I - 4
MARUYA ILIR DRAINAGE IMPROVEMENT

I-4 MARUYA ILIR DRAINAGE IMPROVEMENT

Chapter 1 PROJECT AREA

(1) 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.4.1.1). 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 Project 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.

(2) Storm water of the Project Area is mainly drained by two (2) drainage channels: east channel and west channel. The east and west channels drain respectively the eastern part of 62 ha and western part of 43 ha of the Project Area. Storm water collected by the two (2) channels are further discharged to the upper reaches of the Kembangan and Sepak rivers through the culverts installed across Jl. Tol Jakarta Merak, independently. While, the remaining northern area of 52 ha is drained directly to the upper reaches of the Kembangan and Sepak rivers through the culverts installed across the Jl. Tol Jakarta Merak as well.

(3) The Project Area suffers from frequent flooding due to insufficient capacity of the existing drainage channels and culverts.

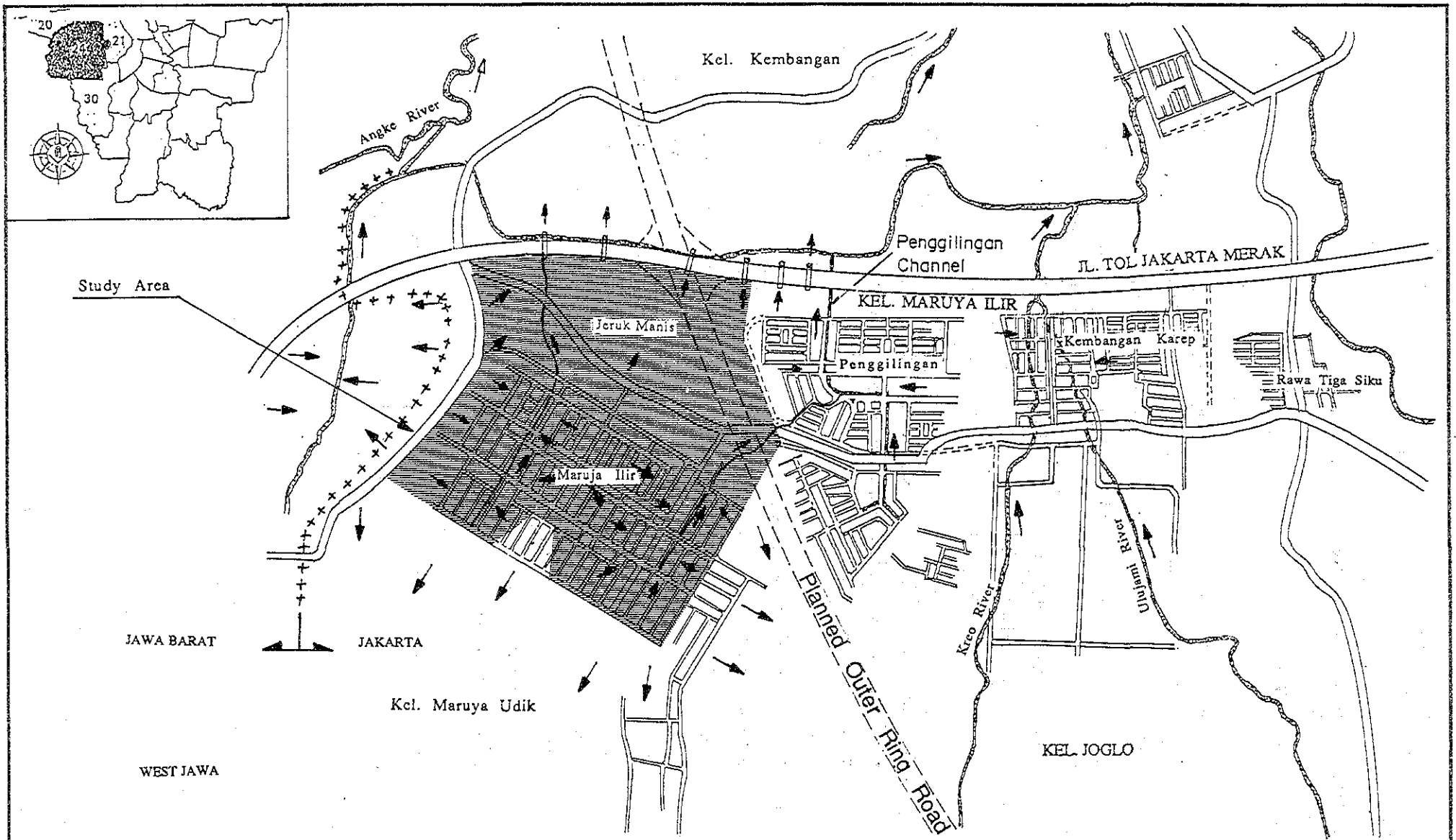


FIG. 4.1.1 LOCATION OF PROJECT AREA

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

JICA A.D 1991

Chapter 2 FLOOD AND FLOOD DAMAGES

2.1 Flood Conditions

There are 35 inundation areas as shown in Fig. 4.2.1 and 4.2.2. The total inundation area at times of potential floods works out to 27.95 ha, out of which 23.13 ha are 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.

2.2 Flood Damages

The number of property by type and by inundation area for 1988 and 2010 is shown in Table 4.2.1. The figures for 2010 were estimated based on the land use plan and economic forecast. Also, the number of vehicles by type and by inundation area for the said two year is presented in Table 4.2.2. The figures for 2010 are projected based on economic forecast.

As Table 4.3.2 shows average annual flood damage, in terms of direct damage to properties, amount to Rp. 42 million as of 1988. Likewise, income losses due to shop closure and damages to traffic amount to Rp. 0.3 million and 0.7 million, respectively. In the target year of 2010 direct damages to properties would reach Rp. 341 million. Similarly, income losses and traffic damages would grow to Rp. 1 million and Rp. 2 million, respectively.

As shown in Table 4.2.4 average annual flood damages add up to Rp. 53 million as of 1988, which would multiply by 8 times to Rp. 423 million in 2010 if no urban drainage project were implemented.

Table 4.2.1 Estimated Number of Properties in Inundation Areas - Maruya Ilir Drainage Improvement

Inundation Area No.	1. Year 1988			2. Year 2010		
	House	Shop	Factory	House	Shop	Factory
1	17	2	0	58	2	0
2	50	2	0	170	4	0
3	58	2	0	198	5	0
4	3	0	0	12	0	0
5	2	0	0	7	0	0
6	2	0	0	7	0	0
7	3	0	0	10	0	0
8	5	0	0	16	0	0
9	1	0	0	5	0	0
10	1	0	0	3	0	0
11	1	0	0	3	0	0
12	7	0	0	22	0	0
13	5	0	0	17	0	0
14	10	0	0	35	2	0
15	4	0	0	15	0	0
16	1	0	0	5	0	0
17	1	0	0	5	0	0
18	7	0	0	26	0	0
19	6	0	0	21	0	0
20	20	2	0	67	2	0
21	12	0	0	42	2	0
22	5	0	0	17	0	0
23	9	0	0	30	0	0
24	3	0	0	11	0	0
25	4	0	0	15	0	0
26	4	0	0	13	0	0
27	2	0	0	8	0	0
28	3	0	0	10	0	0
29	4	0	0	13	0	0
30	1	0	0	5	0	0
31	1	0	0	4	0	0
32	2	0	0	6	0	0
33	1	0	0	5	0	0
34	2	0	0	8	0	0
35	1	0	0	5	0	0
Total	261	6	0	895	17	0

Sources : Statistic Wilayah 1988 and JICA

Table 4.2.2 Estimated Number of Vehicles on Road by Type and by Inundation Area - Maruya Ilir Drainage Improvement

Year	Passenger Car	Bus	Truck	Motor Cycle	Total
1988	37	13	16	72	138
2010	111	53	59	226	449

Inundation Area No.	Year 1988	Year 2010
1	9	29
2	26	85
3	31	100
4	2	6
5	1	4
6	1	4
7	2	5
8	2	8
9	1	2
10	0	2
11	0	2
12	3	11
13	3	9
14	5	18
15	2	8
16	1	2
17	1	2
18	4	13
19	3	10
20	10	34
21	6	21
22	3	8
23	5	15
24	2	6
25	2	8
26	2	6
27	1	4
28	1	5
29	2	7
30	1	2
31	1	2
32	1	3
33	1	2
34	1	4
35	1	2
Total	138	449

Sources : Statistik Wilayah 1988 and JICA

Table 4.2.3 Average Annual Flood Damages by Inundation Area
- Maruya Ilir Drainage Improvement

(Unit : Rp.)

Inundation Area No.	Year 1988 Direct Damages to Properties *	Year 1988 Income Losses **	Year 1988 Traffic Damages	Year 2010 Direct Damages to Properties *	Year 2010 Income Losses **	Year 2010 Traffic Damages
1	2,487,000	49,000	42,000	20,439,000	152,000	152,000
2	5,140,000	57,000	123,000	42,601,000	203,000	448,000
3	11,119,000	110,000	150,000	90,969,000	457,000	524,000
4	359,000	0	9,000	2,974,000	0	31,000
5	223,000	0	5,000	1,849,000	0	19,000
6	223,000	0	5,000	1,849,000	0	19,000
7	442,000	0	7,000	3,634,000	0	27,000
8	691,000	0	12,000	5,678,000	0	42,000
9	207,000	0	3,000	1,703,000	0	13,000
10	138,000	0	0	1,136,000	0	8,000
11	138,000	0	0	1,136,000	0	8,000
12	967,000	0	16,000	7,949,000	0	59,000
13	746,000	0	13,000	6,132,000	0	46,000
14	1,520,000	0	26,000	12,491,000	121,000	93,000
15	649,000	0	11,000	5,337,000	0	40,000
16	207,000	0	3,000	1,703,000	0	13,000
17	207,000	0	3,000	1,703,000	0	13,000
18	1,105,000	0	19,000	9,084,000	0	68,000
19	1,550,000	0	15,000	12,713,000	0	55,000
20	3,470,000	53,000	49,000	28,501,000	185,000	178,000
21	3,452,000	0	30,000	28,309,000	185,000	110,000
22	718,000	0	12,000	5,905,000	0	44,000
23	1,299,000	0	22,000	10,673,000	1	79,000
24	484,000	0	8,000	3,974,000	0	30,000
25	649,000	0	11,000	5,337,000	0	40,000
26	553,000	0	9,000	4,542,000	0	34,000
27	345,000	0	6,000	2,839,000	0	21,000
28	414,000	0	7,000	3,407,000	0	25,000
29	580,000	0	10,000	4,769,000	0	36,000
30	207,000	0	3,000	1,703,000	0	13,000
31	180,000	0	3,000	1,476,000	0	11,000
32	279,000	0	5,000	2,271,000	0	17,000
33	207,000	0	3,000	1,703,000	0	13,000
34	359,000	0	6,000	2,952,000	0	22,000
35	207,000	0	3,000	1,703,000	0	13,000
Total	41,521,000	269,000	650,000	341,143,000	1,303,001	2,363,000

Note : * Related Properties : house, shop and factory
** Related Properties : shop and factory

Source : JICA

Table 4.2.4 Summary of Estimated Average Annual Flood Damages ("Without Project" Case) - Maruya Ilir Drainage Improvement

(Unit : Rp.)

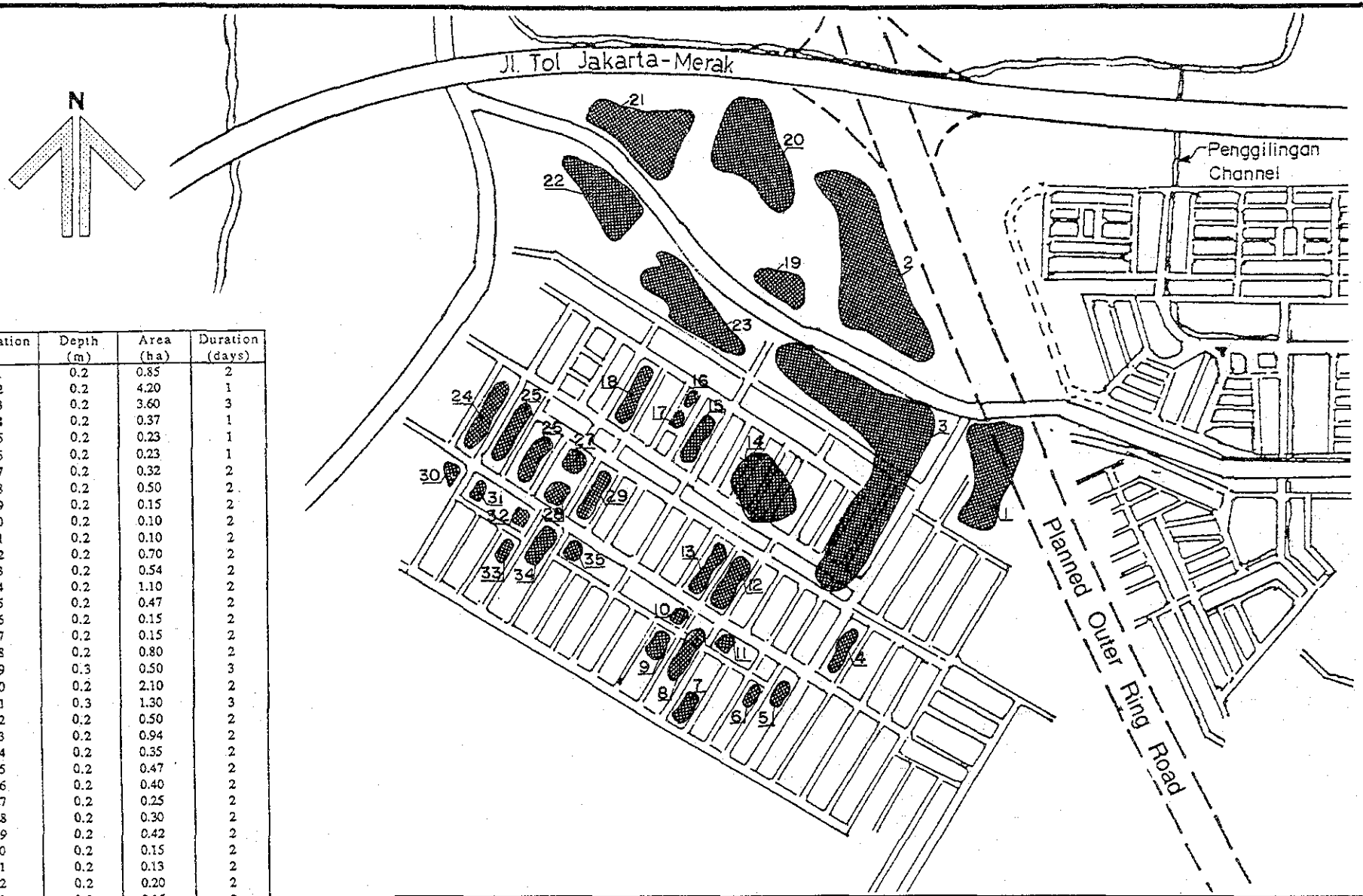
Item	1988	2010
1 Direct Damages to Property		
1) House	37,954,000	323,169,000
2) Shop	3,567,000	17,974,000
3) Factory	0	0
4) Other Specified Property 1/	1,752,000	7,533,000
Sub-Total	43,273,000	348,676,000
2. Indirect Damages		
1) Income Losses due to Shop Closure		
(1) Shop	269,000	1,303,000
(2) Factory	0	0
(3) Other Specified Property 2/	18,000	75,000
Sub-Total	287,000	1,378,000
2) Traffic Damages		
(1) Time Cost	196,000	700,000
(2) Incremental VOC	454,000	1,663,000
Sub-Total	650,000	2,363,000
Total (1.+2.)	44,210,000	352,417,000
3. Damages to Other Unspecified Property Including Infrastructure		
(1. + 2.) x 20 %	8,842,000	70,483,000
Grand Total (1.+2.+3.)	53,052,000	422,900,000

Note : 1/: Hotel, Restaurant, Hospital, Office, School, (Primary, Junior General Hight & High) and Religious Facilities (Mosque, Church & Temple)

2/: Hotel, Restaurant and Hospital

Damages to other specified property were estimated based on the ratios between the number of shops/factories and that of other specified property.

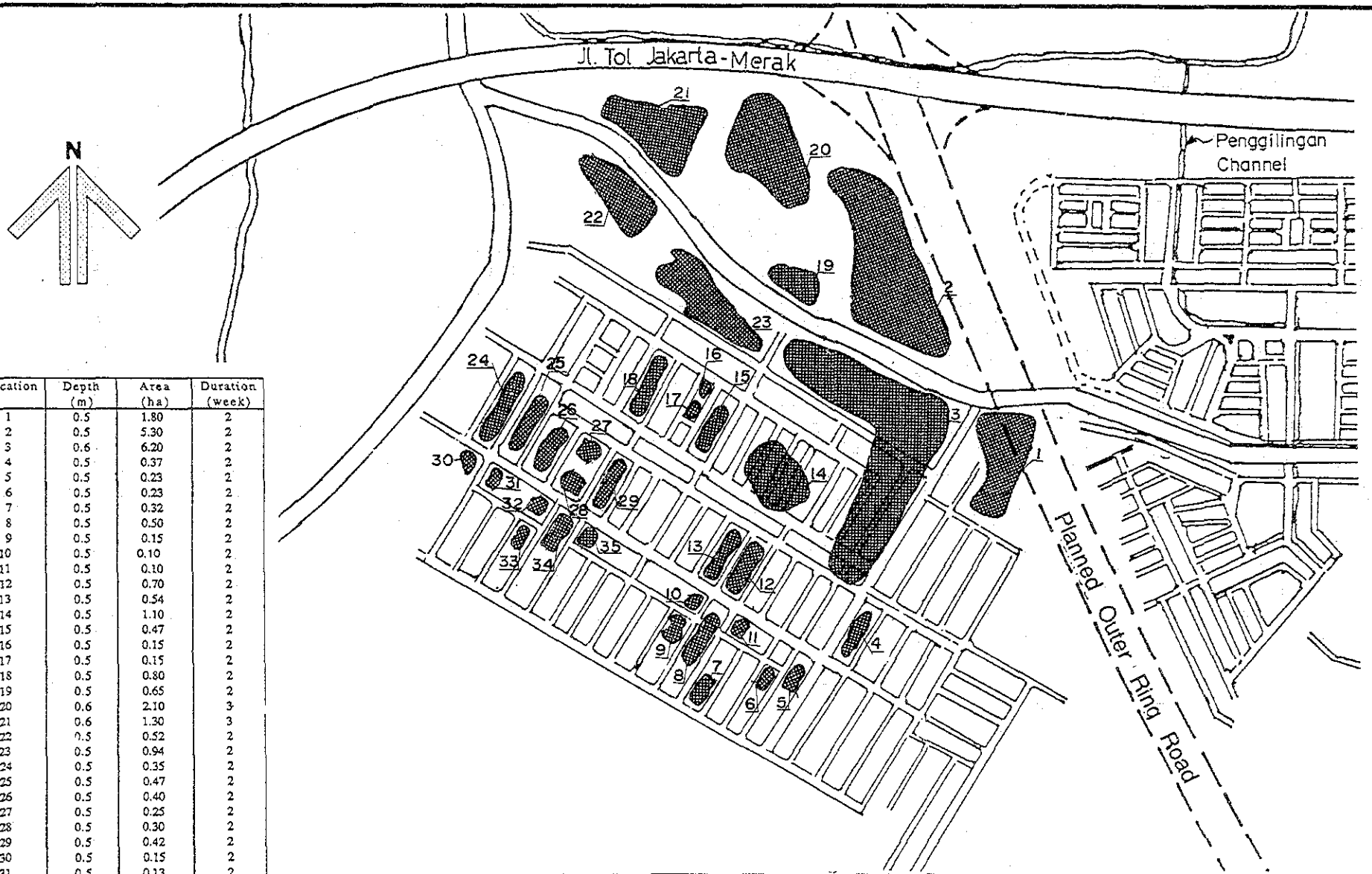
Source : JICA



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

FIG. 4.2.1 HABITUAL INUNDATION AREA (MARUJA ILIR DRAINAGE IMPROVEMENT)

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



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. 4.2.2 POTENTIAL INUNDATION AREA (MARUJA ILIR DRAINAGE IMPROVEMENT)

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

Chapter 3 DRAINAGE IMPROVEMENT PLAN

3.1 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. 4.3.1.

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				

3.2 Existing Flow Capacity of Channel and Culvert

The total drainage basin covers 157 ha. Hence, design flood frequency of five (5) years is applied (Refer to II-1, Cengkareng West Urban Drainage, Chapter 3).

The design flood discharge with a 5-year return period was estimated by the Rational Formula (Refer to II-1 Cengkareng West Urban Drainage,

Chapter 3). In this calculation, run-off coefficient and concentration time were assumed as f = 0.5 and Tc = 65 minutes respectively.

The flow capacity of the existing drainage channel was estimated by the Manning's Formula. Manning's roughness coefficient was assumed as n = 0.025 for the earth channel.

The flow capacity of the existing channel is compared with its design flood discharge as shown in Table 4.3.1.

The flow capacity of the channels is insufficient along the whole reaches with a total length of 2,676 m. The whole channel sections shall be improved.

The downstream channel section of the channel No. 2 has already been improved. It has a sufficient capacity to meet a 5-year flood. For its location, refer to Fig. 4.3.1.

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

ø0.40 m x 1
ø0.85 m x 2
ø1.00 m x 3

The total flow capacity of the six (6) existing culverts is estimated to be 1.8 m^3/s, assuming its average flow velocity as 0.5 m/s. This flow capacity is very small compared to a 5-year flood discharge of 9.8 m^3/s. Moreover, the existing culverts are almost completely clogged by sediments. It is considered difficult to maintain their full flow capacity.

3.3 Proposed Drainage Improvement Plan

(1) Proposed Drainage System

The Outer Ring Road will intersect the Project Area in future. After 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. 4.3.2.

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), the following two (2) alternatives are considered.

(i) To drain toward east into the Periggilingan channel
(ii) To drain toward west into the upstream tributary of the Angke River

Gravity drainage into the upstream tributary of the Angke River is difficult. Hence, drainage into the Periggilingan channel is proposed. A new drainage channel will be excavated along the Jl. Tol Jakarta Merak to carry storm water to the Periggilingan channel. The existing culvert of the Periggilingan channel across the Jl. Jakarta Merak has sufficient capacity to receive the additional flood water.

Location of the proposed new channel is shown in Fig. 4.3.2.

The catchment area, channel length and design discharge of the proposed channels are shown below.

Channel No.	1	2	3	4	5	Total
Catchment Area (ha)	50	4	43	51	9	157
Accumulated Area (ha)	50	54	43	94	103	
Length (m)	1,068	289	1,034	600	510	3,501
Design Discharge (m^3/s)	5.7	5.9	5.0	10.8	10.9	

(2) 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	

The profile and cross sections of the proposed channels are shown in Fig. 4.3.3.

3.4 Proposed Construction Works and Land Acquisition

Major construction works of the proposed channel improvement are channel excavation, embankment, revetment works, inspection road pavement, bridge construction and concrete wall. These are shown below.

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 area of land acquisition and compensation are summarized below.

Land Acquisition		
Residential Area (I)	:	21,300 m^2
Residential Area (II)	:	1,800 m^2
Compensation		
Agricultural Products	:	7,600 m^2
Wooden House	:	350 m^2
Concrete House	:	60 m^2

Break-down of the construction works, and land acquisition and compensation by channel is shown in Table 4.3.2.

The location of the proposed bridges and inspection roads are shown in Fig. 4.3.4.

The structures of the proposed revetment and bridges are shown in Fig. 4.3.5.

Table 4.3.1 Existing Flow Capacity of Drainage Channel

Channel No.	Cross Section No.	Width (m)		Depth (m)	Flow Capacity (m^3/s)	Design Discharge (m^3/s)	Balance (m^3/s)
		Top	Bottom				
2	CR.-3	3.50	1.90	1.30	6.1	6.2	-0.1
	-4	3.00	2.40	0.95	2.7	6.2	-3.5
1	CR.-5	1.33	0.66	0.56	0.5	5.1	-4.6
	6	2.15	1.25	1.60	4.3	5.1	-0.8
	7	3.10	1.80	0.93	3.5	5.1	-1.6
	8	3.10	2.00	1.00	4.0	5.1	-1.1
	9	2.38	1.70	1.00	3.0	5.1	-2.1
	10	2.95	1.70	1.10	4.1	5.1	-2.0
	11	0.30	0.20	0.1	0.1	5.1	-5.0
4	CR.-1	1.27	0.80	0.6	1.0	9.8	-8.8
3	CR.-2	0.98	0.40	0.65	0.2	7.2	-7.0
	-3	0.50	0.40	0.1	0.01	4.5	-4.4
	-4	1.21	0.50	0.71	0.4	4.5	-4.1

Table 4.3.2 Break-down of Construction Works and Land Acquisition & Compensation by Channel

	Unit	No. 1	No. 2	No. 3	No. 4	No. 5	Total
Direct Construction							
Channel Excavation	(m^3)	1,201	578	3619	2,760	4,590	12,748
Embankment	(m^3)	750	260	103	2,400	-	3,513
Revetment	(m)	2,136	578	2,068	1,200	1,020	7,002
	(m^2)	4,293	1,162	3,474	2,280	1,938	13,147
Bridge Construction	(place)	5	1	7	1	-	14
Inspection Road	(m)	110	179	-	600	510	1,399
Pavement	(m^2)	330	537	-	1,800	1,530	4,197
Concrete Wall	(m)	-	145	200	-	300	645
Land Acquisition							
Residential Area (1)	(m^2)	770	-	3,540	9,060	7,900	21,270
Residential Area (2)	(m^2)	420	330	152	930	-	1,832
Compensation							
Agricultural Products	(m^2)	-	-	1,200	6,370	-	7,570
Wooden House	(m^2)	-	200	-	150	-	350
Concrete House	(m^2)	40	-	20	-	-	60

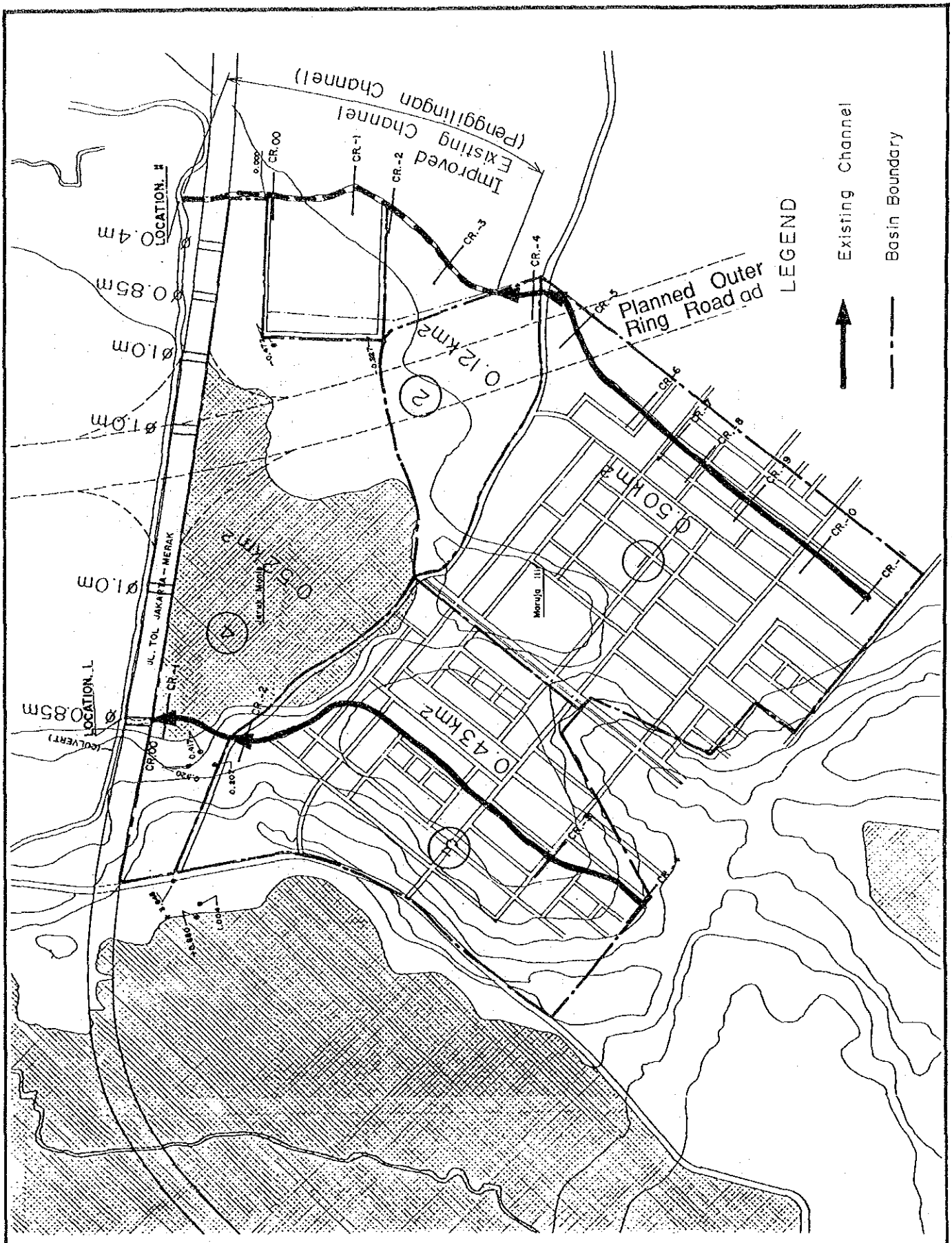


FIG. 4.3.1 EXISTING DRAINAGE SYSTEM

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

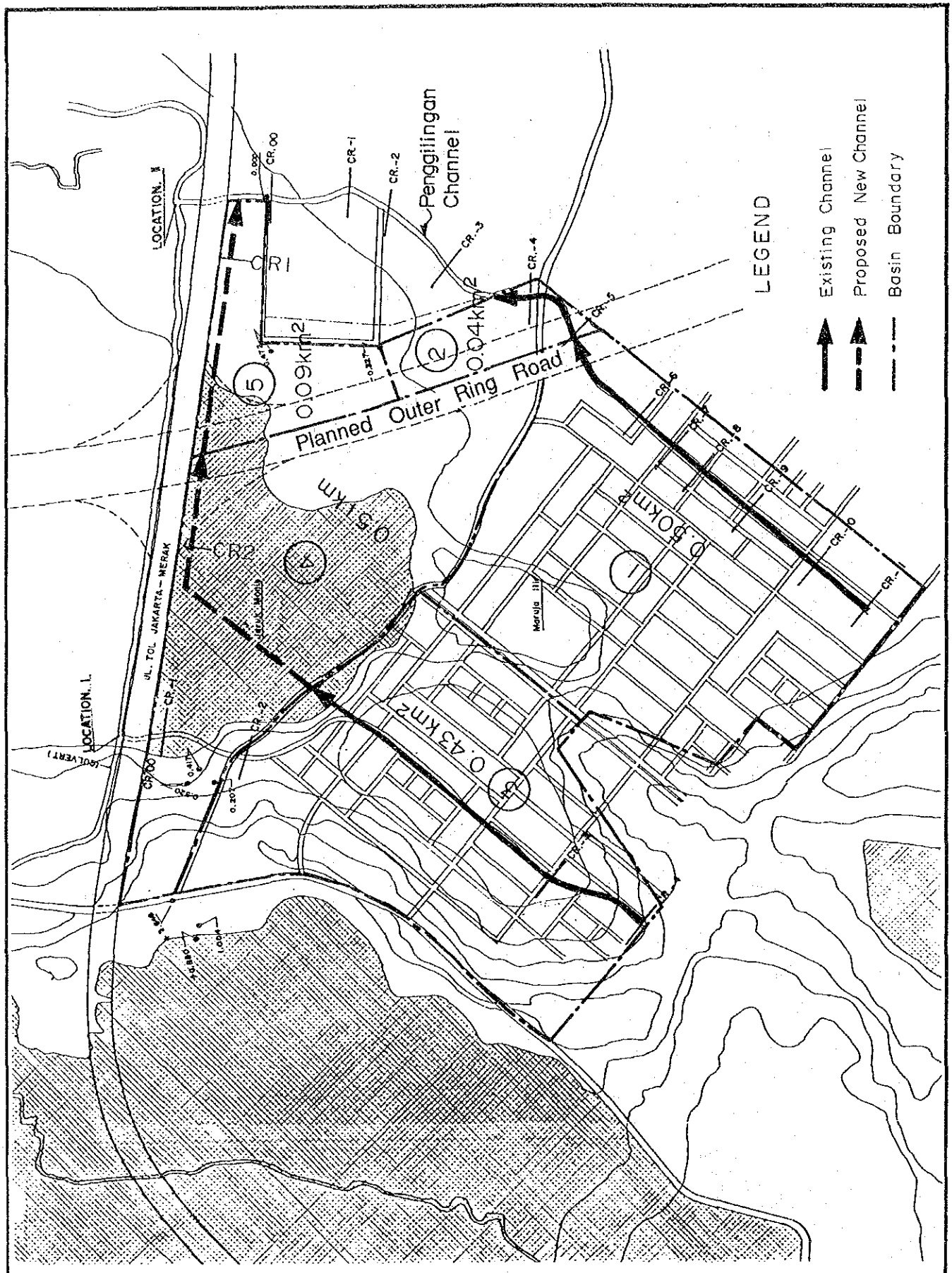


FIG. 4.3.2 PROPOSED DRAINAGE SYSTEM

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

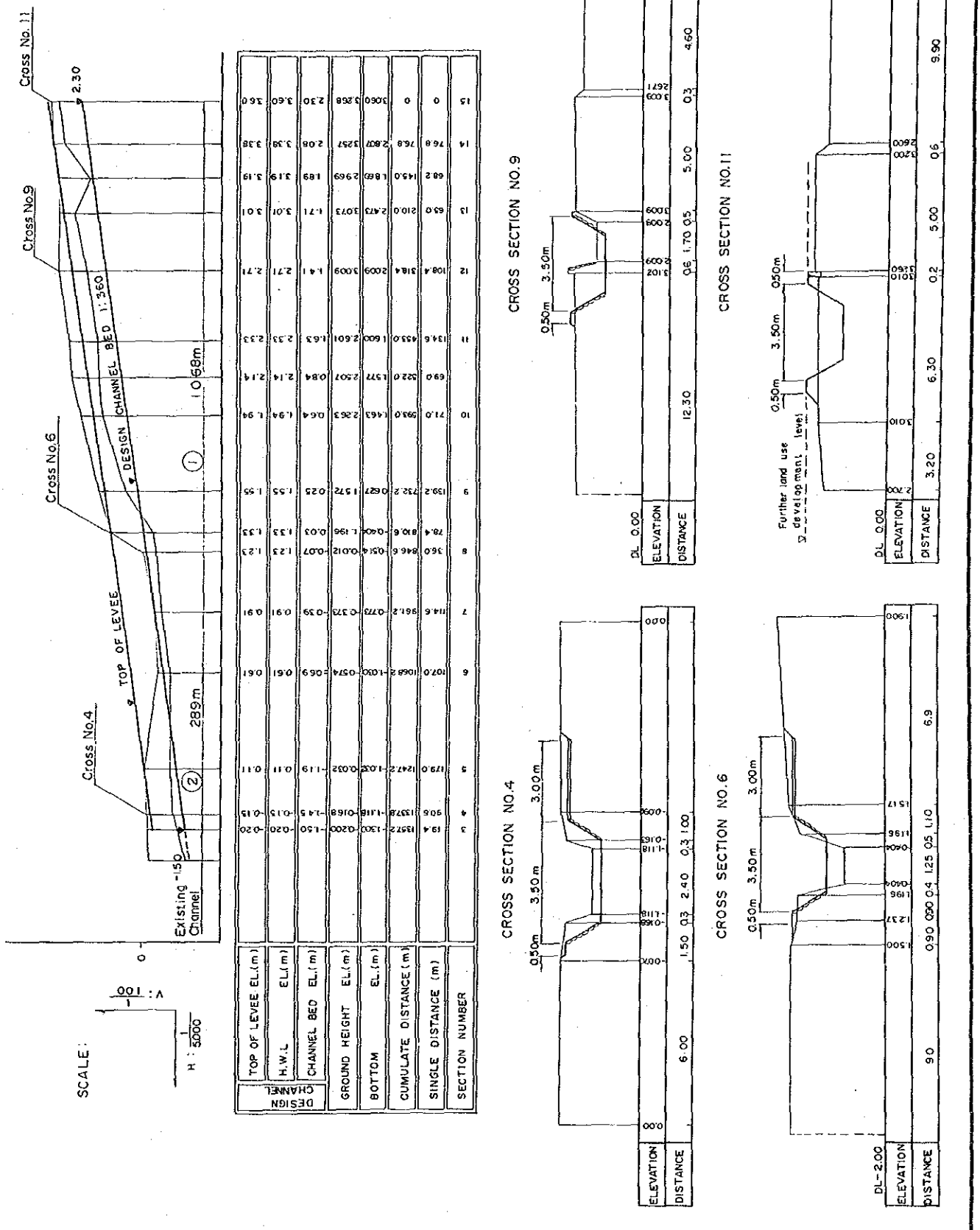
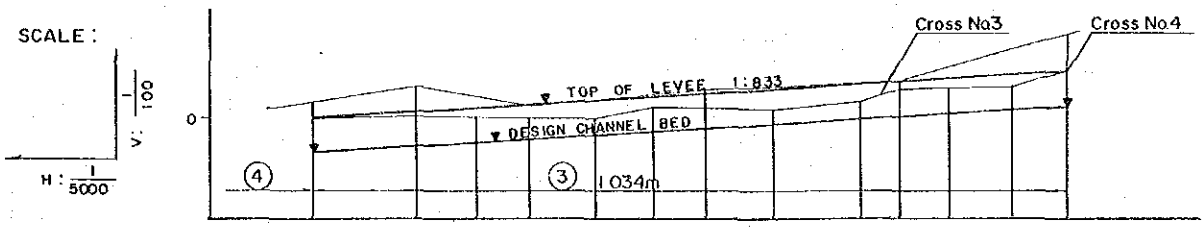


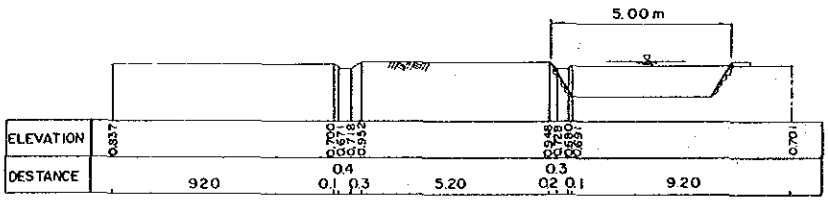
FIG. 4.3.3 (1) PROFILE AND CROSS SECTION OF PROPOSED CHANNEL (EAST CHANNEL)

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



DESIGN CHANNEL	TOP OF LEVEE EL. (m)	0.02		0.19	0.29	0.38	0.48	0.58	0.67	0.76		0.93	0.99	1.07	1.18	1.26									
	H.W.L. EL. (m)	0.02		0.19	0.29	0.38	0.48	0.58	0.67	0.78		0.93	0.99	1.07	1.18	1.26									
	CHANNEL BED EL. (m)	-0.98		-0.81	-0.71	-0.62	-0.52	-0.42	-0.33	-0.22		-0.77	-0.01	0.07	0.18	0.26									
GROUND HEIGHT EL. (m)		0.340		0.868		0.280			0.734				0.948			2.333									
BOTTOM EL. (m)		1.400			-0.062	-0.029	-0.107	0.288		0.179		0.380	0.728	0.734	0.828	1.238									
CUMULATE DISTANCE (m)		1034.0		894.0	811.4	736.8	646.6	564.6	490.0	398.0		278.0	224.6	156.4	70.4	0									
SINGLE DISTANCE (m)				82.6	74.6	90.2	82.0	74.6	92.0	120.0		53.4	68.2	86.0	70.4	0									
SECTION NUMBER		13		12	11	10	9	8	7	6		5	4	3	2	1									

CROSS SECTION NO.3



CROSS SECTION NO.4

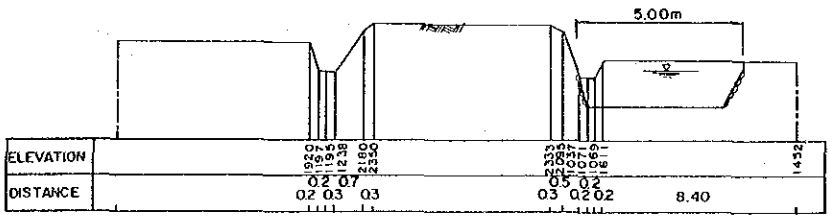
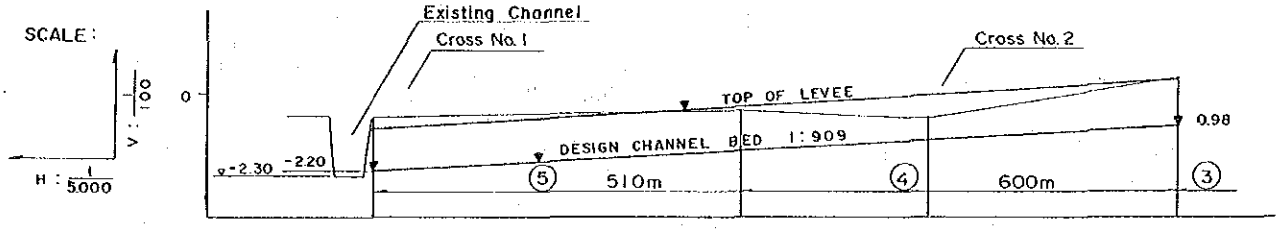
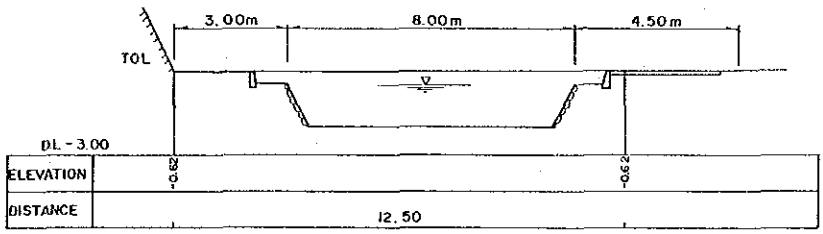


FIG.4.3.3(2) PROFILE AND CROSS SECTION OF PROPOSED CHANNEL (WEST CHANNEL)



DESIGN CHANNEL	TOP OF LEVEE EL. (m)	-2.20	-1.64	-1.35	-0.98
	H.W.L EL. (m)	-2.20	-1.64	-1.35	-0.98
	CHANNEL BED EL. (m)	-2.20	-1.64	-1.35	-0.98
GROUND HEIGHT EL. (m)		-0.820	-0.520	-0.700	-0.340
BOTTOM EL. (m)					
CUMULATE DISTANCE (m)		2144	1634	1374	1034
SINGLE DISTANCE (m)		510	260	340	1400
SECTION NUMBER		16	15	14	13

CROSS SECTION NO. 1



CROSS SECTION NO. 2

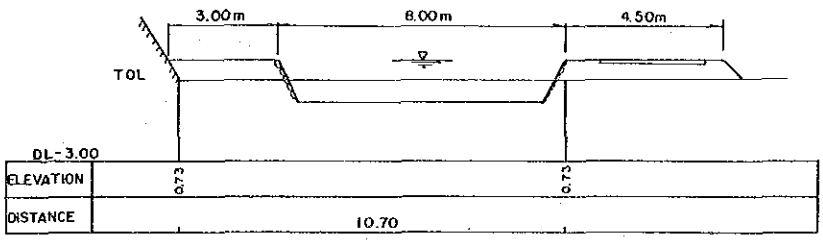


FIG.4.3.3(3) PROFILE AND CROSS SECTION OF PROPOSED CHANNEL (NEW CHANNEL)

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

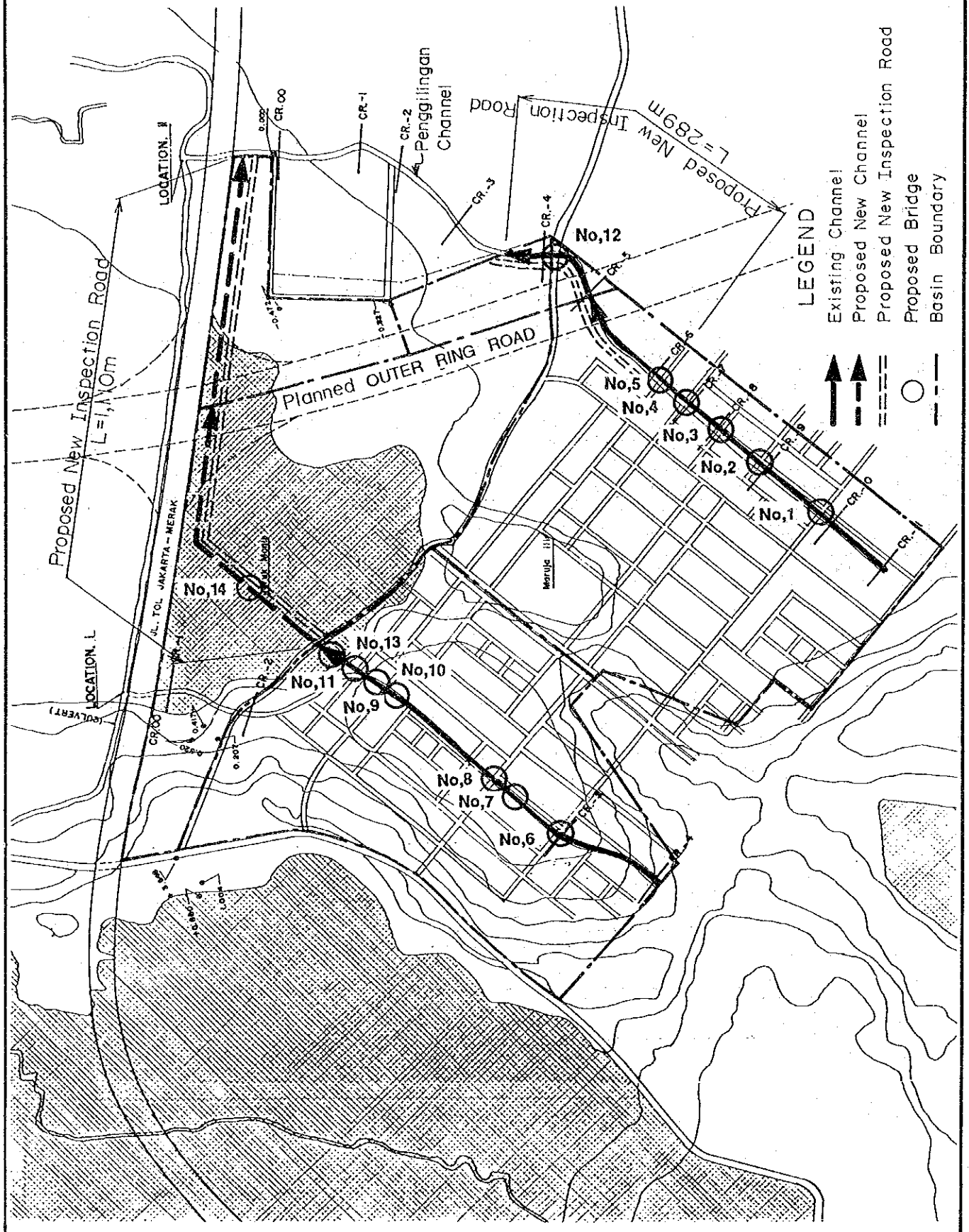
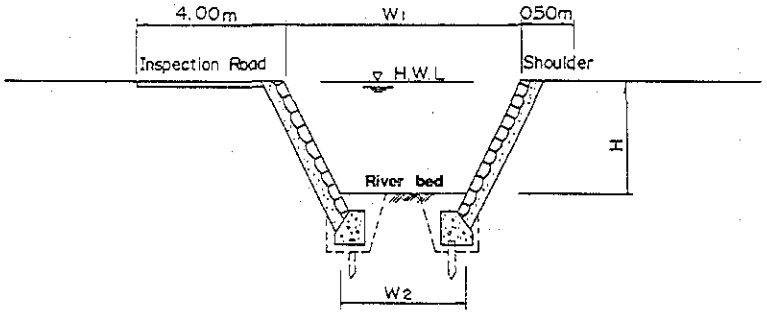
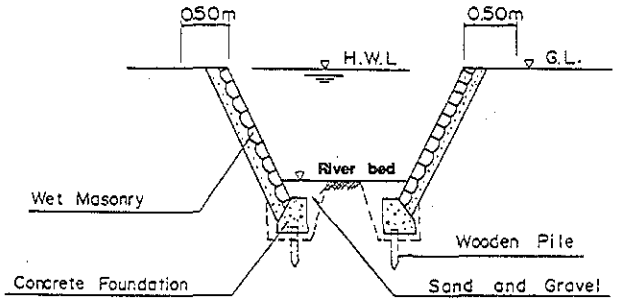


FIG. 4.3.4 LOCATION OF PROPOSED BRIDGE AND INSPECTION ROAD

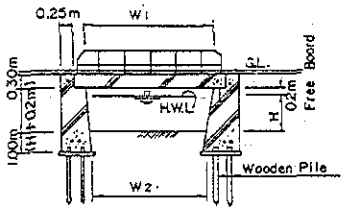
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA





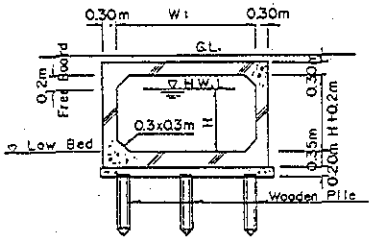
ITEM / CHANNEL NO	W1 (m)	W2 (m)	H (m)	Length (m)
①	3.5	2.0	1.3	1,068
②	3.5	2.0	1.3	289
③	5.0	4.0	1.0	1,034
④	8.0	6.8	1.2	600
⑤	8.0	6.8	1.2	510

TIPE 1



	Bridge NO.1~NO.5 (Five bridges)	Bridge NO.6~NO.11 (Six bridges)
W1 (m)	3.5	5.0
W2 (m)	2.0	4.0
H (m)	1.3	1.0
WIDTH (m)	6.0	6.0

TIPE 2



	Bridge NO.12	Bridge NO.13
W1 (m)	3.5	5.0
H (m)	1.3	1.2
WIDTH (m)	8.0	8.0

TIPE 3

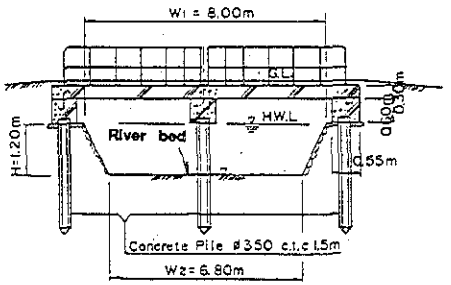


FIG. 4.3.5 STRUCTURE OF PROPOSED REVETMENT AND BRIDGE

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

Chapter 4 COST ESTIMATE

The project cost was estimated in the same manner of 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
I. Direct Construction	1,565
II. Land Acquisition	2,474
III. Engineering Service: I x 10%	156
IV. Administration: (I + II) x 1.5%	61
V. Physical Contingency: I x 10%	156
Total	4,412

Its break-down by construction work is shown in Table 4.4.1.

The break-down of the direct construction and land acquisition costs by channel is shown in Table 4.4.2.

Table 4.4.1 Break-down of Construction Cost

Item	Unit	Unit Cost (Rp.)	Quantity	Cost (million Rp.)
I. Direct Construction				1,564.7
Channel Excavation	(m^3)	3,608	12,748	46.1
Embankment	(m^3)	4,436	3,513	15.6
Revetment	(m m^2)	89,332	7,002 13,147	1,174.4
Bridge Construction	(place)		14	259.7
Inspection Road	(m (m^2)	15,402	1,399 4,197	64.7
Concrete Wall	(m)	6,496	645	4.2
II. Land Acquisition/Compensation				2,473.9
Residential Area (1)	(m^2)	105,000	21,270	2,233.4
Residential Area (2)	(m^2)	115,000	1,832	210.8
Agricultural Products	(m^2)	781	7,570	5.9
Wooden House	(m^2)	3,571	350	19.3
Concrete House	(m^2)	75,000	60	4.5
III. Engineering Service: I x 10%				156.5
IV. Administration: (I+II) x 1.5%				60.6
V. Physical Contingency: I x 10%				156.5
Total				4,412.2

Table 4.4.2 Break-down of Direct Construction and Land Acquisition Cost by Channel

(million Rp.)

	No. 1	No. 2	No. 3	No. 4	No. 5	Total
Direct Construction	473.0	139.0	467.2	270.2	215.3	1,564.7
Channel Excavation	4.3	2.1	13.1	10.0	16.6	46.1
Embankment	3.3	1.2	0.5	10.6	-	15.6
Revetment	383.5	103.8	310.3	203.7	173.1	1,174.4
Bridge Construction	76.8	22.7	142.0	18.2	-	259.7
Inspection Road Pavement	5.1	8.3	-	27.7	23.6	64.7
Concrete Wall	-	0.9	1.3	-	2.0	4.2
Land Acquisition	129.2	38.0	389.2	1,058.3	829.5	2,444.2
Residential Area (1)	80.9	-	371.7	951.3	829.5	2,233.4
Residential Area (2)	48.3	38.0	17.5	107.0	-	210.8
Compensation	3.0	11.0	2.4	13.3	0	29.7
Agricultural Products	-	-	0.9	5.0	-	5.9
Wooden House	-	11.0	-	8.3	-	19.3
Concrete House	3.0	-	1.5	-	-	4.5

II. SEWERAGE

II. SEWERAGE

Chapter 1 SEWERAGE SERVICE AREA

1.1 General

The Project Area for sewerage development covers an area of 4,300 ha located in central Jakarta and excludes an area of about 2,000 ha of the master plan priority area lying south of West Banjir Canal, which consist of Kec. Setia Budi and Tebet Manggarai, where a pilot sewerage development project is ongoing by JSSP.

The Project Area covers 47 Kelurahans with total administrative area of 4,269 ha. The proposed sewerage service area also covers 47 Kelurahans 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.

Group II : Kelurahans with a specific wastewater discharge in between 51 m^3/d/ha and 100 m^3/d/ha.

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

Group I covers the following eight (8) Kelurahans.

Kel. Cideng	Kel. Gambir	Kel. Gunung Sahari Utara
Kel. Senen	Kel. Gondangdia	Kel. Kenari
Kel. Menteng	Kel. Roa Malaka	

Group II includes the 15 Kelurahans listed below.

Kel. Petojo Utara	Kel. Petojo Selatan	Kel. Pegangsaan
Kel. Pademangan Barat	Kel. Pademangan Timur	Kel. Grogol
Kel. Jelambar	Kel. Tomang	Kel. Jelambar Baru
Kel. Pinangsia	Kel. Mangga Besar	Kel. Glodok
Kel. Taman Sari	Kel. Angke	Kel. Duri Utara

Group III comprises the following 24 Kelurahans.

Kel. Duri Pulo	Kel. Kebon Kelapa	Kel. Mangga II Selatan
Kel. Karang Anyar	Kel. Kartini	Kel. Pasar Baru
Kel. Kwitang	Kel. Kebon Sirih	Kel. Cikini
Kel. Kampung Bali	Kel. Kebon Kacang	Kel. Kebon Melati
Kel. Tangki	Kel. Keagungan	Kel. Krukut
Kel. Mahpar	Kel. Pekojan	Kel. Tambora
Kel. Jembatan Lima	Kel. Jembatan Besi	Kel. Krendang
Kel. Tanah Sereal	Kel. Kali Baru	Kel. Duri Selatan

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. 1.2.

This 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 Table 1.1.

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.
(ii) 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.

Residential areas where land readjustment has not been completed will be excluded even though the existing road width is wider than 2 m to avoid reconstruction of the proposed sewage collection system in future.

However, it is difficult to apply this complete system for densely populated Kampungs as there exist no road networks wide enough to install sewer lines. In these areas, the existing road-side ditches will be used for sewage collection and interceptor (main sewer line) will be installed to collect wastewater discharged through the road-side ditches.

Based on the above considerations, interceptor sewage collection system will be applied for the high population density areas which cannot be covered by conventional separate sewage collection system.

This interceptor system will collect only gray water, excluding toilet waste. In the areas covered by interceptor system, toilet waste will be treated by septic tank systems.

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 1.2. Both the conventional and interceptor areas are delineated as shown in Fig. 3. Areas excluded from the service area are also delineated in Fig. 1.3.

Table 1.1 Service Area and Served Population

Sub-Zone A	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1402	KWITANG	45	23,223	24,100	24,700	516.1	535.6	548.9
1403	KENARI	64	13,324	14,200	15,200	208.2	221.9	237.5
1601	KEBON SIRIH	83	34,683	37,900	40,200	417.9	456.6	484.3
1602	GONDANGDIA	146	11,479	17,800	22,500	78.6	121.9	154.1
1603	CIKINI	82	18,604	22,000	24,500	226.9	268.3	298.8
1604	MENTENG	236	49,850	57,600	63,300	211.2	244.1	268.2
1605	PEGANGSAAN	98	38,418	42,700	45,800	392.0	435.7	467.3
Total		754	189,581	216,300	236,200	251.4	286.9	313.3

Sub-Zone B	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1701	KAMPUNG BALI	70	31,241	34,300	36,500	446.3	490.0	521.4
1702	KEBON KACANG	68	38,572	41,600	43,900	567.2	611.8	645.6
1703	KEBON MELATI	110	69,700	75,000	79,000	633.6	681.8	718.2
Total		248	139,513	150,900	159,400	562.6	608.5	642.7

Sub-Zone C	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1106	GAMBIR	154	5,754	17,000	25,300	37.4	110.4	164.3
1401	SENEN	58	9,486	9,800	10,000	163.6	169.0	172.4
Total		212	15,240	26,800	35,300	71.9	126.4	166.5

Sub-Zone D	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1101	CIDENG	85	27,268	29,200	30,600	320.8	343.5	360.0
1103	PETOJO UTARA	112	29,602	31,700	33,300	264.3	283.0	297.3
1104	PETOJO SELATAN	134	33,425	38,700	42,600	249.4	288.8	317.9
Total		331	90,295	99,600	106,500	272.8	300.9	321.8

Sub-Zone E	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1102	DURI PULO	65	47,817	49,200	50,200	735.6	756.9	772.3
1105	KEBON KELAPA	78	21,582	23,000	24,100	276.7	294.9	309.0
1201	MANGA II SEL.	121	59,615	61,900	63,600	492.7	511.6	525.6
1202	KARANG ANYAR	51	43,034	44,000	44,700	843.8	862.7	876.5
1203	KARTINI	48	37,644	38,700	39,400	784.3	806.3	820.8
1204	PASAR BARU	177	26,350	29,900	32,600	148.9	168.9	184.2
3301	PINANGSIA	96	24,951	26,800	28,100	259.9	279.2	292.7
3302	MANGGA BESAR	51	17,674	18,500	19,100	346.5	362.7	374.5
3303	TANGKI	37	26,408	27,100	27,600	713.7	732.4	745.9
3304	GLODOK	38	14,391	14,700	15,000	378.7	386.8	394.7
3305	KEAGUNGAN	32	33,024	33,600	34,100	1032.0	1050.0	1065.6
3306	KRUKUT	55	29,880	30,900	31,700	543.3	561.8	576.4
3307	TAMAN SARI	68	27,444	28,700	29,600	403.6	422.1	435.3
3308	MAHPAR	59	28,982	30,100	30,900	491.2	510.2	523.7
3401	PEKOJAN	78	39,599	41,000	42,000	507.7	525.6	538.5
3402	ROA MALAKA	53	6,592	7,600	8,300	124.4	143.4	156.6
3403	TAMBORA	28	17,237	17,800	18,200	615.6	635.7	650.0
3404	JEMBATAN LIMA	42	33,596	34,500	35,100	799.9	821.4	835.7
3405	ANGKE	68	42,201	43,700	44,800	620.6	642.6	658.8
3406	JEMBATAN BESI	41	39,019	40,000	40,800	951.7	975.6	995.1
3407	KRENDANG	29	32,749	33,400	33,800	1129.3	1151.7	1165.5
3408	TANAH SEREAL	62	47,355	48,500	49,400	763.8	782.3	796.8
3409	DURI U.	67	32,130	33,400	34,400	479.6	498.5	513.4
3410	KALI BARU	17	37,299	37,800	38,200	2194.1	2223.5	2247.1
3411	DURI S.	32	25,227	25,800	26,300	788.3	806.3	821.9
Total		1,493	791,800	820,600	842,000	530.3	549.6	564.0

Sub-Zone F	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
1205	GUNUNG SAHARI U.	121	24,819	24,900	25,000	205.1	205.8	206.6
2206	PADEMANGAN B.	78	66,403	66,700	67,000	851.3	855.1	859.0
2207	PADEMANGAN T.	82	28,920	39,900	48,000	352.7	486.6	585.4
Total		281	120,142	131,500	140,000	427.6	468.0	498.2

Sub-Zone G	Name of Kelurahan	Area (ha)	Population (person)			Population Density (person/ha)		
			1988	2000	2010	1988	2000	2010
3201	GROGOL	95	35,685	38,000	39,700	375.6	400.0	417.9
3202	JELAMBAR	133	52,283	55,000	57,000	393.1	413.5	428.6
3204	TOMANG	172	56,288	59,900	62,500	327.3	348.3	363.4
3210	JELAMBAR BARU	128	57,682	60,400	62,400	450.6	471.9	487.5
Total		528	201,938	213,300	221,600	382.5	404.0	419.7

Grand Total	3,847	1,548,509	1,659,000	1,741,000	402.5	431.2	452.6

Table 1.2 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

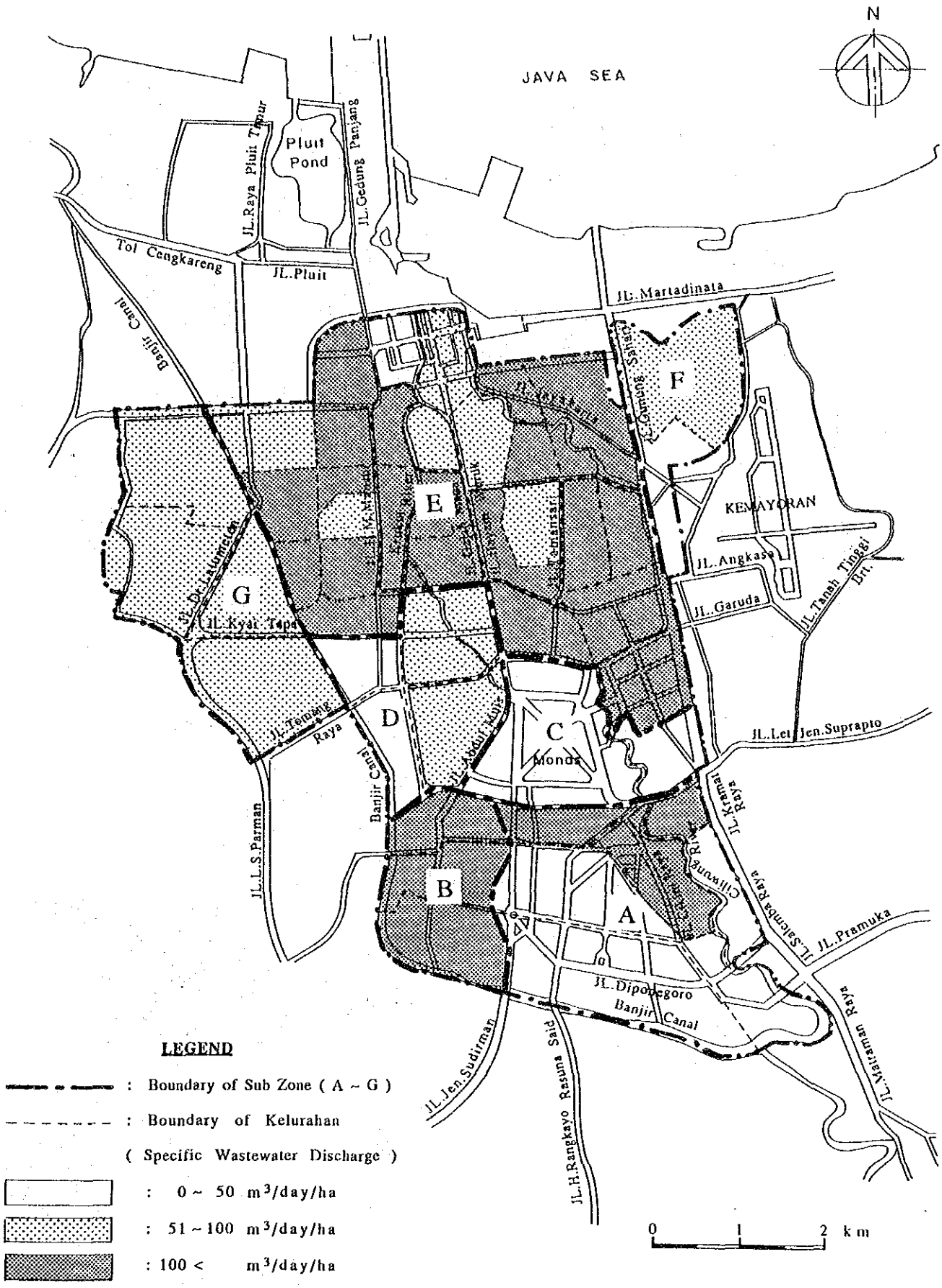


FIG. 1.1 SPECIFIC WASTEWATER DISCHARGE DISTRIBUTION AND SEWERAGE SUB-ZONES OF PROJECT AREA

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

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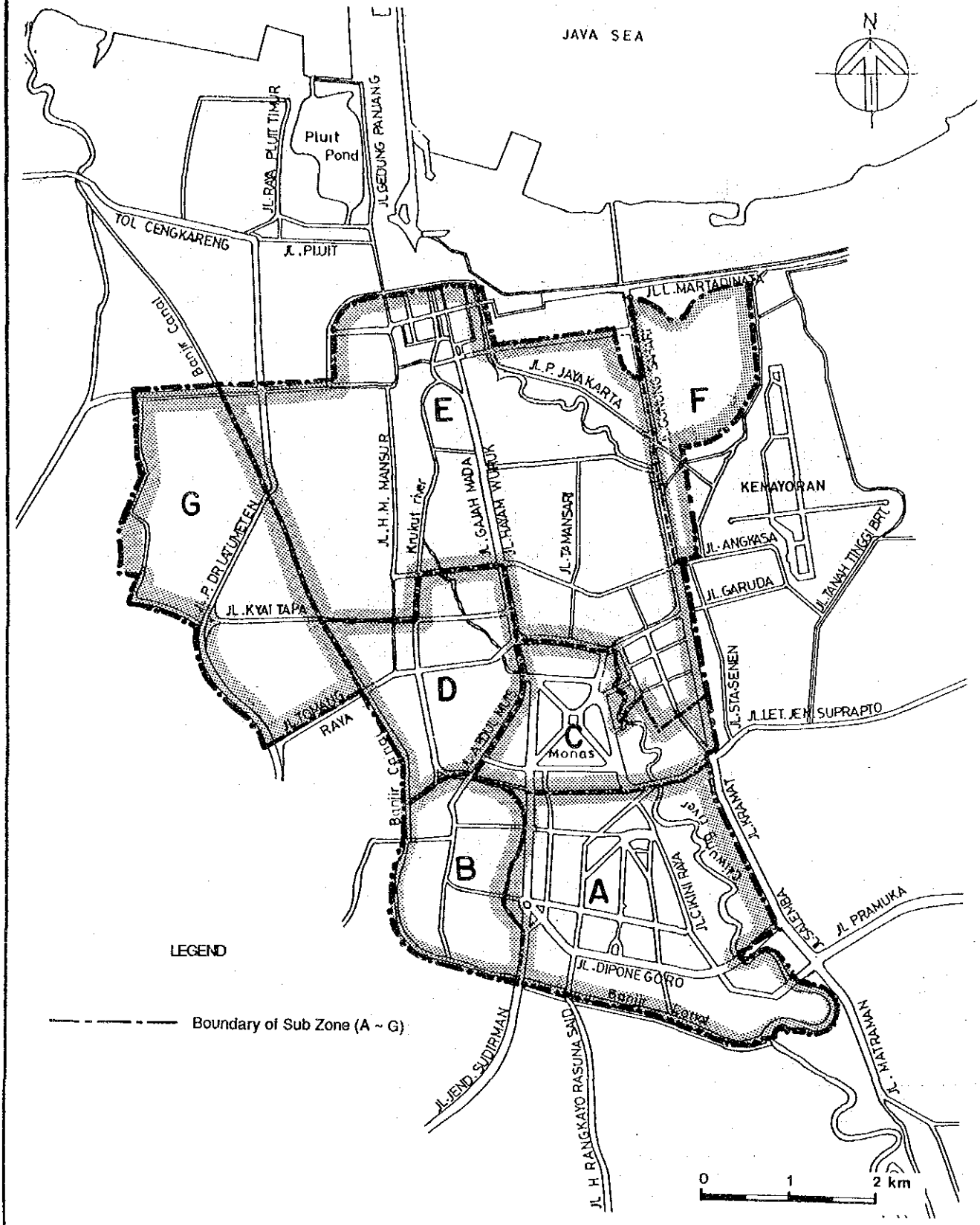


FIG. 1.2 DIVIDED SEWERAGE SUB-ZONE

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

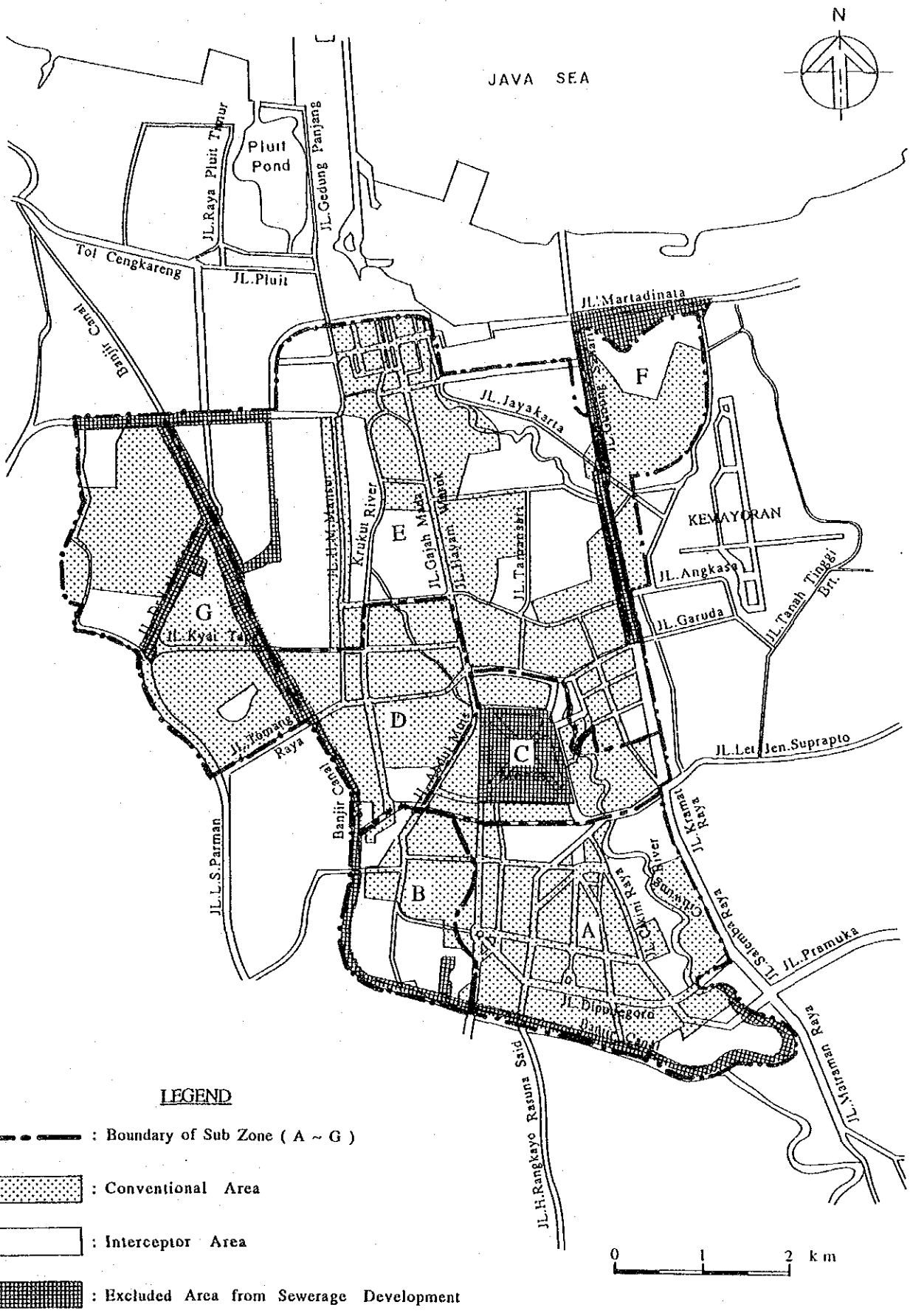


FIG. 1.3 DELINEATED CONVENTIONAL AND INTERCEPTOR AREA

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

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 ditchs, 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.

Then, specific wastewater generation by Kelurahan in 1988, 2000 and 2010 are obtained by dividing the corresponding wastewater generation of each Kelurahan by its sewerage service area. The results are shown in Table 2.1. Specific wastewater generation by sewerage sub-zone in 1988, 2000 and 2010 are also 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. Construction 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 Sewer

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.

Sub-zone	Design Wastewater Discharge (m^3/d)		
	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 Study 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 for treatment plant by sewerage sub-zone is shown in Table 2.2. Its break-down between conventional and interceptor areas is also shown in Table 2.2.

Table 2.1 Specific Wastewater Generation

Sub-Zone A	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1402	KWITANG	45	76.8	93.0	108.0
1403	KENARI	64	35.2	42.8	49.8
1601	KEBON SIRIH	83	60.6	95.5	127.7
1602	GONDANGDIA	146	10.0	20.9	31.0
1603	CIKINI	82	37.7	74.8	109.0
1604	MENTENG	236	27.4	35.9	43.7
1605	PEGANGSAAN	98	57.0	71.3	84.5
Total		754	36.3	52.4	67.2

Sub-Zone B	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1701	KAMPUNG BALI	70	58.2	91.1	121.5
1702	KEBON KACANG	68	68.5	87.5	105.1
1703	KEBON MELATI	110	66.3	85.7	103.6
Total		248	64.6	87.7	109.1

Sub-Zone C	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1106	GAMBIR	154	6.5	21.5	35.3
1401	SENEN	58	27.5	33.4	38.8
Total		212	12.2	24.7	36.3

Sub-Zone D	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1101	CIDENG	85	26.7	37.7	47.9
1103	PETOJO UTARA	112	51.8	75.0	96.4
1104	PETOJO SELATAN	134	34.6	59.2	82.0
Total		331	38.4	59.0	78.1

Sub-Zone E	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1102	DURI PULO	65	90.8	113.8	135.1
1105	KEBON KELAPA	78	62.3	96.5	128.1
1201	MANGA II SEL.	121	58.5	83.7	107.0
1202	KARANG ANYAR	51	107.6	128.0	146.8
1203	KARTINI	48	82.1	109.0	133.9
1204	PASAR BARU	177	77.6	99.6	119.9
3301	PINANGSIA	96	55.0	66.9	77.9
3302	MANGGA BESAR	51	69.3	82.2	94.1
3303	TANGKI	37	101.7	129.2	154.5
3304	GLODOK	38	50.3	66.2	80.9
3305	KEAGUNGAN	32	146.9	204.0	256.7
3306	KRUKUT	55	73.1	96.0	117.2
3307	TAMAN SARI	68	70.7	83.8	95.9
3308	MAHPAR	59	99.7	117.3	133.6
3401	PEKOJAN	78	84.2	93.7	102.5
3402	ROA MALAKA	53	31.8	39.1	45.8
3403	TAMBORA	28	85.2	99.2	112.1
3404	JEMBATAN LIMA	42	94.1	113.3	131.0
3405	ANGKE	68	62.8	80.0	95.9
3406	JEMBATAN BESI	41	89.3	105.1	119.6
3407	KRENDANG	29	124.1	152.3	178.4
3408	TANAH SEREAL	62	94.3	117.8	139.4
3409	DURI U.	67	63.5	72.6	81.0
3410	KALI BARU	17	136.2	156.8	175.9
3411	DURI S.	32	97.4	114.4	130.1
Total		1,493	78.1	98.0	116.5

Sub-Zone F	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
1205	GUNUNG SAHARI U.	121	35.5	43.0	49.9
2206	PADEMANGAN B.	78	52.1	64.3	75.5
2207	PADEMANGAN T.	82	43.8	69.0	92.3
Total		281	42.5	56.5	69.4

Sub-Zone G	Name of Kelurahan	Service Area (ha)	Specific Wastewater Generation (m3/d/ha)		
			1988	2000	2010
3201	GROGOL	95	42.6	51.6	59.9
3202	JELAMBAR	133	52.6	64.7	75.9
3204	TOMANG	172	53.0	64.5	75.1
3210	JELAMBAR BARU	128	66.7	76.4	85.4
Total		528	54.3	65.1	75.1
Grand Total		3,847	56.1	73.5	89.5

Table 2.2 Design Wastewater Discharge by Sub-zone in 2000

Sewerage Sub-Zone	Design Wastewater Discharge (m3/d)				Total
	Conventional Area	Interrceptor Area	Sub-Total	Groundwater Infiltration	
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 TREAMENT PLANT

3.1 General

In general, the following treatment systems are technically applicable to treat the wastewater of the Project Area to a level of 30 mg/l as BOD.

- Conventional activated sludge system
- Extended aeration system
- Oxidation ditch system
- Rotating biological contactor system
- Aerated lagoon system

Among them, aerated lagoon system is most economical in this Project Area, because necessary land space required for this system is available in the north coast area of the Jakarta Bay. The following three (3) alternatives sites are available for construction of the 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

The above three (3) alternative sites are compared in this Chapter.

3.2 Design Criteria

The respective altenative 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.

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 of 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 existing pond with a storage capacity of 2,240,000 m^3 is used for flood control.

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.

Collected wastewater of 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 site.

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 study are as follows (Ref. Fig. 3.4).

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

The estimated direct construction cost and annual O&M cost are shown in Table 3.1.

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 installed at the downstream end of the above conveyance sewer 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. Layout of the treatment plant is shown in Fig. 3.2.

3.4.2 Estimated Cost

The objective facilities and works for cost comparison in this alternative study are as follows (Ref .Fig. 3.4).

(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 shown in Table 3.1.

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 Altenative 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 study are as follows (Ref. Fig. 3.4)

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

The estimated direct construction cost and annual O&M cost are shown in Table 3.1.

3.6 Conclusion

As evident from Table 3.1, Alternative Plan A is the most economical one. Alternative Plan A, with aerated lagoon at existing Pluit Pond, is recommended.

Table 3.1 Estimated Construction and O&M Costs of Three (3) Alternatives

(1) Alternative Plan A

(Unit:Rp.billion)

	Construction Cost	Annual O&M COST
Inflow Pump Station	20.7	2.1
Open Ditch	0.5	0.1
Treatment Plant	19.5	6.7
Total	40.7	8.9

(2) Alternative Plan B

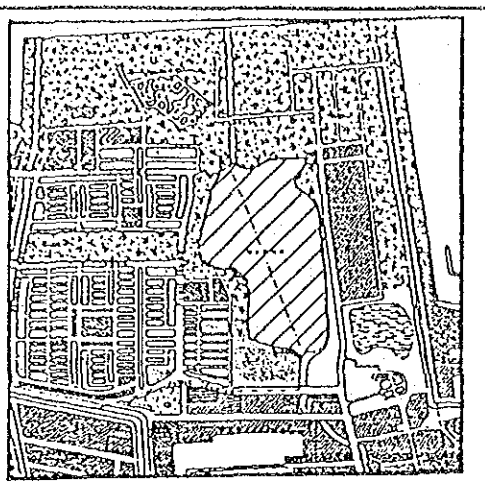
(Unit:Rp.billion)

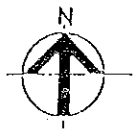
	Construction Cost	Annual O&M COST
Booster Pump Station	25.9	3.3
Conveyance Force Main	34.0	0.2
Treatment Plant	29.3	6.7
Land Acquisition	5.6	-
Total	94.8	10.2

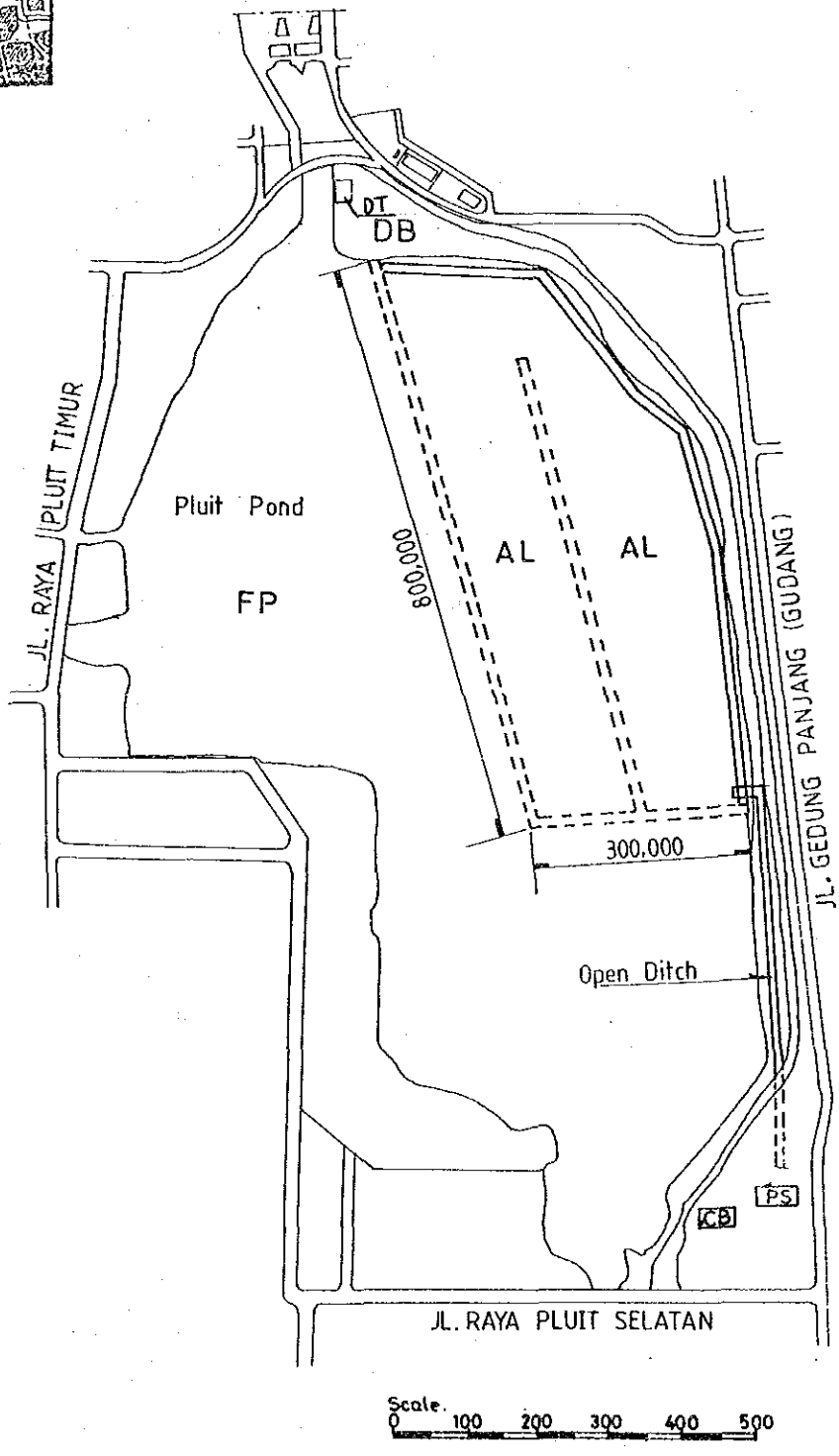
(3) Alternative Plan C

(Unit:Rp.billion)

	Construction Cost	Annual O&M COST
Lift Up Pump Station	20.7	2.1
Open Ditch	1.2	0.1
Treatment Plant	39.2	6.7
Total	61.1	8.9







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)

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

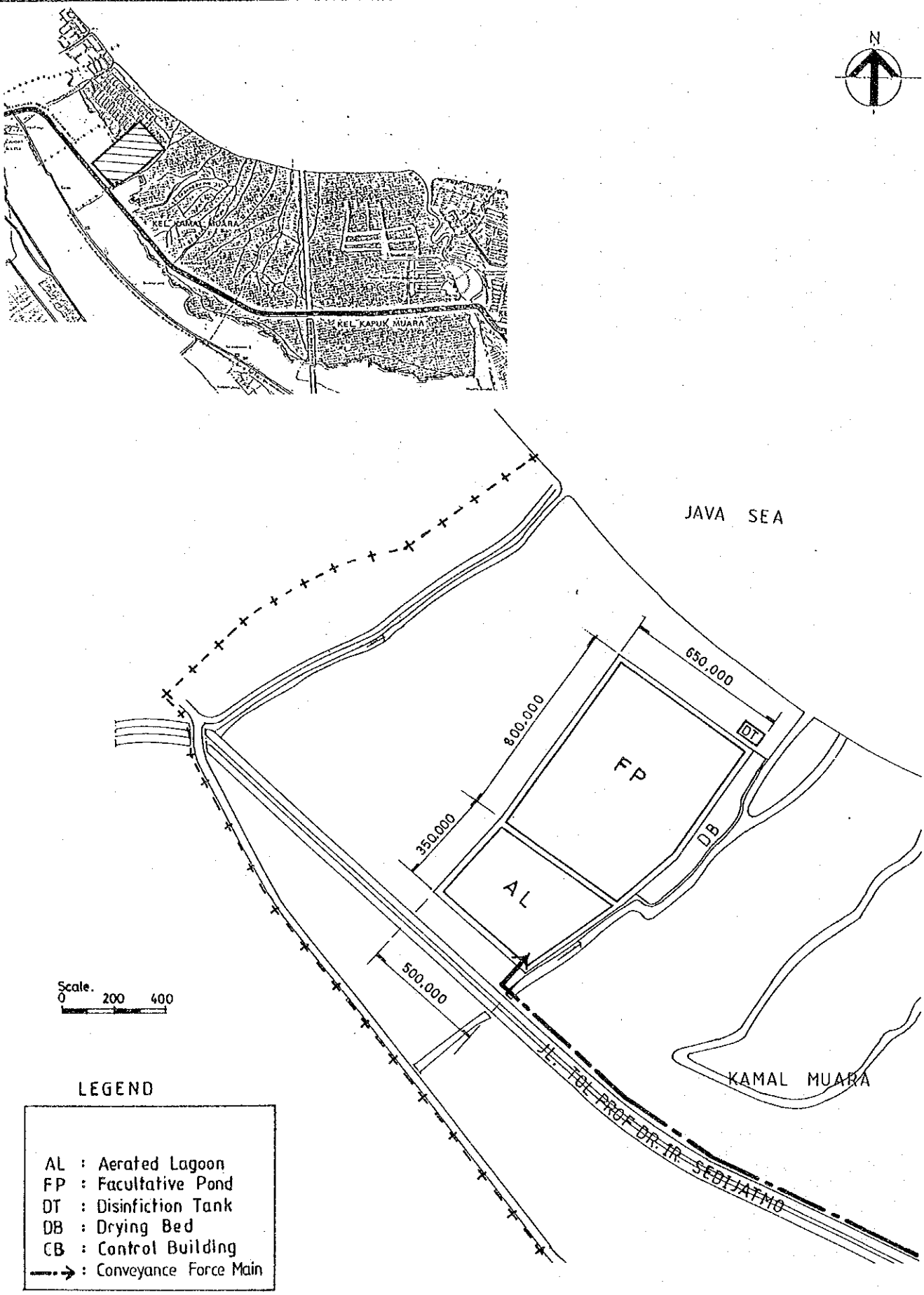
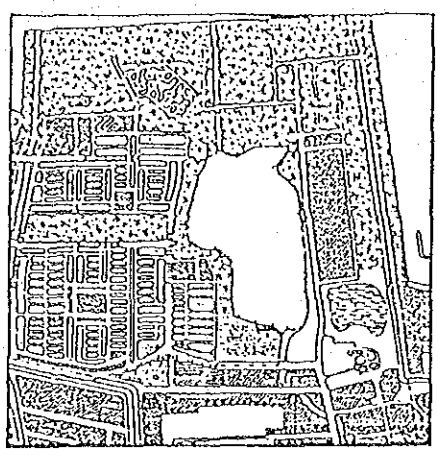
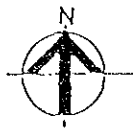
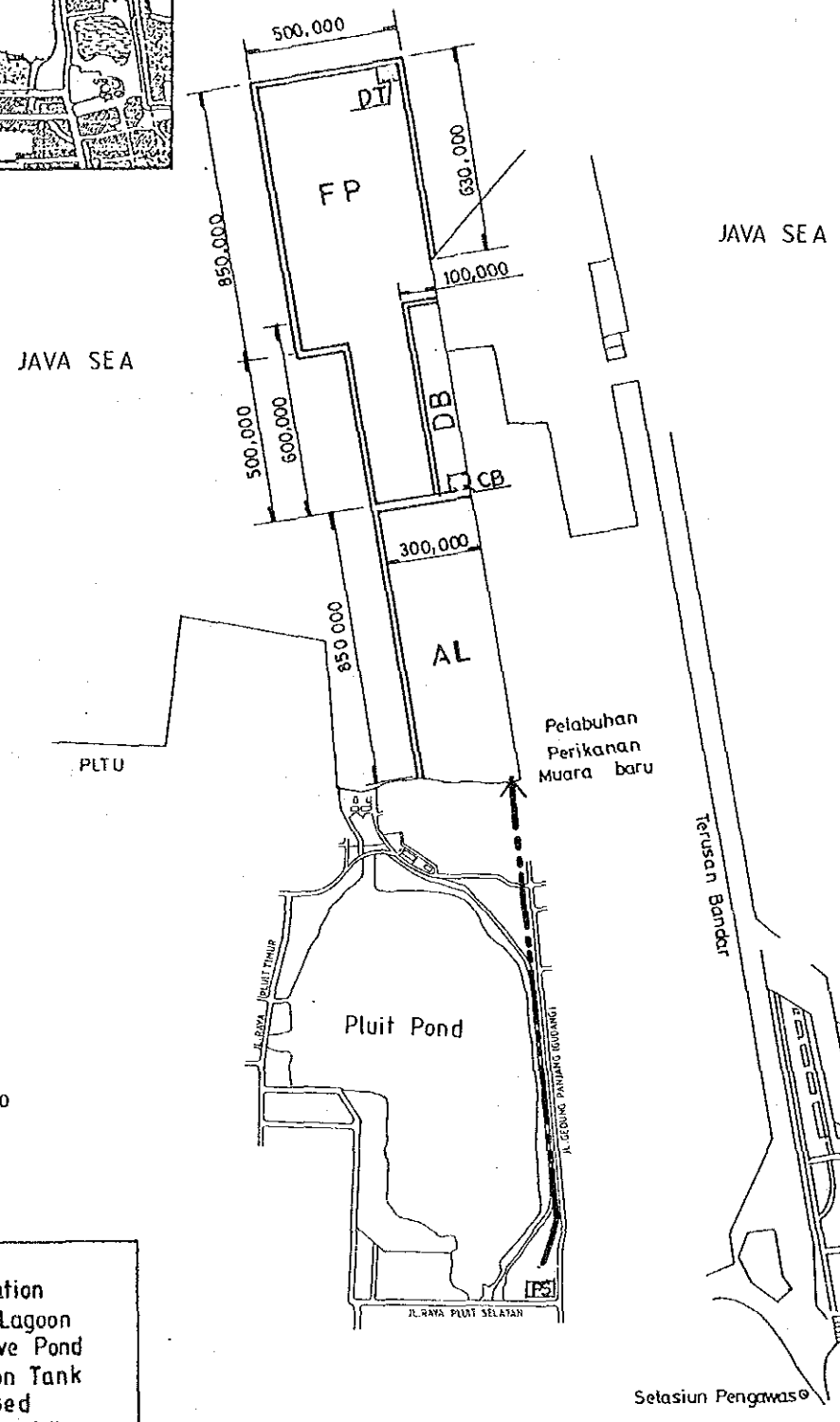


FIG. 3.2 AERATED LAGOON IN KEL. KAMAL MUARA (ALTERNATIVE PLAN B)

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







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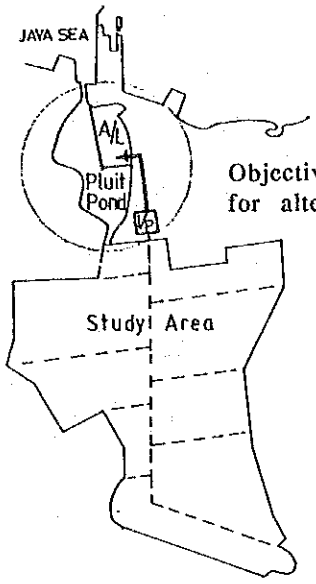
LEGEND

PS : Pump Station
AL : Aerated Lagoon
FP : Facultative Pond
DT : Disinfiction Tank
DB : Drying Bed
CB : Control Building
→ : Open Ditch & Culvert

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

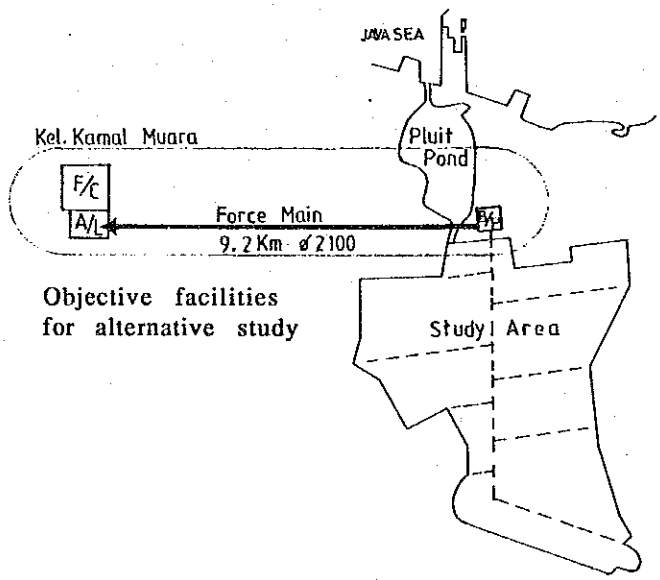
THE STUDY ON URBAN DRAINAGE AND WASTE WATER DISPOSAL PROJECT IN THE CITY OF JAKARTA

Alternative Plan A



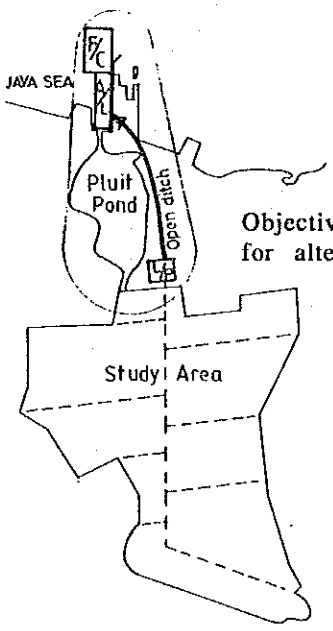
Objective facilities for alternative study

Alternative Plan B



Objective facilities for alternative study

Alternative Plan C



Objective facilities for alternative study

FIG. 3.4 OBJECTIVE FACILITIES OF EACH ALTERNATIVE PLAN

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) Working 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	Open Trench				Shield Tunnelling			
depth	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	15.4	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.

While, required pipe diameter and earth covering depth of the trunk and main sewers connecting to the conveyance sewer vary, depending on location of the conveyance sewer route. However, total length of the trunk and main sewers is almost constant regardless of location of the conveyance sewer route.

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

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

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. (See 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 sewer length by diameter is shown below.

Diameter (mm)	Sewer Length (m)
1,900	1,385
2,100	1,110
2,200	1,460
2,300	1,300
2,400	1,110
2,600	1,320
2,700	1,220
2,900	1,435
Total	10,340

The profile of the conveyance sewer is shown in Fig. 4.3.

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 (Ref. Table 4.1). The total length of the main and trunk sewers by earth covering depth are shown in Table 4.2. The length with earth covering depth deeper than 6.0m account for 24%, while the length shallower than 4.0m a 44%. Hence, open trench method is applied in cost estimation of the main and trunk sewers.

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. 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 western and eastern conveyance sewer routes are shown in Fig. 4.2.

The western conveyance sewer has a total length of 8,385m with a diameter of 2,000 ~ 2,900mm. The earth covering depth is 9.3 ~14.0 m. The total length of the eastern conveyance sewer is 9,300m. Its diameter and earth covering depth is 1,000 ~ 2,100mm and 6.7 ~ 11.7 m, respectively.

The length of both western and eastern conveyance sewers by diameter are shown below.

Diameter (mm)	Sewer Length (m) Western	Eastern
1,000		1,860
1,200		1,090
1,350		1,280
1,650		1,550
1,800		1,430
2,000	2,480	1,430
2,100	900	660
2,200	1,620	
2,300	1,950	
2,900	1,435	
	8,385	9,300

The profiles of the western and eastern conveyance sewers are shown in Fig. 4.4 and Fig. 4.5 respectively.

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 (Ref. Table 4.1). The length with earth covering depth deeper than 6.0m account for 18%, while the length shallower than 4.0m a 48%.

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

Open trench method is also applied in cost estimation of the main and trunk sewers of Alternative B, 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.

Table 4.1 Length of Main & Trunk Sewers of Each Alternative

	Alternative A	Alternative B
Main Sewers (ø 350~ø 800)	60,455 m	70,580 m
Trunk Sewers (ø 900~ø1500)	17,530 m	6,670 m
Total	77,985 m	77,250 m

Table 4.2 Length of Main & Trunk Sewers of Each Earth Covering Depth

Earth Covering Depth (m)	Alternative Plan A	Alternative Plan B
H<2m	6,920 m (8.9%)	7,725m (10.0%)
2m≤H<4m	27,240 m (34.9%)	29,070m (37.6%)
4m≤H<6m	25,280 m (32.4%)	26,660m (34.5%)
6m≤H<8m	13,275m (17.0%)	10,320 m (13.4%)
8m≤H	5,270 m (6.8%)	3,475 m (4.5%)
Total Length	77,985 m	77,250m

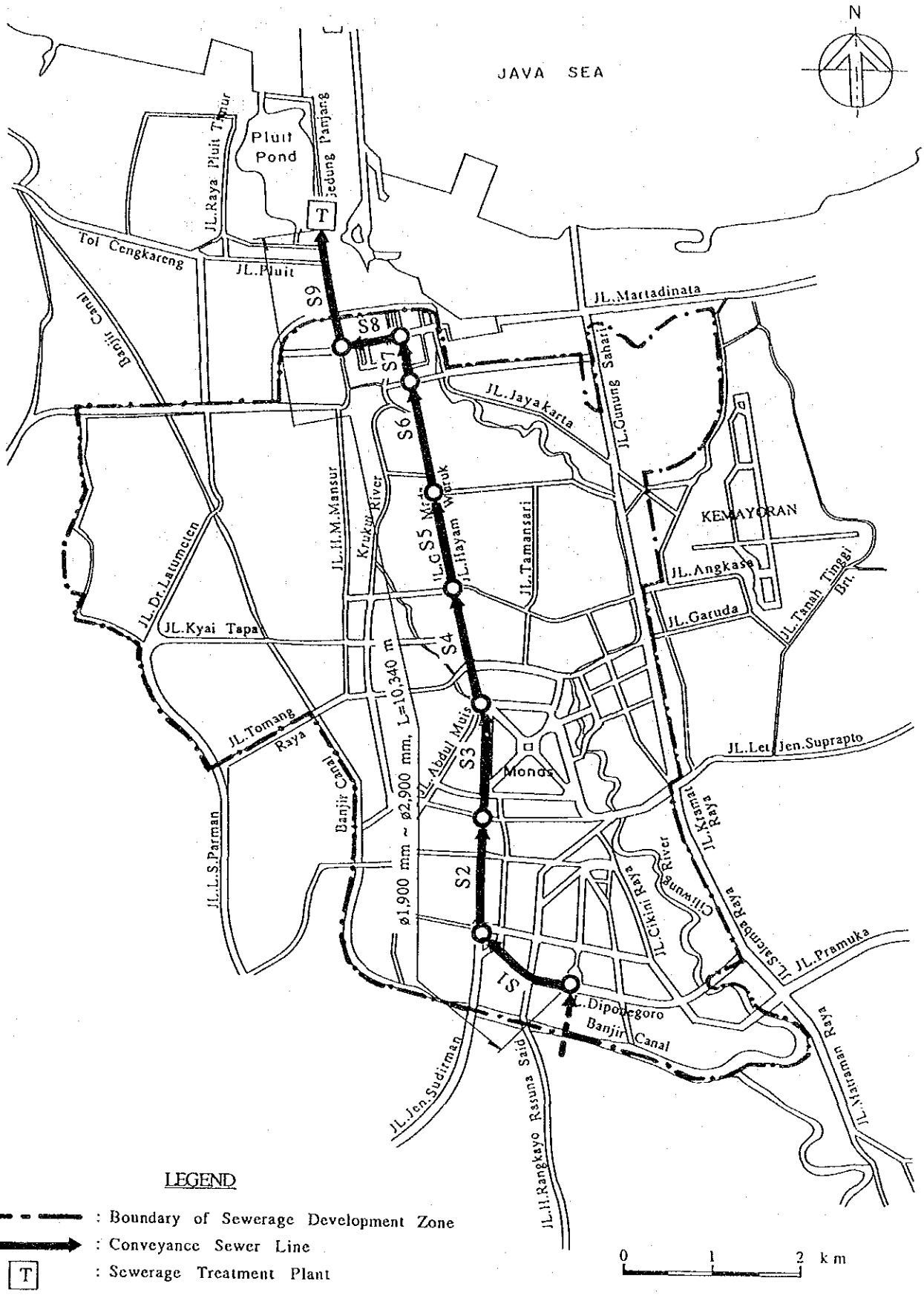


FIG. 4.1 ALTERNATIVE PLAN A (SINGLE CONVEYANCE SEWER)

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

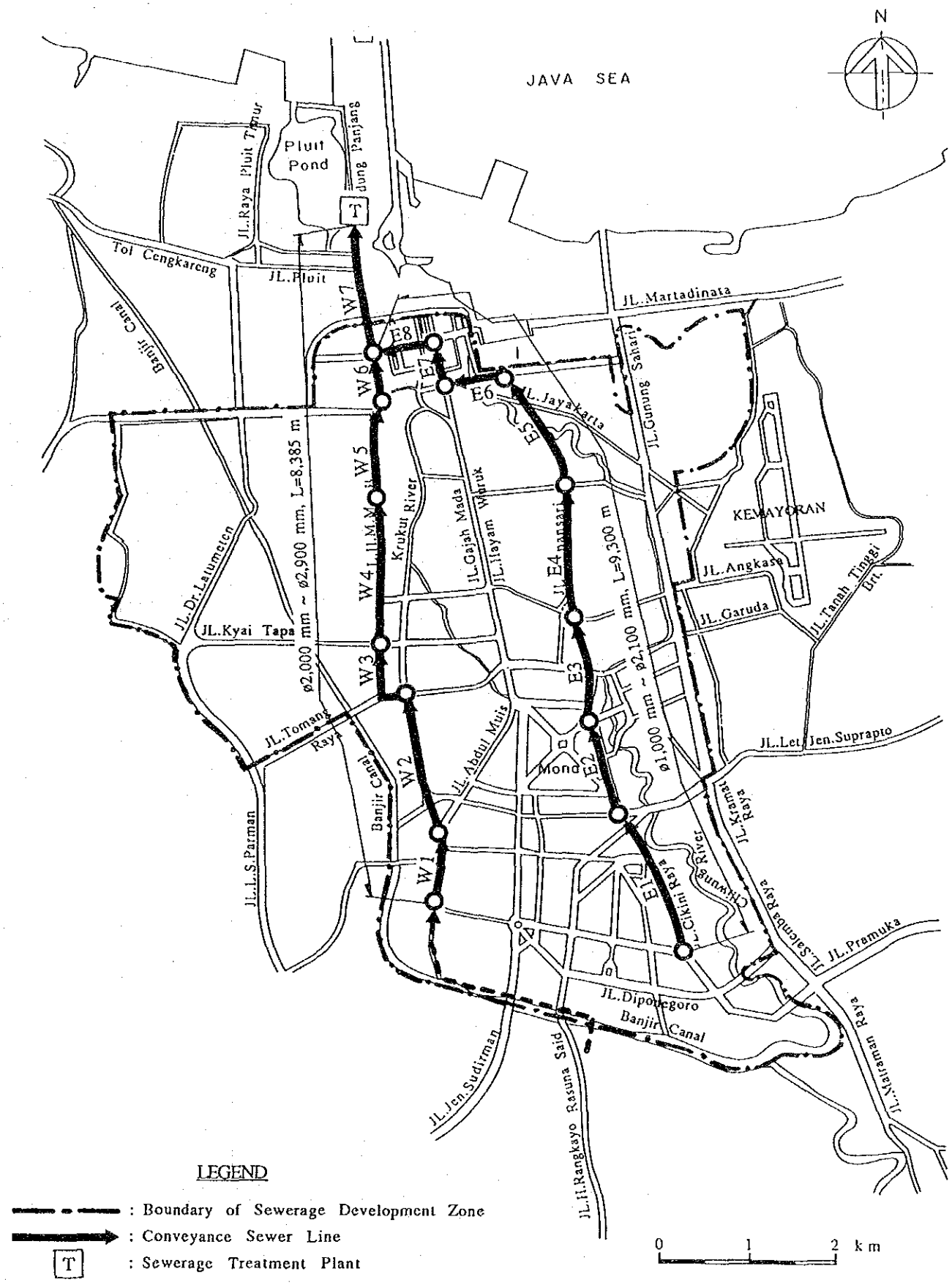
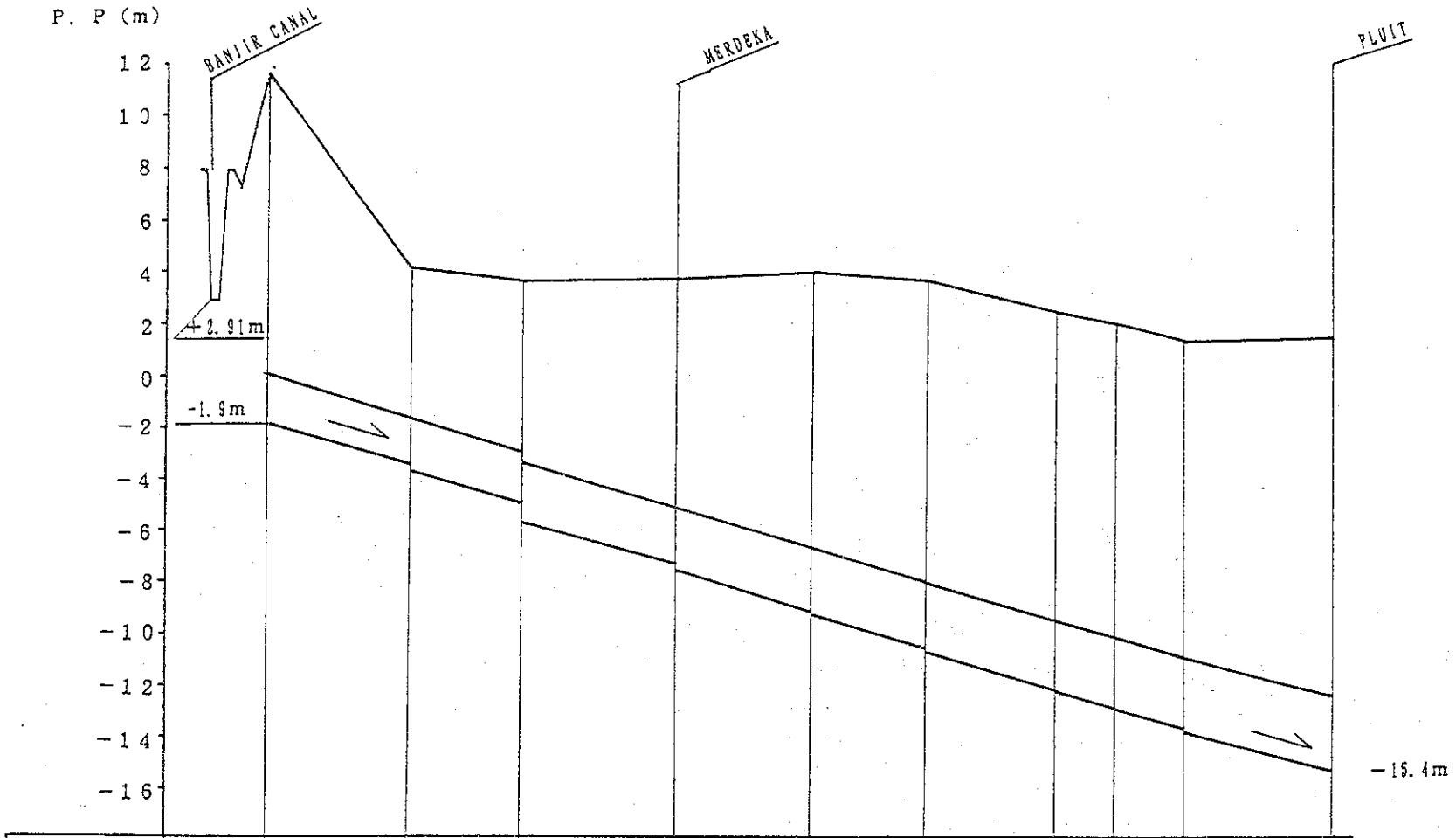


FIG. 4.2 ALTERNATIVE PLAN B (DOUBLE CONVEYANCE SEWER)

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



LINE NO	S1	S2	S3	S4	S5	S6	S7	S8	S9
Diameter (mm)	⊙1900	⊙2100	⊙2200	⊙2300	⊙2400	⊙2600	⊙2700	⊙2700	⊙2900
Length (m)	1385	1110	1460	1300	1110	1320	560	660	1435
Slope (%)	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.0

FIG. 4.3 PROFILE OF SINGLE CONVEYANCE SEWER (ALTERNATIVE PLAN A)

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

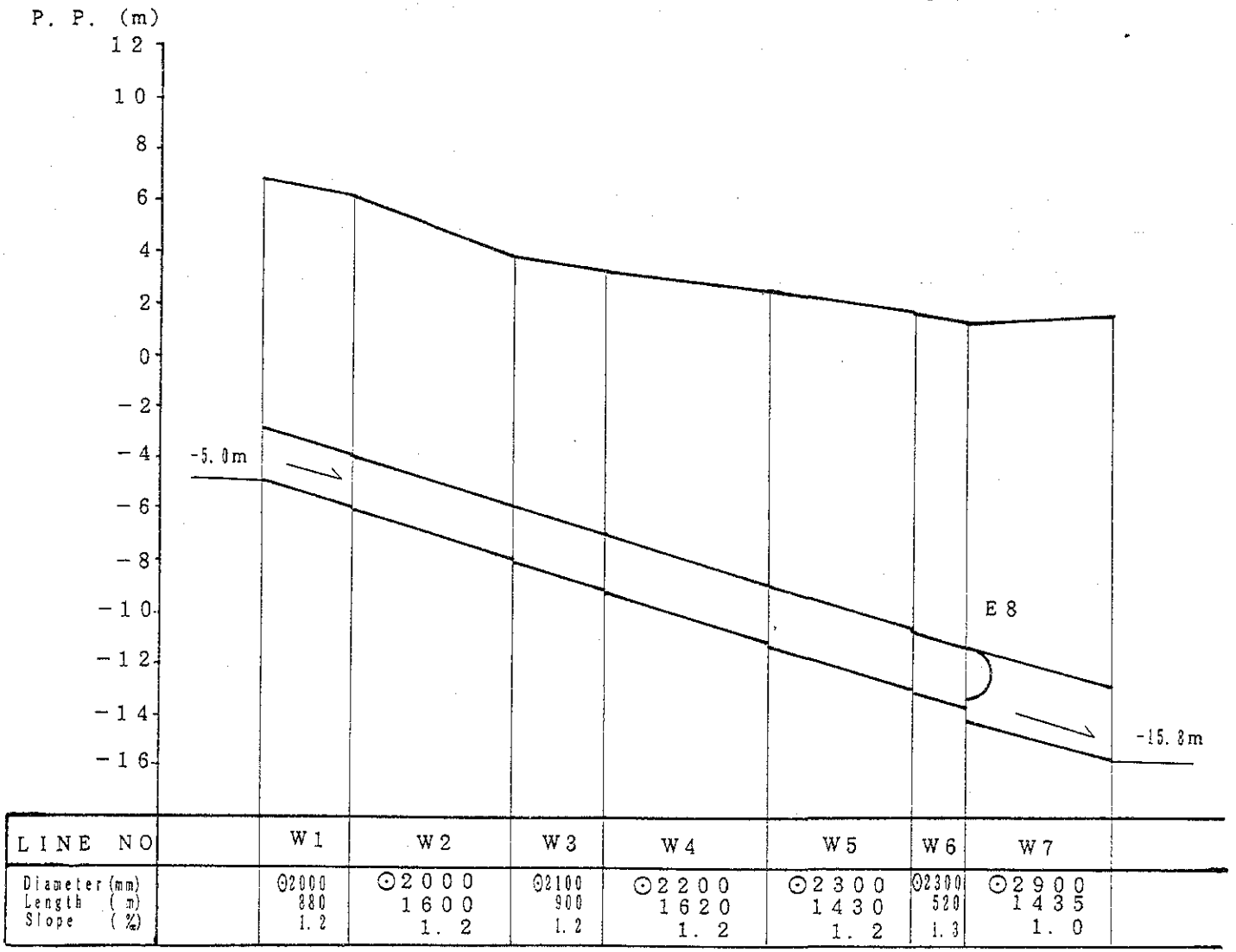
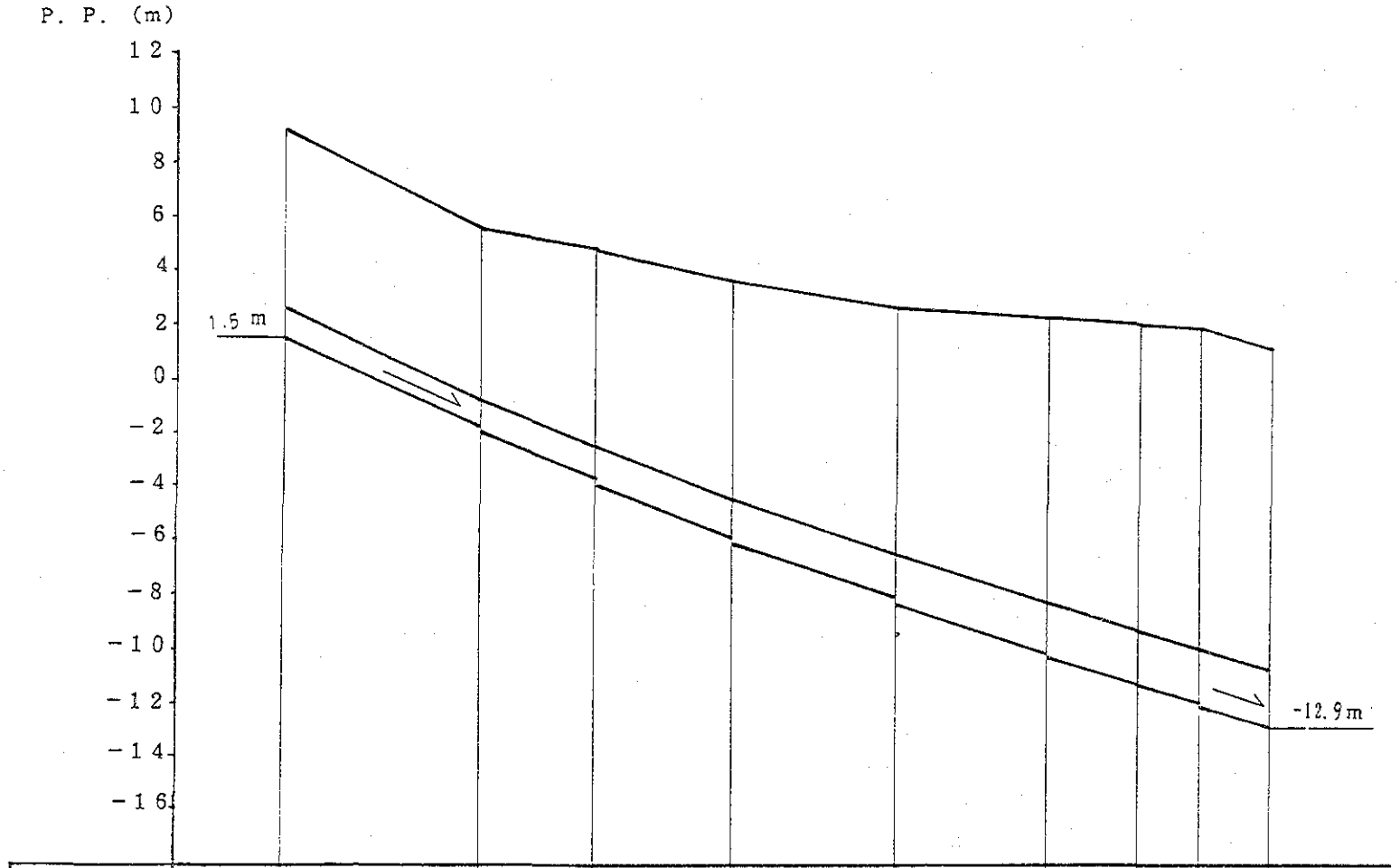


FIG. 4.4 PROFILE OF WESTERN CONVEYANCE SEWER (ALTERNATIVE PLAN B)

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



LINE NO	E1	E2	E3	E4	E5	E6	E7	E8
Diameter (mm)	⊙1000	⊙1200	⊙1350	⊙1650	⊙1800	⊙2000	⊙2000	⊙2100
Length (m)	1860	1090	1280	1550	1430	870	560	660
Slope (%)	1.8	1.6	1.5	1.3	1.2	1.2	1.2	1.2

FIG. 4.5 PROFILE OF EASTERN CONVEYANCE SEWER (ALTERNATIVE PLAN B)

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 150mm and 300mm.

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

(i) conventional area of high income level (low population density area) : Type A
(ii) conventional area of medium income level (medium population density area) : Type B
(iii) interceptor area (low income level area or high population density area) : Type C

As the typical areas of Type A, Type B and Type C, Kel. Gondangdia was selected for Type A, Kel. Cideng for Type B and Kel. Duri Utara & Duri Selatan for Type C (Ref. Fig.5.1)

Sample design of secondary & tertiary sewer networks were carried out for the above three (3) areas. The designed sewer line length by diameter in three (3) areas are shown in Table 5.2. Layout of the

designed sewer networks in the three (3) areas are shown in Fig.5.2-Fig.5.4.

Secondary & tertiary sewer lengths of the Project Area are estimated based on the above sample design. The total length is 462,500m. The length by sub-zone and by diameter is shown in Table 5.3.

(3) Main Sewer

Diameter of the proposed main sewer ranges from 350mm to 800mm. Its total length is 59,995m. The sewer length by sub-zone and diameter for the whole Project Area is shown in Table 5.3.

(4) Trunk Sewer

Diameter of the proposed trunk sewer ranges from 900mm to 1,500mm. Its length is 17,290m. The sewer length by sub-zone and by diameter is also shown in Table 5.3.

(5) 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 G sub-zone. Its design pump capacity is 1.05 m^3/s for the year 2000. The salient features of the pump station are shown in Table 5.4. Layout of the lift pump station is shown in Fig. 5.5 (1)-(3).

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 Area in the future. The sewer has a total length of 10,340m with a diameter of 1,900mm to 2,900mm. The invert elevation of the sewer is -1.9m p.p. at Jl. Madiun and -15.4m p.p. at Pluit Pond.