ANNEX VII. COST ESTIMATES

INDEX TO VOLUME

ANNEX VII COST ESTIMATES

7.1 Construction Costs

Table 7-1 Cost Estimate

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
1	Preparatory Works	Sum	1		6,210		5,040		1,170
2	Embankment	"	1		64,709		46,175		18,534
3	No.1 Pumping Plan	"	1		327,959		165,182		162,777
4	No.2 Pumping Plan	"	1		330,305		164,176		166,129
5	Extension Area	"	1		20,679		15,773		4,906
6	Construction Machinery	"	1		51,370		9,640		41,730
7	Engineering Service	"	1		77,870		13,910		63,960
	Total				879,102		419,896		459,206

(1) Preparatory Works

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Preparatory Works	Sum	1		4,500,000		3,600,000		900,000
	Contingency								
	Physical				450,000		360,000		90,000
	Prices				1,260,000		1,080,000		180,000
	Total				6,210,000		5,040,000		1,170,000

(2) Embankment

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Civil Work				41,968,000		27,711,000		14,257,000
	1. Sitalakkya River								
	Earthwork of embankment	cft	29,413,000	0.16	4,706,080	0.16	4,706,080		
	Compaction of earth	"	29,413,000	0.10	2,941,300	0.04	1,176,520	0.06	1,764,780
	Turfing	sft	4,466,000	0.06	267,960	0.06	267,960		
	1st class brick on edge herring bone soling	"	1,912,000	4.39	8,393,680	3.73	7,131,760	0.66	1,261,920
	Other				1,629,980		1,327,680		302,300
	Sub Total				17,939,000		14,610,000		3,329,000
	2. N-M Railway								
	Earthwork of embankment	cft	31,844,000	0.16	5,095,040	0.16	5,095,040		
	Compaction of earth	"	31,844,000	0.10	3,184,400	0.04	1,273,760	0.06	1,910,640
	Cutting and clearing	sft	1,744,000	0.01	17,440	0.01	17,440		
	Turfing	"	3,676,000	0.06	220,560	0.06	220,560		
	Related structure								
	Closer Type II	Nos	7	151,000.00	1,057,000	116,000.00	812,000	35,000.00	245,000
	Closer Type III	"	1				1,200		300
	Regulating gate Type I	"	1		4,011,000		1,178,000		2,833,000
	Regulating gate Type III	"	3	197,000.00	591,000	49,000.00	147,000	148,000.00	444,000

Embankment

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Other				1,418,060		875,000		543,060
	Sub Total				15,596,000		9,620,000		5,976,000
	3. D-C Road								
	Earthwork of embankment	cft	4,842,000	0.16	774,720	0.16	774,720		
	Compaction of earth	"	4,842,000	0.10	484,200	0.04	193,680	0.06	290,520
	Cutting and clearing	sft	355,000	0.01	3,550	0.01	3,550		
	Turfing	"	698,000	0.06	41,880	0.06	41,880		
	Other				129,650		101,170		28,480
	Sub Total				1,434,000		1,115,000		319,000
	4. T-N Railway								
	Closer Type I	Nos	1		174,000		134,000		40,000
	Regulating gate Type II	"	3	2,275,000.00	6,825,000	744,000.00	2,232,000	1,531,000.00	4,593,000
	Sub Total				6,999,000		2,366,000		4,633,000
	II. Land acquisition				7,380,000		7,380,000		
	Sitalakkya River	ac	276	15,000.00	4,140,000	15,000	4,140,000		
	N-M Railway	"	185	15,000.00	2,775,000	15,000	2,775,000		
	D-C Road	"	31	15,000.00	465,000	15,000	465,000		

Embankment

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	III. Contingency								
	Physical				4,197,000		2,771,000		1,426,000
	Prices				11,164,000		8,313,000		2,851,000
	Total				64,709,000		46,175,000		18,534,000

(3) No. 1 Pumping Plan

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Civil Work				229,336,000		104,123,000		125,213,000
	Pumping Station	Sum	1		99,714,000		15,966,000		83,748,000
	Main Canal	"	1		66,036,000		41,541,000		24,495,000
	Secondary Canal	"	1		11,186,000		8,740,000		2,446,000
	Main Drainage	"	1		14,860,000		12,521,000		2,339,000
	Secondary Drainage	"	1		7,774,000		6,193,000		1,581,000
	Farm Ditch		1		1,351,000		1,351,000		
	Farm Drain	"	1		2,223,000		2,223,000		
	Farm Road	"	1		17,942,000		14,824,000		3,118,000
	Transmission lines		1		8,250,000		764,000		7,486,000
	II. Land acquisition				19,410,000		19,410,000		
	Main Canal	ac	573	15,000	8,595,000	15,000	8,595,000		
	Secondary Canal	"	357	15,000	5,355,000	15,000	5,355,000		
	Main Drainage	"	123	15,000	1,845,000	15,000	1,845,000		
	Secondary Drainage	"	241	15,000	3,615,000	15,000	3,615,000		
	III. Contingency								
	Physical				22,933,000		10,412,000		12,521,000
	Prices				56,280,000		31,237,000		25,043,000
	Total				327,959,000		165,182,000		162,777,000

(4) No. 2 Pumping Plan

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Civil Work	Sum	1		231,025,000		103,233,000		127,792,000
	Pumping Station	"	1		103,365,000		17,259,000		86,106,000
	Main Canal	"	1		52,437,000		32,665,000		19,772,000
	Secondary Canal	"	1		18,828,000		14,708,000		4,120,000
	Main Drainage	"	1		7,020,000		5,332,000		1,688,000
	Secondary Drainage	"	1		7,285,000		5,849,000		1,436,000
	Farm Ditch	"	1		1,884,000		1,884,000		
	Farm Drain	"	1		2,080,000		2,080,000		
	Farm Road	"	1		25,028,000		20,678,000		4,350,000
	Low Lift Pumping Station	"	1		5,148,000		2,052,000		3,096,000
	Transmission Lines	"	1		7,950,000		726,000		7,224,000
	II. Land Acquisition				19,650,000		19,650,000		
	Main Canal	ac	374	15,000	5,610,000	15,000	5,610,000		
	Secondary Canal	"	573	15,000	8,595,000	15,000	8,595,000		
	Main Drainage	"	136	15,000	2,040,000	15,000	2,040,000		
	Secondary Drainage	"	227	15,000	3,405,000	15,000	3,405,000		
	III. Contingency								
	Physical				23,102,000		10,323,000		12,779,000
	Prices				56,528,000		30,970,000		25,558,000
	Total				330,305,000		164,176,000		166,129,000

(5) Extension Area

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Civil Work				12,479,000		8,705,000		3,774,000
	Main Canal	Sum	1		6,758,000		4,240,000		2,518,000
	Secondary Canal	"	1		5,721,000		4,465,000		1,256,000
	II. Land Acquisition				3,585,000		3,585,000		
	Main Canal	ac	57	15,000	855,000	15,000	855,000		
	Secondary Canal	"	182	15,000	2,730,000	15,000	2,730,000		
	III. Contingency								
	Physical				1,248,000		871,000		377,000
	Prices				3,367,000		2,612,000		755,000
	Total				20,679,000		15,773,000		4,906,000

(6) Construction Machinery

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Machinery Cost	Sum	1		27,855,000		1,320,000		26,535,000
	Spares (Machinery x 20%)	"	1		5,565,000		-		5,565,000
	Repairs and General	"	1		5,565,000		5,565,000		-
	Supervision (Machinery x 20%)								
	Sub Total				38,985,000		6,885,000		32,100,000
	Contingency								
	Physical				3,899,000		689,000		3,210,000
	Prices				8,486,000		2,066,000		6,420,000
	Total				51,370,000		9,640,000		41,730,000

(7) Engineering Service

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Engineering Service	Sum			64,000,000		10,700,000		53,300,000
	II. Contingency								
	Prices				13,870,000		3,210,000		10,660,000
	Total				77,870,000		13,910,000		63,960,000

(8) Cost Estimate

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	I. Civil Work				558,293		254,257		304,036
	1. Preparatory Works	Sum	1		4,500		3,600		900
	2. Flood of Embankment								
	Sitalakkya River	Sum	1		17,939		14,610		3,329
	N-M Railway	"	1		15,596		9,620		5,976
	D-C Road	"	1		1,434		1,115		319
	T-N Railway	"	1		6,999		2,336		4,633
	Sub Total				41,968		27,711		14,257
	3. Pumping Station								
	No.1 Pumping Station	Sum	1		99,714		15,966		83,748
	No.2 Pumping Station	"	1		103,365		17,259		86,106
	Sub Total				203,079		33,225		169,854
	4. Irrigation								
	Main Canal								
	No.1	Sum	1		66,036		41,541		24,495
	No.2	"	1		52,437		32,665		19,772
	Extension Area	"	1		6,758		4,240		2,518
	Secondary Canal								
	No.1	Sum	1		11,186		8,740		2,446

Cost Estimate

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	No.2	Sum	1		18,828		14,708		4,120
	Extension Area	"	1		5,721		4,465		1,256
	Sub Total				160,966		106,359		54,607
	5. Drainage								
	Main Drainage								
	No.1	Sum	1		14,860		12,521		2,339
	No.2	"	1		7,020		5,332		1,688
	Secondary Drainage								
	No.1	Sum	1		7,285		5,849		1,436
	No.2	"	1		7,774		6,193		1,581
	Sub Total				36,939		29,895		7,044
	6. Transmission Lines								
	No.1 Pumping Station	Sum			8,250		764		7,486
	No.2 Pumping Station	"			7,950		726		7,224
	Sub Total				16,200		1,490		14,710
	7. On Farm Facilities								
	No.1 Pumping Plan								
	Farm Ditch	Sum			1,351		1,351		
	Farm Drain	"			2,223		2,223		
	Farm Road	"			17,942		14,824		3,118

Cost Estimate

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	No.2 Pumping Plan								
	Farm Ditch	Sum			1,884		1,884		
	Farm Drain	"			2,080		2,080		
	Farm Road	"			25,028		20,678		4,350
	Low lift pumping station	"			5,148		2,052		3,096
	Sub Total				55,656		45,092		10,564
	8. Construction Machinery	Sum	1		38,985		6,885		32,100
	II. Land Acquisitions				50,025		50,025		
	No.1 Pumping Plan	Sum	1		19,410		19,410		
	No.2 " "	"	1		19,650		19,650		
	Extension Area	"	1		3,585		3,585		
	Flood of Embankment	"	1		7,380		7,380		
	III. Engineering Service	Sum			64,000		10,700		53,300
	IV. Contingency								
	Physical				55,829		25,426		30,403
	Prices				150,955		79,488		71,467
	Total				879,102		419,896		459,206

Table 7-2 Detailed Breakdown of Estimated Cost

(1) No. 1 Pumping Station

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in Excavation (A)	cft	293,000	0.14	41,020	0.14	41,020		
	" (B)	"	436,000	0.18	78,480	0.18	78,480		
	Earthwork in Filling	"	186,000	0.11	20,460	0.11	20,460		
	Reinforced cement concrete (B)	"	157,500	25.00	3,940,000	15.43	2,431,768	9.57	1,508,232
	Form work (A)	sft	98,100	4.00	392,400	4.00	392,400		
	Cement concrete (A)	cft	12,800	17.31	221,568	10.34	132,352	6.97	89,216
	Form work (B)	sft	500	3.00	1,500	3.00	1,500		
	1st class brick on edge herring bone soling	"	14,400	4.39	63,216	3.73	53,712	0.66	9,504
	Bailing out water	cft	6,000,000	0.02	120,000	0.02	120,000		
	Water-tight shuttering	sft	8,400	5.00	42,000	3.45	28,980	1.55	13,020
	Compaction of earth	cft	380,000	0.10	38,000	0.04	15,200	0.06	22,800
	M.S. work for rainforcement	cwt	7,042	465	3,274,530	201	1,415,442	264	1,859,088
	Vertical axial pump 5'-6" dia.	sum	1		65,700,000		5,700,000		60,000,000
	Earthwork of embankment	cft	194,000	0.16	31,040	0.16	31,040		
	Sheet pile	ton	55	10,800	594,000	5400	297,000	5400	297,000
	Station building	sft	4,050	1,100	4,455,000	550	2,227,500	550	2,227,000
	Office	"	1,300	700	910,000	350	455,000	350	455,000
	Slide Gate (W 6' H 8')	sum	24	229,000	5,496,000	22,900	549,600	206,100	4,946,400
	" (6.5'x6')	"	2	142,600	285,200	14,620	28,520	128,340	256,680
	Flap Gate (6'x5')	"	24	206,000	4,944,000	20,600	494,400	185,400	4,449,600
	Other				9,065,586		1,451,626		7,613,960
	Total				99,714,000		15,966,000		83,748,000

(2) No. 2 Pumping Station

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in Excavation (A)	cft	341,000	0.14	47,740	0.14	47,740		
	" (B)	"	514,000	0.18	92,520	0.18	92,520		
	Earthwork in Filling	"	288,000	0.11	31,680	0.11	31,680		
	Reinforced cement concrete (B)	"	190,900	25.00	4,772,500	15.43	2,945,587	9.57	1,826,913
	Form work (A)	sft	116,400	4.00	465,600	4.00	465,600		
	Cement concrete (A)	cft	15,700	17.31	271,767	10.34	162,338	6.97	109,429
	Form work (B)	sft	600	3.00	1,800	3.00	1,800		
	1st class brick on edge herring bone soling	"	20,700	4.39	90,873	3.73	77,211	0.66	13,662
	Bailing out water	cft	6,000,000	0.02	120,000	0.02	120,000		
	Water-tight shuttering	sft	14,000	5.00	70,000	3.45	48,300	1.55	21,700
	Compactions of earth	cft	379,000	0.10	37,900	0.04	15,160	0.06	22,740
	M.S. work for reinforcement	cwt	8,530	465	3,966,450	201	1,714,530	264	2,251,920
	Vertical axial pump 5'-6" dia.	sum	1		67,300,000		5,900,000		61,400,000
	Earthwork of embankment	cft	91,000	0.16	14,560	0.16	14,560		
	Sheet pile	ton	55	10,800	594,000	5,400	297,000	5400	297,000
	Station building	sft	4,050	1,100	4,455,000	550	2,227,500	550	2,227,500
	Office	"	1,300	700	910,000	350	455,000	350	455,000
	Slide Gate (W 6' H 8')	sum	24	289,000	5,496,000	22,900	549,600	206,100	4,946,400
	" (6.5'x6')	"	2	142,600	285,200	14,260	28,520	128,340	256,680
	Flap Gate (6'x5')	"	24	206,000	4,944,000	206,000	494,400	185,400	4,449,600
	Other				9,397,000		1,569,954		7,827,456
	Total				103,365,000		17,259,000		86,106,000

(3) Main Canal (No. 1 Pumping plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in excavation (C)	cft	4,271,000	0.11	469,810	0.11	469,810		
	Earthwork in filling	"	4,271,000	0.11	469,810	0.11	469,810		
	Earthwork of embankment	"	57,832,000	0.16	9,253,120	0.16	9,253,120		
	Compaction of earth	"	62,103,000	0.10	6,210,300	0.04	2,484,120	0.06	3,726,180
	Turfing	sft	5,632,000	0.06	337,920	0.06	337,920		
	1st class brick on edge herring bone soling	"	2,149,000	4.39	9,434,110	3.73	8,015,770	0.66	1,418,340
	(Related structure)								
	Turn out Type I	Nos	2	360,000.00	720,000	99,000.00	198,000	261,000	522,000
	" Type II	"	13	354,000.00	4,602,000	78,000.00	1,014,000	276,000	3,588,000
	" Type III	"	5	127,000.00	635,000	34,000.00	170,000	93,000	465,000
	Check gate Type I	"	2	594,000.00	1,188,000	213,000.00	426,000	381,000	762,000
	" Type II	"	1	382,000.00	382,000	151,000.00	151,000	231,000	231,000
	Bridge Type I	"	1	269,000.00	269,000	156,000.00	156,000	113,000.00	113,000
	" Type II	"	4	116,000.00	464,000	68,000.00	272,000	48,000.00	192,000
	" Type III	"	182	61,000.00	11,102,000	35,000.00	6,370,000	26,000.00	4,732,000
	Aqueduct Type I	"	4	633,000.00	2,532,000	352,000.00	1,408,000	281,000.00	1,124,000
	" Type II	"	10	438,000.00	4,380,000	249,000.00	2,490,000	189,000.00	1,890,000
	Siphon Type I	"	2	90,000.00	180,000	55,000.00	110,000	35,000.00	70,000
	" Type II	"	2	63,000.00	126,000	39,000.00	78,000	24,000.00	48,000
	Regulating gate Type II	"	1	2,275,000.00	2,275,000	744,000.00	744,000	1,531,000.00	1,531,000
	Other				11,005,930		6,923,450		4,082,480
	Total				66,036,000		41,541,000		24,495,000

(4) Main Canal (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in excavation (C)	cft	15,176,000	0.11	1,669,360	0.11	1,669,360		
	Earthwork in filling	"	15,176,000	0.11	1,669,360	0.11	1,669,360		
	Earthwork of embankment	"	15,150,000	0.16	2,424,000	0.16	2,424,000		
	Compaction of earth	"	30,326,000	0.10	3,032,600	0.04	1,213,040	0.06	1,819,560
	Turfing	sft	4,140,000	0.06	248,000	0.06	248,000		
	1st class brick on edge herring bone soling	"	2,174,000	4.39	9,543,860	3.73	8,109,020	0.66	1,434,840
	(Related structure)								
	Turn out Type I	Nos	10	360,000	3,600,000	99,000	990,000	261,000	2,610,000
	" Type II	"	8	354,000	2,832,000	78,000	624,000	276,000	2,208,000
	" Type III	"	2	127,000	254,000	34,000	68,000	93,000	186,000
	Check gate Type I	"	1		594,000		213,000		331,000
	" Type II	"	3	382,000	1,146,000	151,000	453,000	231,000	693,000
	Bridge Type I	"	4	269,000.00	1,076,000	156,000.00	624,000	113,000.00	452,000
	" Type II	"	2	116,000.00	232,000	68,000.00	136,000	48,000.00	96,000
	" Type III	"	184	61,000.00	11,224,000	35,000.00	6,440,000	26,000.00	4,784,000
	Aqueduct Type I	"	3	633,000.00	1,899,000	352,000.00	1,056,000	281,000.00	843,000
	" Type II	"	5	438,000.00	2,190,000	249,000.00	1,245,000	189,000.00	945,000
	Siphon Type II	"	1		63,000		39,000		24,000
	Other				8,739,820		5,444,220		3,295,600
	Total				52,437,000		32,665,000		19,772,000

(5) Main Canal (Extension Area)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork of embankment	cft	5,853,000	0.16	936,480	0.16	936,480		
	Compaction of earth	"	5,853,000	0.10	585,300	0.04	234,120	0.06	351,180
	Turfing	"	638,000	0.06	38,280	0.06	38,280		
	1st class brick on edge herring bone soling	sft	239,000	4.39	1,049,210	3.73	891,470	0.66	157,740
	(Related structure)								
	Turn out Type I	Nos	1		360,000		99,000		261,000
	" Type II	"	1		354,000		78,000		276,000
	Check gate Type II	"	1		382,000		151,000		231,000
	Bridge Type I	"	1		269,000		156,000		113,000
	"	"							
	" Type III	"	20	61,000.00	1,220,000	35,000.00	700,000	26,000.00	520,000
	Aqueduct Type II	"	1		438,000		249,000		189,000
	Other				1,125,730		706,650		419,080
	Total				6,758,000		4,240,000		2,518,000

(6) Secondary Canal (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Secondary Canal Type 3	rft	77,100	50.00	3,855,000	39.00	3,006,900	11.00	848,100
	" Type 4	"	23,800	33.00	785,400	26.00	618,800	7.00	166,600
	" Type 5	"	146,300	32.00	4,681,600	25.00	3,657,500	7.00	1,024,100
	Other				1,864,000		1,456,800		407,200
	Total				11,186,000		8,740,000		2,446,000

(7) Secondary Canal (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Secondary Canal Type 1	rft	56,500	50.00	2,825,000	39.00	2,203,500	11.00	621,500
	" Type 2	"	35,900	50.00	1,795,000	39.00	1,400,100	11.00	394,900
	" Type 3	"	62,800	50.00	3,140,000	39.00	2,449,200	11.00	690,800
	" Type 4	"	39,100	33.00	1,290,300	26.00	1,016,600	7.00	273,700
	" Type 5	"	207,500	32.00	6,640,000	25.00	5,187,500	7.00	1,452,500
	Other				3,137,700		2,451,100		686,600
	Total				18,828,000		14,708,000		4,120,000

(8) Secondary Canal (Extension Area)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Secondary Canal Type 3	rft	60,200	50.00	3,010,000	39.00	2,347,800	11.00	662,200
	" Type 5	"	54,900	32.00	1,756,800	25.00	1,372,500	7.00	384,300
	Other				954,200		744,700		209,500
	Total				5,721,000		4,465,000		1,256,000

(9) Main Drainage (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in excavation	cft	55,196,000	0.11	6,071,560	0.11	6,071,560		
	Earthwork in filling	"	8,208,000	0.11	902,880	0.11	902,880		
	Compaction of earth	"	8,208,000	0.10	820,800	0.04	328,320	0.06	492,480
	Turfing	sft	743,000	0.06	44,580	0.06	44,580		
	1st clsss brick on edge herring bone soling	"	396,000	4.39	1,738,440	3.73	1,477,080	0.66	261,360
	(Related Structure)								
	Bridge Type III	Nos	46	61,000.00	2,806,000	35,000.00	1,610,000	26,000.00	1,196,000
	Other				2,475,740		2,086,580		389,160
	Total				14,860,000		12,521,000		2,339,000

(10) Main Drainage (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Earthwork in excavation (C)	cft	54,943,000	0.11	828,520	0.11	828,520		
	Earthwork in filling	"	1,397,000	0.11	153,670	0.11	153,670		
	Compaction of earth	"	1,397,000	0.10	139,700	0.04	55,880	0.06	83,820
	Turfing	sft	1,429,000	0.06	85,740	0.06	85,740		
	1st class brick on edge herring bone soling	"	539,000	4.39	2,366,210	3.73	2,010,470	0.66	355,740
	(Related structure)								
	Bridge Type I	Nos.	1		269,000		156,000		113,000
	" Type II	"	1		116,000		68,000		48,000
	" Type III	"	31	61,000.00	1,891,000	35,000.00	1,085,000	26,000.00	806,000
	Other				1,170,160		888,720		281,440
	Total				7,020,000		5,332,000		1,688,000

(11) Secondary Drainage (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Secondary Drainage Type 2	rft	109,800	59.00	6,478,200	47.00	5,160,600	12.00	1,317,600
	Other				1,295,800		1,032,400		263,400
	Total				7,774,000		6,193,000		1,581,000

(12) Secondary Drainage (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Secondary Drainage Type 1	rft	14,300	87.00	1,244,100	72.00	1,029,600	15.00	214,500
	" Type 2	"	81,800	59.00	4,826,200	47.00	3,844,600	12.00	981,600
	Other				1,214,700		974,800		239,900
	Total				7,285,000		5,849,000		1,436,000

(13) Farm Ditch (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Ditch	rft	1,261,400	1.02	1,286,628	1.02	1,286,628		
	Other				64,372		64,372		
	Total				1,351,000		1,351,000		

(14) Farm Ditch (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Ditch	rft	1,759,600	1.02	1,794,792	1.02	1,794,792		
	Other				89,208		89,208		
	Total				1,884,000		1,884,000		

(15) Farm Drain (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Drain	rft	1,961,000	1.08	2,117,880	1.08	2,117,880		
	Other				105,120		105,120		
	Total				2,223,000		2,223,000		

(16) Farm Drain (No. 2 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Drain	rft	1,833,800	1.08	1,980,504	1.08	1,980,504		
	Other				99,496		99,496		
	Total				2,080,000		2,080,000		

(17) Farm Road (No. 1 Pumping Plan)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Road	rft	952,000	17.95	17,088,400	14.83	14,118,160	3.12	2,970,240
	Other				853,600		705,840		147,760
	Total				17,942,000		14,824,000		3,118,000

(18) Farm Road (No. 2 Pumping Station)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Farm Road	rft	1,328,000	17 95	23,837,600	14 83	19,694,240	3 12	4,143,360
	Other				1,190,400		983,760		206,640
	Total				25,028,000		20,678,000		4,350,000

(19) Low Lift Pumping Station

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Low lift pumping station	Nos	36	143,000.00	5,148,000	57,000.00	2,052,000	86,000.00	3,096,000

(20) Transmission lines (No. 1 Pump)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	H.T Switch 33kV	Nos	1		750,000		50,000		700,000
	Transmission Line	mile	3	300,000	900,000	38,000	114,000	262,000	786,000
	Sub-station	Nos	1		6,600,000		600,000		6,000,000
	(H.T switch 33kV (Switch 3kV (Trans (Combination switch								
	Total			8,250,000			764,000		7,486,000

(21) Transmission lines (No. 2 Pump)

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	H.T Switch 33kV	Nos	1		750,000		50,000		700,000
	Transmission Line	mile	2	30,000	600,000	38,000	76,000	262,000	524,000
	Sub-station	Nos	1		6,600,000		600,000		6,000,000
	(H.T switch 33kV (Switch 3kV (Trans (Combination switch								
	Total				7,950,000		726,000		7,224,000

(22) No. 1 Pumping Equipment

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Pump and Motor, other	Set	6	6,000,000	36,000,000		-		36,000,000
	Support Equipment	Sum	1		3,000,000		-		3,000,000
	Electric Equipment	"	1		5,400,000		-		5,400,000
	Dynamo	"	1		5,700,000		-		5,700,000
	Setting (15%)	"	1		7,500,000		2,600,000		4,900,000
	Package and freight (10%)	"	1		5,000,000		-		5,000,000
	Sub total				62,600,000		2,600,000		60,000,000
	Local Handling (5%)				3,100,000		3,100,000		-
	Total				65,700,000		5,700,000		60,000,000

(23) No. 2 Pumping Equipment

Item No.	Work	Unit	Quantity	Total		Local Currency		Foreign Currency	
				Unit Price	Amount	Unit Price	Amount	Unit Price	Amount
	Pump and Motor, other	Set	6	6,200,000	37,200,000		-		37,200,000
	Support Equipment	Sum	1		3,000,000		-		3,000,000
	Electric Equipment	"	1		5,400,000		-		5,400,000
	Dynamo	"	1		5,700,000		-		5,700,000
	Setting (15%)	"	1		7,700,000		2,700,000		5,000,000
	Package and freight (10%)	"	1		5,100,000		-		5,100,000
	Sub total				64,100,000		2,700,000		61,400,000
	Local Handling (5%)				3,200,000		3,200,000		-
	Total				67,300,000		5,900,000		61,400,000

Table 7-3 Annual Disbursement of Financial Cost

	Total	Proparatory	1st	2nd	3rd	4th	5th	6th
I Civil Work	519,308		73,255	128,382	74,167	90,565	89,176	63,763
Local Currency	247,372		38,589	62,061	34,784	43,598	39,848	28,492
Foreign Currency	271,936		34,666	66,321	39,383	46,967	49,328	35,271
II Construction Machinery	38,985		29,710	1,855	1,855	1,855	1,855	1,855
Local Currency	6,885		2,247	927	927	928	928	928
Foreign Currency	32,100		27,463	928	928	927	927	927
III Land Acquisition	50,025		17,380	9,410		23,235		
Local Currency	50,025		17,380	9,410		23,235		
Foreign Currency	0		0	0		0		
IV Engineering Service	64,000	24,000	6,667	6,667	6,667	6,667	6,666	6,666
Local Currency	10,700	4,000	1,117	1,117	1,117	1,117	1,116	1,116
Foreign Currency	53,300	20,000	5,550	5,550	5,550	5,550	5,550	5,550
V Physical Contingency(I+II)	55,829		10,296	13,024	7,602	9,242	9,103	6,562
Local Currency 10%	25,426		4,084	6,299	3,571	4,453	4,077	2,942
Foreign Currency 10%	30,403		6,212	6,725	4,031	4,789	5,026	3,620
VI Prices Contingency(I+II+IV)	150,955	5,200	26,122	33,792	20,220	24,382	23,729	17,510
Local Currency 30%	79,488	1,200	12,586	19,232	11,048	13,693	12,568	9,161
Foreign Currency 20%	71,467	4,000	13,536	14,560	9,172	10,689	11,161	8,349
Total	879,102	29,200	163,430	193,130	110,511	155,946	130,529	96,356
Local Currency	419,896	5,200	76,003	99,046	51,447	87,024	58,537	42,639
Foreign Currency	459,206	24,000	87,427	94,084	59,064	68,922	71,992	53,717

7.4 Operation and Maintenance Costs

(1) Annual Costs

(a) Operation and Maintenance

In estimating annual operation and maintenance costs associated with pumps, structures, dikes, canals and roads, there exists no explicit criterion in Bangladesh. The standards employed by "Hail Haor Irrigation Project" would, therefore, be used.

	Item	Cost
i)	Pumps and motors	@ TK 200 per P.S.
ii)	Irrigation & drainange canal embankment	2% of field cost
iii)	Others	1% of field cost
iv)	Electrical consumption	
	Fixed charge	@ TK 42 per KVA
	Energy charges	@ TK 0.36 per KWH

Table 7-4 Annual Operation and Maintenance Costs for Phase I

Pumping Station No. 1		
Pumps and motors	200 × 730 × 6 =	876,000 TK
Dike, canal	193,372,000 × 0.02 =	3,867,000
Others	199,296,000 × 0.01 =	1,993,000
Electrical consumption		
Fixed charge	42 × 4,700 KVA × 12 =	2,369,000 TK
Energy charges	0.36×3,500 KW×4,330=	5,456,000
Sub total		7,825,000 TK
Replacement reserve for pumps	65,700,000 × 0.04 =	2,628,000
Sub total		17,189,000 TK
Pumping Station No. 2		
Pumps and motors	200 × 800 × 6 =	960,000 TK
Canal	117,766 × 0.02 =	2,355,000
Others	212,539 × 0.01 =	2,125,000
Electrical consumption		
Fixed charge	42 × 5,100 KVA × 12 =	2,570,000 TK
Energy charges	0.36×3,800 KW×4,280=	5,855,000
Sub total		8,425,000 TK
Replacement reserve for pumps	67,300,000 × 0.04 =	2,692,000
Sub total		16,557,000 TK
Extension Area		
Canal	17,093,000 × 0.02 =	342,000 TK
Others	3,586,000 × 0.01 =	36,000
Sub total		378,000 TK
Total		34,124,000 TK
		($2,275,000)

ANNEX VIII. SOILS AND LAND CLASSIFICATION

ANNEX VIII: SOILS AND LAND CLASSIFICATION

ANNEX VIII SOILS AND LAND CLASSIFICATION

8.1 Introduction

(1) Objectives

The soil survey was carried out as part of the feasibility study on the Narayangaj-Narsingdi Irrigation Project under the technical cooperation programme of the Government of Japan. The main objectives consist of;

- to undertake the field reconnaissance,
- to collect and review the results of the previous studies,
- to check information available on the soil map, and
- to evaluate the potentials for agricultural development.

(2) Procedures of Survey

In this study, topographic maps on scales 1/15,840, 1/31,680 and 1/47,520 and aerial photographs on a scale of 1/15,840 were used. The photographs represented dry-season conditions in 1975.

In the course of the discussions and consultation with the concerned officials visited, the following literatures were collected.

- Reconnaissance Soil Survey Report of Dacca District prepared by Directorate of Soil Survey under the assistance of UNDP/FAO, 1967.
- Soil Survey Project in Bangladesh (Soil Resources and Agricultural Development Possibilities) prepared by UNDP/FAO, 1971.
- Bangladesh Land and Water Resources Sector Study Vol. II prepared by IBRD, 1972.

Among these, a soil map on a scale of 1/125,000 is attached to the Reconnaissance Soil Survey Report of Dacca District above-

mentioned together with other two maps illustrating land use and land capability.

By the review of the documents collected, it was cleared that information available, especially in the said Reconnaissance Report, were enough for land evaluation to be made on the feasibility basis in this report. Thus, checking work of these information was done by the full utilization of aerial photographs and topographic maps as well as the data obtained through the field observation.

(3) Study Area

The results of study on soils and land classification in the project area are described in this report. Also, an area adjacent to the southeastern-most boundary of the project area is included into the study, because this area has high potentials of agricultural development and it can be expected that these potentials be realized by the provision of irrigation water in the dry season.

The project area is bounded by the Sitalakhya River in the west and northwest, the Tungi-Narsingdi Railway in the north, the Narsingdi-Madanganj Railway in the southeast and the Dacca-Chittagong Road in the southwest. Its entire area totals 71,600 ac (29,000 ha). The adjacent area is bordered by the Old Brahmaputra River in the southeast and the Narayanganj-Baidya Bazar Road running along the Menikhali Khal in the west and the Narsingdi-Madangaj Railway in the west and northwest. The whole adjacent area covers 11,400 ac (4,600 ha).

8.2 Soils

8.2.1 Physiography

The physiographical condition of the project area including the adjacent area is represented by two major subdivisions, i.e. Madhupur tract and Brahmaputra floor plain.

The Madhupur tract is a terrace which has been dissected by valleys and includes a wide variety of soils. Somewhat extensive areas of level terrace occur in several places along the left bank of the Sitalakhya River. These mainly have deeply weathered soils. Deeply dissected terrace areas have broad and level uplands covered with clay loamy to clayey soils. These areas stand about 10 ft above broad and steep-sided valleys which are deeply flooded during the monsoon season. The valleys mainly have the soils of heavy clays with dark-greyed colour.

Furthermore, closely dissected terrace areas appear within the Madhupur tract of the project area. They are featured by an undulating or rolling landscape broken by many shallow and narrow valleys almost of which are shallowly flooded during the monsoon season. The uplands have a variety of soils, in all of which there is heavy clay coloured in grey within 1 to 3 ft below the ground surface. The valleys mainly have the silty soils of light grey in colour.

The Brahmaputra floor plain is subdivided into two portions, i.e. old Brahmaputra flood plain and the young Brahmaputra flood plain.

The old Brahmaputra flood plain is a low area of gentle relief. Ridges of the old flood plain which are defined as smoothed-out and abandoned river levees mainly have sandy or silty soils with greyed colour. Basins occupying flat part of the old flood plain have the soils of clay coloured in dark-grey. Over large extent of the old flood plain within the project area, the landscape comprises mixtures of ridges, basins and old river

channels. These basins and river channels are seasonally flooded during the monsoon season.

The young Brahmaputra flood plain is of the flood plain adjoining the Sitalakhya and the Old Brahmaputra Rivers. This young flood plain extends over the adjacent area. The relief is low and gentle, comprising a complex landscape of ridges, basins and beels (permanent water bodies). As it is crossed by numerous rivers and abandoned channels, the relief becomes irregular. A lower part of the young flood plain is subject to river erosion and burial by new sediments. Most of the soils are complex of fresh sandy to silty deposits and young silty soils. They are affected by seasonal flooding water.

8.2.2 Parent Materials

All the soils of the project area including the adjacent area are developed over unconsolidated alluvial sediments. There are two main kinds: compact Madhupur clay which occupies dissected terrace topography in the Madhupur tract and recent or sub-recent mixed flood plain sediments deposited by the Ganges, the Brahmaputra and the Meghna Rivers.

In the northern part of the project area, the compact Madhupur clay, which was derived from the result of large outlier from the Madhupur tract formation, has been uplifted tectonically to form a terrace generally 10 to 15 ft above the neighbouring flood plans, but down-warpped in the southern part where the clay passed unconformably under flood plain sediments.

8.2.3 Soil Classification System

A classification system used broadly in Bangladesh is rather non-technical grouping of soils, because the system is made primarily taking into account easy understanding of soils for non-specialists belonged to district- and village-level authorities. Soil descriptions presented in this report are also based on the above way of thinking.

In the Reconnaissance Soil Survey Report of Dacca District, all the soil series recognized in the district have been again grouped into soil associations from the viewpoint of practical use for agricultural development planning in future. The soil association is defined as a grouping system in which soils occurring regularly together in the following pattern can be turned into one unit. Usually, the occurring pattern of soils is not random. Two or more particular soils are found to occur together in close relation to topography like one soil may occupy the higher parts of the landscape and its associate, or associates, the lower parts.

In the following Section 8.2.4, characteristics of each soil series recognized in the project area will be described and then, in Section 8.2.5, brief explanations on individual soil associations will be presented, grouping two or three soil series into one association from the above viewpoint.

8.2.4 Soil Series Description

(1) Madhupur Tract

(i) Deep Upland Soils

Over extensive terrace area with level topography, deep upland soils are developed. In the project area, four soil series, i.e. Belabo, Tejgaon, Sayek and Payati, have been identified.

Belabo soils have a brown to yellow-brown coloured topsoil with loamy texture. This topsoil is underlain by a thick layer of yellow-brown to strong brown coloured clay which is friable and becomes reddish yellow in colour with depth due to increasingly strong mottling. They are permeable and their moisture retention is moderate in dry periods.

Tejgaon soils, of which topsoil is loamy in texture and pale brown in colour in cultivated areas, are friable. The subsoil consists of friable clay and is red to strong

brown in colour. It is overlying a strongly mottled substratum below 30 to 60 in, which is clay in texture and has wide range from yellow to red, sometimes black, in colour. Tejgaon soils permeable and, therefore, moisture retention in dry periods is rather poor near the surface and moderate in lower layers. A high water-table temporarily appears during periods of heavy monsoon rainfall.

Sayek soils occur locally on high terrace edges and on isollated hillocks. Topsoils are brown to yellow-brown in colour and loam in texture. Clayey subsoils are friable and strongly mottled. Among three kinds of mottles coloured in red, yellow and black, the red and black ones have often hardened into concretions.

Payati soils extend over small hillocks and valley edges. They comprise rather heavy clay red-mottled by effects of seasonal variation in soil-moisture content.

(ii) Shallow Upland Soils

On closely dissected terrace areas having undulating or rolling landscape, shallow upland soils appear and are subject to seasonal flooding. Three soil series named as Demra, Gerua and Bhatpara have been found in the project area.

Demra soils are of heavy clay with overall appearance occupying almost level portion of the said terrace area. The depth of topsoils is about six inches and their texture varies silt loam to silty caly coloured in light grey when dried and olive-grey when flooded. Below these occurs very heavy clay of which colour is grey to olive-grey when wet and turns to olive-yellow when in the dry. These soils are slowly permeable and moisture retention becomes poor during the dry season.

Gerua soils comprise strong brown clays with the shallow depth of topsoil. They occupy gently undulating to rolling

topography in closely dissected areas. The texture of topsoil within an inch or two below the ground surface becomes lighter up to the grade of silty clay loam coloured in reddish yellow to strong brown. These soils are highly erodible and have poor soil-moisture relationships.

Bhatpara soils are of olive-coloured heavy clays and cover gently undulating to gently rolling topography in closely dissected areas.

The topsoil consists of a few inches of silty clay loam to silty clay coloured in grey and mottled in yellow and brown. This topsoil is sticky and plastic when wet and changes to very hard and cracked when dry. Below this occurs olive to olive-grey coloured heavy clay which is somewhat mottled in yellow and redish yellow. Large time concretions are sometimes found, usually below a depth of 1 to 2 ft from the ground surface. The soils are highly erodible and have very poor soil-moisture relationships.

(iii) Valley Soils

Valley soils develop in the lower parts located between both the deeply and closely dissected terrace areas. These soils are mainly of heavy clays with a few variations in somewhere. In the project area, three soil series, i.e. Karail, Khilgaon and Kalma, are recognized.

Karail soils occupy deeply broad valleys and consist of very dark grey coloured clays which often contain buried organic layers. The topsoils having the depth of 6 to 18 in are strongly iron-stained along root channels and cracks. Below this there occur two or more alternating layers of heavy clay coloured in dark grey to black. The soils are very slowly permeable and kept in wet throughout much or all the dry season.

Khilgaon soils appear in upper-valley or valley-edge sites in association with Karail soils. These soils are heavy clay in texture and dark grey in colour, but lack prominent clay layers containing buried organic matters. They become droughty and are sometimes cracked in the dry season.

Kalma soils occur narrow valleys in closely dissected terrace areas, which comprise silty soils coloured in grey and iron-stained along root channels. The topsoil cultivated has a colour of light grey when dry to dark grey when wet and a texture of silt loam to silty clay loam. Below this occurs very porous layer consisting of silty clay loam, usually changing to silty clay then clay below two to three feet, and being variably mottled in reddish yellow or brown. Therefore, these soils are very permeable below the puddled cultivated-layer and droughty in the dry season.

(iv) Flood Plain Soils

In some particularly broad valley areas, heavily clayey soils extend and are subject to deep flooding during the monsoon season. These soils are derived from old basin alluvium and represented by Kajla series in the project area.

Kajla soils are of dark-grey coloured heavy clays, of which topsoils when cultivated change to silty clay to clay in texture and have iron-stained mottles along root channels and cracks. Below this several feet of silty-clayey or clayey layer possess fine mottles coloured in yellow, brown or red and cracks into medium to small hardblocks on drying. Below a depth of 2 or 3 ft from the ground surface, a clayey or mucky layer coloured in black is often found. The soils are very slowly permeable and remain moist or saturated for a long time in the dry season.

(2) Old Brahmaputra Flood Plain

(i) Flood Plain Ridge Soils

Smoothed-out river levees, defined as the flood plain ridges, in the old Brahmaputra flood plain, consist of sandy or silty soils coloured in grey and are subject to seasonal flooding with the shallow to moderately deep depth. There appear five soils series, i.e. Tengar Char, Sonatala, Silmandi, Jalkundi and Godnail, in the project area.

Tengar Char soils occur on the highest flood plain ridges and are sandy soils coloured in grey. In cultivated ridge areas, topsoils consist of a few inches of fine sandy or silt loam iron-stained along root channels, which overly a compact layer of 3 to 6 in thick comprising fine sandy loam to clay loam finely mottled in yellow-brown. Below this compact layer occurs loose and sandy layer coloured in grey.

Sonatala soils extend over almost level to gently undulating areas on flood plain ridges. In general, soils are silty. The cultivated topsoils consist of silt loam with the dpeth of 6 in, the colour of light brownish grey when dry and olive grey when wet, and mottles iron-stained along root channels. The subsoil having the depth of 1 to 3 ft is of silt loam to silty clay loam which is very friable, coloured in olive to grey and finely mottled in brown and brownish yellow. This overlies stratified alluvium usually more sandy and greyer in colour. Sonatala soils are permeable and have good moisture retaining properties in the dry season except where they overlie sandy alluvium at a shallow depth.

Silmandi soils consist of loamy soils and extensively develop on flood plain ridges with almost level to gently undulating landscape. The cultivated topsoils are silt loam to silty clay loam in texture, light grey when dry

and olive-grey when wet in colour, about 6 in in depth, iron-stained along root channels, and make cracks in the dry season. Below these appears 1 to 3 ft in the loam with grey to olive-grey colour and fine mottles colouring in brown and yellow brown. This overlies strafified alluvium usually with the texture of silt loam. The soils are permeable and have good moisture holding properties during the dry season.

Jalkundi soils are of silty soils with dark grey topsoils and extensively develop over broadly low ridges. The depth of topsoils is about 6 in and their texture ranges from silt loam to silty clay loam. These are coloured in grey when dry and very dark grey when wet, and iron-stained along root channels. The subsoils are the same in texture as the topsoils and light grey in colour. These have fine mottles coloured in yellow-brown. Jalkundi soils are moderately permeable and retain aoil-moisture well during the dry season.

Godnail soils develop mainly in shallow depressions among the low ridges where the said Jalkundi soils occur. Thus, the topsoils have the depth of 12 in. Their texture varies from silt loam to silty clay loam and soil colour is grey in the dry and dark grey in the wet. Below these silty clay loam, which is light olive-grey in colour, is finely mottled in yellow and has dark-grey coatings along vertical cracks and in root channels. The soils are slowly permeable and remain wet during the early part of the dry season.

(ii) Basin Soils

In the old Brahmaputra flood plain, flat basin areas extend between flood plain ridges. Generally, soils of the basin comprise dark-grey coloured clays and are deeply flooded in every monsoon season. Within the project area, there are three soil series identified, i.e. Naraibag, Siddhirganj and Kajla.

Naraibag soils are popular in the basin sites. The topsoils consist of silty clay loam to clay, which is iron-stained along root channels and cracks, have the depth of about six inches and are coloured in grey when dry and dark grey when wet. Below this occurs about a foot of compact layer with the texture of silty clay to clay, the colour of dark grey, fine mottles coloured in yellow-brown. This layer cracks into blocks on drying and these blocks have dark grey coatings. Below about 18 in from the ground surface, the texture changes to silt loam to silty clay loam with dark-grey colour, fine mottles of yellow-brown and dark-grey coatings penetrating deeply along vertical cracks. Throughout the profile, the soils are slowly or very slowly permeable and droughty in the dry season.

Siddhirganj soils also extend over basin sites, especially in the southern part of the project area. The topsoils cultivated are of about 6 in of silty clay to clay coloured in grey when dry and in dark grey when wet, cracked widely when dry, and iron-stained along root channels and cracks. Below this occurs very heavy clay with dark-grey colour, yellow-brown mottlings, cracks and blocks when dry. Below about 2 to 3 ft from the ground surface, this heavy clay becomes lighter grey in colour and silt loam or silty clay loam in texture.

The soils throughout the profile are very slowly permeable and droughty in the dry season.

Kajla soils occupying only small areas within the project area comprise rather dark-grey coloured clays that are somewhat acid in the subsoil. These areas are deeply flooded so that the soils remain wet throughout all or most of the dry season.

(iii) Channels Soils

Over river channels which are the lowest part of the flood plain, two soil series, Barar Char and Gorargaon, are recognized in the project area.

Barar Char soils consist of sandy soils occurring abondoned river channels. Such topography causes very poorly drained condition throughout the profile and then the soils remain wet for all or most of the dry season. Their texture is sand, loamy sand or sandy loam. The colour of grey to dark grey changes to light grey if dry.

Gorargaon soils consist of clayey soils with very poor drainability and occupy abandoned river channels, small depressions in basins and the margins of some beels. The topsoils are of silty clay loam or silty clay coloured in grey to dark grey overlying silty clay or clay coloured in grey to dark grey. Sand is often found below one to three feet. These soils also remain wet throughout most of the dry season.

(3) Young Brahmaputra Flood Plain

(i) Flood Plain Ridge Soils

Among the young Brahmaputra flood plain, ridges show linear landscape in active areas of the flood plain and thus are subject to river erosion or burial by new alluvial deposits due to seasonal flooding. Ridges on the young meander part of the flood plain are less irregular in relief. The ridge soils are mostly grey and silty. In the project area, there are two soil series, i.e. Sonatala and Silmandi.

Sonatala Soils comprise overall pale olive-brown silt and occur on individual patches, usually small. The cultivated topsoil consists of about 6 in of silt loam or fine sandy loam coloured in light grey when dry and olive-grey when wet. Iron-staining occurs along root-channels. The subsoil consists of about a foot, or sometimes more, of olive

or olive-grey coloured silt loam, or occasionally find sandy loam. This has very friable structure and fine mottles coloured in brown or brownish yellow. This overlies stratified alluvium, usually of similar texture to the subsoil. The soils throughout the profile are permeable but retain moisture well in the dry season.

Silmandi soils are of mainly greyish brown coloured loam. The cultivated topsoil with the depth of about 6 in varies from silt loam to silty clay in texture. It is coloured in light grey when dry and olive-grey when wet, and iron-stained along root channels. The thickness of subsoil is 1 to 3 ft and the texture is silty clay loam or, occasionally, silty clay. This subsoil is coloured in grey to olive-grey and coated along vertical cracks. Below this occurs stratified alluvium, usually lighter in texture than the subsoil.

(ii) Basin Soils

The basin has a generally smooth relief among both the active and young meander flood plains. It soils are characterized by a mixture of fresh sandy and silty deposits most of which are coloured in grey. Only one soil series, Sabhar Bazar is identified in the project area.

Sabhar Bazar soils develop extensively on the young meander flood plain and locally on the active flood plain. The topsoil consists of about 6 in of silty clay loam to silty clay, of which colour is light grey when dry and olive-grey when wet, iron-staining along root channels and cracks. The subsoil is rather compact layer consisting of silty clay to clay which is coloured in grey, finely mottled in brown and cracked into blocks on drying. The soils usually become lighter in texture below about 15 to 30 in from the ground surface. They are slowly permeable and moderately retentive of moisture in the dry season.

8.2.5 Soil Association Description

In the Madhupur tract, the area of deeply dissected terrace with local alluvium in valleys is occupied by Tejgaon-Khilgaon association (closely dissected phase) which has deep upland soils. Both the associations of Naraibag-Payati-Sayek and Naraibag-Payati, having also deep upland soils, occur in the area of mixed closely dissected terrace and flood plain. On such area consisting of shallow upland soils as mixed closely dissected terrace and flood plain, Sabhar Bazar-Gerua association develops.

In the old Brahmaputra flood plain, Sonatala-Silmandi and Silmandi-Sonatala associations extend on flood plain ridges defined as smoothed-out river levees. The basin part of the flood plain is occupied by Naraibag-Siddhirganj association. On the areas where the landscape comprises mixtures of ridges, basins and old river channels, two associations, Naraibag-Sonatala and Naraibag-Jalkundi, are recognized.

In the young Brahmaputra flood plain, Sabhar Bazar-Sonatala-Silmandi association extends over the landscape of young meander flood plain.

Table 8-1 presents the summary of descriptions on each soil association identified within the project area. These individual soil associations are shown as mapping unit on the soil map attached to this report.

8.3 Agricultural Development Potential

8.3.1 Effect of Water Control

Over the project area, at present, crop yields are often reduced to some extent or totally due to drought, abnormal floods or, in some cases, poor drainage. Flooding, especially deep flooding, severely restricts the kinds of crops that can be grown. On the other hand, most soils meet the shortage of water in the dry season. Flood protection, drainage and irrigation, therefore, could greatly benefit agricultural production in most parts of the project area by extending the range of crops that could be grown, increasing the intensity of cropping, increasing individual crop yields and making crop production more certain.

In the project area, flood protection will need to construct embnakments aiming at prevention of flood water intrusion and to provide drainage pump for the evacuation of excess rain-water from inside areas within the embankments. The capital and operating costs of such improvements will be high, taking into account the enormous amounts of rain water to be pumped out at peak time of the monsoon season, and the minor difference of water level between river and standing rain waters in basin area. It will only be feasible and economic to carry out such improvements, therefore, where they can be paid for by increment of agricultural production from the protected land.

From the viewpoint of topography, it can be said that, the greatest benefit from flood protection and evacuation of rain water could be obtained on the land, presently subject to shallow or moderately deep inundation and possibly being improved completely. More deeply flooded land, especially basins, could probably not be protected completely from inundation. However, reduction of inundated water levels might be make it possible to grow high-yielding paddies in Aus and Aman seasons as well as jute in place of the present low-yielding Broadcasted Aman paddy during the monsoon season.

Though the project area would become simplest to protect flood water and drain excess rain-water in the monsoon season after the construction of new embankment and drainage pump stations along the Sitalakhya River, the provision of such facilities by itself may well not be economic, because it can meet only half of the requirement for the year-round water control which secures the enormous increment of agricultural production. To meet the remaining half, therefore, irrigation development become necessary for proper water supply in the dry season. Irrigation is needed not only to make winter crop production possible but also, equally important, as a safeguard against droughts in April-May and October-November which hamper production of Aus paddy and jute in the first case and that of Transplanted Aman paddy in the second.

Accordingly, in the project area, water control and irrigation should be regarded as complementary requirements for the full realization of agricultural development potentials. From the above viewpoint, large-scale irrigation development might be a more effective means in the project area, although small-scale irrigation development without any drainage improvement, especially by using low-lift pumps, has recently been strengthened through the Government as shown in the following table.

Potential of Small-Scale Irrigation Development

	Gross Potential Area (Acre)	Area Developed (Acre)	Possible Area (Acre)
Project Area	10,400	4,200	6,200
Adjacent Area	2,400	1,600	800
Total	12,800	5,800	7,000

8.3.2 Soil Fertility

Crop production in the project area have been maintained for a long time by "natural soil fertility" supplied as plant nutrients from soils. Crop yields, however, are generally moderate or low, because, usually, the soil fertility is quantitatively or qualitatively not sufficient to meet the nutrient requirement of each crop.

The individual soils of the project area vary widely in their natural fertility. In general, the fertility of most Madhupur tract soils ranges from moderate to low. Flood plain soils, except sandy ones, are relatively more fertile. Most of flood plain areas, particularly the old Brahmaputra flood plain, are not flooded by river-water but by rain-water, and their soils show no evidence of receiving significant amounts of new alluvium each year or even over a long period of years. This fact means that the relative fertility of most flood plain soils is apparently due to release of mineral nutrients from the weathering of parent materials. Anyway, whatever crop obtains nutrient benefit from flood water and any silt as is popularly believed, the benefits to be derived from flood protection and irrigation by far outweigh any possible losses due to cutting off of silt supplied.

8.3.3 Soil Management

Almost all of the flood plain soils and most of cultivated terrace soils are featured by the presence of a conspicuous plough-pan at a depth of a few inches below the ground surface. This plough-pan has been developed by repeated tillage and puddling of the soils, usually carring out as many as 8 to 12 continuous ploughings together with harrowing for land preparation before planting of rice or jute.

This pan may be favourable for paddy cultivation, especially for Transplanted Aman crop, since it assists in keeping the soil submerged. However, it would probably be beneficial to make this pan a few inches deeper than the present so as to provide more effective depth of soil for easy root-development.

As for dry-land crops, it would be desirable to break up this pan periodically by deep cultivation in order to avoid serious impediment of root penetration and also damage caused by surface water-logging under irrigated condition.

Most topsoils have low content of organic matter and become hard when dry. In this case, implement by traditional country plough is insufficient for a satisfactory tilth, especially when drawn by the poor draught animals, and considerable man-power is required for such land preparatory works.

For the increase in the effective soil depth, it is recommended to extend such farming practice as deeper ploughing by using improved ploughs drawn by stronger draught animals than at present or powered machinery incorporation with ploughing-in of organic matter into soils and adopting of pre-irrigation method at the time of land preparation.

8.3.4 Development Potentials

The following terms indicate definitions and descriptions of cropping systems and farming practices.

Perennial dry-land crops: sugarcane, bananas and fruit trees such as jackfruit, mango and citrus

Annual dry-land crops: wheat, barley, millet, leguminous pulse and fodder crops, mustard, tobacco, vegetables, etc.

Wet-land crops: rice and jute

Crop production throughout the year: Production of one crop, or a rotation of two or more crops, which occupies the land for all or nearly all of the year, any remaining part of the year being required for land preparation. Crop possibilities include either perennial or annual dry-land crops or one or more wet-land crops with or without a dry-land crop in addition.

Traditional management: Use of local seed and the traditional country plough where applicable, a low level of manuring and absence of large-scale water control (flood protection, drainage and/or irrigation).

Modern management: Use of a modern steel plough where applicable, use of selected seed and adequate amounts of fertilizers, as well as plant protection and soil conservation practices where necessary.

(1) Madhupur Tract

(i) Deep Upland Soils

Both Belabo and Tejgaon soils are well suited to a wide range of crops. With good management, and moderate expenditure on irrigation and subsoil drainage, they could produce high yields of annual or perennial crops throughout the year. Alternatively, with puddling of the topsoil and irrigation as well as good management, they could produce one or two crops of paddy in the monsoon season in addition to dry-land crops in the dry season, with high yields obtainable from all crops. With intensive management, they could produce vegetables throughout the year.

Sayek soils have a limitation for agricultural development potentials due to their patchy occurrence, irregular relief and sometimes steep slopes.

Payati soils are also restricted in their agricultural value by their occurrence in narrow valley-edge strips or on isolated hillocks.

(ii) Shallow Upland Soils

Demra soils are not well suited to dry-land crops due to slow permeability and poor moisture retention. In the area where flooding is shallow, irrigation would make rice cultivation possible throughout the year. In the area

being subject to deep flooding, on the other hand, expensive flood protection and pump drainage would be required, together with dry-season irrigation, to make high-yielding rice production possible throughout the year.

Gerua soils are mainly poorly suited for intensive agriculture development. A few areas of deeper soils on gentle topography could be used for planting of annual dry-land crops. They would need careful protection against erosion, and irrigation might have to be by overhead methods.

Bhatpara soils are very poorly suited to agricultural use. They are best left under grassland. Pasturage could be considerably improved by better management, including rotational grazing and use of fertilizers, if desirable.

(iii) Valley Soils

Karail soils are well suited to Broadcasted Aman paddy cultivation. With dry-season irrigation, they are well suited to Boro paddy cultivation. They are poorly suited to the cultivation of other crops, especially dry-land crops, with or without food protection.

Khilgaon soils are well suited to Broadcasted Aman paddy cultivation. With dry-season irrigation, provision of funds and a small amount of land levelling, they would be suitable for Boro cultivation. They are more poorly suited to the cultivation of other crops than Karail soils.

Kalma soils are well suited to Transplanted or Broadcasted Aman paddy cultivation according to flooding depth, but are moderately to poorly suited for Aus paddy. They are poorly suited to the cultivation of Boro paddy and dry-land crops without irrigation. With irrigation and good management, good yields of dry-land crops could be obtained in the dry season and also of Aus paddy and jute in the early wet season on the less deeply flooded sites. Boro paddy cultivation would require unduly heavy water consumption on these soils.

(iv) Flood Plain Soils

Kajla soils are well suited to Broadcasted Aman or Boro paddy cultivation, but poorly suited or unsuited dry-land crops.

(2) Old Brahmaputra Flood Plain

(i) Flood Plain Ridge Soils

Tengar Char soils are moderately to poorly suited for dry-land crops and poorly suited for wet-land crops. With intensive management, the soils on higher places could produce moderate to good yields of annual and prennial dry-land throughout the year.

Sonatala soils have a wide range of suitability for dry-land and wet-land crops. Except on the highest sites, they are well suited to cultivation of Aus and Transplated Aman paddies as well as jute during the wet season followed by pulses, fodder crops, vegetables and oilseeds during the dry season. On the highest sites, sugarcane and bananas are important crops, although yields are low. With good management and dry-season irrigation, very high yields could be excepted from all these crops. With flood protection in addition, high-yielding dry-land crops could be grown throughout the year on all sites.

Silmandi soils have a wide range of crop suitabilities. They are well suited to cultivation of Aus and Broadcasted Aman paddies as well as jute during the wet season and dry-land fodder crops, pulses and oilseeds during the dry season. With irrigation and good management, very high yields would be expected from these crops together with other dry-land crops during the dry season. With flood protection and dry-season irrigation, annual and perennial dry-land crops could be grown on the higher sites throughout the year, alternatively, one or two wet-land crops could be grown in the wet season and one or two dry-land crops grown in the dry and pre-monsoon seasons.

Jlakundi soils, without irrigation and flood protection, are well suited to growing Broadcasted Aman paddy followed by dry-land crops during the dry season. With good management and moderate expenditure on dry-season irrigation, very good dry-land crops could be grown in the dry season as well as Aus paddy and jute on the least deeply flooded sites. With flood protection and pump drainage in addition, which might be expensive to provide, a wide range of high yielding dry-land crops could be grown, including sugarcane on the highest sites, although Aus and Transplanted Aman paddies as well as jute would remain most suitable for general cultivation during the monsoon season.

Godnail soils, without irrigation and flood protection, are only well suited to Broadcasted Aman paddy cultivation. With dry-season drainage, they could in addition produce good dry-land crops. With irrigation in the dry season as well, they could produce very high yields of the dry-land crops, alternatively, Boro paddy could be grown. With complete water control, which would be very expensive to provide, a wide range of dry-land crops in the dry season could be grown together with wet-land crops in the monsoon season.

(ii) Basin Soils

Naraibag soils are well suited to Broadcasted Aman paddy cultivation but poorly suited for other crops without irrigation and drainage. With irrigation, the soils would be very good for Boro paddy and moderately good for dry-land crops both in the dry season. With expensive flood protection and drainage in addition, conditions would be very good for paddy cultivation throughout the year, moderately good for dry-land crops during the dry season, but poor or unsuitable for dry-land crops during the monsoon season.

Siddhirganj soils are well suited to Broadcasted Aman paddy cultivation but poorly suited or unsuited for all other

crops without irrigation or drainage. With irrigation, they would be well suited to Boro paddy cultivation, but poorly suited for all other dry-land crops in the dry season. Drainage would be very difficult and expensive to provide to these basin soils.

Kajla soils have very poor potentials for intensive agricultural development due to their location at the lowest sites within the basin resulting in the most expensive investments to be required for the drainage improvement.

(iii) Channel Soils

Barar Char soils are well suited to paddy cultivation throughout the year but poorly suited or unsuited to dry-land crops for all or most of the year. Irrigation may be needed in some areas for Boro paddy cultivation. With intensive management and controlled drainage, dry-land crops such as vegetables and tobacco could given high yields on some sites in the dry season.

Gorargaon soils are well suited to wet-land crops throughout the year but poorly suited or unsuited to dry-land crops. Irrigation would be needed in some areas for Boro paddy cultivation.

(3) Young Brahmaputra Flood Plain

(i) Flood Plain Ridge Soils

Sonatala soils grow a wide range of dry-land and wet-land crops. They are well suited to Aus and Aman (mainly Broadcast) paddy as well as jute in the wet season and pulses, vegetables and potatoes in the dry season. With flood protection and pump drainage of the areas, these soils would be well suited to sugarcane, bananas and other dry-land crops as well as to jute and Transplanted Aman paddy. This improvement, however, may not always be feasible.

Silmandi soils have a wide range of agricultural development potentialities. They are well suited to Aus and Broadcasted Aman paddy as well as jute and dry-land crops. With good management, very high yields from these crops could be expected. Flood protection and drainage would be difficult to provide to most of this area, but, where undertaken, Transplanted Aman paddy could be grown instead of Broadcasted Aman paddy and a wider range of dry-land crops could be grown, including sugarcane and bananas.

(ii) Basin Soils

Sbhar Bazar soils are well suited to rice cultivation, moderately well suited to jute and dry-land crops grown in winter and unsuited to perennial crops. With dry-season irrigation, high yields of Boro paddy or annual dry-land crops would be possible with good management. With flood protection in addition, two good wet-land crops and one good dry-land crop could be produced in a year.

8.4 Land Classification

(1) Classification Criteria

The classification criteria outlined below was established by the Soil Survey Project Team of East Pakistan adding modifications to the U.S. Soil Conservation Service Classification taking into consideration local conditions of natural environment.

Land Capability Class, the first level and broadest grouping, consists of five classes comprising Class I (very good agricultural land) to Class V (non-agricultural land). Class I land has least limitations for crop production throughout the year and a relatively wide range of agricultural use. Classes II to V have increasingly severe limitations for crop production, Class V is considered unfit for economic agricultural use.

Land Capability Subclass, the second level grouping, is of two subclasses D and W. Subclass D includes soils extending over areas situated above normal flood level and Subclass W indicates soils subject to flooding for part or all of the year.

In addition, within the major subclasses above-mentioned, the following ordinary subclasses are differentiated, where required, according to the dominant limitation, other than flooding, which affects agricultural use of the soils.

d : soils restricted in use due to droughtiness in the dry season.

e : soils restricted in use due to erosion hazard.

r : soils having irregular relief restricting irrigation, drainage or tillage.

w : soils restricted in use due to excess water (in the dry season in major subclass W soils, in the rainy season in major subclass D soils).

x : fresh alluvium or young alluvial soils restricted in use due to poor physical condition, barrenness or susceptibility to river erosion or burial by fresh alluvial deposits.

(2) Land Capability Classification by Soil Series

In accordance with the above-mentioned classification criteria, each soil series is classified as shown in Table 8-2.

(3) Land Capability Associations

Land capability associations comprise one or more land capability classes and subclasses occurring side by side in the landscape in defined proportions.

There are seven land capability associations identified within the project area as illustrated on the land capability association map attached to this report. These associations are also listed up in Table 8-3 with their extent and the soil associations included within them as well as summary of their agricultural development possibilities.

A summary of agricultural development possibility of each land capability association is presented in the following paragraphs.

A-1 : The area of seasonally flooded ridges and basins classified into "mainly good and very good agricultural land" is well suited for irrigation and pump drainage: sugarcane, bananas, cereals and oilseeds on ridges and two transplanted rice crops in depressions.

B-4 : The area of seasonally shallowly flooded ridges and basins classified into "good and moderate agricultural land" is as A-1, but more land suitable for two transplanted rice crops per year.

B-6 : The area of mainly seasonally flooded ridges and basins with some moderate or poor land on hillocks classified into "good and moderate agricultural land" is well suited

for irrigation of dry-land crops on ridges and Boro paddy in basins during the dry season. Pump drainage probably more costly than A-1, but pump irrigation from rivers easier. Where feasible, opportunities of suitability for two transplanted rice crops similar to B-4.

C-8 : The area of mainly closely dissected highland with deep soils, with seasonally flooded valleys classified into "mainly moderate agricultural land" is well suited for irrigation of sugarcane, oilseeds and cereals on highland and suitable for one or two transplanted rice crops per year in part highland and part valley, but irrigation of highland mainly by small tube-wells.

C-9 : The area of seasonally deeply flooded ridges and basins, dry in the dry season classified into "mainly moderate agricultural land" is well suited for irrigation of dry-land crops on ridges and Boro paddy in basins during the dry season. Pump drainage probably more costly than A-1.

D-17: The area of complex of hillocks and seasonably deeply flooded land classified into "poor and moderate agricultural land" is well suited for irrigated Boro rice where clayey soils developed.

D-18: The area of seasonally deeply flooded land, droughty in the dry season classified into "poor and moderate agricultural land" is well suited for irrigated Boro rice. Two transplanted rice crops could be grown in parts of Naraibag-Siddhirganj soil association with costly pump drainage.

Table B-1 Summary of Soil Association Descriptions

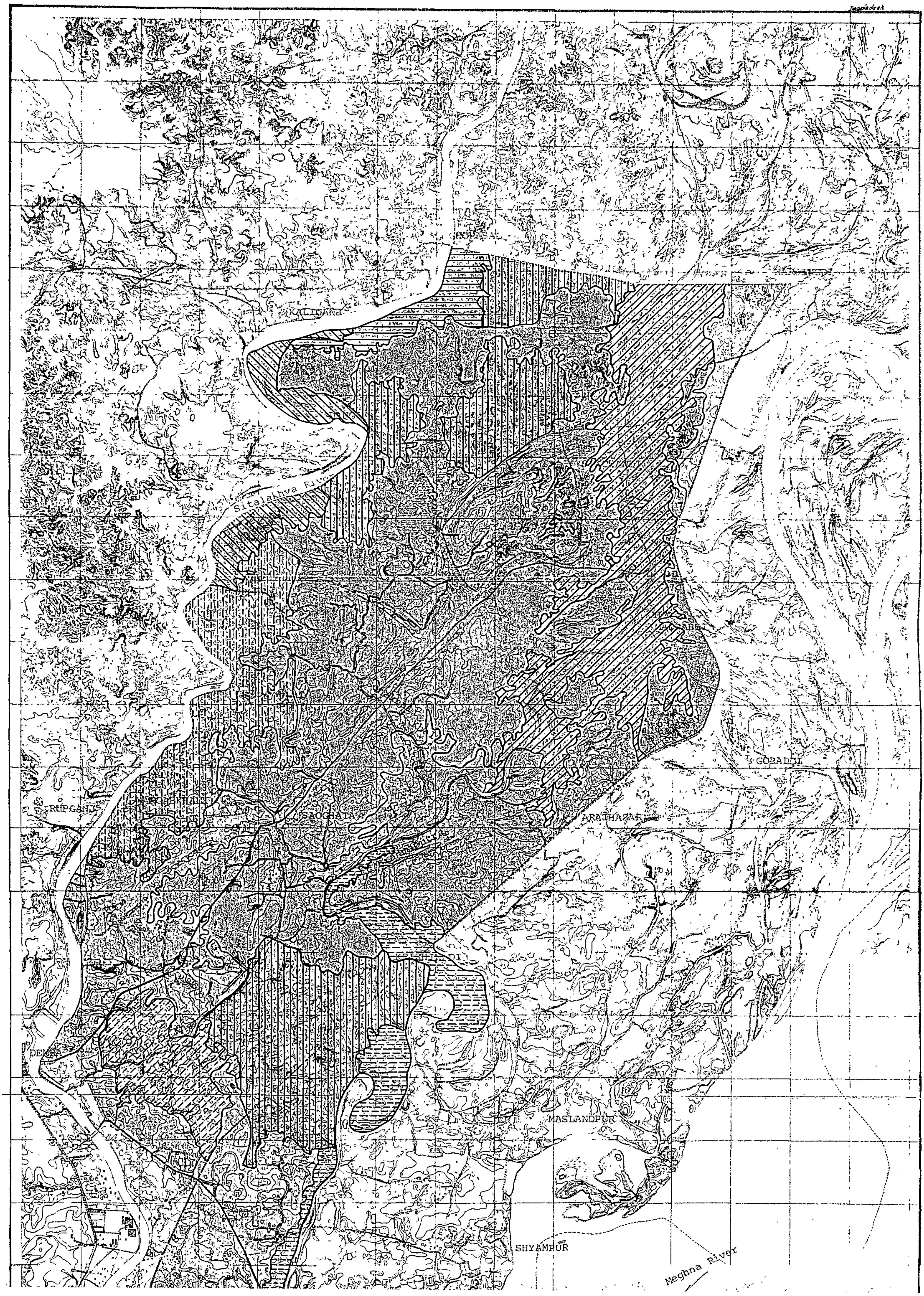
Soil Association	Name of Thana Included	Acreage and proportion				Soil Series Included
		Project (Arce)	Area (%)	Adjacent (Arce)	Area (%)	
Tejgaon-Khilgaon, Closely Dissected Phase	Narsingdi, Rupganj, Baidya Bazar, Narayanganj	8,400	11.7	2,300	20.2	Belabo, Tejgaon, Sayek, Payati, Gerua, Karail, Khilagon, Kalma
Naraibag-Payati-Sayek	Rupganj	4,900	6.8	-	-	Tejgaon, Sayek, Payati, Kajla, Sonatala, Silmandi, Naraibag, Siddhirganj
Naraibag-Payati	Rupganj, Baidya Bazar, Narayanganj	2,400	3.4	-	-	Payati, Silmandi, Jalkundi, Naraibag
Sabhar Bazar-Gerua	Narsingdi, Rupganj	1,200	1.7	-	-	Gerua, Bhatpara, Sonatala, Sabhar Bazar
Sonatala-Silmandi	Narsingdi, Araihazar	8,200	11.4	-	-	Tengar Char, Sonatala, Silmandi, Naraibag, Siddhirganj, Barar Char, Gorargaon
Silmandi-Sonatala	Araihazar, Baidya Bazar	800	1.1	2,100	18.4	Sonatala, Silmandi, Naraibag
Naraibag-Siddhirganj	Narsingdi, Araihazar, Rupganj, Baidya Bazar	27,600	38.6	-	-	Sayek, Payati, Sonatala, Silmandi, Naraibag, Siddhirganj, Kajla
Naraibag-Sonatala	Narsingdi, Araihazar, Baidya Bazar	9,700	13.5	-	-	Sonatala, Silmandi, Naraibag, Siddhirganj, Barar Char, Gorargaon
Naraibag-Jalkundi	Rupganj, Baidya Bazar, Narayanganj	6,700	9.4	7,000	61.4	Sayek, Payati, Demra, Sonatala, Silmandi, Jalkundi, Godnail, Naraibag, Siddhirganj
Sabbar Bazar-Sonatala -Silmandi	Rupganj	1,700	2.4	-	-	Naraibag, Gorargaon, Sonatala, Silmandi, Sabhar Bazar
TOTAL		71,600		11,400		

Table 8-2 Land Capability Classification by Soil Series

Wet-Land Soils	Dry-Land Soils
Class I: Very Good Agricultural Land	
Subclass IW; Silmandi and Sonatala, Very Shallowly Flooded Sites	
Class II: Good Agricultural Land	
Subclass IIW; Silmandi and Sonatala, Deeply Flooded Sites	Subclass IIDw; Belabo Sonatala, Highest Site
Class III: Moderate Agricultural Land	
Subclass IIWd; Demra, Shallowly Flooded Sites Kalma, Naraibag, Jalkundi and Sabhar Bazar	Subclass IIIDw; Tengar Char, Highest Sites
Sonatala and Silmandi, Shallow Over Sand	Subclass IIIDr; Tejgaon, Small Hillocks Sayek, Highland Gerua, Deep
Subclass IIIWw; Godnail and Sonatala, Active Flood Plain	
Class IV: Poor Agricultural Land Subclass IVWd; Demra, Deeply Flooded Khilgaon, Tengar Char, and Siddhirganj	Subclass IVDe; Tejgaon, Steep Terrace Edges Gerua, Moderately Deep
Subclass IVWw; Kharail, Kajla, Barar Char and Gorargaon	
Subclass IVWr; Sayek, Flooded Payati	
Class V: Very Poor and Non- Agricultural Land	Subclass VDe; Bhatpara Gerua, Very Shallow

Table 8-3 Land Capability Associations

Land Capability Association	Acreage and Proportion				Soil Association Included
	Project (Acre)	Area (%)	Adjacent (Acre)	Area (%)	
A. Mainly Good And Very Good Agricultural Land					
1. Seasonally Flooded Ridges and Besins	9,900	13.8	-	-	.Sonatala-Silmandi Bazar- .Sonatala-Silmandi
B. Good and Moderate Agricultural Land					
4. Seasonally Shallowly Flooded Ridges and Basins	10,500	14.6	2,100	18.4	.Silmandi-Sonatala .Naraibag-Sonatala
6. Mainly Seasonally Flooded Ridges and Basins with Some Moderate or Poor Land on Hillocks	1,200	1.7	-	-	.Sabhar Bazar-Gerua
C. Mainly Moderate Agricultural Land					
8. Mainly Closely Dissected Highland with Deep Soils, with Seasonally Flooded Valleys	8,400	11.7	2,300	20.2	.Tejgaon-Khilgaon, Closely Dissected Phase
9. Seasonally Deeply Flooded Ridges and Basins, Dry in the Dry Season	6,700	9.4	7,000	61.4	.Naraibag-Jalkundi
D. Poor and Moderate Agricultural Land					
17. Complex of Hillocks and Seasonally Deeply Flooded Land	7,300	10.2	-	-	.Naraibag-Payati-Sayek .Naraibag-Payati
18. Seasonally Deeply Flooded Land, Droughty in the Dry Season	27,600	38.6	-	-	.Naraibag-Siddhirganj
T O T A L	71,600		11,400		


Sitalakhya River
KALIGANJ
RUPGANJ
SAOGHATA
ARAIHAZAR
GOPALDI
DEMRA
MASLANDPUR
SHYAMPUR
Meghna River

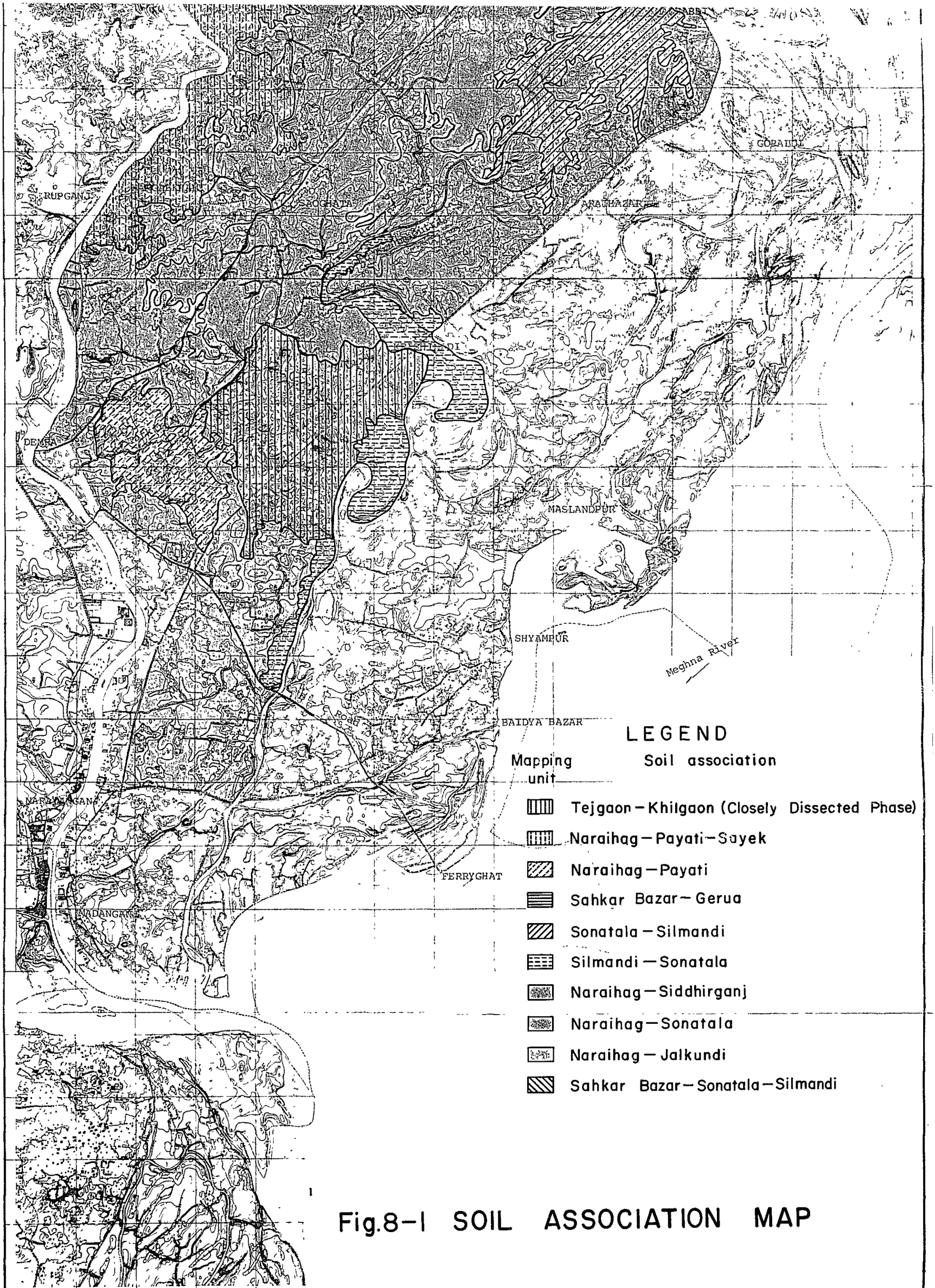
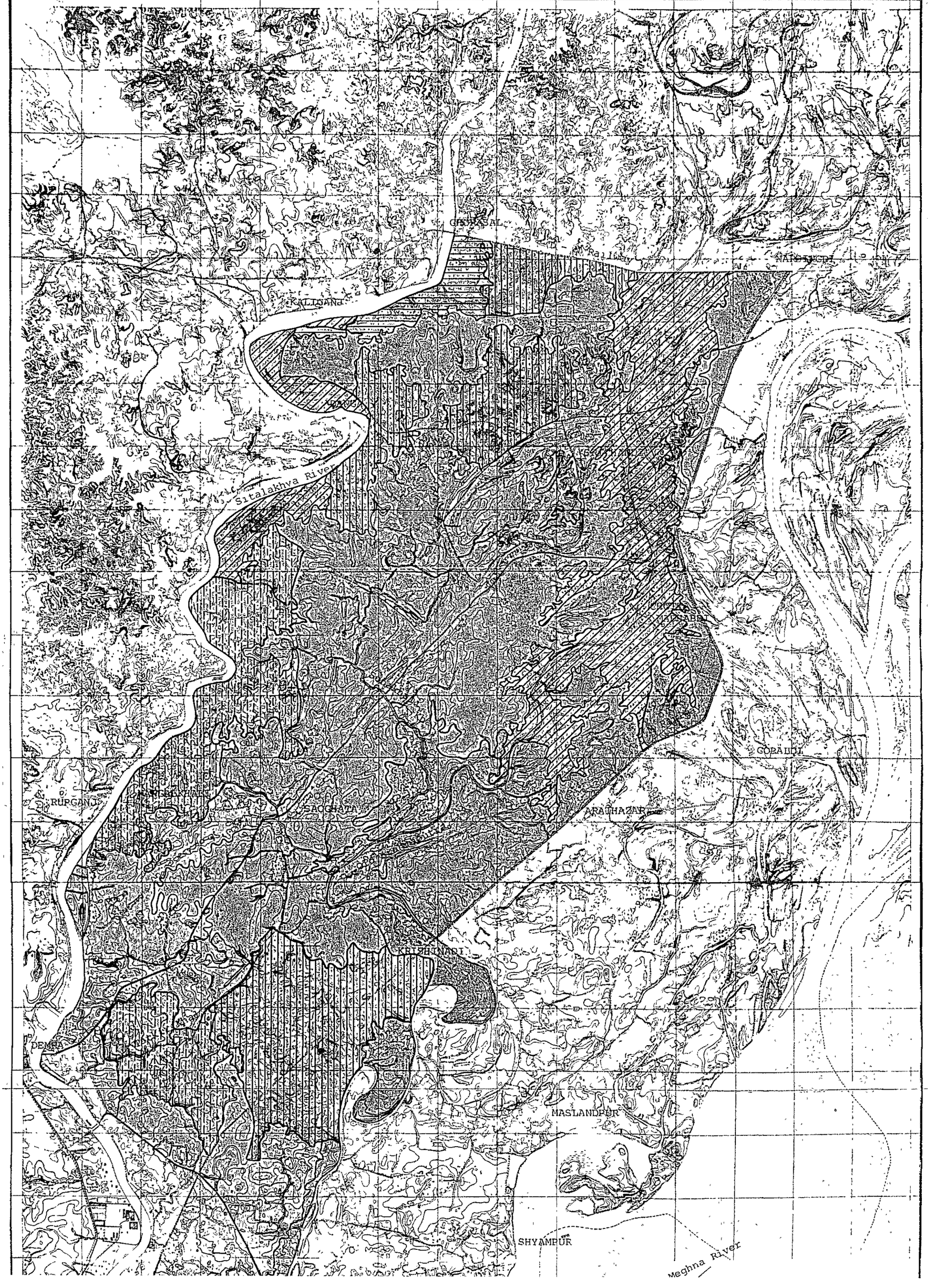


Fig.8-1 SOIL ASSOCIATION MAP


GOPALGANJ
Railway
KALIGANJ
Sitalakhya River
RUPGANJ
SAGHATA
ARAIHAZAR
GOPALDI
KESHINADI
DEMRA
MASLANDPUR
SHYAMPUR
Meghna River

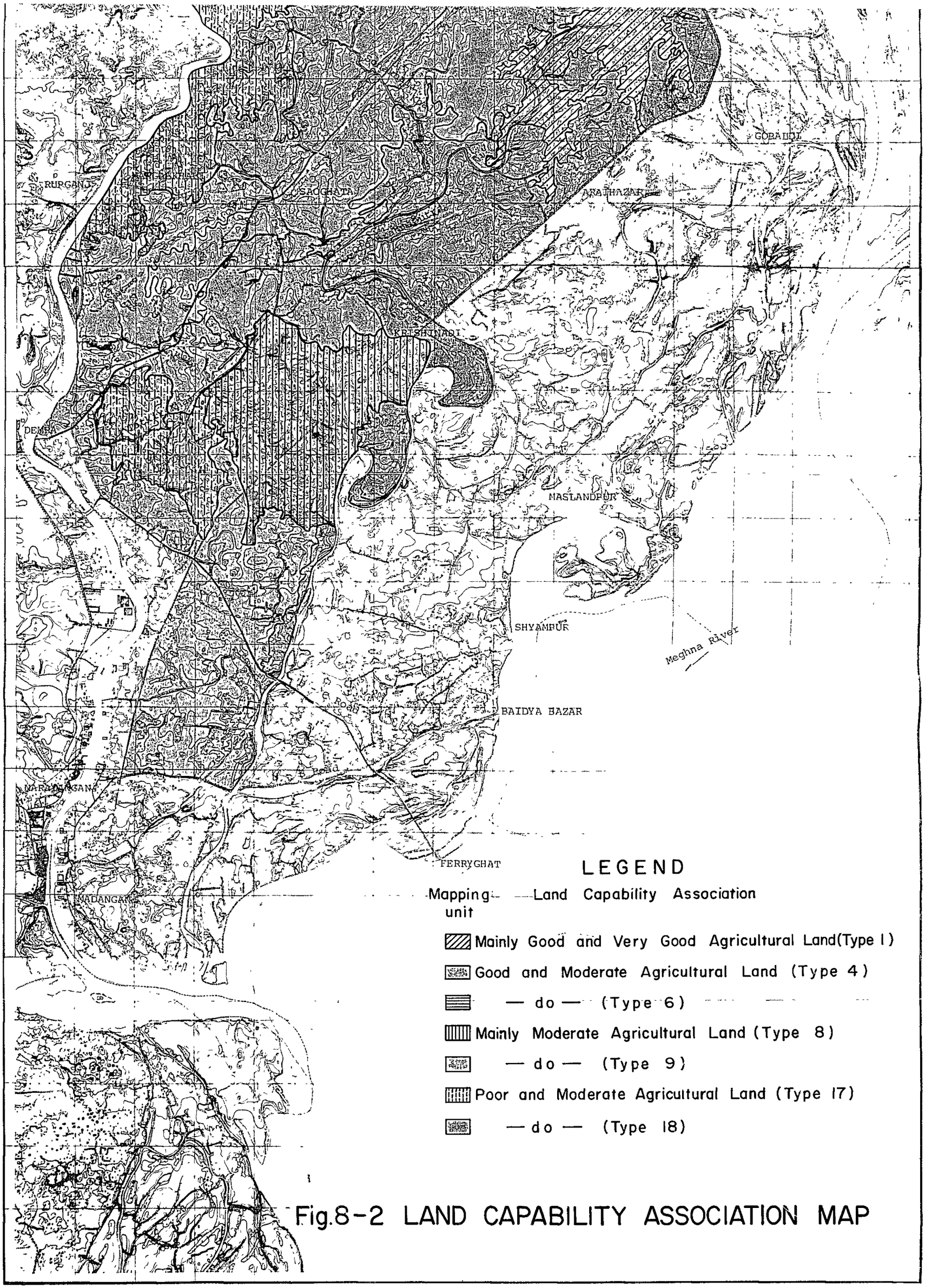


Fig.8-2 LAND CAPABILITY ASSOCIATION MAP