केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

MAHOBA DISTRICT, UTTAR PRADESH

उत्तरी क्षेत्र, लखनऊ

Northern Region, Lucknow

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REPORT ON
AQUIFER MAPPING AND GROUND WATER MANAGEMENT PLAN, MAHOBA DISTRICT, UTTAR PRADESH

By
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1. MAHOBA DISTRICT AT A GLANCE

1.1. GENERAL INFORMATION

Geographical Area (sq km.)	2884
Administrative Divisions Number of Block Number of Town /Villages	04 05/521
Population (2011 census)	875958
Average Annual Rainfall (mm)	943
Geomorphology	Banda Alluvium, Bundelkhand Granite
Major Physiographic Units	Pediplane, Pediments, Inselberg, Burried Pediplain,Denudational Hill, Striped Plain
Major Drainages	Dhasan, Birma , Chandrawal, Arjun

1.2. LAND USE (Sq. Km.)

Forest area	162.13
Net area sown	2372.17
Cultivable Area	2541.93

1.2.1. MAJOR SOIL TYPES : Sandy loam

1.2.2. AREA UNDER PRINCIPAL CROPS Sq. Km. : 3220.22
(Wheat, Pulses, Oilseeds)

1.3. IRRIGATION BY DIFFERENT SOURCES (Numbers of structures)

Tubewells / Borewells	3/6964
Canals	2372.17
Net Irrigated Area	1254.20 Ha
Gross Irrigated Area	1302.76a

1.4. NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31-3-2019)

No. of Dugwells	5
No. of Piezometers	9

1.5. PREDOMINANT GEOLOGICAL FORMATIONS : Banda Alluvium,

Bundelkhand Granite

HYDROGEOLOGY AND AQUIFER GROUP : Alluvial with weathered formation & Hard Rock . Major water bearing formation	Sand, silt, Weathered Granite and Fractured Granite
Pre-monsoon Depth to water level during May' 2018	1.3 to 23.15 mbgl
Post-monsoon Depth to water level during Nov' 2018	1.09 to 20.25 mbgl
Long term water level trend in 10 years (2009-2018) in : m/yr	Pre-monsoon Fall: 5-54 cm/yr. Post-monsoon Fall: 14-66 cm/yr.

1.6. GROUND WATER EXPLORATION BY CGWB (As on 31-3-2019)

No of wells drilled (EW, OW, Total)	EW-70, OW-10
Depth range (m)	100-200
Discharge (litres per second)	0-6
Storativity (S)	3.14×10^{-4}
Transmissivity (m^2/day)	50– 2004 m^2/day

1.7. GROUND WATER QUALITY

Presence of chemical constituents more than permissible	EC : 380 to 3550 µs/cm^2 at 25°C F : 0.22 0-3.45 mg/l NO_3: 0.5 to 470 mg/l
Type of water	Good

1.8. DYNAMIC GROUND WATER RESOURCES (Ham) as on 31 March, 2017

Annual Extractable GW Recharge	21742.14
Gross Annual Ground Water Draft	17674.50
Provision for Domestic and Industrial Requirement	1609.36
Stage of Ground Water Development	87.77%

1.9. GROUND WATER CONTROL AND REGULATION

Number of Over Exploited Blocks	2
Number of Semi Critical Blocks	2
Number of blocks notified	NIL

2. INTRODUCTION

There has been a paradigm shift from "groundwater development" to "Groundwater management" in the past two decades in the country. An accurate and comprehensive micro-level picture of groundwater through aquifer mapping in different hydrogeological settings would enable robust groundwater management plans in an appropriate scale. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. This would help achieving drinking water security, improved irrigation facility and sustainability in water resources development in large parts of rural India, and many parts of urban India.

Central Ground Water Board (CGWB) has implemented the Aquifer Mapping Program /Project in the National Capital Region (NCR) of Bundelkhand Region in U.P. and M.P. with the broad objective of preparing an aquifer-wise management plan for the region. Various multi–disciplinary geo-scientific activities were undertaken in the study through in-house capacity of CGWB and partly through outsourcing for generation of micro-level hydro geological data. This report primarily deals with the Mahoba District of Bundelkhand Region Uttar Pradesh.

2.1. Objective

The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain and characterize them so as to work out the development potential and prepare aquifer-wise management plan using ground water simulation model.

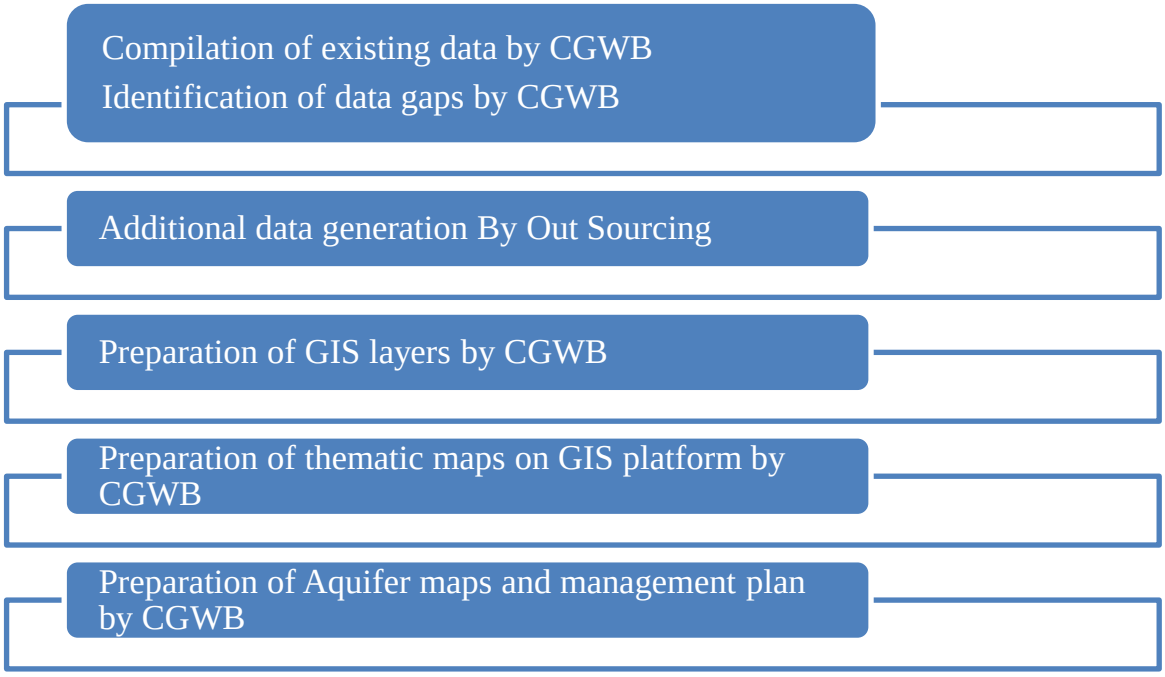
2.2. Scope of Study

The scope of the present study is broadly within the framework of National Aquifer management Programme (NAQUIM) being implemented by CGWB. There are four major activity components viz.: (i) data collection / compilation (ii) Data gap analysis (iii) Data generation and (vi) Preparation of aquifer maps and management plan to achieve the primary objective. Data compilation included collection, and wherever required procurement, of all maps from concerned Agencies, such as the Survey of India, Geological Survey of India, State Governments, etc., computerization and analyses of all acquired data, and preparation of a knowledge base. Identification of Data Gap included to ascertain requirement for further data generation in respect of hydrogeological, geophysical, chemical, hydrological, Hydro meteorological studies, etc. Data generation included those of hydrometeorology, soil infiltration, and sub-surface geophysics, chemical quality of ground water, litho logs and aquifer parameters. Generation of ground water chemical quality data was accomplished by collection of water samples and their laboratory analyses for all major parameters, heavy metals. Sub-surface geophysical studies incorporated vertical electrical sounding, two-dimensional image profiling, and borehole logging. Additional data pertaining to sub-surface lithology and aquifer parameters were obtained through drilling of additional exploratory wells pumping tests at the drilling sites and their analyses.

2.3. Approach and Methodology

An approach and methodology adopted to achieve the major objective have been shown in the form of a flow chart given below.

Plate 1: Flow chart of Approach and Methodology of NAQUIM



2.4. Administrative Details:

Mahoba district, covering an area of 2884 sq. km lies in the south of Uttar Pradesh. It is bounded on the north by the Hamirpur district, Banda district in the east, Chtarpur district of Madhya Pradesh in the south and Jhansi district in the west. The western boundary of the district with Jhansi district is divided by river Dhasan. The district falls in Survey of India Toposheet No. 54O and 54C, covering north latitudes $25^0$03'12" and $25^0$38'16" and east longitude $79^0$24' 07'' and $79^0$10' 50''.For administrative purposes, the district has been sub-divided into 03 tehsils and 4 developmental blocks.

Plate 2: Administrative Division of Mahoba District, U.P.

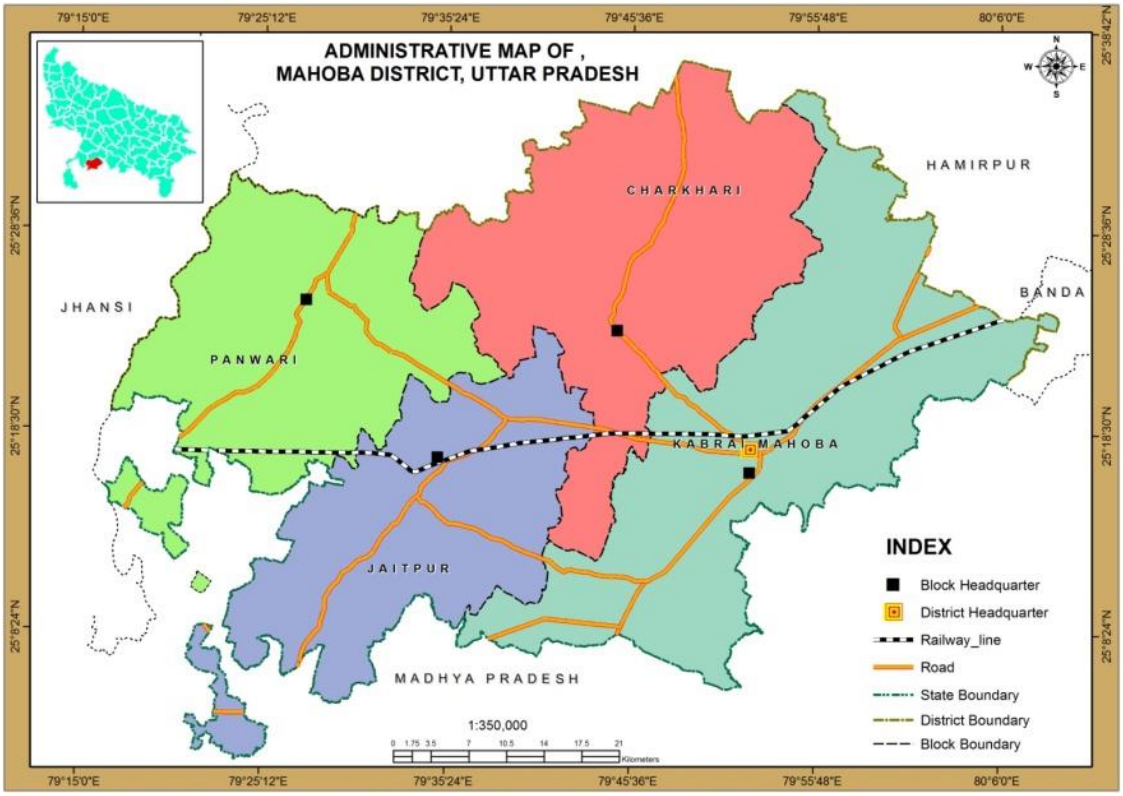


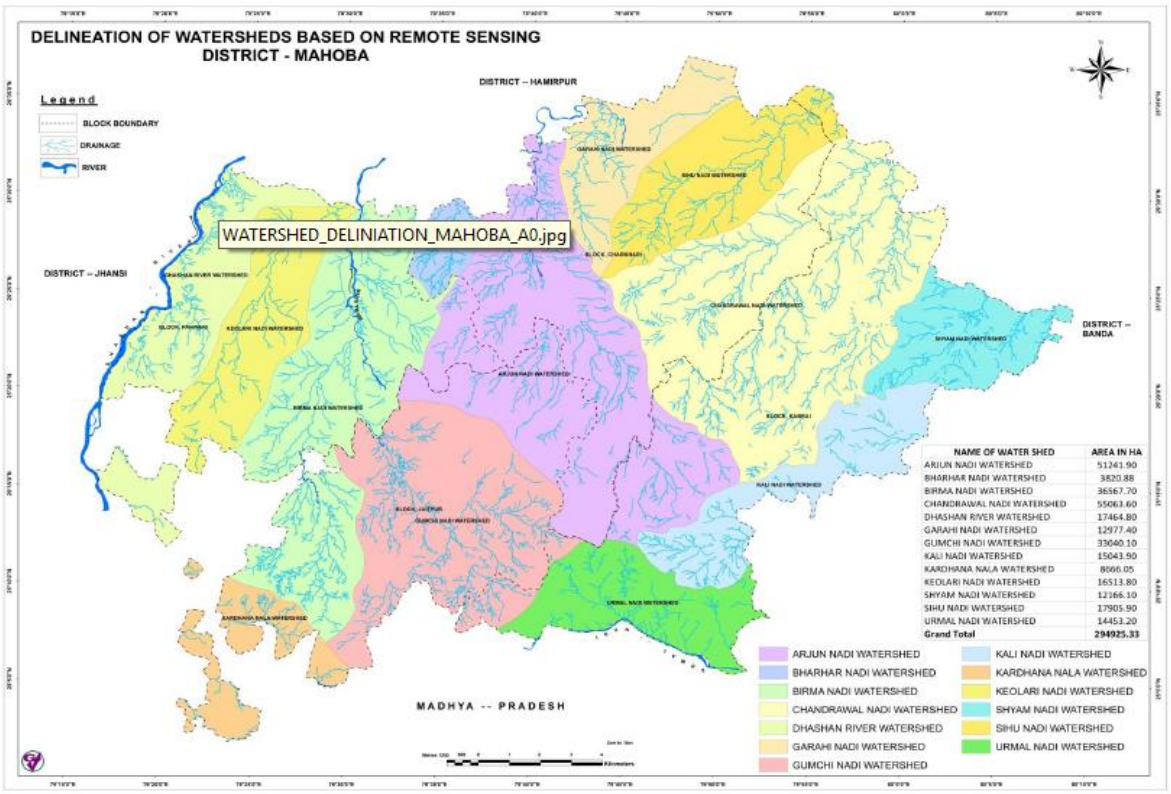
Table 1: Blockwise area and Population Mahoba, District

Block	Area (sqkm)	Total Population (as per 2011 census)		
		Total	Male	Female
Pnawari	614.68	158862	84880	73982
Jaitpur	618.27	158010	83597	74413
Charkhari	803.13	113902	60851	53051
Kabrai	1206.9	259803	138681	121122
Rural	2854.1	690577	368009	322568
Urban	29.95	185381	98349	87032
Total	2884	875958	466358	409600

2.5. Drainage Basin and Sub-Basin:

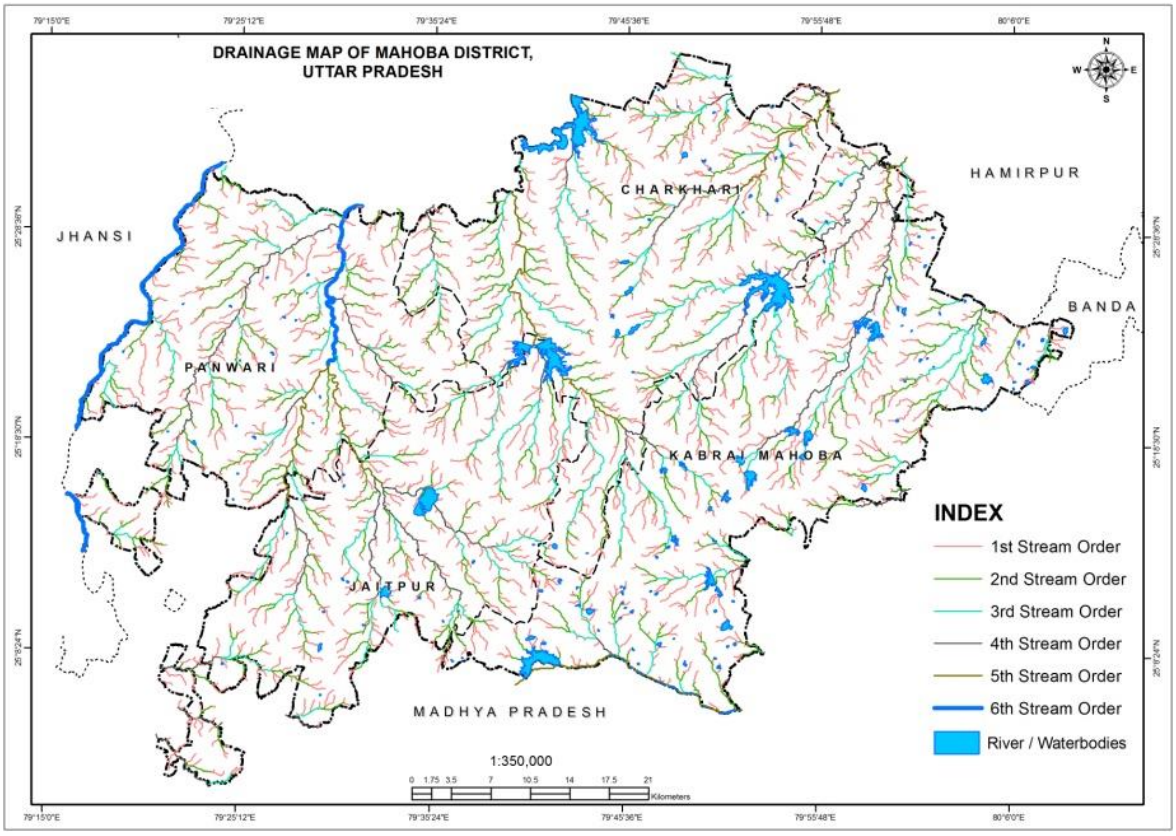
The area is part of Yamuna basin and Betwa sub basin. The watershed delineated are given in Plate 3

Plate 3: Watershed and Sub Basin Map, Mahoba District, UP



Mahoba district is drained by rivers Dhasan, Urmil, Birma, Arjun, Chandrwal and drainage is governed by Lineament. The Dhasan emanating from Vindhyan flows through Charkahari Tehsil forming western boundary of the district. The river Urmil also comes from Vindhyan and separates Charkhari and Mahoba Tehsils and flows in east direction. The Birma is perennial a stream dividing district in two equal halves east and west (Plate 4).

Plate 4: Drainage Map, Mahoba District, UP



2.6. Land Use, Cropping Pattern and Irrigation Practices:

Mahoba is an agriculture dominated district and 72 % area is under active cultivation (Fig 1). About 80% of the total geographical area of the district is cultivated area. The main *rabi* crops are wheat, Barley, Masoor, Gram, Pea, Arhar and Mustard. The main Kharif crops are Moog, Millets, Til, Maize, Urd, Jwar, Ground Nut and Paddy. Zaid crops are Maize, Urd, Moong, and Potato. The block wise details of cropping pattern.

Table 2: Details of the Cropping Pattern, Mahoba District, Uttar Pradesh

Block	Area Sown (Ha)			Gross Sown area (Ha)			Area Irrigated (Ha)		Cropping Intensity	Irrigation intensity
	Net Area Sown	*Area sown more than once*	*Total*	*Rabi*	*Kharif*	*Jayad*	*Net Irrigated*	*Gross Irrigated*		
Panwari	46687	30755	77442	43717	33723	2	29800	30970	165.87	103.93
Jaitpur	40808	22163	62971	41381	21586	4	33271	34538	154.31	103.81
Charkhari	58150	22185	80335	44128	36205	2	22343	23307	138.15	104.31
Kabrai	87027	25933	112960	86005	26949	6	39196	40588	129.80	103.55
Total Rural	232672	101036	333708	215231	118463	14	124610	129403	143.42	103.85
Total Urban	4545	920	5465	3814	1626	25	810	873	120.24	107.78
Total District	237217	101956	339173	219045	120089	39	125420	130276	142.98	103.87

Figure 1: Land use Pattern of Mahoba District, UP

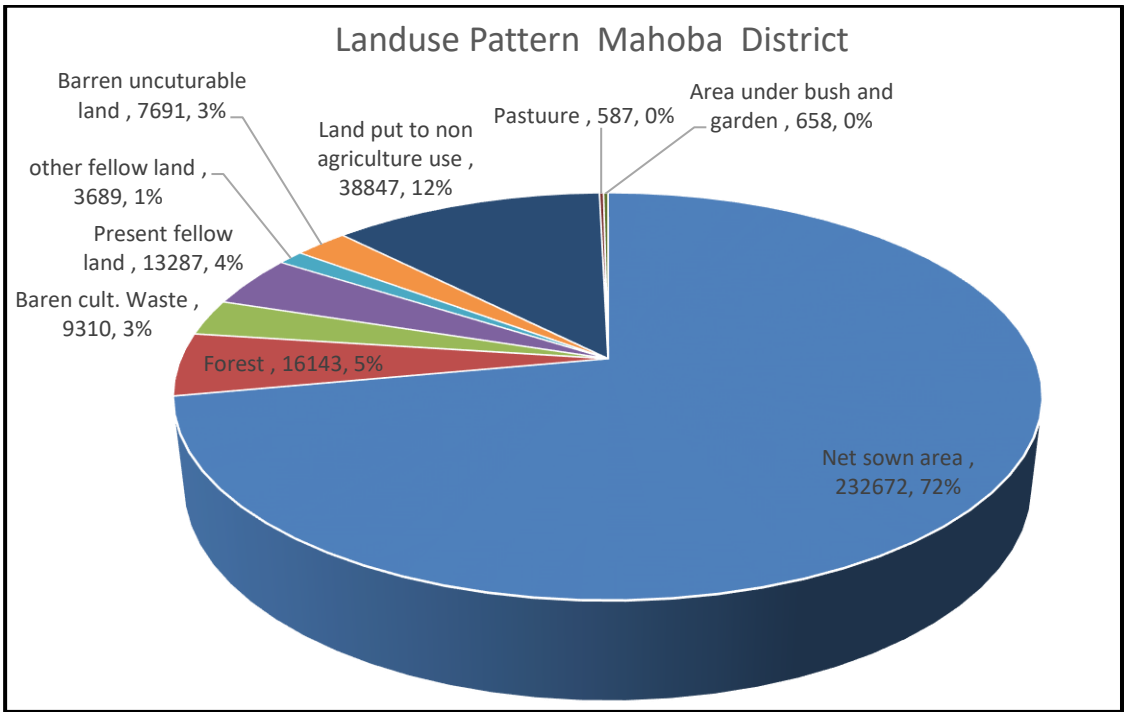


Figure 2: Cropping Pattern Mahoba District (in Ha), UP

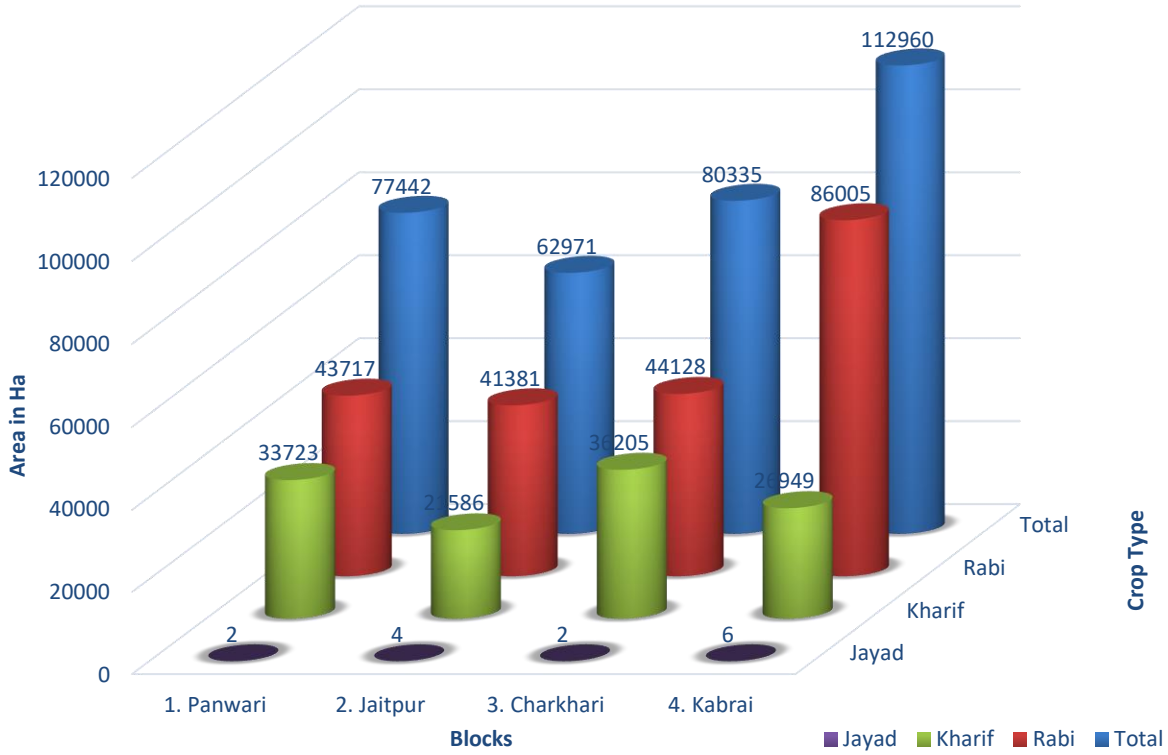


Table 3: Details of Area (Ha) under Different Crops, Mahoba District, UP

Block	Wheat		Barly		Jwar		Pulses		Oil seeds	
	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
Panwari	17927	15961	1494	1148	552	0	45117	14572	12871	802
Jaitpur	16841	14028	2089	1842	358	0	36389	15702	16599	1810
Charkhari	17421	15050	851	419	464	0	49707	11002	10804	320
Kabrai	16136	10987	2813	1978	408	0	56004	16584	21879	717
Total Rural	68325	56026	7247	5387	1782	0	187217	57860	62153	3649
Total Urban	877	658	90	69	32	0	2366	386	1084	13
Total District	69202	56684	7337	5456	1814	0	189583	58246	63237	3662

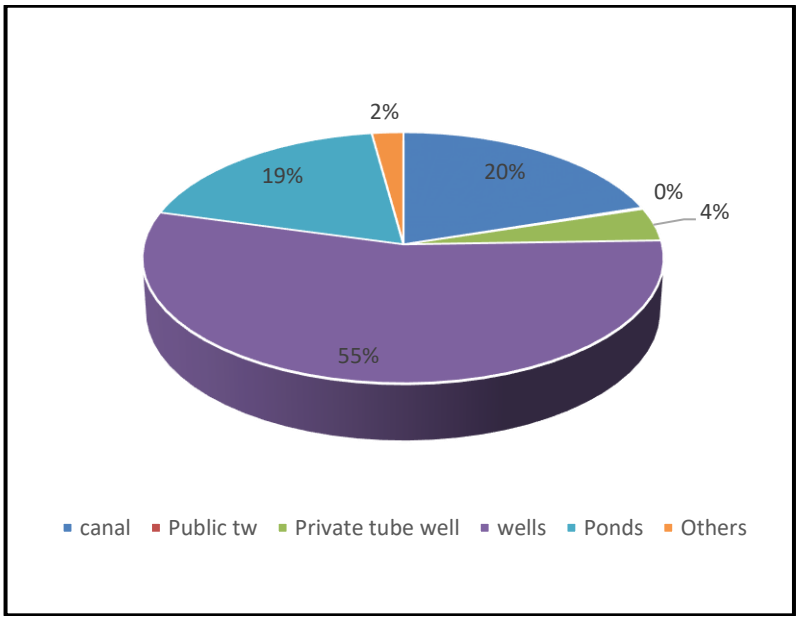
(Area in ha)

Table 4: Details of the Distribution of Surface and Ground Water for Irrigation, Mahoba District, UP

Block wise /year	canal	Public TW	Private tube well	wells	Ponds	Others	Total	% GW
Panwari	7921	0	1338	14145	5053	400	28857	53.65
Jaitpur	2076	0	424	27121	5197	424	35242	78.16
Charkhari	6168	207	625	6880	6076	1595	21551	35.78
Kabrai	8784	56	2911	20066	6823	278	38918	59.18
2015	**24960**	**263**	**5298**	**68956**	**23212**	**2731**	**125420**	**59.22**
1994	**38889**	**38**	**524**	**23004**	**1891**	**12544**	**76890**	**30.66**

For last twenty years contribution of **Contribution of ground water irrigation increased from 30% to 60 % .**

Figure 3: Contribution in Irrigation by different source in Mahoba District, UP



Mahoba district is 60 % irrigation is done by ground water and 40 % surface water. The maximum ground water irrigation is in the Jaitpur block i.e. 75 % followed by Kabari block whereas it is minimum in Charkhari block 35 % (Table 4).

Table 5: Details of the Irrigation Sources, Mahoba District, UP

Block	Canal Length km	Govt Tube wells No	Perma-nent Wells No	Rahats	Pump Sets			Total	Ground Pumpset
					Electric Pumps	Diesel Pumps	Others		
Panwari	67	0	3428	1021	58	654	4	716	147
Jaitpur	101	0	6982	1488	10	0	10	20	22
Charkhari	104	2	2914	966	36	447	2	485	81
Kabrai	183	1	3504	1587	60	237	2	299	132
Total Rural	455	3	16828	5062	164	1338	18	1520	382
Total Urban	0	0	0	0	0	0	0	0	0
Total District	455	3	16828	5062	164	1338	18	1520	382

3. RAINFALL & CLIMATE

The district experiences a typical subtropical climate intense summer mild winter and moderate to heavy rainfall during rainy season. The normal rainfall in Mahoba district based record (1972-2002) indicates 89 % rainfall in monsoon period. The average annual rainfall is 997 mml in the district. About 896 mm, 89% of rainfall takes places from June to September. The mean monthly maximum temperature is about 42.7 ^{0}C in June and mean monthly minimum temperature is about 8.6^{0}C in January. With the onset of southern monsoon by the end of June, there is appreciable drop in temperature. The air is dry during the major parts of the year. In southwest monsoon season, the air is very humid and April and May are usually driest months. The mean monthly relative humidity is 52%. The mean wind velocity is 3.5 Km/hr. The potential evapotranspiration is 1485.5 mm.

Figure 4: Average Monthly Rainfall Mahoba District (1972-2002), UP

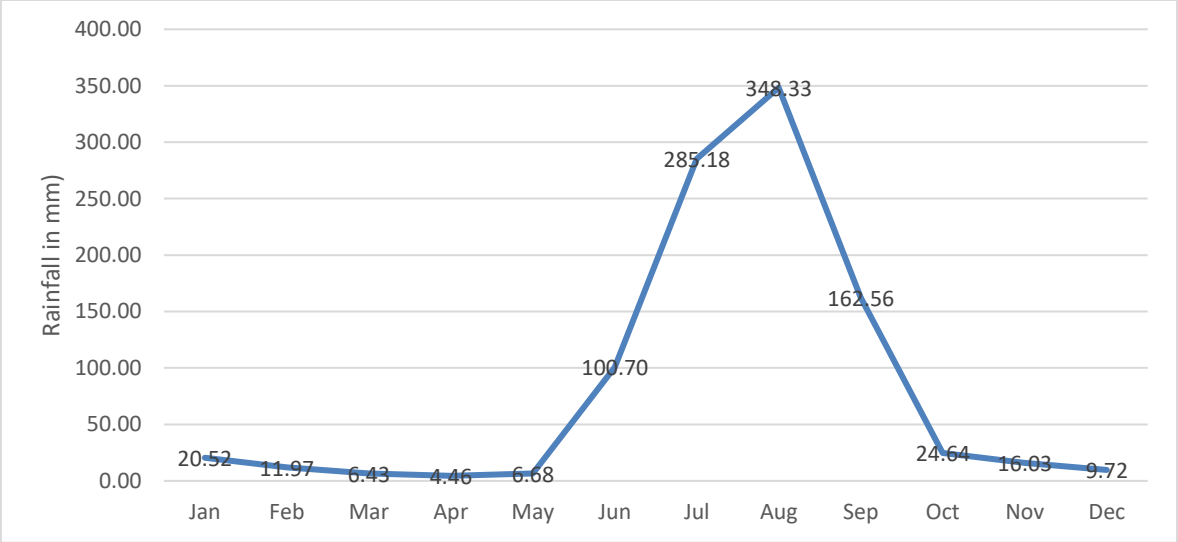


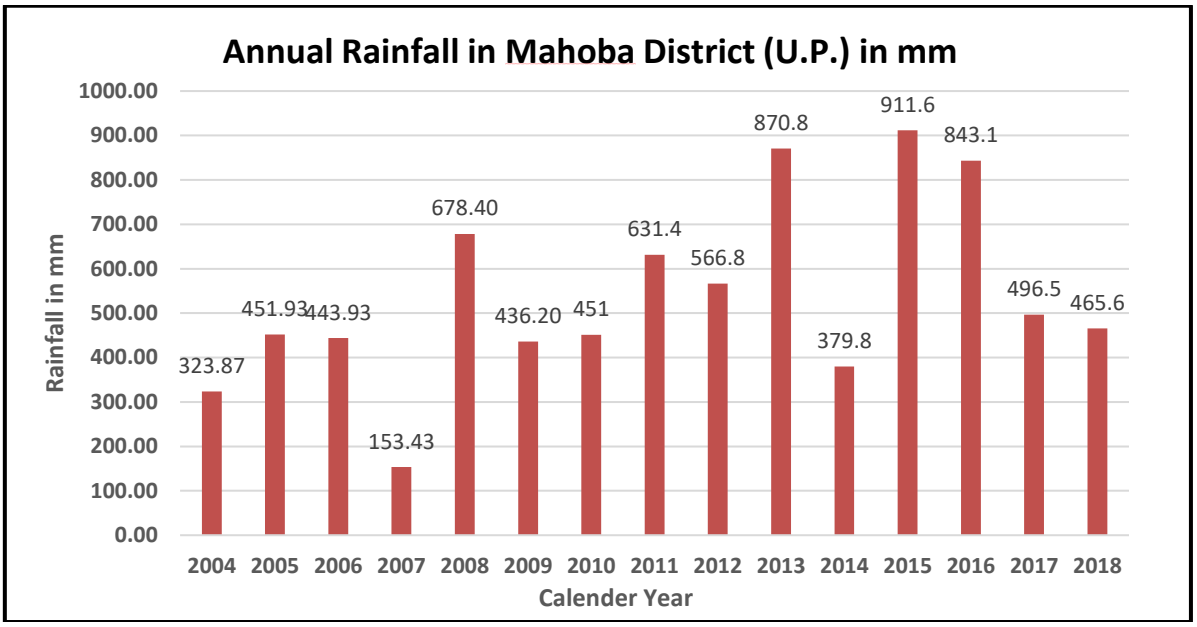
Table 6: Average Monthly Rainfall Mahoba District (1972-2002) (in mm), UP

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average	Monsoon	Non-monsoon
20.5	**11.97**	**6.43**	**4.46**	**6.68**	**100.7**	**285.2**	**348.3**	**162.56**	**24.64**	**16.03**	**9.72**	**997.2**	**896.8**	**100.5**

Table 7: Deviation in Rainfall in Mahoba district, UP

Decade	Frequency of deficit rainfall	Frequency of positive rainfall years
1972-1981	3	7
1981-1992	6	4
1992-2001	7	3

Figure 5: Annual Rainfall in Mahoba District (U.P.) in mm



4. GEOLOGY, GEOMORPHOLOGY AND SOIL

4.1. Geology

The district Mahoba forms a part of the Bundelkhand Massif. The area is underlain by Granite and basic intrusive of Precambrian age. Quaternary alluvial material overlying the Precambrian granites unconformable marks a bid hiatus in the stratigraphic history of the area. Geological sequence of the formation present in the district as follows.

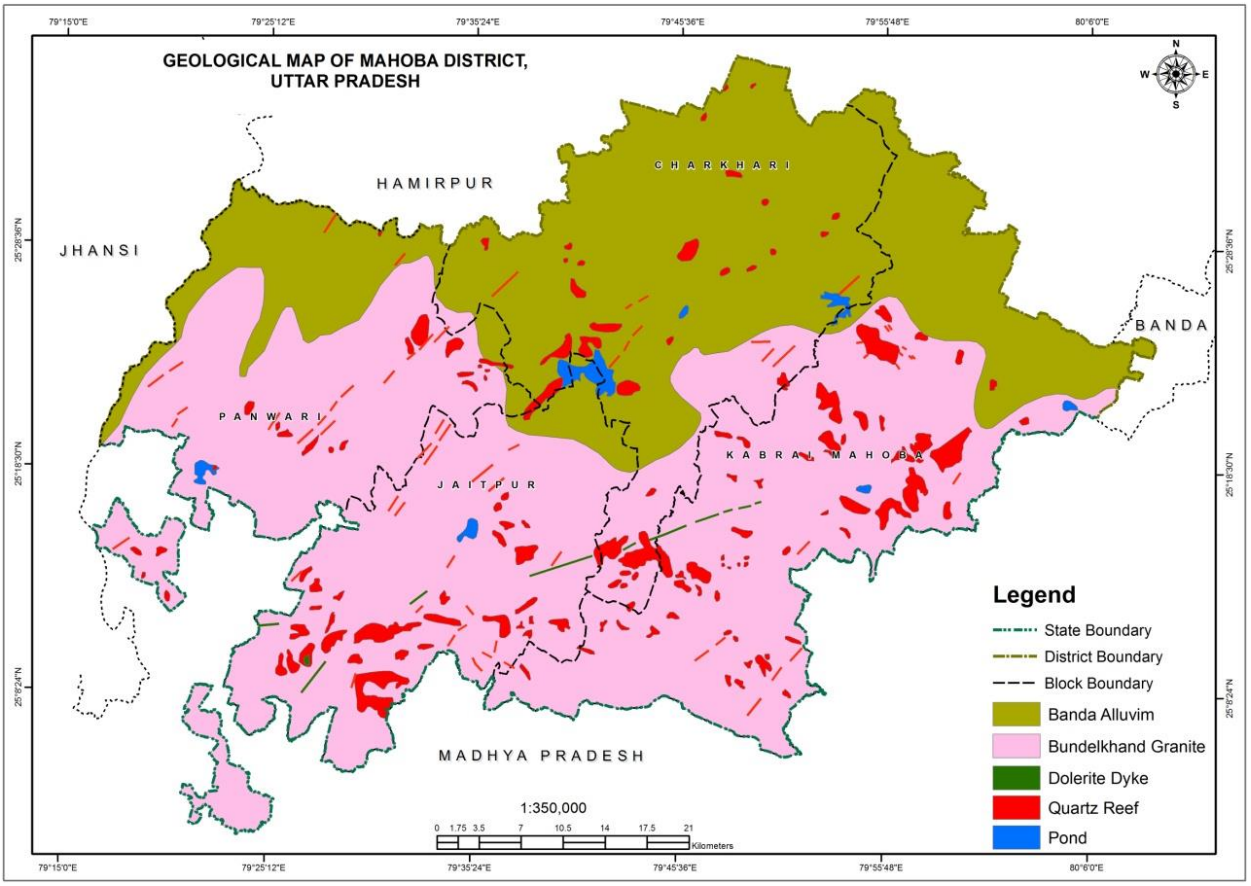
Table 8: Geological Succession of the Formation in Mahoba District, UP

Quaternary	*Recent to sub recent*	*Alluvial, sand, gravel, silt , Clay*
……..Unconformity……		
Precambrian	-	*Bundelkhand massif dolerite, Quartz Reef,Granite, Gneiss, Schist*

Precambrian Bundelkhand massif: This group mainly comprises granites that crop out as isolated or clustered hillocks. Granites occurring in the district reflect considerable heterogeneity in color texture grain size and composition. Most common granite in the district is medium grain pink color composed of quartz, feldspar with mafic minerals biotite and hornblende. Occasionally Corse grain feldspar quartz veins are also encountered in granite. The granite are profusely and extensively jointed and fractured. The quartz reef trending NE-SW occurs as narrow ridge. These reefs are composed of fine grained compact silicon material and are milky white in color. The Bundelkhand Granite is traversed by basic intrusive mainly dolerite of pre and post Cambrian age. They trend EW to NW-SE direction (Plate 5)

The granites are uncomfortably overlain by Quaternary alluvium consisting of Gravel, Sand and Clay. The thickness of overburden varies from 5 to 40.0 m.

Plate 5: Geological Succession of the Formation in Mahoba District, UP



4.2. Geomorphology:

Physiography:

The district is characterized by presence of Bundelkhand Massif Terrain. It is marked by occurrence of clustered hillocks and intervening low relief with undulating plains. The waster lope of the area is mainly towards north east. The district is broadly divided in two physiographic units.

1. Southern part having high relief with hillocks: The area north of $25^0$25' north latitude is cauterized by presence of hills of granitoids and intervening pegmetetic veins. The maximum altitude in the area is 340 masl. The structural and denudational hills are also encountered. A Large number of Nallas and Khads passing in the area meet the different tal /sagars.

2. Northern part with low relief with low hillocks: The area between $25^0$25' and $25^0$39' North is characterized by presence of low hillocks having low relief. The area in and around Panwari mainly covered with thick alluvium and hard rock encountered below 40 mbgl. The maximum altitude in area is 310 masl (Plate 6). The Pediplain, Pediment, Inselberg and Buried Pediplain are Present (Plate 6).

Plate 6: Elevation Map of Mahoba District, UP

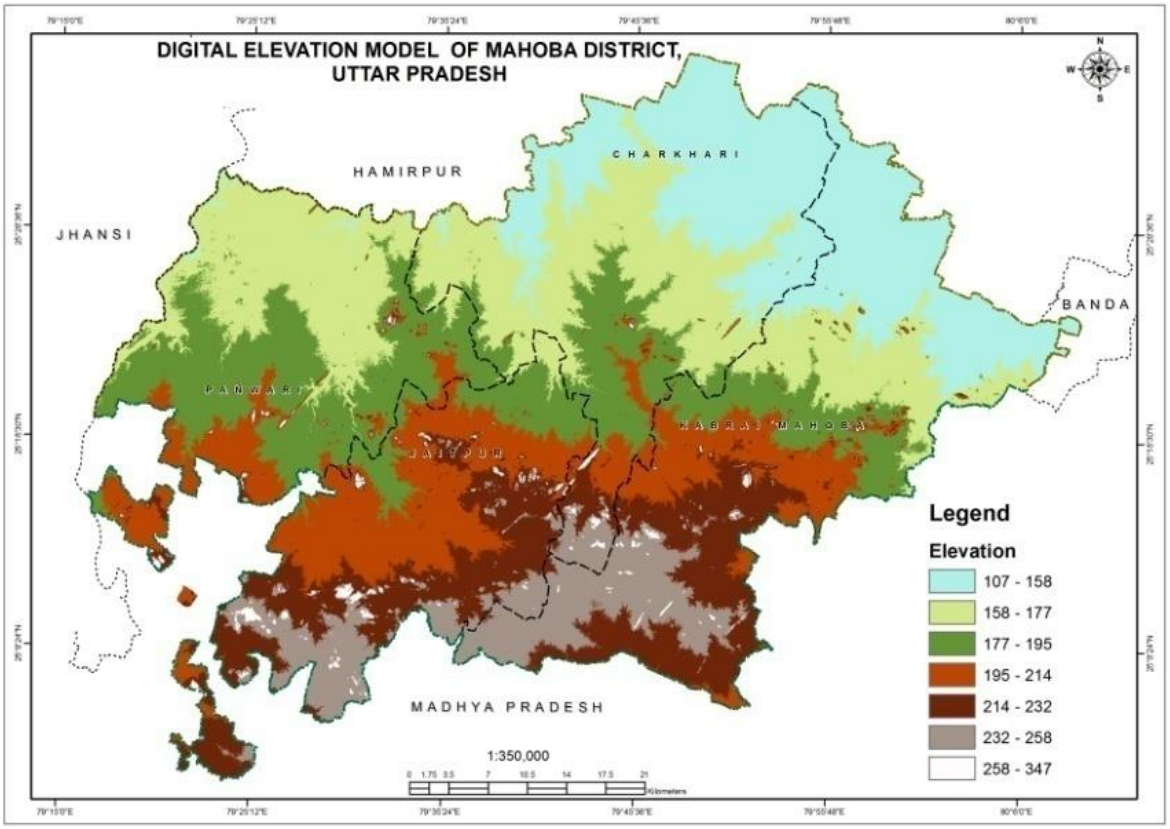
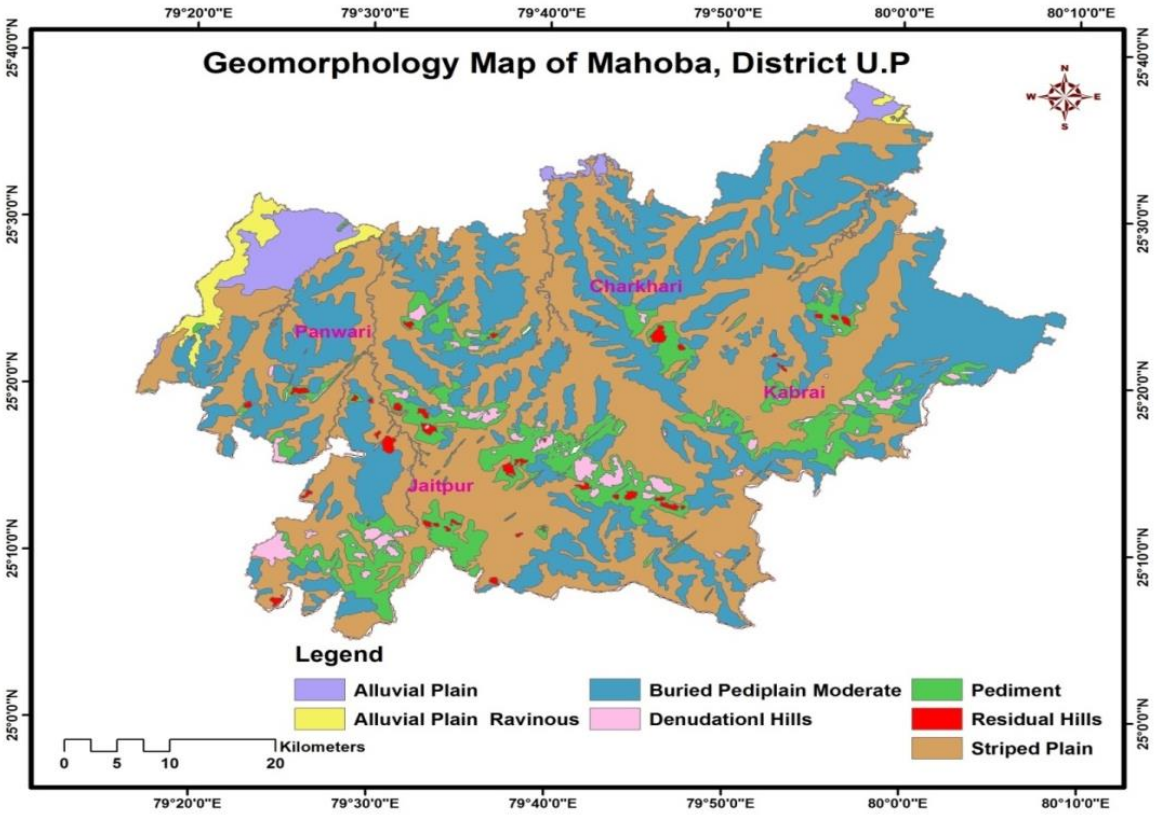


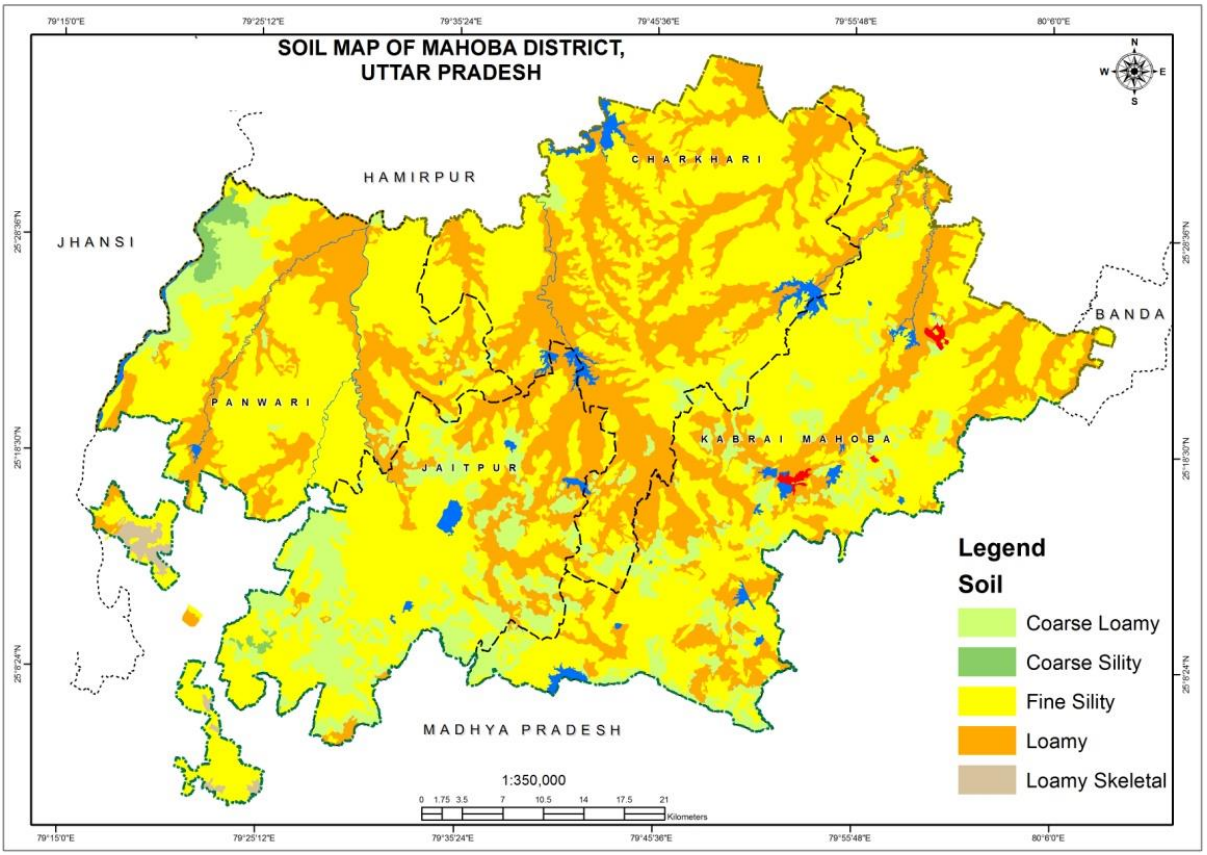
Plate 7: Geomorphology Mahoba district, UP



4.3. Soil

In Mahoba district soil has been produced by the weathering of granites. Well known Bundelkhand varieties are Mar, Kafur, Parana and Rakar. Clayey and loamy soil is dominant in the district. These soils are coarse loamy, coarse silty fine silty and loamy soil (Plate 8).

Plate 8: Soil Map of Mahoba District, UP



5. GROUND WATER OCCURANCE

5.1. Hydrogeology:

Mahoba district comprised of hard rock formation of Bundelkhand massif, rainfall does not percolate and store however secondary porosity in form of fracture allows some water to trickle down. Ground water occurs in shallow zone in phreatic condition in overburden. The granular zones sand silt and weathered granite. The yield of dug well and shallow borewell varies from 100-300 lpm. The ground water occurs in deeper fracture zones in hard rock in semi confined to confined condition. The discharge of borewell is not certain as occurrence and discharge depends on lineament and pinpointing of site of borewell. The potential fracture zones are encountered at 35, 45, 90, 120 mbgl. The yield of Bore well is varies from 0.00 to 400lpm.

Depth to Water Level:

As per the depth to water level data of permanent ground water monitoring stations in the year 2018, pre monsoon water level ranges from 2.7 mbgl (Kabrai) to 23.15 mbgl (Panwari) (Plate 9) . In the post monsoon period, depth to water level varies from 1.09 mbgl to 20.25 mbgl (Plate 10). Water level fluctuation varies from 1.0 to 5.0 m (Plate 11). The fluctuation is more in Panwari and Jaitpur Block whereas low fluctuation observed in parts of Charkhari and Kabrai block. The water table contours of Mahoba district shows ground water flow from south to north following general slop (Plate 12).

Plate 9: Depth to water level Pre monsoon 2018, Mahoba District, UP

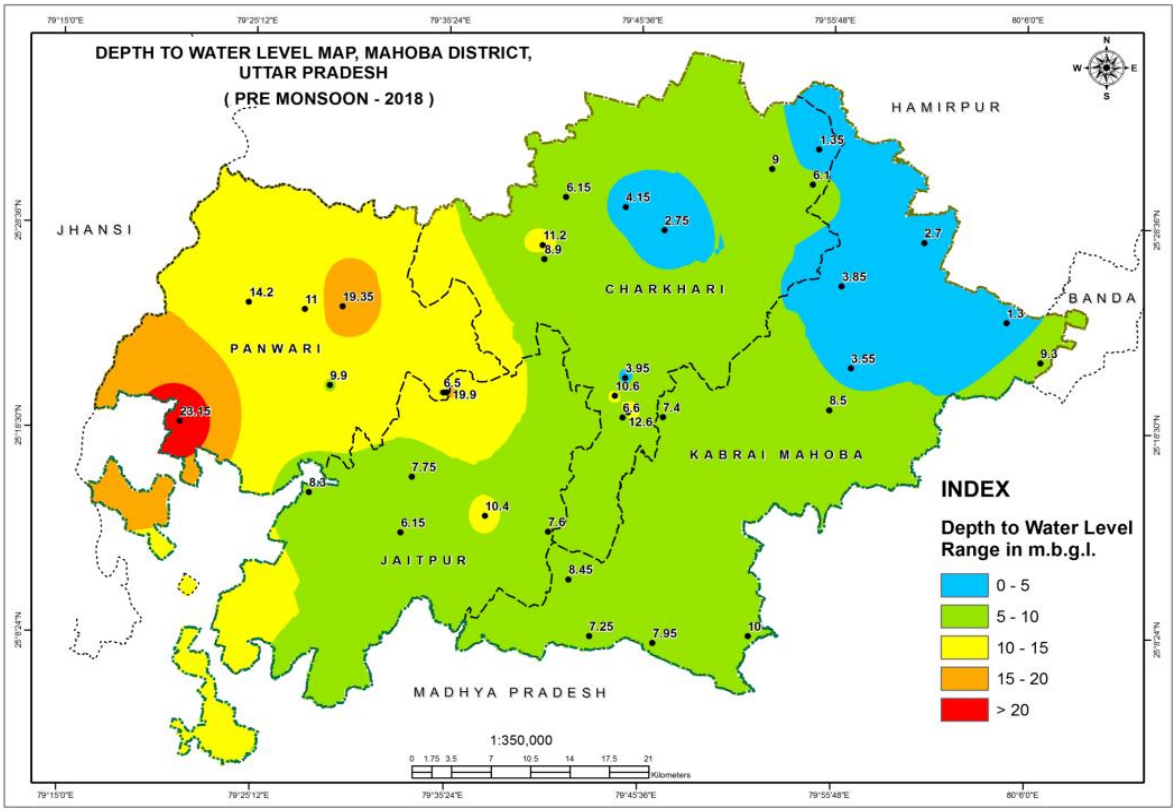


Plate 10: Depth to water level Pre monsoon 2018, Mahoba District, UP

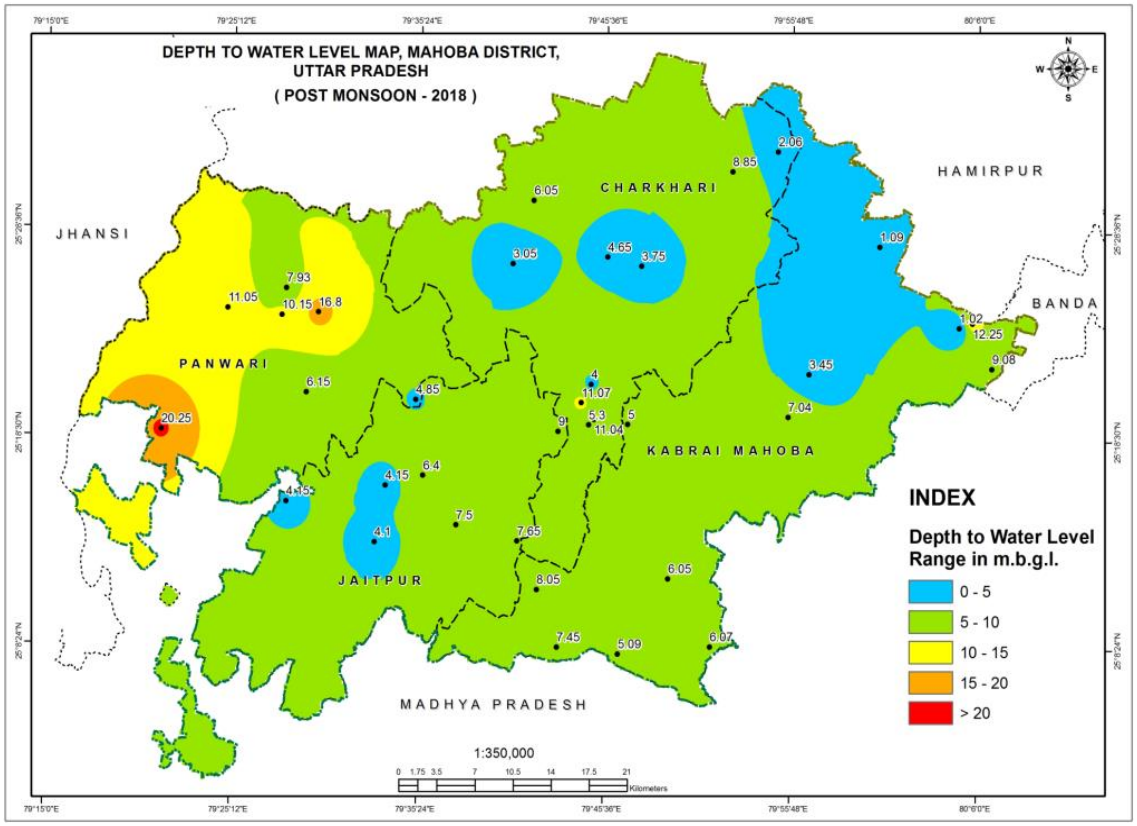


Plate 11: Water Level Fluctuation Map 2018, Mahoba District, UP

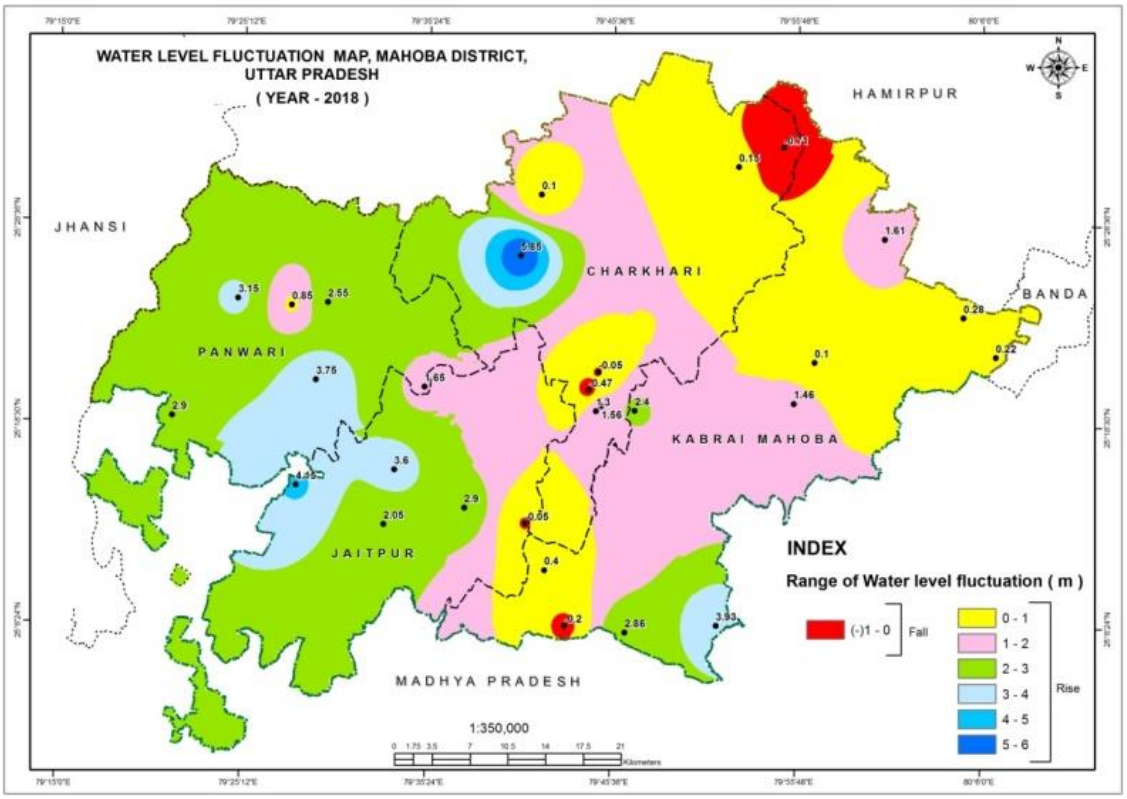


Plate 12: Water Table Map Mahoba district (May 2018), UP

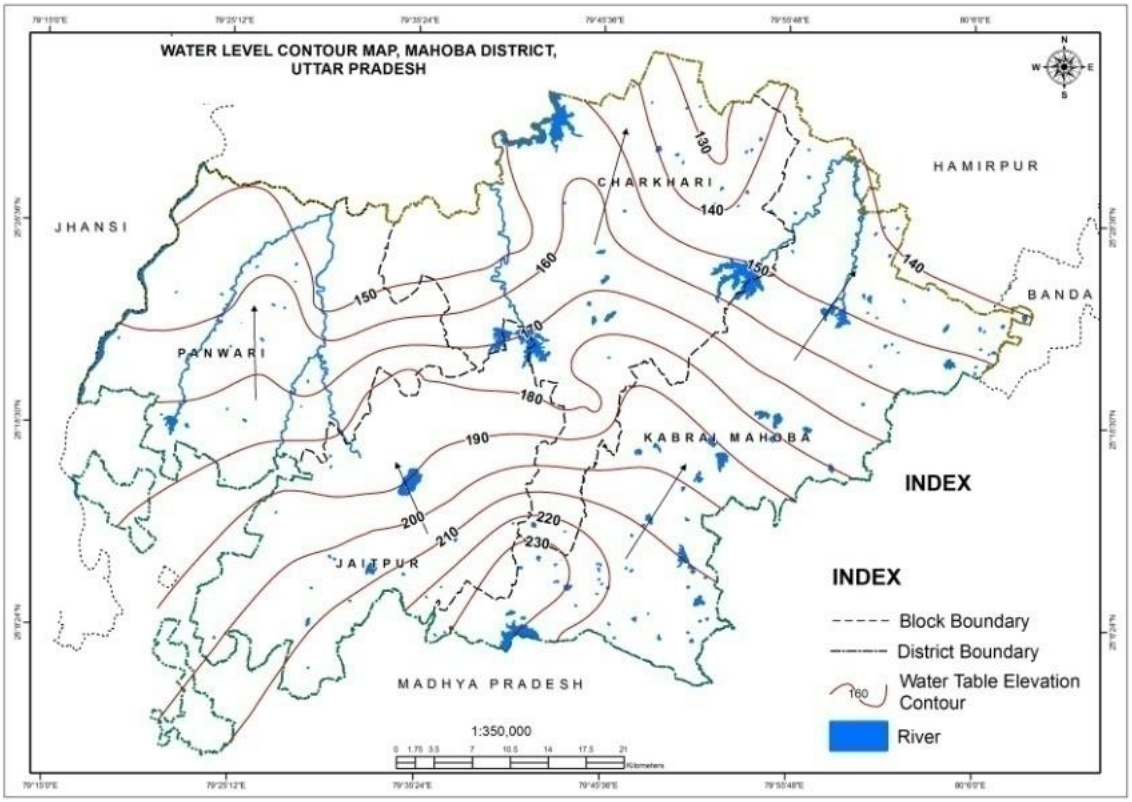


Table 9: Depth to Water Level Data Mahoba District, UP

BLOCK	HYDROGRAPH STATION	LONGITUDE	LATITUDE	Type of Hyd.St.	PRM_18 mbgl	PTM_18 mbgl
KABRAI	SUKAURA	80.0831	25.40000	P	1.30	1.02
CHARKHARI	AAICHANA	79.9167	25.54167	P	1.35	2.06
KABRAI	BARBHAULI	80.0101	25.46536	P	2.70	1.09
KABRAI	SHIVHAR	79.7808	25.47429	P	2.75	0.00
KABRAI	AKABAI	80.2250	25.51667	P	3.50	3.05
KABRAI	GUGAURA	79.9461	25.36179	P	3.55	3.45
KABRAI	UTIYA	79.9375	25.42917	P	3.85	0.00
CHARKHARI	SANTOSH PURA	79.7472	25.35246	P	3.95	4.00
CHARKHARI	SIJAURA	79.7464	25.49306	P	4.15	0.00
CHARKHARI	SOHJANA	79.9113	25.51260	P	6.10	0.00
KABRAI	GHAUNDUWA	80.8833	25.38333	P	6.15	0.00
JAITPUR	MAWAYA	79.5508	25.22374	P	6.15	4.10
CHARKHARI	JATAURA	79.6938	25.50071	P	6.15	6.05
KABRAI	KULLI PAHADIYA	79.5873	25.33908	P	6.50	4.85
CHARKHARI	TIKARI	79.7453	25.31976	P	6.60	5.30
KABRAI	ATGHAR	79.7178	25.14001	P	7.25	7.45
KABRAI	KARHARA KALA	79.7811	25.32034	P	7.40	5.00
KABRAI	BAHINGA	79.6808	25.22535	P	7.60	7.65
JAITPUR	KHADIYA	79.5602	25.26945	P	7.75	4.15
KABRAI	KAHARA	79.7734	25.13472	W	7.95	5.09
JAITPUR	LADPUR	79.4698	25.25610	P	8.30	4.15

KABRAI	NURIYA	79.6990	25.18643	P	8.45	8.05
KABRAI	CHICHARA	79.9274	25.32732	P	8.50	7.04
CHARKHARI	JARAULI	79.6750	25.44949	P	8.90	3.05
CHARKHARI	RIVAI	79.8752	25.52524	W	9.00	8.85
KABRAI	KULKUANWA	80.1131	25.36702	P	9.30	9.08
PANWARI	MAHOBKANTH	79.4874	25.34418	P	9.90	6.15
KABRAI	NAHDAURA	79.8572	25.14103	W	10.00	6.07
JAITPUR	KUDAI	79.6249	25.23796	P	10.40	7.50
CHARKHARI	SUPA	79.5989	25.54458	P	10.60	11.07
PANWARI	LODHIPURA	79.4646	25.40648	P	11.00	10.15
CHARKHARI	GUDHA	79.6736	25.46111	W	11.20	0.00
CHARKHARI	SUPA	79.7502	25.32412	W	12.60	11.04
PANWARI	CHATESAR	79.4150	25.41197	P	14.20	11.05
PANWARI	DEVGANPURA	79.4976	25.40894	P	19.35	16.80
KABRAI	GEUNDI	79.5901	25.33908	P	19.90	0.00
PANWARI	BAHADURPUR KALA	79.3554	25.31346	P	23.15	20.25
PANWARI	RURI KALA	79.4683	25.42819	W	DRY	7.93
KABRAI	NANAURA	80.0951	25.40377	W	DRY	12.25
KABRAI	BARBAI	79.0319	25.48370	W	dry	6.05
JAITPUR	RAGOLIYA BUJURG	79.7175	25.31431	W	dry	9.00
JAITPUR	AJNAR	79.5944	25.27778	W	dry	6.40
CHARKHARI	KAMAL KHEDA	79.7925	25.44849	P	U/L	3.75
CHARKHARI	KUNDAR	79.7615	25.45551	P	U/L	4.65

Water Level Trend:

Long term water level trend records in the area from 12 national hydrographic stations (2009-2017) ten years show that (except Belatal) all other stations are showing declining trend. The falling trend ranges from 0.0390 m/yr (Charkhari) to 0.6396 m/yr at Mahoba.

Table 10: Long Term Water Level Trend (2009 – 2017) , Mahoba District, UP

Block	**Pre-Monsoon (m/yr)**		**Post – Monsoon (m/yr)**	
	Rise	**Fall**	**Rise**	**Fall**
CHARKHARI	-	0.3720	-	-
JAITPUR	-	-	-	0.2430
KABRAI	-	0.2805	-	0.3410
PANWARI	-	0.4700	-	0.2800

Figure 6: Long Term Water Level Trend Belatal, Jaitpur Block (2009 – 2017), Mahoba District, UP

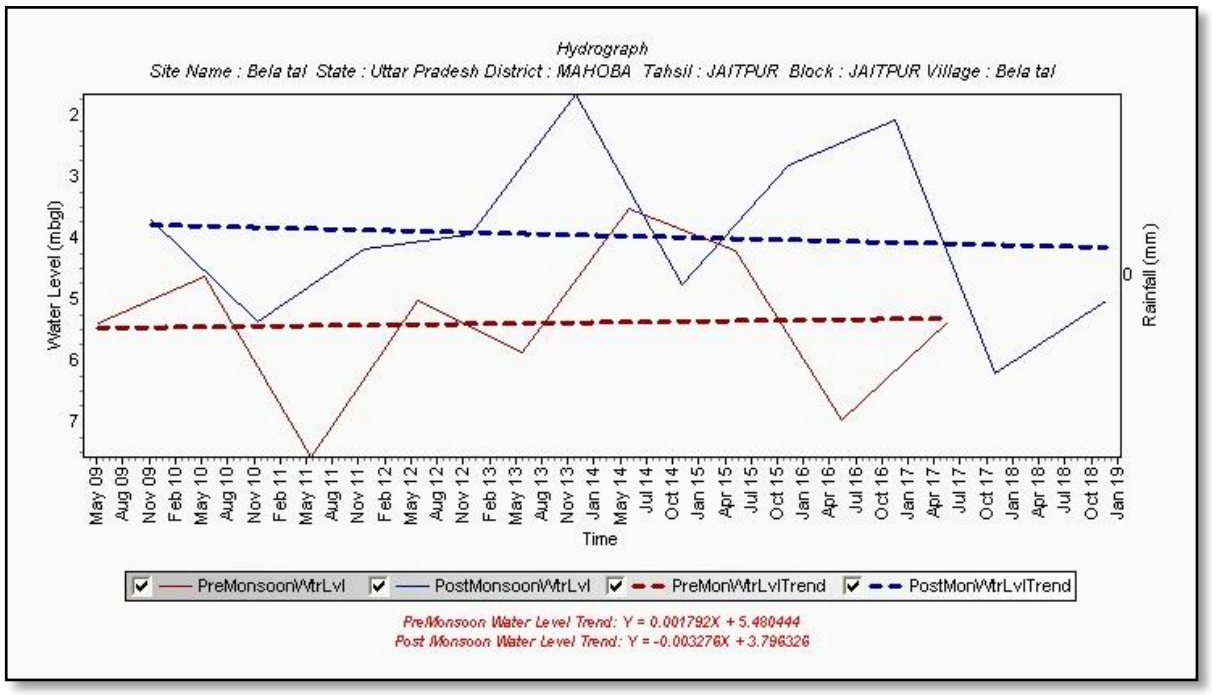


Figure 7: Long Term Water Level Trend Charkhari, Charkhari Block (2009 – 2017), Mahoba District, UP

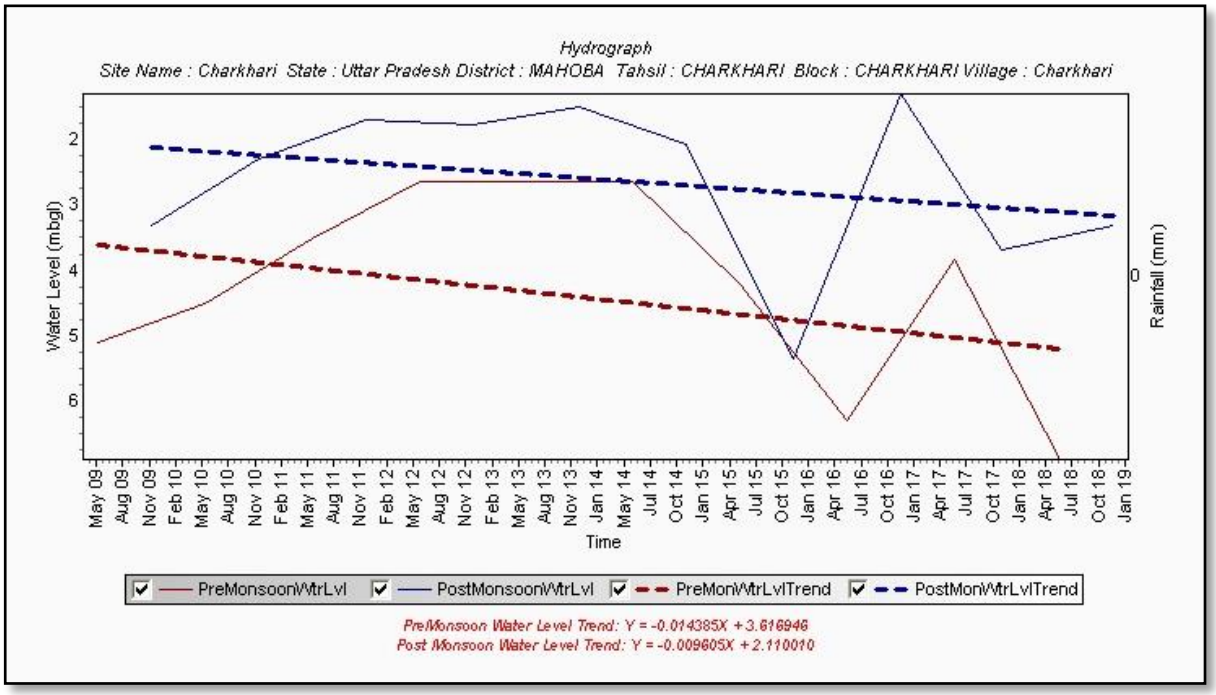


Figure 8: Long Term Water Level Trend Kulpahar Village, Jaitpur Block (2009 – 2017), Mahoba District, UP

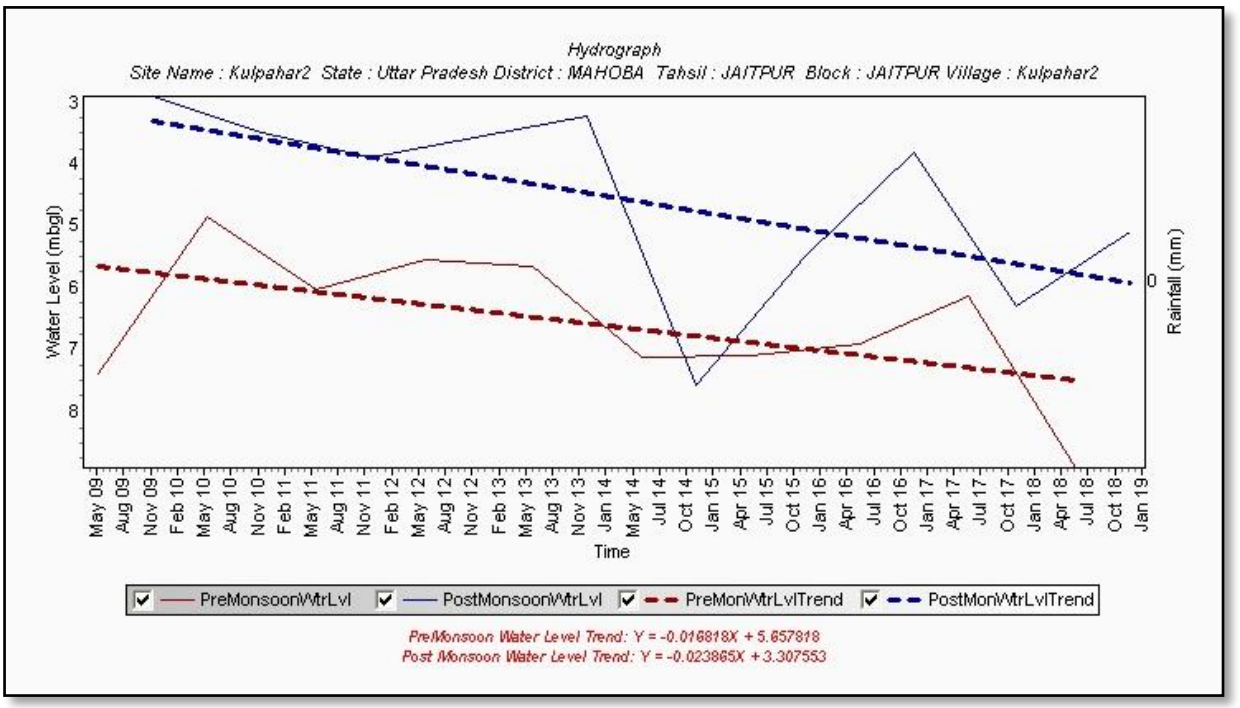


Figure 9: Long Term Water Level Trend Pipramau Village, Kabari Block (2009– 2017), Mahoba District, UP

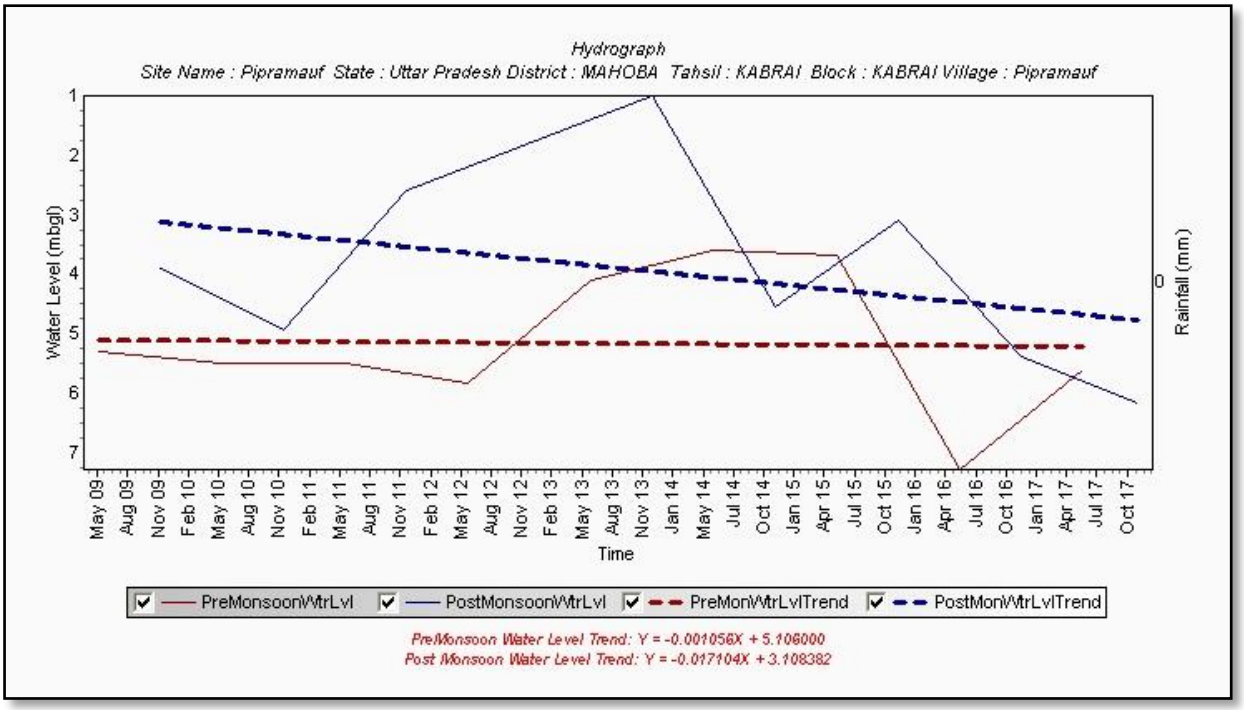
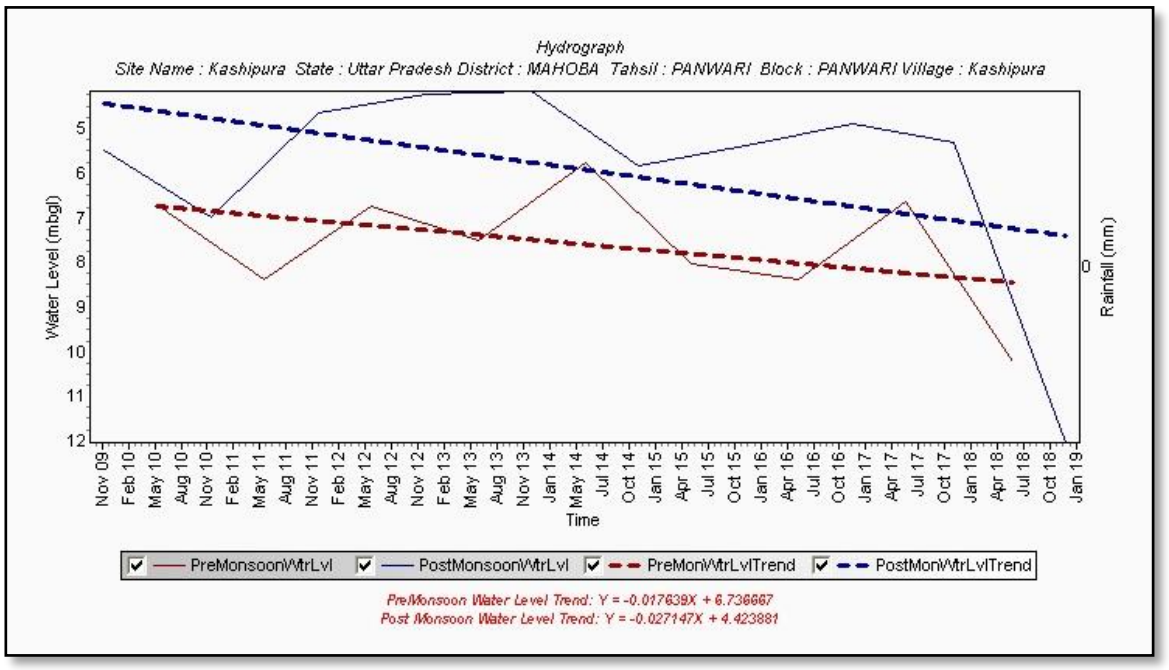


Figure 10: Long Term Water Level Trend Kashipura Village, Panwari Block (2009 – 2017), Mahoba District, UP



5.2. Aquifer Disposition:

The aquifers in the study area were mapped through lithology exploratory drilling geophysical investigations (VES, ERT and Borehole logging), of and aquifer characteristics. The methods and techniques adopted for aquifer mapping are as under:

- Exploratory drilling
  - Lithology
  - Pumping test
- Surface Geophysical Method
  - Vertical Electrical Sounding (VES) technique
  - 2D Electrical Resistivity Imaging (ERI) technique
- Sub-Surface Geophysical (Borehole Logging) Method

Aquifer Group Thickness & Demarcation

For demarcation of aquifer Group in the study area existing exploration data of CGWB and data generation though total of 76 VES, 10.8 line-km ERI and 34 borehole logging were conducted in the area.. The results of exploratory drilling, aquifer parameters, geophysical investigations and chemical analysis results in the study are are utilized for demarcating aquifer groups.

The aquifer material occurs as alluvial/ weathered zones and Bundelkhand Granite with secondary porosity in the form of fracture. The thickness of overburden (Alluvial) varies from 5 to 40 mbgl. The ground water occurs in weathered Granite and fine sand. This is defined as shallow aquifer (Aquifer Group I) and ground water occurs in phreatic condition. The hard rock occurs from exposed in southern part and from 40 mbgl in north eastern part. In hard rock ground water occurs in (secondary porosity) fracture. The depth of occurrence of fracture are at 50,70, 100,150 mgl. The ground water occurs in confined condition.

Plate 13: Location of VES and Exploratory Drilling in Mahoba District, UP

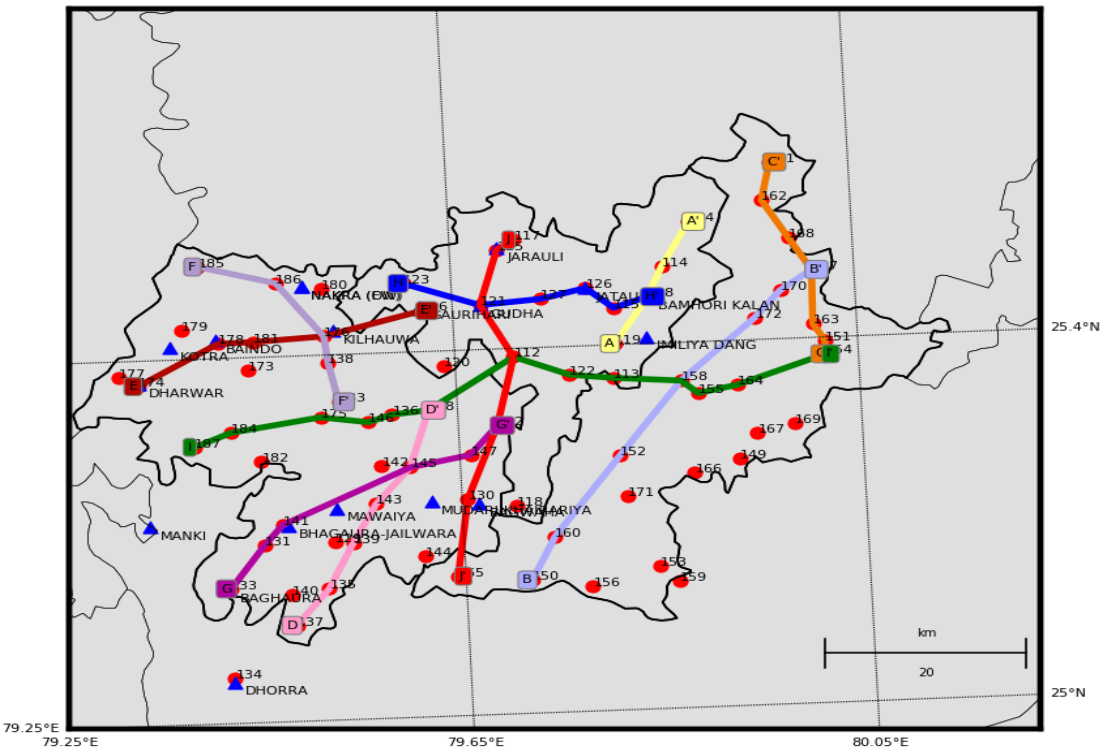


Plate 14: Location of Exploratory Wells in Mahoba District, UP

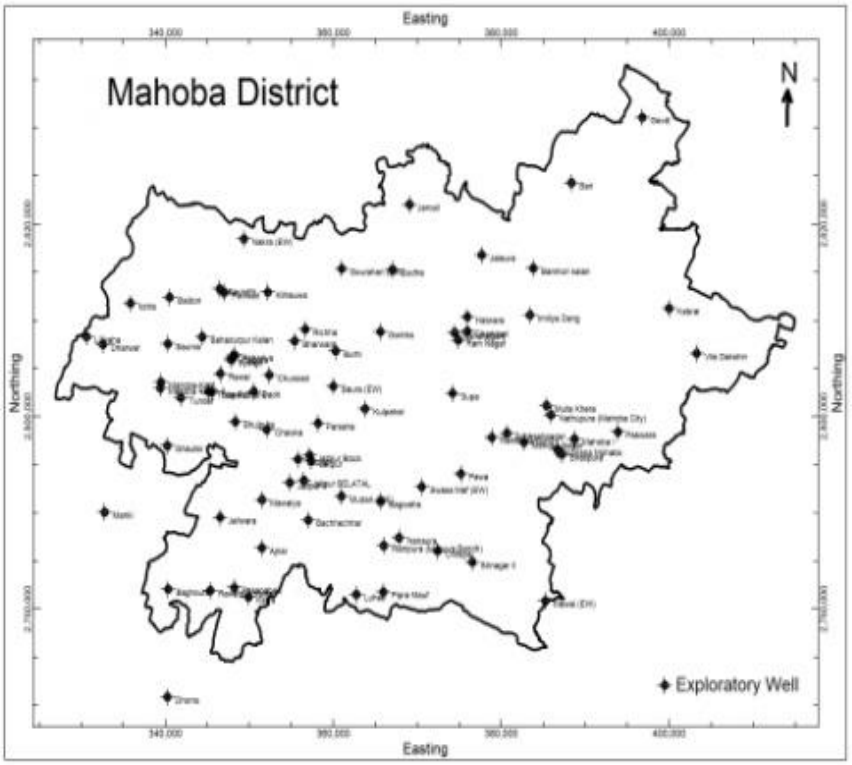


Plate 15: Strip log of Exploratory wells in Mahoba District, UP

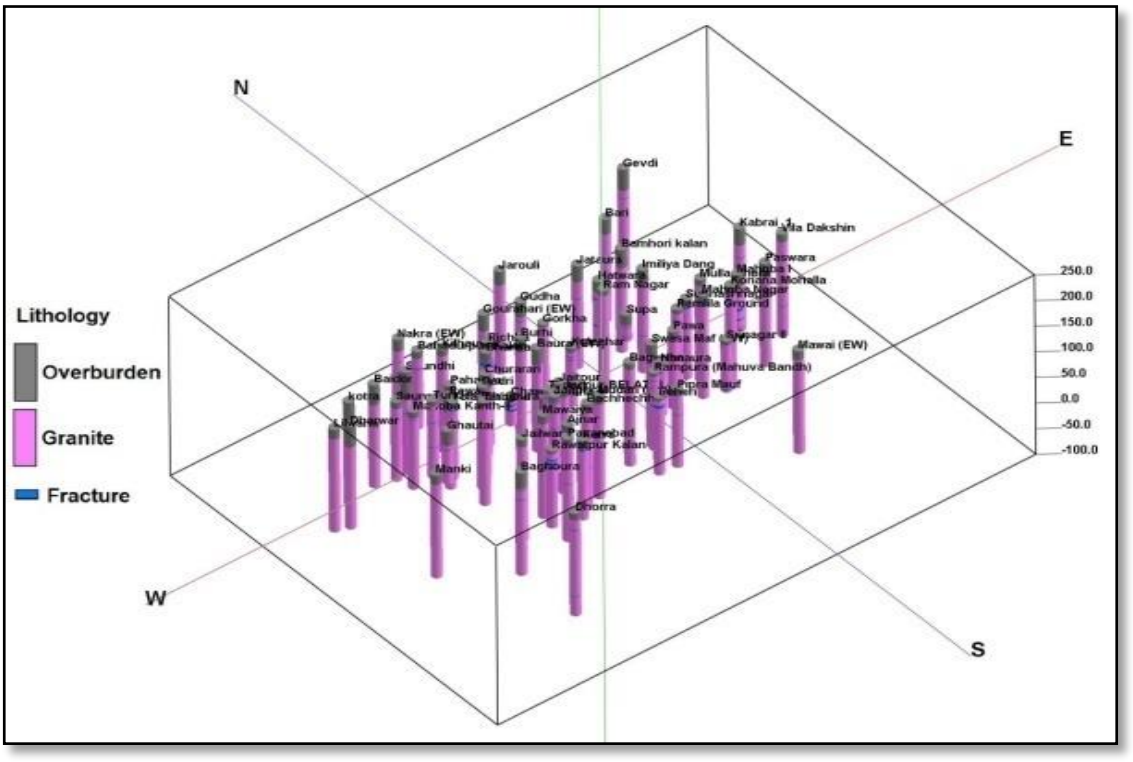


Plate 16: Fence of Exploratory wells in Mahoba District, UP

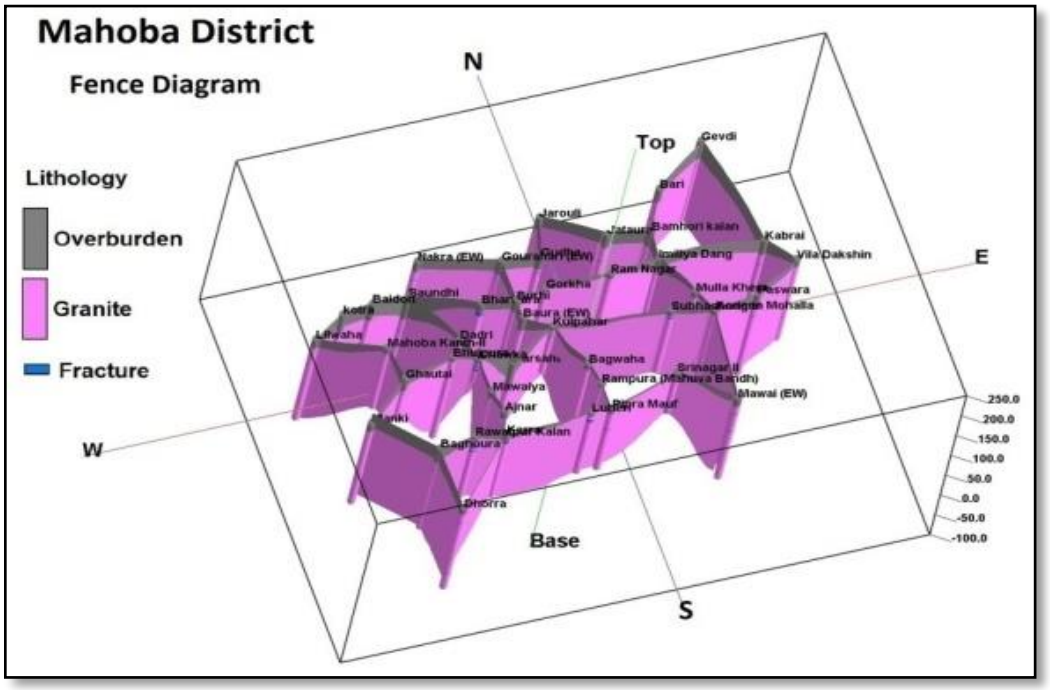


Plate 17: 3 D Section of Exploratory wells in Mahoba District, UP

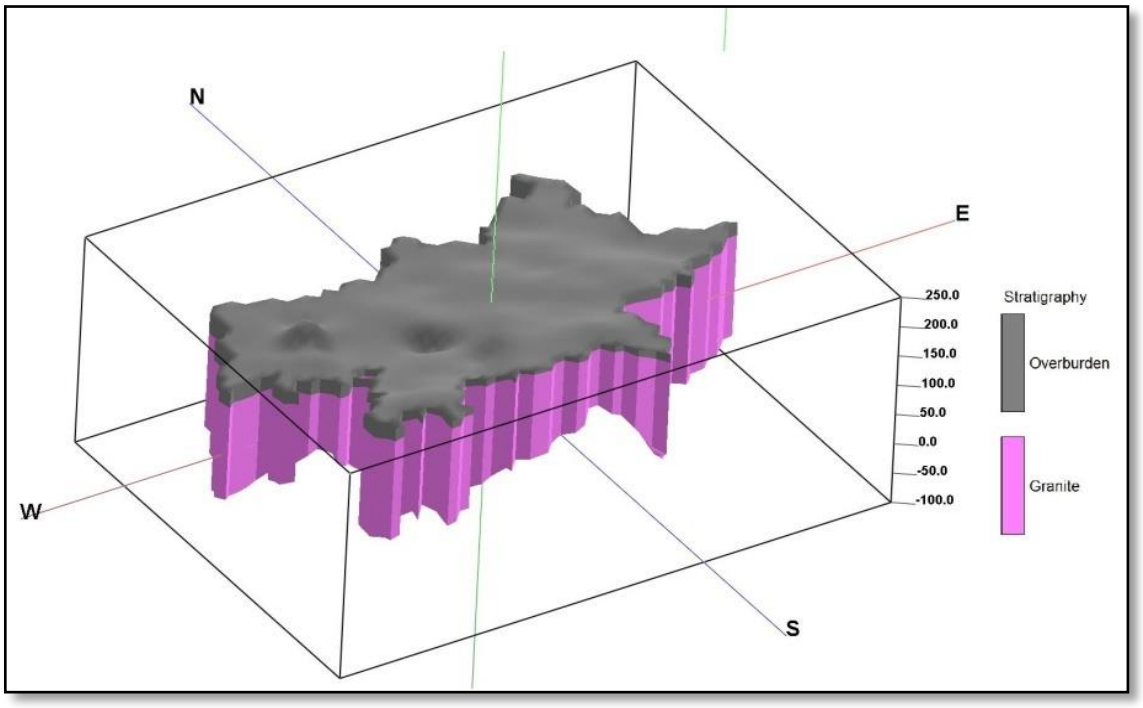


Plate 18: 2D Section along NE-SW, Mahoba District, UP

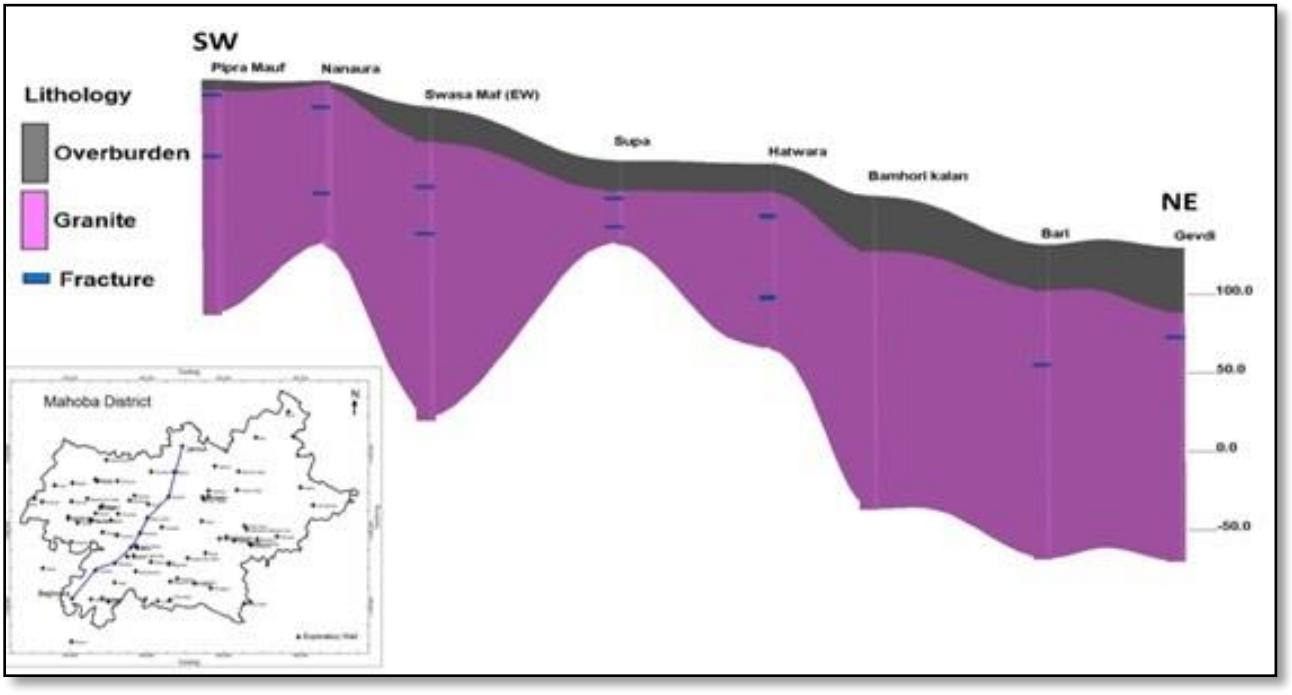


Plate 19: 2D Section along E-W, Mahoba District, UP

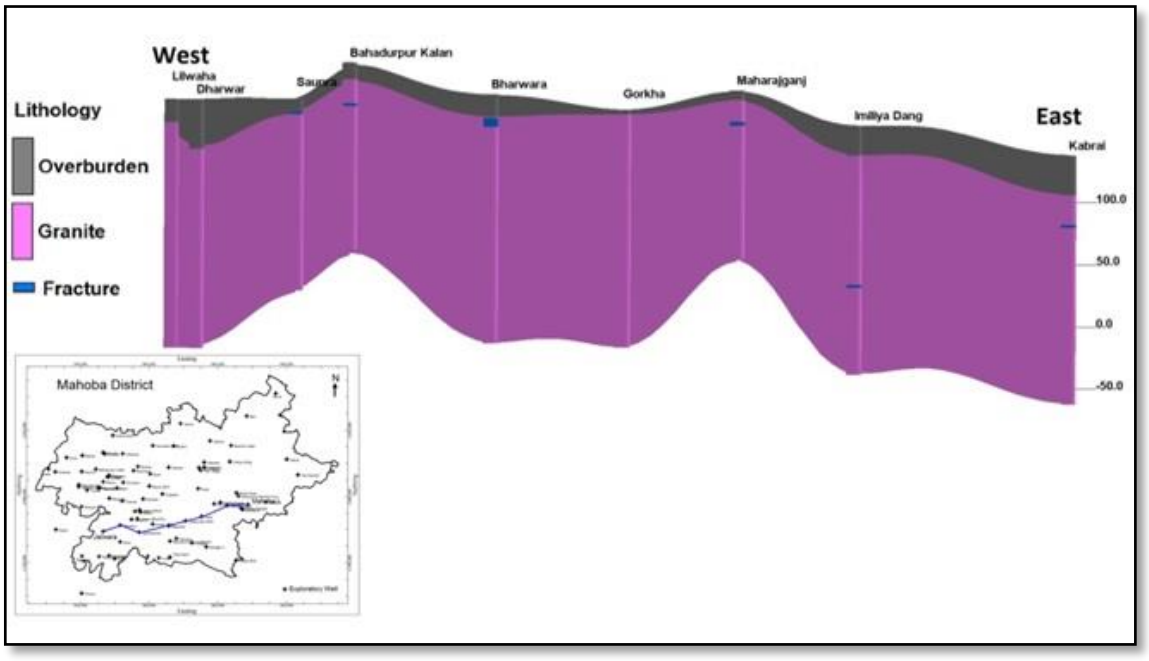


Plate 20: Depth to Basement Map, Mahoba District, UP

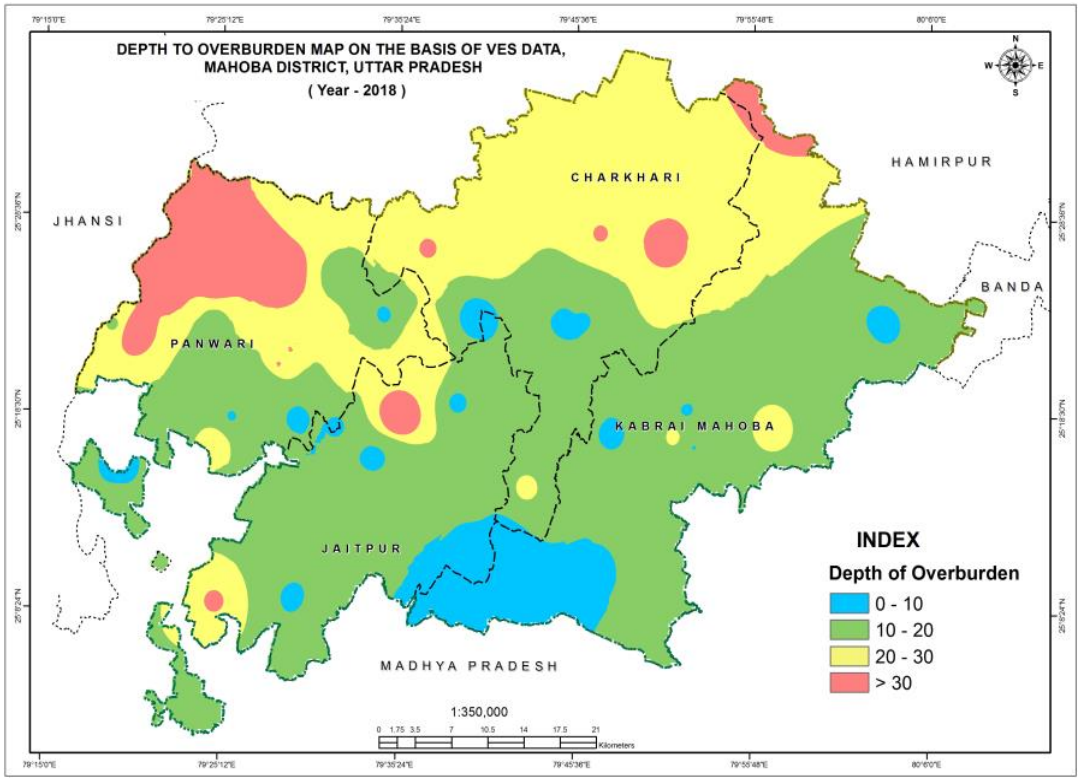


Plate 21: Yield Potential Deep Aquifer Map (Based on Exploratory Drilling), Mahoba

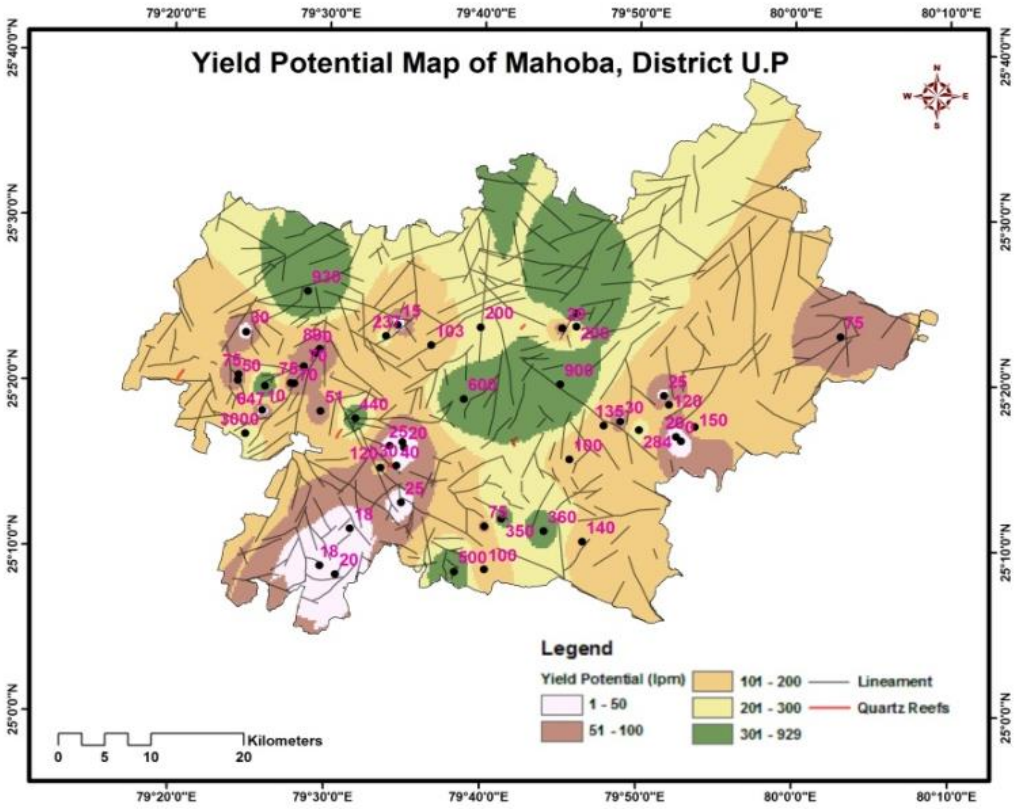
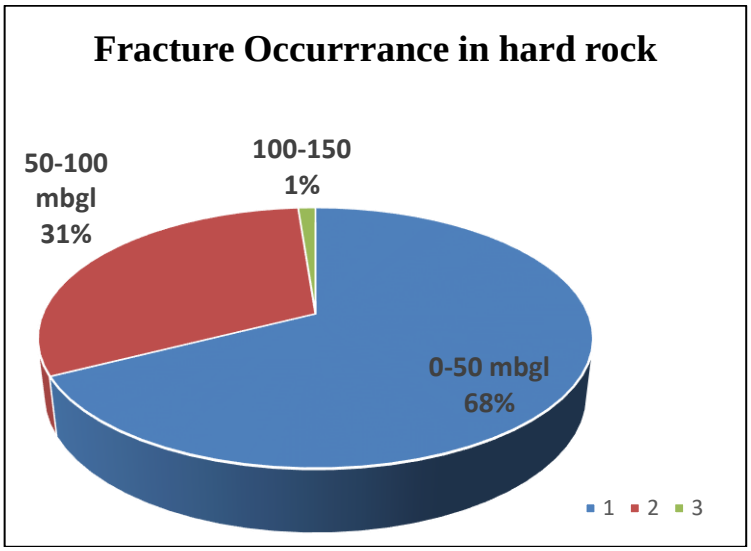


Table 11: Aquifer characteristic Mahoba Diatrict, UP

Type of Aquifer	Formation	Depth Range (mbgl)	SWL (mbgl)	Thick-ness (m)	Dis-charge (lpm)	Sustai na-bility	T^2 (m / d)	Sy/S	Suitability for Drinking & Irrigation
Shallow Aquifer	Weathered Zone/ Alluvium	5-40	2-22	2-25	50-400	Up to 5 hours	-	0.04	Occurrence of Nitrate & Fluoride above permissible in few locations
Deeper Aquifer	Fractured Granite	5-200	1.13 - 20	0-2.0	Dry - 600	Up to 8 hours	50-100	$2.8x10^{-4}$	Only for Drinking purpose

Table 12: Fracture Occurrence in Hard Rock, Mahoba District, UP



6. Groundwater Quality

6.1. Identification of issues

Pre-monsoon sampling was carried out in May 2018 with respect to trace metals and in May 2019 for determination of basic parameters with the intention to delineate areas with spurious quality of groundwater. 36 groundwater samples were collected for analysis of trace metals whereas 105 samples were collected to determine basic parameters.

6.2. Groundwater quality and contamination

6.2.1. General Hydro geochemistry of unconfined aquifer

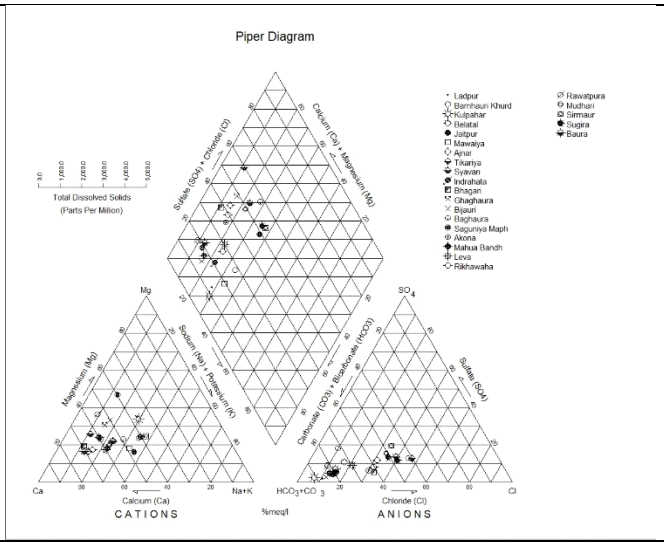
105 groundwater samples collected during May 2019 for ascertaining basic parameters were plotted on the trilinear Hill-Piper diagram (Piper, A.M., 1944) and the samples were classified into the following categories based on the dominant cation and anion.

- 72.38 % of samples lie on Mg^{2+}-HCO_3^- quadrant that indicates $(Ca^{2+}+Mg^{2+}) > (Na^{+}+K^{+})$ and represents groundwater is shallow and fresh in nature,
- 22.85% of samples lie on Mixed type quadrant that indicates $(Ca^{2+}+Mg^{2+}) + (CO_3^{2-} + HCO_3^-) > (Na^{+}+K^{+}) + (Cl^- + SO_4^{2-})$ and represents deep groundwater influenced by ion exchange,
- 3.80 % samples are of Ca-Cl_2 quadrant that indicates $(Na^{+}+K^{+}) > (Ca^{2+}+Mg^{2+})$ and may represent ground and mine drainage,
- 0.95 % of samples lie on Na^+-Cl^- quadrant that indicates $(CO_3^{2-} + HCO_3^-) > (Cl^- + SO_4^{2-})$ and is reminiscent of marine, deep, ancient groundwater.

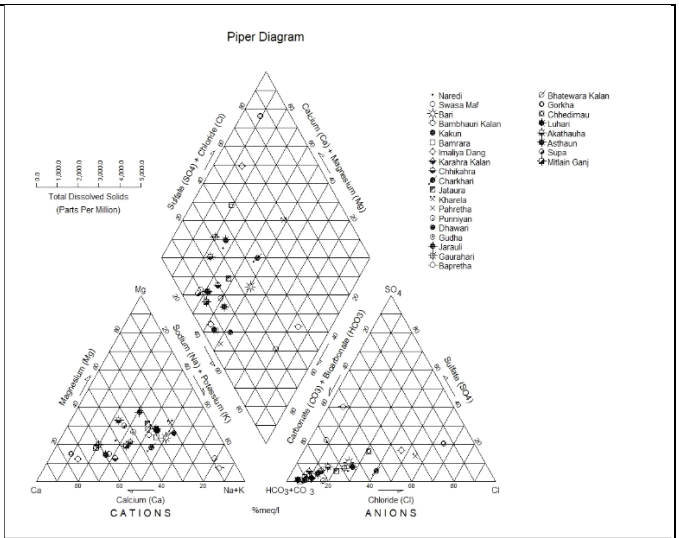
The groundwater samples collected are potable in most of the cases except for high Fluoride at places.

The results of chemical analyses have been attached under Annexure – I and Annexure – II respectively.

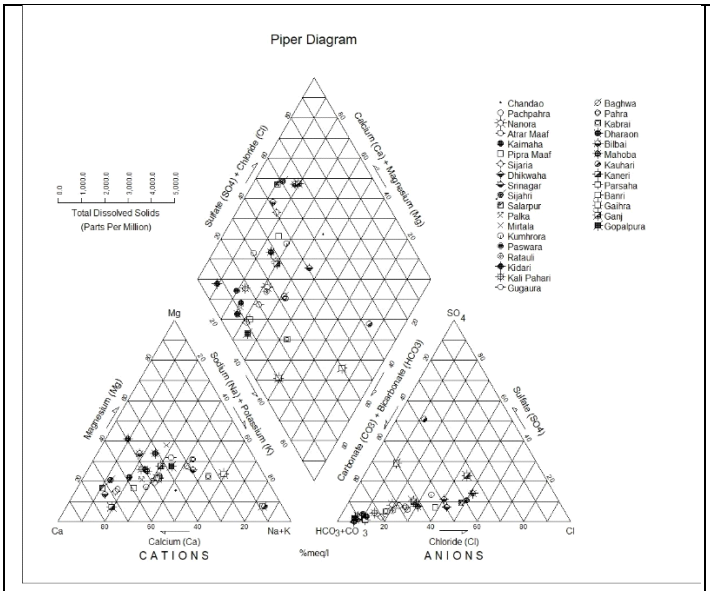
Figure 11: The trilinear Hill-Piper diagram of 105 groundwater samples of Phreatic Aquifer, Mahoba District, UP



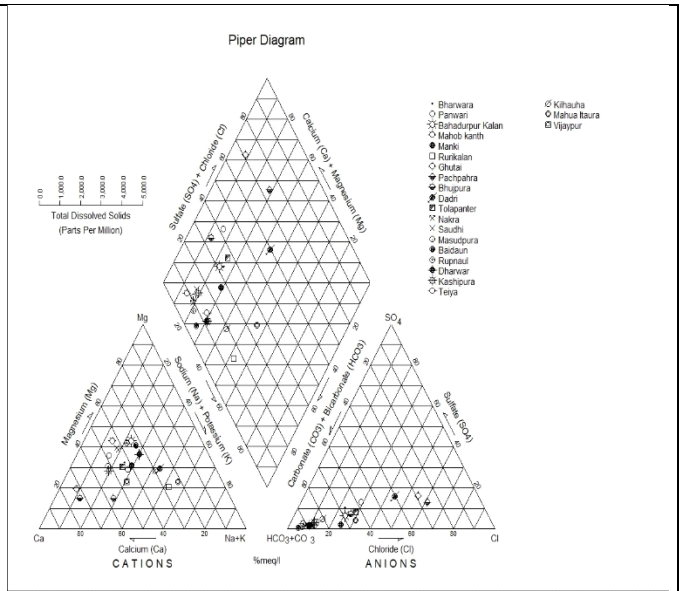
Piper plot of Jaitpur block



Piper plot of Charkhari block

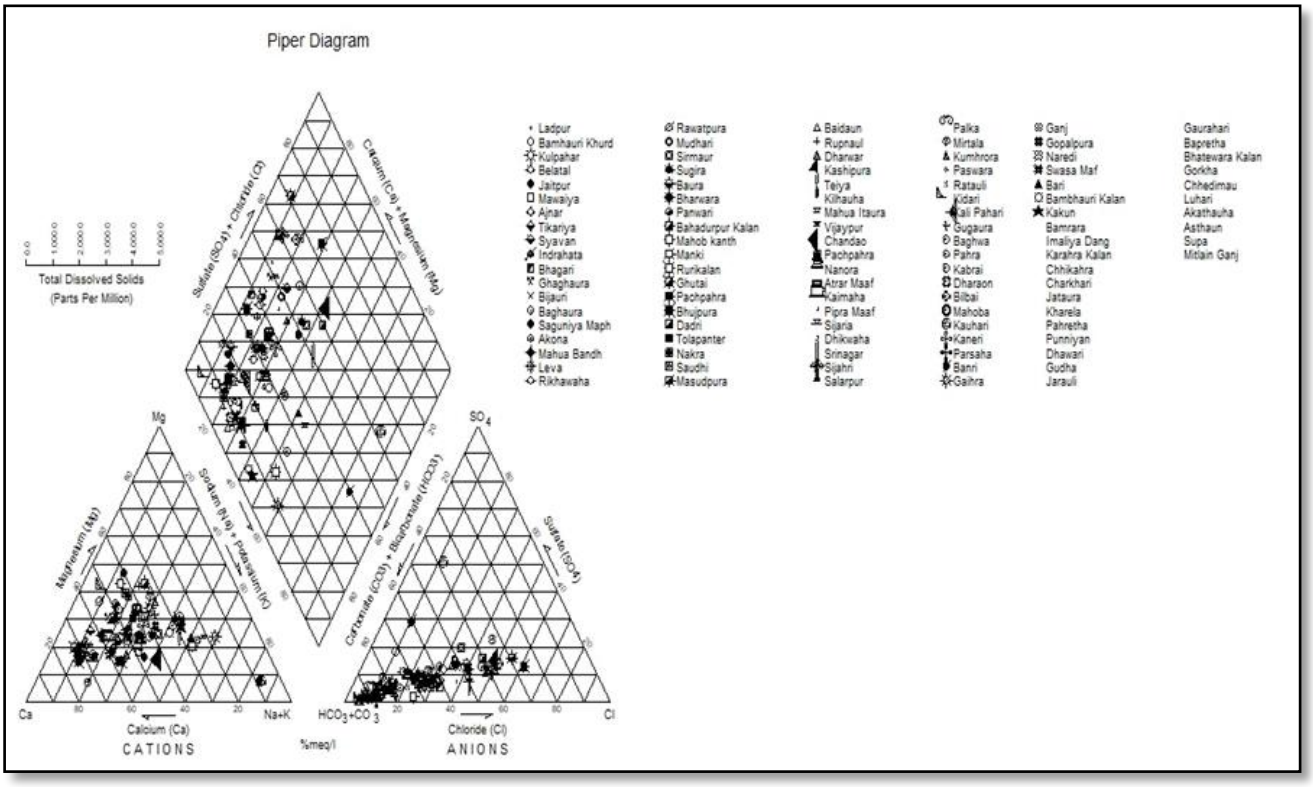


Piper plot of Kabrai block



Piper plot of Panwari block

Figure 12: Trilinear Hill-Piper diagram of unconfined aquifer of Mahoba District,UP



6.2.1.1. Classification with respect to agricultural use

As prescribed by IS 11624-1986[1], the water quality of unconfined aquifer has been classified with respect to agricultural standards and classified below.

•Total salt concentration – It is expressed as Electrical Conductivity (EC) and in relation to the hazardous effect on soils, the classification is given below in Table 11.

Table 13: Summarized table of GW samples w.r.t EC, Mahoba District, UP

SlNo	Class	Range of EC (µS/cm)	No. of samples
1.	Low	0 – 1,500	83
2.	Medium	1,500 – 3,000	19
3.	High	3,000 – 6,000	3
4.	Very High	>6,000	-

The majority of the samples [79.04% of total samples] lie in 'Low' class with reference to EC and are suitable for irrigation. Nineteen samples [18.09% of total samples] lie in 'Medium' class and the soil requires some treatment prior to application of groundwater for irrigation. Three samples lie in 'High' class and require extensive soil treatment and can be used under specific conditions.

- **Residual Sodium Carbonate** – It is given with respect to hazardous effects of Bicarbonate ion concentration on soil and calculated by the following formula where all constituents are in meq/l:

$$RSC = (HCO_3^- + CO_3^{2-}) – (Ca^{2+} + Mg^{2+})$$

The classification as per standard is tabulated below in Table 12.

Table 14: Summarized table of GW samples w.r.t RSC, Mahoba District, UP

Sl.No.	Class	Range of RSC (meq/l)	No. of samples
1.	Low	<1.5	80
2.	Medium	1.5 – 3.0	15
3.	High	3.0 – 6.0	6
4.	Very High	>6.0	4

The majority of the samples [76.19% of total samples] come under 'Low' class with reference to RSC and are suitable for irrigation. Fifteen samples [14.28% of total samples] come under 'Medium' class and the soil requires some treatment prior to application of groundwater for irrigation. Six samples, namely Rurikalan (Panwari block), Gaihra (Kabrai block), Kakun, Bamrara, Pahretha and Dhawari (Charkhari block) [5.71% of total samples] come under 'High' class and can be used under exceptional circumstances. Four samples, namely Bapretha+Punniyan (Charkhari block) in addition to Banri+Kauhari (Kabrai block) [3.80% of total samples] are completely unfit for irrigation purposes.

- **Sodium Adsorption Ratio** - It is an irrigation water quality parameter used in the management of sodium-affected soils. It is an indicator of the suitability of water for use in agricultural irrigation, as determined from the concentrations of the main alkaline and earth alkaline cations present in the water. It is also a standard diagnostic parameter for the sodicity hazard of a soil, as determined from analysis of pore water extracted from the soil.

It is calculated by the following formula:

$$SAR = Na^+/\sqrt{(Ca^{2+} + Mg^{2+})/2}$$

The classification as per standard is tabulated below in Table 13.

Table 15: Summarized table of GW samples w.r.t SAR, Mahoba District, UP

Sl.No.	Class	Range of SAR (meq/l)	No. of samples
1.	Low	<10	101
2.	Medium	10 - 18	3
3.	High	18 - 26	1
4.	Very High	>26	-

101 samples [96.10% of total samples] come under 'Low' category with reference to SAR and there is negligible chance of soil salinity development. Three samples [2.85% of total samples] come under 'Medium' category and there is chance of development of soil salinity and precautions must be taken prior to application of groundwater for irrigation. One sample [0.95% of total samples] comes under 'High' category and is unsuitable for irrigation except for exceptional circumstances.

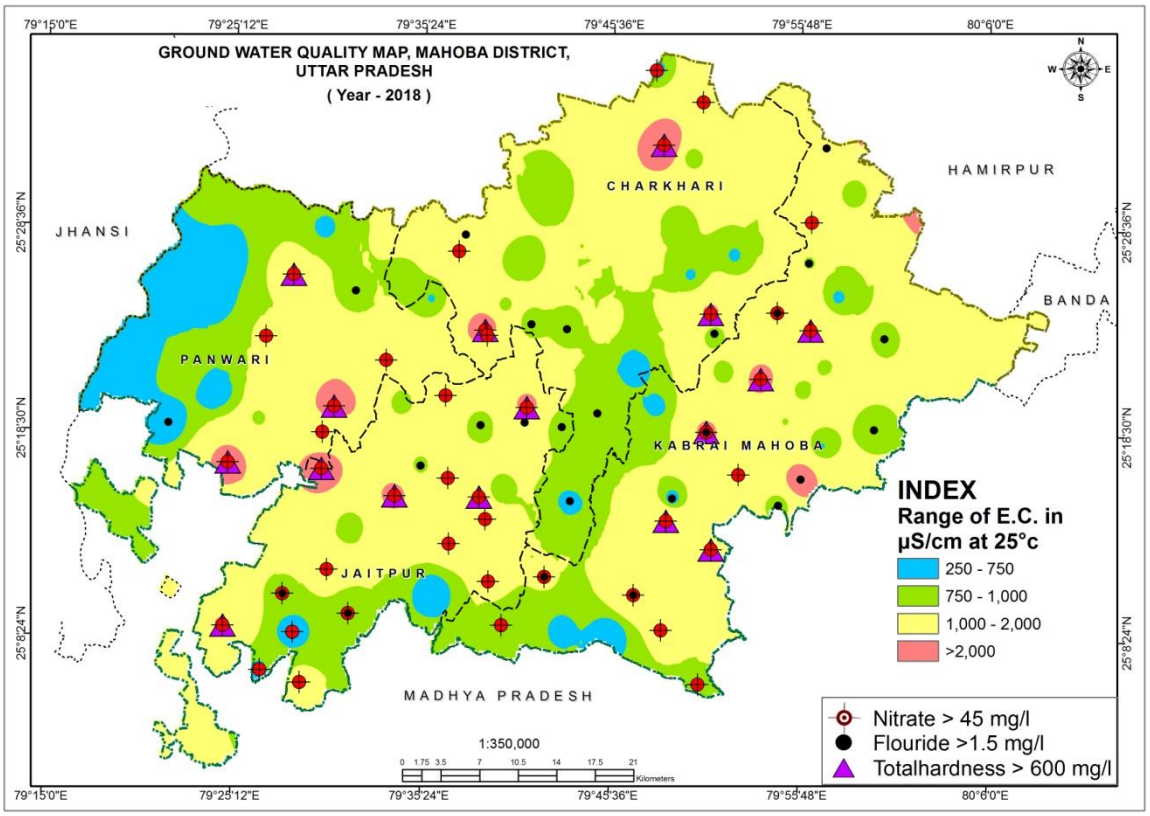
The summarized results of calculations with reference to irrigation standard has been attached under Annexure – III.

6.2.1.2. Note on Trace metals

- Five samples display higher than desirable concentration of Iron in groundwater [Permissible limit > 1.5 mg/l] and one sample each from Panwari, Jaitpur and Kabrai blocks in addition to two samples from Charkhari block have elevated levels of Iron in groundwater.

- Eight samples display higher than desirable concentration of Manganese in groundwater [Permissible limit > 0.3 mg/l] and two samples each from Panwari, Jaitpur, Kabrai and Charkhari blocks have elevated levels of Manganese in groundwater.

Figure 13: Ground Water Quality Map of Phreatic Aquifer, Mahoba District, UP



6.2.2. General Hydro geochemistry of deeper aquifer

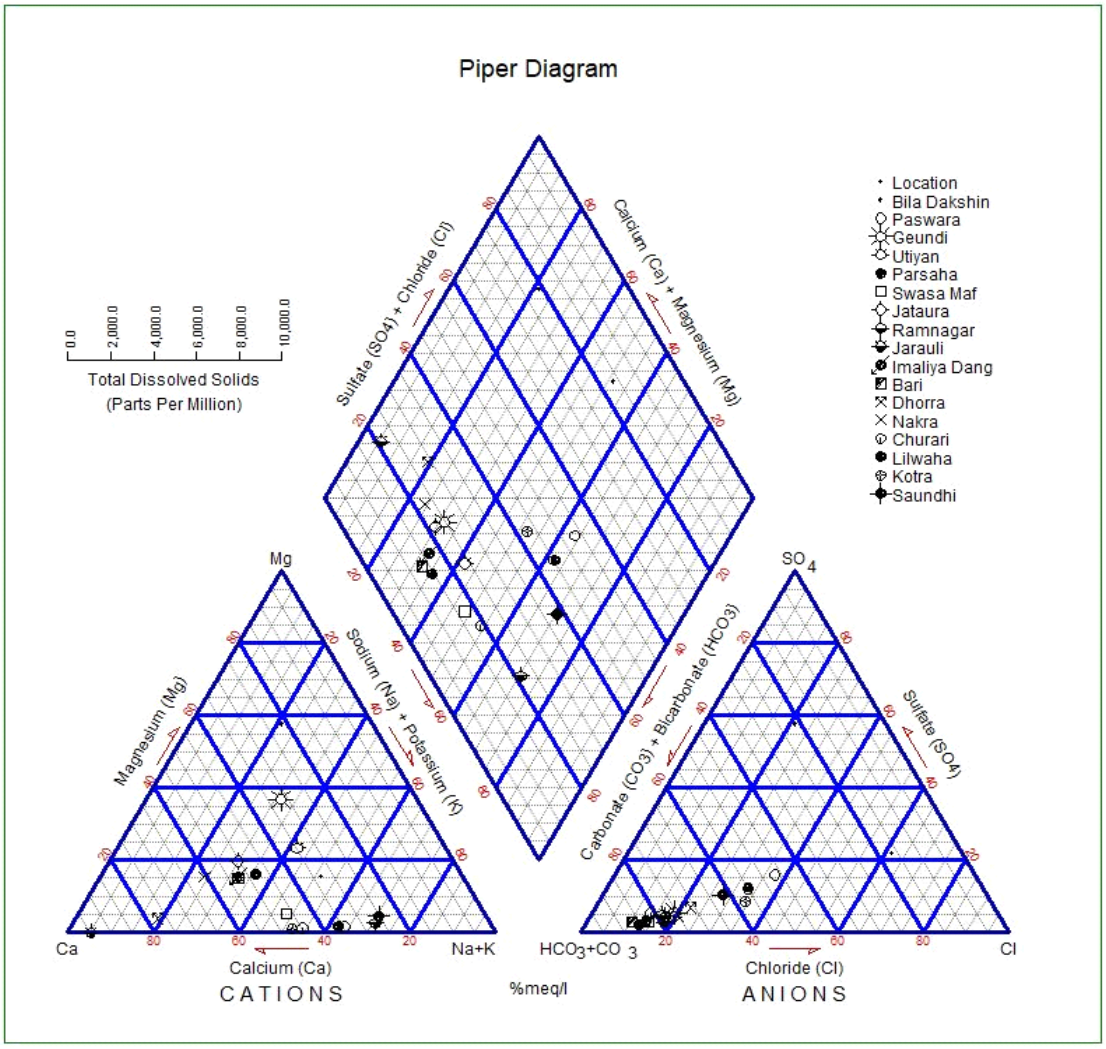
Of the 40 Exploratory bore wells drilled in Mahoba district under AAP 2018-19 of NAQUIM programme, 22 had yielded groundwater in economic quantities to enable collection of Groundwater samples for chemical analysis.

The results of the chemical analyses are been attached under Annexure-IV and Annexure-V respectively.

Plotting the data on Hill-Piper trilinear diagram reveal the following classification –

- 58.82% of samples lie on Mg^{2+}-HCO_3^- quadrant that indicates $(Ca^{2+}+Mg^{2+}) > (Na^{+}+K^{+})$ and represents groundwater is shallow and fresh in nature,
- 23.52% of samples lie on Mixed type quadrant that indicates $(Ca^{2+}+Mg^{2+}) + (CO_3^{2-} + HCO_3^-) > (Na^{+}+K^{+}) + (Cl^- + SO_4^{2-})$ and represents deep groundwater influenced by ion exchange,
- 11.76% of samples lie on Na^{+}-Cl^- quadrant that indicates $(CO_3^{2-} + HCO_3^-) > (Cl^- + SO_4^{2-})$ and is reminiscent of marine, deep, ancient groundwater ,
- 5.90% of samples lie on Na^{+}-HCO_3^- quadrant that indicates $(Cl^- + SO_4^{2-}) > (CO_3^{2-} + HCO_3^-)$ and represents deep groundwater influenced by ion exchange.

Figure 14: Trilinear Hill-Piper diagram of deeper aquifer, Mahoba District, UP



6.2.2.1. Classification for irrigation purpose/ Deeper Aquifer

As prescribed by IS 11624-1986, the water quality of unconfined aquifer has been classified with respect to agricultural standards and classified below.

•**<u>Total salt concentration</u>** **–** It is expressed as Electrical Conductivity (EC) and in relation to the hazardous effect on soils, the classification is given below in Table 14.

Table 16: Summarized table of GW samples w.r.t EC, Mahoba District, UP

Sl.No	Class	Range of EC (µS/cm)	No. of samples
1	Low	<1,500	16
2	Medium	1,500 – 3,000	1
3	High	3,000 – 6,000	-
4	Very High	>6,000	-

The majority of the samples [94.11% of total samples] come under 'Low' class with reference to EC and are suitable for irrigation. Only one sample [5.88% of total samples] comes under

'Medium' class and the soil requires some treatment prior to application of groundwater for irrigation.

•**Residual Sodium Carbonate –** It is given with respect to hazardous effects of Bicarbonate ion concentration on soil and calculated by the following formula where all constituents are in meq/l:

$$RSC = (HCO_3^- + CO_3^{2-}) – (Ca^{2+} + Mg^{2+})$$

The classification as per standard is tabulated below in Table 15.

Table 17: Summarized table of GW samples w.r.t RSC, Mahoba District, UP

Sl.No.	Class	Range of RSC (meq/l)	No. of samples
1	Low	<1.5	13
2	Medium	1.5 – 3.0	4
3	High	3.0 – 6.0	-
4	Very High	>6.0	-

The majority of the samples [76.47% of total samples] come under 'Low' class with reference to RSC and are suitable for irrigation. Four samples [23.52% of total samples] come under 'Medium' class and the soil requires some treatment prior to application of groundwater for irrigation.

•**Sodium Adsorption Ratio -** It is an irrigation water quality parameter used in the management of sodium-affected soils. It is an indicator of the suitability of water for use in agricultural irrigation, as determined from the concentrations of the main alkaline and earth alkaline cations present in the water. It is also a standard diagnostic parameter for the sodicity hazard of a soil, as determined from analysis of pore water extracted from the soil.

It is calculated by the following formula:

$$SAR = Na^+/\sqrt{(Ca^{2+} + Mg^{2+})/2}$$

The classification as per standard is tabulated below in Table 16.

Table 18: Summarized table of GW samples w.r.t SAR, Deeper Aquifer, Mahoba District, UP

Sl.No.	Class	Range of SAR (meq/l)	No. of samples
1.	Low	<10	17
2.	Medium	10 - 18	-
3.	High	18 - 26	-
4.	Very High	>26	-

All samples, 17 in nos. come under 'Low' category with reference to SAR and can be utilized for irrigation without the danger of development of soil salinity.

The summarized results of calculations with reference to irrigation standard has been attached under Annexure – VI.

6.2.2.2. Note on Trace metals

- Three samples display higher than desirable concentration of Iron in groundwater [Permissible limit > 1.5 mg/l] and one sample each from Panwari, Jaitpur and Kabrai blocks have elevated levels of Iron in groundwater.

- Three samples display higher than desirable concentration of Manganese in groundwater [Permissible limit > 0.3 mg/l] and two samples from Charkhari block and one sample from Panwari block have elevated levels of Manganese in groundwater.

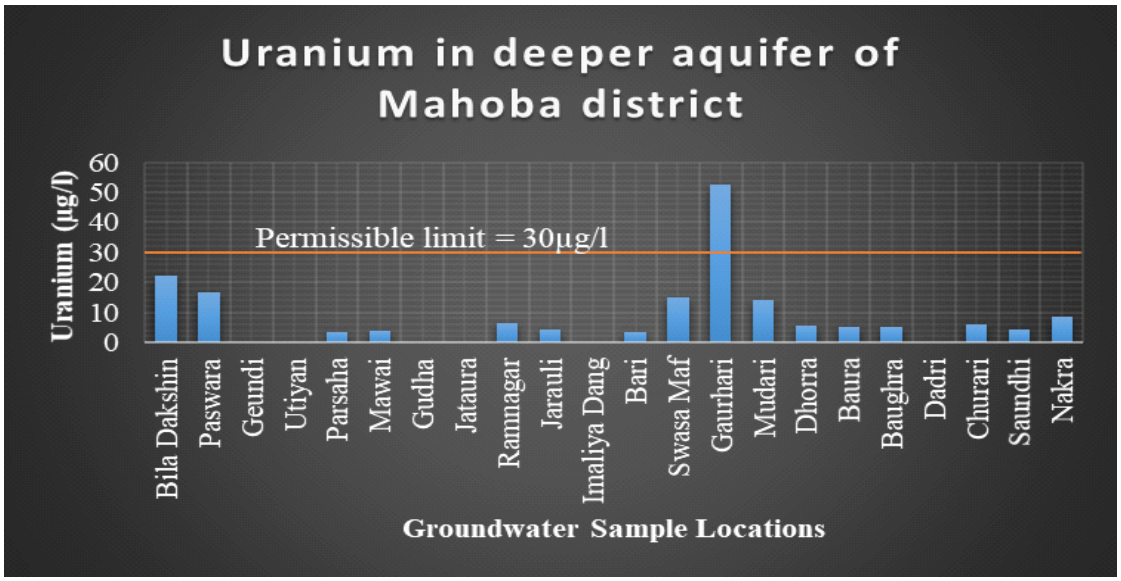
- One sample displays higher than desirable concentration of Chromium in groundwater [Acceptable limit < 0.05 mg/l and no relaxation beyond 0.05 mg/l] and the sample comes from Jaitpur block.

6.2.2.3. Note on Uranium in groundwater

Uranium is a radioactive element in the Actinide series of periodic table, with atomic number of 92 and standard atomic weight of 238.028u. Uranium occurs naturally in the +2, +3, +4, +5 and +6 valence states, but it is most commonly found in the hexavalent form. In nature, hexavalent uranium is commonly associated with oxygen as the uranyl ion, UO_2^{2+}. Naturally occurring uranium (^{nat}U) is a mixture of three radionuclides (^{234}U, ^{235}U and ^{238}U), all of which decay by both alpha and gamma emissions (Cothern & Lappenbusch, 1983; Lide, 1992–1993). Natural uranium consists almost entirely of the ^{238}U isotope, with the ^{235}U and ^{234}U isotopes respectively comprising about 0.72% and 0.0054% (Greenwood & Earnshaw, 1984). Uranium is widespread in nature, occurring in granites and various other mineral deposits (Roessler et al., 1979; Lide, 1992–1993).

All groundwater samples collected during construction of borewells or during pumping test were analysed for the presence of Uranium by ICP-MS in addition to basic parameters. According to data obtained from RCL, the groundwater sample of Gaurhari from Charkhari block exceeds the permissible limit as mandated by WHO (2011).

Figure 15: uranium in Deeper Aquifer, Mahoba District, UP



6.2.3. Comparison between unconfined and deeper aquifer

The difference in quality with respect to different ions/elements present in unconfined and deeper aquifer has been tabulated below in Table 7.

Table 19: Table displaying difference in water quality of unconfined and deeper aquifers, Mahoba District, UP

Constituents	Limits as per BIS 10500-2012: 2nd Revision	Aquifer – I			Aquifer – II		
		Min	Max	No. of Samples above MPL	Min	Max	No. of Samples above MPL
pH	6.5 – 8.5	6.70	8.24	-	7.36	8.30	-
EC (µS/cm)	No limits	380.00	3,550.00	-	452.00	2,808.00	-
TDS	500 – 2,000 mg/l	228.00	2,130.00	2	-	-	-
Calcium	75 -200 mg/l	32.06	585.17	14	36.40	190.80	-
Magnesium	30 – 100 mg/l	12.07	137.40	3	0.00	74.40	-
Potassium	No limits	0.00	273.00	-	0.00	28.00	-
Sodium	No limits	15.13	636.00	-	5.00	339.00	-
Carbonate	No limits	-	-	-	-	-	-
Bicarbonate	No limits	146.40	829.60	-	183.00	624.64	-
Chloride	250 – 1,000 mg/l	14.18	638.10	-	7.09	652.30	-
Sulphate	200 – 400 mg/l	0.00	790.00	2	6.00	286.00	-
Nitrate	45 mg/l (acceptable)	0.50	96.50	14	1.00	42.00	-
Fluoride	1.00 mg/l (acceptable); 1.50 mg/l	0.00	3.45	25	0.4	4.4	7

	(permissible)						
Arsenic	0.01 mg/l (acceptable)	-	-	-	BDL	0.00025	-
Chromium	0.05 mg/l (acceptable)	-	-	-	BDL	0.41	1
Iron	1.0 mg/l (acceptable); 1.5 mg/l (permissible)	0.144	2.73	5	BDL	3.45	3
Manganese	0.1 mg/l (acceptable); 0.3 mg/l (permissible)	0.001	2.54	8	BDL	1.19	3
Copper	0.05 mg/l (acceptable); 1.5 mg/l (permissible)	0.006	0.024	-	BDL	0.00	-
Zinc	5 mg/l (acceptable); 15 mg/l (permissible)	0.026	1.396	-	BDL	0.94	-
Uranium[6]	30 ppb	-	-	No sampling carried out	0.00	52.47	1

7. Ground Water Resource

Ground water resources have been computed jointly by Central Ground Water Board and Ground Water Department, Govt. of U.P. as on 31st March 2017. The salient features of the computations are furnished below –

Table 20: Ground Water Recharge and Natural Discharge (in Ham), Phreatic Aquifer, Mahoba District, UP

Sl. No.	Assessment Units - Blocks/ District	Recharge from Rainfall during Monsoon Season	Recharge from Other Sources during Monsoon Season	Recharge from Rainfall during Non-Monsoon Season	Recharge from Other Sources during Non-Monsoon Season	Total Annual Ground Water Recharge	Provision for Natural Discharges	Net Annual Ground Water Availability
1	CHARKHARI	2857.53	1492.31	0.00	1911.49	6261.32	313.07	5948.26
2	JAITPUR	2202.76	951.81	0.00	1376.38	4530.95	226.55	4304.40
3	KABRAI	2733.55	1290.16	0.00	1777.31	5801.02	290.05	5510.97
4	PANWARI	2584.80	1487.35	0.00	2221.02	6293.17	314.66	5978.51
	Total	10378.64	5221.63	0.00	7286.19	22886.46	1144.32	21742.14

Table 21: Details of Draft for Different Purposes (Ham), Phreatic Aquifer,, Mahoba District, UP

Sl. No.	Assessment Units - Blocks/ District	Net Annual Ground Water Availability (ham)	Existing Gross Ground Water Draft for Irrigation (ham)	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply (ham)	Existing Gross Ground Water Draft for All Uses (ham)	Provision for Domestic and Industrial Requirement Supply for 2038 (ham)	Net Ground Water Availability for future Irrigation development	Stage of Ground Water Development (%)
1	CHARKHARI	5948.26	3947.00	274.56	4221.56	352.26	1648.99	70.97
2	JAITPUR	4304.40	4082.00	432.61	4514.61	432.61	0.00	104.88
3	KABRAI	5510.97	3779.50	323.31	4102.81	445.68	1285.79	74.45
4	PANWARI	5978.51	5866.00	378.81	6244.81	378.81	0.00	104.45
	Total	21742.14	17674.50	1409.29	19083.79	1609.36	2458.27	87.77

Block	Annual Extractable GW Recharge	Existing GW Draft For Irrigation	Draft for Domestic & Industrial Use	Existing Gross Draft	Provi-sion for Domsetic & Industrial Requirement for next 25 years	Net Ground Water Availabi-ity for Irrigation	Stage of Ground Water develop-ment	Category
CHARKHARI	5948.26	3947.00	274.56	4221.56	352.26	1648.99	70.97	Semi - Critical
JAITPUR	4304.40	4082.00	432.61	4514.61	432.61	0.00	104.88	OE
KABRAI	5510.97	3779.50	323.31	4102.81	445.68	1285.79	74.45	Semi-Critical
PANWARI	5978.51	5866.00	378.81	6244.81	378.81	0.00	104.45	OE
TOTAL	21742.14	17674.50	1409.29	19083.79	1609.36	2458.27	87.77	

Table 22: Static Resource in Aquifer- I in Mahoba District, UP

Block	Area (sq.km.)	Avg Pre Monsoon DTW (mbgl)	Depth of Bseme nt (mbgl)	Thick- ness below WL (m) Thickness Granular Zones (m)#	Sp Yield	Resource in MCM (Area x grainular zone thickness x Sp. Yield**)
CHARKHARI	803.13	8.32	25	16.68	0.01	133.96
JAITPUR	618.27	10.33	20	9.67	0.01	59.79
KABRAI	848.23	10.43	20	9.57	0.01	81.18
PANWARI	614.68	10.5	25	14.5	0.01	89.13
Total Resource Available In Unconfined Aquifer (MCM)						**364.05**
# Calculated on the basis of % of granular zones for respective block						

Table 23: Static Resource in Confined Aquifer in Mahoha District (down to 200m), UP

Block	Area (A) (sq. km.)	Depth	Depth to basement(m bgl)	Thicknes of Hard Rock (m)	Av. Thickness of fracture from weathered zone to depth of 200 (1%)	Storage in Aquifer (in MCM) (A*Gr*Sy) (mcm)
CHARKHARI	803.13	200	25	175	1.75	14.05
JAITPUR	618.27	200	20	180	1.85	11.13
KABRAI	848.23	200	20	180	1.55	15.27
PANWARI	614.68	200	25	175	1.8	10.76

Total	304.63					51.21

Table 24: Total G.W. Resources in Mahoba District (down to 200 m) in MCM, UP

Block	Area (sq. km.)	Aquifer-I (Unconfined)			Aq-II (Confined)	Total Storage (MCM)
		Dynamic Resource (MCM)	*Static Storage (MCM)*	*Total Resource (Aq-I) (MCM)*	*Resource (MCM)*	
CHARKHARI	803.13	42.22	133.96	176.18	14.05	190.23
JAITPUR	618.27	45.15	59.79	104.94	11.13	116.07
KABRAI	848.23	41.03	81.18	122.10	15.27	137.37
PANWARI	614.68	62.45	89.13	151.58	10.76	162.34
Total	**2884.31**	**190.84**	**364.05**	**554.48**	**51.21**	**606.10**

Figure 16: Ground Water Resource, Mahoba District, UP

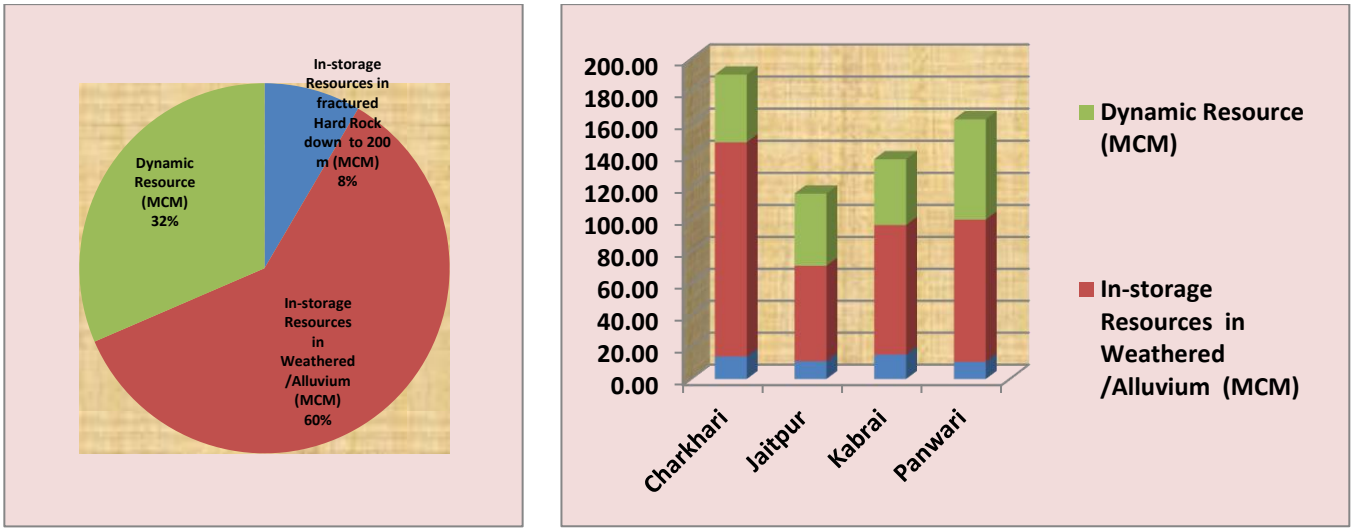
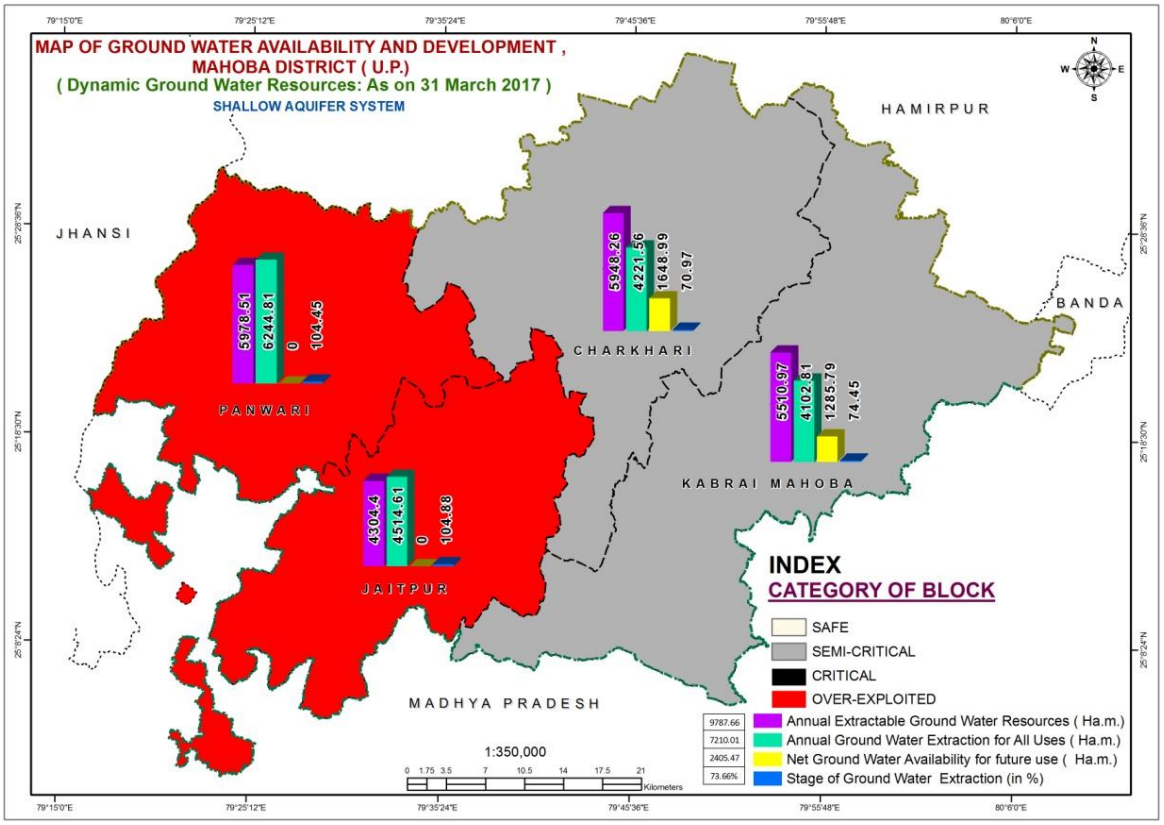


Plate 22: Ground Water Dynamic Resource Map, UP



8. GROUND WATER RELATED ISSUES AND PROBLEMS

The development of ground water in the district, in general, is high as 2(two) blocks (Panwari, Jaitpur) have been categorized as **Over Exploited** and other two blocks (kabrai, Charkahari) are in Semi-critical Category.Reasons for over exploitation are Cropping patter & Irrigation Practice as Ground water Draft for irrigation is in Excess of Net Annual GW Availability. Due to this there is problem of sustainability of ground water in dry season. Dug well becomes dry and yield of bore wells also decrease. The stress in ground water is reflected in decline of ground water trend. At some pockets there is occurrence of nitrate and fluoride in phreatic aquifer ground water.

Although overall stage of ground water development in the district is about 87 %, yet the trend analysis of historical ground water level data indicates a long term fall in most of the wells in the district. Based on the factors mentioned, it is inferred that the district in general could be considered vulnerable to various environmental impacts of water level depletion such as declining ground water levels, drying up of shallow wells, and decrease in yield of bore wells and increased expenditure and power consumption for drawing water from progressively greater depths. Excessive use of fertilizers and pesticides in agriculture has also reportedly resulted in localized enrichment of Nitrate in the phreatic aquifer.

9. GROUND WATER MANAGEMENT STRATEGY

To arrest the further decline in ground water levels and depletion of ground water resources, there is urgent need to implement both Supply side and Demand side measures which includes artificial recharge and water conservation, On-farm activities and adoption of water use efficiency measures.

Table 25: Ground Water Management Strategies, Mahoba District, UP

GW Management options	
Supply side Interventions	**Demand side Interventions**
○ Construction of check dams/nala bunds ○ Revival and renovation of ponds ○ On farm activities like laser leveling, bench terracing, construction of farm ponds, plantation of forests etc.	◦ Water use efficiency through piped and pressurised irrigation (drip & Sprinkler) ◦ Catchment treatment and other rainwater harvesting structures. ◦ Irrigation in checks in close row crops should be practised ◦ Measures for reducing Evapo-transpiration losses etc. ◦ Diversification of cropping pattern. **Most effective option to reduce ground water withdrawal by 35-40% specially for Sugarcane areas by adopting new irrigation practices**

9.1. Supply side Management:

It is proposed to adopt supply side management options only in the Over-Exploited and Semi-Critical blocks. There is considerable scope for implementation of Roof Top Rain Water Harvesting in the urban areas of the district. Check dams, cement plugs, renovation of ponds are ideal structures for rain water harvesting in rural areas. Water conservation structures such as check dams, farm ponds, nala bunds etc. result in ground water recharge to the tune of about 40% of the storage capacity considering 3 annual fillings. It is proposed to construct 44 Check dams of 10,000 cubic m. capacity and 117 nala bunds of 7,500 cubic meter capacity, to revive and renovate 383 ponds and development of 44Km. stream channel.

It is also proposed to adopt On Farm practices such as laser leveling, bench terracing, construction of farm ponds, afforestation, diversification of crops etc. On farm activities are proposed in an area of 39000 hectare. It is expected that above measures will lead to additional recharge of 41.12 MCM of ground water.

9.2. Demand side Management:

Agriculture is the major consumer of ground water. There In the district, about 60% irrigation is dependent on ground water. Even in the canal command areas, enough ground water is being used to irrigate the fields. In the major parts of area, flow irrigation is being used. There is urgent need to promote piped and pressurised irrigation practices which can save 25 to 70% of water use in the agriculture. It is proposed to initiate these measures initially in 9500 hectare area of the district. It is estimated that there may be saving of 8.02 MCM of water with this measure. Such practices have the potential of saving 35-40% irrigation water thereby drastically reducing the draft for irrigation leading the change of category of block from OE to safe.

The measures adopted for supply side and demand side management in Mahoba district will substantially bring down stage of ground water development.

Agricultural Practices for Saving Irrigation Water in Sugarcane Cultivation Advantages

- Water Use Efficiency is increased by 35-40%.
- Water saving: Irrigation water is saved up to 30-40 %
- Normal Cane Yield and Quality is obtained.
- Weed infestation is reduced considerably.

1. Trash Mulching

Trash i.e. dry leaves available after harvesting of the crop is a valuable source of organic matter & water saving. In general farmers burn trash or utilise it for other purposes such as thatching, fuel litter etc. If, it is recycled in the cane field itself it contributes not only in saving precious irrigation water but also adds organic matter as well as other plant nutrients in soil. So it is important to recycle trash by mulching in sugarcane field.

Advantages

- Irrigation water is saved up to 40% as it conserves the soil moisture & reduces evaporation from soil surface.
- Increased availability of nutrients especially Nitrogen and Phosphorus to the plants.
- Mulch also adds large quantity of organic matter thus improves soil health of the soil.

2. Micro Irrigation (Sprinkler/ Drip Irrigation)

Micro irrigation is the frequent application of small quantities of water on, above or through water directly at the root zone of the plant in a uniform and effective way.

Advantages

- Water Use Efficiency can be improved from 50-60 % to 90-95%.
- The consumption of fertilizers can be reduced by 30%.
- Weed infestation is reduced considerably.
- Can be used on undulating topography & on soils having low infiltration rates.

Table 26: Run off availability for recharge and conservation, Mahoba District, UP

Blocks	Total area (sq km)	Normal Monsoon rainfall (mm)	Runoff Generated During Monsoon (MCM)	Run off factor	Non-committed Run-off (%)	Surplus surface runoff (MCM)
Charkhari	803.13	767.7	123.31	20	50	61.66
Jaitpur	618.27	767.7	94.93	20	50	47.46
Kabrai	848.23	767.7	130.24	20	50	65.12
Panwari	614.68	767.7	94.38	20	50	47.19
	2884.31	767.7	442.85	80	200	221.42

Table 27: Proposed Artificial Recharge and WUE Interventions in Mahoba District, UP

Blocks	Check Dams NOS	Stream Dev (Km)	Nala BundsNOS	Ponds NOS	On-farm Area (ha)	WUE Area (ha)
Charkhari	11	11	27	100	6500	1500
Jaitpur	10	10	31	88	12500	3000
Kabrai	12	12	28	106	5000	2000
Panwari	10	10	31	88	15000	3000

Table 28: Block wise number of Check dams and length of stream channel to be developed and Expected Recharge and Supplementary Irrigation, Mahoba District, UP

Blocks	Check Dams (10000 cum)	Total Storage (MCM) considering three Fillings	Expected Annual recharge (MCM)	Supplemental Irrigation (MCM)	Stream Dev (Km)	Storage (MCM) 3 Fillings	Expected Annual recharge (MCM)	Supplemental Irrigation (MCM)
Charkhari	11	0.34	0.06	0.17	11	0.52	0.08	0.26
Jaitpur	10	0.31	0.05	0.15	10	0.46	0.07	0.23
Kabrai	12	0.36	0.06	0.18	12	0.55	0.09	0.27
Panwari	10	0.31	0.05	0.15	10	0.46	0.07	0.26
Total	44	1.32	0.22	0.66	44	1.99	0.31	0.99

Table 29: Block wise number of Nala Bunds, Expected annual recharge and Provision for supplemental irrigation, Mahoba District, UP

Blocks	Nala Bunds (CAPACITY 7500 M3 EACH)	Storage (MCM)	Storage (MCM) 3 FILLINGS	RECH NALA BUNDS (MCM)	SUPPL IRR (MCM)
Charkhari	27	0.20	0.60	0.10	0.30
Jaitpur	31	0.23	0.70	0.12	0.35
Kabrai	28	0.21	0.64	0.11	0.32
Panwari	31	0.23	0.69	0.12	0.35
Total	117	0.88	2.63	0.44	1.31

Table 30: Block wise number of Ponds, Expected annual recharge and Provision for supplemental irrigation, Mahoba District, UP

Blocks	Ponds	Storage (MCM) considering 3 fillings	RECH FROM PONDS (MCM)	Supplemental irrigation (MCM)
Charkhari	100	2.26	0.38	1.13
Jaitpur	88	1.99	0.34	0.99
Kabrai	106	2.39	0.41	1.19
Panwari	88	1.98	0.34	0.99
Total	**383**	**8.61**	**1.46**	**4.30**

Table 31: Blockwise Area under On Form Activity and Water Use Efficiency , Expected annual recharge and Saving in Draft, Mahoba District, UP

Blocks	On-farm Area (ha)	Exp Rech (ham) On-farm	Saving in Draft (ham) On-farm	WUE Area (ha)	Saving in Draft (ham) WUE
Charkhari	6500	650.00	994.50	1500	229.50
Jaitpur	12500	1250.00	562.50	3000	135.00
Kabrai	5000	500.00	240.00	2000	96.00
Panwari	15000	1500.00	1710.00	3000	342.00
Total	39000	3900.00	3507.00	9500	802.50

Table 32: Summary of Interventions and expected Benefits, Mahoba District, UP

Interventions Recommended	
Check Dam of 10000 cum Capacity	44 Nos.
Channel/ Stream Development	44Km
Nala Bunds of 7500 cum Capacity	117 Nos.
Revival of Ponds of 100mx100mx3m dimensions	383 Nos.
On-farm Activities	39000 ha
Water Use Efficiency (WUE) Measures	9500 ha
Expected Benefits	

Expected Annual Recharge	4143.0 ham
Provision for supplemental irrigation	727.0 ham
Conservation from On-farm Activities & WUE Measures	4309.0 ham
Total Recharge/ Saving	**9179.0 ham**

Table 33: Block-wise Projected Status of Groundwater Resource & Utilization in Mahoba District after AR Interventions, Mahoba District, UP

Blocks	Net Annual Ground Water Avail-ability (ham)	Existing Gross Ground Water Draft for All Uses (ham)	Stage of Ground Water Development (%)	Total RECH through interventions (ham)	Total GW Saving through interventions (ham)	Projected Net GW Availability (ham)	Projected Gross GW Draft (ham)	Projected Stage Of Development After Interventions
Charkhari	5948.26	4221.56	70.97	712.18	1483.27	6660.44	2738.29	**41.11**
Jaitpur	4304.40	4514.61	104.88	1307.53	870.10	5611.93	3644.51	**64.94**
Kabrai	5510.97	4102.81	74.45	566.22	532.27	6077.19	3570.54	**58.75**
Panwari	5978.51	6244.81	104.45	1557.24	2223.73	7535.75	4021.08	**53.36**
	21742.14	**19083.79**	**87.77**	**4143.17**	**5109.37**	**25885.31**	**13974.42**	**53.99**

Table 34: Additional Population benefited and Additional area irrigated by Augmented Resourc , Mahoba District, UP

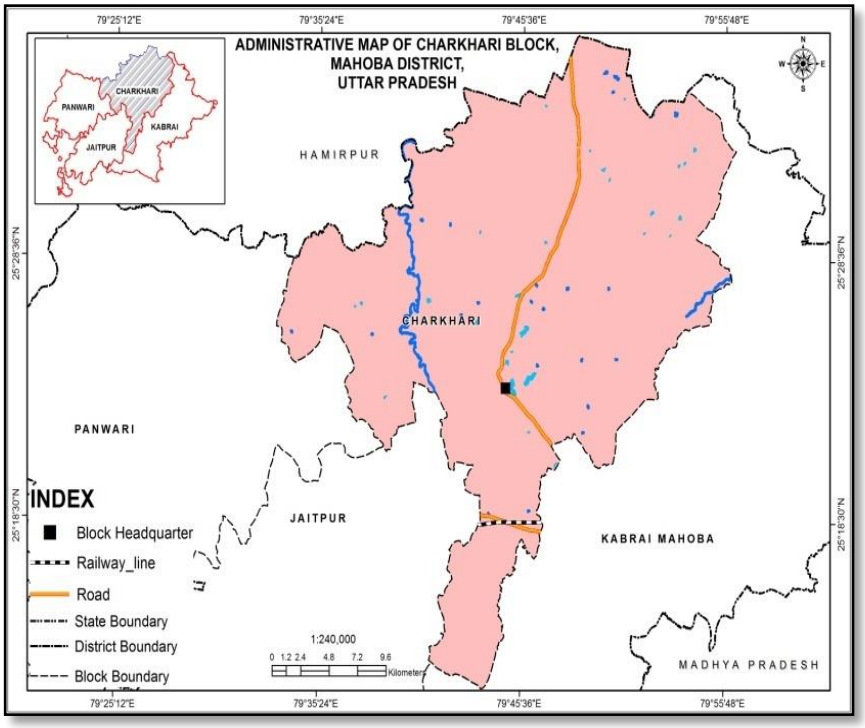
Blocks	Total Augmentation (ham)	15 % for drinking Puipose (ham)	Additional Population Benefited as @70lpcd	85% for Irrigation (ham)	Additional Area Irrigated (ha) Benefited taking delta @0.25m
Charkhari	2195	329	132022	1865	7460
Jaitpur	2177	326	130818	1850	7400
Kabrai	1098	164	65810	933	3732
Panwari	2380	357	143258	2023	8092
	4143	**621**	**249197**	**3521**	**14084**

10. GROUND WATER MANAGEMENT, CHARKHARI BLOCK

10.1. INTRODUCTION:

Charkhari block lies in the Northern part of the Mahoba district encompassing an area of 803.13 Sq Km. It is flanked by Kabrai & Jaitpur block in east and south and Panwari block in the west.

Plate 23: Administrative Block, Charkhari Block, Mahoba District, UP



10.2. Drainage, Soil, Geomorphology, Landuse and GW Resource:

The bock is drained by Chndrwal river trending North- South and has well developed canal network.

Plate 24: Drainage Map, Charkhari Block, Mahoba, UP

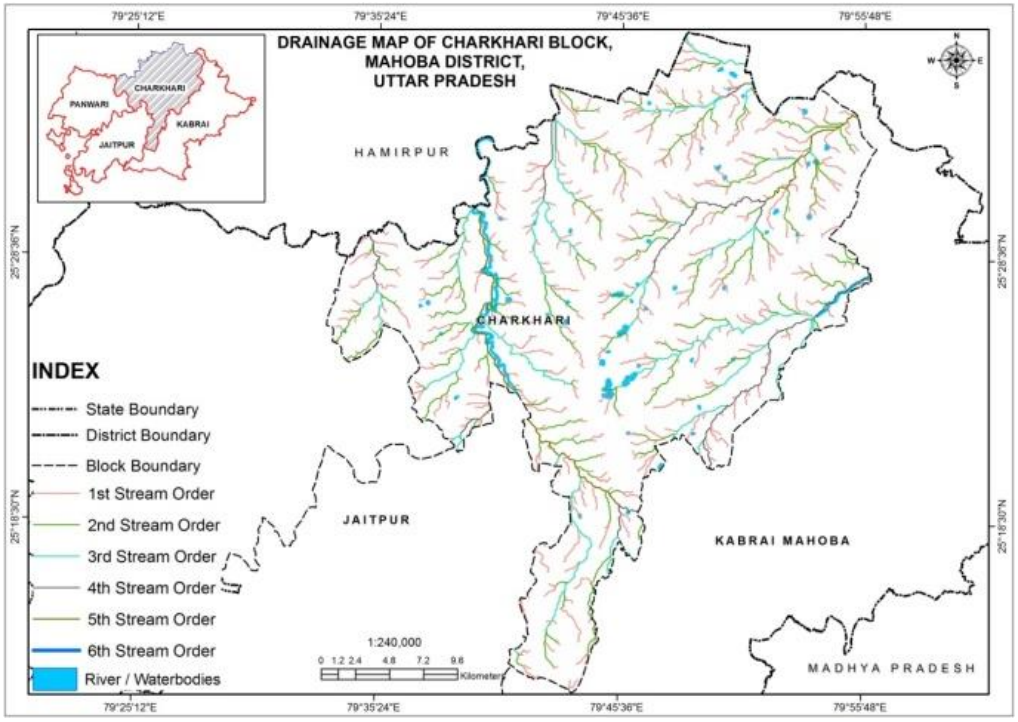


Plate 25: Soil Map, Charkhari Block, Mahoba, UP

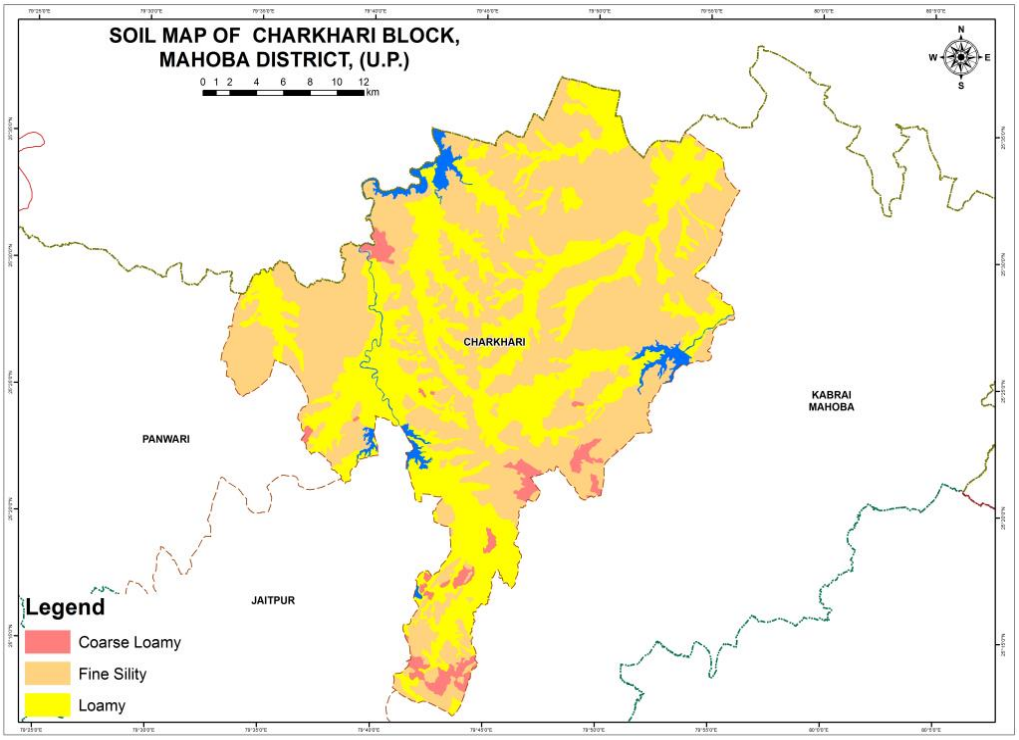


Plate 26: Landuse/ Landcover Map, Charkhari Block, Mahoba, UP

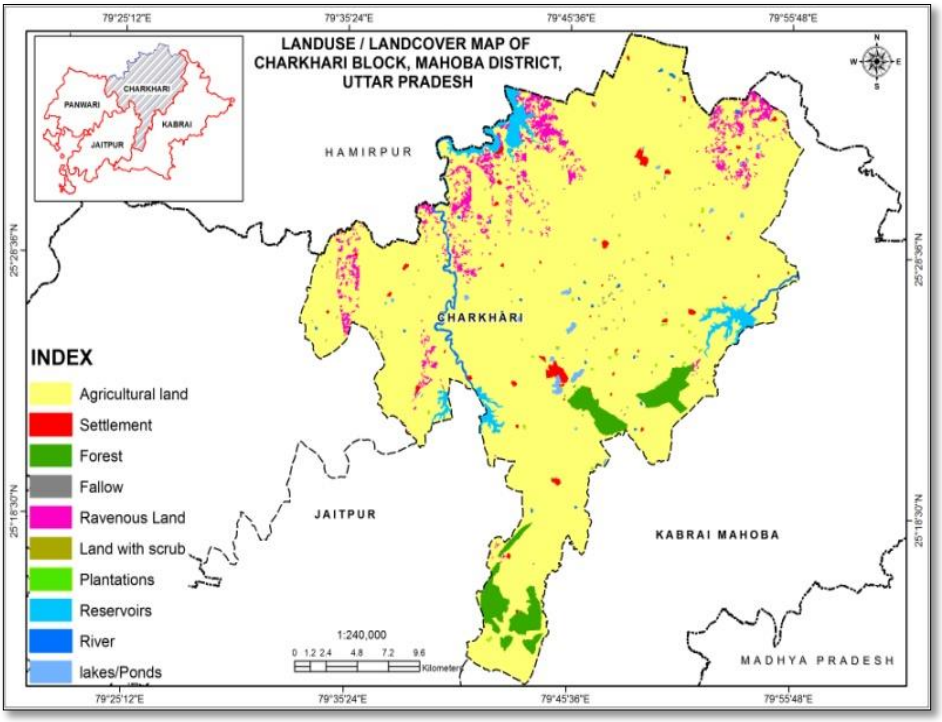


Plate 27: Geomorphology Map, Charkhari Block, Mahoba, UP

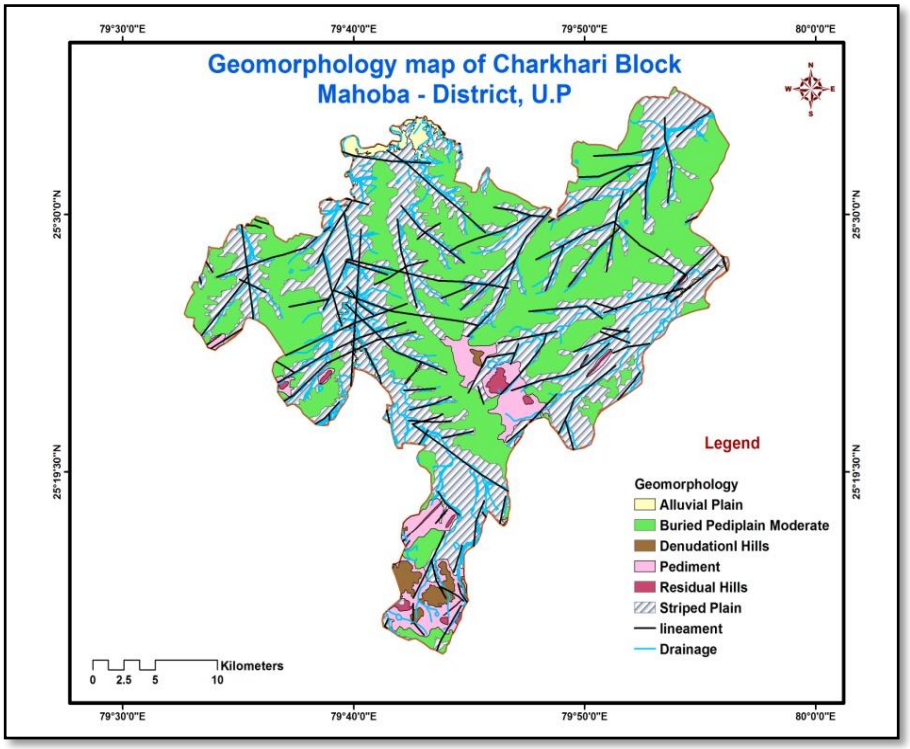
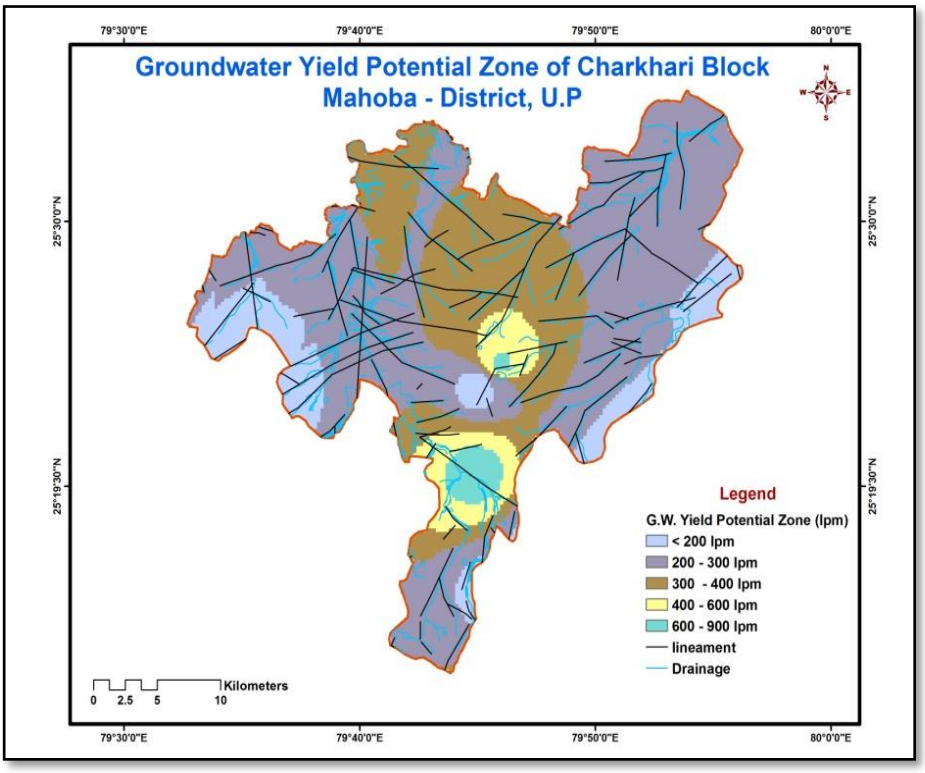


Plate 28: Ground Water Potential Zone Map, Charkhari Block, UP



The soil in the area is Lomy and fine sitly. Geologically granites are unconformably overlain by Quaternary alluvium (Banda Alluvium) consisting of Gravel, Sand and Clay. The thickness of overburden varies from 5 to 40.0 m.

Geomorphologically the block virtually forms a Burried Pediplain, Stripped Plain, and Pediment. The agriculture statics shows cropping intensity 165% and irrigation intensity 103%. The wheat, Pulses and oil seeds are major corps in the area. As per Dynamic Ground water resource estimation 2017 the Net Ground water availability is 5948 ham and stage of development is 70.97%. The block is in semi- critical category.

Agriculture Practices:

(Figures in Ha.)

Table 35: Agricultural Statistics, Charkhari Block, Mahoba, UP

Agricultural Statistics										
	Sown area			**Season-wise Crop Area**			**Irrigated Area**			
Block	*Net Area Sown*	*Area sown more than once*	*Total*	*Rabi*	*Kharif*	*Jayad*	*Net Irrigated*	*Gross Irrigated*	Cropping Intensity	Irrigation intensity
Charkhari	46687	30755	77442	43717	33723	2	29800	30970	165.87	103.93

Table 36: Area under Principal Crops, Charkhari Blocks, Mahoba, UP

Area Under Principal Crops									
Wheat		**Barly**		**jwar**		**Pulses**		**Oilseeds**	
Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
17421	15050	851	419	464	0	49707	11002	10804	320

Table 37: Dynamic Ground Water Resource of Mahoba District, UP (as on 31.3.2017) (Ham), UP

Dynamic Ground Water Resource of Mahoba District, UP (as on 31.3.2017) (Ham)			
Net Annual GW Availability	Gross Ground Water Draft for Irrigation	Existing Gross GW Draft for All Uses	Stage of Ground Water Development (%)
5948.26	**3947.00**	**4221.56**	**70.97**

10.3. Dimensional Aquifer Disposition in Charkhari Block

Plate 29: Location of Exploratory Wells and Section Lines, Charkhari, Mahoba, UP

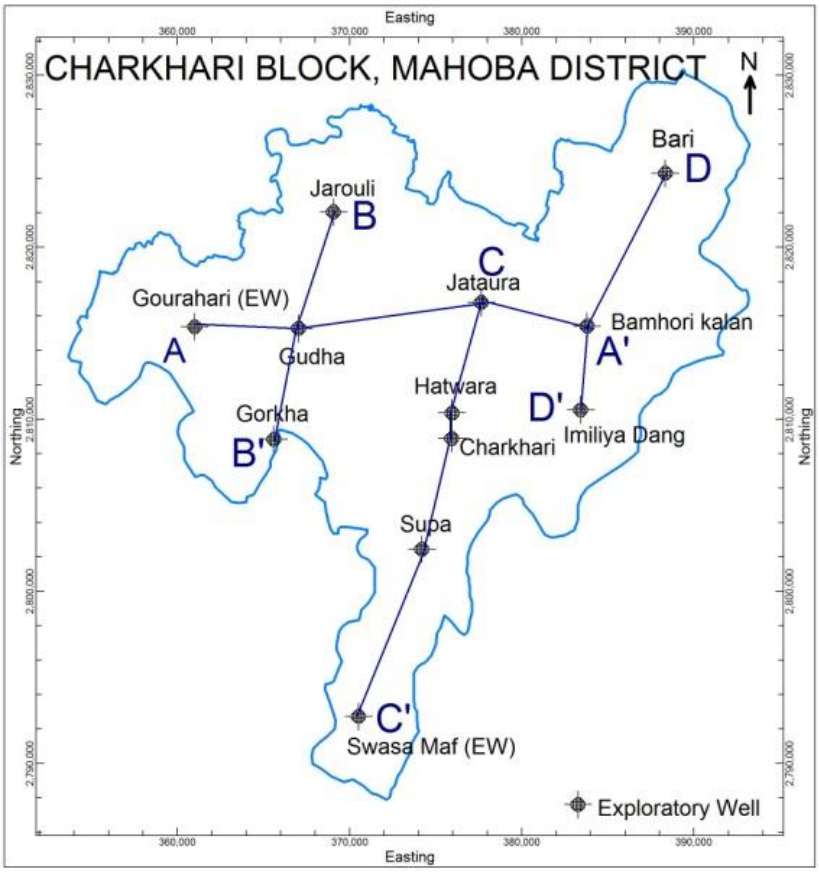


Plate 30: 3D Aquifer Disposition, Charkhari Block, Mahoba, UP

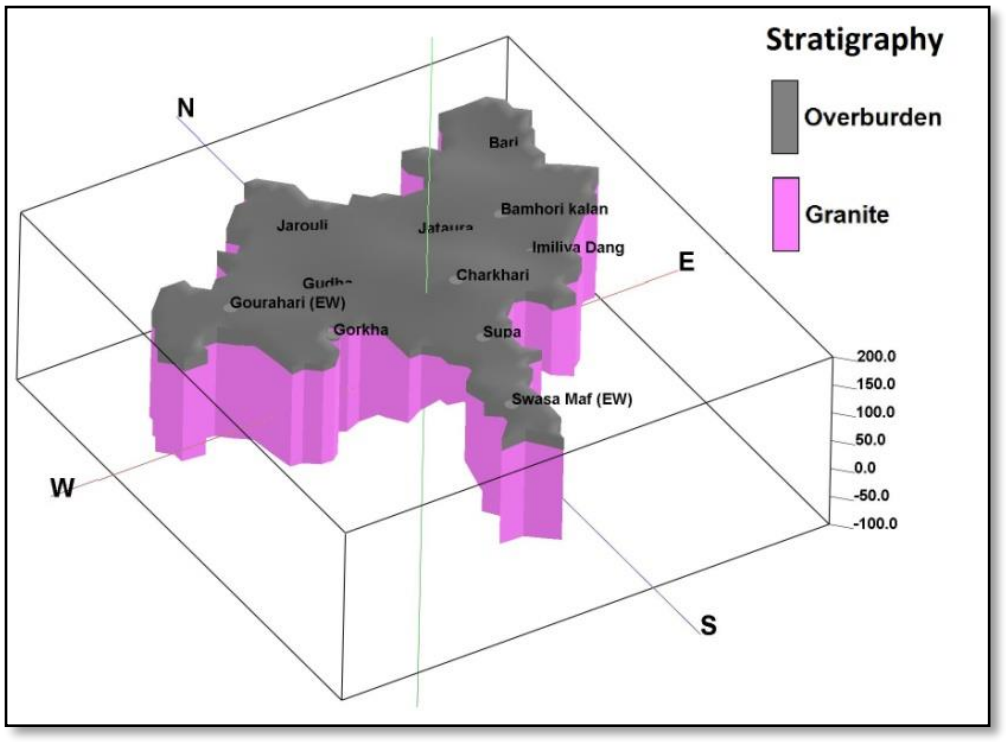


Plate 31: Fence Diagram, Charkhari Block, Mahoba, UP

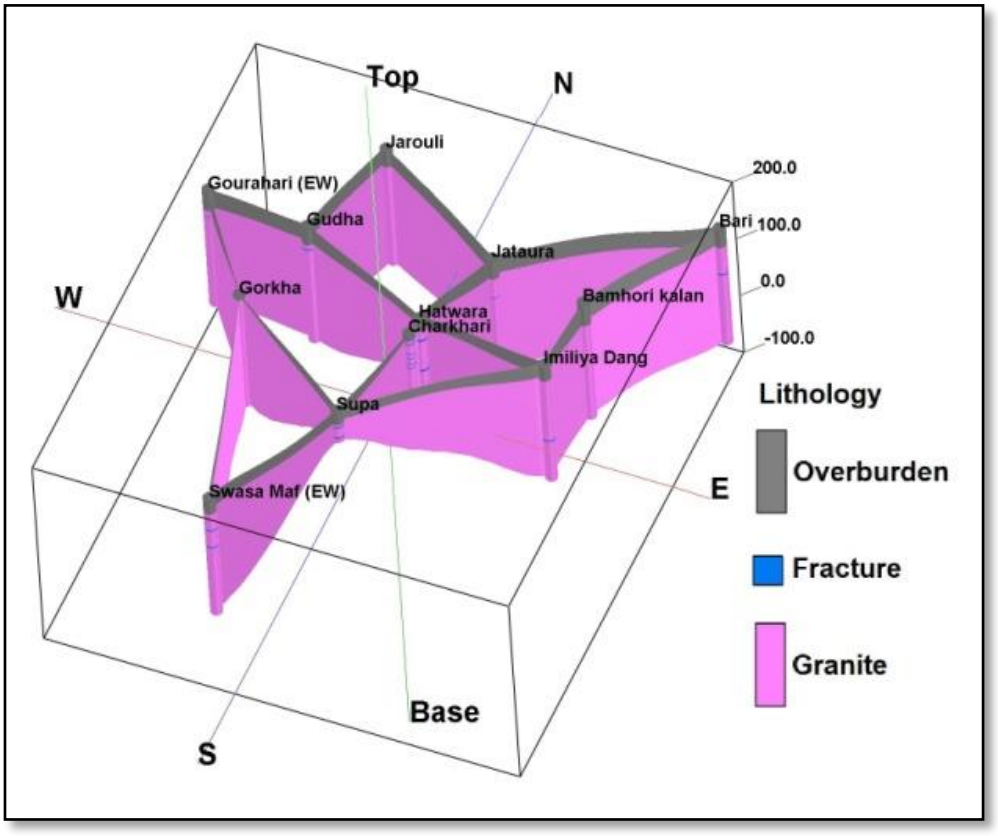
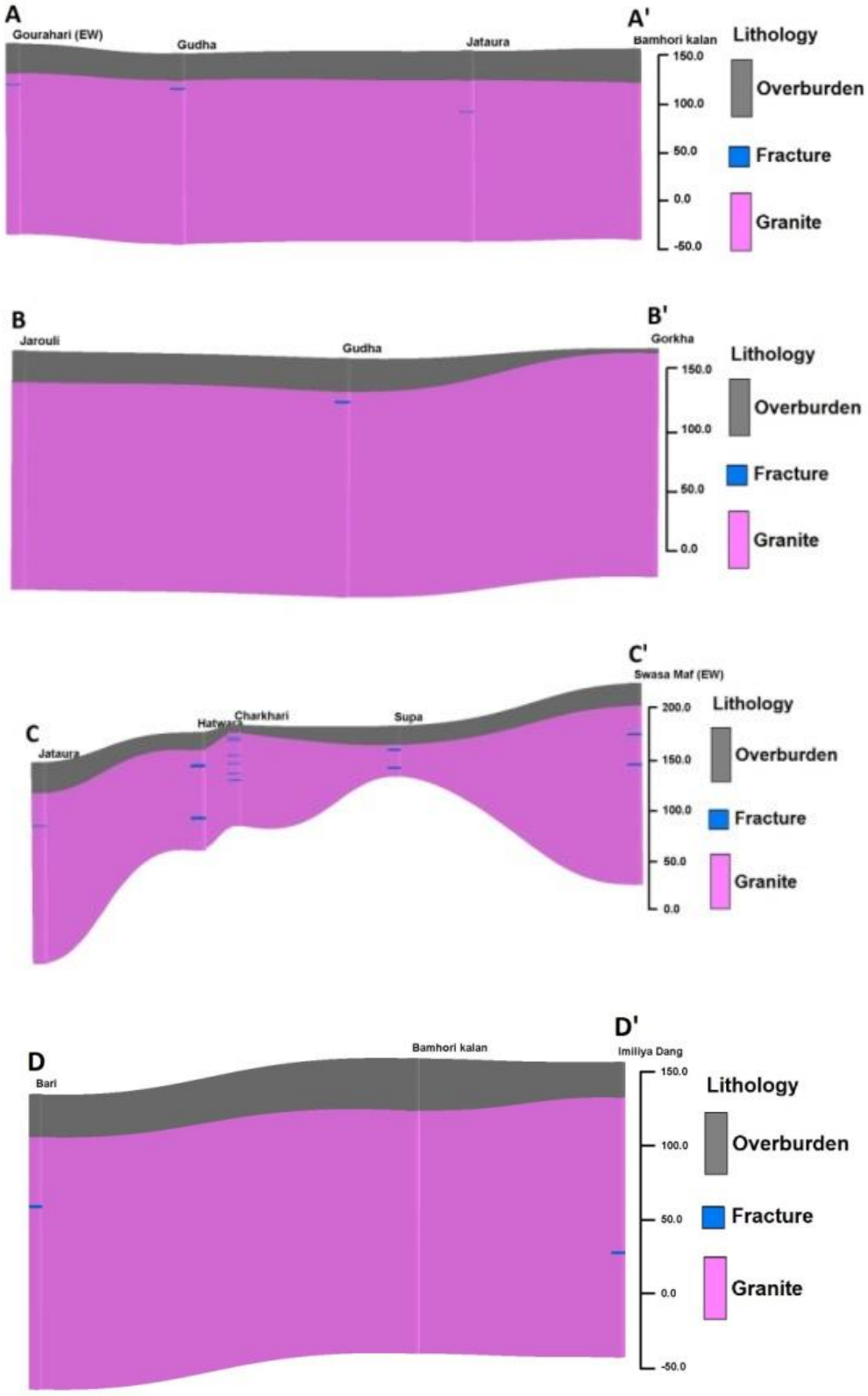


Plate 32: 2D Sections along Section Lines, Charkhari Block, Mahoba, UP



The Figures give an overview of depth to water and 3-dimensional aquifer disposition in Charkhari block down to 200 m depth with dynamic & confined ground water resource.

10.4. GROUND WATER MANAGEMENT OPTIONS:

Ground water issues can be addressed by focusing on measures to increase recharge and reducing the draft. It can be managed by a mix of measures such as:

Supply Side Management

- Water conservation and Artificial Recharge to ground water
- On Farm Activities and

Demand Side Management

- Adoption of techniques to enhance water Use Efficiency
- Adoption of new irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water
- Increasing Storage Capacity and Conservation Of Rainfall: Supply Side Management

Recharge / Water Conservation

- Water conservation structures such as check dams, farm ponds, nala bunds etc result in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings. Further construction of recharge trenches in the upstream side of the check dams is also proposed to enhance rate of infiltration by about 30 to 40%.
- The existing ponds and tanks lose their storage capacity as well as the natural ground water recharge due to siltation and encroachment by farmers for agriculture purposes. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

On Farm Practices: Supply
Side Management

- Leveling of crop field is essential for uniform distribution of water. Laser leveling has been found very effective ensuring saving of 10 to 30% of applied irrigation.

The in situ farm activities such as contour bunding, land leveling, bench terracing, water harvesting structures, afforestation and diversification of cropping pattern are other measures to increase recharge in the block.

Enhancing Water Use Efficiency:

Demand Side Management

Efficient irrigation

- In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant.
- Adoption of efficient irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water. Such practices are as under
  1. Trash Mulching
  2. Micro Irrigation (Sprinkler/ Drip Irrigation)
- While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The conveyance losses (mainly seepage & evaporation) can be saved upto 25 to 40% through utilization of HDPE pipes.
- Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'

Diversification of cropping pattern

- Horticulture department should promote Baghwani in the area. This will bring in money without high use of water. These will also help conserve soil moisture.
- Alternate cropping system having lower requirement of water are better option.
- Summer paddy and maize need to be avoided which are grown over substantial area in the block.
- Late sown wheat/peas are replaced by spring maize which consumes more water. Suggested cropping pattern are as under.
- Kharif- Maize, cotton, sorghum, pulses, groundnut
- Rabi- Mustard, gram, pulses, vegetable

By adopting suggested cropping pattern 20 to 30% of irrigation water saving is possible.

Table 38: Proposed Interventions in Charkhari Block, Mahoba, UP

Block	**Check Dams of 10000 cum Capacity (Nos)**	**Drain/stream development (length in km x Avg.12m x 3m)**	**Nala Bunds of 7500 cum Capacity (Nos)**	**Revival of Ponds (Avg.) 50m x 50m x 3m dimension**	**On-farm Activities (Area in ha)**	**Water Use Efficiency (WUE) Mea-sures (Area in ha)**
Charkhari	11	27	11	100	6500	1500

10.5. BENEFITS:

Table 39: Summarized Expected Benefits, Charkhari, Mahoba, UP

Expected Annual Recharge	7.12 MCM
Provision for supplemental irrigation	1.84 MCM
Conservation from On-farm Activities & WUE Measures	12.24 MCM
Total Recharge/ Saving	21.20 MCM

10.6. PROJECTED IMPACT AFTER INTERVENTIONS:

Net G.W. Availability (Ham)	Additional Recharge from RWH & Re-charge (ham)	Total Net G.W. Availability after intervention (Ham)	Existing G.W Draft for all purpose (ham)	Saving of Ground water through projects (ham)	Net GW draft after interventions (ham)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
5948.26	**712.18**	**6660.44**	**4221.56**	**1408**	**2813.56**	**70.97**	**42.24**

Plate 33: Intervention Summary, Charkhari, Mahoba, UP

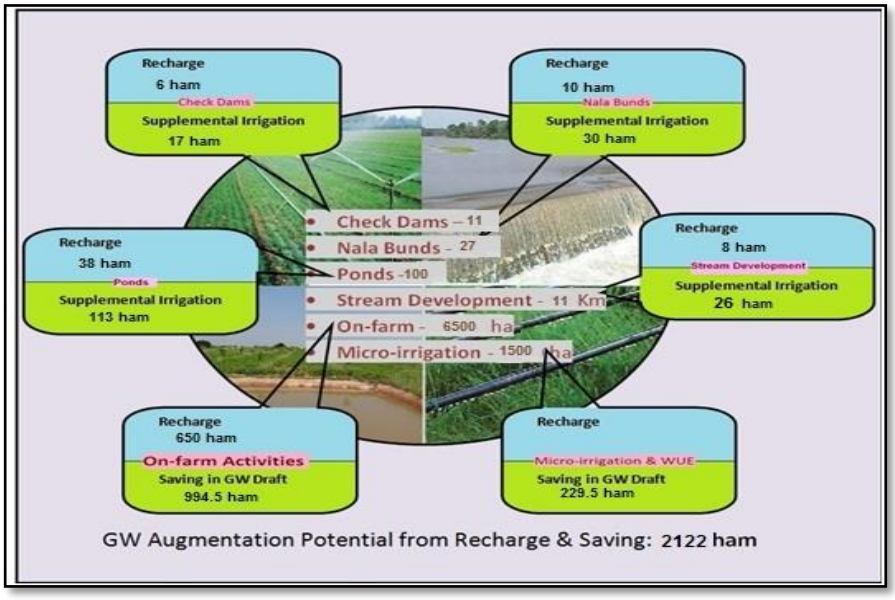
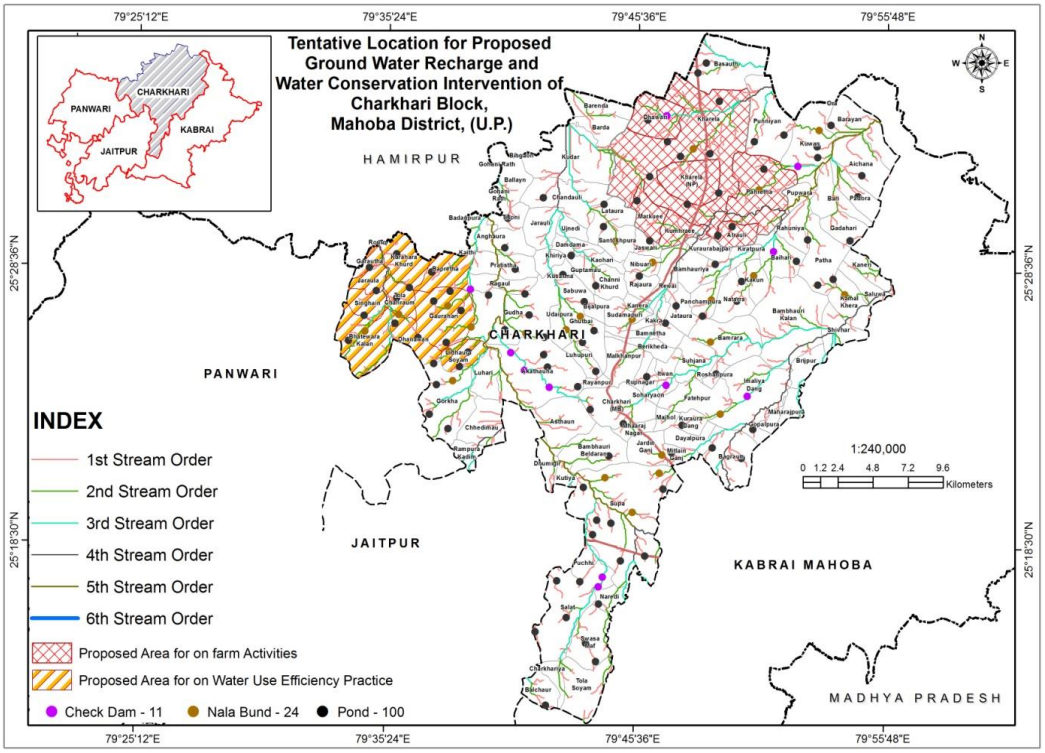


Plate 34: Tentative Locations for Proposed GW Recharge, Charkhari, Mahoba, UP

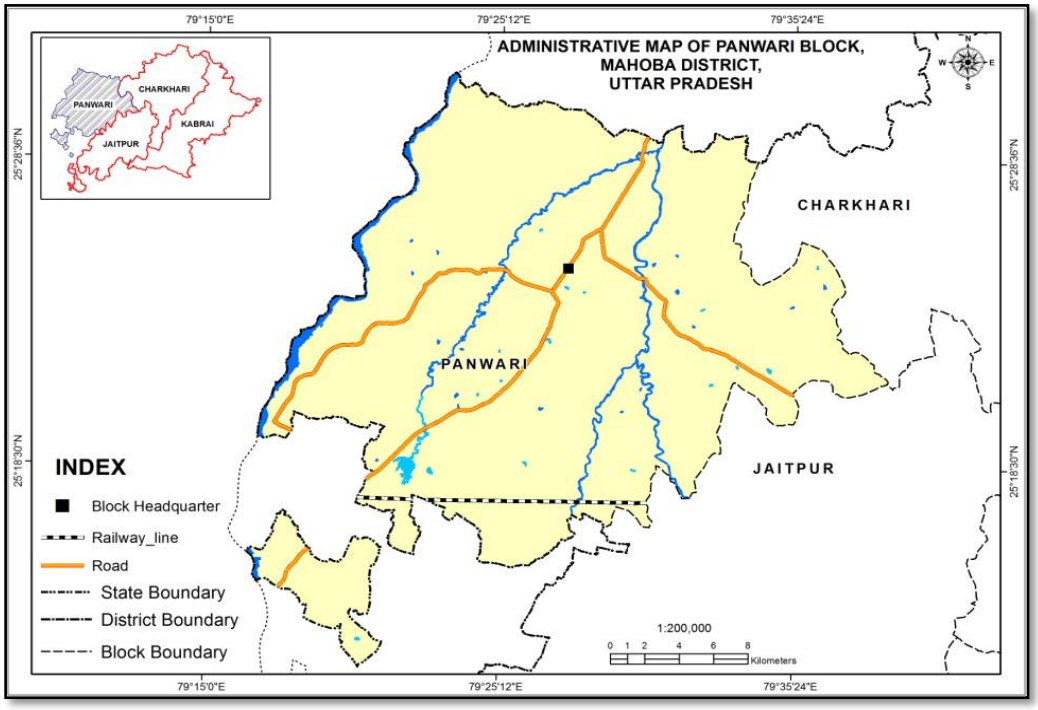


11. GROUND WATER MANAGEMENT IN OE PANWARI BLOCK

11.1. INTRODUCTION:

Panwari block lies in the western part of the Mahoba district encompassing an area of 614.68 Sq Km. It is flanked by Charkhari & Jaitpur block in east and south and Jhansi district and in the west.

Plate 35: Administrative Map, Panwari Block, Mahoba, UP



11.2. Drainage, Soil, Geomorphology, Landuse and GW Resource:

Plate 36: Drainage Map, Panwari Block, Mahoba, UP

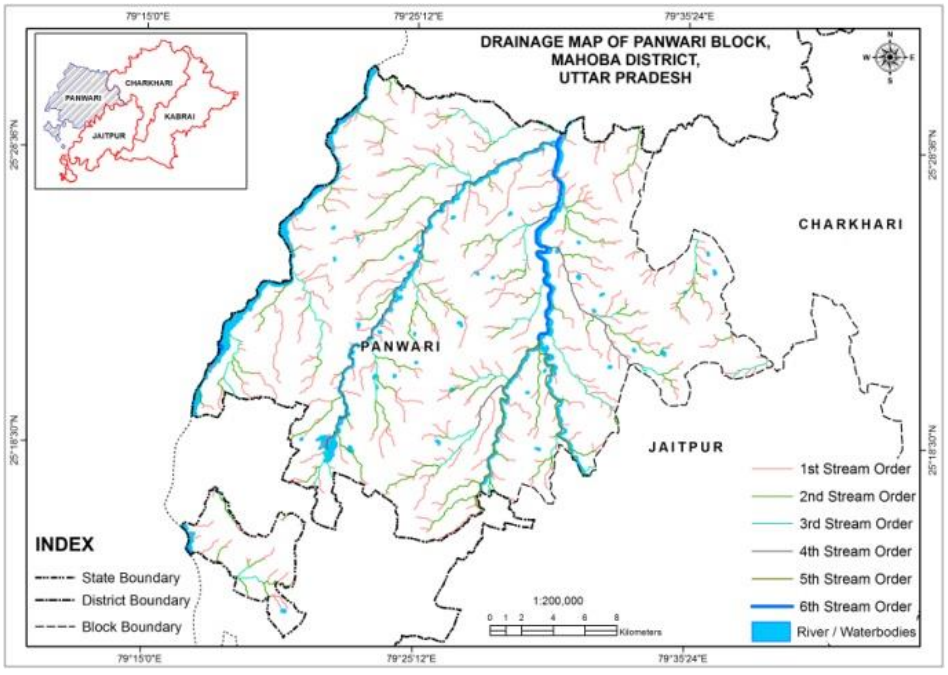


Plate 37: Landuse/ Landcover Map, Panwari Block, Mahoba, UP

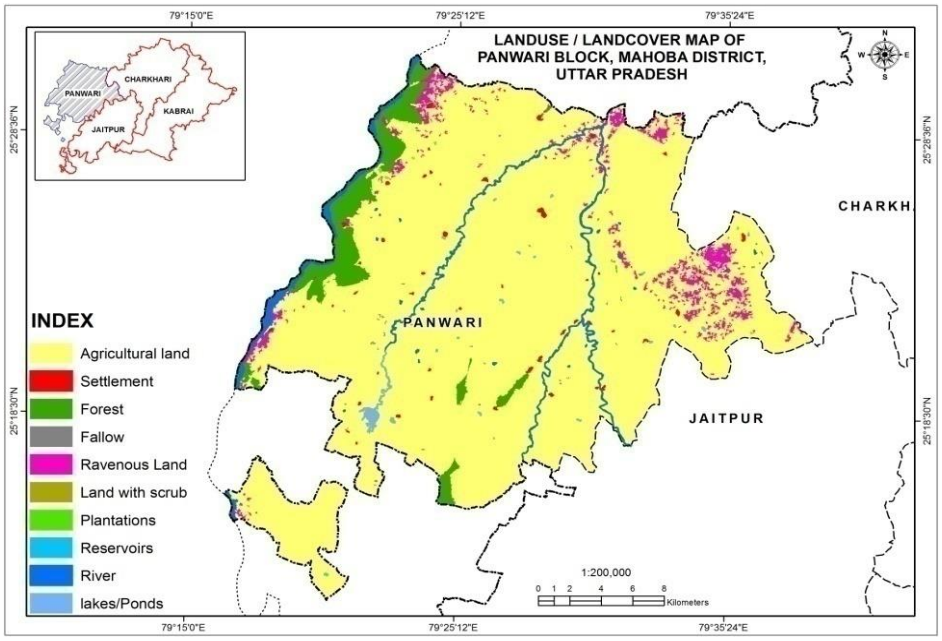
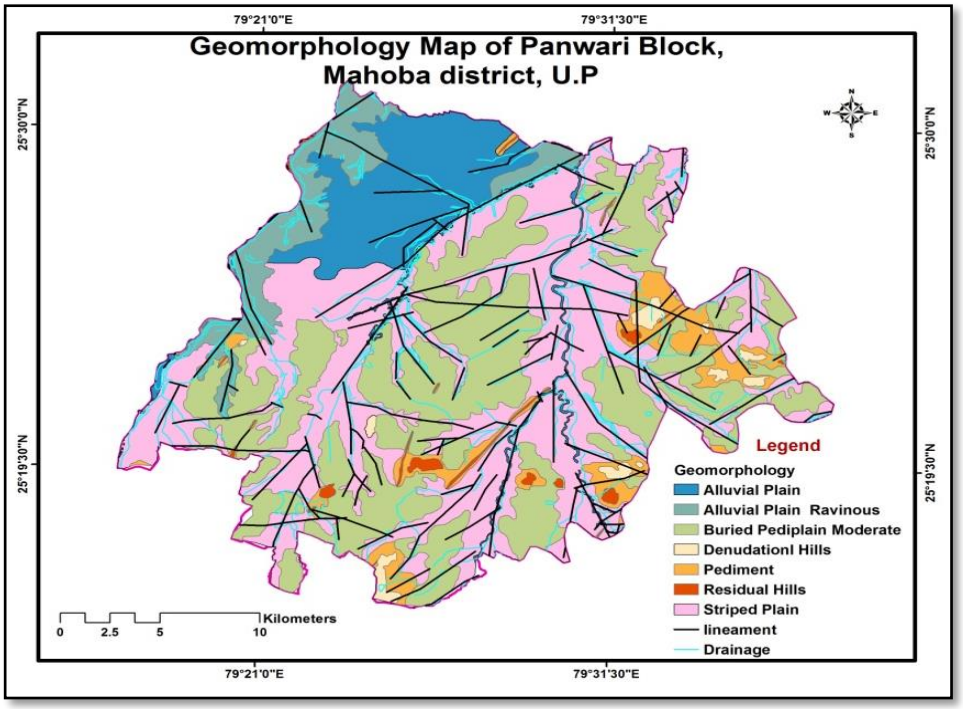


Plate 38: Geomorphology Map, Panwari Block, Mahoba, UP



The soil in the area is Lomy and fine sitly. Geologically granites are unconformable overlain by Quaternary alluvium (Banda Alluvium) consisting of Gravel, Sand and Clay. The thickness of overburden varies from 5 to 40.0 m.

Geomorphologically the block virtually forms a Burried Pediplain, Stripped Plain, and Pediment. The agriculture statics shows cropping intensity 165% and irigation intensity 103%. The wheat, Pulses and oil seeds are major corps in the area. As per Dynamic Ground water resource estimation 2017 the Net Ground water availability is 5948 ham and stage of development is 104.45%. The block is in Over-Exploited category.

Agriculture Practices:

(Figures in Ha.)

Table 40: Agricultural Statistics, Panwari Block, Mahoba, UP

	Sown area			**Season-wise Crop Area**			**Irrigated Area**			
Block	*Net Area Sown*	*Area sown more than once*	*Total*	*Rabi*	*Kharif*	*Jayad*	*Net Irrigated*	*Gross Irrigated*	Cropping Intensity	Irrigation intensity
Panwari	46687	30755	77442	43717	33723	2	29800	30970	165.87	103.93

Table 41: Area Under Principal Crops, Panwari Block, Mahoba, UP

Wheat		**Barly**		**jwar**		**Pulses**		**Oilseeds**	
Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
46687	30755	77442	43717	33723	2	29800	30970	165.87	103.93

Table 42: Dynamic Ground Water Resource of Mahoba District, UP (as on 31.3.2017) (Ham), Panwari Block, Mahoba, UP

Net Annual GW Availability	Gross Ground Water Draft for Irrigation	Existing Gross GW Draft for All Uses	Stage of Ground Water Development (%)
5978.51	**5866.00**	**6244.81**	**104.45**

11.3. 3 Dimensional Aquifer Disposition in Panwari Block

Plate 39: Location of Exploratory Wells and Section Lines, Panwari Block, Mahoba, UP

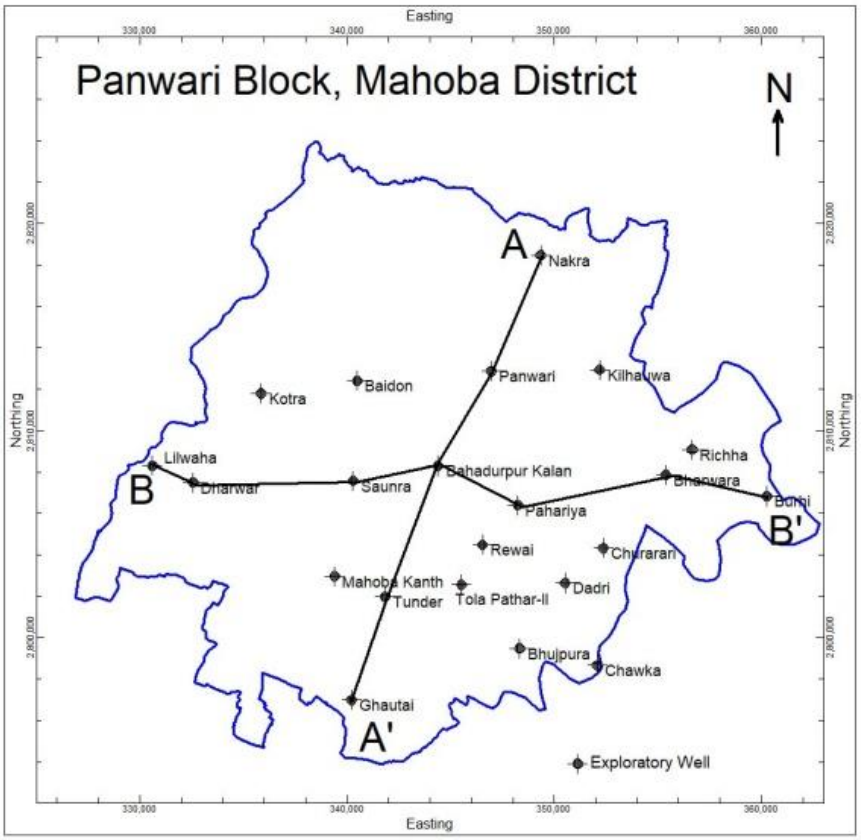


Plate 40: 3D Aquifer Disposition, Panwari Block, Mahoba, UP

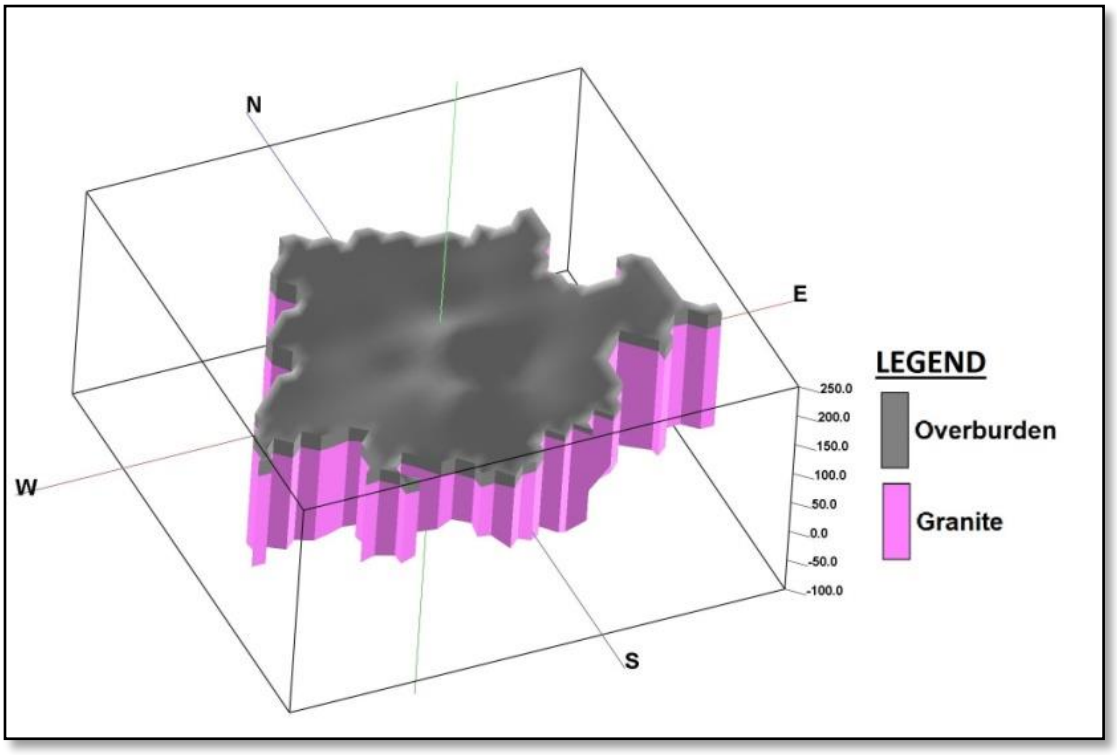


Plate 41: Fence Diagram, Panwari Block, Mahoba, UP

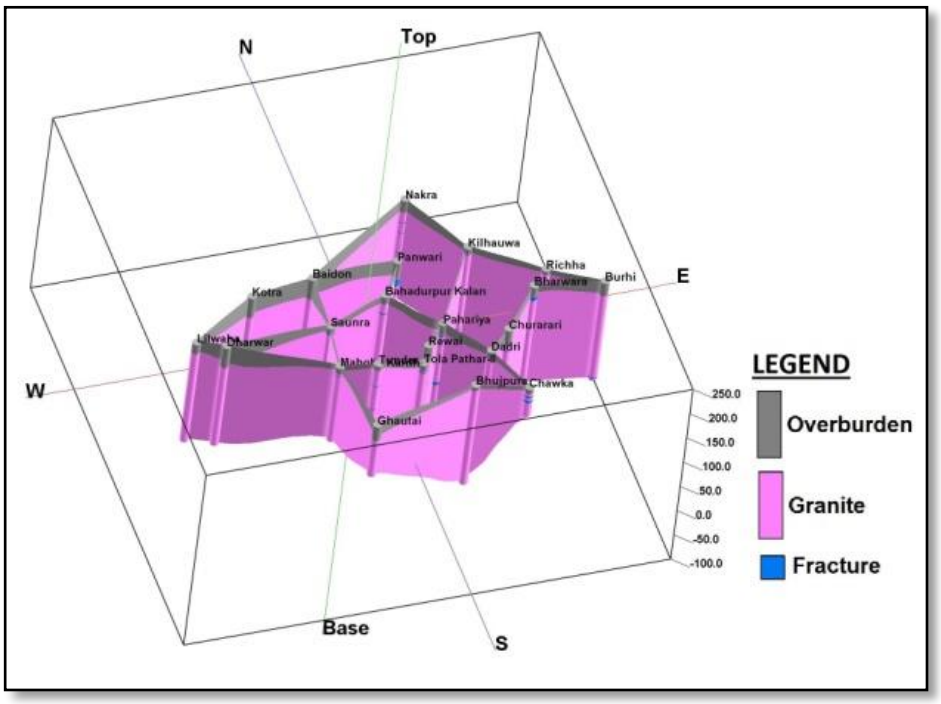
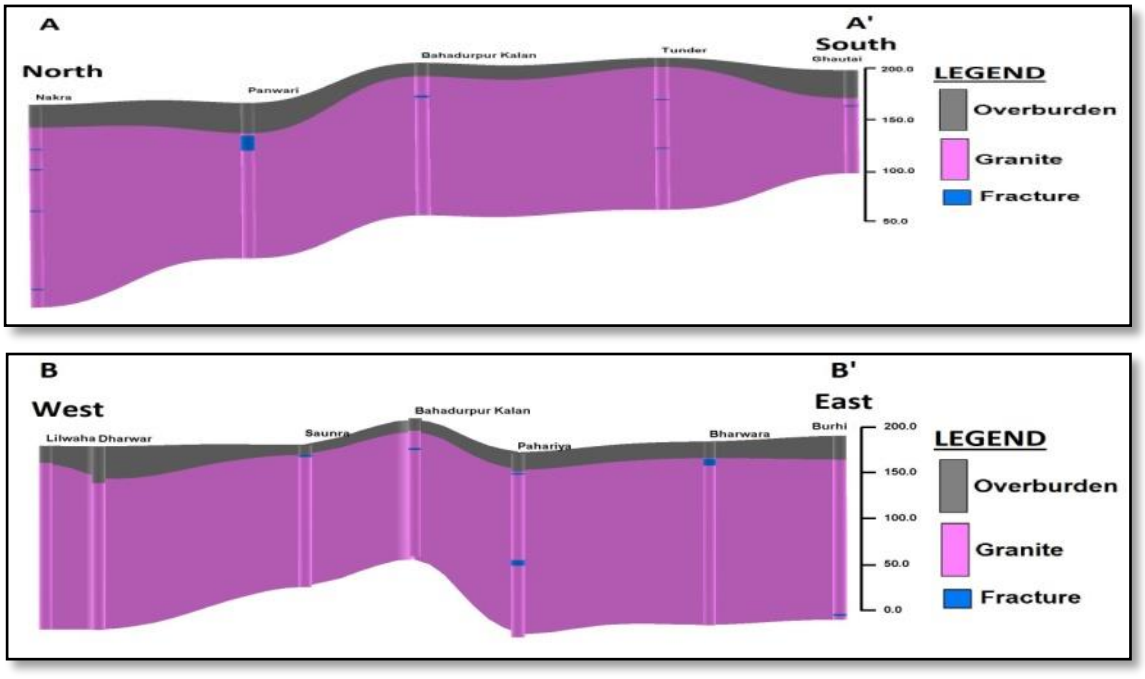


Plate 42: 2D Sections along Section Lines, Panwari Block, Mahoba, UP



The Figures give an overview of depth to water and 3-dimensional aquifer disposition in Panwari block down to 200 m depth with dynamic & confined ground water resource.

11.4. GROUND WATER MANAGEMENT OPTIONS:

Ground water issues can be addressed by focussing on measures to increase recharge and reducing the draft. It can be managed by a mix of measures such as:

Supply Side Management

- Water conservation and Artificial Recharge to ground water
- On Farm Activities and

Demand Side Management

- Adoption of techniques to enhance water Use Efficiency
- Adoption of new irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water

Increasing Storage Capacity and Conservation of Rainfall: Supply Side Management

Recharge / Water Conservation

- Water conservation structures such as check dams, farm ponds, nala bunds etc result in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings. Further construction of recharge trenches in the upstream side of the check dams is also proposed to enhance rate of infiltration by about 30 to 40%.
- The existing ponds and tanks lose their storage capacity as well as the natural ground water recharge due to siltation and encroachment by farmers for agriculture purposes. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

On Farm Practices: Supply Side Management

- Leveling of crop field is essential for uniform distribution of water. Laser leveling has been found very effective ensuring saving of 10 to 30% of applied irrigation.

The in situ farm activities such as contour bunding, land leveling, bench terracing, water harvesting structures, afforestation and diversification of cropping pattern are other measures to increase recharge in the block.

Enhancing Water Use Efficiency:

Demand Side Management

Efficient irrigation

• In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant.

• Adoption of efficient irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water. Such practices are as under

3. Trash Mulching
4. Micro Irrigation (Sprinkler/ Drip Irrigation)

• While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The conveyance losses (mainly seepage & evaporation) can be saved upto 25 to 40% through utilization of HDPE pipes.

• Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'

Diversification of cropping pattern

• Horticulture department should promote Baghwani in the area. This will bring in money without high use of water. These will also help conserve soil moisture.

• Alternate cropping system having lower requirement of water are better option.

• Summer paddy and maize need to be avoided which are grown over substantial area in the block.

• Late sown wheat/peas are replaced by spring maize which consumes more water. Suggested cropping pattern are as under.

• **Kharif**- Maize, cotton, sorghum, pulses, groundnut

• **Rabi-** Mustard, gram, pulses, vegetable

By adopting suggested cropping pattern 20 to 30% of irrigation water saving is possible.

PROPOSED INTERVENTIONS IN MAHOBA BLOCK:

Table 43: Proposed Interventions, Panwari Block, Mahoba, UP

Block	Check Dams of 10000 cum Capacity (Nos)	Drain/stream development (length in km x Avg.12m x 3m)	Nala Bunds of 7500 cum Capacity (Nos)	Revival of Ponds (Avg.) 50m x 50m x 3m dimension	On-farm Activities (Area in ha)	Water Use Efficiency (WUE) Mea-sures (Area in ha)
Panwari	10	10	31	88	15000	3000

11.5. BENEFITS:

Expected Annual Recharge	15.57 MCM
Provision for supplemental irrigation	1.72 MCM
Conservation from On-farm Activities & WUE Measures	20.52 MCM
Total Recharge/ Saving	37.81 MCM

11.6. PROJECTED IMPACT AFTER INTERVENTIONS:

Net G.W. Availability (Ham)	Additional Recharge from RWH & Re-charge (ham)	Total Net G.W. Availability after intervention (Ham)	Existing G.W Draft for all purpose (ham)	Saving of Ground water through projects (ham)	Net GW draft after interventions (ham)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
5978.51	1557.24	7535.75	6244.81	2224	4021.08	104.45	53.99

Plate 43: Summary of Interventions, Panwari Block, Mahoba, UP

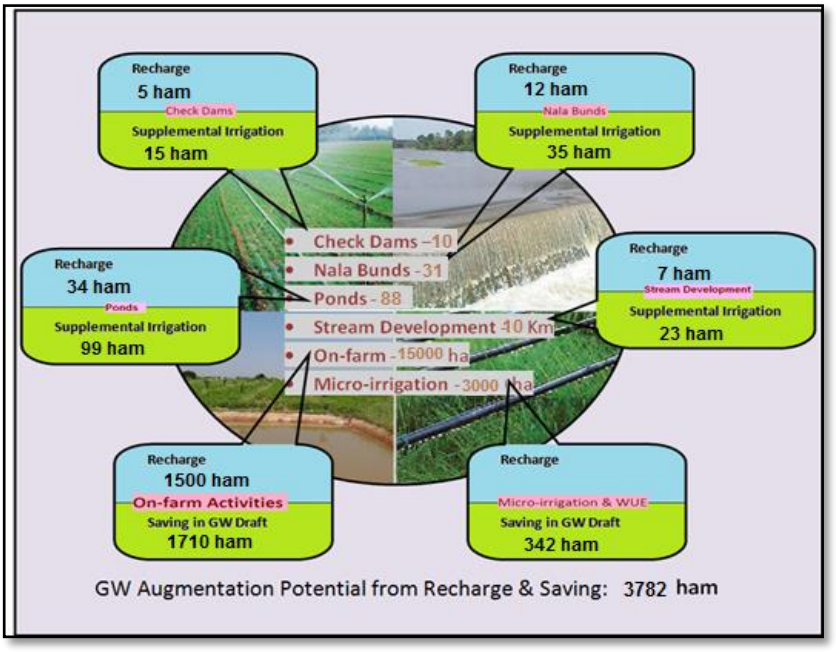
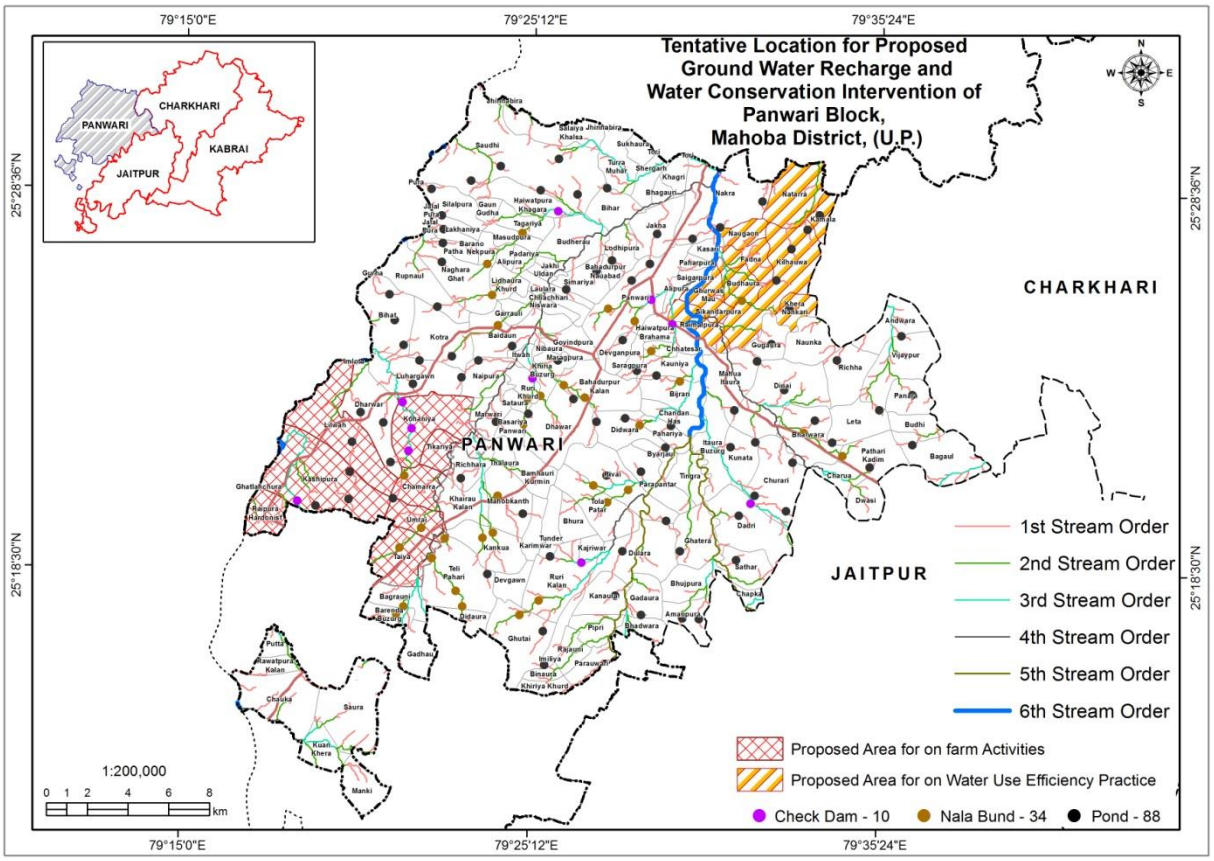


Plate 44: Tentative Locations for Proposed GW Recharge and Water Conservation, Panwari Block, Mahoba, UP

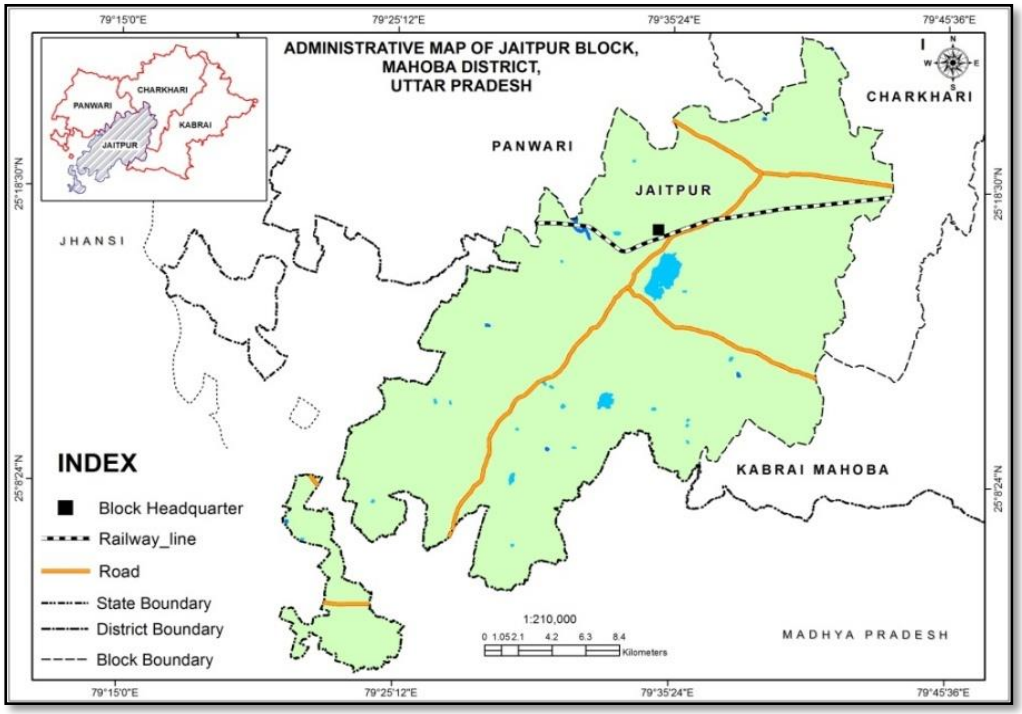


12. GROUND WATER MANAGEMENT IN OE JAITPUR BLOCK

12.1. INTRODUCTION:

Jaitpur block lies in the southern part of the Mahoba district encompassing an area of 618 Sq Km. It is flanked by Charkhari & Panwari block in north and kabrai block in East.

Plate 45: Administrative Map of Jaitpur Block, Mahoba District, UP



12.2. Drainage, Soil, Geomorphology, Landuse and GW Resource:

Plate 46: Drainage Map, Jaitpur Block, Mahoba, UP

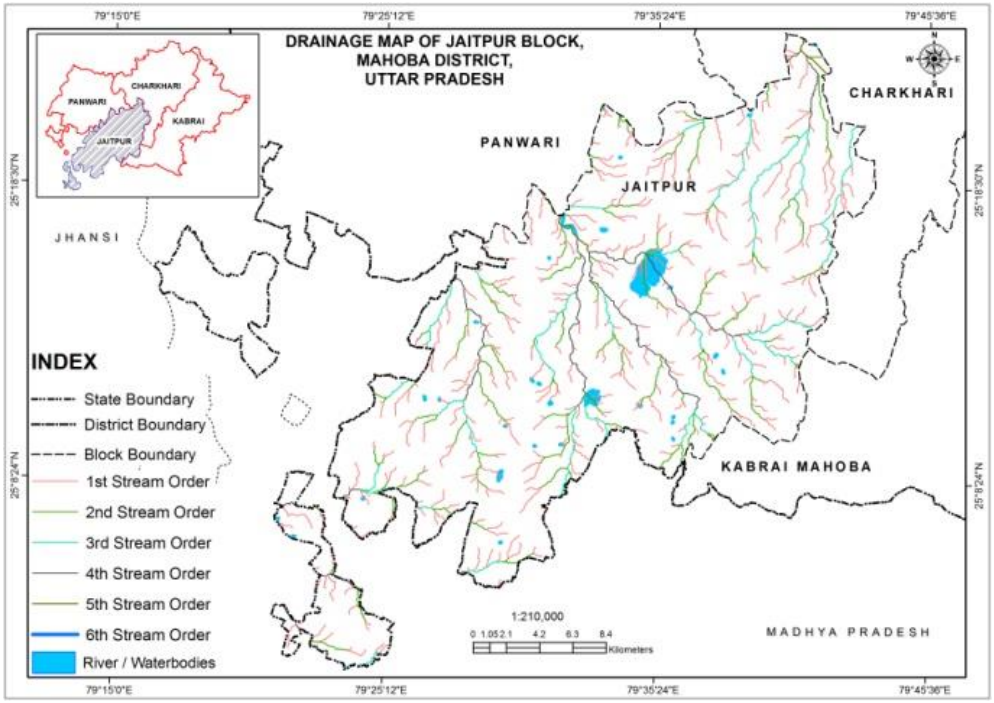


Plate 47: Land use Jaitpur Block, Mahoba Diatrict, UP

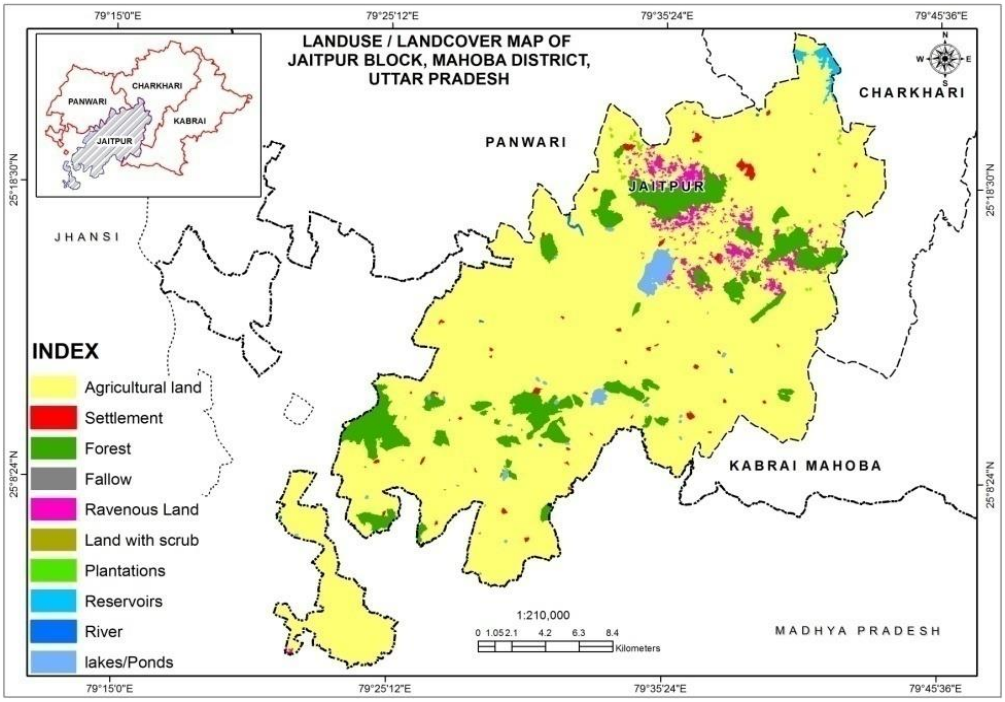
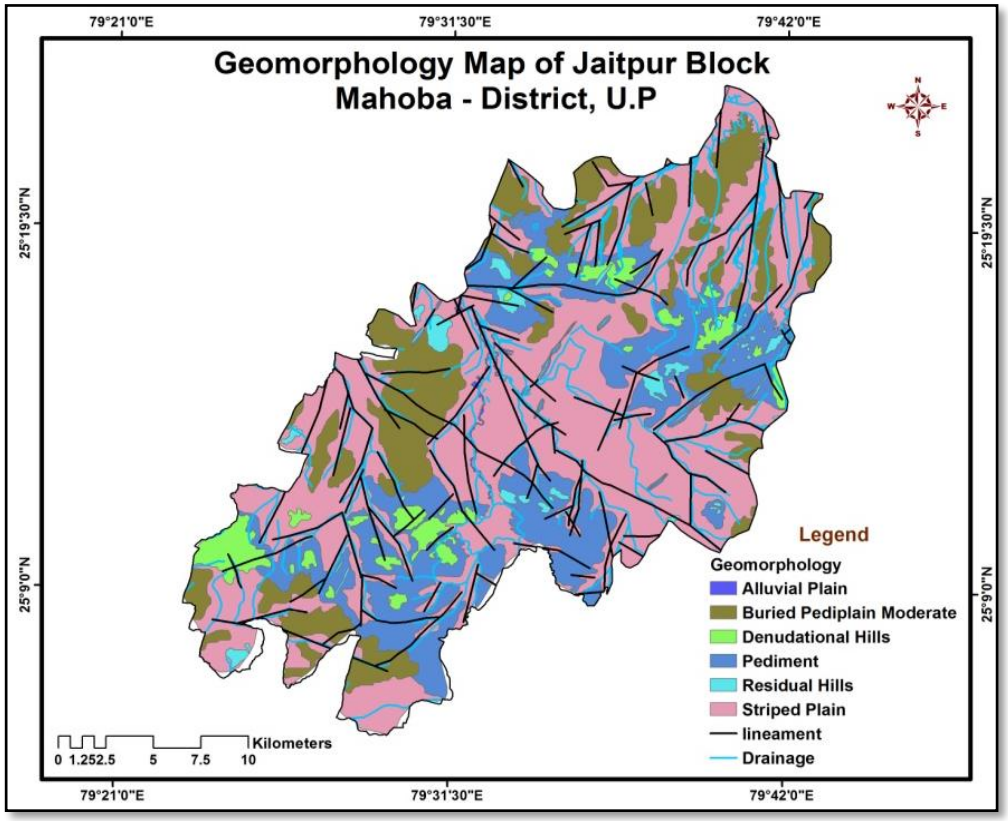


Plate 48: Geomorphological Map, Jaitpur, Mahoba, UP



The soil in the area is Lomy and fine sitly. Geologically granites are unconformably overlain by Quaternary alluvium (Banda Alluvium) consisting of Gravel, Sand and Clay. The thickness of overburden varies from 5 to 40.0 m.

Geomorphologically the block virtually forms a Burried Pediplain, Stripped Plain, and Pediment. The agriculture statics shows cropping intensity 165% and irigation intensity 103% The wheat, Pulses and oil seeds are major corps in the area. As per Dynamic Ground water resource estimation 2017 the Net Ground water availability is 4304 ham and stage of development is 104%. The block is in semi- critical category.

Agriculture Practices :

(Figures in Ha.)

Table 44: Agricultural Statistics, Jaitpur, Mahoba, UP

	Sown area			**Season-wise Crop Area**			**Irrigated Area**			
Block	*Net Area Sown*	*Area sown more than once*	*Total*	*Rabi*	*Kharif*	*Jayad*	*Net Irrigated*	*Gross Irrigated*	Cropping Intensity	Irrigation intensity
Jaitpur	40808	22163	62971	41381	21586	4	33271	34538	154.31	103.81

Table 45: Area Under Principal Crops, Jaitpur Block, Mahoba, UP

Wheat		**Barly**		**jwar**		**Pulses**		**Oilseeds**	
Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
16841	14028	2089	1842	358	0	36389	15702	16599	1810

Table 46: Dynamic Ground Water Resource of Jaitpur Block, Mahoba District, UP (as on 31.3.2017) (Ham)

Net Annual GW Availability	Gross Ground Water Draft for Irrigation	Existing Gross GW Draft for All Uses	Stage of Ground Water Development (%)
4304.40	**4082.00**	**4514.61**	**104.88**

12.3. 3 Dimensional Aquifer Disposition in Jaitpur Block

Plate 49: Location of EW Locations and Section Lines, Jaitpur Block, Mahoba, UP

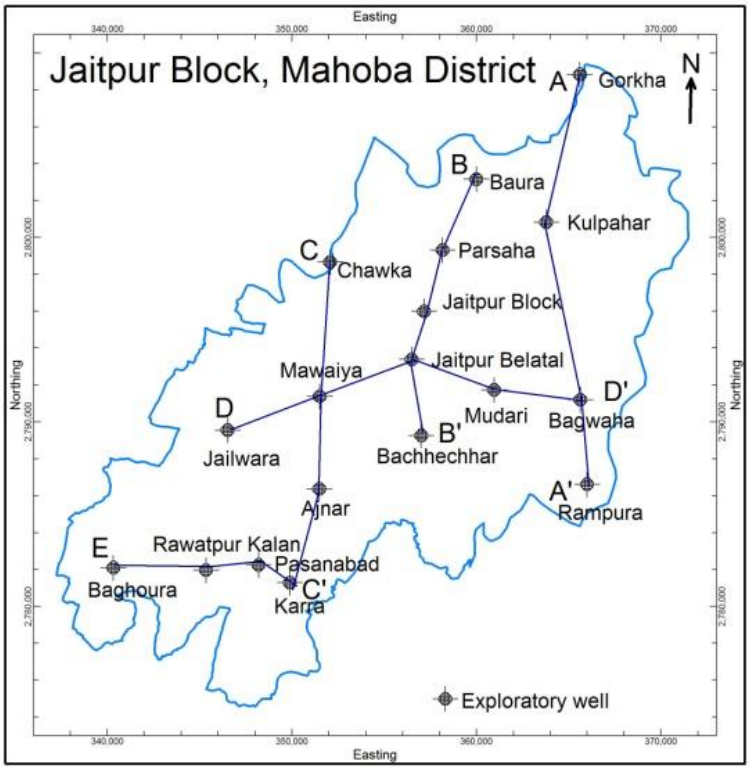


Plate 50: 3D Aquifer Disposition, Jaitpur Block, Mahoba, UP

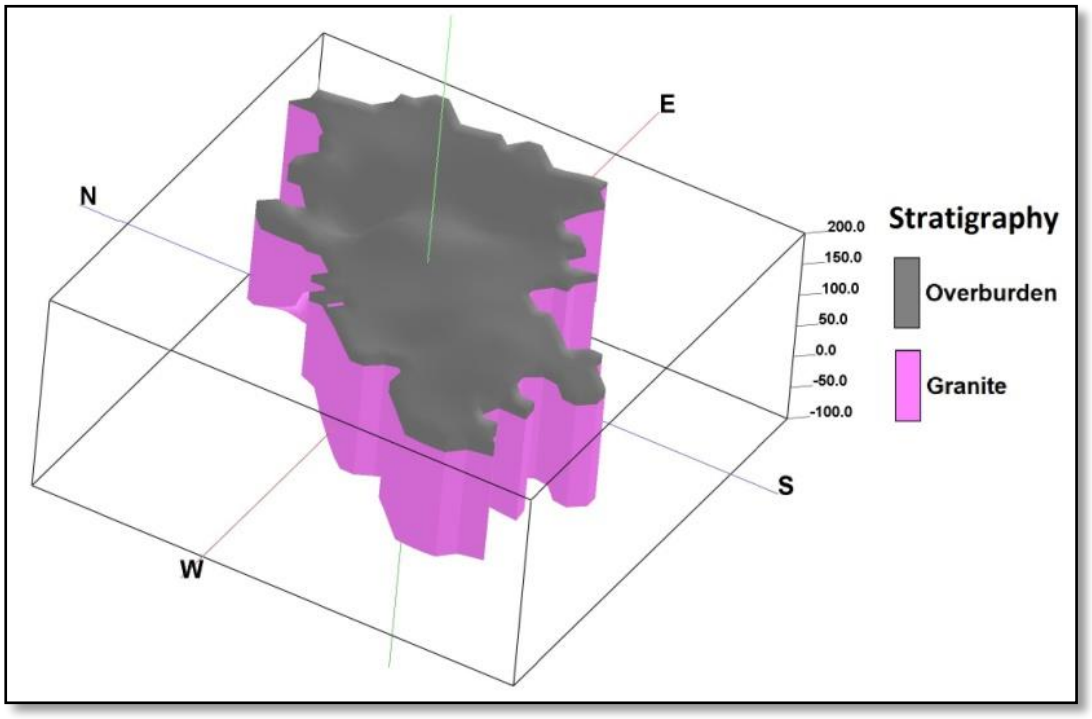
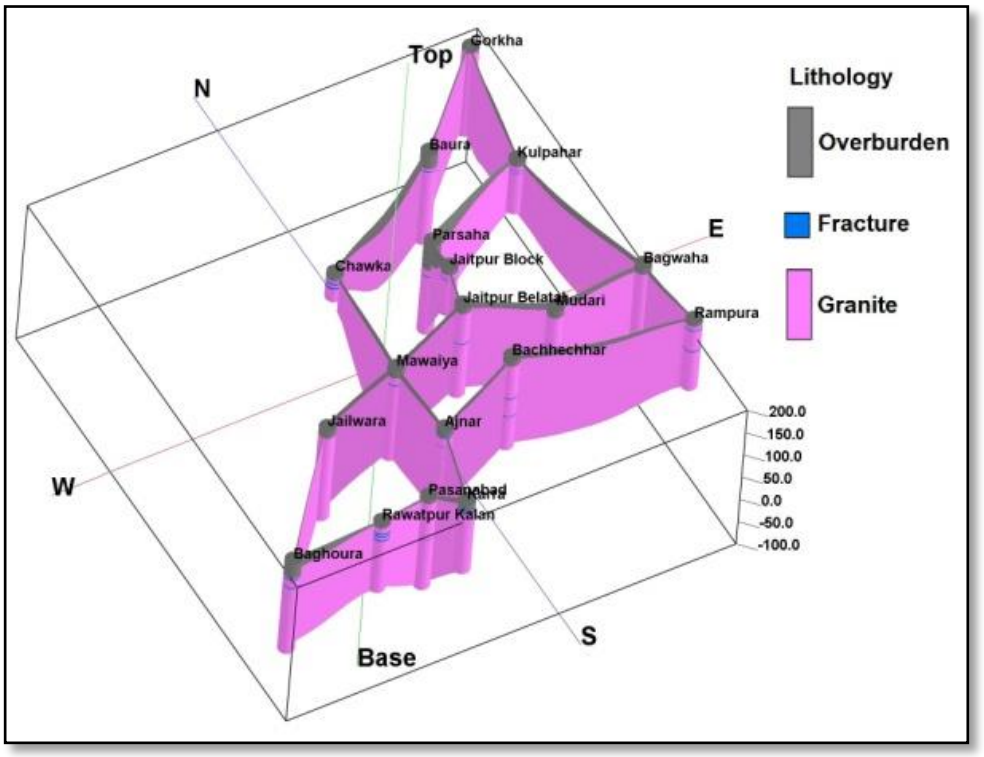
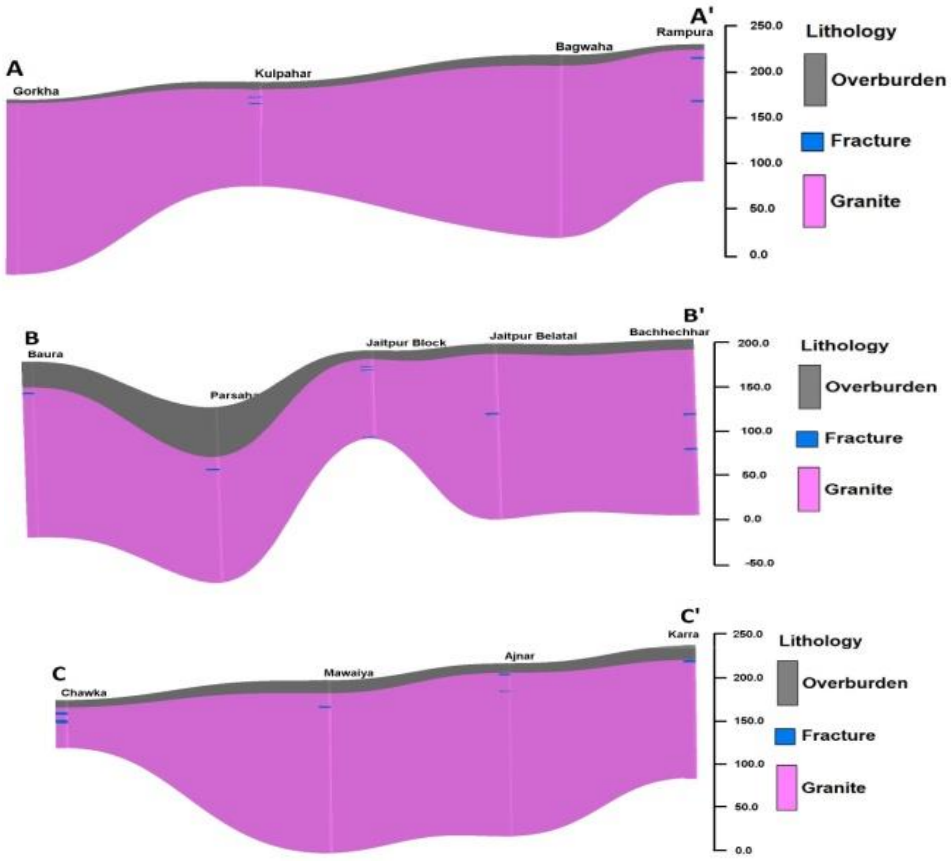


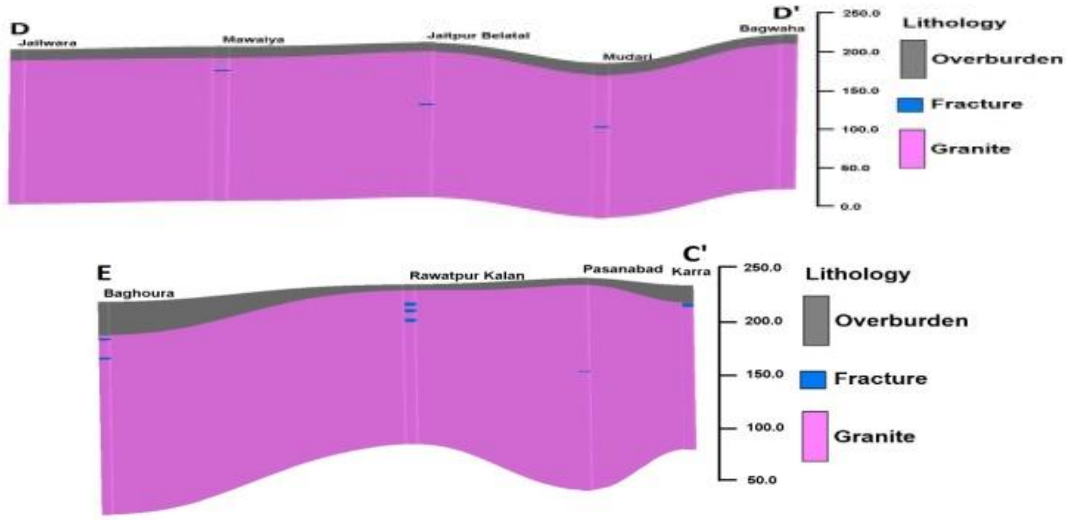
Plate 51: Fence Diagram, Jaitpur Block, Mahoba, UP



Fence Diagram **Jaitpur** Block, Mahoba District

Plate 52: 2D Sections along Section Lines, Jaitpur Block, Mahoba, UP





The Figures 6 & 7 give an overview of depth to water and 3-dimensional aquifer disposition in Charkhari block down to 200 m depth with dynamic & confined ground water resource.

12.4. GROUND WATER MANAGEMENT OPTIONS:

Ground water issues can be addressed by focussing on measures to increase recharge and reducing the draft. It can be managed by a mix of measures such as:

Supply Side Management

- Water conservation and Artificial Recharge to ground water
- On Farm Activities and

Demand Side Management

- Adoption of techniques to enhance water Use Efficiency
- Adoption of new irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water

Increasing Storage Capacity and Conservation of Rainfall:
Supply Side Management
Recharge / Water Conservation

- Water conservation structures such as check dams, farm ponds, nala bunds etc result in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings. Further construction of recharge trenches in the upstream side of the check dams is also proposed to enhance rate of infiltration by about 30 to 40%.
- The existing ponds and tanks lose their storage capacity as well as the natural ground water recharge due to siltation and encroachment by farmers for agriculture purposes. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

On Farm Practices: Supply
Side Management

- Leveling of crop field is essential for uniform distribution of water. Laser leveling has been found very effective ensuring saving of 10 to 30% of applied irrigation.

The in situ farm activities such as contour bunding, land leveling, bench terracing, water harvesting structures, afforestation and diversification of cropping pattern are other measures to increase recharge in the block.

Enhancing Water Use Efficiency:

Demand Side Management

Efficient irrigation

- In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant.
- Adoption of efficient irrigation practices in sugarcane cultivation area to save 35-40

% irrigation water. Such practices are as under

5. Trash Mulching
6. Micro Irrigation (Sprinkler/ Drip Irrigation)

- While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The conveyance losses (mainly seepage & evaporation) can be saved upto 25 to 40% through utilization of HDPE pipes.
- Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'

Diversification of cropping pattern

- Horticulture department should promote Baghwani in the area. This will bring in money without high use of water. These will also help conserve soil moisture.
- Alternate cropping system having lower requirement of water are better option.
- Summer paddy and maize need to be avoided which are grown over substantial area in the block.
- Late sown wheat/peas are replaced by spring maize which consumes more water. Suggested cropping pattern are as under.
- **Kharif-** Maize, cotton, sorghum, pulses, groundnut
- **Rabi-** Mustard, gram, pulses, vegetable

By adopting suggested cropping pattern 20 to 30% of irrigation water saving is possible.

Block	Check Dams of 10000 cum Capacity (Nos)	Drain/stream development (length in km x Avg.12m x 3m)	Nala Bunds of 7500 cum Capacity (Nos)	Revival of Ponds (Avg.) 50m x 50m x 3m dimension	On-farm Activities (Area in ha)	Water Use Efficiency (WUE) Mea-sures (Area in ha)
Jaitpur	12	12	28	106	5000	2000

12.5. BENEFITS:

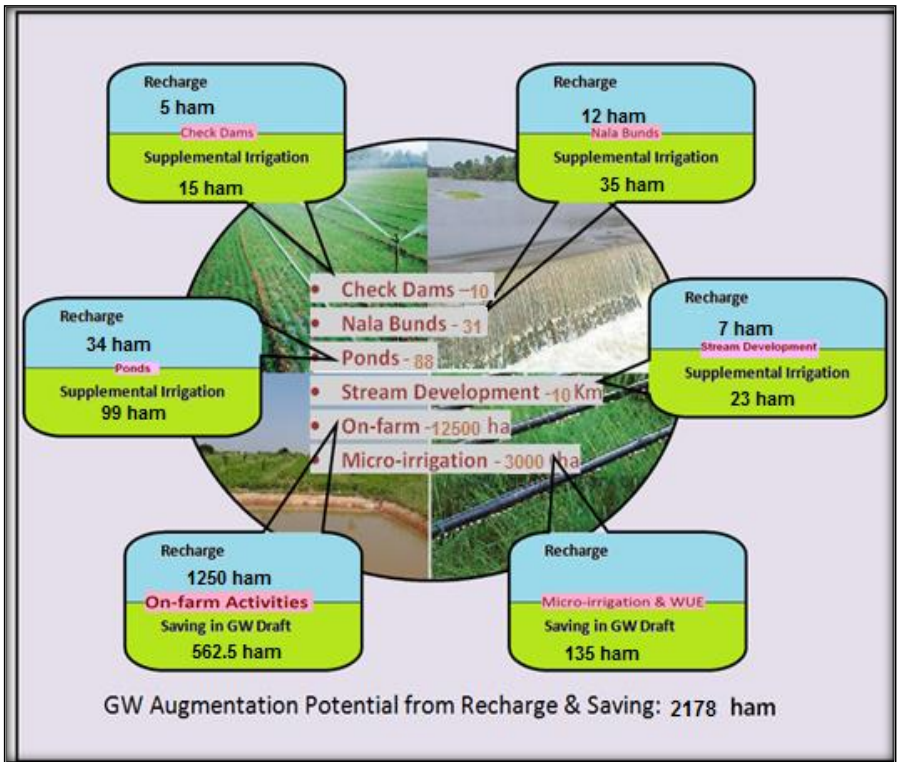
Table 47: Summarized Expected Benefits, Jaitpur Block, Mahoba, UP

Expected Annual Recharge	5.66 MCM
Provision for supplemental irrigation	1.96 MCM
Conservation from On-farm Activities & WUE Measures	3.36 MCM
Total Recharge/ Saving	10.98 MCM

12.6. PROJECTED IMPACT AFTER INTERVENTIONS:

Net G.W. Availability (Ham)	Additional Recharge from RWH & Re-charge (ham)	Total Net G.W. Availability after intervention (Ham)	Existing G.W Draft for all purpose (ham)	Saving of Ground water through projects (ham)	Net GW draft after interventions (ham)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
5510.97	566.22	6077.19	4514.61	532.27	3570.54	104.88	58.75

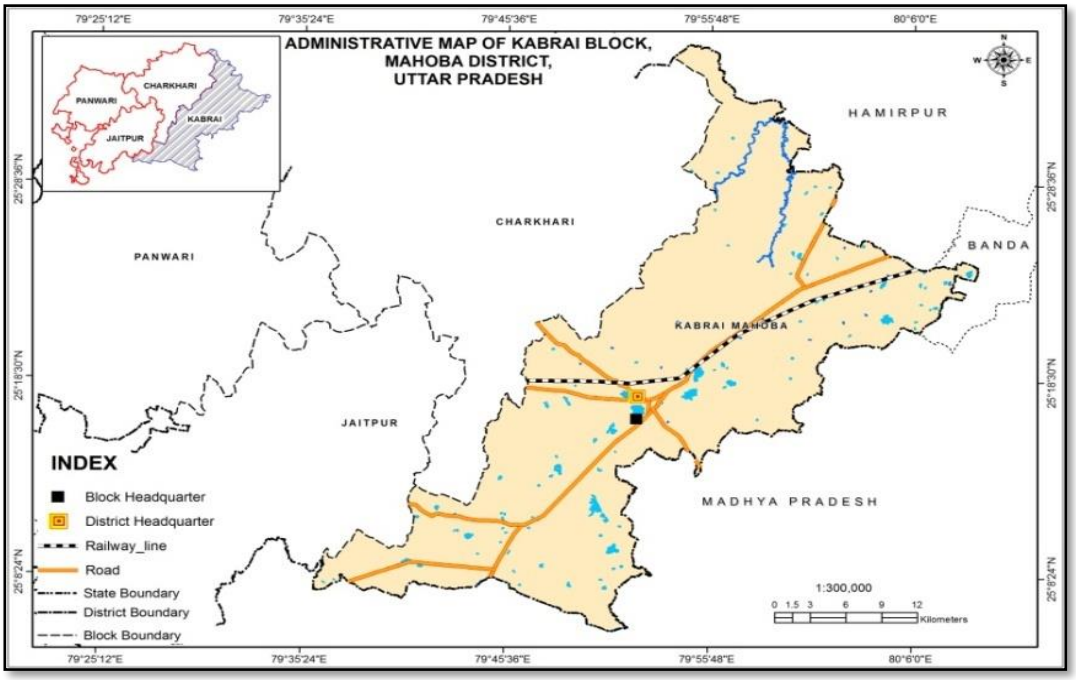
Plate 53: Summary of Interventions, Jaitpur, Mahoba, UP



13. GROUND WATER MANAGEMENT IN KABRAI BLOCK

13.1. INTRODUCTION:

Plate 54: Administrative Map, Kabrai Block, Mahoba, UP



13.2. Drainage, Soil, Geomorphology, Landuse and GW Resource:

Plate 55: Drainage Map of Kabrai Block, Mahoba, UP

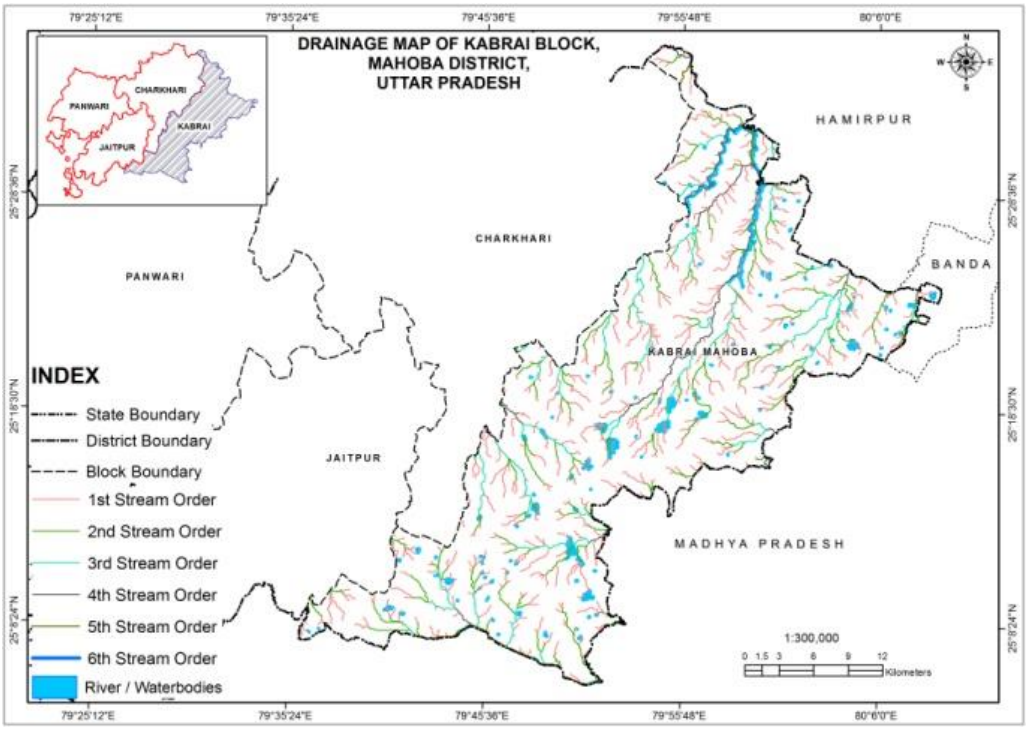


Plate 56: Landuse/ Landcover Map, Kabrai Block, UP

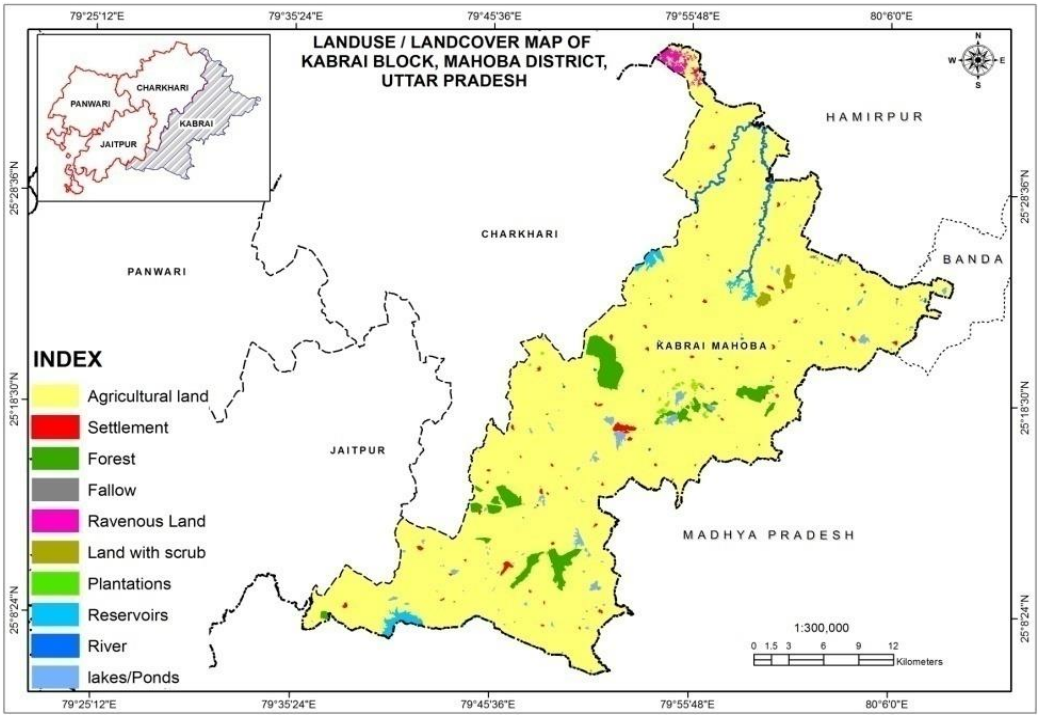
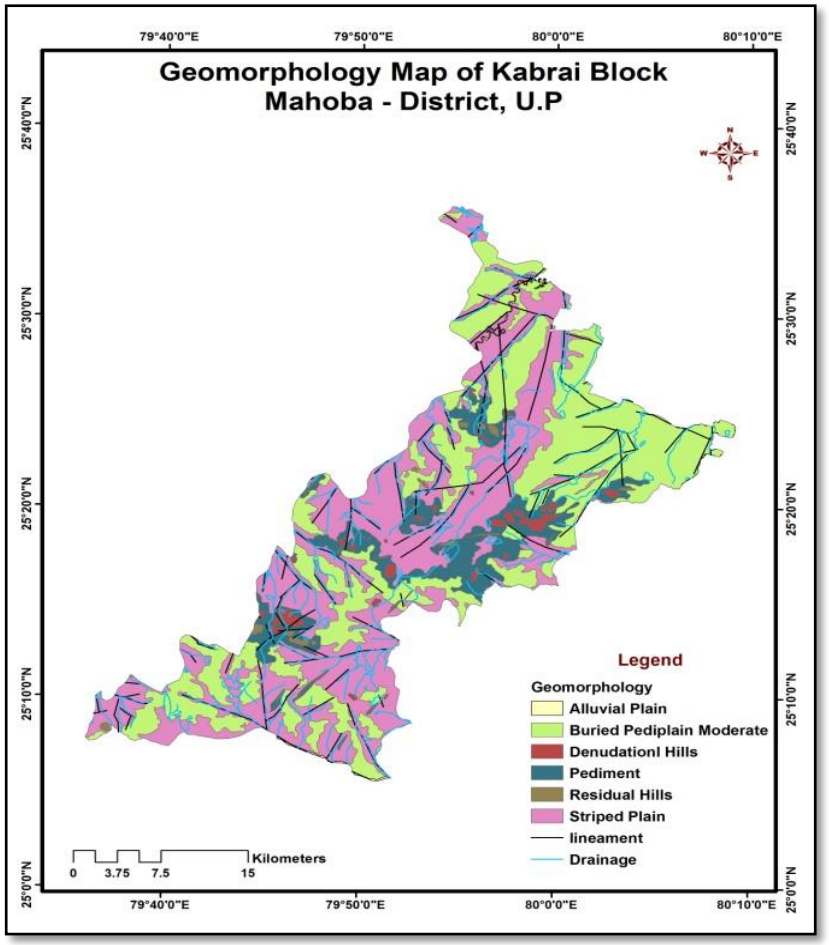


Plate 57: Geomorphology Map of Kabrai Block, Mahoba, UP



The soil in the area is Lomy and fine sitly. Geologically granites are unconformably overlain by Quaternary alluvium (Banda Alluvium) consisting of Gravel, Sand and Clay. The thickness of overburden varies from 5 to 40.0 m.

Geomorphologically the block virtually forms a Burried Pediplain, Stripped Plain, and Pediment. (Fig-5). The agriculture statics shows cropping intensity 165% and irigation intensity 103% (Table 1). The wheat, Pulses and oil seeds are major corps in the area. As per Dynamic Ground water resource estimation 2017 the Net Ground water availability is 5510 ham and stage of development is 74%. The block is in semi- critical category.

Agriculture Practices :

(Figures in Ha.)

Table 48: Agricultural Statistics, Kabrai Block, Mahoba, UP

	Sown area			**Season-wise Crop Area**			**Irrigated Area**			
Block	*Net Area Sown*	*Area sown more than once*	*Total*	*Rabi*	*Kharif*	*Jayad*	*Net Irrigated*	*Gross Irrigated*	Cropping Intensity	Irrigation intensity
Kabrai	87027	25933	112960	86005	26949	6	39196	40588	129.80	103.55

Table 49: Area Under Principal Crops, Kabrai Block, UP

Wheat		**Barly**		**jwar**		**Pulses**		**Oilseeds**	
Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated	Total	Irrigated
16136	10987	2813	1978	408	0	56004	16584	21879	717

Table 50: Dynamic Ground Water Resource of Kabrai Block, Mahoba District, UP (as on 31.3.2017) (Ham)

Net Annual GW Availability	**Gross Ground Water Draft for Irrigation**	**Existing Gross GW Draft for All Uses**	**Stage of Ground Water Development (%)**
5510.97	3779.50	4102.81	74.45

13.3. 3-Dimensional Aquifer Disposition in Kabrai Block

Plate 58: Location of EWs, Section Lines, Kabrai Block, Mahoba District, UP

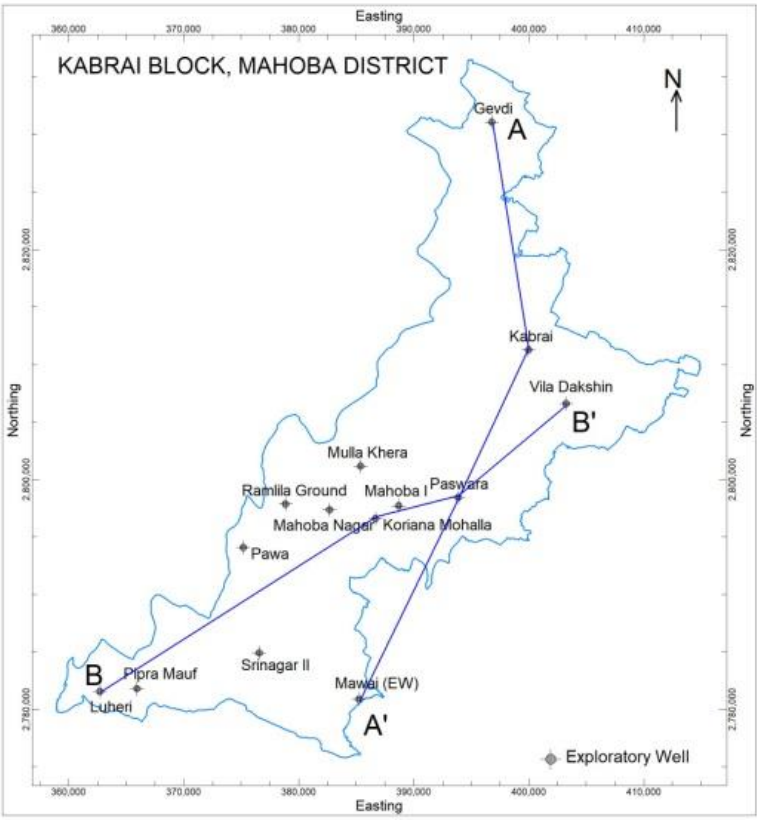


Plate 59: Exploratory Wells with Lithological Description, Kabrai Block, Mahoba, UP

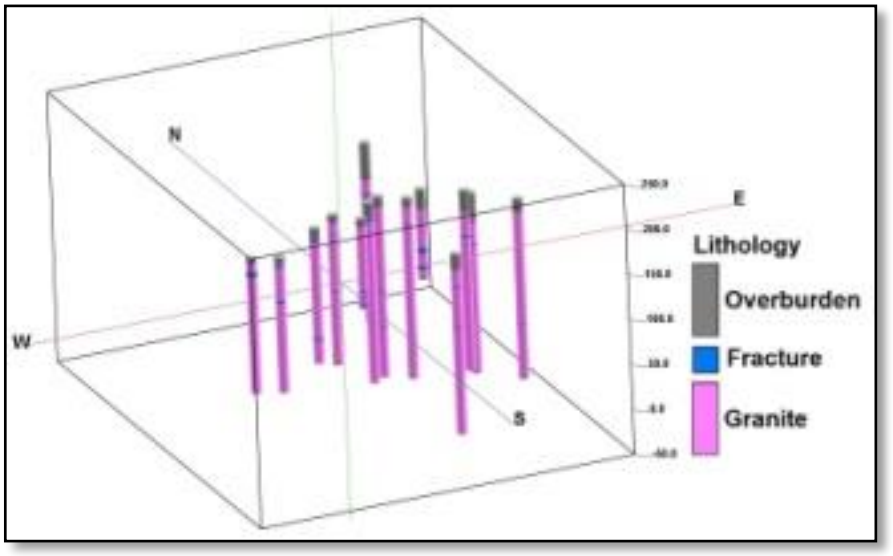


Plate 60: 3D Aquifer Geometry of Kabrai Block, Mahoba, UP

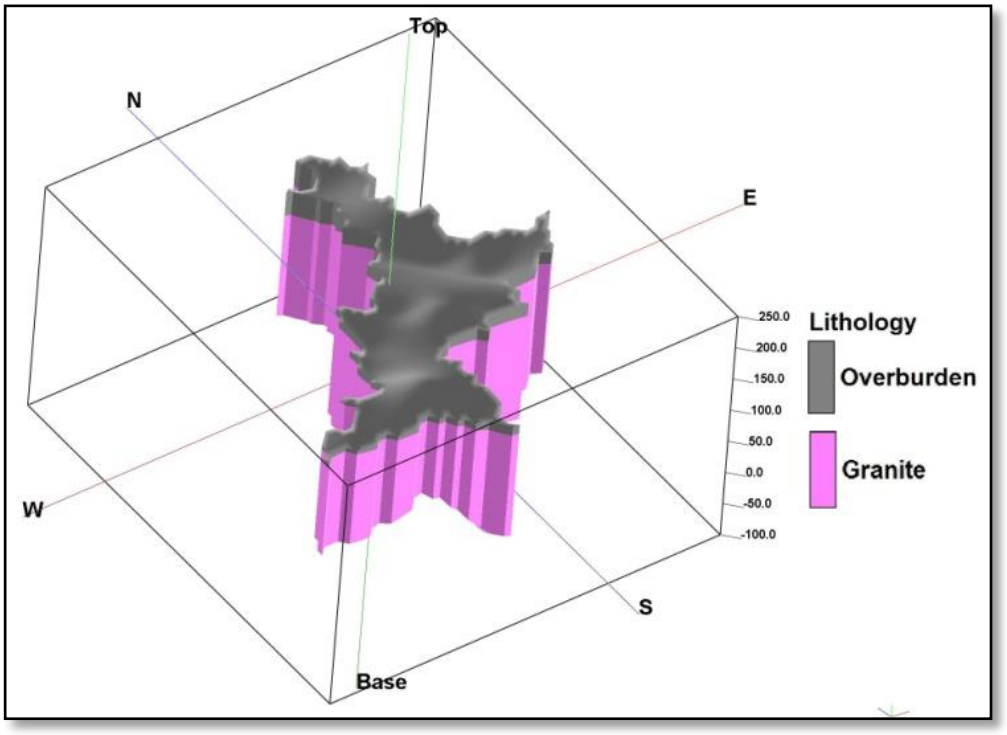


Plate 61: Fence Diagram, Kabrai Block, Mahoba, UP

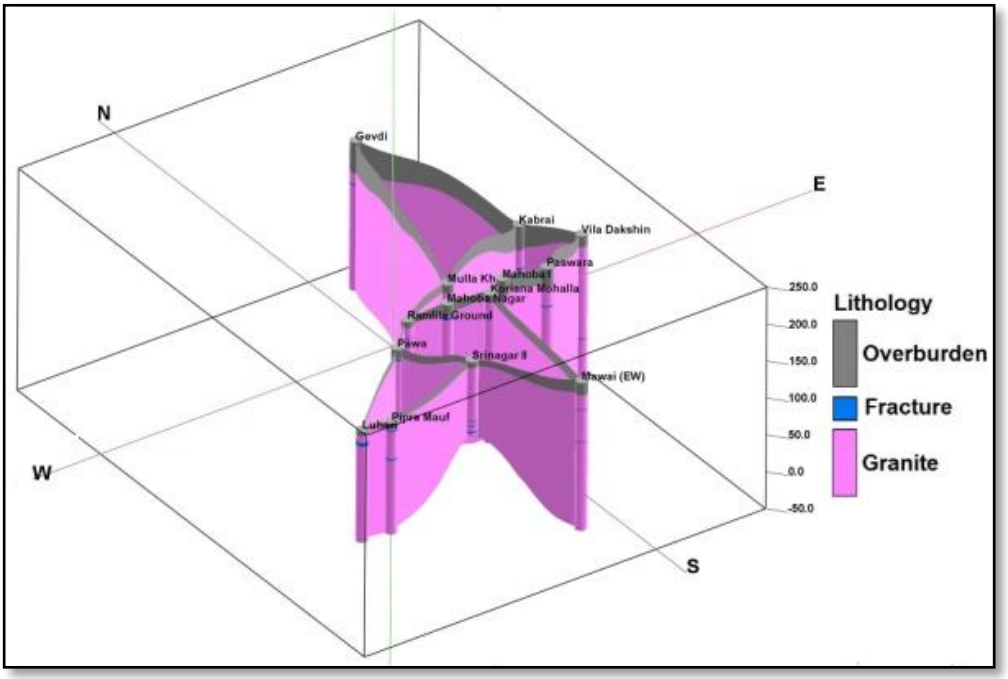
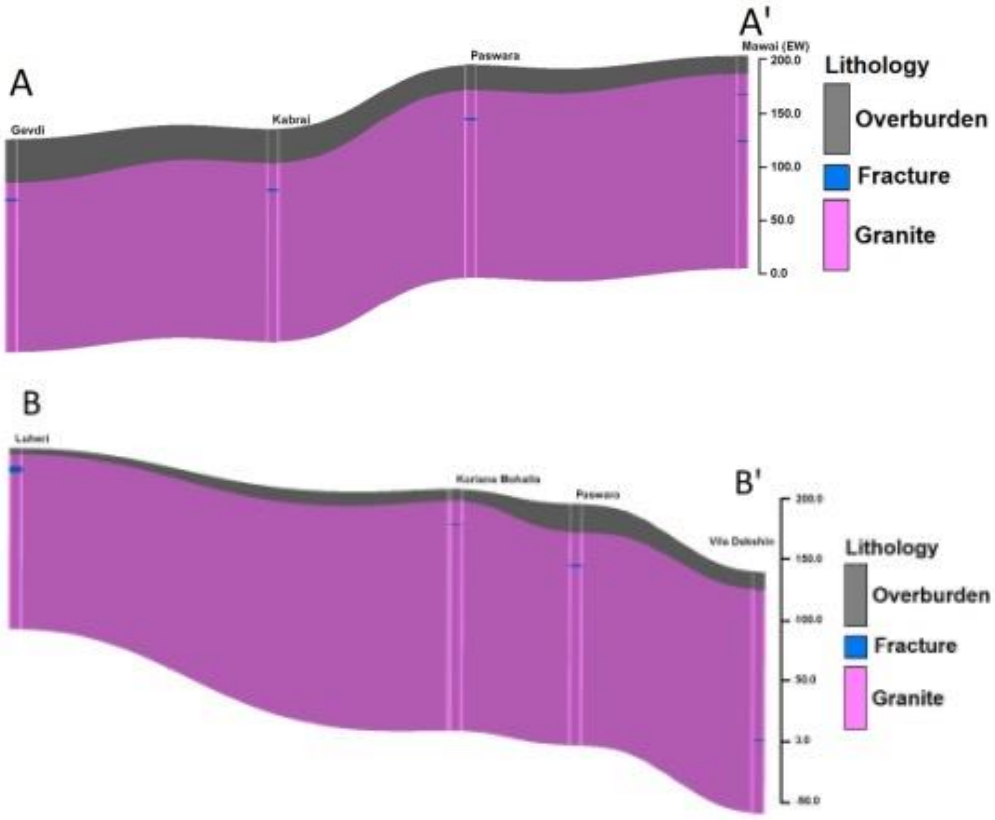


Plate 62: 2D Sections along Section Lines, Kabrai Block, Mahoba, UP



The Figures give an overview of depth to water and 3-dimensional aquifer disposition in **Kabrai** block down to 200 m depth with dynamic & confined ground water resource.

13.4. GROUND WATER MANAGEMENT OPTIONS:

Ground water issues can be addressed by focussing on measures to increase recharge and reducing the draft. It can be managed by a mix of measures such as:

Supply Side Management

- Water conservation and Artificial Recharge to ground water
- On Farm Activities and

Demand Side Management

- Adoption of techniques to enhance water Use Efficiency
- Adoption of new irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water

Increasing Storage Capacity and Conservation of Rainfall: Supply Side Management

Recharge / Water Conservation

- Water conservation structures such as check dams, farm ponds, nala bunds etc result

in ground water recharge to the tune of about 50% of the storage capacity considering 3 annual fillings. Further construction of recharge trenches in the upstream side of the check dams is also proposed to enhance rate of infiltration by about 30 to 40%.

- The existing ponds and tanks lose their storage capacity as well as the natural ground water recharge due to siltation and encroachment by farmers for agriculture purposes. Through desilting, coupled with providing proper waste weir, the village tanks can be converted into recharge structure.

On Farm Practices: Supply
Side Management

- Leveling of crop field is essential for uniform distribution of water. Laser leveling has been found very effective ensuring saving of 10 to 30% of applied irrigation.

The in situ farm activities such as contour bunding, land leveling, bench terracing, water harvesting structures, afforestation and diversification of cropping pattern are other measures to increase recharge in the block.

Enhancing Water Use Efficiency:

Demand Side Management

Efficient irrigation

- In flood/furrow irrigation method more than 50% of applied water is wasted through seepage to deeper level, localized inundation causes loss through evaporation and it leaches out the nutrients from the plant.
- Adoption of efficient irrigation practices in sugarcane cultivation area to save 35-40 % irrigation water. Such practices are as under

7. Trash Mulching
8. Micro Irrigation (Sprinkler/ Drip Irrigation)

- While through drip & sprinkler irrigation wastage of irrigational water could be minimized. The conveyance losses (mainly seepage & evaporation) can be saved upto 25 to 40% through utilization of HDPE pipes.
- Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'

Diversification of cropping pattern

- Horticulture department should promote Baghwani in the area. This will bring in money without high use of water. These will also help conserve soil moisture.
- Alternate cropping system having lower requirement of water are better option.
- Summer paddy and maize need to be avoided which are grown over substantial area in the block.
- Late sown wheat/peas are replaced by spring maize which consumes more water. Suggested cropping pattern are as under.
- Kharif- Maize, cotton, sorghum, pulses, groundnut
- Rabi- Mustard, gram, pulses, vegetable

By adopting suggested cropping pattern 20 to 30% of irrigation water saving is possible.

Table 51: GW Management Interventions, Kabrai Block, Mahoba, UP

Block	Check Dams of 10000 cum Capacity (Nos)	Drain/stream development (length in km x Avg.12m x 3m)	Nala Bunds of 7500 cum Capacity (Nos)	Revival of Ponds (Avg.) 50m x 50m x 3m dimension	On-farm Activities (Area in ha)	Water Use Efficiency (WUE) Mea-sures (Area in ha)
Kabrai	10	10	31	88	12500	3000

13.5. BENEFITS:

Table 52: Summarized Expected Benefits, Kabri Block, Mahoba, UP

Expected Annual Recharge	**13.07 MCM**
Provision for supplemental irrigation	**1.72 MCM**
Conservation from On-farm Activities & WUE Measures	**6.97 MCM**
Total Recharge/ Saving	**21.76 MCM**

13.6. PROJECTED IMPACT AFTER INTERVENTIONS:

Net G.W. Availability (Ham)	Additional Recharge from RWH & Re-charge (ham)	Total Net G.W. Availability after intervention (Ham)	Existing G.W Draft for all purpose (ham)	Saving of Ground water through projects (ham)	Net GW draft after interventions (ham)	Present stage of G.W. development (%)	Projected stage of G.W. Dev. (in %)
4304.40	**1307.53**	**5611.93**	**4514.61**	**870.10**	**3644.51**	**104.88**	**64.94**

Plate 63: Summary Report of GW Management, Mahoba District, UP

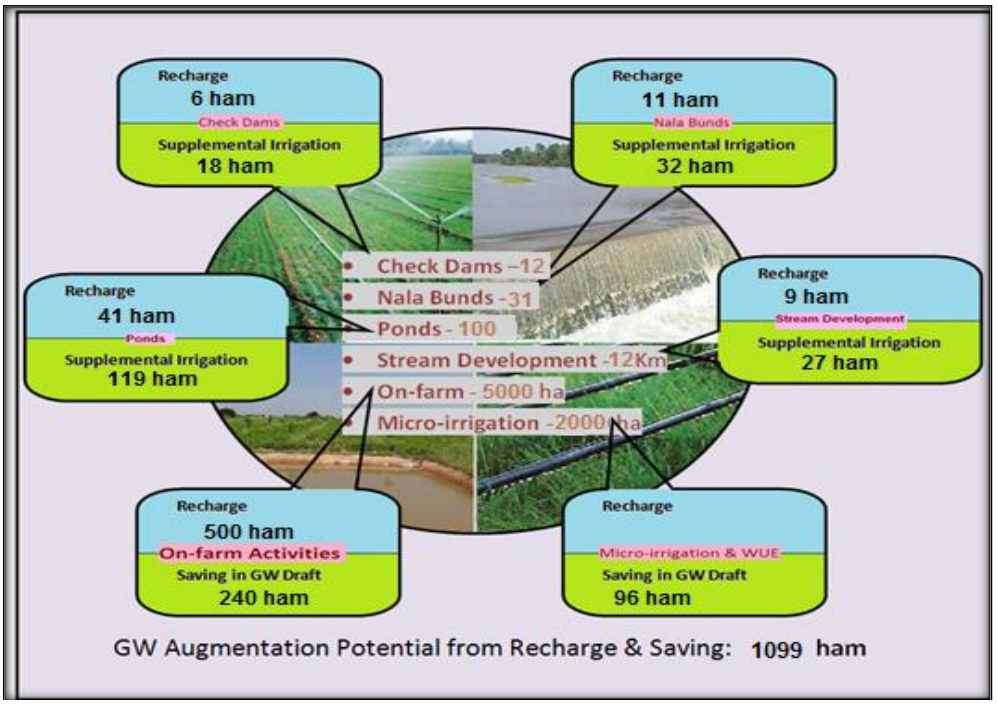
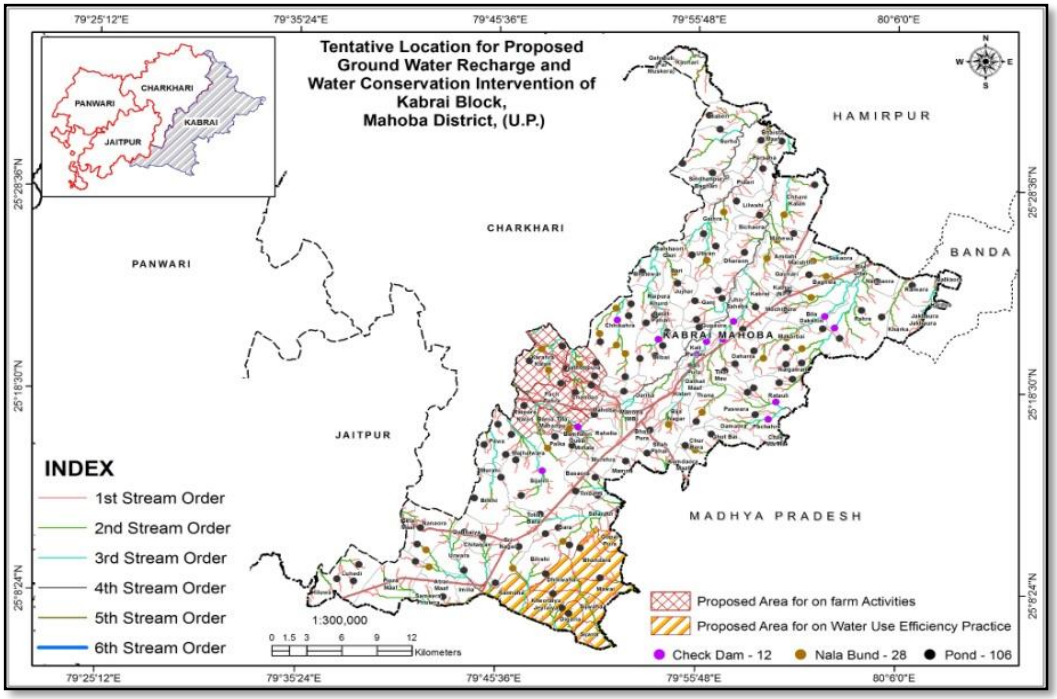


Plate 64: Tentative Location for Proposed GW Recharge and Water Conservation Interventions, Kabrai Block, UP



14. CONCLUSION

1. Mahoba district, covering an area of 2882 sq. km lies in the South of Uttar Pradesh. For administrative purposes, the district has been sub-divided into 3- tehsils and 4 developmentalblocks.
2. The drainage pattern of the district is strictly governed by the rivers Dhasan, Urmil, Arjun and Birma part Yamuna sub basin. The Mahoba district is a undulating terrain falling Bundelkhand area characterized by hilly rocky terrain with rugged topography. Geologically the area is characterized by Bundelkhand Massif consists of granite, quartz reef, dolerite dyke overlain by thin cover of Quaternary alluvium.
3. The average annual rainfall is about 943 mm and 90 % of this is received from south west monsoon. The area prone to drought to severe drought. The area is considered to be economically and socially backward.
4. The loamy soils of the area are very fertile. About 80% of the total geographical area of the district is cultivated area. The main rabi crops are wheat and oil seeds while paddy and pulses are the main kharif crops. The abundantly produced sugarcane is a perennial crop.
5. Net Area Sown in the district is 237217 ha, Net irrigated area is 125420ha and Gross irrigated area is 130227 ha. Tubewell irrigation accounts for about 60% and surface water irrigation 40% in the area.
6. The principal crop of the area are grown in Rabi and Kharif season. The principal crops are Wheat, Pulses, and oilseeds.
7. Pre-monsoon Depth to water level varies from 1.35 to 23.15 mbgl and Post-monsoon Depth to water level varies from 1.02 to 20.25 mbgl. Relatively deeper water level are observed in the western part of the district whereas relatively shallower water levels are present in the central part of the district.
8. Long term water level trend in the past 10 years shows a fall of 28- 47 cm/yr during pre-monsoon and a fall of 24-37 cm/yr during post monsoon period.
9. Groundwater flow direction is broadly fallows topography. The ground water flow from south to north and further in NW and NE direction.
10. Broadly Aquifer Group I extends down to 40 m, Aquifer Group II extend down to around 5-200 m. The yield in phreatic aquifer is up to 200 lpm whereas yield in II Aquifer varires from 0-600 lpm. The Transmissivity of II aquifer varies from – 2204 m2/day and Storativity $1.3*10^{-3}$ to $2.8*10^{-4}$. The ground water exploration down to 200 mbgl shows occurrence of potential fractures are 68% down to 50m, 31% from 50to 100m and only 1% from 100to 200m depth..
11. The total ground water draft is 19083.79 ham, which is being used in present for domestic, irrigation & industrial purposes against the ground water availability of 21742.14 ham. Out of 4 blocks, two blocks falls under over exploited category which are Panwari, Jaitpur, and two blocks Charkhari and Kabrai under Semi-Critical. Overall stage of ground water development in the district is about 87%.
12. The general Chemical quality of ground water is potable and is fit for domestic and irrigation purposes. The EC of shallow ground water in major part varies from 500 to 2000 microseimens /cm^2 at 25 ^{O}C. At few locations fluoride and nitrate are above permissible limits. The majority of the samples [76.19% of total samples] come under 'Low' class with reference to RSC and are suitable for irrigation. Fifteen samples [14.28% of total samples] come under 'Medium' class and the soil requires some treatment prior to application of groundwater for irrigation. Three samples display higher than desirable concentration of Iron in groundwater [Permissible

limit > 1.0 mg/l] and one sample each from Panwari, Jaitpur and Kabrai blocks have elevated levels of Iron in groundwater. One location displays higher than desirable concentration of Chromium in groundwater [Acceptable limit < 0.05 mg/l and no relaxation beyond 0.05 mg/l] and the sample comes from Jaitpur block. According to data obtained from RCL, the groundwater sample of Gaurhari from Charkhari block exceeds the permissible limit as mandated by WHO (2011). According to data obtained from RCL, the groundwater sample of Gaurhari from Charkhari block exceeds the permissible limit as mandated by WHO (2011).

15. RECOMMENDATIONS

1. The study in the area indicates that ground water occurs in shallow aquifer has more potential as compare to potential in deep aquifer (HARD ROCK). Hence dug wells are the major source for irrigation and drinking water need. The deep aquifer may be used for only drinking purpose
2. To arrest the further decline in ground water levels and depletion of ground water resources, there is urgent need to implement both Supply side and Demand side measures which includes artificial recharge and water conservation, On-farm activities and adoption of water use efficiency measures.
3. It is proposed to adopt supply side management options only in the Over-Exploited and Semi-Critical blocks. There is considerable scope for implementation of Roof Top Rain Water Harvesting in the urban areas in Government Building of the district. Check dams, cement plugs, renovation of ponds are ideal structures for rain water harvesting in rural areas. Water conservation structures such as check dams, farm ponds, nala bunds etc. result in ground water recharge to the tune of about 40% of the storage capacity considering 3 annual fillings.
4. It is also proposed to adopt On Farm practices such as laser leveling, bench terracing, construction of farm ponds, afforestation, diversification of crops etc. On farm activities are proposed in an area of 9600hectare.
5. It is proposed to construct 44 Check dams of 10,000 cubic m. capacity and 117 nala bunds of 7,500 cubic meter capacity, to revive and renovate 383 ponds and development of 44 Km. stream channel.
6. In demand side management there is urgent need to promote piped and pressurized irrigation practices which can save 25 to 70% of water use in the agriculture. It is proposed to initiate on farm activity in 39000 hectare and water use efficiency in 9500 hectare area.. The measures adopted for supply side and demand side management in Mahoba district will substantially bring down stage of ground water development.
7. Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of ‘Green Manure’.
8. Alternate cropping system having lower requirement of water should be encouraged in accordance to the irrigation water availability.
9. Conjunctive use of surface and groundwater should be encouraged in the district.
10. The construction of large diameter dug wells in entire area should be monitored and encouraged either for drinking and irrigation purpose.
11. There are crusher used for granite open quarry Industries are extracting ground water to meet their water requirements. There is urgent need that these industries should upgrade their plant for water efficient processes and adopt recycle and reuse of water in their processes. Besides the above, there is urgent need for participatory ground water management in the area which will further help in bringing more

awareness among the common farmers which will reduce the ground water drawl and bring down the stage of ground water development.

12. All efforts should be taken to ensure treatment of waste disposal both solid and liquid from industries and urban areas to prevent pollution of ground water and surface water.

16. ACKNOWLEDGEMENTS

The assignment was carried out under the overall supervision of Sri. Y.B. Kaushik, Regional Director. The author is grateful to him for his consistent guidance. The author expresses sincere thanks to Dr. Sashikant Singh, Scientist 'B' (Jr.Geophysicst) for preparation of aquifer maps. Thanks are also due to the chemists of the Region for the analysis of the water samples. The valuable contribution of Dr. Vikas Ranjan, Scientist 'C' (Sr. Hydrogeologist) in conceptualization and preparation of the GW management plans is also duly acknowledged.

17. REFERENCES

1	Todd, D.K.	1980	Ground Water Hydrology, Second Edition, John Wiley & Sons, Newyork.
2	CGWB	2018	Dynamic Ground Water Resource of Uttar Pradesh
3	UP Govt.	2018	Statistical Diary, Uttar Pradesh Govt

Annexure I: Details of Exploratory wells in Mahoba District

Sl. No	District/Location	Longitude	Latitude	Depth Drilled (m.bgl)	Depth of well/over burden (m.bgl)	Zones tapped/ fractures encountered (m.bgl)	Discharge (lpm)
1	Kulpahar	79.64667	25.31778	114	8	16,23	600
2	Supa	79.75	25.33333	50.2	19.15	23,41	900
3	Jaitpur Block	79.58139	25.27361	100	10	18, 22, 98	30
4	Charkhari	79.76667	25.39167	100	8	12, 15, 30, 38, 48, 55, 90	200
5	Kabrai	80.05	25.38333	100	7	80, 86, 94, 96	75
6	Srinagar II	79.775	25.175	100	8	20, 27, 72, 78, 80, 88, 94	140
7	Mahoba I	79.89444	25.29167	100	10	16, 18 65, 70, 85, 88	150
8	Mahoba-Kant	79.40472	25.34028	101.21	14.8	35	75
9	Ghautai	79.41306	25.28083	101.67	27.65	35	300
10	Tolapatar	79.46111	25.33222	102	12	31	75
11	Bhaura	79.43333	25.32889	20.82	18.96	20.0-24.0	647
12	Byargo	79.48694	25.3625	101.59	31.5	38	75
13	Nanaura	79.68806	25.19722	101.05	2.6	16.00-71.00	350
14	Rampura (Mahuva Bandh)	79.67	25.18972	150	5.9	14 & 61	75
15	Nathupura (Mahoba City)	79.86667	25.31389	150	8.75	5 & 8	120
16	Pawa	79.76056	25.25778	150	11.94	13 & 122	100
17	Pipra Mauf	79.67	25.14611	150	6.9	9 & 48	100
18	Luheri	79.63806	25.14361	150	5.11	15.20-20.20	500
19	Jaitpur-II	79.55833	25.24778	150	11.88	14 & 61	120
20	Mahoba Kanth-II	79.40417	25.33472	150	11	15.2	50
21	Tola Pathar-II	79.465	25.33167	150	11.69	13.4-15.25	70
22	Tingura	79.49028	25.36472	150	14.7	72-72.6	Dry
23	Rewai	79.475	25.34917	150	30.8	73	70
24	Bhatipura	79.87972	25.27694	154.2	10	-	-
25	Chitaya	79.73361	25.18528	160.3	10	9.0-10.0, 36.0-37.0	360 lpm
26	Ramlila Ground	79.79667	25.29222	166.4	8	22-23, 83-84	135 lpm
27	Subhashnagar	79.81472	25.29639	154	10	13.65-16.70	30 lpm
Sl. No	District/Location	Longitude	Latitude	Depth Drilled (m.bgl)	Depth of well/over burden (m.bgl)	Zones tapped/ fractures encountered (m.bgl)	Discharge (lpm)
28	Koriana Mohalla	79.87444	25.28139	200.2	9.8	29 – 29.5	20
29	Mahoba Nagar	79.83472	25.28806	200.2	15.5	17.1 – 20.10	284
30	Jaitpur BELATAL	79.575	25.25	200.2	11.7	79 - 81	40
31	Mulla Khera	79.86111	25.3225	200.3	11.5	105, 145	25
32	Pasanabad	79.49389	25.14861	200.2	6.5	87.4	18
33	Bachhechhar	79.58056	25.21278	200.2	11.8	84.40, 124	25

34	Gorkha	79.66389	25.39028	191.1	3.6	191	200
35	Thurat	79.56778	25.26972	129.65	4.87	13.8	25
36	Hatwara	79.76667	25.405	117.25	18.15	18-20, 32-35, 84-87	726
37	Maharajganj	79.75167	25.39	153.35	7.33	25-28	20
38	Jaitpur - Kasturbagandhi School	79.58333	25.26833	154.1	10.15	13.8-16.65	20
39	Karra	79.51083	25.14	154.4	18.75	17-20	20
40	Panwari	79.47833	25.425	154.3	32.35	32-47	930
41	Saunra	79.3225	25.23833	154.1	10.55	10.75-11.75	20
42	Ajnar	79.52611	25.18611	200.2	12	Fr 12-14, 32.50	18
43	Bharwara	79.5625	25.38056	200.2	18.6	19 -26	237
44	Richha	79.575	25.39167	200.2	7.2	29 - 31	15
45	Burhi	79.61111	25.37167	200.2	26	194 - 196	103
46	Tunder	79.43056	25.30472	150	9	41,89.2	Seepage
47	Bahadurpur Kalan	79.4125	25.38333	150.45	13.25	32.55 - 34.66	30
48	Pahariya	79.49167	25.36667	200.2	19.6	21-23, 116-122	89
49	Chawka	79.53056	25.29722	55.3	8.5	13.85 -17, 23.05-27	440
50	Rawatpur Kalan	79.325	25.25972	150.05	5.5	16.95 -20, 23.08-26, 32.15-35	440
51	Bhujpura	79.49333	25.30417	200.2	6.8		51
Data Generation							
1	Telipahari	25.1825	79.23	202.89	17.68	18.28, 39	60
2	Churarari	25.34835	79.53301	202.89	29.88	24.38, 40	80
3	Dadri	25.33289	79.51483	202.89	11.28	74.67	60
4	Baura (EW)	25.33855	79.60881	202.89	29.27	27.43, 35	250
5	Mawaiya	25.23143	79.52575	202.89	15	30	20
6	Gudha	25.44871	79.67763	202.89	28.05	35.48	80
7	Gourahari (EW)	25.44897	79.61752	202.89	31.09	25.9, 42	200
8	Nakra (EW)	25.47567	79.50134	202.89	22.45	43.89,63.70,104.5,181.8	300
9	Kilhauwa	25.426	79.53024	202.89	12.25	165	20
10	Mudari/Khairarya (EW)	25.23546	79.61954	202.89	15.52	81	200
11	Jailwara/Bhagoura	25.21437	79.47647	202.89	13.88	dry	20
12	Baghoura	25.14633	79.41588	202.89	31.33	34,52	180
13	Bagwaha	25.23109	79.666	202.89	11.89	dry	50
14	Dhorra	25.04525	79.41633	202.89	12.84	33,162,	160
15	Manki	25.2177	79.33979	202.89	17.73	dry	30
16	Dharwar	25.37476	79.33585	202.89	39.83	dry	30
17	kotra	25.41398	79.36787	202.89	38.99	0.5 Inch	60
18	Baidon	25.42003	79.41397	202.89	38.82	dry	20
19	Lilwaha	25.3819	79.3162	202.89	18.6	14.15	60
20	Jarouli	25.50994	79.69704	202.89	26.4	27	30
21	Jataura	25.46315	79.78298	202.89	30.79	63	80
22	Bamhori kalan	25.45128	79.8442	202.89	35.36	dry	30
23	Imiliya Dang	25.4073	79.84086	202.89	23.77	128 mtr	60
24	Ram Nagar	25.38317	79.75615	202.89	9.4		90

25	Police Line Mahoba			202.49	23.6	0.5"	20
26	Saundhi	25.42866	79.4732	202.89	52.2		80
27	Bari	25.53184	79.88867	202.89	29		20
28	Vila Dakshin	25.37286	80.0383	202.89	14.76		330
29	Gevdi	25.59369	79.97214	202.89	41		80
30	Parsaha	25.3037	79.591	202.89	56.73		20
31	Utiyan/Kabrai	25.41491	800.0055	202.89	32		80
32	Paswara	25.29852	79.94577	202.49	23.8		60
33	Mawai (EW)	25.13949	79.86145	202.89	17.15		330
34	Swasa Maf (EW)	25.24524	79.71436	202.49	22.6		400

Annexure II: Chemical Results (Basic) of Phreatic Aquifer, Mahoba, UP

Sl. No.	Village	Block	pH	TDS	EC at 25°C	Ca	Mg	Na	K	HCO3	CO3	Cl	SO4	F
1	Ladpur	Jaitpur	7.53	442.8	738	58.12	34.02	51.57	0.00	402.60	0	28.36	7.70	2.12
2	Bamhauri Khurd	Jaitpur	7.41	579.0	965	84.17	29.12	78.76	1.70	445.30	0	35.45	89.00	1.72
3	Kulpahar	Jaitpur	7.44	438.6	731	56.11	31.59	51.81	0.00	414.80	0	17.73	9.60	2.28
4	Belatal	Jaitpur	7.25	549.6	916	108.22	26.65	53.68	1.28	427.00	0	56.72	50.20	1.62
5	Jaitpur	Jaitpur	7.14	1362.0	2270	244.49	50.84	211.75	3.32	756.40	0	304.87	160.00	1.21
6	Mawaiya	Jaitpur	7.40	474.0	790	80.16	18.17	61.70	1.16	427.00	0	46.09	18.90	1.14
7	Ajnar	Jaitpur	7.10	714.0	1190	164.33	24.15	40.74	0.00	378.20	0	120.53	62.60	1.08
8	Tikariya	Jaitpur	7.24	1076.4	1794	242.48	60.58	48.67	1.44	408.70	0	276.51	103.50	1.00
9	Syavan	Jaitpur	6.88	516.6	861	88.18	21.81	42.50	1.62	176.90	0	85.08	40.80	1.62
10	Indrahata	Jaitpur	7.25	307.2	512	64.13	12.10	28.20	1.01	250.10	0	28.36	13.30	1.44
11	Bhagari	Jaitpur	7.12	700.2	1167	174.35	30.23	31.95	1.05	445.30	0	138.26	32.00	0.57
12	Ghaghaura	Jaitpur	6.70	401.4	669	70.14	24.26	22.10	1.45	146.40	0	60.27	28.00	0.43
13	Bijauri	Jaitpur	7.40	507.6	846	90.18	36.42	34.26	0.00	469.70	0	39.00	12.30	0.68
14	Baghaura	Jaitpur	7.21	1254.0	2090	208.42	59.40	76.06	100.25	414.80	0	258.79	101.50	0.83
15	Saguniya Maph	Jaitpur	7.45	535.8	893	78.16	55.91	28.97	1.10	445.30	0	46.09	18.70	1.76
16	Akona	Jaitpur	7.30	747.6	1246	168.34	39.97	54.47	3.01	475.80	0	131.17	38.30	0.86
17	Mahua Bandh	Jaitpur	7.24	279.0	465	64.13	15.75	19.84	0.00	280.60	0	24.82	13.50	0.33
18	Leva	Jaitpur	7.44	640.2	1067	142.28	25.39	49.74	20.40	445.30	0	77.99	46.00	0.48
19	Rikhawaha	Jaitpur	7.38	660.0	1100	158.32	25.38	44.88	0.00	420.90	0	127.62	45.00	0.46
20	Rawatpura	Jaitpur	7.46	443.4	739	98.20	40.06	15.85	5.39	463.60	0	31.91	40.60	0.47
21	Mudhari	Jaitpur	7.56	777.6	1296	160.32	33.90	54.09	33.40	414.80	0	159.53	100.40	0.56
22	Sirmaur	Jaitpur	7.26	1530.0	2550	234.47	93.46	217.75	81.00	829.60	0	350.96	276.00	0.85
23	Sugira	Jaitpur	7.31	1010.4	1684	146.29	53.39	143.75	2.98	488.00	0	241.06	96.40	0.64
24	Baura	Jaitpur	7.35	516.0	860	126.25	18.11	22.67	6.84	439.20	0	46.09	30.90	0.66
25	Bharwara	Panwari	7.58	644.4	1074	100.20	46.14	66.87	1.13	488.00	0	95.72	58.60	0.51
26	Panwari	Panwari	7.46	823.2	1372	146.29	65.57	53.35	1.99	512.40	0	148.89	90.80	0.43
27	Bahadurpur Kalan	Panwari	7.65	621.0	1035	76.15	58.35	58.05	1.42	481.90	0	99.26	35.20	0.49
28	Mahob kanth	Panwari	7.79	311.4	519	50.10	30.38	15.13	5.81	353.80	0	14.18	7.70	0.48
29	Manki	Panwari	7.53	530.4	884	72.14	34.00	59.56	1.00	433.10	0	85.08	9.30	0.97
30	Rurikalan	Panwari	7.64	573.0	955	64.13	29.14	141.25	0.00	597.80	0	49.63	18.00	1.07
31	Ghutai	Panwari	6.98	1488.0	2480	386.77	64.06	50.53	1.08	402.60	0	443.13	176.00	0.44
32	Pachpahra	Panwari	7.13	1668.0	2780	348.70	55.58	198.75	2.72	420.90	0	570.75	166.00	0.84
33	Bhujpura	Panwari	7.58	490.8	818	116.23	14.47	22.14	0.00	298.90	0	70.90	25.50	0.73
34	Dadri	Panwari	7.42	1932.0	3220	204.41	134.89	216.75	273.00	677.10	0	428.95	211.00	1.19
35	Tolapanter	Panwari	7.63	612.0	1020	100.20	41.27	63.97	0.00	414.80	0	109.90	43.00	1.40
36	Nakra	Panwari	7.71	428.4	714	66.13	36.44	33.37	1.54	420.90	0	21.27	5.30	0.84
37	Saudhi	Panwari	7.72	477.0	795	74.15	41.30	33.09	3.19	439.20	0	35.45	10.70	0.73
38	Masudpura	Panwari	7.88	330.6	551	64.13	23.05	24.78	1.08	347.70	0	21.27	5.40	0.66
39	Baidaun	Panwari	7.90	405.6	676	52.10	38.90	47.01	1.17	469.70	0	14.18	2.10	1.04
40	Rupnaul	Panwari	7.84	393.0	655	56.11	38.89	36.67	1.00	427.00	0	17.73	3.50	1.08
41	Dharwar	Panwari	7.96	369.0	615	46.09	30.38	47.07	1.16	384.30	0	24.82	6.10	0.82

42	Kashipura	Panwari	8.01	228.0	380	44.09	14.56	18.83	0.00	231.80	0	17.73	6.80	0.70
43	Teiya	Panwari	7.93	343.8	573	56.11	23.06	42.44	0.00	353.80	0	28.36	5.70	1.56
44	Kilhauha	Panwari	7.74	525.0	875	56.11	32.80	90.87	0.00	475.80	0	49.63	22.80	2.14
45	Mahua Itaura	Panwari	7.88	964.8	1608	88.18	57.12	259.64	1.04	725.90	0	198.52	35.60	1.32
46	Vijaypur	Panwari	7.86	435.6	726	72.14	21.83	55.08	0.00	408.70	0	28.36	5.50	0.78
47	Chandao	Kabrai	7.22	1362.0	2270	226.45	50.86	264.50	1.44	488.00	0	404.13	164.00	1.70
48	Pachpahra	Kabrai	7.76	547.2	912	130.26	19.32	36.95	3.86	378.20	0	70.90	33.80	1.14
49	Nanora	Kabrai	8.01	622.8	1038	104.21	29.09	81.24	0.00	433.10	0	67.36	39.60	1.70
50	Atrar Maaf	Kabrai	7.53	411.6	686	76.15	18.17	55.66	1.00	390.40	0	21.27	6.10	1.03
51	Kaimaha	Kabrai	7.65	284.4	474	58.12	13.32	22.21	0.00	237.90	0	17.73	5.80	0.96
52	Pipra Maaf	Kabrai	7.34	576.0	960	120.24	20.55	55.88	0.00	286.70	0	116.99	29.30	0.87
53	Sijaria	Kabrai	7.40	563.4	939	134.27	18.10	39.20	0.00	231.80	0	116.99	26.80	0.83
54	Dhikwaha	Kabrai	7.39	625.2	1042	138.28	15.66	27.84	1.37	244.00	0	116.99	44.20	0.84
55	Srinagar	Kabrai	7.76	913.2	1522	96.19	51.02	170.00	0.00	445.30	0	226.88	51.60	2.04
56	Sijahri	Kabrai	7.36	1200.0	2000	278.56	52.01	57.06	1.63	420.90	0	311.96	90.00	0.62
57	Salarpur	Kabrai	7.17	943.8	1573	226.45	31.38	37.04	1.93	341.60	0	226.88	59.50	0.72
58	Palka	Kabrai	7.42	367.2	612	72.14	16.96	39.19	0.00	335.50	0	17.73	9.70	1.54
59	Mirtala	Kabrai	7.55	630.0	1050	80.16	53.47	72.25	2.91	414.80	0	99.26	59.20	0.77
60	Kumhrora	Kabrai	7.38	450.6	751	86.17	16.94	52.81	1.77	231.80	0	85.08	46.00	2.50
61	Paswara	Kabrai	7.75	439.2	732	80.16	25.47	45.09	0.00	414.80	0	24.82	13.90	1.09
62	Ratauli	Kabrai	7.78	501.6	836	80.16	24.25	66.49	0.00	427.00	0	70.90	24.40	2.22
63	Kidari	Kabrai	7.28	589.2	982	116.23	58.30	24.73	1.00	640.50	0	28.36	0.00	0.54
64	Kali Pahari	Kabrai	7.48	544.8	908	102.20	31.53	51.96	0.00	475.80	0	46.09	20.30	0.97
65	Gugaura	Kabrai	7.71	565.8	943	74.15	40.09	77.81	0.00	500.20	0	63.81	11.30	1.11
66	Baghwa	Kabrai	7.73	718.8	1198	78.16	42.52	119.25	1.08	500.20	0	116.99	35.20	1.38
67	Pahra	Kabrai	7.82	634.2	1057	62.12	43.75	112.75	0.00	469.70	0	102.81	40.60	1.44
68	Kabrai	Kabrai	7.86	581.4	969	54.11	30.37	135.00	1.13	488.00	0	67.36	26.30	2.12
69	Dharaon	Kabrai	7.67	419.4	699	78.16	24.26	46.60	0.00	414.80	0	17.73	5.40	0.97
70	Bilbai	Kabrai	7.25	1512.0	2520	254.51	108.05	108.50	2.05	536.80	0	457.31	170.00	0.92
71	Mahoba	Kabrai	7.74	760.8	1268	110.22	54.65	75.19	0.00	494.10	0	141.80	47.80	0.47
72	Kauhari	Kabrai	7.92	1692.0	2820	50.10	30.38	636.00	1.97	738.10	0	134.71	790.00	2.20
73	Kaneri	Kabrai	7.72	666.0	1110	100.20	40.06	81.55	1.90	408.70	0	106.35	51.40	0.54
74	Parsaha	Kabrai	7.84	482.4	804	80.16	23.04	63.82	1.02	469.70	0	35.45	3.50	0.73
75	Banri	Kabrai	7.99	1163.4	1939	36.07	20.65	416.50	1.39	762.50	0	77.99	290.00	1.88
76	Gaihra	Kabrai	8.24	591.6	986	42.08	35.26	167.50	0.00	640.50	0	31.91	14.20	1.68
77	Ganj	Kabrai	7.02	1260.0	2100	316.63	19.10	95.50	1.27	366.00	0	283.60	198.00	1.28
78	Gopalpura	Kabrai	7.34	414.0	690	60.12	26.71	63.94	0.00	445.30	0	17.73	6.00	3.45
79	Naredi	Charkhari	7.71	568.8	948	106.21	27.87	64.08	0.00	390.40	0	88.63	25.30	1.08
80	Swasa Maf	Charkhari	7.73	390.0	650	84.17	13.29	45.46	0.00	378.20	0	21.27	5.60	2.28
81	Bari	Charkhari	7.80	862.2	1437	76.15	41.30	140.75	45.50	567.30	0	124.08	69.80	2.60
82	Bambhauri Kalan	Charkhari	7.56	430.8	718	56.11	25.50	79.88	0.00	457.50	0	14.18	2.80	1.20
83	Kakun	Charkhari	7.51	513.6	856	56.11	32.80	100.50	1.15	579.50	0	17.73	4.70	1.00
84	Bamrara	Charkhari	7.57	428.4	714	54.11	25.50	91.17	1.06	475.80	0	17.73	1.00	0.64
85	Imaliya Dang	Charkhari	7.08	1398.0	2330	378.76	37.28	80.73	1.08	408.70	0	301.33	147.00	0.51
86	Karahra Kalan	Charkhari	7.31	400.8	668	90.18	12.07	58.46	0.00	390.40	0	21.27	19.50	1.44

87	Chhikahra	Charkhari	7.44	493.8	823	88.18	25.46	77.47	1.25	463.60	0	46.09	26.50	0.90
88	Charkhari	Charkhari	7.55	661.2	1102	82.16	25.47	113.25	13.70	396.50	0	170.16	33.40	0.00
89	Jataura	Charkhari	7.43	637.2	1062	76.15	46.17	104.75	1.24	579.50	0	95.72	35.80	0.53
90	Kharela	Charkhari	7.48	2016.0	3360	144.29	137.40	395.50	2.52	628.30	0	638.10	217.00	0.92
91	Pahretha	Charkhari	7.62	477.6	796	42.08	29.17	109.25	0.00	518.50	0	14.18	3.40	0.90
92	Punniyan	Charkhari	7.68	1042.8	1738	32.06	29.18	349.50	1.06	756.40	0	49.63	189.50	1.00
93	Dhawari	Charkhari	7.40	705.0	1175	52.10	38.90	149.00	1.32	707.60	0	53.18	11.00	1.05
94	Gudha	Charkhari	7.63	471.6	786	76.15	30.34	71.76	0.00	500.20	0	28.36	3.30	0.78
95	Jarauli	Charkhari	7.62	472.2	787	60.12	42.54	65.28	1.80	445.30	0	31.91	7.80	1.05
96	Gaurahari	Charkhari	7.34	576.0	960	128.26	25.41	48.77	0.00	384.30	0	77.99	31.30	0.61
97	Bapretha	Charkhari	7.69	1147.2	1912	40.08	20.65	443.50	0.00	713.70	0	53.18	426.00	2.02
98	Bhatewara Kalan	Charkhari	7.55	553.8	923	70.14	37.66	97.39	0.00	524.60	0	63.81	2.00	0.94
99	Gorkha	Charkhari	6.90	2130.0	3550	585.17	69.90	80.86	1.00	207.40	0	538.84	232.00	0.66
100	Chhedimau	Charkhari	7.06	566.4	944	124.25	21.76	42.57	2.26	298.90	0	102.81	73.00	0.57
101	Luhari	Charkhari	7.17	541.2	902	108.22	15.70	53.85	0.00	341.60	0	85.08	32.30	0.68
102	Akathauha	Charkhari	7.63	480.0	800	78.16	35.21	46.75	0.00	384.30	0	46.09	31.10	1.74
103	Asthaun	Charkhari	7.62	523.2	872	54.11	32.81	94.07	0.00	475.80	0	42.54	18.10	2.02
104	Supa	Charkhari	7.56	495.0	825	80.16	33.99	58.13	0.00	524.60	0	24.82	1.50	1.88
105	Mitlain Ganj	Charkhari	7.35	357.6	596	64.13	15.75	51.67	0.00	372.10	0	17.73	7.10	0.41

All constituents in mg/l

Annexure III: Chemical Results (Heavy Metal), Mahoba District, UP

Sl.No.	Village	Block	Cr	Cu	Fe	Mn	Zn	As
1	Bamhauri Khurd	Jaitpur	-	-	-	-	-	BDL
2	Kulpahar	Jaitpur	BDL	BDL	0.339	BDL	0.178	BDL
3	Jaitpur Block	Jaitpur	BDL	0.006	BDL	0.0011	0.559	BDL
4	Sagvan	Jaitpur	BDL	BDL	0.483	0.16	BDL	BDL
5	Dhawwra	Jaitpur	BDL	BDL	0.389	0.314	0.378	BDL
6	Saginia Maf	Jaitpur	BDL	BDL	0.193	BDL	0.242	BDL
7	Leva	Jaitpur	BDL	BDL	0.694	0.043	0.026	BDL
8	Sirmaur	Jaitpur	BDL	BDL	0.423	0.881	0.068	BDL
9	Bahadurur	Panwari	BDL	BDL	0.425	0.006	0.653	BDL
10	Manki	Panwari	BDL	BDL	0.924	0.028	0.101	BDL
11	Gutai	Panwari	BD;	BDL	0.632	1.045	0.155	BDL
12	Nakra	Panwari	BDL	0.024	0.488	0.01	0.198	BDL
13	Rupnaul	Panwari	BDL	BDL	1.56	0.014	1.396	BDL
14	Kashipura	Panwari	BDL	BDL	1.29	0.019	0.89	BDL
15	Kilhaua	Panwari	BDL	BDL	0.227	BDL	0.096	BDL
16	Baura	Jaitpur	BDL	BDL	2.58	2.54	0.207	BDL
17	Pach Pahara	Kabrai	BDL	BDL	BDL	0.396	0.446	BDL
18	Naredi	Charkhari	BDL	0.02	0.563	0.031	1.239	BDL
19	Kaimha	Kabrai	BDL	BDL	0.364	BDL	0.08	BDL

20	Srinagar	Kabrai	BDL	BDL	0.247	BDL	BDL	BDL
21	Salarpur	Kabrai	BDL	BDL	0.315	BDL	0.046	BDL
22	Kundaora	Kabrai	BDL	BDL	1.831	0.379	0.035	BDL
23	Ratauli	Kabrai	BDL	BDL	1	0.035	0.121	BDL
24	Kabrai	Kabrai	BDL	BDL	0.355	0.029	0.032	BDL
25	Bilbai	Kabrai	BDL	BDL	0.323	1.24	BDL	BDL
26	Kabrai Block	Kabrai	BDL	BDL	0.373	0.008	0.933	BDL
27	Parsaha	Kabrai	BDL	BDL	0.362	0.007	0.396	BDL
28	Bamhori Kala	Charkhari	BDL	BDL	0.441	BDL	0.063	BDL
29	Chhikahar	Charkhari	BDL	BDL	0.218	BDL	0.212	BDL
30	Charkhari	Charkhari	BDL	BDL	0.445	0.044	0.193	BDL
31	Kharela	Charkhari	BDL	BDL	0.631	0.024	0.161	BDL
32	Basauth	Charkhari	BDL	BDL	2.73	0.329	0.073	BDL
33	Jarauli	Charkhari	BDL	BDL	0.452	BDL	0.083	BDL
34	Gorkha	Charkhari	BDL	BDL	0.144	BDL	0.072	BDL
35	Akathauha	Charkhari	BDL	BDL	1.958	0.036	0.398	BDL
36	Supa	Charkhari	BDL	0.02	0.45	BDL	0.315	BDL

All constituents in ppm

Annexure IV: Value of Chmical Parameters (Phreatic Aquifer), Mahoba, UP

Sl. No.	Village	Block	CO3 (meq/l)	HCO3 (meq/l)	Ca (meq/l)	Mg (meq/l)	Na (meq/l)	RSC	SAR
1	Ladpur	Jaitpur	0.00	6.60	2.90	2.80	2.24	0.90	1.45
2	Bamhauri Khurd	Jaitpur	0.00	7.30	4.20	2.40	3.42	0.70	2.14
3	Kulpahar	Jaitpur	0.00	6.80	2.80	2.60	2.25	1.40	1.48
4	Belatal	Jaitpur	0.00	7.00	5.40	2.19	2.33	-0.59	1.41
5	Jaitpur	Jaitpur	0.00	12.40	12.20	4.18	9.21	-3.98	4.58
6	Mawaiya	Jaitpur	0.00	7.00	4.00	1.50	2.68	1.50	1.75
7	Ajnar	Jaitpur	0.00	6.20	8.20	1.99	1.77	-3.99	0.99
8	Tikariya	Jaitpur	0.00	6.70	12.10	4.99	2.12	-10.39	1.04
9	Syavan	Jaitpur	0.00	2.90	4.40	1.79	1.85	-3.29	1.17
10	Indrahata	Jaitpur	0.00	4.10	3.20	1.00	1.23	-0.10	0.86
11	Bhagari	Jaitpur	0.00	7.30	8.70	2.49	1.39	-3.89	0.76
12	Ghaghaura	Jaitpur	0.00	2.40	3.50	2.00	0.96	-3.10	0.63
13	Bijauri	Jaitpur	0.00	7.70	4.50	3.00	1.49	0.20	0.90
14	Baghaura	Jaitpur	0.00	6.80	10.40	4.89	3.31	-8.49	1.67
15	Saguniya Maph	Jaitpur	0.00	7.30	3.90	4.60	1.26	-1.20	0.74
16	Akona	Jaitpur	0.00	7.80	8.40	3.29	2.37	-3.89	1.28
17	Mahua Bandh	Jaitpur	0.00	4.60	3.20	1.30	0.86	0.10	0.59
18	Leva	Jaitpur	0.00	7.30	7.10	2.09	2.16	-1.89	1.24
19	Rikhawaha	Jaitpur	0.00	6.90	7.90	2.09	1.95	-3.09	1.10

20	Rawatpura	Jaitpur	0.00	7.60	4.90	3.30	0.69	-0.60	0.41
21	Mudhari	Jaitpur	0.00	6.80	8.00	2.79	2.35	-3.99	1.30
22	Sirmaur	Jaitpur	0.00	13.60	11.70	7.69	9.47	-5.79	4.51
23	Sugira	Jaitpur	0.00	8.00	7.30	4.39	6.25	-3.69	3.38
24	Baura	Jaitpur	0.00	7.20	6.30	1.49	0.99	-0.59	0.59
25	Bharwara	Panwari	0.00	8.00	5.00	3.80	2.91	-0.80	1.69
26	Panwari	Panwari	0.00	8.40	7.30	5.40	2.32	-4.30	1.23
27	Bahadurpur Kalan	Panwari	0.00	7.90	3.80	4.80	2.52	-0.70	1.47
28	Mahob kanth	Panwari	0.00	5.80	2.50	2.50	0.66	0.80	0.44
29	Manki	Panwari	0.00	7.10	3.60	2.80	2.59	0.70	1.63
30	Rurikalan	Panwari	0.00	9.80	3.20	2.40	6.14	4.20	3.99
31	Ghutai	Panwari	0.00	6.60	19.30	5.27	2.20	-17.97	0.99
32	Pachpahra	Panwari	0.00	6.90	17.40	4.57	8.64	-15.07	3.99
33	Bhujpura	Panwari	0.00	4.90	5.80	1.19	0.96	-2.09	0.59
34	Dadri	Panwari	0.00	11.10	10.20	11.10	9.42	-10.20	4.39
35	Tolapanter	Panwari	0.00	6.80	5.00	3.40	2.78	-1.60	1.63
36	Nakra	Panwari	0.00	6.90	3.30	3.00	1.45	0.60	0.92
37	Saudhi	Panwari	0.00	7.20	3.70	3.40	1.44	0.10	0.88
38	Masudpura	Panwari	0.00	5.70	3.20	1.90	1.08	0.60	0.72
39	Baidaun	Panwari	0.00	7.70	2.60	3.20	2.04	1.90	1.32
40	Rupnaul	Panwari	0.00	7.00	2.80	3.20	1.59	1.00	1.02
41	Dharwar	Panwari	0.00	6.30	2.30	2.50	2.05	1.50	1.38
42	Kashipura	Panwari	0.00	3.80	2.20	1.20	0.82	0.40	0.60
43	Teiya	Panwari	0.00	5.80	2.80	1.90	1.85	1.10	1.25
44	Kilhauha	Panwari	0.00	7.80	2.80	2.70	3.95	2.30	2.58
45	Mahua Itaura	Panwari	0.00	11.90	4.40	4.70	11.29	2.80	6.50
46	Vijaypur	Panwari	0.00	6.70	3.60	1.80	2.39	1.30	1.57
47	Chandao	Kabrai	0.00	8.00	11.30	4.19	11.50	-7.49	5.80
48	Pachpahra	Kabrai	0.00	6.20	6.50	1.59	1.61	-1.89	0.95
49	Nanora	Kabrai	0.00	7.10	5.20	2.39	3.53	-0.49	2.13
50	Atrar Maaf	Kabrai	0.00	6.40	3.80	1.50	2.42	1.10	1.60
51	Kaimaha	Kabrai	0.00	3.90	2.90	1.10	0.97	-0.10	0.68
52	Pipra Maaf	Kabrai	0.00	4.70	6.00	1.69	2.43	-2.99	1.46
53	Sijaria	Kabrai	0.00	3.80	6.70	1.49	1.70	-4.39	1.01
54	Dhikwaha	Kabrai	0.00	4.00	6.90	1.29	1.21	-4.19	0.72
55	Srinagar	Kabrai	0.00	7.30	4.80	4.20	7.39	-1.70	4.27
56	Sijahri	Kabrai	0.00	6.90	13.90	4.28	2.48	-11.28	1.20
57	Salarpur	Kabrai	0.00	5.60	11.30	2.58	1.61	-8.28	0.83
58	Palka	Kabrai	0.00	5.50	3.60	1.40	1.70	0.50	1.14
59	Mirtala	Kabrai	0.00	6.80	4.00	4.40	3.14	-1.60	1.85
60	Kumhrora	Kabrai	0.00	3.80	4.30	1.39	2.30	-1.89	1.49
61	Paswara	Kabrai	0.00	6.80	4.00	2.10	1.96	0.70	1.25
62	Ratauli	Kabrai	0.00	7.00	4.00	2.00	2.89	1.00	1.85
63	Kidari	Kabrai	0.00	10.50	5.80	4.80	1.08	-0.10	0.60

64	Kali Pahari	Kabrai	0.00	7.80	5.10	2.60	2.26	0.10	1.36
65	Gugaura	Kabrai	0.00	8.20	3.70	3.30	3.38	1.20	2.08
66	Baghwa	Kabrai	0.00	8.20	3.90	3.50	5.18	0.80	3.14
67	Pahra	Kabrai	0.00	7.70	3.10	3.60	4.90	1.00	3.05
68	Kabrai	Kabrai	0.00	8.00	2.70	2.50	5.87	2.80	3.89
69	Dharaon	Kabrai	0.00	6.80	3.90	2.00	2.03	0.90	1.30
70	Bilbai	Kabrai	0.00	8.80	12.70	8.89	4.72	-12.79	2.19
71	Mahoba	Kabrai	0.00	8.10	5.50	4.50	3.27	-1.90	1.84
72	Kauhari	Kabrai	0.00	12.10	2.50	2.50	27.65	7.10	18.49
73	Kaneri	Kabrai	0.00	6.70	5.00	3.30	3.55	-1.60	2.09
74	Parsaha	Kabrai	0.00	7.70	4.00	1.90	2.77	1.80	1.78
75	Banri	Kabrai	0.00	12.50	1.80	1.70	18.11	9.00	13.24
76	Gaihra	Kabrai	0.00	10.50	2.10	2.90	7.28	5.50	4.87
77	Ganj	Kabrai	0.00	6.00	15.80	1.57	4.15	-11.37	2.03
78	Gopalpura	Kabrai	0.00	7.30	3.00	2.20	2.78	2.10	1.84
79	Naredi	Charkhari	0.00	6.40	5.30	2.29	2.79	-1.19	1.68
80	Swasa Maf	Charkhari	0.00	6.20	4.20	1.09	1.98	0.91	1.30
81	Bari	Charkhari	0.00	9.30	3.80	3.40	6.12	2.10	3.74
82	Bambhauri Kalan	Charkhari	0.00	7.50	2.80	2.10	3.47	2.60	2.33
83	Kakun	Charkhari	0.00	9.50	2.80	2.70	4.37	4.00	2.85
84	Bamrara	Charkhari	0.00	7.80	2.70	2.10	3.96	3.00	2.68
85	Imaliya Dang	Charkhari	0.00	6.70	18.90	3.07	3.51	-15.27	1.62
86	Karahra Kalan	Charkhari	0.00	6.40	4.50	0.99	2.54	0.91	1.66
87	Chhikahra	Charkhari	0.00	7.60	4.40	2.10	3.37	1.10	2.11
88	Charkhari	Charkhari	0.00	6.50	4.10	2.10	4.92	0.30	3.12
89	Jataura	Charkhari	0.00	9.50	3.80	3.80	4.55	1.90	2.74
90	Kharela	Charkhari	0.00	10.30	7.20	11.31	17.20	-8.21	8.29
91	Pahretha	Charkhari	0.00	8.50	2.10	2.40	4.75	4.00	3.26
92	Punniyan	Charkhari	0.00	12.40	1.60	2.40	15.20	8.40	10.74
93	Dhawari	Charkhari	0.00	11.60	2.60	3.20	6.48	5.80	4.17
94	Gudha	Charkhari	0.00	8.20	3.80	2.50	3.12	1.90	1.97
95	Jarauli	Charkhari	0.00	7.30	3.00	3.50	2.84	0.80	1.78
96	Gaurahari	Charkhari	0.00	6.30	6.40	2.09	2.12	-2.19	1.24
97	Bapretha	Charkhari	0.00	11.70	2.00	1.70	19.28	8.00	13.90
98	Bhatewara Kalan	Charkhari	0.00	8.60	3.50	3.10	4.23	2.00	2.64

99	Gorkha	Charkhari	0.00	3.40	29.20	5.75	3.52	-31.55	1.45
100	Chhedimau	Charkhari	0.00	4.90	6.20	1.79	1.85	-3.09	1.10
101	Luhari	Charkhari	0.00	5.60	5.40	1.29	2.34	-1.09	1.46
102	Akathauha	Charkhari	0.00	6.30	3.90	2.90	2.03	-0.50	1.26
103	Asthaun	Charkhari	0.00	7.80	2.70	2.70	4.09	2.40	2.68
104	Supa	Charkhari	0.00	8.60	4.00	2.80	2.53	1.80	1.57
105	Mitlain Ganj	Charkhari	0.00	6.10	3.20	1.30	2.25	1.60	1.54

Annexure V: Chemical Results (Basic), Deeper Aquifer, Mahoba District, UP

Sl. No.	Name	Block	Sample Source	pH	EC at 25°C	HCO_3	Cl	F	NO_3	SO_4	Ca	Mg	Na	K	PO4
1	Bila Dakshin	Kabrai	SDT	7.94	2684	261.08	567.2	4.4	4	276	176.4	50.16	310	4	BDL
2	Paswara	Kabrai	Drilling (EW)	8.04	1085	305	141.8	2.4	1	82	76.4	2.16	151	18	BDL
3	Geundi	Kabrai	Drilling (EW)	7.78	1378	624.64	92.17	0.6	10	36	90.4	63.36	101	2	BDL
4	Utiyan	Kabrai	Drilling (EW)	8.02	1063	479.46	70.9	0.9	18	21	79.6	32.4	109	1	BDL
5	Parsaha	Kabrai	Drilling (EW)	7.85	812	414.8	35.45	0.7	10	8	81.2	16.56	68	2	BDL
6	Swasa Maf	Charkhari	SDT	7.62	578	285.48	28.36	1.9	3	8	54	3.6	64	1	BDL
7	Jataura	Charkhari	Drilling (EW)	8.18	944	436.76	56.72	0.8	15	20	100.4	23.76	67	2	BDL
8	Ramnagar	Charkhari	Drilling (EW)	8.3	640	292.8	35.45	1.7	19	14	36.4	2.16	93	28	BDL
9	Jarauli	Charkhari	Drilling (EW)	7.88	452	213.5	28.36	0.4	9	6	86	0	5	1	BDL
10	Imaliya Dang	Charkhari	Drilling (EW)	7.92	900	447.74	42.54	1.8	11	13	95.6	17.04	67	0	BDL
11	Bari	Charkhari	Drilling (EW)	8.2	571	305	21.27	1.4	2	8	62	10.8	43	1	BDL
12	Dhorra	Jaitpur	Drilling (EW)	8.06	518	195.2	35.45	0.6	42	15	80	2.4	22	1	BDL
13	Nakra	Panwari	SDT	7.75	689	311.1	42.54	0.9	21	14	84	12.96	37	3	BDL
14	Churari	Panwari	Drilling (EW)	7.52	775	366	35.45	1	27	19	70	1.2	97	1	BDL
15	Lilwaha	Panwari	Drilling (EW)	7.98	568	183	63.81	0.8	20	32	40	1.2	78	3	BDL
16	Kotra	Panwari	Drilling (EW)	8.18	872	286.7	99.26	1.7	28	34	82.4	0.96	100	7	BDL
17	Saundhi	Panwari	Drilling (EW)	7.36	873	323.3	85.08	1.7	1	43	44	4.8	137	8	BDL

All constituents in mg/l

Annexure VI: Chemical Results (Heavy Metal), Deeper Aquifer, Mahoba, UP

Sl.No.	Name	Block	Sample Source	Cr	Fe	Mn	Cu	Zn	As	U (ppb)
1	Bila Dakshin	Kabrai	APT	0.01708	2.64	0.14	0.00	0.05	0.00025	22.2
2	Paswara	Kabrai	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	16.52
3	Geundi	Kabrai	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	0
4	Utiyan	Kabrai	Drilling (EW)	BDL	BDL	BDL	BDL	0.94	BDL	0

5	Parsaha	Kabrai	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	3.61
6	Mawai	Kabrai	APT	BDL	BDL	BDL	BDL	BDL	BDL	3.72
7	Gudha	Charkhari	Drilling (EW)	BDL	BDL	0.26	BDL	BDL	BDL	0
8	Jataura	Charkhari	Drilling (EW)	BDL	0.41	BDL	BDL	BDL	BDL	0
9	Ramnagar	Charkhari	Drilling (EW)	BDL	1.11	0.53	BDL	BDL	BDL	6.52
10	Jarauli	Charkhari	Drilling (EW)	BDL	0.74	BDL	BDL	BDL	BDL	4.12
11	Imaliya Dang	Charkhari	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	0
12	Bari	Charkhari	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	3.41
13	Swasa Maf	Charkhari	APT	BDL	0.34	0.32	BDL	BDL	BDL	15.01
14	Gaurhari	Charkhari	APT	BDL	0.63	BDL	BDL	BDL	BDL	52.47
15	Mudari	Jaitpur	APT	BDL	0.54	BDL	BDL	BDL	BDL	13.94
16	Dhorra	Jaitpur	Drilling (EW)	0.04002	0.40	BDL	BDL	BDL	BDL	5.69
17	Baura	Jaitpur	APT	BDL	0.42	BDL	BDL	BDL	BDL	4.94
18	Baughra	Jaitpur	APT	0.11724	3.45	BDL	BDL	BDL	BDL	5.1
19	Dadri	Panwari	Drilling (EW)	0.41561	1.91	1.19	BDL	BDL	BDL	0
20	Churari	Panwari	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	6.11
21	Saundhi	Panwari	Drilling (EW)	BDL	BDL	BDL	BDL	BDL	BDL	4.41
22	Nakra	Panwari	APT	BDL	BDL	BDL	BDL	BDL	BDL	8.66

All constituents in mg/l except for Uranium (ppb)

Annexure VII: Value of Chemical Parameters, Deeper Aquifer, Mahoba, UP

Sl.No.	Name	Block	Sample Source	SAR	RSC
1	Bila Dakshin	Kabrai	SDT	7.10	-8.72
2	Paswara	Kabrai	Drilling (EW)	4.64	1.00
3	Geundi	Kabrai	Drilling (EW)	2.48	0.44
4	Utiyan	Kabrai	Drilling (EW)	2.95	1.18
5	Parsaha	Kabrai	Drilling (EW)	1.94	1.36
6	Swasa Maf	Charkhari	SDT	2.11	1.68
7	Jataura	Charkhari	Drilling (EW)	1.79	0.16
8	Ramnagar	Charkhari	Drilling (EW)	3.40	2.80
9	Jarauli	Charkhari	Drilling (EW)	0.15	-0.80
10	Imaliya Dang	Charkhari	Drilling (EW)	1.85	1.14
11	Bari	Charkhari	Drilling (EW)	1.32	1.00
12	Dhorra	Jaitpur	Drilling (EW)	0.67	-1.00
13	Nakra	Panwari	SDT	1.06	-0.18
14	Churari	Panwari	Drilling (EW)	3.06	2.40
15	Lilwaha	Panwari	Drilling (EW)	2.82	0.90
16	Kotra	Panwari	Drilling (EW)	3.04	0.50
17	Saundhi	Panwari	Drilling (EW)	4.69	2.70