UNITED NATIONS DEVELOPMENT PROGRAMME

GROUNDWATER SURVEY OF BORUNDA AREA

RAJASTHAN, INDIA

TECHNICAL REPORT

MAY 1971

This report is presented to the Government of India without prior approval of either the United Nations or the United Nations Development Programme and therefore does not necessarily represent the views of either organisation.

C O N T E N T S

T A B L E S

ILLUSTRATIONS

Exhibit No.

ABSTRACT

Detailed investigations were conducted in the Borunda area, western Rajasthan from August 1967 to February 1971. The purpose of the project was to investigate and evaluate ground water potentialities and to make appraisals of the feasibility of further ground water development.

Utilization of relatively fresh ground water by a few enterprising agriculturists indicated that the cavernous and fractured limestone of the region yields more water to individual wells than any other aquifer in the entire UNDP project area. Project operations verified this fact. However, the restricted areal extent of the fresh water section of the limestone, limits its regional importance unless water exp-ortation is undertaken. Fresh water (under 2,000 ppm TDS) is found in 161 sq. kms of the area underlain by limestone. Much of the area is covered by alluvial and aeolial deposits but prominent limestone outcrops are also found.

A controlling fault trending NNE-SSW near Borunda, has channelized the flow of fresh ground water by acting as a sump. Caverns and fractures were formed as a result of structural activity as evidenced by the controlling fault and other faults.

Water and soil analyses indicate that ground water can be used in selected areas for agricultural purposes.

A key area of 100 sq. miles (257 sq. kms.) was selected

for water balance studies. The studies indicate that most of the present discharge is through evapotranspiration.

Recharge is mainly from direct precipitation but additional recharge comes from the north and in the monsoon period, from the Luni River via underflow through alluvium.

The amount of fresh water in storage in the limestone was estimated at 1,700 MCM. The "safe yield" of fresh water is about 24.5 MCM/yr and the normal draft of fresh water is about 12.4 MCM/yr. Consequently, about 12 MCM/yr of additional draft can be utilized for further irrigation and other uses without depletion of stored resources. An additional ten high capacity tubewells can be installed along or immediately west of the controlling fault to utilize this additional potential.

The ground water in the alluvium along the Luni River was not studied in detail but there appears to be considerable potential for development based upon limited investigations.

I. INTRODUCTION

Field work was organized under the direction of Mr. D. Pandey, Director, UNDP (SF) Project and hydrogeological investigations were carried out under the supervision of Dr. Achutha Rao, Chief Hydrogeologist, UNDP (SF) Project, Jodhpur. The drilling work was organized by Mr. M. N. Bahuguna Executive Engineer, UNDP (SF) Project and Mr. S. K. Misra, Assistant Executive Engineer, UNDP (SF) Project, Jodhpur. The field work was carried out with the advice and guidance of the U.N.team.

The present report, under the supervision of Mr. D. Pandey Project Director was largely prepared by Dr. A. Achutha Rao, Chief Hydrogeologist and Mr. P. R. N. Nayar, Geologist (Junior) with the assistance of Mr. V. M. Sikka, Assistant Geologist, Mr. A. K. Ghosh, Assistant Chemist, Mr. P. K. Nayar, Assistant Soil Chemist and Mr. V. K. Bhalla, Assistant Hydrometeorologist. The report was enhanced and reviewed by members of the U.N. team.

The following is a list of personnel involved in the field work in the Borunda area:

HYDROGEOLOGY GROUP

Mr. P. R. N. Nayar, area Geologist (Part Time)

Mr. M. L. Shrivastava, area Geologist (Part Time)

Mr. B. P. Verma, Senior Technical Assistant (Hydrogeology)

Mr. G. C. K. Rao, Senior Technical Assistant (-do-)

Mr. S. K. Tyagi -do-

Mr. C.S. Sharma, Senior Technical Assistant (Hydrogeology)

Mr. P. C. Chaturvedi -do-

Mr. A. R. Bakshi -do-

Mr. M. R. Kulkarni -do-

Mr. Ram Ji Lal, Senior Analyst (Chemical)

Mr. A. R. Bhaskaran, Senior Surveyor

Mr. O. P. Manocha -do-

Mr. R. P. Sharma -do-

DRILLING & TESTING GROUP

Mr. Manna Singh, Driller Incharge & Crew

Mr. K. K. Arora -do-

Mr. Jai Singh, Pump Foreman, Test Pump Unit

The project for ground water surveys in western Rajasthan was undertaken by the Government of India through the Central Ground Water Board (previously Exploratory Tubewells Organisation) with the assistance of the U. N. D. P. (SF). The purpose of the project was to investigate and evaluate the ground water potentialities for irrigated agriculture, domestic and livestock water supply and industrial uses in western Rajasthan, and to make appraisals of technical and economic feasibility of ground water development.

The project area comprises about 23,000 sq. miles (60,000 sq. kms.) in Jaisalmer, Jalor and Jodhpur Districts of western Rajasthan (Ex. 1). For detailed hydrogeological studies, the following areas were selected; Jalor, Jaisalmer (Lathi);

Borunda and Doli-Jhanwar-Pal. The latter area was added late in the project operations when it became necessary to seek a supplemental water supply for the city of Jodhpur.

This report presents the results of investigations carried out in the Borunda limestone area in Jodhpur District. The study was made as a result of pumpage of large quantities of relatively fresh ground water from the cavernous limestone.

There was lack of data to accurately evaluate the potential for domestic needs and irrigated farming, even though fairly extensive exploitation of ground water for farming is practised in and around the Borunda area by a few enterprising agriculturists. There was also some consideration by the State authorities to augment the city supply of Jodhpur with ground water from the limestone. Consequently, it was felt that an assessment should be made of the utilisable resources of the Borunda limestone area.

The area selected for regional geological and hydro-chemical investigations covers about 1,500 sq. miles (3,900 sq. kms.) between 25°55' and 26°40' N. latitudes and 73°40 and 74°15 E. longitudes in survey of India Toposheets 45-F and 45-G. The key area for systematic water balance studies covers about 100 sq. miles (257 sq. kms.) as shown in Exhibit 5.

The field work started in August 1967 and continued to February 1971. The area under study is part of the Central Luni drainage basin and is relatively densely populated. There is a possibility of large scale development of irrigated agriculture in

II. REVIEW OF EARLIER WORK DONE AND METHODOLOGY OF PRESENT SURVEY

The Borunda area was investigated to delineate the limestone belt in regard to evaluation of ground water resources. These resources have a potential for additional supply for irrigation and other uses. Another purpose was to estimate the recharge to the ground water resources and the establishment of the safe yield and water balance. In order to achieve the above objectives, the following programme was carried out:

(a) Physiographic and geological delineation of the area;

(b) Selection of observation well net work for qualitative and quantitative evaluation of ground water resources;

(c) Establishment of meteorological observatory at Borunda for supplementing data on rainfall, temperature, etc;

(d) Establishment of river gauge stations at Somaria (26°19'N: 73°44'E); Khoaspura (26°31'N:73°45'E) and Binawas (26°16'N: 73°21'E) which are along tributaries joining the main Luni drainage system;

(e) Construction of test wells and observation wells for subsurface hydrogeological correlation and to compute aquifer parameters such as coefficients of transmissibility, permeability and storage:

(f) Collection of data pertaining to annual draft induced on the ground water reservoir by dug wells which are used for agricultural and domestic purposes.

During the first six months of the project and prior to the commencement of field work, available data were compiled and evaluated. These data were utilised to prepare base maps and other presentations.

For detailed hydrogeological studies, a base map of 1:126,720 (1" = 2 miles) scale showing topographic features was prepared. All available geological data was transferred to this map. Aerial photos for a part of the key area, were also utilised to prepare and evaluate geomorphological and structural details. Pertinent data on the geology of the area were incorporated from the progress reports of the Geological Survey of India.

Detailed mapping with a plane table was carried out in selected areas to delineate structural alignments because these conditions are controlling factors on the occurrence and utilisation of ground water.

Hydrogeological studies were started by selecting a number of observation dug wells to carry out systematic water level measurements. For this purpose, 210 wells were measured. Systematic sampling of water was also carried out. Based upon results achieved, the key area of 100 sq. miles (257 sq. kms.) was demarcated for water balance studies. In this area, the density of observation dug wells was one per 7 sq. kms.

In order to observe seasonal water level fluctuations and variations in chemical quality, pre- and post-monsoon operations were carried out. These observations were performed in Oct.-Nov 1967

April 1968; May-June 1969; Nov-Dec 1969; April-May 1970 and October 1970. Additionally, monthly fluctuations in water levels were recorded in several wells.

The three river gauge stations that were established were also provided with rain gauges. Data from other rain gauge stations in the region at Bilora, Borunda, Pipar and Merta city were also collected.

Draft data were collected from all 52 pumped irrigation wells in the balance area. For wells fitted with electric pumps, pumpage was calculated from electric consumption For wells equipped with diesel or crude oil engines, estimates were supplied by irrigators who gave estimates of operating time, amounts of water pumped or water requirements of crops.

Chemical analyses of water samples for the following elements were carried out:

Ca, Mg, Na, K, Cl, SO_4, HCO_3, CO_3, B, pH,

Total Dissolved Solids and Electrical Conductivity.

In all, 14 boreholes were drilled. Additionally, 8 CGWB boreholes were utilised for lithological evaluation. Details of boreholes drilled in past and present operations are given in Tables 1 and 2.

Drilling operations were carried out with combination mud rotary-air hammer attachment and percussion methods. The presence of caverns posed many drilling problems that were overcome only with great difficulty.

Standard methods of acquiring data at drill sites were employed. Drill cuttings were systematically sampled, studied and recorded. Coring was carried out when necessary for more detailed correlation of geological formations. All boreholes were logged with a single point electric logger.

Preliminary quality tests were conducted by compressor-packer methods. Electrical conductivity measurements of formation water and mud samples were carried out at frequent intervals for checking chemical quality.

Testing procedures were modified to fit conditions in the area. Diesel powered turbine pumps were used for performing step and constant rate tests.

III. HYDROMETEOROLOGICAL CONDITIONS

All available hydrometeorological data for the Borunda area were collected and used for the evaluation of precipitation, temperature, humidity, wind velocity, runoff and evapotranspiration. A large number of observations were performed in the field. Results are given below:

Annual precipitation 1901-1967

	mm
1. Normal annual precipitation	410-440
2. Annual precipitation of 10% probability	640-660
3. Annual precipitation of 25% probability	500-520
4. Annual precipitation of 50% probability	380-390
5. Annual precipitation of 75% probability	275-310
6. Annual precipitation of 90% probability	175-190

The mean monsoon share of annual precipitation ranges from 89 to 91%.

NORMAL ANNUAL RAINFALL AND ANNUAL RAINFALL IN 1968, 1969 and 1970 (mm)

	1968	1969 (I - IX)	1970 (I - IX)	Normal
1. Jodhpur (obsy)	153	162	532	368
2. Binawas	-	165	297.4	392
3. Sojat	235	110	654	460
4. Bilara	298	233	643	424
5. Jaitaran	172	221	553	(448)
6. Khoajpura	-	250	385	393
7. Borunda	-	356	508	408
8. Raipur	376	194	-	479
9. Jawaja	304	230	682	(495)
10. Girinanda	-	155	-	466
11. Beawar	568	406	538	486
12. Merta Road	-	-	-	382
13. Merta City	262	137	458	412
14. Pisangan	-	168	380	(500)
15. Ajmer (obsy.)	473	249	666	529
16. Parbatsar	495	230	605	395
17. Bakri	520	-	-	408
18. Samaria	-	252	431	417

MEAN MONTHLY RAINFALL 1901-1967 (mm)

No. Station	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1. Jodhpur	4.6	5.1	4.8	2.8	9.3	29.6	113.1	128.9	58.2	7.7	2.2	1.7	368.0
2. Bilara	3.9	4.2	5.0	2.7	9.7	39.8	130.6	156.0	61.3	7.1	2.2	1.4	423.9
3. Merta city	4.3	4.9	4.9	3.0	10.6	38.2	138.8	136.5	58.7	8.2	1.6	2.1	411.8
4. Parbatsar	4.0	4.2	2.6	1.9	9.4	35.4	129.6	124.5	60.8	6.9	1.4	4.4	385.1
5. Ajmer	8.5	5.8	6.2	3.2	13.7	57.7	168.4	167.4	76.9	12.6	3.6	5.0	529.0

MEAN NUMBER OF RAINY DAYS 1901 - 1950

No.	Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1.	Jodhpur	0.36	0.58	0.24	0.46	0.98	1.82	5.92	6.08	2.64	0.48	0.14	0.26	19.96
2.	Merta city	0.60	0.60	0.46	0.34	1.14	2.52	6.44	6.26	2.90	0.36	0.16	0.30	22.10
3.	Ajmer	0.86	0.84	0.70	0.36	1.40	3.32	8.80	9.08	4.06	0.68	0.36	0.36	30.82

MEAN MAXIMUM TEMPERATURE 1958 - 1970 (°C)

STATION	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jodhpur	25.5	28.9	34.2	38.9	41.9	40.3	36.3	34.3	35.1	36.5	31.7	26.9
Nagaur	23.2	26.9	32.3	37.2	40.8	40.5	36.8	34.3	32.3	32.6	29.9	24.6
Ajmer	23.5	26.6	31.7	36.5	39.5	38.7	34.0	31.4	32.6	33.8	29.7	25.2

MEAN MINIMUM TEMPERATURE 1958-1970 (°C)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jodhpur	9.4	12.3	17.7	22.9	26.7	28.1	26.8	24.8	24.9	20.3.	15.1	11.1
Nagaur	6.8	10.0	15.4	20.9	25.5	28.0	26.9	24.8	24.0	18.9	12.3	7.8
Ajmer	6.8	10.0	15.8	21.9	26.0	27.3	25.8	24.4	23.7	18.7	11.5	7.6

MEAN AIR HUMIDITY-MORNING 1958- 1970 %

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jodhpur	51.	43	35	30	38	59	72	80	76	50	44	54
Nagaur	52	49	42	39	38	55	71	76	69	44	49	55
Ajmer	67	53	41	31	36	58	76	81	72	57	58	67

MEAN WIND VELOCITY 1958-1970 (km. p.h)

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jodhpur	7.9	7.2	8.7	10.1	13.5	17.9	14.1	13.6	10.1	6.7	6.8	8.9
Nagaur	5.5.	6.0	7.5	8.2	11.5	15.9	13.4	10.7	8.6	5.5	4.8	5.0
Ajmer	3.4.	4.4	6.7	8.3	13.6	17.1	14.1	12.5	9.7	4.7	3.3	3.1

MEAN EVAPORATION FROM SURFACE WATER (1958-70) (MM PER DAY)

(Estimated)

Station	Jan	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Jodhpur	2.6	4.0	5.6	8.5	9.3	9.4	4.8	4.2	5.4	5.4	3.6	2.6
Nagaur	2.3	3.4	4.9	7.5	9.6	9.6	5.6	4.2	4.9	4.8	3.1	2.0
Ajmer	2.3	3.4	4.7	7.0	8.6	8.3	4.2	3.4	4.0	4.1	3.1	2.2
Mean	2.4	3.6	5.1	7.7	9.2	9.1	4.9	3.9	4.8	4.8	3.3	2.3

Mean annual lake evaporation was calculated to be 1760-1840 mm.

ESTIMATION OF MEAN ANNUAL RUNOFF

S. No.	Location of the area giving Runoff	Area in sq. km.	Annual Rain-fall in mm	Runoff Coeffi-cient.	Runoff in mm.	Runoff in McF.
1.	Hills to the SE of Alniawas	627	480	0.222	106	2350
2.	Undulating plains between Alniawas and Jhintia.	137	440	0.078	34	165
3.	Undulating plains along the Luni River between Jhintia and Kaulia.	87	440	0.078	34	104
4.	Undulating plains along the Luni river between Kaulia & the Lilri river.	35	430	0.078	34	42
5.	Hilly and undulating plains between the Lilri river and Jaswantsagar dam.	120	420	0.158	66	280
6.	Hilly and undulating plains to the E of Moria	632	470	0.165	78	1740
7.	Undulating plains along the Lilri river between Morai and Rotara.	71	460	0.081	37	93
8.	Undulating plains along the Lilri river between Rotara and the Luni river.	29	440	0.078	34	36
	Total area and runoff	1738	464	0.17	78	4810
	Real inflow into Jaswant-sagar Tank & percentage of it.	3370	-	-	-	876(18%)
9.	Hills to the NE of Khoaspura	95.2	400	0.38	153	514
10.	Hilly & undulating plains between Koaspura & Malawas	146.8	400	0.153	61	316
11.	Undulating plains along the Jojri Nadi between Malawas & Binawas.	68	390	0.070	27	65
	Total runoff coming to the Jojri Nadi	310	396	0.21	82	895
12.	Hills and undulating plains near Samaria	46	420	0.31	130	211
	Probable Runoff at Samaria and percentage of the whole area.	46	420	0.15	63	102(48%)
13.	Hills and undulating plains near Borunda	58	410	0.30	123	252

ESTIMATION OF RUNOFF IN 1968

No.	Location of the area giving runoff	Area in sq. km.	Annual Rain-fall in mm.	Runoff Coeffi-cient.	Runoff in mm.	Runoff in mcf.
1.	Hills to the SE of Alniawas	627	480	0.315	151	3340
2.	Undulating plain and hilly plain between Alniawas & Jhintia	137	480	0.084	40	194
3.	Undulating plains along the Luni river between Jhintia and Kaulia.	87	430	0.076	33	101
4.	Undulating plains along the Luni river between Kaulia and the Lilri river.	35	310	0.057	18	22
5.	Hilly and undulating plains between the Lilri river & Jaswantsagar dam.	120	290	0.134	39	165
6.	Hilly and undulating plains to the E of Morai	632	400	0.153	61	1360
7.	Undulating plains along the Lilri river between Morai & Rotara	71	200	0.045	9	23
8.	Undulating plains along the Lilri river between Rotara and the Luni river.	29	250	0.051	13	13
	Total area and runoff	1738	417	0.20	85	5218
	Real inflow into Jaswantsagar Tank & percentage of it.	3370	-	-	-	1896(36%)
9.	Hills to the NE of Khoaspur	95.2	240	0.32	77	259
10.	Hilly and undulating plain between Khoaspura & Malawas	146.8	240	0.124	30	156
11.	Undulating plains along the Jojri Nadi between Melawas & Binawas	68	220	0.048	11	26
	Total runoff coming to the Jojri Nadi	310	235	0.17	40	441
	Probable runoff of Jojri Nadi at Binawas and % of it.	103	-	0.064	15	164(37%)
12.	Hilly & undulating plains near Samaria	46	270	0.27	73	119
	Probable Runoff at Samaria & percentage of the whole one.	46	-	0.12	33	54(45%)
13.	Hills and undulating plains near Borunda.	58	250	0.26	65	135

ESTIMATION OF RUNOFF IN 1969

No.	Location of the area giving runoff	Area in sq. km.	Annual Rain fall in mm.	Runoff Coeffi- cient.	Runoff in mm.	Runoff in Mcft.
1.	Hills to the SE of Alniawas	627	230	0.170	39	863
2.	Undulating plains between Alniawas & Jhintia.	137	150	0.039	6	29
3.	Undulating plains along the Luni river between Jhintia and Kaulia.	87	150	0.040	6	18
4.	Undulating plains along the Luni river between Kaulia & the Lilri river.	35	210	0.046	10	12
5.	Hills & undulating plains between the Lilri river and Jaswantsagar dam.	120	230	0.122	28	119
6.	Hilly and undulating plain to the E of Morai	632	180	0.110	20	447
7.	Undulating plains along the Lilri river between Morai and Rotara.	71	180	0.043	8	20
8.	Undulating plains along the river between Rotara and the Luni river.	29	220	0.048	11	11
	Total area and runoff	1738	199	0.12	24.8	1519
	Real inflow into Jaswantsagar Tank and percentage of it.	3370	-	-	-	326(21%)
9.	Hills to the NE of Khoaspur	95.2	290	0.35	101	340
10.	Hilly and undulating plains between Khoaspura & Malawas.	146.8	270	0.130	35	181
11.	Undulating plains along the Jojri Nadi between Malawas and Binawas.	68	190	0.044	8	19
	Total runoff coming to the Jojri Nadi	310	258	0.19	49	540
	Real runoff of Jojri Nadi at Binawas & percentage of it.	1039	-	0.062	16	175(32%)
12.	Hills and undulating plains near Samaria	46	280	0.28	78	127
	Real runoff at Samaria and percentage of it.	46	280	0.125	35	57(45%)
13.	Hills and undulating plains near Borunda	58	340	0.29	99	202

ESTIMATION OF RUNOFF IN 1970

S. No.	Location of the area giving runoff	Area in sq. km.	Rain fall mm.	Tank Coe-ff.	runoff Coeff.	Runoff mm.	Runoff Mcf.
1.	Hills to SE of Alniawas	627	590	.159	.239	141	3130
2.	Undulating plains between Alniwas and Jhintia.	137	490	.057	.086	42	204
3.	Undulating plains along the Luni river between Jhintia and Kaulia.	87	490	.057	.086	42	130
4.	Undulating plains along the Luni river between Kaulia & the Lilri river.	35	520	.060	.090	47	58
5.	Hills & undulating plains between the Lilri river & Jaswantsagar dam.	120	530	.115	.173	92	389
6.	Hilly and undulating plain to the E of Morai	632	550	.116	.174	96	2141
7.	Undulating plains along the Lilri river between Morai and Rotara	71	570	.065	.098	56	140
8.	Undulating plains along the Lilri river between Rotara & the Luni River.	29	570	.065	.098	56	57
	Total area and runoff	1738	-	-	-	-	6249
	Real inflow into Jaswantsagar Dam and percentage of it.	3370					
9.	Hills to the NE of Khoaspur	95.2	470		40	188	634
10.	Hilly and undulating plains between Khoaspura & Malawas	146.8	450	.108	.162	73	379
11.	Undulating plains along the Jojri Nadi between Malawas and Binawas.	68	520	-	.114	59	143
	Total runoff coming to the Jojri Nadi	310					1156
	Real runoff of Jojri Nadi at Binawas & percentage of it.	1039					
12.	Hills and undulating plains near Samaria	46	455	-	.32	146	231
13.	Hills and undulating plains near Borunda	58	520	-	.31	161	331

ESTIMATION OF MEAN ANNUAL EVAPOTRANSPIRATION NEAR CHANNELS OF LUNI & LUNI RIVER

No.	Area between	Mean annual precipitation (mm)	Mean annual runoff (mm)	Mean annual evapotranspiration (mm)
1.	Alniawas and Kaulia	440	34	406
2.	Kaulia and Lilri river	430	34	396
3.	Lilri river and Jaswant-sagar Tank	420	33	387
4.	Morai and Rotara	460	37	423
5.	Rotara and Luni River	440	34	406
	Average	440	34	406

Using the average value of evapotranspiration, the approximate mean annual recharge to the ground water body near the river channels was computed as shown below:-

1.	Groundwater recharge from direct precipitation on 121 sq.km.	146 Mcf
2.	Runoff entering river	4810 Mcf
3.	Mean inflow to the Jaswantsagar tank	876 Mcf
4.	Mean annual recharge (4810+146 - 876)	4080 Mcf or 116 Mcm

Using the above estimate the average annual recharge for km. of river channel was calculated to be about 1.2 Mcm.

Mean annual recharge along the Jojri Nadi between Khoaspura and Binawas was estimated to be 844 Mcf or 24 Mcm.

IV. GEOMORPHOLOGY AND DRAINAGE

The area has six different land forms which are shown in Exhibit 2. Four of the six geomorphic types are important for groundwater potentials. These are the residual hillocks, valley fills, older alluvial plains and younger alluvial plains.

Elevations range from 833 feet above m.s.l. near Pipar to 2669 feet above m.s.l. near Baltupura in the Aravallis.

In the limestone area, rolling and undulating topography with parallel strike ridges and shallow valleys are typical features. The general trend of the limestone outcrop is NNE-SSW to NE-SW. The elevation in the limestone region generally ranges between 950 to 1050 feet above m.s.l. The extreme western part of the area is bounded by NNE-SSW trending hillocks composed of sandstones and cherty and conglomeritic rocks. These are identified near Khoaspura on the north to Pichak on the south. Between the western hillocks and main limestone outcrop area, there is a fertile valley which parallels the hill trend. The eastern boundary of the limestone is marked by isolated and scattered mounds of pebble beds and piedmont alluvial plains. To the extreme east, the area stretches to a wide, low alluvial valley of the Luni River. South of the Luni River an isolated extension of the limestone outcrop is traced from Bilara to Sojat.

The drainage of the area is generally southwesterly, except for the northwesterly flowing tributaries of the Luni River. The Luni River with its tributaries, Lilri, Raipur Luni, Sukri, etc. originates in the Aravalli hills to the east. The Luni River is the main system draining the area and flows only during the monsoon season. The Jojri Nadi in the north is ephemeral and drains a small area. The Jojri Nadi and its tributaries are a part of the Luni drainage system.

The general drainage pattern is dendritic to sub-parallel and trellis in places except for radial pattern around isolated hillocks. The limestone terrain and pebble beds are partly internally drained and the drainage pattern under this situation is linear-subdendritic, with disorganized and discontinuous patterns.

The sandy alluvial areas have drainage mainly by the Luni, Mitri and Sukri Rivers. The rivers in this geomorphic zone are fairly well graded and have meandering courses.

V. GEOLOGY

Earlier workers have classified the Borunda-Bilara-Sojat limestone belt under the trans-Aravalli Vindhyan formations of western Rajasthan. The latter are sedimentary rocks consisting of limestones, sandstones and shales. The geologic sequence and map of the area are shown in Exhibit 3.

The oldest rocks in the area belong to the Aravalli system and are found in isolated low hillocks. They are mostly greenish coloured shales interbedded with argillaceous sandstones, quartzites and occasional schists. The strike of these rocks is NNE-SSW to NE-SW with eastward dips. In the extreme east near the Aravalli hills, the beds are almost vertical.

Near Sojat, dark grey to greenish shales striking E-W and dipping 70°S, belonging to the Aravalli group, are seen underlying Vindhyan sandstones. At Banjakuri, schists were encountered in a borehole at a depth of 110 feet b.g.l.

The Malani suite of rocks are younger than the Aravalli formations, and consist of various types of acidic and basic igneous rocks. The acidic rocks are mostly grey to pink granite, rhyolite and associated quartz veins. The basic rocks are mostly altered epidotized diorite dikes and schists. Exposures of granite were observed near Kejarla, Birawas, Sonia and Garsuria. The rhyolites and basic rocks are present in the eastern Aravalli range.

The Vindhyan system overlies the Malani suite of igneous rocks. Vindhyan rocks consist of shales, conglomeratic sandstones and limestones containing dolomite and chert locally. Sandstones overlie an eroded surface of granite near Goukri Bari, Garsuria and Sonia. These sandstones are, in turn, overlain by dolomitic limestones. The contact between the sandstones and limestones is generally obscure but at places it is identified by surface occurrence of chert and conglomeritic float. Some conglomertic materials are found on tops and slopes of hillocks from Birawas to Sonia and also to the west of Gorawat. The maximum thickness of sandstone exposed between Sonia and Choukri is about 100 metres. The contact between the limestone and the sandstone is conformable. An angular disconformity could be traced between Aravalli schists and basal Vindhyan sandstone near Birawas. Immediately ESE of Sojat City an outcrop of reddish grey calcareous conglomerate occurs which is from 4 to 6 feet thick and lies between the base of the sandstone and the top of the Aravalli basement complex. East of hill 1,350 near Borunda (Ex.2), flat lying cherty limestone was seen overlying the sandstones. The sandstone outcrop at a quarry near Ransigaon is pinkish to reddish-brown in colour with partings of miscaceous shale. The sandstones are highly cross bedded and form flag-stones.

The dolomitic-limestone outcrops are extensive and traceable in a north-south alignment from Sojat to Nagour, a distance of about 150 kms. Boreholes drilled near Nagour showed that limestone becomes more gypsiferous in that area. North of Borunda, these limestones are overlain by red shales. Boreholes drilled at Basini village about 90 kms. north of Borunda and 4.8 kms. west of Nagour town showed limestone at a depth of 475 feet b.g.l. Dolomitic limestone outcrops are [illegible] conspicuously as elongated hummocks forming plateaus. The alignment is N 15° E to NE between Sojat and Borunda and the average dip is less than 5° eastward.

Limestone is the predominant rock type in the Borunda area and forms the primary aquifer. A controlling fault has channelized the flow of water in the cavernous and fractured limestone. Exhibit 4, a cross section, shows the geologic framework of the area and indicates the controlling fault between the two Ransigaon holes. The location and alignment of the cross-section is shown in Exhibit-3. The dolomitic limestones, in the main area of study, are massive, grey to dark grey or pale grey to white with interbeds of chert and shales in the lower parts. Limestones are usually crystalline but are locally dolomitic. It was observed that some of the outcrops of dolomitic limestone between Ransigaon and Hariadyana show algal stromatilitic structures. Nodular characteristics of dolomitic limestones are also common especially in fissures and caverns. Caverns are wide spread and have large dimensions especially north of Borunda and near Markasni. Caverns are sources of prolific groundwater supplies. The limestone has a maximum thickness of about 900 feet. Shales and clays were identified as overlying the Vindhyan limestone near Latoti and Pundlo.

A large part of the area is covered by alluvium and wind blown sand. The alluvial thickness in the valley west of Ransigaon between Rampuria and Borunda varies from a few inches to more than 300 feet. Alluvial deposits are divided into two categories, younger alluvium (including wind blown sand) and older alluvium (mostly in piedmont plains). The latter are considered to be of upper Tertiary age.

Younger alluvial deposits are confined to the Luni River channel and their areal extent is limited. The thickness of the wind blown sand is greatest in the eastern portion along the river channels.

The older alluvial deposits consist of sandy, yellowish to reddish clays with pebbles of quartz and quartzite. In the eastern alluvial plains, cobbles and pebbles form slightly elevated platforms or low hills. Some of these mounds could be identified northwest of Ramlias near Digrana and other places between Kharadi, Senla and Nimbol. These mounds have relatively large pebbles of quartz, ironstone and dolomitic or cherty limestone. Angular and flattened pieces are common The pebble beds which outcrop to the east of the limestone beds are similar to the Mar formation of upper Tertiary age from Bikaner district.

The earliest structural impressions are recorded in the Aravalli formations. Theyconstitute a closely plicated synclinorium with general strike of NNE-SSW veering at places to NW-SE and NE-SW and with steep dip eastward.

Subsequently, Vindhyan sediments, which were deposited on the eroded surface of older rocks, were later subjected to severe compressional forces from the southeast. This resulted in the development of flexures and fracture zones. The valley alignment between Rampuria and Borunda marks one of the major fracture zones.

Variation of dips of limestone beds within short distances is attributable to fault drag and collapse due to leaching.

The important fracture zones are shown in Exhibit 3 and are listed below:

1. Borunda-Rampuria major fault
2. Sonia diagonal fault
3. Luni River fault
4. Jojri (or Mitri) Nadi fault

The Borunda-Rampuria major fault trends NNE-SSW and extends about 25 miles (40 kms) between the Jojri Nadi and the Luni River. The fault probably further extends to Sojat but its trace is obscured by alluvium. The fault scarp is well marked along the prominent cherty limestone ridges from Rampuria to Borunda. This fault seems to have developed a number of subsidiary diagonal breaks which have extended the fracture zone to a width of 4 to 5 miles (6½ to 8 kms). The zone is characterised by a number of caverns which have developed due to leaching of carbonate rocks. The presence of chert has led to silicification of limestone and removal of carbonates which in turn led to development of caverns.

The Sonia diagonal fault, trending E-W is responsible for displacement of the limestone outcrop as shown in Exhibit 3.

The Luni River fault has controlled the alignment of the Luni River and is the cause of caverns near the channel.

The Jojri (or Mitri) Nadi fault is down-thrown on the north. The trace of this fault is covered by fluvial and aeolial materials.

Besides major fractures, there are some minor faults, not indicated, in the eastern margin of the limestone belt. These faults are obscured by wind blown sand and serve as water feeder channels from alluvium to limestone.

VI. CHEMICAL CHARACTERISTICS OF GROUNDWATER

Water samples from 169 dug wells in the area were collected during successive post-monsoon periods in 1968,1969 and 1970. About 600 water samples were analysed for a comparative study of chemical composition and the analytical results were classified into major chemical consituents and ionic ratios for evaluation of significant hydrochemical properties (Table 3). The methods adopted for categorization and interpretation are based on standard techniques and well accepted procedures.

A regional isocone map (Ex. 5) was constructed with the total dissolved solids determinations. The map illustrates variations in degrees of mineralisation in groundwater in the limestone and alluvium. Alluvial regions show the TDS ranges from less than 400 ppm to more than 3000 ppm. The distribution of fresh waters in alluvium is dependant on physiographic, lithologic,and structural control. Water in the recharge areas shows relatively less concentration of salts. Some of these areas are identified to the north and northeast and also along river channels. In the piedmont and older alluvial plains, the water tends to be more saline. In the limestone, the quality is controlled by structural and lithologic phenomena. The T.D.S. generally ranges from 1000 to 3000 ppm. The presence of thin interbeds of impervious rocks greatly influences water movement which in turn influences chemical quality of water. The isocone map shows that along the western margin of the limestone between Borunda and Rampuria, the water is relatively less mineralised.

The less mineralized water in the west might be attributable to the occurrence of relatively more interconnected and well developed fissures and opening in karstic limestone in the Borunda-Rampuria region. This area appears to be in direct contact with fresh water regions lying to the north and north-east of Borunda by means of the Borunda-Rampuria fault zone. In the eastern zone, the degree of mineralisation is relatively high. The eastern margin is remote from the recharge area. Additionally the limestone outcrop in the western region forms a ridge and the dip of limestone beds is gently eastward. In contrast to this, the eastern margin is overlain by alluvium and the limestone is relatively deeply buried. These conditions seem to have considerable influence on the chemical compositon of groundwater. It is evident that part of the limestone is under the influence of saline Na-Cl type of waters from the alluvial regions.

Generally, kastic limestone waters are alkaline earth bicarbonates but groundwaters in the Borunda region are of alkali-chloride type. The fluctuation of the total concentration with respect to single ions is not exceptional as shown in Exhibit 6. In contrast, the waters in alluvial regions show greater fluctuations in total concentrations as well as of individual ions as seen in Exhibit 7. The observed increase in the concentrations is due mainly to Na and Cl ions. The Schematic representation of chemical quality of water (Ex.8) shows that sodium is the major consituent among the cations whereas, among the anions, bicarbonates and chlorides are almost equally distributed.

The chemical compositon of a few representative samples is depicted in Exhibit 9. This diagram indicates the extent of salinity and alkalinity in the waters due to alkali and alkaline earths. The karstic limestones in the Borunda-Ransigaon sector have mostly primary salinity and primary and secondaryalkalinity. Twenty four percent of the samples from alluvium have both primary and secondary salinity and the remaining 76% have primary salinity and primary and secondary alkalinity.

Exhibit 10 is a section along A-A' and its locations is shown on Exhibit 5. The section reveals that along the strike, the anion facies change is quite significant.

The following tabulation indicates data used to construct the section.

CONSTITUENTS IN PARTS PER MILLION							
Well No.	T.D.S.	HCO_3	SO_4	Cl	Ca+Mg (epm)	Na+K (epm)	Geochemical type.
2 D 1	1386	830	144	340	2.4	24.32	$Na-Mg-HCO_3-Cl$
2 D 2	552	561	Trace	70	5.2	6.45	$Na-Ca-HCO_3-Cl$
2 D 4	1480	610	58	550	6.6	20.11	$Na-Ca-Cl-HCO_3$
2 D 3	1272	647	144	310	6.6	15.65	$Na-Ca-HCO_3-Cl$
2 D 6	1248	500	96	370	8.2	12.16	$Na-Ca-Cl-HCO_3$
2 D10	2748	598	144	1120	12.0	31.26	$Na-Mg-Cl-HCO_3$
2 D11	1216	512	211	310	8.0	13.54	$Na-Mg-Cl-HCO_3$
3 D 1	1574	586	96	550	7.0	20.11	$Na-Mg-Cl-HCO_3$
3 D 9	1406	427	173	505	7.4	17.44	$Na-Mg-Cl-HCO_3$

The section shows that waters in the recharge area are HCO_3-Cl type with low salt concentration. As the water picks up more CO_2 and infiltrates into limestone fissures the calcium and magnesium are dissolved to the extent that waters change from Na facies at well 2D-1 to Na-Ca facies at well 2D-3. However, the cation exchange with saline waters balances this reaction and water remains Na-Ca facies. The anion facies in the groundwater progressively changes from HCO_3-Cl to Cl-HCO_3 - type at well 3D-1 near the Borunda region. The higher salt concentration at well 2D-10 is significantly reduced at well 3D-1 by the mixing of fresh water from the north. The general pattern of possible changes is shown in Exhibit 11.

The bicarbonate content generally ranges between 400 and 800 ppm which is generally considered as high for normal fresh water. The sulphate content, on the other hand, is low as compared with chloride or bicarbonate ions. It is likely that the chemical composition of the waters has been modified to a great extent by reduction of sulphate through microorganisms of the organic materials resulting in a higher concentration of bicarbonate and lowering of sulphate content. Generally the increase in salt concentration causes an increase in the non-carbonate hardness in waters owing to simultaneous increase of sulphate concentration in the form of magnesium sulphate (Ex.12). Some samples of water have high dissolved solids contents and high sulphates in the form of sodium sulphate but have low non-carbonate hardness. The softening of the water is possibly due to ion exchange in which calcium and magnesium is absorbed by the saline alluvial formations and sodium is taken into solution. The water from the Borunda-Ransigaon sector does not contain non-carbonate hardness except in a few wells. Only the highly mineralized waters of the limestone region contain non-carbonate hardness ranging from 60 to 460 ppm.

Small areas to the north and south of the Luni River have chloride concentrations of more than 1000 ppm. These waters have mostly stagnated in the alluvium and water samples from wells showed contamination by bacterial decomposition.

There is some vertical zonation of water quality in the limestone. Vindhyan sandstone underlying the limestone contains saline waters which are probably a major cause. The data given below indicates the quality difference between water in regard to depth.

Ransigaon test well

	Depth range (zones)	TDS (ppm)	Chlorides (ppm)	Remarks
Limestone	150'	1354	420	10 days continuous pump test showed no change in quality of composite-water during the period
	244'	1376	435	
	290'	1390	450	
	330'	1388	450	
	360'	1400	450	
	400'	1396	450	
Calcareous sandstone	425'-500'	3176	1130	Test pumped $1\frac{1}{2}$ hours. Initial quality was TDS 2,104 ppm. Increased to 3,176 ppm at end of pumping.

2. Ransigaon - Site 2.

	Depth range	TDS ppm	Cl Ppm	Remarks.
Limestone	600-700' @ 2 hours 45 minuts.	1152	450	Perhaps some saline water from bottom is drawn after 2 hours pumping.
	600'-700' @ 22 hours	1464	650	
Calcareous sandstone	840'-900'	2226	980	

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3. Patel Nagar

Limestone	182'	4528	2084	This site is located at the eastern contact of the limestone with alluvium.
	210'-220'	4528	2084	
	220'-230'	4322	2049	
	230'-239'	4522	2158	
	252'	4632	2134	
	260'	4586	2208	

	Depth range	TDS ppm	Cl ppm	Remarks
4. Rampuria				
	50-84'	2099	840	
	120'	2000	870	
	164'	1992	900	
	200'	2020	920	
	215'	2060	920	
	270'	2166	840	
APT results after 10 days of continuous pumping		2210	860	Well open to 260' only.
5. Pichak (Production tubewell)				
	(i) 30' to 120'	1960	615	Well taps alluvium on top of limestone.
(Test well UNDP)	(ii) 31' to 644'	2152	850	Well taps highly fractured limestone formation.

	Depth range	TDS (ppm)	Cl (ppm)	Remarks
6. <u>Jetti</u>				
	27'-118'	2750	1060	Limestone
	164'-230'	2600	1000	Limestone
	272'-295'	3140	1310	Calcareous sandstone
7. <u>Nimbol</u>				
	200'	798	250	Alluvium S.W.L. 80' b.g.l.
	440'-474'	-	798	Limestone water level 80' b.g.l. (under confined conditons).

It was apparent (Ex. 5) that recharge from the Luni River does not appear to have widespread effects on the salinity in the region except along the river channels.

VII. SUITABILITY OF SOILS AND GROUNDWATER FOR IRRIGATION.

Soils of the region are shown in Exhibit 13. This map was prepared after reconnaisance soil surveys were made.

In the upland the slope of land varies from 1 to 10% The soils in general are sandy to loamy in texture. The soil depth invariably follows the topography. The pH value of soils can be characterised as normal generally ranging from 7.8 to 8.3 although the maximum value was 9.2 in calcareous grey brown soils where the range was from 8.4. to 9.2. There is a tendency for pH to increase with depth.

The fertility of soils ranges from low to medium. The organic carbon content ranges from 0.3% to 0.5%. Most of the coarse textured soils under association I, in the tabulation given below, have organic carbon contents of as low as 0.03%. The available P_2O_5 content ranges from 2 to 60 kg./ha. and in some of the established cultivated soils the value is as high as 80 kg/ha. The status of K_2O is medium to high and it falls in the range of 250 to 500 kg/ha. The list given below gives the soil types of the area.

ASSOCIATION	DISTRIBUTION	GENERAL DESCRIPTION
1. Sandy to loamy sand	Soils of alluvial and aeolian nature, the former occupy relatively small areas to the west of Borunda village and later along the Luni River extending over the south.	Deep to very deep soils with nil to very little horizon differentiation. Mostly the surface soil is non-calcareous to slightly calcareous, with $CaCO_3$ leached down to deeper horizons i.e. 60-100 cm. Rapid to excessively drained.
2. Sandy loam to loam	Most predominant soils type in the area, extending over villages Phalka, Kharadi etc. in the south, to Basni and Mokala in the north. It also encompasses a vast area between the Luni river and its distributaries in the southeast.	Medium heavy textured soils. Surface soil mostly sandy loam with tendency to increase to heaviness with depth Horizon differentiation is conspicuous. Soils are calcareous and $CaCO_3$ increases with depth. Mostly deep to very deep soils with fairly good drainage.
3. Loam to sandy clay loam.	Occupies vast patches in the valley plains, between the slopey uplands and rocky ridges. Covers mainly villages of Ransigaon to Murkasai, Haryadhana to Digrana Senla and east of Borunda village.	Soils under this area slightly different from the above, the texture is relatively heavier particularly in the deeper layers with little suspected drainage impedence.
4. Gravelly soils	Distributed all over the slopey up-land with rocky ridges and stoney material.	Coarse textured soils with shallow depth and ill defined profile. Aeolian sand deposits are frequently seen covering the rocky outcrops.

The utilisation of chemical data with the water classification scheme of the U.S.D.A. did not help in arriving at the proper assessment of the suitability of the groundwaters under local conditons of soil, climate and availability of crops. Amendments to this system to suit the local arid conditions were attempted by various workers following desert research schemes. In the present evaluation, therefore, modified systems were also used. The analytical data from 169 water samples were used for assessment of suitability for irrigation mainly in respect to salinity and alkali hazards. Classifications are shown in Exhibit 14 for waters in limestone and in Exhibit 15 for water in alluvial deposits.

The salinity level in the groundwater is not considered to be high although the major contribution is from the cation Na^+ and the anions Cl^- and SO_4^{-}. By using electrical conductivity as a measure of salinity, 55% of the total wells have only low to medium salinity groundwater with the E.C. being less than 2250 micromhos/cm at 25°C. The remaining wells, however, cross this limit but can be used for successful growth of medium salt tolerent crops under conditions of good drainage and adequate supply of water. The distribution of salinity shows that wells located in alluvium have relatively lower E.C.(mostly less than 3000 micromhos) than water from limestone wells.

The tablulation below gives alkali hazard data and show that 36% of the total wells fall under excellent to permissible classes.

DISTRIBUTION OF WELLS WITH RESPECT TO SSP & RSC CONTENTS

		Soluble Sodium Percentage			Residual Sodium Carbonate m e/L		
Tract	Total Wells	< 60%	60-80	> 80%	0 - 1.25	1.25 - 2.5	> 2.5
		Permissible	Doubtful	Unsuitable	Safely used	for selected crops	Should be restricted
Alluvium	122	50	41	31	47	20	55
Pebble spread	15	3	9	3	8	1	6
Limestone	32	7	20	5	23	3	6

Ground waters from dug wells collected during Oct/Nov. 1970 showed boron concentration from trace to 2 ppm. The results obtained on 65 representative wells are summarized below:

Class	Sensitive crops Range of boron ppm	No. of wells	Semi-tolerant crops range of boron ppm	No. of wells	Tolerent Crops range of boron ppm	No. of wells.
1. Excellent	0.32	16	0.66	38	0.99	57
2. Good	0.33-0.66	22	0.67-1.32	23	1.00-1.99	8
3. Permissible	0.67-0.99	19	1.33-1.99	4	2.99-2.99	-
4. Doubtful	1.00-1.24	4	2.00-2.49	-	3.00-3.74	-
5. Unsuitable	-1.25	4	2.50	-	3.75	-

The table reveals that except for a few wells these groundwaters could be safely used for a wide variety of selected crops under the existing soil and climatic conditons. Although, in general, the distribution of boron concentration does not follow a definite pattern, relatively lower concentrations have been recorded along the river beds. However, the chemical characteristics such as salinity and alkalinity are found to have a definite bearing on the status of boron concentration. The statistical correlation worked out gives positive line of relationships and is summarized below.

	Correlation Coefficient(r)
Boron Vs Electrical conductivity	0.723
Boron Vs SAR	0.860
Boron Vs Sodium %	0.705

It is, therefore suggested that the use of relatively higher salaine and alkaline waters for irrigation purposes needs cautious approach.

VIII. GROUND WATER CONDITIONS

Ground water in the limestone generally occurs under water table conditions in caverns and fractures created mainly by solutional activity in faulted zones. Depths of water levels generally range from 30 to 50 metres b.g.l. The fault east of Borunda and Ransigaon seems to have formed a fresh water - brackish water contact (Ex.5) by channelizing the flow of groundwater. The fault acts as a drain conducting recharge from the north to the southern regions.

Karstification in the limestone is generally limited to an earlier base level of erosion and zone of aeration. At Pichak this zone was identified at a depth of 130 meters b.g.l. For evaluation of ground water resources, an average aquifer thickness of 500 feet (150 m) was used as fractures exist throughout the full saturated section.

Exhibits 16, 17 and 18 show changes of ground water storage during project operations. Specific yield was determined from data shown on the maps and other information and was rounded off to 7% for the limestone of the 257 sq. kms. of the balance region. 161 sq. kms. is underlain by fresh water (under 2,000 ppm TDS). Consequently fresh water storage was estimated at 1,700 MCM. The tabulations below show how specific yield was derived.

By including water having SSP of 60 to 80% (acceptable under local conditons) the amount of satisfactory samples that could be used with proper amendments is 77%. Tractwise, distribution shows that wells located in alluvium have better quality water with respect to Na content that limestone waters. The SA and water given in Table 3 show that 82% of groundwaters have low to medium alkali hazard. The predominace of this hazard is greatest in pebble beds followed by alluvium and limestone. Consequently, it can be concluded that most groundwater can be safely used for irrigation under normal conditons of drainage and adequate supply of water. The remaining water which falls outside the limit due to alkali hazard can also be utilised suitably in conjuction with proper amendments.

An evaluation of boron content of water was also made because excessive boron has detrimental effects on crops. In general a concentration of 0.3 ppm could be safely used for any crop.

DETERMINATION OF SPECIFIC YIEDL OF THE BALANCE REGION, BORUNDA AREA

$$S = \frac{Vp+GWo-IW-GWI}{V}$$

Period	Sub-areas	Average Fall of Ground water level	V Volume of de-watered aqui-fer.	Vp Amount of groundwater pumped out.	GWO Ground water outflow	IW 15% of pumped ground water returned	GWI Ground-water inflow	S specific yield
	Sq.kms.	m.	Mcm	Mcm	Mcm	Mcm	Mcm	
Oct 1967-Jul 1968 (270 days)	92.49	0.30	27.75					
	61.33	0.75	46.10					
	44.65	1.25	55.80	7.47	10.20	1.12	2.83	0.061
	58.53	1.65	96.57					
	257.00		226.22					
Oct 1968-May 1969 (210 days)	3.30	0.35	1.16					
	97.10	0.65	63.12					
	145.00	1.10	159.12					
	11.60	1.30	15.08					
	257.00		238.86	8.85	7.92	1.33	2.21	0.055
Oct 1969-May 1970 (210 days)	1.55	0.25	0.387					
	23.52	0.65	15.300					
	68.13	0.90	61.500					
	49.11	1.10	54.000					
	75.63	1.25	94.500					
	15.23	1.75	26.700					
	23.83	2.25	53.800	12.41	7.92	1.86	2.21	0.052
	257.00		306.187					

Exhibit 19 indicates ground water contours in April 1970 and Exhibit 20 shows depths to ground water from general land surface. Exhibit 19 shows that the general flow of ground water in the limestone region is southward in the dry season and that the controlling fault acts as a sump.

The main source of recharge to the limestone aquifer is rainfall falling within the drainage basin of the Luni River and its tributaries. The groundwater contour map of the region north of the Luni River for October 1970 (Ex. 21), indicates that recharge during and after the monsoon is temporarily from Luni River runoff. The Tertiary alluvium to the east partially contributes ground water inflow to the limestone. Next to direct rainfalls, the most significant recharge contribution is ground water inflow from the north.

Calculations showed that the average coefficient of infiltration was 25%. The average annual precipitation in the area is about 17 inches (425 mm). Consequently the average annual recharge from direct infiltration in the fresh water area [illegible] was computed as 17.1 Mcm/yr. [illegible] in the fresh

Discharge from the limestone aquifer is by present agricultural utilization underflow to the Luni River channel during the dry season and direct evapotranspiration. Most pumpage in the balance region is given below and details for individual wells are given in Table 4.

DRAFT DATA OF BORUNDA AREA. (1967-TO JULY 1970)

Draft in Million U.S.Gallons
Draft in MCM.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1967	-	-	-	-	-	-	-	-	-	236.55 (0.897)	253.90 (0.963)	379.70 (1.435)	870.15 (3.295)
1968	377.36 (1.428)	357.26 (1.352)	299.37 (1.133)	56.82 (0.215)	49.49 (0.187)	86.44 (0.327)	113.06 (0.427)	208.99 (0.791)	292.93 (1.108)	342.80 (1.297)	455.33 (1.723)	401.72 (1.520)	3041.57 (11.508)
1969	429.61 (1.626)	481.29 (1.821)	381.62 (1.444)	106.41 (0.402)	82.55 (0.312)	134.59 (0.509)	98.56 (0.373)	144.46 (0.546)	245.51 (0.929)	479.47 (1.814)	540.82 (2.047)	678.82 (2.569)	3803.84 (14.383)
1970	616.26 (2.332)	612.29 (2.317)	454.00 (1.718)	266.52 (1.008)	110.11 (0.416)	162.44 (0.614)	104.84 (0.396)	146.26 (0.553)	144.41 (0.547)	157.67 (0.597)	-	-	2771.80 (10.498)

NOTE: Only production wells situated within the balance region are taken into account.

The decrease of pumpage from 1969 to 1970 was due to the abnormally high rainfall in 1970. Total water balance was computed for the balance region for the three successive years of the project operations. The following data were used for evaluating the total water balance.

1. Monthly ground water level fluctuations of 7 observation dug wells for 1968 and 1969 and 24 wells for 1970;

2. Precipitation data from 18 meteorological stations for the last three years and five meteorological stations for 67 years of record;

3. River runoff data from Khoaspura, Binawas and Samaria from 1968 to 1970;

4. Monthly data from Rajasthan State Electricity Board, Jodhpur;

5. Geological maps, ground water contour maps, surveying, drilling and test pumping data.

The total water balance equation is:-

$$P = (E + SWO + GWO + EW + IGW) - (GWI + IW + DGW) \text{ where}$$

P = Precipitation
E = Evapotranspiration
SWO = Surface water outflow
GWO = Ground water outflow
EW = Exported water
IGW = Increase in ground water storage
GWI = ground water inflow
IW = Imported water
DGW = Decrease in ground water storage

Results of the balance study are given below.

Year	P	(E	+SWO	+GWO	+ EW	+ IGW)-(GWI	+IW	+DGW)
1968	71.90	57.92	1.46	13.76	10.66	11.48	5.95	1.60	15.83
1969	72.90	60.03	1.38	13.76	13.02	9.34	5.95	1.95	16.73
1970	125.90	95.13	2.68	15.00	15.11	27.67	6.00	2.27	21.42

It is seen that evapotranspiration accounts for the major part of water loss.

By adding the estimated long term inflow to the long term recharge from direct infiltration, the "safe yield" in the fresh (less than 2,000 ppm TDS) and brackish (2,000-3,000 ppm TDS) area as well as in the fresh water area alone was computed. The "safe yield" in the fresh and brackish water area combined was estimated as 26.6 MCM/yr. The 1969 pumpage of fresh and brackish water was estimated as 14.5 MCM/yr. The "safe yield" of fresh water has been calculated at 24.5MCM/yr and the draft of the fresh water is normally about 12.4 MCM/yr. Consequently, about 12 MCM/yr of additional fresh water is available for further irrigation or other uses. In dry years, water would be withdrawn from storage but because of the enormous, quantities of fresh water in storage and rapid recharge during monsoon, there would be no detrimental effects in the long run.

Several pumping tests were run in the limestone aquifer and results are presented below:

DETAILS OF PUMPING TEST ON RAMPURIA TESTWELL

A. STEP DRAWDOWN TEST   DATE: 11 JANUARY, 1971

TEST WELL			OBSERVATION WELL
Step No.	Discharge U.S.G.P.M.	Drawdown feet.	Drawdown
1.	672	2.41	0.06
2.	857	3.64	0.16
3.	1001	4.92	0.22
4.	1200	6.92	0.36
5.	1377	9.13	0.45

B. AQUIFER PERFORMANCE TEST

Discharge 1200 USGPM, Drawdown 7.60 ft. Duration 210 hours. Drawdown in observation well - 0.72 ft.

NOTE:

Duration of each step - five hours S. W. Levels
TW. - 44.89 feet below M. P.
O.W. - 46.29 -do-

DETAILS OF PUMPING TEST (S.D.T) AT RANSIGAON

Date : 31.5.1970

S.W.L. : 107 ft. b.g.l.

Step No.	Duration in hours.	Discharge in USGPM	Drawdown in ft.	Sp. capacity USGPM/ft.
1.	3	1000	6.18	162
2.	3	1210	8.62	141
3.	1	1860	12.07	154
Date: 5 & 6.6.70		S.W.L. 106.79 ft. b.g.l.		
4.	24	1000	6.36	157
5.	24	1100	7.27	151

DETAILS OF AQUIFER PERFORMANCE TEST CONDUCTED AT RANSIGAON TESTWELL

Date of test: 10 to 20.6.1970 (10 days)

Discharge : 1000 USGPM/63.27 litre/sec./3.8 m^3/min

	TW	OH_1	OH_2	OH_3	OH_4
S.W.L. in ft. (in m) b.g.l	106.74 (32.53)	105.21 (32.07)	106.45 (32.45)	112.68 (34.34)	115.87 (35.32)
Draw down in ft. (in m)	6.35 (1.94)	0.74 (0.23)	0.34 (0.10)	0.41 (0.12)	0.29 (0.09)
Measuring point a.g.l. ft.	1.33	1.42	1.25	0.42	5.08
R.L. of M.P. in ft.	974.23	973.20	974.46	979.64	987.97
R.L. of S.W.L. in ft. (in m)	867.49 (264.41)	867.99 (264.56)	868.01 (264.57)	866.96 (264.25)	872.10 (265.81)
Distance from T.W. (feet)	-	108.9	253	300	607

DETAILS OF PUMPING TESTS ON PATELNAGAR TESTWELL

Step drawdown test

Step No.	Date	Duration in hrs.	S.W.L. in ft. b.m.p.	Discharge USGPM	Drawdown in ft.
1.	23.6.1969	2	180.35	618	4.87
2.	-do-	2	-	791	7.13
3.	-do-	2	-	919	9.30
4.	-do-	2	-	1034	11.00
5.	-do-	2	-	1263	14.30
AQUIFER PERFORMANCE TEST					
	24.6.1969	16	180.40	1100	12.20

Measuring point: 0.38 ft. above ground level

DETAILS OF PUMPING TEST ON JHAK TEST WELL

STEP DRAWDOWN TEST

Date 15th Feburary, 1971.

Duration: 28 hours.

Step No.	Duration Minutes	Discharge U.S.G.P.M.	Drawdown T.W.	Drawdown O.W.	Specific capacity U.S.G.P.M./ft.
1.	300	805	9.66	2.05	83.33
2.	300	862	11.96	2.49	73.74
3.	300	955	13.65	2.71	69.97
4.	300	1023	14.99	2.94	68.22
5.	300	1100	13.91	3.21	79.09
6.	180	1150	13.78	3.42	83.45

Distance between T.W. and O.W. - 30 feet

Static water level - 40.19 feet (T.W.) and 39.70 (O.W.)

Total depths of the wells - 168 feet (T.W.) and 74'(O.W)

Assembly:

T.W.
- 0-67 feet, Blank casing, diameter 14"
- 67-168" Slotted casing, diameter 6"

O.W.
- 0-38 feet, blank casing, diameter 4"
- 38-67" , slotted casing, diameter 4"

IX. POTENTIAL FOR ADDITIONAL GROUNDWATER DEVELOPMENT

Exhibit 22 shows present irrigation wells. Groundwater is presently being economically utilised for irrigation. The major pumpage (about 75% to 80%) is at Borunda. Some water is also used for purposes other than irrigation but the amount of water used for purposes other than irrigation is negligible. Because an additional 12 MCM of water per year can be extracted before the safe yield is exceeded in the limestone region, there is margin for further development. It is estimated that ten additional production wells can be installed in the Borunda area along the controlling fault line or immediately west of the fault line.

Based on the assumption that each tubewell will be capable of producing 1,400 US gallons per minute will be drilled to 200 feet (60 metres) and will have a pumping water level of 150 feet (45 metres) the total cost for each fully equipped unit should be about Rs. 90,000. The annual maintenance, depreciation and electricity costs for pumping assuming pumping for 50% of the time should be about Rs. 60,000 for each well.

Because of the limited extent of the fresh water bearing limestone, groundwater in the Borunda area has only local significance unless water exportation is enhanced.

No estimates are given of the additional potential from alluvium near the Luni River as it is felt that a separate detailed study would be needed for this evaluation. A pumping test run in the test well at Jhak did, however, indicate that hydraulic connection exists between the alluvium and the limestone. Measurements taken in the observation well tapping the alluvium showed that drawdown occurred when the test well tapping only limestone was pumped. There appears to be considerable potential for development of groundwater in the alluvium near the Luni River.

X. CONCLUSIONS AND RECOMMENDATIONS

Field investigations in the Borunda area were carried out from August 1967 to February 1971 in an area of about 1,500 sq.miles (3,900 sq.kms.). The study was made as a result of pumpage for irrigation of relatively fresh groundwater from cavernous limestone by a few enterprising agriculturists. There was also some consideration by the State authorities to augment the city supply of Jodhpur with groundwater from the limestone.

2. The area is a part of the upper Luni drainage basin. The average annual precipitation is about 17 inches (425 mm) and runoff from intermittent streams, especially the Luni River, supplies some recharge during and immediately after the monsoon season.

3. Much of the area is covered by alluvial and aeolial deposits but there are prominent outcrops of limestone especially in the eastern area near Borunda. The limestone of Vindhyan age yields more water to individual wells than any other aquifer in the entire UNDP project area, however, its restricted areal extent limits its regional importance. Fresh water (under 2,000 ppm TDS) is found in 161 sq. kms. of the area underlain by limestone. Water occurs in caverns and fractures which were formed as a result of structural activity. A controlling fault has channelized the flow of water by acting as an enormous sump. The favourable fresh water zone is largely along and west of the controlling fault between Borunda and Rampuria.

4. Water and soil analyses indicate that groundwater can be used in selected areas for agricultural purposes.

5. A key area of 100 sq. miles (257 sq.kms.) was selected for water balance studies. The studies indicated that most of the present discharge is through evapotranspiration.

6. Recharge is mainly from direct precipitation but during the dry season recharge comes from the north and is channelized by the NNE-SSW trending controlling fault. Additional recharge comes from the south in the summer and early fall. This additional recharge is supplied by the Luni River via alluvial deposits that are hydraulically connected to the limestone openings.

7. Groundwater in the limestone generally occurs under water table conditions. Depth of water levels generally range from 30 to 50 metres b.g.l. Specific yield was estimated at 7%. The aquifer thickness averaged 500 ft(150 m). Consequently the amount of water in storage in the 161 sq.kms. region was estimated at 1,700 MCM.

8. The "safe yield" of fresh water has been calculated at 24.5 MCM/yr and the draft of the fresh water is normally (was) about ~~12.4~~ MCM/yr. (in the yr 1970. The present draft is about 18 mcm) Consequently about ~~12 MCM/yr~~ (6.5 mcm/yr) of additional fresh water is available for further irrigation and other uses.

9. It is recommended that an additional ten production wells can be installed to utilise the additional capacity in the Borunda area. The wells can be located along the controlling fault line or

immediately west of the fault line.

10. No estimates were made of the potential of the alluvium near the river Luni since this would entail a separate study. There does, however, appear to be considerable potential for developments.

TABLE 1

Details of bore holes drilled by the C.G.W.B. in Borunda area from 1962 to 1966

S. No.	LOCATION	Depth in m (ft.)	Lithology	S.W.L. in m(ft.) b.g.l.	Duration of test in hrs.	Discharge in LPM/usgpm	Drawdown in m(ft.)	Remarks
1.	Banjakuri	46.33 (152)	Alluvium	-	-	-	-	Abandoned, low discharged bad quality.
2.	Chandawal	28.35 (93)	Alluvium	9.14 (30)	-	-	-	Abandoned, low discharge
3.	Pichak	54.86 (180)	Alluvium	3.49 (11.44)	6	1641 (434)	9.27 (30.4)	Successful
4.	Rampuria	49.07 (161)	Alluvium Limestone	-	-	-	-	Abandoned, low discharge
5.	Ransigaon I	41.75	Alluvium Limestone	32.08 (105.25)	6	3059 (808)	2.20 (7.2)	Successful
6.	Ransigaon II	37.80 (124)	Alluvium Limestone	30.65 (100.56)	6	3441 (909)	2.70 (8.86)	Successful
7.	Borunda	111.57 (366)	Limestone	-	-	-	-	Abandoned, low discharge
8.	Mokala	304.80 (1000)	Alluvium	31.79 (104.35)	6	546 (120)	13.58 (44.57)	Successful

DETAILS OF BORE HOLES DRILLED AND WELLS CONSTRUCTED DURING U.N.D.P. PROJECT IN BORUNDA AREA

(NOTE: TW = TEST WELL ; SH = SLIM HOLE; OW = OBSERVATION WELL)

S. No.	Location and status of borehole	R. L. of G. L. in m (ft.) M.S.L.	Depth drilled in meter/ (ft.)	Lithology	Caverns encountered and tapped in m (ft.)	Static water level in m(ft.) b.g.l.	Tested discharge in M^3/m (USGPM)	Drawdown in m(ft.)	Chemical quality (ppm) TDS	Cl
1	2	3	4	5	6	7	8	9	10 (1)	10 (2)
1.	Jeti (SH)	270.27 (885.92)	91.44 (300)	Limestone	28.65-30.48 (94-100) 65.22-69.19 (214-227)	-	-	-	2792	1070
2.	Pichak (TW)	273.92 (895.97)	196.44 (644.5)	Limestone	61.00-68.3 (200-224) 92.35-96.31 (308-316) 110.3-121.92 (352-400) 125.58-129.85 (412-426)	9.10 (29.85)	$374x10^{-3}$ (99)	16.0 (52.47)	2152	850
3.	Rampuria (TW)	278.04 (912.08)	103.94 (341)	Limestone	23.40-24.69 (77-81) 39.02-39.93 (128-131) 45.42-45.72 (149-150) 80.16-80.77 (263-265) 97.23-97.84 (319 - 321) 101.50-103.32 (333-339)	13.41 (44.02)	$4542x10^{-3}$ (1200)	2.32 (7.60)	2216	860

1	2	3	4	5	6	7	8	9	10 (1)	10 (2)
4.	Rampuria(OW)	278.04 (912.08)	107.29 (252)	Limestone	18.60-19.50 (61-64) 34.75-35.05 (114-115) 47.25-48.16 (155-158)	-	-	-	-	-
5.	Nimbol (TW)	292.45 (959.53)	177.09 (581)	Alluvium Pebble bed shale & Limestone	-	-	-	-	-	-
6.	Jhak(TW)	275.93 (905.28)	50.90 (167)	Alluvium Limestone	26.82-29.26 (88-96) 29.26-50.91 (96-167) Fractured zone	-	-	-	-	-
7.	Jhak (OW)I	275.81 (904.78)	20.42 (67)	Allüvium Limestone	-	-	-	-	-	-
8.	Jhak (OW II)	275.15 (902.28)	20.42 (67)	Alluvium Limestone	-	-	-	-	-	-
9.	Ransigaon(TW)	297.82 (975.50)	152.70 (501)	Limestone	32.30-32.99 (106-108) 39.34-40.54 (129-133) 42.97-43.59 (141-143) 73.46-74.06 (241-243) 79.25-81.69 (260-268) 88.70-89.30 (291-293)	32.12 (105.41)	378x10^{-3} (1000)	1.94 (6.35)	1400	450

1	2	3	4	5	6	7	8	9	10	
									1	2
10.	Ransigaon(O.W.I)	296.96 (974.28)	48.75 (160)	Limestone	32.30-32.91 (106 - 108) 39.31-40.53 (129-133) 42.97-43.58 (141-143)	-	-	-	-	-
11.	Ransigaon(O.W-2)	297.25 (975.23)	67.05 (220)	Limestone	32.91-33.52 (108-110) 42.06-42.67 (138 -140)	-	-	-	-	-
12.	Ransigoan(SH)	320.14 (1050.37)	283.76 (931)	Limestone	56.08-56.99 (184 -187) 96.31 -96.92 (316 -318)	-	-	-	-	-
13.	Patelnagar(T.W)	321.19 (1053.21)	79.85 (262)	Limestone	67.36-68.58 (221 -225) 70.10-71.93 (230-236)	54.86 (180.02)	$416x10^{-3}$ (1100)	3.72 (12.2)	4892	2275
14.	Pondlu(SH)	286.66 (940.48)	217.01 (712)	Shale Limestone	40.23-42.06 (132 -138) 42.06-217.01 (138-712) (Fractured Zone)	-	-	-	480	70

TABLE 3

CHEMICAL ANALYSES OF WATER SAMPLES FROM DUG WELLS IN BORUNDA AREA
(JUNE 1970)

S. No.	Location	Well No.	pH	Specific conductance (micromhos/Cm at 25°C)	T.D.S. at 180°C (ppm)	Cations in epm: Ca^{++}	Cations in epm: Mg^{++}	Cations in epm: Na^{+}	Cations in epm: K^{+}	Anions in epm: CO_3	Anions in epm: HCO_3^-	Anions in epm: SO_4	Anions in epm: Cl^-	SAR	SSP %	RSC (epm)	Hardness as $CaCO_3$ in ppm: Ca,Mg	Hardness as $CaCO_3$ in ppm: Non-Carbonate.
1	2	3	4	5	6	7: 1	2	3	4	8: 1	2	3	4	9	10	11	12: 1	2
	A. QUATERNARY ALLUVIUM																	
	A. GEOLOGICAL HORIZON:																	
1.	SONIA	45/E3C-2	7.7	780	422	1.6	3.8	2.67	0.04	Nil	7.0	0.40	0.71	1.62	34.5	1.6	270	0
2.	RANSIGAON	*45/F-3C-3	7.6	1204	610	3.6	3.0	5.19	Tr.	-	8.0	1.0	2.82	2.85	44.2	1.4	330	0
3.	RANSIGAON	45/F-3C-4	7.9	3611	1920	2.8	5.0	27.97	Er.	-	7.8	4.0	23.97	13.98	78.2	Nil	390	0
4.	Khejarla	45/F-3C-4	7.8	2794	1618	4.0	4.8	20.31	Tr.	-	11.6	6.4	11.14	9.67	69.8	2.8	440	0
5.	Samaria	45/F-3C-6	7.9	2533	1522	4.4	6.6	15.22	Tr.	-	8.0	2.6	15.65	6.47	58.1	-3.0	550	150
6.	Bagasni	45/F-3C-7	7.4	2446	1520	14.0	4.0	17.40	0.20	-	8.6	2.4	14.66	8.70	68.8	0.6	400	0
7.	Rampuria	45/F-3C-9	7.8	4008	2402	5.0	5.6	28.00	0.41	-	8.4	5.6	25.38	12.18	72.8	-2.2	530	110
8.	Bilara	45/F-4C-4	7.5	4542	2724	3.8	5.2	36.62	1.00	-	8.6	7.0	31.02	17.27	78.6	-0.4	450	20
9.	Bilara	45/F-4C-7	8.1	5771	3600	4.6	6.2	48.81	0.17	nil	8.6	8.6	42.58	20.95	81.9	-2.2	540	110
10.	Jelwa	45/F-4C-8	7.6	1007	592	2.8	1.2	5.95	0.24	-	4.4	1.0	4.79	4.21	58.3	0.4	200	0
11.	Jeti	45/F-4C-10	7.7	1601	972	2.0	3.0	11.62	0.25	-	8.4	1.0	7.47	7.26	68.8	3.4	250	0
12.	Kharianeo	45/F-4C-14	7.7	3402	2050	5.0	6.8	20.15	1.00	-	7.8	4.0	21.15	8.28	61.1	-4.0	590	200
13.	Mokala	45/F-2D-1	7.5	2700	1386	1.0	1.4	23.80	0.52	-	13.6	3.0	9.59	21.63	89.1	11.2	120	0

1	2	3	4	5	6	7				8				9	10	11	12	
						1	2	3	4	1	2	3	4				1	2
14	Basni	45/F-2D-2	7.5	1000	552	2.6	2.6	6.00	0.45	-	9.2	Tr.	1.97	3.72	51.5	4.2	260	0
15	Indwar	45/F-2D-8	7.8	7200	4428	6.4	10.8	56.00	0.42	-	9.4	6.8	57.81	19.11	78.1	-7.8	860	39
16	Ucharda	45/F-2D-9	7.7	5982	3736	3.0	4.2	51.60	0.90	-	13.0	5.8	41.17	27.15	86.4	5.8	360	[illegible]
17	Baer	45/F-2D-10	7.8	4500	2748	5.8	6.2	31.40	0.86	-	9.8	3.0	31.58	12.81	70.9	-2.2	600	1
18	Hiromkuri	45/F-2D-12	8.2	3707	2278	0.6	1.8	33.20	1.30	-	18.8	2.6	15.79	31.81	89.9	16.4	120	
19	Basni	*45/F-2D-13	7.4	1120	636	3.8	4.0	4.00	0.32	-	8.6	Tr.	3.38	2.00	33.0	0.8	390	
20	Khakharki	45/F-2D-14	7.5	5000	2888	4.0	4.2	39.20	0.65	-	11.0	8.4	28.48	19.60	81.6	2.8	410	
21	Lunfawas	*45/F-2D-15	7.1	1112	668	4.0	2.4	4.60	0.80	-	7.6	0.8	2.82	2.55	38.9	1.2	320	
22	Badgaon	45/F-2D-17	7.4	6020	3796	5.0	8.2	47.14	0.07	-	10.2	5.8	44.41	18.13	78.2	-3.0	660	1
23	Ramliyas	45/F-3D-6	7.5	5500	3392	5.4	7.4	44.00	0.37	-	11.8	7.0	37.51	17.38	77.7	-1.0	640	
24	Happoji-Badiya Ka-Bera	45/F-3D-7	7.5	1400	806	3.4	5.0	6.80	Tr.	-	9.4	1.2	4.23	3.31	44.9	1.0	420	
25	Mugdara	45/F-3D-11	7.3	1220	844	3.6	1.2	7.47	0.35	-	8.2	1.6	2.82	4.81	59.7	3.4	240	
26	Borunda	*45/F-3D-12	7.6	1540	904	2.0	5.0	8.93	Tr.	-	11.0	Tr.	4.93	4.77	55.0	4.0	350	
27	Mukhnaram Jat Ki.Dhani	45/F-3D-13	7.3	2220	1216	3.6	3.8	14.00	0.08	-	9.0	0.6	11.56	7.29	65.5	1.6	370	
28	Borunda P.H.	45/F-3D-17	7.5	2256	1334	4.4	4.2	13.00	0.22	-	8.0	1.6	12.13	6.19	60.6	-0.6	430	
29	Borunda	45/F-3D-20	7.5	2412	1380	2.2	3.2	18.40	0.10	-	11.8	1.6	10.43	11.36	77.4	6.4	270	
30	Palka	45/F-3D-21	8.2	2670	1782	2.4	1.8	24.32	0.40	-	8.8	2.4	16.92	16.80	85.3	4.6	210	
31	Haryadhana	45/F-3D-30	7.7	2412	1454	4.0	4.0	16.73	0.21	-	7.8	3.6	13.54	8.87	68.0	-0.2	400	
32	Kalu to Banks	45/F-3D-35	7.5	770	420	1.2	2.0	4.40	0.10	-	5.6	1.0	1.13	3.39	59.4	2.4	160	
33	Mundal ki Dhani	45/F-3D-36	7.6	1500	864	2.0	3.0	10.40	0.25	-	10.2	1.0	4.79	6.50	66.4	5.2	250	

1	2	3	4	5	6	7				8				9	10	11	12	
						1	2	3	4	1	2	3	4				1	2
34.	Ransigaon	45/F-3D-41	7.9	2412	1380	3.8	3.2	16.37	Tr.	-	8.8	2.4	12.41	8.76	70.1	1.8	350	0
35.	Kalu H.S. School	45/F-3D-46	7.6	550	286	2.2	1.6	1.30	0.20	-	4.2	Tr.	1.13	0.93	24.5	0.4	190	0
36.	Kalu	45/F-3D-51	8.8	1050	612	0.6	1.0	9.11	Tr.	1.2	4.8	2.6	2.11	10.12	85.1	3.2	80	0
37.	Kanecha	45/F-3D-63	7.6	2200	1328	4.0	4.6	13.00	0.72	-	11.0	1.0	10.43	6.28	58.2	2.4	430	0
38.	Kanecha	45/F-3D-65	7.8	780	456	1.4	1.8	3.40	0.45	-	3.4	0.8	2.82	1.88	48.6	0.2	160	0
39.	Balunda	45/F-3D-66	7.6	4520	2964	5.6	9.8	30.60	0.90	-	10.0	3.6	32.99	11.05	65.1	-5.4	770	27
40.	Balunda	45/F-3D-70	8.7	2680	1720	0.6	1.6	26.08	0.09	3.2	12.8	1.8	10.57	23.71	92.3	10.6	110	0
41.	Bakarai	45/F-3D-71	7.3	680	370	3.6	1.0	2.19	0.32	-	5.4	Tr.	1.69	1.43	30.6	0.8	230	0
42.	Malpuria	45/F-3D-74	7.3	700	386	2.0	2.0	3.00	0.36	-	6.2	Tr.	1.13	2.13	40.7	2.2	200	0
43.	Birol	45/F-3D-77	7.6	350	182	1.8	1.0	0.90	0.06	-	3.2	Tr.	0.56	0.75	24.8	0.4	140	0
44.	Lilri river Bed	45/F-3D-78	8.7	670	390	1.0	1.2	4.37	0.14	1.6	3.8	0.6	0.71	4.16	67.2	1.6	110	0
45.	Kuk Prawas	45/F-4D-1	7.6	1247	732	0.8	0.6	11.13	0.15	nil	8.6	1.4	2.68	13.25	89.0	7.2	70	0
46.	Bherkhurd	45/F-4D-2	8.3	1914	1172	1.9	1.8	13.34	1.17	0.4	7.0	1.3	9.31	9.81	73.3	3.7	185	0
47.	Ra[illegible]wal	45/F-4D-3	8.0	670	376	2.4	1.6	2.52	0.15	nil	5.2	0.2	1.27	1.78	37.6	1.2	200	0
48.	Udlias	45/F-4D-4	8.0	2909	1784	5.8	3.8	19.68	0.25	-	6.0	3.8	20.73	8.94	66.3	-3.6	480	18
49.	Kharia	45/F-4D-6	7.4	3201	1852	7.0	7.0	17.88	0.42	-	7.0	5.0	20.30	6.75	55.0	-7.0	700	35
50.	Jaitaran	45/F-4D-7	7.7	154[illegible]	852	0.2	0.4	14.59	0.20	-	8.8	1.8	4.79	29.17	94.8	8.2	30	0
51.	Kharia	*45/F-4D-8	8.0	1615	918	4.6	3.6	7.74	0.17	-	5.2	1.6	9.31	3.87	48.0	-3.0	410	15
52.	Prithipura	45/F-4D-9	8.0	2926	1730	1.8	4.4	22.30	0.12	-	8.4	2.6	17.62	12.67	78.3	2.2	310	0
53.	Garnia	45/F-4D-10	8.2	718	364	1.2	1.2	4.56	0.09	nil	4.2	2.0	0.85	4.14	66.0	1.8	120	0

1	2	3	4	5	6	7				8				9	10	11	12	
						1	2	3	4	1	2	3	4				1	2
54.	Onnas	45/F-4D-12	8.6	1710	986	1.0	0.6	14.37	0.09	1.2	8.4	0.4	6.06	15.96	90.1	6.8	80	0
55.	Rajdan	45/F-4D-14	8.4	2762	1766	1.8	3.2	23.34	0.41	1.2	10.2	2.4	14.95	1.46	81.0	5.2	250	0
56.	Jandanwas	*45/F-4D-15	8.0	1634	960	1.0	1.2	13.96	0.16	nil	9.8	3.0	3.52	13.29	86.6	7.6	110	0
57.	Agewa	45/F-4D-16	7.6	2212	1366	2.4	4.4	16.74	0.14	-	9.4	3.0	11.28	9.04	71.3	2.6	340	0
58.	Nimaj	45/F-4D-17	7.8	880	458	3.2	1.6	3.70	0.12	-	4.4	1.4	2.82	3.34	44.3	-0.4	240	20
59.	Haras	*45/F-4D-18	8.2	1204	746	1.2	1.4	10.27	0.10	-	6.8	2.8	4.37	9.01	82.7	4.2	130	0
60.	Agswa	45/F-4D-19	8.1	1615	1024	3.0	2.0	11.68	0.21	-	11.2	1.6	4.09	7.30	69.0	6.2	250	0
61.	Patwa	45/F-4D-20	8.4	2310	1396	1.2	1.6	21.04	0.15	0.8	14.2	1.8	7.19	1.75	88.3	11.4	140	0
62.	Singla	45/F-4D-21	7.8	2206	1352	2.0	2.2	19.44	0.30	-	12.0	3.2	8.74	13.41	81.3	7.8	210	0
63.	Chandla	45/F-4D-22	8.2	1007	556	0.8	0.8	8.55	0.14	-	7.6	1.0	1.69	9.50	84.4	6.0	80	0
64.	Deoli	45/F-4D-24	8.1	1945	1140	1.0	0.8	18.47	0.20	-	13.6	1.8	4.79	18.47	91.1	11.8	90	0
65.	Chitria	45/F-4D-25	7.5	2256	1364	1.4	1.6	20.59	0.22	-	8.6	2.8	12.41	16.87	87.5	5.6	150	0
66.	Moora	45/F-4D-26	7.9	2190	1210	1.0	1.0	20.43	0.15	-	12.8	1.6	8.18	20.43	91.2	10.8	100	0
67.	Piplia	45/F-4D-28	7.9	2001	1208	1.4	2.0	16.59	0.19	-	10.8	1.2	8.18	12.76	83.2	7.4	340	0
68.	Piplia	45/F-4D-29	7.9	1658	938	4.6	4.0	7.38	0.13	-	5.4	1.4	7.31	2.59	46.6	-3.2	430	16
69.	Piplia	45/F-4D-30	7.9	670	384	4.2	1.2	1.10	0.31	-	5.4	Tr.	1.41	0.66	16.1	nil	270	0
70.	Chandwala	45/F-4D-31	7.9	860	480	1.8	3.0	3.54	0.21	-	5.2	1.8	1.55	2.28	41.4	0.4	240	0
71.	Dangawas	45/F-2A-2	7.8	1232	670	2.8	3.4	5.81	0.41	-	9.6	Tr.	2.82	3.30	46.7	3.4	310	0
72.	Jaśsas	45/FJ-2A-3	7.7	880	444	3.2	2.8	2.52	0.13	-	7.8	Tr.	0.85	1.44	30.6	1.8	300	0
73.	Shejampura	45/F-2A-4	8.2	912	452	1.2	2.6	4.91	0.06	0.4	6.4	Tr.	1.97	3.50	56.7	3.0	190	0
74.	Chaondia	45/J-2A-5	7.5	1250	628	1.8	2.6	7.00	0.20	-	10.8	Tr.	1.41	4.66	60.3	6.4	220	0
75.	Chacndia	45/J-2A-6	7.6	495	272	1.2	1.8	2.15	0.13	-	5.0	Tr.	1.28	1.23	40.7	2.0	150	

1	2	3	4	5	6	7				8				9	10	11	12	
						1	2	3	4	1	2	3	4				1	2
76.	Rataisni	45/J-2A-7	7.9	1880	1012	3.0	7.8	6.18	0.57	–	7.6	2.2	7.75	2.65	35.2	-3.2	540	160
77.	Sansara	45/J-2A-8	7.7	1083	562	2.2	2.7	5.20	0.32	–	7.2	Tr.	2.82	3.35	50.2	2.4	240	0
78.	Rden	45/J-2A-9	7.4	1000	558	1.8	3.0	5.00	0.12	–	5.8	1.8	2.54	3.31	51.8	1.0	240	0
79.	Akeli	45/J-2A-10	7.3	780	470	0.8	1.2	5.80	0.32	–	4.4	Tr.	3.38	5.80	75.3	2.4	100	0
80.	Dhanaria	45/J-2A-12	8.1	2100	1164	2.0	4.6	14.42	0.15	–	10.0	2.0	9.17	7.96	68.9	3.4	330	0
81.	Jhintia	45/J-2A-13	7.7	2446	1488	4.0	4.2	15.40	0.73	–	10.4	2.0	11.13	7.70	63.3	2.2	410	0
82.	Jhintia	45/J-2A-14	7.7	1220	704	3.6	3.6	5.10	0.30	–	8.4	Tr.	3.67	2.81	42.5	1.8	330	0
83.	Jamlias	45/J-3A-1	7.6	3336	2012	1.4	3.2	30.53	0.09	–	14.2	3.4	17.62	20.62	86.9	9.6	230	0
84.	Sandalia	45/J-3A-2	7.7	5000	3130	2.4	3.6	42.60	0.98		11.2	10.0	28.2	24.48	85.8	5.2	300	0
85.	Bhawal	45/J-3A-3	7.7	765	404	1.6	2.4	2.99	0.52	–	6.8	Tr.	0.71	2.10	39.8	2.8	200	0
86.	Badauli	45/J-3A-4	7.6	454	283	2.2	0.8	1.40	0.12	–	3.8	Tr.	0.85	1.14	30.9	0.8	150	0
87.	Roisi	45/J-3A-7	8.0	1266	728	0.8	1.2	9.50	1.80	–	9.0	0.2	4.10	9.50	71.4	7.0	100	0
88.	Bhawal	45/J-3A-8	7.8	1551	828	1.2	1.6	11.28	0.43	–	9.0	1.0	4.51	9.40	77.7	6.2	140	0
89.	Roisi	45/J-3A-9	7.7	1863	1274	3.0	3.6	10.83	1.09	–	9.6	3.0	3.92	5.98	58.5	3.0	330	0
90.	Jaswantiabad	45/J-3A-10	7.5	1112	698	2.4	2.6	6.20	0.21	–	6.0	1.0	4.51	3.90	44.3	1.0	250	0
91.	Meras	45/J-3A-11	8.0	4401	2622	5.0	5.4	32.60	0.18	–	7.4	4.2	31.58	14.18	75.9	-3.0	520	150
92.	Kurki-Roisi	45/J-3A-12	7.9	612	360	1.6	1.2	3.28	0.08	–	5.4	0.2	0.56	2.73	54.5	2.6	140	0
93.	Kekind	45/J-3A-13	7.7	1223	677	2.2	2.6	6.35	0.11	–	6.6	1.0	3.66	4.10	57.4	1.8	240	0
84.	Daoria	45/J-3A-14	8.0	2588	1426	6.6	6.0	12.68	0.39	–	5.4	1.8	18.47	5.05	49.3	-7.2	630	360
95.	Lilian	45/J-3A-15	7.4	880	516	2.4	2.2	3.53	0.49	–	5.8	Tr.	2.82	1.65	40.9	1.2	250	0
96.	Surpura	45/J-3A-16	8.2	2112	1316	0.8	2.4	17.44	0.09	0.2	12.0	1.2	7.33	13.41	84.4	9.6	160	0
97.	Kekindra	45/J-3A-17	8.2	938	528	2.4	1.3	4.58	0.64	–	5.8	0.8	2.82	3.16	48.6	1.6	210	0

98. Lurki	45/J-3A-18	7.8	510	264	3.0	1.4	0.65	Tr.	-	4.2	Tr.	0.85	0.43	12.9	-0.2	220	10
99. Bhakiawar-pura.	45/J-3A-20	8.1	2001	1174	1.0	0.8	17.76	0.15	-	14.0	1.2	4.51	18.70	90.8	12.2	90	0
100. Dhaneri	45/J-3A-21	8.0	4958	3164	5.4	11.6	27.59	4.80	-	8.4	8.0	32.99	9.51	60.8	-8.6	850	430
101. Jaitaran-Merta Road.	45/J-3A-22	8.2	2515	1482	1.2	2.8	20.78	0.09	-	9.0	4.0	11.84	14.71	83.9	5.0	200	0
102. Kaulia	45/J-3A-23	7.5	1021	562	0.8	1.4	7.87	0.22	-	8.6	Tr.	1.69	7.50	76.4	6.4	110	0
103. Lambia	45/J-3A-24	8.5	5771	3586	1.4	5.2	49.19	1.15	2.4	8.4	9.2	36.94	27.00	86.3	4.3	330	0
104. Bhumlia-Lambia	45/J-3A-25	8.1	3611	2072	1.4	3.4	30.42	0.11	-	12.8	4.2	18.33	8.25	86.4	8.0	240	0
105. Bhumalia	45/J-3A-26	7.8	765	408	2.6	1.8	2.82	0.19	-	6.0	0.6	6.71	1.90	39.8	1.6	220	0
106. Kaulia	45/J-3A-27	8.3	978	504	1.0	2.4	5.91	0.06	0.6	6.8	Tr.	1.97	4.34	64.2	4.0	170	0
107. Rawatan-Ki-Dhani	45/J.3A-28	8.0	3611	2178	2.4	4.2	28.67	0.21	-	15.2	2.8	17.48	15.75	81.4	8.6	330	0
108. Amarpura	45/J-3A-29	7.8	4024	2324	4.6	8.4	26.60	0.29	-	8.4	3.2	28.21	10.42	67.3	-4.6	650	230
109. Basi	45/J-3A-31	7.5	740	396	2.0	1.2	3.95	0.10	-	6.2	0.2	0.85	3.04	55.8	3.0	160	0
110. Partappura	45/J-3A-32	8.4	3002	1872	1.2	2.2	30.24	0.11	1.0	14.2	3.4	15.15	23.26	89.9	11.8	170	0
111. Balupura	45/J-3A-33	8.3	1204	728	1.4	1.4	9.15	0.17	0.8	6.6	1.2	3.52	7.62	75.6	4.6	140	0
112. Rabriwas	45/J-3A-34	7.7	1800	1004	1.4	2.4	13.21	0.11	nil	10.0	1.2	5.92	9.43	77.7	6.2	190	0
113. Balara	45/J3A-36	7.8	5101	3040	4.2	8.6	37.16	0.36	nil	11.6	10.8	27.92	13.68	74.6	-1.2	640	60
114. Morrawas	45/J-3A-38	8.0	2224	1346	2.2	7.2	14.34	0.80	-	8.8	2.2	13.54	2.17	58.5	-0.6	470	30
115. Nimaj	45/J-4A-4	8.3	704	368	2.4	1.4	3.00	0.10	0.4	3.4	Tr.	3.10	2.14	45.0	-	190	0
116. Dholkot	45/J.4A.5	8.0	1624	880	3.6	3.8	6.81	0.20	-	5.8	2.0	7.61	4.06	50.7	-1.6	370	80
117. Baranthikala	45/J-4A-6	7.6	828	440	2.2	1.8	3.84	0.22	-	4.6	1.2	2.26	2.72	48.0	0.6	200	0

118.Barr	45/J-4A-7	7.5	828	450	4.2	1.4	2.35	0.27	-	5.4	Tr.	2.82	1.38	28.4	-0.2	280	10
119.Near M.S.50/4 Pali Ajmer Rd.	45/J-4A-8	8.1	1452	702	1.4	2.8	10.08	0.08	-	5.4	0.8	2.96	6.95	70.8	6.4	210	0
120.Raipur	45/J-4A-9	7.2	671	358	2.4	1.2	2.96	0.20	-	3.8	1.4	1.55	2.20	43.7	0.2	180	0
121.Sandia	45/G-1D-1	7.9	1565	962	1.2	20	12.74	0.32	-	714	2.8	6.06	10.03	78.2	4.2	160	0
122.Basan	*45/G-1D-2	8.0	2687	1590	3.2	3.2	21.08	0.17	-	9.6	3.6	14.38	11.67	76.8	3.2	320	0
GEOLOGICAL HORIZON:					B. PEBBLE BED												
123.Birawas	45/F-3C-8	7.8	2794	1726	3.8	4.6	19.56	0.18	Nil	9.2	3.8	15.99	9.54	70.1	0.8	420	0
124.Basni	45/F-2D-4	7.7	2709	1480	3.6	3.0	19.99	0.12	-	10.0	1.2	15.51	11.0	74.9	3.4	330	0
125.Sokhasni	45/F-2D-6	7.5	2000	1248	4.4	3.8	12.00	0.16	-	8.2	2.0	10.43	6.00	59.9	nil	410	0
126.Chauhando ki Dhani	45/F-2D-16	7.7	8285	5068	9.6	11.2	55.86	1.35	-	8.4	5.6	64.01	17.35	71.6	-12.4	1040	620
127.Bithan	45/F-3D-2	8.1	4542	2704	4.2	6.4	33.93	0.32	-	6.4	5.6	32.85	14.75	76.3	-4.2	530	210
Kurdaya	45/F-3D-16	7.4	5004	2944	5.4	7.4	39.60	0.45	-	11.8	7.2	33.28	15.65	75.6	-1.0	6.40	50
129.Bharran ki-Dhani.	45/F-3D-19	8.1	7405	4472	7.4	9.2	55.30	0.18	-	6.4	9.0	56.68	19.07	76.6	-10.2	830	510
130.Bankas	*45/F-3D-27	7.5	6116	3564	1.4	4.4	53.00	0.37	-	15.4	5.2	38.63	22.00	90.2	9.6	290	0
131.Phalka	45/F-3D-34	7.5	2500	1546	3.0	6.0	16.00	0.20	-	9.6	5.0	10.72	7.50	64.7	0.6	450	0
132.Kharodi to Kalu	45/F-3D-50	7.5	3002	1948	1.8	2.0	28.20	0.10	-	12.4	2.2	17.48	18.80	86.5	8.0	220	0
133.Rajputan ki Dhani	45/F-3D-53	7.8	2700	1452	2.8	4.2	20.20	0.20	-	12.0	2.0	13.82	10.80	74.5	5.0	350	0
134.Kharodi	45/F-3D-54	7.6	2762	1612	4.6	6.2	15.92	1.20	-	9.8	3.8	13.82	6.86	58.1	-1.0	540	50
135.Kharodi	*45/F-3D-56	8.8	3321	1960	2.8	2.0	26.43	1.07	3.2	14.8	0.2	14.10	17.05	81.8	10.0	240	0
136.Litaria	*45/F-3D-62	7.6	670	340	2.0	1.0	3.00	0.20	nil	4.2	0.20	1.97	2.46	48.4	1.2	150	0
137.Nimbol	45/F-3D-68	8.6	3005	1904	2.0	4.6	22.83	1.07	1.2	7.2	8.0	14.80	12.80	74.9	1.8	330	0

C. GEOLOGICAL HORIZON: C. LIME STONE

138.Haras	45/F-4C-6	7.8	2102	1230	2.2	2.2	16.62	0.24	Nil	7.6	2.8	10.86	11.08	78.5	3.2	220	0
139.Atbara	45/F-4C-11	8.0	3172	1940	4.6	6.0	22.01	0.27	-	9.0	4.0	19.88	9.57	67.8	-1.6	530	80
140.Gujro ki Dhani	45/F-4C-12	7.8	6705	4038	5.6	10.6	48.48	0.16	-	11.8	8.2	44.84	17.01	75.1	-4.4	810	220
141.Rundia	45/F-4C-13	7.7	1118	628	4.2	3.4	3.77	0.34	-	7.2	Tr.	4.51	1.93	32.2	-0.4	380	20
142.Ganthia	45/F-2D-3	7.7	2212	1272	3.4	3.2	15.00	0.65	-	10.6	3.0	8.74	8.24	67.2	4.2	330	0
143.Pundloo	45/F-2D-11	7.3	2200	1216	3.4	4.6	13.34	0.20	-	8.4	4.4	8.74	6.17	62.8	0.4	400	0
144.Borunda	45/F-3D-1	7.3	2750	1574	3.4	3.6	20.04	0.07	nil	9.6	2.0	15.51	10.71	72.2	2.6	350	0
145.Ghorawas	45/F-3D-3	7.5	1300	986	2.4	3.8	11.20	0.14	-	8.4	1.6	8.18	6.36	64.6	2.2	310	0
146.Borunda	45/F-3D-4	7.2	1780	1046	2.2	3.8	11.20	0.11	-	8.6	0.4	8.46	6.47	65.3	2.6	300	0
147.Borunda	45/F-3d-8	7.3	2310	1366	4.6	2.8	16.09	0.15	-	9.4	2.4	11.84	8.38	68.1	2.0	370	0
148.Borunda Public well	45/F-3D-9	7.8	2515	1406	3.8	3.6	17.31	0.13	-	7.0	3.6	14.24	9.02	70.2	-0.24	370	20
149.Borunda	45/F-3D-14	7.4	3000	1712	4.4	6.8	17.60	0.25	-	8.4	4.8	16.92	7.12	59.5	-3.8	610	190
150.Borunda	45/F-3D-15	7.5	2260	1336	4.0	4.2	15.20	0.20	-	8.2	3.2	12.41	7.60	65.3	nil	410	0
151.Borunda	45/F-3D-18	7.5	2370	1370	3.6	4.6	15.20	0.20	-	7.8	2.2	13.82	7.60	62.2	-0.4	410	20
152.Borunda	45/F-3D-22	7.6	2224	1324	4.2	3.4	14.00	0.26	Nil	8.2	1.4	12.13	7.29	65.9	0.8	370	0
153.Patelnagar	45/F-3D-24	8.1	4450	2620	4.0	6.6	31.02	0.09	-	7.6	5.2	28.91	13.48	74.6	-3.0	530	150
154.Hariya Dhana	45/F-3D-37	8.2	6500	3810	5.8	9.0	49.42	0.12	1.2	5.6	9.6	47.94	18.17	77.0	-8.0	740	400
155.Veron ki dhani	45/F-3D-39	8.0	2450	1476	2.4	4.8	17.53	0.06	nil	8.6	2.8	13.39	9.23	70.9	1.4	360	0
156.Pansigaon	45/F-3D-42	8.1	2412	1344	3.6	4.0	16.20	0.11	-	7.6	3.2	13.11	8.31	68.3	nil	380	0
157.Haryadhana	45/F-3D-44	7.8	6300	3860	7.4	9.4	45.40	0.32	-	7.6	7.2	47.94	15.65	73.2	-9.2	840	460

158. Ransigaon	45/F-3D-45	7.8	2515	1366	3.8	4.0	16.53	0.10	-	8.2	3.4	12.83	8.39	68.0	0.5	390	0
159. Veron-ki-Dhani	45/E-3D-47	8.0	2533	1408	2.8	4.4	17.64	0.10	-	8.0	3.4	13.54	9.28	70.9	0.8	360	0
160. Ransigoan	45/F-3D-48	7.9	2515	1446	3.6	4.0	17.23	0.11	-	8.4	3.0	13.54	8.79	69.6	0.8	380	0
161. Ransigaon Public well	45/F-3D-49	7.9	2472	1416	3.8	3.4	17.73	0.12	-	9.2	2.6	13.25	9.33	70.9	2.0	360	0
162. Ransigaon	45/F-3D-52	8.2	2687	1528	0.8	1.4	24.99	Tr.	-	14.8	2.8	9.49	23.80	91.90	12.6	110	0
163. Murkasni	45/F-3D-60	7.5	3040	1730	8.6	5.0	16.16	0.15	-	8.0	4.0	17.91	6.17	54.6	-5.6	680	280
164. Murkasni	45/F-3D-61	7.6	8008	4890	2.6	9.2	65.00	0.56	-	10.6	10.0	60.07	27.16	85.0	-1.2	590	60
165. Jhak	45/F-3D-72	7.5	2500	1376	6.6	6.2	11.20	0.34	-	5.4	3.2	15.57	4.43	46.0	-7.4	640	370
166. Rao ki Dhani	45/F-3D-76	7.3	3129	1844	6.8	6.4	17.11	0.35	-	6.4	4.8	19.46	6.66	55.7	-6.8	660	340
167. Tulsibera	*45/F-4D-13	8.1	1634	970	3.2	4.4	9.88	0.99	-	6.4	2.0	9.17	5.07	56.8	-1.2	380	60
168. Mandla	*45/F-4D-1	8.0	2012	1224	3.8	3.8	12.55	0.31	-	4.6	1.2	14.66	6.44	63.0	-3.0	380	150
169. Sardarpura	45/E-1C-2	7.8	1007	594	0.4	0.2	9.27	0.07	-	7.4	Tr.	2.54	18.35	94.0	6.8	30	0

*Well not used in the preparation of Iso-cone map due to abnormal behavior of water quality.

Table 4

PUMPAGE DATA OF BORUNDA AREA (OCT., 1967 to OCT., 1970)

MILLION GALLONS (U.S)

1967

S.No.	Location	Well No.	Oct.	Nov.	Dec.
1.	Ransigaon	45F/3 D	–	–	–
2.	"	45F/3D-49	0.49	3.34	5.20
3.	"	–	0.15	4.53	5.54
4.	"	45F/3D-48	Nil	Nil	1.24
5.	"	45F/3D-47	1.30	1.47	1.50
6.	"	45F/3D-45	1.26	3.76	2.57
7.	"	45F/3D-42	Nil	Nil	Nil
8.	Ransigaon Mushid well	–	0.06	1.58	0.68
9.	Ransigaon Hajji Anwar	–	–	–	–
10.	Ransigaon Narpat Singh		0.26	1.96	1.95
11.	Ransigaon-Parasmal	-	0.61	1.27	0.80
12.	Ransigaon Madna Ram	45F/3D-41	1.23	5.50	3.68
13.	Ransigaon Maj.Moti Singh	45F/3 C-9	0.88	0.89	0.44
14.	P.H.D.Ransigaon		–	–	–
15.	Borunda	–	0.18	0.19	0.21
16.	"	45F/3D-14	3.56	3.15	2.26
17.	"	45F/3D-10	4.45	5.62	5.89
18.	"	45F/3D-82	1.19	0.71	0.88
19.	"	–	18.90	30.78	48.27
20.	"	–	1.17	1.96	Nil
21	"	–	–	–	–
22.	"	45F/3D-17	–	–	4.65
23.	"	-do- 18	–	–	–
24.	"	-do- 22	11.09	12.06	13.60
25.	"	45F/3D-8	75.23	33.08	75.10
26.	"	-do- 9	34.12	32.81	49.20
27.	"	-do- 1	10.41	25.54	55.50

S.No.	Location	Well No.	Oct.	Nov.	Dec.
28.	Borunda	45F/3D	-	-	-
29.	"	45F/3D-12	1.60	1.68	1.26
30.	"	-do- 4	3.82	4.75	5.80
31.	"	-	-	-	-
32.	"	-	1.85	2.30	2.00
33.	"	-	7.56	8.96	10.12
34.	"	-	2.25	2.89	3.32
35.	"	-	8.50	10.62	12.00
36.	Borunda Daulat Ram	-	12.82	13.81	22.02
37.	Borunda Prema Mochi	-	-	-	-
38.	Borunda Mukna Ram Jat	- 13	1.85	2.00	2.10
39.	Borunda Happoojee	- 7	2.89	2.85	3.00
40.	Boruna Okar Bhawaria		1.52	2.56	2.60
41.	Borunda Ugra Bhodyar	-	4.02	5.82	5.50
42.	"	45F/3D-15	8.51	7.93	18.12
43.	Patel Nagar	45F/3D-24	12.82	14.75	15.30
44.	Haria Dhana	45F/3D-30	-	-	-
45.	Khoji ki Dhani	45F/3D-44	-	-	-
46.	Bogasni Prema Ram		-	-	-
47.	Bogasni Bhawar Singh		-	-	-
48.	Karoana Dhanna Ram		-	-	-
49.	Karoana Lakohman		-	-	-
50.	Karoana Hukam Singh		-	-	-
51.	Karoana Prema Ram		-	-	-
52.	Karoana Bhagwan Singh		-	-	-
53.	Karoana Jai karan		-	-	-
			236.55	253.90	379.70

PUMPAGE DATA OF BORUNDA AREA (OCT., 1967-OCT., 1970)

1968

MILLION GALLONS (U.S.)

S.No. Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1. Ransigaon	45F/3D	-	-	-	-	-	-	-	-	-	1.39	1.25	0.78
2. "	45F/3D-45	0 0.82	0.60	0.97	0.75	1.28	2.18	0.34	0.30	0.19	2.49	4.47	3.36
3. "	-	5.83	6.00	4.89	1.06	1.03	1.81	0.23	2.39	5.87	3.52	6.08	4.95
4. "	45F/3D-48	3.12	1.99	1.86	0.47	-	0.01	0.01	1.61	1.44	2.11	1.99	3.85
5. "	45F/3D-47	3.44	3.71	1.31	0.22	0.50	0.88	0.31	1.63	4.72	3.74	6.39	4.62
6. "	45F/3D-45	3.46	4.24	1.45	0.04	0.04	0.23	0.04	0.70	1.49	2.36	3.52	2.73
7. "	45F/3D-42	-	-	-	-	-	-	-	-	1.28	1.32	2.06	2.10
8. Ransigaon Mushid well		0.71	0.89	0.52	0.06	0.05	0.98	0.03	0.03	0.20	0.60	0.50	0.66
9. Ransigaon Hajji Anwar		-	-	-	-	-	-	-	-	-	-	-	-
10. Ransigaon Narpat Singh		2.03	1.66	1.37	nil	nil	nil	0.12	nil	nil	1.35	2.28	1.38
11. Ransigaon-Parasmal		nil	1.91	0.53	0.01	0.75	1.07	nil	nil	0.29	0.45	0.58	0.42
12. Ransigaon Madna Ram		5.03	2.88	0.69	-	0.04	0.29	0.09	0.82	2.35	1.83	4.30	3.23
13. Ransigaon Maj. Moti Singh	45F/30-9	0.59	0.38	nil	0.09	0.43	nil	1.58	0.93	1.31	0.98	1.56	0.76
14. P.H.D. Ransigaon		-	-	-	-	-	-	-	-	-	-	-	-
15. Borunda	-	1.10	0.81	0.34	0.37	0.41	0.63	0.16	0.62	0.78	0.89	1.12	0.72
16. "	45F/3D-14	28.70	22.87	21.45	0.46	1.21	1.85	21.58	43.06	41.04	37.69	22.81	16.95
17. "	45F/3D-10	5.85	5.85	5.85	0.18	0.18	0.18	1.35	1.35	3.06	1.35	5.85	5.85

S.No. Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
18. Borunda	45F/3D-82	1.09	0.81	0.34	0.37	0.41	0.63	0.16	0.62	0.78	0.89	1.12	0.72
19. "	-	38.78	35.37	41.91	2.56	0.64	11.28	0.05	25.39	34.45	31.97	59.80	44.46
20. "	-	4.26	1.68	1.74	0.15	0.27	0.20	0.15	1.16	0.94	1.08	1.44	0.59
21. "	-	-	0.20	0.26	0.01	0,25	0.27	0.08	1.13	1.52	0.53	0.64	0.52
22. "	45F/3D-17	5.52	9.64	4.47	2.89	3.91	4.86	3.03	6.62	7.19	3.61	6.92	3.32
23. "	" -18	-	-	-	-	-	-	-	-	-	-	-	-
24. "	" -22	17.62	14.13	13.13	0.18	1.18	0.87	4.12	14.81	9.98	12.71	14.96	84.16
25. "	45 F/3D-8	33.56	37.12	34.09	9.62	12.33	13.61	9.86	26.30	27.90	35.05	46.36	18.62
26. "	" -9	44.46	49.59	43.28	6.09	6.15	2.43	12.88	26.84	21.33	53.04	64.09	45.67
27. "	" -1	58.25	57.84	43.09	1.77	-	-	15.91	28.52	46.50	60.84	76.91	49.13
28. "	45F/3D-	-	-	-	-	-	-	-	-	-	-	-	-
29. "	45F/3D-12	1.97	1.67	1.29	0.23	0.29	0.57	0.41	1.38	1.07	0.65	1.43	1.41
30. "	" -4	5.25	3.91	2.38	2.54	0.33	2.50	1.94	2.14	1.44	2.73	4.36	5.90
31. "	- -	-	-	-	-	-	-	-	-	-	-	-	-
32. "	- -	2.10	2.25	1.36	0.15	0.87	0.89	1.72	1.98	2.01	2.00	2.10	2.35
33. "	- -	12.00	12.00	6.00	0.75	0.75	0.75	3.00	3.00	3.00	3.00	3.00	12.00
34. "	- -	3.60	3.60	3.60	0.90	0.90	22.70	0.90	0.90	0.90	0.90	3.60	3.60
35. "	- -	12.06	12.25	8.96	3.00	2.98	6.00	7.06	6.10	9.00	12.00	12.30	12.70
36. Borunda Daulat Ram	-	18.57	14.31	15.99	3.18	0.84	3.35	3.90	10.60	13.63	15.00	22.31	12.16
37. Borunda Prema Mochi	- -	-	-	-	-	-	-	-	-	-	-	-	-
38. Borunda Mukna Ram Jat	-12	1.99	2.17	1.33	0.10	0.11	0.06	1.33	1.37	1.28	1.66	2.14	2.16
39. Borunda Happoojee	-7	3.06	3.30	2.31	0.18	0.07	0.15	1.62	1.80	2.10	2.31	3.42	3.66

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
40.	Borunda Okar Bhawaria		2.55	2.58	1.55	0.12	0.10	0.09	1.55	1.60	1.67	2.70	2.94	2.55
41.	Borunda Ugra Bhodiyar		6.00	6.22	3.25	0.40	0.10	0.22	2.20	2.80	2.50	3.01	4.80	5.00
42.	"	45F/3D-13	27.65	15.58	15.39	4.41	2.53	0.94	2.99	15.20	24.40	29.24	34.57	19.32
43.	Patel Nagar	45F/3D-24	15.36	17.25	12.98	12.30	7.50	3.30	2.84	3.36	5.10	5.20	15.90	14.70
44.	Haria Dhana	45F/3D-30	-	-	0.86	1.21	1.10	0.76	0.52	-	-	1.11	5.73	4.46
45.	Khojo ki Dhan	45F/3D-44	-	-	-	-	-	-	-	-	-	-	-	-
46.	Bogasni Prma Ram		-	-	-	-	-	-	-	-	-	-	-	-
47.	Bogasni Bhawar Singh		-	-	-	-	-	-	-	-	-	-	-	-
48.	Karoana Dhanna Ram	}												
49.	" Lakchman	}												
50.	" Hukam Singh	}												
51.	" Prema Ram	}												
52.	" Bhawan Singh	}	STARTED FROM NOV' 1969.											
53.	" Jai Karan	}												
			377.36	357.26	299.37	56.82	49.49	86.44	113.06	208.99	292.93	342.80	455.33	401.72

PUMPAGE DATA OF BORUNDA AREA (OCT., -1967-OCT., 1970)

1969

MILLION GALLONS(U.S.)

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1.	Ransigaon	45F/3D	1.09	0.92	0.81	2.25	0.13	0.15	0.11	0.54	0.47	0.11	0.77	1.54
2.	"	45F/3D-49	4.77	4.53	2.23	0.58	0.52	0.88	0.71	0.45	0.46	0.07	0.97	4.68
3.	"	-	4.19	5.37	6.51	0.84	1.32	0.21	2.47	0.17	-	-	-	6.44
4.	"	45F/3D-48	0.48	-	4.33	2.99	0.79	1.03	1.55	0.36	1.06	0.57	1.63	6.31
5.	"	45F/3D-47	7.08	7.84	6.31	1.70	1.68	1.84	2.50	0.72	-	-	-	0.001
6.	"	45F/3D-45	4.46	3.84	1.26	0.08	-	-	-	-	-	-	-	0.001
7.	"	45F/3D-42	2.44	2.74	1.32	0.53	0.67	0.41	0.56	0.56	1.42	0.75	2.44	2.53
8.	Ransigaon Moshid well		0.68	0.41	0.50	0.03	0.05	0.31	0.12	0.13	0.12	0.21	0.39	0.73
9.	Ransigaon Hajji Anwar	-	-	-	-	STARTED FROM NOV'69			-	-	-	-	5.89	5.71
10.	Ransigaon Narpat singh		1.23	1.36	1.29	0.71	0.60	0.96	0.46	0.94	0.97	0.32	0.64	0.98
11.	Ransigaon-Parasmal		0.78	0.75	0.86	0.24	0.13	0.27	0.11	0.005	0.26	0.25	0.85	1.22
12.	Ransigaon Madha Ram	45F/3D-41	5.40	5.35	5.84	0.66	1.04	1.00	0.62	0.17	0.25	0.15	3.72	7.34
13.	Ransigaon Maj. Moti Singh.	45F/3C-9	1.13	1.23	1.19	0.65	0.57	0.88	0.42	0.10	0.10	0.82	0.29	0.59
14.	P.H.D.Ransigaon		-	-	-	-STARTED FROM NOV'69				-	-	-	1.02	5.89
15.	Borunda	-	1.00	0.96	0.54	0.53	0.44	0.39	0.28	0.08	0.50	0.44	0.77	0.68
16.	$ "	45F/3D-14	22.34	21.28	12.40	14.09	11.18	13.88	11.02	17.28	32.71	35.17	28.2	26.67
17.	"	45F/3D-10	5.85	5.85	2.70	0.27	0.27	1.35	1.35	1.35	1.35	1.35	5.85	5.85

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
18.	Borunda	45F/3D-82	1.00	0.96	0.54	0.53	0.44	0.39	0.28	0.08	0.50	4.42	0.77	0.68
19.	"	–	50.17	60.77	54.80	16.18	3.53	4.64	9.87	15.79	25.21	40.14	48.42	78.70
20.	"	–	–	4.10	2.19	0.30	0.37	0.47	0.86	1.98	4.16	2.53	4.29	3.26
21.	"	–	0.49	0.90	0.89	0.28	0.36	0.44	0.42	1.01	1.95	1.00	1.43	0.75
22.	"	45F/3D-17	0.07	0.003	–	–	–	–	0.05	–	–	2.29	10.09	8.82
23.	"	-18	–	–	–	–	–	–STARTED FROM JAN'70 –				–	–	–
24.	"	" -22	14.59	16.00	9.58	3.77	6.65	6.25	5.82	0.85	10.82	15.59	22.60	22.34
25.	"	45F/3D-8	34.50	44.95	37.33	11.95	11.99	15.84	8.42	11.17	6.11	79.66	58.32	62.56
26.	"	" -9	73.69	72.82	65.12	12.24	17.06	16.08	1.61	24.13	31.74	44.16	55.28	83.50
27.	"	– -1	63.54	76.56	67.95	8.37	1.88	–	0.33	0.23	9.13	95.39	46.36	81.40
28.	"	45F/3D-	–	–	–STARTED FROM JULY 69 –				1.65	4.95	4.25	4.95	7.26	7.40
29.	"	45F/3D-12	2.10	1.41	1.09	0.61	0.35	0.68	0.67	1.53	2.77	1.50	2.49	2.51
30.	"	" -4	6.28	5.33	1.45	0.37	0.54	1.45	2.43	2.22	3.29	3.37	6.37	7.90
31.	"	– –	–	–	–	– STARTED FROM SEPT. 69				–	2.95	3.00	3.12	3.20
32.	"	– –	2.06	1.92	1.30	0.50	0.15	0.18	1.82	1.91	2.00	2.00	2.00	2.00
33.	"	– –	12.00	12.00	12.00	1.50	0.75	0.75	3.00	3.00	3.00	11.36	11.75	12.12
34.	"	– –	3.60	3.60	3.60	0.90	0.90	0.90	0.90	0.90	0.90	3.90	3.90	3.90
35.	"	– –	11.85	12.00	3.00	2.10	3.05	7.00	6.00	5.40	7.80	8.72	11.12	12.00
36.	Borunda Daulat Ram		18.96	12.00	3.00	3.10	3.05	7.00	6.00	5.40	7.80	8.72	11.12	12.00
37.	Borunda Prema Mochi		–	–	–	–	–	–	STARTED FROM NOV.'69			–	8.58	7.93
38.	Borunda Mukna Ram Jat	-13	2.22	2.26	1.37	0.07	0.09	0.08	1.03	1.14	1.20	1.33	1.99	2.12
39.	Borunda Happoojee	-7	3.72	3.78	2.10	–	0.07	0.10	1.50	1.71	2.46	2.34	2.92	3.06

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
40.	Borunda Okar Bhawaria		2.57	1.35	0.07	0.10	0.13	1.20	1.90	1.80	1.91	1.93	2.22	2.90
41.	Borunda Ugra Bhodiyar		5.50	5.20	2.50	0.12	0.30	0.24	2.90	2.65	2.80	3.00	5.12	5.10
42.	"	45F/3D-15	32.23	46.18	43.04	6.63	2.21	6.85	6.86	15.39	24.39	44.95	47.07	53.80
43.	Patel Nagar	45F/3D-24	18.15	19.50	17.70	9.99	6.30	1.80	1.85	3.03	5.40	10.50	19.50	18.00
44.	Haria Dhana	45F/3D-30	6.14	6.20	4.91	2.38	1.46	1.56	1.70	1.05	0.73	0.53	1.98	4.37
45.	Khojo ki Dhani	45F/3D-44	-	-	-	-	STARTED FROM OCT'69 -				-	1.15	8.64	6.05
46.	Bogasni Prema Ram	-	-	STARTED FROM JULY '69			-	29.00	11.12	10.52	33.50	25.50	31.00	32.25
47.	Bogasni Bhawar singh		-	-	- STARTED FROM SEPT '69				-	-	3.84	3.50	9.68	13.30
48.	Karoana Dhanna Ram		-	-	-	-	-	-	-	-	-	-	3.61	3.45
49.	Lakchman		-	-	-	-	-	-	-	-	-	-	3.08	2.70
50.	" Hukam singh		-	-	-	-	-	-	-	-	-	-	8.40	9.10
51	" Prema Ram		-	-	-	-	-	-	-	-	-	-	4.60	5.08
52.	" Bhawan singh		-	-	-	-	-	-	-	-	-	-	3.55	3.74
53.	" Jai Karan		-	-	-	-	-	-	-	-	-	-	3.52	4.01
			429.61	481.29	381.62	106.41	82.55	134.59	98.56	144.46	245.51	479.47	540.82	678.82

TOTAL DRAF IN 1969 3803.84

PUMPAGE DATA OF BORUNDA AREA (OCT., 1967 - OCT., 1970)

1970

MILLION GALLONS (U.S.)

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
1.	Ransigaon	45F/3D	1.14	0.97	0.75	0.47	0.126	0.41	0.14	0.81	1.18	1.92
2.	"	45F/3D-49	13.36	10.67	7.46	2.19	3.30	1.85	0.22	0.50	0.33	1.09
3.	"	-	10.94	10.20	5.95	4.68	3.74	7.18	0.89	0.16	0.06	-
4.	"	45F/3D-48	0.80	5.47	2.96	0.07	1.19	2.82	0.43	0.13	0.07	0.97
5.	"	45F/3D-47	7.09	6.27	3.42	2.43	0.74	1.65	0.37	1.20	1.37	1.27
6.	"	45F/3D-45	5.87	5.79	6.50	1.43	0.49	1.29	0.36	0.17	0.18	0.86
7.	"	45F/3D-42	5.06	4.88	3.24	2.63	0.17	3.55	0.48	0.26	0.85	-
8.	Ransigaon Mushid well	-	0.94	1.48	0.98	0.30	0.07	0.12	0.05	0.07	0.05	0.05
9.	Ransigaon Hajji Anwar	-	5.79	4.38	2.72	0.84	-	-	-	-	-	-
10.	Ransigaon Narpat singh		1.08	1.67	1.39	1.27	0.06	0.45	-	-	-	-
11.	Ransigaon-Parasmal		1.27	1.03	0.99	0.59	0.49	-	0.06	-	-	-
12.	Ransigaon Madna Ram	45F/3D-41	5.86	0.95	4.33	0.89	0.11	0.29	0.07	0.74	0.68	0.86
13.	Ransigaon Maj. Moti singh	45F/3C-9	1.00	1.07	0.81	0.45	0.42	1.13	0.12	0.14	0.03	0.27
14.	P.H.D. Ransigaon	-	5.18	5.72	5.25	6.87	3.53	3.32	4.07	-	-	-
15.	Borunda	-	0.28	0.23	0.14	0.29	0.14	0.47	0.20	0.31	0.12	0.25
16.	"	45F/3D-14	2.48	2.43	1.68	1.79	0.58	2.03	0.92	1.73	1.51	2.01
17.	"	45F/3D-10	4.79	4.06	1.90	0.92	0.30	1.42	1.38	1.20	1.25	1.28
18.	"	45F/3D-82	0.53	0.44	0.27	0.71	0.17	0.46	0.18	0.24	0.39	0.34

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
19.	Borunda	-	70.08	68.34	57.97	41.10	8.22	12.89	4.38	12.38	13.52	15.16
20.	"	-	4.33	4.35	2.68	4.21	1.43	2.81	0.60	-	-	-
21.	"	-	0.73	0.63	0.43	0.47	0.35	0.64	0.30	0.92	0.76	0.98
22.	"	45F/3D-17	6.66	7.16	5.31	2.70	0.06	0.01	-	0.78	1.09	1.73
23.	"	- -18	12.19	15.81	15.32	6.82	1.43	2.85	1.59	3.06	3.39	4.35
24.	"	" -22	22.61	21.48	19.03	14.32	0.12	0.02	-	8.43	6.81	7.85
25.	"	45F/3D-8	2.27	1.95	1.13	0.11	0.20	0.76	0.85	30.57	18.82	16.02
26.	"	" -9	9.90	11.25	3.85	1.01	0.64	3.00	3.16	18.90	16.01	15.05
27.	"	- -1	3.42	3.56	0.97	0.48	0.18	0.84	0.96	3.55	4.28	1.75
28.	"	45F/3D-	6.14	5.63	2.47	0.66	0.33	0.27	1.25	3.32	2.82	3.25
29.	"	45F/3D-12	2.51	2.82	2.51	2.17	0.41	3.04	0.19	1.36	0.87	1.78
30.	"	" -4	5.38	4.21	2.20	0.62	0.52	0.45	2.26	2.12	2.88	3.30
31.	"	- -	3.32	3.46	1.75	0.21	0.15	0.14	0.27	1.50	2.00	2.25
32.	"	- -	2.27	1.95	1.13	0.11	0.20	0.76	0.85	1.75	1.66	1.86
33.	"	- -	9.90	11.25	3.85	1.01	0.64	3.00	3.16	1.90	2.22	5.60
34.	"	- -	3.40	3.56	0.97	0.48	0.18	0.84	0.96	0.55	0.60	2.85
35.	"	- -	7.32	9.00	1.12	0.60	0.84	5.60	4.64	4.45	5.62	6.22
36.	Borunda Daulat Ram ✓		31.81	27.44	19.76	25.05	3.50	6.82	5.09	10.38	8.31	8.62
37.	Borunda Prema Mochi ✓	-	7.80	8.70	2.88	2.13	-	-	1.32	2.02	2.85	3.60
38.	Borunda Mukha Ram Jat ✓	-13	2.33	2.12	0.37	0.10	0.111	0.10	1.32	1.10	0.99	1.27
39.	Borunda Happoojee ✓	-7	3.00	3.50	1.38	0.14	0.16	1.56	1.74	0.85	1.12	2.01
40.	Borunda Okar Bhawaria ✓		3.20	2.88	1.08	0.18	0.90	0.60	1.50	1.12	1.65	1.70

S.No.	Location	Well No.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
41.	Borunda Ugra Bhodiyar		4.28	4.75	2.12	0.98	0.40	0.10	1.20	2.25	2.75	3.33
42.	"	45F/3D-15	53.01	56.24	45.80	15.79	4.07	13.55	4.01	11.39	23.95	18.32
43.	Patel Nagar	45F/3D-24	12.36	13.50	11.10	5.10	0.90	1.35	4.50	4.85	4.85	8.95
44.	Haria Dhana	45F/3D-30	2.94	4.64	3.60	5.56	3.20	0.05	-	0.04	0.04	0.10
45.	Khojo ki Dhani	45F/3D-44	7.20	7.80	3.26	1.24	0.24	0.30	1.80	1.12	1.20	1.30
46.	Bogasni Prema Ram		30.13	29.37	12.79	1.79	1.45	3.60	2.89	4.41	1.76	3.28
47.	Bogasni Bhawar Singh		12.08	8.70	4.12	0.80	0.92	3.82	3.50	3.20	3.52	4.02
48.	Karoana Dhanna Ram	}	3.07	2.69	1.45	-	-	-	-	-	-	-
49.	" Lakchma	}	3.17	2.83	1.71	-	-	-	-	-	-	-
50.	" Hukam singh	}	8.74	8.10	3.03	-	-	-	-	-	-	-
51.	" Prema Ram	}	5.12	4.99	2.65	-	-	-	-	-	-	-
52.	" Bhawan singh	}	3.78	4.99	2.65	-	-	-	-	-	-	-
53.	" Jai Karan	} -	4.20	4.11	1.97	-	-	-	-	-	-	-
			616.26	612.29	454.00	266.52	110.11	162.44	104.84	146.26	144.41	157.67

NOTE: (-) Indicate No pumping.