8. RECOMMENDATIONS

8.1 Early Implementation of the Project

The Malir basin has played an important role for a long time in supplying agricultural products such as fruit, vegetables, etc. and in supplying potable water to Karachi city. Despite the fact that demand for such agricultural products is increasing due to rapid population growth of Karachi, agricultural land in the project area is decreasing year by year mainly due to overdraft of groundwater from the potential aquifers in the basin, which will further be accelerated unless appropriate countermeasures are provided for augmentation of recharge to and proper management of the aquifers.

The Water Resources Development Project in the Malir basin is verified herein as technically, and economically as well as financially feasible. It is, therefore, recommended that the necessary arrangements for early implementation of the project be taken as soon as possible.

8.2 Establishment of Pilot Demonstration Farm

Fruit and vegetable crop yields achieved by producers in the project area are significantly lower than those generally achieved in Sindh and much below national averages. The restoration of a reliable and properly managed supply of water under the proposed project will create the conditions for development of more intensive fruit and vegetable production systems in the project area.

The project itself will make only a limited contribution to intensification of crop production in the project area through augmentation of recharge to the aquifers. It is therefore essential to establish a pilot demonstration farm in order to achieve the desired increase in crop yields through adaptive research including testing of crop packages, alternative technologies, including irrigation techniques and management practices to meet the needs of farmers in the area. The proposed Pilot Demonstration Farm should be implemented under the project.

8.3 Groundwater Management

Proper groundwater management should be strictly carried out for the sustainable groundwater use in order to prevent serious groundwater mining and deterioration of water quality, in connection with the implementation of the project. Otherwise, decrease of potential groundwater resources as seen at present in the project area may occur again in the future, even if increased recharge to the aquifers can be provided by the project.

The continuous groundwater monitoring including observation of groundwater level, pumping amount, and water quality is essential for the groundwater management. In the course of this study, two (2) automatic groundwater level recorders were installed. However, it is recommended to add at least three (3) automatic recorders, and ten (10) monthly

observation wells, distributed in the project area. Monthly EC and pH observations at the above 15 wells are also recommended for long-term groundwater monitoring. Moreover, extraction amounts by pumping should be monitored in terms of energy consumption or other appropriate means such as water gauging meters, or information of cropped area, etc., through the proposed Groundwater Users' Association.

No legal framework for the groundwater resources development exists in the province or in the project area. It is strongly recommended that a section of IPD be established for proper groundwater management, including development of the necessary regulations for groundwater resources development to monitor and maintain the aquifer level/status in the project area as well as to ensure proper utilization of potential groundwater resources, in collaboration with the proposed Groundwater Users Association.

LIST OF REFERENCES

01 Water Resources Development in Malir Basin, Feasibility Study, WAPDA, 1979 (updated in 1982)

02 Karachi Flood Control Plan, Feasibility Report, WAPDA, 1985

03 Water Resources Development in Malir Basin, Project Document, National Engineering Services (Pakistan) Ltd., 1984

04 River and Climatological Data of Malir and Layari River Basins, WAPDA, 1989

05 Water Sector Investment Planning Study (Draft), Provincial Plan Sindh, Nov. 1989, UNDP, WB

06 Crop Water Requirement, Irrigation and Drainage Paper No. 24, FAO, 1977

TABLES

Table 1 PARTICIPANTS IN THE STUDY

Name	Position
A. Advisory Committee	
1. Dr. M. Wada	Chairman of Advisory Committee (MAFF)
2. Dr. T. Sugawara	Member, Geology (MAFF)
3. Mr. T. Tachibana	Member, Irrigation and Drainage (MAFF)
4. Mr. M. Tabata	Member, Agriculture (MAFF)
5. Mr. K. Sawada	Member, Agriculture (MAFF)
B. Study Team	
1. Mr. K. Irie	Team Leader
2. Mr. S. Muramoto	Irrigation and Drainage Engineer (Deputy Team Leader)
3. Mr. K. Kotoo	Hydrogeologist/(Groundwater Engineer)
4. Mr. M. Okamoto	Groundwater Engineer
5. Mr. T. Murakami	Hydrologist
6. Mr. M. Taki	Dam Engineer
7. Mr. K. Kameyama	Engineering Geologist
8. Mr. F. Nagao	Agronomist
9. Mr. John D. Pell	Agro-economist
10. Mr. K. Kyoizumi	Structural Design Engineer
11. Mr. T. Kimijima	Project Economist
C. Counterpart Personnel	
1. Mr. Syed I. A. Shah	Advisor, Chief Engineer, Irrigation and Power Dept.
2. Mr. Seth A. Fazal	Team Leader, Director of Design, Irrigation and Power Dept.
3. Mr. Muhammad I. Khan	Deputy Team Leader, Executive Eng., Irrigation and Power Dept.
4. Mr. Muhammad A. Shaikh	Civil Eng. Assistant Executive Engineer, Irrigation and Power Dept.
5. Mr. Noor A. Memon	Design Eng. Assistant Executive Engineer, Irrigation and Power Dept
6. Mr. Chandio S. Nawaz	Groundwater Specialist, Professor, Mehran University
7. Mr. Ali M. Jokyo	Geologist, Assistant Professor, University of Sindh
8. Dr. Muhammad Y. Memon	Agro-economist, Assistant Professor, Sindh Agriculture University
9. Mr. Shamsudin Mangi	Agronomist, Assistant Professor, Sindh Agriculture University
10. Mr. Muhammad I. Panhwer	Project Economist, Assistant Professor, University of Sindh

Table 2 SALIENT FEATURES OF KHADEJI AND MOL DAMS PROPOSED BY WAPDA

		Unit	Khadeji Dam	Mol Dam
a)	General			
	Location		7.2 km upstream of Super Highway Bridge at a distance of about 50 km from Karachi.	8.3 km upstream of Super Highway Bridge.
	River		Khadeji tributary of Maril River	Mol tributary of Maril River
	Type of dam		Concrete Gravity	Earthfill (Homogenious)
	Purpose		Groundwater recharge (Irrigation +Flood+ Drinking Water Supply)	Groundwater recharge (Irrigation +Flood+ Drinking Water Supply)
b)	Hydrology			
	Catchment area	km^2	567	611
	Mean annual rainfall	mm	217	217
	Mean annual runoff	MCM	31.2	33.7
c)	Reservoir			
	Live storage	MCM	32.3	33.2
	Flood control storage	MCM	22.4	17.8
	Dead storage	MCM	7.2	7.7
	Gross storage	MCM	61.9	58.7
	Maximum reservoir area	km^2	14.2	6.3
d)	Dam			
	Type		Concrete Gravity	Earthfill (Homogenious)
	Maximum height	m	39.0	44.2
	Length of crest	m	381	2,347
	Top width	m	9.1	12.2
	Top elevation of dam	EL. m	168.6	177.1
	Nomal full water level	EL. m	162.6	170.7
	Maximum water level	EL. m	166.3	174.7
	Slope: Upstream		1 : 0.1	1 : 3.0
	Downstream		1 : 0.7	1 : 2.0
e)	Spillway			
	Type		Overflow (gated)	Submerged weir (ungated)
	Gates	No. x m x m	5 x 12.2 x 6.1	-
	Capacity	m^3/sec	3,830	3,720
	Reservoir absorption	MCM	48.6	23.2
	Surcharge for design flood	m	3.7	4.0
	Crest elevation	EL. m	156.5	170.7
	Energy dissipation		Stilling Basin (energy dissipation by hydraulic jump)	No Stilling Basin
f)	Off-take Structure		1.8 m dia circular conduit with 1.8 m x 1.8 m control gate at inlet end through middle of overflow section discharge directly into main stilling basin.	1.8 m dia tunnel with control gate at outlet end and emergency control gate at inlet end with stilling basin on downstream end.
	Outfall Channel		-	6.5 ft. wide channel with 1-1/2 : 1 side slope discharging into natural Nullah.
g)	Irrigation System		Recharging aquifer by controlled releases from Khadeji & Mol Dams	
h)	Cropping Area	ha	5,670	
	Drinking Water Supply	MCM	13.4	

Source : Ref. 01

Table 3 PRESENT CROP PRODUCTION IN THE STUDY AREA

Crops	Summer Season			Winter Season			Annual Production
	Area (ha)	Unit Yield (t/ha)	Production (tons)	Area (ha)	Unit Yield (t/ha)	Production (tons)	(tons)
A. Fodder Crops							
Sorghum	210	11.5	2,415				2,415
Lucerne	150	13.9	2,085				2,085
Maize	50	10.6	530	50	10.6	530	1,060
Others	80	12.3	981	30	12.3	369	1,350
All Fodder	490	(12.3)	6,011	80	(11.2)	899	6,910
B. Vegetables							
Solanaceous							
Tomato	480	3.3	1,584				1,584
Eggplant	110	4.9	539	50	4.9	245	784
Chilli	10	1.0	10	40	1.0	40	50
Cucurbits							
Sponge Gourd	130	3.1	403	70	3.1	217	620
Bottle Gourd	100	4.7	470	50	4.7	235	705
Bitter Gourd	30	4.0	120	5	4.0	20	140
Cucumber	20	2.0	40				40
Water Melon	30	3.0	90				90
Musk Melon	10	2.9	29				29
Cole Crops, Green, Herbs							
Cauliflower	120	13.3	1,596				1,596
Spinach	60	2.6	156	60	2.6	156	312
Root Crops							
Carrot	100	5.4	540	50	5.4	270	810
Radish	60	4.0	240	45	4.0	180	420
Turnip	50	6.6	330	15	6.6	99	429
Legumes, others							
Peas	100	2.6	260	5	2.6	13	273
Others	110	4.5	521	30	4.5	155	676
All Vegetables	1,520	(4.6)	6,928	420	(3.9)	1,630	8,558
C. Fruits							
Guava	280	3.8	1,064				1,064
Mango	570	6.1	3,477				3,477
Chikoo	80	2.3	184				184
Coconut Palm	90	2.7	243				243
Papaya	50	7.3	365				365
Dates Palm	40	2.8	112				112
Custard Apple	10	3.0	30				30
Banana	10	8.2	82				82
Others	70	4.9	424				424
All Fruit	1,200	(5.0)	5,981				5,981
D. Other Crops							
Sesame Seed	5						
Rose Flower	5						
Others				10			
All Others	10	2.5	25	10	2.5	25	50
Total	3,220		18,945	510		2,554	21,499

Remarks: Refer to ANNEX-E.

Table 4 PRESENT LAND USE IN THE PROJECT AREA

Unit : ha

Name of Deh / Union Concil		Total Area	Agricultural Land					Non-Agricultural Land
			Irrigated Field		Rainfed	Fallow		
			Orchard	Upland	Upland	Area	Total	
DARSANO CAHANO								
1) Bail	*	120	5	5	0	0	10	110
2) Kathore	*	1,200	170	165	15	410	760	440
3) Amilano		1,150	60	65	10	135	270	880
4) Khadeji	*	220	0	5	0	5	10	210
5) Chuhar	*	650	20	20	20	55	115	535
6) Kotero	*	330	30	45	5	75	155	175
Sub-total		3,670	285	305	50	680	1,320	2,350
KANKAR								
1) Bazar		2,200	200	200	35	415	850	1,350
2) Darsano Channo	*	1,480	70	255	0	295	620	860
3) Kharkharo	*	1,170	80	85	0	135	300	870
4) Malh		1,590	220	105	0	330	655	935
Sub-total		6,440	570	645	35	1,175	2,425	4,015
LANDHI								
1) Kharkhar		990	50	115	15	200	380	610
2) Sanhro		1,010	50	160	0	275	485	525
3) Landhi	*	880	115	100	0	240	455	425
4) Khanto	*	250	25	30	0	65	120	130
Sub-total		3,130	240	405	15	780	1,440	1,690
THANO								
1) Thano		660	85	65	0	165	315	345
Sub-total		660	85	65	0	165	315	345
Total		13,900	1,180	1,420	100	2,800	5,500	8,400
Percentage			(8.5%)	(10.2%)	(0.7%)	(20.1%)	39.6%	60.4%

Remarks: Refer to ANNEX-E.

Table 5 SUMMARY OF PRODUCTION WELLS IN THE PROJECT AREA

No.	Union Council	Deh	No. of Wells shown on Map: Production Wells	Abandon. Wells	Total	Well Nos. in Project Area for Simulation	Study Area: Agri. Electric. Consummer's Record (KESC)	Well Inventory in Oct. 1989: Total	-1940	1950's	1960's	1970's	1980's
1	Darsano Chano	Amilano	21	1	22	27	31	27	3	3	10	7	4
		Chuhar	4	1	5	13	12	13	1		7	2	3
		Kothore	45	8	53	34	4	34		4	17	10	3
		Kotiraro	2	12	14	28	24	28	7	6	6	5	4
		Sub-total	72	22	94	102	71	102	11	13	40	24	14
2	Konkar	Bazar	58	4	62	29	24	29		7	14	4	4
		Darsano Chano	59	7	66	51	60	51	8	5	18	10	10
		Khar Kharo	24	3	27	35	34	35	10	4	13	2	6
		Konkar	12	3	15	0		50	11	1	8	8	22
		Malh	115	4	119	70	133 *	70	24	15	20	10	1
		Thado	1	1	2	9	9	9		1	4		4
		Tore	2		2	7		7					7
		Sub-total	271	22	293	201	260	251	53	33	77	34	54
3	Laundhi	Khakhar	2	2	4	29	30	29	8	4	2	9	6
		Khanto			0	0	7						
		Laundhi	39		39	47	55	47	16	5	11	7	8
		Sanhro	53		53	40	41	40	7	6	19	6	2
		Sub-total	94	2	96	116	133	116	31	15	32	22	16
4	Thano	Thano	27		27	47	47	47	31	7	5	3	1
			464 { 406 }	46 { 108 }	510 { 514 }	466	511	516	126	68	154	83	85

Remarks: * including wells in Konkar and Tore Union Councils.
{ } shows well numbers estimated by WAPDA in 1977.
Refer to ANNEX-G.

Table 6 SALIENT FEATURES OF EXISTING WEIRS

	Location	River	Crest: Height EL. m	Crest: Length m	Flood Water Level: Upstream EL. m	Flood Water Level: Downstream EL. m
1. Upper *	Menon G.	Malir	45.1	470	47.2	46.3
2. Lower	Thano	Malir	25.9	152	28.7	n.a
3. Sukkan	Jam Kanda	Sukkan	n.a.	98	n.a	n.a

Remarks: * Under construction and to be completed in the late 1990.
n.a. Data are not available.
Refer to ANNEX-G.

Table 7 NATURAL RECHARGE AND ARTIFICIAL RECHARGE BY DAMS

Unit: MCM

		Case-1	Case-2	Case-3	Case-4	Case-5	Csae-6	Case-7
Mol :	Natural	43.8 MCM	35.0 MCM	43.8 MCM	35.0 MCM	30.0 MCM	-	-
Khadeji :	Recharge	35.5 MCM	35.5 MCM	-	-	-	35.5 MCM	30.0 MCM
(Year)								
1929	12.9	12.9	12.9	12.9	12.9	12.9	12.9	12.9
1930	137.9	184.7	180.8	170.8	166.4	164.1	165.6	163.3
1931	6.9	6.9	6.9	6.9	6.9	6.9	6.9	6.9
1932	111.0	159.2	155.4	145.7	141.4	139.1	140.6	138.4
1933	152.2	232.8	235.6	225.3	220.9	218.5	215.1	212.8
1934	55.0	104.1	97.3	79.8	79.8	77.5	72.1	72.1
1935	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3
1936	20.4	21.7	21.7	21.7	21.7	21.7	21.7	21.7
1937	70.1	108.6	105.2	107.9	110.5	111.9	109.9	111.5
1938	23.2	24.1	24.1	24.1	24.1	24.1	24.1	24.1
1939	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
1940	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1
1941	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
1942	96.3	134.1	130.4	120.5	116.5	114.1	115.9	113.3
1943	12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
1944	203.8	292.6	296.9	297.7	293.7	291.3	282.7	280.3
1945	32.6	68.2	60.2	51.3	51.3	51.3	44.6	44.6
1946	25.1	25.1	25.1	25.1	25.1	25.1	25.1	25.1
1947	13.4	13.4	13.4	13.4	13.4	13.4	13.4	13.4
1948	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
1949	80.0	132.6	134.6	128.4	130.1	131.3	122.3	124.3
1950	21.0	29.5	25.2	25.2	25.2	25.2	25.2	25.2
1951	10.1	10.1	10.1	10.1	10.1	10.1	10.1	10.1
1952	40.5	81.2	81.2	65.0	65.0	64.8	57.0	57.0
1953	72.4	107.5	108.2	113.1	115.8	91.9	115.1	90.9
1954	47.9	87.3	84.0	71.3	71.3	71.3	62.9	62.9
1955	22.1	35.7	35.7	36.4	36.4	36.4	35.9	35.9
1956	58.8	109.1	109.1	95.7	95.7	95.7	86.6	86.7
1957	8.1	8.1	8.1	8.1	8.1	8.1	8.1	8.1
1958	26.9	55.1	55.1	47.8	47.8	47.8	42.1	42.1
1959	201.6	250.6	261.4	257.8	253.7	251.5	249.6	247.3
1960	20.6	46.3	38.3	20.6	20.6	20.6	20.6	20.6
1961	123.6	224.8	211.9	214.1	210.0	207.6	204.2	202.0
1962	66.1	134.4	126.3	96.6	96.6	96.6	88.0	88.0
1963	14.7	14.7	14.7	14.7	14.7	14.7	14.7	14.7
1964	29.0	34.7	34.7	34.7	34.7	34.7	34.7	34.7
1965	21.0	39.6	39.6	40.3	40.3	40.3	33.6	33.6
1966	17.6	19.4	19.4	19.4	19.4	19.4	19.4	19.4
1967	168.7	260.0	262.6	252.7	248.2	245.8	246.3	243.8
1968	14.4	21.2	14.4	14.4	14.4	14.4	14.4	14.4
1969	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
1970	83.6	146.4	148.9	144.6	141.1	139.8	116.1	115.5
1971	16.3	33.6	25.5	16.3	16.3	16.3	16.3	16.3
1972	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
1973	56.5	107.6	96.8	84.0	82.2	82.0	81.0	81.4
1974	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
1975	16.9	22.5	22.5	22.5	22.5	22.5	22.5	22.5
1976	31.8	55.0	55.0	55.9	55.9	55.9	55.3	55.3
1977	72.5	115.0	115.0	112.6	112.6	112.6	109.8	110.3
1978	112.8	163.4	163.4	152.2	151.1	151.2	147.0	148.3
1979	22.1	32.5	26.7	26.7	26.7	26.7	26.7	26.7
1980	12.7	12.7	12.7	12.7	12.7	12.7	12.7	12.7
1981	28.0	49.6	49.6	37.8	37.8	37.8	50.1	50.1
1982	11.3	21.6	21.6	21.6	21.6	21.6	21.6	21.6
1983	22.4	40.4	40.4	35.7	35.7	35.7	41.0	41.0
1984	107.6	144.8	145.6	135.6	131.5	129.0	130.6	128.3
1985	22.2	29.0	24.3	24.3	24.3	24.3	24.3	24.3
1986	20.4	31.8	31.8	32.3	32.3	32.3	32.0	32.0
1987	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
1988	28.5	41.9	41.9	42.1	42.1	42.1	41.9	41.9
Average	46.5	70.6	69.3	65.4	64.7	63.9	62.7	62.1

Remarks: Refer to ANNEX-D.

Table 8 POTENTIAL AND ANTICIPATED CROP YIELD

Crops	Potential Yield			Anticipated Yield		
	Crop Guide (1)	HRI (2) Mirpurkas	Hyderabad District (3)	Present	Without Project	With Project
	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)	(t/ha)
A. Fodder Crops						
Lucerne	20 - 30	-	25.4	13.9	13.9	26.0
Maize	18 - 23	-	16.4	10.6	10.6	18.0
B. Vegetables						
Solanaceous						
Tomato	5 - 10	23.2	6.0	3.3	3.3	7.0
Eggplant	5 - 10	19.1	7.8	4.9	4.9	9.0
Chilli	5 - 10	7.2	2.3	1.0	1.0	2.5
Cucurbits						
Sponge Gourd	10 - 15	-	9.8	3.1	3.1	11.0
Bottle Gourd	8 - 15	22.2	5.9	4.7	4.7	8.0
Cole Crops, Green, Herbs						
Cauliflower	13 - 18	23.1	9.7	13.3	13.3	16.0
Spinach	10 - 13	-	4.9	2.6	2.6	6.0
Root Crops						
Carrot	10 - 13	14.2	10.1	5.4	5.4	11.0
Radish	18 - 20	16.8	11.0	4.0	4.0	13.0
Turnip	13 - 20	12.2	13.8	6.6	6.6	15.0
Legunes, others						
Peas	8 - 10	6.2	3.9	2.6	2.6	5.0
C. Fruits						
Guava	-	-	6.3	3.8	3.8	7.0
Mango	-	-	8.5	6.1	6.1	9.0
Chikoo	-	-	2.7	2.3	2.3	3.0
Coconut	-	-	-	2.7	2.7	4.0
Papaya	-	-	6.9	7.3	7.3	8.5

Sources : 1) Crop Guide ; Agricultural Extension Depertment, Government of Sindh
2) HRI ; Vegetable Reseach Station, Horticulture Research Institute, Mirpurkhas
3) Hyderabad District , 1987/88 ; Bureau of Statistics, Planning and Development Department, Government of Sindh

Remarks : Refer to ANNEX-E

Table 9 INCREMENTAL CROP PRODUCTION WITHOUT AND WITH PROJECT

Crops	Without Project			With Project			Incremental Production
	Cropped Area (ha)	Unit Yield (t/ha)	Production (tons)	Cropped Area (ha)	Unit Yield (t/ha)	Production (tons)	(tons)
A. Fodder Crops							
Lucerne	100	13.9	1,390	100	26.0	2,600	1,210
Maize, others	90	10.6	954	100	18.0	1,800	846
All Fodder	190	(12.3) *	2,344	200	(22.0) *	4,400	2,056
B. Vegetables							
Tomato	400	3.3	1,320	1,000	7.0	7,000	5,680
Eggplant	140	4.9	686	500	9.0	4,500	3,814
Chilli	20	1.0	20	350	2.5	875	855
Sponge Gourd	160	3.1	496	1,000	11.0	11,000	10,504
Bottle Gourd	120	4.7	564	400	8.0	3,200	2,636
Cauliflower	100	13.3	1,330	300	16.0	4,800	3,470
Spinach	110	2.6	286	300	6.0	1,800	1,514
Carrot	120	5.4	648	200	11.0	2,200	1,552
Radish	70	4.0	280	150	13.0	1,950	1,670
Turnip	50	6.6	330	150	15.0	2,250	1,920
Peas	80	2.6	208	200	5.0	1,000	792
Others	170	4.5	788	750	8.9	6,071	5,283
All Vegetables	1,540	(4.5) *	6,956	5,300	(8.8) *	46,646	39,690
C. Fruits							
Guava	280	3.8	1,064	280	7.0	1,960	896
Mango	390	6.1	2,379	390	9.0	3,510	1,131
Chikoo	80	2.3	184	80	3.0	240	56
Coconut	90	2.7	243	90	4.0	360	117
Papaya	50	7.3	365	50	8.5	425	60
Others	110	4.8	523	110	6.9	761	238
All Fruit	1,000	(4.8) *	4,758	1,000	(7.3) *	7,256	2,498
Total	2,730		14,058	6,500		58,302	44,244

Remarks : (*) ; weighted average.
Refer to ANNEX-E

Table 10 UNIT NET INCOME WITHOUT AND WITH PROJECT

Crops	Without Project				With Project			
	Unit Yield (tons/ha)	Gross Income (Rs./ha)	Product. Cost (Rs./ha)	Net Income (Rs./ha)	Unit Yield (tons/ha)	Gross Income (Rs./ha)	Product. Cost (Rs./ha)	Net Income (Rs./ha)
A. Fodder Crops								
Lucerne	13.9	5,838	3,785	2,053	26.0	10,920	5,539	5,381
Maize, others	10.6	3,392	2,546	846	18.0	5,760	3,596	2,164
B. Vegetables								
Tomato	3.3	11,418	7,471	3,947	7.0	24,220	9,440	14,780
Eggplant	4.9	12,005	6,447	5,558	9.0	22,050	9,033	13,017
Chilli	1.0	7,660	5,759	1,901	2.5	19,150	8,560	10,590
Sponge Gourd	3.1	10,261	5,258	5,003	11.0	36,410	6,770	29,640
Bottle Gourd	4.7	13,536	5,841	7,695	8.0	23,040	7,190	15,850
Cauliflower	13.3	40,698	6,843	33,855	16.0	48,960	8,681	40,279
Spinach	2.6	4,498	4,274	224	6.0	10,380	6,145	4,235
Carrot	5.4	8,424	5,822	2,602	11.0	17,160	8,744	8,416
Raddish	4.0	7,800	6,200	1,600	13.0	25,350	8,807	16,543
Tunip	6.6	14,652	6,400	8,252	15.0	33,300	8,954	24,346
Peas	2.6	9,568	5,754	3,814	5.0	18,400	7,526	10,874
Others	4.5	12,991	6,289	6,702	8.8	24,196	8,124	16,072
C. Fruit								
Mango (2)	6.1	8,982	4,650	4,332	9.0	25,263	6,019	19,244
Guava (2)	3.8	8,071	4,954	3,117	7.0	19,824	6,299	13,525
Chikoo (2)	2.3	4,830	3,878	952	3.0	9,100	4,577	4,523
Coconut (2)	2.7	5,940	4,531	1,409	4.0	19,338	4,932	14,406
Papaya	7.3	15,257	10,159	5,098	8.5	12,584	6,471	6,113
Others	4.8	8,360	4,974	3,387	1.9	20,788	5,893	14,894

Remarks: Refer to ANNEX-F.

Table 11 INCREMENTAL NET INCOME WITHOUT AND WITH PROJECT

Unit : Rs ,000

Crops	Without Project			With Project			Incremental Value
	Gross Income	Total Cost	Net Income	Gross Income	Total Cost	Net Income	
A. Fodder Crops							
Lucerne	584	379	205	1,092	554	538	333
Maize, others	305	229	76	576	360	216	140
Sub-total	889	608	281	1,668	914	755	473
B. Vegetables							
Tomato	4,567	2,988	1,579	24,220	9,440	14,780	13,201
Eggplant	1,681	903	778	11,025	4,517	6,509	5,730
Chilli	153	115	38	6,703	2,996	3,707	3,668
Sponge Gourd	1,642	841	800	36,410	6,770	29,640	28,840
Bottle Gourd	1,624	701	923	9,216	2,876	6,340	5,417
Cauliflower	4,070	684	3,386	14,688	2,604	12,084	8,698
Spinach	495	470	25	3,114	1,844	1,271	1,246
Carrot	1,011	699	312	3,432	1,749	1,683	1,371
Radish	546	434	112	3,803	1,321	2,481	2,369
Turnip	733	320	413	4,995	1,343	3,652	3,239
Peas	765	460	305	3,680	1,505	2,175	1,870
Others	2,208	1,069	1,139	18,147	6,093	12,054	10,915
Sub-total	19,495	9,685	9,810	139,432	43,057	96,375	86,564
C. Fruit							
Guava	6,522	1,960	4,561	9,853	2,348	7,505	2,944
Mango	3,013	1,460	1,554	5,551	1,764	3,787	2,234
Chikoo	558	322	236	728	366	362	126
Coconut	1,176	374	802	1,740	444	1,297	495
Papaya	540	261	279	629	324	306	27
Others	1,460	541	919	2,287	648	1,638	720
Sub-total	13,269	4,918	8,351	20,788	5,893	14,894	6,544
Total	33,653	15,211	18,442	161,888	49,864	112,024	93,581

Remarks : Refer to ANNEX-F.

Table 12 SUMMARY OF IRRIGATION WATER DEMAND

Unit:MCM

	Item	Irrigation Water Demand	
		WAPDA Report*1	JICA Estimate*2 (1929 - 1988)
1	WAPDA Report (1982) (Without Project Condition)		
	- Condition in 1977	62.0	65.3 *3
	- Projection in 1987	-	53.1 *3
	- Projection in 2002	-	35.6 *3
2	Present Cropping Pattern in 1987/88	-	42.0
3	Pumped Volume in 1987/88 Estimated based on KESC's Data	-	35.5

Remarks: *1 Pan evaporation data (1960-1966) were used in estimating irrigation demand.
*2 Only field application efficiency of 60% is considered, since irrigation area is limited to only 5-20 ha.
*3 Shows average irrigation water demand (1929 - 1988).

Refer to ANNEX-G.

Table 13 IRRIGATION WATER DEMAND - PROPOSED CROPPING PATTERN (1/3)

Summary of Crop and Basic Assumption

No.	Crop	Application Efficiency	Percolation Loss Code	Land prepartion Code	Pre-irrigation Code	Growing Stages
1	1 Crucifers	0.60	0	0	1	6
2	2 Cucumber	0.60	0	0	1	8
3	3 Tomatoes	0.60	0	0	1	9
4	4 Melon	0.60	0	0	1	8
5	5 Raddish	0.60	0	0	1	6
6	6 Fodder (Maize)	0.60	0	0	1	6
7	7 Alphalfa	0.60	0	0	1	24
8	8 Chillies	0.60	0	0	1	9
9	9 Beans (green)	0.60	0	0	1	6
10	10 Orchard (Citrus) 70%	0.60	0	0	0	24
11	11 Orchard (citrus) 20%	0.60	0	0	0	24
12	12 Upland Crops	0.60	0	0	1	6

No.	Crop	Crop Coefficient (by growing stage)											
1	1 Crucifers	0.42	0.50	0.70	0.95	0.95	0.85						
2	2 Cucumber	0.40	0.45	0.70	0.90	0.92	0.92	0.92	0.85				
3	3 Tomatoes	0.42	0.42	0.55	0.80	1.00	1.05	1.05	0.95	0.70			
4	4 Melon	0.38	0.40	0.60	0.90	0.98	0.98	0.98	0.90				
5	5 Raddish	0.45	0.55	0.80	1.05	1.05	0.75						
6	6 Fodder (Maize)	0.45	0.55	0.85	1.05	1.05	0.95						
7	7 Alphalfa	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
		0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
8	8 Chillies	0.65	0.75	0.85	0.95	1.00	1.00	1.00	0.95	0.90			
9	9 Beans (green)	0.45	0.52	0.75	0.95	0.95	0.90						
10	10 Orchard (Citrus) 70%	0.75	0.75	0.75	0.75	0.70	0.70	0.70	0.70	0.70	0.70	0.65	0.65
		0.65	0.65	0.65	0.65	0.65	0.65	0.70	0.70	0.70	0.70	0.70	0.70
11	11 Orchard (citrus) 20%	0.55	0.55	0.55	0.55	0.50	0.50	0.50	0.50	0.50	0.50	0.45	0.45
		0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.50	0.50	0.50	0.50
12	12 Upland Crops	1.00	1.00	1.00	1.00	1.00	1.00						

Remarks; 1 growing stage = 15 days

Summary of crop and basic assumptionin Malir Project (Proposed Cropping P., C.I=1.50)

No.	Crop	Cultiva. Area(ha)	Date of Water Issue	Land Preparation Period (stages)
1	1 Crucifers	600.	7/ 1	6
3	3 Tomatoes	1500.	7/ 1	6
5	5 Raddish	500.	8/ 1	6
6	6 Fodder (Maize)	50.	8/ 1	4
7	7 Alphalfa	100.	7/ 1	12
9	9 Beans (green)	600.	8/ 1	6
10	10 Orchard (Citrus) 70%	1000.	7/ 1	12
2	2 Cucumber	1400.	1/ 1	8
3	3 Tomatoes	350.	1/ 1	8
6	6 Fodder (Maize)	50.	1/ 1	4
9	9 Beans (green)	350.	1/ 1	8
	Total Project Area	4350.		

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Potential ET (mm)	110.0	125.0	192.0	224.0	253.0	233.0	193.0	176.0	179.0	166.0	123.0	101.0
Conveyance Efficiency	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Return Flow Factor	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15

Unit:mm

Code	1	2	3	4	5	6	7	8	9	10
Land Preparation	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Percoration Losses	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
Pre-irrigation	50.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Table 13 IRRIGATION WATER DEMAND - PROPOSED CROPPING PATTERN (2/3)

Diversion Water Requirement for Malir Project (Proposed Cropping P., C.I=1.50)
(Total Area : 4350. ha)

Unit : MCM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1929	3.29	3.24	5.87	8.15	9.00	7.23	4.49	5.83	7.85	8.89	5.22	3.44	72.50
1930	3.07	3.24	5.87	8.06	9.00	5.66	0.03	5.96	7.85	8.89	6.31	3.95	67.89
1931	3.29	3.13	5.71	8.15	9.00	7.23	5.71	5.96	7.85	8.89	6.31	3.95	75.17
1932	3.20	3.24	5.87	8.15	9.00	7.23	0.29	5.17	7.85	8.89	6.31	3.95	69.15
1933	3.29	3.21	5.87	8.10	8.79	7.23	0.01	3.84	6.55	8.89	6.31	3.95	66.06
1934	3.31	3.24	5.80	8.15	9.00	6.26	1.92	5.83	7.85	8.89	6.31	3.69	70.25
1935	2.97	2.64	5.87	7.02	9.00	7.23	5.63	5.86	7.85	8.89	6.31	3.95	73.23
1936	3.29	2.94	5.84	8.15	9.00	6.67	4.15	5.99	7.85	8.89	6.31	3.89	72.96
1937	3.31	2.74	5.87	8.15	9.00	7.23	1.16	5.99	7.85	8.89	6.31	2.23	68.74
1938	3.31	3.24	5.87	8.10	8.87	7.20	4.75	4.14	7.85	8.89	6.31	3.80	72.33
1939	3.31	2.22	4.27	8.06	9.00	7.23	5.82	5.99	7.85	8.89	6.12	3.95	72.72
1940	1.96	2.58	4.54	8.15	9.00	6.91	4.49	4.46	7.85	8.89	6.31	3.69	68.83
1941	3.26	3.24	5.87	8.15	9.00	7.23	4.68	5.99	7.85	8.89	6.31	3.95	74.43
1942	2.99	2.68	5.74	8.15	9.00	7.23	0.63	5.45	7.85	8.89	6.31	3.66	68.59
1943	2.93	3.24	5.87	8.15	9.00	7.13	4.56	5.93	7.85	8.89	6.31	3.95	73.80
1944	3.20	2.30	5.87	8.15	9.00	7.23	0.33	0.07	7.85	8.89	6.31	3.92	63.11
1945	2.28	3.24	5.87	8.15	9.00	7.23	3.24	5.93	7.71	8.89	6.31	3.89	71.74
1946	3.31	3.24	5.87	8.15	9.00	7.16	4.44	4.81	7.85	8.89	6.31	3.95	72.98
1947	3.31	3.21	5.87	8.15	9.00	7.23	5.82	4.65	7.75	8.89	6.31	3.74	73.95
1948	3.31	2.70	4.99	8.15	9.00	6.00	4.92	5.99	7.85	8.89	6.31	3.74	71.85
1949	3.31	3.24	5.87	8.15	9.00	7.23	2.51	1.14	7.85	8.89	6.31	3.95	67.45
1950	3.07	3.24	5.87	8.15	9.00	7.23	4.01	5.99	7.85	8.89	6.31	3.95	73.57
1951	3.31	3.24	5.87	8.06	9.00	7.23	4.82	5.03	7.80	8.89	6.31	3.95	73.52
1952	3.31	2.53	5.87	8.15	9.00	7.23	2.01	5.99	6.86	8.89	6.31	3.86	70.02
1953	3.29	3.24	5.87	8.15	9.00	6.00	5.79	0.74	7.85	8.89	6.31	3.74	68.87
1954	2.93	2.62	5.87	8.15	9.00	7.23	4.44	5.00	2.24	8.89	6.31	3.95	66.64
1955	3.09	2.98	5.87	8.15	9.00	7.23	5.82	5.12	4.18	8.89	6.31	3.86	70.50
1956	2.87	3.24	5.87	7.98	9.00	5.94	2.08	3.53	7.85	4.29	6.31	3.95	62.90
1957	3.24	3.24	5.87	7.94	9.00	7.23	5.39	5.80	7.85	8.89	6.12	3.80	74.39
1958	3.18	3.19	5.87	8.15	9.00	7.23	2.67	5.99	6.55	8.89	6.26	2.56	69.55
1959	3.24	3.19	5.87	8.15	9.00	7.23	0.85	4.68	0.01	8.89	3.02	3.92	58.06
1960	3.26	3.24	4.93	8.15	9.00	7.23	4.73	5.17	7.85	8.89	6.31	3.33	72.10
1961	2.95	2.18	5.87	7.71	9.00	6.73	1.83	1.11	1.68	8.89	6.31	3.92	58.17
1962	3.31	3.24	5.87	8.15	9.00	7.23	3.82	4.78	2.31	8.89	6.31	3.77	66.70
1963	3.31	3.24	5.87	8.10	9.00	7.23	5.79	5.71	7.85	8.89	5.06	3.95	74.01
1964	3.26	3.13	5.87	8.15	9.00	7.16	3.92	4.59	7.71	8.89	6.31	3.95	71.95
1965	3.31	3.24	5.87	8.02	9.00	7.23	3.22	5.45	7.85	8.89	6.31	3.95	72.35
1966	3.31	3.24	5.84	8.15	9.00	7.23	4.13	5.99	7.85	8.89	6.31	3.95	73.89
1967	3.31	3.24	2.31	7.24	9.00	6.88	0.00	3.29	7.85	8.89	6.08	3.55	61.63
1968	3.07	3.15	5.87	8.15	9.00	7.23	5.82	5.83	7.85	8.89	6.31	3.77	74.95
1969	3.31	3.21	5.87	8.15	9.00	7.23	4.85	5.99	7.85	8.89	6.31	3.95	74.62
1970	3.16	3.08	4.11	8.15	9.00	7.06	2.21	1.81	4.54	8.89	6.31	3.95	62.28
1971	3.24	3.24	5.87	8.15	9.00	7.23	4.97	5.12	7.85	8.89	6.31	3.92	73.78
1972	3.31	3.17	5.87	8.15	9.00	6.61	5.39	5.99	7.85	8.89	6.31	3.83	74.37
1973	3.31	3.24	5.87	8.15	9.00	7.23	1.47	5.40	7.85	8.89	6.31	3.71	70.43
1974	3.31	3.24	5.87	8.15	9.00	7.23	5.82	5.99	7.85	8.89	6.31	3.80	75.47
1975	3.03	2.80	4.99	8.15	9.00	7.23	5.82	3.87	6.98	8.89	6.31	3.95	71.02
1976	2.00	3.02	4.99	8.15	9.00	7.23	1.04	4.95	6.10	8.89	6.31	3.95	65.63
1977	3.09	3.24	5.87	8.06	9.00	6.20	0.18	4.73	4.47	8.89	6.08	3.95	63.77
1978	3.01	3.15	5.87	8.15	9.00	7.03	1.58	1.30	7.85	8.89	6.31	3.95	66.09
1979	3.29	1.38	5.87	8.15	9.00	7.13	5.82	0.33	7.85	8.72	6.31	3.58	67.43
1980	3.31	3.24	5.56	8.15	9.00	5.94	4.68	5.99	7.85	7.73	6.04	2.28	69.77
1981	3.31	2.72	3.81	8.02	9.00	7.23	4.80	4.76	7.85	8.89	6.31	3.95	70.65
1982	3.26	2.74	5.87	8.15	9.00	7.23	5.12	3.11	7.85	8.89	6.31	3.92	71.45
1983	3.31	3.17	5.87	6.74	9.00	7.23	4.46	1.71	6.82	8.89	6.31	3.95	67.47
1984	3.31	3.24	5.87	8.15	9.00	7.23	5.32	0.40	7.67	8.89	6.31	3.95	69.34
1985	3.31	3.24	5.87	6.42	9.00	7.23	3.85	5.26	7.85	8.89	6.31	3.95	71.17
1986	3.31	3.24	5.53	8.15	9.00	6.70	5.82	4.24	7.85	8.89	6.31	3.95	72.99
1987	3.31	3.24	5.87	8.15	9.00	7.23	5.82	5.99	7.85	8.89	6.31	3.95	75.62
1988	3.29	3.24	5.87	8.15	9.00	7.23	3.99	3.63	7.85	8.89	6.31	3.95	71.40
Ave.	3.17	3.04	5.62	8.04	9.00	7.03	3.73	4.59	7.12	8.79	6.20	3.79	70.10

Table 13 IRRIGATION WATER DEMAND - PROPOSED CROPPING PATTERN (3/3)

Deep Percolation of Malir Project (Proposed Cropping P., C.I=1.50)
(Total Area : 4350. ha)

Unit : MCM

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1929	0.49	0.49	0.88	1.22	1.35	1.08	0.67	0.88	1.18	1.33	0.78	0.52	10.87
1930	0.46	0.49	0.88	1.21	1.35	0.85	0.00	0.89	1.18	1.33	0.95	0.59	10.18
1931	0.49	0.47	0.86	1.22	1.35	1.08	0.86	0.89	1.18	1.33	0.95	0.59	11.28
1932	0.48	0.49	0.88	1.22	1.35	1.08	0.04	0.78	1.18	1.33	0.95	0.59	10.37
1933	0.49	0.48	0.88	1.22	1.32	1.08	0.00	0.58	0.98	1.33	0.95	0.59	9.91
1934	0.50	0.49	0.87	1.22	1.35	0.94	0.29	0.88	1.18	1.33	0.95	0.55	10.54
1935	0.45	0.40	0.88	1.05	1.35	1.08	0.84	0.88	1.18	1.33	0.95	0.59	10.98
1936	0.49	0.44	0.88	1.22	1.35	1.00	0.62	0.90	1.18	1.33	0.95	0.58	10.94
1937	0.50	0.41	0.88	1.22	1.35	1.08	0.17	0.90	1.18	1.33	0.95	0.33	10.31
1938	0.50	0.49	0.88	1.22	1.33	1.08	0.71	0.62	1.18	1.33	0.95	0.57	10.85
1939	0.50	0.33	0.64	1.21	1.35	1.08	0.87	0.90	1.18	1.33	0.92	0.59	10.91
1940	0.29	0.39	0.68	1.22	1.35	1.04	0.67	0.67	1.18	1.33	0.95	0.55	10.32
1941	0.49	0.49	0.88	1.22	1.35	1.08	0.70	0.90	1.18	1.33	0.95	0.59	11.16
1942	0.45	0.40	0.86	1.22	1.35	1.08	0.10	0.82	1.18	1.33	0.95	0.55	10.29
1943	0.44	0.49	0.88	1.22	1.35	1.07	0.68	0.89	1.18	1.33	0.95	0.59	11.07
1944	0.48	0.34	0.88	1.22	1.35	1.08	0.05	0.01	1.18	1.33	0.95	0.59	9.47
1945	0.34	0.49	0.88	1.22	1.35	1.08	0.49	0.89	1.16	1.33	0.95	0.58	10.76
1946	0.50	0.49	0.88	1.22	1.35	1.07	0.67	0.72	1.18	1.33	0.95	0.59	10.95
1947	0.50	0.48	0.88	1.22	1.35	1.08	0.87	0.70	1.16	1.33	0.95	0.56	11.09
1948	0.50	0.41	0.75	1.22	1.35	0.90	0.74	0.90	1.18	1.33	0.95	0.56	10.78
1949	0.50	0.49	0.88	1.22	1.35	1.08	0.38	0.17	1.18	1.33	0.95	0.59	10.12
1950	0.46	0.49	0.88	1.22	1.35	1.08	0.60	0.90	1.18	1.33	0.95	0.59	11.04
1951	0.50	0.49	0.88	1.21	1.35	1.08	0.72	0.75	1.17	1.33	0.95	0.59	11.03
1952	0.50	0.38	0.88	1.22	1.35	1.08	0.30	0.90	1.03	1.33	0.95	0.58	10.50
1953	0.49	0.49	0.88	1.22	1.35	0.90	0.87	0.11	1.18	1.33	0.95	0.56	10.33
1954	0.44	0.39	0.88	1.22	1.35	1.08	0.67	0.75	0.34	1.33	0.95	0.59	10.00
1955	0.46	0.45	0.88	1.22	1.35	1.08	0.87	0.77	0.63	1.33	0.95	0.58	10.58
1956	0.43	0.49	0.88	1.20	1.35	0.89	0.31	0.53	1.18	0.64	0.95	0.59	9.43
1957	0.49	0.49	0.88	1.19	1.35	1.08	0.81	0.87	1.18	1.33	0.92	0.57	11.16
1958	0.48	0.48	0.88	1.22	1.35	1.08	0.40	0.90	0.98	1.33	0.94	0.38	10.43
1959	0.49	0.48	0.88	1.22	1.35	1.08	0.13	0.70	0.00	1.33	0.45	0.59	8.71
1960	0.49	0.49	0.74	1.22	1.35	1.08	0.71	0.78	1.18	1.33	0.95	0.50	10.81
1961	0.44	0.33	0.88	1.16	1.35	1.01	0.27	0.17	0.25	1.33	0.95	0.59	8.73
1962	0.50	0.49	0.88	1.22	1.35	1.08	0.57	0.72	0.35	1.33	0.95	0.57	10.00
1963	0.50	0.49	0.88	1.22	1.35	1.08	0.87	0.86	1.18	1.33	0.76	0.59	11.10
1964	0.49	0.47	0.88	1.22	1.35	1.07	0.59	0.69	1.16	1.33	0.95	0.59	10.79
1965	0.50	0.49	0.88	1.20	1.35	1.08	0.48	0.82	1.18	1.33	0.95	0.59	10.85
1966	0.50	0.49	0.88	1.22	1.35	1.08	0.62	0.90	1.18	1.33	0.95	0.59	11.08
1967	0.50	0.49	0.35	1.09	1.35	1.03	0.00	0.49	1.18	1.33	0.91	0.53	9.24
1968	0.46	0.47	0.88	1.22	1.35	1.08	0.87	0.88	1.18	1.33	0.95	0.57	11.24
1969	0.50	0.48	0.88	1.22	1.35	1.08	0.73	0.90	1.18	1.33	0.95	0.59	11.19
1970	0.47	0.46	0.62	1.22	1.35	1.06	0.33	0.27	0.68	1.33	0.95	0.59	9.34
1971	0.49	0.49	0.88	1.22	1.35	1.08	0.75	0.77	1.18	1.33	0.95	0.59	11.07
1972	0.50	0.48	0.88	1.22	1.35	0.99	0.81	0.90	1.18	1.33	0.95	0.57	11.16
1973	0.50	0.49	0.88	1.22	1.35	1.08	0.22	0.81	1.18	1.33	0.95	0.56	10.56
1974	0.50	0.49	0.88	1.22	1.35	1.08	0.87	0.90	1.18	1.33	0.95	0.57	11.32
1975	0.45	0.42	0.75	1.22	1.35	1.08	0.87	0.58	1.05	1.33	0.95	0.59	10.65
1976	0.30	0.45	0.75	1.22	1.35	1.08	0.16	0.74	0.91	1.33	0.95	0.59	9.84
1977	0.46	0.49	0.88	1.21	1.35	0.93	0.03	0.71	0.67	1.33	0.91	0.59	9.57
1978	0.45	0.47	0.88	1.22	1.35	1.05	0.24	0.20	1.18	1.33	0.95	0.59	9.91
1979	0.49	0.21	0.88	1.22	1.35	1.07	0.87	0.05	1.18	1.31	0.95	0.54	10.11
1980	0.50	0.49	0.83	1.22	1.35	0.89	0.70	0.90	1.18	1.16	0.91	0.34	10.46
1981	0.50	0.41	0.57	1.20	1.35	1.08	0.72	0.71	1.18	1.33	0.95	0.59	10.60
1982	0.49	0.41	0.88	1.22	1.35	1.08	0.77	0.47	1.18	1.33	0.95	0.59	10.72
1983	0.50	0.48	0.88	1.01	1.35	1.08	0.67	0.26	1.02	1.33	0.95	0.59	10.12
1984	0.50	0.49	0.88	1.22	1.35	1.08	0.80	0.06	1.15	1.33	0.95	0.59	10.40
1985	0.50	0.49	0.88	0.96	1.35	1.08	0.58	0.79	1.18	1.33	0.95	0.59	10.68
1986	0.50	0.49	0.83	1.22	1.35	1.00	0.87	0.64	1.18	1.33	0.95	0.59	10.95
1987	0.50	0.49	0.88	1.22	1.35	1.08	0.87	0.90	1.18	1.33	0.95	0.59	11.34
1988	0.49	0.49	0.88	1.22	1.35	1.08	0.60	0.54	1.18	1.33	0.95	0.59	10.71
Ave.	0.47	0.46	0.84	1.21	1.35	1.05	0.56	0.69	1.07	1.32	0.93	0.57	10.52

Table 14 SALIENT FEATURES OF MOL DAM

		Unit	Mol Dam
a)	General		
	Location		8.3 km upstream of Super Highway Bridge.
	River		Mol tributary of Maril River
	Type of dam		Rockfill (Zone type)
	Purpose		Groundwater recharge (Irrigation + Domestic Water Supply)
b)	Hydrology		
	Catchment area	km^2	596
	Mean annual rainfall	mm	231
	Mean annual runoff	MCM	44.9
c)	Reservoir		
	Live storage	MCM	35.0
	Flood control storage	MCM	0.0
	Dead storage	MCM	10.7
	Gross storage	MCM	45.7
	Maximum reservoir area	km^2	5.5
d)	Dam		
	Type		Rockfill (Zone type)
	Maximum height	m	48.8
	Length of crest	m	2,347
	Top width	m	10.0
	Crest elevation of dam	EL. m	175.3
	Nomal full water level	EL. m	169.6
	Maximum water level	EL. m	173.0
	Slope: Upstream		1 : 2.5
	Downstream		1 : 2.0
	Dam volume	10^3 m^3	1,730
e)	Spillway		
	Type		Submerged weir (ungated)
	Portable maximum flood	m^3/sec	4,280
	Design capacity	m^3/sec	4,100
	Surcharge for design flood	m	3.4
	Crest elevation	EL. m	169.6
	Energy dissipation		No Stilling Basin
f)	Off-take Structure		2.4 m dia tunnel with control gate at outlet end and emergency control gate at inlet end with stilling basin on downstream end.
	Outfall Channel		Channel into natural Nullah.
g)	Irrigation System		Recharging aquifer by controlled releases from Mol Dam
h)	Irrigation Area (Cropped area)	ha	4,350 (6,500)
	Domestic Water Supply	MCM	3.3

Refer to ANNEX-H

Table 15 SUMMARY OF PROJECT COST

Unit: Rs.10^6

Item	Foreign Currency	Local Currency	Total
1. Direct Construction Cost			
1.1 Preparatory Works	27.0	5.9	32.9
1.2 Mol Dam	362.6	76.8	439.4
A. Main Dam	212.3	36.5	248.8
B. Saddle Dam	10.9	2.0	12.9
C. Spillway	51.8	16.7	68.5
D. Intake Facility	68.9	13.2	82.1
E. Diversion Works	9.9	3.5	13.4
F. Access Road	8.8	3.8	12.6
G. Land Acquisition	0.0	1.1	1.1
1.3 Causeway	2.4	3.8	6.2
1.4 Pilot Demonstration Farm	10.4	2.9	13.3
1.5 Project Office	0.4	0.8	1.2
Sub-total	402.8	90.2	493.0
2. Procurement of O & M Equipment	10.3	0.0	10.3
3. Physical Contingency	58.2	12.8	71.0
4. Administration Cost	0.0	6.7	6.7
5. Engineering Services	59.6	16.4	76.0
Sub-total	530.9	126.1	657.0
6. Price Contingency	0.0	28.6	28.6
Grand Total	530.9	154.7	685.6

Table 16 BREAKDOWN OF DIRECT CONSTRUCTION COST FOR MOL DAM (35 MCM)

Work Item	Unit	Unit Rate (Rs.) F/C	Unit Rate (Rs.) L/C	Q'ty	Amount (1000 Rs.) F/C	Amount (1000 Rs.) L/C	Amount (1000 Rs.) Total
1. Direct Construction Cost							
1.1 Preparatory Works				7%	27,029	5,903	32,933
1.2 Mol Dam					362,656	76,840	439,496
A. Main Dam							
1) Excavation							
a) Common (Backehoe)	m3	39.0	6.5	38,100	1,486	248	1,734
b) Common (Bulldozer) (1)	m3	57.7	7.4	44,500	2,568	329	2,897
c) Common (Bulldozer) (2)	m3	57.7	7.4	44,400	2,562	329	2,890
d) W. Rock (1)	m3	88.7	10.8	36,900	3,273	399	3,672
e) W. Rock (2)	m3	40.1	4.8	86,000	3,449	413	3,861
f) Rock (1)	m3	129.2	24.5	15,800	2,041	387	2,428
g) Rock (2)	m3	76.1	26.9	36,800	2,800	990	3,790
2) Filling							
a) Zone 1 (Core)	m3	119.9	16.4	298,900	35,838	4,902	40,740
b) Zone 2 (Random) (1)	m3	63.7	9.1	154,300	9,829	1,404	11,233
c) Zone 2 (Random) (2)	m3	63.7	9.1	99,300	6,325	904	7,229
d) Zone 2 (Random) (3)	m3	87.4	11.7	312,400	27,304	3,655	30,959
e) Zone 3 (Rock) (1)	m3	81.9	10.0	81,100	6,642	811	7,453
f) Zone 3 (Rock) (2)	m3	81.9	10.0	162,000	13,268	1,620	14,888
g) Zone 3 (Rock) (3)	m3	136.4	23.5	323,800	44,166	7,609	51,776
h) Rock facing	m3	136.4	23.5	83,000	11,321	1,951	13,272
i) Filter	m3	168.5	21.1	181,100	30,515	3,821	34,337
3) Foundation Treatment							
a) Curtain Gronting	m	555.8	421.6	9,500	5,280	4,005	9,285
b) Blanket Gronting	m	555.8	421.6	6,600	3,668	2,783	6,451
Total (A)					212,336	36,558	248,895
B. Saddle Dam							
1) Excavation							
a) Common (Bulldozer) (1)	m3	57.7	7.4	5,200	300	38	339
b) Common (Bullozoer) (2)	m3	16.1	2.4	5,100	82	12	94
c) W. Rock (1)	m3	88.7	10.8	15,400	1,366	166	1,532
d) W. Rock (2)	m3	40.1	4.8	35,900	1,440	172	1,612
e) Rock (1)	m3	129.2	24.5	12,300	1,589	301	1,891
f) Rock (2)	m3	76.1	26.9	28,800	2,192	775	2,966
2) Filling							
a) Zone 1 (Core)	m3	119.9	16.4	24,800	2,974	407	3,380
b) Zone 3 (Rock)	m3	81.9	10.0	4,200	344	42	386
c) Rock Facing	m3	136.4	23.5	4,400	600	103	704
Total (B)					10,886	2,018	12,904
C. Spillway							
1) Excavation							
a) Common (1)	m3	57.7	7.4	35,600	2,054	263	2,318
b) Common (2)	m3	16.1	2.4	35,600	573	85	659
c) W. Rock (1)	m3	88.7	10.8	32,000	2,838	346	3,184
d) W. Rock (2)	m3	40.1	4.8	74,800	2,999	359	3,359
e) Rock (1)	m3	129.2	24.5	53,400	6,899	1,308	8,208
f) Rock (2)	m3	63.8	16.8	124,600	7,949	2,093	10,043
2) Concrete Works							
a) Concrete (210 kg/cm2)	m3	1435.1	503.7	1,400	2,009	705	2,714
b) Concrete (180 kg/cm2)	m3	1134.4	405.9	18,800	21,327	7,631	28,958
c) Reiforcement bar	ton	13003.4	9827.1	400	5,201	3,931	9,132
Total (C)					51,851	16,722	68,573
D. Intake Facilities							
1) Earth Works							
a) Common Excavation	m3	57.7	7.4	14,900	860	110	970
b) W. Rock	m3	88.7	10.8	124,100	11,008	1,340	12,348
c) Rock	m3	133.5	33.8	53,200	7,102	1,798	8,900
2) Concrte Works							
a) Concrete (210kg/cm2)	m3	1435.1	503.7	11,100	15,930	5,591	21,521
b) Reinforcement bar	ton	13003.4	9827.1	440	5,721	4,324	10,045
c) Steel pipe	ton	28600.0	0.0	100	2,860	0	2,860
d) High pressure gate	set			2	11,424	0	11,424
e) Gates	set			4	14,000	0	14,000
Total (D)					68,905	13,164	82,068
E. Diversion Works					9,900	3,540	13,440
F. Acess Road					8,778	3,762	12,540
G. Land Acquisition					0	1,076	1,076
1.3 Causeway	Nos.	605,328	946,553	4	2,421	3,786	6,208
1.4 Pilot Demonstration Farm					10,393	2,869	13,262
1.5 Project Office					360	840	1,200
2. O &M Equipment		10,300	0		10,300	0	10,300
3. Physical Contingency					58,152	12,750	70,902
4. Administration Cost					0	6,700	6,700
5. Engineering Services					59,600	16,400	76,000
Total(1-5)					530,912	126,088	657,000

Table 17 ANNUAL DISBURSEMENT SCHEDULE

(Unit: Rs.10^3)

Work Item	Amount			1,991			1,992		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Preparatory Works	27,029	5,903	32,933	-	-	-	27,029	5,903	32,933
2. Mol Dam									
A. Main Dam	212,336	36,558	248,895	-	-	-	15,479	4,254	19,733
B. Saddle Dam	10,886	2,018	12,904	-	-	-	-	-	-
C. Spillway	51,851	16,722	68,573	-	-	-	16,320	3,119	19,438
D. Intake Facilities	68,905	13,164	82,068	-	-	-	26,103	4,665	30,768
E. Diversion Works	9,900	3,540	13,440	-	-	-	9,900	3,540	13,440
F. Acess Road	8,778	3,762	12,540	-	-	-	8,778	3,762	12,540
G. Land Acquisition	0	1,076	1,076	0	538	538	0	538	538
Sub-total(2)	362,656	76,840	439,496	0	538	538	76,579	19,878	96,457
3. Causeway	2,421	3,786	6,208	-	-	-	-	-	-
4. Pilot Demonstration Fan	10,393	2,869	13,262	-	-	-	-	-	-
5. Project Office	360	840	1,200	-	-	-	360	840	1,200
6. O & M Equipment	10,300	0	10,300	-	-	-	-	-	-
Total (2-6)	386,131	84,335	470,465	0	538	538	76,939	20,718	97,657
7. Physical Contingency	58,152	12,750	70,902	0	81	81	11,564	3,118	14,682
Total (1 - 7)	471,311	102,989	574,300	0	619	619	115,533	29,739	145,272
8. Administration Cost	0	6,700	6,700	-	-	-	0	1,675	1,675
9. Engineering Services	59,600	16,400	76,000	10,575	3,600	14,175	14,900	4,100	19,000
Total (1 - 8)	530,912	126,088	657,000	10,575	4,219	14,794	130,433	35,514	165,947
10. Price Contingency	0	28,642	28,642	0	295	295	0	5,146	5,146
Grand Total	530,912	154,730	685,642	10,575	4,514	15,089	130,433	40,660	171,093

Work Item	1,993			1,994			1,995		
	F/C	L/C	Total	F/C	L/C	Total	F/C	L/C	Total
1. Preparatory Works	-	-	-	-	-	-	-	-	-
2. Mol Dam									
A. Main Dam	91,524	16,191	107,715	82,183	12,778	94,961	23,151	3,335	26,486
B. Saddle Dam	-	-	-	10,886	2,018	12,904	-	-	-
C. Spillway	24,830	9,003	33,833	10,701	4,600	15,302	-	-	-
D. Intake Facilities	42,801	8,499	51,300	-	-	-	-	-	-
E. Diversion Works	-	-	-	-	-	-	-	-	-
F. Acess Road	-	-	-	-	-	-	-	-	-
G. Land Acquisition	-	-	-	-	-	-	-	-	-
Sub-total(2)	159,155	33,693	192,848	103,771	19,396	123,167	23,151	3,335	26,486
3. Causeway	0	0	0	2,421	3,786	6,208	-	-	-
4. Pilot Demonstration Fan	10,393	2,869	13,262	-	-	-	-	-	-
5. Project Office	-	-	-	-	-	-	-	-	-
6. O & M Equipment	-	-	-	10,300	0	0	-	-	-
Total (2-6)	169,548	36,562	206,110	116,492	23,182	129,374	23,151	3,335	26,486
7. Physical Contingency	25,524	5,524	31,049	17,543	3,507	21,050	3,521	520	4,041
Total (1 - 7)	195,072	42,086	237,159	134,035	26,690	160,724	26,672	3,855	30,527
8. Administration Cost	0	2,233	2,233	0	2,233	2,233	0	558	558
9. Engineering Services	15,167	3,867	19,033	15,167	3,867	19,033	3,792	967	4,758
Total (1 - 8)	210,239	48,186	258,425	149,201	32,790	181,991	30,463	5,380	35,843
10. Price Contingency	0	10,844	10,844	0	10,191	10,191	0	2,166	2,166
Grand Total	210,239	59,030	269,269	149,201	42,980	192,182	30,463	7,545	38,009

Table 18 STRUCTURE OF FINANCIAL AND ECONOMIC COST

Unit: %

Cost Component	Financial Cost				Economic Cost				Weighted Conversion Factor
		Local Cost				Local Cost			
	Foreign Cost	Transfer Payment	Un-skilled labour	Others	Foreign Cost	Transfer Payment	Un-skilled labour	Others	
A. Capital Cost									
1. Preparatory Works	82	0	4	14	82	0	3	12	97
2. Mol Dam	83	0	4	13	83	0	3	11	97
3. Causeway	39	0	14	47	39	0	10	40	89
4. Pilot Demonstration Farm	78	0	5	17	78	0	4	14	96
5. Project Office	30	0	17	54	30	0	12	45	87
6. O&M Equipment	100	0	0	0	100	0	0	0	100
7. Physical Contingency	82	0	4	14	82	0	3	12	97
8. Administration Cost	0	0	24	76	0	0	16	65	81
9. Engineering Servoces	78	0	5	17	78	0	4	14	96
B. O&M Cost									
1. Administration Staff	0	0	0	100	0	0	0	85	85
2. Operation Cost of O&M Equipment	0	0	0	100	0	0	0	85	85
3. Office Operation Cost	0	0	0	100	0	0	0	85	85

Table 19 ECONOMIC COST AND BENEFIT FLOW

EIRR= 10.60%
NPV(8%)= 196.4 million Rs.
B/C(8%)= 1.36

Unit: Rs.1,000

		Cost				Benefit			
	Year	Investment	Annual O&M	Replacement	Total	Irrigation	Well Ope.	Total	Balance
1	1991	13,662			13,662	0		0	-13,662
2	1992	159,528			159,528	0		0	-159,528
3	1993	249,731			249,731	0		0	-249,731
4	1994	175,373			175,373	0		0	-175,373
5	1995	34,507			34,507	0		0	-34,507
6	1996		4,335		4,335	50,137	2,551	52,688	48,353
7	1997		4,335		4,335	63,210	2,551	65,761	61,426
8	1998		4,335		4,335	76,283	2,551	78,833	74,498
9	1999		4,335		4,335	84,998	2,551	87,548	83,213
10	2000		4,335		4,335	93,713	2,551	96,264	91,929
11	2001		4,335		4,335	93,713	4,450	98,163	93,828
12	2002		4,335		4,335	93,713	4,450	98,163	93,828
13	2003		4,335		4,335	93,713	4,450	98,163	93,828
14	2004		4,335		4,335	93,713	4,450	98,163	93,828
15	2005		4,335	10,300	14,635	93,713	4,450	98,163	83,528
16	2006		4,335		4,335	93,713	1,203	94,916	90,581
17	2007		4,335		4,335	93,713	1,203	94,916	90,581
18	2008		4,335		4,335	93,713	1,203	94,916	90,581
19	2009		4,335		4,335	93,713	1,203	94,916	90,581
20	2010		4,335		4,335	93,713	1,203	94,916	90,581
21	2011		4,335		4,335	93,713	1,203	94,916	90,581
22	2012		4,335		4,335	93,713	1,203	94,916	90,581
23	2013		4,335		4,335	93,713	1,203	94,916	90,581
24	2014		4,335		4,335	93,713	1,203	94,916	90,581
25	2015		4,335	10,300	14,635	93,713	1,203	94,916	80,281
26	2016		4,335		4,335	93,713	1,203	94,916	90,581
27	2017		4,335		4,335	93,713	1,203	94,916	90,581
28	2018		4,335		4,335	93,713	1,203	94,916	90,581
29	2019		4,335		4,335	93,713	1,203	94,916	90,581
30	2020		4,335	25,500	29,835	93,713	1,203	94,916	65,081
31	2021		4,335		4,335	93,713	1,203	94,916	90,581
32	2022		4,335		4,335	93,713	1,203	94,916	90,581
33	2023		4,335		4,335	93,713	1,203	94,916	90,581
34	2024		4,335		4,335	93,713	1,203	94,916	90,581
35	2025		4,335	10,300	14,635	93,713	1,203	94,916	80,281
36	2026		4,335		4,335	93,713	1,203	94,916	90,581
37	2027		4,335		4,335	93,713	1,203	94,916	90,581
38	2028		4,335		4,335	93,713	1,203	94,916	90,581
39	2029		4,335		4,335	93,713	1,203	94,916	90,581
40	2030		4,335		4,335	93,713	1,203	94,916	90,581
41	2031		4,335		4,335	93,713	1,203	94,916	90,581
42	2032		4,335		4,335	93,713	1,203	94,916	90,581
43	2033		4,335		4,335	93,713	1,203	94,916	90,581
44	2034		4,335		4,335	93,713	1,203	94,916	90,581
45	2035		4,335	10,300	14,635	93,713	1,203	94,916	80,281
46	2036		4,335		4,335	93,713	1,203	94,916	90,581
47	2037		4,335		4,335	93,713	1,203	94,916	90,581
48	2038		4,335		4,335	93,713	1,203	94,916	90,581
49	2039		4,335		4,335	93,713	1,203	94,916	90,581
50	2040		4,335		4,335	93,713	1,203	94,916	90,581
51	2041		4,335		4,335	93,713	1,203	94,916	90,581
52	2042		4,335		4,335	93,713	1,203	94,916	90,581
53	2043		4,335		4,335	93,713	1,203	94,916	90,581
54	2044		4,335		4,335	93,713	1,203	94,916	90,581
55	2045		4,335		4,335	93,713	1,203	94,916	90,581

Table 20 INCREMENTAL GROSS MARGIN OF OWNER AND TENANT OPERATED FARMS AT VARIOUS SCALES

Unit : Rs.

Item	Holding Size (ha) 1.0	3.0	5.0	10.0	20.0
1 Owner Operated Farm					
A. Without Project					
Gross income	6,851	20,552	34,253	68,505	137,011
Production cost incl. labor cost	3,094	9,282	15,469	30,939	61,878
Gross margin	3,757	11,270	18,783	37,567	75,133
B. With project					
Gross income	30,794	92,383	153,971	307,942	615,884
Production cost incl. labor cost	10,483	31,448	52,414	104,827	209,654
Gross margin	20,311	60,934	101,557	203,115	406,229
C. Increment					
Gross income	23,944	71,831	119,718	239,436	478,873
Production cost incl. labor cost	7,389	22,166	36,944	73,888	147,777
Gross margin	16,555	49,664	82,774	165,548	331,096
2 Tenant Operated Farm					
A. Without Project					
Gross income	3,425	10,276	17,126	34,253	68,505
Production cost incl. labor cost	2,926	8,779	14,631	29,263	58,526
Family labor cost	1,379	4,138	6,897	13,793	27,587
Farmer's income	1,878	5,635	9,392	18,783	37,567
B. With project					
Gross income	15,397	46,191	76,985	153,971	307,942
Production cost incl. labor cost	9,978	29,933	49,888	99,775	199,551
Family labor cost	4,736	14,209	23,681	47,362	94,724
Farmer's income	10,156	30,468	50,779	101,557	203,115
C. Increment					
Gross income	11,972	35,915	59,859	119,718	239,436
Production cost incl. labor cost	7,051	21,154	35,256	70,513	141,025
Family labor cost	3,357	10,071	16,784	33,569	67,137
Farmer's income	8,278	24,833	41,387	82,775	165,548

Refer to ANNEX - J

FIGURES

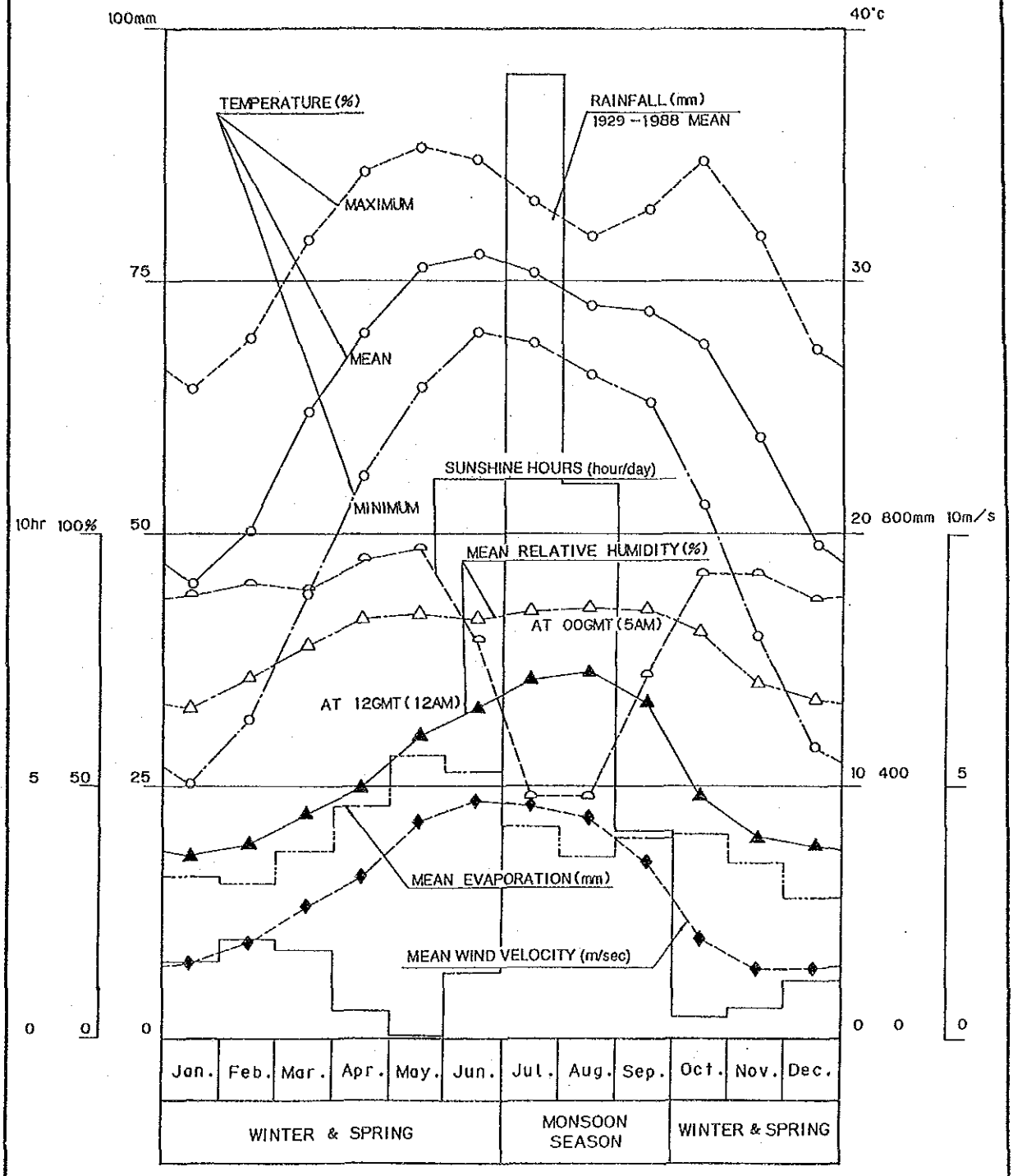

Fig.1 Meteorological Characteristics

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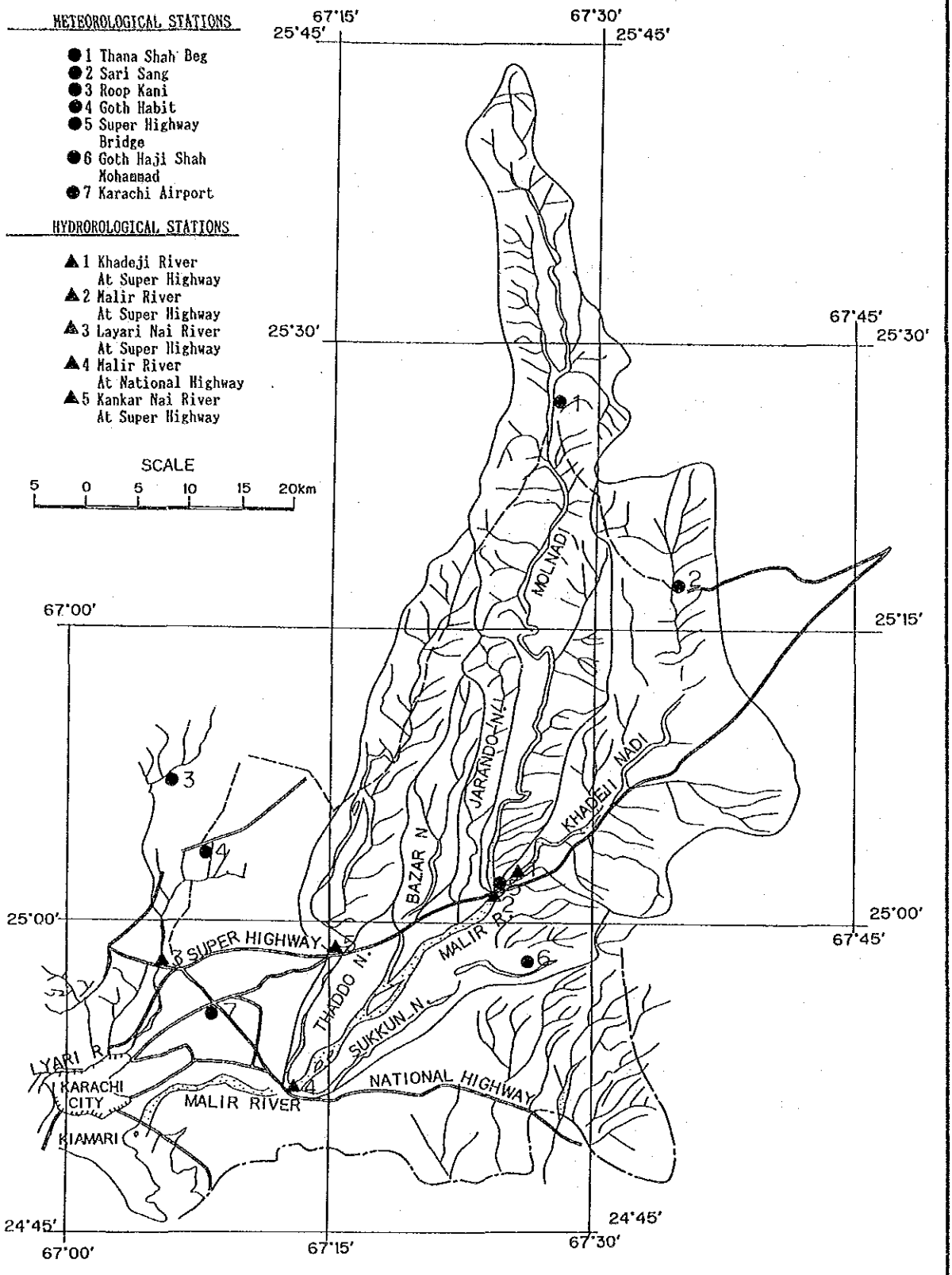

Fig.2 Location of Meteorological and Hydological Stations

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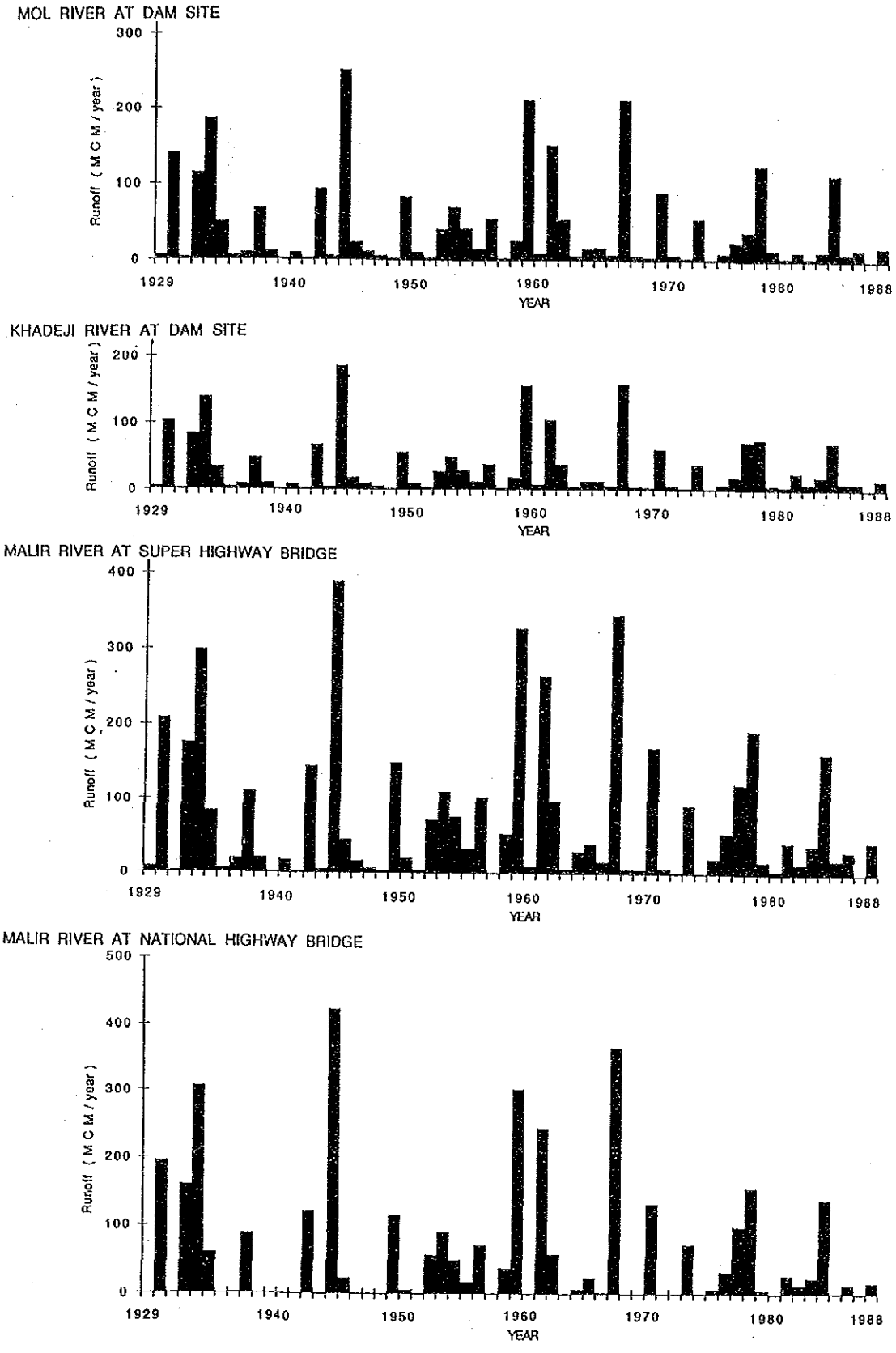

Fig.3 Simulated Annual River Runoff at Major Control Points

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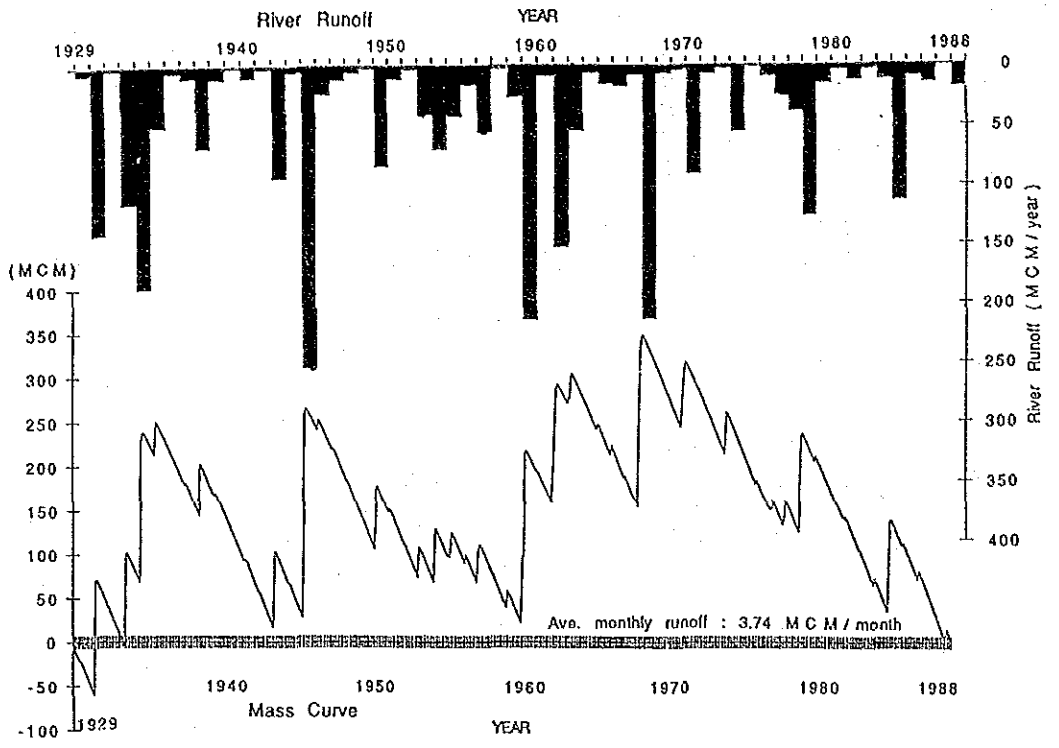
MOL RIVER AT DAM SITE



KHADEJI RIVER AT DAM SITE

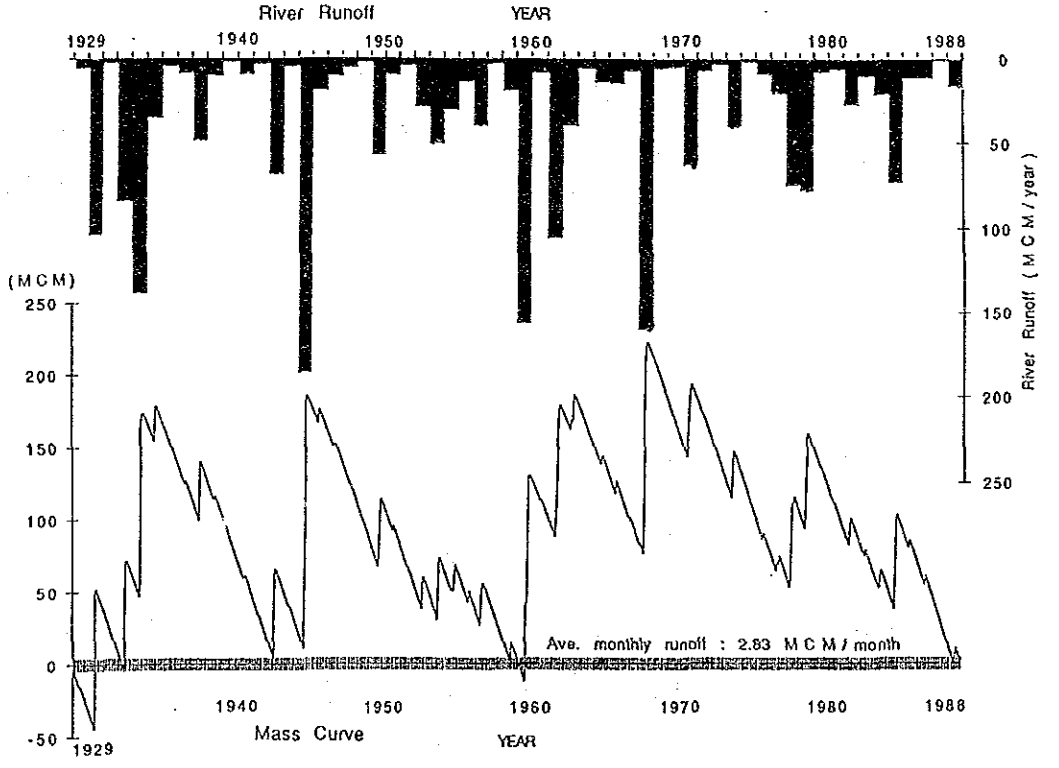


Fig.4 River Runoff Pattern and Masscurves at Mol and Khadeji Damsites

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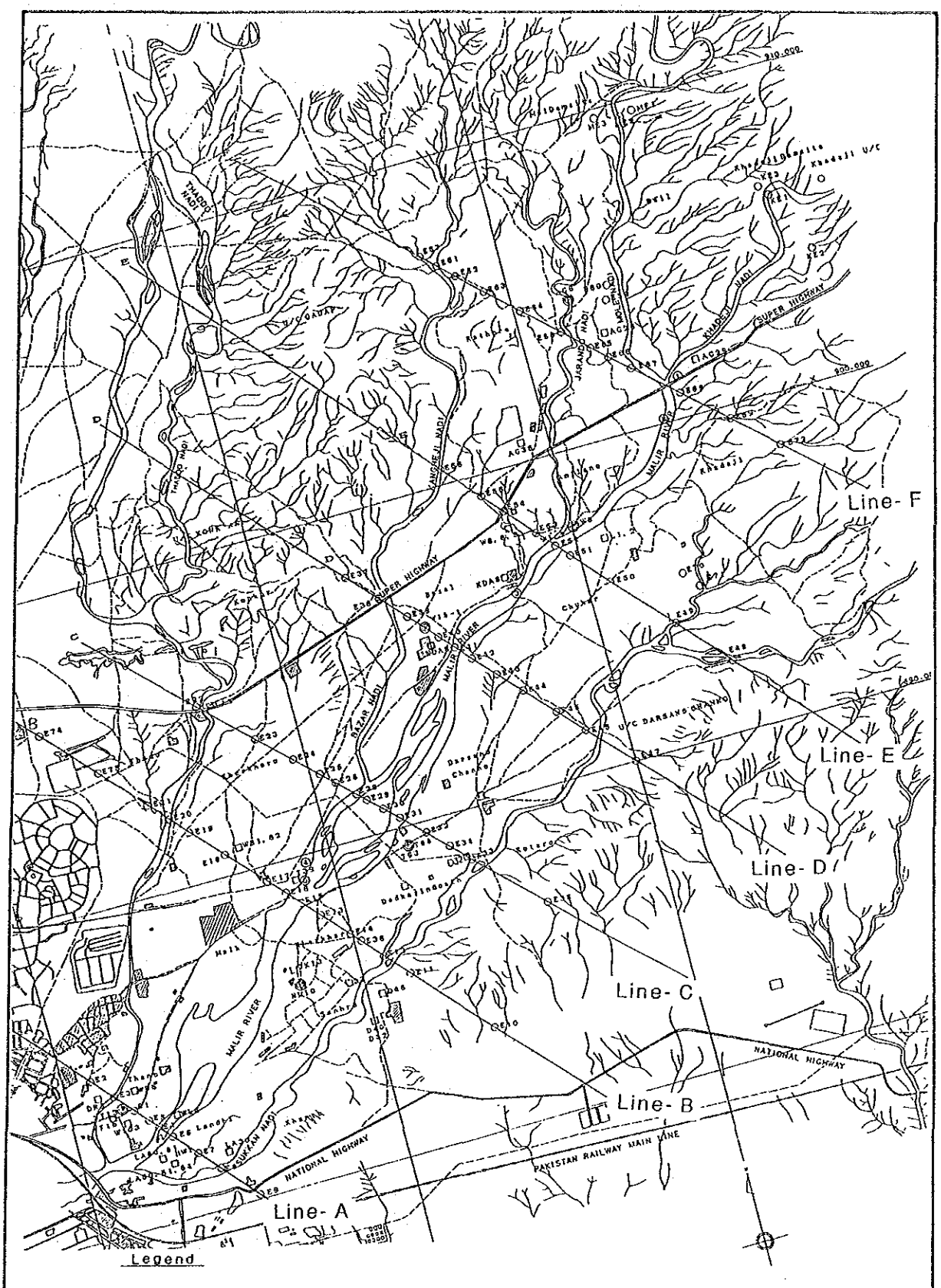

Fig.5 Location Map of Hydrogeological Investigations

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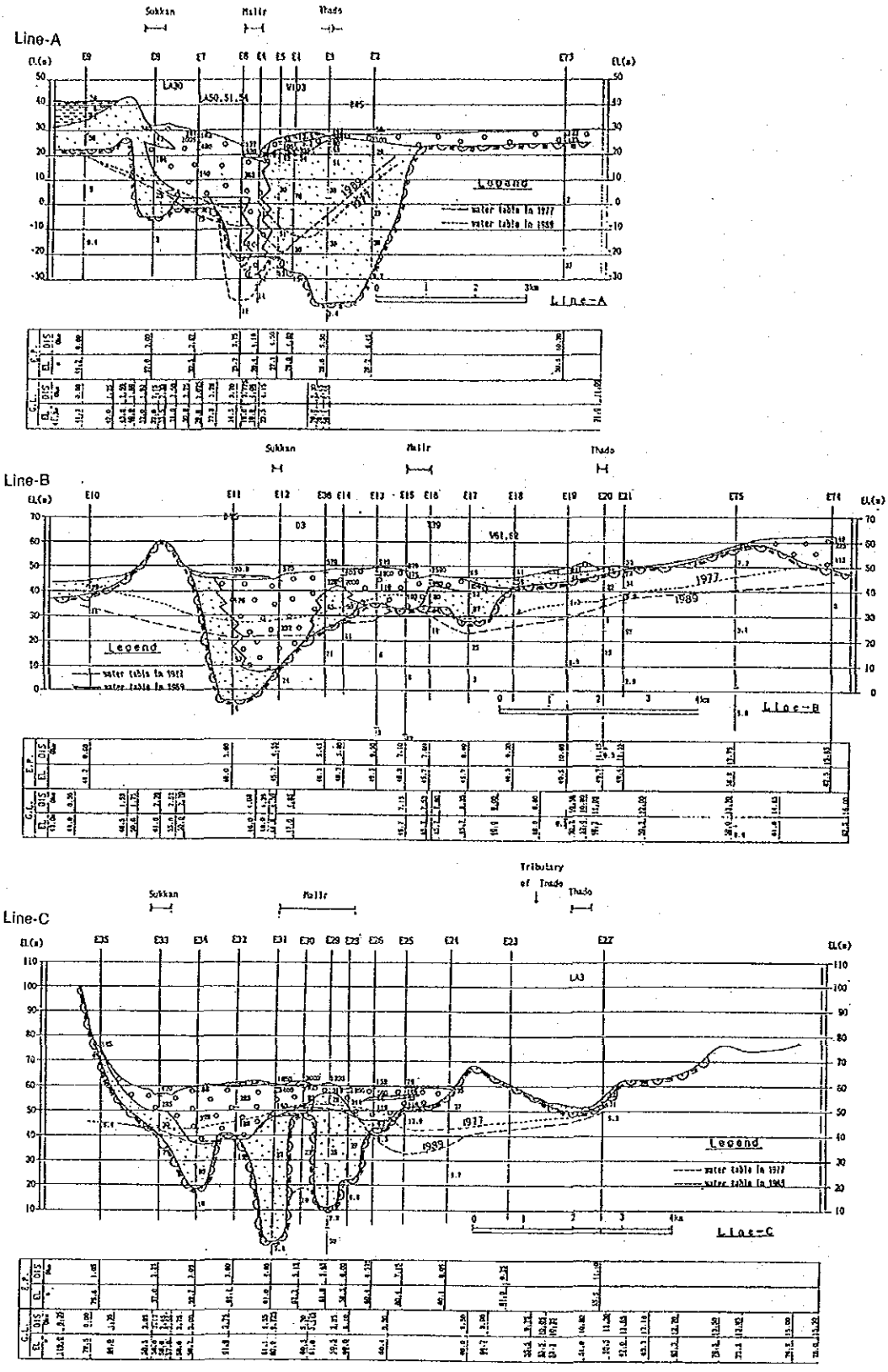

Periods	Symbol	Hydrogeology		True Resistivities of Individual layers. unit : ohm-meters
Quaternary deposits		Aquifer	Gravelly layer	100 ~ 3000
		Aquitard	Arenaceous layer	20 ~ 100
		Aquiclude	Argillaceous layer	5 ~ 20
Pliocene-Tertiary		Aquifuge	Manchar Formation	0.4 ~ 40
Miocene-Tertiary		Aquifuge	Gaj formation	7 ~ 20
				(20 ~70)

Fig.6 Hydrogeological Profiles (1/2)

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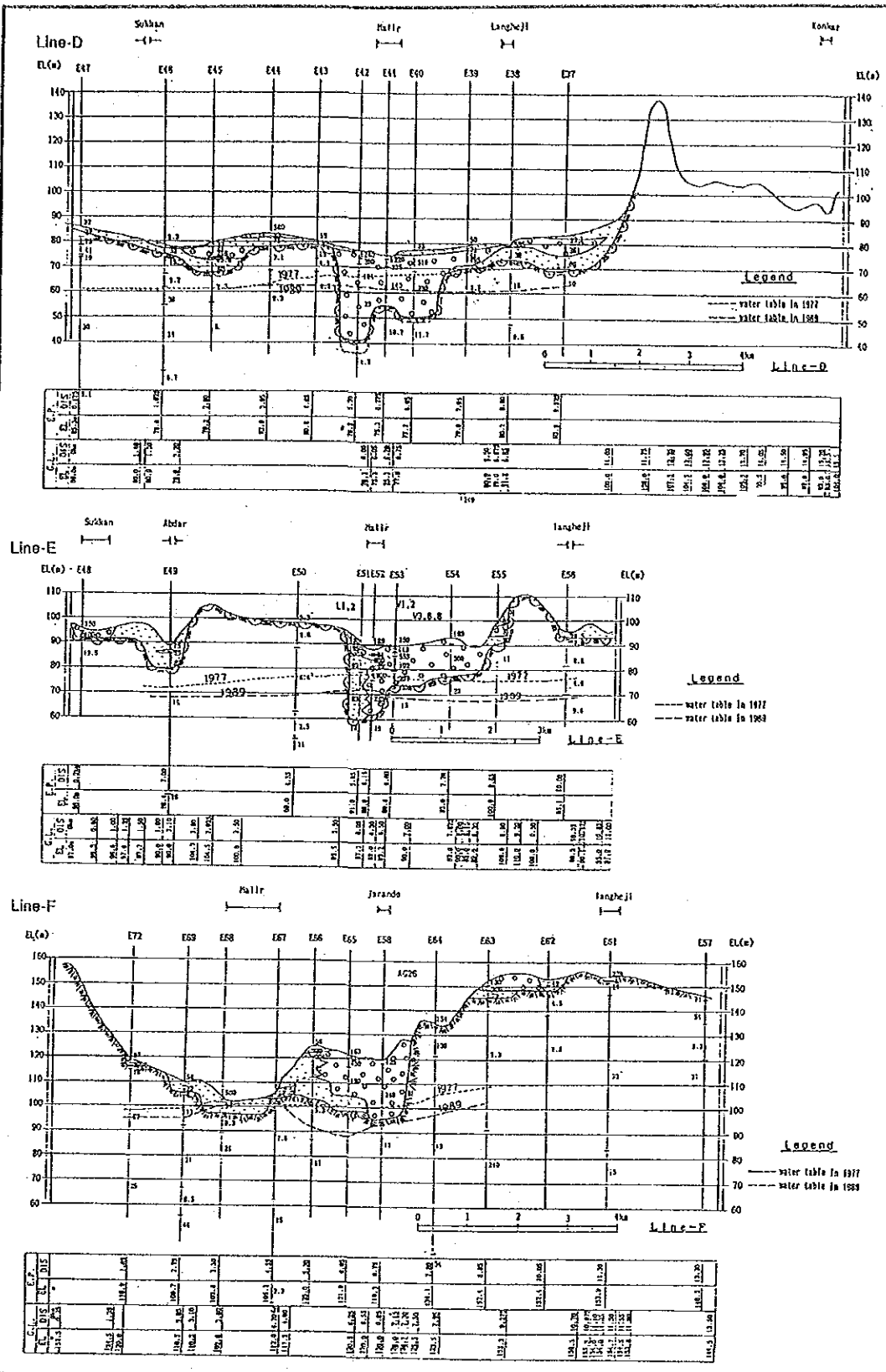

Periods	Symbol	Hydrogeology		True Resistivities of Individual layers. unit : ohm-meters
Quaternary deposits		Aquifer	Gravelly layer	100 ~ 3000
		Aquitard	Arenaceous layer	20 ~ 100
		Aquiclude	Argillaceous layer	5 ~ 20
Pliocene-Tertiary		Aquifuge	Manchar formation	0.4 ~ 40
Miocene-Tertiary		Aquifuge	Gaj formation	7 ~ 20 (30 ~70)

Fig.6 Hydrogeological Profiles (2/2)

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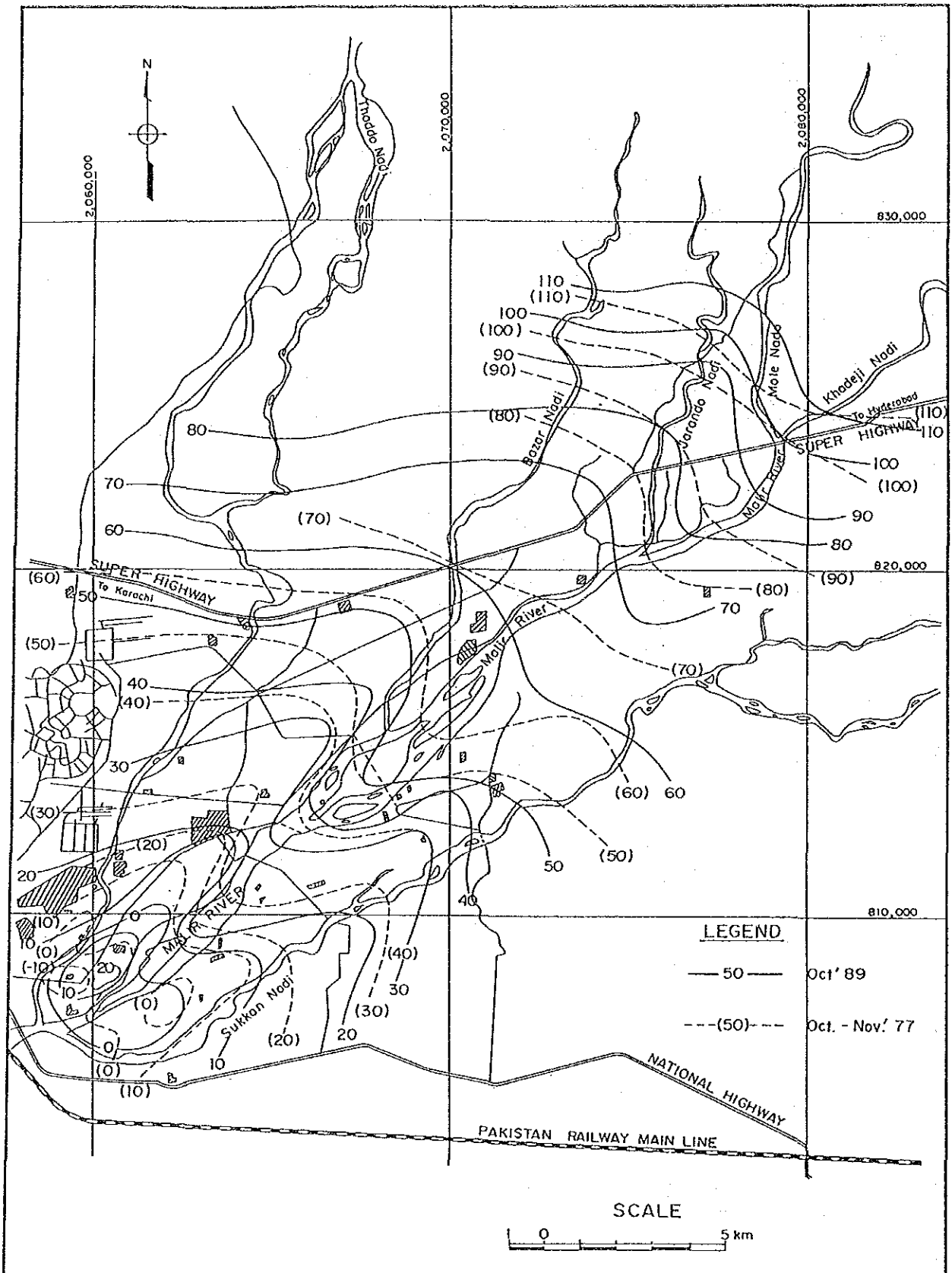

Fig.7 Groundwater Contour Map in 1977 and 1989

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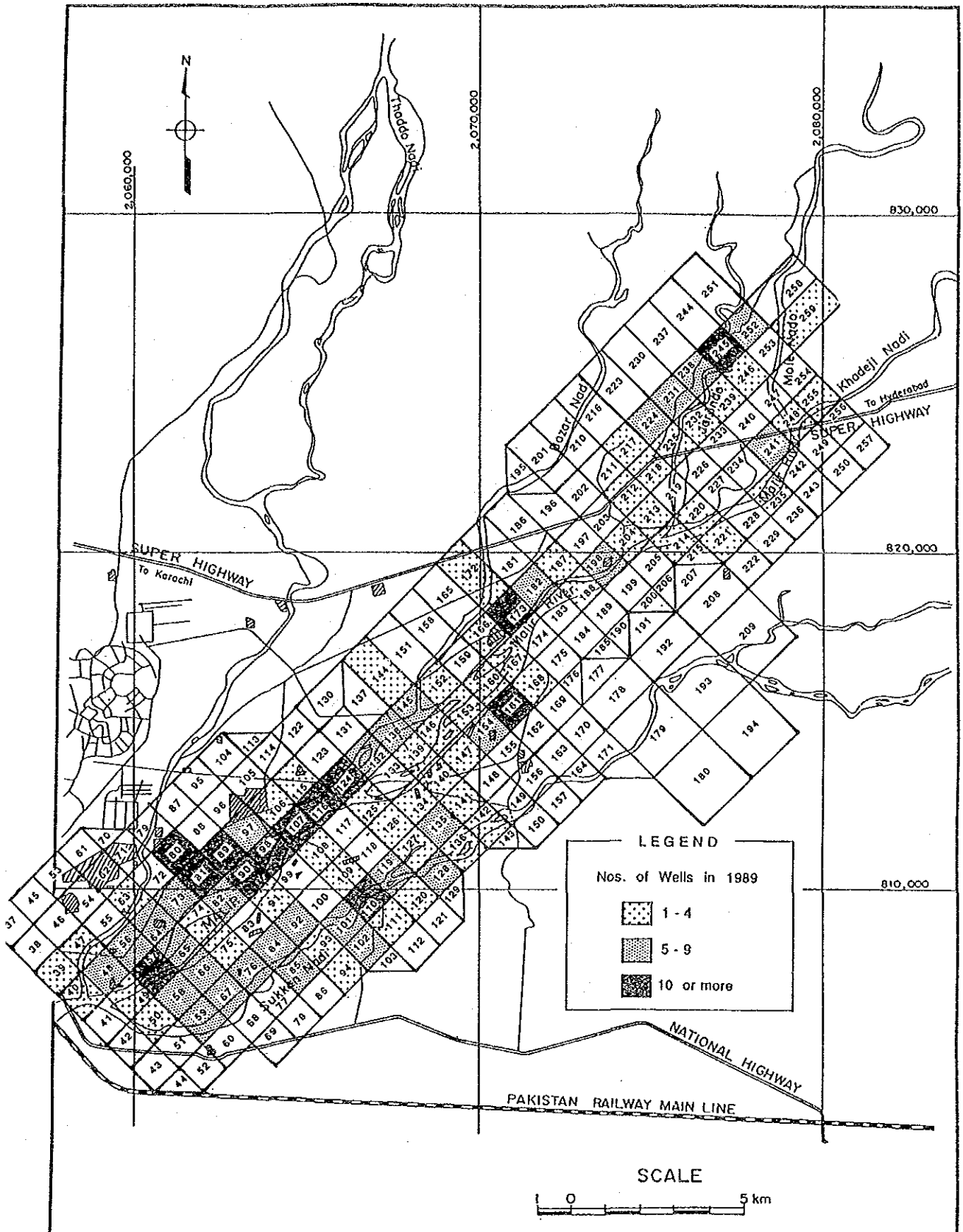

Fig.8 Density of Production Well

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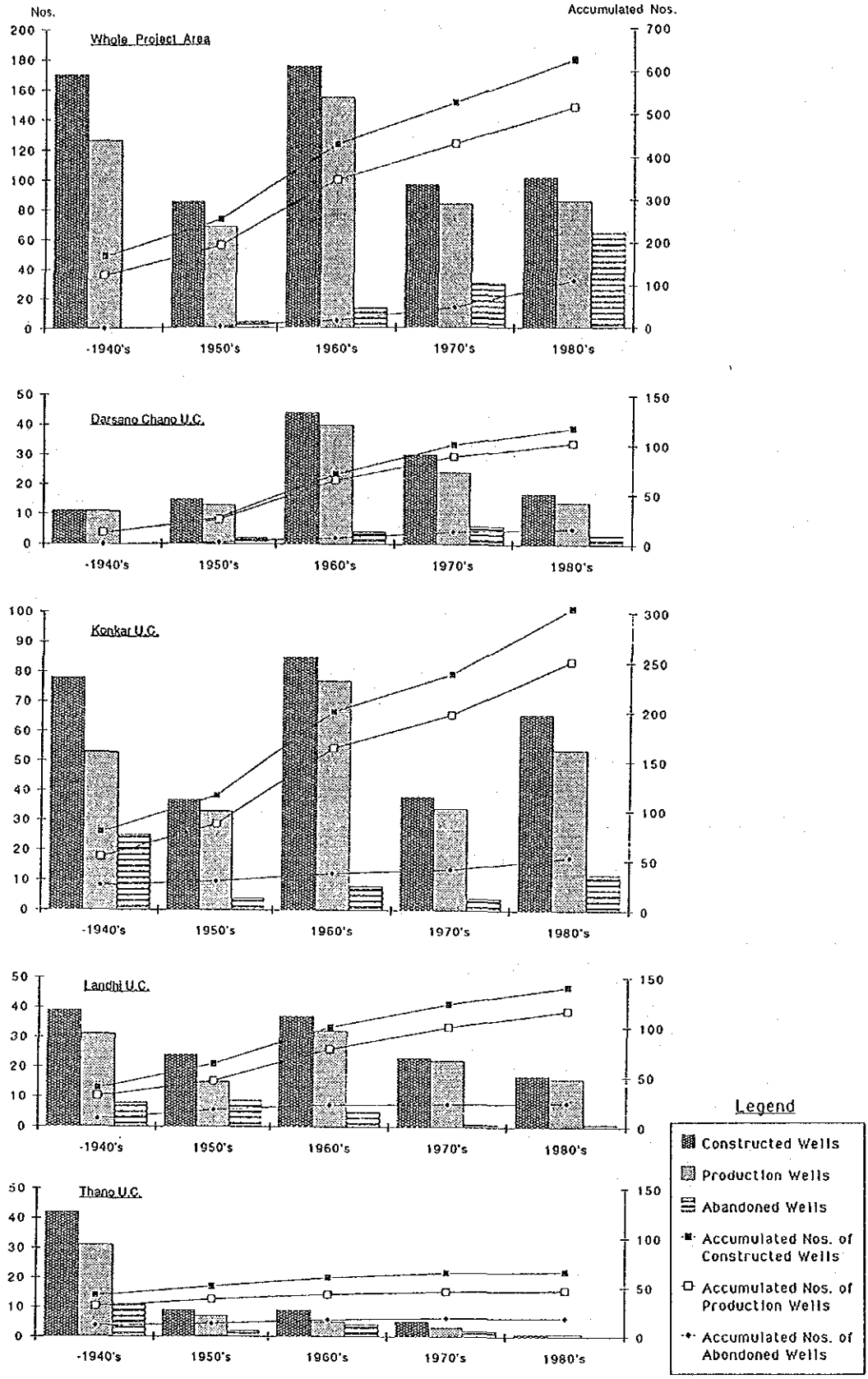

Fig.9 History of Well Construction in the Study Area

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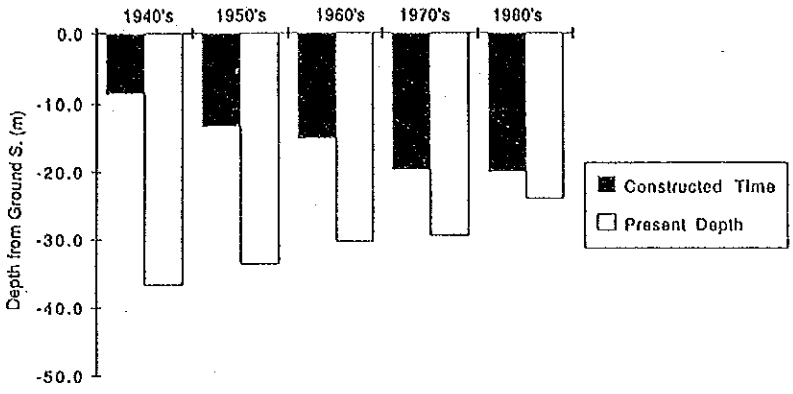
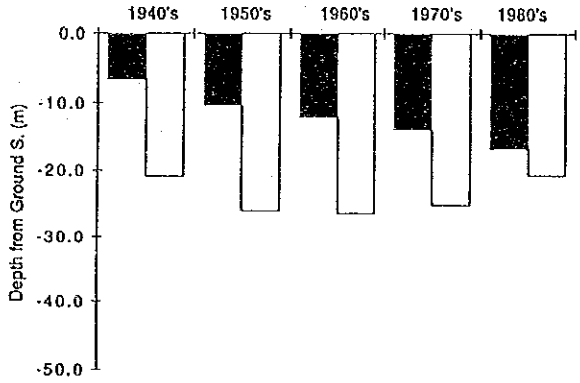
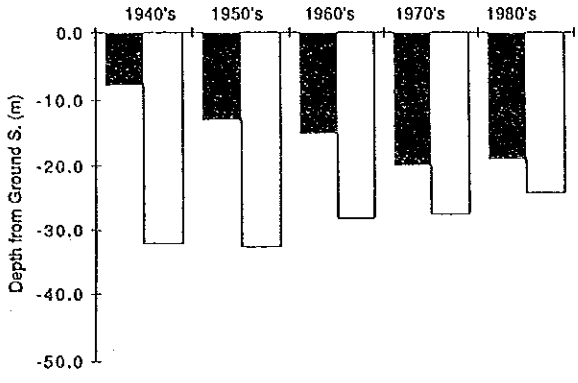
1. Whole Project Area



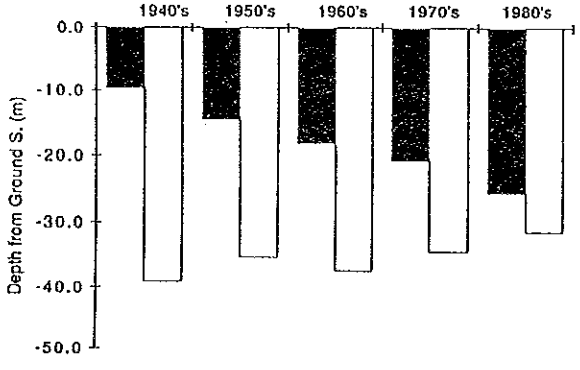
2. Darsano Chano U.C.



3. Konkar U.C.



4. Laundhi U.C.



5. Thano U.C.

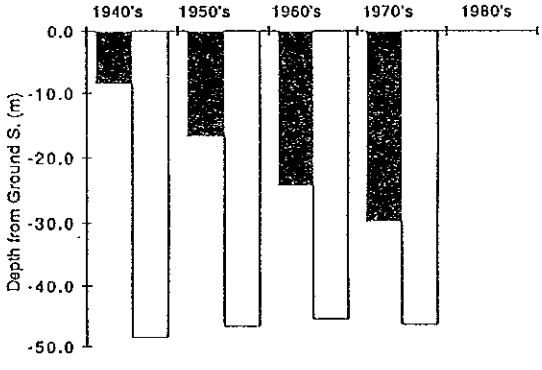


Fig.10 Depth of Production Dugwells in Each Decade

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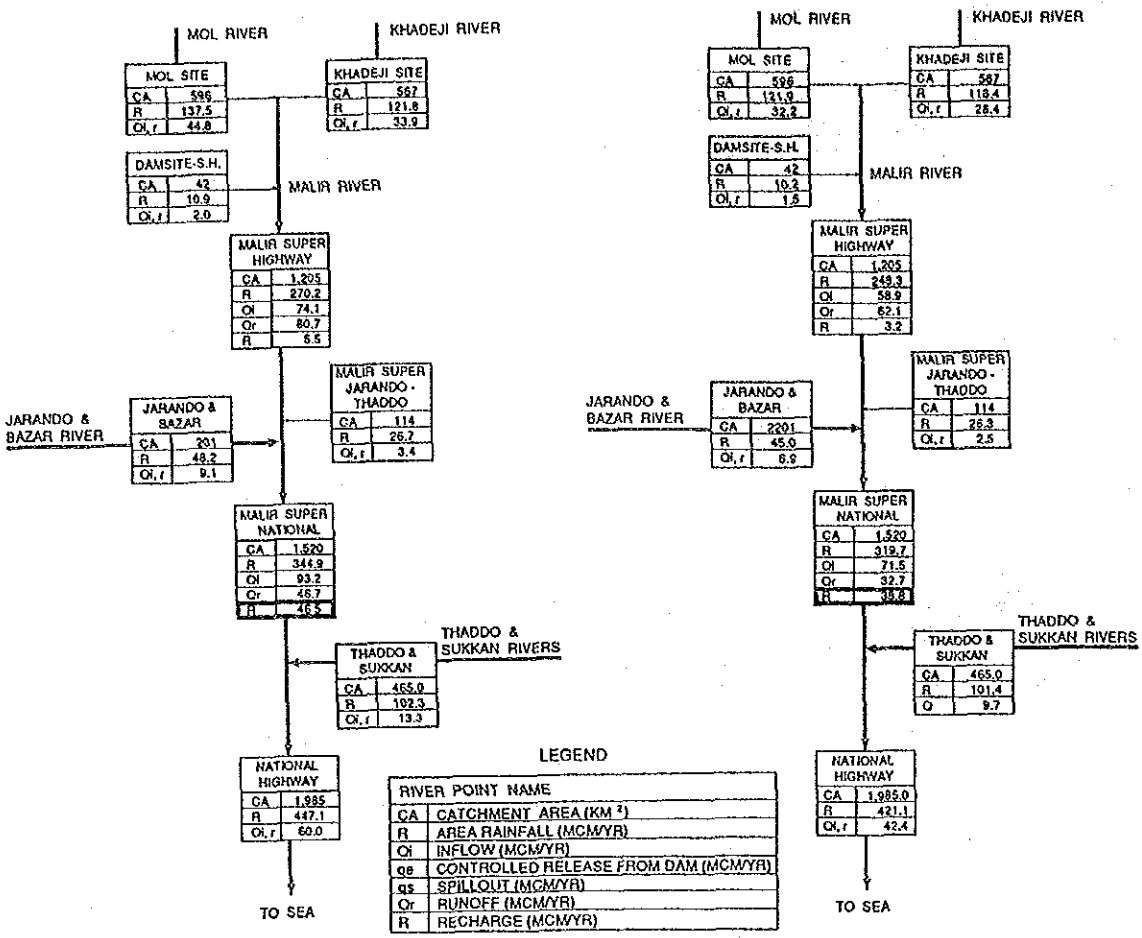

1. Natural Condition (1929 - 1988)

2. Natural Condition (1977 - 1988)

Fig.11 Water Balance (Natural Condition)

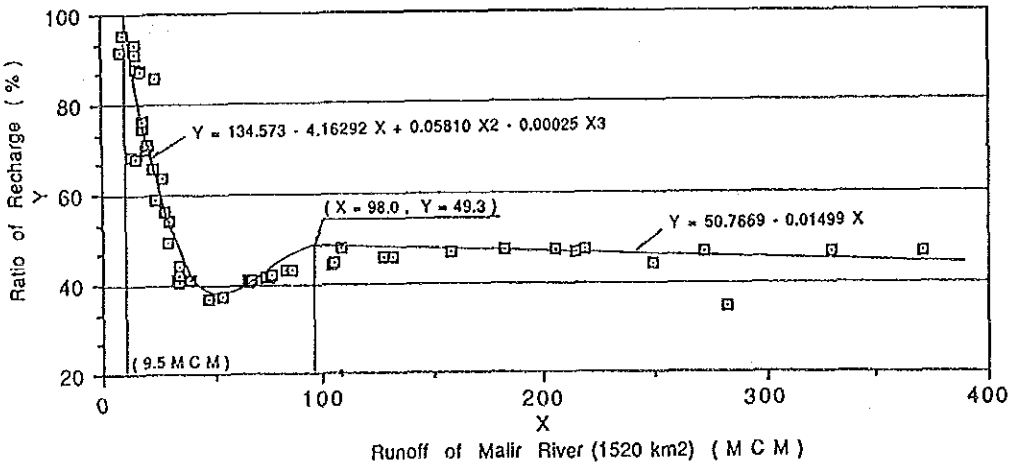

Fig.12 Relationship Between River Runoff and Recharge to Aquifer

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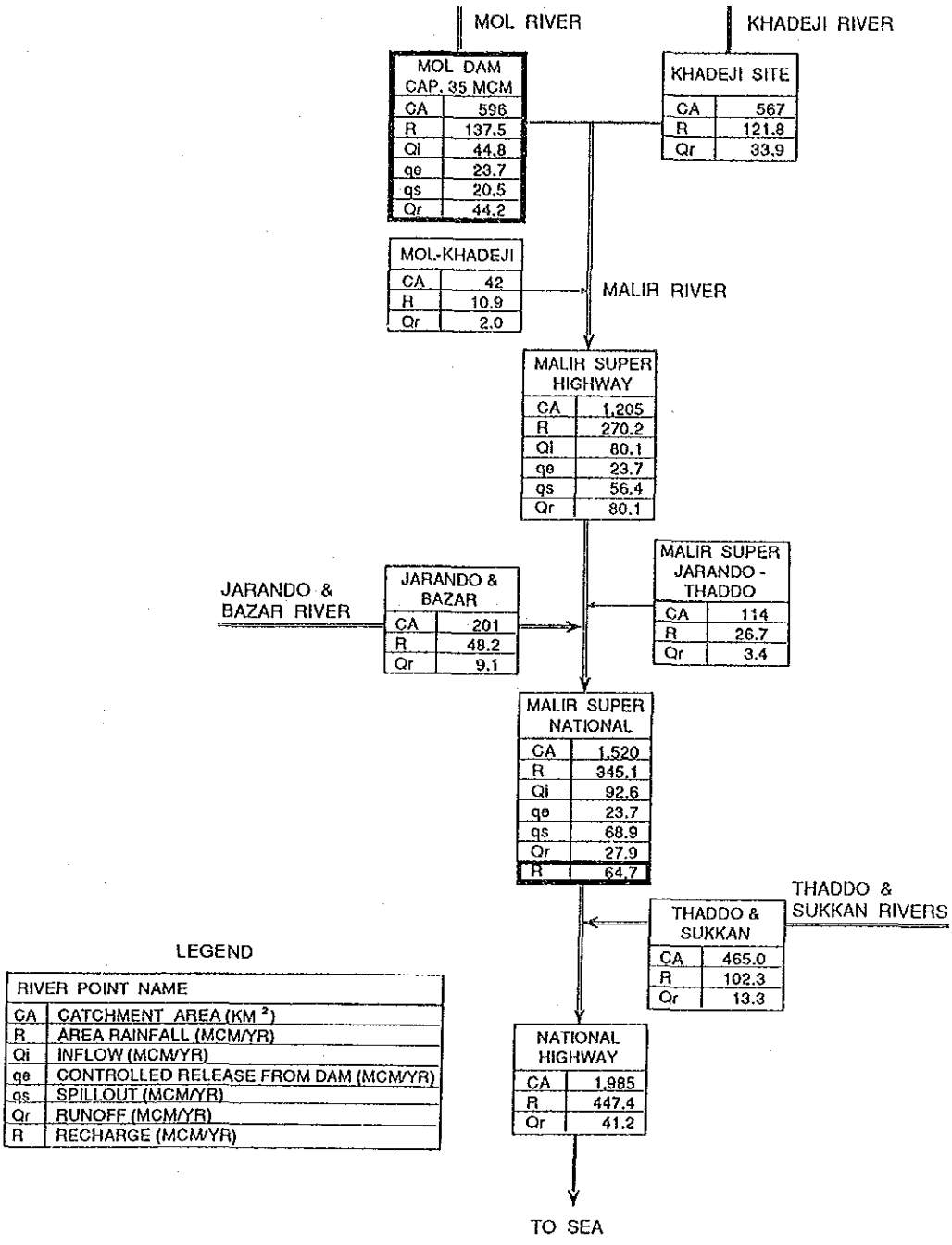

Case-4 Mol Dam : 35 MCM
(1929 - 1988)

Fig.13 Water Balance with Mol Dam
(Case 4 ; 35MCM)

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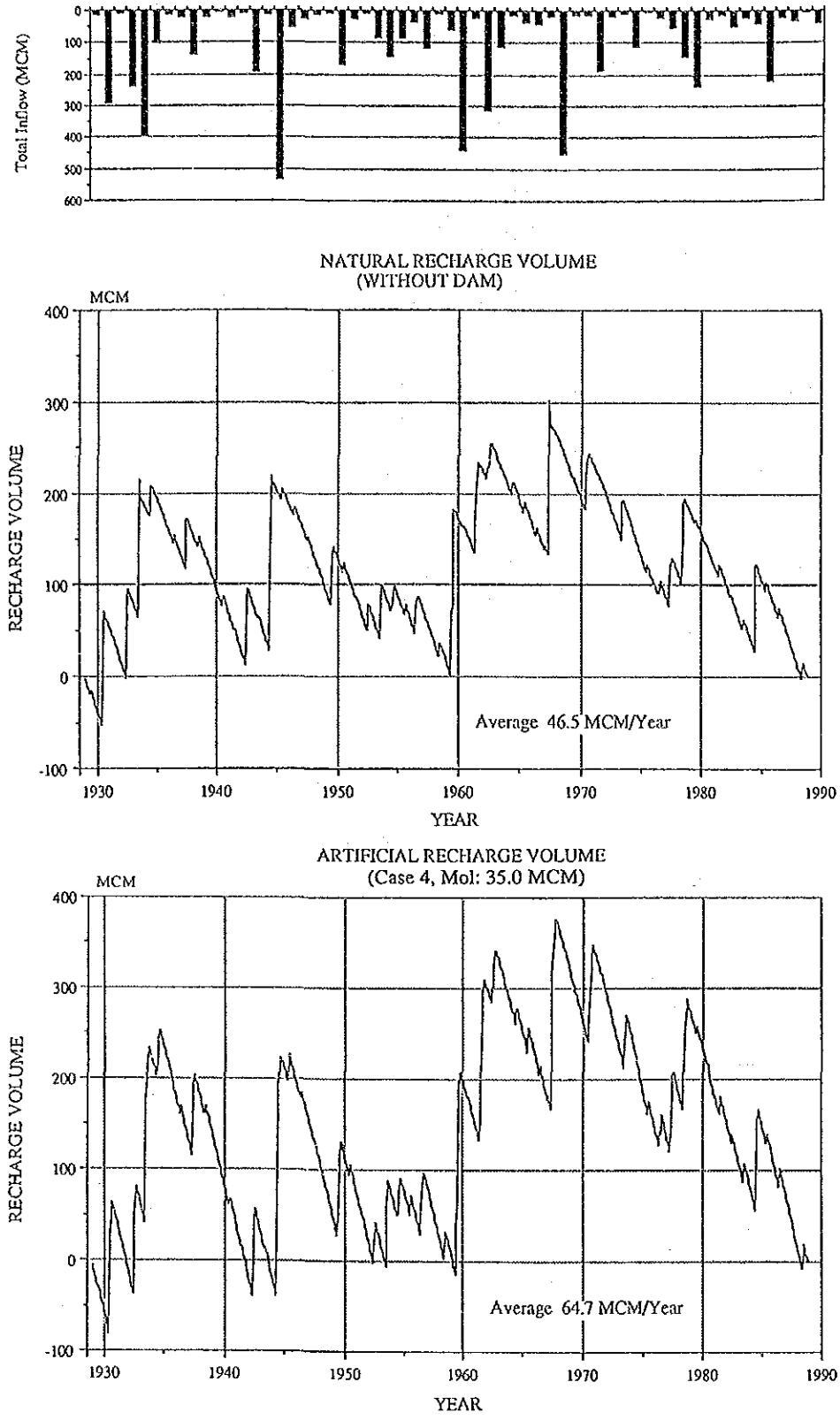

Fig.14 Masscurves of Natural and Artificial Recharge by Mol Dam (Case 4 ; 35 MCM)

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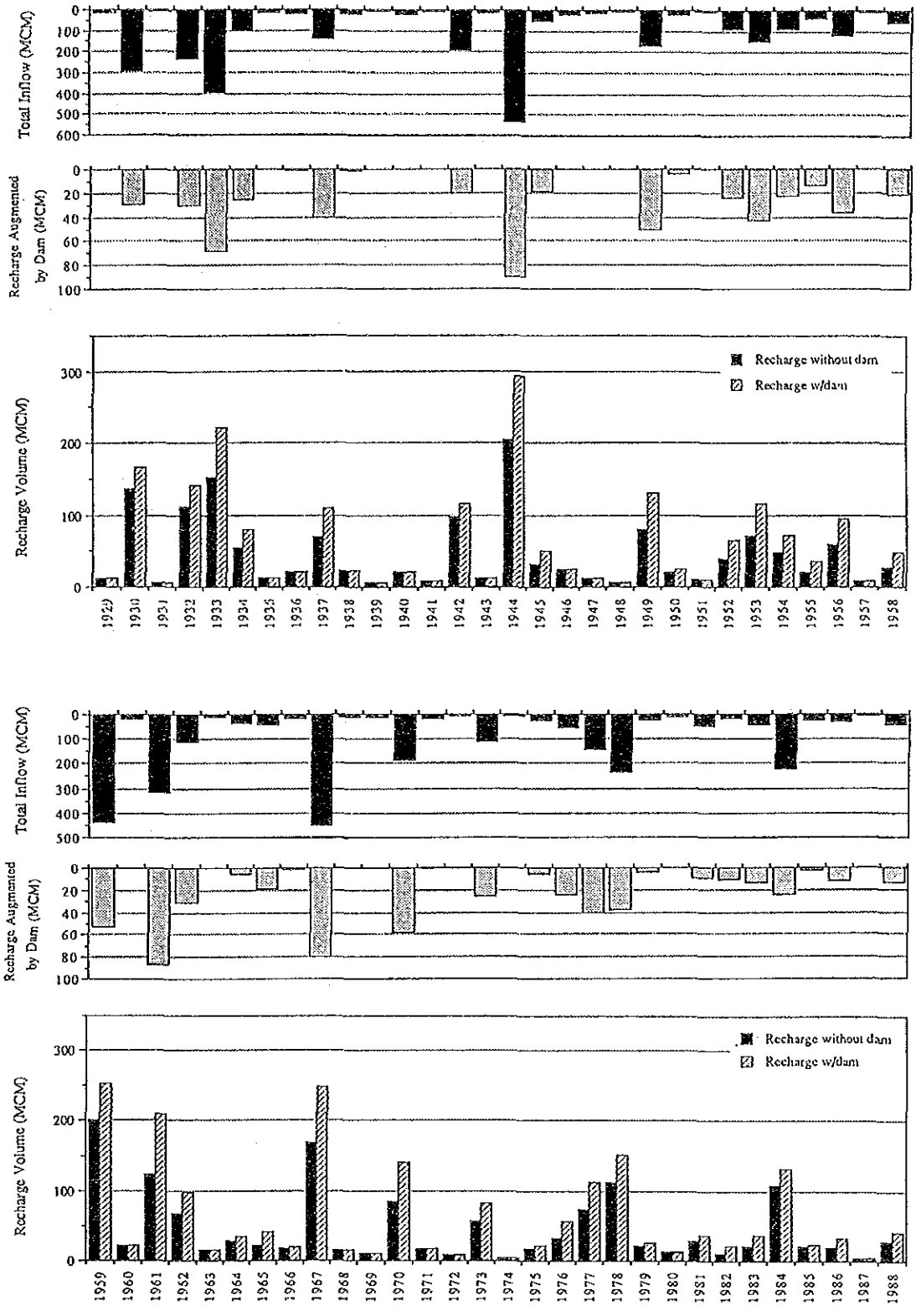

Fig.15 Artificial Recharge by Dam
(Case 4 ; Mol : 35.0 MCM)

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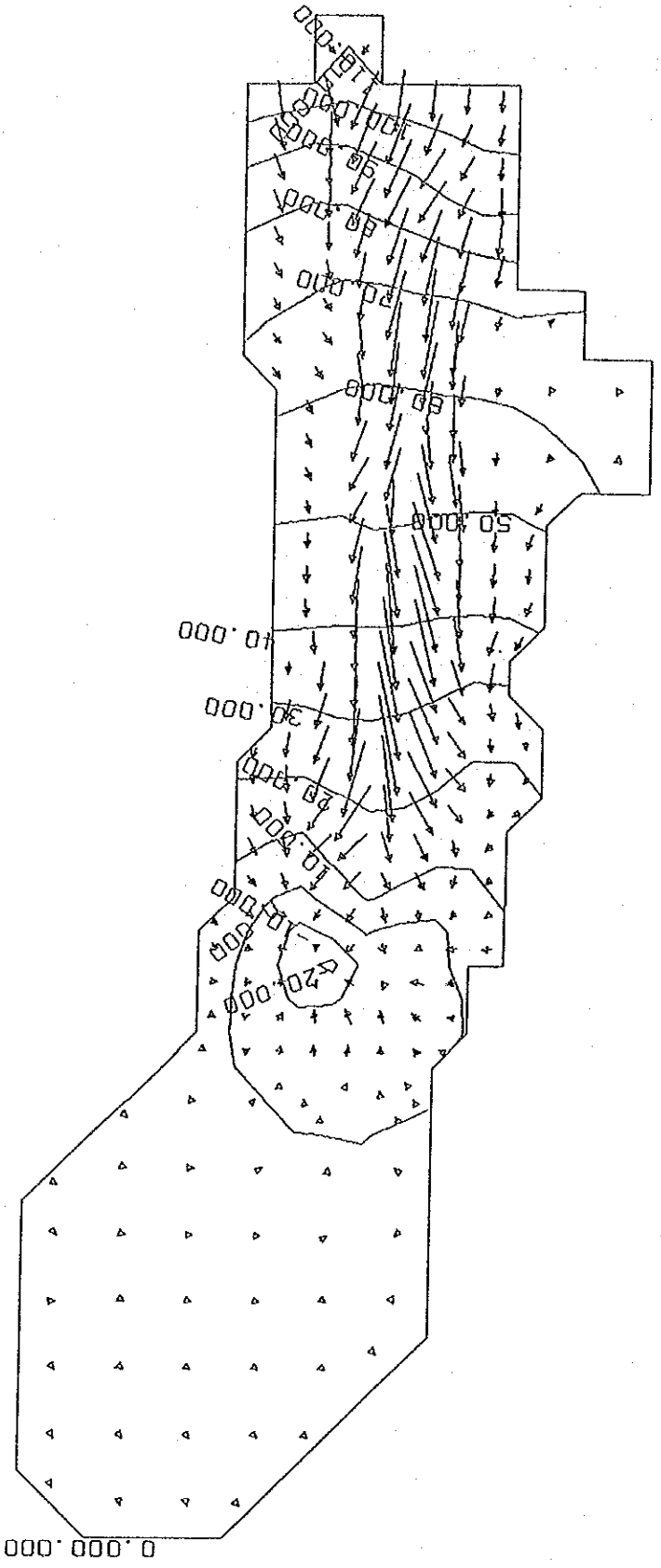

Fig.16 Calculated Groundwater Table and Movement (without Dam)

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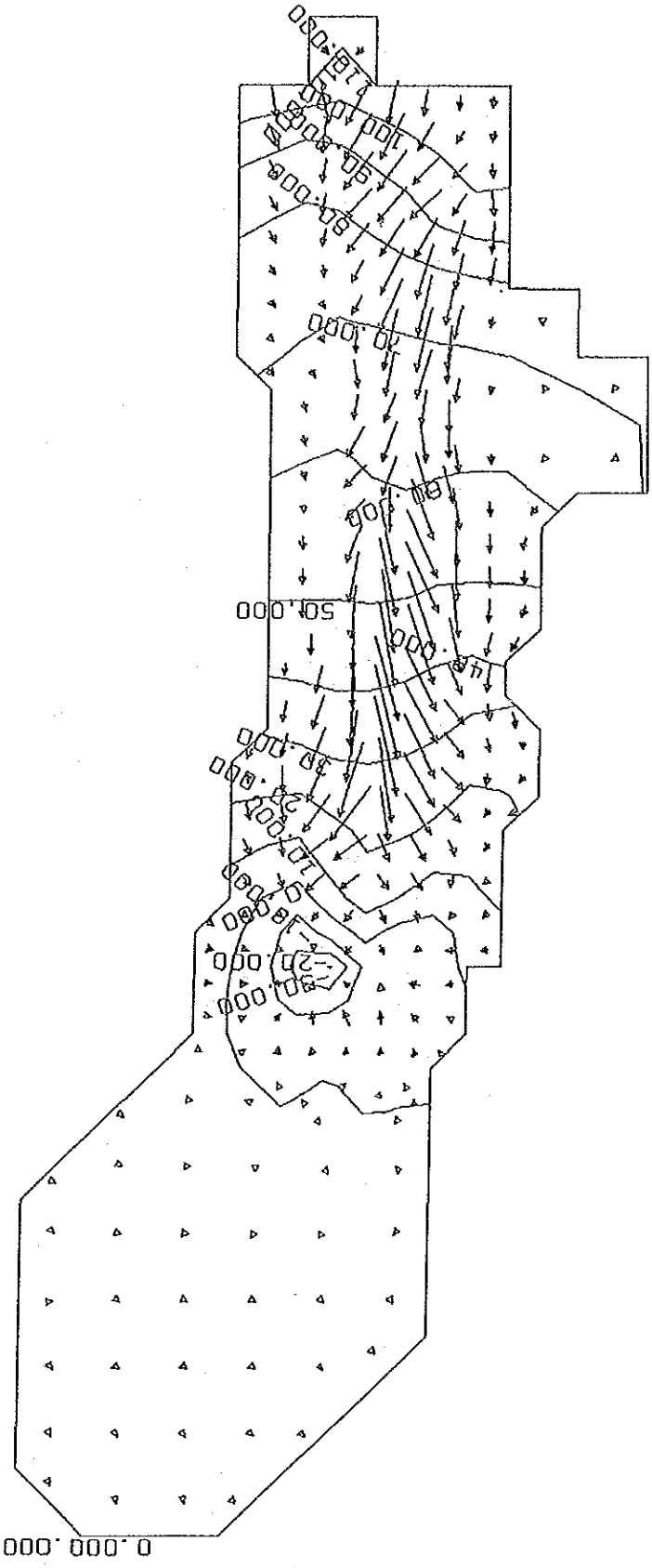

Fig.17 Predicted Groundwater Table and Movement (with Mol Dam ; 35 MCM)

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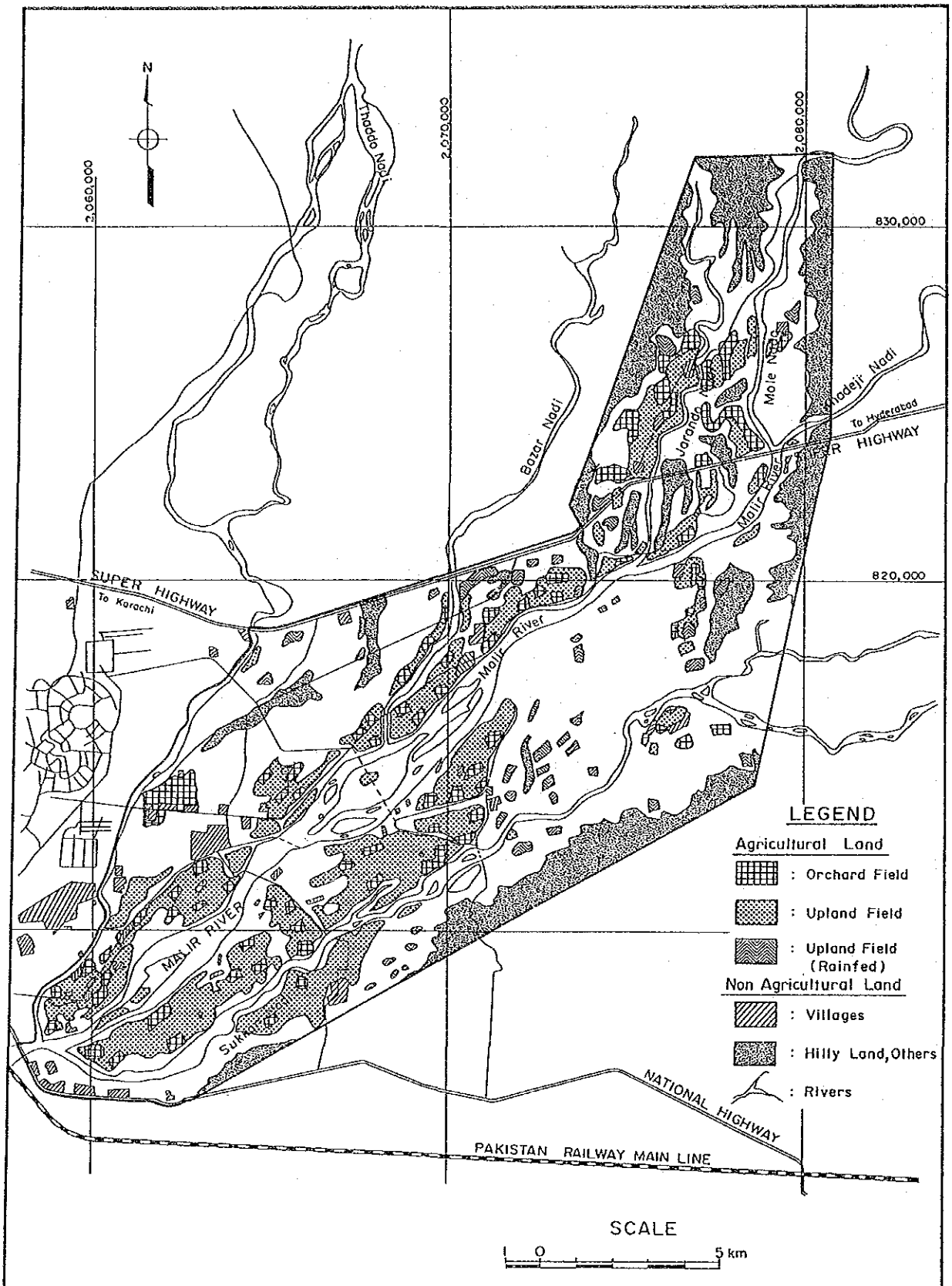

Fig.18 Present Land Use Map

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FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
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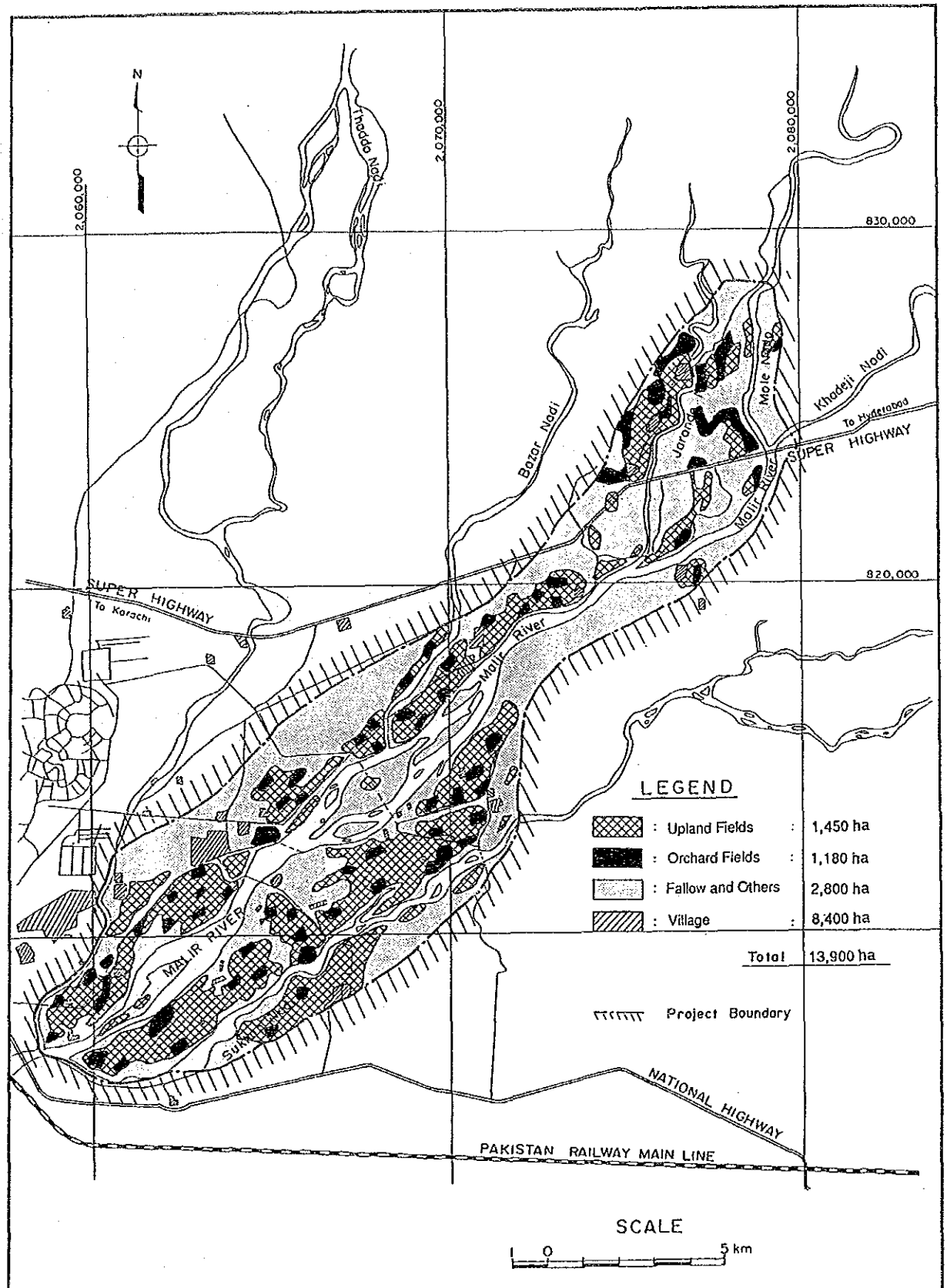

Fig.19 Project Boundary and Land Use

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FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
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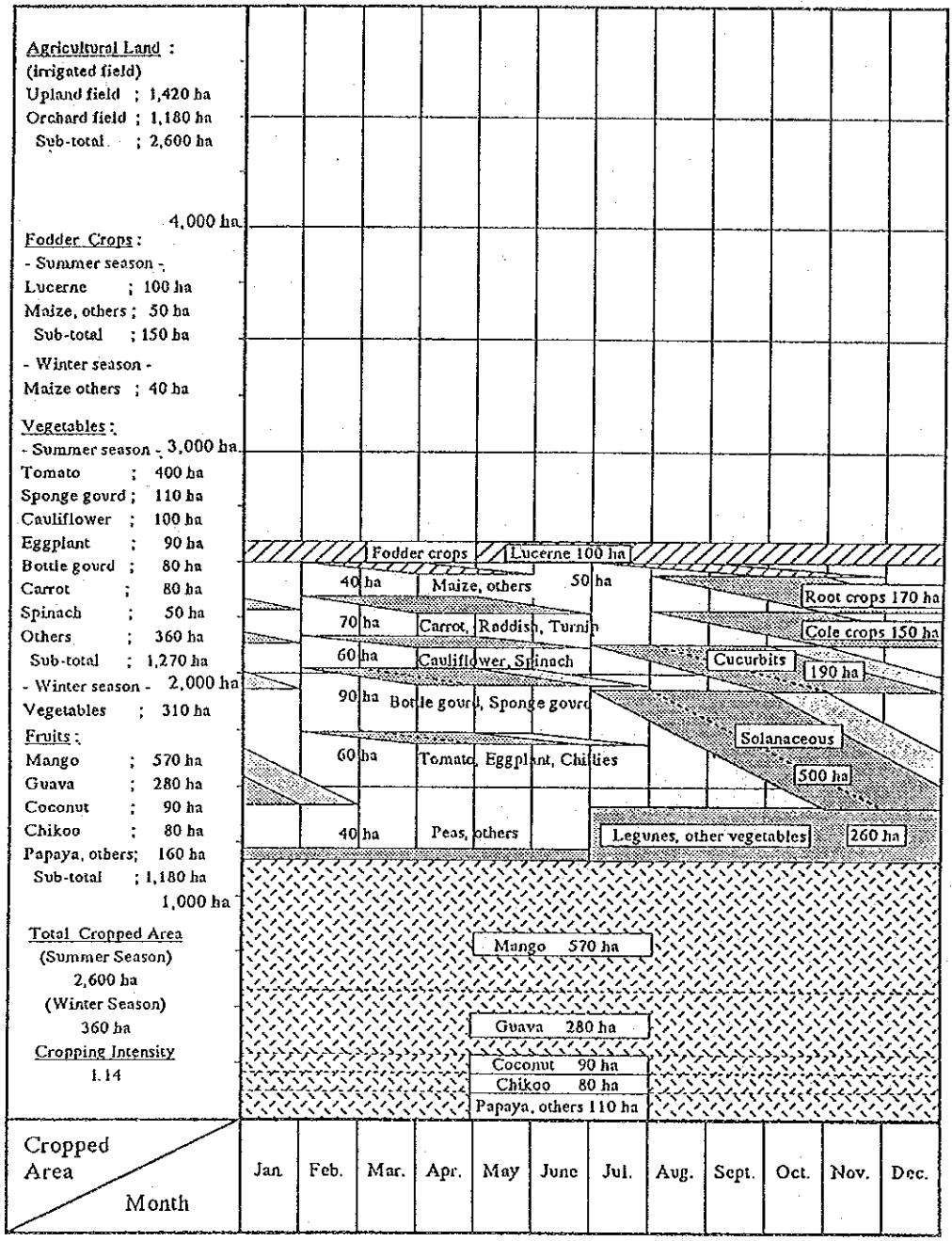

Fig.20 Present Cropping Pattern in the Project Area

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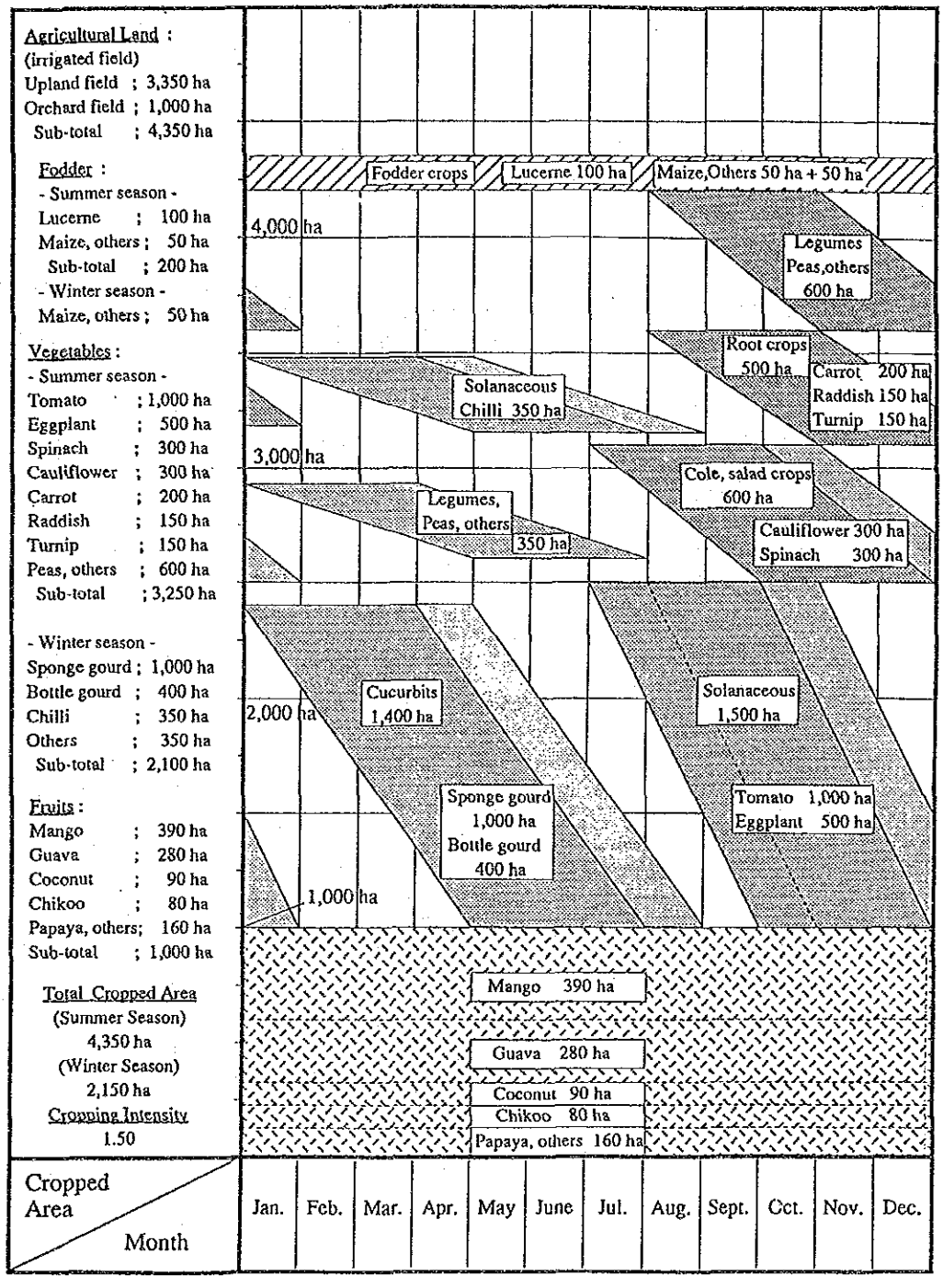

Fig.21 Proposed Cropping Pattern (with Project)

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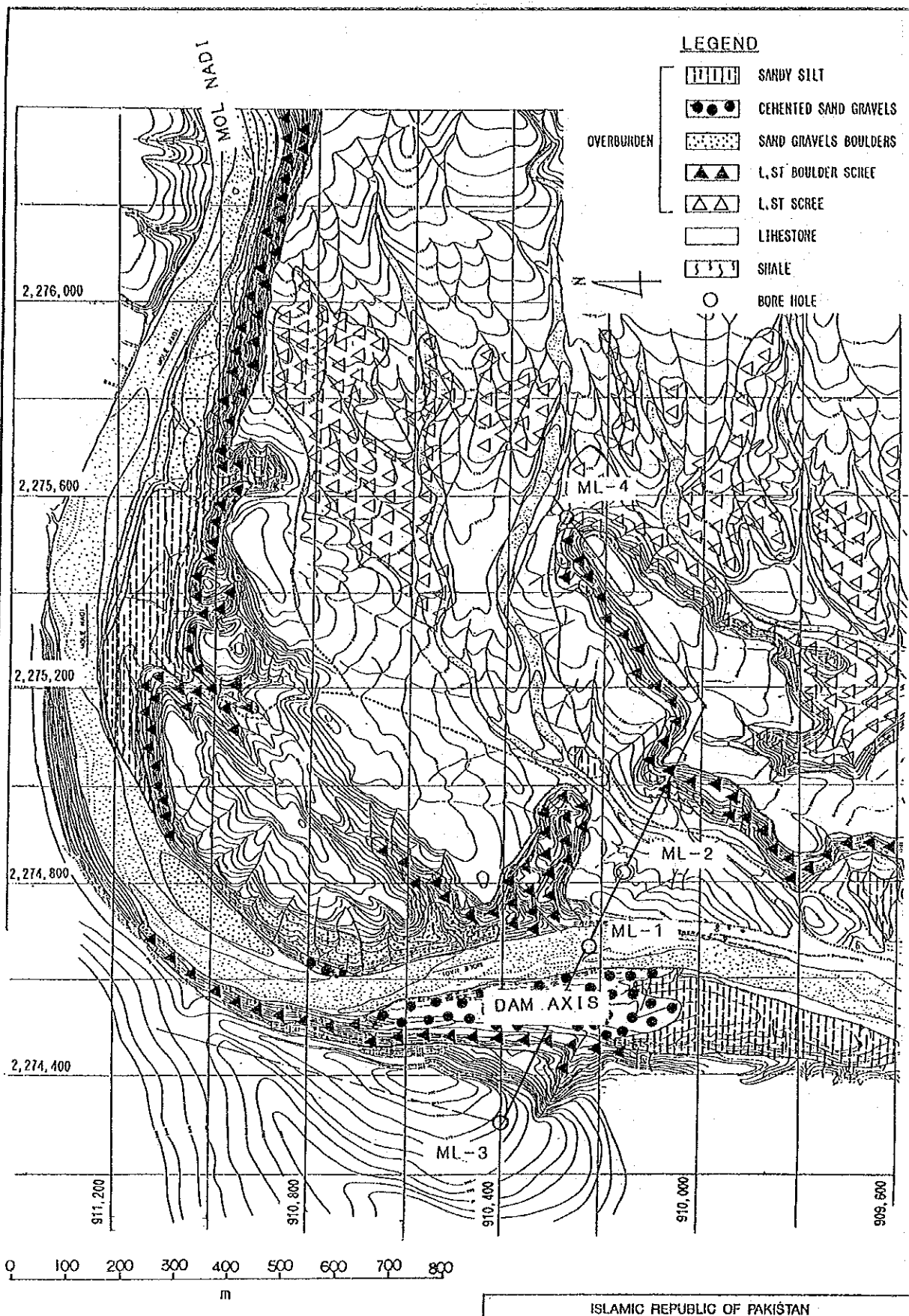

Fig.22 Geological Map of Mol Damsite

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JAPAN INTERNATIONAL COOPERATION AGENCY

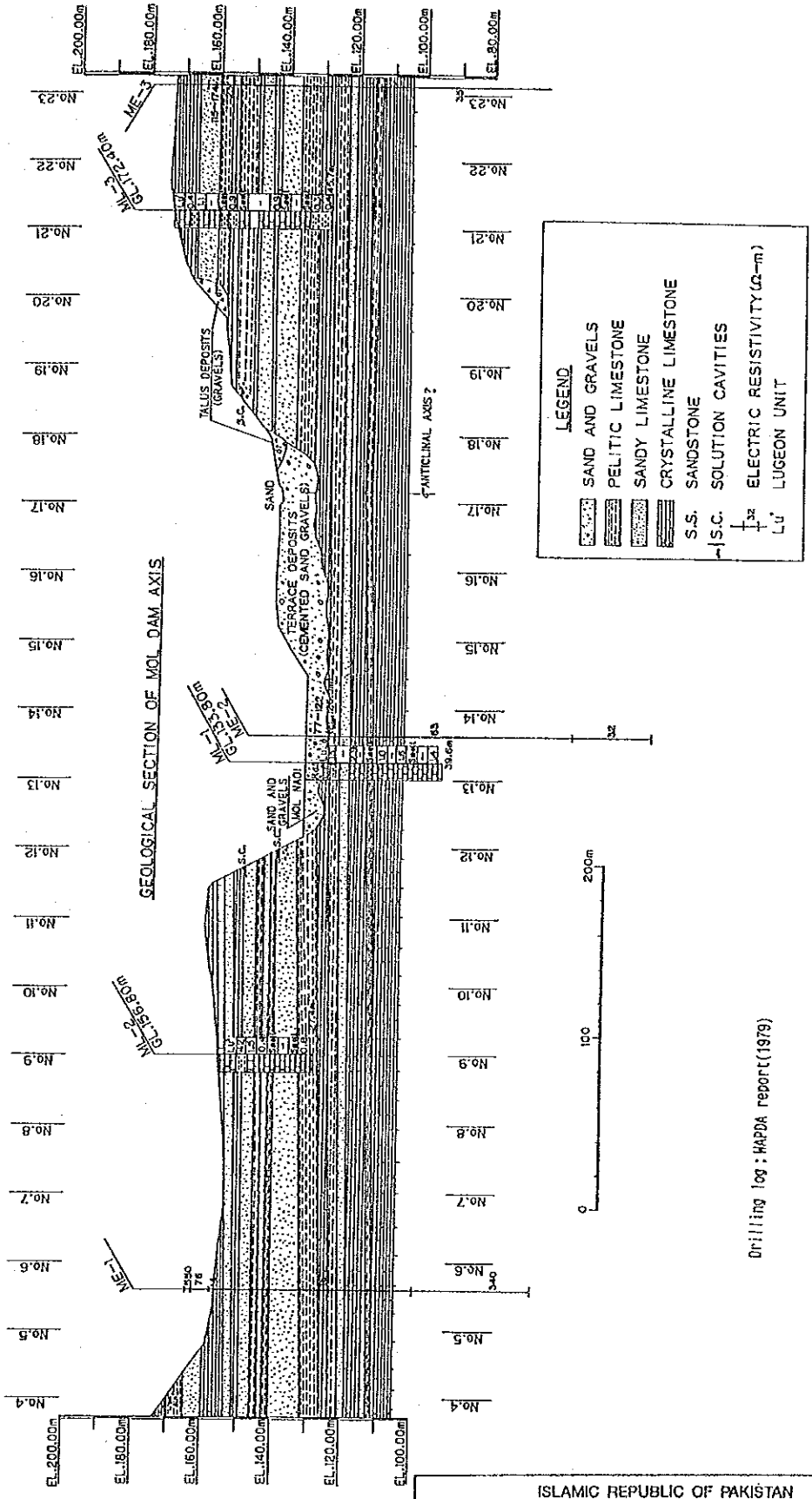


Fig.23 Geological Section of Mol Dam Axis (Looking Downstream)

ISLAMIC REPUBLIC OF PAKISTAN GOVERNMENT OF SIND
FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

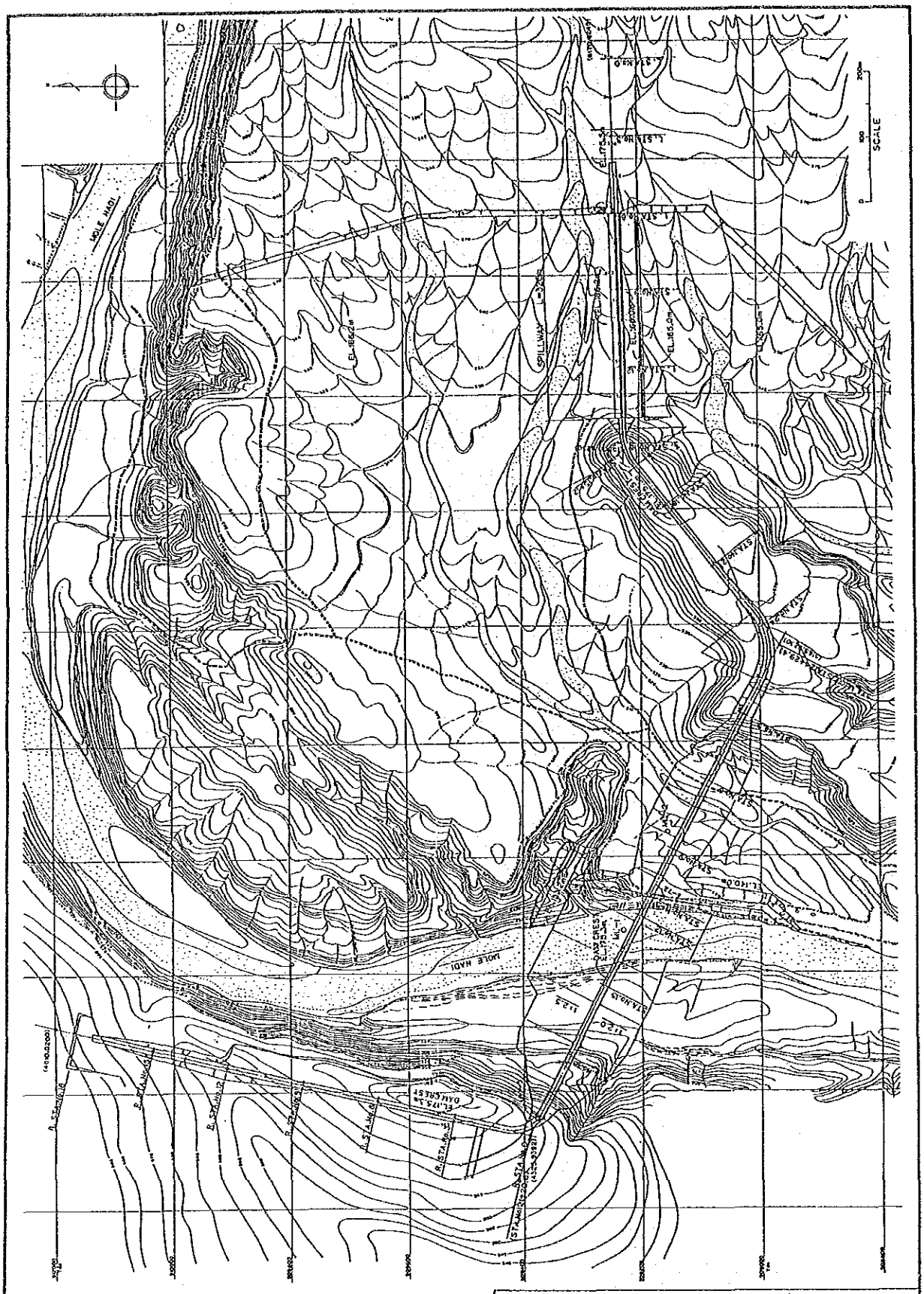


Fig.24 General Plan of Mol Dam

ISLAMIC REPUBLIC OF PAKISTAN GOVERNMENT OF SIND
FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

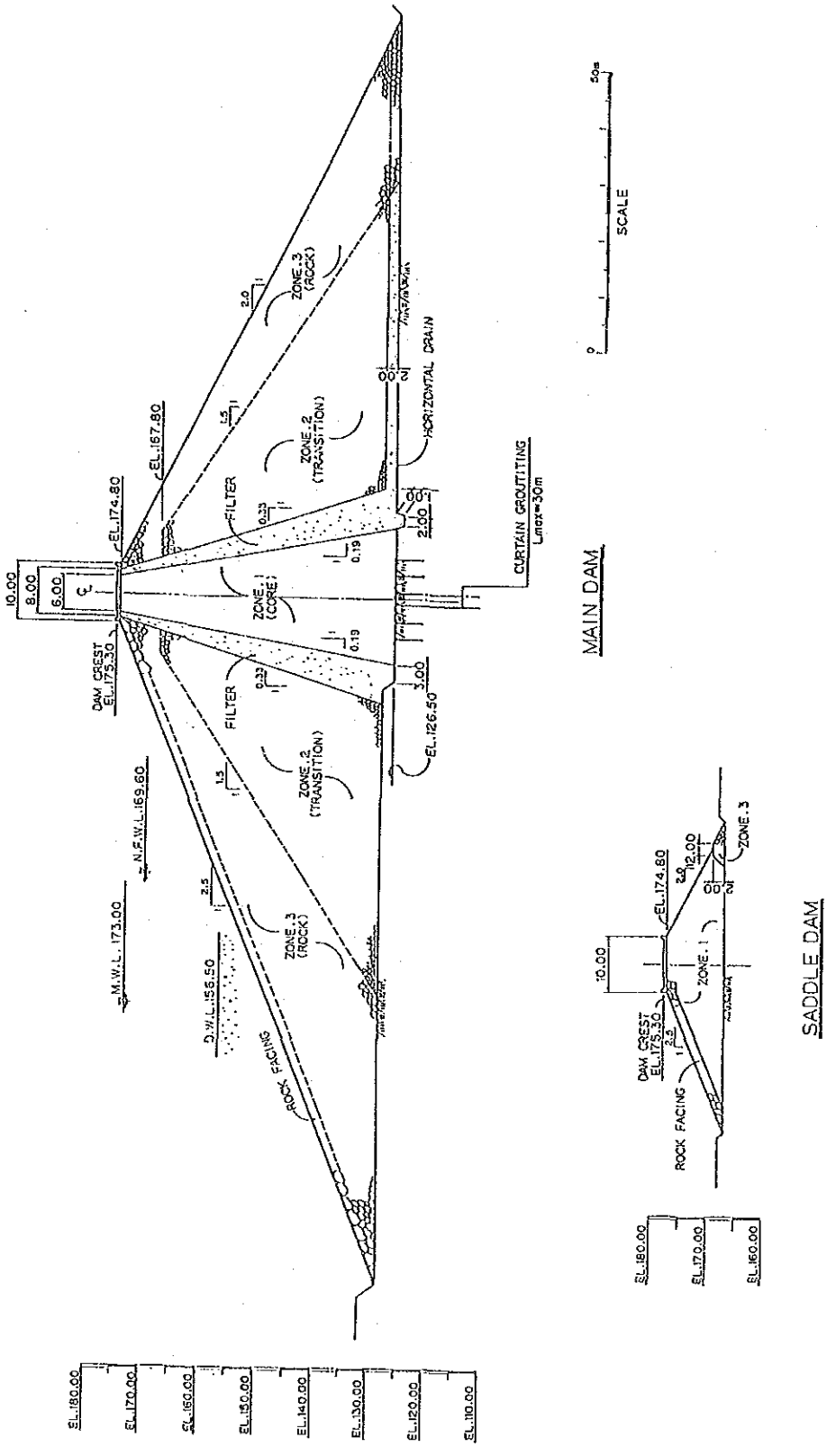


Fig.25 Standard Section of Mol Dam

ISLAMIC REPUBLIC OF PAKISTAN GOVERNMENT OF SIND
FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

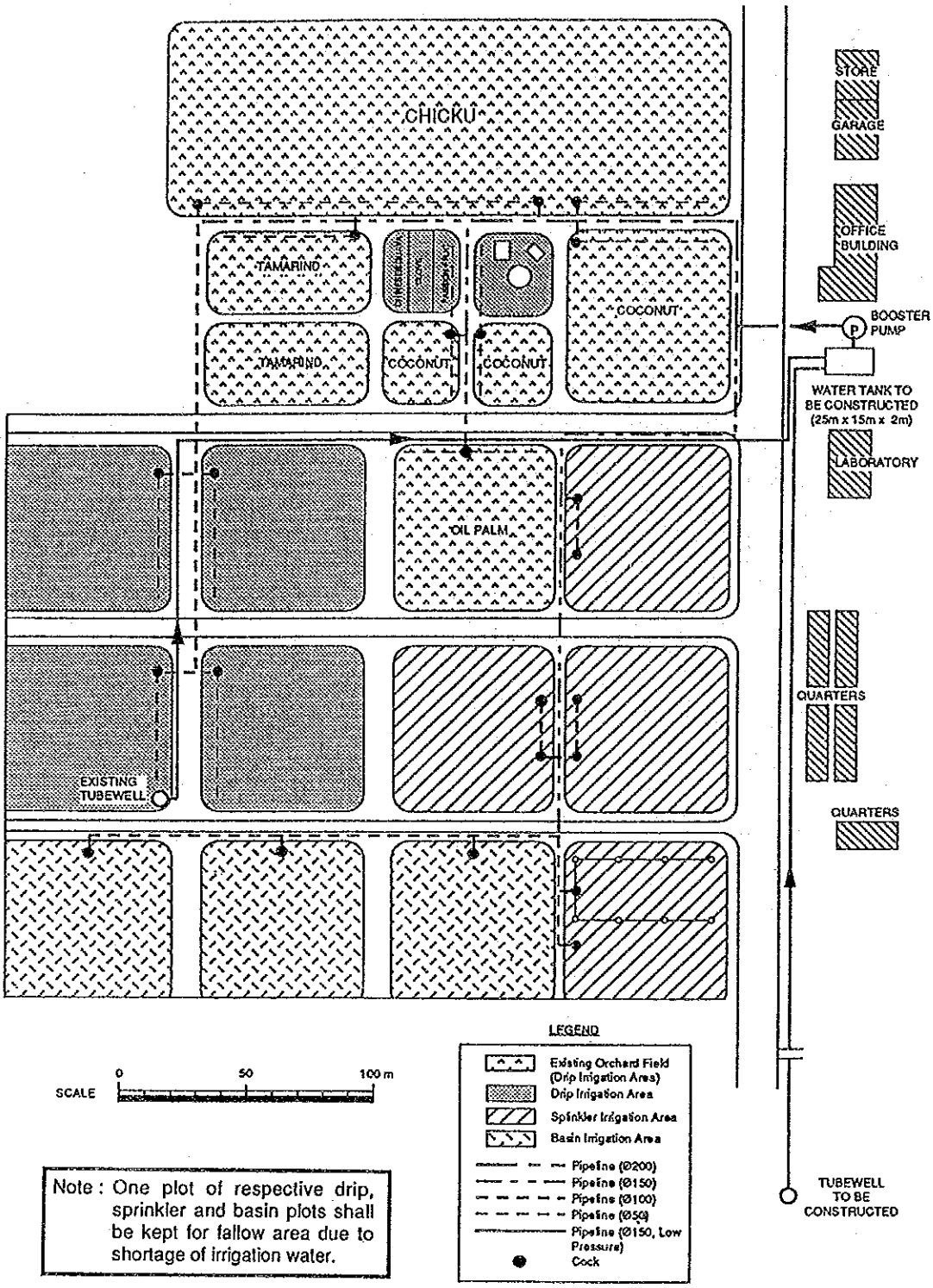


Fig.26 General Layout of Pilot Demonstration Farm

ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF SIND

FEASIBILITY STUDY ON
WATER RESOURCES DEVELOPMENT PROJECT
IN THE MALIR BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

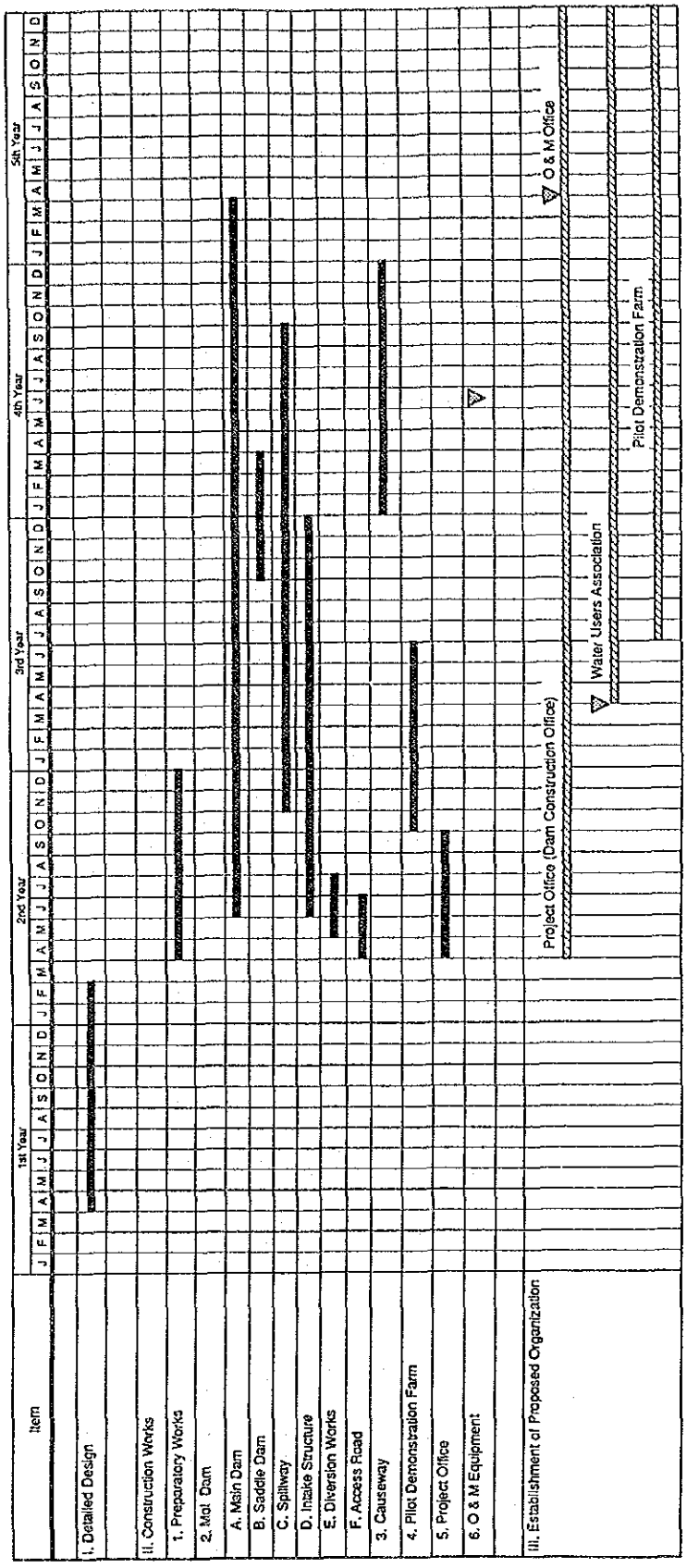


Fig.27 Project Implementation Schedule

ISLAMIC REPUBLIC OF PAKISTAN GOVERNMENT OF SIND
FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN THE MALIR BASIN
JAPAN INTERNATIONAL COOPERATION AGENCY

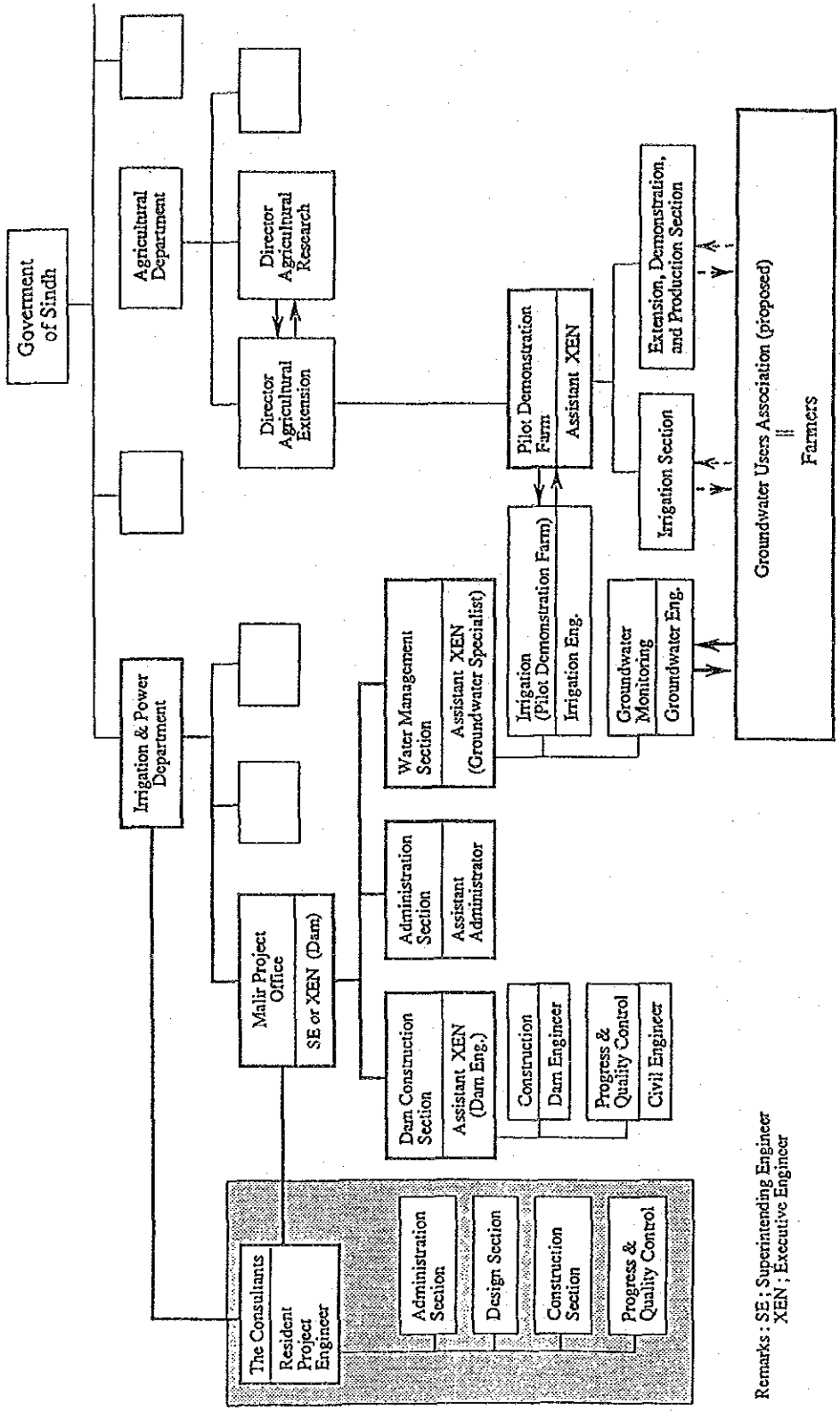


Fig.28 Organization for Project Implementation

ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF SIND

FEASIBILITY STUDY ON
WATER RESOURCES DEVELOPMENT PROJECT
IN THE MALIR BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

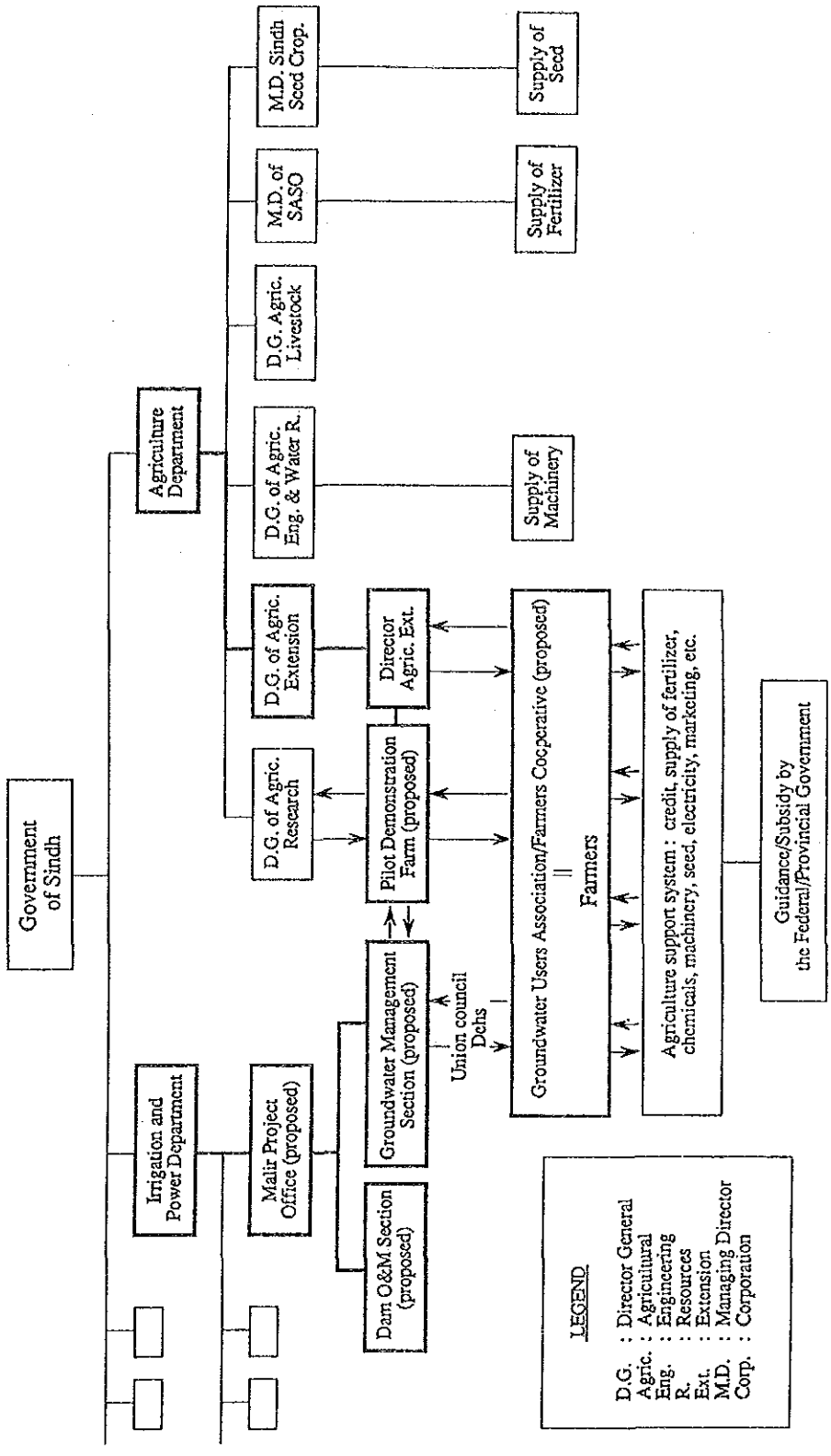


Fig.29 Organization for Operation and Maintenance of the Project

ISLAMIC REPUBLIC OF PAKISTAN
GOVERNMENT OF SIND

FEASIBILITY STUDY ON
WATER RESOURCES DEVELOPMENT PROJECT
IN THE MALIR BASIN

JAPAN INTERNATIONAL COOPERATION AGENCY

ATTACHMENTS

SCOPE OF WORK

FOR

THE FEASIBILITY STUDY

WATER RESOURCES DEVELOPMENT PROJECT

IN

MALIR BASIN

AGREED UPON BETWEEN

THE GOVERNMENT OF SIND

ISLAMIC REPUBLIC OF PAKISTAN

AND

THE JAPAN INTERNATIONAL COOPERATION AGENCY

Karachi, February 6,1989

Ghulam Mustafa Abro
Chief Water and Power,
Planning and Development:
Government of Sind

Mr. Norio UCHIYAMA
Leader of the Preliminery
Survey Team
Japan International
Cooperation Agency.

Mr. Akhtar Iqbal
Deputy Secretary,
Economic Affairs Division,
Ministry of Finance & Economics,
The Government of Pakistan,
Islamabad.

I. INTRODUCTION

In response to the request of the Government of the Islamic Republic of Pakistan (hereinafter referred to as "Pakistan"), the Government of Japan decided to conduct the feasibility study on Water Resources Development in Malir Basin (hereinafter referred to as "the Study") in accordance with the relevant laws and regulations in force in Japan.

Accordingly, Japan International Cooperation Agency (hereinafter referred to as "JICA), the official agency responsible for the implementation of technical cooperation programmes of the Government of Japan, will undertake the Study in close cooperation with the authorities concerned of Pakistan. The present document sets forth the Scope of Work with regard to the Study.

II. OBJECTIVES OF THE STUDY

The objectives of the Study are:

1. to formulate the Agricultural and Water Resources Development project in Malir Basin and verify the feasibility of the project

2. to undertake technology transfer to the counterpart personnel in the course of the study

III. STUDY AREA

The study area is to cover the Malir River Basin, about 30,000ha, including agricultural land, (map attached)

IV. SCOPE OF THE STUDY

The study to be undertaken by the team will be carried out in two phases as follows:

Phase 1

(1) Collection of data and information and review of the various studies already conducted.

Contd..P/2.

a) Physical conditions
   - Topography
   - Meteorology and hydrology
   - Geology and soil mechanics
   - Ground Water Survey
   - Hydrogeological survey, (electrical resistivity if needed)
   - Vegetation

b) Socio-economic status
   - Demographic conditions
   - Regional and national economy
   - Rural infrastructure
   - Municipal water demand

c) Agriculture
   - Agriculture
   - Agro-economy and institutional arrangement.
   - Land use
   - Soil
   - Irrigation and drainage

(2) Home Office Work

analysis of the result of field survey and investigation

Contd..P/3.

Phase 2

(1) Supplement field survey and investigations

- Soil land use and land capability
- Irrigation and drainage survey
- Agro-economy and institutional arrangement.
- Regional economy
- Geological investigation at dam site
- Construction material and cost

(2) Establishment of basic concept

- Outline of agricultural development plan
- Outline of ground water recharge plan
- Basic layout of major structures
- Rough cost estimation
- Strategy for implementation

(3) Home Office Work

Analysis of the field survey and investigations including the following work items

- Final delineation of the project area paying particular attention to the results of ground water study
- Formulation of agriculture development, water resources development and management plan
- Layout of the project works including preliminary design of major structure
- Establishment of implementation plan and schedule
- Benefit and cost estimation
- Economic evaluation

Contd..P/4.

V. WORKING SCHEDULE

The Study will be executed in accordance with the attached tentative schedule.

VI. RE-PORTS

JICA will prepare and submit the following reports in English to the Government of Pakistan.

(1) Inception Report

Thirty (30) copies at the commencement of the first stage of the work

(2) Progress Report

Thirty (30) copies at the middle of the field work.

(3) Interim Report

Thirty (30) copies at the end of the field work.

(4) Draft Final Report

Thirty (30) copies within one (1) month after the end of the second stage home office work.
The Government of Pakistan will provide its comments on the draft final report within one (1) month after its reception.

(5) Final Report

Fifty (50) copies within two (2) months after the receipt of the comments on the draft final report.

VII. UNDERTAKING OF THE GOVERNMENT OF PAKISTAN

1. To facilitate smooth conduct of the Study, the Government of Pakistan will take necessary measures;

(1) to secure the safety of the Japanese study team,

Contd..P/5.

(2) to permit the members of the Japanese study team to enter, leave and sojourn in Pakistan for the duration of their assignment therein, and exempt them from alien registration requirements and cons-ular fees,

(3) to exempt the members of the Japanese study team from taxes, duties, fees and other charges on equipment, machinery and other materials brought into Pakistan for the conduct of the study,

(4) to exempt the members of the Japanese Study team from income tax and other charges of any kind imposed on or in connection with any emoluments or allowance paid to the members of the Japanese study team for their services in connection with the implementation of the Study,

(5) to provide necessary facilities to the Japanese study team for remittances as well as utlization of the funds introduced into Pakistan from Japan in connection with implementation of the Study.

(6) to secure permission for entry into private properties or restricted areas for the conduct of the Study,

(7) to secure permission for the Japanese team to take all data and documents (including photographs) related to the Study out of Pakistan to Japan by the Japanese study team, and

(8) to provide medical services as needed. Its expenses will be chargeable on the members of the Japanese study team.

2. The Government of Pakistan shall bear claims, if any arises, against the members of the Japanese study team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or wilful misconduct on the part of the members of the Japanese study team.

Contd..P/6.

3. Irrigation Department, the Government of Sind (hereinafter referred to as "the Department") shall act as a counterpart agency to the Japanese study team and also as a coordinating body to other relevant organizations for the smooth implementation of the Study.

4. The Department shall provide or arrange the Japanese study team with the following, in cooperation with other agencies concerned.

   (1) Available data and information related to the Study
   (2) Counterpart personnel
   (3) Suitable office with necessary equipment and furniture
   (4) Credentials or ID cards
   (5) Necessary number of vehicles with drivers

VIII. UNDERTAKFING OF JICA

For the implementation of the Study, JICA shall take following measures:

1. To dispatch, at its own expense, the study teams
2. To pursue technology transfer to the Pakistani counterpart personnel in the course of the Study

IX. OTHERS

JICA and the Department shall consult with each other in respect of any matter that arise from or in connection with the Study.

ATTACHMENT-1

TENTATIVE SCHEDULE

Item Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
WORK IN PAKISTAN		(Phase I)					(Phase II)											
WORK IN JAPAN																		
REPORTS		△			△		△			△					△		△	
		Inc.R			P.R. 1		P.R. 2			Int.R					D.F.R.		F.R.	

(Remarks) Inc.R.: Inception Report P.R.: Progress Report

Int.R.: Interim Report D.F.R.:Draft Final Report

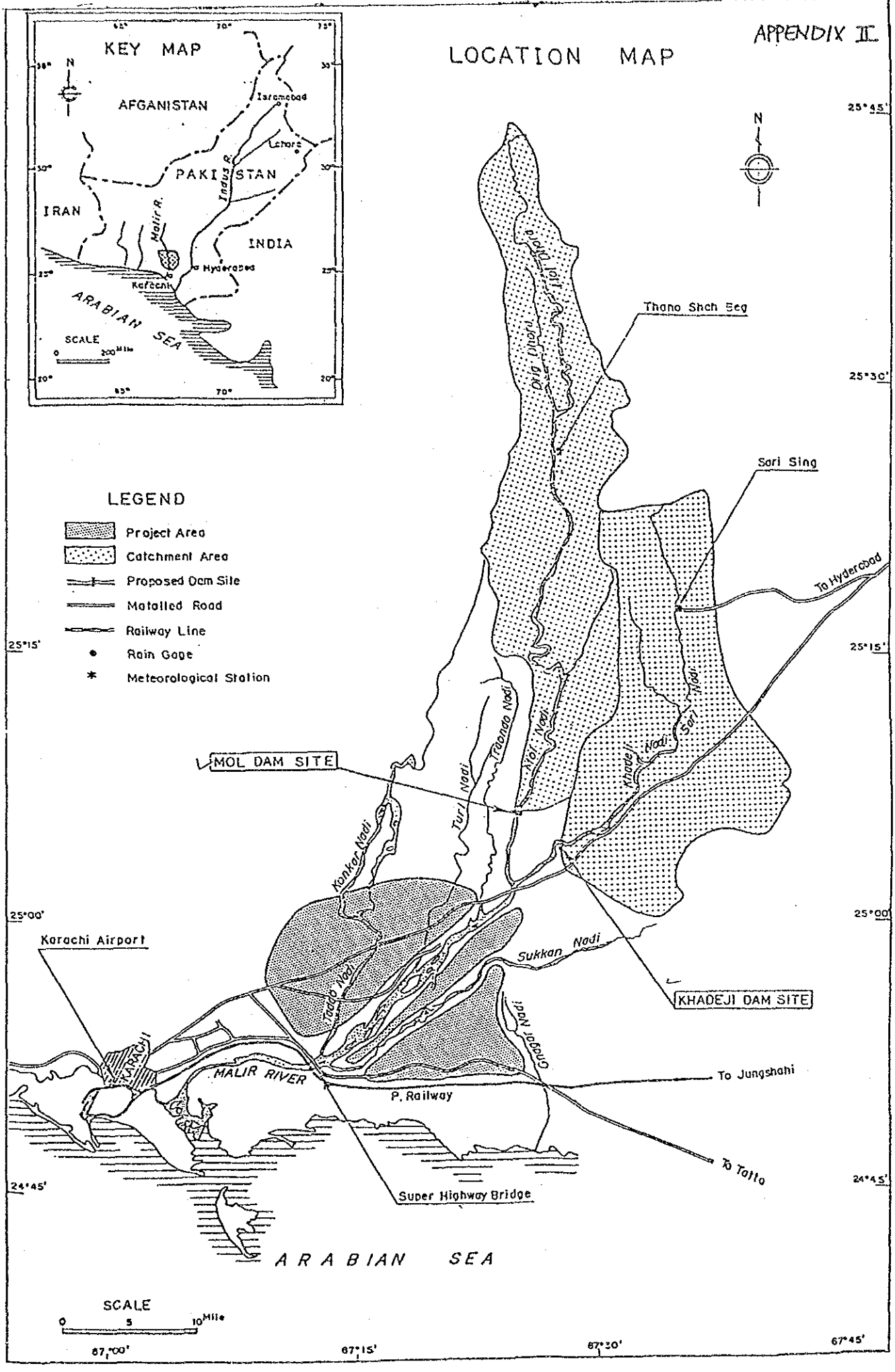
F.R. : Final Report

◎ Comments on D.F.R. by Pakistan side

▤ : Field Work

▭ : Home Office Work

APPENDIX II


KEY MAP
AFGANISTAN
PAKISTAN
IRAN
INDIA
ARABIAN SEA
Islamabad
Lahore
Hyderabad
Karachi
Indus R.
Malir R.
SCALE
LOCATION MAP
LEGEND
Project Area
Catchment Area
Proposed Dam Site
Metalled Road
Railway Line
Rain Gage
Meteorological Station
Thano Shah Beg
Sari Sing
To Hyderabad
MOL DAM SITE
KHADEJI DAM SITE
Karachi Airport
KARACHI
MALIR RIVER
P. Railway
Super Highway Bridge
To Jungshahi
To Tatta
Orangi Nadi
Konka Nadi
Turi Nadi
Thadho Nadi
Khadeji Nadi
Sukkan Nadi
Taddo Nadi
ARABIAN SEA
SCALE
25°45'
25°30'
25°15'
25°00'
24°45'
67°00'
67°15'
67°30'
67°45'

MINUTES OF MEETING

FOR

THE FASIBILITY STUDY

WATER RESOURCES DEVELOPMENT PROJECT IN MALIR RIVER BASIN

IN

THE ISLAMAIC REPUBLIC OF PAKISTAN

KARACHI, FEBRUARY 6, 1989

Ghulam Mustafa Abro
Chief Water and Power,
Planning and Development
Government of Sind.

Norio UCHIYAMA
Leader of the Preliminary
Survey Team
Japan International
Cooperation Agency.

The preliminary survey team for the Feasibility Study of Water Resources Development project in Malir Basin sent by JICA had series of discussions on the above mentioned project with the relevant officails of the Government of Sind from 30th January, 1989 to 10th February, 1989. The followings are summarized conclussions of the discussions.

1. The both sides agreed that this project sets the highest priority on irrigation.

2. The team requested to carry out the following items by the time of commencement of the study.

   (1) Hydrology

   . to obtain copies of the data observed by the Surface Water and Hydrology Division WAPDA concerning with the Malir River
   . to obtain the basic data from WAPDA in Lahore concerning with the dam, justifying the proposed sediment volume and scale of spillway
   . to observe the front line of the surface water in the Malir River in case of any occurence of the flood

   (2) Ground Water

   . to prepare the geological map, concerning the whole study area about 30,000 ha

   . to obtain detailed map of the solution cavities or solution channels of KHADEJI dam from WAPDA

3. The team suggested as follows :

   (1) Hydrology

   . that it would be necessary to repair the automatic rain gauge at the metrological observation station on super highway

   (2) Ground Water

   . that the Govt. of Sind, Irrigation Department, would record the long term fluctuation of ground water level and quality
   . that the Govt of Sind would make contour map of ground water surface in rainy and dry season respectively.

   (3) Agriculture
   . that the Govt. of Sind would study the possibility of expanding the planted area

4. The team recommended that the Govt. of Sind carry out the pumping tests.

5. Pakistan side requested that the study would include the application of new irrigation method in relation to the scope of work IV. phase 2. (3).

6. Pakistan side requested that the Govt. of Japan would provide the necessary vehicles and measuring equipment for the study.

M.U.

Minutes of Meeting

on

Draft Final Report
of
Feasibility Study
on
Water Resources Development Project
in
Malir Basin

Agreed upon Between

The Government of Sindh
Islamic Republic of Pakistan
and
Japan International Cooperation Agency

Karachi, Dated 25th August, 1990

25.8.90

MOHAMMED IDRESS RAJPUT
Additional Secretary,
Irrigation and Power Dept.
The Government of Sindh

KUNIO IRIE
Team Leader
JICA Study Team

Witness
DR. MASAYUKI WADA
Chairman of JICA
Advisory Committee

PRESENTATION OF THE DRAFT FINAL REPORT OF FEASIBILITY STUDY ON WATER RESOURCES DEVELOPMENT PROJECT IN MALIR BASIN

Date : August 23, 1990

Place : 9:00 - The Conference Room of Planing and Development Dept.
12:00 - The Office of Secretary of Agriculture and Livestock Dept.
14:30 - The Office of Additional Secretary of Irrigation and Power Dept.

Attendants : As per annexure

In accordance with the Scope of Works for Feasibility Study on Water Resources Development Project in Malir Basin signed on February 6, 1989 between the Japan International Cooperation Agency (JICA) and the Government of Sindh (GOS), Islamic Republic of Pakistan, the JICA Study Team (the Team) carried out the Study. As a result of the Study, the Team prepared and submitted the Draft Final Report on August 22nd and meeting was held for the discussion on the Draft Final Report presenting the results of the Study. Both parties have mutually confirmed the following:

1. The JICA Study Team briefly explained the results of the Study, and the Draft Final Report describing results of the Study was accepted by GOS.

2. GOS requested to describe the staffing and O & M costs of the proposed Pilot Demonstration Farm. The Team agreed to do it in the Final Report.

3. GOS requested to submit eighty (80) copies of the Final Report, instead of 50 copies stipulated in the Scope of Work. The Team agreed to transfer the GOS's request to JICA.

4. GOS is keen to implement the project as early as possible, in due consideration of the socio-economic conditions in the project area.

5. GOS will send comments if any before September 21st,1990 in accordance with the Scope of Work agreed upon between JICA and GOS on February 06,1989. The Team expressed to receive comments if any as early as possible, and prepare the Final Report in due consideration of comments if necessary within two (2) months after receiving comments.

6. GOS expressed thanks to the Team for their dedicated works on this project, and is pleased to receive the Final Report for early implementation.

LIST OF ATTENDANTS

A. The Government of Sindh

A.1 9:00 -

1. Mr. Fazlullah Qureshi	Additional Chief Secretary (Dev), P & D Dept.
2. Mr. Munmir A. Qazi	Chief (Agriculture), P & D Dept.
3. Mr. Ghulam M. Abro	Chief (Water & Power), P & D Dept.
4. Mr. Khair M. Soomro	Deputy Secretary (Technical) Agriculture & Livestock Dept.
5. Mr. G. Sarwar Khero	Chief (Foreign Aid) P & D Dept.
6. Mr. Allah B. Kalhoro	Assistant Chief (Foreign Aid) P & D Dept.
7. Mr. M. Iqbal Shaikh	Executive Engineer Irrigation & Power Dept.

A-2 12:00 -

1. Mr. Kamaluddin Qureshi	Secretary, Agriculture & Livestock Dept.
2. Mr. Shaukat Rahmoo	Deputy Secretary (Technical) Agriculture & Livestock Dept.
3. Mr. Khair M. Soomro	Deputy Secretary (Technical) Agriculture & Livestock Dept.
4. Mr. Masood Ahmed Bhutto	Director, Agricultural Engineering, Sindh, Hyderabad.
5. Mr. M. Arif Ali	Section Officer, Agriculture & Livestock Dept.
6. Mr. M. Arif Khairi	Section Officer, Agriculture & Livestock Dept.

A-3 14:30-

1. Mr. Mohammed I. Rajput	Additional Secretary, Irrigation and Power Dept.
2. Mr. Iqbal Shaikh	Executive Engineer Irrigation & Power Dept.
3. Mr. Noor Ahmed Memon	Assistant Ex. Engineer Irrigation and Power Dept.

B. JICA Advisory Committee

1. Dr Masayuki Wada	Chairman of Advisory Committee, MAFF

C. JICA Study Team

1. Mr. Kunio Irie	Team Leader
2. Mr. Shunichi Muramoto	Deputy Team Leader
3. Mr. Motoo Taki	Dam Engineer