ANNEX G4-IB: ENGINEERING ANNEX OF SUBPROJECTS
(For CAD Subprojects)

[This document, a part of the Guidelines for SSWR Development, will contain hydrological and hydraulic data and analysis for Feasibility Study of a SSWRD Subproject (CAD) and form the Engineering Annex of the FS Report]

Appendix G4-IB.A
Data, Layout and Preliminary Design of CAD Subproject

A1 General Subproject Information

Subproject Name			**Type**
Location		**Subproject Area:**	
Zone		Gross	ha
District		Net	ha
Upazila			
Union:			
Subproject Processing Dates			**Comments**
Proposal received in IWRMU			
Pre-screening			
Field reconnaissance			
PRA			
Name of PRA Firm/NGO	Date of Assigning Work: Field Work: Date Start: End: PRA Report Completed (date):		
Feasibility Study			
Name of FSDD Firm			Assign Date:
Data Collection			
Multidisciplinary Field Visit Period	Start Date:		End Date:
Concept Report	Submitted:		Finalized:
Detail Data Collection			
- *Socio-Economic*	Date From:		Date To:
- *Agricultural*	Date From:		Date To:
- *Fisheries*	Date From:		Date To:
- *Environmental*	Date From:		Date To:
- *Engineering Survey*	Date From:		Date To:
Feasibility Analysis			
Feasibility Report - Draft	Submitted		Reviewed
Feasibility Report – Final Draft	Submitted		Reviewed
Planning Discussion Meeting	Date Held		Place
Feasibility Report	Submitted		Approved
Clearances			
DLIAPEC Clearance	Date Obtained		
Environmental Clearance	Date Submitted		
Detail Engineering Design			
Detail Design of Works - Draft	Submitted		Reviewed
Design Discussion Meeting	Date Held		Place
Detail Design of Works - Final	Submitted		Approved
LA Plan and BOQ			
Preparation of LA Plan	Date Form		Date To
Preparation of Detail BOQ	Date Form		Date To
Preparation of Bid Documents	Date Form		Date To
Comments:			

A2 Average Monthly Climate & Rainfall Data
(Subproject data same as this reference District)

[This is an example District data. FS Consultants will select applicable reference District and provide that District data here. Refer to G4 Feasibility Study of Subprojects, Subsection-3.2.5]

Barisal								
Month	**Rainfall**			**Min Temp ^{0}C**	**Max Temp ^{0}C**	**Humidity %**	**Wind km/day**	**Sunshine hours**
	Average	**Dry**	**Wet**					
Jan.	3.8	3.3	4.3	11.8	25.5	79	74	8.1
Feb.	22.3	19.2	25.1	14.9	28.3	76	81	8.1
Mar.	47.5	40.9	53.4	20.1	31.3	75	103	8.3
Apr.	94.4	81.2	106.0	23.6	32.3	80	158	8.2
May	221.3	190.2	248.5	24.7	33.0	83	173	6.8
Jun.	429.7	369.4	482.5	25.6	31.6	88	163	4.3
Jul.	421.9	362.7	473.8	25.5	30.9	90	148	4.2
Aug.	356.4	306.4	400.2	25.6	31.0	89	133	4.5
Sep.	293.9	252.6	330.0	25.3	30.5	88	111	5.2
Oct.	183.7	158.0	206.3	23.6	31.5	86	70	7.2
Nov.	39.5	34.0	44.4	18.9	29.5	83	68	7.9
Dec.	5.9	5.0	6.6	13.4	26.5	80	76	8.0
Average	2,120	1,823	2,381	21.1	30.2	83	113	6.7

A3 Crop Water & Irrigation Water Requirements and Design Duties *(Subproject data same as this reference District data)*

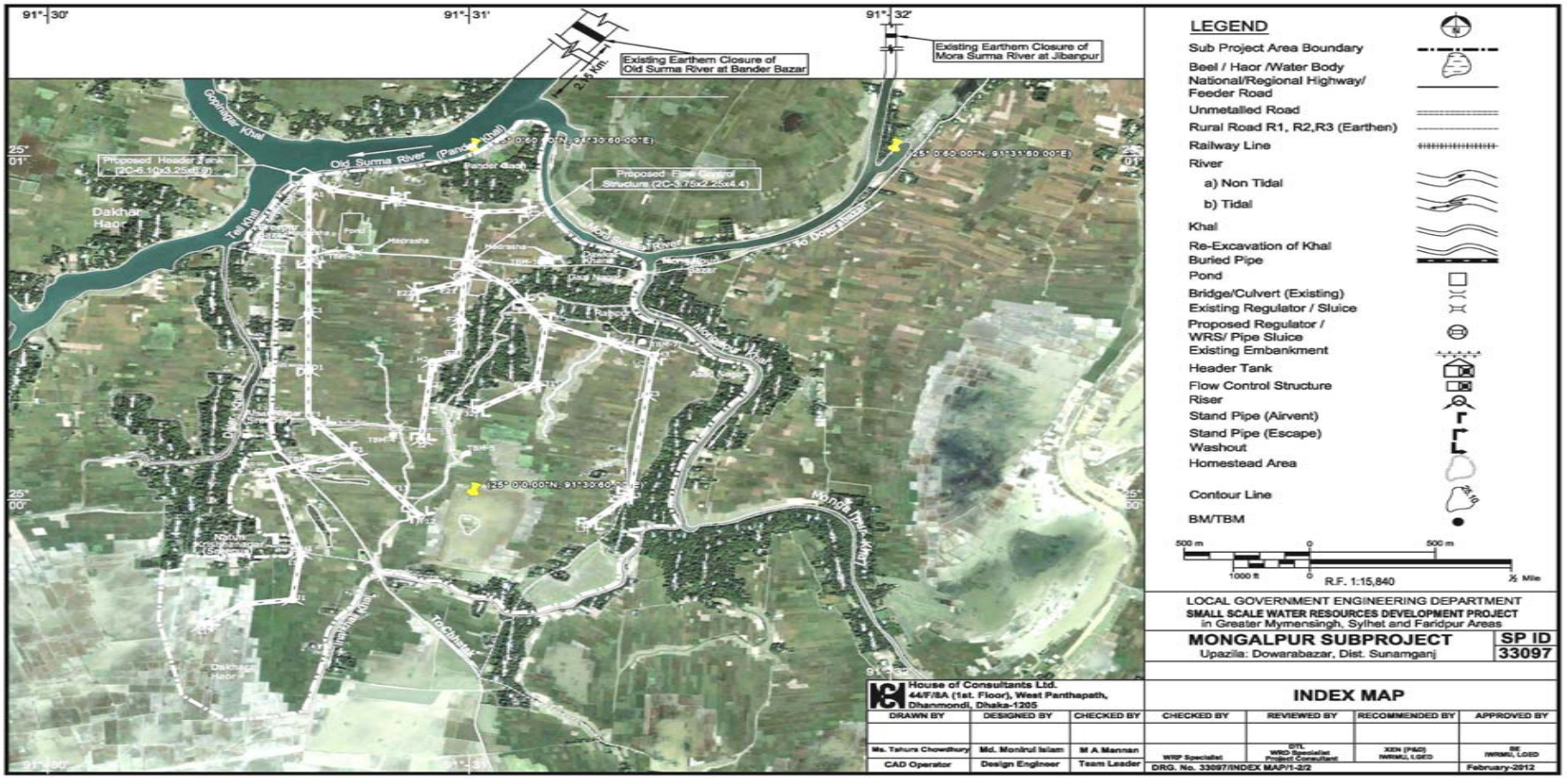
Barisal *[This is example District. Consultants will select applicable District and provide that District data here. Refer G4 Feasibility Study of Subprojects, Subsection-3.2.5]*

Description	Units	100% Rice: Early Planting (Dec to Feb)	100% Rice: Late Planting (Jan to Feb)	100% Vegetables	100% Pulses	10% Vegetables; 10% Pulses & 80% Rice	20% Vegetables; 20% Pulses & 60% Rice
Net irrigation requirements incl. land preparation & effective rainfall							
Nov	mm/month	0	0	0	0	0	0
Dec	mm/month	121	18	0	0	14	11
Jan	mm/month	**164**	**162**	54	32	138	114
Feb	mm/month	80	128	65	66	116	103
March	mm/month	108	105	**88**	**102**	103	101
April	mm/month	78	89	12	25	75	61
May	mm/month	8	18	0	0	14	11
Totals	**mm**	**559**	**520**	**219**	**225**	**460**	**401**
Peak net duty (based on peak month)	mm/d	5.29	5.23	2.84	3.29	4.79	4.36
	l/s/ha	0.61	0.60	0.33	0.38	0.55	0.50
Peak net duty (based on peak 3-month period)	mm/d	4.06	4.39	2.30	2.22	3.96	3.54
	l/s/ha	0.47	0.51	0.27	0.26	0.46	0.41
ratio duties 3-months / 1 month		0.77	0.84	0.81	0.68	0.83	0.81
Efficiencies, Duties & Water Requirements							
At Field boundary							
Field irrigation efficiency (weighted)	%	65%	65%	55%	55%	63%	61%
Peak field irrigation duty (based on 3 month period)	mm/d	6.2	6.8	4.2	4.0	6.3	5.8
	l/s/ha	0.72	0.78	0.48	0.47	0.73	0.67
Total water requirement at field level	**mm**	**860**	**800**	**398**	**409**	**731**	**657**
At Pumping Point at Head of System							
Conveyance efficiency (pipe outlet to field	%	80%	80%	80%	80%	80%	80%
Peak duty for at pipe outlet (based on 3 month period)	mm/d	7.8	8.4	5.2	5.1	7.9	7.2
	l/s/ha	0.90	0.98	0.61	0.58	0.91	0.84
Total water requirement at pipe outlet	mm	1,075	1,000	498	511	913	821
Conveyance efficiency (HT to pipe outlet)	%	100%	100%	100%	100%	100%	100%
Total water requirement at pumping point	mm	**1,075**	**1,000**	**498**	**511**	**913**	**821**

Appendix G4-IB.B
Layout Planning and Preliminary Design of Buried Pipe Irrigation Systems

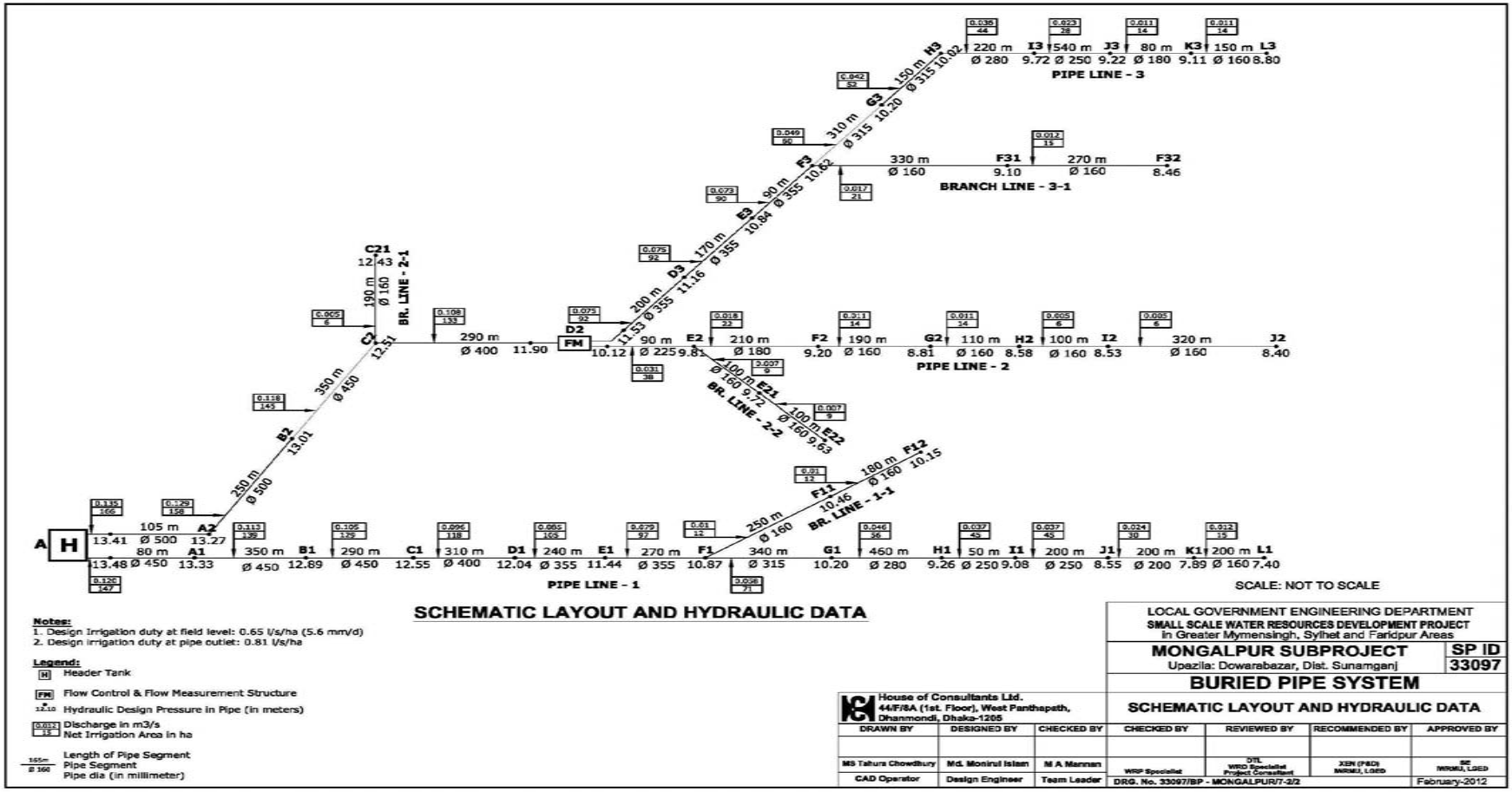
B1 Layout Planning of Buried Pipe Irrigation System of CAD Subprojects using Google Imagery of Subproject Area

(This is for example. FS Consultants will provide Google Imagery of concerned subproject and show layout planning on it. Refer Guidelines G4 Feasibility Study of Subprojects, *Subsection-3.2.5*)



B2 Schematic Layout of Pipeline System

(This is an example layout. FS Consultants will provide layout for the concerned subproject here. Refer *Guidelines G4 Feasibility Study of Subprojects, Subsection-3.2.5*)



B3 Command Areas, Design Flows & Minimum Pipe Diameters

(This is an example calculation for the pipeline layout system shown in B2 above. FS Consultants will furnish data of concerned subproject in this format. Refer *Guidelines G4 Feasibility Study of Subprojects, Subsection-3.2.5)*

Command Areas, Design Flows & Minimum Pipe Diameters Associated with Maximum PipeFlow
Name of SP : Mongalpur Subproject
Up : Dowrabazar
Dist : Sunamganj

Available PVC pipe sizes outer diameter (mm): 160, 180, 200, 225, 250, 280, 315, 355,400, 450 & 500
Max flow velocity is 1.5 m/s for PVC pipes. Typical max is 1.2 m/s
Pipe thickness for 3.25 bar working pressure

Pipeline-1

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	KL	200	2,990	6.60	15	0.0093	0.65	80	0.012	1.20	1.50	114	102	160	2.00	156
2	JK	200	2,790	7.00	30	0.0093	0.65	80	0.024	1.20	1.50	161	144	160	2.00	156
3	IJ	200	2,590	7.10	45	0.0093	0.65	80	0.037	1.20	1.50	197	176	200	2.50	195
4	HI	50	2,390	8.25	45	0.0093	0.65	80	0.037	1.20	1.50	197	176	200	2.50	195
5	GH	460	2,340	8.30	56	0.0093	0.65	80	0.046	1.20	1.50	220	197	225	2.80	219
6	FG	340	1,880	8.26	71	0.0093	0.65	80	0.058	1.20	1.50	248	221	250	3.10	244
7	EF	270	1,540	8.05	97	0.0093	0.65	80	0.079	1.20	1.50	289	259	315	4.00	307
8	DE	240	1,270	7.55	105	0.0093	0.65	80	0.085	1.20	1.50	301	269	315	4.00	307
9	CD	310	1,030	8.20	118	0.0093	0.65	80	0.096	1.20	1.50	319	285	355	4.40	346
10	BC	290	720	7.30	129	0.0093	0.65	80	0.105	1.20	1.50	334	298	355	4.40	346
11	AB	350	430	7.21	139	0.0093	0.65	80	0.113	1.20	1.50	346	310	355	4.40	346
12	HT-A	80	80	8.50	147	0.0093	0.65	80	0.120	1.20	1.50	356	319	400	5.00	390
		2,990		8.45												

Pipeline-2

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	IJ	320	2,015	7.60	6	0.0093	0.65	80	0.005	1.20	1.50	72	64	160	2.00	156
2	HI	100	1,695	7.51	6	0.0093	0.65	80	0.005	1.20	1.50	72	64	160	2.00	156
3	GH	110	1,595	7.55	14	0.0093	0.65	80	0.011	1.20	1.50	110	98	160	2.00	156
4	FG	190	1,485	7.80	14	0.0093	0.65	80	0.011	1.20	1.50	110	98	160	2.00	156
5	EF	210	1,295	8.20	22	0.0093	0.65	80	0.018	1.20	1.50	138	123	160	2.00	156
6	DE	90	1,085	8.70	38	0.0093	0.65	80	0.031	1.20	1.50	181	162	200	2.50	195
7	CD	290	995	8.17	133	0.0093	0.65	80	0.108	1.20	1.50	339	303	355	4.40	346
8	BC	350	705	8.55	145	0.0093	0.65	80	0.118	1.20	1.50	354	316	400	5.00	390
9	AB	250	355	7.68	158	0.0093	0.65	80	0.129	1.20	1.50	369	330	450	5.60	439
10	HT-A	105	105	8.05	166	0.0093	0.65	80	0.135	1.20	1.50	378	339	450	5.60	439
		2,015		8.45												

Pipeline-3

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	KL	150	1,910	7.42	14	0.0093	0.65	80	0.011	1.20	1.50	110	98	160	2.00	156
2	JK	80	1,760	8.30	14	0.0093	0.65	80	0.011	1.20	1.50	110	98	160	2.00	156
3	IJ	540	1,680	8.00	28	0.0093	0.65	80	0.023	1.20	1.50	155	139	180	2.30	175
4	HI	220	1,140	8.20	44	0.0093	0.65	80	0.036	1.20	1.50	195	174	200	2.50	195
5	GH	150	920	8.68	52	0.0093	0.65	80	0.042	1.20	1.50	212	189	225	2.80	219
6	FG	310	770	8.35	60	0.0093	0.65	80	0.049	1.20	1.50	228	204	280	3.50	273
7	EF	90	460	8.32	90	0.0093	0.65	80	0.073	1.20	1.50	279	249	280	3.50	273
8	DE	170	370	8.30	92	0.0093	0.65	80	0.075	1.20	1.50	282	252	355	4.40	346
9	D2-D3	200	200	9.17	92	0.0093	0.65	80	0.075	1.20	1.50	282	252	355	4.40	346
		1,910		8.17												

Branch 1-1

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	F11-F12	180	430	7.68	12	0.0093	0.65	80	0.010	1.20	1.50	102	91	160	2.00	156
2	F1-F11	250	250	7.90	12	0.0093	0.65	80	0.010	1.20	1.50	102	91	160	2.00	156
		430		8.05												

Branch 2-1

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	C2-C21	190	190	8.45	6	0.0093	0.65	80	0.005	1.20	1.50	72	64	160	2.00	156
		190		8.55												

Branch 2-2

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	E21-E22	100	200	7.93	9	0.0093	0.65	80	0.007	1.20	1.50	88	79	160	2.00	156
2	E2-E21	100	100	7.91	9	0.0093	0.65	80	0.007	1.20	1.50	88	79	160	2.00	156
		200		8.70												

Branch 3-1

Sl No	Pipeline Reach	Length	RD	EL	Command Area (cumulative)	Design Duty		Irrigation Efficiency d/s of Outlet	Design Discharge, Q	Pipe Flow Velocity		Pipe diameters		Suggested Pipe Thickness & Diameter (mm)		
										Typ	Max	Typ	Min			
		m	m	m	ha	cfs/acre	l/s/ha	%	m3/s	m/s	m/s	mm	mm	External Dia	Thickless	Internal Dia
1	F31-F32	270	600	7.40	15	0.0093	0.65	80	0.012	1.20	1.50	114	102	160	2.00	156
2	F3-F31	330	330	7.85	21	0.0093	0.65	80	0.017	1.20	1.50	135	120	160	2.00	156
		600		8.32												

Pumping Plant and Power Requirements

Total discharge at peak demand (for boro paddy - see note below)	0.254	m3/s	80% efficiency		
	8.979	cusecs			
Nr of pumps	5	Nr	(Notes: (I) not less than the nr of Rotation units; (II) no standby pump)		
Pump discharage	51	l/s per pump			
	1.80	cusecs/pump			
Adopted pump capacity	57	l/s per pump			
	2.01	cusecs/pump			
	205	m3/hr per pump			
	902	USG/m per pump		1 USG =	3.8 ltr
Pump spare capacity	12%		(Note: adopt 10-20%)	1 USG =	0.83 UKG
Top of header tank	**14.45**	m			
EGL at header tank / near river (ie where pump to be located)	**8.50**	m			
River level during dry season (ie Dec - March)	**3.60**	m	(refer feasibility report: note data not too reliable)		
Total Static Head	10.85	m			
Suction Head	4.90	m	Note: recommended limit: 2-3 m		
Allowance for friction losses (pipe and fittings)	**0.50**	m	(Note: distance maybe about 50 m)		
Total Pumping Head	11.35	m			
Adopted power unit efficiency	**0.80**		Note: electric unit: 75-85%)		
Adopted pump efficiency	**0.60**		Note: 40 - 80%		
Overall efficiency	0.48				
Power Demand per pump (for adopted pump capacity)	13.2	kW	Power (kW) = 9.81 x discharge (m3/s) x head (m) / overall efficiency		
	18.0	HP (1 kW= 1.36 HP)			
Total Peak Power Demand for SP	66.1	kW			
	89.9	HP (1 kW= 1.36 HP)			

Note: 24/7 pumping at peak demand period is assumed. However electical power shortages mean that pumping may only be possible during night hours. If 100% rice cropping occurs in the SP area and if peak demand occurs over the whole command area simultaneously then the pipe system and pumps cannot meet crop water demand by only pumping at night. In practice: (i) some vegetables / wheat etc may be cropped; and (ii) transplanting of boro rice is usually staggered reducing peak water demand. None-the-less water shortage may occur due to non-availability of power in which case the WMCA may have to arrange hire / purchase of a generator for day time use over the peak water demand period.

B4 Number of Rotation and Irrigator Units and Related Data

(This Data Table is for an example subproject. FS Consultants will furnish data of concerned subproject in this format. Refer *Guidelines G4 Feasibility Study of Subprojects, Subsection-3.2.5)*

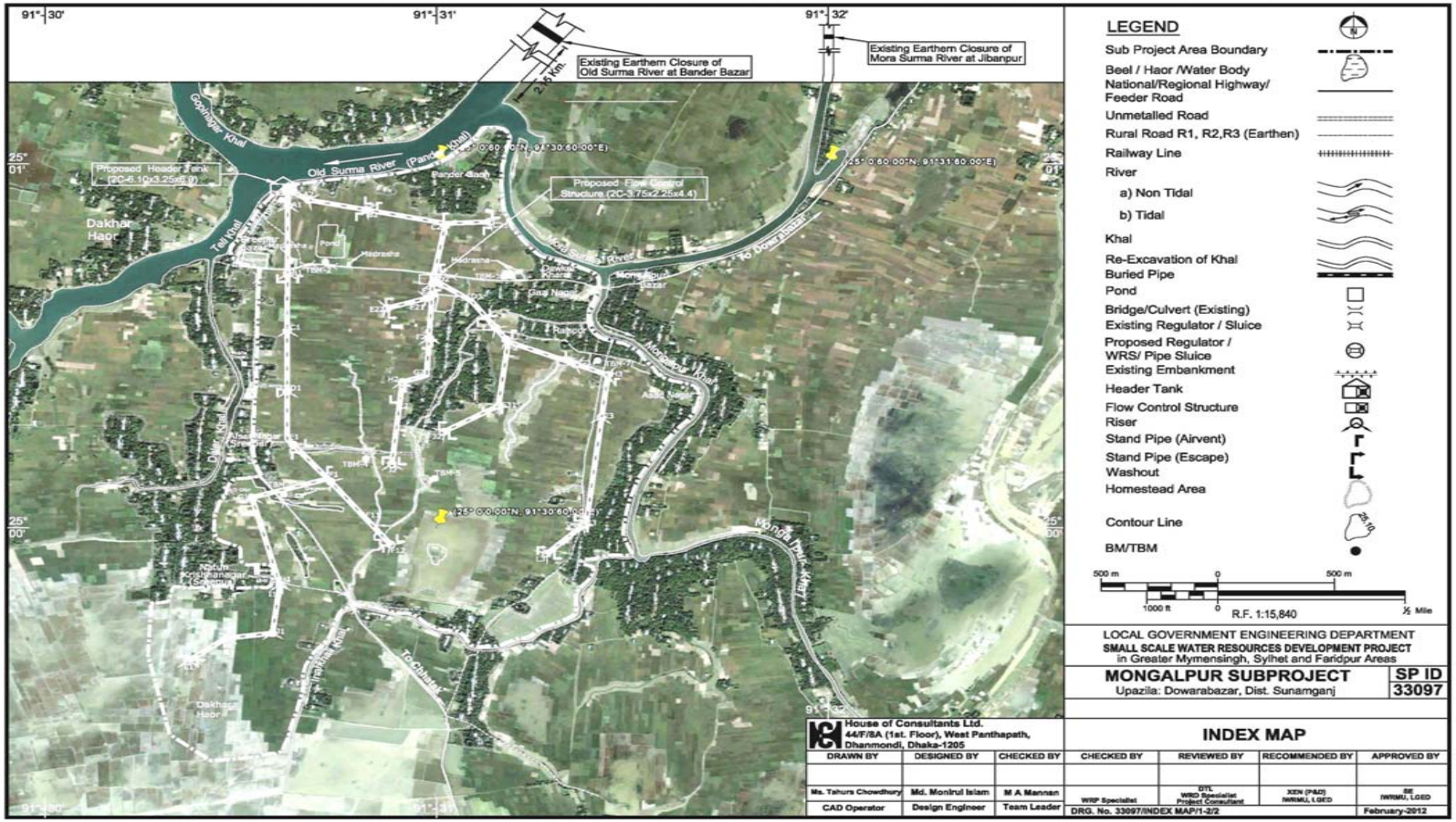
Nr of Rotation & Irrigator Units

Name of SP : Mongalpur Subproject
Up : Dowrabazar
Dist : Sunamganj

Item	Units	Quantity	Remarks
Gross Area	ha	**401**	
Net Irrigable Area	ha	**313**	
Crop Water Requirements	l/s/ha	**0.65**	
Efficiency d/s of outlet	%	**80.0%**	
Water Requirements at Outlet	l/s/ha	0.81	
Number of Rotation Units	Nr	**3**	Select to give 80-120 ha Rotation Units
Net Irrigable Area of Rotation Units (avg)	ha	104.3	
Number of Outlets (risers) ie Irrigator Units	Nr	**30**	Select to give 5-15 ha Irrigator Units, and generally
Net Irrigable Area of Irrigator Units (avg)	ha	10.4	every 200-500 m along pipe line
Nr of standpipes	Nr	15	Adopt about 50% of nr of riser outlets
Number of benefitting HHs	Nr	**704**	
Number of HH per Rotation Units	Nr	235	
Number of HH per Irrigator Units	Nr	23	
Rotation flows (avg)	l/s	85	
Irrigator flows (avg)	l/s	8	

Appendix G4-IB.C
Maps & Drawings

C1 **Subproject Index Map** (Example Subproject. FS Consultants will provide Index Map of concerned subproject following this example)



C2 Schematic Drawing for Pipeline System Layout *(Layout of example subproject)*