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B. 1. 1 Availability of Water Resources

1. Effective Rainfall

Effective rainfall is estimated at 0.75 of monthly rainfall as recommended in the M/P study.

$$Re = 0.75 * R$$

Where : Re = Effective rainfall (mm/month)
R = Monthly rainfall (mm/month)

Re < = 200 mm/month in paddy field

Re < = 120 mm/month in upland field

Monthly effective rainfall during irrigation periods (Apr. ~ Sep.) was estimated in design year and normal year as follows:

(Unit: mm)

Year \ Month	Apr.	May	Jun.	Jul.	Aug.	Sep.	Total
1967	36.5	9.5	36.3	5.7	16.0	75.7	179.7
1990	21.8	18.9	13.4	17.6	32.9	21.2	125.8

1990: Design year
1967: Normal year

2. Surface Water

(1) River Runoff

Annual runoff of the Haraz river was estimated at around 1,086 MCM comprising the Irrigation Period (Apr. ~ Sep.) of 728 MCM and Non-Irrigation Periods (Oct. ~ Mar.) of 358 MCM.

(2) Probable Runoff in Haraz River

Probable annual runoff was calculated based on results of hydrological analysis for the Haraz river basin.

Probable Runoff in the Haraz River

(Unit: MCM)

Station	Annum.			Runoff Discharge in Irrigation Period (Apr. ~ Aug.)			Design Year (1969 ~1970)	
	1/2	1/5	1/10	1/2	1/5	1/10	Annual	Irri.Period
Polur	416	310	274	328	232	199	285	176
Direct River Basin	670	551	510	402	271	227	523	225
Karehsang	1,086	863	784	730	530	454	808	401

The annual surface runoff at the design year in the Haraz river has been determined based on 227 MCM of the runoff in direct catchment area.

Normal year 240 MCM + 402 MCM = 642 MCM
Design year 240 MCM + 225 MCM = 465 MCM

Note: 240 MCM is maximum guaranteed release water of Lar dam.

3. Groundwater

(1) Availability of Irrigation Water

Optimum utilization of groundwater for irrigation within the subjective project area was assessed as follows;

Wells :	137 MCM
Spring :	8 MCM
Total	145 MCM

(2) Irrigable Area

1) Water Requirement

The water requirement at the paddy field has been estimated under the consideration of effective rainfall in design year as follows.

Early Matured Variety	(EV)	317.4 mm
Middle Matured Variety	(HV)	341.8 〃
Late Matured Variety	(LV)	281.5 〃
Nursery		2.6 〃
Total		943.3 mm

Irrigation efficiency

- Conveyance efficiency (Ec) = 0.89
- Field canal efficiency (Eb) = 0.91
- Field application efficiency (Ea) = 0.87
- Overall efficiency (Eo) = 0.70 (Note: Ecx Ebx Ea)

Irrigation efficiency for water resources

- Surface water 0.70 = (0.89 × 0.91 × 0.87)
- Groundwater 0.79 = (0.91 × 0.87)
- Abbandan 0.79 = (0.91 × 0.87)
- Return flow 0.79 = (0.91 × 0.87)

Water requirement for water resources

- Surface water 943.3/0.70 = 1,347.6 mm (1,347.6 m^3/ha)
- Groundwater 943.3/0.79 = 1,194.1 mm (1,194.1 m^3/ha)
- Abbandan 943.3/0.79 = 1,194.1 mm (1,194.1 m^3/ha)
- Return flow 943.3/0.79 = 1,194.1 mm (1,194.1 m^3/ha)

2) Groundwater Yield and Irrigable Area

Irrigable area by the groundwater at present are summarized as follows;

Water Resources	No. of Facilities	Total Yield	Unit Yield	Irrigable area of Unit
Shallow-well	5,837	135 MCM	23,000 m^3/unit	23,000/11,941 ≒ 2 ha
Spring	48	8 MCM	166,600/unit	166,600/11,941 ≒ 14 ha

5,837 wells × 2	=	11,674 ha
48 springs × 14	=	672 ha
Total		12,346 ha

The detail of irrigable area and kind of water resources (well and spring) are compiled in Table B.1.1-1.

4. Farm Pond (Abbandan)

(1) Present Situation of Farm Pond

There are 206 number of existing farm pond in the Project Area, and it's storage capacity was estimated about 36 MCM, furthermore, these ponds have a function to control excess water, return-flow of irrigation water and storing flood water appropriately.

The summary of the pond are shown at following table.

Summary of Farm Ponds (Abbandan)

District	No. of Pond	Reservoir Area (ha)	Reservoir Capacity (10^3m^3)
H.W.D	3	28	364
H.E.D	25	449	6,687
A.W.D	81	1,106	10,200
A.E.D	92	1,703	16,683
Total	201	3,286	33,934
Urban Area	5	216	2,066
Ground total	206	3,502	36,000

Note: One farm pond (AE 88) under the control of Ramsar Treaty includes the above table in A.E.D.

The list of the farm pond in the Project Area are prepared compiled in attached table B.1.1-2.

(2) Improvement Plan of the Farm Ponds

1) Objective for the Improvement

The existing farm ponds have problems of declining function due to heavy sedimentation. Therefore, it is required to increase the reservoir capacity with the digging of reservoir bed.

2) Estimated of excavation volume and incremental reservoir capacity.

The computation method of excavation volume at the reservoir bed are summarized as follows.

- One farm pond selected as a representative pond in each District
- Excavation volume of representative pond calculated with typical feature as shown in attached Figure B.1.1-1, and estimated excavation volume per (ha) of reservoir area

- Excavation volume of the District calculated based on said excavation volume per (ha) and total surface area of the reservoir in each Districts.

The results of estimation on the excavation volume in each District are shown as follows.

District \ Items	Existing Storage Volume (10^3m^3)	Incremental Storage Volume (10^3m^3)	Total	Excavation Volume (10^3m^3)	Acreage (ha)
HWD	364	143	507	176	28
HED	6,687	1,989	8,676	2,475	453
BUA	2,066	-	2,066		
Sub-Total	8,753	1,989	10,742		
AWD	10,200	5,574	15,774	6,862	1,090
AED	16,425	6,688	23,113	8,546	1,674
(AW 88)	258	-	258		
Sub-total	16,683	6,688	23,371		
Total	36,000	14,394	50,394	18,059	3,245

Irrigable area; 50 MCM / 11,941 m^3/ha = 4,187 (ha)

5. Return Flow

(1) Mechanism of Return Flow

The main canals and secondary canals for the irrigation have been constructed with 10 km to 30 km long, generally. The total canal length is estimated at about 1,800 km in the Project Area, and the canal density is counted at around 22.0 m/ha.

On the other hands, these irrigation canals are functioned also as the drainage canals in rainy season (winter), and these canals are connected to abbandans is some cases at the down stream in order to keep and regulate return flow water. Typical reuse of the return flow in the Project Areas is as follows;

- The terminal drainage canals of upper irrigation block is connected with the secondary or tertiary canals at downstream irrigation block

- The excess water of the upper blocks flows into next lower blocks through above mentioned canals.

(2) Estimation of Volumes of Return Flow

The functions, or procedures of the return flow could be understood through the field investigation. However, it is required to have the systematic discharge measurement in the canals for the evaluation of return flow.

The measurement survey of return flow have been examined at three pilot project area, (Eslam Abad, Ejibar Kola and Suteh). However, the results of measurement could not achieved successfully due to shortage of irrigation water at each pilot project area.

Accordingly, the estimation of return flow has been carried out based on following assumptions:

- Operation allowance in canal system
  oa = 15%
- Application allowance at field level
  aa = 15%
- Return-flow (RF)
  Return flow may appears at 50% (r) of (1) lateral percolation, (2) operation allowance and (3) application allowance.
  $r = (\text{Overall efficiency})^2 = (0.70)^2 = 0.5$
- 1.0 mm of the percolation will flow out to irrigation canals, of which 50% will be return flow.
- 50% of the conveyance losses will flow out as return flow.
- 50% of the field application losses will flow out as return flow.

(3) Effective Return-flow

Since operation and application losses occur unsteadily in operation of irrigation system, it is rather difficult to reuse such losses without storage function as abbandans in the system.

On the other hand, lateral percolation is drained as steady outflow to drainage ditches. Therefore, return-flow of lateral percolation can be easily utilized without abbandans in downstream.

However, in case with abbandans, it is necessary to subtract evaporation and percolation losses from abbandans, because most of return-flow is reused through abbandans.

Based on above elements, effective return-flow rate has been computed as in Table B.1.1-3. According to the result of computation, effective return-flow rate are as follows;

Effective return-flow rate
- with abbandans at present
  Diversion Irrigation amount * 8%
- with abbandans in future
  Diversion Irrigation amount * 12%
- without abbandans in future
  Diversion Irrigation amount * 4%

6. Irrigation Area by Water Resources at Present Stage

(1) Water Requirement (Design Year)

The water requirement of paddy field has been estimated at present stage as follows.

Variety	Irrigation Requirement	Effective Rainfall	Field Requirement
	(mm)	(mm)	(mm)
Early Matured	872.8	- 90	782.8 × 0.44 = 344.4
Medium Matured	980.7	- 90	890.7 × 0.40 = 356.3
Late Matured		- 104	1,081.1 × 0.16 = 173.0
Nursery	1,185.1		12.1
Total		284	885.8

On farm level : 885.8mm/0.87 = 1,018.2mm (10,182 m^3/ha)
Tertiary canal level : 885.8mm/0.79 = 1,121.3mm (11,213 m^3/ha)
Main and secondary canal level : 885.8mm/0.70 = 1,265.4mm (12,654 m^3/ha)

(2) Water Requirement (Normal Year)

Variety	Irrigation Requirement	Effective Rainfall	Field Requirement
	(mm)	(mm)	(mm)
Early Matured	872.8	- 86.0	786.8 × 0.44 = 346.2
Medium Matured	980.7	- 89.1	891.6 × 0.40 = 356.6
Late Matured	1,185.1	-144.9	1,040.2 × 0.16 = 166.4
Nursery			12.1
Total		320	881.3

On farm level : 881.3mm/0.87 = 1,013.0mm (10,130 m^3/ha)
Tertiary canal level : 881.3mm/0.79 = 1,115.6mm (11,156 m^3/ha)
Main and secondary canal level : 881.3mm/0.70 = 1,259.0mm (12,590 m^3/ha)

TABLE B.1.1-1 LIST OF SHALLOW-WELL AND SPRING (1/3)

District	Sub District	Zone	Shallow-Well		Shallow-Well		Total (Irrigable-A)	Remarks
			No of Well	Irrigable Area	No of Spring	Irrigable Area		
HE	HE (I)	HE 1	75	150(ha)	15	210(ha)	360(ha)	
		HE 2	12	24	5	70	94	
		HE 3	1	2	6	84	86	
		HE 4	-	-	-	-	-	
		HE 5	-	-	-	-	-	
		HE 5A	-	-	2	28	28	
		HE 5B	2	4	-	-	4	
	Sub-Total		90	180	28	392	572	
HE	HE (II)	KL 1	-	-	-	-	-	KL 1~KL 6
		KL 2	-	-	-	-	-	
		KL 3	21	42	-	-	42	
		KL 4	19	38	-	-	38	
		KL 5	362	724	-	-	724	
		KL 6	3	6	-	-	6	
		KL 6A	30	60	-	-	60	
		KL 6B	110	220	-	-	220	
	Sub-Total		545	1,090	-	-	1,090	
HE	HE (III)	KR 1	-	-	-	-	-	
		KR 2	-	-	-	-	-	
		KR 3	10	20	-	-	20	
		KR 4	430	860	-	-	860	
		KR 5	27	54	-	-	54	
	Sub-Total		467	934	-	-	934	
Total			1,102	2,204	28	392	2,596	

TABLE B.1.1-1 LIST OF SHALLOW-WELL AND SPRING (2/3)

District	Sub District	Zone	Shallow-Well		Shallow-Well		Total (Irrigable-A)	Remarks
			No of Well	Irrigable Area	No of Spring	Irrigable Area		
HW	-	HW 1	-	(ha)	-	- (ha)	- (ha)	
	-	HW 2A	213	426	3	42	468	
	-	HW 2B	53	106	-		106	
	-	HW 3	62	124	7	98	222	
	-	HW 4	6	12	1	14	26	
	-	HW 5	14	28	1	14	42	
	-	HW 6	10	20	3	42	62	
Total	-		358	716	15	210	926	
AW	AW (I)	AW 1	57	114	-	-	114 (ha)	
	〃	AW 2	186	372	-	-	372	
	〃	AW 3A	154	308	-	-	308	
	〃	AW 3B	98	196	-	-	196	
	〃	AW 4	112	224	-	-	224	
	Sub-Total		607	1,214	-	-	1,214	
AW	AW (II)	AW 5	302	604	-	-	604	
	〃	AW 6	51	102	-	-	102	
	〃	AW 7	281	562	-	-	562	
	〃	AW 8	2	4	5	70	74	
	〃	AW 9	1	2	-	-	2	
	〃	AW 9A	318	636	-	-	636	
	〃	AW 9B	129	258	-	-	258	
	Sub-Total		1,084	2,168			2,238	
Total	AW-I + AW-II		1,691	3,382	5	70	3,452	

TABLE B. 1.1-1 LIST OF SHALLOW-WELL AND SPRING (3/3)

District	Sub District	Zone	Shallow-Well		Shallow-Well		Total (Irrigable-A)	Remarks
			No of Well	Irrigable Area	No of Spring	Irrigable Area		
AE	AE (I)	AE 1	1	2	-	-	2	
		AE 2	15	30	-	-	30	
		AE 3A	6	12	-	-	12	
		AE 3Aa	84	168	-	-	168	
		AE 3Ab	-	-	-	-	-	
		AE 3B	8	16	-	-	16	
		AE 3C	78	156	-	-	156	
	Sub-Total		192	384	-	-	384	
AE	AE (II)	AE 4	3	6	-	-	6	
		AE 4A	151	302	-	-	302	
		AE 4B	165	330	-	-	330	
		AE 5	10	20	-	-	20	
		AE 6A	69	138	-	-	138	
		AE 6B	46	92	-	-	92	
	Sub-Total		444	888	-	-	888	
	AE (III)	AE 7	143	286	-	-	286	
		AE 8	186	372	-	-	372	
		AE 9	387	774	-	-	774	
		AE 10	534	1,068	-	-	1,068	
		AE 11	42	84	-	-	84	
		AE 11A	142	284	-	-	284	
		AE 11B	323	646	-	-	646	
	Sub-Total		1,757	3,514	-	-	3,514	
Total			2,393	4,786	-	-	4,786	Babol Urban Area
BUA			293	586	-	-	586	
G.T			5,837	11,674	48	672	12,346	

TABLE B.1.1-2 LIST OF ABBANDAN (1/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
HW	HW							
		HW 2B	5-2	HW 1	5	1.30	65	
		HW 3	12-1	〃 2	11	〃	143	
		〃	12-2	〃 3	12	〃	156	
		〃						
	Total	〃			28		364	
AW	AW I	AW 1	5-1	AW 1	39	0.75	293	
		〃	2-1	〃 2	10	〃	75	
		〃	4-2	〃 3	11	〃	83	
		〃	5-1	〃 4	2	0.85	17	
		〃	4-2	〃 5	3	0.50	15	
		〃	3-1	〃 6	24	0.90	216	
		〃	3-1	〃 7	20	〃	180	
		〃	7-1	〃 8	81	1.70	1,377	
		〃	7-1	〃 9	17	〃	298	
		AW 2	3-1	〃 10	52	0.65	338	
		〃	1-1	〃 11	6	1.00	60	
		〃	1-1	〃 12	8	〃	80	
		〃	3-3	〃 13	106	〃	1,060	
		AW 3A	2-5	〃 14	20	0.75	150	
		〃	2-4	〃 15	7	0.65	46	
		〃	2-4	〃 16	6	〃	39	
		〃	3-1	〃 17	18	0.70	126	
		〃	5-1	〃 18	17	0.90	153	
		〃	2-7	〃 19	31	1.00	310	
		AW 3B	3-1	〃 20	6	1.25	75	
		〃	4-2	〃 21	17	1.00	170	
		〃	5-1	〃 22	7	〃	70	
		AW 4	3-4	〃 23	4	0.90	36	
		〃	6-1	〃 24	18	0.95	171	
		〃	6-2	〃 25	8	0.90	72	
		〃	6-2	〃 26	8	〃	72	
		〃	5-5	〃 27	22	〃	198	
		〃	5-4	〃 28	10	0.75	75	
		〃	5-6	〃 29	17	0.90	153	
		〃						
	Sub-t	〃			595		6,008	

A ; Reservoir Area (ha) V ; Storage Capacity (10^3m^3)
M.W.D ; Mean Water Depth (m)

TABLE B. 1.1-2 LIST OF ABBANDAN (2/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
AW	AW II	AW 5	3-1	AW 30	8	1.00	80	
		〃	3-2	〃 31	13	1.00	130	
		〃	〃	〃 32	3	〃	30	
		〃	〃	〃 33	15	〃	150	
		〃	5-4	〃 34	23	1.15	265	
		〃	5-3	〃 35	12	0.65	78	
		〃	5-3	〃 36	5	0.90	45	36-1
		〃	5-4	〃 36	4	0.90	36	36-2
		〃	5-4	〃 37	11	〃	99	
		AW 6	5-2	〃 38	3	0.50	15	
		〃	2-1	〃 39	8	〃	40	
		AW 5	3-4	〃 40	17	1.00	170	
		AW 7	11-1	〃 41	8	0.90	72	
		AW 6	3-1	〃 42	8	1.00	80	
		〃	4-2	〃 43	5	〃	50	
		〃	3-5	〃 44	7	〃	70	
		〃	3-4	〃 45	2	0.50	10	
		AW 7	4-2	〃 46	3	0.90	27	
		〃	〃	〃 47	10	〃	90	
		〃	4-4	〃 48	8	〃	72	
		〃	10-4	〃 49	17	0.70	119	
		〃	3-2	〃 50	22	1.00	220	
		〃	5-1	〃 51	8	0.50	40	
		〃	6-1	〃 52	2	〃	10	
		〃	8-1	〃 53	23	0.75	173	
		〃	7-1	〃 54	14	0.70	98	
		〃	7-1	〃 55	11	〃	77	
		〃	8-1	〃 56	6	0.65	39	
		〃	6-1	〃 57	11	0.90	99	
		〃	6-1	〃 58	10	0.70	70	
		AW 9A	6-2	〃 59	8	1.00	80	

TABLE B. 1.1-2 LIST OF ABBANDAN (3/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
AW	AW II	AW 9A	7-1	AW 60	10	0.75	75	
		〃	8-1	〃 61	8	1.25	100	
		〃	8-1	〃 62	20	0.95	190	
		〃	7-1	〃 63	6	0.75	45	
		〃	7-3	〃 64	17	〃	128	
		〃	7-1	〃 65	14	〃	30	
		〃	7-3	〃 66	2	0.50	10	
		〃	7-3	〃 67	15	0.75	113	
		〃	7-4	〃 68	31	0.60	186	
		〃	4-4	〃 69	4	0.75	30	
		〃	7-5	〃 70	12	〃	90	
		〃	2-1	〃 71	3	1.00	30	
		AW 9B	3-1	〃 72	4	0.75	30	
		AW 9B	3-1	〃 74	10	0.65	65	
		〃	4-1	〃 75	12	〃	78	
		〃	〃	〃 76	6	〃	39	
		〃	5-1	〃 77	2	〃	13	
		〃	7-3	〃 78	7	0.50	35	
		AW 9A	9-1	〃 79	18	0.90	162	
		AW 9	3-1	〃 80	11	0.75	83	
		AW 9B	5-3	〃 81	4	0.65	26	
	Sub-t				511		1,558	
	Total				1,106		10,200	

TABLE B.1.1-2 LIST OF ABBANDAN (4/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
HE	HE I	HE 5B	6-5	HE 1	6	1.65	99	
	HE II	KL 3	6-6	〃 2	21	1.45	304	
		KL 4	3-2	〃 3	12	2.20	264	
		KL 5	1-2	〃 4	15	1.25	188	
		KL 4	6-2	〃 5	142	1.20	1,704	
		〃	〃	〃 6	5	1.05	53	
		〃	〃	〃 7	13	1.75	228	
		〃	6-3	〃 8	14	1.45	203	
		KL 6B	1-2	〃 9	6	1.95	117	
		KL 6A	2-2	〃 10	15	1.45	217	
		〃	2-1	〃 11	5	1.45	72	
		〃	〃	〃 12	16	1.30	208	
		〃	1-3	〃 13	10	2.70	270	
		KL 5	4-1	〃 14	12	0.90	108	
		〃	5-3	〃 15	45	1.70	765	
		〃	3-1	〃 16	4	1.70	68	
		〃	3-2	〃 17	10	1.75	175	
		〃	〃	〃 18	4	1.70	68	
		KL 5	5-1	〃 20	4	2.75	110	
		〃	〃	〃 21	22	2.85	627	
		KL 6B	2-2	〃 22	32	1.20	384	
		〃	3-3	〃 23	9	〃	108	
		KR 4	9-2	〃 24	8	1.25	100	
		〃	9-2	〃 25	19	1.30	247	
	Total				449		6,687	
HE		BUA		26	12	1.10	132	
				27	17	1.10	187	
				28	15	0.80	40	
				29	177	0.95	1,682	
				30	5	0.50	25	
	Total				216		2,066	

A ; Reservoir Area (ha) V ; Storage Capacity (10^3m^3)
A.D.; Mean Water Depth (m)

TABLE B.1.1-2 LIST OF ABBANDAN (5/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
AE	AE I	AE 3B	1-1	AE 1	6	0.75	45	
		AE 3Aa	2-8	〃 2	24	0.90	216	
		〃	2-8	〃 3	12	〃	108	
		〃	2-9	〃 4	9	〃	81	
		AE 3B	3-1	〃 5	14	〃	126	
	AE II	AE 4A	2-1	〃 6	9	〃	81	
		AE 4B	4-1	〃 7	31	1.45	450	
		〃	5-2	〃 8	13	0.90	117	
		〃	7-2	〃 9	9	〃	114	
		〃	9-1	〃 10	43	0.70	301	
	AE I	AE 3Ab	4-1	〃 11	9	0.50	45	
		〃	4-1	〃 12	64	1.10	704	
		〃	4-2	〃 13	33	0.75	248	
	AE II	AE 5	5-1	14	6	0.65	39	
			5-1	15	9	0.65	59	
		〃	6-1	〃 16	16	0.40	64	
		AE 4B	8-1	〃 18	3	0.50	15	
		〃	7-1	〃 19	4	0.90	36	
		〃	9-2	〃 20	11	0.70	77	
		AE 5	5-1	AE 24	22	0.65	143	
		AE 5	5-1	〃 26	8	0.65	52	
		AE 6A	4-1	〃 27	22	〃	143	
		AE 6B	4-3	〃 28	15	0.75	113	
		AE 6A	6-1	〃 29	26	1.25	325	
		AE 6B	2-2	〃 30	6	0.65	39	
		〃	3-3	〃 31	16	0.90	144	
		〃	3-2	〃 32	15	〃	135	
		〃	4-1	〃 33	3	0.50	15	
		〃	4-1	〃 34	4	〃	20	

TABLE B.1.1-2 LIST OF ABBANDAN (6/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V (10^3m^3)	
AE	AE II	AE 6B	4-2	AE 35	8	0.50	40	
		〃	4-2	〃 36	5	〃	25	
	AE III	AE 7	2-1	〃 37	9	0.75	68	
		〃	3-1	〃 38	38	0.60	228	
	AE II	AE 6B	4-1	〃 39	12	〃	72	
	AE III	AE 7	3-4	〃 40	11	0.65	72	
	AE II	AE 6A	6-3	〃 41	14	1.15	161	
	AE III	AE 7	3-5	〃 42	6	1.50	90	
		〃	4-4	〃 43	29	0.90	261	
		〃	4-7	〃 44	27	1.15	311	
		〃	〃	〃 45	11	0.90	99	
		〃	4-6	〃 46	19	〃	171	
		〃	1-4	〃 48	23	0.90	207	
		AE 8	2-1	〃 49	15	〃	135	
		AE 7	1-6	〃 50	8	〃	72	
		AE 8	3-1	〃 51	14	〃	126	
		〃	3-2	〃 52	30	〃	270	
		〃	1-5	〃 53	13	0.60	78	
		〃	〃	〃 54	10	0.65	65	
		AE 9	4-4	〃 55	11	0.75	83	
		〃	2-1	〃 56	4	0.90	36	
		〃	2-1	〃 57	6	〃	54	
		〃	2-2	〃 58	5	〃	45	
		〃	2-4	〃 59	14	0.75	105	
		〃	〃	〃 60	12	〃	90	
		〃	3-1	〃 61	8	0.90	72	
		〃	3-2	〃 62	22	1.25	275	
		〃	〃	〃 63	9	〃	113	
		〃	4-1	〃 64	21	0.90	189	
		〃	4-1	〃 65	13	〃	117	

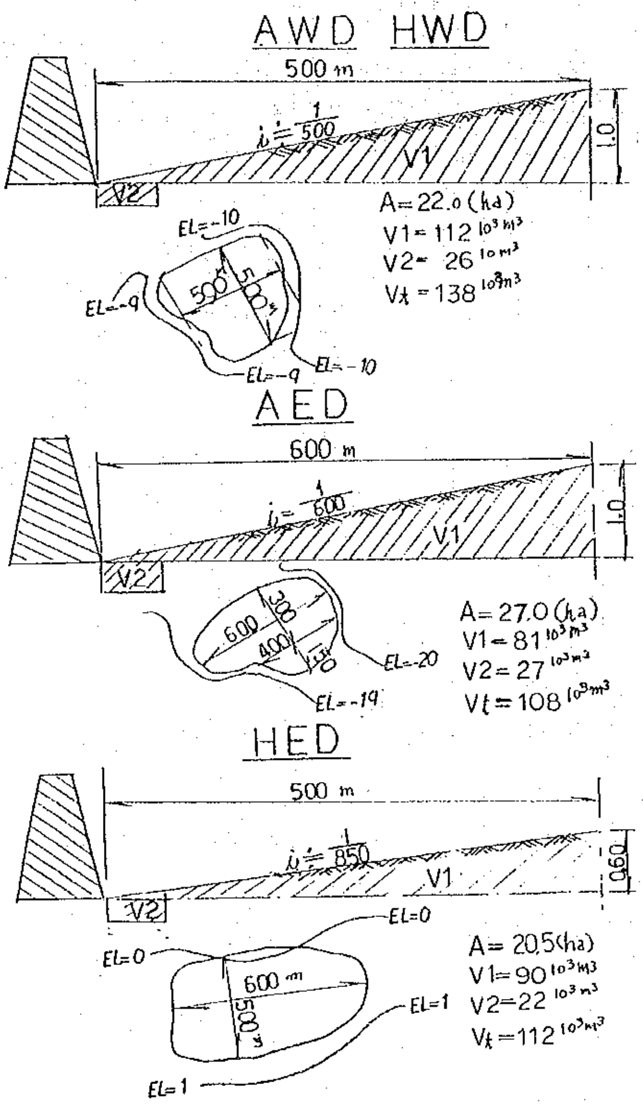
TABLE B.1.1-2 LIST OF ABBANDAN (7/7)

District	Sub-Distrcit	Zone	Sub-Block	Abbandan				Remarks
				No. of Abbandan	A (ha)	MWD	V ($10^3 m^3$)	
AE	AE III	AE 9	4-3	AE 66	17	0.75	128	
		AE 10	1-1	〃 67	16	1.25	200	
		〃	1-4	〃 68	44	〃	550	
		〃	2-5	〃 70	24	1.25	300	
		〃	〃	〃 71	22	0.75	165	
		AE 11A	3-1	〃 72	26	0.75	195	
		〃	3-2	〃 73	60	1.20	720	
		〃	3-3	〃 74	10	1.25	125	
		AE 10	2-3	〃 75	54	0.75	405	
		〃	2-4	〃 76	23	〃	173	
		〃	2-3	〃 77	5	0.55	28	
		〃	2-4	〃 78	23	0.85	196	
		〃	〃	〃 79	13	〃	111	
		AE 11A	1-3	〃 80	61	0.85	519	
		〃	2-3	〃 81	11	0.75	83	
		AE 11B	2-3	〃 82	9	〃	68	
		AE 11A	2-3	〃 83	3	〃	23	
		AE 11B	2-2	〃 84	68	〃	510	
		〃	6-1	〃 85	30	1.60	480	
		〃	6-4	〃 86	90	〃	1440	
		〃	6-3	〃 87	14	〃	224	
		〃	6-5	〃 88	41	0.63	258	
		〃	5-4	〃 89	42	1.60	672	
		〃	5-5	〃 90	15	1.13	170	
		〃	〃	〃 91	3	0.60	18	
		〃	4-3	〃 92	56	1.30	728	
		〃	4-4	〃 93	34	〃	442	
	Total				1,703		16,683	

TABLE B. 1.1-3 IRRIGATION EFFICIENCY AT PRESENT AND FUTURE

Description		Unit	Present	Future With Abbandans	Future W/O Abbandons
Irrigation Area	1A	ha	82,643	78,669	82,171
Canal Area					
Secondary Canals	AS	ha	2,001	2,001	2,001
Tertiary to Irrigation Ditches	AT	ha	885	885	885
Total	AC	ha	2,886	2,886	2,886
Abbandan Area	AB	ha	3,502	3,502	0
Potential Evapotranspiration					
ETo in June	ETo	mm/day	5.5	5.5	5.5
Crop Coefficient					
Free Water Surface	Kw		1.00	1.00	1.00
Crop Coefficient	Kc		1.10	1.10	1.10
Percolation of Canals and Abbandans					
Canal Bed and Abbandan Bottom	PC	mm/day	5.0	5.0	5.0
Percolation at Paddy Fields					
Deep Percolation	PD	mm/day	2.0	2.0	2.0
Lateral Percolation	PL	mm/day	0.0	1.0	1.0
Total Percolation	P	mm/day	2.0	3.0	3.0
Net Irrigation Requirement					
(ETo * Kc + P) * 1A * 10	In	cu.m/day	6,652,762	7,119,545	7,436,476
Operation Allowance in Canal Level	Oa	%	15	15	15
Application Allowance at Field Level	aa	%	15	15	15
Losses of Irrigation Water					
Evaporation from Secondary Canals					
ETo * Kw * AS * 10	Les	cu.m/day	110,055	110,055	110,055
Evaporation from Tertiary & Below					
ETo * Kw * AS * 10	Let	cu.m/day	48,675	48,675	48,675
Total of Evaporation Losses	Le	cu.m/day	158,730	158,730	158,730
Percolation from Secondary Canals					
PC * AS * 10	Lps	cu.m/day	100,050	100,050	110,050
Percolation from Tertiary & Below					
PC * AS * 10	Lpt	cu.m/day	44,250	44,250	44,250
Total of Operation Losses	Lp	cu.m/day	144,300	144,300	144,300
Application Loss at Field					
In + aa	La	cu.m/day	997,914	1,067,932	1,115,471
Operation Loss in Secondary Canal					
(In + Le + Lp + La) * oa * 0.5	Los	cu.m/day	596,528	636,788	664,123
Operation Loss in Tertiary & Below					
(In + Le + Lp + La) * oa * 0.5	Lot	cu.m/day	596,528	636,788	664,123
Total of Operation losses	Lo	cu.m/day	1,193,056	1,273,576	1,328,246
Total of Losses(Le * Lp * La * Lo)	Lt	cu.m/day	2,494,000	2,644,538	2,746,747
Return-flow Rate	r		0.5	0.5	0.5
Return-flow					
Return-flow by Lateral Percolation					
PL * r * 1A * 10	RFp	cu.m/day	0	393,345	410,855
Return-flow by Operation Losses					
LO * r	RFo	cu.m/day	596,528	636,788	664,123
Return-flow by Application Loss					
La * r	RFa	cu.m/day	498,957	533,966	557,736
Total of Return-flow	Rf	cu.m/day	1,095,485	1,564,099	1,632,714
Effective Return-flow					
with Abbandans (RF - (ETo * Kw * PC) * AB * 10)	RFe	cu.m/day	727,775	1,196,389	
w/o Abbandans (RFp)	RFe	cu.m/day			410,855
Irrigation Efficiency w/o Return-flow					
Conveyance Efficiency					
In/(In + Les + Lps + Los)	Ec		0.89	0.89	0.90
Field Canal Efficiency					
In/(In + Let + Lpt + Lot)	Eb		0.91	0.91	0.91
Field Application Efficiency					
In/(In + La)	Ea		0.87	0.87	0.87
Overall Irrigation Efficiency					
Ec * Eb * Ea	Eo		0.70	0.70	0.71
Return-flow utilization rate					
RFe/ (In* Lt)	RFr		0.08	0.12	0.04
Increase Rate by Return-flow Utilization					
1* RFr	Ir		1.08	1.12	1.04
Operation Efficiency with Return-flow					
Eo* 1r	Oe		0.76	0.79	0.74

FIGURE B.1.1-1 TYPICAL FEATURE FOR IMPROVEMENT



B. 1. 2 Preliminary Study of New Water Resources Development

1. Introduction

(1) Irrigation Area by Water Resources at Proposed Plan

The irrigable area depending on water resources has been examined in B. 1. 1 and summarized as below.

Groundwater;

Shallow-wells	5,387 places × 2 ha	=	11,674 ha
Springs	48 places × 14 ha	=	672 ha
Total			12,346 ha

Abbandans;

Effective storage volume	50 MCM
Water requirement	11,941 m^3/ha
Irrigation Area	50 MCM/11,941 = 4,187 ha

(2) Estimation of Return-flow and Its Irrigation Area

In case of full development with Mangol Dam, the return flow and its irrigable area have been estimated based on following procedure.

Required irrigable area by surface water

78,850 ha - 12,346 ha - 4,187 ha = 62,317 ha

Required irrigation water and its return flow

62,317 ha × 13,476 m^3/ha × 0.12 = 100,774 10^3m^3

Irrigable area of said return flow

100,774 10^3m^3/11,941 m^3/ha = 8,439 ha

Net irrigation area by surface water

78,850 - 12,346 - 4,187 - 8,439 = 53,878 ha

Accordingly, the balance of irrigation area based on water resources can be summarized as below.

Water Resources	Available Water	Irrigable Area
- Surface water	726 MCM	53,878 ha
- Ground water	143 MCM	12,346 ha
- Small pond	50 MCM	4,187 ha
- Reuse water	87 MCM	8,439 ha
Total	1,006 MCM	78,850 ha

Note: Required surface water; 53,878 ha × 13,476 m^3/ha = 726 MCM
Reuse water; 726 MCM × 0.12 = 87 MCM

(3) Optimum Size of Regulating Reservoir

Maximum water release of 240 MCM from the Lar reservoir out of total surface water resources will be expected to use as irrigation water for the project. Therefore, the remaining 486 MCM will have to be developed with regulating reservoir in the residual area of Haraz river basin.

In order to estimate the optimum size of such regulating reservoir on the Haraz river, MOE proposed Mangol dam at most upstream of Karehsang gaging station.

According to the results of preliminary review on the geological conditions of the Mangol damsite nearby based on the geological map with scale of 1/250,000 which was provided by the Mazandaran Regional Water Board, geological features of original damsite are not suitable for dam construction due to predominant limestone extended around dam axis and reservoir area and some fault zone existed.

As an alternative plan proposed damsite at 15 km upstream of the original damsite is more suitable than original site. Reservoir storage capacity of the alternative site, however, is slightly smaller than that of original site and catchment area at alternative site will be decreased to 93% of Karehsang gauging station. (4,061 - 288 = 3,773 sq.km.)

General features of both damsites are as follows:

Item	Original damsite	Alternative damsite
1. Catchment area (km^2)	4,061	3,773
2. Sediment load (MCM)	180	170

The summary of geological conditions for both damsites will be described in the following section B. 1. 3 of this Appendix.

Therefore, this water balance study is made mainly determined optimum regulating reservoir size for two proposed damsites. (Refer to Figure B. 1. 2-1, Figure B.1. 2-3 and Figure B.1. 2-4)

2. Basic Input Data of the Simulation

Most of the basic data on irrigation water requirement was referred from B. 2 "the Irrigation " of this Appendix.

Summarized figures and factors to be used are described as follows.

(1) Irrigation Water Requirement

1) Crops and Varieties to be Irrigated

Crop to be irrigated is paddy rice only in summer season for the project and varieties of the rice proposed and cropping intensity are the followings.

Variety	Intensity (%)
Amol - 3	25.0
Khazar	37.5
Tarom	37.5

2) Crop Water Requirement

Crop water requirements for respective rice varieties can be estimated based on the cropping calendar, crop evapotranspiration, crop coefficient and percolation value etc.

Weighed irrigation water requirements for each ten days period is indicated in the Table B. 1. 2-1, and summarized figure is as follows.

Month Decade		Irrigation Water Requirement (mm/10 days)	
		Net I.W.R	Gross I.W.R. (Ei = 0.70)
Apr.	3	47.3	67.6
May	1	81.1	115.9
	2	78.1	111.6
	3	94.1	134.4
Jun.	1	94.4	134.9
	2	91.9	131.3
	3	92.2	131.7
Jul.	1	90.2	128.9
	2	89.7	128.1
	3	95.9	137.0
Aug.	1	69.3	99.0
	2	52.8	75.4
	3	34.4	49.1
Sep.	1	17.4	24.9
	2	5.3	7.6
Total		1,034.1	1,477.4

(2) Effective Rainfall

Effective areal rainfall of the Project Area during irrigation periods from 1951 to 1990 are tabulated in the Table B. 1. 2-2. The conversion method of effective rainfall from the monthly rainfall is described as follows.

- In case of monthly rainfall is less than 200 mm, Re = Rm × 0.75
- In case of monthly rainfall is more than 200 mm, Re = 200 × 0.75 = 150 mm

(3) Evaluation on Runoff Discharge Records of Haraz River Basin

1) Available Data of Release Discharges at the Lar Dam

Water release records at the Lar damsite for irrigation are existed eight (8) years from 1984 (1363) to 1991 (1370) after completion of the Dam as tabulated in the Table B. 1. 2-3. According to the records on the water allocation agreement between Ministry of Energy and Irrigation Users in the

Haraz river basin, the Ministry of Energy guarantees to release required irrigation water of 240 MCM as maximum volumes. The average release water to the downstream of Lar dam for the water balance simulation purpose is as followings.

(Unit : cu.m/sec)

Month	Decade	Average	Maximum	Minimum	Applied
Apr.	3	13.27	22.02	1.38	19.91
May	1	16.76	35.94	1.96	25.14
	2	20.18	42.21	2.71	30.27
	3	24.34	29.89	18.52	36.51
Jun.	1	24.74	30.26	19.17	37.11
	2	21.03	31.49	12.89	31.55
	3	12.89	25.10	2.75	19.34
Jul.	1	14.40	31.09	0.74	21.60
	2	12.86	30.02	0.44	19.29
	3	10.27	27.92	0.68	15.41
Aug.	1	6.89	26.75	0.46	10.34
	2	2.67	12.27	0.46	4.01
	3	1.56	4.84	0.34	2.34
Sep.	1	1.53	4.85	0.38	2.30
	2	1.53	4.85	0.38	2.30

Applied release discharge assumed about 1.50 times of "Average value". Because, total release discharges during irrigation period are about 163.8 MCM, and the ratio between Guaranteed Volume by MOE and the average volume is about 1.5 times ($240 \div 163.8 = 1.50$).

2) Discharge Records of Proposed Mangol Damsite Near the Karehsang

Available discharge data of the proposed Mangol damsite before operating Lar reservoir can be applied 28 years from 1956 to 1982 for water balance study of Mangol dam. The proposed Mangol damsite, however, has geological constraints. Therefore, careful studies on selection of the proposed damsite shall be made from the view points of geological conditions, stability of dam, hydrological availability and project economy.

Tentatively, the following two alternative damsites are considered for water balance simulation.

Original damsite (ODS) :	Extremely upstream of Karehsang gauging station with catchment are of 4,061 sq.km.
Alternative damsite (ADS):	About 15 km upstream of the original damsite with catchment area of 3,773 sq.km. (93% of the original site)

(4) Water Demands Other Than Irrigation Water

According to the Master Plan Report on the "Water Resources Planning of Haraz Plain and Mangol Dam" under the Water Development Plan of the Basin of Talar - Babol - Haraz Rivers, June 1990, water supply to the capital city of the Tehran and river maintenance flow in order to keep the environmental condition of the river are recommended the following values. These figures mentioned below shall be used for the water balance study unless otherwise any other suggestion from Irainan Government.

(Unit : cu.m/sec)

Month	Tehran Water Supply	Maintenance Flow
JAN.	0.00	0.30
FEB.	0.00	0.60
MAR.	0.00	0.60
APR.	6.85	0.30
MAY	6.85	0.30
JUN.	6.85	0.30
JUL.	9.34	0.30
AUG.	9.34	0.30
SEP.	9.34	0.30
OCT.	6.17	0.60
NOV.	6.17	0.60
DEC.	6.17	0.60

3. Water Balance Simulation

(1) Simulation Diagrams

Schematic diagrams of the Haraz river basin water balance (mainly surface water of Haraz river) can be illustrated in the Figure B.1.2-2.

(2) Reservoir Operation Rule of the Lar Dam

Operation of the Lar dam has not been functioned at full scale since the reservoir operation was commenced due to storage water leakage from the dam foundation and view points of keeping stability of the dam body. According to the operation records on the dam provided by MOE, maximum storage water level was recorded at about 2,507 m, which is equivalent to the gross storage volume of about 400 MCM including dead storage volume of 100 MCM. Therefore, maximum net storage volume of the dam for current water balance study shall be 300 MCM, and if there are water level exceeding 2,507 m (Effective reservoir volume 300 MCM) at Lar dam as the result of water balance, these water shall be spillaged to the downstream of Lar river, automatically.

(3) Case Study

The following two case study was conducted for two proposed damsites, such as "Case Study I" for original water allocation method for both Drinking (177 MCM) and Irrigation (248 MCM) and "Case Study II" for modified water allocation method.

	ODS	ADS
Case Study I	A= 53,878 (ha)	A= 53,878 (ha)
	For drinking 177 MCM (1.0)	
	For Irrigation 248 〃 (1.0)	

Note : ODS ; Original Dam site
ADS ; Alternative Dam site

	ODS	ADS
Case Study (II)	A= 53,878 (ha)	A= 53,878 (ha)
	For drinking 239 MCM (1.3)	
	For Irrigation 186 〃 (0.75)	

(4) Results of Water Balance Simulation

The results of water balance simulation for each cases can be summarized as follows.

1) Appropriate Mangol Dam Size

According to the results of water balance simulation combining the Lar and Mangol dams, required effective storage volume of Mangol dam for each cases is tabulated in the Table B. 1. 2-4. Appropriate reservoir size under once in ten years probable drought period are summarized as follows.

Case	Damsite	Live Storage (MCM)	Total Loss (5%) MCM	Dead Storage	Total Storage (MCM)
I	ODS	280	14	180	474
	ADS	305	15	170	490
II	ODS	323	16	180	519
	ADS	362	18	170	550

2) Conclusion

Optimum sizing of the proposed Mangol dam is approximately 305 MCM live storage volume (Case Study I) at "Alternative Damsite" under the condition that allowable live storage capacity of existing Lar dam is upto 300 MCM with maximum water level of 2,507 m.

TABLE B. 1. 2 - 1 WEIGHTED AVERAGE IRRIGATION WATER REQUIREMENT

Month/Decade	Tarom	Khazar	Amol - 3
Crop Calendar	(CVR = 37.5%)	(CVR = 37.5%)	(CVR = 25.0%)
-Nursary (20 days)	(Apr. 01 - May 10)	(Apr. 11 - May 20)	(Apr. 11 - May 20)
-Land preparation	(Apr. 21 - May 31)	(May 01 - Jun. 10)	(May 01 - Jun. 10)
-End of irrigation	(Apr. 01 - Aug. 20)	(Aug. 11 - Aug. 31)	(Sep. 01 - Sep. 15)

W. Req'ment		Tarom BWR	Tarom WWR	Khazar BWR	Khazar WWR	Amol - 3 BWR	Amol - 3 WWR	Total
(Month/Decade)		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
April	1st	-	-	-	-	-	-	-
	2nd	-	-	-	-	-	-	-
	3rd	60.2	22.6	-	-	98.9	24.7	47.3
May	1st	64.9	24.3	64.9	24.3	129.8	32.5	81.1
	2nd	91.1	34.2	64.9	24.3	78.4	19.6	78.1
	3rd	97.1	36.4	96.3	36.1	86.2	21.6	91.1
June	1st	92.3	34.6	99.1	37.2	90.5	22.6	94.4
	2nd	93.3	35.0	91.4	34.3	90.5	22.6	91.1
	3rd	92.0	34.5	92.3	34.6	92.3	23.1	92.2
July	1st	88.3	33.1	91.0	34.1	91.8	23.0	90.2
	2nd	87.1	32.7	89.7	33.6	93.6	23.4	89.7
	3rd	93.3	35.0	97.1	36.4	98.1	24.5	95.9
August	1st	51.8	19.4	80.6	30.2	78.6	19.7	69.3
	2nd	24.9	9.3	66.7	24.8	74.7	18.7	52.8
	3rd	-	-	46.8	17.6	67.2	16.8	34.4
Sep.	1st	-	-	21.1	7.9	37.8	9.5	17.4
	2nd	-	-	-		21.1	5.3	5.3
Total		936.3	351.1	1,001.3	375.4	1,229.5	307.6	1,034.1

Note: (1) BWR = Basic Water Requirement
CVR = Crop Variety Ratio
WWR = Weighted Water Requirement

(2) Whole land preparation period within the same irrigation zone is expected 50 days instead of 40 days for the period of each varieties.

(3) Harvesting time is expected at 10 days after irrigation water was stopped (maturing period of paddy rice).

TABLE B. 1. 2 - 2 MONTHLY EFFECTIVE RAINFALL FOR RICE

(Unit: mm)

Year	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.
1951	35.7	14.1	23.4	21.6	12.5	25.7	73.9
1952	68.3	48.1	27.6	24.1	26.8	37.6	29.2
1953	76.9	32.3	34.5	14.0	44.6	14.3	118.1
1954	35.2	29.3	23.0	11.4	62.2	15.0	64.2
1955	50.7	25.4	13.9	32.5	13.4	43.4	45.5
1956	60.2	29.4	16.4	11.4	39.2	16.3	82.1
1957	58.9	19.6	23.3	73.5	46.4	67.1	21.8
1958	31.6	38.0	11.7	31.7	72.8	31.5	29.9
1959	37.4	22.2	33.5	17.0	15.7	44.3	59.0
1960	73.7	20.3	12.8	14.9	21.2	28.2	78.3
1961	44.0	33.9	20.3	14.0	37.8	39.5	103.5
1962	29.6	31.4	15.0	64.4	13.0	41.2	29.2
1963	57.5	16.4	30.4	29.8	18.4	49.4	20.2
1964	31.7	107.3	5.9	11.7	7.3	27.3	46.1
1965	43.7	31.9	18.0	8.6	24.8	7.1	46.4
1966	70.5	23.9	20.5	14.2	17.5	14.9	31.3
1967	52.5	36.5	9.5	36.3	5.7	16.0	75.7
1968	62.7	87.8	21.7	19.8	40.1	50.9	6.3
1969	72.2	58.4	19.2	16.7	18.8	23.1	113.3
1970	76.7	19.8	13.8	13.4	21.5	49.4	86.9
1971	42.6	36.6	11.9	13.4	0.0	2.7	22.4
1972	53.6	17.5	35.9	23.6	20.9	59.2	33.5
1973	36.5	9.3	13.1	22.3	3.1	52.1	55.1
1974	31.7	34.9	4.4	23.2	104.5	16.4	59.3
1975	39.2	31.1	36.5	13.6	3.2	84.3	25.6
1976	61.4	27.3	17.9	17.2	15.6	1.1	57.2
1977	27.2	14.8	23.6	8.2	17.2	55.8	20.0
1978	42.2	32.9	55.3	35.4	11.6	38.6	19.9
1979	40.8	22.0	22.1	11.2	10.6	17.0	48.0
1980	45.7	12.8	6.2	3.8	1.1	45.7	66.5
1981	44.0	59.2	35.6	3.2	52.1	18.4	133.4
1982	69.9	10.4	35.1	31.1	13.9	32.9	29.3
1983	49.3	12.5	18.5	35.0	4.5	64.4	37.7
1984	26.6	7.7	24.3	21.1	1.6	62.9	6.0
1985	48.7	14.9	13.3	14.6	16.7	49.6	22.1
1986	63.1	17.6	12.5	32.9	20.1	19.0	63.8
1987	44.4	34.8	13.2	11.9	17.4	117.8	32.2
1988	39.2	43.4	21.8	16.7	69.1	90.9	27.8
1989	75.2	13.7	12.1	12.5	11.4	46.4	166.3
1990	48.5	21.8	18.9	13.4	17.6	32.9	21.2

Note: 1990, Drought Year (1/10)

TABLE B. 1. 2 - 3 RELEASE RECORD AT LAR DAM FOR HARAZ RIVER

(Unit: m³/sec)

Month	Decade	Irri. Period	1984	1985	1986	1987	1988	1989	1990	1991	Average	Max.	Min.	Applied	
Apr.	1	I.P	1.62	0.77	0.41	0.50	N.A	2.71	0.28	0.27	0.94	2.71	0.27	1.41	
	2	〃	5.09	1.29	9.48	0.90	N.A	3.86	0.39	0.28	3.03	9.48	0.28	4.55	
	3	〃	22.02	16.07	20.08	1.38	4.48	20.66	2.42	19.04	13.27	22.02	1.38	19.91	
May	1	〃	20.17	18.86	21.63	1.96	4.57	35.94	13.22	17.70	16.76	35.94	1.96	25.14	
	2	〃	12.73	28.96	24.28	2.71	4.85	42.21	25.70	20.00	20.18	42.21	2.71	30.27	
	3	〃	20.63	29.89	29.43	29.09	18.52	29.22	20.62	19.31	24.34	29.89	18.52	36.51	*
Jun.	1	〃	27.06	28.97	24.18	23.60	30.26	20.94	23.75	19.17	24.74	30.26	19.17	37.11	*
	2	〃	12.89	18.25	21.91	24.09	31.49	16.75	27.88	14.94	21.03	31.49	12.89	31.55	
	3	〃	2.75	11.25	5.28	21.30	25.10	19.10	11.87	6.43	12.89	25.10	2.75	19.34	
Jul.	1	〃	13.54	4.60	8.28	25.14	31.09	15.72	0.74	16.07	14.40	31.09	0.74	21.60	
	2	〃	19.14	1.53	13.16	24.14	30.02	6.17	0.44	8.31	12.86	30.02	0.44	19.29	
	3	〃	18.82	1.69	5.97	21.32	27.92	4.00	0.68	1.79	10.27	27.92	0.68	15.41	
Aug.	1	〃	7.45	1.57	5.24	N.A	26.75	6.21	0.55	0.46	6.89	26.75	0.46	10.34	
	2	〃	1.79	1.41	1.25	N.A	12.27	1.02	0.48	0.46	2.67	12.27	0.46	4.01	
	3	〃	1.70	1.36	1.25	N.A	4.84	0.95	0.45	0.34	1.56	4.84	0.34	2.34	
Sep.	1	〃	1.67	1.29	1.19	N.A	4.85	0.92	0.38	0.40	1.53	4.85	0.38	2.30	
	2	Non. I.P	1.64	1.21	1.15	N.A	4.80	0.90	0.32						
	3	〃	1.56	1.17	1.09	N.A	4.75	0.80	0.31						
Oct.	1	〃	1.49	1.22	1.09	N.A	N.A	0.68	0.29						
	2	〃	1.45	1.14	1.05	N.A	N.A	0.54	0.27						
	3	〃	1.33	1.11	0.99	N.A	4.05	0.58	0.29						
Nov.	(Monthly)	〃	1.16	0.94	0.91	N.A	3.77	1.30	0.26						
Dec.	(Monthly)	〃	1.01	0.86	0.82	N.A	3.32	0.26	0.26						
Jan.	(Monthly)	〃	0.63	0.61	0.47	N.A	3.10	0.20	0.22						
Feb.	(Monthly)	〃	0.41	0.45	0.42	N.A	2.62	0.21	0.17						
Mar.	(Monthly)	〃	0.38	0.36	0.47	N.A	2.19	0.22	0.17						
Total (Irrigation Period: MCM)			166.91	146.96	185.84	154.63*	222.72*	198.54	119.53	165.00	163.81				

Applied values shall be almost same as committed volume (about 240 MCM) to be released to Haraz River such as:

Total volumes of averaged discharge during irrigation period are (163.81 MCM) × 1.5 ≒ 245.7 MCM

Therefore, applied value shall be 1.5 times of the average values indicated above.

TABLE B. 1. 2 - 4 RESULT OF WATER BALANCE SIMULATION (REQUIRED STORAGE LIVE VOLUME)

Item	Order	ODS	ADS
1. Case (I)			
	1	311	332
	2	285	313
	3	280	305
	4	279	304
	5	269	301
2. Case (II)			
	1	336	417
	2	328	368
	3	323	362
	4	321	359
	5	296	349

Note : Summary of water balance simulation for each cases
Mentioned above is tabulated in Table B. 1. 2-5, -6, -7 and -8, respectively.
Besides this, more detailed outputs were compiled in the Data Book.

TABLE B. 1. 2 - 5 SUMMARY OF WATER BALANCE (CASE-I, ODS)

```
output device printer or screen (p/s)?p
operation start year =1956
operation end   year =1982
 1956 - 1982
summary only (y/n)?y
irrigation area(ha) =  53878
Mangol DAM reservoir (1000*CU.M)=0
Mangol DAM initial vol (1000*CU.M)=0
Lar DAM reservoir (1000*CU.M)=300000
**** LAR DAM operation rule (when enpty)****
* case 1 .... drinking:release=50:50        *
* case 2 .... drinking only                 *
*********************************************
```

```
LAR DAM OPERATION RULE CASE = 1
 start of print table No.=1
 end   of print table No.=1
 LARDAM DRINKING WATER RATE =1
 LARDAM RELEASE  WATER RATE =1
***** Dam Site of Mangol Dam ********************
* 1 ..... ODS(Original    Dam Site CA=4,061km2)  *
* 2 ..... ADS(Alternative Dam Site CA=3,773km2)  *
**************************************************
 Dam Site of Mangol Dam = 1
```

```
Dam Site of Mangol Dam : ODS
Lar DAM OPERATION RULE CASE = 1
        DRINKING WATER RATE = 1
        RELEASE  WATER RATE = 1
           ***** Lar DAM Operation Summary *****         (MCM)
```

year	LAR DAM inflow (1)	drkn (2)	release (3)	excess (1)-(2)-(3) (4)	deficit (5)	over flow (6)	reservoir (7)	down excess (8)
1956	584	177	248	191	32	188	269	435
1957	540	177	248	159	45	131	255	378
1958	350	177	248	98	173	53	127	300
1959	411	177	248	90	104	0	114	248
1960	229	122	222	30	144	0	0	222
1961	242	101	141	25	25	0	0	141
1962	331	124	207	35	35	0	0	207
1963	449	177	248	86	62	0	3	248
1964	385	162	248	141	165	0	0	248
1965	360	130	230	68	68	0	0	230
1966	345	126	219	47	47	0	0	219
1967	273	101	171	35	35	0	0	171
1968	536	177	248	165	53	0	3	248
1969	791	177	248	374	7	179	119	427
1970	249	177	248	55	230	54	70	302
1971	420	177	248	100	105	0	65	248
1972	588	177	248	205	41	0	73	248
1973	434	177	248	116	107	45	193	292
1974	319	177	248	39	145	0	86	248
1975	363	177	248	65	126	0	25	248
1976	459	177	248	107	73	0	28	248
1977	324	146	237	33	92	0	0	237
1978	415	168	248	100	100	0	0	248
1979	450	177	248	104	78	0	2	248
1980	354	141	239	65	91	0	0	239
1981	392	146	247	67	67	0	0	247
1982	332	128	203	39	38	0	0	203

```
Dam Site of Mangol Dam ; ODS
Lar DAM OPERATION RULE CASE = 1
        DRINKING WATER RATE = 1
        RELEASE  WATER RATE = 1
         ***** Mangol DAM Operation Summary *****         (MCM)
```

year	inflow	Haraz H.W. 27,855(ha) demand	Haraz H.W. 27,855(ha) defici	Amol H.W. 26,023(ha) demand	Amol H.W. 26,023(ha) defici	demand 53,878 total	Mangol DAM shorta	Mangol DAM resorvoir
1956	1,341	347	0	324	93	670	93	93
1957	1,349	299	0	279	0	578	0	0
1958	912	320	0	299	128	619	128	128
1959	1,089	337	0	315	99	651	99	99
1960	897	350	22	327	196	678	217	217
1961	671	335	71	313	240	648	311	311
1962	726	327	48	305	158	632	206	222
1963	776	332	6	310	142	642	148	145
1964	818	354	11	331	188	685	199	198
1965	954	356	18	333	153	689	171	171
1966	879	354	28	331	168	684	196	196
1967	691	352	68	329	217	681	285	285
1968	1,031	326	1	304	63	630	64	169
1969	1,535	345	0	322	27	667	27	27
1970	769	342	34	320	233	662	268	268
1971	906	369	9	345	208	714	216	216
1972	1,170	326	0	304	40	630	40	54
1973	1,281	346	0	324	129	670	129	129
1974	723	320	20	299	164	619	184	184
1975	992	326	28	304	140	630	168	168
1976	1,025	359	0	336	130	695	130	128
1977	977	342	0	319	120	661	120	120
1978	824	325	23	303	195	628	218	217
1979	837	357	39	333	241	690	280	280
1980	789	359	17	336	262	695	279	279
1981	917	332	0	310	151	643	151	151
1982	702	338	47	315	222	653	269	269

TABLE B. 1. 2 - 6 SUMMARY OF WATER BALANCE (CASE-I, ADS)

```
)utput device printer or screen (p/s)?p
)peration start year =1956
)peration end   year =1982
 1956 - 1982
summary only (y/n)?y
irrigation area(ha) =  53878
Mangol DAM reservoir (1000*CU.M)=0
Mangol DAM initial vol (1000*CU.M)=0
Lar DAM reservoir (1000*CU.M)=300000
**** LAR DAM operation rule (when enpty)****
* case 1 .... drinking:release=50:50       *
* case 2 .... drinking only                *
********************************************
```

```
LAR DAM OPERATION RULE CASE = 1
 start of print table No.=1
 end   of print table No.=1
 LARDAM DRINKING WATER RATE =1
 LARDAM RELEASE  WATER RATE =1
***** Dam Site of Mangol Dam ********************
* 1 ..... ODS(Original    Dam Site CA=4,061km2) *
* 2 ..... ADS(Alternative Dam Site CA=3,773km2) *
*************************************************
 Dam Site of Mangol Dam = 2
```

Dam Site of Mangol Dam ; ADS
Lar DAM OPERATION RULE CASE = 1
DRINKING WATER RATE = 1
RELEASE WATER RATE = 1

***** Lar DAM Operation Summary ***** (MCM)

year	LAR DAM inflow (1)	drkn (2)	release (3)	excess (1)-(2)-(3) (4)	deficit (5)	over flow (6)	reservoir (7)	down excess (8)
1956	584	177	248	191	32	188	269	435
1957	540	177	248	159	45	131	255	378
1958	350	177	248	98	173	53	127	300
1959	411	177	248	90	104	0	114	248
1960	229	122	222	30	144	0	0	222
1961	242	101	141	25	25	0	0	141
1962	331	124	207	35	35	0	0	207
1963	449	177	248	86	62	0	3	248
1964	385	162	248	141	165	0	0	248
1965	360	130	230	68	68	0	0	230
1966	345	126	219	47	47	0	0	219
1967	273	101	171	35	35	0	0	171
1968	536	177	248	165	53	0	3	248
1969	791	177	248	374	7	179	119	427
1970	249	177	248	55	230	54	70	302
1971	420	177	248	100	105	0	65	248
1972	588	177	248	205	41	0	73	248
1973	434	177	248	116	107	45	193	292
1974	319	177	248	39	145	0	86	248
1975	363	177	248	65	126	0	25	248
1976	459	177	248	107	73	0	28	248
1977	324	146	237	33	92	0	0	237
1978	415	168	248	100	100	0	0	248
1979	450	177	248	104	78	0	2	248
1980	354	141	239	65	91	0	0	239
1981	392	146	247	67	67	0	0	247
1982	332	128	203	39	38	0	0	203

Dam Site of Mangol Dam ; ADS
Lar DAM OPERATION RULE CASE = 1
DRINKING WATER RATE = 1
RELEASE WATER RATE = 1

***** Mangol DAM Operation Summary ***** (MCM)

year	inflow	Haraz H.W. 27,855(ha) demand	Haraz H.W. 27,855(ha) defici	Amol H.W. 26,023(ha) demand	Amol H.W. 26,023(ha) defici	demand 53,878 total	Mangol DAM shorta	Mangol DAM resorvoir
1956	1,237	347	1	324	111	670	112	112
1957	1,248	299	0	279	3	578	3	3
1958	845	320	0	299	154	619	154	154
1959	1,002	337	0	315	115	651	115	115
1960	834	350	29	327	207	678	236	236
1961	617	335	83	313	249	648	332	332
1962	666	327	56	305	166	632	222	304
1963	709	332	8	310	171	642	179	256
1964	755	354	17	331	203	685	220	220
1965	878	356	23	333	166	689	189	189
1966	808	354	35	331	183	684	217	217
1967	635	352	78	329	224	681	301	301
1968	939	326	1	304	83	630	83	197
1969	1,402	345	0	322	41	667	41	41
1970	719	342	41	320	246	662	287	287
1971	831	369	16	345	229	714	245	245
1972	1,067	326	1	304	58	630	59	98
1973	1,181	346	5	324	138	670	143	143
1974	667	320	24	299	188	619	212	212
1975	915	326	34	304	145	630	178	178
1976	938	359	3	336	159	695	162	152
1977	902	342	0	319	144	661	144	144
1978	755	325	31	303	213	628	244	244
1979	765	357	47	333	266	690	313	313
1980	725	359	25	336	280	695	305	305
1981	842	332	0	310	180	643	180	180
1982	643	338	57	315	238	653	295	295

TABLE B. 1. 2 - 7 SUMMARY OF WATER BALANCE (CASE-II, ODS)

```
)utput device printer or screen (p/s)?p
)peration start year =1956
)peration end   year =1982
 1956 - 1982
;ummary only (y/n)?y
 rrigation area(ha) =  53878
langol DAM reservoir (1000*CU.M)=0
langol DAM initial vol (1000*CU.M)=0
.ar DAM reservoir (1000*CU.M)=300000
·*** LAR DAM operation rule (when enpty)****
· case 1 .... drinking:release=50:50       *
  case 2 .... drinking only                *
*******************************************
```

```
.AR DAM OPERATION RULE CASE = 1
 start of print table No.=1
 end   of print table No.=1
 LARDAM DRINKING WATER RATE =1.3
 LARDAM RELEASE  WATER RATE =0.75
·**** Dam Site of Mangol Dam ********************
· 1 ..... ODS(Original    Dam Site CA=4,061km2)  *
· 2 ..... ADS(Alternative Dam Site CA=3,773km2)  *
*************************************************
 Dam Site of Mangol Dam = 1
```

```
Dam Site of Mangol Dam ; ODS
Lar DAM OPERATION RULE CASE = 1
     DRINKING WATER RATE = 1.3
     RELEASE  WATER RATE = .75
          ***** Lar DAM Operation Summary *****        (MCM)
```

year	LAR DAM inflow (1)	drkn (2)	release (3)	excess (1)-(2)-(3) (4)	deficit (5)	over flow (6)	reserv oir (7)	down excess (8)
1956	584	230	186	217	49	217	251	403
1957	540	230	186	187	64	138	236	324
1958	350	230	186	101	167	38	133	223
1959	411	230	186	104	109	0	128	186
1960	229	173	184	30	158	0	0	184
1961	243	123	119	26	26	0	0	119
1962	331	159	172	46	46	0	0	172
1963	449	230	186	114	80	0	3	186
1964	385	230	186	150	180	0	2	186
1965	360	178	184	84	87	0	0	184
1966	345	165	180	62	62	0	0	180
1967	273	126	146	41	41	0	0	146
1968	536	230	186	195	75	0	3	186
1969	791	230	186	400	24	217	128	403
1970	249	230	186	53	219	31	81	217
1971	420	230	186	123	119	0	83	186
1972	588	230	186	236	64	16	92	202
1973	434	230	186	135	117	76	183	261
1974	319	230	186	43	141	0	86	186
1975	363	230	186	82	134	0	33	186
1976	459	230	186	139	96	0	35	186
1977	324	213	186	35	110	0	0	186
1978	415	230	186	112	112	0	0	186
1979	450	230	186	129	94	0	2	186
1980	354	203	186	65	100	0	0	186
1981	392	207	186	87	87	0	0	186
1982	332	163	169	42	42	0	0	169

```
Dam Site of Mangol Dam ; ODS
Lar DAM OPERATION RULE CASE = 1
     DRINKING WATER RATE = 1.3
     RELEASE  WATER RATE = .75
          ***** Mangol DAM Operation Summary *****        (MCM)
```

year	inflow	Haraz H.W 27,855(ha) demand	Haraz H.W 27,855(ha) defici	Amol H.W 26,023(ha) demand	Amol H.W 26,023(ha) defici	demand 53,878 total	Mangol DAM shorta	Mangol DAM resorvoir
1956	1,308	347	2	324	105	670	107	107
1957	1,295	299	0	279	1	578	1	1
1958	835	320	0	299	177	619	178	178
1959	1,028	337	0	315	119	651	119	119
1960	859	350	16	327	222	678	238	237
1961	650	335	78	313	242	648	321	321
1962	691	327	41	305	167	632	208	267
1963	714	332	12	310	184	642	196	215
1964	756	354	26	331	216	685	242	242
1965	908	356	9	333	173	689	183	183
1966	839	354	16	331	192	684	208	208
1967	666	352	74	329	212	681	286	285
1968	969	326	1	304	83	630	84	170
1969	1,511	345	0	322	35	667	35	35
1970	684	342	56	320	267	662	323	323
1971	844	369	23	345	238	714	260	260
1972	1,123	326	0	304	43	630	43	98
1973	1,250	346	11	324	138	670	149	149
1974	661	320	27	299	212	619	240	240
1975	930	326	42	304	146	630	188	188
1976	963	359	2	336	164	695	166	157
1977	925	342	2	319	145	661	147	147
1978	762	325	39	303	229	628	268	268
1979	775	357	55	333	281	690	336	336
1980	735	359	40	336	288	695	328	328
1981	856	332	0	310	195	643	195	195
1982	668	338	38	315	257	653	296	296

TABLE B.1.2-8 SUMMARY OF WATER BALANCE (CASE-II, ADS)

```
output device printer or screen (p/s)?p
operation start year =1956
operation end   year =1982
 1956 - 1982
summary only (y/n)?y
irrigation area(ha) =  53878
Mangol DAM reservoir (1000*CU.M)=0
Mangol DAM initial vol (1000*CU.M)=0
Lar DAM reservoir (1000*CU.M)=300000
**** LAR DAM operation rule (when enpty)****
* case 1 .... drinking:release=50:50       *
* case 2 .... drinking only                *
********************************************
```

```
LAR DAM OPERATION RULE CASE = 1
 start of print table No.=1
 end   of print table No.=1
 LARDAM DRINKING WATER RATE =1.3
 LARDAM RELEASE  WATER RATE =0.75
***** Dam Site of Mangol Dam ********************
* 1 ..... ODS(Original    Dam Site CA=4,061km2)  *
* 2 ..... ADS(Alternative Dam Site CA=3,773km2)  *
**************************************************
 Dam Site of Mangol Dam = 2
```

Dam Site of Mangol Dam ; ADS
Lar DAM OPERATION RULE CASE = 1
DRINKING WATER RATE = 1.3
RELEASE WATER RATE = .75
***** Lar DAM Operation Summary ***** (MCM)

year	LAR DAM inflow (1)	drkn (2)	release (3)	excess (1)-(2)-(3) (4)	deficit (5)	over flow (6)	reserv oir (7)	down excess (8)
1956	584	230	186	217	49	217	251	403
1957	540	230	186	187	64	138	236	324
1958	350	230	186	101	167	38	133	223
1959	411	230	186	104	109	0	128	186
1960	229	173	184	30	158	0	0	184
1961	242	123	119	26	26	0	0	119
1962	331	159	172	46	46	0	0	172
1963	449	230	186	114	80	0	3	186
1964	385	230	186	150	180	0	2	186
1965	360	178	184	84	87	0	0	184
1966	345	165	180	62	62	0	0	180
1967	273	126	146	41	41	0	0	146
1968	536	230	186	195	75	0	3	186
1969	791	230	186	400	24	217	128	403
1970	249	230	186	53	219	31	81	217
1971	420	230	186	123	119	0	83	186
1972	588	230	186	236	64	16	92	202
1973	434	230	186	135	117	76	183	261
1974	319	230	186	43	141	0	86	186
1975	363	230	186	82	134	0	33	186
1976	459	230	186	139	96	0	35	186
1977	324	213	186	35	110	0	0	186
1978	415	230	186	112	112	0	0	186
1979	450	230	186	129	94	0	2	186
1980	354	203	186	65	100	0	0	186
1981	392	207	186	87	87	0	0	186
1982	332	163	169	42	42	0	0	169

Dam Site of Mangol Dam ; ADS
Lar DAM OPERATION RULE CASE = 1
DRINKING WATER RATE = 1.3
RELEASE WATER RATE = .75
***** Mangol DAM Operation Summary ***** (MCM)

year	inflow	Haraz H.W 27,855(ha) demand	Haraz H.W 27,855(ha) defici	Amol H.W 26,023(ha) demand	Amol H.W 26,023(ha) defici	demand 53,878 total	Mangol DAM shorta	Mangol DAM resorvoir
1956	1,204	347	5	324	121	670	126	126
1957	1,194	299	0	279	4	578	4	4
1958	768	320	4	299	200	619	205	205
1959	940	337	3	315	138	651	140	140
1960	796	350	25	327	238	678	263	263
1961	595	335	92	313	251	648	342	342
1962	631	327	49	305	186	632	235	349
1963	647	332	19	310	215	642	234	362
1964	693	354	36	331	228	685	264	359
1965	832	356	16	333	190	689	206	256
1966	769	354	24	331	206	684	230	230
1967	610	352	84	329	228	681	312	310
1968	877	326	1	304	105	630	106	206
1969	1,378	345	0	322	50	667	50	50
1970	634	342	65	320	278	662	343	343
1971	769	369	35	345	258	714	293	320
1972	1,021	326	1	304	59	630	60	173
1973	1,150	346	18	324	145	670	163	163
1974	605	320	35	299	233	619	267	267
1975	853	326	48	304	152	630	200	198
1976	876	359	9	336	200	695	209	207
1977	851	342	4	319	170	661	174	170
1978	693	325	50	303	248	628	298	298
1979	703	357	64	333	304	690	368	368
1980	672	359	55	336	300	695	354	417
1981	781	332	4	310	223	643	227	310
1982	610	338	50	315	272	653	323	332

FIGURE B. 1. 2 - 1 LOCATION MAP OF PROPOSED DAM

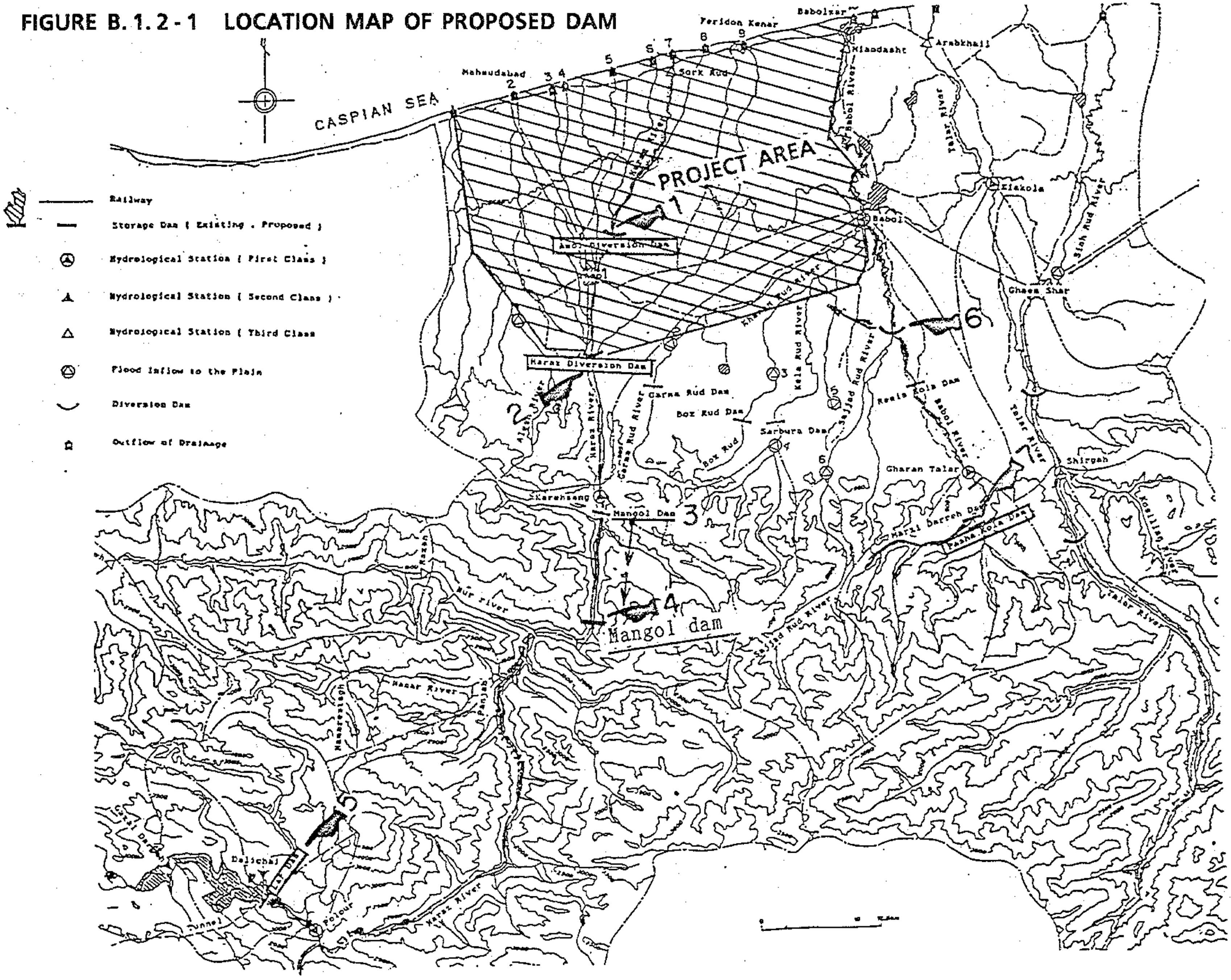


FIGURE B.1.2-2 SCHEMATIC DIAGRAM OF HARAZ RIVER BASIN FLOW

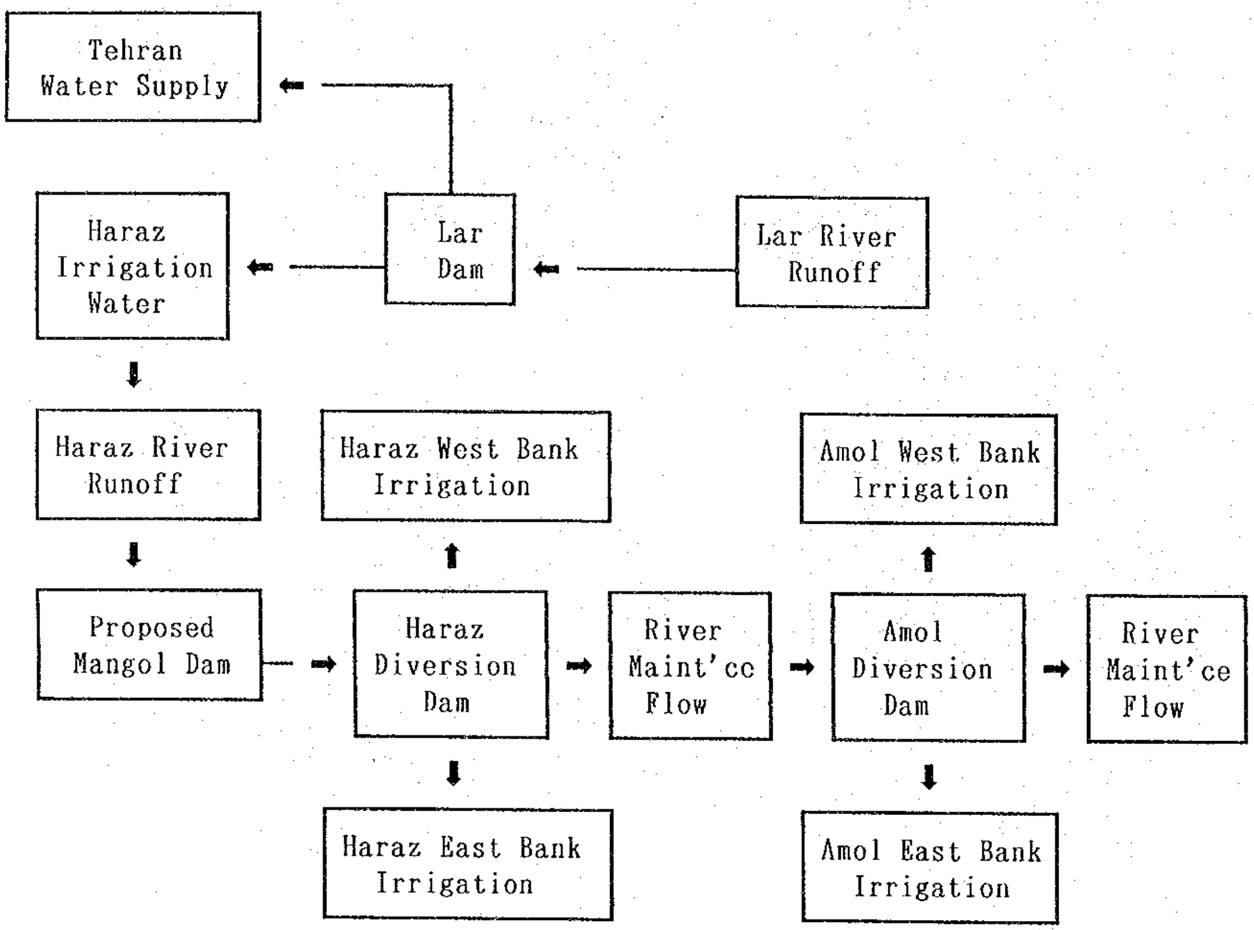


FIGURE B. 1. 2 - 3 MANGOL DAM H-V H-A CURVE
(ORIGINAL DAM SITE : ODS)

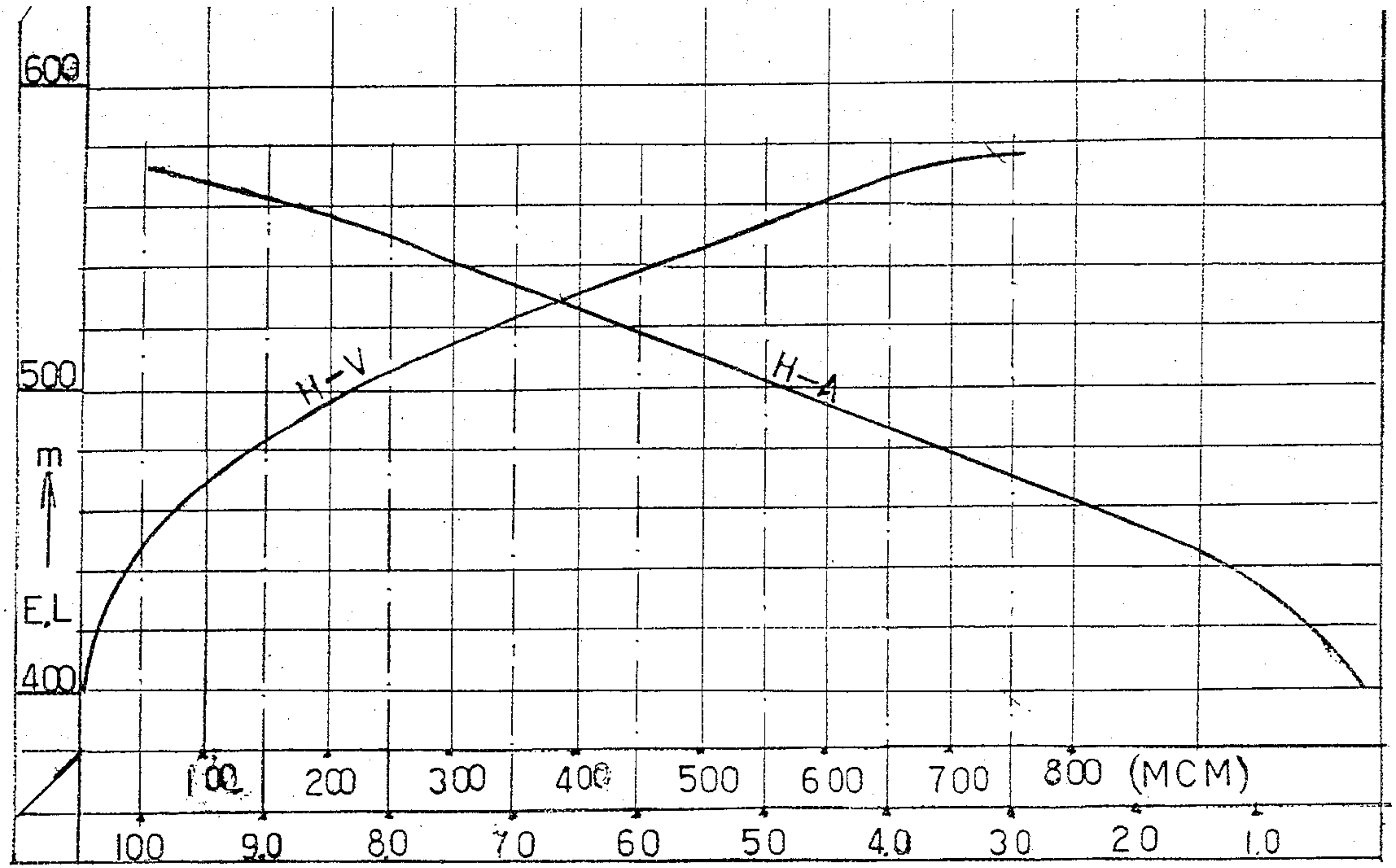
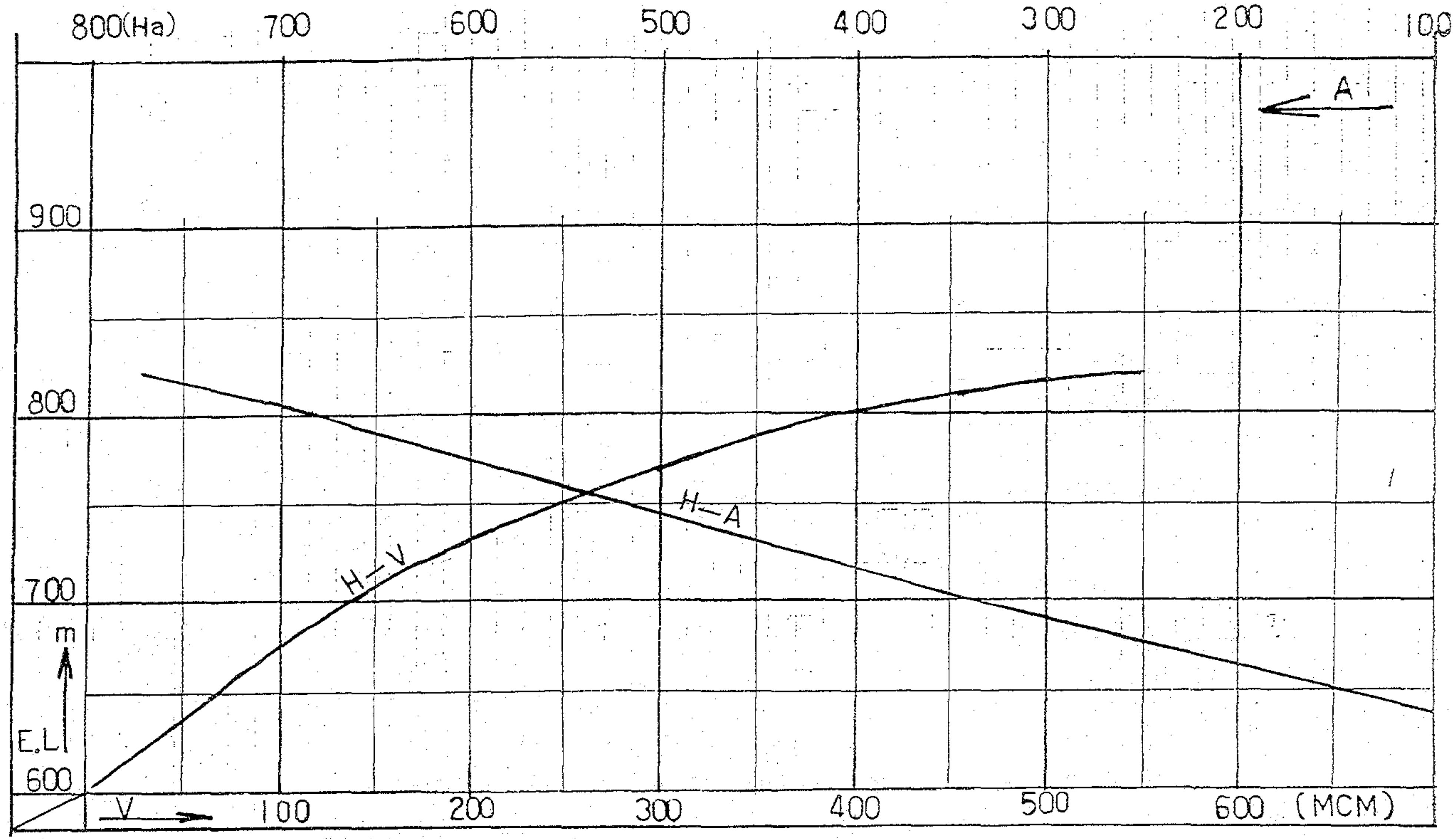


FIGURE B. 1. 2 - 4 MANGOL DAM H-V H-A CURVE
(ALTERNATIVE DAM SITE: ADS)



B. 1. 3 Outline of Geology in Mangol Damsite

Table B. 1. 3 - 1 shows geologic stratigraphy in the proposed damsite, which is referred to geological map attached in Fig B. 1. 3 - 2.

TABLE B. 1. 3 - 1 GEOLOGIC STRATIGRAPHY IN THE DAMSITE

Age	Symbol	Lithofacies and facies
Quaternary	Qa 1	Loose alluvium (river deposits)
	Qs	Talus, fans
	Qv 3	Lava, tuff,
	Qv 2	
Mio-Pliocene	Plc	Conglomerate, with sands, sandy tuff
Eocene	Mm.s.l	Marl, calcareous sandstone sandy limestone
	Pe (FAJAN F.)	Marl, sandstone, gypsum, limestone, locally may include undifferentiated younger deposit.
Cretaceous	K2v	Basalt, andesitic tuff, pyroclasstics.
	K2l	Limestone
	K2pl.m	Limestone, marl, Marly limestone, silty marl, : locally at base may include indifferent deposits
	Klt (TIZ KUH F.)	Orbitolina limestone.
	Klv	Diabase, basalt, pyroclasstics.
	Klg	Gypsum, dolomitic limestone and shale intercalations
Jurassic	J1 (Lar limestone)	Limestone : locally dolomitic in the upper part.
	Jd (Dalichai F.)	Ammonite bearing marl and limestone, calcareous sandstone.
	Js (Shemshak F.)	Shale, sandstone, siltstone, quartzite, conglomerate
Triassic	Re 2 (Elika F.)	Thick bedded to massive dolomite, dolomitic limestone, limestone
	Re 1 (Elika F.)	Thin bedded limestone with worm trace, calcareous shale.
	Pn (Nesen F.)	Limestone, marly and sandy shales.
	Pr (Ruteh F.)	Fusulina limestone, dolomitic limestone
	Pd (Dorud F.)	Shale, sandstone, limestone, siltstone, quartzite.

Lithofacies in the area along Haraz river mainly consists of talus, river deposits and sedimentary rocks before Miocene. Most of them are calcareous and partially intercalated basaltic lava in Quaternary and basic pyroclasstics in Cretaceous. The eminent facies of them repeatedly appears with hundreds or thousands meter cycle. In the conditions of rock outcrop, they were crashed and cracks and corrosion holes are prominent.

It is confirmed that pyroclasstics outcrops at two places, that is, one is a section between 50 km and 60 km of the downstream side, and another point is near Lar damsite. The rock body in the downstream area is able to be correlative with basalt, andesitic lithic tuff and pyroclasstics in Cretaceous. Existence of open cracks at welded time and breakable layers are remarkable in the basaltic lava and its circumference. And then the old basalt probably has the open cracks and very weak part as same as the basaltic lava by reason of the origin.

Geological structure along Haraz river is restricted by the anticline structure which runs in the suburbs of Emarat. The structure has an axis of ENE-WSW in direction, and the axis and its environs make an anticlinal valley by differential erosion. The oldest stratum such as calcareous rocks outcrops in the circumference of the anticline axis near Emarat by the reason of the structure. Newer stratum appears from the axis to the wing of fold, that is, from the suburb of Emarat to the upstream and down stream sides of Haraz river in the geological section. The fault system in the area is eminent in the direction of NW - SE in view of the structure and tectonic movement.

Table B. 1. 3 - 2 shows geography, typical stratum and recommendations in 4 geologic areas.

Based on the geological and geographical recommendation mentioned above, it can be stated that;

1. Economic damsite is not found out in Area 1 because of geographical condition, that is, large width of river bed.

2. Distribution of high permeable strata consisting of limestone and lava is big obstruction for dam construction in Area 4.

3. Area 2 and 3 except Area 1 and 4 mainly consists of calcareous stratum, and volcanic rocks or pyroclasstics respectively. It is delicate matter to say that these strata have good geological condition for dam

foundation in all cases. Comparing with both Areas, some points of difference can be described as follows;

a) Area 2 is much nearer to the anticline axis and the fault system is more remarkable.

b) Composed Strata in Area 2 is mainly limestone and solution holes and underground channels, are therefore distinguished.

c) Limestone in area 2 spreads in the most part.

d) On the contrary, distribution off calcareous stratum in Area 3 is set a limit or small area in the upstream side of the area.

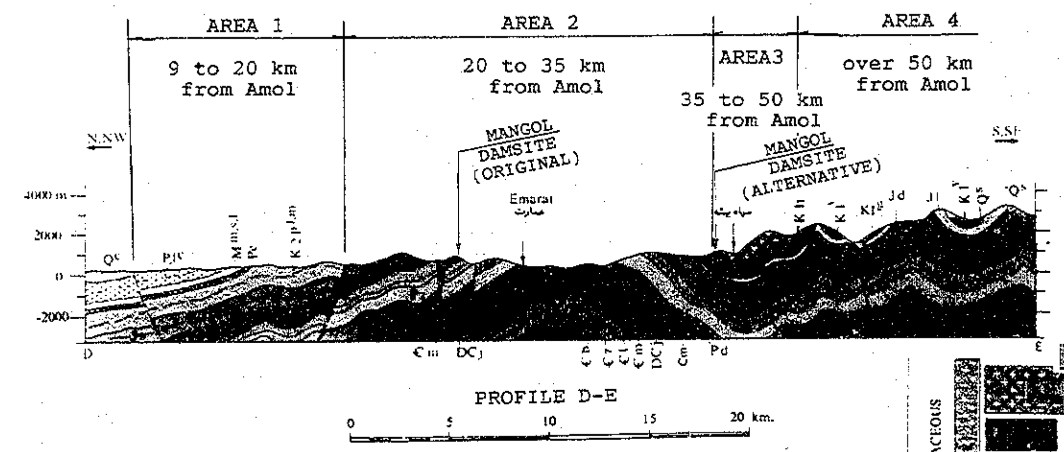
e) Volcanic rocks in Area 3 are old and there is some possibility to differ from younger lava appeared surrounding Lar dam.

At present, details of lithofacies and structure in Area 2 and 3 are not enough but based on the study of the geological maps and primary reconnaissance, it is more feasible to propose a damsite at the upstream side in Area 2 than in Area 3.

TABLE B. 1. 3 - 2 COMPARISON TABLE OF GEOLOGIC AREA

Geologic Area	Geography	Typical Stratum	Recommendations
Area 1	Hilly area spreads out with 700 to 800 meters in fixed height. Height and width of river bed area 200 to 350 meters and 400 to 800 meters respectively. Cross-profile of valley is flat-floored type.	Limestone, Marl, Conglomerate, Sandstone, and Tuff.	The scale of dam will be large because of vast river bed. this area is geologically not appropriate as damsite because dam foundation is soft rock in Tertiary. The dam foundation may be permeable due to existing of conglomerate and limestone in the composed strata.
Area 2	The mountains surrounding Area 2, having 2,000 meter height at the highest top, makes many U-shaped valley with narrow river bed and a few V-shaped valleys in part. The height of river bed is 350 to 600 meters. There are some appropriate sites with large pocket and narrow river bed for dam construction in the downstream area.	Bedded limestone, marl, dolomite, shale, sandstone, silt stone, conglomerate.	Typical stratum consists of bedded limestone, dolomite and marl which are highly permeable. These permeable strata exist in widely in Area 2. It is, therefore, necessary that water leak may be occurred not in dam foundation but also from reservoir. Since this area locates nearby the fold axis, fault system can be concentrated.
Area 3	The mountain slope in Area 3 is steep and the top of mountains reaches 3,000 meters in height. Haraz river makes U-shapes valley in an indentation of the river. Height of river bed varies from 600 to 700 meters. River slope is steep and forms 1/75 in gradient.	Basalt, andesite, tuff, lisic tuff, pyroclasstics, limestone, marl, silty marl	The Area 3 mainly consists of volcanic rocks such as basalt and andesite, and pyroclasstics Key question for dam foundation is generally extent of cracks and existence of high permeable layers in accordance with the cracks extended. But it is not judged at present whether the Area is appropriate or not, because the origin and characteristic of the rock body in Mesozoic is not clear. As limestone outcrops somewhere in all the area, it is need to study water leaks from reservoir.
Area 4	The mountain slope is steep as same as Area 3 and the river makes V-shaped valley in the Area 4. The slope of river bed is also perpendicular with gradient of 1/25. There is not an efficient damsite in the downstream area.	Lava, andesite, agglomerate, andesitic tuff, pyroclasstics, limestone, marl, silty marl, trachyandesitic lava.	Typical stratum extended in Area 4 is limestone or marl, and trachyandesitic lava. Both was leakage strata in Lar dam located at more upstream area. At present, definite countermeasure for cut-off treatment of water leakage from the strata is not found yet out. The treatment of the high permeable strata is indispensable for a plan of dam construction in the Area, which makes big obstruction to future plan.

FIGURE B. 1. 3-1 GEOLOGICAL STRATIGRAPHY IN THE PROPOSED DAMSITE



LEGEND

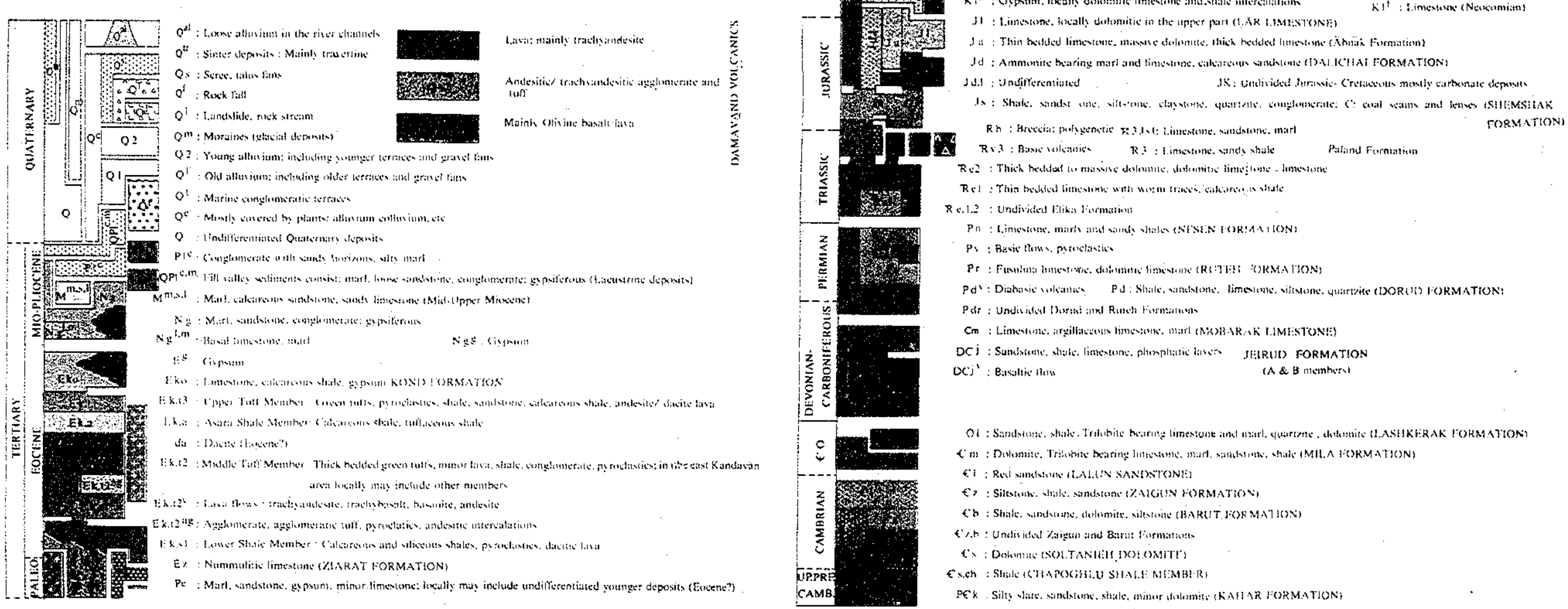


FIGURE B. 1. 3-1 GEOLOGICAL STRATIGRAPHY IN THE PROPOSED DAMSITE

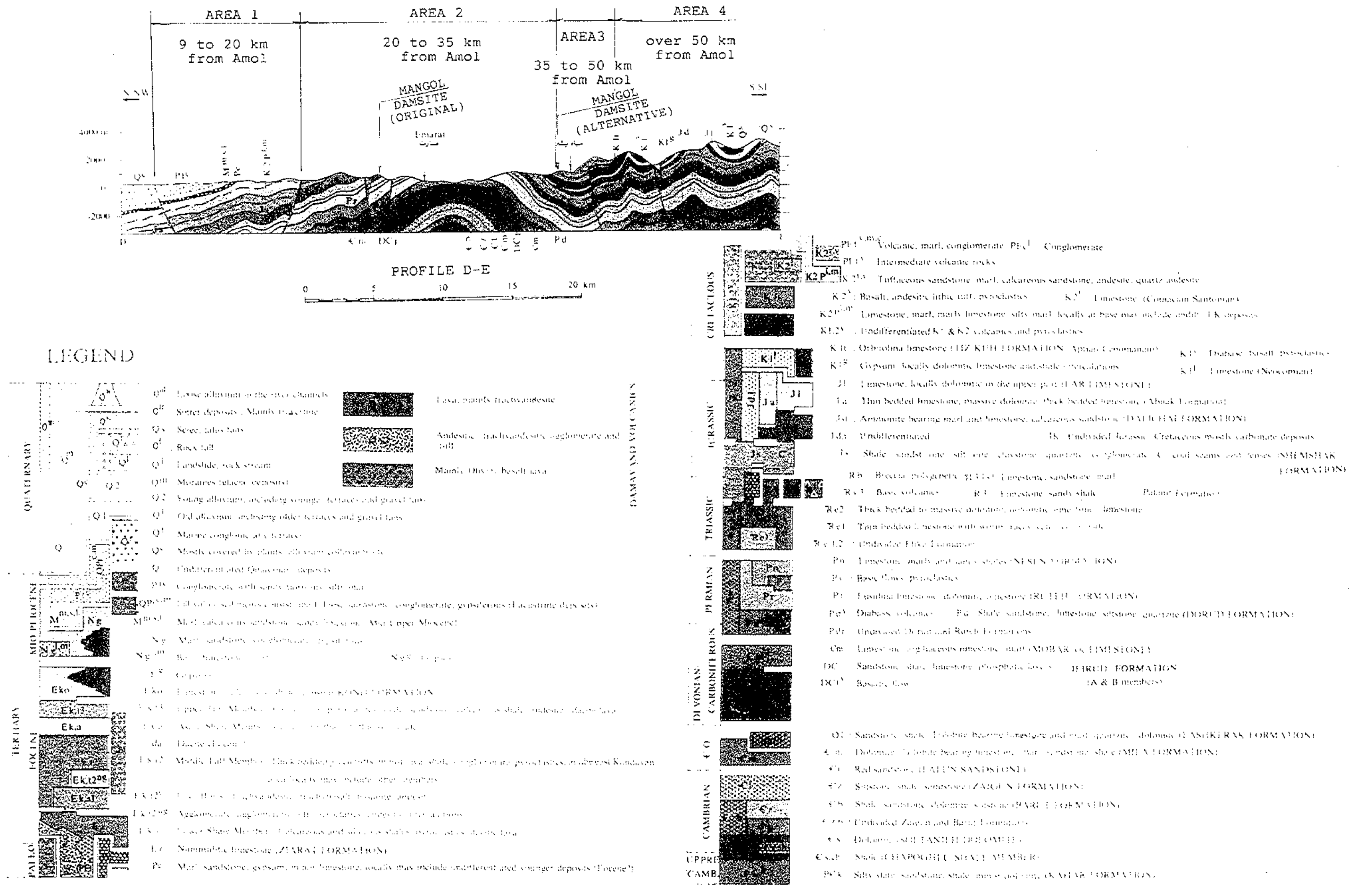


FIGURE B. 1. 3-2 SHOWS A GEOLOGICAL ALONG HARAZ RIVER FOR THE GEOLOGICAL STUDY OF DAM CONSTRUCTION

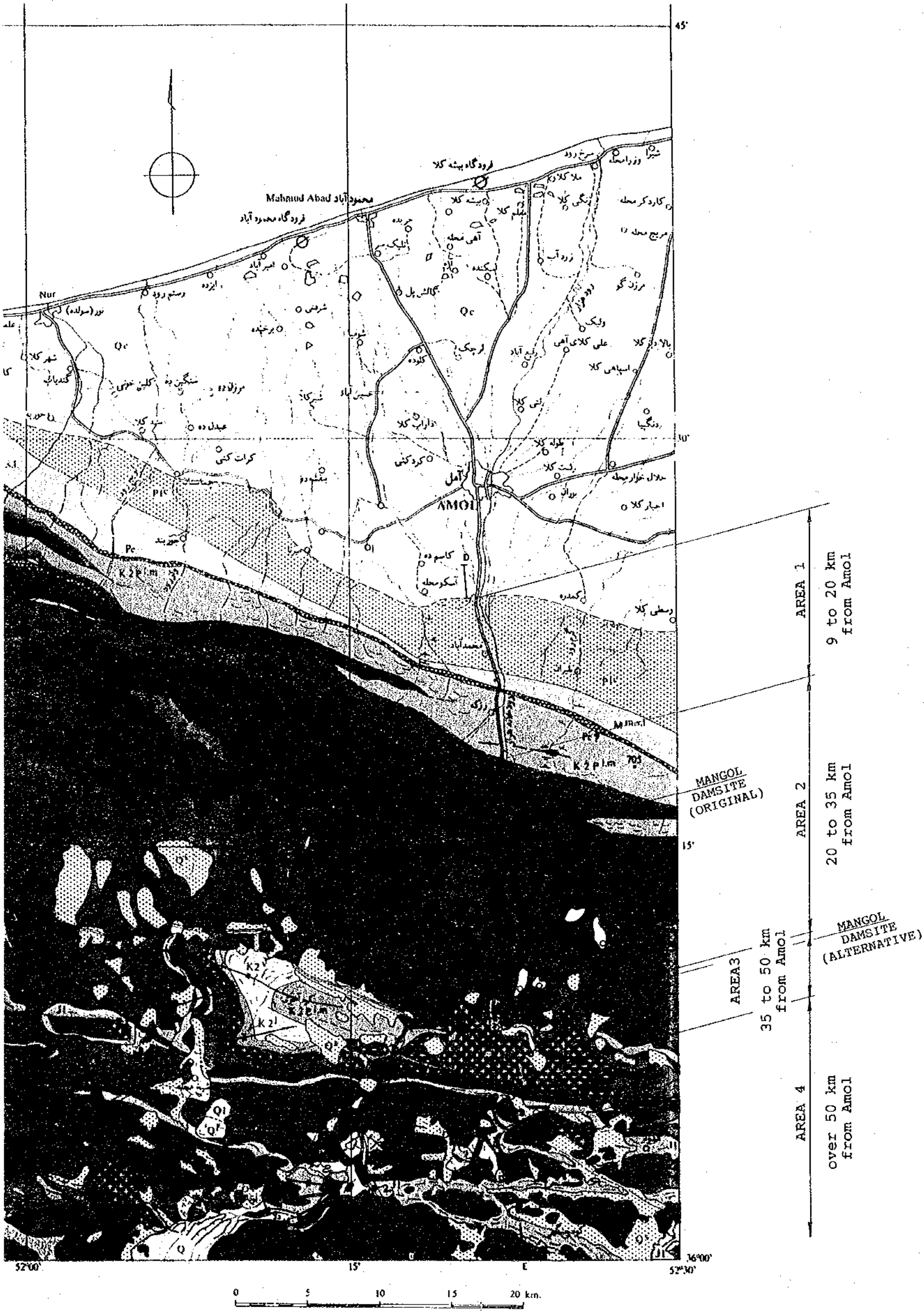
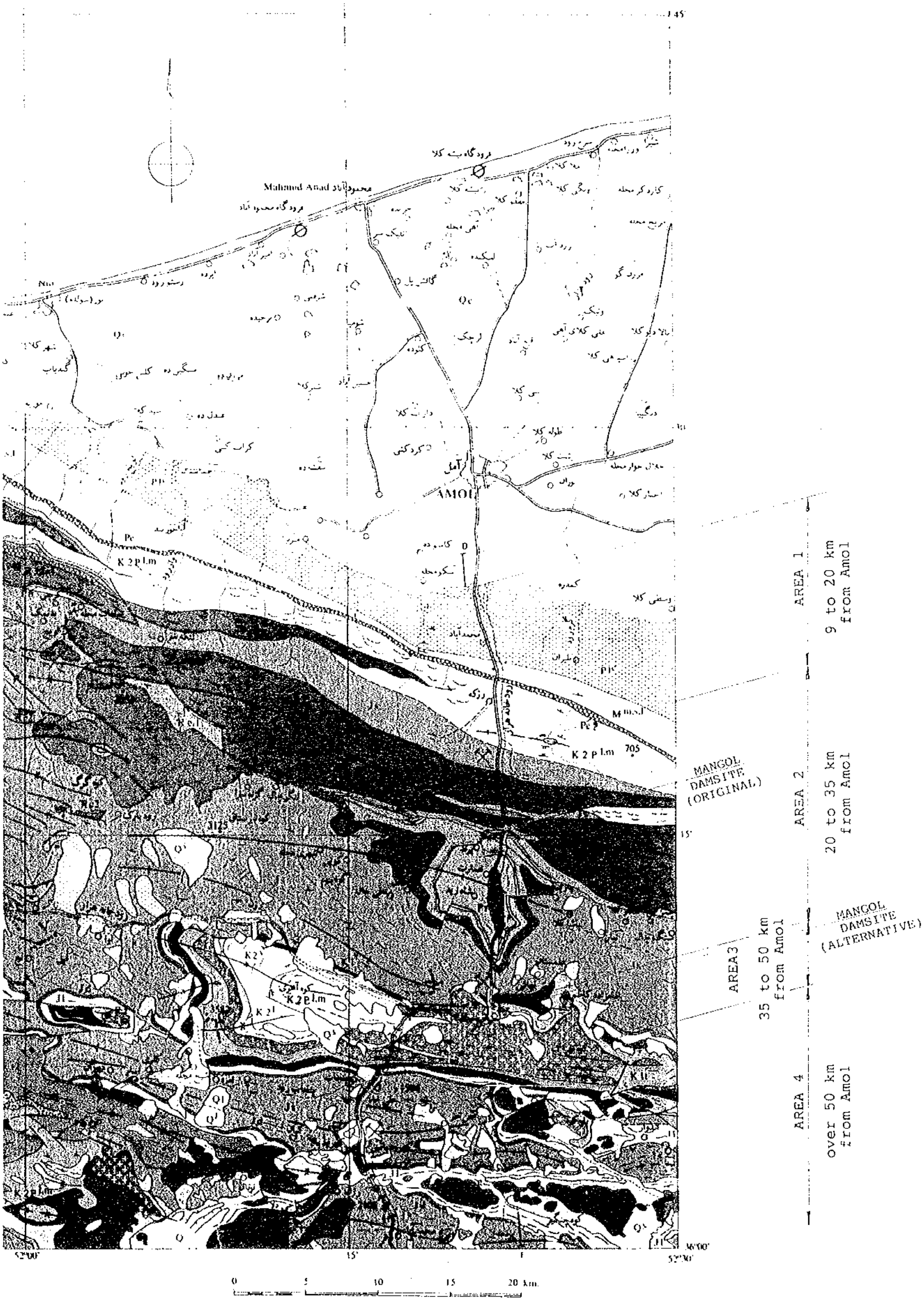


FIGURE B. 1. 3-2 SHOWS A GEOLOGICAL ALONG HARAZ RIVER FOR THE GEOLOGICAL STUDY OF DAM CONSTRUCTION



B. 1. 4 Preliminary Water Balance Study in Case of Lar Dam Only

1. Introduction

As studied in Paragraph 4. 4. 5 "Availability of Water Resources" in the Main Report, water shortage will not be avoidable not only in a drought year but in a normal year even operated with the Lar dam. The shortage amount of irrigation water is estimated at 133 MCM in a normal year and at 317 MCM in a drought year respectively. For ensuring the irrigation water, as mentioned in Paragraph B. 1. 2 "Preliminary Study of New Water Resources Development", it is necessary to construct the Mangol dam, of which live storage capacity is 305 MCM, for ensuring the necessary irrigation supply to irrigate the project area without water shortage.

In this Paragraph B. 1. 4, additional study has been given to the said Paragraph 4. 4. 5 for examining the water balance for the conditions at Present Stage and at after-land-consolidation (referred as Proposed Stage).

Major differences between Present Stage and Proposed Stage are (1) increase of abbandan storage capacity from 36 MCM to 50 MCM, (2) decrease of irrigation area from 82,834 ha to 78,850 ha due to land consolidation, and (3) increase of return-flow rate from 8% to 12%. Although unit water requirement increases in Proposed Stage due to increase of percolation rate from 2 mm/day at Present Stage to 3 mm/day at Proposed Stage by drainage improvement, total irrigation demand decreases slightly in Proposed Stage due to decrease of irrigation area and change of cropping pattern of rice. Water requirement of rice is discussed in Paragraph B. 2. 5 "Irrigation Water Requirement".

Water supply condition will be improved slightly in Proposed Stage due to slight decrease of total irrigation demand and increase of abbandan capacity. However, improvement is limited and water supply condition is almost same as Present Stage.

On the other hand, there is unconfirmed groundwater of about 23 MCM in present groundwater utilization. (see Table A. 3 . 8) Most of this amount is considered to be for irrigation. It is necessary to evaluate this effect in water balance.

In this Paragraph, the study has been carried out to evaluate water shortage in case of provision of the Lar dam only. The aims of this study are as follows;

(1) Aims of the Study

In Paragraph 4. 4. 5 in the Main Report, availability of water resources and the shortage are examined in monthly basis. However, in this Paragraph, the study has been carried out in 10-day basis to clarify the necessary operation when water shortage. The aims of this study are as follows;

- clarification of amount and occurrence period of water shortage.
- clarification and evaluation of yield decrease by water shortage.
- optimum operation of the Lar dam and the abbandans under water shortage.
- clarification of effect of te unconfirmed groundwater amounting to 23 MCM.
- clarification of differences on crop yield and water supply conditions between Present Stage and Proposed Stage.

(2) Relation between Water Shortage and Yield of Rice

This relation is mentioned in Paragraph B. 2. 7 "Relation between Water Shortage and Yield of Rice". In this study, as an index of water shortage, water shortage causing 10% yield decrease (equivalent to 90% Yield Level) is selected as below;

Decadal Day		Water Saving	Growing Stage
Apr	III	10%	Vegetative
May	I	〃	〃
	II	〃	〃
	III	〃	〃
Jun	I	〃	〃
	II	〃	〃
	III	〃	〃
Jul	I	〃	〃
	II	5%	Flowering
	III	〃	〃
Aug	I	10%	Yield Formation
	II	〃	〃
	III	〃	〃
Sep	I	〃	〃
	II	〃	〃

From the results of calculation of water saving amount at 90% Yield Level for 27 years from 1956 to 1982 (see Table B. 1. 4-1 and B. 1. 4-2), water saving amount is around at 90 MCM both for present and proposed stages. If another 90 MCM of water saving is conducted, yield will decrease to 80% Yield Level.

2. Operation Case and Rule of Water Resources Facility

(1) Preconditions of Water Resources Allocation

Allocation of water resources is preconditioned as below;

1) Maintenance Flow of the Haraz River

Maintenance flow of the Haraz river is environmentally necessary and it is prior to irrigation demand. The amount of this flow is set as below;

Jan	I	0.30 cms
	II	0.30
	III	0.30
Feb	I	0.60
	II	0.60
	III	0.60
Mar	I	0.60
	II	0.60
	III	0.60
Apr	I	0.30
	II	0.30
	III	0.30
May	I	0.30
	II	0.30
	III	0.30
Jun	I	0.30
	II	0.30
	III	0.30
Jul	I	0.30
	II	0.30
	III	0.30
Aug	I	0.30
	II	0.30
	III	0.30
Sep	I	0.30
	II	0.30
	III	0.30
Oct	I	0.60
	II	0.60
	III	0.60
Nov	I	0.60
	II	0.60
	III	0.60
Dec	I	0.60
	II	0.60
	III	0.60

2) Irrigation Requirement

Irrigation requirement is calculated based on water requirement (Table B. 2. 5-5 to 7 for present and Table B. 2. 5-8 to 10 for proposed) and effective rainfall (Table B. 1. 2-2), and using the overall irrigation efficiency 0.7 for surface water (Paragraph B. 2. 5. 6). Irrigation requirement of 10-day basis is summarized as below;

Water Requirement

(Unit : mm)

Month		Present Stage					Proposed Stage				
		EMV	MMV	LMV	Ave.	Month	EMV	MMV	LMV	Ave.	Month
Apr	I	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
	II	0.0	0.0	0.0	0.0	68.9	0.0	0.0	0.0	0.0	47.3
	III	101.3	0.0	152.0	68.9		60.2	0.0	98.9	47.3	
May	I	101.3	101.3	152.0	109.4		64.9	64.9	129.8	81.1	
	II	101.3	101.3	68.4	96.0	291.4	91.9	64.9	78.4	78.1	253.3
	III	76.0	101.3	75.2	86.0		97.1	96.3	86.2	94.1	
Jun	I	83.3	80.5	80.5	81.7		92.3	99.1	90.5	94.4	
	II	84.2	81.4	80.5	82.5	247.2	93.3	91.4	90.5	91.9	278.5
	III	82.9	83.3	82.3	83.0		92.0	92.3	92.3	92.2	
Jul	I	77.1	81.8	81.8	79.7		88.3	91.0	91.8	90.2	
	II	74.8	80.6	83.6	78.5	228.8	87.1	89.7	93.6	89.7	275.8
	III	51.8	84.8	87.1	70.6		93.3	97.1	98.1	95.9	
Aug	I	28.0	68.6	68.6	50.7		51.8	80.6	78.6	69.3	
	II	10.8	55.9	64.7	37.5	113.1	24.9	66.1	74.7	52.8	156.5
	III	0.0	38.8	58.6	24.9		0.0	46.8	67.2	34.4	
Sep	I	0.0	21.1	32.0	13.6		0.0	21.1	37.8	17.4	
	II	0.0	0.0	17.8	2.8	16.4	0.0	0.0	21.1	5.3	22.7
	III	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	
Total		872.8	980.7	1,185.1	965.8		936.3	1,001.3	1,229.5	1,034.1	

(Note) Average is calculated based on the weight of cropping intensity.
1) Present Stage : EMV = 0.44, MMV = 0.40, LMV = 0.16
2) Proposed Stage : EMV = 0.375, MMV = 0.375, LMV = 0.250

3) Irrigation Area

Out of the total irrigation areas of 82,834 ha for present and of 78,850 ha for proposed, water balance study has been carried out for the irrigation areas which are irrigated by surface water from the Haraz river and abbandans. Subject study areas are 65,892 ha for present and 60,056 ha for proposed respectively. Irrigation areas commanded by groundwater and return-flow are constant, and excluded from the study of water balance of surface water. Irrigation areas by water resources are as follows;

Irrigation Areas by Water Resources

Water Resources	Present Stage		Proposed Stage	
	Available Water (MCM)	Irrigation Area (ha)	Available Water (MCM)	Irrigation Area (ha)
Groundwater	143	12,394	143	12,346
Return-flow	51	4,548	77	6,448
Surface Water	678	65,892	692	60,056
(Haraz River)	(642)	(62,681)	(642)	(55,869)
(Abbandans)	(36)	(3,211)	(50)	(4,187)
Total	872	82,834	912	78,850

(Note) based on Table in Paragraph B. 1. 1. 6

(2) Operation Cases

Study has been made on three cases both for present stage and proposed stage, that are for the averaged year, the normal year and the drought year. Those years are as follows;

Averaged Year : averaged from 1956 to 1982 (27 years)

Normal Year : 1977 (Runoff of the residual basin during irrigation period is closest to the averaged year)

Drought Year : 1970 (Runoff of the residual basin during irrigation period is close to 1/10-year probable value. see Paragraph. A. 2. 2. 1)

(3) Operation Rule

Water balance study was carried out under following operation rule;

- Maintenance flow of the Haraz river is prior to irrigation water.
- Storage water of abbandans is utilized prior to storage water of the Lar dam.
- Abbandans will store excess water when river flow is more than irrigation demand and abbandans have a room to store excess water.

- Lar dam will release irrigation water only when irrigation water is deficient and abbandans are empty.

3. Runoff Discharge of the Haraz River

Runoff discharge of the Haraz river has been given on decadal day (10-day basis) of Gregorian calendar converted from the daily basis data of Iranian calendar, which were given from MahabGhodss Consulting Engineer. The study used the data of a period from 1956 to 1982, in which the Lar dam was not yet constructed and runoff was virgin flow.

Runoff discharge of the residual basin below the Lar dam was calculated subtracting the runoff discharge of Polour from that of Karehsang. Runoff discharge of the residual basin is shown in Table B. 1. 4-9.

4. Storage Capacity of Abbandan and Available Release of Lar Dam

Storage capacity of abbandans is totally 36 MCM at present stage and 50 MCM after excavation at proposed stage. Abbandans will be filled before irrigation, and when excess water is available during irrigation period.

Release of Lar dam is maximumly 240 MCM for irrigation during an irrigation period. Release will be made when irrigation water is deficient and abbandans are empty.

5. Calculation of Water Balance

Water balance study has been made for three cases both for present stage and proposed stage as mentioned above. Other than three cases, all years from 1956 to 1982 have been studied for clarifying excess water utilization by abbandans and water shortage with and without the unconfirmed groundwater.

The results of water balance of three cases are presented in Table B. 1. 4-3 to 5 for present stage and Table B. 1. 4-6 to 8, and water balance is illustrated in Figure B. 1. 4-1 for proposed stage.

Summary of Water Balance of Three Cases

(Unit : MCM)

	Present Stage			Proposed Stage		
	Averaged year (1956-82)	Normal year (1977)	Drought year (1970)	Averaged year (1956-82)	Normal year (1977)	Drought year (1970)
Irrigation Demand	791	797	795	775	783	778
Water Saving (90% Yield) [1]	93	76	97	99	91	104
Irrigation Demand after Water Saving	698	721	698	676	691	674
Intake during Irrigation Period	363	359	172	369	372	173
Irrigated by Abbandans	36	36	36	50	50	50
Irrigated by Lar Dam	240	240	240	240	240	240
Total of Irrigation	639	635	448	659	662	463
Deficiency [2]	59	86	250	17	29	211
Deficiency with 23 MCM	36	63	227	0	6	188
Deficiency W/O Saving	152	162	347	116	120	315

(Note) 1. 23 MCM : Unconfirmed groundwater
2. Deficiency W/O saving = [1] + [2]

As seeing above table, when yield is allowed at 90% level, water shortage will be 86 MCM for present stage and 29 MCM for proposed stage in normal year. When unconfirmed groundwater of 23 MCM is considered for irrigation use, 90% Yield Level can be retained in proposed stage and slightly lower in present stage. However, extensive water shortage will be caused in drought year, and its shortage will be estimated at 188 MCM in proposed stage.

On the other hand, water shortages of proposed stage are 120 MCM and 315 MCM in a normal year and in a drought year respectively from an aspect of 100% yield level.

6. Conclusions

(1) Yield Level

Under water supply only by the Lar dam, same yield level can be retained in proposed stage as in present stage as mentioned above.

(2) Utilization of Excess Water by Abbandans

Availability and utilization of excess water of the Haraz river have been examined for both stages based on the residual flow and irrigation demand on 10-day basis for 27 years from 1956 to 1982. The results are shown in Table B. 1. 4-1 for present stage and Table B. 1. 4-2 for proposed stage. The results are summarized as below;

- Chance of availability and utilization of excess water is not frequent for both stages in the irrigation period, because residual flow is generally smaller than irrigation demand through irrigation period. Available years are only 3 years in 27 years, and those years are 1956, 1965 and 1975.

(3) Water Shortage

Frequency of water shortage and yield level of both stages are calculated in Table B. 1. 4-1 and B. 1. 4-2. Yield levels of both stages are almost same, but yield level of proposed stage is slightly higher as compared as follows;

Yield Levels of Both Stages due to Water Shortage

	Frequency of Yield Level							
	Present Stage				Proposed Stage			
	in 27 years		Frequency		in 27 years		Frequency	
Without Unconfirmed Groundwater 23 MCM								
100% Yield	5	(5)	1/5	(1/5)	6	(6)	1/5	(1/5)
90 = <Yield<100%	2	(7)	1/13	(1/4)	2	(8)	1/13	(1/3)
80 = <Yield< 90%	7	(14)	1/4	(1/2)	8	(16)	1/3	(2/3)
Yield < 80%	13	(27)	1/2	(1/1)	11	(27)	1/2	(1/1)
With Unconfirmed Groundwater 23 MCM								
100% Yield	6	(6)	1/5	(1/5)	7	(7)	1/4	(1/4)
90 = <Yield<100%	2	(8)	1/13	(1/3)	2	(9)	1/13	(1/3)
80 = <Yield< 90%	7	(15)	1/4	(1/2)	9	(18)	1/3	(2/3)
Yield < 80%	12	(27)	1/2	(1/1)	9	(27)	1/3	(1/1)

(Note) ( ) : Shown in accumulation.

(4) Effect of Unconfirmed Groundwater

As mentioned in Table A. 3. 8 "Groundwater utilization Quantity for Project Area", unconfirmed groundwater is estimated totally at 23 MCM. The purpose of its utilization is not identified, but it is considered mostly for agriculture. Especially in drought year, it will be able to be utilized for agriculture. When it is utilized fully for agriculture, yield level can be improved at certain level.

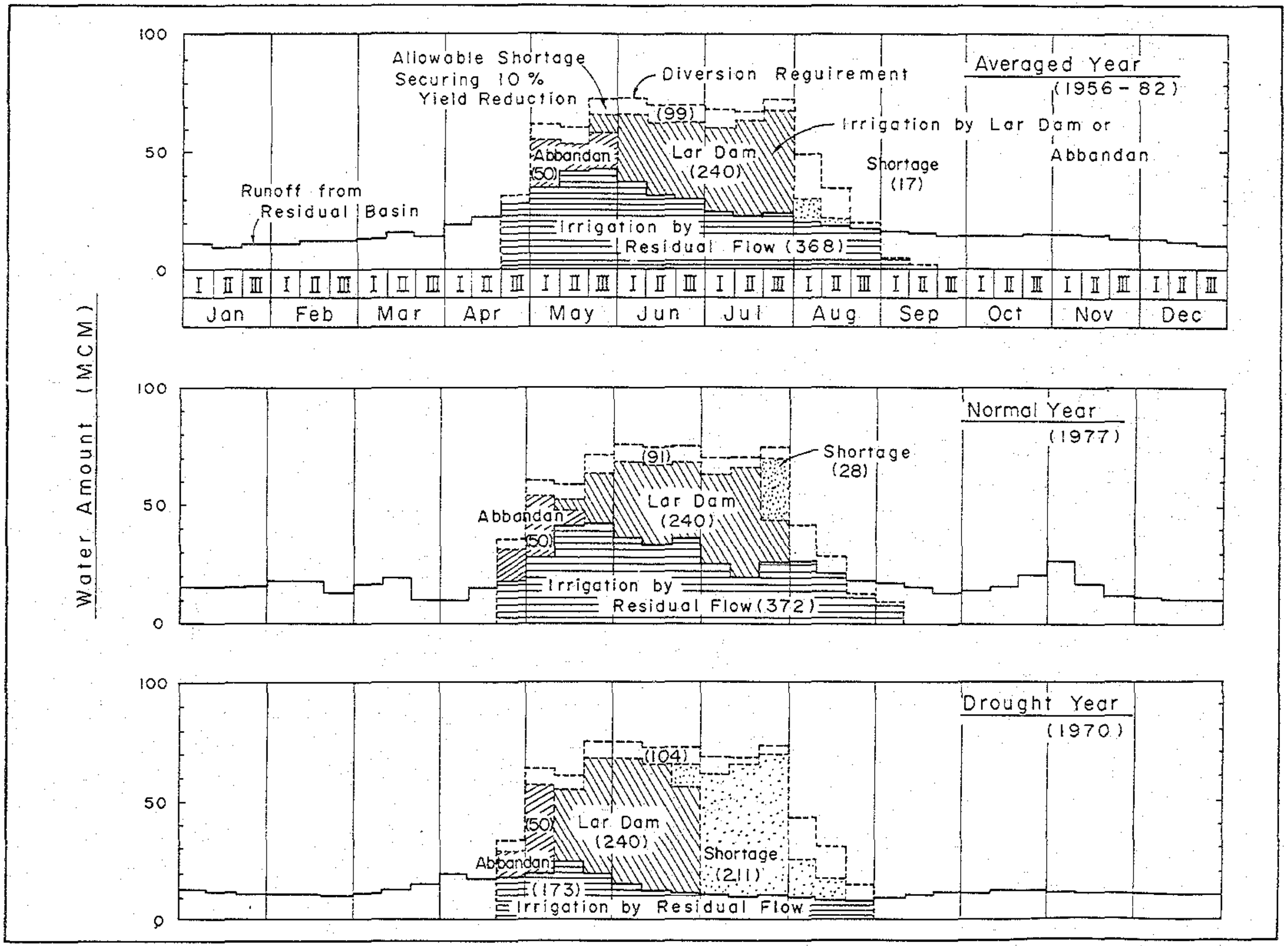
(5) Effect of Water Saving

In case water saving is introduced beforehand, yield reduction can be minimized. Yield more than 80% can be expected twice in three years, and 90% and 100% yields are once in three and four years respectively at proposed stage. If water saving is not introduced, water shortage will cause sever damage in late stage of rice growing.

(6) Prediction of Water Saving

If snow depth is less in the Alborz and sever water shortage is predicted beforehand, it is recommended to operate surface water irrigation at 90 % or 80%-yield level. In this case, yield of 80% or more can be ensured in most years.

FIGURE B.1.4-1 ILLUSTRATION OF PRELIMINARY WATER BALANCE STUDY IN CASE OF LAR DAM ONLY (PROPOSED)



(Note) Calculation of above studies is presented in Table B.1.4-6 ~ B1.4-8.

TABLE B.1.4-1 SUMMARY OF WATER BALANCE (PRESENT) IN CASE OF LAR DAM ONLY (UNIT : MCM)

Year	Irrigation Demand	Water Save (securing 10% Yield Level)	Irrigation Demand after Water Saving	Residual flow: Annual Runoff	Residual flow: Intake in Irrigation Period	Irrigation by Abbandan	Irrigation by Lar Dam	Water Shortage W/O 23 MCM	Water Shortage W/ 23 MCM
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]	[7]	[8]	[9]
1956	805.84	60.29	745.55	881.59	415.66	39.49	240.00	50.40	27.40
1957	695.21	38.23	656.98	953.97	439.09	36.00	181.89	0.00	0.00
1958	745.81	97.81	648.00	603.65	300.05	36.00	240.00	71.95	48.95
1959	782.47	81.02	701.45	827.23	509.79	36.00	155.66	0.00	0.00
1960	814.29	96.62	717.67	663.94	285.07	36.00	240.00	156.60	133.60
1961	777.71	95.49	682.22	523.12	238.52	36.00	240.00	167.70	144.70
1962	761.78	97.47	664.31	510.21	283.98	36.00	240.00	104.33	81.33
1963	774.70	93.87	680.83	521.67	285.64	36.00	240.00	119.19	96.19
1964	810.80	98.07	712.73	562.67	321.03	36.00	240.00	115.70	92.70
1965	828.32	103.65	724.67	711.86	425.69	36.00	240.00	22.98	0.00
1966	826.22	103.65	722.57	648.84	383.98	36.00	240.00	62.59	39.59
1967	818.65	103.65	715.00	511.50	285.48	36.00	240.00	153.52	130.52
1968	752.75	73.38	679.37	770.45	476.24	36.00	167.13	0.00	0.00
1969	801.97	75.13	726.84	1090.85	627.16	36.76	62.92	0.00	0.00
1970	794.90	96.62	698.28	460.60	172.31	36.00	240.00	249.97	226.97
1971	861.32	102.70	758.62	648.51	318.64	36.00	240.00	163.98	140.98
1972	758.83	64.96	693.87	905.27	514.19	36.00	143.68	0.00	0.00
1973	805.45	52.16	753.29	970.10	566.83	43.59	142.87	0.00	0.00
1974	742.94	103.65	639.29	467.69	224.87	36.00	240.00	138.42	115.42
1975	762.10	59.55	702.55	730.55	411.54	72.00	219.01	0.00	0.00
1976	836.22	101.45	734.77	763.40	382.82	36.00	240.00	75.95	52.95
1977	797.10	76.07	721.03	728.04	359.17	36.00	240.00	85.86	62.86
1978	757.23	103.36	653.87	566.94	196.65	36.00	240.00	181.22	158.22
1979	829.50	100.84	728.66	584.18	174.92	36.00	240.00	277.74	254.74
1980	836.11	85.76	750.35	540.72	205.81	36.00	240.00	268.54	245.54
1981	772.11	101.16	670.95	661.86	309.40	36.00	240.00	85.55	62.55
1982	787.53	96.62	690.91	492.10	210.11	36.00	240.00	204.80	181.80
Average	790.29	87.53	702.76	677.83	345.36	37.77	217.52	102.11	85.07
100% Yield Level : Years not requiring water saving (240-[7])>=[2])							5		
More than 90% Yield Level : without 23MCM								7	
More than 90% Yield Level : with 23MCM									8
More than 80% Yield Level : [8] <= 90 MCM without 23MCM								14	
More than 80% Yield Level : [9] <= 90 MCM with 23MCM									15

(Note)

1. Annual: Jan - Dec , Irrigation Period: Apr III - Sep II
2. 23 MC: Unconfirmed Groundwater (probably for Agricultural Use)
3. W/O: without, W/: with
4. [8]=[3]-([5]+[6]+[7]) [9]=[8]-23

TABLE B.1.4-2 SUMMARY OF WATER BALANCE (PROPOSED) IN CASE OF LAR DAM ONLY (UNIT : MCM)

Year	Irrigation Demand	Water Save (securing 10% Yield level)	Irrigation Demand after Water Saving	Residual Flow		Irrigation by		Water Shortage	
				Annual Runoff	Intake in Irrigation Period	Abbandan	Lar Dam	W/O 23 MCM	W/ 23 MCM
	[1]	[2]	[3]=[1]-[2]	[4]	[5]	[6]	[7]	[8]	[9]
1956	787.75	49.27	738.48	881.59	461.67	53.24	223.57	0.00	0.00
1957	690.10	36.51	653.59	953.97	506.04	50.22	97.33	0.00	0.00
1958	736.24	100.87	635.37	603.65	295.06	50.00	240.00	50.31	27.31
1959	766.44	78.94	687.50	827.23	489.31	50.00	148.19	0.00	0.00
1960	795.50	101.44	694.06	663.94	287.32	50.00	240.00	116.74	93.74
1961	761.99	102.91	659.08	523.12	239.62	50.00	240.00	129.46	106.46
1962	750.83	104.90	645.93	510.21	286.90	50.00	240.00	69.03	46.03
1963	762.48	96.81	665.67	521.67	295.77	50.00	240.00	79.90	56.90
1964	793.86	100.39	693.47	562.67	312.06	50.00	240.00	91.41	68.41
1965	809.80	94.90	714.90	711.86	419.64	53.11	240.00	2.15	0.00
1966	809.50	94.64	714.86	648.84	383.63	50.00	240.00	41.23	18.23
1967	799.34	105.66	693.68	511.50	285.48	50.00	240.00	118.20	95.20
1968	744.75	91.79	652.96	770.45	465.27	50.00	137.69	0.00	0.00
1969	784.04	83.14	700.90	1090.85	586.43	50.00	64.47	0.00	0.00
1970	777.72	104.02	673.70	460.60	172.56	50.00	240.00	211.14	188.14
1971	841.50	101.60	739.90	648.51	318.24	50.00	240.00	131.66	108.66
1972	748.19	64.28	683.91	905.27	549.50	50.00	84.41	0.00	0.00
1973	787.28	64.09	723.19	970.10	515.12	50.00	158.07	0.00	0.00
1974	730.33	105.24	625.09	467.69	224.87	50.00	240.00	110.22	87.22
1975	748.31	72.54	675.77	730.55	402.84	86.86	186.07	0.00	0.00
1976	815.45	103.36	712.09	763.40	382.82	50.00	240.00	39.27	16.27
1977	782.95	91.39	691.56	728.04	372.65	50.00	240.00	28.91	5.91
1978	746.62	109.12	637.50	566.94	196.65	50.00	240.00	150.85	127.85
1979	810.45	105.66	704.79	584.18	176.12	50.00	240.00	238.67	215.67
1980	815.12	97.73	717.39	540.72	210.66	50.00	240.00	216.73	193.73
1981	756.82	101.60	655.22	661.86	302.98	50.00	240.00	62.24	39.24
1982	774.27	103.14	671.13	492.10	213.72	50.00	240.00	167.41	144.41
Average	775.10	91.33	683.77	677.83	346.40	51.61	209.62	76.13	60.72
100% Yield Level : Years not requiring water saving (240-[7]>=[2])							6		
More than 90% Yield Level : without 23MCM								8	
More than 90% Yield Level : with 23MCM									9
More than 80% Yield Level : [8] <= 90 MCM without 23MCM								16	
More than 80% Yield Level : [9] <= 90 MCM with 23MCM									18

(Note)

1. Annual: Jan - Dec , Irrigation Period: Apr III - Sep II
2. 23 MC: Unconfirmed Groundwater (probably for Agricultural Use)
3. W/O: without, W/: with
4. [8]=[3]-([5]+[6]+[7])   [9]=[8]-23

TABLE B.1.4-3 PRELIMINARY WATER BALANCE STUDY (PRESENT) FOR AVERAGED YEAR IN CASE OF LAR DAM ONLY

Year: Averaged Year 1956-1982
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun		
Runoff Discharge from the Residual Basin below the Lar Dam																		
(cms)	11.86	11.20	11.81	12.36	13.16	13.40	14.69	17.36	15.78	21.14	25.91	31.71	38.95	47.86	49.40	43.95	36.49	33.65
(MCM)	10.25	9.68	10.20	10.68	11.37	11.58	12.69	15.00	13.64	18.26	22.38	27.40	33.66	41.35	42.68	37.98	31.53	29.07
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																		
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																		
(MCM)	9.99	9.42	9.94	10.16	10.85	11.06	12.17	14.48	13.12	18	22.12	27.14	33.4	41.09	42.42	37.72	31.27	28.81
Water Requirement (mm) [Crop Water Requirement + Percolation]	0	0	0	0	0	0	0	0	0	0	0	68.9	109.4	96	86	81.7	82.5	83
Mean Net Irrigation Requirement (mm)	0	0	0	0	0	0	0	0	0	0	0	58	102.4	89	79	74.5	75.3	75.8
Diversion Water Requirement (mm) [N.W.R./0.7]	0	0	0	0	0	0	0	0	0	0	0	82.9	146.3	127.1	112.9	106.4	107.6	108.3
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																		
65,892																		
Diversion Requirement to Surface Water (MCM)	0	0	0	0	0	0	0	0	0	0	0	54.62	96.4	83.75	74.39	70.11	70.9	71.36
Irrigation by Residual Flow (MCM)	0	0	0	0	0	0	0	0	0	0	0	27.14	33.4	41.09	42.42	37.72	31.27	28.81
Accuml.	0	0	0	0	0	0	0	0	0	0	0	27.14	60.54	101.63	144.05	181.77	213.04	241.85
Deficiency (MCM) [D.R.-Available Water]	0	0	0	0	0	0	0	0	0	0	0	27.48	63	42.66	31.97	32.39	39.63	42.55
Accuml.	0	0	0	0	0	0	0	0	0	0	0	27.48	90.48	133.14	165.11	197.5	237.13	279.68
Excess (MCM)	9.99	9.42	9.94	10.16	10.85	11.06	12.17	14.48	13.12	18	22.12	0	0	0	0	0	0	0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																		
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10
Allowable Shortage (MCM)												6.49	10.30	9.04	8.10	7.69	7.77	7.81
Water Saving Amount securing 90% Yield (MCM)	0	0	0	0	0	0	0	0	0	0	0	6.49	10.3	9.04	8.1	7.69	7.77	7.81
Accuml.	0	0	0	0	0	0	0	0	0	0	0	6.49	16.79	25.83	33.93	41.62	49.39	57.2
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	0	0	0	0	0	0	0	0	0	0	0	20.99	52.7	33.62	23.87	24.7	31.86	34.74
Accuml.	0	0	0	0	0	0	0	0	0	0	0	20.99	73.69	107.31	131.18	155.88	187.74	222.48
Available Water Storages in Abbandans and Lar Dam (MCM)																		
Abbandans	36																	
Lar Dam	240																	
Total	276																	
Operation of Abbandans																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	20.99	15.01	0	0	0	0	0
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Storage	36	36	36	36	36	36	36	36	36	36	36	15.01	0	0	0	0	0	0
Shortage after Release from Abbandans (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	37.69	33.62	23.87	24.7	31.86	34.74
Accuml.	0	0	0	0	0	0	0	0	0	.0	0	0	37.69	71.31	95.18	119.88	151.74	186.48
Operation of Lar Dam																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	37.69	33.62	23.87	24.7	31.86	34.74
Storage	240	240	240	240	240	240	240	240	240	240	240	240	202.31	168.69	144.82	120.12	88.26	53.52
Final Shortage (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																			
(cms)	28.06	25.33	26.67	23.50	20.64	19.78	18.67	18.28	15.68	15.41	15.69	16.22	16.62	16.67	15.23	14.65	14.17	12.56	21.79
(MCM)	24.24	21.88	23.04	20.30	17.84	17.09	16.13	15.79	13.55	13.31	13.55	14.02	14.36	14.41	13.16	12.66	12.24	10.85	677.82
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																			
(cms)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																			
(MCM)	23.98	21.62	22.78	20.04	17.58	16.83	15.87	15.53	13.29	12.79	13.03	13.5	13.84	13.89	12.64	12.14	11.72	10.33	664.56
Water Requirement (mm) [Crop Water Requirement + Percolation]	79.7	78.5	70.6	50.7	37.5	24.9	13.6	2.8	0	0	0	0	0	0	0	0	0	0	965.8
Mean Net Irrigation Requirement (mm)	71.6	70.4	62.5	39.2	26	13.5	2.5	0	0	0	0	0	0	0	0	0	0	0	839.7
Diversion Water Requirement (mm) [N.W.R./0.7]	102.3	100.6	89.3	56	37.1	19.3	3.6	0	0	0	0	0	0	0	0	0	0	0	1,199.7
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																			
65,892																			
Diversion Requirement to Surface Water (MCM)	67.41	66.29	58.84	36.9	24.45	12.72	2.37	0	0	0	0	0	0	0	0	0	0	0	790.51
Irrigation by Residual Flow (MCM)	23.98	21.62	22.78	20.04	17.58	12.72	2.37	0	0	0	0	0	0	0	0	0	0	0	362.94
Accuml.	265.83	287.45	310.23	330.27	347.85	360.57	362.94	362.94	362.94	362.94	362.94	362.94	362.94	362.94	362.94	362.94	362.94	362.94	
Deficiency (MCM) [D.R.-Available Water]	43.43	44.67	36.06	16.86	6.87	0	0	0	0	0	0	0	0	0	0	0	0	0	427.6
Accuml.	323.11	367.78	403.84	420.7	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	427.57	
Excess (MCM)	0	0	0	0	0	4.11	13.5	15.53	13.29	12.79	13.03	13.5	13.84	13.89	12.64	12.14	11.72	10.33	301.6
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																			
Allowable Shortage Rate to Irrigation Requirement (%)	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)	7.50	3.69	3.32	14.32	10.59	7.03	3.84	0.79											108.28
Water Saving Amount securing 90% Yield (MCM)	7.5	3.69	3.32	14.32	6.87	0	0	0	0	0	0	0	0	0	0	0	0	0	92.90
Accuml.	64.7	68.39	71.71	86.03	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	92.9	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	35.93	40.98	32.74	2.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	334.67
Accuml.	258.41	299.39	332.13	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	334.67	
Available Water Storages in Abbandans and Lar Dam (MCM)																			
Operation of Abbandans																			
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36.00
Inflow	0	0	0	0	0	4.11	13.5	15.53	2.86	0	0	0	0	0	0	0	0	0	
Storage	0	0	0	0	0	4.11	17.61	33.14	36	36	36	36	36	36	36	36	36	36	
Shortage after Release from Abbandans (MCM)	35.93	40.98	32.74	2.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	298.67
Accuml.	222.41	263.39	296.13	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	298.67	
Operation of Lar Dam																			
Outflow	35.93	17.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	17.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)	0	23.39	32.74	2.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58.67
Accuml.	0	23.39	56.13	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	58.67	

TABLE B. 1. 4-4 PRELIMINARY WATER BALANCE STUDY (PRESENT) FOR NORMAL YEAR IN CASE OF LAR DAM ONLY

Year: Normal Year (1977)
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun		
Runoff Discharge from the Residual Basin below the Lar Dam																		
(cms)	17.77	17.88	18.99	20.78	20.90	15.62	20.16	22.73	11.84	12.44	17.18	21.04	32.35	48.41	48.56	41.85	38.10	40.56
(MCM)	15.35	15.45	16.41	17.95	18.06	13.50	17.42	19.64	10.23	10.75	14.84	18.18	27.95	41.83	41.96	36.16	32.92	35.04
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																		
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																		
(MCM)	15.09	15.19	16.15	17.43	17.54	12.98	16.9	19.12	9.71	10.49	14.58	17.92	27.69	41.57	41.7	35.9	32.66	34.78
Water Requirement (mm) [Crop Water Requirement + Percolation]	0	0	0	0	0	0.	0	0	0	0	0	68.9	109.4	96	86	81.7	82.5	83
Mean Net Irrigation Requirement (mm)	0	0	0	0	0	0	0	0	0	0	0	64	101.5	88.1	78.1	79	79.8	80.3
Diversion Water Requirement (mm) [N.W.R./0.7]	0	0	0	0	0	0	0	0	0	0	0	91.4	145	125.9	111.6	112.9	114	114.7
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1] 65,892																		
Diversion Requirement to Surface Water (MCM)	0	0	0	0	0	0	0	0	0	0	0	60.23	95.54	82.96	73.54	74.39	75.12	75.58
Irrigation by Residual Flow (MCM)	0	0	0	0	0	0	0	0	0	0	0	17.92	27.69	41.57	41.7	35.9	32.66	34.78
Accuml.	0	0	0	0	0	0	0	0	0	0	0	17.92	45.61	87.18	128.88	164.78	197.44	232.22
Deficiency (MCM) [D.R.-Available Water]	0	0	0	0	0	0	0	0	0	0	0	42.31	67.85	41.39	31.84	38.49	42.46	40.8
Accuml.	0	0	0	0	0	0	0	0	0	0	0	42.31	110.16	151.55	183.39	221.88	264.34	305.14
Excess (MCM)	15.09	15.19	16.15	17.43	17.54	12.98	16.9	19.12	9.71	10.49	14.58	0	0	0	0	0	0	0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																		
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10
Allowable Shortage (MCM)												6.49	10.30	9.04	8.10	7.69	7.77	7.81
Water Saving Amount securing 90% Yield (MCM)	0	0	0	0	0	0	0	0	0	0	0	6.49	10.3	9.04	8.1	7.69	7.77	7.81
Accuml.	0	0	0	0	0	0	0	0	0	0	0	6.49	16.79	25.83	33.93	41.62	49.39	57.2
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	0	0	0	0	0	0	0	0	0	0	0	35.82	57.55	32.35	23.74	30.8	34.69	32.99
Accuml.	0	0	0	0	0	0	0	0	0	0	0	35.82	93.37	125.72	149.46	180.26	214.95	247.94
Available Water Storages in Abbandans and Lar Dam (MCM)																		
Abbandans	36																	
Lar Dam	240																	
Total	276																	
Operation of Abbandans																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	35.82	0.18	0	0	0	0	0
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Storage	36	36	36	36	36	36	36	36	36	36	36	0.18	0	0	0	0	0	0
Shortage after Release from Abbandans (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	57.37	32.35	23.74	30.8	34.69	32.99
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	57.37	89.72	113.46	144.26	178.95	211.94
Operation of Lar Dam																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	57.37	32.35	23.74	30.8	34.69	32.99
Storage	240	240	240	240	240	240	240	240	240	240	240	240	182.63	150.28	126.54	95.74	61.05	28.06
Final Shortage (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																			
(cms)	29.49	23.27	30.11	30.25	24.56	21.42	21.22	17.21	15.33	16.51	18.60	24.61	31.31	20.22	14.39	12.70	12.02	12.23	23.41
(MCM)	25.48	20.11	26.02	26.14	21.22	18.51	18.33	14.87	13.25	14.26	16.07	21.26	27.05	17.47	12.43	10.97	10.39	10.57	728.04
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																			
(cms)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																			
(MCM)	25.22	19.85	25.76	25.88	20.96	18.25	18.07	14.61	12.99	13.74	15.55	20.74	26.53	16.95	11.91	10.45	9.87	10.05	714.78
Water Requirement (mm) [Crop Water Requirement + Percolation]	79.7	78.5	70.6	50.7	37.5	24.9	13.6	2.8	0	0	0	0	0	0	0	0	0	0	965.8
Mean Net Irrigation Requirement (mm)	74	72.8	64.9	32.1	18.9	6.3	6.9	0	0	0	0	0	0	0	0	0	0	0	846.7
Diversion Water Requirement (mm) [N.W.R./0.7]	105.7	104	92.7	45.9	27	9	9.9	0	0	0	0	0	0	0	0	0	0	0	1,209.7
Diversion Requirement to Surface Water (MCM)	69.65	68.53	61.08	30.24	17.79	5.93	6.52	0	0	0	0	0	0	0	0	0	0	0	797.10
Irrigation by Residual Flow (MCM)	25.22	19.85	25.76	25.88	17.79	5.93	6.52	0	0	0	0	0	0	0	0	0	0	0	359.17
Accuml.	257.44	277.29	303.05	328.93	346.72	352.65	359.17	359.17	359.17	359.17	359.17	359.17	359.17	359.17	359.17	359.17	359.17	359.17	
Deficiency (MCM) [D.R.-Available Water]	44.43	48.68	35.32	4.36	0	0	0	0	0	0	0	0	-0	0	0	0	0	0	437.9
Accuml.	349.57	398.25	433.57	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	437.93	
Excess (MCM)	0	0	0	0	3.17	12.32	11.55	14.61	12.99	13.74	15.55	20.74	26.53	16.95	11.91	10.45	9.87	10.05	355.6
Allowable Shortage Rate to Irrigation Requirement (%)	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)	7.50	3.69	3.32	14.32	10.59	7.03	3.84	0.79											108.28
Water Saving Amount securing 90% Yield (MCM)	7.5	3.69	3.32	4.36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	76.07
Accuml.	64.7	68.39	71.71	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	76.07	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	36.93	44.99	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	361.86
Accuml.	284.87	329.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	361.86	
Operation of Abbandans																			
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36.00
Inflow	0	0	0	0	3.17	12.32	11.55	8.96	0	0	0	0	0	0	0	0	0	0	
Storage	0	0	0	0	3.17	15.49	27.04	36	36	36	36	36	36	36	36	36	36	36	
Shortage after Release from Abbandans (MCM)	36.93	44.99	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	325.86
Accuml.	248.87	293.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	325.86	
Operation of Lar Dam																			
Outflow	28.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)	8.87	44.99	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85.86
Accuml.	8.87	53.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	85.86	

TABLE B. 1. 4-5 PRELIMINARY WATER BALANCE STUDY (PRESENT) FOR DROUGHT YEAR IN CASE OF LAR DAM ONLY

Year: Drought Year (1970)
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																																					
(cms)	15.06	14.58	13.50	12.75	13.27	12.81	13.00	14.67	17.50	22.86	20.18	20.32	22.37	28.03	22.16	18.15	14.47	12.83	11.86	10.98	12.20	10.62	9.87	9.74	10.44	12.53	13.95	13.72	14.32	14.49	13.85	13.73	13.10	13.29	12.58	13.29	14.81
(MCM)	13.01	12.60	11.66	11.02	11.47	11.07	11.23	12.67	15.12	19.75	17.44	17.56	19.33	24.22	19.15	15.68	12.50	11.09	10.25	9.49	10.54	9.18	8.53	8.42	9.02	10.83	12.05	11.85	12.37	12.52	11.97	11.86	11.32	11.48	10.87	11.48	460.6
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																																					
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																																					
(MCM)	12.75	12.34	11.4	10.5	10.95	10.55	10.71	12.15	14.6	19.49	17.18	17.3	19.07	23.96	18.89	15.42	12.24	10.83	9.99	9.23	10.28	8.92	8.27	8.16	8.76	10.57	11.79	11.33	11.85	12	11.45	11.34	10.8	10.96	10.35	10.96	447.34
Water Requirement (mm) [Crop Water Requirement + Percolation]																																					
	0	0	0	0	0	0	0	0	0	0	0	68.9	109.4	96	86	81.7	82.5	83	79.7	78.5	70.6	50.7	37.5	24.9	13.6	2.8	0	0	0	0	0	0	0	0	0	0	965.8
Mean Net Irrigation Requirement (mm)																																					
	0	0	0	0	0	0	0	0	0	0	0	62.3	104.8	91.4	81.4	77.2	78	78.5	72.5	71.3	63.4	34.2	21	8.4	0	0	0	0	0	0	0	0	0	0	0	0	844.4
Diversion Water Requirement (mm) [N.W.R./0.7]																																					
	0	0	0	0	0	0	0	0	0	0	0	89	149.7	130.6	116.3	110.3	111.4	112.1	103.6	101.9	90.6	48.9	30	12	0	0	0	0	0	0	0	0	0	0	0	0	1,206.4
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																																					
65,892																																					
Diversion Requirement to Surface Water (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	58.64	98.64	86.05	76.63	72.68	73.4	73.86	68.26	67.14	59.7	32.22	19.77	7.91	0	0	0	0	0	0	0	0	0	0	0	0	794.90
Irrigation by Residual Flow (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	17.3	19.07	23.96	18.89	15.42	12.24	10.83	9.99	9.23	10.28	8.92	8.27	7.91	0	0	0	0	0	0	0	0	0	0	0	0	172.31
Accuml.	0	0	0	0	0	0	0	0	0	0	0	17.3	36.37	60.33	79.22	94.64	106.88	117.71	127.7	136.93	147.21	156.13	164.4	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	172.31	
Deficiency (MCM) [D.R.-Available Water]																																					
	0	0	0	0	0	0	0	0	0	0	0	41.34	79.57	62.09	57.74	57.26	61.16	63.03	58.27	57.91	49.42	23.3	11.5	0	0	0	0	0	0	0	0	0	0	0	0	0	622.6
Accuml.	0	0	0	0	0	0	0	0	0	0	0	41.34	120.91	183	240.74	298	359.16	422.19	480.46	538.37	587.79	611.09	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	622.59	
Excess (MCM)																																					
	12.75	12.34	11.4	10.5	10.95	10.55	10.71	12.15	14.6	19.49	17.18	0	0	0	0	0	0	0	0	0	0	0	0	0.25	8.76	10.57	11.79	11.33	11.85	12	11.45	11.34	10.8	10.96	10.35	10.96	275.0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																																					
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)												6.49	10.30	9.04	8.10	7.69	7.77	7.81	7.50	3.69	3.32	14.32	10.59	7.03	3.84	0.79											108.28
Water Saving Amount securing 90% Yield (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	6.49	10.3	9.04	8.1	7.69	7.77	7.81	7.5	3.69	3.32	14.32	10.59	0	0	0	0	0	0	0	0	0	0	0	0	0	96.62
Accuml.	0	0	0	0	0	0	0	0	0	0	0	6.49	16.79	25.83	33.93	41.62	49.39	57.2	64.7	68.39	71.71	86.03	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	96.62	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]																																					
	0	0	0	0	0	0	0	0	0	0	0	34.85	69.27	53.05	49.64	49.57	53.39	55.22	50.77	54.22	46.1	8.98	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0	525.97
Accuml.	0	0	0	0	0	0	0	0	0	0	0	34.85	104.12	157.17	206.81	256.38	309.77	364.99	415.76	469.98	516.08	525.06	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	525.97	
Available Water Storages in Abbandans and Lar Dam (MCM)																																					
Abbandans	36																																				
Lar Dam	240																																				
Total	276																																				
Operation of Abbandans																																					
Outflow	0	0	0	0	0	0	0	0	0	0	0	34.85	1.15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36.00
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	8.76	10.57	11.79	4.63	0	0	0	0	0	0	0	0	
Storage	36	36	36	36	36	36	36	36	36	36	36	1.15	0	0	0	0	0	0	0	0	0	0	0	0.25	9.01	19.58	31.37	36	36	36	36	36	36	36	36	36	
Shortage after Release from Abbandans (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	0	68.12	53.05	49.64	49.57	53.39	55.22	50.77	54.22	46.1	8.98	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0	489.97
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	68.12	121.17	170.81	220.38	273.77	326.99	379.76	433.98	480.08	489.06	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	489.97	
Operation of Lar Dam																																					
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	68.12	53.05	49.64	49.57	19.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	240	240	240	240	240	240	240	240	240	240	240	240	171.88	118.83	69.19	19.62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33.77	55.22	50.77	54.22	46.1	8.98	0.91	0	0	0	0	0	0	0	0	0	0	0	0	0	249.97
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33.77	88.99	139.76	193.98	240.08	249.06	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	249.97	

TABLE B.1.4-6 PRELIMINARY WATER BALANCE STUDY (PROPOSED) FOR AVERAGED YEAR IN CASE OF LAR DAM ONLY

Year: Averaged Year 1956-1982
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun		
Runoff Discharge from the Residual Basin below the Lar Dam																		
(cms)	11.86	11.20	11.81	12.36	13.16	13.40	14.69	17.36	15.78	21.14	25.91	31.71	38.95	47.86	49.40	43.95	36.49	33.65
(MCM)	10.25	9.68	10.20	10.68	11.37	11.58	12.69	15.00	13.64	18.26	22.38	27.40	33.66	41.35	42.68	37.98	31.53	29.07
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																		
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																		
(MCM)	9.99	9.42	9.94	10.16	10.85	11.06	12.17	14.48	13.12	18	22.12	27.14	33.4	41.09	42.42	37.72	31.27	28.81
Water Requirement (mm) [Crop Water Requirement + Percolation]																		
	0	0	0	0	0	0	0	0	0	0	0	47.3	81.1	78.1	94.1	94.4	91.9	92.2
Mean Net Irrigation Requirement (mm)																		
	0	0	0	0	0	0	0	0	0	0	0	36.4	74.1	71.1	87.1	87.2	84.7	85
Diversion Water Requirement (mm) [N.W.R./0.7]																		
	0	0	0	0	0	0	0	0	0	0	0	52	105.9	101.6	124.4	124.6	121	121.4
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																		
60,056																		
Diversion Requirement to Surface Water (MCM)																		
	0	0	0	0	0	0	0	0	0	0	0	31.23	63.6	61.02	74.71	74.83	72.67	72.91
Irrigation by Residual Flow (MCM)																		
	0	0	0	0	0	0	0	0	0	0	0	27.14	33.4	41.09	42.42	37.72	31.27	28.81
Accuml.	0	0	0	0	0	0	0	0	0	0	0	27.14	60.54	101.63	144.05	181.77	213.04	241.85
Deficiency (MCM) [D.R.-Available Water]																		
	0	0	0	0	0	0	0	0	0	0	0	4.09	30.2	19.93	32.29	37.11	41.4	44.1
Accuml.	0	0	0	0	0	0	0	0	0	0	0	4.09	34.29	54.22	86.51	123.62	165.02	209.12
Excess (MCM)																		
	9.99	9.42	9.94	10.16	10.85	11.06	12.17	14.48	13.12	18	22.12	0	0	0	0	0	0	0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																		
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10
Allowable Shortage (MCM)												4.06	6.96	6.70	8.07	8.10	7.88	7.91
Water Saving Amount securing 90% Yield (MCM)																		
	0	0	0	0	0	0	0	0	0	0	0	4.06	6.96	6.7	8.07	8.1	7.88	7.91
Accuml.	0	0	0	0	0	0	0	0	0	0	0	4.06	11.02	17.72	25.79	33.89	41.77	49.68
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]																		
	0	0	0	0	0	0	0	0	0	0	0	0.03	23.24	13.23	24.22	29.01	33.52	36.19
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0.03	23.27	36.5	60.72	89.73	123.25	159.44
Available Water Storages in Abbandans and Lar Dam (MCM)																		
Abbandans	50																	
Lar Dam	240																	
Total	290																	
Operation of Abbandans																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	0.03	23.24	13.23	13.5	0	0	0
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Storage	50	50	50	50	50	50	50	50	50	50	50	49.97	26.73	13.5	0	0	0	0
Shortage after Release from Abbandans (MCM)																		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.72	29.01	33.52	36.19
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.72	39.73	73.25	109.44
Operation of Lar Dam																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.72	29.01	33.52	36.19
Storage	240	240	240	240	240	240	240	240	240	240	240	240	240	240	229.28	200.27	166.75	130.56
Final Shortage (MCM)																		
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																			
(cms)	28.06	25.33	26.67	23.50	20.64	19.78	18.67	18.28	15.68	15.41	15.69	16.22	16.62	16.67	15.23	14.65	14.17	12.56	21.79
(MCM)	24.24	21.88	23.04	20.30	17.84	17.09	16.13	15.79	13.55	13.31	13.55	14.02	14.36	14.41	13.16	12.66	12.24	10.85	677.82
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																			
(cms)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																			
(MCM)	23.98	21.62	22.78	20.04	17.58	16.83	15.87	15.53	13.29	12.79	13.03	13.5	13.84	13.89	12.64	12.14	11.72	10.33	664.56
Water Requirement (mm) [Crop Water Requirement + Percolation]																			
	90.2	89.7	95.9	69.3	52.8	34.4	17.4	5.3	0	0	0	0	0	0	0	0	0	0	1,034.1
Mean Net Irrigation Requirement (mm)																			
	82.1	81.6	87.8	57.8	41.3	22.9	4.4	0.1	0	0	0	0	0	0	0	0	0	0	903.6
Diversion Water Requirement (mm) [N.W.R./0.7]																			
	117.3	116.6	125.4	82.6	59	32.7	6.3	0.1	0	0	0	0	6	0	0	0	0	0	1,290.9
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																			
60,056																			
Diversion Requirement to Surface Water (MCM)																			
	70.45	70.03	75.31	49.61	35.43	19.64	3.78	0.06	0	0	0	0	0	0	0	0	0	0	775.28
Irrigation by Residual Flow (MCM)																			
	23.98	21.62	22.78	20.04	17.58	16.83	3.78	0.06	0	0	0	0	0	0	0	0	0	0	368.52
Accuml.	265.83	287.45	310.23	330.27	347.85	364.68	368.46	368.52	368.52	368.52	368.52	368.52	368.52	368.52	368.52	368.52	368.52	368.52	
Deficiency (MCM) [D.R.-Available Water]																			
	46.47	48.41	52.53	29.57	17.85	2.81	0	0	0	0	0	0	0	0	0	0	0	0	406.8
Accuml.	255.59	304	356.53	386.1	403.95	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	406.76	
Excess (MCM)																			
	0	0	0	0	0	0	12.09	15.47	13.29	12.79	13.03	13.5	13.84	13.89	12.64	12.14	11.72	10.33	296.0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																			
Allowable Shortage Rate to Irrigation Requirement (%)	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)	7.74	3.85	4.11	17.84	13.59	8.85	4.48	1.36											111.50
Water Saving Amount securing 90% Yield (MCM)																			
	7.74	3.85	4.11	17.84	13.59	2.81	0	0	0	0	0	0	0	0	0	0	0	0	99.62
Accuml.	57.42	61.27	65.38	83.22	96.81	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	99.62	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]																			
	38.73	44.56	48.42	11.73	4.26	0	0	0	0	0	0	0	0	0	0	0	0	0	307.14
Accuml.	198.17	242.73	291.15	302.88	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	307.14	
Available Water Storages in Abbandans and Lar Dam (MCM)																			
Operation of Abbandans																			
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50.00
Inflow	0	0	0	0	0	0	12.09	15.47	13.29	9.15	0	0	0	0	0	0	0	0	
Storage	0	0	0	0	0	0	12.09	27.56	40.85	50	50	50	50	50	50	50	50	50	
Shortage after Release from Abbandans (MCM)																			
	38.73	44.56	48.42	11.73	4.26	0	0	0	0	0	0	0	0	0	0	0	0	0	257.14
Accuml.	148.17	192.73	241.15	252.88	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	257.14	
Operation of Lar Dam																			
Outflow	38.73	44.56	47.27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	91.83	47.27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)																			
	0	0	1.15	11.73	4.26	0	0	0	0	0	0	0	0	0	0	0	0	0	17.14
Accuml.	0	0	1.15	12.88	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	17.14	

TABLE B.1.4-7 PRELIMINARY WATER BALANCE STUDY (PROPOSED) FOR NORMAL YEAR IN CASE OF LAR DAM STUDY

Year: Normal Year (1977)
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun		
Runoff Discharge from the Residual Basin below the Lar Dam																		
(cms)	17.77	17.88	18.99	20.78	20.90	15.62	20.16	22.73	11.84	12.44	17.18	21.04	32.35	48.41	48.56	41.85	38.10	40.56
(MCM)	15.35	15.45	16.41	17.95	18.06	13.50	17.42	19.64	10.23	10.75	14.84	18.18	27.95	41.83	41.96	36.16	32.92	35.04
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																		
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																		
(MCM)	15.09	15.19	16.15	17.43	17.54	12.98	16.9	19.12	9.71	10.49	14.58	17.92	27.69	41.57	41.7	35.9	32.66	34.78
Water Requirement (mm) [Crop Water Requirement + Percolation]	0	0	0	0	0	0	0	0	0	0	0	47.3	81.1	78.1	94.1	94.4	91.9	92.2
Mean Net Irrigation Requirement (mm)	0	0	0	0	0	0	0	0	0	0	0	42.4	73.2	70.2	86.2	91.7	89.2	89.5
Diversion Water Requirement (mm) [N.W.R./0.7]	0	0	0	0	0	0	0	0	0	0	0	60.6	104.6	100.3	123.1	131	127.4	127.9
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1] 60,056																		
Diversion Requirement to Surface Water (MCM)	0	0	0	0	0	0	0	0	0	0	0	36.39	62.82	60.24	73.93	78.67	76.51	76.81
Irrigation by Residual Flow (MCM)	0	0	0	0	0	0	0	0	0	0	0	17.92	27.69	41.57	41.7	35.9	32.66	34.78
Accuml.	0	0	0	0	0	0	0	0	0	0	0	17.92	45.61	87.18	128.88	164.78	197.44	232.22
Deficiency (MCM) [D.R.-Available Water]	0	0	0	0	0	0	0	0	0	0	0	18.47	35.13	18.67	32.23	42.77	43.85	42.03
Accuml.	0	0	0	0	0	0	0	0	0	0	0	18.47	53.6	72.27	104.5	147.27	191.12	233.15
Excess (MCM)	15.09	15.19	16.15	17.43	17.54	12.98	16.9	19.12	9.71	10.49	14.58	0	0	0	0	0	0	0
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																		
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10
Allowable Shortage (MCM)												4.06	6.96	6.70	8.07	8.10	7.88	7.91
Water Saving Amount securing 90% Yield (MCM)	0	0	0	0	0	0	0	0	0	0	0	4.06	6.96	6.7	8.07	8.1	7.88	7.91
Accuml.	0	0	0	0	0	0	0	0	0	0	0	4.06	11.02	17.72	25.79	33.89	41.77	49.68
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	0	0	0	0	0	0	0	0	0	0	0	14.41	28.17	11.97	24.16	34.67	35.97	34.12
Accuml.	0	0	0	0	0	0	0	0	0	0	0	14.41	42.58	54.55	78.71	113.38	149.35	183.47
Available Water Storages in Abbandans and Lar Dam (MCM)																		
Abbandans	50																	
Lar Dam	240																	
Total	290																	
Operation of Abbandans																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	14.41	28.17	7.42	0	0	0	0
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Storage	50	50	50	50	50	50	50	50	50	50	50	35.59	7.42	0	0	0	0	0
Shortage after Release from Abbandans (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	0	4.55	24.16	34.67	35.97	34.12
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	4.55	28.71	63.38	99.35	133.47
Operation of Lar Dam																		
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	4.55	24.16	34.67	35.97	34.12
Storage	240	240	240	240	240	240	240	240	240	240	240	240	240	235.45	211.29	176.62	140.65	106.53
Final Shortage (MCM)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																			
(cms)	29.49	23.27	30.11	30.25	24.56	21.42	21.22	17.21	15.33	16.51	18.60	24.61	31.31	20.22	14.39	12.70	12.02	12.23	23.41
(MCM)	25.48	20.11	26.02	26.14	21.22	18.51	18.33	14.87	13.25	14.26	16.07	21.26	27.05	17.47	12.43	10.97	10.39	10.57	728.04
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																			
(cms)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																			
(MCM)	25.22	19.85	25.76	25.88	20.96	18.25	18.07	14.61	12.99	13.74	15.55	20.74	26.53	16.95	11.91	10.45	9.87	10.05	714.78
Water Requirement (mm) [Crop Water Requirement + Percolation]	90.2	89.7	95.9	69.3	52.8	34.4	17.4	5.3	0	0	0	0	0	0	0	0	0	0	1,034.1
Mean Net Irrigation Requirement (mm)	84.5	84	90.2	50.7	34.2	15.8	10.7	0	0	0	0	0	0	0	0	0	0	0	912.5
Diversion Water Requirement (mm) [N.W.R./0.7]	120.7	120	128.9	72.4	48.9	22.6	15.3	0	0	0	0	0	0	0	0	0	0	0	1,303.7
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1] 60,056																			
Diversion Requirement to Surface Water (MCM)	72.49	72.07	77.41	43.48	29.37	13.57	9.19	0	0	0	0	0	0	0	0	0	0	0	782.95
Irrigation by Residual Flow (MCM)	25.22	19.85	25.76	25.88	20.96	13.57	9.19	0	0	0	0	0	0	0	0	0	0	0	372.65
Accuml.	257.44	277.29	303.05	328.93	349.89	363.46	372.65	372.65	372.65	372.65	372.65	372.65	372.65	372.65	372.65	372.65	372.65	372.65	
Deficiency (MCM) [D.R.-Available Water]	47.27	52.22	51.65	17.6	8.41	0	0	0	0	0	0	0	0	0	0	0	0	0	410.3
Accuml.	280.42	332.64	384.29	401.89	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	410.3	
Excess (MCM)	0	0	0	0	0	4.68	8.88	14.61	12.99	13.74	15.55	20.74	26.53	16.95	11.91	10.45	9.87	10.05	342.1
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																			
Allowable Shortage Rate to Irrigation Requirement (%)	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)	7.74	3.85	4.11	17.84	13.59	8.85	4.48	1.36											111.50
Water Saving Amount securing 90% Yield (MCM)	7.74	3.85	4.11	17.6	8.41	0	0	0	0	0	0	0	0	0	0	0	0	0	91.39
Accuml.	57.42	61.27	65.38	82.98	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	91.39	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]	39.53	48.37	47.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	318.91
Accuml.	223	271.37	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	318.91	
Operation of Abbandans																			
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50.00
Inflow	0	0	0	0	0	4.68	8.88	14.61	12.99	8.84	0	0	0	0	0	0	0	0	
Storage	0	0	0	0	0	4.68	13.56	28.17	41.16	50	50	50	50	50	50	50	50	50	
Shortage after Release from Abbandans (MCM)	39.53	48.37	47.54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	268.91
Accuml.	173	221.37	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	268.91	
Operation of Lar Dam																			
Outflow	39.53	48.37	18.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	67	18.63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)	0	0	28.91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28.91
Accuml.	0	0	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	28.91	

TABLE B. 1. 4-8 PRELIMINARY WATER BALANCE STUDY (PROPOSED) FOR DROUGHT YEAR IN CASE OF LAR DAM ONLY

Year: Drought Year (1970)
Avalable Storage of Lar Dam for Irrigation: 240 MCM

	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec			Total
Runoff Discharge from the Residual Basin below the Lar Dam																																					
(cms)	15.06	14.58	13.50	12.75	13.27	12.81	13.00	14.67	17.50	22.86	20.18	20.32	22.37	28.03	22.16	18.15	14.47	12.83	11.86	10.98	12.20	10.62	9.87	9.74	10.44	12.53	13.95	13.72	14.32	14.49	13.85	13.73	13.10	13.29	12.58	13.29	14.81
(MCM)	13.01	12.60	11.66	11.02	11.47	11.07	11.23	12.67	15.12	19.75	17.44	17.56	19.33	24.22	19.15	15.68	12.50	11.09	10.25	9.49	10.54	9.18	8.53	8.42	9.02	10.83	12.05	11.85	12.37	12.52	11.97	11.86	11.32	11.48	10.87	11.48	460.6
Required Outflow to the Caspian Sea as a Maintenance Flow of the Haraz River																																					
(cms)	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
(MCM)	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	13.26
Available Water of Runoff Discharge from the Residual Basin for Irrigation (MCM)																																					
(MCM)	12.75	12.34	11.4	10.5	10.95	10.55	10.71	12.15	14.6	19.49	17.18	17.3	19.07	23.96	18.89	15.42	12.24	10.83	9.99	9.23	10.28	8.92	8.27	8.16	8.76	10.57	11.79	11.33	11.85	12	11.45	11.34	10.8	10.96	10.35	10.96	447.34
Water Requirement (mm) [Crop Water Requirement + Percolation]																																					
	0	0	0	0	0	0	0	0	0	0	0	47.3	81.1	78.1	94.1	94.4	91.9	92.2	90.2	89.7	95.9	69.3	52.8	34.4	17.4	5.3	0	0	0	0	0	0	0	0	0	0	1,034.1
Mean Net Irrigation Requirement (mm)																																					
	0	0	0	0	0	0	0	0	0	0	0	40.7	76.5	73.5	89.5	89.9	87.4	87.7	83	82.5	88.7	52.8	36.3	17.9	0	0	0	0	0	0	0	0	0	0	0	0	906.4
Diversion Water Requirement (mm) [N.W.R./0.7]																																					
	0	0	0	0	0	0	0	0	0	0	0	58.1	109.3	105	127.9	128.4	124.9	125.3	118.6	117.9	126.7	75.4	51.9	25.6	0	0	0	0	0	0	0	0	0	0	0	0	1,295.0
Irrigation Area to be irrigated by Surface Water (ha) [see Appendix B.1.2.1]																																					
60,056																																					
Diversion Requirement to Surface Water (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	34.89	65.64	63.06	76.81	77.11	75.01	75.25	71.23	70.81	76.09	45.28	31.17	15.37	0	0	0	0	0	0	0	0	0	0	0	0	777.72
Irrigation by Residual Flow (MCM)																																					
	0	0	0	0	0	0	0	0	.0	0	0	17.3	19.07	23.96	18.89	15.42	12.24	10.83	9.99	9.23	10.28	8.92	8.27	8.16	0	0	0	0	0	0	0	0	0	0	0	0	172.56
Accuml.	0	0	0	0	0	0	0	0	0	0	0	17.3	36.37	60.33	79.22	94.64	106.88	117.71	127.7	136.93	147.21	156.13	164.4	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	172.56	
Deficiency (MCM) [D.R.-Available Water]																																					
	0	0	0	0	0	0	0	0	0	0	0	17.59	46.57	39.1	57.92	61.69	62.77	64.42	61.24	61.58	65.81	36.36	22.9	7.21	0	0	0	0	0	0	0	0	0	0	0	0	605.2
Accuml.	0	0	0	0	0	0	0	0	0	0	0	17.59	64.16	103.26	161.18	222.87	285.64	350.06	411.3	472.88	538.69	575.05	597.95	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	605.16	
Excess (MCM)																																					
	12.75	12.34	11.4	10.5	10.95	10.55	10.71	12.15	14.6	19.49	17.18	0	0	0	0	0	0	0	0	0	0	0	0	0	8.76	10.57	11.79	11.33	11.85	12	11.45	11.34	10.8	10.96	10.35	10.96	274.8
Allowable Shortage of Irrigation Water for securing 90% Yield (10% Yield Reduction)																																					
Allowable Shortage Rate to Irrigation Requirement (%)												10	10	10	10	10	10	10	10	5	5	30	30	30	30	30											
Allowable Shortage (MCM)												4.06	6.96	6.70	8.07	8.10	7.88	7.91	7.74	3.85	4.11	17.84	13.59	8.85	4.48	1.36											111.50
Water Saving Amount securing 90% Yield (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	4.06	6.96	6.7	8.07	8.1	7.88	7.91	7.74	3.85	4.11	17.84	13.59	7.21	0	0	0	0	0	0	0	0	0	0	0	0	104.02
Accuml.	0	0	0	0	0	0	0	0	0	0	0	4.06	11.02	17.72	25.79	33.89	41.77	49.68	57.42	61.27	65.38	83.22	96.81	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	104.02	
Necessary Irrigation Water to be supplied from Lar Dam and Abbandans (MCM) [Defficiency-Allowable Shortage]																																					
	0	0	0	0	0	0	0	0	0	0	0	13.53	39.61	32.4	49.85	53.59	54.89	56.51	53.5	57.73	61.7	18.52	9.31	0	0	0	0	0	0	0	0	0	0	0	0	0	501.14
Accuml.	0	0	0	0	0	0	0	0	0	0	0	13.53	53.14	85.54	135.39	188.98	243.87	300.38	353.88	411.61	473.31	491.83	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	501.14	
Available Water Storages in Abbandans and Lar Dam (MCM)																																					
Abbandans	50																																				
Lar Dam	240																																				
Total	290																																				
Operation of Abbandans																																					
Outflow	0	0	0	0	0	0	0	0	0	0	0	13.53	36.47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50.00
Inflow	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8.76	10.57	11.79	11.33	7.55	0	0	0	0	0	0	0	
Storage	50	50	50	50	50	50	50	50	50	50	50	36.47	0	0	0	0	0	0	0	0	0	0	0	0	8.76	19.33	31.12	42.45	50	50	50	50	50	50	50	50	
Shortage after Release from Abbandans (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	0	3.14	32.4	49.85	53.59	54.89	56.51	53.5	57.73	61.7	18.52	9.31	0	0	0	0	0	0	0	0	0	0	0	0	0	451.14
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	3.14	35.54	85.39	138.98	193.87	250.38	303.88	361.61	423.31	441.83	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	451.14	
Operation of Lar Dam																																					
Outflow	0	0	0	0	0	0	0	0	0	0	0	0	3.14	32.4	49.85	53.59	54.89	46.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	240.00
Storage	240	240	240	240	240	240	240	240	240	240	240	240	236.86	204.46	154.61	101.02	46.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Final Shortage (MCM)																																					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.38	53.5	57.73	61.7	18.52	9.31	0	0	0	0	0	0	0	0	0	0	0	0	0	211.14
Accuml.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10.38	63.88	121.61	183.31	201.83	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	211.14	

TABLE B.1.4-9 10-DAY RUNOFF DISCHARGE OF RESIDUAL BASIN (CMS)

	Jan			Feb			Mar			Apr			May			Jun		
1956	9.57	8.94	11.81	12.41	13.61	14.96	15.44	14.74	2.22	6.95	46.85	19.11	29.91	69.51	92.05	27.4	9.1	28.41
1957	4.57	4.57	6.33	6.24	6.24	7.35	8.1	8.1	0	1	16.7	0	5.7	33	30.64	79.14	68.64	122.45
1958	16.62	16.33	12.77	11.9	11.45	13.85	14.59	15.64	17.83	29.6	28.3	43.9	34.6	34	34.36	29.6	28.1	26
1959	11.44	4.61	14.31	12.64	11.18	9.53	12.59	11.21	21.03	19.96	13.3	65.9	72.1	70.6	70.27	65.8	52.8	46.4
1960	18.82	13.62	19.38	18.22	18.15	17.19	17.92	19.21	20.79	37.34	27.11	34.3	34.1	41.9	35.73	28.2	22.6	21.22
1961	14.56	15.13	14.49	15.26	15.71	15.35	15.29	13.51	14.86	18.41	21.42	25.58	40.6	32.8	32.19	26.4	16.7	7.6
1962	10.05	9.94	10.5	12.36	12.47	10.12	9.06	9.14	10.32	12.21	13.97	22.5	25.4	36.3	45.55	45.2	40.4	24.5
1963	9.67	8.03	9.9	9.41	9.81	9.58	12.08	11.52	13.38	14.24	17.4	24.6	22.4	29.9	30	45.4	40	28.9
1964	0	8.06	0	14.26	13.89	13.93	10.46	12.15	9.52	26.9	30.8	24.1	46.8	68.8	36.54	38.2	30.9	23.5
1965	9.3	10.48	9.82	9.62	10.5	9.59	12.9	16.2	19.33	21.12	27.95	42	53.1	75.5	65.18	54.2	42.3	36.2
1966	11.63	11.01	10.83	14.64	10.26	7.74	8.45	18.96	16.5	20.26	34.8	42.7	74.5	44.4	51.73	45.4	39.8	31.6
1967	10.75	9.72	9.95	9.75	10.22	10.94	11.81	11.67	12.44	13.28	17.81	30.4	35	50.3	44.46	33	28.7	23.4
1968	8.09	7.85	6.39	0	8.48	11.76	12.48	22.52	18.38	31.97	49.87	51.2	44.8	48	60.63	80.1	55.9	47.4
1969	8.17	7.56	12.62	10.19	9.65	13.88	24.55	45.4	37.96	72.7	39.1	41.9	84.2	98.8	70.09	79.1	53.4	53.8
1970	15.06	14.58	13.5	12.75	13.27	12.81	13	14.67	17.5	22.86	20.18	20.32	22.37	28.03	22.16	18.15	14.47	12.83
1971	13.74	12.67	12.63	13.1	11.77	11.6	16.41	22.73	23.65	31.04	29.36	38.76	44.94	43.64	33.37	23.4	34.6	25.9
1972	7.44	0.08	0	5.52	11.06	9.5	14.96	16.92	19.13	25.39	34.12	30.79	59.37	47.9	72.35	78.78	67.36	50.69
1973	12.41	15.14	15.05	15.35	17.14	19.58	19.45	18.12	21.77	20.91	36.51	79.98	93.99	105.68	150.46	88.29	58.92	41.2
1974	8.09	7.85	10.22	10.43	10.68	15.17	15.78	21.63	25.94	19.19	28.58	31.54	12.12	27.05	37.52	20.6	15.82	12.89
1975	6.72	5.28	6.28	8.36	9.11	12.69	12.24	11.1	1.06	11.66	33.89	19.07	31.15	118.08	120.35	96.81	71.89	38.14
1976	14.42	13.64	13.05	10.9	12.61	12.8	14.48	13.66	13.68	16.08	33.92	36.21	33.2	28.5	53.4	47.12	48.57	40.14
1977	17.77	17.88	18.99	20.78	20.9	15.62	20.16	22.73	11.84	12.44	17.18	21.04	32.35	48.41	48.56	41.85	38.1	40.56
1978	11.59	9.84	7.5	6.31	13.69	11.12	8.65	22.47	26.12	27.31	14.55	16.55	22.6	18.29	23.93	20.83	25.77	22.2
1979	29.01	29.21	29.25	29.35	29.42	29.53	29.53	29.53	10.52	10.62	19.6	5.95	10.25	17.24	19.94	21.42	28.03	31.28
1980	14.86	14.65	13.91	14.5	14.86	14.93	15.35	14.54	14.7	21.64	20.49	28.55	26.92	16.37	13.24	13.24	13.24	16.22
1981	14.67	14.67	17.28	17.28	17.28	18.11	18.11	18.11	12.73	12.73	12.73	35.11	35.11	35.11	23.63	23.63	23.63	35.13
1982	11.16	11.16	12.01	12.01	12.01	12.67	12.67	12.67	12.96	12.96	12.96	24.14	24.14	24.14	15.52	15.52	15.52	19.95

	Jul			Aug			Sep			Oct			Nov			Dec		
1956	24.41	19.71	101.9	63.43	61.23	67.16	60.6	65.1	31.88	13.38	10.68	10.06	10.06	10.06	10.56	11.56	10.76	4.84
1957	65.25	70.95	79.74	66.66	57.16	50.44	41.44	34.44	24.4	22.1	28.1	23.83	24.32	30.82	24.17	18.87	16.07	16.62
1958	24.4	22.27	18.38	19.59	17.5	14.61	14.95	13.59	13.9	14.28	15.8	13.47	14.78	13.4	12.79	14.68	13.18	7.66
1959	35.7	28.8	26.73	25.09	22.49	20.33	20.91	15.79	11.53	18.49	17.25	17.61	18.71	19.43	19.6	17.39	17.63	18.11
1960	20.82	20.88	21.8	17.23	17.92	19.76	20.99	18.31	17.91	17.84	17.9	17.7	17.2	17.03	15.54	15.69	13.64	14.51
1961	18.48	17.38	15.86	17.53	15.81	14.31	16.72	16.67	15.36	11.46	10.5	13.98	11.2	11.61	11.15	11.07	10.92	9.61
1962	21.3	17.3	12.99	13.28	12.08	11.52	12	14.97	12.66	10.9	13.6	12.37	11.24	13.52	10.4	10.34	10.29	9.77
1963	23.6	22.7	16.82	19.1	14.11	20.17	12.91	11.04	9.25	11.17	15.16	11.58	13.44	17.3	15.65	13.43	9.96	0
1964	22.93	19.25	17.66	16.05	14.9	15.86	14.48	14.8	10.54	10.88	10.62	11.44	12.05	11.4	11.01	9.7	9.7	8.97
1965	32.8	24.11	22.3	20.71	14.11	14.08	15.12	12.28	12.54	17.33	13.57	14.62	15.86	16.4	15.46	14	12.19	11.13
1966	25.2	21.7	22.85	18.76	14.07	12.12	12.51	12.14	11.63	14.51	13.69	11.76	11.88	12.2	11.07	9.92	9.31	10.45
1967	20.37	17.33	14.27	13.33	12.92	10.85	10.09	10.74	11.81	13.21	11.54	10.63	10.87	11.41	11.26	10.6	8.98	8.22
1968	43.6	36.9	28.82	22.9	20.41	16.81	15.1	13.31	10.99	11.78	11.99	13	11.77	14.22	13.86	12.8	14.23	13.4
1969	65.8	59.1	44.73	35.2	25.5	22.1	19.36	25.04	21.3	19.23	21.57	24.4	23.88	21.95	19.41	18.5	16.95	15.52
1970	11.86	10.98	12.2	10.62	9.87	9.74	10.44	12.53	13.95	13.72	14.32	14.49	13.85	13.73	13.1	13.29	12.58	13.29
1971	22.13	19.8	20.40	20.49	19.16	19.42	18.63	18.14	14.35	13.79	16.28	16	15.99	16.44	14.74	13.79	14.58	13.08
1972	46.69	43.9	38.89	48.91	44.86	43.6	39.28	37.95	17.41	13.05	12.6	13.42	15.77	15.06	14.05	17.09	17.72	16.1
1973	20.77	23.53	25.36	24.56	20.6	14.98	15.25	14.3	14.4	16.07	14.75	14.13	13.08	14.04	14.06	11.68	10.65	10.64
1974	29.14	29.44	17.64	11.78	7.79	10.83	9.94	12.23	10.56	7.07	7.07	8.06	8.35	9.71	9.21	7.86	6.91	6.61
1975	16.75	8.09	11.81	10.27	10.73	11.45	9.23	8.06	8.82	10.94	10.24	14.19	16.98	16.03	16.59	16.93	16.98	17.62
1976	40.37	29.85	27.01	22.43	18.8	21.4	21.54	22.65	23.08	21.97	20.07	22.82	22.47	21.15	21.97	23.94	26.67	19.02
1977	29.49	23.27	30.11	30.25	24.56	21.42	21.22	17.21	15.33	16.51	18.6	24.61	31.31	20.22	14.39	12.7	12.02	12.23
1978	17.69	20.24	14.53	9.98	5.73	6.47	7	7.75	16.75	24.02	25.78	26.12	26.29	26.5	27.54	27.74	27.94	28.8
1979	6.76	5	15.73	14.87	13.56	16.31	16.23	16.17	18.31	17.72	17	17.49	17.14	16.3	15.09	13.69	14.41	14.67
1980	16.22	16.22	23.67	23.67	23.67	16.52	16.52	16.52	18.84	18.84	18.84	16.24	16.24	16.24	16.91	16.91	16.91	14.67
1981	35.13	35.13	21.61	21.61	21.61	15.56	15.56	15.56	19.25	19.25	19.25	27.89	27.89	27.89	15.54	15.54	15.54	11.16
1982	19.95	19.95	16.21	16.21	16.21	16.19	16.19	16.19	16.58	16.58	16.58	16.12	16.12	16.12	15.9	15.9	15.9	12.39

TABLE B.1.4-10 10-DAY RUNOFF DISCHARGE AT KAREHSANG (CMS)

Year	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
1956	18.63	18.00	18.00	18.60	19.80	20.22	20.70	20.00	20.27	25.00	64.90	76.80	87.60	127.20	150.45	85.80	67.50	55.00	51.00	46.30	115.27	76.80	74.60	76.36	69.80	74.30	38.60	20.10	17.40	16.00	16.00	16.00	15.80	16.80	16.00	13.27
1957	13.00	13.00	12.09	12.00	12.00	12.25	13.00	13.00	13.09	17.80	33.50	41.50	59.40	86.70	85.00	133.50	123.00	147.20	90.00	95.70	92.18	79.10	69.60	59.00	50.00	43.00	30.40	28.10	34.10	28.91	29.40	35.90	29.30	24.00	21.20	22.00
1958	23.20	21.00	18.45	18.00	18.10	18.25	19.60	21.70	27.82	47.80	71.90	83.90	68.20	63.20	58.00	52.50	48.00	42.20	37.80	31.80	26.00	26.30	23.60	20.00	19.50	18.00	18.00	18.10	19.60	17.09	18.20	16.60	16.70	18.20	16.80	14.64
1959	15.00	16.50	16.18	14.90	13.50	14.38	14.70	15.50	26.82	40.10	52.60	112.60	110.30	106.60	110.09	98.20	86.30	71.40	53.10	41.80	38.00	34.30	29.90	26.91	27.10	21.70	16.90	23.50	21.90	21.91	22.50	23.00	23.00	21.00	21.70	22.45
1960	22.20	21.70	21.82	20.80	20.80	21.33	22.30	22.60	24.45	42.60	33.30	51.20	53.70	71.00	57.09	45.80	36.40	31.50	29.00	27.50	28.45	22.90	23.30	24.73	25.70	22.70	22.10	22.00	22.00	21.73	21.00	20.50	19.00	19.20	18.30	18.91
1961	18.40	19.00	18.91	18.20	18.00	18.00	17.70	17.00	17.91	21.50	27.70	43.90	68.90	60.00	55.55	43.60	32.10	21.60	29.20	25.80	22.82	23.70	21.70	19.73	21.90	21.70	19.80	15.80	14.80	18.00	15.00	15.30	15.00	14.60	14.60	13.73
1962	14.00	14.00	14.00	15.80	16.00	13.88	13.10	14.00	18.09	20.50	22.80	40.90	58.70	72.50	85.82	76.60	66.10	43.90	36.80	29.40	22.82	22.00	20.10	18.82	18.30	20.70	17.90	16.10	18.80	16.91	15.80	17.60	14.20	13.60	13.40	13.00
1963	13.00	12.60	13.18	12.70	12.40	12.50	14.70	14.50	17.73	25.40	41.70	56.50	58.40	70.00	73.36	106.10	86.30	58.70	44.30	39.00	29.73	32.90	23.90	29.18	20.00	17.60	15.20	16.80	20.00	16.17	17.90	20.90	19.20	17.30	16.20	15.91
1964	13.60	16.10	13.36	17.60	16.20	17.00	14.50	17.10	23.18	47.90	49.50	52.60	95.70	114.90	69.36	58.50	46.20	34.70	31.10	26.10	23.55	21.50	20.00	21.18	19.60	20.10	14.90	14.90	14.60	15.09	15.40	14.50	14.30	13.00	13.00	12.00
1965	12.20	13.20	12.82	12.50	13.30	12.50	15.70	20.40	25.55	28.60	40.70	78.30	104.70	130.00	108.18	86.20	65.20	53.40	45.50	34.00	30.55	27.90	20.40	19.82	20.30	17.00	17.00	21.90	17.80	18.82	20.40	20.70	19.50	17.60	15.90	15.09
1966	15.00	14.80	14.09	18.20	13.60	10.88	12.00	25.60	21.27	27.80	56.50	70.90	113.70	81.20	93.00	78.80	63.50	49.50	38.70	33.10	32.73	26.30	20.50	17.73	17.50	16.50	15.90	19.40	18.70	16.91	16.50	16.60	15.10	14.00	13.20	14.09
1967	14.00	13.00	13.00	12.80	13.20	13.75	14.70	14.60	15.91	17.00	24.80	46.20	61.50	100.10	81.73	58.10	45.60	36.70	30.90	25.90	21.36	19.80	18.50	15.73	14.60	15.00	16.00	17.40	15.30	14.00	14.20	14.70	14.00	13.60	13.10	11.27
1968	11.00	11.40	11.36	10.80	11.90	14.00	15.10	26.60	21.55	37.40	67.00	92.70	94.90	98.90	146.27	151.80	105.50	83.20	71.20	53.90	41.55	33.90	30.30	26.36	23.90	21.30	17.90	18.00	17.60	17.91	17.90	20.30	18.70	17.20	18.30	17.73
1969	16.40	16.00	17.18	17.10	16.30	16.00	31.10	59.00	49.82	114.60	67.80	95.00	183.10	205.80	166.64	146.20	122.70	100.20	99.10	87.10	69.00	52.50	38.80	33.55	29.70	34.00	28.92	26.02	28.90	35.27	32.14	29.60	26.43	25.02	22.60	21.11
1970	20.71	19.75	18.37	17.51	17.83	17.15	17.31	19.39	23.47	37.92	44.06	38.74	40.46	50.31	43.61	34.35	26.33	22.70	20.74	18.65	19.34	16.62	15.35	14.77	15.08	17.03	18.13	17.55	18.07	18.02	17.21	16.87	16.13	16.32	15.81	15.93
1971	16.38	15.33	15.27	15.42	15.30	14.44	19.08	26.78	30.02	38.70	48.21	75.10	94.31	113.00	94.40	66.74	66.49	47.22	36.50	32.03	29.61	28.60	26.00	25.38	24.06	23.17	19.27	18.49	20.60	20.24	20.00	20.43	18.41	17.14	18.04	17.35
1972	16.72	16.66	15.98	16.24	17.09	16.87	17.68	20.22	22.35	30.04	47.37	79.79	118.92	94.60	133.09	141.20	119.99	96.86	80.55	66.97	55.16	64.99	55.47	52.65	46.67	44.53	24.76	20.29	19.46	19.35	21.38	19.48	18.40	21.60	21.84	19.80
1973	18.02	18.67	18.71	18.94	21.02	23.90	24.66	24.07	28.83	35.52	65.02	123.32	143.96	164.10	205.00	128.49	88.09	62.47	36.69	35.35	34.65	32.39	27.71	21.22	20.87	19.61	19.44	20.83	19.36	18.45	17.06	17.96	18.00	15.42	14.77	14.07
1974	11.58	11.34	13.37	13.58	13.83	18.34	18.95	24.80	36.94	30.19	39.58	63.02	43.60	58.53	62.97	46.05	41.27	28.09	44.34	44.64	26.52	20.66	16.67	17.77	16.88	19.17	16.13	12.64	12.64	11.91	12.20	13.56	12.30	10.95	10.00	9.39
1975	9.50	8.06	8.47	10.55	11.30	14.84	14.39	13.25	19.85	30.45	52.68	57.05	69.13	156.06	158.64	135.10	110.18	51.56	30.17	21.51	18.70	17.16	17.62	16.44	14.22	13.05	12.72	14.84	14.14	17.74	20.53	19.58	19.35	19.69	19.74	20.44
1976	17.39	16.33	15.29	13.36	14.98	15.25	16.34	15.92	16.17	19.30	45.40	69.73	89.11	97.84	115.75	99.34	92.19	71.17	65.11	47.46	42.38	32.60	27.19	28.84	27.98	28.59	27.87	26.76	24.86	27.19	26.84	25.52	25.40	27.37	30.10	21.95
1977	20.70	20.81	21.87	23.66	23.78	19.55	24.09	26.66	21.72	22.32	27.06	48.26	59.57	75.63	81.35	74.64	70.89	53.87	42.80	36.58	37.47	37.61	31.92	27.09	26.89	22.88	21.28	22.46	24.55	30.21	36.91	25.82	19.45	17.76	17.08	16.01
1978	15.22	13.61	10.31	9.70	17.33	15.00	12.43	27.21	33.17	56.57	60.22	54.13	56.66	65.67	62.19	51.67	55.81	47.71	36.59	33.35	25.37	19.96	14.17	13.81	12.93	13.19	21.14	28.41	30.17	30.35	30.52	30.73	30.93	31.13	31.33	31.58
1979	31.79	31.99	32.20	32.30	32.37	32.40	32.40	32.40	32.50	32.60	41.58	52.80	57.10	64.09	62.66	64.14	70.75	53.10	28.58	26.82	26.04	25.18	23.87	22.94	22.86	22.80	23.03	22.44	21.72	21.65	21.30	20.46	18.12	16.72	17.44	17.67
1980	17.92	17.44	16.51	17.04	17.36	17.64	17.84	17.32	19.27	43.82	60.87	61.07	53.85	44.27	46.14	46.14	46.14	31.20	31.20	31.20	31.20	31.20	31.20	21.70	21.70	21.70	23.77	23.77	23.77	20.60	20.60	20.60	21.04	21.04	21.04	20.85
1981	20.85	20.85	21.50	21.50	21.50	21.70	21.70	21.70	25.04	25.04	25.04	74.48	74.48	74.48	63.48	63.48	63.48	53.27	53.27	53.27	30.73	30.73	30.73	21.83	21.83	21.83	23.13	23.13	23.13	31.32	31.32	31.32	18.56	18.56	18.56	16.02
1982	16.02	16.02	15.33	15.33	15.33	15.49	15.49	15.49	22.65	22.65	22.65	55.12	55.12	55.12	46.88	46.88	46.88	34.23	34.23	34.23	23.39	23.39	23.39	21.13	21.13	21.13	22.47	22.47	22.47	21.33	21.33	21.33	20.49	20.49	20.49	19.78

TABLE B.1.4-11 10-DAY RUNOFF DISCHARGE AT POLOUR (CMS)

Year	Jan			Feb			Mar			Apr			May			Jun			Jul			Aug			Sep			Oct			Nov			Dec		
1956	9.06	9.06	6.19	6.19	6.19	5.26	5.26	5.26	18.05	18.05	18.05	57.69	57.69	57.69	58.40	58.40	58.40	26.59	26.59	26.59	13.37	13.37	13.37	9.20	9.20	9.20	6.72	6.72	6.72	5.94	5.94	5.94	5.24	5.24	5.24	8.43
1957	8.43	8.43	5.76	5.76	5.76	4.90	4.90	4.90	16.80	16.80	16.80	53.70	53.70	53.70	54.36	54.36	54.36	24.75	24.75	24.75	12.44	12.44	12.44	8.56	8.56	8.56	6.00	6.00	6.00	5.08	5.08	5.08	5.13	5.13	5.13	5.38
1958	6.58	4.67	5.68	6.10	6.65	4.40	5.01	6.06	9.99	18.20	43.60	40.00	33.60	29.20	23.64	22.90	19.90	16.20	13.40	9.53	7.62	6.71	6.10	5.39	4.55	4.41	4.10	3.82	3.80	3.62	3.42	3.20	3.91	3.52	3.62	6.98
1959	3.56	11.89	1.87	2.06	2.32	4.85	2.11	4.29	5.79	20.14	39.30	46.70	38.20	36.00	39.82	32.40	33.50	25.00	17.40	13.00	11.27	9.21	7.41	6.58	6.19	5.91	5.37	5.01	4.65	4.30	3.79	3.57	3.40	3.61	4.07	4.34
1960	3.38	8.08	2.44	2.58	2.65	4.14	4.38	3.39	3.66	5.26	6.19	16.90	19.60	29.10	21.36	17.60	13.80	10.28	8.18	6.62	6.65	5.67	5.38	4.97	4.71	4.39	4.19	4.16	4.10	4.03	3.80	3.47	3.46	3.51	4.66	4.40
1961	3.84	3.87	4.42	2.94	2.29	2.65	2.41	3.49	3.05	3.09	6.28	18.32	28.30	27.20	23.36	17.20	15.40	14.00	10.72	8.42	6.96	6.17	5.89	5.42	5.18	5.03	4.44	4.34	4.30	4.02	3.80	3.69	3.85	3.53	3.68	4.12
1962	3.95	4.06	3.50	3.44	3.53	3.76	4.04	4.86	7.77	8.29	8.83	18.40	33.30	36.20	40.27	31.40	25.70	19.40	15.50	12.10	9.83	8.72	8.02	7.30	6.30	5.73	5.24	5.20	5.20	4.54	4.56	4.08	3.80	3.26	3.11	3.23
1963	3.33	4.57	3.28	3.29	2.59	2.92	2.62	2.98	4.35	11.16	24.30	31.90	36.00	40.10	43.36	60.70	46.30	29.80	20.70	16.30	12.91	13.80	9.79	9.01	7.09	6.56	5.95	5.63	4.84	4.59	4.46	3.60	3.35	3.87	6.24	18.49
1964	46.30	8.04	26.17	3.34	2.31	3.07	4.04	4.95	13.66	21.00	18.70	26.50	48.90	46.10	32.82	20.30	15.30	11.20	8.17	6.85	5.89	5.45	5.10	5.32	5.12	5.30	4.36	4.02	3.78	3.65	3.35	3.10	3.29	3.30	3.30	3.03
1965	2.90	2.72	3.00	2.88	2.80	2.91	2.80	4.20	6.22	7.48	12.75	36.30	51.60	54.50	43.00	32.00	22.90	17.20	12.70	9.89	8.25	7.19	6.29	5.74	5.18	4.72	4.46	4.57	4.23	4.20	4.54	4.30	4.04	3.60	3.71	3.96
1966	3.37	3.79	3.26	3.56	3.34	3.14	3.55	6.64	4.77	7.54	21.70	28.20	39.20	36.80	41.27	33.40	23.70	17.90	13.50	11.40	9.88	7.54	6.43	5.61	4.99	4.36	4.27	4.89	5.01	5.15	4.62	4.40	4.03	4.08	3.89	3.64
1967	3.25	3.28	3.05	3.05	2.98	2.81	2.89	2.93	3.47	3.72	6.99	15.80	26.50	49.80	37.27	25.10	16.90	13.30	10.53	8.57	7.09	6.47	5.58	4.88	4.51	4.26	4.19	4.19	3.76	3.37	3.33	3.29	2.74	3.00	4.12	3.05
1968	2.91	3.55	4.97	15.67	3.42	2.24	2.62	4.08	3.17	5.43	17.13	41.50	50.10	50.90	85.64	71.70	49.60	35.80	27.60	17.00	12.73	11.00	9.89	9.55	8.80	7.99	6.91	6.22	5.61	4.91	6.13	6.08	4.84	4.40	4.07	4.33
1969	8.23	8.44	4.56	6.91	6.65	4.12	6.55	13.60	11.86	41.90	28.70	53.10	98.90	107.00	96.55	67.10	69.30	46.40	33.30	28.00	24.27	17.30	13.30	11.45	10.34	8.96	7.62	6.79	7.33	10.87	8.26	7.65	7.02	6.52	5.65	5.59
1970	5.65	5.17	4.87	4.76	4.56	4.34	4.31	4.72	5.97	15.06	23.88	18.42	18.09	22.28	21.45	16.20	11.86	9.87	8.88	7.67	7.14	6.00	5.48	5.03	4.64	4.50	4.18	3.83	3.75	3.53	3.36	3.14	3.03	3.03	3.23	2.64
1971	2.64	2.66	2.64	2.32	3.53	2.84	2.67	4.05	6.37	7.66	18.85	36.34	49.37	69.36	61.03	43.34	31.89	21.32	14.37	12.23	9.13	8.11	6.84	5.96	5.43	5.03	4.92	4.70	4.32	4.24	4.01	3.99	3.67	3.35	3.46	4.27
1972	9.28	16.58	36.90	10.72	6.03	7.37	2.72	3.30	3.22	4.65	13.25	49.00	59.55	46.70	60.74	62.42	52.63	46.17	33.86	23.07	16.27	16.08	10.61	9.05	7.39	6.58	7.35	7.24	6.86	5.93	5.61	4.42	4.35	4.51	4.12	3.70
1973	5.61	3.53	3.66	3.59	3.88	4.32	5.21	5.95	7.06	14.61	28.51	43.34	49.97	58.42	54.54	40.20	29.17	21.27	15.92	11.82	9.29	7.83	7.11	6.24	5.62	5.31	5.04	4.76	4.61	4.32	3.98	3.92	3.94	3.74	4.12	3.43
1974	3.49	3.49	3.15	3.15	3.15	3.17	3.17	3.17	11.00	11.00	11.00	31.48	31.48	31.48	25.45	25.45	25.45	15.20	15.20	15.20	8.88	8.88	8.88	6.94	6.94	6.94	5.57	5.57	5.57	3.85	3.85	3.85	3.09	3.09	3.09	2.78
1975	2.78	2.78	2.19	2.19	2.19	2.15	2.15	2.15	18.79	18.79	18.79	37.98	37.98	37.98	38.29	38.29	38.29	13.42	13.42	13.42	6.89	6.89	6.89	4.99	4.99	4.99	3.90	3.90	3.90	3.55	3.55	3.55	2.76	2.76	2.76	2.82
1976	2.97	2.69	2.24	2.46	2.37	2.45	1.86	2.26	2.49	3.22	11.48	33.52	55.91	69.34	62.35	52.22	43.62	31.03	24.74	17.61	15.37	10.17	8.39	7.44	6.44	5.94	4.79	4.79	4.79	4.37	4.37	4.37	3.43	3.43	3.43	2.93
1977	2.93	2.93	2.88	2.88	2.88	3.93	3.93	3.93	9.88	9.88	9.88	27.22	27.22	27.22	32.79	32.79	32.79	13.31	13.31	13.31	7.36	7.36	7.36	5.67	5.67	5.67	5.95	5.95	5.95	5.60	5.60	5.60	5.06	5.06	5.06	3.78
1978	3.63	3.77	2.81	3.39	3.64	3.86	3.78	4.74	7.05	29.26	45.67	37.56	34.06	47.38	38.26	30.84	30.04	25.51	18.90	13.11	10.84	9.98	8.44	7.34	5.93	5.44	4.39	4.39	4.39	4.23	4.23	4.23	3.39	3.39	3.39	2.78
1979	2.78	2.78	2.95	2.95	2.95	2.87	2.87	2.87	21.98	21.98	21.98	46.85	46.85	46.85	42.72	42.72	42.72	21.82	21.82	21.82	10.31	10.31	10.31	6.63	6.63	6.63	4.72	4.72	4.72	4.16	4.16	4.16	3.03	3.03	3.03	3.00
1980	3.06	2.79	2.60	2.54	2.50	2.71	2.49	2.78	4.57	22.18	40.38	32.52	26.93	27.90	32.90	32.90	32.90	14.98	14.98	14.98	7.53	7.53	7.53	5.18	5.18	5.18	4.93	4.93	4.93	4.36	4.36	4.36	4.13	4.13	4.13	6.18
1981	6.18	6.18	4.22	4.22	4.22	3.59	3.59	3.59	12.31	12.31	12.31	39.37	39.37	39.37	39.85	39.85	39.85	18.14	18.14	18.14	9.12	9.12	9.12	6.27	6.27	6.27	3.88	3.88	3.88	3.43	3.43	3.43	3.02	3.02	3.02	4.86
1982	4.86	4.86	3.32	3.32	3.32	2.82	2.82	2.82	9.69	9.69	9.69	30.98	30.98	30.98	31.36	31.36	31.36	14.28	14.28	14.28	7.18	7.18	7.18	4.94	4.94	4.94	5.89	5.89	5.89	5.21	5.21	5.21	4.59	4.59	4.59	7.39

APPENDIX B. 2 IRRIGATION

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B. 2. 1 TIB Survey on Irrigation

1. General of Terminal Irrigation Block (TIB) Survey

The TIB survey has been carried out for clarifying the present condition on irrigation and water management in the Project Area. The survey was conducted both for the zone mirabs and the village mirabs using the questionnaires (see DATA BOOK II, B2. Irrigation (TIB Survey)). The Survey was carried out for the entire zone mirabs and the sampled village mirabs.

Surveyed Mirabs

Zone Mirab	116 mirabs	(conducted by entire survey)
Village Mirab	67 mirabs	(conducted by sampling survey)

Village mirabs were compiled district-wise, and the zone mirabs were compiled river-system-wise. Because the command areas of zone mirabs are following the existing canal system and its boundary are not correspond to the districts which are arranged in accordance with the proposed canal network.

The arrangements of the village mirabs and the zone mirabs are as follows;

Arrangement of Zone Mirab

District	Zone Mirab		
	Code	Number	Percent
Alesh Rud	1 - 7	7	6.0%
Haraz Left	8 - 29	22	19.0
Haraz Right	30 - 44	15	12.9
Kari Left	45 - 96	52	44.8
Kari Right	97 - 110	14	12.1
Garma Rud	111 - 115	5	4.3
Kharan Rud	116	1	0.9
Total		116	100.0%

(Note) Location of zone mirab allocation is shown in Figure B. 2. 1-1.

Arrangement of Village Mirab

District	Zone Mirab		
	Code	Number	Percent
Haraz West	1 - 17	17	25.4%
Amol West	18 - 31	14	20.9
Haraz East	32 - 52	21	31.3
Amol East	53 - 67	15	22.4
Total		67	100.0%

(Note) Location of selected village mirabs is shown in Figure B. 2. 1-2.

2. Number of Mirabs in the Project Area

There are 624 mirabs (including a part of irrigation area of the Garma Rud and the Kharan Rud) in the Project Area. Out of 624 mirabs, 116 are zone mirabs and 508 are village mirabs.

Distribution of zone mirabs and village mirabs are as follows;

Distribution of Mirabs

River System	Zone Mirabs Number (%)		Village Mirabs Number (%)		Total Mirabs Number (%)	
Alesh Rud	7	(6.0)	6	(1.2)	13	(2.1)
Haraz Left	22	(19.0)	135	(26.6)	157	(25.2)
Haraz Right	15	(12.9)	61	(12.0)	76	(12.2)
Kari Left	52	(44.8)	224	(44.1)	276	(44.2)
Kari Right	14	(12.1)	53	(10.4)	67	(10.7)
Sub-Total	110	(94.8)	479	(94.3)	589	(94.4)
Garma Rud	5	(4.3)	10	(2.0)	15	(2.4)
Kharan Rud	1	(0.9)	19	(3.7)	20	(3.2)
Total	116	(100)	508	(100)	624	(100)

Note: 1. see details in Table B. 2. 1-1.

As seeing above table, Kari Left Area has the largest number of mirabs for irrigation.

3. Ages and Experiences of Mirabs

Average age of mirab is 49 years old for the zone mirabs and 47 years old for the village mirabs. Average experienced years are 11 years for the zone mirabs and 8 years for the village mirabs.

4. Selection Method of Mirabs

Mirabs are selected generally every year and maximumly once in every three years, but same experienced men are selected in many cases. The village mirab is selected by farmers themselves, but the zone mirab is selected generally by the irrigation office.