3. Crop Evapotranspiration (ETcrop)

Crop evapotranspiration is estimated by equation below at each growing stage of crops;

$$ETcrop = ETo \times Kc$$

ETcrop	:	Crop evapotranspiration (mm)
ETo	:	Reference crop evapotranspiration (mm)
Kc	:	Crop coefficient

Crop coefficients of crops are as below;

Crop Coefficient

Crop	Crop Coefficient	Growing Stage
Amol - 3	1.1	Transplanting - 60th day
	1.2	61th day - 90th day
	0.95	91th day - 120th day
Khazar	1.1	Transplanting - 45th day
	1.2	46th day - 75th day
	0.95	76th day - 105th day
Tarom	1.1	Transplanting - 35th day
	1.2	36th day - 65th day
	0.95	66th day - 95th day
Nursery of Rice	1.1 (Shallow depth with free surface)	Sowing - Transplanting

4. Percolation

In the paddy field and at the bottom of abbandans, percolation is estimated as below;

Paddy Field

Puddling period
: 5 mm/day for first 3 days, and 3 mm/day subsequently.

Growing period
: 2 mm/day at present, and 3 mm/day for future
Where ; 2 mm/day : deep percolation
1 mm/day : lateral percolation due to drainage improvement in future.

Abbandan : 5 mm/day from bottom, when water is stored
Canal : 5 mm/day from bottom, when flowing

Lateral percolation will appear in downstream drainage canal as a part of return flow.

5. Land Preparation Water

Land preparation water is composed of following four different purposes of water in usage;

- Water for saturating soil for necessary depth of 30 cm.
- Standing water of 5 cm in depth.
- Evapotranspiration during land preparation.
- Percolation loss during land preparation.

(1) Land Preparation Water of Nursery Bed

Land preparation water of nursery bed is estimated for present and future respectively. Evapotranspiration is estimated in April, because major part of nursery bed is prepared in April.

Land Preparation Water of Nursery Bed (April)

Water by Purposes		Present	Future
Water to saturate soil of 30 cm depth		75 mm	75 mm
Standing water		50 mm	50 mm
Percolation			
First 3 days	5 mm/day × 3 days = 15 mm 2 mm/day × 22 days = 44 mm	59 mm	15 mm
Evapotranspiration		85 mm	10 mm
ETo * Kc * n (days)	3.1 mm/day * 1.1 * 3 days = 10 mm 3.1 mm/day * 1.1 * 25 days = 85 mm		
Total		269 mm	150 mm

(2) Land Preparation Water of Main Field

Land preparation water of main field is also estimated for present and future as well as of nursery bed. Evapotranspiration is estimated in May, because most of the field is prepared in May.

Land Preparation Water of Main Field (May)

Water by Purposes		Present	Future
Water to saturate soil of 30 cm depth		75 mm	75 mm
Standing water		50 mm	50 mm
Percolation			
First 3 days	5 mm/day × 3 days = 15 mm 2 mm/day × 22 days = 44 mm	59 mm	15 mm
Evapotranspiration		120 mm	15 mm
ETo * Kc * n (days)	4.4 mm/day * 1.1 * 3 days = 15 mm 4.4 mm/day * 1.1 * 25 days = 120 mm		
Total		304 mm	155 mm

6. Applicable Irrigation Efficiency for the Project

Irrigation efficiency is estimated for present and future by irrigation water sources, taking FAO Irrigation efficiencies into consideration.

(1) Irrigation Efficiency of Surface Water

Irrigation efficiency of surface water is composed of following 3 elements;

- Conveyance Efficiency (Ec) : Main and secondary canals
- Field Canal Efficiency (Eb) : Tertiary and fourth canals
- Field Application Efficiency (Ea) : Irrigation ditches

For evaluating above three efficiencies in the project, following elements are to be considered;

1) Irrigation Area
   - Present (IAp) = 82,643 ha
   - Future (IAf) = 78,669 ha
   - (IAfn) = 82,171 ha (note : without abbandans)

2) Canal Areas
   - Secondary canal (AS) = 2,001 ha
   - Tertiary canal to irrigation ditch (AT) = 885 ha

3) Abbandan Areas
   - Present and Future (AB) = 3,502 ha
   - Future in case reclaimed (AB) = 0 ha

4) Potential Evapotranspiration (ETo) = 5.5 mm/day in June
   - Coefficient of free surface water (Kw) = 1.0
   - Crop coefficient of rice in June (Kc) = 1.1

5) Percolation
   - From canal bed (PC) = 5 mm/day
   - Present stage at field (Pp) = Pd = 2 mm/day
   - Future stage at field (Pf) = Pd + Pl = 3 mm/day
     - Deep percolation (Pd) = 2 mm/day
     - Lateral percolation (Pl) = 1 mm/day

6) Net Irrigation Requirement (In)
   In = (ETo * Kc + P) * IA

7) Operation Allowance in Canal System
   oa = 15%

8) Application Allowance at Field Level
   aa = 15%

Based on the above elements, irrigation efficiency and effective return-flow rate have been computed as in the Table B. 1. 1 - 11. From the above procedure, irrigation efficiency and effective return-flow rate are estimated as follows:

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)

On the other hand, the following values of irrigation efficiency in the HWDP - 1 study (MOE) are adopted as for groundwater case.

Ea	Ed	Ep	
0.90	0.95	0.86	-- HWDP - 1 Study
(0.95)	(0.95)	(0.90)	-- Master Plan Study

Note ; Ea : Field Application Efficiency
Ed : Distribution Efficiency
Dp: Overall Efficiency

7. Results of Detail Calculation of the Water Requirement

According to above mentioned basic factor for the computation, the water requirement of 10 days interval have been estimated for present and proposed cropping calendar, respectively. The attached table are shown the details of procedure on the estimation.

Number of Table and its contents are shown as follows:

TABLE B.2.5-1 WEIGHTED NET IRRIGATION WATER REQUIREMENT OF PADDY RICE

(Design Year)

(Unit: mm)

	E V			M V			L V			Total	Remarks
	WRe	C I	ACC	WRe	C I	ACC	WRe	C I	ACC		
APR	60.2			-			98.9			NIWR	
	7.0			-			7.0			←	E. R.
	53.2	0.375	20.0	-	0.375	-	91.9	0.250	23.0	43.0	
MAY	253.1			226.1			294.4				
	19.0			19.0			19.0			←	E. R.
	234.1	0.375	87.8	207.1	0.375	77.7	275.4	0.250	68.9	234.4	
JUN	277.6			282.8			273.3				
	13.0			13.0			13.0			←	E. R.
	264.6	0.375	99.2	269.8	0.375	101.2	260.3	0.250	65.1	265.5	
JUL	268.7			277.8			283.5				
	18.0			18.0			18.0			←	E. R.
	250.7	0.375	94.0	259.8	0.375	97.4	265.5	0.250	66.4	257.8	
AUG	76.7			193.5			220.5				
	33.0			33.0			33.0			←	E. R.
	43.7	0.375	16.4	160.5	0.375	60.2	187.5	0.250	46.9	123.5	
SEP	-			21.1			58.9				
	-			7.0			14.0			←	E. R.
	-	-	-	14.1	0.375	5.3	44.9	0.250	11.2	16.5	
	936.3			1,001.3			1,229.5				
E. R.	-90.0			-90.0			-104.0				
TOTAL	846.3		317.4	911.3		341.8	1,125.5		281.5	940.7	

Notes :
1) EV : Eary Matured Variety
2) MV : Medium Matured Variety
3) LV : Late Matured Variety
4) NIWR : Net Irrigation Water Requirement
5) CI : Crop Intensity
6) ACC : Accumulated
7) E.R. : Effective Rainfall

TABLE B. 2. 5 - 2 WEIGHTED NET IRRIGATION WATER REQUIREMENT OF PADDY RICE

(Normal Year)

(Unit: mm)

	E V			M V			L V			Total	Remarks
	WRe	C I	ACC	WRe	C I	ACC	WRe	C I	ACC		
APR	60.2			-			98.9			NIWR	
	18.0			-			18.0			←	E. R.
	42.2	0.375	15.8	-	0.375	-	80.9	0.250	20.2	36.0	
MAY	253.1			226.1			294.4				
	10.0			10.0			10.0			←	E. R.
	243.1	0.375	91.2	216.1	0.375	81.0	284.4	0.250	71.7	243.9	
JUN	277.6			282.8			273.3				
	36.0			36.0			36.0			←	E. R.
	241.6	0.375	90.6	246.8	0.375	92.6	237.3	0.250	59.3	242.5	
JUL	268.7			277.8			283.5				
	6.0			6.0			6.0			←	E. R.
	262.7	0.375	98.5	271.8	0.375	101.9	277.5	0.250	69.4	269.8	
AUG	76.7			193.5			220.5				
	16.0			16.0			16.0			←	E. R.
	60.7	0.375	22.8	177.5	0.375	66.6	204.5	0.250	51.1	140.5	
SEP	-			21.1			58.9				
	-			21.1			58.9			←	E. R.
	-	-	-	0	0.375	0.0	0.0	0.250	0.0	0.0	
	936.3			1,001.3			1,229.5				
E. R.	-86.0			-89.1			-144.9				
TOTAL	850.3		318.9	912.2		341.2	1,084.6		271.7	932.7	

Notes :
1) EV : Eary Matured Variety
2) MV : Medium Matured Variety
3) LV : Late Matured Variety
4) NIWR : Net Irrigation Water Requirement
5) CI : Crop Intensity
6) ACC : Accumulated
7) E.R. : Effective Rainfall

TABLE B. 2. 5 - 3 WATER REQUIREMENT OF NURSERY (DESIGN YEAR)

(Unit: mm)

		APR.			MAY			JUN			TOTAL	REMARKS
		1	2	3	1	2	3	1	2	3		
TAROM (EV) 37.5%	C.Re	21.4	21.4	21.4	26.1	26.1	28.7				145.1	
	L.P	7.5	30.0	37.5	37.5	30.0	7.5				150.0	
	Sub-t	28.9	51.4	58.9	63.6	56.1	36.2				295.1	Effective Re Rainfall
	ER	←	22.0	→	←	19.0	→				41.0	
	Total	←	117.2	→	←	136.9	→				254.1	
KHAZAR (MV) 37.5%	C.Re		21.4	21.4	26.1	26.1	28.7	30.2			153.9	
	L.P		7.5	30.0	37.5	37.5	30.0	7.5			150.0	
	Sub-t		28.9	51.4	63.6	63.6	58.7	37.7			303.9	
	E.R	←	15.0	→	←	19.0	→	4.0			38.0	〃
	Total	←	65.3	→	←	166.9	→	33.7			265.9	
AMOL - 3 (LV) 25.0%	C.Re	21.4	42.7	42.7	26.1						132.9	
	L.P	19.0	56.0	56.0	19.0						150.0	
	Sub-t	40.4	98.7	98.7	45.1						282.9	
	E.R	←	22.0	→	6.0						28.0	〃
	Total	←	215.8	→	39.1						254.9	
Total (Average)	(254.1 × 0.375) + (265.9 × 0.375) + (254.9 × 0.250) =										258.7	Net W.R. is estimated at 2.6 mm/day
Net W.Re												258.7mm × 0.01 ≒ 2.6m/m

TABLE B. 2. 5 - 4 WATER REQUIREMENT OF NURSERY (NORMAL YEAR)

(Unit: mm)

		APR.			MAY			JUN			TOTAL	REMARKS
		1	2	3	1	2	3	1	2	3		
TAROM (EV) 37.5%	C.Re	21.4	21.4	21.4	26.1	26.1	28.7				145.1	
	L.P	7.5	30.0	37.5	37.5	30.0	7.5				150.0	
	Sub-t	28.9	51.4	58.9	63.6	56.1	36.2				295.1	Effective Re Rainfall
	ER	←	37.0	→	←	10.0	→				47.0	
	Total	←	102.2	→	←	145.9	→				248.1	
KHAZAR (MV) 37.5%	C.Re		21.4	21.4	26.1	26.1	28.7	30.2			153.9	
	L.P		7.5	30.0	37.5	37.5	30.0	7.5			150.0	
	Sub-t		28.9	51.4	63.6	63.6	58.7	37.7			303.9	
	E.R	←	37.0	→	←	10.0	→	18.0			65.0	〃
	Total	←	43.3	→	←	175.9	→	19.7			238.9	
AMOL - 3 (LV) 25.0%	C.Re	21.4	42.7	42.7	26.1						132.9	
	L.P	19.0	56.0	56.0	19.0						150.0	
	Sub-t	40.4	98.7	98.7	45.1						282.9	
	E.R	←	37.0	→	10.0						47.0	〃
	Total	←	200.8	→	35.1						235.9	
Total (Average)	(248.1 × 0.375) + (238.9 × 0.375) + (235.9 × 0.250) =										241.6	Net W.R. is estimated at 2.4 mm/day
Net W.Re												241.6mm × 0.01 ≒ 2.4m/m

TABLE B. 2. 5 - 5 WATER REQUIREMENT OF EARLY MATURED VARIETY (TAROM) AT PRESENT

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Total
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration					3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7				
	ETo (mm/day)																							
3.	Cropping Pattern						S		T						H				HV		End of Irrigation			
	ETo (mm/day)																							
4.	Crop Coefficient							1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95								
	days							10	10	10	11	10	10	10	10	10								
5.	Crop Water Requirement							34.1	48.4	48.4	55.7	66.0	66.0	59.4	50.4	50.4								
6.	Percolation							20	20	20	22	20	20	20	20	20								
7.	Total (1)							54.1	68.4	68.4	77.7	86.0	86.0	79.4	70.4	70.4								
8.	Crop Coefficient								1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95	0.95						
	days								5	10	11	10	10	10	10	10	10	3						
9.	Crop Water Requirement								24.2	48.4	53.2	63.3	66.0	66.0	57.2	50.4	50.4	13.4						
10.	Percolation								10	20	22	20	20	20	20	20	20	6.0						
11.	Total (2)								34.2	68.4	75.2	83.3	86.0	86.0	77.2	70.4	70.4	19.4						
12.	Crop Coefficient										1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95					
	days										11	10	10	10	10	10	11	10	5					
13.	Crop Water Requirement										53.2	60.5	60.5	63.3	63.6	63.6	63.0	44.7	22.3					
14.	Percolation										22	20	20	20	20	20	22	20	10					
15.	Total (3)										75.2	80.5	80.5	83.3	83.6	83.6	85.0	64.7	32.3					
16.	Total (1)+(2)+(3)							54.1	102.6	136.8	228.1	249.8	252.5	248.7	231.2	224.4	155.4	84.1	32.3					
17.	Average {(1)+(2)+(3)} × 1/3							(18.0)	(34.2)	(45.6)	76.0	83.3	84.2	82.9	77.1	74.8	51.8	28.0	10.8					568.9
18.	Land Preparation							101.3	101.3	101.3														303.9
19.	Field Water Requirement							101.3	101.3	101.3	76.0	83.3	84.2	82.9	77.1	74.8	51.8	28.0	10.8					872.8

S ; Sowing T ; Transplanting *H ; Heading* *HV ; Harvesting* ( ) ; Not Including in Total

TABLE B. 2. 5-6 WATER REQUIREMENT OF MEDIUM MATURED VARIETY (KHAZAR) AT PRESENT

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Total
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration ETo (mm/day)		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7	3.5	3.5	3.5	
3.	Cropping Pattern						S			T							H				HV	End of Irrigation		
4.	Crop Coefficient								1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95	0.95					
	days								10	10	11	10	10	10	10	10	11	10	5					
5.	Crop Water Requirement								48.4	48.4	53.2	60.5	63.3	66.0	63.6	57.2	55.4	44.7	22.3					
6.	Percolation								20	20	22	20	20	20	20	20	22	20	10					
7.	Total (1)								68.4	68.4	75.2	80.5	83.3	86.0	83.6	77.2	77.4	64.7	32.3					
8.	Crop Coefficient									1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95	0.95				
	days									5	11	10	10	10	10	10	11	10	10	8				
9.	Crop Water Requirement									24.2	53.2	60.5	60.5	63.3	63.6	63.6	63.0	44.7	44.7	35.7				
10.	Percolation									10	22	20	20	20	20	20	22	20	20	16				
11.	Total (2)									34.2	75.2	80.5	80.5	83.3	83.6	83.6	85.0	64.7	64.7	51.7				
12.	Crop Coefficient											1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95			
	days											10	10	10	10	10	11	10	10	10	10			
13.	Crop Water Requirement											60.5	60.5	60.5	58.3	61.0	70.0	56.4	50.8	44.7	33.3			
14.	Percolation											20	20	20	20	20	22	20	20	20	20			
15.	Total (3)											80.5	80.5	80.5	78.3	81.0	92.0	76.4	70.8	64.7	53.3			
16.	Total (1)+(2)+(3)								68.4	92.6	150.4	241.5	244.3	249.8	245.5	241.8	254.4	205.8	167.8	116.4	53.3			
17.	Average {(1)+(2)+(3)} × 1/3								(22.8)	(30.9)	(50.1)	80.5	81.4	83.3	81.8	80.6	84.8	68.6	55.9	38.8	21.1			676.8
18.	Land Preparation								101.3	101.3	101.3													303.9
19.	Field Water Requirement								101.3	101.3	101.3	80.5	81.4	83.3	81.8	80.6	84.8	68.6	55.9	38.8	21.1			980.7

S ; Sowing T ; Transplanting H ; Heading HV ; Harvesting ( ) ; Not Including in Total

TABLE B. 2. 5 - 7 WATER REQUIREMENT OF LATE MATURED VARIETY (AMOL-3) AT PRESENT

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Total
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration ETo (mm/day)		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7	3.5	3.5	3.5	
3.	Cropping Pattern					S			T									H			HV	End of Irrigation		
								1.10						1.20			0.95							
4.	Crop Coefficient							1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	0.95	0.95	0.95	0.95				
	days							10	10	10	11	10	10	10	10	10	11	10	10	5				
5.	Crop Water Requirement							34.1	48.4	48.4	53.2	60.5	60.5	66.0	63.6	63.6	55.4	44.7	44.7	22.3				
6.	Percolation							20	20	20	22	20	20	20	20	20	22	20	20	10				
7.	Total (1)							54.1	68.4	68.4	75.2	80.5	80.5	86.0	83.6	83.6	77.4	64.7	64.7	32.3				
									1.10						1.20			0.95						
8.	Crop Coefficient								1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	0.95	0.95	0.95	0.95			
	days								10	10	11	10	10	10	10	10	11	10	10	11	8			
9.	Crop Water Requirement								48.4	48.4	53.2	60.5	60.5	60.5	63.6	63.6	70.0	44.7	44.7	49.1	26.6			
10.	Percolation								20	20	22	20	20	20	20	20	22	20	20	22	16			
11.	Total (2)								68.4	68.4	75.2	80.5	80.5	80.5	83.6	83.6	92.0	64.7	64.7	71.1	42.6			
										1.10						1.20			0.95					
12.	Crop Coefficient									1.1	1.1	1.1	1.1	1.1	1.1	1.20	1.20	1.20	0.95	0.95	0.95	0.95		
	days									10	11	10	10	10	10	10	11	10	10	11	10	10		
13.	Crop Water Requirement									48.4	53.2	60.5	60.5	60.5	58.3	63.6	70.0	56.4	44.7	49.1	33.3	33.3		
14.	Percolation									20	22	20	20	20	20	20	22	20	20	22	20	20		
15.	Total (3)									68.4	75.2	80.5	80.5	80.5	78.3	83.6	92.0	76.4	64.7	71.1	53.3	53.3		
16.	Average {(1) + (2) + (3)} × 1/3							(18.0)	(45.6)	68.4	75.2	80.5	80.5	82.3	81.8	83.6	87.1	68.6	64.7	58.6	32.0	17.8		881.1
17.	Land Preparation							152	152															304
18.	Field Water Requirement							152	152	68.4	75.2	80.5	80.5	82.3	81.8	83.6	87.1	68.6	64.7	58.6	32.0	17.8		1,185.1

S ; Sowing T ; Transplanting H ; Heading HV ; Harvesting ( ) ; Not including in Total

TABLE B.2.5-8 WATER REQUIREMENT OF EARLY MATURED VARIETY (TAROM)

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Total
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration ETo (mm/day)					3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7				
3.	Cropping Pattern							S	T				MSD		H				HV		End of Irrigation			
	ETo (mm/day)								1.10			1.20			0.95									
4.	Crop Coefficient							1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95	0.95							
	days							10	10	10	11	10	10	10	10	10	11							
5.	Crop Water Requirement							34.1	48.4	48.4	55.7	66.0	66.0	59.4	50.4	50.4	55.4							
6.	Percolation							30	30	30	33	30	30	30	30	30	33							
7.	Total (1)							64.1	78.4	78.4	88.7	96.0	96.0	89.4	80.4	80.4	88.4							
										1.10			1.20			0.95								
8.	Crop Coefficient									1.1	1.1	1.1	1.15	1.2	1.2	1.08	0.95	0.95						
	days									10	11	10	10	10	10	10	11	10						
9.	Crop Water Requirement									48.4	53.2	60.5	63.3	66.0	63.6	57.2	55.4	44.7						
10.	Percolation									30	33	30	30	30	30	30	33	30						
11.	Total (2)									78.4	86.2	90.5	93.3	96.0	93.6	87.2	88.4	74.7						
													1.10			1.20			0.95					
12.	Crop Coefficient											1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95					
	days											10	10	10	10	10	11	10	10					
13.	Crop Water Requirement											60.5	60.5	60.5	61.0	63.6	70.0	50.8	44.7					
14.	Percolation											30	30	30	30	30	33	30	30					
15.	Total (3)											90.5	90.5	90.5	91.0	93.6	103.0	80.8	74.7					
16.	Total (1)+(2)+(3)							64.1	78.4	156.8	174.9	277.0	279.8	275.9	265.0	261.2	279.8	155.5	74.7					
17.	Average {(1)+(2)+(3)} × 1/3							21.4	26.1	52.3	58.3	92.3	93.3	92.0	88.3	87.1	93.3	51.8	24.9					781.1
18.	Land Preparation							38.8	38.8	38.8	38.8													155.2
19.	Field Water Requirement							60.2	64.9	91.1	97.1	92.3	93.3	92.0	88.3	87.1	93.3	51.8	24.9					936.3

S ; Sowing T ; Transplanting MSD ; Misdummer Drainage H ; Heading HV ; Harvesting

TABLE B.2.5-9 WATER REQUIREMENT OF MEDIUM MATURED VARIETY (KHAZAR)

	Component of Water Requirement	Unit	Mar. 1	Mar. 2	Mar. 3	Apr. 1	Apr. 2	Apr. 3	May 1	May 2	May 3	Jun. 1	Jun. 2	Jun. 3	Jul. 1	Jul. 2	Jul. 3	Aug. 1	Aug. 2	Aug. 3	Sep. 1	Sep. 2	Sep. 3	Total
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration ETo (mm/day)		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7	3.5	3.5	3.5	
3.	Cropping Pattern									S	T										End of Irrigation			
											1.10				1.20		0.95							
4.	Crop Coefficient								1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95	0.95					
	days								10	10	11	10	10	10	10	10	11	10	5					
5.	Crop Water Requirement								48.4	48.4	53.2	60.5	63.3	66.0	63.6	57.2	55.4	44.7	22.3					
6.	Percolation								30	30	33	30	30	30	30	30	33	30	15					
7.	Total (1)								78.4	78.4	86.2	90.5	93.3	96.0	93.6	87.2	88.4	74.7	37.3					
8.	Crop Coefficient										1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95	0.95				
	days										11	10	10	10	10	10	11	10	10	8				
9.	Crop Water Requirement										53.2	60.5	60.5	60.5	61.0	63.6	70.0	50.8	44.7	35.7				
10.	Percolation										33	30	30	30	30	30	33	30	30	24				
11.	Total (2)										86.2	90.5	90.5	90.5	91.0	93.6	103.0	80.8	74.7	59.7				
															1.10				1.20	0.95				
12.	Crop Coefficient												1.1	1.1	1.1	1.1	1.15	1.20	1.20	1.08	0.95			
	days												10	10	10	10	11	10	10	10	10			
13.	Crop Water Requirement												60.5	60.5	58.3	58.3	67.0	56.4	56.4	50.8	33.3			
14.	Percolation												30	30	30	30	33	30	30	30	30			
15.	Total (3)												90.5	90.5	88.3	88.3	100.0	86.4	86.4	80.8	63.3			
16.	Total (1)+(2)+(3)								78.4	78.4	172.4	181.0	274.3	277.0	272.9	269.1	291.4	241.9	198.4	140.5	63.3			
17.	Average {(1)+(2)+(3)} × 1/3								26.1	26.1	57.5	60.3	91.4	92.3	91.0	89.7	97.1	80.6	66.1	46.8	21.1			846.1
18.	Land Preparation								38.8	38.8	38.8	38.8												155.2
19.	Field Water Requirement								64.9	64.9	96.3	99.1	91.4	92.3	91.0	89.7	97.1	80.6	66.1	46.8	21.1			1,001.3

S ; Sowing T ; Transplanting MSD ; Midsummer Drainage H ; Heading HV ; Harvesting

TABLE B. 2. 5 - 10 WATER REQUIREMENT OF LATE MATURED VARIETY (AMOL-3)

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.			Jul.			Aug.			Sep.			Total
			1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	10	10	10	10	11	10	10	11	10	10	10	
2.	Reference Crop Evapotranspiration ETo (mm/day)		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	5.5	5.5	5.3	5.3	5.3	4.7	4.7	4.7	3.5	3.5	3.5	
3.	Cropping Pattern						S	T														End of Irrigation		
										1.10					1.20			0.95						
4.	Crop Coefficient							1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	0.95	0.95	0.95	0.95				
	days							10	10	10	11	10	10	10	10	10	11	10	10	5				
5.	Crop Water Requirement							34.1	48.4	48.4	53.2	60.5	60.5	66.0	63.6	63.6	55.4	44.7	44.7	22.3				
6.	Percolation							30	30	30	33	30	30	30	30	30	33	30	30	15				
7.	Total (1)							64.1	78.4	78.4	86.2	90.5	90.5	96.0	93.6	93.6	88.4	74.7	74.7	37.3				
											1.10				1.20					0.95				
8.	Crop Coefficient								1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.2	1.2	0.95	0.95	0.95	0.95			
	days								10	10	11	10	10	10	10	10	11	10	10	11	8			
9.	Crop Water Requirement								48.4	48.4	53.2	60.5	60.5	60.5	63.6	63.6	70.0	44.7	44.7	49.1	26.6			
10.	Percolation								30	30	33	30	30	30	30	30	33	30	30	33	24			
11.	Total (2)								78.4	78.4	86.2	90.5	90.5	90.5	93.6	93.6	103.0	74.7	74.7	82.1	50.0			
												1.10					1.20			0.95				
12.	Crop Coefficient									1.1	1.1	1.1	1.1	1.1	1.1	1.20	1.20	1.20	0.95	0.95	0.95	0.95		
	days									10	11	10	10	10	10	10	11	10	10	11	10	10		
13.	Crop Water Requirement									48.4	53.2	60.5	60.5	60.5	58.3	63.6	70.0	56.4	44.7	49.1	33.3	33.3		
14.	Percolation									30	33	30	30	30	30	30	33	30	30	33	30	30		
15.	Total (3)							64.1	156.8	78.4	86.2	90.5	90.5	90.5	88.3	93.6	103.0	86.4	74.7	82.1	63.3	63.3		
16.	Average {(1) + (2) + (3)} × 1/3							21.4	52.3	78.4	86.2	90.5	90.5	92.3	91.8	93.6	98.1	78.6	74.7	67.2	37.8	21.1		1,074.5
17.	Land Preparation							77.5	77.5															155.0
18.	Field Water Requirement							98.9	129.8	78.4	86.2	90.5	90.5	92.3	91.8	93.6	98.1	78.6	74.7	67.2	37.8	21.1		1,229.5

S ; Sowing T ; Transplanting MSD ; Midsummer Drainage H ; Heading HV ; Harvesting

TABLE B. 2. 5 - 11 WATER REQUIREMENT OF NURSERY (TAROM)

	Component of Water Requirement	Unit	Mar.			Apr.			May			Jun.	Total
			1	2	3	1	2	3	1	2	3	1	(Unit m.m)
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	
2.	Reference Crop Evapotranspiration					3.1	3.1	3.1	4.4	4.4	4.4	5.5	
	ETo (mm/day)												
3.	Cropping Pattern							S		T			
	ETo (mm/day)					1.10							
4.	Crop Coefficient					1.1	1.1						
	days					10	10						
5.	Crop Water Requirement					34.1	34.1						
6.	Percolation					30	30						
7.	Total (1)					64.1	64.1						
								1.10					
8.	Crop Coefficient							1.1	1.1				
	days							10	10				
9.	Crop Water Requirement							34.1	48.4				
10.	Percolation							30	30				
11.	Total (2)							64.1	78.4				
										1.10			
12.	Crop Coefficient									1.1	1.1		
	days									10	11		
13.	Crop Water Requirement									48.4	53.2		
14.	Percolation									30	30		
15.	Total (3)									78.4	86.2		
16.	Total (1)+(2)+(3)					64.1	64.1	64.1	78.4	78.4	86.2		
17.	Average {(1)+(2)+(3)} × 1/3					21.4	21.4	21.4	26.1	26.1	28.7		145.1
18.	Land Preparation					7.5	30	37.5	37.5	30	7.5		150.0
19.	Field Water Requirement					28.9	51.4	58.9	63.6	56.1	36.2		295.1

TABLE B. 2. 5 - 12 WATER REQUIREMENT OF NURSERY (KHAZAR)

Component of Water Requirement		Unit	Mar.			Apr.			May			Jun.	Total
			1	2	3	1	2	3	1	2	3	1	(Unit m.m)
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	
2.	Reference Crop Evapotranspiration		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	
	ETo (mm/day)												
3.	Cropping Pattern								S		T		
							1.10						
4.	Crop Coefficient						1.1	1.1					
	days						10	10					
5.	Crop Water Requirement						34.1	34.1					
6.	Percolation						30	30					
7.	Total (1)						64.1	64.1					
									1.10				
8.	Crop Coefficient								1.1	1.1			
	days								10	10			
9.	Crop Water Requirement								48.4	48.4			
10.	Percolation								30	30			
11.	Total (2)								78.4	78.4			
											1.10		
12.	Crop Coefficient										1.1	1.1	
	days										11	10	
13.	Crop Water Requirement										53.2	60.5	
14.	Percolation										33	30	
15.	Total (3)										86.2	90.5	
16.	Total (1)+(2)+(3)						64.1	64.1	78.4	78.4	86.2	90.5	
17.	Average {(1)+(2)+(3)} × 1/3						21.4	21.4	26.1	26.1	28.7	30.2	153.9
18.	Land Preparation						7.5	30	37.5	37.5	30	7.5	150.0
19.	Field Water Requirement						28.9	51.4	62.6	63.6	58.7	37.7	303.9

TABLE B. 2. 5 - 13 WATER REQUIREMENT OF NURSERY (AMOL-3)

Component of Water Requirement		Unit	Mar.			Apr.			May			Jun.	Total
			1	2	3	1	2	3	1	2	3	1	(Unit m.m)
1.	Days / Decade or Month		10	10	11	10	10	10	10	10	11	10	
2.	Reference Crop Evapotranspiration		2.0	2.0	2.0	3.1	3.1	3.1	4.4	4.4	4.4	5.5	
	ETo (mm/day)												
3.	Cropping Pattern						S		T				
						1.10							
4.	Crop Coefficient					1.1	1.1						
	days					10	10						
5.	Crop Water Requirement					34.1	34.1						
6.	Percolation					30	30						
7.	Total (1)					64.1	64.1						
							1.10						
8.	Crop Coefficient						1.1	1.1					
	days						10	10					
9.	Crop Water Requirement						34.1	34.1					
10.	Percolation						30	30					
11.	Total (2)						64.1	64.1					
								1.10					
12.	Crop Coefficient							1.1	1.1				
	days							10	10				
13.	Crop Water Requirement							34.1	48.4				
14.	Percolation							30	30				
15.	Total (3)					64.1	128.7	128.2	78.4				
16.	Average { (1) + (2) + (3) } × 1/3					21.4	42.7	42.7	26.1				132.9
17.	Land Preparation					19	56	56	19				150.0
18.	Field Water Requirement					40.4	98.7	98.7	45.1				282.9

B. 2. 6 Operation and Maintenance

1. Proposed Organization

For the proper water management of the post Project, more appropriate organization on the operation and maintenance of the facilities shall be established based on the actual conditions and status of the project facilities and requirements. In accordance with the agreement made by the MOA, MOE and BPO on the rationalization of water management, water management administration was proposed as main body of the O & M activity under the MOE. The proposed organization chart illustrated in the Figure B.2.6 - 1.

2. Staffing Plan (Preliminary basis)

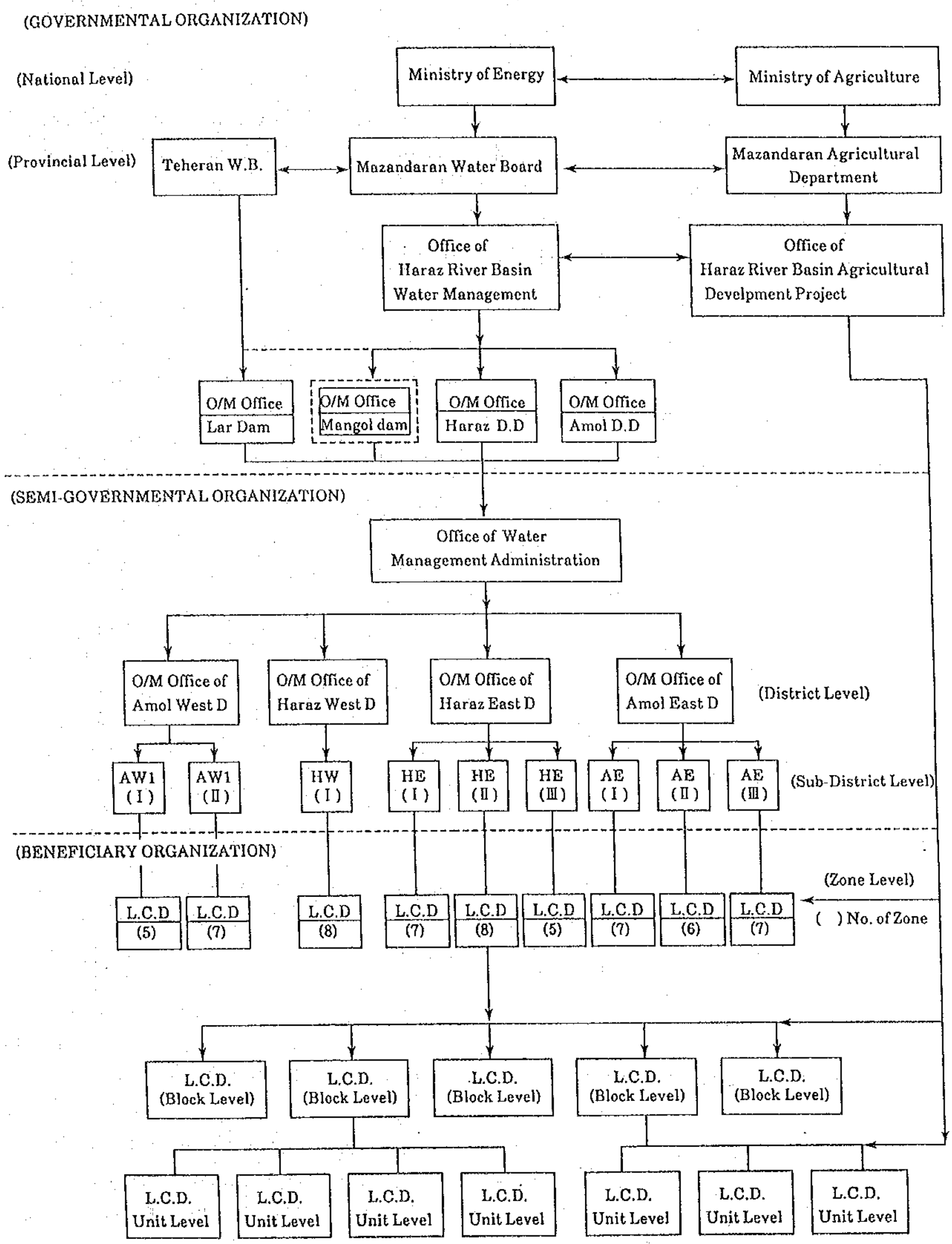
2. 1 Governmental Organization

Designation	Office of H.R.B. W.M	O/M Office Haraz D.D	O/M Office Amol D.D	Total
Manager	1	-	-	1
Deputy Manager	2	-	-	2
Branch Manager	-	1	1	2
Chief Engineer	2	2	2	6
Chief Administration	2	1	1	4
Engineer	5	2	2	9
Technician	4	2	2	8
Assistant Staff	10	2	2	14
Total	26	10	10	46

2. 2 Semi-Governmental Organization

Designation	Main Office	H. W. Office	H. E. Office	A. W. Office	A.E. Office	Total
Superintendent	1	-	-	-	-	1
Deputy S.I.	2	-	-	-	-	2
Chief Engineer	4	-	-	-	-	4
Division Director	10	-	-	-	-	10
Branch Manager	-	1	1	1	1	4
Deputy B.M.	-	1	3	2	3	9
Engineer	9	2	6	4	6	27
Clark	20	4	12	8	12	56
Agronomist	2	1	1	1	1	6
Chief Mirab	2	1	1	1	1	6
Zone Mirab	-	8	20	12	20	60
Canal Tender	-	35	110	86	100	331
Technician	-	8	24	16	24	72
Assistant Staff	20	4	12	8	12	56
Total	70	65	190	139	180	644

FIGURE. B.2.6 - 1. ORGAINZATION CHART OF OPERATION AND MAINTENANCE



L.C.D : Land Consolidation District

B. 2. 7 Relation Between Yield of Rice and Water Shortage

1. Target Yield of Rice for The Project

The relationship between improvement of irrigation/farming practice, introduction of farm mechanization and average yield of rice for the project are summarized as follows;

Target Yield of Rice

(Unit : kg/ha)

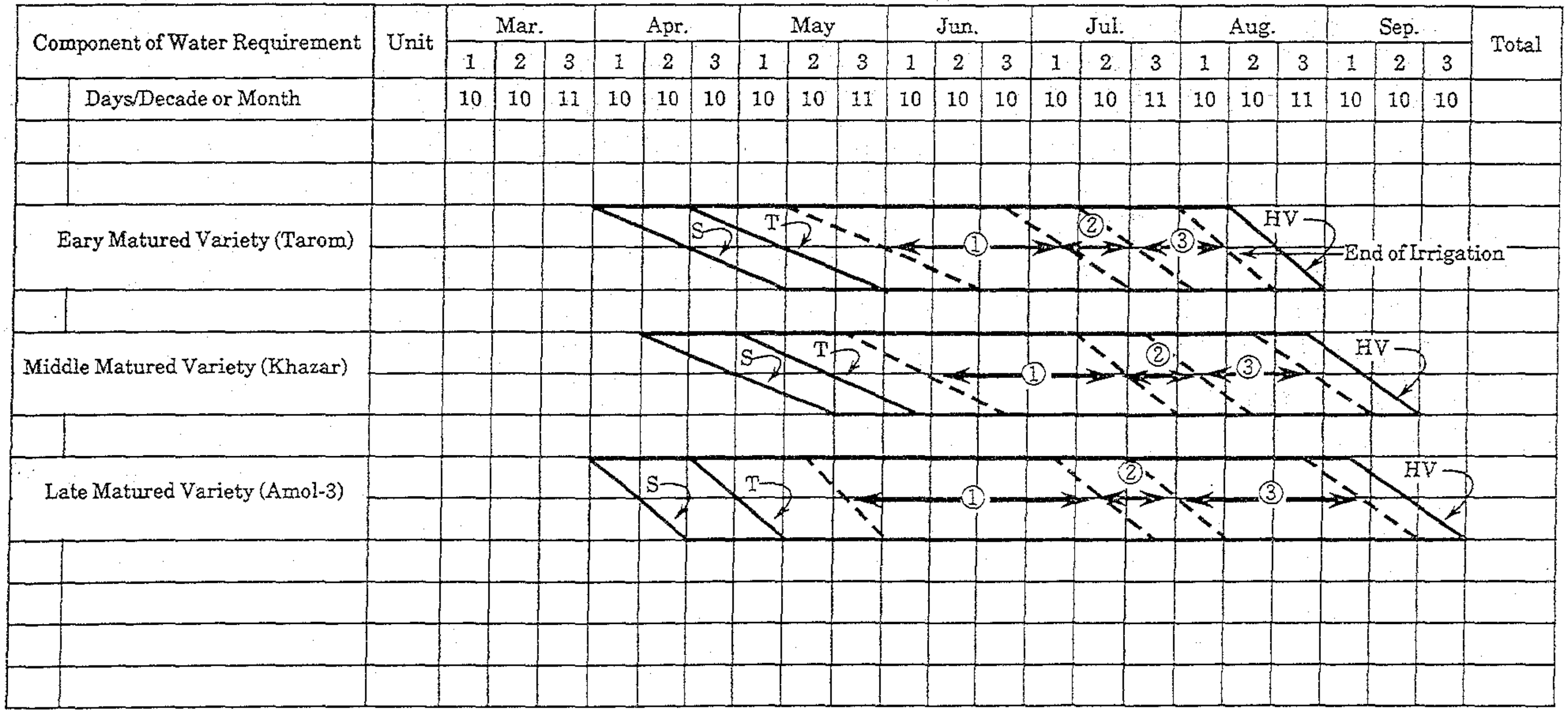
Item	Tarom		Khazar	Amol - 3
1. Prevailing averaged yield	4,135		5,741	7,375
2. First stage target (Without Mangol dam case)				
- Effects by mainly land consolidation with farm mechanization	(7.3%)	[1]	(11.1%)	(8.1%)
	4,437		6,378	7,972
3. Second stage target (With Mangol dam case)				
- Effects by mainly irrigation and mid-summer drainage improvement	(5.6%)	[1]	(5.6%)	(5.6%)
	4,668		6,700	8,385
4. Yield decrease by water shortage				
- 10% decrease for 2nd target	4,200		6,030	7,540
	(1.02)	[2]	(1.05)	(1.02)
- 15% decrease for 2nd target	3,970		5,700	7,130
	(0.97)	[2]	(0.99)	(0.97)
- 20% decrease for 2nd target	3,730		5,360	6,700
	(0.90)	[2]	(0.93)	(0.91)

Note : [1] The figures in parenthesis indicate incremental yield ratio to prevailing rice yield.
[2] The figures in parenthesis indicate decreased yield ratio to the second stage target yield.

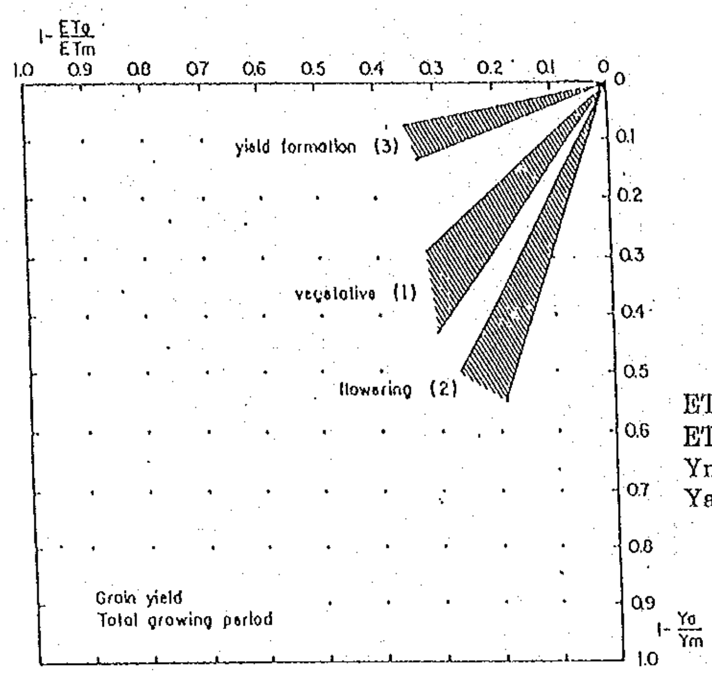
2. Relation Between Irrigation Water Shortage and Rice Yield

The growing periods of respective rice varieties in the project area are shown in the Figure B. 2. 7-1. The relationship between relative yield decrease (1 - Ya/Ym) and relative evapotranspiration deficit (1 - ETa/ ETm) for the total rice growing stage is illustrated in the Figure B. 2. 7-2 and standard rice growing periods are indicated in the Figure B. 2. 7-3, respectively.

FIGURE B. 2. 7-1 GROWTH PERIODS OF RICE



S; Sowing T; Transplanting HV; Harvesting ① Vegetative ② Flowering ③ Yield Formation



ETm ; Maximum Euapotranspiration
ETa ; Reference Euapotranspiration
Ym ; Maximum (Target) Yield
Ya ; Reference Yield

FIGURE B.2.7-2 Relationship Between Relative Yield (1 - Ya/Ym) and Relative Evapotranspiration (1 - ETa/ETm) for Rice

Pre-emergence Seedling	Yellows	Tillering · Head Development	Heading	Grain Filling + Ripening	
Establishment (0)		Vegetative (1)	Flowering (2)	Yield Formation (3)	Ripening (4)
Nursery	Transplanting · Field				
25-35 days	10 days	40-60+ days	10-15 days	25-35 days	10-20 days

FIGURE B.2.7-3 Growth Periods of Rice

Data source ; No.33 Yield response to water, 1979(C.E.F.S.)FAO Technical Papers

APPENDIX B.3 DRAINAGE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

B. 3. 1 Existing Drainage Network and Conditions

1. Surface Drainage Network and Conditions

(1) Topography of the Project Area

1) Altitude of the Project Area

Altitude of the Project Area ranges about 200 m from minimum EL.(-)24.5 m behind Feridon Kenar to maximum EL.188 m at the southern most of the Project Area, and half of the total area locates below EL.0.0 m. As seeing in Figure B.3. 1-1, the low-lying area, where altitude is below (-)24.0 m, is located mostly in the hinterland of Feridon Kenar, and at very limited area in the Alamdeh Rud Drainage Area. Altitude distribution of the low land area is as shown in the table below;

Ground Elevations in the Low Land Area

Elevation	Areas by Elevation: Amol West District (Min. Elevation(-) 24.2 m)	Areas by Elevation: Amol East District (Min. Elevation(-) 24.5 m)	Total (ha)	Proportion to the Whole Project Area of 108,009 ha (%)
less than(-) 24 m	4 ha	538 ha	542	0.5
〃 (-) 23 m	29	1,681	1,710	1.6
〃 (-) 22 m	667	4,337	5,044	4.7
〃 (-) 20 m	3,968	8,098	12,066	11.2
〃 (-) 18 m	6,469	10,528	16,997	15.7
〃 (-) 16 m	8,442	13,021	21,463	19.9

2) Slope of the Project Area

As seeing in the Table B.3.1-2, ground slope of the Project Area is mostly steeper than 1/500, however, Amol East District is rather flatter and its slope is mostly gentler than 1/500. In such flat and low land, drainage is so difficult that many problems are concentrated in this district.

(2) Existing Drainage Network

As explained in the Main Report, existing drainage network is classified into 16 networks, that 11 networks in the Haraz Left Bank Drainage District and 5 networks in the Haraz Right Bank Drainage District.

Drainage Area by Existing Drainage Network

Drainage Districts / Drainage Zone	Drainage Area (ha)	Ratio (%)
Haraz Left Bank Drainage District	42,880	39.7
1) Haraz Upper Drainage Zone	399	0.4
2) Alesh Drainage Zone	3,587	3.3
3) Changar Drainage Zone	6,634	6.1
4) Mahmudabad Drainage Zone	16,170	15.0
5) Siahrud Sar Drainage Zone	2,353	2.2
6) Tifangah Drainage Zone	6,119	5.6
7) Bisheh Kola Drainage Zone	291	0.3
8) Alamdeh Rud Drainage Zone	1,792	1.7
9) Shiah Kola Drainage Zone	761	0.7
10) Bir Rud Drainage Zone	3,793	3.5
11) Haraz Direct Drainage Zone	981	0.9
Haraz Right Bank Drainage District	65,129	60.3
1) Haraz Direct Drainage Zone	1,254	1.2
2) Shira Rud Drainage Zone	1,130	1.0
3) Feridon Kenar Drainage Zone	49,070	45.4
4) Babol Drainage Zone	8,195	7.6
5) Kari Right Bank Drainage Zone	5,480	5.1
Total	108,009	100

(3) Outlets to the Caspian Sea

As shown in the Figures B. 3. 1-5 "Profile of Lower Reach of the Mahmudabad Drain" and B. 3. 1-6 "Profile of Lower Reach of the Feridon Kenar Main Drain", the Feridon Kenar Main Drain and its tributaries are of very low elevation and flat slope in the hinter-land. On the other hand, the Mahmudabad drain flows into the Caspian Sea with rather steeper slope. Most outlets of the Haraz left bank area are likely same profile as the Mahmudabad drain.

Even in case the Caspian sea level reaches to the design surcharge level (-)24.65 m, the Mahmudabad drain has a enough water head to flush out the river mouth deposit. Therefore, those drains in the Haraz left bank area have not serious problems on river mouth deposit. On the other hand, the Feridon Kenar drains are already serious on river mouth deposit and drainage of the hinter-land.

2. Subsurface Drainage Conditions

(1) Fluctuation of Subsurface Groundwater

From the results of piezometer observation (MOA, 1985), it is found that the irrigation and the autumn and winter rainfall are clearly relating to the groundwater recharge. They raise groundwater sharply at the beginning of irrigation and rainfall. This phenomena is clearly illustrated in the Figure B. 3. 1-7.

(2) Hydraulic Conductivity and Depth to Impermeable Layer

Subsurface groundwater table, hydraulic conductivity and depth to impermeable layer were observed in the entire Project Area by HWDP-I Study. This F/S Study uses this result on subsurface drainage plan. The study of HWDP-I defines the problem area on subsurface drainage where groundwater rises 50 cm or more to the field surface. According to this definition, the Project Area is divided into two areas that the well-drained area and the poorly-drained area as shown in the Figure B. 3. 1-1. In the poorly-drained area, the area is divided into 38 blocks by the permeability and the depth to impermeable layer as shown in Figure B.3. 1-8 and Table B. 3. 1-3. Depend on the range of the depth to impermeable lay and the permeability, 38 blocks are classified into 16 zones as shown in Table B. 3. 1-4. Table B.3. 1-5 shows acreages of the district-wise subsurface drainage zones.

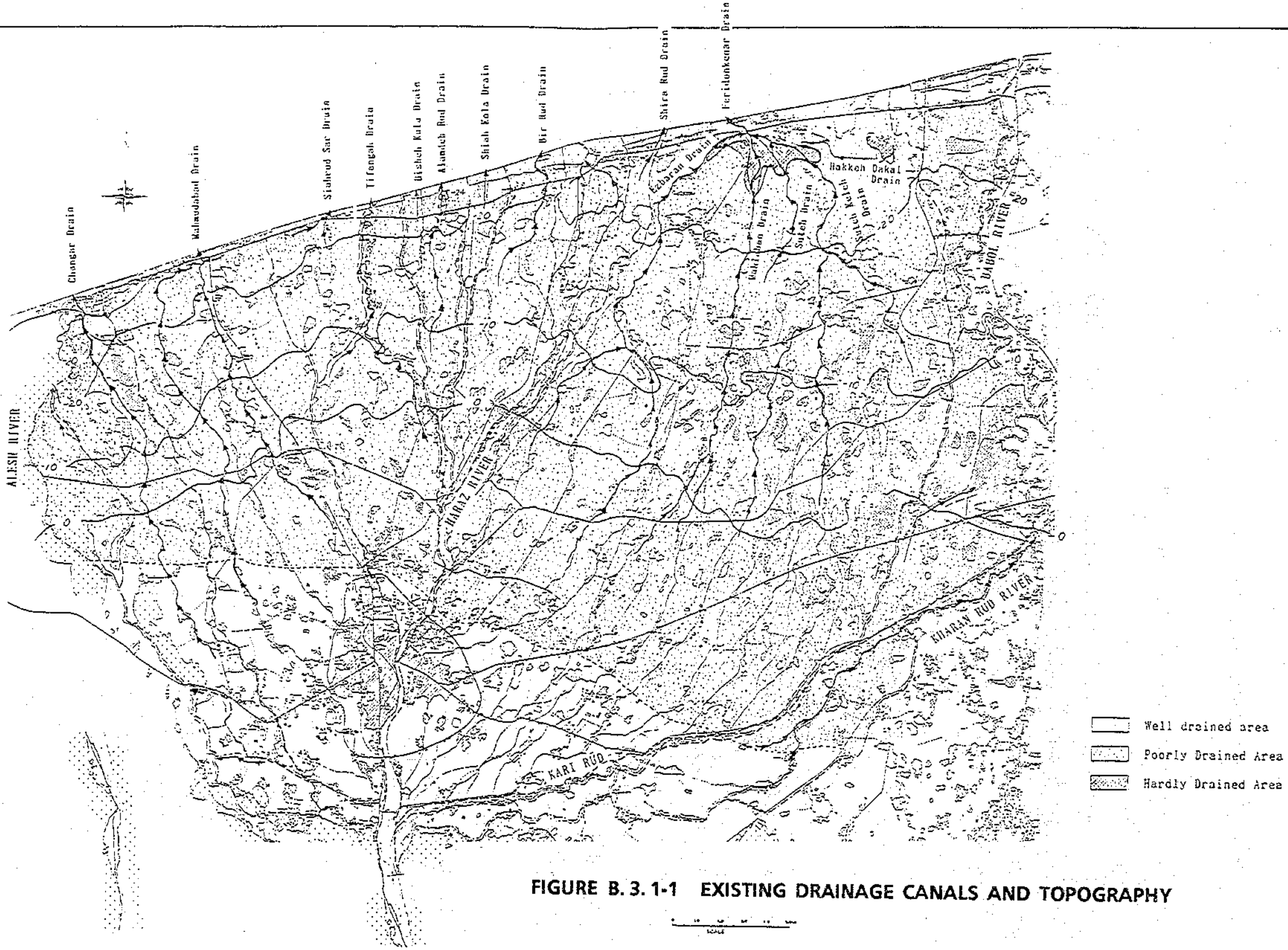


FIGURE B. 3. 1-1 EXISTING DRAINAGE CANALS AND TOPOGRAPHY

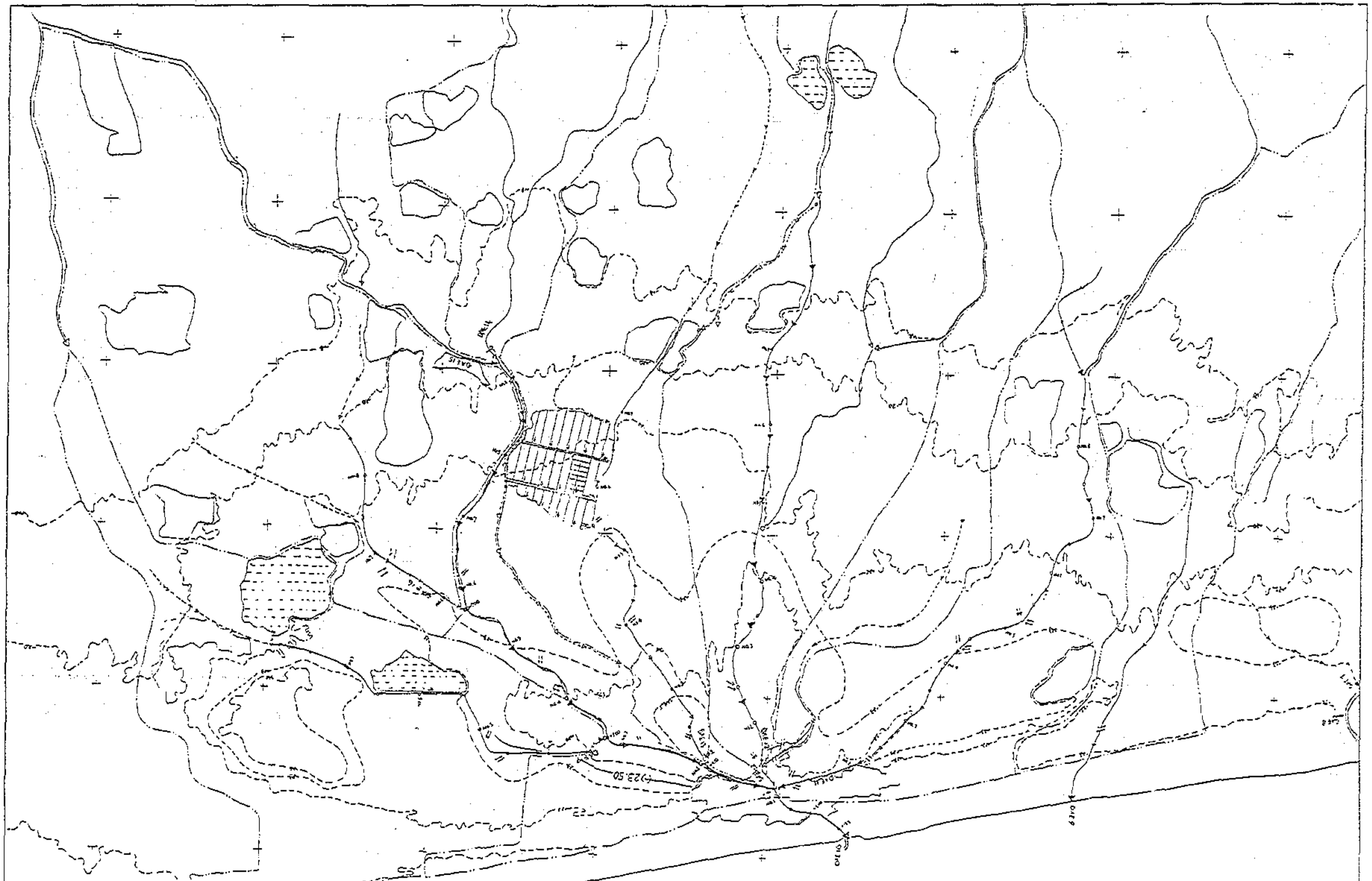
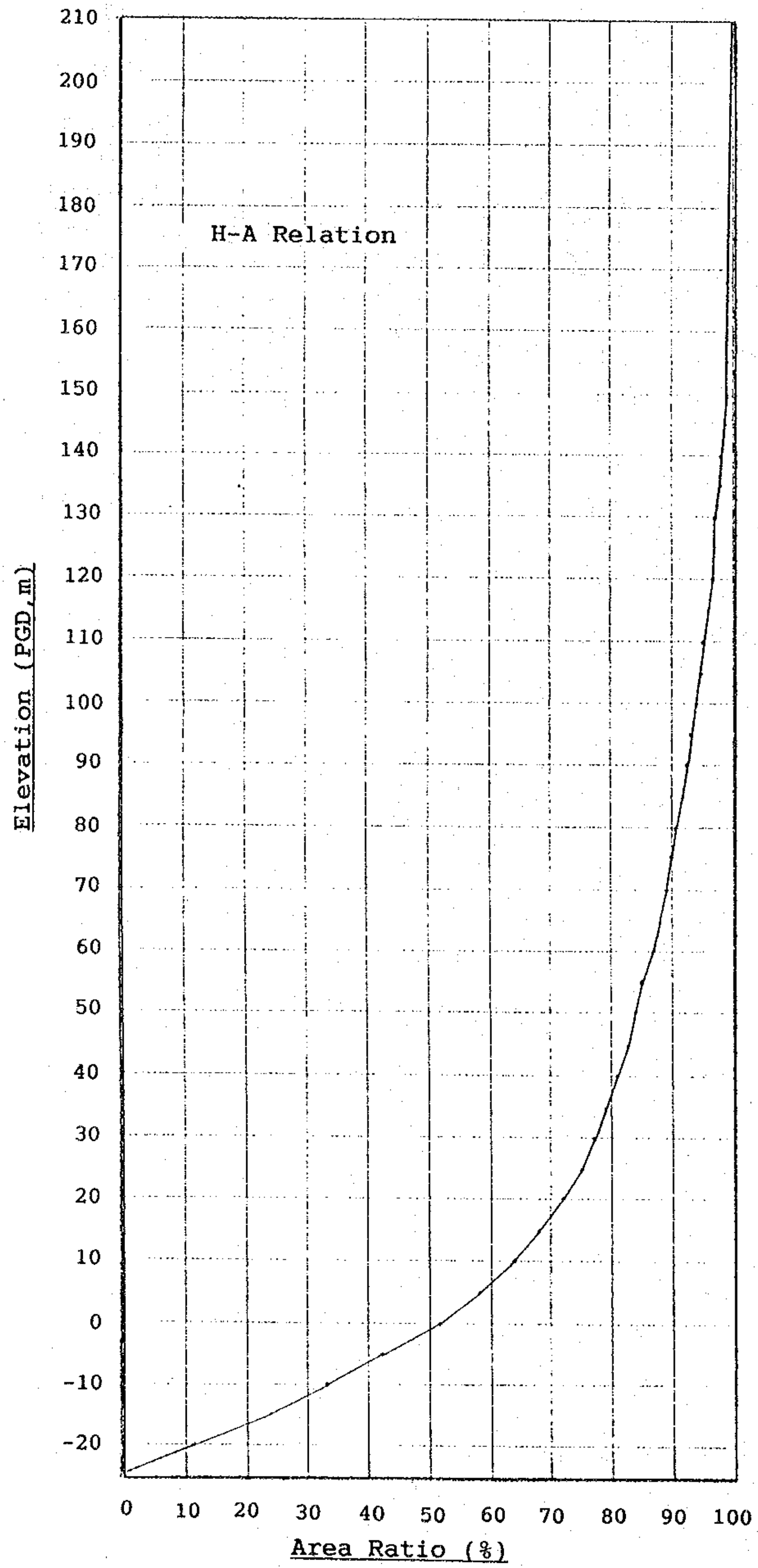
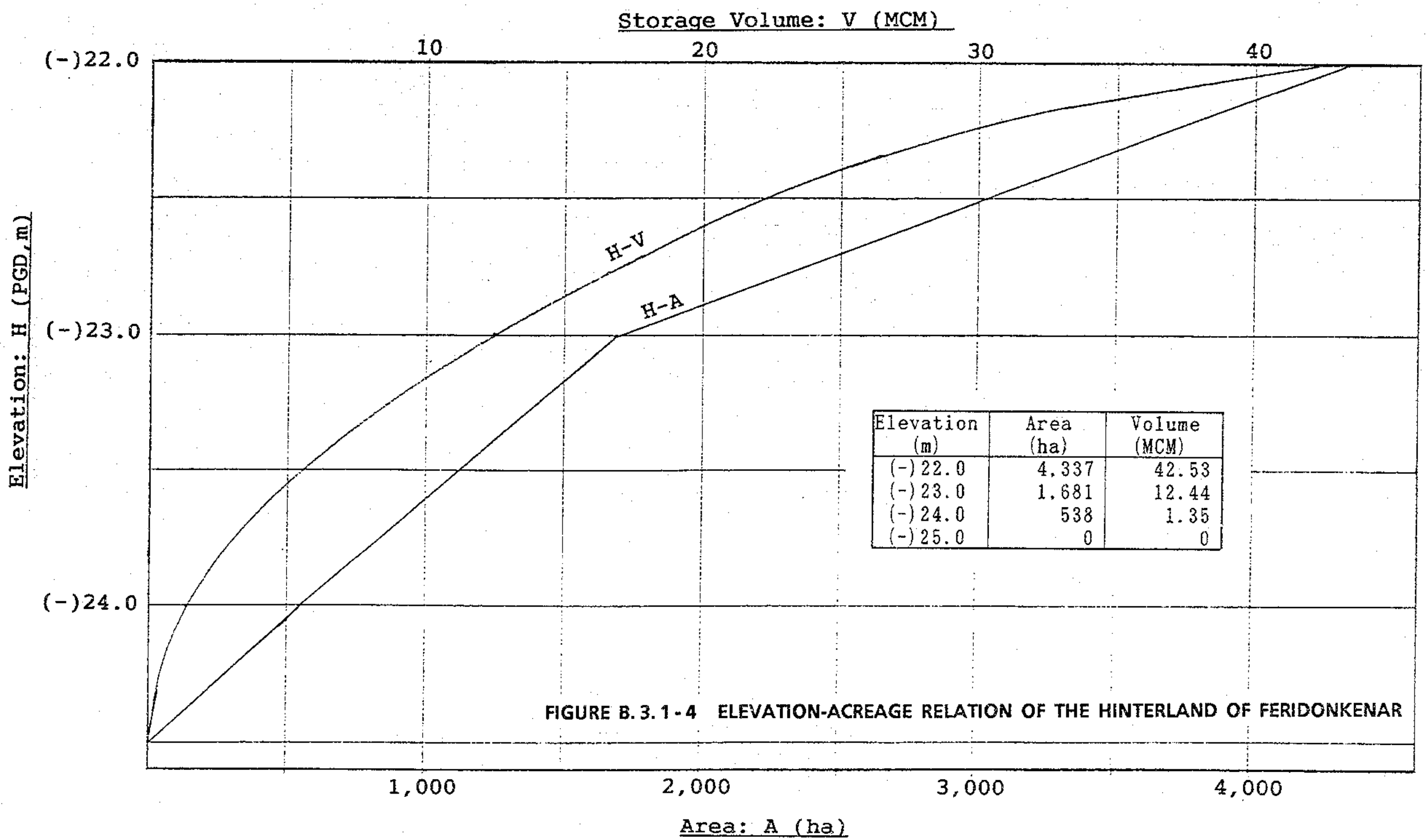


FIGURE B. 3. 1 - 2 TOPOGRAPHY OF HINTERLAND OF FERIDONKENAR

FIGURE B.3.1-3 ELEVATION-AREA RELATION OF THE PROJECT AREA





Elevation (m)	Area (ha)	Volume (MCM)
(-)22.0	4,337	42.53
(-)23.0	1,681	12.44
(-)24.0	538	1.35
(-)25.0	0	0

FIGURE B.3.1-4 ELEVATION-ACREAGE RELATION OF THE HINTERLAND OF FERIDONKENAR

FIGURE B.3.1-5 PROFILE OF LOWER REACH OF THE MAHMUDABAD DRAIN

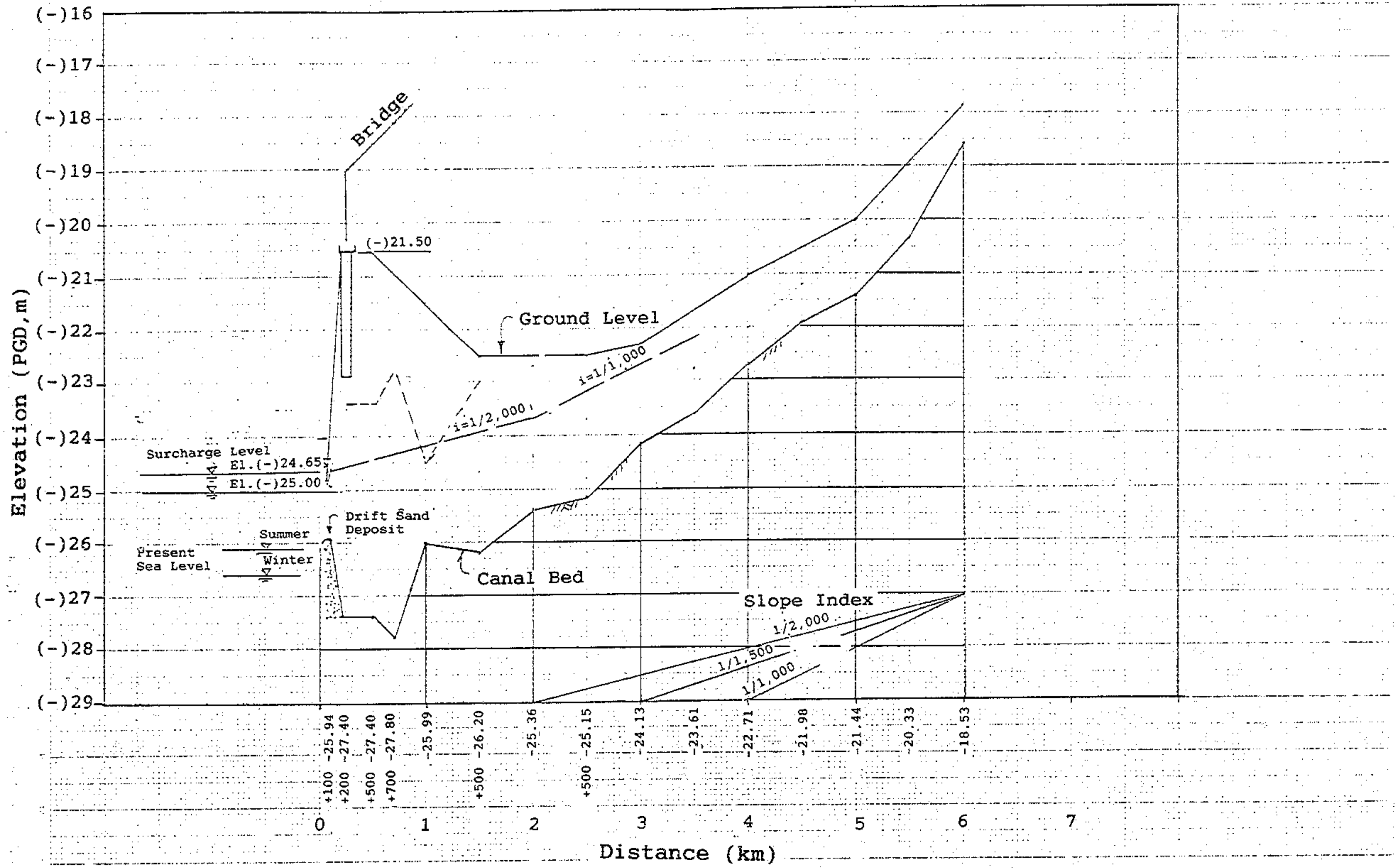


FIGURE B. 3. 1 - 6 PROFILE OF DRAINS IN THE HINTERLAND OF FERIDONKENAR

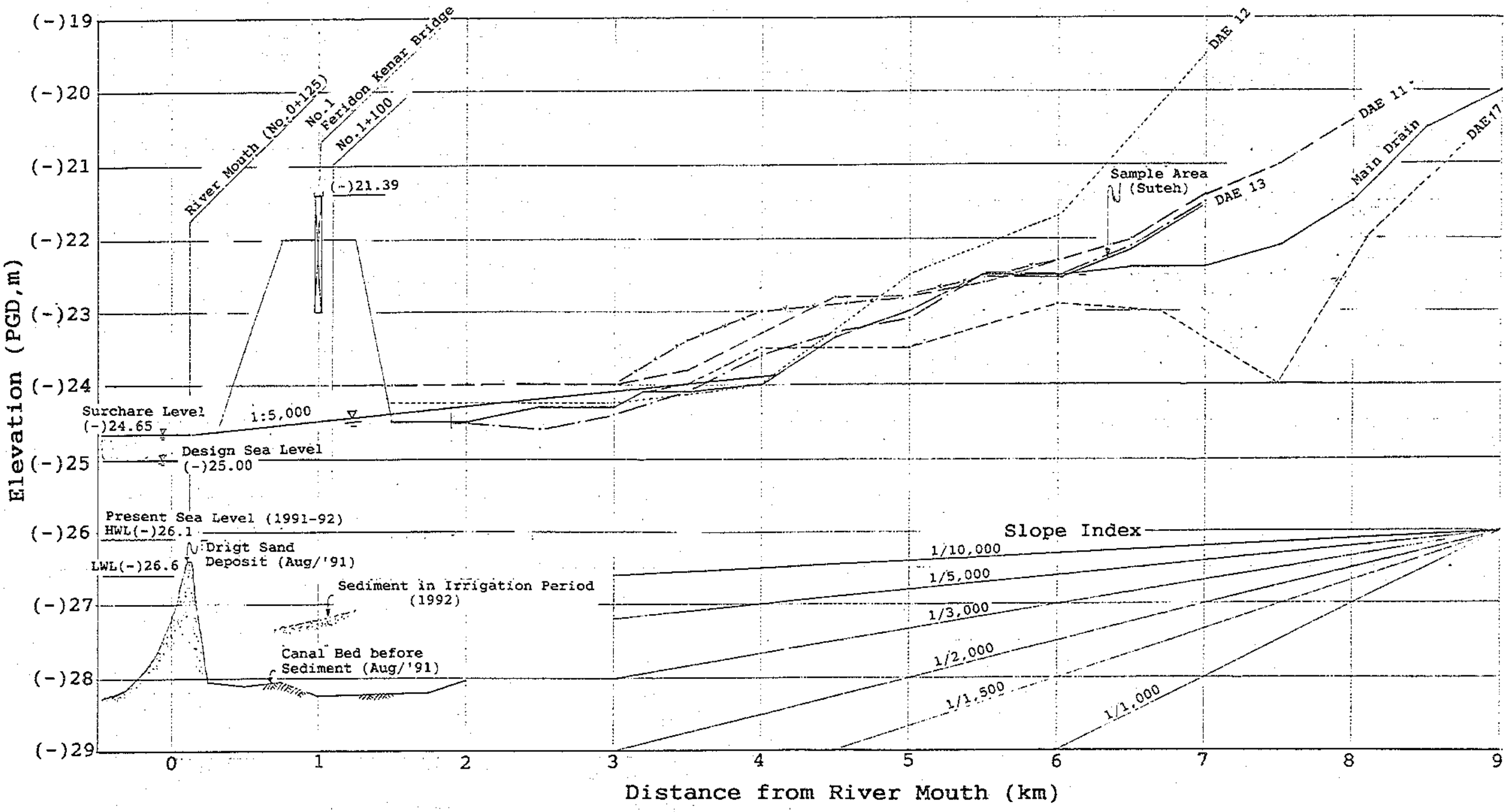
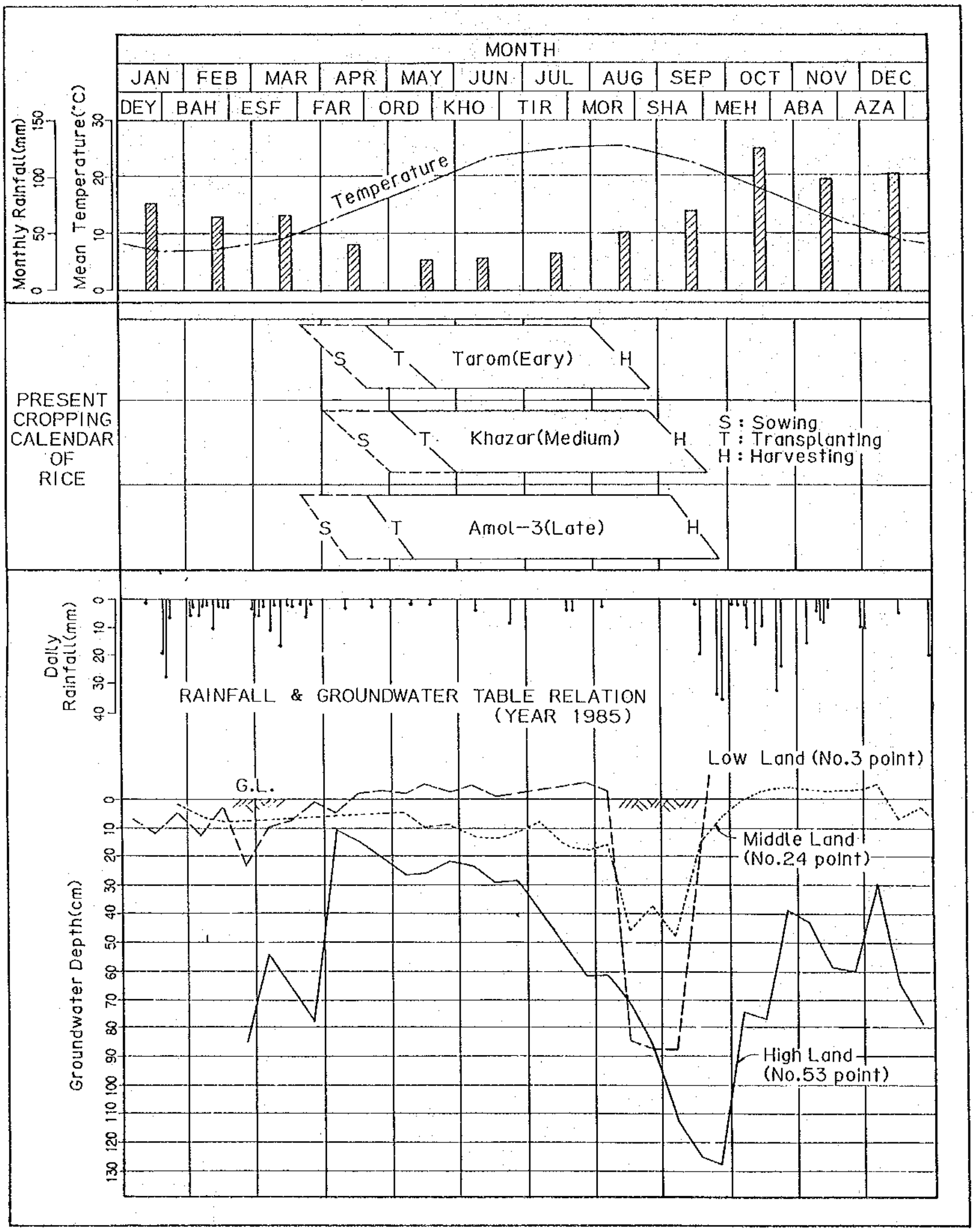


FIGURE B. 3. 1 - 7 AFFECTING FACTORS ON SUBSURFACE DRAINAGE



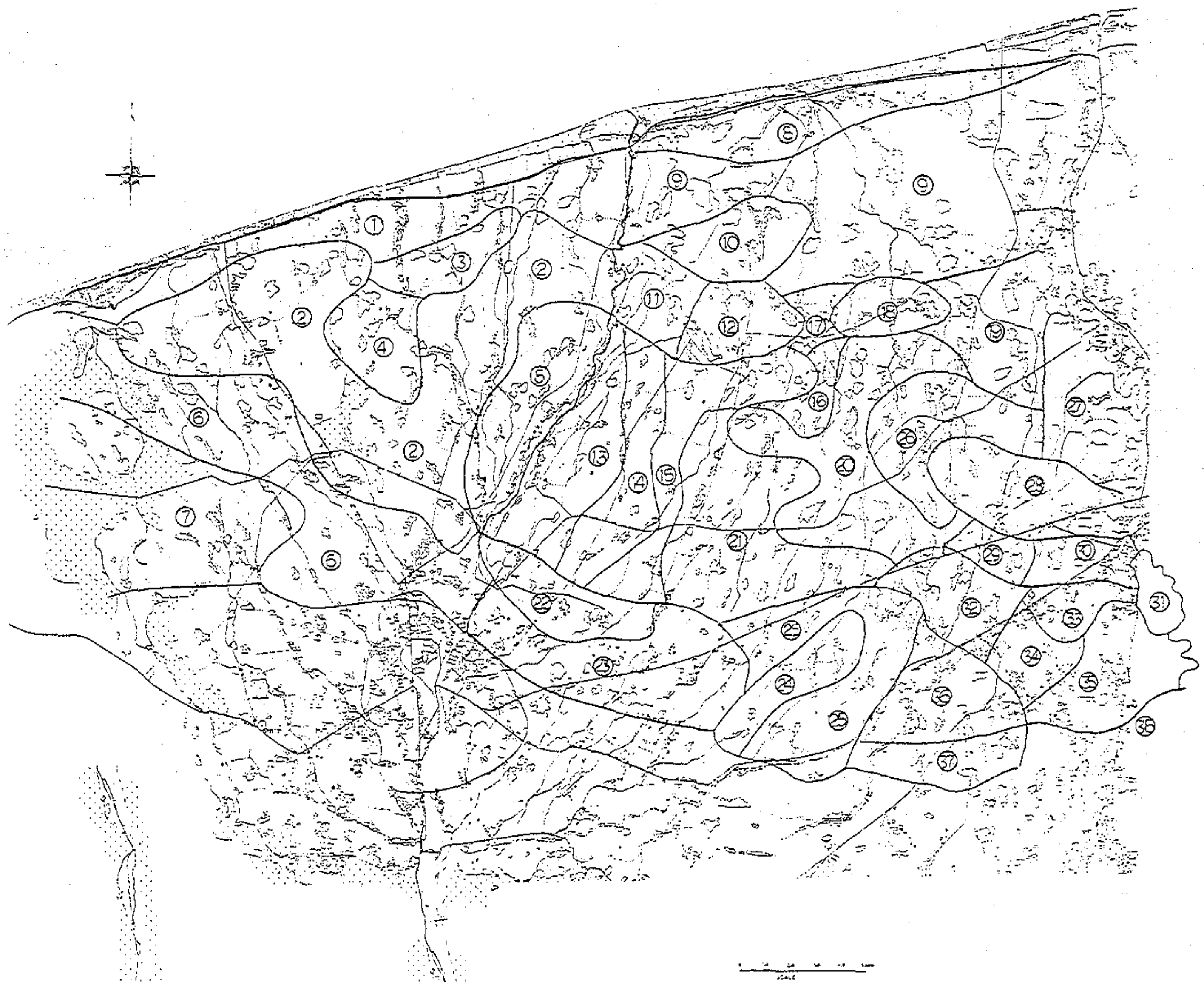


FIGURE B. 3. 1 - 8 CLASSIFICATION OF LAND BY HYDRAULIC CONDUCTIVITY AND DEPTH TO IMPERMEABLE LAYER

TABLE B.3.1-1 ELEVATION-AREA DISTRIBUTION OF THE PROJECT AREA

Division	Elevation (PGD,m)	Area (sq.Km)	Accumlted	Ratio (%)
1	-20	121	121	11.2
2	-15	137	258	24.0
3	-10	103	361	33.5
4	-5	100	461	42.8
5	0	99	560	52.0
6	5	71	631	58.6
7	10	60	691	64.2
8	15	43	734	68.2
9	20	43	777	72.1
10	25	33	810	75.2
11	30	24	834	77.4
12	35	21	855	79.4
13	40	17	872	81.0
14	45	17	889	82.5
15	50	17	906	84.1
16	55	12	918	85.2
17	60	18	936	86.9
18	65	10	946	87.8
19	70	13	959	89.0
20	75	9	968	89.9
21	80	10	978	90.8
22	85	8	986	91.6
23	90	9	995	92.4
24	95	10	1005	93.3
25	100	7	1012	94.0
26	105	6	1018	94.5
27	110	7	1025	95.2
28	115	10	1035	96.1
29	120	5	1040	96.6
30	125	4	1044	96.9
31	130	4	1048	97.3
32	135	6	1054	97.9
33	140	2	1056	98.1
34	145	6	1062	98.6
35	150	3	1065	98.9
36	155	0	1065	98.9
37	160	3	1068	99.2
38	165	3	1071	99.4
39	170	0	1071	99.4
40	175	2	1073	99.6
41	180	0	1073	99.6
42	185	1	1074	99.7
43	190	2	1076	99.9
44	195	0	1076	99.9
45	200	0	1076	99.9
46	205	0	1076	99.9
47	210	0	1076	99.9
48	215	0	1076	99.9
49	220	1	1077	100.0

(Note) Area of HWU (300 ha) is excluded in above table.

TABLE B. 3. 1 - 2 SLOPE DISTRIBUTION OF THE PROJECT AREA BY 1 KM GRID

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	
41																																															41
40																																										50	50				40
39																																						10	4	4	10	50					39
38																																	3	3	4	4	4	5	6	8	15	50					38
37																											4	5	4	3	4	4	3	3	4	5	4	5	6	9	15	15					37
36																							10	10	8	5	4	5	4	3	5	5	9	9	5	5	6	4	4	9	8	6					36
35																					4	4	5	8	4	3	4	5	9	9	6	5	9	15	7	7	8	4	4	7	8	5					35
34																	10	5	4	5	5	4	5	9	5	3	4	5	5	8	5	6	10	8	10	10	6	4	5	5	4	5					34
33														6	3	4	8	5	4	4	5	6	7	5	8	9	7	4	5	7	6	9	5	5	7	6	5	4	4	5	4	5					33
32										5	7	6	7	5	3	3	3	3	4	5	5	6	7	5	5	4	6	4	7	6	5	4	5	5	6	6	6	4	4	4	5	5					32
31								4	4	5	9	5	4	4	5	3	3	3	4	5	5	6	4	4	5	4	5	6	7	5	5	4	6	6	8	8	7	4	4	8	6						31
30					5	6	4	4	7	5	4	3	3	3	4	3	3	3	4	4	4	4	4	4	4	4	5	5	5	6	6	8	5	6	5	7	5	4	6	7	4						30
29			15	7	5	6	4	3	3	2	2	2	2	3	3	3	3	3	4	4	4	3	4	5	4	4	4	5	5	6	5	5	5	4	5	6	5	4	5	5	4		2				29
28			15	15	5	5	4	3	3	2	2	2	2	2	3	3	3	5	3	3	3	3	4	5	6	5	5	5	4	6	5	5	4	4	5	5	4	3	4	4	6	4	2				28
27			10	4	3	4	3	2	3	3	3	3	3	5	3	3	4	4	3	3	3	4	4	4	5	4	4	5	4	6	6	5	6	6	5	5	4	3	4	4	4	3	4				27
26			2	3	3	4	3	2	3	3	3	3	3	4	3	3	3	4	3	4	3	4	5	4	3	3	4	4	5	5	6	10	10	8	5	6	4	4	3	4	4	3	4	5			26
25		2	2	3	3	3	4	4	4	4	3	3	3	3	4	3	3	3	3	3	3	3	2	4	3	3	4	4	4	4	6	5	9	6	4	5	4	5	3	4	4	4	3	2	4		25
24		3	3	3	4	3	4	4	4	3	2	2	3	3	4	3	3	2	3	3	2	2	2	3	3	3	3	4	4	4	7	5	5	7	4	5	4	6	7	7	4	4	2	2			24
23		3	3	3	3	3	3	3	3	3	2	2	3	3	3	2	2	2	2	3	2	2	3	3	3	3	3	4	3	3	4	5	5	6	9	4	5	7	7	6	3	3	2	2			23
22		3	3	3	3	3	3	2	2	3	2	2	3	2	2	2	2	2	2	2	1	2	3	3	3	3	4	3	3	3	4	3	4	6	4	4	4	2	3	4	3	5	5	4			22
21		3	3	3	3	3	3	3	2	2	2	2	2	1	1	1	2	2	2	2	1	2	2	3	3	3	3	3	3	3	3	3	4	4	4	3	3	2	3	4	3	5	5	9			21
20		3	3	3	3	3	3	3	3	2	2	2	2	1	1	1	1	2	2	1	2	2	2	2	2	2	3	3	3	3	3	4	4	4	5	3	3	4	3	3	4	4	5	5			20
19		4	3	2	2	2	2	2	2	2	2	2	2	1	1	2	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	4	4	5	3	3	5	3	4	4	4	4	5			19
18				2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	4	4	5	5	5	5	6	4	7	5	4				18
17					2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	3	3	4	4	4	4	4	3	3	9	6	7					17
16						2	2	2	2	2	2	1	1	1	1	1	1	1	2	1	1	1	1	2	1	2	2	2	2	2	3	3	4	4	4	4	4	3	3	4							16
15						2	2	[illegible]	2	2	2	1	1	1	1	1	1	2	2	1	1	1	2	1	1	2	2	2	2	2	3	3	4	4	4	3	4	4	3								15
14							2	1	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2	1	2	1	2	2	2	2	3	3	2	3	3	3	3	5	5								14
13								1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	5	5	4	3	3								13
12									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	3	2	2	2	7	3	3	3									12
11									1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	3	3	3	3									11
10										1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	3										10
9										1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2											9
8										1	1	1	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	4													8
7												1	0	0	0	0	1	0	0	0	0	0	1	1	2			2	2	2	2																7
6																0	0	0	0	0	0																										6
5																		0																													5
4																																															4
3																																															3
2																																															2
1																																															1
0																																															0
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	

(Note) Classification of slope is as follows:

0	> 1/50
1	> 1/100
2	> 1/200
3	> 1/300
4	> 1/400
5	> 1/500
6	> 1/600
7	> 1/700
8	> 1/800
9	> 1/900
10	> 1/1000
15	> 1/1500
20	> 1/2000
50	> 1/5000

TABLE B.3.1-3 AREA BY SUB-SURFACE DRAINAGE BLOCKS

Zone	HW	HE	KR	AW	AE	AU	BU	Total
0	8,745	6,388	3,413	0	0	3,849	0	22,395
1	0	0	0	3,683	0	0	0	3,683
2	521	0	0	9,124	0	0	0	9,645
3	0	0	0	1,042	0	0	0	1,042
4	0	0	0	1,275	0	0	0	1,275
5	0	0	0	2,341	0	0	0	2,341
6	2,377	0	0	3,729	0	0	0	6,106
7	3,383	0	0	1,981	0	0	0	5,364
8	0	0	0	0	2,467	0	0	2,467
9	0	0	0	0	8,944	0	0	8,944
10	0	0	0	0	1,362	0	0	1,362
11	0	0	0	0	954	0	0	954
12	0	0	0	0	1,136	0	0	1,136
13	0	15	0	0	2,153	0	0	2,168
14	0	106	0	0	2,015	0	0	2,121
15	0	257	0	0	1,958	0	0	2,215
16	0	0	0	0	549	0	0	549
17	0	0	0	0	433	0	0	433
18	0	0	0	0	703	0	0	703
19	0	162	0	0	2,140	0	0	2,302
20	0	1,016	0	0	2,438	0	0	3,454
21	0	2,748	0	0	1,771	0	0	4,519
22	0	1,264	0	0	271	0	0	1,535
23	0	2,645	0	0	21	0	0	2,666
24	0	1,385	0	0	0	0	0	1,385
25	0	2,803	122	0	0	0	0	2,925
26	0	1,144	0	0	1,243	0	0	2,387
27	0	462	0	0	100	0	863	1,425
28	0	1,305	0	0	0	0	624	1,929
29	0	652	0	0	0	0	0	652
30	0	660	0	0	0	0	28	688
31	0	0	0	0	0	0	0	0
32	0	1,158	72	0	0	0	0	1,230
33	0	261	0	0	0	0	0	261
34	0	76	94	0	0	0	0	170
35	0	0	0	0	0	0	0	0
36	0	264	1,113	0	0	0	0	1,377
37	0	0	665	0	0	0	0	665
38	0	0	0	0	0	0	0	0
Coastal	0	0	0	1,655	1,877	0	0	3,532
Total	15,026	24,771	5,479	24,830	32,535	3,849	1,515	108,005

TABLE B.3.1-4 ZONING BY PERMEABILITY AND MEAN DEPTH OF IMPERVIOUS LAYER

Zone No.	Subsurface Block	Mean Depth Impervious (m)	Permeability (m/day)	Classfi cation	Area (ha)
1	1 4 12	4	>4.65	V.R	6,096
2	2 7 11 21 29	4	3.05 -4.65	R	21,134
3	3 5 13 15 32	4	1.52 -3.05	S.R	8,996
4	6 22 35	4	0.49 -1.52	M	7,641
5	8	> 6	1.52 -3.05	S.R	2,467
6	9 14 17 36	2	1.52 -3.05	S.R	12,875
7	10 19 30	2	3.05 -4.65	R	4,352
8	16 26 37	0.8	1.52 -3.05	S.R	3,601
9	18 25 28	1.5 - 2	>4.65	V.R	5,557
10	20 24	0.8 - 1	3.05 -4.65	R	4,839
11	23	2.3	0.49 -1.52	M	2,666
12	33	1.7 - 2	0.49 >	S	261
13	27	5.6	0.49 -1.52	M	1,425
14	31	0.2	3.05 -4.65	R	0
15	34	4	0.49 >	S	170
16	38	1.5	0.49 -1.52	M	0
Total					82,080

(Data Source) HWDP-1 Study (B3 Deep Drainage)
(Note) Acreage is measured on 1:50,000 map.

TABLE B. 3. 1 - 5 DISTRIC-WISE SUBSURFACE DRAINAGE ZONE

Drain Zone	HW	HE	KR	AW	AE	AU	BU	Total
0	8,745	6,389	3,414			3,849		22,397
1				4,958	1,138			6,096
2	3,904	3,400		11,105	2,725			21,134
3		1,430	72	3,383	4,111			8,996
4	2,377	1,264		3,729	271			7,641
5					2,467			2,467
6		370	1,113		11,392			12,875
7		822			3,502		28	4,352
8		1,144	665		1,792			3,601
9		4,108	122		703		624	5,557
10		2,401			2,438			4,839
11		2,645			21			2,666
12		261						261
13		462			100		863	1,425
14								0
15		76	94					170
16								0
17				1,655	1,877			3,532
Total	15,026	24,772	5,480	24,830	32,537	3,849	1,515	108,009

B. 3. 2 Drainage Monitoring

1. Monitoring Sites and Period

Drainage discharge and water level were monitored from June 1991 to September 1992 at 18 sites, of which 16 sites are at the outlet of drains to the Caspian Sea and 2 sites are at the inner irrigation canals. Location of monitoring sites is shown in Figure B. 3. 2-1, and detailed in the table below;

DRAINAGE MONITORING SITES

Site No.	Drain or Canal Name	Village	Water Level	Discharge Measuring
0-3	Changar Drain	Keshteh Sar	○	×
0-3 (1)	〃	Ahlam	×	4 times
0-4	Mahmudabad Drain	Mahmudabad	○	5 times
0-5	Feridon Kenar Drain	Feridon Kenar	○	4 times
0-5 (1)	Ezbaran Drain	〃	○	4 times
0-5 (2)	Tail of Irrigation	〃	○	4 times
0-5 (3)	Mahlaban Drain	〃	○	4 times
0-5 (4)	Sutehkeleh Drain	〃	○	4 times
0-5 (5)	Hakkeh Dakel Drain	〃	○	4 times
0-6 (1)	Siah Rud Drain	Siah Rud	○	4 times
0-6 (2)	〃	〃	○	4 times
0-7	Tifangah Drain	Darya Sar	○	4 times
0-8	Bisheh Kola Drain	Bisheh Kola	○	4 times
0-9	Alamdeh Rud Drain	Alamdeh	○	4 times
0-10	Bir Rud Drain	Haji Kola	○	4 times
0-11	Shiera Rud Drain	Varza Mahalleh	○	4 times
I-1	Piteh Rud	CAPIC site	○	3 times
I-2	Said Rud	Ali Abad	○	3 times

Note: × : not observed due to destruction of stuff gage for water level or too large section for discharge measurement.

2. Water Level of the Drains

Water level was monitored over one year from June 1991. The Figure B. 3. 2-2 shows the water level in the Feridon Kenar Drain. The water level of drain fluctuates corresponding to the Caspian sea level fluctuation not only at the outlet (0 - 5) but at the hinterland (0-5(1) to 0-5(5)) far from the outlet around 1.0 km to 2.0 km. The sea level is high in summer and low in winter generally because of the balance of inflow and evaporation. The range of its fluctuation is around 30 cm.

Discharge measurement was conducted during said monitoring period however rating curve of discharge was not able to obtain due to fluctuation of sea level. Observed maximum discharge of the Feridon Kenar Drain (0-5) was 27 cms in April 1992.

3. River Mouth Closing

All of outlets of the drains are closed by drift sand deposit at their mouth. The deposit level is still lower at most outlets except the Feridon Kenar drain because the hinter-land of the Feridon Kenar Drain is exceptionally low. Even if the sea level rises to the design level (-)25.00 m, drift sand deposit will not affect the land in its drainage except the Feridon Kenar as mentioned in B. 3. 1.

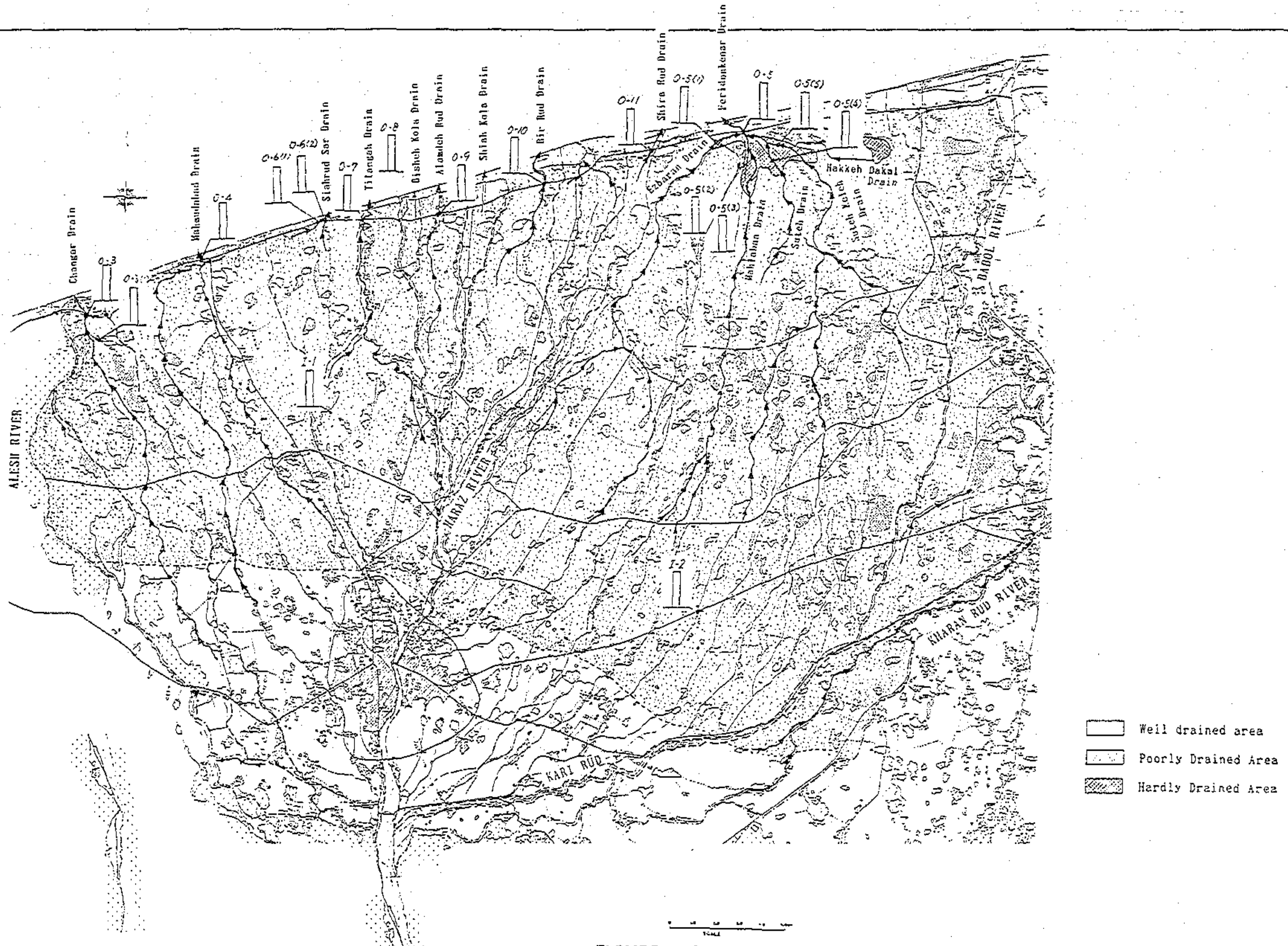


FIGURE B.3.2-1 LOCATION MAP OF DRAINAGE MONITORING SITES

FIGURE B.3.2-2 FLUCTUATION OF WATER LEVELS OF DRAINAGE CANALS IN THE FERIDONKENAR DRAIN SYSTEM

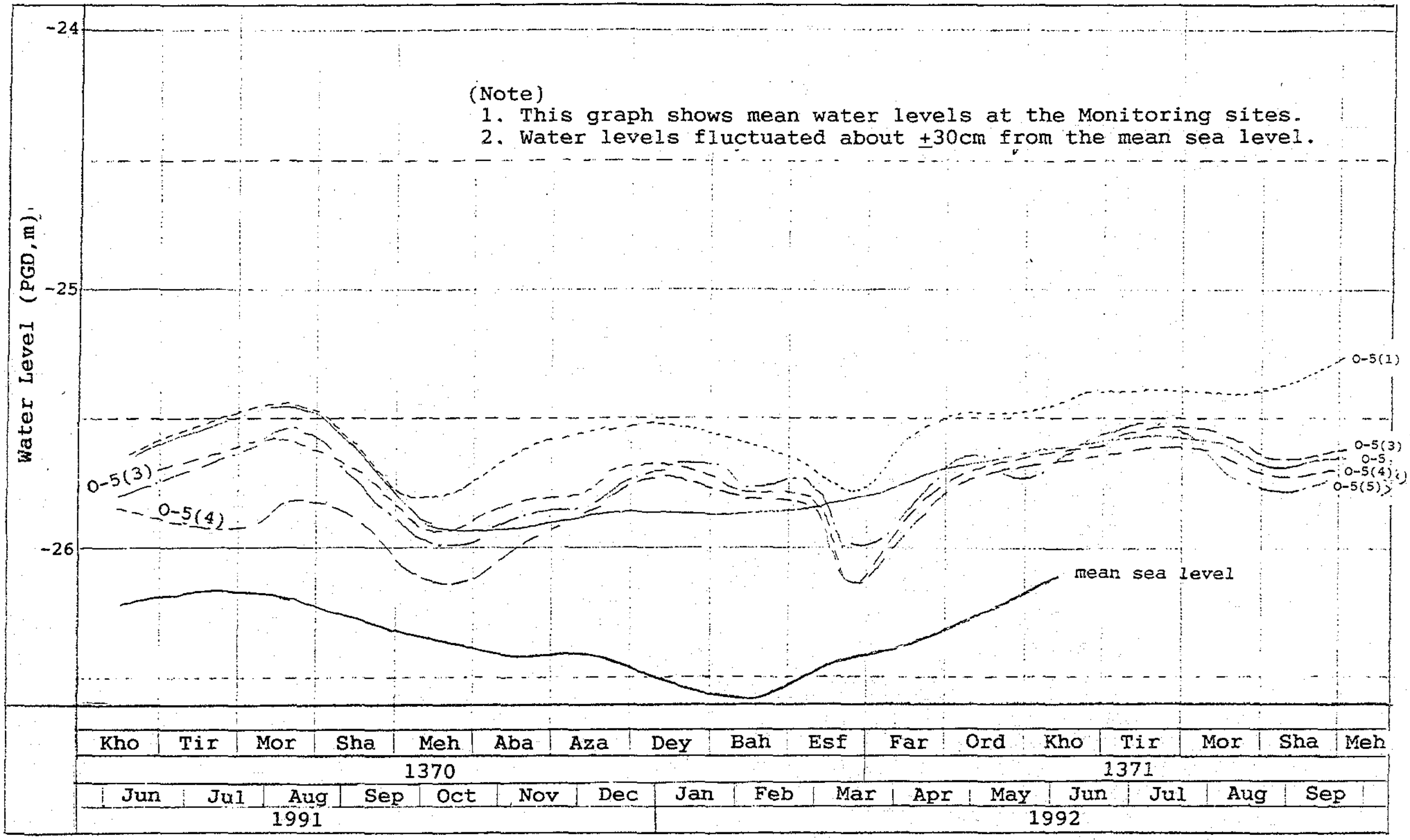


FIGURE B. 3.2-3 CROSS-SECTION OF DRAINS AT MONITORING SITE (1/2)

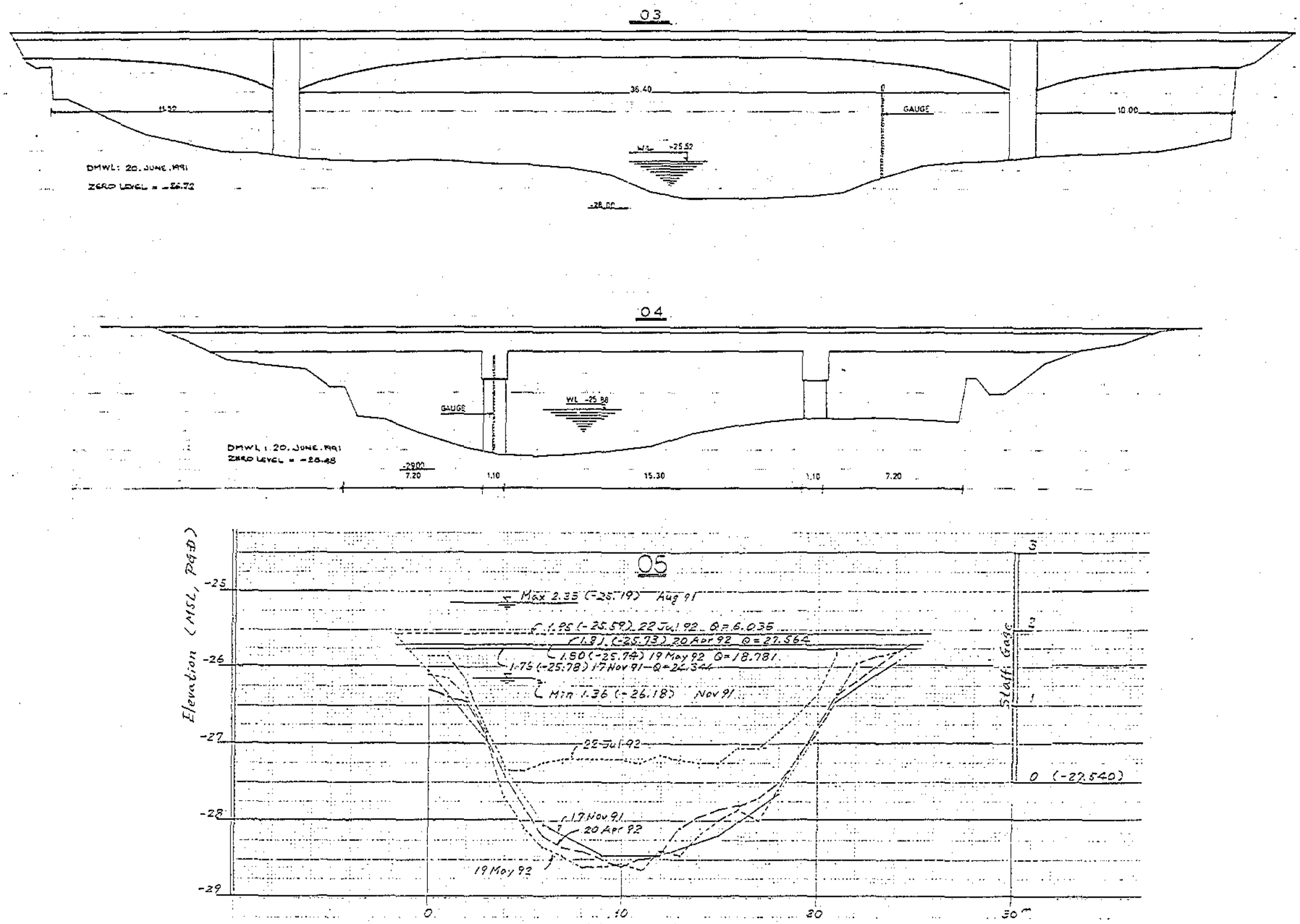
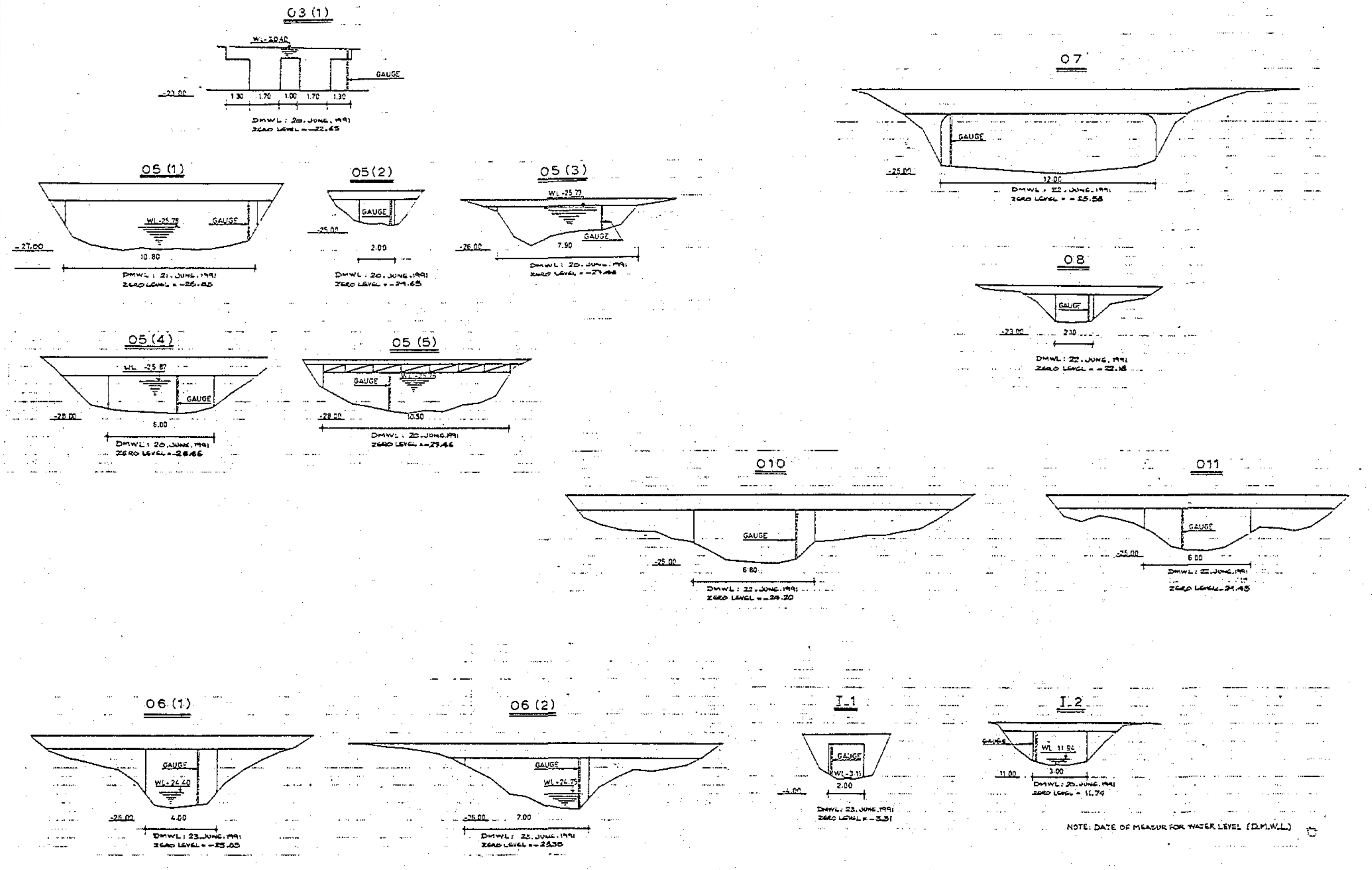


FIGURE B. 3. 2 - 3 CROSS-SECTION OF DRAINS AT MONITORING SITE (2/2)



B. 3. 3 TIB Survey on Drainage

1. Introduction

TIB (Terminal Irrigation Block) survey was conducted on drainage as well as on irrigation using the questionnaires to the village mirabs and the zone mirabs (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%

Arrangement of Village Mirab

District	Village 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%

2. Difficulties on Drainage

Table B. 3. 3-1 and Table B. 3. 3-2 show the difficulties on drainage by zone mirabs and village mirabs respectively. According to the said tables, difficulties on drainage are summarized as follows;

(1) Percentage of Difficulties

Difficulties on drainage are reported by 19% of zone mirabs and 21% of village mirabs. The ratio of difficulties on drainage is considerably lower than the ratio of difficulties on irrigation. The ratio of difficulties on irrigation is reported at 73% by zone mirabs and 99% by village mirabs (analyzed in Appendix B. 2. 1 TIB Survey on Irrigation). It may be considered that the mirabs are not interesting in drainage comparing irrigation, because they are interesting mainly in drainage of irrigated paddy field in connection with irrigation during irrigation period.

Reported Difficulty on Drainage

	Zone Mirab						
	Alesh Rud	Haraz Left	Haraz Right	Kari Left	Kari Right	Garma Kharan	Number (%)
Mirabs	7	22	15	52	14	6	116
Difficult	0	6	2	14	0	0	22
Percent (%)	0	27	13	27	0	0	19%

Village Mirab

	Zone Mirab				
	Haraz West	Amol West	Haraz East	Amol East	Number (%)
Village Mirab	17	14	21	15	67
Difficult	1	3	4	6	14
Percent (%)	5.9	21.4	19.0	40.0	20.9%

From above tables, it is understood that the difficulties are concentrated to the Amol East district particularly.

(2) Difficult Season on Drainage

Difficult season on drainage is understood differently by zone mirab and village mirab. The zone mirab answered that the difficulties are mainly in irrigation period particularly at the first half season of irrigation period (April - June), and contrary the village mirab answered that the difficulties are concentrated in the winter season.

Difficult Season on Drainage

	Apr. - Jun. (Far - Kho)	Jul. - Sep. (Tir - Sha)	Oct. - Dec. (Meh - Aza)	Jan. - Mar. (Dey - Esf)
Zone Mirab	53%	16%	20%	11%
Village Mirab	(36%)		(64%)	

(3) Difficulties on Drainage

Relating to the above understanding, answer of zone mirabs is concentrated into the difficulties in the irrigation period.

Difficulties on Drainage

Difficulties	Zone Mirab Answer (%)	Village Mirab Answer (%)
1) Transplanting of Rice	16 (26)	4 (6)
2) Rice Growing	11 (18)	5 (8)
3) Rice Farming	6 (10)	6 (9)
4) Harvesting of Rice	6 (10)	7 (10)
5) Problems on Second Crops	0 (0)	2 (3)
6) Traffic in Summer	1 (2)	3 (5)
7) Traffic in Autumn	5 (8)	7 (10)
8) Traffic in Winter	5 (8)	8 (12)
9) Traffic in Spring	3 (5)	4 (6)
10) Inundation of Houses	6 (10)	7 (10)
11) Erosion of Canal	3 (5)	8 (12)
12) Erosion of Road	0 (0)	6 (9)
Total	62 (100)	67 (100)

From above results, followings are introduced;

1) Zone mirabs are interesting in drainage of irrigated paddy field.
2) Water depth control is difficult particularly in transplanting.
3) Interest of second crops is low both for zone and village mirabs.

4) Traffic difficulty is more sever for village mirabs than for zone mirabs.

(4) Reasons of Drainage Difficulties

Answer of reasons of drainage difficulties is similar both by the zone mirab and the village mirab. Most difficulties are caused by the drainage canal concern (reason 1 to 4), and total percent of four reasons shares 70% or more among reasons of difficulty.

Reasons of Difficulties on Drainage

	Reasons	Zone Mirab Answer (%)	Village Mirab Answer (%)
1)	No Particular Drainage Canal	13 (18)	11 (18)
2)	Less Drainage Canal Capacity	16 (22)	13 (22)
3)	Excess Water from Upstream	14 (19)	11 (18)
4)	Over-Flood from River/Canal	13 (18)	7 (12)
5)	Obstruction by Road	1 (1)	2 (3)
6)	Heavy Texture of Soil	2 (3)	5 (8)
7)	Heavy Rainfall	10 (14)	11 (18)
8)	Other Reasons	3 (4)	0 (0)
	Total	72 (100)	60 (100)

(5) Counter-measures Taken for Drainage Difficulties

It is remarkable for zone mirabs not to provide in many cases particular counter-measures to prevent drainage difficulties. On the other hand, village mirabs answered to provide counter-measures in any case. It seems that the scale of drainage difficulties is more extensive for zone mirabs than for village mirabs. The most counter-measures taken for prevention of drainage difficulties are conducted by farmers themselves, but the scale of counter-measures is limited in voluntary works.

Counter-measures for the Difficulties on Drainage

	Counter-Measures	Zone Mirab Answer (%)	Village Mirab Answer (%)
1)	None Counter-Measures	5 (31)	0 (0)
2)	Provision of Drainage Canal	0 (0)	2 (5)
3)	Improvement of Drainage Canal	4 (25)	12 (30)
4)	Provision of River Training	3 (19)	8 (20)
5)	Provision of Bank Protection	4 (25)	14 (35)
6)	Soil Improvement	0 (0)	4 (10)
7)	Other Counter-Measures	0 (0)	0 (0)
	Total	16 (100)	40 (100)

TABLE B. 3. 3-1 DIFFICULTIES ON DRAINAGE BY ZONE MIRABS (1/2)

River System	Responsible Canal Zone	Code	Name	Dra Pro	Months in Drainage Problem													Villages in Drainage Problem					Item on Drainage Problem												Reasons of Drainage Problem									Counter-measures taken for Drainage Problem							
					N	1	2	3	4	5	6	7	8	9	10	11	12	N	1	2	3	4	N	1	2	3	4	5	6	7	8	9	10	11	N	1	2	3	4	5	6	7	8	N	1	2	3	4	5	6	7
	1	1010	Kasemdeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	1020	Khoshkeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	1030	Galan Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Alesh Rud	4	1040	Kukdeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	1050	Vagozari-e-Zamin Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	1060	Shir Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	1070	Kalajpareh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	2010	Piteh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	3010	Razekeh Rud (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	3020	Razekeh Rud (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	3030	Mohammadabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	3040	Valekan Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	3050	Shaleh Pat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	14	3060	Taj Rud	1	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	1	3	1	1	1	0	0	0	0	0	2	1	0	0	0	1	0	0
	15	3070	Darmeh Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	3080	Lakoni Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	3081	Lakoni Rud (Down Stream)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haraz Left	18	3090	Mastband Kileh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19	3100	Shah Rud	1	2	0	0	0	0	1	1	0	0	0	0	0	0	1	306	0	0	0	2	0	0	1	0	1	0	0	0	0	0	0	4	1	1	1	0	0	0	1	0	1	1	0	0	0	0	0	0
	20	3110	Ahi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	21	3111	Ahi Rud (Lower)	1	3	0	1	1	0	1	0	0	0	0	0	0	0	3	256	242	249	0	5	1	1	0	1	0	0	1	0	1	0	0	6	1	1	1	1	0	0	1	1	3	1	0	1	0	1	0	0
	22	3120	Ahangar Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23	3130	Ali Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	3131	Tifangah Drain	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	3140	Molla Rud	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	91	281	0	0	2	1	0	0	0	0	0	0	1	0	0	0	4	1	1	1	1	0	0	0	0	1	0	0	0	1	0	0	0
	26	3141	Alavi Kola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	3142	Ahi Rud	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3	294	295	313	0	4	0	0	0	0	0	0	1	1	0	1	1	5	1	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0
	28	3150	Zangi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	3160	Changar Drain	1	3	0	0	0	0	0	1	1	1	0	0	0	0	2	258	252	0	0	2	0	0	1	0	0	1	0	0	0	0	0	5	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
	30	4010	Zane Mard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	31	4011	Sangar Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	32	4020	Sag Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	33	4030	Tork Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	4040	Rash Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	4050	Khoshkeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haraz	36	4051	Khoshkeh Rud (Lower)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1	1	0	0	0	0	1	1	1	1	0	6	1	1	1	1	0	0	1	1	2	0	0	1	0	1	0	0
Right	37	4060	Alavi Kola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	38	4070	Valik Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	39	4080	Jamshid Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	40	4090	Kachab Rud	1	2	0	0	0	0	0	0	0	0	0	1	1	0	4	276	275	416	328	2	0	0	0	0	0	0	0	1	0	1	0	3	0	1	1	0	0	0	1	0	2	0	0	1	0	1	0	0
	41	4100	Marj Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	42	4110	Mohammadabad Rud (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	43	4120	Mohammadabad Rud (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	44	4130	Cheshmeh HaftKhal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	45	5010	Sang Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	46	5020	Niaki Rud	1	4	1	1	0	0	0	1	1	0	0	0	0	0	1	82	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	47	5030	Barik Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	48	5040	Katel Kash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	49	5050	Maliard	1	6	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	4	1	1	1	1	0	0	0	0	0	0	0	5	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
	50	5051	Esbukola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	51	5060	Maseh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	52	5080	Sheikh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	53	5090	Vozara Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	54	5100	Vakeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	55	5110	Mozaffar Rud	1	3	0	0	0	0	0	1	1	1	0	0	0	0	3	404	398	371	0	3	0	0	0	0	0	0	1	1	0	1	0	5	1	1	1	1	0	1	0	0	2	0	0	1	1	0	0	0
	56	5120	Khatib Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	57	5130	Traghchi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kari Left	58	5140	Kazembeigi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	59	5150	Karo Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	60	5160	Zahed Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	61	5170	Mashin Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	62	5180	Sang Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	63	5190	Khandagh Kileh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	64	5200	Zardab Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	65	5210	Juleh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(continued)

TABLE B. 3. 3-1 DIFFICULTIES ON DRAINAGE BY ZONE MIRABS (2/2)

River System	Responsible Canal			Dra Pro	Months in Drainage Problem													Villages in Drainage Problem					Item on Drainage Problem												Reasons of Drainage Problem									Counter-measures taken for Drainage Problem							
	Zone	Code	Canal Name		N	1	2	3	4	5	6	7	8	9	10	11	12	N	1	2	3	4	N	1	2	3	4	5	6	7	8	9	10	11	N	1	2	3	4	5	6	7	8	N	1	2	3	4	5	6	7
	66	5220	Matekeh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	67	5240	Soragh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	68	5250	Sotan Beigi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	69	5260	Archirud Kuchak	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	70	5270	Archirud Bozorg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	71	5280	Basra Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	72	5290	Actich Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	73	5300	Garmich Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	74	5310	Chamazin Rud	1	2	0	1	1	0	0	0	0	0	0	0	0	0	1	382	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	4	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0
	75	5320	Kotisar Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	76	5330	Vaghfirud Kamangar	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	77	5340	Kard Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	78	5350	Oulia Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	79	5360	Bala Haghabeh Rahkola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	80	5370	Pain Haghabeh Rahkola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	81	5380	Tajoddoleh Rud	1	3	1	1	1	0	0	0	0	0	0	0	0	0	1	419	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0
	82	5390	Rakun Rud	1	2	0	1	1	0	0	0	0	0	0	0	0	0	1	365	0	0	0	2	1	0	0	0	0	0	0	0	0	0	1	2	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Kari Left	83	5400	Bala Haghabeh Karikola	1	3	0	1	1	1	0	0	0	0	0	0	0	0	2	358	363	0	0	1	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
	84	5410	Khandagh Kileh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	85	5420	Raiss Rud	1	3	1	1	1	0	0	0	0	0	0	0	0	0	2	358	363	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	86	5430	Vale Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	87	5440	Kard Rud	1	3	1	1	1	0	0	0	0	0	0	0	0	0	1	356	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	4	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0
	88	5450	Kikha Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	89	5460	Rudbast Rud	1	3	1	1	1	0	0	0	0	0	0	0	0	0	1	348	0	0	0	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	90	5470	Seid Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	91	5480	Esfandiar Rud	1	2	0	1	1	0	0	0	0	0	0	0	0	0	1	355	0	0	0	3	1	1	1	0	0	0	0	0	0	0	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	92	5490	Sorayya Drain	1	3	1	1	1	0	0	0	0	0	0	0	0	0	1	348	0	0	0	3	1	1	1	0	0	0	0	0	0	0	0	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	93	5052	Hakkeh Dakal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	94	5042	Suteh Kileh Drain	1	12	1	1	1	1	1	1	1	1	1	1	1	1	2	351	504	0	0	5	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	95	5041	Mahlaban Drain	1	12	1	1	1	1	1	1	1	1	1	1	1	1	2	333	503	0	0	5	1	1	1	1	0	0	0	0	0	1	0	5	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0	0
	96	5111	Khoni Cheshmeh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	97	6010	Ziya Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	98	6020	Moallem Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	99	6050	Mileh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	100	6060	Charsin Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	101	6070	Siah Vardi Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	102	6080	Tashan Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kari Right	103	6090	Khatib Rud (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	104	6100	Actich Rud (2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	105	6110	Seid Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	106	6120	Marzun Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	107	6130	Kamangar Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	108	6140	Abdanrud Barsemnan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	109	6150	Zagh Kileh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	110	6160	Kallehbast Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	111	7010	Komdarreh Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	112	7020	Zavarak Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Garma Rud	113	8010	Ahangar Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	114	8020	Shahneh Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	115	8030	Vosta Kola Rud	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kharan Rud	116	9000	Kharan Rud River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	116			22	74	10	15	14	3	4	5	6	5	4	3	3	2	34					62	16	11	6	6	0	1	5	5	3	6	3	72	13	16	14	13	1	2	10	3	16	5	0	4	3	4	0	0
Average					3													2					3												3.3									1							
Percent(%)						14	20	19	4	5	7	8	7	5	4	4	3							26	18	10	10	0	2	8	8	5	10	5		18	22	19	18	1.4	2.8	14	4.2		31	0	25	19	25	0	0

(Note)

0: No problem on Drainage
1: Problem on Drainage

1: Problem on Transplanting of Rice.
2: Problem on Rice Growing.
3: Problem on Rice Farming.
4: Problem on Harvesting of Rice.
5: Problem on Second Crops.
6: Problem on Trafic in Summer.
7: Problem on Trafic in Autumn.
8: Problem on Trafic in Winter.
9: Problem on Trafic in Spring.
10: Inundation of Houses.
11: Erosion of Canals.
(12: Erosion of Roads.)

1: No drainage canals.
2: Less drainage capacity.
3: Excess water from Upstream.
4: Over-flood from River/Canal.
5: Obstruction by Roads.
6: Heavy texture of Soil.
7: Heavy Rainfall.
8: Other Reasons.

1: Non counter-measures.
2: New drainage canal.
3: Improvement of Drainage canals.
4: River training.
5: Bank protection.
6: Soil improvement.
7: Other counter-measures.

TABLE B. 3. 3-2 DIFFICULTIES ON DRAINAGE BY VILLAGE MIRABS

Dist-rict	Survey Code	Village where Village Mirab lives: Code	Name	Number Mirabs	Y/N	Difficulties in Drainage: Month		1		2		3		4		5		6		7		8		9		10		11		12		13		Reasons of Difficulties								Counter-measure taken						
						From	to	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	cm	Yr	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7
	1	18	No Gardan	1	N																																									
	2	15	Marzon Kola	1 *	N																																									
	3	13	Khas Kola	1	N																																									
	4	7	Derazan	1	N																																									
	5	6	Chandar Mahalleh	1 *	N																																									
	6	23	Varam Deh	1	N																																									
	7	8	Div Raz	1	N																																									
	8	60	Zaron Deh	2	N																																									
HW	9	39	Kord Koti	1	N																																									
	10	39	Kord Koti	1	N																																									
	11	35	Mali Koti	2	N																																									
	12	208	Kalikan Olia	1	N																																									
	13	37	Kaseb Mahalleh	1 *	N																																									
	14	206	Jafar Abad	1	N																																									
	15	197	Aski Mahalleh	1	Y	3	3	15		20		20		50																				1	1	1				1				1		1		
	16	254	Mir Alamdeh	1	N																																									
	17	245	Ghassab Koti	1 *	N																																									
	18	225	Rafi Abad	1	N																																									
	19	231	Sheikh Abad	1	N																																									
	20	233	Zagh Deh	1 *	Y	6	11							30	1	20	2	5	2	5	2	3	2	4	3	10								1	1	1	1			1			1	1	1	1		
	21	310	Kalosa	1 *	N																																									
	22	265	Zangi Kola	1	N																																									
	23	277	Kenes Marz	1	N																																									
AW	24	303	Eskan Deh	1 *	N																																									
	25	307	Jura Kola	1	N																																									
	26	291	Abolhassan Abad	1 *	N																																									
	27	308	Kale Marz Olia	2	Y	8	9					100	1	100	1													200	1														1	1	1	1		
	28	313	Moallem Kola	1	N																																									
	29	306	Marab Deh	1	N																																									
	30	300	Bisheh Kola	1 *	Y	8	9															50	1366			100	1364	40	1366	40	1366			1	1	1	1	1		1				1		1		
	31	252	Khesht Sar	1	N																																									
	32	184	Rudbar Dasht	1	N																																									
	33	190	Tork Kola	1	N																																									
	34	153	Buran	1	N																																									
	35	159	Firuz Kola Vosta	1	N																																									
	36	157	Firuz Kola Olia	1	N																																									
	37	158	Firuz Kola Sofla	1	N																																									
	38	173	Mahdi Kheil	1	Y	8	11									150	1368					70	1365	20	1365	15	1365	20	1365	20	1365			1	1	1			1	1				1		1		
	39	210	Kamangar Kola	1	N																																									
	40	88	Galesh Kola	1	N																																									
	41	122	Rash Kola	2	N																																									
HE	42	165	Hendu Kola	1	N																																									
	43	164	Harun Kola	1	N																																									
	44	156	Ejbar Kola	1	Y	4	4			50	1368	50	1368	50	1369					15	1369													1	1									1	1	1	1	
	45	179	Nezam Abad	1	N																																									
	46	76	Bur Mahalleh	1	N																																									
	47	65	Aloo	1	N																																									
	48	95	Heshtel Pain	1	N																																									
	49	160	Ghaleh Kash	1 *	N																																									
	50	150	Bagheban Kola	1 *	N																																									
	51	91	Haji Abad	1 *	Y	10	12													15	1368	15	1368							15	1368			1	1	1				1				1	1	1		
	52	136	Tanha Kola	1 *	Y	2	6	150	1366	150	1366	150	1366	50	1366														1367						1					1				1		1	1	
	53	200	Farah Abad	1 *	Y	6	11		4						4			30	2	30	2	50	2						1					1	1	1	1							1	1	1		
	54	211	Karati	1	Y	7	11													50	2			50	2	40	2							1	1	1	1		1	1						1		
	55	219	Mohammad Abad	1	Y	10	12															20	1						5		1			1	1	1		1	1	1						1	1	
	56	141	Valik Sofla	2	N																																									
	57	86	Espahi Kola Olia	1	N																																									
	58	72	Bamer Kola	1	N																																									
	59	116	Narges Marz	1 *	N																																									
AE	60	73	Banser Kola	1 *	N																																									
	61	74	Barik Mahalleh	1	N																																									
	62	89	Ghias Kola	1 *	Y	1	5	80	4	80	4	80	4	80	4			80	4	80	4	80	4	80	4	80	4		4		4			1	1	1	1		1	1				1	1	1	1	
	63	62	Abo Mahalleh	1	N																																									
	64	275	Kachab Olia	1	Y	10	12													40	1370	60	1365			50	1368	50	1368	50	1365				1	1	1			1				1	1	1		
	65	276	Kachab Sofla	1	Y	2	6	200		200		200		200												60		60						1	1	1	1		1	1				1	1	1		
	66	278	Merij Mahalleh	1	N																																									
	67	287	Vozara Mahalleh	1	N																																									
Answer		* : Shora Member		67																												11	13	11	7	2	5	11	0	0	2	12	8	14	4	0
Total		17 villages		72																																										
Average				1.1	N 53																																									
Standard Deviation				0.3	Y 14																																									
Min.				1																																										
Max.				2																																										

B.3.4 Evaluation of Drainage Design Year

1. Introduction

It is very important to evaluate design year properly on project planning. This paragraph describes the evaluation of the design year on drainage improvement.

2. Conclusion

As the results of economic evaluation on several design years, 10-year has been selected as the design year for drainage improvement. Reasons of selection is as below;

1) Design years between 5-year and 10-year are recommendable from an economical viewpoint.
2) Design years less than 5-year or greater than 10-year are not recommendable because of less economy.
3) Design year of 5-year is recommendable as the highest economical development.
4) Design year of 10-year is recommendable from viewpoints of higher benefit and higher economical development.
5) Design year of 10-year is more recommendable than 5-year for drainage improvement, because drainage system has to be capable to drain 25-year flood with its bankful capacity from a viewpoint of safety. Flood of 5-year is too small comparing 25-year flood.

3. Design Rainfall

Design rainfall is a 2-day rainfall in the period for seeding berseem from September to October.

Design rainfalls for design years are calculated using maximum daily rainfalls in above period at Babolsar Station, and modifying those maximum daily rainfalls using ration of the 2-day rainfall to the daily rainfall at MOE stations. The following table shows design 2-day rainfalls for several design years;

Table B. 3. 4 -1 DESIGN 2-DAY RAINFALLS FOR THE PERIOD FROM SEPTEMBER TO OCTOBER

Return Period	Maximum Daily Rainfall (mm/day)	Ratio of 2-day Rain to Daily	Design 2-day Rainfall (mm^2 days)	Ratio to 2-day Rainfall
1/2 year	61	1.39	85	1.00
1/5 year	91	1.35	123	1.45
1/10 year	114	1.30	148	1.74
1/15 year	127	1.27	161	1.89
1/20 year	137	1.25	171	2.01
1/25 year	145	1.23	178	2.09
1/30 year	151	1.22	184	2.16
1/50 year	170	1.18	201	2.36
1/100 year	196	1.13	221	2.60

4. Cost Ratio by Design Rainfalls

Cost ratio has been estimated in accordance with following assumptions;

1) Cost increases in proportion to the flow-section (A) of drainage canal.
2) Flow-section of drainage canal increases in proportion to Q3/4 (Q: discharge) under the most hydraulically effective flow-section of drainage canal.

   A = f(q3/4)..........eq.1
3) Discharge increase in proportion to rainfall.

In accordance with above assumptions, cost ratios have been calculated to the cost of 2-year return period. The following table shows the cost ratios for several design years to the 2-year design year cost.

Table B.3. 4 - 2 COST RATIOS TO THE 2-YEAR DESIGN YEAR COST

Return Period	Ratio to 2-day Rainfall (p)	Cost Ratio to 2-year Design Year ($P^{3/4}$)
1/2 year	1.00	1.00
1/5 year	1.45	1.32
1/10 year	1.74	1.51
1/15 year	1.89	1.61
1/20 year	2.01	1.69
1/25 year	2.09	1.74
1/30 year	2.16	1.78
1/50 year	2.36	1.90
1/100 year	2.60	2.05

5. Economic Evaluation

Economic evaluation has been given to the several design years, using above cost ratios and estimating the benefit ratios under different interests. Table B.3. 4-3 shows the results under 5%, 10%, and 15% interests. Figure B. 3.4-1 shows the result of 10% interest for better understanding.

TABLE B.3.4-3 BENEFIT AND COST RATIO ON DRAINAGE IMPROVEMENT PROJECT BY DIFFERENT RETURN-PERIOD

Return Period	Cost Ratio (Cr)	Interests 5 % Present Worth	Worth Ratio to 1/2 year (Br)	Br/Cr	10 % Present Worth	Worth Ratio to 1/2 year (Br)	Br/Cr	15 % Present Worth	Worth Ratio to 1/2 year	Br/Cr
1/ 2 Year	1.00	8.99	1.000	1.00	4.71	1.000	1.00	3.06	1.000	1.00
1/ 5 Year	1.32	14.38	1.539	1.21	7.52	1.596	1.21	4.87	1.590	1.20
1/ 10 Year	1.51	16.16	1.797	1.19	8.42	1.787	1.18	5.42	1.770	1.17
1/ 15 Year	1.61	16.76	1.864	1.16	8.70	1.845	1.15	5.57	1.819	1.13
1/ 20 Year	1.69	17.05	1.896	1.12	8.82	1.871	1.11	5.62	1.837	1.09
1/ 25 Year	1.74	17.18	1.911	1.10	8.88	1.884	1.08	5.65	1.844	1.06
1/ 30 Year	1.78	17.32	1.926	1.08	8.91	1.891	1.06	5.66	1.848	1.04
1/ 50 Year	1.90	17.46	1.941	1.02	8.95	1.899	1.00	5.66	1.850	0.97
1/100 Year	2.05	17.54	1.950	0.95	8.95	1.900	0.93	5.66	1.850	0.90

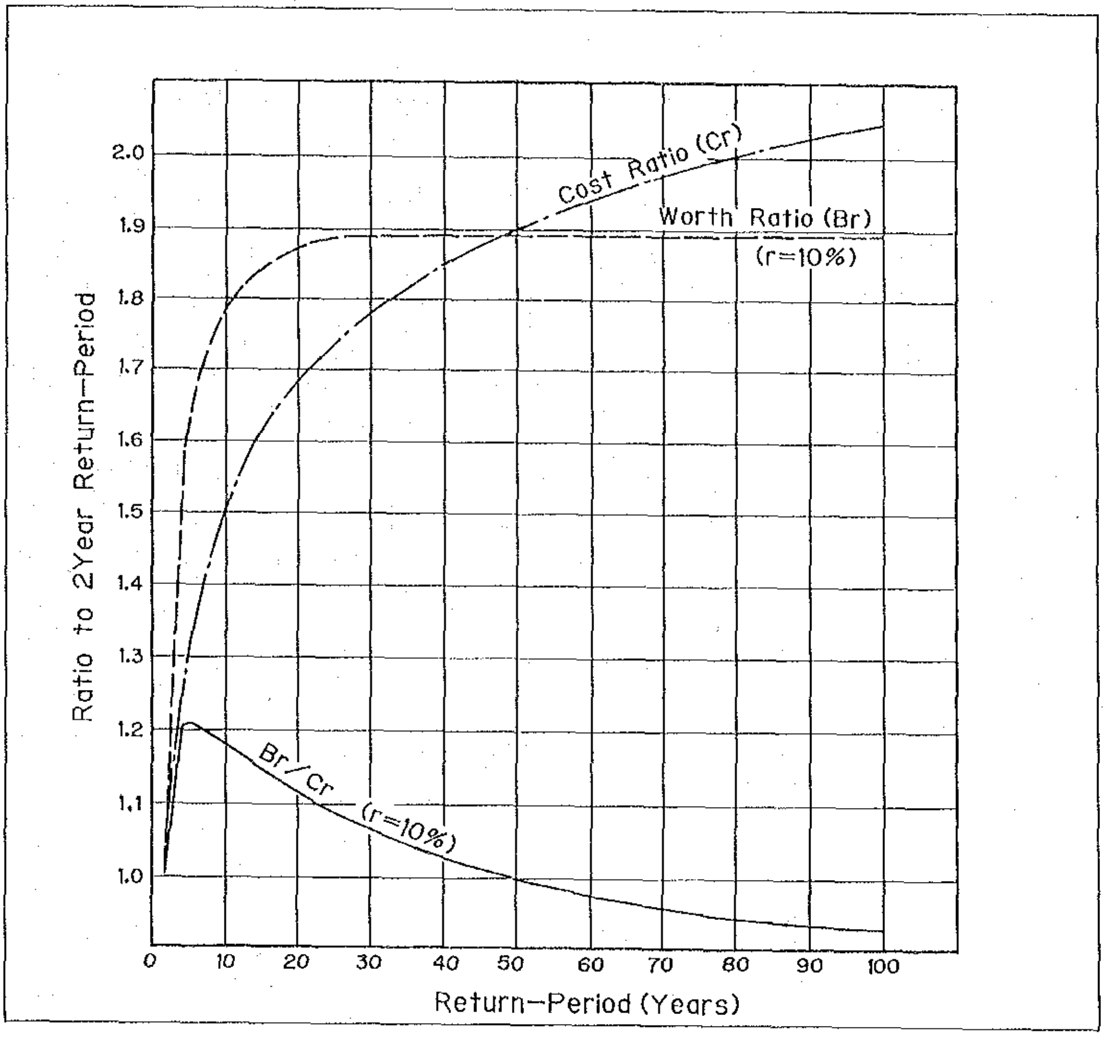
(Notes) 1. Project life is assumed at 50 years.
2. Present worth is calculated as following procedure.

		1	2	3	4	5	6	7	8	9	10
	0.95	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
2	8.9939	0.95	0	0.8574	0	0.77	0	0.6983373	0	0.6302494	0
5	14.381	0.95	0.9	0.8574	0.81450625	0	0.7351	0.6983373	0.66	0.6302494	0
10	16.161	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0
15	16.761	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
20	17.051	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
25	17.184	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
30	17.323	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
50	17.461	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369
100	17.538	0.95	0.9	0.8574	0.81450625	0.77	0.7351	0.6983373	0.66	0.6302494	0.5987369

	1	2	3	4	5	6	7
0.9	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
4.7124	0.9	0	0.729	0	0.59	0	0.4782969
7.5191	0.9	0.81	0.729	0.6561	0	0.531441	0.4782969
8.421	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.6966	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.8173	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.8767	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.9112	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.9485	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969
8.9536	0.9	0.81	0.729	0.6561	0.59	0.531441	0.4782969

	1	2	3	4
0.85	0.85	0.72	0.614125	0.5220063
3.0622	0.85	0	0.614125	0
4.8676	0.85	0.72	0.614125	0.5220063
5.4199	0.85	0.72	0.614125	0.5220063
5.5693	0.85	0.72	0.614125	0.5220063
5.6247	0.85	0.72	0.614125	0.5220063
5.6475	0.85	0.72	0.614125	0.5220063
5.6574	0.85	0.72	0.614125	0.5220063
5.6647	0.85	0.72	0.614125	0.5220063
5.665	0.85	0.72	0.614125	0.5220063

FIGURE B.3.4-1 COST RATIO (CR), WORTH RATIO (BR), AND BR/CR UNDER 10% INTEREST



B. 3. 5 Concepts on Drainage Canal Profile and Depth

In this Paragraph, concepts are explained on canal profile and depth from the terminal field level to the outlets into the Caspian Sea.

1. Concepts on the Terminal Level

(1) Depth of the Drainage Ditch and the Lateral Drainage Ditch

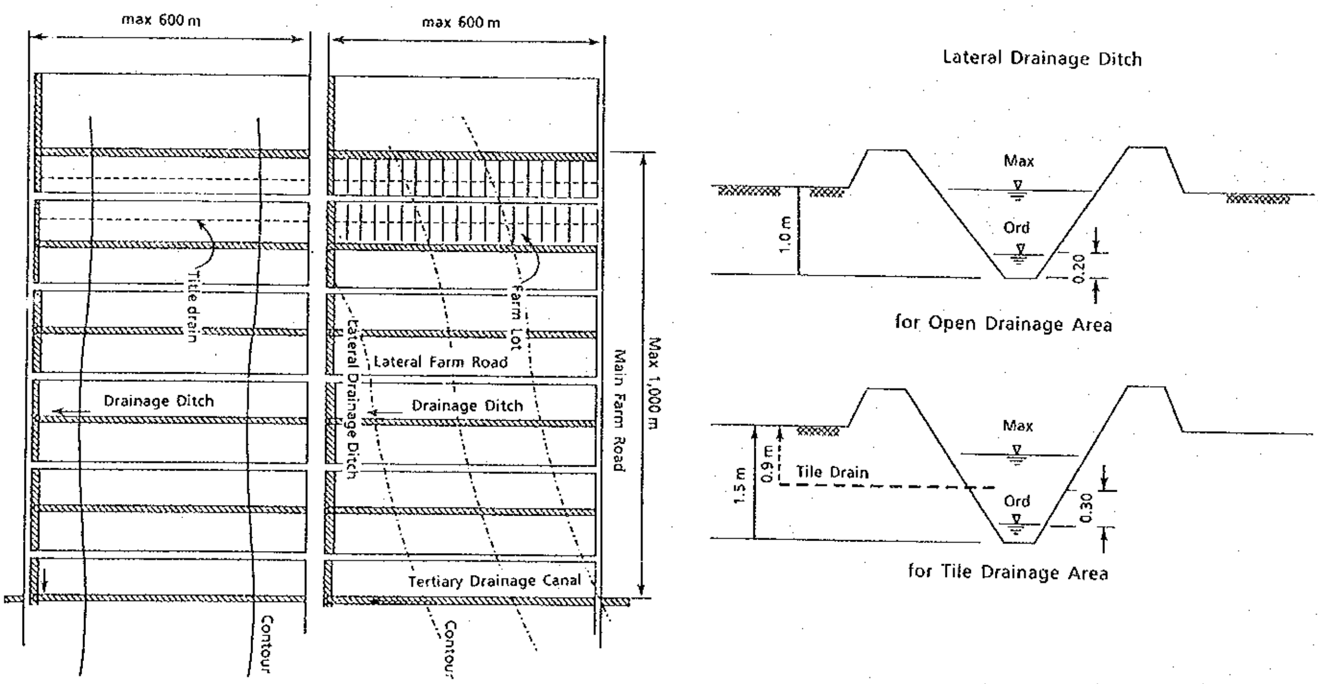
The terminal fields will be standardized on shape and alignment for farm mechanization and irrigation/drainage improvement by the land consolidation. Two different drainage ditches are provided in the field as below;

<u>Drainage ditch</u>: provided along the field lots to drain excess water from the field lots, and flows to the land slope direction.

<u>Lateral drainage ditch</u>: provided along the main farm road to collect excess water from drainage ditches, and generally flows along contour line with minimum slope of 1 : 2,000.

Above ditches are provided as shown in the figure below;

FIGURE B. 3. 5 - 1 TERMINAL DRAINAGE SYSTEM



(2) Classification of Lands by Slope

Lands are classified by the slope into two types which a sloping land and a flat land. Sloping land has an enough gradient to provide drainage ditches and lateral drainage ditches. Flat land has not an enough gradient to provide ditches. Division of gradient is differed by the necessity of tile drains, because tile drains require a minimum hydraulic gradient of 1 : 600.

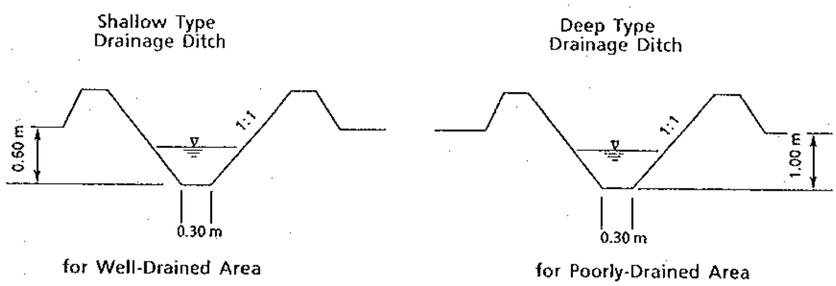
Sloping Land :	Open drainage area	slope	> 1 : 1,000
	Tile drainage area	slope	> 1 : 600
Flat Land :	Open drainage area	slope	< 1 : 1,000
	Tile drainage area	slope	< 1 : 600

In the improvement of drainage ditches in the terminal fields, different depth of ditches will be provided to conform with the drainability of the field.

(3) Dept of Drainage Ditch

Two types of drainage ditches will be provided in the terminal field level.

FIGURE B. 3. 5-2 CROSS-SECTION OF DRAINAGE DITCH



Shallow type drainage ditch	:	depth 0.60 m
Deep type drainage ditch	:	depth 1.00 m

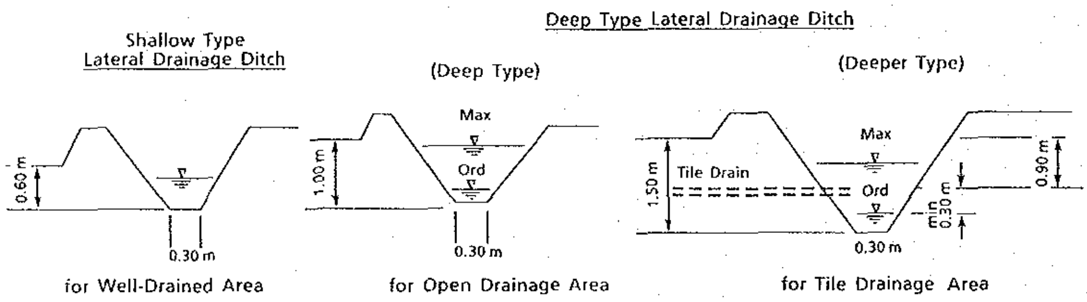
Shallow type drainage ditch is applied to the well-drained areas on sub-surface drainage where groundwater table is kept below 0.20 m depth through the year even in rainy period at present stage. This drainage ditch works exclusively to drain excess surface water.

Deep type drainage ditch is applied to the poorly-drained area where groundwater rises more than 0.20 m depth from the field surface in rainy period at present stage, and it works both for draining excess surface water and groundwater.

(4) Depth of Lateral Drainage Ditch

Lateral drainage ditch is classified into three types of ditches by the depth. One is a shallow type with a depth of 0.60 m, and others are a deep type with a depth of 1.0 m and a deeper type with a depth of 1.5 m. Shallow type lateral drainage ditch is applied to the well-drained areas, and deep and deeper types of lateral drainage ditches are applied to the poorly-drained areas. Deeper type of lateral drainage ditch is applied to the areas where tile drains are necessary to drain groundwater, and deep type one is applied to the areas where sub-surface drainage is satisfied by a open drainage system, that is a depth of 1.0 m. Applied three type of lateral drainage ditches are as follows;

FIGURE B. 3. 5 - 3 CROSS-SECTION OF LATERAL DRAINAGE DITCHES

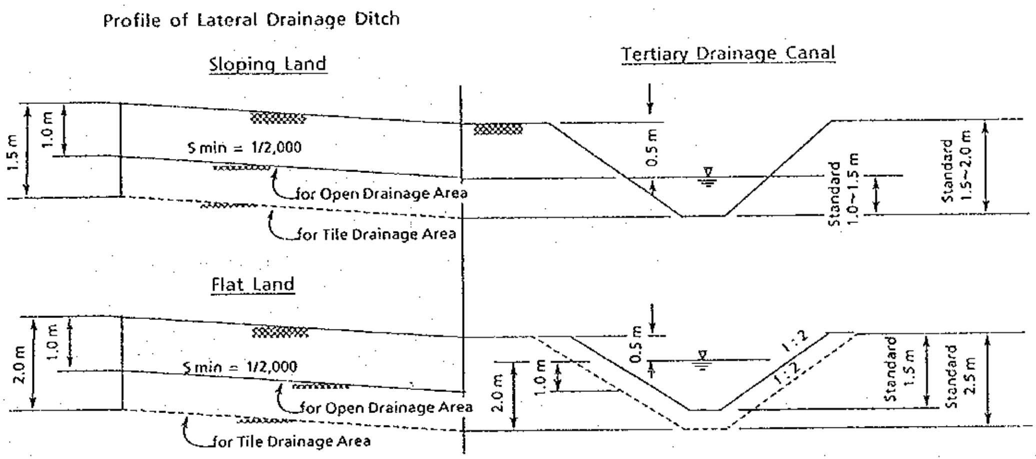


Shallow type lateral drainage ditch	:	depth 0.60 m
Deep type lateral drainage ditch	:	depth 1.00 m
Deep type lateral drainage ditch	:	depth 1.50 m

2. Concepts on Tertiary Drainage Canals

Terminal field is drained generally into tertiary drainage canal through drainage ditches and lateral drainage ditches. However, in the low-land areas terminal field is mostly drained directly into secondary drainage canal. Taking terminal field conditions into consideration, tertiary drainage canals are necessary to have a depth of 1.50 m to 2.50 m as shown in the figure below;

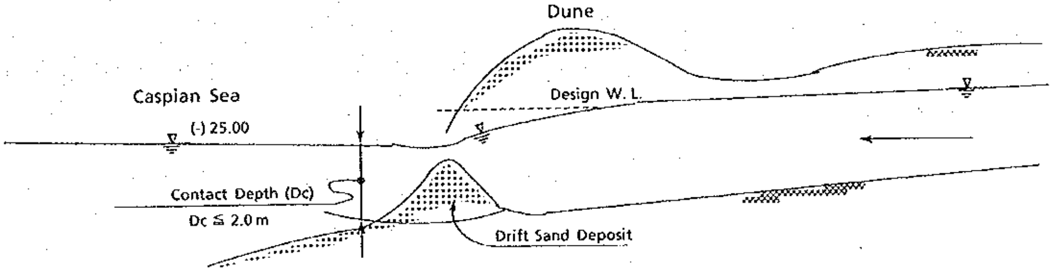
FIGURE B. 3. 5-4 CROSS-SECTION OF TERTIARY DRAINAGE CANALS



3. Concepts on Secondary and Main Drainage Canals

The depth of secondary canal is to be 2.50 m or more in the flat land taking a depth of a tertiary drainage canal as shown in the Figure B. 3. 5-4. However, outlets of the drainage to the Caspian Sea have to be ensured from river mouth closuring. Safety contact water depth of outlets is considered to be less than 2.00 m for preventing the mouth blockade. Consequently, depth and profile of the secondary and the main drainage canals which are drained to the Caspian Sea is to be decided to keep the contact depth less than 2.00 m.

FIGURE B. 3. 5-5 DRAINAGE OUTLET TO THE CASPIAN SEA



4. Hydraulic Conditions of Drainage Canals

Hydraulic conditions of drainage canals are as follows:

Hydraulic gradient : minimum $s = 1:5{,}000$
Maximum velocity : 1.35 m/sec (0.90 m/sec × 1.5)

Roughness coefficient:
Drainage ditches : n = 0.35 (good maintenance)
Lateral drainage ditches : n = 0.035 (good maintenance)
Tertiary drainage canals : n = 0.045 (ordinary maintenance)
Secondary drainage canals:
n = 0.040 (ordinary maintenance)
n = 0.035 (good maintenance)
main drainage canal : n = 0.035 (good maintenance)

It is recommended that the secondary and the main drainage canals are to be maintained under good condition taking difficulties in the flat low-lying area into consideration.

5. Restrictions on Drainage

There still remain some restrictions partly in the low-lying area even after the project in connection with the Caspian sea level and the land elevation.

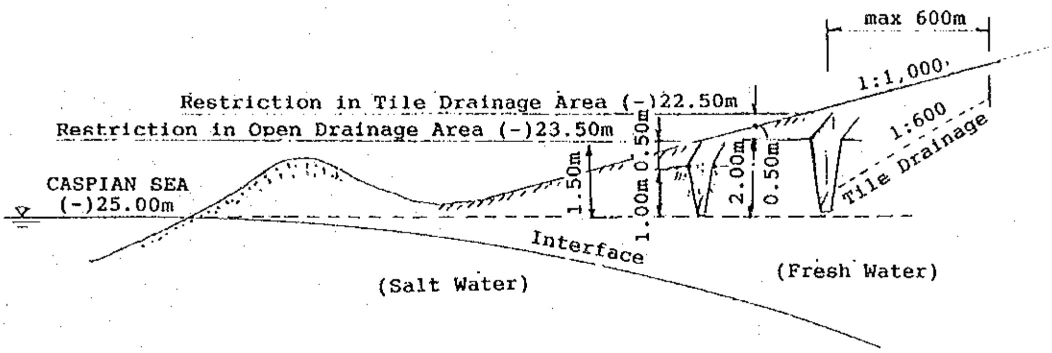
(1) Restriction on Sub-surface Drainage

Restriction arises in the low-lying areas where the land elevation is lower. In case of the tile drainage area, restriction arises in the areas lower than (-)22.50 m, and (-)23.5 m for open drainage area respectively. Such low-elevation-lands are generally flatter than 1/1,000. On the other hand, tile drainage requires a gradient steeper than or equal to 1/600 slope. Therefore, lateral drainage ditches necessarily become deeper to be 1.5 m in the open drainage area.

Where the land is lower than above mentioned elevation, ditch bottom goes down below the design elevation (-)25.0 of sea level. Therefore, in such areas, sub-surface groundwater control is rather difficult.

This restriction arises to the hinterlands of 1,309 ha behind Feridon Kenar.

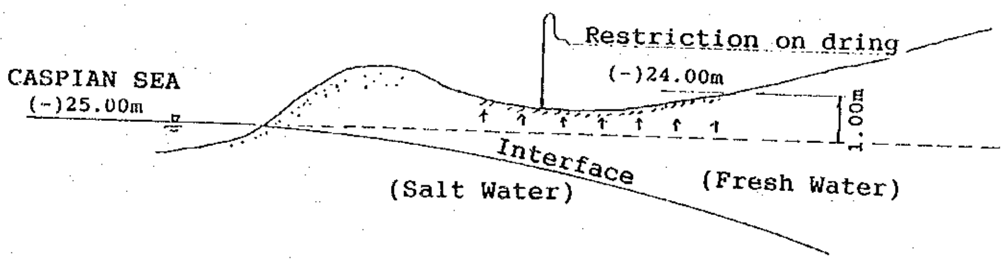
FIGURE B.3.5-6 RESTRICTION OF SUB-SURFACE DRAINAGE



(2) Restriction on Field Drying for Farm Mechanization

The areas, where the elevation is lower than (-)24.0 m, are too close to the sea level elevation, so that it is difficult to dry up the soil due to high groundwater level in this area. Therefore, restriction arises on farm mechanization in this area. The acreage of this area is estimated at 511 ha.

FIGURE B.3.5-7 RESTRICTION ON FIELD DRYING



B. 3. 6 Proposed Surface Drainage

1. Proposed Drainage Network

The Project Area will be divided primarily into two drainage areas, viz. the upper and the lower, by the Amol West Main Drain (AWMD) and the Amol East Amol Drain (AEMD) as shown in the flow diagram, Figure B. 3. 6-1. The AWMD (drainage area : 15,453 ha, discharge : 47.59 cms) will be drained to the Alesh river, and the AEMD (drainage area : 22,834 ha, discharge : 66.11 cms) to the Babol river. These two main drains eliminate the drainage rates of the drains pouring into the Caspian Sea.

Modification of drainage areas from the existing drainage network is summarized as below;

Comparison of the Existing and the Proposed Drainage Areas

(Unit : ha)

Drainage District		Existing	Proposed	Difference
Haraz Left Bank District				
- Alesh River Drainage District				
DHW1 - 4, DAW1 - 2		3,587	3,536	Δ51
AEMD	Amol West Main Drain	0	15,453	15,453
DAW3	Changar Drain	6,634	3,382	Δ3,252
- Caspian Sea Direct Drainage				
DAW4	Mahmudabad Drain	16,170	4,126	Δ12,044
DAW5	Siahrud Sar Drain	2,353	3,152	1,159
DAW6	Tifangah Drain	6,119	3,974	Δ2,145
DAW7	Bishen Kola Drain	291	381	90
DAW8	Alamden Rud Drain	1,792	1,692	Δ100
DAW9	Shian Kola Drain	761	620	Δ141
DAW10	Bir Rud Drain	3,793	2,949	Δ844
Caspian Sea Direct		0	683	683
- Haraz River Drainage District				
UHW Haraz River Upper		399	399	0
Haraz River Direct		981	2,173	1,192
Sub-total		42,880	42,880	0
Haraz Right Bank District				
- Haraz River Drainage District		1,254	2,926	1,672
- Caspian Sea Direct Drainage District				
DAE9 Shira Rud Drain		1,130	6,675	5,545
DAE10	Feridon Kenar Main Drain	49,070	18,691	Δ30,379
Caspian Sea Direct		0	1,090	1,090
- Babol River Drainage District				
Babol River Direct		8,195	7,433	Δ762
AEMD	Amol East Main Drain	0	22,834	22,834
KR	Kari Right Bank	5,480	5,480	0
Sub-total		65,129	65,129	0
Total		108,009	108,009	0

(Note) Δ ; indicating the decrease

2. Proposed Surface Drainage Rate

(1) Excess Runoff Rainfall and Equation

1) Estimation of Drainage Rate in Iran

Excess runoff rainfall and discharge are computed using the procedure recommended by the SCS, USDA. This procedure is composed of following two steps;

Step-1 : Estimation of Excess Rainfall
based on Curve Number (CN) defined by soil and crops
Step-2 : Estimation of Discharge based on Excess Rainfall
by the Cypress Creek Formula

This procedure has been applied to several irrigation and drainage projects in Iran, and these projects are reported as operated without any particular difficulties. These projects are as follows;

Zarinehrud Project (40,000 ha) in West Azarbaijan Province
Dorudzan Project (40,000 ha) in the North of Fars Province
(Note) Information from Mahab Ghodss (Letter 10/19561, date 70/12/26, 16/Mar/'92)

2) Rainfalls by Different Seasons

Rainfall varies by seasons in this Project Area. Analysis of rainfall is mentioned in Appendix A.1. Following rainfalls have been considered in this study.

Rainfalls Considered on Surface Drainage

(Unit: mm)

Crop Season	2-day Rainfall	
	1/10 year	1/25 year
Annual Maximum	166	204
Second Crop Season (Sep.-Oct. harmful to berseem)	148	178
Rice Growing Season (Apr. - Aug.)	73	80
Rice Harvesting Period (Aug.- Sep.)	107	128

(2) Equations for Estimating Excess Runoff Rainfall

For selection of equation and formula, drainage conditions are considered under improved drainage conditions by the project. Applied drainage equation and formula, and selection reasons of those are as follows;

1) Excess Runoff Rainfall in Rice Growing Season (Apr. - Aug.)

Excess runoff rainfall is generally calculated by hydraulic equations of drainage capacities of field notch and drainage ditch depending on depth of standing water by rainfall in Japan.

Standard width of field notch is 1 meter/ha (or 0.3 m/0.3 ha) in Japan. However, this standard width is too large for the Project Area, because rainfall amount is rather less in this region than in Japan. On the other hand, drainage ditch is 0.6 to 1.0 m depth which is almost same size as Japan, because depth of drainage ditch is decided taking subsurface drainage into consideration. Therefore, flow capacity of drainage ditch becomes much larger than it of field notch in the Project Area. As the results, flow capacity of field notch will regulate excess runoff rainfall in the Project Area.

Consequently, it is sufficiently enough to give the field notches a 2-day drainage capacity for 2-day rainfall, without any harm to rice growing. Excess runoff rainfall during rice growing is 68 mm for 1/10 years and 75 mm for 1/25 years for 2-days taking 5 mm interception by paddy leaves.

Excess Runoff Rainfall in Rice Growing Period

Probability	Rainfall (mm/2 day)	Interception (mm)	Excess runoff	
			(mm/2 day)	(lit/s/ha)
1/10 yr	73	5	68	3.94
1/25 yr	80	5	75	4.34

(Note) Interception of 5 mm is a standard value in Japan

2) Excess Runoff Rainfall in Second Crop Season (Sep. - Oct.)

In this season, the farm fields are proposed to be cultivated as upland fields mainly with berseem. It is, therefore, recommended to estimate excess runoff rainfall by the method presented in the National Engineering Handbook (NEH), Section 4, Hydrology, Chapter 10, Soil Conservation Service (SCS), USDA. Excess runoff rainfall is estimated depending on following elements;

- Hydrologic soil groups
- Runoff curve number (CN) by hydrologic soil-cover complex
- Antecedent moisture condition (AMC)

(a) Hydrologic Soil Groups

The soils are classified into D (High runoff potential) except sand-dunes along the coastal area.

(b) Runoff Curve Number (CN)

The runoff curve number (CN) is estimated taking the hydrologic soil-cover complex into consideration. Hydrologic soil-cover complex is a hydrologic soil group (soil) and a land use and treatment class (cover).

Table B. 3. 6-1 shows the CN by hydrologic soil-cover complexes, and CN is adjusted by the antecedent moisture condition (AMC) as shown in Table B. 3. 6-2. In accordance with the tables, CN of the Project Area is estimated as below;

Runoff Curve Number (CN) for Second Crop Season

Probable Rainfall	Landuse	Hydrologic Condition	CN	AMC	CN (Adj)
148 mm (1/10 yr for Sep. - Oct.)					
	Pasture/ Range	poor (*1)	89	III	96
204 mm (1/25 yr for Annual)					
	Pasture/ Range	fair (*2)	84	III	93

(Note) 1: Hydrologic soil group is classified into D.
2: Considered to be poor due to germination stage(*1).
3: Considered to be fair due to mixture of grown and grazed berseem.
4: AMC is estimated at III, considering antecedent 5 days rainfall.

(c) Potential Maximum Retention (S)

Potential maximum retention (S) is estimated by following equation;

$S = 25{,}400 / CN - 254$

for 1/10 yr $S = 25{,}400 / 96 - 254 = 10.58$ mm
for 1/25 yr $S = 25{,}400 / 93 - 254 = 19.12$ mm

(d) Excess Runoff Rainfall (Re)

Excess runoff rainfall (Re) is estimated by following equation;

$Re = (P - 0.2 \times S)^2 / (P + 0.8 \times S)$

for 1/10 yr $Re = (148 - 0.2 \times 10.58)^2 / (148 + 0.8 \times 10.58)$
$= 136.02$ m
for 1/25 yr $Re = (204 - 0.2 \times 19.12)^2/(204 + 0.8 \times 19.12)$
$= 182.72$ mm

3) Rice Harvesting Period (Aug. - Sep.)

As seeing in the Figure 4. 3-1 in the Main Report (Proposed cropping calendar), Amol-3 is remaining in the field and still irrigated at the beginning of September. Therefore, in this period, excess runoff rainfall is estimated under the condition that 1/3 of fields are irrigated and 2/3 of fields are under harvesting or harvested. AMC is predicted at I for harvesting fields due to dry field conditions.

(a) Runoff Curve Number (CN) for Dry Field

CN is estimated at 94 under fallow condition and AMC-II, and adjusted to 85 by AMC-I.

(b) Potential Maximum Retention (S) for dry fields

$$S = 25{,}400/CN - 254 = 25{,}400/85 - 254 = 44.82 \text{ mm}$$

(c) Excess Runoff Rainfall (Re)

1) for 1/10 yr

$Re1 = (107 - 0.2 \times 44.82)^2/(107 + 0.8 \times 44.82) = 67.28$ mm

$Re2 = 107 - 5 = 102$ mm

Mean $Re = 67.28 \times 2/3 + 102 \times 1/3 = 78.85$ mm

$= 4.56$ lit/s/ha

2) for 1/25 yr

$Re1 = (128 - 0.2 \times 44.82)^2/(128 + 0.8 \times 44.82) = 86.47$ mm

$Re2 = 128 - 5 = 123$ mm

Mean $Re = 86.47 \times 2/3 + 123 \times 1/3 = 98.65$ mm

$= 5.71$ lit/s/ha

(Note) Re1 : for dry fields, Re2 : for irrigated fields

(3) Application of Equations for Estimating Runoff in Canal System

There are two ways to apply equations for estimating the runoff in canal system. One is to apply mathematical equations for a theoretical model which is created taking the canal size and slope, gate size, topographical depressions, and canal storage functions into consideration. The other way is to apply an empirical method which is applicable to the Project.

Cypress-Creek Formula is an empirical method which is developed in United State. This formula is applicable to the flat lands with a land slope of 1 :

100 or less. It takes much computation and work for creating a theoretical model for mathematical equation.

Cypress-Creek Formula has been applied to several completed drainage projects and experienced in Iran. Therefore, it is recommended to apply Cypress-Creek Formula to the project. Cypress-Creek Formula is as follows;

$$Q = C \times M^{5/6} \quad \text{(lit/sec)}$$

Where;
$C = 4.52 + 0.16032 \times re(24)$
re(24) : 24 hours rainfall (mm)
M : Drainage Area (ha)

(4) Runoff Equation by Cypress-Creek Formula

1) Drainage Equation for Second Crop Season (Sept. - Oct.)

(a) $C_{10} = 4.52 + 0.16032 \times (136.02/2) = 15.42$
$C_{25} = 4.52 + 0.16032 \times (182.72/2) = 19.17$

(b) Drainage Equation

$Q_{10} = 15.42 \times M^{5/6}$ (lit/sec)
$Q_{25} = 19.17 \times M^{5/6}$ (lit/sec)

2) Drainage Equation for Harvesting Period (Aug. - Sep.)

(a) Drainage Coefficient

$C_{10} = 4.52 + 0.16032 \times (78.85/2) = 10.84$
$C_{25} = 4.52 + 0.16032 \times (98.65/2) = 12.43$

(b) Drainage Equation

$Q_{10} = 10.84 \times M^{5/6}$ (lit/sec)
$Q_{25} = 12.43 \times M^{5/6}$ (lit/sec)

3) Drainage Equation for Rice Growing Season (Apr. - Aug.)

(a) Drainage Coefficient

$C_{10} = 4.52 + 0.16032 \times (68/2) = 9.97$
$C_{25} = 4.52 + 0.16032 \times (75/2) = 10.53$

(b) Drainage Equation

$Q_{10} = 9.97 \times M^{5/6}$ (lit/sec)
$Q_{25} = 10.53 \times M^{5/6}$ (lit/sec)

Above equations are illustrated in the Figure B. 3. 6-3 for convenient for use.

3. Alternative Routes and Canal Size of Major Drains

(1) Canal Size

1) Feridon Kenar Drain

Q10 (cms)	Depth (m)	Bottom Width (m)	Gradient	Side Slope	Side Protection	Velocity (m/sec)
58.08	2.37	35.0	1 : 5,000	1 : 0.5	Riprap	0.68

2) AWMD

Q10 (cms)	Depth (m)	Bottom Width (m)	Gradient	Side Slope
47.6	2.55	10.0	1 : 1,000	1 : 2

3) AEMD

Q10 (cms)	Depth (m)	Bottom Width (m)	Gradient	Side Slope
66.11	3.00	15.0	1 : 1,910	1 : 2

(2) Alternative Routes

1) Feridon Kenar Drain

By diverting the Ezbaran drain, the Fereidon Kenar drain can be improved with slightly enlarging the width. It does not cause demolishment of houses in large scale.

2) AEMD

Location of outlet of the AEMD has been examined. However, the Babol river does not get any influence by the location of outlet because the Babol river requires its improvement far downstream from the outlet.

TABLE B.3.6-1 RUNOFF CURVE NUMBERS FOR HYDROLOGIC SOIL-COVER COMPLEXES

(Antecedent moisture condition II, and $I_a = 0.2\ S$)

Land use	Cover: Treatment or practice	Cover: Hydrologic condition	Hydrologic soil group A	B	C	D
Fallow	Straight row	----	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	"and terraced	Poor	66	74	80	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	"and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes 1/ or rotation meadow	Straight row	Poor	66	77	85	89
	" "	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	"	Good	55	69	78	83
	"and terraced	Poor	63	73	80	83
	"and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
	Contoured	Poor	47	67	81	88
	"	Fair	25	59	75	83
	"	Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		----	59	74	82	86
Roads (dirt) 2/		----	72	82	87	89
(hard surface) 2/		---	74	84	90	92

1/ Close-drilled or broadcast.
2/ Including right-of-way.

TABLE B.3.6-2 CURVE NUMBERS (CN) AND CONSTANTS FOR THE CASE Ia = 0.2 S

1	2	3	4	5	1	2	3	4	5
CN for condition II	CN for conditions I	III	S values*	Curve* starts where P =	CN for condition II	CN for conditions I	III	S values*	Curve* starts where P =
			(inches)	(inches)				(inches)	(inches)
100	100	100	0	0	60	40	78	6.67	1.33
99	97	100	.101	.02	59	39	77	6.95	1.39
98	94	99	.204	.04	58	38	76	7.24	1.45
97	91	99	.309	.06	57	37	75	7.54	1.51
96	89	99	.417	.08	56	36	75	7.86	1.57
95	87	98	.526	.11	55	35	74	8.18	1.64
94	85	98	.638	.13	54	34	73	8.52	1.70
93	83	98	.753	.15	53	33	72	8.87	1.77
92	81	97	.870	.17	52	32	71	9.23	1.85
91	80	97	.989	.20	51	31	70	9.61	1.92
90	78	96	1.11	.22	50	31	70	10.0	2.00
89	76	96	1.24	.25	49	30	69	10.4	2.08
88	75	95	1.36	.27	48	29	68	10.8	2.16
87	73	95	1.49	.30	47	28	67	11.3	2.26
86	72	94	1.63	.33	46	27	66	11.7	2.34
85	70	94	1.76	.35	45	26	65	12.2	2.44
84	68	93	1.90	.38	44	25	64	12.7	2.54
83	67	93	2.05	.41	43	25	63	13.2	2.64
82	66	92	2.20	.44	42	24	62	13.8	2.76
81	64	92	2.34	.47	41	23	61	14.4	2.88
80	63	91	2.50	.50	40	22	60	15.0	3.00
79	62	91	2.66	.53	39	21	59	15.6	3.12
78	60	90	2.82	.56	38	21	58	16.3	3.26
77	59	89	2.99	.60	37	20	57	17.0	3.40
76	58	89	3.16	.63	36	19	56	17.8	3.56
75	57	88	3.33	.67	35	18	55	18.6	3.72
74	55	88	3.51	.70	34	18	54	19.4	3.88
73	54	87	3.70	.74	33	17	53	20.3	4.06
72	53	86	3.89	.78	32	16	52	21.2	4.24
71	52	86	4.08	.82	31	16	51	22.2	4.44
70	51	85	4.28	.86	30	15	50	23.3	4.66
69	50	84	4.49	.90					
68	48	84	4.70	.94	25	12	43	30.0	6.00
67	47	83	4.92	.98	20	9	37	40.0	8.00
66	46	82	5.15	1.03	15	6	30	56.7	11.34
65	45	82	5.38	1.08	10	4	22	90.0	18.00
64	44	81	5.62	1.12	5	2	13	190.0	38.00
63	43	80	5.87	1.17	0	0	0	infinity	infinity
62	42	79	6.13	1.23					
61	41	78	6.39	1.28					

*For CN in column 1.

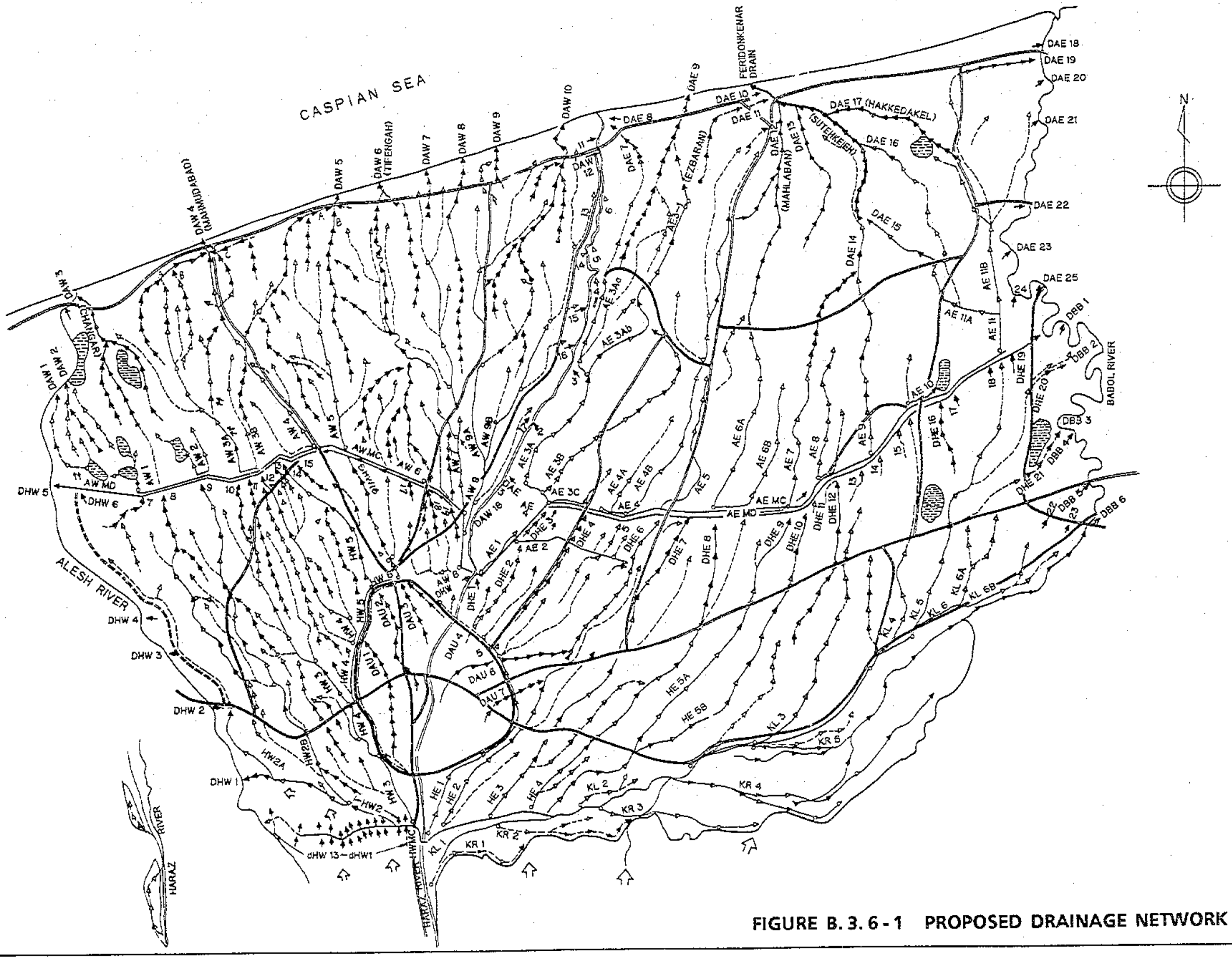


FIGURE B. 3. 6 - 1 PROPOSED DRAINAGE NETWORK

FIGURE B. 3. 6 - 2 DIAGRAM OF PROPOSED DRAINAGE NETWORK

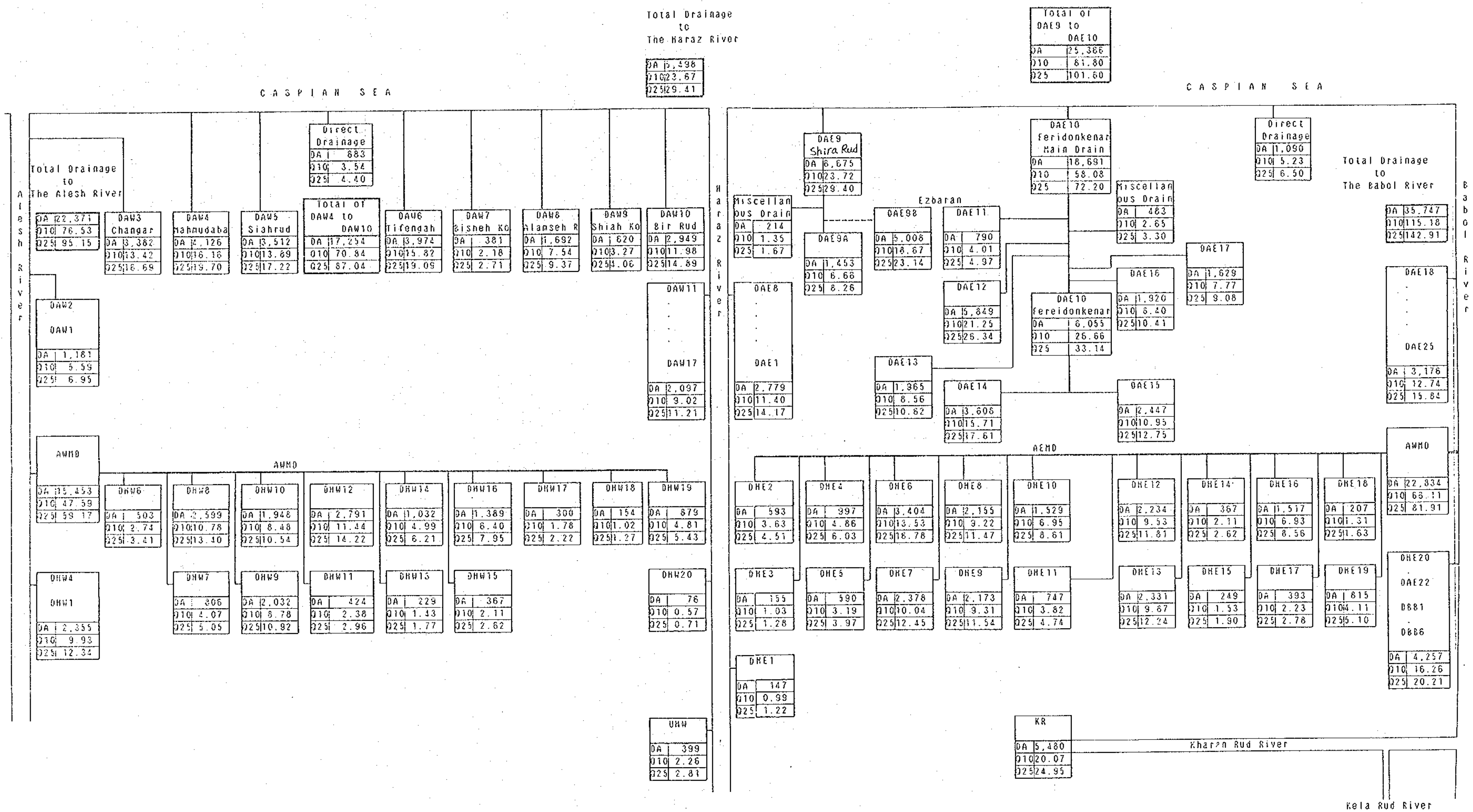


FIGURE B.3.6-3 EQUATIONS OF DRAINAGE RATE FOR DIFFERENT SEASON