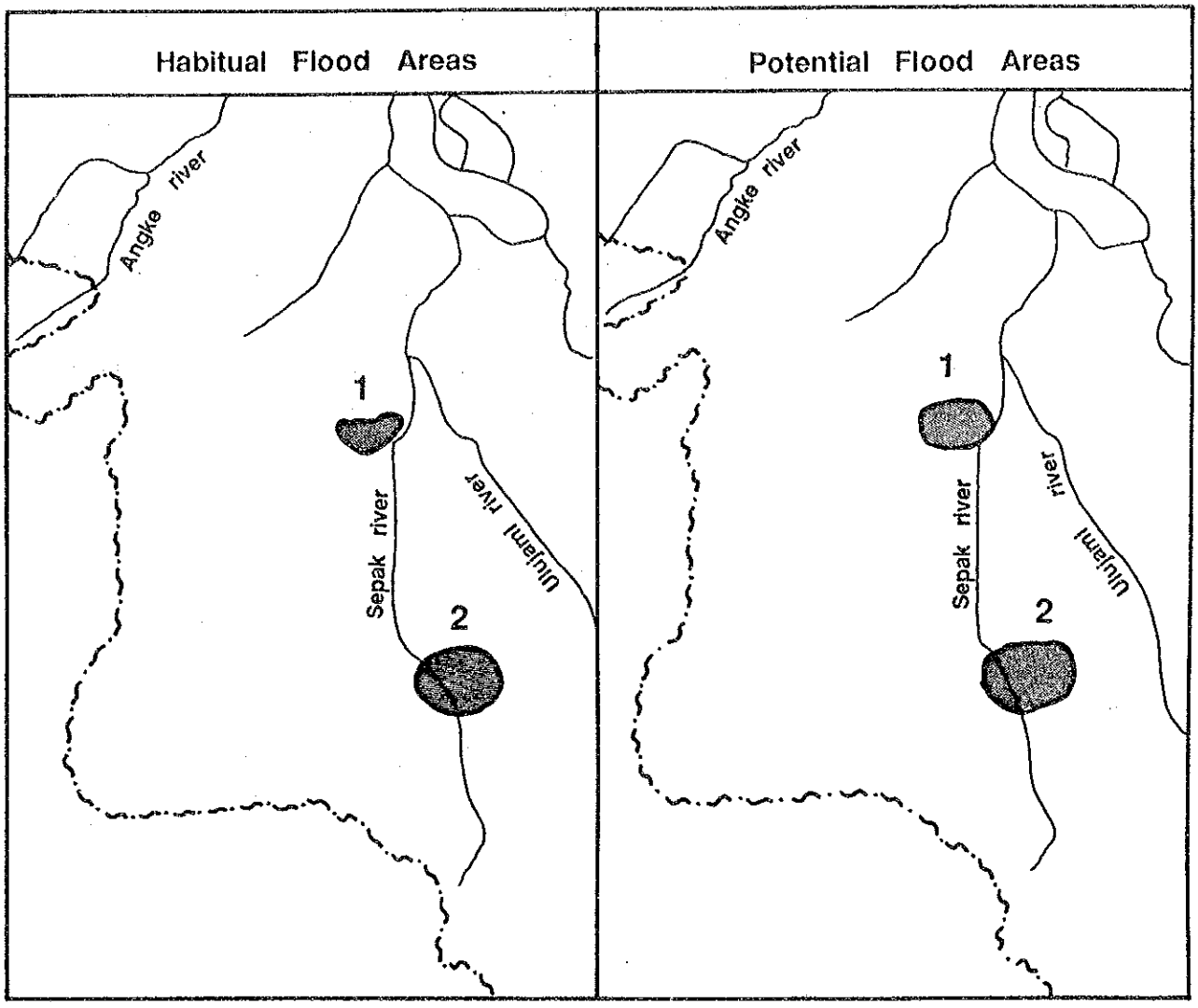


FIG. 2.1 LOCATION OF PROJECT AREA

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



Habitual Flood Areas				Potential Flood Areas			
Location	Depth (cm)	Area (ha)	Duration (hr)	Location	Depth (cm)	Areas (ha)	Duration (hr)
1	5	14.7	1	2	49	18.4	22
2	11	28.2	1	3	19	33.1	13

FIG. 2.2 HABITUAL AND POTENTIAL INUNDATION AREA (SEPAK RIVER IMPROVEMENT)

Chapter 3 BOJONG DRAINAGE IMPROVEMENT

3.1 Project Area

(1) General

The Project Area covers the whole Bojong housing area of 40.0 ha with a total population of 5,589. It is located in the low-lying area encompassed by Jl. Raya Kamal to the west, Angke River to the south, Cengkareng Floodway to the east and Mookervart River to the north.

(2) Existing Drainage System

Storm water of the Bojong housing area is drained by the pump station of capacity 0.9 m^3/s and a retarding basin of storage capacity 29,000 m^3 into a tributary of the Mookervart River.

The main features of the drainage system are shown below.

(i)	Drainage Area	:	40.0 ha
(ii)	Pump Station		
	H.W.L. of Receiving River	:	P.B.M. + 3.40 m
	Pump	:	ø254 mm x 0.15 m^3/s x 6 units
(iii)	Retarding Basin		
	Surface Area	:	14,500 m^2
	Effective Storage Capacity	:	29,000 m^3
	H.W.L.	:	P.B.M. + 1.56 m
	N.W.L.	:	P.B.M. - 0.44 m
(iv)	Drainage Channel		
	Open Ditch	:	4,250 m long
	Pipe	:	290 m long

The capacity of the existing system is insufficient. The existing drainage system was designed to meet floods of the original housing development area of 31.0 ha. However, the area has been further developed by 9.0 ha thereafter.

Location of the existing pump station, retarding basin and channel networks are shown in Fig. 3.1. Size of the existing drainage channels are also shown in Fig. 3.1.

3.2 Floods and Flood Damages

There exist seven (7) potential inundation areas, of which three (3) are habitually inundated. The total hectareage of the potential inundation areas sums up to 13.8 ha, of which 3.7 ha is subjected to habitual inundation.

The depth of inundation in the potential inundation areas ranges from 50 cm to 75 cm, while the duration of inundation falls between 4 days and 5 days. Inundation depth and duration in the habitual inundation areas are 15 to 30 cm and 1.5 to 3 hours, respectively.

The area, depth and duration of potential and habitual inundations are shown in Fig. 3.2.

In this Study, the following damages were estimated in monetary terms.

- Damages to properties including house, shop and factory
- Income losses due to closure of shop and factory
- Damages to traffic
- Damages to infrastructure and others

The total average annual flood damage in 1988 and 2010 are estimated to be Rp. 224 million and Rp. 1,208 million respectively. Its break-down is shown below.

(Unit: million Rp.)

Item		1988	2010
(i)	Damages to Property	177.9	931.2
(ii)	Income Losses	1.8	49.8
(iii)	Traffic Damages	7.2	26.0
(iv)	Damages to Infrastructure & Others	373.	201.4
	Total	224.2	1,208.4

3.3 Drainage Improvement Plan

The existing capacity of the pump station and drainage channel are assessed to identify the cause of the existing flood problems as follows.

(1) Pump Station

The existing pump station drains an area of 40 ha. Hence, design flood frequency of two (2) years is applied. The design flood hydrograph was estimated by the Unit Hydrograph Method based on the design point rainfall mass curve proposed in the 1973 Master Plan. The estimated design hydrograph is shown in Fig. 3.3.

The required capacity of the retarding basin is estimated to be 12,000 m^3 based on the mass curve calculation as shown also in Fig. 3.3. The existing effective storage capacity of 29,000 m^3 can meet the design floods with a two (2) year return period.

It is not necessary to improve the existing pump station.

(2) Drainage Channel

The design flood discharge with a 2-year return period was estimated by the Rational Formula.

The existing flow capacity of the channels is compared with the estimated design flood discharge. The existing flow capacity is

insufficient in the following 12 channel sections with a total length of 1,850 m.

- No. 1, 2, 9, 11, 13, 17, 20, 23, 24, 25, 29, 31 (See Fig. 3.1)

It is necessary to improve the above channel sections.

(4) Proposed Channel Improvement Plan

The above twelve (12) channel sections with insufficient flow capacity and one (1) related channel section will be improved to meet the design flood discharge of 2-year return period. The total channel improvement length is 1,995 m. The main features of the respective sections of the proposed channel are shown in Table 3.1.

3.4 Cost Estimate

The project costs were estimated in the same manner of Supporting Report, II-1, Cengkareng West Urban Drainage, Chapter 4.

The total project cost amounts to Rp. 549 million at July, 1990 prices as given below.

(Unit: million Rp.)

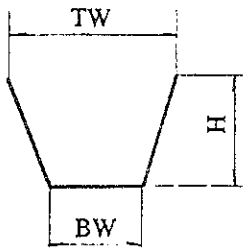
Item	Cost	Remarks
I. Direct Construction	430	
II. Land Acquisition	26	
III. Engineering Service	43	I x 10%
IV. Administration	7	(I + II) x 1.5%
V. Physical Contingency	43	I x 10%
Total	549	

Table 3.1 Main Features of Proposed Channel

Channel Route	Channel No.	Length (m)	Design Discharge (m^3/s)	Slope (1/1000)	Top Width (m)	Bottom Width (m)	Depth (m)
I	1	145	0.41	2.0	0.50	0.50	1.00
	2	45	0.52	2.0	0.50	0.50	1.00
	17	190	0.75	0.3	1.44	0.50	1.25
II	9	110	0.20	4.0	0.50	0.50	0.50
	11	60	0.31	4.0	0.50	0.50	0.50
	13	180	0.52	3.0	ϕ0.7		
III	23	50	1.49	2.0	1.32	1.00	1.24
	25	60	1.82	2.0	1.32	1.00	1.24
	20	110	0.51	4.0	0.65	0.50	0.60
	24	300	0.41	3.9	0.79	0.40	0.50
	21	145	1.19	2.0	1.32	1.00	1.24
IV	29	300	0.22	0.5	0.77	0.77	0.68
	31	300	0.21	0.5	0.77	0.77	0.68

For channel location., refer to Fig. 3.1.

Channel Route	Channel No.	Shape (m) BW	TW	H
I	1	0.20	0.45	0.56
	2	0.20	0.45	0.56
	3	0.50	1.44	1.22
	14	0.50	1.44	1.22
	15	1.10	1.20	1.10
	16	0.50	1.44	1.25
	17	0.50	1.44	1.25
	4	0.25	0.45	0.50
	6	0.40	1.10	1.10
	5	0.40	1.10	1.10
II	8	0.40	1.10	1.10
	9	0.20	0.48	0.50
	11	0.20	0.40	0.50
	12	ø 600		
	13	ø 600		
	7	0.40	1.10	1.10
	10	0.20	0.40	0.50
III	18	0.30	0.40	0.25
	19	0.60	1.30	1.30
	21	1.32	1.32	1.24
	23	0.22	0.44	0.40
	25	0.30	0.90	1.50
	20	0.50	0.65	0.60
	22	0.35	1.06	0.80
	24	0.35	0.79	0.40
	26	0.30	0.91	1.50
IV	27	0.60	1.50	1.00
	28	0.90	1.50	1.50
	30	0.90	1.50	1.50
	32	0.90	1.50	1.50
	29	0.35	0.77	0.60
	31	0.28	0.46	0.50



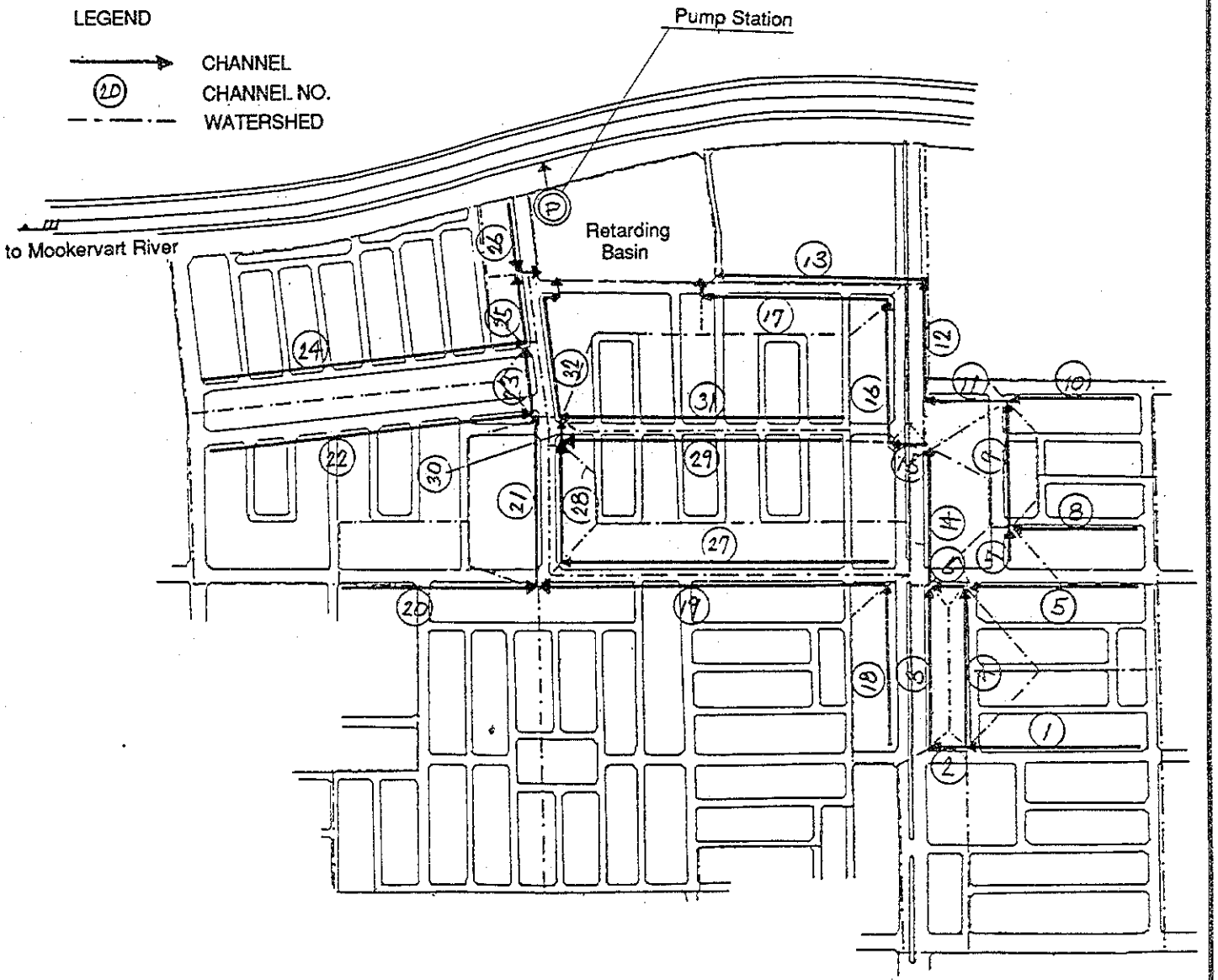


FIG. 3.1 EXISTING CHANNEL NETWORKS

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

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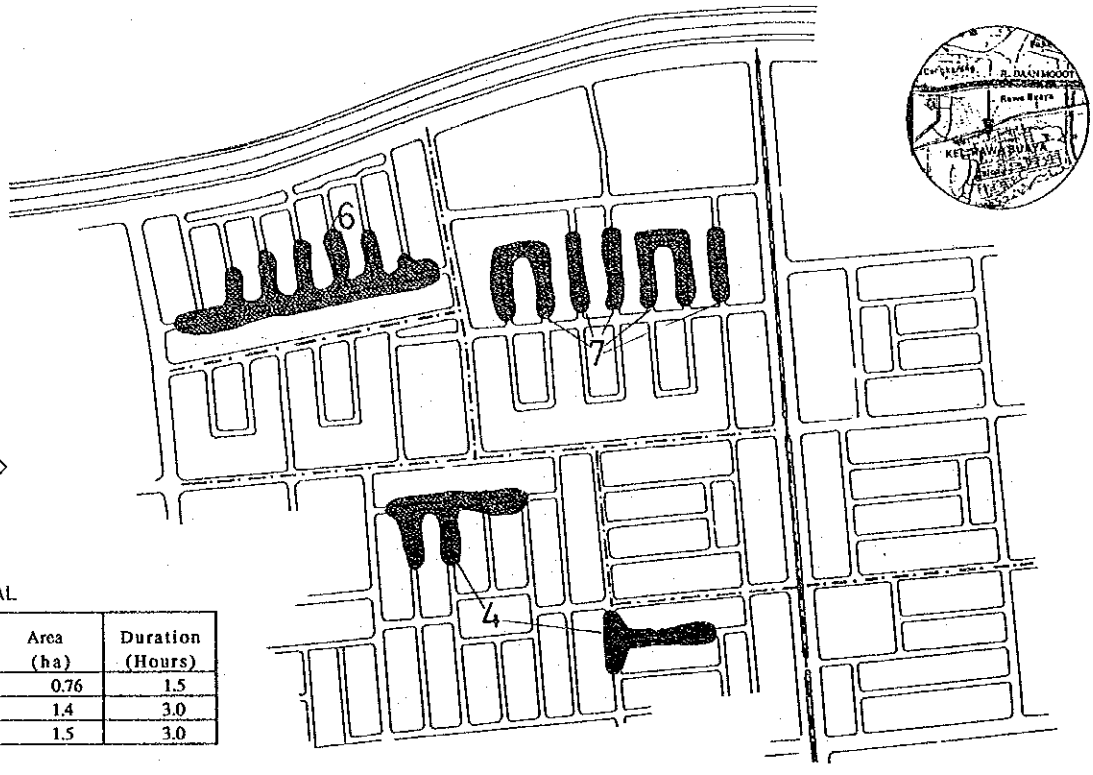
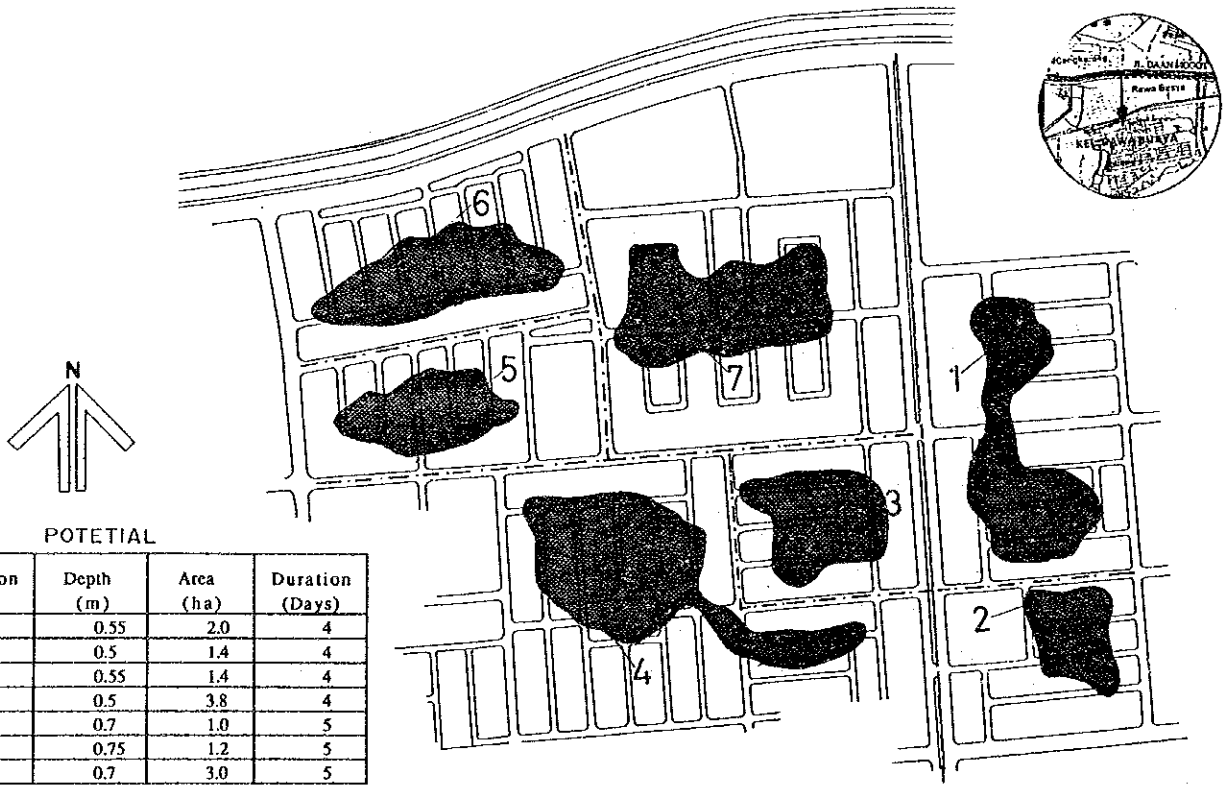


HABITUAL

Location	Depth (m)	Area (ha)	Duration (Hours)
4	0.15	0.76	1.5
6	0.3	1.4	3.0
7	0.3	1.5	3.0

HABITUAL



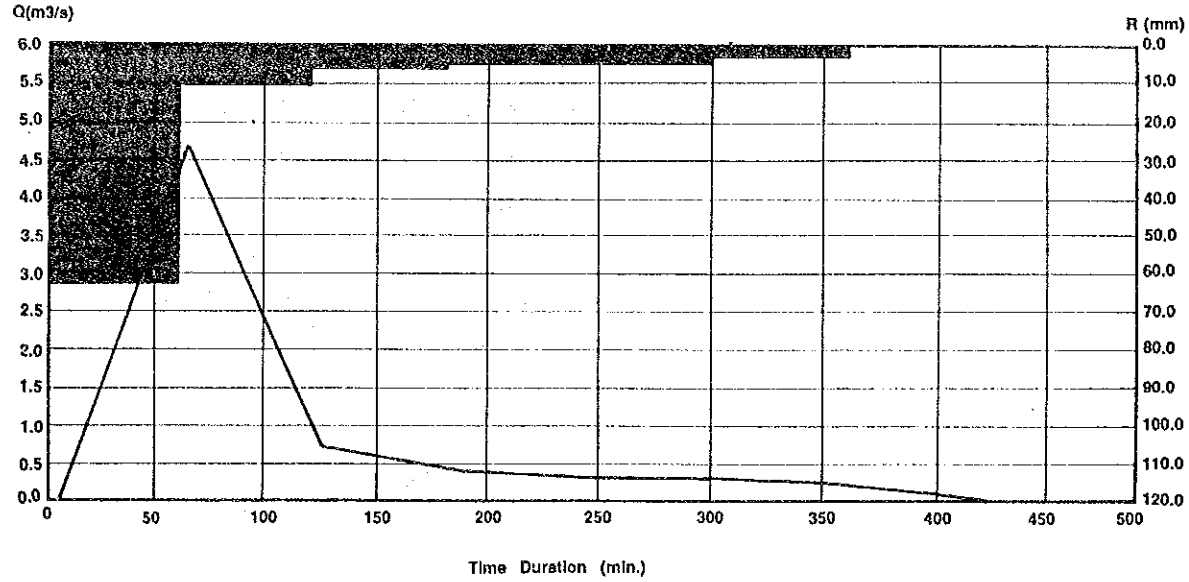
POTETIAL

Location	Depth (m)	Area (ha)	Duration (Days)
1	0.55	2.0	4
2	0.5	1.4	4
3	0.55	1.4	4
4	0.5	3.8	4
5	0.7	1.0	5
6	0.75	1.2	5
7	0.7	3.0	5

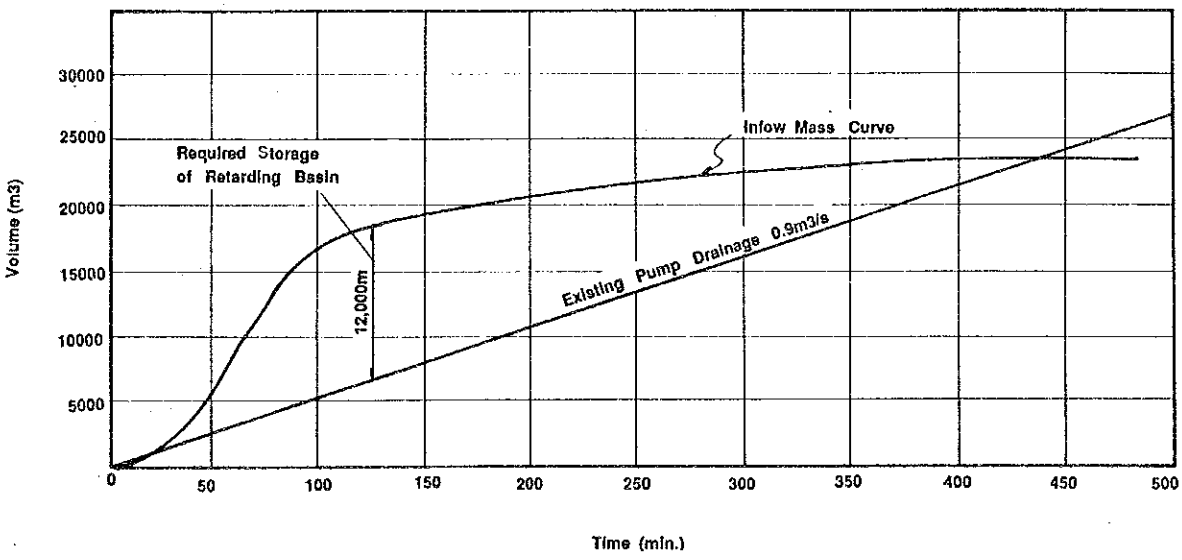
POTENTIAL

FIG. 3.2 HABITUAL AND POTENTIAL INUNDATION AREA (BOJONG DRAINAGE IMPROVEMENT)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



HYDROGRAPH



MASS CURVE

FIG. 3.3 DESIGN HYDROGRAPH AND PUMP DRAINAGE MASS CURVE

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 4 MARUYA ILIR DRAINAGE IMPROVEMENT

4.1 Project Area

Project Area is located in Kel. Maruya Ilir encompassed by Jl. Tol Jakarta Merak to the north, tributary of the Angke River to the west and Kreo River to the east. The Project Area covers a drainage area of 157 ha including Maruya Ilir and Jeruk Manis areas (See Fig. 4.1). Maruya Ilir area is undergoing housing developments, while Jeruk Manis area is still undeveloped. However, according to the DKI, Jakarta Structure Plan 2005, the whole area will be developed for residential use by 2005.

Population of the Area is estimated at 6,600 or 30% of the total population of Kel. Maruya Ilir in 1990. It will increase to 50,000 in 2010.

4.2 Floods and Flood Damages

There are 35 inundation areas in the Project Area. The total inundation area at times of potential floods works out to 27.95 ha, out of which 23.13 ha is habitually inundated.

The depth of inundation of potential floods ranges 50 ~ 60 cm, while the duration of inundation falls between two (2) weeks and three (3) weeks. Inundation depth and duration of habitual floods are 20 to 30 cm and one (1) to three (3) days, respectively.

The area, depth and duration of potential and habitual inundations are shown in Fig. 4.2.

In this Study, the following damages were estimated in monetary terms.

- Damages to properties including house, shop and factory
- Income losses due to closure of shop and factory
- Damages to traffic
- Damages to infrastructure and others

The total average annual flood damage in 1988 and 2010 are estimated to be Rp. 53 million and Rp. 423 million respectively. Its break-down is shown below.

(Unit: million Rp.)

Item		1988	2010
(i)	Damages to Property	43.3	348.7
(ii)	Income Losses	0.3	1.4
(iii)	Traffic Damages	0.7	2.4
(iv)	Damages to Infrastructure & Others	8.8	70.4
	Total	53.1	422.9

4.3 Drainage Improvement Plan

(1) Existing Drainage System

The Project Area is drained by two (2) main drainage channels: east and west channels, and six (6) drainage culverts installed across the Jl. Tol Jakarta Merak into the upper reaches of the Kembangan and Sepak rivers. The Project Area is divided into four (4) sub-basins with a total catchment area of 157 ha. Division of the catchment area, location of the drainage channels and culverts are shown in Fig. 4.3.

Sub-basin (1) covering a south-east high land of 50 ha is drained by the channel No. 1. Its downstream sub-basin (2) of 12 ha is drained through the channel No. 2. The south-west sub-basin (3) covering a high land of 43 ha is discharged to the low-lying flood plain of sub-basin (4) through the channel section No. 4. Sub-basin (4) has an indigenous catchment area of 52 ha. Storm water of the sub-basins (3) and (4) is drained through the channel No. 4 and six (6) culverts across the Jl. Tol Jakarta Merak.

The main features of the existing drainage channels are shown below.

Channel No.	Catchment Area (ha)	Length (m)	Top Width (m)	Bottom Width (m)	Depth (m)	Channel Condition
1	50	1,247	1.33 - 3.10	0.60 - 2.00	0.60 - 1.60	Earth
2	54	178	3.00	2.40	0.95	Earth
3	43	1,085	0.50 - 1.21	0.40 - 0.50	0.65 - 0.71	Earth
4	107	166	1.27	0.80	0.60	Earth
Total	157	2,676				

(2) Existing Flow Capacity of Channel and Culverts

The total drainage basin covers 157 ha. Hence, design flood frequency of five (5) years is applied based on the guidelines of the Government of Indonesia. The design flood discharge was estimated by using the Rational Formula.

The flow capacity of the existing channel was compared with its design flood discharge. It is found out that the flow capacity of the existing channels is insufficient in all channel sections: channel No. 1, 2, 3 and 4.

However, the downstream reaches of the channel No. 2 has already been improved. It has sufficient capacity to meet a 5-year floods.

The size of the existing six (6) culverts installed across the Jl. Tol Jakarta Merak is as follows.

- ø0.40 m x 1 place, ø0.85 m x 2 place, ø1.00 m x 3 place

The flow capacity of these culverts are very small compared to the 5-year flood discharge. Moreover, the existing culverts are almost clogged by sediments. It is considered difficult to maintain their full flow capacity.

(3) Proposed Drainage System

The Outer Ring Road will intersect the Project Area in future. After the completion of the Road, the existing sub-basins (2) and (4) will

be divided into three (3) sub-basins (2), (4) and (5) as shown in Fig. 4.4.

The existing drainage channels of No. 1, No. 2 and No. 3 will be widened/deepened to improve the drainage conditions of sub-basins (1), (2) and (3) respectively.

For drainage of the sub-basins (4) and (5), a new drainage channel will be excavated along the Jl. Tol Jakarta Merak to convey storm water run-off toward east to the Periggiligan channel.

Location of the proposed drainage system is shown in Fig. 4.4.

The catchment area and design discharge of the proposed channel is shown below.

Channel No.	1	2	3	4	5
Catchment Area (ha)	50	54	43	94	103
Design Discharge (m^3/s)	5.7	5.9	5.0	10.8	10.9

(4) Profile and Cross Section of Proposed Channel

The channel bed gradient, width and depth of the proposed channels are summarized below.

Channel No.	1	2	3	4	5	Total
Length (m)	1,068	289	1,034	600	510	3,501
Gradient	1/360	1/360	1/830	1/910	1/910	
Top Width (m)	3.5	3.5	5.0	8.0	8.0	
Bottom Width (m)	2.0	2.0	4.0	6.8	6.8	
Depth (m)	1.3	1.3	1.0	1.2	1.2	

(5) Proposed Construction Works and Land Acquisition

Major construction works of the proposed channel improvement are as follows.

Channel excavation	:	12,700 m^3
Embankment	;	3,500 m^3
Revetment works	:	7,002 m, 13,100 m^2
Bridge construction	:	14 places
Inspection road pavement	:	1,399 m, 4,200 m^2
Concrete wall	:	650 m

The required land acquisition area is estimated to be 23,100 m^2 of residential area.

4.4 Cost Estimate

The project cost was estimated in the same manner of Supporting Report, II-1, Cengkareng West Urban Drainage, Chapter 4.

The total project cost amounts to Rp. 4,412 million at July, 1990 prices as given below.

(Unit: million Rp.)

Item	Cost	Remarks
I. Direct Construction	1,565	
II. Land Acquisition	2,474	
III. Engineering Service	156	I x 10%
IV. Administration	61	(I + II) x 1.5%
V. Physical Contingency	156	I x 10%
Total	4,412	

Its break-down by construction work is shown in Table 4.1.

Table 4.1 Break-down of Project Cost

Item	Cost (million Rp.)	Remarks
I. Direct Construction	1,564.7	
Channel Excavation	46.1	
Embankment	15.6	
Revetment	1,174.4	
Bridge Construction	259.7	
Inspection Road	64.7	
Concrete Wall	4.2	
II. Land Acquisition/Compensation	2,473.9	
Land Acquisition	2,444.2	
Compensation	29.7	
III. Engineering Service	156.5	I x 10%
IV. Administration	60.6	(I + II) x 1.5%
V. Physical Contingency	156.5	I x 10%
Total	4,412.2	

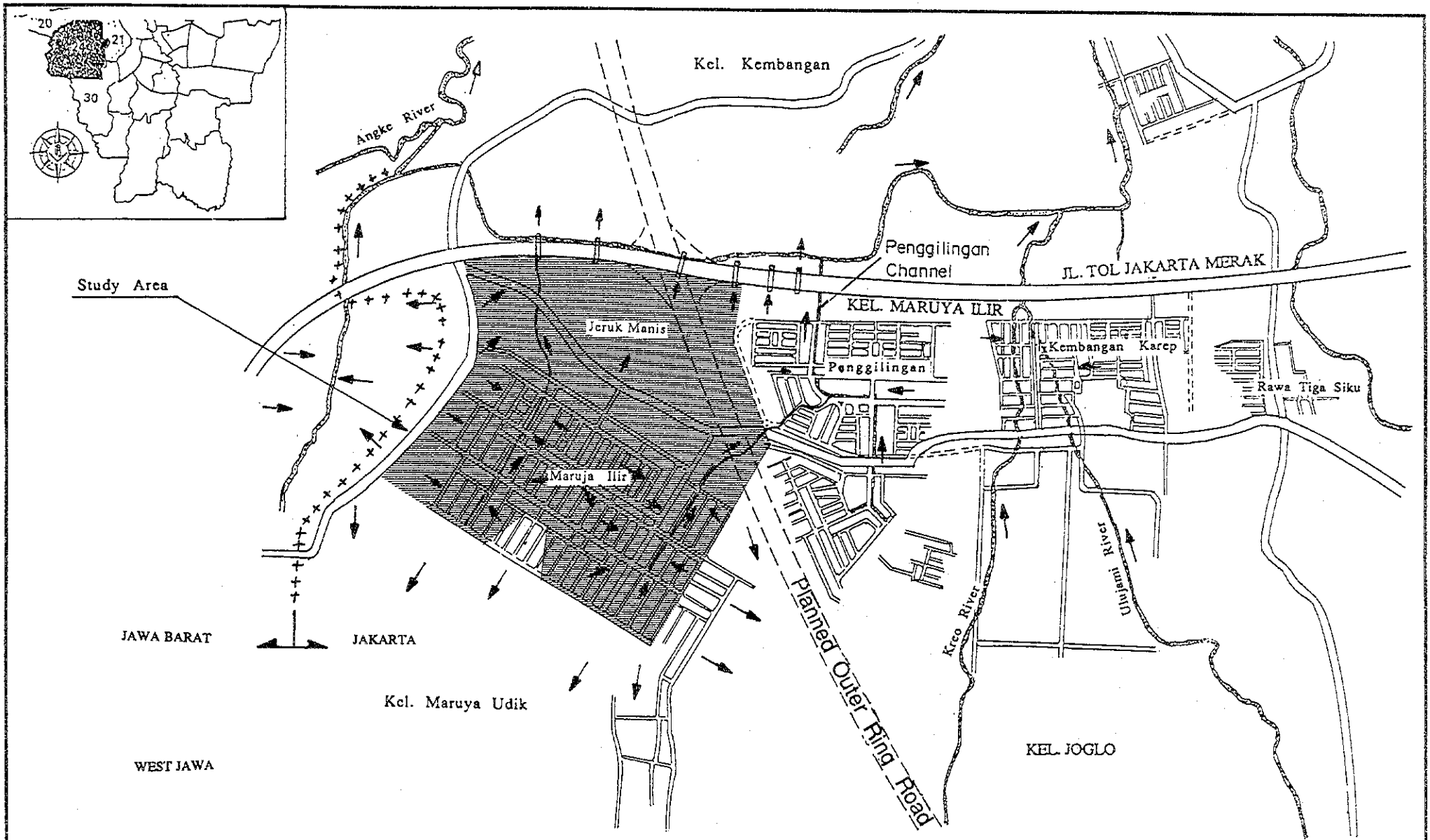
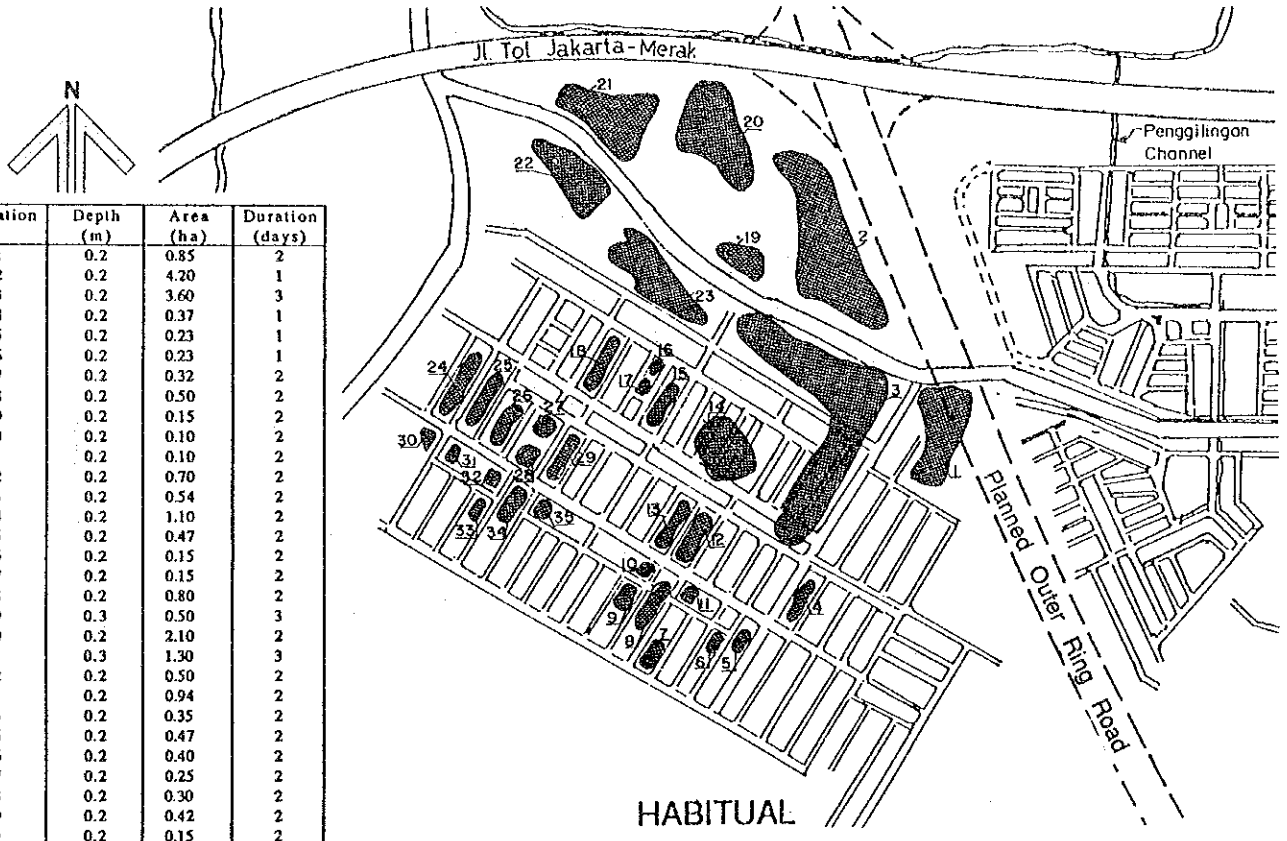
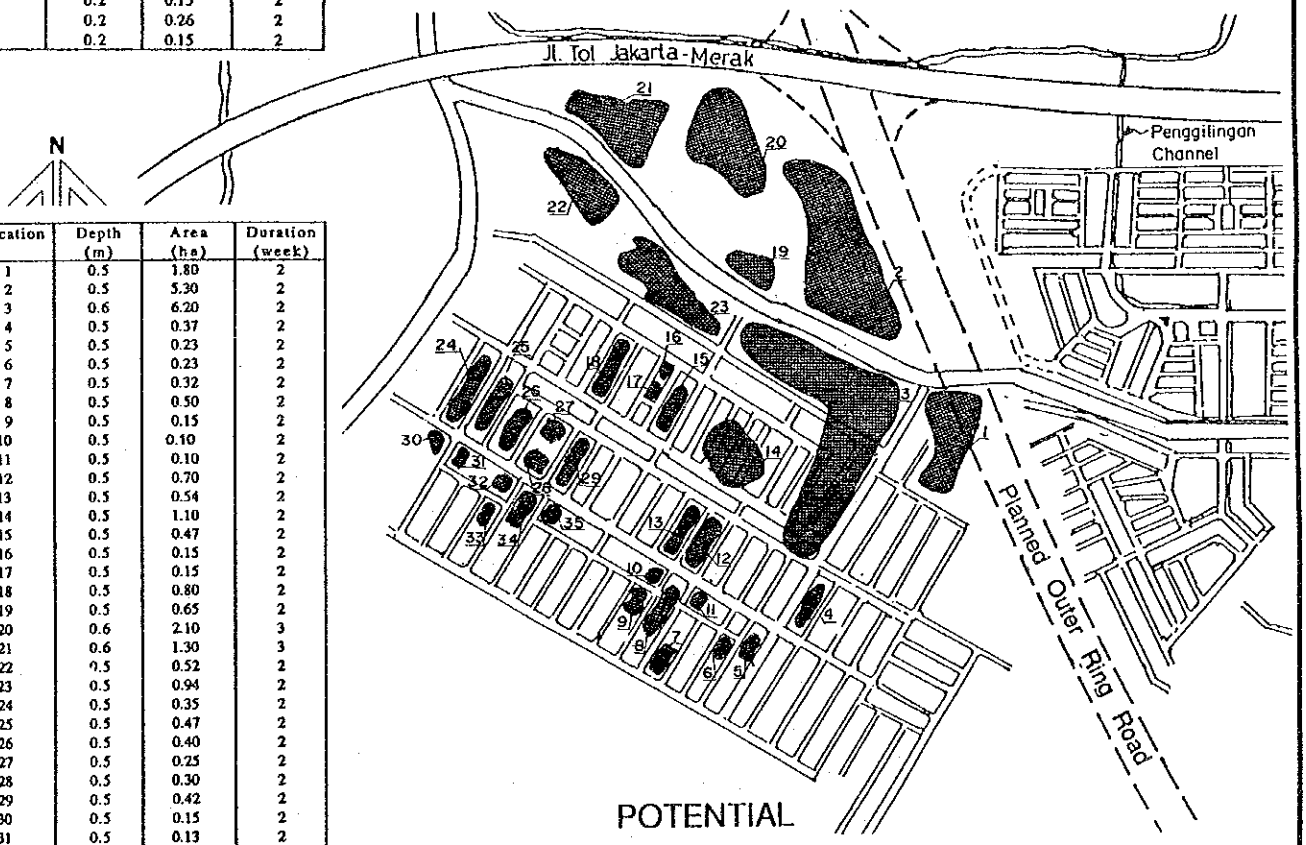


FIG. 4.1 LOCATION OF PROJECT AREA

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA



Location	Depth (m)	Area (ha)	Duration (days)
1	0.2	0.85	2
2	0.2	4.20	1
3	0.2	3.60	3
4	0.2	0.37	1
5	0.2	0.23	1
6	0.2	0.23	1
7	0.2	0.32	2
8	0.2	0.50	2
9	0.2	0.15	2
10	0.2	0.10	2
11	0.2	0.10	2
12	0.2	0.70	2
13	0.2	0.54	2
14	0.2	1.10	2
15	0.2	0.47	2
16	0.2	0.15	2
17	0.2	0.15	2
18	0.2	0.80	2
19	0.3	0.50	3
20	0.2	2.10	2
21	0.3	1.30	3
22	0.2	0.50	2
23	0.2	0.94	2
24	0.2	0.35	2
25	0.2	0.47	2
26	0.2	0.40	2
27	0.2	0.25	2
28	0.2	0.30	2
29	0.2	0.42	2
30	0.2	0.15	2
31	0.2	0.13	2
32	0.2	0.20	2
33	0.2	0.15	2
34	0.2	0.26	2
35	0.2	0.15	2



Location	Depth (m)	Area (ha)	Duration (week)
1	0.5	1.80	2
2	0.5	5.30	2
3	0.6	6.20	2
4	0.5	0.37	2
5	0.5	0.23	2
6	0.5	0.23	2
7	0.5	0.32	2
8	0.5	0.50	2
9	0.5	0.15	2
10	0.5	0.10	2
11	0.5	0.10	2
12	0.5	0.70	2
13	0.5	0.54	2
14	0.5	1.10	2
15	0.5	0.47	2
16	0.5	0.15	2
17	0.5	0.15	2
18	0.5	0.80	2
19	0.5	0.65	2
20	0.6	2.10	3
21	0.6	1.30	3
22	0.5	0.52	2
23	0.5	0.94	2
24	0.5	0.35	2
25	0.5	0.47	2
26	0.5	0.40	2
27	0.5	0.25	2
28	0.5	0.30	2
29	0.5	0.42	2
30	0.5	0.15	2
31	0.5	0.13	2
32	0.5	0.20	2
33	0.5	0.15	2
34	0.5	0.26	2
35	0.5	0.15	2

FIG. 4.2 HABITUAL AND POTENTIAL INUNDATION AREA (MARUJA ILIR DRAINAGE IMPROVEMENT)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

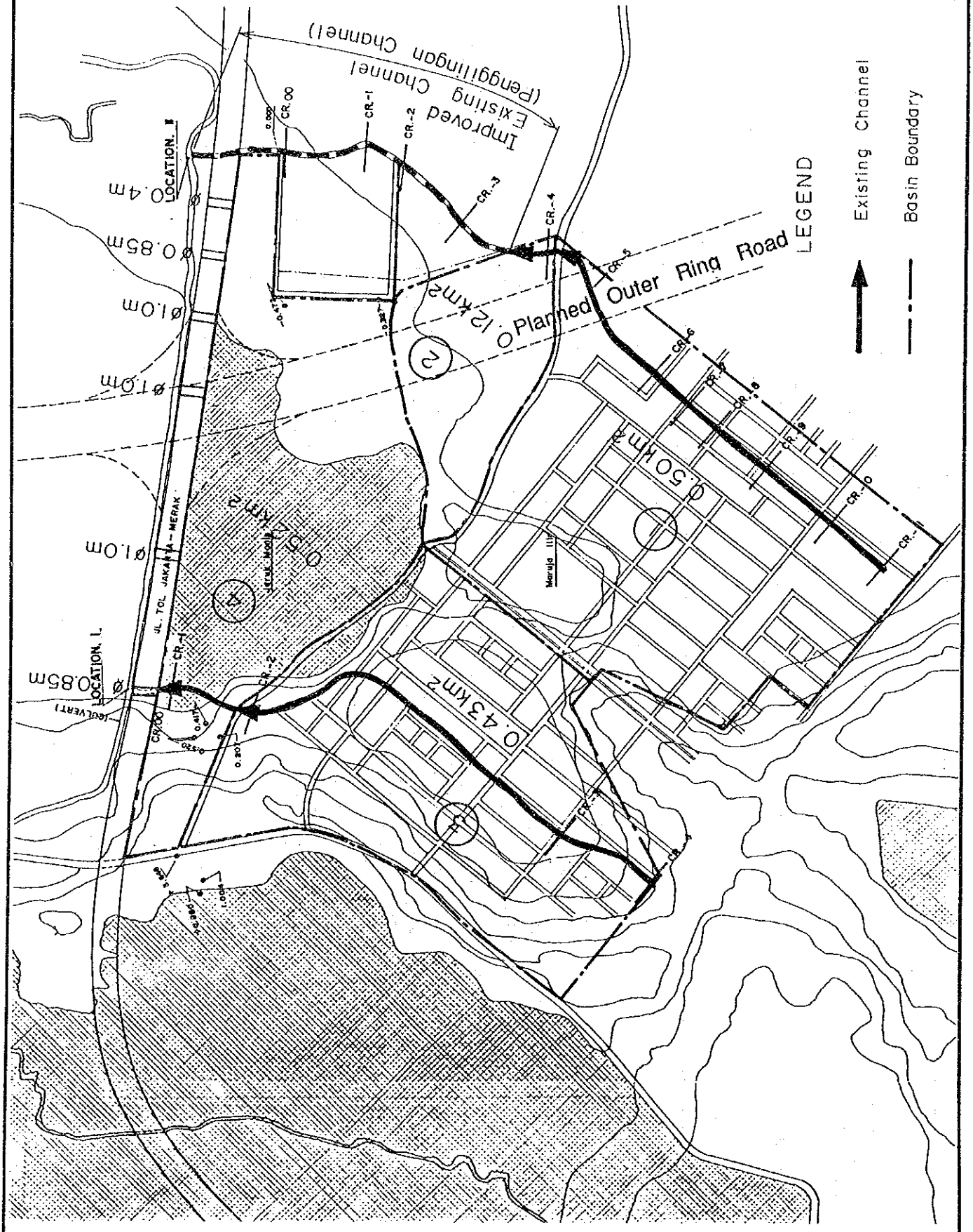


FIG. 4.3 EXISTING DRAINAGE SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

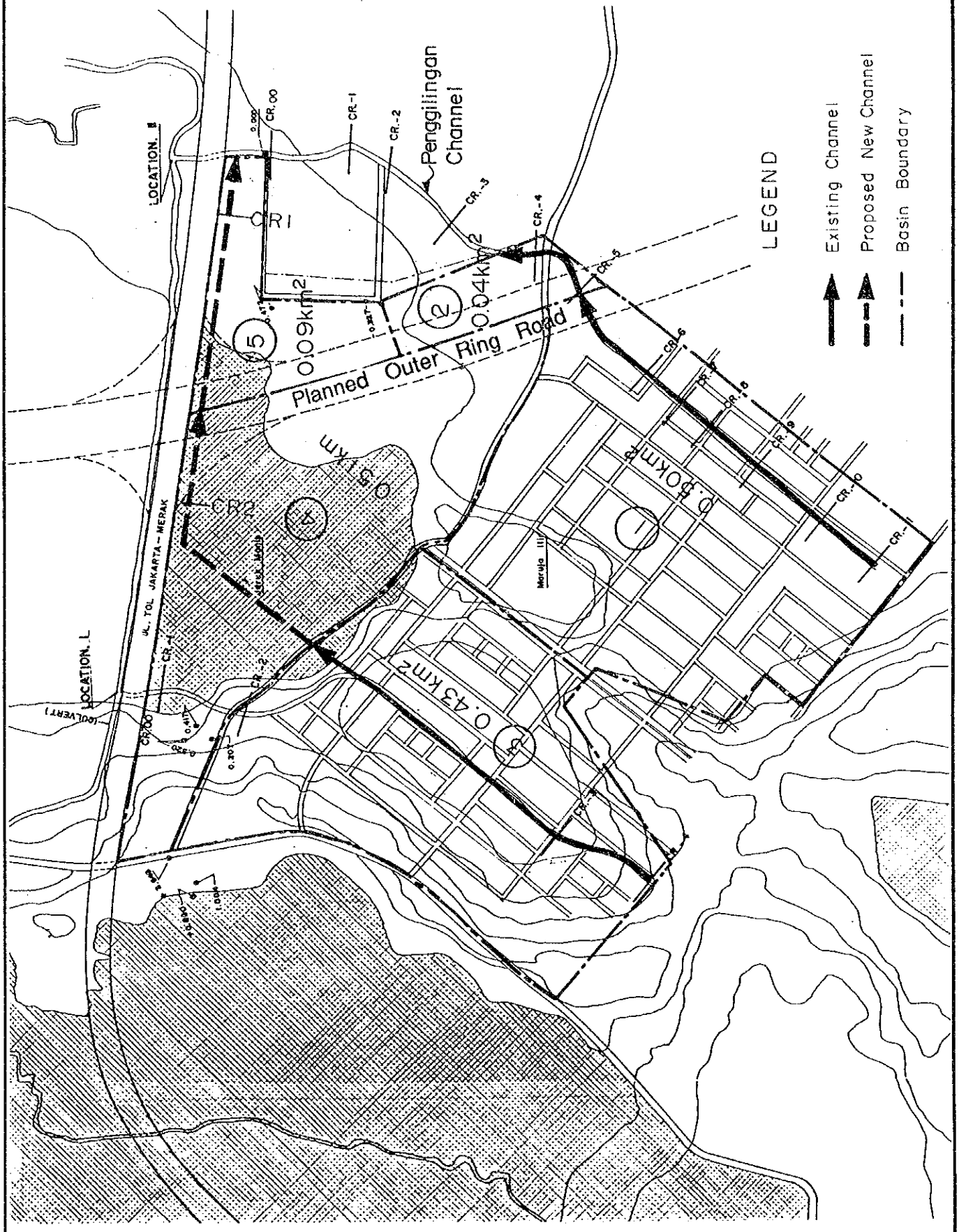


FIG. 4. 4 PROPOSED DRAINAGE SYSTEM

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 5 RECOMMENDATION

5.1 Immediate Project Implementation

An immediate implementation of the project in Cengkareng west and other areas is recommended in consideration to the progressing and future land development activities and the resultant increase in rainfall runoff.

In order to facilitate timely implementation of the project in 1992, the necessary financial procurement shall be made at the earliest. The negotiation for procurement of foreign loans, if necessary, shall be accomplished by 1992 so that the project implementation could be commenced by 1992.

III. SEWERAGE

III. SEWERAGE

Chapter 1 SEWERAGE SERVICE AREA

1.1 General

The Project Area, located in the central area of DKI Jakarta, covers 47 Kelurahans with total administrative area of 4,269 ha. The existing population in 1988 is 1,548,500.

The ground elevation of northern part of the Project Area ranges from P.P. + 1.2 m to P.P. + 2.5 m with its surface slope ranging from 0.2 to 0.3 m per thousand meters declining toward the sea. While in the southern part, the ground elevation ranges from P.P. + 4.0 m to P.P. + 13.5 m with surface slope of one (1) to two (2) meters per thousand meters.

The proposed sewerage service area also encompasses the whole project area but excludes the following areas:

- Banjir Canal of 146 ha, Ciliwung River of 42 ha, Merdeka Park of 104 ha, Grogol River of 22 ha, Melati Pond of 4 ha, reserved area along the existing railway of 29 ha and reserved area of the Laks. Re. Martadinata road of 75 ha.

Hence, the sewerage service area covers 3,847 ha with a total population of 1,659,000 in 2000.

1.2 Division of Sewerage Zone

(1) Regional Distribution of Specific Wastewater Discharge

Specific wastewater discharge by Kelurahan in the Project Area ranges from 31.0 m^3/d/ha in Kel. Gondangdia to 256.7 m^3/d/ha in Kel. Keagungan with an average of 89.5 m^3/d/ha.

The included 47 Kelurahans are classified into the following three (3) groups according to the magnitude of their specific wastewater discharge.

Group I : Kelurahans with specific wastewater discharge less than 50 m^3/d/ha (8 Kelurahans)

Group II : Kelurahans with specific wastewater discharge in between 51 m^3/d/ha and 100 m^3/d/ha (15 Kelurahans)

Group III : Kelurahans with specific wastewater discharge more than 101 m^3/d/ha (24 Kelurahans)

Regional distribution of the specific wastewater discharge is shown in Fig. 1.1.

(2) Division of Sewerage Zone

The sewerage zone of 3,847 ha is divided into seven (7) sub-zones as shown in Fig. 1.1.

The division is made based on regional distribution of specific wastewater discharge, main road networks, rivers, land slope and administrative boundary.

Sewerage service area and served population in 2000 by sub-zone are as follows:

Sub-zone	Service Area (ha)	Served Population
A	754	216,300
B	248	150,900
C	212	26,800
D	331	99,600
E	1,493	820,600
F	281	131,500
G	528	213,300
Total	3,847	1,659,000

Its break-down by Kelurahan is shown in Chapter 1 in Appendix of Feasibility Study.

1.3 Conventional and Interceptor Areas

The proposed sewerage service area of 3,847 ha is covered by two (2) sewage collection systems: conventional sewage collection system and interceptor sewage collection system.

Conventional sewage collection system collects both toilet waste and gray water through a complete sewer pipe networks consisting of house connection, main, secondary and tertiary sewers with lift pumps, manholes and other appurtenances.

This system will be applied for the following areas in principle.

(i) Commercial and institutional areas located along main roads.
(2) Residential areas where redevelopment has been completed and besides, the existing road width is wider than 2 m, which is the minimum width required for laying sewer lines and other appurtenances.

While, the interceptor system will collect only gray water utilizing partially developed sewage collection system installed along main roads. Toilet waste in interceptor areas will be treated by on-site septic tank systems.

The interceptor system will cover the following areas in principle.

(i) High population density Kampung areas as there exist no road networks wide enough for sewer installation

(ii) Residential areas where land readjustment has not been completed even where the existing road width is more than 2 m in order to avoid future sewer reconstruction.

The proposed conventional collection system covers 2,285 ha or 59% of the total service area of 3,847 ha. The population served in 2000 by this system is estimated to be 765,000.

While, the interceptor system covers 1,562 ha or 41%. The population served in 2000 by this system is 894,000.

Service area and served population in 2000 by sub-zone and by collection system are shown in Table 1.1. Both the conventional and interceptor areas are delineated as shown in Fig. 1.2. Areas excluded from the service area are also delineated in Fig. 1.2.

Table 1.1 Service Area and Served Population in 2000 by Sub-zone

Sub-Zone	Area (ha)					Population (person) in 2000				
	Total	Conventional		Interceptor		Total	Conventional		Interceptor	
A	754	558	0.74	196	0.26	216,300	131,000	0.61	85,300	0.39
B	248	124	0.50	124	0.50	150,900	72,600	0.48	78,300	0.52
C	212	199	0.94	13	0.06	26,800	24,600	0.92	2,200	0.08
D	331	205	0.62	126	0.38	99,600	60,200	0.60	39,400	0.40
E	1,493	612	0.41	881	0.59	820,600	232,200	0.28	588,400	0.72
F	281	149	0.53	132	0.47	131,500	69,000	0.52	62,500	0.48
G	528	438	0.83	90	0.17	213,300	175,400	0.82	37,900	0.18
Total	3,847	2,285	0.59	1,562	0.41	1,659,000	765,000	0.46	894,000	0.54

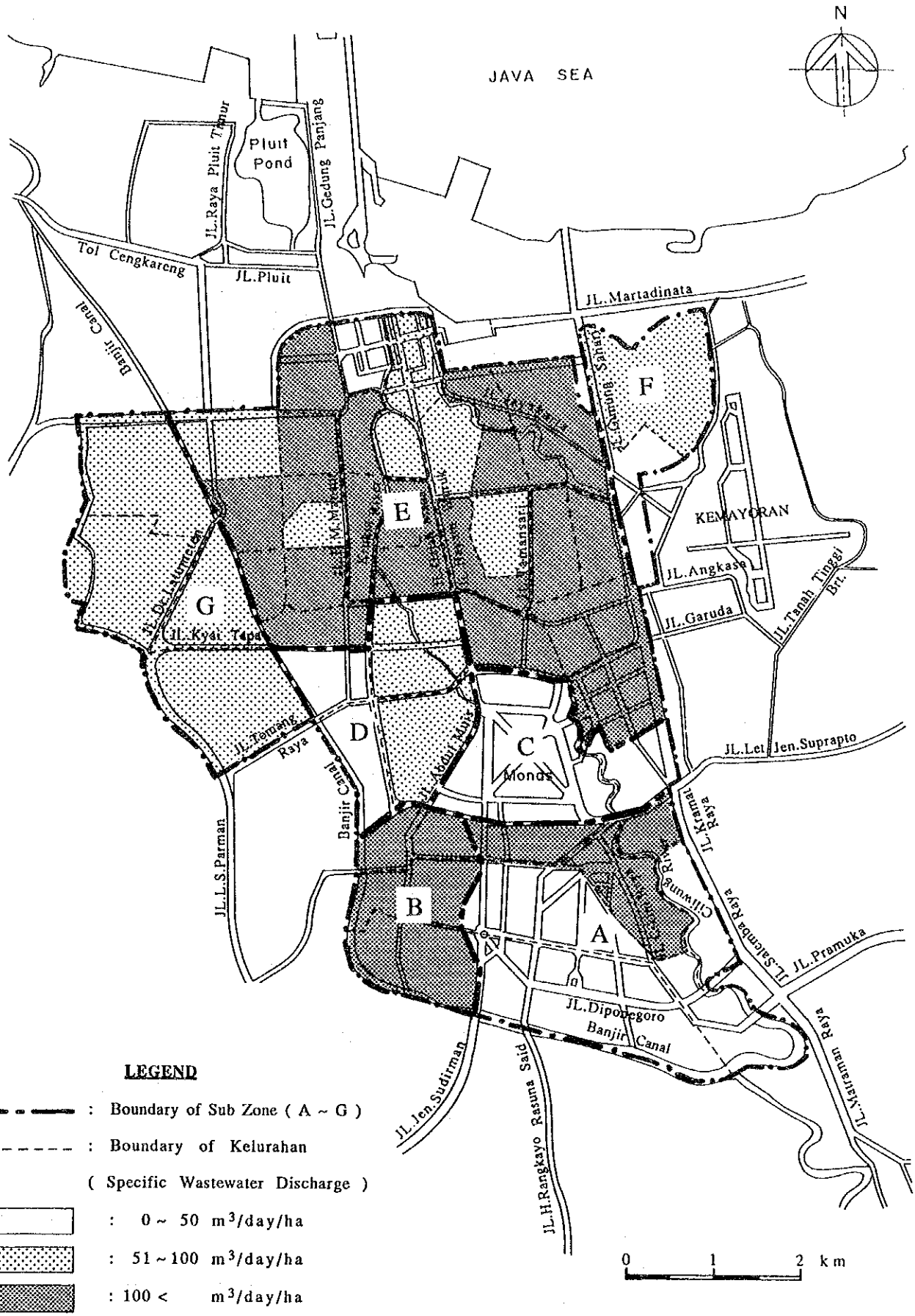


FIG. 1.1 SPECIFIC WASTEWATER DISCHARGE DISTRIBUTION AND SEWERAGE SUB-ZONES OF PROJECT AREA

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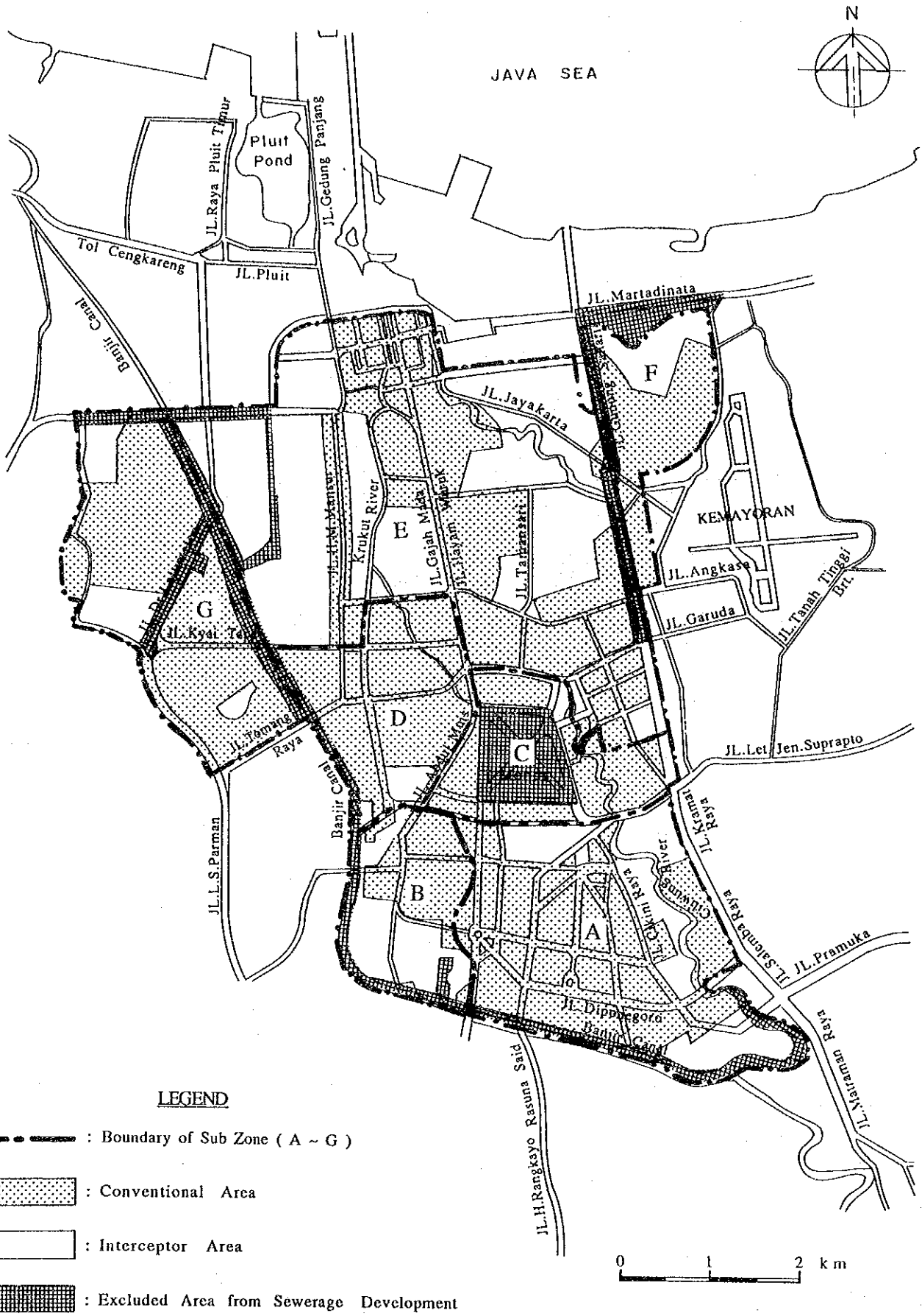

FIG. 1.2 DELINEATED CONVENTIONAL AND INTERCEPTOR AREA

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

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Chapter 2 DESIGN WASTEWATER DISCHARGE

2.1 Specific Wastewater Generation

A considerable portion of the toilet waste in the Project Area is infiltrated to natural soil by septic tank/leaching system. In this Study, wastewater generation is defined as wastewater including whole toilet waste. While, wastewater discharge is defined as wastewater discharged into ditches, canals or rivers from residence.

Specific wastewater generation (wastewater generation per hectare per day) including domestic, commercial and institutional, and industrial wastes varies depending on household income level and land use pattern of the objective area.

Wastewater generation of the Project Area in 1988 and 2010 by Kelurahan were estimated in Appendix D, Master Plan Report. Wastewater generation in 2000 by Kelurahan is obtained by interpolating those in 1988 and 2010.

Specific wastewater generation by sewerage sub-zone in 1988, 2000 and 2010, obtained by dividing the respective wastewater generation of each Kelurahan by its sewerage service area, are shown in Table 2.1.

2.2 Design Wastewater Discharge

2.2.1 General

According to the Master Plan, wastewater of the JSSP Area will be transferred to the Pluit Pond treatment plant by the conveyance sewer after full completion of it. Consturction of the conveyance sewer is expected to complete by the year 2000. Hence, design wastewater discharge of the conveyance sewer shall include wastewater discharge of the JSSP Area.

2.2.2 Design Wastewater Discharge of Collection and Conveyance Sewers

Size of collection and conveyance sewers is designed to meet the possible maximum wastewater discharge in the future since flow capacity of collection and conveyance sewers cannot be enlarged in stages. Hence, design wastewater discharge of collection and conveyance sewers is determined to be wastewater generation in 2010 plus 10% groundwater infiltration.

Design wastewater discharge for collection and conveyance sewers by sub-zone are shown below.

Design Wastewater Discharge by Sub-zone in the year 2010

(Unit : m^3/d)

Sub-zone	Wastewater	Groundwater	Total
A	51,044	5,104	56,148
B	29,392	2,939	32,331
C	11,349	1,135	12,484
D	27,824	2,782	30,606
E	185,062	18,506	203,568
F	25,900	2,590	28,490
G	44,649	4,465	49,114
JSSP Area	135,986	13,599	149,585
Total	511,206	51,120	562,326

2.2.3 Design Wastewater Discharge for Treatment Plant

Treatment plant is designed for mid-term period since its capacity can be expanded according to increase in wastewater discharge in the Project Area.

Design wastewater discharge for treatment plant is determined based on the wastewater generation in 2000. However,

(1) Toilet waste in the interceptor areas is excluded since it is infiltrated to natural soil.

(2) Groundwater infiltration equivalent to 10% of wastewater discharge is added.

Design wastewater discharge of the treatment plant shall also include wastewater discharge of the JSSP Area.

The design wastewater discharge to treatment plant by sewerage sub-zone, along with its break-down between conventional and interceptor areas, is shown in Table 2.2.

Table 2.1 Specific Wastewater Generation by Sub-zone

Sewerage Sub-zone	Area (ha)	Specific Wastewater Generation (m^3/d/ha)		
		1988	2000	2010
A	754	36.3	52.4	67.2
B	248	64.6	87.7	109.1
C	212	12.2	24.7	36.3
D	331	38.4	59.0	78.1
E	1,493	78.1	98.0	116.5
F	281	42.5	56.5	69.4
G	528	54.3	65.1	75.1
Total	3,847	56.1	73.5	89.5

Table 2.2 Design Wastewater Discharge by Sub-zone for Treatment Plant Design

Sewerage Sub-zone	Design Wastewater Discharge (m^3/d)				
	Conventional Area	Interceptor Area	Sub-total	Groundwater Infiltration	Total
A	24,090	13,724	37,814	3,781	41,595
B	11,386	10,478	21,864	2,186	24,050
C	6,857	562	7,419	742	8,161
D	12,753	7,441	20,194	2,020	22,214
E	44,120	98,268	142,388	14,239	156,627
F	11,197	8,706	19,903	1,990	21,893
G	31,858	6,012	37,870	3,787	41,657
JSSP Area	-	-	113,450	11,350	124,800
Total	142,261	145,191	400,902	40,095	440,997

Chapter 3 ALTERNATIVE STUDY OF TREATMENT PLANT

3.1 General

From economic viewpoint, as the wastewater treatment system, only aerated lagoon is applied in this alternative study. This is because the land space required for this system is available along the north coast area of Jakarta Bay. The following three (3) available alternative sites are compared for the provision of aerated lagoon treatment plant (Ref. Fig. 3.1 ~ Fig. 3.3).

- Pluit Pond
- Coastal Area in Kel. Kamal Muara
- Sea area near-by Pluit Pond

3.2 Design Criteria

The respective alternative aerated lagoon treatment plants are designed based on the following design criteria.

3.2.1 Design Flow

Daily average wastewater discharge including groundwater infiltration (10%) in the year 2000 is used for design of the treatment plant. The design flow is 441,000 m^3/d including the wastewater of 124,800 m^3/d of JSSP Area.

3.2.2 Design Influent and Effluent Water Quality

Wastewater quality of a mixture of toilet waste and gray water in the future is estimated to be 224 mg/l as BOD (Refer to Appendix D, Table D.8, Master Plan Study). Design influent water quality is determined to be 200 mg/l as BOD considering the dilution effects of groundwater infiltration.

Design effluent water quality is determined to be 30 mg/l considering the existing river water quality and environmental water quality standards of rivers in the Project Area.

3.2.3 Treatment Plant

Treatment plant consisting of aerated lagoon and facultative/anaerobic pond is applied.

Design detention time of the aerated lagoon is determined to be more than two (2) days with an expected BOD reduction of 85%. Design water depth in the lagoon is 5.0 m.

Design detention time of more than four (4) days is applied for the facultative/anaerobic pond to remove suspended organic matters by sedimentation and to treat them under anaerobic condition.

3.3 Alternative Plan A

3.3.1 Proposed Treatment Plant

The aerated lagoon treatment plant is proposed in the Pluit Pond which lies 1.0 km north of the Project Area. The pond with a storage capacity of 2,240,000 m^3 is used for flood control at present.

The pond will be used for a multipurpose of flood control and wastewater treatment. The pond area of 80 ha is divided into two (2) parts by embankment. The north-east part of 24 ha is used as aerated lagoon and the remaining 56 ha as facultative and anaerobic pond.

The wastewater collected in the Project Area is transported by a conveyance sewer to the southern edge of the Pluit Pond by free flow. Elevation of the conveyance sewer reaches 17 m deep from the ground surface at this location.

An inflow pump station of capacity 7.6 m^3/s is installed at the downstream end of the conveyance sewer to lift up the wastewater. An open ditch of 500 m length is constructed to introduce the pumped wastewater into the aerated lagoon. The aerated lagoon area is dredged by 340,000 m^3 to obtain the required storage capacity. Aerator of 24 units are installed. Moreover, drying beds for sludge treatment are constructed at the north on-land area

of the Pluit Pond. No pond reclamation is required. Layout of the treatment plant is shown in Fig. 3.1.

3.3.2 Estimated Cost

The objective facilities and works for cost comparison in this alternative are as follows.

(1) Inflow pump station
(2) Open ditch
(3) Treatment plant

The estimated direct construction cost and annual O&M cost are Rp. 40.7 billion and Rp. 8.9 billion per annum respectively.

3.4 Alternative Plan B

3.4.1 Proposed Treatment Plant

The aerated lagoon treatment plant is planned at the northern coast area of Kel. Kamal Muara (Ref. Fig. 3.2). It is 9.2 km away from the Project Area. The existing land use of the area is swamp and fish pond. The required land space is 80 ha. The aerated lagoon and facultative/anaerobic pond is constructed by excavation of this swamp and fish pond area. Total excavation volume is 3.5 million m^3.

A booster pump station of 7.6 m^3/s capacity and 35 m of effective hydraulic head is constructed at the southern edge of the Pluit Pond to further transport the wastewater to the aerated lagoon through a conveyance force main. The force main of 2.1 m diameter is laid along the toll road "Jl. Prof. Dr. Sediyatmo" for 9.2 km distance. In the aerated lagoon, aerator of 24 units are installed. Moreover, drying beds of sludge treatment are constructed along the banks of the pond.

3.4.2 Estimated Cost

The objective facilities and works for cost comparison in this alternative are as follows.

(1) Booster pump station
(2) Conveyance force main
(3) Treatment plant

The estimated direct construction cost, land acquisition cost and annual O&M cost are Rp. 89.2 billion, Rp. 5.6 billion and Rp. 10.2 billion per annum.

3.5 Alternative Plan C

3.5.1 Proposed Treatment Plant

The aerated lagoon treatment plant is planned in the sea nearby the Pluit Pond (Ref. Fig. 3.3). The aerated lagoon and facultative/anaerobic pond of fresh water are created by construction of polder embankments. The total area of the aerated lagoon and facultative/anaerobic pond is 80 ha. Both the aerated lagoon and facultative/anaerobic pond are excavated to obtain the required storage capacity. The required excavation volume is 3.2 million m^3. Total length of the polder embankment is 3.9 km.

Wastewater conveyed from the Project Area to the southern edge of the Pluit Pond is pumped up by a lift up pump station in the same manner as Alternative Plan A. The required pump capacity and effective hydraulic head are 7.6 m^3/s and 21 m respectively. An open ditch of 1.2 km and a box culvert of 0.3 km are constructed to convey the wastewater from the pump station to the aerated lagoon. In the aerated lagoon, aerator of 24 units are installed. Also, drying beds for sludge treatment are provided.

3.5.2 Estimated Cost

The objective facilities and works for cost comparison in this alternative are as follows.

(1) Lift up pump station
(2) Open ditch & box culvert
(3) Treatment plant

The estimated direct construction cost and annual O&M cost are Rp. 61.1 billion and Rp. 8.9 billion per annum respectively.

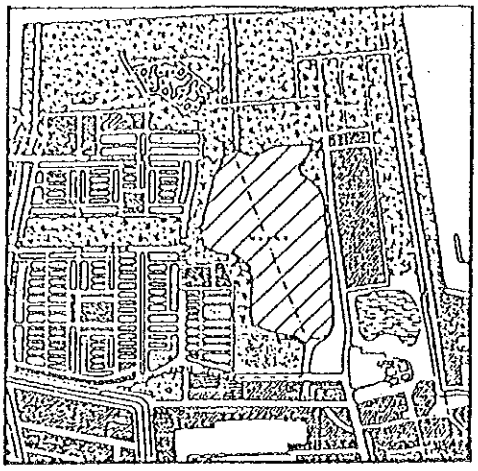
3.6 Comparative Evaluation

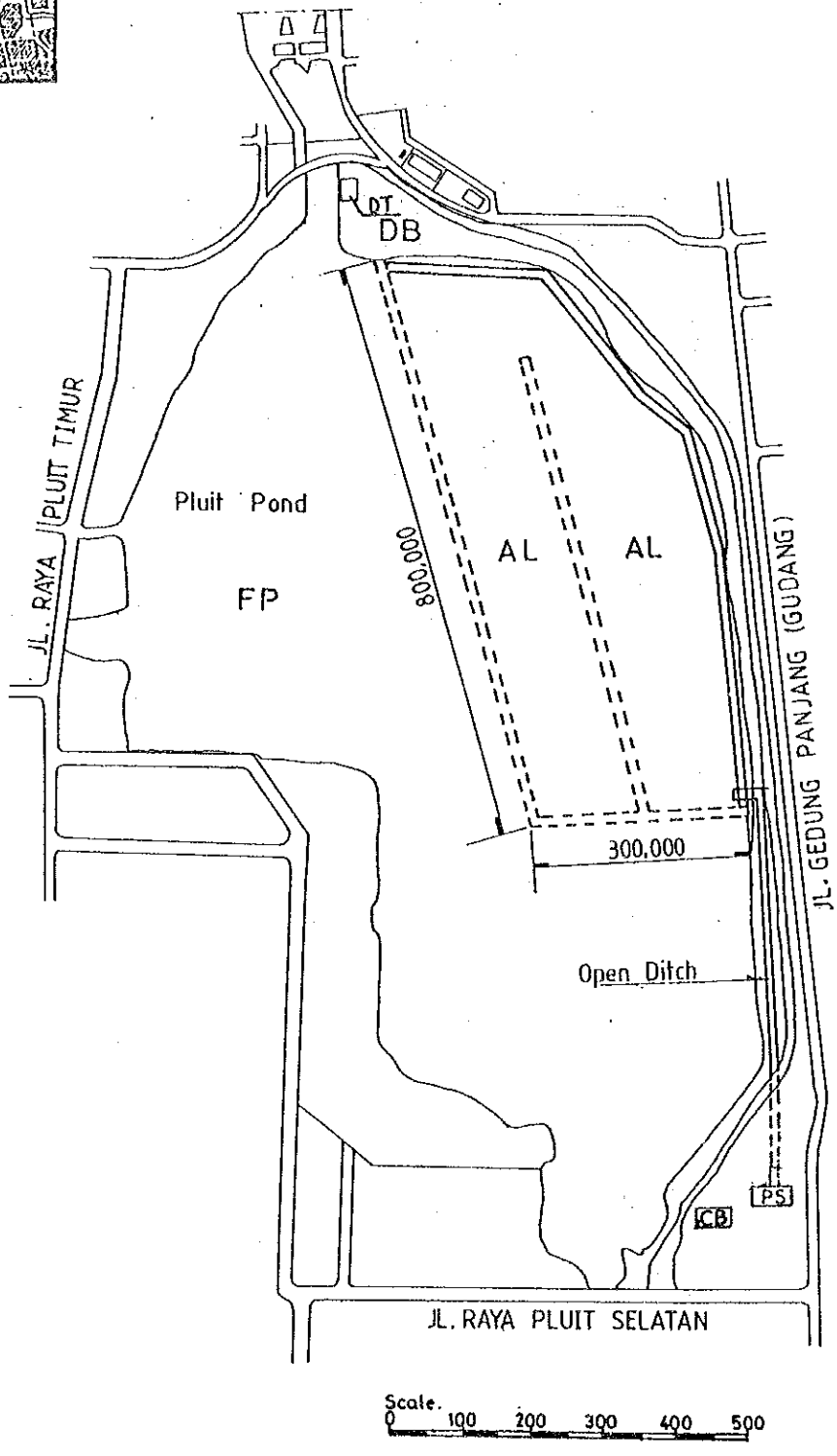
The construction costs, annual O&M costs and land acquisition costs of three (3) alternatives A, B and C are compared as below.

(Unit: Rp. billion)

	Alternative A	Alternative B	Alternative C
Construction Cost	40.7	89.2	61.1
Annual O&M Cost	8.9	10.2	8.9
Land Acquisition	-	5.6	-

As evident from the above cost comparative table, Alternative Plan A of aerated lagoon at existing Pluit Pond (ref. Fig. 3.1), is the most economical one and hence recommended.





LEGEND

PS	:	Pump Station
AL	:	Aerated Lagoon
FP	:	Facultative Pond
DT	:	Disinfiction Tank
DB	:	Drying Bed
CB	:	Control Building

FIG. 3.1 AERATED LAGOON IN THE PLUIT POND (ALTERNATIVE PLAN A)

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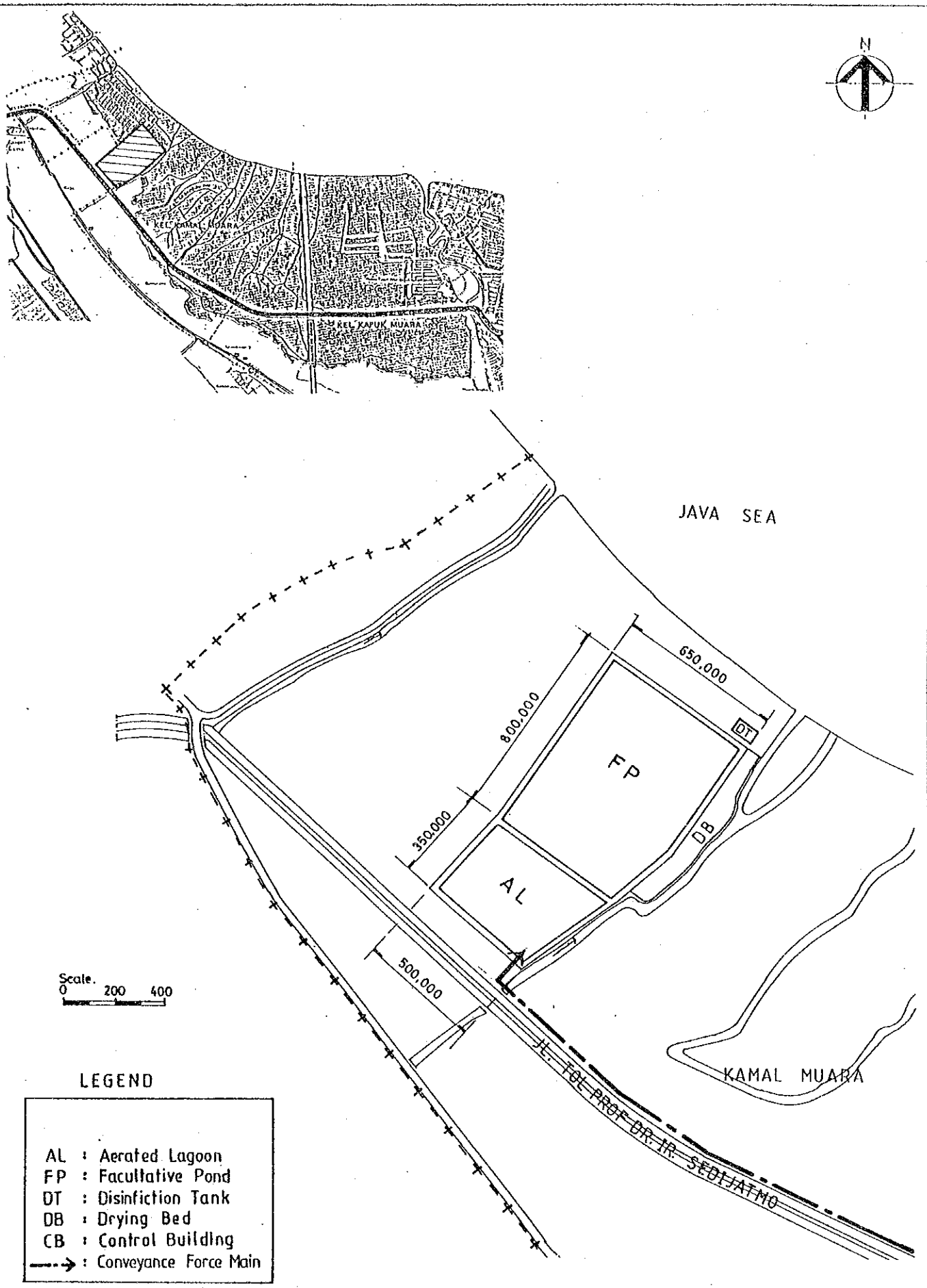

FIG. 3.2 AERATED LAGOON IN KEL. KAMAL MUARA (ALTERNATIVE PLAN B)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

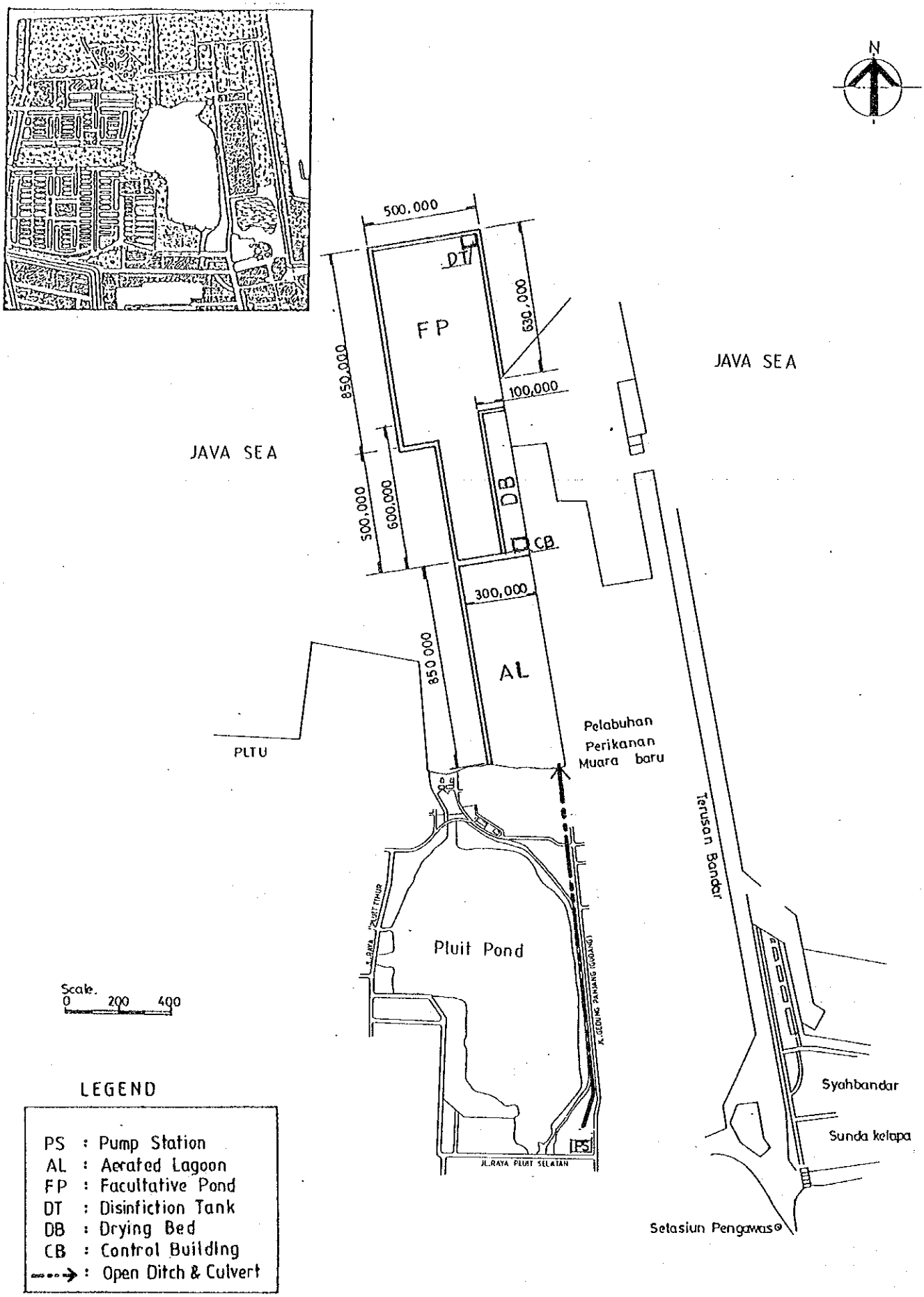

FIG. 3.3 AERATED LAGOON IN THE SEA (ALTERNATIVE PLAN C)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 4 ALTERNATIVE STUDY OF CONVEYANCE SEWER ROUTE

4.1 Optimum Construction Method

4.1.1 General

Three (3) typical construction methods : open trench method, shield tunnelling method and micro-tunnelling method, are applicable for sewer pipe laying in general.

Open trench method is generally applied for laying a shallow sewer. In this method, trench bracing and sheeting is usually required to prevent collapse of trench walls. Dewatering from trench is also required during rains or in case of high groundwater table.

Shield tunnelling method is widely applied for laying a deep sewer. Applicable diameter for shield tunnelling is larger than 1.35 m. Construction of a vertical shaft is required in every 1.0 to 2.0 km distance.

Micro-tunnelling method is usually applicable for construction of a short distance tunnel. A vertical shaft is required in every 80 m to 100 m distance.

However, micro-tunnelling method is considered not applicable for construction of the conveyance sewer of this project. This is because, construction of a number of vertical shafts will result in much traffic disturbance.

4.1.2 Comparison of Construction Method

Construction costs of open trench method and shield tunnelling method are compared in this section.

Unit construction costs of both methods vary according to magnitude of sewer diameter and earth covering depth. Hence, unit construction costs for sewer laying by open trench method and shield tunnelling method are

compared for the following four (4) cases of sewer diameter and four (4) cases of earth covering depth.

Sewer Diameter (mm)	Earth Covering Depth (m)
1,500	4
2,000	6
2,500	8
3,000	10

In this comparative study, it is assumed that :

(1) Work time for open trench method is limited to night-time only. Trench is covered by steel deck in day-time for traffic use.
(2) Steel sheet piles are used for sheeting trench walls.
(3) Reinforced concrete sewer pipe is laid in case of open trench method.
(4) Mechanical closed face type of shield machine is used in shield tunnelling method.
(5) Vertical shaft is constructed at intervals of 1.0 km.
(6) Concrete lining of shield tunnelling method forms a sewer pipe.

The estimated unit construction cost of both methods are summarized below.

(Unit: Rp.million/m)

Earth Covering Depth	Open Trench				Shield Tunnelling			
	4m	6m	8m	10m	4m	6m	8m	10m
ø 1,500mm	5.8	7.1	8.5	9.8	8.3	8.4	8.5	8.6
ø 2,000mm	7.1	8.5	9.9	11.2	9.6	9.7	9.8	9.9
ø 2,500mm	10.3	11.7	13.1	14.5	11.4	11.5	11.6	11.7
ø 3,000mm	12.5	14.0	15.0	16.9	13.5	13.6	13.7	13.8

Shield tunnelling method is more economical than open trench method in placing sewer pipe with a large diameter of 2,500-3,000 mm when earth covering depth is deeper than 6 m. While sewer diameter of less than 2,000 mm open trench method is more economical than shield tunnelling method when earth covering depth is shallower than 8 m.

4.2 Selection of Alternative Route

Two (2) conveyance sewer systems are considered as typical alternatives for this Project Area. One is of single conveyance sewer route. The other consists of two (2) conveyance sewer routes. The single conveyance route system requires larger pipe diameter and deeper sewer laying (deeper earth covering depth) compared to the double route system. However, total sewer line length of the single route system is shorter than that of the double route system.

Construction cost of sewer pipe varies according to its length, diameter and earth covering depth in general.

Length, pipe diameter and earth covering depth of secondary and tertiary sewers are considered constant regardless of conveyance sewer route.

Based on the above considerations, the integrated construction costs of conveyance sewer, and trunk and main sewers are estimated and compared for the above two (2) alternative systems. The alternative routes are selected, considering route length, land elevation and road condition as shown in Fig. 4.1 and Fig. 4.2.

4.3 Alternative A

This is single route system. The route A runs from Kel. Menteng located at southern edge of the Project Area to the Pluit Pond, mainly along the M.H. Thamrin Rd. and Gajah Mada Rd. (Ref. Fig. 4.1). Traffic condition of these two (2) roads are the heaviest in Jakarta city.

The proposed conveyance sewer has a total length of 10,340 m with its diameter ranging from 1,900mm to 2,900mm. The earth covering depth of the conveyance sewer is 5.6 m to 13.5 m.

The profile of the conveyance sewer is shown in supporting report, Chapter 4.

Shield tunnelling method is applied in cost estimation of Alternative A conveyance sewer, based on the fact that earth covering depth is deeper than 6.0 m for almost the whole sections of the conveyance sewer line.

Construction cost of the conveyance sewer of Alternative A is estimated at Rp. 117.0 billion at 1990 price.

The length of main and trunk sewers are 60,455 m and 17,530 m respectively. The sewer length with earth covering depth deeper than 6.0 m accounts for 24%, while the length shallower than 4.0 m a 44%. Open trench method is applied in cost estimation of the main and trunk sewers, considering the earth covering depth.

Total construction cost of the main and trunk sewers is estimated at Rp. 133.7 billion at 1990 price.

4.4 Alternative B

This is the double route system consisting of two (2) conveyance sewer lines. The Project Area is divided into two (2) parts by MH. Thamrin Rd. and Gajah Mada Rd. (Ref. Fig. 4.2). The conveyance sewer for the western part is proposed along Banjir Canal, KH. Mas. Mansur Rd., Cideng River, Jembatan Lima Rd., Pintu Besar Raya Rd. and Tongkol Rd., between Kel. Menteng and Pluit Pond. The conveyance sewer for the eastern part runs along Medan Merdeka Timur and the railway (Kebon Kelapa - Mangga Besar) from Cikini Raya Rd. to Roa Malaka where it connects to the western conveyance sewer.

The total length, diameter and earth covering depth of western and eastern conveyance sewers are respectively, 8,385 m and 9,300 m, 2,000 ~ 2,900 mm and 1,000 ~ 2,100 mm, and 9.3 ~ 14.0 m and 6.7 ~ 11.7 m.

The profiles of the western and eastern conveyance sewers are shown in supporting report, Chapter 4.

Shield tunnelling method is also applied in cost estimation of the conveyance sewers of both routes, considering their earth covering depth.

The total construction cost of the western and eastern conveyance sewers is estimated at Rp. 154.0 billion at 1990 price.

The total length of the main and trunk sewers of Alternative B is 77,250 m with a break-down of 70,580 m for the main sewer and 6,670 m for the trunk sewer. The length with earth covering depth deeper than 6.0 m account for 18%, while the length shallower than 4.0 m a 48%.

The total length of main and trunk sewers of this Alternative B is nearly equal to that of Alternative A. However, the diameter and earth covering depth of the main and trunk sewers are smaller or shallower than those of Alternative A.

Open trench method is applied in cost estimation of the main and trunk sewers, considering the earth covering depth.

Total construction cost of the main and trunk sewers is estimated at Rp. 119.0 billion at 1990 price.

4.5 Comparative Evaluation

The construction costs of conveyance sewer, and main and trunk sewers of Alternative A and Alternative B are compared as follows.

(Unit: Rp.billion)

	Alternative A	Alternative B
Conveyance Sewer	117.0	154.0
Main & Trunk Sewer	133.7	119.0
Total	250.7	273.0

Alternative A is more economical than Alternative B.
Alternative A is recommended.

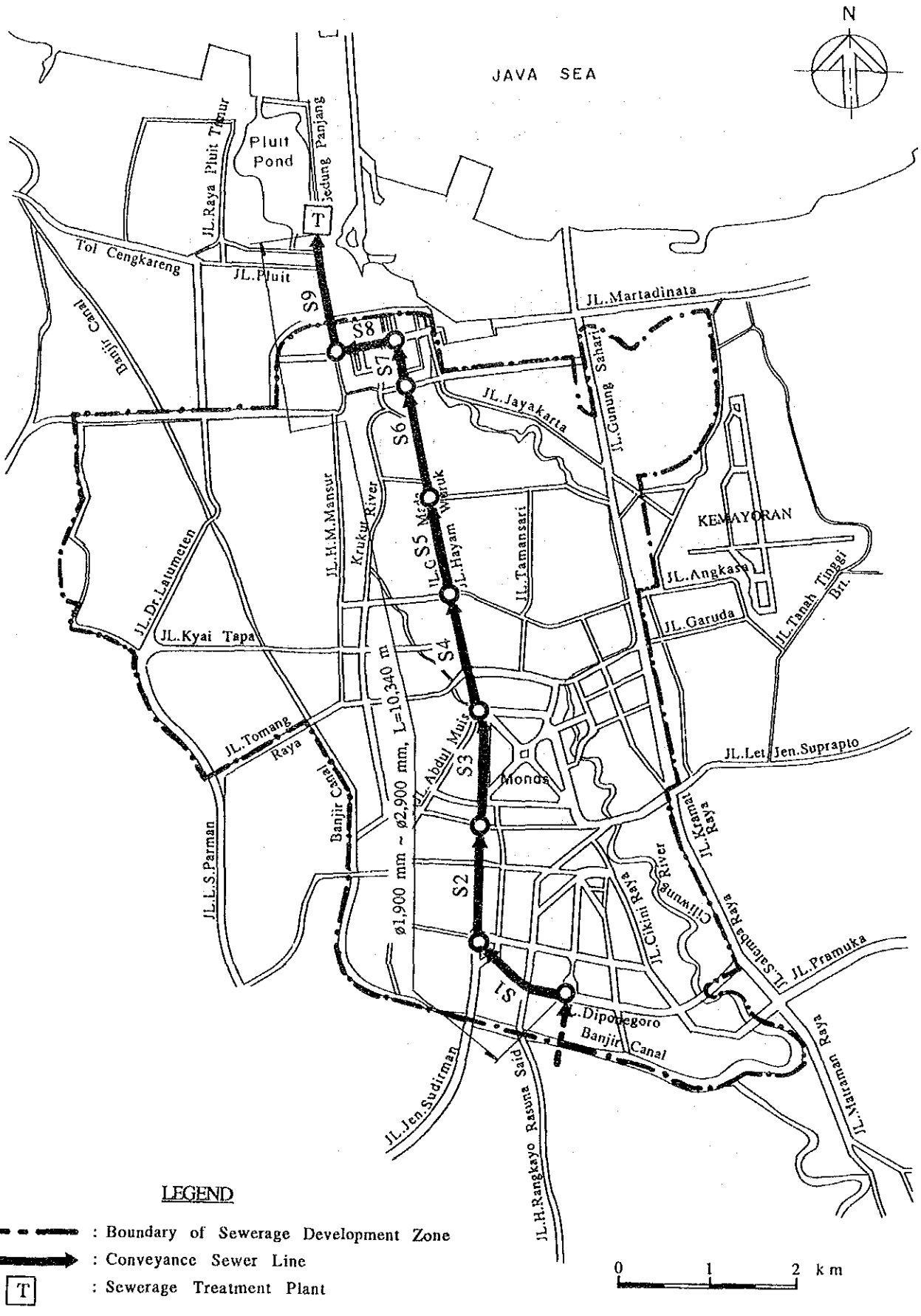

FIG. 4.1 ALTERNATIVE PLAN A (SINGLE CONVEYANCE SEWER)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

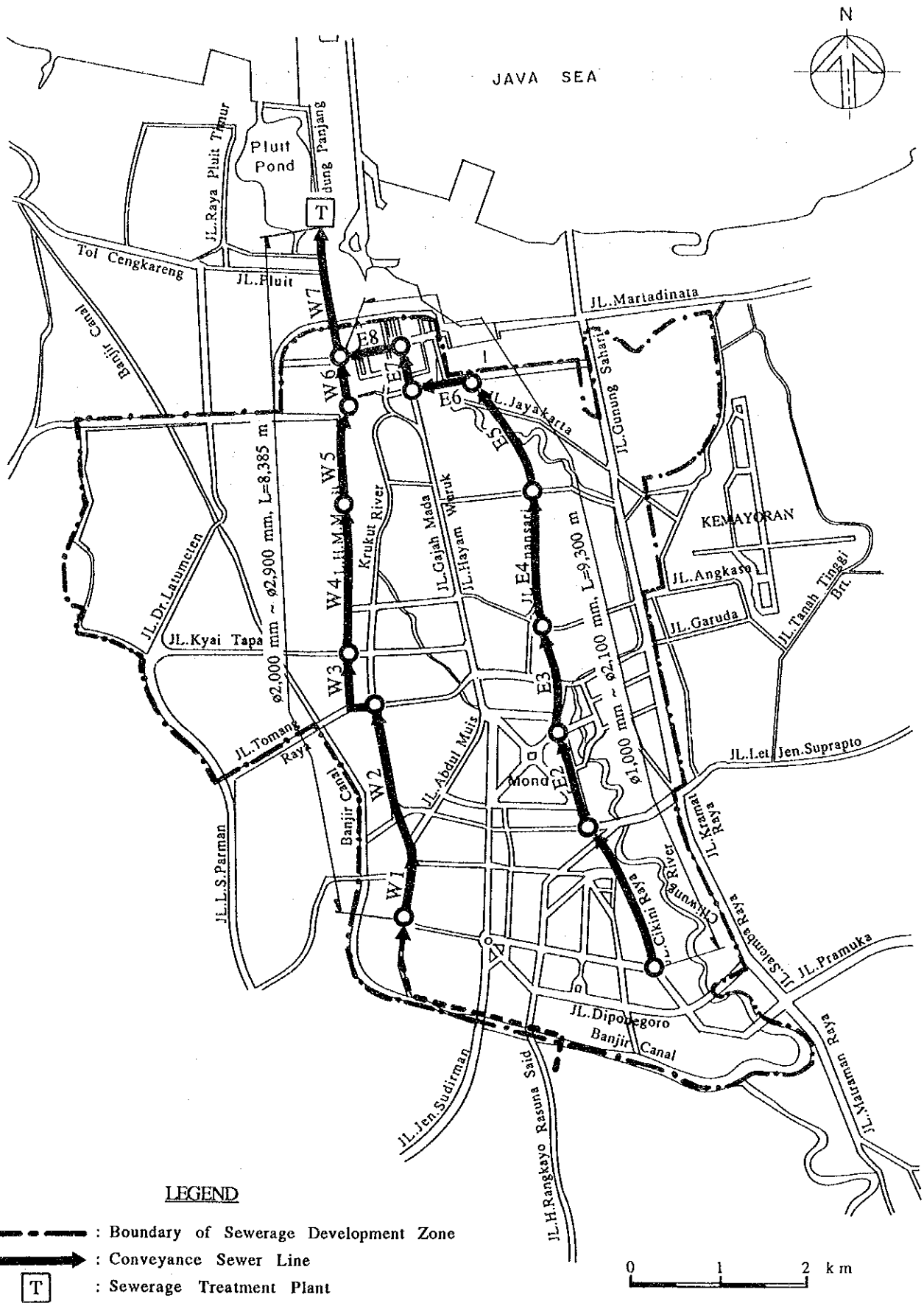

FIG. 4.2 ALTERNATIVE PLAN B (DOUBLE CONVEYANCE SEWER)

THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Chapter 5 PROPOSED SEWERAGE DEVELOPMENT PLAN

5.1 Collection System

The proposed collection system includes house connection, secondary & tertiary sewer, main sewer, trunk sewer, manhole and lift pump station.

(1) House Connection

Until the year 2000, 115,000 houses will be connected to the proposed sewerage system. Those house connections include 96,000 of domestic ones and 19,000 of others such as commercial, institutional and small industrial connections. Number of house connections by sub-zone is shown in Table 5.1.

(2) Secondary & Tertiary Sewer

Diameter of the proposed secondary & tertiary sewer is in the range of 150 mm and 300 mm.

Required length and diameter of secondary & tertiary sewer varies depending on the income level or population density of the objective area. Accordingly, the Project Area is classified into three (3) areas.

(i) Type A: Conventional area of high income level (low population density area)

(ii) Type B: Conventional area of medium income level (medium population density area)

(iii) Type C: Interceptor area (low income level area or high population density area)

Sample design of secondary & tertiary sewer networks were carried out for the above three (3) areas, respectively in Kel. Gondangdia for Type A, Kel. Cideng for Type B and Kel. Duri Utara and Duri Selatan for Type C.

Based on the above sample design, the total length of secondary and tertiary sewers of the Project Area is estimated to be 460,000 m. The length by sub-zone and by diameter is shown in Table 5.2.

(3) Main Sewer

Diameter of the proposed main sewer ranges from 350 mm to 800 mm. Its total length is 59,955 m. The sewer length by sub-zone and by diameter for the whole Project Area is shown in Table 5.2.

(4) Trunk Sewer

Diameter of the proposed trunk sewer ranges from 900 mm to 1,500 mm. Its length is 17,290 m. The sewer length by sub-zone and by diameter is also shown in Table 5.2.

(5) Force Main

Force mains are proposed at two (2) locations in sub-zone A and G. Diameter and length of force mains of sub-zone A and G are respectively 300 mm and 1,000 mm with length of 500 m and 240 m.

(6) Lift Pump Station

A lift pump station will be installed at the western bank of the Banjir Canal to lift up the collected wastewater of sub-zone G. Its design pump capacity is 1.05 m^3/s until the year 2000. Four (4) units of pump, two (2) with capacity 18 m^3/min and two (2) with capacity 36 m^3/min, will be installed. Of these one (1) pump of capacity 36 m^3/min is stand-by.

5.2 Conveyance Sewer

The conveyance sewer will be laid mainly along Jl. M.H. Thamrin and Jl. Gajah Mada between Jl. Madiun and Pluit Pond. The sewer is designed to convey the design wastewater discharge of 3.5 m^3/s-9.7 m^3/s by free flow. This design discharge includes the design inflow of 3.1 m^3/s from JSSP