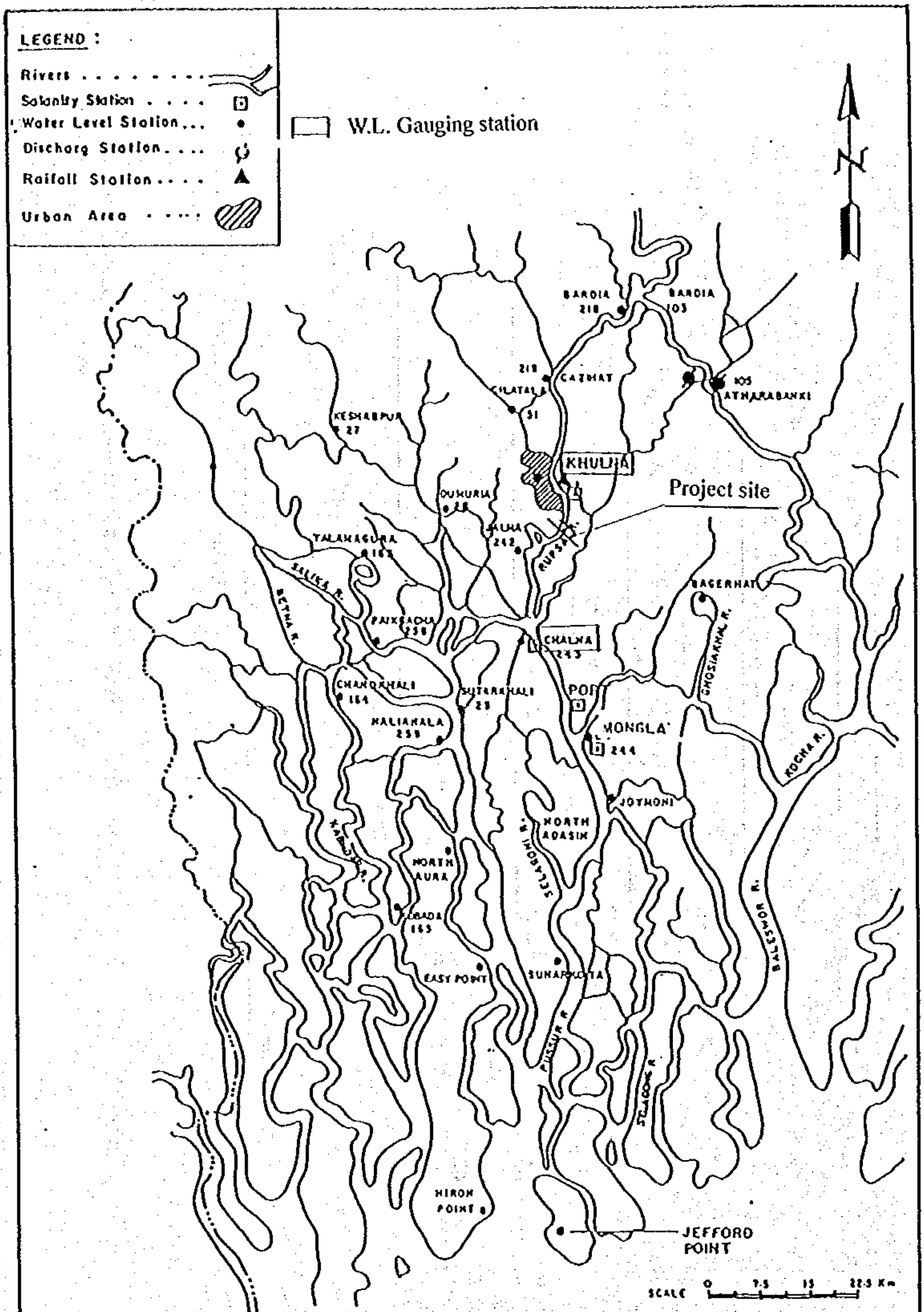


Fig. A4.3.1.1 RIVER SYSTEM IN THE SOUTH WEST REGION OF BANGLADESH

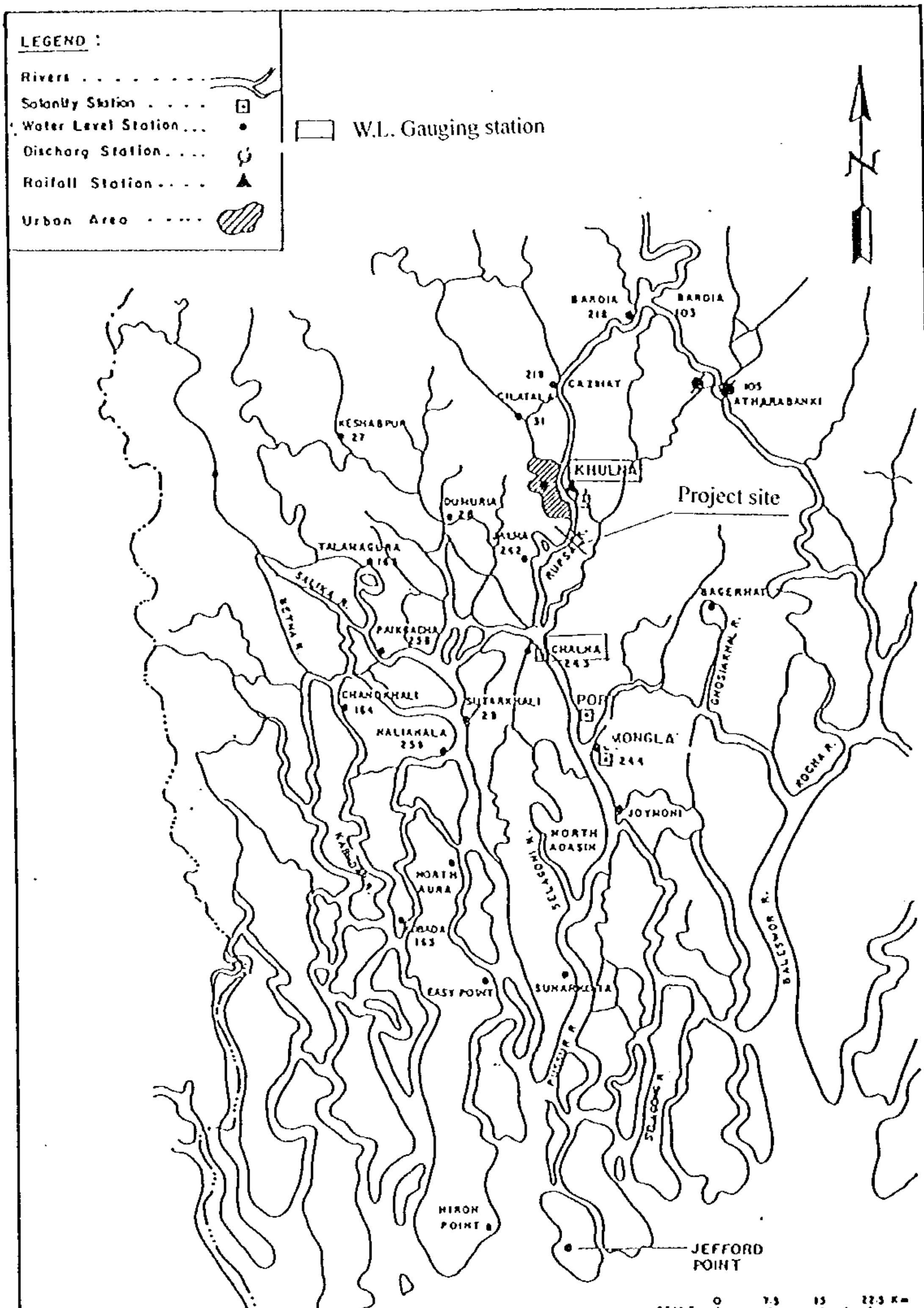


Fig. A4.3.1.1 RIVER SYSTEM IN THE SOUTH WEST REGION OF BANGLADESH

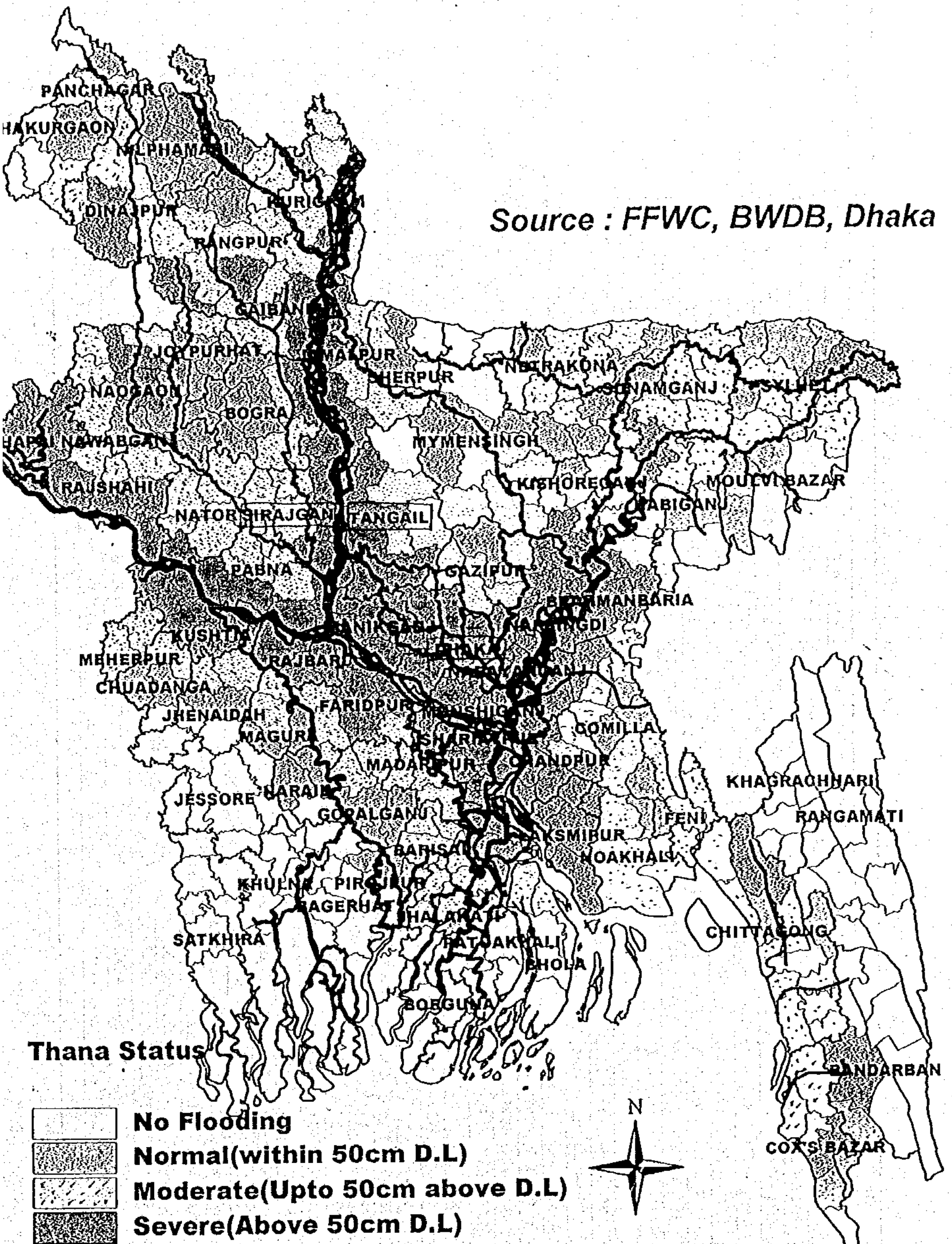


Fig. A4.3.1.2 Total Flood in 1998

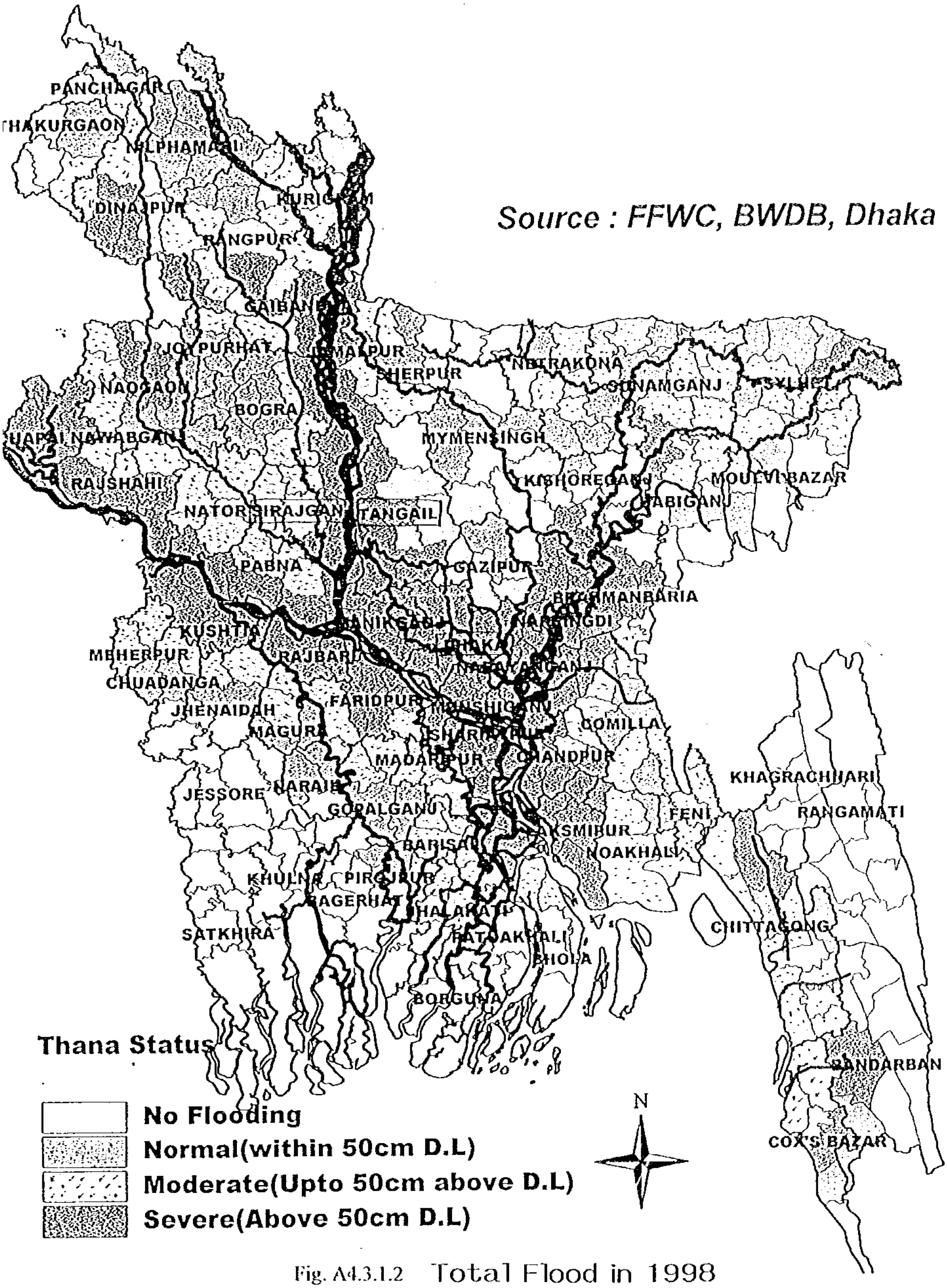


Fig. A4.3.1.2 Total Flood in 1998

Table A4.3.1.1 Gauge Height of Rupsa River at Khulna

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1968							2.03	-0.5	2.04	-0.24	2.13	-0.09	2.32	0.49	2.33	0.75	2.29	0.37	2.23	0.34	1.87	0.03	1.77	-0.24	2.33	
1969	1.62	-0.52	1.69	-0.58	1.91	-0.64	1.97	-0.56	1.97	-0.53	2.07	-0.18	2.38	0.3	2.35	0.62	2.41	0.73	2.16	0.21	1.92	0	1.68	-0.21	2.41	-0.64
1970	1.72	-0.49	1.71	-0.58	1.86	-0.64	1.86	-0.49	2.01	-0.2	2.05	-0.03	2.33	0.32	2.38	0.68	2.39	0.56	2.15	0.55	2.01	0.12	1.72	-0.09	2.39	-0.64
1971	1.74	-0.23	1.83	-0.55	2.04	-0.52	1.97	-0.4	2	-0.12	2.19	0	2.29	0.58	2.44	0.67	2.68	1.37	2.42	0.73	2.07	0.03	1.63	0.03	2.68	-0.55
1972	1.65	-0.24	1.62	-0.55	1.84	-0.52	1.95	-0.27	1.94	-0.15	2.12	-0.06	2.27	0.34	2.32	0.69	2.41	0.43	2.1	0	1.8	-0.05	1.68	-0.26	2.41	-0.55
1973	1.57	0.11	1.65	-0.58	1.74	-0.66	1.97	-0.41	2.04	-0.29	2.33	0.05	2.41	0.59	2.41	0.87	2.33	0.87	2.51	0.67	2.19	0.32	2.01	0.02	2.51	-0.66
1974	1.83	-0.27	1.71	-0.59	2.03	-0.41	1.98	-0.34	2.09	-0.17	2.16	0.2	2.39	0.32	2.61	0.87	2.41	0.91	2.35	0.44	2.03	0.21	1.83	-0.3	2.61	-0.59
1975	1.83	-0.44	1.95	-0.59	1.93	-0.66	2.09	-0.44	2.09	-0.2	2.26	0.02	2.45	0.38	2.55	0.69	2.51	0.52	2.45	0.41	2.19	0.09	1.86	-0.14	2.55	-0.66
1976	1.74	-0.55	1.87	-0.64	2.09	-0.7	2.15	-0.56	2.18	-0.34	2.19	-0.14	2.5	0.15	2.59	0.51	2.62	0.47	2.3	0.14	1.95	-0.2	1.84	-0.24	2.62	-0.7
1977	1.74	-0.56	1.83	-0.61	2	-0.64	2.27	-0.56	2.21	-0.53	2.39	-0.23	2.65	0.18	2.65	0.5	2.73	0.32	2.48	0.08	2.15	-0.11	1.97	-0.24	2.73	-0.64
1978	1.75	-0.56	1.86	-0.64	2	-0.66																				-0.66
1979							2.09	-0.41	2.27	-0.23	2.3	-0.4	2.57	0.19	2.69	0.44	2.65	0.18	2.54	0.12	2.08	-0.17	1.87	-0.36	2.69	-0.41
1980	1.76	-0.47	1.98	-0.6	2.1	-0.65	2.16	-0.6	2.28	-0.26	2.36	-0.7	2.75	0.35	2.76	0.65	2.69	0.43	2.48	0.24	2.02	-0.13	1.96	-0.18	2.76	-0.65
1981	1.84	-0.45	1.83	-0.6	2.1	-0.64	2.21	-0.63	2.31	-0.51	2.36	-0.08	2.71	0.09	2.83	0.7	2.73	0.5	2.62	0.15	2.24	0.07	2.08	-0.21	2.83	-0.64
1982	1.75	-0.47	1.75	-0.65	2.05	-0.67																				-0.67
1983							2.25	-0.57	2.45	-0.32	2.43	-0.13	2.62	0.13	2.88	0.54	2.92	0.65	2.91	0.35	2.42	0.18	1.96	-0.17	2.92	
1984	1.81	-0.5	2.1	-0.59	2.34	-0.53	2.43	-0.56	2.51	-0.28	2.9	-0.06	2.95	0.5	3.28	0.49	3.18	1.05	2.85	0.64	2.06	-0.18	1.88	-0.17	3.28	-0.59
1985	1.79	-0.35	1.92	-0.58	2.23	-0.54	2.27	-0.61	2.46	-0.27	2.8	0	2.83	0.08	3	0.63	2.97	0.49	2.93	0.38	2.5	0.1	2.04	-0.22	3	-0.58
1986	2.23	-0.92	1.98	-0.52	2.18	-0.52	2.34	-0.45	2.38	-0.38	2.42	-0.25	2.92	0.2	2.94	0.42	2.84	0.24	2.91	0.19	2.43	0.04	2.1	-0.37	2.94	-0.92
1987	1.79	-0.55	1.97	-0.62	2.04	-0.73	2.3	-0.64	2.33	-0.44	2.4	-0.21	2.81	0.29	3.06	0.62	3.12	0.8	2.78	0.11	2.35	0.05	1.93	-0.09	3.12	-0.73
1988	1.95	-0.53	2.15	-0.55	2.31	-0.59	2.56	-0.54	2.63	-0.37	2.71	0.18	3.11	0.26	3.41	0.61	3.37	0.61	2.78	0.09	2.32	-0.07	2.39	-0.15	3.41	-0.54
1989	1.9	-0.39	2.05	-0.45	2.45	-0.42	2.65	-0.37	2.65	-0.2	2.7	0.03	2.95	0.35	2.83	0.33	2.9	0.57	2.71	0.4	2.42	0.05	2.25	-0.44	2.95	-0.45
1990	1.85	-0.48	2.17	-0.55	2.42	-0.59	2.52	-0.37	2.49	-0.33	2.6	0.06	3.1	0.27	3.15	0.62	2.92	0.39	3.04	0.27	2.61	0	2.15	-0.27	3.15	-0.59
1991	1.97	-0.65	1.81	-0.64	2.18	-0.74	2.34	-0.68	2.37	-0.4	2.55	-0.11	2.77	0.23	3.03	0.37	3.15	0.34	2.7	0.02	2.12	-0.26	2.01	-0.42	3.15	-0.74
1992	1.98	-0.56	2.22	-0.72	2.34	-0.66	2.3	-0.64	2.36	-0.52	2.52	-0.28	2.88	-0.11	3.1	0.1	3.01	0.15	2.64	0.12	2.23	-0.1	1.96	-0.29	3.1	-0.72
1993	1.99	-0.54	2.25	-0.65	2.36	-0.72	2.46	-0.62	2.6	-0.32	2.7	-0.04	2.88	0.1	3.24	0.52	3.25	0.44	3	0.12	2.45	-0.1	2.2	-0.26	3.25	-0.72
1994	2.22	-0.44	2.35	-0.63	2.58	-0.63	2.52	-0.67	2.5	-0.43	3	-0.24	2.86	0.04	3.22	0.22	3.15	0.09	2.72	-0.22	2.38	-0.44	2.04	-0.48	3.22	-0.63
1995	1.89	-0.7	2.13	-0.68	2.31	-0.73	2.78	-0.62	2.98	-0.3	2.8	-0.3	3.14	0.2	3.15	0.19	3.11	0.2	2.92	-0.32	2.6	-0.4	2.58	-0.59	3.15	-0.73
1996	2.03	-0.82	2.27	-0.73	2.29	-0.79	2.42	-0.74	2.6	-0.5	2.61	-0.4	3.1	-0.34	3.25	0.17	3.12	0.05	2.84	-0.16	2.49	-0.17	2.15	-0.45	3.25	-0.82
1997	2.56	-0.58	2.29	-0.75	2.44	-0.76	2.47	-0.75	2.65	-0.7	2.71	-0.39	3.03	-0.15	3.21	0.02	3.2	0.06	2.76	-0.56	2.32	-0.51	1.82	-0.75	3.21	-0.75
1998	1.82	-0.75	2.43	-0.86	2.44	-0.86	2.5	-0.71	2.68	-0.52	2.73	-0.04	3.13	0.13	3.29	0.31	3.46	0.33	3	0.12	2.75	-0.21	2.34	-0.32	3.46	-0.86
1999																										

Table A4.3.1.2 Gauge Height of Rupsa River at Chalna

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec		Annual	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1968							2.23	-1.04	2.23	-0.64	2.23	-0.43	2.26	-0.15	2.26	-0.09	2.19	-0.24	2.19	-0.15	1.95	-0.37	1.77	-0.67	2.26	-1.04
1969	1.65	-0.88	1.89	0.46	2.13	-1.01	2.19	-0.98	2.16	-0.98	2.19	-0.58	2.38	-0.24	2.35	-0.12	2.26	0.03	2.16	-0.24	2.1	-0.38	2.36	-0.14	2.38	-1.01
1970	2.85	-0.58	2.19	-0.88	1.98	-0.98	2.07	-0.61	2.29	-0.24	2.13	-0.24	2.29	-0.12	2.36	0.05	2.27	0.05	2.7	0.11	2.09	-0.23	1.85	-0.47	2.85	-0.98
1971	1.91	-0.59	2.03	-0.96	2.06	-0.93	2.15	-0.9	2.3	-0.68	2.27	-0.62	2.3	-0.1	2.37	-0.16	2.43	0.17	2.37	0.38	2.15	-0.23	1.79	-0.53	2.43	-0.96
1972	1.79	-0.59	1.85	-1.02	2.15	-1.02	2.35	-0.7	2.26	-0.64	2.25	-0.55	2.33	-0.46	2.33	-0.08	2.45	-0.35	2.15	-0.44	2.01	-0.58	1.86	-0.61	2.45	-1.02
1973	1.69	-1.01	1.86	-1.01	2.01	-1.13	2.35	-0.85	2.47	-0.55	2.32	-0.55	2.35	0.03	2.47	0.06	2.72	0.17	2.56	0.17	2.3	-0.24	1.94	-0.75	2.72	-1.13
1974	1.99	-0.75	2.02	-0.96	2.24	-0.99	2.3	-0.9	2.33	-0.51	2.33	-0.18	2.51	-0.29	2.62	-0.29	2.43	-0.21	2.31	0.18	2.19	-0.18	2.04	-0.3	2.62	-0.99
1975	1.83	-0.15	1.98	-0.61	1.98	-1.01	2.04	-1.07	2.32	-0.85	2.62	-0.18	2.59	-0.21	2.62	0.09	2.59	0.03	2.29	-0.15	2.19	-0.12	2.01	-0.43	2.62	-1.07
1976	2.07	-0.52	2.16	-1.01	2.06	-0.87	2.33	-0.69	2.36	-0.72	2.36	-0.44	2.64	-0.08	2.7	0.05	2.7	-0.08	2.45	-0.2	2.18	-0.47	2.09	-0.59	2.7	-1.01
1977	1.97	-0.94	1.89	-0.94	2.19	-0.94	2.44	-0.99	2.36	-0.99	2.64	-0.47	2.61	-0.44	2.68	-0.37	2.62	-0.27	2.44	-0.46	2.19	-0.49	2.19	-0.46	2.68	-0.99
1978	2.13	-1.01	1.83	-1.16	1.95	-1.01																			2.13	-1.16
1979																									0	0
1980							2.29	-1.07	2.62	-0.76	2.38	-0.58	2.68	-0.18	2.71	-0.37	2.65	-0.49	2.62	-0.58	2.38	-0.64	2.16	-0.58	2.71	-1.07
1981	1.8	-0.67	1.62	-0.7	1.89	-0.83	2.38	-0.85	2.32	-0.82	2.59	-0.49	2.8	-0.27	3.05	-0.06	2.9	-0.24	2.59	-0.37	2.38	-0.24	2.13	-0.12	3.05	-0.85
1982	1.83	-0.34	1.74	-1.01	1.68	-1.46																			1.83	-1.46
1983							2.29	-0.98	2.42	-0.83	2.62	-0.65	2.72	-0.53	2.95	-0.28	3.02	-0.18	3.155	-0.045	3.175	-0.055	2.645	-0.445	3.175	-0.98
1984	2.285	-0.675	2.33	-0.82	2.56	-0.87	2.73	-1.07	3.05	-0.6	3.16	-0.4	3.3	-0.16	3	-0.17	3.21	-0.2	2.7	-0.4	2.8	-0.7	2.35	-0.55	3.3	-1.07
1985	2	-0.7	1.86	-0.84	2.2	-0.92	2.6	-1.07	2.92	-0.86	2.97	-0.68	2.92	-0.52	3.07	-0.28	2.96	-0.42	3.62	-0.46	2.92	-0.75	2.36	-0.7	3.62	-1.07
1986	2.16	-0.67	1.97	-1.14	1.92	-1.15	2.16	-1.1	2	-1	2.5	-0.86	3.9	-0.62	2.1	-0.3	1.8	-0.7	1.84	-0.7	1.8	-0.6	1.78	-0.77	3.9	-1.15
1987	1.7	-1	1.94	-1.06	2.33	-1.38	2.61	-1.1	2.62	-0.94	2.59	-0.99	2.7	-0.72	2.94	0.2	3.08	0.12	2.96	-0.3	2.37	-0.59	2.1	-0.49	3.08	-1.38
1988	2.08	-0.53	2.21	-0.6	2.37	-0.59	2.3	-0.6	2.68	-1.12	2.75	-1.12	2.85	-0.9	2.84	-0.77	2.75	-1.14	2.65	-0.93	2.74	-0.64	2.2	-1.09	2.85	-1.14
1989	1.86	-1.12	2	-1.12	2.66	-1.12	2.98	-1.12	3.3	-1.08	2.94	-0.68	3.3	-0.82	2.98	-0.81	3.71	-0.86	3.67	-0.35	3.55	-0.35	2.85	-0.61	3.71	-1.12
1990	2.11	-0.58	1.96	-0.95	2.36	-1.05	2.89	-1.04	2.9	-0.75	2.86	-0.58	2.9	-0.54	3.07	-0.15	2.86	-0.33	2.9	-0.53	3.68	-1.27	2.5	-0.8	3.68	-1.27
1991	2.21	-0.98	2.28	-1.08	2.67	-1.13	2.87	-1.18	2.79	-1.03	3.14	-0.63	2.92	-0.34	3.03	-0.28	3.11	-0.22	2.81	-0.75	2.5	-0.72	2.38	-0.82	3.14	-1.18
1992	2.3	-1.02	2.63	-1.21	2.76	-1.26																			2.76	-1.26
1993							3.76	-0.48	3.74	-0.13	3.89	0.15	3.91	-0.47	3.36	-0.37	3.16	-0.29	3.05	-0.52	2.76	-0.61	3.05	-0.25	3.91	-0.61
1994	3.19	-0.46	3.23	-0.49	3.35	-1.43	2.64	-1.26	2.62	-1.31	2.99	-0.88	3.02	-0.53	3.12	-0.54	3.06	-0.78	2.96	-0.79	2.77	-0.9	2.5	-0.82	3.35	-1.43
1995	2.2	-1	2.86	-1.03	2.87	-1.25	2.62	-1.14	3.09	-1.15	2.96	-0.81	3.18	-0.66	3.12	-0.54	3.08	-0.45	2.92	-0.81	2.88	-0.86	2.74	-0.79	3.18	-1.25
1996	2.4	-0.69	2.49	-0.92	3.51	-0.86	2.9	-0.85							3.29	-0.41	3.09	-0.47	3.29	-0.53	2.87	-0.59	2.08	-0.83	3.51	-0.92
1997	2.08	-0.83	1.99	-0.93			1.66	-2.26	2.57	-1.72	2.2	-1.58	2.2	-1.68	3.59	-0.94	3.08	-1.17	2.74	-1.17	2.52	-1.28	1.6	-1.28	3.59	-2.26
1998	1.62	-1.47	2.98	-1.5	2.29	-1.7	2.31	-1.43	2.6	-1.49	2.68	-1.09	3.3	-0.8	3.25	-0.83	3.12	-0.24	2.72	-0.46	2.9	-0.75	2.32	-0.92	3.3	-1.7
1999	2.02	-0.96	2	-0.9	2.61	-1.46																			2.61	-1.46

Table A4.3.1.3 Calculation of Velocity & Discharge on each propose bridge site

TIME	Max.V	MV_1	A_1	Q_1	MV_2	A_2	Q_2	MV_3	A_3	Q_3	Σ Q	Σ A	AverageV
Q1			①			②			③				
9:00	2.160	1.164	1352.75	1574.60	1.439	1116.23	1606.25	1.790	1455.13	2604.68	5785.53	3924.11	1.474
11:30	-0.877	-0.423	1607.29	-679.88	-0.019	1292.12	-24.55	-0.554	1754.72	-972.11	-1676.54	4654.13	-0.360
Q2			①			②			③				
9:00	2.095	0.946	1139.93	1078.37	1.341	1061.12	1422.96	1.891	1754.57	3317.89	5819.22	3955.62	1.471
12:30	-0.700	-0.588	1668.49	-981.07	-0.559	1364.48	-762.74	-0.514	2217.91	-1140.01	-2883.82	5250.88	-0.549
Q3			①			②			③				
8:30	1.771	1.098	1163.42	1277.44	1.558	1328.41	2069.66	1.388	1151.78	1598.67	4945.77	3643.61	1.357
11:30	-0.568	-0.435	1504.68	-654.54	-0.422	1649.33	-696.02	-0.339	1381.17	-468.22	-1818.78	-4535.18	-0.401

Table A4.3.1.4 Lowest River Bed Data on past years

1986 (-1.71ft)			1989 (-1.48ft)			1992 (-2.17ft)		
Distance (m)	Acc. Dis. (m) 1986 Jul.	Elevation from PWD 1986 Jul.	Distance (m)	Acc. Dis. (m) 1989 Mar.	Elevation from PWD 1989 Mar.	Distance (m)	Acc. Dis. (m) 1992 Nov.	Elevation from PWD 1992 Nov.
-260	-2294	-12.72	-194.00	-2295	-14.48	-289	-2172	-13.77
-275	-2034	-11.50	-113	-2101	-12.65	-225	-1883	-12.55
-253	-1759	-10.28	-140	-1988	-11.43	-262	-1658	-11.03
-220	-1506	-13.63	-385	-1848	-10.82	-77.00	-1396	-17.13
-148	-1286	-15.77	-331	-1463	-18.44	-403	-1319	-19.26
-204	-1138	-17.29	-270	-1132	-18.74	-59	-916	-23.53
-215	-934	-18.51	-270	-862	-21.18	-323	-857	-16.52
-200	-719	-17.59	-240	-592	-17.52	-93	-534	-17.73
-190	-519	-16.98	-258	-352	-16	-178	-441	-16.21
-165	-329	-16.68	-94	-94	-19.66	-156	-263	-15.91
-164	-164	-16.68	149.00	149.00	-18.44	-58	-107	-21.7
0	0	-18.51	283.00	432	-13.26	-32	-49	-24.44
35	35	-18.81	274.00	706	-9.60	-17	-17	-18.34
200	235	-15.46	234.00	940	-10.82	48.00	48	-22.92
205	440	-11.50	254.00	1194	-10.51	56.00	104	-17.73
195	635	-10.58	312.00	1506	-11.12	202.00	306	-18.65
208	843	-9.67	247.00	1753	-8.07	94.00	400	-13.77
186	1029	-11.19				258.00	658	-11.94
195	1224	-10.28				303.00	961	-11.33
191	1415	-10.89				80.00	1041	-10.42
193	1608	-9.36				511.00	1552	-10.72

1998 (2.46ft)			1999 from SWMC					
Distance (m)	Acc. Dis. (m) 1998 Sep.	Elevation from PWD 1998 Sep.	Distance from Q1C1	Acc. Dis. (m) 1999 Jul.	Distance from Jetty (m) 1999 Jul.	Elevation from PWD 1999 Jul.	Section	
-210	-2362	-15.71	-662.9	-7494	-4993.82	-30.43	RQ3U1	
-268	-2152	-14.49	-2535.5	-6831	-4330.92	-11.09	RQ3U2	
-250	-1884	-10.23	-962.9	-4295	-1795	-14.64	Q3UX3	
-302	-1634	-10.84	-851.61	-3333	-833	-17.32	Q3UX4	
-321	-1332	-14.49	-780.93	-2481	19	-19.92	Q3UX5	
-271	-1011	-19.07	-944.55	-1700	800	-14.205	Q3C1R	
-254	-740	-12.05	-705.45	-755	1745	-10.569	Q2C1R	
-241	-486	-16.02	-50	-50	2450	-9.75	Q1U50	
-245	-245	-16.02	0	0	2500	-9.938	Q1C1	
57	57	-17.54	50	50	2550	-9.93	Q1D50	
255	312	-8.4		200	2700	-11.9	Q1D200R	
263	575	-9.92		260	2760	-12.86	Q1DX1R	
266	841	-10.23		317	2817	-13.7	Q1DX2R	
270	1111	-7.79		521	3021	-14.8	Q1DX3R	
270	1381	-7.18		759	3259	-16.5	Q1DX4R	
265	1646	-5.96		969	3469	-17.64	Q1DX5R	

Fig. A4.3.1.3 Logitudinal Profile of Lowest River Bed Elevation

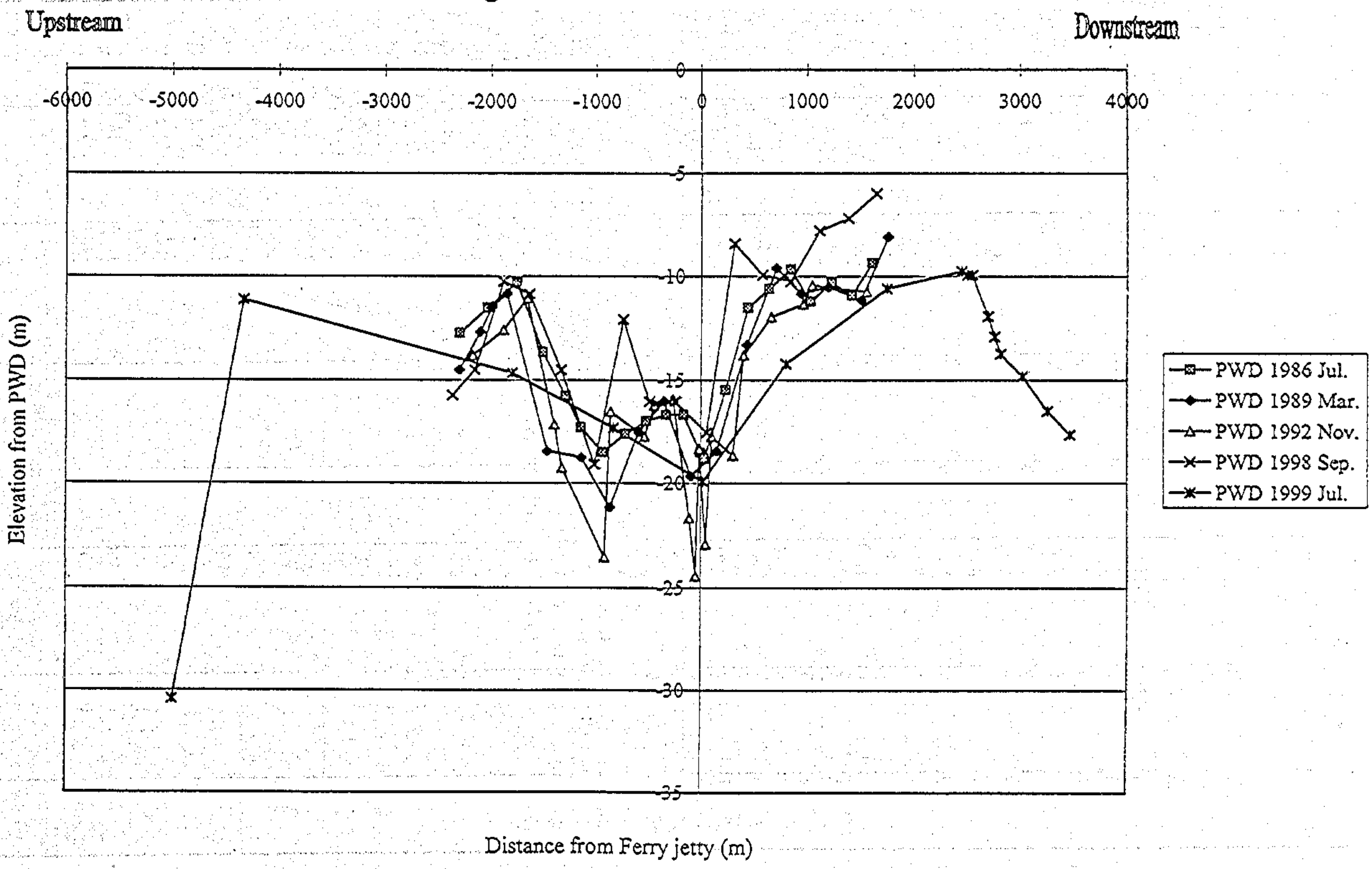
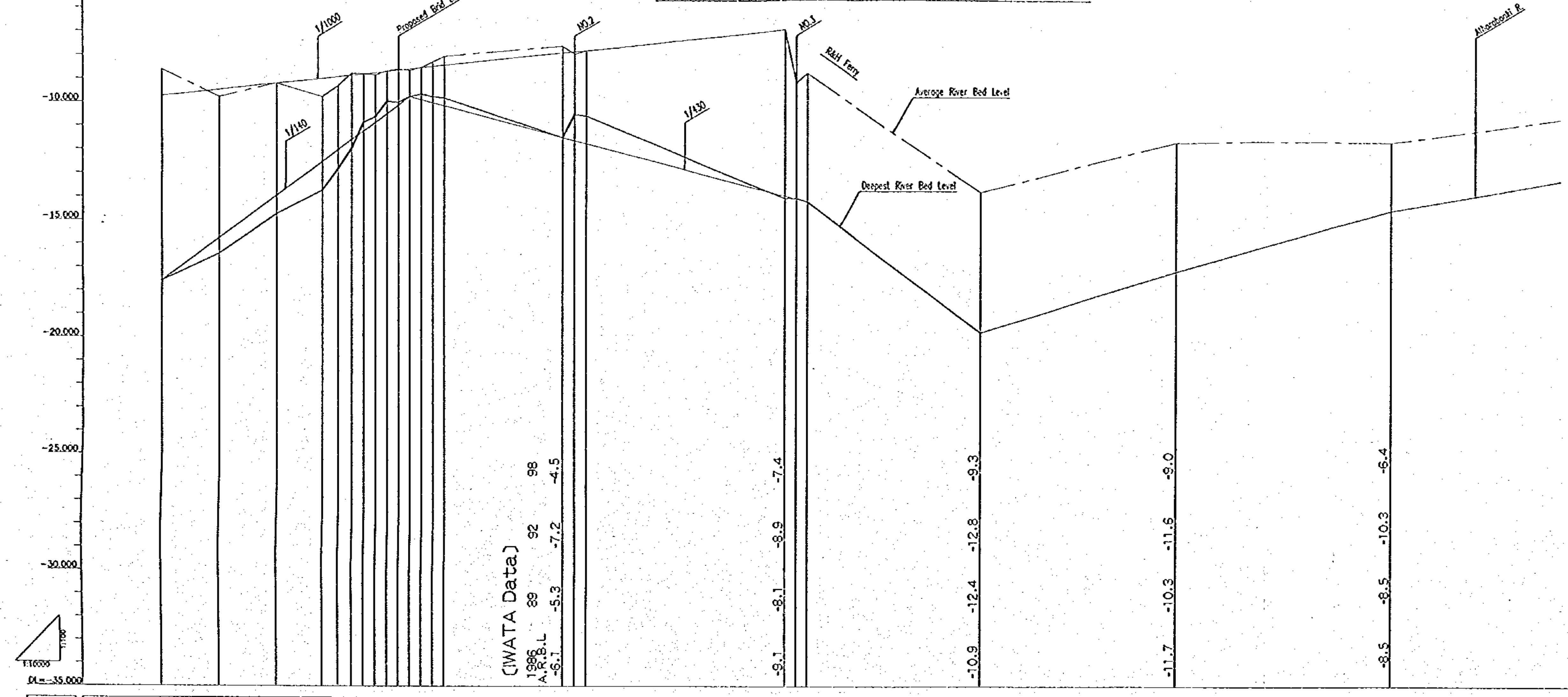


Fig. A4.3.1.4 Longitudinal profile in Rupsa River



NO./ID	Distance	Add.D	Average	Max Water DepthR.B.	Right	Left	Transect Length
Q1DX5	0.000	0.000	-8.61	-17.58		80.0	709.0
Q1DX4	250.000	250.000	-9.79	-16.45		115.0	631.0
Q1DX3	250.000	500.000	-9.23	-14.77		58.0	522.0
Q1DX2	200.000	700.000	-9.80	-13.76		70.0	582.0
Q1DX1	70.000	770.000	-9.33	-12.86		28.0	463.0
Q1D200	60.000	830.000	-8.82	-12.00		52.0	564.0
Q1D150	50.000	880.000	-8.82	-10.88		70.0	525.0
Q1D100	50.000	930.000	-8.88	-10.65		47.0	530.0
Q1D50	50.000	980.000	-8.71	-10.00		44.0	562.0
Q1C1	50.000	1030.000	-8.65	-10.06		65.0	635.0
Q1U50	50.000	1080.000	-8.71	-9.82		216.0	635.0
Q1U100	50.000	1130.000	-8.59	-9.71		239.0	656.0
Q1U150	50.000	1180.000	-8.35	-9.82	260.0		660.0
Q1U200	50.000	1230.000	-8.11	-9.88	264.0		709.0
Q2D50	520.000	1750.000	-7.68	-11.55		186.0	588.0
Q2C2	50.000	1800.000	-8.00	-10.57		190.0	627.0
Q2U50	50.000	1850.000	-7.88	-10.63		163.0	628.0
Q3D50	875.000	2725.000	-6.97	-14.13		29.0	535.0
Q3C1	50.000	2775.000	-9.24	-14.14		28.0	431.0
Q3U50	50.000	2825.000	-8.85	-14.29		29.0	535.0
Q3UX5	760.000	3585.000	-13.88	-19.86	124.0		361.0
Q3UX4	860.000	4445.000	-11.77	-17.26	132.0		394.0
Q3UX3	950.000	5395.000	-11.75	-14.65	71.0		439.0

Table A4.3.2.1 Temperature Data at Khulna (Unit : C)

AD	January		February		March		April		May		June	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1988	28.4	7.5	32.8	10.8	36.8	16.3	38.6	19.6	36.2	20.2	37.0	22.5
89	27.2	7.4	33.6	9.0	36.8	14.0	38.4	19.6	40.0	21.4	35.8	23.4
90	30.5	7.7	31.6	13.1	35.0	13.5	37.0	15.8	36.3	21.5	36.0	22.4
91	29.2	8.4	33.7	13.5	37.4	18.6	37.0	19.2	36.5	20.8	35.2	23.0
92	28.5	7.4	29.7	10.6	36.5	16.2	38.8	20.2	37.4	19.4	37.2	22.2
93	29.0	7.0	33.5	10.4	35.8	12.8	36.5	19.5	35.7	20.2	35.2	23.0
94	30.2	8.6	31.6	9.8	36.7	13.3	37.8	16.0	37.7	20.4	37.0	23.2
95	28.0	7.3	32.6	9.2	37.7	13.8	39.4	20.6	38.2	23.6	36.2	23.2
96	30.4	8.0	32.5	9.0	36.9	16.0	38.4	18.4	37.8	21.4	36.4	22.0
97	28.6	7.2	32.0	9.4	35.6	13.4	35.6	17.8	36.5	19.6	36.5	20.8
98	29.0	6.8	32.0	12.0	34.4	15.2	36.3	18.4	37.7	21.0	36.5	25.3
Mean	29.0	7.6	32.3	10.6	36.3	14.8	37.6	18.6	37.3	20.9	36.3	22.8
Max	30.5	8.6	33.7	13.5	37.7	18.6	39.4	20.6	40.0	23.6	37.2	25.3
Min	27.2	6.8	29.7	9.0	34.4	12.8	35.6	15.8	35.7	19.4	35.2	20.8

AD	July		August		September		October		November		December		Annual	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
1988	35.0	24.5	34.0	25.0	39.1	25.0	33.7	20.8	32.3	13.9	29.0	12.0	39.1	7.5
89	35.5	24.7	34.6	24.5	34.6	24.0	35.5	21.8	32.5	15.6	29.1	8.0	40.0	7.4
90	35.0	24.6	34.5	24.8	35.0	24.2	34.5	18.4	32.5	13.8	29.3	10.2	37.0	7.7
91	34.8	25.0	35.5	24.0	35.0	24.0	34.5	21.2	30.6	13.0	29.8	9.0	37.4	8.4
92	35.4	22.2	35.0	23.3	36.6	22.2	34.5	19.6	33.2	15.5	28.2	8.8	38.8	7.4
93	34.0	24.0	33.9	24.8	35.3	23.8	34.8	19.4	32.0	14.8	29.8	11.5	36.5	7.0
94	35.1	25.0	34.3	23.0	35.5	24.0	35.4	22.0	32.8	15.4	30.4	10.2	37.8	8.6
95	35.0	24.2	35.4	24.6	35.1	22.6	35.0	19.0	34.0	11.9	29.6	11.9	39.4	7.3
96	35.5	24.0	33.8	22.3	37.0	24.2	35.0	20.8	33.5	13.4	29.3	9.3	38.4	8.0
97	34.8	24.0	35.6	24.2	35.0	22.3	34.2	19.8	33.7	16.2	30.1	9.2	36.5	7.2
98	34.8	24.4	34.5	24.4	36.6	23.6	36.4	22.6	34.2	16.8	30.0	11.8	37.7	6.8
Mean	35.0	24.2	34.6	24.1	35.9	23.6	34.9	20.5	32.8	14.6	29.5	10.2	38.1	7.6
Max	35.5	25.0	35.6	25.0	39.1	25.0	36.4	22.6	34.2	16.8	30.4	12.0	40.0	8.6
Min	34.0	22.2	33.8	22.3	34.6	22.2	33.7	18.4	30.6	11.9	28.2	8.0	36.5	6.8

Source : Province Meteorology Office at Khulna

Air Temperature at Khulna
Period 1988-1998 (Unit : C)

	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Extreme Max	30.5	33.7	37.7	39.4	40.0	37.2	35.5	35.6	39.1	36.4	34.2	30.4	40.0
Mean Max	29.0	32.3	36.3	37.6	37.3	36.3	35.0	34.6	35.9	34.9	32.8	29.5	
Mean Min	7.6	10.6	14.8	18.6	20.9	22.8	24.2	24.1	23.6	20.5	14.6	10.2	
Extreme Min	6.8	9.0	12.8	15.8	19.4	20.8	22.2	22.3	22.2	18.4	11.9	8.0	6.8

Source : Province Meteorology Office - Khulna

Table A4.3.2.2 Precipitation Data at Khulna (1/3) (Unit : mm)

Year	January				February				March				April			
	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days
1968	0	0	0	0	0	0	0	0	32	32	1	1	19	19	1	1
69	0	0	0	0	0	0	0	0	106	38	5	4	54	31	3	3
70	0	0	0	0	0	0	0	0	0	0	0	0	51	51	1	1
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	64	19	7	4
73	****	****	****	****	****	****	****	****	****	****	****	****	22	13	4	1
74	****	****	****	****	0	0	0	0	174	68	5	4	37	14	4	3
75																
76	0	0	0	0	70	37	2	2	0	0	0	0	59	37	3	3
77	4	4	1	0	0	0	0	0	0	0	0	0	157	52	11	7
78	0	0	0	0	3	2	2	0	19	9	3	0	81	32	9	2
79	12	9	2	0	26	14	3	1	1	1	1	0	12	5	4	0
80	0	0	0	0	101	50	5	4	151	61	5	4	23	13	2	2
81	23	11	3	2	42	23	4	2	220	91	7	6	347	122	12	8
82	0	0	0	0	15	6	3	0	23	11	3	1	135	37	11	5
83	49	41	2	1	60	15	6	2	37	17	5	2	163	121	5	3
84	32	24	3	1	1	1	1	0	0	0	0	0	97	36	7	3
85	9	4	3	0	6	4	2	0	30	22	2	1	35	21	4	2
86	8	7	2	0	0	0	0	0	1	1	1	0	147	99	8	2
87	2	1	2	0	3	3	1	0	55	47	4	0	134	80	4	4
88	0	0	0	0	50	25	3	2	18	11	3	1	53	25	6	2
89	0	0	0	0	8	7	2	0	2	2	1	0	54	46	2	1
90	0	0	0	0	62	27	6	3	212	35	10	10	58	37	5	2
91	10	6	2	0	54	24	3	3	36	22	2	2	38	11	4	2
92	13	13	1	0	203	64	10	4	0	0	0	0	2	2	1	0
93	70	70	1	1	52	32	2	2	127	53	5	3	69	23	9	3
94	1	1	1	0	15	8	3	0	0	0	0	0	105	36	8	4
95	8	3	4	0	104	53	4	3	34	27	3	1	18	10	3	1
96	1	1	1	0	17	9	3	0	1	1	1	0	64	22	6	2
97	10	8	2	0	22	12	4	1	99	66	4	2	80	20	11	3
98	59	24	4	3	91	38	5	3	213	95	5	5	105	35	9	3
Mean	11.1	8.1	1.2	0.3	34.7	15.7	2.6	1.1	54.9	24.5	2.6	1.6	76.1	35.6	5.5	2.6
Max	70	70	4	3	203	64	10	4	220	95	10	10	347	122	12	8
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table A4.3.2.2 Precipitation Data at Khulna (2/3) (Unit : mm)

Year	May				June				July				August			
	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days
1968	36	0	2	1	522	104	14	10	415	130	12	9	134	36	7	5
69	61	25	4	3	301	254	4	3	73	31	5	2	507	93	16	12
70	129	41	4	4	548	105	14	13	634	96	16	14	270	51	12	11
71	37	28	3	1	63	44	3	2	48	13	5	3	135	32	8	5
72	121	60	4	3	****	****	****	****	137	51	12	3	****	****	****	****
73	373	127	12	9	250	89	9	5	107	20	9	5	110	31	7	4
74	301	97	11	9	251	42	14	8	792	85	26	19	442	174	20	10
75																
76	288	73	11	8	340	57	14	8	305	59	25	12	378	89	21	11
77	245	86	14	6	355	81	19	12	****	****	****	****	276	93	22	7
78	226	35	15	8	436	132	15	8	341	47	22	13	301	78	22	8
79	97	48	7	3	356	69	17	10	533	153	18	9	633	391	16	7
80	222	51	10	8	348	58	17	11	300	58	25	12	421	89	26	12
81	236	74	19	7	227	57	15	7	425	64	27	14	268	31	19	12
82	30	27	3	1	340	69	16	9	129	29	14	5	386	131	25	10
83	358	97	16	11	302	74	15	10	****	****	****	****	448	89	21	13
84	227	58	8	6	783	216	27	12	300	57	24	9	486	69	26	15
85	158	39	16	6	308	92	18	9	161	24	23	5	344	40	26	15
86	251	65	12	7	239	99	18	5	390	88	27	12	215	42	17	7
87	113	54	7	3	315	95	12	7	517	87	27	18	498	186	21	8
88	305	89	13	8	599	129	21	10	326	54	22	8	302	56	24	9
89	185	51	12	6	257	67	17	9	239	27	18	9	80	12	20	2
90	261	74	12	7	261	62	19	7	436	83	26	14	206	53	21	8
91	100	22	14	5	421	57	19	12	229	54	21	9	318	58	24	10
92	192	61	14	6	157	44	12	6	254	62	22	9	198	38	21	8
93	211	52	11	6	638	185	13	8	288	48	22	10	290	74	23	10
94	115	43	8	5	239	36	19	10	210	32	24	9	217	35	22	6
95	181	89	7	3	308	81	17	8	407	74	24	13	594	100	23	13
96	117	59	7	3	453	97	17	10	223	35	21	9	275	79	21	7
97	181	66	13	5	218	39	18	7	456	112	24	14	321	57	22	11
98	161	46	9	7	175	46	14	7	343	103	25	9	258	42	23	11
Mean	183.9	57.9	9.9	5.5	345.2	89.0	15.4	8.4	322.1	63.4	20.2	9.9	321.1	81.0	19.9	9.2
Max	373	127	19	11	783	254	27	13	792	153	27	19	633	391	26	15
Min	30	0	2	1	63	36	3	2	48	13	5	2	80	12	7	2

Table A4.3.2.2 Precipitation Data at Khulna (3/3)

(Unit : mm)

Year	September				October				November				December				Annual		
	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Monthly	Max Daily	0< Days	10< Days	Precipitation	Max Monthly	Max Daily
1968	47	0	5	2	17	13	2	1	0	0	0	0	0	0	0	0	1222	522	130
69	587	254	8	7	50	25	2	2	28	28	1	1	0	0	0	0	1767	587	254
70	115	49	6	4	190	71	8	6	13	13	1	1	0	0	0	0	1950	634	105
71	80	53	5	2	106	62	4	2	6	6	1	0	0	0	0	0	475	135	62
72	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****	****
73	39	13	3	3	****	****	****	****	****	****	****	****	4	4	1	0	*905	*373	*127
74	452	120	16	11	312	68	7	7	1	1	1	0	0	0	0	0	2762	792	174
75																			
76	363	68	20	11	114	50	6	3	11	11	1	1	0	0	0	0	1928	378	89
77	57	11	9	2	****	****	****	****	17	11	5	1	11	5	3	0	*1122	*355	*93
78	453	113	17	9	127	70	9	3	0	0	0	0	0	0	0	0	1987	453	132
79	239	64	13	7	93	75	5	1	0	0	0	0	31	29	2	1	2033	633	391
80	137	23	17	5	126	70	10	3	0	0	0	0	1	1	1	0	1830	421	89
81	188	56	13	7	29	11	5	1	0	0	0	0	65	62	2	1	2070	425	122
82	268	53	18	11	22	14	3	1	29	18	2	2	3	3	1	0	1380	386	131
83	244	42	19	9	276	74	13	8	6	6	1	0	6	6	1	0	*1949	*448	*121
84	159	39	13	8	80	24	7	3	0	0	0	0	6	6	1	0	2171	783	216
85	143	22	21	4	136	62	5	3	12	12	1	1	0	0	0	0	1342	344	92
86	843	430	22	12	168	33	11	6	152	108	4	3	1	1	1	0	2415	843	430
87	189	46	20	4	41	19	4	2	48	37	4	1	7	7	1	0	1922	517	186
88	67	17	14	3	95	29	8	4	140	102	3	2	0	0	0	0	1955	599	129
89	246	57	15	9	330	103	8	8	0	0	0	0	1	1	1	0	1402	330	103
90	205	41	22	7	156	53	9	4	77	27	5	4	4	2	2	0	1938	436	83
91	342	40	19	14	161	59	10	5	4	4	1	0	47	31	4	2	1760	421	59
92	111	25	13	6	88	42	8	2	0	0	0	0	0	0	0	0	1218	254	64
93	196	42	22	8	124	35	12	4	14	13	2	1	0	0	0	0	2079	638	185
94	160	52	12	6	63	25	6	4	5	2	3	0	0	0	0	0	1130	239	52
95	303	60	17	8	86	38	7	2	162	113	8	2	0	0	0	0	2205	594	113
96	70	29	12	2	242	115	6	3	8	8	1	0	0	0	0	0	1471	453	115
97	364	81	22	11	44	35	3	1	2	2	1	0	19	7	4	0	1816	456	112
98	300	49	17	9	157	34	14	5	132	87	4	2	0	0	0	0	1994	343	103
Mean	240.2	67.2	14.8	6.9	127.1	48.5	7.1	3.5	31.0	21.8	1.8	0.8	7.1	5.7	0.9	0.1	1754.4	475.6	140
Max	843	430	22	14	330	115	14	8	162	113	8	4	65	62	4	2	2762	843	430
Min	39	0	3	2	17	11	2	1	0	0	0	0	0	0	0	0	475	135	52

Table A4.3.2.3 Monthly Humidity at Khulna (Unit : percent)

AD	January Max	January Min	February Max	February Min	March Max	March Min	April Max	April Min	May Max	May Min	June Max	June Min
1988	100.0	32.0	100.0	31.0	100.0	24.0	100.0	36.0	100.0	45.0	100.0	55.0
89	100.0	27.0	100.0	24.0	100.0	20.0	98.0	20.0	100.0	27.0	100.0	52.0
90	100.0	30.0	100.0	35.0	100.0	20.0	100.0	26.0	100.0	45.0	100.0	62.0
91	100.0	35.0	100.0	32.0	100.0	30.0	100.0	29.0	98.0	41.0	100.0	64.0
92	100.0	32.0	100.0	28.0	100.0	30.0	98.0	28.0	100.0	43.0	100.0	50.0
93	100.0	10.0	100.0	22.0	100.0	13.0	100.0	23.0	100.0	54.0	100.0	30.0
94	100.0	32.0	100.0	32.0	100.0	22.0	100.0	26.0	100.0	46.0	100.0	55.0
95	100.0	29.0	100.0	29.0	100.0	25.0	98.0	23.0	100.0	41.0	100.0	55.0
96	100.0	32.0	100.0	33.0	100.0	28.0	100.0	30.0	100.0	48.0	100.0	52.0
97	100.0	28.0	100.0	26.0	98.0	26.0	98.0	30.0	100.0	42.0	100.0	53.0
98	100.0	9.0	100.0	35.0	100.0	22.0	100.0	31.0	100.0	43.0	100.0	56.0
Mean	100.0	26.9	100.0	29.7	99.8	23.6	99.3	27.5	99.8	43.2	100.0	53.1
Max	100.0	35.0	100.0	35.0	100.0	30.0	100.0	36.0	100.0	54.0	100.0	64.0
Min	100.0	9.0	100.0	22.0	98.0	13.0	98.0	20.0	98.0	27.0	100.0	30.0

AD	July Max	July Min	August Max	August Min	September Max	September Min	October Max	October Min	November Max	November Min	December Max	December Min	Annual Max	Annual Min
1988	100.0	63.0	98.0	67.0	98.0	60.0	100.0	43.0	100.0	31.0	100.0	39.0	100.0	24.0
89	98.0	62.0	100.0	65.0	100.0	63.0	100.0	53.0	100.0	40.0	100.0	34.0	100.0	20.0
90	100.0	62.0	100.0	65.0	100.0	63.0	100.0	45.0	100.0	34.0	100.0	35.0	100.0	20.0
91	100.0	46.0	100.0	61.0	100.0	65.0	100.0	48.0	100.0	32.0	100.0	32.0	100.0	29.0
92	100.0	61.0	100.0	57.0	100.0	41.0	100.0	45.0	99.0	45.0	100.0	28.0	100.0	28.0
93	100.0	26.0	100.0	58.0	100.0	61.0	100.0	47.0	100.0	40.0	100.0	28.0	100.0	10.0
94	100.0	64.0	100.0	67.0	100.0	50.0	99.0	39.0	100.0	38.0	100.0	30.0	100.0	22.0
95	100.0	61.0	100.0	61.0	100.0	64.0	100.0	54.0	100.0	42.0	100.0	37.0	100.0	23.0
96	100.0	59.0	100.0	63.0	100.0	52.0	100.0	39.0	100.0	35.0	100.0	30.0	100.0	28.0
97	100.0	63.0	100.0	54.0	100.0	62.0	100.0	42.0	98.0	39.0	100.0	40.0	100.0	26.0
98	100.0	61.0	100.0	51.0	100.0	52.0	100.0	46.0	100.0	42.0	100.0	32.0	100.0	9.0
Mean	99.8	57.1	99.8	60.8	99.8	57.5	99.9	45.5	99.7	38.0	100.0	33.2	100.0	21.7
Max	100.0	64.0	100.0	67.0	100.0	65.0	100.0	54.0	100.0	45.0	100.0	40.0	100.0	29.0
Min	98.0	26.0	98.0	51.0	98.0	41.0	99.0	39.0	98.0	31.0	100.0	28.0	100.0	9.0

Source : Province Meteorology Office at Khulna

Monthly Humidity at Khulna
Period 1988-1998 (Unit : percent)

	January	February	March	April	May	June	July	August	September	October	November	December	Mean
Extreme Max	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Mean Max	100.0	100.0	99.8	99.3	99.8	100.0	99.8	99.8	99.8	99.9	99.7	100.0	99.8
Mean Min	26.9	29.7	23.6	27.5	43.2	53.1	57.1	60.8	57.5	45.5	38.0	33.2	41.3
Extreme Min	9.0	22.0	13.0	20.0	27.0	30.0	26.0	51.0	41.0	39.0	31.0	28.0	28.1

Source : Province Meteorology Office - Khulna

Table A4.3.2.4 Wind Velocity Data at Khulna

(Unit : m/s)

AD	January	February	March	April	May	June	July	August	September	October	November	December	Mean	Max	Min
1988	5.1	4.6	4.6	8.2	10.3	10.3	9.3	9.3	6.2	8.2	9.8	10.3	8.0	10.3	4.6
89	10.3	9.3	10.3	8.7	11.8	8.7	9.8	6.2	6.2	9.3	5.1	7.7	8.6	11.8	5.1
90	4.1	7.7	8.2	7.7	9.3	7.7	6.2	5.1	6.2	4.1	3.6	10.3	6.7	10.3	3.6
91	4.1	4.1	6.2	19.5	12.8	18.0	10.3	8.7	4.1	8.3	4.1	7.2	9.0	19.5	4.1
92	7.2	5.1	8.2	15.4	10.3	7.2	9.3	6.2	5.1	6.2	4.1	5.1	7.5	15.4	4.1
93	5.1	7.7	7.7	15.9	10.3	8.2	8.2	7.2	7.2	4.1	4.1	5.1	7.6	15.9	4.1
94	5.1	6.2	7.2	20.6	8.2	9.3	9.3	6.2	8.2	4.1	3.1	4.1	7.6	20.6	3.1
95	6.2	7.2	13.9	6.2	9.3	6.2	7.7	7.7	6.2	4.1	8.2	4.6	7.3	13.9	4.1
96	15.9	7.2	6.2	23.1	6.2	8.2	4.6	6.2	3.1	7.7	18.5	18.5	10.4	23.1	3.1
97	6.2	5.1	8.2	7.7	7.7	9.3	6.2	11.3	33.4	2.1	2.1	10.8	9.2	33.4	2.1
98	4.1	4.1	6.2	7.2	6.2	5.1	7.2	10.3	4.1	4.1	15.4	3.1	6.4	15.4	3.1
Mean	6.7	6.2	7.9	12.8	9.3	8.9	8.0	7.7	8.2	5.7	7.1	7.9	8.0	17.2	3.7
Max	15.9	9.3	13.9	23.1	12.8	18.0	10.3	11.3	33.4	9.3	18.5	18.5	10.4	33.4	5.1
Min	4.1	4.1	4.6	6.2	6.2	5.1	4.6	5.1	3.1	2.1	2.1	3.1	6.4	10.3	2.1

Monthly Mean Wind Velocity at Khulna

Period 1988-98 (Unit : m/s)

	January	February	March	April	May	June	July	August	September	October	November	December	Annual Max & Min
Mean	6.7	6.2	7.9	12.8	9.3	8.9	8.0	7.7	8.2	5.7	7.1	7.9	
Max	15.9	9.3	13.9	23.1	12.8	18.0	10.3	11.3	33.4	9.3	18.5	18.5	33.4
Min	4.1	4.1	4.6	6.2	6.2	5.1	4.6	5.1	3.1	2.1	2.1	3.1	2.1

Source : Province Meteorology Office - Khulna (Unit m/s)

APPENDIX TO CHAPTER 6

Preliminary Engineering Design

LIST OF APPENDIX TO CHAPTER 6

Appendix to Section 6.1.1 Geometric Design Criteria

(1) Maximum Superelevation (i_{max}), Minimum Radius (R_{min}) and Value of Superelevation on Curvature (i)

These three factors, i_{max}, R_{min} and i are related each other together with the design speed. The design speeds of 60 km/h is recommended as discussed previously to the Southern Section of Khulna Bypass.

The relation between minimum radius and maximum superelevation is calculated from the following formula.

$$R = \frac{Vd^2}{127*(i+f)}$$

where R : Radius (m)
Vd : Design Speed (km/h)
i : Superelevation (m/m)
f : Side Friction Factor

The side friction factor of 0.15 at the normal high speed are selected as the maximum allowable value in the RMSS, considering comfort of drivers and traffic safety.

Absolute maximum side friction factor of 0.4 may be used in order to check the safety on curves assuming that a vehicle is being operated at an excessive speed (20 km/h higher than the design speed i.e. Vd= 80 km/h) as shown in Table A-1.

Table A-1 Maximum Superelevation And Minimum Radius

Design Speed (km/h)	60
Max. Allowable Side Friction Factor (f)	0.15
Max. Superelevation (i max) %	3.0
Minimum Radius (m)	160
Side Friction Factor if 20 km/h higher than Vd	0.28
Absolute Max. Side Friction Factor	0.40

The side friction factor f = 0.15 and resulting maximum Superelevation i max = 3%

are also justified to be applicable to the urban street where the high accessibility to adjacent buildings and facilities should be maintained.

Crossfall of 2% applicable to traveled ways is mainly determined by drainage requirements. The minimum curvature which requires superelevation is determined by setting consistently low friction factor values, considering the effect of crossfall. Side friction factor of 0.05 recommended in the RMSS are used to determine sharpest curve without superelevation as shown in Table A-2.

Table A-2 Sharpest Curve without Superelevation

Design Speed (km/h)	60
Side Friction Factor (f)	0.05
Crossfall (%)	-2.0
Sharpest Curve without Superelevation (m)	950

(2) Sight Distance

Stopping sight distance is the sum of two distances:

- The distance traversed by the vehicle from the instant that the driver sights an object necessitating a stop to the instant that the brakes are applied (Brake Reaction Time); and
- The distance required to stop the vehicle the brake from the instant that brake application begins (Braking Distance).

2.5 seconds is used for the former and the later is dependent on the initial speed and the coefficient of friction between tires and pavement .

The following equation is used for the calculation of stopping sight distance:

$$D = 0.694 * V + 0.00394 * V^2/f$$

where

D: Stopping Sight Distance (m)

V: Initial Speed (km/h)

f: Coefficient of Friction between Tires and Pavement

Stopping sight distances by each design speeds on the wet condition are shown in Table A-3.

Table A-3 Stopping Sight Distance on Wet Pavement

Design Speed (km/h)	Initial Speed		Friction Coefficient on Wet Pavement	Stopping Sight Distance (m)	
	%	km/h		Calculated	Rounded
80	100	80	0.30	139.6	140
60	100	60	0.33	84.6	85

Sight distance is defined as the distance along a roadway that an object of specified height is continuously visible to the driver with eye-height above the road surface. The height of 0.15 m of object height is recommended by the RMSS and it is also specified in AASHTO. The height of driver's eye ranges 1.07 m to 1.2 m in international standards.

1.2 m is used as the eye-height for the Study, which is recommended by the RMSS and also specified in Japanese Standard. Table 4.4 tabulates the object and eye height specified in the RMSS and other standards.

As far as the Study may concerns, only the design element of minimum vertical curve length is affected by this value.

Table A-4 Summary of Object and Eye Height Specified

	Japan	AASHTO	RMSS	the Study
Driver's Eye Height for Stopping (m)	1.20	1.07	1.20	1.20
Object (m)	0.10	0.15	0.15	0.15

Vehicles frequently overtake slower moving vehicles on 2-lane two ways highway such as the Southern Section of Khulna Bypass. The passing must accomplished on lanes regularly used by opposing traffic. Accordingly, passing sight distance for use in design should be determined on the basis of the length to safely complete normal passing maneuvers.

AASHTO recommends the minimum passing sight distance of 407 m for Vd= 60km/h. If the design speed should increase up to 80 km/h, it would have to extend to 541 m or more.

Either passing sight distances could not be applicable on Rupsa Bridge because the bridge length should extend considerably due to applying larger vertical curve, and accordingly no passing/overtaking is allowed.

(3) Minimum Vertical Curve Length

Vertical curves effect gradual change between tangent grades in crest and sag curves and should result in a design that is safe, comfortable in operation, pleasing in appearance and adequate for drainage.

The major control for safe operation on crest vertical curves is the provision of ample sight distance for the design speed and rider comfort, while headlight sight distance and rider comfort govern the length of a sag vertical curve.

The following equations are used for the calculation of required vertical curve length and radius of vertical curve, of which longer length is applicable.

1 . Rider comfort (tolerable limit)

$$L = \frac{Vd}{3.6} * t$$

where

L : Vertical curve length (m)

Vd : Design speed (km/h)

t : Minimum required time, t = 3 sec.

2. On Crest Curve (object height : 0.15 m, eye-height : 1.2 m)

$$L = \frac{D^2 * i}{440} \quad \text{OR} \quad R = \frac{100 * D^2}{440}$$

where

L = Vertical curve length (m)

D = Sight distance (m)

R = Radius of vertical curve (m)

i : Algebraic difference in grade (%)

As discussed previously, the design speeds of 60 km/h is recommended to the Southern Section of Khulna Bypass. However, the following comparison may ascertain its justification.

Design Speed Vd (Km/h)	Sight Distance (m)	On Crest Curve	
		Min. Vertical Curve Length (m)	Min. Radius (m)
60	85	99	1,643
80	140	267	4,458

Note: The computation is made on the condition that the algebraic difference of grades is 6%.

In case that the elevations of the top surface of Rupsa Bridge and the abutment are kept the same level, the bridge length will increase 84m long.

3. On Sag Curve (headlight sight distance : headlight height=0.75 m, angle=1°)

$$L = \frac{D^2 * i}{150 + 3.49 * D} \quad OR \quad R = \frac{100 * D^2}{150 + 3.49 * D}$$

where

L = Vertical curve length (m)
D = Sight distance (m)
R = Radius of vertical curve (m)
i : Algebraic difference in grade (%)

Design Speed Vd (Km/h)	Sight Distance (m)	On Sag Curve	
		Min. Vertical Curve Length (m)	Min. Radius (m)
60	85	97	1,617

Note: The computation is made on the condition that the algebraic difference of grades is 6%.

(4) Minimum Transition Curve Length

Transition curves are desirable on high speed roads between circular curves of substantially different radii and between tangents and circular curves.

The length necessary for controlling the steering on a curve is calculated from the following formula which provides required length for a natural and easy-to-follow path for drivers.

$$L = \frac{Vd}{3.6} * t$$

where

L : Minimum transition curve length (m)
V : Design speed (km/h)
t : Running time through the transition curve (sec)

Desirable running time through the curve to allow control of the steering is reported to be 3 to 5 seconds. The minimum transition curve length is set 50 m using the running time through the transition curve t = 3 sec and the design speed Vd = 60 km/h.

To make the change of centrifugal acceleration tolerable, the rate of increase of centripetal acceleration (P m/sec^3) is examined by Short's equation where Pmax = 0.75 m/sec^3 for the urban street are adopted.:

$$P = \frac{\left(\frac{Vd}{3.6}\right)^3}{L * R}$$

where

P : Rate of increase of centripetal acceleration (m/sec^3)

V : Design speed (kin/h)

L : Minimum transition curve length (m)

R : Minimum curve radius (m)

Table A-5 Minimum Transition Curve Lengths and its Rate of Acceleration.

Design Speed (km/h)	60
Running Time t (sec)	3
Minimum Transition Curve Length : L (m)	50
Minimum Curve Radius : R (m)	160
Rate of Increase of Centripetal Acceleration : P (m/sec^3)	0.58 < 0.75

(5) Minimum Horizontal Curve Length

The following values are designated to cover all the horizontal curve lengths, including transition curves if any, and to be of sufficient length for drivers to comfortably adjust their steering to allow for the change in curvature.

<u>Rider Comfort</u> (tolerable limit)

L = 0.278 * Vd * t

where

L : Minimum horizontal curve length (m)

Vd : Design speed (km/h)

t : Minimum required steering time on curve (sec), t = 6 sec

Design Speed (km/h)	60
Min. length calculated (m)	100
Adopted Value (m)	100

In the cases where the intersection angle (θ) is small, 7° or less, it is desirable to use a longer horizontal curve length than the minimum value. Minimum horizontal curve length is calculated as follows:

Minimum Secant Length, N min

$N\ min = \theta_0 * L/6 = 0.020 * L$

where

θ_0 : Intersecting angle to govern min. secant length $\theta_0 = 7° = 0.122$ rad.

L : Minimum transition curve length (m)

Design Speed (km/h)	60
Min. Transition Curve Length (m)	50
Min. Secant Length (m) N min	1.00

Minimum Horizontal Curve Length, L min

$L\ min = 12 * N\ min/\theta\ (rad.) = 688 * N\ min/\theta\ (degree)$

Design Speed (km/h)	60
Min. Secant Length (m) N min	1.00
Min. Curve Length (m)	$700/\theta$

(6) Minimum Radius of Curve not Required Transition Curves

The minimum radius of curve for which no transition curves are required is calculated by using the following formula:

$$R = \frac{1}{24} \times \frac{L^2}{S}$$

where

S : Shift in meters between curve and tangent

L : Transition curve length (m)

R : Radius of circular curve (m)

Maximum shift Smax = 0.20 applied to the above formula and then minimum radius R min is calculated as follows:

Design Speed (km/h)	Min. Transition Curve Length (m)	Min. Rudius (m)	
		Calculated	Rounded
60	50	520	500

(7) Pavement widening on Curves

Pavements on curves are sometimes widened to make operating conditions on curves comparable to those on tangents or large radii of horizontal curves.

These widening on curves occur on ramps of interchange and turning roadways at channelizations of at-grade intersection.

Table A-6 shows the design widths of the pavement for turning roadways at channelizations.

Table A-6 Widening of Auxiliary Lane for At-grade Intersection for 1-lane One-way

in Meter

Radius on Turning R (m)	Widening excluding Shoulder		
	Semitrailer	Truck	Passenger Car
6			R≧6.82 m
7			
8			3.5
9			
10			
11			
12	R≧13.0 m	R≧13.36 m	
13	9.5		
14	8.5	6.0	
15	8.0		
16	7.5	5.5	
17			
18	7.0		
19			
20	6.5	5.0	
21			
22			
23	6.0		
24			
25			
26			
27			
28			
29	5.5	4.5	
30			
32			
34			
36	5.0		
38			
40	4.5		
45			
50			
55			
60		4.0	
70			
80			
90			
100	4.0		
110			
120			
130			
140			
150	3.5	3.5	3.0

(7) Superelevation Runoff

For added comfort and safety, the superelevation runoff should be effected uniformly over a length adequate for the design speed. In other words the length of superelevation runoff should exceed what is specified by the maximum relative slope mentioned below.

On the contrary, for the requirements of pavement drainage, the length of superelevation runoff in between -2% and 2% should not exceed what is computed by the minimum relative slope of 1/300.

$$1/q = \frac{Vd}{3.6 * B * W}$$

where

B : Roadway width from axle of rotation (m)

W : Rolling speed of vehicle (radian/sec.)

Design Speed (km/h)		60
B (m)		6.0
W (rad./sec)		0.020
q	calculated value	139
	adopted value	140

Note: The axle of rotation is located at the inner edge of through traveled lane.

Table A6.2.1.1 Traffic Capacity Analysis

	Daily Future Traffic Volume						K-factor	Hour Future	Flow Rate	Capacity
	Motorcycle	Autorickshaw	Car	Bus	Truck	Total	%	Traffic Volume		
PCU Ratio	0.3	1.0	1.0	2.5	2.0		8.0			
PCU Conversion	335	2,536	1,120	8,663	5,829	18,483		1,479		1,687
Vehicle Conversion	1,117	2,536	1,120	3,465	2,915	11,152		892	959	1,292

*PCU : Passenger Car Unit

**K-factor : The rate of the 30th highest volume during the year to the AADT.

Japanese Standard			
Ideal Capacity (2-lanes)		pcu/hour	2,500
Level of Service (level-2)			0.90
Adjustment Narrow Lanes			1.00
Factors	Restricted shoulder width		1.00
	Roadside condition of development		0.90
	Grade and presence of heavy vehicles		0.90
	Presence of motorcycles		0.93
Possible Traffic Volume		pcu/hour	1,874
Design Traffic Volume		pcu/hour	1,687

AASHTO			
Ideal Capacity (2-lanes)		pcu/hour	2,800
Level of Service			D
Ratio of Flow Rate to Ideal Capacity for Level of Service			0.64
Adjustment Factors	Directional distribution		0.94
	Narrow lanes and restricted shoulder width		0.85
	Presence of heavy vehicles		0.903
Service Flow Rate		vehicle/hour	1,292
Full-hour Volume		vehicle/hour	892
Peak Hour Factor			0.93
Flow Rate		vehicle/hour	959

Factored Geotechnical Bearing Capacity of Bored Pile

Depth	φ3.0m	φ2.5m	φ2.0m	φ1.5m
10.5	79	227	310	329
15.0	685	764	765	690
21.0	2,355	2,199	1,948	1,602
25.5	4,349	3,892	3,328	2,657
30.0	5,899	5,216	4,413	3,490
36.0	5,993	5,337	4,544	3,614
40.5	7,043	6,244	5,296	4,197
45.0	6,858	6,123	5,224	4,162
51.0	10,239	8,982	7,546	5,930
55.5	12,144	10,602	8,868	6,940
60.0	12,840	11,214	9,383	7,346
66.0	14,176	12,371	10,343	8,092
70.5	15,047	13,129	10,975	8,585
75.0	15,919	13,887	11,607	9,079
81.0	17,080	14,898	12,450	9,736
85.5	17,951	15,656	13,082	10,230
90.0	18,822	16,414	13,715	10,723
96.0	19,984	17,425	14,558	11,381
100.5	20,855	18,183	15,190	11,875
105.0	21,726	18,941	15,822	12,368
111.0	22,888	19,952	16,665	13,026
115.5	23,759	20,710	17,297	13,520
120.0	24,630	21,468	17,929	14,013
126.0	25,791	22,479	18,772	14,671
130.5	26,663	23,237	19,405	15,165
135.0	27,534	23,995	20,037	15,658
141.0	28,695	25,006	20,880	16,316
145.5	29,566	25,764	21,512	16,809
150.0	30,437	26,522	22,144	17,303

Fig. A6.3.1.1

Factored Geotechical Bearing Capacity of Bored Pile

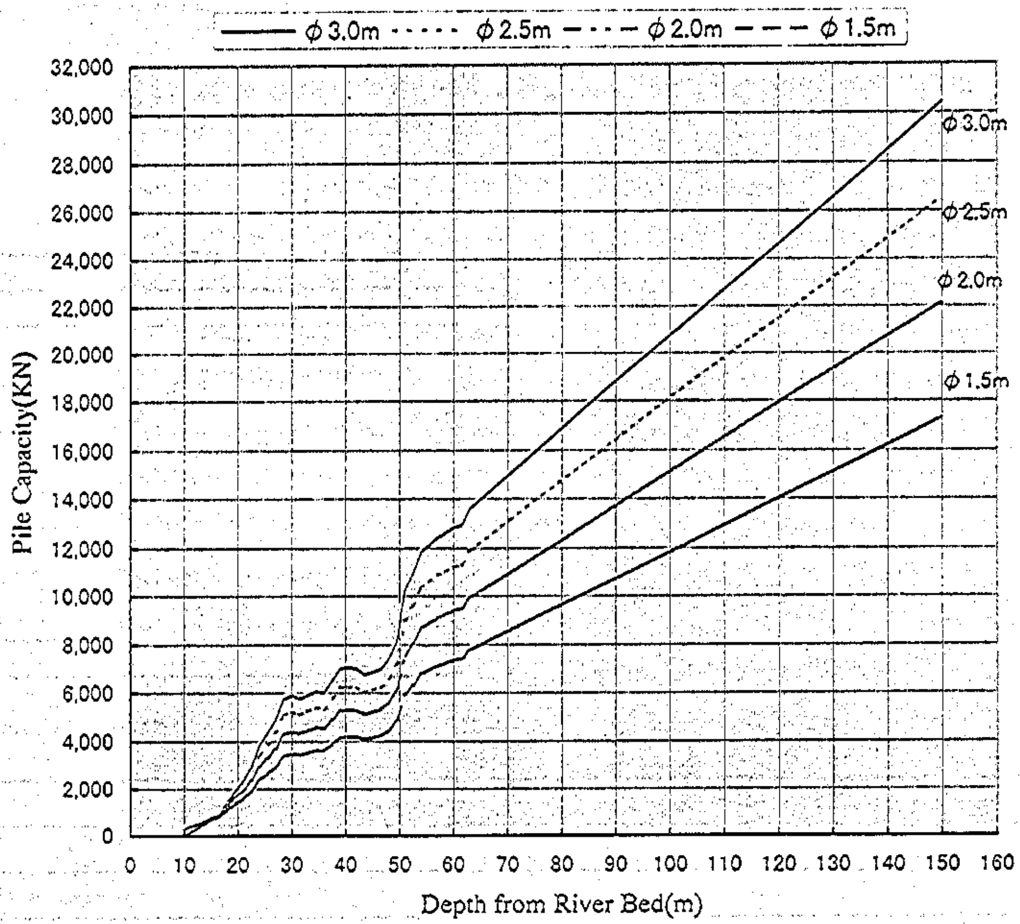


Fig. A6.3.1.2 **Ultimate Geotechnical Bearing Capacity of Bored Pile(ϕ 1.5m)**

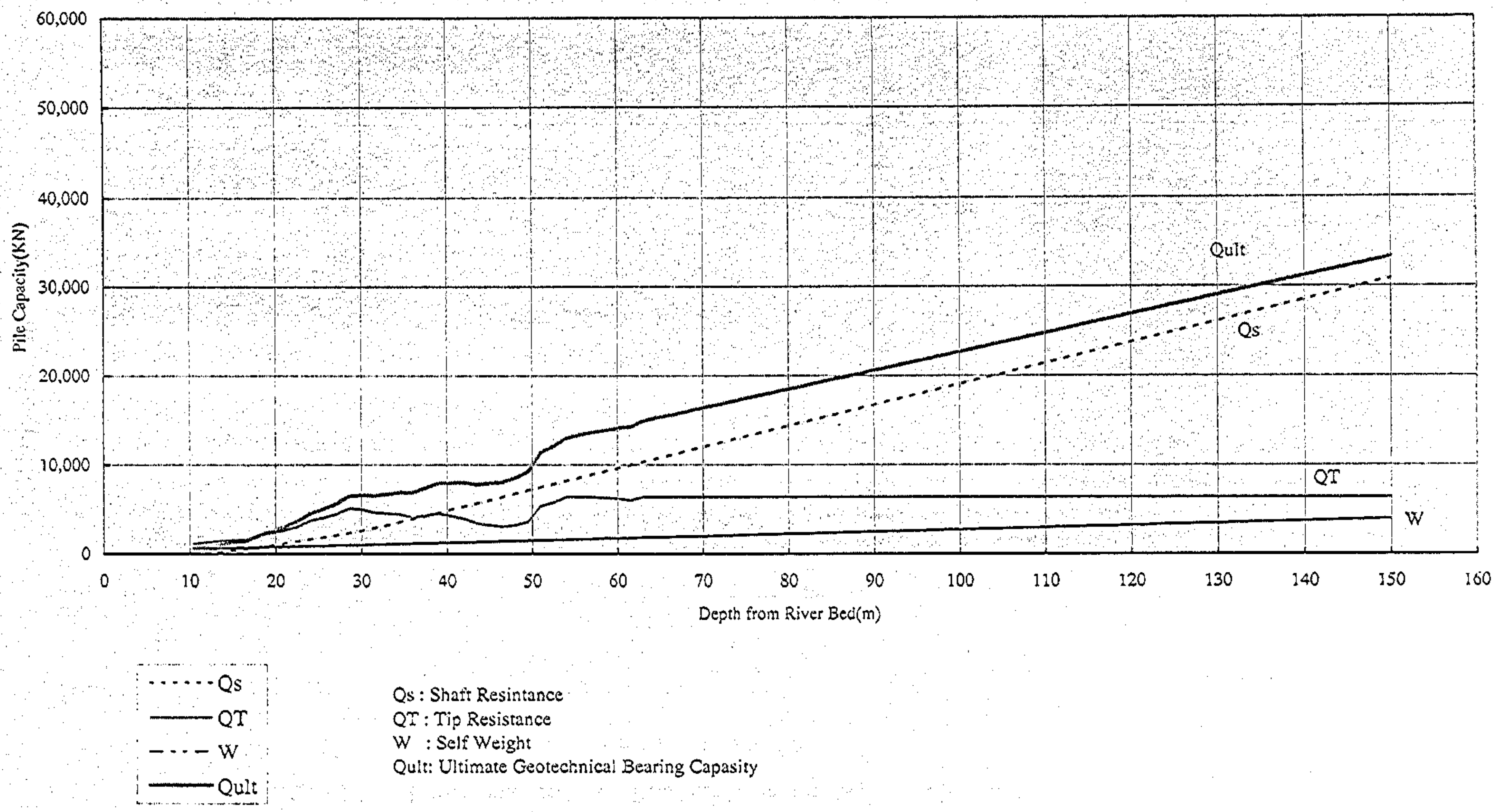


Fig. A6.3.1.3 Ultimate Geotechnical Bearing Capacity of Bored Pile(ϕ 2.0m)

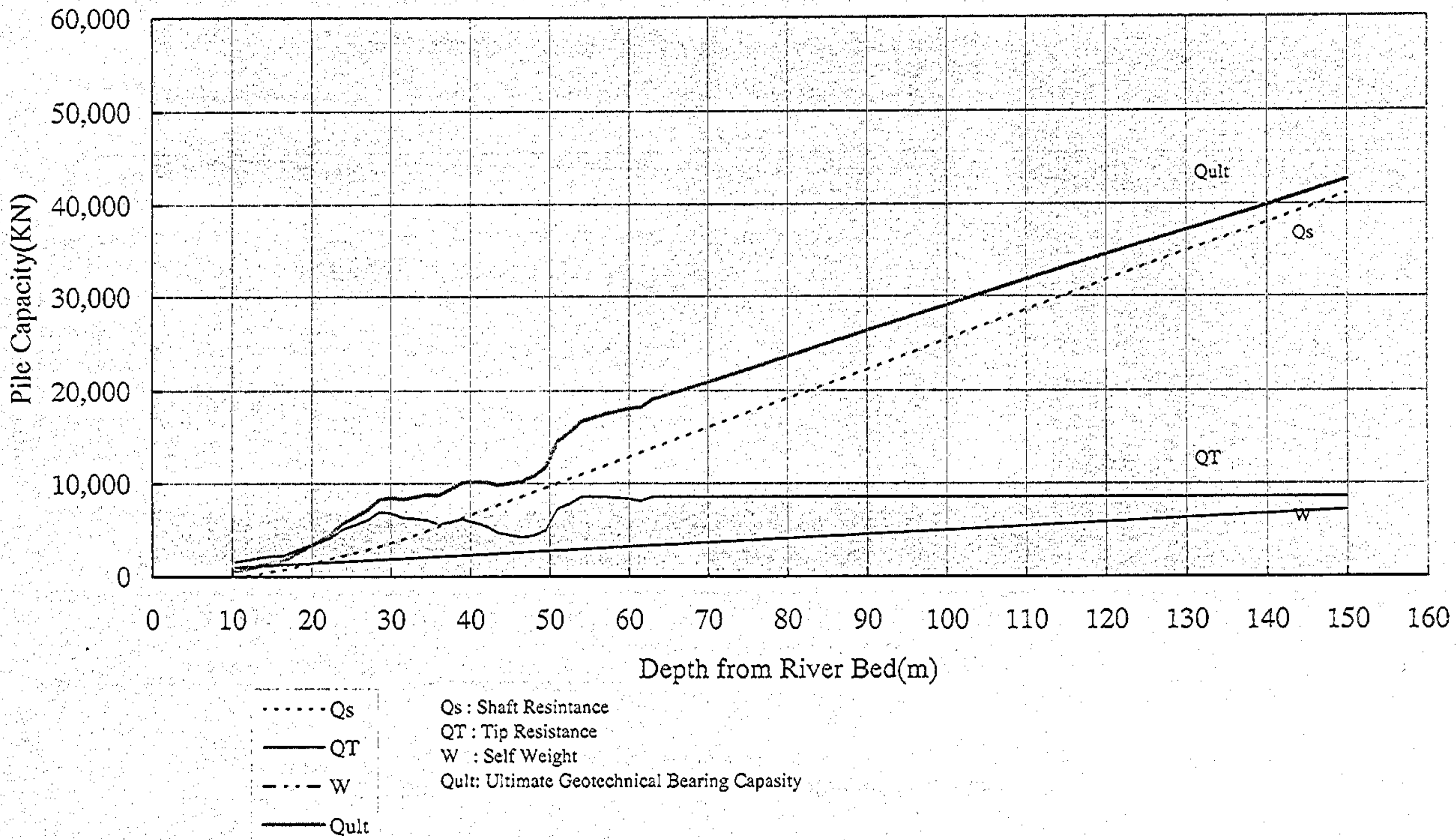


Fig. A6.3.1.4　Ultimate Geotechnical Bearing Capacity of Bored Pile(ϕ 2.5m)

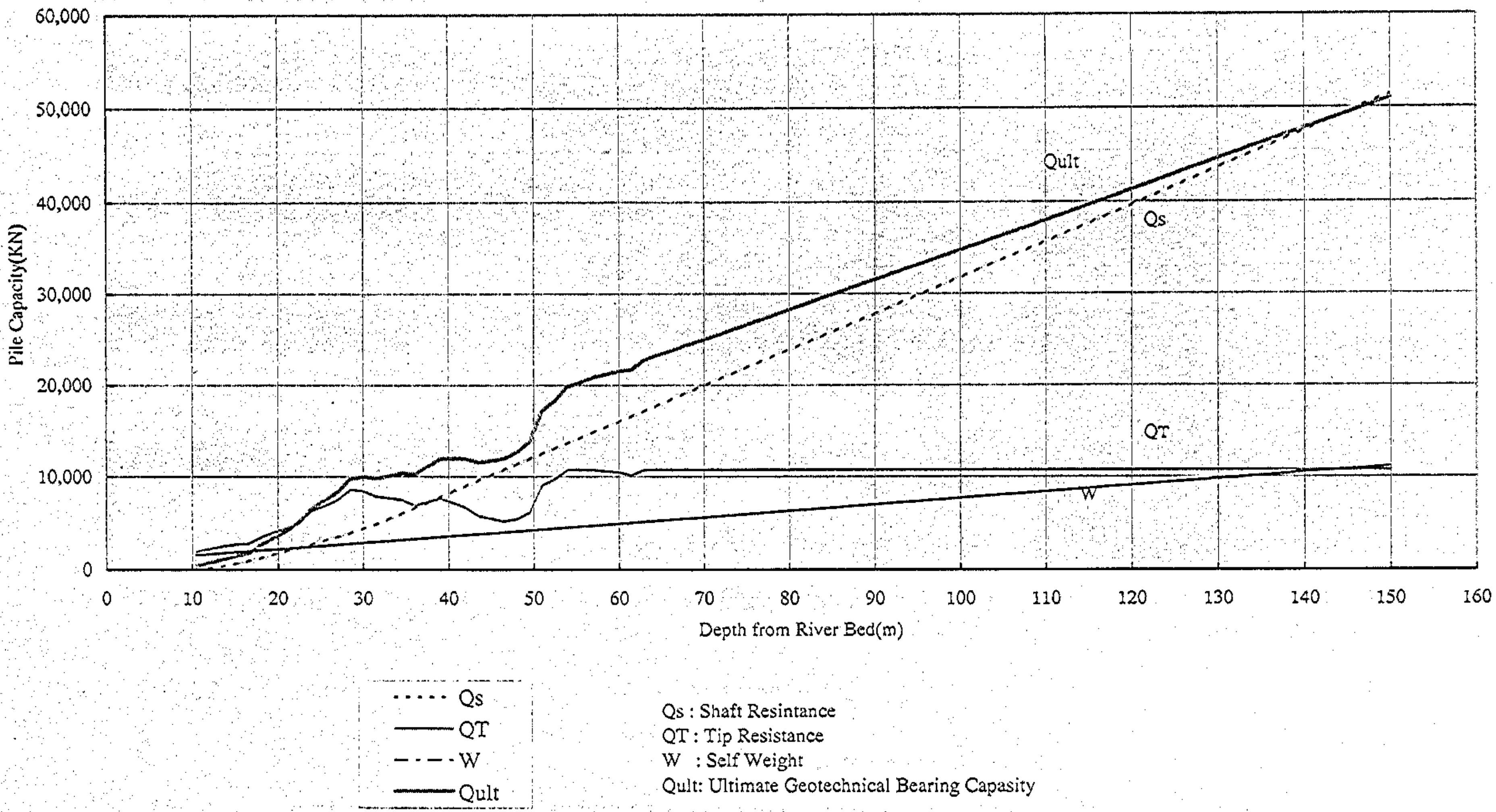
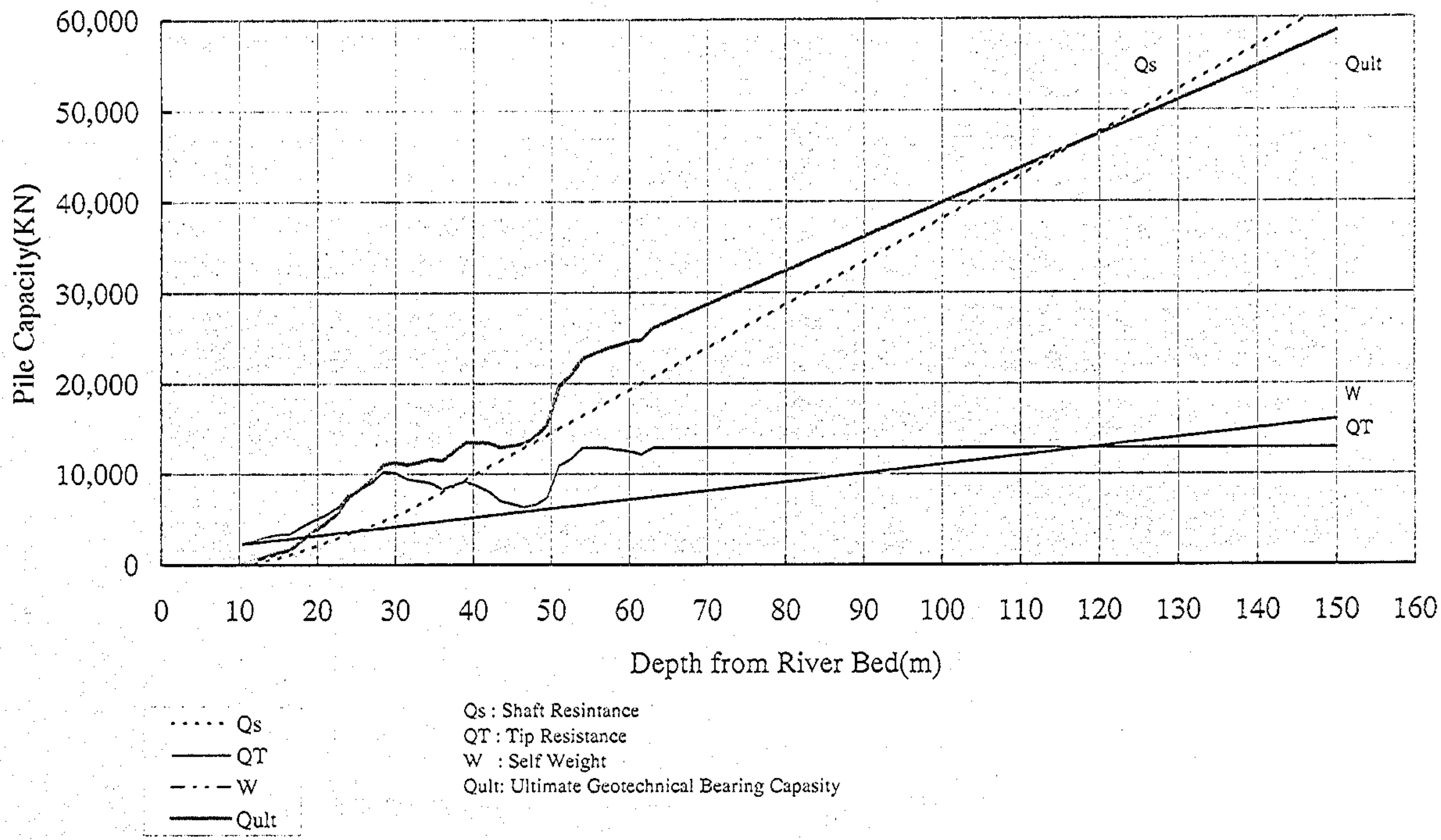


Fig. A6.3.1.5 Ultimate Geotechnical Bearing Capacity of Bored Pile(ϕ3.0m)



Factored Geotechnical Bearing Capacity of Driven Pile

Depth(m)	1.5 m	2.0 m	2.5 m	3.0 m
10.5	149	215	276	331
15.0	2,042	2,751	3,473	4,168
19.5	4,054	6,475	8,838	10,605
25.5	11,216	17,016	22,177	26,612
30.0	15,798	28,666	33,182	39,818
34.5	13,566	23,190	34,819	41,783
40.5	13,680	22,855	32,702	46,109
45.0	11,294	16,902	25,649	35,741
51.0	11,448	19,933	36,862	51,698
55.5	18,385	30,895	45,538	63,994
60.0	17,727	28,056	40,403	56,229
64.5	15,894	29,916	47,931	66,783
70.5	25,800	42,756	63,892	89,227
75.0	27,103	44,494	66,064	91,811
81.0	29,040	47,076	69,291	95,685
85.5	30,592	49,146	71,879	98,790
90.0	32,236	51,338	74,618	102,077
96.0	34,577	54,459	78,520	106,759
99.0	35,816	56,111	80,585	109,237

Fig. A6.3.1.6

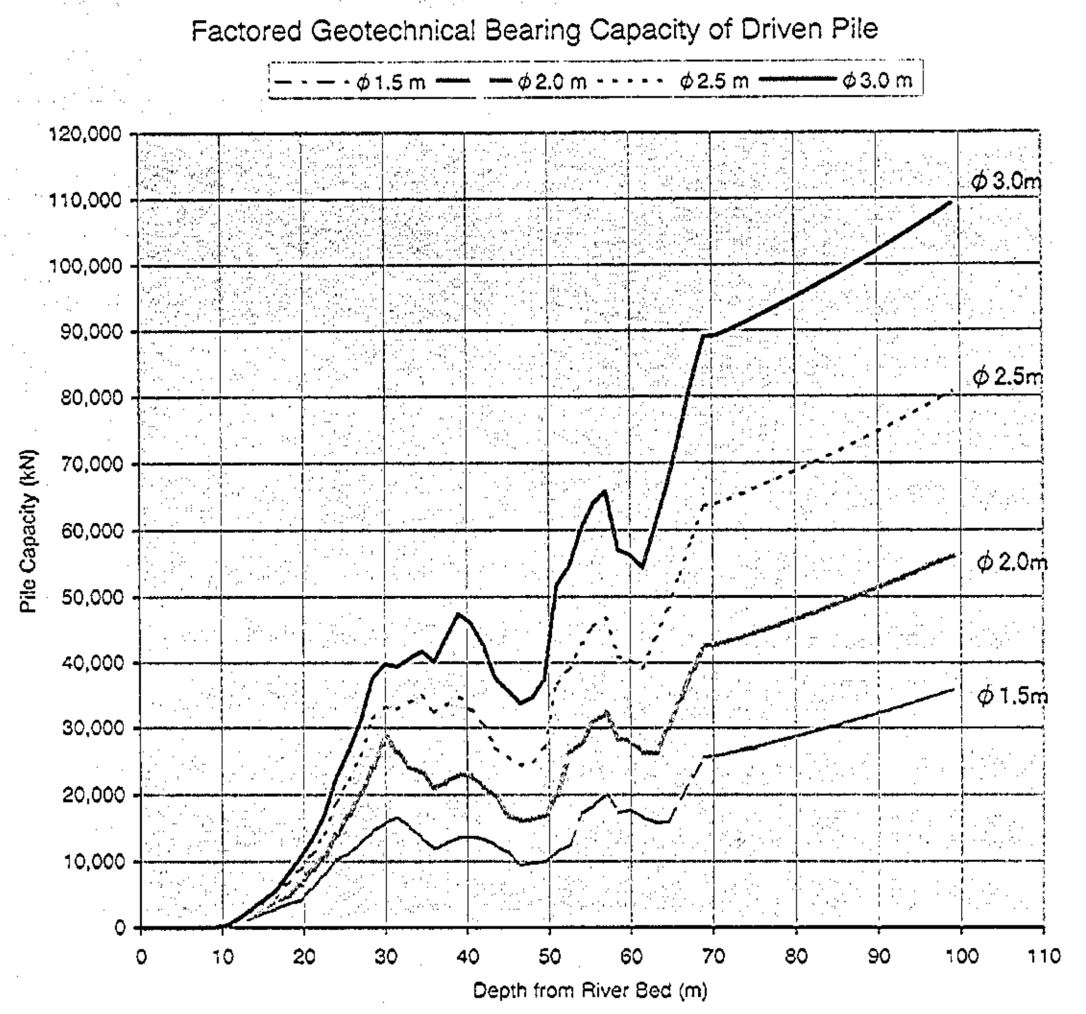


Fig. A6.3.1.7 **Ultimate Geotechnical Bearing Capacity of Driven Pile (ϕ 1.5 m)**

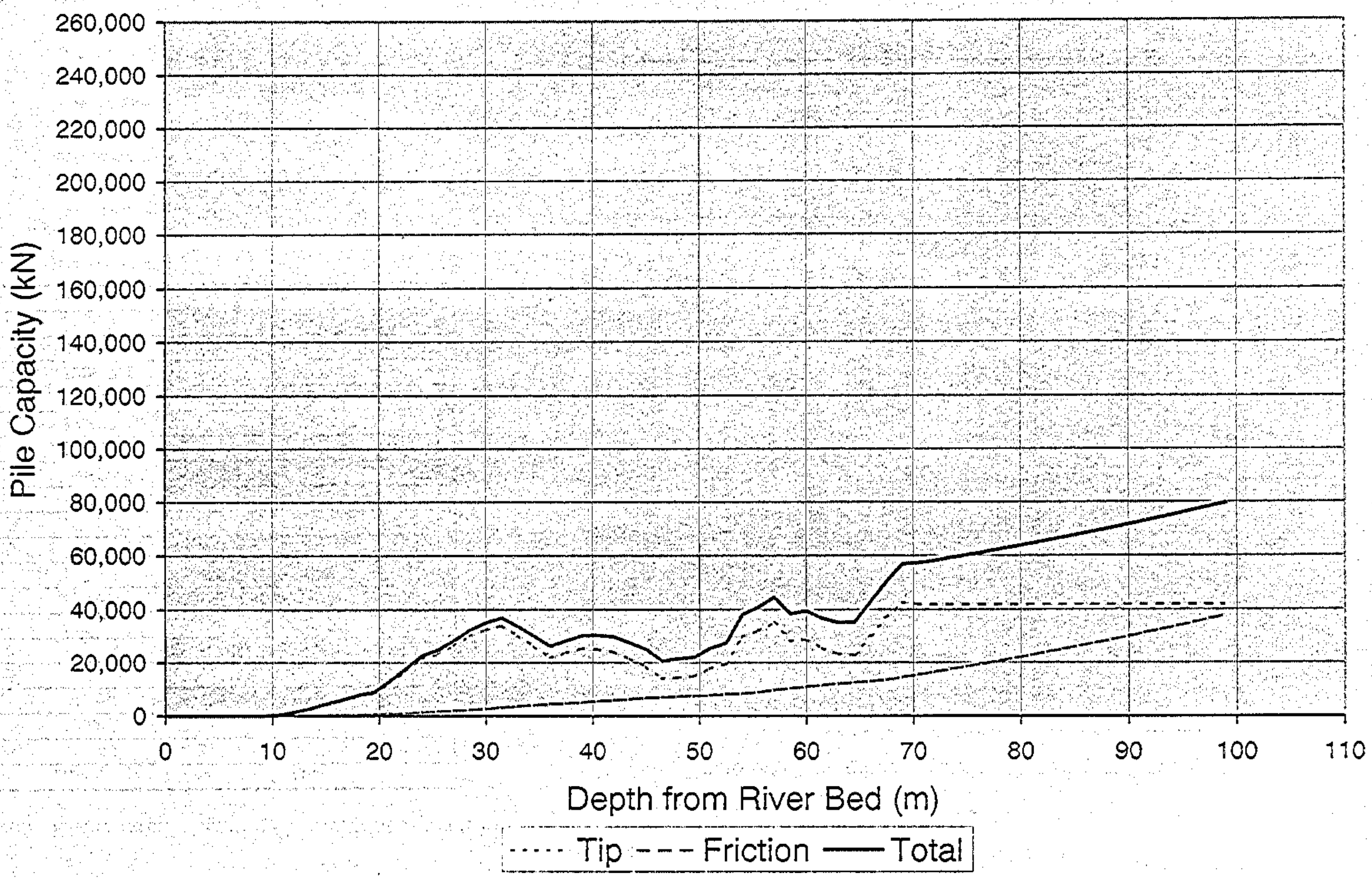


Fig. A6.3.1.8 **Ultimate Geotechnical Bearing Capacity of Driven Pile (ϕ2.0 m)**

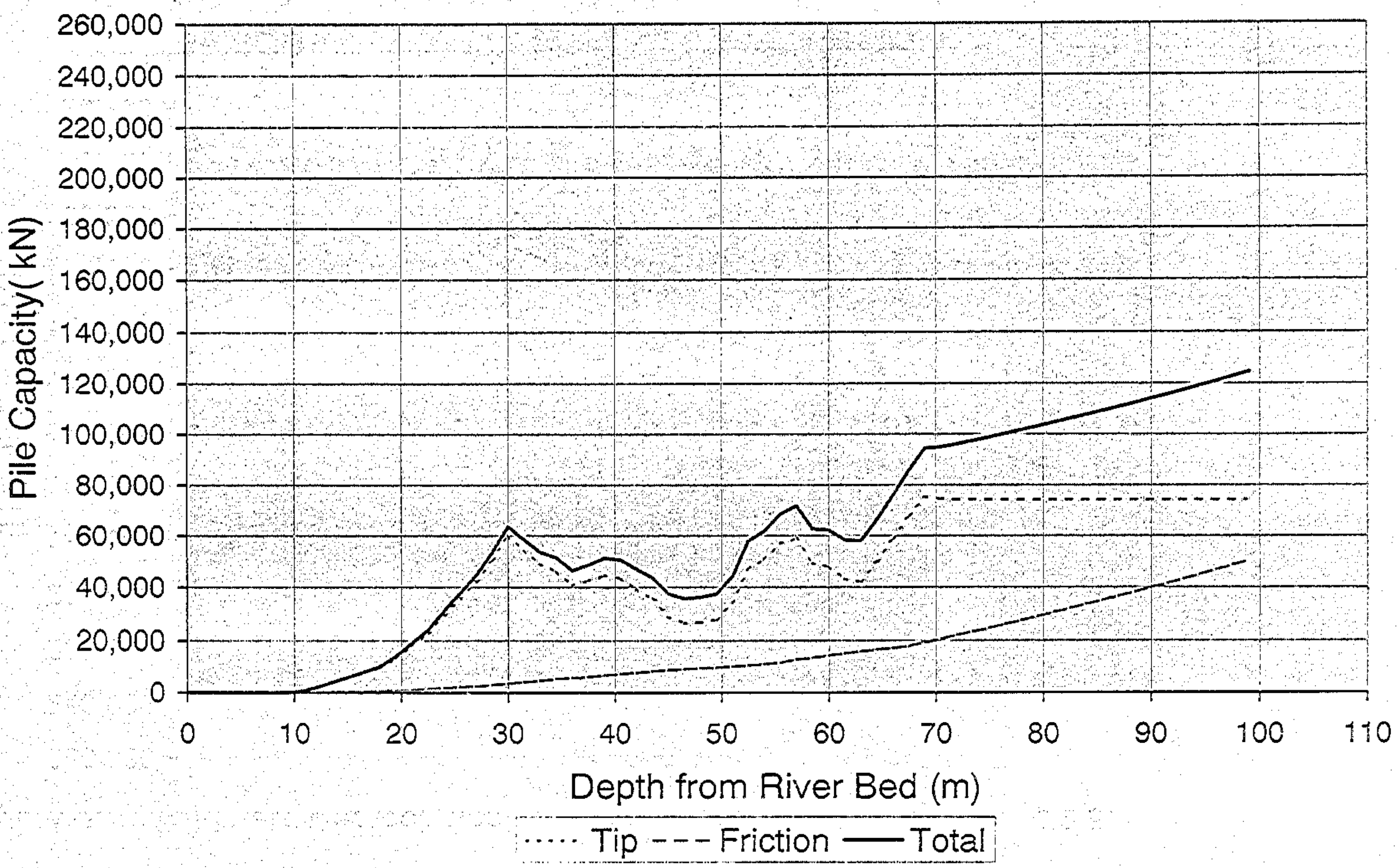


Fig. A6.3.1.9 **Ultimate Geotechnical Bearing Capacity of Driven Pile (ϕ2.5m)**

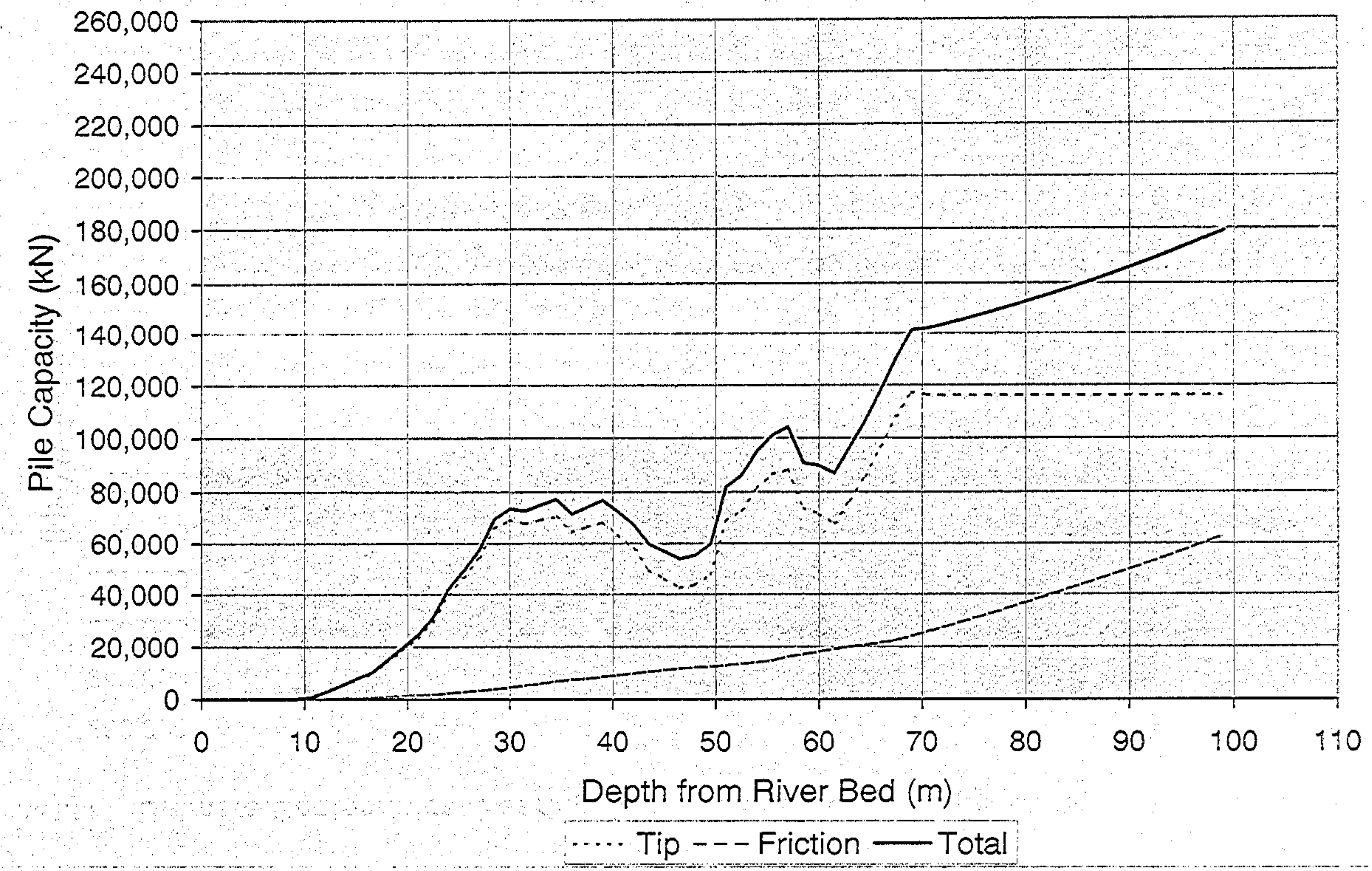
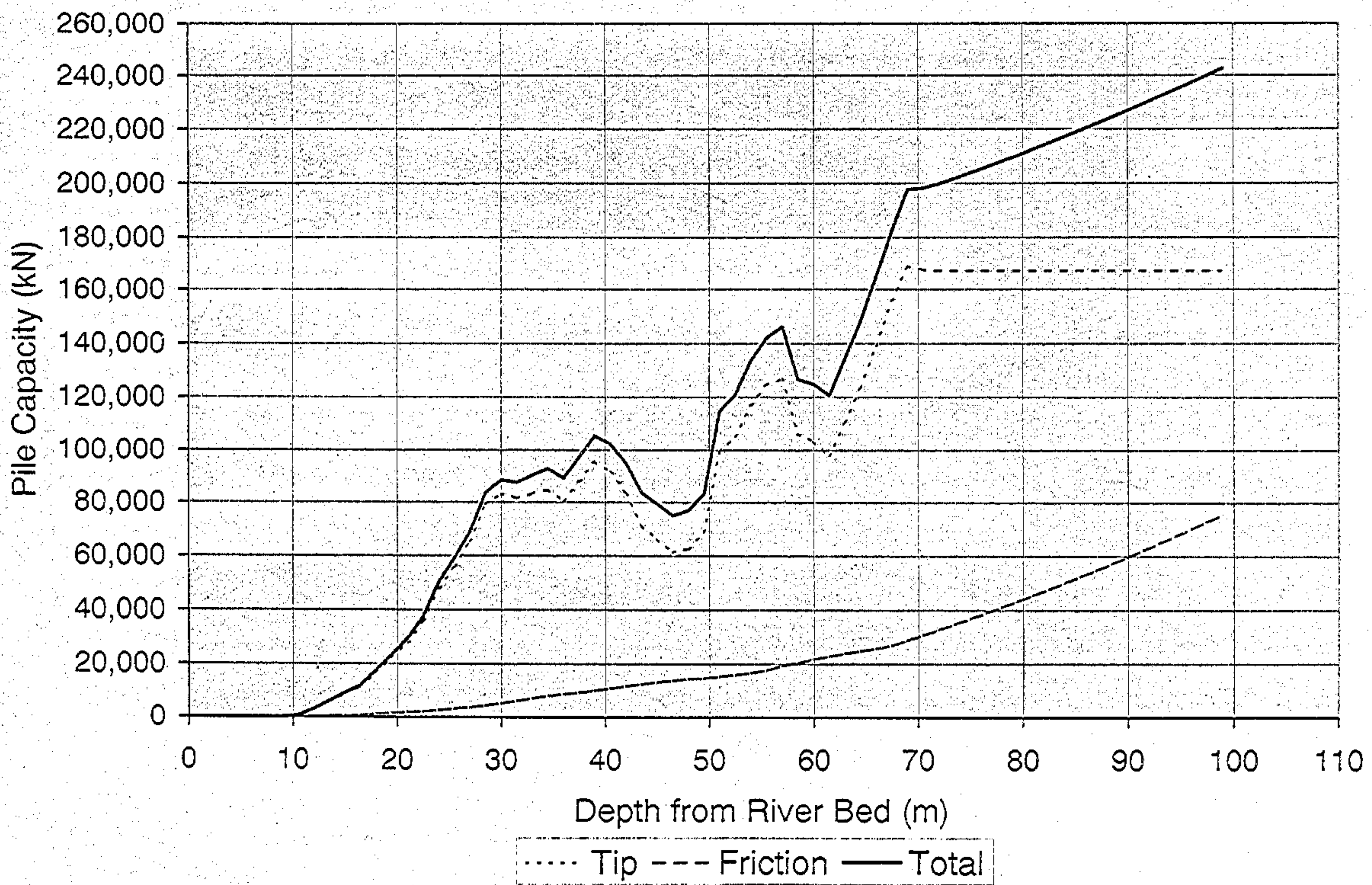


Fig. A6.3.1.10 **Ultimate Geotechnical Bearing Capacity of Driven Pile (φ3.0m)**



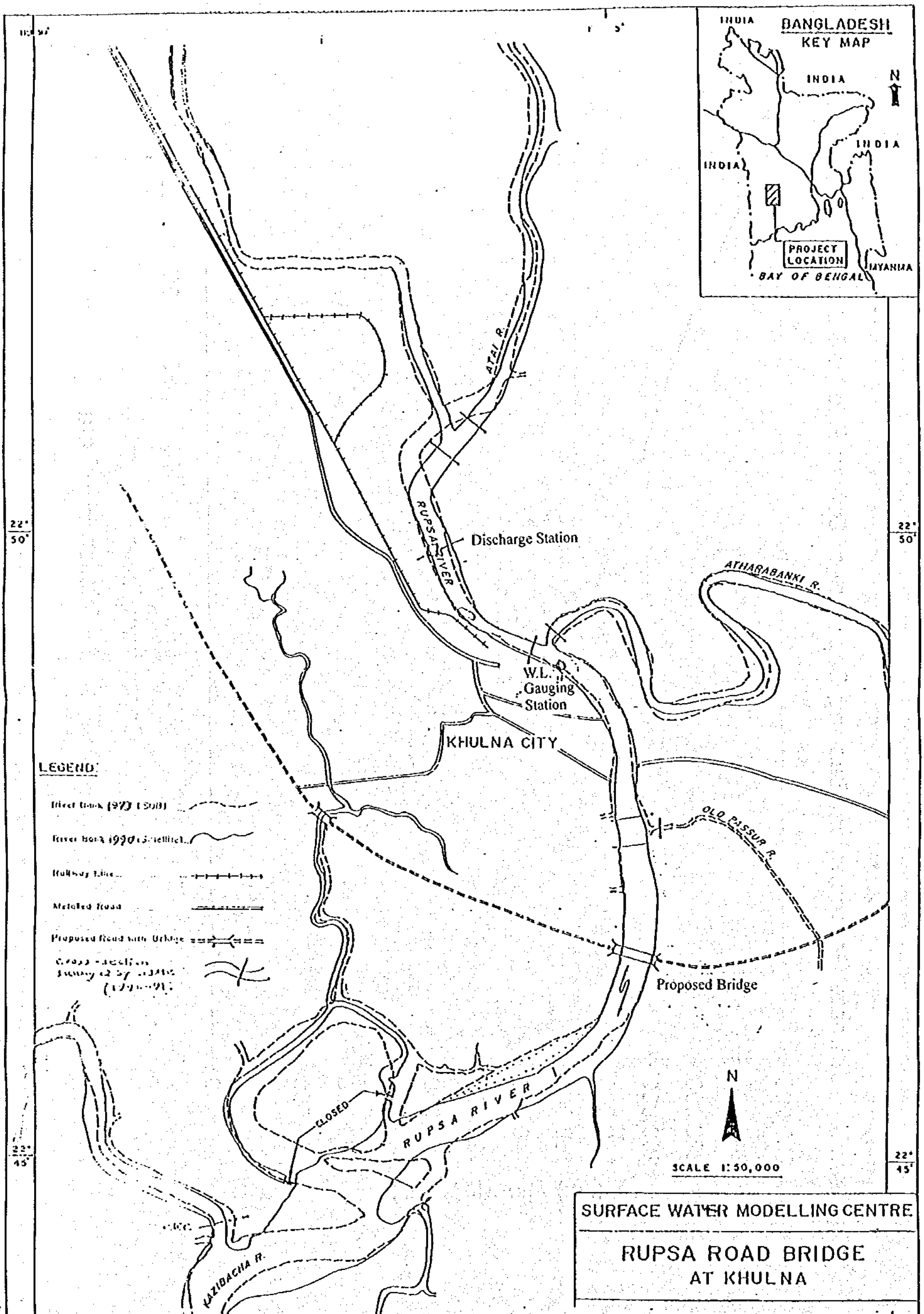


Fig. A6.4.1.1 Transformation of Bark in Rupsa River

source : phase I Report

Appendix 6.5

STUDY ON CONSTRUCTION OF THE BRIDGE OVER THE RIVER RUPSA IN KHULNA (PHASE 2)

ALTERNATIVE:
ROUTE : ALT-1 Urban Structure Scheme L=10.043 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

AT 1999 PRICES

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST (Tk.)	COST (Tk.)
2.01	Site Clearing	M2	337,640	30	10,129,200
3.01	Removal of Old Pavement	M2	4,400	38	167,200
4.01	Common Excavation	M3	171,349	103	17,648,968
4.02	Borrow Material	M3	232,327	177	41,121,844
4.03	Free-Draining Material	M3	155,440	270	41,968,800
4.04	Horizontal Sand Drain	M3	52,350	503	26,332,050
4.05	Permeable Backfill	M3	17,828	1,347	24,014,316
5.01	Structure Excavation Up To 2m	M3	11,022	92	1,014,024
5.02	Structure Excavation Over 2m	M3	0	3,686	0
5.03	Blinding Stone	M3	1,098	970	1,065,060
5.04	Lean Concrete (t=10cm)	M2	15,630	262	4,095,060
6.01	R.C. Pipe D=40cm	M	1,502	4,746	7,128,492
6.02	R.C. Pipe D=120cm	M	2,140	14,915	31,918,100
6.03	U-Ditch	M	6,946	2,303	15,996,638
6.04	Inlet	EACH	298	18,843	5,615,214
6.05	Concrete Curb	M	2,712	555	1,505,160
6.06	RC Box Culvert 1.5 m (H) x 4.0 m (w)	M	25	62,946	1,573,650
6.07	RC Box Culvert 2.0 m (H) x 4.0 m (w)	M	23	70,786	1,628,078
6.08	RC Box Culvert 2.0 m (H) x 7.5 m (w)	M	27	135,439	3,656,853
6.09	RC Box Culvert 2.0 m (H) x 12.5 m (w)	M	30	208,160	6,244,800
6.10	RC Box Culvert 3.5 m (H) x 14.0 m (w)	M	23	297,860	6,850,780
6.11	RC Box Culvert 4.0 m (H) x 8.0 m (w)	M	30	186,856	5,605,680
6.12	RC Box Culvert 4.0 m (H) x 12.0 m (w)	M	46	270,960	12,464,160
6.13	RC Box Culvert, 5.0m (H) x 16.5m (w)	M	36	484,170	17,430,120
6.14	Hatia Canal Bridge	L.S.	1	114,790,000	114,790,000
6.15	Telok Canal Bridge	L.S.	1	43,153,000	43,153,000
6.16	Pier Protection	M2	5,810	4,894	28,434,140
6.17	River Revetment	M2	9,000	6,780	61,020,000
7.01	Sub-grade Preparation	M2	223,840	12	2,686,080
7.02	Granular Sub-base	M3	54,435	2,269	123,513,015
7.03	Mechanical Stabilized Base	M3	17,747	3,463	61,457,861
7.04	Bituminous Prime Coat/Tack Coat	Litre	406,388	34	13,817,192
7.05	Asphalt Treated Base Course (t=10cm)	M2	135,463	807	109,318,641
7.06	Asphalt Concrete Surface (t=15cm)	M2	135,463	1,238	167,703,194
7.07	Concrete Pavement (t=25cm)	M2	1,644	3,171	5,213,124
7.08	Brick Pavement	M2	37,173	149	5,538,777
8.01	Main Span Superstructure	L.S.	1	441,900,000	441,900,000
8.02	Main Span Substructure	L.S.	1	820,200,000	820,200,000
8.03	Approach Span Superstructure	L.S.	1	260,000,000	260,000,000
8.04	Approach Span Substructure	L.S.	1	320,600,000	320,600,000
9.01	Structural Members	TON	0	46,529	0
10.01	Solid Sodding	M2	138,425	24	3,322,200
10.02	Guardrail	M	9,739	2,201	21,435,539
10.03	Regulatory & Warning Sign	EACH	84	6,103	512,652
10.04	Guide Sign	EACH	34	268,581	9,131,754
10.05	Road Marking	M2	34,847	307	10,698,029
10.06	Concrete Barrier	M	3,620	3,835	13,882,700
10.07	Street Tree	EACH	4,057	489	1,983,873
10.08	KM Post	EACH	18	934	16,812
10.09	ROW Marker	EACH	374	467	174,658
10.10	Street Lighting Unit	EACH	281	48,832	13,721,792
10.11	Street Lighting Control Panel	EACH	2	61,041	122,082
10.12	Traffic Signal Unit	EACH	56	36,625	2,051,000
10.13	Traffic Signal Control Panel	EACH	6	432,812	2,596,872
10.14	Toll Paza	EACH	1	3,416,672	3,416,672
10.15	Toll Office	EACH	1	1,394,356	1,394,356
	TOTAL				2,948,980,261

ALTERNATIVE:
ROUTE : ALT-2 Mobility Scheme L=9.234 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

AT 1999 PRICES

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST (Tk.)	COST (Tk.)
2.01	Site Clearing	M2	305,223	30	9,156,690
3.01	Removal of Old Pavement	M2	4,400	38	167,200
4.01	Common Excavation	M3	160,708	103	16,552,929
4.02	Borrow Material	M3	219,321	177	38,819,808
4.03	Free-Draining Material	M3	138,718	270	37,453,860
4.04	Horizontal Sand Drain	M3	52,350	503	26,332,050
4.05	Permeable Backfill	M3	15,735	1,347	21,195,045
5.01	Structure Excavation Up To 2m	M3	9,648	92	887,616
5.02	Structure Excavation Over 2m	M3	0	3,686	0
5.03	Blinding Stone	M3	944	970	915,680
5.04	Lean Concrete (t=10cm)	M2	13,830	262	3,623,460
6.01	R.C. Pipe D=40cm	M	1,528	4,746	7,251,888
6.02	R.C. Pipe D=120cm	M	1,873	14,915	27,935,795
6.03	U-Ditch	M	5,443	2,303	12,535,229
6.04	Inlet	EACH	299	18,843	5,634,057
6.05	Concrete Curb	M	2,683	555	1,489,065
6.06	RC Box Culvert 1.5 m (H) x 4.0 m (w)	M	25	62,946	1,573,650
6.07	RC Box Culvert 2.0 m (H) x 4.0 m (w)	M	23	70,786	1,628,078
6.08	RC Box Culvert 2.0 m (H) x 7.5 m (w)	M	27	135,439	3,656,853
6.09	RC Box Culvert 2.0 m (H) x 12.5 m (w)	M	30	208,160	6,244,800
6.10	RC Box Culvert 3.5 m (H) x 14.0 m (w)	M	23	297,860	6,850,780
6.11	RC Box Culvert 4.0 m (H) x 8.0 m (w)	M	30	186,856	5,605,680
6.12	RC Box Culvert 4.0 m (H) x 12.0 m (w)	M	46	270,960	12,464,160
6.13	RC Box Culvert, 5.0m (H) x 16.5m (w)	M	36	484,170	17,430,120
6.14	Hatia Canal Bridge	L.S.	1	114,790,000	114,790,000
6.15	Telok Canal Bridge	L.S.	1	43,153,000	43,153,000
6.16	Pier Protection	M2	5,810	4,894	28,434,140
6.17	River Revetment	M2	9,000	6,780	61,020,000
7.01	Sub-grade Preparation	M2	202,699	12	2,432,388
7.02	Granular Sub-base	M3	49,473	2,269	112,254,237
7.03	Mechanical Stabilized Base	M3	16,438	3,463	56,924,794
7.04	Bituminous Prime Coat/Tack Coat	Litre	366,719	34	12,468,446
7.05	Asphalt Treated Base Course (t=10cm)	M2	122,240	807	98,647,680
7.06	Asphalt Concrete Surface (t=15cm)	M2	122,240	1,238	151,333,120
7.07	Concrete Pavement (t=25cm)	M2	1,644	3,171	5,213,124
7.08	Brick Pavement	M2	33,898	149	5,050,802
8.01	Main Span Superstructure	L.S.	1	441,900,000	441,900,000
8.02	Main Span Substructure	L.S.	1	820,200,000	820,200,000
8.03	Approach Span Superstructure	L.S.	1	260,000,000	260,000,000
8.04	Approach Span Substructure	L.S.	1	320,600,000	320,600,000
9.01	Structural Members	TON	0	46,529	0
10.01	Solid Sodding	M2	128,380	24	3,081,120
10.02	Guardrail	M	6,682	2,201	14,707,082
10.03	Regulatory & Warning Sign	EACH	84	6,103	512,652
10.04	Guide Sign	EACH	34	268,581	9,131,754
10.05	Road Marking	M2	31,213	307	9,582,391
10.06	Concrete Barrier	M	3,620	3,835	13,882,700
10.07	Street Tree	EACH	3,613	489	1,766,757
10.08	KM Post	EACH	16	934	14,944
10.09	ROW Marker	EACH	330	467	154,110
10.10	Street Lighting Unit	EACH	271	48,832	13,233,472
10.11	Street Lighting Control Panel	EACH	2	61,041	122,082
10.12	Traffic Signal Unit	EACH	56	36,625	2,051,000
10.13	Traffic Signal Control Panel	EACH	6	432,812	2,596,872
10.14	Toll Paza	EACH	1	3,416,672	3,416,672
10.15	Toll Office	EACH	1	1,394,356	1,394,356
	TOTAL				2,875,474,188

ALTERNATIVE:
ROUTE : ALT-3 Accessibility Scheme L=7.758 km
BRIDGE : OPT-1 PC Box Girder Bridge 7-Span Option

AT 1999 PRICES

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	UNIT COST (Tk.)	COST (Tk.)
2.01	Site Clearing	M2	265,362	30	7,960,860
3.01	Removal of Old Pavement	M2	3,900	38	148,200
4.01	Common Excavation	M3	129,148	103	13,302,265
4.02	Borrow Material	M3	180,748	177	31,992,361
4.03	Free-Draining Material	M3	119,502	270	32,265,540
4.04	Horizontal Sand Drain	M3	52,350	503	26,332,050
4.05	Permeable Backfill	M3	13,952	1,347	18,793,344
5.01	Structure Excavation Up To 2m	M3	9,415	92	866,180
5.02	Structure Excavation Over 2m	M3	0	3,686	0
5.03	Blinding Stone	M3	905	970	877,850
5.04	Lean Concrete (t=10cm)	M2	12,420	262	3,254,040
6.01	R.C. Pipe D=40cm	M	1,517	4,746	7,199,682
6.02	R.C. Pipe D=120cm	M	1,581	14,915	23,580,615
6.03	U-Ditch	M	5,482	2,303	12,625,046
6.04	Inlet	EACH	296	18,843	5,577,528
6.05	Concrete Curb	M	2,708	555	1,502,940
6.06	RC Box Culvert 1.5 m (H) x 4.0 m (w)	M	25	62,946	1,573,650
6.07	RC Box Culvert 2.0 m (H) x 4.0 m (w)	M	23	70,786	1,628,078
6.08	RC Box Culvert 2.0 m (H) x 7.5 m (w)	M	27	135,439	3,656,853
6.09	RC Box Culvert 2.0 m (H) x 12.5 m (w)	M	30	208,160	6,244,800
6.10	RC Box Culvert 3.5 m (H) x 14.0 m (w)	M	23	297,860	6,850,780
6.11	RC Box Culvert 4.0 m (H) x 8.0 m (w)	M	30	186,856	5,605,680
6.12	RC Box Culvert 4.0 m (H) x 12.0 m (w)	M	46	270,960	12,464,160
6.13	RC Box Culvert, 5.0m (H) x 16.5m (w)	M	36	484,170	17,430,120
6.14	Hatia Canal Bridge	L.S.	1	114,790,000	114,790,000
6.15	Telok Canal Bridge	L.S.	1	43,153,000	43,153,000
6.16	Pier Protection	M2	5,810	4,894	28,434,140
6.17	River Revetment	M2	9,000	6,780	61,020,000
7.01	Sub-grade Preparation	M2	173,202	12	2,078,424
7.02	Granular Sub-base	M3	42,535	2,269	96,511,915
7.03	Mechanical Stabilized Base	M3	13,667	3,463	47,328,821
7.04	Bituminous Prime Coat/Tack Coat	Litre	319,027	34	10,846,918
7.05	Asphalt Treated Base Course (t=10cm)	M2	106,342	807	85,817,994
7.06	Asphalt Concrete Surface (t=15cm)	M2	106,342	1,238	131,651,396
7.07	Concrete Pavement (t=25cm)	M2	1,644	3,171	5,213,124
7.08	Brick Pavement	M2	28,026	149	4,175,874
8.01	Main Span Superstructure	L.S.	1	441,900,000	441,900,000
8.02	Main Span Substructure	L.S.	1	820,200,000	820,200,000
8.03	Approach Span Superstructure	L.S.	1	260,000,000	260,000,000
8.04	Approach Span Substructure	L.S.	1	320,600,000	320,600,000
9.01	Structural Members	TON	0	46,529	0
10.01	Solid Sodding	M2	105,404	24	2,529,696
10.02	Guardrail	M	7,171	2,201	15,783,371
10.03	Regulatory & Warning Sign	EACH	76	6,103	463,828
10.04	Guide Sign	EACH	30	268,581	8,057,430
10.05	Road Marking	M2	27,961	307	8,584,027
10.06	Concrete Barrier	M	3,460	3,835	13,269,100
10.07	Street Tree	EACH	3,141	489	1,535,949
10.08	KM Post	EACH	14	934	13,076
10.09	ROW Marker	EACH	282	467	131,694
10.10	Street Lighting Unit	EACH	268	48,832	13,086,976
10.11	Street Lighting Control Panel	EACH	2	61,041	122,082
10.12	Traffic Signal Unit	EACH	52	36,625	1,904,500
10.13	Traffic Signal Control Panel	EACH	5	432,812	2,164,060
10.14	Toll Paza	EACH	1	3,416,672	3,416,672
10.15	Toll Office	EACH	1	1,394,356	1,394,356
	TOTAL				2,787,911,044

Cost of Approach Bridge

(1) Superstructure Cost

Item of works	Unit	Quantity	Rate in Taka	Cost in million Taka
Structural Concrete (Low design strength)	Cum	3,140	12,098	37.988
Structural Concrete (High design strength)	Cum	3,406	25,224	85.913
Reinforcing Steel	Ton	768	69,889	53.675
Prestressing Steel	Ton	168	170,775	28.690
Pavement & Ancillary works	Sqm	11,520	4,662	53.706
			Total	259.972

(2) Substructure Cost

Item of works	Unit	Quantity	Rate in Taka	Cost in million Taka
Structural Concrete (Low design strength)	Cum	2,780	12,098	33.632
Reinforcing Steel	Ton	300	69,889	20.967
Bored Pile(D=900mm)	m	8,160	32,618	266.163
			Total	320.762

Cost of Canal Bridges and Culverts

(1) Cost of Bridge over Hatia canal

Item of works	Unit	Quantity	Rate in Taka	Cost in million Taka
Structural Concrete (Low design strength)	Cum	1,285	12,098	15.546
Structural Concrete (High design strength)	Cum	570	25,224	14.378
Bored Pile(D=750mm)	m	3,325	22,657	75.335
Reinforcing Steel	Ton	231	69,889	16.144
Prestressing Steel	Ton	28.5	170,775	4.867
Pavement & Ancillary works	Sqm	1,620	4,662	7.552
			Total	133.822

(2) Cost of Bridge over Telok canal

Item of works	Unit	Quantity	Rate in Taka	Cost in million Taka
Structural Concrete (Low design strength)	Cum	580	12,098	7.017
Structural Concrete (High design strength)	Cum	190	25,224	4.793
Bored Pile(D=750mm)	m	1,200	22,657	27.188
Reinforcing Steel	Ton	98	69,889	6.849
Prestressing Steel	Ton	9.5	170,775	1.622
Pavement & Ancillary works	Sqm	540	4,662	2.517
			Total	49.986

(3) Cost of Culverts

All cost are in Million Taka

Culvert at Station	Height(m)	Width(m)	Unit	Quantity/Length(m)	Rate in Taka	Total Cost
2+218.5	1.5	4.0	m	24.37	69,241	1.687
2+760.5	2.0	7.5	m	26.44	148,983	3.939
3+660.0	5.0	16.5	m	35.63	532,587	18.976
4+500.0	2.0	4.0	m	22.90	77,865	1.783
4+643.0	3.5	14.0	m	22.90	327,646	7.503
4+882.0	4.0	12.0	m	22.90	298,056	6.825
5+266.5	4.0	12.0	m	22.90	298,056	6.825
5+495.5	2.0	12.5	m	29.90	228,976	6.846
8+860.5	4.0	8.0		29.90	205,542	6.146
					Total	60.53