Fig.H-3 Proposed Long-Term Plan of Bunut River (1/3)

(Dike Alignment)

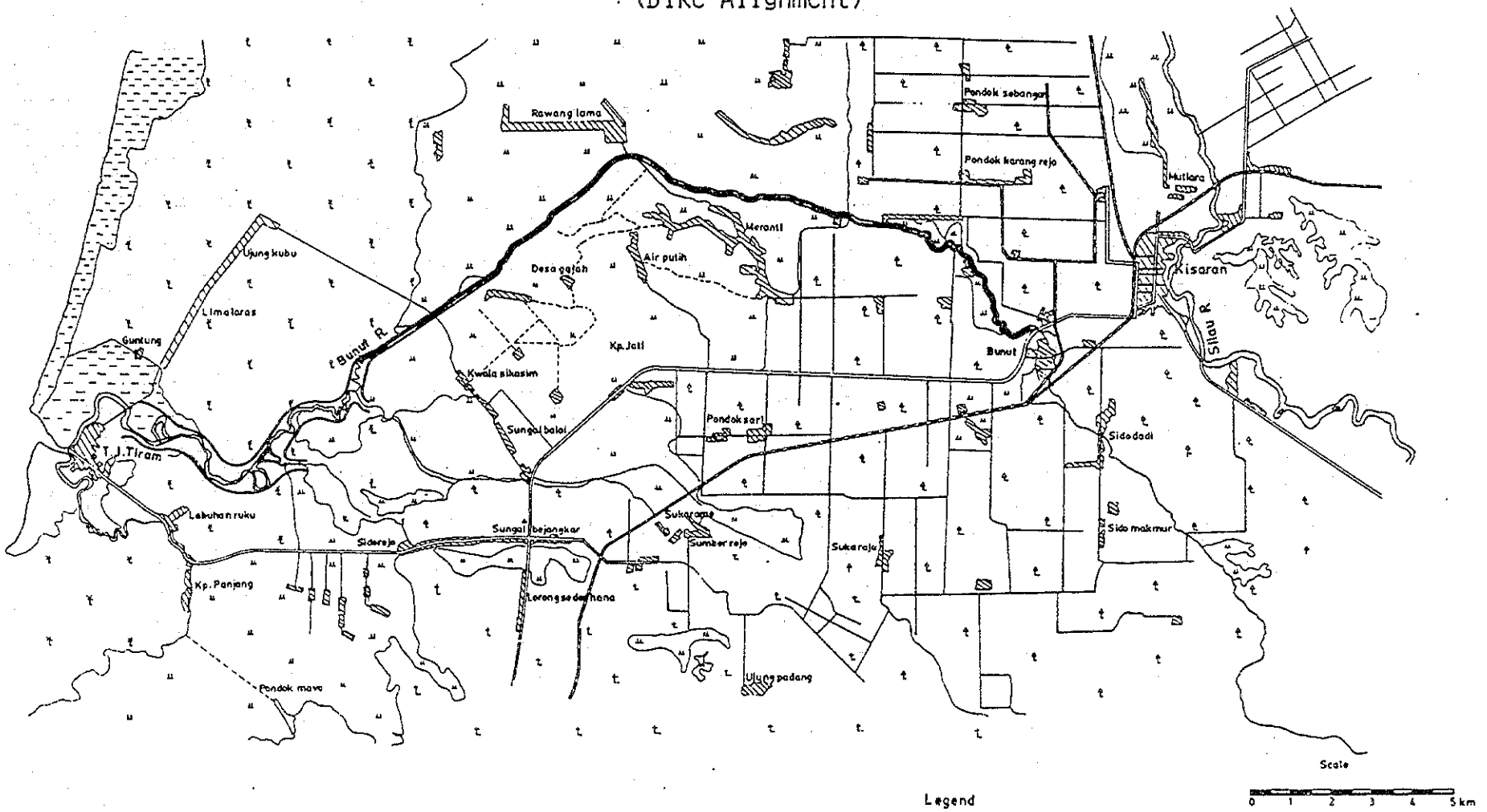


Fig.H-3 Proposed Long-Term Plan of Bunut River (2/3)
(Longitudinal Profile)

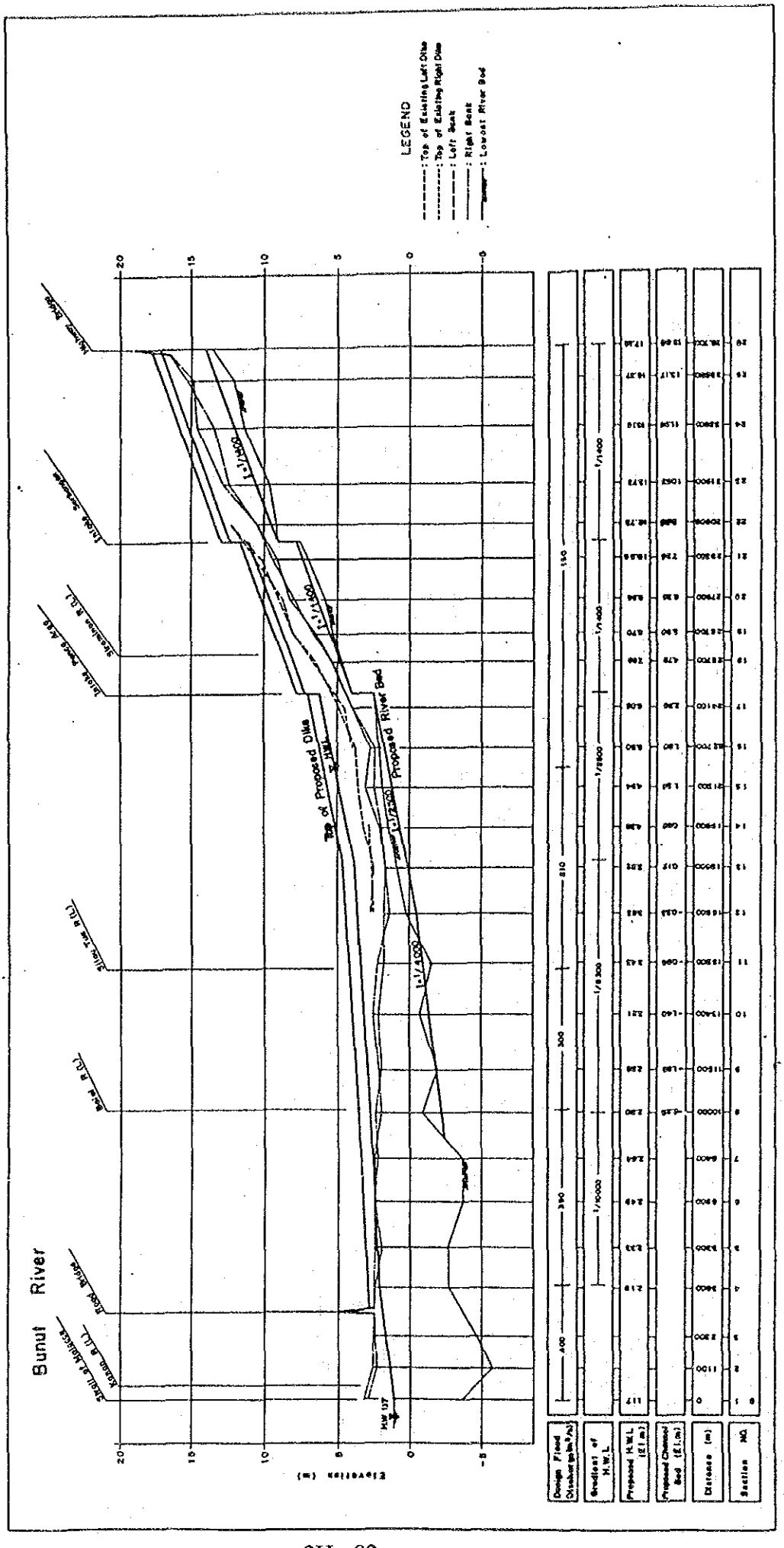


Fig.H-3 Proposed Long-Term Plan of Bunut River (3/3)

(Cross-section)

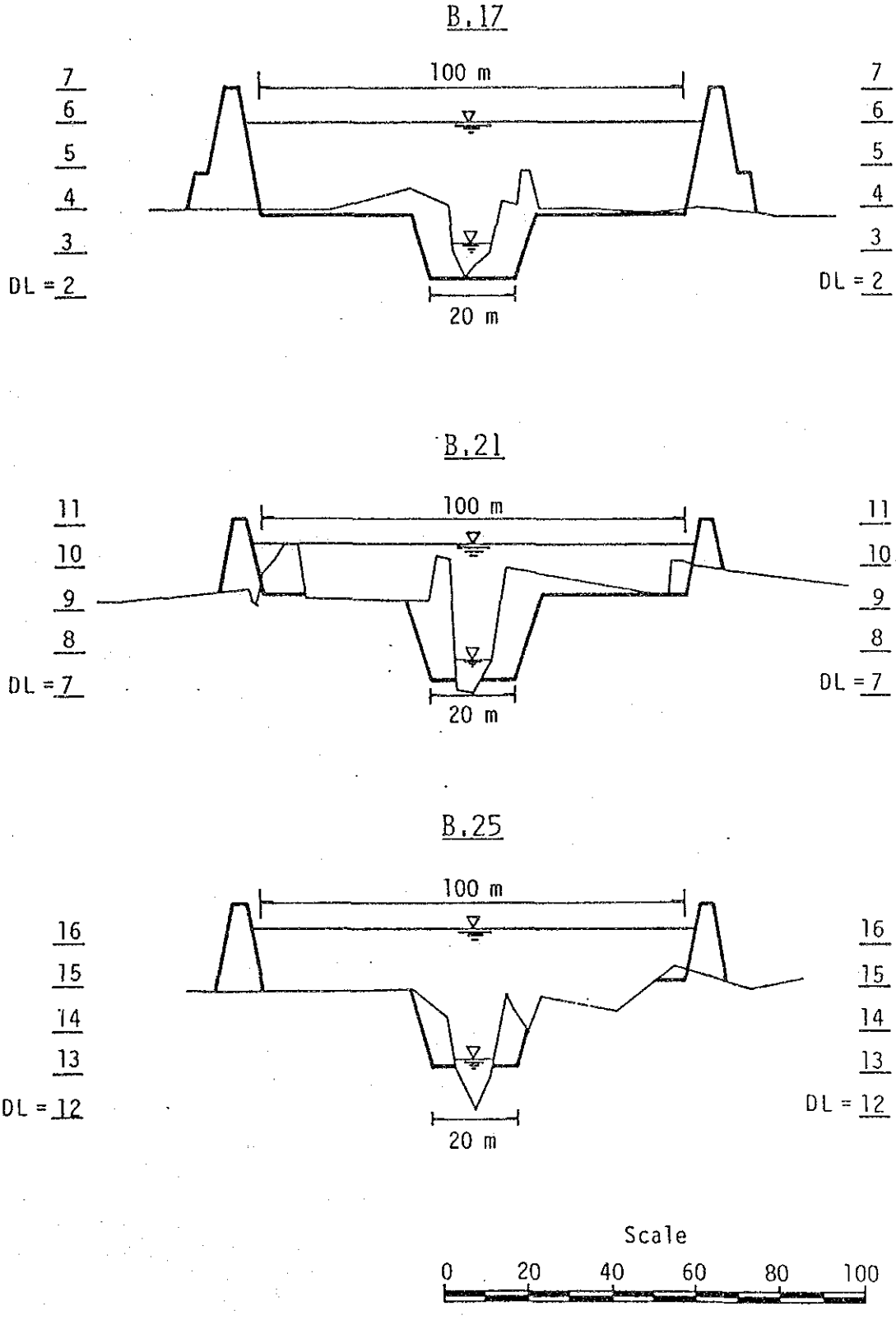


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (1/6)

(Dike Alignment)

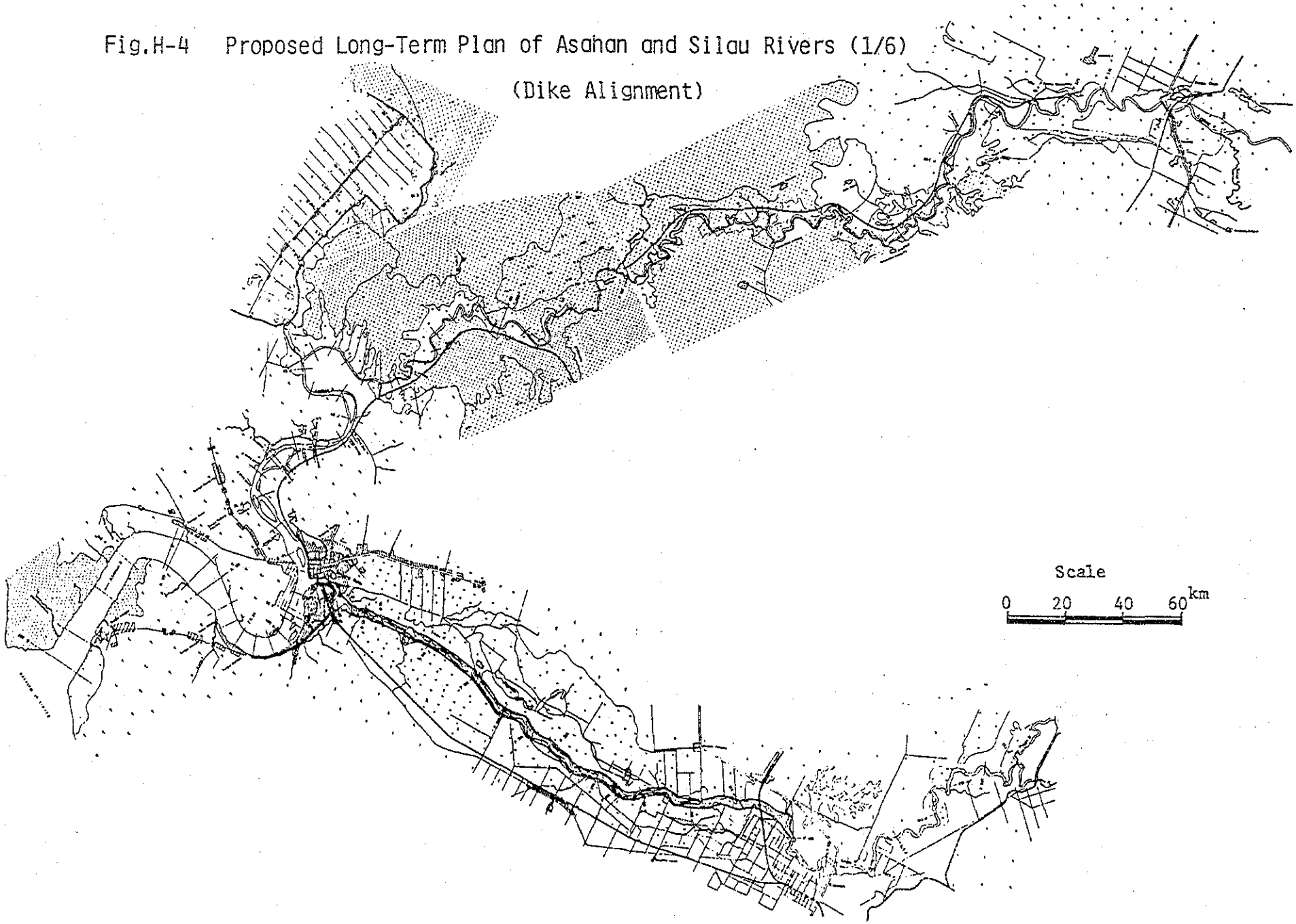


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (2/6)

(Longitudinal Profile of Asahan River)

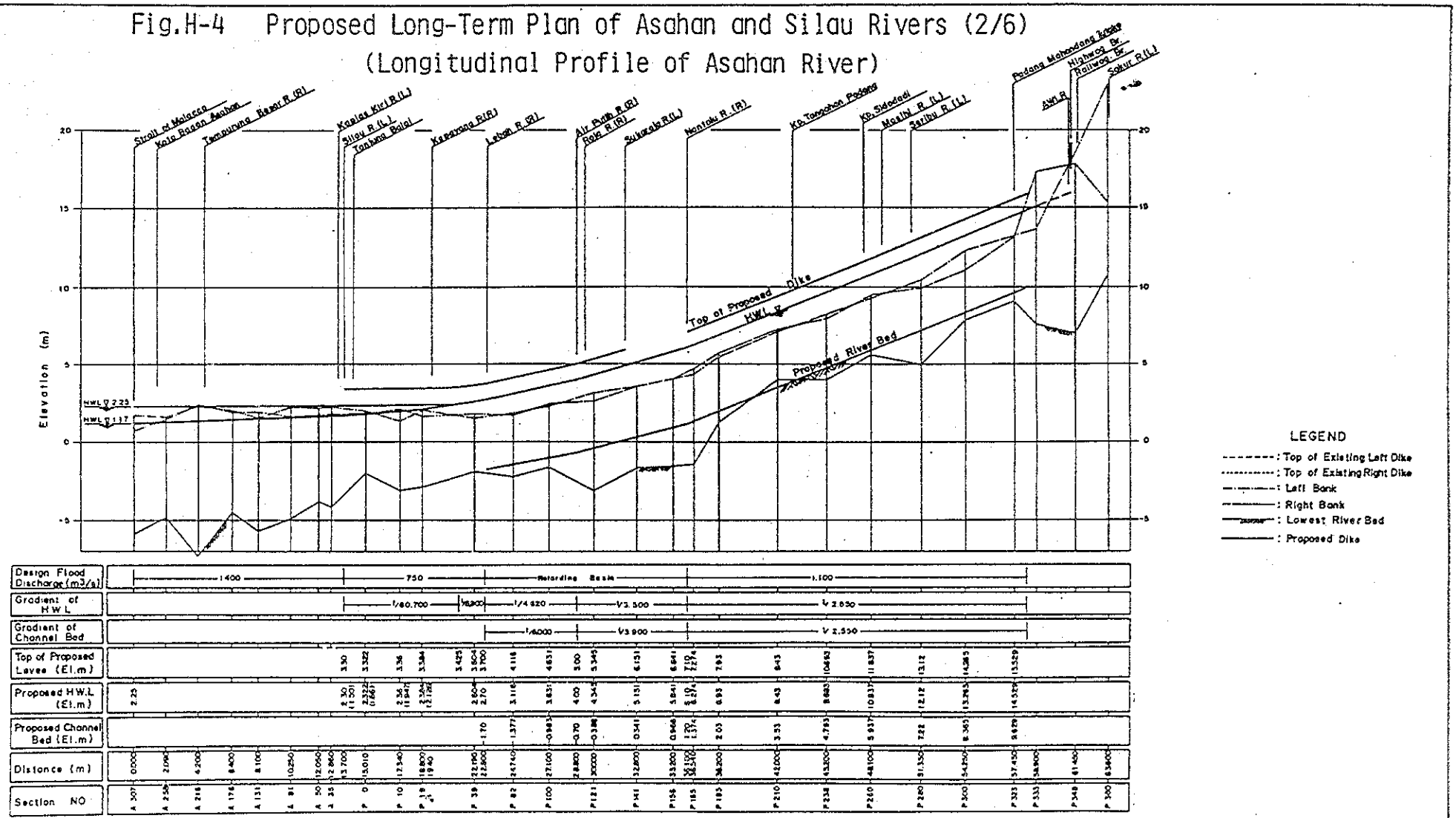


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (3/6)

(Cross-sections of Asahan River)

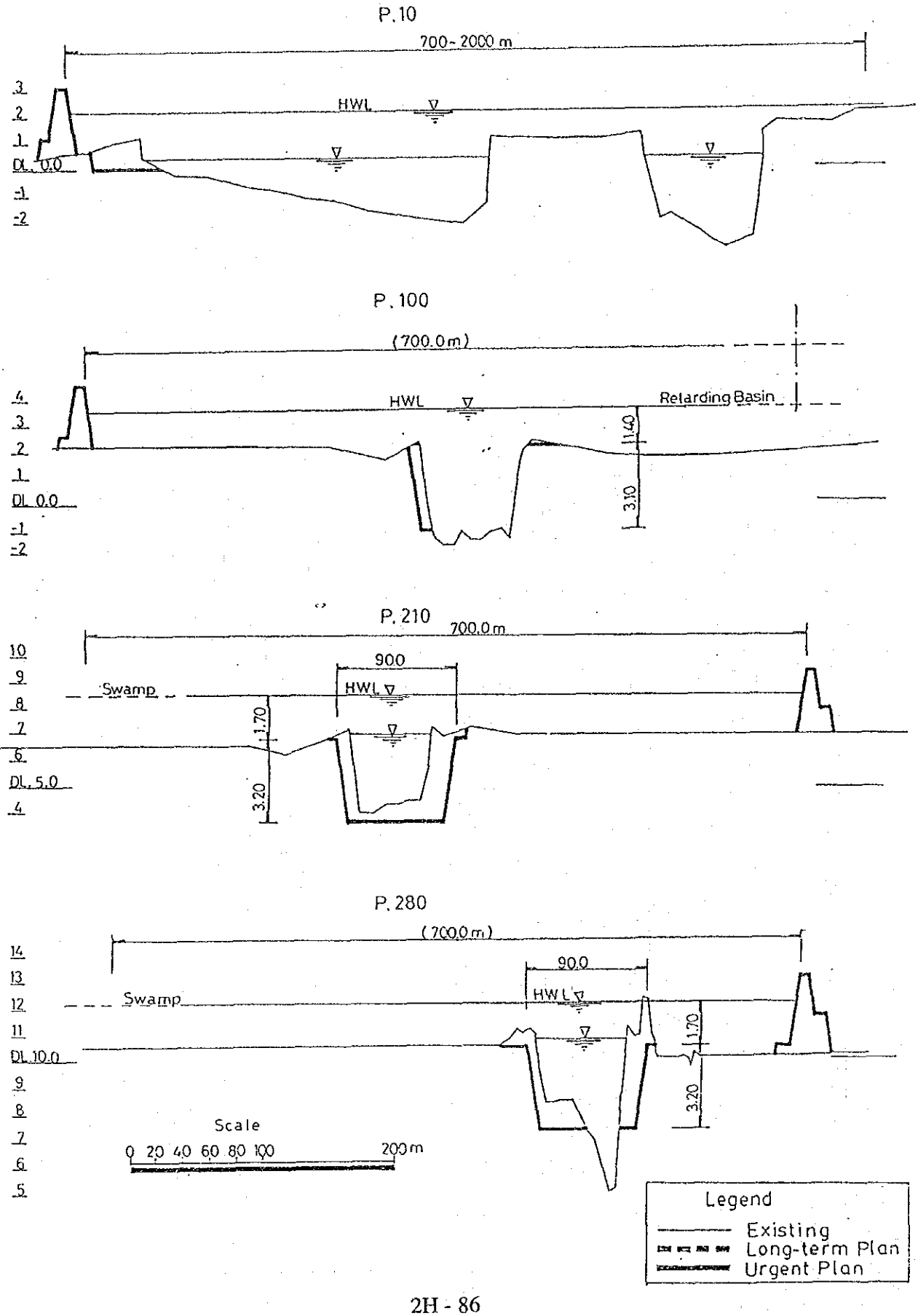
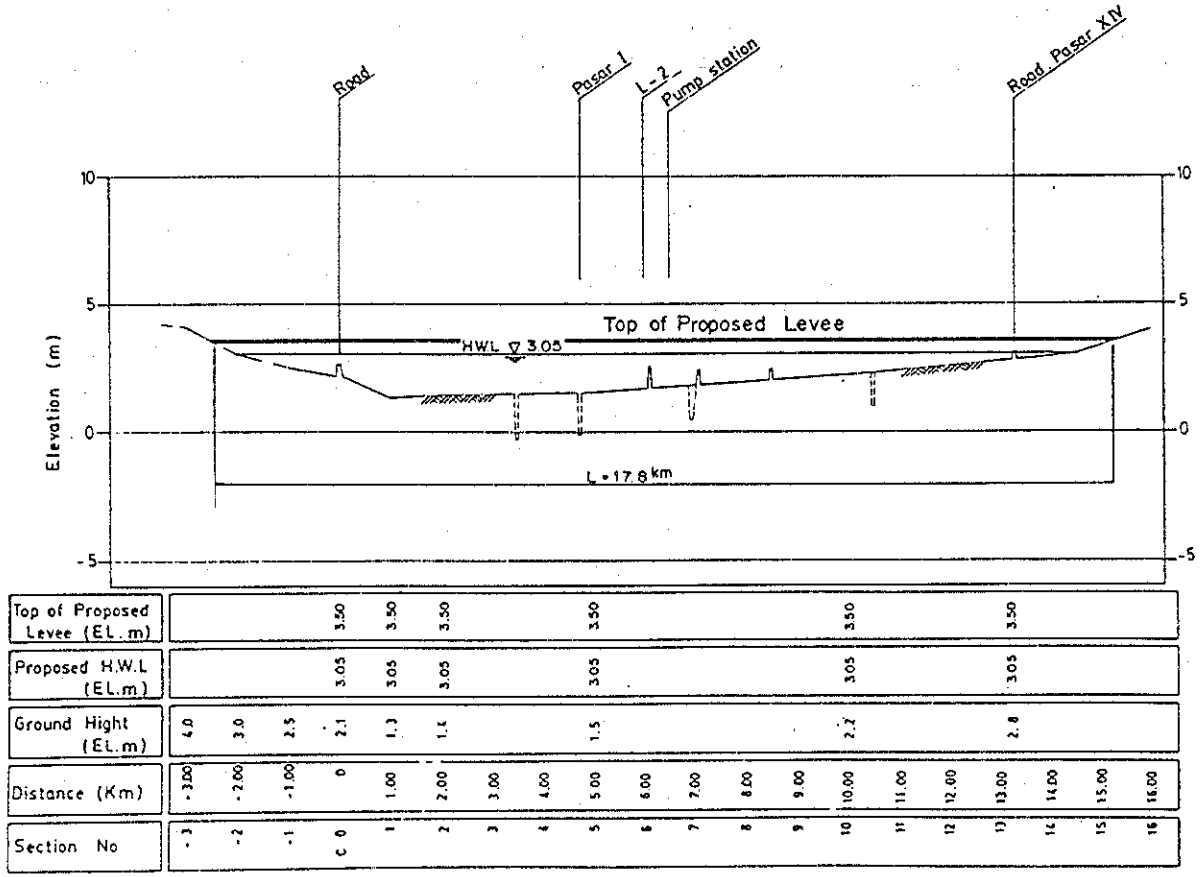
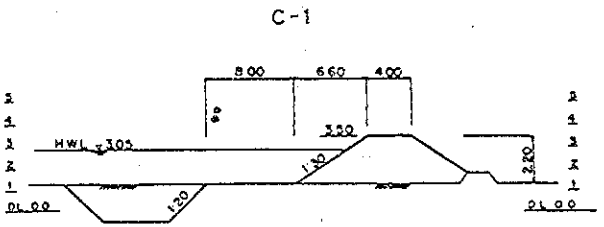
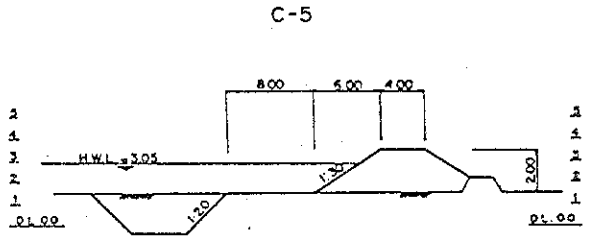


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (4/6)

(Longitudinal Profile and Cross-sections of Lebah River)







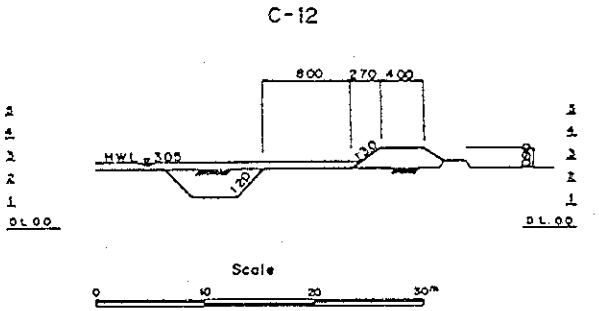


Fig.H-4 Proposed Long-Term Plan of Asahan AND Silau Rivers (5/6)

(Longitudinal Profile of Silau River)

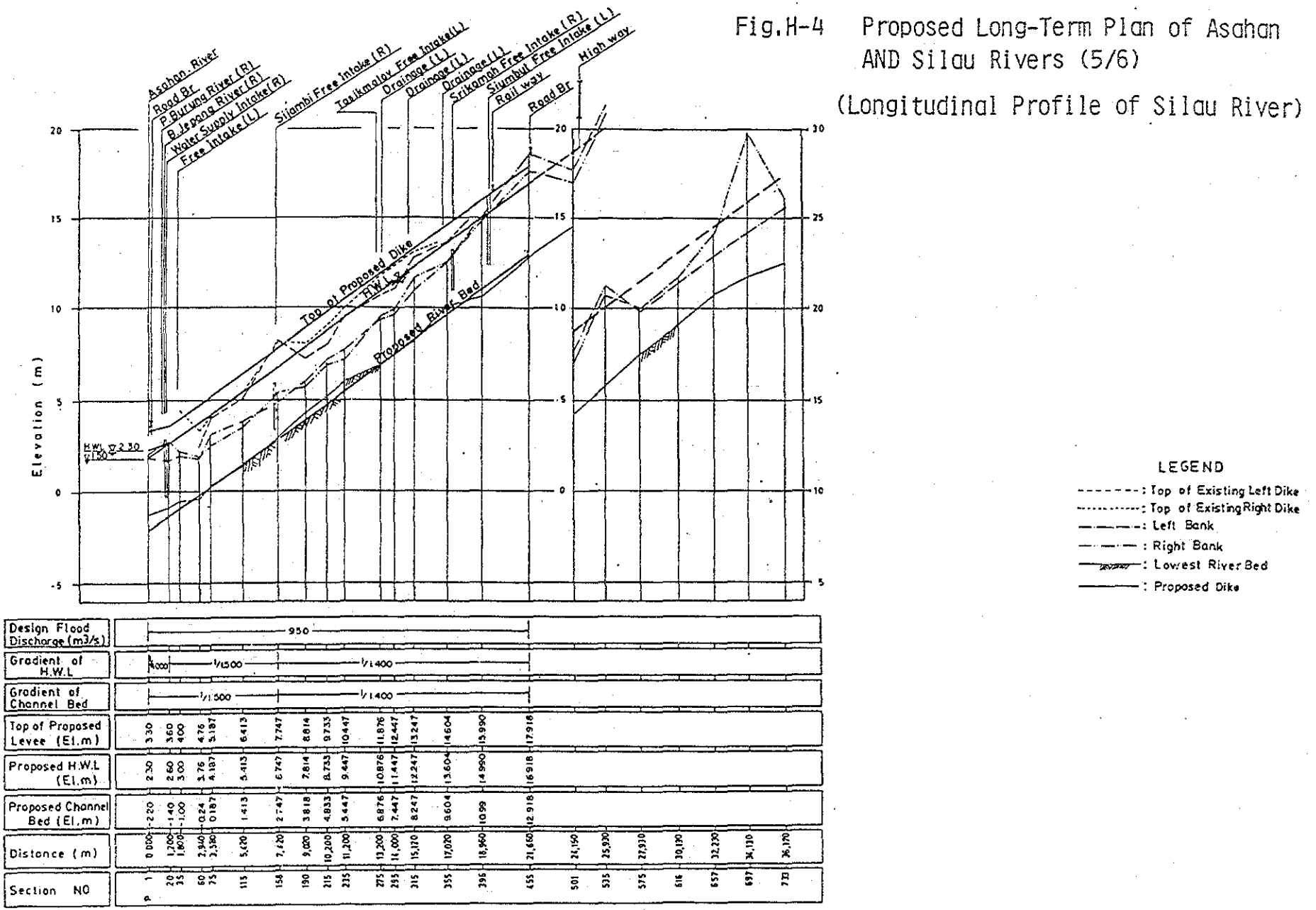


Fig.H-4 Proposed Long-Term Plan of Asahan and Silau Rivers (6/6)

(Cross-sections of Silau River)

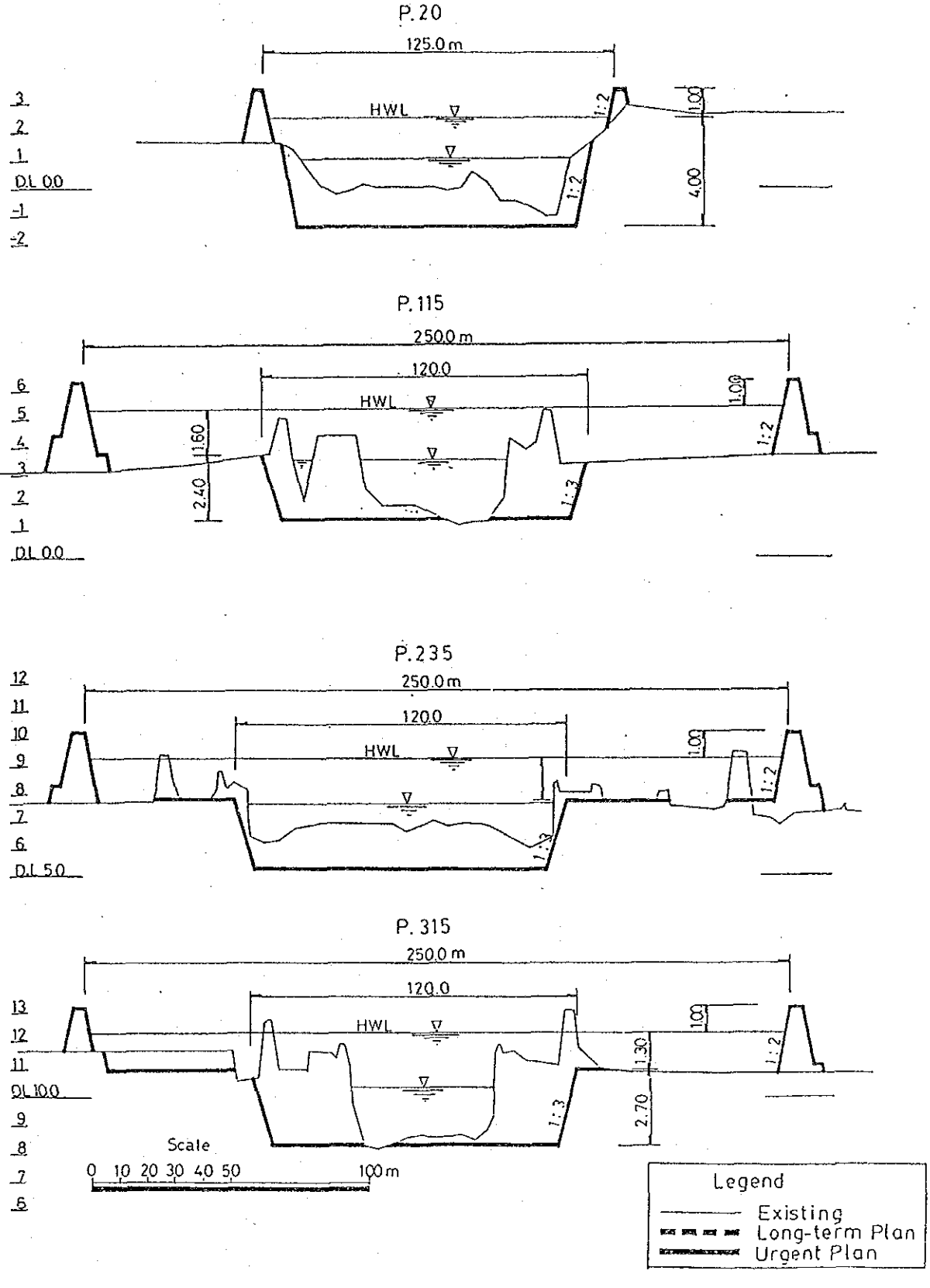


Fig.H-5 Proposed Long-Term Plan of Kualuh River (1/3)

(Dike Alignment)

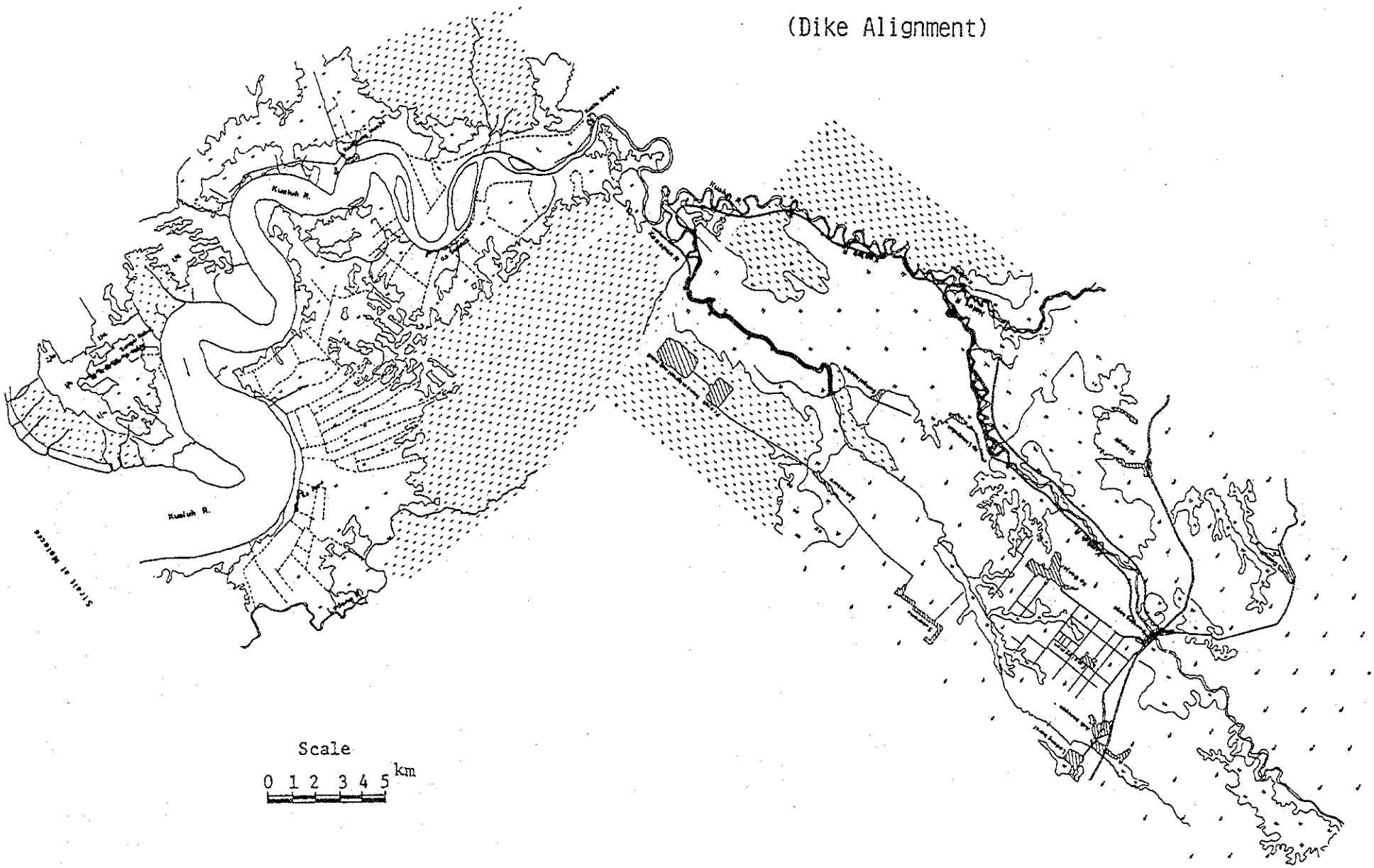


Fig.H-5 Proposed Long-Term Plan of Kualuh River (2/3)
(Longitudinal Profile)

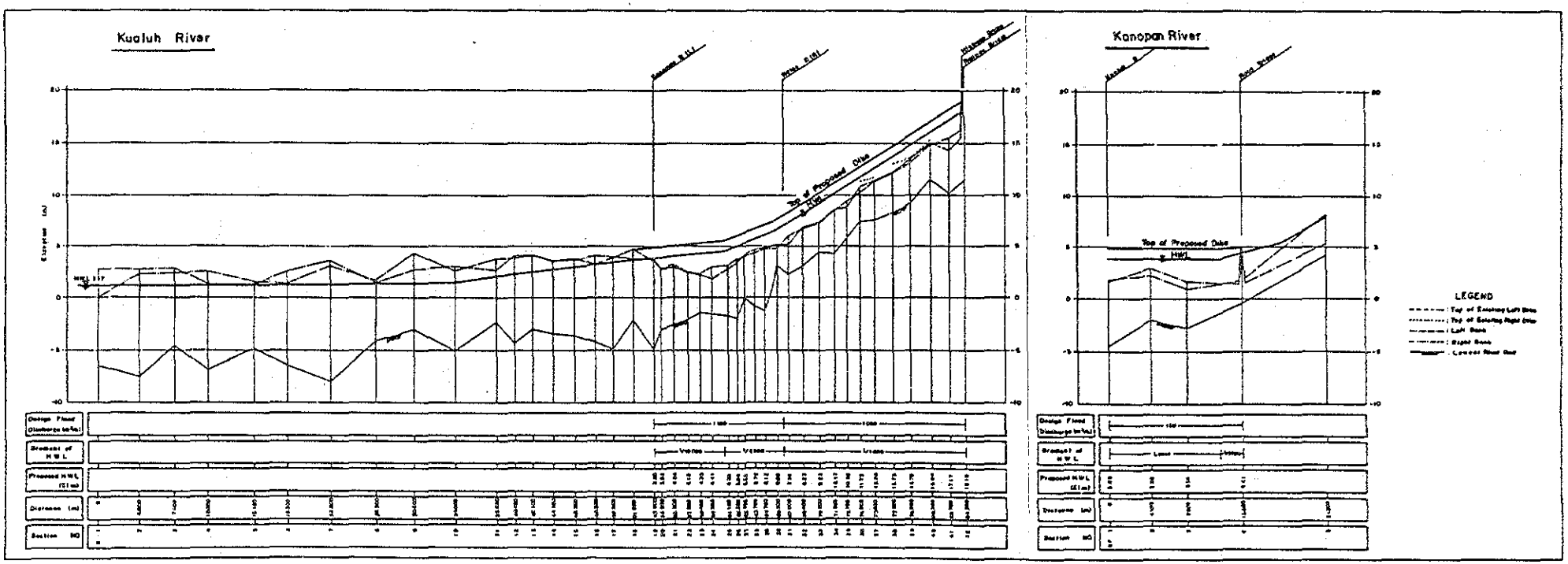


Fig.H-5 Proposed Long-Term Plan of Kualuh River (3/3)

(Cross-section)

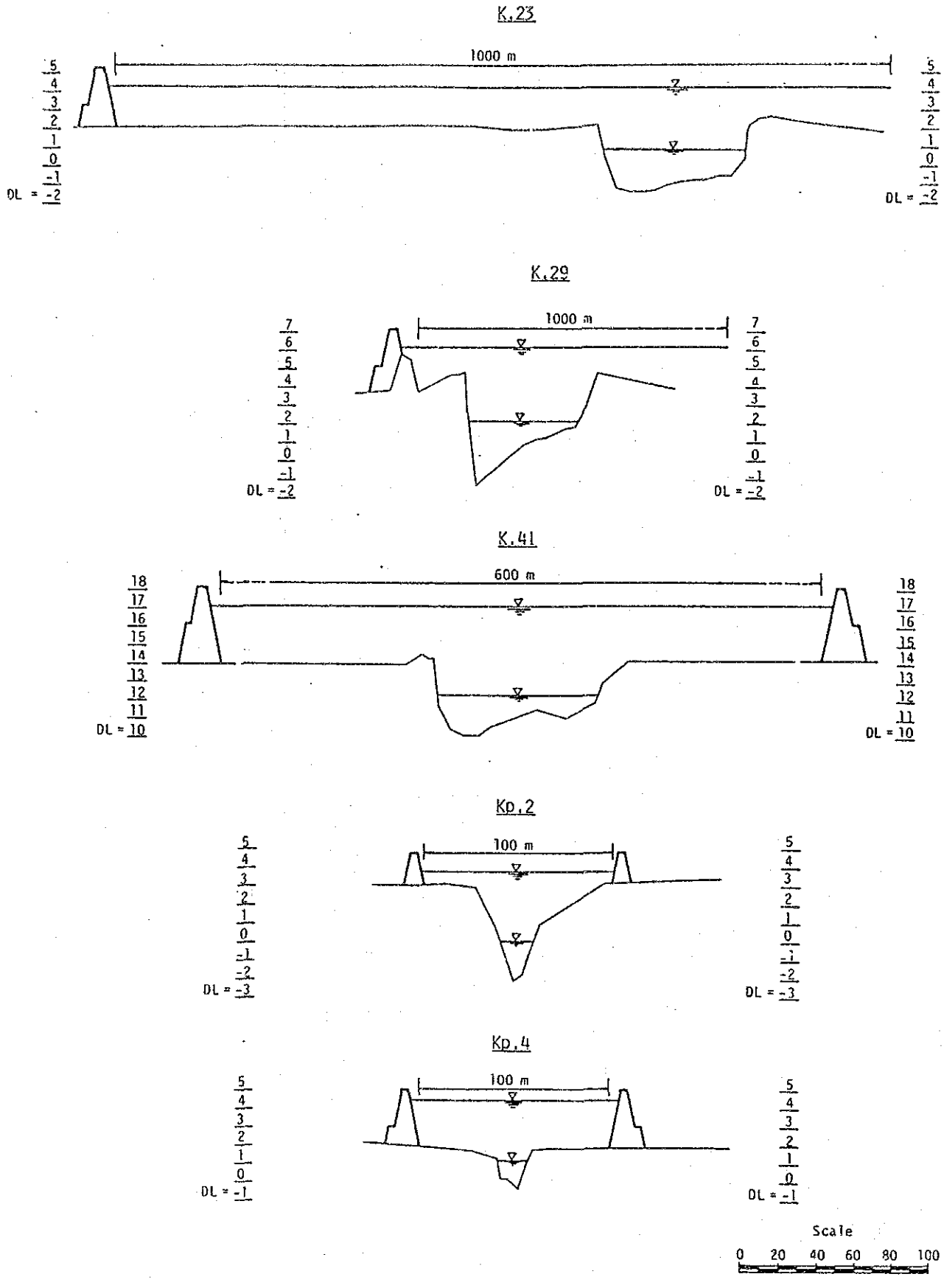


Fig.H-6 Design Flood Discharges for Proposed Urgent Plan

(Unit: m^3/s)

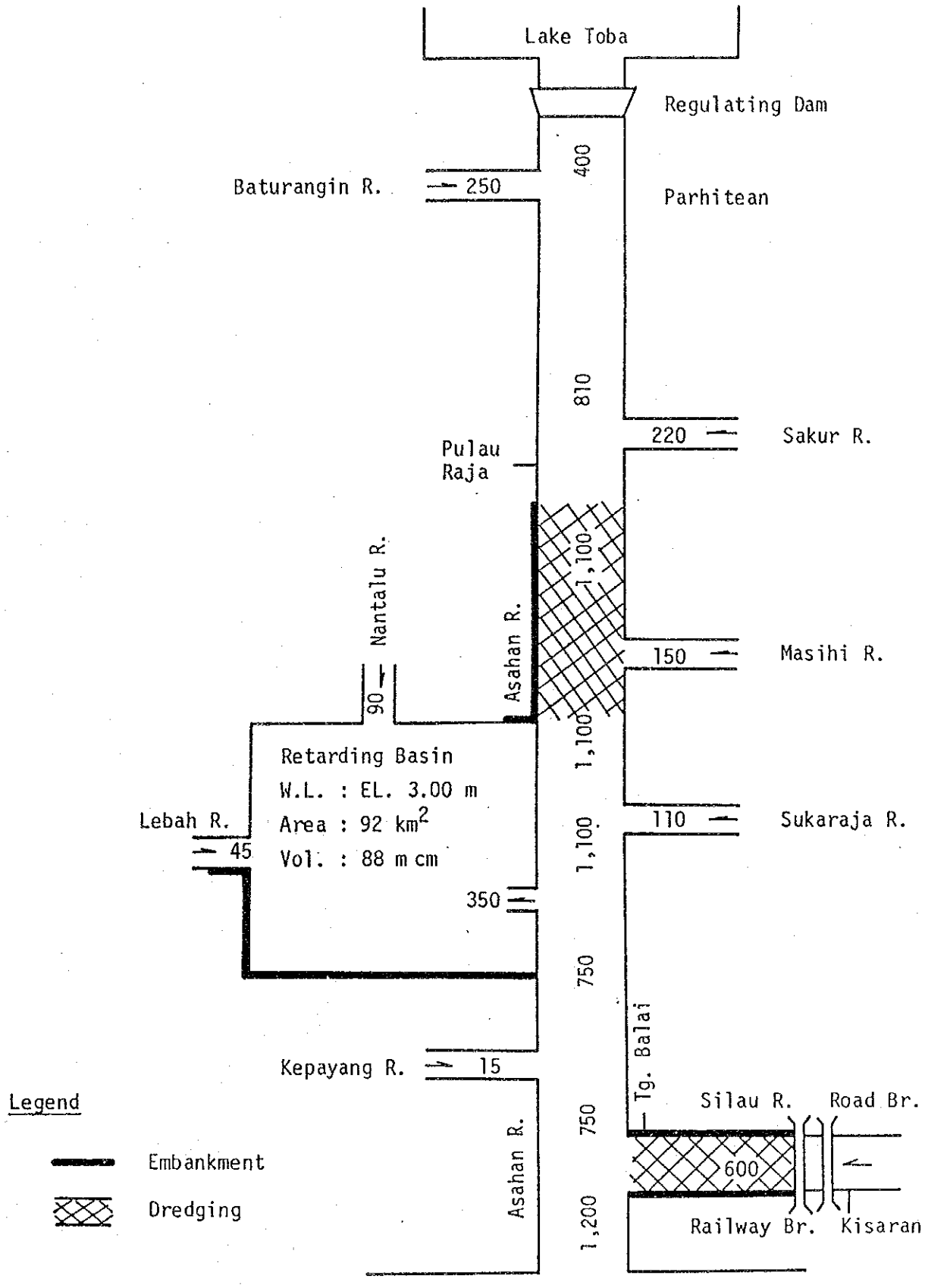


Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (1/6)

(Dike Alignment)

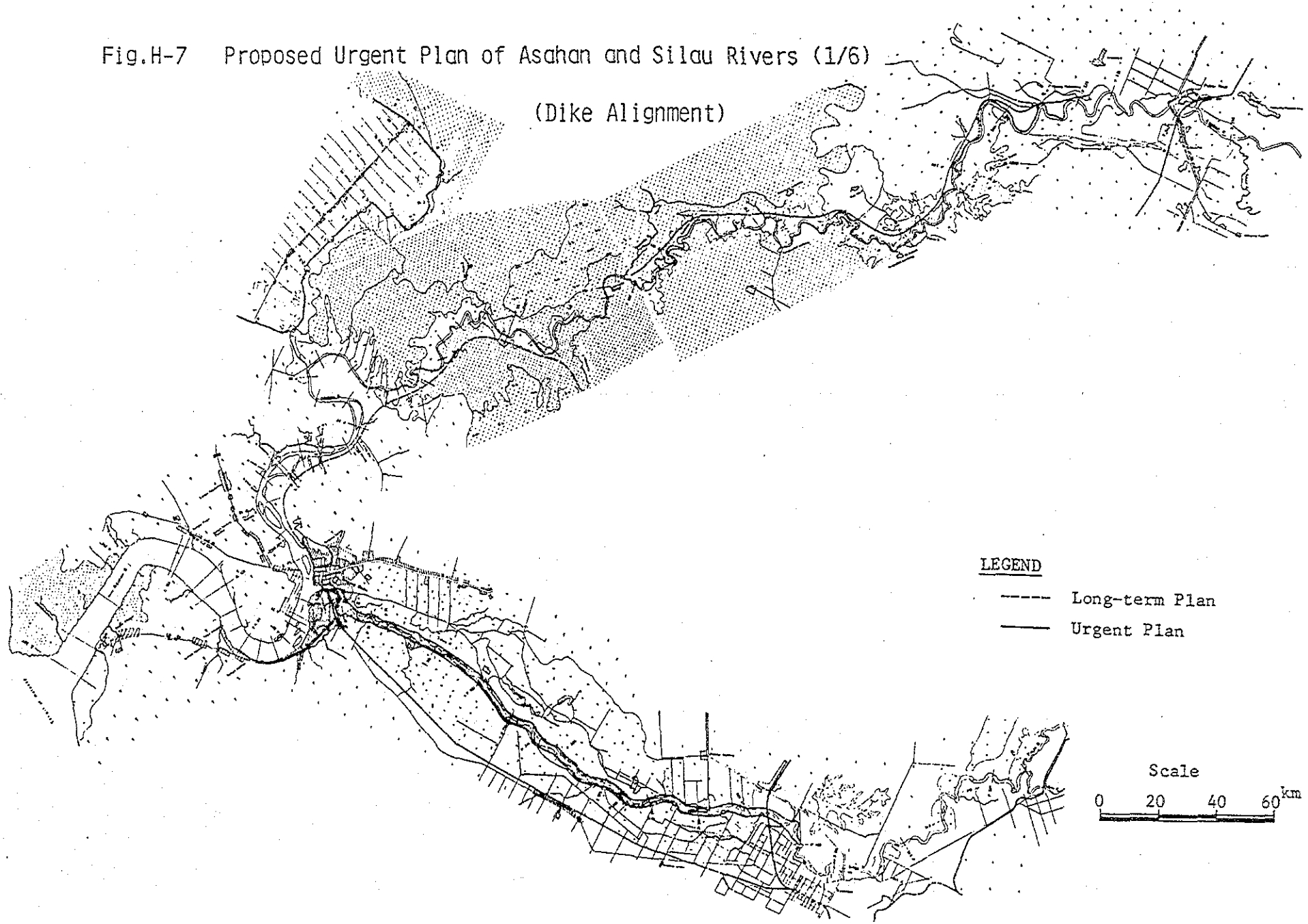


Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (2/6)
(Longitudinal Profile of Asahan River)

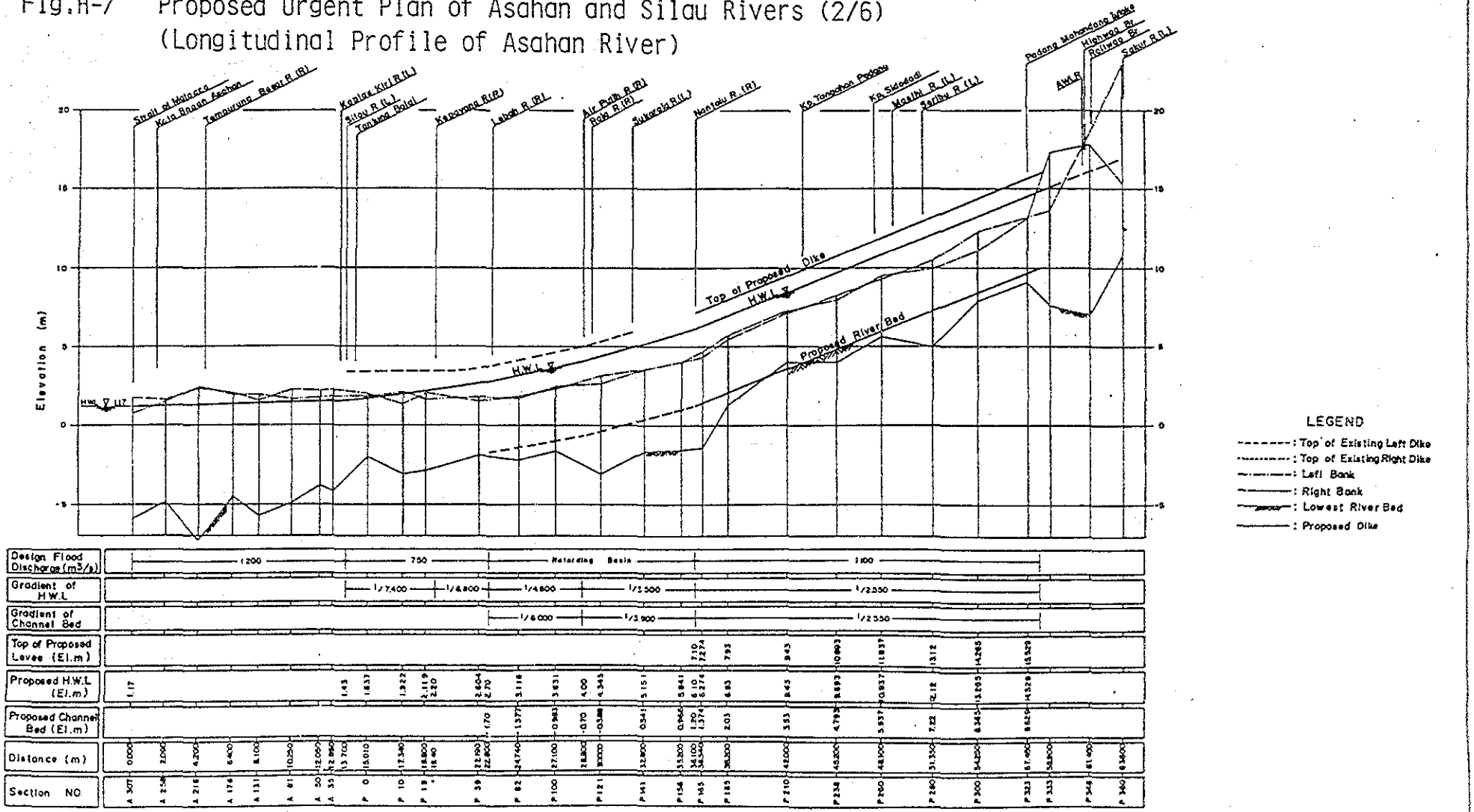


Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (3/6)

(Cross-sections of Asahan River)

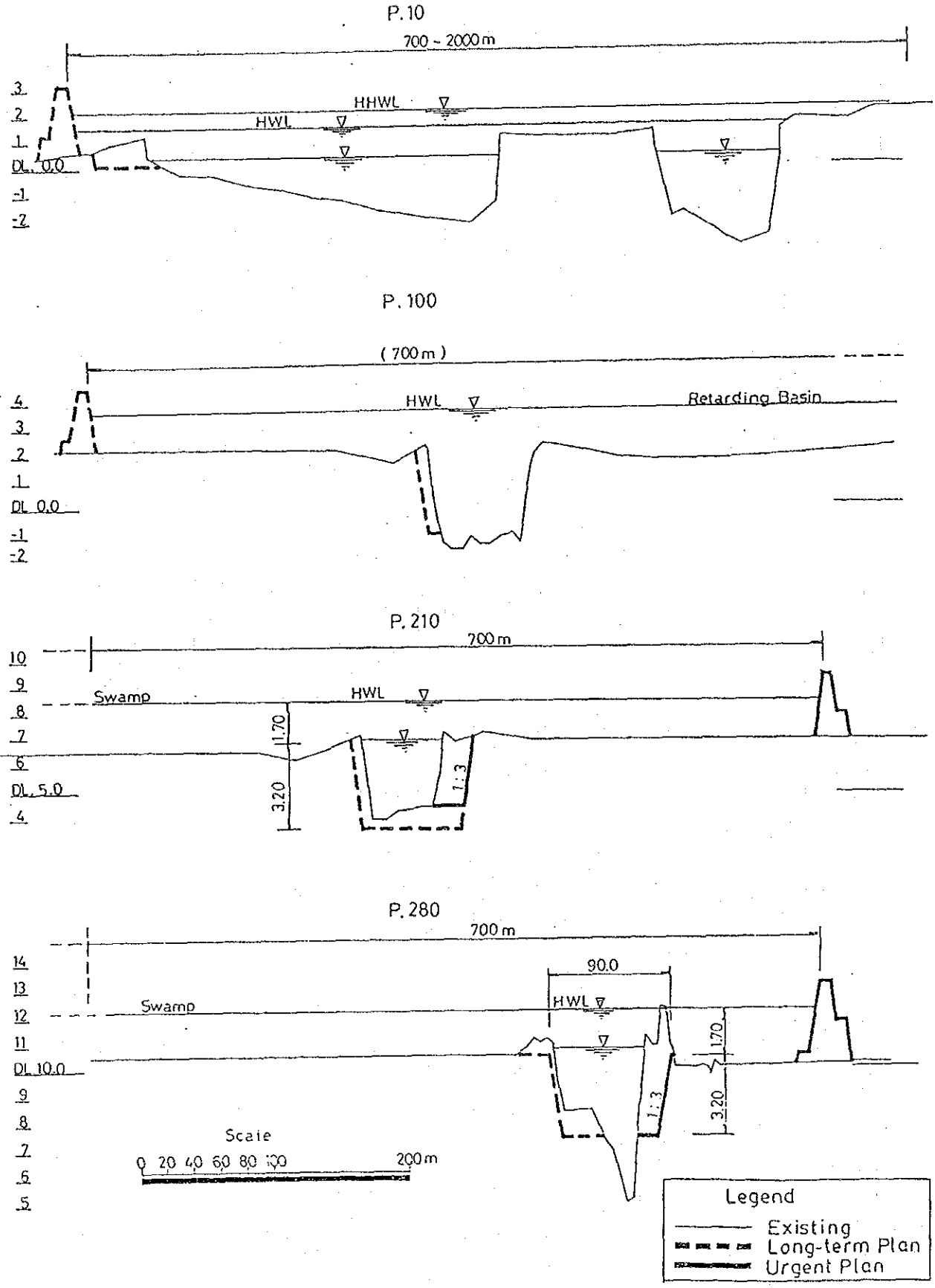
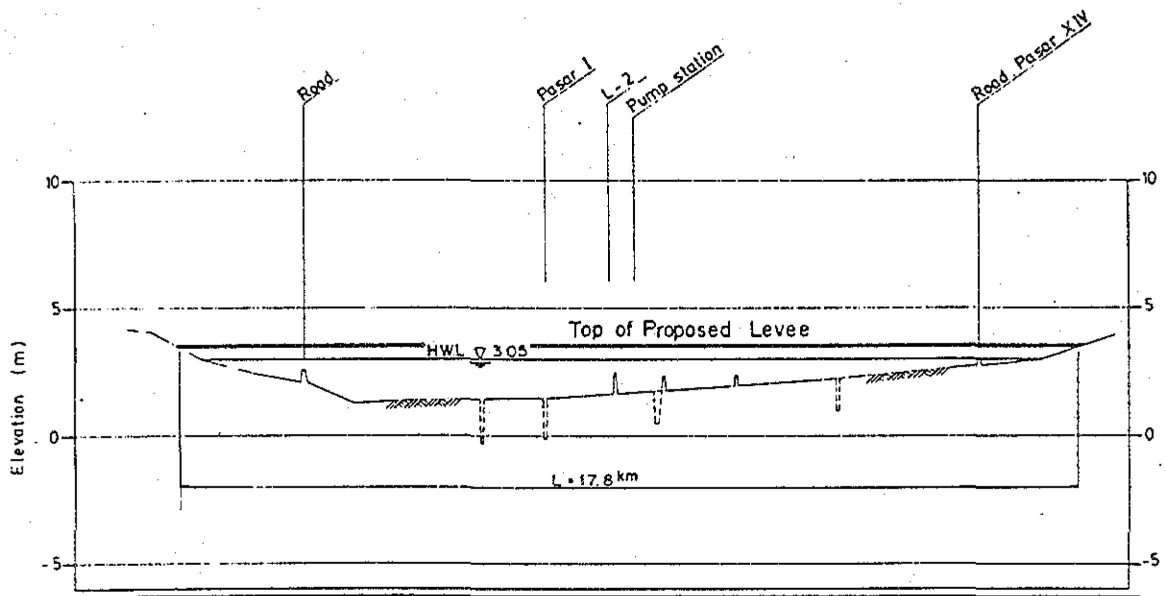


Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (4/6)

(Longitudinal Profile and Cross-sections of Lebah River)



Top of Proposed Levee (EL.m)				3.50	3.50	3.50			3.50					3.50			3.50			
Proposed H.W.L (EL.m)				3.05	3.05	3.05			3.05					3.05			3.05			
Ground Hight (EL.m)	4.0	3.0	2.5	2.1	1.3	1.4			1.5					2.2			2.8			
Distance (Km)	-3.00	-2.00	-1.00	0	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
Section No	-3	-2	-1	C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

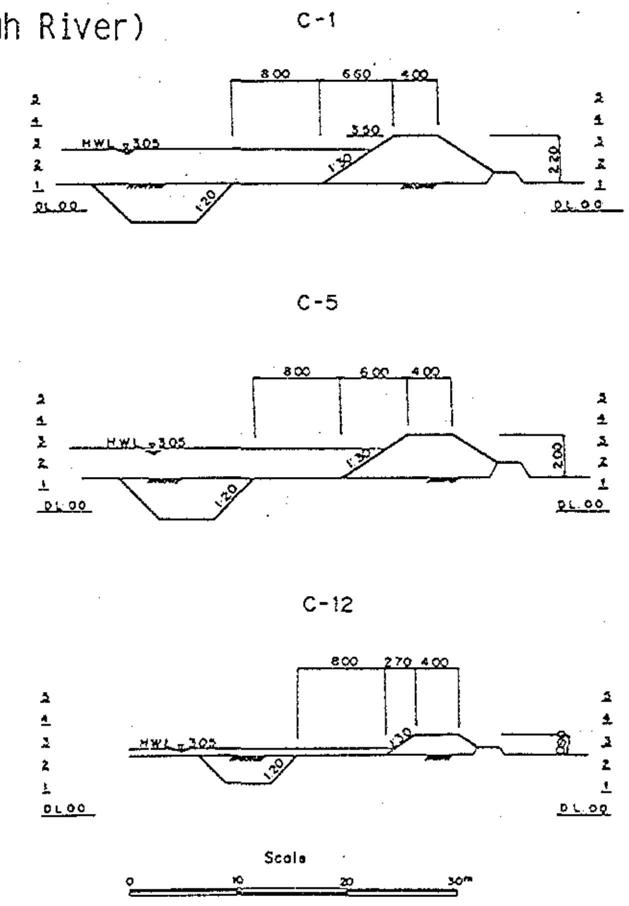
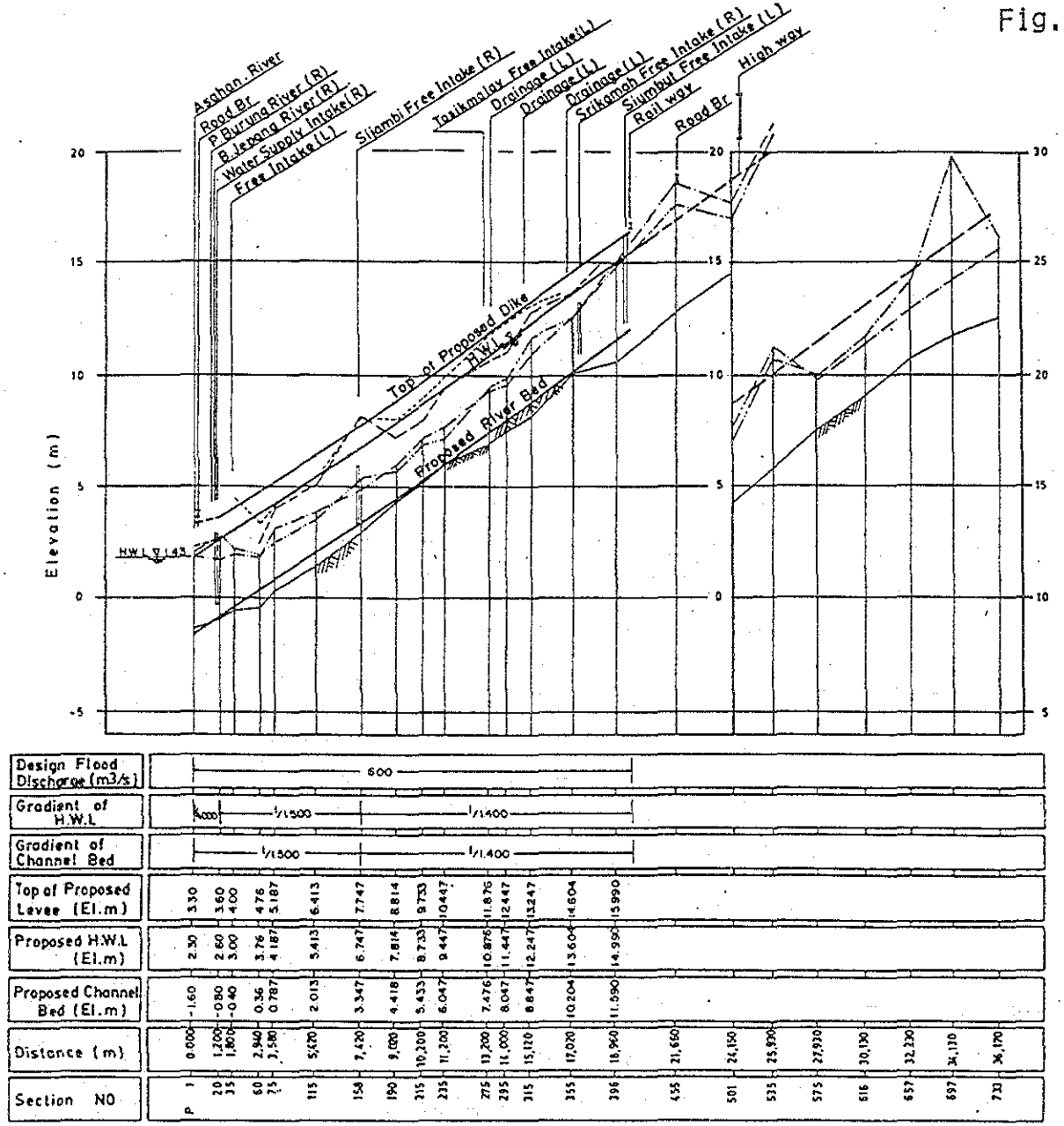


Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (5/6)
(Longitudinal Profile of Silau River)



LEGEND :

- : Top of Existing Left Dike
- : Top of Existing Right Dike
- : Left Bank
- : Right Bank
- : Lowest River Bed
- : Proposed Dike

Fig.H-7 Proposed Urgent Plan of Asahan and Silau Rivers (6/6)

(Cross-sections of Silau River)

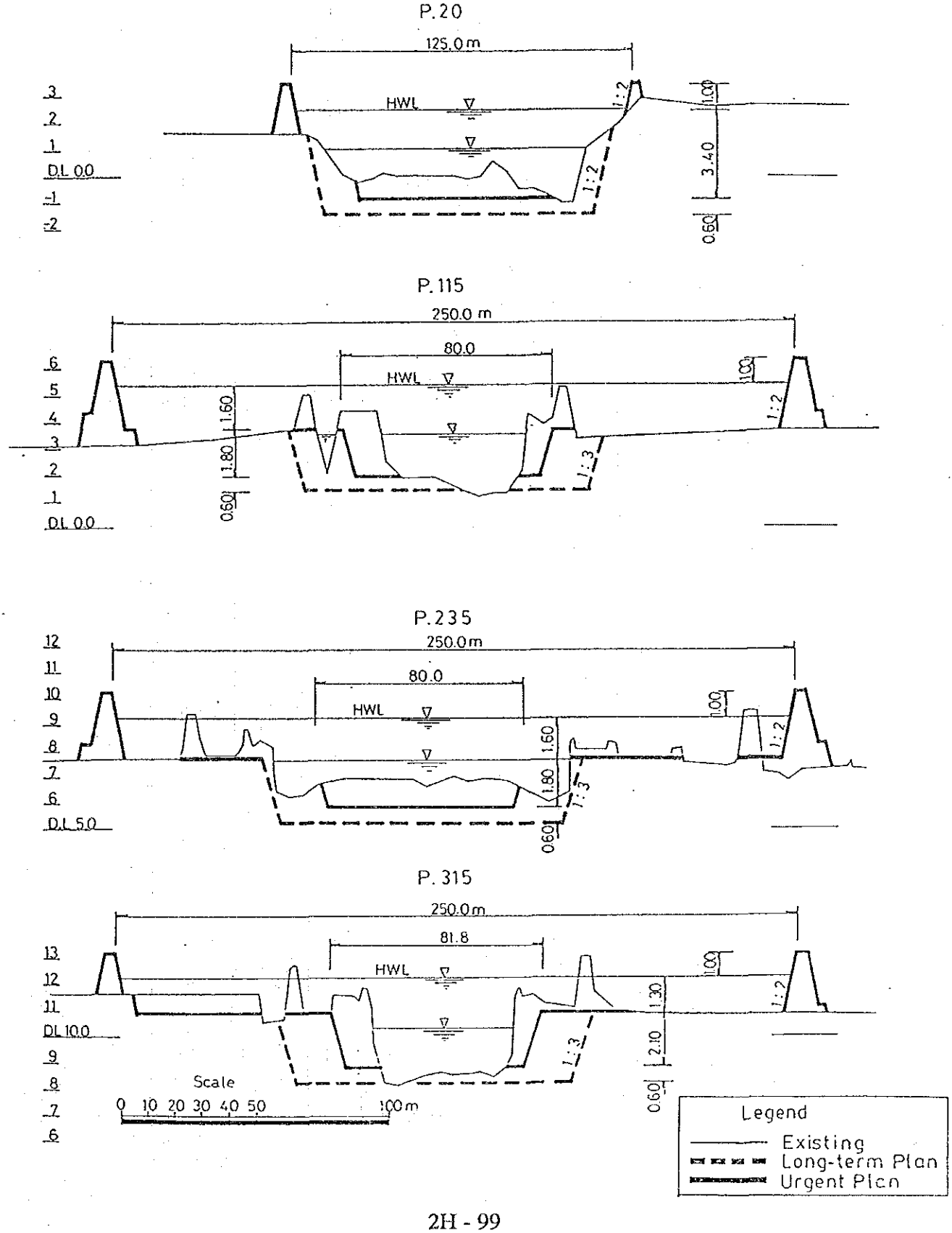


Fig.H-8 Construction Time Schedule for Urgent Flood Control Project

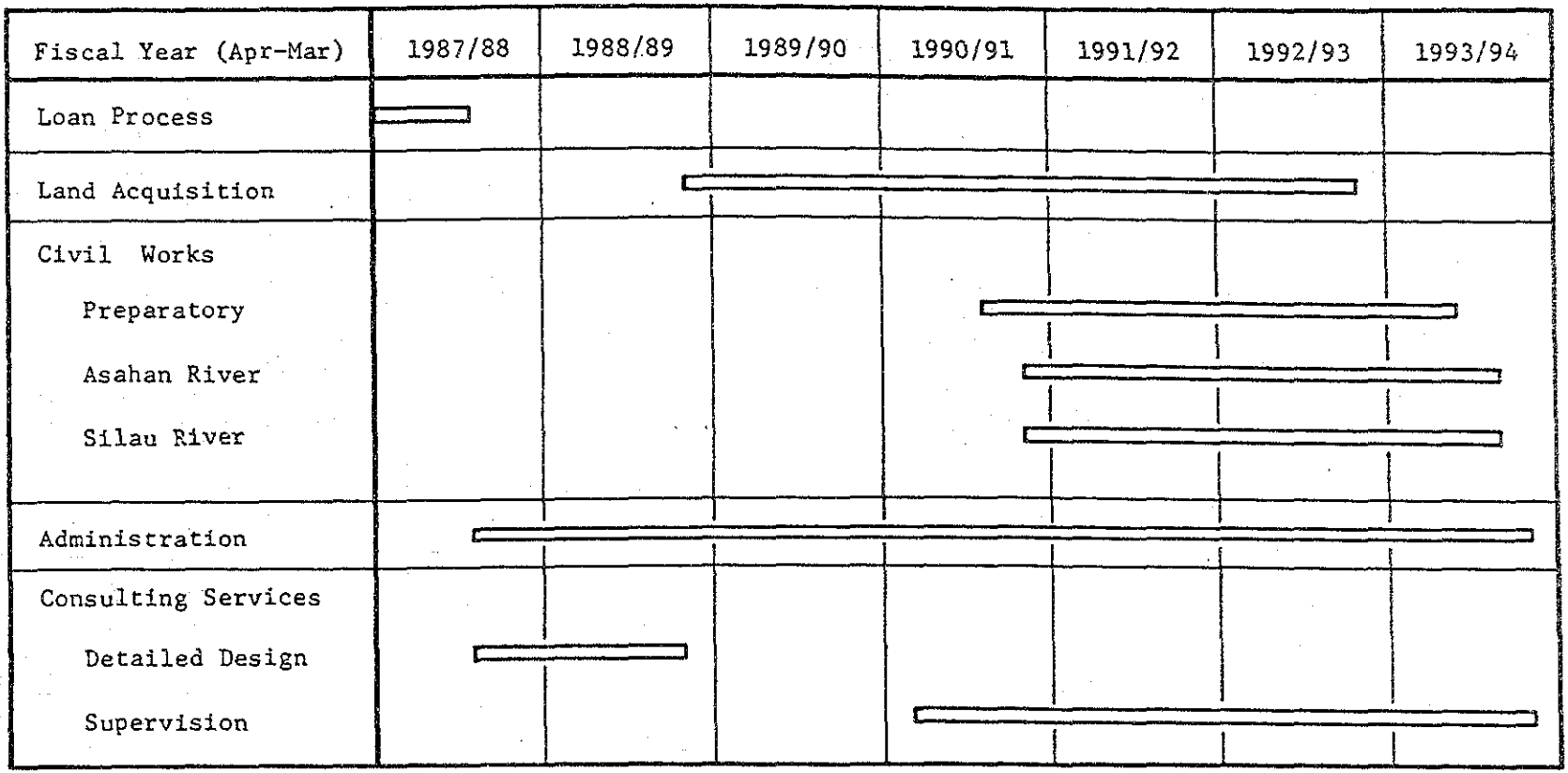


Fig.H-9 Present Organization for Flood Control Works

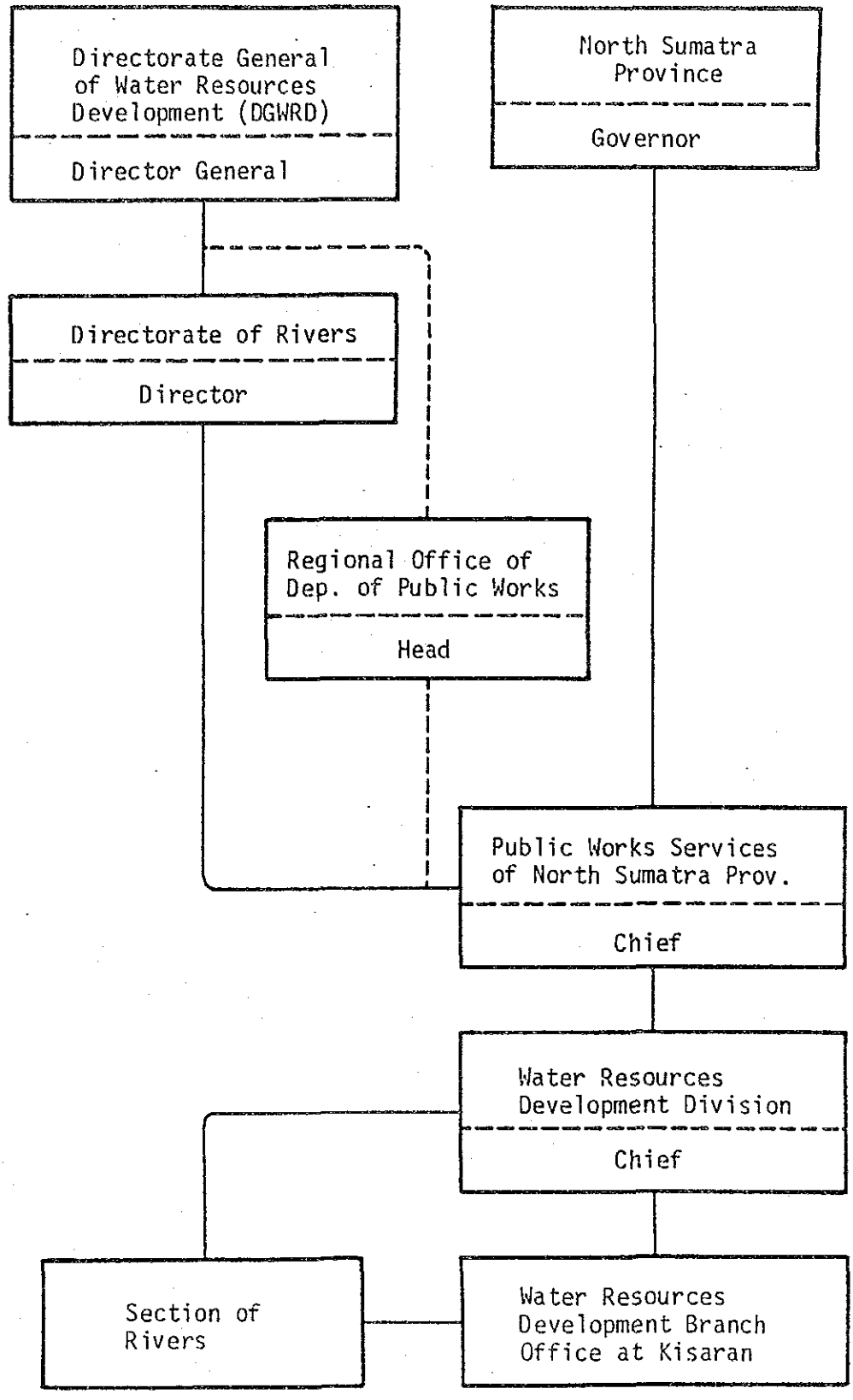


Fig.H-10 Organization for Project Implementation (1/2)
(Detailed Design Stage)

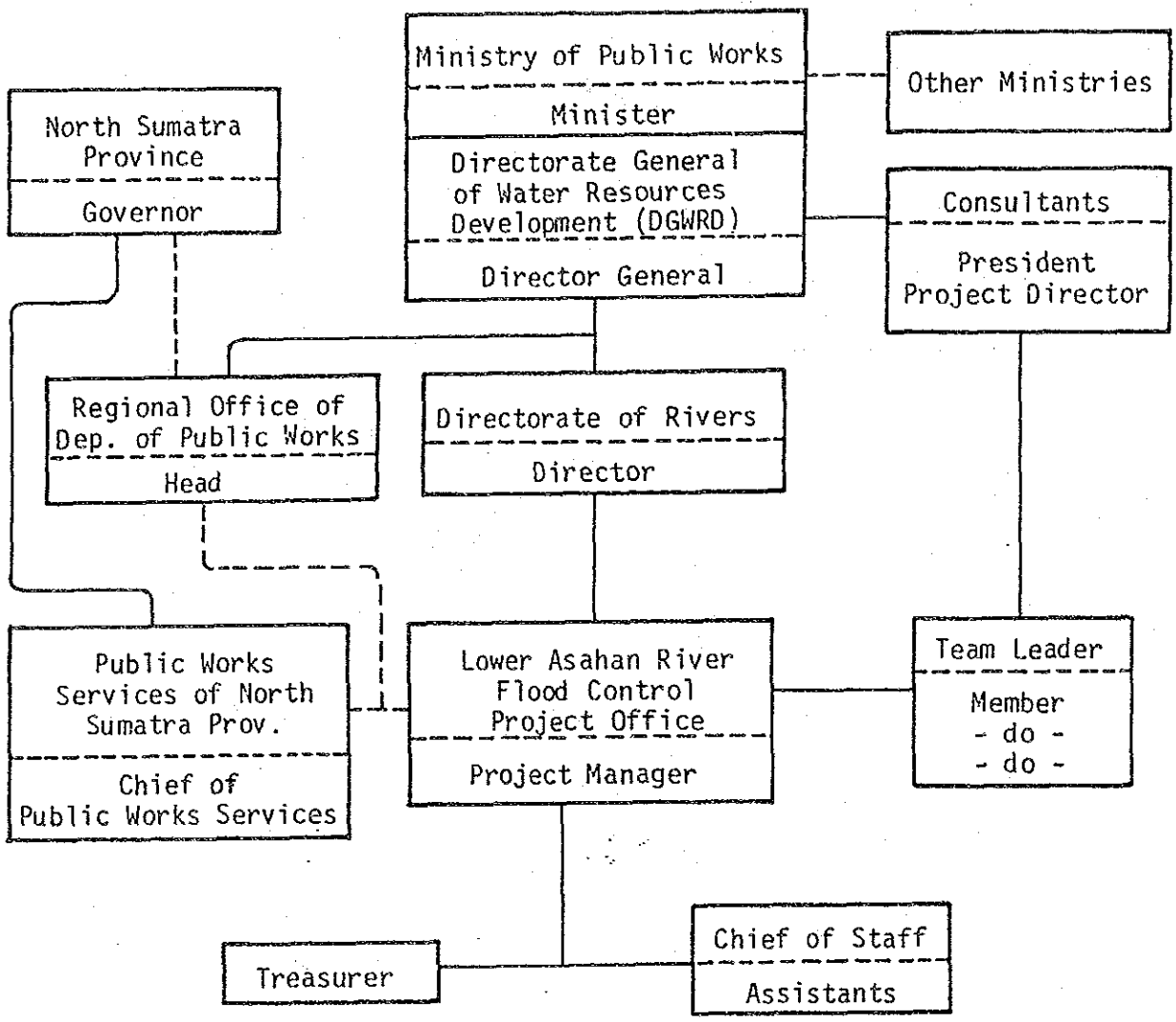


Fig.H-10 Organization for Project Implementation (2/2)

(Construction Stage)

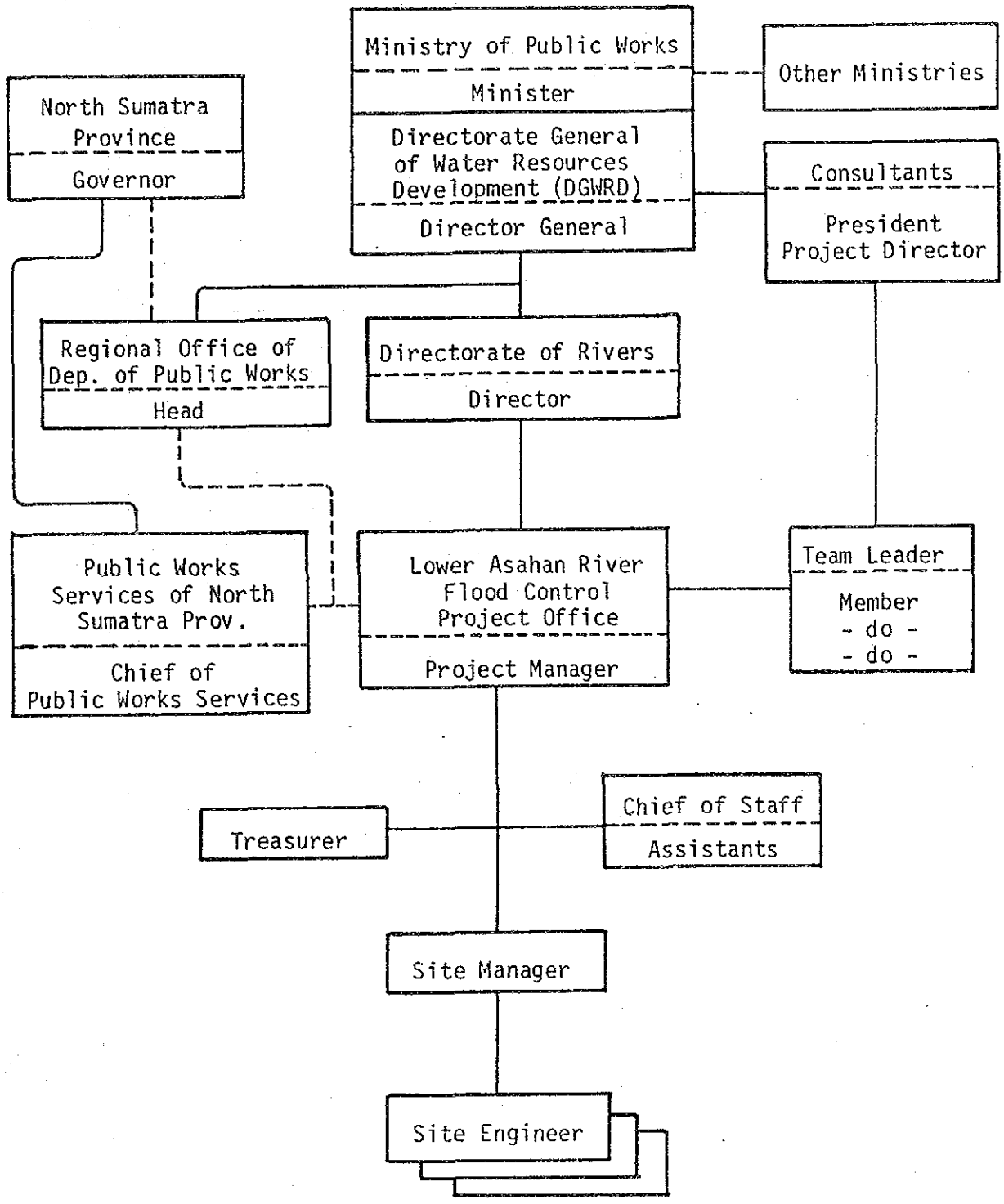
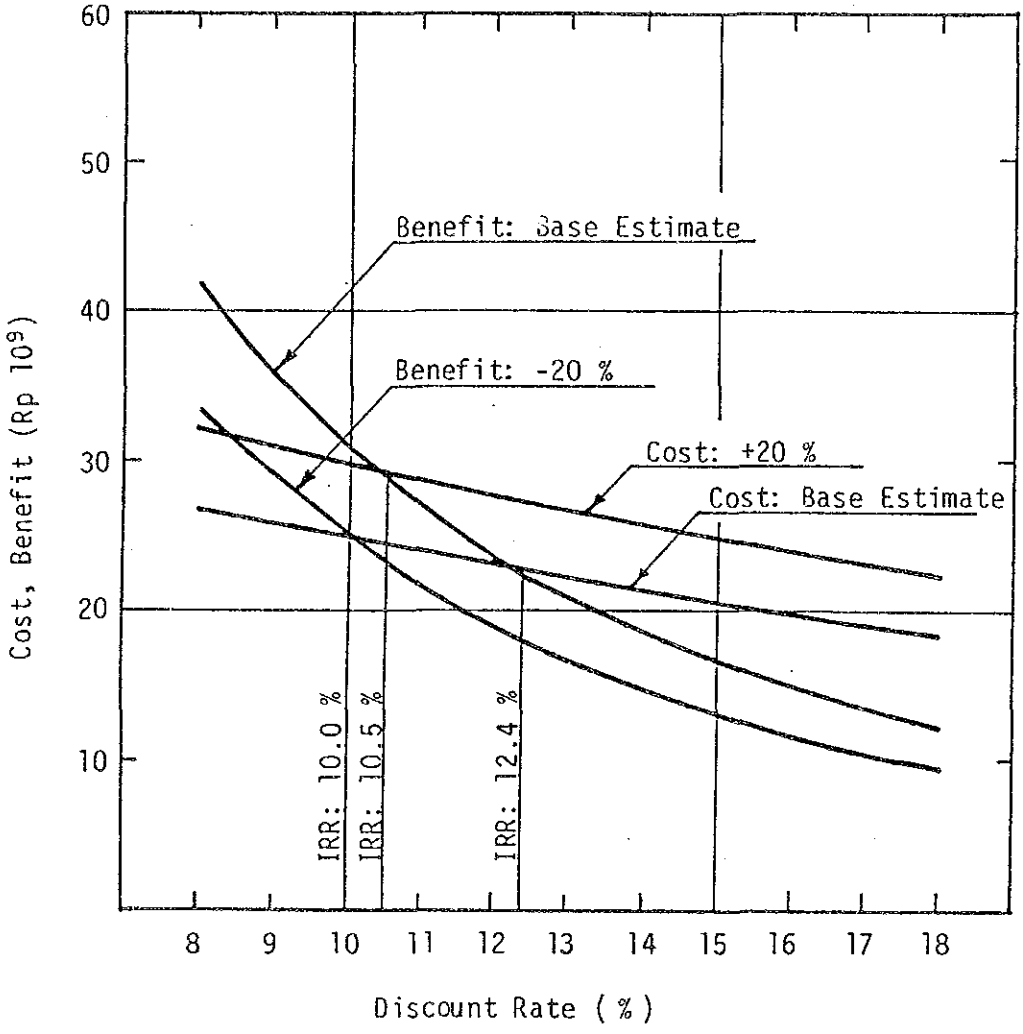


Fig.H-11 Sensitivity of IRR of Urgent Flood Control Project



Appendix 2-I

Regulation of Water Level of Lake Toba

Appendix 2-I

REGULATION OF WATER LEVEL OF LAKE TOBA

LIST OF TABLES

LIST OF FIGURES

Table I-1 Rainfall Data Available in and around Lake Toba

Name of Station	Type of Data	Available Year
Sidi Kalang	Monthly	1913, 1914, 1916, 1919-1941, 1951-1964
Seribu Dolok	Daily	1910-1930, 1935-1941, 1953-1958
Pangururan	Monthly	1918-1940, 1953-1956
	Daily	1973-1984
Gorbus	Daily	1953-1958, 1973-Feb. 1985
Ambarita	Monthly	1919-1940
Prapat	Monthly	1918-1941, 1955-1958
	Daily	1973-1984
Palipi	Monthly	1922-1940
Onanrunggu	Monthly	1922-1940
Balige	Monthly	1918-1941, 1954-1960
	Daily	1961-1980
Dolok Sangul	Monthly	1936-1939, 1954-1956, 1958, 1959, 1963, 1964
Siborong Borong	Monthly	1936-1939, 1952, 1954-1956, 1958, 1959, 1964
Hataraja	Daily	1952-1954, 1958, 1976, 1978-1984
Simangkuk	Daily	1961-1980

Table I-2 Monthly Rainfall of Lake Toba Basin

	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940
Jan.	163	222	145	322	205	191	188	128	209	176	68	170	306	82	192	147	99	151	154	132	128	274
Feb.	116	136	160	144	145	199	246	151	113	60	103	125	48	238	122	110	144	99	103	97	103	180
Mar.	213	117	206	330	247	414	256	74	93	145	222	140	161	200	230	168	198	147	241	251	170	138
Apr.	214	290	144	191	169	188	231	140	181	109	138	169	223	259	186	281	134	119	167	330	160	112
May	71	74	137	114	154	116	127	127	69	138	173	136	163	202	150	85	82	185	194	95	188	124
June	26	112	72	37	43	138	134	50	19	8	70	137	68	100	21	65	81	117	28	33	45	42
July	124	6	54	12	29	43	89	149	25	44	4	10	279	44	55	91	36	6	18	18	1	66
Aug.	25	57	129	38	82	95	46	81	55	103	44	116	38	203	239	138	277	97	26	218	28	46
Sept.	216	64	178	146	95	189	307	143	248	69	179	80	190	77	118	59	125	166	178	178	119	125
Oct.	169	197	223	224	224	118	409	239	220	162	163	320	125	102	112	215	175	207	212	162	214	375
Nov.	214	196	115	204	174	112	428	237	237	246	240	330	157	194	279	262	202	228	272	97	117	281
Dec.	264	42	107	255	144	288	269	245	175	207	156	185	282	147	134	74	177	142	112	171	358	175
Annual	1817	1514	1669	2017	1710	2090	2729	1763	1642	1467	1561	1918	2040	1849	1841	1715	1731	1662	1706	1783	1629	1938

	1974	1975	1976	1977	1978	1979	1980	1981*	1982	1983	1984
Jan.	144	120	165	107	146	158	100	89	97	85	394
Feb.	286	169	221	139	102	136	108	121	78	33	331
Mar.	114	226	193	69	258	115	238	130	355	129	364
Apr.	297	240	328	136	208	216	157	210	280	100	207
May	241	192	125	130	77	61	200	321	265	249	370
June	200	39	176	68	27	234	78	41	46	91	78
July	164	214	123	125	87	174	153	44	65	146	135
Aug.	28	29	167	132	56	83	186	80	138	157	43
Sept.	247	240	102	94	95	133	141	298	166	322	115
Oct.	128	76	305	440	161	201	121	170	293	334	101
Nov.	151	213	318	320	229	294	242	83	247	104	202
Dec.	185	188	325	159	230	103	200	104	202	271	239
Annual	2181	1941	2544	1916	1672	1905	1921	1691	2230	2018	2575

*Gorbus alone

Table I-3 Monthly Mean Net Inflow into Lake Toba

unit : m3/s

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
1916	105.0	10.5	141.1	89.5	109.8	45.3	84.1	87.6	-22.4	109.6	112.2	238.3	93.4
1917	95.4	227.1	71.4	152.8	102.5	33.9	69.9	127.7	73.7	57.8	86.3	155.0	103.6
1918													
1919							38.3	9.6	153.7	101.0	174.5	234.3	
1920	222.2	125.4	93.6	225.7	62.1	61.3	-25.0	19.2	54.2	41.6	147.5	36.5	88.1
1921	100.7	110.0	135.3	119.0	149.9	1.5	19.6	63.5	64.8	172.2	80.2	112.0	94.2
1922	223.2	84.2	208.0	36.1	157.8	11.0	-22.4	67.1	-12.7	171.3	76.2	190.0	100.1
1923	144.3	89.3	136.8	100.9	70.6	-7.9	5.0	46.4	62.7	132.2	128.1	86.1	82.9
1924	136.4	117.7	296.9	152.0	87.9	111.3	28.8	73.2	74.8	87.4	53.0	178.1	116.6
1925	172.7	205.7	184.7	292.0	64.9	78.9	67.3	3.0	208.9	239.7	229.1	201.1	161.5
1926	111.3	151.6	97.3	133.2	35.8	53.6	56.3	29.1	48.9	141.5	149.8	208.9	101.1
1927	179.8	138.9	91.4	143.4	38.4	-6.5	-17.4	26.9	175.7	174.4	149.4	189.3	106.6
1928	164.3	50.3	78.7	110.7	64.7	-13.6	-4.6	19.3	14.9	116.7	187.2	168.3	80.0
1929	48.9	119.8	185.0	125.1	112.1	27.0	-46.0	11.6	80.7	93.8	192.6	155.7	91.8
1930	97.9	77.9	89.5	140.9	33.8	70.6	-24.3	79.8	7.5	273.9	383.0	247.3	123.2
1931	363.6	38.0	124.5	235.2	129.1	13.2	201.9	-29.9	203.2	104.0	211.1	451.0	171.5
1932	53.7	166.5	164.1	193.0	142.8	40.1	-54.9	157.4	84.0	26.9	199.2	163.1	110.8
1956												194.4	
1957	102.9	47.6	179.5	236.3	271.8	-0.8	-10.3	-8.2	72.7	204.0	203.8	179.6	123.8
1958	126.8	147.8	88.8	93.7	84.9	35.2	-84.8	-56.0	32.4	66.0	204.2	243.8	81.3
1959	71.4	69.8	109.0	258.2	161.8	104.9	-5.7	5.6	102.5	286.0	246.6	110.3	126.6
1960	89.3	185.4	103.9	204.8	48.8	-54.1	43.6	77.1	-26.0	220.1	188.4	215.3	108.0
1961	79.8	103.9	35.9	173.6	-67.4	-10.7	13.3	-43.8	112.1	100.7	145.4	237.0	72.7
1962	114.3	39.1	185.8	185.1	91.1	97.6	-18.8	86.9	30.8	94.5	132.0	148.5	99.3
1963	73.1	85.5	95.7	-9.6	50.0	22.5	55.0	51.3	58.4	237.9	290.5	251.1	105.4
1964	43.3	59.6	97.1	102.2	10.8	60.7	98.7	3.7	104.8	52.0	78.0	127.4	69.7
1965	-0.9	89.1	127.3	155.2	96.5	11.2	0.9	73.4	115.5	203.3	98.2	175.4	95.5
1966	154.8	103.9	167.0	145.3	38.8	102.6	88.7	82.0	96.8	167.4	184.5	149.2	123.5
1967	133.0	121.0	113.6	194.9	165.6	25.4	3.4	16.8	143.6	152.2	187.8	93.6	112.2
1968	251.7	121.4	76.2	121.6	99.3	103.5	54.3	-6.0	32.6	141.3	198.0	177.6	114.3
1969	133.4	175.7	92.4	163.8	176.7	55.0	-0.0	124.8	51.0	189.8	191.7	356.8	142.6
1970	154.7	105.4	125.1	122.1	85.5	8.6	55.8	33.9	122.2	82.9	120.1	97.5	92.7
1971	189.9	144.1	162.6	101.5	52.2	38.1	-9.9	94.4	126.7	30.1	79.0	169.1	97.9
1972	10.0	90.2	84.4	167.9	181.7	61.4	-24.7	42.8	89.1	143.3	252.7	109.2	100.3
1973	78.1	44.4	163.2	159.8	103.5	77.4	24.2	48.1	73.3	144.3	87.5	249.9	105.0
1974	91.8	169.9	73.8	90.2	126.5	91.8	90.6	-7.2	176.5	22.5	84.6	210.1	101.1
1975	53.6	48.1	133.8	215.3	10.2	5.9	81.7	-28.1	89.9	28.2	88.4	100.9	68.8
1976	71.7	83.1	116.3	178.2	80.0	78.0	33.5	52.7	30.9	111.4	220.7	203.1	104.8
1977	119.4	90.5	75.6	112.5	45.4	39.2	-20.5	44.7	13.5	253.9	232.0	168.1	97.9
1978	57.0	71.3	76.3	145.9	48.6	-20.8	10.5	-17.7	22.2	88.1	135.9	108.6	60.3
1979	73.4	68.7	53.5	108.2	1.0	93.6	7.0	13.3	76.8	101.8	234.3	118.6	78.7
1980	57.0	88.9	178.3	58.2	104.2	9.7	-7.1	37.9	16.4	49.7	176.3	113.7	73.6
1981	87.4	113.3	10.4	118.7	193.0	-0.4	-8.5	-15.8	72.0	107.8	18.0	27.5	59.9
1982	8.6	120.8	170.6	271.0	230.3	31.1	8.1	31.8	77.6	137.9	129.3	84.2	108.1
1983	52.6	18.4	79.5	37.7	84.1	5.3	38.0	16.7	137.2	148.7	52.5	182.0	71.6
1984	264.8	178.4	172.9	131.1	228.0	37.6	68.7	-5.0	39.0	36.3	159.1	110.2	118.4
1985	108.6												
Average	115.2	104.6	122.0	146.3	96.9	37.9	21.9	35.0	76.4	128.3	158.6	171.7	100.9

Table I-4 Comparison of Lake Toba Operation Method

Case	0 (Current Ope. Rule)	I	II	III	IV	V
Seasonal Restricted WL (RWL)	None	None	July e. 5.00 m Aug. e. 4.84 Sept.e. 4.68 Oct. e. 4.52 Nov. e. 4.64 Dec. e. 4.76 Jan. e. 4.88 Feb. e. 5.00 Mar-July 5.00	Ditto	Ditto	Ditto
Flood release incld. power discharge	WL Q >5.05 186 m3/s >5.10 242 >5.15 315 >5.20 400	WL Q >5.00 m 300 m3/s >5.50 400	WL Q >5.00 m 300 m3/s >5.50 400	WL Q >5.00 m 300 m3/s >5.50 400	WL Q >5.00 m 200 m3/s >5.10 250 >5.20 300 >5.50 400	Ditto
Discharge for power generation	WL Q ≥2.40 m 101 m3/S <2.40 0	WL≤5.00 WL>RWL SP 100 m3/s WL Q ≥4.50 m 101 m3/S <4.50 95 <4.20 90 <3.90 87.5 <3.60 85 <3.30 82.5 <3.00 80 <2.40 0	WL≤5.00 WL>RWL SP=75 m3/s WL Q ≥4.50 101 <4.50 92 <4.00 86 <3.50 80 <2.40 0	WL≤5.00 WL>RWL SP=50 WL>RWL+.2SP=75 WL Q ≥4.50 101 <4.50 98 <4.00 95 <3.75 92 <3.50 86 <3.00 80 <2.40 0	WL≤5.00 WL>RWL SP=50 WL>RWL+.2SP=75 WL Q ≥4.50 101 4.50-4.25 101/98 4.25-4.00 98/95 4.00-3.75 95/92 3.75-3.50 92/86 3.50-3.25 86/80 3.25-2.40 80 <2.40 0	WL≤5.00 m WL>RWL SP=50 >RWL+.2 SP=75 WL Q ≥4.50 101 4.50-4.25 101/98 4.25-4.00 98/95 4.00-3.75 95/92 3.75-3.50 92/80 3.50-3.25 86/80 3.25-2.40 80 <2.40 0
Operation results						
Highest WL	WL m	905.42	905.37	905.17	905.27	905.34	905.34
Flood release	m3/s	400	300	300	300	300	300
Lowest WL	WL m	902.33	902.41	902.58	902.35	902.38	902.44
Duration of 0 dis. for 43.08 year	days	443	0	0	52	10	0
Ave. power dis. for 43.08 year	m3/s	-	94.6	93.9	-	(95.6)	95.6

Table I-5 Major Flood Inflow (net) into Lake Toba

Duration	Volume
1 Sept. 1919 - 30 Apr. 1920	3,494 x 10^6 m^3
11 Oct. 1924 - 10 May 1925	3,219
1 Sept. 1925 - 30 Apr. 1926	3,586
21 Oct. 1926 - 20 Apr. 1927	2,636
1 Oct. 1930 - 31 May 1931	4,743
21 Oct. 1931 - 20 May 1932	3,990
11 Dec. 1956 - 31 May 1957	2,687
21 Sept. 1957 - 20 May 1958	3,162
11 Sept. 1959 - 20 May 1960	3,608
1 Oct. 1963 - 31 Dec. 1963	2,063
21 Sept. 1965 - 30 Apr. 1966	2,895
21 Aug. 1966 - 20 May 1967	3,614
1 Oct. 1968 - 31 May 1969	3,295
1 Oct. 1969 - 31 May 1970	3,511
21 Sept. 1977 - 20 Dec. 1977	1,756
1 Feb. 1982 - 31 May 1982	2,068
1 Sept. 1983 - 31 May 1984	3,947

Table I-6 Probable Flood Inflow into Lake Toba

Unit: 10^6 m^3

Return Period	Hazen	Gumbel	Pearson III	Iwai	Adopted
100 year	4,527	4,917	4,548	4,428	4,500
50	4,253	4,546	4,278	4,186	4,300
30	4,049	4,270	4,068	4,000	4,100
10	3,569	3,667	3,595	3,560	3,600
5	3,252	3,268	3,256	3,240	3,300
2	2,697	2,665	2,693	2,693	2,700

Table I-7 Net Inflow Volume into Lake Toba during Flood Season

(1 Oct. thru 31 May)

No.	Year	Volume $4,743 \times 10^6$ m^3
1	1930/31	
2	31/32	3,917
3	83/84	3,592
4	69/70	3,511
5	59/60	3,344
6	68/69	3,295
7	19/20	3,262
8	24/25	3,234
9	66/67	3,228
10	25/26	3,141
11	58/59	3,114
12	23/24	3,001
13	57/58	2,961
14	67/68	2,909
15	61/62	2,903
16	16/17	2,889
17	63/64	2,882
18	26/27	2,864
19	65/66	2,862
20	21/22	2,844
21	28/29	2,790
22	72/73	2,777
23	77/78	2,769
24	73/74	2,709
25	27/28	2,598
26	22/23	2,584
27	76/77	2,569
28	81/82	2,501
29	70/71	2,490
30	60/61	2,485
31	79/80	2,480
32	29/30	2,314
33	80/81	2,255
34	20/21	2,200
35	71/72	2,139
36	74/75	2,046
37	75/76	1,962
38	64/65	1,897
39	62/63	1,761
40	78/79	1,668
41	82/83	1,652

Table I-8 Operation of Lake Toba: Case V

(Tentative Operation Prior to Completion of the UrgentFlood Control Project)

	Siruar Q (cms)	N WL (m)	Net Inflow (cms)	Discharge (cms)	Spill (cms)	WL (m)	RWL (m)
1931							
Sept. 30						904.810	904.680
Oct.							
1	134.0	5.66	-120.62	101	50	4.789	4.675
2	133.0	5.64	-121.64	101	50	4.767	4.670
3	132.0	5.62	-122.63	101	50	4.746	4.665
4	130.0	5.60	2.69	101	50	4.734	4.660
5	129.0	5.59	1.68	101	50	4.722	4.655
6	129.0	5.58	1.69	101	50	4.711	4.650
7	129.0	5.57	1.68	101	50	4.699	4.645
8	128.0	5.56	0.69	101	50	4.687	4.640
9	126.0	5.55	-1.32	101	50	4.675	4.635
10	124.0	5.54	-3.32	101	50	4.663	4.630
			-36.11				
11	124.0	5.53	-3.31	101	50	4.651	4.625
12	123.0	5.52	-131.63	101	50	4.629	4.620
13	122.0	5.50	-5.31	101	50	4.616	4.615
14	122.0	5.49	-5.32	101		4.608	4.610
15	122.0	5.48	-5.31	101		4.600	4.605
16	120.0	5.47	-7.32	101		4.591	4.600
17	119.0	5.46	-8.32	101		4.583	4.595
18	118.0	5.45	-9.31	101		4.574	4.590
19	118.0	5.44	-9.32	101		4.565	4.585
20	117.0	5.43	-10.31	101		4.557	4.580
			-19.55				
21	116.0	5.42	-11.32	101		4.548	4.575
22	115.0	5.41	115.00	101		4.549	4.570
23	114.0	5.41	241.32	101		4.560	4.565
24	119.0	5.42	-8.32	101		4.551	4.560
25	112.0	5.41	1257.84	101		4.642	4.555
26	125.0	5.50	377.63	101	50	4.660	4.550
27	127.0	5.52	1400.15	101	50	4.758	4.545
28	136.0	5.62	138.00	101	75	4.755	4.540
29	136.0	5.62	8.68	101	75	4.742	4.535
30	132.0	5.61	132.00	101	75	4.738	4.530
31	131.0	5.61	131.00	101	75	4.735	4.520
			345.82				

	Siruar Q (cms)	N WL (m)	Net Inflow (cms)	Discharge (cms)	Spill (cms)	WL (m)	RWL (m)
Nov.							
1	130.0	5.61	2.69	101	75	4.721	4.524
2	129.0	5.60	1.69	101	50	4.710	4.528
3	129.0	5.59	1.68	101	50	4.698	4.532
4	128.0	5.58	0.69	101	50	4.686	4.536
5	127.0	5.57	890.89	101	50	4.744	4.540
6	130.0	5.63	1148.52	101	75	4.821	4.544
7	146.0	5.71	18.68	101	75	4.808	4.548
8	145.0	5.70	17.69	101	75	4.796	4.552
9	140.0	5.69	140.00	101	75	4.793	4.556
10	138.0	5.69	138.00	101	75	4.790	4.560
			236.05				
11	136.0	5.69	8.68	101	75	4.777	4.564
12	135.0	5.68	7.69	101	75	4.764	4.568
13	135.0	5.67	7.68	101	50	4.752	4.572
14	133.0	5.66	5.69	101	50	4.741	4.576
15	131.0	5.65	3.69	101	50	4.729	4.580
16	130.0	5.64	1148.52	101	50	4.808	4.584
17	143.0	5.72	143.00	101	75	4.805	4.588
18	140.0	5.72	12.68	101	75	4.792	4.592
19	137.0	5.71	264.32	101	50	4.801	4.596
20	138.0	5.72	519.94	101	75	4.828	4.600
			212.19				
21	141.0	5.75	650.26	101	75	4.865	4.604
22	146.0	5.79	146.00	101	75	4.862	4.608
23	145.0	5.79	272.32	101	75	4.871	4.612
24	148.0	5.80	275.31	101	75	4.878	4.616
25	149.0	5.81	403.63	101	75	4.896	4.620
26	155.0	5.83	27.69	101	75	4.885	4.624
27	149.0	5.82	21.68	101	75	4.873	4.628
28	146.0	5.81	18.69	101	75	4.860	4.632
29	145.0	5.80	17.68	101	75	4.848	4.636
30	144.0	5.79	16.68	101	75	4.835	4.640
			184.99				

	Siruar Q (cms)	N WL (m)	Net Inflow (cms)	Discharge (cms)	Spill (cms)	WL (m)	RWL (m)
Dec.							
1	143.0	5.78	652.26	101	50	4.875	4.644
2	150.0	5.82	277.31	101	75	4.883	4.648
3	151.0	5.83	405.63	101	75	4.901	4.652
4	156.0	5.85	156.00	101	75	4.899	4.656
5	154.0	5.85	1427.15	101	75	4.997	4.660
6	160.0	5.95	2378.99	101	75	5.186	4.664
7	171.0	6.14	425.82	101	99	5.204	4.669
8	175.0	6.16	175.00	101	99	5.202	4.672
9	174.0	6.16	46.69	101	99	5.190	4.676
10	172.0	6.15	44.69	101	99	5.178	4.680
			618.93				
11	171.0	6.14	1953.40	101	99	5.315	4.684
12	188.0	6.28	60.69	101	99	5.304	4.688
13	185.0	6.27	185.00	101	99	5.303	4.692
14	185.0	6.27	-69.63	101	99	5.282	4.696
15	180.0	6.25	180.00	101	99	5.280	4.700
16	180.0	6.25	180.00	101	99	5.279	4.704
17	180.0	6.25	52.69	101	99	5.267	4.708
18	179.0	6.24	179.00	101	99	5.266	4.712
19	179.0	6.24	179.00	101	99	5.264	4.716
20	178.0	6.24	305.31	101	99	5.272	4.720
			320.55				
21	179.0	6.25	51.69	101	99	5.261	4.724
22	177.0	6.24	177.00	101	99	5.259	4.728
23	177.0	6.24	177.00	101	99	5.257	4.732
24	177.0	6.24	177.00	101	99	5.255	4.736
25	177.0	6.24	451.62	101	99	5.273	4.740
26	179.0	6.26	1324.84	101	99	5.362	4.744
27	194.0	6.35	66.69	101	99	5.351	4.748
28	188.0	6.34	188.00	101	99	5.350	4.752
29	188.0	6.34	1588.46	101	99	5.459	4.756
30	202.0	6.45	329.32	101	99	5.470	4.760
31	202.0	6.46	74.68	101	99	5.460	4.760
			416.94				

	Siruar Q (cms)	N WL (m)	Net Inflow (cms)	Discharge (cms)	Spill (cms)	WL (m)	RWL (m)
1932							
Jan.							
1	195.0	6.45	195.00	101	99	5.459	4.764
2	196.0	6.45	68.69	101	99	5.449	4.768
3	193.0	6.44	-60.64	101	99	5.429	4.772
4	192.0	6.42	-62.62	101	99	5.408	4.776
5	189.0	6.40	-65.63	101	99	5.387	4.780
6	188.0	6.38	60.68	101	99	5.376	4.784
7	188.0	6.37	60.68	101	99	5.365	4.788
8	189.0	6.36	-65.62	101	99	5.344	4.792
9	188.0	6.34	-66.63	101	99	5.323	4.796
10	186.0	6.32	58.68	101	99	5.312	4.800
			12.26				
11	184.0	6.31	56.69	101	99	5.301	4.804
12	182.0	6.30	54.68	101	99	5.290	4.808
13	182.0	6.29	-72.63	101	99	5.268	4.812
14	180.0	6.27	52.68	101	99	5.257	4.816
15	178.0	6.26	50.69	101	99	5.245	4.820
16	177.0	6.25	49.69	101	99	5.233	4.824
17	176.0	6.24	-78.63	101	99	5.211	4.828
18	175.0	6.22	175.00	101	99	5.209	4.832
19	174.0	6.22	301.31	101	99	5.217	4.836
20	178.0	6.23	178.00	101	99	5.215	4.840
			76.75				
21	178.0	6.23	50.69	101	99	5.204	4.844
22	176.0	6.22	50.68	101	99	5.192	4.848
23	176.0	6.21	48.68	101	99	5.180	4.852
24	175.0	6.20	47.69	101	99	5.168	4.856
25	174.0	6.19	46.68	101	99	5.156	4.860
26	174.0	6.18	46.69	101	99	5.144	4.864
27	173.0	6.17	45.68	101	99	5.132	4.868
28	172.0	6.16	299.32	101	99	5.140	4.872
29	174.0	6.17	46.68	101	99	5.128	4.876
30	174.0	6.16	46.69	101	99	5.116	4.880
31	173.0	6.15	45.69	101	99	5.104	4.880
			70.47				

```
230 ' Operation of Lake Toba
231 '
232 IF YR=1931    THEN
    IF WL>=5      THEN R=101:SP=200-R:GOTO 250
235 IF WL>=5.5    THEN R=101:SP=400-R
240 IF WL< 5.5    THEN R=101:SP=300-R
244 IF WL< 5.2    THEN       SP=250-R
246 IF WL< 5.1    THEN       SP=200-R
250 IF WL< 5      THEN
    IF WL>RWL+.2 THEN SP=75 ELSE
    IF WL>RWL     THEN SP=50 ELSE SP=0
260 IF WL<=4.52   THEN SP=0
261 '
262 IF Q=101 THEN IF WL<4.25 THEN R= 98                                  ELSE R=101
264 IF Q= 98 THEN IF WL<4    THEN R= 95 ELSE IF WL>4.5  THEN R=101 ELSE R= 98
266 IF Q= 95 THEN IF WL<3.75 THEN R= 92 ELSE IF WL>4.25 THEN R= 98 ELSE R= 95
268 IF Q= 92 THEN IF WL<3.5  THEN R= 86 ELSE IF WL>4!   THEN R= 95 ELSE R= 92
270 IF Q= 86 THEN IF WL<3.25 THEN R= 80 ELSE IF WL>3.75 THEN R= 92 ELSE R= 86
274 IF Q= 80 THEN IF WL<2.4  THEN R=  0 ELSE IF WL>3.75 THEN R= 92 ELSE R= 80
276 IF Q=  0                            THEN IF WL>2.4  THEN R= 80 ELSE R=  0
285 RETURN
299 '
```

Fig. I-1 Location of Rain Gage Station in and around Lake Toba Basin

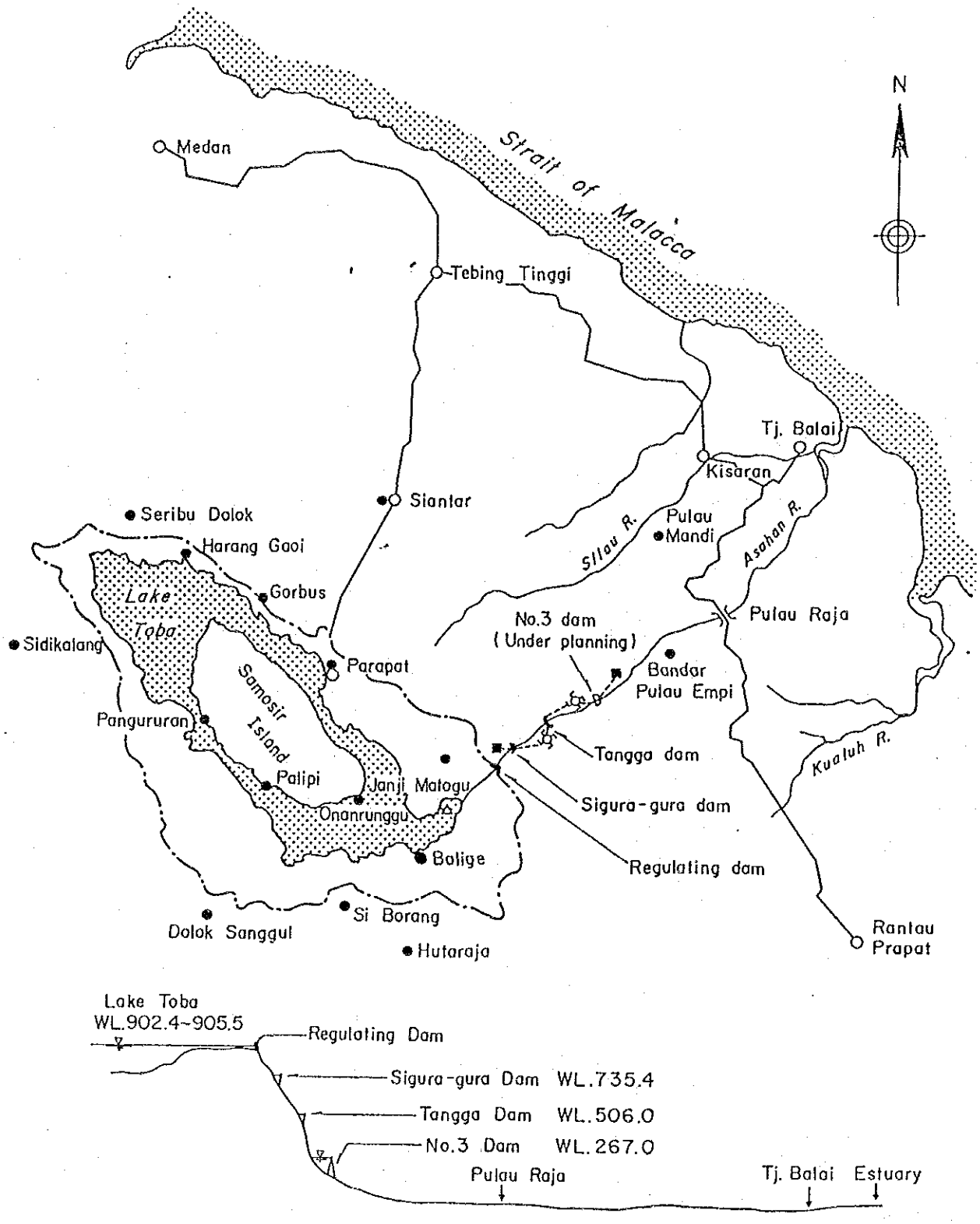


Fig. I-2 Rating Curve for Estimating Water Level of Lake Toba

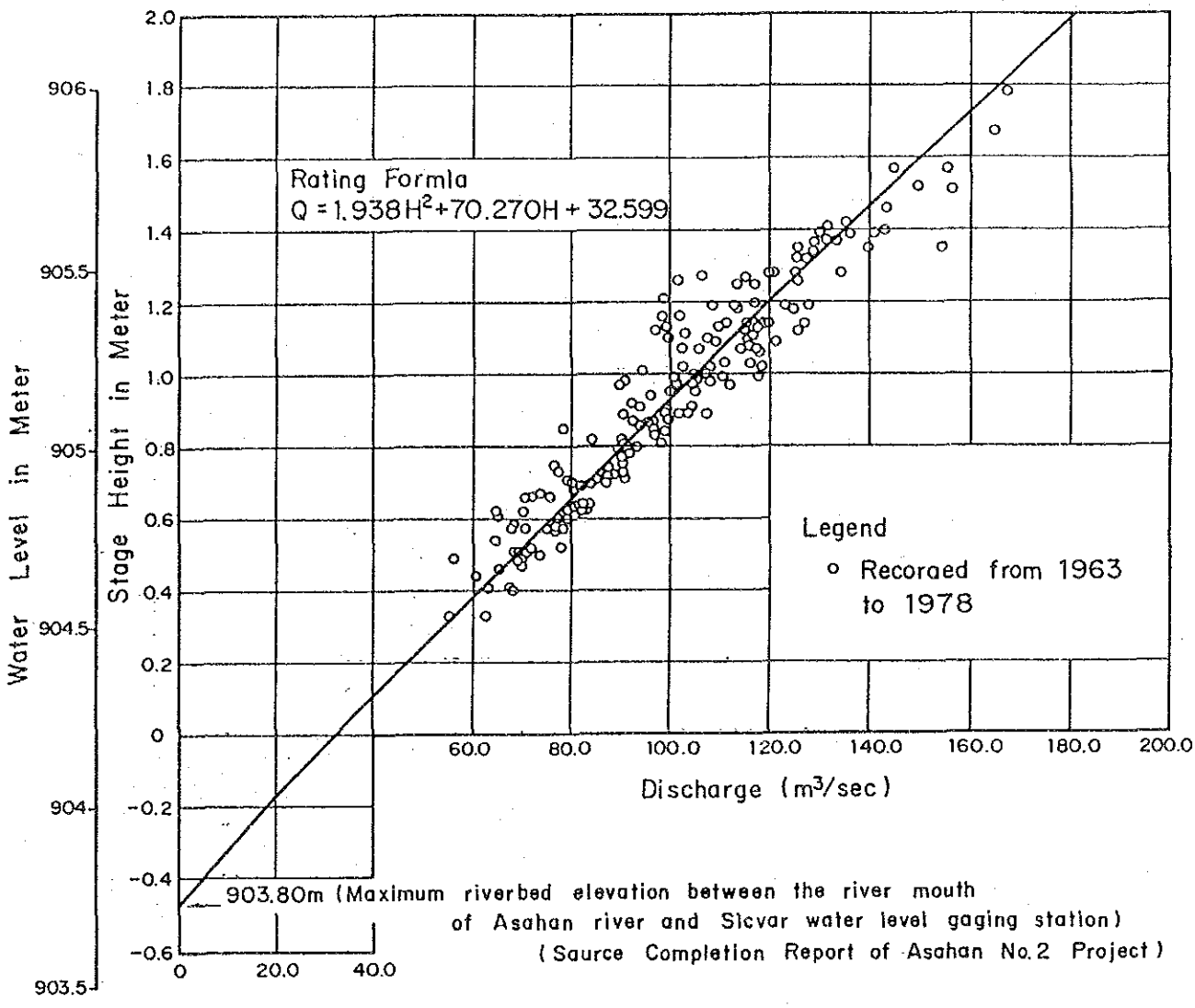
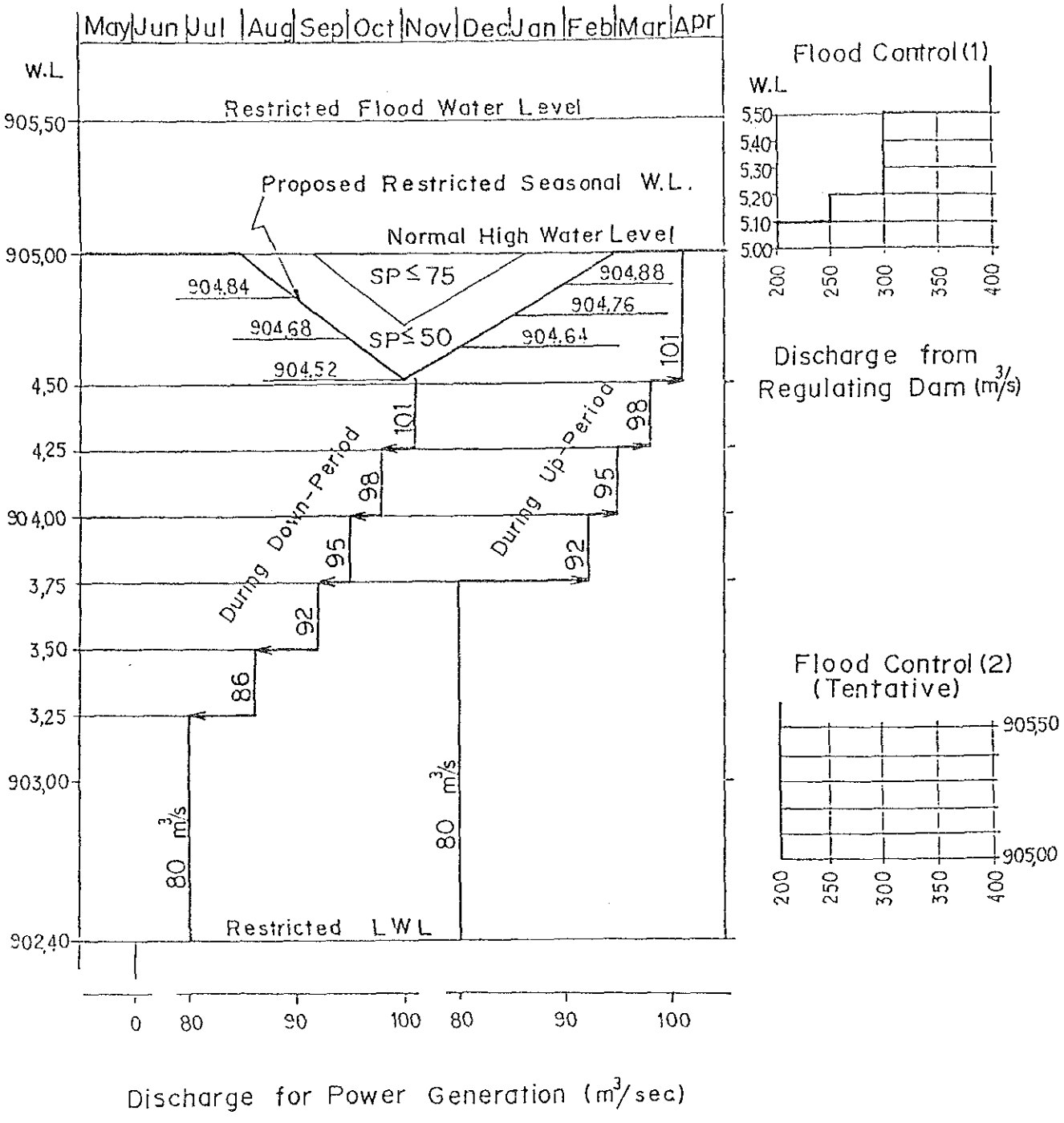


Fig. I-3 Case V Operation of Lake Toba for Flood Control and Water Utilization



Appendix 2-J

Drawings of Urgent Flood Control Project

Appendix 2-J

DRAWINGS OF URGENT FLOOD CONTROL PROJECT

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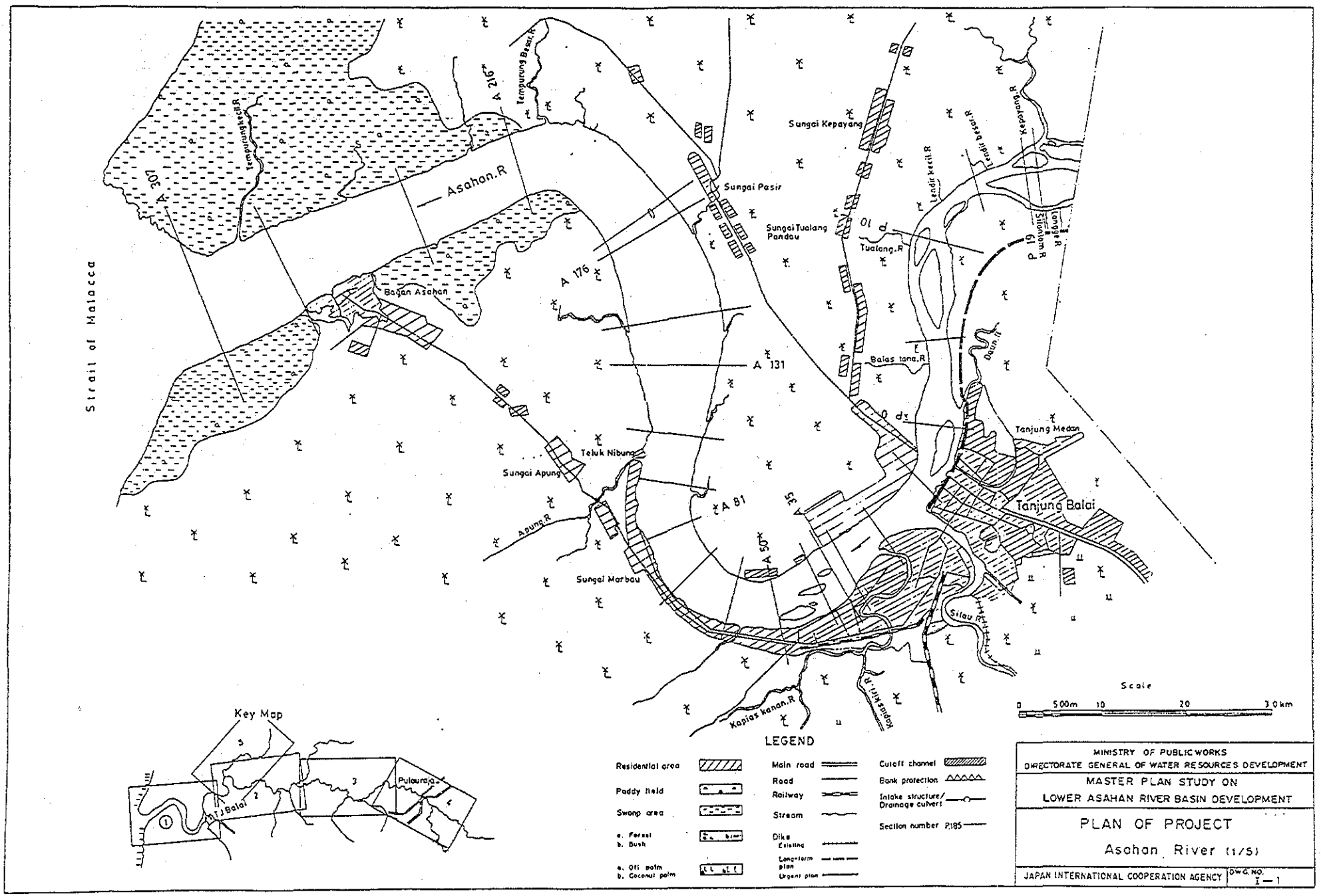
Strait of Malacca
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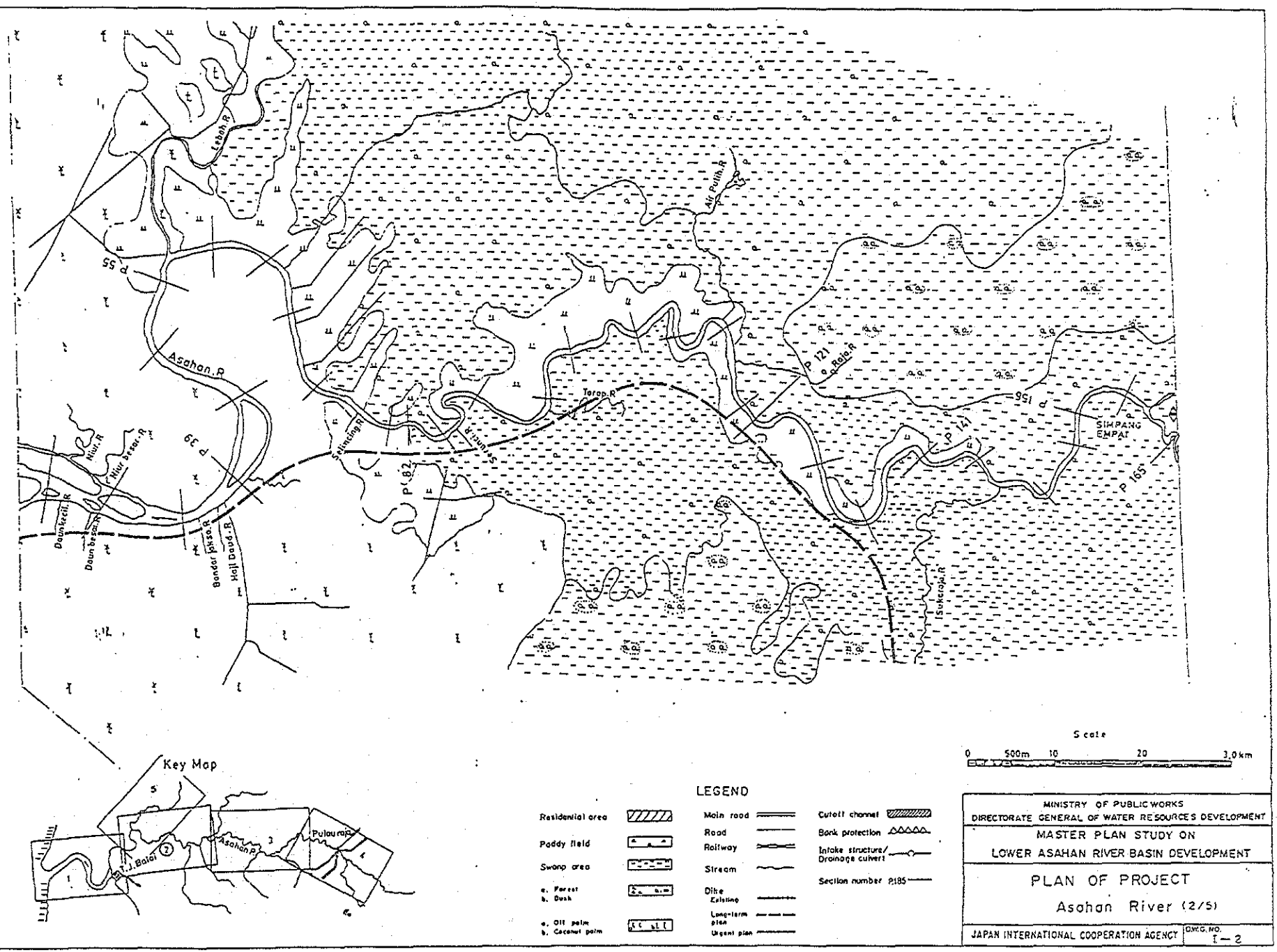
Bagan Asahan
Teluk Nibung
Sungai Apung
Apung.R
Sungai Marbau
Kapias kanan.R
Tanjung Balai
Tanjung Medan
Sungai Kepayang
Sungai Pasir
Sungai Tualang Pandau
Tualang.R
Balas tana.R
Silau R.
A 307
A 216
A 176
A 131
A 81
A 50
P 10
P 19
Key Map
Pulaurasa
T.J Balai
Scale
0 500m 10 20 30 km
LEGEND
Residential area
Paddy field
Swamp area
a. Forest
b. Bush
a. Oil palm
b. Coconut palm
Main road
Road
Railway
Stream
Dike
Existing
Long-term plan
Urgent plan
Cutoff channel
Bank protection
Intake structure/ Drainage culvert
Section number P.185
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PLAN OF PROJECT
Asahan River (1/5)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I — 1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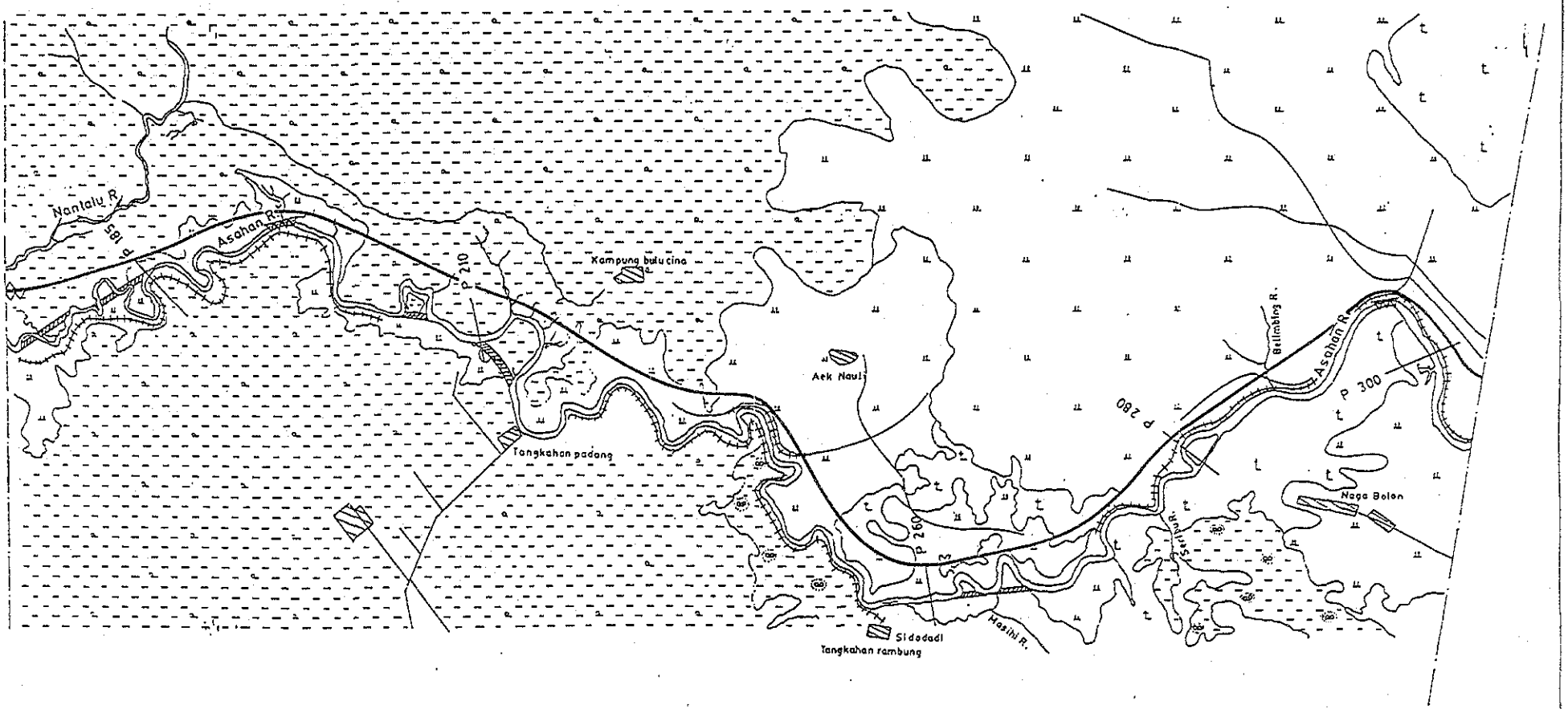
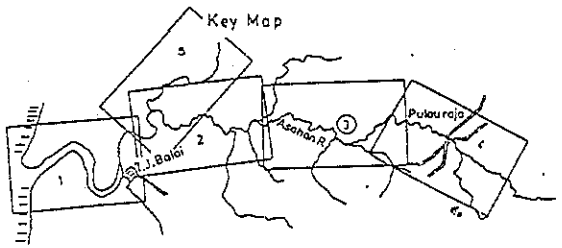
Tebah R.
Air Putih R.
P 55
P 121
Rela R.
P 156
P 141
SIMPANG EMPAT
P 165
Teras R.
Selirching R.
P 82
P 39
Nibur R.
Nibur Besar R.
Daun kecil R.
Daun besar R.
Bandar Jakso R.
Hajl Daud R.
Sukeraja R.
Key Map
Pulau raja
Asahan R.
Sei T.J. Balai
LEGEND
Residential area
Paddy field
Swamp area
a. Forest
b. Bush
a. Oil palm
b. Coconut palm
Main road
Road
Railway
Stream
Dike
Existing
Long-term plan
Urgent plan
Cutoff channel
Bank protection
Intake structure/ Drainage culvert
Section number P.185
Scale
0 500m 10 20 3.0 km
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PLAN OF PROJECT
Asahan River (2/5)
JAPAN INTERNATIONAL COOPERATION AGENCY
D.W.G. NO.
I – 2





LEGEND

Residential area
Paddy field
Swamp area
a. Forest
b. Bush
a. Oil palm
b. Coconut palm
Main road
Road
Railway
Stream
Dike
Existing
Long-term plan
Urgent plan
Cutoff channel
Bank protection
Intake structure/ Drainage culvert
Section number P.185

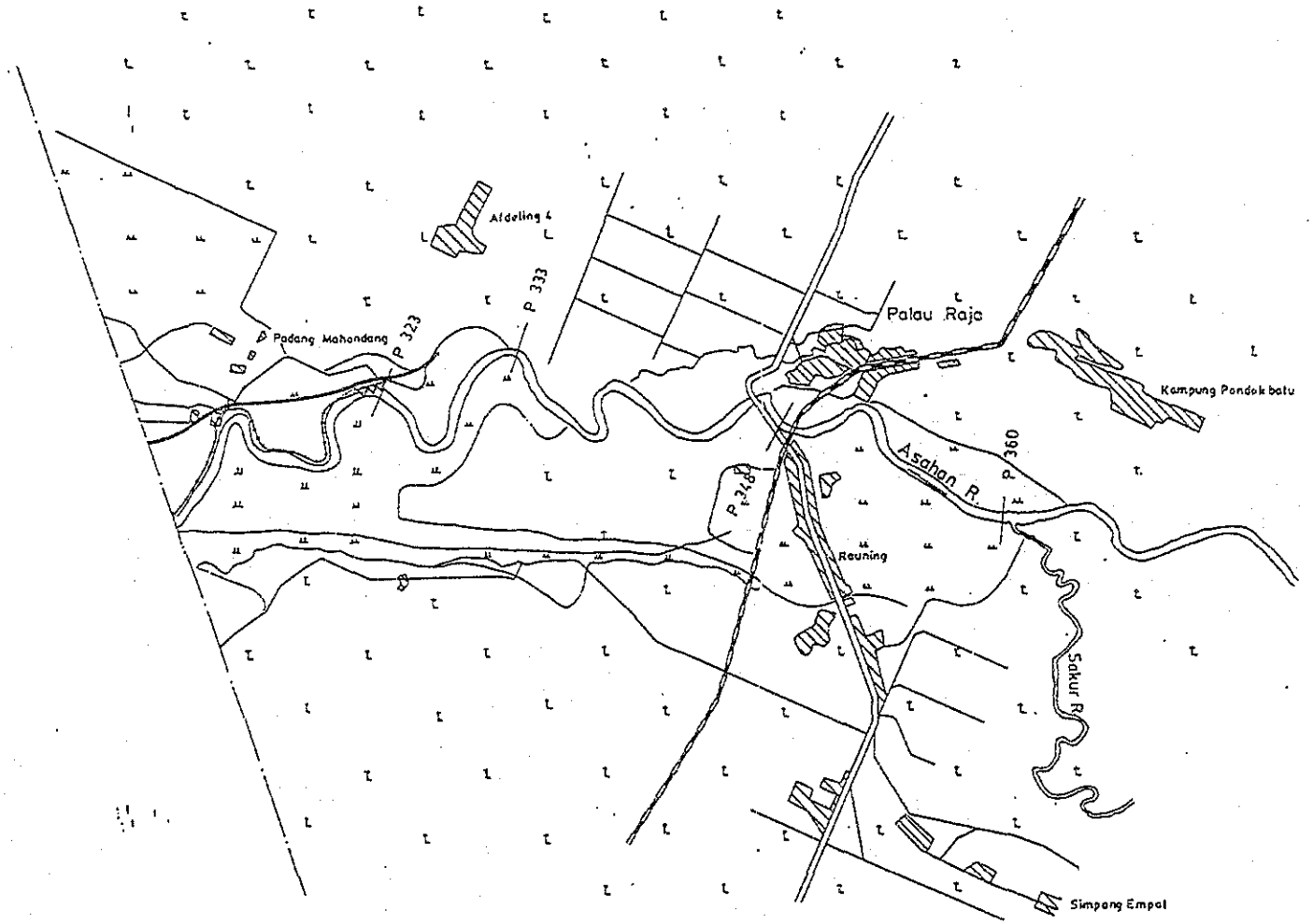
0 500m 10 20 3.0km

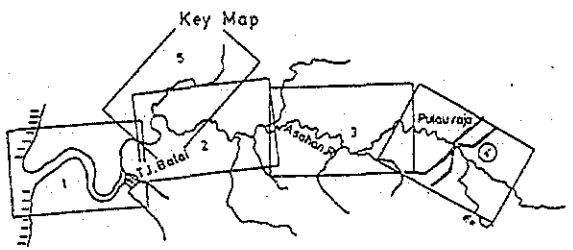
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

PLAN OF PROJECT
Asahan River (3/5)

JAPAN INTERNATIONAL COOPERATION AGENCY | DWG. NO. I-3





Scale

0 500m 10 .20 3.0km

LEGEND

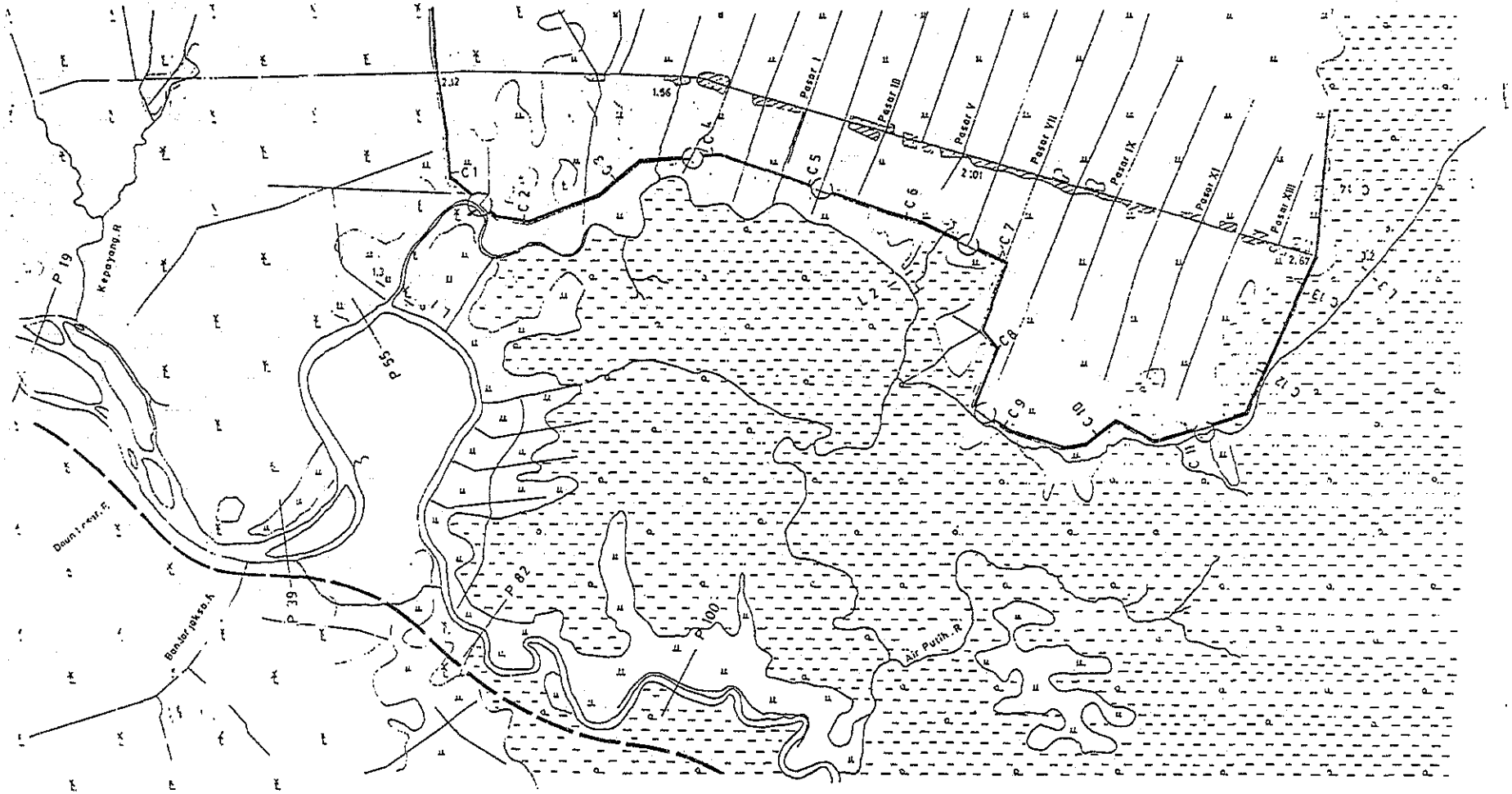
- Residential area
- Paddy field
- Swamp area
- a. Forest b. Bush
- a. Oil palm b. Coconut palm
- Main road
- Road
- Railway
- Stream
- Dike Existing
- Long-term plan
- Urgent plan
- Cutoff channel
- Bank protection
- Intake structure/ Drainage culvert
- Section number P.185

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

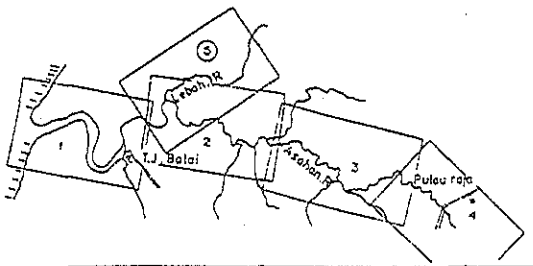
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

PLAN OF PROJECT
Asahan River (4/5)

JAPAN INTERNATIONAL COOPERATION AGENCY | DWG. NO. I — 4



Key Map



LEGEND

- Residential area
- Paddy field
- Swamp area
- a. Forest, b. Bush
- a. Oil palm, b. Coconut palm
- Main road
- Road
- Railway
- Stream
- Dike: Existing; Long-term plan; Urgent plan
- Cutoff channel
- Bank protection
- Intake structure / Drainage culvert
- Section number P.185

Scale

0 500m 1.0 2.0 3.0 km

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

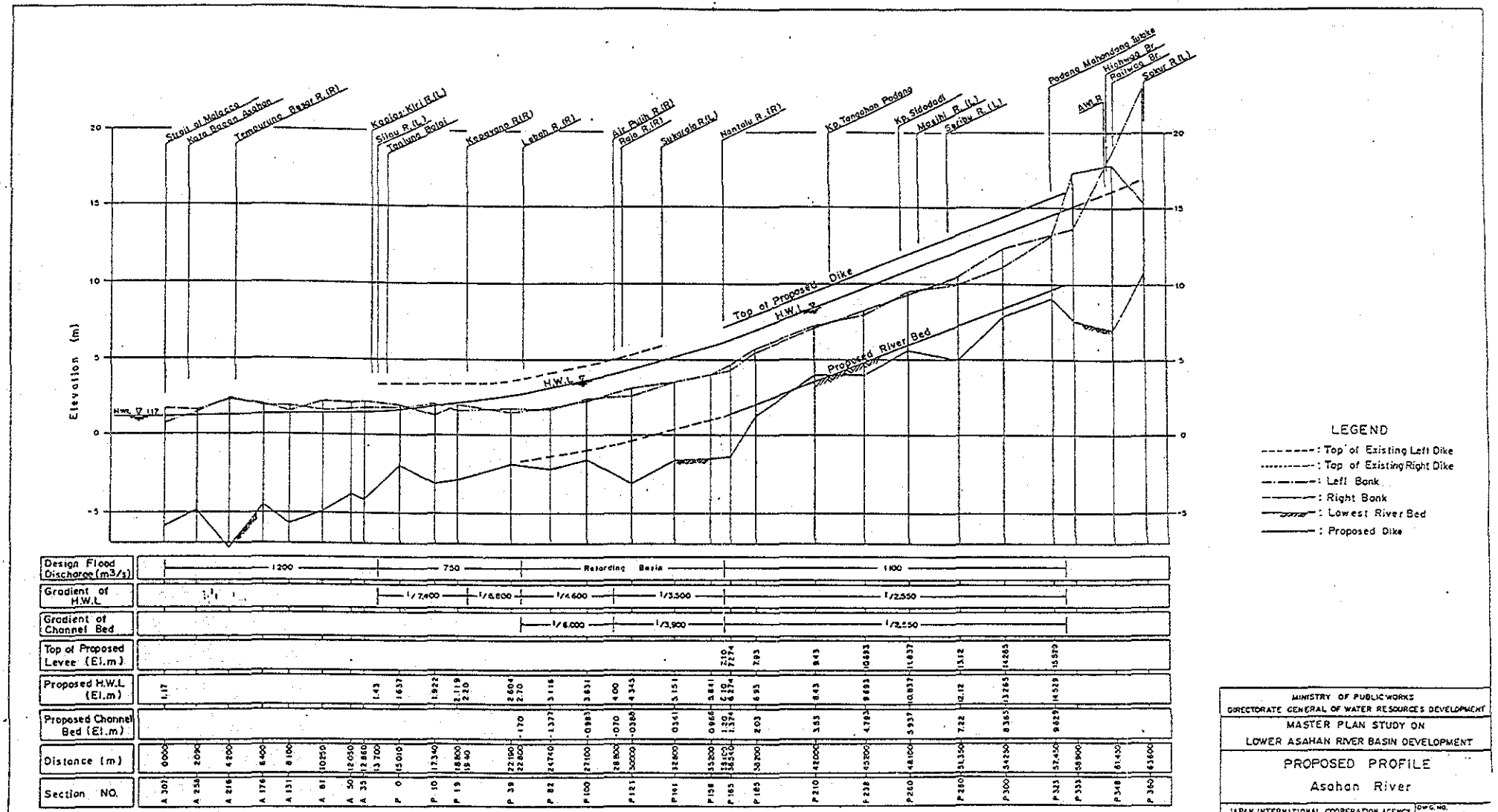
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

PLAN OF PROJECT

Asahan River (5/5)

JAPAN INTERNATIONAL COOPERATION AGENCY

DWG NO. I — 5



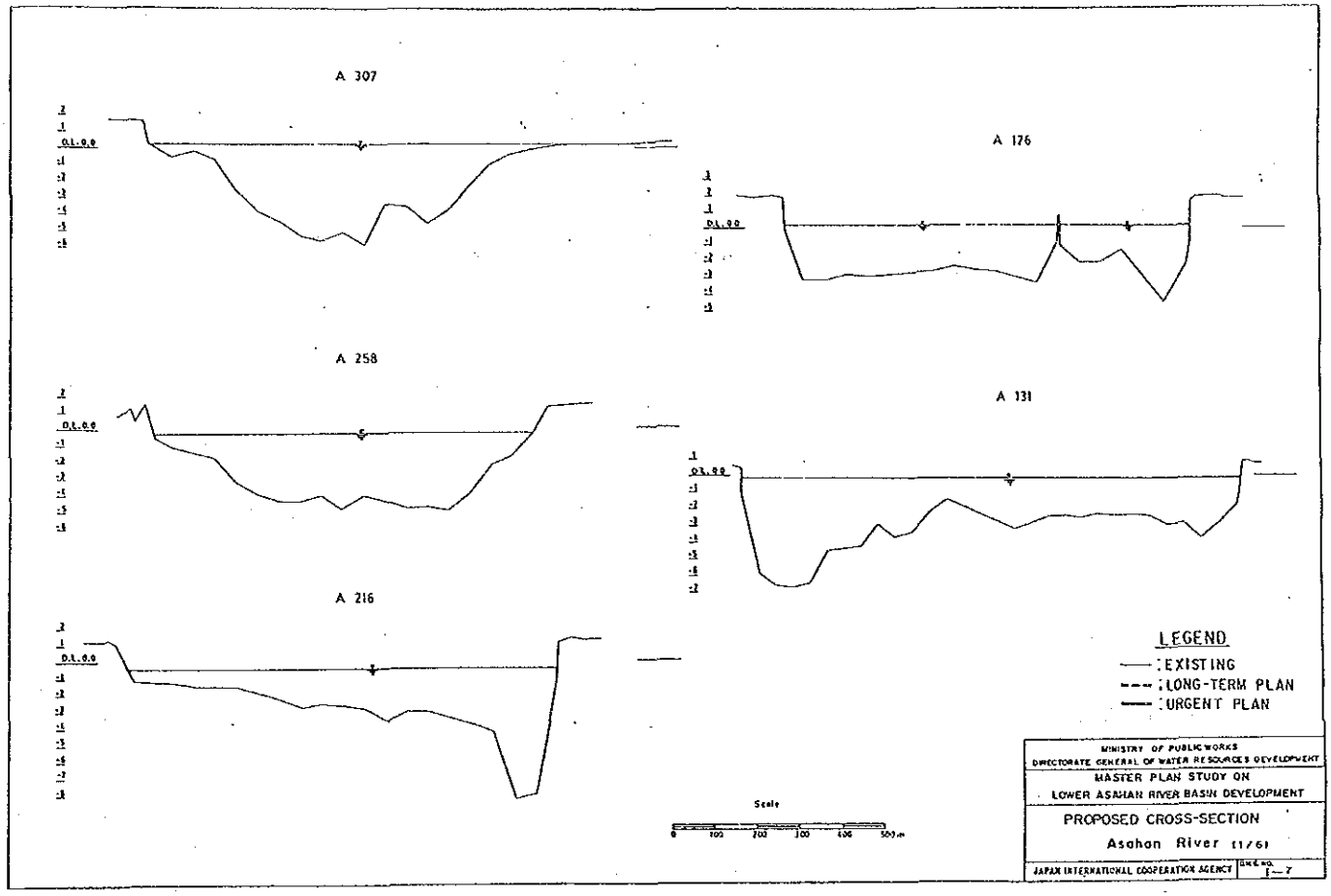
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

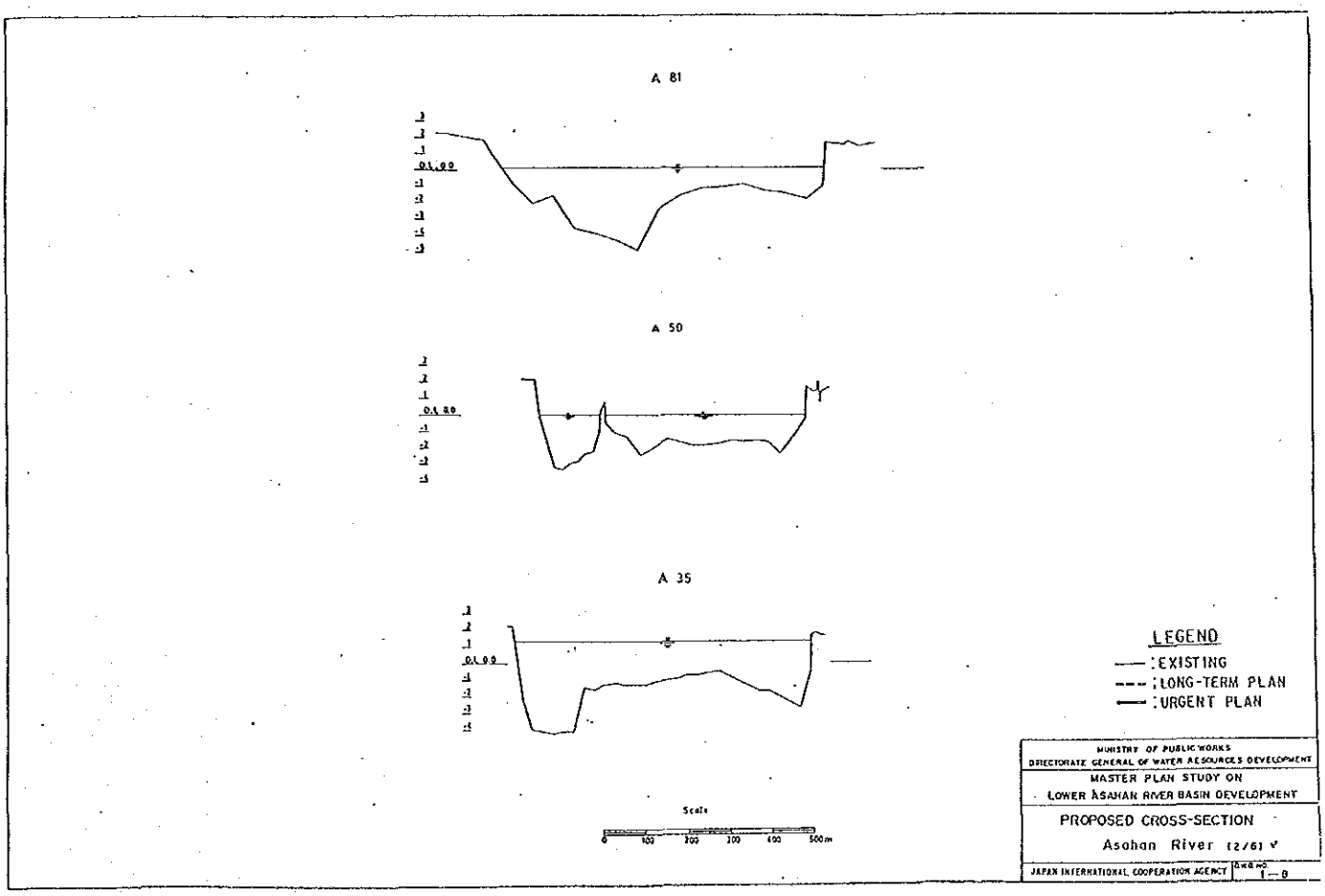
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

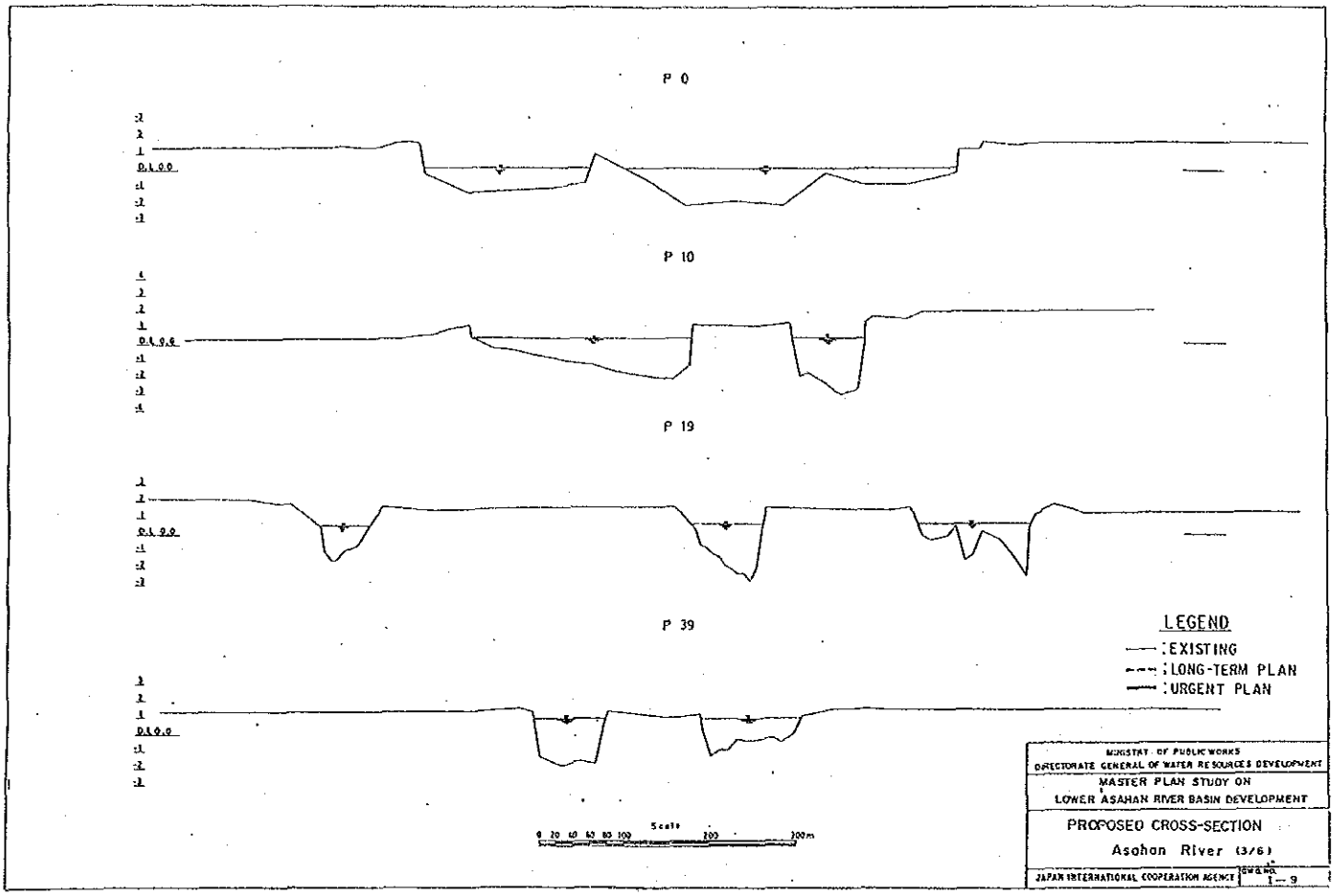
PROPOSED PROFILE
Asahan River

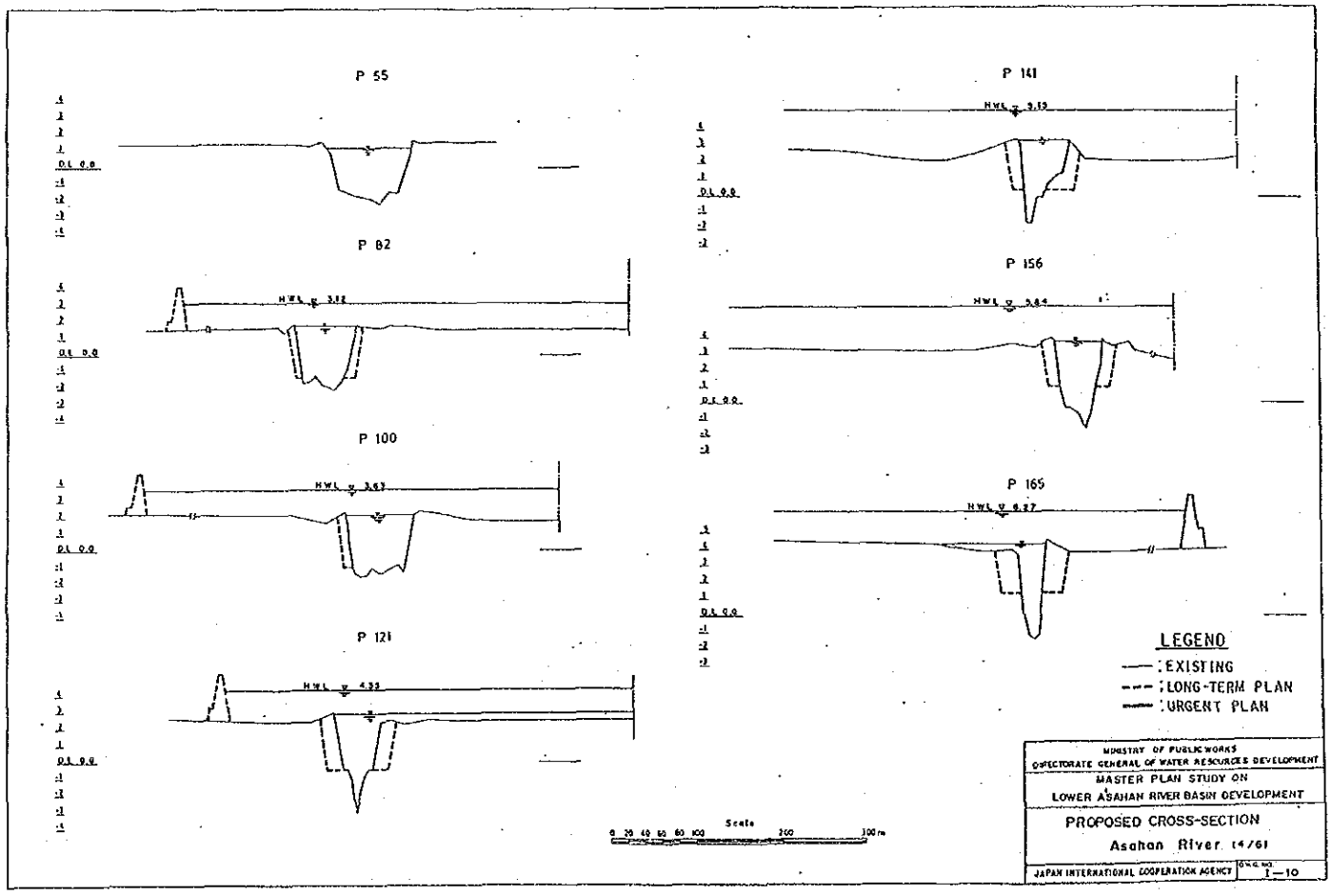
JAPAN INTERNATIONAL COOPERATION AGENCY

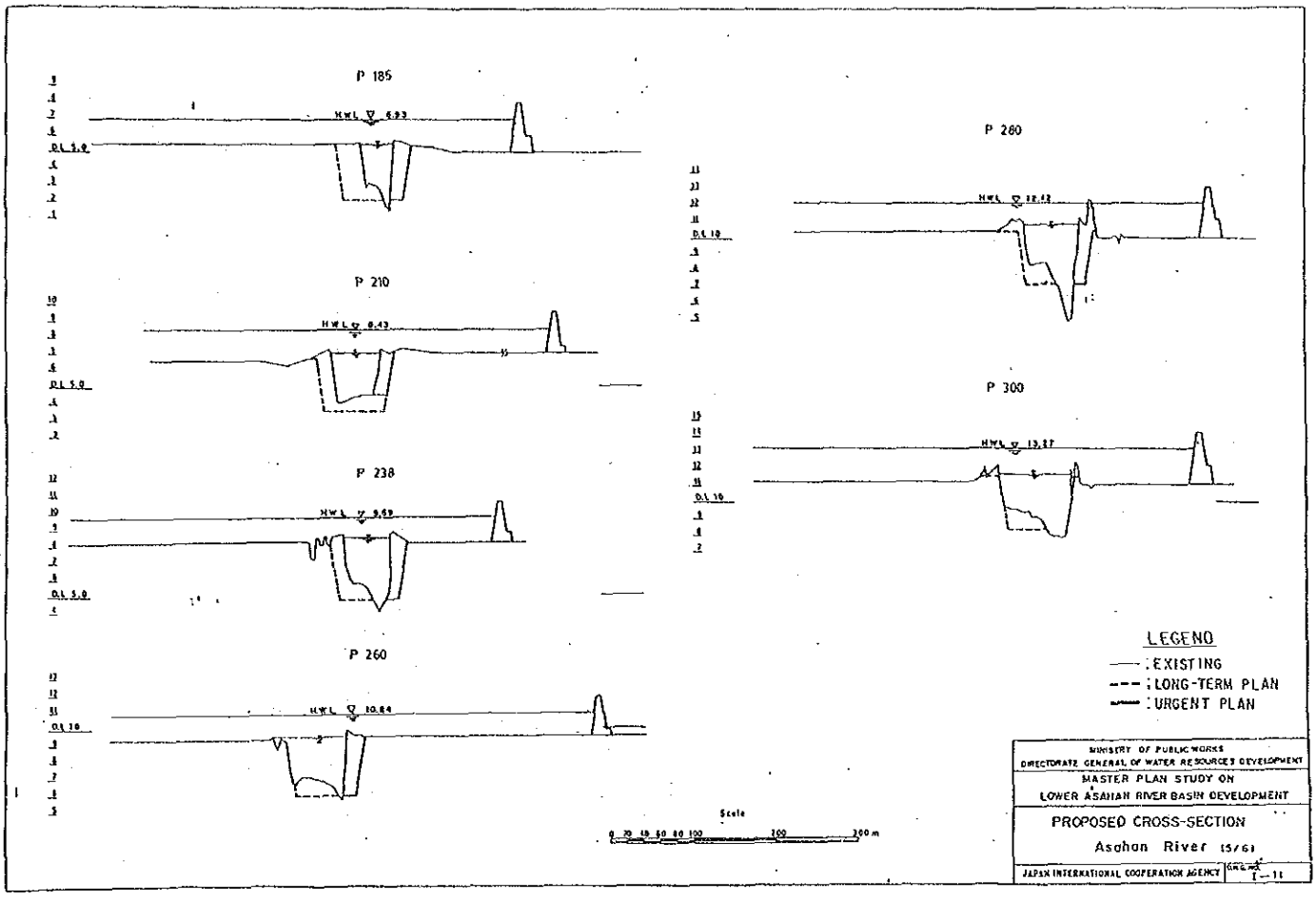
DWG.NO. I — 6

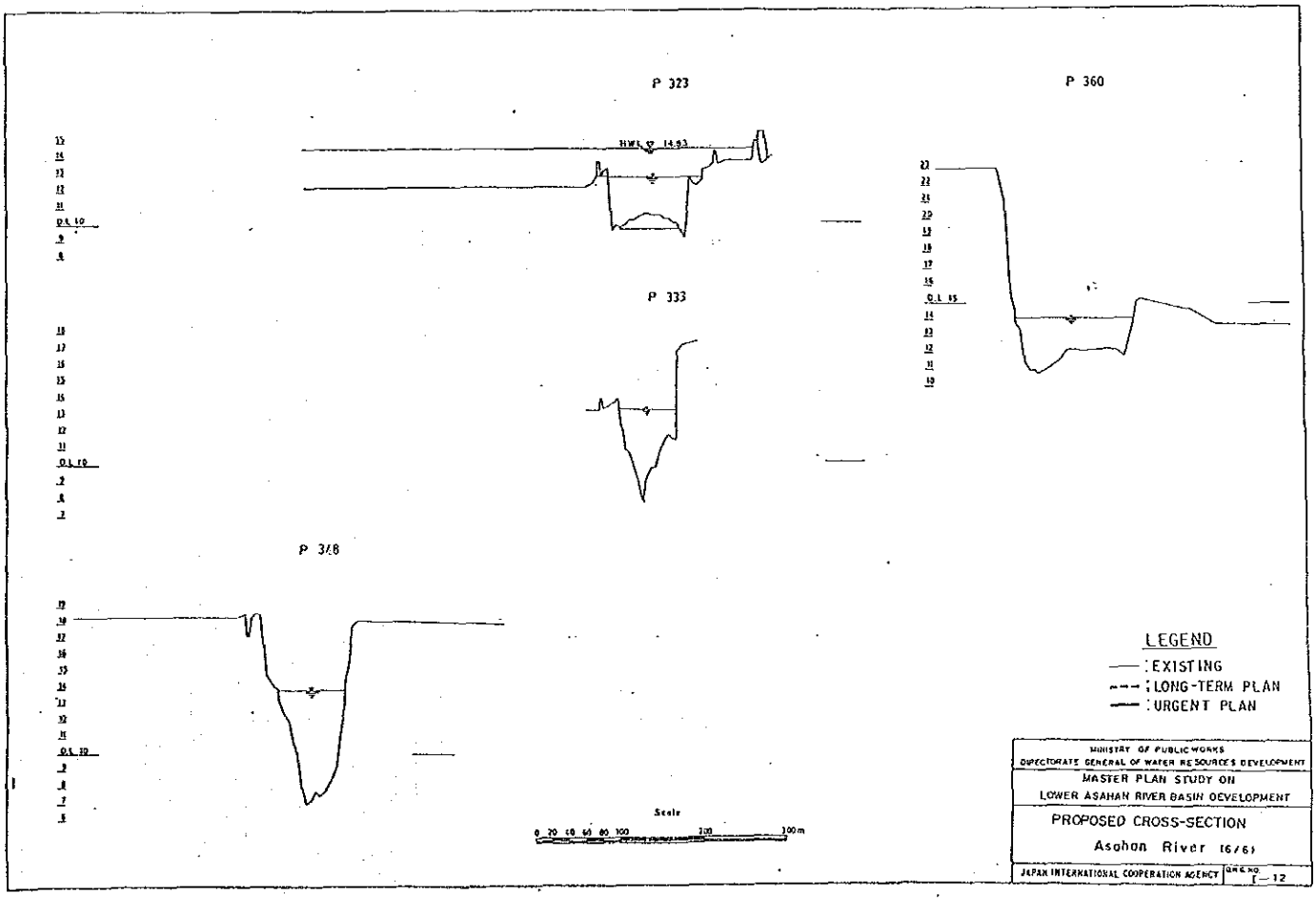

A 307
A 176
A 258
A 131
A 216
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
Scale
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (1/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG NO. 1-7

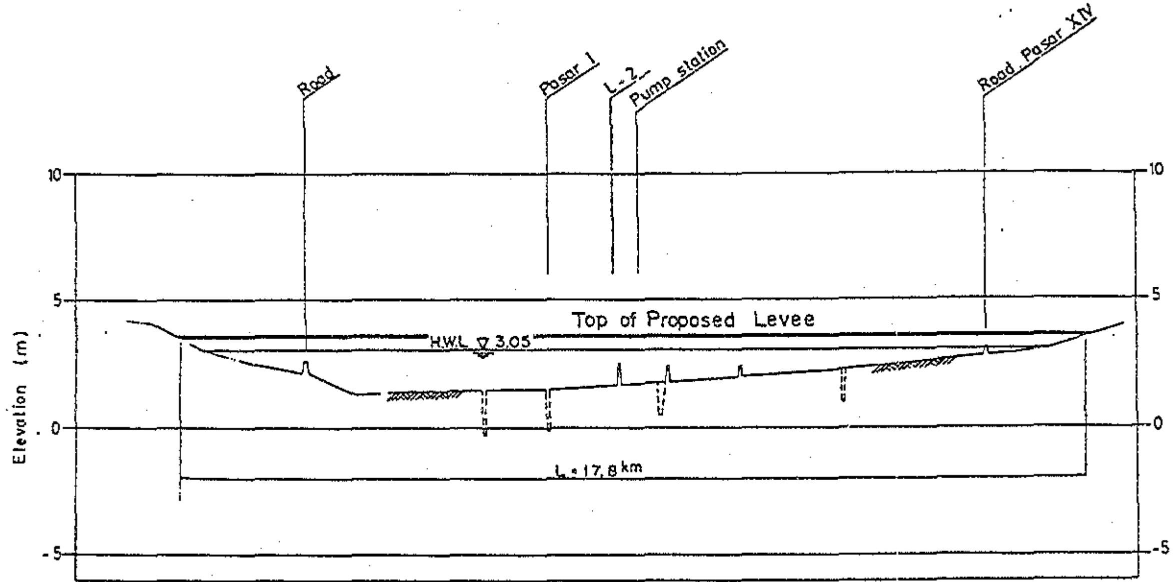

A 81
A 50
A 35
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
Scale
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (2/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG NO. 1-8


P 0
P 10
P 19
P 39
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (3/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I-9

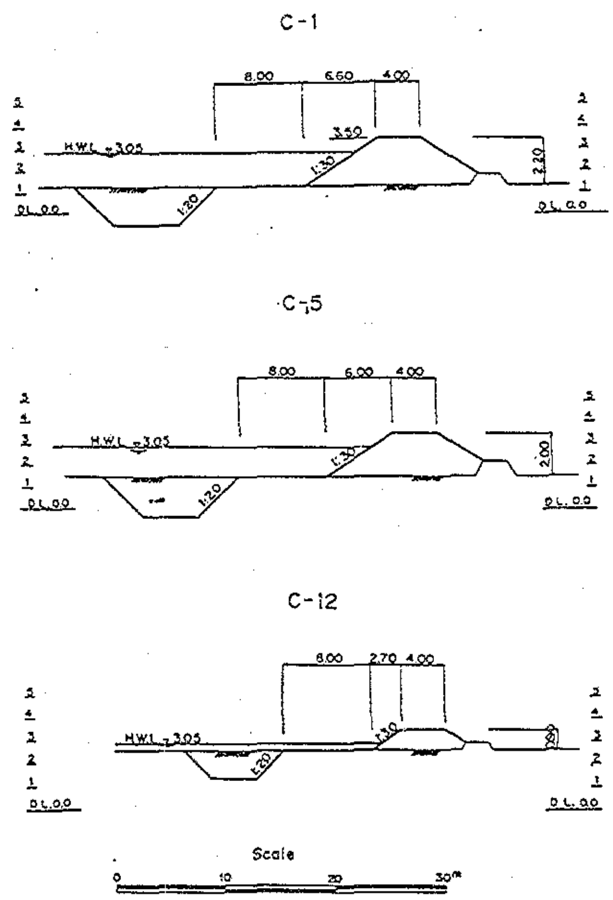

P 55
P 82
P 100
P 121
P 141
P 156
P 165
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (4/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I-10


P 185
P 210
P 238
P 260
P 280
P 300
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (5/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I-11


P 323
P 333
P 348
P 360
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Asahan River (6/6)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I-12



Item	-3	-2	-1	C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Top of Proposed Levee (EL.m)				3.50	3.50	3.50			3.50					3.50			3.50			
Proposed H.W.L (EL.m)				3.05	3.05	3.05			3.05					3.05			3.05			
Ground Hight (EL.m)	4.0	3.0	2.5	2.1	1.3	1.4			1.5					2.2			2.8			
Distance (Km)	-3.00	-2.00	-1.00	0	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00
Section No	-3	-2	-1	C 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

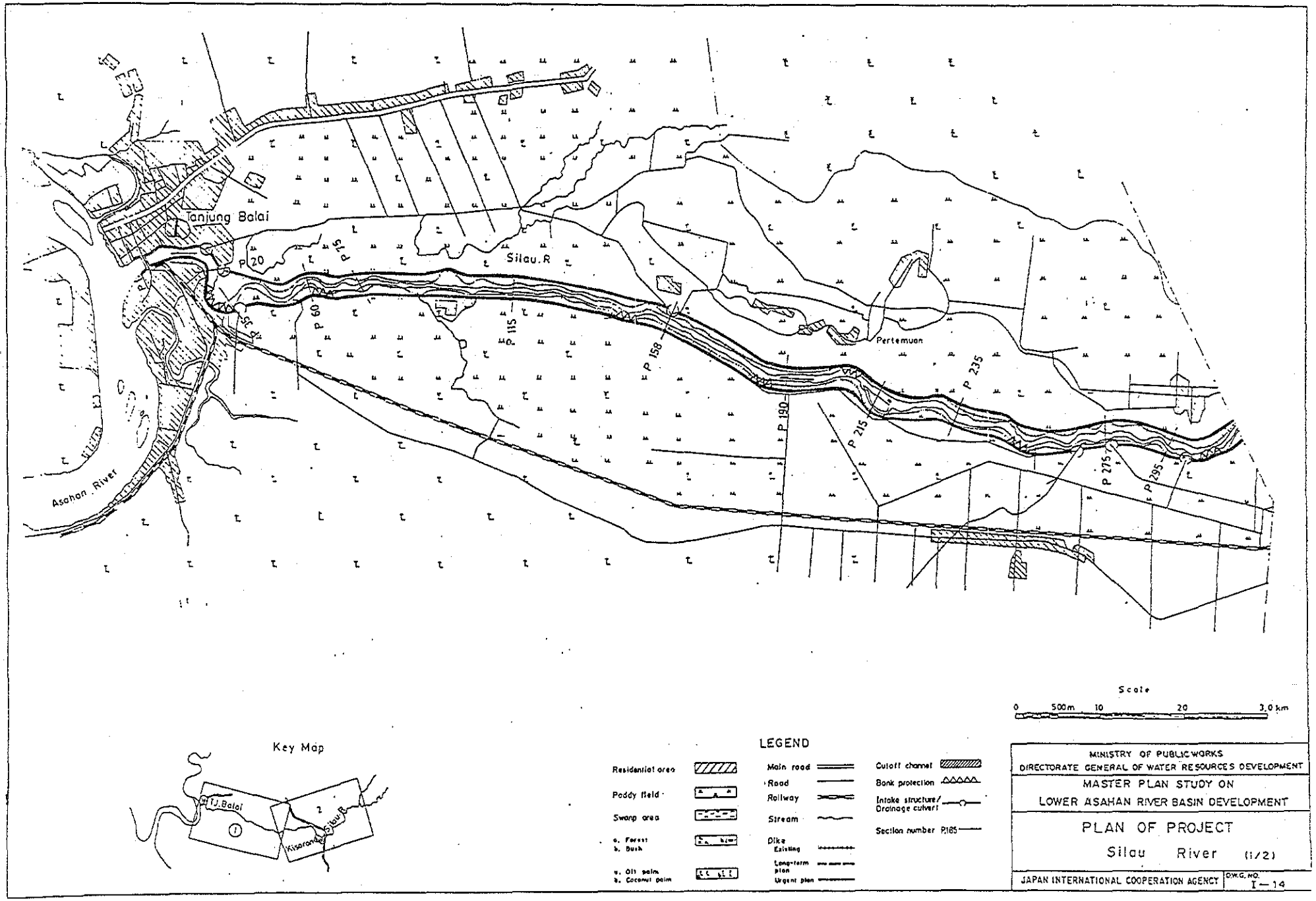


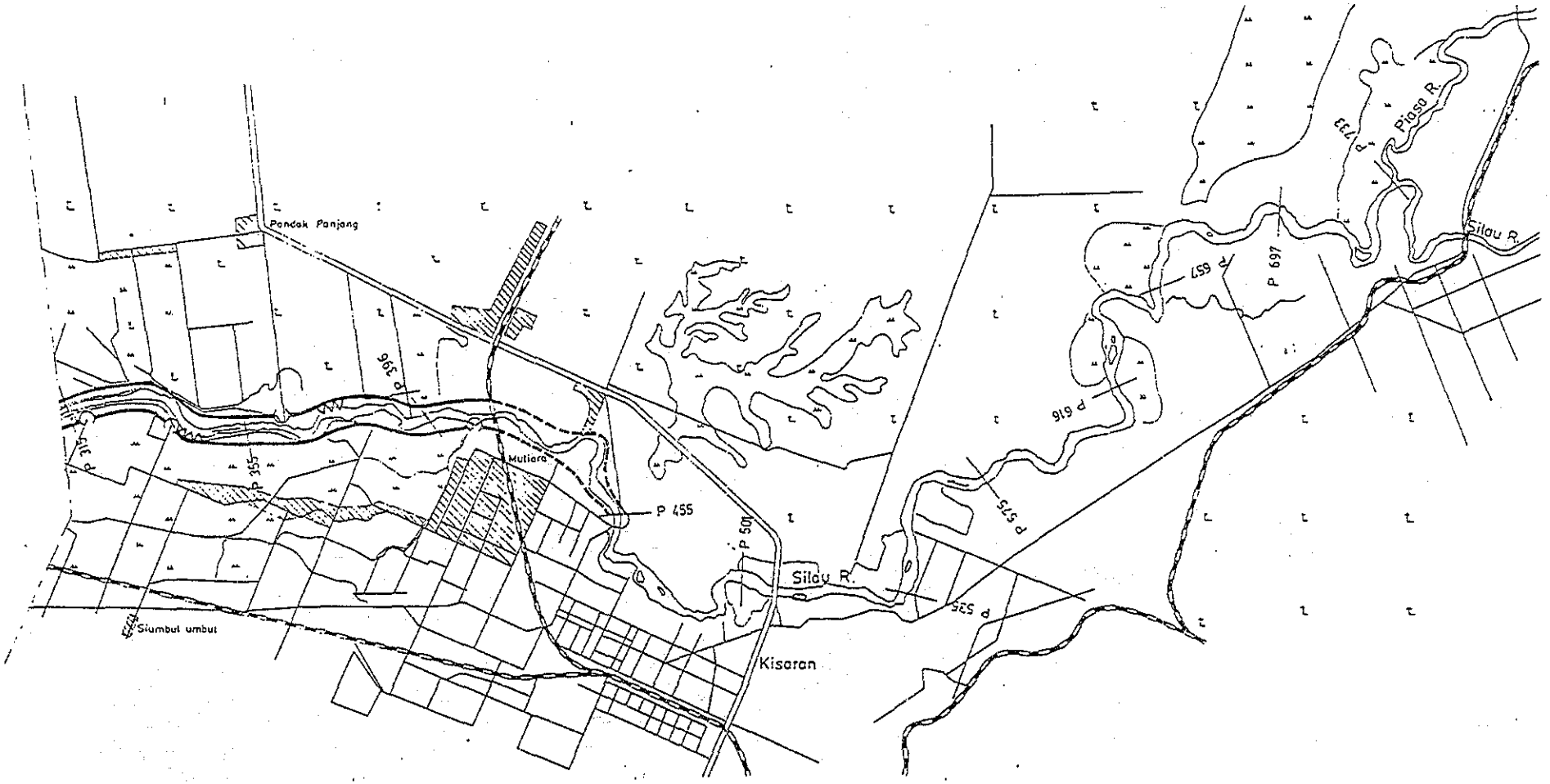
MINISTRY OF PUBLICWORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

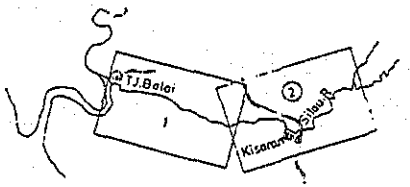
PROPOSED PROFILE
AND CROSS-SECTION
Asahan Retarding Basin

JAPAN INTERNATIONAL COOPERATION AGENCY | DWG.NO. I-13


Tanjung Balai
Silau.R
P 20
P 50
P 115
P 158
P 190
P 215
P 235
P 275
P 295
Pertemuan
Asahan River
Key Map
TJ.Balai
Kisaran
Silau R
LEGEND
Residential area
Paddy field
Swamp area
a. Forest
b. Bush
a. Oil palm
b. Coconut palm
Main road
Road
Railway
Stream
Dike
Existing
Long-term plan
Urgent plan
Cutoff channel
Bank protection
Intake structure/ Drainage culvert
Section number P185
Scale
0 500m 10 20 3.0 km
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PLAN OF PROJECT
Silau River (1/2)
JAPAN INTERNATIONAL COOPERATION AGENCY
DWG. NO. I-14



Key Map



LEGEND

- Residential area
- Paddy field
- Swamp area
- a. Forest / b. Bush
- a. Oil palm / b. Cocunut palm
- Main road
- Road
- Railway
- Stream
- Dike: Existing / Long-term plan / Urgent plan
- Cutoff channel
- Bank protection
- Intake structure / Drainage culvert
- Section number P.185

Scale

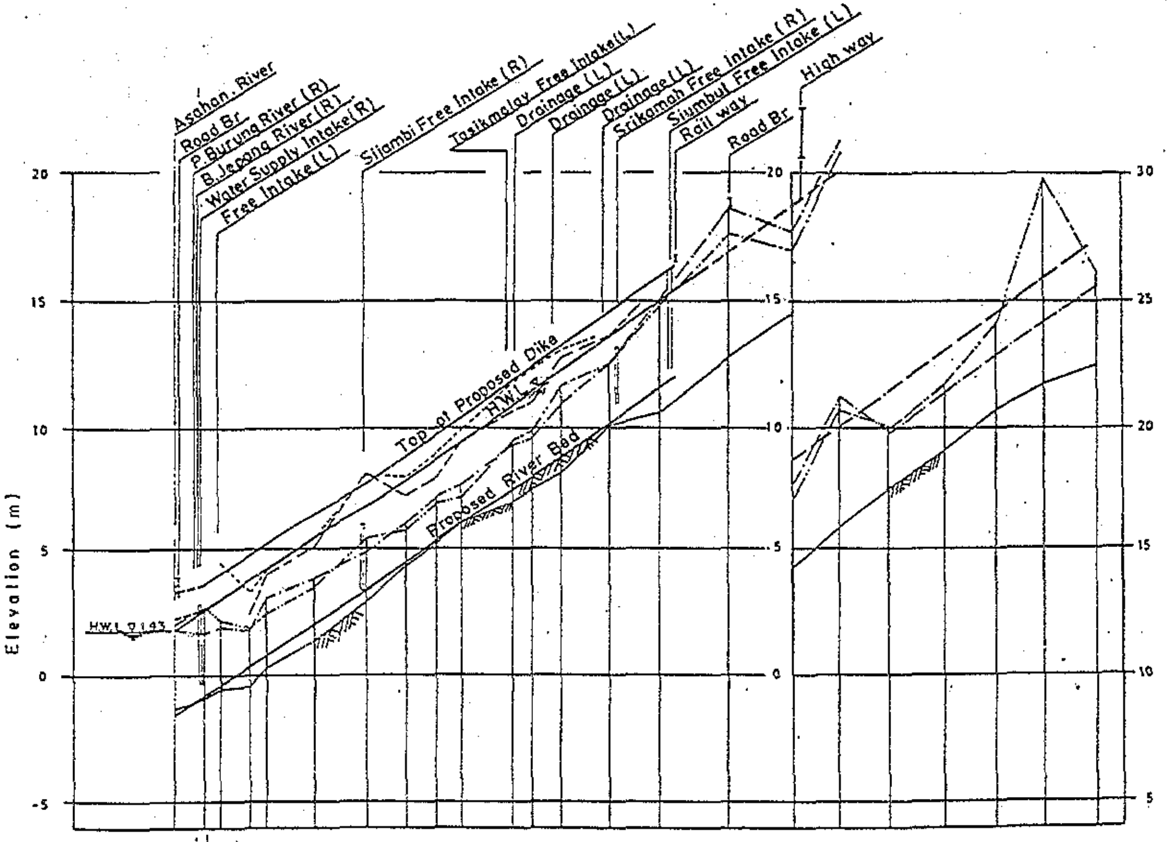
0 500m 10 20 3.0 km

MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

PLAN OF PROJECT
Silau River (2/2)

JAPAN INTERNATIONAL COOPERATION AGENCY | DWG. NO. I — 15



Design Flood Discharge (m3/s)	600																						
Gradient of H.W.L	1/4000	1/1,500					1/1,400																
Gradient of Channel Bed	1/1,500						1/1,400																
Top of Proposed Levee (El.m)	3.30	3.60	4.00	4.76	5.187	6.413	7.747	8.814	9.733	10.447	11.876	12.447	13.247	14.604	15.990								
Proposed H.W.L (El.m)	2.30	2.60	3.00	3.76	4.187	5.413	6.747	7.814	8.733	9.447	10.876	11.447	12.247	13.604	14.990								
Proposed Channel Bed (El.m)	-1.60	-0.80	-0.40	0.36	0.787	2.013	3.347	4.418	5.433	6.047	7.476	8.047	8.847	10.204	11.590								
Distance (m)	0.000	1,200	1,800	2,940	3,580	5,420	7,420	9,020	10,200	11,200	13,200	14,000	15,120	17,020	18,960	21,660	24,150	25,930	27,530	30,130	32,230	34,130	36,120
Section NO	P 1	20	35	60	75	115	158	190	215	235	275	295	315	355	396	455	501	535	575	616	657	697	733

LEGEND

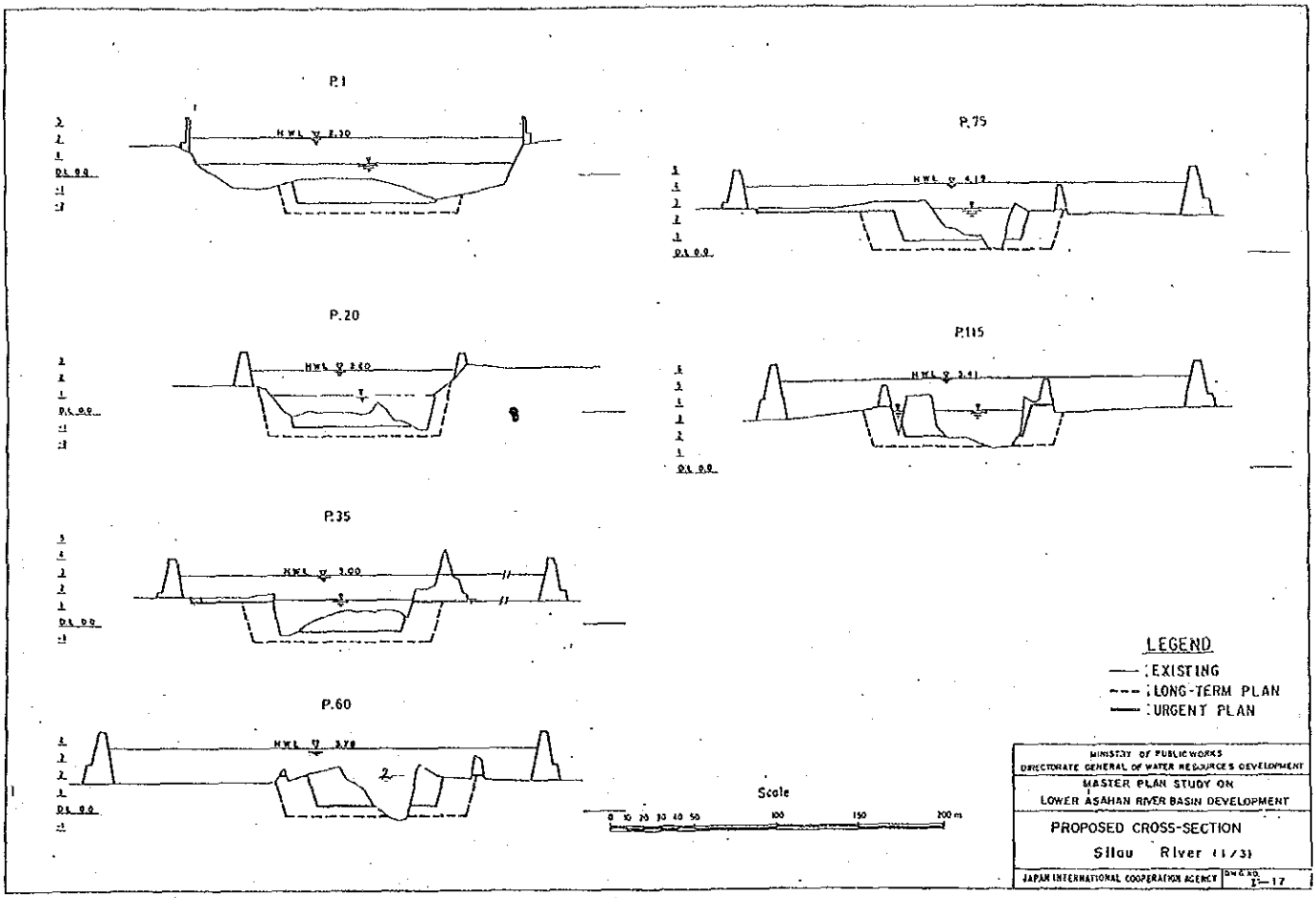
- - - - - - : Top of Existing Left Dike
- ·········· : Top of Existing Right Dike
- —·—·— : Left Bank
- —··—··— : Right Bank
- ////// : Lowest River Bed
- ——— : Proposed Dike

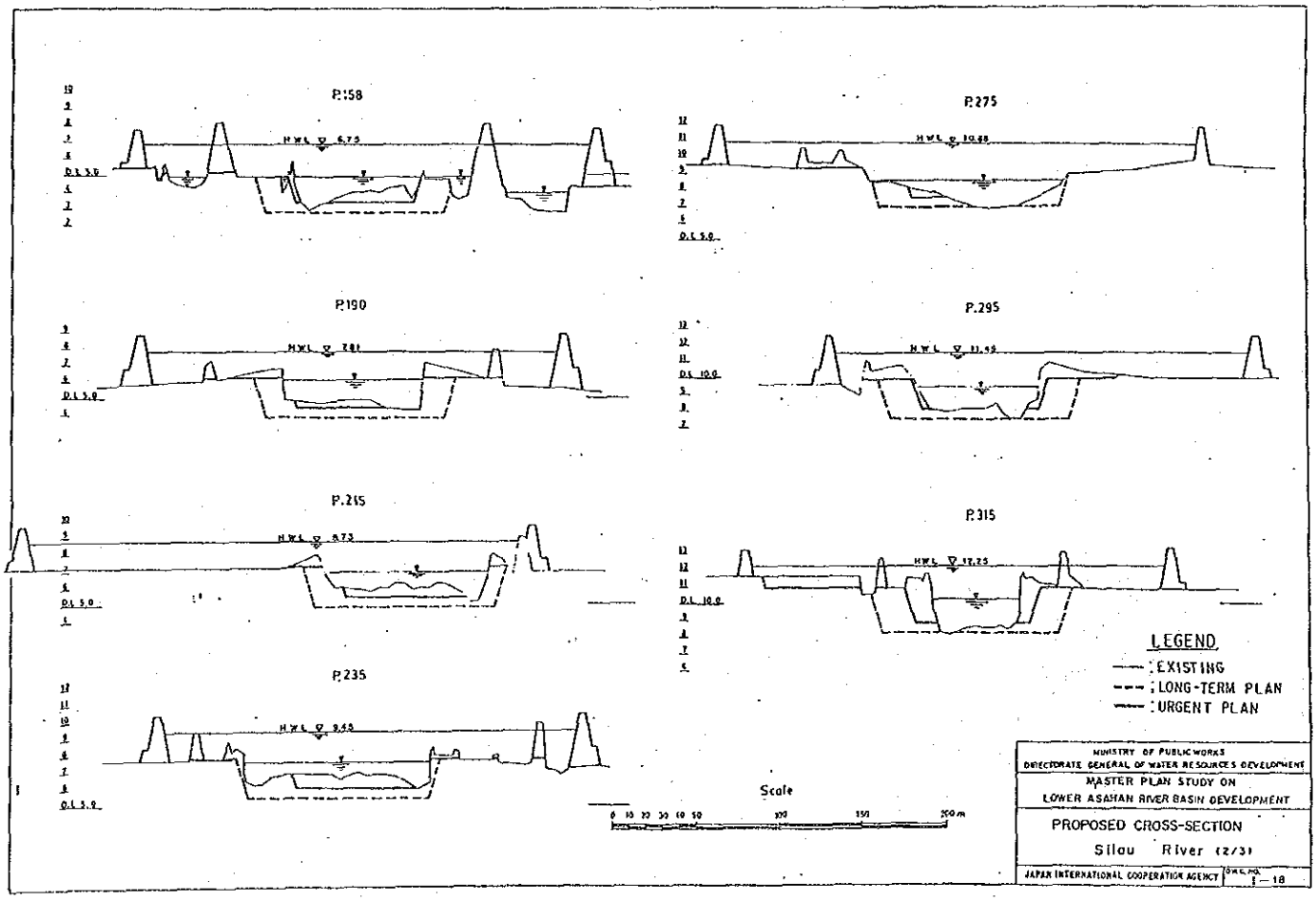
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT

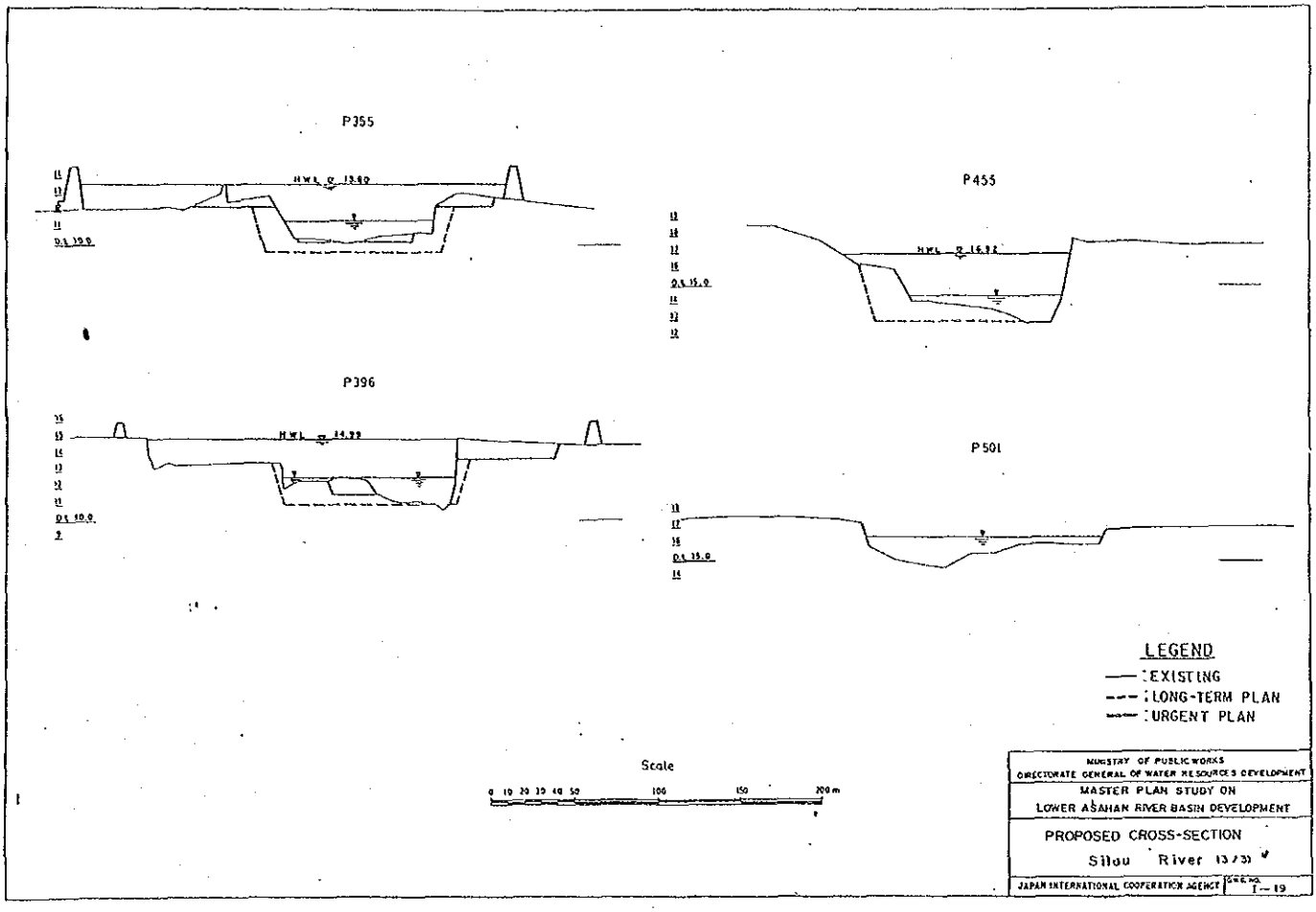
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT

PROPOSED PROFILE
Silau River

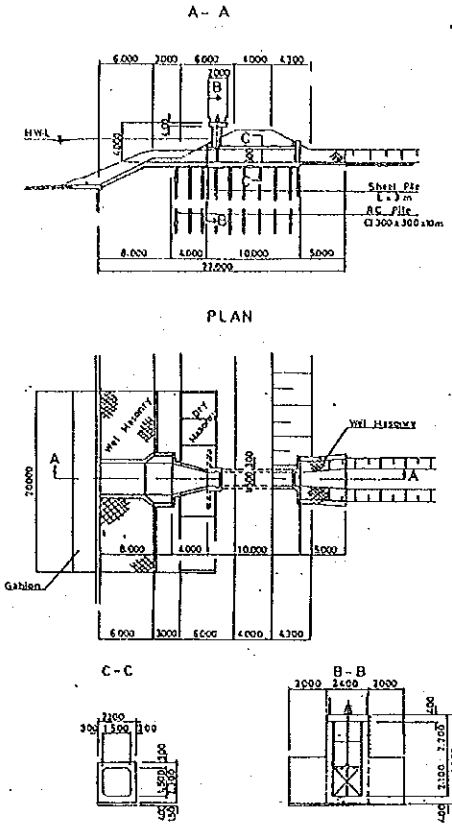
JAPAN INTERNATIONAL COOPERATION AGENCY | DWG. NO. I — 16


P.1
P.75
P.20
P.115
P.35
P.60
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
Scale
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Silau River (1/3)
JAPAN INTERNATIONAL COOPERATION AGENCY
I-17

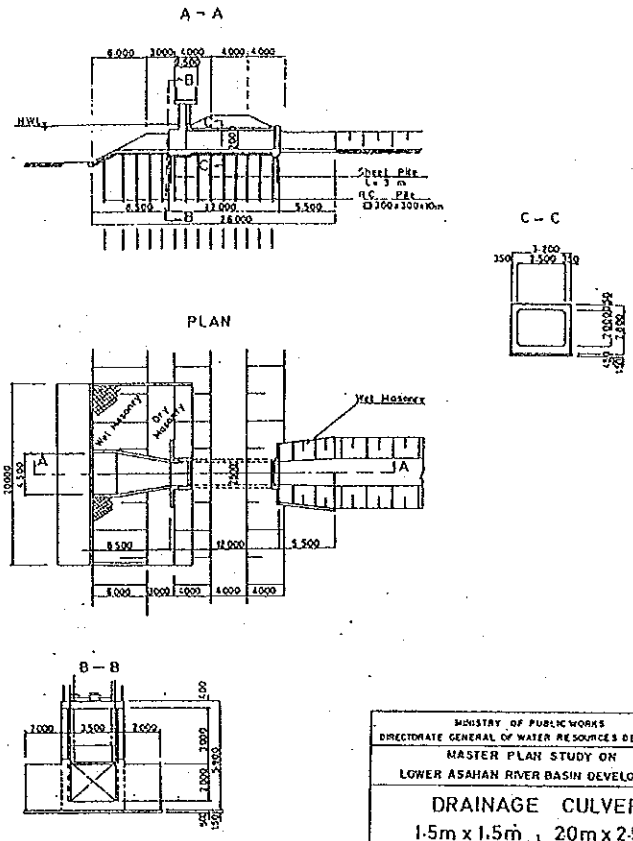

P.158
P.275
P.190
P.295
P.215
P.315
P.235
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
Scale
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Silau River (2/3)
JAPAN INTERNATIONAL COOPERATION AGENCY
I-18


P355
P455
P396
P501
LEGEND
: EXISTING
: LONG-TERM PLAN
: URGENT PLAN
Scale
0 10 20 30 40 50 100 150 200 m
MINISTRY OF PUBLIC WORKS
DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON
LOWER ASAHAN RIVER BASIN DEVELOPMENT
PROPOSED CROSS-SECTION
Silou River (3/3)
JAPAN INTERNATIONAL COOPERATION AGENCY
DRG. NO. T-19

DRAINAGE CULVERT (1.5m x 1.5m)

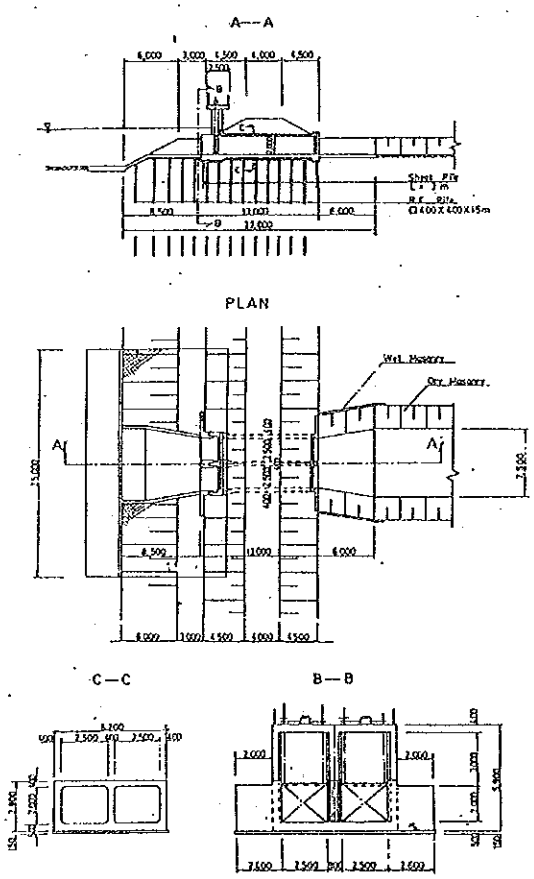


DRAINAGE CULVERT (2.0m x 2.5m)



MINISTRY OF PUBLIC WORKS DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON LOWER ASAHAN RIVER BASIN DEVELOPMENT
DRAINAGE CULVERT 1.5m x 1.5m , 2.0m x 2.5 m
JAPAN INTERNATIONAL COOPERATION AGENCY — DWG. NO. E — 1

DRAINAGE CULVERT (2.0m x 2.5m x 2)



MINISTRY OF PUBLIC WORKS DIRECTORATE GENERAL OF WATER RESOURCES DEVELOPMENT
MASTER PLAN STUDY ON LOWER ASAHAN RIVER BASIN DEVELOPMENT
DRAINAGE CULVERT 2.0mX2.5mX2
JAPAN INTERNATIONAL COOPERATION AGENCY — DWG. NO. E — 2