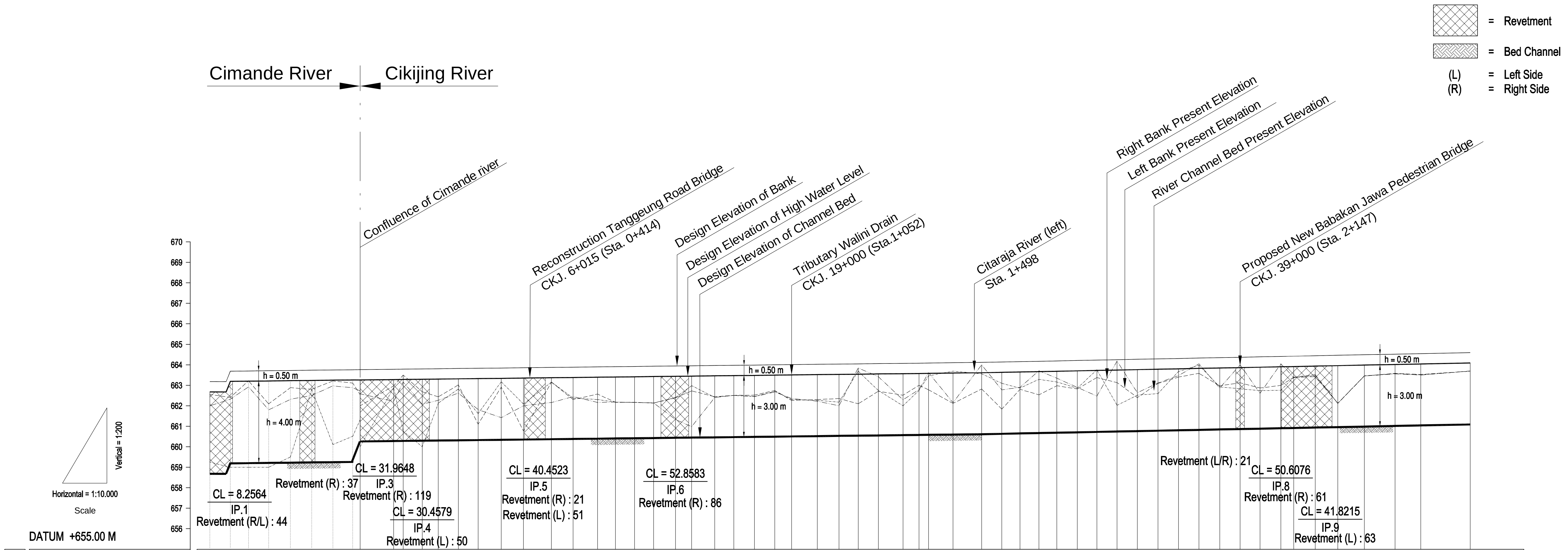


PRESENT ELEVATION	RIGHT BANK	(m)	662.00	662.32	662.92	661.80	662.31	662.51	662.97	662.87	662.58	662.21	663.15	662.07	662.26	662.62	661.81
	LEFT BANK	(m)	662.55	662.40	663.21	662.09	662.88	662.80	663.21	663.11	662.00	662.97	663.50	662.68	662.43	663.02	661.10
	RIVER CHANNEL BED	(m)	659.25	659.00	659.00	659.00	659.50	662.79	660.10	660.51	660.00	662.87	660.76	660.00	662.12	662.82	661.61
CHANNEL BED SLOPE		(m)															
DESIGN ELEVATION	BANK	(m)	663.17	663.69	663.70	663.71	663.72	663.73	663.74	663.75	663.75	663.77	663.78	663.79	663.80	663.81	663.82
	DESIGN HIGH WATER	(m)	662.67	663.19	663.20	663.21	663.22	663.23	663.24	663.25	663.25	663.27	663.28	663.29	663.30	663.31	663.32
	RIVER CHANNEL BED	(m)	658.67	659.19	659.20	659.21	659.22	659.23	659.24	659.25	660.25	660.27	660.28	660.29	660.30	660.31	660.32
ACCUMULATIVE DISTANCE		(m)	0+035.00	0+084.78	0+129.39	0+178.60	0+231.62	0+283.50	0+335.10	0+383.59	0+000.00	0+081.77	0+105.10	0+151.56	0+190.72	0+239.63	0+287.75
DISTANCE		(m)	35.00	49.79	44.61	49.20	53.03	51.87	51.61	48.49	00.00	81.77	23.33	46.46	39.16	48.91	48.12
STATION NO.		(m)	D.1	D.2	D.3	D.4	D.5	D.6	D.7	D.8	D.8a	D.10	D.11	D.12	D.13	CKJ.4a	CKJ.4

PRESENT ELEVATION	RIGHT BANK	(m)	661.42	662.00	662.16	662.44	662.16	662.18	662.16	662.14	661.33	660.98	662.40	662.50	662.44	662.67	662.36
	LEFT BANK	(m)	662.91	660.76	663.15	662.30	662.57	662.17	662.17	662.13	662.38	662.73	662.43	662.51	662.52	662.74	662.25
	RIVER CHANNEL BED	(m)	663.17	662.08	663.15	662.37	662.30	662.17	662.16	662.13	662.40	662.98	662.41	662.51	662.45	662.70	662.30
CHANNEL BED SLOPE		(m)									1/4300 0.000233						
DESIGN ELEVATION	BANK	(m)	663.83	663.85	663.86	663.88	663.89	663.90	663.91	663.92	663.93	663.94	663.96	663.97	663.98	663.99	664.00
	DESIGN HIGH WATER	(m)	663.33	663.35	663.36	663.38	663.39	663.40	663.41	663.42	663.43	663.44	663.46	663.47	663.48	663.49	663.50
	RIVER CHANNEL BED	(m)	660.33	660.35	660.36	660.38	660.39	660.40	660.41	660.42	660.43	660.44	660.46	660.47	660.48	660.49	660.50
ACCUMULATIVE DISTANCE		(m)	0+344.21	0+398.52	0+466.79	0+519.65	0+579.28	0+622.80	0+669.36	0+715.75	0+769.11	0+808.62	0+865.15	0+911.36	0+961.87	1+011.59	1+052.47
DISTANCE		(m)	56.46	54.31	68.27	52.86	59.63	43.52	46.56	46.38	53.36	39.51	56.53	46.21	50.50	49.73	40.87
STATION NO.		(m)	CKJ.5	CKJ.6	CKJ.7	CKJ.8	CKJ.9	CKJ.10	CKJ.11	CKJ.12	CKJ.13	CKJ.14	CKJ.15	CKJ.16	CKJ.17	CKJ.18	CKJ.19

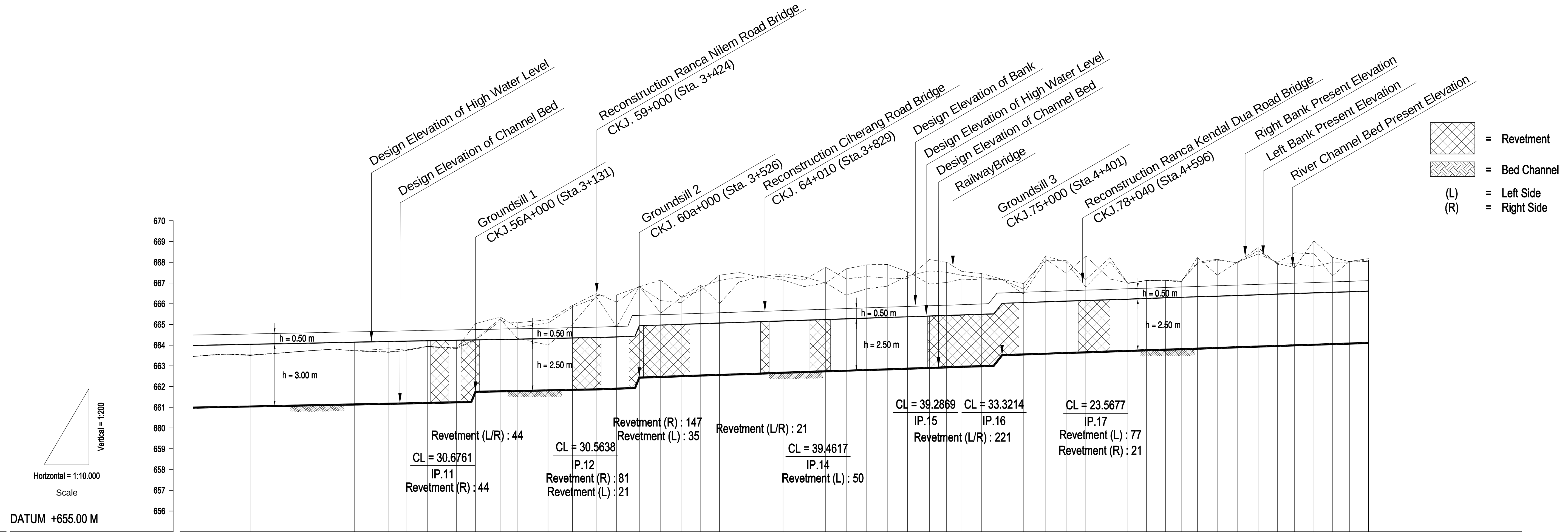
PRESENT ELEVATION	RIGHT BANK	(m)	662.22	662.00	663.84	663.42	662.28	662.78	663.62	662.14	664.00	662.77	662.90	663.70	663.34	662.90	662.47	664.18
	LEFT BANK	(m)	662.30	662.35	662.10	662.70	662.51	663.00	662.78	662.11	662.82	661.84	662.80	662.53	662.97	662.82	663.37	663.13
	RIVER CHANNEL BED	(m)	662.26	662.17	663.69	662.74	662.00	662.75	663.46	663.69	663.56	663.09	662.86	663.28	663.16	662.85	663.75	662.02
CHANNEL BED SLOPE		(m)																
DESIGN ELEVATION	BANK	(m)	664.01	664.03	664.04	664.05	664.06	664.07	664.08	664.09	664.11	664.13	664.14	664.16	664.18	664.20	664.22	664.24
	DESIGN HIGH WATER	(m)	663.51	663.53	663.54	663.55	663.56	663.57	663.58	663.59	663.61	663.63	663.64	663.66	663.68	663.70	663.72	663.74
	RIVER CHANNEL BED	(m)	660.51	660.53	660.54	660.55	660.56	660.57	660.58	660.59	660.61	660.63	660.64	660.66	660.68	660.70	660.72	660.74
ACCUMULATIVE DISTANCE		(m)	1+115.09	1+168.15	1+214.91	1+264.13	1+324.21	1+363.24	1+386.53	1+446.25	1+516.10	1+565.26	1+609.65	1+655.78	1+699.56	1+749.39	1+797.11	1+846.43
DISTANCE		(m)	62.62	53.06	46.77	49.21	60.09	39.03	23.29	59.72	69.85	49.16	44.39	46.13	43.78	49.83	47.72	49.33
STATION NO.		(m)	CKJ.21a	CKJ.21	CKJ.22	CKJ.23	CKJ.24	CKJ.25	CKJ.26	CKJ.27	CKJ.28	CKJ.29	CKJ.30	CKJ.31	CKJ.32	CKJ.33	CKJ.34	CKJ.35

PRESENT ELEVATION	RIGHT BANK	(m)	662.63	663.11	663.47	664.05	662.86	664.00	662.61	664.05	663.37	663.42	662.12	663.45	663.56	663.50	663.70
	LEFT BANK	(m)	662.39	663.08	663.40	663.58	662.97	663.12	662.86	662.99	663.39	663.52	662.12	663.46	663.58	663.53	663.69
	RIVER CHANNEL BED	(m)	662.51	662.59	663.67	663.98	662.92	662.82	662.73	662.75	663.38	663.47	662.12	663.45	663.57	663.51	663.69
CHANNEL BED SLOPE		(m)										1/2500 0.0004					
DESIGN ELEVATION	BANK	(m)	664.26	664.28	664.30	664.32	664.34	664.36	664.38	664.40	664.41	664.43	664.45	664.48	664.51	664.54	664.58
	DESIGN HIGH WATER	(m)	663.76	663.78	663.80	663.82	663.84	663.86	663.88	663.90	663.91	663.93	663.95	663.98	664.01	664.04	664.08
	RIVER CHANNEL BED	(m)	660.76	660.78	660.80	660.82	660.84	660.86	660.88	660.90	660.91	660.93	660.95	660.98	661.01	661.04	661.08
ACCUMULATIVE DISTANCE		(m)	1+895.95	1+946.09	1+996.38	2+046.17	2+096.81	2+146.50	2+195.03	2+245.94	2+277.46	2+329.72	2+384.79	2+449.40	2+524.55	2+585.39	2+707.67
DISTANCE		(m)	49.52	50.13	50.30	49.79	50.64	49.69	48.53	50.91	31.53	52.26	55.07	64.61	75.15	62.82	120.94
STATION NO.		(m)	CKJ.35a	CKJ.36	CKJ.37	CKJ.38	CKJ.38a	CKJ.39	CKJ.39a	CKJ.40	CKJ.41	CKJ.42a	CKJ.43a	CKJ.44a	CKJ.45a	CKJ.47a	CKJ.49a

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKIJING RIVER (1/3)

DRAWING NO.
P00-040PF001



PRESENT ELEVATION RIGHT BANK (m)	663.45	663.56	663.50	663.70	663.82	663.72	663.68	663.74	663.92	663.83	664.25	665.16	665.08	665.22	665.91	666.49	666.07	666.84
PRESENT ELEVATION LEFT BANK (m)	663.46	663.58	663.53	663.69	663.81	663.73	663.82	663.77	663.94	663.87	664.29	665.27	664.33	664.00	665.00	666.40	666.42	666.81
PRESENT ELEVATION RIVER CHANNEL BED (m)	663.45	663.57	663.51	663.69	663.81	663.72	663.65	663.74	663.95	663.84	665.03	665.36	664.85	665.07	665.83	666.30	664.88	666.82
CHANNEL BED SLOPE (m)					1/2500 0.0004													
DESIGN ELEVATION BANK (m)	664.48	664.51	664.54	664.58	664.61	664.64	664.67	664.69	664.71	664.74	664.75	664.77	664.79	664.82	664.84	664.86	664.89	664.93
DESIGN ELEVATION DESIGN HIGH WATER (m)	663.98	664.01	664.04	664.08	664.11	664.14	664.17	664.19	664.21	664.24	664.25	664.27	664.29	664.32	664.34	664.36	664.39	664.43
DESIGN ELEVATION RIVER CHANNEL BED (m)	660.98	661.01	661.04	661.08	661.11	661.14	661.17	661.19	661.21	661.24	661.75	661.77	661.79	661.82	661.84	661.86	661.89	661.93
ACCUMULATIVE DISTANCE (m)	2+449.40	2+524.55	2+585.39	2+707.67	2+780.53	2+837.89	2+921.71	2+963.47	3+014.42	3+085.46	3+130.69	3+190.43	3+231.53	3+306.07	3+364.70	3+423.57	3+471.37	3+525.86
DISTANCE (m)	64.61	75.15	62.82	120.29	81.50	57.36	83.82	41.75	50.95	71.04	45.23	59.74	41.09	74.54	58.63	58.87	47.80	54.49
STATION NO. (m)	CKJ.44a	CKJ.45a	CKJ.47a	CKJ.49a	CKJ.51	CKJ.52	CKJ.52a	CKJ.53a	CKJ.55	CKJ.55a	CKJ.56A	CKJ.56a	CKJ.57	CKJ.57a	CKJ.58	CKJ.59	CKJ.60A	CKJ.60a

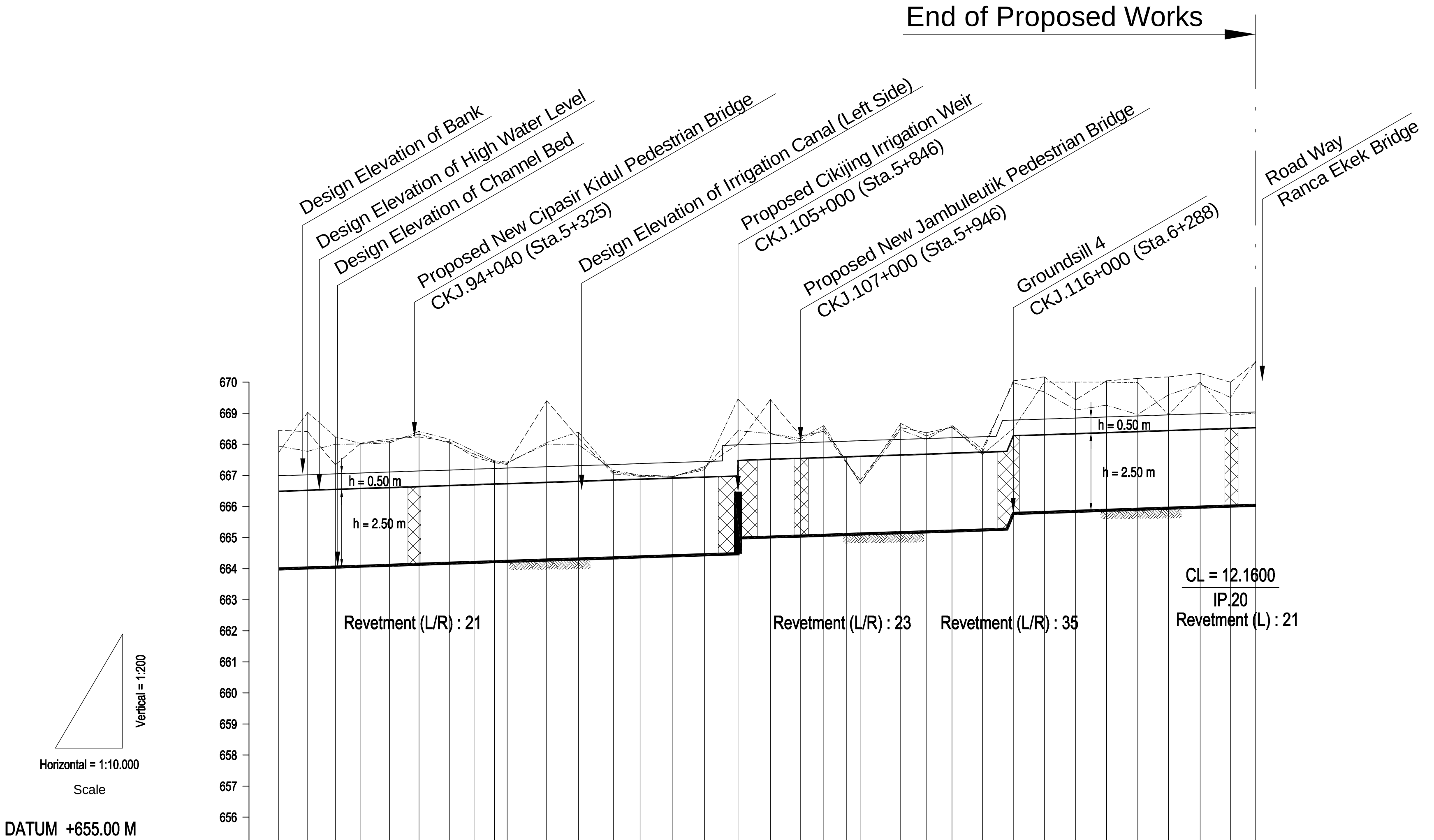
PRESENT ELEVATION RIGHT BANK (m)	665.54	666.29	666.64	667.37	667.50	667.27	667.31	667.14	667.75	667.19	667.31	667.23	667.21	668.13	668.00	667.55	667.45	667.18
PRESENT ELEVATION LEFT BANK (m)	667.14	666.32	666.89	666.00	667.04	667.31	667.44	667.29	667.00	667.68	667.88	667.89	667.54	666.94	667.02	667.18	667.14	667.17
PRESENT ELEVATION RIVER CHANNEL BED (m)	666.14	666.04	666.79	667.12	667.27	667.29	667.14	666.82	667.00	666.41	666.71	666.84	667.33	667.58	667.51	667.37	667.24	667.17
CHANNEL BED SLOPE (m)													1/1500 0.000667					
DESIGN ELEVATION BANK (m)	665.47	665.50	665.53	665.56	665.59	665.63	665.66	665.70	665.73	665.76	665.80	665.83	665.86	665.90	665.93	665.96	665.99	666.52
DESIGN ELEVATION DESIGN HIGH WATER (m)	664.97	665.00	665.03	665.06	665.09	665.13	665.16	665.20	665.23	665.26	665.30	665.33	665.36	665.40	665.43	665.46	665.49	666.02
DESIGN ELEVATION RIVER CHANNEL BED (m)	662.47	662.50	662.53	662.56	662.59	662.63	662.66	662.70	662.73	662.76	662.80	662.83	662.86	662.90	662.93	662.96	662.99	663.52
ACCUMULATIVE DISTANCE (m)	3+577.68	3+626.75	3+673.99	3+719.44	3+766.56	3+819.34	3+872.60	3+923.65	3+975.83	4+025.19	4+074.79	4+124.35	4+172.95	4+226.09	4+267.46	4+304.26	4+351.12	4+401.23
DISTANCE (m)	51.82	49.08	47.23	45.45	47.12	52.78	53.27	51.04	52.18	49.36	49.60	49.56	48.61	53.14	41.37	36.80	46.86	50.11
STATION NO. (m)	CKJ.61	CKJ.61a	CKJ.62	CKJ.62a	CKJ.63	CKJ.64	CKJ.65	CKJ.66	CKJ.67	CKJ.68	CKJ.69	CKJ.70	CKJ.71	CKJ.72	CKJ.73a	CKJ.73b	CKJ.74	CKJ.75

PRESENT ELEVATION RIGHT BANK (m)	666.97	668.14	667.47	668.30	667.19	666.99	667.10	667.13	667.09	667.93	668.09	667.98	668.71	667.88	667.94	667.77	668.00	668.01	668.04
PRESENT ELEVATION LEFT BANK (m)	666.47	668.07	668.08	667.17	668.22	666.97	667.12	667.12	667.04	668.22	667.38	668.00	668.40	667.99	668.45	668.41	667.34	668.04	668.17
PRESENT ELEVATION RIVER CHANNEL BED (m)	666.70	668.31	668.00	666.81	668.00	666.98	667.11	667.13	667.07	668.00	668.14	667.96	668.55	667.94	667.73	669.03	668.24	668.02	668.10
CHANNEL BED SLOPE (m)																			
DESIGN ELEVATION BANK (m)	666.55	666.58	666.62	666.65	666.69	666.72	666.75	666.78	666.80	666.83	666.86	666.89	666.93	666.96	666.98	667.02	667.05	667.07	667.10
DESIGN ELEVATION DESIGN HIGH WATER (m)	666.05	666.08	666.12	666.15	666.19	666.22	666.25	666.28	666.30	666.33	666.36	666.39	666.43	666.46	666.48	666.52	666.55	666.57	666.60
DESIGN ELEVATION RIVER CHANNEL BED (m)	663.55	663.58	663.62	663.65	663.69	663.72	663.75	663.78	663.80	663.83	663.86	663.89	663.93	663.96	663.98	664.02	664.05	664.07	664.10
ACCUMULATIVE DISTANCE (m)	4+452.47	4+506.53	4+555.59	4+603.12	4+661.47	4+704.60	4+749.31	4+795.23	4+833.18	4+872.13	4+920.11	4+968.46	5+018.80	5+065.65	5+106.87	5+153.31	5+197.88	5+238.87	5+285.09
DISTANCE (m)	51.24	54.07	49.05	47.54	58.35	43.13	44.71	45.92	37.95	38.95	47.98	48.35	50.34	46.85	41.21	46.45	44.56	41.00	46.22
STATION NO. (m)	CKJ.76	CKJ.77	CKJ.78	CKJ.79	CKJ.80	CKJ.81	CKJ.82	CKJ.83	CKJ.84	CKJ.85	CKJ.86	CKJ.87	CKJ.88	CKJ.89	CKJ.90	CKJ.91	CKJ.92	CKJ.93	CKJ.94

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKIJING RIVER (2/3)

DRAWING NO.
P00–040PF002



▨ = Revetment
▨ = Bed Channel
(L) = Left Side
(R) = Right Side

DATUM +655.00 M

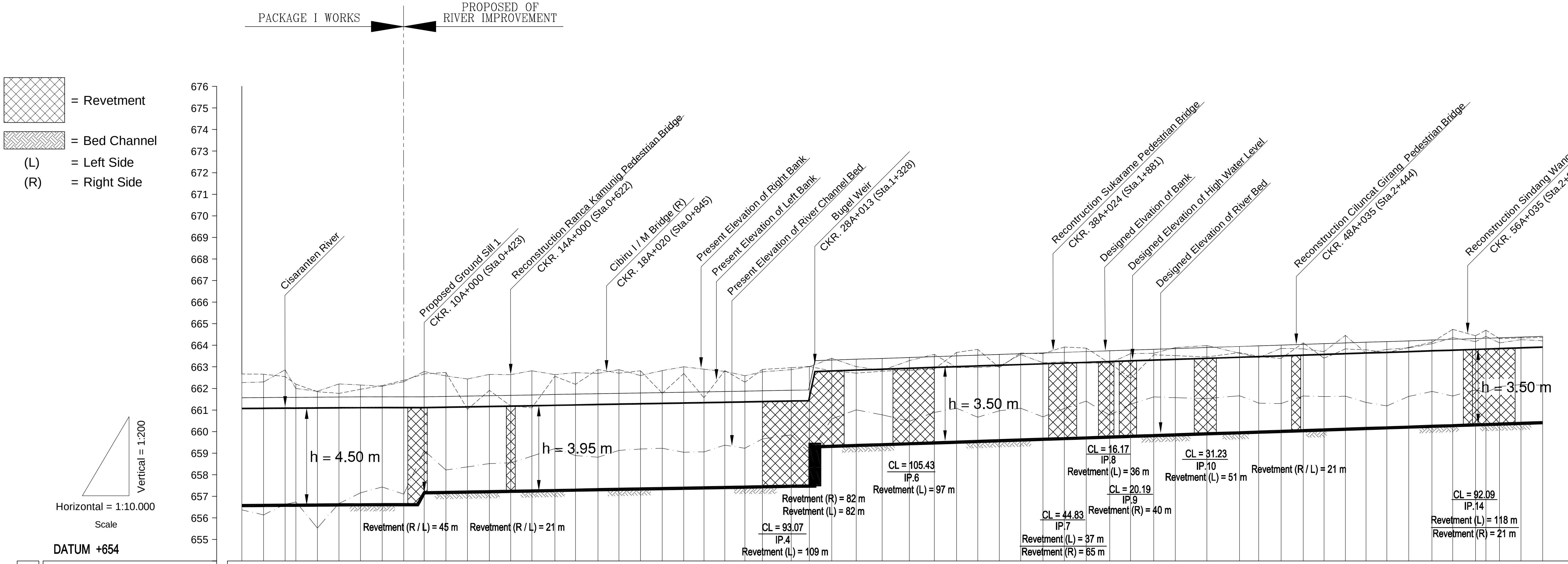
			CKJ.90	CKJ.91	CKJ.92	CKJ.93	CKJ.94	CKJ.95	CKJ.96	CKJ.96a	CKJ.97	CKJ.98	CKJ.99	CKJ.100	CKJ.101	CKJ.102	CKJ.103	CKJ.104	CKJ.105	CKJ.106
PRESENT ELEVATION	RIGHT BANK	(m)	667.94	667.77	668.00	668.01	668.04	668.41	668.16	667.77	667.46	667.42	668.00	668.00	667.15	667.00	666.97	667.23	668.44	668.34
	LEFT BANK	(m)	668.45	668.41	667.34	668.04	668.17	668.23	668.08	667.59	667.41	667.34	669.40	668.20	667.04	666.97	666.94	667.28	668.00	669.44
	RIVER CHANNEL BED	(m)	667.73	669.03	668.24	668.02	668.10	668.32	668.04	667.68	667.43	667.38	668.05	668.39	667.10	667.00	666.97	667.17	669.46	668.35
CHANNEL BED SLOPE		(m)																	1/1500 0.000667	
DESIGN ELEVATION	BANK	(m)	666.98	667.02	667.05	667.07	667.10	667.14	667.17	667.19	667.22	667.23	667.28	667.31	667.35	667.38	667.41	667.44	667.98	668.01
	DESIGN HIGH WATER	(m)	666.48	666.52	666.55	666.57	666.60	666.64	666.67	666.69	666.72	666.73	666.78	666.81	666.85	666.88	666.91	666.95	667.48	667.51
	RIVER CHANNEL BED	(m)	663.98	664.02	664.05	664.07	664.10	664.14	664.17	664.19	664.22	664.23	664.28	664.31	664.35	664.38	664.41	664.44	664.98	665.01
ACCUMULATIVE DISTANCE		(m)	5+106.87	5+153.31	5+197.88	5+238.87	5+285.09	5+332.58	5+381.03	5+420.85	5+453.98	5+474.24	5+537.92	5+588.92	5+645.24	5+688.00	5+739.97	5+791.92	5+845.71	5+897.66
DISTANCE		(m)	41.21	46.45	44.56	41.00	46.22	47.49	48.45	39.82	33.12	20.26	63.68	51.00	56.32	42.76	51.97	51.95	53.80	51.95
STATION NO.		(m)	CKJ.90	CKJ.91	CKJ.92	CKJ.93	CKJ.94	CKJ.95	CKJ.96	CKJ.96a	CKJ.97	CKJ.98	CKJ.99	CKJ.100	CKJ.101	CKJ.102	CKJ.103	CKJ.104	CKJ.105	CKJ.106

			CKJ.107	CKJ.108	CKJ.110	CKJ.111	CKJ.112	CKJ.113	CKJ.114	CKJ.115	CKJ.116	CKJ.117	CKJ.118	CKJ.119	CKJ.120	CKJ.121	CKJ.122	CKJ.123	CKJ.124
PRESENT ELEVATION	RIGHT BANK	(m)	668.09	668.49	667.43	666.74	668.47	668.15	668.61	667.84	669.98	669.68	669.10	669.25	668.96	669.59	669.93	669.51	670.66
	LEFT BANK	(m)	668.26	668.41	667.39	666.85	668.53	668.37	668.54	667.74	670.04	670.17	669.43	670.04	670.12	670.17	670.27	670.00	670.64
	RIVER CHANNEL BED	(m)	668.18	668.60	667.41	666.73	668.66	668.26	668.57	667.67	668.50	670.00	670.00	670.00	669.98	668.94	670.00	668.93	669.01
CHANNEL BED SLOPE		(m)																	
DESIGN ELEVATION	BANK	(m)	668.04	668.07	668.09	668.11	668.15	668.18	668.21	668.24	668.77	668.81	668.84	668.87	668.91	668.94	668.97	669.01	669.03
	DESIGN HIGH WATER	(m)	667.54	667.57	667.59	667.61	667.65	667.68	667.71	667.74	668.27	668.31	668.34	668.37	668.41	668.44	668.47	668.51	668.53
	RIVER CHANNEL BED	(m)	665.04	665.07	665.09	665.11	665.15	665.18	665.21	665.24	665.77	665.81	665.84	665.87	665.91	665.94	665.97	666.01	666.03
ACCUMULATIVE DISTANCE		(m)	5+946.20	5+983.68	6+020.52	6+042.28	6+107.36	6+148.36	6+189.67	6+238.78	6+288.29	6+338.50	6+388.76	6+438.28	6+488.92	6+538.10	6+588.92	6+637.79	6+678.52
DISTANCE		(m)	48.54	37.48	36.84	21.75	65.08	41.00	41.31	49.12	49.51	50.21	50.26	49.52	50.64	49.18	50.82	48.87	40.73
STATION NO.		(m)	CKJ.107	CKJ.108	CKJ.110	CKJ.111	CKJ.112	CKJ.113	CKJ.114	CKJ.115	CKJ.116	CKJ.117	CKJ.118	CKJ.119	CKJ.120	CKJ.121	CKJ.122	CKJ.123	CKJ.124

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKIJING RIVER (3/3)

DRAWING NO.
P00-040PF003



PRESENT ELEVATION	RIGHT BANK	(m)	662.27	662.30	662.86	662.00	661.87	662.21	662.16	662.10	662.31	662.78	662.58	662.44	662.65	662.64	662.82	662.64
	LEFT BANK	(m)	662.67	662.66	662.55	662.20	661.85	661.77	661.96	662.13	662.38	662.67	662.74	661.03	661.91	661.19	661.10	662.56
	RIVER CHANNEL BED	(m)	656.37	656.14	656.63	656.74	655.53	656.67	657.16	657.43	657.10	659.12	658.22	658.36	658.52	658.55	658.86	659.21
DESIGN CHANNEL BED SLOPE							1/7500 0.00013											
DESIGN ELEVATION	RIGHT BANK	(m)	661.57	661.57	661.58	661.58	661.59	661.60	661.61	661.61	661.61	661.61	661.62	661.64	661.66	661.68	661.69	661.71
	LEFT BANK	(m)	661.57	661.57	661.58	661.58	661.59	661.60	661.61	661.61	661.61	661.61	661.62	661.64	661.66	661.68	661.69	661.71
	HIGH WATER LEVEL	(m)	661.07	661.07	661.08	661.08	661.09	661.10	661.10	661.11	661.11	661.11	661.12	661.14	661.16	661.18	661.19	661.21
	CHANNEL BED	(m)	656.57	656.57	656.58	656.58	656.59	656.60	656.60	656.61	656.61	657.16	657.17	657.19	657.21	657.23	657.24	657.26
CUMULATIVE DISTANCE		(m)	0+000.00	0+050.08	0+100.10	0+125.11	0+175.09	0+225.04	0+275.12	0+325.26	0+375.25	0+422.79	0+473.00	0+522.07	0+572.83	0+622.27	0+671.27	0+724.70
DISTANCE		(m)	0.00	50.08	50.02	25.01	49.98	49.95	50.08	50.14	49.99	47.54	50.21	50.21	50.76	49.44	49.00	53.43
STATION NO.			CKR.1	CKR.2	CKR.3	CKR.4	CKR.5	CKR.6	CKR.7	CKR.8	CKR.9A	CKR.10A	CKR.11A	CKR.12A	CKR 13A	CKR.14A	CKR.15A	CKR.16A

PRESENT ELEVATION	RIGHT BANK	(m)	662.73	662.70	662.87	662.60	662.83	663.00	662.89	662.79	662.59	662.77	662.87	663.01	663.40	663.01	662.84	663.29
	LEFT BANK	(m)	662.19	662.88	662.71	662.82	661.78	662.69	661.57	662.83	662.29	662.88	662.96	663.02	662.81	662.71	662.80	662.84
	RIVER CHANNEL BED	(m)	658.89	658.81	659.13	659.19	659.23	659.04	659.06	659.37	659.23	659.66	659.85	659.01	660.59	661.01	660.78	660.48
DESIGN CHANNEL BED SLOPE					1/2800 0.00036													
DESIGN ELEVATION	RIGHT BANK	(m)	661.73	661.75	661.77	661.78	661.80	661.82	661.84	661.85	661.87	661.89	661.91	661.92	663.31	663.35	663.39	663.43
	LEFT BANK	(m)	661.73	661.75	661.77	661.78	661.80	661.82	661.84	661.85	661.87	661.89	661.91	661.92	663.31	663.35	663.39	663.43
	HIGH WATER LEVEL	(m)	661.23	661.25	661.27	661.28	661.30	661.32	661.34	661.35	661.37	661.39	661.41	661.42	662.81	662.85	662.89	662.93
	CHANNEL BED	(m)	657.28	657.30	657.32	657.33	657.35	657.37	657.39	657.40	657.42	657.44	657.46	657.47	659.31	659.35	659.39	659.43
CUMULATIVE DISTANCE		(m)	0+772.52	0+824.73	0+873.42	0+923.07	0+973.69	1+023.56	1+070.45	1+118.80	1+165.37	1+205.97	1+272.85	1+314.69	1+367.00	1+423.59	1+483.61	1+546.98
DISTANCE		(m)	47.82	52.39	48.69	49.65	50.62	49.87	46.89	48.35	46.57	40.60	66.88	41.84	52.31	56.59	60.02	63.37
STATION NO.			CKR.17A	CKR.18A	CKR.19A	CKR.20A	CKR.21A	CKR.22A	CKR.23A	CKR.24A	CKR.25A	CKR.26A	CKR.27A	CKR.28A	CKR.29A	CKR.30A	CKR.31A	CKR.32A

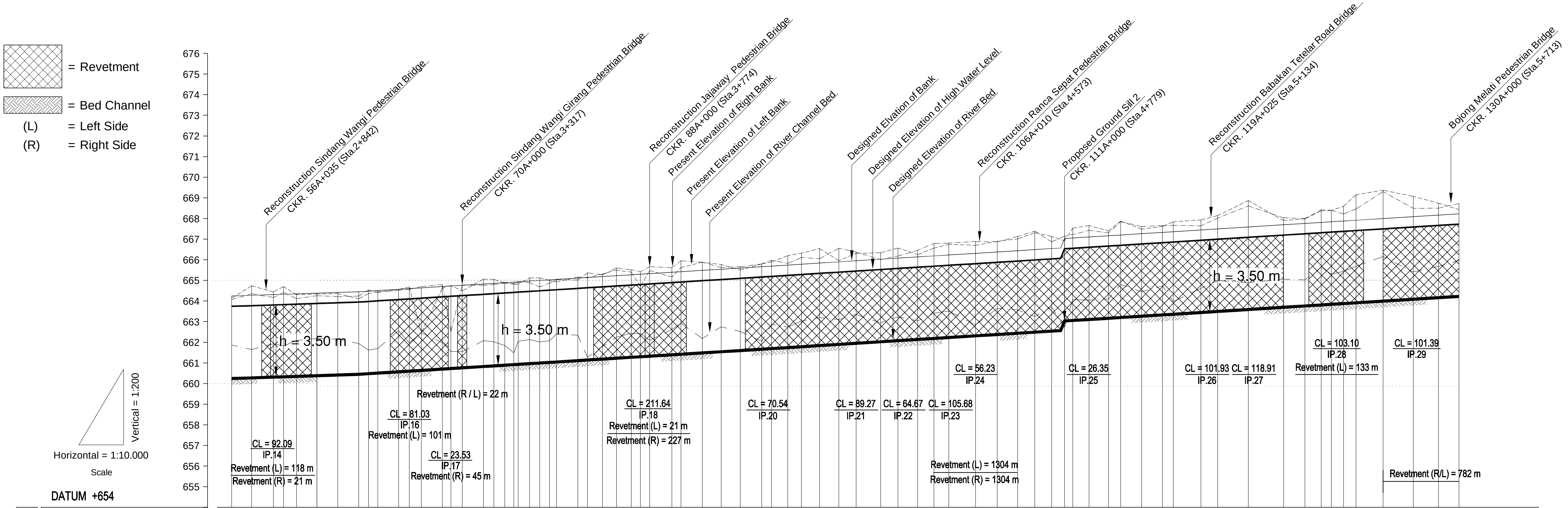
PRESENT ELEVATION	RIGHT BANK	(m)	663.58	662.97	662.97	663.02	663.57	663.19	663.23	663.17	663.18	663.61	663.63	663.89	663.99	663.63	663.43	663.86
	LEFT BANK	(m)	662.90	663.67	663.81	662.97	663.64	663.61	663.92	663.87	663.17	662.47	663.56	663.52	663.46	663.66	663.48	663.39
	RIVER CHANNEL BED	(m)	660.89	661.08	660.67	660.96	661.08	660.68	661.07	661.41	660.76	661.27	661.61	661.57	661.53	661.66	661.32	661.30
DESIGN CHANNEL BED SLOPE														1/1500 0.0006				
DESIGN ELEVATION	RIGHT BANK	(m)	663.47	663.50	663.53	663.57	663.60	663.64	663.67	663.70	663.74	663.77	663.81	663.84	663.89	663.94	663.97	664.00
	LEFT BANK	(m)	663.47	663.50	663.53	663.57	663.60	663.64	663.67	663.70	663.74	663.77	663.81	663.84	663.89	663.94	663.97	664.00
	HIGH WATER LEVEL	(m)	662.97	663.00	663.03	663.07	663.10	663.14	663.17	663.20	663.24	663.27	663.31	663.34	663.39	663.44	663.47	663.50
	CHANNEL BED	(m)	659.47	659.50	659.53	659.57	659.60	659.64	659.67	659.70	659.74	659.77	659.81	659.84	659.89	659.94	659.97	660.00
CUMULATIVE DISTANCE		(m)	1+604.64	1+656.29	1+705.36	1+755.33	1+804.86	1+856.51	1+906.06	1+957.12	2+011.52	2+059.88	2+113.86	2+163.50	2+236.87	2+312.77	2+357.16	2+409.31
DISTANCE		(m)	57.66	51.65	49.07	49.97	49.53	51.65	49.55	51.06	54.40	48.36	53.98	49.64	73.37	75.89	44.39	52.15
STATION NO.			CKR.33A	CKR.34A	CKR.35A	CKR.36A	CKR.37A	CKR.38A	CKR.39A	CKR.40A	CKR.41A	CKR.42A	CKR.43A	CKR.44A	CKR.45A	CKR.46A	CKR.47A	CKR.48A

PRESENT ELEVATION	RIGHT BANK	(m)	663.83	663.71	664.46	663.64	663.81	663.88	664.07	664.35	664.17	664.41	664.11	664.26	664.21
	LEFT BANK	(m)	664.11	663.40	663.83	663.79	663.66	663.90	664.14	664.74	664.44	664.70	664.31	664.34	664.36
	RIVER CHANNEL BED	(m)	661.65	661.62	661.64	661.35	661.19	661.63	661.86	661.65	661.93	661.82	662.09	662.18	662.15
DESIGN CHANNEL BED SLOPE															
DESIGN ELEVATION	RIGHT BANK	(m)	664.04	664.07	664.10	664.14	664.17	664.20	664.24	664.27	664.30	664.32	664.34	664.37	664.41
	LEFT BANK	(m)	664.04	664.07	664.10	664.14	664.17	664.20	664.24	664.27	664.30	664.32	664.34	664.37	664.41
	HIGH WATER LEVEL	(m)	663.54	663.57	663.60	663.64	663.67	663.70	663.74	663.77	663.80	663.82	663.84	663.87	663.91
	CHANNEL BED	(m)	660.04	660.07	660.10	660.14	660.17	660.20	660.24	660.27	660.30	660.32	660.34	660.37	660.41
CUMULATIVE DISTANCE		(m)	2+460.44	2+508.72	2+558.34	2+605.86	2+654.08	2+705.14	2+758.82	2+807.08	2+859.85	2+884.33	2+915.71	2+965.41	3+015.80
DISTANCE		(m)	51.13	48.28	49.62	47.52	48.22	51.06	53.68	48.26	52.76	24.48	31.38	49.70	50.39
STATION NO.			CKR.49A	CKR.50A	CKR.51A	CKR.52A	CKR.53A	CKR.54A	CKR.55A	CKR.56A	CKR.57A	CKR.58A	CKR.59A	CKR.60A	CKR.61A

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKERUH RIVER (1/3)

DRAWING NO.
P00-050PF001



PRESENT ELEVATION	RIGHT BANK (m)	664.07	664.35	664.17	664.41	664.11	664.26	664.21	664.24	664.54	664.42	664.52	664.57	664.70	664.80	662.51	664.78	664.76	664.80	664.87	664.84	664.92	664.88	664.68	664.87	665.03	665.02	665.37
	LEFT BANK (m)	664.14	664.74	664.44	664.70	664.31	664.34	664.36	664.11	664.36	664.44	664.56	664.68	662.46	664.63	664.75	664.49	665.06	665.05	664.88	664.82	664.82	665.12	665.12	665.00	664.92	665.16	665.12
	RIVER CHANNEL BED (m)	661.86	661.65	661.93	661.82	662.09	662.18	662.15	661.94	661.62	661.70	662.56	661.97	662.46	661.98	661.56	661.55	662.08	662.02	661.84	661.49	662.05	662.13	662.01	662.07	662.41	662.34	661.28
DESIGN CHANNEL BED SLOPE				1/1500 0.0006																								
DESIGN ELEVATION	RIGHT BANK (m)	664.24	664.27	664.30	664.32	664.34	664.37	664.41	664.44	664.47	664.50	664.56	664.60	664.63	664.70	664.72	664.76	664.82	664.85	664.88	664.91	664.92	664.96	664.99	665.02	665.04	665.11	665.13
	LEFT BANK (m)	664.24	664.27	664.30	664.32	664.34	664.37	664.41	664.44	664.47	664.50	664.56	664.60	664.63	664.70	664.72	664.76	664.82	664.85	664.88	664.91	664.92	664.96	664.99	665.02	665.04	665.11	665.13
	HIGH WATER LEVEL (m)	663.74	663.77	663.80	663.82	663.84	663.87	663.91	663.94	663.97	664.00	664.06	664.10	664.13	664.20	664.22	664.26	664.32	664.35	664.38	664.41	664.42	664.46	664.49	664.52	664.54	664.61	664.63
	CHANNEL BED (m)	660.24	660.27	660.30	660.32	660.34	660.37	660.41	660.44	660.47	660.50	660.56	660.60	660.63	660.70	660.72	660.76	660.82	660.85	660.88	660.91	660.92	660.96	660.99	661.02	661.04	661.11	661.13
CUMULATIVE DISTANCE (m)		2+758.82	2+807.08	2+859.85	2+884.33	2+915.71	2+965.41	3+015.80	3+066.62	3+090.04	3+112.61	3+163.01	3+188.91	3+218.23	3+269.04	3+289.52	3+317.18	3+368.63	3+393.93	3+420.12	3+441.95	3+452.79	3+480.42	3+504.72	3+528.41	3+545.56	3+597.05	3+620.19
DISTANCE (m)		53.68	48.26	52.76	24.48	31.38	49.70	50.39	50.82	23.42	22.57	50.40	25.90	29.32	50.81	20.48	27.53	51.45	25.30	26.19	21.83	10.84	27.63	24.30	23.69	17.15	51.49	23.14
STATION NO.		CKR.55A	CKR.56A	CKR.57A	CKR.58A	CKR.59A	CKR.60A	CKR.61A	CKR.62A	CKR.63A	CKR.64A	CKR.65A	CKR.66A	CKR.67A	CKR.68A	CKR.69A	CKR.70A	CKR.71A	CKR.72A	CKR.73A	CKR.74A	CKR.75A	CKR.76A	CKR.77A	CKR.78A	CKR.79A	CKR.80A	CKR.81A

PRESENT ELEVATION	RIGHT BANK (m)	665.27	665.60	665.51	665.42	665.66	665.62	665.95	665.88	665.62	665.66	665.80	665.98	665.82	666.11	666.05	666.56	666.37	666.01	666.18	666.46
	LEFT BANK (m)	665.31	665.50	665.40	664.70	665.48	665.16	665.62	665.88	665.77	665.50	665.80	665.89	666.20	666.32	666.54	665.96	666.31	666.34	666.57	666.25
	RIVER CHANNEL BED (m)	661.80	662.25	662.44	662.42	662.10	662.62	662.92	662.18	662.75	662.52	662.05	662.87	662.73	663.03	663.20	663.10	663.35	662.94	663.23	663.04
DESIGN CHANNEL BED SLOPE																			1/800 0.00125		
DESIGN ELEVATION	RIGHT BANK (m)	665.18	665.22	665.27	665.29	665.32	665.39	665.42	665.48	665.54	665.60	665.66	665.69	665.74	665.78	665.84	665.90	665.95	666.02	666.07	666.13
	LEFT BANK (m)	665.18	665.22	665.27	665.29	665.32	665.39	665.42	665.48	665.54	665.60	665.66	665.69	665.74	665.78	665.84	665.90	665.95	666.02	666.07	666.13
	HIGH WATER LEVEL (m)	664.68	664.72	664.77	664.79	664.82	664.89	664.92	664.98	665.04	665.10	665.16	665.19	665.24	665.28	665.34	665.40	665.45	665.52	665.57	665.63
	CHANNEL BED (m)	661.18	661.22	661.27	661.29	661.32	661.39	661.42	661.48	661.54	661.60	661.66	661.69	661.74	661.78	661.84	661.90	661.95	662.02	662.07	662.13
CUMULATIVE DISTANCE (m)		3+656.96	3+690.63	3+726.74	3+751.73	3+774.04	3+827.79	3+849.91	3+901.55	3+947.23	3+993.35	4+045.57	4+069.07	4+108.51	4+141.78	4+185.71	4+232.26	4+274.30	4+333.48	4+375.41	4+423.28
DISTANCE (m)		36.77	33.67	36.13	21.99	22.33	53.78	22.12	51.64	45..62	46.08	52.22	23.50	39.44	33.27	43.93	46.55	42.04	59.18	41.93	47.87
STATION NO.		CKR.83A	CKR.85A	CKR.86A	CKR.87A	CKR.88A	CKR.89A	CKR.90A	CKR.91A	CKR.92A	CKR.93A	CKR.94A	CKR.95A	CKR.96A	CKR.97A	CKR.98A	CKR.99A	CKR.100A	CKR.101A	CKR.102A	CKR.103A

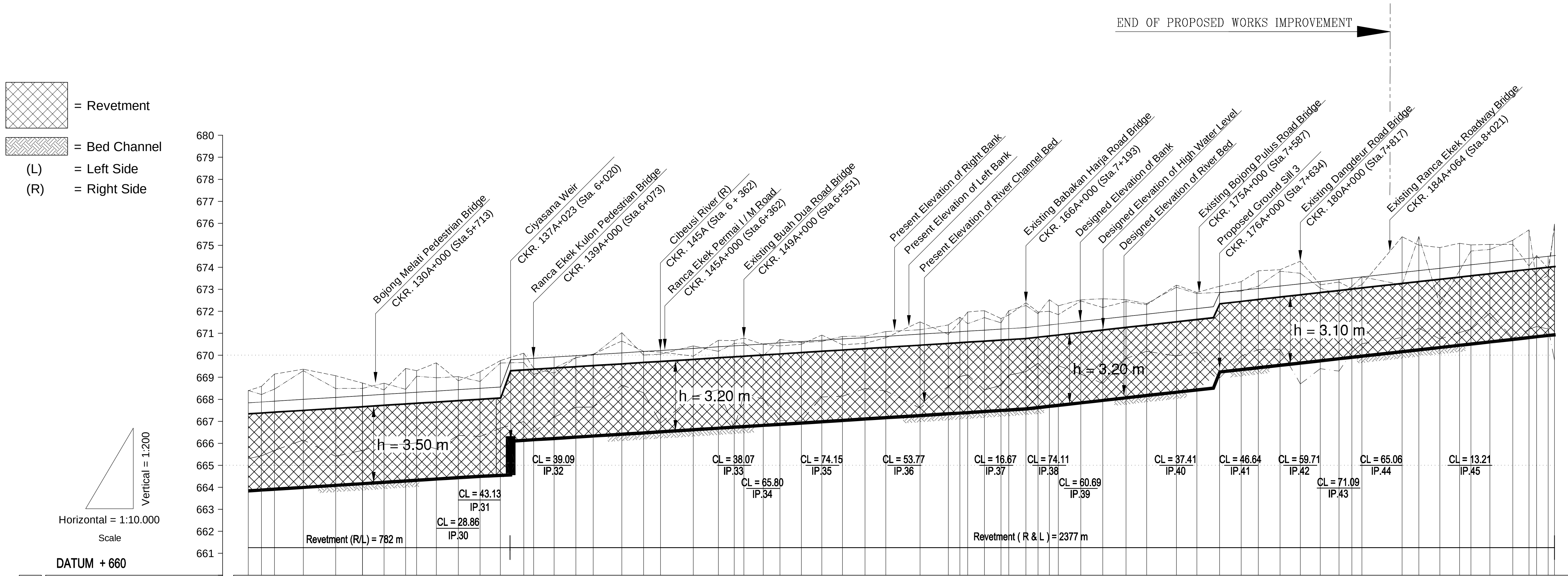
PRESENT ELEVATION	RIGHT BANK (m)	666.79	666.81	666.88	666.87	667.13	667.39	666.87	667.14	667.23	667.42	667.30	667.85	667.61	667.65	667.67	667.64	668.02	668.61
	LEFT BANK (m)	666.56	666.75	666.70	666.89	667.01	667.31	667.13	666.92	667.53	667.66	667.40	667.87	667.48	667.61	667.84	667.93	668.14	668.87
	RIVER CHANNEL BED (m)	663.41	663.51	662.84	663.64	663.57	663.25	663.71	662.72	664.07	664.04	664.10	664.80	664.45	664.73	663.98	664.61	664.99	664.89
DESIGN CHANNEL BED SLOPE																			
DESIGN ELEVATION	RIGHT BANK (m)	666.18	666.23	666.31	666.37	666.44	666.49	666.54	667.03	667.05	667.10	667.16	667.20	667.26	667.33	667.36	667.44	667.49	667.58
	LEFT BANK (m)	666.18	666.23	666.31	666.37	666.44	666.49	666.54	667.03	667.05	667.10	667.16	667.20	667.26	667.33	667.36	667.44	667.49	667.58
	HIGH WATER LEVEL (m)	665.68	665.73	665.81	665.87	665.94	665.99	666.04	666.53	666.55	666.60	666.66	666.70	666.76	666.83	666.86	666.94	666.99	667.08
	CHANNEL BED (m)	662.18	662.23	662.31	662.37	662.44	662.49	662.54	663.03	663.05	663.10	663.16	663.20	663.26	663.33	663.36	663.44	663.49	663.58
CUMULATIVE DISTANCE (m)		4+462.45	4+498.46	4+563.34	4+615.69	4+665.30	4+706.66	4+747.35	4+778.64	4+798.74	4+837.95	4+884.99	4+914.81	4+965.36	5+015.86	5+042.20	5+108.77	5+148.44	5+222.64
DISTANCE (m)		39.17	36.01	64.88	52.23	49.61	41.36	40.69	31.29	20.10	39.22	47.04	29.82	50.55	50.50	26.34	66.57	40.71	74.20
STATION NO.		CKR.104A	CKR.105A	CKR.106A	CKR.107A	CKR.108A	CKR.109A	CKR.110A	CKR.111A	CKR.112A	CKR.113A	CKR.114A	CKR.115A	CKR.116A	CKR.117A	CKR.118A	CKR.119A	CKR.120A	CKR.121A

PRESENT ELEVATION	RIGHT BANK (m)	668.03	668.00	668.42	668.40	668.22	668.46	669.30	668.49	668.50	668.73
	LEFT BANK (m)	667.90	667.98	668.37	668.39	668.59	669.15	669.37	669.07	668.74	668.43
	RIVER CHANNEL BED (m)	665.06	665.02	665.64	665.30	665.43	665.68	666.15	665.41	665.68	665.96
DESIGN CHANNEL BED SLOPE											
DESIGN ELEVATION	RIGHT BANK (m)	667.69	667.76	667.81	667.84	667.87	667.91	667.99	668.08	668.16	668.22
	LEFT BANK (m)	667.69	667.76	667.81	667.84	667.87	667.91	667.99	668.08	668.16	668.22
	HIGH WATER LEVEL (m)	667.19	667.26	667.31	667.34	667.37	667.41	667.49	667.58	667.66	667.72
	CHANNEL BED (m)	663.69	663.76	663.81	663.84	663.87	663.91	663.99	664.08	664.16	664.22
CUMULATIVE DISTANCE (m)		5+308.00	5+359.88	5+399.35	5+423.73	5+453.53	5+483.25	5+549.06	5+622.45	5+683.44	5+732.79
DISTANCE (m)		85.36	51.88	39.47	24.38	29.80	29.72	65.80	73.39	60.99	49.35
STATION NO.		CKR.122A	CKR.123A	CKR.124A	CKR.125A	CKR.126A	CKR.127A	CKR.128A	CKR.129AA	CKR.130A	CKR.131A

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKERUH RIVER (2/3)

DRAWING NO.
P00-050PF002



PRESENT ELEVATION	RIGHT BANK (m)	668.40	668.22	668.46	669.30	668.49	668.50	668.73	668.45	669.05	668.98	669.03	668.81
	LEFT BANK (m)	668.39	668.59	669.15	669.37	669.07	668.74	668.43	669.40	669.30	669.66	668.84	669.25
	RIVER CHANNEL BED (m)	665.30	665.43	665.68	666.15	665.41	665.68	665.96	665.96	666.02	665.74	666.36	666.31
DESIGN CHANNEL BED SLOPE													
DESIGN ELEVATION	RIGHT BANK (m)	667.84	667.87	667.91	667.99	668.08	668.16	668.22	668.28	668.32	668.37	668.43	668.50
	LEFT BANK (m)	667.84	667.87	667.91	667.99	668.08	668.16	668.22	668.28	668.32	668.37	668.43	668.50
	HIGH WATER LEVEL (m)	667.34	667.37	667.41	667.49	667.58	667.66	667.72	667.78	667.82	667.87	667.93	668.00
	CHANNEL BED (m)	663.84	663.87	663.91	663.99	664.08	664.16	664.22	664.28	664.32	664.37	664.43	664.50
CUMULATIVE DISTANCE (m)		5+423.73	5+453.53	5+483.25	5+549.06	5+622.45	5+683.44	5+732.79	5+781.67	5+806.94	5+851.60	5+901.78	5+951.18
DISTANCE (m)		24.38	29.80	29.72	65.80	73.39	60.99	49.35	48.88	25.27	44.66	50.17	49.39
STATION NO.		CKR.125A	CKR.126A	CKR.127A	CKR.128A	CKR.129AA	CKR.130A	CKR.131A	CKR.132A	CKR.133A	CKR.134A	CKR.135A	CKR.136A

PRESENT ELEVATION	RIGHT BANK (m)	669.65	669.67	669.13	669.42	669.89	670.01	671.03	670.01	670.05	670.43	670.18	670.54
	LEFT BANK (m)	669.76	670.10	669.42	669.19	669.89	670.05	670.65	670.18	670.15	669.96	670.68	670.67
	RIVER CHANNEL BED (m)	666.69	666.99	666.52	667.19	667.64	667.65	668.64	668.30	666.92	668.12	668.44	666.71
DESIGN CHANNEL BED SLOPE										1/800 0.00125			
DESIGN ELEVATION	RIGHT BANK (m)	668.55	669.83	669.86	669.92	669.98	670.03	670.11	670.17	670.22	670.31	670.38	671.43
	LEFT BANK (m)	668.55	669.83	669.86	669.92	669.98	670.03	670.11	670.17	670.22	670.31	670.38	670.43
	HIGH WATER LEVEL (m)	668.05	669.33	669.36	669.42	669.48	669.53	669.61	669.67	669.72	669.81	669.88	669.93
	CHANNEL BED (m)	664.55	666.13	666.16	666.22	666.28	666.33	666.41	666.47	666.52	666.61	666.68	666.73
CUMULATIVE DISTANCE (m)		5+997.41	6+050.80	6+072.91	6+119.74	6+169.00	6+208.71	6+273.67	6+323.30	6+361.60	6+436.14	6+493.28	6+529.63
DISTANCE (m)		46.23	30.00	22.11	46.83	49.26	39.71	64.96	49.63	38.30	74.54	57.14	36.35
STATION NO.		CKR.137A	CKR.138A	CKR.139A	CKR.140A	CKR.141A	CKR.142A	CKR.143A	CKR.144A	CKR.145A	CKR.146A	CKR.147A	CKR.148A

PRESENT ELEVATION	RIGHT BANK (m)	670.56	669.97	670.72	670.58	670.63	670.86	670.87	671.08	671.16	671.38	671.73	671.44
	LEFT BANK (m)	670.78	670.50	670.43	670.50	670.92	670.48	670.54	670.80	671.52	670.95	671.52	671.97
	RIVER CHANNEL BED (m)	668.21	668.02	667.03	667.02	668.11	668.14	668.49	668.38	667.60	668.59	669.04	669.11
DESIGN CHANNEL BED SLOPE													
DESIGN ELEVATION	RIGHT BANK (m)	670.46	670.51	670.56	670.62	670.68	670.74	670.80	670.86	670.96	671.04	671.07	671.09
	LEFT BANK (m)	670.46	670.51	670.56	670.62	670.68	670.74	670.80	670.86	670.96	671.04	671.07	671.09
	HIGH WATER LEVEL (m)	669.96	670.01	670.06	670.12	670.18	670.24	670.30	670.36	670.46	670.54	670.57	670.59
	CHANNEL BED (m)	666.76	666.81	666.86	666.92	666.98	667.04	667.10	667.16	667.26	667.34	667.37	667.39
CUMULATIVE DISTANCE (m)		6+551.37	6+595.34	6+633.73	6+682.38	6+728.73	6+775.65	6+826.81	6+874.07	6+952.02	7+016.66	7+042.75	7+060.69
DISTANCE (m)		21.74	43.97	38.39	48.65	46.36	46.93	51.37	47.26	77.95	64.64	26.09	17.94
STATION NO.		CKR.149A	CKR.150A	CKR.151A	CKR.152A	CKR.153A	CKR.154A	CKR.155A	CKR.156A	CKR.157A	CKR.159A	CKR.161A	CKR.162A

PRESENT ELEVATION	RIGHT BANK (m)	671.71	671.48	672.03	672.26	671.89	672.53	672.25	672.52	672.57	672.53	672.35	673.09
	LEFT BANK (m)	672.03	671.67	671.83	672.39	671.97	672.00	671.85	672.47	672.17	672.44	672.30	673.19
	RIVER CHANNEL BED (m)	668.43	668.63	669.10	669.26	669.64	669.13	669.53	669.15	668.72	669.86	670.18	669.97
DESIGN CHANNEL BED SLOPE													
DESIGN ELEVATION	RIGHT BANK (m)	671.14	671.19	671.21	672.26	671.32	671.38	671.42	671.54	671.65	671.76	671.87	672.02
	LEFT BANK (m)	671.14	671.19	671.21	671.26	671.32	671.38	671.42	671.54	671.65	671.76	671.87	672.02
	HIGH WATER LEVEL (m)	670.64	670.69	670.71	670.76	670.82	670.88	670.92	671.04	671.15	671.26	671.37	671.52
	CHANNEL BED (m)	667.44	667.49	667.51	667.56	667.62	667.68	667.72	667.84	667.95	668.06	668.17	668.32
CUMULATIVE DISTANCE (m)		7+098.45	7+136.23	7+154.17	7+193.16	7+220.62	7+246.31	7+266.61	7+317.98	7+367.59	7+420.55	7+467.59	7+535.44
DISTANCE (m)		37.76	37.78	17.94	38.99	27.46	25.69	20.30	51.47	49.66	52.96	47.04	67.84
STATION NO.		CKR.163A	CKR.164A	CKR.165A	CKR.166A	CKR.167A	CKR.168A	CKR.169A	CKR.170A	CKR.171A	CKR.172A	CKR.173A	CKR.174A

PRESENT ELEVATION	RIGHT BANK (m)	672.81	672.86	672.92	673.14	673.82	673.73	673.05	672.77	673.13	673.57	673.20	675.40
	LEFT BANK (m)	672.86	673.14	673.35	673.84	673.89	674.28	673.20	673.33	673.03	673.21	675.39	675.01
	RIVER CHANNEL BED (m)	670.13	668.97	669.96	670.26	670.27	668.70	669.39	669.28	670.14	670.53	670.81	671.24
DESIGN CHANNEL BED SLOPE							1/450 0.00222						
DESIGN ELEVATION	RIGHT BANK (m)	672.12	672.94	673.95	673.03	673.14	673.25	673.35	673.44	673.51	673.56	673.76	673.84
	LEFT BANK (m)	672.12	672.94	672.95	673.03	673.14	673.25	673.35	673.44	673.51	673.56	673.76	673.84
	HIGH WATER LEVEL (m)	671.62	672.44	672.45	672.53	672.64	672.75	672.85	672.94	673.01	673.06	673.26	673.34
	CHANNEL BED (m)	668.42	669.24	669.35	669.43	669.54	669.65	669.75	669.84	669.91	669.96	670.16	670.24
CUMULATIVE DISTANCE (m)		7+581.87	7+633.57	7+682.89	7+721.58	7+771.15	7+817.47	7+862.59	7+905.60	7+934.63	7+957.33	8+049.06	8+087.02
DISTANCE (m)		46.43	51.70	49.32	38.69	49.57	46.31	45.12	43.01	29.03	22.70	91.73	37.96
STATION NO.		CKR.175A	CKR.176A	CKR.177A	CKR.178A	CKR.179A	CKR.180A	CKR.181A	CKR.182A	CKR.183A	CKR.184A	CKR.185A	CKR.186A

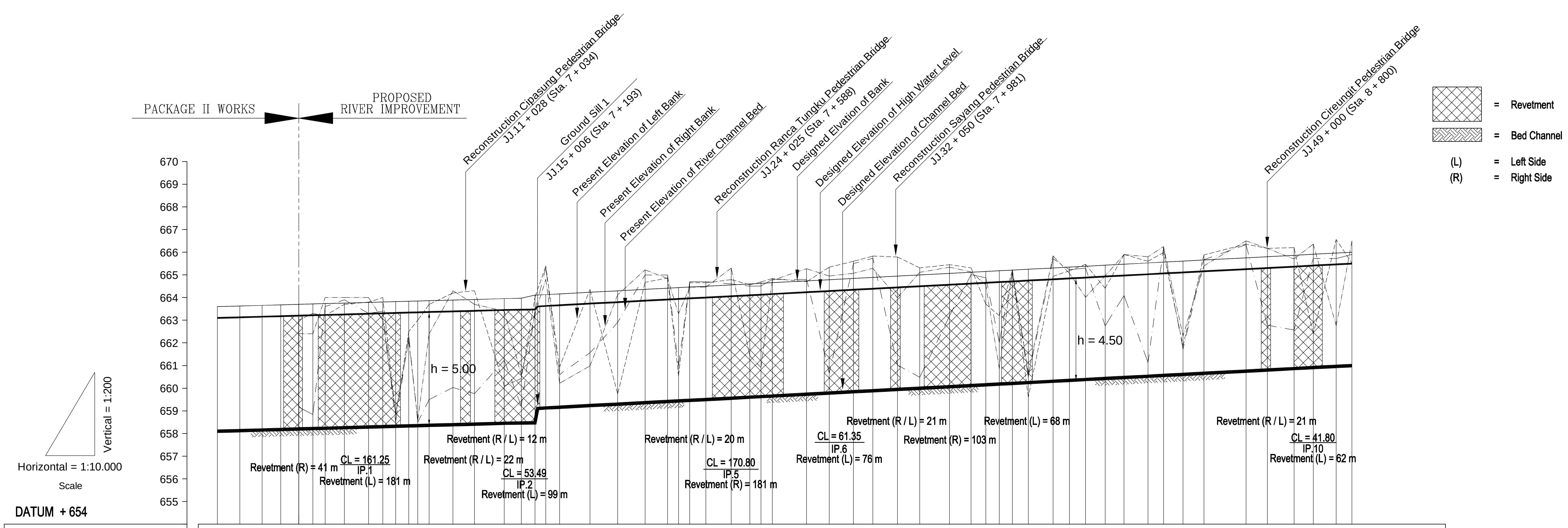
PRESENT ELEVATION	RIGHT BANK (m)	672.30	673.85	674.74	674.81	675.23	675.70	673.34	673.63	675.96
	LEFT BANK (m)	674.90	675.09	675.02	675.04	675.04	674.06	674.53	673.95	675.80
	RIVER CHANNEL BED (m)	670.74	671.04	671.19	671.92	670.77	671.18	671.31	671.20	669.78
DESIGN CHANNEL BED SLOPE										
DESIGN ELEVATION	RIGHT BANK (m)	674.95	674.05	674.11	674.20	674.32	674.40	674.44	674.50	674.53
	LEFT BANK (m)	673.95	674.05	674.11	674.20	674.32	674.40	674.44	674.50	674.53
	HIGH WATER LEVEL (m)	673.45	673.55	673.61	673.70	673.82	673.90	673.94	674.00	674.03
	CHANNEL BED (m)	670.35	670.45	670.51	670.60	670.72	670.80	670.84	670.90	670.93
CUMULATIVE DISTANCE (m)		8+134.99	8+179.73	8+205.45	8+248.84	8+301.02	8+337.61	8+355.16	8+382.16	8+397.76
DISTANCE (m)		47.97	44.74	25.72	43.39	52.18	36.59	17.55	26.28	14.38
STATION NO.		CKR.187A	CKR.188A	CKR.189A	CKR.190A	CKR.191A	CKR.192A	CKR.193A	CKR.194A	CKR.195A

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIKERUH RIVER (3/3)

DRAWING NO.

P00-050PF003



PRESENT ELEVATION	RIGHT BANK	(m)	0.00	0.00	0.00	0.00	662.40	662.40	664.00	664.00	664.00	663.00	658.90	662.10	658.60	662.40	664.30	663.70	663.40	660.56	663.26	664.81	660.22
	LEFT BANK	(m)	0.00	0.00	0.00	0.00	663.00	663.30	663.20	663.70	663.80	664.00	658.80	662.50	663.00	663.70	664.20	664.30	660.10	660.43	664.01	665.39	660.93
	RIVER CHANNEL BED	(m)	0.00	0.00	0.00	0.00	659.17	658.84	663.60	663.90	663.30	663.40	658.50	662.30	658.50	659.50	660.03	659.76	661.23	659.20	663.42	665.30	660.60
DESIGN CHANNEL BED SLOPE														1/1800 0.000714									
DESIGN ELEVATION	RIGHT BANK	(m)	663.60	663.62	663.65	663.67	663.70	663.71	663.73	663.75	663.78	663.80	663.81	663.83	663.84	663.86	663.88	663.91	663.95	663.97	664.10	664.12	664.16
	LEFT BANK	(m)	663.60	663.62	663.65	663.67	663.70	663.71	663.73	663.75	663.78	663.80	663.81	663.83	663.84	663.86	663.88	663.91	663.95	663.97	664.10	664.12	664.16
	HIGH WATER LEVEL	(m)	663.10	663.12	663.15	663.17	663.20	663.21	663.23	663.25	663.28	663.30	663.31	663.33	663.34	663.36	663.38	663.41	663.45	663.47	663.60	663.62	663.66
	CHANNEL BED	(m)	658.10	658.12	658.15	658.17	658.20	658.21	658.23	658.25	658.28	658.30	658.31	658.33	658.34	658.36	658.38	658.41	658.45	658.47	659.10	659.12	659.16
CUMULATIVE DISTANCE		(m)	6+486.73	6+536.26	6+585.65	6+626.47	6+666.23	6+697.26	6+724.32	6+766.58	6+820.24	6+851.39	6+879.69	6+908.65	6+928.51	6+953.45	7+005.97	7+053.47	7+118.89	7+156.48	7+186.55	7+210.48	7+240.71
DISTANCE		(m)	39.40	49..53	49.39	40.82	39.77	31.03	27.06	42.26	53.66	31.15	28.31	28.96	19.85	24.95	52.52	47.50	65.42	37.59	30.07	23.93	30.23
STATION NO.			Y.164	Y.165	Y.166	Y.167	JJ.1/Y168	JJ.2	JJ.3	JJ.4	JJ.5	JJ.6	JJ.7	JJ.8	JJ.9	JJ.10	JJ.11	JJ.12	JJ.13	JJ.14	JJ.15	JJ.16	JJ.17

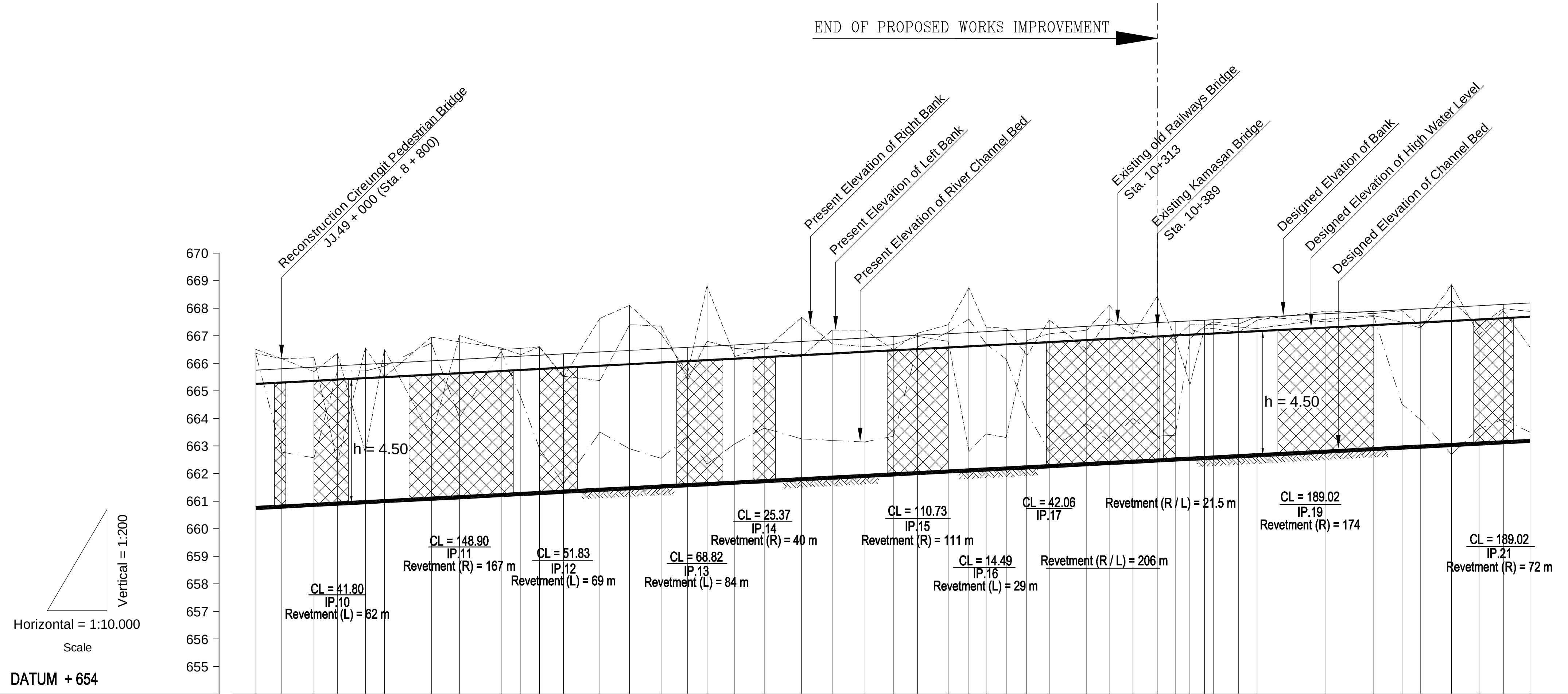
PRESENT ELEVATION	RIGHT BANK	(m)	660.98	664.12	665.22	664.84	663.28	664.46	664.46	665.30	661.43	660.91	664.76	665.27	664.95	665.07	665.29	663.99	665.11	665.34	665.13	664.56	660.87	665.23	660.66
	LEFT BANK	(m)	664.36	659.75	664.67	664.86	660.56	664.65	664.65	664.79	664.56	664.69	664.84	664.70	665.34	665.60	665.83	665.79	665.31	665.45	665.31	663.70	663.20	665.19	659.60
	RIVER CHANNEL BED	(m)	661.56	662.90	664.99	664.99	660.98	664.70	664.70	664.60	664.50	664.51	664.80	664.80	660.66	665.50	665.73	661.02	660.48	663.19	665.01	664.87	662.02	665.10	660.50
DESIGN CHANNEL BED SLOPE																			1/950 0.0011						
DESIGN ELEVATION	RIGHT BANK	(m)	664.23	664.29	664.35	664.41	664.43	664.46	664.50	664.55	664.60	664.62	664.65	664.73	664.78	664.84	664.88	664.94	664.99	665.06	665.11	665.15	665.18	665.21	665.24
	LEFT BANK	(m)	664.23	664.29	664.35	664.41	664.43	664.46	664.50	664.55	664.60	664.62	664.65	664.73	664.78	664.84	664.88	664.94	664.99	665.06	665.11	665.15	665.18	665.21	665.24
	HIGH WATER LEVEL	(m)	663.73	663.79	663.85	663.91	663.93	663.96	664.00	664.05	664.10	664.12	664.15	664.23	664.28	664.34	664.38	664.44	664.49	664.56	664.61	664.65	664.68	664.71	664.74
	CHANNEL BED	(m)	659.23	659.29	659.35	659.41	659.43	659.46	659.50	659.55	659.60	659.62	659.65	659.73	659.78	659.84	659.88	659.94	659.99	660.06	660.11	660.15	660.18	660.21	660.24
CUMULATIVE DISTANCE		(m)	7+307.78	7+368.87	7+429.04	7+478.83	7+502.72	7+527.59	7+562.90	7+619.05	7+659.86	7+684.57	7+709.57	7+785.03	7+835.03	7+888.04	7+930.90	7+985.16	8+034.41	8+099.90	8+147.28	8+179.82	8+209.31	8+238.26	8+273.32
DISTANCE		(m)	67.07	61.09	60.17	49.79	23.89	24.87	35.31	56.15	40.82	24.70	25.00	75.46	50.00	53.01	42.86	54.26	49.24	65.50	47.38	32.53	29.49	28.96	35.06
STATION NO.			JJ.18	JJ.19	JJ.20	JJ.21	JJ.22	JJ.23	JJ.24	JJ.25	JJ.26	JJ.27	JJ.28	JJ.29	JJ.30	JJ.31	J.32	J.32A	J.32B	JJ.33	JJ.34	JJ.35	JJ.36	JJ.37	JJ.38

PRESENT ELEVATION	RIGHT BANK	(m)	665.84	665.07	664.01	664.95	665.90	665.80	666.25	662.30	665.40	666.50	666.17	665.70	666.36	662.76	666.50
	LEFT BANK	(m)	664.94	665.18	665.47	664.41	665.90	665.60	665.99	661.87	665.88	666.36	666.17	666.20	662.40	666.56	665.51
	RIVER CHANNEL BED	(m)	665.71	665.23	665.30	662.75	664.09	661.13	666.21	661.72	665.67	666.33	662.78	662.57	665.72	665.72	665.90
DESIGN CHANNEL BED SLOPE																	
DESIGN ELEVATION	RIGHT BANK	(m)	665.30	665.34	665.38	665.42	665.47	665.52	665.56	665.60	665.65	665.75	665.80	665.86	665.90	665.96	665.99
	LEFT BANK	(m)	665.30	665.34	665.38	665.42	665.47	665.52	665.56	665.60	665.65	665.75	665.80	665.86	665.90	665.96	665.99
	HIGH WATER LEVEL	(m)	664.80	664.84	664.88	664.92	664.97	665.02	665.06	665.10	665.15	665.25	665.30	665.36	665.40	665.46	665.49
	CHANNEL BED	(m)	660.30	660.34	660.38	660.42	660.47	660.52	660.56	660.60	660.65	660.75	660.80	660.86	660.90	660.96	660.99
CUMULATIVE DISTANCE		(m)	8+327.96	8+363.88	8+399.50	8+442.62	8+484.39	8+537.13	8+571.32	8+614.40	8+660.18	8+753.05	8+799.98	8+858.74	8+901.05	8+951.71	8+986.54
DISTANCE		(m)	54.64	35.92	35.62	43.11	41.78	52.73	34.20	43.08	45..78	92.86	46.94	58.76	42.31	50.66	34.83
STATION NO.			JJ.39	JJ.40	JJ.41	JJ.42	JJ.43	JJ.44	JJ.45	JJ.46	JJ.47	JJ.48	JJ.49	JJ.50	JJ.50A	JJ.51	JJ.52

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CISANGKUY UPSTREAM RIVER (1/2)

DRAWING NO.
P00-070PF001



▨ = Revetment
▨ = Bed Channel
(L) = Left Side
(R) = Right Side

DATUM + 654

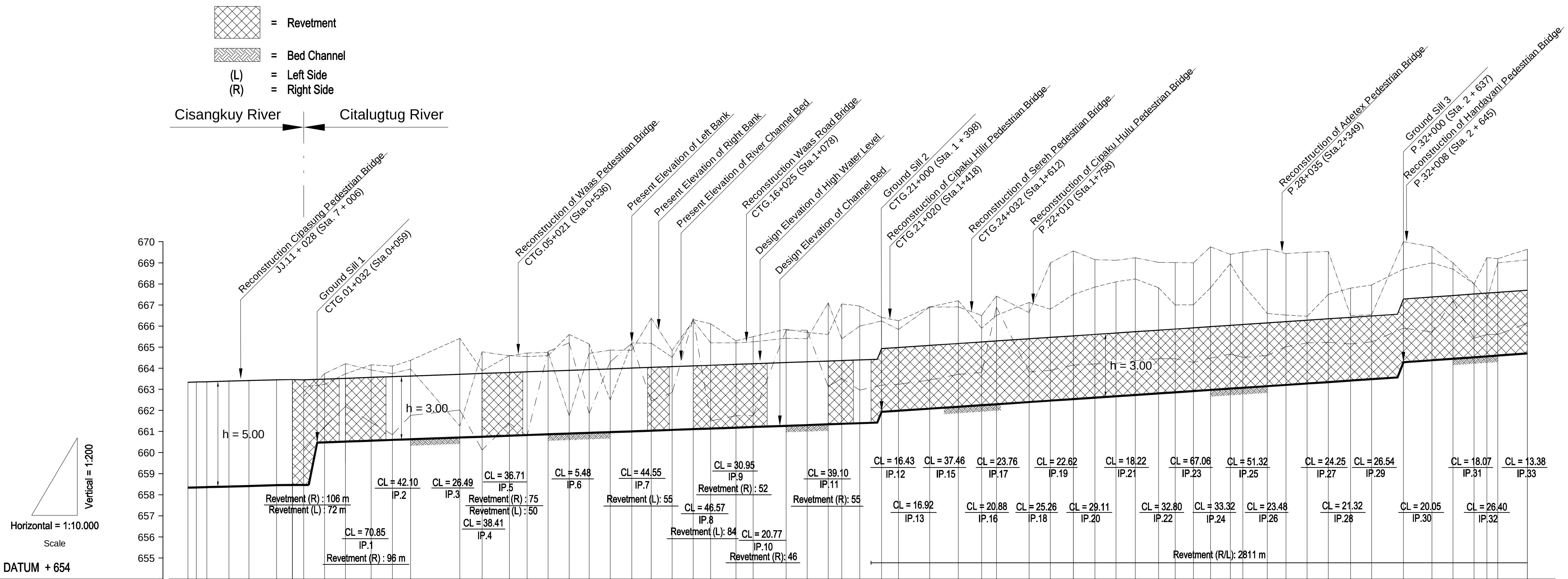
STATION NO.	DISTANCE (m)	CUMULATIVE DISTANCE (m)	PRESENT ELEVATION RIGHT BANK (m)	PRESENT ELEVATION LEFT BANK (m)	PRESENT ELEVATION RIVER CHANNEL BED (m)	DESIGN ELEVATION RIGHT BANK (m)	DESIGN ELEVATION LEFT BANK (m)	DESIGN ELEVATION HIGH WATER LEVEL (m)	DESIGN ELEVATION CHANNEL BED (m)
JJ.48	92.86	8+753.05	666.50	666.36	666.33	665.75	665.75	665.25	660.75
JJ.49	46.94	8+799.98	666.17	666.17	662.78	665.80	665.80	665.30	660.80
JJ.50	58.76	8+858.74	665.70	666.20	662.57	665.86	665.86	665.36	660.86
JJ.50A	42.31	8+901.05	666.36	662.40	665.72	665.90	665.90	665.40	660.90
JJ.51	50.66	8+951.71	662.76	666.56	665.72	665.96	665.96	665.46	660.96
JJ.52	34.83	8+986.54	666.50	665.51	665.90	665.99	665.99	665.49	660.99
JJ.53	84.86	9+071.40	663.33	666.95	666.74	666.08	666.08	665.58	661.08
JJ.54	51.16	9+122.56	667.01	666.78	664.04	666.14	666.14	665.64	661.14
JJ.54A	75.40	9+197.96	666.50	666.56	666.44	666.22	666.22	665.72	661.22
JJ.54B	35.60	9+233.57	666.54	666.31	664.76	666.25	666.25	665.75	661.25
JJ.55	34.18	9+267.75	666.60	666.59	662.90	666.29	666.29	665.79	661.29
JJ.56	43.54	9+311.28	665.53	665.50	661.62	666.34	666.34	665.84	661.34
JJ.57	65.83	9+377.11	665.37	667.63	663.50	666.41	666.41	665.91	661.41
JJ.58A	53.80	9+430.91	667.40	668.10	662.90	666.46	666.46	665.96	661.46
JJ.59A	57.11	9+488.02	667.35	667.07	662.55	666.52	666.52	666.02	661.52
JJ.60A	48.53	9+536.56	665.39	665.66	663.36	666.57	666.57	666.07	661.57
JJ.61	34.79	9+571.35	666.80	668.81	662.34	666.61	666.61	666.11	661.61
JJ.62	50.52	9+621.88	666.54	666.25	663.08	666.66	666.66	666.16	661.66
JJ.62A	53.53	9+675.41	666.48	666.56	663.65	666.72	666.72	666.22	661.72
JJ.63	67.41	9+742.81	667.67	666.24	663.26	666.79	666.79	666.29	661.79
JJ. 64	55.72	9+798.54	666.70	667.20	663.20	666.85	666.85	666.35	661.85
JJ. 65	59.45	9+857.99	666.60	667.20	663.15	666.91	666.91	666.41	661.91
JJ. 66	51.25	9+909.24	666.68	666.49	663.35	666.97	666.97	666.47	661.97
JJ. 68	44.30	9+953.54	666.97	667.09	666.59	667.01	667.01	666.51	662.01
JJ.69	55.50	10+009.04	666.80	667.40	667.13	667.07	667.07	666.57	662.07
JJ.70	37.60	10+046.64	662.80	668.74	667.60	667.11	667.11	666.61	662.11
JJ.70A	31.07	10+077.71	663.43	667.31	666.70	667.14	667.14	666.64	662.14
JJ.71A	36.61	10+114.32	663.31	667.27	666.14	667.18	667.18	666.68	662.18
JJ.72A	37.28	10+151.60	666.82	666.28	664.20	667.22	667.22	666.72	662.22
JJ.73	40.58	10+192.18	667.07	667.57	662.82	667.26	667.26	666.76	662.26
JJ.74A	68.36	10+260.54	667.20	666.50	663.81	667.34	667.34	666.84	662.34
JJ.74B	40.34	10+300.88	668.10	667.60	663.16	667.38	667.38	666.88	662.38
JJ.74C	43.08	10+343.96	667.20	667.05	664.00	667.42	667.42	666.92	662.42
J.133	44.05	10+388.01	666.96	668.43	663.36	667.47	667.47	666.97	662.47
J.86	32.86	10+420.87	666.90	666.91	663.38	667.50	667.50	667.00	662.50
J.134	26.78	10+447.65	667.40	665.23	666.90	667.53	667.53	667.03	662.53
J.135	26.37	10+474.02	667.38	667.28	667.33	667.56	667.56	667.06	662.56
JJ. 88	15.95	10+489.97	667.42	667.26	667.50	667.58	667.58	667.08	662.58
JJ. 89	45.84	10+535.81	667.32	667.13	667.42	667.63	667.63	667.13	662.63
JJ. 90	33.39	10+569.20	667.26	667.57	667.70	667.66	667.66	667.16	662.66
CO.16	125.20	10+694.40	667.60	667.90	667.50	667.79	667.79	667.29	662.79
J.146	86.83	10+781.22	667.73	667.80	667.70	667.88	667.88	667.38	662.88
J.147	50.96	10+832.18	667.49	667.91	664.52	667.94	667.94	667.44	662.94
J.148	33.99	10+866.17	667.28	667.32	663.95	667.97	667.97	667.47	662.97
J.149	55.99	10+922.16	668.85	668.27	662.70	668.03	668.03	667.53	663.03
J.150	49.74	10+971.90	667.03	667.35	663.62	668.08	668.08	667.58	663.08
J.151	44.26	11+016.16	667.90	667.98	663.98	668.13	668.13	667.63	663.13
J.152	47.98	11+064.14	666.59	667.88	663.50	668.18	668.18	667.68	663.18

DESIGN CHANNEL BED SLOPE: 1/950 0.0011

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CISANGKUY UPSTREAM RIVER (2/2)

DRAWING NO.
P00–070PF002



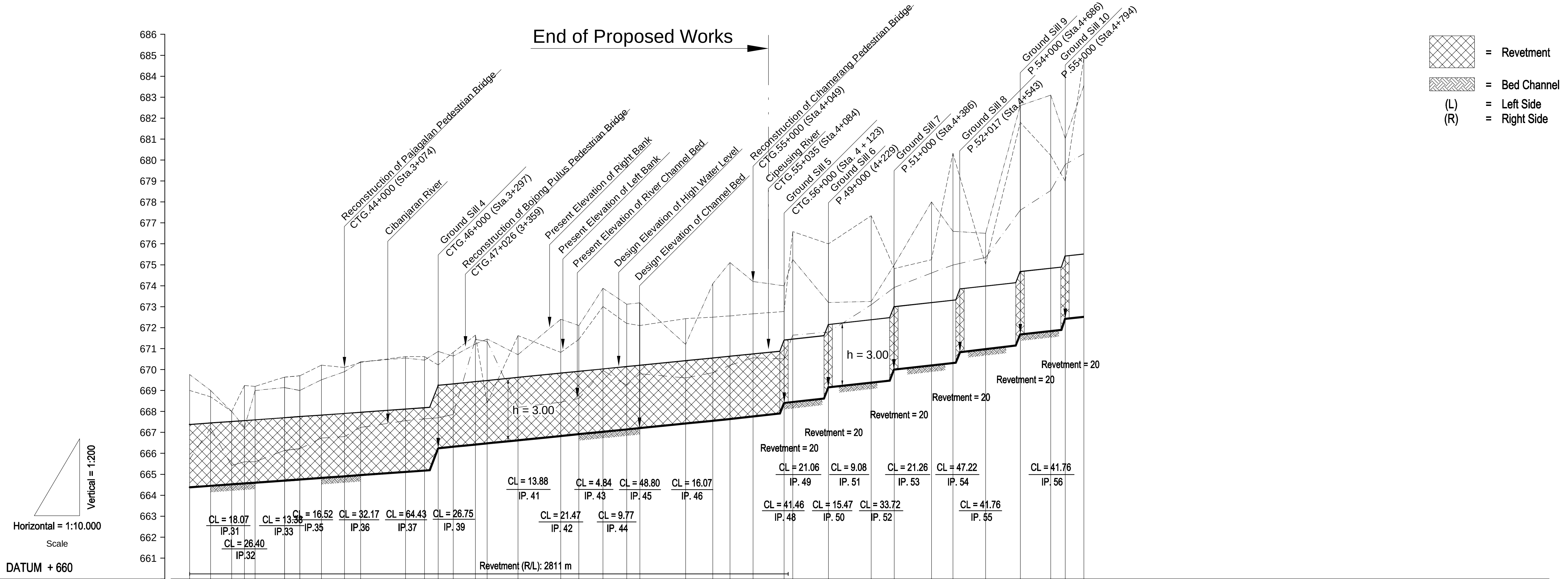
CHANNEL BED SLOPE: 1/1400 0.000714 · 1/1400 0.000714 · 1/750 0.001333 · 1/700 0.001429

STATION NO. (m)	DISTANCE (m)	ACCUMULATIVE DISTANCE (m)	DESIGN ELEVATION RIVER CHANNEL BED (m)	DESIGN ELEVATION DESIGN HIGH WATER (m)	DESIGN ELEVATION LEFT BANK (m)	DESIGN ELEVATION RIGHT BANK (m)	PRESENT ELEVATION RIVER CHANNEL BED (m)	PRESENT ELEVATION LEFT BANK (m)	PRESENT ELEVATION RIGHT BANK (m)
JJ8	28.96	6+908.65	659.33	663.33			662.30	662.50	662.10
JJ9	19.86	6+928.51	659.34	663.34			658.50	663.00	658.60
JJ10	24.95	6+953.45	659.36	663.36			659.50	663.70	662.40
JJ11	52.52	7+005.97	659.38	663.38			660.03	664.20	664.30
JJ12	47.50	7+053.47	659.41	663.41			659.76	664.30	663.70
JJ13	65.42	7+118.89	659.45	663.45			661.23	660.10	663.40
JJ14	37.59	7+156.48	659.47	663.47			659.20	660.43	660.56
CTG.01	26.89	0+026.89	659.47	663.47			660.07	663.11	662.67
CTG.01A	49.55	0+076.44	660.48	663.48			661.22	663.23	663.74
CTG.02	49.83	0+126.27	660.52	663.52			662.19	663.73	664.21
CTG.02A	60.96	0+187.23	660.56	663.56			661.42	664.15	663.91
CTG.02B	50.05	0+237.28	660.60	663.60			660.85	664.10	663.74
CTG.02C	43.38	0+280.66	660.63	663.63			661.76	664.37	663.96
CTG.03	116.78	0+397.44	660.71	663.71			662.01	665.41	661.25
CTG.04	52.71	0+450.15	660.75	663.75			660.12	663.88	664.78
CTG.05	64.97	0+515.12	660.79	663.79			661.38	664.60	664.59
CTG.06	41.94	0+557.05	660.82	663.82			660.80	664.55	664.72
CTG.07	50.04	0+607.09	660.86	663.86			664.80	664.60	664.75
CTG.08	50.04	0+657.13	660.90	663.90			665.20	665.60	661.75
CTG.09	47.10	0+704.23	660.93	663.93			661.85	665.15	664.70
CTG.10	50.05	0+754.28	660.97	663.97			664.30	662.50	664.86
CTG.11	51.13	0+805.41	661.00	664.00			665.18	665.20	664.85
CTG.12	46.35	0+851.76	661.03	664.03			662.45	665.18	666.37
CTG.13	49.58	0+901.33	661.07	664.07			662.85	664.52	664.85
CTG.14	50.00	0+951.33	661.11	664.11			666.35	666.30	666.25
CTG.15	41.54	0+992.88	661.14	664.14			661.50	666.11	665.20
CTG.16	60.05	1+052.93	661.18	664.18			661.75	665.30	665.20
P.10	40.51	1+093.44	661.21	664.21			661.75	665.50	665.25
CTG.17	78.10	1+171.54	661.26	664.26			665.80	665.85	665.42
CTG.18	50.01	1+221.55	661.30	664.30			665.80	665.70	665.40
CTG.19	50.01	1+271.56	661.33	664.33			663.14	665.60	667.10
CTG.20	32.19	1+303.75	661.36	664.36			663.52	667.05	665.40
CTG.20A	42.96	1+346.71	661.39	664.39			662.96	666.95	666.00
CTG.21	51.52	1+398.23	661.93	664.93			663.20	666.41	666.24
CTG.22	40.28	1+438.51	661.98	664.98			663.24	666.25	665.84
CTG.23	74.02	1+512.53	662.08	665.08			663.44	666.91	666.90
CTG.24	67.94	1+580.47	662.17	665.17			663.71	667.20	666.91
CTG.25	55.30	1+635.76	662.24	665.24			663.80	665.90	666.50
CTG.26	35.32	1+671.09	662.29	665.29			666.90	666.51	667.42
P.22	77.18	1+748.26	662.39	665.39			663.82	667.12	666.64
CTG.28	50.66	1+798.92	662.46	665.46			663.90	666.80	669.00
P.23	54.31	1+853.24	662.53	665.53			664.15	667.50	669.56
CTG.30	51.26	1+904.50	662.60	665.60			664.20	667.85	669.15
P.24	50.04	1+954.54	662.67	665.67			664.23	668.10	669.12
CTG.31	45.92	2+000.46	662.73	665.73			664.36	668.23	669.24
P.25	55.19	2+055.65	662.80	665.80			664.45	667.82	669.02
CTG.32	39.59	2+095.24	662.85	665.85			664.45	667.00	669.01
P.26	42.85	2+138.09	662.91	665.91			664.28	667.01	669.00
CTG.33	40.87	2+178.96	662.97	665.97			664.48	667.82	669.76
P.27	46.74	2+225.70	663.03	666.03			664.67	668.96	669.40
CTG.34	29.81	2+255.50	663.07	666.07			664.52	667.99	669.50
P.28	58.03	2+313.53	663.15	666.15			664.60	666.60	669.65
CTG.35	44.59	2+358.11	663.20	666.20			665.02	666.52	669.44
P.29	50.00	2+408.11	663.27	666.27			665.20	666.46	669.50
CTG.36	50.32	2+458.44	663.34	666.34			665.23	667.50	669.54
CTG.37	52.79	2+511.22	663.41	666.41			665.15	667.80	666.50
CTG.38	50.01	2+561.23	663.48	666.48			665.25	667.95	666.54
P.32	75.49	2+636.72	664.28	667.28			665.90	668.70	670.00
CTG.39	67.45	2+704.17	664.37	667.37			665.72	669.00	669.76
CTG.40	50.01	2+754.18	664.44	667.44			667.21	668.70	669.00
CTG.41	50.07	2+804.25	664.52	667.52			665.42	668.00	668.00
P.34	30.62	2+834.88	664.56	667.56			665.60	669.24	667.24
CTG.42	25.58	2+860.45	664.60	667.60			665.60	669.20	669.00
P.35	70.29	2+930.74	664.70	667.70			666.14	669.64	669.14

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CITALUGTUG RIVER (1/2)

DRAWING NO.
P00-080PF001



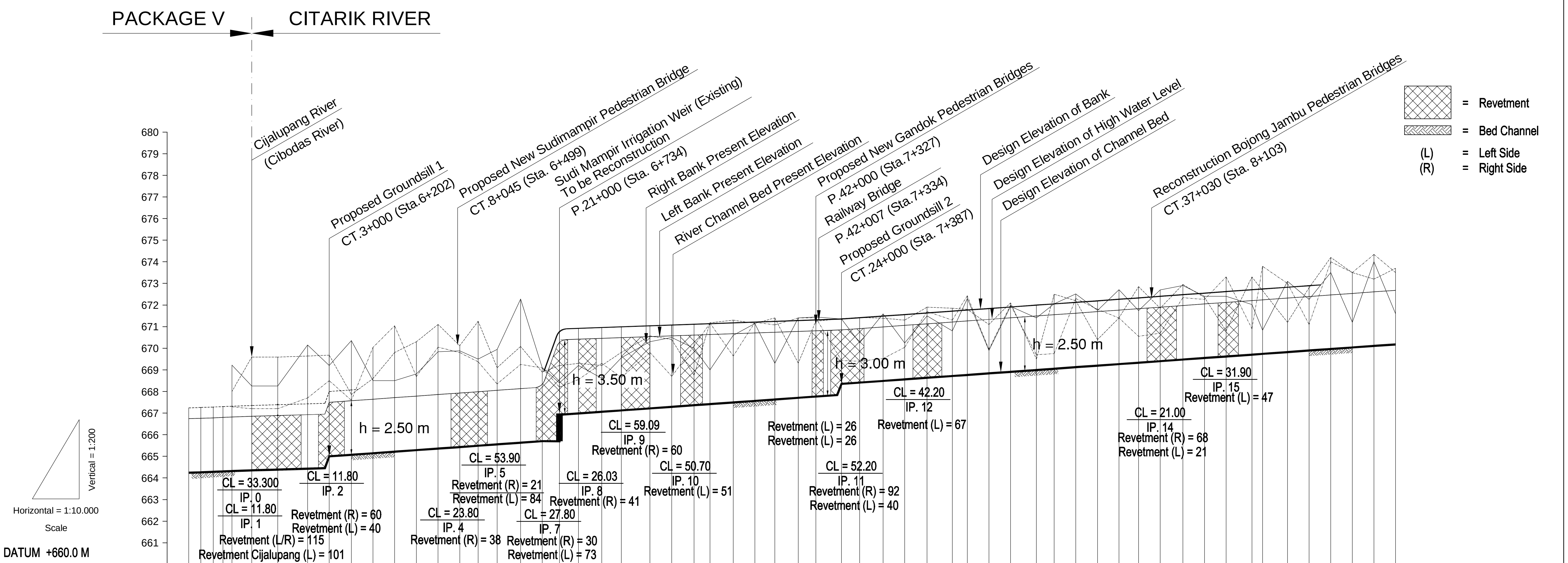
		CTG.39	CTG.40	CTG.41	P.34	CTG.42	P.35	CTG.43	P.36	CTG.44	P.37	CTG.45	CTG.45A	CTG.46	CTG.47	CTG.48	CTG.49	CTG.50	P.42	CTG.51
PRESENT ELEVATION	RIGHT BANK (m)	669.76	669.00	668.00	667.24	669.00	669.14	669.00	669.51	669.90	670.37	670.55	670.45	670.86	670.64	671.22	671.46	670.71	672.40	672.10
	LEFT BANK (m)	669.00	668.70	668.00	669.24	669.20	669.64	669.70	670.21	670.10	670.34	670.62	670.62	670.22	670.82	671.64	668.40	671.62	670.82	671.44
	RIVER CHANNEL BED (m)	665.72	667.21	665.42	665.60	665.60	666.14	666.22	666.73	666.80	667.24	667.56	667.65	667.70	667.86	671.44	671.34	668.20	668.44	668.62
CHANNEL BED SLOPE								1/700 0.001429												
DESIGN ELEVATION	RIGHT BANK (m)																			
	LEFT BANK (m)																			
	DESIGN HIGH WATER (m)	667.37	667.44	667.52	667.56	667.60	667.70	667.75	667.82	667.90	667.96	668.11	669.17	669.24	669.31	669.42	669.47	669.62	669.82	669.91
	RIVER CHANNEL BED (m)	664.37	664.44	664.52	664.56	664.60	664.70	664.75	664.82	664.90	664.96	665.11	666.17	666.24	666.31	666.42	666.47	666.62	666.82	666.91
ACCUMULATIVE DISTANCE (m)		2+704.17	2+754.18	2+804.25	2+834.88	2+860.45	2+930.74	2+966.97	3+018.56	3+073.66	3+112.15	3+219.38	3+264.45	3+297.21	3+333.07	3+386.17	3+414.13	3+487.74	3+589.69	3+633.13
DISTANCE (m)		67.45	50.01	50.07	30.62	25.58	70.29	36.23	51.59	55.10	38.49	107.22	45.07	32.76	35.86	53.10	27.95	73.61	101.95	43.44
STATION NO. (m)		CTG.39	CTG.40	CTG.41	P.34	CTG.42	P.35	CTG.43	P.36	CTG.44	P.37	CTG.45	CTG.45A	CTG.46	CTG.47	CTG.48	CTG.49	CTG.50	P.42	CTG.51

		P.43	CTG.52	CTG.53	P.45	CTG.54	P.46	CTG.55	CTG.56	P.48	P.49	CTG.57	P.51	CTG.58	P.52	P.53	P.54	CTG.59	P.55	CTG.60
PRESENT ELEVATION	RIGHT BANK (m)	673.88	673.12	673.18	671.20	674.10	675.11	674.20	674.00	675.25	673.20	673.25	675.00	678.00	676.60	676.50	682.60	683.10	681.03	683.55
	LEFT BANK (m)	673.01	672.20	672.10	672.43	672.50	672.56	672.66	672.77	676.58	676.00	677.34	674.82	675.24	680.32	675.03	681.80	680.22	678.99	684.85
	RIVER CHANNEL BED (m)	669.96	669.25	669.80	669.60	669.85	670.20	670.56	670.51	671.64	671.79	673.09	673.92	674.61	674.99	675.35	677.61	678.54	679.79	680.29
CHANNEL BED SLOPE		1/500 0.002												1/450 0.002222						
DESIGN ELEVATION	RIGHT BANK (m)																			
	LEFT BANK (m)																			
	DESIGN HIGH WATER (m)	670.03	670.14	670.20	670.42	670.55	670.63	670.74	671.41	671.46	672.15	672.35	673.00	673.20	673.83	673.99	674.67	674.84	675.41	675.51
	RIVER CHANNEL BED (m)	667.03	667.14	667.20	667.42	667.55	667.63	667.74	668.41	668.46	669.15	669.38	670.00	670.20	670.83	670.99	671.67	671.84	672.41	672.51
ACCUMULATIVE DISTANCE (m)		3+690.49	3+747.24	3+778.44	3+887.62	3+952.64	3+993.46	4+048.67	4+122.58	4+143.48	4+228.77	4+330.78	4+385.57	4+474.45	4+525.67	4+603.56	4+686.48	4+759.23	4+793.82	4+838.05
DISTANCE (m)		57.36	56.75	31.20	109.18	65.01	40.83	55.21	73.91	20.90	85.29	102.00	54.79	88.87	51.22	77.89	82.92	72.75	34.59	44.23
STATION NO. (m)		P.43	CTG.52	CTG.53	P.45	CTG.54	P.46	CTG.55	CTG.56	P.48	P.49	CTG.57	P.51	CTG.58	P.52	P.53	P.54	CTG.59	P.55	CTG.60

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CITALUGTUG RIVER (2/2)

DRAWING NO.
P00-080PF002



PRESENT ELEVATION	RIGHT BANK (m)					669.22	668.25	668.25	670.15	669.20	670.35	668.50	668.50	668.81	669.84	669.88
	LEFT BANK (m)					668.00	669.59	669.59	669.64	669.68	667.86	668.60	669.80	670.30	671.10	670.12
	RIVER CHANNEL BED (m)					667.29	667.20	667.20	667.70	668.50	667.59	670.04	671.04	668.69	670.05	669.80
CHANNEL BED SLOPE (m)																
DESIGN ELEVATION	RIGHT BANK (m)															
	LEFT BANK (m)															
	DESIGN HIGH WATER (m)	666.74	666.76	666.78	666.80	666.81	666.85	666.88	666.92	667.49	667.57	667.64	667.71	667.78	667.85	667.92
	RIVER CHANNEL BED (m)	664.24	664.26	664.28	664.30	664.31	664.35	664.38	664.42	664.99	665.07	665.14	665.21	665.28	665.35	665.42
ACCUMULATIVE DISTANCE (m)		5+908.69	5+936.53	5+965.35	5+987.91	6+008.53	6+054.45	6+101.47	6+152.44	6+202.44	6+253.67	6+303.67	6+353.67	6+403.80	6+454.05	6+504.06
DISTANCE (m)		29.62	27.84	28.82	22.56	20.62	45.92	59.95	69.09	50.00	51.23	50.00	50.00	50.13	50.25	50.00
STATION NO. (m)		N.135.	N.136	N.137	N.137.A	CT.0	CT.1	P.O	CT.2	CT.3	CT.4	CT.5	CT.6	CT.7	CT.8	CT.9

PRESENT ELEVATION	RIGHT BANK (m)	669.50	669.95	672.28	669.10	668.40	669.20	668.61	669.56	670.30	670.50	670.00	669.00	670.60	671.14	669.30
	LEFT BANK (m)	671.25	669.10	670.08	668.90	669.20	669.30	669.20	669.81	670.57	670.40	668.75	671.18	671.30	671.15	671.40
	RIVER CHANNEL BED (m)	669.37	668.35	669.25	669.09	668.20	668.55	669.30	668.65	669.80	668.70	670.10	671.16	669.64	671.20	671.08
CHANNEL BED SLOPE (m)				1/700 0.001429												
DESIGN ELEVATION	RIGHT BANK (m)				668.70	670.95	670.95	670.95	670.99	671.03	671.06	671.12	671.13	671.17	671.20	671.23
	LEFT BANK (m)				668.70	670.95	670.95	670.95	670.99	671.03	671.06	671.12	671.13	671.17	671.20	671.23
	DESIGN HIGH WATER (m)	667.99	668.05	668.13	668.20	670.45	670.45	670.45	670.49	670.53	670.56	670.62	670.63	670.67	670.70	670.73
	RIVER CHANNEL BED (m)	665.49	665.55	665.63	665.70	666.98	666.98	667.05	667.12	667.21	667.28	667.36	667.41	667.49	667.56	667.62
ACCUMULATIVE DISTANCE (m)		6+546.68	6+590.47	6+644.68	6+694.68	6+734.49	6+778.48	6+832.29	6+877.76	6+943.82	6+994.24	7+045.62	7+082.65	7+136.38	7+186.38	7+232.35
DISTANCE (m)		42.63	43.79	54.21	50.00	39.81	43.99	53.81	45.47	66.06	50.42	51.38	37.03	53.74	50.00	45.97
STATION NO. (m)		CT.10	CT.11	CT.12	CT.13	P.21	CT.14	P.23	CT.15	CT.16	CT.17	CT.18	CT.19	CT.20	CT.21	CT.22

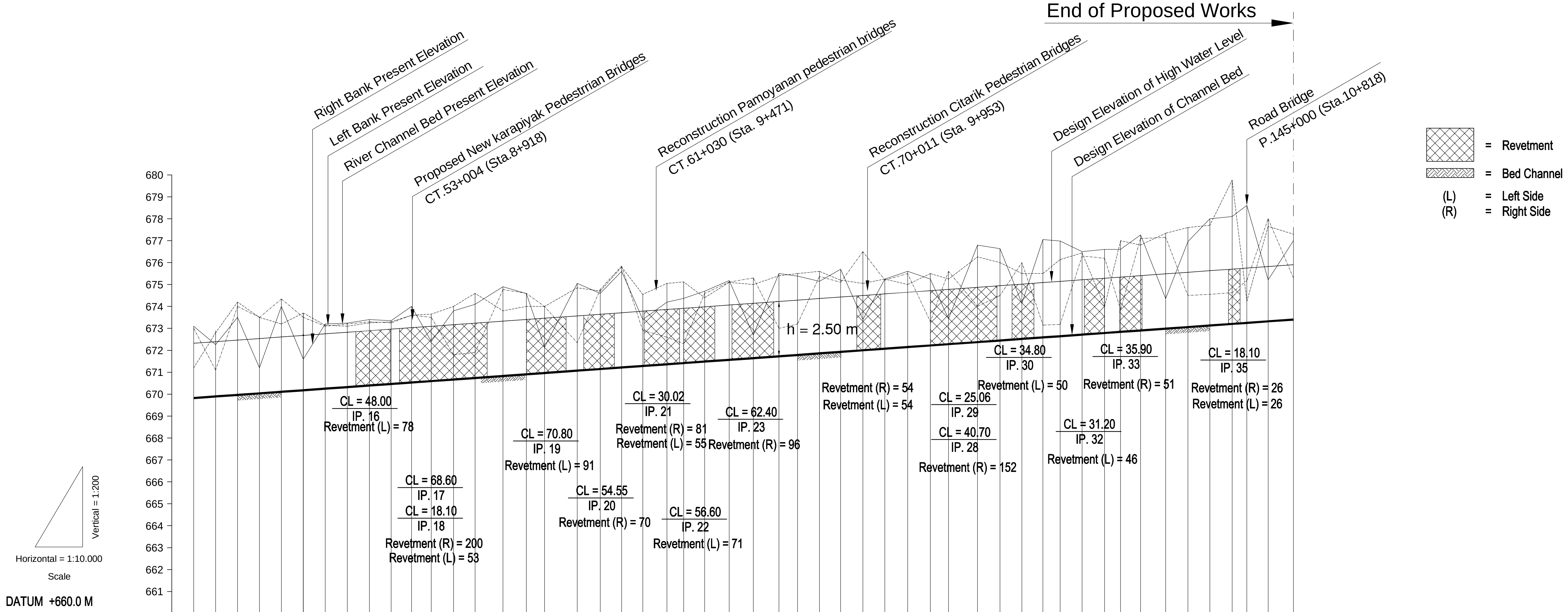
PRESENT ELEVATION	RIGHT BANK (m)	671.40	671.45	671.35	670.25	671.59	670.24	671.50	670.80	672.30	669.90	671.94	671.40	672.06	672.51	671.75
	LEFT BANK (m)	669.31	671.25	671.37	671.42	671.39	671.30	671.90	671.85	671.80	671.10	672.10	669.50	672.50	672.20	670.40
	RIVER CHANNEL BED (m)	671.40	671.41	669.43	669.40	669.52	670.04	671.70	671.30	672.43	669.95	672.00	669.70	669.75	672.30	671.80
CHANNEL BED SLOPE (m)																1/650 0.001538
DESIGN ELEVATION	RIGHT BANK (m)	671.27	671.30	671.35	671.41	671.48	671.55	671.63	671.71	671.76	671.83	671.90	671.99	672.05	672.12	672.19
	LEFT BANK (m)	671.27	671.30	671.35	671.41	671.48	671.55	671.63	671.71	671.76	671.83	671.90	671.99	672.05	672.12	672.19
	DESIGN HIGH WATER (m)	670.77	670.80	670.85	670.91	670.98	671.05	671.13	671.21	671.26	671.33	671.40	671.49	671.55	671.62	671.69
	RIVER CHANNEL BED (m)	667.70	667.76	668.35	668.41	668.48	668.55	668.63	668.71	668.76	668.83	668.90	668.99	669.05	669.12	669.19
ACCUMULATIVE DISTANCE (m)		7+286.61	7+327.08	7+386.61	7+428.52	7+482.49	7+532.49	7+584.22	7+642.78	7+677.18	7+727.18	7+777.18	7+837.18	7+878.20	7+928.20	7+978.20
DISTANCE (m)		54.25	40.47	59.53	41.91	53.97	50.00	51.73	58.56	34.40	50.00	50.00	59.99	41.02	50.00	50.00
STATION NO. (m)		CT.23	P.42	CT.24	CT.25	CT.26	CT.27	CT.28	CT.29	CT.30	CT.31	CT.32	CT.33	CT.34	CT.35	CT.36

PRESENT ELEVATION	RIGHT BANK (m)	672.71	671.74	672.70	672.90	672.40	672.40	672.02	670.84	673.10	672.26	673.50	671.20	674.00	671.60
	LEFT BANK (m)	671.40	672.85	671.85	672.95	672.35	670.80	673.30	672.67	671.20	672.80	674.20	673.50	673.20	673.70
	RIVER CHANNEL BED (m)	671.40	670.55	670.70	672.34	672.26	673.30	670.90	673.79	673.00	671.10	674.00	673.50	674.34	673.50
CHANNEL BED SLOPE (m)															
DESIGN ELEVATION	RIGHT BANK (m)	672.26	672.33	672.40	672.47	672.54	672.62	672.70	672.74	672.82	672.89	672.96			
	LEFT BANK (m)	672.26	672.33	672.40	672.47	672.54	672.62	672.70	672.74	672.82	672.89	672.96			
	DESIGN HIGH WATER (m)	671.76	671.83	671.90	671.97	672.04	672.12	672.20	672.24	672.32	672.39	672.46	672.53	672.60	672.67
	RIVER CHANNEL BED (m)	669.26	669.33	669.40	669.47	669.54	669.62	669.70	669.74	669.82	669.89	669.96	670.03	670.10	670.17
ACCUMULATIVE DISTANCE (m)		8+027.80	8+073.20	8+123.20	8+175.52	8+225.52	8+275.52	8+335.28	8+359.68	8+417.30	8+467.30	8+517.30	8+567.30	8+617.30	8+667.30
DISTANCE (m)		49.60	45.40	50.00	52.32	50.00	50.00	59.76	24.40	57.62	50.00	50.00	50.00	50.00	50.00
STATION NO. (m)		P.70	CT.37	CT.38	CT.39	CT.40	CT.41	CT.42	P.79	CT.43	CT.44	CT.45	CT.46	CT.47	CT.48

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CITARIK UPSTREAM RIVER (1/2)

DRAWING NO.
P00-020PF001



PRESENT ELEVATION	RIGHT BANK	(m)	673.10	672.26	673.50	671.20	674.00	671.60	673.20	673.24	673.40	673.35	674.00	672.40	673.80
	LEFT BANK	(m)	671.20	672.80	674.20	673.50	673.20	673.70	673.14	673.10	673.25	673.30	673.60	673.65	674.00
	RIVER CHANNEL BED	(m)	673.00	671.10	674.00	673.50	674.34	673.50	673.10	673.20	673.30	673.25	673.60	673.50	671.80
CHANNEL BED SLOPE		(m)													
DESIGN ELEVATION	RIGHT BANK	(m)													
	LEFT BANK	(m)													
	DESIGN HIGH WATER	(m)	672.32	672.39	672.46	672.53	672.60	672.67	672.75	672.82	672.89	672.96	673.03	673.09	673.16
	RIVER CHANNEL BED	(m)	669.82	669.89	669.96	670.03	670.10	670.17	670.25	670.32	670.39	670.46	670.53	670.59	670.66
ACCUMULATIVE DISTANCE		(m)	8+417.30	8+467.30	8+517.30	8+567.30	8+617.30	8+667.30	8+717.30	8+767.30	8+817.66	8+867.46	8+913.74	8+958.92	9+009.52
DISTANCE		(m)	57.62	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.35	49.81	46.28	45.17	50.60
STATION NO.		(m)	CT.43	CT.44	CT.45	CT.46	CT.47	CT.48	CT.49	CT.50	CT.51	CT.52	CT.53	CT.54	CT.55

PRESENT ELEVATION	RIGHT BANK	(m)	674.10	674.90	674.59	672.14	675.05	674.60	675.60	673.40	674.20	674.37	674.70	675.18	672.70
	LEFT BANK	(m)	674.60	673.80	674.00	674.00	674.85	674.70	675.80	674.55	675.05	675.12	674.40	675.10	675.00
	RIVER CHANNEL BED	(m)	671.90	674.77	674.60	674.00	672.34	674.78	675.84	672.90	672.60	672.30	674.60	675.11	675.30
CHANNEL BED SLOPE		(m)													
DESIGN ELEVATION	RIGHT BANK	(m)													
	LEFT BANK	(m)													
	DESIGN HIGH WATER	(m)	673.23	673.32	673.40	673.46	673.57	673.64	673.71	673.78	673.86	673.91	673.98	674.06	674.14
	RIVER CHANNEL BED	(m)	670.73	670.82	670.90	670.96	671.07	671.14	671.21	671.28	671.36	671.41	671.48	671.56	671.64
ACCUMULATIVE DISTANCE		(m)	9+058.65	9+122.42	9+175.49	9+216.88	9+291.50	9+344.10	9+392.68	9+440.94	9+495.96	9+534.08	9+582.10	9+637.88	9+692.98
DISTANCE		(m)	49.13	63.76	53.07	41.40	74.61	52.60	48.58	48.26	55.03	38.12	48.02	55.77	55.10
STATION NO.		(m)	CT.56	P.102	CT.57	CT.58	P.106	CT.59	CT.60	CT.61	CT.62	CT.63	CT.64	CT.65	P.118

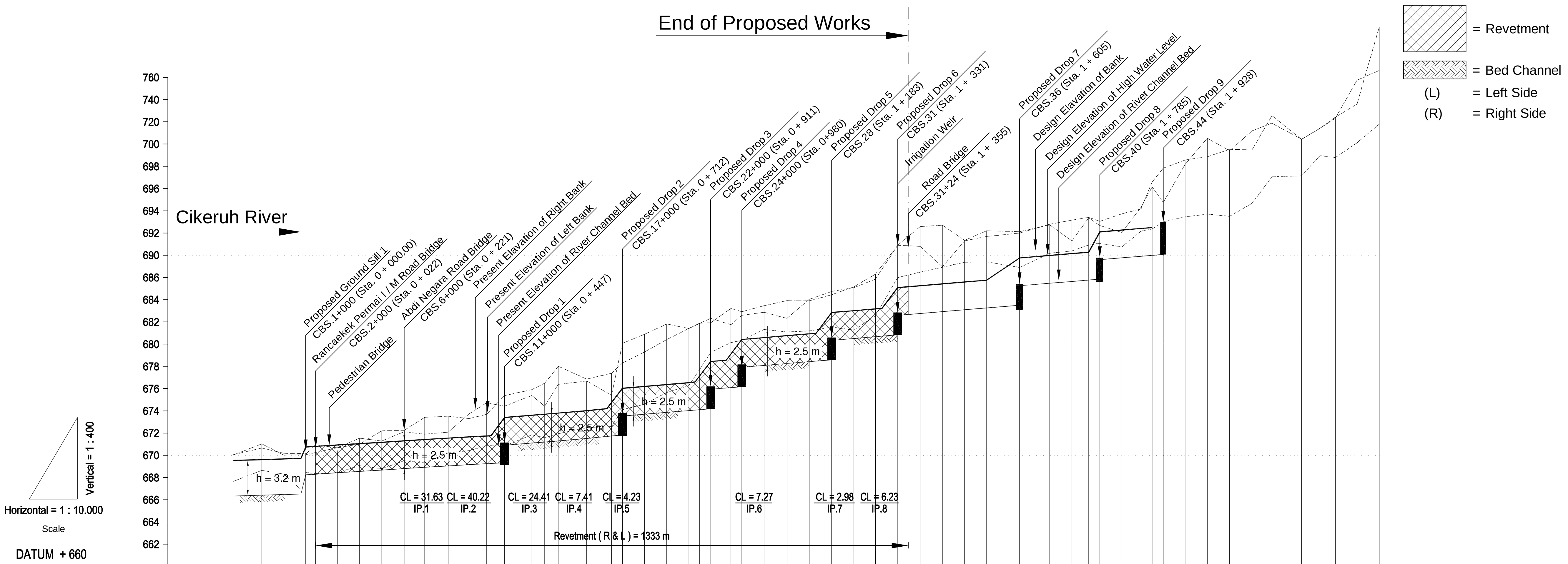
PRESENT ELEVATION	RIGHT BANK	(m)	675.50	675.38	675.15	675.70	673.40	675.25	675.60	675.25	673.44	676.80	676.64	674.14	677.05
	LEFT BANK	(m)	675.40	675.50	675.60	675.20	675.05	675.25	675.00	675.50	675.25	676.26	676.00	675.50	675.50
	RIVER CHANNEL BED	(m)	673.00	673.20	675.37	675.10	676.50	675.20	675.50	673.30	675.60	674.00	674.50	676.00	673.15
CHANNEL BED SLOPE		(m)	1/650 0.001538												
DESIGN ELEVATION	RIGHT BANK	(m)													
	LEFT BANK	(m)													
	DESIGN HIGH WATER	(m)	674.22	674.28	674.36	674.42	674.50	674.57	674.64	674.72	674.78	674.87	674.94	675.01	675.08
	RIVER CHANNEL BED	(m)	671.72	671.78	671.86	671.92	672.00	672.07	672.14	672.22	672.28	672.37	672.44	672.51	672.58
ACCUMULATIVE DISTANCE		(m)	9+751.42	9+793.63	9+843.62	9+891.96	9+942.63	9+992.67	10+044.68	10+096.54	10+137.95	10+203.98	10+255.13	10+305.19	10+353.13
DISTANCE		(m)	58.44	42.21	49.99	48.34	50.66	50.04	52.01	51.86	41.41	66.03	51.15	50.05	47.94
STATION NO.		(m)	CT.66	CT.67	CT.68	CT.69	CT.70	CT.71	CT.72	CT.73	CT.74	P.130	CT.75	CT.76	CT.77

PRESENT ELEVATION	RIGHT BANK	(m)	676.98	676.50	676.60	676.60	677.26	674.36	676.96	678.00	678.10	678.61	675.21	677.00
	LEFT BANK	(m)	676.14	676.44	674.00	677.00	676.80	677.34	677.60	677.70	679.76	674.23	677.65	677.30
	RIVER CHANNEL BED	(m)	673.18	676.30	676.20	673.86	677.10	677.15	674.50	674.55	674.63	675.18	678.00	675.30
CHANNEL BED SLOPE		(m)												
DESIGN ELEVATION	RIGHT BANK	(m)												
	LEFT BANK	(m)												
	DESIGN HIGH WATER	(m)	675.14	675.21	675.28	675.34	675.40	675.48	675.55	675.63	675.70	675.75	675.82	675.90
	RIVER CHANNEL BED	(m)	672.64	672.71	672.78	672.84	672.90	672.98	673.05	673.13	673.20	673.25	673.32	673.40
ACCUMULATIVE DISTANCE		(m)	10+392.19	10+442.28	10+493.66	10+530.10	10+575.42	10+632.86	10+683.43	10+733.43	10+784.28	10+817.94	10+866.28	10+924.11
DISTANCE		(m)	39.07	50.09	51.38	36.44	45.32	57.44	50.57	50.00	50.84	33.67	48.34	57.83
STATION NO.		(m)	P.134	CT.78	CT.79	P.138A	CT.80	CT.81	CT.82	CT.83	CT.84	P.145	CT.85	CT.86

SCALE V 1 : 200
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CITARIK UPSTREAM RIVER (2/2)

DRAWING NO.
P00-020PF002



PRESENT ELEVATION	RIGHT BANK (m)	670.01	671.03	670.01	670.05	670.09	670.95	670.67	671.54	671.28	672.12	671.90	672.08
	LEFT BANK (m)	670.05	670.65	670.18	670.15	670.05	670.25	670.68	671.00	672.20	672.25	673.41	673.52
	RIVER CHANNEL BED (m)	667.65	668.64	668.30	666.92	668.45	668.34	668.43	669.07	668.79	669.51	669.32	670.21
	DESIGN CHANNEL BED SLOPE		1/800 0.00125								1/400 0.0025		
DESIGN ELEVATION	RIGHT BANK (m)	670.82	670.90	670.96	671.01	671.24	671.30	671.42	671.54	671.67	671.79	671.91	672.04
	LEFT BANK (m)	670.03	670.11	670.17	670.22	671.24	671.30	671.42	671.54	671.67	671.79	671.91	672.04
	HIGH WATER LEVEL (m)	669.53	669.61	669.67	669.72	670.74	670.80	670.92	671.04	671.17	671.29	671.41	671.54
	CHANNEL BED (m)	666.33	666.41	666.47	666.52	668.24	668.30	668.42	668.54	668.67	668.79	668.91	669.04
	CUMULATIVE DISTANCE (m)	6+208.71	6+273.67	6+323.30	6+361.60	0+000.00	0+022.22	0+071.22	0+120.91	0+171.02	0+221.40	0+267.49	0+320.42
	DISTANCE (m)	39.71	64.96	49.63	38.30	10.59	22.22	49.00	49.70	50.11	50.38	46.09	52.92
	STATION NO.	CKR.142A	CKR.143A	CKR.144A	CKR.145A	CBS.1	CBS.2	CBS.3	CBS.4	CBS.5	CBS.6	CBS.7	CBS.8

PRESENT ELEVATION	RIGHT BANK (m)	673.72	674.72	674.42	675.38	674.42	676.38	676.69	675.40	680.08	680.88	681.81	681.41
	LEFT BANK (m)	673.30	673.69	675.37	675.91	676.48	678.01	676.86	677.38	678.29	679.29	680.41	681.42
	RIVER CHANNEL BED (m)	670.42	670.86	670.84	671.84	671.57	671.94	672.48	672.58	674.10	674.60	675.65	676.28
	DESIGN CHANNEL BED SLOPE												
DESIGN ELEVATION	RIGHT BANK (m)	672.16	672.26	673.89	674.10	674.19	674.29	674.51	675.25	676.52	676.69	676.86	677.02
	LEFT BANK (m)	672.16	672.26	673.89	674.10	674.19	674.29	674.51	675.25	676.52	676.69	676.86	677.02
	HIGH WATER LEVEL (m)	671.66	671.76	673.39	673.60	673.69	673.79	674.01	674.75	676.02	676.19	676.36	676.52
	CHANNEL BED (m)	669.16	669.26	670.89	671.10	671.19	671.29	671.51	672.25	673.52	673.69	673.86	674.02
	CUMULATIVE DISTANCE (m)	0+367.13	0+406.77	0+446.91	0+508.47	0+537.34	0+567.83	0+631.50	0+687.62	0+712.05	0+761.64	0+811.76	0+861.56
	DISTANCE (m)	46.71	39.64	40.14	61.56	28.86	30.49	63.67	56.12	24.43	49.59	50.13	49.79
	STATION NO.	CBS.9	CBS.10	CBS.11	CBS.12	CBS.13	CBS.14	CBS.15	CBS.16	CBS.17	CBS.18	CBS.19	CBS.20

PRESENT ELEVATION	RIGHT BANK (m)	681.89	681.92	683.21	682.92	683.46	683.91	683.90	684.44	685.16	686.30	688.89	690.57
	LEFT BANK (m)	681.87	682.32	681.75	682.59	682.87	682.32	684.03	684.74	685.08	685.85	688.90	688.80
	RIVER CHANNEL BED (m)	677.72	679.26	680.14	680.34	681.32	681.09	681.19	681.54	681.26	682.56	685.99	686.48
	DESIGN CHANNEL BED SLOPE							1/300 0.0033					
DESIGN ELEVATION	RIGHT BANK (m)	677.63	678.93	679.62	680.92	681.08	681.26	681.42	683.34	683.51	683.67	685.58	685.75
	LEFT BANK (m)	677.63	678.93	679.62	680.92	681.08	681.26	681.42	683.34	683.51	683.67	685.58	685.75
	HIGH WATER LEVEL (m)	677.13	678.43	679.12	680.42	680.58	680.76	680.92	682.84	683.01	683.17	685.08	685.25
	CHANNEL BED (m)	674.63	675.93	676.62	677.92	678.08	678.26	678.42	680.34	680.51	680.67	682.58	682.75
	CUMULATIVE DISTANCE (m)	0+885.51	0+910.50	0+955.91	0+980.38	1+030.45	1+082.03	1+132.14	1+182.53	1+232.33	1+280.94	1+330.86	1+381.31
	DISTANCE (m)	23.95	24.99	45.41	24.47	50.07	51.58	50.10	50.39	49.80	48.61	49.92	50.45
	STATION NO.	CBS.21	CBS.22	CBS.23	CBS.24	CBS.25	CBS.26	CBS.27	CBS.28	CBS.29	CBS.30	CBS.31	CBS.32

PRESENT ELEVATION	RIGHT BANK (m)	690.71	689.34	690.20	690.12	690.73	689.28	691.37	690.67	690.05	692.32	694.15	692.76
	LEFT BANK (m)	686.96	689.30	689.69	689.99	690.79	691.16	691.40	691.05	691.73	692.17	694.59	695.83
	RIVER CHANNEL BED (m)	686.92	687.37	687.40	686.89	688.18	688.38	688.92	689.07	688.74	690.17	690.36	691.00
	DESIGN CHANNEL BED SLOPE												
DESIGN ELEVATION	RIGHT BANK (m)	685.92	686.09	686.25	688.25	688.47	688.64	688.76	690.60	690.76	690.91	690.99	
	LEFT BANK (m)	685.92	686.09	686.25	688.25	688.47	688.64	688.76	690.60	690.76	690.91	690.99	
	HIGH WATER LEVEL (m)	685.42	685.59	685.75	687.75	687.97	688.14	688.26	690.10	690.26	690.41	690.49	
	CHANNEL BED (m)	682.92	683.09	683.25	685.25	685.47	685.64	685.76	687.60	687.76	687.91	687.99	691.00
	CUMULATIVE DISTANCE (m)	1+431.56	1+481.32	1+531.03	1+605.06	1+672.73	1+722.65	1+760.22	1+785.21	1+835.08	1+877.82	1+902.91	1+928.10
	DISTANCE (m)	50.25	49.76	49.71	74.03	67.67	49.92	37.57	24.99	49.87	42.74	25.09	25.19
	STATION NO.	CBS.33	CBS.34	CBS.35	CBS.36	CBS.37	CBS.38	CBS.39	CBS.40	CBS.41	CBS.42	CBS.43	CBS.44

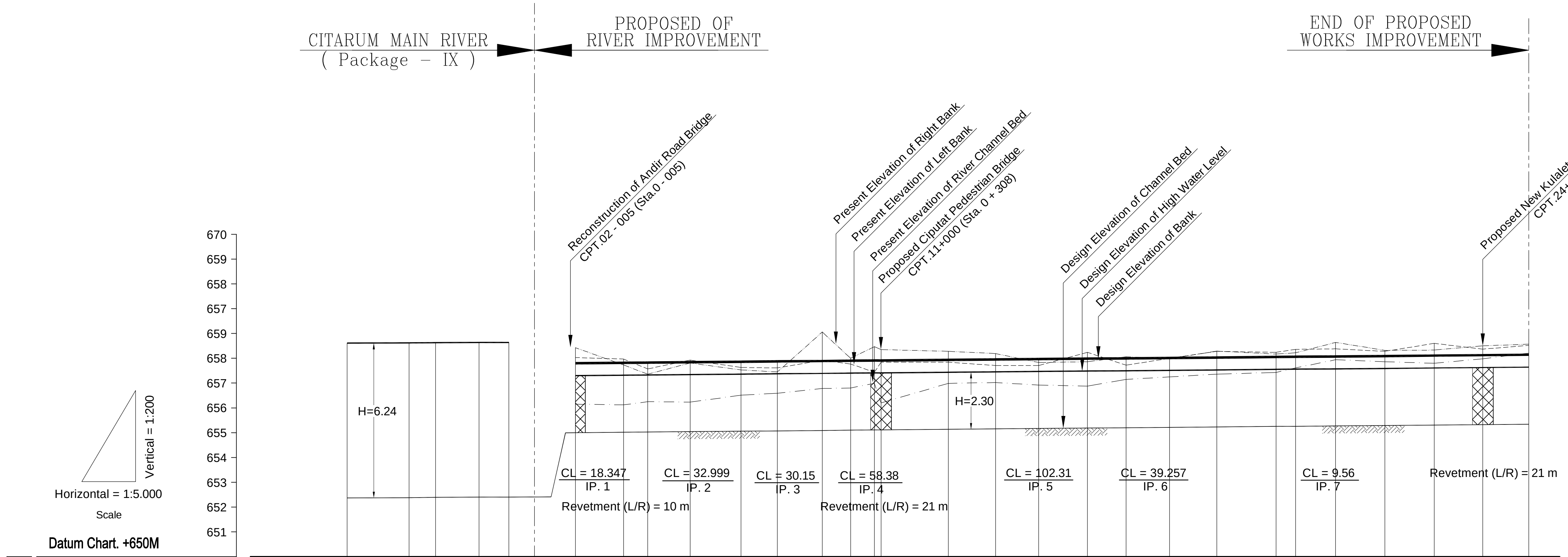
PRESENT ELEVATION	RIGHT BANK (m)	696.17	698.53	697.41	699.19	699.88	698.44	699.42	700.33	703.75	704.62
	LEFT BANK (m)	696.57	696.86	697.53	697.48	700.56	698.42	699.42	700.42	701.60	708.51
	RIVER CHANNEL BED (m)	691.45	691.70	691.50	692.67	695.06	695.14	696.96	696.79	698.11	699.79
	DESIGN CHANNEL BED SLOPE										
DESIGN ELEVATION	RIGHT BANK (m)										
	LEFT BANK (m)										
	HIGH WATER LEVEL (m)										
	CHANNEL BED (m)										
	CUMULATIVE DISTANCE (m)	1+976.99	2+026.96	2+077.02	2+127.56	2+172.32	2+238.84	2+280.35	2+314.95	2+363.40	2+413.36
	DISTANCE (m)	48.89	49.97	50.06	50.54	44.76	66.52	41.51	34.60	48.45	49.96
	STATION NO.	CBS.45	CBS.46	CBS.47	CBS.48	CBS.49	CBS.50	CBS.51	CBS.52	CBS.53	CBS.54

SCALE V 1 : 400
SCALE H 1 : 10000

LONGITUDINAL PROFILE OF CIBEUSI RIVER

DRAWING NO.
P00-060PF001

▨ = Revetment
▨ = Bed Channel
(L) = Left Side
(R) = Right Side



STATION NO.	DISTANCE (m)	CUMULATIVE DISTANCE (m)	PRESENT ELEVATION RIGHT BANK (m)	PRESENT ELEVATION LEFT BANK (m)	PRESENT ELEVATION RIVER CHANNEL BED (m)	DESIGN CHANNEL BED SLOPE	DESIGN ELEVATION RIGHT BANK (m)	DESIGN ELEVATION LEFT BANK (m)	DESIGN ELEVATION HIGH WATER LEVEL (m)	DESIGN ELEVATION CHANNEL BED (m)
B.136	38.80	6+233.67							658.60	652.36
B.137	62.61	6+296.28							658.61	652.37
B.138	26.65	6+322.93				1/5500 0.00018			658.62	652.38
B.139	43.80	6+366.73							658.63	652.39
B.140	30.13	6+396.86							658.63	652.39
CPT.2	66.87	0+000.00	658.43	658.03	656.15		657.80	657.80	657.30	655.00
CPT.3	48.50	0+048.50	657.73	657.97	656.12		657.81	657.81	657.31	655.01
CPT.4	24.40	0+072.90	657.36	657.57	656.25		657.82	657.82	657.32	655.02
CPT.5	42.66	0+115.56	657.81	657.93	656.23		657.84	657.84	657.34	655.04
CPT.6	5132	0+166.88	657.53	657.63	656.51		657.86	657.86	657.36	655.06
CPT.7	36.69	0+203.57	657.45	657.61	656.59		657.87	657.87	657.37	655.07
CPT.8	45.18	0+248.75	659.06	657.92	656.78		657.88	657.88	657.38	655.08
CPT.9	28.52	0+277.27	658.00	657.77	656.80		657.89	657.89	657.39	655.09
CPT.10	24.08	0+301.35	658.47	657.44	656.99		657.90	657.90	657.40	655.10
CPT.11	6.61	0+307.96	658.35	657.84	656.20		657.91	657.91	657.41	655.11
CPT.12	67.93	0+375.89	658.28	657.84	656.99		657.93	657.93	657.43	655.13
CPT.13	47.50	0+423.39	658.19	657.71	657.02		657.95	657.95	657.45	655.15
CPT.14	43.40	0+466.79	657.83	657.71	656.92	1/2800 0.00035	657.96	657.96	657.46	655.16
CPT.15	49.10	0+515.89	657.86	658.24	656.88		657.98	657.98	657.48	655.18
CPT.16	38.89	0+554.78	658.06	657.72	657.15		657.99	657.99	657.49	655.19
CPT.17	43.99	0+598.77	657.99	658.00	657.25		658.01	658.01	657.51	655.21
CPT.18	47.61	0+646.38	658.29	658.28	657.36		658.03	658.03	657.53	655.23
CPT.19	59.64	0+706.02	658.17	658.24	657.43		658.05	658.05	657.55	655.25
CPT.20	19.75	0+725.77	658.22	658.36	657.61		658.05	658.05	657.55	655.25
CPT.21	40.16	0+765.93	658.64	658.38	657.94		658.07	658.07	657.57	655.27
CPT.22	49.70	0+815.63	658.32	658.28	657.86		658.09	658.09	657.59	655.29
CPT.23	49.67	0+865.30	658.33	658.60	657.80		658.10	658.10	657.60	655.30
CPT.24	49.02	0+914.32	658.50	658.37	657.98		658.12	658.12	657.62	655.32
CPT.25	46.29	0+960.61	658.57	658.52	658.21		658.14	658.14	657.64	655.34

Legend: RIGHT BANK (present) - - - · - - -; LEFT BANK (present) - - - - -; RIVER CHANNEL BED (present) — · —; RIGHT BANK (design) ━━; LEFT BANK (design) ━━; HIGH WATER LEVEL ———; CHANNEL BED ———

Note :
Flood level of Ciputat River is affected by flood level of Citarum Main River due to the low land area

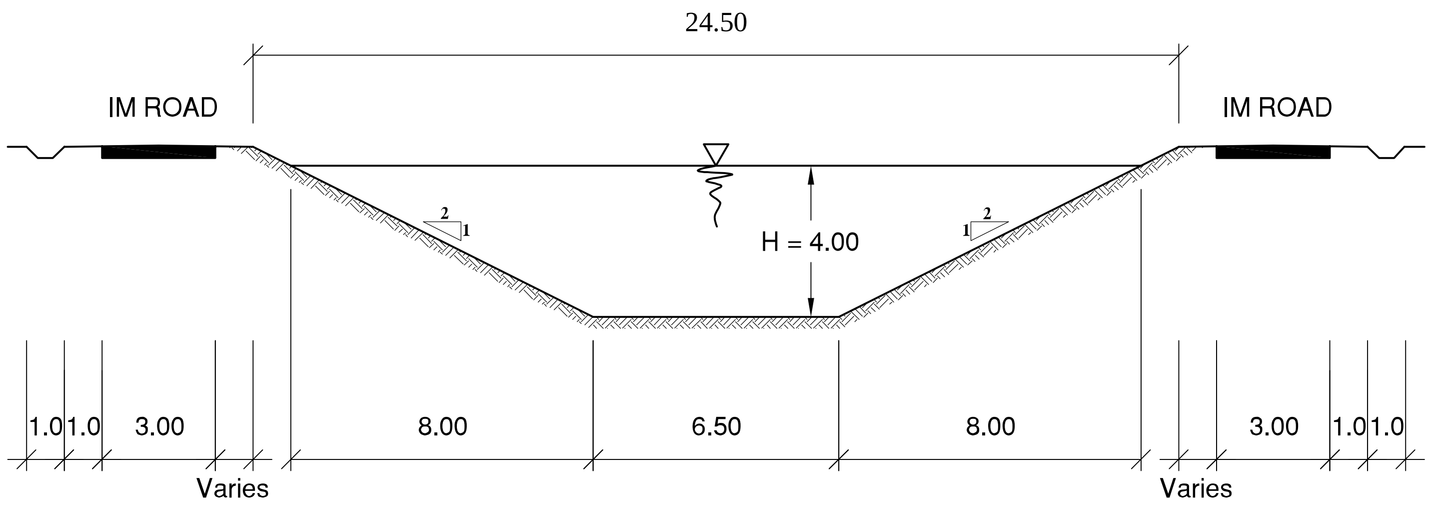
SCALE V 1 : 200
SCALE H 1 : 5000

LONGITUDINAL PROFILE OF CIPUTAT RIVER

DRAWING NO.
P00-090PF001

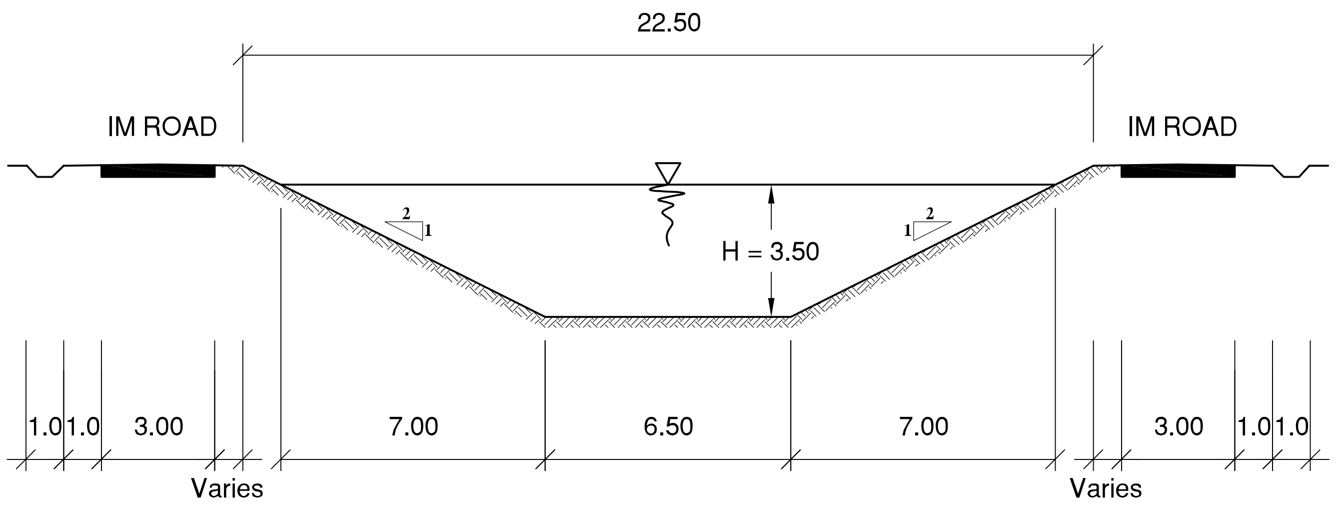
APPENDIX II-3:

STANDARD CROSS SECTION OF TRIBUTARIES



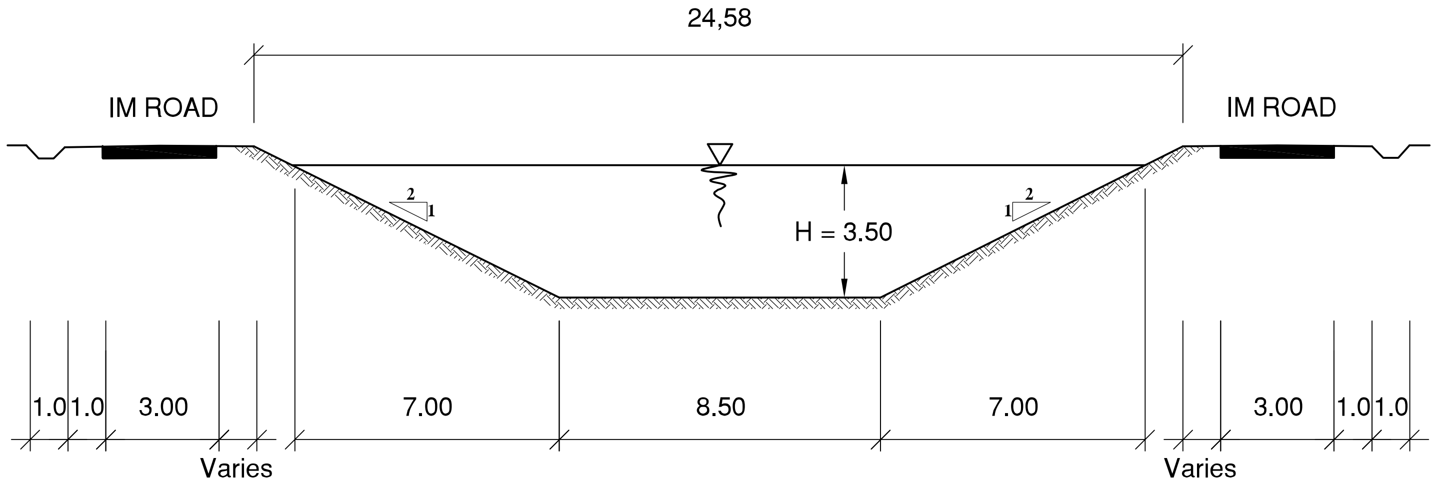
TYPE I

FROM : KK.0 - KK.10
STA. 0 + 000 - STA. 0 + 367



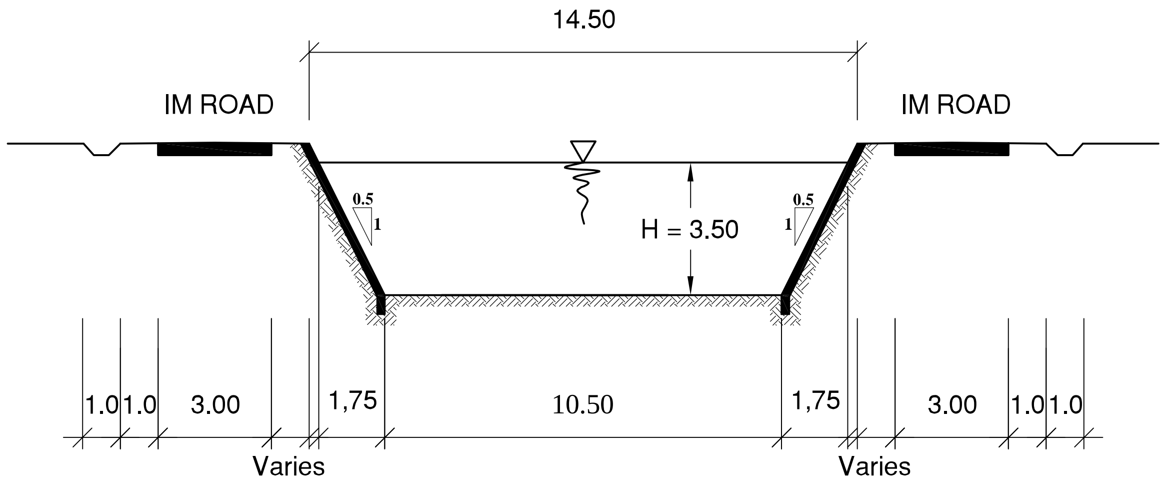
TYPE III

FROM : KK.52 - KK.83
STA.2 + 389 - STA.3 + 839



TYPE II

FROM : KK.10 - KK.52
STA. 0 + 367 - STA.2 + 389



TYPE IV

FROM : KK.84 - KK.159
STA.3 + 839 - STA.7 + 734

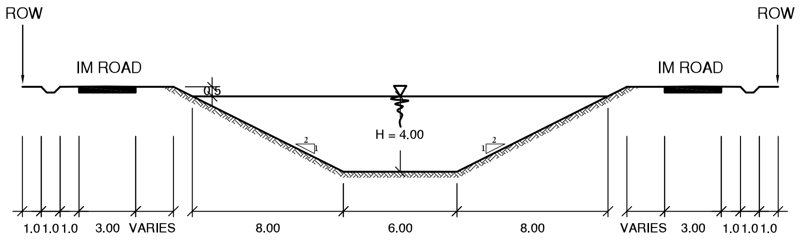
SCALE 1 : 200

0 2 4 6 8 10 M

STANDARD CROSS SECTION OF CITARUM UPSTREAM RIVER

DRAWING NO.

P00-010SS001



TYPE I
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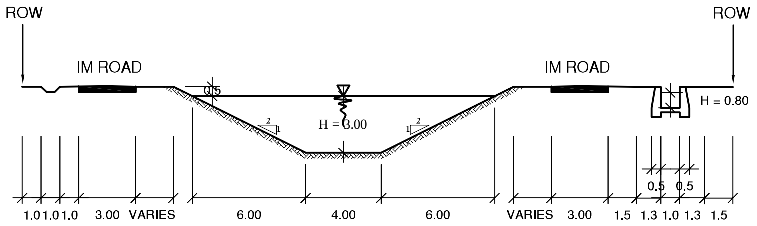
STA. 0 + 035 - STA.1+190



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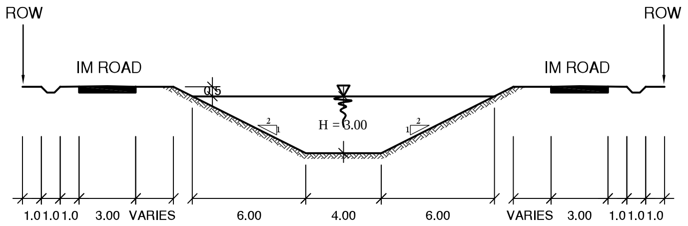

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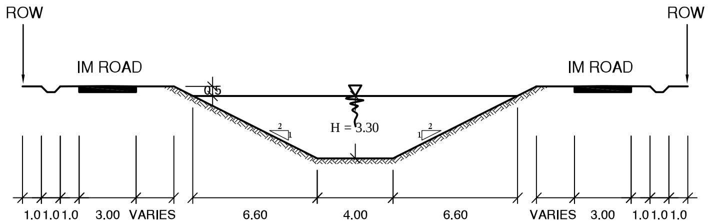

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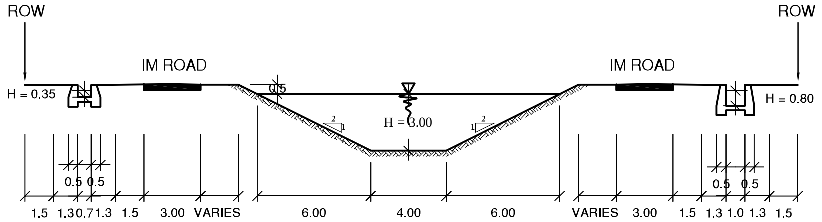

TYPE IV
FROM : D.1.38a - D.156
STA. 7+153 - STA. 7 + 988

SCALE 1 :400

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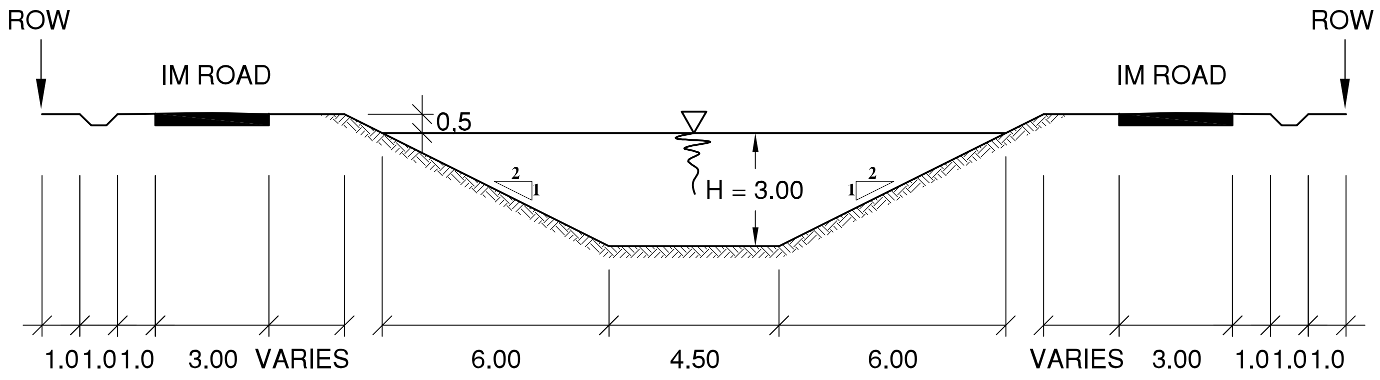
STANDARD CROSS SECTION OF CIMANDE RIVER

DRAWING NO.

P00-030SS001



TYPE I

CKJ.1 - CKJ.28
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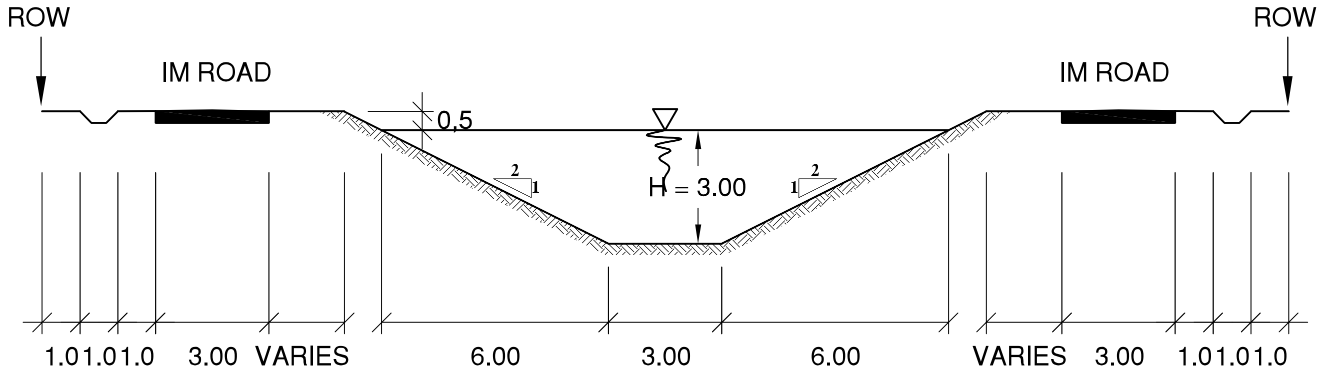
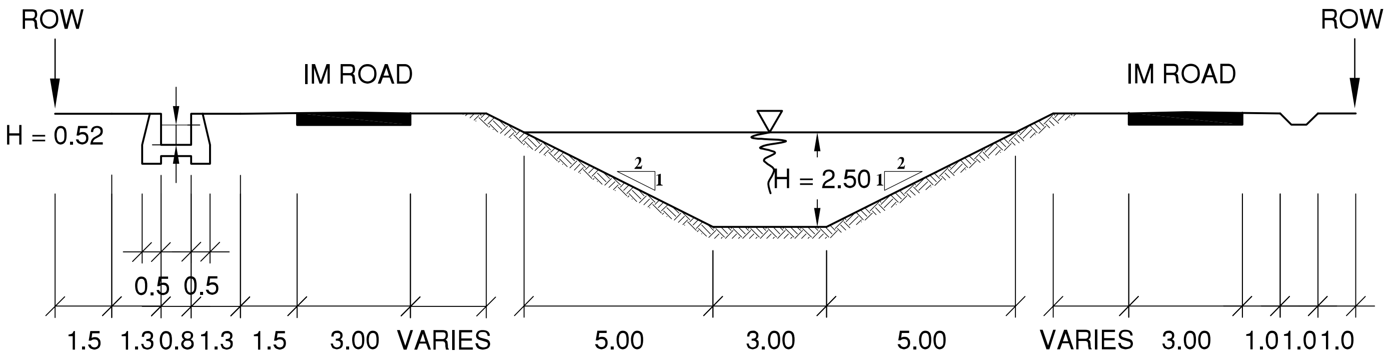


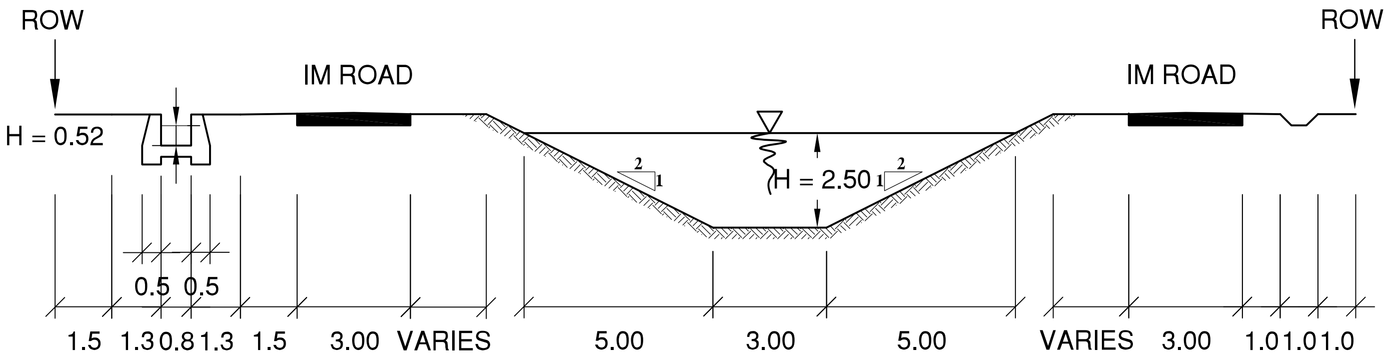
TYPE II

CKJ.28 - CKJ.56a
STA.1+516 - STA.3+131



TYPE III

CKJ.85 - CKJ.106
STA.4+872 - STA.5+898



TYPE IV

CKJ.56a - CKJ.124
STA.3+131 - STA.6+679

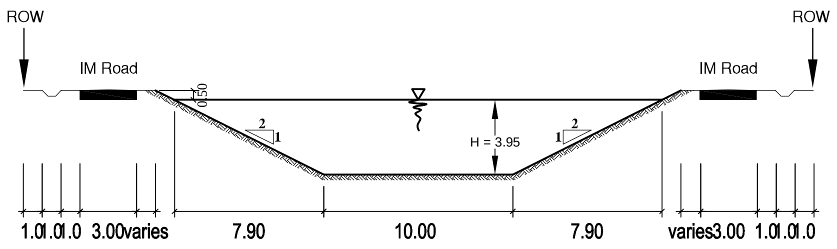
SCALE 1 : 200

0 2 4 6 8 10 M

STANDARD CROSS SECTION OF CIKIJING RIVER

DRAWING NO.

P00–040SS001



TYPE I

FROM : CKR.9A - CKR.28A
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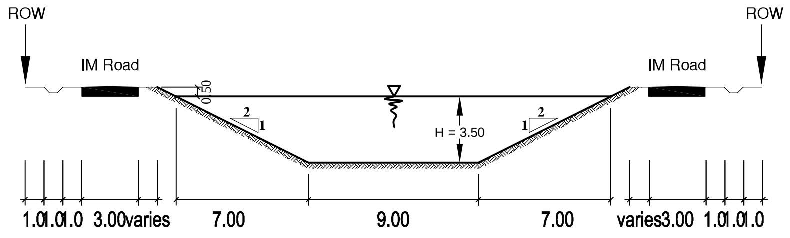

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FROM : CKR.28A - CKR.60A
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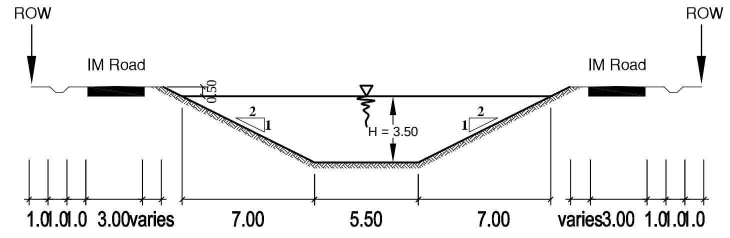

TYPE III

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STA. 3 + 016 - STA. 4 + 046
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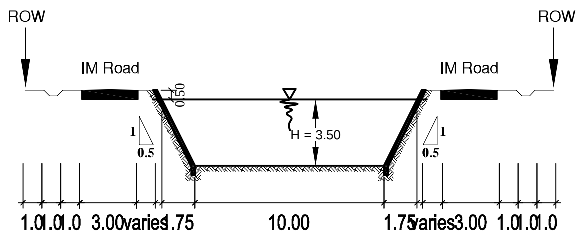
STA. 5 + 223 - STA. 5 + 549



TYPE IV

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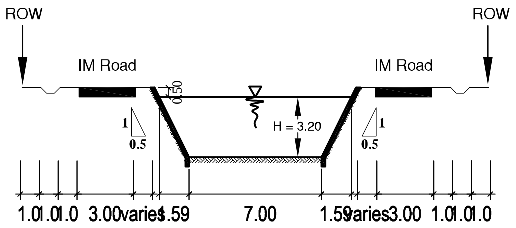

TYPE V

FROM : CKR. 137A - CKR. 176A
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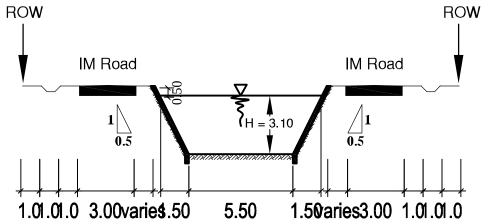


TYPE VI

FROM : CKR. 176A - CKR. 195A
STA. 7 + 634 - STA. 8 + 398

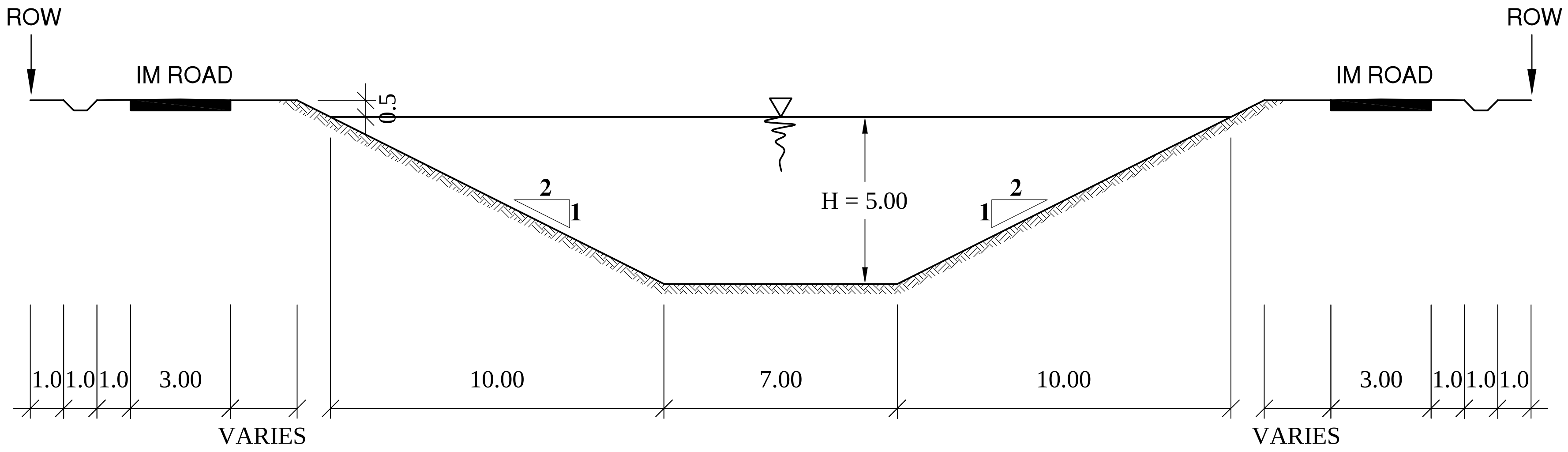
SCALE 1 :400

0 4 8 12 16 20 M

STANDARD CROSS SECTION OF CIKERUH RIVER

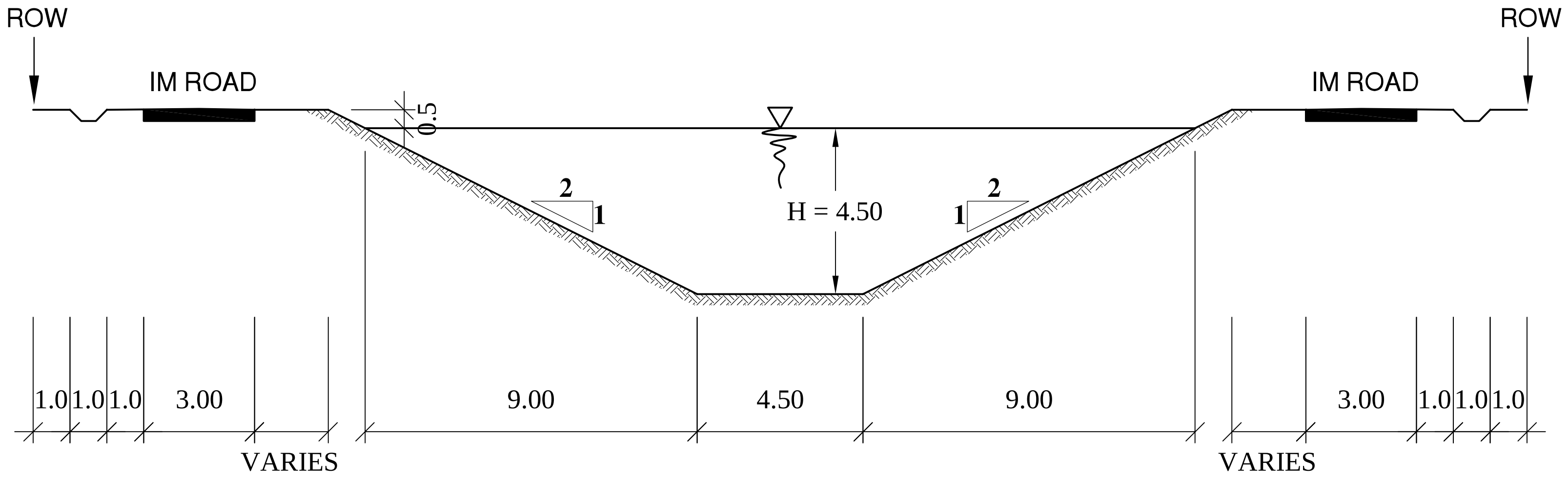
DRAWING NO.

P00-050SS001



TYPE I

JJ.1 - JJ.15
STA.6+650 - STA.7+187



TYPE II

JJ.15 - JJ.152
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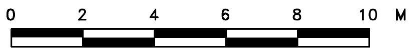

STANDARD CROSS SECTION OF CISANGKUY UPSTREAM RIVER

DRAWING NO.

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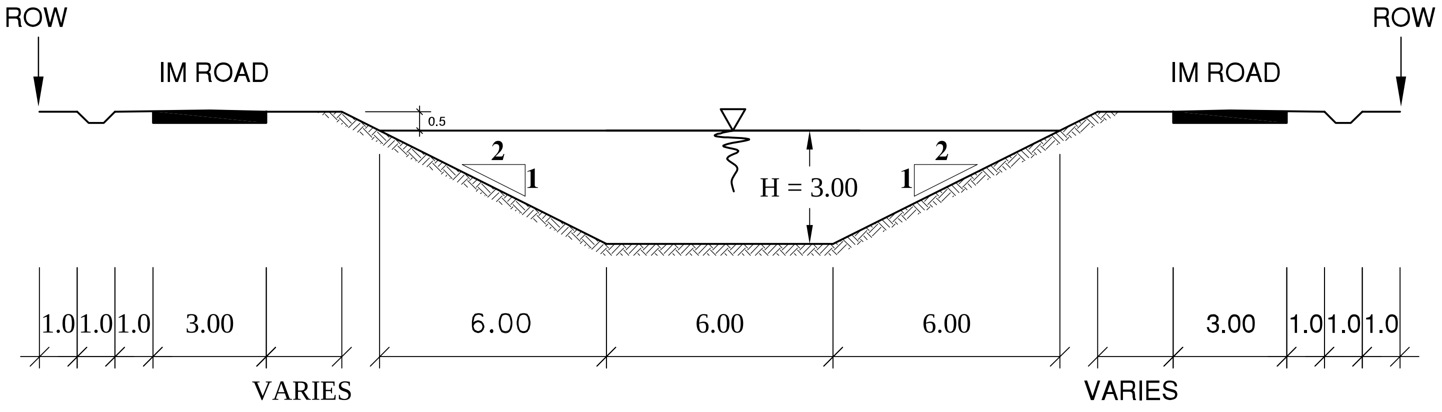
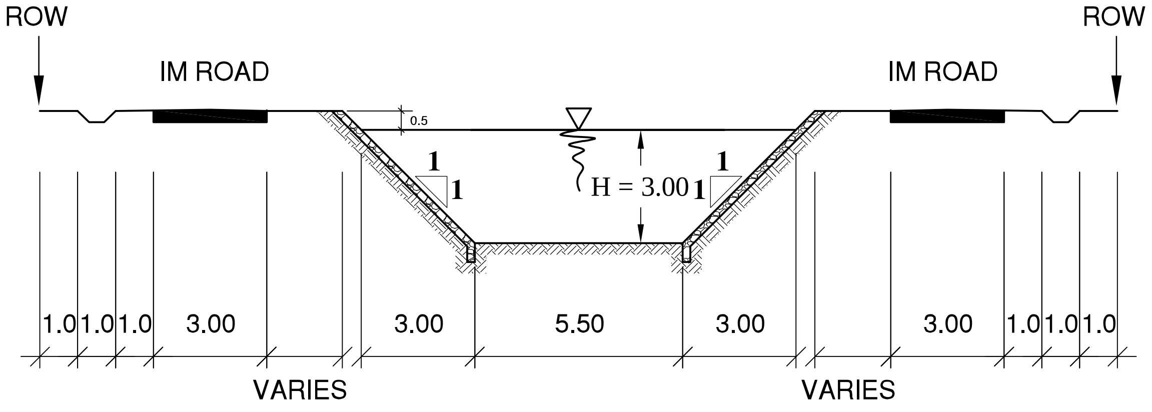


TYPE I

CTG.01 - CTG.21
STA.0+000 - STA.1+398



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P.27 - CTG.45
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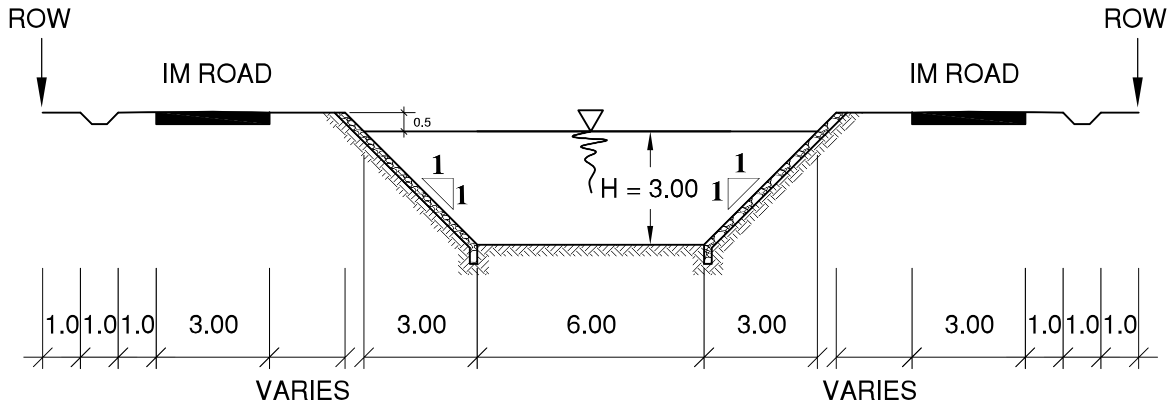

TYPE II

CTG.21 - P.27
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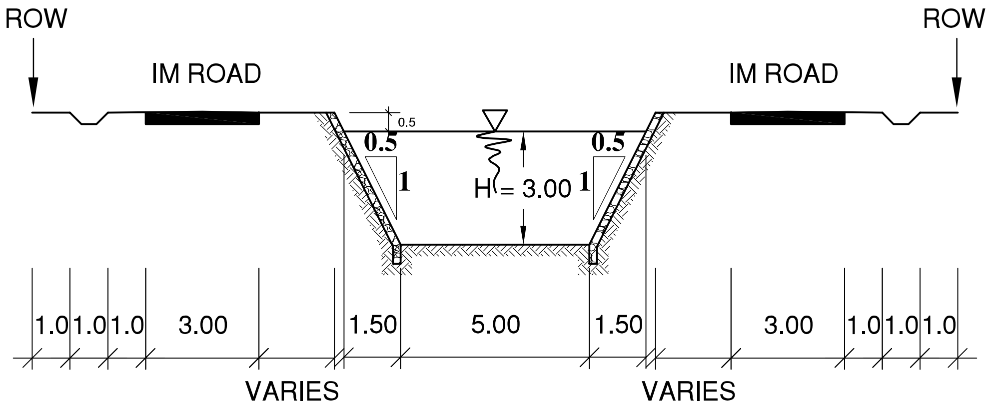

TYPE IV

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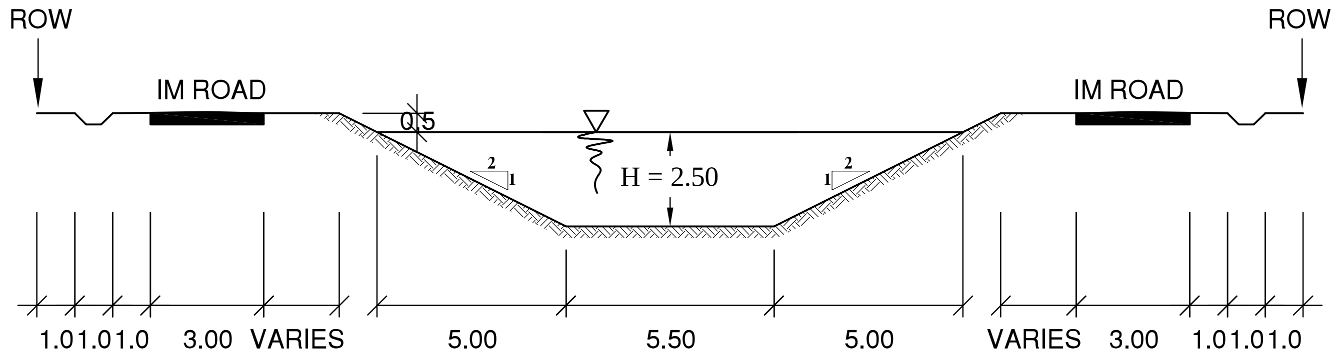
STANDARD CROSS SECTION OF CITALUGTUG RIVER

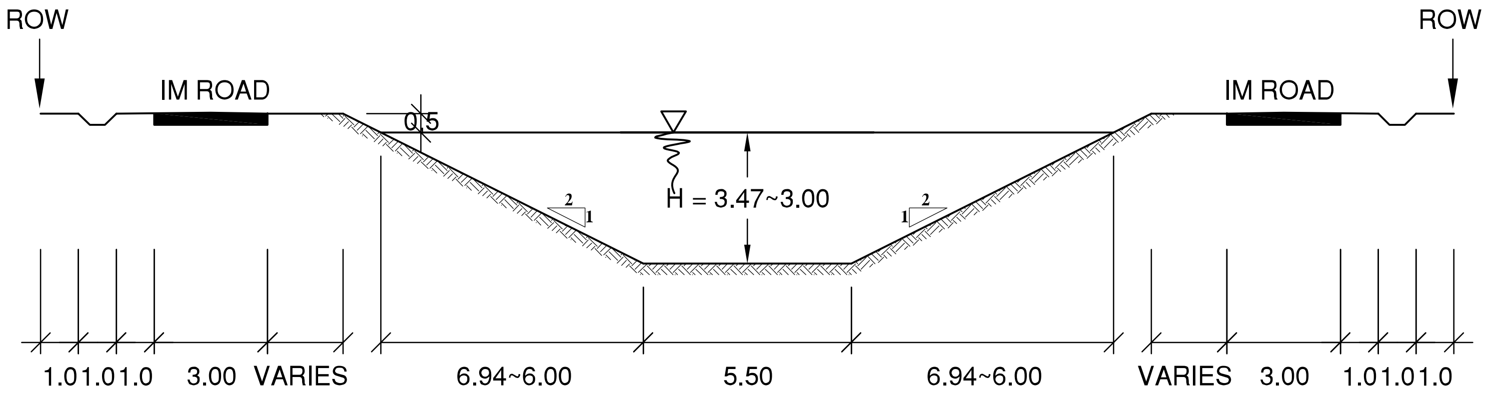
DRAWING NO.

P00-080SS001



TYPE I

FROM : CT.1 - CT.13
STA 0+0.000 - STA.6+695



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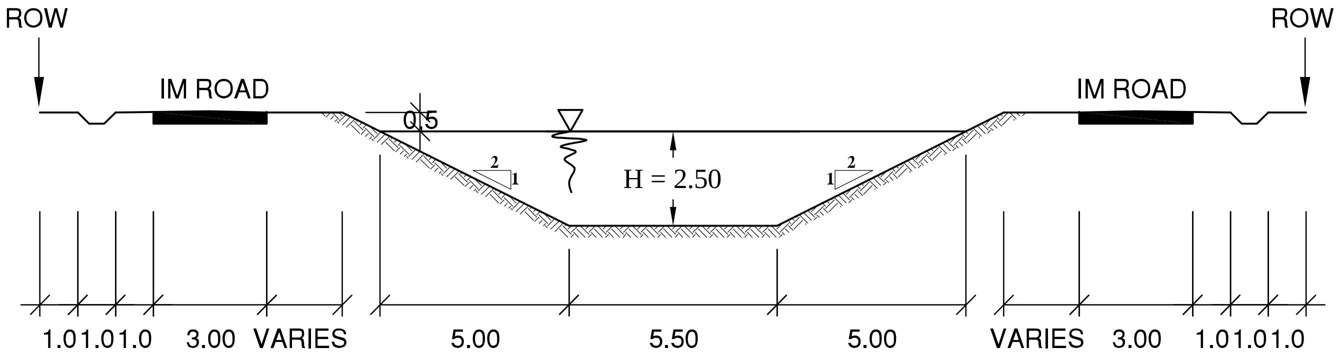
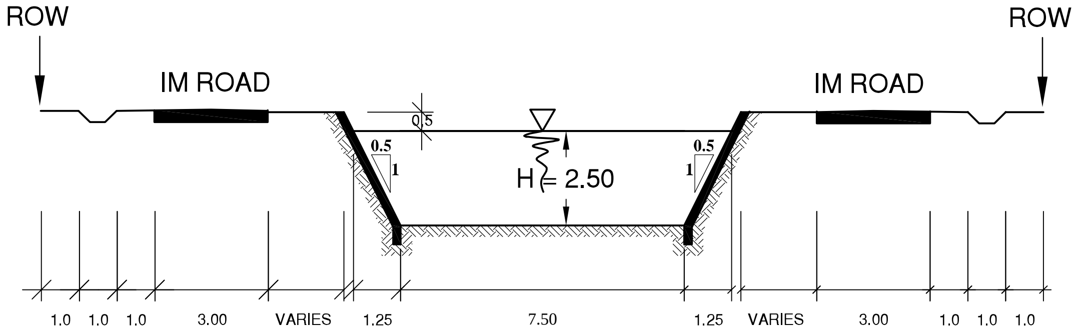


TYPE III

SCALE 1 : 200
0 2 4 6 8 10 M

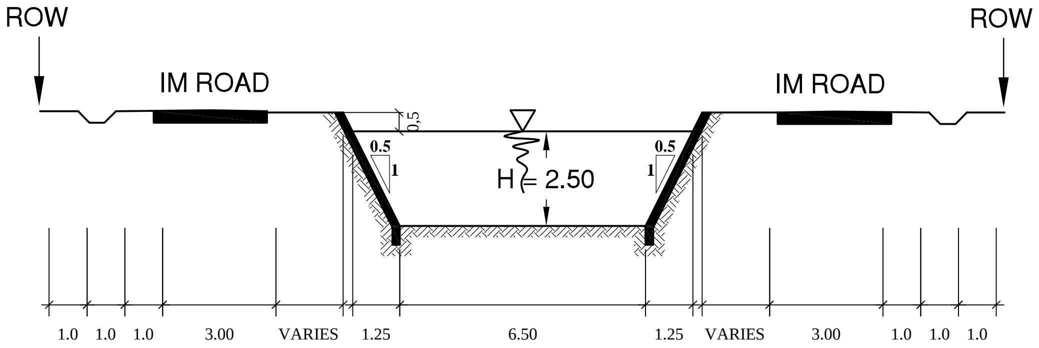
STANDARD CROSS SECTION OF CITARIK UPSTREAM RIVER

DRAWING NO.
P00-020SS001



TYPE I

FROM : CBS.1 - CBS.10
STA. 0 + 000 - STA. 0 + 407



TYPE II

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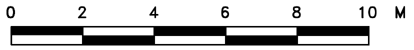
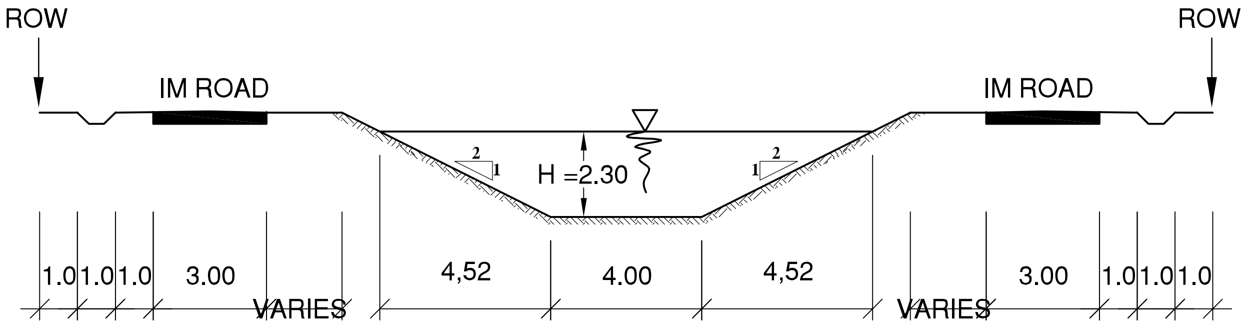
SCALE 1 : 200



STANDARD CROSS SECTION OF CIBEUSI RIVER

DRAWING NO.
P00-060SS001



FROM : CPT.02 - CPT.25
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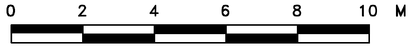
SCALE 1 : 200

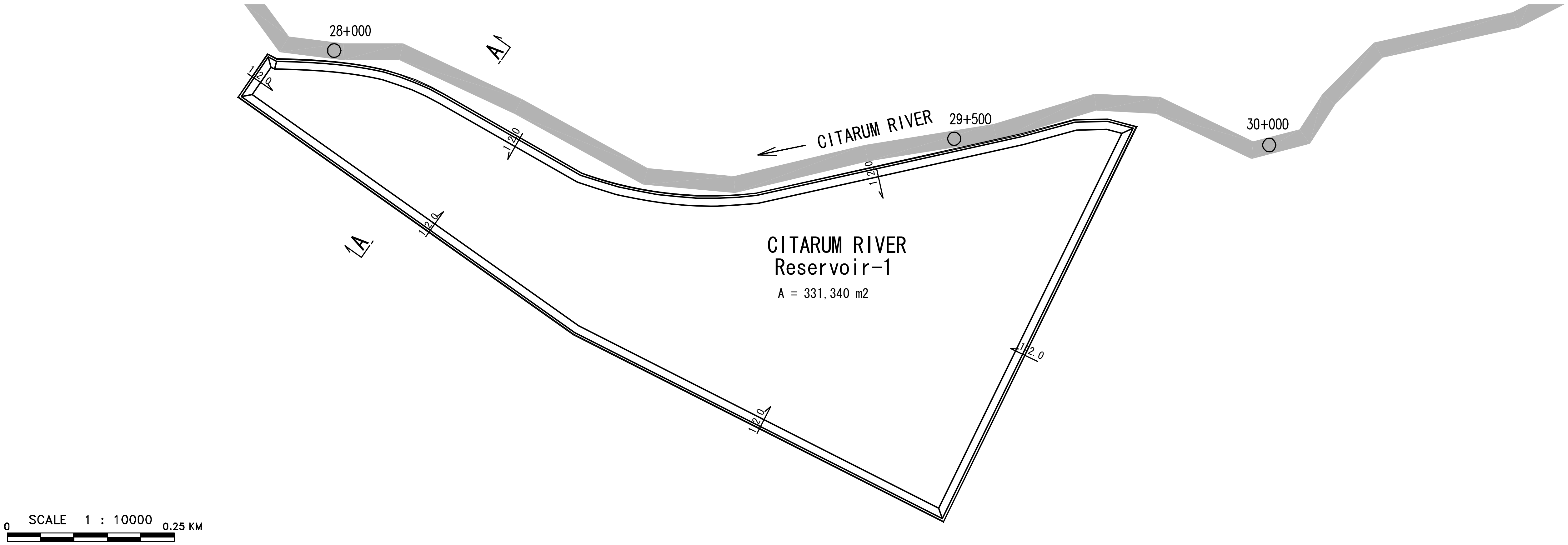


STANDARD CROSS SECTION OF CIPUTAT RIVER

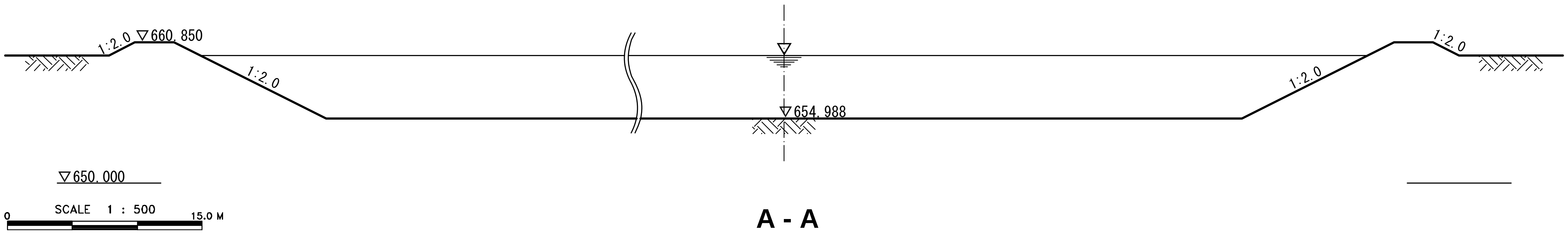
DRAWING NO.
P00-090SS001

APPENDIX II-4:

PLAN OF RESERVOIRS



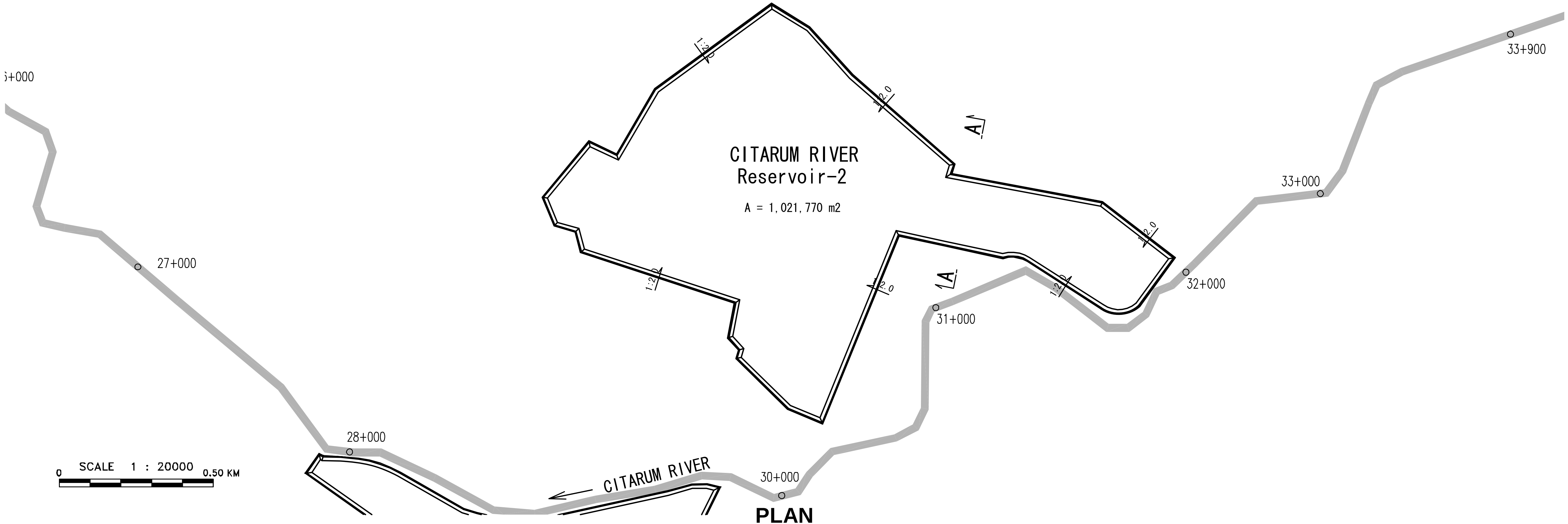
PLAN



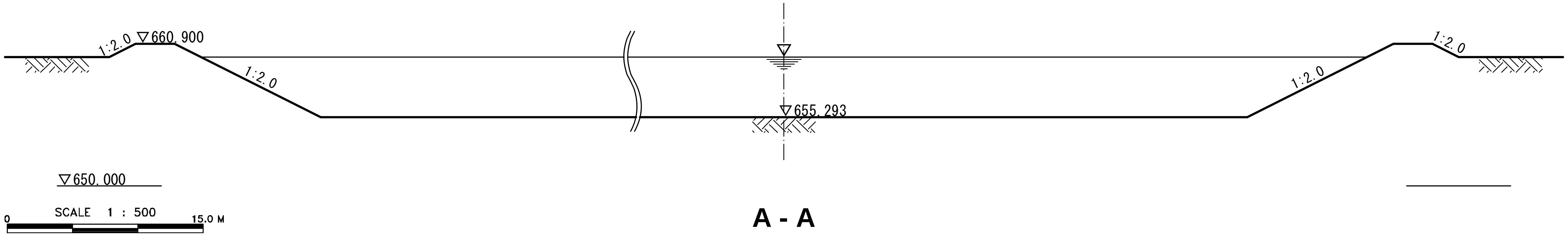
A - A

STANDARD CROSS SECTION

Citarum River Reservoir (1/3)



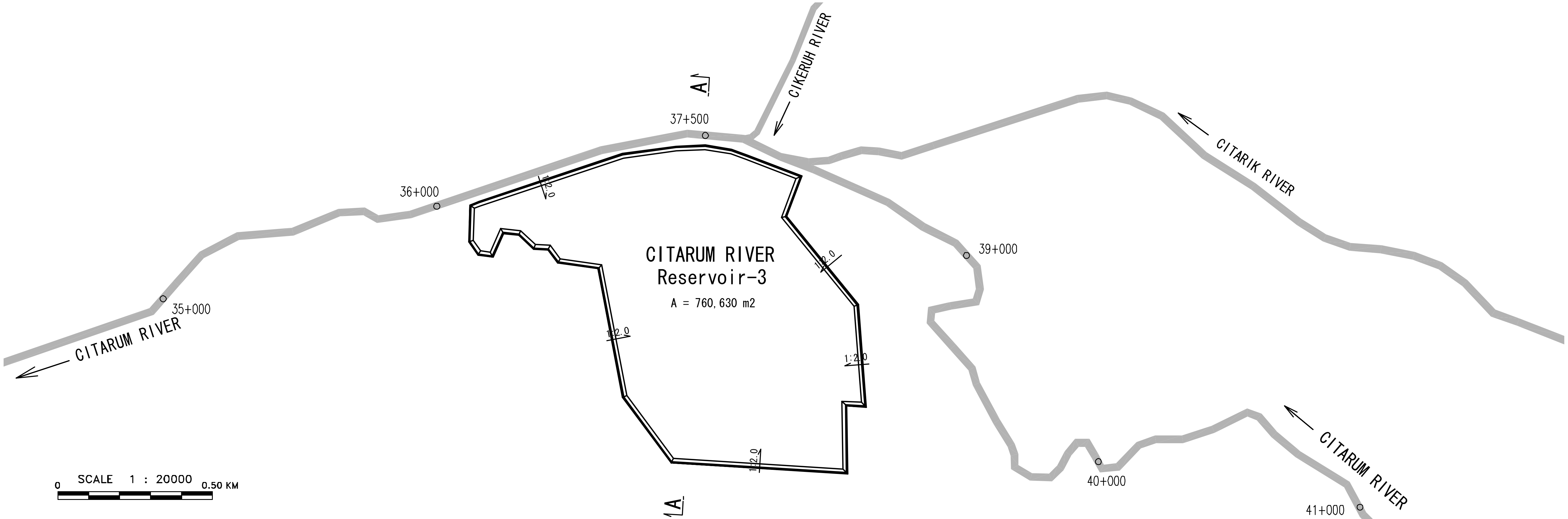
PLAN



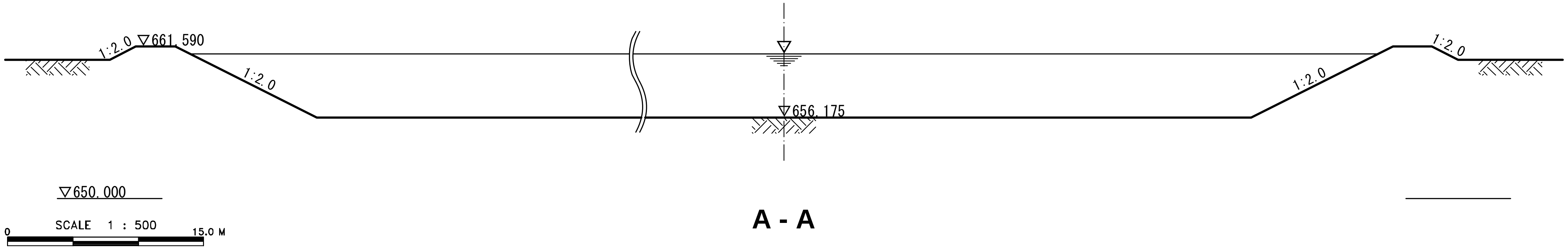
A - A

STANDARD CROSS SECTION

Citarum River Reservoir (2/3)



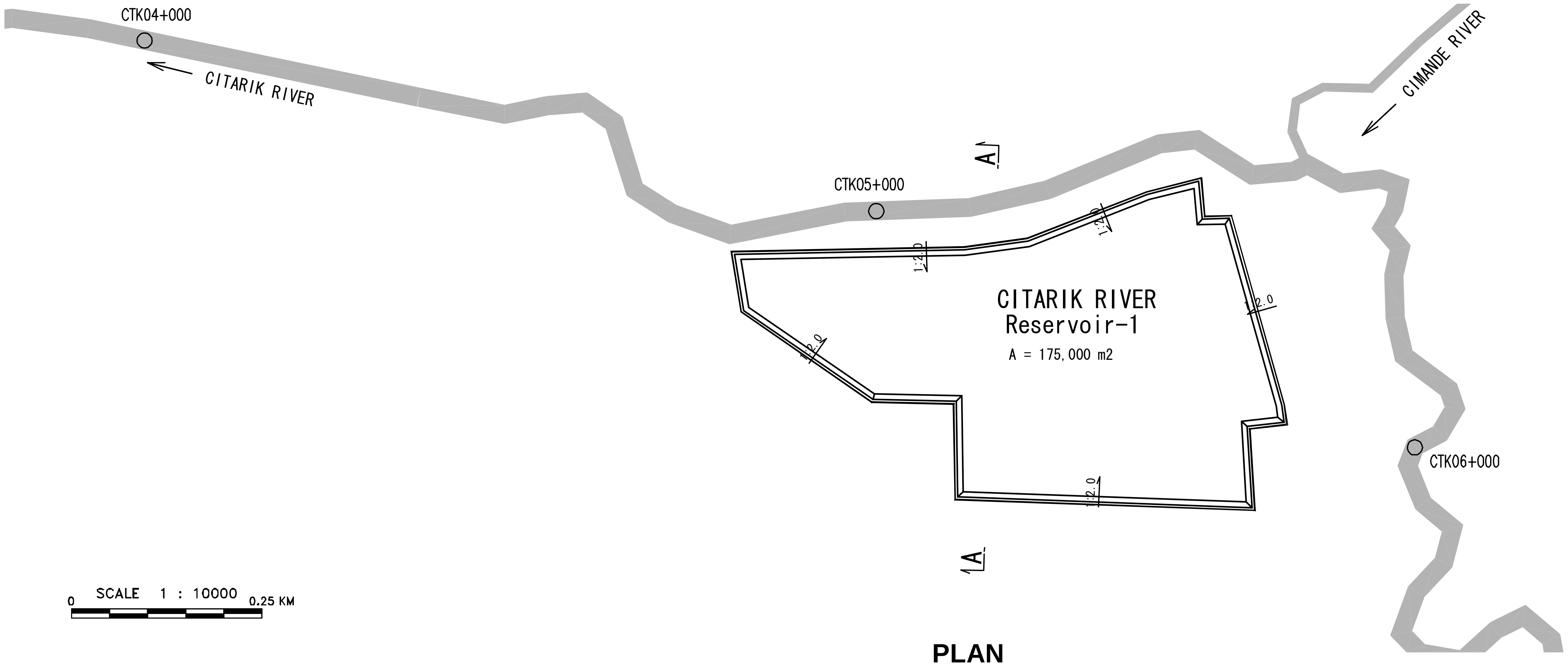
PLAN



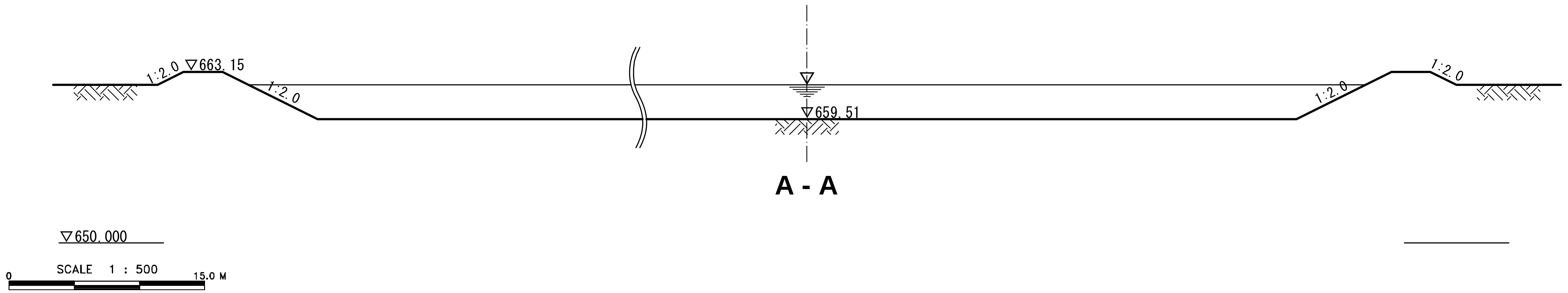
A - A

STANDARD CROSS SECTION

Citarum River Reservoir (3/3)



PLAN



A - A

STANDARD CROSS SECTION

Citarik River Reservoir (1/1)

APPENDIX III:

SUPPLEMENTAL REPORT FOR GEOLOGY AND LAND SUBSIDENCE

SUPPLEMENTAL REPORT FOR GEOLOGY AND LAND SUBSIDENCE

1. Introduction

1.1 Background

Stages I and II of the improvement works of the Upper Citarum River were completed in 2007. As a result of the works, flood inundation, which frequently occurred in the Citarum basin before the work, has been drastically reduced and the effects have been evidenced, especially in the flood-prone areas along the Citarum main stream. The remaining inundation areas converge at the stretch of upper stream tributaries that have not yet been improved.

In February 2005, flood inundation occurred in a 4,700 ha area (Citarum River Basin Office, 2006) including the Cisaraten, Citaric and Citarum mainstream, even after channel improvement works had already been completed in 1999 in the first stage of the project. In particular, the Dayeuh Kolot area had serious flood damage.

In addition, major upper tributaries of the Citarum River such as the Cikeruh, Cimande, Citarik upstream, Citarum upstream, Cisangkuy upstream river etc., have recently been suffering from recurrent seasonable floods due to the increasing flood peak discharge resulting from the rapid development of the area and an increase in population due to expansion of urban zones into the flood-prone areas.

Due to the above circumstances, the Direct General of Water Resources (DGWR) has decided to undertake a review and update all aspects of the Flood Control Plan including flood plan management for the basin. In addition, implementation of detailed design preparation for Stage III Construction of the Urgent Project will be done by confirming and identifying the need for and validity of proposed construction.

A review of all aspects of the Flood Control Plan for the basin has been carried out. The review showed that floods at Dayeuh Kolot are caused by three factors: i) the progression of land subsidence, ii) the occurrence of floods on a larger scale than the current design scale, and iii) the long detour of tributary meandering in joining with Citarum main river.

For the prevailing situation, based on the results of the review by JICA, the Project Team has prepared a detailed design for 9 tributaries of the Upper Citarum River Basin. However, further studies and reviews of technical and other aspects are necessary because the design has a significant impact on the downstream of the river.

1.2 Object of the Survey

In this survey, the main object of the activities in the frame of geological, topographical and geotechnical surveys are as follows:

(1) Leveling survey along the Citarum River and Dayeuh Kolot

The Citarum River Basin Office conducted a leveling survey along the Citarum River in May 2004 in order to grasp the condition of land subsidence. In addition, the Citarum River Basin Office set up benchmarks in order to measure land subsidence at Dayeuh Kolot and conducted survey work.

In order to grasp the scale of land subsidence and update existing data, a leveling survey will be carried out. Furthermore, the output data from the land subsidence survey may be used for flood control planning and design.

(2) Correcting information and data on latest land subsidence and groundwater conditions

Information on the number of wells and water extraction and regulation will be corrected to determine the correlation between groundwater extraction and land subsidence.

(3) Forecasting and analyzing of land subsidence by the survey data

Forecasting and analyzing of land subsidence will be performed by laboratory test and the correlation between the decreasing groundwater level and the land subsidence rate will be determined.

(4) Countermeasures for reducing land subsidence

Possible countermeasures, which should be taken by the concerned agencies or private companies such as industry and developers, will be proposed.

(5) Proposed technical assistance

The Bandung Basin has land subsidence and groundwater issues. Based on the site survey and corrected information, technical assistance (draft) will be proposed in order to reduce the effects of these issues.

2. Natural Condition

2.1Topographical Condition

Bandung is the capital of West Java province, Indonesia. Topographically, it is surrounded by up to 2,400 m high Late Tertiary and Quaternary volcanic terrain and forms an intra-montane basin known as the Bandung Basin (see Figure 2.1 Bandung Basin and its Surroundings). The basin, which is a highland plateau at approximately 650 to 700 m above sea level, lies in the catchment area of the Upper Citarum River (Dam et al. 1996).

The Basin has an area of about 2,300m km² and includes five administrative areas with three regencies and two cities. The central part of the basin, mostly comprising of urban and industrial areas, is a plain measuring about 40 km east to west and about 30 km north to south.

The Upper Citarum River, which is the survey area, rises from the surrounding mountains of the Bandung Basin and flows from south to east. It then feeds into the Java Sea through the Saguling Reservoir. The tributary rivers of the Upper Citarum River are fed by the high slopes of the surrounding mountains.

The Bandung Basin was a lake 50,000 to 16,000 years ago and became a flatland due to an abundance of sediment from the surrounding mountains (Dam et al., 1996).

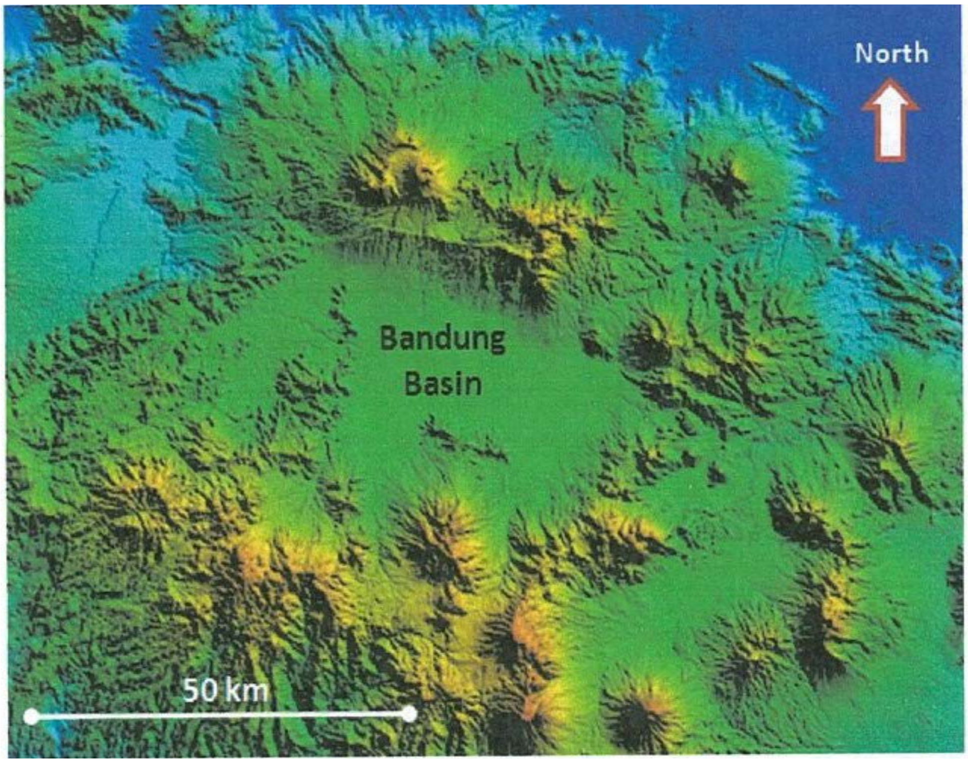


Figure 2.1 Bandung Basin and its Surroundings

2.2 Geological Condition

The Basin is dominated by various Quaternary volcanic rocks consisting of andesitic to dacitic lava, breccia, agglomerate, tuff, lahar, and intrusive rocks. The western flanks of the basin consist of old Tertiary sediment comprising of sandstone, clay stone, and limestone, while the younger alluvium and fluvial sediment of reworked volcanic deposits are widespread in the center of the basin (Suhari and Siebenhuner, 1993). A Geological Map of the Bandung Basin and the surrounding area is shown in Figure 2.2 and a Geological Cross Section of the Bandung Basin is shown in Figure 2.3.

The correlation between the lithostraitigraphic unit and hydrostraitigraphic unit of each geological formation in Bandung basin is shown in Table 2.1.

According to the drilling results (Citarum Basin Office 2007) of the Upper Citarum River and its 9 tributaries, the soil consists of sand, clay (silt) and a sand-clay mixture. The soil material is lake deposit. Andesitic rock is found at the Upper Cikeruh River at a depth of 10m to 20m b.g.l.

2.3 Hydrogeology

The Bandung Basin has two (2) main aquifers: i) shallow aquifers (a few meters to 40 m below the surface) and ii) deep aquifers (more than 40 m to 250 m below the surface). These aquifers are composed of volcanic products from the volcanic complexes that border the Bandung Basin, and lake sediments that were deposited when the central part of the Bandung Basin was a lake (Dam et al. 1996).

The Bandung groundwater basin mostly covers the Upper Citarum Basin. Direct recharge of groundwater for the unconfined aquifer occurs mostly from the entire basin. Direct recharge of groundwater for the confined aquifer occurs on the upstream part of the basin only (Groundwater Potential Study by the DEG, 2000). Therefore, for the confined aquifer, the Bandung basin could be subdivided into a recharge area and a discharge area. The recharge area is located on the slope of the intermountain basin upwards of about 725 meters elevation with a width of about 1,265km². The discharge area is located on the flat plain of the basin below 725 meters elevation with a width of about 506 km².

The regional groundwater flow system in the Bandung Basin is recharged mainly from the north and south highlands, while the one local flow system appears in the shallow layers (Roberto et al., 2001).

In Dayeuhkolot, the aquifer system can be divided into 3 groups (WJOM, 1997) as follows: (a) shallow aquifer with 0 – 30 meter depth as unconfined aquifer, (b) middle aquifer with 40 – 130 meter depth as semi-confined/confined aquifer, which includes Cibeureum or Kosambi formations, (c) deep aquifer with more than 140 meter depth as semiconfined/confined aquifer, which includes Cikapundung formation.

Based on the hydrogeological cross-section from the existing deep wells in the Dayeuhkolot area with depths between 84 to 255 meters, the lithological characteristics of the aquifers are heterogeneous, both in horizontal and vertical distribution as shown in Figure 2.4 (West Java Provincial Office of Mining, 1997).

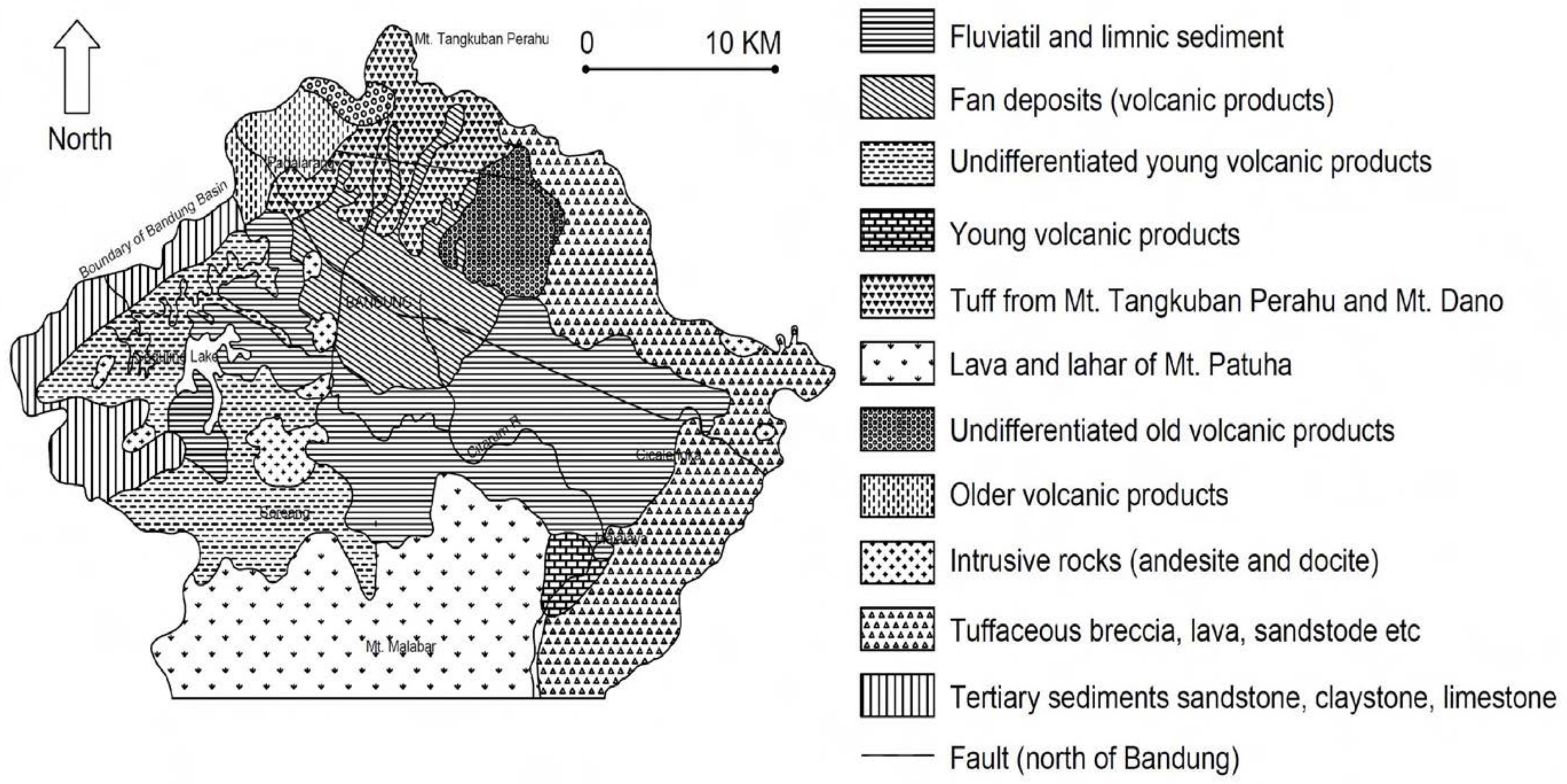


Figure 2.2 Geological Map of Bandung Basin and surrounding area (Suhari and Siebenhuner, 1993)

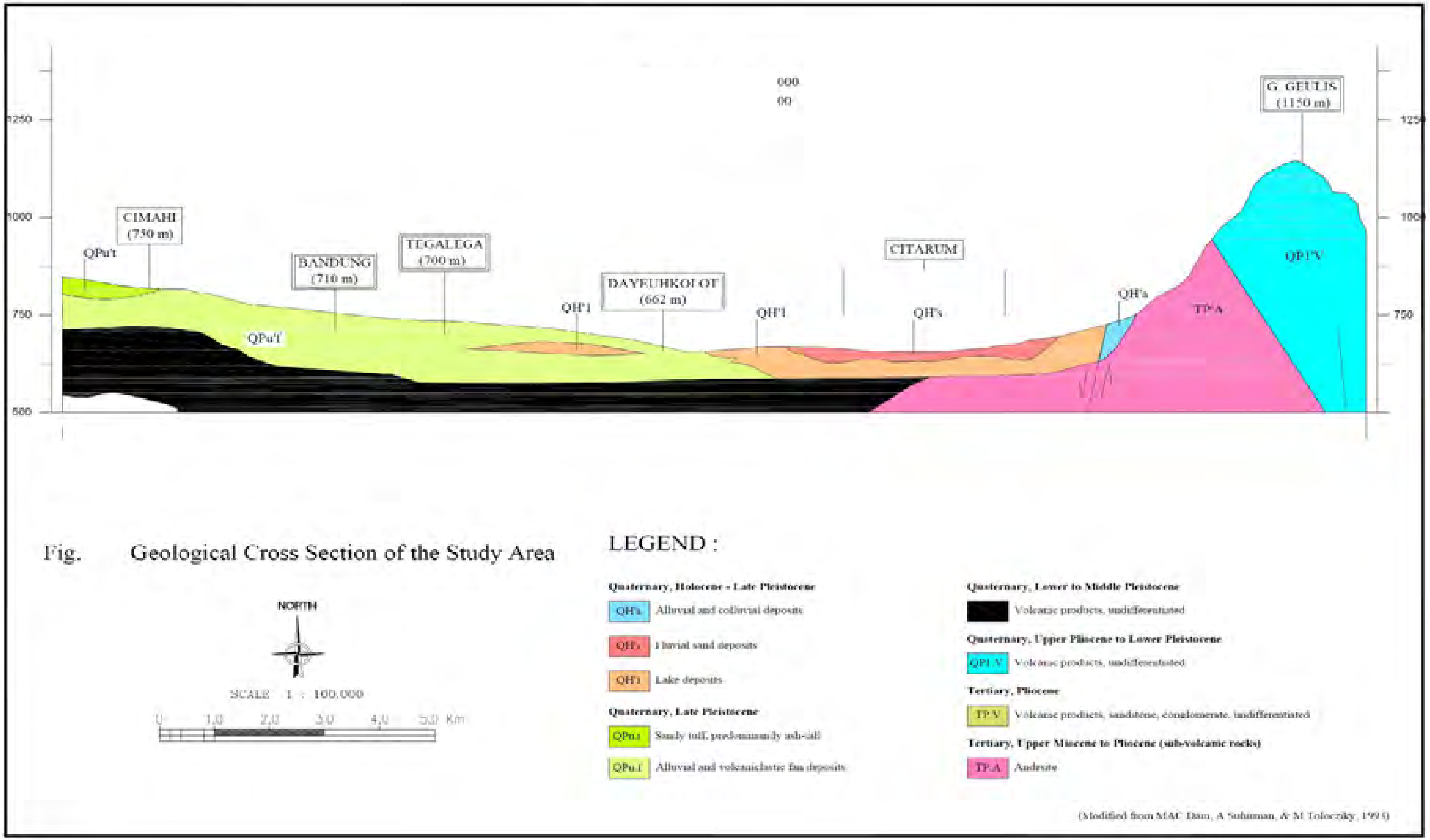


Figure 2.3 Geological Cross Section of Bandung Basin

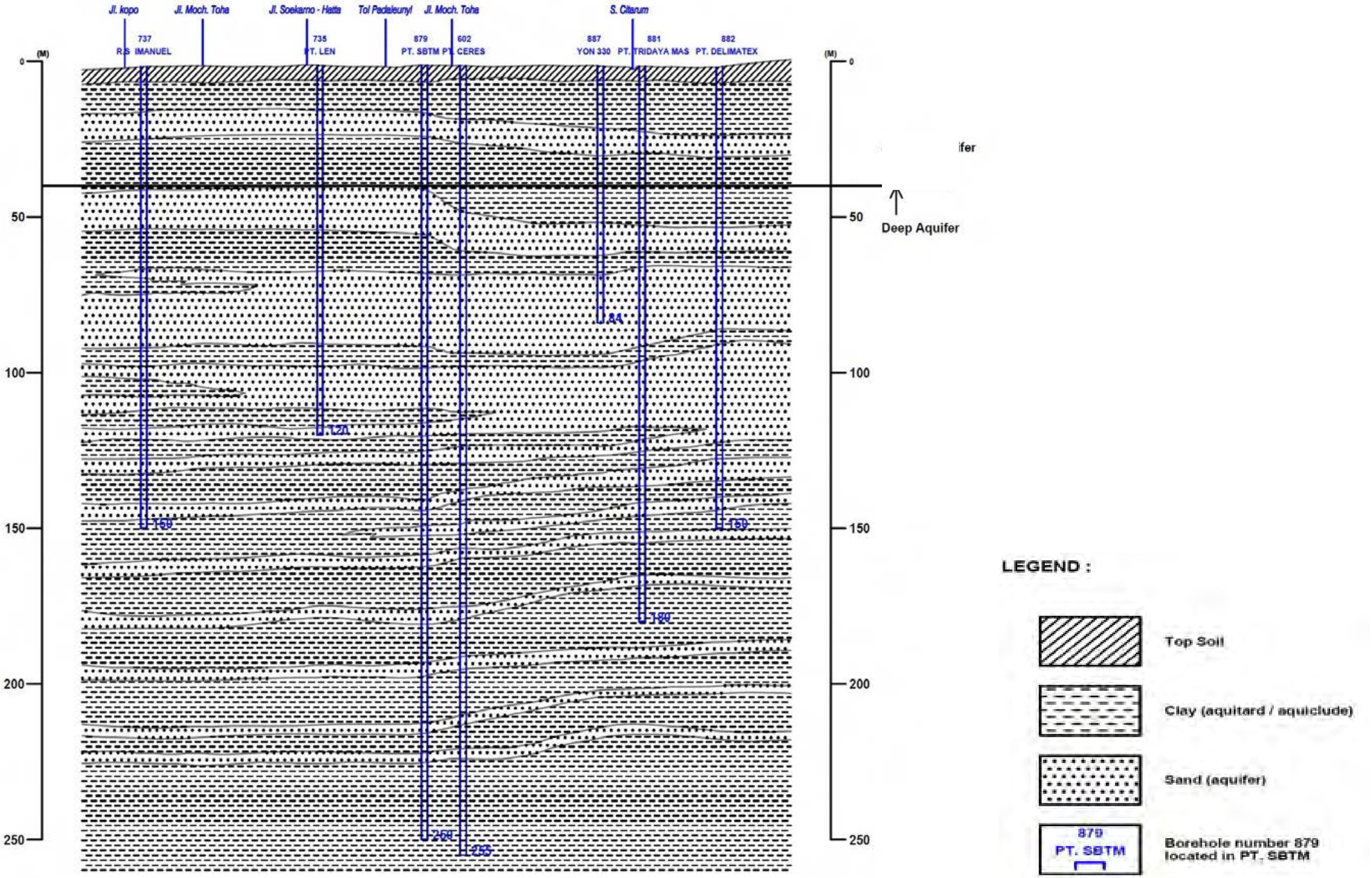


Figure 2.4 Hydro-Geological Cross Section

(Modified from Hydrogeological Study on M.Toha-Cisirung Area, WJOM, 1997)

Table 2.1 Correlation between Lithostratigraphic Unit and Hydrostratigraphic Unit

(Compiled from Directorate of Environmental Geology and West Java Provincial Office of Mining 1997)

Formation	Lithostratigraphic Unit	Hydrostratigraphic Unit	Depth
Alluvium and Fluviatil deposits (QH'a)	Tuffaceous material deposits consists of sand, clay and mud	Shallow Aquifer (phreatic) Thickness: max. 10 m	0 – 10 m
	River deposits consists of sand dominantly	Shallow Aquifer (phreatic) Thickness: max. 10 m	0 – 10 m
Kosambi Formation (QH'l) and	Lake deposits composed of tuffaceous materials consists of clay, silt, sand and gravel	Shallow Aquifer (phreatic) Thickness: 8 – 10 m	0 m – 30 m
Cibeureum Formation (QPu'f)	Young volcanic product undifferentiated, consists of volcanic breccia, lapili, lava and intercalation of tuff	Shallow Aquifer (phreatic) Thickness: 8 – 10 m	0 m – 30 m
Kosambi Formation (QH'l) and	Lake deposits composed of tuffaceous materials consists of clay, silt, sand and gravel	Middle Aquifer (semi-confined/confined) Thickness: 10 – 30 m T = 55 m^2/day – 216 m^2/day Aquitard / Aquiclude: Thickness: 4 – 14 m	40 – 130 m
Cibeureum Formation (QPu'f)	Young volcanic product undifferentiated, consists of volcanic breccia, lapili, lava and intercalation of tuff	Middle Aquifer (semi-confined/confined) Thickness: 10 – 30 m T = 102 m^2/day – 1100 m^2/day Aquitard / Aquiclude: Thickness: 4 – 14 m	40 – 130 m
Cikapundung Formation	Old volcanic product undifferentiated, consists of volcanic breccia sandy tuff, lahar and lava	Deep Aquifer (semi-confined/confined) Thickness: 2 – 7 m T = 47.04 m^2/day – 121.92 m^2/day k = 1.2 m/day – 5.52 m/day Aquitard / Aquiclude: Thickness: 4 – 20 m	140 m - 225 m

3. Groundwater Extraction and Land Subsidence Phenomena

3.1 Groundwater Issues

The Bandung groundwater basin consists of semi-solidified deposits, un-solidified deposits, and it is surrounded by mountains with impermeable rocks. In natural conditions, surface water and groundwater drain out of the basin through the river. In the Bandung groundwater basin, groundwater is recharged by an aquifer at the mountain border.

In general, groundwater is clean and easy to access. Therefore, groundwater is useful resource for drinking water, industrial processes and other requirements.

However, because the amount of extraction of groundwater has far exceeded the sustainable amount of basin groundwater, it has caused a reduction in the groundwater level and has given rise to serious land subsidence and drying up of shallow wells.

In the subject area, especially Dayeuh Kolot, reductions in the groundwater level and land subsidence phenomena have occurred. In addition, these areas have recently been suffering from recurrent seasonable floods due to land subsidence.

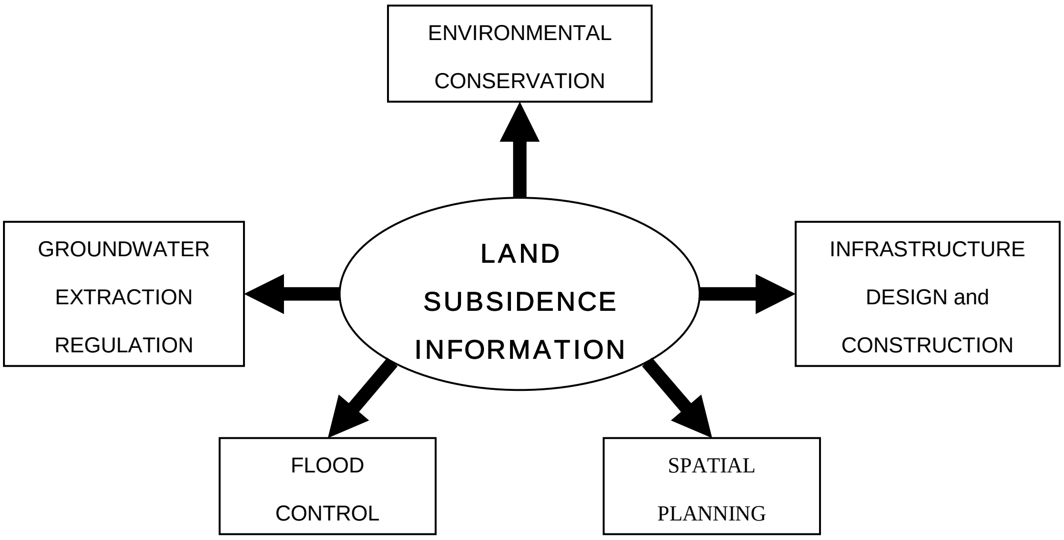


Figure 3.1 Benefit of Land Subsidence Information (Abiden et a l .2008)

Since information on land subsidence characteristics will be useful for managing many developmental and environmental aspects (refer to Figure 3.1), systematic and continuous monitoring of land subsidence is obviously important, and critical to the welfare of the city. Comprehensive information on land subsidence is important for several tasks, such as those shown in figures, especially in the Dayeuh Kolot area where seasonable floods are a serious problem.

3.2 Groundwater Extraction

The use of groundwater resources in the Bandung Basin has been rapidly increasing due to industrial activities since the 1980s.

In 2000, groundwater usage as a water resource in Greater Bandung was 60% of the whole water supply usage in Bandung. Industrial use is 80 %, while 20% is for domestic use and is not used for irrigation.

The water supply for industries, commercial centers, offices and large scale residential areas in the Bandung Basin have mostly relied on groundwater resources from their own deep wells, due to insufficient domestic water supply. In addition, the water supply of Bandung City requires an additional 42 % (i.e. 800 litters per second) (Bandung City 2010). Also, about 60% of the total clean water required in the Greater Bandung area is supplied by groundwater, and industry relies on nearly 100% of the groundwater resource (Wirakusmah, 2006). 80% of the groundwater resource is used for industry and 20% is used for domestic water supply (IGES 2006).

The registered number of deep wells and water extraction volume in the Bandung Basin as of December 2009 is shown in Figure 3.2. According to this latest data, extraction is 44.5 million cubic meters and the number of wells is 2,400. Although extraction is decreasing, the number of wells has recently been increasing.

The Dayeuh Kolot area is one of the industrial development areas and has 119 units of factories. The main users of groundwater are the textile industry, which consists of 100 factories. The volume of extraction and number of deep wells (WJOM, 1997) are shown in Table 3.1.

A location map of deep wells at Dayeuh Kolot area is shown in Figure 3.3.

Table 3.1 Volume of extraction and number of well in Dayeuh Kolot

Description	1992	1993	1994	1995	1996
Volume of extraction(million m3/year)	4.16	5.14	5.23	6.92	7.45
( ) % in total extraction in Bandung basin	(8.65)	(10.28)	(8.57)	(10.34)	(9.70)
Number of Production Well	138	168	196	232	256
( ) % in total deep well in Bandung Basin	(10.40)	(10-.08)	(9.91)	(10.43)	(9.74)

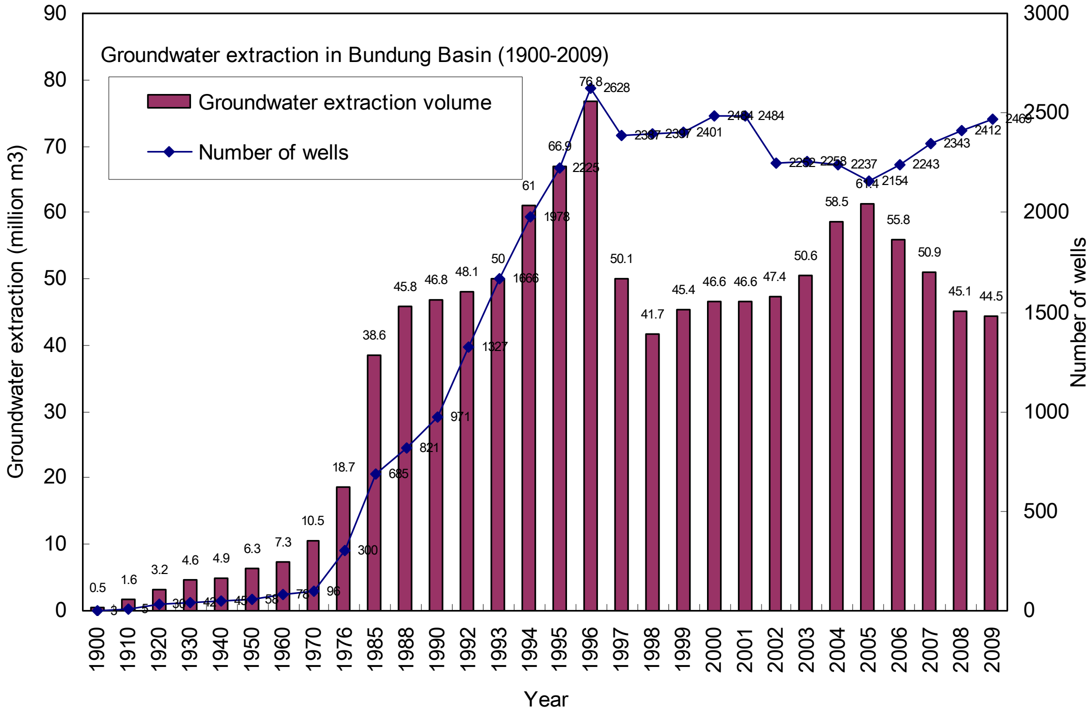


Figure 3.2 Registered Groundwater Extraction in Greater Bandung (1900-2009) from the Deep Aquifer (40-250m) below the Surface

(Source: West Java Provincial Office of Energy and Mineral Resources, 2010)

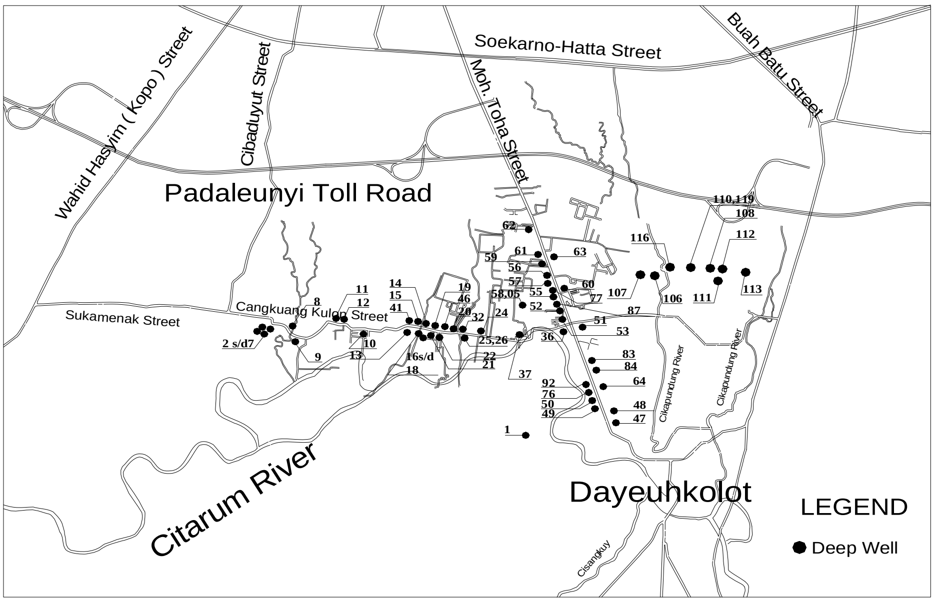


Figure 3.3 Location of Deep Well at Dayeuh Kolot Area

3.3 Groundwater Level

Availability of groundwater depends on the physical characteristics of the geologic formation (such as porosity, permeability and storability of the aquifer system) and the infiltration to the aquifer as the recharge. Infiltration to the aquifer also depends on the rainfall, morphology and land use condition in the surrounding area of the aquifer. Based on the previous investigation by the Directorate of Environmental Geology in 2000, the availability of groundwater in the Bandung Basin was identified according to a general formula for water balance calculation (Dunne, Leopold, 1978) as follows:

$$P = R + E_{at} + U \pm \Delta S$$

where: P: Average annual rainfall (mm)
R: Surface run-off (mm)
E_{at}: Evapotranspiration (mm)
U: Percolation (mm)
ΔS: Change in groundwater storage, which annually constant

When the groundwater extraction exceeds the groundwater recharge, the Hydrologic in the aquifer causes the un-balanced condition. Increased groundwater extraction has led to a rapid sinking of the water table.

The groundwater potential from the deep aquifers under the normal flow from the recharge area to the discharge area totals 117 million m³ per year, of which 67 million m³ per year flows from the north and 50 million m³ per year flows from the east and the south in the Bandung Basin (Haryadi & Schmidt, 1991).

In the Dayeuh Kolot area, allowable groundwater extraction totaling 6.78 million m³ per year (WJOM, 1997) far exceeds the sustainable yield of 2.7 million m³ per year. This means that the allowable abstraction volume of groundwater is almost 151% of its sustainable yield (approximately 1.5 times of the sustainable yield).

Increased groundwater extraction has led to a rapid sinking of water tables on the plain (Table 3.2), which in turn causes land subsidence. During the 1980s, the average annual drop in water tables in the basin was one (1) meter, while in the most heavy extracted areas, annual drops up to 2.5 meters were recorded (Soetrisno, 1991). As shown in Table 3.1, from 1980 to 2004, the groundwater level in the Bandung Basin has dropped by about 20 to 100 m.

Table 3.2 Groundwater level decreases in Bandung Basin (Wirakusumah 2006, Wangsaatmaja et al. 2007)

No.	Location	1920	1980	1985	1995	2004
1	Cimahi	+19m	+15m	-10m	-40m	-86m
2	Kebon Kawung	-	+22	-	-	-36m
3	Rancaekek	-	+1m	-	-	-39m
4	Lanud Sulaeman	-	+7m	-	-	-14m

5	Dayeuh Kolot	+4m	+2m	-	-	-55m
6	Banjaran		+2m	-	-	-20m
6	Majalaya		+3m	-	-	-41m

Figure 3.4 shows declining of the water level in a factory in the Dayeuh Kolot area. The groundwater level had been declining to the depth of about 51 meters b.g.l. in 1994 (WJOM, 1997).

In addition, the groundwater level in Dayeuh Kolot had been declining significantly and a depression cone occurred with the lowest level of 62 meters b.g.l. in 2004, which caused a decrease in artesian pressure in the aquifer system by more than 6 atmospheres.

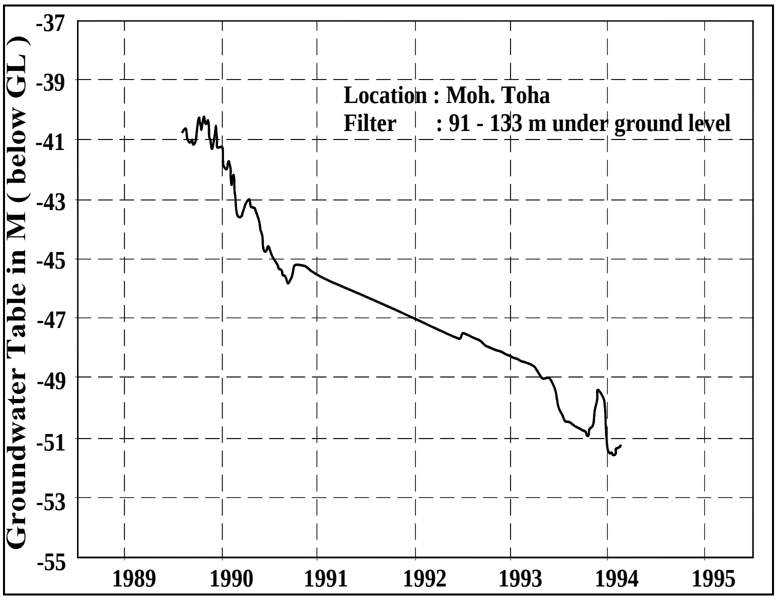


Figure 3.4 Lowering of Groundwater Level in Dayeuh Kolot Area

The WJOM implemented the simulation analysis on the change of groundwater level due to over extraction in 1997. Assuming that groundwater over extraction would be continuously under the same conditions, the simulated groundwater level is shown in Figure 3.5.

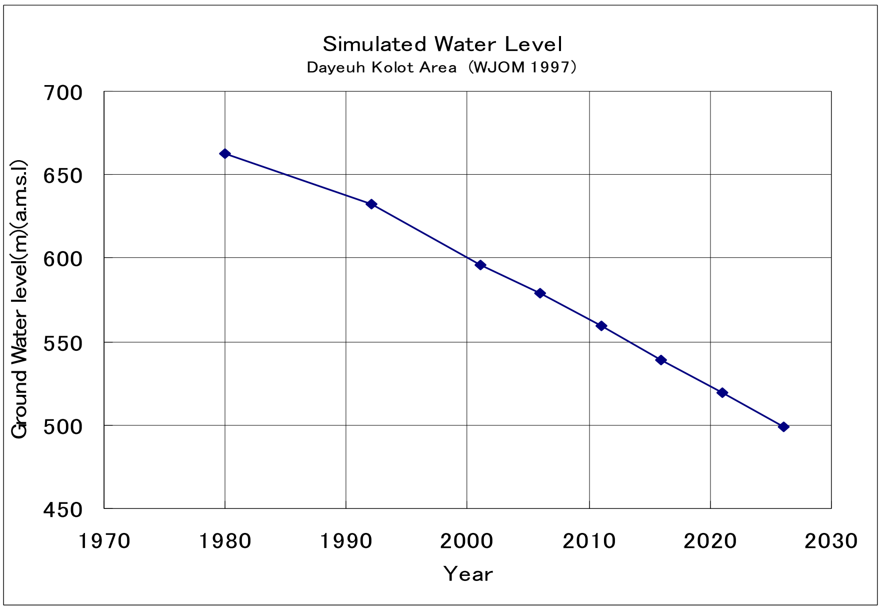


Figure 3.5 Simulated Groundwater Level (middle aquifer) at Dayeuh Kolot Area

Monitoring by WJOM (2004) in the period from 1992 until 2001 (9 years), showed the change of the water level in Dayeuh Kolot area was 35.98 m with a maximum drawdown rate of about 4.00 m per year. The simulated groundwater levels in 1992 and 2011 are shown in Figure.3.6. The lowest groundwater level in 1992 was 27.90 m b.g.l (+632.1m a.m.s.l) and changed to +556.22 m in 2011. This means that the water level has 75.88 m drawdown.

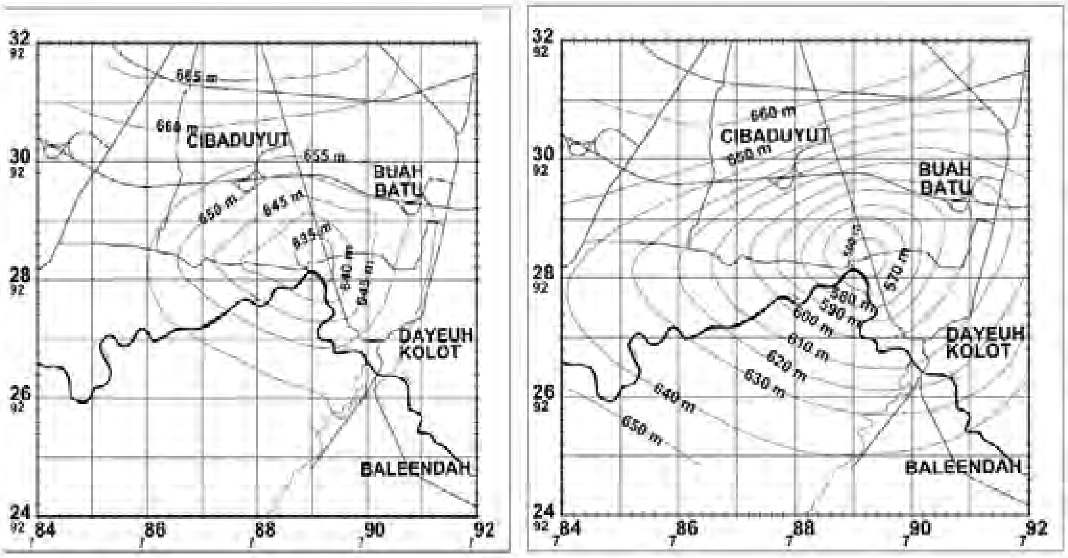


Figure 3.6 Simulated Groundwater Levels (1992 and 2011) in Dayeuh Kolot

Data from the investigation of groundwater potential in the Bandung Basin by WJOM in 2004 on groundwater level and lowering rate is shown in Table 3.2. WJOM is currently processing data for 2009.

3.4 Land Subsidence Phenomena

Theoretically, excessive groundwater extraction will lead to a decrease in the groundwater level, which in turn will cause land subsidence.

Land subsidence phenomena in Bandung basin have been studied several times using GPS survey methods since 2000, and using Interferometric System Aperture Reader (InSAR) since 2006.

In December 2003, topographic surveys were conducted by the Citarum Flood Control Project. According to the results of these surveys, discrepancies between the elevations of the surveyed points indicating the lowering of ground surface along the Citarum River, especially in the vicinity of Dayeuh Kolot, were observed. Land subsidence at Dayeuh Kolot has also been confirmed by the various observation methods mentioned above.

(1) Field Exploration

Photo 3.1 are samples of subsidence phenomena in Dayeuh Kolot. There are countless cracks in this area in buildings as well as roads. According to interviews with residents, the flood level is 2 m above the ground surface and floods have occurred recently, three or four times with every rainfall.

Photo 3.1 Sample of Subsidence Phenomena in Dayeuh Kolot
Left: Slanted wall by subsidence
Right: Some houses were re-built with the floor elevated above ground level to prevent flooding water (houses on the left). The house on the right was before the re-build.

(2) Existing Land Subsidence Data

ITB have been carrying out an investigation of land subsidence in Bandung Basin using GPS and InSAR. According to the investigation, land subsidence is continuing and becoming serious. Results from the GPS survey show that land subsidence has both temporal and spatial variations (Figure 3.6). In general, the rate of land subsidence is about 2-10 mm/month or 2-24cm/year (Abiddin et al. 2008) and 7.6 to 23 cm/year for the period 2000 to 2008 (Hassnudin et al. 2009). In particular, Cimahi, Dayeuh Kolot, Rancaekek and Gede Bage textile industry area have higher subsidence compared to other places. The results obtained from InSAR(Abidin et al. 2008) also show the same tendency of land subsidence.

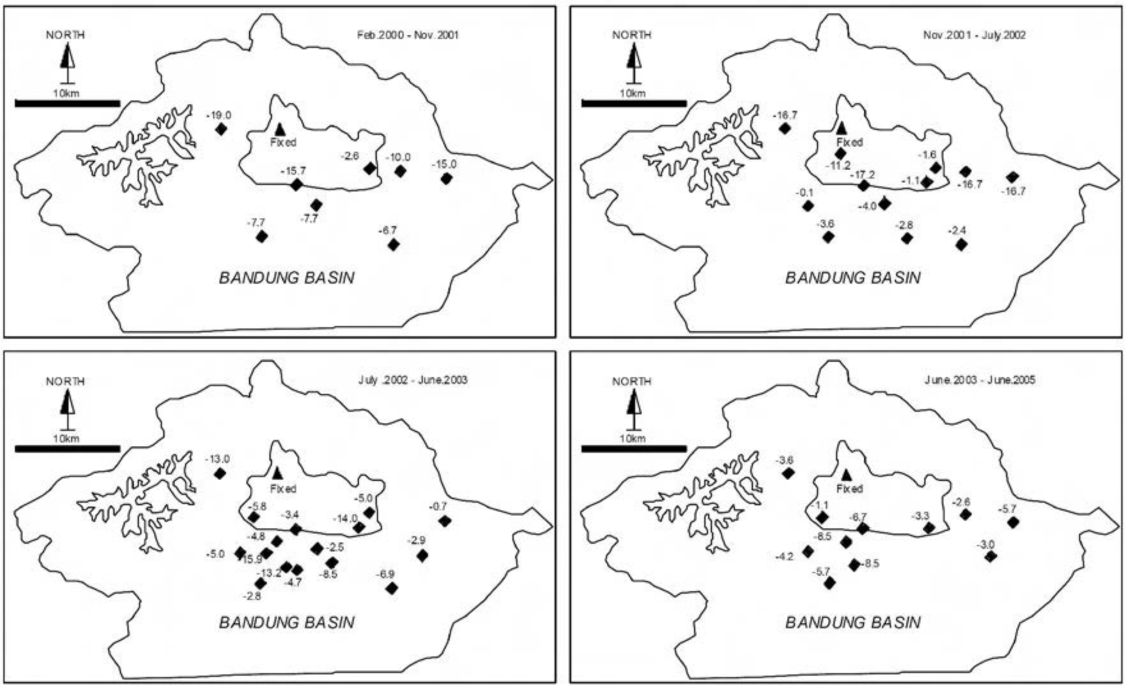


Figure 3.6 Subsidence rate (mm/month) in Bandung Basin During the period 2000-2005(Abidin et al. 2008)

In addition, the groundwater level reduction rate has increased recently in the Majalaya area and land subsidence is observed in the Majalaya area (Sri Sumantoyo Josaphat Tekuko, 2008).

(3) Field Survey

Field surveys were conducted at a) along the Citarum River and b) Dayeuh Kolot area using leveling instruments.

a) Location of the surveys is shown in Figure 3.7 and the results of the leveling surveys along the Citarum River (1996-2005 and 2003-2010) are shown in Figure 3.8 and 3.9. List of level at each survey point are shown in Table 3.3(1), 3.3(2) and 3.3(3).

According to Figure 3.8, during the period 2003 to 2010, 90 cm of land subsidence was observed at a rate of about 12 cm/year in the Dayeuh Kolot area.

b) In addition, since 2006, the Citarum Flood Control Project has established a monitoring system for land subsidence in the Dayeuh Kolot area comprised of 55 points with gridiron. The progression of land subsidence from 1996 until 2006 and the land subsidence rate in May 2010 are shown in Figure 3.10 and Figure 3.11. The progression of land subsidence at each survey point is shown in Table 3.4.

As shown in Figure 3.10, land subsidence is continuing, resulting in a total of more than 40 cm/3.5 years. A rate of 12 cm/year has been measured in the Dayeuh Kolot area.

The subsidence rate of each area in the Bandung basin obtained by GPS survey and leveling survey (JICA 2010) is shown in Table 3.4.

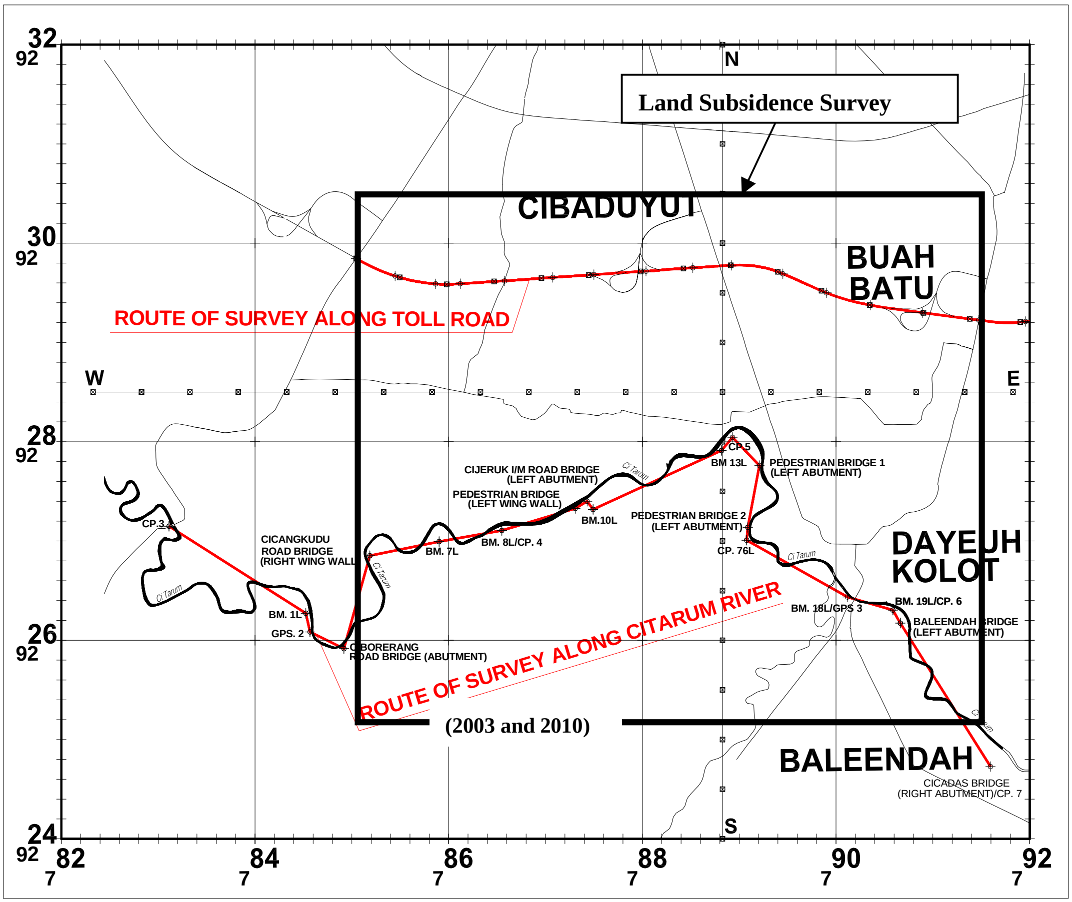


Figure 3.7 Location of Route Survey of along the Citarum River and Dayeuh Kolot Area

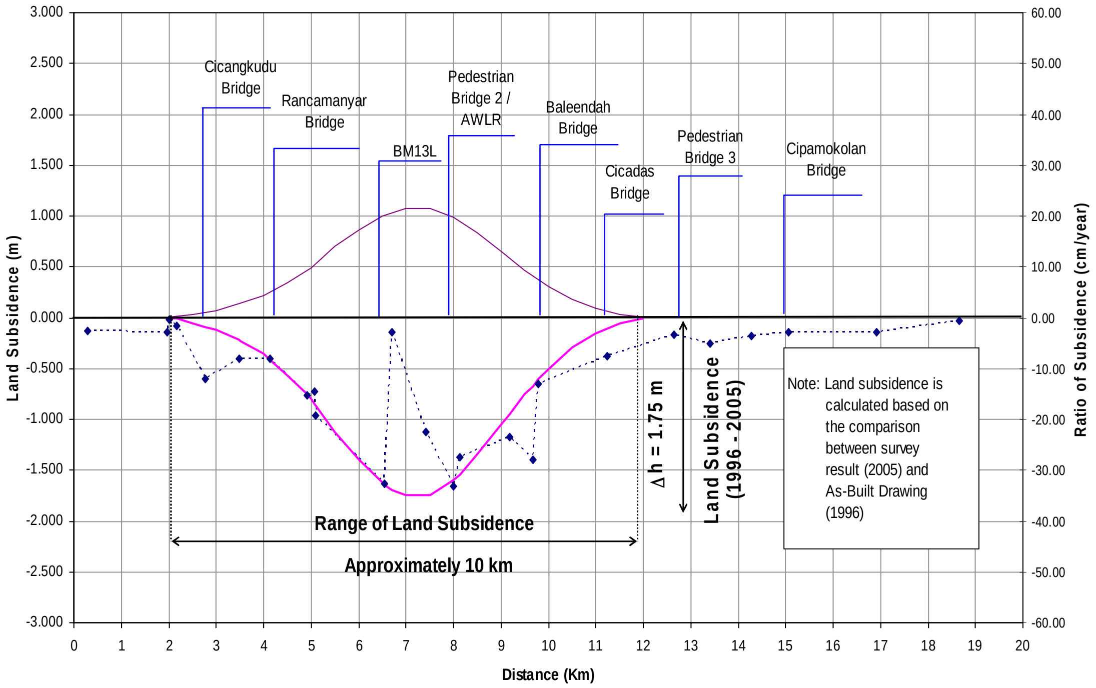


Figure 3.8 Section of Land Subsidence along the Citarum River (1996-2005)

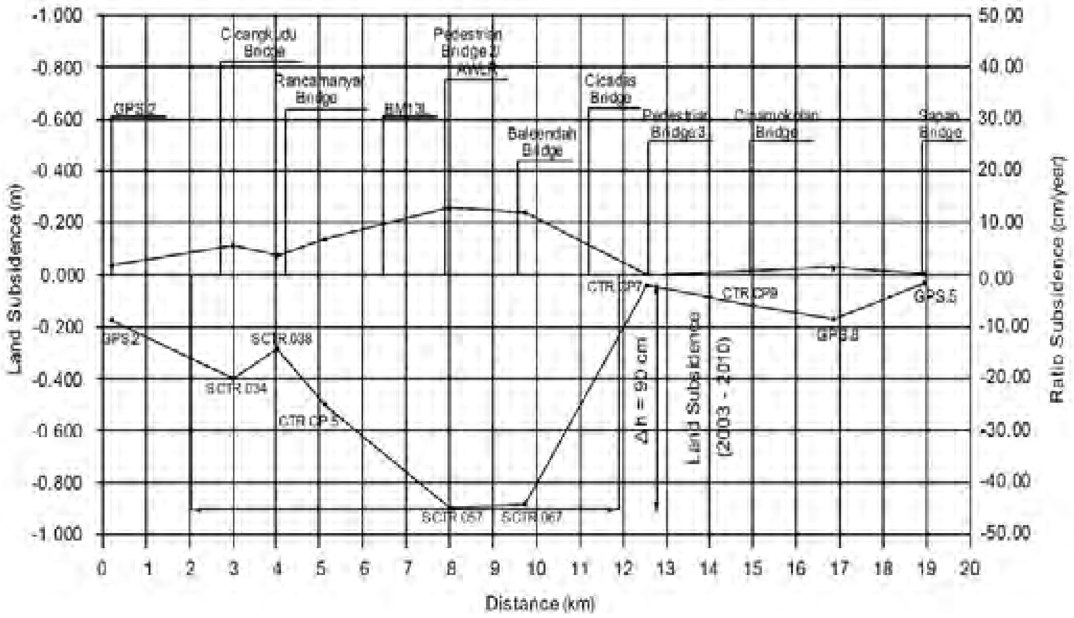


Figure 3.9 Section of Land Subsidence along the Citarum River (2003-2010)

Table 3.3(1)　List of Level at Each Survey Point（JICA 2010）

No of Structure	COORDINATE		Elevation	Elevation	Discrepancy	Elevation	Discrepancy	Elevation	Discrepancy	Discrepancy	Discrepancy	REMARK
	E	N	Dec,2003	Oct,2005	1 - 2	Nov,2007	2 - 3	April,2010	3 - 4	1 - 4	2 - 4	
	(m)	(m)	1	2	(cm)	3	(cm)	4	(cm)	(cm)	(cm)	
SCTR.001	780,748	9,228,776	+ 658.464	+ 658.432	3.2	+ 658.364	6.8	+ 658.128	23.6	33.6	30.4	At Citarum left bank, about 900m upstream of Daraulin Bridge, on drainage structure.
SCTR.002	781,657	9,228,247	+ 657.665	***+ 658.229***	***point changed***	***+ 657.440***	***point changed***	***no survey***	-		-	At Citarum left bank, on culvert at Sekene Village.
SCTR.003	782,200	9,227,759	+ 658.008	***+ 657.531***	***point changed***	+ 657.466	6.5	***no survey***	-		-	At Citarum left bank, on culvert at Cilampeni Village.
SCTR.004	782,416	9,227,570	+ 656.424	***+ 658.136***	***point changed***	***+ 657.760***	***point changed***	***no survey***	-		-	At Citarum left bank, on culvert at Cilampeni Village.
SCTR.005			+ 658.273	***+ 657.011***	***point changed***	+ 656.937	7.4	***no survey***	-		-	At Citarum left bank, on culvert at Cilampeni Village.
SCTR.006	782,199	9,227,761	+ 660.487	***+ 659.695***	***point changed***	+ 659.626	6.9	+ 659.155	47.1		54.0	At Citarum left bank, on culvert at Cilampeni Village.
SCTR.007			+ 656.995	***+ 658.177***	***point changed***	***no survey***	-	***no survey***	-		-	
SCTR.008			+ 656.333	***+ 656.866***	***point changed***	+ 656.815	5.1	+ 656.321	49.4		54.5	At Citarum left bank, on culvert .
SCTR.009			+ 657.071	+ 656.966	10.5	***no survey***	-	+ 657.055	-		-	
SCTR.010			+ 656.944	+ 656.841	10.3	***no survey***	-	***no survey***	-		-	
SCTR.011			+ 657.353	+ 657.243	11.0	+ 657.198	4.5	***no survey***	-		-	At Citarum left bank, on culvert at Pangauban Village.
SCTR.012			+ 658.017	+ 657.904	11.3	+ 657.851	5.3	***no survey***	-		-	At Citarum left bank, on culvert at Pangauban Village.
SCTR.013	782,811	9,226,563	+ 658.497	***no survey***	-	+ 658.413	-	+ 657.960	45.3		-	
SCTR.014			+ 654.645	***no survey***	-	***no survey***	-	***no survey***	-		-	
SCTR.015	783,001	9,226,309	+ 657.545	***no survey***	-	+ 657.435	-	+ 657.145	29.0		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.016			+ 656.758	+ 656.684	7.4	***no survey***	-	***no survey***	-		-	
SCTR.017	783,260	9,226,438	+ 659.197	***+ 657.603***	***point changed***	+ 657.586	1.7	+ 657.276	31.0		32.7	At Citarum left bank, at wing wall of Cisungka Bridge at Sangkanhurip Village.
SCTR.018	783,486	9,226,524	+ 657.445	+ 657.392	5.3	+ 657.421	-2.9	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.019			+ 658.646	+ 658.636	1.0	+ 658.636	0.0	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.020	783,771	9,226,244	-	+ 659.698	-	+ 659.668	3.0	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.021	783,973	9,226,263	+ 657.452	+ 657.430	2.2	+ 657.401	2.9	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.022	784,023	9,226,306	+ 657.922	***+ 657.019***	***point changed***	+ 657.015	0.4	***+ 657.914***	***point changed***		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.023			+ 657.033	+ 657.004	2.9	***no survey***	-	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.024	784,186	9,226,489	+ 658.494	+ 658.471	2.3	+ 658.424	4.7	+ 658.300	12.4	19.4	17.1	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.025			+ 657.786	+ 657.721	6.5	+ 657.703	1.8	***no survey***	-		-	At Citarum left bank, on culvert at Sangkanhurip Village.
SCTR.026	784,367	9,226,489	+ 658.260	***no survey***	-	***no survey***	-	+ 658.017	-		-	
SCTR.027	784,557	9,226,166	+ 657.233	***+ 658.206***	***point changed***	+ 658.161	4.5	+ 658.014	14.7		19.2	At Citarum left bank, on small bridge at Sangkanhurip Village.
SCTR.028	784,670	9,225,947	+ 660.036	+ 660.014	2.2	+ 659.987	2.7	+ 659.859	12.8	17.7	15.5	At Citarum left bank, on small bridge at Sangkanhurip Village.
SCTR.029	784,925	9,225,922	+ 660.505	+ 660.480	2.5	+ 660.456	2.4	+ 660.303	15.3	20.2	17.7	At Citarum left bank, at Cibolerang Bridge at Sukamukti Village.
SCTR.030	784,988	9,226,006	+ 658.156	+ 658.142	1.4	+ 658.142	0.0	+ 657.947	19.5	20.9	19.5	At Citarum left bank, at small bridge at Sukamukti Village.
SCTR.031	785,308	9,226,252	+ 658.602	+ 658.565	3.7	+ 658.525	4.0	+ 658.291	23.4	31.1	27.4	At Citarum left bank, at small bridge at Sukamukti Village.
SCTR.032	785,372	9,226,434	+ 658.983	+ 658.706	27.7	+ 658.485	22.1	***no survey***	-		-	At Citarum left bank, on culvert at Sukamukti Village.
SCTR.033			+ 658.325	+ 658.253	7.2	***no survey***	-	***no survey***	-		-	
SCTR.034	785,183	9,226,840	+ 658.950	***+ 659.181***	***point changed***	+ 658.895	28.6	+ 658.783	11.2		39.8	At Citarum left bank, on Cicangkudu Bridge.
SCTR.035			+ 658.260	***+ 659.221***	***point changed***	***no survey***	-	***no survey***	-		-	
SCTR.036			+ 658.226	+ 658.182	4.4	***no survey***	-	***no survey***	-		-	
SCTR.037	786,184	9,226,958	+ 659.083	+ 659.039	4.4	+ 658.986	5.3	+ 658.777	20.9	30.6	26.2	At Citarum left bank, on culvert, Rancamanyar Village.
SCTR.038	786,281	9,226,993	+ 658.907	+ 658.860	4.7	+ 658.816	4.4	+ 658.620	19.6	28.7	24.0	At Citarum left bank, on small bridge, Rancamanyar Village.
SCTR.039	786,445	9,227,071	+ 659.517	+ 659.465	5.2	***no survey***	-	+ 659.225	-		24.0	
SCTR.040A	786,531	9,227,123	+ 660.882	+ 660.677	20.5	+ 660.781	-10.4	***no survey***	-		-	At Citarum left bank, at wing wall of Rancamanyar Bridge, Rancamanyar Village.
SCTR.041	787,306	9,227,328	+ 658.134	***no survey***	-	***no survey***	-	+ 659.756	-		-	
SCTR.042	787,457	9,227,401	+ 658.970	***+ 659.874***	***point changed***	+ 659.846	2.8	***+ 658.219***	***point changed***		-	At Citarum left bank, at Cijambe/ Cijeruk Bridge, Rancamanyar Village.
SCTR.043			+ 658.410	+ 658.302	10.8	***no survey***	-	***no survey***	-		-	
SCTR.044			+ 658.561	***no survey***	-	***no survey***	-	***no survey***	-		-	
SCTR.045			+ 659.424	+ 659.240	18.4	***no survey***	-	***no survey***	-		-	
SCTR.046			+ 657.683	***+ 658.444***	***point changed***	***no survey***	-	***no survey***	-		-	
SCTR.047			+ 658.788	+ 658.570	21.8	***no survey***	-	***no survey***	-		-	
SCTR.048			+ 658.366	+ 658.177	18.9	***no survey***	-	+ 658.524	-		-34.7	
SCTR.051	789,221	9,227,760	+ 659.476	+ 659.294	18.2	+ 659.120	17.4	+ 658.830	29.0	64.6	46.4	At Citarum left bank, at Suspension Bridge, vicinity Suhada Mosque, Parunghalang Village.
SCTR.052	789,108	9,227,108	+ 659.512	+ 659.301	21.1	***no survey***	-	***no survey***	-		-	
SCTR.053			+ 660.004	+ 659.801	20.3	+ 659.717	8.4	***no survey***	-		-	At Citarum left bank, at Suspension Bridge, vicinity of AWLR Station, Bojongasih Village.
SCTR.054			+ 658.620	+ 658.418	20.2	+ 659.121	***point changed***	+ 658.690	43.1		-	At Citarum left bank, on culvert, Bojongasih Village.
SCTR.055			+ 658.603	+ 658.410	19.3	+ 658.678	***point changed***	***+ 657.753***	***point changed***		65.7	At Citarum left bank, on drainage structure, Bojongasih Village.
SCTR.056			+ 659.218	+ 659.000	21.8	+ 659.147	***point changed***	***no survey***	-		-	At Citarum left bank, on drainage structure, Ciodeng Village.
SCTR.057	789,371	9,226,777	+ 659.059	+ 658.846	21.3	+ 658.528	31.8	+ 658.146	38.2	91.3	70.0	At Citarum left bank, at Ciputat Bridge, Andir Village.
SCTR.058			+ 658.467	+ 658.280	18.7	+ 658.256	2.4	+ 657.901	35.5	56.6	37.9	At Citarum left bank, on box culvert, Andir Village.
SCTR.059			+ 658.414	+ 658.228	18.6	***no survey***	-	+ 658.137	-		9.1	

Table 3.3(2) List of Level at Each Survey Point (JICA 2010)

No of Structure	COORDINATE		Elevation	Elevation	Discrepancy	Elevation	Discrepancy	Elevation	Discrepancy	Discrepancy	Discrepancy	REMARK
	E	N	Dec,2003	Oct,2005	1 - 2	Nov,2007	2 - 3	April,2010	3 - 4	1 - 4	2 - 4	
	(m)	(m)	1	2	(cm)	3	(cm)	4	(cm)	(cm)	(cm)	
SCTR.060			+ 659.289	+ 659.106	18.3	+ 659.094	1.2	***no survey***	-		-	At Citarum left bank, on culvert, Andir Village.
SCTR.061			+ 658.910	+ 658.724	18.6	+ 659.191	***point changed***	+ 658.794	39.7		-	At Citarum left bank, on culvert, Andir Village.
SCTR.062			+ 659.708	+ 659.500	20.8	+ 659.450	5.0	***+ 658.641***	***point changed***		-	At Citarum left bank, on culvert, Andir Village.
SCTR.063			+ 658.559	+ 658.252	30.7	***no survey***	-	***no survey***	-		-	
SCTR.064	790,188	9,226,399	+ 658.529	+ 658.241	28.8	+ 658.236	0.5	***no survey***	-		-	At Citarum left bank, on kirmur of Dayeuhkolot New Bridge.
SCTR.065	790,244	9,226,363	+ 659.323	+ 659.142	18.1	+ 658.660	48.2	***no survey***	-		-	At Citarum left bank, on the floor of Dayeuhkolot Old Railway Bridge.
SCTR.066			+ 659.178	+ 658.840	33.8	+ 658.310	53.0	***no survey***	-		-	At Citarum left bank, on the wall of drain water gate Cieunteung Village.
SCTR.067	790,715	9,226,155	+ 660.025	***+ 661.133***	***point changed***	+ 660.705	42.8	+ 660.240	46.5		89.3	At Citarum left bank, at Baleendah Bridge.
SCTR.068			+ 659.717	***no survey***	-	***no survey***	-	***no survey***	-		-	
SCTR.069			+ 659.651	***+ 660.433***	***point changed***	+ 660.136	29.7	***+ 659.414***	***point changed***		-	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.071	791,012	9,225,692	+ 659.982	+ 659.959	2.3	+ 659.840	11.9	+ 659.529	31.1	45.3	43.0	At Citarum right bank, on small bridge at Bojongsari Village.
SCTR.072	791,075	9,225,433	+ 660.488	+ 660.487	0.1	+ 660.461	2.6	+ 660.345	11.6	14.3	14.2	At Citarum right bank, on small bridge at Bojongsari Village.
SCTR.073	791,212	9,225,374	+ 660.573	+ 660.570	0.3	+ 660.502	6.8	+ 660.467	3.5	10.6	10.3	At Citarum right bank, on small bridge at Bojongsari Village.
SCTR.074	791,325	9,225,277	+ 660.144	+ 660.166	-2.2	+ 660.137	2.9	+ 660.047	9.0	9.7	11.9	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.075	791,405	9,225,206	+ 660.877	***+ 660.415***	***point changed***	+ 660.433	-1.8	+ 660.330	10.3		8.5	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.076	791,484	9,225,153	+ 660.461	+ 660.489	-2.8	***+ 660.855***	***point changed***	+ 660.407	44.8		8.2	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.077	791,563	9,225,087	+ 660.252	+ 660.274	-2.2	+ 660.306	-3.2	+ 660.205	10.1	4.7	6.9	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.078	791,794	9,224,884	+ 660.484	+ 660.563	-7.9	+ 660.540	2.3	***no survey***	-		-	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.079			+ 660.385	+ 660.424	-3.9	+ 660.323	10.1	***no survey***	-		-	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.080	791,850	9,224,819	+ 660.407	+ 660.444	-3.7	+ 660.470	-2.6	+ 660.378	9.2	2.9	6.6	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.081	792,057	9,224,712	+ 661.430	+ 661.455	-2.5	+ 661.484	-2.9	+ 661.397	8.7	3.3	5.8	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.082	792,331	9,224,589	+ 660.670	+ 660.713	-4.3	+ 660.748	-3.5	+ 660.662	8.6	0.8	5.1	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.083	792,573	9,224,523	+ 660.932	+ 660.953	-2.1	+ 660.960	-0.7	+ 660.872	8.8	6.0	8.1	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.084	792,693	9,224,540	+ 660.879	+ 660.884	-0.5	+ 660.894	-1.0	+ 660.804	9.0	7.5	8.0	At Citarum right bank, on culvert at Bojongsari Village.
SCTR.085	792,840	9,224,580	+ 660.246	+ 660.274	-2.8	***+ 660.629***	***point changed***	+ 660.553	7.6		-	At Citarum right bank, on culvert at Leuwinutug Village.
SCTR.086	793,013	9,224,610	+ 661.519	+ 661.563	-4.4	+ 661.558	0.5	+ 661.419	13.9	10.0	14.4	At Citarum right bank, on small bridge at Leuwinutug Village.
SCTR.087	793,282	9,224,601	+ 660.580	+ 660.631	-5.1	+ 660.651	-2.0	+ 660.568	8.3	1.2	6.3	At Citarum right bank, on small bridge at Leuwinutug Village.
SCTR.088	793,325	9,224,581	+ 662.354	+ 662.283	7.1	+ 662.300	-1.7	+ 661.908	39.2	44.6	37.5	At Citarum right bank, at suspension bridge at Leuwinutug Village.
SCTR.089	793,483	9,224,671	+ 661.373	+ 661.410	-3.7	***+ 661.676***	***point changed***	+ 661.394	28.2		1.6	At Citarum right bank, on sluiceway at Leuwinutug Village.
SCTR.090	793,589	9,224,735	+ 660.889	+ 660.939	-5.0	+ 660.887	5.2	+ 660.887	0.0	0.2	5.2	At Citarum right bank, on sluiceway at Leuwinutug Village.
SCTR.091			+ 660.847	***+ 661.276***	***point changed***	+ 660.799	47.7	***no survey***	-		-	At Citarum right bank, on culvert at Leuwinutug Village.
SCTR.092	793,772	9,225,021	+ 661.262	+ 661.276	-1.4	+ 661.174	10.2	+ 661.126	4.8	13.6	15.0	At Citarum right bank, on culvert at Leuwinutug Village.
SCTR.093	793,801	9,225,161	+ 661.700	+ 661.695	0.5	+ 661.581	11.4	+ 661.510	7.1	19.0	18.5	At Citarum right bank, at Ciwastra Bridge.
SCTR.094	793,975	9,225,218	+ 661.184	+ 661.183	0.1	+ 661.081	10.2	+ 661.019	6.2	16.5	16.4	At Citarum right bank, at small bridge, Bojongsari Village.
SCTR.095	794,252	9,225,226	+ 660.730	+ 660.743	-1.3	+ 660.666	7.7	+ 660.632	3.4	9.8	11.1	At Citarum right bank, at small bridge, Cibisoro Village.
SCTR.096	794,463	9,225,101	+ 661.496	+ 661.522	-2.6	+ 661.440	8.2	+ 661.440	0.0	5.6	8.2	At Citarum right bank, at small bridge, Cibisoro Village.
SCTR.097	794,659	9,225,294	+ 661.521	+ 661.549	-2.8	+ 661.463	8.6	+ 661.443	2.0	7.8	10.6	At Citarum right bank, at small bridge, Cibisoro Village.
SCTR.098	794,820	9,225,517	+ 663.278	+ 663.297	-1.9	***no survey***	-	***no survey***	-		-	At Citarum right bank, using old benchmark, right bank of Cidurian , Cibisoro Village.
SCTR.099	794,879	9,225,474	+ 661.636	+ 661.668	-3.2	+ 661.597	7.1	+ 661.585	1.2	5.1	8.3	At Citarum right bank, on sluiceway , Cibisoro Village.
SCTR.100	795,260	9,225,770	+ 661.719	+ 661.748	-2.9	+ 661.684	6.4	+ 661.644	4.0	7.5	10.4	At Citarum right bank, on sluiceway , Rancaoray Village.
SCTR.101			+ 661.960	***no survey***	-	***no survey***	-	***no survey***	-		-	
SCTR.102	795,480	9,225,945	+ 661.960	+ 661.963	-0.3	+ 661.883	8.0	+ 661.862	2.1	9.8	10.1	At Citarum right bank, on sluiceway , Cibisoro Village.
SCTR.103	795,659	9,226,005	+ 661.305	+ 661.328	-2.3	+ 661.260	6.8	+ 661.227	3.3	7.8	10.1	At Citarum right bank, on sluiceway , Cibisoro Village.
SCTR.104			+ 662.673	+ 662.494	17.9	+ 662.418	7.6	***no survey***	-		-	At Citarum right bank, on sluiceway , Ciputat (Sapan) Village.
SCTR.105	796,173	9,226,181	+ 662.651	+ 662.664	-1.3	+ 662.593	7.1	+ 662.549	4.4	10.2	11.5	At Citarum right bank, on sluiceway , Ciputat (Sapan) Village.
SCTR.106	796,281	9,226,213	+ 662.158	+ 662.182	-2.4	***no survey***	-	+ 662.075	-		10.7	At Citarum right bank, on sluiceway , Ciputat (Sapan) Village.
SCTR.107	796,508	9,226,404	+ 662.028	+ 662.047	-1.9	+ 661.994	5.3	+ 661.970	2.4	5.8	7.7	At Citarum right bank, at pump house , Rancatatang Village.
SCTR.108	796,664	9,226,481	+ 661.603	+ 661.628	-2.5	+ 661.579	4.9	+ 661.540	3.9	6.3	8.8	At Citarum right bank, on sluice way , Rancatatang Village.
SCTR.109	796,942	9,226,533	+ 661.008	+ 661.054	-4.6	+ 660.986	6.8	+ 660.954	3.2	5.4	10.0	At Citarum right bank, on sluice way , Rancatatang Village.
SCTR.110	797,082	9,226,557	+ 661.551	+ 661.583	-3.2	+ 661.544	3.9	+ 661.493	5.1	5.8	9.0	At Citarum right bank, on sluice way , Sapan Village.
SCTR.111	797,266	9,226,569	+ 661.392	+ 661.428	-3.6	+ 661.385	4.3	+ 661.281	10.4	11.1	14.7	At Citarum right bank, on sluice way , Sapan Village.
SCTR.112	797,605	9,226,684	+ 661.680	+ 661.695	-1.5	+ 661.666	2.9	+ 661.616	5.0	6.4	7.9	At Citarum right bank, on sluice way , Sapan Village.
SCTR.113	797,828	9,226,754	+ 661.680	***+ 661.876***	***point changed***	+ 661.822	5.4	+ 661.750	7.2		12.6	At Citarum right bank, on sluice way , Sapan Village.
SCTR.114	797,935	9,226,778	+ 661.691	+ 661.693	-0.2	+ 661.633	6.0	+ 661.409	***point changed***		-	At Citarum right bank, on sluice way , vicinity of Citra Factory, Sapan Village.
SCTR.115	798,346	9,226,757	+ 661.539	+ 661.551	-1.2	+ 661.464	8.7	+ 661.373	9.1	16.6	17.8	At Citarum right bank, on sluice way , vicinity of Cikeruh estuary, Sapan Village.
SCTR.116	798,563	9,226,711	+ 661.556	+ 661.575	-1.9	+ 661.531	4.4	+ 661.467	6.4	8.9	10.8	At Citarum right bank, on sluice way , vicinity of Citarik estuary, Sapan Village.
SCTR.117	798,758	9,226,572	+ 662.164	+ 662.167	-0.3	+ 662.114	5.3	+ 662.017	9.7	14.7	15.0	At Citarum right bank, on sluice way , 100m downstream of Sapan Bridge, Sapan Village.

- The discrepancies cannot be obtained if the point changed, damaged or no surveyed.

- Coordinates of points observed by Handheld GPS with accuracy of 10m.

Table 3.3(3) List of Level at Each Survey Point (JICA 2010)

No.	No. of Control Point	COORDINATE		Elevation		Discrepancy	Elevation	Discrepancy	Elevation	Discrepancy			REMARK
		E	N	Des,2003	Oct,2005	1 - 2	Nov,2007	2 - 3	April, 2010	3 - 4	1 - 4	2 - 4	
				1	2	(cm)	3	(cm)	4	(cm)	(cm)	(cm)	
1	GPS.1	780,267	9,229,623	+ 663.565	+ 663.565	0.0	+ 663.548	1.7	+ 663.377	17.1	18.8	18.8	On the Daraulin Bridge Side walk, Nanjung Village.
2	GPS.2	784,551	9,226,077	+ 660.574	+ 660.553	2.1	+ 660.527	2.6	+ 660.396	13.1	17.8	15.7	At the left bank of Citarum River, Sangkanhurip Village, Katapang Sub-district.
3	GPS.3	790,118	9,226,438	+ 659.386	+ 659.118	26.8	*no survey*	-	*no survey*	-	-	-	At the left bank of Citarum River, Andir Village, ± 100m down-stream of Dayeuhkolot Bridge,covered by illegal house.
4	GPS.4	795,384	9,225,940	+ 663.428	+ 663.450	-2.2	+ 663.391	5.9	+ 663.340	5.1	8.8	11.0	On the Cipamokolan Bridge Side walk, Buahbatu Village, Bojongsoang Sub-district.
5	GPS.5	798,888	9,226,488	+ 664.953	+ 664.982	-2.9	+ 664.964	1.8	+ 664.901	6.3	5.2	8.1	On the Sapan Bridge Side walk.
6	CTR.CP.1	780,711	9,228,827	+ 658.178	+ 658.143	3.5	+ 658.085	5.8	+ 657.852	23.3	32.6	29.1	At the left abutment of Mahmud Bridge, Cicukang Village, Margahayu Sub-district.
7	CTR.CP.2	780,757	9,228,784	+ 659.295	+ 659.233	6.2	+ 659.174	5.9	+ 658.886	28.8	40.9	34.7	On the Ciwidey Bridge Side walk.
8	CTR.CP.3	783,121	9,227,146	+ 659.495	+ 659.367	12.8	*no survey*	-	*no survey*	-	-	-	Close to Cilampeni Bridge, previously BM.CP.40AL, damaged.
9	CTR.CP.4	786,562	9,227,104	+ 661.418	+ 661.363	5.5	+ 661.309	5.4	*no survey*	-	-	-	At the yard corner of Primary School, Rancamanyar II, damaged.
10	CTR.CP.5	788,923	9,228,043	+ 658.959	+ 658.813	14.6	+ 658.690	12.3	+ 658.421	26.9	53.8	39.2	At the left abutment of Cable Bridge, Parunghalang.
11	CTR.CP.6	784,551	9,226,077	+ 659.669	+ 659.272	39.7	+ 658.729	54.3	*no survey*	-	-	-	At the Mekarsari Village, vicinity Baaleendah Bridge, buried.
12	CTR.CP.7	791,999	9,224,728	+ 662.400	+ 662.422	-2.2	+ 662.466	-4.4	+ 662.368	9.8	3.2	5.4	On the Cicadas Bridge Side Walk.
13	CTR.CP.8	793,808	9,225,184	+ 662.509	+ 662.543	-3.4	+ 662.420	12.3	+ 662.366	5.4	14.3	17.7	At the corner of field of Bojongsari Village.
14	CTR.CP.9	797,165	9,226,542	+ 662.612	+ 662.646	-3.4	+ 662.620	2.6	+ 662.566	5.4	4.6	8.0	At the bolt of right abutment of Suspension Bridge, Tegal Luar Village.

Note :
- GPS.3 cannot be measured due to occupied by illegal house.
- CP.3 was damaged before November 2007.
- Coordinates of points observed by Handheld GPS with accuracy of 10m.

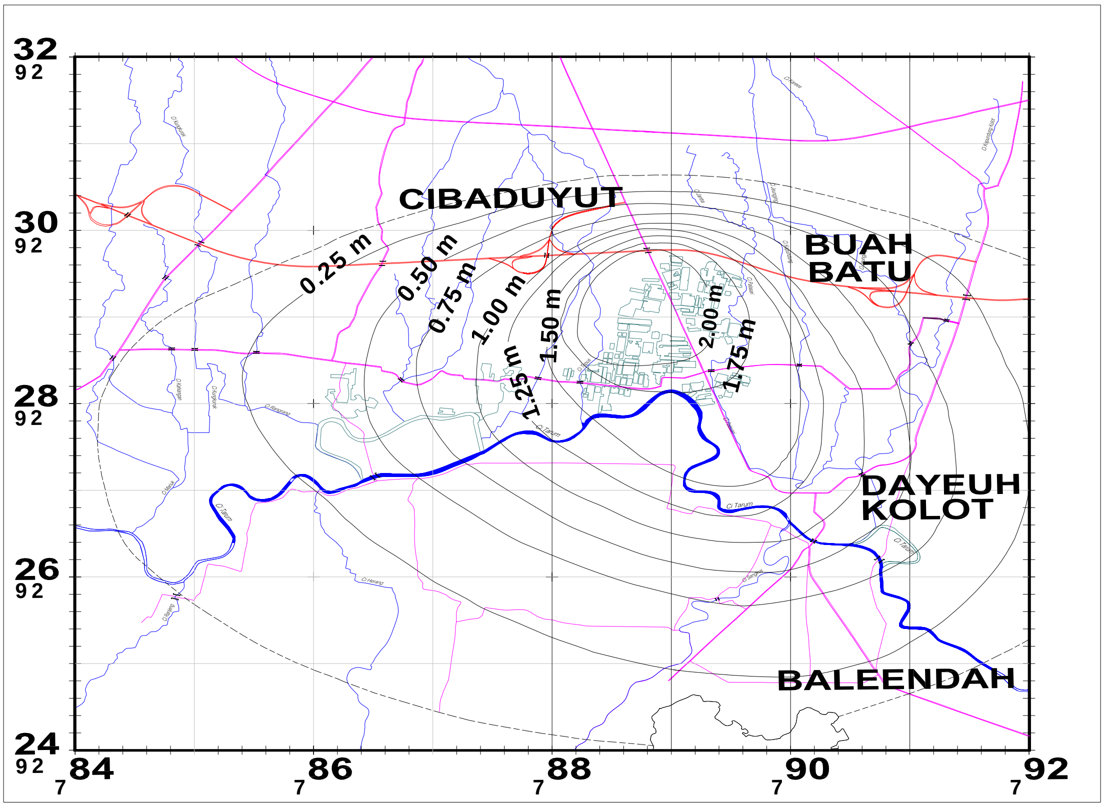


Figure. 3.10 Progress of Land Subsidence from 1996 until 2006(Citarum Basin office, 2007)

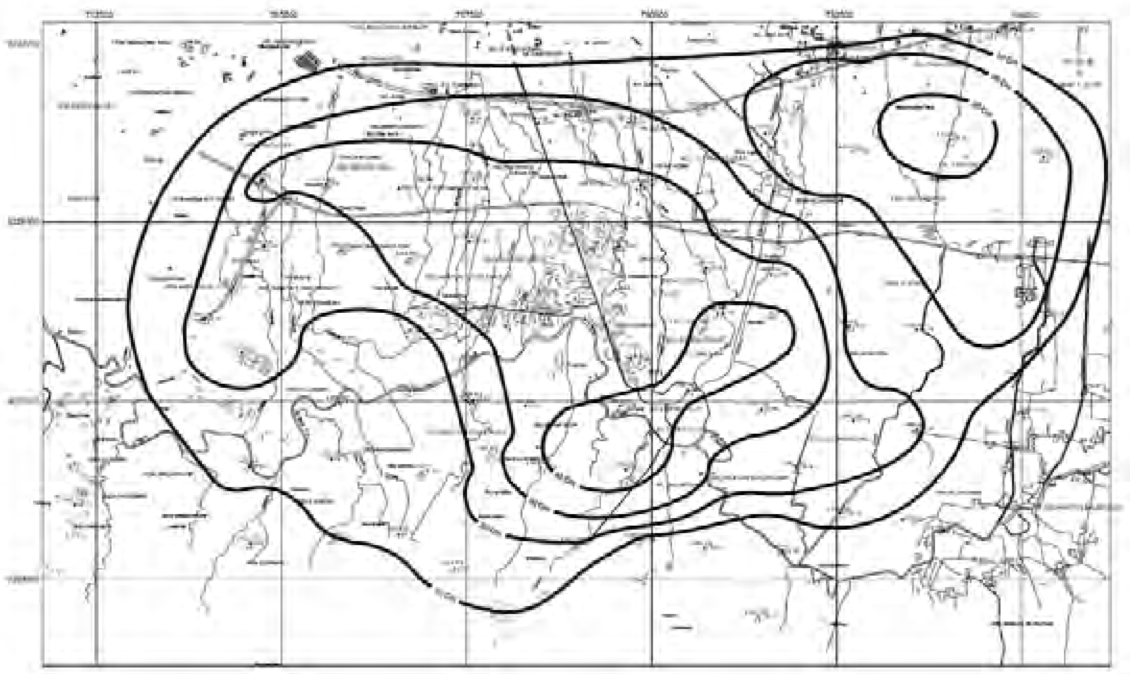


Figure 3.11 Land Subsidence Rate from Nov.2006 until May 2010(JICA 2010)

Table 3.4 Progress of Land Subsidence at Dayeuh Kolot

No	Point	Location		Coordinate		Elevation of Point			Progress of Subsidence (cm) (1−2)	Progress of Subsidence (m amsl) (1−3)	Progress of Subsidence (cm) (2−3)
		village	Sub−District	X	Y	Nov 2006 (m amsl) (1)	May 2007 (m amsl) (2)	May 2010 (m amsl) (3)			
1	TTG. 6	Cileunyi	Cileunyi	804227	9232068	+ 693.801	+ 693.801	+ 693.801	0.00	0.000	0.00
2	BM.26							+ 673.950			
3	Survey	Cibaduyut	Bojongloa Kidul	786610	9230956	+ 679.155	+ 679.148	−	0.70		
4	GPS.2	Sangkanhurip	Katapang	784564	9226083	+ 660.541	+ 660.489	+ 660.415	5.20	12.6	7.4
5	BPN.1	Cibaduyut Kidul	Bojongloa Kidul	786585	9229969	+ 671.770	+ 671.738	−	3.20		
6	PU.1	Wates	Bandung Kidul	788799	9229771	+ 671.049	+ 670.969	−	8.00		
7	LS−1	Margasuka	Margahayu	784739	9230089	+ 672.914	+ 672.894	+ 672.608	2.00	30.6	28.6
8	LS−2	Sayati	Margahayu	784767	9229152	+ 666.914	+ 666.895	+ 666.616	1.90	29.8	27.9
9	LS−3	Sayati	Margahayu	784348	9228585	+ 664.604	+ 664.603	+ 664.322	0.10	28.2	28.1
10	LS−4	Sayati	Margahayu	784467	9227674	+ 662.240	+ 662.146	+ 661.950	9.40	29.0	19.6
11	LS−5	Sukamukti	Pameungpeuk	784577	9225003	+ 663.777	+ 663.772	+ 663.721	0.50	5.6	5.1
12	LS−6	Cirangrang	Bojongloa Kidul	785597	9230023	+ 672.188	+ 672.171	+ 671.883	1.70	30.5	28.8
13	LS−7	Sukamenak	Margahayu	785793	9229096	+ 666.306	+ 666.302	+ 666.047	0.40	25.9	25.5
14	LS−8	Sukamenak	Margahayu	785886	9227806	+ 660.913	***+ 659.952***	+ 659.773	−		
15	LS−9	Rancamanyar	Baleendah	785787	9226978	+ 658.390	***+ 658.502***	+ 658.452	−		
16	LS−10	Sukamukti	Katapang	785677	9226191	+ 659.293	+ 659.270	***+ 659.157***	2.30	13.6	11.3
17	LS−11	Sukamukti	Katapang	785699	9225074	+ 662.659	+ 662.658	+ 662.564	0.10	9.5	9.4
18	LS−12	Cangkuang Kulon	Dayeuhkolot	786724	9228981	+ 665.196	+ 665.142	+ 664.892	5.40	30.4	25.0
19	LS−13	Cangkuang Kulon	Dayeuhkolot	786886	9228219	+ 663.652	+ 663.620	+ 663.448	3.20	20.4	17.2
20	LS−14	Rancamanyar	Baleendah	786733	9227141	+ 661.826	+ 661.804	+ 661.702	2.20	12.4	10.2
21	LS−15	Rancamanyar	Baleendah	786880	9226003	+ 662.135	+ 662.132	+ 662.007	0.30	12.8	12.5
22	LS−16	Rancamanyar	Baleendah	786584	9225132	+ 663.571	+ 663.568	+ 663.449	0.30	12.2	11.9
23	LS−17	Mekarwangi	Bojongloa Kidul	787581	9230953	+ 679.773	+ 679.750	+ 679.527	2.30	24.6	22.3
24	LS−18	Cibaduyut Wetan	Bojongloa Kidul	787590	9230106	+ 673.648	+ 673.624	+ 673.338	2.40	31.0	28.6
25	LS−19	Cangkuang Wetan	Dayeuhkolot	787546	9229224	+ 665.983	+ 665.942	***+ 666.833***	4.10		
26	LS−20	Cangkuang Wetan	Dayeuhkolot	787493	9228273	+ 662.530	+ 662.510	***+ 662.372***	2.00		
27	LS−21	Bojongmalaka	Baleendah	787598	9227023	+ 659.060	+ 659.021	+ 658.815	3.90	24.5	20.6
28	LS−22	Bojongmalaka	Baleendah	787810	9226269	+ 661.226	+ 661.250	+ 660.981	−2.40	24.5	26.9
29	LS−23	Malaka Sari	Pameungpeuk	787338	9224658	+ 661.929	+ 661.925	+ 661.774	0.40	15.5	15.1
30	LS−24	Ciseureuh	Bandung Kidul	788467	9230878	+ 678.348	+ 678.279	***+ 678.418***	6.90		
31	LS−25	Pasawahan	Dayeuhkolot	789016	9229107	+ 663.633	+ 663.564	***+ 663.301***	6.90		
32	LS−26	Pasawahan	Dayeuhkolot	788515	9228207	+ 660.295	+ 660.237	***+ 660.561***	5.80		
33	LS−27	Bojongmalaka	Baleendah	788336	9227001	+ 659.832	+ 659.632	***+ 659.356***	20.00		
34	LS−28	Andir	Baleendah	788495	9226060	+ 662.349	+ 662.285	+ 661.950	6.40	39.9	33.5
35	LS−29	Andir	Baleendah	788954	9224990	+ 661.514	+ 661.509	+ 661.350	0.50	16.4	15.9
36	LS−30	Batununggal	Bandung Kidul	789683	9230894	+ 677.749	+ 677.732	+ 677.518	1.70	23.1	21.4
37	LS−31	Mengger	Bandung Kidul	789847	9230002	+ 671.851	+ 671.802	+ 671.506	4.90	34.5	29.6
38	LS−32	Sukapura	Dayeuhkolot	789567	9229151	+ 664.890	+ 664.856	+ 664.546	3.40	34.4	31.0
39	LS−33	Citeureup	Dayeuhkolot	789414	9227951	+ 659.043	+ 658.855	+ 658.727	18.80	31.6	12.8
40	LS−34	Dayeuhkolot	Dayeuhkolot	789574	9226932	+ 659.095	+ 658.916	+ 658.648	17.90	44.7	26.8
41	LS−35	Andir	Baleendah	789644	9226042	+ 659.676	+ 659.508	***+ 659.262***	16.80		
42	LS−36	Baleendah	Baleendah	789826	9225049	+ 660.633	+ 660.627	+ 660.537	0.60	9.6	9.0
43	LS−37	Batununggal	Bandung Kidul	790641	9231068	+ 678.603	+ 678.603	+ 678.437	0.00	16.6	16.6
44	LS−38	Mengger	Bandung Kidul	790634	9229897	+ 670.958	+ 670.912	−	4.60		
45	LS−39	Sukapura	Dayeuhkolot	790734	9228848	+ 665.862	+ 665.694	+ 665.515	16.80	34.7	17.9
46	LS−40	Citeureup	Dayeuhkolot	790892	9228218	+ 663.068	+ 662.901	+ 662.661	16.70	40.7	24.0
47	LS−41	Dayeuhkolot	Dayeuhkolot	790490	9227151	+ 660.571	+ 660.484	+ 660.157	8.70	41.4	32.7
48	LS−42	Baleendah	Baleendah	790663	9225983	+ 660.546	+ 660.438	−	10.80		
49	LS−43	Baleendah	Baleendah	790706	9224932	+ 663.530	+ 663.529	+ 663.515	0.10	1.5	1.4
50	LS−44	Batununggal	Bandung Kidul	791531	9230741	+ 673.060	+ 673.058	***+ 672.963***	0.20	9.7	9.5
51	LS−45	Kujangsari	Margacinta	791652	9229933	+ 668.761	+ 668.732	+ 668.566	2.90	19.5	16.6
52	LS−46	Cipagalo	Bojong Soang	791616	9228757	+ 666.208	+ 666.144	***+ 665.834***	6.40	37.4	31.0
53	LS−47	Lengkong	Bojong Soang	791623	9228221	+ 664.586	+ 664.547	+ 664.151	3.90	43.5	39.6
54	LS−48	Bojong Soang	Bojong Soang	791478	9226892	+ 661.488	+ 661.439	+ 661.162	4.90	32.6	27.7
55	LS−49	Bojong Soang	Bojong Soang	791959	9226066	+ 661.631	+ 661.593	+ 661.389	3.80	24.2	20.4
56	LS−50	Bojongsari	Bojong Soang	791771	9224902	+ 660.733	+ 660.706	+ 660.651	2.70	8.2	5.5
57	CP.1			802318	9232163	+ 678.495	+ 678.495	−	0.00		
58	CP.2	Pasir Mekar	Cibiru	800548	9232585	+ 678.561	+ 678.561	+ 678.551	0.00	1.0	1.0
59	CP.3	Mekar Mulya	Cipadung	798750	9232430	+ 670.578	+ 670.578	−	0.00		
60	CP.4	Cisaranten Kulon	Arcamanik	796716	9232301	+ 670.409	+ 670.409	−	0.00		
61	CP.5	Sekejati	Margasari	794672	9232159	+ 672.518	+ 672.518	−	0.00		
62	CP.6	Sekejati	Margacinta	792801	9231723	+ 675.181	+ 675.189	+ 674.980	−0.80	20.1	20.9
63	CP.7	Ciseureuh	Bojongloa Kidul	788173	9231170	+ 682.560	+ 682.539	***+ 682.097***	2.10		
64	CP.8	Cibaduyut	Bojongloa Kidul	786153	9231453	+ 685.867	+ 685.861	***+ 685.192***	0.60		
65	CP.9	Sayati	Margahayu	785034	9229817	+ 672.042	+ 672.041	+ 671.767	0.10	27.5	27.4
66	CP.10	Sayati	Margahayu	783956	9228129	+ 663.495	+ 663.494	+ 663.251	0.10	24.4	24.3
67	CP.11	Pangauban	Katapang	782208	9225547	+ 665.429	+ 665.429	***+ 665.288***	0.00		
68	CP.12	Baleendah	Baleendah	791445	9223966	+ 664.833	+ 664.833	+ 664.792	0.00	4.1	4.1
69	CP.13/	Jelekong	Baleendah	793372	9223179	+ 664.281	−	−			
70	CP.14	Bojongsari	Bojongsoang	793903	9225147	+ 661.569	+ 661.552	+ 661.541	1.70	2.8	1.1
71	CP.15	Bojongsari	Bojongsoang	794885	9226328	+ 664.585	+ 664.583	***+ 664.253***	0.20		
72	CP.16	Buahbatu	Bojongsoang	795427	9228369	+ 664.914	+ 664.913	***+ 664.627***	0.10		
73	CP.17	Margasari	Margacinta	795296	9230412	+ 668.214	+ 668.198	+ 667.934	1.60	28.0	26.4
74	CP.18	Margasari	Margacinta	794034	9230644	+ 668.717	+ 668.714	+ 668.361	0.30	35.6	35.3
75	CP.19	Cipagalo	Bojongsoang	793576	9227987	+ 663.392	+ 663.382	***+ 662.984***	1.00		
76	CP.20	Lengkong	Bojongsoang	793585	9226603	+ 662.227	+ 662.205	+ 662.027	2.20	20.0	17.8
77	CP.21	Bojongsari	Bojongsoang	793390	9225341	+ 661.830	+ 661.816	−	1.40		
78	CP.22	Margasenang	Margacinta	792715	9230482	+ 670.260	+ 670.216	***+ 670.223***	4.40		
79	CP.23	Lengkong	Bojongsoang	792662	9228031	+ 663.602	+ 663.571	+ 663.410	3.10	19.2	16.1
80	CP.24	Bojongsoang	Bojongsoang	792595	9226766	+ 662.224	+ 662.214	***+ 662.130***	1.00		
81	CCD.1L	Bojongsari	Bojongsoang	792555	9225422	+ 662.245	+ 662.222	+ 662.101	2.30	14.4	12.1

Note : Coordinates of points observed by Handheld GPS.

Table 3.5 Subsidence Rate in the Bandung basin (Hasanuddin et al.2009) (cm)

GPS Location	**Feb.2000 -Nov.2001**	**Nov.2001 -Jul.2002**	**Jul.2002 -Jun.2003**	**Jun.2003 -Jun2005**	**Jun.2005 -Aug.2008**	**Nov.2006 -May 2010 (JICA 2010)**
Cimahi (CMH1)	-22.8	-17.6	-15.7	-4.4	-	-
Dayeuh Kolot (DYHK)	-18.8	-18.2	-4.1	-8.1	-10.9	-34.4
Majalaya (MJL1)	-8.1	-2.5	-8.2	-	-2.2	-
Rancaekek (RCK2)	-18.0	-14.8	-0.8	-6.9	-5.9	-

4. Forecasting of Land Subsidence

4.1 Calculated by Laboratory Test

Settlement of cohesive soil is calculated by the following formula:

$$S = H\frac{Cc}{1+e_0}\log\frac{p_0+\Delta p}{p_0} \text{ ……………………………………………………. (4-1)}$$

Where:

S: Settlement

H: Thickness of Cohesive soil

Cc: Coefficient of Compressibility

e_0 : Initial Void Ratio

p_0 : Initial Consolidation Pressure

Δp : Increased Consolidation Pressure

If the water level decreases from 4.45 m (b.g.l) to 60 m (b.g.l) at Dayeuh Kolot (Borehole No. BH26 (Soil Investigation Vol. I, II, Citarum Basin Office 2006), the settlement of cohesive soil (4.45 m – 33 m b.g.l) is calculated as follows (refer Figure. 4.1):

H=28.55 m

Cc= 0.33(from result of laboratory test)

e_0 =1.2(from result of laboratory test)

p_0 =16.62 t/m^2

Δp =13.5 t/m^2

When the above value is substituted into formula (4-1),

S= 1.10 m

the relationship between time and settlement is calculated by the following formula:

$$T_v = C_v t / H^2 \text{ ………………………………………………………………. (4-2)}$$

$$St = S \times U = S \times f(T\ ) \text{ ……………………………………………………... (4.3)}$$

Where:

T_v : Time factor

C_v : Coefficient of consolidation (=0.006 cm^2/secfrom result of laboratory test)

t: Consolidation time

2H: Thickness of Cohesive soil (=28.55m)

St: Settlement of its time

S: Final settlement

U: Degree of consolidation

The relationship between *U* and *Tv* is shown in the table below:

Table 4.1 Relationship between U and Tv (drainage length is H)

U(%)	10	20	30	40	50	60	70	80	90
Tv	0.048	0.090	0.115	0.207	0.281	0.371	0.488	0.652	0.933

The relationship between *St* and *t* calculated by the above formula is shown in Figure 4.2. Actual settlement is about 1.75 m (Citarum Basin Office 2007) during the 10-year period and actual settlement is bigger than the calculated final settlement (=110 cm).

The discrepancy can be explained by the following reasons:

- The amount of estimated settlement of subject layers is from the surface to 33 m.
- The amount of actual settlement includes deep layer’s settlement.
- The amount of land subsidence is influenced by other factors (geological structure, compressibility at the observed locations).

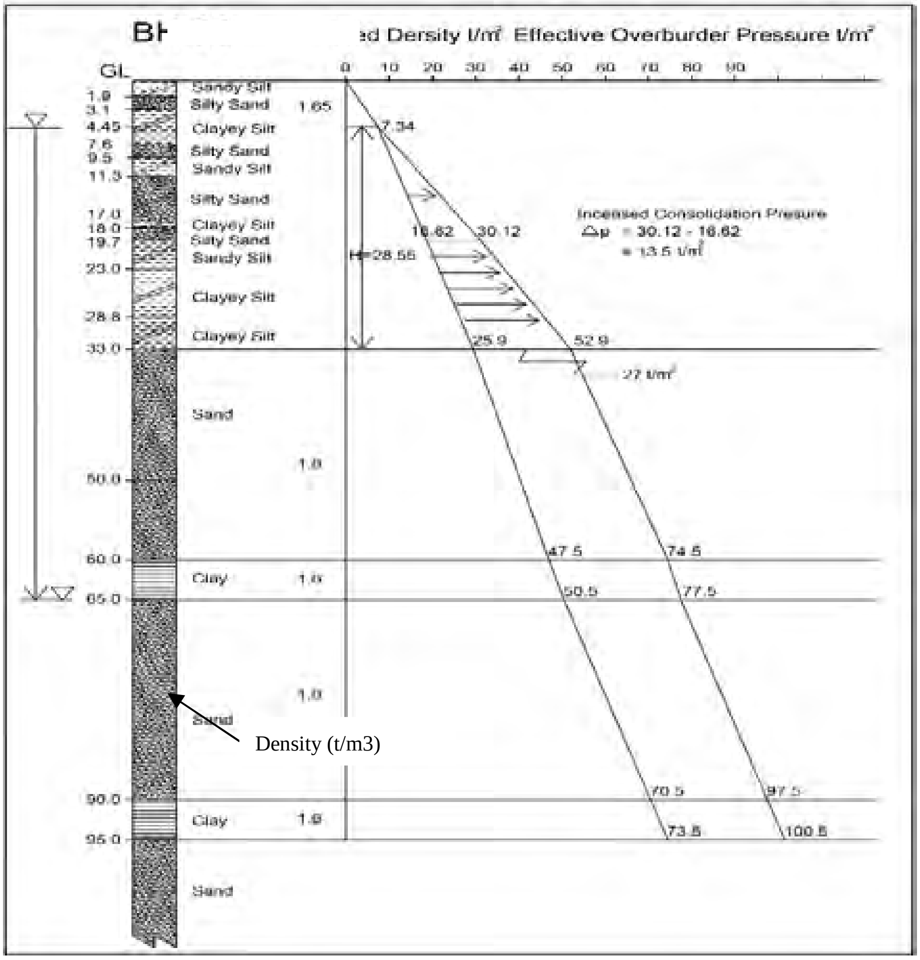


Figure 4.1 Calculation of Increased Consolidation Pressure

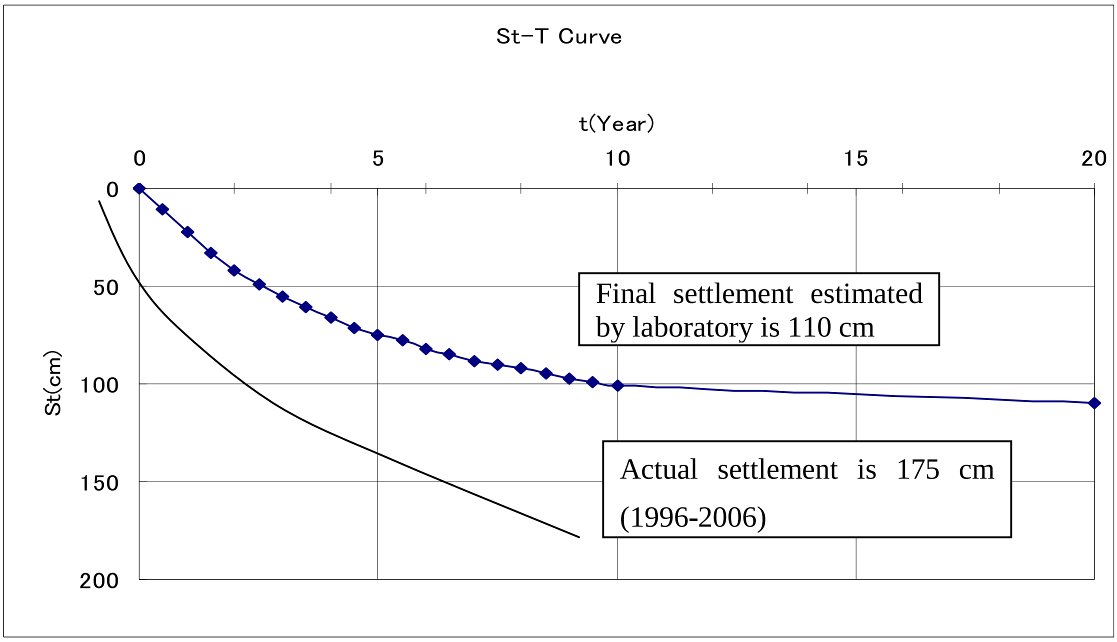


Figure 4.2 Relationship between settlement and time at Dayeuh Kolot

4.2 Correlation between Lowering Groundwater Level and Land Subsidence Rate

Correlation between land subsidence and groundwater extraction can be done by measuring the registered groundwater extraction volume and the observed groundwater level as shown in the study by Abidin et al. (2006, 2008) using a GPS survey. However, GPS-delivered land subsidence data does not always have a positive correlation with the volume of groundwater extraction around the corresponding GPS because of the following factors:

- The registered groundwater extraction volume does not reflect the real groundwater use.
- The amount of land subsidence is influenced by other factors (geological structure, compressibility at the observed locations).

The above reasons may be valid for the Bandung Basin.

The correlation between lowering rates of the groundwater level and rates of land subsidence in the Bandung Basin (Hasanuddin et al. 2009) is shown in Figure 4.3.

Actual land subsidence at Dayeuh Kolot observed with GPS and the leveling survey is shown in Figure 4.4. (Lowering rates of groundwater is 4.1m/year and rate of land subsidence is 12 cm/year) As shown in this figure, estimated land subsidence and observed subsidence is nearly the same but the discrepancy is due to the geological condition and compressibility at the observed locations.

Furthermore, according to the Citarum Basin Office 2006, the lowering rate of groundwater is 4 m/year and the land subsidence rate is from 10 to 20 cm/year based on the present groundwater level and observed land subsidence at Dayeuh Kolot (Figure 4.5 and Table 4.2).

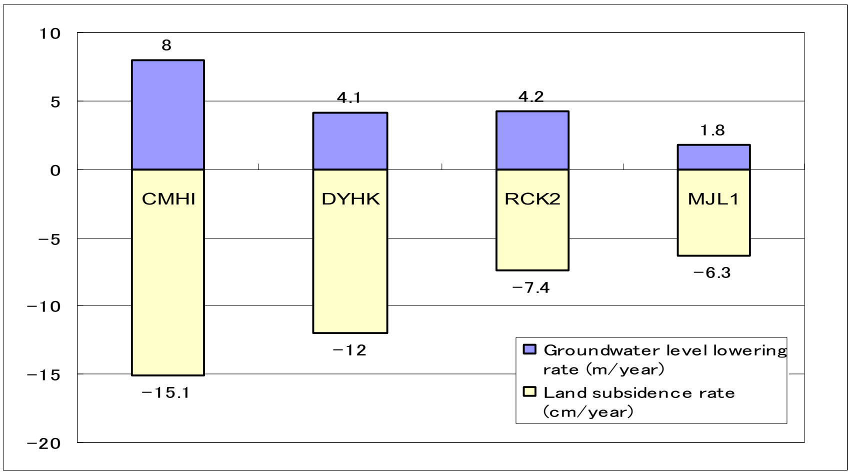


Figure 4.3 Correlation between Lowering Rate and Land Subsidence (Hasanuddin et al.2009) rate

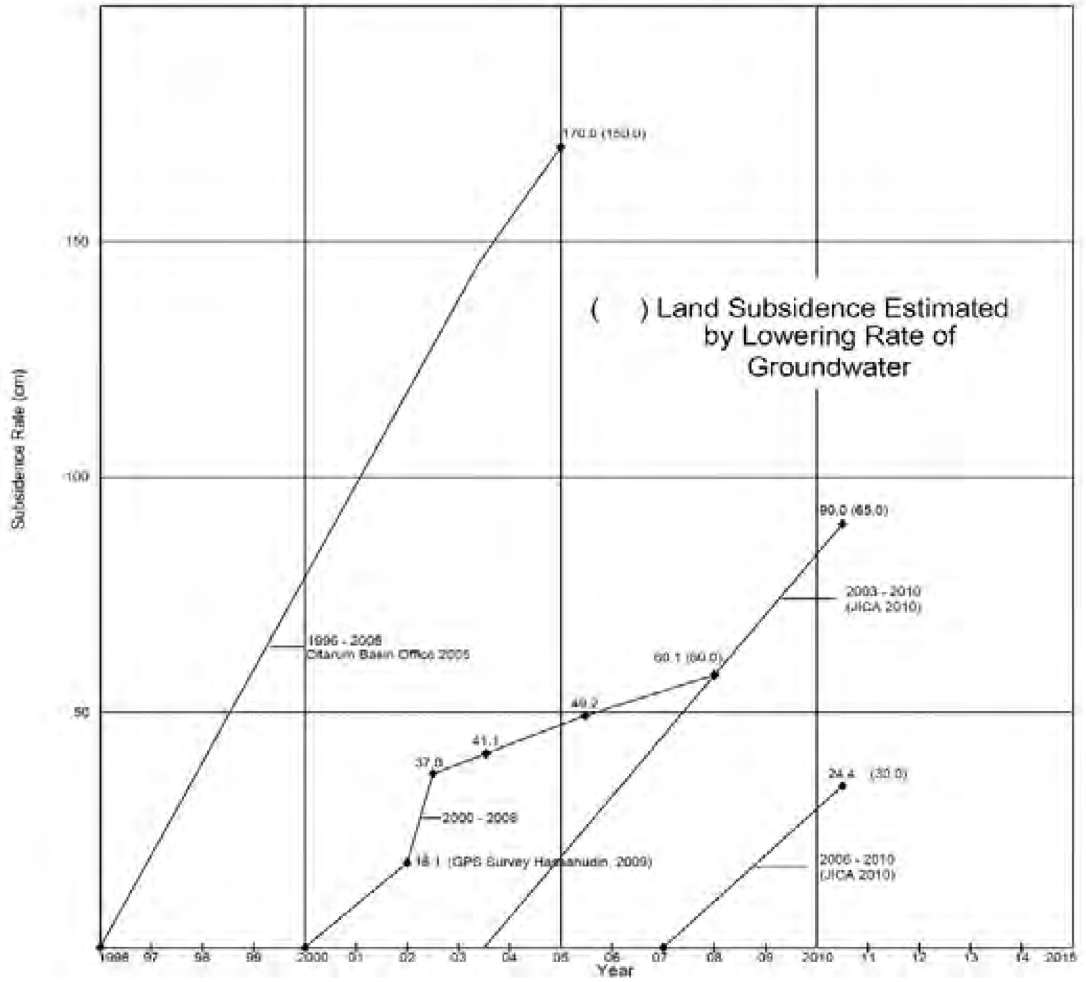


Figure 4.4 Observed Land Subsidence and Estimated by Lowering Rate of Groundwater

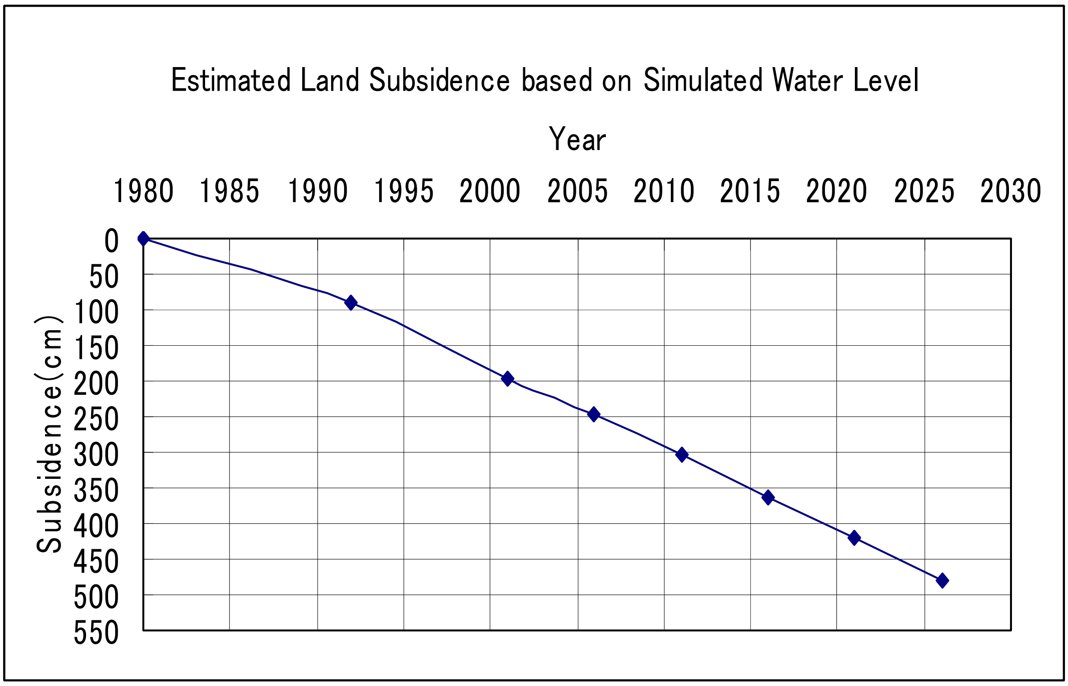


Figure 4.5 Estimated Land Subsidence (based on simulation by WJOM 2004)

Table 4.2 Prediction of Groundwater Level and Future Subsidence at Dayeuh Kolot area (Citarum Basing Office 2006)

No.	Year	Lowering Groundwater Level (m)	Predicted Elevation of Groundwater level (m.a.m.s.l)	Future Land Subsidence (m)
1	2006	0.00	582.97	0.00
2	2011	18.56	564.39	0.98
3	2016	37.11	545.83	1.95
4	2021	55.67	527.28	2.93
5	2026	74.22	508.72	3.90

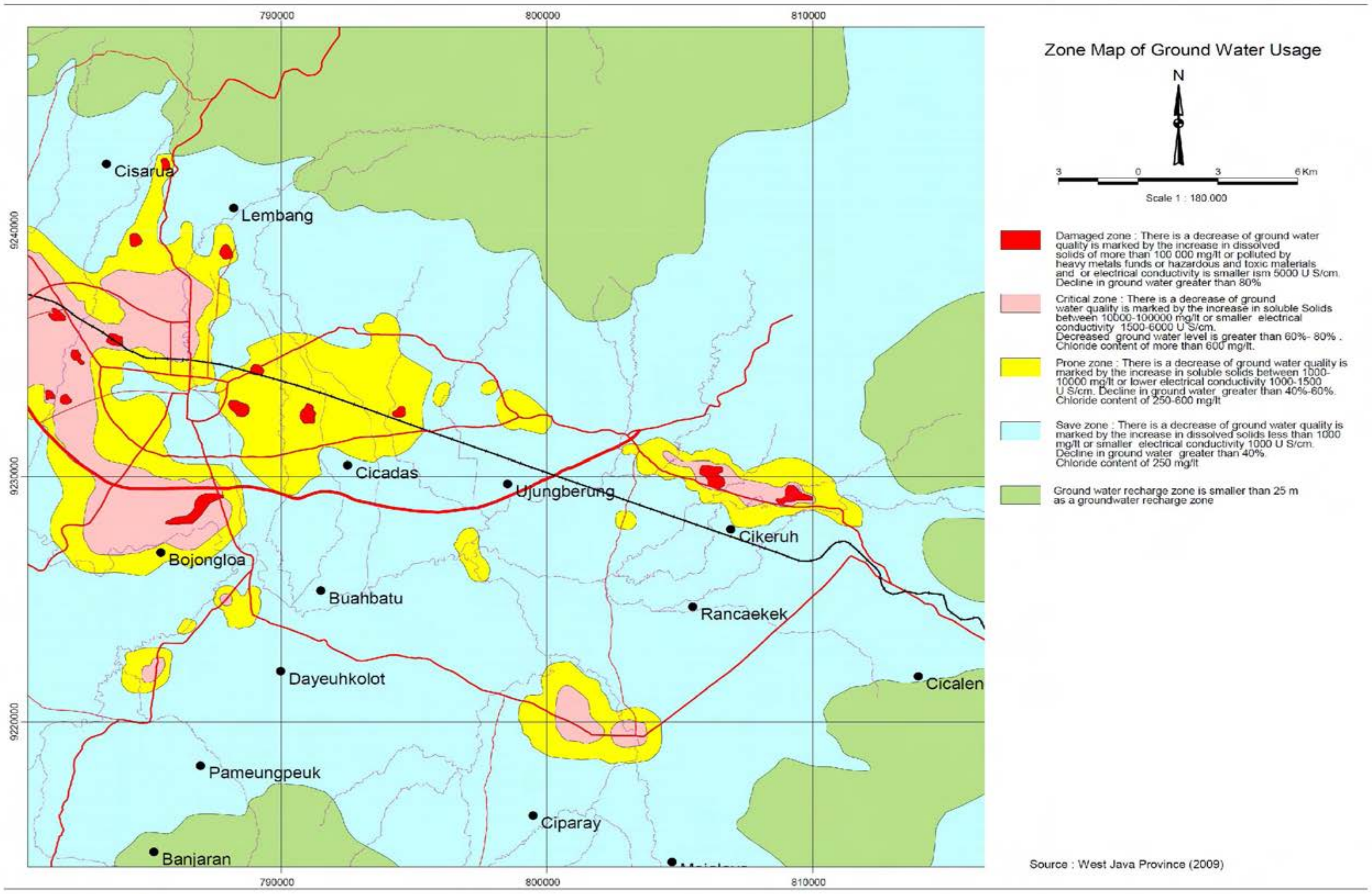
5. Countermeasures of Land Subsidence

5.1 Management of Groundwater

The subsidence of the ground surface in the Dayeuh Kolot area affects the design of the flood risk area under the Citarum Flood Control project. The land subsidence occurred for many reasons, such as geological activity, mining, oil and gas activities, reduction of the groundwater level and new load caused by construction work. In Dayeuh Kolot subsidence has been caused mainly by excessive ground water extraction. For stainable development, the use of groundwater must be controlled and supervised by the concerned institution or agency.

In order to grasp the characteristics of land subsidence and establish essential measures to resolve the land subsidence and groundwater problem, various studies and monitoring have been carried out by concerned agencies such as the West Java Province office of Energy and Mineral Resources. Furthermore, a monitoring system of land subsidence has been established in recent years by utilizing a Global Positioning System (GPS) with the cooperation of the Institute of Technology Bandung (ITB). Results show the severe problem of land subsidence and groundwater extraction in the Bandung basin. However, efficient countermeasures to reduce the problems have not yet been implemented. Additionally, taxes have been levied on groundwater extraction. However, reductions of groundwater have continued and aquifer layers in some areas have been damaged (Figure 5.1).

West Java Province Office of Energy and Water Resources has been carrying out a campaign for groundwater resources. It is called, “One Groundwater Basin, One planning, One Integrated Management” (WJOEW 2009). Since groundwater resources are limited, they have to be managed for effective utilization.



Source : West Java Province (2009)

Figure 5.1 Zone Map of Groundwater Usage (Provincial Government of West Java, 2009)

5.2 Regulations Relevant to Groundwater

In Bandung, groundwater is managed by the Provincial Government. The ownership of groundwater is defined as public domain in a statutory form and the government is entitled to manage the resources.

Indonesia has different contents of management for groundwater (extraction control, registration etc.) for each Province. West Java Province has managed groundwater under the relevant regulations listed below:

- Ministry of Mining and Energy No. 03/P/M/Pertamben/1983
- Decree of Directorate general of Geology and Mineral Resources No. 392./K/526/060000/85
- West Java Governor Decree 181.1/sk.1624-Bapp/82, 1976
- Act Number 18/1997, Groundwater Tax
- Act. Number 22/1999 on local Government
- Bandung City Government No. 03/1998 on Groundwater tax
- West Java Province Government Regulation No. 16/2001 on Groundwater Management
- West Java Governor Degree No. 29/2003
- West Java Regulation approved by Parliament No.31/2006 on Bandung groundwater basin management Technical
- West Java Governor Decree No.5/2008 Bandung Groundwater Policy.

Based on the above regulations, groundwater is monitored by the West Java Province office of Energy and Mineral Resources. A tax is levied on the extraction of groundwater. The rate of tax is based on the following factors:

i) Natural factor (Well location, Water Quality, Aquifer and Extraction depth etc.)
ii) Recharge factor (Extraction volume, Usage volume)
iii) Raw water charge.

Groundwater tax is calculated as factor of i) x ii) x iii).

The total income of groundwater tax of West Java in 2008 and from January to October 2009 is 52.1 Billion Rupiah and 43.5 Billion Rupiah respectively (West Java Provincial Office of Energy and Mineral Resources).

In Bandung, wells have to be registered and extraction volume and groundwater levels should be declared to West Java Province. However, the registered groundwater extraction is only about 30 % of the actual amount (Hutasoit 2008). In 1995, illegal extraction of groundwater was estimated to be 120% of the registered volume (Soetrisno 1996). It is known that the textile industry usually extracts very large volumes of groundwater.

5.3 Causes of Excessive Extraction of Groundwater

From the aspect of land subsidence issues, the cause and effect relationship is shown in Figure 5.2.

Excessive concentration of people and industry cause a water shortage. Then groundwater is used as a water resource, because it is not only clean but also accessible. Therefore, a balance of supply and demand is urgently required. Consequently, development of water resources shall be executed. Additionally, enlightenment and policy for conserving water is also required.

According to this figure, a main cause of land subsidence is excessive extraction of groundwater. Therefore, to protect the land from subsidence, in the first instance, lowering of groundwater level by excessive extraction is to be protected. However, tightening the regulations for groundwater extraction greatly affects economic activities and daily life. Effects of the regulations should be shown to the affected people.

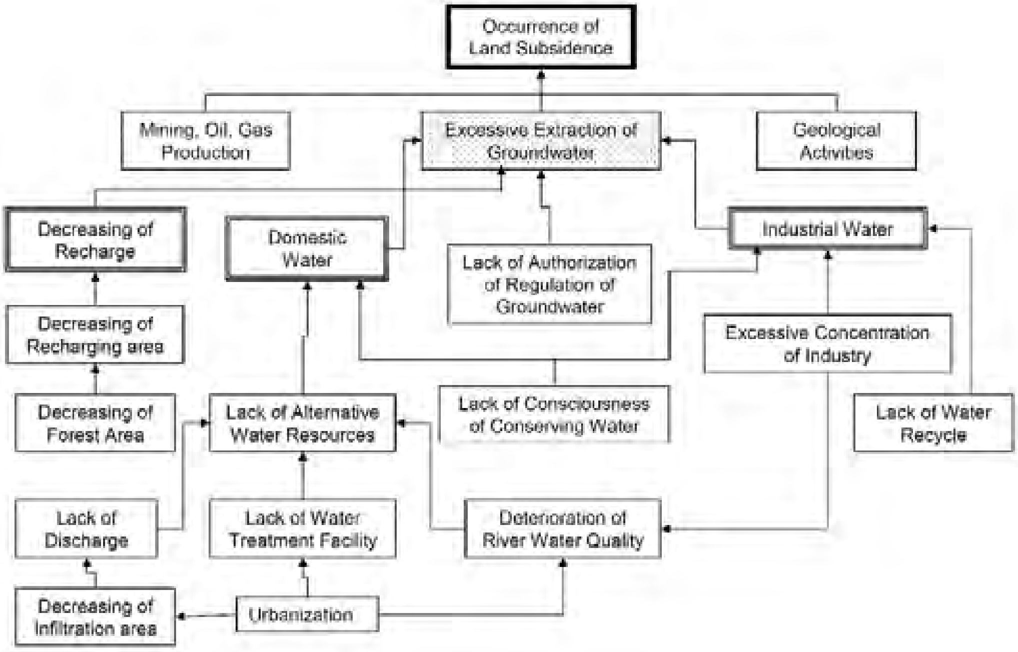


Figure 5.2 Factors in Land Subsidence

5.4 Recharge into Aquifer Layers

Lowering of groundwater means that when the groundwater extraction exceeds the groundwater recharge, the hydrologic in the aquifer causes the un-balanced condition. Increased groundwater extraction has led to rapid sinking of the water table.

According to previous data, shallow and middle aquifers (refer to Table 2.1) in some aquifer layers are damaged (Figure 5.1) due to excessive extraction. Therefore, recharge to aquifers is one of the countermeasures for the reduction in the groundwater. The hydrogeological structure of the Bandung

Basin is shown in Figure 5.3.

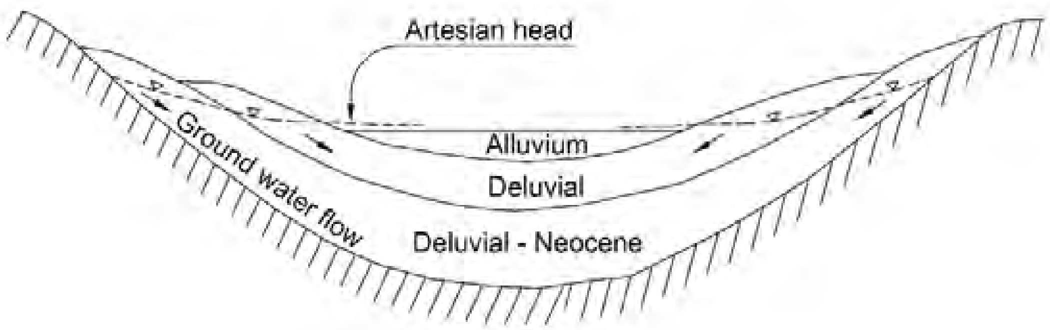


Figure 5.3 Hydro Geological Structure in Bandung Basin

Due to the recharge of aquifer layers, pore water pressure is decreased. This means that consolidation pressure to cohesive soil is decreased. The Recharge Method is useful for mitigation of land subsidence of long period. The Recharge Method is shown in Figure 5.4.

The Recharge Method consists of 2 methods. One is through wells and the other is through the ground surface.

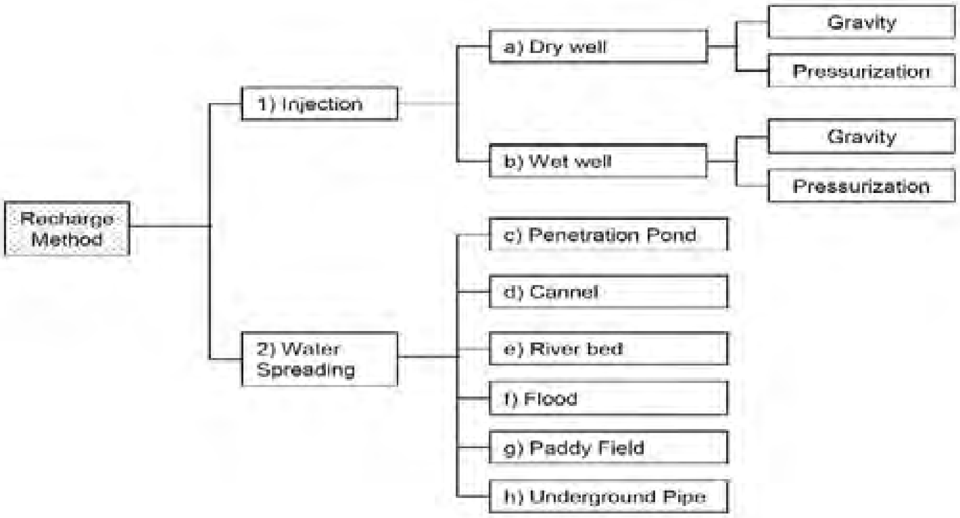


Figure 5.4 Recharge Method for Aquifer layers

1) Injection Method

The Injection Method is used for dry wells and wet wells. In wet wells, where the depth is up to water level, injection into aquifers occurs by gravity or pressurization system. On the other hand, depth of drywells is not up to water level.

The Injection method may cause clogging. However, it is useful when space is limited. In addition, injection can be done in an existing well such a dried well. The typical structure of an injection well is shown in Figure 5.5. As of 2009, the number of injection wells is only 5 (owned by a private industrial company) in West Java province (West Java Provincial Office of Energy and Mineral Resources 2009).

2) Water Spreading

The Water Spreading Method is classified as in Figure 5.4 based on the facilities, penetration method and site condition. For flood management regarding a) river beds (penetration from river bed, high water channel etc.), b) floods (floodwater is infiltrated into the flood plain, retarding pond and reservoir), and c) paddy fields (flood plain is the paddy field), the methods require broad areas. However, when a retention pond(s) is provided for mitigation of flood management, the Water Spreading Method is useful for shallow aquifer layers.

Canal method is available for middle and deep aquifers because recharge is from mountain areas. Rivers in alluvial fan surrounding mountain are very infiltrative. However, recharge by the river alone is not enough because during flooding, the river flows rapidly with high capacity. New infiltration canals are required as additional recharge areas. A typical canal for infiltration is shown in Figure 5.6.

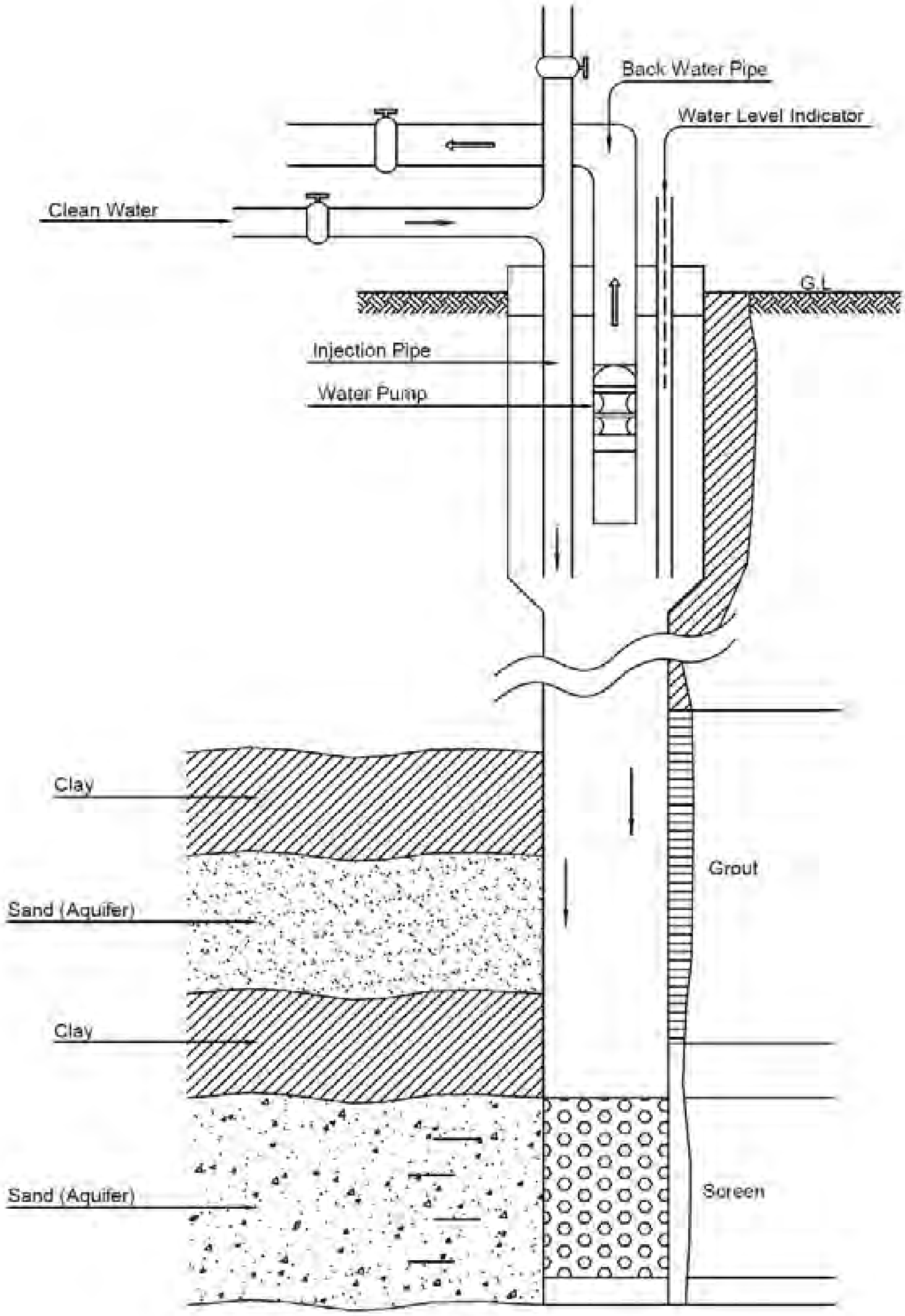


Figure 5.5 Typical Structure of Injection Well (Murashita 1976)

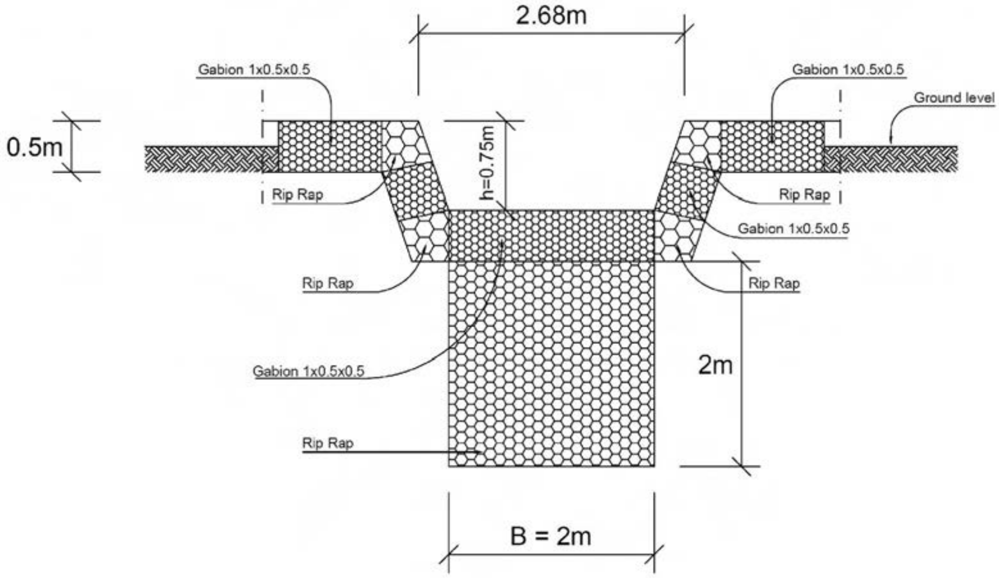


Figure 5.6 Typical Structure of Infiltration Canal (Citarum Basin Office 2007)

5.5 Alternative Water Supply

When a ban of extraction of groundwater is enforced, alternative water supply shall be provided. Generally, the water resource for the alternative water supply is a river. However, water supply in land subsidence areas is limited. It is difficult to obtain water from the river. Consequently, new resources such as dams or reservoirs may be necessary. Examination of the cost and water distribution is required for a new dams and reservoirs plan.

The Cilenca reservoir provides the water resource for the domestic water supply of Bandung City. However, it does not provide enough water volume necessary for the clean water supply for domestic and industrial needs. The Saguling reservoir is used for the domestic water supply for Jakarta City. Bandung City is planning their domestic water supply system using the Saguling reservoir.

5.6 Rationalization of Water Usage

Conservation of water and rationalization of water usage shall be carried out especially in areas with groundwater issues. Rationalization of water usage for consumers consists of a) enhancing the consciousness of conserving water, b) water recycling, c) improvement of water consumption equipment and of its usage, d) maintenance of water tariff system etc. and for enterprising bodies regarding e) stopping a leakage water, f) control of water pressure valves.

Regarding water recycling, large buildings, shopping complexes and the textile industry, which usually extracts very large volumes of groundwater, shall carry it out stringently.

It is important that enterprising bodies or related agencies shall preach on groundwater issues to extractors and consumers.

6. Assistance Program for Groundwater Issues and Land Subsidence

6.1 Background

As mentioned in Section 3, groundwater issues such as a) land subsidence, b) drying up of shallow wells, c) decreasing of discharge of wells, d) increasing of pumping cost, e) flooding, f) damage of public facilities etc. have been occurring in the Bandung Basin. All these issues are caused by the reduction in groundwater level due to excessive groundwater extraction. In particular, the flooding of the Dayeuh Kolot area is a serious problem.

Even though groundwater management has been executed through related regulations, the reduction of the ground water level has still continued. Related agencies for groundwater urgently require maintenance of groundwater management.

On the other hand, registered wells have increased year by year, but there are still many unregistered wells. The administration of wells is insufficient.

Regarding land subsidence, ITB, overseas institutes and related agencies have studied and measured it by GPS, InSAR and leveling. However, the countermeasures for mitigation of land subsidence have not yet been executed.

Therefore, the control of land subsidence is necessary. Data and materials shall be shared and related agencies should cooperate. To reach an overall solution on the land subsidence issues, comprehensive study and investigation including monitoring shall be carried out in order to evaluate and to find suitable countermeasures.

6.2 Recommendation of Assistance Program (Draft)

For settlement of the groundwater issues, the following assistance programs are recommended:

Table 6.1 Recommended Assistance Program (Draft)

Purpose	Assistance Program	Main Outputs
Strengthening of Groundwater Management	Groundwater management	-Establishment of conservation targets for groundwater resources -Recharge of groundwater -Rationalization of water usage -Development of alternative water resources -Establishment of data base
Improvement of Monitoring System for Land Subsidence	Establishment of monitoring system for land subsidence	-Establishment of executing agencies for monitoring -Installation of monitoring wells -Establishment of data base

Program summaries are shown in Table 6.2 and 6.3.

Table 6.2 Summary of Assistance Program (1)

Name of Assistance Program-Groundwater Management	
Background	The Bandung Basin is a large intra-mountane basin surrounded by volcanic highland. In the Bandung Basin, with the expansion of manufacturing and the textile industry, urbanization increased in 2005 and more than 7 million people inhabited the basin. This increase in both population and industry in turn increased the degree of groundwater withdrawal from the aquifers in the Bandung Basin. About 60% of the total clean water required in the Great Bandung area is supplied by groundwater; and the industry relies nearly 100% on groundwater resources. Increased groundwater extraction has led to a rapid sinking of the water table on the plain. From 1980 to 2004 (24 years), the groundwater level in the Bandung Basin has dropped by about 20 to 100m. This drop in groundwater level has both spatial and temporal variations. Increased groundwater extraction will also decrease well productivity, and has led to drastic changes in time and direction of travel of groundwater. Continuous lowering of the groundwater level in the industrial area has considerably changed the flow characteristic of the groundwater system, in which vertical downward leakage occurs. Also, due to excessive extraction of groundwater, land subsidence has occurred and aquifer layers have been damaged. In addition, a monitoring system has not been established. Therefore, strengthening of groundwater management is required urgently for sustainability of groundwater resources.
Overall Goal	Strengthening of Groundwater Management
Program Purpose	1. Signpost of conservation of groundwater resource is established. 2. Monitoring system is established. 3. Rationalization of water usage is planned 4. Groundwater is used effectively. 5. Administration of wells is enhanced.
Outputs	1.Illegal extraction is decreased. 2.Groundwater is recharged 3.Lowering rate of groundwater level is decreased. 4.Rate of land subsidence is decreased. 5.Groundwater is used effectively. 6.Database related groundwater is developed. 7.Guideline of monitoring is established.
Activities	1. Assistance of establishment of database Collection data (Number of registered and unregistered wells, quality, extraction volume, water level), Maintenance of database. 2. Assistance of monitoring Development of periodical monitoring, monitoring technology and methods, in charge of monitoring staff, construction of monitoring wells (water level and land subsidence). 3. Assistance of construction of recharge structures Construction of trial recharge well(s), construction of trial infiltration canal(s) 4. Assistance of water recycling Enlightenment activities for water recycling 5. Assistance of cooperation with related agencies and authorities.
Period	2 years

Table 6.3 Summary of Assistance Program (2)

Name of Assistance Program- Improvement of Monitoring System for Land Subsidence	
Background	The Bandung Basin is a large intra-mountane basin surrounded by volcanic highland. In the Bandung Basin, with the expansion of manufacturing and the textile industry, urbanization increased in 2005 and more than 7 million people inhabited the basin. This increase in both population and industry in turn increased the degree of groundwater withdrawal from the aquifers in the Bandung Basin. About 60% of the total clean water required in the Great Bandung area is supplied by groundwater; and industry relies nearly 100% on groundwater resources. Increased groundwater extraction has led to not only a rapid sinking of the water table on the plain but also land subsidence. In the period 2003 to 2010, 90 cm of land subsidence was observed and its rate is about 12 cm/year in the Dayeuh Kolot area. In addition, due to land subsidence, floods have occurred frequently and have become a serious social issue in the Great Bandung Basin. For analysis of the characteristics of land subsidence, periodical monitoring is necessary. Although many agencies and institutes have observed land subsidence, efficient countermeasures to reduce the problems have not been implemented yet. Also cooperative systems have not been established. Therefore, the establishment of a monitoring system is required urgently.
Overall Goal	Improvement of monitoring system of land subsidence
Program Purpose	1. Monitoring system is established 2. Forecasting of land subsidence is performed. 3. Monitoring technology is improved.
Outputs	1. Monitoring well is installed. 2. Forecasting of land subsidence is performed 3. Database related to land subsidence is developed. 4. Monitoring technology is improved. 5. Countermeasures to reduce the problems are recommended 6. Guidelines for monitoring are established.
Activities	1. Assistance of establishment of database of land subsidence Collection data (Leveling, GPS, InSAR, Private observation, locations), Maintenance of database. 2. Assistance of monitoring Development of periodical monitoring, monitoring technology and methods, in charge of monitoring staff, construction of monitoring wells (water level and land subsidence). 3. Assistance of establishment of organizations for cooperation with related agencies and authorities 4. Assistance of construction of observation well(s)
Period	2 years

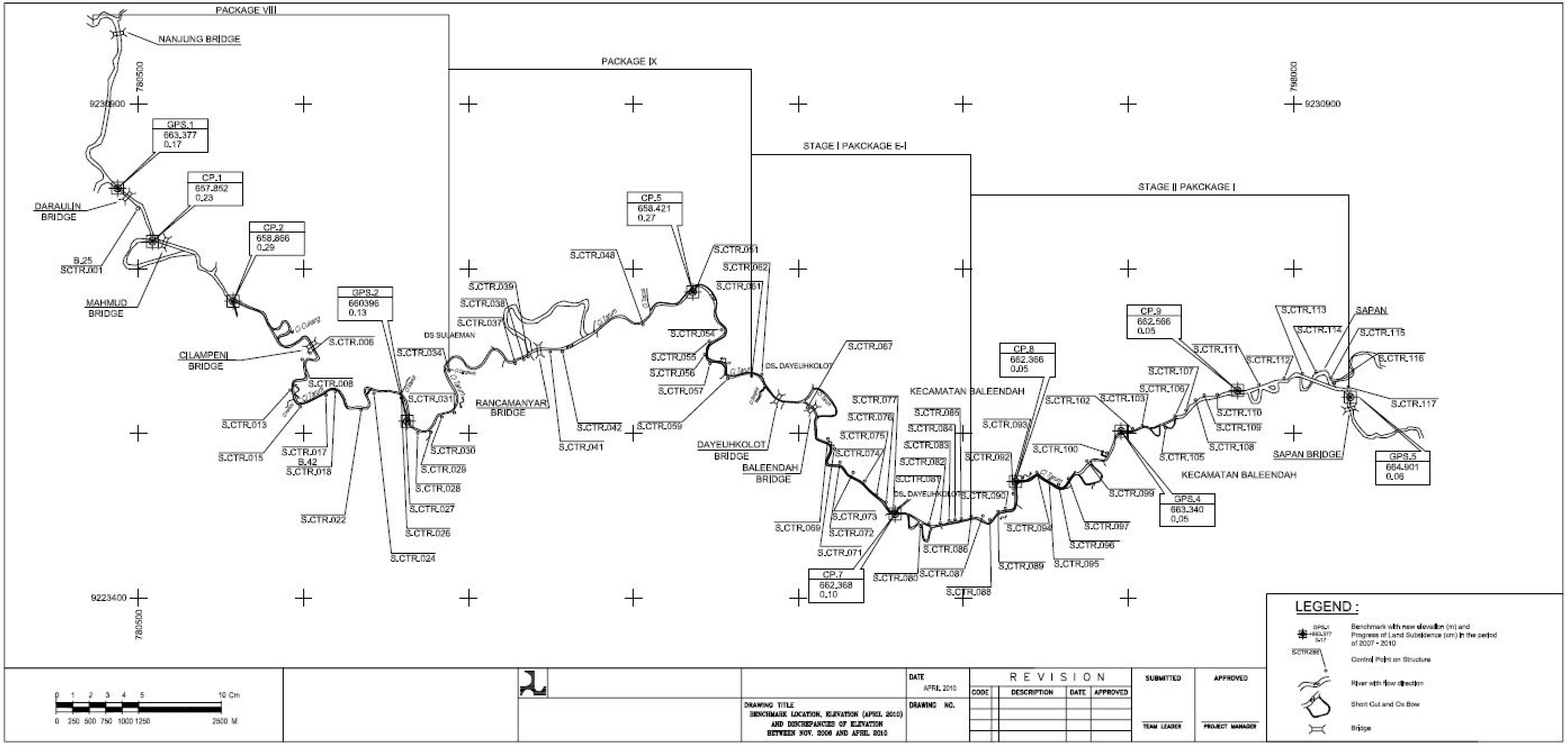


Figure 3.12   Location Map of Survey Point along Citarum River

APPENDIX IV:

ENVIRONMENTAL CONSIDERATION AND ENVIRONMENTAL PROTECTION

Table River Water Quality Standards (Japan)

Class and water use	pH	BOD_5 (mg/L)	SS (mg/L)
AA: Water supply class 1, Conservation of natural environment, and uses listed in A-E	6.5-8.5	≤1	≤25
A: Water supply class 2, Fishery Class 1, Bathing, and uses listed in B-E	6.5-8.5	≤2	≤25
B: Water supply class 3, Fishery Class 2, and uses listed in C-E	6.5-8.5	≤3	≤25
C: Fishery class 3, Industrial water Class 1, and uses listed D-E	6.5-8.5	≤5	≤50
D: Industrial water class 2, Agricultural water, and uses listed in E	6.0-8.5	≤8	≤100
E: Industry water class 3 and conservation of environment	6.0-8.5	≤10	Floating matter such as garbage should not be observed

Source: Environmental water quality standard for conservation of the living environment, Japan

Table Water Quality Criteria for Aquatic Biodiversity (Japan)

Class	NH_4-N (mg/L)
A: Very good environment for habitat, growing and breeding	≤0.2
B: Good environment for habitat, growing and breeding	≤0.5
C: Poor environment for habitat, growing and breeding	≤2.0
D: Not good environment for habitat, growing and breeding	2.0<

Source: Environmental water quality standard for conservation of the living environment, Japan

Table Index of Eutrophication

Japan (Common indicator)	T-N: > 0.15-0.2 mg/L : eutrophic T-P: > 0.02mg/L : eutrophic

Source: Japanese common indicator: Water Indication System, Min. of Land, Infrastructure and Transport, Japan, URL: http://www1.river.go.jp/

Table Zinc (Zn) Standard Value to Protect Aquatic Life (Japanese standard)

Aquatic life	Value
Mountain trout, Salmon, Trout, etc. (Fish prefer low temperature)	< 0.03mg/L
Spawning site and habitat of juvenile fish of Mountain trout, Salmon, Trout, etc.	< 0.03mg/L
Carp, Crucian, etc. (Fish prefer high temperature)	< 0.03mg/L
Spawning site and habitat of juvenile fish of Carp, Crucian, etc.	< 0.03mg/L

Reference: Adaptability to aquatic life habitat conditions, Japanese environmental quality standards for conservation of the living environment (Rivers)

Source: Environmental water quality standard for conservation of the living environment, Japan

Appendix IV-2)

Heavy metal concentration in Citarum main stream and 9 tributaries sediment
(mg/kg)

Item	Cikeruh	Cikeruh branch	Cikeruh 1	Citarik3	Citarik2	CitarikA	Cimande1	Cimande2	Cimande3	Cikijing	Citarum Upstrm A	Citarum Upstrm 2	Cisaranten 2	Cisaranten 1	Cisangkuy Upstrm	Cisangkuy - Citarum	Citarum A	Citalugtug	Ciputat	Citarum Ranca manyar
Arsenic (As)	N.D.	N.D.	N.D.	N.D.	N.D.	25.7	1.84	N.D.	2.33	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	25.4	N.D.	N.D.	N.D.	13.77
Barium (Ba)	805	2578	4185	1691	1276	2514	81.6	3497	96.0	354	1525	1263	2366	1389	2226	4176	1359	1729	2556	3083
Cadmium (Cd)	15.3	24.1	305	89.3	37.7	226	7.61	107	10.6	273	69.8	125	67.2	190	173	175	123	111	37.1	336
Chromium (Cr)	803	2089	2345	1109	1400	708	41.2	508	21.0	709	653	997	1912	254	236	1042	509	459	472	672
Copper (Cu)	1330	2485	1418	1853	1036	1621	38.8	2568	54.0	736	1321	1703	715	467	591	3003	1974	422	1568	903
Cobalt (Co)	56.3	160	243	152	96.9	165	34.1	213	38.7	N.D.	96.7	119	40.3	13.4	79.7	234	150	84.5	N.D.	22.0
Lead (Pb)	194	641	1669	433	299	540	38.6	721.3	61.2	N.D.	389	249	N.D.	N.D.	24.7	823	219	636	252	446
Mercury (Hg)	N.D.	N.D.	N.D.	N.D.	N.D.	0.0008	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0004	N.D.	N.D.	N.D.	0.00008
Molybdenum (Mo)	46.0	26.7	81.8	125	86.1	79.8	0.03	21.9	0.03	73.6	37.6	205	48.4	13.4	27.5	55.9	21.9	68.6	15.9	52.3
Nickel (Ni)	N.D.	724	N.D.	230	148	458	11.8	312	12.2	68.2	220	22.2	1805	93.5	203	417	150	92.4	339	90.9
Tin (Sn)	486	663	1390	176	1112	803	0.03	2246	0.03	845	577	748	229	321	195	348	159	322	244	127
Selenium (Se)	17.4	24.1	167	59.5	127	46.3	0.03	8.47	0.03	49.1	25.5	N.D.	2.69	14.7	21.2	10.2	16.4	22.4	29.1	64.4
Silver (Ag)	N.D.	N.D.	N.D.	N.D.	N.D.	5.66	3.15	2.73	3.37	N.D.	N.D.	1.38	N.D.	N.D.	N.D.	N.D.	N.D.	1.32	1.32	N.D.
Zinc (Zn)	752	1630	2631	1320	1715	1686	222	3915	211	1077	2489	2250	1183	497	1262	1458	790	1742	2986	2015
Cyanide (CN)	N.D.	3.21	1.36	N.D.	N.D.	N.D.	N.D.	2.46	N.D.	N.D.	2.15	N.D.	N.D.	N.D.	4.12	2.79	N.D.	N.D.	N.D.	N.D.
Fluoride (F)	N.D.	134	136	N.D.	N.D.	N.D.	N.D.	68.3	N.D.	N.D.	67.1	N.D.	N.D.	N.D.	206	127	N.D.	N.D.	N.D.	N.D.

N.D.

As: <0.0001

Cd: <0.001

Co: <0.001

Hg: <0.00001

Mo: <0.001

Ni: <0.001

Ag: <0.001

CN: <0.001

F: <0.001

Appendix IV-2)

Heavy metal concentration in leachate in Citarum main stream and 9 tributaries sediment

(mg/L)

Item	Cikeruh	Cikeruh branch	Cikeruh 1	Citarik3	Citarik2	CitarikA	Cimande1	Cimande2	Cimande3	Cikijing	Citarum Upstrm A	Citarum Upstrm 2	Cisaranten 2	Cisaranten 1	Cisangkuy Upstrm	Cisangkuy - Citarum	Citarum A	Citalugtug	Ciputat	Citarum Ranca manyar
Arsenic (As)	N.D.	N.D.	N.D.	N.D.	N.D.	0.05	0.01	N.D.	0.01	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.05	N.D.	N.D.	N.D.	0.05
Barium (Ba)	1.00	0.75	4.29	1.44	1.25	3.11	0.69	2.82	1.00	0.29	0.89	0.93	2.65	1.08	2.74	2.11	1.44	3.48	0.56	1.16
Cadmium (Cd)	N.D.	0.08	0.03	0.02	0.02	0.04	0.01	0.04	0.001	0.011	N.D.	N.D.	N.D.	0.02	N.D.	0.04	0.02	0.02	0.01	0.02
Chromium (Cr)	0.05	0.55	0.25	0.05	0.28	0.30	0.02	0.14	0.03	0.20	0.02	0.36	0.08	0.08	0.07	0.15	0.09	0.05	0.25	0.19
Copper (Cu)	0.67	0.69	2.70	1.83	1.22	1.45	0.003	0.96	0.001	1.48	0.92	3.72	6.15	2.44	0.73	1.70	2.19	1.22	0.89	2.35
Lead (Pb)	N.D.	0.28	N.D.	0.09	0.16	N.D.	0.22	0.42	0.05	0.11	N.D.	0.94	N.D.	0.05	0.25	0.14	0.22	0.37	0.09	0.15
Mercury (Hg)	N.D.	N.D.	N.D.	N.D.	N.D.	0.00042	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.0006
Selenium (Se)	N.D.	N.D.	0.05	0.02	N.D.	0.02	N.D.	0.04	N.D.	N.D.	0.06	N.D.	N.D.	0.06	0.04	N.D.	0.03	0.01	0.08	0.14
Silver (Ag)	N.D.	0.01	N.D.	N.D.	N.D.	0.01	0.01	0.01	0.001	N.D.	N.D.	0.01	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc (Zn)	0.98	5.44	1.75	1.93	2.46	1.45	0.03	4.73	1.15	1.39	2.07	5.22	0.98	1.19	1.57	1.75	0.93	2.63	4.30	3.83

N.D.

As: <0.0001

Cd: <0.001

Pb: <0.001

Hg: <0.00001

SE: <0.001

Ag: <0.001

CN: <0.001

Appendix IV-2)

Physical and chemical in Citarum main stream and 9 tributaries water

pH: No unit

Water temperature: °C

Other: mg/L

Item	Cikeruh	Cikeruh branch	Cikeruh 1	Citarik3	Citarik2	CitarikA	Cimande1	Cimande2	Cimande3	Cikijing	Citarum Upstrm A	Citarum Upstrm 2	Cisaranten2	Cisaranten1	Cisangkuy Upstrm	Cisangkuy - Citarum	Citarum A	Citalugtug	Ciputat	Citarum Ranca manyar
pH	7.2	6.9	6.9	7.2	7.5	7.6	7.5	7.6	7.3	7.2	7.5	6.6	7.0	6.8	7.4	7.8	7.8	6.9	7.3	7.3
Water Temperature	31.4	31.5	31.9	31.6	31.5	32.1	31.6	31.6	32.2	31.4	32.1	31.8	31.9	32	32.8	32.6	32.2	32.7	32.6	32.6
SS	8.0	5.0	12.0	32.0	2.0	52.0	340	3.0	31.0	120	41.0	44.0	18.0	41.0	39.0	32.0	22.0	22.o	59.0	16.0
DS	71.6	219	88.5	95.8	85.0	264	3800	95.9	716	1466	145.1	136.4	162.4	210	54.2	70.9	193.2	127.3	67.4	179.8
T-P	N.D.	0.343	0.113	N.D.	N.D.	0.113	0.320	N.D.	0.180	0.113	0.098	0.113	0.107	0.107	0.012	0.012	0.012	0.735	0.012	0.303
BOD_5	18.4	40.0	24.0	48.0	33.2	89.8	111	22.4	66.3	132	48.0	38.4	38.4	40.0	28.8	24.0	33.6	56.0	19.2	32.0
COD_{cr}	36.9	92.1	55.3	92.1	55.3	147	368	36.9	184.3	202.7	92.1	73.7	73.7	92.1	55.3	55.3	55.3	92.1	36.9	73.7
NH_4-N	0.101	1.396	0.107	0.272	0.095	1.081	1.420	0.223	0.745	0.832	0.369	0.075	0.223	0.134	0.239	0.086	0.121	1.08	0.634	0.543
T-N	0.141	2.03	0.756	0.168	0.283	0.448	1.176	0.224	0.336	1.779	0.252	0.476	0.308	0.168	0.196	0.154	0.196	0.392	0.602	0.434

N.D.

T-P: <0.001

Heavy metal concentration in Citarum main stream and 9 tributaries water

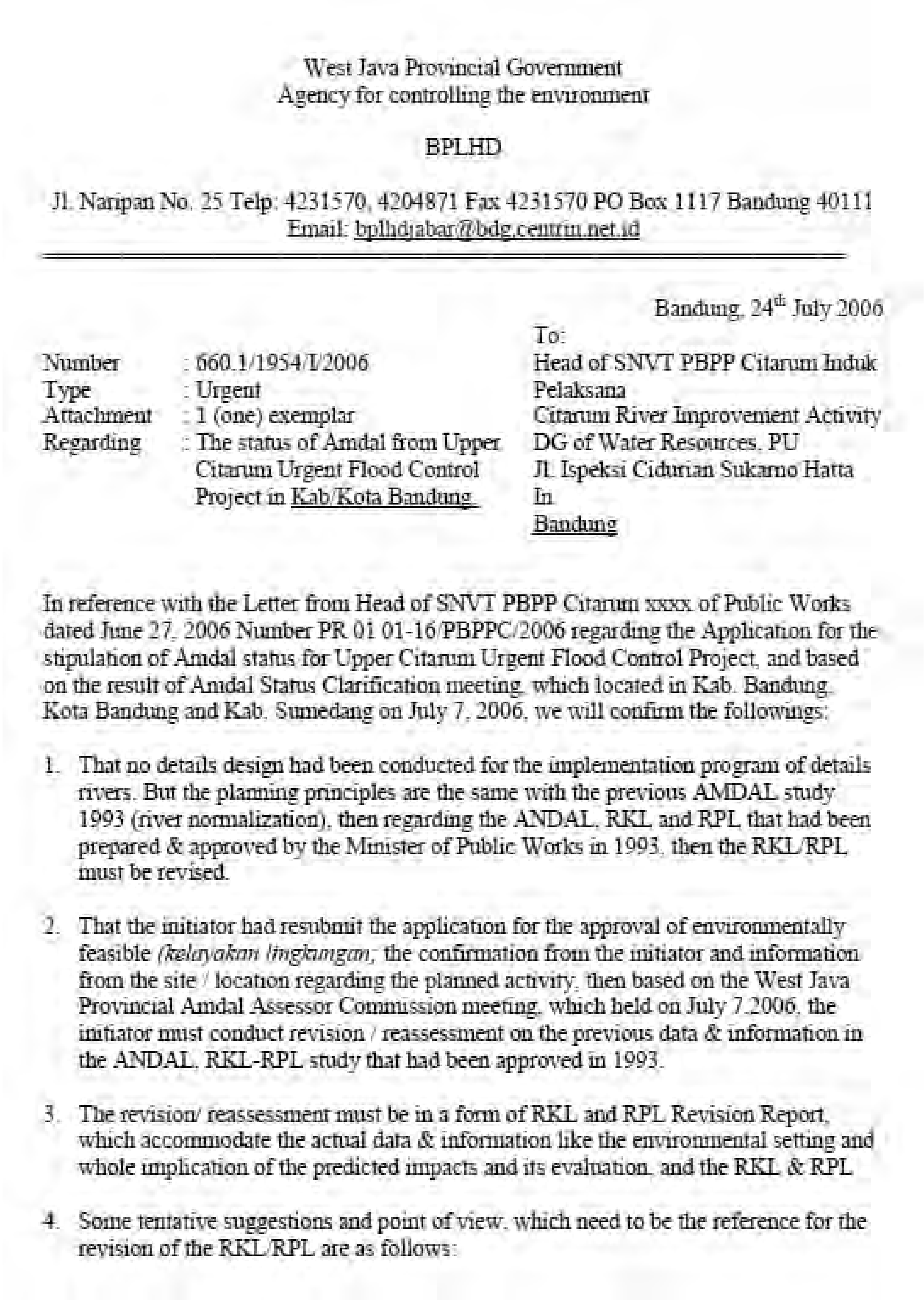
(mg/L)

Item	Cikeruh	Cikeruh branch	Cikeruh 1	Citarik3	Citarik2	CitarikA	Cimande1	Cimande2	Cimande3	Cikijing	Citarum Upstrm A	Citarum Upstrm 2	Cisaranten2	Cisaranten1	Cisangkuy Upstrm	Cisangkuy - Citarum	Citarum A	Citalugtug	Ciputat	Citarum Ranca manyar
Arsenic (As)	N.D.	0.05	N.D.	N.D.	N.D.	0.05	0.01	0.05	0.01	N.D.	N.D.	N.D.	0.05	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.10
Barium (Ba)	6.22	11.24	12.28	4.88	7.37	2.70	0.25	10.15	0.25	3.92	6.11	3.44	6.45	4.80	3.77	4.30	9.25	1.85	9.55	2.20
Cadmium (Cd)	0.05	N.D.	0.44	0.15	0.08	0.05	0.03	0.22	0.03	0.32	0.16	0.05	0.17	N.D.	0.05	0.28	N.D.	0.12	N.D.	0.56
Chromium (Cr)	1.95	3.74	0.90	9.12	3.60	1.60	0.20	2.25	0.06	6.55	2.72	1.94	3.55	6.22	0.50	6.20	0.95	2.44	3.88	1.20
Copper (Cu)	6.60	2.85	4.15	5.10	2.49	1.18	0.04	3.70	0.02	6.20	8.33	3.30	3.28	5.65	2.90	1.75	2.25	7.21	0.60	4.28
Cobalt (Co)	N.D.	0.05	0.31	N.D.	0.16	0.05	0.05	0.33	0.03	0.05	0.18	0.40	0.10	0.05	0.05	0.11	N.D.	0.14	N.D.	0.26
Lead (Pb)	2.75	1.70	1.45	0.90	1.60	2.30	0.40	4.15	0.41	6.32	1.80	2.28	3.10	1.65	1.77	0.55	3.30	0.80	4.18	6.05
Mercury (Hg)	N.D.	0.00008	0.00004	N.D.	0.0004	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	0.00004	N.D.	N.D.	N.D.	N.D.
Molybdenum (Mo)	0.77	N.D.	0.22	0.34	0.15	0.44	N.D.	N.D.	N.D.	0.05	0.20	0.60	N.D.	N.D.	0.35	0.18	0.05	N.D.	0.62	0.20
Nickel (Ni)	0.11	0.95	N.D.	0.05	0.24	0.32	0.01	0.75	0.004	N.D.	0.61	N.D.	0.36	N.D.	0.08	0.15	0.10	0.05	0.25	N.D.
Tin (Sn)	0.88	3.05	2.60	1.10	2.15	0.85	0.0001	4.17	0.0001	0.95	2.64	1.15	1.70	1.90	0.89	3.15	7.22	1.30	1.40	0.65
Selenium (Se)	0.06	0.11	0.01	0.04	0.21	0.07	0.0001	0.09	0.0001	0.03	0.05	0.01	0.35	0.13	0.05	0.42	0.23	0.17	0.08	0.03
Silver (Ag)	N.D.	N.D.	N.D.	N.D.	0.01	N.D.	0.04	N.D.	0.02	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Zinc (Zn)	11.5	2.39	2.50	3.10	4.22	7.25	0.15	8.75	0.07	6.20	4.86	1.10	5.50	3.60	0.61	9.28	1.55	5.30	2.70	12.4
Cyanide (CN)	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Fluoride (F)	N.D.	0.75	N.D.	N.D.	0.50	0.25	N.D.	N.D.	N.D.	N.D.	N.D.	1.50	N.D.	0.75	0.75	N.D.	0.50	0.50	N.D.	N.D.

N.D.
As: <0.0001
Cd: <0.001
Co: <0.001
Hg: <0.00001
Mo: <0.001
Ni: <0.001
Ag: <0.001
CN: <0.001
F: <0.001

Appendix IV-3)

Letter from BPLHD: The order to develop a supplemental report, 2006.



West Java Provincial Government
Agency for controlling the environment

BPLHD

Jl. Naripan No. 25 Telp: 4231570, 4204871 Fax 4231570 PO Box 1117 Bandung 40111
Email: bplhdjabar@bdg.centrin.net.id

Bandung, 24th July 2006

Number : 660.1/1954/I/2006
Type : Urgent
Attachment : 1 (one) exemplar
Regarding : The status of Amdal from Upper Citarum Urgent Flood Control Project in Kab/Kota Bandung.

To:
Head of SNVT PBPP Citarum Induk Pelaksana
Citarum River Improvement Activity
DG of Water Resources, PU
Jl. Ispeksi Cidurian Sukarno Hatta
In
Bandung

In reference with the Letter from Head of SNVT PBPP Citarum xxxx of Public Works dated June 27, 2006 Number PR 01 01-16/PBPPC/2006 regarding the Application for the stipulation of Amdal status for Upper Citarum Urgent Flood Control Project, and based on the result of Amdal Status Clarification meeting, which located in Kab. Bandung, Kota Bandung and Kab. Sumedang on July 7, 2006, we will confirm the followings:

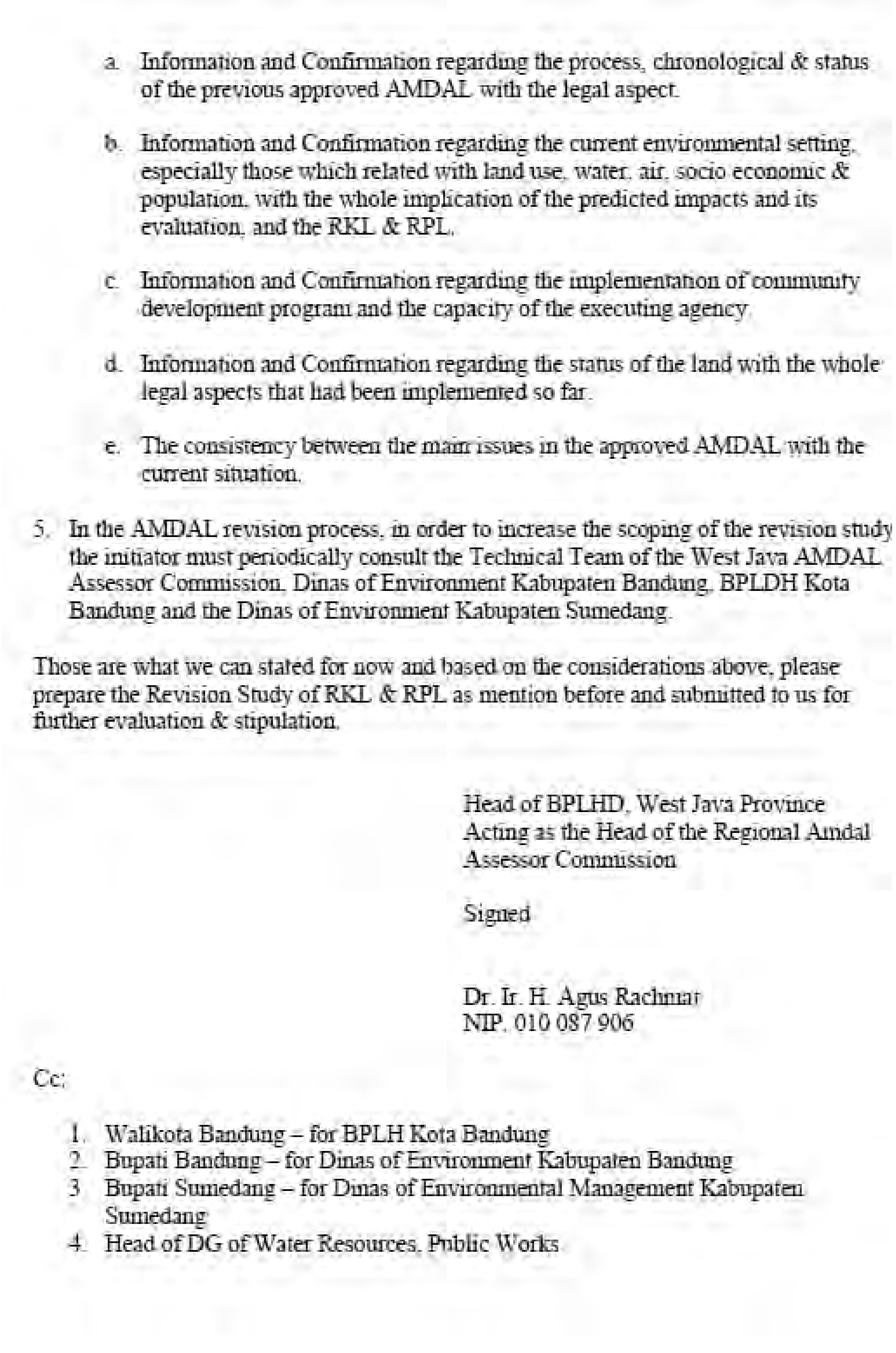
1. That no details design had been conducted for the implementation program of details rivers. But the planning principles are the same with the previous AMDAL study 1993 (river normalization), then regarding the ANDAL, RKL and RPL that had been prepared & approved by the Minister of Public Works in 1993, then the RKL/RPL must be revised.

2. That the initiator had resubmit the application for the approval of environmentally feasible *(kelayakan lingkungan;* the confirmation from the initiator and information from the site / location regarding the planned activity, then based on the West Java Provincial Amdal Assessor Commission meeting, which held on July 7.2006, the initiator must conduct revision / reassessment on the previous data & information in the ANDAL, RKL-RPL study that had been approved in 1993.

3. The revision/ reassessment must be in a form of RKL and RPL Revision Report, which accommodate the actual data & information like the environmental setting and whole implication of the predicted impacts and its evaluation, and the RKL & RPL

4. Some tentative suggestions and point of view, which need to be the reference for the revision of the RKL/RPL are as follows:

Appendix IV-3)



a. Information and Confirmation regarding the process, chronological & status of the previous approved AMDAL with the legal aspect.

b. Information and Confirmation regarding the current environmental setting, especially those which related with land use, water, air, socio economic & population, with the whole implication of the predicted impacts and its evaluation, and the RKL & RPL.

c. Information and Confirmation regarding the implementation of community development program and the capacity of the executing agency.

d. Information and Confirmation regarding the status of the land with the whole legal aspects that had been implemented so far.

e. The consistency between the main issues in the approved AMDAL with the current situation.

5. In the AMDAL revision process, in order to increase the scoping of the revision study the initiator must periodically consult the Technical Team of the West Java AMDAL Assessor Commission, Dinas of Environment Kabupaten Bandung, BPLDH Kota Bandung and the Dinas of Environment Kabupaten Sumedang.

Those are what we can stated for now and based on the considerations above, please prepare the Revision Study of RKL & RPL as mention before and submitted to us for further evaluation & stipulation.

Head of BPLHD, West Java Province
Acting as the Head of the Regional Amdal
Assessor Commission

Signed

Dr. Ir. H. Agus Rachmat
NIP. 010 087 906

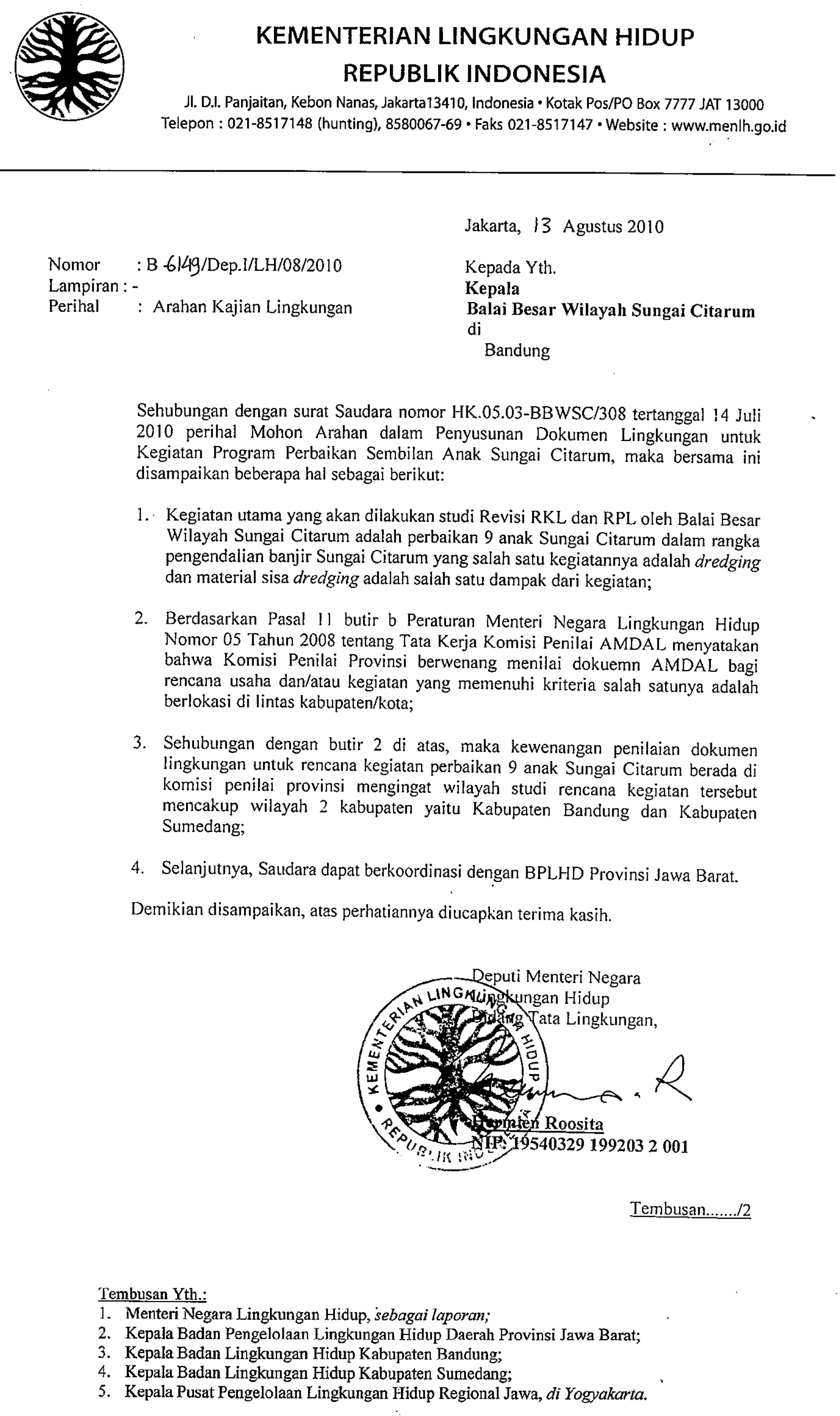
Cc:

1. Walikota Bandung – for BPLH Kota Bandung
2. Bupati Bandung – for Dinas of Environment Kabupaten Bandung
3. Bupati Sumedang – for Dinas of Environmental Management Kabupaten Sumedang
4. Head of DG of Water Resources, Public Works

Appendix IV-3)

Letter from the Ministry of Environment: Regarding AMDAL implementation procedure for the proposed project, 2010.

Original (Indonesian)



KEMENTERIAN LINGKUNGAN HIDUP
REPUBLIK INDONESIA
Jl. D.I. Panjaitan, Kebon Nanas, Jakarta13410, Indonesia • Kotak Pos/PO Box 7777 JAT 13000
Telepon : 021-8517148 (hunting), 8580067-69 • Faks 021-8517147 • Website : www.menlh.go.id

Jakarta, 13 Agustus 2010

Nomor : B 6149/Dep.I/LH/08/2010
Lampiran : -
Perihal : Arahan Kajian Lingkungan

Kepada Yth.
Kepala
Balai Besar Wilayah Sungai Citarum
di
Bandung

Sehubungan dengan surat Saudara nomor HK.05.03-BBWSC/308 tertanggal 14 Juli 2010 perihal Mohon Arahan dalam Penyusunan Dokumen Lingkungan untuk Kegiatan Program Perbaikan Sembilan Anak Sungai Citarum, maka bersama ini disampaikan beberapa hal sebagai berikut:

1. Kegiatan utama yang akan dilakukan studi Revisi RKL dan RPL oleh Balai Besar Wilayah Sungai Citarum adalah perbaikan 9 anak Sungai Citarum dalam rangka pengendalian banjir Sungai Citarum yang salah satu kegiatannya adalah *dredging* dan material sisa *dredging* adalah salah satu dampak dari kegiatan;
2. Berdasarkan Pasal 11 butir b Peraturan Menteri Negara Lingkungan Hidup Nomor 05 Tahun 2008 tentang Tata Kerja Komisi Penilai AMDAL menyatakan bahwa Komisi Penilai Provinsi berwenang menilai dokuemn AMDAL bagi rencana usaha dan/atau kegiatan yang memenuhi kriteria salah satunya adalah berlokasi di lintas kabupaten/kota;
3. Sehubungan dengan butir 2 di atas, maka kewenangan penilaian dokumen lingkungan untuk rencana kegiatan perbaikan 9 anak Sungai Citarum berada di komisi penilai provinsi mengingat wilayah studi rencana kegiatan tersebut mencakup wilayah 2 kabupaten yaitu Kabupaten Bandung dan Kabupaten Sumedang;
4. Selanjutnya, Saudara dapat berkoordinasi dengan BPLHD Provinsi Jawa Barat.

Demikian disampaikan, atas perhatiannya diucapkan terima kasih.

Deputi Menteri Negara
Lingkungan Hidup
Bidang Tata Lingkungan,

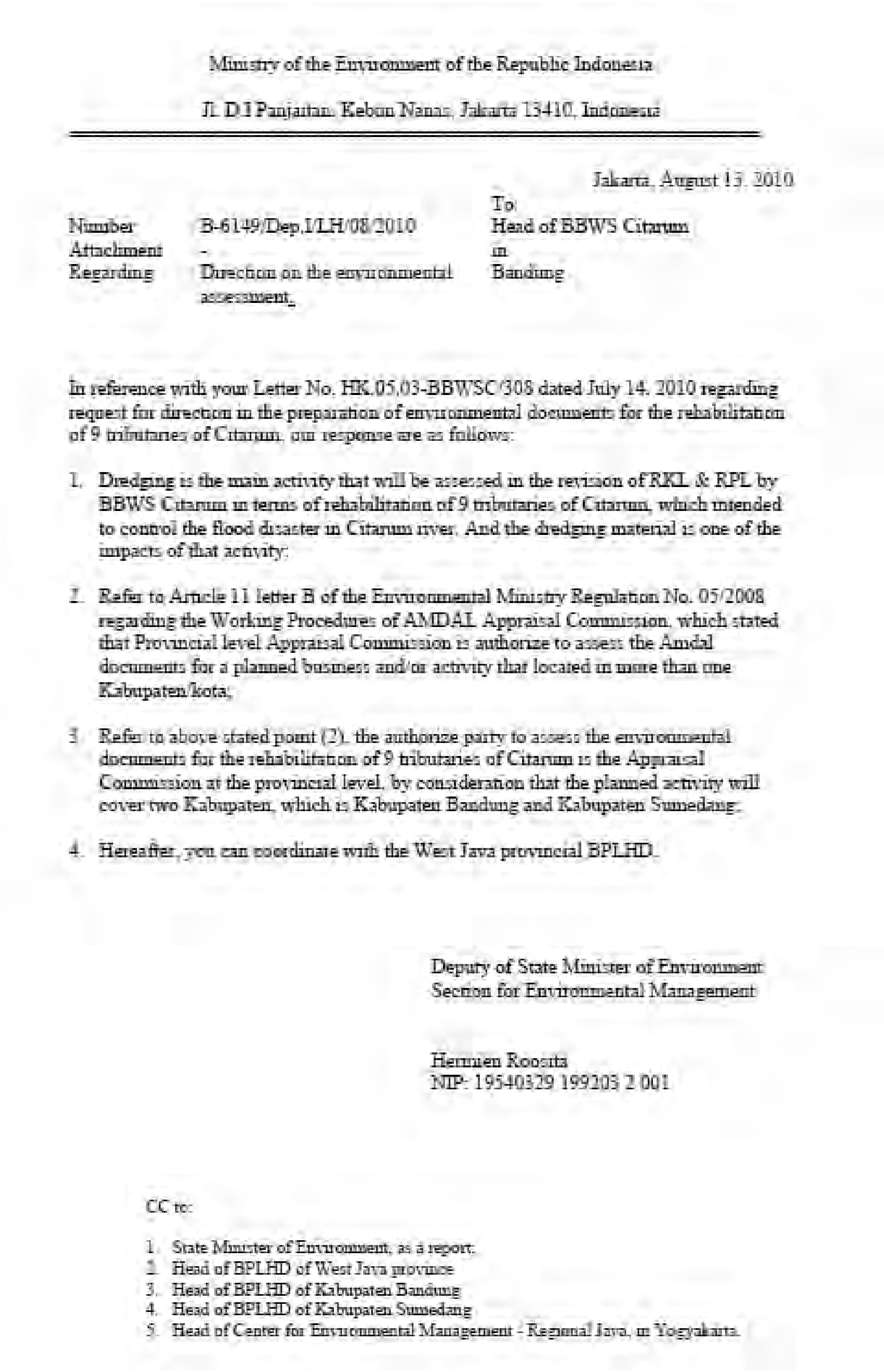
Hermien Roosita
NIP: 19540329 199203 2 001

Tembusan……/2

Tembusan Yth.:
1. Menteri Negara Lingkungan Hidup, *sebagai laporan;*
2. Kepala Badan Pengelolaan Lingkungan Hidup Daerah Provinsi Jawa Barat;
3. Kepala Badan Lingkungan Hidup Kabupaten Bandung;
4. Kepala Badan Lingkungan Hidup Kabupaten Sumedang;
5. Kepala Pusat Pengelolaan Lingkungan Hidup Regional Jawa, *di Yogyakarta.*

Appendix IV-3)

Translated (English)



Ministry of the Environment of the Republic Indonesia

Jl. D.I Panjaitan, Kebun Nanas, Jakarta 13410, Indonesia

Jakarta, August 13, 2010

		To:
Number	B-6149/Dep.I/LH/08/2010	Head of BBWS Citarum
Attachment	-	in
Regarding	Direction on the environmental assessment.	Bandung

In reference with your Letter No. HK.05.03-BBWSC/308 dated July 14, 2010 regarding request for direction in the preparation of environmental documents for the rehabilitation of 9 tributaries of Citarum, our response are as follows:

1. Dredging is the main activity that will be assessed in the revision of RKL & RPL by BBWS Citarum in terms of rehabilitation of 9 tributaries of Citarum, which intended to control the flood disaster in Citarum river. And the dredging material is one of the impacts of that activity;

2. Refer to Article 11 letter B of the Environmental Ministry Regulation No. 05/2008 regarding the Working Procedures of AMDAL Appraisal Commission, which stated that Provincial level Appraisal Commission is authorize to assess the Amdal documents for a planned business and/or activity that located in more than one Kabupaten/kota;

3. Refer to above stated point (2), the authorize party to assess the environmental documents for the rehabilitation of 9 tributaries of Citarum is the Appraisal Commission at the provincial level, by consideration that the planned activity will cover two Kabupaten, which is Kabupaten Bandung and Kabupaten Sumedang;

4. Hereafter, you can coordinate with the West Java provincial BPLHD.

Deputy of State Minister of Environment
Section for Environmental Management

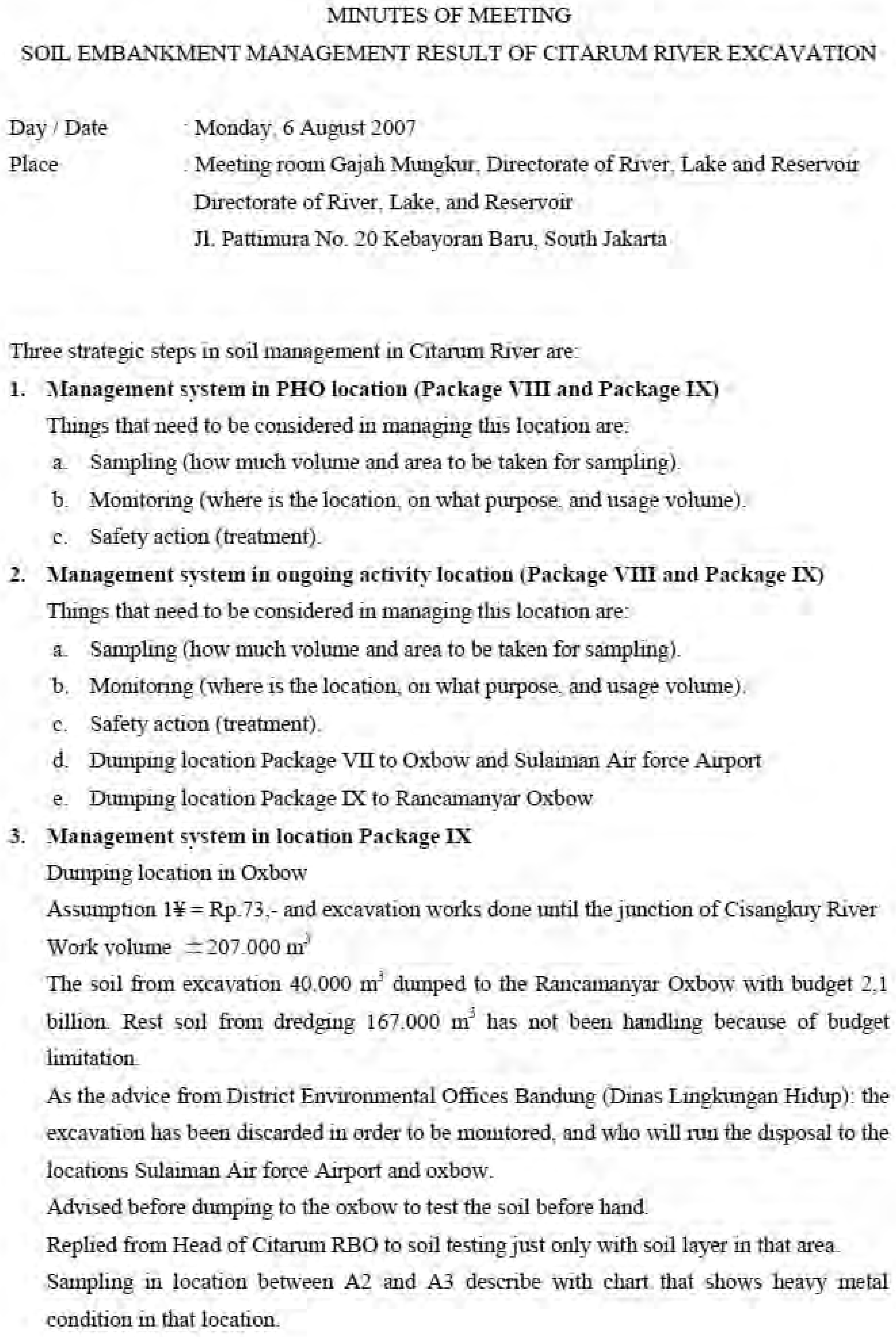
Hermien Roosita
NIP: 19540329 199203 2 001

CC to:

1. State Minister of Environment, as a report;
2. Head of BPLHD of West Java province
3. Head of BPLHD of Kabupaten Bandung
4. Head of BPLHD of Kabupaten Sumedang
5. Head of Center for Environmental Management - Regional Java, in Yogyakarta.

Appendix IV-3)

Minutes of Meeting regarding sludge disposal in oxbows and the air force base during Stage (II), 2007



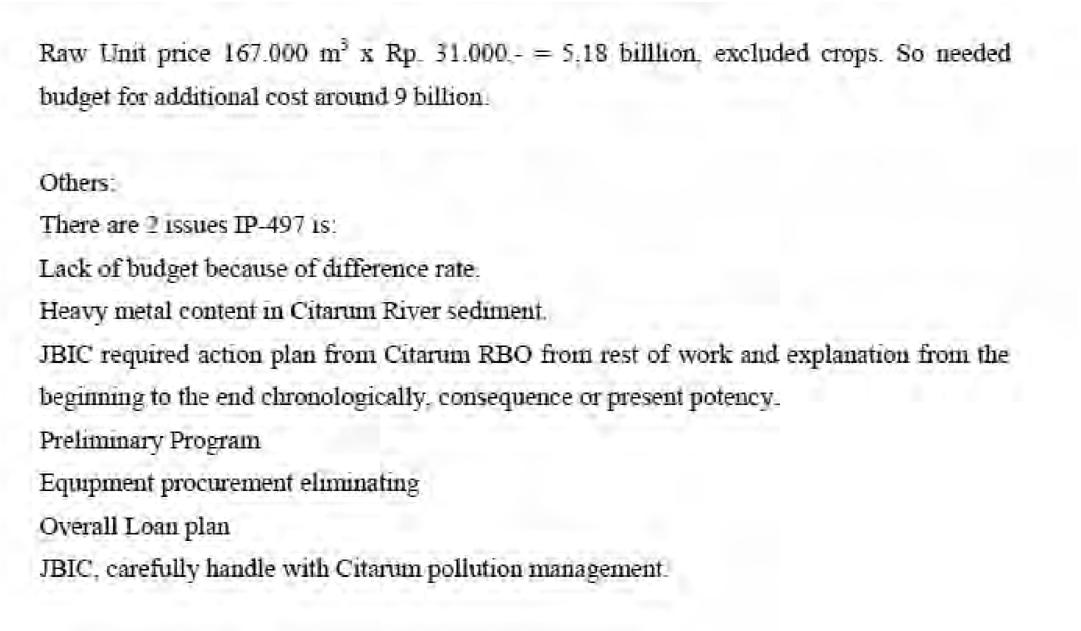
MINUTES OF MEETING
SOIL EMBANKMENT MANAGEMENT RESULT OF CITARUM RIVER EXCAVATION

Day / Date : Monday, 6 August 2007
Place : Meeting room Gajah Mungkur, Directorate of River, Lake and Reservoir
Directorate of River, Lake, and Reservoir
Jl. Pattimura No. 20 Kebayoran Baru, South Jakarta

Three strategic steps in soil management in Citarum River are:

1. **Management system in PHO location (Package VIII and Package IX)**
   Things that need to be considered in managing this location are:
   a. Sampling (how much volume and area to be taken for sampling).
   b. Monitoring (where is the location, on what purpose, and usage volume).
   c. Safety action (treatment).
2. **Management system in ongoing activity location (Package VIII and Package IX)**
   Things that need to be considered in managing this location are:
   a. Sampling (how much volume and area to be taken for sampling).
   b. Monitoring (where is the location, on what purpose, and usage volume).
   c. Safety action (treatment).
   d. Dumping location Package VII to Oxbow and Sulaiman Air force Airport
   e. Dumping location Package IX to Rancamanyar Oxbow
3. **Management system in location Package IX**
   Dumping location in Oxbow
   Assumption 1¥ = Rp.73,- and excavation works done until the junction of Cisangkuy River
   Work volume ±207.000 m^3
   The soil from excavation 40.000 m^3 dumped to the Rancamanyar Oxbow with budget 2,1 billion. Rest soil from dredging 167.000 m^3 has not been handling because of budget limitation.
   As the advice from District Environmental Offices Bandung (Dinas Lingkungan Hidup): the excavation has been discarded in order to be monitored, and who will run the disposal to the locations Sulaiman Air force Airport and oxbow.
   Advised before dumping to the oxbow to test the soil before hand.
   Replied from Head of Citarum RBO to soil testing just only with soil layer in that area.
   Sampling in location between A2 and A3 describe with chart that shows heavy metal condition in that location.

Appendix IV-3)



Raw Unit price 167.000 m^3 x Rp. 31.000,- = 5,18 billlion, excluded crops. So needed budget for additional cost around 9 billion.

Others:

There are 2 issues IP-497 is:

Lack of budget because of difference rate.

Heavy metal content in Citarum River sediment.

JBIC required action plan from Citarum RBO from rest of work and explanation from the beginning to the end chronologically, consequence or present potency.

Preliminary Program

Equipment procurement eliminating

Overall Loan plan

JBIC, carefully handle with Citarum pollution management.