GROUND WATER EVALUATION IN JAWAI CATCHMENT, WESTERN RAJASTHAN

By

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Abstract -

Analysis of drainage system, meteorological data, hydrogeological conditions, environmental degradation, water balance and fluctuation in water levels in wells of Jawai catchment indicate that there is gradual decrement in the statis reserves of ground water in Jawai catchment of Western Rajasthan and an adverse condition has been noticed at many places where the saline water facies have encroached the fresh water reservoir.

The meteorological aspect is indicative of the fact that in the Jawai catchment, there is sufficient water surplus which is being lost as evaporation and run-off. The catchment was hit by severe floods during 1973 and 1979 and by moderate floods during 1961, 1964, 1975, 1977, 1983 and 1990, 1991 etc. The computation of one of the factor that there was huge run-off during these rainfall years. The great amount of run-off during these rainfall years was noticed when the frequency and intensity of showers was high although, the rainfall was less than the normal rainfall. There is no adequate storage capacity to use this huge quantity of surplus water. Inspite of the water being surplus, there is declining trend of water levels in the wells, which conclude that water is lost due to run-off in most parts of the catchment whereas in main Jawai Canal the decrease in ground water storage is due to with-holding of water in Jawai Dam. However, it is also estimated that a great quantum of water is lost due to evaporation and run-off.

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INTRODUCTION

The object of this paper is to acquaint the scientists, agriculturist, engineers, planners, and administrators, for taking suitable measures to preserve environmental, cultural heritage, and ecological aspects and to bring this part of state to be with main national upliftment programme.

The "JAWAI CATCHMENT" (Plate J-1 and Plate J-2) contributes surface water from western ghat portion of main Aravali ranges. The Ghat portion receives water from rainfall and speedly supply to lower portion of the catchment in direct response to surface gradient. The surface flow establishes network of streams of first to seventh order, till it merge in the rann of kutch in association with Luni catchment, the only drainage basin in western Rajasthan.

Since historic time the region of this catchment is self maintained as it has got favourable climatic condition, fertile soil cover and healthy human and cattle inhabitants supported by traditional way of distribution of workmanship.

In recent years for efficient utilisation and conservation of surface water and to bring more and more land suitable for cultivation but un-irrigated in to the fold of irrigation, in almost all the villages minor or major civil structures were installed. The installation of such civil structures have partly fulfilled the need of the local residence to match with irrigation, drinking and live stocks requirements.

Due to uncertainity of rainfall, these structures played a vital role to develop harmony in the society and also given an understanding of co-operation.

The potentiality of this catchment was adjudged and viewed by Late Hishighness of Jodhpur in the wider prospective of Marwar State and he transferred the thoughts to the eminents planners for conservation of surface water for intensive irrigation and also simultaneously to match with drinking water requirement of Jodhpur City. The major Jawai Dam is outcome of this thought. The historic potentiality of this catchment has not been adversely effected for many decades as the natural environment, forest, and the traditional method of taking out water from wells were in favour till 1965. Development of ground water resources became the need of the region for increased agriculture product and speedly expansion of the water supply schemes to connect all the villages with a suitable quality of water. The indiscriminate use of ground water, deforstation, and preserving the dame water for drinking water supply has effected the local harmony in the aquifers to sustain pumping.

Ground water investigation has explored the entire catchment to make use of the ground water for irrigation, drinking and live stocks. The decreasing/depleting trends of water level, the wells of the catchment has invited the attention of the local residents and planners of respective sub-divisional and divisional authorities. In following pages an attempt is made to deciper technical understanding to apprise the local resident for use of water.

I. <u>PHYSIOGRAPHIC SET UP AND WATER BALANCE IN JAWAI CATCHMENT</u>

The whole catchment area can be divided into sub-basins namely:-

(a) Jawai river sub-basin
(area - 2130 sq.km. excluding the catchment area of Jawai dam - 714.0 sq.km.)

(b) Khari river sub-basin
(area 2318.0 sq.km.)

(c) Bandi river sub-basin
(area 1330.0 sq.km.)

(d) Sagi river sub-basin
(area 912.0 sq.km.)

(e) Sukri river sub-basin
(Saila to Luni - area 1136.0 sq.km.)

(a) <u>Jawai river sub-basin</u>:

Jawai river originates from the Aravalli ranges in Sirohi district in all the direction except south, near village Dhakuji. In initial stage it flows from south to north and some nallahs east to west. The Goriya river originates from the Aravalli ranges in Udaipur and Pali districts and after flowing for about 40 km., joins Jawai about 1.0 km., east of Bhandar Village in Pali. The two moves from south to north for about 25 kilometres then fall in Jawai dam.

The Tarawari nadi is formed by the confluence of Chirpin nallah and Harganga-ka-Wara joins the Jawai river near village Sena. The slope of the river in the up-stream of Jawai dam is 1 in 300. After Jawai bund, the river flows in flat areas of Pali district with a slope of 1 in 350 to 400.

After flowing for 55 kilometres below Jawai dam, it is being joined by Sukri Nadi (i) near village Palasi in Jalore and flows in north-western direction. It meets Sukri Nadi

(ii) between village Paharpura and Nawakhera and then is called Sukri river. The total length upto this point from Jawai dam is 85 kilometres and upto Saila, it is 125 kilometres. Between Jalore and Saila, many nallahs originating from local hills, meet it at the time of heavy discharge otherwise, disappear in the sand dunes. Near village Saila, Khari river meets it. The Jawai river flows partly in hilly areas and partly in plain from Jawai dam to its confluence with Sukri. The river flows through sandy plains of Jalore and Barmer below its confluence with Sukri upto Khari at Saila.

Sukri Nadi (i) is formed by the confluence of Shivnagri-ka-Nallah and Anka-Ka-Bala. Shivnagri-ka-Nallah originates from the local out crops about 2 km., south of village Malnu in Pali district. After flowing for about 20 km., in NW direction, meets Anka-ka-Bala near village Chotila-ki-Bhagli.

The Anka-ka-Bala originates from eastern slopes of Aravalli ranges and after flowing for 13 km., meets Shivnagri-ka-Nallah.

After the confluence of these two, Sukri Nadi (i) is formed and flows in NW direction and then from south to north and meets Jawai river near Palasia in Jalore.

(b) <u>Khari river sub-basin</u>:

Khari river sub-basin is formed by the confluence of Khari nadi, Kameri nadi, Krishawati nadi, Khari nalla, Bandi nadi and Rel nadi.

Khari river originates from hills of Bankli-Bhakar near village Won in Sirohi district. One off-shoot of this river starts from western slopes of Aravalli ranges near Sukri and joins the Khari river near village Gol in Sirohi district.

Ora dam is a good source of storage tank on it. It joins Krishnawati nadi near village Umedgarh, which originates from the western slopes of Aravalli hills near village Isara and flows in north for 20 kilometres. With it meets the Kameri nadi which originates from the same source as that of Krishnawati. The Khari Nallah originates between village Bithura and Mandur and joins Krishnawati near Siyana village and afterwards the river is known by the name of Khari nadi. To this meets the Bandi nallah which starts from the rock outcrops of Kuma village and flows from south to north for 80 kilometres, joins Khari near village Akoli and then the river is called Bandi nadi. Rel nadi is formed by the confluence of Mongu nadi and Jalia bala. The Mongu nadi is an off-shoot of Rel nadi originates from the rock outcrops near village Kuma and Jalia bala from Phalwadi. These two off-shoots join near village Deldari to form Rel nadi.

The Khari river ultimately joins Jawai - Sukri river near village Saila.

(c) Bandi River sub-basin:

Bandi river originates from the Nandwan hills near village Kivaj. Another off-shoot originates from eastern slopes of Jaswantpura hills. The whole river flows from south to north for a distance of 20 kilometres and then SW to NW for a distance of 30 kilometres and then from east to west for 22 kilometres and then joins Jawai - Sukri river near Dhumbalia. To it meets Kapalganga nadi which starts from the hills near village Stankra in Sirohi and flows in NW direction about 13 kilometres in hilly region and then joins Bandi river near village Chandur in Jalore district. The slope of the river is 1 in 250 in hilly region while it is 1 in 700 in sandy region.

(d) Sagi river sub-basin:

Sagi river originates from the western slopes of mountaneous ranges near Jaswantpura. In the initial stage it is known by Dhani river and becomes Sagi nadi when it flows in the plain. To this, meets another river known as Sukri or Khara nadi which also originates from the same mountains, near village Alari. The whole moves from west to east and after flowing for about 80 kilometres in the plain and sandy terrain, joins the Sukri near village Itada of Jhab, which ultimately joins Luni. The river traverses wholly in Jalore district.

(e) Sukri river sub-basin (Saila to Luni):

This sub-basin is formed by the confluence of Jawai Sukri and Khari river near village Saila in Jalore. It flows in west direction with a slope of 1 in 800. After flowing for 35 kilometres, Bandi (Jaswantpura) river joins it on left bank near village Dhumbadia. Here, Sukri bifurcates, the left branch is joined by Sagi near village Junibali. The right branch again bifurcates and enters Barmer district near village Rampura. These branches ultimately joins Luni river near village Padori. The another branch joins Luni about 9 kilometres down-stream of first one. The whole river flows in the sandy regions of Jalore and Barmer district.

Existing Tanks in Jawai River Sub-basin (upto Khari and Bandi River Sub-basin)

Name of Tanks	Catchment area in sq.km.	Yield stored in mcm	Average irrigation in hectares	Tehsil/ District
1	2	3	4	5
(A) MAIN JAWAI RIVER SUB-BASIN:				
Jawai dam	714.00	207.85	18413.4	Bali/Pali
Shivnath Sagar	3.63	1.2743	222.6	,,
Songiri-ka-bala	15.54	0.9684	87.4	,,
Boki-Ka-bala	7.02	1.0622	122.2	,,
Krishna Sagar	4.33	0.2761	31.6	Sheoganj/ Sirohi
Kana Kolar	3.73	0.6074	98.3	,,
Durbana	8.81	0.7578	73.2	,,
Godana Bund	21.5	1.8720	167.1	,,
Palri Tank	42.1	0.5380	54.6	,,
Khiwandi Bankli	126.9	6.1411	797.6	Bali/Pali
Takhatgarh Tank	49.2	1.9666	329.8	Bali/Pali
Proposed Schemes:				
Sukri Inundation Scheme	-	7.4332	1618.8	Sheoganj/ Sirohi
Harji Irrigation Project	-	9.911	1254.5	Ahore/ Jalore
Sardargarh Irrigation Project	-	2.8317	323.8	Jalore
[illegible]niwara Irrigation Project	-	0.7929	91.1	Jalore
Chipparpala Irrigation Project	-	0.2832	32.4	Ahore/ Jalore

1	2	3	4	5
(B) KHARI RIVER BASIN:				
List of existing tanks:				
Tawari Tank	6.5	0.2860	30.8	Sheoganj/ Sirohi
Akhelao Mansarowar	20.7	0.8495	224.4	Sirohi
Palri Tank (Karan Sagar)	5.2	0.5380	54.6	,,
Ora Dam	238.3	22.6536	3670.5	,,
Churiyal Tank	43.5	0.7716	49.8	,,
Bithan Tank	75.1	6.3888	752.3	Bhinmal/ Jalore
Kallapura Tank	153.33	3.3980	253.7	Jalore
Under construction:				
Angore Dam (On Krishnawati)	-	13.4506	-	Sirohi
Future proposal for Irrigation:				
Kameri Irrigation Project	-	10.1941	1456.9	
Pibalbar Tank	-	1.1327	161.9	
Total Irrigation Project	-	2.5485	364.2	
(C) BANDI RIVER SUB-BASIN:				
Poidra Ram	42.74	3.0299	406.3	Sirohi
Chekala	5.20	0.2265	25.5	Bhinmal/ Jalore
Under proposal:				
Bandi Sendra Scheme	46.6	13.9744	1419.2	Bhinmal/ Jalore

1	2	3	4	5
(D) SAGI RIVER SUB-BASIN:				
Silwasan	10.72	0.4964	48.0	Bhinmal/ Jalore
Baratha	8.03	0.5584	14.6	,,
Lakhawas	6.48	0.3752	11.3	,,
Under construction:				
Vandhar	358.0	3.3131	703.8	,,
Future proposals:				
Sagi diversion scheme near Dhani Golia	-	9.0614	1295.0	
Derari Tank	-	2.1238	283.3	
Sagi Inundation near Dhani Golia	-	2.5485	526.1	
(E) SUKRI RIVER SUB-BASIN (SAYALA TO LUNI)				
List of existing cross-bunds:				
Bamal bund	-	0.8495	203.2	Sanchore/ Jalore
Hemaguda bund	-	2.5485	625.7	,,
Zhab bund	-	1.161	265.5	,,
Sindhasva	-	0.3115	66.8	,,
Bhakarpura	-	0.3115	68.8	,,
Proposals for three cross bunds:				
Mali Ki Dhani bund	-	0.8495	182.1	
Rampura bund	-	0.8495	182.1	
Tanitra bund	-	0.8495	182.1	

II. GENERAL CLIMATIC FEATURES

(A) Rainfall:

The climate of the area is dominated by the south-west monsoon which starts by the end of June and withdraws from the region by the second week of September. Rainfall over the region mostly occurs in spells associated with depressions originating in the Bay of Bengal region and passing across the country and over the Rajasthan region. Occasionally such spells gets strengthened due to feeding of moisture by moisture laden SW winds from Gujrat coast giving rise to heavy rainfall in short duration and leading to flash floods in the catchment area.

The monsoon season provides an average of 90% to 92% of the annual rainfall and nearly 64% to 66% of the total rainfall occurs in July and August. This is mainly due to the influence of the depression passing across nearer to the Rajasthan which causes low pressure over the catchment. Breaks of about a week in which the rainfall activity is the least is another feature of themonsoon. The average annual rainfall of the catchment area is 445.3 mm as determined by the Theissen Polygon method whereas, the arthmatical average is 450.4 mm. The average monsoon rainfall is 406.4 by Theissen Polygon method whereas, arthmatical monsoon average is 410.7 mm. The major part of the catchment area comes under the classification of arid climate except the small region around Sheoganj and Sirohi in the east and south-eastern part, which is semi-arid in nature. The average monsoon rainfall of Sheoganj and Sirohi is 518.2 and 584 mm. The rainfall decreases as we move towards north and western part of the catchment. The average monsoon rainfall in the north and western part of the catchment varies from 335.0 to 350.0 mm.

The main reason of the decrease in rainfall is topography of the area. The east and south-eastern part of the catchment is covered by hills whereas, the west and northern part is plain desert (part of Thar desert). A small quantity of rain about 3% to 5% of the annual rainfall is received occasionally during the hot weather period (March to May). The contribution of rainfall during post monsoon season (October-November) towards annual is 3 to 6%. The rainfall during winter season (December to February) is very small and its contribution to annual rainfall is even less than 1%.

The region around Jaswantpura receives an average monsoon rainfall of 408.0 mm which is higher due to intervention of hills surrounding this locality. The main feature of the rain over the whole catchment is that it comes inspells and each spell has a concentration of rains limited to a day or two.

The variability of rainfall occurrence from year to year is high during the non-monsoon season (October-May) as can be seen from the table. During the monsoon season (June-September), the co-efficient of variability is comparatively lower only during July and August. July generally indicates a lower variability in rain fall as compared to August at all the stations in the catchment except at Sanchore which lies outside the catchment. The co-efficient of variability in July can be seen to vary from 65% at Sheoganj and Sirohi in the east and south-eastern part of the catchment to 80% in the central part and 84% in the western part.

The co-efficient of variability is maximum in the month of September during monsoon season mainly due to the withdrawal of the monsoon at different time of the month.

Computation of average rainfall over a basin

(Thiessen Polygon method or weighted mean method)

Name of station	Annual rainfall (in mm)	Area under influence (sq.km.)	Fraction of total area	Weighted P (in mm)
Ahore	376.6	629.0	0.080373	30.2685
Bhinmal	368.7	2344.0	0.29951	110.4293
Jalore	388.21	1631.0	0.20841	80.9068
Jaswantpura	448.95	867.0	0.11078	49.7347
Sanchore	376.8	257.0	0.03284	12.3741
Sheoganj	558.94	886.0	0.11321	63.2776
Sirohi	634.47	1212.0	0.15487	98.26
Total:		7826.0		445.251

Average annual rainfall over the catchement - 445.25
(By Thiessen Polygon Method)

Arithmatical average - 450.38 mm.

Average monsoon rainfall

Name of station	Monsoon rainfall (in mm)	Weighted P (in mm)
Ahore	335.76	26.986
Bhinmal	338.35	101.339
Jalore	347.35	72.391
Jaswantpura	407.977	45.196
Sanchore	343.67	11.286
Sheoganj	518.167	58.662
Sirohi	584.44	90.512
		406.372

Average monsoon rainfall over the catchment - 406.372

Arithmatical average - 410.673.

Table showing dates and months (year-wise) of rainy spells yielding rainfall equal to or above 50.0 mm. STATION - AKORE

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
1957	257.3	24-25/8	1975	190.2	16/7
	205.0	24/8		71.2	6/9
1961	90.0	5-6/9	1976	153.1	16-17/8
	117.0	12-13/9		105.2	16/8
1963	82.0	2/8	1977	88.6	28/7
1964	82.0	13/8	1978	56.6	15/7
	121.0	17-18/8		55.8	23/8
1965	150.0	30-31/7	1979	304.0	16-18/7
	119.0	30/7		126.0	18/7
1966	80.0	8/9	1982	72.0	24/7
1967	70.8	7/9	1983	96.0	30/6-1/7
1970	50.0	24/9		60.0	30/6
1971	112.0	3[illegible]/7		193.0	26-28/7
1972	290.0	15-23/8		114.0	26/7
	95.2	21/8	1984	51.0	10/6
	189.4	20-22/8		69.0	11-12/8
1973	212.0	14-15/8	1986	58.2	29/7
	124.0	19/8			
	155.2	18-19/8			

STATION - BHINMAL

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
1957	147.0	20-25/8	1975	116.8	7-8/8
	99.1	24/8		182.6	10-16/8
1959	78.6	8-10/9		126.6	3-7/9
1960	139.7	3-4/7		115.4	13-15/9
	76.2	4/7	1976	128.4	15-17/8
1961	144.5	11-14/9	1977	178.7	29/6-4/7
	137.0	12-13/9		118.0	8-9/7
	92.0	13/9		140.4	16-18/7
1963	106.4	6-11/9		102.0	27-28/7
	88.2	9-10/9	1979	149.4	15-19/7
1964	126.2	12-14/8		146.0	25/7
	90.0	13/8	1982	155.6	24-26/7
	181.4	16-19/8	1983	103.4	17-19/7
	145.0	17/8		124.8	25-27/7
1965	248.4	27-31/7		114.0	26/7
	96.0	28/7		115.1	2/8
1967	109.4	7/9	1984	107.6	3/8
1970	125.2	31/8-4/9	1985	113.0	1-6/8
1972	91.4	27-30/6			
	70.0	30/6			
	224.8	16-22/8			
1973	79.6	11/7			
	88.2	15/8			
	189.8	14-20/8			
	86.6	22/8			
	123.4	29/8-2/9			
	100.2	8-10/9			

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
				STATION - JALORE	
1957	218.7	24-25/8	1975	147.2	16/7
	153.2	24/8	1977	118.7	27-28/7
1960	90.5	4-5/7	1978	91.2	14-15/7
1961	103.2	5-6/9	1979	151.0	18/7
	169.8	11-12/9	1982	71.5	25/7
1966	75.2	8/9	1983	112.8	2/7
1970	91.0	24/9		167.7	18/7
1971	168.3	30/7		160.8	26-27/7
	152.5	21/8		130.6	26/7
1972	234.1	19-21/8	1985	107.8	16/7
1973	177.0	14-15/8	1986	113.0	29/7
	240.7	18-19/8			
				STATION - JASWANTPURA	
1957	98.0	24/8	1975	90.0	7-8/8
1959	110.5	27-28/7		267.0	10-16/8
	83.8	27/7		80.0	13/9
1960	353.9	4-5/7	1976	80.0	1/8
	183.9	4/7		300.0	6/8
1963	118.0	8-9/9		180.0	16-17/8
	75.0	8/9		129.0	16/8
1964	100.0	17/8		86.0	8-9/9
1965	224.0	27-30/7	1977	75.0	28/6
	81.0	27/8		180.0	8-9/7
1967	178.0	24-25/7	1978	75.0	16/7
	88.0	24/8		80.0	24/7
1970	75.0	27/6	1979	160.0	15-17/7
	110.0	23-24/8	1983	72.0	4/9
1972	80.0	16/8	1984	123.0	5-6/8
	171.0	19-22/8		95.0	5/8
1973	275.0	15/8			
	212.0	17-19/8			
	357.0	30/8-2/9			
	239.0	1-2/9			

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
				STATION - SANCHORE	
1957	181.8	21-25/8	1975	271.3	13-16/7
1958	85.1	10-11/7	1976	123.6	16-18/7
1959	83.3	7/7		85.8	16-17/8
	165.1	27/7		97.6	8-9/9
	51.3	1/9	1977	148.0	29/6
1960	107.9	5/7		79.8	3-4/7
	82.0	6/8		324.6	6-10/7
1961	63.3	18/7		151.0	7/7
	91.4	25/8	1978	59.4	17/8
	419.8	11-12/9		57.6	23/8
1962	56.8	7/7	1979	104.4	10-13/8
1964	97.0	7-8/7	1981	131.0	28/8
1965	102.0	29-30/7	1982	67.0	18/8
1966	78.0	7-8/9	1983	206.1	2-7/8
1967	66.8	4/9		113.8	6/8
1970	68.7	7/7		250.5	17-18/8
	293.2	31/8-3/9		197.3	18/8
	213.0	1/9	1984	225.6	4-6/8
1971	57.0	30/7		204.6	5-6/8
1972	82.0	20-21/8		83.2	12/8
	61.8	20/8			
1973	91.4	1/9			
	82.6	8-9/9			

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
				STATION - SHEOGANJ	
1957	130.8	24/8	1972	115.8	29-30/6
1958	9[illegible].7	20/7	1973	266.0	14-16/8
1959	102.8	26-27/8		241.0	14-15/8
	194.3	30/8-3/9		312.9	18-20/8
1960	147.4	3-4/7		280.5	19-20/8
1961	102.9	4/7		693.3	29/8-5/9
	156.0	3-4/7		446.4	1-2/9
	94.0	6/9		315.4	2/9
	175.3	11-13/9	1975	68.2	13/7
1962	213.9	18-19/7		221.4	16-20/7
1964	168.9	12-13/8		98.4	5/9
	133.3	13/8	1976	90.8	14/7
	135.1	18/8		195.6	5-6/8
1965	127.5	17-19/7		146.4	6/8
	205.2	26-31/7	1977	81.6	25/6
	115.6	31/7	1978	108.4	15/7
	80.3	24/8		77.8	17/8
	90.2	26/8	1979	413.0	16-18/8
1966	84.3	21/6		176.0	17/8
	219.7	7/9	1983	228.0	30/6-1/7
1967	110.5	7/9		99.0	30/6
1968	137.2	2/8		118.4	17-18/7
1970	92.8	9-10/7		126.4	26/7
	135.9	23-24/8		89.0	15-16/8
	152.4	1-2/9	1968	232.0	24-25/7
1971	95.2	19-20/7		168.6	25/7
	144.8	30/7		94.2	7-8/8

Year	Rainfall (in mm)	Rainfall duration date/month	Year	Rainfall (in mm)	Rainfall duration date/month
				STATION - SIROHI	
1957	226.0	24-25/8	1971	158.7	20/7
	193.0	24/8		193.0	30/7
1959	146.9	27-28/7	1972	140.0	20-22/8
	351.2	24/8-7/9	1973	154.0	14-16/8
1960	149.1	3-5/7		142.0	18-20/8
	137.1	4-6/8		777.0	29/8-5/9
1961	169.3	19-26/6		531.0	1-2/9
	155.4	2-4/7	1975	123.0	12-13/7
	111.8	5-6/9		221.0	20-21/7
	269.2	10-13/9	1976	188.0	13-15/7
1962	379.8	18-20/7		204.0	6/8
1964	149.9	7-8/7		165.0	16-17/8
	101.6	12-13/8		135.0	16/8
	301.0	16-18/8	1977	90.0	8/7
1965	346.8	28-31/7		98.0	27-28/7
1966	225.3	8/9	1978	189.0	14-15/7
	120.6	29-31/7		104.0	30/8-1/9
	123.2	13-14/8	1979	221.6	16-18/7
	108.0	7/9	1980	115.0	28/6
1968	186.7	1-2/8	1983	180.0	29-30/6
1969	153.7	27-28/8		136.0	1/7
	127.0	28/8		95.0	26/7
1970	152.4	23-24/8	1984	85.0	5/8
	205.7	30-31/8	1985	74.2	1/8
			1986	133.0	25/7

III. TEMPERATURE

Major part of the catchment area comes under the classification of arid climate except the small area around Sirohi which experiences semi-arid type of climate.

The eastern region generally records lower day temperature as compared to northern and western parts except during winter (December-February). The night temperature is generally lower in the eastern part as compared to the rest of the area.

Maximum Temperature:

The mean maximum temperature over the catchment during winter varies from 25.5 to 28.5, lowest being in the month of January and is around 25.0 to 26.0°C.

The temperature increases sharply during the hot weather (March-June) and attains highest value in May around 41.0 to 42.0°C. Temperature above 46°C is recorded when a heat wave passes across the region.

The day temperature decreases with the on-set of monsoon over the region. The mean maximum temperature varies from 31.5 to 33.5°C in the eastern part and from 34.5 to 36.5°C in the western part (July-September). The mean maximum temperature varies between 33.0 to 35.0°C in the northern part, lowest being in the month of August. The temperature rises once again with the recession of monsoon from the region and varies from 36.0 to 37.0°C in the western and northern part of the catchment.

Minimum Temperature:

The mean minimum temperature over the catchment area is lowest during winter season varying from 7.0 to 10.0°C in the eastern and 10 to 13.0°C in the western part, the lowest being in the month of January.

The minimum temperature are comparatively higher in western and northern part of the catchment.

The minimum temperature increases sharply from April onwards and attains highest value in June which is around 27.0°C in the eastern and western parts and around 29.0°C in the northern region.

The mean minimum temperature during rainy season varies from 23.0 to 24.0°C in the eastern region and 24.0 to 26.0°C in the western part and 26.0 to 27.5°C in the northern part having lowest in the month of September throughout the region.

The night temperature beings to decrease sharply from October onwards to less than 20.0°C and decreases continuously until it reaches the lowest value in January.

IV. RELATIVE HUMIDITY

Relative humidity is the ratio of amount of moisture present in a unit volume to the amount of moisture required to saturate it. It is measured in percentage and mainly observed twice in a day at 0830 and 1730 hours IST. The relative humidity is generally lower in the western and northern parts as compared to the rest of the area both at 0830 and 1730 hrs IST. Lowest values of relative humidity over the catchment area are recorded during March and April in western and northern parts while, it is lowest during April and May in the east and south-eastern region. The average relative humidity values recorded varies from 40 to 43% in the north-western at 0830 hours and 21 to 23% at 1730 hrs. IST. The average relative humidity values vary from 53 to 56% at 0830 hrs and 33 to 37% at 1730 hrs in the eastern region.

The relative humidity builds up sharply from May onwards and is highest during July-August when monsoon current brings in high amount of vapour. The average relative humidity value varies from 76 to 80% in the north-west region and 83.0 to 85.0% in the eastern part of 0830 hours.

At 1730 hrs. average relative humidity values varies from 51.0 to 55.0% in the western, 57.0 to 62.0% in the northern region and 70.0 to 73.0% in the eastern region around the Jawai dam.

The relative humidity drops sharply during October due to the withdrawal of the monsoon current from the region. The average relative humidity during the post-monsoon season (October-November) varies from 51.0 to 55.0% in the northern and western parts while it varies from 63.0 to 70.0% in the eastern region at 0830 hrs. At 1730 hours, the average relative humidity varies between 35.0 to 37.0% in the northern, around 51.0% in the eastern and 31.0 to 32.0% in the western region.

A slight increase in the relative humidity values is recorded during the winter months due to the influx of moisture over the region under the influence of passing western disturbances. The relative humidity varies from 48.0 to 52.0% in the western, 52.0 to 58.0% in the northern region at 0830 hrs. At 1730 hrs, the average relative humidity varies from 32.0 to 36.0% in the northern and 22.0 to 30.0% in the western region. The average relative humidity varies from 73.0 to 79.5% at 0830 hrs and 40.0 to 53.0% during winter (December-February) in the region around Jawai dam. The relative humidity indicates a decreasing trend from February onwards reaching to minimum in April.

(V) VAPOUR PRESSURE

Vapour pressure is the pressure exerted by the water vapour present in the atmosphere and is always higher in the monsoon season. The mean vapour pressure is higher at 0830 hrs. IST than what it is observed at 1730 hrs. except during winter (December-February). The vapour pressure increases from January onwards and reaches its peak value in the month of July at 0830 hrs. The vapour pressure at 1730 hrs. generally follows the same trend.

The vapour pressure around 26 to 30 mb during the monsoon months (June-September) over the region at 0830 hrs and varies from 23 to 28 mb in the northern and western region and 25.5 to 31.0 mb in the eastern region at 1730 hrs. The vapour pressure decreases sharply from October onwards until it attains lowest value in January. The vapour pressure is between 8 to 10 mb in the western and northern regions and 10 to 12 mb in the eastern region at 0830 hrs during winter.

The vapour pressure at 1730 hrs during winter varies from 12.5 to 14.0 mb in the eastern region and 8 to 10 mb in the remaining part.

(VI) EVAPORATION

The lowest values of evaporation are recorded over the catchment during the coldest months (December-January). The mean values during winter are also lower. The mean evaporation is around 4.5 to 5.0 mm/day during winter. The mean daily evaporation over the catchment area begins to increase sharply from middle of March onwards alongwith the increase in the day time temperature and reaches a peak during May when evaporation of the order of 14 to 16.0 mm/day is observed over the region.

The mean daily evaporation decreases with the onset of monsoon and varies between 6 to 8.5 mm/day during monsoon season. The evaporation rate increases slightly during September and October in association with the withdrawal of monsoon and a general increase in day temperature, over the region. The mean evaporation decreases. from October onwards and are lowest during January.

(VII) <u>WIND REGIME</u>

The wind speeds are generally lower over the catchment area during the winter. The wind speed is around 2.5 to 3.0 kmph in the eastern region and an increase in the trend is observed in the west and north-west direction. The wind speed is around 4.5 to 6.0 kmph in the western part during winter (December-February).

The wind regime starts building up alongwith the temperature regime from April onwards. Peak wind speeds are recorded in May and June and is around 7 to 8 kmph in the eastern region and 10 to 12 kmph in the western region.

The average wind speed is around 12 to 13 kmph during May and June in the northern region near Jalore and Ahore.

The average wind speeds around 5 to 6.5 kmph in the eastern and 8.5 to 10.0 kmph in the western region have been observed during monsoon period. The wind speed decreases sharply from October onwards and remains less than 6.0 kmph on the average over the whole catchment area during the post-monsoon season (October-November).

VIII. GEOLOGICAL SUCCESSION

The general geological succession in the catchment is as under:-

Geological succession of Jalore District

Era	Period	Systems
Quaternary	Recent & Sub-recent to Pleistocene	Aeolian sediments Alluvium younger Alluvium older
Tertiary		Consolidated clays and coarse to medium sand with shale fragments
Late Palaeozoic	Post-Delhi	Malani volcanics Jalore granites Erinpura granites
Pre-Cambrian	Delhi Super Group	Meta sediments

A brief geology of the rock system encountered in the catchment is as under:-

Meta sediments:

It consist of phyllite, schist and gneisses with intrusives of quarts and applitic veins etc. It has developed three sets of joints and well defined folds and distinct faults. It cover upper part of catchment and subjected to erosion in natural coarse.

Jalore granites:

Jalore granites belong to Malani suite of igneous rocks. These are generally fine to coarse grained with phenocryst of feldspar. The Jalore granite is pink in colour, composed of quartz, orthoclase, feldspar with some plagioclase, feldspar, biotite and acgirine. Biotite in Jalore granite is the most abundant mineral amongst the ferroma gnesium minerals.

These granites are considered to be intrusive in rocks of Delhi system and occur in the form of largest rock unit. Joints are well developed in the Jalore granites. These joints are vertical, horizontal and sometimes angular. The strike direction of these joints is more towards east and west. The topography of the region and development of the drainage system is controlled by these joint systems. The vertical joints are good conduits of ground water movement while the angular joints are not much effective conduits.

Malani volcanics:

Rock types of this group consist of rhyolites associated with agglomerate, volcanic ash, felsites, intercalated with acid tuffs and pyroclastic materials. Bhadarajun and Israna hillocks are partly composed of Malani volcanics. These rocks also exhibit well patterned joints which show a tendency of becoming tight with depth. At places it shows abscure bedding planes which are probably developed due to stresses operating during cooling of magma.

Older alluvium:

Occupics large area of the catchment and is identified in the form of pediments, alluvial sediments and high river terrace deposits. Pediment alluvial sediments are located along the slopes of the Jalore, Israna and other granite hills as alluvial fans and cones. These consists of unsorted disintegrated rock fragments accumulated as a result of weathering as gravel, sand with high clay content.

High river terrace deposits cover the entire area between the piedmont plains and low terrace deposits. These deposits are identified between Khari - Bandi river, north of Jawai - Sukri rivers between Dangra and Dadhal. These sediments consist of an upper layer of sandy loam, kankar and lower layer of medium to fine sand and gravel with minor silt.

Younger alluvium:

Younger alluvium is second wide spread lithological unit and occurs in the form of river flood deposits and low terrace deposits confined to the present and past drainage channels. These are heterogenous sediments comprising of unconsolidated sand, gravel and intercalated clay and silt beds. The extent and thickness of these deposits are highly variable. The sand grains, gravel, pebbles and cobbles are practically sub-rounded to rounded in shape. Better sorting of sediments is found in river flood deposits as compared to low terrace deposits. In fact, it is difficult to separate them in the field. These deposits are well identified on both sides of the Jawai-Sukri river channel.

Wind blown sands:

These are the recent aeolian deposits in the catchment. The occurrence of sand dunes is more pronounced in the central part and north-western part of the district. These blown sands are generally non-calcareous and are fine to medium grained in textures. Sometimes, calcareous sand dunes act as hydrological barrier in the area by checking surface drainage.

(IX) HYDROGEOLOGICAL ASPECTS

All geological formation form aquifers where ever encountered below the zone of saturation. The depth to water varies from less than 5 mt. to 50 mt. below ground levels.

however along major coarses of rivers the depth to water is 5 mt. to 15 mt. below surface. Granites, Rhyolites and Meta sediments are forming poor aquifers. The Alluvium followed by tertiary developed major thick aquifers in the middle and lower part of catchment. These are most potential area for ground water development.

(X) SUITABILITY FOR DEVELOPMENT OF FOREST

The Jawai catchment is a unique one for development of forest as soil, ground water and climates favours to grow all types of plants and trees. The net work of stream-lets further attracts to develop dense forestation.

(XI) FENCE DIAGRAM - INDICATIVE OF SALINE WATER FACIES

A fence diagram (Plate J-3) has been prepared to have a general view of the middle part of catchment. Vertical scale of the diagram represents one centimetre equal to 20 metres of depth column. Village Mandia when connected to village Bishangarh shows that surface soil is of alluvium nature. It is clear from the fence diagram that this alluvium soil cover occupies the total length of the map from west to east, varying only in thickness. The second layer of sandy clay saturated with brackish to potable quality of water, encountered at a depth of 30 metres, does not continue to village Bishangarh.

The next layer is of saline water, which continues upto Bishangarh and continues to the northern part of the study area upto eastern end of the base map. The only variation in the saline water column is of thickness. The last layer of the diagram is of weathered granite which too has a similar continuity as the saline water zone having varying depth of encounter at different localities.

Village Muri, when connected with Bishangarh, seems to have a zone of brackish to potable quality of water of 30 metres which narrows in the thickness towards village

Bi...angarh and village Bokra. Extension of this layer towards village Nawakhera, shows that thickness of this column narrow but does not extinct. The same layer if extended to village Desu and further extended to village Mithri, shows some water potential, varying in thickness.

Village Desu when connected to village Bokra shows that this layer diminishes in that direction, proving that village Bokra does not have water potential for potable water.

All the villages, discussed above have a common layer of saline water column with varying thickness with underlying bed of compact to weathered granite. Most of the villages have a thin layer of brackish to potable quality of water but a few of them missing this layer.

Gene. ally speaking, fresh water has lower density than saline water and, therefore, the fresh water layer floats over t. e saline interface in the region of saline water zones. Thickness of such floating layer may vary from few metres to few tens of metres. Similar is the case in the coastal areas where people use to drink this accumulated water for drinking purpose through small pits.

Village Maheshpura when connected with Badanwari, Sedria or Sakarna, shows that potable water zone is missing in all the directions. Saline water zone however, varies in thickness in various directions.

Village Godan when connected through fence to village Samuja, shows prominent zone in thickness for potable quality of ground water. At village Godan, thickness of this zone is about 50 metres which increases towards village Samuja and towards Jawai river. This zone however, diminishes t wards village Leta. This part of study area does not have saline water, however quality of ground water is not fairly good but it has agricultural value for almost all normal crops.

The southern part of the study area does not have this layer of potable quality of ground water. On the contrary the saline strip as evident by the "Aquifer Percentage" has very high salinity having an aquifer resistivity less than 5 ohm metres. A further continuation of the fence in the north of Jalore village, the saline layer continues with varying thickness. It is also observed that surface soil is coarse sand due to Jawai river having a 5 metres thick clay bed at J-24.

An important zone, as regard to fair quality of ground water is Jawai river bed near Paharpura. Sounding taken in the Jawai bed in the north of village Sanphada, Khanpur and Singudia area are connected, show that first layer of surface soil is river sand which has a thickness varying from 10 to 20 metres which reduces towards Maheshpura or towards village Leta. The nett bed is of argillaceous clay or sandy clay which may at few places have fair quality of ground water. The layer is underlain by weathered granite. Villages Tikhi and Paharpura have a good aquifer of alluvium, having potable quality of ground water, which in general suits tonormal crops.

Thus on the basis of the fence diagram, it seem that the entire area can be explained qualitatively.

(XII) <u>WATER BALANCE EVALUATION</u>

Water balance studies reveal the area and the period of water surplus and water deficit which are the basic requirements in proper development of water resources. It gives a fair assessment of surplus water to be stored during the brief monsoon period for regulated use during the long succeeding dry period.

The study reveals that the region around Sheoganj and Sirohi yield enomous surplus water as the rainfall is high in these parts of the catchment. This is evident from the fact that during the study period of 30 years, there were only 8 years in Sheoganj and 4 years in Sirohi in which water surplus was either zero or less than 50.0 mm. The average water surplus for Sheoganj and Sirohi during the study period is 229.7 and 281.95 mm. The maximum surplus water occurs in the month of August with an average value of 93.9 and 110.97 mm for Sheoganj and Sirohi. The water surplus of the amount of 1524.8 mm and 1148.8 mm of Sheoganj and Sirohi during August and September of 1973 has caused severe flood in the region.

The probability of surplus water to exceed 200.0 mm during the monsoon period for Sheoganj and Sirohi is 46.7 and 53.3 per cent whereas, the probability of surplus water to exceed 100.0 mm is 63.3 and 76.7 percent which can safely be taken into consideration for future planning process. The average water surplus for the region around Ahore, Bhinmal, Jalore and Sanchore is 88.6, 103.0, 100.5 and 108.7 mm respectively, for the monsoon period. The main feature of water surplus at these stations is that it is mainly concentrated in a single month, which causes more run-off. The maximum water surplus occurs in the month of August with an average values of 41.2, 54.1, 41.6 and 40.8 mm for Ahore, Bhinmal, Jalore and Sanchore.

The probability of water surplus to exceed even 50.0 mm during the whole monsoon period is 60.0, 48.3, 56.7 and 43.3 percent for Ahore, Bhinmal, Jalore and Sanchore.

The primary feature of the rainfall in the region around Ahore, Bhinmal, Jalore and Sanchore is its high variability in time and space of the small amount received, thus, the water available for run-off and recharge is irregular and discontinuous.

The average surplus water during the monsoon period at Jaswantpura is 156.3 mm. The region around Jaswantpura is mainly hilly terrain, which causes more runoff. The maximum surplus water occurs in the month of August with an average of 80.0 mm. The probability of surplus water to exceed 50.0 mm and 100.0 mm is 59.3 and 40.7 percent, for the region around Jaswantpura.

Water deficit is pronounced in the region around Ahore, Bhinmal, Jalore and Sanchore even in the monsoon season. This is due to high water heed (PE) and low rainfall in these regions. Average water deficit is 369.6, 379.8, 368.6 and 382.3 mm respectively for these stations during the monsoon season. The water deficit is low in the east and south-eastern region around Sheoganj and Sirohi. The average water deficit for these stations is 278.85 and 289.81 mm.

The water deficit in the region around Jaswantpura is more compared to the east and south-eastern part but is less in comparison to the other parts of the catchment. Average water deficit of Jaswantpura is 315.8 mm during the monsoon season.

Water deficit is minimum in the month of August throughout the catchment and is around 22.0 to 24.0 mm in the east and south and south-eastern part. It is around 32.0 mm in the region around Jaswantpura. The average water deficit varies from 44.0 to 49.0 mm for the rest of the catchment during the monsoon period.

The average water deficit for Sheoganj and Sirohi is 47.6 and 50.6 mm during September whereas, it is 67.2, 72.7, 68.5, 59.1 and 71.2 mm. for Ahore, Bhinmal, Jalore, Jaswantpura and Sanchore respectively. This indicates that the region around Sheoganj and Sirohi requires less water for irrigation in Kharif season (July-October) whereas, more irrigation facilities are required for the rest of the catchment. The water deficiency indicates the amount of supplemental irrigation required for efficient growth and development of Kharif crops.

The study reveals that major part of the rain is returned back to atmosphere through evapo-transpiration. The percentage contribution of rainfall to actual evapotranspiration during the monsoon period for the region around Ahore, Bhinmal, Jalore, Jaswantpura, Sanchore, Sheoganj and Sirohi is 65.7, 62.2, 63.8, 53.2, 60.5, 48.9 and 44.9 respectively.

The only source of ground water recharge in the catchment is by precipitation on the area itself. From the computation it isobserved that even in the years of normal rainfall, no significant amount of water is available for recharge in the regions around Ahore, Bhinmal, Jalore, Jaswantpura and Sanchore. The region around Sheoganj and Sirohi occasionally shows a good amount of water available for recharge even in the years of below normal rainfall because a maximum part of the rainfall was concentrated in a month or two.

The contribution of monsoon rainfall towards recharge is 8.0 to 9.0 percent for the region which is under the influence of Ahore and Sanchore. It is from 9.0 to 12.0 percent for the region around Jalore and Bhinmal. The percentage contribution of monsoon rain towards recharge for the region around Jaswantpura is 13.0 and is 16.0 to 17.0 for the region around Sheoganj and Sirohi.

The computation of run-off revealed that the years in which the rainfall is above the normal, the distribution of rain is improper. The major part of the rain is concentrated in a month or two in short spells. Its contribution to run-off is high resulting in floods.

There are occasions where the rainfall is below normal but being concentrated in a short spell, gives pronounced surface run-off with negligible recharge.

The average water available for run-off and recharge for the area under study is 785.71 and 367.23 mcm during the monsoon period. This amount will not be available every year. In fact, run-off and recharge available during the years 1980 to 1985 is insignificant except in 1983. The schemes should be framed in such a way that whenever a significant run-off is available, there must be storage facilities which at present is not sufficient. Reservoirs across the rivers will have to be built in large numbers if the available water resources during the monsoon months are to be stored and utilised properly.

As there is no hydrometric station for the measurement of run-off and the rainfall pattern is high erratic an accurate estimation of water potential of the catchment can not be made. Nevertheless, 70.0 to 80.0% of the quantum of run-off and recharge estimated can be taken up for planning purpose.

(XIII) GROUND WATER SURPLUS

The analysis of water level record of Jawai catchment for the last 15 years indicates that their is gradual decrement in the ground water storage as their remain no surplus in previous years. In the course of main Jawai catchment right from Sheoganj to Sayla, comparatively there is more declining trend.

DISCUSSIONS ON TECHNICAL ASPECTS:

(A) In the Jawai catchment there is sufficient water surplus which is being lost as run off. The catchment area was hit by the severe flood during year 1973, and 1979, and by moderate floods during 1961, 1964, 1975, 1977, 1983, 1990 and 1991 etc. Computation of run-off revealed that there was huge run-off during surplus rainfall year. Higher amount of run-off was also available during the years with more frequency of high intensity of showers although the total rainfall was lower than the normal rainfall. There is no adequate storage capacities to harness this huge quantity of surplus water.

(B) It is estimated that surplus water available in the east and south-eastern parts and the region around Jaswantpura is appreciable.

(C) Inspite of water surplus there is declining trend of water levels in the wells conclude that water is lost due to run-off in most part of catchment where as in main Jawai the decrease in ground water storage due to with holding water in Jawai Dam. However it is also established that a great quantum of water is lost due to evaporation and run-off.

PROCESS OF RETURNING TO POTENTIALITY:

(A) During lean rainfall year, 20 to 25% of storage water from Jawai dam may be allowed to given flow in main Jawai stream.

(B) A divergent canal be installed from upper catchment of Khari river to Join Jawai near village Harji to substiantiate ground water recharge.

(C) All along major channels of Jawai catchment batteries of tubewells/dugwells, be constructed and water may be pumped and taken on either sides and be used to recharge the ground water through percolation tanks. This will create a room in main stream channels for rainy days.

(D) The entire catchment be covered with sub-surface barriers to save water lost due to base flow in the main stream for ground water recharge.

(E) Intensive forestation programme by net work of suitable plants and trees by way of taking co-operation from private sectors. Incentives be given to active farmers, un-employed youth and societies etc.

(F) The proposed/under execution schemes be modified as a base for ground water recharge and water collected during rainy days be allowed to flow at suitable intervals, where-ever possible recharging of aquifer be done by pvt/infitration wells methods.

(G) Rain-water harvesting structures be installed in otherwise flouride effected areas where human and animal suffers due to flowrsis for drinking water supplies.

(H) The upper part of catchment be fenced for growing new plants with suitable advance methods and people be educated and motivated to have social awareness for this important venture.

(I) Rural and Urban fares be organised to give touch to cultural heritage and demostration for not migrating elswhere for water and fodder for animals.

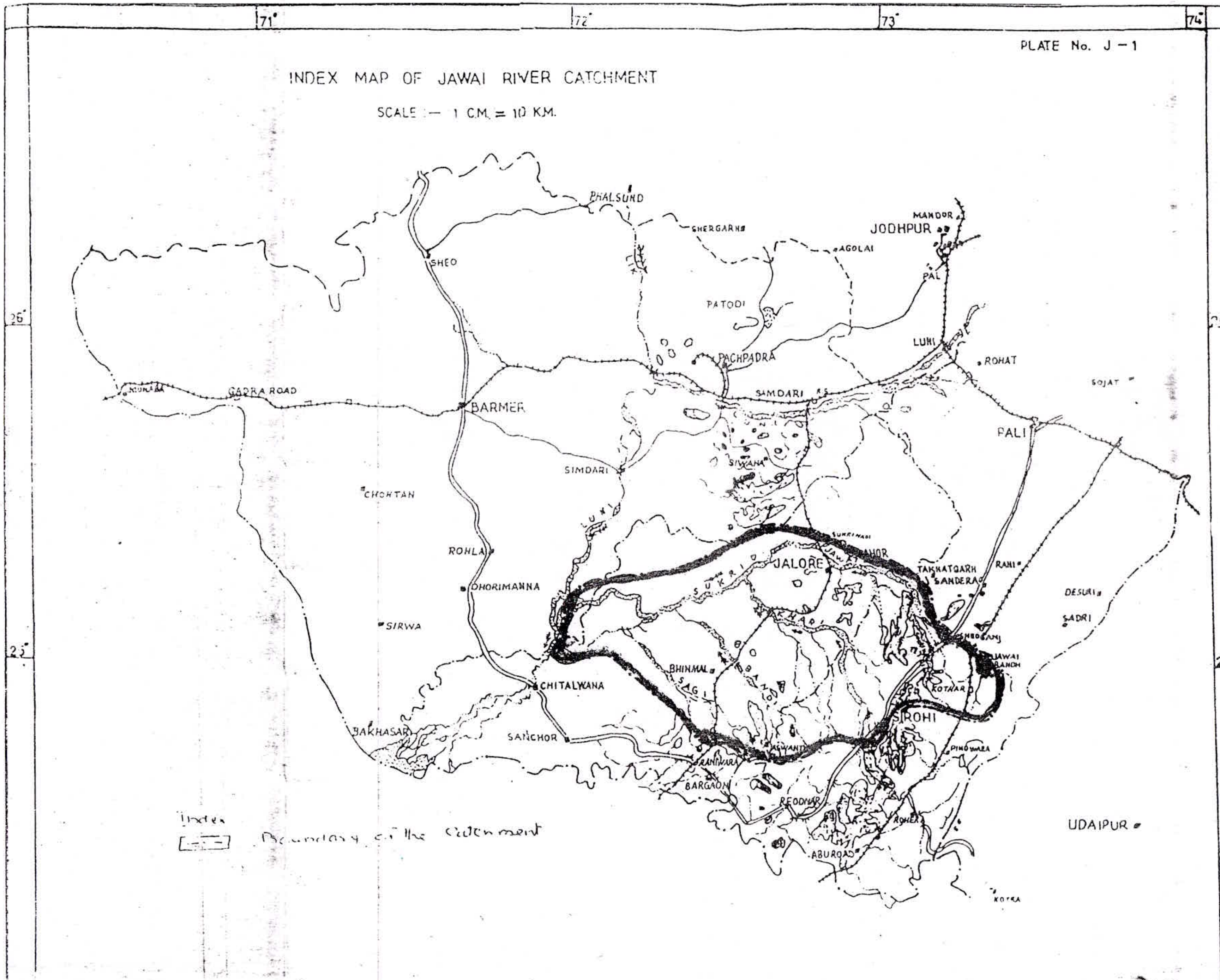
ACKNOWLEDGEMENT

The author feel emence pleasure to extend due congnizence and acknowledgement to Shri B.P. Borana, Hydrometeorologist, author of publication of official document Water Balance Studies in Jawai River Catchment and Shri S.M. Pandey, Senior Geophysicist and Shri J.P. Shukla, Geophysicist of Ground Water Department for their publication "Geophysical Report in parts of Jawai River Catchment, District Jalore".

The base of this paper is finding of these two important publications with sound technical back-ground and collection of ample field data.

INDEX MAP OF JAWAI RIVER CATCHMENT

SCALE :— 1 CM. = 10 KM.



Index
Boundary of the catchment

PLATE No. J-2

DRAINAGE MAP OF JAWAI RIVER CATCHMENT

SCALE — 1 : [illegible]

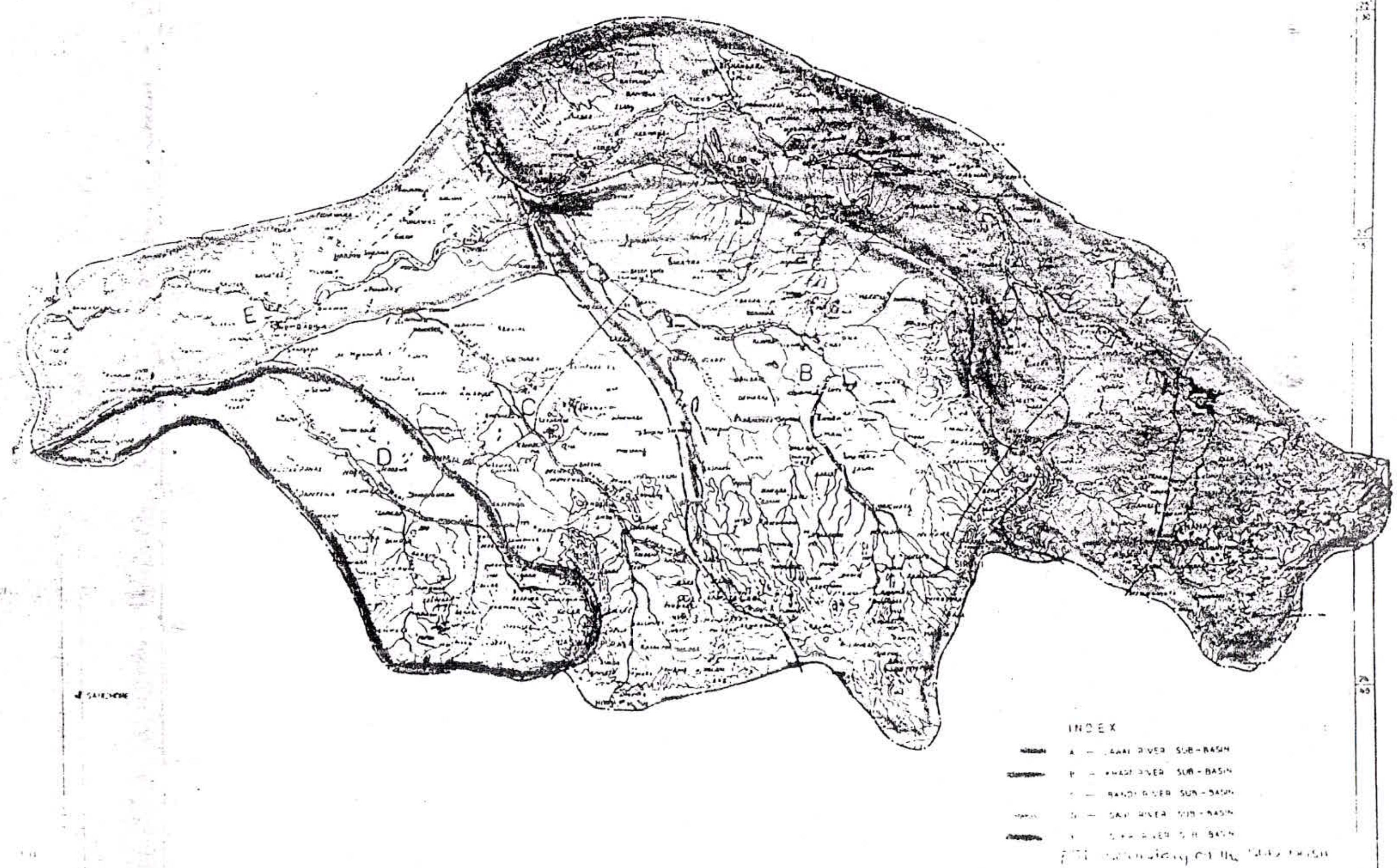
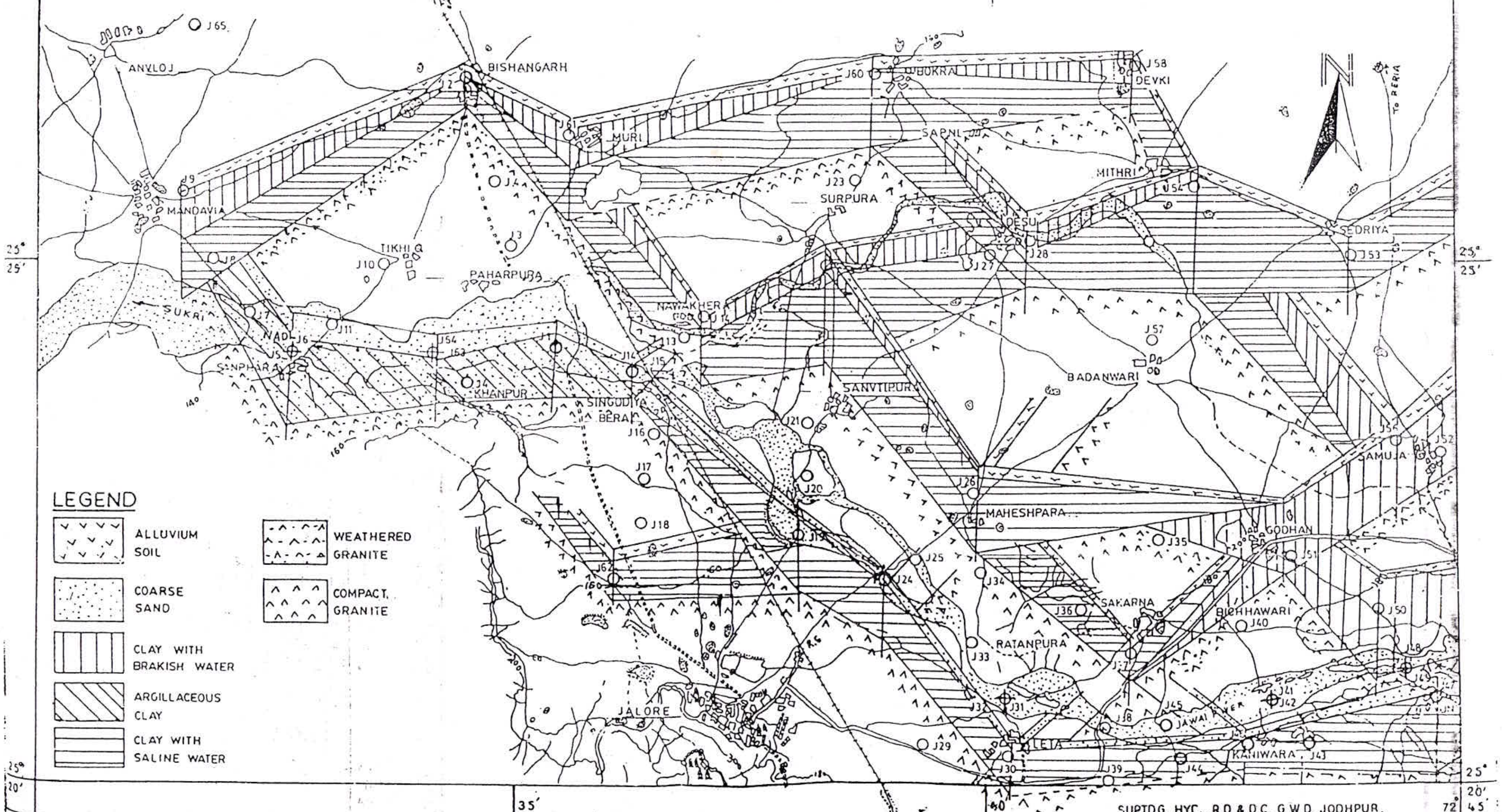


PLATE - J-3

FENCE DIAGRAM FOR ARTIFICIAL RECHARGE STUDIES IN JALORE AREA

SCALE :—1:50000 OR 500 MTS. TO 1 CM.



SUPTDG. HYC., R.D.& D.C., G.W.D., JODHPUR.