



केन्द्रीय 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

Varanasi District
Uttar Pradesh

उत्तरी क्षेत्र, लखनऊ
Northern Region, Lucknow



**CENTRAL GROUND WATER BOARD
Ministry of Jal Shakti
Govt. of India**

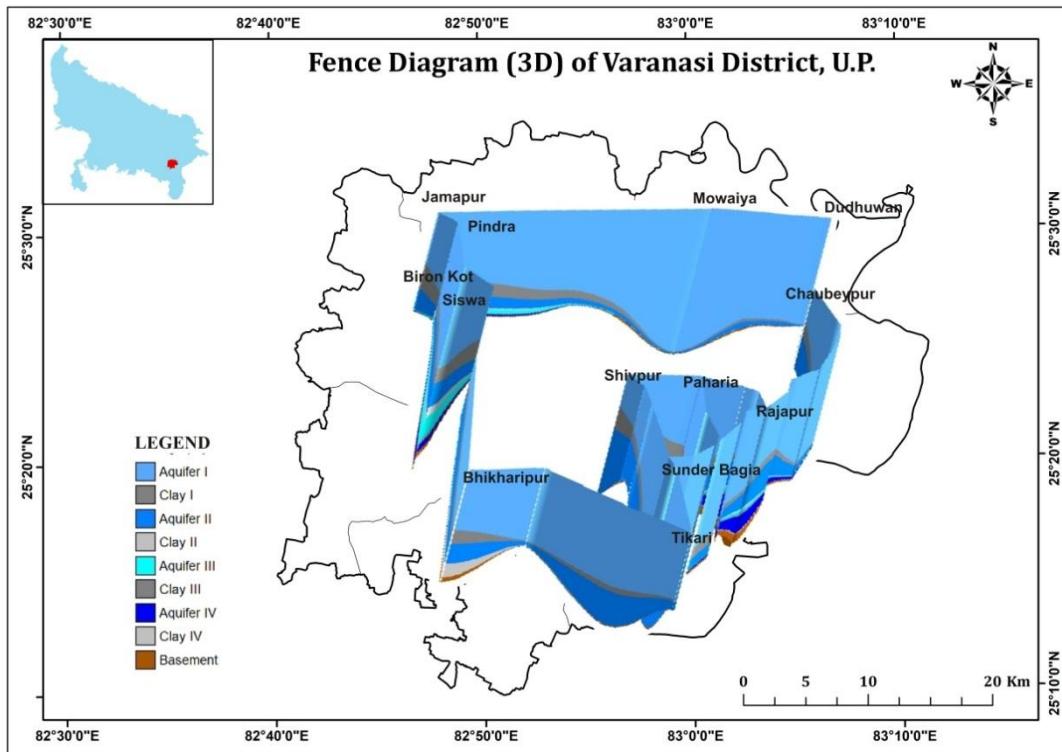
**AQUIFER MAPPING AND GROUND WATER
MANAGEMENT PLAN
VARANASI DISTRICT, UTTAR PRADESH**

Report on

By

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UTTAR PRADESH
(AAP 2016-2017)**

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VARANASI DISTRICT AT A GLANCE

District Profile			
District Name	Varanasi	Latitude	Longitude
		25°10' to 25°35' N	82° 40' to 83°12' E
1	Area (Sq. Km)		
	Geographical Area		1535 sq km
2	Administrative		
	Total Number of blocks	08	
	Number of Tehsil	03	
	Total Number of Panchayat	702	
	Total Number of Villages	1327	
	Total Population	3676841 Male: 1921857 Female: 1754984 Population Growth Rate (Decadal) 17.32%	
3	Land Use (Sq. Km)		
	Area under Forest	28.37	
	Net Sown Area	1007	
	Gross Sown Area	1639	
	Net irrigated area	898	
	Gross irrigated Area	1378	
4	Rainfall		
		1019 mm	
5	Geomorphology		
		Middle Gangetic Plains & Eastern Plains	
6	Major Physiographic Unit		
		Older & Younger Alluvium	
7	Major Drainages		
		Ganga, Gomti, Varuna, Nand	
8	Major Soil Types		
		Khadar & Bhanger	
9	Area under Principal Crops (sq km)		

	Rabi	684.72
	Kharif	833.94
10	Depth to Water level	
	Pre-monsoon Depth to water level during May' 2021	2.90 to 19.39 m bgl
	Post-monsoon Depth to water level during Nov' 2021	0.80 to 16.39 m bgl
11.	Number of Ground Water Monitoring Wells of CGWB (as on 31-03-2021)	
	No. of Dugwells	14
	No. of Piezometers	Nil
12.	Dynamic Ground Water Resources (Ham) as on 31 March, 2020	
	Annual Extractable GW Resources	: 53394.36
	Net Ground Water availability for future use	: 8690.25
	Gross Annual Ground Water Draft	: 48703.44
	Projected Demand for Domestic/Irrigation Uses up to 2025	: 10946.31
	Stage of Ground Water Development	: 91.21%
13.	Ground Water Control and Regulation	
	Number of Over Exploited Blocks	: 02
	Number of Semi Critical Blocks	: 05
	Number of Critical Blocks	: 00

	Number of Safe Blocks	: 01
	Number of blocks notified	: None
14.	Major Ground Water Problems and Issues	: Dependency on ground water for Irrigation; Rapid Urbanization has put stress on groundwater resources

AQUIFER MAPPING AND MANAGEMENT PLAN OF VARANASI DISTRICT, UTTAR PRADESH

1.0 Introduction

Central Ground Water Board (CGWB), Northern Region Lucknow has implemented Aquifer Mapping Program /Project in Varanasi district of Uttar Pradesh 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. The report prepared on “Aquifer Mapping and Management Plan, Varanasi District, U.P.” will be very useful for the planners, stakeholders and various executive agencies engaged in the development and management of ground water for agricultural, industrial and drinking purposes.

1.1 Objectives

The objectives of the project are:-

- i. To define the aquifer geometry, type of aquifers, groundwater regime behaviours, hydraulic characteristics and geochemistry of multi-layered alluvial aquifer systems on 1:50,000 scale
- ii. Intervention of new geophysical techniques and establishing the utility, efficacy and suitability of these techniques in different hydrogeological setup.
- iii. Finalizing the approach and methodology on which National Aquifer Mapping programme of the entire country can be implemented.
- iv. The experiences gained can be utilized to upscale the activities for micro level aquifer mapping.

1.2 Administrative Details

Varanasi one of the ancient cities and seat of learning in India is located on the left bank of the most sacred river Ganga. Varuna and Assi are the two streams bounding it from north and south. The city seems to have acquired its name from the combination of the names of these two streams and the district has been named after it.

Varanasi district covers an area of 1535 sq km and administratively the district comprises 03tehsils and 08 blocks. The area lies between North Latitude 25°10' to 25°35'N and East Longitude 82° 40' to 83°12' E (figure 1). It falls in the Survey of India degree sheets no. 63K and 63O. It is bounded by Jaunpur district in north and northwest, by Mirzapur and Sant Ravidas Nagar in south and southwest and in the east by Chandauli and Gazipur district. Historically, Varanasi is also very famous as 'Kashi'. Varanasi district is characterized by alluvial formations consisting of older and younger alluvium. According to the 2011 census Varanasi district has a population of 3,676,841. The district has a population density of 2,399 inhabitants per square kilometre (6,210/sq mi). Its population growth rate over the decade 2001-2011 was 17.32%. Varanasi has a sex ratio of 909 females for every 1000 males, and a literacy rate of 77.05%.

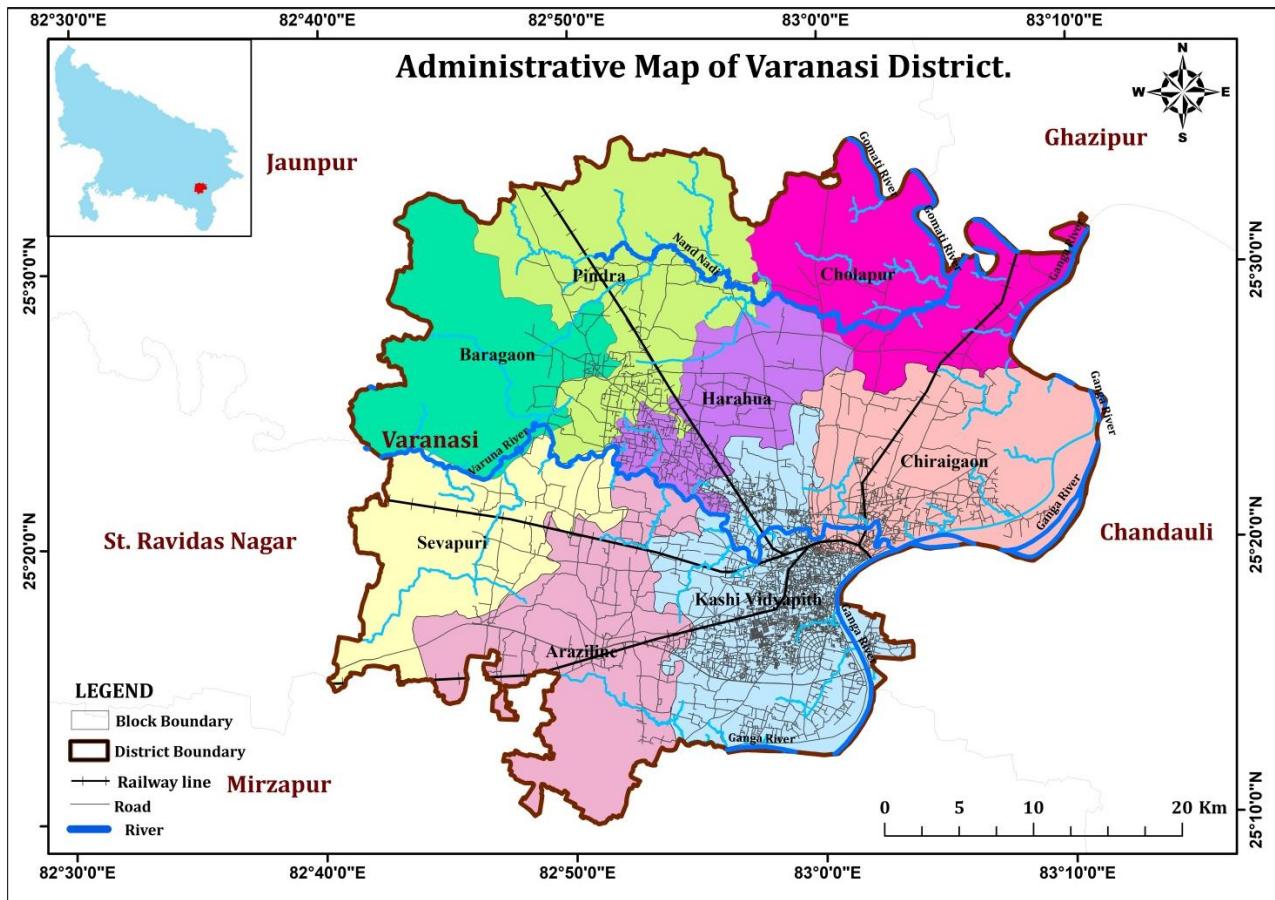


Figure 1: Administrative Map of Varanasi District

1.3. Climate

Varanasi is located on the banks of the holy river, Ganges. During summers, weather can be as hot as 45° C and humid too as Varanasi lies at the Tropic of cancer. Torrential rains and high humidity accompanies the monsoons that usually come in late June or early July for about two months. On the other hand, winters are pleasant and temperature dips down to about 7°C. In Varanasi, the climatic conditions are most favorable for the tourists between Octobers to April. The average annual rainfall in the district is 1019.00 mm.

1.4. Physiography

The district is characterized with alluvial formations and plain topographic features. The district area in general is more or less flat. River Ganga is most important stream apart from river Varuna. There is significant meandering in the area of the district where river Ganga has taken its course. The average elevation of the land surface is about 85 to 105 m amsl. The general slope of the tract is from west to east. The topography is influenced or modified by the existing rivers and streams.

1.5. Geomorphology

Geomorphologically the district is divided into following three units (figure-2).

- *Flood Plain:* It occurs on either side of river channel. The area is mostly covered by present rivers (Ganga and Varuna) and its adjacent smooth plains. It is comprised of coarse to fine sand, silt, and clay. The sand bar, point bars, River Island, is the landforms common in the area.
- *Newer Alluvial Plain:* It refers to old flood plain cycle of deposition. It is mostly seen along Ganga and Varuna River of the district. It is mostly consists of unconsolidated coarse to fine sand, silt and clay of varying amounts.
- *Older Alluvial Plain:* The older alluvial plain forms the western part of the Ganga river in the district. The older alluvium of the Ganga valley form slightly elevated land surface of the area. It gently slopes towards east besides north and south of water divide. It is mainly constituted of coarse to fine sand, silt and clay. Paleo-channels meander scars, old meander are the landforms common in the area.

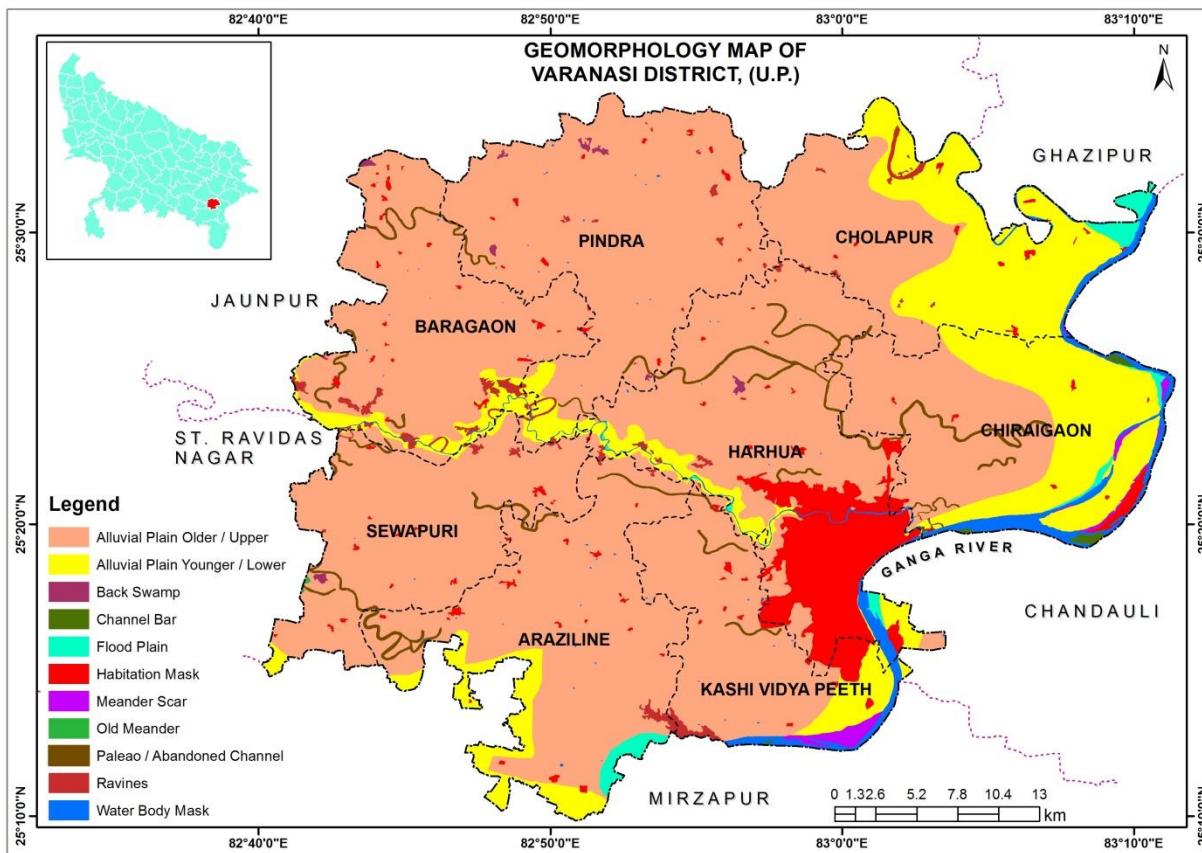


Figure 2: Geomorphological Map of Varanasi district

1.6. Drainage:

The drainage system of the district is controlled by river Ganga and its tributaries. The river Ganga flows in the east of city flowing in north-eastern direction along the NE and SW boundaries of the district. The Ganga with its tributaries, Gomti and Varuna, form the drainage pattern of the study area (figure-3). Ganga river is an important source of drinking water as well for irrigation. The river flow towards the east in Araziline development block and takes a turn towards the north where the city of Varanasi is located on high platform formed of pebble and kankar. From Chandrawati to Kaithi (in Cholapur development block) it flows northwards, resembling to its flow at Varanasi, thus Kaithi is known as Up- Kashi.

Gomti river is the biggest tributary of Ganga flowing at northern borders of the district, maintain its SE trend and ultimately joins river Ganga.

Nand river, a tributary of Gomti river flows towards SE and then turns east in an irregular course and joins Gomti near village Dhaura.

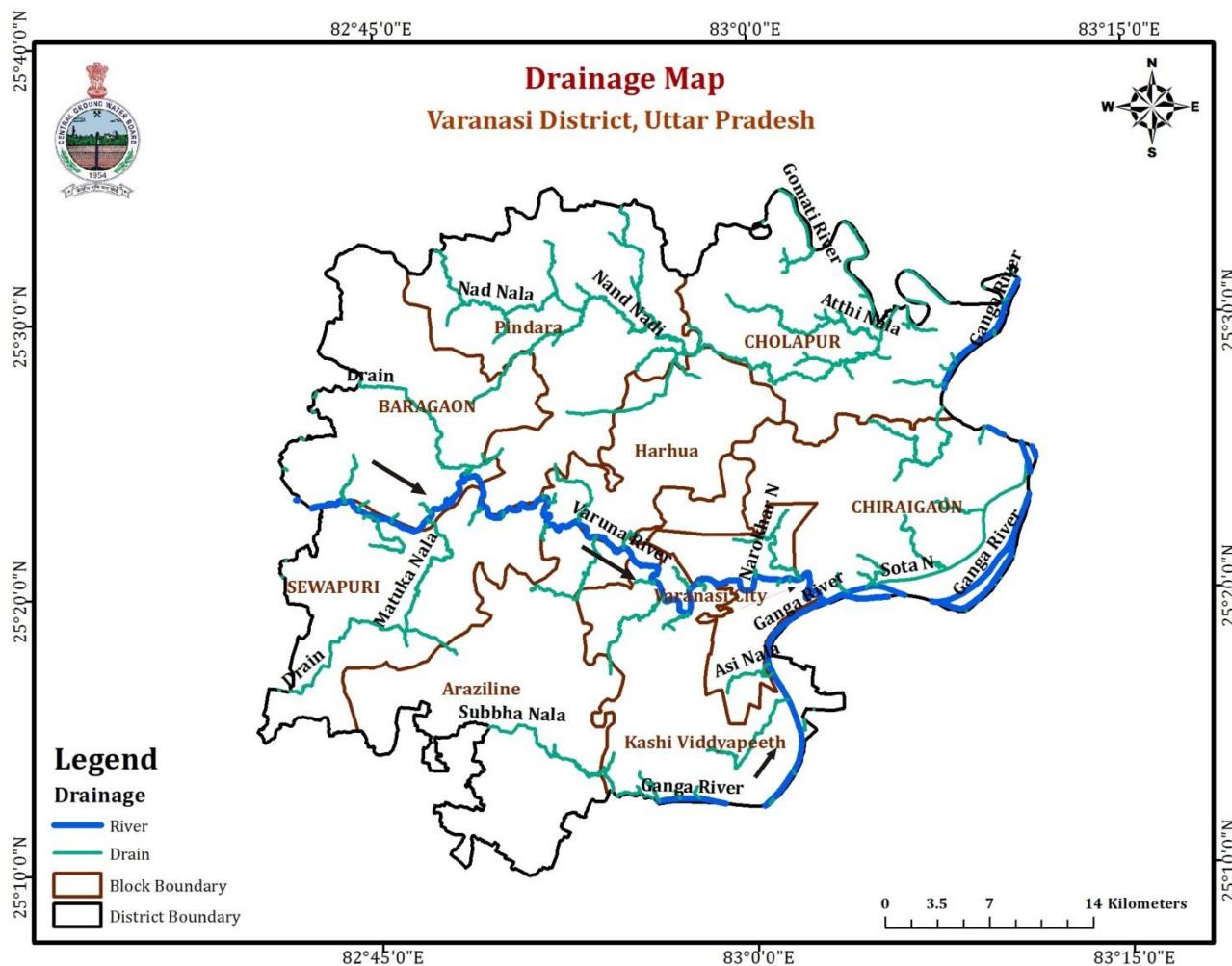


Figure-3: Drainage Map of Varanasi district

Basin and Sub-Basin:

The **Varuna-Gomati Interfluence** covers about 40.84% of the total area of the district.

The **Upper Ganga-Varuna plain** is spread over nearly 31.05% of the district. Varanasi is situated on the left bank of the Ganga river and lies in the heart of the Middle Ganga plain. Varuna river enters from the western side along the Dhaukalganj lying in Baragaon development block and drains Pindra and Harahua development blocks.

The **Ganga-Varuna interfluence** covers the areas of Sewapuri, Araziline and Kashi Vidyapeeth development blocks lying in the western and southern part of the district. It covers about 28.11% of the total areas of the district.

1.7. Geology

Geologically the district is characterized by quaternary alluvium consisting of older and younger alluvium (figure-4). The sediments are unconformable overlying the basement of the Vindhyan Super Group. The geological succession is given as follows-

Age	Formation	Lithology
Upper Pleistocene to Recent	Newer Alluvium	Clay, Sand and Kankar
Middle to Upper Pleistocene	Older Alluvium	Fairly consolidated clay with kankar, sand, fine to medium with some gravel.
-----Un conformity-----		
Upper Vindhyan	Kaimur Sandstone	Sandstones, grey to white, buff, arkosic with capping of laterites and Bauxite

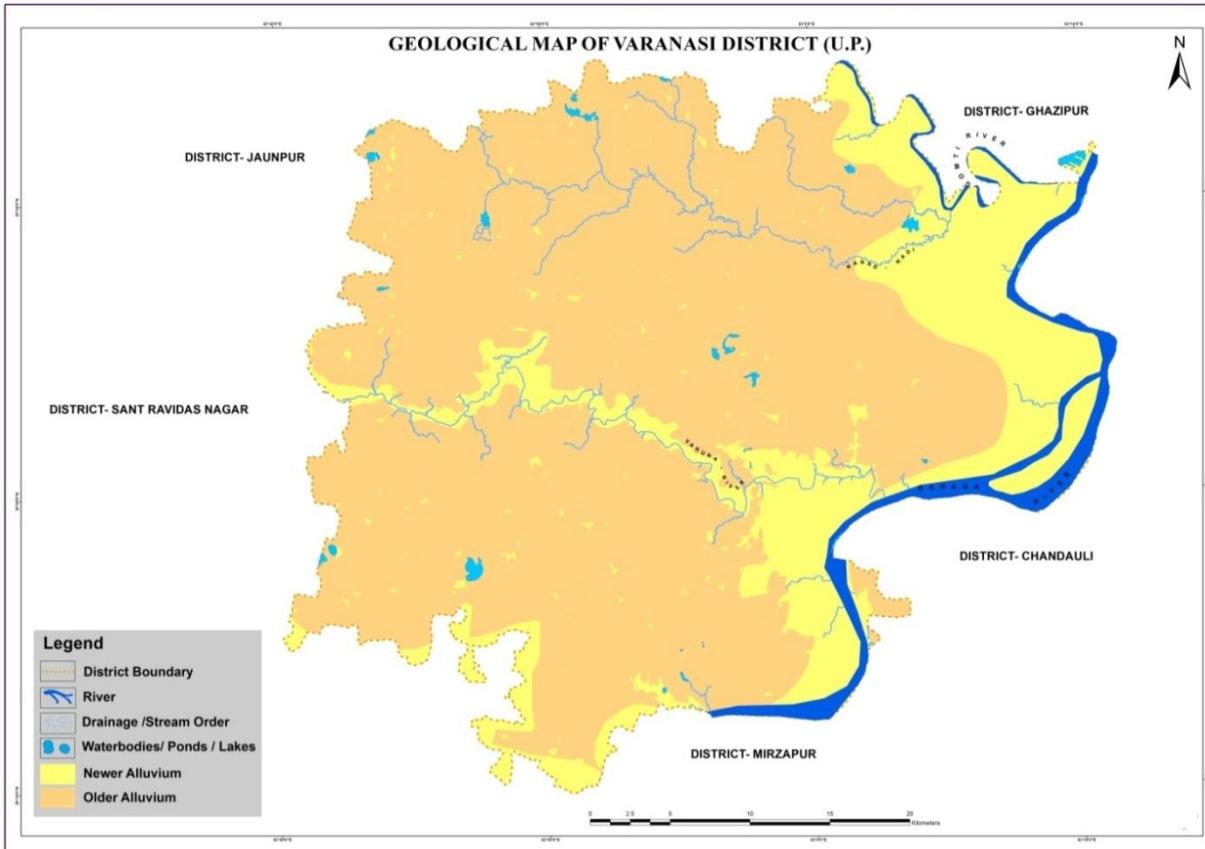


Figure 4: Geological Map of Varanasi district

1.8. Soil

In general, the soils of the district may broadly be divided into two major types:

(i) Khadar and (ii) Bhanger. Khadar, new or younger alluvium soil covers the flood plains in the vicinity of the rivers including their reaches. It is replenished annually by new deposits. It is the mixture of minerals, organic matter, gases, liquids, and the countless organisms that together support life on Earth. It is fertile in nature. Bhanger soil is an old alluvial soil. Bangar areas are less prone to flooding but are usually more sandy. These soil are less fertile in nature. They consist of a higher concentration of kankar nodules (figure-5). There are certain usar and semi usar (barren land) patches scattered here and there in Cholapur and Chiraigaon development blocks.

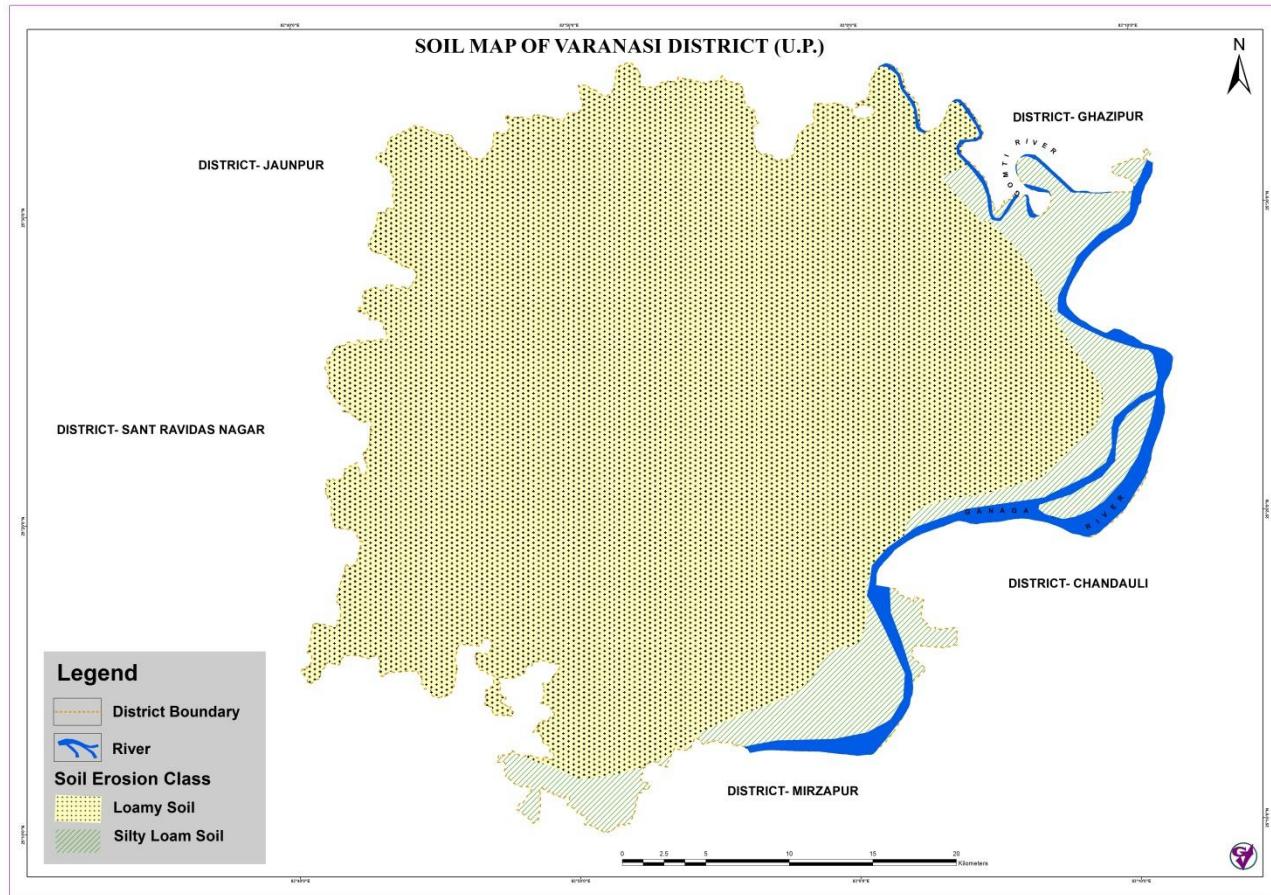


Figure-5: Soil Map of Varanasi district

1.9. Landuse/ Landcover

About 66% area of the district is utilized for agriculture purpose and the rest covered with built up area and other features (figure-6). Dense settlement can be seen in Kaashi Vidyapeeth block and South west of Chiraigaon block of Varanasi district which includes the Urban area. Blockwise data of land utilization under the standard heads of land uses are given in table-1& 2 and shown in figure- 7.

Table: 1 Blockwise land use/ land cover (in hectare) in the district								
Block	Total Reported Area	Forest	Cultivable Waste Land	Current Fallow	Other Fallow	Uncultivable Land	Land other than Agriculture	Grassland / Trees, Shrubs
Baragaon	17286	9	236	580	463	214	3090	277
Pindra	22552	6	278	592	644	325	3275	288
Cholapur	18060	5	198	558	499	225	2910	278
Chiraigaon	19529	8	559	492	585	308	4122	237
Harhua	13775	4	225	393	521	142	2911	254
Sewapuri	16924	7	372	524	750	200	3283	418
Araji Line	21770	5	242	526	623	215	3585	383
Kashi	15250	8	216	820	770	230	5174	349

Vidyapeeth								
Total Rural	145146	52	2326	4485	4855	1859	28350	2484
Total Urban	7532	2	210	285	1506	46	5240	112
Total District	152678	54	2536	4770	6361	1905	33590	2596
<i>Source- Statistical diary- 2018-19</i>								

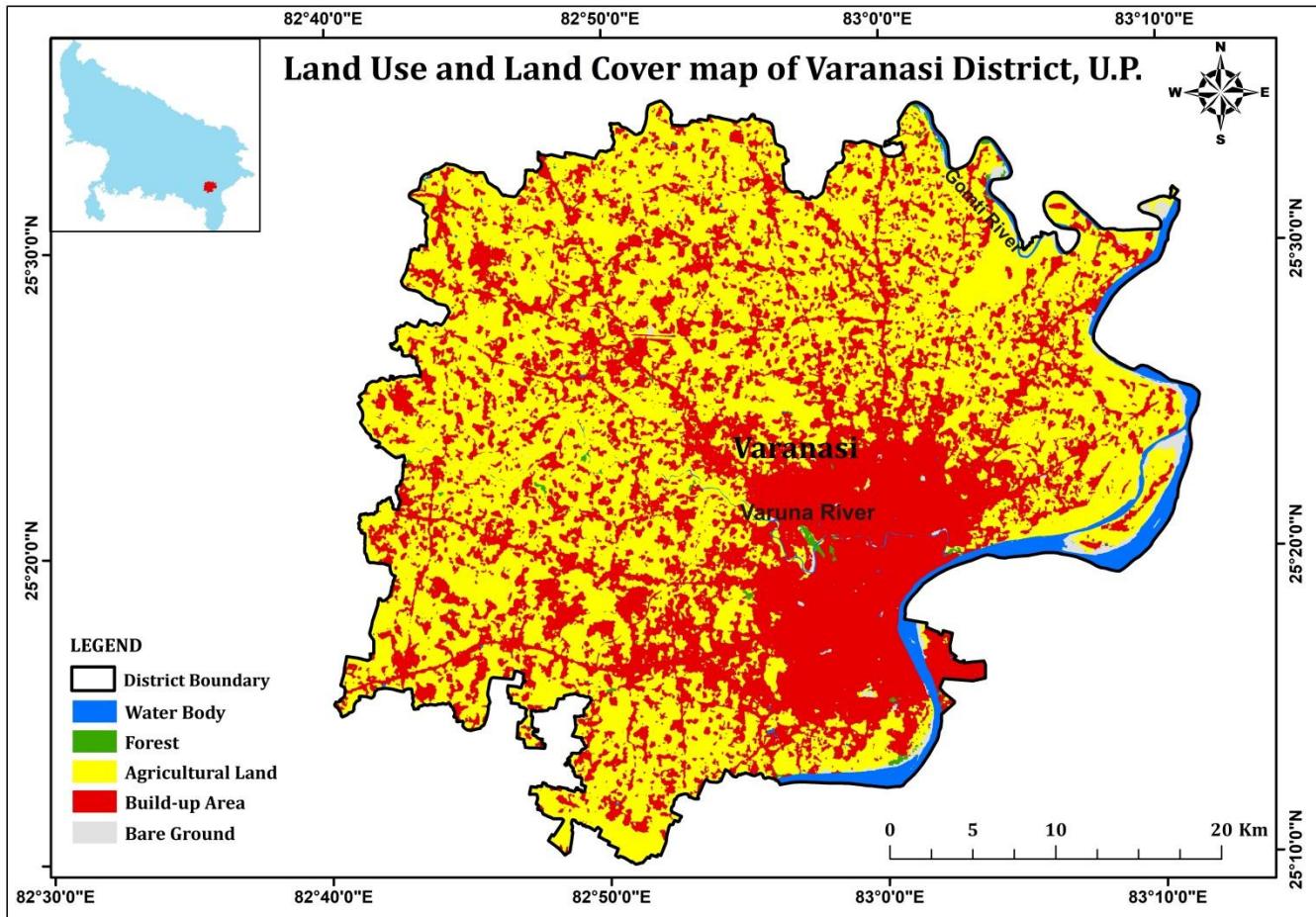


Figure-6: Landuse/ Landcover Map of Varanasi district (Source Sentinel-2)

Table: 2 Blockwise land use (in hectare) in the district					
Block	Net Area Sown	Area sown more than once	Gross Area Sown	Net Irrigated area	Gross Irrigated area
Baragaon	12415	9436	21851	10911	18432
Pindra	17144	11801	28945	15135	24991
Cholapur	13385	8162	21547	11459	17235
Chiraigaon	13216	6588	19804	10752	15561
Harhua	9323	8599	17922	8838	14431
Sewapuri	11364	8291	19655	10963	16209
Araji Line	16190	7724	23914	14020	20777
Kashi Vidyapeeth	7681	2624	10305	7694	10223
Total Rural	100718	63225	163943	89772	137859
Total Urban	131	405	536	490	393
Total District	100849	63630	164479	90262	138252

Source- Statistical diary- 2018-19

From the above table it can be infer that percentage of net irrigated area to net sown area is 90.15% in the district.

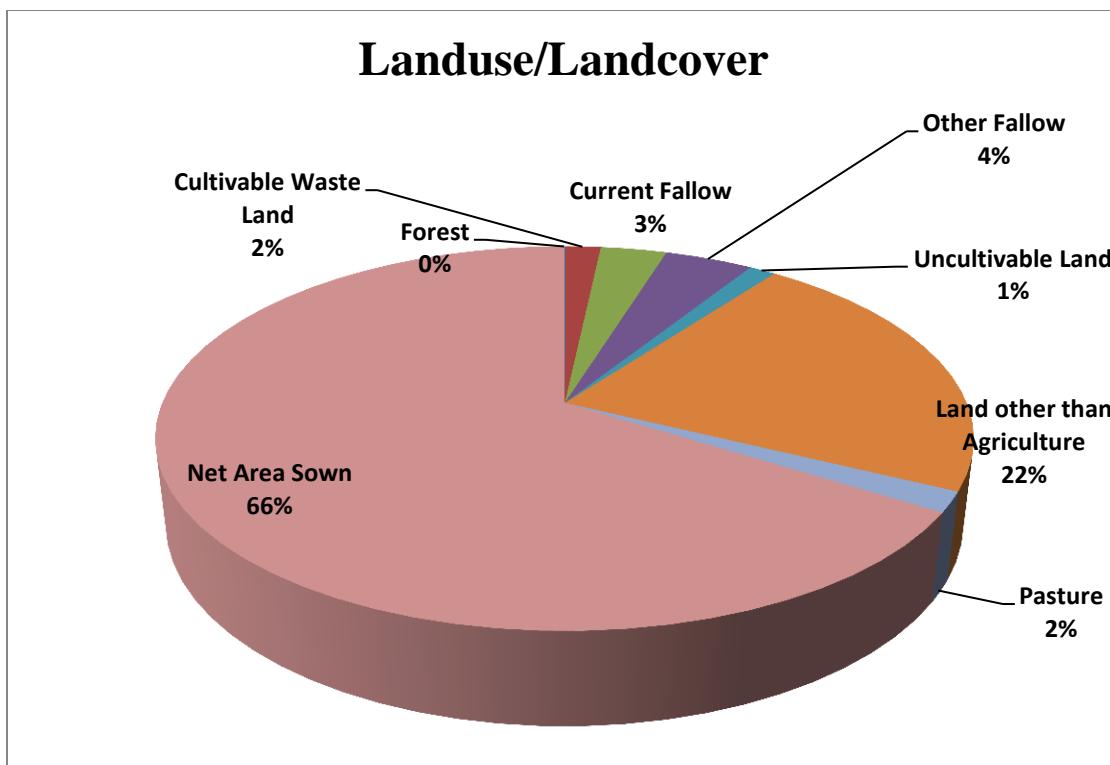


Figure 7: Landuse Pattern of Varanasi district (Source Statistical Diary-2019)

1.10. Agriculture and Cropping Pattern

Entire district of Varanasi falls between Ganga and Varuna rivers. The loamy soils of the area are very fertile. About 85% 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. Block-wise area under main crops in the district is given in table-3.

Table :3 Block-wise area under main crops (in hectare) in the district							
Block	Wheat	Rice	Millet	Sugarcane	Maize	Jowar	Oilseeds
Baragaon	8615	7597	390	558	514	240	181
Pindra	12520	10501	371	641	793	201	177
Cholapur	9648	5698	1146	631	207	376	54
Chiraigaon	8340	3531	2407	334	96	536	63
Harhua	7186	5236	215	448	463	358	153
Sewapuri	7874	6138	386	525	383	322	165
Araji Line	10488	6827	280	715	363	184	273
Kashi Vidyapeeth	4208	2397	148	128	172	214	12
Total Rural	68879	47925	5343	3980	2991	2431	1078
Total Urban	239	97	22	3	29	31	6
Total District	69118	48022	5365	3983	3020	2462	1084
<i>Source- Statistical diary- 2018-19</i>							

1.11. Irrigation

At district level 90.15% of total cultivable area has got the irrigation facility. The main source of irrigation in the district is tube well as shown in table-4 and figure-8.

Table :4 Block-wise actual irrigated area (in hectare) by various means in the district					
Block	Canal	Tubewell	Well	Pond	Other
Baragaon	1611	9133	166	0	1
Baragaon	1395	13601	137	0	2
Pindra	2253	9065	140	0	1
Cholapur	1206	9362	182	0	2
Chiraigaon	1059	7613	166	0	0
Harhua	1288	9521	151	0	3
Sewapuri	618	13262	138	0	2
Araji Line	386	7162	144	0	2
Kashi Vidyapeeth	9816	78719	1224	0	13
Total Rural	0	476	10	0	4
Total Urban	9816	79195	1234	0	17
Total District	1611	9133	166	0	1
<i>Source- Statistical diary- 2018-19</i>					

From the above table it can be infer that percentage of net irrigated area by total tube wells to total net irrigated area is 87.55% and Percentage of net irrigated area by canals to total net irrigated area is only 11% in the district.

2.0 DATA COLLECTION AND GENERATION

2.1. Hydrogeology

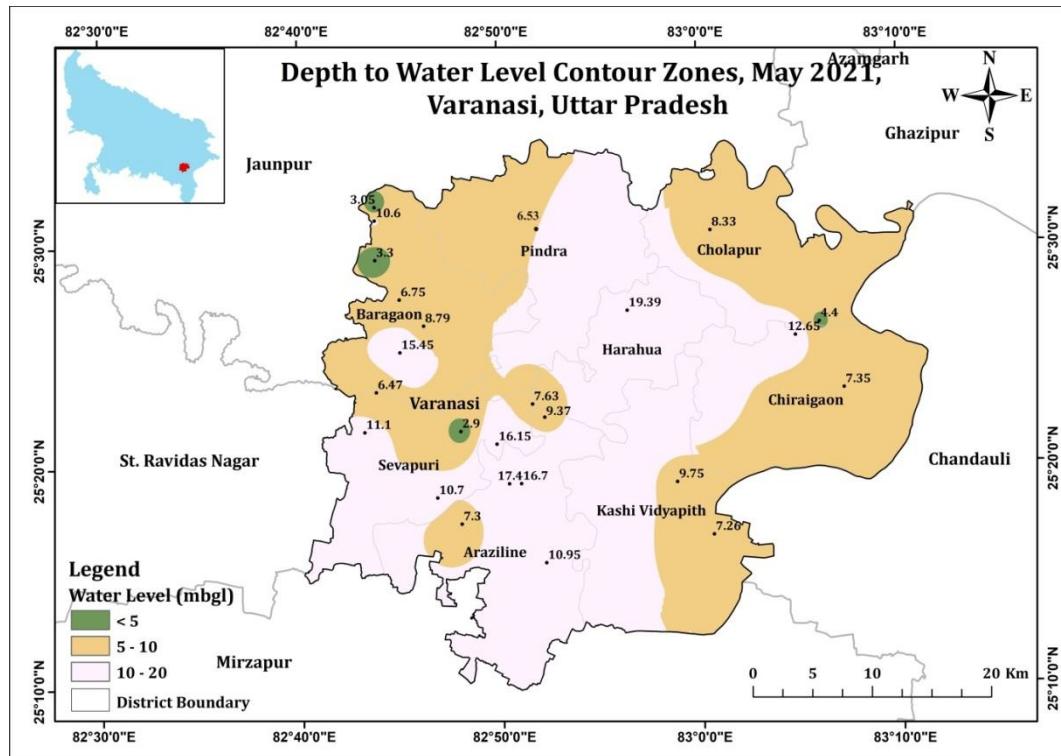
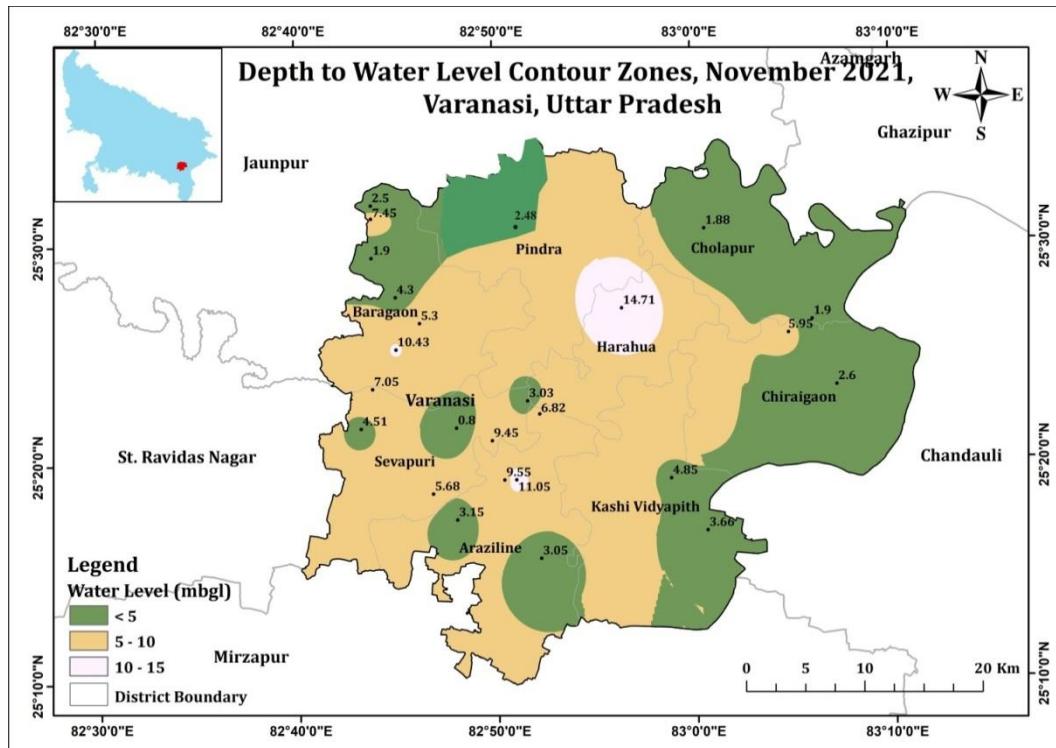
Varanasi district is underlain by Quaternary alluvium deposited by Ganga river system. Lithologically the alluvial sediments comprise of sand, silt, clay and kankar in varying proportions. Exploratory drilling data of C.G.W.B. and state tubewells department shows that ground water occurs in both, Kaimur Sandstone (Vindhyan) and unconsolidated alluvial sediments.

In Kaimur Sandstone (Vindhyan) the occurrence and movement of ground water controlled by joints, fractures and fissures. The availability of ground water depends upon the number of weak planes and extent of weathering. In unconsolidated alluvial sediments ground water occurs in pore spaces in the zone of saturation. The ground water occurs under water table condition in shallow aquifer whereas the ground water in deeper aquifer occurs under semi confined to confined condition.

2.2. Depth to Water Level

Based on premonsoon water level data of May 2021 of hydrograph stations, a depth to water level map for premonsoon period 2021 has been prepared. The depth to water level in the district ranges from 2.90 to 19.39 mbgl (Annexure-I). In major area depth to water level ranges between 5.0-10.0 mbgl (figure-8).

During monsoon period the ground water recharge takes place and depth to water level becomes shallower. During post-monsoon, water levels range from 0.80 to 16.39 mbgl (figure-9), with maximum number of wells having water levels between 2.0-5.0 mbgl.

**Figure-8: Depth to Water Level Map of Varanasi district- Pre Monsoon****Figure-9: Depth to Water Level Map of Varanasi district- Post Monsoon**

2.2.1. Water Level Fluctuation:

Based on water level data of 26 wells for the year 2021 it is observed that there is rise in water level in most part of the district showing rising trend of 0.55 to 7.85 m/year with fall in 2 wells of -2.55 and -0.58 m/yr. Water level fluctuation in most part of the district ranges in between 3-6 m. Fluctuation in water level is shown in figure-10.

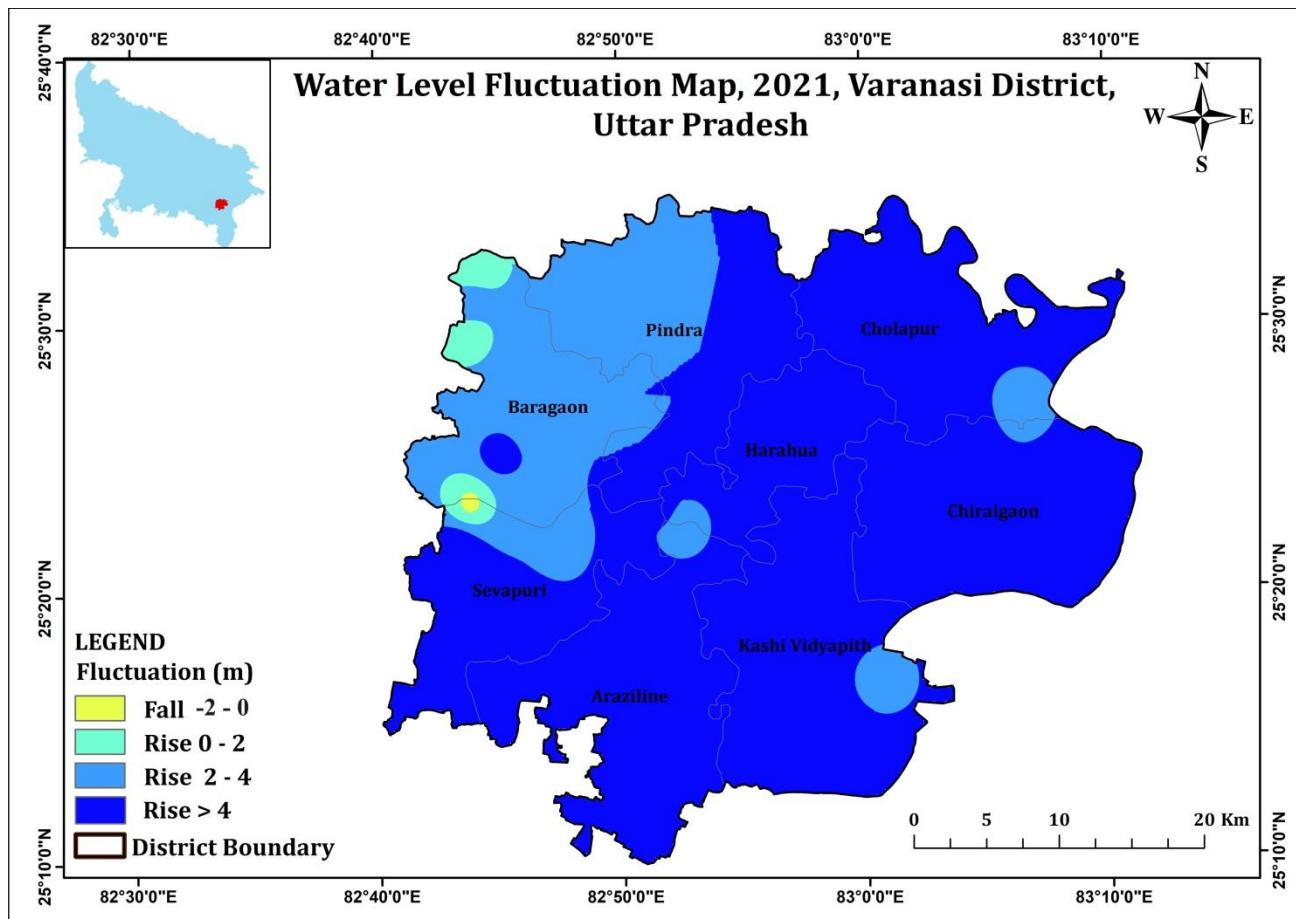


Figure-10: Water Level Fluctuation Map of Varanasi district

2.2.2. Water Table:

Water table contour map prepared for pre-monsoon period in order to determine the flow direction (figure-11). Water table contour map shows that the general ground water movement direction is from North-West to South-East following the slope, except for some localized variations which correspond with the general topography of the area. The elevation of water table contour varies from 54 m amsl to 81 m amsl. The maximum elevation of 81 m above mean sea level is in the NW part of the district and minimum of 54 m above mean sea level is in north central part.

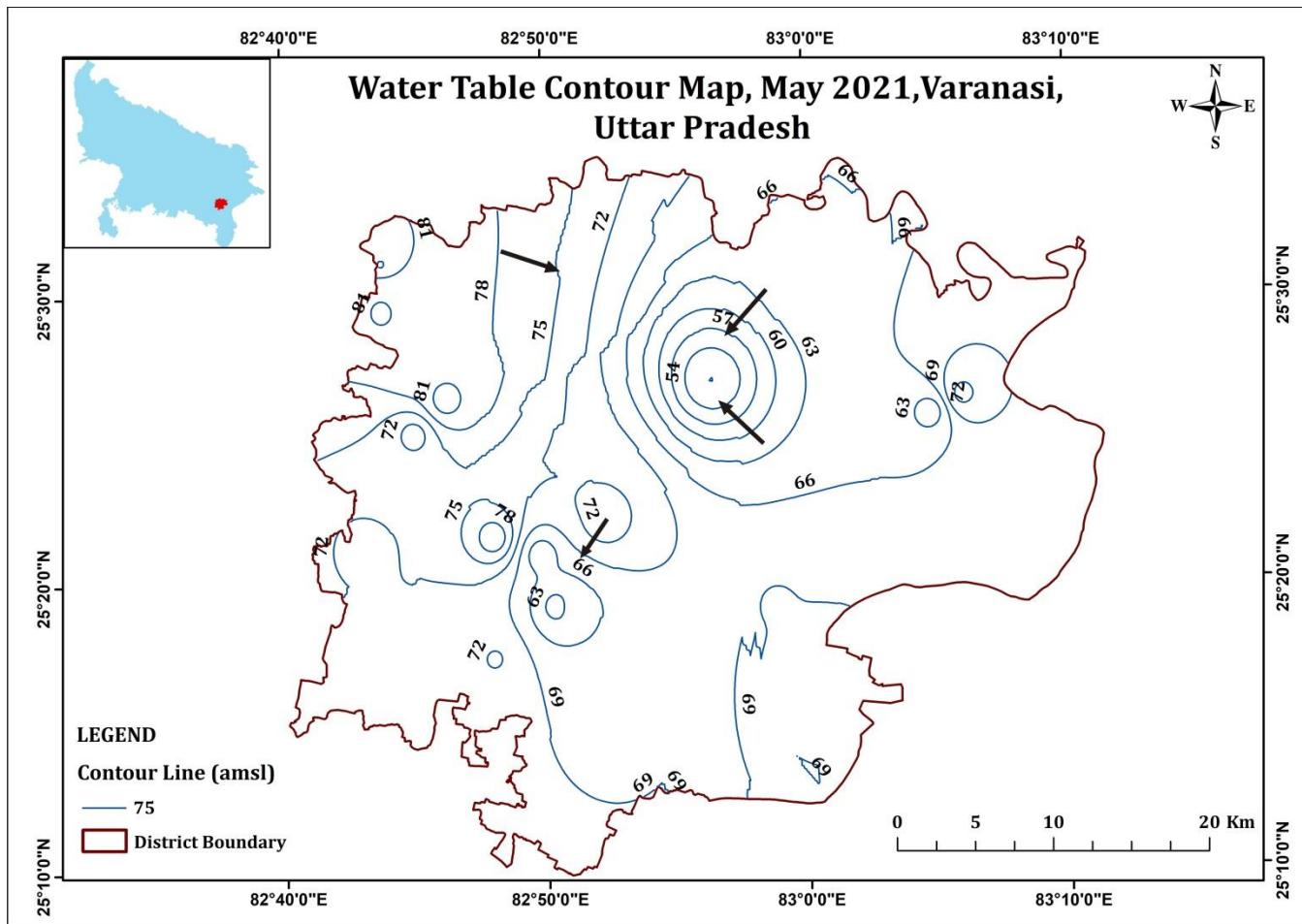


Figure 11: Water Table Contour Map of Varanasi district

2.2.3. Water Level Trend:

Analysis of long term water levels for the period 2011-2020 (table-5) in respect of CGWB monitoring wells in the district shows rising trends, with range of rise as 0.11 to 0.62 m/yr during pre-monsoon and 0.01 to 1.84 m/yr during postmonsoon (Plate-I).

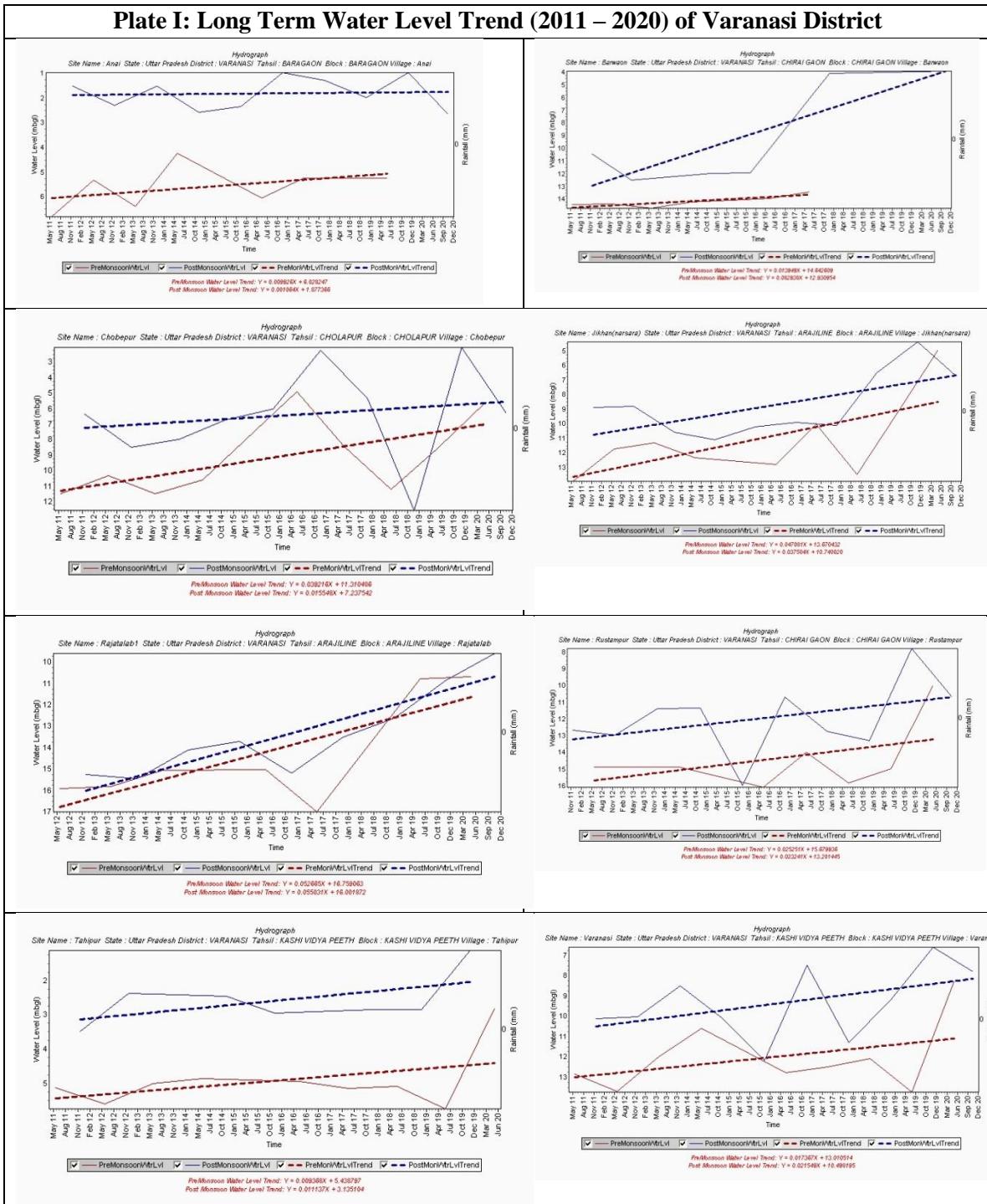
Table 5 : Long Term Water Level Trend (2011 – 2020) , Varanasi District, U.P

Sl No.	Location	PreMonsoon		PostMonsoon		Annual	
		Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)	Rise (m/year)	Fall (m/year)
1	Chobepur	0.4638		0.1839		0.3973	
2	Varanasi	0.2054		0.2549		0.2754	
3	Thatra	0.3673		0.1982		0.3540	
4	Tahipur	0.1108		0.1317		0.0462	
5	Barwaon	0.1650		0.9809		0.8347	
6	Kakrahwan	0.2756		1.8386		0.9211	
7	Rajatalab1	0.6229		0.6509		0.6530	
8	Anai	0.1174		0.0126		0.1539	
9	Jikhan(narsara)	0.5568		0.4445		0.4726	
10	Rustampur	0.2987		0.2749		0.3318	

2.2.4. Long Term Ground Water Fluctuation

In order to remove the rainfall anomalies the long term water level is considered as this would normalize the erratic highs and lows. For this the water level of each season has been compared to the mean water level of past 10 years. Ground Water monitoring stations with continuous data from 2011 to 2021 of CGWB, NR and UPGWD have been analysed. The pre-monsoon water level data for 2021 has been compared to the decadal mean (2011-2020). There is rise in 86% of the wells with values ranging from 0.015m-7.0 m while 14% of the wells show fall in water level ranging from 0.18 m to 0.80 m (figure-12 and Annexure-II).

Similarly, the average water level of last 10 years (2011-20) for each hydrograph station for the month of November has been evaluated and compared with the water level data of November'21. There is rise in 95% of the wells with values ranging from 0.06m to 7.87m while only one well show fall in water level with a fall 0.208 m (figure-13 and Annexure-III).

Plate I: Long Term Water Level Trend (2011 – 2020) of Varanasi District

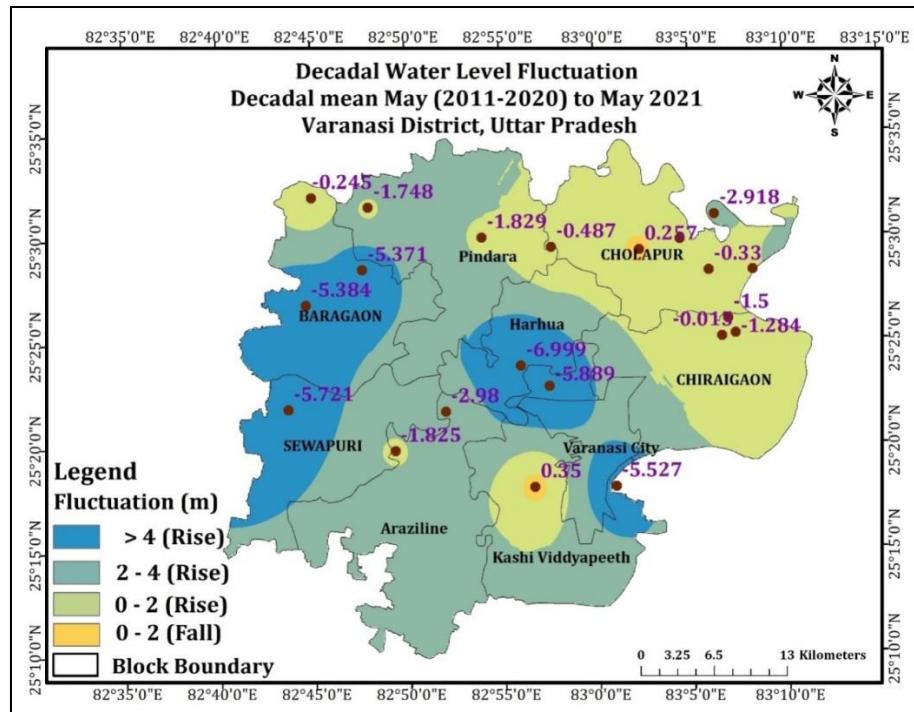


Figure 12: Decadal Water Level Fluctuation Map of Varanasi district, Decadal Mean May (2011-2020) to May 2021

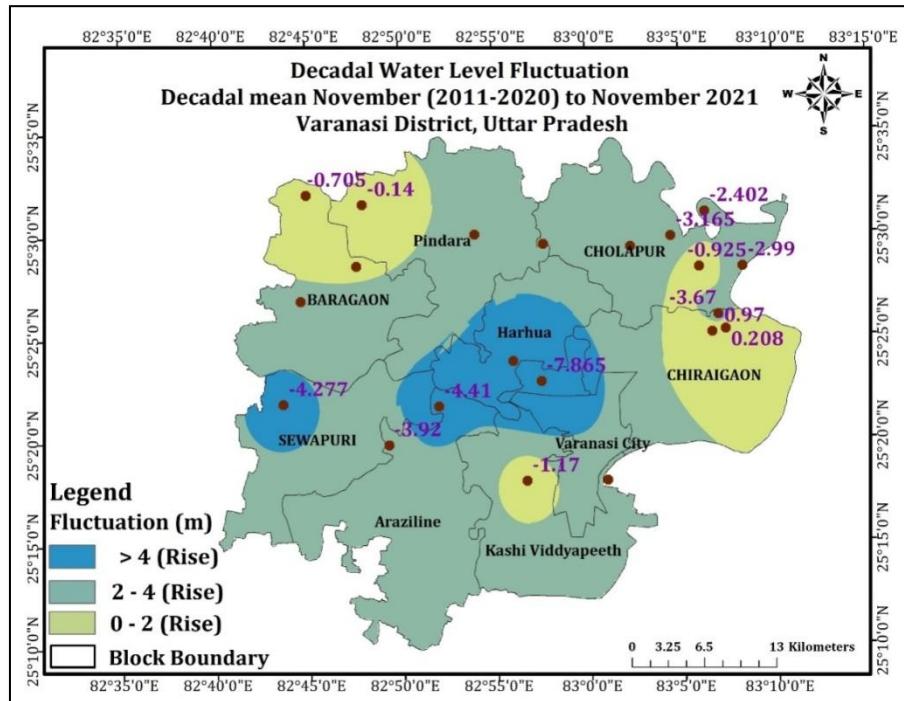


Figure 13: Decadal Water Level Fluctuation Map of Varanasi district, Decadal Mean November (2011-2020) to November 2021

2.3. Hydrochemistry

The concentration of ions/elements in natural water is governed by general factors, like nature of formation through which water circulates, soil characteristics, concentration due to anthropogenic activities etc. A total of 35 samples were collected from different dugwells and handpumps falling in the study area. All the collected samples were analyzed by adopting standard methods of analysis (APHA) in chemical laboratory of CGWB NR, Lucknow. The chemical analysis of shallow ground water result reflects that the ground water is safe and potable in the entire district (Annexure-IV). The chemical quality map shows all the basic constituents are well within the permissible limit of BIS in the study area except for sporadic occurrence of Nitrate (>45 mg/l) and Fluoride (>1.5 mg/l) in localized pocket (figure- 14).

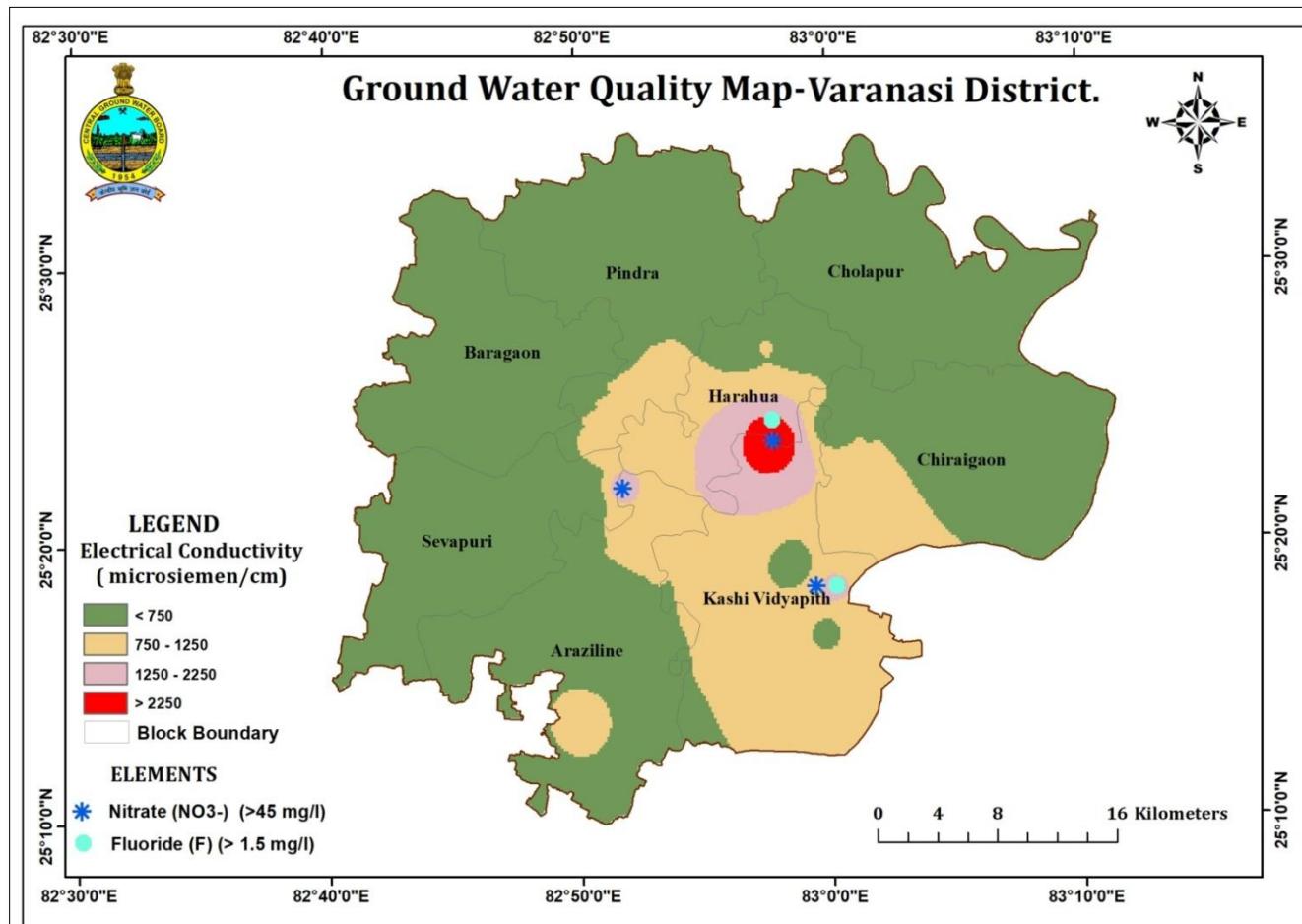


Figure-14: Chemical Quality Map of Varanasi district

2.3.1 Hydrochemical facies:

Piper Diagram

To interpret the hydrochemical facies of shallow/ phreatic aquifer in the study area Piper diagram has been plotted (figure-15) which shows the ground water samples are Calcium-Magnesium-Bicarbonate type, which are typical of shallow fresh ground waters. From the diamond plot we can also interpret that weak acids exceeds strong acids and alkaline earth exceeds alkalies in the samples.

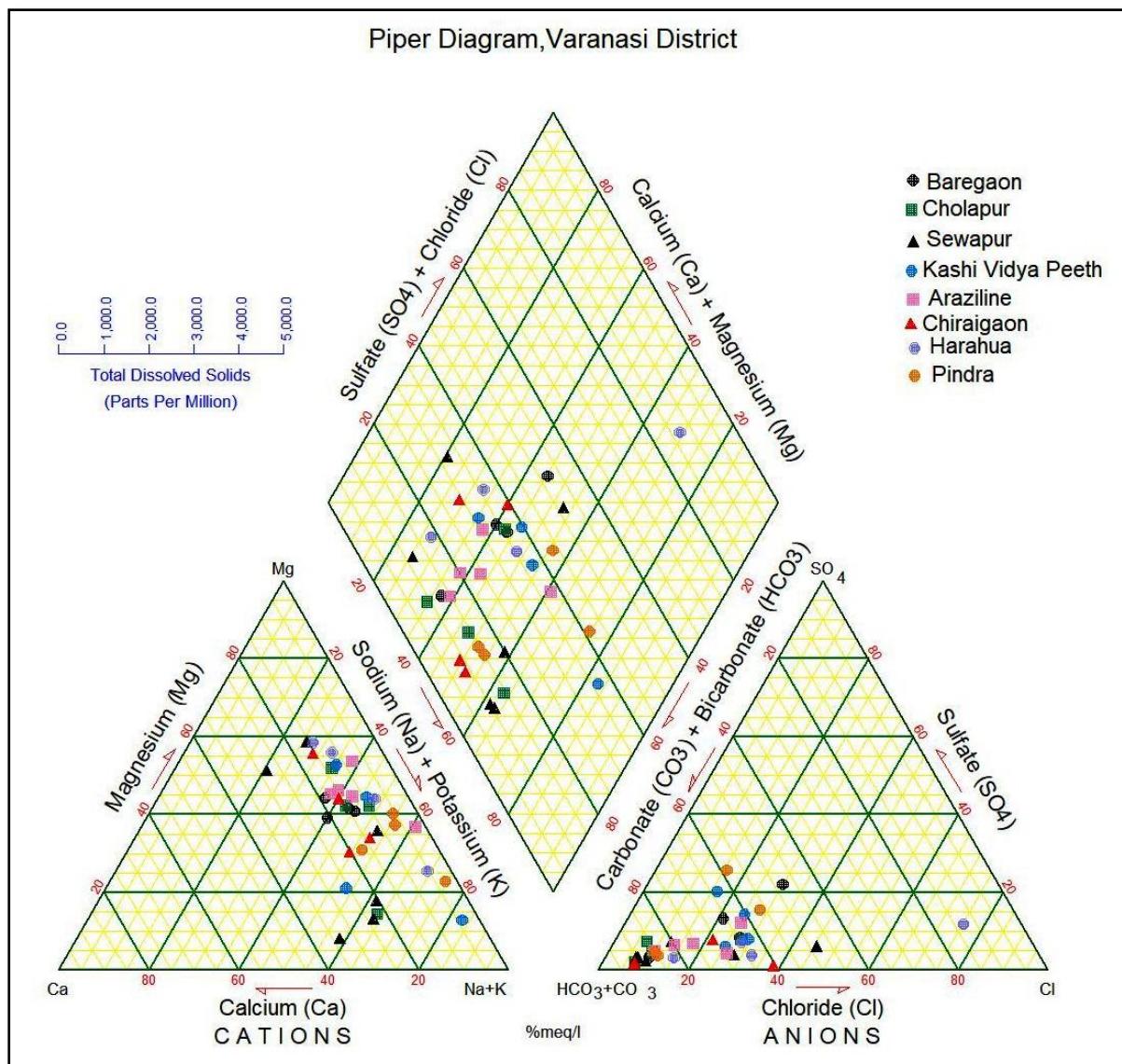


Figure-15: Piper diagram for Hydrochemical facies

2.3.2 Quality of Ground Water for Irrigation Use:

To determine the suitability of ground water for irrigation purposes Sodium Adsorption Ratio and soluble Sodium percentage has been calculated.

Method	Formula	Category			
		Good	Permissible	Doubtful	Unsuitable
Sodium Adsorption Ratio	$SAR = \frac{Na}{\sqrt{(Ca + Mg)/2}}$	0-10	10-18	18-28	>28
Sodium percentage	$Na\% = \frac{(Na+K)}{(Ca+Mg+Na+K)} * 100$	0-40	50-65	65-90	>92

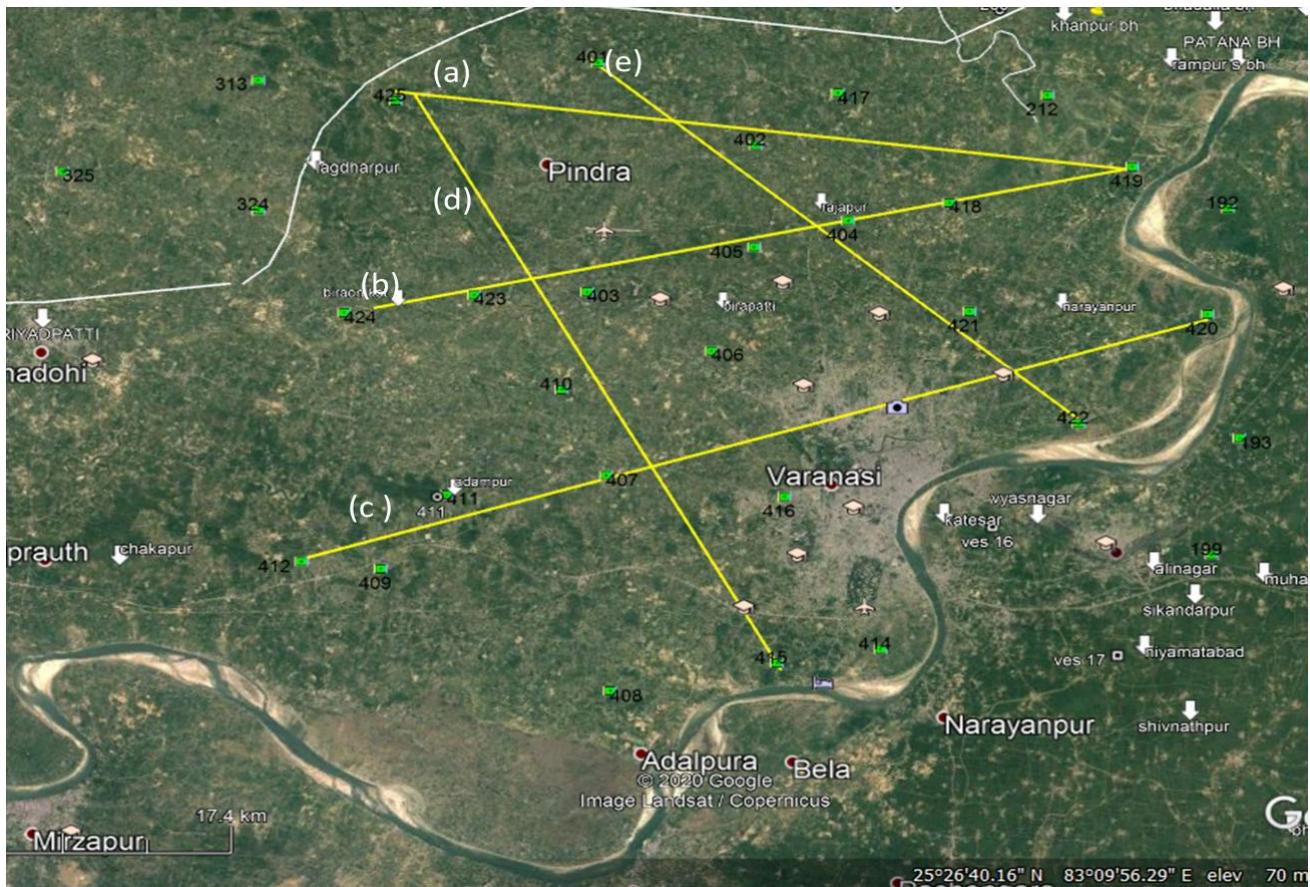
As per SAR value, all the samples are in good to permissible quality with values ranging from 0.68-11.16. Sodium percentage value ranges from 19.3-82.7 with only two samples in doubtful category. Overall ground water in the district is suitable for irrigation purpose.

2.3.3 Ground Water Quality of Comparatively Deeper Aquifers:

Chemical analysis results of the ground water collected from the comparatively deeper Aquifers (semi-confined / confined) through departmental Exploratory wells shows that all the basic constituents are well within the permissible limit of Bureau of Indian Standards (BIS, 2012) recommendation. Analytical results of basic parameters of ground water samples are given in Annexure- V. Heavy metal analyses for deeper aquifer were not done in the region at the time of construction of wells, so no data available.

2.4.Geophysical Investigations

In Varanasi district total 23 VES were conducted by the department as shown in figure-16. The VES were interpreted using IX1D software. The interpreted layer parameters were compared with the lithologs and resistivity logs of existing boreholes to define the resistivities for various litho units. For this forward modeling was also done. The resistivity of clay and kankar bed ranges from 5 to about 13 ohm.m. Mixing of kankar increases the resistivity. The resistivity of granular sediments ranges from about 20 to 60 ohm.m depending on granularity and presence of clay interbeds. It has not been possible to differentiate various lithounits at depth by VES. The geoelectrical layers are with weighted resistivities, representing different depth ranges. Using geoelectrical layer parameters of the VES, 5 hydrogeophysical cross-sections have been prepared. These cross-sections reveal the presence of thick clay and kankar in the northern part of the district. At a few VES sites in the northern part as well as near river Ganga towards south, the entire sediments up to the Vindhyan bed rock are predominantly clayey. The maximum depth to the Vindhyan bed rock inferred is about 454 m.



2.4.1 Hydrogeophysical Cross-Section

On the basis of interpreted results of VES five hydrogeophysical cross-sections(a,b,c,d and e) (Figures 17 to 21) have been prepared. Out of these 3 are in W-E and SW-NE directions and 2 are in NW-SE direction and eastern end of all these cross-sections are close to river Ganga. These cross-sections are based on inferred litho-resistivities and reveal the general subsurface disposition of clay and kankar, fine to coarse sand and the Vindhyan bed rock.

The northern most cross-section (a) (Figure - 17) in west to east direction between Malhat (VES 425) and Bandhar Khurd (VES 419) over 39 km reveals the presence of thick clay and kankar bed except at Malhat and Gajokhar located towards west and Bandhar Khurd in extreme east near river Ganga where considerably thick aquifers in fine to coarse sand are present. The Vindhyan bed rock could not be delineated at Gajokhar. The clay and kankar is predominant near river Gomti which traverses in NW-SE direction at about 10 km north of these sites.

The cross-section (b) in SW-NE direction between Koailar(VES 424) and Bandhar Khurd (VES 419) is located towards south of the earlier section and covers a stretch of 43 km (Figure-18). This cross-section presents an improvement in subsurface lithofacies. The shallow level clay and kankar bed is relatively thin compared to northern most cross-section except at Gopalpatti (VES 403) in the western part where predominance of finer sediments and clays is observed throughout the depth up to about 350 m. The cross-section uses the results of two boreholes – Biraon Kot and Rajapur drilled by CGWB. Biraon Kot borehole in the western part is the only borehole where Vindhyan bed rock was encountered at the bottom at 356 m depth. The Rajapur borehole in eastern part drilled up to 402 m depth did not encounter Vindhyan bed rock. The granular zones tapped in these boreholes and the 64" normal resistivities against the zones as recorded by the resistivity log are shown in figure-18. It reveals that VES delineates the aquifer with resistivities of 40-60 ohm.m averaged over a much larger depth range. The aquifers extend up to the Vindhyan bed rock which is delineated throughout the cross-section within 350 to 450 m depth.

Further south, the cross-section (c) between Thatra (VES 412) and Raimala (VES 420) over a stretch of about 50 km is also in SW-NE direction (Figure-19). This cross-section uses the lithologs and resistivity logs of boreholes at Admapur, Birapatti and Narayanpur. The clay and kankar bed thickens towards the northeastern part of the cross-section and granular sediments occur throughout its stretch. It indicates that the thickening of shallow clay and kankar bed is towards north as well as the prevalence of clay and kankar bed throughout the depth investigated exists over a limited area towards north of the cross-section. A comparison of resistivities against the zones tapped in boreholes with those obtained from VES reiterates the fact that VES gives an average resistivity over a much larger depth range and can be used to assess the generalized resistivity character and aquifer quality.

The cross section (d) between Malhat (VES 425) and Balipur (VES 415) is 40 km long and is oriented in NW-SE direction (Figure-20) and is located west of Varanasi city area. The cross-secion clearly reveals the deepening of Vindhyan bed rock and the thickening of shallow level clay and kankar bed towards north. Fine to coarse sand with resistivity varying from 35 to 62 ohm.m forms the aquifer. An increase in resistivity towards north is observed indicating the improvement in granularity of sediments towards north along this cross-section. At Balipur (VES 415) located very close to river Ganga the Vindhyan bed rock is very shallow.

Another cross-section (e) in NW-SE direction is between Gajokhar (VES 401) and Chadur (VES 422) (Figure-21). It is 32 km long and placed towards east of Varanasi city area. As expected the shallow clay and kankar bed thickens towards north. A significant finding is the presence of a thick geoelectrical layer of 19 ohm.m resistivity up to the Vindhyan bed rock (depth: 297m) at Chadur (VES 422) located within a kilometer from river Ganga. The predominance of clay and kankar up to about

120- 125 m depth in and around Varanasi city area is known through borehole drillings. It is therefore inferred that the geoelectrical layer with average resistivity about 19 ohm.m may hold granular sediments in its bottom part which could not be distinguished from the clay mixed sediments in the top part of the geoelectrical layer. The Vindhyan bed rock is delineated in the southern part of the cross-section.

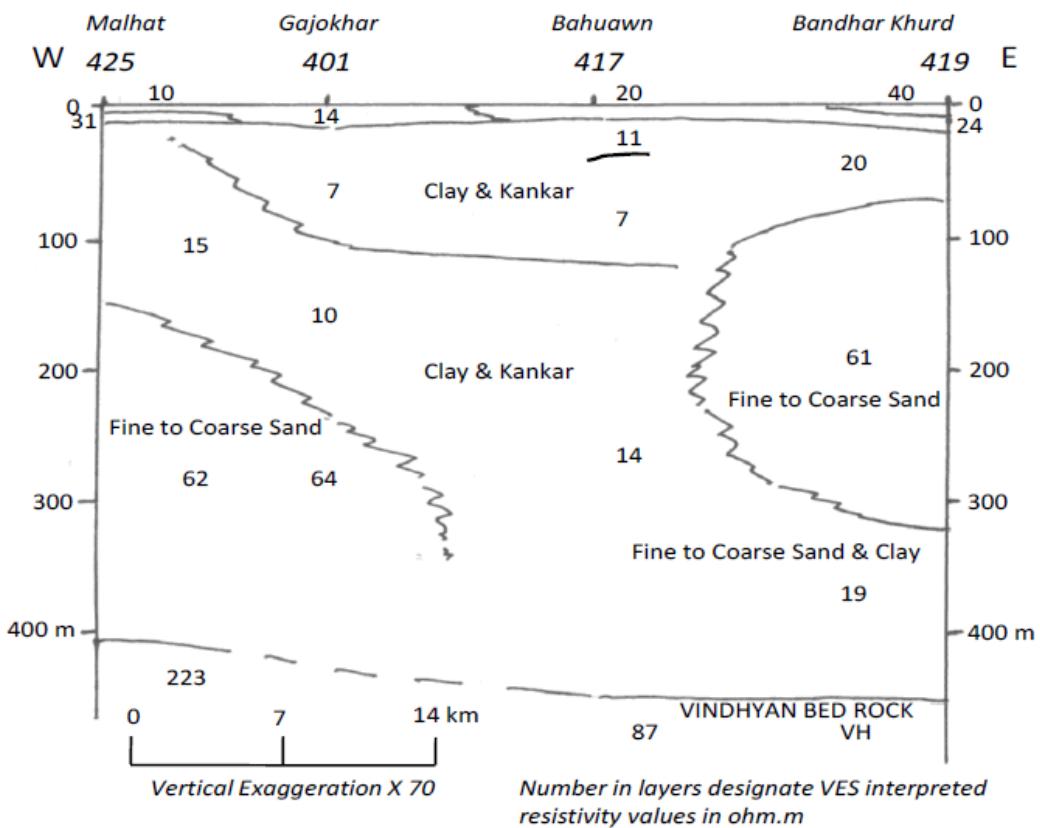


Figure 17: Cross-section (a) in west to east direction between Malhat (VES 425) and Bandhar Khurd (VES 419)

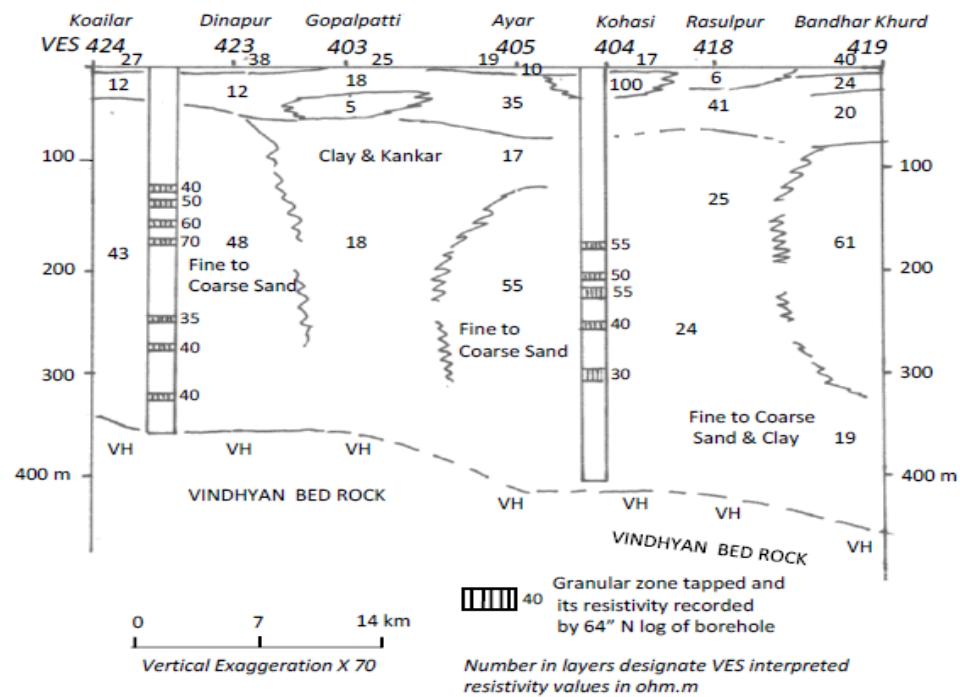


Figure 18: Cross-section (b) in SW-NE direction between Koilar (VES 424) and Bandhar Khurd (VES 419) is located towards south of the earlier section

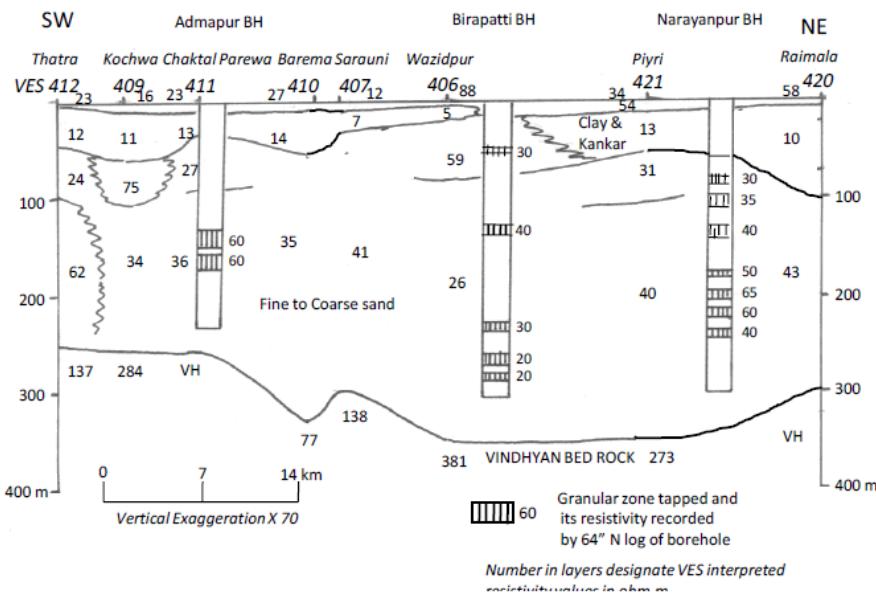


Figure 19: Cross-section (c) between Thatra (VES 412) and Raimala (VES 420) over a stretch of about 50 km is also in SW-NE direction

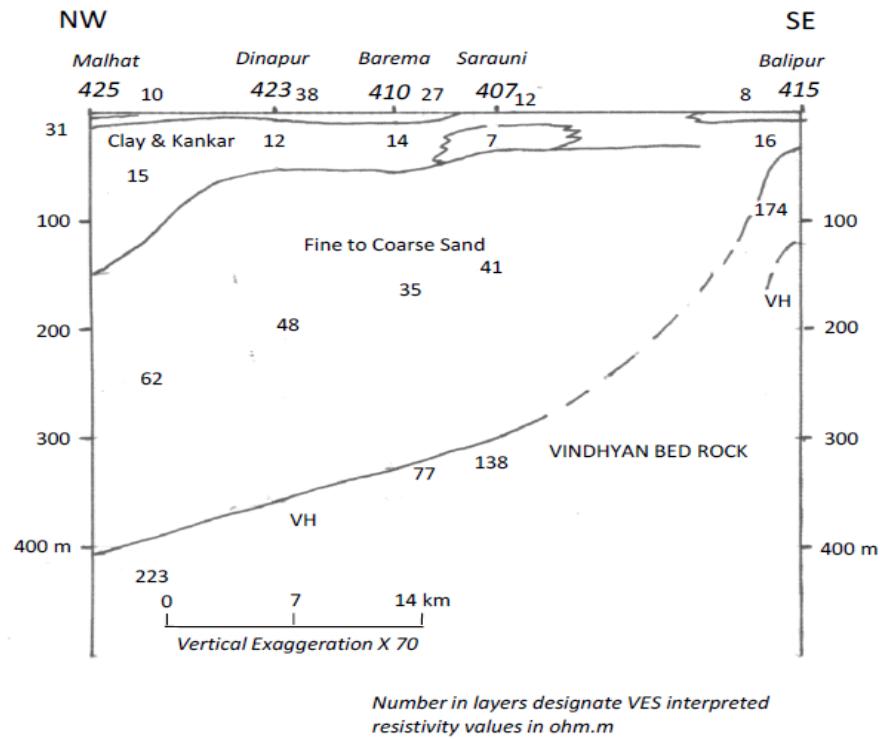


Figure 20: Cross section (d) between Malhat (VES 425) and Balipur (VES 415)

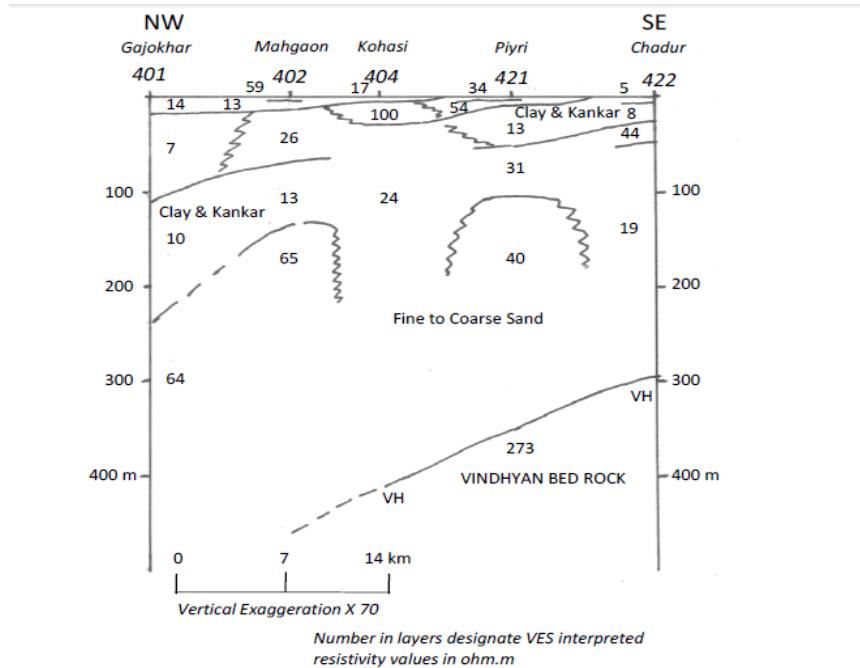


Figure 21: Cross-section (e) in NW-SE direction is between Gajokhar (VES 401) and Chadur (VES 422)

2.5. Exploration

Under ground water exploration 19 exploratory wells, 11 observation wells and 09 deposit wells have been drilled by Central Ground Water Board, NR as on 31-03.2022. The drilled depth of these wells ranges from 155.0 m bgl to 402 mbgl. The storativity ranges from 5.8×10^{-6} to 0.028×10^{-2} and transmissivity ranges from 1017-8604 m²/day. Discharge varies from 1007 to 3456 lpm. Vindhyan bed rock encountered at Biraon Kot borehole (at 352 m depth), Nati Imli (at 273 m depth), Rajapur (at 342 m depth), Sarnath (107 m depth) and Bhikharipur (150 m depth).The location map of exploratory wells used in preparation of aquifer maps, models, fence diagram and cross sections shown in figure-22 and the details of each well is given in Annexure-VI.

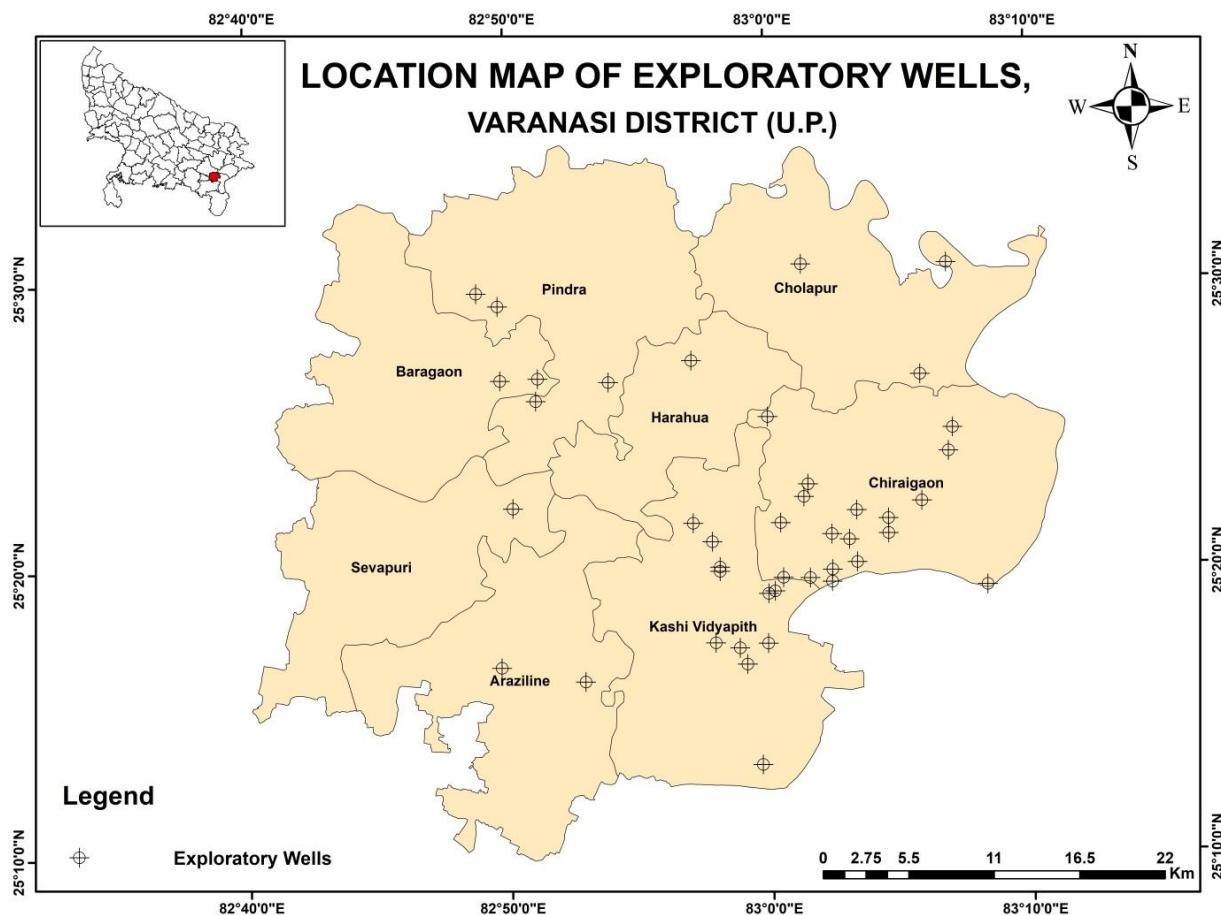


Figure-22: Location Map of Exploratory wells in Varanasi district

3.0 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

3.1 Lithological Disposition and Aquifer Disposition

To understand the lithological and aquifer disposition in the study area, 3-D model, sections and fence diagrams have been prepared using Rockworks software, based on the lithological information obtained through exploratory drilling (Annexure-VII) and geophysical investigations undertaken by CGWB and private drillers in the district.

3.2 Principal Aquifer System in the study area

The principal aquifers in the study area have been delineated by grouping the sand, kankar, silt as aquifers separated by confining clay layers as aquiclude. On the basis of lithological logs, Electrical logs, linear cross sections and fence diagram it has been established that four tier aquifer system exists in Varanasi district upto the depth of 402 m bgl which are grouped as *Aquifer group-I*, *Aquifer group-II*, *Aquifer group-III* and *Aquifer group-IV*. Basement has been encountered at Biraon Kot, Nati Imlı, Rajapur, Sarnath and Bhikharipur borehole.

- *Aquifer group-I* Below the top soil is the Aquifer group-I and occurs generally between the depth of 150.00 mbgl. This aquifer is mostly tapped by shallow tube wells, dug wells and hand pumps. The quality of this aquifer group is potable except for sporadic occurrence of nitrate and fluoride in few localised pockets.
- *Aquifer group-II* This aquifer group lies below the first Aquifer unit and is separated with the confining clay layer. It occurs generally between the depths of 160.00- 240.00 mbgl. The aquifer material is generally sand and kankar. This aquifer is tapped by deep tube wells. The quality of this aquifer group is fresh and good.
- *Aquifer group-III* This aquifer group lies below the second Aquifer unit and is separated with the confining clay layer. It occurs generally between the depths of 260.00-370.00 mbgl. This aquifer is tapped by deep tube wells. The quality of this aquifer group is fresh and good.
- *Aquifer group-IV* This aquifer group lies below the third Aquifer unit and is separated with the confining clay layer. It occurs generally between the depths of 370.00-480.00 mbgl. This aquifer is tapped by deep tube wells. The quality of this aquifer group is fresh and good.

3.3 3-D Aquifer Model

The 3-D aquifer model of the complete aquifer mapping area depicts the presence of various grades of sand, silt and kankar acting as Aquifers with alternation of clay layer acting as Aquiclude. Detailed study shows that the Vindhyan bed rock (sandstone and shale) encountered at varying depth ranging from 150 mbgl to 352 mbgl. On regional scale, a single aquifer system is seen extending down to the depth of 150 mbgl. The maximum depth of exploration in the study area of 402 mbgl at Rajapur in Chraigaon block.

A 3-D aquifer model of the district is shown in figure-23.

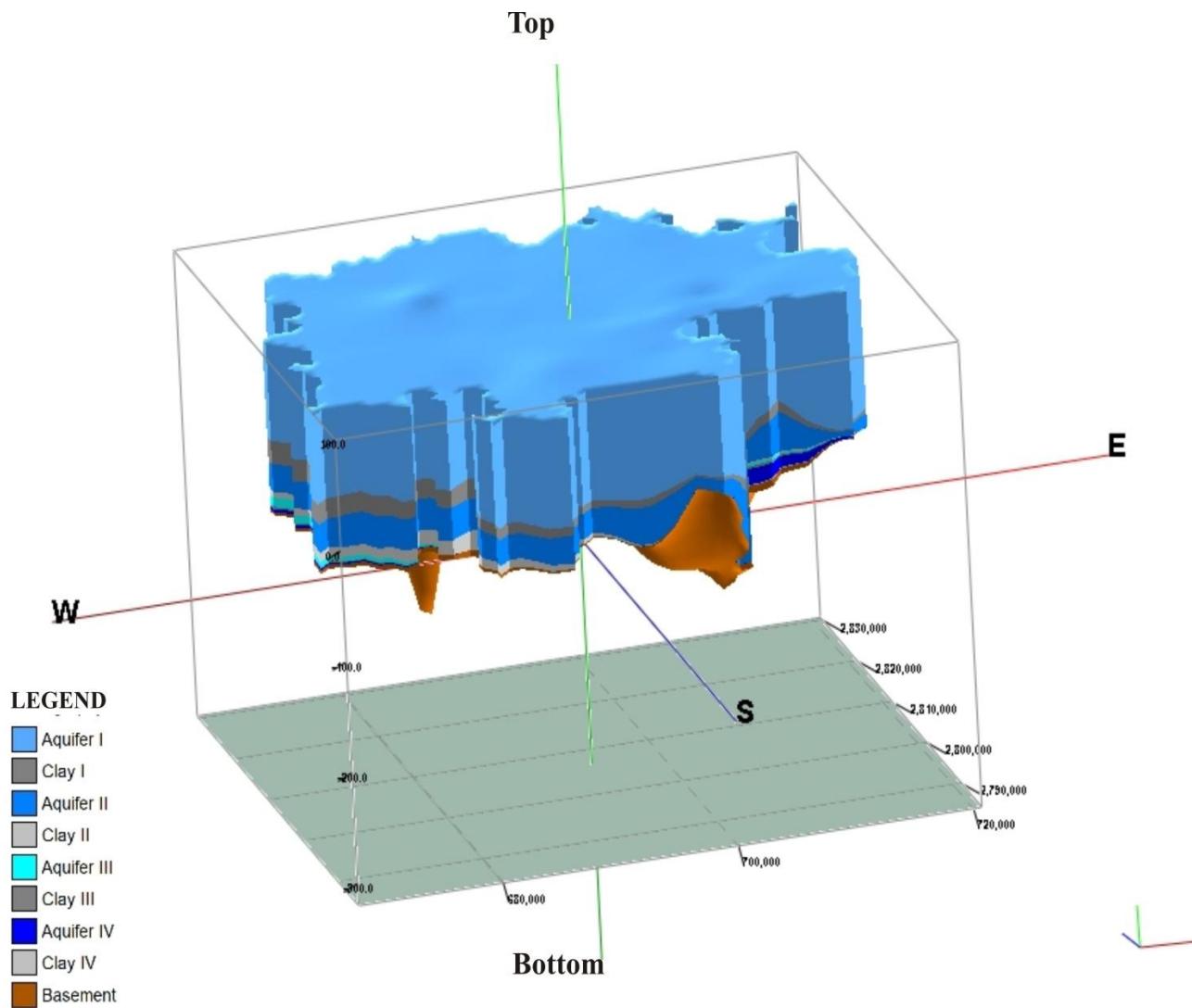


Figure 23: 3-D Aquifer model of Varanasi district

3.4 Fence diagram

In order to understand the regional sub-surface disposition of aquifer system, a fence diagram of the study area has been prepared utilizing lithological logs of tubewells shown in figure-24 and 25. On perusal of the fence diagram it can be inferred that an interlayered sequence of sands, silt and clays with kankar is present in the entire district. On the regional scale, one single aquifer system is seen extending down to the drilled depth of 149 meters. The sediments forming the aquifer are fine to coarse grained sand and silt. Basement has been encountered in few boreholes.

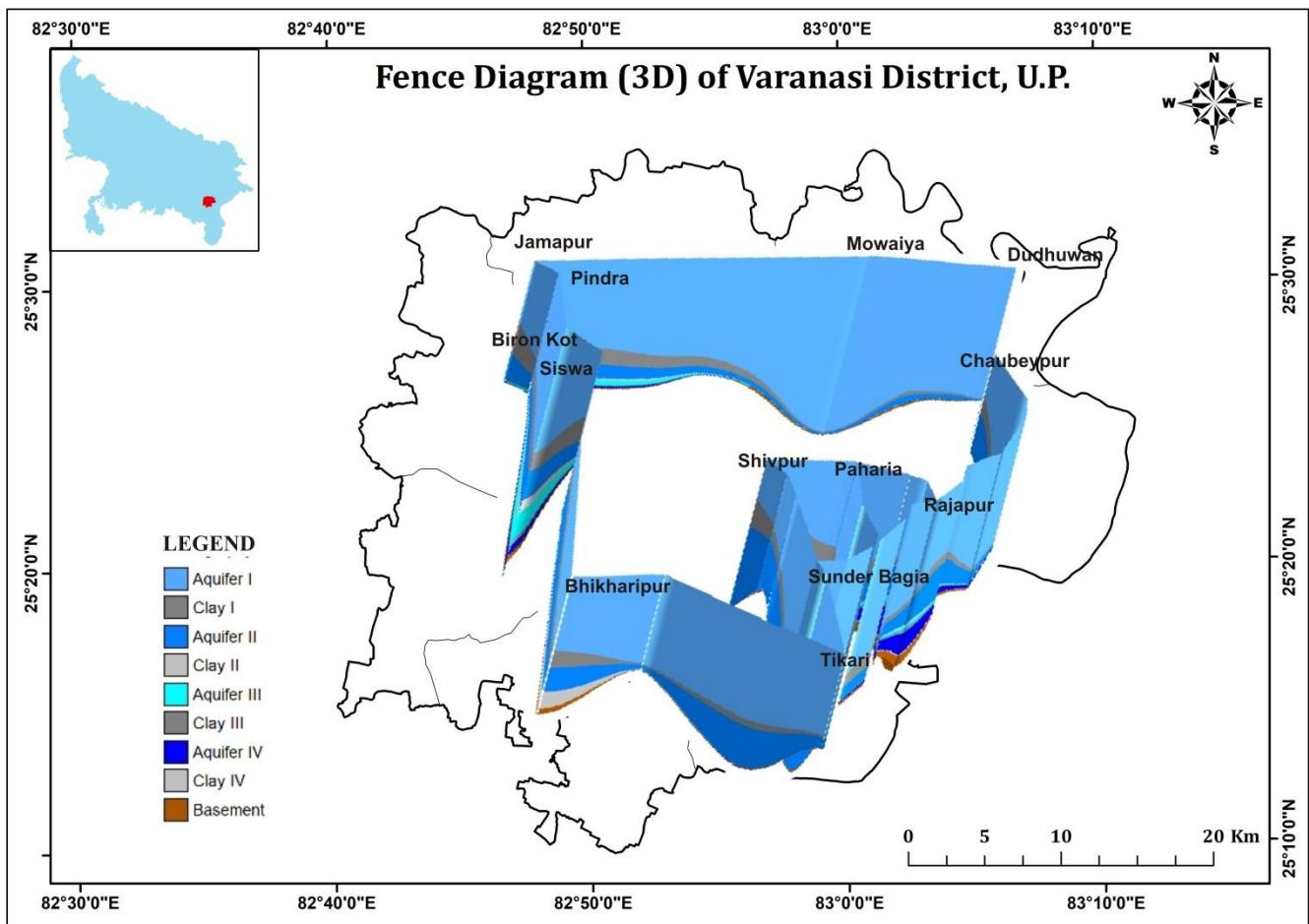


Figure 24: Fence diagram of Varanasi district

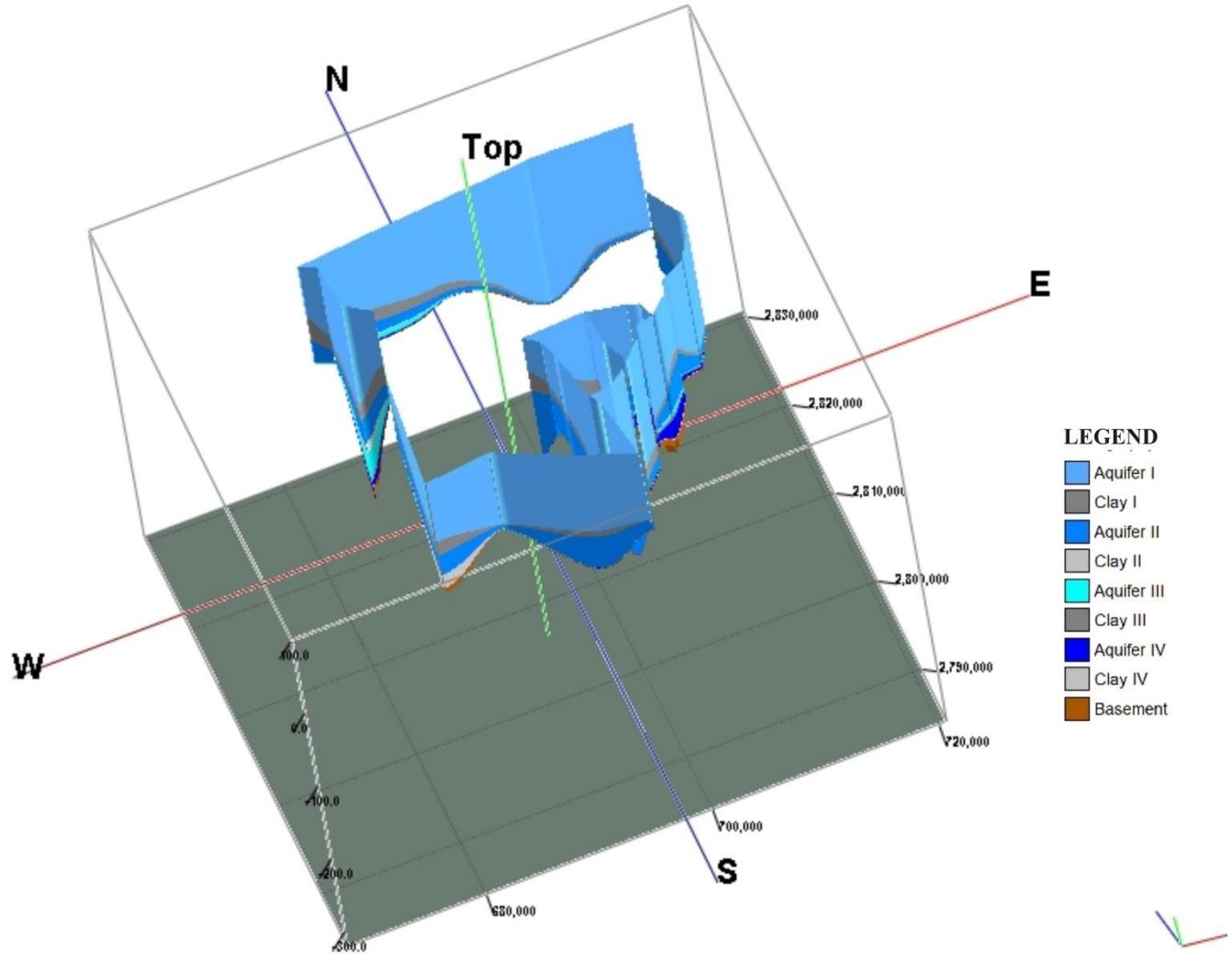
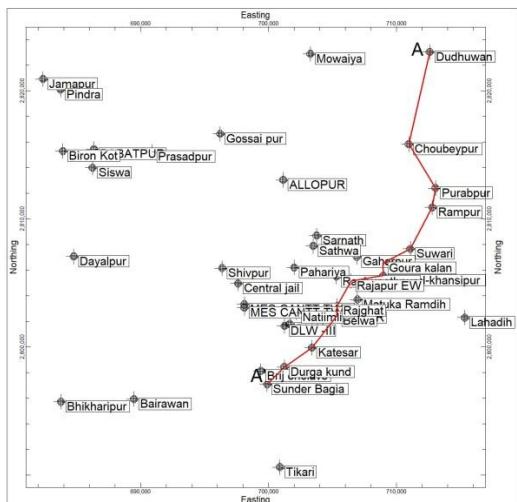


Figure 25: Fence diagram showing Aquifer groups in Varanasi district

3.5 Cross-sections (in 2-D)

To obtain two-dimensional generalized view of the aquifer dispositions, cross-sections have been prepared on the basis of integrated lithologs using Rockworks software. As per the data available four cross-sections has been prepared viz. A-A', B-B', C-C' and D-D'. Cross-sections along various bore holes are shown in figure-26 to 29. 2-D Cross section shows that basement have been encountered at various depth indicating gradual thinning of alluvial sediments.

Cross-section A-A' drawn from Dudhuwan in Cholapur block to Sunder Bagha in Kashi Vidyapith block (figure-26) and runs in N-S direction covering the borehole across district. The section is 33 kms long covering wells of Cholapur-Chiraigaon-Kashi Vidyapith blocks. The depth of borehole ranges from 98 m bgl for Choubeypur to 402 m bgl for Rajapur. From the section A-A' it can be deciphered that Basement is encountered at Rajapur (depth 342 m bgl) and Katesar (depth 280 m bgl). Maximum four groups of aquifer present in the given section with fourth group present at Rajapur drilled with departmental rig. The cross-section depicts the occurrence of sand, silty sand and kankar as aquifers separated by confining layers of clay as aquiclude.



Cross-Section A-A'

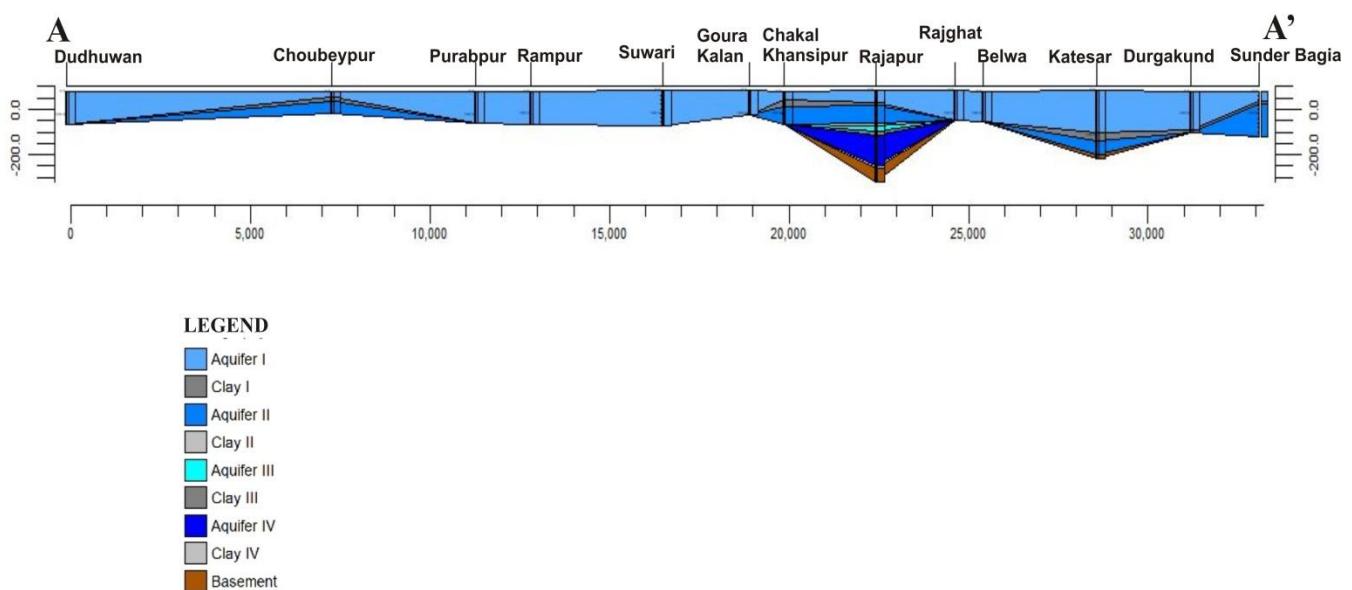


Figure 26: Cross-section depicting Aquifer disposition along A-A'

Cross-section B-B' drawn from Biron Kot in Baragaon block to Rajapur in Chiraigaon block (figure-27) and runs in NW-SE direction. The section is 27 kms long covering wells of Baragaon-Pindra-Harahua-Chiraigaon blocks. The depth of borehole ranges from 79 m bgl for Allopur to 402 m bgl for Rajapur. From the section B-B' it can be deciphered that Basement is encountered at Rajapur (depth 342 m bgl) and Sarnath (depth 107 m bgl). Maximum four groups of aquifer encountered in the given section with fourth group present at Rajapur drilled with departmental rig. The cross-section depicts the occurrence of sand, silty sand and kankar as aquifers separated by confining layers of clay as aquiclude.

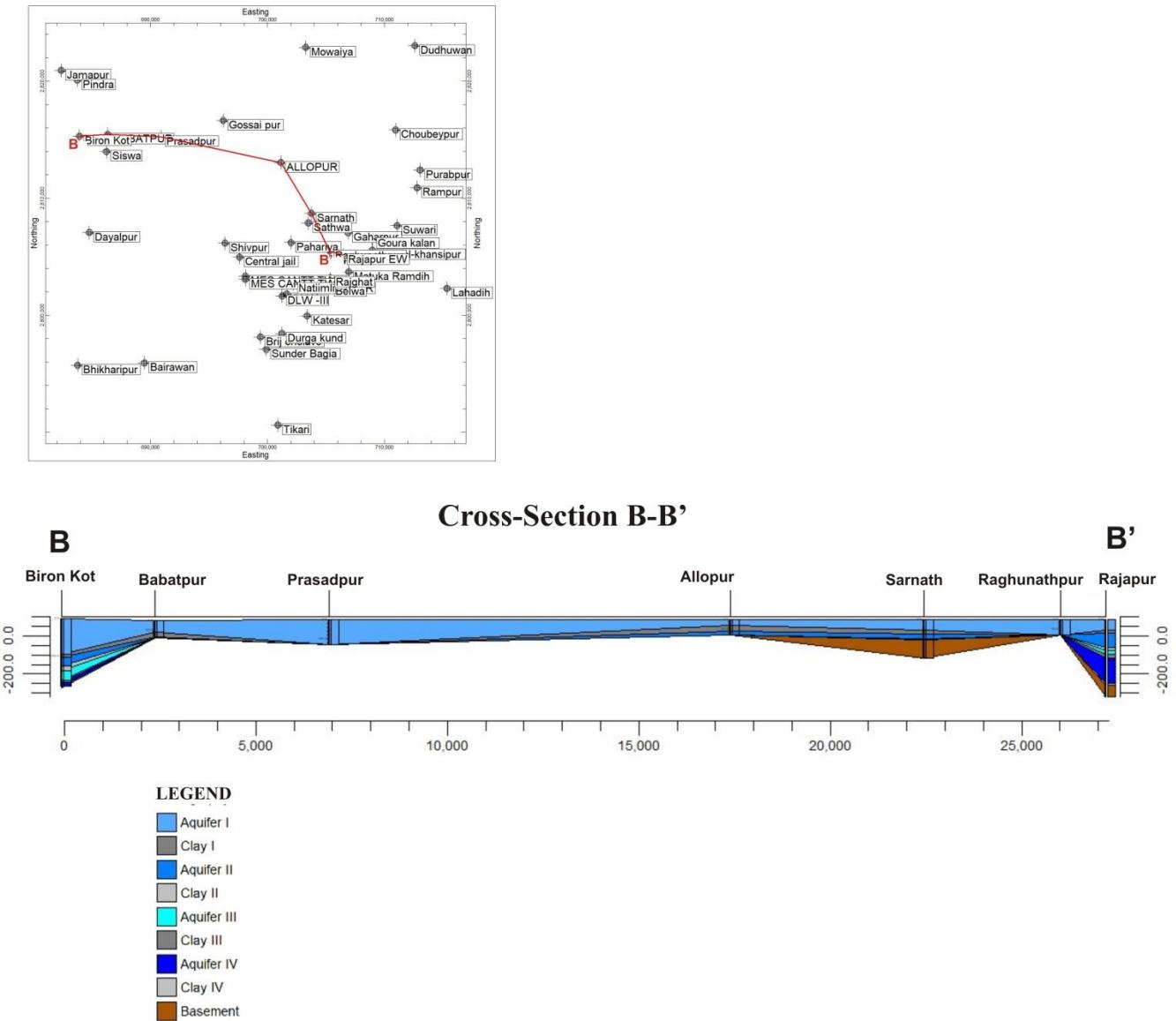
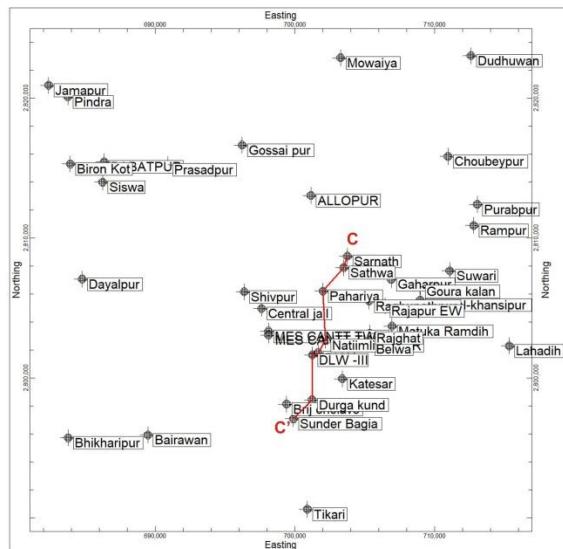


Figure 27: Cross-section depicting Aquifer disposition along B-B'

Cross-section C-C' drawn from Sarnath in Chiraigaon block to Sunder Baghia in Kashi Vidyapith block (figure-28) and runs in N-S direction. The section is 13 kms long covering wells of Chiraigaon-Kashi Vidyapith blocks. The depth of borehole ranges from 147 m bgl for Sathwa to 293 m bgl for Nati Imli. From the section C-C' it can be deciphered that Basement is encountered at Nati Imli (depth 273 m bgl) and Sarnath (depth 107 m bgl). Maximum two groups of aquifer present in the given section. The cross-section depicts the occurrence of sand, silty sand and kankar as aquifers separated by confining layers of clay as aquiclude.



Cross-Section C-C'

C

C'

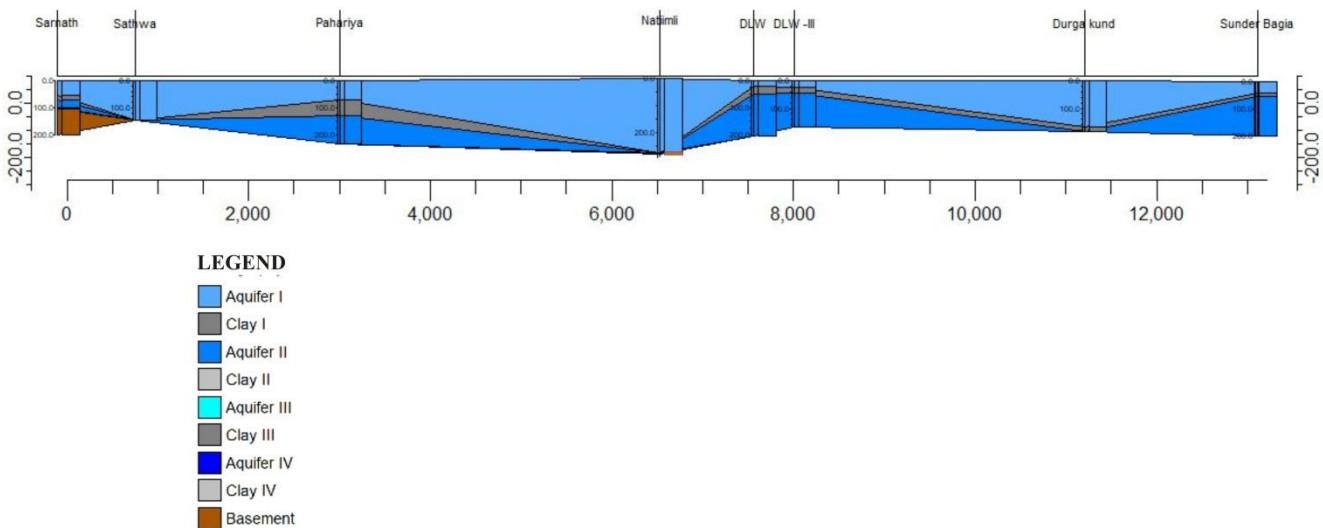
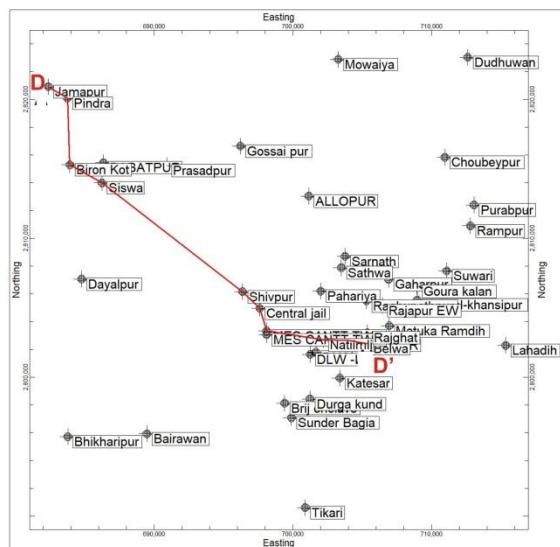


Figure 28: Cross-section depicting Aquifer disposition along C-C'

Cross-section D-D' drawn from Jamapur in Pindra block to Belwa in Kashi Vidyapith block (figure-29) and runs in NW-SE direction. The section is 32 kms long covering wells of Pindra-Harhua-Kashi Vidyapith blocks. The depth of borehole ranges from 61 m bgl for Central Jail to 356 m bgl for Biron Kot. From the section D-D' it can be deciphered that Basement is encountered at Biron Kot (depth 352 m bgl). All four groups of aquifer present in the given section. The cross-section depicts the occurrence of sand, silty sand and kankar as aquifers separated by confining layers of clay as aquiclude.



Cross-Section D-D'

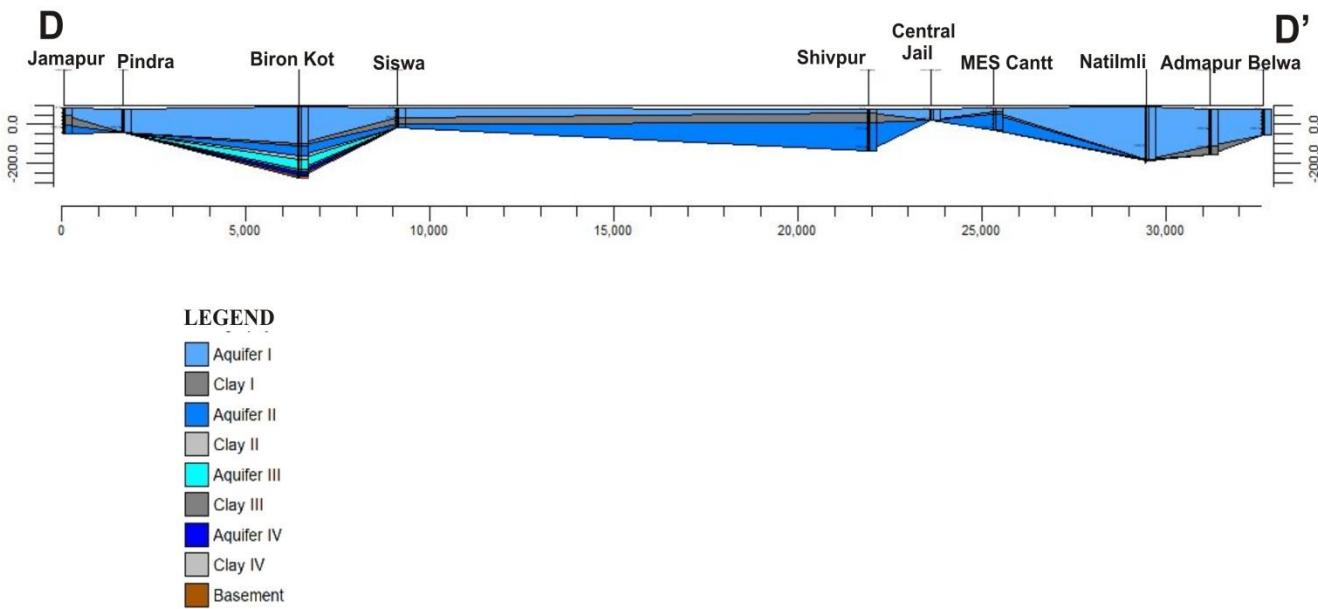


Figure 29: Cross-section depicting Aquifer disposition along D-D'

4.0 GROUND WATER RESOURCES

To facilitate the ground water development the ground water resources of the district have been worked out. The assessment of total availability of ground water resources encompasses two component namely Dynamic and In-storage resources.

On the recommendation of National Water policy 2012 and the changes in the GEC-15, Central Ground Water Board (CGWB) and Ground Water Department, Government of U.P. has jointly estimated Dynamic Ground Water Resources of Uttar Pradesh in 836 assessment units (826 blocks and 10 Urban area) for the base year 2019-20 (As on March-2020).

4.1 Dynamic Ground water resources of Unconfined Aquifer

Dynamic Ground Water Resource Estimation as on 31.3.2020 has been carried out for 9 assessment units (8 blocks and City) by GWD and CGWB jointly adopting Ground Water Estimation Committee (2015) methodology. Only one block of the district comes under Safe category. Development of ground water is generally high as 3 Assessment units (Araziline block, Harhua block & Varanasi City) out of 9 Assessment units in the district have been categorized as Over Exploited and 5 blocks categorized as Semi-Critical with the ground water development of the district 91.21%. The details are given in the table-7 and shown in figure-30.

Table 7 : Dynamic Ground water Resources of Varanasi district (as on 31.03.2020)

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Recharge from Rainfall-Monsoon Season	Recharge from Other Sources-Monsoon Season	Recharge from Rainfall- Non Monsoon Season	Recharge from Other Sources- Non Monsoon Season	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)
Araziline	24002	24002	4926.42	1210.27	54.6	1947.51	8138.8	406.94
Baragaon	17853	17853	2721.48	1135.12	40.61	1775.2	5672.41	283.62
Chiraigaon	20865	20865	4358.77	702.01	47.46	1161.23	6269.47	313.47
Cholapur	17937	17937	2587.85	1875.36	40.8	2850.21	7354.22	735.42
Harahua	14117	14117	2468.07	1654	32.11	2653.49	6807.67	340.38
Kashi Vidyapith	14340	14340	3091.81	795.91	32.62	1249.72	5170.06	258.51
Pindra	22350	22350	4492.29	1711.03	50.84	2696.76	8950.92	447.55
Sevapuri	16913	16913	2440.11	1205.71	38.47	1867.27	5551.56	555.15
Varanasi City	7997	7997	519.19	857.75	5.46	1751.25	3133.65	313.36

*Ground water draft for Industrial Use has not been taken up during GW Resource Estimation of UP as on March, 2020 hence not included.

* Due to insufficient data instorage resources couldn't be estimated.

Assessment Unit Name	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization
Araziline	7731.86	7671.2	803.9709	8475.17	814.74	0	109.61	over exploited
Baragaon	5388.79	3347.6	569.1985	3916.80	613.23	1427.97	72.68	semi_critical
Chiraigaon	5956	4019.28	740.9493	4760.23	765.42	1171.3	79.92	semi_critical
Cholapur	6618.8	3941.04	602.9771	4544.02	664.87	2012.89	68.65	safe
Harahua	6467.29	7020.12	728.9612	7749.08	846.58	0	119.82	over exploited
Kashi Vidyapith	4911.55	2916.16	569.746	3485.91	573.84	1421.56	70.97	semi_critical
Pindra	8503.37	6392.4	688.1221	7080.52	752.53	1358.44	83.27	semi_critical
Sevapuri	4996.41	3067.6	580.2602	3647.86	630.72	1298.09	73.01	semi_critical
Varanasi City	2820.29	0	5043.862	5043.86	5284.38	0	178.84	over exploited

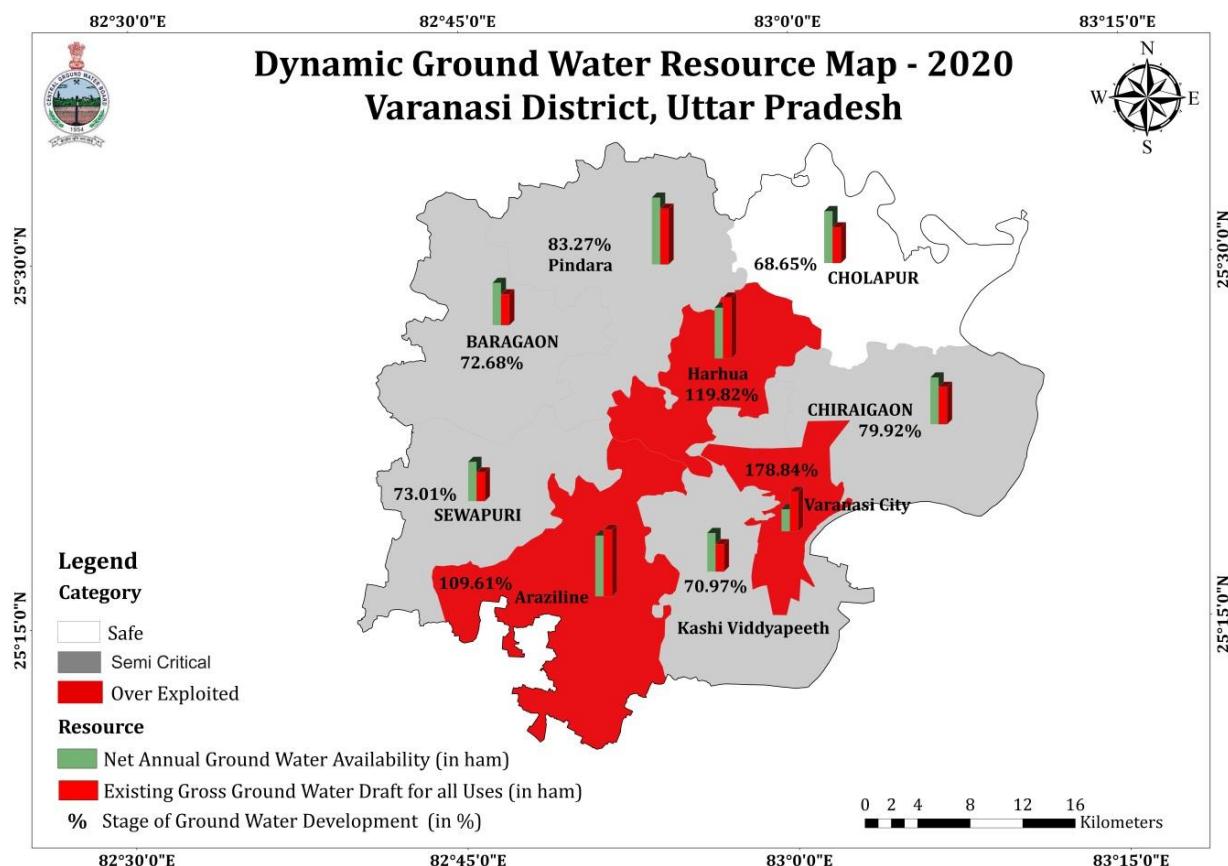


Figure 30: Dynamic Ground Water Resources Map of Varanasi district

5 GROUND WATER RELATED ISSUES AND PROBLEMS

- Development of ground water is generally high as 3 Assessment units (Araziline block, Harhua block & Varanasi City) out of 9 Assessment units in the district have been categorized as Over Exploited and 5 blocks categorized as Semi-Critical with the ground water development of the district 91.21%.
- Irrigation is the main reason for over exploited blocks as the Ground Water Draft for Irrigation is in excess (7671 Ham for Araziline block & 7020 Ham for Harhua block) against the Net Annual GW Availability for future use (0 Ham for each block).
- Percentage of net irrigated area to net sown area is 90.15%.
- The major source of irrigation in the district is ground water, irrigating 89772 ha area contributing about 87.55 % to the total irrigation potentials of the district with only 11% area irrigated by canals. Block wise irrigated area through different sources given in figure-31.

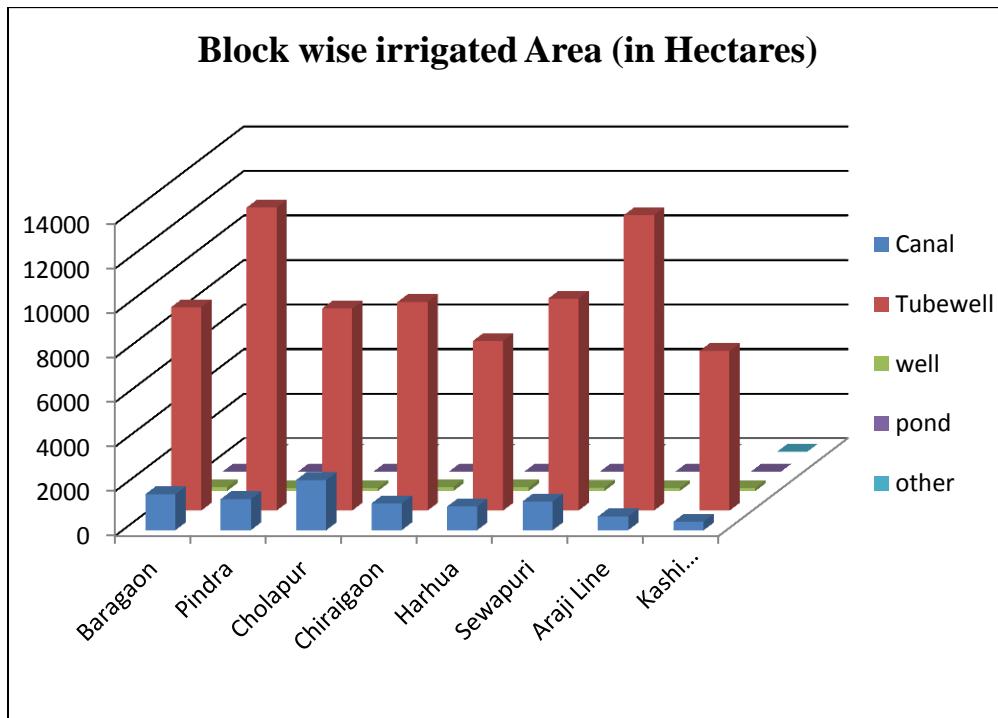


Figure 31: Block-wise irrigated area (in hectare) by various means in Varanasi district

- Poor sewerage and drainage facilities, leakage of human excreta from very old septic tanks and application of nitrogenous fertilizer might have also contributed to nitrate enrichment in the ground water.

- Excessive use of fertilizers and pesticides in agriculture has also reportedly resulted in localized enrichment of Nitrate in the phreatic aquifer at few localized pockets.
 - Ground water pollution resulting from land disposal of liquid or solid waste by sewage (old drains) has become serious problem in city area.
 - Farmers are growing mainly cash crops throughout the year resulting in long duration pumping hours annually.
 - Decrease in yield of bore wells resulting in increased expenditure and power consumption for drawing water from progressively greater depths.
 - Rapid increase in infrastructure development leads to increase in domestic demand for ground water.
- From the table given below it can be infer that the urban area has increased 14% for the last 10 yrs.

Year	City Area
2009	70 sq km
2019	80 sq km

- Ponds used to be a good source of water for domestic needs as well as recharge to ground water but due to rapid expansion of the city, most of these sacred ponds have been encroached with settlement. This shows utter disregard of environmental conservation to accommodate growing population.
- Varanasi Industrial area has put an additional stress on ground water resources. Manufacturing industries like spinning and weaving, metal, printing and publishing, electrical machinery. In the metal manufacturing sector, Diesel Locomotive Works is a major employer. BHEL, a large power equipment manufacturer, also operates a heavy equipment maintenance plant. Coke has green field bottling plant in Varanasi district.

6.0 MANAGEMENT STRATEGIES

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 schemes, On-farm activities and adoption of water use efficiency measures.

6.1 Demand Side Management:

i. Management of Surface water resources

- Surface water resources like canal and ponds should be used to meet the specified demand in a given area especially for irrigation purposes.
- Need to increase the surface water irrigation to reduce the stress on ground water along with intervention practices.

ii. Change in Irrigation practices and Cropping pattern

- Quality production and increase in productivity by adopting drip and sprinkler irrigation system in horticulture and agricultural crops.
- Farmers should grow more food crops than cash crops.
- Less water intensive crops may be encouraged in OE blocks.

iii. On farm activities

- Farmers should adopt On Farm practices such as laser levelling, bench terracing, construction of farm ponds, afforestation, diversification of crops etc. which will prevent wastage of water in field and increasing crop yield as well.
- Agriculture department should promote to conserve the soil moisture by reducing ET losses through cultivation of 'Green Manure'.

iv. Water use efficiency

It mainly includes adoption of techniques to enhance water Use Efficiency for reducing draft of ground water. 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. While through drip and sprinkler irrigation wastage of irrigational water could be minimized.

Block-wise Demand side proposed numbers of interventions are given in table-8 which is calculated on the basis of area of the blocks, water level, long term ground water trend and feasibility of the aquifer.

Table-8: Blockwise Demand Side Management, Varanasi District, U.P			
Block	Demand Side Management		
	On-farm Area (ha)	WUE Area (ha)	Total Saving from On-farm & WUE MCM
Araziline	648	648	2.13
Gograpur	2483	2483	4.57
Chiraigaon	2643	2643	5.93
Cholapur	1339	1339	2.76
Varanasi	3729	3729	17.77
Harhua	1536	1536	3.49
Kashi Vidyapith	3429	3429	8.69
Pindra	2273	2273	3.82
Total	18079	18079	49

6.2 Supply Side Management:

i. *Lining/ efficient use of canals*

- Canal lining will improve the water use efficiency of canal water but recharge to ground water from canal seepage will be reduced. So, canal lining is not advisable except in the heavy filling patches, where canal seepage is more than the ground water use and the seepage water is converting the adjacent land to sodic lands.
- Even in the canal command areas the existing canals are losing their utility and storage capacity for agriculture purposes due to siltation and improper management. Through desiltation and proper management, canals can be efficiently used for irrigation purposes. Thus the stress on ground water can be minimize.

ii. *Restoration of Minor irrigation sources*

Restoring the existing minor irrigation sources by taking up de-silting of tanks, restoration of existing tanks and ponds, repairing and renovation of water bodies arresting the leakages from bund, weir and sluices etc., and restoring irrigation channels, filed channels, canal structures to original standards.

iii. Water Conservation and Artificial Recharge to Ground water

Artificial recharge of shallow aquifers is viable in the area where ground water level exists beyond 8-10 metres depth round the year. Out of 8 blocks, 2 blocks are under over exploited category and 5 blocks are under semi-critical category. Artificial recharge measures and conservation of water techniques can be adopted in these blocks to arrest further decline in water levels by constructing structures like check dams / cement plugs / nala bunds etc. In urban areas Roof top rain water harvesting techniques need to be adopted.

iv. Mass awareness

As Araziline and Harhua Blocks falls under over exploited category as per GWRE-2020, there is urgent need for participatory ground water management in the area which will help in bringing more awareness among the common people about the judicious and optimum utilization of ground water and the problems related with ground water pollution and over exploitation.

On the auspicious occasion of 'Azadi ka Amrit Mahotsav, India @ 75' Central Ground Water Board, Lucknow has organized a Public Interaction Programme (PIP) and Tier- III training at Banaras Hindu University, Varanasi district on 24-11-2021 (Plate-II).



Plate-II: CGWB, NR, Lucknow organized PIP on 75 years of India's Independence and Tier III training at Banaras Hindu University, Varanasi District on 24.11.2021

Block-wise Supply side proposed numbers of interventions are given in table-9 that has been calculated on the basis of area of the blocks, water level, long term ground water trend and feasibility of the aquifer.

Table-9 : Blockwise Supply Side Management, Varanasi District, UP

Block	Check Dam				Stream Development				Nala Bunds				Ponds				Annual Recharge (MC M) (~50 % of total storage)	Supply for Irrigation (MC M)
	Check Dams (10000cum)	Storage (MC CM) 3 Fillings	Recharge from Check Dams (MC M)	Supply for Irrigation (MC M)	Stream Development (Km)	Storage (MC M) 3 Fillings	Recharge Stream Dev (MC M)	Supply for Irrigation (MC M)	Nala Bunds (Capacity 7500 cub. m each)	Storage (MC CM)	GW Recharge Nala Bunds (MC M)	Supply for Irrigation (MC M)	Ponds (capacity 10000 cub. m each)	Storage (MC CM)	GW Recharge from Ponds (MC M)	Supply for Irrigation (MC M)		
Araziline	6	0.18	0.09	0.09	6	0.27	0.14	0.14	6	0.14	0.07	0.07	10	0.29	0.14	0.14	0.87	0.44
Baragaon	2	0.07	0.03	0.03	2	0.10	0.05	0.05	2	0.05	0.03	0.03	2	0.07	0.03	0.03	0.28	0.14
Chiraiqaon	3	0.08	0.04	0.04	3	0.12	0.06	0.06	3	0.06	0.03	0.03	3	0.08	0.04	0.04	0.33	0.17
Cholapur	2	0.05	0.03	0.03	2	0.08	0.04	0.04	2	0.04	0.02	0.02	2	0.05	0.03	0.03	0.23	0.11
Harahua	4	0.11	0.05	0.05	4	0.16	0.08	0.08	4	0.08	0.04	0.04	6	0.17	0.08	0.08	0.51	0.26
Kashi Vidyapith	2	0.05	0.03	0.03	2	0.08	0.04	0.04	2	0.04	0.02	0.02	2	0.05	0.03	0.03	0.23	0.11
Pindra	3	0.08	0.04	0.04	3	0.13	0.06	0.06	3	0.06	0.03	0.03	3	0.08	0.04	0.04	0.36	0.18
Sevapuri	2	0.06	0.03	0.03	2	0.10	0.05	0.05	2	0.05	0.02	0.02	2	0.06	0.03	0.03	0.27	0.13
Total	23	0.69	0.34	0.34	23	1.03	0.51	0.51	23	0.51	0.26	0.26	29	0.86	0.43	0.43	3.09	1.54

6.3 Blockwise Ground Water Management Interventions

Aquifer Management Plan for Varanasi district has been prepared block wise and shown in table-10 which discusses the tentative framework of ground water situation in each block, status of water availability, identification of feasible areas for interventions, feasibility of artificial recharge and other water conservation structures and their numbers. Based on the total area for each block, net ground water availability, draft, physiography and drainage a tentative location map of the district has been prepared (figure-32). The unit costs of structures were taken from the Master Plan to GW Recharge-2020, CGWB, Ministry of Jal Shakti (table-11). The projected change in stage of ground water development after interventions are given in table-12 and figure-33.

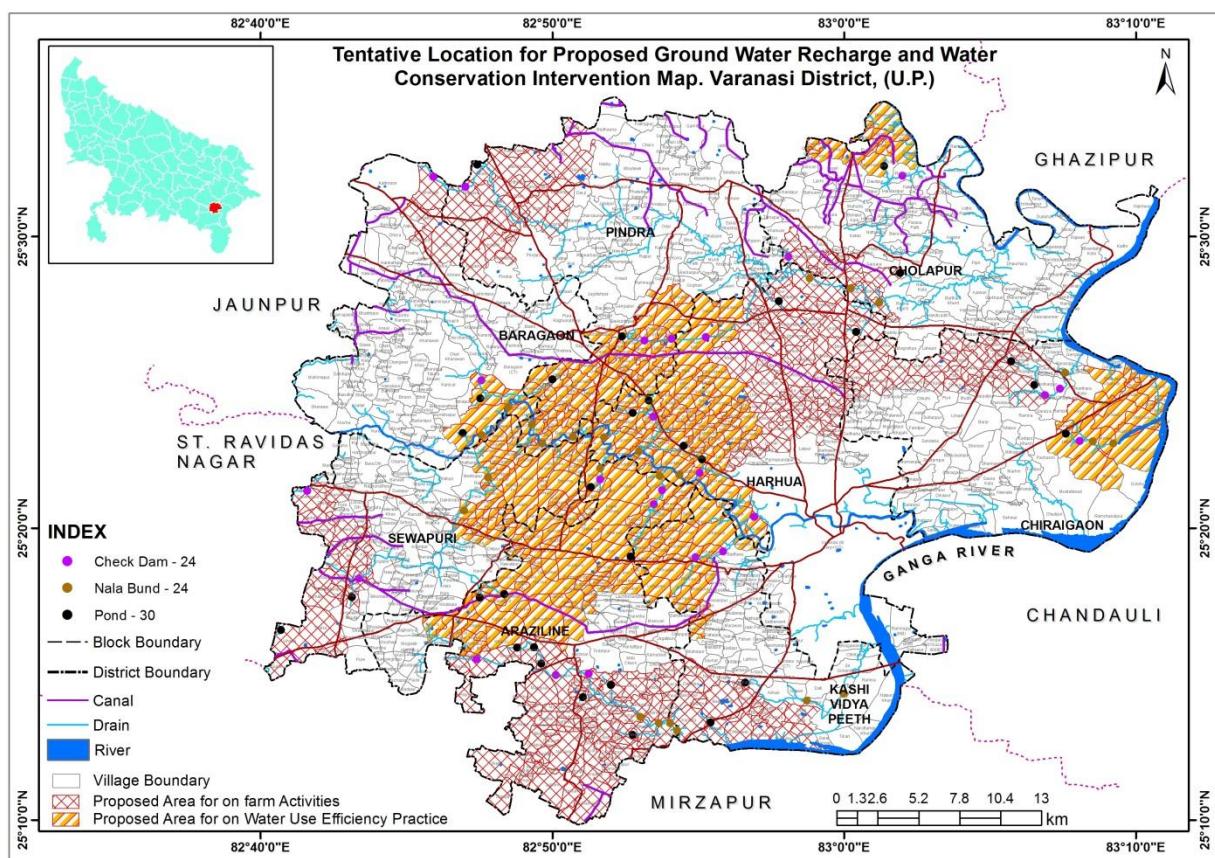


Figure-32: Tentative Locations of Supply side and Demand side Management Interventions, Varanasi District

Table-10: Blockwise Proposed Interventions in Varanasi district													
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Ponds (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech from Str MCM	Saving from Str MCM	Saving from On-farm & WUE MCM	Total Recharge MCM	Total Saving MCM	Present Stage of Ground Water Development (%)	Projected Stage of Development (%) After Interventions
Araziline	6	6	6	10	648	648	0.44	0.44	2.13	0.44	2.56	109.61	105.70
Baragaon	2	2	2	2	2483	2483	0.14	0.14	4.57	0.14	4.71	72.68	63.77
Chiraigaon	3	3	3	3	2643	2643	0.17	0.17	5.93	0.17	6.09	79.92	69.50
Cholapur	2	2	2	2	1339	1339	0.11	0.11	2.76	0.11	2.88	68.65	64.20
Harahua	4	4	4	6	3729	3729	0.26	0.26	17.77	0.26	18.03	119.82	91.58
Kashi Vidyapith	2	2	2	2	1536	1536	0.11	0.11	3.49	0.11	3.61	70.97	63.48
Pindra	3	3	3	3	3429	3429	0.18	0.18	8.69	0.18	8.87	83.27	72.69
Sevapuri	2	2	2	2	2273	2273	0.13	0.13	3.82	0.13	3.95	73.01	64.93
Total	23	23	23	29	18079	18079	2	2	49	2	51	86	74

Table-11: Cost of AR Structures in Varanasi district, U.P													
Unit Cost of Structures (Lakh)													
CD/NB/ CP	DW/TW/ RS	Pond	RTRWH (per 100sq m)				PT						
20.0	1.5	30.0	1.0				60.0						
<i>Source: Master Plan to GW Recharge -2020_CGWB_Ministry of Jal Shakti</i>													

CD/NB/CP- Check Dam/ Nala Bunding/ Cement Plug

RS/ DW/ TW Rech.- Recharge Shaft/ Dug Well/ Tube Well Recharge

PT = Percolation tank

Table- 12: Projected Change in stage of Ground Water Development after Interventions									
Blocks	Area	Net Annual Ground Water Availability (MCM)	Existing Gross Ground Water Draft for All Uses (MCM)	Present Stage of Ground Water Development (%)	Total RECH through interventions (MCM)	Total GW Saving through interventions (MCM)	Projected Net GW Availability (MCM)	Projected Gross GW Draft (MCM)	Projected Stage of Development After Interventions
Araziline	240.02	77.32	84.75	109.61	0.44	2.56	77.76	82.19	105.70
Baragaon	178.53	53.89	39.17	72.68	0.14	4.71	54.03	34.45	63.77
Chiraigaon	208.65	59.56	47.60	79.92	0.17	6.09	59.73	41.51	69.50
Cholapur	179.37	66.19	45.44	68.65	0.11	2.88	66.30	42.56	64.20
Harahua	141.17	64.67	77.49	119.82	0.26	18.03	64.93	59.46	91.58
Kashi Vidyapith	143.4	49.12	34.86	70.97	0.11	3.61	49.23	31.25	63.48
Pindra	223.5	85.03	70.81	83.27	0.18	8.87	85.21	61.94	72.69
Sevapuri	169.13	49.96	36.48	73.01	0.13	3.95	50.10	32.53	64.93
Total	1483.77	505.7407	436.595853	86.33	1.54	50.70	507.28	385.89	74
Estimates based upon GW Resource Estimation as on 31.03.2020									

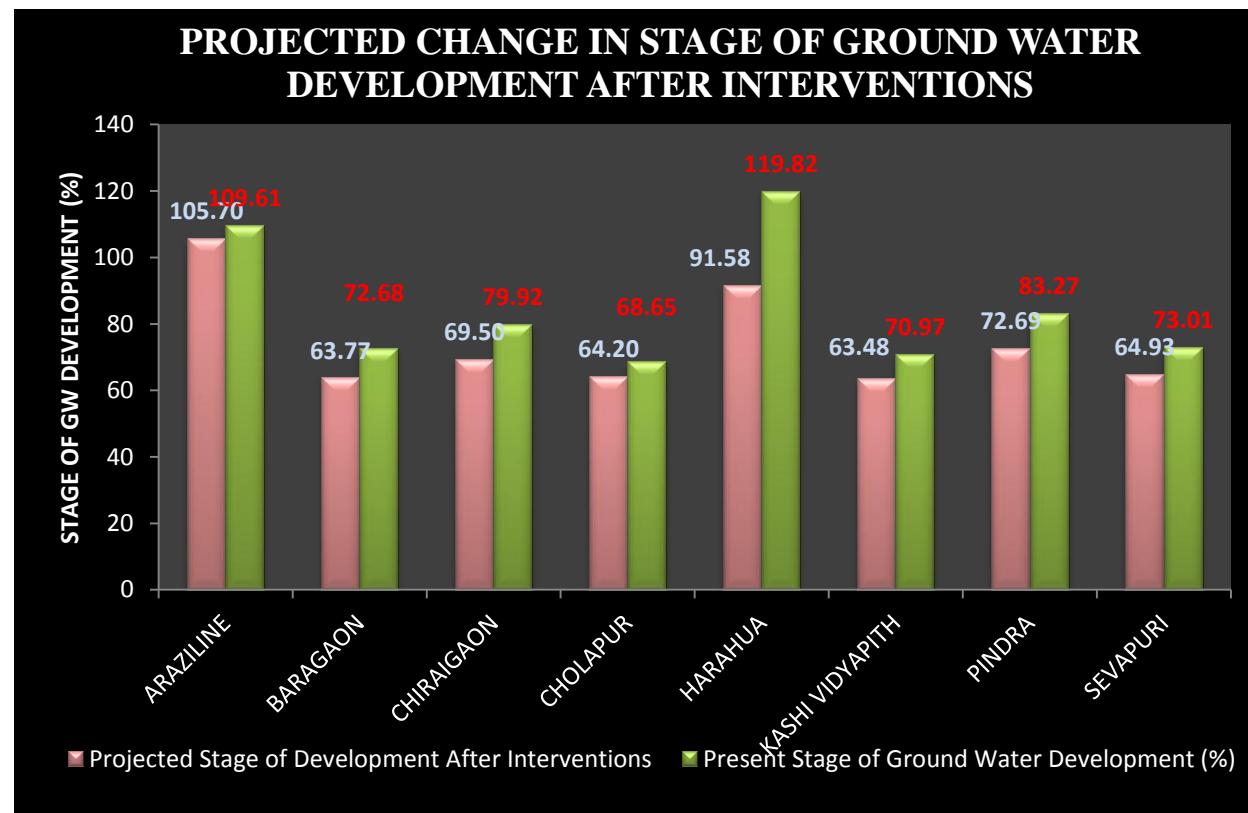
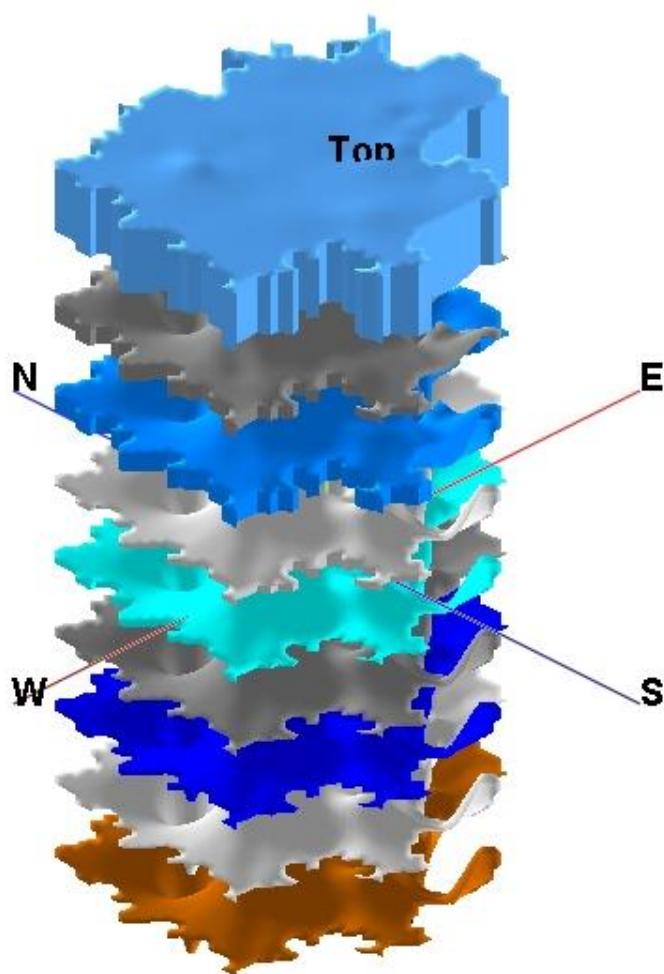


Figure-33: Blockwise projected Change in Stage of Ground Water Extraction after Interventions, Varanasi District

7.0 RECOMMENDATIONS

- I. Availability of water at the tail end should be ensured in canal command areas of the district.
- II. Canal network needs to be extended in Harhua Block as the block is having only 4 kms canal length and categorized under OE.
- III. Deeper GW aquifer system should be developed to lessen the thrust on 1st Aquifer.
- IV. The surface runoff from paved area should be diverted into pit, tanks and ponds during monsoon season to avoid wastage of water and the same can be used for domestic purposes like gardening, car washing etc.
- V. 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. An action-oriented policy for rehabilitation and maintenance of existing ponds/ tanks needs to be adopted so that they may continue to augment groundwater in future also.
- VI. It is recommended that piezometer of 50-70.0 m depth may be constructed in each block for actualizing the water level trend and in assessing the impact of the project implementation in the district.
- VII. Chemical quality is good and potable except for sporadic occurrence of nitrate and fluoride in shallow aquifer reported more than the permissible limit of BIS.
 - Nitrate concentration in may be checked by developing leakage of sewage tanks, lining of drain system and leakage of old septic tanks. Instead of synthetic chemical fertilizers, farmers should be advised to use compost fertilizers, manures etc. in agriculture lands.
 - Fluoride concentration may be checked by cement sealing in the particular zone or if the concentration is marginal the water may be blended with surface water before use.
- VIII. Aquifer wise ground water exploration is recommended in all the blocks to ascertain characteristics of each aquifer.

BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLAN OF VARANASI DISTRICT



I. Aquifer Mapping and Management plan of *Araziline Block*

1. Salient Information

Geographical Area:	240.02 sq km
Population (2011):	Total : 317123 male- 165907, female- 151216
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-162 sq. km Net Irrigated Area-140 sq. km Tube well irrigated area- 133 sq km Well irrigated area- 1.38 sq km Canal irrigated area- 6.18 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 7731.86 Ham/ 77.32 MCM Draft- 8475.17 Ham/ 84.75 MCM Stage of GW Extraction- 109.61% Category- Over Exploited

2. Location :

Araziline block lies in S of Varanasi district encompassing an area of 240.02 Sq Km (figure-34).

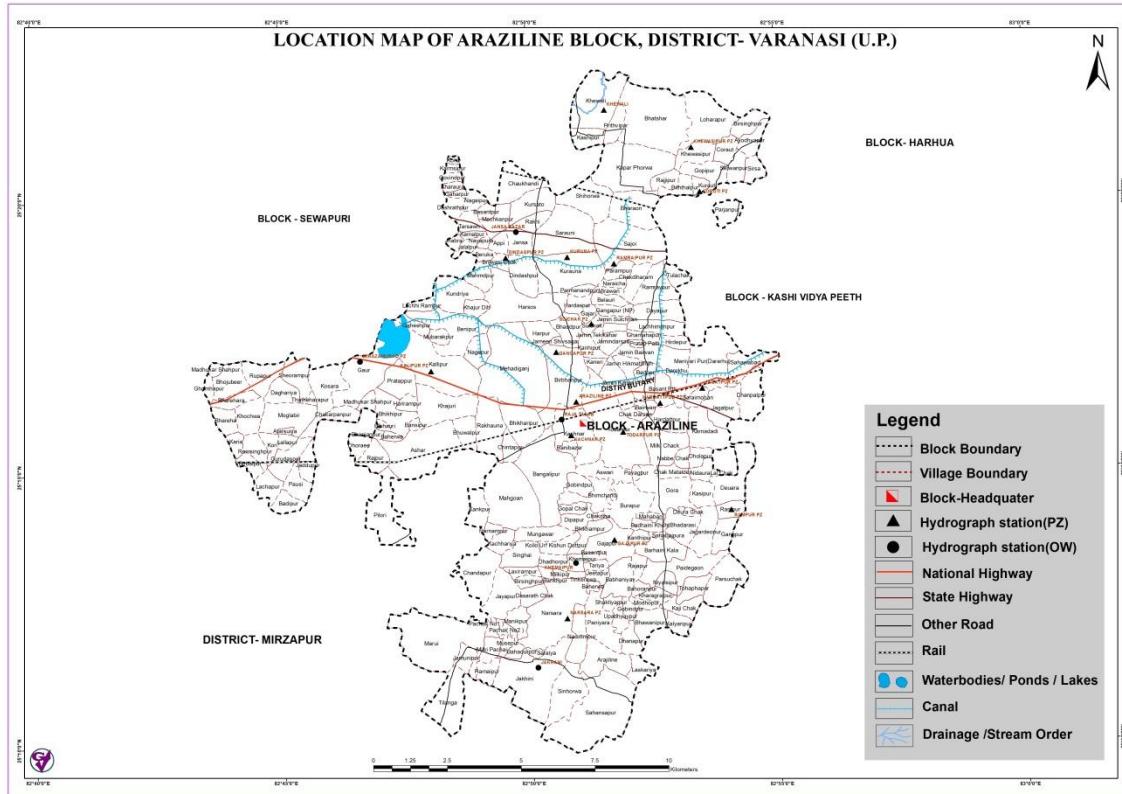


Figure 34: Administrative Map of Araziline block, Varanasi district

3. Geology

Araziline block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades with silt, clay and kankar of Quaternary age (figure-35).

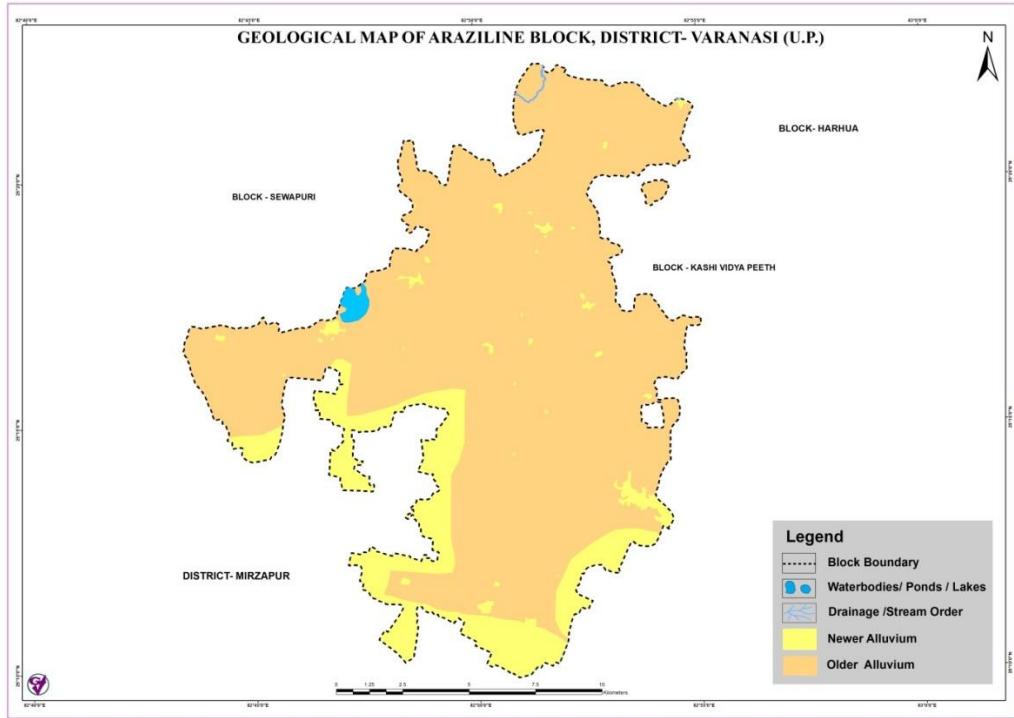


Figure 35: Geology Map of Araziline block, Varanasi district

4. Drainage

Araziline Block mainly drained by flowing nalas (figure-36).

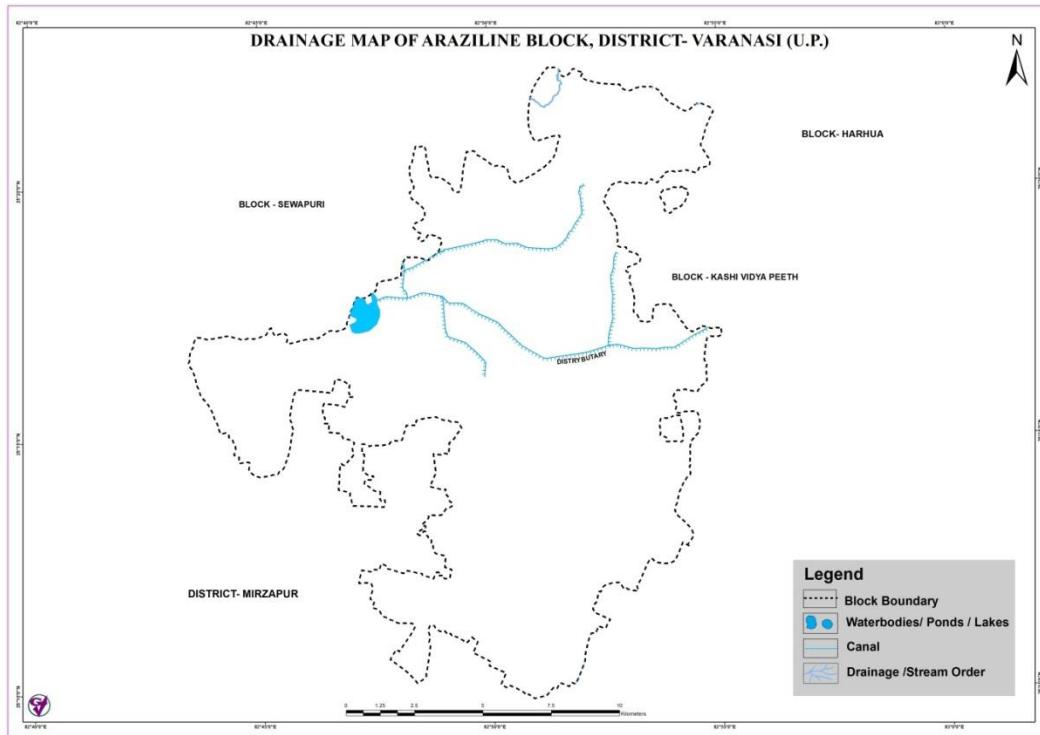


Figure 36: Drainage Map of Araziline block, Varanasi district

5. Soil

The block is mainly covered with fine silt with varying grades of loamy soil (figure-37).

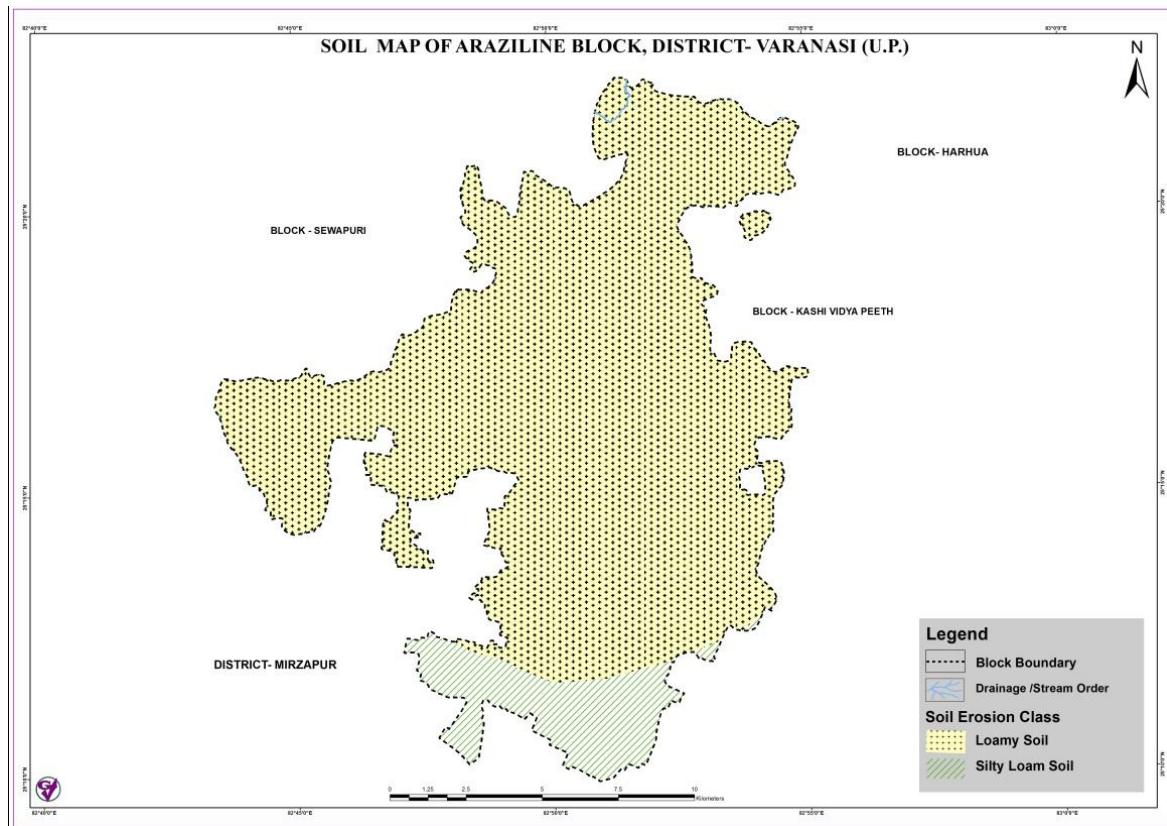


Figure 37: Soil Map of Araziline block, Varanasi district

6. Geomorphology

The block is mainly covered with older/upper alluvial plain. Flood plains and habitation mask can be seen in south ofblock (figure-38).

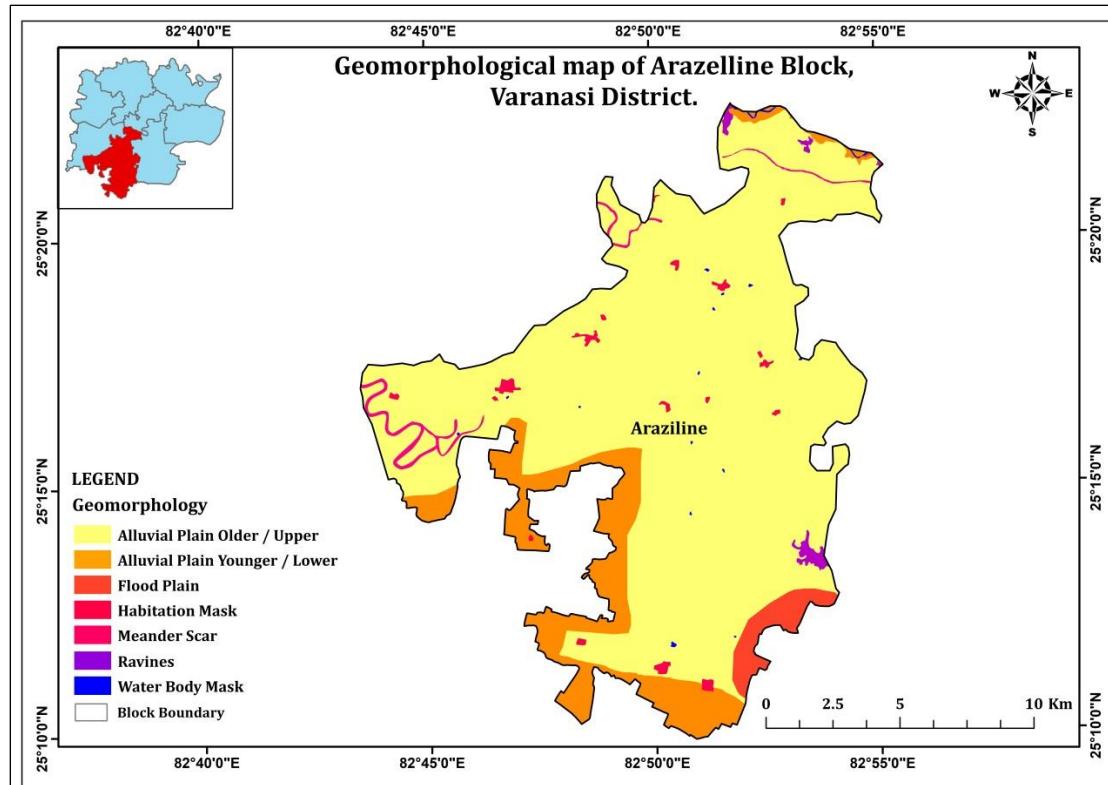


Figure 38: Geomorphology Map of Araziline block, Varanasi district

7. Landuse/ Land cover

The block is well covered with built up area with scattered agricultural land and wasteland (figure-39).

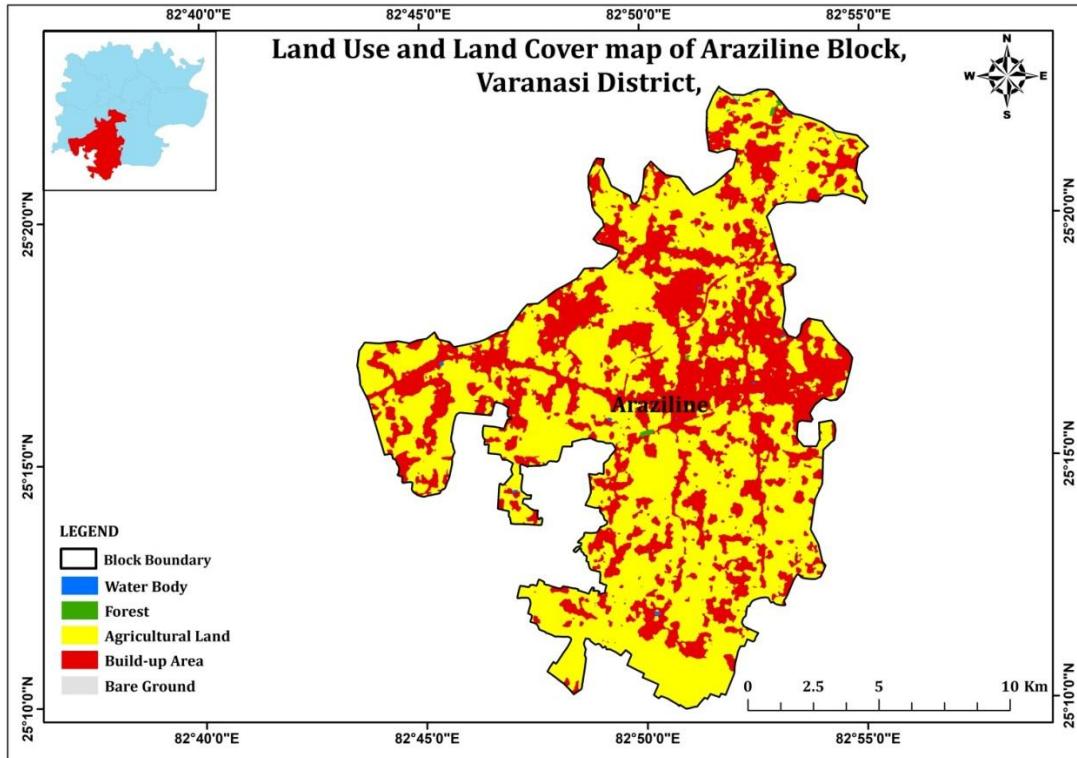


Figure 39: Landuse/Landcover Map of Araziline block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally deep throughout the block ranging in between 10.0 m bgl to 15.0 m bgl (figure-40).

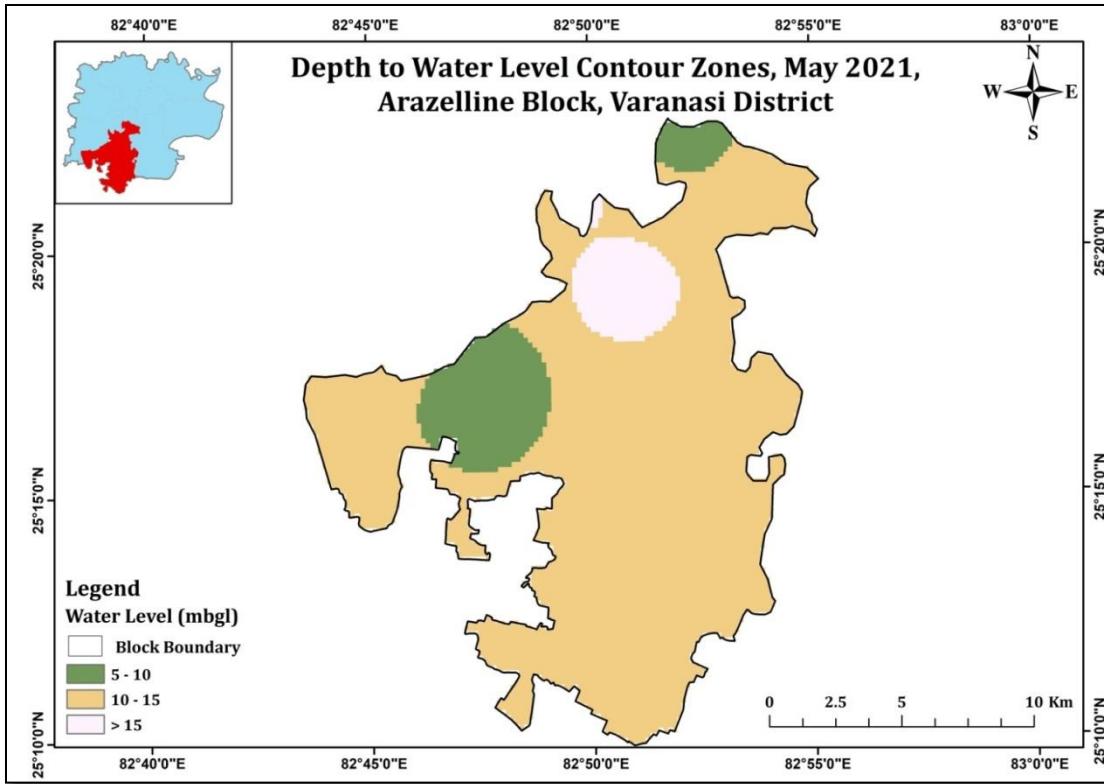


Figure 40: Depth to Water level Map (Pre-Monsoon) of Araziline block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is deep throughout the block ranging in between 5.0 m bgl (figure-41).

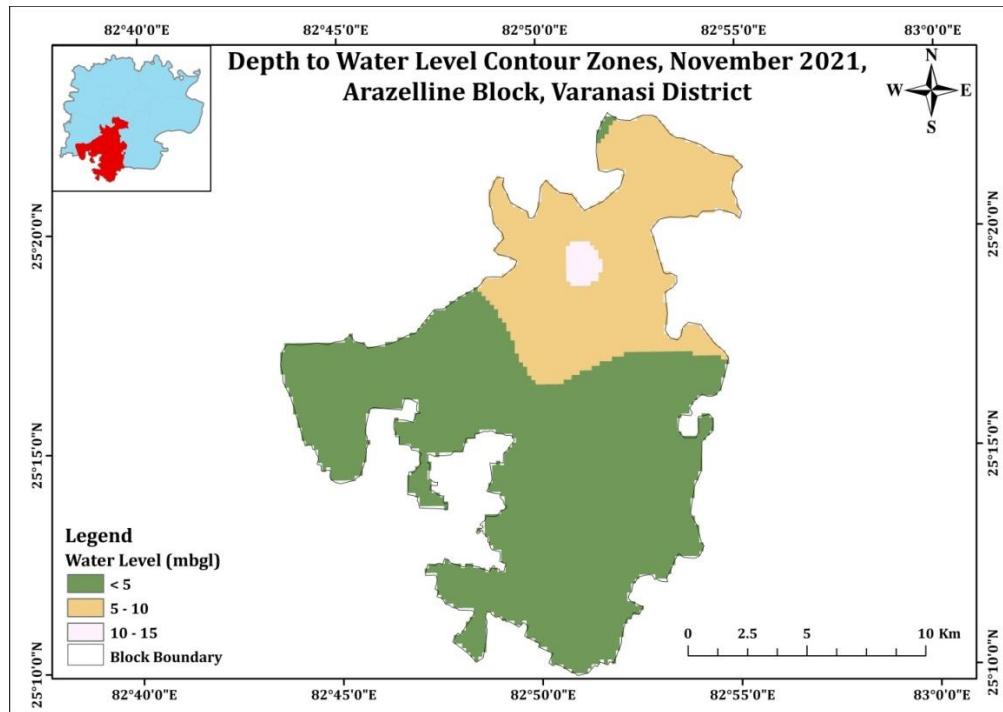


Figure 41: Depth to Water level Map (Post-Monsoon) of Araziline block, Varanasi district

10. Ground water Resources

The block is categorized as Over Exploited as per 2020 ground water resource assessment with 109.61% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

Quality of ground water is potable and all the chemical constituents are within the permissible limit of BIS-2012 except for sporadic occurrence of Nitrate ($>45 \text{ mg/l}$) (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Two aquifer groups reported from the exploration carried out in Araziline block. Basement has been encountered at a depth of 149 mbgl in Bhikharipur borewell drilled by the department. Ground water occurs under water table condition at shallow depths while the confined aquifers are under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-42).

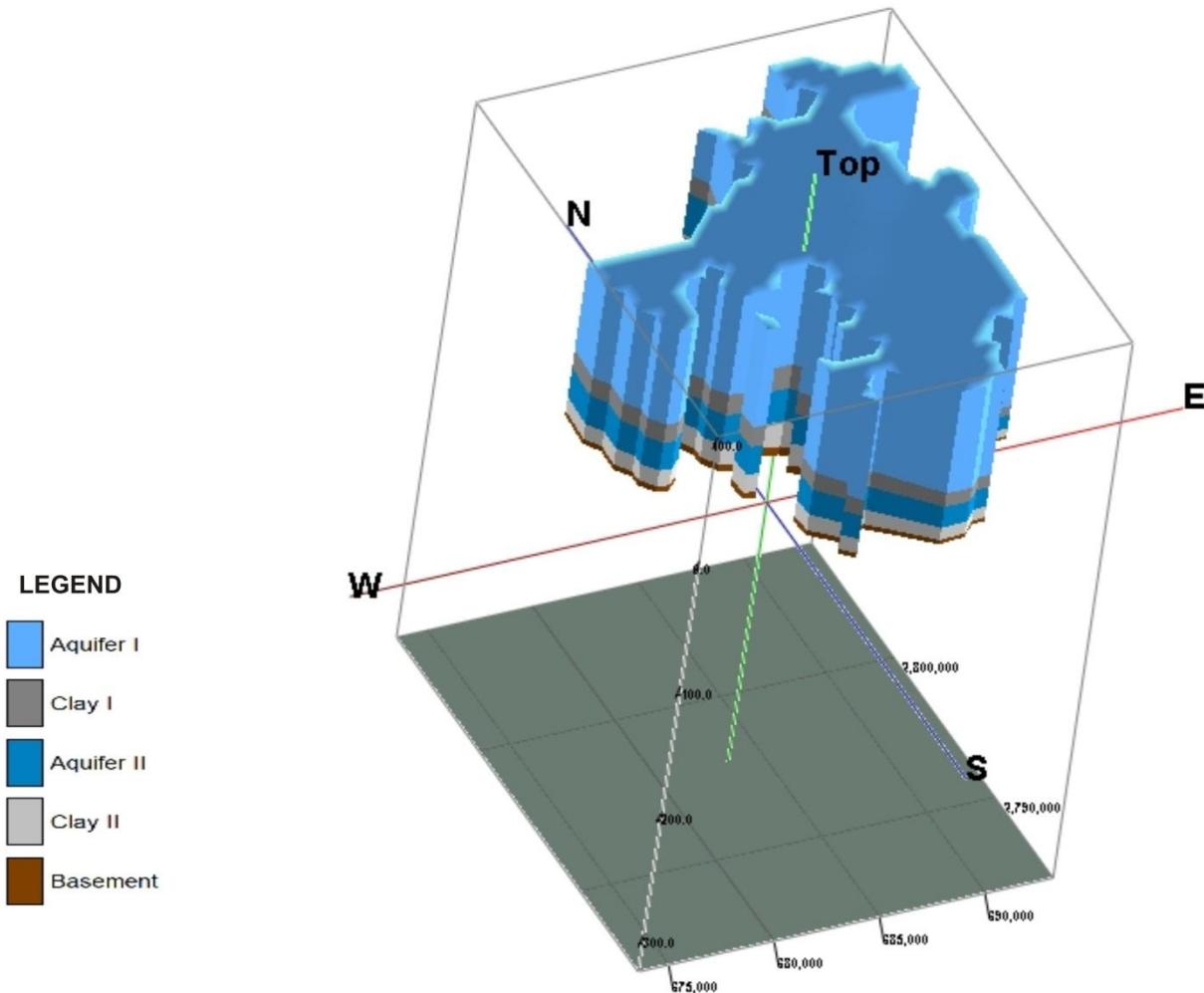


Figure 42: 3-D Model depicting Aquifer geometry of Araziline block, Varanasi district

13. Management Plan

- Block is Over exploited as per GW Resource Estimation, 2020 with 109.61% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 86.6% wherein the contribution of ground water for irrigation in this block is 94.59%.
- As the block is over exploited, hence artificial recharge measures and conservation of water techniques should be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-43.

Ground Water Management Strategies and Projected Stage of Extraction of Araziline Block, Varanasi District,													
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns
Araziline	6	6	6	10	8676	8676	0.44	0.44	17.06	0.44	17.50	109.61	86.49

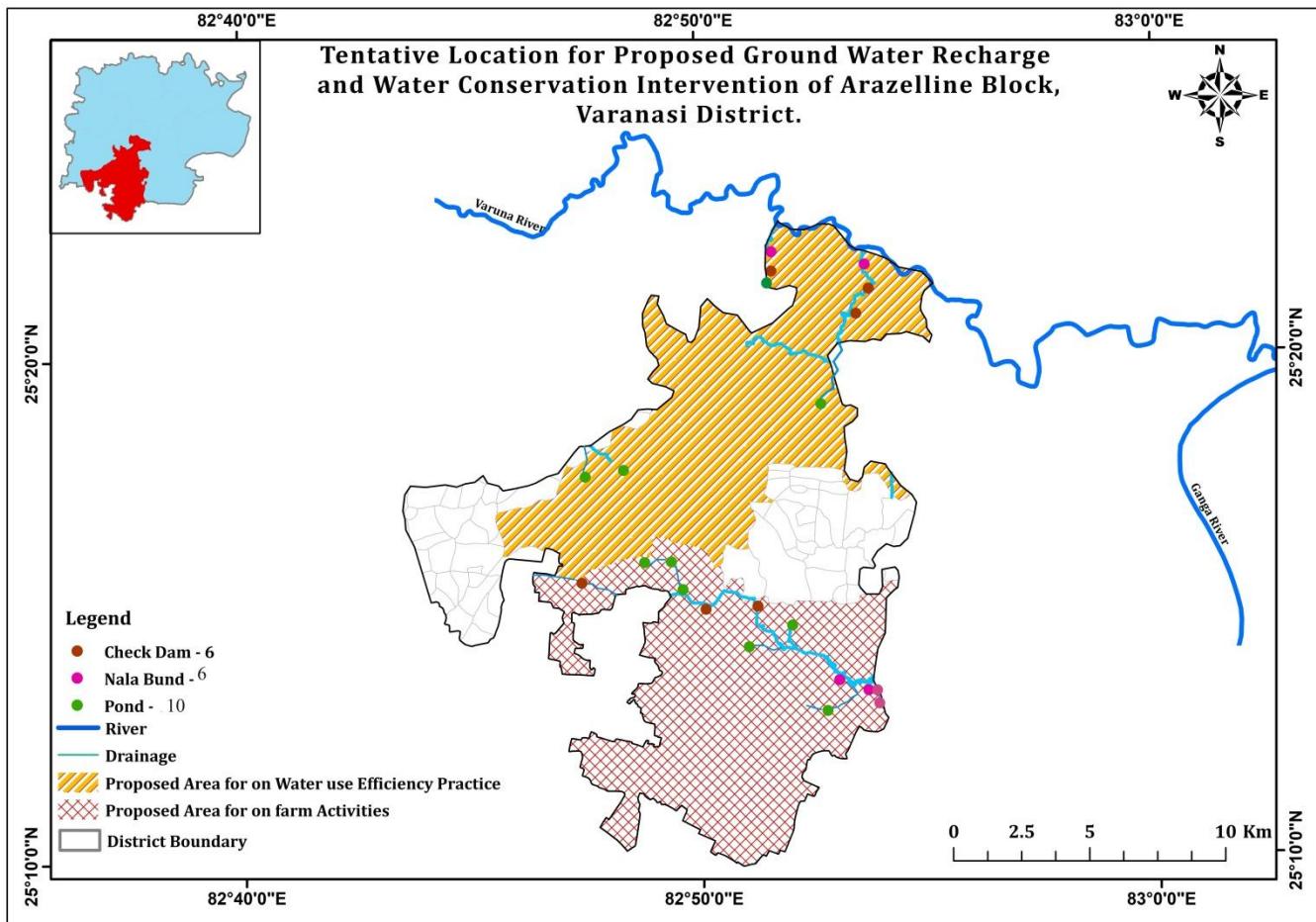


Figure-43: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Araziline Block, Varanasi District

II. Aquifer Mapping and Management plan of *Baragaon Block*

1. Salient Information

Geographical Area:	178.53 sq km
Population (2011):	Total : 221376 male- 110751, female- 110625
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-124 sq. km Net Irrigated Area-109 sq. km Tube well irrigated area- 91 sq km Well irrigated area- 1.66 sq km Canal irrigated area- 16 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 5388.79 Ham/ 53.88 MCM Draft- 3916.80 Ham/ 39.16 MCM Stage of GW Extraction- 72.68% Category- Semi-Critical

2. Location :

Baragaon block lies in West of Varanasi district encompassing an area of 178.53 Sq Km (figure-44).

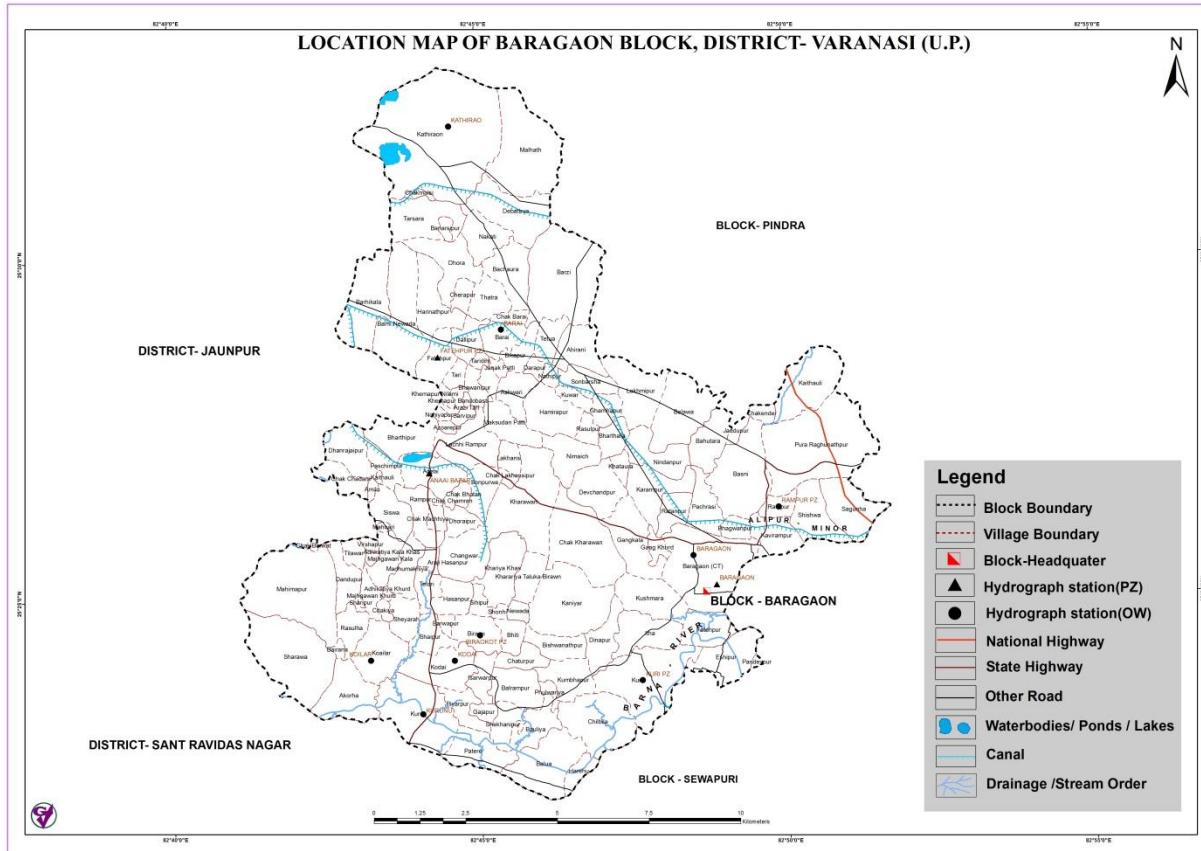


Figure 44: Administrative Map of Baragaon block, Varanasi district

3. Geology

Baragaon block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades with silt, clay and kankar of Quaternary age (figure-45).

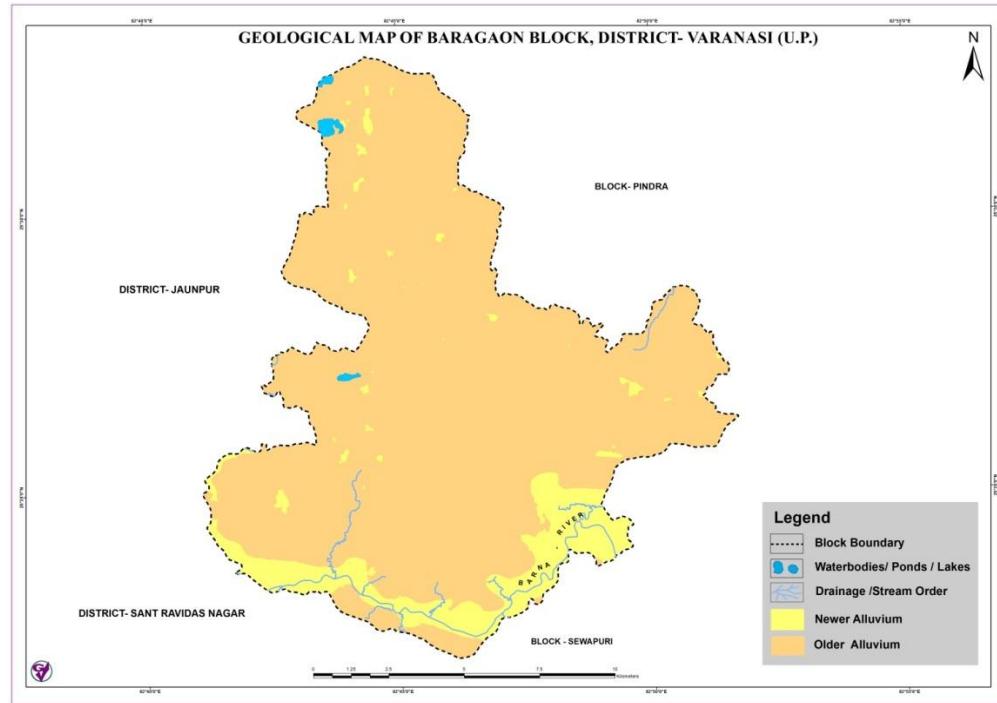


Figure 45: Geology Map of Baragaon block, Varanasi district

4. Drainage

Baragaon block mainly drained by the tributaries of Varuna river (figure-46).

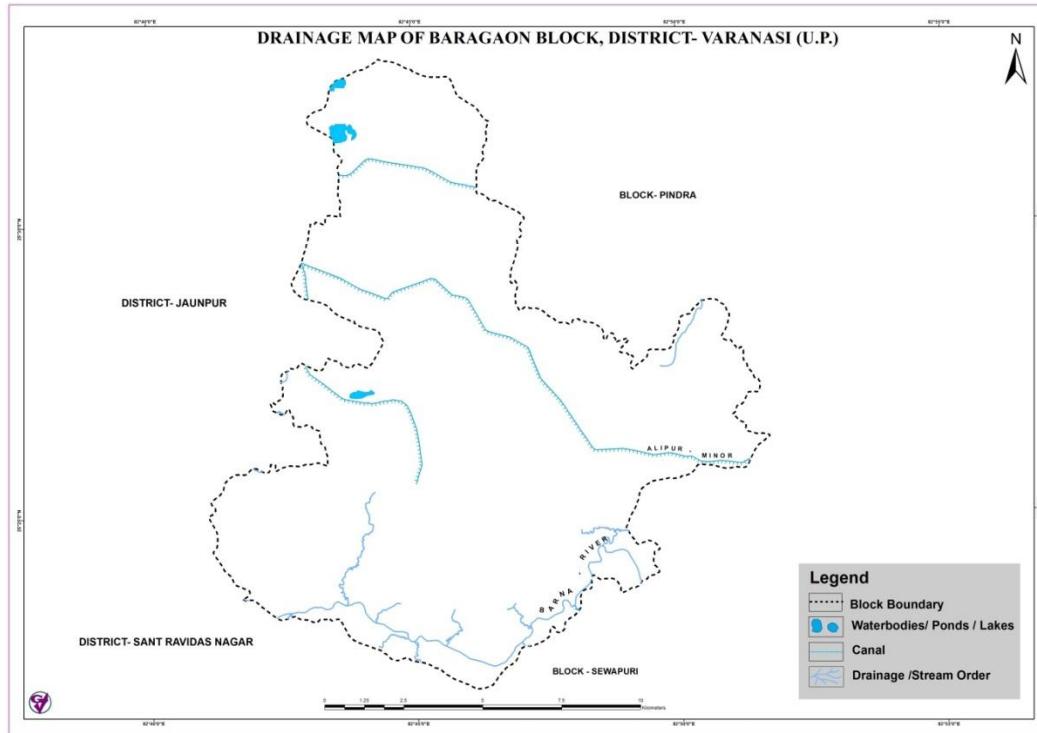


Figure 46: Drainage Map of Baragaon block, Varanasi district

5. Soil

The block is mainly covered with varying grades of loamy soil (figure-47).

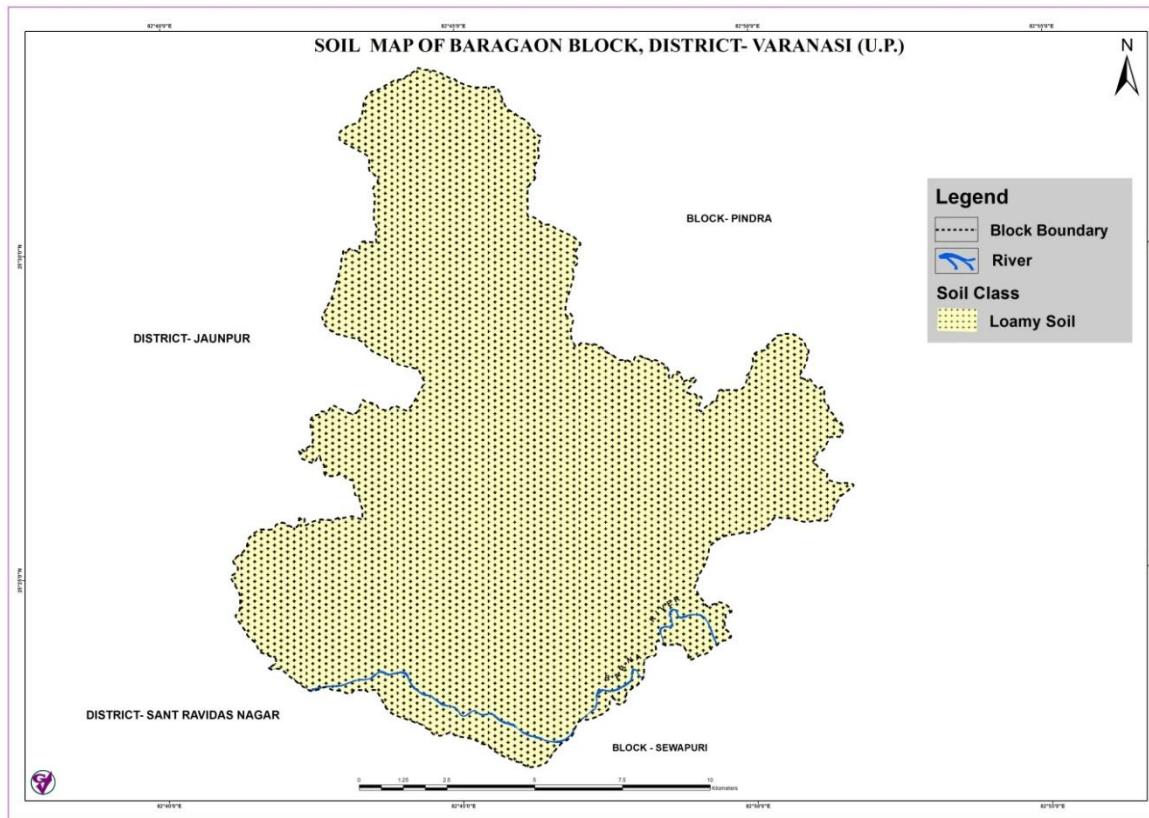


Figure 47: Soil Map of Baragaon block, Varanasi district

6. Geomorphology

The block is mainly covered with older/upper alluvial plain. Food plains, ravines and habitation mask can be seen southern part of the block (figure-48).

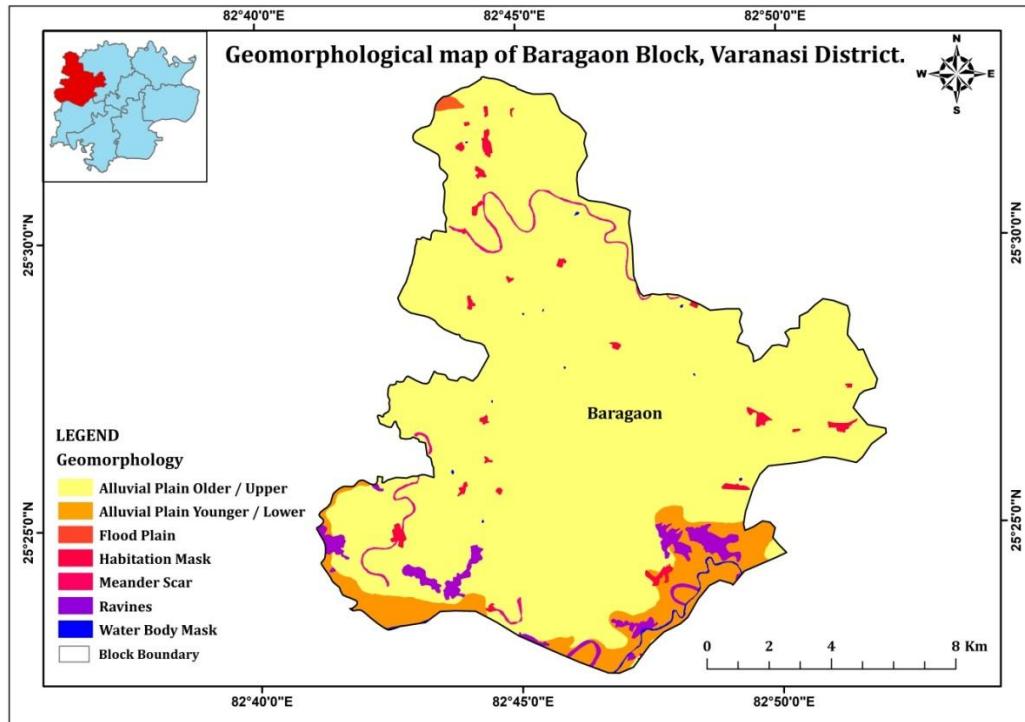


Figure 48: Geomorphology Map of Baragaon block, Varanasi district

7. Landuse/ Land cover

The block is covered with built up area and agricultural land (figure-49).

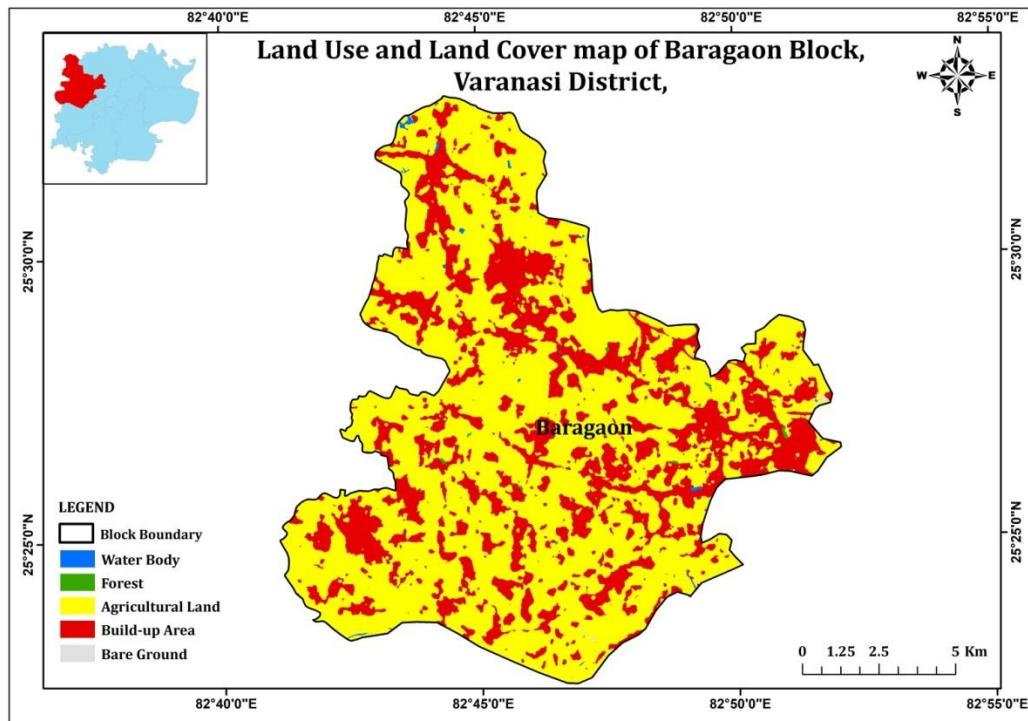


Figure 49: Landuse/Landcover Map of Baragaon block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally deep throughout the block ranging in between 5.0 m bgl to 10.0 m bgl (figure-50).

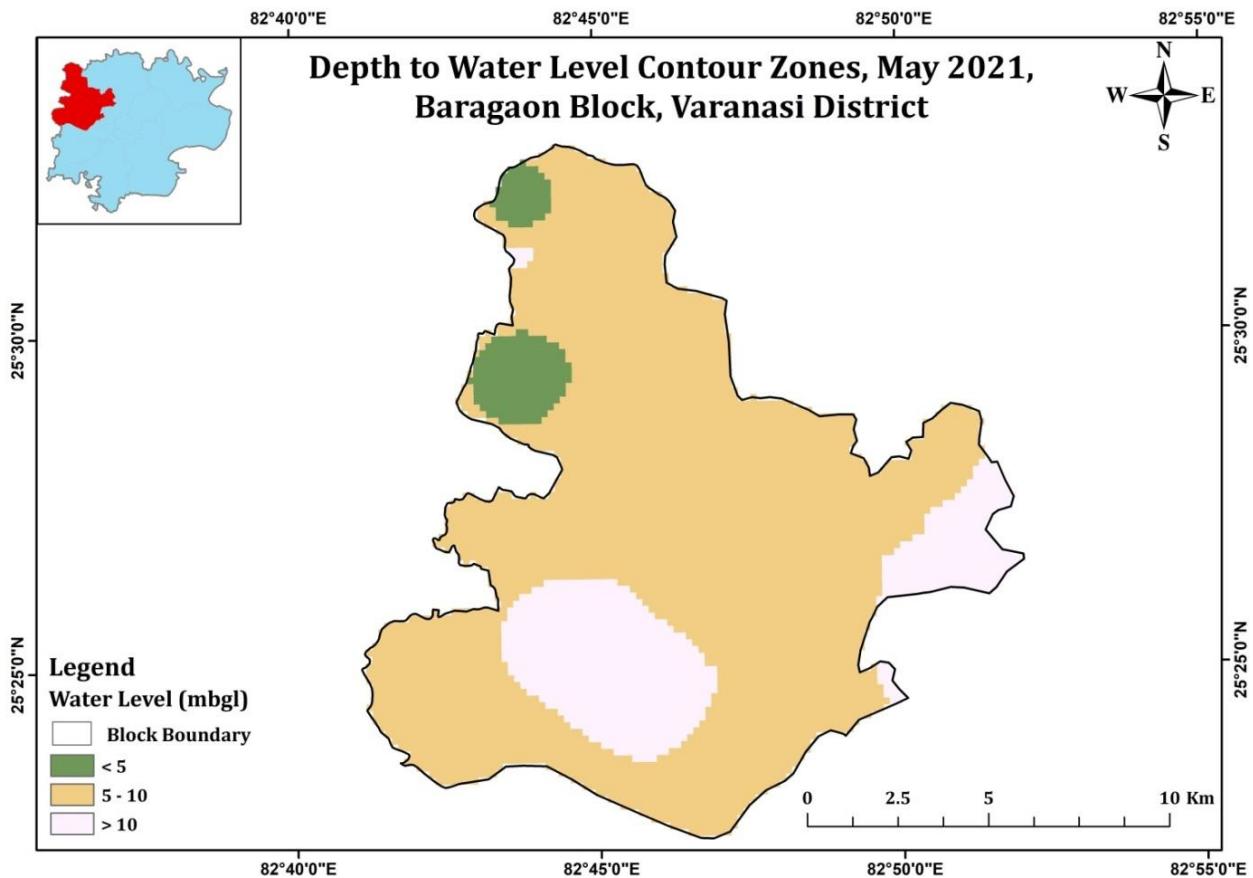


Figure 50: Depth to Water level Map (Pre-Monsoon) of Baragaon block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is throughout the block ranging in between 5.0 m bgl to 7.0 m bgl (figure-51).

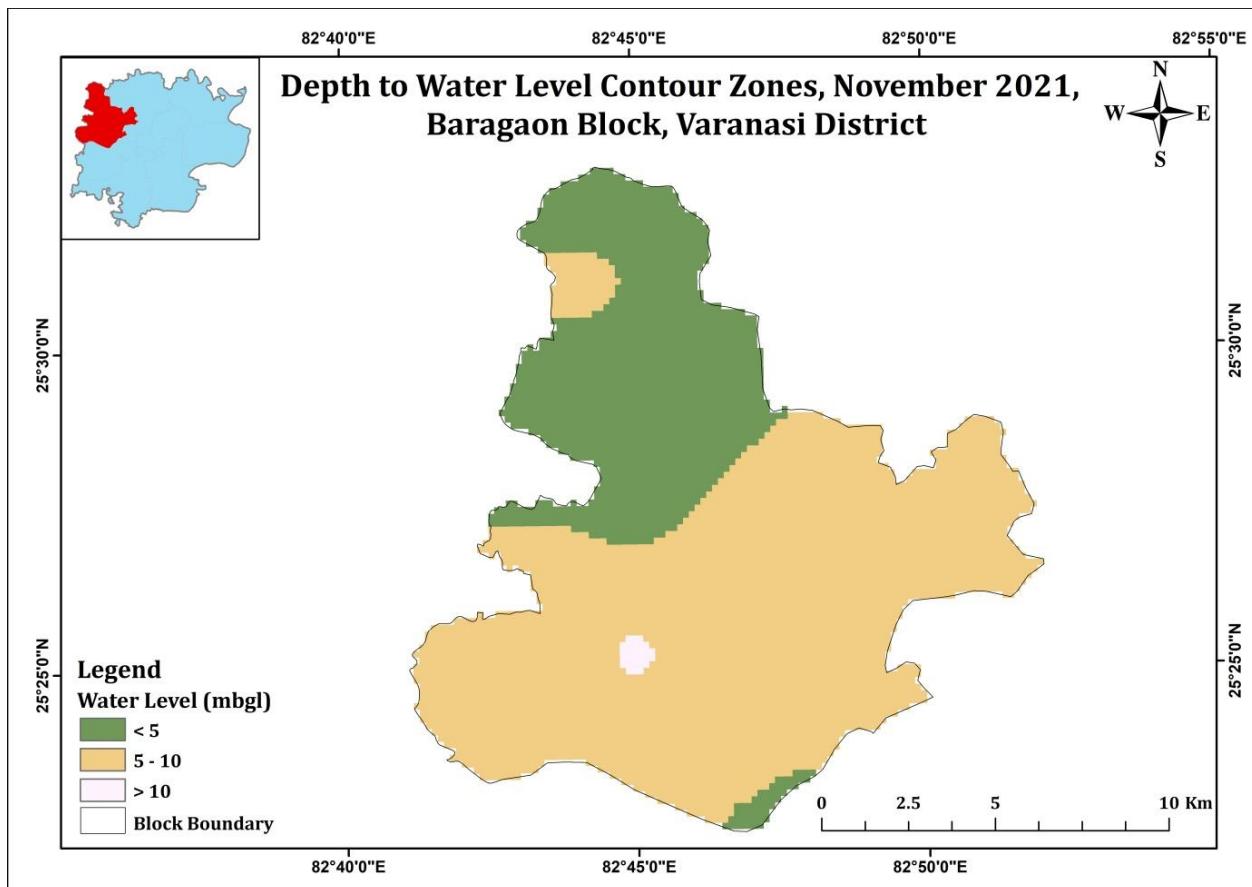


Figure 51: Depth to Water level Map (Post-Monsoon) of Baragaon block, Varanasi district

10. Ground water Resources

The block is categorized as Semi Critical as per 2020 ground water resource assessment with 72.68% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

Quality of ground water is potable and all the chemical constituents are within the permissible limit of BIS-2012 (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

There is a data gap in the block as only one exploratory well is drilled by the department and no state department data is available. Basement has been encountered at a depth of 352 m bgl in Biron kot borewell. Ground water occurs under water table condition at shallow depths while the confined aquifers are under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-52).

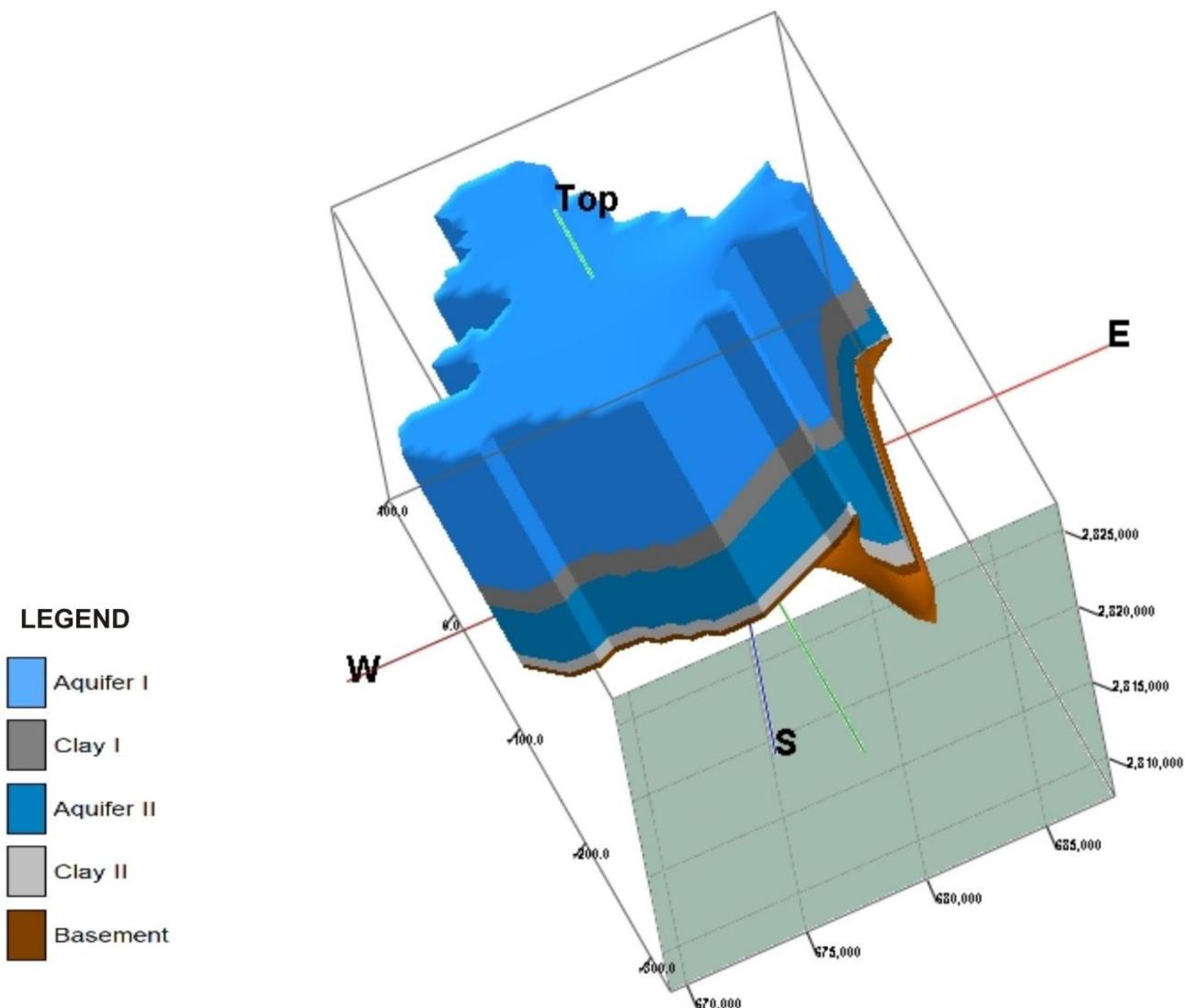


Figure 52: 3-D Model depicting Aquifer geometry of Baragaon block, Varanasi district

13. Management Plan

- Block is semi critical as per GW Resource Estimation, 2020 with 72.68% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 87.89% wherein the contribution of ground water for irrigation in this block is 83.7%.
- Artificial recharge measures and conservation of water techniques can be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-53.

Ground Water Management Strategies and Projected Stage of Extraction of Baragaon Block, Varanasi District,														
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns	
Baragaon	2	2	2	2	1025	1025	0.14	0.14	1.55	0.14	1.69	72.68	69.36	

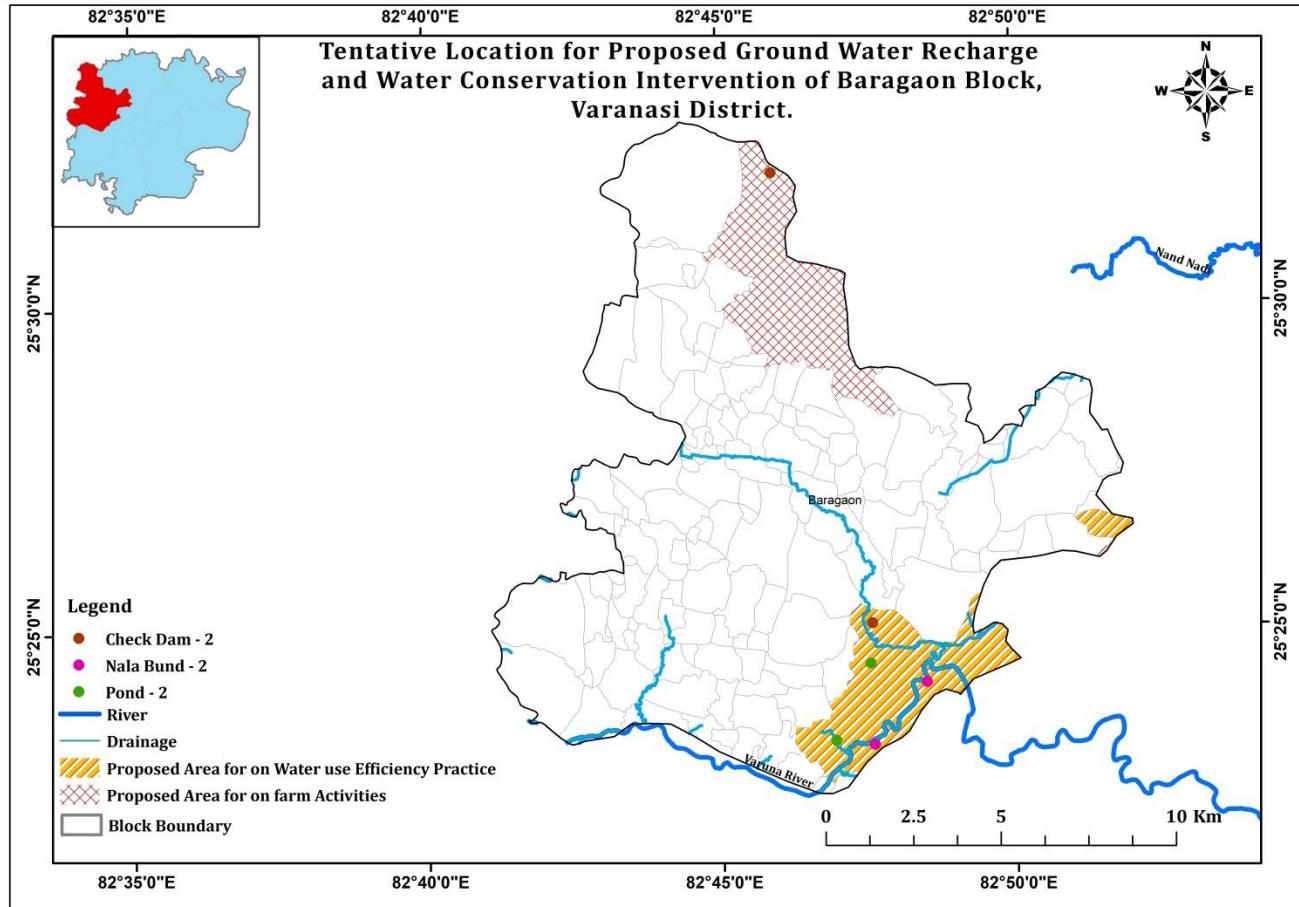


Figure-53: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Baragaon Block, Varanasi District

III. Aquifer Mapping and Management plan of *Chiraigaon Block*

1. Salient Information

Geographical Area:	208.65 sq km
Population (2011):	Total : 262324 male- 138132, female- 124192
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-132 sq. km Net Irrigated Area-107 sq. km Tube well irrigated area- 93 sq km Well irrigated area- 1.82 sq km Canal irrigated area- 12 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 5956 Ham/ 59.56 MCM Draft- 4760 Ham/ 47.60 MCM Stage of GW Extraction- 79.92% Category- Semi-Critical

2. Location

Chiraigaon block lies in East of Varanasi district along the left bank of Ganga river encompassing an area of 208.65 sq km, is the second largest block of district (figure-54).

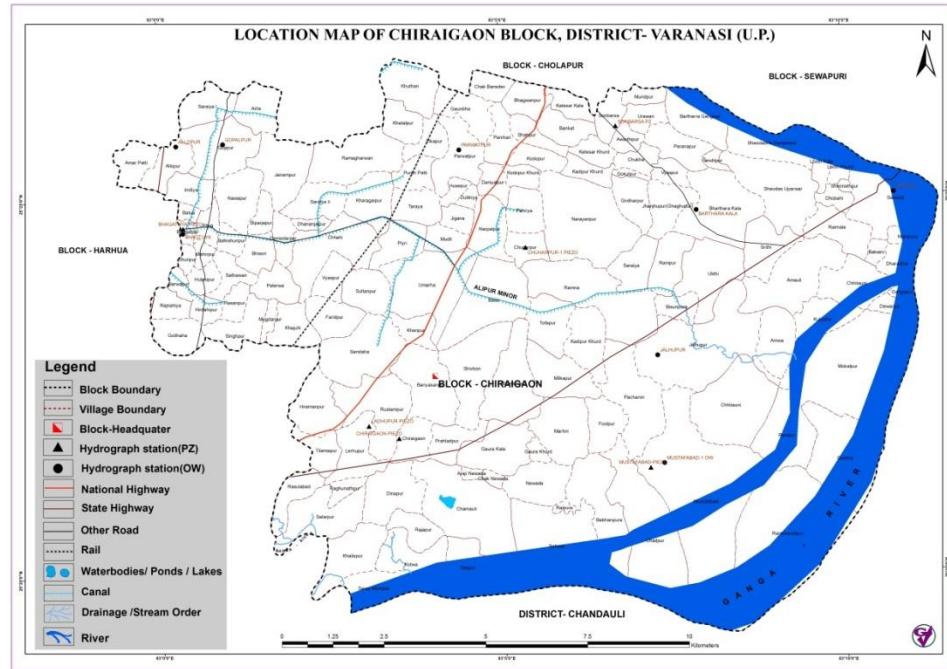


Figure 54: Administrative Map of Chiraigaon block, Varanasi district

3. Geology

Chiraigaon block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades with sand, silt and clay with kankar of Quaternary age (figure-55).

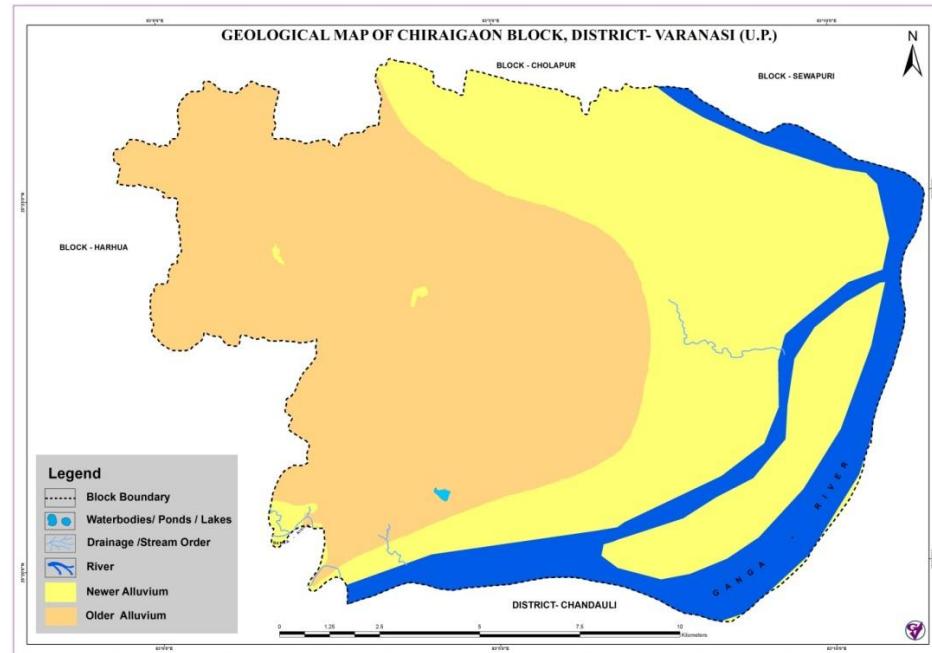


Figure 55: Geology Map of Chiraigaon block, Varanasi district

4. Drainage

Chiraigaon Block mainly drained by Ganga river and its tributaries as the block is located on the left bank of Ganga river (figure-56).

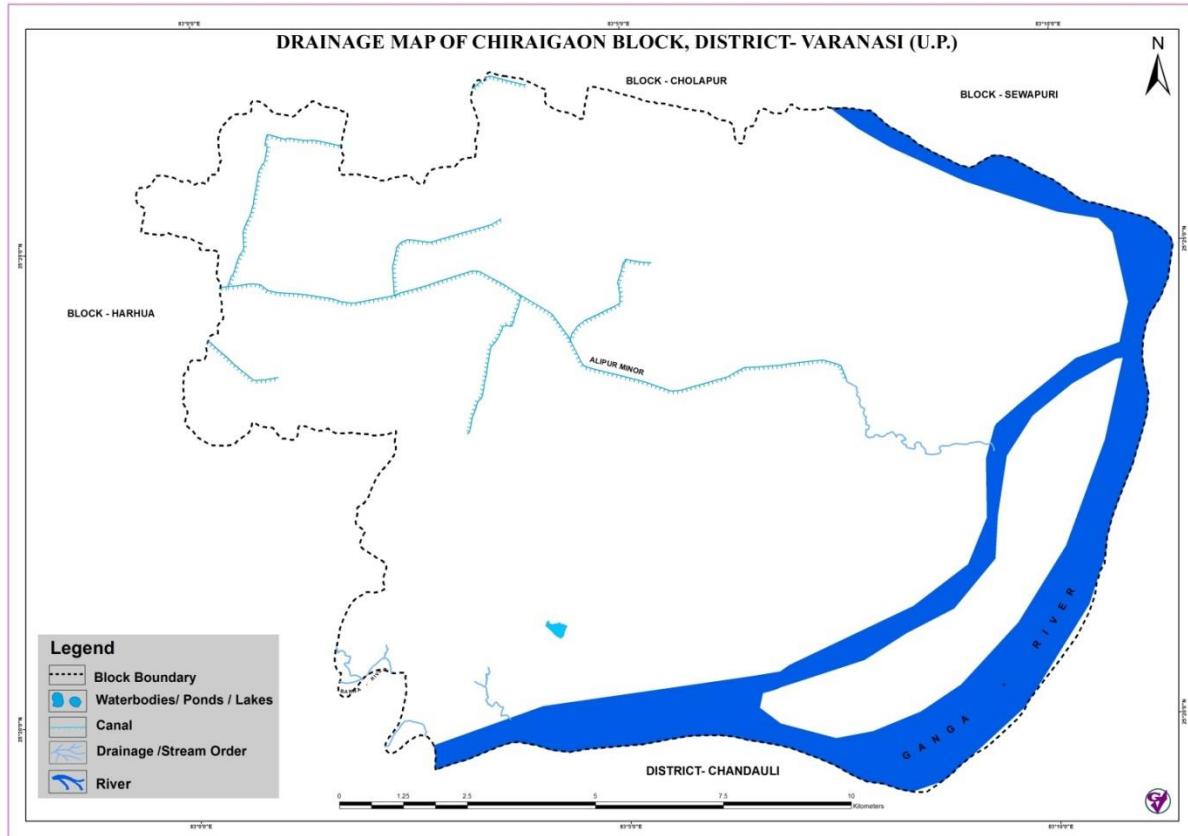


Figure 56: Drainage Map of Chiraigaon block, Varanasi district

5. Soil

The block is mainly covered with fine silt with varying grades of loamy soil (figure-57).

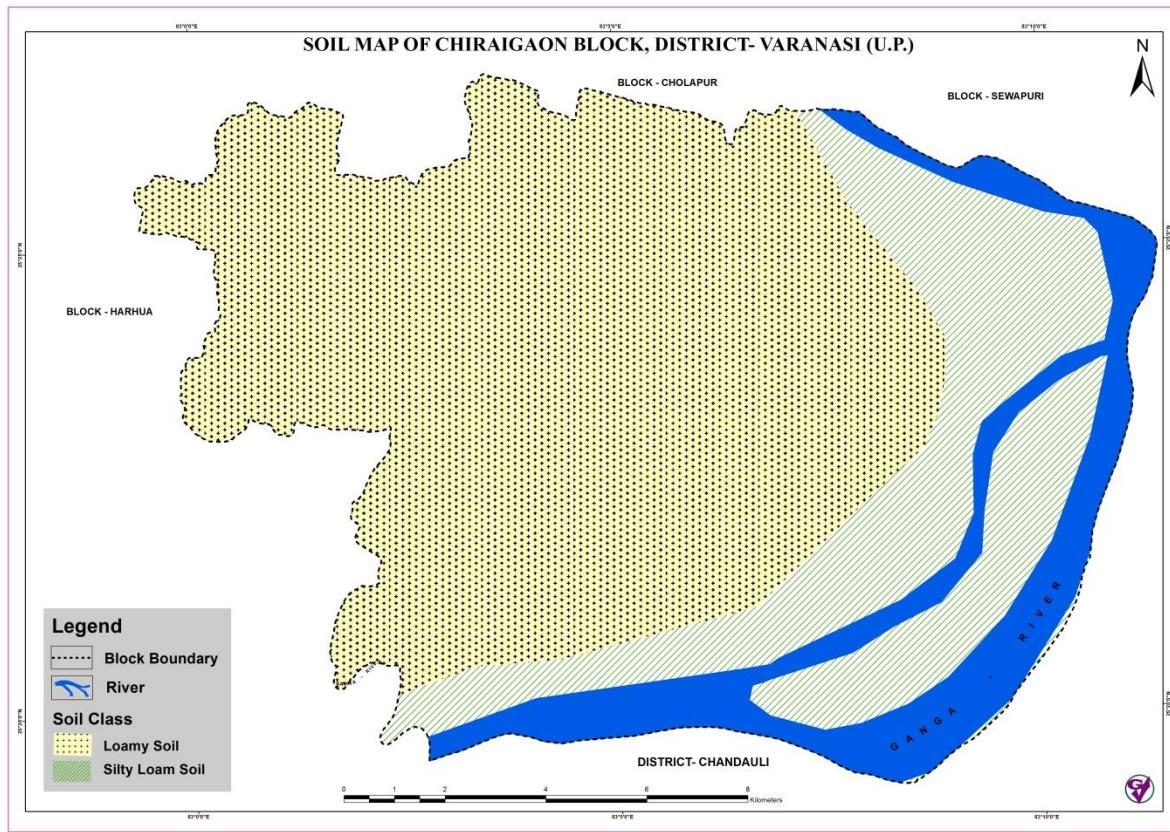


Figure 57: Soil Map of Chiraigaon block, Varanasi district

6. Geomorphology

The block is mainly covered with older/upper alluvial plain with habitation mask and flood plains (figure-58).

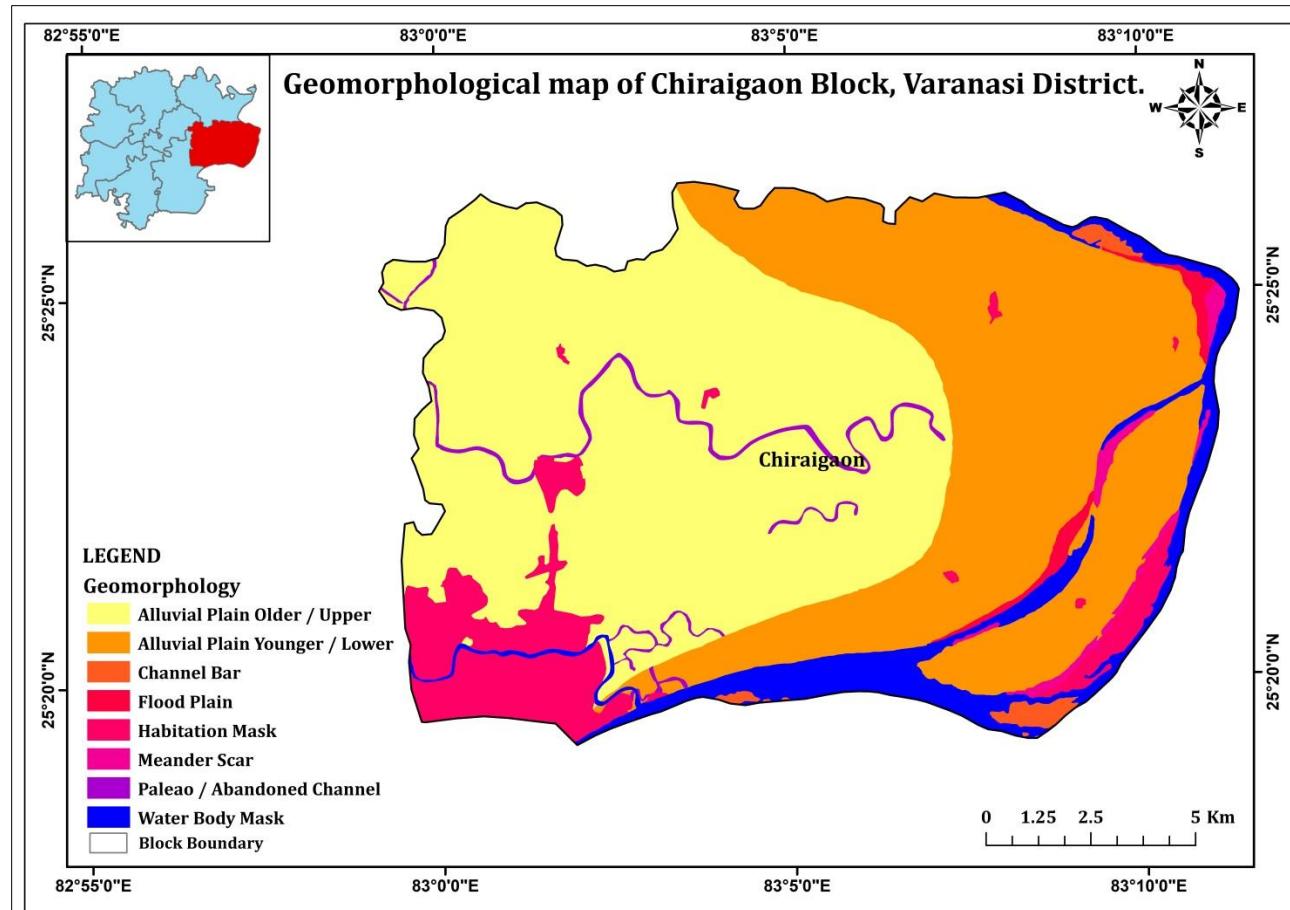


Figure 58: Geomorphology Map of Chiraigaon block, Varanasi district

7. Landuse/ Land cover

Western part of the Block is mostly covered with built-up area with scattered agricultural land in central and western part of the block and wasteland in eastern part along river (figure-59).

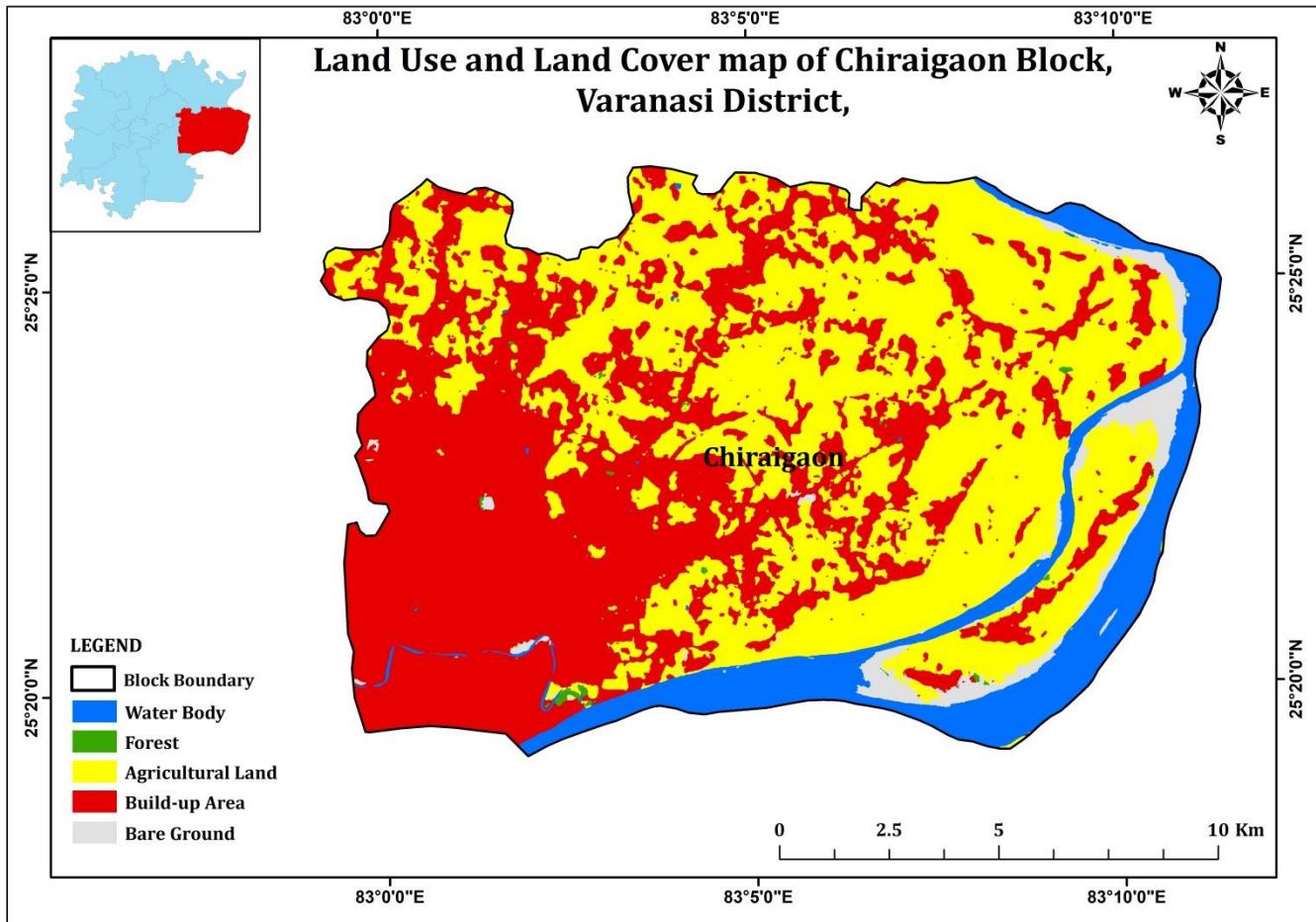
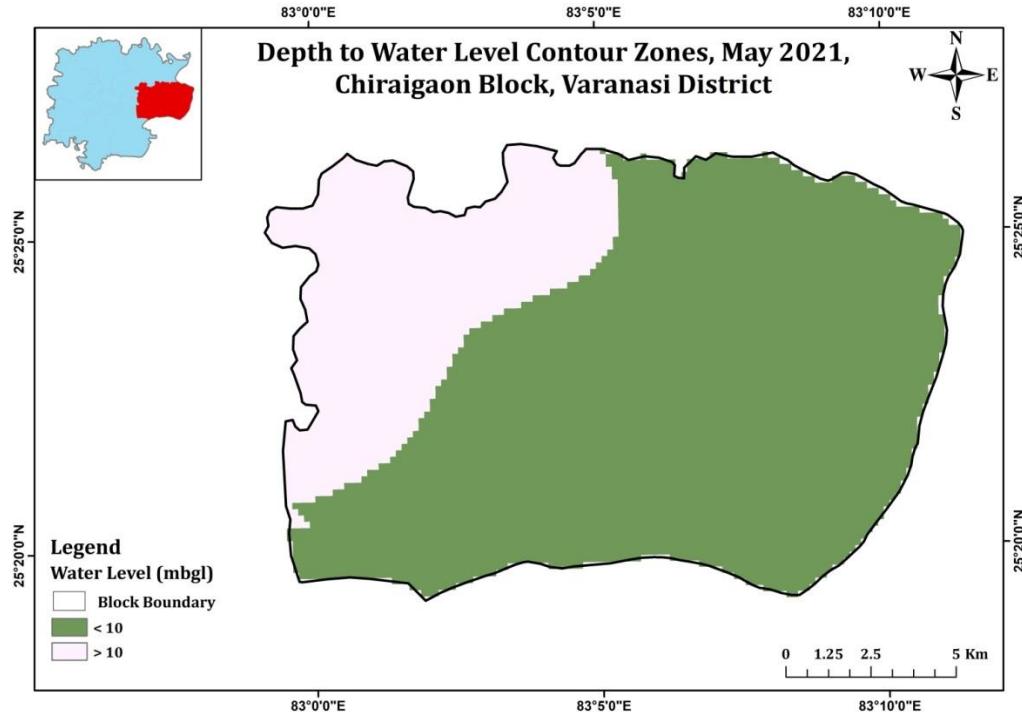


Figure 59: Landuse/Landcover Map of Chiraigaon block, Varanasi district

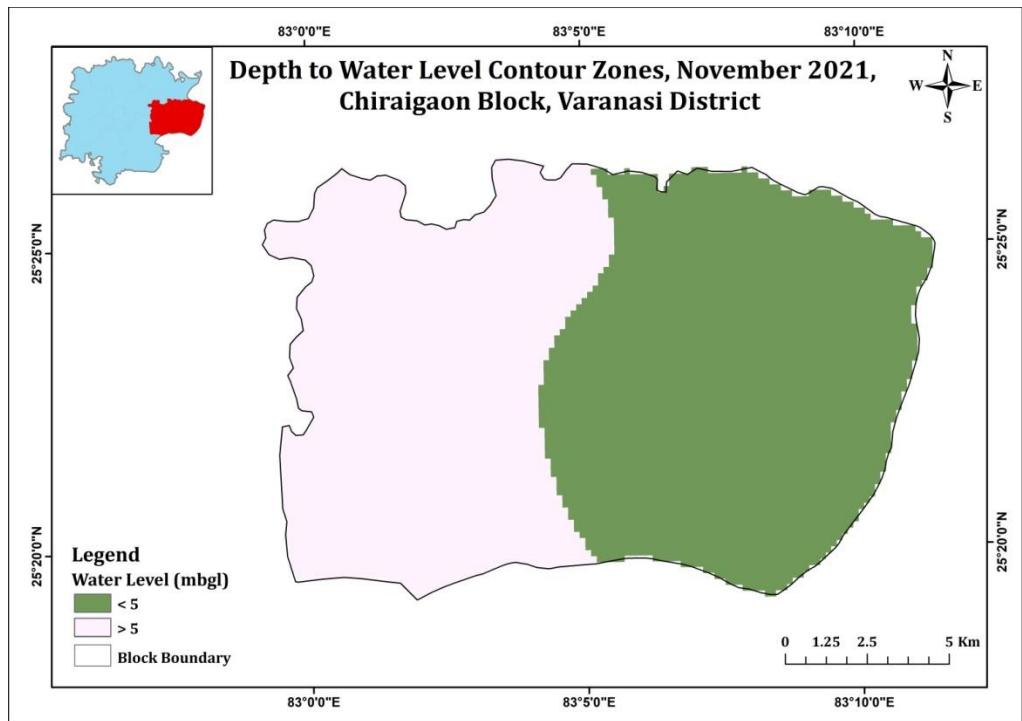
8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally shallow because of canal command area ranging in between 7.0 m bgl to 13.0 m bgl (figure-60).

**Figure 60: Depth to Water level Map (Pre-Monsoon) of Chiraigaon block, Varanasi district**

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is shallow ranging in between <2.0 m bgl to 7.0 m bgl (figure-61).

**Figure 61: Depth to Water level Map (Post-Monsoon) of Chiraigaon block, Varanasi district**

10. Ground water Resources

The block is categorized as Semi Critical as per 2020 ground water resource assessment with 79.92% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

Quality of ground water is potable and all the chemical constituents are within the permissible limit of BIS-2012 (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Two aquifer groups reported from the exploratory drilling in Chiraigaon block. Basement has been encountered at a depth of 402 m bgl in Rajapur Borewell drilled by the departmental rig. Ground water occurs under water table condition at shallow depths while the confined aquifers are under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-62).

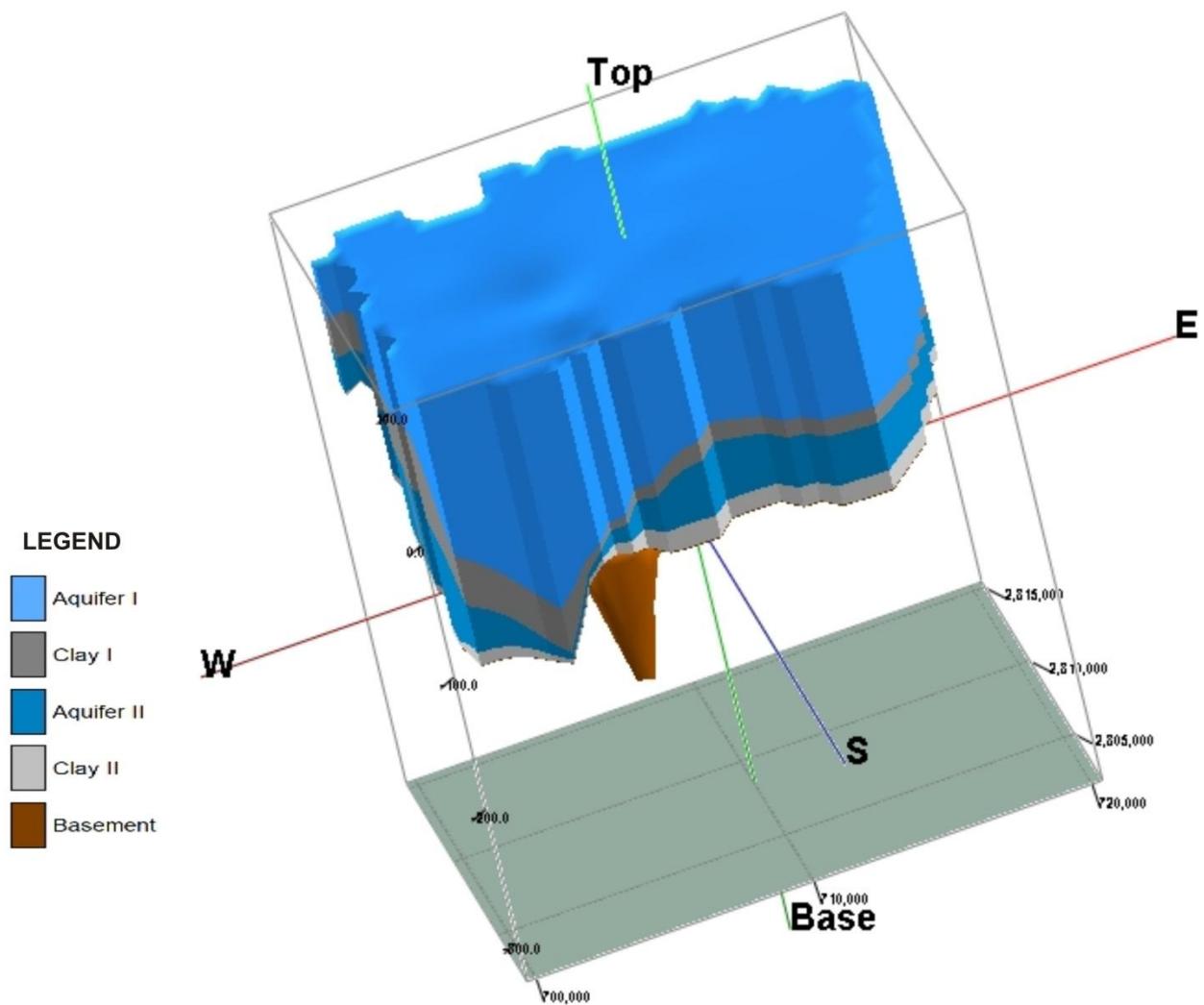


Figure 62: 3-D Model depicting Aquifer geometry of Chiraigaon block, Varanasi district

13. Management Plan

- Block is semi critical as per GW Resource Estimation, 2020 with 79.92% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 81.36% wherein the contribution of ground water for irrigation in this block is 87.07%.
- Artificial recharge measures and conservation of water techniques can be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-63.

Ground Water Management Strategies and Projected Stage of Extraction of Chiraigaon Block, Varanasi District,														
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns	
Chiraigaon	3	3	3	3	3432	3432	0.17	0.17	8.44	0.17	8.60	79.92	65.30	

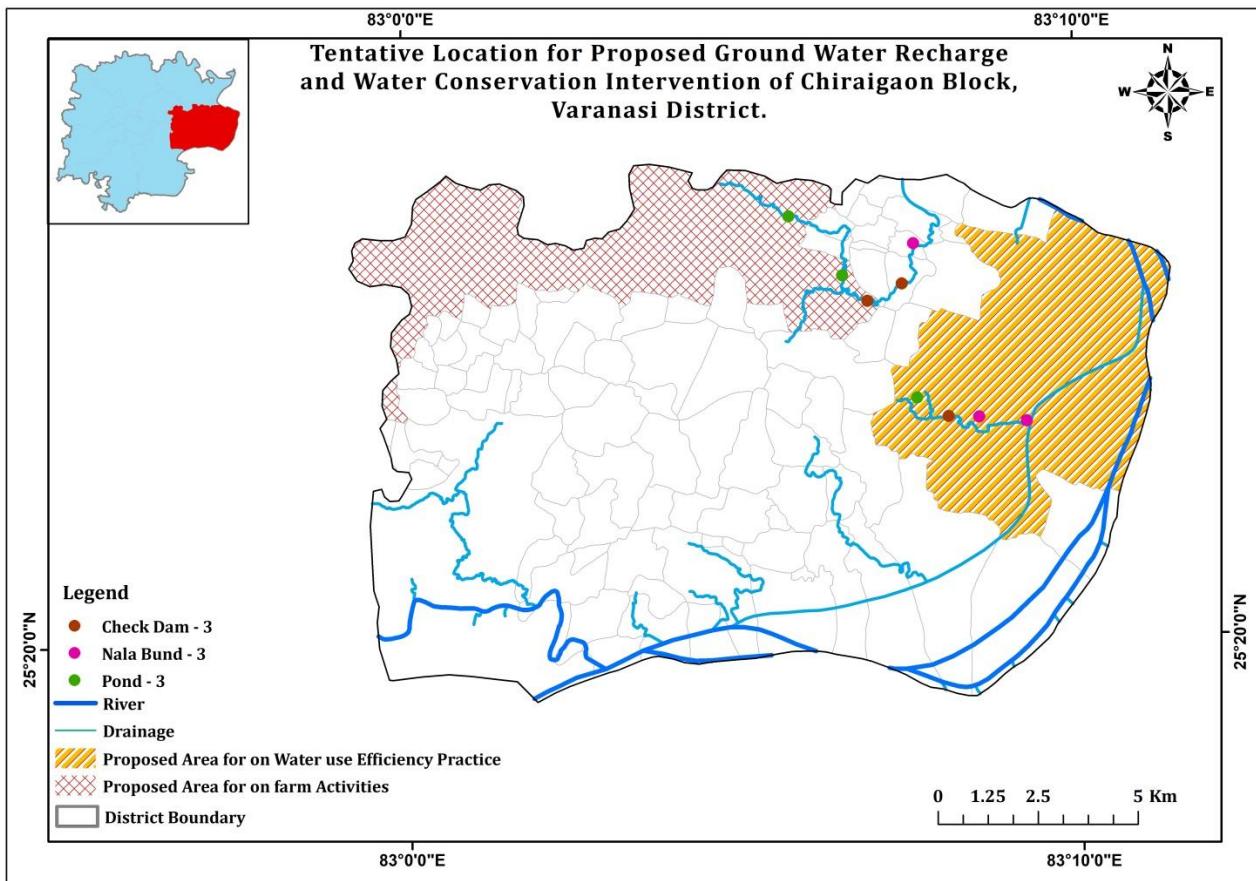


Figure-63: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Chiraigaon Block, Varanasi District

IV. Aquifer Mapping and Management plan of *Cholapur Block*

1. Salient Information

Geographical Area:	179.37 sq km
Population (2011):	Total : 238931 male- 122937, female- 115994
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-134 sq. km Net Irrigated Area-114 sq. km Tube well irrigated area- 91 sq km Well irrigated area- 1.40 sq km Canal irrigated area- 22 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 6618.8 Ham/ 66.18 MCM Draft- 4544 Ham/ 45.44 MCM Stage of GW Extraction- 68.65% Category- Safe

2. Location

Cholapur block lies in North of Varanasi district, encompassing an area of about 179.37 sq km sharing border with Gazipur district in north (figure-64).

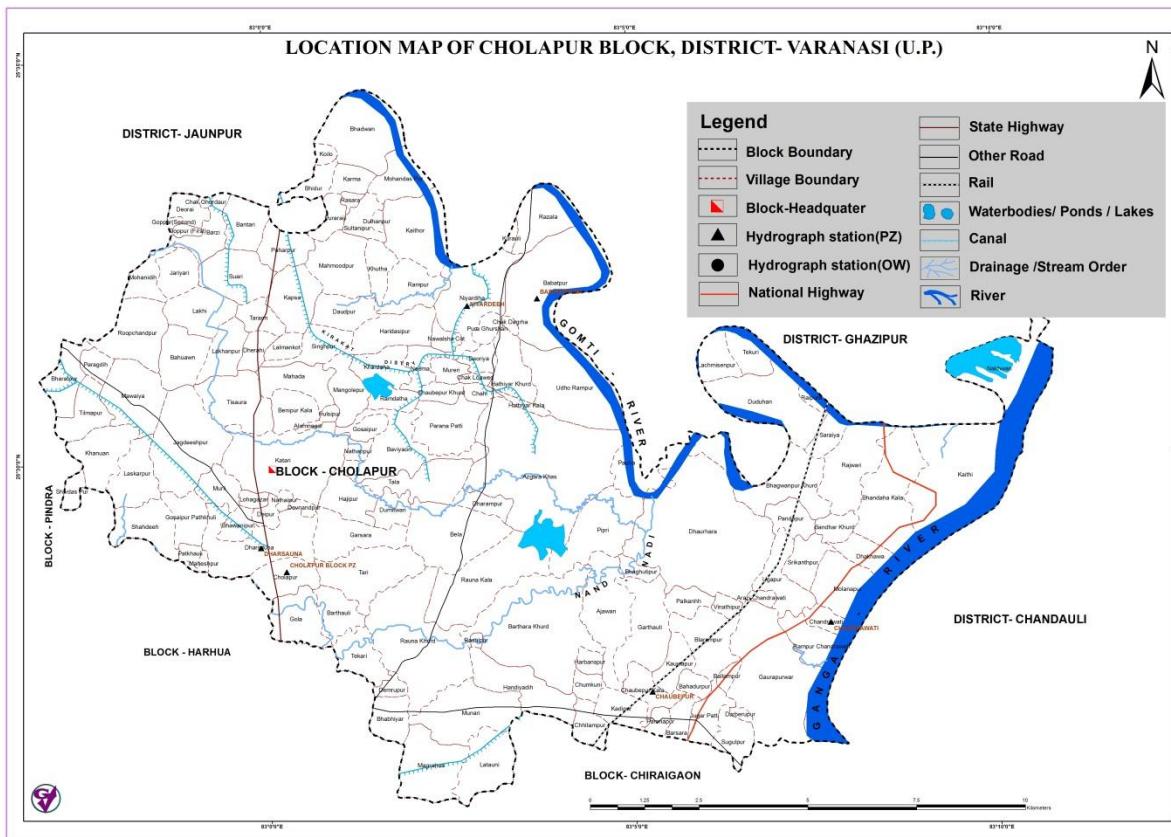


Figure 64: Administrative Map of Cholapur block, Varanasi district

3. Geology

Cholapur block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades with sand, silt and clay with kankar of Quaternary age (figure-65).

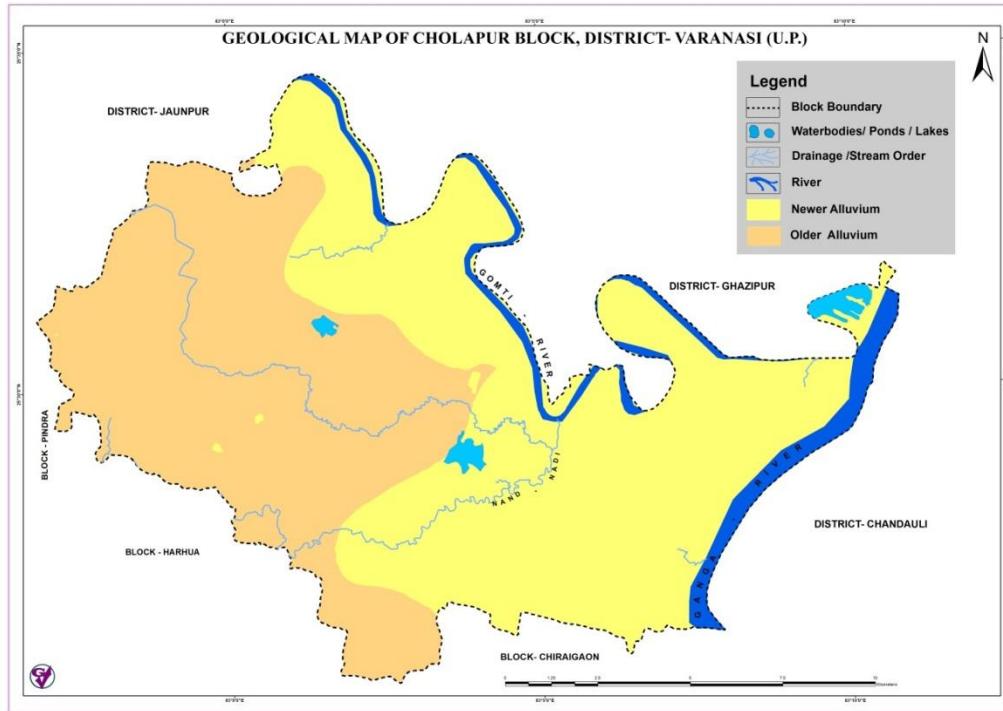


Figure 65: Geology Map of Cholapur block, Varanasi district

4. Drainage

Cholapur block mainly drained by Gomati, Ganga and Nand river and their tributaries (figure-66).

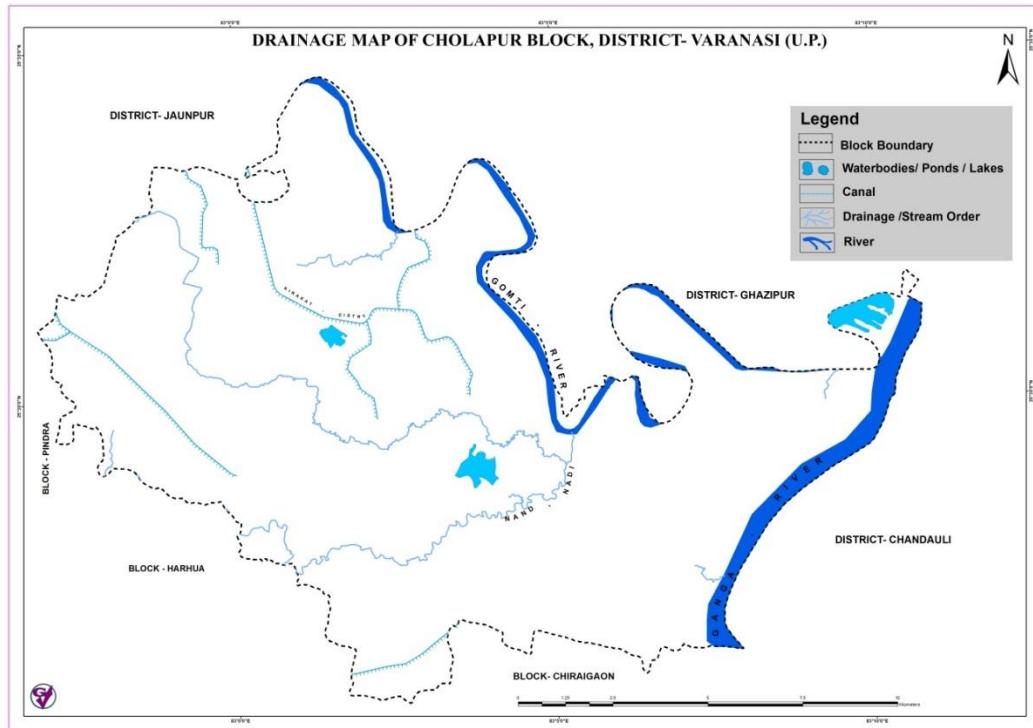


Figure 66: Drainage Map of Cholapur block, Varanasi district

5. Soil

The block is mainly covered with varying grades of loamy soil and fine silt (figure-67).

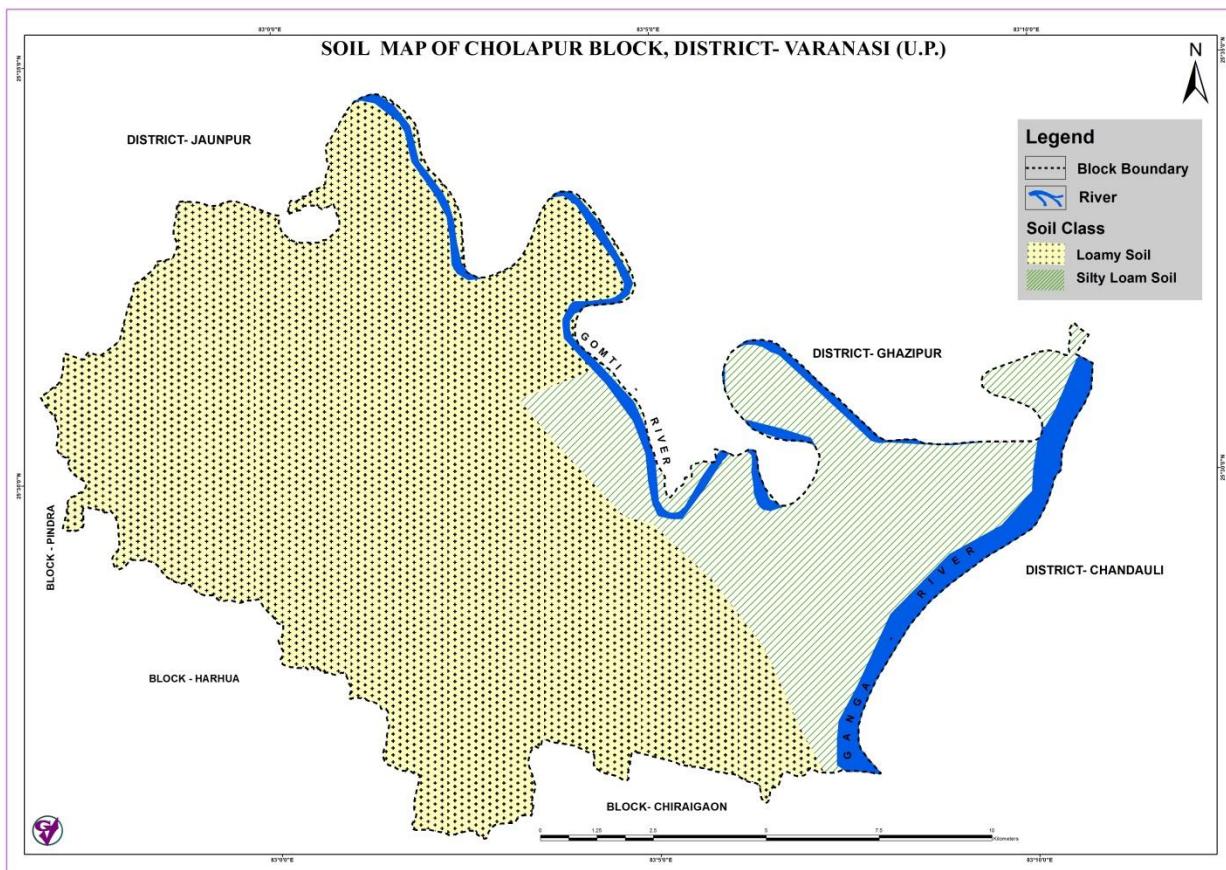


Figure 67: Soil Map of Cholapur block, Varanasi district

6. Geomorphology

The block is mainly covered with older/upper alluvial plain and younger/lower alluvial plain. Flood plains and ravines can be seen in younger alluvial plain (figure-68).

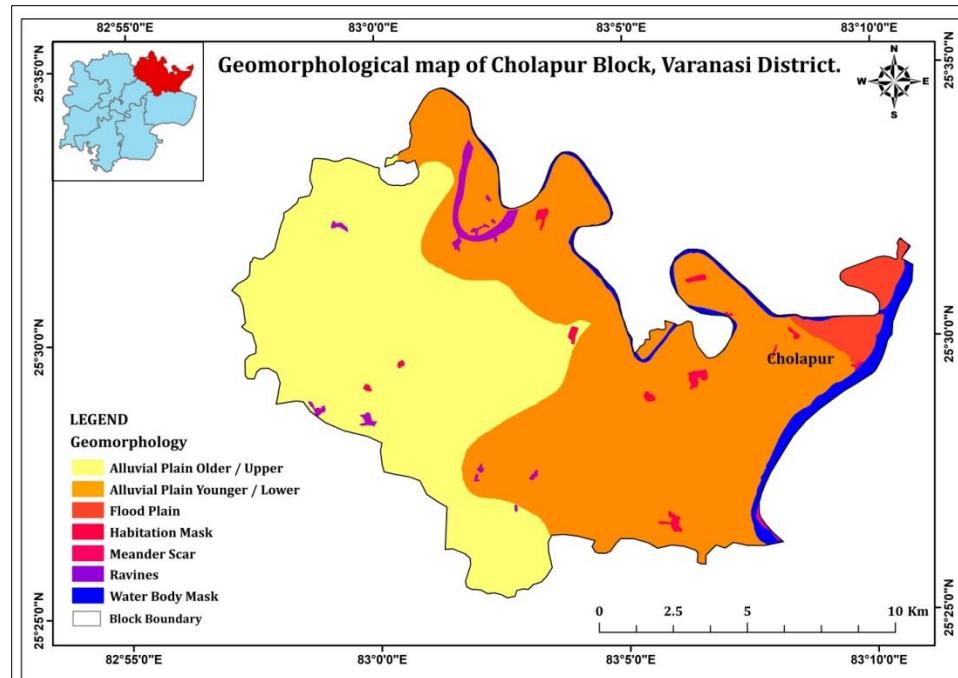


Figure 68: Geomorphology Map of Cholapur block, Varanasi district

7. Landuse/ Land cover

Block is mostly covered with built up area with scattered agricultural land throughout the block and wasteland along river (figure-69).

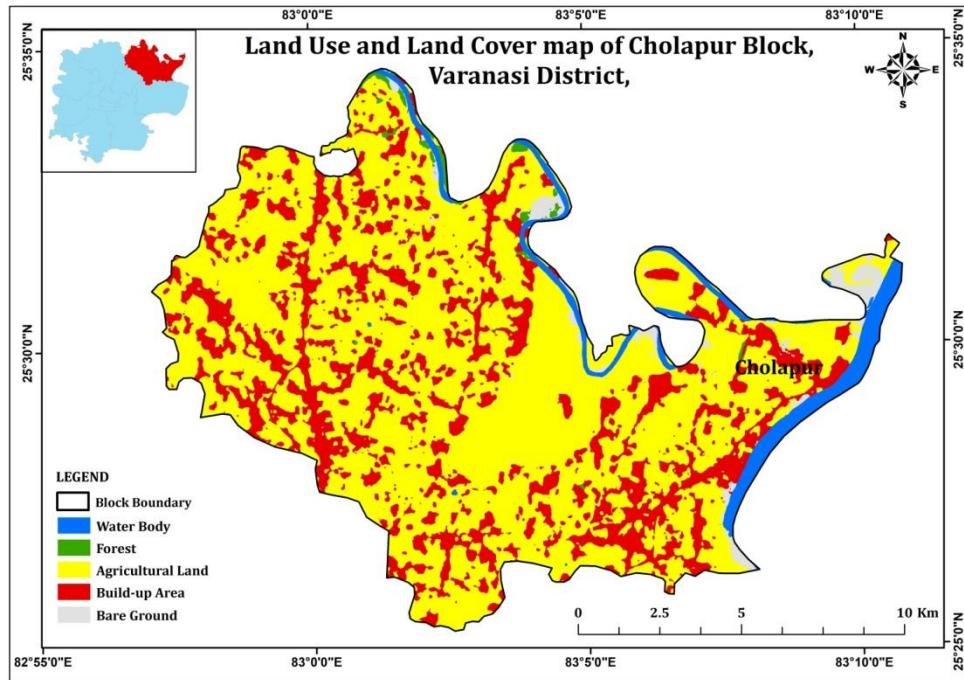


Figure 69: Landuse/Landcover Map of Cholapur block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is very deep ranging in between 5.0 m bgl to 10.0 m bgl (figure-70).

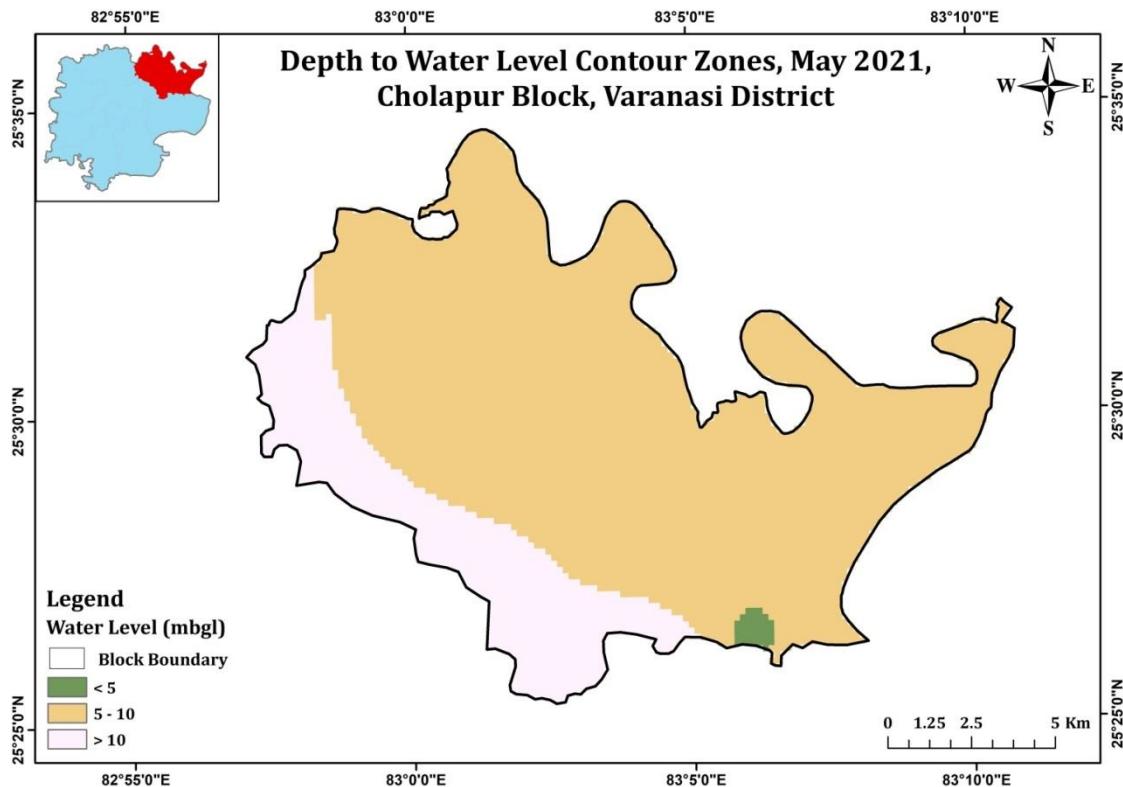


Figure 70: Depth to Water level Map (Pre-Monsoon) of Cholapur block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Pre-monsoon is ranging in between 2.0 m bgl to 5.0 m bgl (figure-71).

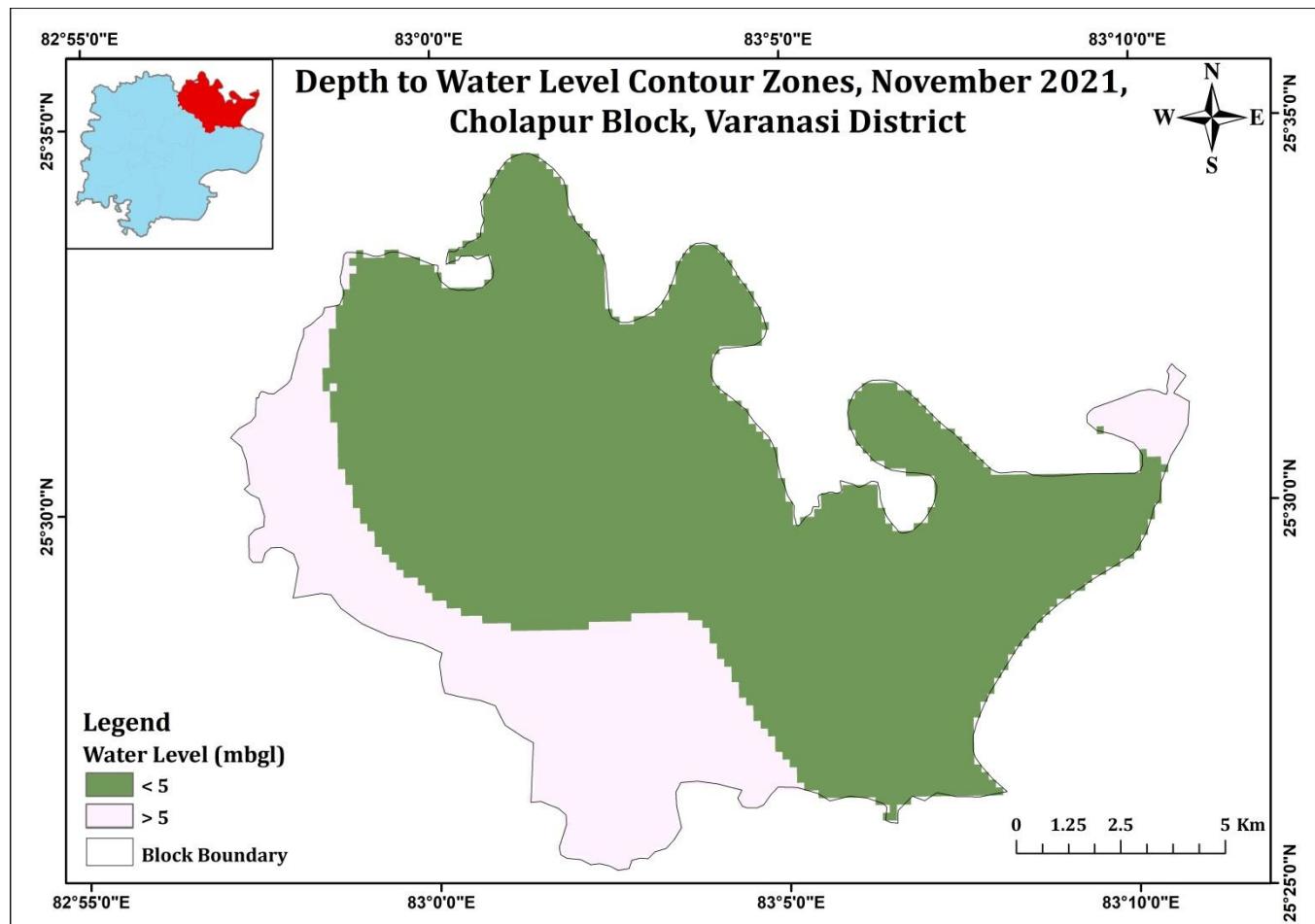


Figure 71: Depth to Water level Map (Post-Monsoon) of Cholapur block, Varanasi district

10. Ground water Resources

The block is categorized as Safe as per 2020 ground water resource assessment with 68.65% of stage of ground water extraction, which is the lowest amongst the blocks of Varanasi district (refer figure-30).

11. Chemical Quality

All the chemical constituents are within the permissible limit of BIS-2012 (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Three exploratory wells have been drilled by the department in Cholapur block down to the depth of 301 mbgl but no basement encountered. Ground water occurs under water table condition at shallow depths. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-72).

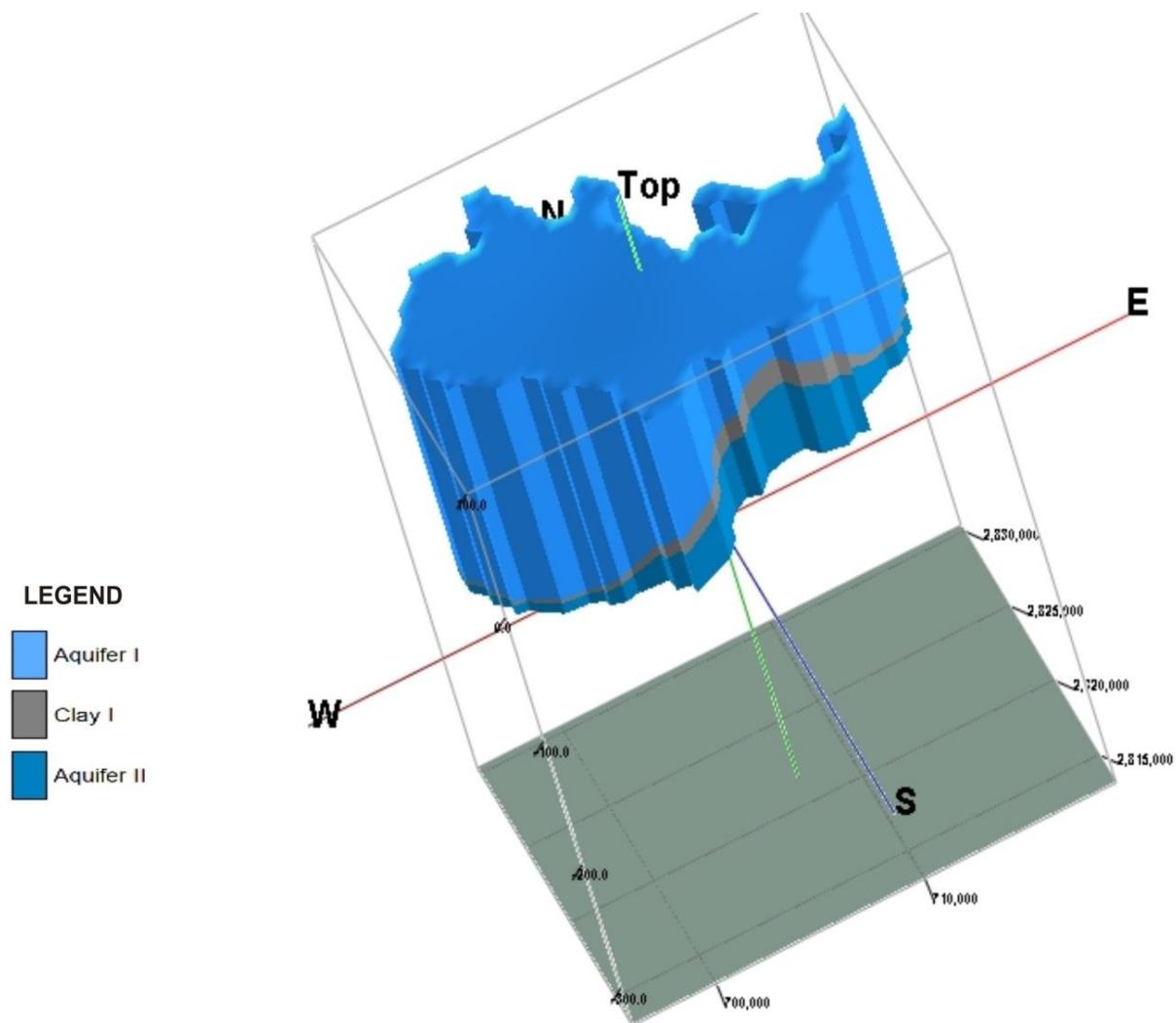


Figure 72: 3-D Model depicting Aquifer geometry of Cholapur block, Varanasi district

13. Management Plan

Block is safe as per GW Resource Estimation, 2020 with 68.65% of stage of ground water extraction. Percentage of net irrigated to net sown area is 85.61% and the contribution of ground water for irrigation in this block is 79.11 %. Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-73.

Ground Water Management Strategies and Projected Stage of Extraction of Cholapur Block, Varanasi District,														
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns	
Cholapur	2	2	2	2	1349	1349	0.11	0.11	1.11	0.11	1.22	68.65	66.69	

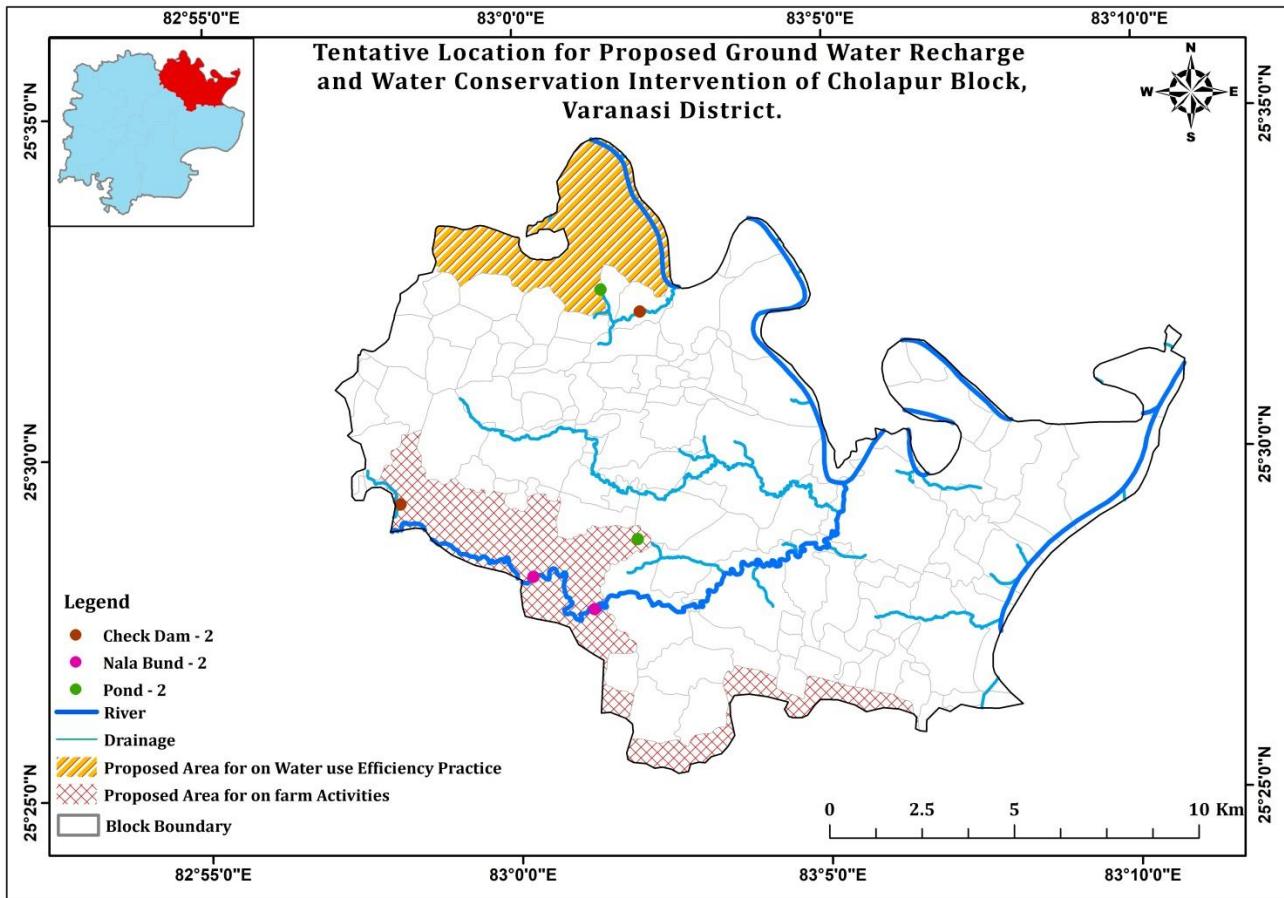


Figure-73: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Cholapur Block, Varanasi District

V. Aquifer Mapping and Management plan of *Harhua Block*

1. Salient Information

Geographical Area:	141.17 sq km
Population (2011):	Total : 271019 male- 141526, female- 129493
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-93 sq. km Net Irrigated Area-88 sq. km Tube well irrigated area-76 sq km Well irrigated area- 1.66 sq km Canal irrigated area- 10 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 6467.29Ham/ 64.67 MCM Draft- 7749 Ham/ 77.49 MCM Stage of GW Extraction- 119.82% Category- Over Exploited

2. Location

Harhua block lies in the centre of Varanasi district, shares border with all blocks except for Baragaon. The block encompasses an area of about 141.17 sq km, area wise smallest in district (figure-74).

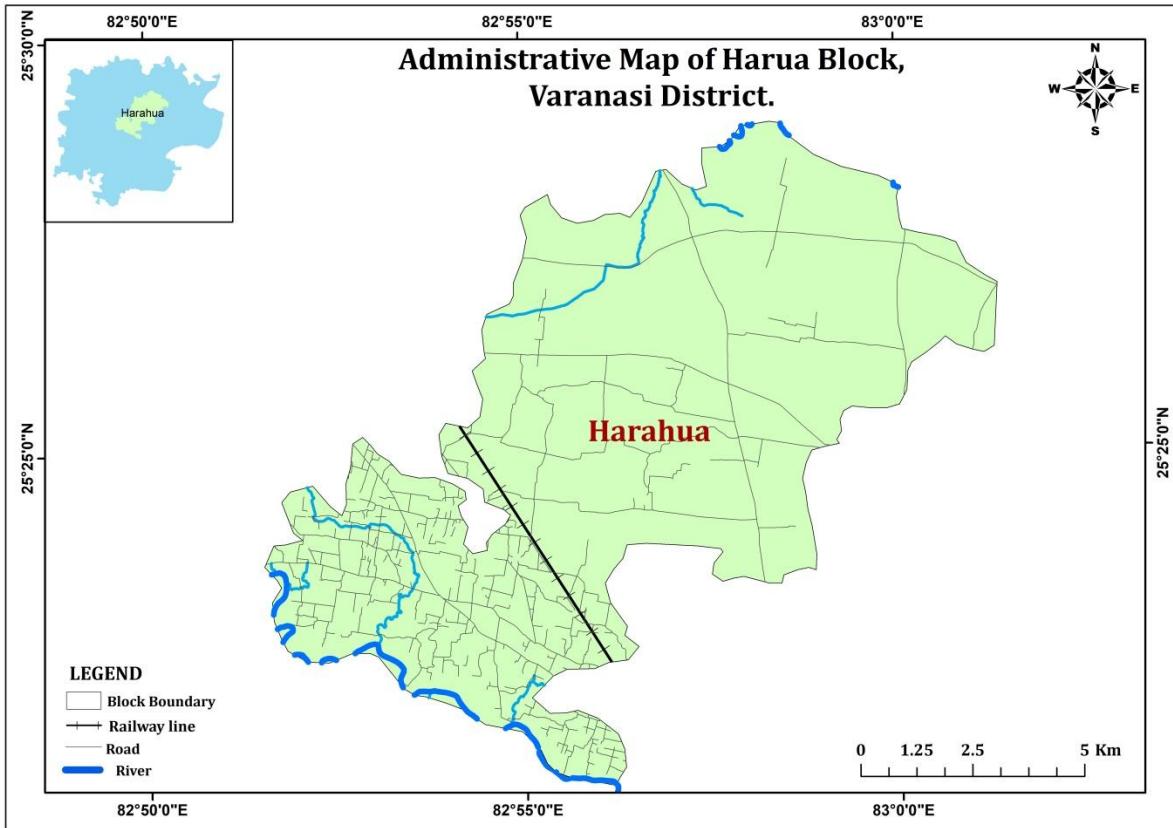


Figure 74: Administrative Map of Harhua block, Varanasi district

3. Geology

Harhua block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades, silt and clay of Quaternary age (figure-75).

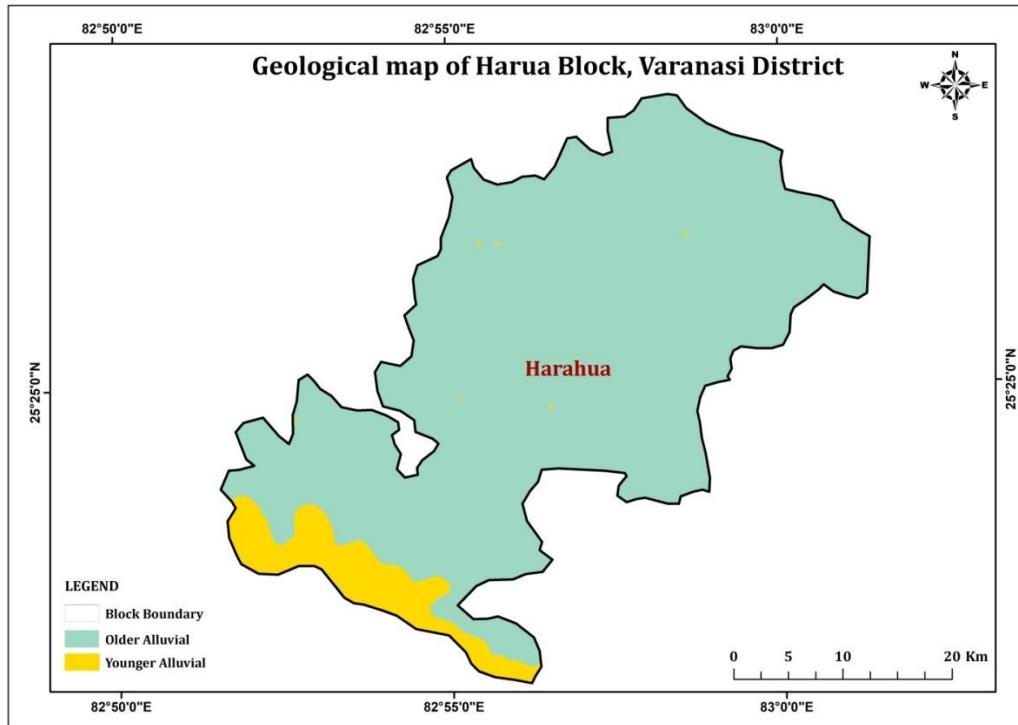


Figure 75: Geology Map of Harhua block, Varanasi district

4. Drainage

Harhua Block mainly drained by tributaries of Varuna river (figure-76).

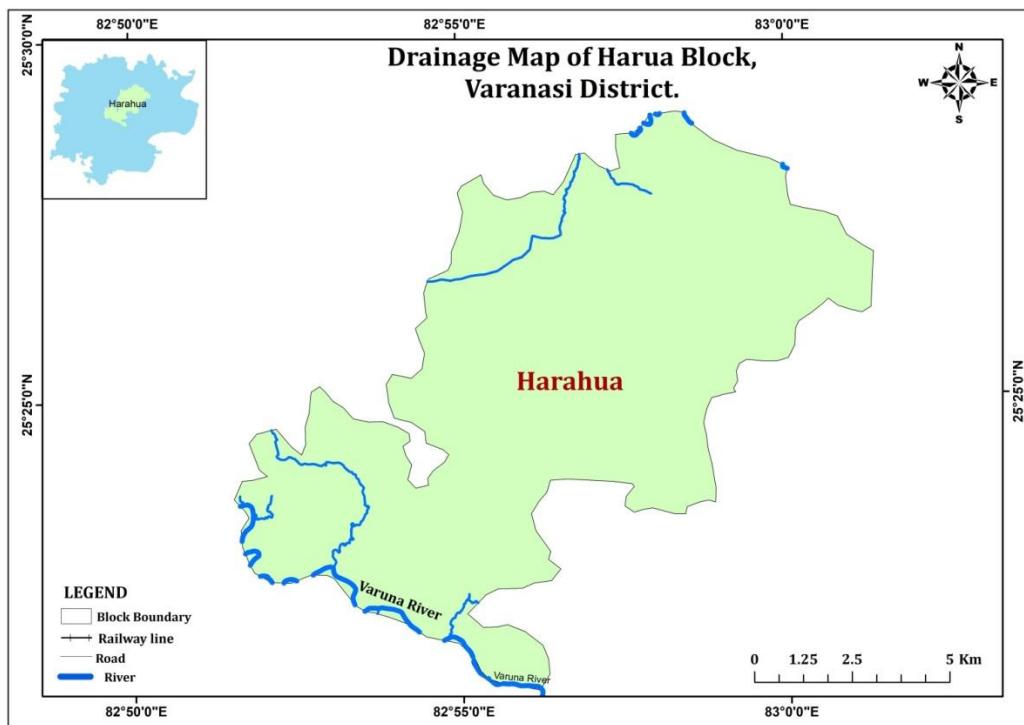


Figure 76: Drainage Map of Harhua block, Varanasi district

5. Soil

The block is mainly covered with varying grades of loamy soil and minor silt.

6. Geomorphology

The block is mainly covered with older/upper alluvial plain and younger/lower alluvial plain. Flood plain and meander scar feature of younger alluvium can be seen (figure-77).

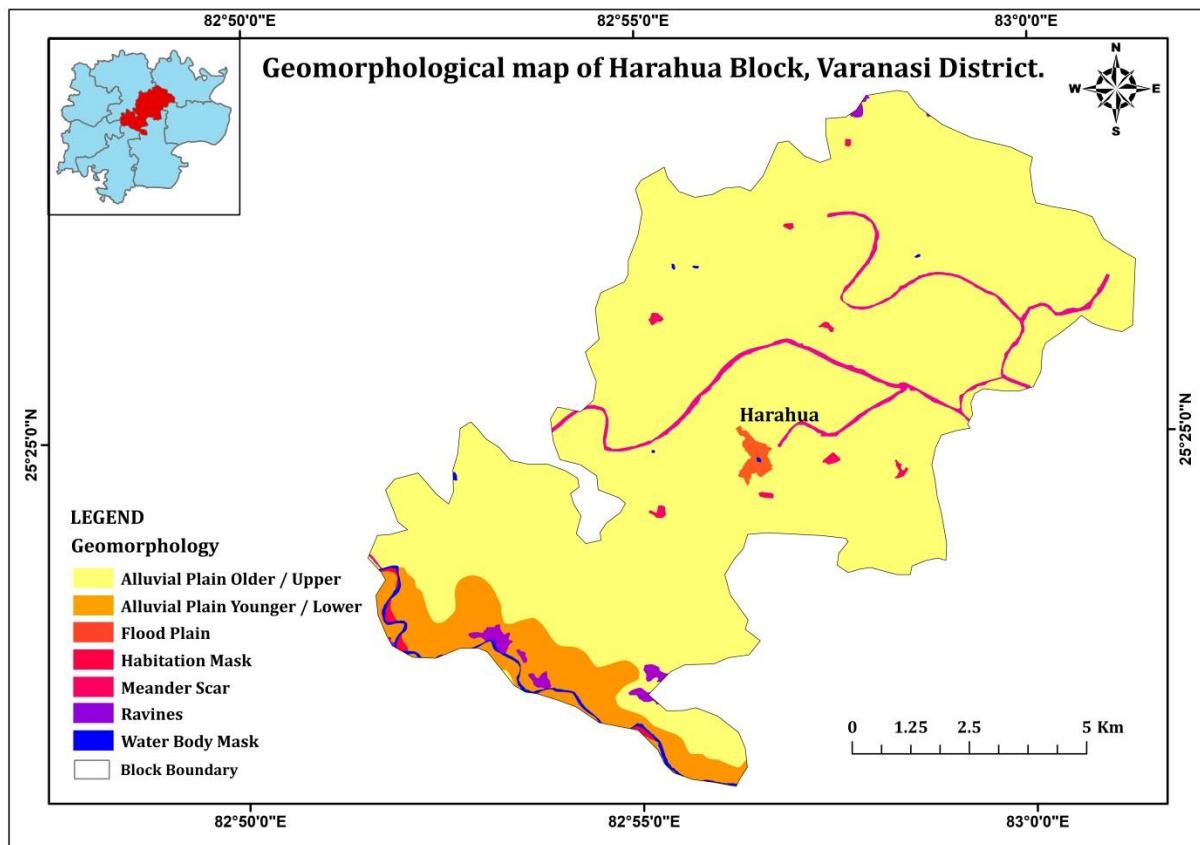


Figure 77: Geomorphology Map of Harhua block, Varanasi district

7. Landuse/ Land cover

Block is mostly covered with agricultural land with scattered settlement throughout the block (figure-78).

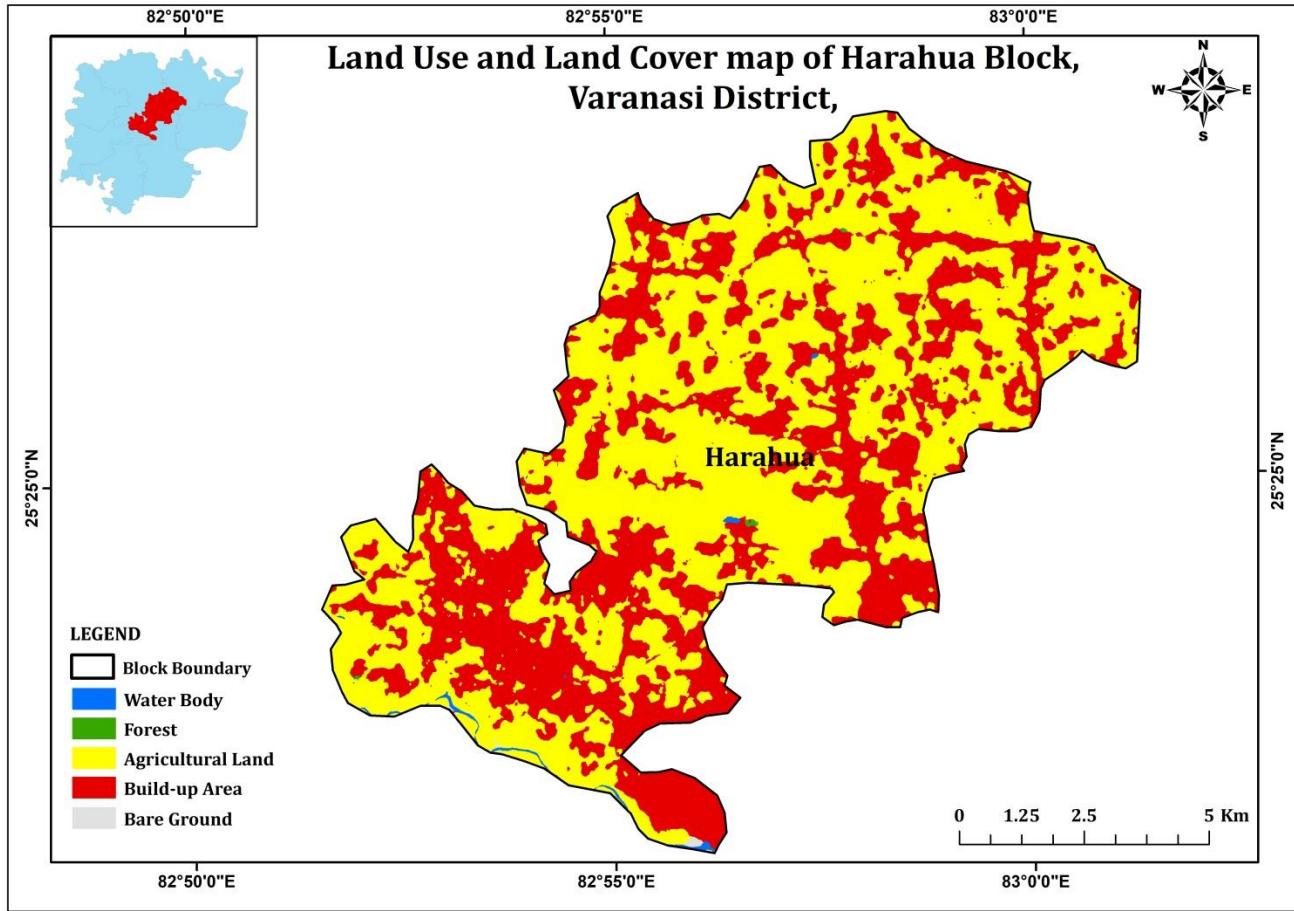


Figure 78: Landuse/Landcover Map of Harhua block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally ranging in between 10.0 m bgl to 15.0 m bgl (figure-79).

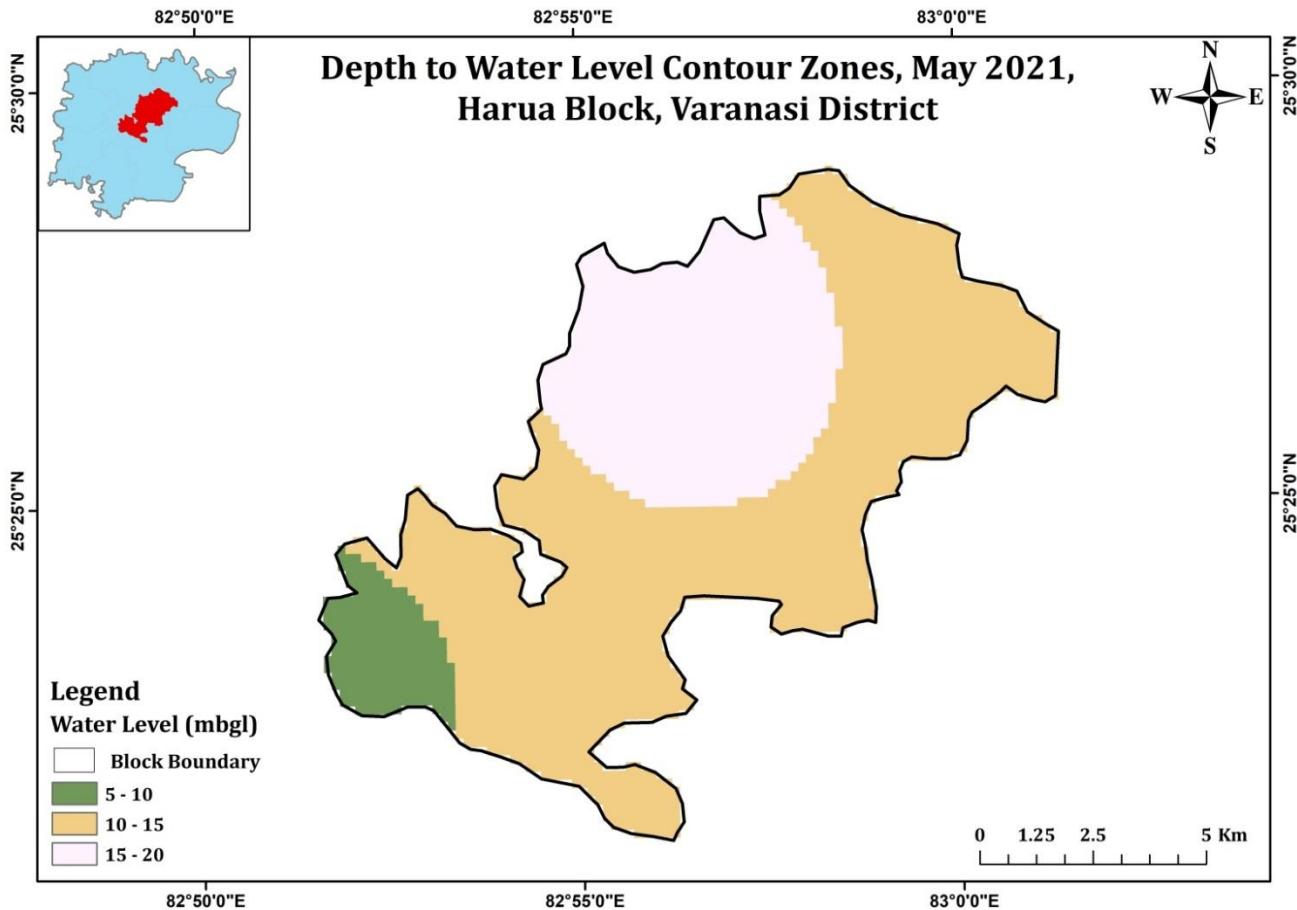


Figure 79: Depth to Water level Map (Pre-Monsoon) of Harhua block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is generally deep throughout the block ranging in between 5.0 m bgl to 12.0 m bgl (figure-80).

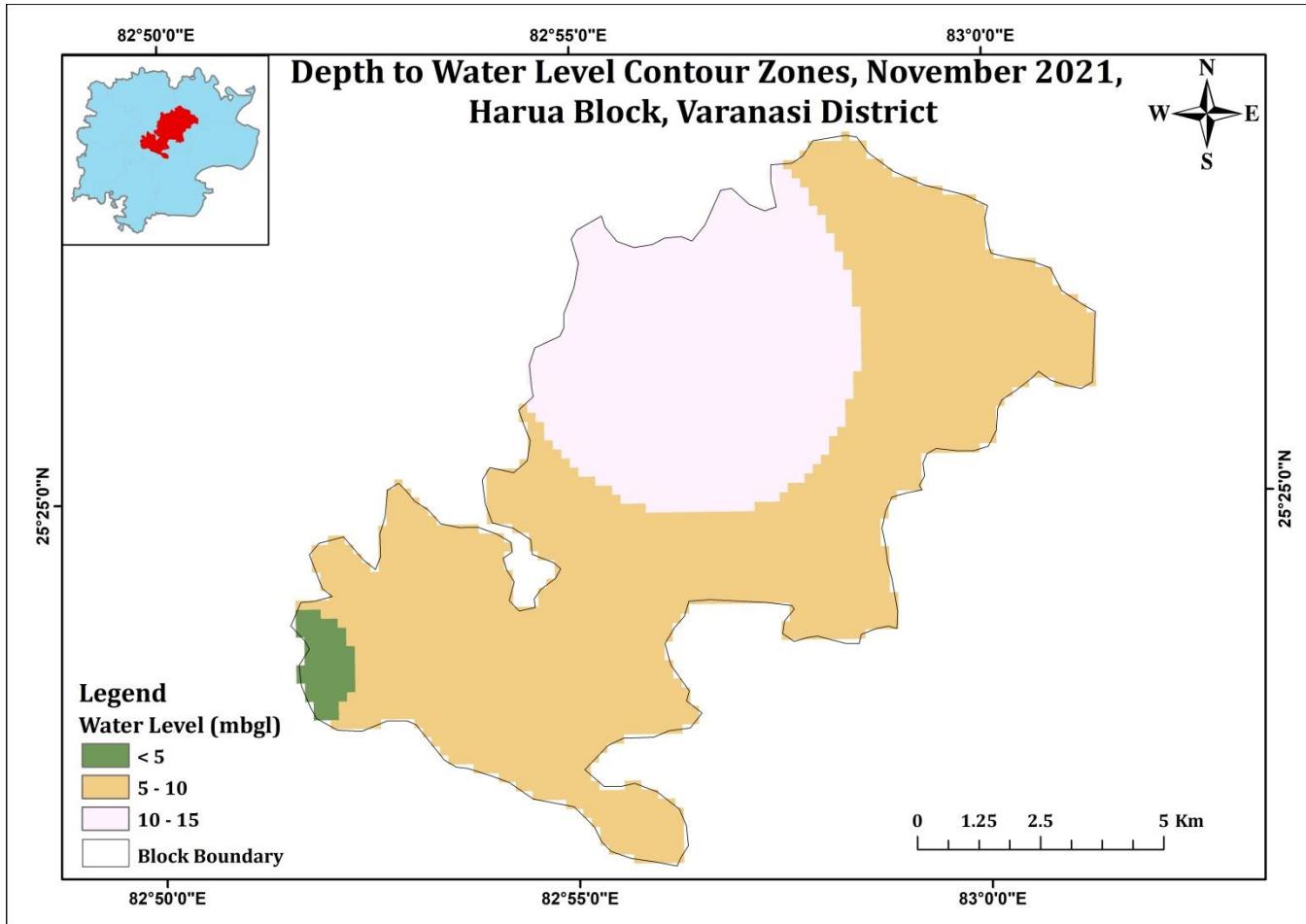


Figure 80: Depth to Water level Map (Post-Monsoon) of Harhua block, Varanasi district

10. Ground water Resources

The block is categorized as Over Exploited as per 2020 ground water resource assessment with 119.82 % of stage of ground water extraction which is highest amongst the blocks (figure-24).

11. Chemical Quality

All the chemical constituents are within the permissible limit of BIS-2012 except for sporadic occurrence of nitrate and fluoride in isolated pockets (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Only two exploratory wells have been drilled by the department in the block down to the depth of 304 m bgl. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-81).

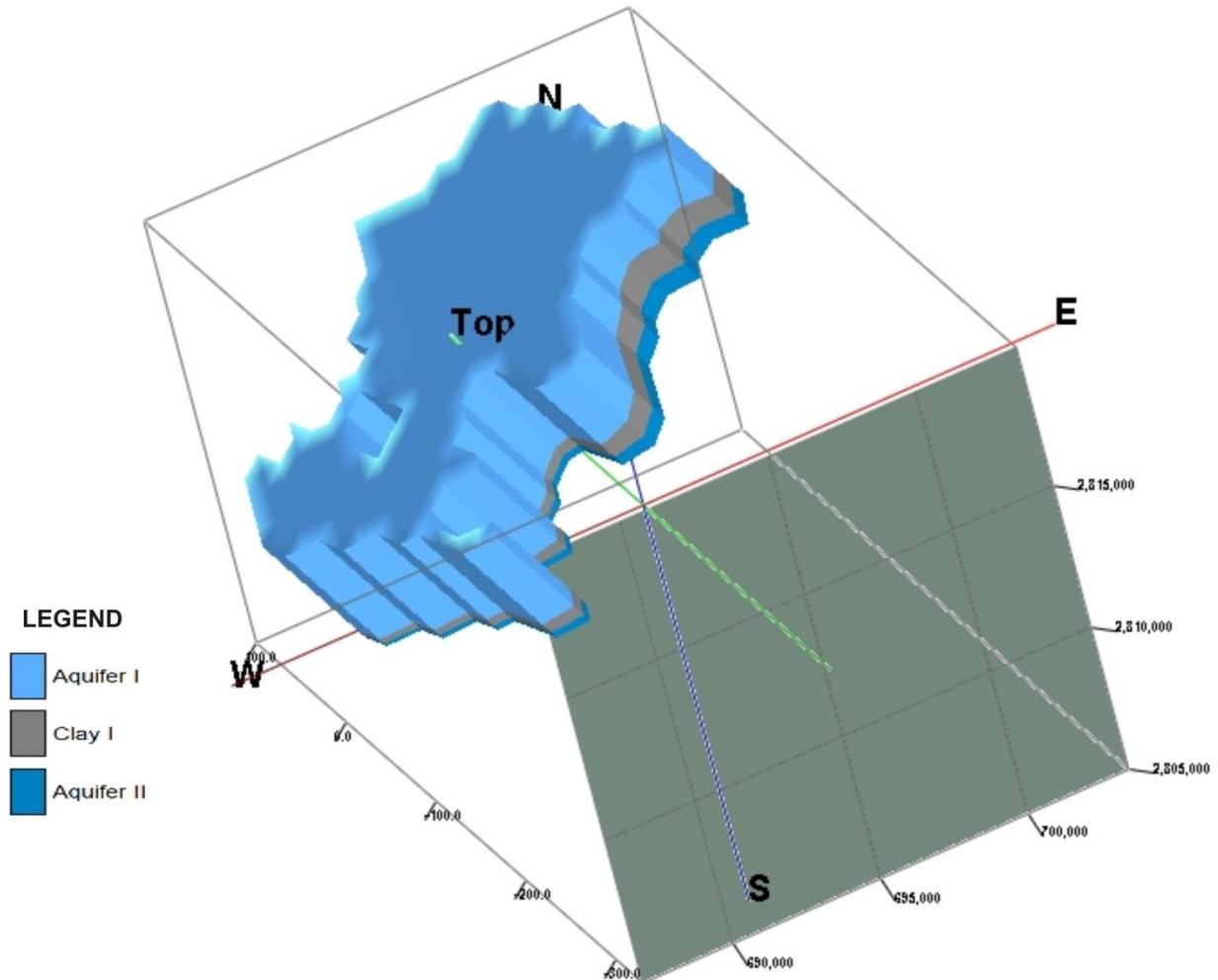


Figure 81: 3-D Model depicting Aquifer geometry of Harhua block, Varanasi district

13. Management Plan

- Block is Over-exploited as per GW Resource Estimation, 2020 with 119.82% of stage of ground water extraction which is highest among the blocks.
- Percentage of net irrigated to net sown area is 94.8% and the contribution of ground water for irrigation in this block is 86.14%.
- Establishing additional canal network as the canal length in the block is only 4 km.
- As the block is over exploited, hence artificial recharge measures and conservation of water techniques should be adopted in the block to arrest further decline in water levels.

Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-82.

Ground Water Management Strategies and Projected Stage of Extraction of Harhua Block, Varanasi District													
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns
Harhua	4	4	4	6	7060	7060	0.26	0.26	8.15	0.26	8.41	119.82	106.40

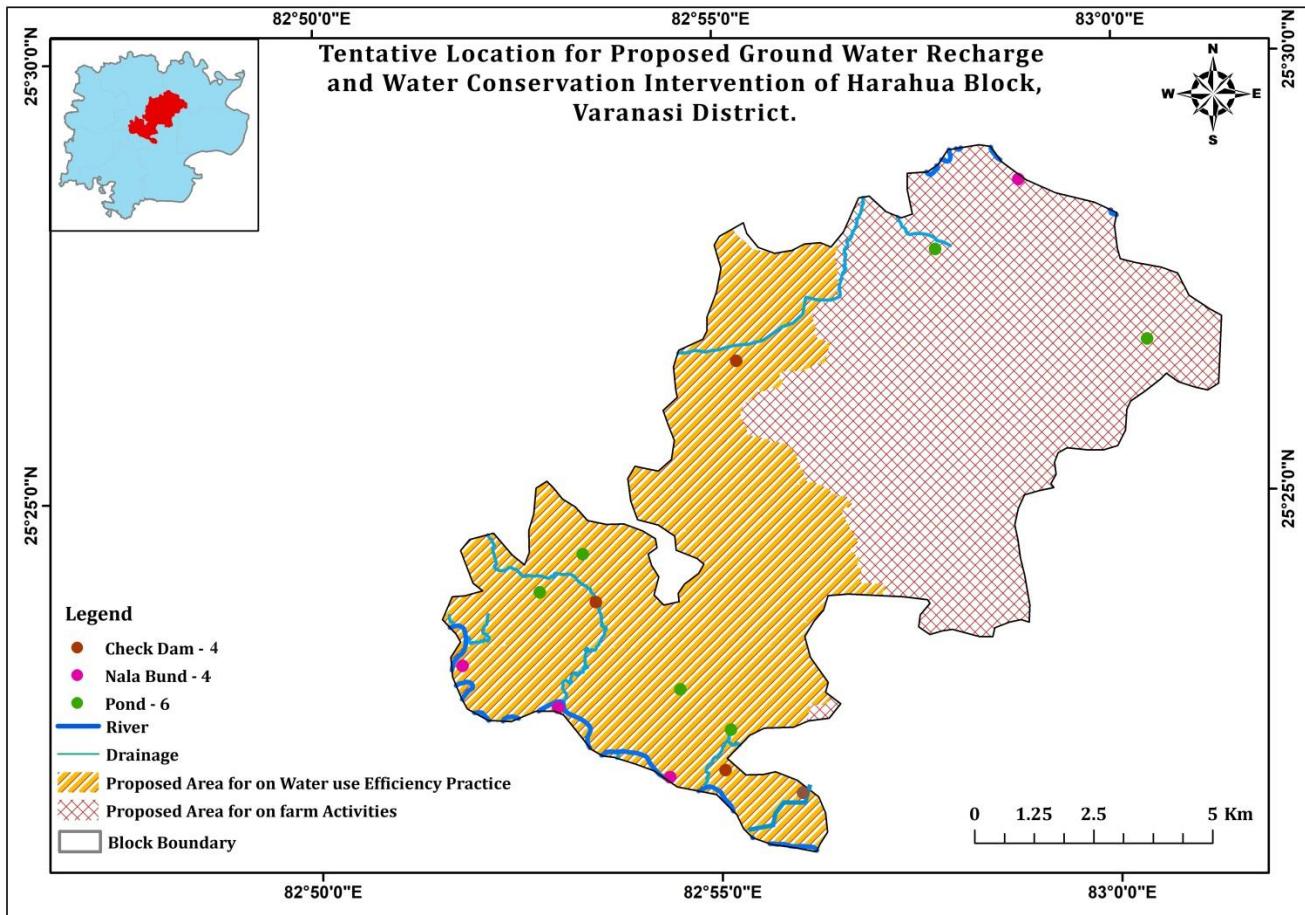


Figure-82: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Harhua Block, Varanasi District

VI. Aquifer Mapping and Management plan of *Kashi Vidyapith Block*

1. Salient Information

Geographical Area:	143.40 sq km
Population (2011):	Total : 258946 male- 136746, female- 122200
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-77 sq. km Net Irrigated Area-77 sq. km Tube well irrigated area-72 sq km Well irrigated area- 1.44 sq km Canal irrigated area- 4.0 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 4911.55 Ham/ 49.11 MCM Draft- 3485.91 Ham/ 34.85 MCM Stage of GW Extraction- 70.97% Category- Semi Critical

2. Location

Kashi Vidyapith block lies in south-east of Varanasi district along the left bank of Ganga river, covering an area of 143.40 sq km (figure-83).

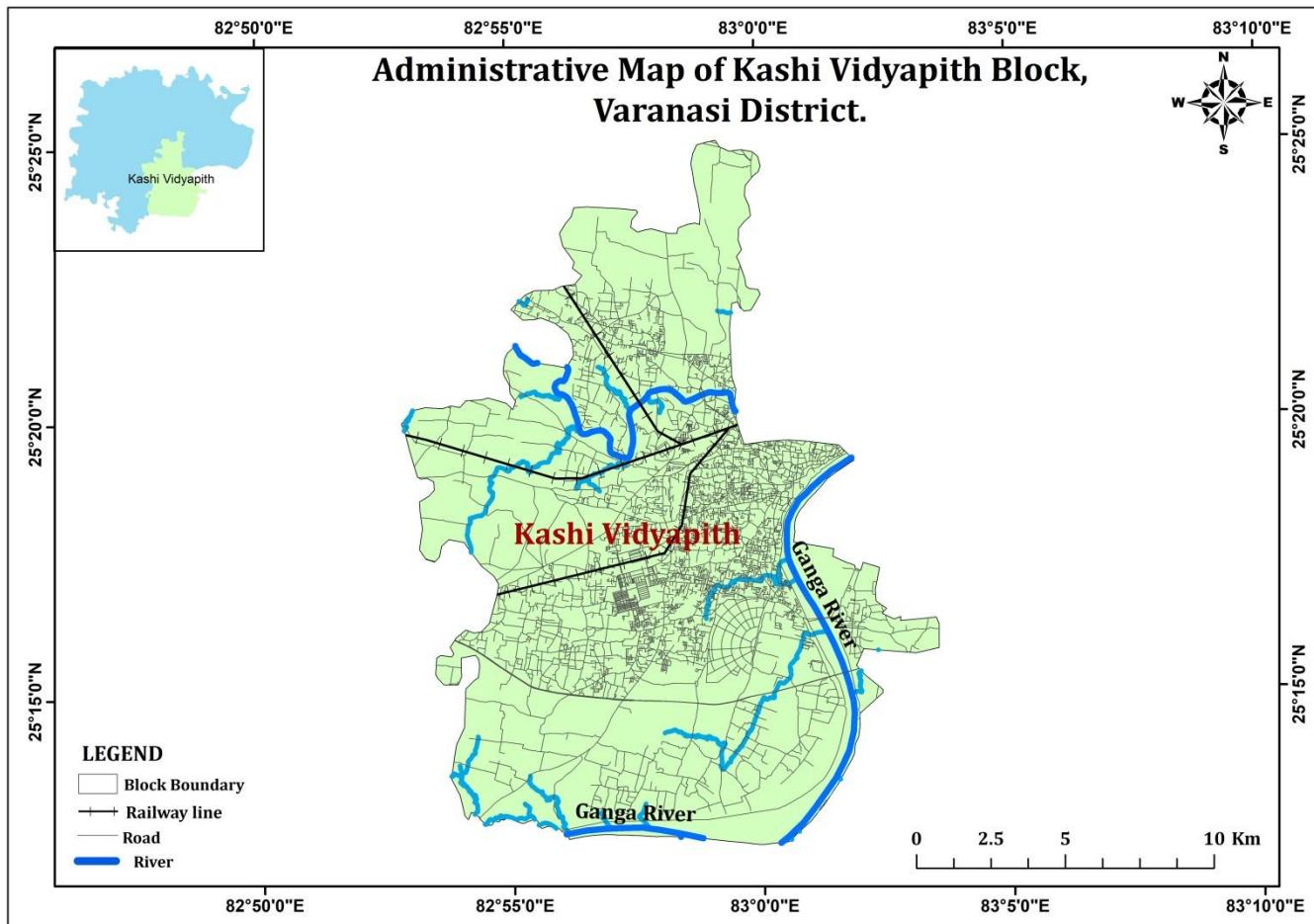


Figure 83: Administrative Map of Kashi Vidyapith block, Varanasi district

3. Geology

Kashi Vidyapith block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades, silt and clay with kankar of Quaternary age (figure-84).

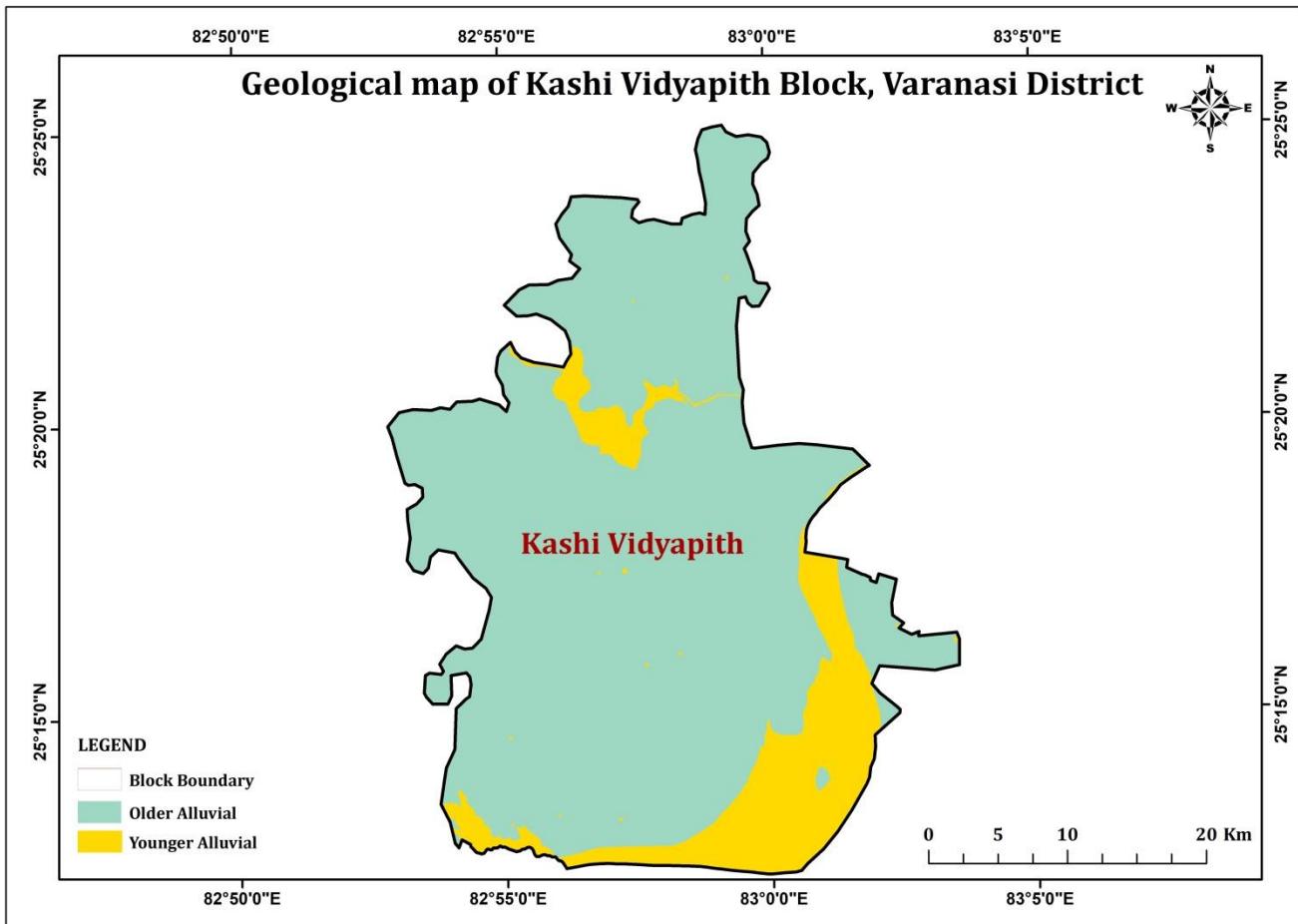


Figure 84: Geology Map of Kashi Vidyapith block, Varanasi district

4. Drainage

Kashi Vidyapith block mainly drained Ganga river and its tributaries (figure-85).

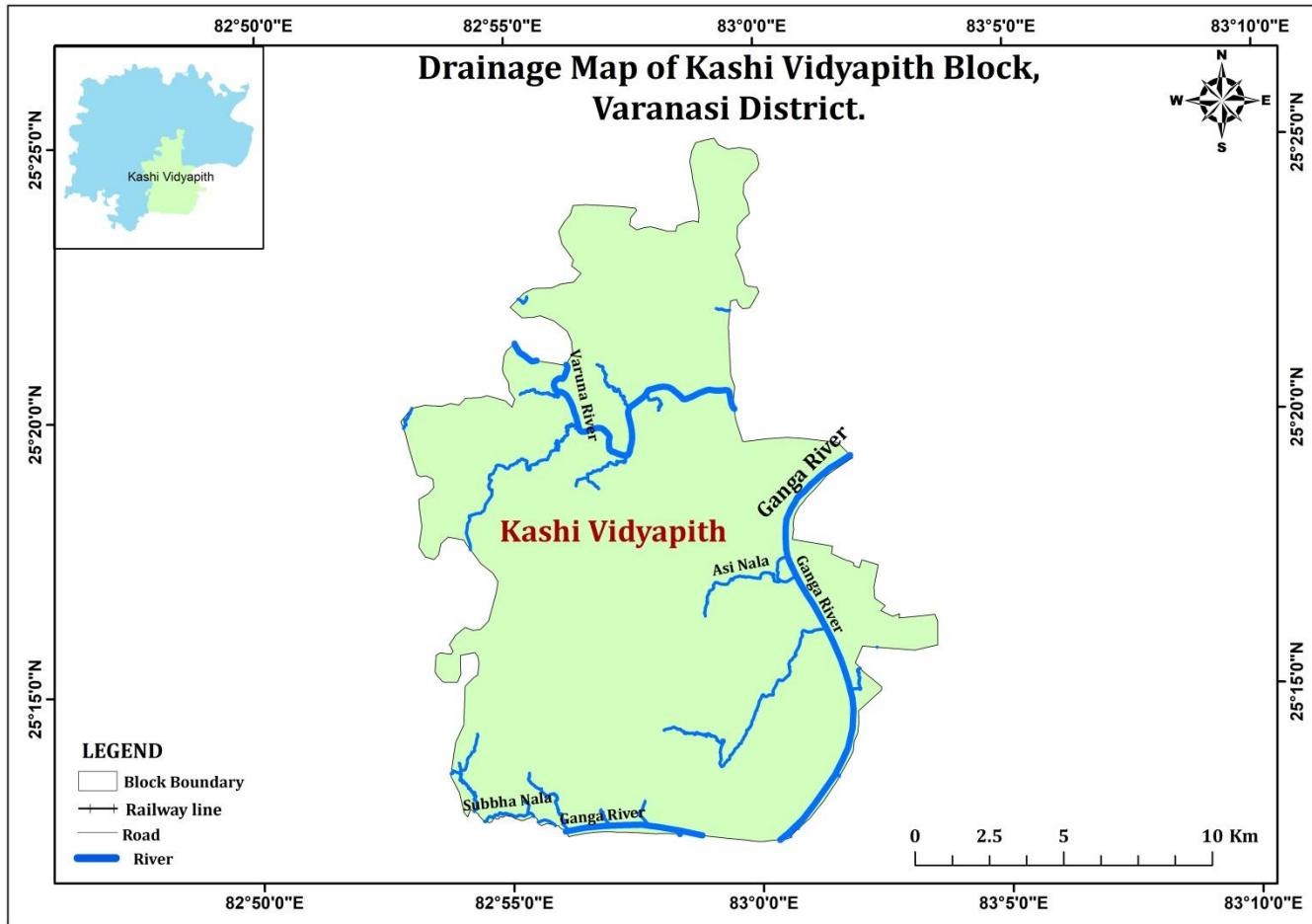


Figure 85: Drainage Map of Kashi Vidyapith block, Varanasi district

5. Soil

The block is mostly covered with varying grades of loamy soil and fine silt.

6. Geomorphology

The block is mainly covered with older/upper alluvial plain and younger/lower alluvial plain. Flood plains and habitation mask are common geomorphological features (figure-86).

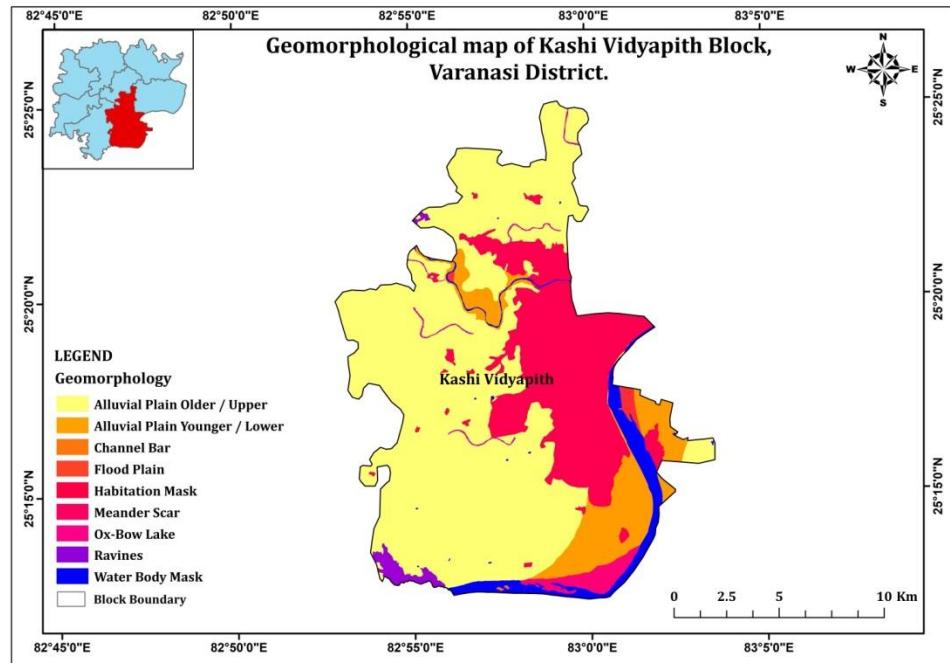


Figure 86: Geomorphology Map of Kashi Vidyapith block, Varanasi district

7. Landuse/ Land cover

Block is mostly covered with built up area with scattered agricultural land throughout the block and wasteland along river (figure-87).

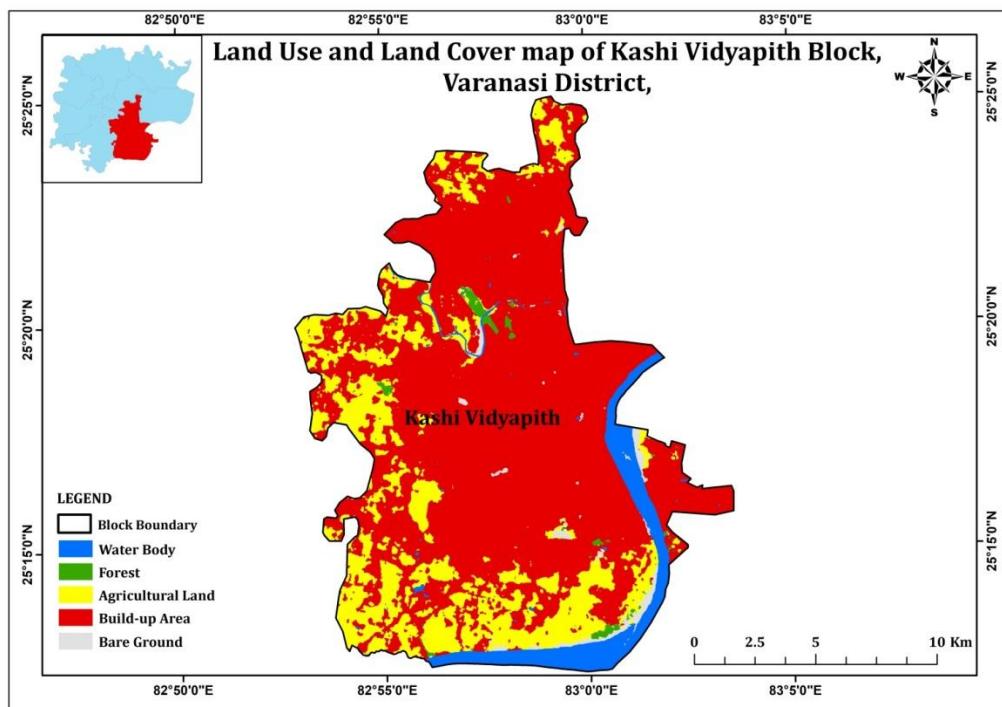


Figure 87: Landuse/Landcover Map of Kashi Vidyapith block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is deep ranging in between 10.0 m bgl to 15.0 m bgl (figure-88).

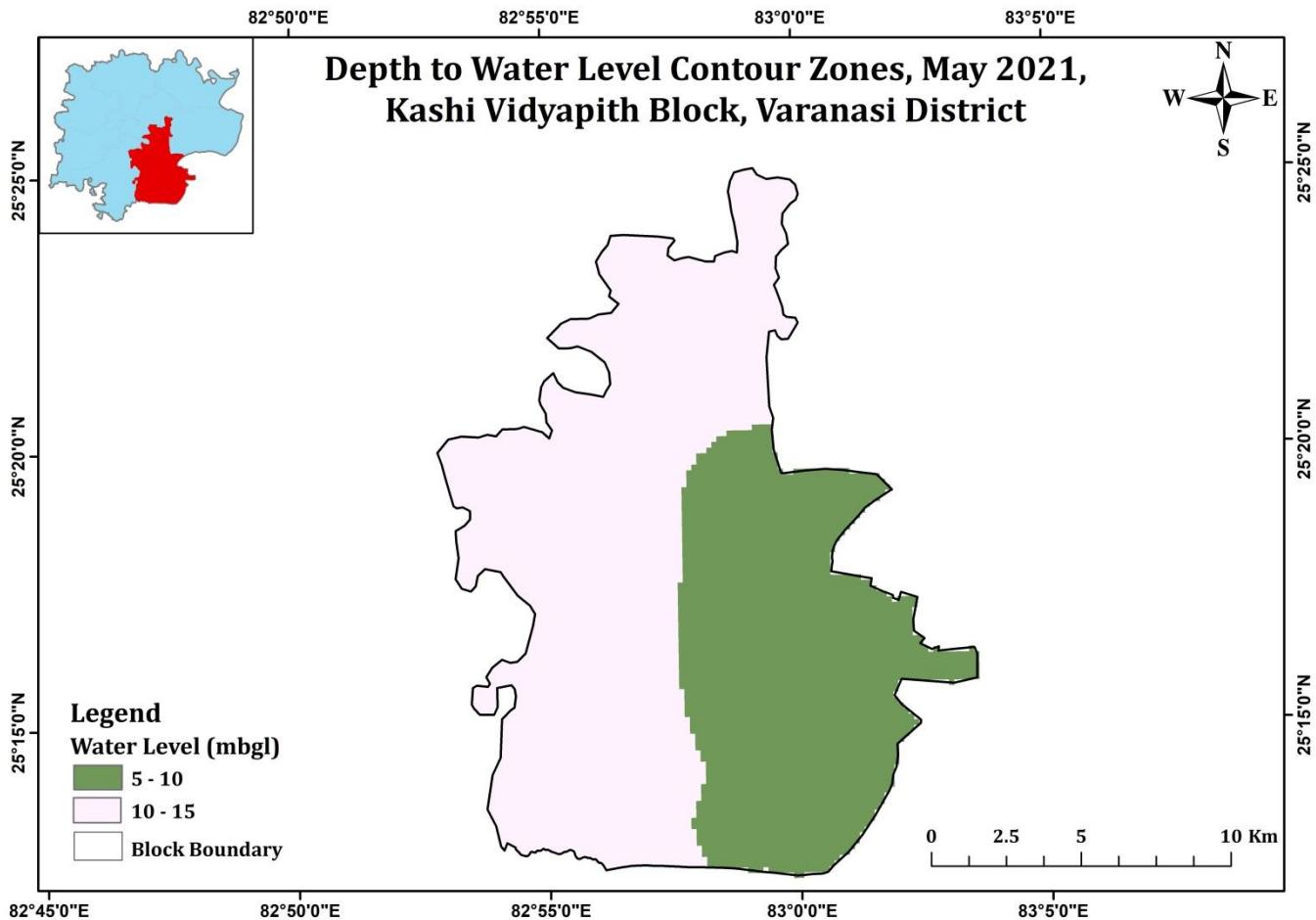


Figure 88: Depth to Water level Map (Pre-Monsoon) of Kashi Vidyapith block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is shallow ranging in between 2.0 m bgl to 5.0 m bgl (figure-89).

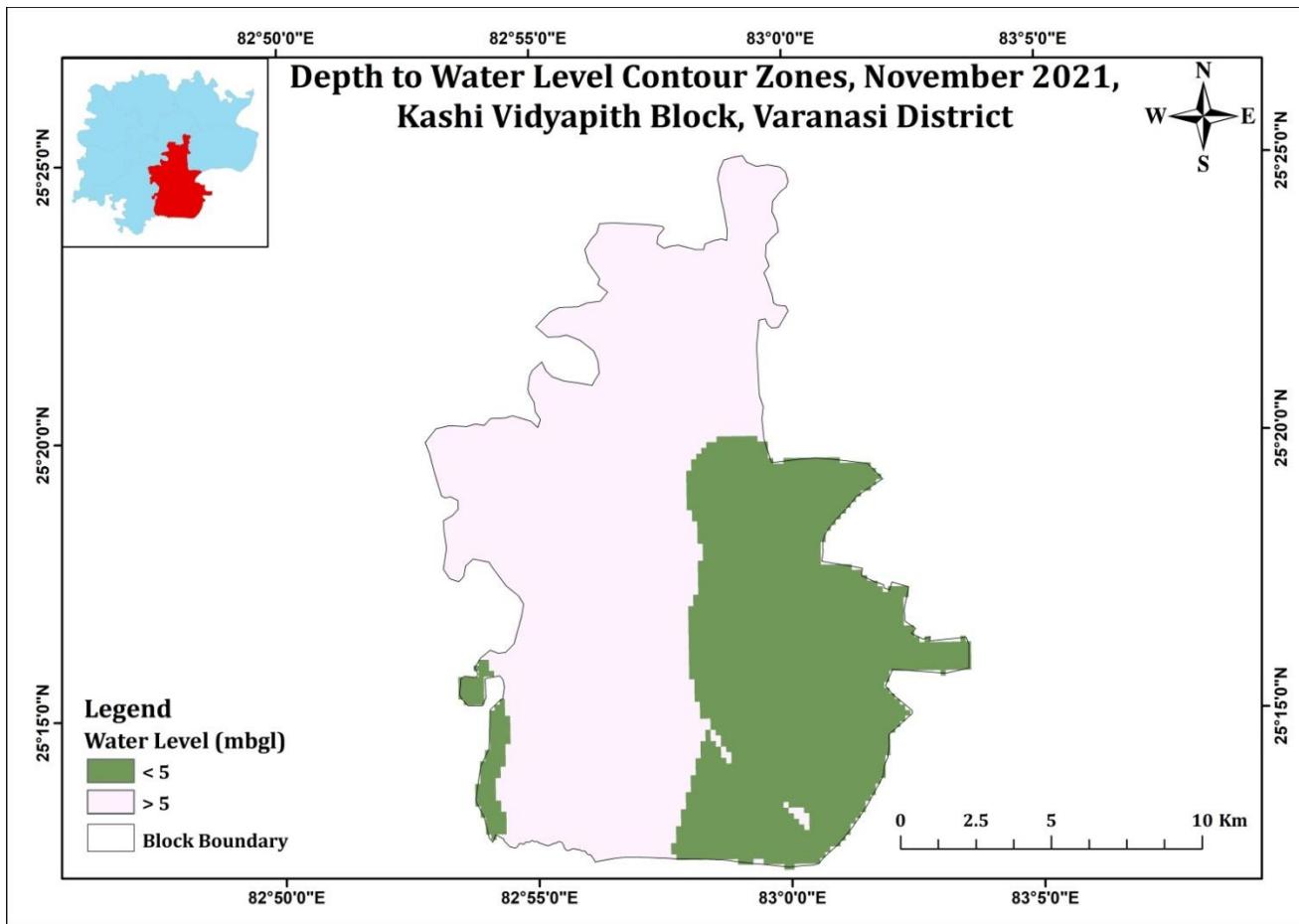


Figure 89: Depth to Water level Map (Post-Monsoon) of Kashi Vidyapith block, Varanasi district

10. Ground water Resources

The block is categorized as Semi critical as per 2020 ground water resource assessment with 70.97% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

All the chemical constituents are within the permissible limit of BIS-2012 except for sporadic occurrence of nitrate and fluoride in isolated pockets (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Two aquifer groups reported from the exploratory drilling in d in Kashi Vidyapith block. Basement has been encountered at a depth of 273 m bgl in NatiImli Borewell drilled by the departmental rig. Ground water occurs under water table condition at shallow depths while the confined aquifers are under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-90).

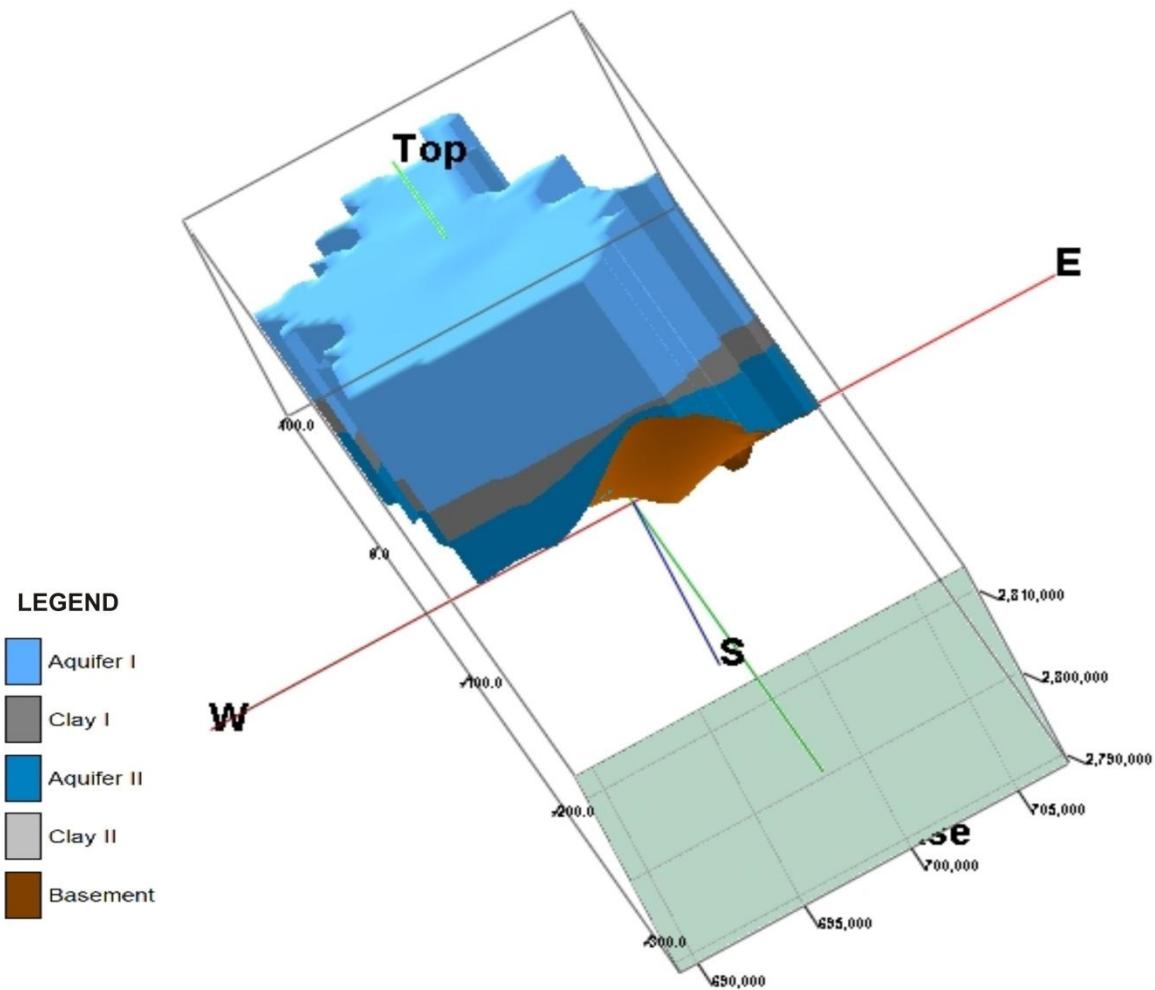


Figure 90: 3-D Model depicting Aquifer geometry of Kashi Vidyapith block, Varanasi district

13. Management Plan

- Block is Semi critical as per GW Resource Estimation, 2020 with 70.97% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 100.17% which is highest among the blocks and the contribution of ground water for irrigation in this block is 93.09 %.
- Establishing canal network as the canal network in the block is only 2 km.
- Artificial recharge measures and conservation of water techniques should be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-91

Ground Water Management Strategies and Projected Stage of Extraction of Kashi Vidyapith Block, Varanasi District													
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns
Kashi Vidyapith	2	2	2	2	3073	3073	0.11	0.11	5.13	0.11	5.25	70.97	60.15

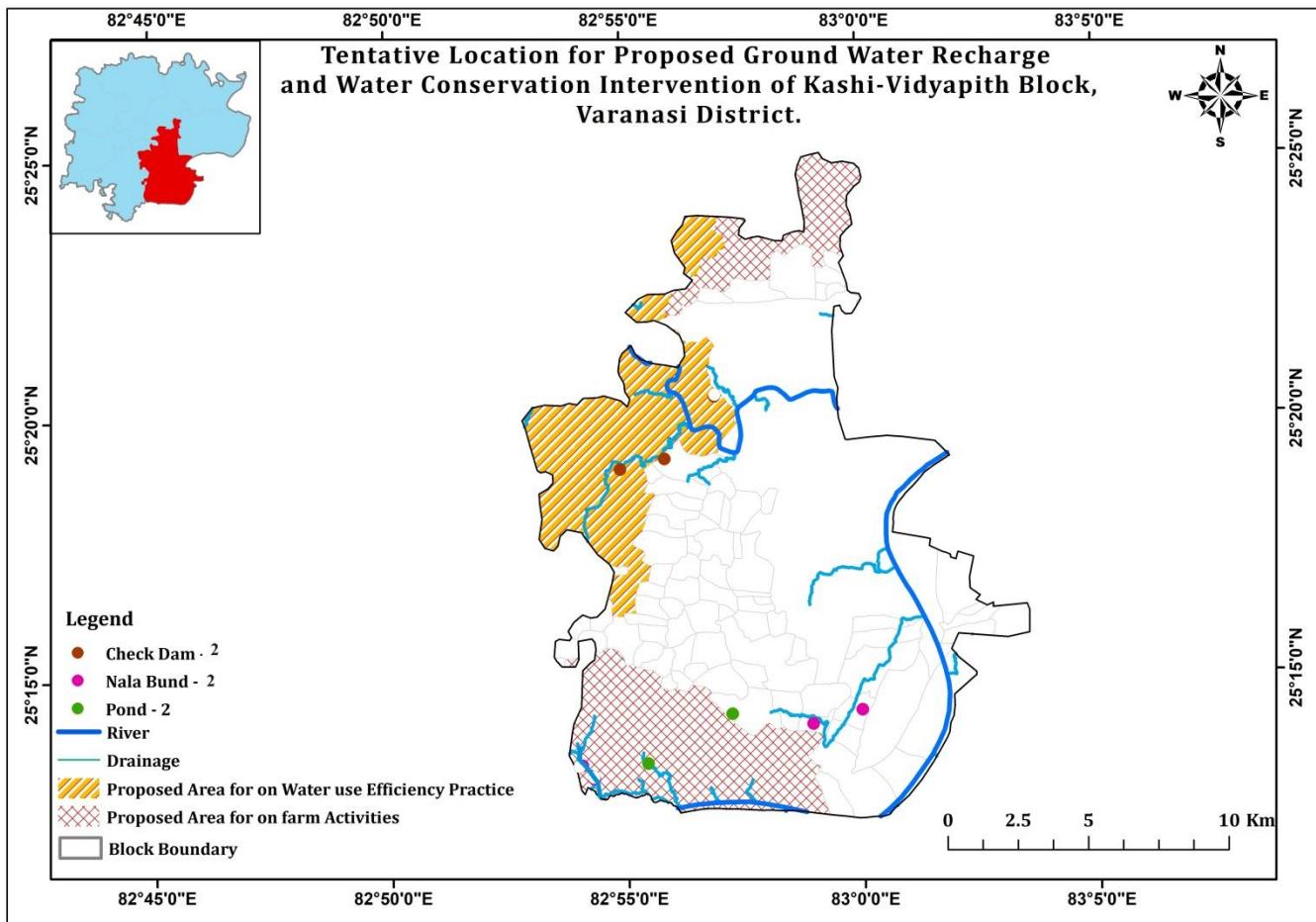


Figure-91: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Kashi Vidyapith Block, Varanasi District

VII. Aquifer Mapping and Management plan of *Pindra Block*

1. Salient Information

Geographical Area:	223.50 sq km
Population (2011):	Total : 275679 male- 139511, female- 136168
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-171 sq. km Net Irrigated Area-151 sq. km Tube well irrigated area-136 sq km Well irrigated area- 1.37 sq km Canal irrigated area- 14 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 8503.37 Ham/ 85.03 MCM Draft- 7080 Ham/ 70.80 MCM Stage of GW Extraction- 83.27% Category- Semi Critical

1. Location

Pindra block lies in north of Varanasi district, encompassing an area of about 223.50 sq km (figure-92).

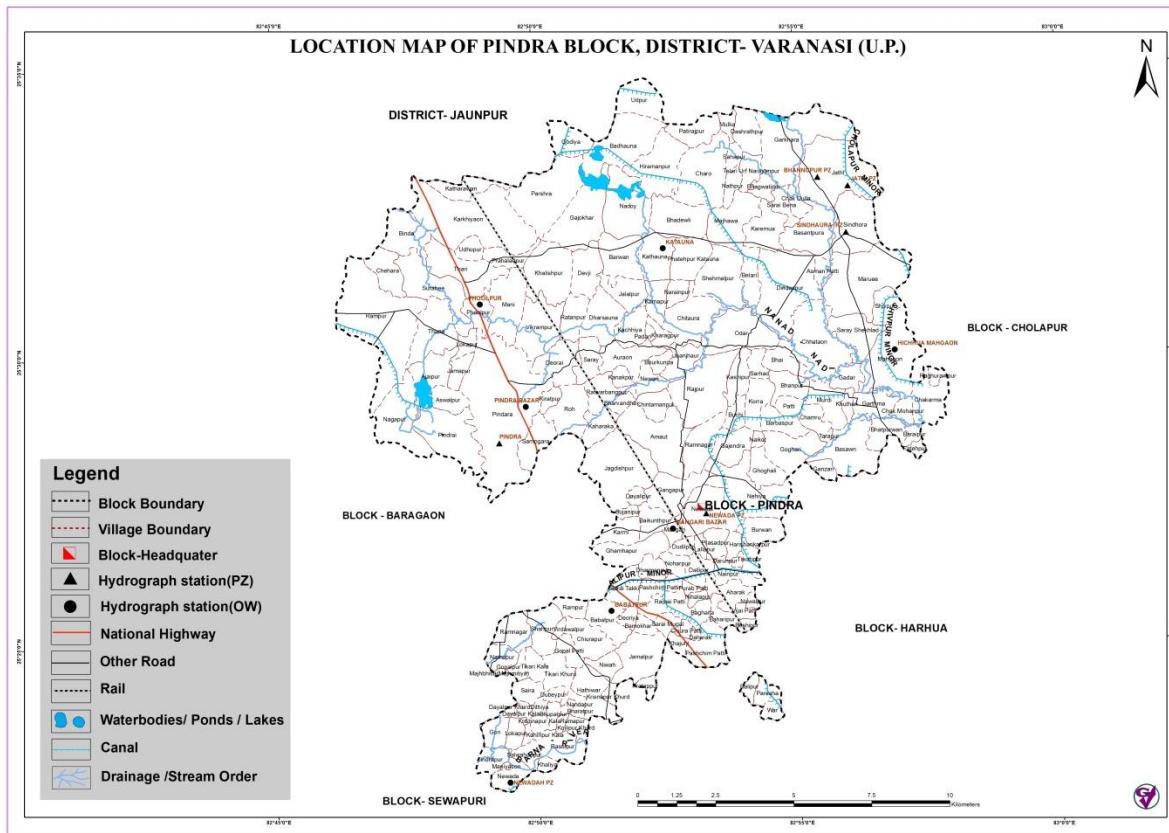


Figure 92: Administrative Map of Pindra block, Varanasi district

3. Geology

Pindra block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades, silt and clay with kankar of Quaternary age (figure-93).

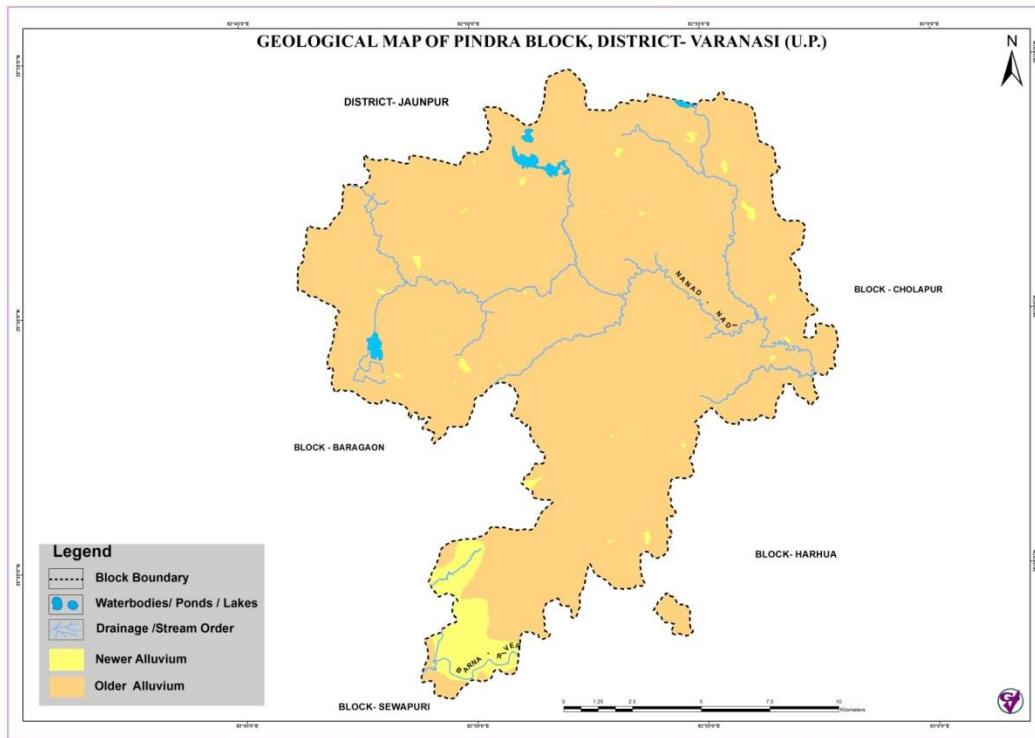


Figure 93: Geology Map of Pindra block, Varanasi district

4. Drainage

Pindra Block mainly drained by tributaries of Nand river (figure-94).

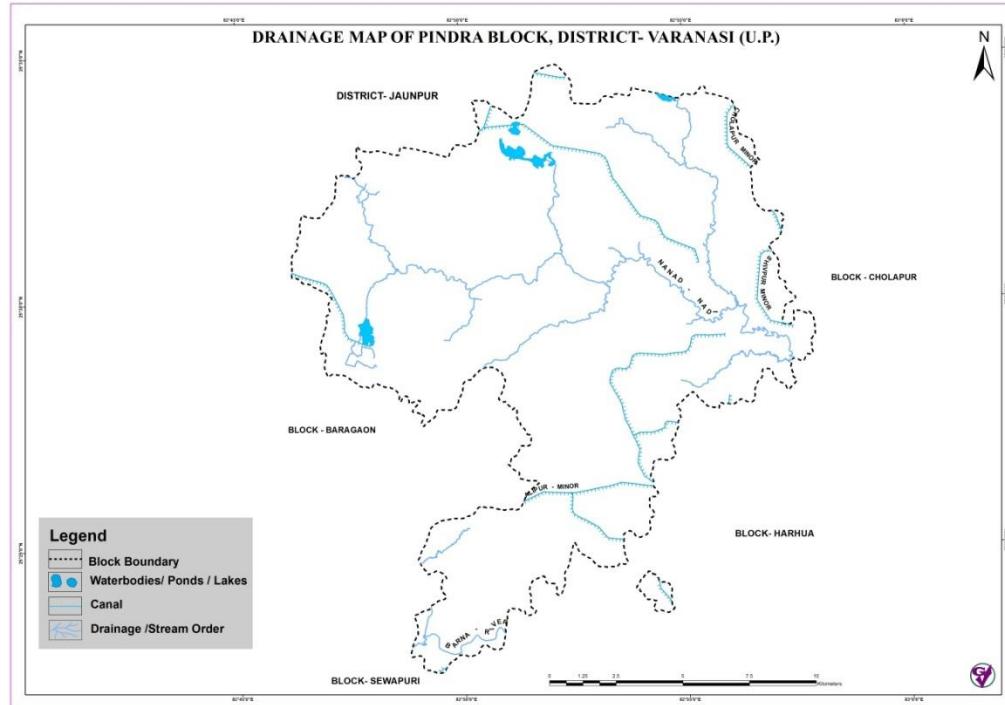


Figure 94: Drainage Map of Pindra block, Varanasi district

5. Soil

The block is mainly covered with varying grades of loamy soil (figure-95).

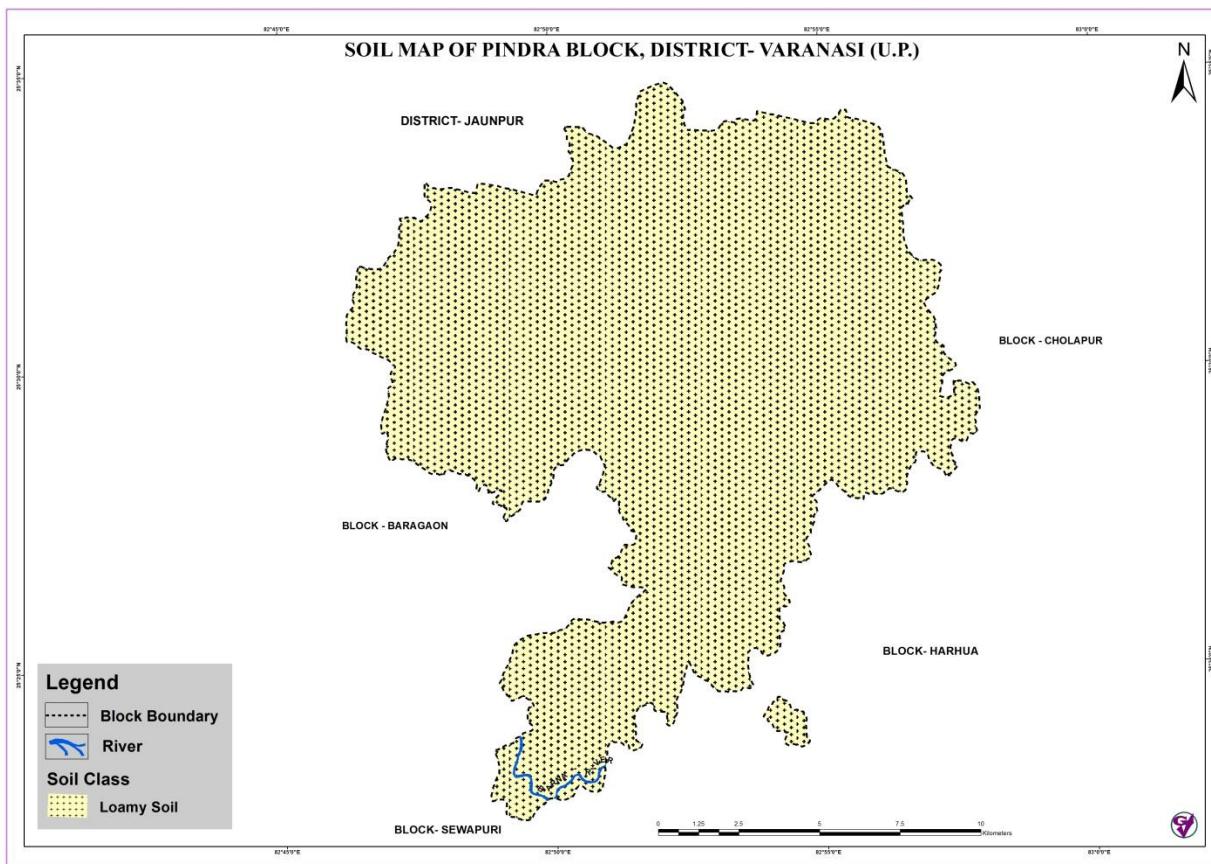
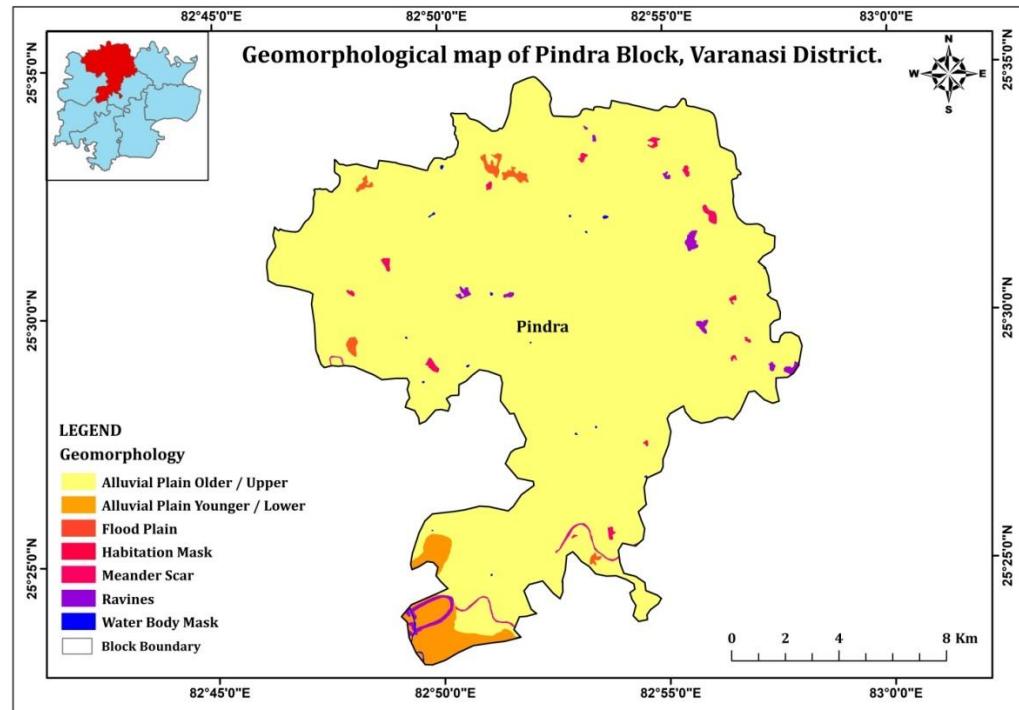


Figure 95: Soil Map of Pindra block, Varanasi district

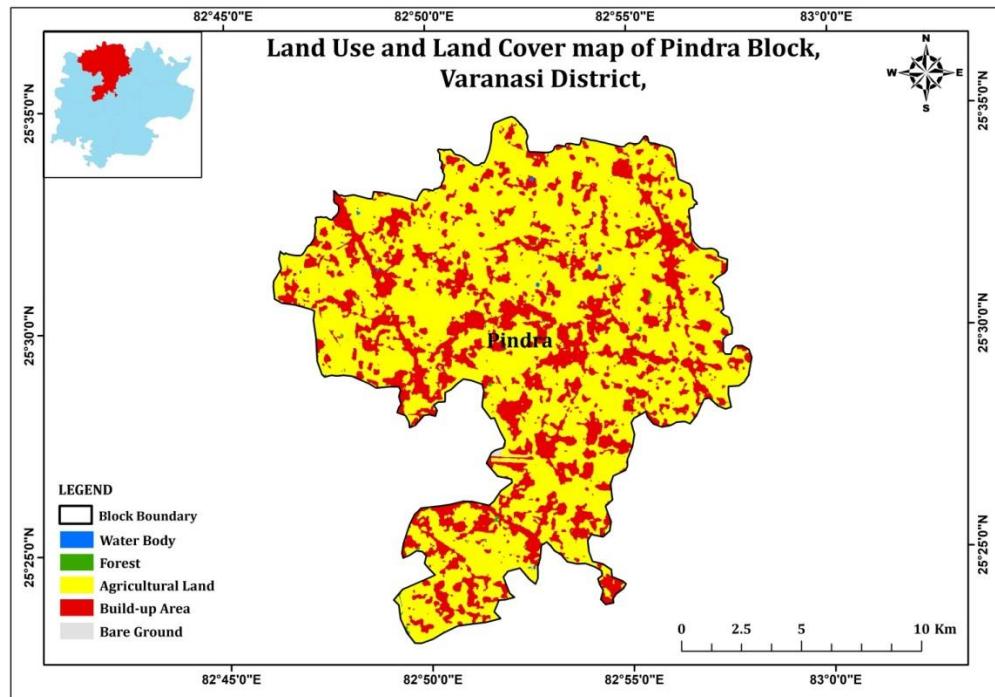
6. Geomorphology

The block is mainly covered with older/upper alluvial plain with scattered habitation mask (figure-96).

**Figure 96: Geomorphology Map of Pindra block, Varanasi district**

7. Landuse/ Land cover

Block is covered with agricultural land and built up area throughout the block (figure-97).

**Figure 97: Landuse/Landcover Map of Pindra block, Varanasi district**

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally ranging in between 5.0 m bgl to 10.0 m bgl (figure-98).

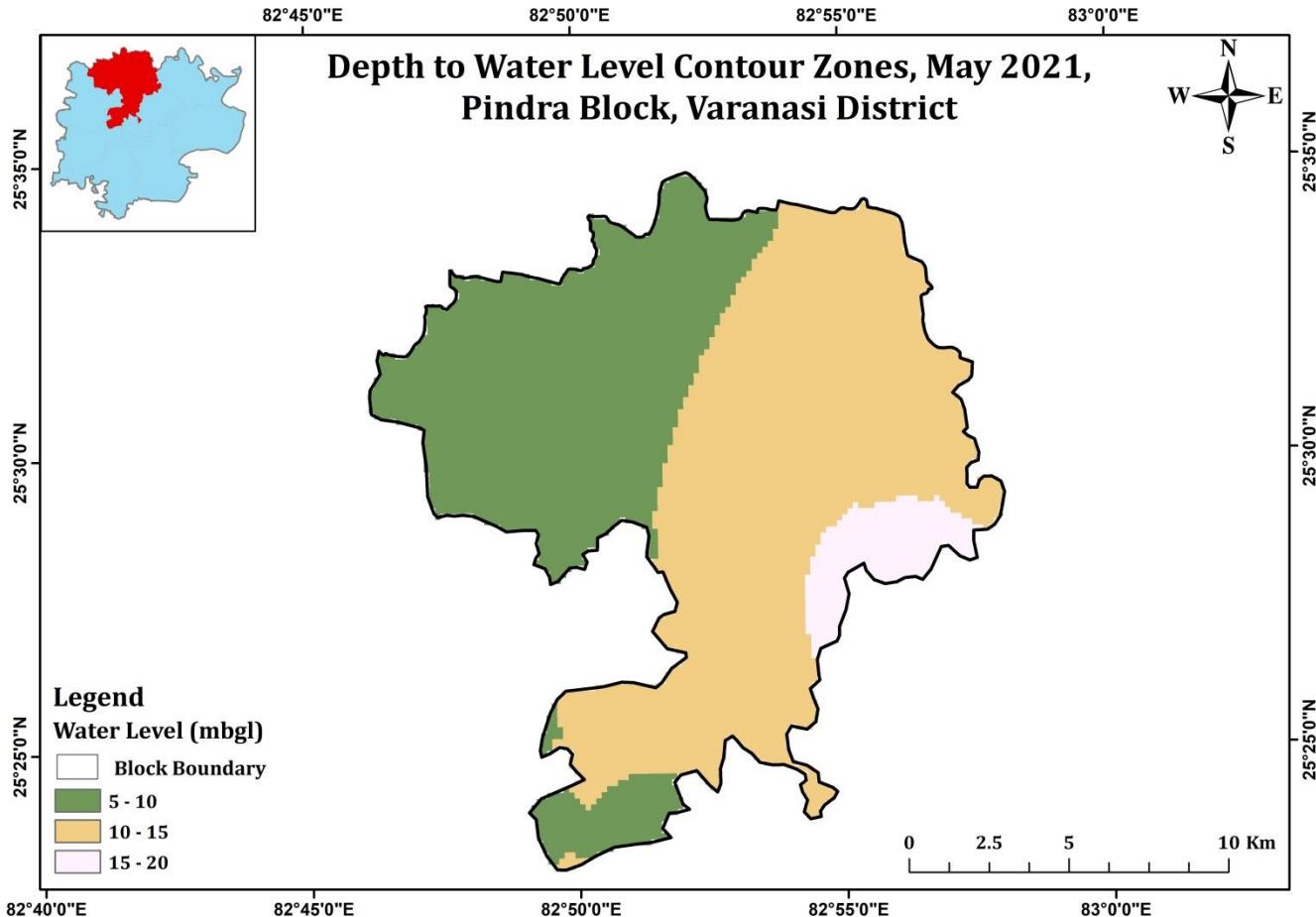


Figure 98: Depth to Water level Map (Pre-Monsoon) of Pindra block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is ranging in between 5.0 m bgl to 12.0 m bgl (figure-99).

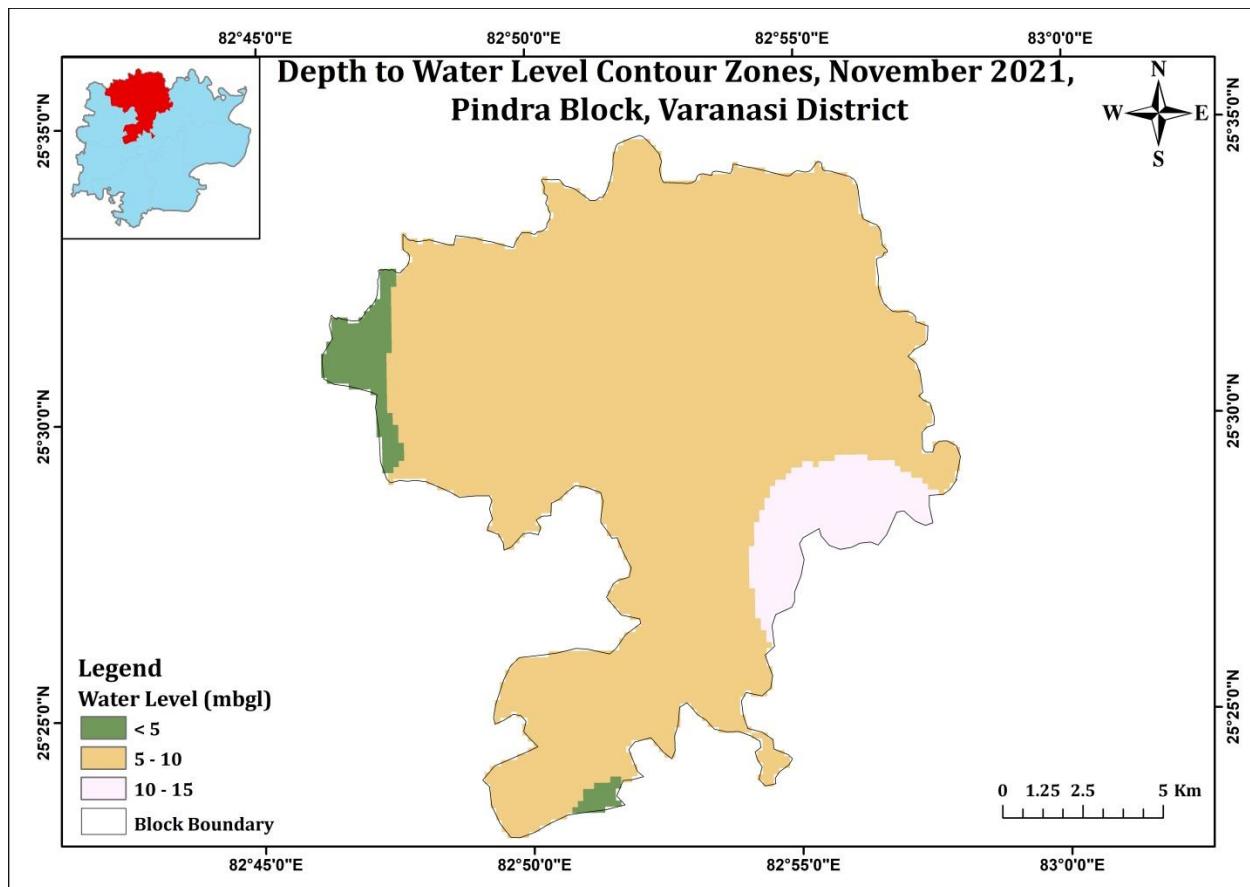


Figure 99: Depth to Water level Map (Post-Monsoon) of Pindra block, Varanasi district

10. Ground water Resources

The block is categorized as Semi critical as per 2020 ground water resource assessment with 83.27% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

Quality of ground water is potable and all the chemical constituents are within the permissible limit of BIS-2012 (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Two groups of aquifer are reported from the exploratory drilling in Pindra block. Only one exploratory well has been drilled by the department in the block. Ground water occurs under water table condition at shallow depths while the deeper aquifer is under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers mixed with kanka acting as aquiclude (figure-100).

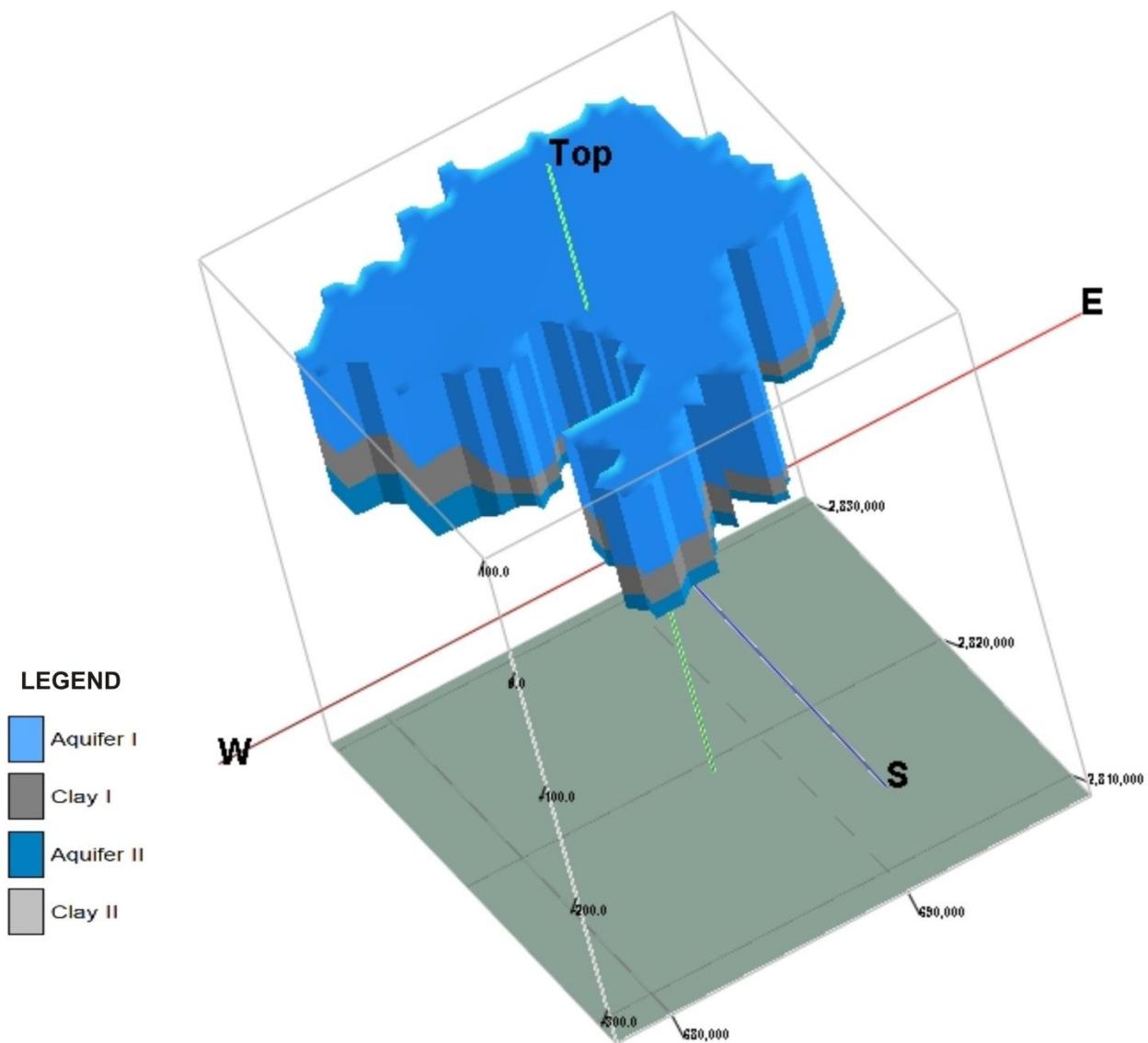


Figure 100 3-D Model depicting Aquifer geometry of Pindra block, Varanasi district

13. Management Plan

- Block is Semi critical as per GW Resource Estimation, 2020 with 83.27% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 88.28% and the contribution of ground water for irrigation in this block is 89.86 %.
- Artificial recharge measures and conservation of water techniques should be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-101.

Ground Water Management Strategies and Projected Stage of Extraction of Pindra Block, Varanasi District														
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On- farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On- farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns	
Pindra	3	3	3	3	4555	4555	0.18	0.18	12.94	0.18	13.12	83.27	67.70	

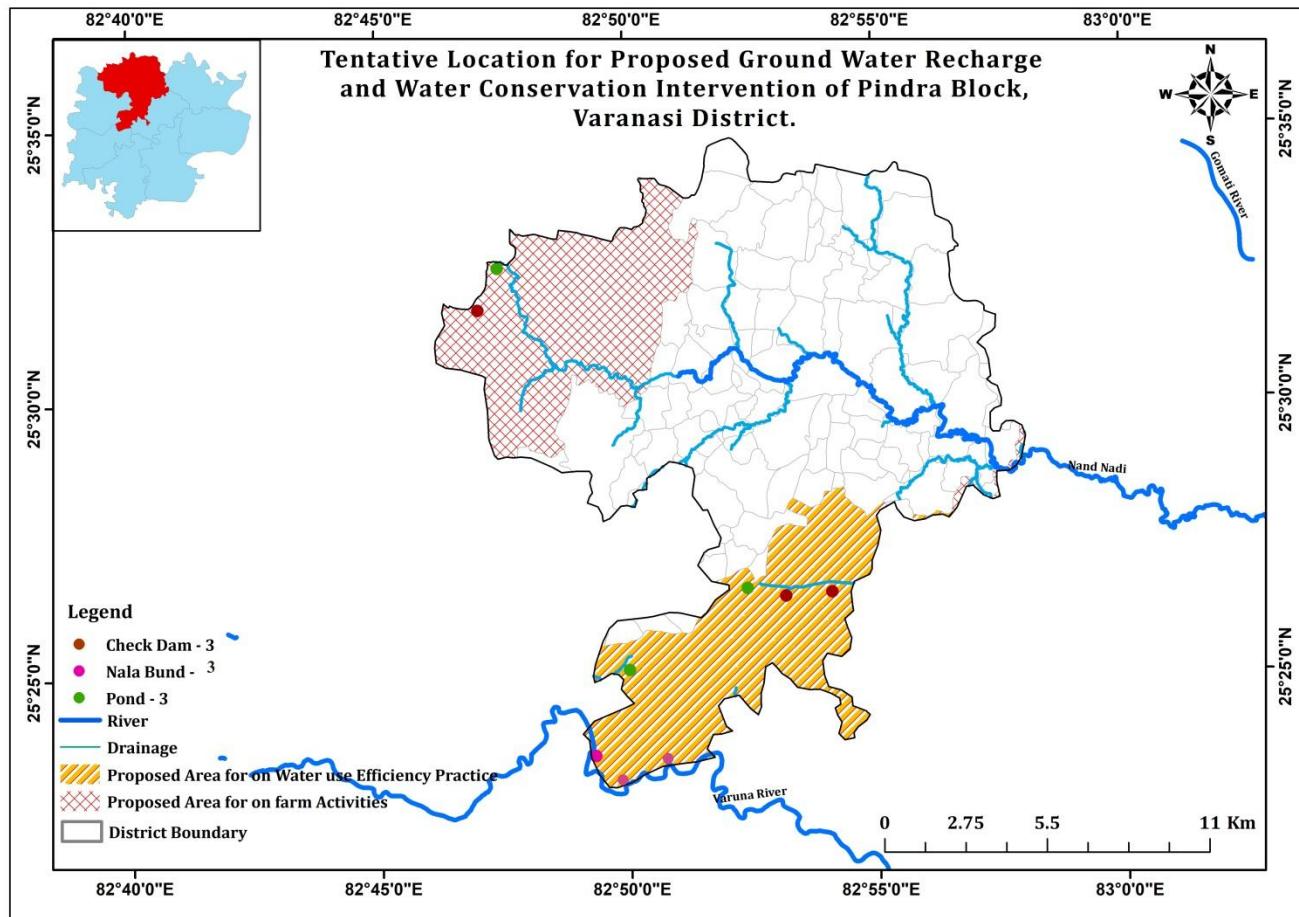


Figure-101: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Pindra Block, Varanasi District

VIII. Aquifer Mapping and Management plan of *Sevapuri Block*

1. Salient Information

Geographical Area:	169.13 sq km
Population (2011):	Total : 234392 male- 121016, female- 113376
Normal Annual Rainfall 2020 (Varanasi District):	1032 mm
Agriculture and Irrigation(2018):	Major Crops- Wheat and Rice Other crops- Sugarcane, Maize and Millet Net Area Sown-114 sq. km Net Irrigated Area-109 sq. km Tube well irrigated area-95 sq km Well irrigated area- 1.51 sq km Canal irrigated area- 13 sq km
Ground water resource (as on 31-03-2020)	<i>Dynamic</i> Net GW Availability- 4996.41 Ham/ 49.96 MCM Draft- 3648 Ham/ 36.48 MCM Stage of GW Extraction- 73.01% Category- Semi Critical

2. Location

Sevapuri block lies in SW of Varanasi district, shares border with St. Ravidas Nagar district in west, the block encompasses an area of about 169.13 sq km (figure-102).

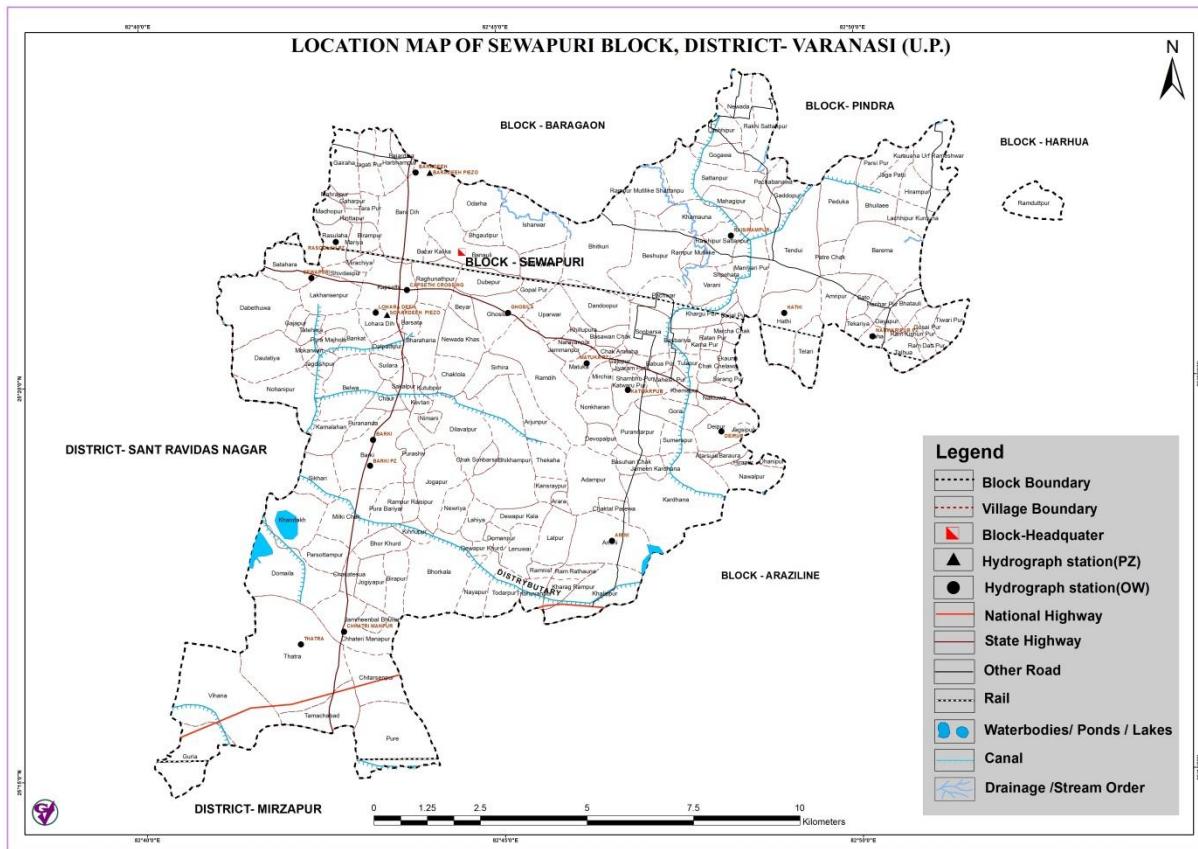


Figure 102: Administrative Map of Sevapuri block, Varanasi district

3. Geology

Sevapuri block constitutes a part of Ganga basin with flat alluvial terrain which is underlain by sands of various grades and clay with kankar of Quaternary age (figure-103).

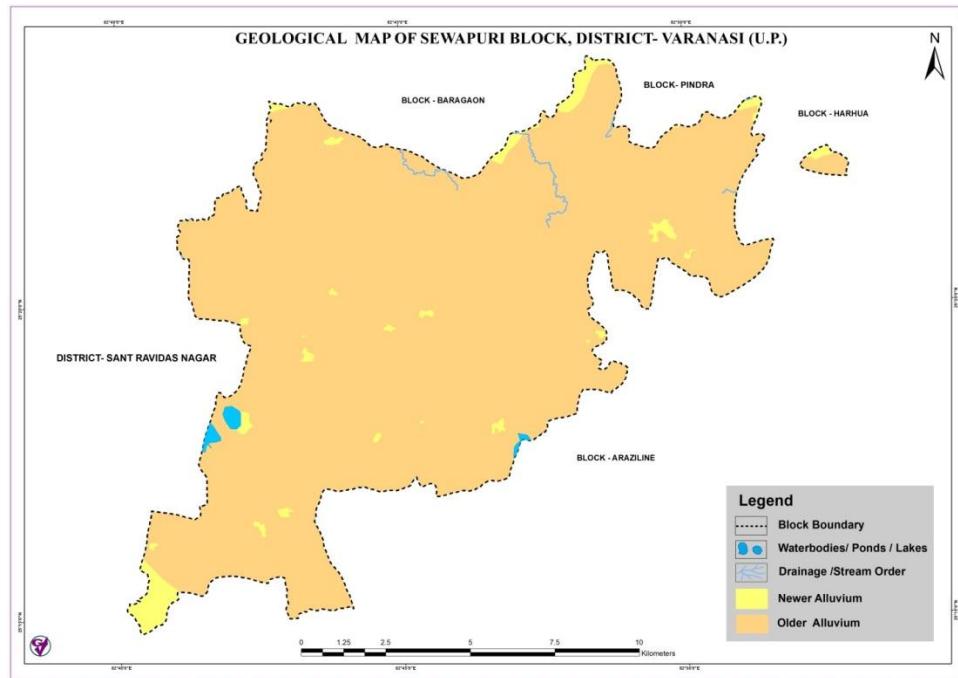


Figure 103: Geology Map of Sevapuri block, Varanasi district

4. Drainage

Sevapuri Block mainly drained by tributaries of Varuna river flowing north of the block (figure-104).

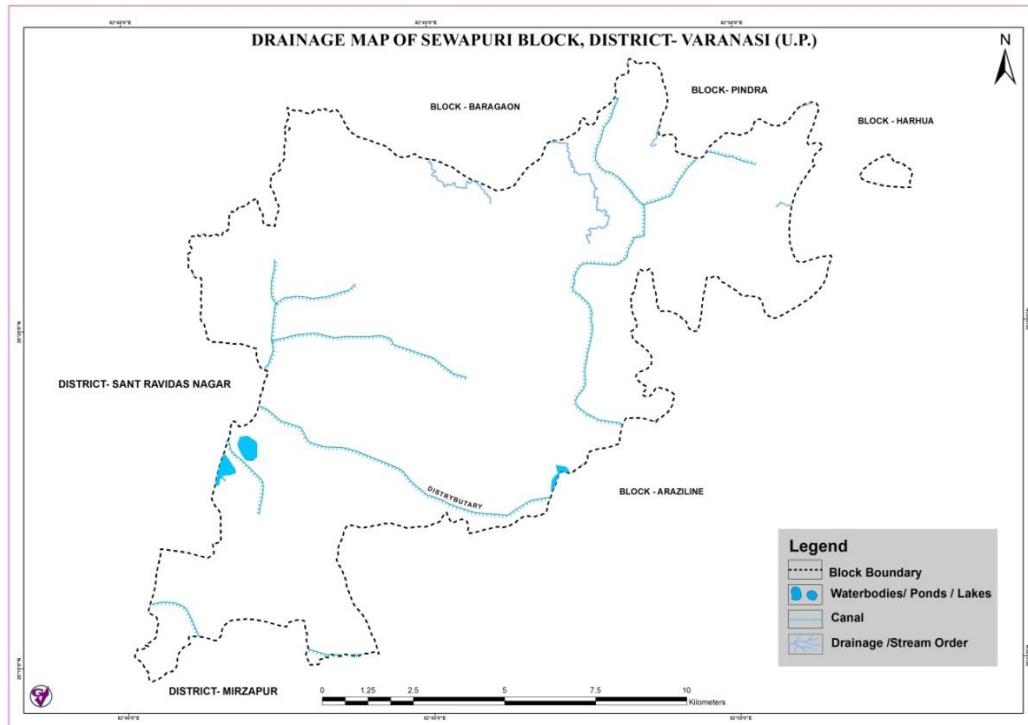


Figure 104: Drainage Map of Sevapuri block, Varanasi district

5. Soil

The block is mainly covered with varying grades of loamy soil (figure-105).

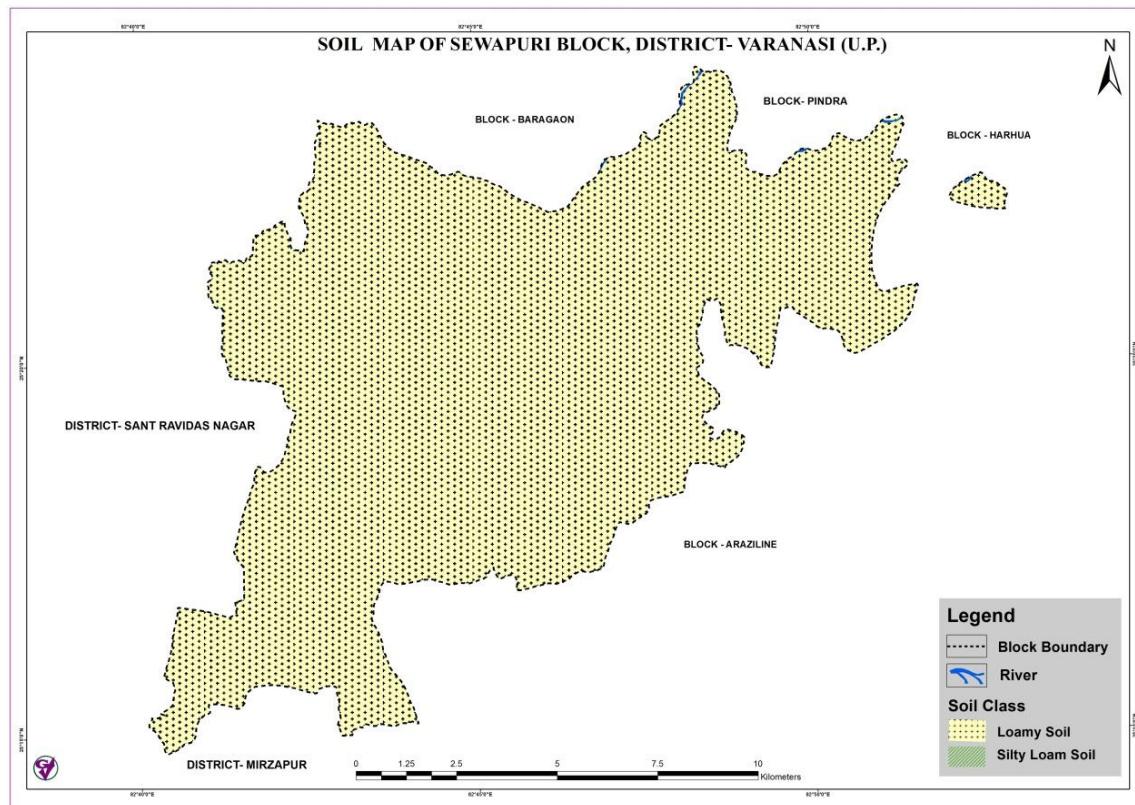


Figure 105: Soil Map of Sevapuri block, Varanasi district

6. Geomorphology

The block is mainly covered with older/upper alluvial plain with scattered habitation mask and ravines in northern part (figure-106).

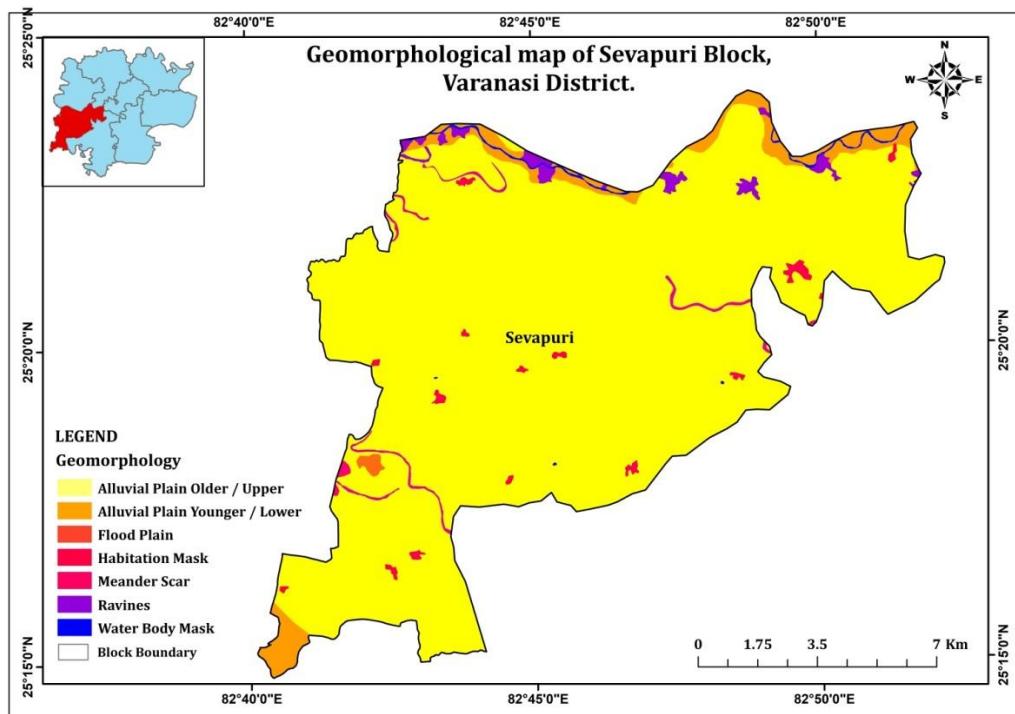


Figure 106: Geomorphology Map of Sevapuri block, Varanasi district

7. Landuse/ Land cover

Block is covered with agricultural land with scattered built up area (figure-107).

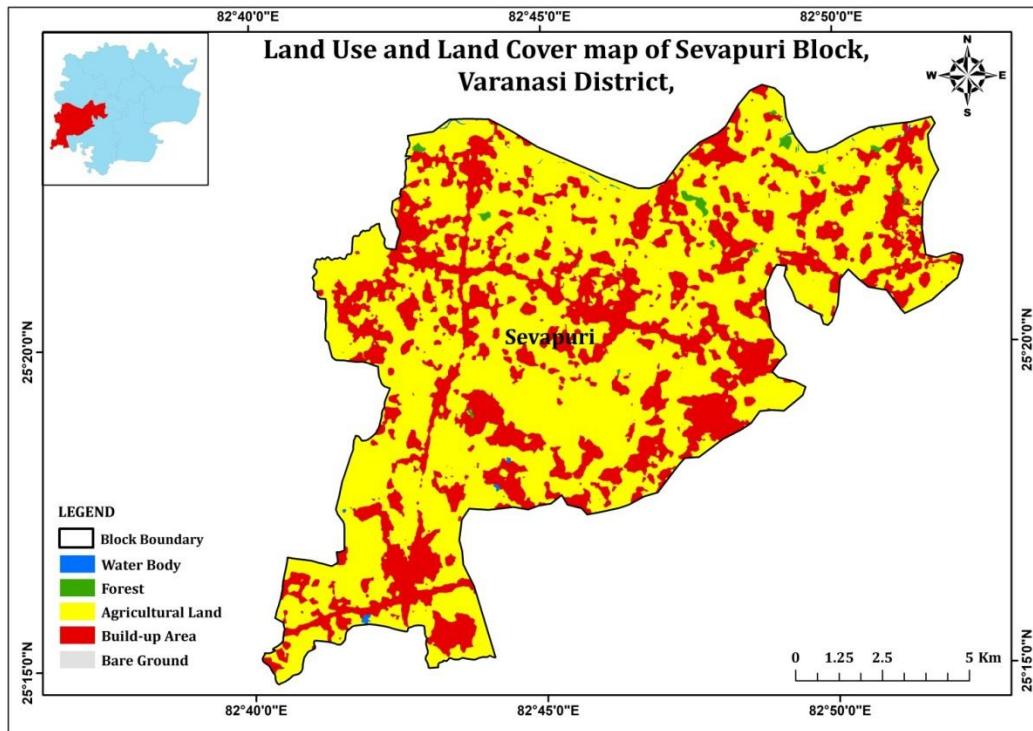


Figure 107: Landuse/Landcover Map of Sevapuri block, Varanasi district

8. Depth to Water Level (Pre-monsoon-2021)

Depth to water level during Pre-monsoon is generally ranging in between 10.0 m bgl to 20.0 m bgl (figure-108).

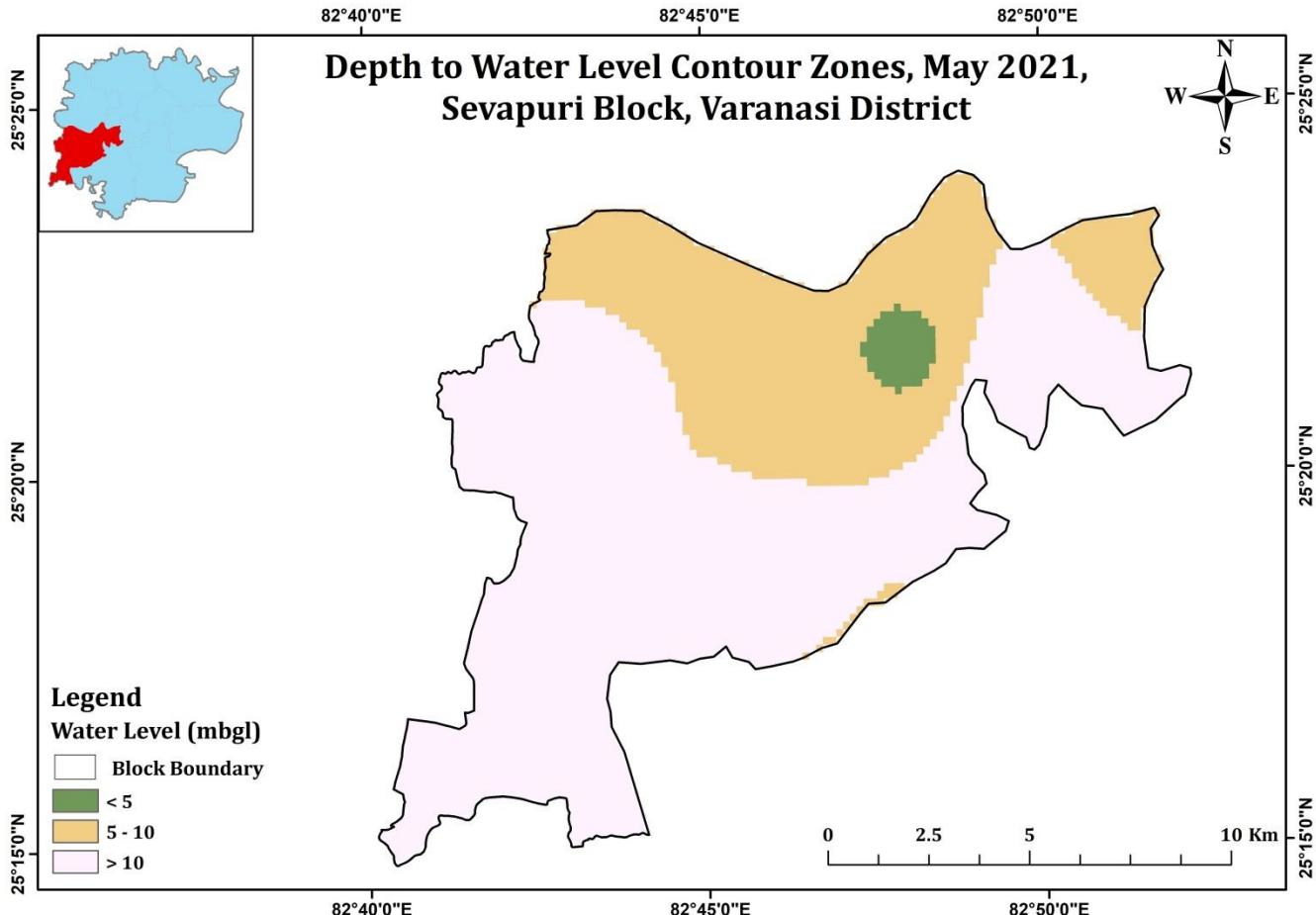


Figure 108: Depth to Water level Map (Pre-Monsoon) of Sevapuri block, Varanasi district

9. Depth to Water Level (Post-monsoon-2021)

Depth to water level during Post-monsoon is shallow ranging in between 3.0 m bgl to 5.0 m bgl (figure-109).

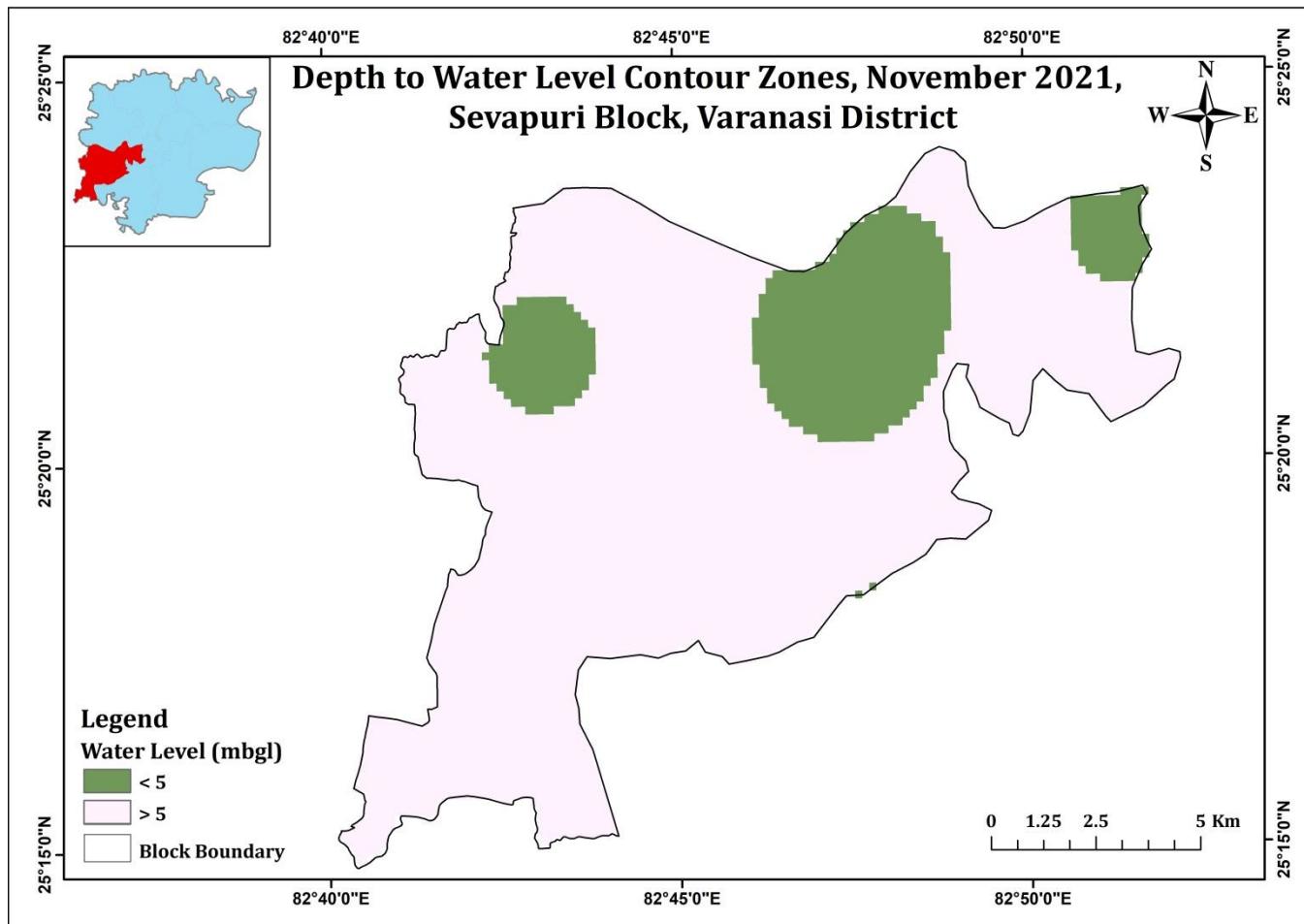


Figure 109: Depth to Water level Map (Post-Monsoon) of Sevapuri block, Varanasi district

10. Ground water Resources

The block is categorized as Semi critical as per 2020 ground water resource assessment with 73.01% of stage of ground water extraction (refer figure-30).

11. Chemical Quality

Quality of ground water is potable and all the chemical constituents are within the permissible limit of BIS-2012 (Annexure-IV & V).

12. 3-Dimensional Aquifer Disposition

Two groups of aquifer are reported from the exploratory drilling by state department in Sevapuri block. Only one exploratory well has been drilled down to the depth of 236 mbgl by CGWB in the block. Ground water occurs under water table condition at shallow depths while the deeper aquifer is under confined state of disposition. Sand, silty sand forms the principal aquifers in the study area separated by confining clay layers acting as aquiclude (figure-110).

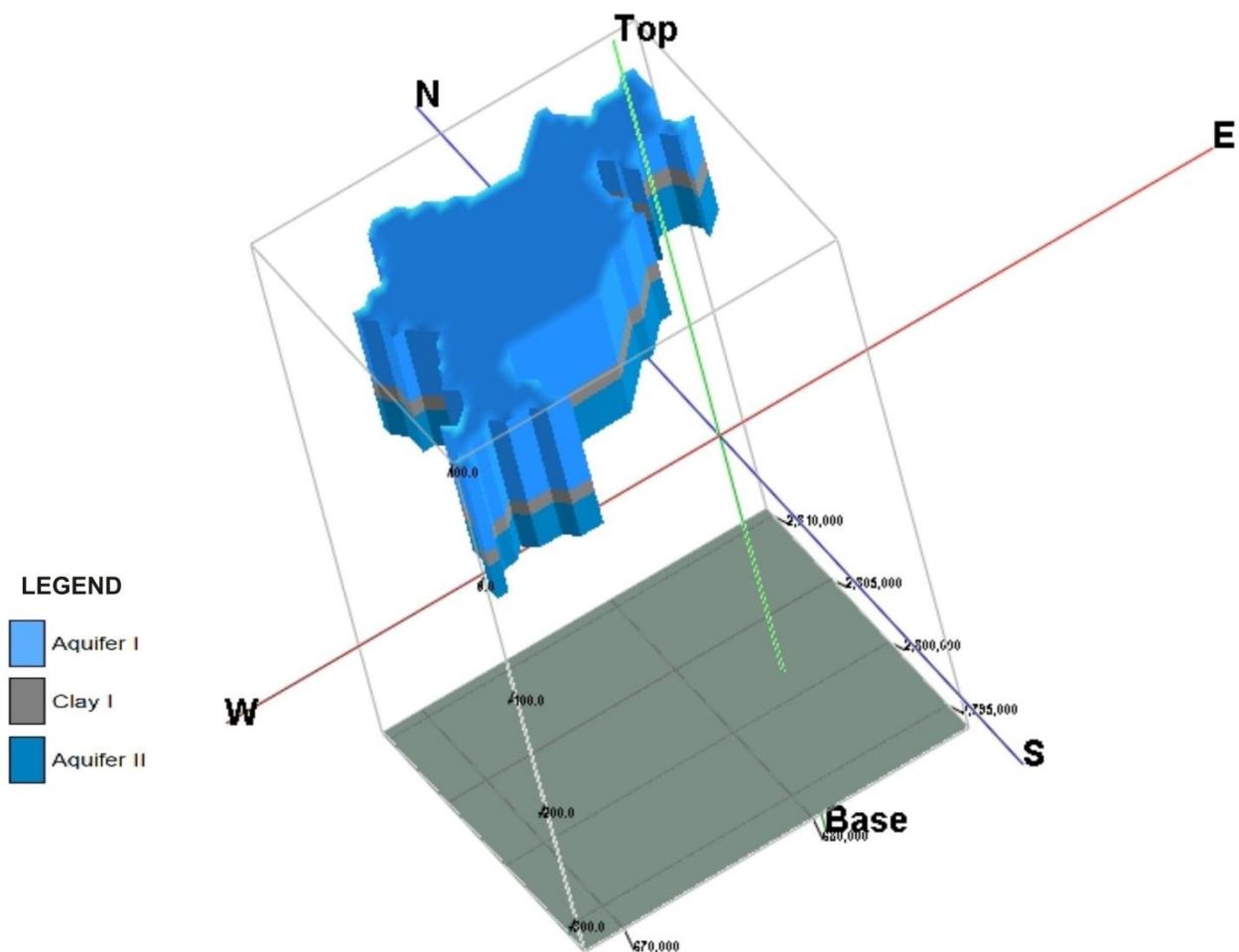


Figure 110: 3-D Model depicting Aquifer geometry of Sevapuri block, Varanasi district

13. Management Plan

- Block is Semi critical as per GW Resource Estimation, 2020 with 73.01% of stage of ground water extraction.
- Percentage of net irrigated to net sown area is 96.47% and the contribution of ground water for irrigation in this block is 86.85%.
- Artificial recharge measures and conservation of water techniques should be adopted in the block to arrest further decline in water levels.
- Ground water management strategies and the projected change in stage of ground water development after interventions for the block are given below and shown in figure-111.

Ground Water Management Strategies and Projected Stage of Extraction of Sevapuri Block, Varanasi District														
Block	CDs (Nos)	NBs (Nos)	Str Dev (Km)	Pond s (Nos)	On-farm (ha)	Water Use Efficiency WUE (ha)	Rech frm Str MC M	Savin g from Str MCM	Savin g frm On-farm & WUE MCM	Total Rech MC M	Total Savin g MCM	Present Stage of Ground Water Developme nt (%)	Projected Stage of Developme nt (%) After Interventio ns	
Sevapuri	2	2	2	2	3512	3512	0.13	0.13	4.78	0.13	4.92	73.01	63.00	

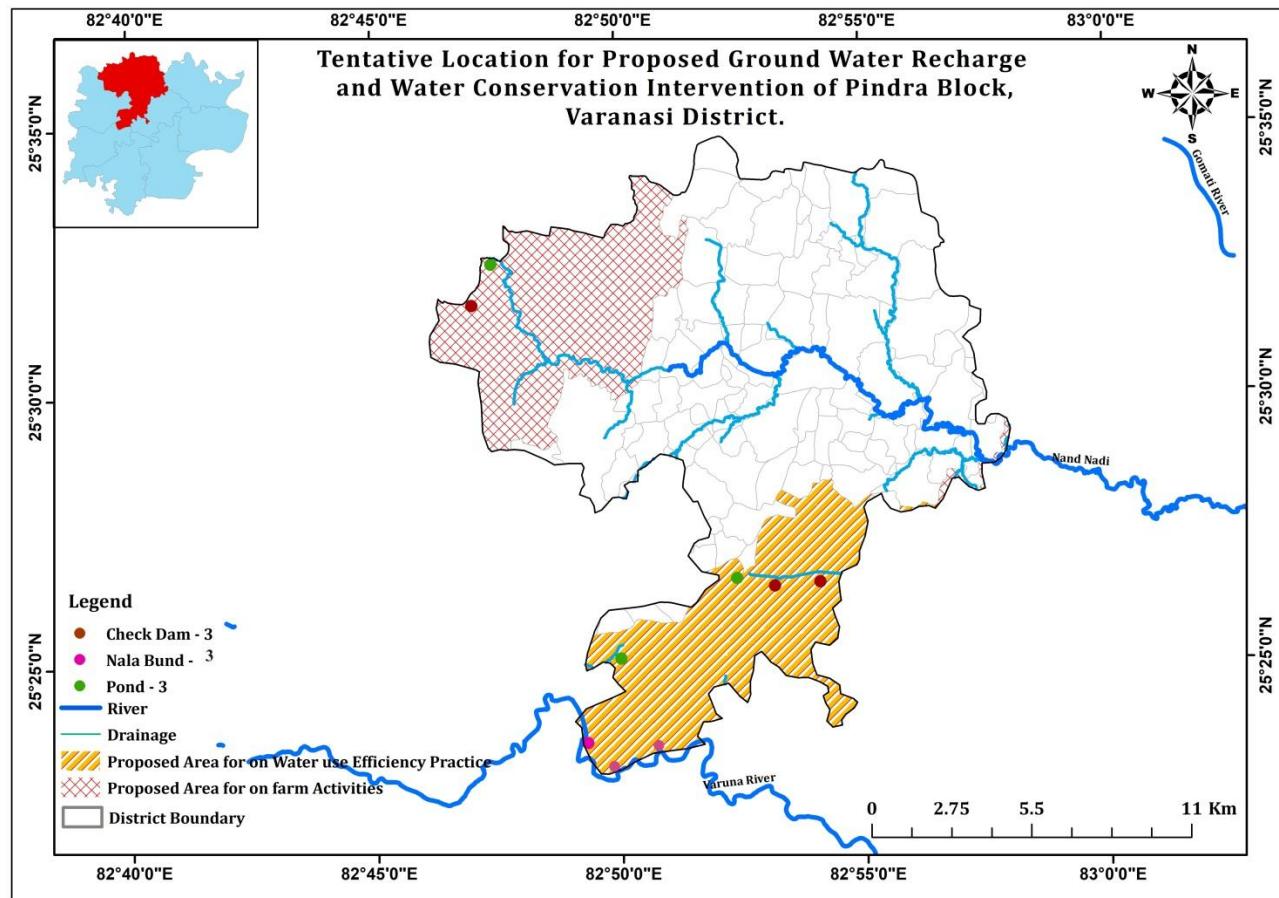


Figure-111: Tentative Locations for Proposed Ground Water Recharge & Water Conservation Interventions, Sevapuri Block, Varanasi District

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- UP Jal Nigam website www.upjn.org
- Census India website www.censusindia.gov.in
- Varanasi KVK website [https:// Varanasi.kvk4.in/district-profile.html](https://Varanasi.kvk4.in/district-profile.html)
- Irrigation and Water Resources Department, U.P website www.idup.gov.in
- India WRIS website www.indiawris.gov.in
- The Energy and Resources Institute website www.teriin.org
- Pradhan Mantri Krishi Sinchayi Yojana website www.pmksy.gov.in

Annexure-I

Depth to Water Level-2021, Varanasi District							
S.No .	Block	Hydrograph Station	Longitude	Latitude	Pre-Monsoon	Post Monsoon	Fluctuation
					(mbgl)	(mbgl)	(m)
1	Araziline	Dindaspur	82.84	25.32	17.40	9.55	7.85
2	Araziline	Gangapur	82.87	25.37	9.37	6.82	2.55
3	Araziline	Jansa Baz	82.85	25.32	16.70	11.05	5.65
4	Araziline	Kalipur	82.80	25.29	7.30	3.15	4.15
5	Araziline	Todarpur	82.87	25.26	10.95	3.05	7.90
6	Baragaon	Anaai Baz	82.75	25.46	6.75	4.30	2.45
7	Baragaon	Barahi	82.73	25.49	3.30	1.90	1.40
8	Baragaon	Biraokot	82.75	25.42	15.45	10.43	5.02
9	Baragaon	Kathi Rao	82.73	25.53	3.05	2.50	0.55
10	Baragaon	Sadhoganj	82.77	25.44	8.79	5.30	3.49
11	Baragaon	Kudai	82.73	25.52	10.60	7.45	3.15
12	Chiraigaon	Jalhupur	83.12	25.39	7.35	2.60	4.75
13	Chiraigaon	Mustafaba	83.13	25.38	13.84	16.39	-2.55
14	Chiraigaon	Parwat Pur	83.08	25.43	12.65	5.95	6.70
15	Cholapur	Chaubepur	83.10	25.44	4.40	1.90	2.50
16	Cholapur	Niyardeeh	83.01	25.51	8.33	1.88	6.45
17	Harhua	Bhopapur	82.94	25.45	19.39	14.71	4.68
18	Kaashi Vidyapeeth	Kashi Vidyapeeth	82.98	25.32	9.75	4.85	4.90
19	Kaashi Vidyapeeth	Lanka	83.01	25.28	7.26	3.66	3.60
20	Sewapuri	Amni	82.78	25.31	10.70	5.68	5.02
21	Sewapuri	Baradeeh-2	82.73	25.39	6.47	7.05	-0.58
22	Sewapuri	Barki	82.80	25.36	2.90	0.80	2.10
23	Sewapuri	Hathi	82.83	25.35	16.15	9.45	6.70
24	Sewapuri	Rameshwar	82.86	25.38	7.63	3.03	4.60
25	Sewapuri	Rasoolaha	82.72	25.36	11.10	4.51	6.59
26	Pindra	Pindra Bazar	82.83	25.50	6.53	2.48	4.05

Decadal Water Level Fluctuation 2011-2020 Vs 2021 (Pre-Monsoon)							
S.No.	BLOCK	HYDROGRAPH	LATTITUDE	LONGITUDE	PRM Avg11-20	PRM-21	Fluctuation
1	Araziline	Gangapur	25° 13' 30.000" N	82° 51' 59.859" E	14.897	9.37	-5.527
2	Araziline	Jakhani	25° 15' 28.845" N	82° 44' 31.850" E	8.275	6.45	-1.825
3	Araziline	Jansa Baz	25° 19' 23.000" N	82° 50' 45.000" E	22.589	16.7	-5.889
4	Araziline	Todarpur	25° 15' 40.000" N	82° 52' 0.000" E	13.93	10.95	-2.98
5	Baragaon	Anaai Baz	25° 27' 30.000" N	82° 45' 0.000" E	6.995	6.75	-0.245
6	Baragaon	Barahi	25° 29' 15.000" N	82° 43' 30.000" E	5.048	3.3	-1.748
7	Baragaon	Biraokot	25° 24' 55.000" N	82° 45' 15.000" E	19.309	15.45	-3.859
8	Baragaon	Kathi Rao	25° 31' 55.000" N	82° 43' 36.479" E	6.085	3.05	-3.035
9	Baragaon	Sadhoganj	25° 26' 15.000" N	82° 46' 10.000" E	14.161	8.79	-5.371
10	Baragaon	Kudai	25° 30' 58.036" N	82° 43' 45.417" E	15.898	10.6	-5.298
11	Chiraigao	Barthara Kala	25° 25' 20.000" N	83° 5' 20.000" E	8.645	6.7	-1.945
12	Chiraigao	Chiraigao	25° 22' 47.000" N	83° 2' 15.000" E	20.656	19.7	-0.956
13	Chiraigao	Chuharpur	25° 25' 20.000" N	83° 6' 0.000" E	6.93	6.6	-0.33
14	Chiraigao	Jalhupur	25° 23' 30.000" N	83° 7' 23.000" E	7.897	7.35	-0.547
15	Chiraigao	Mustafaba	25° 22' 40.000" N	83° 7' 55.000" E	13.66	13.84	0.18
16	Chiraigao	Sarsaul	25° 25' 5.000" N	83° 10' 40.000" E	13.92	12.8	-1.12
17	Chiraigao	Sonbarsa	25° 26' 0.000" N	83° 07' 00.000" E	10.45	8.95	-1.5
18	Cholapur	Chaubepur	25° 26' 30.000" N	83° 6' 2.000" E	7.318	4.4	-2.918
19	Cholapur	Niyardeeh	25° 30' 40.354" N	83° 0' 23.894" E	7.531	8.33	0.799
20	Cholapur	Block Office	25° 28' 00" N	83° 08'15.00" E	10.82	5.65	-5.17

Decadal Water Level Fluctuation 2011-2020 Vs 2021 (Pre-Monsoon)							
S.No.	BLOCK	HYDROGRAPH	LATTITUDE	LONGITUDE	PRM Avg11-20	PRM-21	Fluctuation
21	Harhua	Bhawanipur	25° 20' 56.000" N	82° 56' 38.000" E	11.293	11.55	0.257
22	Harhua	Bhopapur	25° 27' 15.000" N	82° 56' 10.000" E	19.877	19.39	-0.487
23	Kashi Viddyapeeth	Cannt.	25° 19' 37.766" N	82° 58' 56.313" E	6.704	5.42	-1.284
24	Kashi Viddyapeeth	Khanav	25° 13' 30.000" N	82° 55' 10.000" E	6.85	7.2	0.35
25	Kashi Viddyapeeth	Lanka	25° 16' 55.000" N	83° 0' 40.000" E	7.275	7.26	-0.015
26	Pindra	Pindra Bazar	25° 30' 0.000" N	82° 49' 30.000" E	8.359	6.53	-1.829
27	Sewapuri	Ghosila	25° 21' 5.000" N	82° 42' 10.000" E	11.891	6.17	-5.721
28	Sewapuri	Rameshwar	25° 23' 5.000" N	82° 51' 30.000" E	14.629	7.63	-6.999
29	Sewapuri	Rasoolaha	25° 21' 35.000" N	82° 43' 10.000" E	16.484	11.1	-5.384

Annexure-III

Decadal Water Level Fluctuation 2011-2020 Vs 2021 (Post-Monsoon)							
S.No.	BLOCK	HYDROGRAPH	LATTITUDE	LONGITUDE	PTM Avg11-20	PTM-21	Fluctuation
1	Araziline	Jakhani	25° 15' 28.845" N	82° 44' 31.850" E	6.21	2.29	-3.92
2	Araziline	Jansa Baz	25° 19' 23.000" N	82° 50' 45.000" E	18.085	10.22	-7.865
3	Araziline	Todarpur	25° 15' 40.000" N	82° 52' 0.000" E	7.55	3.14	-4.41
4	Baragaon	Anaai Baz	25° 27' 30.000" N	82° 45' 0.000" E	5.095	4.39	-0.705
5	Baragaon	Barahi	25° 29' 15.000" N	82° 43' 30.000" E	2.08	1.94	-0.14
6	Baragaon	Kathi Rao	25° 31' 55.000" N	82° 43' 36.479" E	3.56	2.53	-1.03
7	Baragaon	Kudai	25° 30' 58.036" N	82° 43' 45.417" E	13.535	7.46	-6.075
8	Chiraigao	Barthara Kala	25° 25' 20.000" N	83° 5' 20.000" E	4.19	1.2	-2.99
9	Chiraigao	Chiraigao	25° 22' 47.000" N	83° 2' 15.000" E	17.415	14.25	-3.165
10	Chiraigao	Chuharpur	25° 25' 20.000" N	83° 6' 0.000" E	4.085	3.16	-0.925
11	Chiraigao	Jalhupur	25° 23' 30.000" N	83° 7' 23.000" E	4.775	2.64	-2.135
12	Chiraigao	Sarsaul	25° 25' 5.000" N	83° 10' 40.000" E	10.595	10.54	-0.055
13	Chiraigao	Sonbarsa	25° 26' 0.000" N	83° 07' 00.000" E	6.85	3.18	-3.67
14	Cholapur	Chaubepur	25° 26' 30.000" N	83° 6' 2.000" E	4.312	1.91	-2.402
15	Cholapur	Niyardeeh	25° 30' 40.354" N	83° 0' 23.894" E	4.767	1.91	-2.857
16	Kashi Viddyaapeeth	Cantt.	25° 19' 37.766" N	82° 58' 56.313" E	3.662	3.87	0.208
17	Kashi Viddyaapeeth	Khanav	25° 13' 30.000" N	82° 55' 10.000" E	2.86	1.69	-1.17
18	Kashi Viddyaapeeth	Lanka	25° 16' 55.000" N	83° 0' 40.000" E	4.72	3.75	-0.97
19	Sewapuri	Ghosila	25° 21' 5.000" N	82° 42' 10.000" E	7.777	3.5	-4.277

Annexure-IV

Chemical Analysis Results of Basic Constituents in Ground Water Samples of Shallow Aquifer																		
S.No.	Block	Location	Latitude	Longitude	pH	EC μS/cm at 25°C	CO ₃	HCO ₃	Cl	F	NO ₃	SO ₄	TH	Ca	Mg	Na	K	SiO ₂
							mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Pindra	Katauna	25.53194	82.88333	8.7	534	48	207	21	1.09	0	13	140	20	22	68	2.9	23
2	Baregaon	Baragaon	25.45833	82.84583	8.5	544	48	171	50	0.49	0	43	205	28	32	59	5.1	26
3	Baregaon	Anai	25.45833	82.75	8.5	578	12	207	57	0.42	36	24	190	20	34	58	15.3	21
4	Baregaon	Birankot	25.41528	82.75417	8.5	690	12	171	71	0	43	71	200	20	36	74	2.8	27
5	Baregaon	Koilar	25.4125	82.725	8.5	320	12	195	14	0.23	8.1	6.8	135	16	23	35	2.5	29
6	Cholapur	Vikas khand	25.44472	83.0975	8.70	440	36	244	14	0.87	6.2	6	200	16	38	47	1.4	26
7	Cholapur	Chandrawati	25.47667	83.14028	8.6	540	24	207	64	0.49	6.5	25	190	20	34	63	3.2	26
8	Cholapur	Dharsauna	25.45111	83.025	8.7	521	60	201	21	0.5	5.6	14	160	12	31	65	2.1	25
9	Cholapur	Block office	25.47278	83.00194	8.8	590	24	244	14	0.48	0	20	100	24	9.6	78	2.5	24
10	Sewapur	Rasulahha	25.35972	82.71944	8.5	535	48	244	21	0.56	0	7.4	240	20	46	36	3.5	27
11	Sewapur	Nauhwanipur	25.35972	82.84333	8.6	449	36	159	21	0	8.3	17.0	100	32	4.8	62	3.7	27
12	Sewapur	Baraki	25.36139	82.79944	8.7	726	48	317	18	0.5	0	12.0	150	32	17	53	98.7	17
13	Sewapur	Matuka	25.34389	82.775	8.7	513	60	183	14	0.00	20	9.1	110	28	9.6	85	3.07	28
14	Sewapur	Thatra	25.27639	82.70139	8.5	416	60	85	50	0.28	9.1	9.8	200	28	31	22	2.5	29
15	Sewapur	Mirzamurad	25.28583	82.76139	8.6	632	48	110	113	0	5	21	170	16	31	84	4.2	23
16	Kashi vidhyapeeth	Quench college	25.32444	82.99944	8.9	980	60	256	92	0.92	0	71	290	20	58	112	2.6	18
17	Kashi vidhyapeeth	Rewadi talab	25.305	83.00139	8.9	1460	84	354	78	3.38	69	132	130	12	24	291	2.8	20

NAQUIM REPORT_VARANASI DSITRICT (1535 sq km),U.P.

Chemical Analysis Results of Basic Constituents in Ground Water Samples of Shallow Aquifer																			
S.No.	Block	Location	Latitude	Longitude	pH	EC µS/cm at 25°C	CO ₃	HCO ₃	Cl	F	NO ₃	SO ₄	TH	Ca	Mg	Na	K	SiO ₂	
							mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	
18	Kashi vidhyapeeth	Chandpur	25.31917	82.9775	8.2	430	0	159	43	0.28	36	16	110	24	12	56	2.5	31	
19	Kashi vidhyapeeth	Sunerpur	25.27944	82.99722	8.5	665	48	171	57	0.32	28	19	220	16	43	53	2.30	29	
20	Araziline	Kallipur	25.36685	82.86056	9.00	1600	120	378	149	0.45	63	97	350	8	79	245	3.1	28	
21	Araziline	Block office	25.26806	82.85139	8.4	375	48	110	14	0	0	9.7	125	12	23	34	4.6	28	
22	Araziline	Gangapur	25.37389	82.84583	8.7	695	60	232	35	0.84	0	23	235	12	49	64	3.7	30	
23	Araziline	Kurana	25.30694	82.8	8.5	401	36	134	28	0.5	9.7	15	140	12	26	46	2.1	30	
24	Araziline	Raja talab	25.26667	82.84861	8.3	440	36	122	43	0.7	0	9.8	150	16	26	39	3.5	27	
25	Chiraigaon	Purana bridge	25.40139	83	8.5	489	48	220	14	0.54	0	4.7	140	16	24	68	2.6	29	
26	Chiraigaon	Ashapur	25.38	83.1	8.3	530	42	146	85	0.23	0	3.9	190	20	34	57	2.7	22	
27	Chiraigaon	Block office	25.42222	83.1	8.4	367	24	110	28	0.38	10.9	14	140	12	26	24	2.2	31	
28	Chiraigaon	Parwatpur	25.42472	83.07194	8.7	500	90	134	14	0.81	0	5.6	150	24	22	66	2.8	28	
29	Harahua	Bhawnipur	25.39306	82.96278	8.6	3428	42	122	702	2.82	316	150	470	32	94	457	43	25	
30	Harahua	Shivpur	25.44972	82.95889	8.6	776	48	183	71	0.24	22	25	200	12	41	83	3	28	
31	Harahua	Bhapapur	25.45417	82.94222	8.4	384	48	98	21	0.31	16	6.1	155	12	30	25	2.5	30	
32	Harahua	Mohan	25.455	82.97861	8.5	436	42	110	57	0	12	9.3	180	12	36	36	6.7	32	
33	Pindra	Babatpur	25.23333	82.83472	8.7	922	72	171	92	0	0	69	200	12	41	114	4	27	
34	Pindra	Mangri	25.53194	82.86833	8.8	584	60	244	28	0.23	0	13	165	8	35	87	4	29	
35	Pindra	Pindra bazar	25.5	80.825	8.9	1363	96	354	85	0.53	5.5	190	200	8	43	262	4.9	26	

Annexure-V

Chemical Analysis Results of Basic Constituents in Ground Water Samples of Deeper Aquifer																
S.No.	Location	Latitude	Longitude	pH	EC μS/cm at 25°C	CO ₃	HCO ₃	Cl	NO ₃	SO ₄	F	Ca	Mg	Na	K	TH
						mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
1	Puari Khurd	25.4333	83.9369	8.1	445	-	244	21	-	7.2	-	12	29	40	1.2	120
2	Admapur	25.3267	83.0259	8.0	375	nil	244	7	-	-	-	16	34	18	11	18
3	Rajapur	25.3488	83.0513	7.9	380	nil	220	14	nil	nil	20	17	35	4	120	
4	Ramnagar	25.2764	82.8281	8.1	507	nil	390	11	4	5	0.4	52	49	22	4	250
5	Mowaiya Pokhar	25.5092	83.0225	7.9	520	-	299	14	1.9	10	0.41	44	22	33	2.9	200

Annexure-VI

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Wate r Level	Discharge	Dra w dow n	Specific Capacity	Transmissivit y	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
1	Admapur	83.03	25.33	236	Alluvium	132	150	18.94	2520	6.16	409	4770		130	
						156	168								
2	Bhikharipur	82.83	25.27	156	Alluvium/ Basement (Vindhyan SST.)	62	78	12.04	3244	5.47	593				
						102	116								
3	Bhisampur	82.76	25.34	200	Alluvium	110	122	12.04	3244	5.47	593				
						160	186								
4	Biraon Kot	82.83	25.44	356	Alluvium/ Basement (Vindhyan SST.)	116	122	14.68	3410	12.9 3	264	8604	4.29X10E- 4		
						131	137								
						149	155								
						167	173								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivit y	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
						242	248								
						272	278								
						318	324								
5	Birapatti-I	82.92	25.41	304	Alluvium	226	238	24.96	2074						
						258	270								
						278	284								
6	Birapatti-II	82.92	25.41	155	Alluvium	51	57	9.57	1007						
						133	142								
7	Brij Enclave	82.98	25.29	202	Alluvium	84	96	17.8	1457	3.63	401				
						114	130								
						148	164								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
8	Katesar	83.02	25.30	304	Alluvium/ Basement (shale)	124	135	8.57	2700	3.85	701				
						141	149								
						157	163								
						168	180								
9	Mauiy Pokhar	83.02	25.51	204	Alluvium	85	101					5589			
						116	120								
						136	148								
						178	194								
10	Monglabeer	82.76	25.27	155	Alluvium	108	144	10.33	3092	6.45	479	3911			
11	Narayanpur-I	83.09	25.41	301	Alluvium	174	180		Low Discharge						Pumpi ng Test not done

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
						194	202								
						213	222								
						234	242								
12	Narayanpur-II	83.09	25.41	157	Alluvium	80	86	20.54	1040	7.87	132	1017			
						100	112								
						132	144								
13	Natiimli	83.01	25.33	293	Alluvium/ Basement (shale)	84	96	14.87	3456	5.37	643	8285		101	
						110	122								
						129	135								
						144	147								
						156	162								
						186	192								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivit y	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
						196	202								
						207	213								
14	Phulwaria	82.83	25.49	187	Alluvium	145	154	23							
						170	179								
15	Pindara	82.83	25.49	170	Alluvium	32	36								
						60	63								
16	Puari Khurd	82.94	25.43	200	Alluvium	94	106	7.33	3289	4.83					
						156	174								
17	Rajapur	83.05	25.35	402	Alluvium/ Basement	172	178	11.84	2443	7					
						201	207								
						214	226								
						250	256								
						295	307								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
18	Town Hall	83.02	25.33	229	Alluvium	61	67	16.3	3245	3.62	896	3884	8.0x10E-2		
						70	76								
						88	94								
						100	112								
						127	133								
						145	157								
						160	166								
19	Wazidpur	82.92	25.38	200	Alluvium	106	112	15.4	1518	3.27	464				
						126	142								
						150	168								
	Observation Well (OW)														
1	Biraon Kot	82.8291	25.4433	352	Alluvium/ Basement (Vindhyan SST.)	118	121	13.83	3614	6	602	8604	4.29x10-4	40.59	
						133	136								
						151	155								
						170	174								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
						244	247								
						275	278								
						321	324								
2	Bhikharipur	82.83	25.27	130	Alluvium	60	69					3766	0.046x10E-2		
						102	114								
3	Birapatti-I	82.91929	25.40961	300	Alluvium	236	238								
						264	270								
						278	284								
4	Birapatti-II	82.91929	25.40961		Alluvium										
5	Katesar	83.0202	25.3022	195	Alluvium	129	135					6541	0.36x10E-3		
						145	148								
						160	163								
						172	178								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
6	Monglabeer	82.7578	25.27083	145	Alluvium	112	130					3543	0.062x10E-2		
7	Narayanpur-I	83.09306	25.40917	264	Alluvium	174	180								
						196	202								
						216	222								
						236	242								
8	Narayanpur-II	83.09305	25.40916	146	Alluvium	81	85					2288	8.93x10-5		
				556	667										
						102	110								
						134	142								
9	Puari Khurd	82.94	25.43	200	Alluvium	94	106					5026	0.246x10E-4		
						156	174								
10	Rajapur	83.0513	25.3488	319	Alluvium	174	177	11.4	2290			8545	5.8x10E-6		
						203	206								
						218	224								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Wate r Level	Discharge	Dra w dow n	Specific Capacity	Transmissivit y	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
						252	255								
						300	303								
11	Wazidpur	82.92	25.38	176	Alluvium	109	112		2196	3.22	682	7817	0.028x10E-2		
						130	138								
						152	162								
	Deposit Well														
1	BHU-I	82.0333	25.3661	175	Alluvium	85.5	115.5	9.57	3790	3.18	1192	5886			
						132.5	173.6								
2	BHU-II	82.0336	25.3663	200	Alluvium	100	197	10.98	3478	2.81	1237	3531		36.4	
3	BHU-III	82.9851	25.2769	200	Alluvium	89	125	12.09	3950	2.93	1348	4640		72.7	
						135	163								
4	DLW	83.0033	25.3192	203	Alluvium										

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drilled depth	Lithology	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Draw down	Specific Capacity	Transmissivity	Storativity	Hydraulic Conductivity	Remarks
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
5	DLW-III	82.9992	25.3178	167	Alluvium	41.95	58.5	10.95 5	3710	3.73	992	1967		36	
						118.3	165. 11								
6	DLW-IV	82.4579	25.2783	168	Alluvium	92	162	9.95	3030	2.6	1165	517		73	
7	Ramnagar-I	82.5722	25.3949	169	Alluvium	93	102	9.5	2270	6.48	350	8210			
						121	130								
						135	140								
						145	149								
						155	165								
8	Ramnagar-II	82.8281	25.2764	149	Alluvium	51	88								
						94	103								
						107	123								
						126	146								

Details of Tube Wells drilled by CGWB, NR in Varanasi District															
S.No .	Location	Longitude	Latitude	Drille d depth	Litho logy	Aquifer Zones Tapped (mbgl)		Static Water Level	Discharge	Dra w dow n	Specific Capacity	Transmissivit y	Storativity	Hydraulic Conductivi ty	Remark s
				(mbgl)		from	to	(mbgl)	(lpm)	(m)	(lpm/m) of DD	T (m ² /day)	S	K(m/day)	
9	Sarnath	83.0252	25.3812	201	Alluvium	8	24								
						39	58								
						64	83								
						88	95								
						101	105								
						108	130								
						149	162								
						165	176								

Annexure-VII

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth		Lithology
						from	to	
1	Admapur	83.0259	25.3267	236	80.7	0	57	Silt
						57	61	kankar
						61	191	Sand
						191	236	Clay
2	Allopur	82.9999	25.4207	79	83.3	0	31	Silt
						31	60	Clay
						60	79	Sand
3	Babatpur	82.8532	25.4443	95	81.2	0	61	Silt
						61	88	Clay
						88	95	Sand
4	Bairawan	82.8816	25.2678	98	87	0	36	Silt
						36	98	Sand
5	Belwa	83.0400	25.3244	137	80.7	0	47	Silt
						47	137	Sand
6	Bhikharipur	82.8250	25.2667	156	80.7	0	25	Silt
						25	54	Clay
						54	81	Sand

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth from to	Lithology	
						81	101	Clay
						101	128	Sand
						128	149	Clay
						149	156	Basement
7	Biron Kot	82.8291	25.4433	356	91	0	36	Silt
						36	46	Clay
						46	189	Sand
						189	203	Clay
						203	250	Sand
						250	272	Clay
						272	324	Sand
						324	334	Clay
						334	352	Sand
						352	356	Basement
8	Brij enclave	82.9804	25.2864	202	82.3	0	55	Silt
						55	202	Sand
9	Central jail	82.9636	25.3483	61	80.7	0	40	Silt
						40	61	Sand
10	Chakal-khansipur	83.0764	25.3522	147	80.3	0	40	Silt
						40	67	Clay

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth from to	Lithology	
						67	147	Sand
11	Choubeypur	83.0978	25.4445	98	79.3	0	23	Silt
						23	43	Clay
						43	98	Sand
12	Dayalpur	82.8364	25.3689	76	82.2	0	25	Silt
						25	40	Clay
						40	76	Sand
13	DLW	83.0033	25.3192	204	82.3	0	16	Silt
						16	22	kankar
						22	51	Clay
						51	58	Sand
						58	61	kankar
						61	186	Sand
						186	200	Clay
						200	204	Sand
14	DLW -III	82.9992	25.3178	167	81	0	25	Silt
						25	43	Clay
						43	167	Sand
15	Dudhuwan	83.1153	25.5092	147	77.7	0	97	Silt
						97	147	Sand

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth		Lithology
						from	to	
16	Durga kund	82.9986	25.2889	183	80.8	0	28	Silt
						28	61	Sand
						61	67	Clay
						67	169	Sand
						169	183	Clay
17	Gaharpur	83.0561	25.3658	136	76.2	0	33	Silt
						33	50	Clay
						50	136	Sand
18	Gossai pur	82.9515	25.4538	109	83.3	0	36	Silt
						36	109	Sand
19	Goura kalan	83.0764	25.3609	107	81.3	0	31	Silt
						31	107	Sand
20	Jamapur	82.8144	25.4942	131	81.8	0	37	Silt
						37	88	Clay
						88	131	Sand
21	Katesar	83.0202	25.3022	304	84	0	52	Silt
						52	186	Sand
						186	221	Clay
						221	280	Sand
						280	304	Basement

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth from to	Lithology	
22	Lahadiah	83.1392	25.3217	126	82	0	48	Silt
						48	126	Sand
23	Matuka Ramdih	83.0561	25.3356	133	76.2	0	46	Silt
						46	133	Sand
24	MES CANTT TW 3	82.9683	25.3335	116	85	0	21	Silt
						21	34	Clay
						34	116	Sand
25	MES CANTT TW 4	82.9683	25.3311	114	83.2	0	28	Silt
						28	38	Clay
						38	108	Sand
						108	114	Clay
26	Mowaiya	83.0225	25.5092	204	82.7	0	49	Silt
						49	204	Sand
27	Natiimli	83.0088	25.3271	293	91.6	0	42	Silt
						42	273	Sand
						273	293	Basement
28	Pahariya	83.0074	25.3589	232	83.3	0	73	Silt
						73	128	Clay
						128	232	Sand
						232	232	Basement

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth		Lithology
						from	to	
29	Pindra	82.8280	25.4866	124	81	0	82	Silt
								Sand
30	Prasadpur	82.8984	25.4418	126	81.7	0	56	Silt
								Sand
31	Purabpur	83.1181	25.4133	136	78	0	73	Silt
								Sand
32	Raghunathpur	83.0401	25.3520	80	84.7	0	31	Silt
								Sand
33	Rajapur EW	83.0513	25.3488	402	84.7	0	23	Silt
								kankar
						23	40	
						40	46	Clay
						46	56	Sand
						56	69	Clay
						69	147	Sand
						147	160	Clay
						160	182	Sand
						182	202	Clay
						202	332	Sand
						332	342	Clay
						342	402	Basement

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth from to	Lithology	
34	Rajghat	83.0403	25.3314	132	84	0	24	Silt
						24	132	Sand
35	Rampur	83.1153	25.3997	150	81.2	0	103	Silt
						103	150	Sand
36	Sarnath	83.0252	25.3812	201	84.7	0	6	Silt
						6	14	kankar
						14	47	Clay
						47	55	kankar
						55	74	Clay
						74	81	Sand
						81	87	Clay
						87	101	Sand
						101	107	Clay
						107	201	Basement
37	Sathwa	83.0225	25.3739	147	82.7	0	100	Silt
						100	147	Sand
38	Shivpur	82.9515	25.3592	214	80.7	0	22	Silt
						22	69	Clay
						69	214	Sand
39	Siswa	82.8519	25.4312	100	82.7	0	48	Silt

Details of Exploratory Wells considered for Aquifer Mapping in Varanasi District								
S. No.	Bore hole	Longitude	Latitude	Total Depth (mbgl)	Elevation	Drilled Depth from to	Lithology	
						48	82	Clay
						82	100	Sand
40	Sunder Bagia	82.9851	25.2769	200	79.6	0	16	Silt
						16	29	Clay
						29	44	kankar
						44	54	Clay
						54	89	kankar
						89	200	Sand
41	Suwari	83.0978	25.3708	154	82.8	0	93	Silt
						93	154	Sand
42	Tikari	82.9940	25.2184	85	83	0	35	Silt
						35	85	Sand

