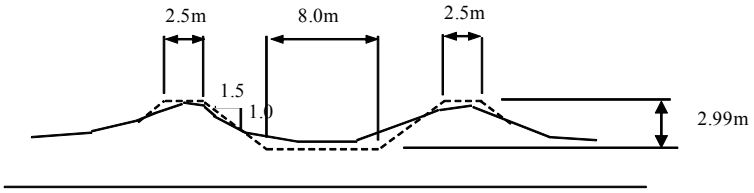
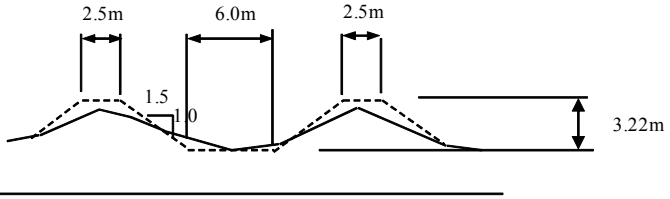
ANNEX 4 REHABILITATION PLAN OF IRRIGATION FACILITIES

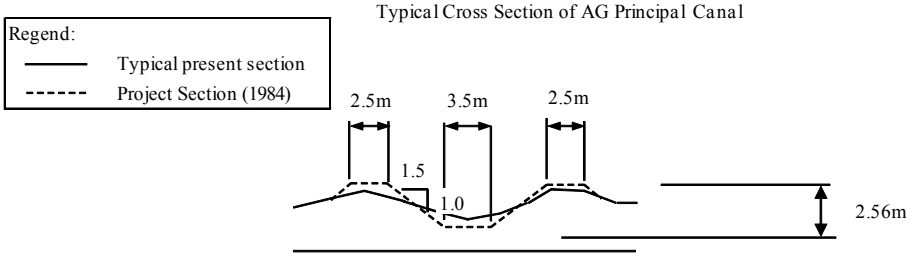
A4.1 Typical Cross Sections of Major Irrigation Canals



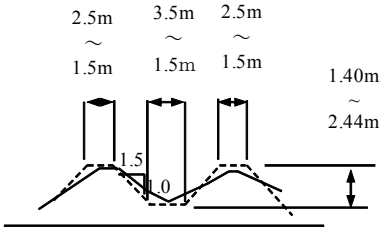
Typical Cross Section of AO Principal Canal



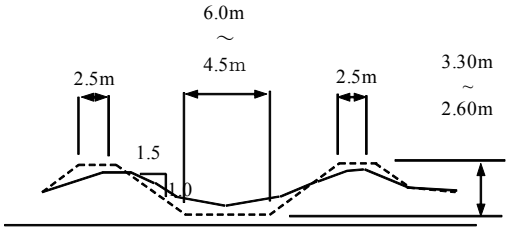
Typical Cross Section of AG Principal Canal



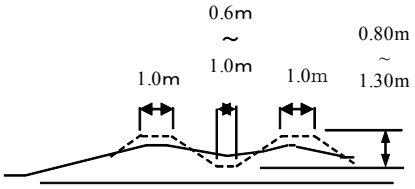
Typical Cross Section of AD Principal Canal



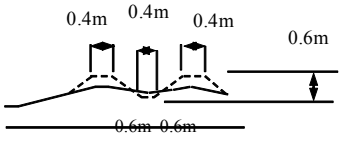
Typical Cross Section of P1 Primary Canal



Typical Cross Section of P2 Primary Canal



Typical Cross Section of Secondary Canal



Typical Cross Section of Tertiary Canal

Source: Drawings for "Bon pour Execution" by SONADER, 1981-82

A4.2 Project Dimension (1984) of Major Irrigation Canals

Irrigation Canal	Distance (m) Reference	Accum.	Canal Gradient	Digue EL	Fond EL	Eau EL	Digue m	Eau Depth m	Freeboard m	Bottom Width m	Dike wid. m	Notes
Principal												
OA												
BP(End of Rectangler Flume)		0	0.000074	29.25	26.26	28.50	2.99	2.24	0.75	8.0	2.5	
Dart (4-boxes culvert)		900	0.000074	29.18	26.19	28.43	2.99	2.24	0.75	8.0	2.5	
Buse 800 dia.		1660	0.000074	29.13	26.14	28.38	2.99	2.24	0.75	8.0	2.5	
Buse 800 dia.		2160	0.000074	29.09	26.10	28.34	2.99	2.24	0.75	8.0	2.5	
Evacuator 2-box		3060	0.000074	29.02	26.03	28.27	2.99	2.24	0.75	8.0	2.5	Evacuator
RP2(Bridge)		3362	0.000074	29.00	26.01	28.25	2.99	2.24	0.75	8.0	2.5	
EP(Partituer)		3781	0.000074	28.97	25.98	28.22	2.99	2.24	0.75	8.0	2.5	Circular diversion weir
AD												
BP(Partiteur)		0	0.000034	28.32	25.76	27.61	2.56	1.85	0.71	3.5	2.5	
Pont Aqueduc		875		28.29	25.73	27.58	2.56	1.85	0.71	3.5	2.5	P. Aqueduct
		975		28.07	25.53	27.38	2.54	1.85	0.69	3.5	2.5	
P1 BP		1821	0.000024	28.05	25.51	27.36	2.54	1.85	0.69	3.5	2.5	
AG												
BP(Partiteur)		150	0.0000286	28.09	24.87	27.36	3.22	2.49	0.73	6.0	2.5	
Siphon(SF7)		1,475		28.05	24.83	27.32	3.22	2.49	0.73	6.0	2.5	Siphon,Spillway, flush
		1,600		27.89	24.67	27.14	3.22	2.47	0.75	6.0	2.5	
P2 BP		3005	0.0000345	27.81	24.62	27.09	3.19	2.47	0.72	6.0	2.5	
Primary			Bottom	Digue	Fond	Eau	Digue	Eau	Freeboard	Bottom	Dike wid.	**Weir type**
P1 Secondary Intake	Ref.	Accum.	Gradient	EL	EL	EL	m	Depth m	m	Width m	m	Other work
S1 (amont)	0	0		28.05	25.51	27.36	2.44	1.85	0.69	3.5	2.5	
(aval)			0.000018	27.95	25.51	27.36	2.44	1.85	0.59	3.5	2.5	
S2 (amont)	563	550	0.000018	27.94	25.5	27.34	2.44	1.84	0.6	3.5	2.5	
(aval)		575	0.000018	27.9	25.5	27.3	2.44	1.80	0.6	3.5	2.5	
S3	1356.19	1345	0.000018	27.87	25.47	27.27	2.40	1.80	0.6	3.5	2.5	Trapezoidal
		1370	0.00002	27.81	25.47	27.22	2.34	1.75	0.59	3.5	2.5	
S4	935	2305	N.A	N.A	25.45						2.5	*NA: Not Available
S4.1	24	2329	N.A	N.A	25.45						2.5	
Aqueduct(DP2)	654	2983	N.A	N.A	25.44		2.2			3.5	2.5	Spillway
	92	3075	0.0001	27.34	25.5	26.89	1.84	1.39	0.45	2.5	2	
S5	500	3575	0.0001	27.29	25.45	26.78	1.84	1.33	0.51	2.5	2	
		3600	0.0001	27.19	25.45	26.69	1.74	1.24	0.5	2.5	2	
S6	5015	5005	0.0001	27.05	25.31	26.55	1.74	1.24	0.5	2.5	2	Rectangler
		5025	0.0001	26.88	25.22	26.38	1.66	1.16	0.5	2.5	2	Spillway
S7	5710	5690	0.0001	26.81	25.15	26.31	1.66	1.16	0.5	2.5	2	
		5720	0.0001	26.81	25.15	26.31	1.66	1.16	0.5	2.0	1.5	
S8	6705	6690	0.0001	26.68	25.03	26.2	1.65	1.17	0.48	2.0	1.5	Trapezoidal
		6715	0.0001	26.37	24.82	25.88	1.55	1.06	0.49	2.0	1.5	
S9	7760	7750	0.0001	26.26	24.71	25.77	1.55	1.06	0.49	2.0	1.5	Rectangler
		7775	0.0001	24.99	23.59	24.48	1.40	0.89	0.51	2.0	1.5	Sw, escape
S10	8165	8155	0.0001	24.95	23.55	24.44	1.40	0.89	0.51	2.0	1.5	Trapezoidal
		8180	0.0001	24.67	23.27	24.16	1.40	0.89	0.51	1.5	1.5	
DP5	9150		0.0001	24.58	23.18	24.07	1.40	0.89	0.51	1.5	1.5	
		9175	0.0001	24.31	22.99	23.86	1.32	0.87	0.45	1.5	1.5	
P2												
S16	41.07	30		27.83	24.62	27.08	3.21	2.46	0.75	6.0	2.5	
		55	0.00003	27.80	24.62	27.06	3.18	2.44	0.74	6.0	2.5	
S17	975.33	965	0.00003	27.77	24.59	27.03	3.18	2.44	0.74	6.0	2.5	
		990	0.00003	27.72	24.59	26.98	3.13	2.39	0.74	6.0	2.5	
Siphone(DP8)		1885	0.00003	27.70	24.56	26.96	3.14	2.40	0.74	6.0	2.5	Spillway
		1920	0.00003	27.50	24.19	26.76	3.31	2.57	0.74	5.0	2.5	
S18	2002.48	1990	0.00003	27.49	24.19	26.75	3.30	2.56	0.74	5.0	2.5	
		2015	0.00003	27.45	24.18	26.73	3.27	2.55	0.72	5.0	2.5	
S19	2744.93	2735	0.00003	27.45	24.17	26.71	3.28	2.54	0.74	5.0	2.5	Trapezoidal
		2760	0.00003	27.42	24.16	26.66	3.26	2.50	0.76	5.0	2.5	
S20	5755.75	5748	0.00003	27.33	24.07	26.57	3.26	2.50	0.76	5.0	2.5	Trapezoidal
		5775		27.30	24.16	26.53	3.14	2.37	0.77	5.0	2.5	
Siphon(DP9)		6085		27.29	24.15	26.52		2.37	0.77	5.0	2.5	Spillway
		6110		27.07	23.95	26.32		2.37	0.75	5.0	2.5	
S21	6376.29	6365	0.00003	27.06	23.94	26.31	3.12	2.37	0.75	5.0	2.5	
		6379.3	0.00003	26.98	23.94	26.23	3.04	2.29	0.75	5.0	2.5	
S22	6813.05	6800	0.00003	26.97	23.93	26.22	3.04	2.29	0.75	5.0	2.5	Trapezoidal
		6825	0.00003	26.94	23.92	26.2	3.02	2.28	0.74	5.0	2.5	
S23	7965	7955	0.00003	26.90	23.88	26.16	3.02	2.28	0.74	5.0	2.5	None
		7980		26.90	23.88	26.13	2.84	2.25	0.77	4.5	2.5	Spillway
S24	9096.28	9081	0.00003	26.69	23.85	26.1	2.80	2.25	0.59	4.5	2.5	
		9110	0.00003	26.65	23.85	26.04		2.19	0.61	4.5	2.5	
S25	10534.14	10524	0.00003	26.6	23.8	25.99	2.80	2.19	0.61	4.5	2.5	
		10545	0.00003	26.52	23.8	25.94		2.14	0.58	4.5	2.5	
PR3(Bridge)	10865										2.5	
S26	11583.74	11570	0.00003	26.49	23.77	25.91	2.80	2.14	0.58	4.5	2.5	None
		11595	0.00003	26.37	23.77	25.86		2.09	0.51	4.5	2.5	
S27	11785.5	11780	0.00003	26.36	23.76	25.85	2.60	2.09	0.51	4.5	2.5	Trapezoidal
		11805	0.00003	26.06	23.56	25.47		1.91	0.59		2.5	Spillway
							2.50			4		
DP10		12950										

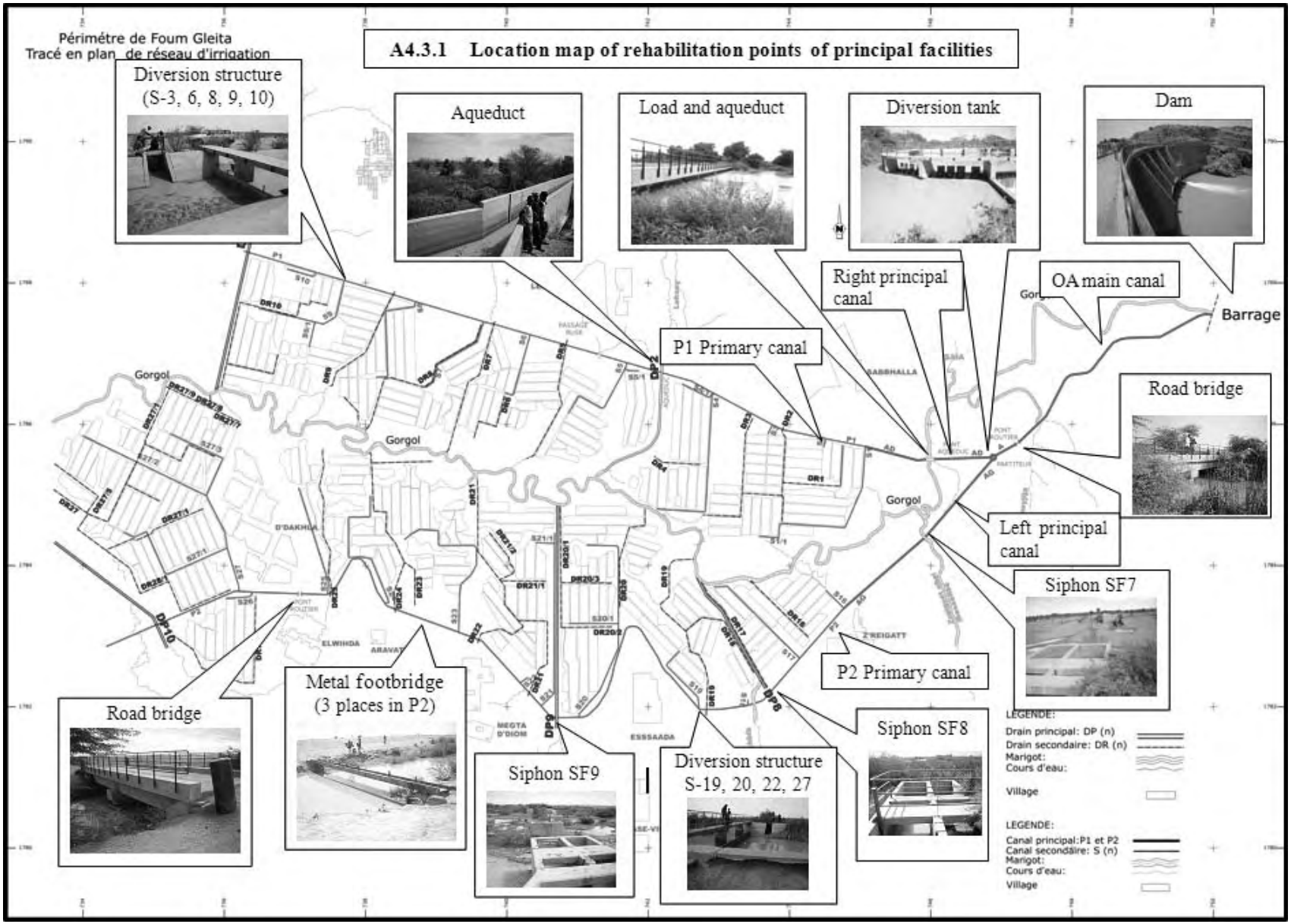
Source: Data from the profile drawing for "Bon pour Execution (1981-82)" except some data which were estimated because of no data.
A circular partituer at the end of OA, 2 aqueduct for AD & P1, 3 siphons for AG & P2, a road bridge on the OA and P2, and a bridge over Golgol river provided.
Box culverts are provided at DR2, 5, 7, 9, 19, 21, 22, 24 and 25 in P1, P2 primary canals and 4 boxculverts along OA principal canal.
All weirs are provided by RC foot bridge with a width of 1m at S3, 6, 8, 9, 10 along P1 and S19, 20, 22, 27 along P2
3 metal foot bridges are provided at the locations, between S16/17, S19/20 and S23/24.

A4.3 Location map of principal irrigation facilities

Principal facilities in Foum Gleita are as follows

- Dam(effective storage 4 hundred million m^3)
- Principal canal（OA principal canal 3.8km、AD right principal canal 1.8km、AG left principal canal 3.0km）
- Diversion tank
- P1(8.2km) and P2(11.8km) primary canal
- Aqueduct × 2 places (one side between 2 places is established with spillway)
- Siphon ×3 places (established with spillway)
- Secondary canal diversion structure × 23 places (9 places between 23 places are established with check gate, footbridge and spillway)
- Cross conduit of drainage canal × 13 places (4 places in OA, 1 place between 4 places is established with outlet)

Location map of these facilities is shown below


Périmétre de Foum Gleita
Tracé en plan de réseau d'irrigation
A4.3.1 Location map of rehabilitation points of principal facilities
Diversion structure (S-3, 6, 8, 9, 10)
Aqueduct
Load and aqueduct
Diversion tank
Dam
Right principal canal
OA main canal
Barrage
P1 Primary canal
Road bridge
Left principal canal
Siphon SF7
P2 Primary canal
Siphon SF8
Diversion structure S-19, 20, 22, 27
Siphon SF9
Metal footbridge (3 places in P2)
Road bridge
Gorgol
D'AKHLIA
ELWIHDA
ARAVAT
MEGTA D'DIOM
ESSSAADA
Z'REIGATT
GABBHALLA
LEGENDE:
Drain principal: DP (n)
Drain secondaire: DR (n)
Marigot:
Cours d'eau:
Village
LEGENDE:
Canal principal:P1 et P2
Canal secondaire: S (n)
Marigot:
Cours d'eau:
Village

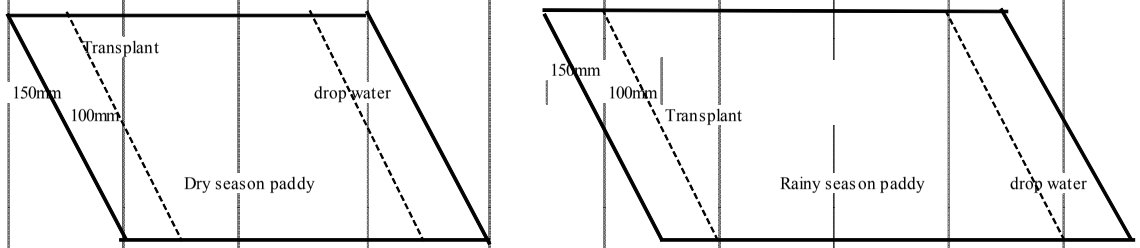
A4.4.1 Penman Montheis Calculations for Rice

Give :	Station name :			Foum Gleita									
	Latitude :			16.07	16.12	0.28	rad						
	Altitude :			25	m.								
Parameters :		Short Wave Rad			a =	0.25	b =	0.50	alpha=				
		Albedo			alpha =	0.23							
		Long Wave Rad.			a =	0.90	b =	0.10					
					al =	0.34	bl =	-0.139					
		Instrument height				wind	temp	Cropheight		AeroT Cff			
		AerDyn Resistance		ra * U =	206	200	190	12		900			
					Grass	Alfalfa							
		Canopy resistance		rc =	70	86		12					

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Tmax	31.8	34.6	37.4	40.4	41.6	39.8	37.0	35.6	36.1	38.8	36.1	32.1	
Tmin	17.2	19.6	22.1	25.3	27.0	27.2	25.9	25.5	25.2	24.9	21.6	18.1	
RHmean	27.9	20.5	20.6	22.0	27.0	39.5	54.8	63.3	61.7	46.8	29.8	27.5	
RHmin	16	12	12	13	17	26	38	46	43	29	18	17	
Wind km/d)	224.6	250.6	276.5	293.8	319.7	311.0	319.7	285.1	259.2	172.8	190.1	241.9	
Sunhours	6.4	7.2	7.0	7.0	6.7	6.5	6.6	6.6	7.1	7.9	7.4	5.3	
ET fao	5.91	7.26	8.50	9.49	9.95	8.80	7.50	6.43	6.35	6.15	6.17	6.14	
Avg Temp	24.50	27.10	29.75	32.85	34.30	33.50	31.45	30.55	30.65	31.85	28.85	25.10	
n/N	57%	63%	59%	56%	52%	50%	51%	53%	59%	68%	66%	48%	
Wind (m/s)	2.60	2.90	3.20	3.40	3.70	3.60	3.70	3.30	3.00	2.00	2.20	2.80	
Ea(Tmax)	4.70	5.50	6.41	7.53	8.03	7.30	6.27	5.81	5.97	6.92	5.97	4.78	
Ea(Tmin)	1.96	2.28	2.66	3.22	3.57	3.61	3.34	3.26	3.21	3.15	2.58	2.08	
Ea(Tx)-Ea(Tn)	3.33	3.89	4.54	5.38	5.80	5.45	4.81	4.54	4.59	5.03	4.28	3.43	
Edew	0.77	0.66	0.77	0.99	1.33	1.91	2.39	2.65	2.57	2.03	1.07	0.80	
RH(max-min)	28%	21%	21%	22%	27%	40%	55%	63%	62%	47%	30%	28%	
Dlt(ETx-ETn)	0.20	0.22	0.26	0.30	0.32	0.30	0.27	0.26	0.26	0.28	0.24	0.20	
P-atm.	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	101.0	
lambda	2.44	2.44	2.43	2.42	2.42	2.42	2.43	2.43	2.43	2.43	2.43	2.44	
gamma	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	
rc	70	70	70	70	70	70	70	70	70	70	70	70	
ra	79	71	64	61	56	57	56	62	69	103	94	74	
gamma*	0.13	0.13	0.14	0.15	0.15	0.15	0.15	0.14	0.14	0.11	0.12	0.13	
dl/dl+gm*	0.61	0.63	0.64	0.67	0.67	0.67	0.64	0.64	0.66	0.71	0.67	0.60	
gm/dl+gm*	0.21	0.19	0.17	0.15	0.14	0.15	0.16	0.17	0.17	0.17	0.19	0.20	
Aeroterm	4.22	5.31	6.12	6.74	7.01	5.65	4.25	3.14	3.07	3.06	3.94	4.53	
Month	1	2	3	4	5	6	7	8	9	10	11	12	
dayno	15	46	76	107	137	168	198	229	259	290	320	351	
soldeclin	-0.370	-0.230	-0.033	0.179	0.334	0.408	0.372	0.233	0.036	-0.176	-0.336	-0.408	
xx	-0.101	-0.063	-0.009	0.049	0.091	0.110	0.101	0.064	0.010	-0.049	-0.091	-0.110	
yy	0.896	0.935	0.960	0.945	0.908	0.882	0.895	0.935	0.960	0.946	0.907	0.882	
omega	1.46	1.50	1.56	1.62	1.67	1.70	1.68	1.64	1.58	1.52	1.47	1.45	
dr	1.03	1.02	1.01	0.99	0.98	0.97	0.97	0.98	0.99	1.01	1.02	1.03	
Ra	28.83	32.22	35.85	38.16	38.73	38.63	38.54	38.10	36.37	33.02	29.55	27.76	
N	11.14	11.48	11.93	12.40	12.77	12.96	12.86	12.52	12.08	11.61	11.23	11.04	
Rns	11.9	14.0	15.0	15.6	15.3	14.9	15.0	15.1	15.2	15.0	13.2	10.5	
f(n/N)	0.62	0.66	0.63	0.61	0.57	0.55	0.56	0.57	0.63	0.71	0.69	0.53	
sigma(Tx_Tn)	38.60	39.98	41.41	43.12	43.94	43.44	42.27	41.76	41.83	42.54	40.91	38.91	
emissivity	0.22	0.23	0.22	0.20	0.18	0.15	0.13	0.11	0.12	0.14	0.20	0.22	
Rbo	8.39	9.05	8.99	8.67	7.87	6.42	5.28	4.75	4.88	6.04	8.00	8.38	
LWR	5.19	6.03	5.66	5.28	4.51	3.55	2.97	2.73	3.08	4.31	5.56	4.47	
Rn (Rns-Rl)	6.74	7.95	9.34	10.36	10.77	11.35	12.06	12.33	12.16	10.70	7.63	6.00	
G	-0.08	0.36	0.37	0.43	0.20	-0.11	-0.29	-0.13	0.01	0.17	-0.42	-0.53	
Rn-G	6.82	7.59	8.97	9.92	10.56	11.46	12.35	12.46	12.14	10.53	8.05	6.53	
Rad Term	1.67	2.04	2.48	2.86	3.00	3.12	3.18	3.26	3.28	3.14	2.11	1.49	
Rad Term(-G)	1.69	1.95	2.38	2.74	2.94	3.15	3.25	3.29	3.28	3.09	2.23	1.62	
ETcomb	5.89	7.36	8.59	9.61	10.01	8.77	7.42	6.40	6.35	6.20	6.05	6.01	
	-0.4%	1.3%	1.1%	1.2%	0.6%	-0.4%	-1.0%	-0.5%	0.1%	0.8%	-1.9%	-2.2%	
ET (-G)	5.91	7.26	8.50	9.49	9.95	8.80	7.50	6.43	6.35	6.15	6.17	6.14	
				2.20	2.80	3.60	3.80	3.50					
ET (-G)	1.01	1.45	2.20	3.01	3.96	4.91	5.66	4.87	3.56	2.13	1.41	1.01	
				284.6	298.6	264.0	225.0	192.9					1265.1

Source:
Penman-Montheis calculation by FAO
Meteorological date by APD2, 2007, SONADER

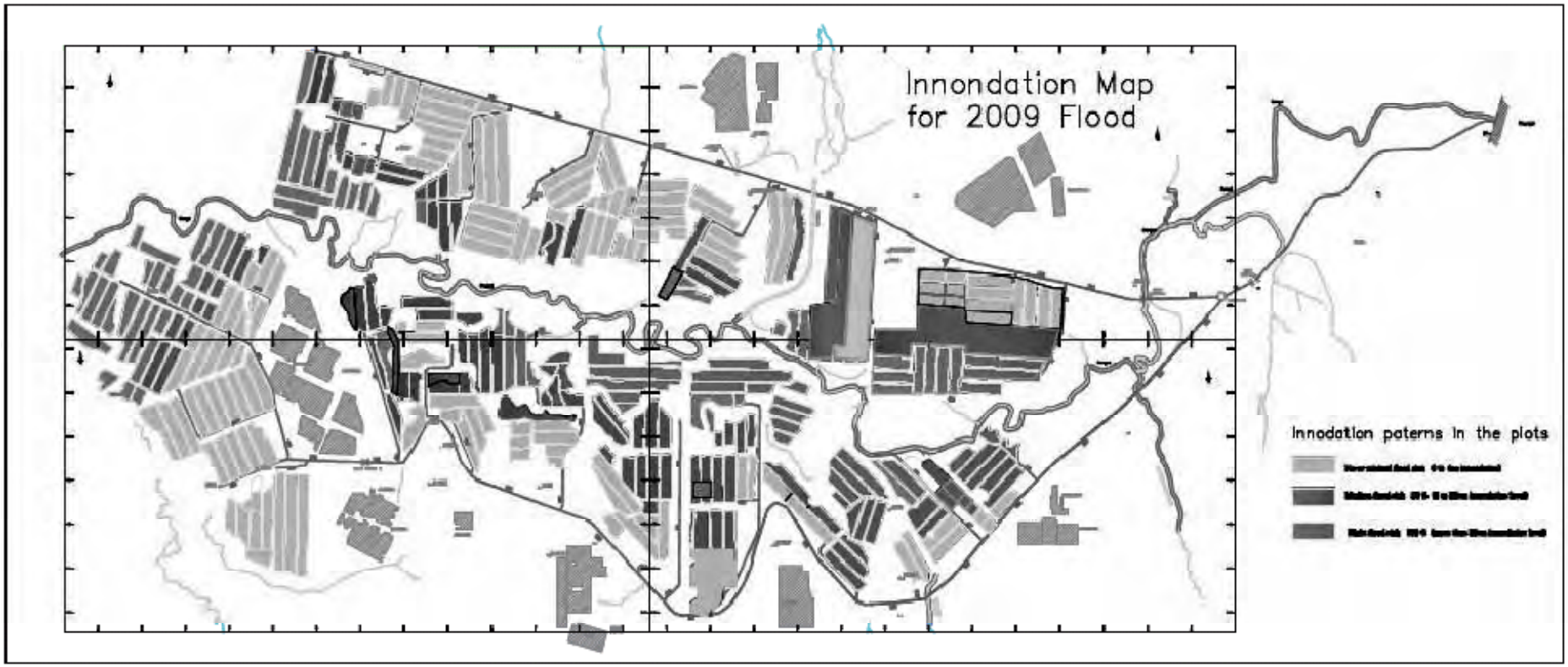
A4.4.2 Diversion Water Requirement



		J	F		M		A		M		J	J		A		S		O		N	D
Basic Kc			1	1.1	1.25	1.25	1.35	1.15			1	1.1	1.1	1.25	1.25	1.25	1.35	1.15			
Date			8	25	38		12	17			8	25		38			12	17		100	
Area factor * Kc			0.250	0.500	0.250																
			0.250	0.500	0.250						0.250	0.500	0.250								
				0.275	0.550	0.275						0.275	0.550	0.275							
					0.313	0.625	0.313						0.275	0.550	0.275						
						0.313	0.625	0.313						0.313	0.625	0.313					
							0.338	0.675	0.338						0.313	0.625	0.313				
																0.313	0.625	0.313			
																	0.338	0.675	0.338		
Weighted Kc			0.250	0.775	1.113	1.213	1.275	0.988	0.338		0.250	0.775	1.075	1.138	1.213	1.250	1.275	0.988	0.338		
Days			15	13	15	16	15	15	15		15	15	16	15	16	15	15	15	16		
ETo (mm/day)			7.4	7.4	8.6	8.6	9.6	9.6	10.0		8.8	7.4	7.4	6.4	6.4	6.4	6.4	6.2	6.2		
ETc (mm/day)			1.8	5.7	9.6	10.4	12.2	9.5	3.4		2.2	5.8	8.0	7.3	7.8	7.9	8.1	6.1	2.1		
(mm)			27.6	74.1	143.4	166.7	183.7	142.3	50.7		32.9	86.3	127.7	109.1	124.1	119.1	121.4	91.8	33.5		
Percolation (mm)			3.8	13.0	15.0	16.0	15.0	11.3	3.8		3.8	11.3	16.0	15.0	16.0	15.0	15.0	11.3	4.0		
Saturation & Paddling (mm)																					
150			75.0	75.0							75.0	75.0									
100				50.0	50.0							50.0	50.0								
0					0.0	0.0							0.0	0.0							
Total (mm)			106.3	212.1	208.4	182.7	198.7	153.5	54.4	1116	111.6	222.6	193.7	124.1	140.1	134.1	136.4	103.1	37.5	1203	
Effective rain (mm)									0.0		28.5	4.0	32.0	41.0	0.0	50.0	42.0	4.5	1.3		
Net req. (mm)			106.3	212.1	208.4	182.7	198.7	153.5	54.4		83.1	218.6	161.7	83.1	140.1	84.1	94.4	98.6	36.2		
Field req.(l/s/ha)			0.82	**1.89**	1.61	1.32	1.53	1.18	0.42		0.64	1.69	1.17	0.64	1.01	0.65	0.73	0.76	0.26		
Diversion req. (l/s/ha)	0.65		1.26	**2.91**	2.47	2.03	2.36	1.82	0.65		0.99	**2.59**	1.80	0.99	1.56	1.00	1.12	1.17	0.40	(Irrigation efficiency)	
Qm3/s/1950ha			2.46	5.67	4.82	3.97	4.60	3.55	1.26	Subtotal	1.92	5.06	3.51	1.92	3.04	1.95	2.19	2.28	0.79	Subtotal	
Vm3/1950ha/year	000 m3		3190	6363.2	6252.3	5481.6	5961.578	4606.3	1633	33488	2494.1	6556.7	4850.8	2493.8	4202.3	2521.9	2833.3	2956.9	1086.7	29997	
Monthly average(m3/s)				4.0633		4.3948		4.0771			0.9622		4.2841		2.482		2.0661		1.5338		

Source: ETo by FAO; Crop factor by Irrigation & Agricultural Development Project in Upper Delt of the Senegal River Basin, 1997, JICA.
Effective rain: 80% of 2006 at Foum Gleita (average year from 1999-2008), SONADER
Croping pattern with rice for 2 cropping season remains unchanged from the original plan for the construction in 1980's (APD2).

A4.5 Inundation Map (2009 Flood)



Source: Prepared by JICA study team based on the results of interview to SONADER and farmers in 2009

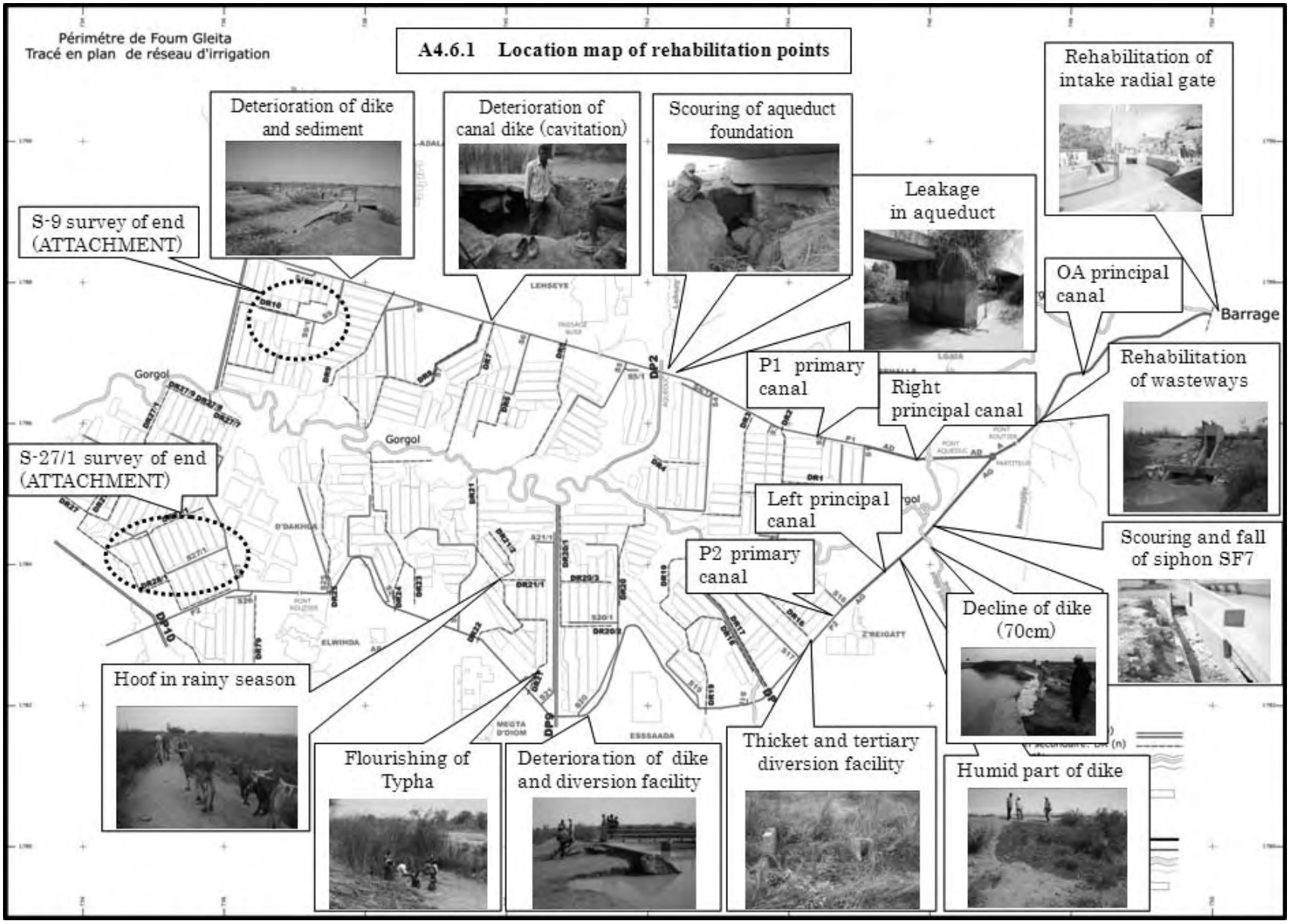
A4.6 Location map of rehabilitation points of principal facilities

Location map of rehabilitation points of principal facilities in Foum Gleita irrigation area is shown in following table.

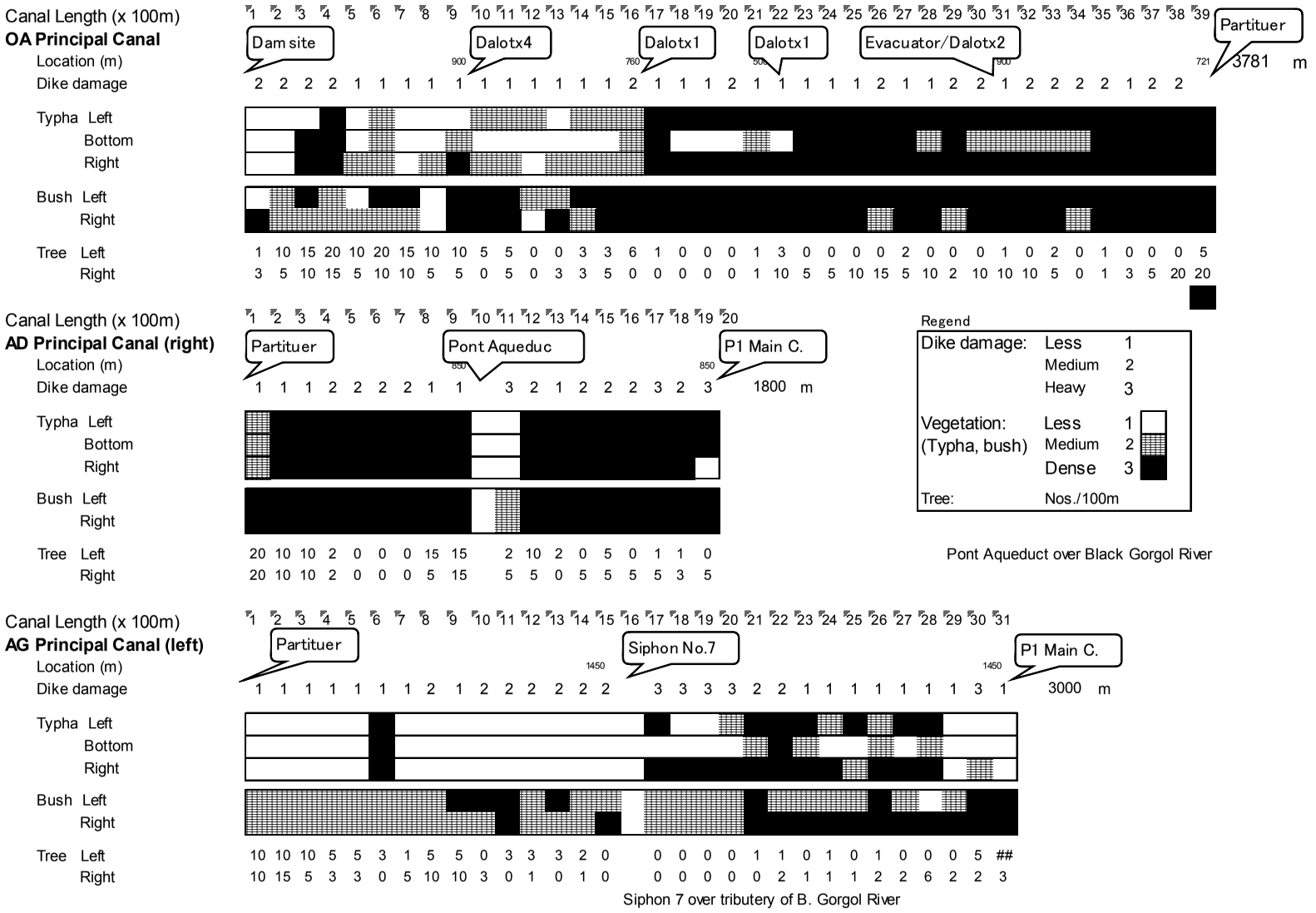
Main problems and measures are as below.

(1) Works needed urgent measures

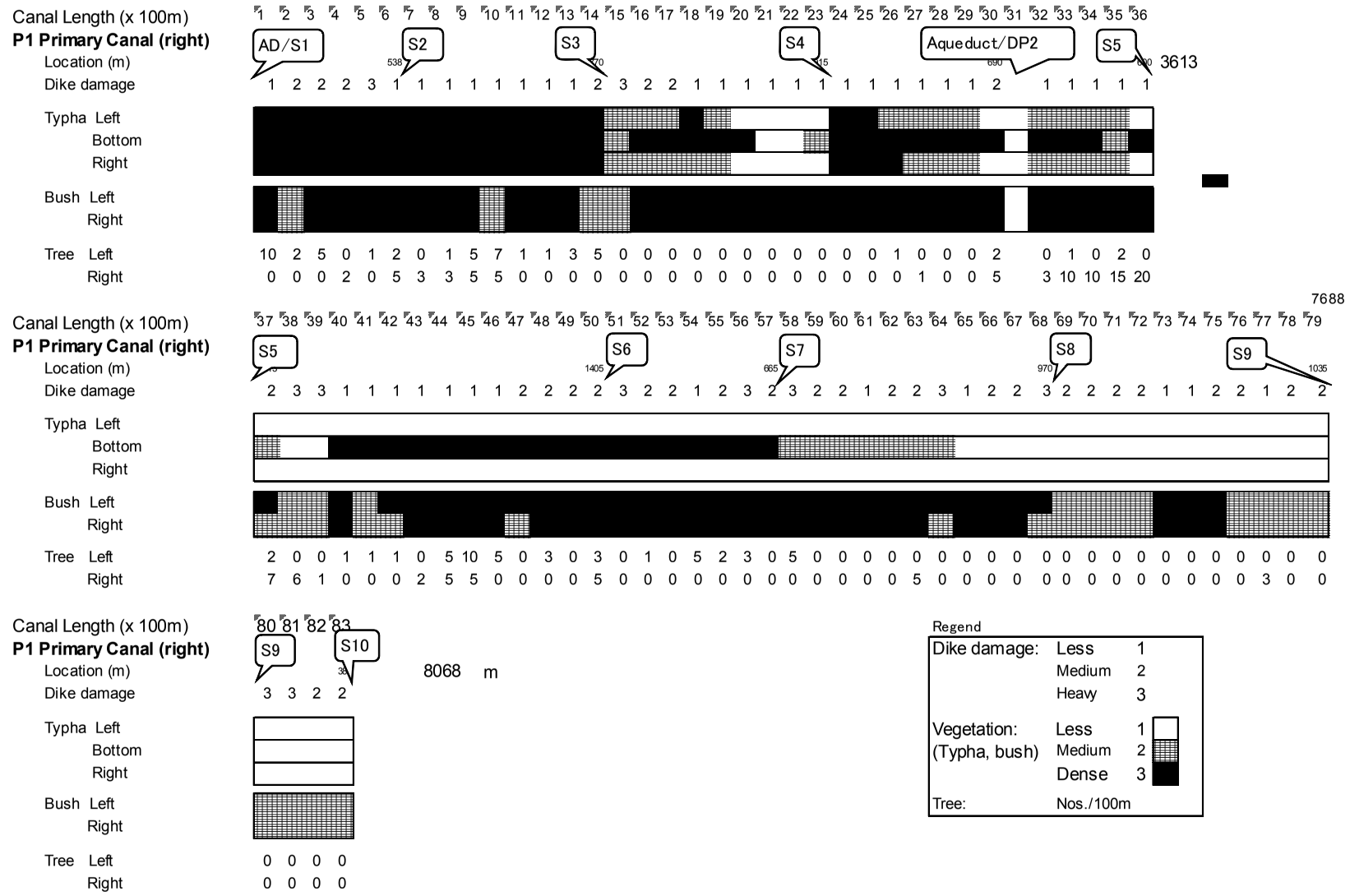
Facility	State	Measure	Problem
Siphon SF7	Leakage, scouring・cavitation, fall of spillway	Earthwork, reinforced-concrete work	If the measure is late, stop the water supply in left bank (1,134ha)
Aqueduct AQ	Leakage, scouring・cavitation	Earthwork, reinforced-concrete, gabion works	If the measure is late, stop the water supply in left bank (592ha)
Elimination of Typhus, thicket and sediment	Reduction of cross sectional area of	Cut down, uprooting, earthwork	Reduction of irrigated area
Canal dike	Deteriorated of dike	Earthwork	Overflow and leakage from dike
Intake radial gate in downstream of dam	Leakage	Exchange of hydraulic system, water-stopping rubber, remove the rust, repainting	Actually manual operation
Principal and primary canal dike	Damaged by livestock	Protect all area with fence	Principal cause of deterioration of dike
Principal and primary canal dike	Damaged by livestock	Installation of water troughs × 25 places	Principal cause of deterioration of dike
Principal and primary canal dike	Washhouse	Earthwork, reinforced-concrete work	
Principal canal dike	Flourishing of Typha, Thicket	Reinforced-concrete lining of principal canal	Management by cooperative is difficult because canal scale is big and far distant
Other facility and gate of principal and primary canal	Partially deteriorated	Reinforced-concrete・hardware・painting work	Leakage
Origin of OA principal canal	Catchment drainage and flow of sediment	Establish box-culvert	Sediment, overflow from downstream canal
Secondary canal	Partially deteriorated	Reinforced-concrete・hardware・painting work, earthwork	Leakage
Drainage outlet	Poor drainage	Earthwork	It is necessary to dredge every year
Road	Flourishing of Thicket in road for collecting cargo	Cutting the thicket and partially reparation	Transport for collect farm products after completion is difficult
Tertiary canal	Deteriorated	Restoration by participatory maintenance	Annual routine work


Périmétre de Foum Gleita
Tracé en plan de réseau d'irrigation
A4.6.1 Location map of rehabilitation points
Deterioration of dike and sediment
Deterioration of canal dike (cavitation)
Scouring of aqueduct foundation
Rehabilitation of intake radial gate
Leakage in aqueduct
S-9 survey of end (ATTACHMENT)
OA principal canal
Barrage
P1 primary canal
Right principal canal
Rehabilitation of wasteways
S-27/1 survey of end (ATTACHMENT)
Left principal canal
Scouring and fall of siphon SF7
P2 primary canal
Decline of dike (70cm)
Hoof in rainy season
Flourishing of Typha
Deterioration of dike and diversion facility
Thicket and tertiary diversion facility
Humid part of dike
Gorgol
LEHSEYE
D'AKHOR
ELWIHDA
Z'REIGATT
MEGTA D'OUM
ESSSAADA

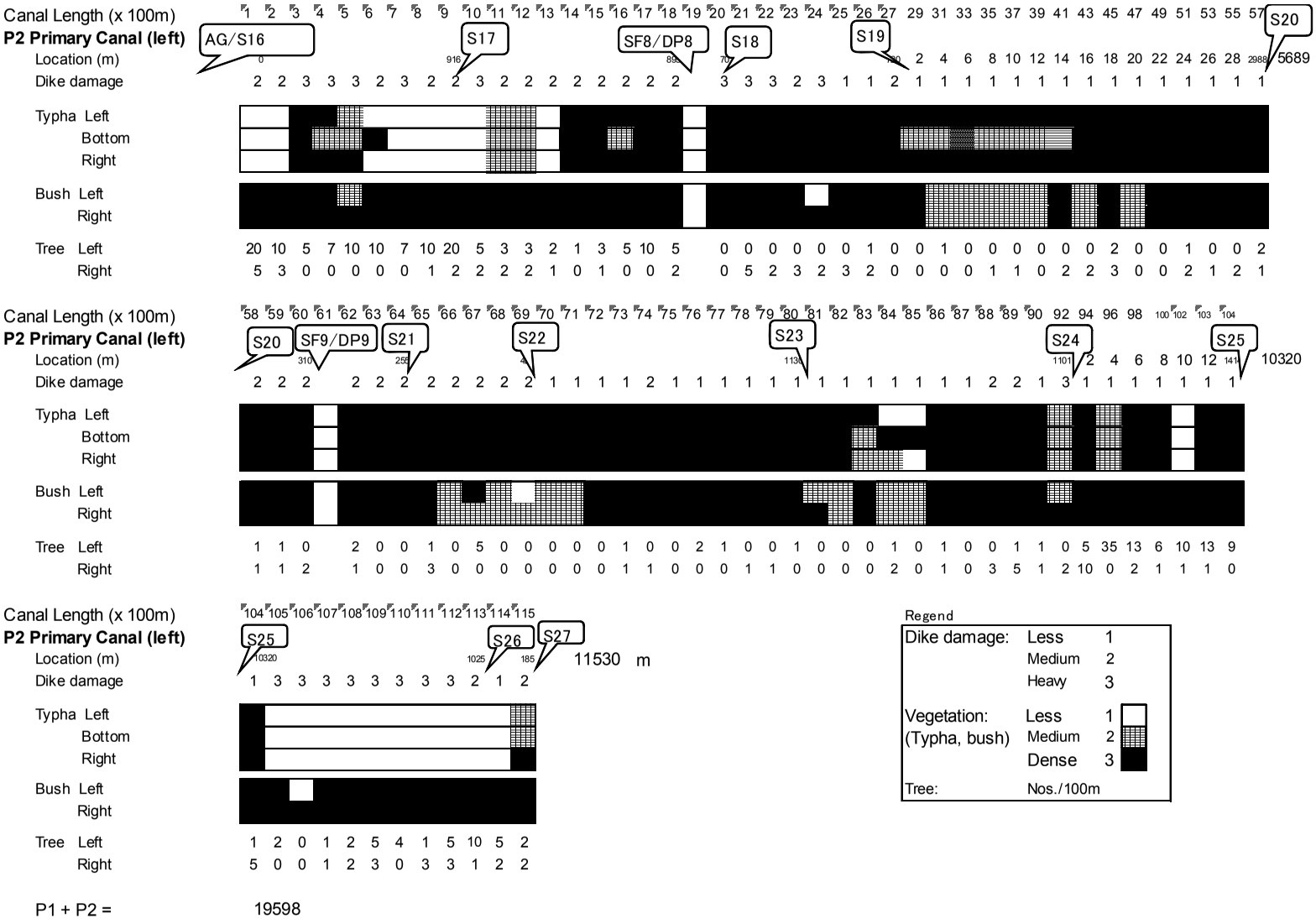
A4.7.1 Present Canal Condition (Vegetation and Dike of Principal Canal OA, AD and AG)



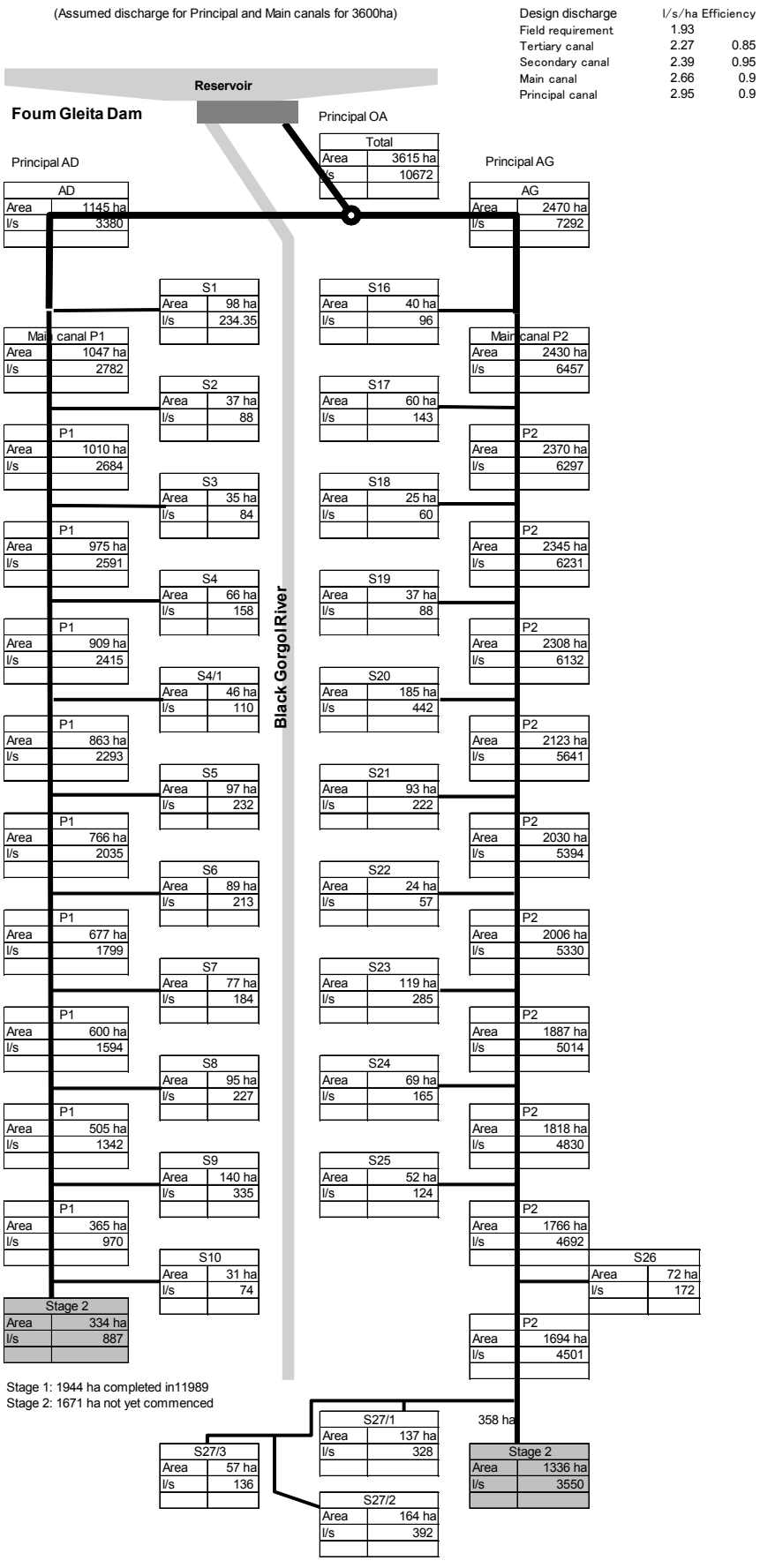
A4.7.2 Present Canal Condition (Vegetation and Dike of Primary Canal P1



A4.7.3 Present Canal Condition (Vegetation and Dike of Primary Canal P2



A4.8.1 Irrigation System Diagram for Foum Gleita Irrigation Project (3600ha)

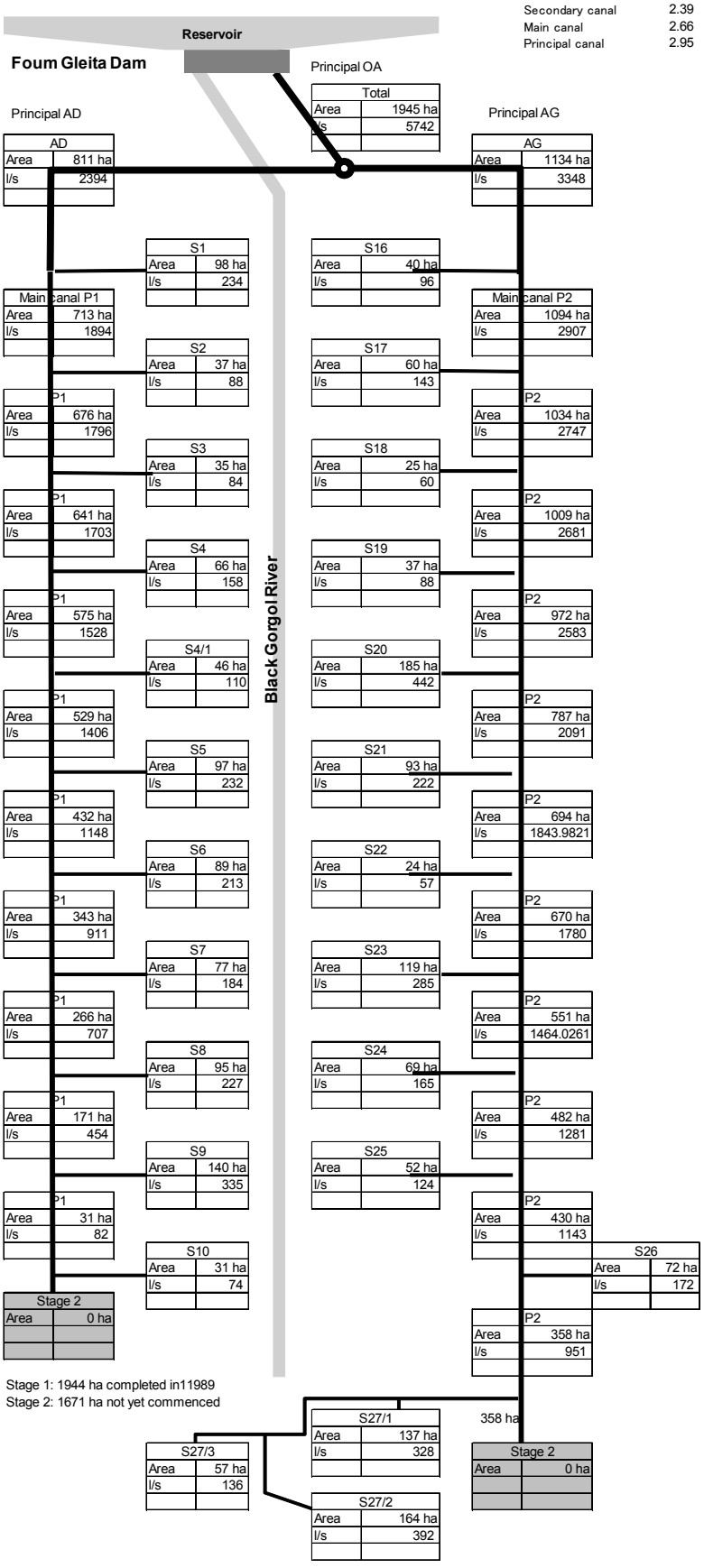


Source: Estimated by JICA Study Team based on available data in SONADER.

A4.8.2 Irrigation System Diagram for Foum Gleita Irrigation Project (1950ha)

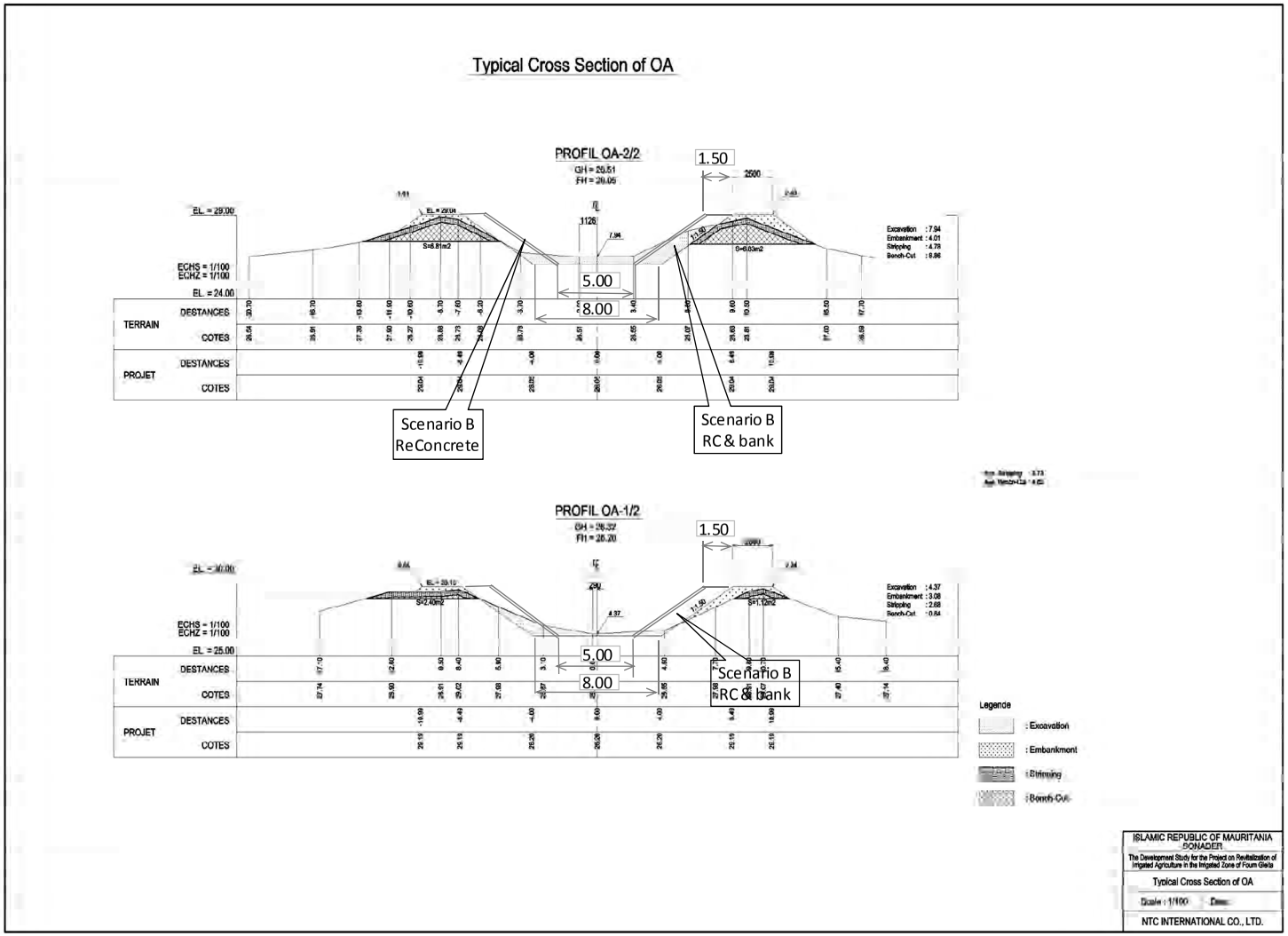
(Design discharge for Principal and Main canals for 1950ha)

Design discharge	l/s/ha	Efficiency
Field requirement	1.93	
Tertiary canal	2.27	0.85
Secondary canal	2.39	0.95
Main canal	2.66	0.9
Principal canal	2.95	0.9

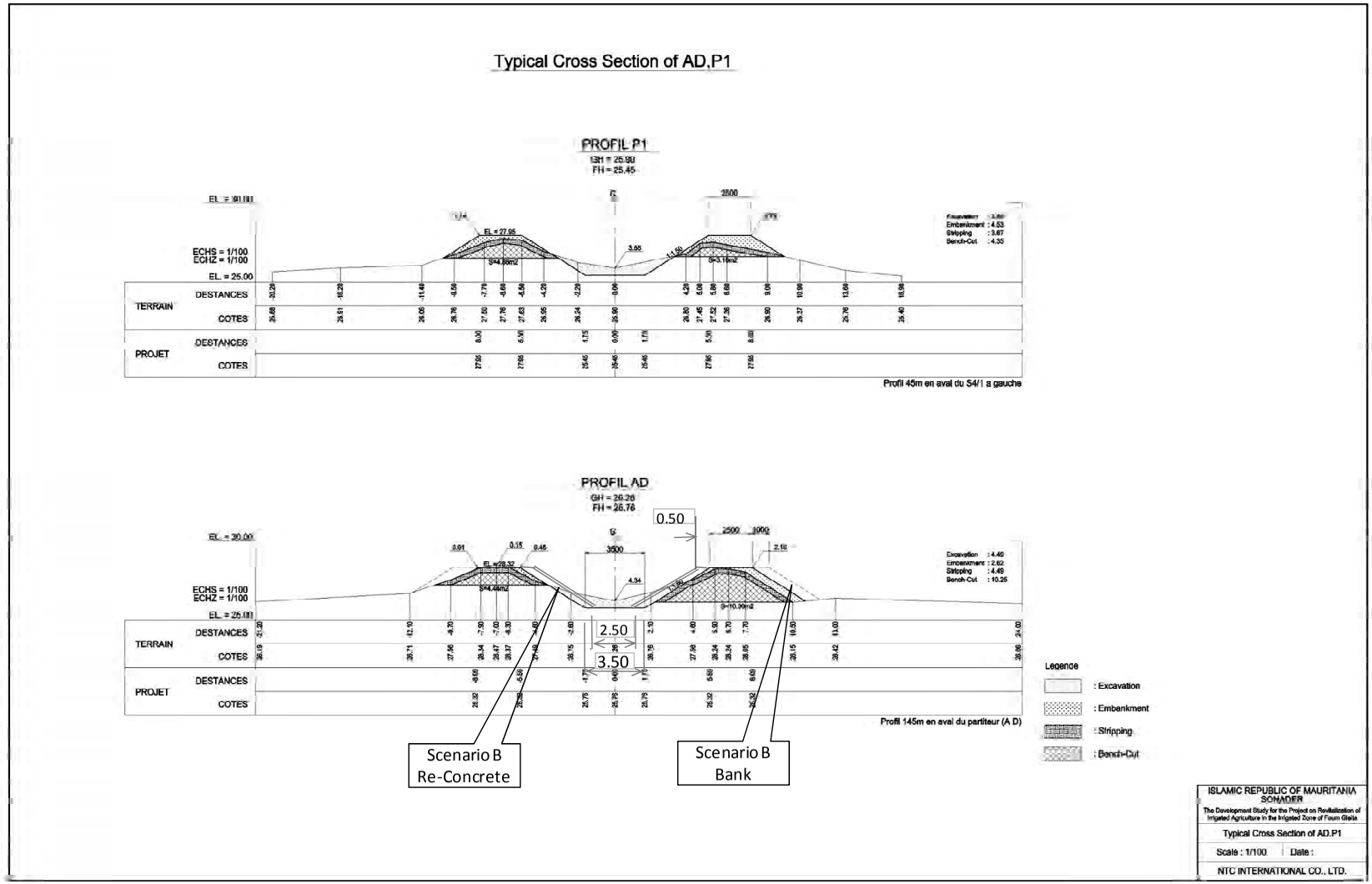


Source: Estimated by JICA Study Team based on available data in SONADER.

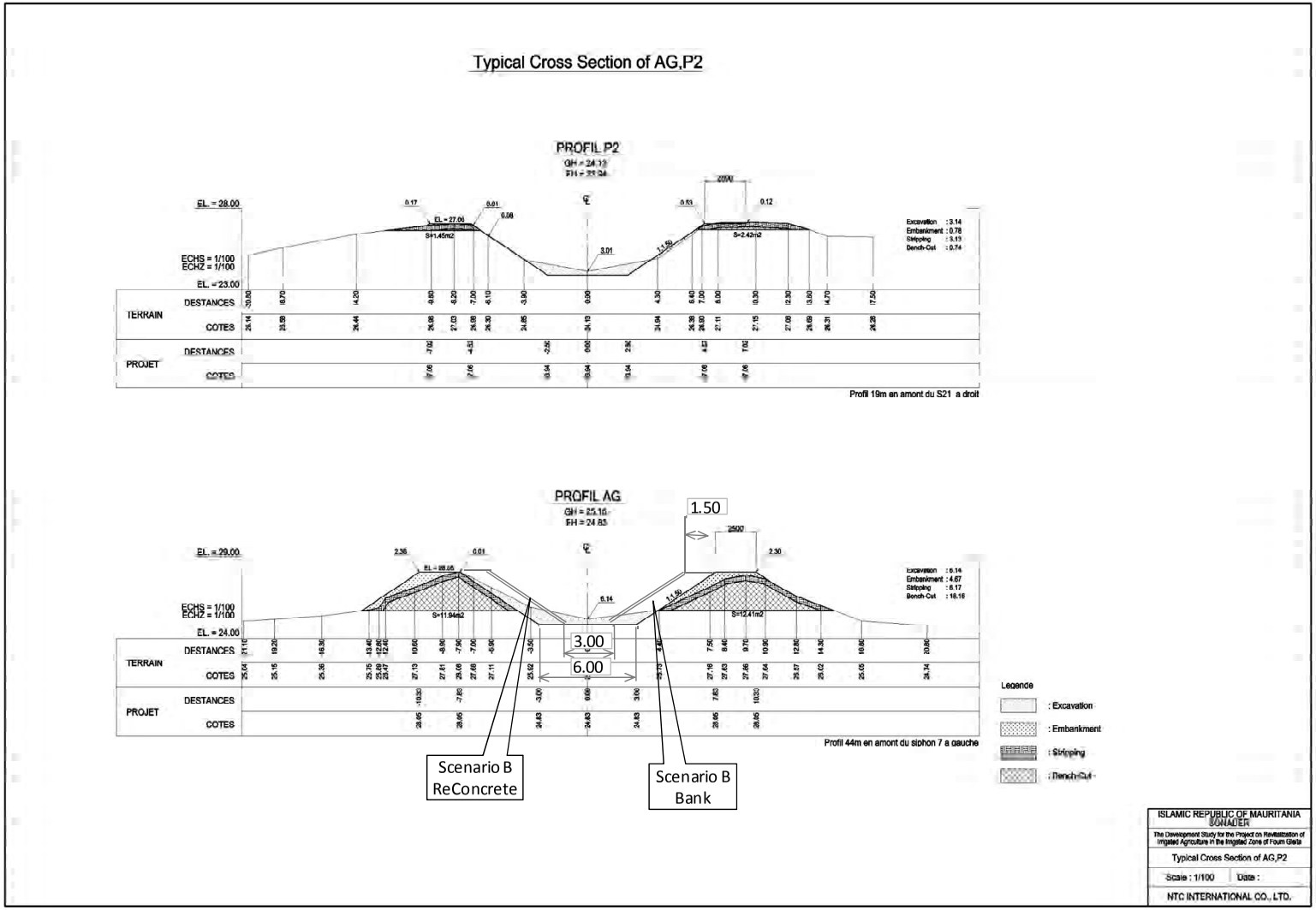
A4.9.1 Typical cross section of OA principal canal



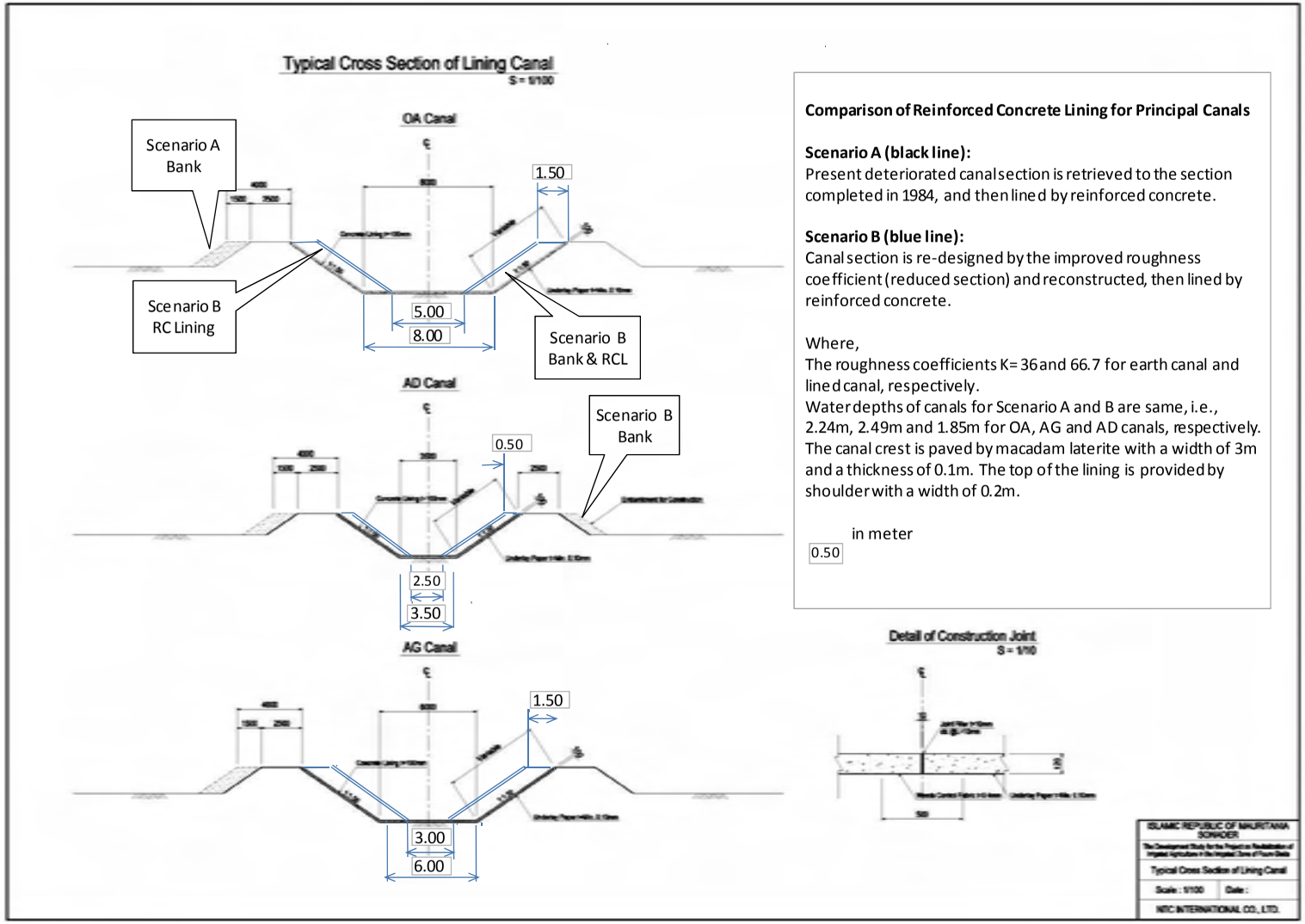
A4.9.2 Tipical cross section of AD, P1 canal



A4.9.3 Tipical cross section of AD, P2 canal

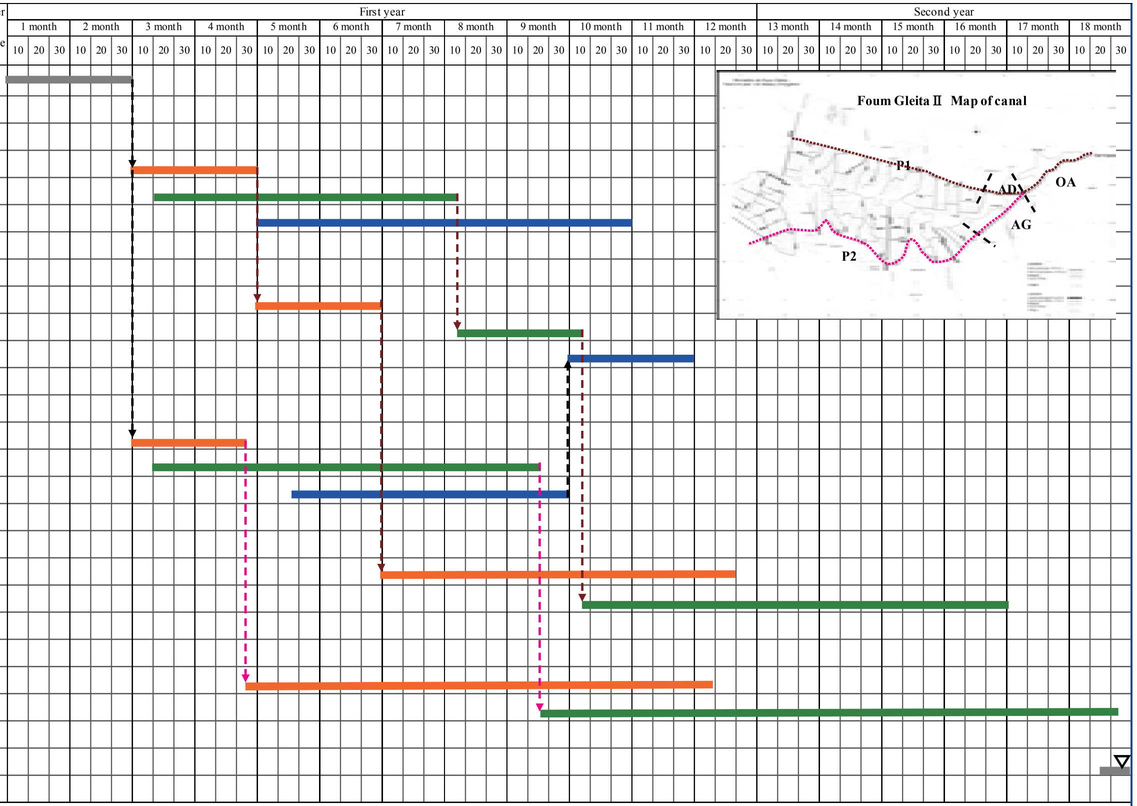


A4.9.4 Tipical cross section of lining canal



A4.10 Mauritania Foum Gleita Ⅱ work schedule（alternative plan）

Works	Quantity	Capacity	Set number	Actual number of days	Number of available day
1. Preparation work (included importation of machines)					60
2. OA canal L=3,781m					
1) Excavation work (sediment)	18,709 m^3	210	2	45	61
2) Banking work (side slope)	44,548 m^2	70	6	106	145
3) Concreat work	8,976 m^3	68	1	132	180
3. AD canal L=1,821m					
1) Excavation work (sediment)	5,820 m^3	210	1	28	38
2) Banking work (side slope)	18,632 m^2	70	6	44	60
3) Concreat work	3,001 m^3	68	1	44	60
4. AG canal L=3.005m					
1) Excavation work (benchcut)	27,285 m^3	224	3	41	55
2) Banking work (side slope)	37,899 m^2	70	4	135	185
3) Concreat work	6,713 m^3	68	1	99	135
5. P1 canal L=8,180m					
1) Excavation work (sediment)	25,716 m^3	210	2	61	83
2) Banking work (BD3t)	54,683 m^3	91	4	150	205
6. P2 canal L=11,805m					
1) Excavation work (sediment)	64,533 m^3	210	2	154	210
2) Banking work (BD3t)	113,082 m^3	91	4	311	424
7. Finishing work					15



Remark:

The work is conducted as folowing order
First group OA→AD→P1 (▪▪▪▪▪▪▪▪)
Second group AG→P2 (▪▪▪▪▪▪▪▪)

※Work suchedule in case of no use heavy machine in P1, P2 as alternative plan

Machinery	1 month 10	20	30	2 month 10	20	30	3 month 10	20	30	4 month 10	20	30	5 month 10	20	30	6 month 10	20	30	7 month 10	20	30	8 month 10	20	30	9 month 10	20	30
1. BH0.8m3				0	4	4	15	30	30	30	30	32	25	25	25	25	22	22	22	22	22	26	26	26	26	29	22
2. BD20t							6	6	6	6	6	5	2	2	2	4	4	4	7	7	7	7	7	7	8	8	8
3. DT10t				0	0	0	6	14	14	14	14	19	22	22	22	22	22	22	13	13	13	18	27	27	27	27	23
4. BD21t								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
5. TR8-20t								2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
6. BD3t																						4	4	4	4	11	11
7. TR3-4t																						4	4	4	4	11	11
8. T60-80Kg					40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40
9. Agitator car													2	4	4	4	4	4	4	4	4	4	4	4	4	4	4
10. Concreat plant													1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Machinery	10 month 10	20	30	11 month 10	20	30	12 month 10	20	30	13 month 10	20	30	14 month 10	20	30	15 month 10	20	30	16 month 10	20	30	17 month 10	20	30	18 month 10	20	30
1. BH0.8m3	24	22	16	16	16	16	15	13	13	13	13	13	13	13	13	7	7	7	7	7	7	7	7	7			
2. BD20t	7	6	6	3	3	3	1	1	1	1																	
3. DT10t	28	25	25	25	25	25	25	25	20	15	15	15	11	11	11	11	11	11	11	11	11	6	6	6	6	6	6
4. BD21t	1																										
5. TR8-20t	1																										
6. BD3t	15	15	15	15	15	15	15	15	15	15	15	15	15	11	11	11	11	11	11	11	11	7	7	7	7	7	7
7. TR3-4t	15	15	15	15	15	15	15	15	15	15	15	15	15	11	11	11	11	11	11	11	11	7	7	7	7	7	7
8. T60-80Kg	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40	40		
9. Agitator car	4	4	4	2	2	2																					
10. Concreat plant	1	1	1	1	1	1																					

Source: Estimated by JICA Study Team, 2010

A4.11 Rehabilitation cost

Work Item	Cost (mMO)	Cost+PC (mMO)	FEX rate %	FEX (mMO)	LEX (mMO)	Econ. LEX (mMO)	First year %	FY FEX (mMO)	FY LEX (mMO)	FY Total (mMO)	2ndY FEX (mMO)	2ndY LEX (mMO)	2Y total (mMO)	G. Total (mMO)
Rehabilitation Work														
Preparatory work	241.2	265.3	72.0	191.0	74.3	65.0	90.0	171.9	58.5	230.4	19.1	6.5	25.6	256.1
Irrigation canal	3,147.1	3,461.8	42.3	1,464.3	1,997.4	1,747.8	80.0	1,171.5	1,398.2	2,569.7	292.9	349.6	642.4	3,212.1
Related structures	123.8	136.2	31.4	42.8	93.5	81.8	80.0	34.2	65.4	99.6	8.6	16.4	24.9	124.6
Farm road	84.4	92.8	60.0	55.7	37.1	32.5	60.0	33.4	19.5	52.9	22.3	13.0	35.3	88.2
Drainage canal	151.0	166.1	60.0	99.7	66.5	58.2	60.0	59.8	34.9	94.7	39.9	23.3	63.1	157.8
Miscellaneous work	177.9	195.7	60.0	117.4	78.3	68.5	60.0	70.4	41.1	111.5	47.0	27.4	74.4	185.9
Urgent additional work	294.5	323.9	60.0	194.4	129.6	113.4	60.0	116.6	68.0	184.6	77.7	45.4	123.1	307.7
Sub total	4,219.9	4,641.9	46.6	2,165.3	2,476.6	2,167.0		1,657.9	1,685.6	**3,343.5**	507.4	481.4	**988.8**	**4,332.3**
Physical contingency (PC) 10%	422.0													
Total	4641.9													
Price contingency (5%/year)	268.5									167.2			101.4	268.5
Grand total excluding tax	4,910.4													
and custom duty														

Cost of water supply for 4500 people (MO 38.5 million) by water rolly and for the existing pump station to Base Vie at S20 (MO 80 million) are included in the Preparatory Work.
The foreign exchange rate (FEX) in APD2 is applied.
The conversion factor of 0.875 (average of 0.85 for common labor and 0.90 for others in APD2) is applied to the Local Exchange (LEX) rate.
Proportion of the first year construction cost is estimated from the construction schedule.
Physical contingency of 10% in APD2 is applied.
Price escalation factor of 5% per annum is estimated and applied on the basis of the IMF project to both FEX and LEX portions.

A4.11(2) Financial and Economic Cost for Foum Gleita Irrigation Rehabilitation Project (Allocated by 1950/3600 ha)

Work Item	Cost (mMO)	Cost+PC (mMO)	FEX rate %	FEX (mMO)	LEX (mMO)	Econ. LEX (mMO)	First year %	FY FEX (mMO)	FY LEX (mMO)	FY Total (mMO)	2ndY FEX (mMO)	2ndY LEX (mMO)	2Y total (mMO)	G. Total (mMO)
Rehabilitation Work														
Preparatory work	241.2	265.3	72.0	191.0	74.3	65.0	90.0	171.9	58.5	230.4	19.1	6.5	25.6	256.1
Irrigation canal	1,853.3	2,038.6	42.3	862.3	1,176.3	1,029.2	80.0	689.9	823.4	1,513.2	172.5	205.8	378.3	1,891.6
Related structures	123.8	136.2	31.4	42.8	93.5	81.8	80.0	34.2	65.4	99.6	8.6	16.4	24.9	124.6
Farm road	84.4	92.8	60.0	55.7	37.1	32.5	60.0	33.4	19.5	52.9	22.3	13.0	35.3	88.2
Drainage canal	151.0	166.1	60.0	99.7	66.5	58.2	60.0	59.8	34.9	94.7	39.9	23.3	63.1	157.8
Miscellaneous work	177.9	195.7	60.0	117.4	78.3	68.5	60.0	70.4	41.1	111.5	47.0	27.4	74.4	185.9
Urgent additional work	159.5	175.5	60.0	105.3	70.2	61.4	60.0	63.2	36.8	100.0	42.1	24.6	66.7	166.7
Sub total	2,791.1	3,070.2	48.0	1,474.2	1,596.0	1,396.5		1,122.9	1,079.6	**2,202.5**	351.3	316.9	**668.3**	**2,870.7**
Physical contingency (PC) 10%	279.1													
Total	3070.2													

A4.12 Estimated cost of construction

A4.12.1 Foum Gleita rehabilitation cost

Désignation			Total HT/HD (UM)
Série 10	**TRAVAUX PREPARATOIRES**		**241,220,000**
Série 20	**TRAVAUX DE REHABILITATION DES CANAUX ET DRAINS**		**3,147,054,700**
	Canaux principal et primaires		2,822,826,100
	Canaux secondaires		267,588,600
	Canaux d'irrigation tertiaires		56,640,000
Série 30	**TRAVAUX DE REALISATION ET DE REHABILITATION DES OUVRAGES**		**123,848,200**
	Canaux principal et primaires		117,334,600
	Canaux secondaires		1,203,600
	Canaux d'irrigation tertiaires		5,310,000
Série 40	**TRAVAUX DES PISTES DIGUES ET AMENAGEMENTS DES PARCELLES**		**84,370,000**
	Pistes		84,370,000
	Parcelles et amenagemens des parcelles		0
Série 50	**TRAVAUX DE REHABILITATION DU RESEAU DE DRAINAGE**		**151,040,000**
	Terrassements		92,040,000
	Profilage et curage des drains tertiaires		59,000,000
Série 60	**TRAVAUX DIVERS**		**177,885,000**
	Canaux principal et primaires		36,285,000
	Parcelles		141,600,000
Série 70	**Travaux supplémentaires urgents (après 2007)**		**294,481,600**
	Canaux principal et primaires (Réhabilitation de siphon, pont aqueduc, barrieres en grillage, vanne radial)		
Total Général			**4,219,899,500**

BORDEREAU DES PRIX ET DETAIL ESTIMATIF					
PERIMETRE DE FOUM GLEITA					
TRAVAUX PREPARATOIRES					
N° des prix	**Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)**	**Unité**	**Qté**	**PU HT/HD (UM)**	**Total partiel en UM (HT/HD)**
10.00	**INSTALLATION DE CHANTIER**	Ft	1	70,800,000	70,800,000
10.02	**ETABLISSEMENT DES PLANS ET DES ETUDES D' EXECUTION**	Ft	1	44,840,000	44,840,000
10.03	**Deux camions-citerne d'eau pour 4,500 personnes pendant 15 mois**	Ft	1	38,500,000	38,500,000
	Installation provisoire d'approvisionnement en eau vers le systè	Ft	2	80,000,000	80,000,000
10.04	**CONSTRUCTION ET EQUIPEMENT DU LOCAL DE GESTION**	U	1	7,080,000	7,080,000
TOTAL SERIE 10					**241,220,000**

A4.12.2 Foum Gleita rehabilitation cost ②

Travaux de réhabilitation des canaux et drains

N° des prix	Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)	Unité	Qté	PU HT/HD (UM)	Total partiel en UM (HT/HD)
Canaux principal et primaires					
20.02	**Déblai ordinaires**	m 3	313,700	1,534	481,215,800
20.04	**Terrassements en remblais**	m 3	369,791	2,500	924,477,500
20.06	**Bétonnage des canaux d'irrigation primaires**	m3	12,863	106,200	1,366,050,600
20.12	Construction d'ouvrage pour franchissement de canaux primaires et principal ou drains (Dalot, abreuvoir, Lavoir)	m3	450	112,100	50,445,000
20.14	**Curage des Passages Busés existants.**				
20.14.02	Ouvrage de franchissement existant de diamètre ou base (dalot) variable y compris toutes sujétions.	U	0	11,800	-
20.16	**Entretien des ouvrages de dérivation**				
20.16.02	Ouvrage de dérivation (départ) sur canal y compris toutes sujétions.	U	0	23,600	-
20.18	**Curage des siphons de traversées**				
20.18.02	Siphons SF 7	Ens	1	11,800	11,800
20.18.04	Siphon SF 8	Ens	1	11,800	11,800
20.18.06	Siphon SF 9	Ens	1	11,800	11,800
20.18.08	Aqueduct	Ens	1	11,800	11,800
20.20	**Curage de l'ouvrage Pont-Canal de traversée du Gorgol sur 60 ml de longueur**				
20.20.02	Ouvrage conçu en dalot double (4m x 4 m)	Ens	1	590,000	590,000
Canaux secondaires					
20.02	Déblai ordinaires	m 3	55,000	1,534	84,370,000
20.04	Terrassements en remblais	m 3	45,000	1,416	63,720,000
20.08	Revêtement des canaux secondaires en amont et aval des ouvrages de traversée existants et projetés	m3	1000	112,100	112,100,000
20.12	Construction d'ouvrage pour franchissement de canaux secondaires	m3	50	112,100	5,605,000
20.14	Ouvrage de franchissement existant de diamètre ou base (dalot) variable y compris toutes sujétions.	U	52	11,800	613,600
20.16	Ouvrage de dérivation (départ) sur canal y compris toutes sujétions.	U	50	23,600	1,180,000
					-
Canaux d'irrigation tertiaires					
20.10	Profilage et curage des canaux d'irrigation tertiaires	ml	120,000	472	56,640,000
TOTAL SERIE 20					**3,147,054,700**

Travaux de réalisation et de réhabilitation des ouvrages

N° des prix	Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)	Unité	Qté	PU HT/HD (UM)	Total partiel en UM (HT/HD)
30.02	**APPAREILLAGE HYDRAULIQUE: Hydraulic equipment**				
Canaux d'irrigation tertiaires					
30.02.02	Module à Masque X2 pour un débit de 30 l/s	Unité	10	59,000	590,000
30.02.04	Module à Masque X2 pour un débit de 60 l/s	Unité	10	118,000	1,180,000
30.02.06	Module à Masque X2 pour un débit de 90 l/s	Unité	10	165,200	1,652,000
30.10	Remise en état des pièces spéciales dans les ouvrages de départ des canaux d'irrigation tertiaires.	U	60	29,500	1,770,000
30.04	Fournitures et installations d'échelles limnimétriques	ml	10	11,800	118,000
Canaux secondaires					
30.08	Remise en état des pièces spéciales dans les ouvrages de départ des canaux d'irrigation secondaires	U	23	47,200	1,085,600
30.04	Fournitures et installations d'échelles limnimétriques	ml	10	11,800	118,000
Canaux principal et primaires					
30.02.08	**Fourniture, transport, montage, calage, essais et mise en ordre de marche, y compris béton de scellement calage, essais et toutes sujestions.**	Unité	50	35,400	1,770,000
30.04	**Fournitures et installations d'échelles limnimétriques**				
30.06	**Remise en état des vannes murales de l'ouvrage de tête situé à l'aval du barrage**	Ens	1	236,000	236,000
30.08	**Remise en état des pièces spéciales dans les ouvrages de départ des canaux d'irrigation secondaires**	Secondaires			
30.10	**Remise en état des pièces spéciales dans les ouvrages de départ des canaux d'irrigation tertiaires.**	Tertiaires			
30.12	**Béton de structutre**	m3	50	118,000	5,900,000
30.14	**Béton de propreté**	m3	80	82,600	6,608,000
30.16	**Acier pour Béton**	Kg	4800	472	2,265,600
30.18	**Fourniture et mise en oeuvre de perré sec.**	m3	250	11,800	2,950,000
30.20	**Fournitures et Mise en oeuvre de perré Maçonné.**	m3	500	9,440	4,720,000
30.22	**Fournitures et Mise en oeuvre de gabions**	m3	50	17,700	885,000
30.24	**Réalisation des aires de repos en béton armé**	Unité	40	2,300,000	92,000,000
TOTAL SERIE 30					**123,848,200**

A4.12.3 Foum Gleita rehabilitation cost ③

Travaux des pistes digues et aménagements des parcelles

N° des prix	Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)	Unité	Qté	PU HT/HD (UM)	Total partiel en UM (HT/HD)
Pistes					
40.02	**Réfection de Pistes principales et secondaires**	m2	100,000	472	47,200,000
40.04	**Réalisation de nouvelle piste**	m2	35,000	1,062	37,170,000
Parcelles					
40.06	**Nivellement et Planage des Parcelles**				
40.06.02	Nivellement et Planage des Parcelles (600ha)	ha	0	141,600	-
40.06.04	Exécution de diguettes dans les blocs du riz (8000m)	ml	0	354	-
TOTAL SERIE 40					**84,370,000**

Travaux de réhabilitation du réseau de drainage

N° des prix	Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)	Unité	Qté	PU HT/HD (UM)	Total partiel en UM (HT/HD)
Drainage					
50.02	**Profilage et curage des drains principaux et secondaires**	m 3	150,000	472	70,800,000
50.04	**Terrassements en remblais**	m 3	60,000	354	21,240,000
Drains tertiaires					
50.06	**Profilage et curage des drains tertiaires**				
50.06.02	Drain tertiaires de section trapézoidale	ml	200,000	295	59,000,000
TOTAL SERIE 50					**151,040,000**

Travaux divers

N° des prix	Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)	Unité	Qté	PU HT/HD (UM)	Total partiel en UM (HT/HD)
Parcelles					
60.02	**Débroussaillement**	ha	1000	141,600	141,600,000
Canaux principal et primaires					
60.04	**Clôture Du partiteur principal circulaire**	ml	0	14,020	-
60.06	**Prix pour la réalisation d'ouvrages divers**				
60.06.02	**Béton: Concrete**				
60.06.02.02	Béton vibré, dosé à 250 kg HRS pour fondation, radier non armé, enrobage, branchage.	m3	50	112,100	5,605,000
60.06.02.04	Béton vibré, dosé à 300 kg HRS, y compris ferraillage.	m3	50	118,000	5,900,000
60.06.02.06	Béton vibré, dosé à 350 kg HRS, y compris ferraillage.	m3	50	141,600	7,080,000
60.06.02.08	Béton préfabriqué dosé à 400 kg HRS, y compris ferraillage.	m3	50	177,000	8,850,000
60.06.04	**Mortier: Mortar**				
60.06.04.02	Mortier M1 pour enduit é tanche dos é à 500 kg y compris adjuvant	m2	50	47,200	2,360,000
60.06.04.04	Mortier M2 pour enduit ordinaire dosé à 400 kg	m2	50	41,300	2,065,000
60.06.04.06	Mortier M3 pour enduit inférieur dosé à 300 kg	m2	50	35,400	1,770,000
60.06.04.08	Mortier M4 pour enduit sur maçonnerie ordinaire sauf scellement	m2	50	5,900	295,000
60.06.04.10	Mortier M5 de chaux pour enduit extérieur	m2	50	5,900	295,000
60.06.06	Construction de maçonnerie y compris mortier de rejointement	m3	50	11,800	590,000
60.06.08	La pelle mécanique	h	50	11,800	590,000
60.06.10	Le camion	h	50	11,800	590,000
60.06.12	Le maçon	j	50	3,540	177,000
60.06.14	L'ouvrier	j	50	2,360	118,000
TOTAL SERIE 60					**177,885,000**

Urgent Work （Additional Work after 2007）

Urgent Work（Additional Work after 2007)					
N° des prix	**Désignation des fournitures (prix unitaires hors taxes et hors douanes en toutes lettres)**	**Unité**	**Qté**	**PU HT/HD (UM)**	**Total partiel en UM (HT/HD)**
TRAVAUX DE REHABILITATION DES CANAUX Principal et Primary					
70.02	Rehabilitation siphon SF7	Ens	1	13,216,000	13,216,000
.70.04	Rehabilitation Aquaduct (P2)	Ens	1	2,265,600	2,265,600
	New construction of dalot OA (double)	Ens	0	318,600	-
.70.06	Cloture	ml	**50,000**	5,000	250,000,000
	Abreuvoirs (double)	Unité	0	949,900	-
	Lavoir (double)	Unité	0	1,424,850	-
.70.08	Rehabilitation vanne radiaux	Ens	1	29,000,000	29,000,000
TOTAL SERIE 70					**294,481,600**

ANNEX 4

ATTACHMENT Terminal irrigation facilities possible to repair with participation of farmers

Irrigation system was completed in 2 stages, namely:

a. First stage development (started to use in 1984)

Canal networks irrigated by the secondary canal S9 & S10 and S27 located at the downstream ends of the northern primary canal P1 and the southern primary canal P2, respectively were completed and started to use in1984. However, now the irrigation water does not reach to S9 (140ha). These, irrigated agriculture isn't generally practiced herein. On the other hand, S27/1(137ha) is the most active area for irrigated agriculture and the largest irrigated area among all secondary areas in the project.

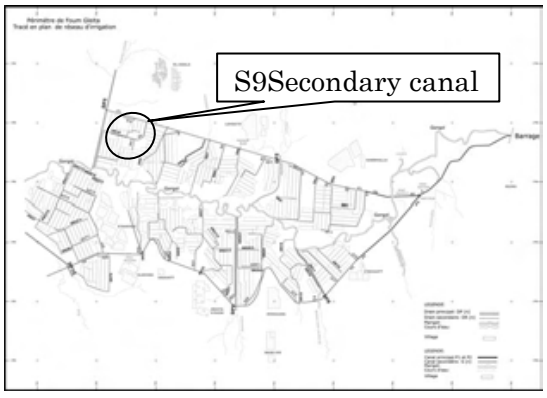
b. Second development (started to use in 1990)

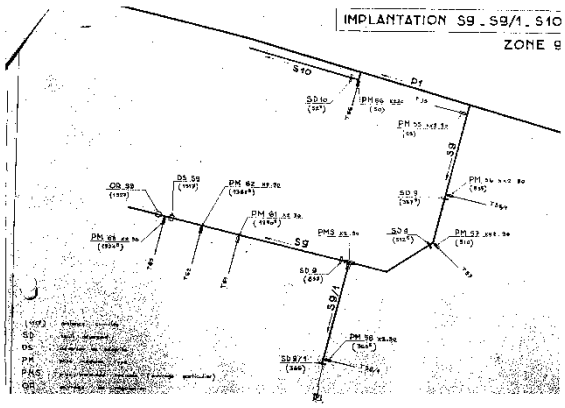
Canal networks irrigated by the secondary canal S1-S8 and S16-S26 located along the P1and P2 primary canal, respectively were completed in 1989 on the heels of the first development and started to use.

In order to judge whether it is possible to implement the maintenance of terminal facility by the farmers' participatory approach, the survey of terminal facility was conducted by JICA study team for the facilities of S9 and S27-1 secondary and tertiary canal systems which were the oldest facilities as developed in the third stage. The survey results reveal that sediment and deterioration of dike are remarkable yet the state of concrete structures is good, accordingly it was judged that if the maintenance of check gate, division box, surrounding dike and so on is diligently conducted by farmers the function can be kept. Therefore it is expected that the facility completed in second stage development is in similar sound and good condition.

(1) S9 Secondary canal facility

S9 Secondary canal system and location map of the facilities are shown as below.





The state of each canal facility is reported with following photos.

a. S9 Primary canal diversion

S9 Primary canal diversion gate and spillway (Right bank)

S9 Primary canal diversion facility (Left bank)

b. S9-1 Secondary canal

Tertiary canal diversion facility (Module Amasuk)

Tertiary canal diversion box

Quaternary canal diversion facility (Removal of sediment, banking and gate of iron plate are necessary)

c. S9.2 Secondary canal diversion (+337.5m)

Drop and diversion regulating gate

Tertiary canal diversion facility (Module Amasuk)

Tertiary canal diversion box

d. S9.3 Secondary canal diversion (+512.5m)

Diversion check gate

Tertiary canal diversion facility
(Module Amasuk)

d. S9.4 Secondary canal diversion(+857m)

Diversion check gate

Tertiary canal diversion facility
(Module Amasuk)

e. S9.5 Secondary canal diversion (+1250.5m)

Secondary canal diversion facility

Tertiary canal diversion facility
(Module Amasuk)

f. S9.6 Secondary canal diversion (+1387.5m)

Secondary canal diversion facility

Cross load facility of tertiary canal

g. S9.7 Secondary canal diversion (+m)

Secondary canal diversion facility

Secondary canal spillway

Tertiary canal diversion facility

Secondary terminal canal diversion facility (Module Amasuk)

h. Other facilities

Farm load along secondary canal

Thicket of farm

i. S9/1 Second canal facility

Drop and diversion check gate

Tertiary canal diversion facility (Module Amasuk)

Diversion facility to tertiary canal

Diversion facility to fourth canal

Farm load along secondary canal

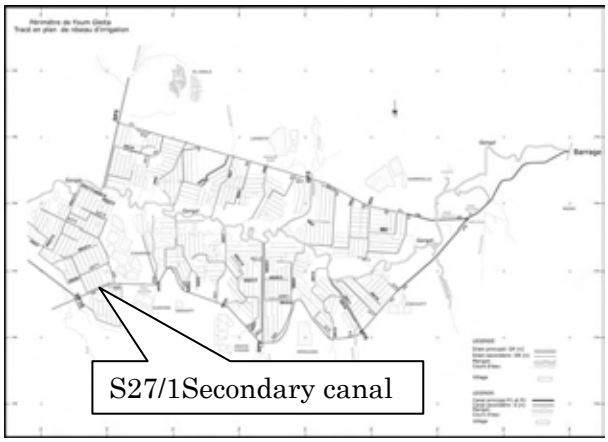
Cross load conduit

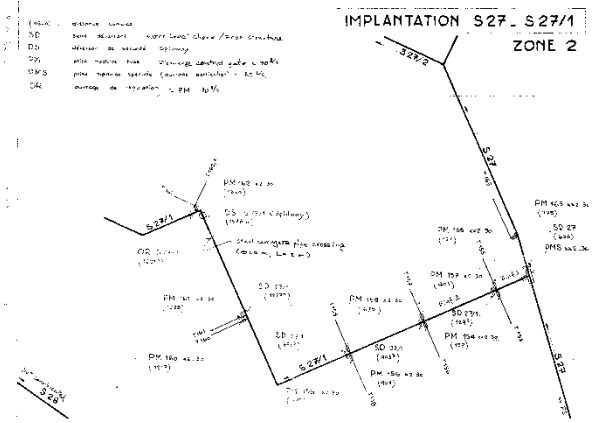
As shown above the study team judged that almost all of the facilities are sufficiently functional by simple maintenance such as removal of sediment and bush, painting of gate, supply of lubricant and so on through participation of farmers in S9 secondary canal (completed in first stage 1984).

Irrigation water doesn't reach to S10 secondary canal at the downstream end of P1 Primary canal for a long time. The S10 secondary canal is covered with sand, yet all of Module Amasuk is still available and functional.

(2) Terminal facility survey S27/1 Secondary canal facility (Nov. 5, 2009)

Terminal survey is conducted in canal derived from S27/1 secondary canal because the location map exists. The positions are shown as following figure. The canal is diverged from upper stream of check gate located 636m downstream from diversion facility to left bank side in upper stream of 3 diverged canal of S27 secondary canal system in the P2 primary terminal canal. Although the S27/1 secondary diverged line area is located in the most terminal, the cultivation is most actively performed in almost irrigated area in Foum Gleita all 27 area.





The result of survey is as follows. As conclusion, the easy works possible by participation of farmers (removal of sediment in the canal, rehabilitation of dike, removal of weed, back filling of side slope protection facility with concrete, rehabilitation of iron plate gate of diversion box in tertiary canal and guide frame) is necessary.

a. The intake gate from P2 primary canal of S 27secondary canal is the only double spindle gate in the district (all of others is single). However, the mate is under repairing. Sediment and deterioration of dike are remarkable in 636m secondary canal yet typha isn't generally exists. Only bush (Toffelhena) exist.

P2 Primary canal
S27 Diversion facility

S27 Diversion facility and
secondary canal in down stream

b. The diversion facility from S27 secondary canal to S27/1 diverged canal is composed from check gate and big PM (Prise Modulee: 5,10,15,30,30,45,45 l/s=180 l/s: net width 180cm). The facility has nothing particular problem.

Upper stream of S27 secondary canal diversion

Big PM to S27/1 secondary diverged canal

c. The total length of secondary diverged canal is about 2km, irrigated area is 137ha. Now irrigated cultivation is performed in the most area. The diverged canal have 5 diversion facilities and cross road conduit made of corrugated pipe (diameter 1.05m, total length 12m), spillway. The diversion facility is composed from check gate and PM (5,10,15 l/s,etc) diversion gate of the upper stream. It was judged that if the maintenance (back filling of facility and gabion to upper and downstream terminal) is conducted by farmers, in future also these diversion gates has no problem on the function. About the cross conduit and spillway also have no problem. It is possible to cope with removal of sediment in canal and weed though cooperative of farmers.

Diversion check gate at 677m point

Diversion PM at 1620m point

Spillway at 1578m point

Cross load conduit at about 200m upper stream from spillway

Almost all of tertiary canal function. However, diversion gate (iron plate) and guide flame are lost or broken in the most diversion box. Diversion is conducted by not discharge but time rotation and then, open and close are conducted in order with iron plate and soil at hand. Therefore for the present problem isn't existed on practical use（according to what the farmer of SONADER department of civil work said）.

Tertiary canal along the diverged line surrounding 1300m

Iron plate gate at hand of tertiary box

Intake water pipe from tertiary to fourth canal

d. Load (width 3m at the lowest) is established along the diverged canal. If the bush is removed, pick up and shipment by small truck is no problem.

Farm load along diverged line 500m

Farm load surrounding 1300m

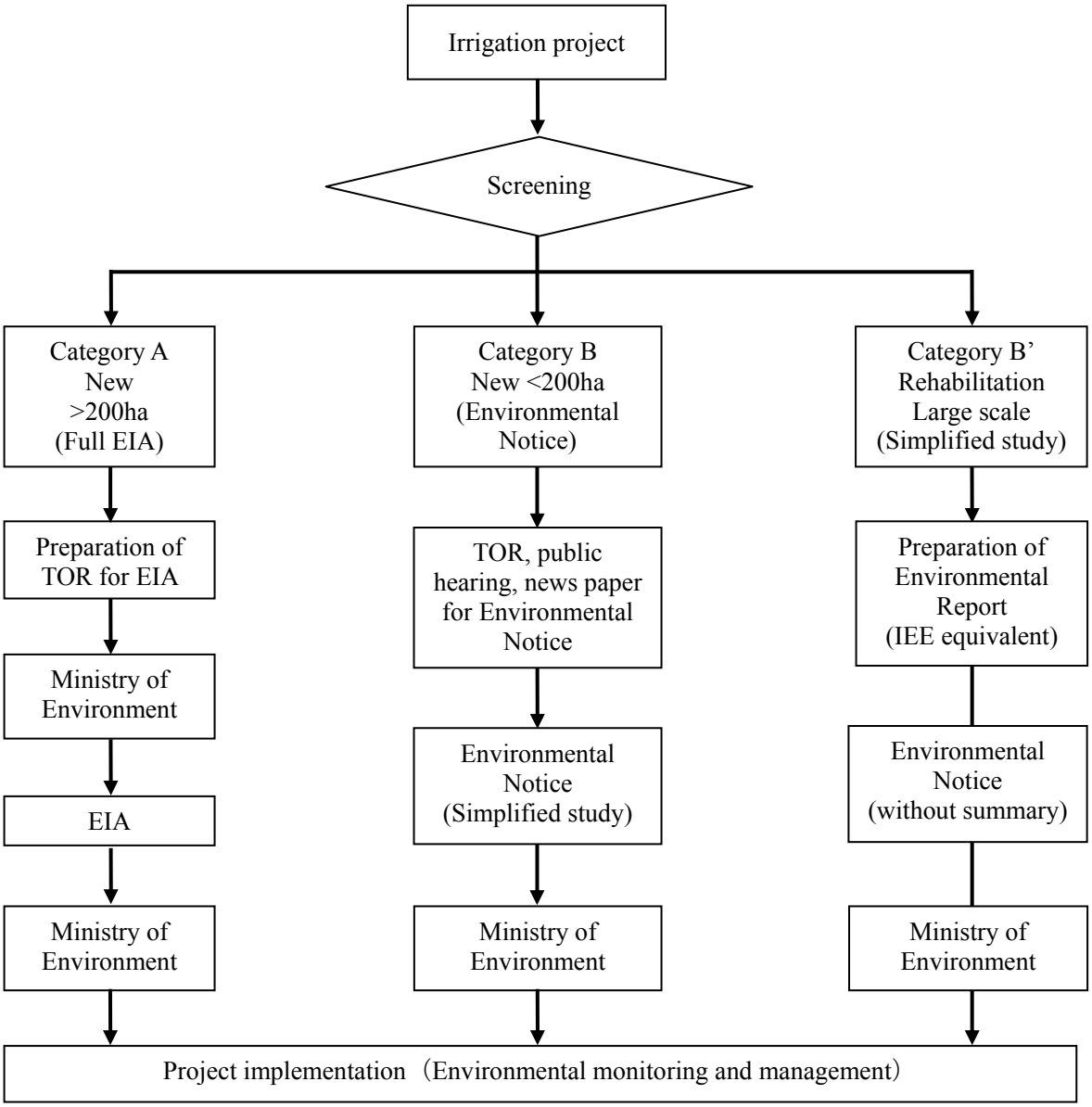
e. It is possible to dump the sediment of terminal facility in the field and around load. It was judged that it is possible to incinerate the bush after drying in around.

ANNEX 5 ENVIRONMENTAL CONSIDERATIONS

A5.1 Process of Environmental Impact Assessment

(1) Flow of environmental examination

The process of EIA and Environmental Notice (same level as IEE) is shown as below.



According to SONADER, the environmental impact assessment is not necessary because the object of the project is rehabilitation of the irrigation facilities to original condition. Therefore similar rehabilitation projects were implemented without meeting with the ministry of environment. However, SONADER and Ministry of Environment has agreed for Foum Gleita project that SONADER will submit a simplified environmental notice for approval of MOE as detailed hereunder.

(2) Procedure of EIA (Category A)

- The developers prepare the terms of reference for the environmental impact assessment or environmental notifications they submit to the Ministry of Environment. The MOE convenes the developer and the competent authorities within 14 days to review the adequacy of the terms of reference and approve (Article 13).
- The implementation of the environmental impact assessment requires the participation of stakeholders such as public administrations, residents and NGOs (Article 17).
- At the end of the study a summary of environmental impact assessment will be published in newspapers and information will be opened to the stakeholders, if any of them require for 30 days after the date of publication (Article 22).
- After this period of 30 days, comments will be accepted for 7 days (Article 23).
- The comments will be studied within 5 days (Article 24).
- The results of study will be summarized in a report, and the project viability is proposed (Article 25).
- The report is addressed to the Minister of Environment, and the minister send it to the authorities in charge and the residents within 5 days (article 26)
- The Minister of Environment will notify an advice on the validity of the project within 20 days of receipt of the EIA report or the environmental notifications. The advice will be valid from the date of notification. (article 31)
- During the project implementation, the Ministry of Environment and competent authorities conduct environmental monitoring based on the environmental management plan (Article 32).

(3) Procedure of Simplified Environmental Notice (Category B')

The Interim Director for Study and Work, SONADER and Director Control, Ministry of Environment agreed in the meeting held on Sept. 2, 2010 at MOE that a simplified environmental notice (Category B') will be applied to Foum Gleita because it is rehabilitation project though the scale is lager size. Both directors also agreed that:

- First of all, a joint survey will be made by SONAQDER with 1-2 experts of MOE for few days at the site,
- SONADER prepares the environmental notice report (about 30 pages) for 1 week, and submit to MOE,
- MOE reviews the notice report and inform SONADER an approval within about 1 week, and
- Approval of TOR, summary of the notice, public hearing, announcement on news paper are not required for Foum Gleita.

The Director General of SONADER explained the JICA Team to submit the environmental notice to MOE for approval as soon as the financial source being more clearly decided.

SONADER's environmental report has been completed in 2006 in APD1.

A5.2 Natural and Social Environment of Foum Gleita

a) Superficies, climate, population and industries of Gorgol

The region of Gorgol is one of 12 regions covering an area of 13,891 km2, a population of 300,000 inhabitants. 75% of the population lives in rural areas. Agriculture accounts for 63% of the economy, and livestock accounts for 10%

About the climate in Kaédi, the maximum temperature of monthly average is 42℃ in May and the minimum is 17℃ in January. Between February and May the harmattan frequently blows influenced by the climatic zone of Sudan.

The annual rainfall is 250-300 mm, the monthly average from July to September is 90mm. Outside of the rainy season, which runs between June and October, the climate is dry. The maximum relative humidity is 63% in August, and the minimum is 20% in February in Kaedi.

b) Overview, cooperatives, tribes, education and health of Foum Gleita,

On the irrigated area of Gleita Foum, the village population of beneficiaries is about 20,000 people. There are 45 men's cooperatives (1,300 men in total) and 49 women's cooperatives (2700 women in total) and three Cooperatives Unions (one for men, 2 women). A few are currently active. This population is mainly composed of Poularies (Africans) and Moors (Arabs). There are schools in 10 villages, a health center Foum Gleita with two nurses and a nurse for women, and a branch in Dakhra (Bashat). The lighting is powered by solar energy and drug storage refrigerator and a generator powered by gas. Consultations are free, medicines is bought based on prescription in the pharmacy with low cost by subsidy. 90% of the population has access to health centers within 5 km in Kaedi, the access rate is only 59% in M'bout that is project area, lowest in four mughatas. Malaria and bilharzia are the major waterborne diseases and morbid conditions identified in Foum Gleita (their percentage of the number of visitors to the health center is shown below).

Table A5.1 Waterborne diseases and morbidity (%)

Water borne Diseases	2001	2007
Malaria	25	29
Bilharzia	14	6

Source: Etude sanitaire des mesures concrètes d'atténuation des impacts environnementaux du PDIAIM

Malaria is increasing, but schistosomiasis decreases. According to nurses, this is explained by the fact that it is absolutely forbidden to urinate in the canals that is the source of drinking water. Larvae and snail (intermediate host) living or dead weren't found in standing water and canals in the investigation. Meanwhile the Guinea worm was completely eradicated in the last three years with the support of international agencies, including Japan. There aren't epidemics caused by irrigation water, such as Rift Valley Fever river blindness (onchocerciasis) and elephantiasis.

Health Centre of Foum Gleita

c) Public infrastructures (road, water supply, electricity, drinking water)

Foum Gleita is 10 km from Siliwa on Kaedi - M'bout national road. It is a desert road, crossing of the normally dry river which is often cut for several days in rainy season. Water is supplied by the Foum Gleita dam with a capacity of 400 million m^3. Yet the water of the only pipe from the canal is poorly treated and not safe. In two villages pedal pumps to draw water from the ground water are installed, but in seven other villages don't have the facility, the population draws water from irrigation canals. Electrical power is not existent, and electricity supply plan isn't scheduled for now and future. A mini hydraulic system of 10 KVA is established in the dam, which has not been repaired for over 10 years. Only stores are equipped with a solar generator to recharge mobile phones.

d) Agriculture, Soil and Land Use

The area was developed aimed at double cropping of rice. The double cropping was started in 1990, but the flow of irrigation canals have been deteriorated because of the invasion of typha and damage to dikes by livestock, the area under rice cropping fell to 350ha (2008) against 1950ha in 1989.

e) National Parks

Mauritania has Banc d'Arguin national park in the north-west coastal zone and Diawling national park in the estuary of Senegal River The first is famous worldwide for rich biodiversity such as varieties of fish, dolphins and birds, a lagoon recognized by the Ramsar Convention. The latter is in Aftout es Saheli（coastal zone）downstream of Rosso, included Chott Boul marsh that is famous for Mangrove and large concentrations of rare birds such as the Flamingo Phoenicopterus ruber, or the Lesser Flamingo Phoenicopterus minor. But this park is located 400 km linear distance from Foum Gleita. They are not related from the ecological point of view.

There is not national park in Gorgol. The five areas of protected forests are along the right bank of Senegal river on 400-1800ha. But these areas are removed several tens of kilometers from Foum Gleita, and unrelated ecologically.

f) Ecosystem

The lands are designated primarily for farming and housing villages. The existence of rare species is not informed. The main animals of the area are cattle, horses, goats, sheep, and camels. Apart from crops (rice, vegetables, legumes), the flora is composed of shrubs, grasses and thorn grown wild in places not maintained by cooperatives such as desert farm end and channel. Especially the Balanites which is the prickly thorn and Tofelhena which is not prickly bush grow in colony, impede access to the irrigation facilities. They also cause the collapse of dikes. A tree less than 1.5 m is called the Acacia Senegal, and a tree of 4 to 5 m is called the balborigie in Hassania. There is also a tree called "big leaf". It is expected that the these trees are removed by farmer's participatory approach. The Typha grown in the canal block the water passage. Freshwater fish (carp and catfish) populate in the canal. In the dam lake cultivations of tilapia are implemented with the cooperation of Japan.

Foum Gleita irrigated area in the left side of Gorgol river

g) Desertification

The two tributaries of Gorgol,ie., Gorgol black and Gorgol white are fed by mountains of low altitude in wilayas Assaba and Tagant northern sector. Gorgol has a catchment area of 21,000 km2. Both Gorgol flows south along the chain of mountains Wa-Wa (altitude 150 m). Gorgol black enters the dam, and from the dam down to the west passing through of the project areas the center sector meets the Gorgol white at the upstream of Lexeiba and at Kaedi on the right bank of the river Senegal. Before the dam completed in 1983 the river was dry during the dry season, but now it is supplied by the dam, and flows all year. The basin is a desert of earth and stones, without sand dunes or shifting sand dunes.

A5.3 Initial Environmental Examination

In this study, a pilot project was planned to be implemented, however, whose environmental impact was anticipated null because it involves verification of agricultural technologies and participatory management using the existing crop land and waterways.

The project, however, if implemented in future, could cause noise, vibration, waste, but considering the distance between homes and rehabilitation sites.

An initial environmental examination (IEE) has been by the study team based on the discussion with SONADER referring from the environmental report prepared under the assistance by the World Bank. The draft was attached an appendix, and submitted the SONADER for this review.

Appendix IEE: Initial Environmental Examination

(1) Framework for Initial Environmental Examination for Draft Action Plan

The main objectives of the initial environmental examination (IEE) are to identify potential negative environmental impacts caused by implementation of proposed program/project components of the Action Plan and to suggest mitigation measures and monitoring methods in order to avoid and/ or mitigate the potential negative impacts.

The framework of the IEE study is shown in the following figure. After the screening of the program/project components of the Action Plan, IEEs are implemented for selected program /project components which need to be examined. The potential impacts are examined on the basis of the activities of the program/project components. In addition, the mitigation measures and monitoring methods are preliminarily proposed. On the other hand, the impacts that would result without implementation of any activities of the Action Plan was also examined based on the current condition. The Result is compared with the impacts that would result with implementation of selected projects/program.

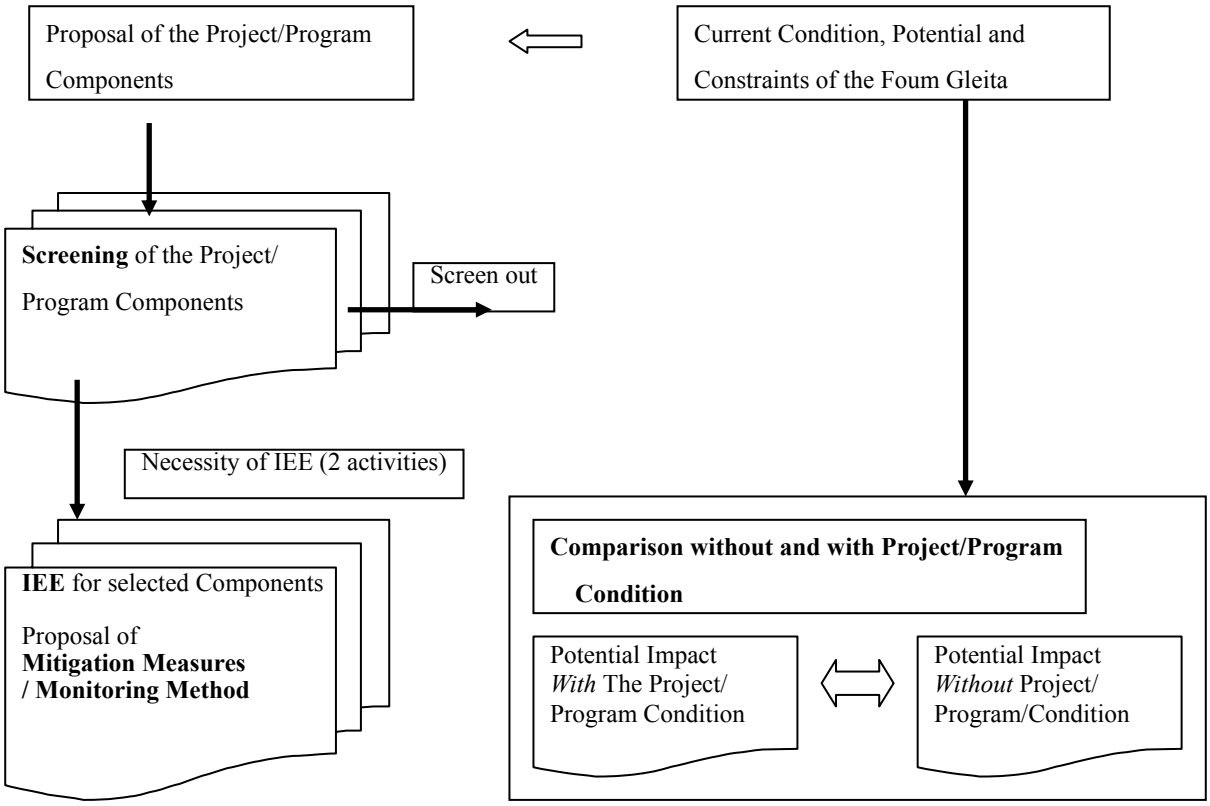


Fig. A5.3.11.1 Framework for IEE for the Proposed Project/Program

(2) Screening of Project/Program Components

a. Result of Screening of Project/Program Components

The results of the screening of the proposed program/project components are summarized below.

TableA5.1 Summary of Result of Screening of the Project/Program Components

Program/Project	Program/Project Component	Screening	Remarks
Institutional Development Program (Participatory Water Management)	1. Strengthening of SONADER (FG & Kaedi)	Screened Out	Capacity Development and Training
	2. Strengthening of Cooperative & Union	Screened Out	Capacity Development and Training
Improvement of Farm Management Techniques	Agriculture input and credit, and marketing	**IEE**	Fertilizer and Agriculture Input
Rehabilitation of Irrigation and Drainage System	Rehabilitation project	**IEE**	Removal of sediment & vegetation, recovery of dike and repair of structures, and construction of fence

Note: Screening result is categorized into two groups; i) project/program component needs Initial Environmental Examination which is stated as IEE in the table and ii) project/ program component is screened out and no IEE is required.

b. Screening of Project/Program Components in Action Plan

Future program/project components proposed in this study have been screened from view-points of environment and social consideration. Two-step screenings have been carried out hereunder and finally tentative "Environmental and Social Issues to be Noted" have been prepared for future actions.

Environmental and Social Consideration
On the Development Study on Reactivation of Irrigated Agriculture Project in Foum Gleita

1. Proposed Project/Program

Future project/program components proposed in the Study have been screened from view-points of environment and social consideration. **Two-step screenings** have been carried out hereunder:

1-1 Preliminary Screening of Proposed Project/Program Components

A5.3 Preliminary Screening of Proposed Project/Program Components

Project Component in the Proposed Project/Program	Outline of the Component	Necessity of the Component	Main Activity of the Component	Preliminary Environmental Screening
A. Improvement of Farm Management Techniques	This program component aims at recovery of productivity and quality of agricultural produce through application of the existing farming techniques, strengthening of extension services, agriculture credit, marketing and farmers cooperative, and sustainable linkage with research institute. Especially, it is necessary to keep a close communication among them in order to develop applicable farming techniques. Only the existing techniques and know-how will be employed in the proposed project.	Improvement of farm management system needs to focus on the following areas: 1. Proper cropping plan, and linkage among farmers, extension service and research, 2. Provision of timely financial assistance for procurement of agriculture input, and agriculture machineries, 3. Extension of farming technology, 4. Shipping and storage of agricultural produce, 5. Constraints by animal, bird, bush, typha, etc. which invade farm land and reduce produce.	For improvement of productivity and quality of crops, the following activities will be strengthened:. 1. Organization of workshop for research and extension staffs for the better linkage, 2. Reinforcement of credit line, market information, crop calendar, etc. 3. Dissemination of farming technology such as seeds, agricultural inputs and mechanization 4. Training program for farmers cooperative through workshop and visit of progressive similar sites	(1) The activities in this program component will be carried out in existing research areas, existing farmlands or in offices. (2) Construction of new infrastructure is not included. Accordingly, it is judged to be "**Screened Out**", in general for rehabilitation and improvement activities in this project component. However, it is necessary to proceed to further screening because the present development study is categorized as "B" by JICA.

Project Component in the Proposed Project/Program	Outline of the Component	Necessity of the Component	Main Activity of the Component	Preliminary Environmental Screening
B. Participatory Water Management (Strengthening of SONADER, Union and Farmers Cooperatives)	This program component aims at recovery of function of existing institution through workshop and training program.	Constraints of the existing system are poor transparency in financial management of union cooperatives, limited delegation of SONADER, default of obligation (SONADER) and loan repayment (farmers), stagnant of personnel (union cooperative), lack of communication, credibility gap, etc. Accordingly, it is essential to recover the function for provision of efficient and effective management services to farmers based on the fund paid by farmers.	Major activities of this component are capacity development of staff of water master (SONADER), and training of the cooperative staff in dissemination techniques and knowledge of water management and exposure visits to advanced area and focus on the following items: 1. Capacity development of staff of extension services and water master in SONADER 2. Training of the cooperative and union staff in dissemination of participatory approach. 3. Transparency in finance, strengthening of SONADER, fulfillment of mandatory, periodical erection of cooperative and union staff, close communication and recovery of trust. 4. Monitoring and Evaluation	• The activities in this program component are staff capacity development, strengthening of function of existing institution. Accordingly, it is judged to be "**Screened Out**" in this program component. No further screening or discussion of this component will be made hereinafter.

Project Component in the Proposed Project/Program	Outline of the Component	Necessity of the Component	Main Activity of the Component	Preliminary Environmental Screening
C. Rehabilitation of the existing Irrigation and Drainage System	This project component aims at rehabilitation of the existing irrigation and drainage system of the Foum Gleita Irrigation Project area with a irrigation area of 1950 ha at the time of completion in 1984 and 1989.	The present irrigation area has been reduced to only 400ha or less due to the reduction in canal capacity from 10.7 m3/s in 1989 to only 1.2 m3/s at present mainly because of bottom sediment, degradation of canal dike damaged by livestock and excessive vegetation. It is, therefore, essential to rehabilitate/improve existing irrigation and drainage systems.	Major activities of this component are rehabilitation/repair of existing irrigation and drainage system By these activities, the following will be attained; 1 Existing irrigation systems will be rehabilitated and upgraded. 2. Irrigation area will be recovered from present 400ha to the initial 1950ha. 3. Function of irrigation and drainage facilities for 1950ha will be recovered. 4. Agriculture production will increase through sufficient irrigation water supply and drainage.	• Rehabilitation and improvement activities in this component will be carried out in existing irrigation and drainage systems. Accordingly, it is judged to be "**Screened Out**", in general for rehabilitation and improvement activities in this project component. However, it is necessary to proceed to further screening because the present development study is categorized as "B" by JICA.

The results of the above preliminary screening of all the project components are summarized below:

Considering the environmental category "B" given by JICA, only **(B) Participatory Water Management (Capacity development of SONADER, Union and Farmers Cooperatives)** in the project/program components have been screened out through the preliminary screening, and following project/program components are selected for the Initial Environmental Examination:

(A) **Improvement of Farm Management Techniques**

(C) **Rehabilitation of the existing Irrigation and Drainage System**

1-2 Result of Initial Environment Examination

(1) Summary of Initial Environmental Examination

In accordance with the results of preliminary screening of all the project/program components, the following project components have been further assessed hereafter:

(A) **Improvement of Farm Management Techniques, and**
(C) **Rehabilitation of the existing Irrigation and Drainage System Project**

Impact matrix has been prepared for the above 2 activities of the project/program components. In the matrix, the following screening toward potential impacts and phase-wise impacts has been carried out.

Initial environment examination is conducted by adoption of Impact Matrix as follow:

Table A5.4

Remarks in Impact Matrix
Potential impacts towards a) social environment, b) natural environment and c) pollution were studied in each separated phase, i.e. i) designing phase, ii) construction phase, and iii) operation phase. The mark in the table means categories of impact.
Left-side of each cell represents a direction of impact and right-side represents a magnitude of impact as follows: Left side; ++: Positive impact --: Negative Impact =: Neutral Impact Right side; **A**: relatively significant impact, **B**: relatively medium-size impact, **C**: relatively small impact, **D**: unknown as of now, **＊**: No impact or no corresponding impact

Table A5.5 Summary of Initial Environmental Examination of the Project/Program Component

	Potential Impacts	Improvement of Farm Management Techniques	Rehabilitation of the existing Irrigation and Drainage System	Notes
Social Environment				
1	Involuntary Resettlement	*	*	
2	Local economy (employment, livelihood, etc)	++/B	++/B	
3	Land use and utilization of local resources	++/B	++/B	
4	Social institutions (social infrastructure & local decision-making institution)	++/C	++/B	
5	Existing social infrastructures and services	*	++/C	
6	The poor, indigenous and ethnic people	++/B	++/B	
7	Misdistribution of benefit and damage	++/B	++/B	
8	Cultural heritage	*	*	
9	Local conflict of interests	++/B	++/B	
10	Water Usage or water rights and communal rights	*	++/B	
11	Sanitation	*	++/C	
12	Hazards (Risk), Infectious diseases as HIV/AIDS	*	=/C	
Natural Environment				
13	Topography & Geographical features	*	*	
14	Soil Erosion	*	++/B	
15	Groundwater	*	++/C	
16	Hydrological Situation	*	*	
17	Coastal Zone	*	*	
18	Flora, Fauna and Biodiversity	*	*	
19	Meteorology	*	*	
20	Landscape	*	*	
21	Global Warming	*	*	
Pollution				
22	Air Pollution	*	*	
23	Water Pollution	--/C	*	
24	Soil Contamination	--/C	*	
25	Waste	--/C	*	
26	Noise and Vibration	*	*	
27	Ground Subsidence	*	*	
28	Offensive Odor	*	*	
29	Bottom sediment	*	*	
30	Accidents	*	--/C	

(1) Improvement of Farm Management Techniques

This work consists of ①Dissemination of farming technology such as seeds, agricultural inputs and mechanization, ②Reinforcement of credit line, market information, crop calendar, etc., ③ Training program for farmers' cooperative through workshop and visit of progressive similar sites, ④Organization of workshop for research and extension staffs for the better linkage.

A5.6 Impact Matrix for Improvement of Farm Management Techniques

Activity / Potential Impact		Improvement of Farm Management Techniques			
		Designing	Construction	Operation	Comments
Social Environment					
1	Involuntary Resettlement	✻	✻	✻	
2	Local economy (employment, livelihood, etc)	✻	✻	++/B	Local economy will be reactivated. Farmers engaged in migratory working in the outside will return to their families for cultivation.
3	Land use and utilization of local resources	✻	✻	++/B	Abandoned farm land will be reactivated.
4	Social institutions (social infrastructure & local decision-making institution)	✻	✻	++/C	Strengthening of farmers' cooperatives and union cooperatives.
5	Existing social infrastructures and services	✻	✻	✻	
6	The poor, indigenous and ethnic people	✻	✻	++/B	Beneficiaries are mostly small and marginal farmers.
7	Misdistribution of benefit and damage	✻	✻	++/B	Fair water distribution from 400ha to 1950ha
8	Cultural heritage	✻	✻	✻	
9	Local conflict of interests	✻	✻	++/B	Irrigation water will be satisfied.
10	Water Usage or water rights and communal rights	✻	✻	✻	
11	Sanitation	✻	✻	✻	
12	Hazards (Risk), Infectious diseases as HIV/AIDS	✻	✻	✻	
Natural Environment					
13	Topography & Geographical features	✻	✻	✻	
14	Soil Erosion	✻	✻	✻	
15	Groundwater	✻	✻	✻	
16	Hydrological Situation	✻	✻	✻	
17	Coastal Zone	✻	✻	✻	
18	Flora, Fauna and Biodiversity	✻	✻	✻	
19	Meteorology	✻	✻	✻	
20	Landscape	✻	✻	✻	
21	Global Warming	✻	✻	✻	
Pollution					
22	Air Pollution	✻	✻	✻	
23	Water Pollution	✻	✻	--/C	Aiming at low input and high return
24	Soil Contamination	✻	✻	--/C	
25	Waste	✻	✻	--/C	
26	Noise and Vibration	✻	✻	✻	
27	Ground Subsidence	✻	✻	✻	
28	Offensive Odor	✻	✻	✻	
29	Bottom sediment	✻	✻	✻	
30	Accidents	✻	✻	✻	

Remarks: Left side; ++: Positive impact --: Negative Impact =: Neutral Impact
Right side; **A**: relatively significant impact, **B**: relatively medium-size impact, **C**: relatively small impact, **D**: unknown as of now, ✻: No impact or no corresponding impact
No comments means 'not applicable'

A5.7 Potential Negative Impacts and Possible Mitigation Measure of Improvement of Farm Management Techniques

	Potential Impact	Phase	Rating	Impact Cause/Severity	Mitigation Measure/ Monitoring Method	Action Time for Avoidance/Mitigation
23	Water Pollution	Operation	C	Fertilizer & chemical input/Less	Less application/ SONADER monitoring	Operation at field/ Mitigation
24	Soil Contamination	Operation	C	Fertilizer & chemical input/Less	Less application/ SONADER monitoring	Operation at field/ Mitigation
25	Waste	Operation	C	Residual waste of vegetable & fruit/Less	Livestock feed & compost/Extension worker	Operation at field & market/ Mitigation

Note: A: relatively significant impact, B: relatively medium-size impact, C: relative small impact, D: unknown as of now

Conclusion:

Effort of on-going application of less input & high return will be continued by lessens obtained from the verification trial in the present study. Effective use of vegetable waste has been practiced at the field and market. Accordingly, significant negative impacts are not predicted with proper management during operation phase. The proposed mitigation measures are expected to minimize the negative impact.

(2) Rehabilitation of Irrigation and Drainage Facilities

This work consists of rehabilitation of irrigation and drainage facilities for the irrigation area of 1950ha.

Table A5.8 Impact Matrix for Rehabilitation of Irrigation and Drainage Facilities

Activity / Potential Impact		Rehabilitation of Irrigation and Drainage Facilities			
		Designing	Construction	Operation	Comments
Social Environment					
1	Involuntary Resettlement	*	*	*	
2	Local economy (employment, livelihood, etc)	*	*	++/B	Local economy will be reactivated. Farmers engaged in migratory working outside will return to their families. Subsidy or employment is available during construction.
3	Land use and utilization of local resources	*	*	++/B	Abandoned farm land will be reactivated. Illegal off-takers along principal canals will return to the irrigation area
4	Social institutions (social infrastructure & local decision-making institution)	*	*	++/B	Strengthening of farmers' cooperatives and union cooperatives.
5	Existing social infrastructures and services	*	*	++/C	Existing irrigation & drainage related facilities will be rehabilitated.
6	The poor, indigenous and ethnic people	*	*	++/B	Beneficiaries are mostly small and marginal farmers.
7	Misdistribution of benefit and damage	*	*	++/B	Fair water distribution from 400ha to 1950ha
8	Cultural heritage	*	*	*	
9	Local conflict of interests	*	*	++/B	Irrigation water will be satisfied.
10	Water Usage or water rights and communal rights	*	*	++/B	Fair water distribution may be expected by sufficient water discharge.

Potential Impact \ Activity		Rehabilitation of Irrigation and Drainage Facilities			
		Designing	Construction	Operation	Comments
11	Sanitation	✻	✻	++/C	Expected increase in farm income will enhance livelihood and sanitation.
12	Hazards (Risk), Infectious diseases as HIV/AIDS	✻	✻	=/C	Number of vectors and hosts may increase with irrigation and decrease with drainage improvement.
Natural Environment					
13	Topography & Geographical features	✻	✻	✻	
14	Soil Erosion	✻	✻	++/B	Paddy field dike will mitigate soil erosion
15	Groundwater	✻	✻	++/C	Groundwater will be recharged by paddy irrigation
16	Hydrological Situation	✻	✻	✻	
17	Coastal Zone	✻	✻	✻	
18	Flora, Fauna and Biodiversity	✻	✻	✻	
19	Meteorology	✻	✻	✻	
20	Landscape	✻	✻	✻	
21	Global Warming	✻	✻	✻	
Pollution					
22	Air Pollution	✻	✻	✻	
23	Water Pollution	✻	✻	✻	
24	Soil Contamination	✻	✻	✻	
25	Waste	✻	✻	✻	
26	Noise and Vibration	✻	✻	✻	
27	Ground Subsidence	✻	✻	✻	
28	Offensive Odor	✻	✻	✻	
29	Bottom sediment	✻	✻	✻	
30	Accidents	✻	--/C	✻	During construction, some accident may occur.

Remarks: Left side; ++: Positive impact --: Negative Impact =: Neutral Impact
Right side; **A**: relatively significant impact, **B**: relatively medium-size impact, **C**: relatively small impact, **D**: unknown as of now, ✻: No impact or no corresponding impact
No comments means 'not applicable'

Table A5.9 Potential Negative Impacts and Possible Mitigation Measure of Rehabilitation of Irrigation and Drainage Facilities

	Potential Impact	Phase	Rating	Impact Cause/Severity	Mitigation Measure/ Monitoring Method	Action Time for Avoidance/Mitigation
12	Hazards (Risk), Infectious diseases as HIV/AIDS	Operation	C	Vector and host may increase with irrigation and decrease with drainage improvement/ Less.	Mosquito-net, medicine, filter are effective for malaria and Guinea worm. Education is effectively on-going/ Health Center and Kaedi Hospital against bilharzias.	Operation/ Mitigation
30	Accidents	Construction	C	Some accident may occur/Less	Appropriate maintenance of machinery and vehicles and periodic caution to workers on disciplines for safety operation/ SONADER	Construction/ Mitigation

Note: A: relatively significant impact, B: relatively medium-size impact, C: relative small impact, D: unknown as of now

Conclusion:

WFP's (World Food Program) food subsidy for farmers during rehabilitation was applied in Foum Gleita project up to the beginning of 1990's, and some other projects. Common labor is needed by the Contractor during rehabilitation.

Illegal off-take along the upstream of canal will be improved through proper guidance and regulation by SONADER and union cooperatives in order to settle constraints of land use in the outside irrigation area.

Increase in farm income will accelerate the application of mitigation measures against water borne diseases.

The proposed mitigation measures are expected to minimize the negative impact.

1-3 Comparison between With and Without Proposed Project/Program

The following tables show the supposed conditions under the "Without the Project/Program" case compared with the "With the Project/Program" case. It is noted that in the case of "With Project/Program" mitigation measures are assumed to be implemented properly under Implementation of the Project/Program.

Table A5.10 Condition Without and With the Project/Program

Item	Without Project/Program	With Project/Program
Agriculture	Production increase and poverty eradication are not expected because farm income will continue to decline. Farm family may continue to leave for other area to find other job.	Production will increase through recovery of irrigated area, and quality and quantity of produce will be recovered through improvement of seeds, crop calendar, agriculture credit and marketing, and appropriate fertilizer application, chemical inputs and mechanization.
Irrigation Facilities	Present irrigation area (about 400ha) may reduce further by densely growing typha and heavy sediment & dike degradation being damaged by livestock.	Present irrigation area will increase toward 1950 ha (area in 1989) through rehabilitation of irrigation & drainage system such as removal of typha and sediment in major canal by heavy equipment and partly by concrete lining, and provision of fence to protect livestock encroachment.
Institution	Present opaque situation in finance, decision making, staff election, etc. remains unchanged. Accordingly, farmers' motivation to revitalization of irrigated agriculture is unable to realize.	SONADER and union cooperative will be strengthened through transparency in financial management and decision making, rejuvenation by periodic election, and farmers' spontaneity by application of participatory approach.
Environmental Impact	Situations remain unchanged or worsen gradually.	Large social advantages can be expected through increase in farm income and most of negative impact can be mitigated through application of the proposed countermeasures.

(1) Examination of the Condition Without Project/Program

The following table shows potential negative impacts without implementation of the project/program.

Table A5.11 Potential Negative Impacts Without Project/Program

Potential Impacts	Impact cause/severity
Social Environment	
Local economy (employment, livelihood, etc)	Local economy, agricultural employment and livelihood will be farther declined by the malfunction of irrigation facilities under growing typha and canal dike damaged by livestock.
Land use and utilization of local resources	Once developed farm land will be deteriorated and will not be effectively used.
Existing social infrastructures and services	Irrigation and drainage canal, and farm road will not function nor activate.
The poor, indigenous and ethnic people	Most of the farmers cultivate only 0.5 ha of crop land, who require the double cropping to overcome the poverty.
Misdistribution of benefit and damage	Only less than 20 % of developed land (400ha/1950ha) receives irrigation water and the rest are unable to receive irrigation water due to deterioration of the irrigation system.
Local Conflicts of Interest	Irrigation water dispute between the upstream and downstream of canal system may occur.
Water Usage or water rights and communal rights	Irrigation water dispute between the water users in the cooperative and illegal water users outside of the cooperative.
Hazards (Risk), Infectious diseases as HIV/AIDS	There is no record of HIV/AIDS, but there are records for malaria and bilharzias which are under control by mosquito-net, medicine and customary practice.
Natural Environment	

(2) Examination of the Condition With Project/Program

The following table shows potential negative impacts with implementation of the project/program. As described above, the project/program is assumed to be implemented with appropriate environmental management activities in order to avoid and/or mitigate the negative impacts.

Table A5.12 Potential Negative Impacts with Project/Program

Potential Impacts	Impact cause/severity
Social Environment	
Land use and utilization of local resources	Once abandoned farm land to be re-irrigated and re-cultivated by the farmers who returned from migratory working, etc. is positive impact, however, careful and fair observation are required considering priority to be given to the poor and small scale cultivators.
Water Usage or water rights and communal rights	The recovery of water use, water rights and rights of common is positive impact, however, careful and fair distribution is required.
Hazards (Risk), Infectious diseases as HIV/AIDS	There is no record of HIV/AIDS, but there are records for malaria and bilharzias which are under control by mosquito-net, medicine and customary practice. Irrigation rehabilitation increase host & vector, and drainage rehabilitation reduce them.
Natural Environment	
Pollution	
Water Pollution	Water pollution by fertilizer and chemical input will be applied so as to realize “less input & high return”
Soil Contamination	Soil contamination by fertilizer and chemical input will be applied so as to realize “less input & high return”
Waste	Crop residue will increase, however it can be used for livestock feed.
Accidents	Traffic accident may increase in construction and operation stages, however such can be mitigated by traffic control.

(3) Result of Comparison

The result of comparison between with and without Project/Program conditions is shown in the following table.

Table A5.13

Potential Impact		Without Project/Program	With Project/Program
Social Environment			
1	Involuntary Resettlement	✻	✻
2	Local economy (employment, livelihood, etc)	--/B	++/B
3	Land use and utilization of local resources	--/B	++/B, --/C
4	Social institutions (social infrastructure & local decision-making institution)	✻	++/B
5	Existing social infrastructures and services	--/C	++/C
6	The poor, indigenous and ethnic people	--/B	++/B
7	Misdistribution of benefit and damage	--/C	++/B
8	Cultural heritage	✻	✻
9	Local conflict of interests	--/C	++/B
10	Water Usage or water rights and communal rights	--/B	++/B, --/C
11	Sanitation	✻	++/C
12	Hazards (Risk), Infectious diseases as HIV/AIDS	--/C	=/C
Natural Environment			
13	Topography & Geographical features	✻	✻
14	Soil Erosion	✻	++/B
15	Groundwater	✻	++/C
16	Hydrological Situation	✻	✻
17	Coastal Zone	✻	✻
18	Flora, Fauna and Biodiversity	✻	✻
19	Meteorology	✻	✻
20	Landscape	✻	✻
21	Global Warming	✻	✻
Pollution			
22	Air Pollution	✻	✻
23	Water Pollution	✻	--/C
24	Soil Contamination	✻	--/C
25	Waste	✻	--/C
26	Noise and Vibration	✻	✻
27	Ground Subsidence	✻	✻
28	Offensive Odor	✻	✻
29	Bottom sediment	✻	✻
30	Accidents	✻	--/C

Remarks: Left side; ++: Positive impact --: Negative Impact =: Neutral Impact
Right side; **A**: relatively significant impact, **B**: relatively medium-size impact,
C: relatively small impact, ✻: No impact or no corresponding impact

It is understood from above table that implementation of the Project/Program will bring about positive impacts with avoidance and/or mitigation measures against the negative impacts.

(4) Conclusion

The IEE study for Project/Program concludes as follows:

- Project/Program would have positive impacts for social environment, especially for local economy to encourage and social institution to strengthen. Project/Program also made consideration of poor, indigenous and ethnic group. Thus, it could be judged to be acceptable

from an environmental view point.

- Implementation of Project/Program would not bring about serious social and natural negative environmental impacts and that impacts can be avoided/mitigated by proposed countermeasures.
- It is understood that implementation of the Project/Program will bring about positive impact with avoidance and/or mitigation measures against the negative impacts.

In accordance with the results of the IEE of the program/project components, a full scale Environmental Impact Assessment is not considered necessary if the proposed mitigation measures are concurrently carried out.