TABLES

CHAPTER 7

DETAILED DESIGN

LIST OF TABLES

Chapter 7

Table 7.2.1 FREQUENCY OF QUALITY CONTROL TEST FOR EACH ZONE

Zone	Material	Location	No.	Sampling	Items	Frequency
Impervious Zone	Contact Material	Borrow Area	1	Before Stockpiling	Moisture Content	as directed
					Gradation	as directed
					Specific Gravity	as directed
					Atterberg Limit	as directed
					Density	as directed
					Permeability	as directed
		Stockpile	2	During Stockpiling	Moisture Content	as directed
					Gradation	as directed
					Specific Gravity	as directed
					Atterberg Limit	as directed
			3	Before Loading	Moisture Content	1 per day
					Gradation	1 per day
					Specific Gravity	1 per day
			4	During Embankment	Moisture Content	2 per month
					Gradation	2 per month
					Specific Gravity	2 per month
					Atterberg Limit	2 per month
					Density	2 per month
					Permeability	2 per month
		Embankment	5	After Compaction	Moisture Content	1 per layer
					Gradation	1 per unit
					In Situ Density	1 per unit
	Regular Impervious Material	Borrow Area for Sand & Gravel	1	Before Stockpiling	Gradation	as directed
					Specific Gravity	as directed
		Borrow Area for Cohesive Soil	2	Before Stockpiling	Moisture Content	as directed
					Gradation	as directed
					Specific Gravity	as directed
					Atterberg Limit	as directed
					Density	as directed
					Permeability	as directed
		Stockpile	3	During Stockpiling	Moisture Content	as directed
					Gradation	as directed
					Specific Gravity	as directed
					Atterberg Limit	as directed
			4	After Completion of Stockpiling	Moisture Content	3 per stockpile
					Gradation	3 per stockpile
					Specific Gravity	3 per stockpile
					Atterberg Limit	3 per stockpile
					Density	3 per stockpile
					Permeability	3 per stockpile
					Tri-Axial	3 per stockpile
			5	Before Loading	Moisture Content	2 per day
					Gradation	1 per day
			6	During Embankment	Moisture Content	2 per month
					Gradation	2 per month
					Specific Gravity	2 per month
					Atterberg Limit	2 per month
					Density	2 per month
					Permeability	2 per month
					Tri-Axial	as directed
		Embankment	7	After Compaction	Moisture Content	1per unit
					Gradation	1 per unit
					Density	1 per unit
					In Situ Density	1 per unit
					In Situ Permeability	2 per month
Semi-pervios Zone	Semi-pervious Material	Crushing Plant	1	Before Stockpiling	Gradation	as directed
					Specific Gravity	as directed
		Stockpile	2	During Embankment	Gradation	2 per month
					Specific Gravity	2 per month
					Minimum Density	2 per month
					Maximum Density	2 per month
					Permeability	2 per month
		Embankment	3	After Compaction	In Situ Density	1 per unit
					In Situ Permeability	2 per month
Pervious Zone	Pervious Material	Quarry	1	During Embankment	Gradation	1 per 50,000m3
					Specific Gravity	1 per 50,000m3
		Embankment	2	After Compaction	Gradation	1 per 100,000m3
					Specific Gravity	1 per 100,000m3
					In Situ Density	1 per 100,000m3
					In Situ Permeability	1 per 100,000m3

Table 7.2.2 ESTIMATED WET AND SATURATED DENSITIES IN ZONES

Zone	Sample Size	Item	Symbol	Value	Unit	Remarks
Impervious Zone	smaller than 19.0mm	D Value 95% Dry Density	γd'	1.739	tf/m^3	from Test Results
		Optimum Moisture Content	w'	15.5%		from Test Results
		Apparent Specific Gravity	Gs	2.716		from Test Results
		Void Ratio	e'	0.560		Gs/γd'-1
		Wet Density	γt'	2.010	tf/m^3	(1+w')xγd'
		Saturated Density	γsat'	2.100	tf/m^3	(Gs+e')/(1+e')
	larger than 19.0mm	Apparent Specific Gravity	Gs2	2.750		from Test Results
		Natural Moisture Content	w	1.0%		from Test Results
		Estimated Bulk Specific Gravity	pd2	2.676		Gs2/(1+wxGs2)
	Complete Grading	Gravel Content Ratio	P	20.0%		Assumed Value
		Average Specific Gravity	Gbf	2.720		(1-P)xGs2+PxGb
		Average Moisture Content	wf	12.6%		(1-P)xw'+Pxw
		Average Void Ratio	ef	0.450		Gbf/γdf-1
		Estimated Dry Density	γdf	1.870	tf/m^3	γdx'pd2/(Pxγd'+(1-P)xpd2)
		Estimated Wet Density	γtf	2.110	tf/m^3	(1+wf)γdf
		Estimated Saturated Density	γsatf	2.190	tf/m^3	(Gbf+ef)/(1+ef)
Downstream Semi-pervious Zone (Fine Filter)	smaller than 19.0mm	Bulk Specific Gravity	Gb'	2.580		from Test Results
		Void Ratio	e'	0.390		from Test Results
		Natural Moisture Content	w'	2.0%		from Test Results
		Dry Density	γd'	1.860	tf/m^3	Gb'/(1+e')
		Wet Density	γt'	1.900	tf/m^3	(1+w')xγd'
		Saturated Density	γsat'	2.140	tf/m^3	(Gb'+e')/(1+e')
Downstream Semi-pervious Zone (Coarse Filter)	Complete Grading	Bulk Specific Gravity	Gb	2.540		from Test Results
		Void Ratio	e	0.325		from Test Results
		Natural Moisture Content	w	1.0%		from Test Results
		Estimated Dry Density	γd	1.920	tf/m^3	Gb/(1+e)
		Estimated Wet Density	γt	1.940	tf/m^3	(1+w)xγd
		Estimated Saturated Density	γsat	2.160	tf/m^3	(Gb+e)/(1+e)
Upstream Semi-pervious Zone	smaller than 19.0mm	Bulk Specific Gravity	Gb'	2.580		from Test Results
		Void Ratio	e'	0.390		from Test Results
		Natural Moisture Content	w'	2.0%		from Test Results
		Dry Density	γd'	1.860	tf/m^3	Gb'/(1+e')
		Wet Density	γt'	1.900	tf/m^3	(1+w')xγd'
		Saturated Density	γsat'	2.140	tf/m^3	(Gb'+e')/(1+e')
	larger than 19.0mm	Bulk Specific Gravity	Gb	2.540		from Test Results
		Natural Moisture Content	w	1.0%		from Test Results
	Complete Grading	Gravel Content Ratio	P	40.0%		Assumed Value
		Average Specific Gravity	Gbf	2.560		(1-P)xGb'+PxGb
		Average Moisture Content	wf	1.6%		(1-P)xw'+Pxw
		Average Void Ratio	ef	0.230		Gbf/γdf-1
		Estimated Dry Density	γdf	2.080	tf/m^3	1/((1-P)/γd'+P/Gb)
		Estimated Wet Density	γtf	2.110	tf/m^3	(1+wf)xγdf
		Estimated Saturated Density	γsatf	2.270	tf/m^3	(Gbf+ef)/(1+ef)
Pervious Zone	Complete Grading	Bulk Specific Gravity	Gb	2.540		from Test Results
		Void Ratio	e	0.325		from Test Results
		Natural Moisture Content	w	1.0%		from Test Results
		Estimated Dry Density	γd	1.920	tf/m^3	Gb/(1+e)
		Estimated Wet Density	γt	1.940	tf/m^3	(1+w)xγd
		Estimated Saturated Density	γsat	2.160	tf/m^3	(Gb+e)/(1+e)

Table 7.3.1 (1/2) HISTORICAL SEISMIC DATA AROUND JATIBARANG MULTIPURPOSE DAM

No.	DATE	TIME	LOCATION			DEPTH	MAGNITUDE	DISTANCE	ACCELERATION
			LATITUDE	LONGITUDE	AREA	(km)	(M)	(km)	(gal)
1	1966/1/25	4:21:32	7.10 S	110.40 E	JAVA	238.00	5.0	8.94	150.00
2	1986/9/12	21:54:52	6.98 S	110.29 E	JAVA	33.00	4.8	9.16	138.24
3	1995/10/2	16:02:08	7.02 S	110.24 E	JAVA	33.00	4.1	12.36	100.86
4	1998/12/11	5:58:51	7.21 S	110.37 E	JAVA	33.00	5.0	19.45	75.03
5	1968/1/9	10:03:14	6.90 S	110.60 E	JAVA	220.00	5.4	31.39	65.91
6	1996/7/12	16:47:14	7.01 S	110.54 E	JAVA	33.00	4.6	21.08	56.33
7	1999/6/5	13:24:51	6.96 S	110.52 E	JAVA	72.10	4.5	20.50	54.19
8	1997/8/13	21:23:41	7.24 S	110.50 E	JAVA	160.00	4.5	28.01	42.96
9	1997/7/11	9:55:10	6.33 S	110.55 E	JAVA	585.00	6.1	81.53	37.61
10	1961/6/20	20:27:00	7.60 S	110.00 E	JAVA	163.00	5.5	73.67	29.84
11	1997/8/21	6:48:57	7.16 S	110.92 E	JAVA	80.00	5.2	64.29	29.19
12	1997/7/11	9:55:11	6.09 S	110.61 E	JAVA	571.50	6.2	109.02	28.12
13	1998/1/7	10:32:13	6.64 S	109.95 E	JAVA	292.90	5.0	62.43	26.84
14	1994/9/28	16:39:51	5.79 S	110.35 E	JAVA SEA	638.00	6.6	138.55	26.20
15	1997/3/31	2:01:13	7.47 S	110.64 E	JAVA	216.30	4.7	57.83	24.48
16	1965/1/16	20:58:19	6.80 S	109.10 E	JAVA	242.00	6.5	140.53	24.28
17	1996/10/23	6:31:26	6.72 S	110.81 E	JAVA	160.00	4.8	61.68	24.21
18	1997/2/22	23:09:35	7.23 S	110.99 E	JAVA	240.00	5.1	73.74	23.64
19	1996/8/14	9:54:57	7.35 S	109.90 E	JAVA	33.00	4.6	60.75	21.92
20	1979/10/7	19:27:49	7.67 S	110.75 E	JAVA	180.00	5.1	83.09	20.60
21	1997/11/4	0:50:34	6.92 S	110.99 E	JAVA	160.00	4.8	71.71	20.50
22	1957/10/11	18:58:58	8.00 S	111.00 E	JAVA	33.00	6.0	128.86	20.30
23	1994/11/15	20:18:11	5.59 S	110.19 E	JAVA SEA	561.00	6.5	161.76	20.21
24	1997/1/26	8:57:43	7.28 S	110.93 E	JAVA	150.00	4.7	69.41	20.06
25	1998/9/7	21:40:48	7.33 S	107.97 E	JAVA	33.00	7.6	264.65	19.63
26	1969/4/1	7:25:54	7.99 S	110.42 E	JAVA	105.00	5.5	106.33	19.32
27	1997/3/4	3:11:36	6.65 S	110.82 E	JAVA	82.60	4.5	67.27	18.50
28	1998/7/2	15:19:56	6.06 S	110.80 E	JAVA	33.00	5.6	119.33	17.74
29	1943/7/22	14:54:51	9.50 S	110.00 E	SOUTH OF JAVA	90.00	7.5	276.65	17.41
30	1926/9/9	10:35:31	9.00 S	111.00 E	JAVA	80.00	7.0	229.75	16.85
31	1997/9/18	12:02:39	7.19 S	111.11 E	JAVA	160.00	4.8	85.49	16.74
32	1961/12/25	6:35:10	5.60 S	110.70 E	JAVA SEA	549.00	6.2	164.27	16.64
33	1999/3/26	9:04:56	6.34 S	109.93 E	JAVA	160.00	4.9	90.28	16.63
34	1988/9/25	7:01:14	7.45 S	109.42 E	JAVA	150.00	5.3	112.51	16.04
35	1965/4/28	15:49:03	5.60 S	110.20 E	JAVA SEA	504.00	6.0	160.54	15.27
36	1937/9/26	8:56:50	9.50 S	111.00 E	SOUTH OF JAVA	33.00	7.3	283.10	15.02
37	1999/2/19	18:16:51	8.00 S	109.86 E	JAVA	100.00	5.3	120.05	14.79
38	1996/7/1	14:04:51	6.12 S	110.57 E	JAVA	33.00	5.0	104.69	14.74
39	1997/12/28	17:07:50	7.20 S	109.16 E	JAVA	416.60	5.5	132.64	14.64
40	1972/2/8	14:12:21	6.37 S	109.67 E	JAVA	245.00	5.0	105.53	14.59
41	1964/9/19	3:26:24	6.80 S	108.90 E	JAVA	240.00	5.9	162.27	14.21
42	1998/2/2	1:44:03	7.19 S	111.24 E	JAVA	160.00	4.8	99.58	13.95
43	1997/11/20	0:56:04	7.87 S	110.70 E	JAVA	230.60	4.8	100.39	13.81
44	1998/9/28	13:34:29	8.40 S	112.39 E	JAVA	173.40	7.0	271.05	13.41
45	1997/6/2	4:50:37	6.06 S	111.28 E	JAVA	80.00	5.6	149.37	13.31
46	1999/5/25	23:32:33	7.75 S	110.73 E	JAVA	222.20	4.5	89.71	13.29
47	1968/6/1	20:33:49	6.84 S	109.43 E	JAVA	249.00	4.8	103.94	13.24
48	1994/9/28	17:33:58	5.73 S	110.36 E	JAVA SEA	628.00	5.5	145.22	13.03
49	1997/3/10	18:43:50	7.14 S	109.39 E	JAVA	33.00	4.8	106.64	12.83
50	1979/5/14	9:14:21	7.67 S	111.20 E	JAVA	37.00	5.0	117.20	12.81

* Location of Jatibarang damsite - Latitude 7°2′ 10″ S, Longitude 110°21′ 3″ E

** Past seismic records from 1900 to 1999 around Jatibarang dam, qualified by Meteorological and Geophysical agency.

Table 7.3.1 (2/2) HISTORICAL SEISMIC DATA AROUND JATIBARANG MULTIPURPOSE DA

No.	DATE	TIME	LOCATION			DEPTH (km)	MAGNITUDE (M)	DISTANCE (km)	ACCELERATION (gal)
			LATITUDE	LONGITUDE	AREA				
51	1967/3/23	9:01:41	5.99 S	112.33 E	JAVA SEA	595.00	6.7	247.64	12.77
52	1992/7/5	6:00:51	7.67 S	111.27 E	JAVA	33.00	5.1	123.45	12.72
53	1996/9/12	21:18:12	6.59 S	111.32 E	JAVA	80.00	5.0	117.93	12.71
54	1997/7/11	9:55:12	5.70 S	110.80 E	JAVA SEA	574.00	5.6	156.62	12.51
55	1971/4/3	4:34:18	8.05 S	109.98 E	JAVA	121.00	5.0	119.91	12.45
56	1992/6/9	0:31:56	8.47 S	111.10 E	JAVA	64.00	5.9	179.52	12.43
57	1994/10/4	9:54:20	5.96 S	110.22 E	JAVA SEA	652.00	5.0	120.51	12.37
58	1997/7/21	2:40:05	6.02 S	110.15 E	JAVA	130.60	4.9	115.13	12.36
59	1984/7/9	23:19:03	5.79 S	111.30 E	JAVA SEA	533.00	5.8	173.76	12.25
60	1981/1/30	10:29:09	5.61 S	110.21 E	JAVA SEA	562.00	5.6	159.32	12.23
61	1993/11/28	10:50:27	5.60 S	110.27 E	JAVA SEA	569.00	5.6	159.92	12.17
62	1986/10/18	22:09:31	5.63 S	110.00 E	JAVA SEA	643.00	5.6	161.07	12.06
63	1986/6/14	15:33:56	5.65 S	110.34 E	JAVA SEA	562.00	5.5	154.12	12.06
64	1982/2/28	5:25:04	8.04 S	110.15 E	JAVA	147.00	4.8	113.79	11.84
65	1997/10/7	9:46:42	6.25 S	111.19 E	JAVA	33.00	5.0	127.39	11.53
66	1998/1/16	11:01:24	6.00 S	110.18 E	JAVA	33.00	4.8	116.73	11.47
67	1969/8/28	15:23:32	5.87 S	110.68 E	JAVA SEA	543.00	5.1	134.65	11.39
68	1974/11/8	2:26:33	8.19 S	110.45 E	JAVA	106.00	5.0	128.76	11.38
69	1997/12/5	14:09:57	8.30 S	110.25 E	JAVA	200.30	5.2	140.96	11.38
70	1998/3/10	2:11:51	7.17 S	109.02 E	JAVA	300.00	5.3	147.58	11.36
71	1985/7/9	13:26:57	8.50 S	110.31 E	JAVA	58.00	5.5	162.82	11.22
72	1997/5/10	21:14:16	5.91 S	110.68 E	JAVA SEA	600.00	5.0	130.38	11.20
73	1983/8/9	22:33:36	5.80 S	110.39 E	JAVA SEA	655.00	5.1	137.50	11.08
74	1965/11/22	16:32:55	8.70 S	111.00 E	JAVA	60.00	5.9	198.33	10.87
75	1998/6/23	7:44:43	7.89 S	108.85 E	JAVA	100.00	5.8	190.75	10.81
76	1977/1/1	17:35:54	7.89 S	109.01 E	JAVA	113.00	5.6	175.68	10.75
77	1998/10/20	22:37:16	8.13 S	110.74 E	JAVA	240.00	4.9	128.96	10.71
78	1971/6/16	14:44:22	7.22 S	109.08 E	JAVA	35.00	5.1	141.69	10.66
79	1997/6/9	23:16:56	7.70 S	111.32 E	JAVA	33.00	4.9	129.88	10.62
80	1995/5/5	17:19:19	8.73 S	111.03 E	JAVA	77.00	5.9	202.64	10.56
81	1998/3/22	5:17:09	7.88 S	111.33 E	JAVA	80.00	5.1	143.02	10.54
82	1997/1/26	8:57:19	8.63 S	110.60 E	JAVA	400.00	5.6	179.33	10.46
83	1997/8/13	21:20:16	6.23 S	111.15 E	JAVA	80.00	4.8	125.79	10.44
84	1999/3/4	16:21:45	9.32 S	111.78 E	SOUTH OF JAVA	80.00	6.8	298.69	10.42
85	1996/4/9	20:34:08	8.88 S	110.34 E	JAVA	33.00	5.9	205.01	10.40
86	1994/3/13	10:50:11	7.67 S	111.43 E	JAVA	97.00	5.0	138.30	10.38
87	1983/8/13	22:28:19	8.67 S	111.24 E	JAVA	81.00	5.9	206.37	10.30
88	1997/1/23	13:21:57	6.50 S	111.49 E	JAVA	33.00	5.0	139.18	10.30
89	1997/5/30	8:34:53	8.24 S	110.89 E	JAVA	200.00	5.1	146.45	10.22
90	1967/2/2	12:49:52	5.60 S	110.46 E	JAVA SEA	547.00	5.3	160.13	10.21
91	1998/5/28	17:13:39	8.38 S	109.82 E	JAVA	400.00	5.3	160.46	10.18
92	1999/1/26	15:53:28	7.94 S	108.86 E	JAVA	160.10	5.7	192.63	10.07
93	1992/2/4	1:58:39	7.14 S	109.07 E	JAVA	58.00	5.0	141.79	10.05
94	1997/12/23	14:16:51	8.38 S	109.94 E	JAVA	219.70	5.2	156.12	9.96
95	1991/12/24	3:38:17	5.70 S	110.21 E	JAVA SEA	533.00	5.1	149.37	9.96
96	1996/7/23	9:23:26	7.30 S	111.56 E	JAVA	188.00	4.9	136.58	9.96
97	1982/1/27	21:46:24	6.10 S	111.67 E	JAVA	627.00	5.5	179.06	9.89
98	1997/3/30	21:25:29	8.13 S	110.94 E	JAVA	206.40	4.9	137.87	9.84
99	1996/11/11	16:47:55	8.22 S	108.92 E	JAVA	183.90	5.8	205.39	9.79
100	1977/8/8	1:42:55	7.78 S	109.20 E	JAVA	113.00	5.1	151.46	9.78

* Location of Jatibarang damsite - Latitude 7°2′ 10″ S, Longitude 110°21′ 3″ E

** Past seismic records from 1900 to 1999 around Jatibarang dam, qualified by Meteorological and Geophysical agency.

Table 7.4.1 WATER SURFACE PROFILE IN SIDE CHANNEL

Station	Distance Δx (m)	Channel Bottom (EL. m)	Trial Δh (m)	Water Surface (EL. m)	Water Depth d (m)	Width B (m)	Sectional Area A (m^2)	Discharge Q (m^3/s)	Velocity v (m/s)	Q_1+Q_2 (m^3/s)	$Q_1/(g \times 11)$ ($1/m/s^2$)	v_1+v_2 (m/s)	$\Delta v=v_1-v_2$ (m/s)	$q \cdot v_2 \cdot \Delta x/Q1$ (m/s)	15+14 (m/s)	Δh =12x13x16 (m)	Judgement	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)		
0	0	139.6	0.000	150.591	10.991	24.000	306.065	1,310.0	4.280	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	OK
2	2	139.6	0.121	150.712	11.112	23.165	300.624	1,256.0	4.178	2566.0	0.052	8.458	0.102	0.172	0.274	0.121	0.000	OK
4	2	139.6	0.120	150.832	11.232	22.330	294.954	1,202.0	4.075	2458.0	0.052	8.253	0.103	0.175	0.278	0.120	0.000	OK
6	2	139.6	0.118	150.950	11.350	21.495	289.060	1,148.0	3.971	2350.0	0.052	8.047	0.104	0.178	0.282	0.118	0.000	OK
8	2	139.6	0.118	151.068	11.468	20.660	282.950	1,094.0	3.866	2242.0	0.052	7.838	0.105	0.182	0.287	0.118	0.000	OK
10	2	139.6	0.117	151.184	11.584	19.826	276.630	1,040.0	3.760	2134.0	0.052	7.626	0.107	0.186	0.292	0.117	0.000	OK
12	2	139.6	0.116	151.300	11.700	18.991	270.104	986.0	3.650	2026.0	0.052	7.410	0.109	0.190	0.299	0.116	0.000	OK
14	2	139.6	0.115	151.415	11.815	18.156	263.377	932.0	3.539	1918.0	0.052	7.189	0.112	0.194	0.306	0.115	0.000	OK
14.373	0.373	139.6	0.021	151.437	11.837	18.000	262.094	921.9	3.518	1853.9	0.051	7.056	0.021	0.038	0.059	0.021	0.000	OK

Notes:

Δx: distance between sections (m)
Δh: a rise in water level in the Δx section (m)
Q_1: discharge of downstream section (m^3/s)
Q_2: discharge of upstream section (m^3/s)
v_1: average velocity at downstream section (m/s)
v_2: average velocity at upstream section (m/s)
q: inflow per unit width (m^2/s)

Table 7.4.2(1/2) WATER SURFACE PROFILE IN CHUTE (Q=340m^3/s : 100-year Probable Flood Discharge at Damsite)

Station Sta.S	Distance ΔL (m)	Channel Width B (m)	Discharge Q (m^3/s)	Roughness Coefficient n	Gradient of Slope 1:I	Water Depth d (m)	Sectional Area A (m^2)	Flow Velocity v (m/s)	Velocity Enegy hv (m)	Wetted Perimeter p (m)	Hydraulic Radius R (m)	$R^{4/3}$	S^*	$(S_1+S_2)/2$	Δh_L^* (2)x(15) (m)	Chute Bottom (EL. m)	(7)+(10) +(17)	(18) +(16)	Judgement		Freeboard F (m)	Wall Height (7)+(20) (m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)			(20)	(21)
91.60	-	24.0	340	0.018	-	2.736	65.662	5.178	1.368	29.472	2.228	2.910	0.003	-	-	140.600	144.704	-	0.000	OK	0.8780	3.614
99.00	7.4	24.0	340	0.018	4.0	1.536	36.868	9.222	4.339	27.072	1.362	1.509	0.018	0.011	0.079	138.750	144.625	144.704	0.000	OK	1.0037	2.540
105.00	6.0	24.0	340	0.018	4.0	1.316	31.577	10.767	5.915	26.631	1.186	1.255	0.030	0.024	0.145	137.250	144.481	144.625	0.000	OK	1.0465	2.362
115.00	10.0	24.0	340	0.018	4.0	1.117	26.801	12.686	8.211	26.233	1.022	1.029	0.051	0.040	0.403	134.750	144.078	144.481	0.000	OK	1.0970	2.214
125.00	10.0	24.0	340	0.018	4.0	1.001	24.031	14.148	10.213	26.003	0.924	0.900	0.072	0.061	0.614	132.250	143.464	144.078	0.000	OK	1.1337	2.135
135.00	10.0	24.0	340	0.018	4.0	0.925	22.204	15.313	11.963	25.850	0.859	0.816	0.093	0.083	0.825	129.750	142.639	143.464	0.000	OK	1.1621	2.087
145.00	10.0	24.0	340	0.018	4.0	0.871	20.912	16.259	13.487	25.743	0.812	0.758	0.113	0.103	1.030	127.250	141.608	142.639	0.000	OK	1.1846	2.056
155.00	10.0	24.0	340	0.018	4.0	0.832	19.960	17.034	14.805	25.663	0.778	0.715	0.131	0.122	1.222	124.750	140.386	141.608	0.000	OK	1.2027	2.034
165.00	10.0	24.0	340	0.018	4.0	0.802	19.238	17.674	15.937	25.603	0.751	0.683	0.148	0.140	1.398	122.250	138.988	140.386	0.000	OK	1.2174	2.019
171.00	6.0	24.0	340	0.018	4.0	0.787	18.886	18.002	16.535	25.574	0.739	0.668	0.157	0.153	0.916	120.750	138.072	138.988	0.000	OK	1.2250	2.012
176.00	5.0	24.0	340	0.018	4.0	0.776	18.612	18.268	17.026	25.551	0.728	0.655	0.165	0.161	0.806	119.465	137.266	138.071	0.000	OK	1.2310	2.006
181.00	5.0	24.0	340	0.018	4.0	0.761	18.263	18.617	17.684	25.522	0.716	0.640	0.175	0.170	0.851	117.969	136.414	137.265	0.001	OK	1.2389	2.000
186.00	5.0	24.0	340	0.018	4.0	0.743	17.842	19.056	18.527	25.487	0.700	0.622	0.189	0.182	0.912	116.231	135.502	136.413	0.000	OK	1.2487	1.992
191.00	5.0	24.0	340	0.018	2.0	0.724	17.370	19.574	19.548	25.447	0.683	0.601	0.207	0.198	0.990	114.240	134.512	135.502	0.000	OK	1.2602	1.984
196.00	5.0	24.0	340	0.018	2.0	0.703	16.862	20.163	20.743	25.405	0.664	0.579	0.228	0.217	1.085	111.982	133.427	134.512	0.000	OK	1.2732	1.976
201.00	5.0	24.0	340	0.018	2.0	0.681	16.355	20.788	22.048	25.363	0.645	0.557	0.251	0.239	1.197	109.500	132.230	133.427	0.000	OK	1.2869	1.968
211.00	10.0	24.0	340	0.018	2.0	0.649	15.564	21.845	24.347	25.297	0.615	0.523	0.295	0.273	2.734	104.500	129.496	132.230	0.000	OK	1.3096	1.958
221.00	10.0	24.0	340	0.018	2.0	0.625	14.997	22.672	26.225	25.250	0.594	0.499	0.334	0.315	3.145	99.500	126.350	129.495	0.001	OK	1.3272	1.952
231.00	10.0	24.0	340	0.018	2.0	0.608	14.580	23.319	27.745	25.215	0.578	0.482	0.366	0.350	3.497	94.500	122.852	126.349	0.001	OK	1.3408	1.948
241.00	10.0	24.0	340	0.018	2.0	0.595	14.269	23.827	28.966	25.189	0.566	0.469	0.392	0.379	3.791	89.500	119.061	122.852	0.001	OK	1.3513	1.946
	149.4																					

* Notes:
ΔL: distance between sections (m)
S: average energy gradient in the section
S_1: energy gradient at upstream section
S_2: energy gradient at downstream section
Δh_L: energy losses (m)

Table 7.4.2(2/2) WATER SURFACE PROFILE IN CHUTE (Q=1,310m^3/s : PMF Outflow through the Reservoir)

Station Sta.S	Distance ΔL (m)	Channel Width B (m)	Discharge Q (m^3/s)	Roughness Coefficient n	Gradient of Slope 1:l	Water Depth d (m)	Sectional Area A (m^2)	Flow Velocity v (m/s)	Velocity Enegy hv (m)	Wetted Perimeter p (m)	Hydraulic Radius R (m)	$R^{4/3}$	S^*	$(S_1+S_2)/2$	Δh_L^* (2)x(15) (m)	Chute Bottom (EL. m)	(7)+(10) +(17)	(18) +(16)	Freeboard F (m)	Wall Height (7)+(20) (m)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)
91.60	-	24.0	1310	0.018	-	6.724	161.377	8.118	3.362	37.448	4.309	7.013	0.003	-	-	140.600	150.686	-	0.0000	6.724
99.00	7.4	24.0	1310	0.018	4.0	4.551	109.229	11.993	7.338	33.102	3.300	4.913	0.009	0.006	0.046	138.750	150.640	150.686	0.0000	4.551
105.00	6.0	24.0	1310	0.018	4.0	4.049	97.176	13.481	9.272	32.098	3.027	4.380	0.013	0.011	0.069	137.250	150.571	150.640	0.0000	4.049
115.00	10.0	24.0	1310	0.018	4.0	3.543	85.029	15.407	12.110	31.086	2.735	3.825	0.020	0.017	0.168	134.750	150.403	150.571	0.0000	3.543
125.00	10.0	24.0	1310	0.018	4.0	3.215	77.171	16.975	14.702	30.431	2.536	3.458	0.027	0.024	0.236	132.250	150.168	150.403	0.0000	3.215
135.00	10.0	24.0	1310	0.018	4.0	2.979	71.486	18.325	17.134	29.957	2.386	3.189	0.034	0.031	0.306	129.750	149.862	150.168	0.0000	2.979
145.00	10.0	24.0	1310	0.018	4.0	2.796	67.115	19.519	19.438	29.593	2.268	2.980	0.041	0.038	0.378	127.250	149.484	149.862	0.0000	2.796
155.00	10.0	24.0	1310	0.018	4.0	2.651	63.620	20.591	21.632	29.302	2.171	2.811	0.049	0.045	0.451	124.750	149.033	149.484	0.0000	2.651
165.00	10.0	24.0	1310	0.018	4.0	2.531	60.748	21.564	23.726	29.062	2.090	2.673	0.056	0.053	0.526	122.250	148.507	149.033	0.0000	2.531
171.00	6.0	24.0	1310	0.018	4.0	2.469	59.256	22.108	24.936	28.938	2.048	2.600	0.061	0.059	0.352	120.750	148.155	148.507	0.0000	2.469
176.00	5.0	24.0	1310	0.018	4.0	2.420	58.080	22.555	25.956	28.840	2.014	2.543	0.065	0.063	0.314	119.465	147.840	148.154	0.0000	2.420
181.00	5.0	24.0	1310	0.018	4.0	2.365	56.767	23.077	27.170	28.731	1.976	2.479	0.070	0.067	0.336	117.969	147.504	147.840	0.0000	2.365
186.00	5.0	24.0	1310	0.018	4.0	2.305	55.325	23.678	28.605	28.610	1.934	2.409	0.075	0.072	0.362	116.231	147.142	147.504	0.0000	2.305
191.00	5.0	24.0	1310	0.018	2.0	2.241	53.786	24.356	30.266	28.482	1.888	2.334	0.082	0.079	0.394	114.240	146.747	147.142	0.0000	2.241
196.00	5.0	24.0	1310	0.018	2.0	2.174	52.178	25.106	32.159	28.348	1.841	2.256	0.091	0.086	0.432	111.982	146.315	146.747	0.0000	2.174
201.00	5.0	24.0	1310	0.018	2.0	2.107	50.575	25.902	34.231	28.215	1.792	2.177	0.100	0.095	0.476	109.500	145.838	146.314	0.0000	2.107
211.00	10.0	24.0	1310	0.018	2.0	1.993	47.843	27.381	38.251	27.987	1.709	2.044	0.119	0.109	1.093	104.500	144.745	145.838	0.0000	1.993
221.00	10.0	24.0	1310	0.018	2.0	1.901	45.626	28.712	42.059	27.802	1.641	1.936	0.138	0.128	1.284	99.500	143.460	144.744	0.0000	1.901
231.00	10.0	24.0	1310	0.018	2.0	1.825	43.790	29.915	45.660	27.649	1.584	1.846	0.157	0.148	1.475	94.500	141.985	143.460	0.0000	1.825
241.00	10.0	24.0	1310	0.018	2.0	1.760	42.246	31.009	49.059	27.520	1.535	1.771	0.176	0.166	1.665	89.500	140.319	141.984	0.0000	1.760
	149.4																			

* Notes:

ΔL: distance between sections (m)
S: average energy gradient in the section
S_1: energy gradient at upstream section
S_2: energy gradient at downstream section
Δh_L: energy losses (m)

Table 7.5.1 ROCK MASS CLASSIFICATION STANDARD

Rock Mass Classification Standard											Rock Mass Classification Standard				
Rock Class	Rock Type	(1) Elastic Wave Velocity (vp km/s)						(2) Competence Factor	(3) Boring Core		(4) Geological Condition	(5) Observation		(6) State of after excavation	
		1.0	2.0	3.0	4.0	5.0	6.0		Condition of Core	RQD * (%)	(Result of investigation and condition of face)	Appearance of rock broken by hammer	Fissure int. (cm)	Nature of self-support at face	Inner disp. (mm)
C I	a				—			-----	The rate of core sampling is 40 - 70% and has lot of fissures. It is easily broken into small pieces and sampled as many small fragments of under 5 cm. It is from nearly impossible to impossible to return to the original form.	70 ~ 20	Due to weathering, rock has changed in quality and became slightly soft. Even rock is fairly hard and solid, there are some cracks and they contain thin layer of clay. The rock has clear stratifications and easily split into very thin layers. The rock has narrow fault. There is little deterioration caused by water.	Easily broken by hammering. It breaks into considerably small pieces along cracks, however it is rather difficult to break at other than cracks.	Less than approx. 50	Cutting face stands by itself. Shotcrete lining be required at the crown right after blasting operations. Loosening height be 2.0 - 4.0 m.	Less than 50
	b				—										
	c				—										
	d1			—				more than 4							
	d2		—	—	- -										
C II	a				—			-----						Cutting face stands by itself. No support face may fall of rocks at crown and needs of rock support in advance. Loosening height be 2.0 - 4.0 m.	
	b				—										
	c				—										
	d1			—				more than 4							
	d2		—	—	- -										
D I	a			—	-			4 ~ 2	The ratio of core sampling decreases; it generally get under 40%. Core becomes like splinters and sometimes it appears as sand or clay with fragment having angles.	Less than 20 in general	Caused by sever weathering, there are some parts already changed into soil. Some hard parts remains but generally soft and breakable. There are joints in the rock to a very high degree and can be scaled easily at any part even other than fissured.	Easily broken into pieces by hammering. The rock is breakable and easily disintegrated by fingertips.	-----	Rock well falls from cutting face and no support surface. Sometimes side wall squeezes slightly. Face support in advance and timely conventional support are required. Plastic or loosed	Less than 60
	b			—	—										
	c			—											
	d1		—	—											
	d2		—	—											
	e							> 2							
D II	a		- -	—				2 ~ 1			It is a fault but not became to clay yet. It is a mixture of clay like material and small pieces of rock fragment. There contains some fairly hard parts.	It disintegrates with slight hammerings. Hammer point penetrates into the rock.	-----	Rock falls from cutting face considerably. No support side wall squeezes. Plasticized range or loosened height will be 3.0 - 6.0 m.	Less than 200
	b		- -	—											
	c		- -	—											
	d1	- -	—												
	d2	- -	—								Earth and soil, talus, etc.				
	e										If face become soft by water, it is DH				

Note: *RQD = Rock Quality Designation

Table 7.5.2 STANDARDIZED SELECTION OF TUNNEL SUPPORT CATEGORIES (CROSS SECTIONAL AREA OF 20 to 100 m^2)

Classification of rock mass	Characteristics	Object of Support	Support Categories					Auxiliary method	Description
			Shot-crete	Rock-bolt	Steel supp.	Lining			
						Con. L.	Invert		
Hard rock	Less cracks	Falling rock lumps.	△	△					No stress affect on secondary lining.
	Many cracks but no clay in them	Falling rock lumps. Loosening pressure.	△	○	△				Steel support may set upper half only.
	Many cracks and crushed	Falling rock lumps. Loosening pressure. True earthpressure.	○	○	○		△	Face stabilization measures (cutting face, crown stabilization)	For maintaining roadbed during services, it is recommended to place invert.
Soft rock	Larger competence factor	Falling rock lumps.	△	△			○		For maintaining roadbed during services, mudstone and the like needs invert in principle.
	Smaller competence factor	Loosening pressure. True earthpressure.	○	○	○		○		Early construction of invert.
	Extremely smaller competence factor	Loosening pressure. True earthpressure.	○	○	○	△	○	Face stabilization measures (cutting face stabilization)	Early closure of lining, high efficient shotcrete, confirmation of converging movement, allow some margin for movement.

Notes: Con. L. = Concrete Lining

Table 7.6.1 (1/6) HEAD LOSSES OF OUTLET FACILITIES

1. Head Losses of Outlet Facilities

The head losses of outlet facilities are calculated as follows.

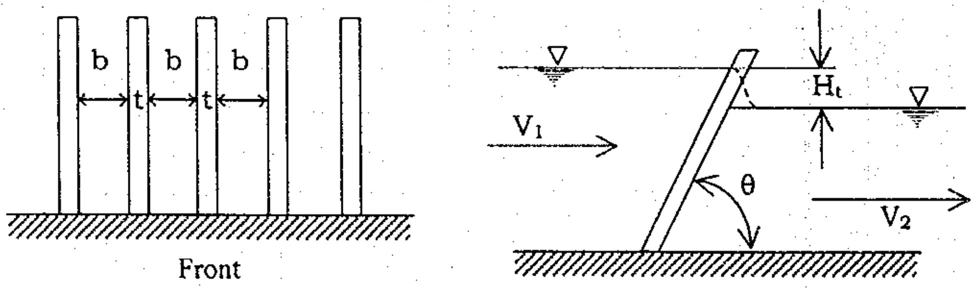
(1) Head Loss through Trash Racks

$$K_t = \beta \cdot \sin\theta \cdot \left(\frac{t}{b}\right)^{4/3}$$

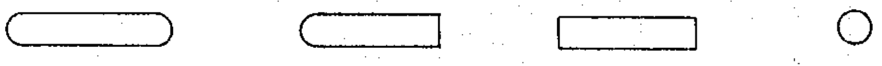
$$H_t = \alpha \cdot K_t \cdot \frac{V_1^2}{2g} = \alpha \cdot K_t \cdot \frac{1}{A_1^2} \cdot \frac{Q^2}{2g}$$

Where,

H_t : head loss through Trash Rack (m)
K_t : trash racks loss coefficient
V_1 : mean velocity before trash rack (m/s) = Q/A_1
β : bar shape coefficient = 2.34
θ : trash rack inclination (degree) = 35.538°
t : width of bar (m)
b : clear span between bars (m) t/b = 0.25
α : safety factor for clogging due to trash = 3.0
Q : discharge (m^3/sec)
A_1 : flow sectional area before trash rack (m^2) = 2.0×6.0 = 12.0 (m^2)



Trash Racks



β = 1.60
(a)

β = 1.77
(b)

β = 2.34
(c)

β = 1.73
(d)

Bar Shape Coefficient

Therefore, the head loss through trash racks becomes as follows.

$K_t = 0.214$

$$H_t = 0.005 \cdot \frac{Q^2}{2g} \text{ (m)}$$

Table 7.6.1 (2/6) HEAD LOSSES OF OUTLET FACILITIES

(2) Friction head loss of Intake Structure

$H_f = K_f \cdot L/R \cdot V^2/(2g) = K_f \cdot L/R \cdot (Q/A)^2/(2g)$

$K_f = 2g \cdot n^2/R^{1/3}$

Where,

H_f : friction head loss (m)
n : Kutter's coefficient of roughness = 0.015 (concrete)
L : length of pipe (m) = 24.939 (m)
V : flow velocity (m/s)
R : hydraulic depth of pipe= A/S = 3.2/7.2 = 0.444 (m)
Q : discharge (m3/sec)
A : flow area (m2) = 2.0×1.6 = 3.2 (m2)
S : wetted perimeter (m) = 2×2.0+2×1.6 = 7.2 (m)

Therefore, the Friction head loss of Intake Structure becomes as follows.

$K_f = 0.00578$

$H_f = 0.032 \cdot Q^2/(2g)$ (m)

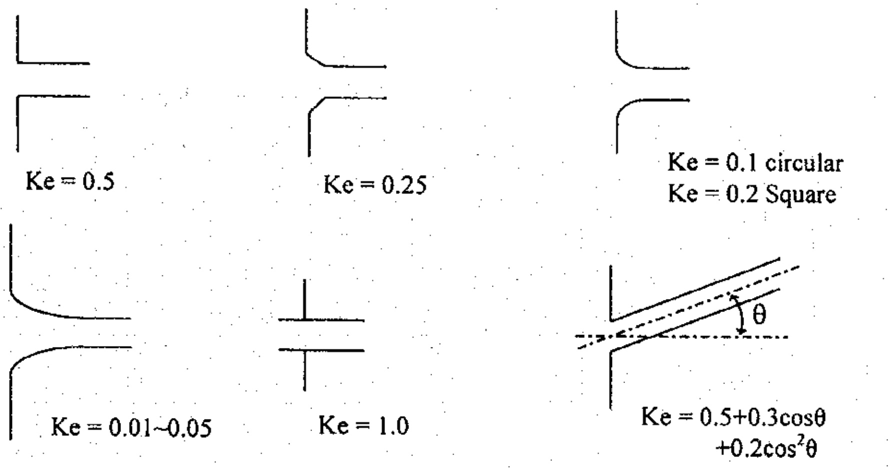
(3) Entrance Loss (from Intake Structure into Outlet Pipe)

$H_e = K_e \cdot V^2/(2g) = K_e \cdot (Q/A)^2/(2g)$

Where,

H_e : entrance loss (m)
K_e : entrance loss coefficient = 0.5
V : flow velocity (m/s) = Q/A
Q : discharge (m3/sec)
A : flow area at entrance (m2) = 1.4×1.4 = 1.96 (m2)
g : gravity acceleration (9.8 m/s2)

The values of K_e are as follows:



Entrance Loss Coefficient

Therefore, the Entrance loss becomes as follows.

$H_e = 0.013 \cdot Q^2/(2g)$ (m)

Table 7.6.1 (3/6) HEAD LOSSES OF OUTLET FACILITIES

(4) Bending head losses

$H_b = K_{b1} \cdot K_{b2} \cdot V^2/(2g) = K_{b1} \cdot K_{b2} \cdot (Q/A)^2/(2g)$

Where,

H_b : bending head loss (m)

K_{b1} : loss coefficient determined by the ratio (=ρ/D) bending radius ρ to the pipe diameter D, in case that a center angle of bending is 90°

K_{b2} : ratio of the loss for a center angle θ to the loss for a center angle of 90°

V : flow velocity (m/s)

Q : discharge (m3/sec)

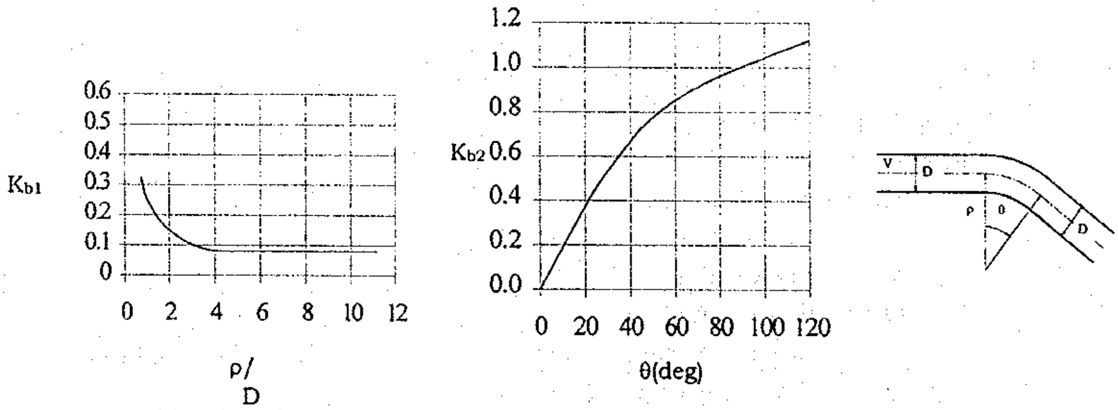
A : flow area (m2)

The following empirical formula is frequently used for Kb_1 and Kb_2:

K_{b1} : $0.131 + 0.1632 \cdot (D/\rho)7/2$

K_{b2} : $(\theta/90°)1/2$

H_b given by the above formula does not include the friction head loss.



(a) Value of K_{b1} (90°)

(b) Value of K_{b2}

Bending Head Loss

Therefore, Bending head losses are summarized in the following table.

IP	D (m)	ρ (m)	θ (°)	Kb_1	Kb_2	A (m^2)	H_b (m)
VIP1	1.400	2.800	50°33'26.7"	0.145	0.749	1.539	0.046 $\cdot Q^2/(2g)$
HIP1	1.400	45.000	90°	0.131	1.000	1.539	0.055 $\cdot Q^2/(2g)$
HIP2	1.400	45.000	45°	0.131	0.707	1.539	0.039 $\cdot Q^2/(2g)$
VIP2	1.400	4.200	3°54'17.7"	0.134	0.208	1.539	0.012 $\cdot Q^2/(2g)$
HIP3	1.400	4.200	19°21'04.4"	0.134	0.464	1.539	0.026 $\cdot Q^2/(2g)$
VIP3	0.650	1.950	30°	0.134	0.577	0.332	0.701 $\cdot Q^2/(2g)$
HIP4	0.650	1.950	90°	0.134	1.000	0.332	1.216 $\cdot Q^2/(2g)$
VIP4	0.250	0.500	25°	0.145	0.527	0.0491	31.697 $\cdot Q^2/(2g)$
HIP5	0.250	0.500	90°	0.145	1.000	0.0491	60.146 $\cdot Q^2/(2g)$

Table 7.6.1 (4/6) HEAD LOSSES OF OUTLET FACILITIES

(5) Friction head losses of Outlet Pipe

For circular pipes,
$H_f = 124.5n^2/D^{4/3}\cdot L\cdot V^2/(2g) = 124.5n^2/D^{4/3}\cdot L\cdot (Q/A)^2/(2g)$
Where,

H_f : friction head loss (m)
n : Kutter's coefficient of roughness = 0.012 (steel pipe)
D : internal diameter of the pipe (m)
L : length of pipe (m)
V : flow velocity (m/s) = Q/A
Q : discharge (m^3/sec)
A : flow area (m^2)

Friction head losses of circular pipes are summarized in the following table.

Part	D (m)	n	L (m)	A (m^2)	H_f (m)
1	1.400	0.012	403.161	1.539	1.948 $\cdot Q^2/(2g)$
2	0.650	0.012	9.710	0.332	2.805 $\cdot Q^2/(2g)$
3	0.650	0.012	6.500	0.332	1.878 $\cdot Q^2/(2g)$
4	0.250	0.012	9.056	0.049	429.361 $\cdot Q^2/(2g)$

(6) Branching Losses

$H_\alpha - H_\beta = Kd_\beta\cdot V_\alpha^2/(2g) = Kd_\beta\cdot(Q_\alpha/A_\alpha)^2/(2g)$

$Kd_\beta = 0.95\,(1-q_\beta)^2 + q_\beta^2\,(1.3\cot(\theta/2) - 0.3 + (0.4 - 0.1\cdot\phi)/\phi^2)(1 - 0.9\sqrt{(\rho/\phi)})$
$+0.4\,q_\beta\,(1-q_\beta)(1+1/\phi)\cot(\theta/2)$

Where,

H_α : working pressure head before branching (m) (sum of location head and pressure head)
H_β : working pressure head in branched pipe (m)
V_α : flow velocity before branching (m/s) (V = Q/A)
Q : discharge (m^3/sec)
A : sectional flow area (m^2)
Kd_β : head loss coefficient by branching
θ : intersecting angle made by original pipe and branching pipe (degree)
ϕ : ratio of sectional area of branched pipe to original pipe = A_β/A_α
ρ : ratio of tangential radius at branching to diameter of original pipe = r/D
r : radius at the portion illustrated below (m) = 0.0 (m)
D : internal diameter of the pipe (m)
q_β : ratio of branched discharge Q_β to original discharge Q_α = $Q_\beta/Q_\alpha = 1.0$ ($Q_\beta = Q_\alpha$)

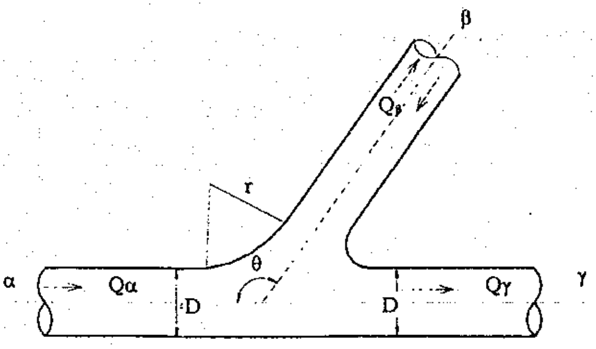


Table 7.6.1 (5/6) HEAD LOSSES OF OUTLET FACILITIES

Branching losses are summarized in the following table.

Branch	D_α (m)	D_β (m)	θ (°)	φ	ρ	q_β	Kd_β	A_α (m^2)	$H_\alpha - H_\beta$ (m)
D1400 to D900	1.400	0.900	90°	0.4133	0	1	3.100	1.539	1.309 $\cdot Q^2/(2g)$
D650 to D500	0.650	0.500	90°	0.5917	0	1	1.973	0.332	17.900 $\cdot Q^2/(2g)$

(7) Transition Losses (Gradual Contraction Loss)

$H_{gc} = K_{gc} \cdot V_2^2 / (2g) = K_{gc} \cdot (Q/A_2)^2 / (2g)$

Where,

H_{gc} : gradual contraction loss (m)
K_{gc} : gradual contraction loss coefficient
V_2 : velocity after contraction (m/s) ($V = Q/A_2$)
Q : discharge (m^3/sec)
A_1 : sectional flow area before contraction (m^2)
A_2 : sectional flow area after contraction (m^2)

Gradual Contraction Losses are summarized in the following table.

D (mm)	A_1 (m^2)	A_2 (m^2)	A_2/A_1	θ (°)	K_{gc}	H_{gc} (m)
900 to 650	0.636	0.332	0.522	21°46'15.8"	0.011	0.100 $\cdot Q^2/(2g)$
500 to 250	0.196	0.049	0.250	45°14'23.0"	0.068	28.322 $\cdot Q^2/(2g)$

(8) Gate losses

$H_v = K_v \cdot V^2 / (2g) = K_v \cdot (Q/A)^2 / (2g)$

Where,

H_v : Gate or Valve loss (m)
K_v : Gate or Valve loss coefficient = 0.06 (High pressure slide gate)
V : Flow velocity (m/s)
Q : discharge (m^3/sec)
A : sectional flow area (m^2)

Gate or Valve	K_v
High pressure slide gate	(0.03)*[1] 0.06
Ring follower gate	0.0
Sluice valve	0.06

*[1] In case of same structure as main control gate

Gate losses are summarized in the following table.

D (mm)	K_v	A (m^2)	H_v (m)
650	0.06	0.332	0.544 $\cdot Q^2/(2g)$
250	0.06	0.049	24.990 $\cdot Q^2/(2g)$

Table 7.6.1 (6/6) HEAD LOSSES OF OUTLET FACILITIES

2. Summarization of Head Losses

The Head Losses of Outlet Facilities are summarized in the following table.

Head Losses of Outlet Facilities			Control Gate	
			D650mm	D250mm
Head Loss through Trash Racks			0.005	0.005
Friction Head Loss of Intake Structure			0.032	0.032
Entrance Loss			0.013	0.013
Bending Head Losses	VIP1	D1400	0.046	0.046
	HIP1	D1400	0.055	0.055
	HIP2	D1400	0.039	0.039
	VIP2	D1400	0.012	0.012
	HIP3	D1400	0.026	0.026
	VIP3	D650	0.701	0.701
	HIP4	D650	1.216	1.216
	VIP4	D250	-	31.697
	HIP5	D250	-	60.146
Friction Head Losses of Outlet Pipe		D1400	1.948	1.948
		D650	2.805	2.805
		D650	1.878	-
		D250	-	429.361
Branching Losses		D1400~D900	1.309	1.309
		D650~D500	-	17.90
Transition Losses (Gradual Contraction Loss)		D900~D650	0.100	0.100
		D500~D250	-	28.322
Gate or Valve loss		D650	0.544	-
		D250	-	24.990
Other Head Losses (10% of the sum of head loss)			1.073	60.072
Total			11.802	660.795

Therefore, total head losses of outlet facilities at each control gate are determined by the following formula.

Diameter of Control Gate	Total Head Loss : H_L (m)
D650mm	$H_L = 11.802 \cdot Q^2/(2g)$
D250mm	$H_L = 660.795 \cdot Q^2/(2g)$

Table 7.6.2 (1/2) RELATIONSHIP BETWEEN DISCHARGE AND GATE OPENING HEIGHT

Control Gate 650 mm in Diameter

Res. Water Surface (EL. m)	Discharge m^3/s																														REMARK
	0.40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60	5.80	6.00	6.20	
	Opening Height of Control Gate (cm)																														
151.80	8.0	11.0	13.0	14.0	16.0	18.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	35.0	35.0	36.0	38.0	39.0	40.0	42.0	43.0	45.0	47.0	S.W.L
151.00	8.0	11.0	13.0	14.0	16.0	18.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	33.0	34.0	35.0	35.0	37.0	38.0	39.0	40.0	42.0	44.0	45.0	47.0	
150.00	8.0	11.0	13.0	15.0	16.0	18.0	19.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	39.0	41.0	42.0	44.0	46.0	47.0	
149.00	8.0	11.0	13.0	15.0	16.0	18.0	19.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	40.0	41.0	42.0	44.0	46.0	48.0	
148.90	8.0	11.0	13.0	15.0	16.0	18.0	19.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	40.0	41.0	42.0	44.0	46.0	48.0	N.W.L
148.00	8.0	11.0	13.0	15.0	16.0	18.0	19.0	21.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	39.0	40.0	41.0	43.0	45.0	46.0	49.0	
147.00	8.0	11.0	13.0	15.0	17.0	18.0	19.0	21.0	22.0	23.0	25.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	38.0	39.0	40.0	42.0	44.0	45.0	47.0	49.0	
146.00	10.0	11.0	13.0	15.0	17.0	18.0	19.0	21.0	22.0	23.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	33.0	35.0	35.0	36.0	38.0	39.0	40.0	42.0	44.0	46.0	47.0	50.0	
145.00	10.0	11.0	13.0	15.0	17.0	19.0	19.0	21.0	22.0	23.0	25.0	26.0	27.0	28.0	29.0	30.0	31.0	32.0	34.0	35.0	35.0	37.0	38.0	39.0	41.0	42.0	44.0	46.0	48.0	50.0	
144.00	10.0	11.0	13.0	15.0	17.0	19.0	19.0	21.0	22.0	23.0	25.0	26.0	27.0	28.0	29.0	30.0	32.0	33.0	34.0	35.0	36.0	37.0	38.0	40.0	41.0	43.0	45.0	46.0	49.0	51.0	
143.00	10.0	11.0	13.0	15.0	17.0	19.0	20.0	21.0	22.0	23.0	25.0	26.0	27.0	28.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	37.0	39.0	40.0	41.0	43.0	45.0	47.0	50.0	52.0	
142.00	10.0	11.0	13.0	15.0	17.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	38.0	39.0	40.0	42.0	44.0	45.0	47.0	50.0	53.0	
141.00	10.0	12.0	13.0	15.0	17.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	38.0	39.0	41.0	42.0	44.0	46.0	48.0	51.0	54.0	
140.00	10.0	12.0	13.0	15.0	17.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	33.0	35.0	35.0	37.0	38.0	39.0	41.0	43.0	45.0	46.0	49.0	52.0	56.0	
139.00	10.0	12.0	13.0	15.0	17.0	19.0	20.0	22.0	23.0	24.0	25.0	26.0	27.0	29.0	30.0	31.0	32.0	34.0	35.0	36.0	37.0	38.0	40.0	41.0	43.0	45.0	47.0	50.0	53.0	57.0	
138.00	10.0	12.0	14.0	15.0	17.0	19.0	20.0	22.0	23.0	24.0	25.0	27.0	28.0	29.0	30.0	31.0	33.0	34.0	35.0	36.0	37.0	39.0	40.0	42.0	44.0	46.0	47.0	50.0	54.0	58.0	
137.00	10.0	12.0	14.0	16.0	18.0	19.0	20.0	22.0	23.0	25.0	26.0	27.0	28.0	29.0	30.0	32.0	33.0	34.0	35.0	36.0	38.0	39.0	41.0	42.0	44.0	46.0	48.0	51.0	54.0	62.0	
136.00	10.0	12.0	14.0	16.0	18.0	19.0	21.0	22.0	23.0	25.0	26.0	27.0	28.0	30.0	31.0	32.0	33.0	34.0	35.0	36.0	38.0	39.0	41.0	42.0	45.0	46.0	49.0	52.0	57.0	65.0	L.W.L

Table 7.6.2 (2/2) RELATIONSHIP BETWEEN DISCHARGE AND GATE OPENING HEIGHT

Control Gate 250 mm in Diameter

Res. Water Surface (EL. m)	Discharge m^3/s																													REMARK
	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	0.26	0.28	0.30	0.32	0.34	0.36	0.38	0.40	0.42	0.44	0.46	0.48	0.50	0.55	0.60	0.65	0.70	0.75	0.80	0.85	0.87	
	Opening Height of Control Gate (cm)																													
151.80	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.0	11.5	12.0	12.5	13.5	14.0	15.0	16.0	17.0	17.5	S.W.L
151.00	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.0	11.5	12.0	13.0	13.5	14.0	15.0	16.0	17.0	18.0	
150.00	4.5	5.0	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.0	11.5	12.0	13.0	13.5	14.0	15.0	16.0	17.5	18.0	
149.00	4.5	5.0	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	12.5	13.0	13.5	14.5	15.5	16.5	17.5	18.0	
148.90	4.5	5.0	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	12.5	13.0	13.5	14.5	15.5	16.5	17.5	18.0	N.W.L
148.00	4.5	5.0	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.0	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.5	13.0	13.5	14.5	15.5	16.5	17.5	18.5	
147.00	4.5	5.0	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.5	13.0	13.5	14.5	15.5	16.5	18.0	18.5	
146.00	4.5	5.0	5.5	6.5	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	9.5	10.0	10.5	11.0	11.0	11.5	11.5	12.5	13.0	14.0	14.5	15.5	17.0	18.0	19.0	
145.00	4.5	5.0	5.5	6.5	6.5	7.0	7.0	8.0	8.0	8.5	8.5	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.0	11.5	11.5	12.5	13.0	14.0	14.5	15.5	17.0	18.5	19.0	
144.00	4.5	5.0	5.5	6.5	6.5	7.0	7.0	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	11.5	12.5	13.5	14.0	15.0	16.0	17.0	18.5	19.5	
143.00	4.5	5.0	6.0	6.5	6.5	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	12.0	12.5	13.5	14.0	15.0	16.0	17.0	19.0	19.5	
142.00	4.5	5.0	6.0	6.5	6.5	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.0	12.5	13.5	14.0	15.0	16.0	17.5	19.0	20.0	
141.00	4.5	5.0	6.0	6.5	6.5	7.0	7.5	8.0	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.0	13.0	13.5	14.5	15.5	16.5	17.5	19.5	20.5	
140.00	4.5	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	9.5	10.0	10.5	11.0	11.0	11.5	11.5	12.0	13.0	13.5	14.5	15.5	16.5	18.0	19.5	21.0	
139.00	4.5	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	12.0	12.0	13.0	13.5	14.5	15.5	17.0	18.0	20.0	21.5	
138.00	4.5	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	10.0	10.0	10.5	11.0	11.5	11.5	12.0	12.5	13.0	13.5	14.5	15.5	17.0	18.5	20.5	22.5	
137.00	4.5	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	8.5	9.0	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.0	12.5	13.0	14.0	14.5	15.5	17.0	18.5	21.0	23.0	
136.00	4.5	5.5	6.0	6.5	7.0	7.0	7.5	8.0	8.5	9.0	9.0	9.5	9.5	10.0	10.5	10.5	11.0	11.5	11.5	12.0	12.5	13.0	14.0	15.0	16.0	17.0	19.0	21.5	25.0	L.W.L

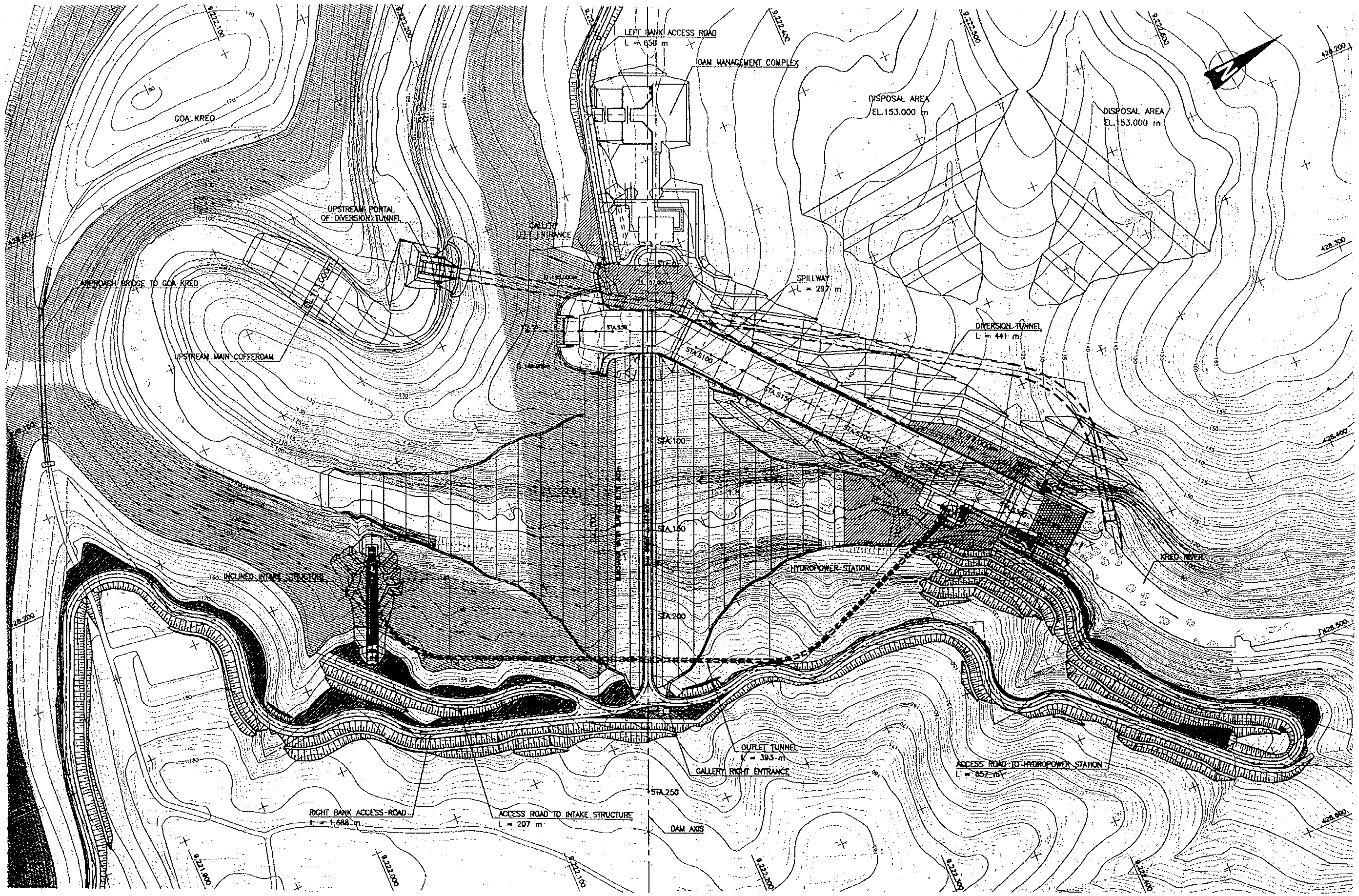
FIGURES

CHAPTER 7

DETAILED DESIGN

LIST OF FIGURES

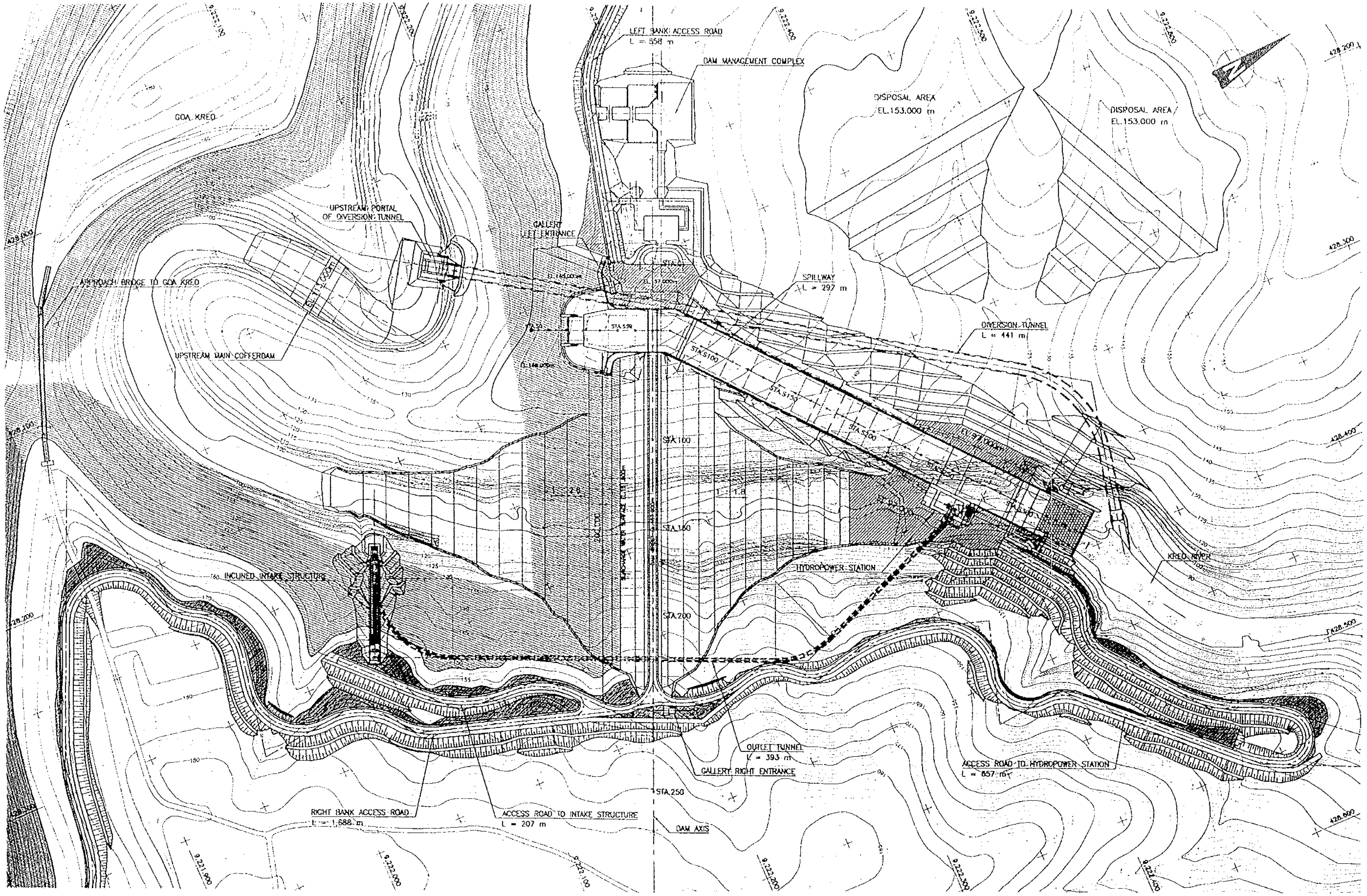
Chapter 7



NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. 7.1.1 LAYOUT PLAN OF JATIBARANG MULTIPURPOSE DAM
JAPAN INTERNATIONAL COOPERATION AGENCY	



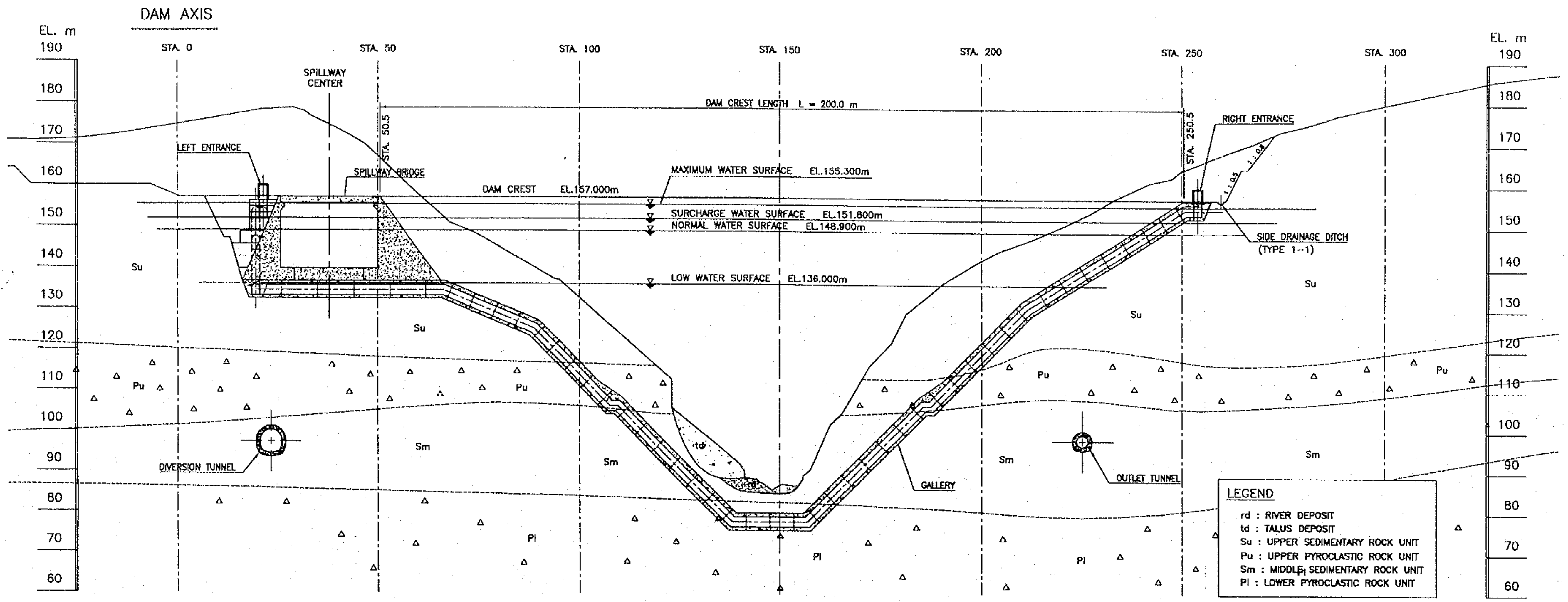
NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.

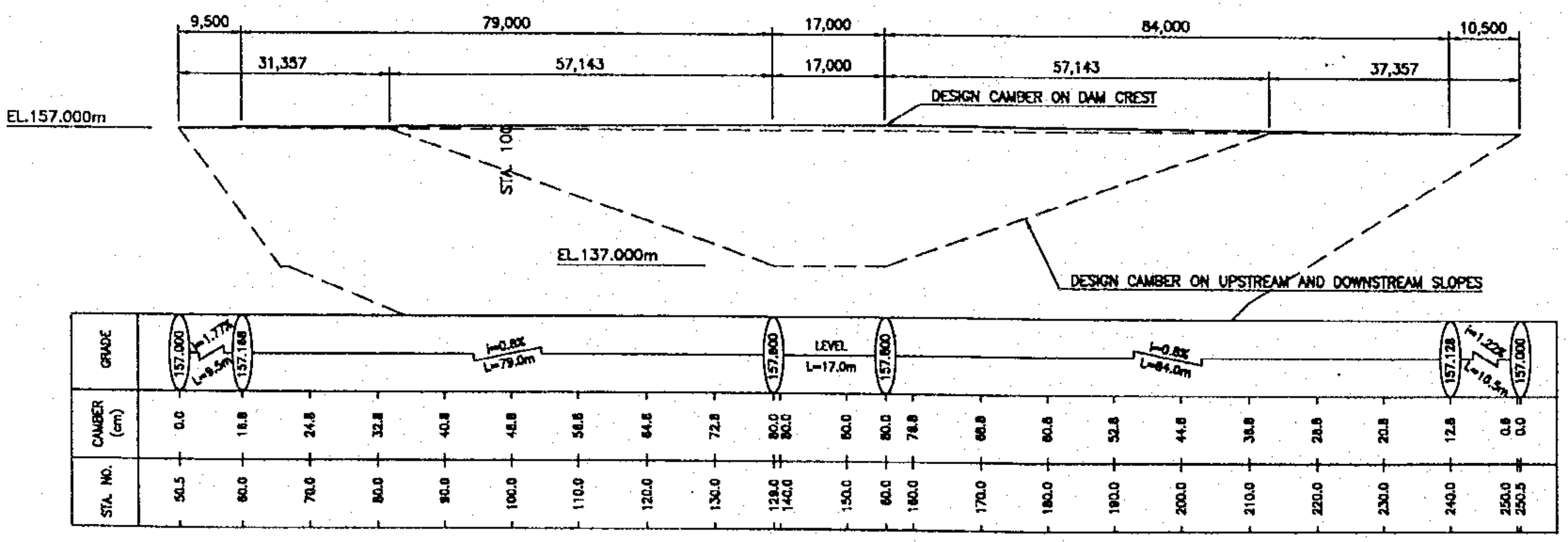
THE DETAILED DESIGN OF FLOOD CONTROL, URBAN
DRAINAGE AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.1.1
LAYOUT PLAN OF JATIBARANG MULTIPURPOSE DAM

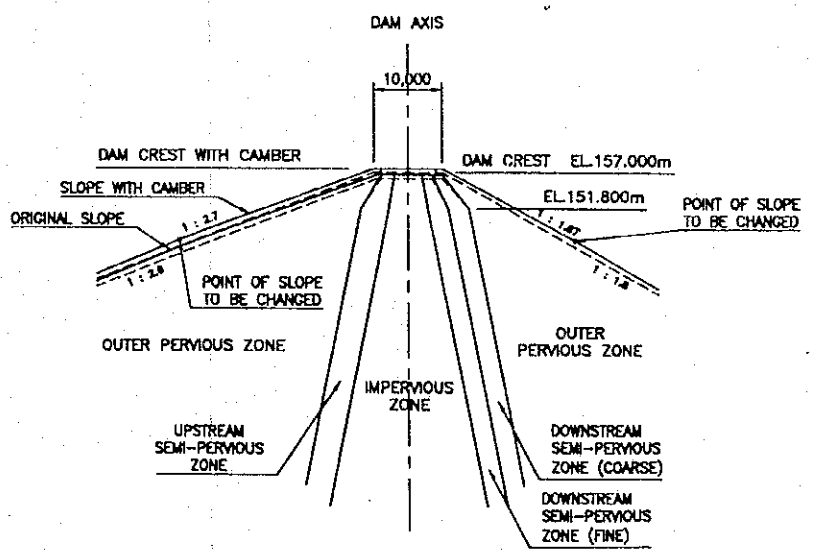


LONGITUDINAL PROFILE



STA. NO.	CAMBER (cm)
50.5	0.0
60.0	16.8
70.0	24.8
80.0	32.8
90.0	40.8
100.0	48.8
110.0	56.8
120.0	64.8
130.0	72.8
128.0 140.0	80.0 80.0
150.0	80.0
60.0	80.0
160.0	78.8
170.0	68.8
180.0	60.8
190.0	52.8
200.0	44.8
210.0	36.8
220.0	28.8
230.0	20.8
240.0	12.8
250.0 250.5	0.8 0.0

CAMBER ARRANGEMENT (PROFILE)



CAMBER ARRANGEMENT (SECTION)

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS, UNLESS OTHERWISE NOTED.

REFERENCE DRAWINGS

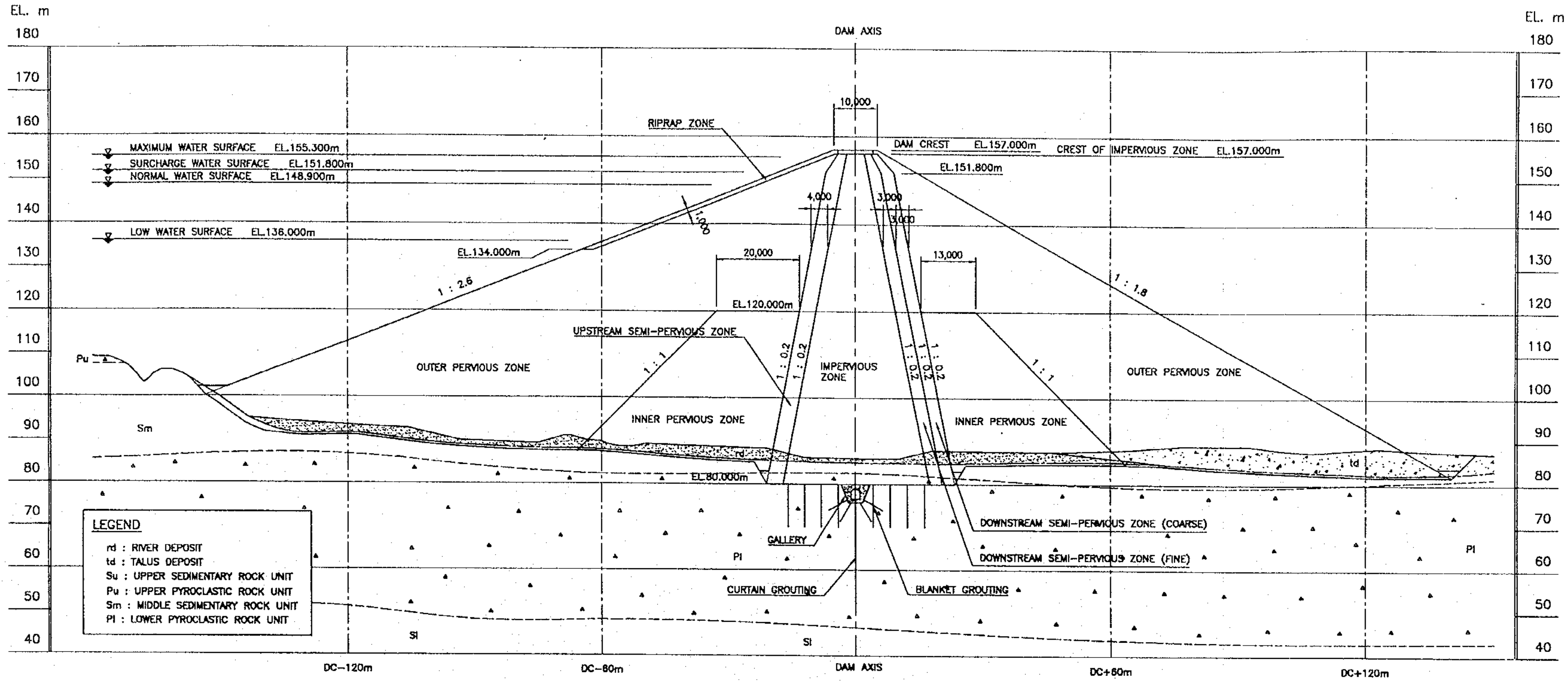
JD-P1-GE-Pl-2 GEOLOGICAL PLAN OF DAMSITE
JD-P1-GE-Pr-1 GEOLOGICAL PROFILE ALONG DAM AXIS

SCALE 0 10 20 30 40 50m

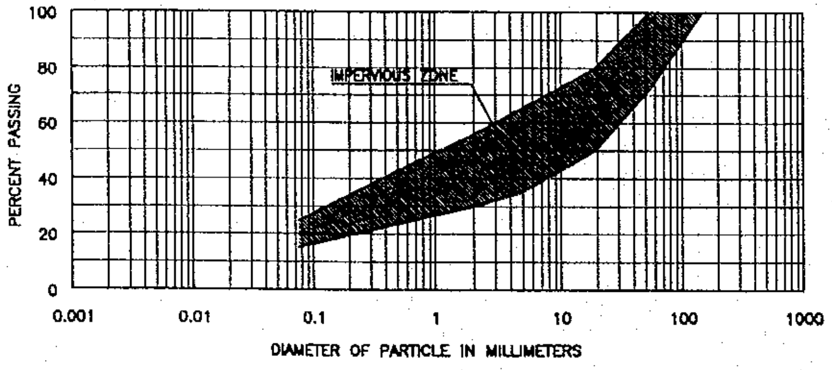
THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

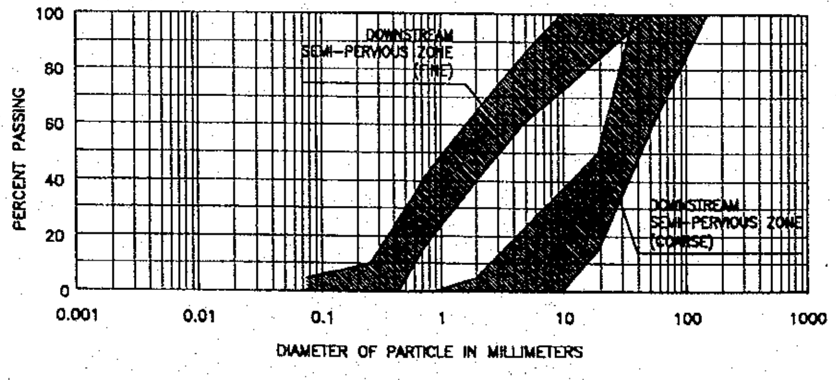
Fig. 7.1.2
PROFILE ALONG JATIBARANG MULTIPURPOSE DAM AXIS



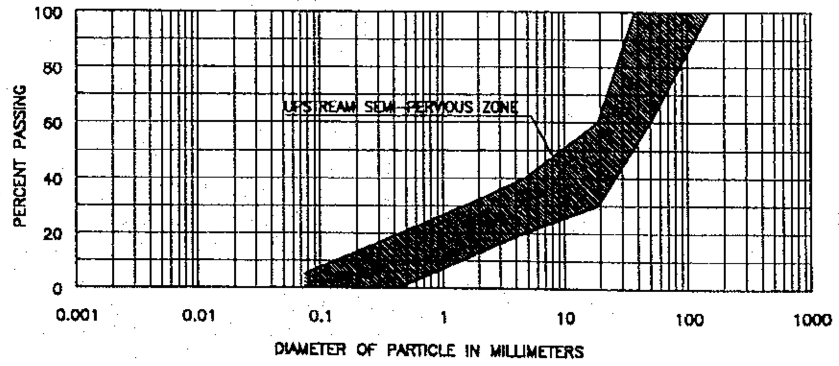
TYPICAL CROSS SECTION



GRADATION LIMIT FOR IMPERVIOUS ZONE



GRADATION LIMIT FOR DOWNSTREAM SEMI-PERVIOUS ZONE



GRADATION LIMIT FOR UPSTREAM SEMI-PERVIOUS ZONE

NOTES

1. INNER AND OUTER PERVIOUS ZONES AND RIP RAP ARE GRADATION AS PER SPECIFICATION.

REFERENCE DRAWINGS

JD-P1-ED-Ge-1 EMBANKMENT DAM – LAYOUT PLAN
JD-P1-ED-Ge-2 EMBANKMENT DAM – PROFILE ALONG DAM AXIS

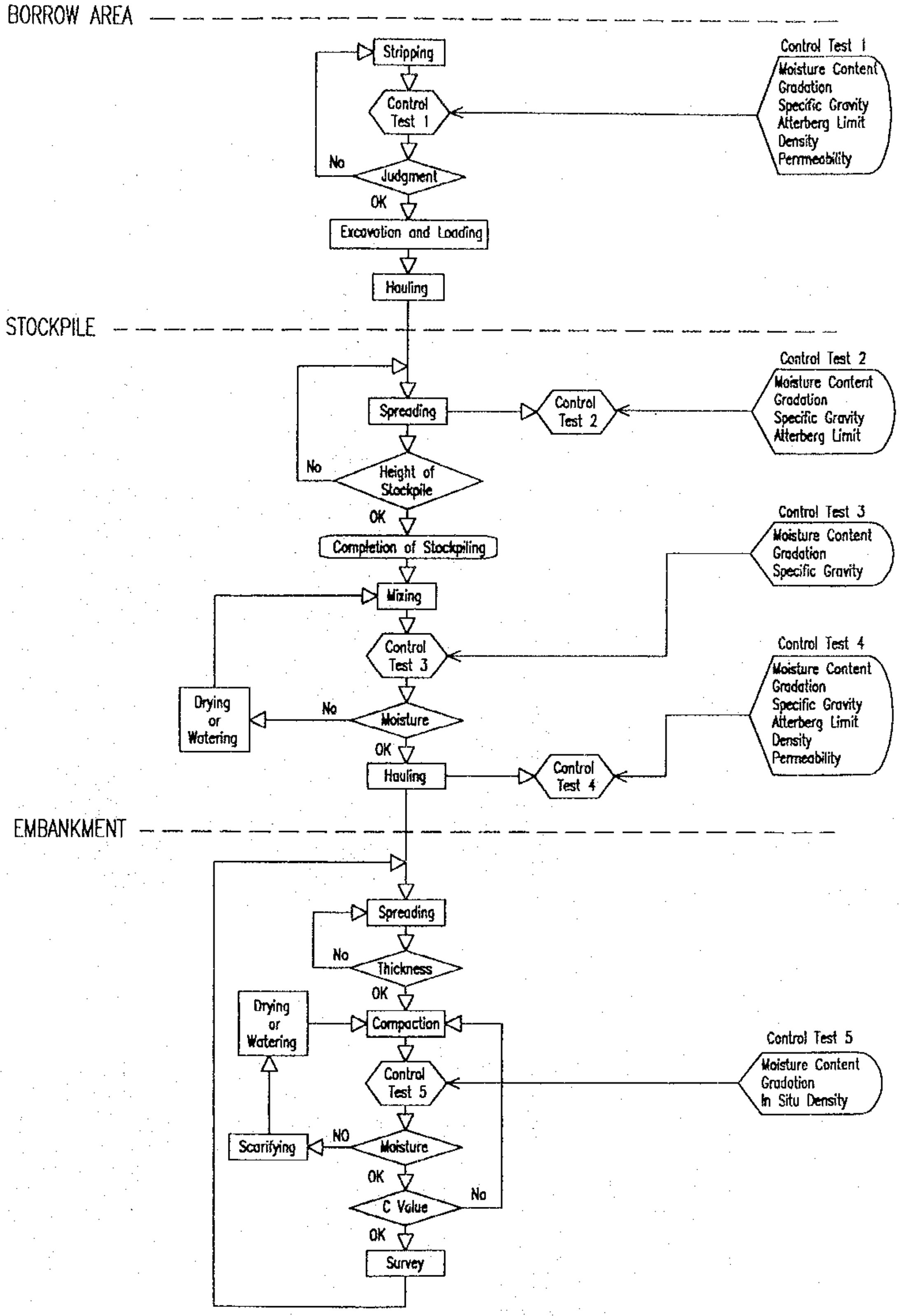
SCALE 0 10 20 30 40 50m

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.1.3

TYPICAL CROSS SECTION OF JATIBARANG MULTIPURPOSE DAM



QUALITY CONTROL PROCEDURE FOR CONTACT MATERIAL

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

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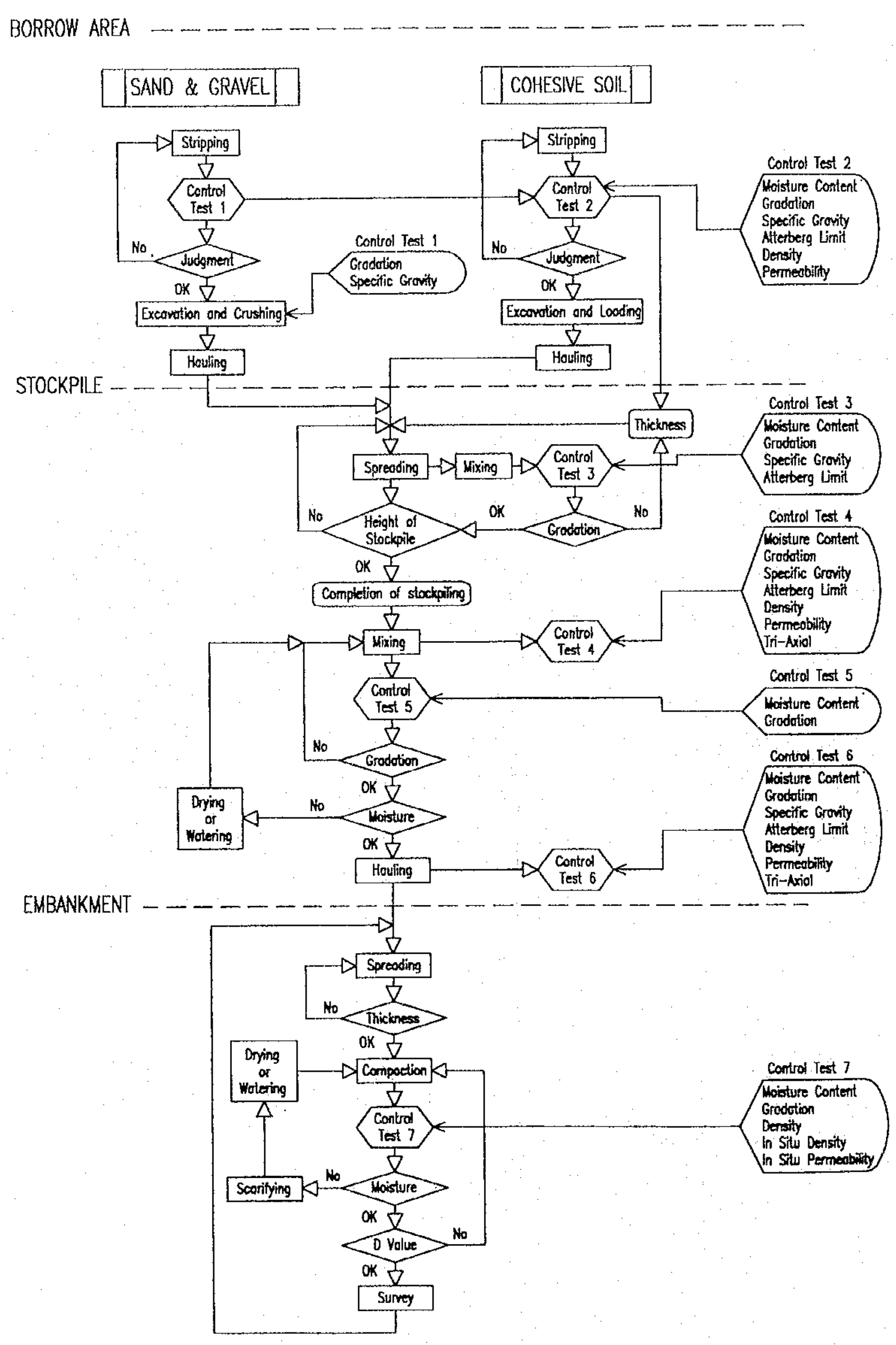
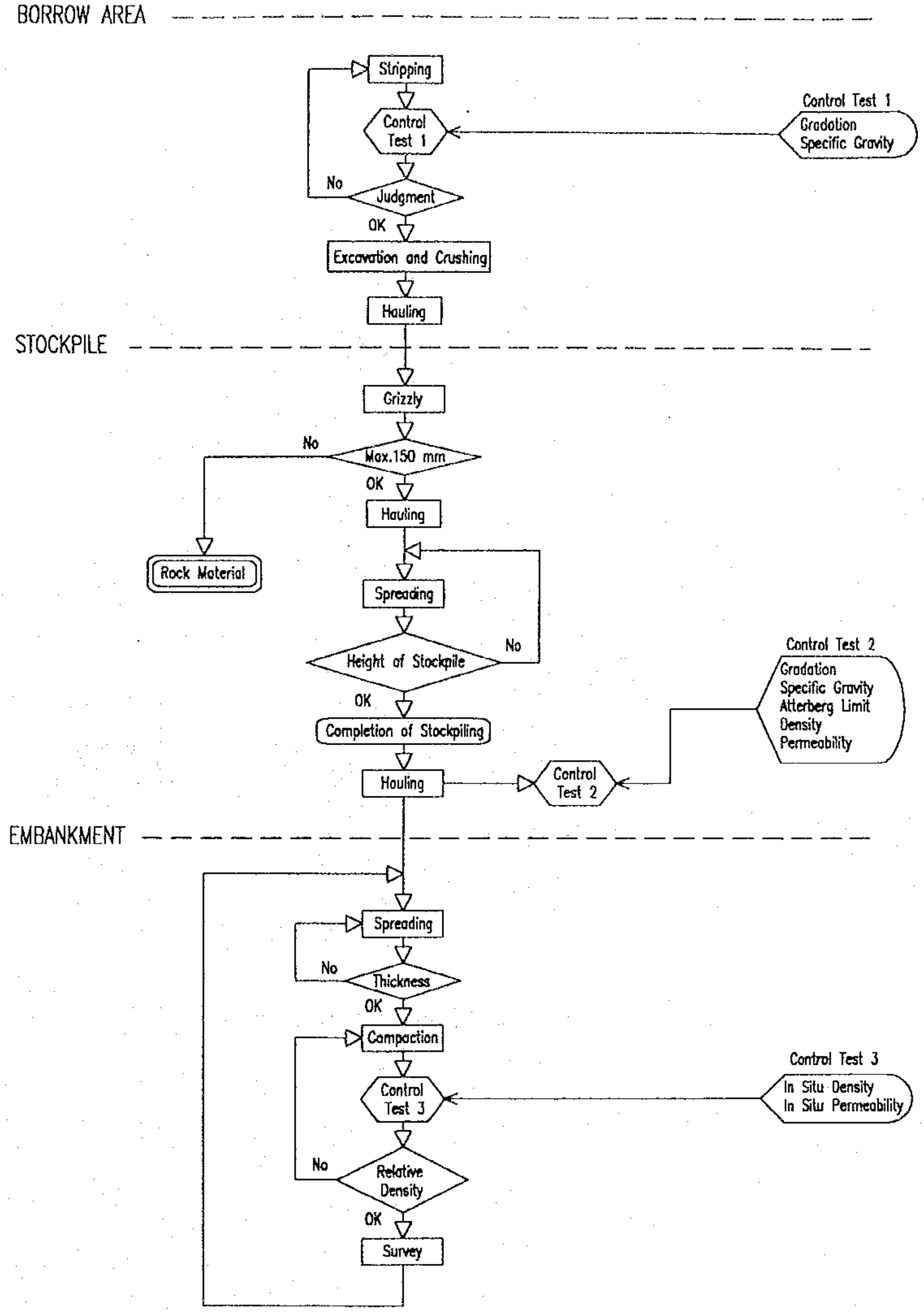
Fig. **7.2.1 (1/4)**

FLOW CHART OF QUALITY CONTROL PROCEDURE OF DAM EMBANKMENT



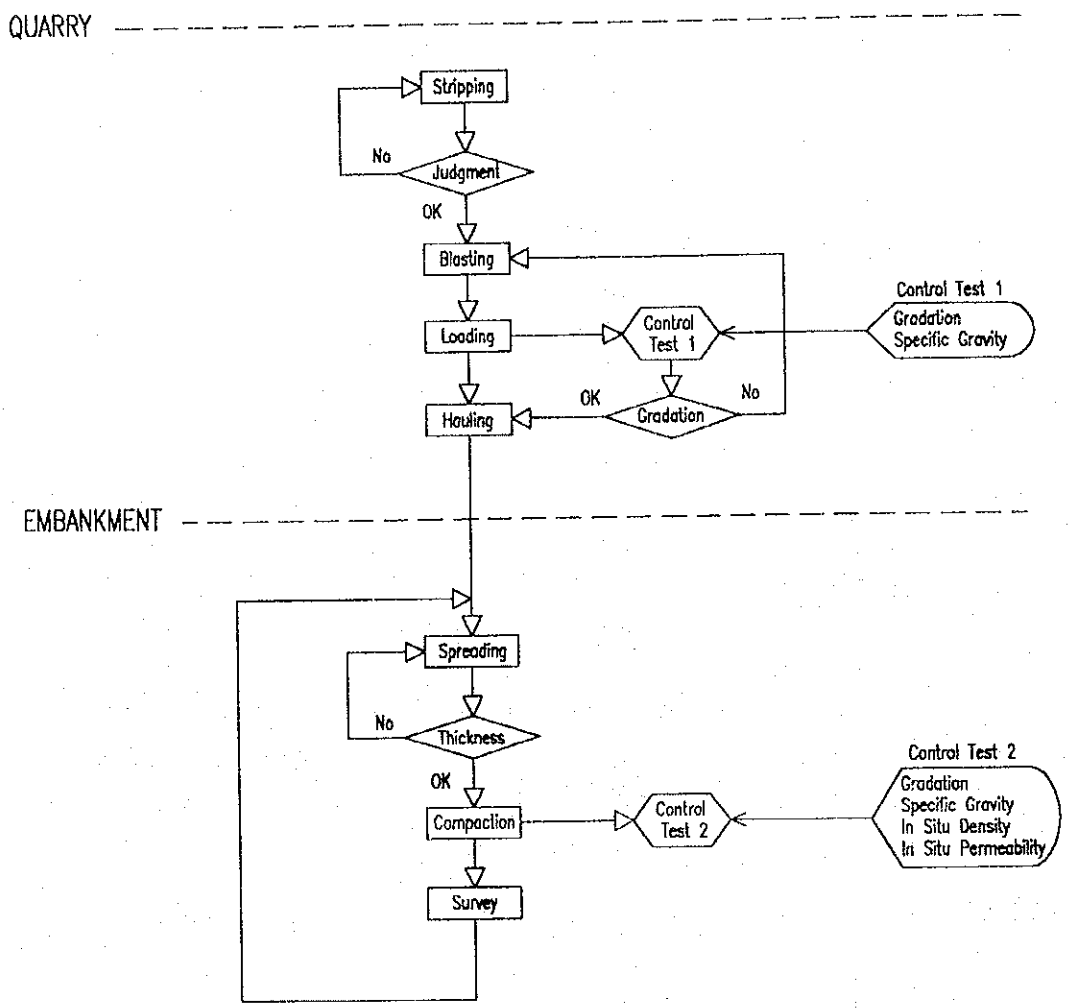
QUALITY CONTROL PROCEDURE FOR IMPERVIOUS MATERIAL

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. **7.2.1 (2/4)** **FLOW CHART OF QUALITY CONTROL PROCEDURE OF DAM EMBANKMENT**
JAPAN INTERNATIONAL COOPERATION AGENCY	



QUALITY CONTROL PROCEDURE FOR SEMI-PERVIOUS MATERIAL

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA	Fig. **7.2.1 (3/4)**
JAPAN INTERNATIONAL COOPERATION AGENCY	**FLOW CHART OF QUALITY CONTROL PROCEDURE OF DAM EMBANKMENT**



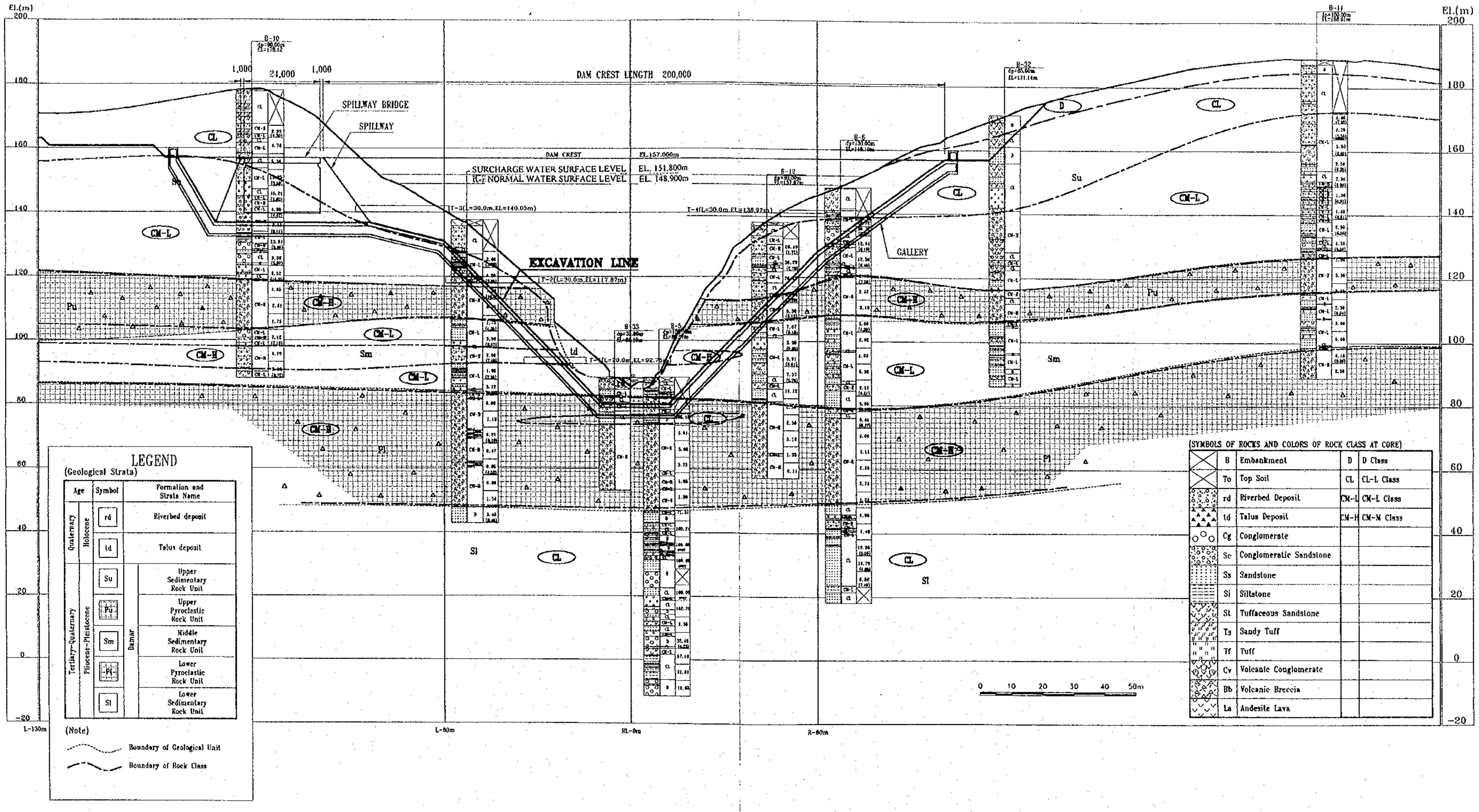
QUALITY CONTROL PROCEDURE FOR PERVIOUS MATERIAL

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN
DRAINAGE AND WATER RESOURCES DEVELOPMENT
IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. **7.2.1 (4/4)**

FLOW CHART OF QUALITY CONTROL PROCEDURE DAM EMBANKMENT



LEGEND
(Geological Strata)

Age		Symbol	Formation and Strata Name	
Quaternary	Holocene	rd	Riverbed deposit	
		td	Talus deposit	
Tertiary-Quaternary	Pliocene-Pleistocene	Su	Damar	Upper Sedimentary Rock Unit
		Pu		Upper Pyroclastic Rock Unit
		Sm		Middle Sedimentary Rock Unit
		Pl		Lower Pyroclastic Rock Unit
		Sl		Lower Sedimentary Rock Unit

(Note)

Boundary of Geological Unit

Boundary of Rock Class

(SYMBOLS OF ROCKS AND COLORS OF ROCK CLASS AT CORE)

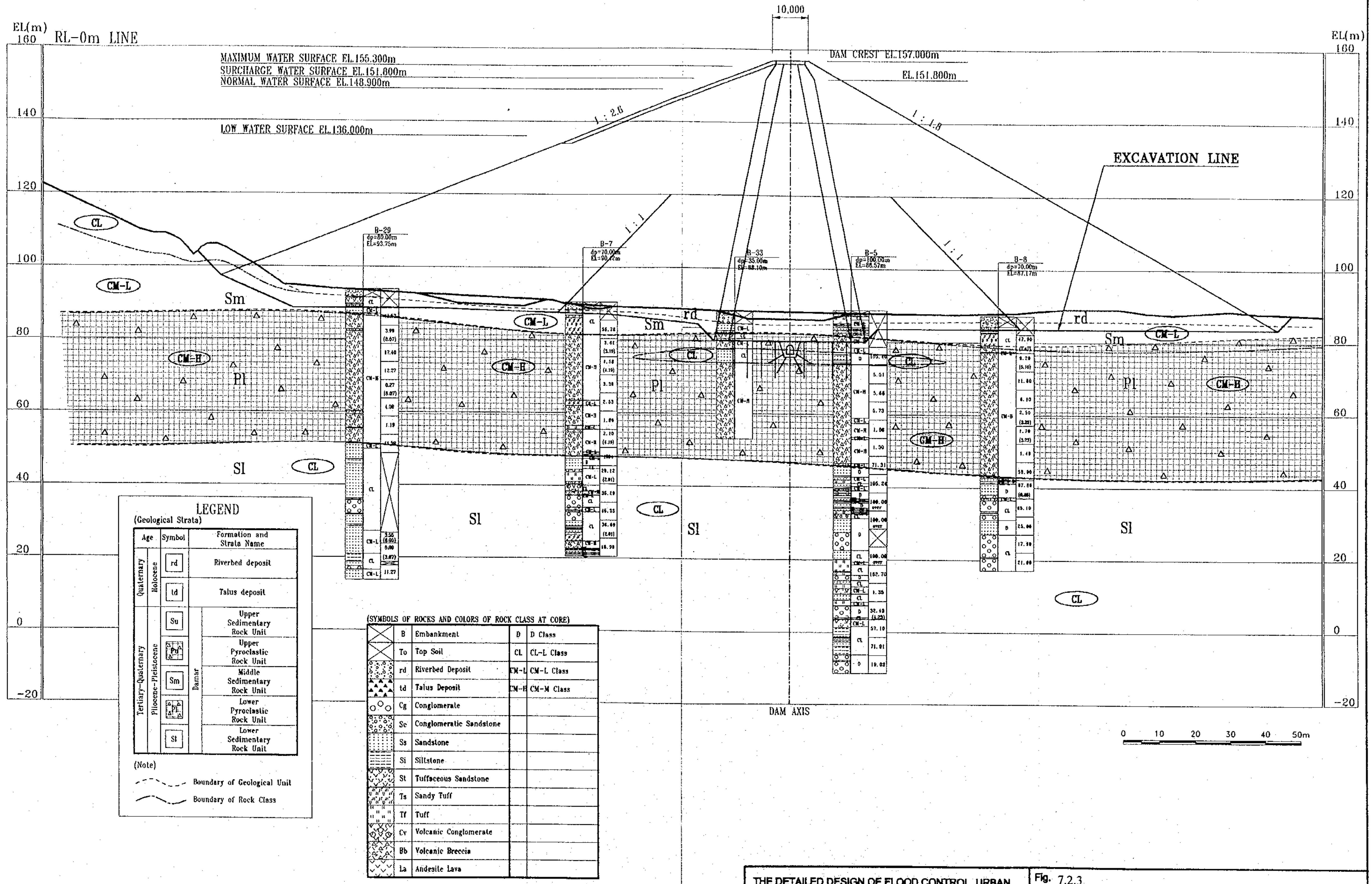
☒	B	Embankment	D	D Class
☒	To	Top Soil	CL	CL-L Class
	rd	Riverbed Deposit	CM-L	CM-L Class
▲	td	Talus Deposit	CM-H	CM-M Class
○	Cg	Conglomerate		
	Sc	Conglomeratic Sandstone		
	Ss	Sandstone		
☰	Si	Siltstone		
	St	Tuffaceous Sandstone		
	Ts	Sandy Tuff		
	Tf	Tuff		
	Cv	Volcanic Conglomerate		
	Bb	Volcanic Breccia		
	La	Andesite Lava		

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.2.2

EXCAVATION LINE FOR IMPERVIOUS ZONE ALONG DAM AXIS



LEGEND

(Geological Strata)

Age			Symbol	Formation and Strata Name
Quaternary	Holocene		rd	Riverbed deposit
			td	Talus deposit
Tertiary−Quaternary	Pliocene−Pleistocene	Damar	Su	Upper Sedimentary Rock Unit
			Pu	Upper Pyroclastic Rock Unit
			Sm	Middle Sedimentary Rock Unit
			Pl	Lower Pyroclastic Rock Unit
			Sl	Lower Sedimentary Rock Unit

(Note)

Boundary of Geological Unit

Boundary of Rock Class

(SYMBOLS OF ROCKS AND COLORS OF ROCK CLASS AT CORE)

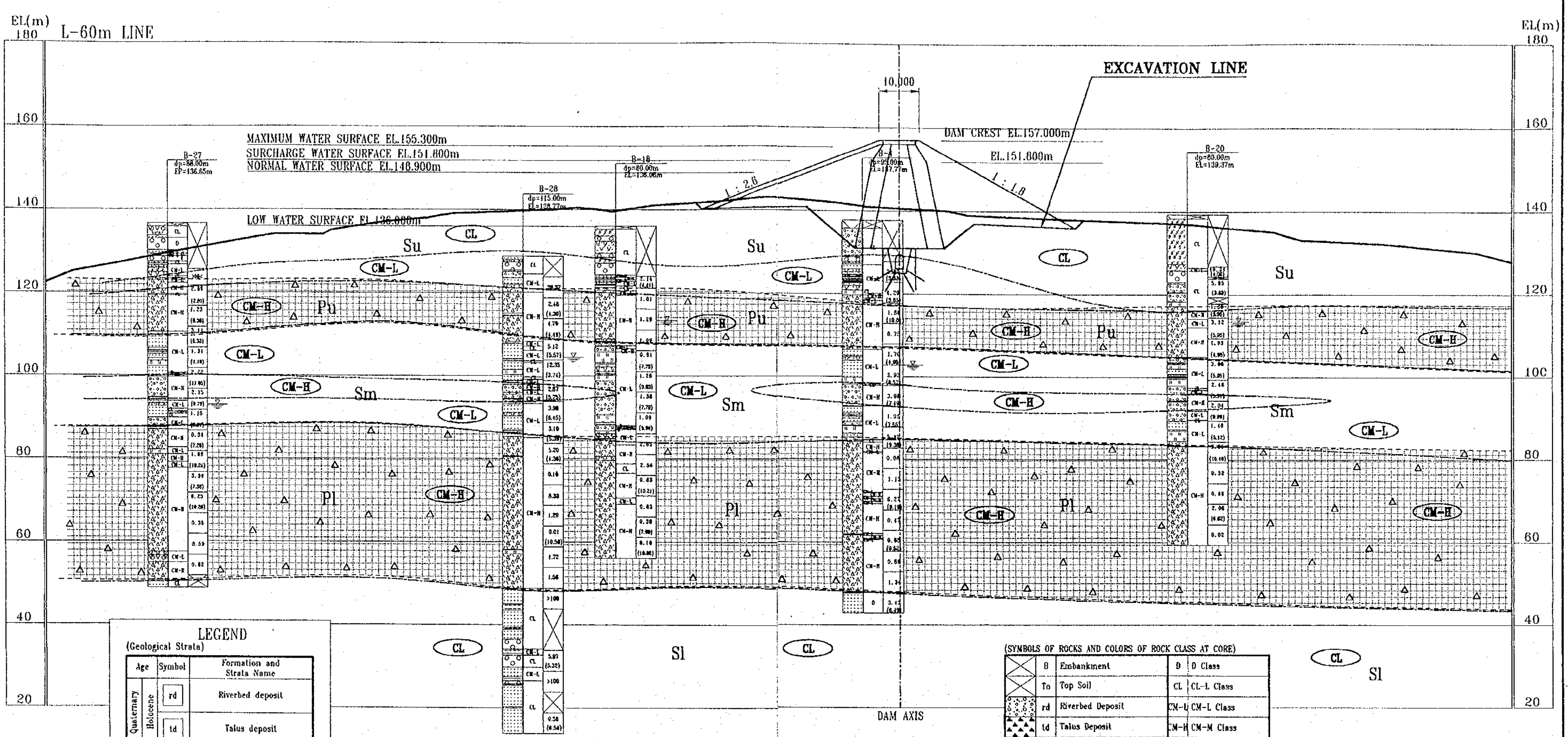
☒	B	Embankment	D	D Class
☒	To	Top Soil	CL	CL−L Class
	rd	Riverbed Deposit	CM−L	CM−L Class
▲	td	Talus Deposit	CM−H	CM−M Class
○	Cg	Conglomerate		
	Sc	Conglomeratic Sandstone		
	Ss	Sandstone		
	Si	Siltstone		
	St	Tuffaceous Sandstone		
	Ts	Sandy Tuff		
	Tf	Tuff		
	Cv	Volcanic Conglomerate		
	Bb	Volcanic Breccia		
	La	Andesite Lava		

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.2.3

EXCAVATION LINE ALONG RIVER (RL0M)



LEGEND

(Geological Strata)

Age		Symbol	Formation and Strata Name	
Quaternary	Holocene	rd	Riverbed deposit	
		td	Talus deposit	
Tertiary-Quaternary	Pliocene-Pleistocene	Su	Damar	Upper Sedimentary Rock Unit
		Pu		Upper Pyroclastic Rock Unit
		Sm		Middle Sedimentary Rock Unit
		Pl		Lower Pyroclastic Rock Unit
		Sl		Lower Sedimentary Rock Unit

(Note)

Boundary of Geological Unit

Boundary of Rock Class

(SYMBOLS OF ROCKS AND COLORS OF ROCK CLASS AT CORE)

⊠	B	Embankment	D	D Class
⊠	To	Top Soil	CL	CL-L Class
▨	rd	Riverbed Deposit	CM-L	CM-L Class
▲	td	Talus Deposit	CM-H	CM-M Class
○	Cg	Conglomerate		
▨	Sc	Conglomeratic Sandstone		
▨	Ss	Sandstone		
▤	Si	Siltstone		
▨	St	Tuffaceous Sandstone		
▨	Ts	Sandy Tuff		
▨	Tf	Tuff		
▨	Cv	Volcanic Conglomerate		
▨	Bb	Volcanic Breccia		
▨	La	Andesite Lava		

THE DETAILED DESIGN OF FLOOD CONTROL, URBAN DRAINAGE AND WATER RESOURCES DEVELOPMENT IN SEMARANG IN THE REPUBLIC OF INDONESIA

JAPAN INTERNATIONAL COOPERATION AGENCY

Fig. 7.2.4

EXCAVATION LINE AT LEFT ABUTMENT (L60M)