केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation

Government of India

Report

on

AQUIFER MAPPING AND GROUND WATER MANAGEMENT

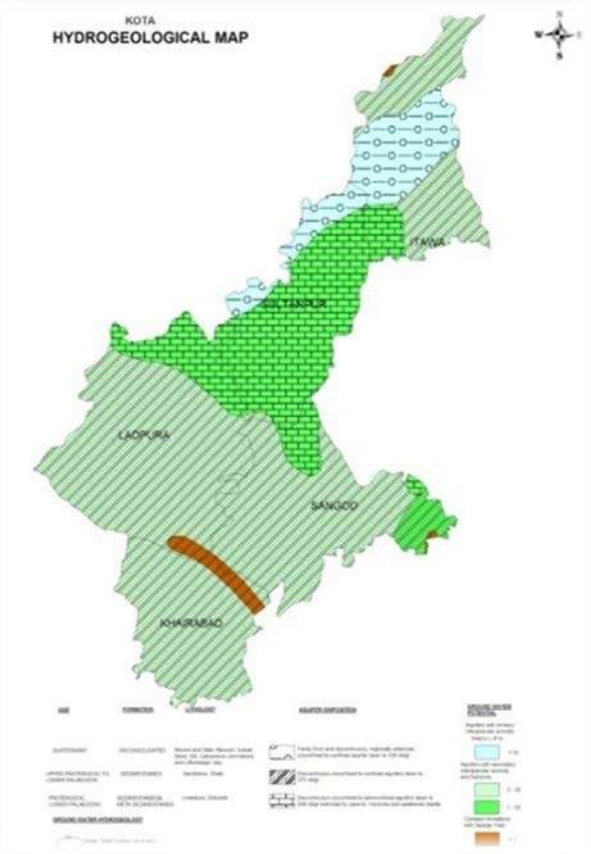
Kota District, Rajasthan

पश्चिमी क्षेत्र जयपुर

Western Region, Jaipur

CENTRAL GROUND WATER BOARD
Ministry of Water Resources, River Development & Ganga Rejuvenation
Government of India

NATIONAL AQUIFER MAPPING AND MANAGEMENT
KOTA DISTRICT, RAJASTHAN
(AAP 2017-18)



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NATIONAL AQUIFER MAPPING AND MANAGEMENT
KOTA DISTRICT, RAJASTHAN

1. INTRODUCTION

1.1 Objectives:

Various developmental activities over the years have adversely affected the groundwater regime in the state. There is a need for scientific planning in development of groundwater under different hydrogeological situation and to evolve effective management practices with involvement of community for better ground water governance. In view of sprouting challenges in the ground water sector in the state there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resource available in different hydrogeological setting through a process of systematic data collection, compilation, data generation, analysis and synthesis. Hence, aquifer mapping and management of the study area is the need of the hour.

1.2 Scope of the study:

Aquifer mapping can be understood as a scientific process wherein a combination of geological, geophysical, hydrological & chemical fields and laboratory analyses are applied to characterize quantity, quality, and sustainability of ground water in aquifers. Aquifer mapping is expected to improve our understanding of the geological framework of aquifer, their hydrologic characteristics, water level in aquifer and how they change over time space and the occurrence of natural and anthropogenic contaminants that affect the portability of groundwater. Results of these studies will contribute significantly to resource management tools such as long term aquifer monitoring network and conceptual and quantitative regional groundwater flow models to be used by planners, policy makers and other stake holders. Aquifer mapping at appropriate scale can help to prepare, implement, and monitor the efficacy of various management interventions aimed at long term sustainability of our precious groundwater recourses, which in turn will help to achieve drinking water scarcity, improved irrigation facilities and sustainability of water resource in the state.

1.3 Approach & Methodology:

Aquifer mapping is an attempt to integrate the geological, geophysical, hydrological & chemical field and laboratory analyses and are applied to characterize the quality, quantity and sustainability of groundwater in aquifer. Under the National Aquifer Programme, it is proposed to generate Aquifer Maps on 1:50000 scale, which basically aims at characterizing the aquifer geometry, behavior of groundwater levels and status of groundwater development in various aquifer system to facilitate planning of their suitable management. The major activities involved in this process encompass compilation of existing data, identification of data gaps, generation of data for feeling data gaps and preparation of different aquifer layers.

1.4 Location, administrative set up and population:

Kota district with an area of 5203.94 sq km is located between 24°32' & 25°50 N Longitude and 75°37' & 76°34' E Longitude in the southeast of the state of Rajasthan. It is bounded on the north by Bundi and Sawai Madhopur districts, on the east by Baran district, on the south by Jhalawar district and on the west by Chittorgarh district. In the northeast, the district is bounded by Madhya Pradesh. District is named after Kota town and is part of Kota Division. Administratively, the district is divided into five development blocks and five tehsil. Total numbers of villages in the district is 805 and it has 5 urban towns including 1 municipal corporation. The population of the district as per 2011 census is 1951014 persons including rural and urban population of 774410 and 1176604 respectively. The administrative set up of Kota district is presented in Figure 1.

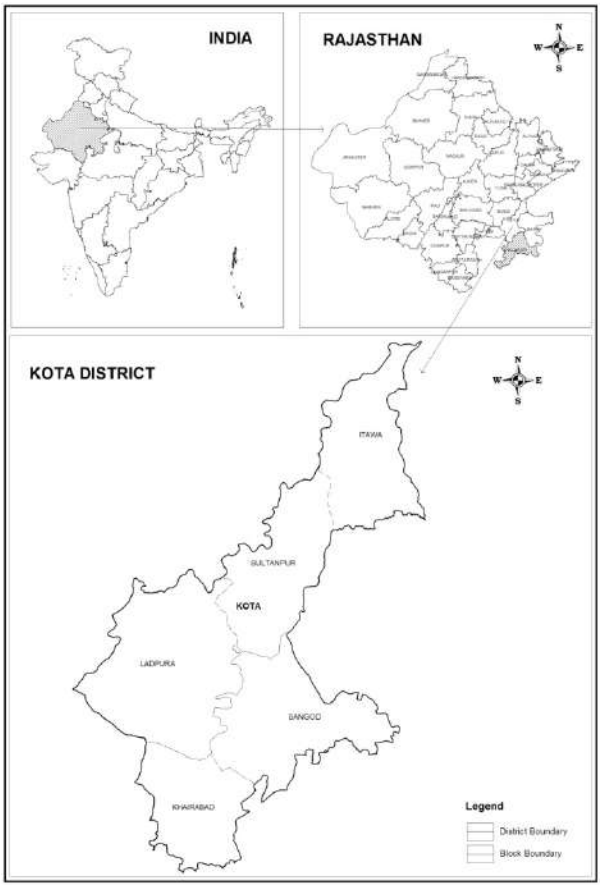


Figure 1- Administrative Map, Kota District

1.5 Data availability and Data requirement:

1.5.1 Data Availability

Various ground water related data viz. water level, exploration, aquifer parameters, quality, resources etc. generated so far by CGWB have been utilized for aquifer mapping programme in the area and similar consistent data of Ground Water Department, Govt. of Rajasthan have been amalgamated for the purpose.

CGWB has explored aquifer geometry and aquifer parameters determination and deciphering of aquifer quality through construction of 25 exploratory wells, 1 observation well, 1 slim hole and 1 piezometer in the district as on March, 2016. 110 no. of vertical electrical sounding (VES) have been carried out to decipher sub-surface geology and vertical ground water quality variations in the area. Ground water regime monitoring is being done through 19 hydrograph stations representing various hydrogeolgical settings to observe the changes in water level in time and space along with ground water quality. To minimize the data gap, consistent available ground water data of GWD, Govt. of Rajasthan have been integrated and utilized for aquifer mapping.

1.5.2 Data requirement

The available data of CGWB and validated data of State GWD have been integrated and analyzed the data gap in the area. Data gap analysis indicates that the existing ground water data are not adequate to represent the area. Ground water regime monitoring data are not adequate for better understanding of its behaviors in terms of quantity and quality therefore, there is need to increase the density of hydrograph stations in the area.

1.5.3 Data Gap Analysis

Based on the available data of CGWB and relevant ground water related data collected from State agencies like PHED, WRD, Agriculture Department and their integration on 1:50,000 scale, data gaps have been identified in the district. Therefore, to attain a clear 3D hydrogeological geometry of the aquifer system, it is proposed to generate the required information/data through construction of 7 additional exploratory bore holes & integration of key wells of State GWD for better representation of existing aquifers and understanding of behaviors of ground water regime in terms of quantity and quality.

1.5.4 Data Generation

Based on data gap analysis, 7 additional exploratory bore holes are to be drilled in the district and integration of key wells of State GWD for better representation of existing aquifers and understanding of behaviors of ground water regime in terms of quantity and quality.

1.6 Rainfall and Climate

Rainfall received in the district is fairly good. The total annual average rainfall is 663.4 mm based on the data of available blocks. Itawa block received highest rainfall (917.6 mm) whereas lowest was in Sangod block (418.4 mm). Maximum average annual rainfall recorded in Itawa block was about 773.6 mm. Climate Kota district is semi-arid climate. Summers are long, hot and dry, starting in late March and lasting till the end of June. The monsoon season follows summer with comparatively lower temperatures, but higher humidity and frequent, torrential downpours. The monsoons subside in October and temperatures rise again moderately. The brief but pleasant winter starts in late November and lasts until the last week of February. Temperature ranges between 26.7°C (max) to 12°C (min). Most of the rainfall can be attributed to the southwest monsoon which has its beginning around the last week of June and may last till mid-September. Pre-monsoon showers begin towards the middle of June with post-monsoon rains occasionally occurring in October. The winter is largely dry, although some rainfall does occur as a result of the Western Disturbance passing over the region.

Long term rainfall data for the period 1971-16 given below in Table 1.

Table1: Rainfall data (1971-16), Kota district

YEAR	Kota	Deegod	Pipalda	Sangod	Ramgang_M	Mandana	Mean	DEP(%)
71	1463.4	1548.0	1305.6	1139.6	1131.7		**1317.7**	66.9
72	386.2	406.0	489.1	562.9	658.8		**500.6**	-36.6
73	794.2	821.8	551.3	762.3	1184.0		**822.7**	4.2
74	1056.1	1167.4	999.4	907.1	1004.0		**1026.8**	30.1
75	1005.2	906.6	1028.2	1007.0	1059.0		**1001.2**	26.8
76	850.2	1084.6	718.4	827.3	1019.0		**899.9**	14.0
77	1108.6	695.8	867.1	609.7	888.0		**833.8**	5.6
78	906.2	692.0	846.0	699.1	789.0		**786.5**	-0.4
79	661.0	674.0	839.0	520.3	618.5		**662.6**	-16.1
80	413.4	399.0	737.0	423.7	865.2		**567.7**	-28.1
81	511.8	775.0	945.0	755.0	773.2		**752.0**	-4.7
82	846.4	805.0	787.0	921.3	1017.5		**875.4**	10.9
83	517.3	521.0	1058.0	769.2	750.0		**723.1**	-8.4
84	548.4	388.0	552.6	783.0	911.0		**636.6**	-19.4
85	596.0	507.0	500.0	931.2	1319.9	_	**770.8**	-2.4
86	895.2	1209.0	947.0	1108.0	1374.0	1194.0	**1121.2**	42.0

87	490.6	519.0	721.0	910.6	1000.0	649.6	**715.1**	-9.4
88	955.0	628.0	732.0	723.0	793.1	907.4	**789.8**	0.0
89	452.6	571.0	362.0	505.0	665.2	595.9	**525.3**	-33.5
90	659.2	895.0	751.0	1031.6	925.0	804.2	**844.3**	6.9
91	829.2	828.0	1020.0	801.0	814.5	606.9	**816.6**	3.4
92	698.4	768.0	766.0	509.0	796.1	716.8	**709.1**	-10.2
93	759.6	823.0	507.0	639.0	986.9	732.0	**741.3**	-6.1
94	919.0	1075.0	966.0	760.6	1068.3	912.0	**950.2**	20.3
95	829.2	814.5	844.0	696.0	708.2	608.5	**750.1**	-5.0
96	781.2	1053.4	866.0	1137.8	1616.4	1163.0	**1103.0**	39.7
97	799.2	1157.0	926.0	742.5	1056.0	749.0	**905.0**	14.6
98	519.3	678.0	712.0	628.0	583.0	450.0	**595.1**	-24.6
99	573.6	1074.0	680.0	905.8	1161.0	740.0	**855.7**	8.4
2k	791.3	948.0	459.0	909.2	928.0	580.0	**769.3**	-2.6
1	1083.2	856.0	747.0	1230.0	1016.0	892.0	**970.7**	23.0
2	463.0	382.0	239.0	438.2	438.4	357.0	**386.3**	-51.1
3	525.5	572.1	714.0	557.0	685.0	760.0	**635.6**	-19.5
4	572.0	840.0	686.0	841.0	911.0	875.0	**787.5**	-0.3
5	606.0	601.4	542.0	774.0	585.0	563.0	**611.9**	-22.5
6	679.0	1253.0	574.0	989.0	1232.0	1016.0	**957.2**	21.2
7	800.5	721.0	587.0	650.0	892.0	581.0	**705.3**	-10.7
8	712.0	1075.0	1019.0	567.0	702.0	809.0	**814.0**	3.1
9	648.0	778.0	468.0	473.0	645.0	463.0	**579.2**	-26.6
10	572.0	638.5	484.8	415.8	847.0	596.0	**592.4**	-25.0
11	969.0	1113.0	1269.0	1634.0	1234.0	1153.0	**1228.7**	55.6
12	625.0	690.0	577.0	624.0	712.0	447.0	**612.5**	-22.4
13	1138.0	1224.0	1409.0	1433.7	1245.0	1162.0	**1268.6**	60.7
14	747.0	766.0	560.0	974.0	984.0	641.0	**778.7**	-1.4
15	799.0	648.0	611.0	900.0	1121.0	658.0	**789.5**	0.0
16	993.0	902.0	828.0	671.0	1211.0	618.0	**870.5**	10.3

Mean	**751.1**	**815.0**	**756.5**	**799.9**	**933.2**	**741.9**	**801.9**	1.6
STDEV	**223.8**	**1548.0**	**245.9**	**258.4**	**241.4**	**224.4**	**201.0**	-74.5
CV (%)	**29.8**	**406.0**	**32.5**	**32.3**	**25.9**	**30.2**	**25.1**	**DEP (%)**

1.7 Soil, Land Use, Agriculture, Irrigation, Cropping Pattern

1.7.1 Soil

There are mainly three types of soils in the district are present namely:

Major Soils	**Area ('000 ha)**	**Percent (%) of total**
Deep black clayey soils	216.5	42
Deep brown clayey soils	78.4	15
Deep brown loamy soils	57.6	11

1.7.2 Land Use

The socio-cultural and economic factors have significantly influenced over land use both in rural and urban areas in the district. Data are based on district statistics outline 2016. The land use pattern of district is presented in **Table 2.**

Table2: Land Use, Kota District

Sl.No.	**Land Use**	**Area in hectare**
1	Total geographical area	518345
2	Forest	126498
3	Uncultivable land	23257
4	Land not cultivated including pasture land; barren land; trees, grooves & orchards; padat land	13942
5	Uncultivable land apart from padat land	7747
6	Padat land	12555
7	Net sown area (subtracting double)	272000
8	Gross sown area	448000
9	Area sown more than once	176000

1.7.3 Agriculture

Agriculture activity is spread over both Kharif and Rabi cultivation. Kharif cultivation is rain fed and Rabi cultivation is mostly based on ground water. During Kharif cultivation 182382 hac area is under irrigation, whereas during Rabi cultivation 257918 hac areas is under cultivation .The main Kharif crops grown in the area are Soyabean (143423hac), Black Gram (urad) (7767hac),

Maize (corn) (2873hac), Sesame (till) (5516hac), Jowar(2297hac), Rice (paddy) (18948hac) whereas Principal Rabi crop is wheat (135748hac).

KHARIF CROPS	AREA(Hac)
Rice (paddy)	18948
Jowar	2297
Millet	53
Maize (corn)	2873
Soyabean	143423
Turmeric	1262
Groundnut	166
Sugarcane	10
Green Gram (moong)	58
Sesame (till)	5516
Arhar (tur)	9
Black Gram (urad)	7767

RABI CROPS		
CEREALS(AREA IN Hac)	SEED PLANTS(AREA IN Hac)	VEGETABLES(AREA IN Hac)
Wheat(135748)	linseed (26)	potato(208)
Barley (262)	coriander (67744)	
	mustard (44212)	
	fenugreek(1202)	
	Garlic (8516)	

SOURCE: DISTRICT STATISTICS OUTLINE 2016

1.7.4 Irrigation Practices

The principal means of irrigation in the district are canals and wells/ tube wells. Ground water is abstracted through tube wells, dug wells and dug cum bore wells. Net irrigated areas in the district are 260282 ha and gross irrigated area 280607 ha. The details of the area irrigated by different sources are given in Table 3.

Table 3: Source wise irrigated area

SOURCE	NET IRRIGATED AREA (Hac)	GROSS IRRIGATED AREA (Hac)
Dug wells	40230	40799
Tubewells	87766	97752
Canals	130707	140387
Ponds	30	30
Other sources	1549	1639
Total	**260282**	**280607**

1.7.5 Cropping Pattern

Gross sown area is 448000 ha with Net sown area is 272000 ha and area sown more than once is 176000 ha. Crop wise irrigated area is given in Table 4.

Table 4: Irrigated area wise crops, Kota district

	Crops	Irrigated area in ha.
Food grain	Wheat	135743
	Rice	18944
	Maize	2
Cereals	Gram	2000
Oil seeds	Rai and Mustard	43079
Other crops	Spices (coriander, fenugreek and garlic, red chilli and other spices)	76043
	Vegetables (potato, onion and other vegetables)	1823
	Fresh fruits	0

Major crops under irrigation are wheat, rice, gram, Rai and Mustard, spices and vegetables

1.8 Physiography

1.8.1 Geomorphology and Drainage

Physiographically, the district is characterized by undulating topography with gentle plains. The land slopes from south to north and is drained by the river Chambal and its tributaries. In the south there is 145 km long Mumundra range of Vindhyan hills. The physiography is rugged and the tributaries of Chambal River drain through undulating plains which slope from SSE to NNW. The maximum height of the hills in the district is 517 m amsl at village Borabas in block Ladpura and minimum height is 207m amsl at Khatoli in block Itawa. Chambal is the

principal perennial river in the district. Its tributaries are Kalisindh, Parvan and Parvati which are all perennial in nature.

ORIGIN	LANDFORM UNIT	DESCRIPTION
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials.
	Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain,comprised of varied lithology, criss-crossed by fractures and faults.
Fluvial	Alluvial Plain	Mainly undulating landscape formed due to fluvial activity, comprising of gravels, sand, silt and clay. Terrain mainly undulating, produced by extensive deposition of alluvium.
	Ravine	Small, narrow, deep, depression, smaller than gorges, larger than gulley, usually carved by running water.
Structural	Plateau	Formed over varying lithology with extensive, flat, landscapes, bordered by escarpment on all sides. Essentially formed horizontally layered rocky marked by extensive flat top and steep slopes. It may be criss crossed by lineament.
Hills	Denudational	Steep sided, relict hills undergone denudation, comprising of varying lithology with joints, fractures and lineaments.
	Structural Hill	Linear to acute hills showing definite trend-lines with varying lithology associated with folding, faulting etc.
	Linear Ridge	Long narrow low-lying ridge usually barren, having high run off may form over varying lithology with controlled strike.

2.0 DATA INTEGRATION, INTERPRETATION, AQUIFER MAPPING AND GROUND WATER SCENARIO.

2.1 Geology

Geologically, most of the parts of Kota district are occupied by Vindhyan Super Group which forms the part of Great Vindhyan basin. The Vindhyan Super Group is divided into Khorip, Kaimur, Rewa and Bhander Groups comprising Sandstones, Shales and Limestone. The Bhander Group comprises almost 70% of the area of the district. The southern part of the district consists of Deccan trap formation within Khairabad block. Rewa and Kaimur Group of rocks occupy small patches in Khairabad, Sangod and Ladpura block.

Super Group	**Group**	**Formation**
	Recent	Alluvium (Sand, silt & clay)
Vindhyan	Bhander	Shale, Limestone, Sandstone
	Rewa	Shale, Sandstone
	Kaimur	Sandstone
	Khorip	Shale

2.2 Hydrogeology

In Kota district, ground water occurs in mainly four hydrogeological formations. These hydrogeological formations are alluvium, sandstone, shale and limestone and among these formations alluvium is the most important formation as it covers the maximum area and also it is the most potential among different hydrogeological formation. Occurrence of ground water depends upon topography, physiography and structural features of the geological formations. The movement of the ground water in hard rock areas is governed by size, openness, interconnection and continuity of structurally weak planes while in unconsolidated rocks, ground water movement takes place through pore spaces between grains. In the district, ground water occurs under water table condition both in unconsolidated and consolidated formations.Shale also occurs as intercalations with both limestone and sandstone. Limestone, sandstone and shale cover an area of 5123.17 sq.km out of which 2111.77 sq.km areas falls under command area. Most of the command area is irrigated by Chambal Canal and comparatively small area by canals of Alniya, Sawan Bhadon and Harish Chandra Sagar Dams.

GROUND WATER CONDITIONS

The principal sources of groundwater is precipitation of the total rainfall received, a major part is lost as runoff and by evapotranspiration through soil and vegetation. Only a small part of rainwater infilterates down to enrich the Groundwater body.

- **Groundwater in Sandstones:**
  Vindhyan sandstone is very widely distributed in eastern, south western and some portion in the central parts of the district. They are invariably hard, compact and quartzitic in nature. Ground water occurs under unconfined conditions in weathered residual and in joints, fractures, bedding planes and other planes of structural weakness. The movement of groundwater is controlled by nature, size and extent of these secondary openings and continuity of the fracture system. From borehole data discharge range from 40 lpm – 732 lpm and Transimisivity range from 39 - 1138 m^2/day
- **Groundwater in Limestone and Shale:**
  Shales are highly fractured, laminated and splintary whereas limestone are argillaceous to calcareous in nature. Groundwater occurs in weathered and fracture zones and in joints and voids formed by chemical action of water in limestone. From borehole data discharge range from 10 lpm –156 lpm and Transimisivity range from 3.4 - 46 m^2/day
- **Groundwater in Quaternary Alluvium :**
  Alluvium is one of the important aquifers in the area along the course of river chambal and its main tributaries.Quaternary deposits occurs as terraces.Thickness of the alluvium is high in the interstream area between river chambal and kalisindh.It increases in the general direction of the slope and is maximum at the Digod. Alluvium comprises of admixture of silt , fine to medium sand , clay and kankar ,kankar is invariably associated with alluvial material occurring at shallow depth.Groundwater in alluvium occurs in the pores, under water table and semi-confined conditions.From borehole data discharge range from 142 lpm – 563 lpm and Transimisivity range from 69 m^2/day .

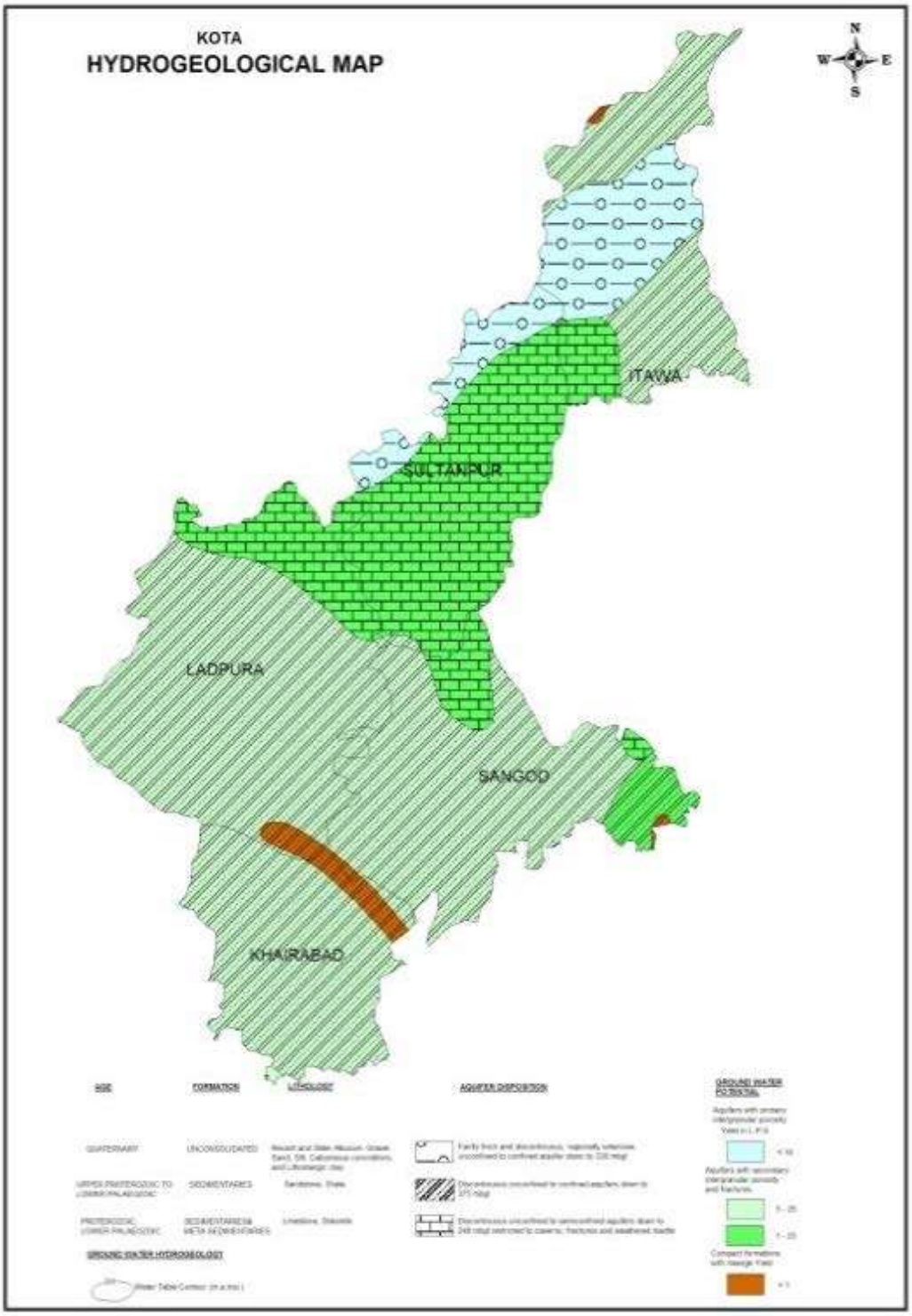


Figure 2: Hydrogeological map, Kota District

2.2.1 Aquifer systems, potentiality and parameters

Exploration data of Central Ground Water Board and Ground Water Board were analysed to prepare regional 3D lithological model. Lithological disposition is presented in figure 3.

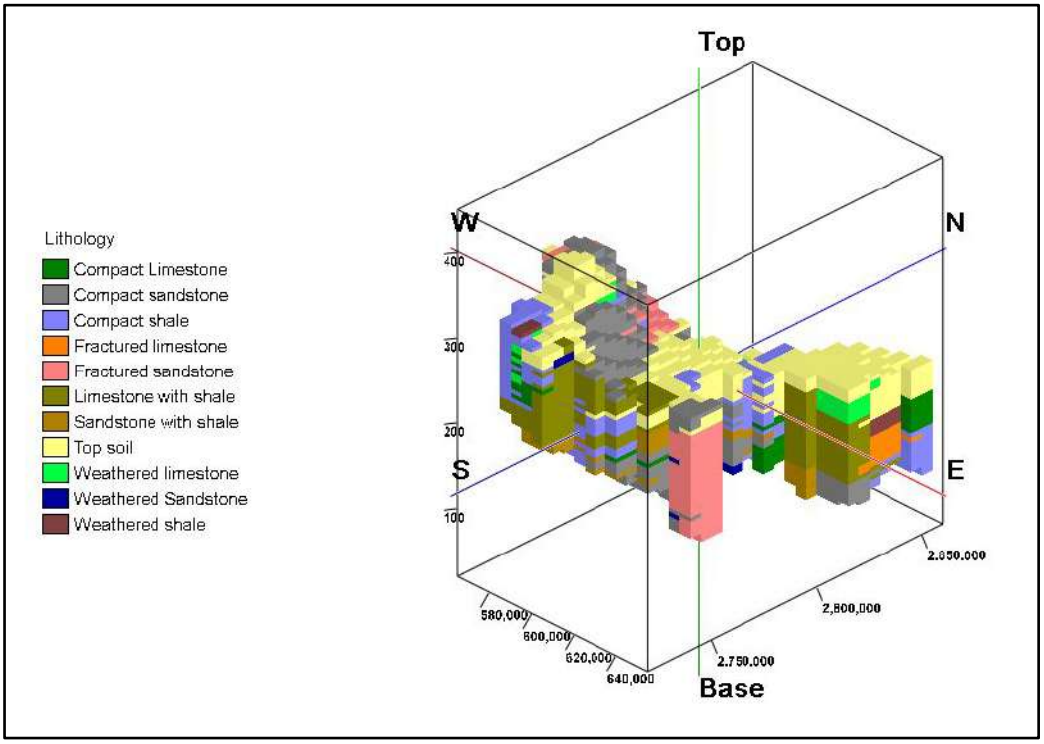


Figure 3: 3-D Lithological Model

Lithological data of exploration were further processed considering water level to prepare 3D Aquifer Disposition Model as shown in figure 4

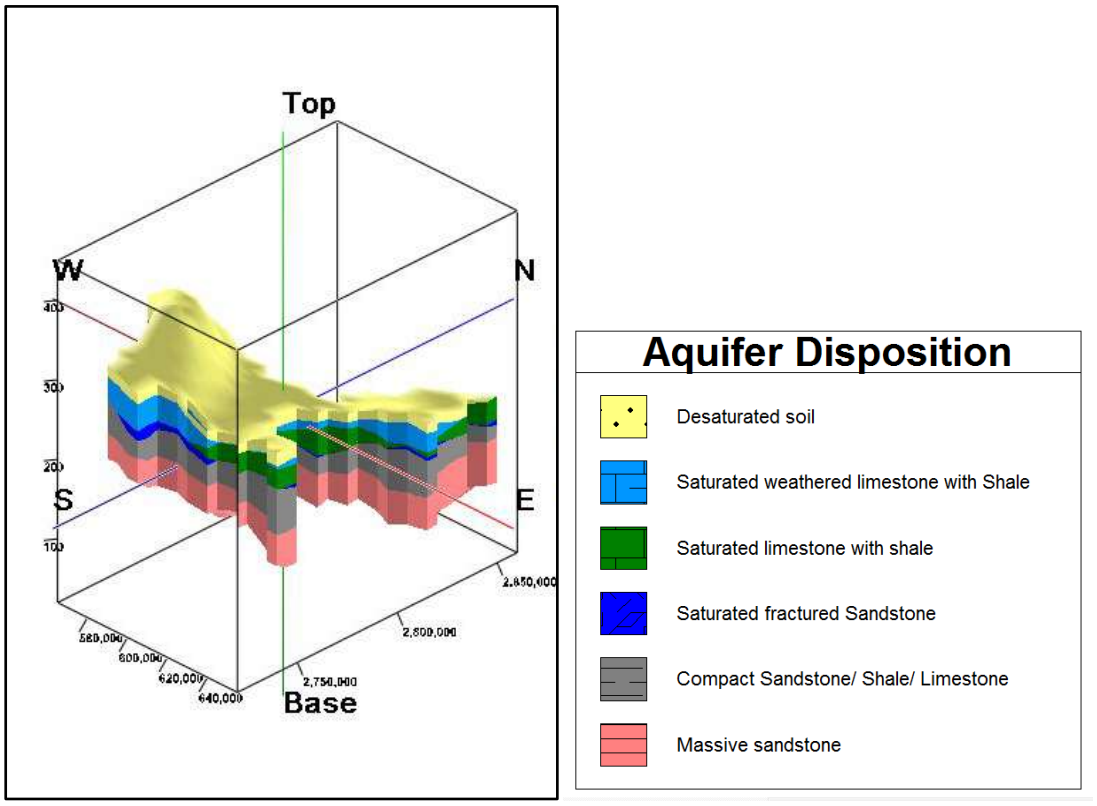


Figure 4: 3-D Aquifer Disposition

Based on 3D Aquifer Disposition Model ,3D Fence diagram depicting aquifer disposition from southwest to northeast direction and 3D Fence diagram depicting aquifer disposition in vertical direction has been prepared which is shown in figure 5 and 6

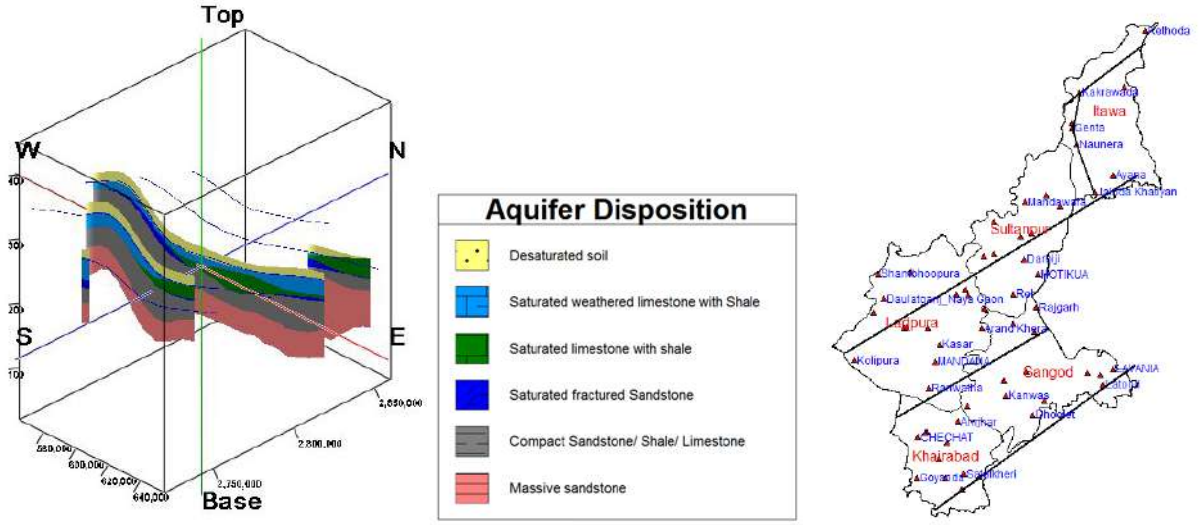


Figure 5: 3D Fence diagram depicting aquifer disposition from southwest to northeast direction

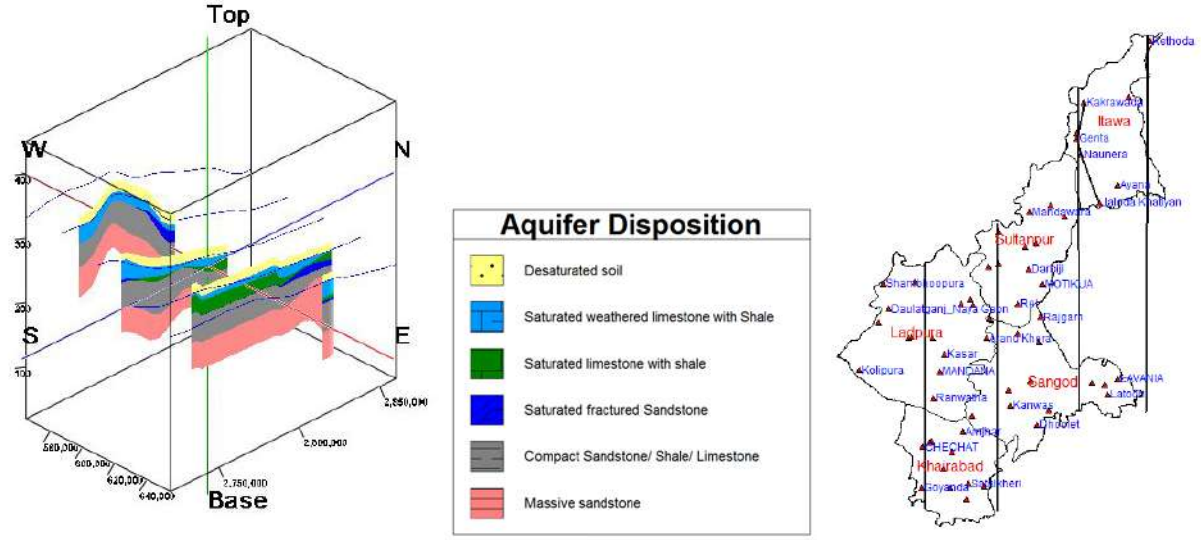
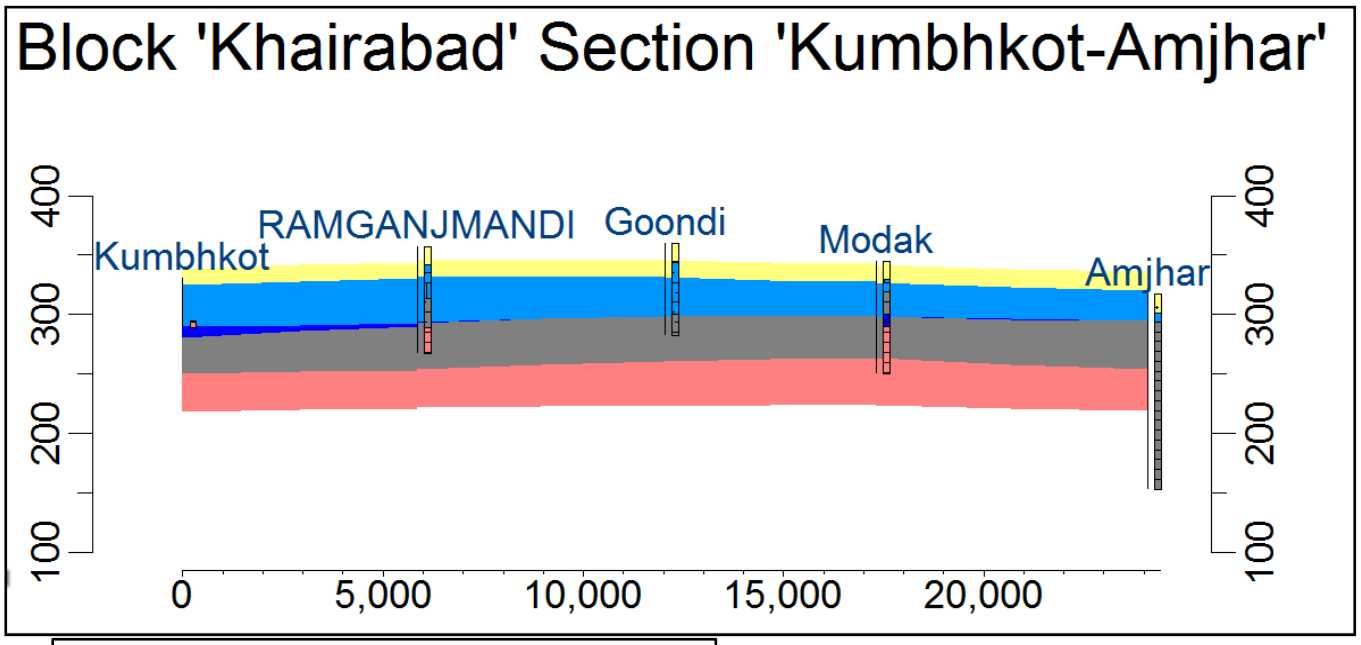
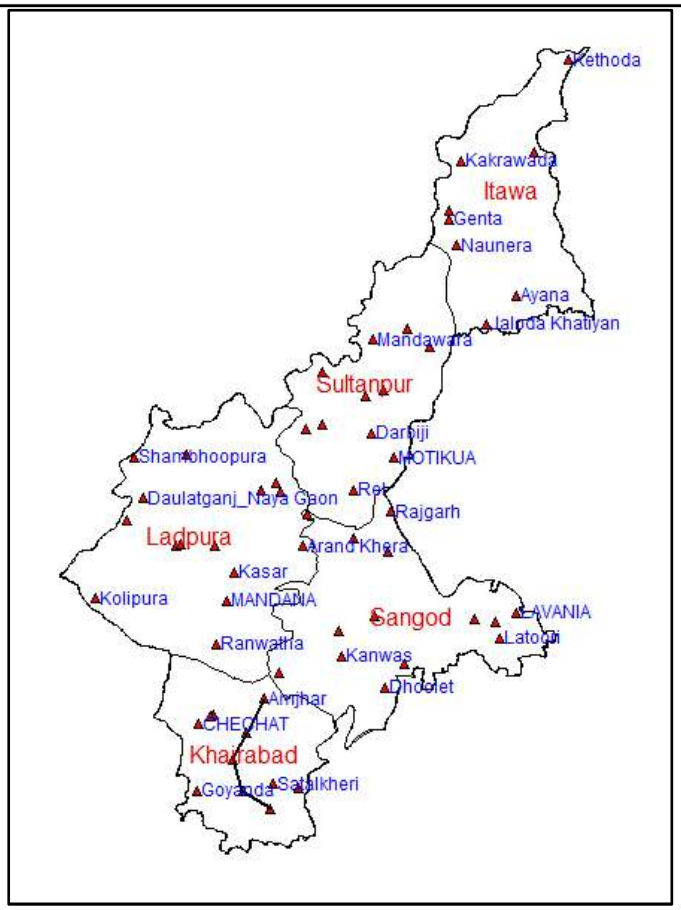
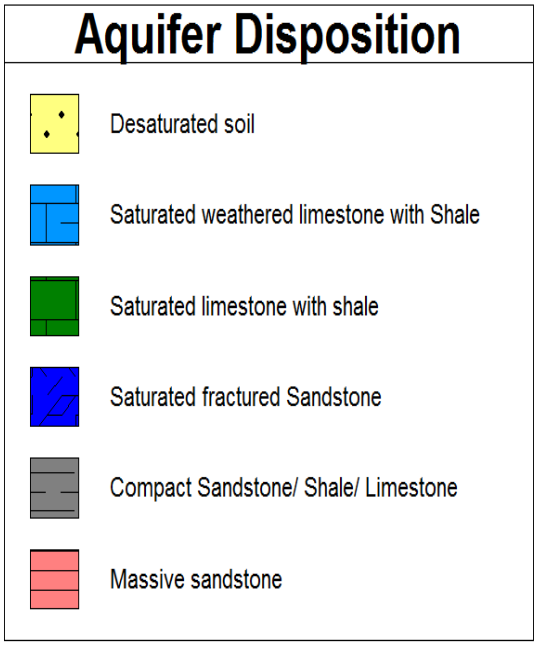


Figure 6: 3D Fence diagram depicting aquifer disposition in vertical direction

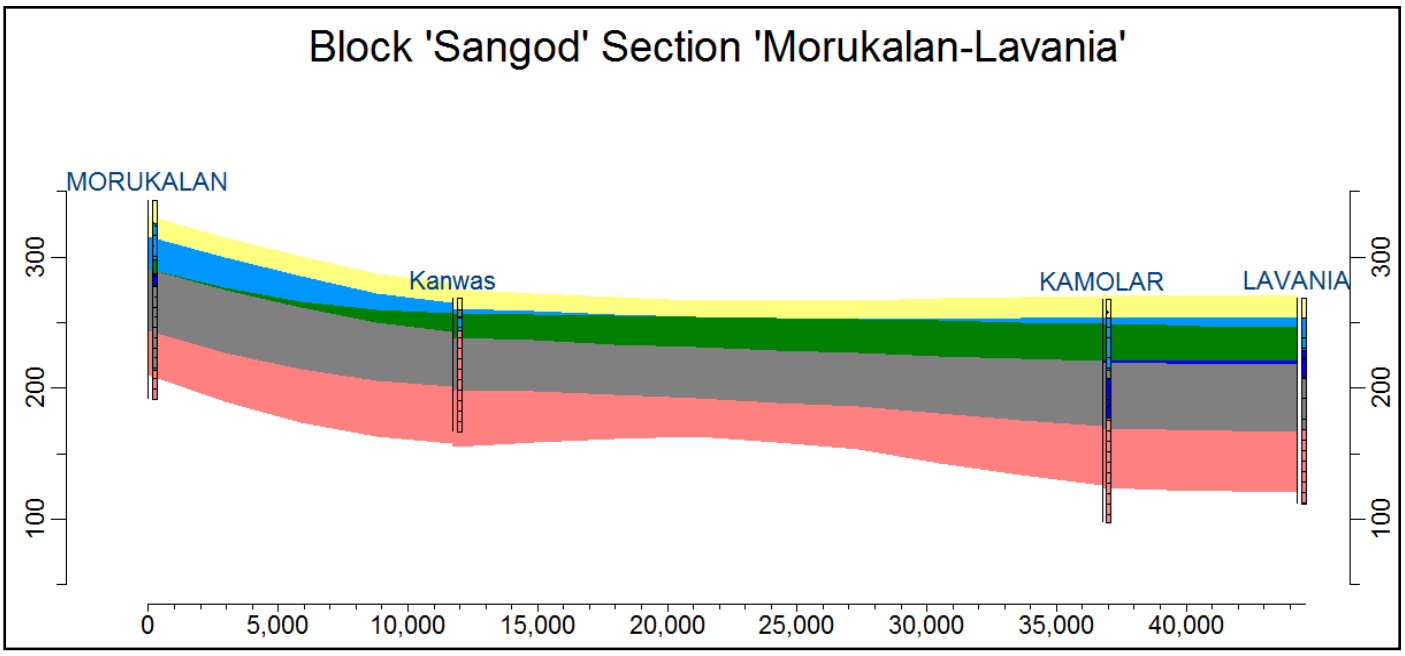
Aquifer disposition map showing section from Kumbhkot to Amihar for Khairabad block is presented in figure given below

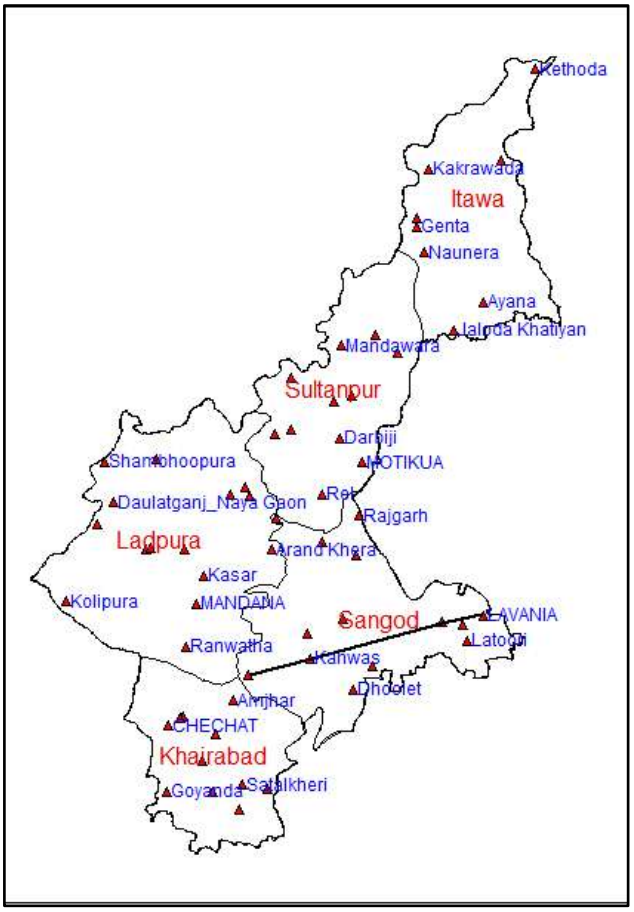


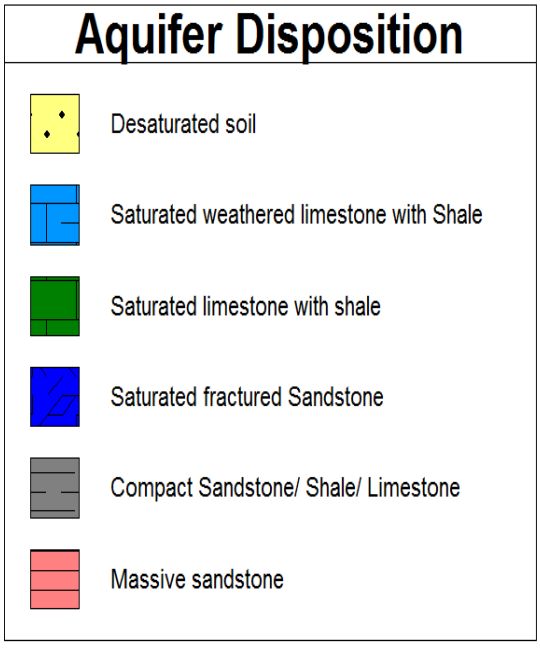




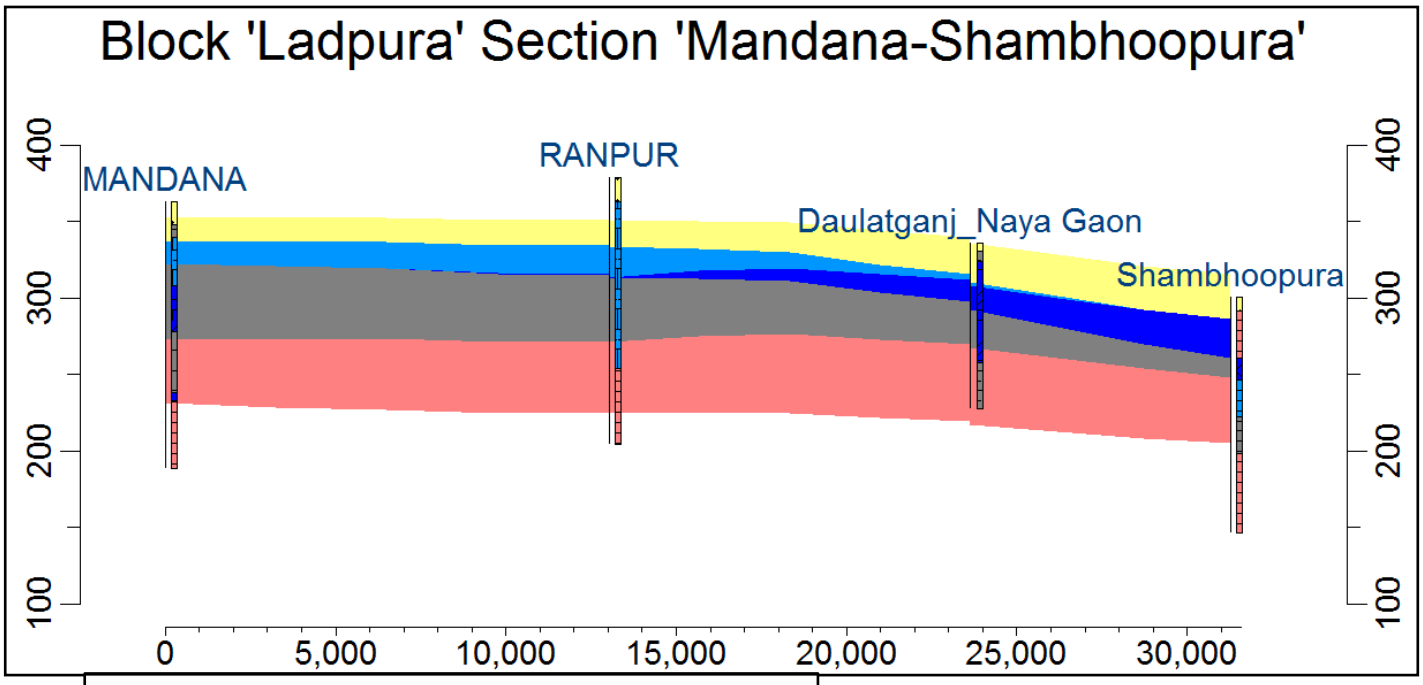
Aquifer disposition map showing section from Morukalan to Lavania for Sangod block is presented in figure given below

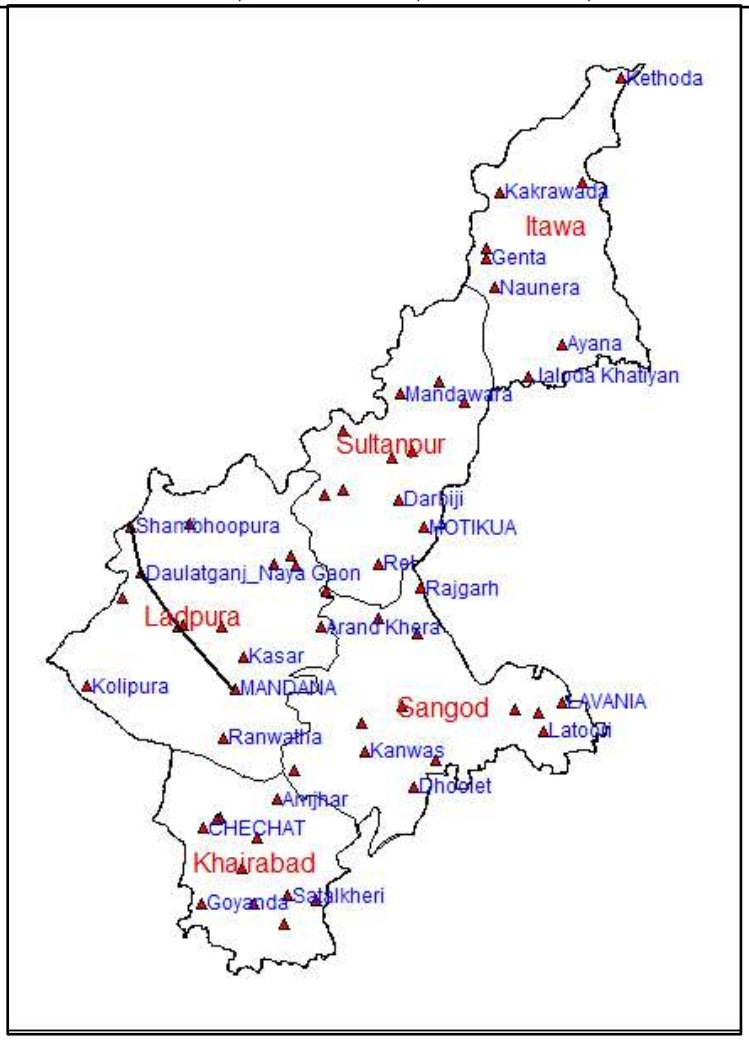


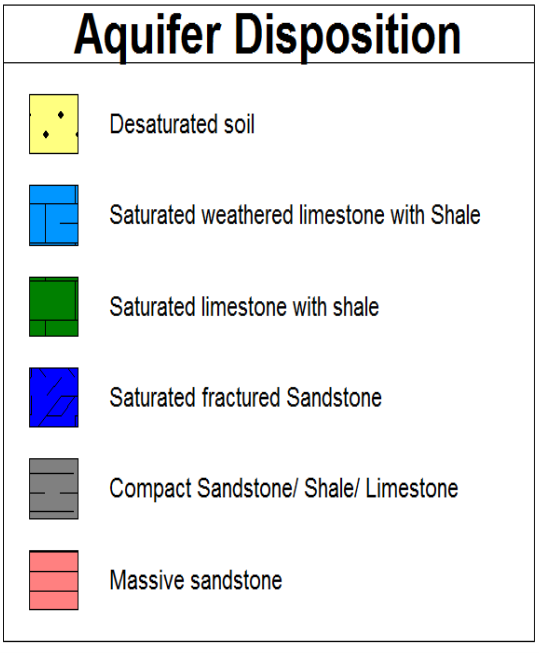




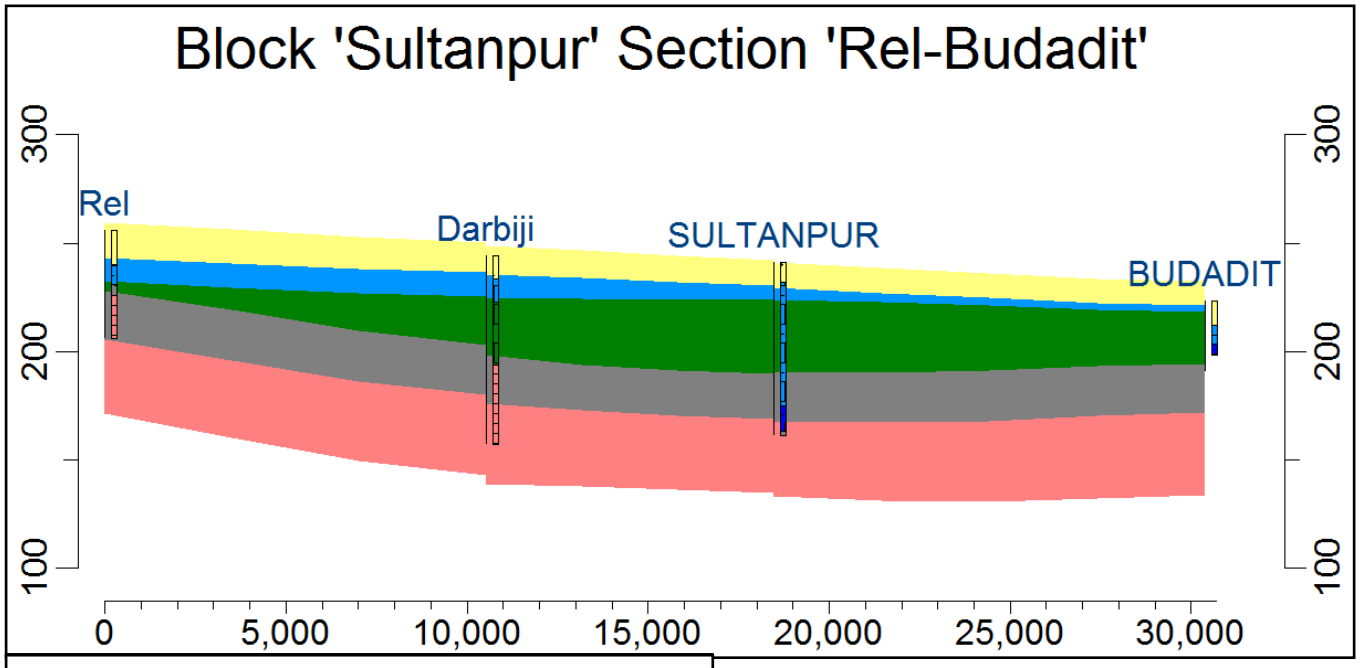
Aquifer disposition map showing section from Mandana to Shambhoopura for Ladpura block is presented in figure given below

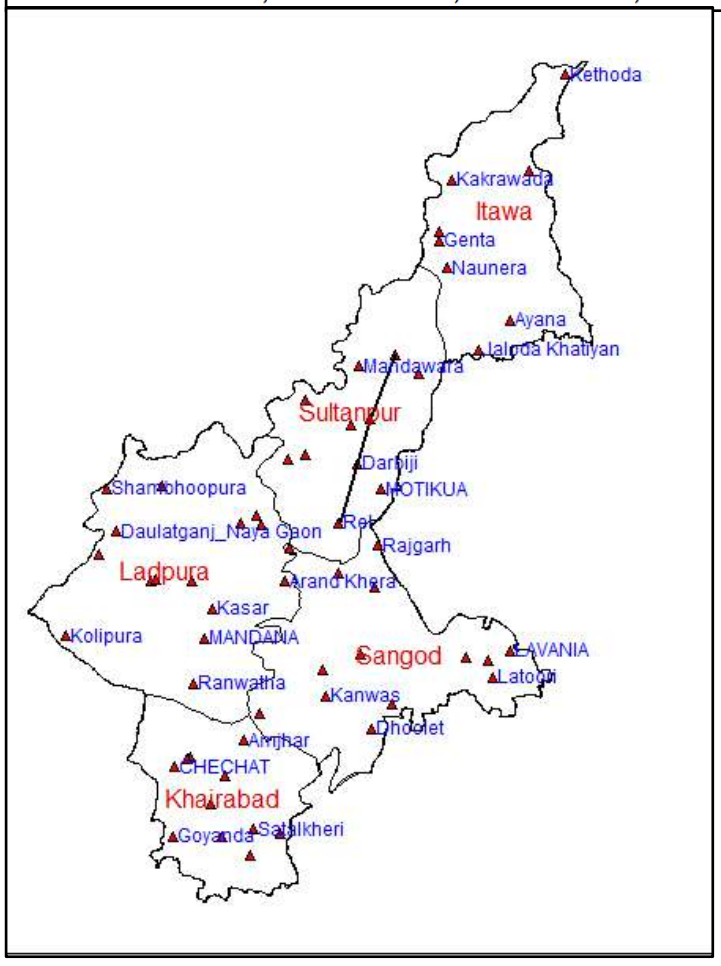


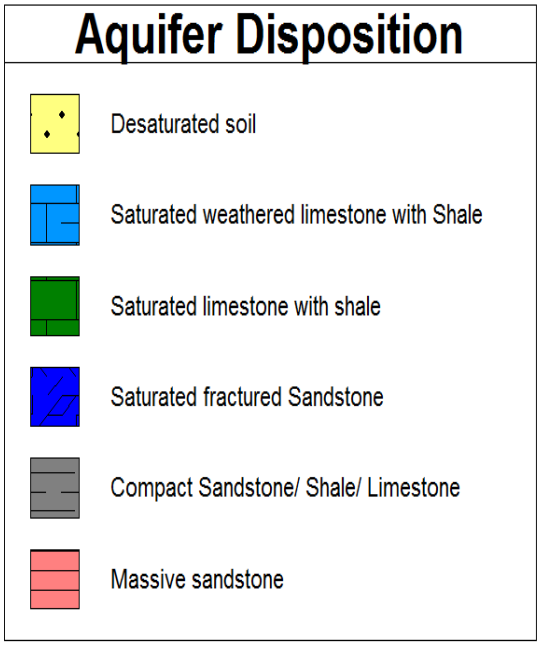




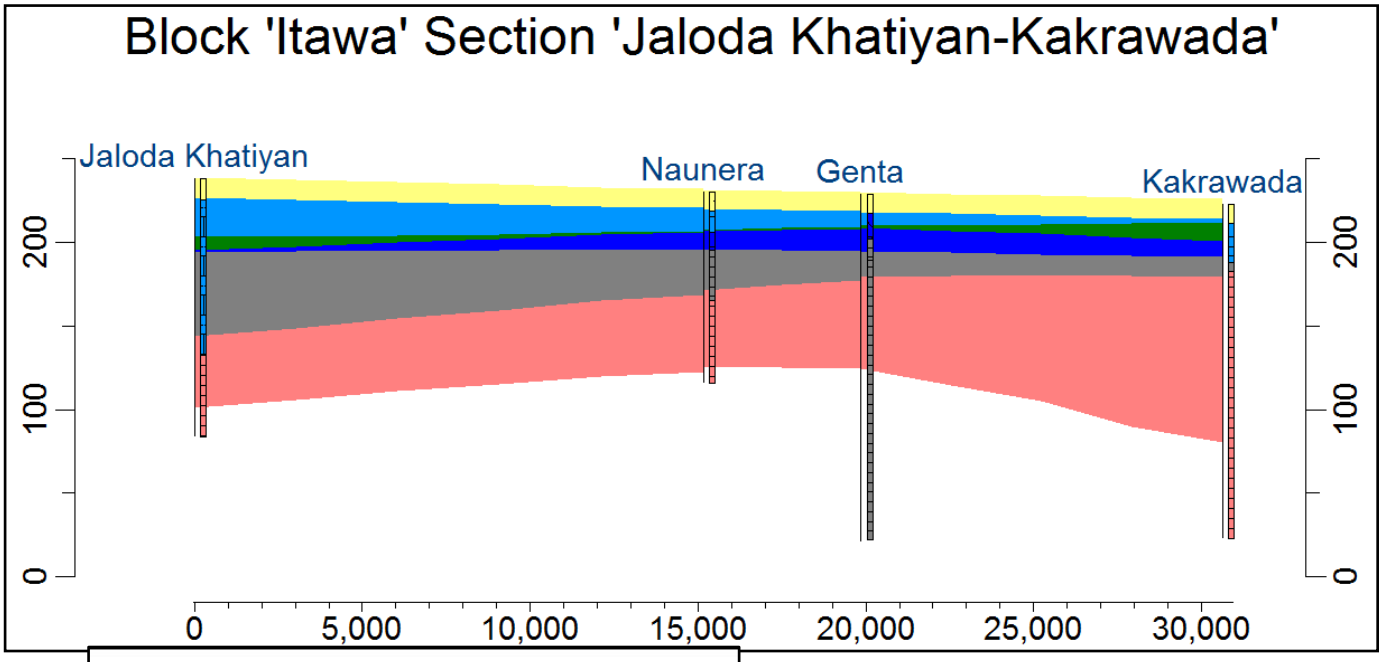
Aquifer disposition map showing section from Rel to Budadit for Sultanpur block is presented in figure given below

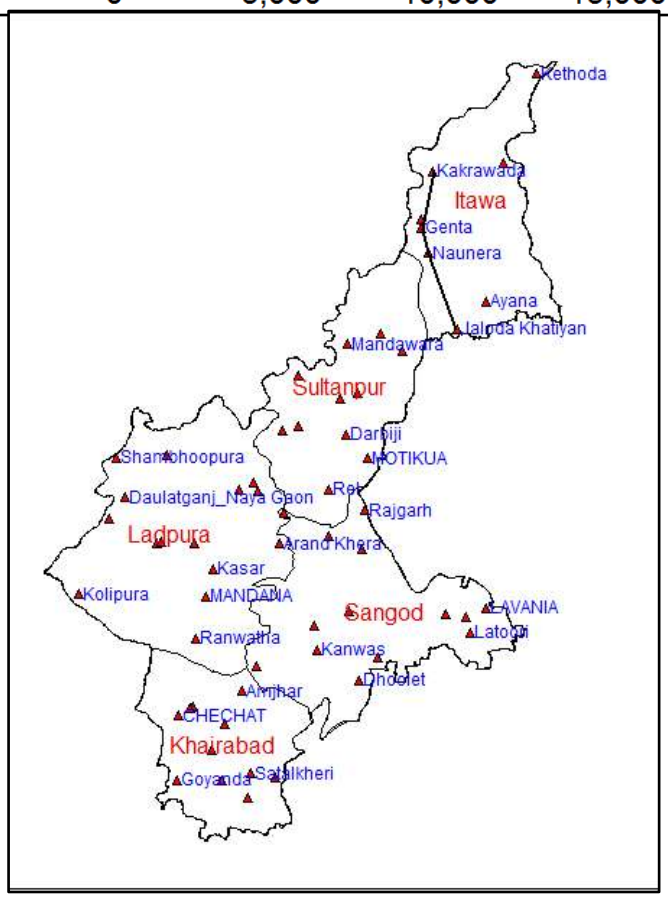


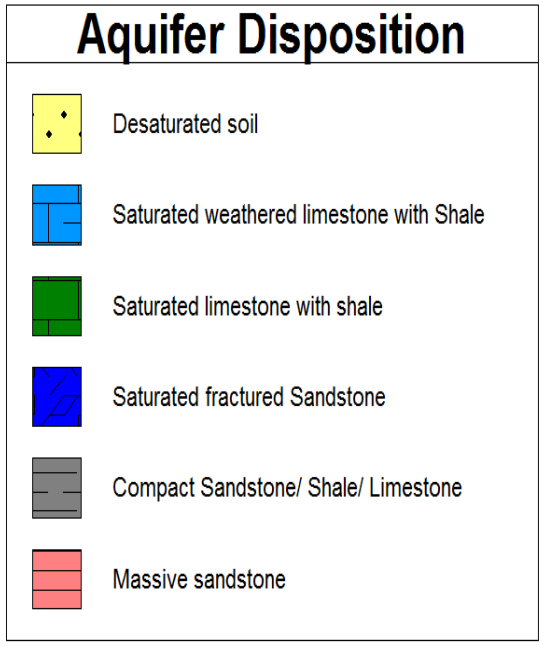




Aquifer disposition map showing section from Jaloda Khatiyan to Kakrawada for Itawa block is presented in figure given below







Study of various cross sections representing the area, reveals that thickness of saturated portion of alluvial aquifer has been reduced significantly owing to the over draft of ground water resources over the years for various uses.

3.0 DEPTH TO WATER LEVEL

Central Ground Water Board periodically monitors the ground water regime through 16 number of National Hydrograph Network stations four times a year i.e. in January, May (Pre-monsoon), August and November (Post-monsoon) including one time ground water sampling during May. Based on analysis of Ground water level (both temporal & long term), the following inferences have been made

3.01 Pre-monsoon (May-2017)

The depth to water level varies widely from 1.90mbgl to 18.00 mbgl. Block-wise No. / Percentage of Wells Showing Depth to Water Table (mbgl) are given below in Table 5

Table 5: Block-wise No. / Percentage of Wells Showing Depth to Water Table (mbgl) (May, 2017)

Block	No. of Wells Analysed	Depth to		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0 - 2	2 - 5	5 - 10	10 - 20	20 - 40	>40
ITAWA	4	3.90	15.07	0	1 25.00%	0	3 75.00%	0	0
LADPURA	8	2.75	11.10	0	5 62.50%	2 25.00%	1 12.50%	0	0
SULTANPUR	4	1.90	18.00	1 25.00%		1 25.00%	2 50.00%	0	0

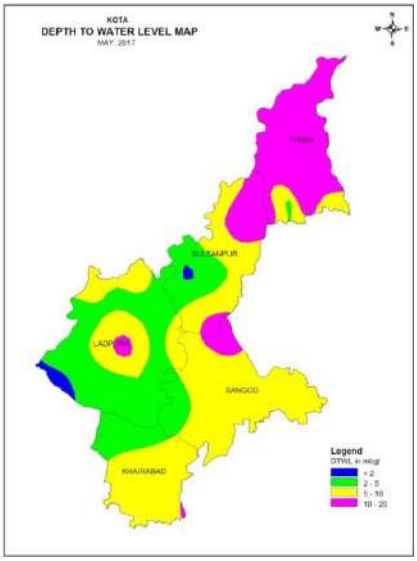


Figure 7: Depth to Ground Water Level (May, 2017)

The study of map given below reveals that in major part of the district water levels were between 2 and 10 mbgl (Figure 7). Depth to water level in the range of 10 to 20 mbgl were observed in the

form of small patches in southern part of Khairabad block, in major parts of Itawa block and in some parts of Sultanpur, Sangod and Ladpura block.

3.02. Post-monsoon (Nov, 2017)

The depth to water level varies widely from 0.15mbgl to 17.30 mbgl. Block-wise No. / Percentage of Wells Showing Depth to Water Table (mbgl) are given below in Table 6

Table 6: Block-wise No. / Percentage of Wells Showing Depth to Water Table (mbgl) (Nov., 2017

Block	No. of Wells Analysed	Depth to		No. / Percentage of Wells Showing Depth to Water Table (mbgl) in the Range of					
		Min	Max	0 - 2	2 - 5	5 - 10	10 - 20	20 - 40	>40
ITAWA	4	2.90	9.90	0	1 25.00%	3 75.00%	0	0	0
LADPURA	8	0.15	3.42	4 50.00%	4 50.00%	0	0	0	0
SULTANPUR	4	0.86	17.30	1 25.00%	2 50.00%	0	1 25.00%	0	0

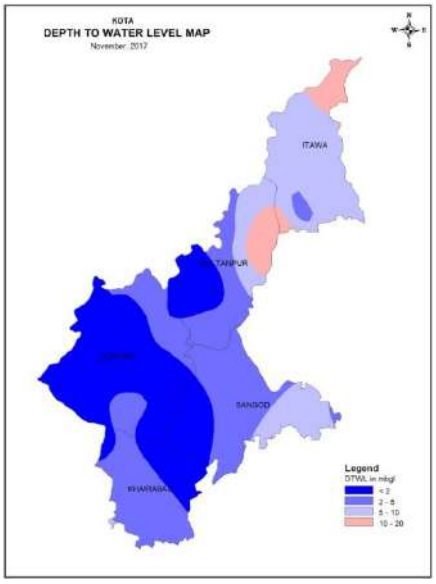


Figure 8: Depth to Ground Water Level (Nov. 2017)

The perusal of map reveals that during post-monsoon period in major part of the district water levels were shallow ranging between 0 and 10 mbgl (Figure 8). Water levels in the range of 0 to 2 mbgl have been observed in parts of Ladpura, Sangod, Khairabad and Sultanpur block. Depth to water levels between 10 and 20 mbgl have been reported in parts of Sultanpur and Itawa block.

3.03 Seasonal Water level Fluctuation (May, 2017 versus Nov, 2017)

The range of fluctuation shows rise in water level . Minimum rise observed in Itawa Block is 1.0m whereas Maximum rise is 10.90m in Ladpura Block. . Block-wise Seasonal Ground Water Level Fluctuation (pre versus post-monsoon, 2017) are given below in Table 7

Table 7: Block-wise Seasonal Ground Water Level Fluctuation (pre versus post-monsoon, 2017)

Block	No. of Wells Analysed	Range of Fluctuations(m)				No. of Wells/ Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
SULTANPUR	4	0.70	7.62	-	-	2 50.00%	0	2 50.00%	0	0	0	4	0
LADPURA	8	1.90	10.90	-	-	2 25.00%	5 62.50%	1 12.50%	0	0	0	8	0
ITAWA	4	1.0	8.70	-	-	1 25.00%	1 25.00%	2 50.00%	0	0	0	4	0

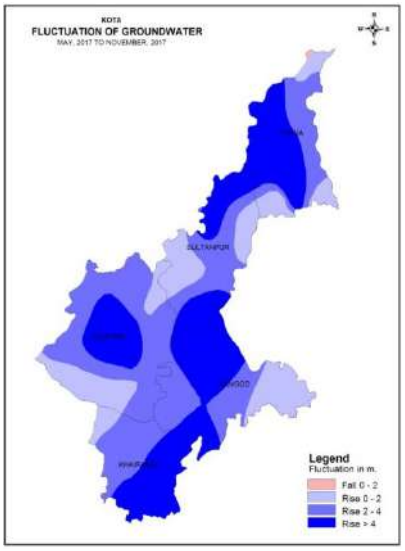


Fig. 9: Seasonal Ground Water Level Fluctuation (pre versus post-monsoon, 2017)

The perusal of map reveals that exceptionally rise in water level in entire district (Figure 9). Perusal of the fluctuation data indicates that extent of rise in water levels varies from 2 to 4 m. Majority of wells (75%) in the district have registered rise in water level in the range of 0 to 4 m (75%) and the remaining wells (25%) have registered rise of more than 4 m.

3.04 Decadal Water level Fluctuation

The range of fluctuation shows minimum rise is 3.33m in sultanpur block and maximum rise is 1.12m in ladpura block whereas minimum fall is 0.04m in sultanpur block and maximum fall if 2.7m in ladpura block. Block-wise Decadal fluctuation Water Level (2007-16 and May, 2017) are given below in Table 8

Table 8: Block-wise Decadal fluctuation Water Level (2007-16 and May, 2017)

Block	No. of Wells Analysed	Range of Fluctuations(m)				No. of Wells/ Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
SULTANPUR	4	3.33	0.44	0.04	1.22	1 25.00%	1 25.00 %	0	2 50.00 %	0	0	2	2
LADPURA	8	4.59	1.12	0.18	2.7	2 25.00%	1 12.50 %	1 12.50 %	3 37.50 %	1 12.50%	0	4	4
ITAWA	4	12.39	0.11	-	-	3 75.00%	0	1 25.00 %	0	0	0	4	0

The range of fluctuation shows minimum rise is 5.00m in ladpura block and maximum rise is 1.95m in itawa block. Block-wise Decadal fluctuation Water Level (2007-16 and Nov., 2017) are given below in Table 9

Table 9: Block-wise Decadal fluctuation Water Level (2007-16 and Nov., 2017)

Block	No. of Wells Analysed	Range of Fluctuations(m)				No. of Wells/ Percentage Showing Fluctuation						Total No. of Wells	
		Rise		Fall		Rise			Fall			Rise	Fall
		Min	Max	Min	Max	0 to 2	2 to 4	>4	0 to 2	2 to 4	>4		
SULTANPUR	4	7.03	0.12	-	-	2 50.00%	0	2 50.00 %	0	0	0	4	0
LADPURA	8	5.00	0.17	1.73	1.73	3 37.50%	1 12.50 %	3 37.50 %	1 12.50 %	0	0	7	1
ITAWA	4	17.42	1.95	-	-	1 25.00%	1 25.00 %	2 50.00 %	0	0	0	4	0

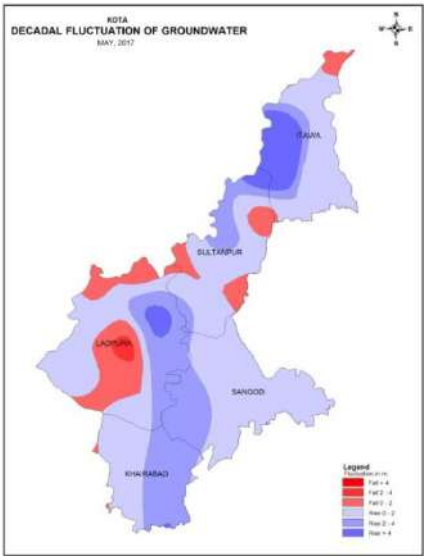


Figure 10: Decadal fluctuation Water Level (2007-16 and May, 2017)

Decadal water level fluctuation map (2007-16 versus May, 2017) has been prepared (Figure10). Perusal of map indicates that there has been rising trend of upto 25cm/year in water levels in major parts of the district. Declining trend of upto 25cm/year has been registered in water levels in parts of Ladpura , Sultanpur and Itawa block.

3.05 Long Term Water Level Trend (2007-2016)

Water level trend data indicate that declining trend ranging has been observed during pre-monsoon period. Declining trend has resulted due to the over draft of ground water resources than its natural replenishment. The long term hydrograph of select monitoring stations representing all the blocks are depicted in Figure 11A to 11E

Table10: Trend of Water Level (Pre-Monsoon)

SI No.	Location	Rise(m/year)	Fall(m/year)
1.	Alania	-	-
2.	Antralia	-	-
3.	Ayana	0.2860	-
4.	Borawas	0.1857	-
5.	Dara	0.6882	-
6.	Digod 1	-	0.0146
7.	Gadepan	0.0927	-
8.	Gainta	1.3582	-
9.	Ganeshganj	-	-
10.	Girdharpura	-	0.1370
11.	Gudli	0.0658	-
12.	Kagania	-	-
13.	Keshavpura	0.3612	-
14.	Khatoli	0.1974	-
15.	Kherarasulpur	0.3250	-
16.	Kota 1	0.2612	-
17.	Mandana	-	0.1753
18.	Mandavra	0.4557	-
19.	Nayaroad	-	-
20.	Rajgarh 1	-	0.0608
21.	Rattanpura	-	-
22.	Sultanpur	-	0.8624

Table 11: Trend of Water Level (Post- Monsoon)

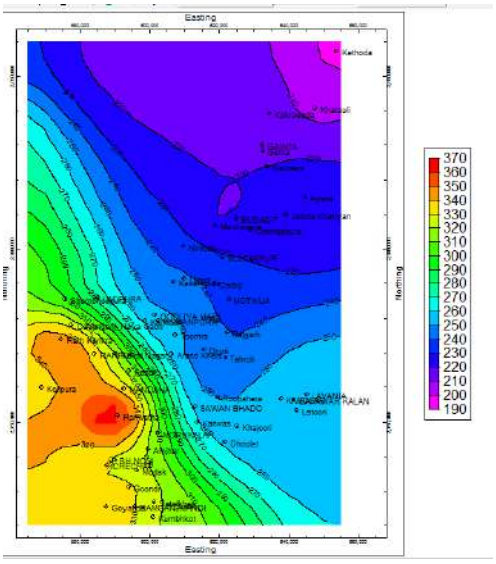
SI No.	Location	Rise(m/year)	Fall(m/year)
1.	Alania	-	0.0352
2.	Antralia	-	-
3.	Ayana	0.0864	-
4.	Borawas	0.3871	-
5.	Dara	0.1607	-

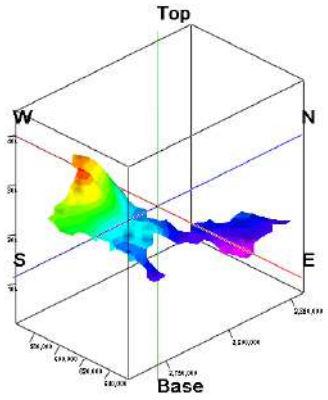
6.	Digod 1	0.0227	-
7.	Gadepan	0.0190	-
8.	Gainta	1.8569	-
9.	Ganeshganj	-	-
10.	Girdharpura	0.0465	-
11.	Gudli	0.0069	-
12.	Kagania	-	-
13.	Keshavpura	0.3974	-
14.	Khatoli	0.4037	-
15.	Kherarasulpur	0.5612	-
16.	Kota 1	0.5512	-
17.	Mandana	-	0.0465
18.	Mandavra	0.8149	-
19.	Nayaroad	-	-
20.	Rajgarh 1	0.8588	-
21.	Rattanpura	-	0.0456
22.	Sultanpur	-	0.0082

Perusal of Table 10 & 11 reveals that Ground Water level on long term perspective show both rise & fall in period of consideration. As seen in table10 rise in Ground Water level varied from 0.0658-1.3582 m/year during pre-monsoon period. While fall in Ground Water level have been found varying from 0.0146-0.8624 m/year. As observed in table11 rise in Ground Water level varied from 0.0069-1.8569 m/year during post-monsoon period. While fall in Ground Water level have been found varying from 0.0082-0.0465 m/year.

3.06 Water Table

The highest elevation of water table is about 370 m amsl in the south western part of the district. The lower elevation of water table is 190 m amsl in extreme north eastern part of the district.





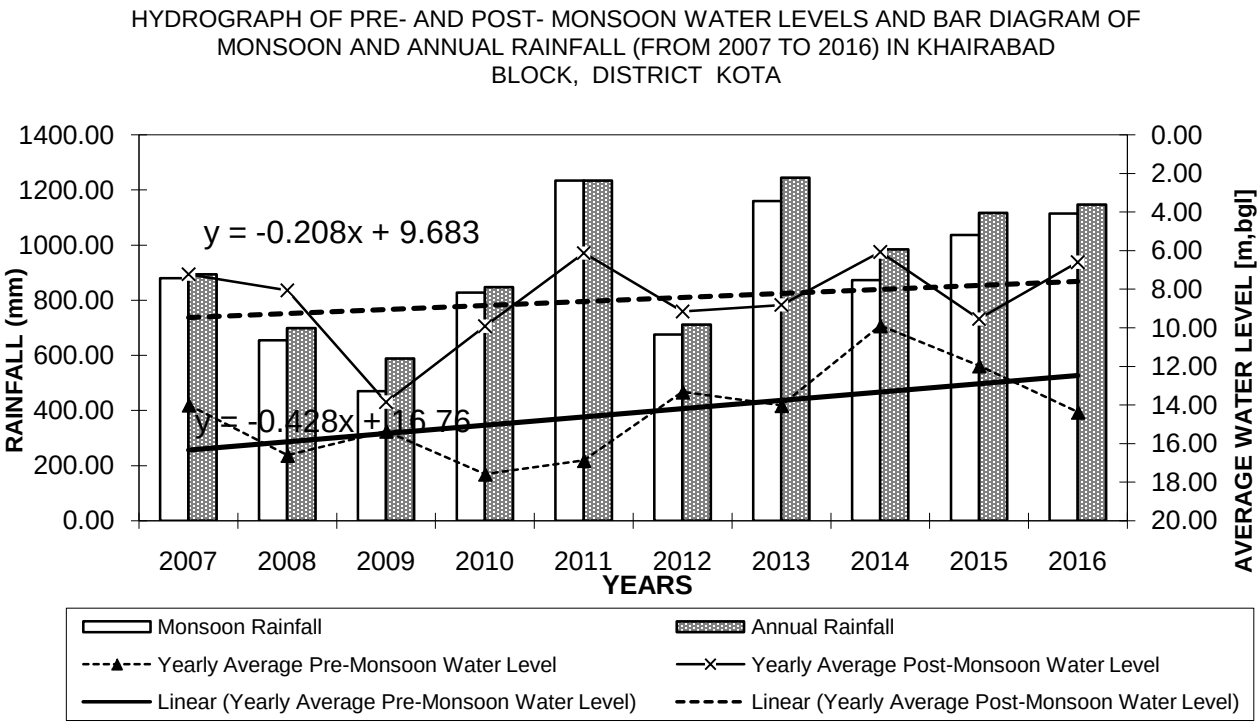


Figure 11A: Hydrograph of Block Khairband

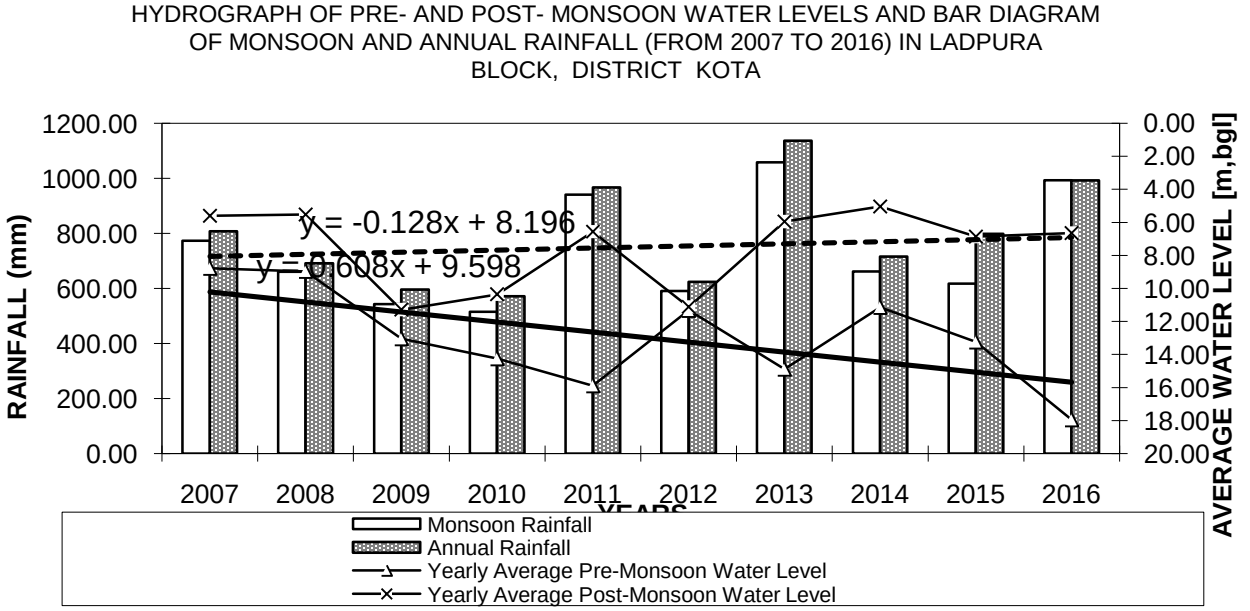


Figure 11B: Hydrograph of Block Ladpura

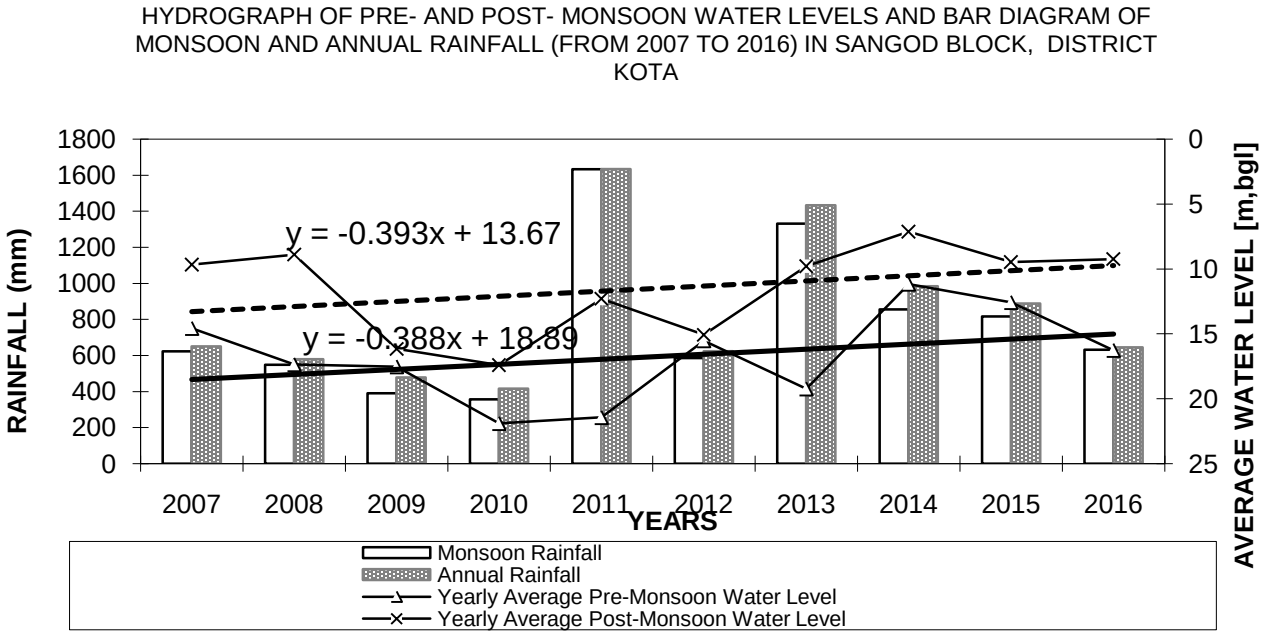


Figure 11C: Hydrograph of Block Sangod

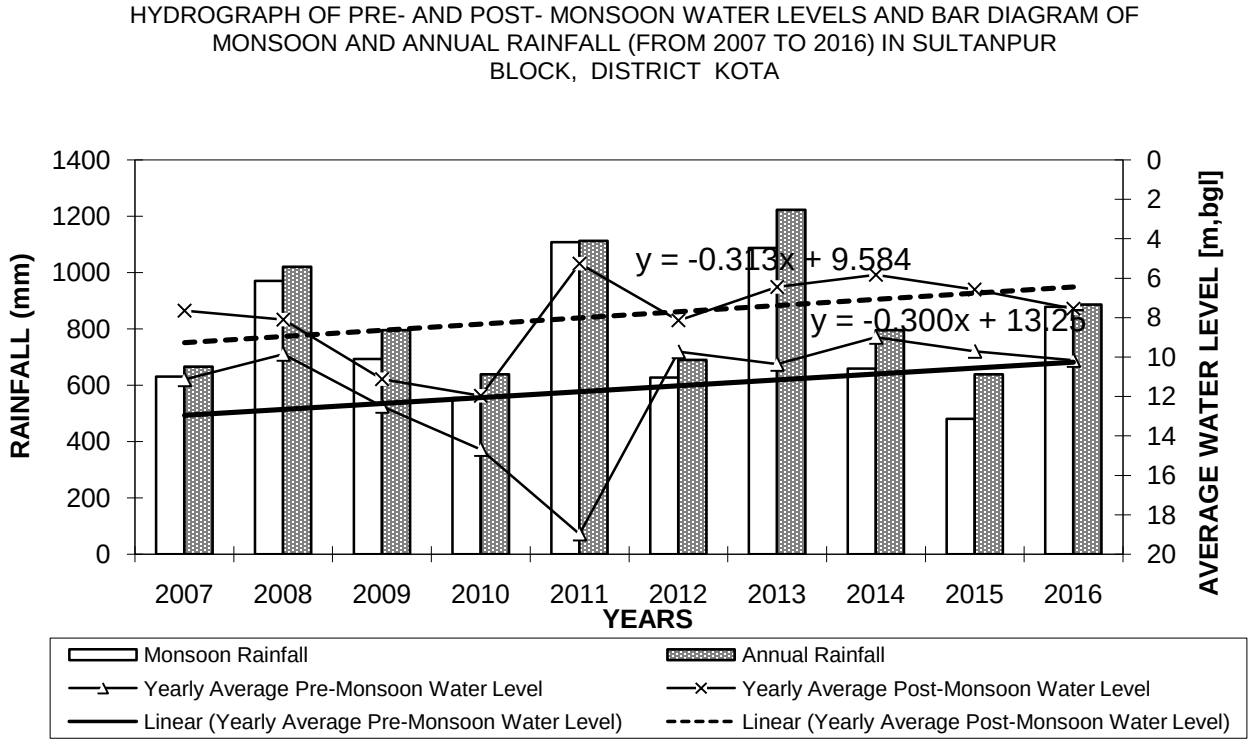


Figure 11D: Hydrograph of Block Sultanpur

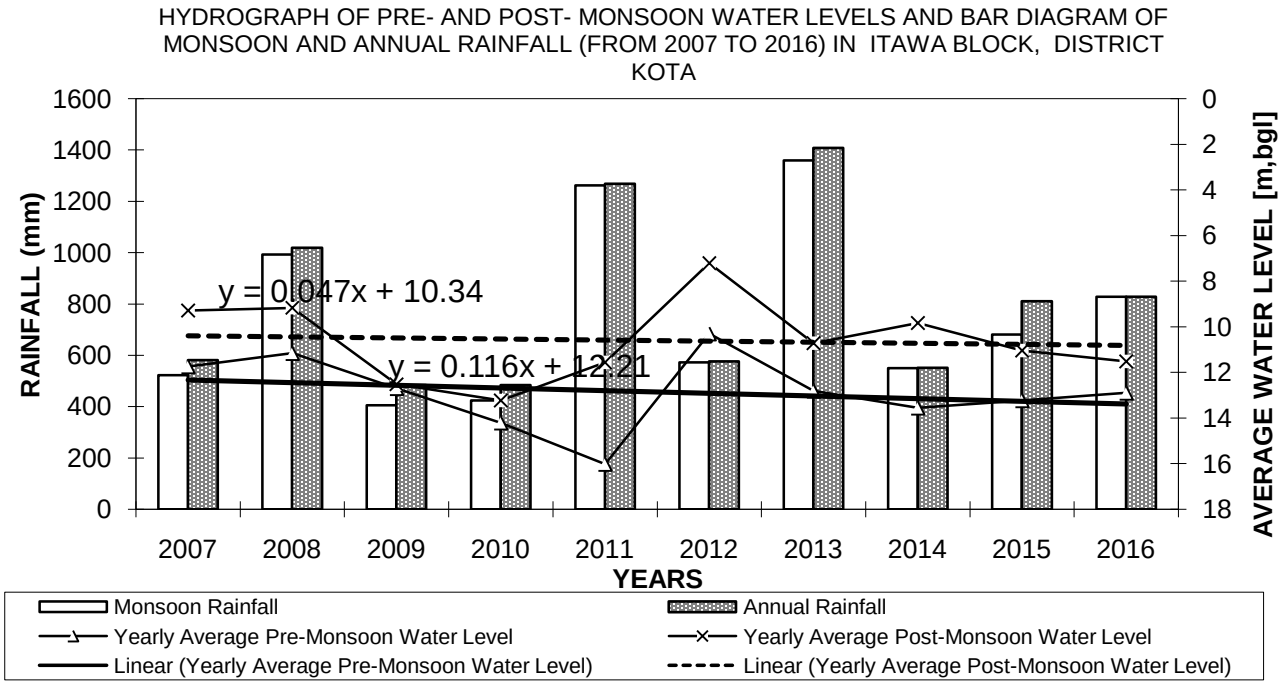


Figure 11E: Hydrograph of Block Itawa

3.07 Details of key wells established during the study period

The details of key wells are presented in Annexure V.These wells are in addition to the NHS wells and the wells established by Ground Water Department in the area. The monitoring data shows variation in Ground Water level from 7m bgl (Sangod) to 87m bgl (Jagpura).It has been observed that Ground Water level Data of key wells are in conformity with the Data of NHS-wise located in the area.

4. GROUND WATER QUALITY

The distribution of chemical constituents of ground water samples of NHS (National Hydrographic Stations) in Kota district during pre-monsoon 2017 is given in Table **12**.

Table 12: Distribution of chemical constituents in ground water (NHS Samples)

S.No.	Chemical constituent	Range
1	pH	7.03 -8.47
2	Chloride	15-496 ppm
3	Electrical conductivity at 25°C	420 - 4880 µS/cm at 25°C
4	Total hardness as $CaCo_3$	150 - 870 mg/l
5	Calcium	32 - 136 mg/l
6	Magnesium	14.59-144.7 mg/l
7	Iron	0.01 - 6.14 mg/l
8	NO_3	0.02 - 52 mg/l
9	F	0.0 - 1.79 mg/l

The distribution of chemical constituents of ground water samples collected during aquifer mapping studies in Kota district (Annexure- VI) during pre-monsoon 2017 is given in Table13

Table 13: Distribution of chemical constituents in ground water (Samples from key wells)

S.No.	Chemical constituent	Range
1	pH	7.25 -7.94
2	Chloride	43-468 ppm
3	Electrical conductivity at 25°C	710 - 3600 µS/cm at 25°C
4	Total hardness as $CaCo_3$	260 - 600 mg/l
5	Calcium	40 - 104 mg/l
6	Magnesium	24-88 mg/l
7	Iron	0.00 - 4.10 mg/l
8	NO_3	7 - 41 mg/l
9	F	0.04 - 1.05 mg/l

As evident from the above table and Annexure -VII, the GW quality in the study area is fresh to brackish in nature. The pH of GW varies from 7.25 -7.94 and the EC varies from 710 - 3600 µS/cm at 25°C. EC values are observe to be high (>1000 µS/cm at 25°C) at four locations namely Digod, Devpura, Bammori, Ramganjmandi. In the remaining areas the quality of GW is found to be fresh and potable. Nitrate values vary from 7 to 41 mg/l indicating the concentration of this constituent within the permissible limit of drinking water standard. Similarly concentration of F is also within the permissible limit with variation from 0.04 mg/l (Digod) to 1.05 mg/l (Kaithoon). The GW is slightly alkaline in nature with pH varying from 7.25(Jagpura) to 7.94(Devpura).

4.1 Electrical Conductivity

As per water quality data and NHS wells located in kota district, shallow ground water of dug well zone is found to be alkaline in nature with pH ranging from 7.4 to 8.5. Electrical Conductivity (EC) varies from 320 to 3650 µS/cm at 25°C. EC is within 3000 µS/cm at 25°C in majority of wells. EC above 3000 µS/cm at 25°C has been observe d in the southern part of the district along the adjoining borders of Sangod, Khairabad and Ladpura blocks (Figure 12). The Chloride content varies from 25 to 740 mg/l. In most parts of the district, the electrical conductivity values are less than 1500 µS/cm at 25°C. In southern part of Khairabad block, northern part of Sultanpur block and in the whole Itawa block electrical conductivity values more than 1500 µS/cm have been reported.

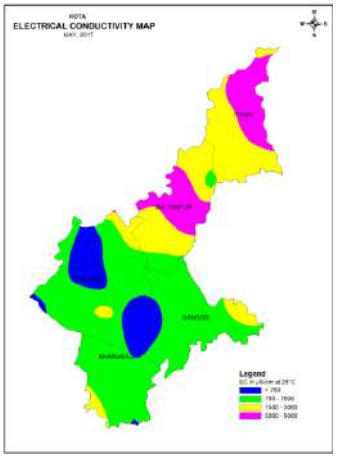


Figure 12: Distribution of Electrical Conductivity

4.2 Fluoride

The fluoride content in ground water in the district is generally within 1.5 mg/l, the maximum permissible limit in drinking water as prescribed by the BIS. Excess fluoride has been reported from northwestern part of Sultanpur block.

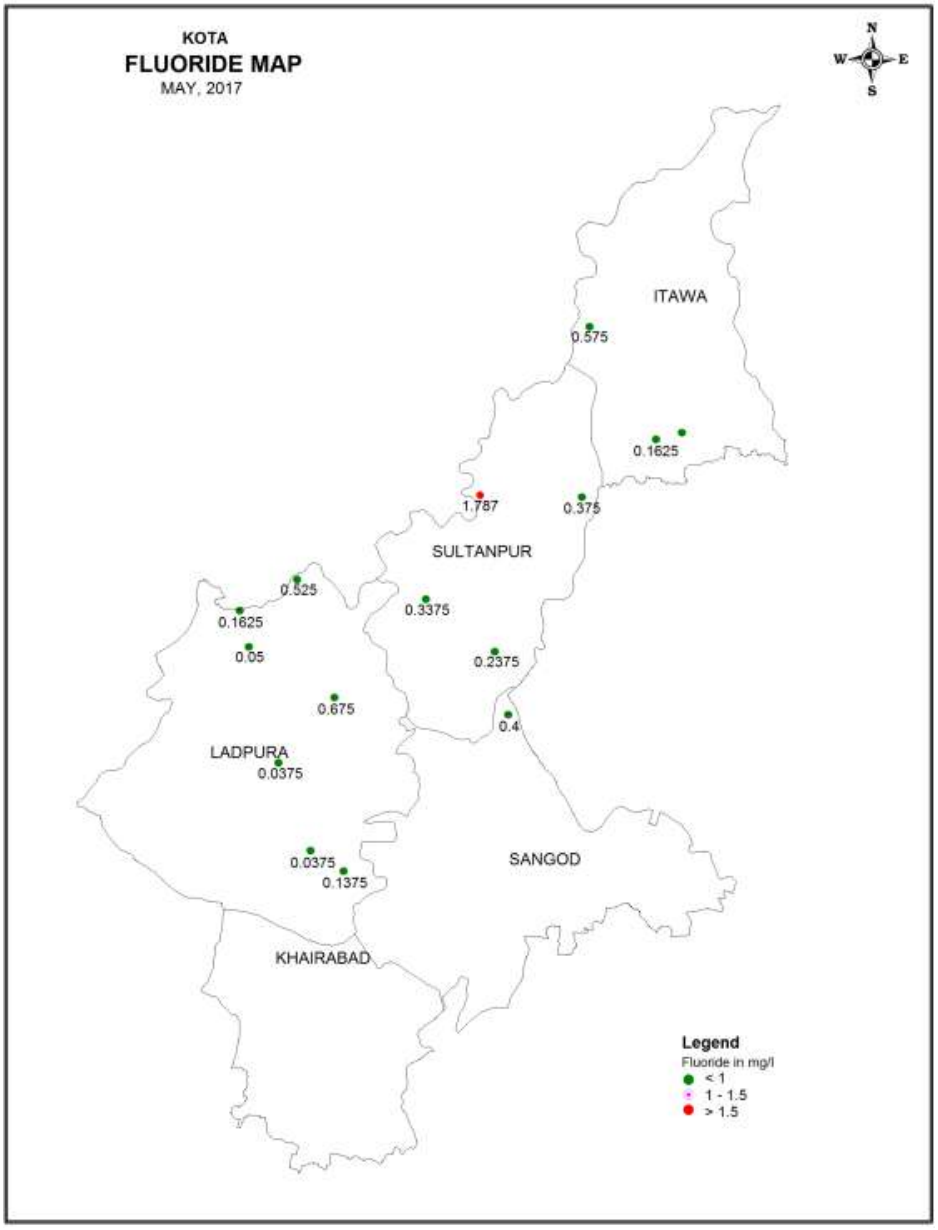


Figure 13: Distribution of Fluoride

4.3 Nitrate

The concentration of Nitrate ranges from 9.0 mg/l to 125 mg/l. Nitrate values in major part of the district are within 45 mg/l, the maximum permissible limit in drinking water as prescribed by BIS (Figure 8). Higher concentration of nitrate in ground water has been reported from parts of itawa blocks.

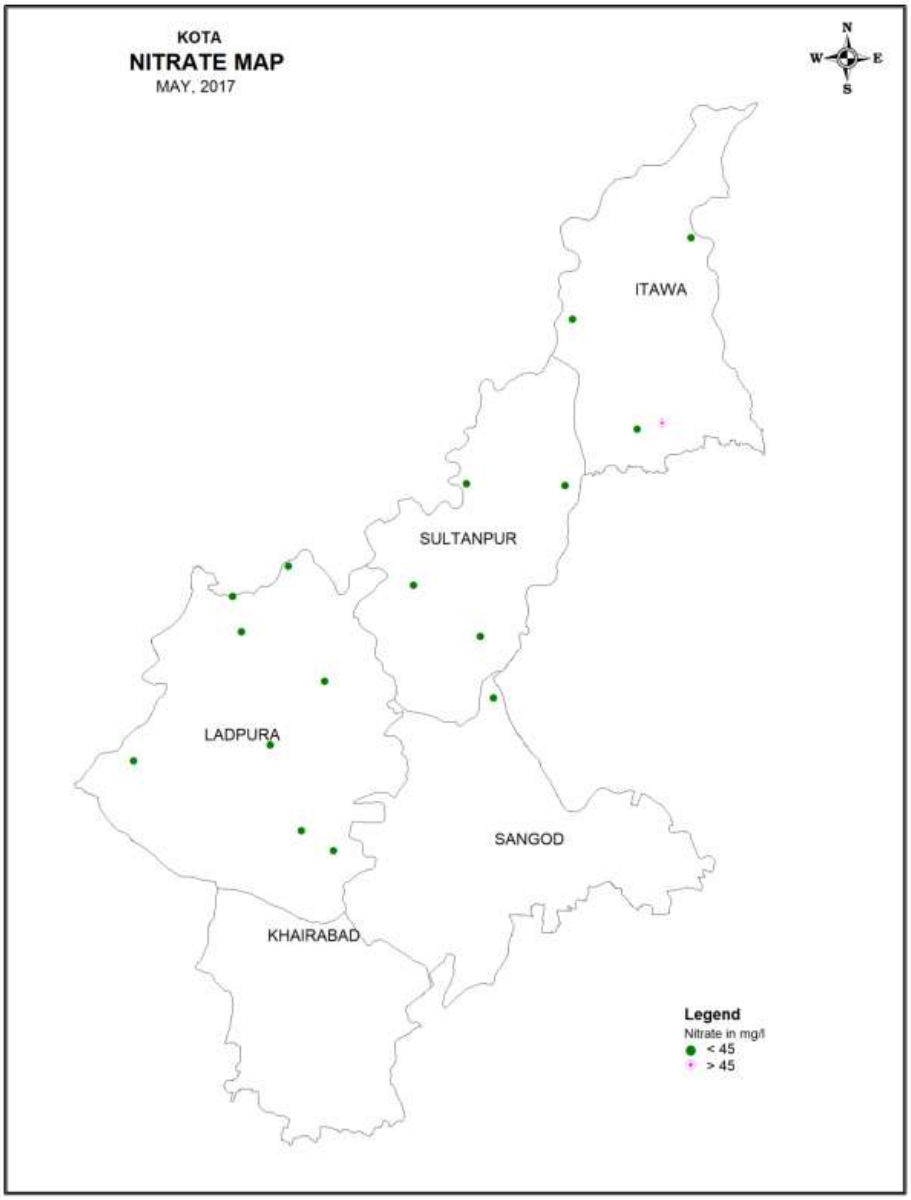


Figure 14: Distribution of Nitrate

4.4 Iron

The concentration of iron in ground water has been found to vary from 12 to 2.6 mg/l. High iron concentration (exceeding maximum permissible limit of 1 mg/l) in substantial part of the district covering Itawa block, Ladpura block and Sultanpur block is a matter of concern. In the remaining parts of the district, iron content is well within the permissible limit. It has been observed that samples collected and analysed from NHS and during aquifer mapping studies shows strong correlation.

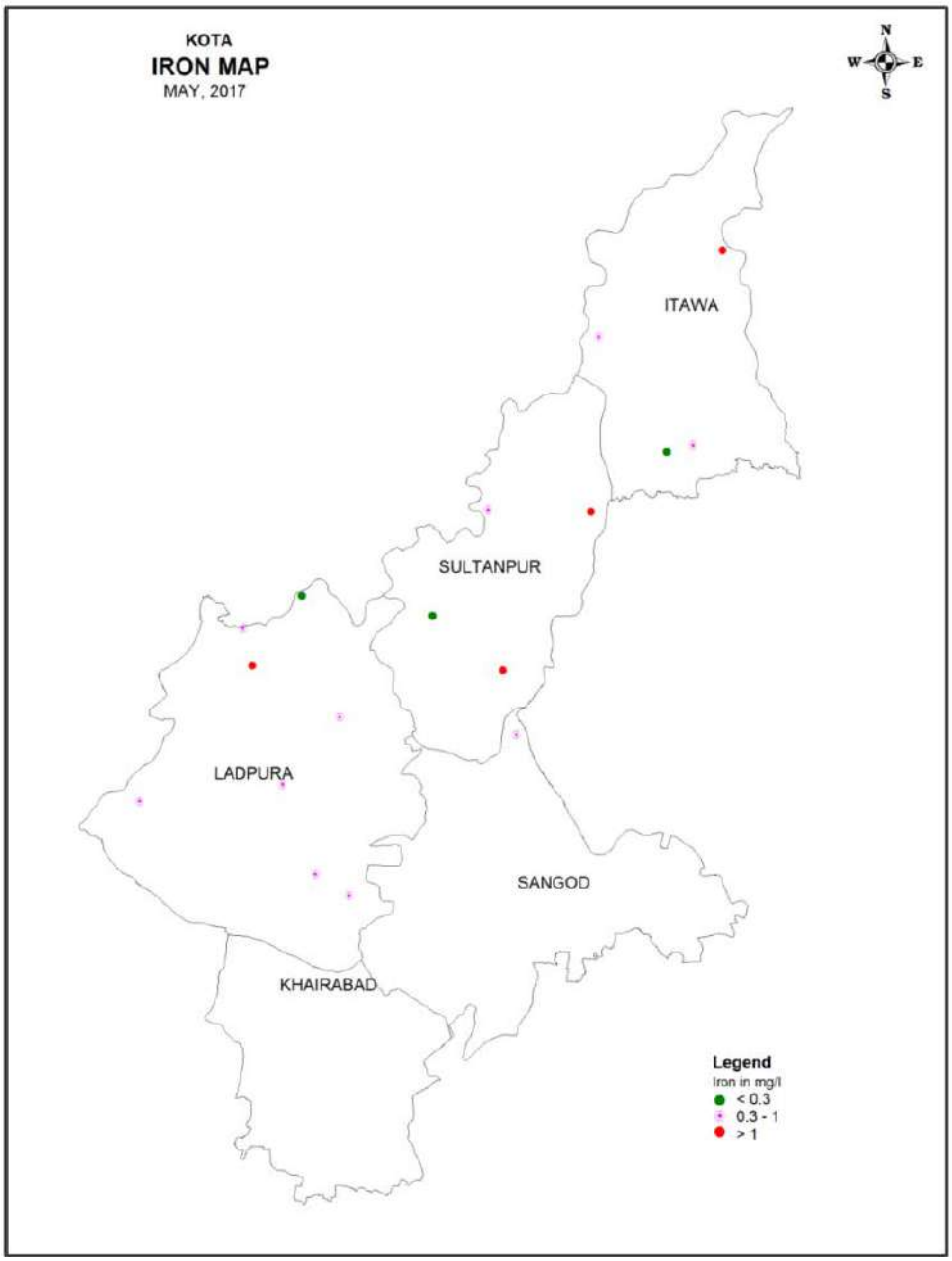


Figure 15: Distribution of Iron

5. GROUND WATER RESOURCES

Based on Ground Water Estimation Committee (1997), dynamic groundwater resources of Rajasthan as on 31.03.2013 have been reassessed jointly by Central Ground Water Board and Ground Water Department, Govt. of Rajasthan. Block and zone wise details of resources are given in Table 14.

Block	Area of block (Km2)	Type of Area	Water bearing formation	Potential zone area (Km2)	Net annual ground water availability (Mm3)	Existing gross ground water draft for irrigation (Mm3)	Existing gross ground water draft for domestic & industrial use (Mm3)	Existing gross ground water draft for all uses (Mm3)	Allocation for domestic & industrial requirement as on year 2025 (Mm3)	Net ground water availability for future irrigation development (Mm3)	Stage of ground water development (%)	Category
1	2	3	4	5	8	9	10	11	12	13	14	17
ITAWA	898.51	C	Alluvium	731.7	88.18	102.11	4.89	107.01	9.93	0.00	121.35	
		C	Limestone	165.81	42.62	10.70	1.18	11.89	1.77	30.15	27.89	
Total of block				**897.51**	**130.80**	**112.82**	**6.07**	**118.89**	**11.70**	**30.15**	**90.9**	**CRITICAL**
KHAIRABAD *	794.26	NC	Limestone	556.85	36.84	46.79	6.00	52.78	8.52	0.00	143.26	
		NC	Sandstone	193.75	12.24	17.13	3.02	20.15	4.29	0.00	164.65	
Total of block				**750.6**	**49.08**	**63.91**	**9.02**	**72.93**	**12.81**	**0.00**	**148.59**	**OVER EXPL.**
LADPURA	1540.8	C	Limestone	64.95	6.07	2.82	3.36	6.17	5.04	0.00	101.78	
		C	Sandstone	324.32	51.23	32.80	4.27	37.06	7.26	11.18	72.35	
		NC	Sandstone	1132.1	57.07	43.81	7.18	50.99	14.35	0.00	89.34	
Total of block				**1521.4**	**114.37**	**79.42**	**14.80**	**94.23**	**26.65**	**11.18**	**82.39**	**SEMICRITICAL**
SANGOD	1057.8	NC	Limestone	161.9	12.77	21.72	1.19	22.91	3.58	0.00	179.38	
		C	Sandstone	65.17	9.36	8.43	1.63	10.06	2.44	0.00	107.49	
		NC	Sandstone	665.57	43.41	69.12	5.62	74.74	17.98	0.00	172.16	
		C	Shale	25.25	1.98	4.48	0.38	4.86	0.69	0.00	246.05	
		NC	Shale	126.25	6.61	17.37	1.45	18.82	2.32	0.00	284.9	
Total of block				**1044.1**	**74.12**	**121.12**	**10.27**	**131.39**	**27.00**	**0.00**	**177.25**	**OVER EXPL.**
SULTANPUR	912.57	C	Alluvium	494.84	84.51	80.03	6.43	86.45	8.36	0.00	102.3	
		C	Limestone	278.11	60.98	32.68	2.14	34.82	2.56	25.74	57.09	
		NC	Limestone	136.62	8.39	6.75	1.47	8.23	1.91	0.00	98.04	
Total of block				**909.57**	**153.89**	**119.46**	**10.04**	**129.50**	**12.84**	**25.74**	**84.15**	**SEMICRITICAL**
Total of District		Command		2150.2	344.92	274.05	24.27	298.32	38.04	67.06	86.49	SEMICRITICAL
		Non-Command		2973	177.33	222.68	25.93	248.61	52.95	0.00	140.2	OVER EXPL.
Total of District				**5123.2**	**522.26**	**496.74**	**50.20**	**546.94**	**90.99**	**67.06**	**104.73**	**OVER EXPL.**

Data indicate that out of 5 blocks, 2 blocks (Khairabad and Sangod) are OE, 2 blocks (Ladpura & Sultanpur) comes under Semi-critical category and 1 block Itawa is comes under critical category. The stage of ground water development ranges from 82.39% (minimum in Ladpura block) to 177.25% (maximum in Sangod Block). As a whole the district is comes under OE category.

The changing scenario of ground water development over the years since 2004 to 2013 as per ground water resource estimation has been presented in **Table 15** and depicted with the help of bar diagram in **Figure 16**.

Table 15: Status of Ground Water Development, Kota District

Year	Gross recharge (mcm)	Gross draft (mcm)	Stage of GW development (%)
2004	406.47	470.74	115.82
2009	557.99	503.25	90.19
2011	513.3	469.9	91.54
2013	522.25	546.93	104.73

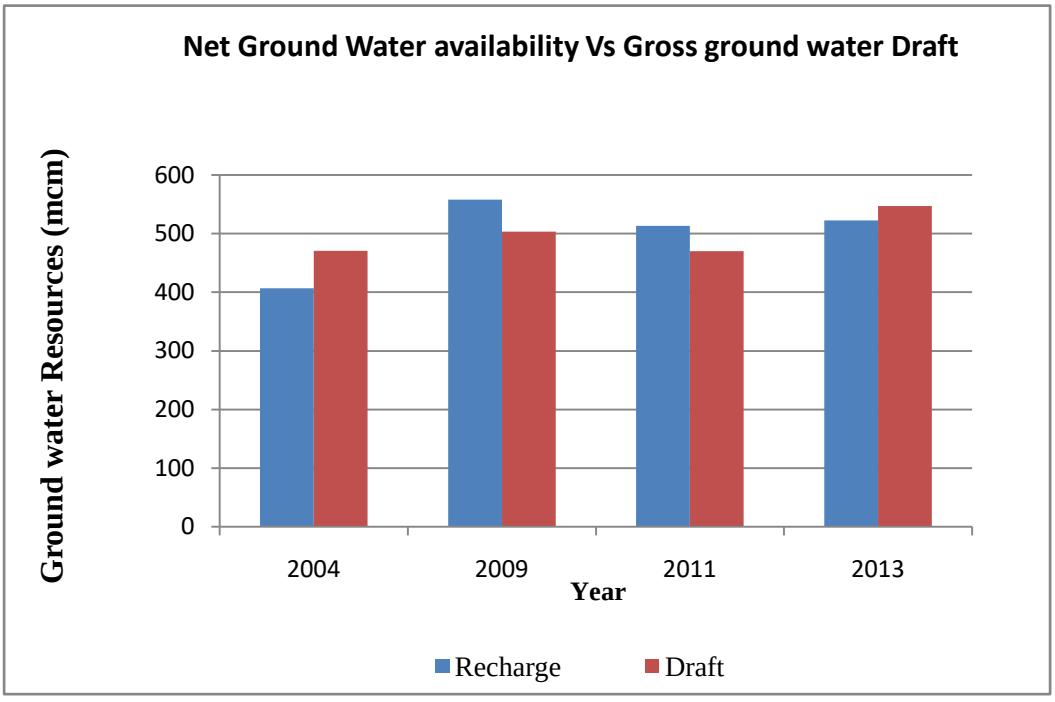


Figure 16: Ground Water Development Status

6.0 GROUND WATER RELATED ISSUES

The following ground water related issues have been emerged:

1. Decline in Water Level

Long term water level data (pre and post monsoon, 20011-16) indicate declining trend in all the blocks during pre-monsoon period and post-monsoon period. Declining trend has resulted due to the over draft of ground water resources than its natural replenishment. Ground water resources data indicate that out of 5 blocks, only 1 block (Itawa) is critical, 2 are semicritical (Ladpura and Sultanpur) and remaining 2 blocks (Khairabad and Sangod) are over exploited. The stage of ground water development ranges from 82.39% (minimum in Ladpura block) to 177.25% (maximum in Sangod Block). It has resulted in decline in water level. Deeper water level causes more consumption of power to draw ground water and deterioration in ground water quality.

2. Ground Water Salinity

In most parts of the district, the electrical conductivity values are less than 1500 μS/cm at 25°C. In southern part of Khairabad block, northern part of Sultanpur block and in the whole Itawa block electrical conductivity values more than 1500 μS/cm have been reported.

7.0 MANAGEMENT STRATEGIES

As a whole the district is comes under OE category thereby, leaving no/limited scope of further ground water development for various consumptions. In order to manage the ground water resources and to control further decline in water levels, a management plan has been proposed. The management plan comprises two components - supply side management and demand side management.

7.1 Supply Side Management

The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the desaturated aquifer volume available for recharge. The supply side management of ground water resources can be done through the artificial recharge of surplus runoff available within river sub basins and micro watersheds. Also it is necessary to understand the unsaturated aquifer volume available for recharge. The unsaturated volume of aquifer for the Kota district is computed based on following; the area feasible for recharge, unsaturated depth below 5 m bgl and the specific yield of the aquifer. The block-wise volume available for the recharge is given below in Table 16.

Table 16: Area Feasible and Volume Available for Artificial Recharge, Kota District

Block	Potential area suitable for recharge (Sq.km.)	Sp Yield (%)	Average Depth (desaturated)	Volume of sub surface storage available for artificial recharge (mcm)	Water required for recharge for the space available (mcm)	Surplus water available (mcm) @30% runoff coefficient
Itawa	897.51	0.015	11.8	158.19	237.28	202.24
Khairabad	750.6	0.015	14.6	164.38	246.57	169.13
Ladpura	1521.35	0.015	11.7	267.00	400.50	342.81
Sangod	1044.14	0.015	13.4	209.87	314.81	235.28
Sultanpur	909.57	0.015	11.6	158.27	237.40	204.95
Total	5123.17				1436.55	1154.40

It can be seen that huge volume is available for artificial recharge in this district. The total unsaturated volume available is 957. However, adequate surplus surface water is not available to recharge this volume. The basin wise and watershed wise surplus surface water availability at 75% dependability level was obtained from the Water Resources Department of Govt. of Rajasthan for calculation of surplus surface water. The available surplus runoff can be utilized for artificial recharge through construction of recharge shafts in existing ponds and Percolation tanks at suitable location. The number of Recharge Shaft is decided based on the number of suitable ponds available within the zone. If still some surplus remains unallocated, than few Percolation tanks are proposed at suitable locations. Thus, the entire surplus available cannot be utilized in some areas where suitable ponds for recharge shaft of suitable locations for percolation tanks are not available. Besides, the areas with shallow water levels (less than 6 m bgl) are also to be excluded.

After taking into consideration all the factors, the surplus of 23.48 MCM has been calculated for Kota district which can be utilized for recharge. The usage of this surplus in various types of recharge structures is given in **Table 17**. By taking surplus of 0.03 MCM for each recharge shaft, 100 no. of recharge shafts can be constructed in existing ponds and by taking 0.06 MCM for each Farm Ponds, 341 no. of percolation tanks can be constructed in the district after allocation of surplus water for recharge shafts. These structures will lead to effective recharge of about 13.24 MCM/year.

Table 17: Recharge Structures Proposed, Kota District

Block	Surplus available in zone as per the water level (in Mm3)	No. of RS 0.03 MCM/RS	No of RS possible in block (as per water bodies)	Surplus for Farm pond (0.06 MCM)	No of Farm Pond	Additional Recharge from recharge shafts (mcm)	Additional Recharge from percolation tanks (mcm)	Total Recahrge (mcm)
Itawa	3.74	125	12	3.38	56	0.36	1.69	2.05
Khairabad	2.64	88	20	2.04	34	0.60	1.02	1.62
Ladpura	8.43	281	17	7.92	132	0.51	3.96	4.47
Sangod	4.84	161	25	4.09	68	0.75	2.05	2.80
Sultanpur	3.83	128	26	3.05	51	0.78	1.53	2.31
Total	23.48	783	100	20.48	341	3.00	10.24	13.24

7.2 Demand Side Management

Demand side management has been proposed through two interventions – changing the more water intensive wheat crop to gram (chick pea) and use of sprinkler irrigation in half of the total irrigated area which is being irrigated through ground water.

7.2.1 Change in cropping pattern

In view of the alarming decline of water level, drastic reduction in saturated thickness of aquifer and resulting of depletion of aquifer, there is need to bring paradigm change/shift in cropping pattern in the area. It is proposed to grow low water requirement crop like gram in the instead of wheat. Growing of gram will save the water to the tune of about 68 mcm per annum @ 0.1m(Table18)

Table 18: Block-wise water saving through change in cropping pattern, Kota district

Block	Irrigated Area (ha) under wheat (ha)	Irrigated Area (ha) under wheat proposed for Gram cultivation	Water Saving by change in cropping pattern in mcm @0.1 m
Itawa	26220	13110	13.11
Khairabad	6780	3390	3.39
Ladpura	25334	12667	12.67
Sangod	30238	15119	15.12
Sultanpur	47171	23586	23.59
Total	135743	67872	68

Source: District Statistics Outline, Department of Economics and Statistics, Kota, Govt. of Rajasthan (2016)

7.2.2 Adoption of modern practice of sprinkler irrigation/improved irrigation practices

Data indicate that flooding method of irrigation is still in practice in many parts of the district which causes wastage of ample quantity of water. In view of this, it is proposed to bring about 50% of total irrigated area under sprinkler irrigation which may save water to the tune of about 112mcm/annum @0.08m **(Table 19)**.

Block	**Irrigated Area (ha)**	**Irrigated Area (ha) proposed for irrigation through sprinkler**	**No. of Sprinklers proposed/ ha**	**Water Saving by sprinkler in mcm @0.08 m**
Itawa	60311	30156	25	24.12
Khairabad	35921	17961	25	14.37
Ladpura	49278	24639	25	19.71
Sangod	69834	34917	25	27.93
Sultanpur	65263	32632	25	26.11
Total	280607	140304	125	112

8.0 EXPECTED BENEFIT OF MANAGEMENT STRATEGIES

Considerable saving of ground water can be achieved if the proposed supply side and demand side management plans are implemented. There is no supply side management in view of non feasibility. With the proposed use of sprinkler irrigation in the half of total irrigated area which is being irrigated through ground water it is expected that 112 mcm/year can be saved due to reduction in pumping and with changing the wheat crop to gram (chick pea) and additional 68 mcm/year can be saved due to reduction of pumping. With implementation of these two interventions, a total of 180 mcm/year can be saved. This may lead to a total reduction in ground water draft from 546.94 mcm/year to 431.75 mcm/year and with this; the stage of ground water development may come down from 104.73% to 80.63%. These interventions may progressively lead to further improvement in ground water situation over the years. Enhancement of ground water resources through artificial recharge, improved irrigation practices and change in cropping pattern is abridged below as under.

Sprinkler

- Area proposed under irrigation by sprinkler – 140304 ha (50% of gross irrigated area)
- Net Water saving - 112 mcm/year

Change in cropping pattern

- From wheat to gram in 67872 ha irrigated area
- Net water saving - 68 mcm/year

- **Total water saving :** 180 mcm/year

Block wise details of ground water recharged and saved along with expected improvement in stage of ground water development is given in Table 20.

Table 20: Summary of Expected Benefit of Management Strategies

Block	Net G.W. Availability (mcm)	Additional Recharge from recharge shafts (mcm)	Additional Recharge from percolation tanks (mcm)	Total Recahrge (mcm)	Total Net G.W. Availability after intervention (mcm)	Existing G.W Draft for all purpose (mcm)	Saving of Ground water through projects (mcm)	Net GW draft after interventions (mcm)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
Itawa	130.80	0.36	1.69	2.05	132.85	118.89	19.62	99.27	90.90	74.73
Khairabad	49.08	0.60	1.02	1.62	50.70	72.93	18.69	54.25	148.59	106.99
Ladpura	114.37	0.51	3.96	4.47	118.83	94.23	23.62	70.61	82.39	59.42
Sangod	74.12	0.75	2.05	2.80	76.92	131.39	23.13	108.26	177.25	140.74
Sultanpur	153.89	0.78	1.53	2.31	156.19	129.50	30.14	99.36	84.15	63.61
Total	522.26	3.00	10.24	13.24	535.50	546.94	115.19	431.75	104.73	80.63

The perusal of data indicate that saving of ground water through projects may lead to decrease in the net ground water draft and may reduce the stage of ground water development from 104.73% to 80.63% after interventions.

PART B
BLOCK WISE AQUIFER MANAGEMENT PLANS OF
5 BLOCKS OF KOTA DISTRICT

1. Aquifer Management Plan of Block -Itawa, District-Kota

Salient Information	**Block**	**Itawa**
	Geographical Area (km2)	898.51
	Forest Area (Sq.km)	1
	Potential Area (Sq.km)	897.51
Climate & Rainfall	Climate	Semi Arid
	Average Rainfall (1971-2016)	756.5 mm
Ground Water Issues	Aquifer Characteristics	Alluvium and Unconfined aquifer
	Main Aquifers in the area	Alluvium/ Limestone
Aquifer System	Aquifer Disposition	Weathered alluvium followed by Limestone
	Geology	Alluvium and Limestone
	Maximum Depth of Aquifer in meter	208
	Type of Aquifer	Unconfined
	Thickness of Aquifer (Utilisable)	138.31
	Hydraulic Characters (sp.yield%)	0.015
Water Level Behaviour, DTW (m)	Depth to Water Level (m BGL)	11.75
	Trend (m/yr)	0.17
Groundwater Resources	Total annual ground water recharge(mcm)	145.3331
	Natural discharge during non-monsoon season(mcm)	14.5333
	Net ground water availability(mcm)	130.7998
	Existing gross ground water draft for irrigation(mcm)	112.8188
	Existing gross ground water draft for domestic & industrial uses(mcm)	6.0719
	Existing gross ground water draft for all uses(mcm)	118.8907

Salient Information	**Block**	**Itawa**
	Allocation for domestic & industrial requirement(mcm)	11.7001
	Net ground water availability for future irrigation development(mcm)	30.1451
	State of ground water development	90.90
	Category	Critical
Supply Side Management	Space Available for Recharge (mcm)	897.51
	Area of Block (Sq.km.)	898.51
	Potential area suitable for recharge (Sq.km.)	897.51
	Area feasible for artificial recharge (Sq km)	897.51
	Sp Yield	0.015
	Average DTW (m bgl)	11.75
	Thickness of unsaturated zone 3 m below ground level (m)	8.78
	Volume of sub surface storage space available for artificial recharge (MCM)	158.19
	Surplus Runoff Availability	202.14
	Surplus available (MCM)	6.74
	Surplus available in zone as per the water level (in Mm3)	3.74
	Recharge Shafts Proposed in existing water bodies	12
	Percolation Tanks Proposed	56
Demand side Management	Use of Advanced Irrigation Practices to be promoted	
	(i)Use of Sprinklers	
	Total Irrigated Area (ha)	3614
	Irrigated Area (ha) proposed for irrigation through sprinkler	1807
	Water Saving by Use of Sprinklers	1.45
	(ii)Change in Cropping pattern	
	Irrigated Area under wheat (ha)	32961
	Irrigated Area (ha) under wheat proposed for Gram cultivation	16481
	Water Saving by change in cropping pattern	16.48
Expected Benefits	Net G.W. Availability (MCM)	130.80

Salient Information	Block	Itawa
	Additional Recharge from RWH & water conservation (MCM)	2.05
	Total Net G.W. Availability after intervention (MCM)	132.85
	Existing G.W Draft for all purpose (MCM)	118.89
	Saving of Ground water through demand side intervention (MCM)	19.62
	Net GW draft after interventions (MCM)	99.27
	Present stage of G.W. development (in %)	90.90
	Expected stage of G.W. Dev. (in %)	74.73
Other Interventions proposed, if any	Alternate water Sources available	Canal Network

2. Aquifer Management Plan of Block - Khairabad, District-Kota

Salient Information	Block	Khairabad
	Geographical Area (km2)	794.26
	Forest Area (Sq.km)	43.66
	Potential Area (Sq.km)	750.6
Climate & Rainfall	Climate	Semi arid
	Average Rainfall (1971-2016)	933.2 mm
Ground Water Issues	Aquifer Characteristics	Limestone/Sandstone, Unconfined aquifer
	Main Aquifers in the area	Alluvium/Limestone
Aquifer System	Aquifer Disposition	Weathered alluvium followed by Limestone/Sandstone
	Geology	Sandstone/Limestone
	Maximum Depth of Aquifer in meter	261
	Type of Aquifer	Unconfined Aquifer
	Thickness of Aquifer (Utilisable)	172.2

Salient Information	**Block**	**Khairabad**
	Hydraulic Characters (sp.yield%)	0.015
Water Level Behaviors, DTW (m)	Depth to Water Level (m BGL)	15.35
	Trend (m/yr)	-0.64
Groundwater Resources	Total annual ground water recharge(mcm)	54.5348
	Natural discharge during non-monsoon season(mcm)	5.4535
	Net ground water availability(mcm)	49.0813
	Existing gross ground water draft for irrigation(mcm)	63.9104
	Existing gross ground water draft for domestic & industrial uses(mcm)	9.0211
	Existing gross ground water draft for all uses(mcm)	72.9315
	Allocation for domestic & industrial requirement(mcm)	12.8100
	Net ground water availability for future irrigation development(mcm)	0.0000
	State of ground water development	148.59
	Category	Over-Exploited
Supply Side Management	Space Available for Recharge (mcm)	750.6
	Area of Block (Sq.km.)	794.26
	Potential area suitable for recharge (Sq.km.)	750.6
	Area feasible for artificial recharge (Sq km)	750.6
	Thickness of unsaturated zone 3 m below ground level (m)	12
	Volume of sub surface storage space available for artificial recharge (MCM)	164.38
	Surplus Runoff Availability	169.13
	Surplus available (MCM)	5.64
	Surplus available in zone as per the water level (in Mm3)	2.64
	Recharge Shafts Proposed in existing water bodies	20
	Percolation Tanks Proposed	34

Salient Information	Block	Khairabad
Demand side Management	Use of Advanced Irrigation Practices to be promoted	
	(i)Use of Sprinklers	
	Total Irrigated Area (ha)	35434
	Irrigated Area (ha) proposed for irrigation through sprinkler	17717
	Water Saving by Use of Sprinklers	14.17
	(ii)Change in Cropping pattern	
	Irrigated Area under wheat (ha)	6986
	Irrigated Area (ha) under wheat proposed for Gram cultivation	3493
	Water Saving by change in cropping pattern	3.49
Expected Benefits	Net G.W. Availability (MCM)	49.08
	Additional Recharge from RWH & water conservation (MCM)	1.62
	Total Net G.W. Availability after intervention (MCM)	50.70
	Existing G.W Draft for all purpose (MCM)	72.93
	Saving of Ground water through demand side intervention (MCM)	18.69
	Net GW draft after interventions (MCM)	54.25
	Present stage of G.W. development (in %)	89.04
	Expected stage of G.W. Dev. (in %)	106.99
Other Interventions proposed, if any	Alternate water Sources available	Nil

3. Aquifer Management Plan of Block –Ladpura, District-Kota

Salient Information	Block	Ladpura
	Geographical Area (km2)	1540.80
	Forest Area (Sq.km)	19.4
	Potential Area (Sq.km)	1521.4
Climate & Rainfall	Climate	Semi arid
	Average Rainfall (1971-2016)	Mm

Salient Information	**Block**	**Ladpura**
Ground Water Issues	Aquifer Characteristics	Limestone/Sandstone, Unconfined aquifer
	Main Aquifers in the area	Alluvium/limestone
Aquifer System	Aquifer Disposition	Weathered alluvium followed by Limestone/Sandstone
	Geology	Sandstone/Limestone
	Maximum Depth of Aquifer in meter	175
	Type of Aquifer	Unconfined Aquifer
	Thickness of Aquifer (Utilisable)	123.25
	Hydraulic Characters (sp.yield%)	0.015
Water Level Behaviour, DTW (m)	Depth to Water Level (m BGL)	16.85
	Trend (m/yr)	0.48
Groundwater Resources	Total annual ground water recharge(mcm)	127.0726
	Natural discharge during non-monsoon season(mcm)	12.7072
	Net ground water availability(mcm)	114.3654
	Existing gross ground water draft for irrigation(mcm)	79.4244
	Existing gross ground water draft for domestic & industrial uses(mcm)	14.8030
	Existing gross ground water draft for all uses(mcm)	94.2274
	Allocation for domestic & industrial requirement(mcm)	26.6462
	Net ground water availability for future irrigation development(mcm)	11.1760
	State of ground water development	82.39
	Category	Semi-critical
Supply Side Management	Space Available for Recharge (mcm)	1521.4
	Area of Block (Sq.km.)	1540.80

Salient Information	**Block**	**Ladpura**
	Potential area suitable for recharge (Sq.km.)	1521.4
	Area feasible for artificial recharge (Sq km)	1521.4
	Thickness of unsaturated zone 3 m below ground level (m)	8.38
	Volume of sub surface storage space available for artificial recharge (MCM)	267
	Surplus Runoff Availability	342.801
	Surplus available (MCM)	11.43
	Surplus available in zone as per the water level (in Mm3)	8.43
	Recharge Shafts Proposed in existing water bodies	17
	Percolation Tanks Proposed	132
Demand side Management	Use of Advanced Irrigation Practices to be promoted	
	(i)Use of Sprinklers	
	Total Irrigated Area (ha)	17929
	Irrigated Area (ha) proposed for irrigation through sprinkler	8965
	Water Saving by Use of Sprinklers	7.17
	(ii)Change in Cropping pattern	
	Irrigated Area under wheat (ha)	24972
	Irrigated Area (ha) under wheat proposed for Gram cultivation	12486
	Water Saving by change in cropping pattern	12.49
Expected Benefits	Net G.W. Availability (MCM)	114.37
	Additional Recharge from RWH & water conservation (MCM)	4.47
	Total Net G.W. Availability after intervention (MCM)	118.83
	Existing G.W Draft for all purpose (MCM)	94.23
	Saving of Ground water through demand side intervention (MCM)	23.62
	Net GW draft after interventions (MCM)	70.61
	Present stage of G.W. development (in %)	98.26

Salient Information	Block	Ladpura
	Expected stage of G.W. Dev. (in %)	59.42
Other Interventions proposed, if any	Alternate water Sources available	Canal network

4. Aquifer Management Plan of Block –Sangod, District-Kota

Salient Information	Block	Sangod
	Geographical Area (km2)	1057.80
	Forest Area (Sq.km)	19.4
	Potential Area (Sq.km)	1044.1
Climate & Rainfall	Climate	Semi arid
	Average Rainfall (1971-2016)	799.9 mm
Ground Water Issues	Aquifer Characteristics	Limestone,Sandstone & Shale, Unconfined aquifer
	Main Aquifers in the area	Sandstone/Limestone
Aquifer System	Aquifer Disposition	Weathered alluvium followed by Limestone/Sandstone/Shale
	Geology	Sandstone,Limestone,Shale
	Maximum Depth of Aquifer in meter	174
	Type of Aquifer	Unconfined Aquifer
	Thickness of Aquifer (Utilisable)	112.64
	Hydraulic Characters (sp.yield%)	0.015
Water Level Behaviour, DTW (m)	Depth to Water Level (m BGL)	15.3
	Trend (m/yr)	-0.78
Groundwater Resources	Total annual ground water recharge(mcm)	82.3609

Salient Information	**Block**	**Sangod**
	Natural discharge during non-monsoon season(mcm)	8.2361
	Net ground water availability(mcm)	74.1248
	Existing gross ground water draft for irrigation(mcm)	121.1211
	Existing gross ground water draft for domestic & industrial uses(mcm)	10.2679
	Existing gross ground water draft for all uses(mcm)	131.3890
	Allocation for domestic & industrial requirement(mcm)	27.0029
	Net ground water availability for future irrigation development(mcm)	0.0000
	State of ground water development	175.25
	Category	Over-exploited
Supply Side Management	Space Available for Recharge (mcm)	1044.1
	Area of Block (Sq.km.)	1057.80
	Potential area suitable for recharge (Sq.km.)	1044.1
	Area feasible for artificial recharge (Sq km)	1044.1
	Thickness of unsaturated zone 3 m below ground level (m)	10.36
	Volume of sub surface storage space available for artificial recharge (MCM)	209.87
	Surplus Runoff Availability	235.28
	Surplus available (MCM)	7.84
	Surplus available in zone as per the water level (in Mm3)	4.84
	Recharge Shafts Proposed in existing water bodies	25
	Percolation Tanks Proposed	68
Demand side Management	Use of Advanced Irrigation Practices to be promoted	
	(i)Use of Sprinklers	
	Total Irrigated Area (ha)	35781
	Irrigated Area (ha) proposed for irrigation through sprinkler	17891
	Water Saving by Use of Sprinklers	14.31

Salient Information	Block	Sangod
	(ii)Change in Cropping pattern	
	Irrigated Area under wheat (ha)	13539
	Irrigated Area (ha) under wheat proposed for Gram cultivation	6770
	Water Saving by change in cropping pattern	6.77
Expected Benefits	Net G.W. Availability (MCM)	74.12
	Additional Recharge from RWH & water conservation (MCM)	2.80
	Total Net G.W. Availability after intervention (MCM)	76.92
	Existing G.W Draft for all purpose (MCM)	131.39
	Saving of Ground water through demand side intervention (MCM)	23.13
	Net GW draft after interventions (MCM)	108.26
	Present stage of G.W. development (in %)	109.63
	Expected stage of G.W. Dev. (in %)	140.74
Other Interventions proposed, if any	Alternate water Sources available	Canal network

5. Aquifer Management Plan of Block –Sultanpur, District-Kota

Salient Information	Block	Sultanpur
	Geographical Area (km2)	912.57
	Forest Area (Sq.km)	
	Potential Area (Sq.km)	909.57
Climate & Rainfall	Climate	Semi arid
	Average Rainfall (1971-2016)	815.0 mm
Ground Water Issues	Aquifer Characteristics	Alluvium & Limestone, Unconfined aquifer
	Main Aquifers in the area	Alluvium/Limestone
Aquifer System	Aquifer Disposition	Weathered alluvium

Salient Information	**Block**	**Sultanpur**
		followed by Limestone
	Geology	Alluvium,Limestone
	Maximum Depth of Aquifer in meter	170
	Type of Aquifer	Unconfined Aquifer
	Thickness of Aquifer (Utilisable)	98.60
	Hydraulic Characters (sp.yield%)	0.015
Water Level Behaviour, DTW (m)	Depth to Water Level (m BGL)	15.3
	Trend (m/yr)	-0.61
	Fluoride in mg/litre (Min/Max)	
Groundwater Resources	Total annual ground water recharge(mcm)	167.4174
	Natural discharge during non-monsoon season(mcm)	13.5320
	Net ground water availability(mcm)	153.8854
	Existing gross ground water draft for irrigation(mcm)	119.4619
	Existing gross ground water draft for domestic & industrial uses(mcm)	10.0316
	Existing gross ground water draft for all uses(mcm)	129.4995
	Allocation for domestic & industrial requirement(mcm)	12.8352
	Net ground water availability for future irrigation development(mcm)	25.7395
	State of ground water development	84.15
	Category	Semi-critical
Supply Side Management	Space Available for Recharge (mcm)	909.57
	Area of Block (Sq.km.)	912.57
	Potential area suitable for recharge (Sq.km.)	909.57
	Area feasible for artificial recharge (Sq km)	909.57
	Thickness of unsaturated zone 3 m below ground level (m)	8.35
	Volume of sub surface storage space available for artificial recharge (MCM)	158.27

Salient Information	**Block**	**Sultanpur**
	Surplus Runoff Availability	204.95
	Surplus available (MCM)	6.83
	Surplus available in zone as per the water level (in Mm3)	3.83
	Recharge Shafts Proposed in existing water bodies	26
	Percolation Tanks Proposed	51
Demand side Management	Use of Advanced Irrigation Practices to be promoted	
	(i)Use of Sprinklers	
	Total Irrigated Area (ha)	12701
	Irrigated Area (ha) proposed for irrigation through sprinkler	6351
	Water Saving by Use of Sprinklers	5.08
	(ii)Change in Cropping pattern	
	Irrigated Area under wheat (ha)	47067
	Irrigated Area (ha) under wheat proposed for Gram cultivation	23534
	Water Saving by change in cropping pattern	23.53
Expected Benefits	Net G.W. Availability (MCM)	153.89
	Additional Recharge from RWH & water conservation (MCM)	2.31
	Total Net G.W. Availability after intervention (MCM)	156.19
	Existing G.W Draft for all purpose (MCM)	129.50
	Saving of Ground water through demand side intervention (MCM)	30.14
	Net GW draft after interventions (MCM)	99.36
	Present stage of G.W. development (in %)	97.00
	Expected stage of G.W. Dev. (in %)	63.61
Other Interventions proposed, if any	Alternate water Sources available	Canal network

ANNEXURE I-LOCATION OF EXPLORATORY WELL BY RGWD

DISTRICT	BLOCK	VILLAGE	TYPE	MP	DEPTH	WELL LOCATION	LONG	LAT	ELEVATION
KOTA	Itawa	AYANA	Dug	0.53	21.17	LHS of road from Mangrol to Itawa, Owner-Boraji,Back side of Dhakad stationary	76.43	25.45	245
KOTA	Itawa	GAINTA	Dug	0.94	27	In the village near Patwar's house.	76.31	25.58	224
KOTA	Itawa	KESHAVPURA	Dug	0.9	12.12	10 m RHS of Khatoli-Itawa road at the entrance of village. Village is 8 kms from Itawa and 13 km from Khatoli, Near Transformar.	76.4	25.44	247
KOTA	Itawa	KHATOLI	Dug	0.9	15.5	Behind Govt Secondary School.	76.48	25.68	208
KOTA	Ladpura	ALANIA	Dug	1.1	12.2	LHS of Kota-Jhalawar road near kmstone 62 Jhalawar & 23 Kota. Adjoining Carrier Point University in front of Payal haritage gate.	75.89	25.04	348
KOTA	Ladpura	BORAWAS	Dug	1.35	7.15	About 300 m RHS of road from Kota to Rawatbhata,well is called Sarkari kua(PHED) near baori.	75.7	25.02	468
KOTA	Ladpura	DARA	Dug	0.65	4	20 mt. LHS of Kota-Jhalawar road, about 34.2 kms from Jhalawar. Well is 20 m east of road towards Jhalawar at kmstone Jhalawar 34,in front of Rly bridge.	75.98	24.91	363
KOTA	Ladpura	GIRDHARPURA	Dug	0	7	Village is about 1 km east of Kota-Bundi road about 4.5 kms from Kota. Well is 100m westof Mataji Ka Sthan (Sarawati Mata ji) in the field of sh. Mohanlal	75.84	25.23	253

						mali.			
KOTA	Ladpura	GUDLI	Dug	0.88	14.82	On Kota-Kehavaraipatan road, 16 kms from Kota. Well is LHS of road 500 m after toll tax.	75.92	25.27	250
KOTA	Ladpura	KHERARASULPUR	Dug	0.69	11.83	Village is 1.5 kms from main road. Well is Opposite to Jain Agro Service Petrol pump on Kaithun road,opp Bharat Petroleum. Raipur to Kaithun road.	75.97	25.12	259
KOTA	Ladpura	KOTA1	Dug	0.59	18.31	In the premises of Neel Kanth Mahadeo Temple towards Kota Barrage.	75.85	25.18	261
KOTA	Ladpura	MANDANA	Dug	0.68	13.42	50 m N25E of Govt.Veternary Hospital between milestone 10/4 and 19/5 on Kota-Jhalawar road.	75.93	24.93	373
KOTA	Sultanpur	DIGOD1	Dug	1.2	6.25	Kota Sultanpur road RHS of the road,just on and before the entry of the village near a big abondoned baori (Maharaj ka kua).	76.09	25.24	262
KOTA	Sultanpur	GADEPAN	Dug	0.9	10.99	LHS of Kota-Baran road. Near Hanuman Temple on the road side (Old road)	76.18	25.18	247
KOTA	Sultanpur	MANDAVRA	Dug	0.68	16.28	500M SE of village,LHS of road at the entrance of village.	76.16	25.37	219
KOTA	Sultanpur	RAJGARH1	Dug	0.1	22.9	100 m LHS of Palayat road behind the house of Sri Moti Lal Mali,NW of village known as Gaoraka ka kua.	76.2	25.1	251
KOTA	Sultanpur	RATTANPURA	Dug	0.8	21.17	LHS of road from Sultanpur-Itawa opp. house of Sri Chandanlal Meena,village is 19 km from Sultanpur. Before toll Near Chatri tample	76.3	25.37	235

ANNEXURE II-LOCATION OF EXPLORATORY WELLS BY CGWB

BLOCK	LOCATION	VILLAGE	LAT	LONG	TYPE	YEAR _CONS	DEPTH DRILLED	SWL_ m	DIS(LMP)	EC
Sangod	Sagod	Sangod (M)	24°55'00"	76°17'00"	OW	1979-82	56	12.32	243	
Khairabad	Suket	Suket (Ct)	24°39'00"	76°02'00"	EW	1979-82	90	6.85		605
Khairabad	Ramganj Mandi	Ramganj Mandi (M)	24°38'00"	75°56'00"	EW	1979-82	90	6.9	10	1180
Khairabad	Chechat	Chechat (Ct)	24°45'00"	75°53'00"	EW	1979-82	90	7.93	40	535
Sangod	Sagod	Sangod (M)	24°55'00"	76°17'00"	EW	1979-82	57	12.23	360	1090
Ladpura	Anwa	Bheenlot	24°55'00"	76°00'00"	EW	1979-82	55	3.112		960
Sangod	Darah	Moru Khurd	24°50'00"	76°00'00"	EW	1979-82	57	8.122	60	205
Itawa	Ganta	Genta	25°35'00"	76°19'00"	EW	1979-82	58.5	12.46	142	1015
Itawa	Khatoli	Khatauli	25°41'00"	76°28'00"	EW	1979-82	24.4	6.8	563	1535
Ladpura	Adarshnagar	Kota (M Corp.)	25°11'00"	75°51'00"	EW	2001-02	70.5	5.55	50	1320
Ladpura	Ranpur	Ranpur	25°02'35"	75°50'35"	EW	2001-02	120	22.85	40	640
Ladpura	Rangbari	Kota (M Corp.)	25°11'00"	75°51'00"	EW	2001-02	90	2.05	125	300
Ladpura	Anantpura - II (EW)	Kota (M Corp.)	25°11'00"	75°51'00"	EW	2002-03	25.8			400
Sultanpur	Sultanpur	Zalimpura	25°17'00"	76°10'00"	EW	2003-04	108.76	22.61	600	2900
Sultanpur	Motikua	Rugghi	25°10'04"	76°13'04"	EW	2003-04	170.47	20.04	72	2070
Sangod	Bapawar	Bhoola Heri	24°55'00"	76°24'00"	EW	2003-04	170.47			
Sangod	Kamolar	Kamolar	24°55'13"	76°21'49"	EW	2003-04	170.47	95.74	347	7530
Sangod	Sawan bhadon	Sawan Bhadon	24°54'08"	76°07'07"	EW	2003-04	175	8.62	45	1120
Sangod	Morukalan	Kishor Sagar	24°50'02"	76°00'44"	EW	2003-04	152	13.65	660	380
Ladpura	Dobra	Dobara	24°51'24"	75°59'25"	EW	2003-04	175	44.15		
Khairabad	Chechat	Chandrapura	24°45'00"	75°52'00"	EW	2003-04	175	18.84	156	1350
Sangod	Lavania	Kotra	24°55'54"	76°26'17"	EW	2003-04	156.65	36.85	529	1220
Ladpura	Godaliya heri	Godalyaheri	25°08'30"	76°00'20"	EW	2003-04	175	82.34	528	880
Ladpura	Kishanpura	Kishanpura Kaithoon	25°07'40"	76°00'55"	EW	2003-04	118.55	62.12	732	730
Ladpura	Ranpur	Ranpur	25°02'30"	75°50'00"	EW	2003-04	175	27.26	660	280
Ladpura	Mandana	Hirapur	24°57'00"	75°55'00"	EW	2003-04	175	40.3	600	580
Sultanpur	Budait	Budhadeet	25°23'00"	76°15'00"	SH	1979-82	32.4			1440
Sangod	Sagod	Sangod (M)	24°55'00"	76°17'00"	PZ	1979-82	56	13.035	154	

ANNEXURE- III-LOCATION OF MONITORING WELLS BY RGWB

POINT_X	POINT_Y	BLOCK	VILLAGE	WELL_TYPE	TOTAL_DEPTH	AQUIFER
647262.75	2813319.18	Itawa	Ayana	D/W	31.7	Limestone
639498.99	2813411.24	Itawa	Ayani	D/W	60	Limestone
631732.25	2832858.88	Itawa	Bambooliya Kalan	D/W	20.95	Younger Alluvium
631673.1	2832916.64	Itawa	Bambooliya Kalan	P/Z		Younger Alluvium
652869.61	2816224.69	Itawa	Baroli	D/W		Limestone
641497.73	2837138.46	Itawa	Bhopalganj	D/W	36	Younger Alluvium
635183.43	2813051.75	Itawa	Binayaka	D/W	28	Younger Alluvium
640935.69	2817255.93	Itawa	Chanda	D/W	28.8	Younger Alluvium
638749.39	2842239.23	Itawa	Dheepri (Chambal)	D/W	29.6	Younger Alluvium
639119.56	2827975.64	Itawa	Fatehpura (Rampura)	D/W	20.25	Younger Alluvium
640263.97	2817586.97	Itawa	Ganeshganj	D/W	26	Younger Alluvium
634302.02	2828804.73	Itawa	Genta	D/W	35	Younger Alluvium
637894.64	2822836.13	Itawa	Gondi	D/W	12.9	Younger Alluvium
654167.59	2814110.68	Itawa	Haripura	D/W	16.75	Limestone
637553.23	2835197.08	Itawa	Hatholi	D/W	7.5	Younger Alluvium
637176.52	2834559.46	Itawa	Hatholi	P/Z		Younger Alluvium
637415.78	2824706.05	Itawa	Itawa	D/W	23.6	Younger Alluvium
639182.06	2827308.59	Itawa	Itawa	P/Z		Younger Alluvium
638851.38	2808209.41	Itawa	Jaloda Khatiyan	D/W	15	Limestone
637719.67	2809886.53	Itawa	Jaloda Khatiyan	P/Z		Limestone
639332.81	2809143.25	Itawa	Jaloda Khatiyan	D/W	15	Limestone
632581.39	2838383.72	Itawa	Kakrawada	D/W	60	Younger Alluvium
647437.89	2812680.97	Itawa	Kamalda	D/W	20.6	Limestone
644898.42	2830261.71	Itawa	Karwar	D/W	10.5	Younger Alluvium
645673.03	2830694.79	Itawa	Karwar	P/Z		Younger Alluvium
640208.76	2832580.39	Itawa	Keshopura	D/W	18	Younger Alluvium
646557.2	2841829.44	Itawa	Khatauli	P/Z		Younger Alluvium
646939.04	2842419.24	Itawa	Khatauli	D/W	18.13	Younger Alluvium
643377.35	2827981.36	Itawa	Kherda	D/W	20.9	Younger Alluvium
643403.64	2826428.76	Itawa	Kherli Borda	D/W	50	Younger Alluvium
652233.82	2816135.24	Itawa	Laxmipura	P/Z	18.4	Limestone
647500.61	2819257.77	Itawa	Luhawad	D/W	14.5	Younger Alluvium
637414.87	2817491.25	Itawa	Mugena	D/W	19.35	Younger Alluvium
633682.82	2823892.99	Itawa	Naunera	D/W	22.9	Younger Alluvium
632841.86	2823687.96	Itawa	Naunera	P/Z		Younger Alluvium
638874.03	2847936.28	Itawa	Neemola	D/W	13.5	Younger Alluvium
654881.53	2814195.83	Itawa	Nimoda	D/W	60	Limestone
647050.42	2827689.53	Itawa	Peepalda Kalan	D/W	21.5	Younger Alluvium

639303.56	2830614.72	Itawa	Rajopa	D/W	10.35	Younger Alluvium
637256.23	2830996.17	Itawa	Rampura	D/W	15.8	Younger Alluvium
642342.49	2839417.69	Itawa	Talab	D/W	16.3	Younger Alluvium
582036.95	2742529	Khairabad	Alod	D/W	19	Sandstone
605579.09	2721562.13	Khairabad	Bansya Heri	D/W	25	Limestone
609239.84	2730769.91	Khairabad	Barodiya Antari	D/W	32.1	Sandstone
594095.93	2740608.56	Khairabad	Bholoo	D/W	60	Limestone
586964.68	2727611.31	Khairabad	Boodhan Kheri	D/W	25.3	Limestone
589725.19	2740042.73	Khairabad	Chechat (Ct)	D/W	90	Limestone
585773.12	2743598.57	Khairabad	Deoli Kalan	D/W	23	Sandstone
595688.06	2721392.55	Khairabad	Deoli Khurd	D/W	17.5	Limestone
587389.2	2748784.36	Khairabad	Ghatoli	D/W	29.8	Sandstone
594485.92	2731743.91	Khairabad	Goondi	D/W	60	Limestone
587530.52	2725472.13	Khairabad	Goyanda	D/W	22	Limestone
586884.45	2740464.51	Khairabad	Jagpura Khurd	D/W	6.1	Sandstone
599768.22	2719488.5	Khairabad	Julmi	P/Z		Limestone
599127.24	2719620.89	Khairabad	Julmi	D/W	53	Limestone
602582.46	2732575.96	Khairabad	Kheemach	D/W	22	Limestone
599482.09	2726495.71	Khairabad	Kudayla	D/W	17	Limestone
601170.7	2723254.56	Khairabad	Kumbhkot (Ct)	P/Z	60	Limestone
602893.9	2725876.64	Khairabad	Mandi Nathan	D/W	22	Limestone
593099.31	2746137.36	Khairabad	Manoharpura	D/W	25	Sandstone
599212.6	2727669.45	Khairabad	Mayla	D/W	60	Limestone
598224.8	2735698.8	Khairabad	Modak (Ct)	D/W	36	Limestone
597553.25	2735442.75	Khairabad	Modak (Ct)	D/W		Limestone
598695.52	2744213.4	Khairabad	Mukundara	D/W	20	Sandstone
598240.63	2721487.64	Khairabad	Nalodiya	D/W	28	Limestone
595911.42	2724431.93	Khairabad	Ramganj Mandi (M)	D/W		Limestone
595319.74	2724058.63	Khairabad	Ramganj Mandi (M)	D/W	60	Limestone
592170.48	2722129.32	Khairabad	Rawali	D/W	20	Limestone
582375.95	2740385.14	Khairabad	Reenchhi	D/W	22.6	Sandstone
606854.42	2729814.71	Khairabad	Salawad Khurd	D/W	20.25	Sandstone
589488.24	2736599.88	Khairabad	Salera Kalan	D/W	18	Sandstone
589655.93	2735998.89	Khairabad	Salera Kalan	D/W	18.5	Sandstone
596523.12	2723433.43	Khairabad	Sandpur	D/W	24.75	Limestone
605092.96	2726699.73	Khairabad	Suket (Ct)	D/W		Limestone
604143.96	2726736.73	Khairabad	Suket (Ct)	P/Z	20.6	Limestone
604516.61	2723550.38	Khairabad	Surera	D/W	12.35	Limestone
603896.56	2717159.4	Khairabad	Udpura	D/W	16.4	Limestone
604572.82	2727296.62	Khairabad	Ummedpura	D/W		Limestone

590035.17	2719497.99	Khairabad	Undwa	D/W	22	Limestone
599631.06	2739193.58	Khairabad	Zalimpura	D/W	20	Limestone
589683.46	2767984.65	Ladpura	Alniya	D/W		Sandstone
593591.17	2755417.12	Ladpura	Bakshpura	D/W	25.5	Sandstone
604712.45	2772888.62	Ladpura	Balapura	D/W	19.95	Sandstone
569636.94	2767620.3	Ladpura	Borawas	D/W	50	Sandstone
569264.8	2768209.37	Ladpura	Borawas	P/Z		Sandstone
593506	2786287.6	Ladpura	Borkhandi	D/W	9.1	Sandstone
580800.71	2779898.47	Ladpura	Daulatganj @ Naya Gaon	D/W	9.5	Sandstone
591861.2	2781855.47	Ladpura	Dhakarkheri	D/W	11.8	Sandstone
605533.28	2774796.49	Ladpura	Galana	D/W	13.8	Sandstone
603341.69	2780930.27	Ladpura	Godalyaheri	D/W	19.7	Limestone
598265.02	2754083.47	Ladpura	Gopalpura	D/W	20	Sandstone
591952.13	2764451	Ladpura	Kasar	D/W	65	Sandstone
583636.17	2762686.66	Ladpura	Kolana @ Laxmipura	D/W	60	Sandstone
569247.36	2761149.56	Ladpura	Kolipura	D/W	12.15	Sandstone
586376.93	2782712.95	Ladpura	Kota (M Corp.)	D/W	33	Sandstone
579554.27	2792591.82	Ladpura	Kota (M Corp.)	D/W	20.5	Sandstone
582298.81	2785499.67	Ladpura	Kota (M Corp.)	D/W	17.8	Sandstone
582716.1	2789675.6	Ladpura	Kota (M Corp.)	D/W	11.1	Sandstone
585197.72	2783994.55	Ladpura	Kota (M Corp.)	D/W	21	Sandstone
581594.17	2788892.42	Ladpura	Kota (M Corp.)	P/Z		Sandstone
592849.21	2779914.89	Ladpura	Kota (M Corp.)	D/W	8.2	Sandstone
591020.35	2792196.48	Ladpura	Kota (M Corp.)	D/W	18.6	Limestone
588355.89	2789436.21	Ladpura	Kota (M Corp.)	D/W	18.3	Limestone
599966.01	2777942.57	Ladpura	Ladpura Kaithoon	D/W		Sandstone
598831.72	2777898.68	Ladpura	Ladpura Kaithoon	D/W	20	Sandstone
595889.19	2759259.36	Ladpura	Mandana	D/W	96	Sandstone
597749.14	2791604.14	Ladpura	Notana	D/W	12.1	Limestone
590195.44	2767432.97	Ladpura	Pachpahar	P/Z	57	Sandstone
593720.58	2796234.13	Ladpura	Rangpur	D/W	19.75	Limestone
582946.53	2769160.86	Ladpura	Ranpur	D/W	11.9	Sandstone
593167.02	2753231.8	Ladpura	Ranwatha	D/W	11.5	Sandstone
576001.65	2774396.84	Ladpura	Rath Kankra	D/W	12.5	Sandstone
593506.71	2772384.07	Ladpura	Rooparel	D/W	2.4	Sandstone
600348.09	2767548.17	Ladpura	Shankarpura	D/W	36	Sandstone
598893.25	2787055.23	Ladpura	Tather	D/W	80	Limestone

576045.65	2755123.96	Ladpura	Udpura	D/W	50	Sandstone
643876.63	2757920.04	Sangod	Bapawar Kalan	D/W	15.2	Sandstone
614482.92	2747324.03	Sangod	Basyaheri	D/W	14.2	Sandstone
642561.52	2755282.91	Sangod	Bhoola Heri	D/W		Sandstone
643420.28	2760017.9	Sangod	Boodhani	D/W	21.6	Sandstone
634389.21	2757481.12	Sangod	Borda	D/W	43	Shale
626055.39	2752149.39	Sangod	Borina Kalan	D/W	50	Sandstone
621070.17	2744866.4	Sangod	Dhoolet	D/W	60	Sandstone
615576.62	2769996.76	Sangod	Dhoti	P/Z	60	Limestone
614801.22	2770480.65	Sangod	Dhoti	D/W		Limestone
615151.66	2769488.91	Sangod	Dhoti	D/W	10	Limestone
634551.15	2756150.32	Sangod	Digod	D/W	60	Shale
635348.68	2756392.51	Sangod	Digod	D/W	60	Shale
641473.95	2752390.97	Sangod	Doongarpur	D/W	16.5	Sandstone
640175.09	2758267.89	Sangod	Gehun Kheri	D/W	18.8	Sandstone
616307.26	2752759.27	Sangod	Hingoniya	D/W	50	Sandstone
629739.28	2754937.4	Sangod	Jogara	D/W	18.3	Shale
632488.16	2752918.79	Sangod	Jogari	D/W	60	Shale
620674.57	2746064.74	Sangod	Kalya Kheri	D/W	23.1	Sandstone
636679.52	2756432.41	Sangod	Kamolar	D/W	28	Shale
612756.21	2749760.78	Sangod	Kanwas	D/W	23.5	Sandstone
610218.47	2766630.76	Sangod	Khajoori	P/Z	45	Limestone
608363.51	2760626.7	Sangod	Khajoorna	D/W	24	Sandstone
604635.44	2748706.03	Sangod	Kishor Sagar	D/W	10	Sandstone
608739.96	2771473.4	Sangod	Kurar	D/W	12	Limestone
643340.33	2755130.62	Sangod	Latoora	P/Z	44	Sandstone
624805.6	2756088.19	Sangod	Laxmipura	D/W	19.8	Sandstone
611274.42	2751775.24	Sangod	Madhopur	D/W	12.2	Sandstone
618661.43	2765114.34	Sangod	Makrawad	D/W	20	Limestone
632290.44	2750379.52	Sangod	Moi Khurd	D/W	11.7	Shale
641302.03	2750622.62	Sangod	Moikalan	D/W	60	Sandstone
611738.3	2749660.91	Sangod	Moru Kalan	D/W	22	Sandstone
611345.86	2761228.64	Sangod	Peesahera	D/W	50	Sandstone
623702.05	2767278.15	Sangod	Rolana	D/W	60	Sandstone
619609.93	2756660.38	Sangod	Roopahera	D/W	68	Sandstone
613492.05	2755615.78	Sangod	Sawan Bhadon	D/W	42.5	Sandstone
633502.61	2756690.71	Sangod	Talchhi	D/W	18.45	Shale
607032.36	2775724.93	Sangod	Toomra	D/W	50	Limestone
615293.83	2762726.93	Sangod	Umarheri	D/W	11	Limestone
620331.5	2795090.07	Sultanpur	Amarpura	D/W	20	Younger Alluvium
627277.9	2805105.23	Sultanpur	Banethiya	D/W	10	Younger Alluvium
632209.06	2807653.7	Sultanpur	Barod	D/W	29.7	Younger Alluvium
607804.57	2779890.75	Sultanpur	Bhanda Hera	P/Z		Limestone
612965.16	2779768.93	Sultanpur	Bhanda Hera	D/W	40	Limestone

611956.13	2779534.29	Sultanpur	Bhanda Hera	D/W	50	Limestone
617892.9	2784447.14	Sultanpur	Bhauran	D/W	15	Limestone
618598.2	2784321.59	Sultanpur	Bhauran	P/Z		Limestone
619808.63	2784123.22	Sultanpur	Bhauran	D/W	60	Limestone
605239.44	2790053.12	Sultanpur	Bhimpura	D/W	8.1	Younger Alluvium
624243	2800409.76	Sultanpur	Borkhera	P/Z		Younger Alluvium
627162.86	2807747.63	Sultanpur	Budhadeet	P/Z		Younger Alluvium
625456.61	2808034.54	Sultanpur	Budhadeet	D/W	11	Younger Alluvium
612834.02	2776336.91	Sultanpur	Chomakot	D/W	60	Limestone
618651.56	2790655.46	Sultanpur	Darbiji	D/W	13.6	Limestone
624460.29	2802924.95	Sultanpur	Dhanwa	D/W	14.1	Younger Alluvium
607920.57	2789946.48	Sultanpur	Digod	D/W	12.6	Younger Alluvium
624619.08	2813761.22	Sultanpur	Jharol	D/W	25.1	Younger Alluvium
618600.93	2804125.89	Sultanpur	Kherli Tawran	P/Z		Younger Alluvium
622500.48	2804303.47	Sultanpur	Kherli Tawran	D/W	17.8	Younger Alluvium
627858.79	2808029.72	Sultanpur	Kishan Ganj	D/W	11.8	Younger Alluvium
624925.57	2796174.41	Sultanpur	Kishorpura	P/Z		Younger Alluvium
624219.98	2796507.1	Sultanpur	Kishorpura	D/W	10.2	Younger Alluvium
616866.41	2804298.92	Sultanpur	Mandawara	D/W	22.75	Younger Alluvium
605114.74	2789365.17	Sultanpur	Moondla	D/W	11	Younger Alluvium
617205.1	2813633.52	Sultanpur	Morana	D/W	28.5	Younger Alluvium
609098.9	2800412.09	Sultanpur	Nimoda	D/W	8.5	Younger Alluvium
620597.58	2800896.51	Sultanpur	Notara	D/W	20.5	Younger Alluvium
623866.86	2799776.02	Sultanpur	Notara	D/W	12	Younger Alluvium
631088.78	2811679.24	Sultanpur	Peepalda Beeram	D/W		Younger Alluvium
613671.06	2779803.17	Sultanpur	Rel	P/Z		Limestone
617451.34	2776919.14	Sultanpur	Saderi	D/W	17.6	Limestone
626814.53	2804624.36	Sultanpur	Saneeja Baori	D/W	11.3	Younger Alluvium
621876.74	2789300.06	Sultanpur	Sarola	D/W	12.1	Limestone
614935.82	2784787.65	Sultanpur	Seemalya	D/W	60	Limestone
618117.64	2798981.42	Sultanpur	Sultanpur	D/W	14.2	Younger Alluvium
628435.47	2806264.96	Sultanpur	Ummedpura	D/W		Younger Alluvium
615442	2796301.33	Sultanpur	Zalimpura	D/W	23	Younger Alluvium

ANEXXURE IV - LOCATION OF MONITORING WELLS BY CGWB

S.NO	Block	Village	Type	MP	Depth	Long	Lat	DTWL
1	Ladpura	ALANIA	Dug	1.1	12.2	75.89	25.04	11.1
2	Itawa	AYANA	Dug	0.53	21.17	76.43	25.45	15.07
3	Ladpura	BORAWAS	Dug	1.35	7.15	75.7	25.02	2.75
4	Ladpura	DARA	Dug	0.65	4	75.98	24.91	3.15
5	Sultanpur	DIGOD1	Dug	1.2	6.25	76.09	25.24	1.9
6	Itawa	GAINTA	Dug	0.94	27	76.31	25.58	13.71
7	Ladpura	GIRDHARPURA	Dug	0	7	75.84	25.23	6.41
8	Ladpura	GUDLI	Dug	0.88	14.82	75.92	25.27	6.42
9	Itawa	KESHAVPURA	Dug	0.9	12.12	76.4	25.44	3.9
10	Itawa	KHATOLI	Dug	0.9	15.5	76.48	25.68	12.9
11	Ladpura	KHERARASULPUR	Dug	0.69	11.83	75.97	25.12	4.11
12	Ladpura	KOTA1	Dug	0.59	18.31	75.85	25.18	4.31
13	Ladpura	MANDANA	Dug	0.68	13.42	75.93	24.93	4.12
14	Sultanpur	MANDAVRA	Dug	0.68	16.28	76.16	25.37	8.27
15	Sultanpur	RAJGARH1	Dug	0.1	22.9	76.2	25.1	11.5
16	Sultanpur	RATTANPURA	Dug	0.8	21.17	76.3	25.37	18

ANEXXURE V - LOCATION OF ESTABLISHED KEY WELLS DURING STUDY PERIOD

S.No.	Block	Village	Type	MP (m)	Depth (m)	Lat	Long	DTWL (m)
1	Ladpura	Jagpura	Boring	0	121	25°03'21.27"N	75°52'05.61"E	87
2	Ladpura	Kasar	Boring	0	152	24°59'33.24"N	75°55'25.76"E	45
3	Ladpura	Ganeshpura Kasar	DW	0.3	20	24°45'27.36"N	75°57'52.91"E	11
4	Sultanpur	Digod	Boring Old	0	38	25°13'15.55"N	76°04'45.94"E	36
5	Sultanpur	Digod	Boring New	0	91	25°13'15.55"N	76°04'45.94"E	60
6	Sultanpur	Devpura	Boring	0	106	25°36'42.47"N	76°27'16.92"E	38
7	Sultanpur	Bammori	DW	0.5	40	25°10'56.06"N	76°10'10.90"E	16
8	Ladpura	Kaithoon	DW	0.1	13	25°07'21.98"N	75°58'28.82"E	11
9	Sangod	Balooheda	Boring	0	61	24°56'55.66"N	76°9'29.13"E	45
10	Sangod	Sangod	Babdi	0.1	70	24°55'33.14"N	76°17'08.03"E	7
11	Khairabad	Heeriakhedi	Boring	0	75	25°10'10.19"N	74°26'16.46"E	64
12	Khairabad	Ramganjmandi	DW	0.3	25	24°38'58.48"N	75°56'36.30"E	12

ANEXXURE VI - The distribution of chemical constituents of ground water samples of NHS (National Hydrograph Stations) in Kota district during pre-monsoon 2017

Block	Village	Longitude	Latitude	pH	EC in µS	Cl	NO3	TH	Ca	Mg	F	Fe
Itawa	AYANA	76.4347	25.4458	7.03	2,150	347	52	870	110	144.70	0.0375	0.97
Itawa	GAINTA	76.3100	25.5758	8.14	1,550	15	9	260	36	41.34	0.575	0.74
Itawa	KESHAVPURA	76.4000	25.4375	8.03	1,800	163	24	390	60	58.37	0.1625	0.015
Itawa	KHATOLI	76.4750	25.6781	7.98	4,090	482	33	620	112	82.69	0	6.14
Ladpura	ALANIA	75.8900	25.0408	8.20	600	28	31	220	40	29.18	0.0375	0.17
Ladpura	BORAWAS	75.7000	25.0208	8.07	820	92	25	280	48	38.91	0	0.07
Ladpura	DARA	75.9778	24.9083	7.94	620	28	1	210	36	29.18	0.1375	0.9
Ladpura	GIRDHARPURA	75.8378	25.2275	8.04	460	57	0	160	32	19.46	0.1625	0.05
Ladpura	GUDLI	75.9153	25.2658	8.00	1,440	85	22	380	60	55.94	0.525	0.015
Ladpura	KHERARASULPUR	75.9656	25.1211	8.03	1,380	156	28	330	44	53.50	0.675	0.095
Ladpura	KOTA1	75.8500	25.1833	7.83	420	64	2	150	36	14.59	0.05	1.02
Ladpura	MANDANA	75.9333	24.9333	7.66	1,610	178	13	270	72	21.89	0.0375	0.045
Sultanpura	DIGOD1	76.0889	25.2417	7.97	2,250	128	3	350	52	53.50	0.3375	0.014
Sultanpura	GADEPAN	76.1822	25.1772	7.67	2,870	496	24	700	136	87.55	0.2375	2.655
Sultanpura	MANDAVRA	76.1625	25.3692	8.47	4,880	482	16	200	48	19.46	1.787	0.065
Sangod	RAJGARH1	76.2000	25.1000	8.35	900	71	21	340	48	53.50	0.4	0.03
Sultanpura	RATTANPURA	76.3000	25.3667	8.37	1,410	92	16	270	44	38.91	0.375	1.75

ANEXXURE VII - The distribution of chemical constituents of ground water samples collected during aquifer mapping studies in Kota district during pre-monsoon 2017

Block	Village	Lat	Long	pH	EC in µS	Cl	NO3	TH	Ca	Mg	F	Fe
Ladpura	Jagpura	25°03'21.27"N	75°52'05.61"E	**7.25**	**735**	**57**	**36.0**	**320**	**72**	**34**	**0.35**	**na**
Ladpura	Kasar	24°59'33.24"N	75°55'25.76"E	**7.51**	**1000**	**107**	**27.0**	**350**	**64**	**46**	**0.38**	**na**
Ladpura	Ganeshpura Kasar	24°45'27.36"N	75°57'52.91"E	**7.7**	**710**	**43**	**41.0**	**330**	**76**	**34**	**0.08**	**0.0**
Sultanpur	Digod	25°13'15.55"N	76°04'45.94"E	**7.73**	**3600**	**468**	**18.2**	**600**	**104**	**83**	**0.20**	**na**
Sultanpur	Digod	25°13'15.55"N	76°04'45.94"E	**7.75**	**2095**	**283**	**7.0**	**360**	**56**	**54**	**0.04**	**na**
Sultanpur	Devpura	25°36'42.47"N	76°27'16.92"E	**7.94**	**2380**	**284**	**41.0**	**340**	**56**	**49**	**0.58**	**na**
Sultanpur	Bammori	25°10'56.06"N	76°10'10.90"E	**7.85**	**1200**	**99**	**21.5**	**460**	**40**	**88**	**0.54**	**0.6**
Ladpura	Kaithoon	25°07'21.98"N	75°58'28.82"E	**7.74**	**940**	**78**	**27.4**	**340**	**68**	**41**	**1.05**	**0.1**
Sangod	Balooheda	24°56'55.66"N	76°9'29.13"E	**7.65**	**820**	**64**	**36.0**	**340**	**60**	**46**	**0.43**	**0.0**
Sangod	Sangod	24°55'33.14"N	76°17'08.03"E	**7.7**	**970**	**106**	**22.7**	**440**	**92**	**51**	**0.30**	**1.1**
Khairabad	HiriyaKhedi	25°10'10.19"N	74°26'16.46"E	**7.34**	**980**	**184**	**40.0**	**360**	**104**	**24**	**0.10**	**4.1**
Khairabad	Ramganjmandi	24°38'58.48"N	75°56'36.30"E	**7.76**	**1690**	**227**	**39.0**	**470**	**84**	**63**	**0.43**	**0.1**