



केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga

Rejuvenation

Government of India

Report

on

NATIONAL AQUIFER MAPPING

Parts of Bhojpur and Buxar Districts, Bihar

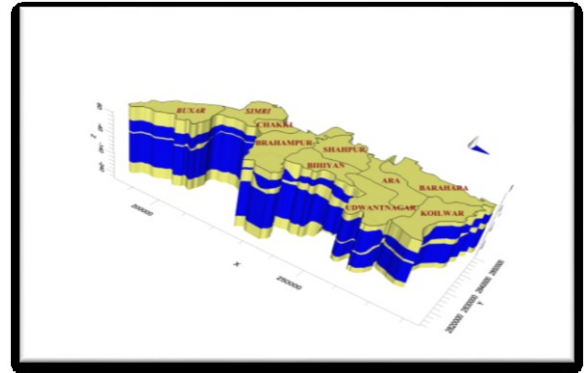
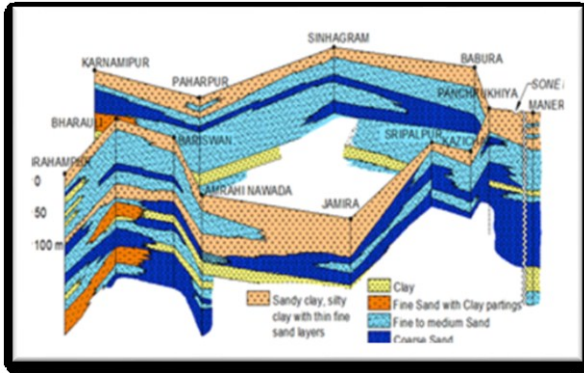
मध्य पूर्वी क्षेत्र, पटना

Mid-eastern Region, Patna



**Report
on**

***National Aquifer Mapping in parts of Bhojpur and Buxar districts, Bihar
(NAQUIM_Phase-I)***



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1

CENTRAL GROUND WATER BOARD
MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA
REJUVENATION
GOVERNMENT OF INDIA
MID EASTERN REGION, PATNA

JULY 2016



**Report
on**

***National Aquifer Mapping in parts of Bhojpur and Buxar districts,
Bihar (NAQUIM_Phase-I)***

Principal Contributors

Hydrogeologist

***Sh. S .N. Dwivedi, Scientist C
(Nodal Officer)***

Dr. Rakesh Singh, Scientist B

Dr. Fakhre Alam, Sr.Tech. Astd.

Geophysist

Dr. S.K.Adhikari, Scientist B

Sh. P. Raghavender, Sr.Tech. Astd.

Chemist

Sh. Suresh Kumar, Asst. Chemist

Sushri. Supriya Singh, Sr.Tech. Astd.

Report on

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List of Block (Phase- I)

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	Barhara	107-111
	Bihea	112-116
	Koelwar	117-122
	Shahpur	123-128
	Udwantnagar	129-133
Buxar	Brahampur	134-138
	Buxar	139-144
	Chakki	145-148
	Simri	149-153



CHAPTER-I INTRODUCTION

Under the phase I of National Aquifer Mapping programme (NAM) a total of 12 Blocks falling in Bhojpur, Buxar and Saran districts have been taken up for detailed hydrogeological survey and preparation of Aquifer Management plan. In the study, hydrogeological survey, geophysical investigations and groundwater quality studies have been undertaken and the data generated have been used in conjunction with the existing data available for the area in preparation of the aquifer maps and formulation of the aquifer management plan. The present report documents the findings of 10 Blocks of Buxar and Bhojpur district. The remaining 2 blocks of Saran district have been included in the report of area covered under phase 2.

1.1 Objective & Scope

The project envisages detailed characterisation of the aquifers by integrating the available data pertaining to lithology, groundwater geophysics, groundwater quality with the newly generated data during the course of National Aquifer Mapping programme. The generation of the fresh data under the NAM has been made on the basis of the data gaps identified. Phase wise national Aquifer Mapping area are given in Fig. 1.1. Attempt has also been made to develop a 3 –D aquifer model using visual mudflow package.

1.2 Approach and Methodology

The work plan for the aquifer mapping envisaged compilation, integration, validation and analysis of the existing database at one platform with a view to generate various thematic maps like administrative map, land use and land cover map, geomorphology maps, geology, hydrogeology etc using various GIS and geoscientific computer softwares. Data were collected from all concerned agencies for preparing the status of data gap. Greater attention was paid on activities that required generation of additional data to fill the identified gap.



1.3 Area Details

The area falling under Phase I of NAM in Bihar State is located in the western part of the State covering the Bhojpur and Buxar districts. Two Blocks of Saran district has also been covered under this phase.

The study area spreads over 2202 Sq Kms covering 12 administrative blocks. The area lies between N latitudes 25.46106 and 25.731779 and E longitudes 83.84217 and 84.87881 falling in Survey of India toposheet nos 63O/14, 15 and 72C/2, 3, 6 7 9, 10, 11, 13 14, 15. The location of the study area is shown in Fig. 1.2. The population density of the study area is 3230 person per sq. km. The salient demographic details of the administrative blocks falling in the area is given in Table 1.1.

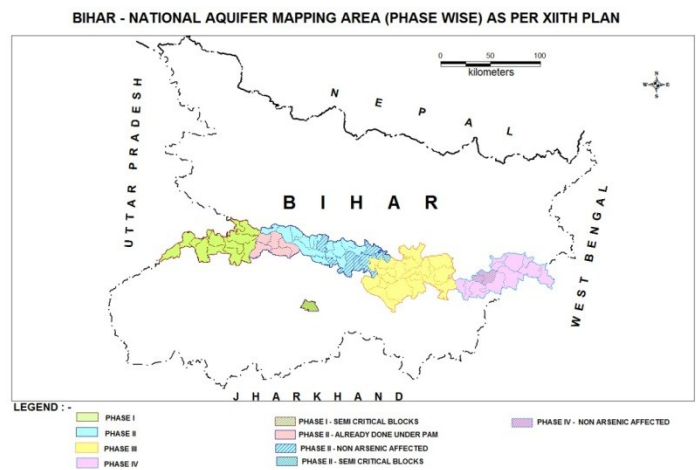


Fig. 1.1 Area to be covered under NAQUIM in different phases

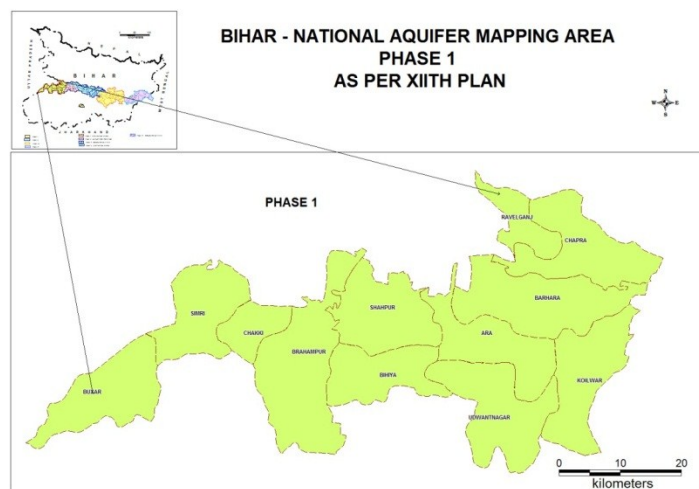


Fig. 1.2. Base map of the Study area



Table 1.1: Demographic details of the administrative blocks falling under National Aquifer Mapping area – Phase 1

Sl No	Block	Total Area (in Sq. Km.)	Population (as per 2011 census)		
			Rural	Urban	Total
1.	Buxar	181	180308	110881	291189
2.	Simri	161	207225	0	207225
3.	Ara	165	201188	261430	462618
4.	Bihiya	142	151722	26707	178429
5.	Koilwar	186	184450	17725	202175
6.	Chakki	70	42256	0	42256
7.	Brahampur	286	196070	0	196070
8.	Shahpur	181	194486	17767	212253
9.	Barhara	237	240636	0	240636
10.	Udwantnagar	208	157809	0	157809
Total Population			1756150	434510	2190660

1.4 Brief Description

The area under NAQUIM Phase I cover the western part of the State spreading over Bhojpur and Buxar districts have been taken up for detailed hydrogeological survey.

1.4.1 Data availability

Central Ground Water Board has carried out hydrogeological surveys and groundwater exploration in the area. Ground water regime monitoring is carried out on a regular basis. The data available from the earlier surveys have been compiled and data gap analysis has been carried out for working out the need for additional data generation in the study area.



1.4.2 Data adequacy and data gap analysis and data generation

As per the existing data, data gap analysis was done. On the basis of this data gap analysis, fresh data was generated. All the data gap analysis is done on the basis of area of the blocks under study. Some of the requirement in the area has been reworked considering homogeneity in aquifers for fresh data to be generated (Table. 1.2, 1.3, 1.4).

Table 1.2: Water level monitoring data of Phase- I

S. No.	State	District	Reqt. prospect as per area of block	Data availability	Data Gap	Data Generated
1	Bihar	Buxar	12	2	10	10
2	Bihar	Buxar	10	1	9	9
3	Bihar	Buxar	5	0	5	5
4	Bihar	Buxar	18	0	18	18
5	Bihar	Bhojpur	15	0	15	15
6	Bihar	Bhojpur	12	1	11	11
7	Bihar	Bhojpur	12	1	11	11
8	Bihar	Bhojpur	9	1	8	8
9	Bihar	Bhojpur	13	1	12	12
10	Bihar	Bhojpur	10	0	10	10



Table 1.3 : Groundwater quality data of Phase-I

S. No.	State	District	Block	Reqd. prospect as per area of block	Data availability	Data Gap	Data Generated
1	Bihar	Buxar	Buxar	27	2	25	25
2	Bihar	Buxar	Simri	24	1	23	23
3	Bihar	Buxar	Chakki	11	0	11	11
4	Bihar	Buxar	Brahampur	43	0	43	43
5	Bihar	Bhojpur	Barahara	36	0	36	36
6	Bihar	Bhojpur	Koilwar	28	1	27	27
7	Bihar	Bhojpur	Shahpur	27	1	26	26
8	Bihar	Bhojpur	Bihiya	21	1	20	20
9	Bihar	Bhojpur	Udwantnagar	31	1	30	30
10	Bihar	Bhojpur	Ara	24	0	24	24

Table 1.4: Geophysical data (VES) of Phase-I

S. No.	State	District	Block	Reqd. prospect as per area of block	Data availability	Data Gap	Data Generated
1	Bihar	Buxar	Buxar	6	2	4	4
2	Bihar	Buxar	Simri	6	1	5	5
3	Bihar	Buxar	Chakki	3	0	3	3
4	Bihar	Buxar	Brahampur	10	0	10	10
5	Bihar	Bhojpur	Barahara	8	0	8	8
6	Bihar	Bhojpur	Koilwar	7	1	6	6
7	Bihar	Bhojpur	Shahpur	6	1	5	5
8	Bihar	Bhojpur	Bihiya	5	1	4	4
9	Bihar	Bhojpur	Udwantnagar	7	1	6	6
10	Bihar	Bhojpur	Ara	6	0	6	6

1.4.3 Rainfall-spatial, temporal and secular distribution,

The area experiences a humid sub-tropical climate. The monsoon season initiates by the third week of June and continues till the end of September. There is slight rainfall in October but November and December are quite dry. The rainy season receives Southwest monsoon and accounts for about 90% of the total rainfall. The area receives an average normal monsoon rainfall of about ~ 1100 mm/year.



1.4.4 Physiographic setup

The area under NAQUIM Phase I cover the western part of the State spreading over Bhojpur and Buxar districts. The area comprises of fertile alluvial plains with a general slope towards north-east. The River Ganga forms the levee or upland all along its southern bank. The area is characterized by fertile flat land, the northern part of which is highly prone to floods during the monsoon season. The alluvium deposits covering the entire region are of Quaternary period. The region is characterized by silt deposited from the river Ganges almost every year and is extremely fertile.

1.4.5 Physiography/DEM

The digital elevation model of the area prepared on the basis of the SRTM data shows variation in the ground elevation from 46 m amsl to 82 m amsl with a general slope from south-west to north-east (Fig 1.3).

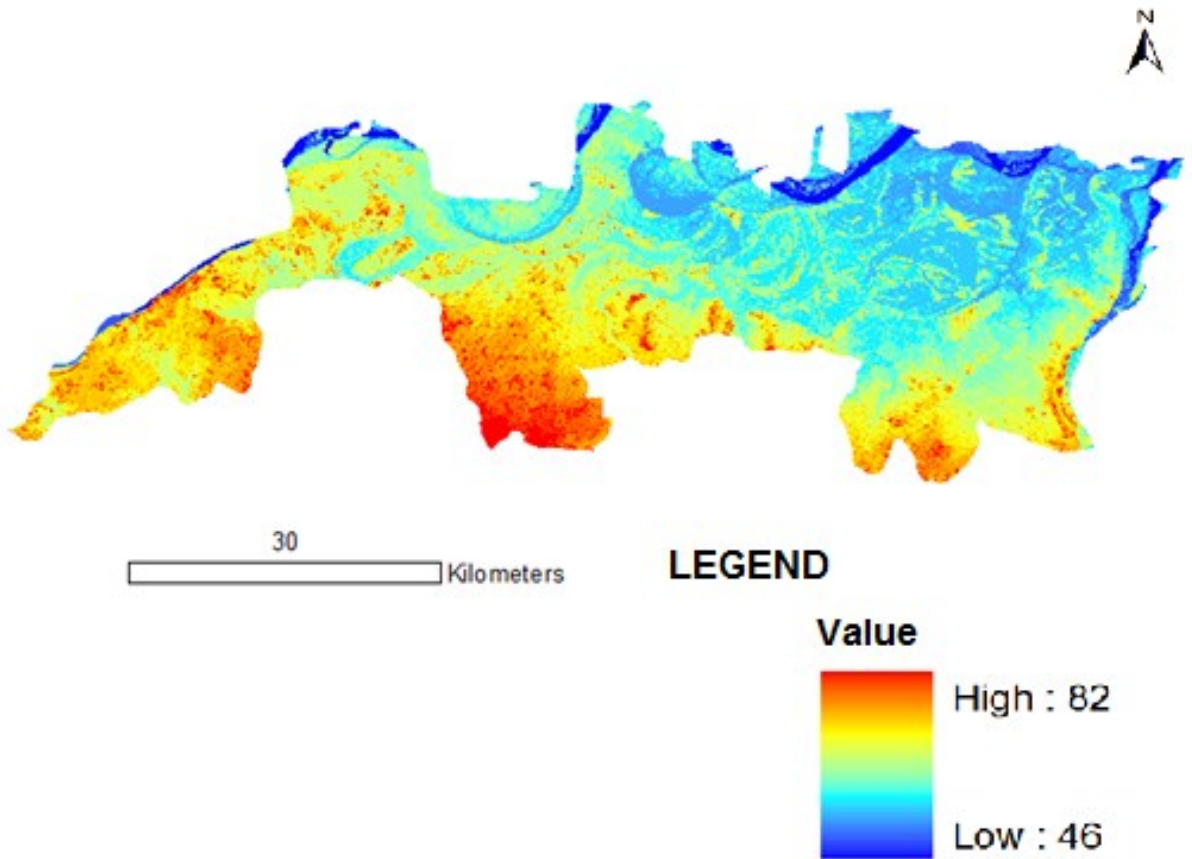


Fig. 1.3 Digital Elevation Model of the study area



1.4.6 Geomorphology

Physiographically, the area represents a monotonously flat topography. The land surface slopes due north with a gradient of about 0.62 m/km in general. The ground slopes from the west to the east with a gradient of 0.08m/km. The topographical variation for the area falling in the southern banks of the River Gnaga falling in Bhojpur and Buxar district indicates that the general slope is from south-west to north-east with minor variations.

The area is drained by the mighty river Ganga forming the northern boundary of the Bhojpur and Buxar districts. The River Ganga forms the levee or upland all along its southern bank. The geomorphological map of the area is produced in Fig 1.4.

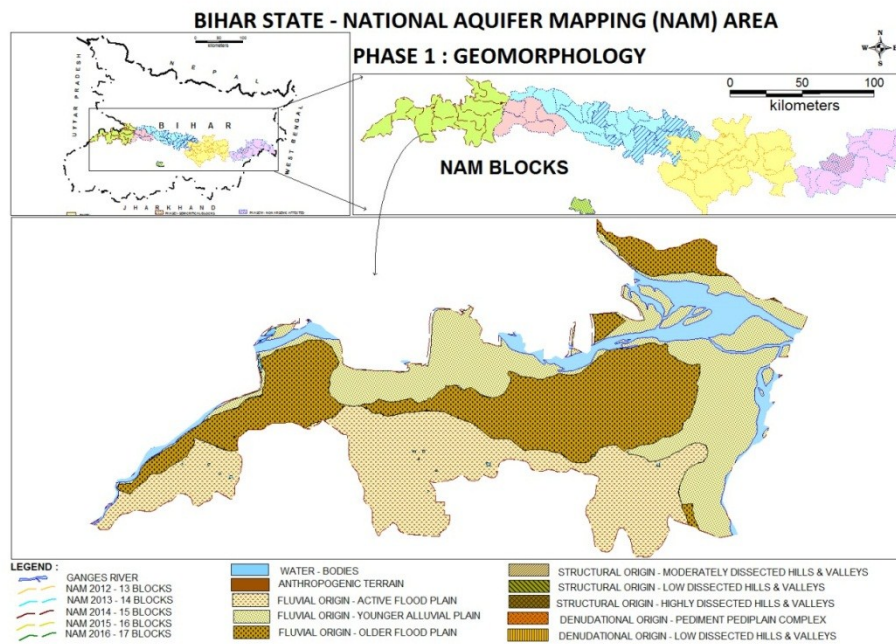


Fig. 1.4. Geomorphological Map

1.4.7 Landuse

Land use and land cover have direct linkage to the water demand of any area. The most reliable land use statistics are available from the reports of the Agriculture Department, Government of Bihar (2009), which provides district wise information.

Of the total geographical area of 669225 hectares of Bhojpur, Buxar and Saran districts, the total cultivable area is 235188, 166826, and 218689 hectares respectively. The principal source of assured irrigation is by wells and tube wells, which together account for about 90%



of the total irrigation. The cropping intensity of Bhojpur and Buxar districts are 126.4% and 124% respectively (Table 1.5).

During the study, the landuse land cover map of the area falling under Phase I has been prepared based on the NRSA data. The landuse landcover map based on the NRSA data is produced as under in Fig. 1.5.

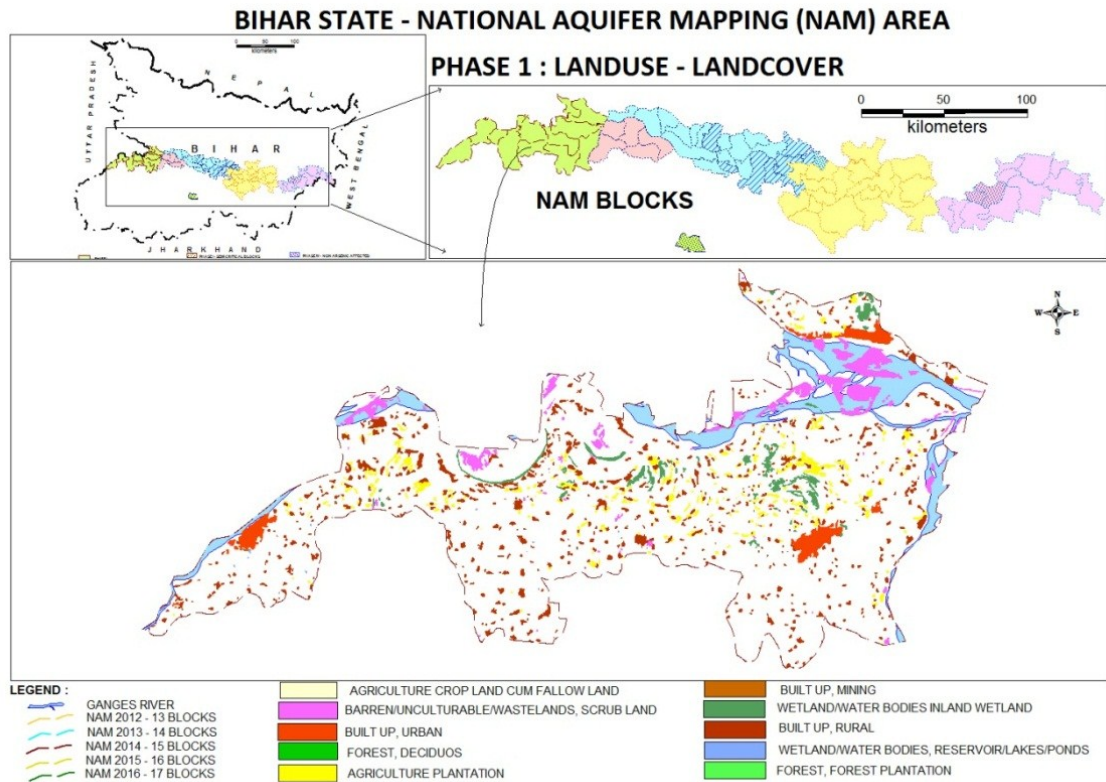


Fig. 1.5. Landuse & Landcover Map



Table 1.5 District wise Land Utilisation Statement of Bihar during 2009-10

Sl. No.	Name Of District	Geographical Area	Forest Area	Land put to Non-agricultural use				Barren Unculturable Area	Permanent Pastures & Grazing Land	Land under Misc. Tree crop & Groves not included in net area sown	Turbable Waste Land	Fallow Land			Total Non-Agricultural Land	Net Sown Area (3-16)	Total Cropped Area	Area Sown more than once
				Land Area	Water		Total col. 5, 6 & 7					Other Fallow Land	Current Fallow land	Total				
					Perennial	Temporary												
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Bhojpur	237339	0	29842	2823	1409	34074	6702	72	2009	618	2564	5375	7939	51414	185925	235188	49263
2	Buxar	166999	0	12840	3230	1330	17400	2180	23	737	659	609	11930	12539	33538	133461	166826	33365

(Source: Agriculture Department, Govt. of Bihar)



1.4.8 Soil

Information collected from various sources indicates that soils of the study area are predominantly sandy loams or loamy sand along the course of the River Sone and parts of Ganga, however, for major parts of the study area, it constitutes of sandy silt. Traditionally, soils in the area are classified on the basis of mode of deposition and have accordingly been divided into two groups viz. (i) recent alluvium and (ii) older alluvium. Both the districts in general possess rich alluvial soil suitable for paddy and vegetables cropping. The soils are of poorly drained type and brownish yellow to gray and blackish in colour. The black colour in the Newer Alluvium is obtained due to rich composition of organic matter (humus). The area adjoining the rivers consists of sandy loam, loamy sand and sand, whereas, the area away from the river channels are clayey loam in character. Texturally, it varies from sandy loam to loam in the meander scroll and levee forming the upland bounding of the flood plains, to silty loam, silty to clayey loam in low-lying flood plains. Though, there are indicators of pedogenesis in Older Alluvium, there is no such soil profile developed in the Newer Alluvium (terraced alluvium). The permeability of the soil is low to moderate, which makes the shallow aquifer in the area unconfined. The organic mass rich soil in the Newer Alluvium is observed particularly in the nearly levelled palaeochannel cut offs, which serve as paddy fields in the districts. They form geomorphic depressions, which carry flood water to the plains and hold water for considerable time after flood retreats.

1.4.9 Hydrology and Drainage

The west to east flowing Ganga River forms the master drainage of the area. River Sone forms the eastern boundary of the area. Besides the major river Ganga, the other important streams in the district are, Dharmawati, Chher, Gaur Bhagar and Thora, which are mostly 2nd or 3rd order streams forming tributaries to the Ganga. They are ephemeral and plains-fed in nature. The drainage pattern is sub-dendritic to dendritic with the streams in particularly Older Alluvium showing meandering pattern. These rivers are east to northeast flowing, except the Thora, which flows westward. The streams Dharmawati and Gaura Bhagar in the area show Yazoo pattern in a considerable distance along the southern bank/levee of river Ganga. A few of the rivers like Banas and Gangi in some instances cut across the meander scars to join river Ganga, but in many cases follow the same semi-circular path of the old meanders of Ganga at their convex sides (outer swale).



1.4.10 Agriculture

Agriculture is the mainstay of the population in the area. The area falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

1.4.11 Irrigation

Tube wells and Canals are the main source of irrigation in Bhojpur and Buxar district. In Bhojpur district, about 72% of the total irrigated area is under tube well irrigation while in Buxar district about 58% of the irrigated area is under tube well irrigation. However, in the Blocks located in the northern parts of the districts, tube wells are the most important source of irrigation.

1.4.12 Cropping patterns

As per the agro-climatic zonation of the State of Bihar, Bhojpur and Buxar districts fall in the agro-climatic Zone IIIB. The cropping sequence followed in this zone is Rice-Wheat, Rice-Gram, Rice- lentil and Rice- Rai.

1.4.13 Prevailing water conservation/recharge practices

A large part of the area remains seasonally water logged and are locally known as *Chauras*. These water bodies act as indirect sources of ground water recharge in the area.

1.5 Climate

Climate records are available from the IMD database. It indicates that the area enjoys a typical subtropical climate. The winter season starts from the month of October and continues up to February. Summer season starts from April and continues up to mid –June. The rainy season continues from mid –June to the end of September, which receives Southwest monsoon and accounts for about 90% of the total rainfall. The area receives an average normal monsoon rainfall of about 1100 mm/year.

1.6 Geology

The area forms a part of the Gangetic plain underlain by immensely thick alluvial deposits comprising sediments (sand, gravel and clay) of Quaternary age deposited



unconformably over the Precambrian basement. The alluvial deposits are characteristically divided into the Older and the Younger Alluvium.

Older Alluvium

The Older Alluvium (called Bhangar in the Ganges valley) forms slightly elevated terraces, generally above the flood level. These are dark coloured and in general are rich in concretion and nodules of impure calcium carbonate known as 'kankar', of various shapes and sizes.

Newer Alluvium

The Newer Alluvium is in general, light coloured and poor in calcareous matter. It contains lenticular beds of sand and gravel and peat beds. The geological map on 1:50,000 for the area is shown in the Fig. 1.6.

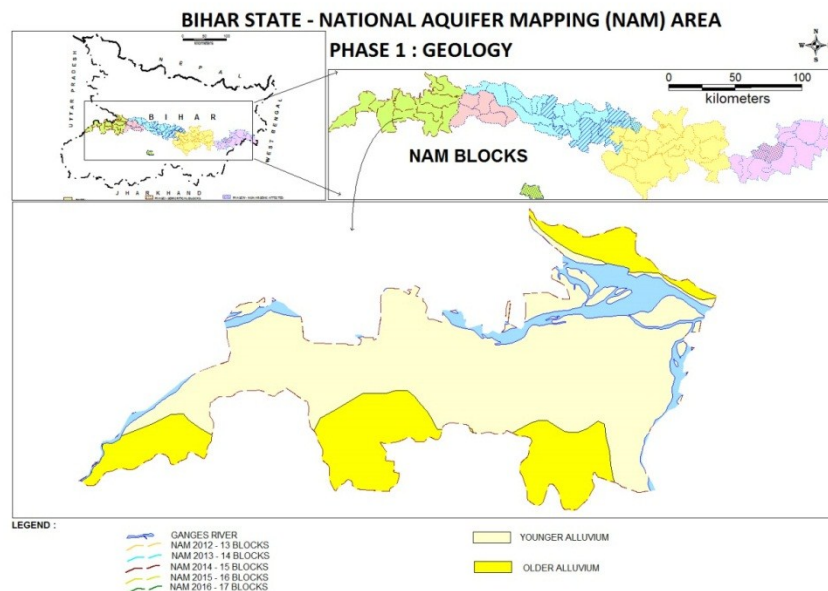


Fig 1.6: Geological Map of the area (Source: GSI)

The area is located in the central axial part of Middle Ganga Plain occupying the central part of the Ganga Basin. The Ganga basin is an active foreland basin formed in response to the uplift of Himalaya due to collision of the Indian and the Asian plate. The Middle Ganga Plain lies between the Munger-Saharsa ridge in the east and Faizabad ridge in the west exhibiting an asymmetrical sediment wedge, with thickness varying from less than a meter in basin margin areas with Peninsular craton to more than 5 km near the Himalayan orogen. The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits. Delineation of aquifer geometry based on the available data reveals presence of a thick pile of alluvial sediments of Quaternary age comprising various grades of clay, silt and



sand which constitutes the ground water reservoir. Geophysical investigations have revealed that the thickness of the alluvium overlying the bed rock is around 520m at Buxar, 580 m at Ara and around 700 m near the confluence of the Ganga and the Sone. The thickness reduces to 300-350 m close to the south of the Ara- Buxar railway line.

The sands brought and deposited by the Ganga are grey, micaceous and rich in ferromagnesian minerals and occupy the topmost horizon along the course of the river upto a few kilometres south of it constituting the newer alluvium consisting of clay, kankars, fine to coarse grained sands, gravels and pebbles at depths.



CHAPTER-II

DATA COLLECTION AND GENERATION

2.1 Hydrogeology

Available literature of previous surveys in the study area reveals the hydrogeology of the area. The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits. Assessment of the subsurface configuration of aquifer based on the available data reveals presence of a thick pile of alluvial sediments of Quaternary age comprising various grades of clay, silt and sand. A pervasive layer of clay mixed sand constitutes the top of the succession. The presence of kankar and fine sand makes this clay layer semi pervious. The area is characterized by occurrence of fairly thick sands of various grades forming prolific aquifers.

Available data indicate presence of two aquifer system up to 300m,bgl. The deeper aquifer is made up of medium to coarse grained sand often grading to gravelly sand at the bottom.

2.1.1 Water level, pumping tests, soil infiltration studies, slug tests

Water Level

Monitoring of water level was carried out at 74 stations in the study area (Annexure-I). The depth to water level maps of pre and post-monsoon season has been prepared for the phreatic aquifers. The ground water occurs under water table condition in the phreatic aquifer and under semi-confined to confined condition in deeper aquifers. The depth to water level map of the study area for the pre-and post-monsoon period is produced as below.

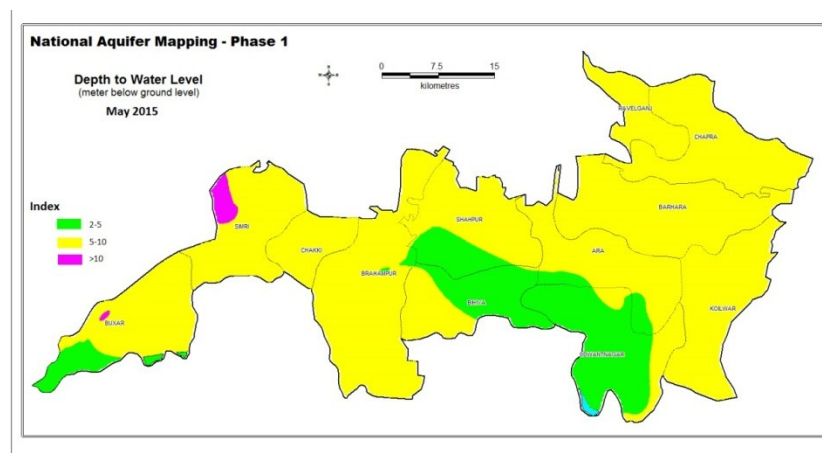


Fig. 2.1a Depth to water level map of pre-monsoon 2015

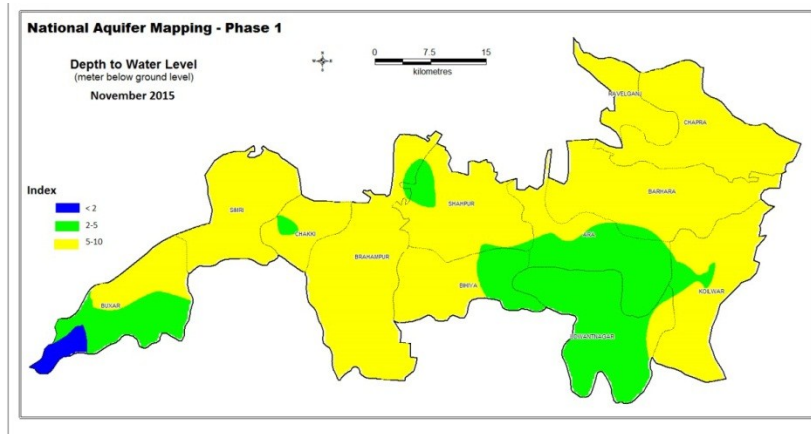


Fig. 2.1b Depth to water level map of post-monsoon 2015

Perusal of the depth to water level map of the study area reveals that the depth to water level in large part of the study area remains in the range of 5-10m both during pre and post monsoon season. Depth to water level in a small part in Simri block of Buxar district occurs at >10 m during the pre-monsoon season.

Comparison of the depth to water level in the study area has been made with a historical water level record for the year 1982. Changes in water level during the post-monsoon season are apparent. During the year 1982, large part of the area was under the depth to water level range of 2-5 m which now remains in the range of 5-10 m. The other discernible change is the disappearance of area under depth to water level range of 0-2 m in the southern part of udwantnagar Block.

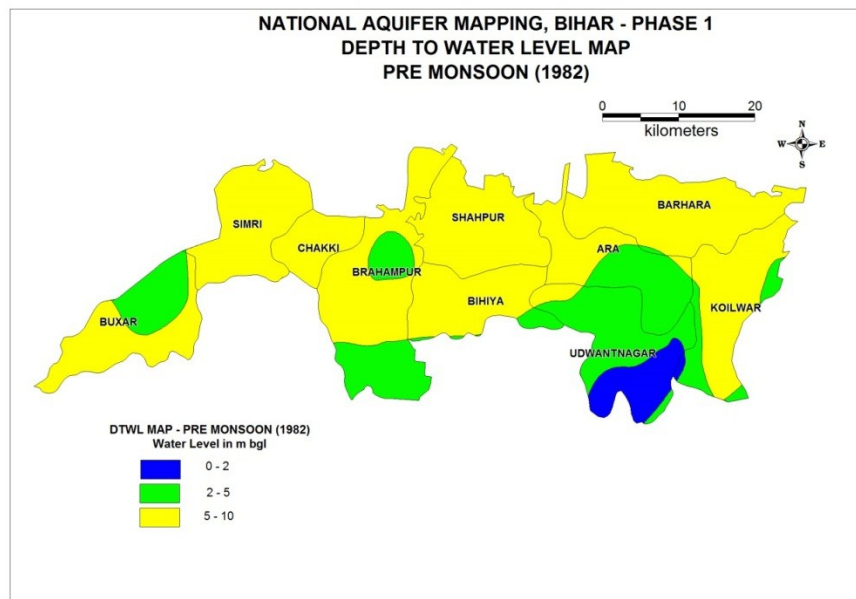


Fig. 2.2a Depth to water level map of pre-monsoon 1982

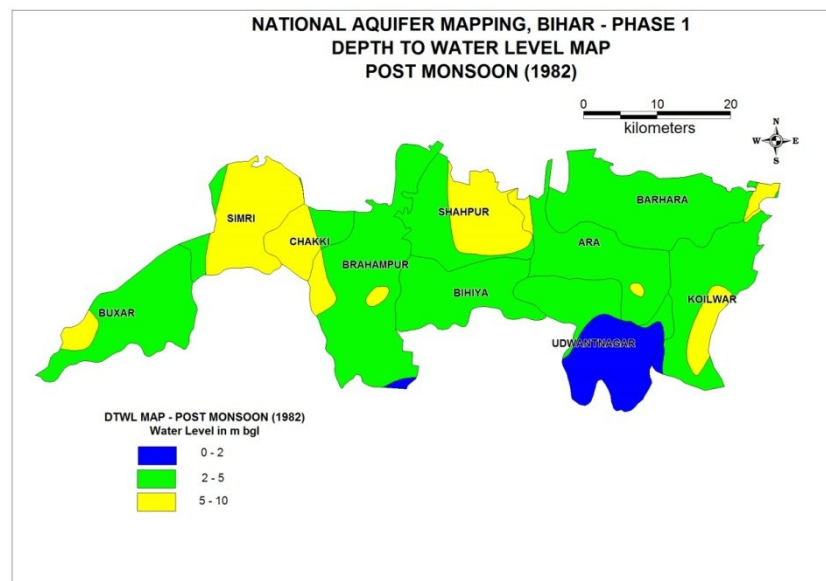


Fig. 2.2b Depth to water level map of post-monsoon 1982

Pumping tests

Pumping test data of CGWB wells (Table-2 and Table- 3) indicate that the transmissivity value of the aquifers ranges between 1776 and 21000 m²day⁻¹ with a mean of 8528.5 m²day⁻¹ indicating significant potentiality of the deeper aquifer. The specific capacity of the wells ranges from 8.18 to 46.0095 m³hr⁻¹m⁻¹ and the mean hydraulic conductivity (K) has been found as 177.58 m day⁻¹ corresponding to that of coarse sand and coarse sand mixed with gravel. The storage coefficient has been found ranging between 1.1X10⁻³ and 7.49 x10⁻³ respectively indicating that the deeper aquifer remains in semi-confined to confined condition.

Table 2.1: Summarized salient characteristic of the exploratory wells drilled by CGWB in the study area

S.No	Location	Depth drilled (m bgl)	Depth range of tapped Granular zones (m)	Discharge (m ³ /hr.)	Drawdown (m)	Transmissivity (m ² /day)	Storativity
1	Brahampur	246		200	7.04	10980	
2	Shahpur	303.1		194.6	4.75	8552	4X10 ⁻³
3	Amrahi Nawada	224.5		188.7	8.55	5919	
4	Karnamepur	250.8		194.58	9.91	4461	1.98X10 ⁻³



5	Bharauli	250.4		182.79	8.48	8920	2.72X10 ⁻³
6	Nargada Narayanpur	250		188.7	9.62	5529	
7	Paharpur	286		194.62	4.23	8553	7.49X10 ⁻³
8	Bariswan	211.9		189	6.35	10239	4.0X10 ⁻⁴
9	Arjunpur High School	204		180	8.50	9690	1.1X10 ⁻³
10	Churamanpur	223		197.3	3.62	7884	1.849X10 ⁻⁵

Table 2.2: Summarized salient characteristic of the exploratory wells drilled by State Govt.

S.No	Location	Depth drilled (m bgl)	Depth range of tapped Granular zones (m)	Discharge (m ³ /hr.)	Drawdown	Transmissivity
					(m)	(m ² /day)
1	Kithpura	111.6	70.53-82, 85.4-109.7	174.6	3.41	3653
2	Shahpur	76.14	29.87-61.13, 67.23-74.3	165	1.53	4749
3	Ratanpur	71.6	27.28-36.57, 40.23-64.60, 68.57-70.10	222.6	1.39	9300
4	Basantpur	81.53	42.8-78.5	220.2	3	15886
5	Basudeopur	76.2	24.38-30.46, 33.52-48.92, 56.56-60.53, 68.58-73.45	232.2	1.72	9685

2.2 Hydrochemical

2.2.1 Water quality sampling, number of samples and analysis mechanism

Groundwater is the most important and essential natural resource for domestic, industrial and agricultural needs. Water quality in an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities.

Quality of ground water is as much demanding as its quantity. Suitability of ground water for drinking and irrigational purpose is important for its safe and effective use. The state of Bihar is mainly dependent on ground water for the domestic and irrigation demand. The pressure on ground water is considerable also in the Pilot aquifer mapping area to meet



urban and rural water requirements as well as the irrigation requirements in the semi-urban and rural areas. Chemically, the ground water is an aqueous solution in the sub-surface geological formation. The concentration of the major ions and other dissolved ions in ground water are functions of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulate, are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality.

To study the groundwater chemistry of different aquifer present in the area, a total no. of 70 groundwater samples was collected from different aquifers during different time periods for analysis of major parameters (Annexure-II). The water samples were collected and stored in 1 liter capacity clean plastic bottles. Before collection of samples, the bottles were properly washed. Prior to collecting the samples, the containers were rinsed by the water to be sampled. The wells were duly pumped before collecting ground water sample so that the stagnant water, if any, is completely removed from storage within the well assembly

These water samples were analysed in chemical laboratory of CGWB MER-Patna, and PHED, Govt. of Bihar. Besides these, available historical data of chemical analysis of ground water were also studied to have an understanding of ground water chemistry of the area. Analytical results of ground water samples are given in the annexure.

Type of groundwater

The major ion composition of groundwater was used to classify groundwater into various types based on the dominant cations and anions (Deutsch, 1997). The piper diagrams were prepared for groundwater collected from different aquifers of the area. Piper diagram indicate that groundwater of the area is mainly of Ca-Mg-HCO₃ type (Fig 2.3).

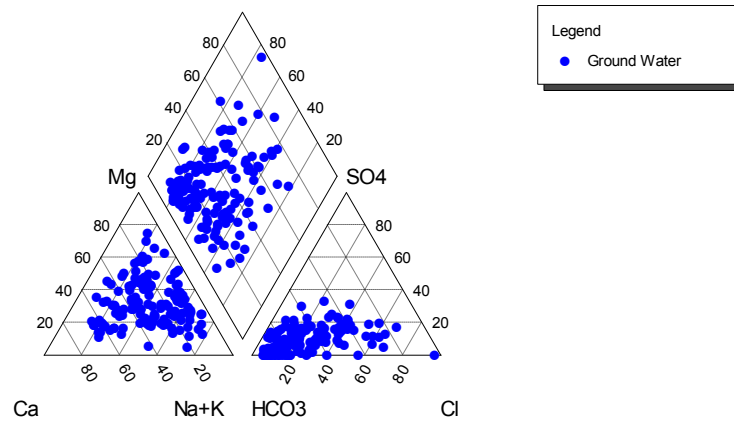


Fig 2.3: Piper's Diagram of the ground water samples from the shallow aquifer

Isotope Hydrology

In an earlier study by CGWB and BARC, isotopic investigations were carried out in parts of the study area. The isotopic investigation has thrown light on groundwater flow regime and its geochemical evolution. Hydraulic connectivity between the aquifers and comparative age of groundwater in different aquifer systems have also been studied by using the isotopic data.

Tritium concentration of arsenic contaminated samples varies from 2.55 to 7.64 TU. Tritium concentration indicates modern component of recharge in varying proportions. Tritium concentration of rain water from the area was determined as 7.4 TU and Ganga river water as 15.4 TU indicating the major component of flowing river water is snowmelt from higher Himalayan region. For dug wells and shallow piezometers having total depth as < 20 m, the concentration varies from 6.2 to 9.1 TU. Relatively higher values of tritium in this zone (<20 m) than deepzones (>20 m) indicates that shallow zone is getting recharge from precipitation as well as river water.

The depth of hand pumps ranges from 18.3 to 33.5 m. Shallow piezometers and hand pumps are confined within top 35 m. Tritium concentration of these hand pump samples collected in 2004, varied from 2.55 to 7.64 TU. The wide variation in tritium content reflects that the zones tapped by the hand pumps ranges widely in hydraulic characters particularly hydraulic conductivity. In many cases the hand pumps tap sand lenses embedded within clay or sandy clay sequence. In such cases the lenses are hydraulically separated from the land surface immediately above. However, tritium concentration of some hand pumps (5 Nos) was found > 5.0 TU indicating significant recharge from rainfall infiltration. During 2006, tritium concentration of hand pumps and shallow piezometers were found in the range of 1.55 to 8.48 TU. A comparative study does not indicate much variation in tritium concentration between 2004 and 2006.



Two deep piezometers (Bariswan and Pahadpur) samples showed low tritium content in 2004 (1.1 TU & 2.3 TU) and 2006 (1.4 and 1.3 TU) showing high residence time of deep aquifer water, resulting in loss of tritium due to radioactive decay before reaching the deep aquifer. Both the wells were constructed just one year before the sampling (2003). Detection of tritium in these wells may be due to mixing of deep and shallow groundwater during drilling operation.

Carbon-14 of handpump samples range from 132-158 pMC. ^{14}C values of deep piezometers of Bariswan and Pahadpur were found 64 and 78 pMC respectively indicating older water compared to shallow aquifer water. In a deep piezometer sample from Bahrauli in Shahpur block, collected in 2006, ^{14}C concentration of 30 pMC indicating old water. The concentration from deep piezometers in Bariswan and Bahrauli indicate the age of deep groundwater as more than 3000 years, indicating long residence time of deep aquifer's water. Very low tritium content in Bariswan deep piezometer (1.1 TU in 2004 and 1.35 TU in 2006) also corroborates the view. High carbon-14 content in handpumps, which are confined within 35 m bgl and also in Paharpur piezometer (tapped zone 34-99 m bgl) indicates that the shallow aquifer is recharged from rainfall infiltration for its entire thickness. The relation Tritium and carbon-14 shows positive correlation indicating older groundwater depleted both in tritium and carbon-14. In the study area the $\delta^{18}\text{O}$ (measured in 2004) ranges from -4.75 to -7.69‰. The average values of $\delta^{18}\text{O}$ of hand pumps (-6.47‰) falls in between deep piezometers (-7.37‰) and dug wells (-6.13‰). This indicates that the dug wells are getting modern recharge. The $\delta^2\text{H}$ values range from -36.52 to 47.95‰. Most of the samples are plotted on or slightly below the meteoric water line, indicating an origin from local rain or rivers, with or without some evaporation before infiltration. Interestingly a few samples from hand pumps and the piezometers are plotted above the GMWL. Ganga river water shows enriched value of stable isotopes due to evaporation effect.

Ground water quality problem in the Watershed

The major issue in ground water quality problem of the study area was high arsenic level (> 50 ppb which is the limit considered for drinking water) as reported by PHED, Govt. of Bihar and analysis of Ground water sample by CGWB from area (Annexure IIIa & IIIb).

Aquifer disposition

The subsurface configuration of aquifer has been made based on available lithological logs of CGWB and State agencies along with interpreted records from VES survey. Several sections along different orientation have been prepared to depict aquifer geometry. The lithologs and the geophysical logs reveal the presence of a thick pile of alluvial sediments with alternating sequence of various grades of sand with clay and silt.



2.3 Geophysical

2.3.1 Location, number, analytical techniques

128 Surface electrical resistivity investigation (VES) was carried out by CGWB within the study area (Annexure IV). The field data were interpreted with the help of empirical curves (Master curves) based on curve matching technique and computer based software. On the basis of interpreted results, geoelectrical sections have been prepared and vertical and horizontal disposition of granular zones of various grades are analysed within the investigated area.

Surface geophysical survey:

In all 128 VES were performed within the aquifer mapping area (Fig. 2.4). The VES were performed in the field and the data were interpreted with computer and manual process. The interpreted VES data of the area is given in annexure iv. The final results are analyzed and discussed in details below.

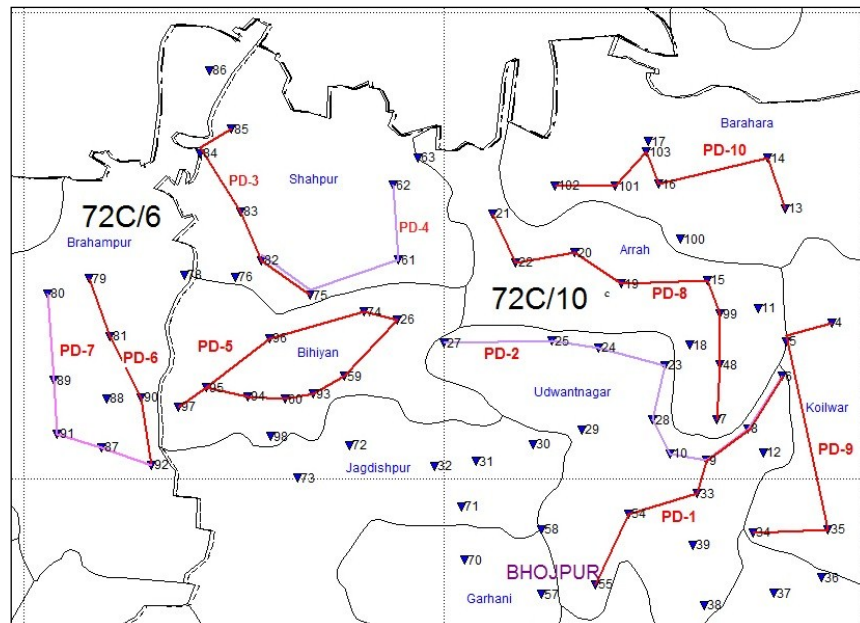


Fig 2.4 Location of VES points within aquifer mapping area.

Instrument used

During the surface resistivity investigation a Syscal R2 resistivity meter (manufactured by IRIS, France) was used. The instrument measures potential differences between two potential electrodes when current is sent through two current electrodes and there by apparent resistivity is calculated automatically by the instrument.



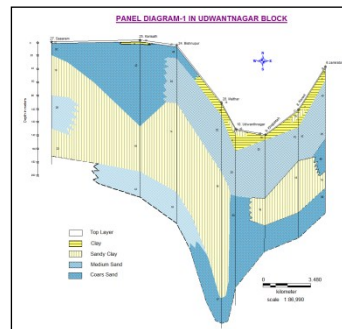
All the curves are interpreted with the help of partial curve matching technique and also by the resistivity sounding interpretation software. The interpreted data is correlated with the available borehole information near by the survey area and the following resistivity range with respect to lithology is given as follows:-

Resistivity range	Lithology
09 -15 Ohm-m	Clay
14-30 Ohm-m	Sand mixed with little clay
16 -25 Ohm-m	Fine Sand
30 -50 Ohm-m	Medium to Coarse Sand
60-200 Ohm-m	Coarse sand mixed with gravel/Kankar
200-500 Ohm-m	Desaturated sand

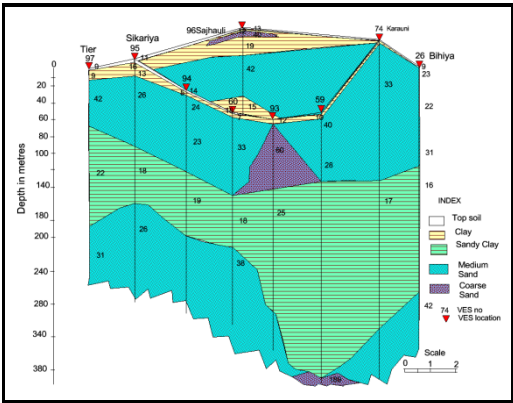
All the interpreted results are tabulated in the Annexure-1. Based on these results of the VES ,the sub-surface layered structure is identified.

Geo electrical Section

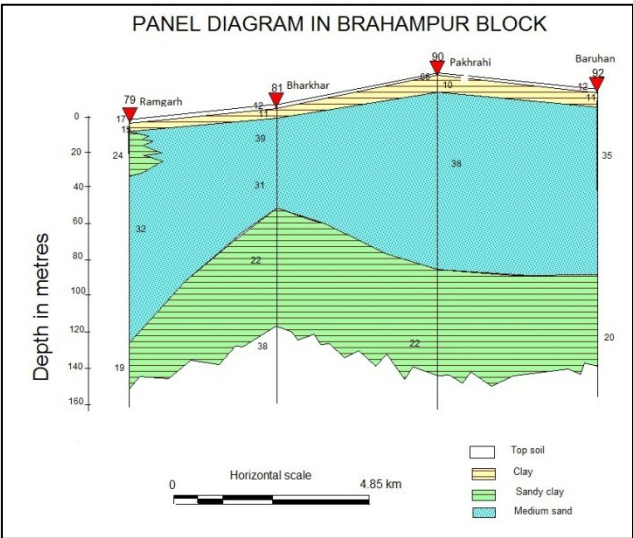
Geo electrical section are given below (fig 2.5a to j)



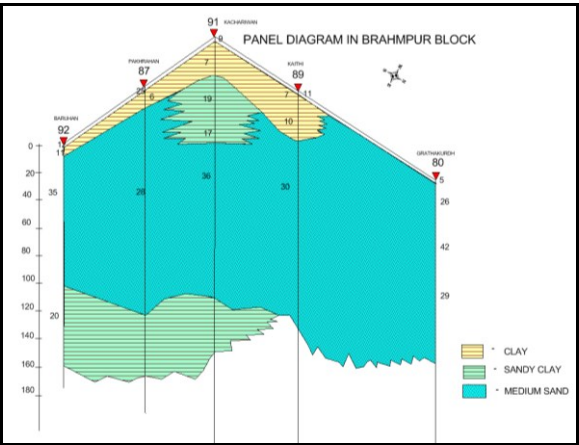
a.Udwantnagar(Jamiratola to Dubauli)



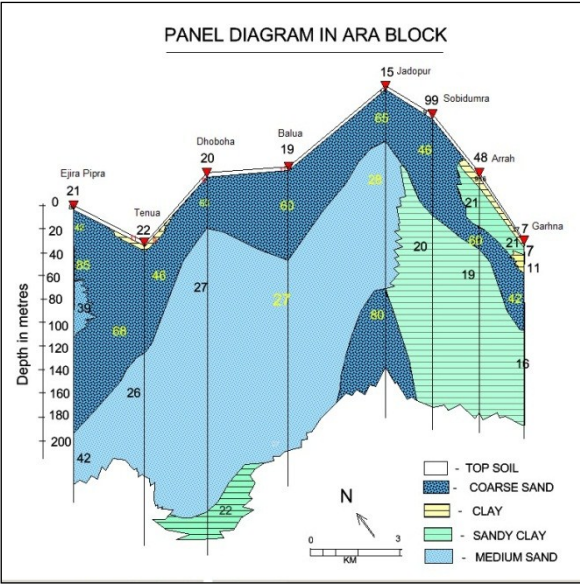
e. Panel diagram of Bihiya block



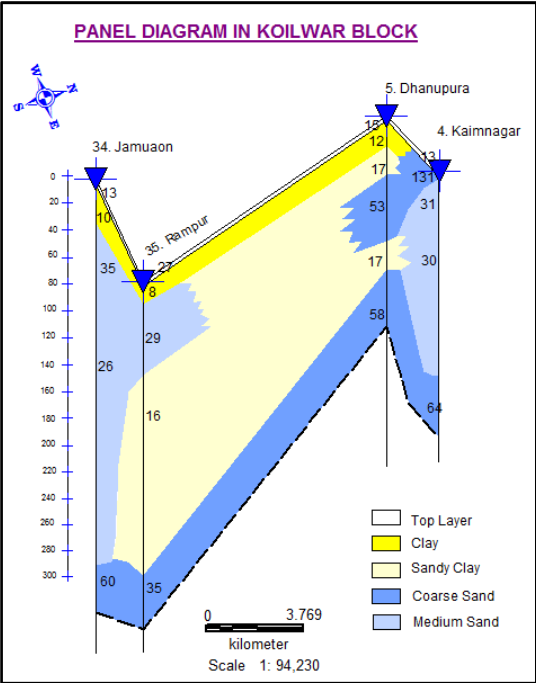
f. Brahmampur1 (V79. Ramgarh - V92. Baruhan)



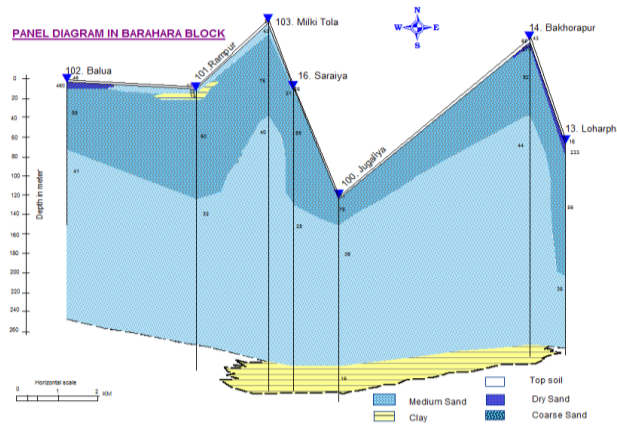
g. Brahmampur2 (V92. Baruhan - V80. Grathakurdh)



h. Ara (V21. Ejira Pipra -V7. Garhna)



i. Koilwar (V34. Jamuaon – V4. Kaimnagar)



j.Barahara (V102. Balua – V13. Loharpharna)

Fig. 2.5a to j: Geo electrical section of the study area

2.4 Exploratory drilling-State, CGWB and private wells

2.4.1 Number, location, depths, well design

Sub-surface lithological information (> 200m, bgl) from the available drilling records of exploratory well of CGWB and state govt. have been tabulated in Table 2.3a & b. The lithologs and e-logs of wells are given in annexure.

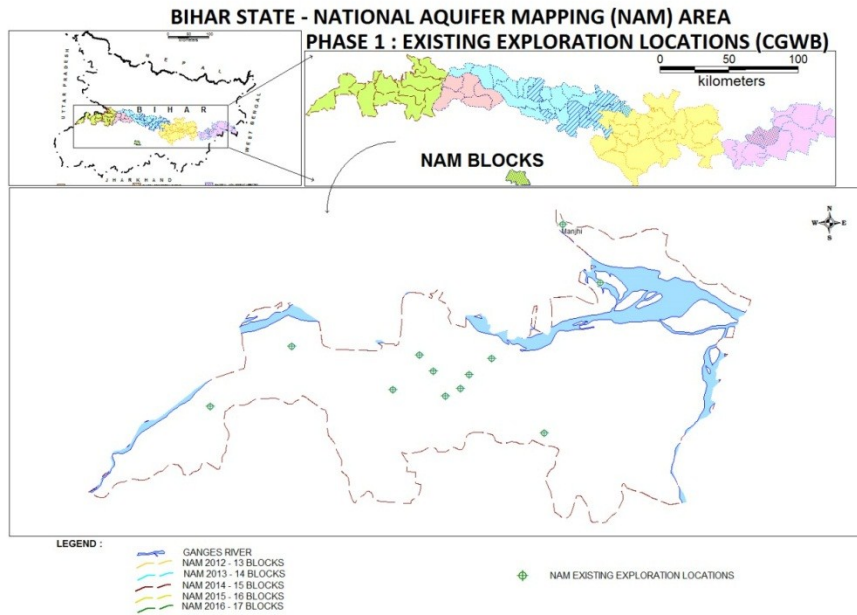


Fig 2.6a: Locations of exploratory wells (drilled by CGWB)



Table 2.3a: Location detail of wells drilled by CGWB

S No	Location	Long	Lat	Depth drilled (m,bgl)
1	Brahampur	84.3166	25.6048	246
2	Shahpur	84.3987	25.5964	303.1
3	Amrahi Nawada	84.5531	25.5441	224.5
4	Karnamepur	84.3581	25.6542	250.8
5	Bharauli	84.3801	25.631	250.4
6	Nargada Narayanpur	84.4222	25.6067	250
7	Paharpur	84.4712	25.6494	286
8	Bariswan	84.4359	25.6265	211.9
9	Arjunpur High School	84.1579	25.6666	204
10	Churamanpur	84.0306	25.5813	223

In addition to the CGWB data, lithologs of 32 bore wells from other sources have also been collected, the locations details of which are given in table. The lithologs of these wells are given in annexure. These lithologs are available mainly up to 100m and hence providing lithological information up to 100m bgl only.

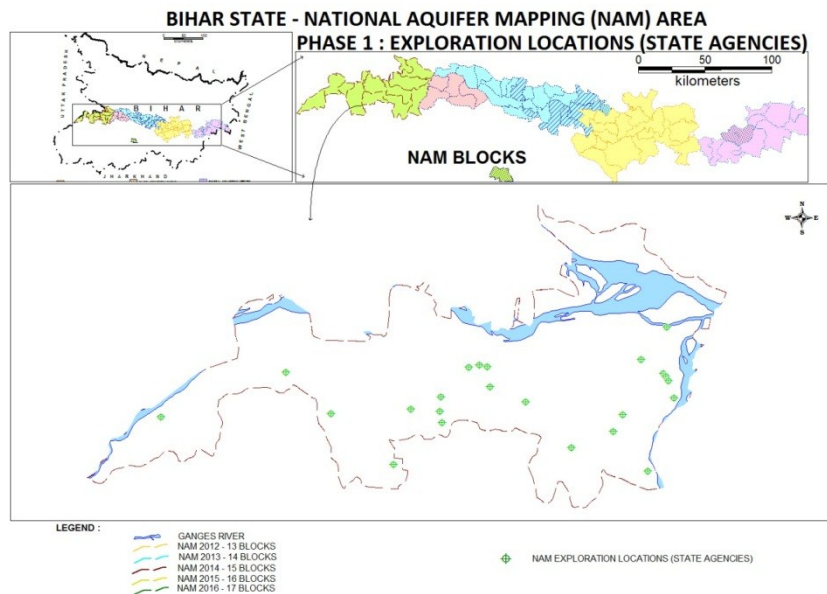


Fig 2.6b: Locations of wells from other agencies

**Table 2.3b:** Location detail of bore well drilled by other agencies

S. No.	Location	Longitude	Latitude	Depth drilled (m,bgl)
1	Basudeopur	84.4939	25.5936	91.44
2	Kataria	84.3458	25.3034	80.77
3	Sahar	84.6261	25.2512	83.82
4	Chakri	84.1631	25.6146	77
5	Chanda	84.4766	25.6254	79
6	Barka Nuawan	83.9606	25.5495	106
7	Bhadwar	84.3372	25.4808	99
8	Chakwath	84.4163	25.542	94
9	Sandesh	84.7421	25.4042	93
10	Barap	84.5649	25.4265	79
11	Charpokhari	84.4827	25.3634	108
12	Udwantnagar	84.6252	25.5046	109
13	Akhgaon	84.7491	25.471	98
14	Sowan	84.2359	25.5544	96
15	Koilwar	84.7917	25.5774	102
16	Pachaina	84.7749	25.6135	96
17	Pachrukhiya	84.7783	25.6091	102
18	Kajichak	84.7829	25.6026	102
19	Ganj Sripalpur	84.7389	25.6334	101.5
20	Babura	84.7803	25.681	102
21	Karisath	84.5512	25.5715	105
22	Yogibir	84.3648	25.5613	99
23	Osai	84.4123	25.5576	102
24	Ranadih	84.414	25.5793	105
25	Kharauni	84.4888	25.6232	105
26	Bemari	84.4593	25.622	105
27	Jamira	84.7088	25.5533	104
28	Gothula	84.6934	25.5286	105



CHAPTER-III GENERATION OF AQUIFER MAP

3.1 Aquifer Disposition

The study area is located in the central axial part of Middle Ganga Plain occupying the central part of the Ganga Basin. The area forms a part of the Gangetic plains underlain by immensely thick alluvial deposits of Quaternary age comprising various grades of clay, silt and sand which constitutes the ground water reservoir.

3.1.1 Aquifer disposition in the area

To know the aquifer disposition in the study area, separate sections and fence diagrams have also been prepared based on the lithological information obtained through exploratory drilling undertaken by CGWB in conjunction with the available lithological logs of tubewells constructed by State Government.

From the geological sections and fence diagrams prepared the detailed aquifer geometry on regional scale has been established in the study area. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers.

Aquifer disposition of the area are described through various sections and fence diagram prepared in different orientation which are presented as under (Fig. 3.1 to 3.5).

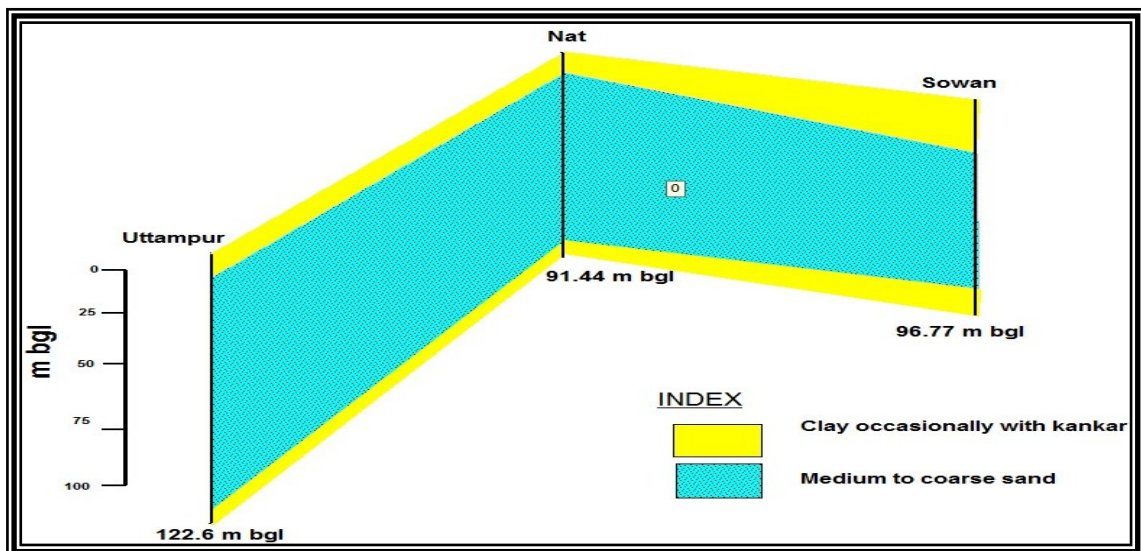


Fig. 3.1 Hydrogeological section from Udwantnagar to Sowan.

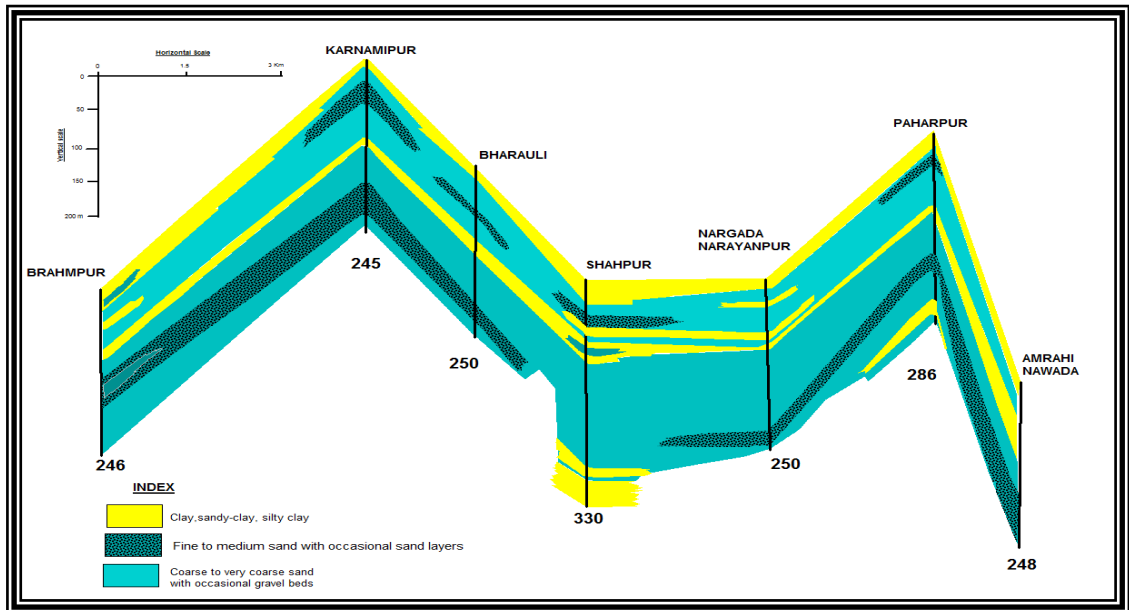


Fig. 3.2 Hydrogeological section fom Brahampur to Amrahi Nawada.

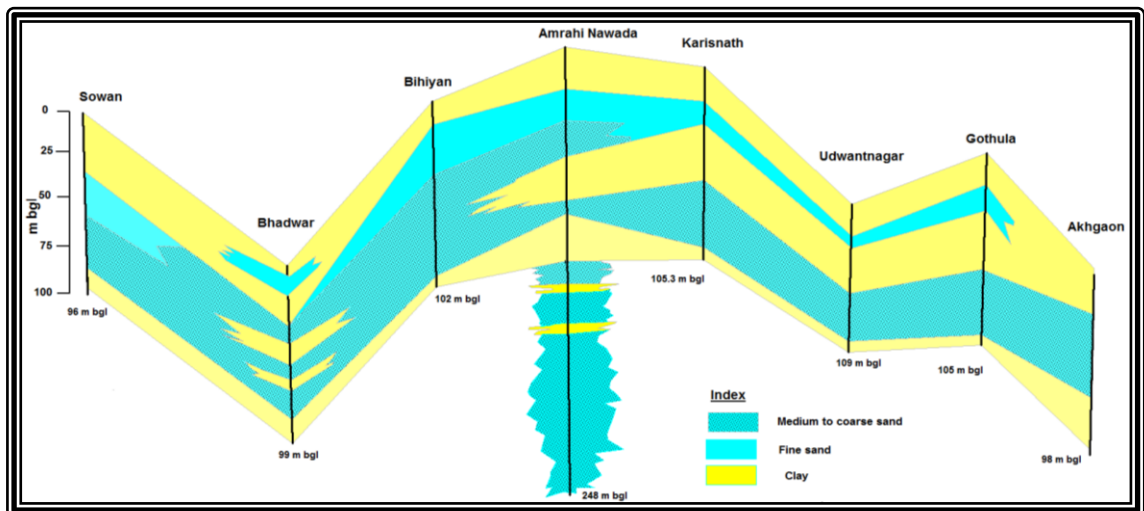


Fig. 3.3 Hydrogeological section fom Sowan to Akhgaon.

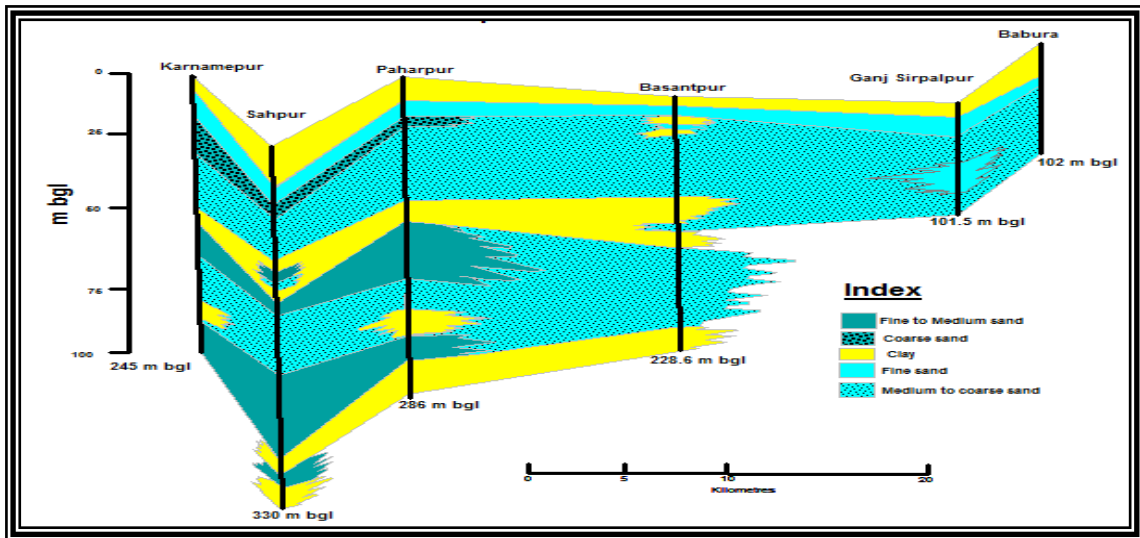


Fig. 3.4 Hydrogeological section from Karnamepur to Babura.

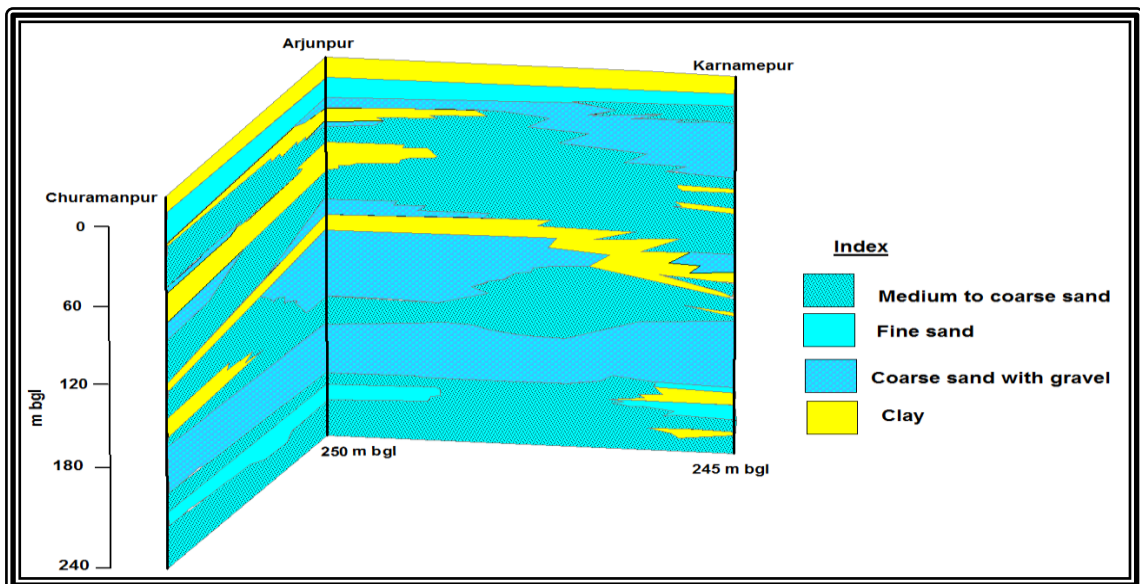


Fig. 3.5 Hydrogeological section from Churamanpur to Karnamepur.

3.1.2 Aquifer Characterizations

Characterization of aquifer upto 300 m bgl in the study area have been arrived at by convergence of the observations from the study of the different lithological sections, fence diagrams, geoelectrical sections, sections based on logs and overall lithological model of the area. All these figures reveal the presence of a thick pile of alluvial sediments with alternation of various grades of sand with clay and silt. The area is characterized by occurrence of fairly thick sands of various grades forming prolific aquifers.

The study of sections, fence diagram and lithological model indicate that there are mainly two principal aquifer systems in the area up to depth of 300m depth.

Isopach map of the individual aquifers have been prepared which provide a clear impression of the spatial variation of aquifer thickness in the area. The isopach reveals that the thickness of the 1st principal aquifer varies from about 50 to over 90 m.

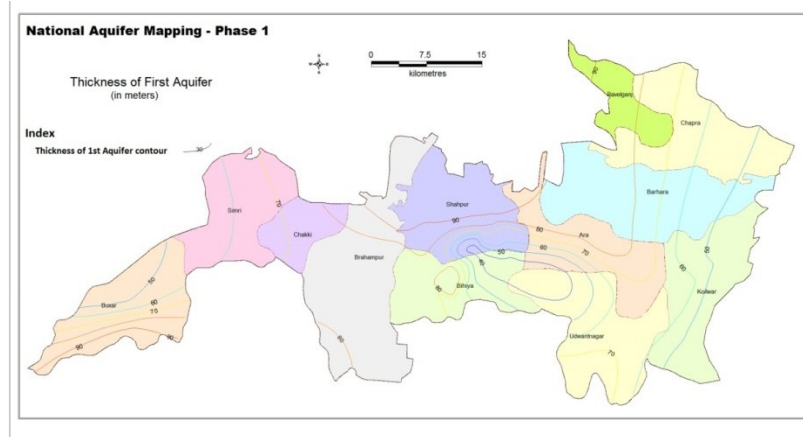


Fig 3.6a: Thickness of the 1st principal aquifer

The 2nd principal aquifer is comparatively much thicker than the 1st principal aquifer. The thickness of the 2nd principal aquifer in the central part even extends beyond 150 m. The general thickness of this aquifer is around 100 m in major part of the area.

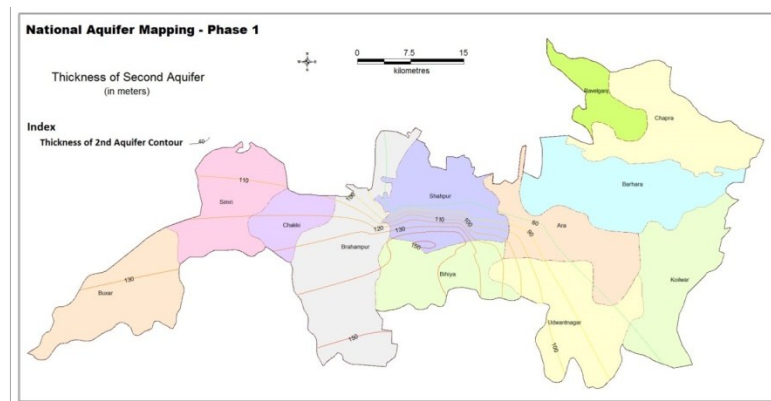


Fig 3.6b: Thickness of the 2nd principal aquifer

Perusals of these sections indicate that there are two principal aquifers below the top aquitard layer (water table aquifer) upto 300m depth separated by clay and sandy clay layers

The disposition of aquifers may be summarised as:

(1) Top layer consisting of clay, sandy clay and fine sand: This layer is highly mixed in nature. The presence of sands in the top zones at places renders it semi-pervious in nature. This layer sustains the dug wells and shallow hand pumps of the area.

(2) First Principal Aquifer: The first principal aquifer starts from 40 -60m and it goes up to 80 - 130m bgl in general. .The thickness of the first principal aquifer in general is about 50m.



(3) First impervious Layer: The 1st principal aquifer is separated by 9 to 60 m impervious layer consisting of clay and sandy clay. This layer is thin in north-eastern part in comparison to the other parts of the area.

(4) Second Aquifer: Below the first confining layer, there is a 2nd principal aquifer which is much thicker in comparison to the first principal aquifer. At places, this aquifer zone is intercalated with thin lenses of clay and sandy clay.

(5) Second impervious Layer: there is a thick clay and sandy clay bed impervious in nature below the second confining layer. Except at few places, it continues up to depth of 300m, bgl.

Sand beds below the second impervious layer has been detected at places, however, precise delineation of the 3rd aquifer requires drilling even beyond 300m to establish its regional continuity.

3.1.3 Aquifer disposition and its hydraulic characteristics

The aquifer geometry and its characterisation up to 300 m bgl have been studied through drilling at various parts of arsenic affected areas of Bihar. In the Newer Alluvium in Sone Ganga alluvial tract, a two-tier aquifer system has been delineated below the top aquitard zone (16-45 m thick). The 1st aquifer extends up to a depth of 87-126 m bgl, while the lower one starts at depths varying between 116 and 139 m bgl and continues up to ~250 m below ground. The upper slice of the upper aquifer (within 60 m bgl) including the top aquitard zone comprises fine to very fine sand of Himalayan origin, interleaved with grey to dark grey clay. Further below, the bottom part of the upper aquifer as well as the lower aquifer is made up of yellow to brownish yellow, medium to coarse sand and gravels of cratonic origin. The two aquifers are separated by 8-24 m thick clay/mud zone, henceforth referred as middle clay.

Groundwater in the lower aquifer occurs under semi-confined to confined condition as indicated by the storativity values (2.5×10^{-3} – 6.9×10^{-4}) as well as the hydraulic conductivity of the middle clay (0.047 – 0.0072 mday⁻¹). Transmissivity of the same aquifer ranged between 4,130-6,960 m²day⁻¹ in Bhojpur district and 9427-10980 m²day⁻¹ in Buxar district. The argillaceous unit at the top of the succession acts as a semi-permeable barrier for the upper aquifer. The yield of the deeper aquifer within the depth of ~125-250 m below ground varies between ~100-200 m³ per hour.

The thin sand lenses (mostly fine-grained) within the top aquitard zone in MGP, which are widely tapped by hand pumps and bore wells, are particularly found to be *As* contaminated. In aquifer-specific investigation in Bhojpur district, the sand lenses within the top aquitard as well as the top 15-20 m slice of the upper aquifer has been found to be contaminated. Though, the bottom



part of the upper aquifer and the lower aquifer are found with low As load, the former is considered as vulnerable for its hydraulic connectivity with the upper contaminated zone. However, the lower aquifer with negligible hydraulic connectivity with the upper aquifer has been identified as the alternate arsenic safe aquifer in the area with low As load in groundwater. An analysis campaign covering 8 tube wells tapping the lower aquifer in Bhojpur and Buxar districts revealed maximum concentration of $5 \mu\text{gL}^{-1}$, while 5 wells reported as BDL. In Samastipur district also, the groundwater As conc. of the lower aquifer has also been reported as BDL. Though the top slice of the upper aquifer has been found to be contaminated, the lower part ($>6\text{m}$ bgl) exhibited the concentration in safe range of $8\text{-}12 \mu\text{gL}^{-1}$.

CGWB has drilled number of wells in the area tapping multiple zones in different aquifers. Pumping test data of CGWB wells have been analysed to arrive at the hydraulic characteristics of the aquifers. These apart, the data of the wells constructed by State Government in the western and South-western part of the study area. indicate that the yield potential of the tubewell tapping first aquifer (within 110m bgl) varies from $165 \text{ m}^3/\text{hr}$ to $232.2 \text{ m}^3/\text{hr}$ for a maximum drawdown of 3.41 m (Table 2.2).

Salient characteristic of the exploratory wells drilled by CGWB in the area is given in table 2.1 Perusal of these data reveal significant potentiality of the aquifer of the area as the transmissivity ranges between 4461 and $10980 \text{ m}^2\text{day}^{-1}$ with mean value of $7893 \text{ m}^2\text{day}^{-1}$. The storage coefficient has been found ranging from 1.1×10^{-3} to 7.49×10^{-3} respectively (Annexure V, VI & VII).



CHAPTER-IV GROUND WATER RESOURCES

4.1 Dynamic ground water resources

The dynamic ground water resources of the 10 Blocks of Bhojpur and Buxar district as per the assessment made as on March 2011 is presented as under. The overall stage of groundwater development in the area is 47.6% and all the Blocks have been categorised under safe category on the basis of the status of ground water utilisation.

Perusal of the above table indicates that the existing stage of groundwater development varies from 29.1% in Barhara block to 88.5% in Chakki block. Considering the nature of the aquifers in the study area, recommendations for increasing groundwater development upto 70% stage of development can be made (Annexure VIII). The number of additional shallow tube wells that can be recommended in different blocks considering the above criteria is as under (Table 4.1).

Table 4.1: The number of additional shallow tube wells

Sl. No.	Block	District	No of additional shallow tube wells Recommended (allowing stage of development upto 70%)
1	Ara	Bhojpur	49
2	Barhara	Bhojpur	749
3	Behea	Bhojpur	35
4	Koilbar	Bhojpur	0
5	Shahpur	Bhojpur	21
6	Udwantnagar	Bhojpur	612
7	Brahampur	Buxar	346
8	Chakki	Buxar	0
9	Dumraon	Buxar	964
10	Simari	Buxar	198



4.2 Static resource and extraction from unconfined aquifer as well as in/deeper aquifers

In the present exercise, attempt has been made to estimate the availability of the total ground water resource in the aquifers. In order to estimate the total availability of groundwater resource, a generalized 3 D disposition of the aquifer has been made using Visual Modflow Flex package. To prepare the 3 D disposition of the aquifers, a number of lithological logs available for the study area have been considered along with the results of the geophysical investigations made in the area. The generalized 3 D disposition of the aquifer represents the Principal aquifer groups. A number of minor layers/clay intercalations recorded in the individual lithological logs have been subsumed into the dominant lithological layers immediately overlying/underlying it.

The availability of the total ground water resource in Aquifer I considering an average specific yield of 4% has been worked out as 3708 MCM. Thus it can be surmised that the area is blessed with significant groundwater reserves which can be harnessed during the lean seasons. The distribution of the total groundwater resource has been apportioned Block wise considering the variation in the thickness of the Aquifer I in different Blocks. The Block wise estimated total resource in Aquifer I is as under (Table 4.2).

Table 4.2 Block wise estimated total resource in Aquifer I

Block	Total Area (in Sq. Km.)	Average Thickness of aquifer in each Block	Total available Ground Water resource Aquifer I (MCM)
Buxar	181	42	304
Simri	161	42	271
Ara	165	48	317
Bihiya	142	50	284
Koilwar	186	48	357
Chakki	70	62	174
Brahampur	286	62	703
Shahpur	181	62	449
Barhara	237	50	474
Udwanagar	208	45	375

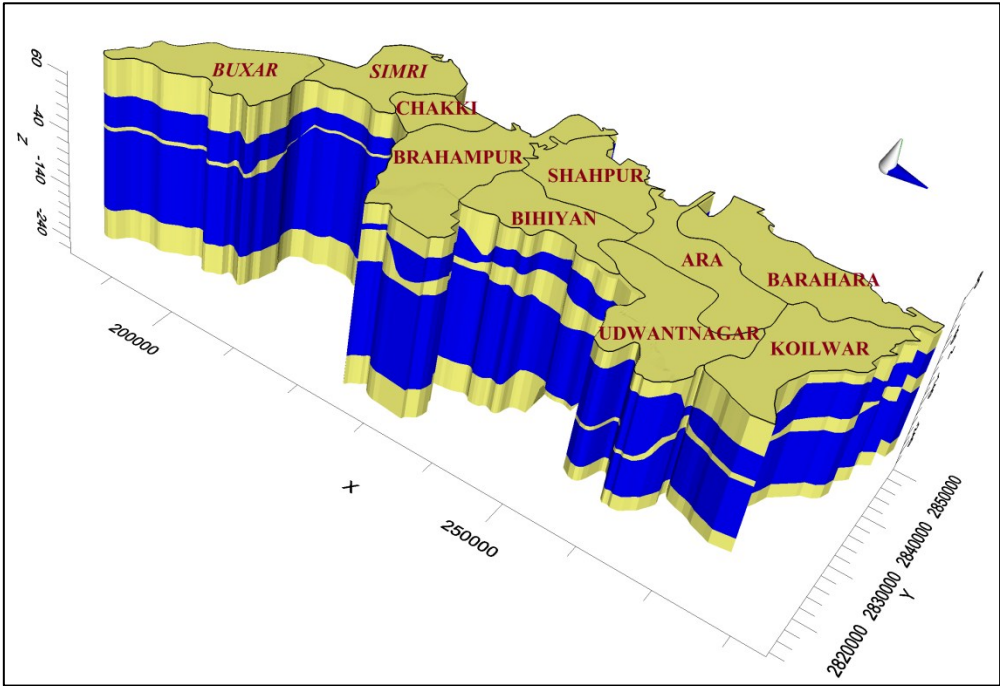


Fig. 4.1 3 D disposition of the aquifer

CHAPTER-V GROUND WATER RELATED ISSUES

5.1 Identification of issues

The most important groundwater issue in the study area is the arsenic contamination of groundwater affecting the upper part of the 1st aquifer. Detailed investigations carried out by CGWB have established that the 2nd aquifer occurring below the 1st aquifer and separated from it by an aquitard layer is free from arsenic contamination. The distribution of some of the affected villages in the study area is shown in Fig ---

5.2 Major Ground Water Issues:

- Arsenic contamination affecting the 1st aquifer
- Contamination levels locally reaching upto 1400 ppb
- Large population living in the affected villages (7.68 lakhs in 273 arsenic affected villages in Bhojpur and Buxar districts)

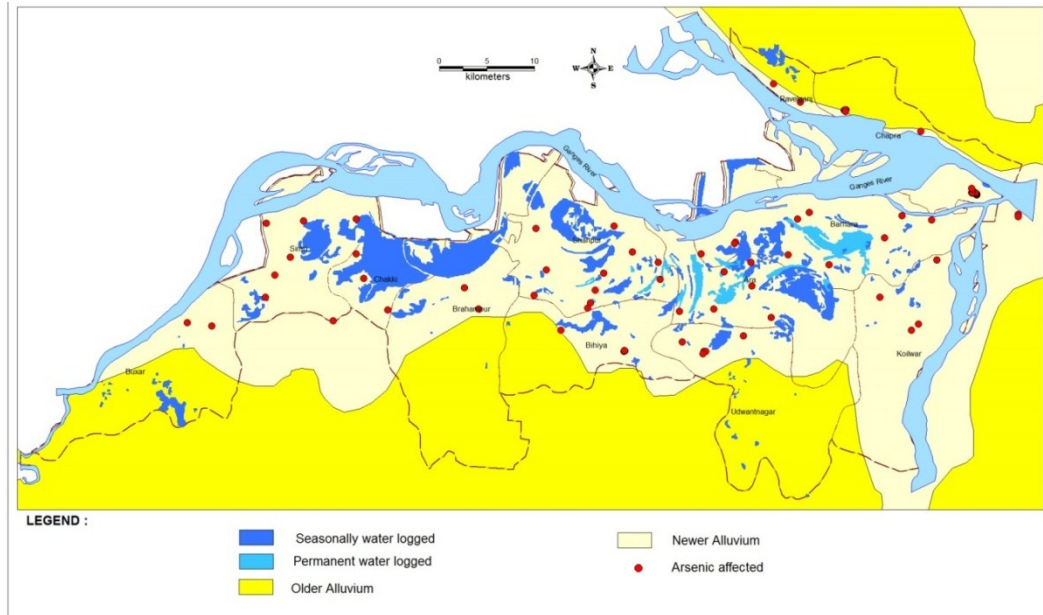


Fig. 5.1 Arsenic affected villages in the study area.



CHAPTER-VI MANAGEMENT STRATEGIES

In order to address the problem of groundwater contamination in the affected area and to ensure safe water supply in the affected villages, it is important to prepare the groundwater development plan from the 2nd aquifer which has been found as arsenic safe considering the aquifer characteristics so as to ward off any possible threats of cross-contamination of the 2nd aquifer from the 1st aquifer through vertical leakage. A distance- drawdown analysis has been carried out for preparing the development plan for the 2nd aquifer.

6.1 Distance- Drawdown Modeling of the 2nd aquifer

Central Ground Water Board has carried out exploratory drilling to delineate the arsenic safe deeper aquifers in the study area. The exploratory drilling has confirmed the presence of potential deeper aquifer system in the study area characterised by very low arsenic concentration and has been found safe for drinking uses. Using the field determined aquifer parameters, an attempt has been made to determine the spacing criteria for community water supply wells in the arsenic affected areas. The aquifer parameters of the following 6 locations have been considered in the analysis. The drawdown at the end of a day's pumping at various distances (r) for discharge of 250m³/hr and 50 m³/hr are shown in the table 6.1.

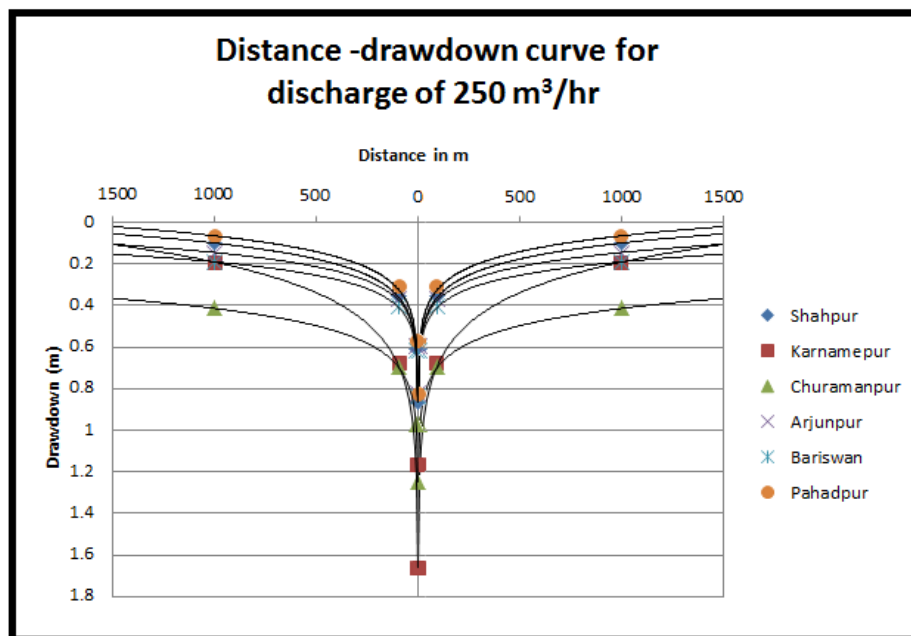
Table 6.1 Analysed well with aquifer parameters.

Location	T	S	r (m)	Drawdown (250 m ³ /hr)	Drawdown (50 m ³ /hr)
Shahpur	8552	0.004	1	0.87	0.17
			10	0.61	0.12
			100	0.35	0.07
			1000	0.10	0.02
Karnamepur	4461	0.00198	1	1.66	0.33
			10	1.17	0.23
			100	0.68	0.14
			1000	0.20	0.04
Churamanpur	7884	1.85E-05	1	1.25	0.25
			10	0.97	0.19
			100	0.69	0.14
			1000	0.41	0.08
Arjunpur	9690	0.0011	1	0.83	0.17

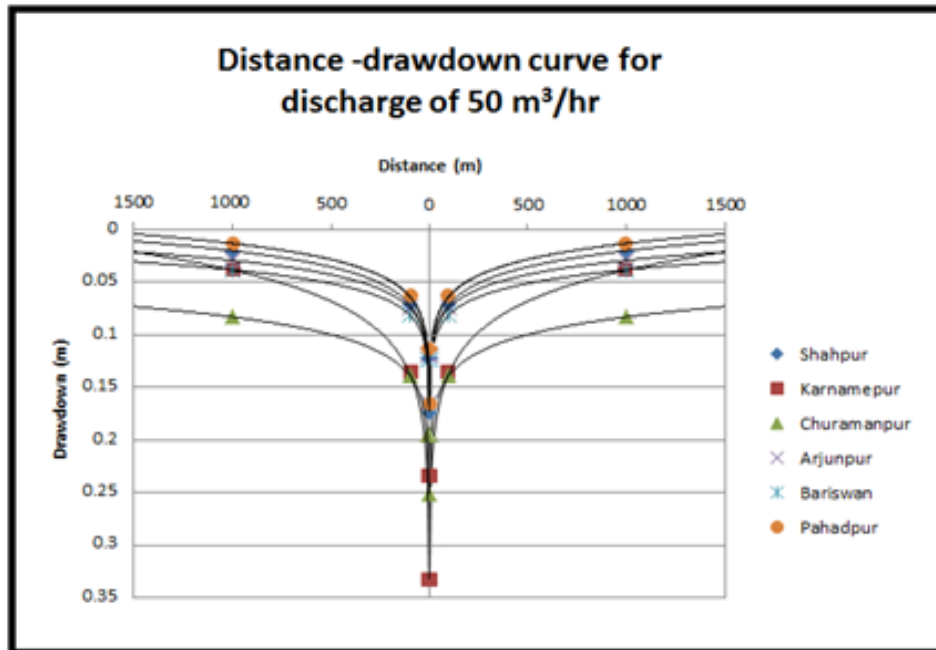


			10	0.60	0.12
			100	0.37	0.07
			1000	0.15	0.03
Bariswan	10239	0.0004	1	0.83	0.17
			10	0.62	0.12
			100	0.41	0.08
			1000	0.19	0.04
Pahadpur	8553	0.00749	1	0.83	0.17
			10	0.57	0.11
			100	0.31	0.06
			1000	0.07	0.01

The shape of the cone of the depression formed ignoring the well loss component is shown in the following figures (Fig 6.1a & b). Considering a drawdown of 5 cm as acceptable, it is recommended to design the water supply schemes tapping the deeper aquifers for a maximum discharge of 50 m³/hr with a minimum of 2 Km as spacing between the two adjacent water supply schemes.



(a)



(b)

Fig 6.1a & b: The shape of the cone of the depression formed ignoring the well loss component

6.2 Proposed Design of Arsenic Free Wells

Development of the deeper aquifers should be made through properly designed wells which must be sealed from the overlying contaminated aquifers through cement sealing. The cement sealing is applied to a suitably thick intervening clay layer separating the arsenic contaminated aquifer from arsenic free aquifer. This cement seal prevents seeping of contaminated water through the annular space which is filled with gravels. A schematic design is presented as under.

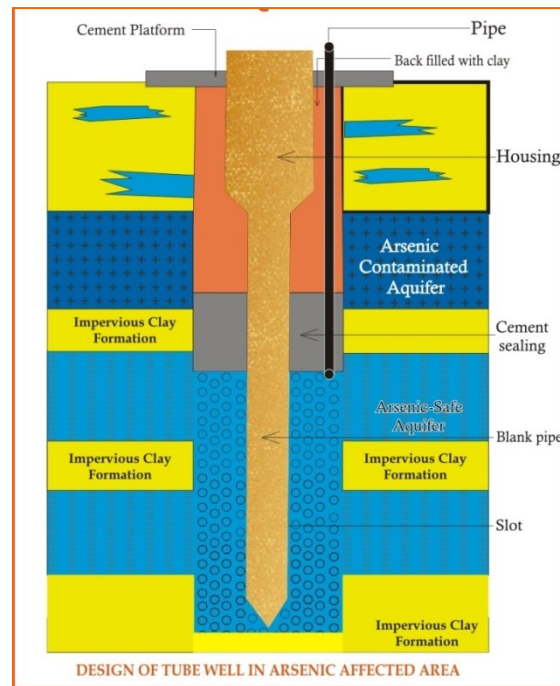


Fig 6.2 Schematic design of tube well with cement seal for arsenic affected area.

6.3 Implementation plan and recommendation

The most important groundwater issue in the study area is the arsenic contamination of groundwater reported from the 12 Blocks affecting the upper part of the 1st aquifer. Detailed investigations carried out by CGWB have established that the 2nd aquifer occurring below the 1st aquifer and separated from it by an aquitard layer is free from arsenic contamination. However, the most important management challenge in the area lies in protecting the deeper aquifers from the threats of cross-contamination. At the present level of our understanding of the arsenic contamination, prediction of the future arsenic concentrations is not possible. Studies have also cautioned over the development of the deeper aquifers. To arrive at a sustainable development strategy for the deeper aquifers in the arsenic affected areas, a distance-drawdown analysis for varying pumping rates has been attempted for the deeper aquifers in the affected areas on the basis of the aquifer parameters of the 2nd aquifer. From the analysis it has been observed that in order to minimize the effects of well interference, water supply schemes in the affected Blocks should be designed for a maximum discharge of 50m³/hr only and the radial distance between two pumping schemes



should be kept at a minimum of 1Km. On this basis, the number of schemes recommended for each of the 12 Blocks is as under (Table 6.2).

Table 6.2 The number of schemes recommended for each of the 12 Blocks.

Sl No	Block	Total Area in Sq.Km	Total Population of the affected villages (as per 2011 census)	No. of schemes required to meet the existing domestic water requirement @40 lpcd
1.	Buxar	181	38359	4
2.	Simri	161	187792	19
3.	Ara	165	9614	1
4.	Bihiya	142	21991	2
5.	Koilwar	186	12648	1
6.	Chapra	201	39471	4
7.	Ravelganj	74	14150	1
8.	Chakki	70	16563	2
9.	Brahampur	286	95407	10
10.	Shahpur	181	117628	12
11.	Barhara	237	199840	20
12.	Udwantnagar	208	15379	2
Total Population			768842	77

Groundwater in the dug well zone has been found to contain low arsenic load and considering the 50 ppb as the limit, they have been found as safe in the study area. However, owing to the prevalence of the handpumps and the ease of drawing water from it, dugwells are sparingly being used. The other concern with the dug wells is the faecal contamination resulting in high bacteriological load. However, if the existing dug wells are revived and care is taken to protect them from sewage contamination, the dugwells can be an alternative source of water supply. The UNICEF model of converting the dugwells into sanitary wells is also recommended.

A detailed study involving experts from agriculture, soil science, agronomy, chemistry and hydrogeology is required to assess the impact of the use of the arsenic contaminated groundwater for irrigation.

Industrial demand for groundwater is on the rise as a number of water intensive industries are steadily coming up in the area. It is recommended that extraction for industrial uses should be allowed only from the aquifer I and in no case from the aquifer II.



For three of the district towns where there is concentrated withdrawal of groundwater, it is recommended to adopt rainwater harvesting in 5% of the built up area. The harvested rainwater should be used for recharging the 2nd Aquifer (deeper aquifer) through recharge pit with a recharge well.

For the 1st Aquifer which is arsenic contaminated in its uppermost part, it is recommended to implement the use of solar photovoltaic groundwater pumping system with grounded tank for water storage developed for eastern India by the ICAR Research Complex for Eastern Region, Patna (Rahman and Bhatt, 2015). This technique has several advantages and the occurrence of shallow water level condition in the study area makes it more relevant. In addition to reduction in reliance on the fossil fuels for groundwater pumpage, this model may also be tested for the reduction in the arsenic load upon surface storage before being fed for irrigation.



Water level monitoring stations

NAQUIM PHASE 1 - MONITORING WELLS															
S. No.	Village	Block	Block wise no. of wells	District	Long	Lat	Dia (m)	M.P. (m)	Depth of Well (mbgl)	Water Level May 2014 (mbmp)	WL MAY 2015 (mbgl)	WL AUG 2015 (mbgl)	WL NOV 2015 (mbgl)	WL Jan 2015 (mbgl)	WL Jan 2016 (mbgl)
1	Dulapur kosik	Ara	9	Bhojpur	84.6111	25.5761	2.34	0.42	7.72	7	6.1	4.64	3.42	3.74	3.9
2	Jarawarpur Milki	Ara		Bhojpur	84.5339	25.6008	2.34	0.54	5.4	5.76	5.12	4.3	3.66	4.13	5.5
3	Belghat	Ara		Bhojpur	84.5922	25.6011	2.1	1.23	5.63	6.4	6.15	3.97	3.6	3.97	4.9
4	Birampur	Ara		Bhojpur	84.7247	25.6033	1.54	0.64	7.49	7.56	7.33	5.12	7.36	8	8
5	Keshopur Bintoli	Ara		Bhojpur	84.7225	25.6653	1.85	0.52	8.88	8.7	8.22	5.48	7.34	7.53	7.7
6	Barhara	Ara		Bhojpur	84.7286	25.6828	1.8	0.45	9.82	9.4	8.9	5.71	8.53	9.51	9.51
7	Farhda	Ara		Bhojpur	84.6556	25.6817	1.82	0.52	7.75	7.55	6.74	4.23	6.21	6.78	6.78
8	Sobhi Dumra	Ara		Bhojpur	84.5783	25.5928	1.92	0.77	5.43	5.3	4.23	2.48	3.68	4.2	3
9	Abhula tola	Ara		Bhojpur	84.6064	25.6561	1.87	0.6	6.55	5.02	4.26	2.65	3.97	4.4	3.52
10	Jagatpur	Barhara	4	Bhojpur	84.5981	25.6747	3.44	1.04	8.48	8.2	7.16	4.53	6.18	6.74	6.68
11	Balua	Barhara		Bhojpur	84.5564	25.6569	2.1	0.6	9.55	9.5	9.05	5.65	8.58	9.2	9.2
12	Ekauna	Barhara		Bhojpur	84.7389	25.6863	1.90	0.82	11.15	10.47	6.81	6.18	8.7	7.61	7.61
13	Dhusaria	Barhara		Bhojpur	84.7735	25.6714	2.13	0.97	8.41	8.37	7.48	5.33	6.9	7.41	7.41
14	Bara	Bihia	3	Bhojpur	84.4783	25.6175	2.1	0.6	8.5	7.17	6.45	4.85	5.61	7.06	6
15	Itwa	Bihia		Bhojpur	84.3828	25.6008	1.44	0.3	11.1	6.97	6.2	4.93	5.68	6.8	6.05
16	Majhaoli	Bihia		Bhojpur	84.4286	25.5539	1.87	0.26	7.79	7.05	6.54	4.79	5.57	6.19	5.9
17	Nainijore	Brahampur	9	Buxar	84.3461	25.7042	2.25	0.82	9.88	9.7	9.18	7.61	8.83	9.38	9.23



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18	Dhabi	Brahampur		Buxar	84.3642	25.7303	2.32	0.2	12.1	11.78	11.75	9.42	10.05	11.34	10.41
19	Jogiya	Brahampur		Buxar	84.2495	25.6048	2.02	0.52	6.98	5.25	6.58	5.95	6.61	7.68	7.2
20	Maharajganj	Brahampur		Buxar	84.3425	25.6092	2.48	0.6	10.73	5.4	4.95	6.25	8.2	9.9	9.9
21	Bagen Bazar	Brahampur		Buxar	84.2928	25.5011	1.6	1.36	6.24	6.08	6.22	4.74	7.59	8.79	8.79
22	Kochariwan tola	Brahampur		Buxar	84.2736	25.5231	1.92	0.36	7.01	4.89	7.02	5.6	7.37	7.01	7.37
23	Jugia Derra	Brahampur		Buxar	84.2553	25.5931	1.8	0.5	6.95	6.7	7.1	5.23	7.72	8.08	8.08
24	Hathilpur	Brahampur		Buxar	84.3186	25.6317	2.2	0.95	8.19	5.82	6.05	4.32	7	7.41	7.83
25	Karnaipur Bazar	Brahampur		Buxar	84.3611	25.6672	2.43	0.81	6.99	6.31	6.09	5.19	4.94	6.49	6.49
26	Thoda gaon	Buxar	15	Buxar	83.9469	25.5543	1.93	0.25	10.496	6.78	6.78	10.486	10.75	Well filled	Well filled
27	Kritpura	Buxar		Buxar	83.9416	25.5486	2.4	0.87	15.24	9.60	10.93	4.6	6.46	8.78	8.78
28	Laxmipur	Buxar		Buxar	83.9367	25.5466	2.02	0.38	10.22	7.06	7.56	3.82	5.44	6.62	6.2
29	Dani Kutia, Kamarpur	Buxar		Buxar	83.9319	25.5467	1.75	1.05	9.55	8.52	8.52	5.37	5.55	6.4	6.4
30	Kamarpur	Buxar		Buxar	83.9327	25.5378	2.4	1.12	8.1	8.97	7.98	5.13	5.42	6.43	6.35
31	Mishrvalia	Buxar		Buxar	83.9146	25.5340	1.81	0.80	10.1	7.76	8.67	2.23	3.35	4.85	4.85
32	Ahirauli	Buxar		Buxar	84.0025	25.5927	1.82	0.54	13.16	10.92	11.15	6.95	7.61	8.91	8.25
33	Churamanpur	Buxar		Buxar	84.0260	25.5872	2.52	0.45	8.01	7.10	7.55	3.55	6.4	7.75	7.96
34	Arjunpur	Buxar		Buxar	84.0192	25.5996	2.57	1.30	8.36	8.32	7.84	6.35	7.2	8.59	8.21
35	Sherpur	Buxar		Buxar	84.0334	25.5957	1.88	1.15	7.4	6.88	4.78	2.98	4.45	5.83	5.82
36	Ramobariya	Buxar		Buxar	84.0535	25.6063	2.10	1.43	8.37	8.30	7.97	6.73	7.42	7.05	7.05
37	Manjhariya	Buxar		Buxar	84.0479	25.6082	2.42	0.75	9.5	7.70	7.47	7.35	8.35	9.4	8.6
38	Dahibar	Buxar		Buxar	84.0549	25.5980	2.40	0.53	5.87	5.85	5.37	4.68	5.82	6.47	6.1
39	Dudharchak	Buxar		Buxar	84.0558	25.6151	2.35	1.47	8.23	9.25	8.23	7.73	7.53	8.21	9.7
40	Dullapur	Buxar		Buxar	84.0877	25.6249	2.37	1.00	7.05	6.68	6.33	5.71	6.52	7.7	8
41	Chanda	Chakki	2	Buxar	84.2347	25.6046	1.88	0.38	6.66	4.83	5.11	4.82	5.62	6.87	6.4
42	Henwan	Chakki		Buxar	84.2271	25.6044	1.48	0.52	8.86	5.72	7.05	6.63	5.93	7.58	7.1
43	Sakkadi	Koilwar	11	Bhojp	84.7564	25.5756	3.24	0.32	10.56	5.27	5.36	3.12	4.48	4.93	4.93



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44	Lodhipur	Koilwar		Bhojp	84.7349	25.5106	1.84	0.82	8.66	8.84	6.48	6.18	7.98	8.4	8.4
45	Jogta	Koilwar		Bhojp	84.7093	25.4869	1.26	0.42	9.41	6.1	8.14	7.68	8.58	9.37	9.45
46	Giddha	Koilwar		Bhojpur	84.7470	25.5868	1.22	0.80	6.43	6.86	6.42	6.26	7.22	6.4	7.23
47	Mokhlisa	Koilwar		Bhojpur	84.7497	25.6035	2.60	0.32	7.6	7.23	7.03	6.48	7.92	7.58	7.9
48	Songhata	Koilwar		Bhojpur	84.7634	25.6099	1.90	0.80	7.53	7.63	7.17	7.52	8.33	7.53	8.33
49	Dharampar	Koilwar		Bhojpur	84.7758	25.6221	1.18	0.50	7.86	6.82	7.40	6.3	6.65	5.74	6.89
50	Pachrukhiya	Koilwar		Bhojpur	84.7874	25.6423	1.86	0.67	7.95	7.74	7.51	5.73	7.23	8.5	8.5
51	Rajapur Bazar	Koilwar		Bhojpur	84.7859	25.6435	1.80	0.50	7.87	7.53	7.5	6.5	7.25	7.86	8.37
52	Inglishpur	Koilwar		Bhojpur	84.7835	25.6456	1.90	1.10	7.92	7.74	7	5.8	6.9	7.3	7.3
53	Muhammadpur (new)	Koilwar		Bhojpur	84.7877	25.6149	1.68	0.40	7.3	7.22	7.4	6.65	7.7	7.3	7.7
54	Barsaun	Shahpur	4	Bhojpur	84.4392	25.6283	2.2	1.02	8.31	7.65	6.15	7	3.26	4.67	5
55	Bharauli	Shahpur		Bhojpur	84.3736	25.6342	2.3	0.3	7.02	7.08	6.57	6.95	5.28	6.53	6.15
56	Jhua	Shahpur		Bhojpur	84.3611	25.6672	2.43	0.81	6.99	7.12	5.09	5.19	4.94	6.16	6.49
57	Balihar	Shahpur		Bhojpur	84.5133	25.6294	2.75	0.41	7.77	7.32	6.57	5	5.24	5.94	5.84
58	Manikpur	Simri	11	Buxar	84.0937	25.6279	1.98	0.68	7.86	8.23	10.22	5.78	8.8	7.85	9.65
59	Chotka Rajpur	Simri		Buxar	84.0930	25.6726	2.50	0.00	11.45	9.40	10.5	5.5	8.8	10.25	9.65
60	Barka Rajpur	Simri		Buxar	84.1087	25.6719	2.37	0.65	9.7	9.12	9.85	6.06	7.18	9.48	9.46
61	Shivnath Ka Dera, Neazipur	Simri		Buxar	84.1294	25.6847	2.43	1.27	9.5	7.04	9.23	6	7.18	7.98	8.8
62	Neazipur	Simri		Buxar	84.1402	25.6812	1.76	0.80	8.98	7.85	7.7	5.84	7.61	7.63	7.24
63	Sohiar	Simri		Buxar	84.1527	25.6775	2.64	1.08	8.21	8.20	7.45	5.18	6.89	7.83	7.32
64	Dubauli	Simri		Buxar	84.1575	25.6619	2.32	0.78	8.62	7.62	7.94	5.5	7.07	7.87	7.32
65	Kharathar	Simri		Buxar	84.1776	25.6582	2.90	0.88	8.22	7.65	7.62	4.82	6.91	7.5	7.23
66	Dumri	Simri		Buxar	84.1841	25.6515	2.32	1.15	8.31	7.00	5.65	3.35	4.57	5.03	4.8
67	Durasan	Simri		Buxar	84.1830	25.6340	1.66	1.38	6.33	5.23	5.42	5.34	5.55	6.79	7.22
68	Harnath Kundi	Simri		Buxar	84.1735	25.6094	1.87	0.95	7.29	7.15	7.21	1.48	4.37	4.38	4.9



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69	Sasaram (Chota)	Udwananagar	6	Bhojp	84.5727	25.5725	2.42	0.43	7.04	5.03	4.35	4	4.89	4.03	5.16
70	Belaur	Udwananagar		Bhojp	84.5253	25.5697	1.93	0.54	5.53	5.3	4.76	3.89	4.89	5.81	5.16
71	Kasap	Udwananagar		Bhojp	84.6436	25.5199	1.54	0.97	7.76	4.21	2.03	0.14	2.58	2.56	2.95
72	Pianniya	Udwananagar		Bhojp	84.6428	25.4509	1.62	0.51	8.99	3.97	4.59	0.38	2.64	3.08	2.56
73		Udwananagar		Bhojp	84.6085	25.4781	2.21	0.58	8.85	3.04	2.42	1.1	2.58	3.15	2.95
74		Udwananagar		Bhojp	84.6533	25.4952	1.96	0.5	9.1	6.38	7.26	2.19	4.5	5.19	4.89



Annexure-II

Chemical analysis of groundwater sample of the study area.

NAM PHASE 1 ALL CHEMICAL RESULTS - Basic Parameters																				
S. No.	Village	Block	Long	Lat	pH	EC	CO ₃ --	HCO ₃ -	Cl ⁻	F	SO ₄ ²⁻	NO ₃ ⁻	TH	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	PO ₄	SiO ₂	TDS
1	Bara	Shahpur	84.4783	25.6175	7.7	1298	nil	378	213	0.7	40	55	470	108	48	94	18	nd	32	844
2	Barsaun	Shahpur	84.4392	25.6283	8	354	nil	183	7	0.6	20	0.8	120	16	19	28	3.7	nd	19	230
3	Bharauli	Shahpur	84.3736	25.6342	8	489	nil	305	14	0.5	10	3	220	44	26	47	7.7	nd	31	318
4	Itwa	Bihia	84.3828	25.6008	8	428	nil	256	14	0.6	nd	nd	150	48	7.2	36	1.4	nd	17	278
5	Shapur patti	Shahpur	84.4089	25.5986	7.6	610	nil	354	43	0.5	10	7	140	36	12	103	0.61	nd	15	397
6	Bihia (Dogra)	Bihia	84.4706	25.5842	8	1608	nil	476	362	0.5	nd	24	470	72	70	213	19	nd	16	1045
7	Philingi Jamua	Bihia	84.4442	25.5647	7.8	441	nil	146	57	0.6	nd	32	165	40	16	30	0.62	nd	26	287
8	Chakwan	Bihia	84.4258	25.5206	8	523	nil	220	53	0.8	nd	30	170	40	17	31	32	nd	29	340
9	Shobatola	Bihia	84.4461	25.5283	7.8	315	nil	201	14	0.7	nd	6.1	165	32	20	12	0.51	nd	21	205
10	Majhaoli	Bihia	84.4286	25.5539	7.8	350	nil	220	28	0.5	nd	2.8	160	52	7.2	19	3	nd	17	228
11	Jataopur	Bihia	84.3925	25.5372	7.9	665	nil	390	35	0.7	10	22	310	40	50	42	0.77	nd	16	432
12	Maharajanj	Brahampur	84.3425	25.6092	8	2077	nil	366	525	0.6	50	54	460	108	46	310	4.84	nd	22	1350



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13	Ragunathpur	Brahampur	84.3069	25.5608	7.6	548	nil	274	42	0.6	nd	12	210	64	12	39	0.9	nd	29	356
14	Bagen Bazar	Brahampur	84.2928	25.5011	7.9	453	nil	281	28	0.5	nd	3.1	210	64	12	29	1.8	nd	24	294
15	Khochariwan tola	Brahampur	84.2736	25.5231	7.8	397	nil	220	14	0.7	20	6.3	170	44	14	26	1.1	nd	20	258
16	Jugia Derra	Brahampur	84.2553	25.5931	7.7	390	nil	207	14	0.5	nd	1.8	135	60	8.4	25	1	nd	17	254
17	Hathilpur	Brahampur	84.3186	25.6317	7.9	302	nil	122	14	0.6	nd	30	120	36	7.2	11	3.3	nd	28	196
18	Dhanupra	Ara	84.6992	25.5764	6.9	416	nil	226	14	0.3	0	nd	160	48	9.6	19	1	nd	27	270
19	Chndwa	Udwantnagar	84.6372	25.5603	7.2	458	nil	293	14	0.1	nd	nd	205	28	41	27	1.2	nd	16	298
20	Dulapur kosik	Udwantnagar	84.6111	25.5761	7.7	402	nil	262	14	nd	nd	0.79	175	44	16	26	3.2	nd	22	261
21	Jarawarpur Milki	Ara	84.5339	25.6008	7.5	500	nil	281	28	nd	nd	1.3	210	64	12	27	2.5	nd	15	325
22	Belghat	Ara	84.5922	25.6011	7.9	543	nil	287	43	1.5	nd	0.89	210	64	12	37	4.5	nd	16	353
23	Birampur	Koilwar	84.7247	25.6033	8	3644	nil	573	950	0.1	250	55	835	112	133	575	23	nd	16	2369
24	Birampur	Koilwar	84.7247	25.6033	8	561	nil	244	14	0.1	nd	53	220	68	12	20	2.5	nd	17	365
25	Keshopur Bintoli	Barhara	84.7225	25.6653	7.7	441	nil	354	14	0.2	nd	12	215	52	20	25	2.7	nd	25	287
26	Barahara	Barhara	84.7286	25.6828	7.6	773	nil	415	14	nd	40	0.99	265	80	16	52	19	nd	15	502
27	Bakharapur	Barhara	84.6928	25.6681	7.4	300	nil	171	14	0.2	nd	nd	135	32	13	10	4.3	nd	17	195
28	Farhda	Barhara	84.6556	25.6817	7	330	nil	183	25	0.1	nd	nd	160	48	9.6	11	3.5	nd	15	215
29	SobhiDumra	Ara	84.6617	25.5928	7.9	361	nil	232	14	0.1	nd	nd	150	40	12	26	2.2	nd	18	235



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30	Bahmangawan	Barhara	84.6064	25.6561	8	250	nil	146	21	0.3	nd	nd	115	28	11	14	2.7	nd	26	163
31	Abhulaltola	Barhara	84.6064	25.6561	8	536	nil	329	14	0.5	nd	1.4	230	68	14	27	1.8	nd	19	348
32	Jagatpur	Barhara	84.5981	25.6747	8	400	nil	244	21	0.4	10	1.1	165	36	18	36	1.5	nd	32	260
33	Balua	Barhara	84.5564	25.6569	7.9	532	nil	360	21	0.5	nd	nd	270	44	38	24	3	nd	16	346
34	Jhua	Shahpur	84.5133	25.6294	7.8	316	nil	201	14	0.6	nd	nd	150	44	9.6	15	2	nd	23	205
35	Sakkadi	Koilwar	84.7564	25.5756	7.5	1290	nil	573	78	0	107	84	420	108	36	88	117	nd	50	839
36	Lodhipur	Koilwar	84.7349	25.5106	7.6	2480	nil	732	383	0.3	222	17	720	188	61	271	61	0.14	53	1612
37	Jogta	Koilwar	84.7093	25.4869	7.7	1360	nil	573	780	0.4	190	16	330	52	49	211	3	nd	27	884
38	Nasratpur	Koilwar	84.7504	25.4516	7.7	1690	nil	598	156	0.1	34	213	420	100	41	228	2	nd	35	1099
39	Pinniya	Udwantnagar	84.6533	25.4952	7.9	1590	nil	781	50	0.6	185	19	240	36	36	309	8	nd	32	1034
40	Belaur	Udwantnagar	84.6428	25.4509	7.4	1650	nil	781	99	0.5	63	2	450	48	80	181	5	nd	34	1073
41	Pauna	Udwantnagar	84.6288	25.4065	7.6	800	nil	366	57	0.5	25	13	290	56	36	59	1	nd	27	520
42	Nadhi	Udwantnagar	84.6528	25.3169	7.6	2300	nil	781	255	0.1	113	88	420	96	44	228	215	nd	29	1495
43	Ekauna	Udwantnagar	84.6436	25.5199	7.7	2471	nil	817	298	0.4	140	30	480	44	90	298	105	nd	33	1606
44	Udwantnagar	Udwantnagar	84.6252	25.5001	7.5	750	nil	415	36	0.4	34	8	250	60	24	73	19	nd	31	488
45	Kasap	Udwantnagar	84.6085	25.4781	7.8	850	nil	451	28	0.7	73	3	350	48	56	63	3	nd	21	553
46	Harnath kundi	Udwantnagar	84.5727	25.5725	7.7	2280	nil	647	255	0.2	288	81	610	52	117	249	83	nd	19	1482



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47	Sasaram	Udwantnagar	84.5253	25.5697	7.6	1610	nil	610	128	0.3	134	24	560	128	58	89	69	0.02	54	1047
48	Koilwar	Koilwar	84.7564	25.5756	7.6	1088	0	403	71	0.1	65.4	41.1	175	30	24	55	130	0.85	13.4	707
49	Koilwar	Koilwar	84.7349	25.5106	8.5	481	6	92	43	0.6	39.5	39.6	110	24	12	45	0	nd	8.6	313
50	Nasratpur	Koilwar	84.7504	25.4516	8.4	515	3	128	39	0.2	34.2	41.1	125	22	16.8	52	0	nd	9.5	335
51	Udwantnagar	Udwantnagar	84.6252	25.5001	8.7	618	12	317	21	0	9.9	2	165	6	36	58	3.64	0.39	7.9	402
52	Kasap	Udwantnagar	84.6085	25.4781	8.9	528	15	246	11	0.5	9.6	5.3	130	8	26.4	55	3.52	0.16	8.7	343
53	Udwantnagar	Udwantnagar	84.6333	25.5500	8.5	345	9	163	14	0.5	8.8	2.1	95	20	10.8	35	3.8	0.61	10.9	224
54	Shahpur	Shahpur	84.4783	25.6175	7.6	852	0	366	64	0.1	37	0	315	26	60	46	6.9	nd	4.7	554
55	Shahpur	Shahpur	84.4392	25.6283	8.4	180	9	104	11	0.4	8	0	100	24	9.6	10	5.3	nd	3.5	117
56	Bihia	Bihia	84.3736	25.6342	8.6	389	15	116	32	0.2	13.7	0	80	14	10.8	41	5.4	nd	7.3	253
57	Brahampur	Brahampur	84.4286	25.5539	8.5	186	12	96	18	0.1	6.3	0.67	75	20	6	22	4	nd	8.4	121
58	Brahampur	Brahampur	84.3069	25.5608	8.3	394	3	153	28	0.7	8.3	18.4	100	26	8.4	38	3.5	0.43	7.5	256
59	Brahampur	Brahampur	84.2928	25.5011	8.6	356	12	153	14	1.1	5.7	3.6	75	8	13.2	38	3.8	1.51	7.9	231
60	Brahampur	Brahampur	84.2736	25.5231	7.9	801	0	275	78	0.9	37.8	37.1	285	48	39.6	39	8.7	1.57	6.1	521
61	Dulapur Kosik	Udwantnagar	84.6111	25.5761	8.4	936	9	153	96	0.6	67.5	41.7	170	26	25.2	56	75	0.94	4.2	608
62	Jarwarpur Milki	Ara	84.5339	25.6008	7.9	545	0	244	50	0.3	4	6	250	60	24	11	4	0.2	11	354
63	Belghat	Ara	84.5922	25.6011	8	527	0	256	25	0	18.4	0.45	180	36	21.6	35	4.8	0.77	5.3	343



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64	Keshopur Bintoli	Barhara	84.7225	25.6653	8.6	310	12	116	32	0.7	10.8	0	135	14	24	14	4.6	0.82	4.6	202
65	Barhara	Barhara	84.7286	25.6828	7.4	911	0	323	64	0.1	62.8	20.7	325	60	42	47	8.1	0.44	3.7	592
66	Bokharapur	Barhara	84.6928	25.6681	7.4	450	0	183	46	0	3	2	165	16	30	18	10	0	5	293
67	Farhada	Barhara	84.6556	25.6817	8	437	0	232	18	0	7.7	0	180	56	9.6	14	6.7	0.72	3.6	284
68	Sobhi Dumra	Ara	84.6617	25.5928	7.8	609	0	311	32	0.3	4.8	0	215	56	18	39	4.9	1.02	4.5	396
69	Abhula Tola	Barhara	84.6064	25.6561	8.5	382	15	195	7	0.1	4.1	1.6	110	18	15.6	41	5.1	0.12	5.2	248
70	Jagatpur	Barhara	84.5981	25.6747	8.7	400	18	147	25	0.1	18.2	0	80	8	14.4	46	4.1	0.39	6	260
71	Balua	Barhara	84.5564	25.6569	8.5	342	12	37	56	0	26	2.9	95	18	12	24	8	0.45	4	222
72	Simariya	Barhara	84.7239	25.6724	8.6	381	36	116	32	0	2.6	0.3	145	22	22	24	3.9	nd	3.9	248
73	Ekauna	Barhara	84.7389	25.6863	8.8	309	21	140	11	0	1.3	1.7	120	18	18	19	3.9	nd	2.9	201
74	Dusaria	Barhara	84.7735	25.6714	8.49	765	9	177	99	0.4	69.9	19.5	200	20	36	83	9.5	nd	3.3	497
75	Barhara	Barhara	84.7228	25.6699	8.4	427	18	183	14	0.4	2.2	1.6	170	26	25	14	3.8	nd	4	278
76	Giddha	Koilwar	84.7470	25.5868	8.1	1495	0	177	117	0.2	135	209	265	44	37	117	62.8	nd	5.5	972
77	Mokhlisa	Koilwar	84.7497	25.6035	8.3	385	15	91.5	18	0.3	22.5	24.4	120	16	19	16	21.8	nd	3.8	250
78	Songhata	Koilwar	84.7634	25.6099	7.7	1969	0	427	227	0	154	85	620	126	73	118	0.0	nd	2.3	1280
79	Dharampur	Koilwar	84.7758	25.6221	7.8	1156	0	317	156	0	97.9	2.05	245	18	48	84	116.0	nd	4.5	751
80	Bamnauli	Koilwar	84.7819	25.6317	7.8	703	0	244	25	0.9	44.3	87.2	300	58	37	17	0.0	nd	5	457



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81	Pachrukhiya	Koilwar	84.7874	25.6423	8.2	1102	0	494	67	0	54.3	2.8	410	72	55	58	3.8	0.18	4.4	716
82	Rajapur	Koilwar	84.7910	25.6445	8.5	550	18	104	50	0.5	43.9	17.6	110	18	16	27	59.7	nd	4.1	358
83	Rajapur bazar	Koilwar	84.7859	25.6435	8	510	0	48.8	35	0.8	15.5	180	215	52	20	18	0.0	nd	2.2	332
84	Inglisipur	Koilwar	84.7835	25.6456	7.6	1766	0	433	78	0.1	133	146	345	34	62	68	166.0	nd	5.4	1148
85	Harhangi tola	Koilwar	84.7929	25.6372	8.2	751	0	305	50	0	61.9	0	280	36	46	45	15.5	nd	5.1	488
86	Koilwar	Koilwar	84.7945	25.5798	7.9	636	0	183	67	0.4	19.9	0.73	190	60	10	32	2.3	nd	2.6	413
87	birampur	Koilwar	84.7247	25.6033	7.6	851	0	439	28	0.3	20.8	0.55	335	68	40	36	4.4	nd	3.7	553
88	Bhada	Brahampur	84.3022	25.4839	8.3	310	0	104	35	0.4	20.2	14.7	100	16	14	26	2.0	nd	5.5	202
89	Bararhi	Brahampur	84.3271	25.4739	8	586	0	348	11	0.1	10.9	4.4	105	12	18	89	1.1	nd	3.5	381
90	Jogiya	Brahampur	84.2495	25.6048	8.6	288	15	122	7	0.2	4.6	0	60	10	8	33	3.3	nd	5.6	187
91	Maharjganj	Brahampur	84.3425	25.6092	8.2	328	0	128	32	0.2	4.8	0.45	85	14	12	34	2.0	nd	5.7	213
92	Hatilpur	Brahampur	84.3186	25.6317	7.5	558	0	104	35	0	25.4	140	160	30	20	38	27.0	0	3.4	363
93	Chanda	Brahampur	84.2347	25.6046	8	941	0	244	131	0	67.2	11.9	165	16	30	116	37.7	0.08	0.56	612
94	Henwan	Brahampur	84.2271	25.6044	7.5	1219	0	604	14	0	82.2	102	200	10	42	216	7.8	nd	3.7	792
95	Kathar	Chakki	84.2152	25.5986	8	290	0	146	18	0	6.05	2.3	105	16	16	21	1.6	0.04	6.1	189
96	Balihar	Simri	84.0937	25.6279	8.3	336	0	153	28	0.2	3.5	0	55	10	7	47	8.8	0	2.7	218
97	Nagpura	Simri	84.0902	25.6443	7.8	350	0	85.4	82	0.4	23.7	1.1	60	14	6	66	4.3	0	3.4	228



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98	Kesopur	Simri	84.0850	25.6739	8.7	748	21	183	53	0.2	106	0	275	12	59	36	13.5	0	1.9	486
99	Manikpur	Simri	84.0930	25.6726	8.6	555	15	122	14	0	27.4	133	155	10	31	52	6.2	0	4.1	361
100	Chotka rajpur	Simri	84.1087	25.6719	8.5	600	12	146	89	0.1	65.7	0	150	10	30	81	6.4	0	2.7	390
101	Simri	Simri	84.1149	25.6447	8.1	861	0	390	21	0.3	58.1	19.3	200	42	23	95	12.8	2.13	1.4	560
102	Barka Rajpur	Simri	84.1291	25.6838	8.1	706	0	366	35	0.1	4.3	6.1	180	44	17	73	4.8	0	3.4	459
103	Shivnath ka dera	Simri	84.1402	25.6812	8.2	999	0	311	149	0.4	45.8	7.2	345	54	50	77	0.0	0	4.8	649
104	Neazipur	Simri	84.1527	25.6775	7.9	1424	0	342	209	0	106	7.8	475	70	72	93	7.2	0	3.05	926
105	Sohiar	Simri	84.1575	25.6619	8.1	1672	0	732	92	0.3	99.6	5.3	650	56	122	68	26.8	0	4.4	1087
106	Ekauna	Simri	84.1692	25.6595	7.9	1206	0	549	71	0.2	47.7	55.7	415	60	64	73	53.0	0	3.8	784
107	Dubauli	Simri	84.1776	25.6582	8.4	731	18	146	53	0.6	56.2	98.5	275	40	42	41	0.7	0	2.2	475
108	Kharathar	Chakki	84.1841	25.6515	8.3	643	0	42.7	117	0.4	40	86.6	160	24	24	71	0.2	0	3.7	418
109	Mehrauli	Chakki	84.1841	25.6433	8	1055	0	427	11	0.5	55.3	132	350	46	56	87	0.2	0	4.7	686
110	Dumri	Chakki	84.1830	25.6340	8.3	265	0	79.3	39	0.4	16.9	29.9	100	22	11	28	0.0	0	2.8	172
111	Durasan	Chakki	84.1748	25.6126	8.1	635	0	244	60	0	23.8	0	165	38	17	67	0.5	0	4	413
112	Durasan	Chakki	84.1735	25.6094	8.4	612	15	287	39	0.8	41.9	0	165	18	29	74	28.1	0	3.6	398
113	Kazipur	Chakki	84.1661	25.6159	7.6	1954	0	769	74	0	76.1	35.1	695	24	152	63	7.1	0	4	1270
114	Rampur	Simri	84.1577	25.5992	8.3	659	0	153	18	0.1	62.2	165	225	30	36	55	2.8	0	5.3	428



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115	Buxar	Buxar	83.9884	25.5698	8.6	268	18	110	14	0.8	6.5	0	70	16	7	34	1.0	0	5.6	174
116	Buxar	Buxar	83.9651	25.5545	8.4	833	27	275	14	0	40.5	86.3	265	26	48	63	2.8	0	4.5	541
117	Thoda gaon	Buxar	83.9487	25.5525	8.7	373	18	97.6	32	1.5	11.2	11.5	65	6	12	52	1.6	0	5.2	242
118	Thoda gaon	Buxar	83.9469	25.5543	8.7	409	36	122	18	0.3	11.9	10.3	90	20	10	52	2.3	0	5.8	266
119	Kritpur	Buxar	83.9416	25.5486	8.7	1696	39	555	124	1.1	132	78.1	260	12	55	287	10.4	0	5.1	1102
120	Laxmipur	Buxar	83.9367	25.5466	8.9	618	36	226	25	0.4	22.2	0	80	8	14	101	1.3	0	5.3	402
121	Dani kutia	Buxar	83.9319	25.5467	8.7	455	36	122	21	1	14.6	1.8	70	10	11	65	1.1	0	4.2	296
122	Kamarpur	Buxar	83.9327	25.5378	8.7	910	21	183	121	0.4	69.3	70.1	230	12	48	102	1.6	0	4.9	592
123	Mishrvillea	Buxar	83.9146	25.5340	7.7	2420	0	409	468	0.2	128	17	840	124	127	136	3.1	0	0.2	1573
124	Chausa	Buxar	83.9009	25.5159	8.1	3650	0	1556	82	2.5	168	49.9	895	26	199	238	158.0	0	6.1	2373
125	Chausa gaon	Buxar	83.8880	25.4858	8.4	1574	96	616	43	1	58.9	0	370	26	73	98	157.0	0	6.7	1023
126	Saranja	Buxar	83.8971	25.4473	8.8	483	18	183	25	0.5	17.8	17.3	190	10	40	21	0.1	0	5.3	314
127	Pandari	Buxar	84.0330	25.5822	8.8	1246	57	238	106	0.3	62.2	65.1	380	10	85	83	2.5	0	6.2	810
128	Ahirauli	Buxar	84.0025	25.5927	8.5	893	12	281	21	0.6	54.7	88.5	195	20	35	87	19.0	0	5.3	580
129	Churamanpur	Buxar	84.0260	25.5872	8.8	383	39	54.9	28	0	13.6	0	45	14	2	54	3.0	0	5	249
130	Arjunpur	Buxar	84.0192	25.5996	8.7	437	21	122	35	0.6	23	14.8	95	22	10	53	4.4	0	3.7	284
131	Sherpur	Buxar	84.0334	25.5957	8.7	449	21	153	18	0	23	21.6	110	10	20	51	3.4	0	2.4	292



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132	Garni	Buxar	84.0483	25.5989	8.8	328	24	85.4	43	0.7	10	0	125	14	22	24	2.7	0	2.7	213
133	Ramobariya	Simri	84.0535	25.6063	8.8	501	21	207	11	0	21	3.1	105	18	14	62	3.1	0	3	326
134	Manjhariya	Buxar	84.0479	25.6082	8.8	315	24	48.8	53	0.1	7.8	0	105	16	16	22	4.2	0	3.8	205
135	Dahibar	Simri	84.0549	25.5980	8.8	1250	30	604	14	2.2	60.7	45.9	355	6	82	118	31.0	0	3.4	813
136	Dudharchak	Simri	84.0558	25.6151	8.8	188	12	73.2	21	0	5.4	0	80	10	13	15	2.6	0	2.6	122
137	Sonbarsa	Simri	84.0753	25.6191	8.7	328	24	67.1	7	0.2	17	0	85	18	10	16	1.9	0	2.1	213
138	Barkagaon	Simri	84.0782	25.6259	8.6	177	12	42.7	7	0	5.6	0	35	12	1	16	2.6	0	3	115
139	Dullapur	Simri	84.0877	25.6249	8.7	390	36	122	11	0.5	5.3	0	120	18	18	25	3.1	0	5.5	254
140	Dalsagar	Buxar	84.0479	25.5795	8.6	796	27	97.6	106	0	51	0	70	12	10	113	4.8	0	4.8	517



Annexure-IIIa

Status of Groundwater As in the deep aquifers in Middle Ganga Plain (MGP)

Sl No	Location	Longitude	Latitude	Slot position	District	As
				(m bgl)		(μgL^{-1})
Bihar						
1	Nargada Narayanpur	84.4222	25.6067	136-142, 156-162, 179-188, 191-194, 205-208, 214-217, 222-228	Bhojpur	3
2	Karnamepur	84.3581	25.6542	136-142, 147-153, 161-167, 173-179, 187-199	Bhojpur	BDL
3	Shahpur	84.3987	25.5964	127-133, 139-145, 150-156, 169-175, 206-212	Bhojpur	BDL
4		-	-	38-44, 52-58, 86-92	Bhojpur	BDL
5		-	-	127-133, 139-145, 169-175, 206-212	Bhojpur	BDL
6	Bariswan	84.4359	25.6265	170-182, 191-197	Bhojpur	BDL
7		-	-	22-28, 37-43, 53-59	Bhojpur	7.0
8		-	-	94-106, 109-115, 128-140, 156-162, 169-181, 187-199	Bhojpur	BDL
9	Paharpur	84.4712	25.6494	140-146, 185-191, 199-205, 244-250	Bhojpur	BDL
10	Amrahi Nawada	84.5531	25.5441	124-129, 135-141, 166-170, 173-177, 181-187, 193-196	Bhojpur	BDL
11	Bharauli	84.3801	25.631	162-171, 174-180, 183-186, 189-196, 203-215	Bhojpur	5.0
12	Neazipur	84.1579	25.6666	150-156, 164-176, 182-188, 194-200	Bhojpur	BDL
13	Brahmpur	84.3166	25.6048	120-132, 156-162, 156-162, 176-182, 190-202	Bhojpur	3.5
14	Churamanpur	84.0306	25.5813	158-164, 176-182, 208-220	Bhojpur	BDL
15	Madudabad	85.7285	25.5862	90-96, 116-128, 132-138, 222-228	Samastipur	BDL
16		-	-	126-132	Samastipur	8



Annexure-IIIb

NAQUIM PHASE 1 : ARSENIC AFFECTED VILLAGES *

District	Block	Village
Bhojpur(aara)	Arrah	Karari
Bhojpur(aara)	Arrah	Mahuli
Bhojpur(aara)	Arrah	Rampur mathia
Bhojpur(aara)	Barhara	Akauna
Bhojpur(aara)	Barhara	Babhangawan
Bhojpur(aara)	Barhara	Babura
Bhojpur(aara)	Barhara	Bakhorapur
Bhojpur(aara)	Barhara	Balua
Bhojpur(aara)	Barhara	Barahra
Bhojpur(aara)	Barhara	Bhusahula
Bhojpur(aara)	Barhara	Bishambharpur
Bhojpur(aara)	Barhara	Bishunpur
Bhojpur(aara)	Barhara	Chhinegaon
Bhojpur(aara)	Barhara	Chhotka lauhar
Bhojpur(aara)	Barhara	Deorath
Bhojpur(aara)	Barhara	English
Bhojpur(aara)	Barhara	Gazipur farhada
Bhojpur(aara)	Barhara	Gunri
Bhojpur(aara)	Barhara	Gunri west
Bhojpur(aara)	Barhara	Gyanpur
Bhojpur(aara)	Barhara	Jhokipur
Bhojpur(aara)	Barhara	Jokahri
Bhojpur(aara)	Barhara	Karja
Bhojpur(aara)	Barhara	Keotia
Bhojpur(aara)	Barhara	Khawaspur
Bhojpur(aara)	Barhara	Krishnagarh
Bhojpur(aara)	Barhara	Kuiya
Bhojpur(aara)	Barhara	Lauhar
Bhojpur(aara)	Barhara	Majhauri
Bhojpur(aara)	Barhara	Milki
Bhojpur(aara)	Barhara	Nargada
Bhojpur(aara)	Barhara	Nurpur
Bhojpur(aara)	Barhara	Pakri
Bhojpur(aara)	Barhara	Panditpur
Bhojpur(aara)	Barhara	Parasrampur
Bhojpur(aara)	Barhara	Piparpanti
Bhojpur(aara)	Barhara	Raepur binganwan
Bhojpur(aara)	Barhara	Ram shahar



Bhojpur(aara)	Barhara	Rampur
Bhojpur(aara)	Barhara	Ramsagar
Bhojpur(aara)	Barhara	Saraiya
Bhojpur(aara)	Barhara	Sheo diara (ditto)
Bhojpur(aara)	Barhara	Sinha
Bhojpur(aara)	Barhara	Sohra
Bhojpur(aara)	Behea	Andauli
Bhojpur(aara)	Behea	Bara
Bhojpur(aara)	Behea	Basdeopur
Bhojpur(aara)	Behea	Doghra
Bhojpur(aara)	Behea	Kaleyanpur
Bhojpur(aara)	Behea	Moti rampur
Bhojpur(aara)	Behea	Narayanpur
Bhojpur(aara)	Behea	Narayanpur
Bhojpur(aara)	Behea	Nawada
Bhojpur(aara)	Behea	Ramdatahi
Bhojpur(aara)	Behea	Rampur
Bhojpur(aara)	Behea	Teghra
Bhojpur(aara)	Koilwar	Jamalpur
Bhojpur(aara)	Koilwar	Majhauwan
Bhojpur(aara)	Koilwar	Makhdumpur semra
Bhojpur(aara)	Koilwar	Pachrukha
Bhojpur(aara)	Koilwar	Rajapur
Bhojpur(aara)	Shahpur	Abatana
Bhojpur(aara)	Shahpur	Bahoranpur dakhinwar
Bhojpur(aara)	Shahpur	Bansipur
Bhojpur(aara)	Shahpur	Barsaun
Bhojpur(aara)	Shahpur	Bimari
Bhojpur(aara)	Shahpur	Bishunpur
Bhojpur(aara)	Shahpur	Chakkinaurangajhwaliadiara
Bhojpur(aara)	Shahpur	Chamarpur
Bhojpur(aara)	Shahpur	Char ghat
Bhojpur(aara)	Shahpur	Damodarpur (ditto)
Bhojpur(aara)	Shahpur	Deomalpur
Bhojpur(aara)	Shahpur	Dhauri
Bhojpur(aara)	Shahpur	Dhiratpura
Bhojpur(aara)	Shahpur	Dudh ghat
Bhojpur(aara)	Shahpur	Dumariya
Bhojpur(aara)	Shahpur	Gaura
Bhojpur(aara)	Shahpur	Gosainpur
Bhojpur(aara)	Shahpur	Isharpura
Bhojpur(aara)	Shahpur	Jhaua
Bhojpur(aara)	Shahpur	Karja



Bhojpur(aara)	Shahpur	Karnamenpur
Bhojpur(aara)	Shahpur	Khutaha
Bhojpur(aara)	Shahpur	Lachatola bersingha (ditto)
Bhojpur(aara)	Shahpur	Lachhmanpur
Bhojpur(aara)	Shahpur	Milki gopalpur
Bhojpur(aara)	Shahpur	Mirchaiya ka dera (ditto)
Bhojpur(aara)	Shahpur	Misrauliya
Bhojpur(aara)	Shahpur	Nargada
Bhojpur(aara)	Shahpur	Paharpur
Bhojpur(aara)	Shahpur	Pakri
Bhojpur(aara)	Shahpur	Parsonda
Bhojpur(aara)	Shahpur	Patti siswa
Bhojpur(aara)	Shahpur	Ram karhi (ditto)
Bhojpur(aara)	Shahpur	Ramchandar semaria
Bhojpur(aara)	Shahpur	Ramdatahi
Bhojpur(aara)	Shahpur	Sahjauli
Bhojpur(aara)	Shahpur	Sarna
Bhojpur(aara)	Shahpur	Semariya palti ojha
Bhojpur(aara)	Shahpur	Sonbarsa
Bhojpur(aara)	Udwant nagar	Kari sath
Bhojpur(aara)	Udwant nagar	Mahuli buzurg
Bhojpur(aara)	Udwant nagar	Saraiya
Bhojpur(aara)	Udwant nagar	Sasram
Buxar	Barhampur	Arak
Buxar	Barhampur	Bairia
Buxar	Barhampur	Balua
Buxar	Barhampur	Bedauli
Buxar	Barhampur	Bhariat
Buxar	Barhampur	Bisupur
Buxar	Barhampur	Chakani
Buxar	Barhampur	Chakki
Buxar	Barhampur	Chanda
Buxar	Barhampur	Chandarpura
Buxar	Barhampur	Chunsey chak
Buxar	Barhampur	Dallupur
Buxar	Barhampur	Dhan chhapra
Buxar	Barhampur	Dubauli
Buxar	Barhampur	Gahauna
Buxar	Barhampur	Garhatha kalan
Buxar	Barhampur	Garhatha khurd
Buxar	Barhampur	Gayghat
Buxar	Barhampur	Harnathpur
Buxar	Barhampur	Hathilpur



Buxar	Barhampur	Hemdapur
Buxar	Barhampur	Henwan
Buxar	Barhampur	Jaipur
Buxar	Barhampur	Jawahin diara
Buxar	Barhampur	Jogia
Buxar	Barhampur	Kapurpur
Buxar	Barhampur	Kathia
Buxar	Barhampur	Kisagar
Buxar	Barhampur	Kuawan
Buxar	Barhampur	Liladharpur
Buxar	Barhampur	Maharajganj
Buxar	Barhampur	Mahuar
Buxar	Barhampur	Nainijor
Buxar	Barhampur	Nandpur
Buxar	Barhampur	Nimej
Buxar	Barhampur	Ojhwalia
Buxar	Barhampur	Panrepur
Buxar	Barhampur	Parasia
Buxar	Barhampur	Pokahra
Buxar	Barhampur	Ramgarh
Buxar	Barhampur	Sapahi (ditto)
Buxar	Barhampur	Udhaura
Buxar	Barhampur	Umedpur
Buxar	Buxar	Amsari
Buxar	Buxar	Belaur
Buxar	Buxar	Dahiwar
Buxar	Buxar	Dalsagar
Buxar	Buxar	Desarbuzurg
Buxar	Buxar	Dubauli
Buxar	Buxar	Dudhar chak
Buxar	Buxar	Garani
Buxar	Buxar	Gogaura
Buxar	Buxar	Harkishunpur
Buxar	Buxar	Jagdara
Buxar	Buxar	Kharanti
Buxar	Buxar	Khutaha
Buxar	Buxar	Kothia
Buxar	Buxar	Majharia
Buxar	Buxar	Marwa
Buxar	Buxar	Misrauliya
Buxar	Buxar	Mungraul
Buxar	Buxar	Nat
Buxar	Buxar	Nat



Buxar	Buxar	Panrepur
Buxar	Buxar	Parari
Buxar	Buxar	Parasiya
Buxar	Buxar	Patelawa
Buxar	Buxar	Rampur
Buxar	Buxar	Ramubariya
Buxar	Buxar	Sonbarsa
Buxar	Buxar	Tiwaripur
Buxar	Buxar	Umarpur
Buxar	Buxar	Upadhyapur
Buxar	Chakki	Arak
Buxar	Chakki	Bhariat
Buxar	Chakki	Chanda
Buxar	Chakki	Hemdapur
Buxar	Chakki	Liladharpur
Buxar	Chakki	Parsia
Buxar	Chakki	Pokhra (ditto)
Buxar	Simri	Arjunpur
Buxar	Simri	Bal batra
Buxar	Simri	Bhakura
Buxar	Simri	Bhan bahrauli
Buxar	Simri	Bharathpa
Buxar	Simri	Bhaudatahi
Buxar	Simri	Chakani
Buxar	Simri	Chandpali
Buxar	Simri	Chunidanr
Buxar	Simri	Daunpura
Buxar	Simri	Dhanaha
Buxar	Simri	Dhanaipur
Buxar	Simri	Dhanrajepur
Buxar	Simri	Dia parmeswar
Buxar	Simri	Diaman
Buxar	Simri	Dubauli mahesh
Buxar	Simri	Dubha
Buxar	Simri	Dubha taufir
Buxar	Simri	Dullahpur
Buxar	Simri	Dullahpur
Buxar	Simri	Dumri
Buxar	Simri	Durasan
Buxar	Simri	Ekauna
Buxar	Simri	Ganauli
Buxar	Simri	Gangauli
Buxar	Simri	Gayaghat



Buxar	Simri	Gop bharauli
Buxar	Simri	Gopalpur
Buxar	Simri	Hirpur
Buxar	Simri	Jalalpur
Buxar	Simri	Kathar
Buxar	Simri	Kazipur
Buxar	Simri	Keshopur
Buxar	Simri	Khaira
Buxar	Simri	Khaira
Buxar	Simri	Khandhara
Buxar	Simri	Kharhatanr
Buxar	Simri	Mahrauli
Buxar	Simri	Majhwari
Buxar	Simri	Majhwari gautam
Buxar	Simri	Makundpur
Buxar	Simri	Manikpur
Buxar	Simri	Misrauliya
Buxar	Simri	Nag singhanpura
Buxar	Simri	Nagarpura
Buxar	Simri	Nagwan jagdish
Buxar	Simri	Nagwan kalika
Buxar	Simri	Narayanpur
Buxar	Simri	Narayanpur bisen
Buxar	Simri	Nemauiwa
Buxar	Simri	Niyazipur
Buxar	Simri	Paigambarpur
Buxar	Simri	Paila dih
Buxar	Simri	Panrepur
Buxar	Simri	Parari
Buxar	Simri	Parmanpur
Buxar	Simri	Partappur
Buxar	Simri	Pitambarpur
Buxar	Simri	Raipur kalan (rajipah)
Buxar	Simri	Rajapur
Buxar	Simri	Rajapur taufir
Buxar	Simri	Rajauli
Buxar	Simri	Rajpur kalan
Buxar	Simri	Rajpur kalan (bishunpur)
Buxar	Simri	Rajpur kalan (dalipur)
Buxar	Simri	Rajpur kalan (dalpatpur)
Buxar	Simri	Rajpur kalan (dilia)
Buxar	Simri	Rajpur kalan (dullahpah)
Buxar	Simri	Rajpur kalan (parnahi)



Buxar	Simri	Rajpur kalan (parsanpah)
Buxar	Simri	Rajpur kalan (patsar)
Buxar	Simri	Ramdhanpur
Buxar	Simri	Rampur mathiya
Buxar	Simri	Rani singhanpura
Buxar	Simri	Ranipatti
Buxar	Simri	Sahiyar
Buxar	Simri	Salempur
Buxar	Simri	Simri
Buxar	Simri	Sirkhiri

**Source - Ministry of Drinking Water & Sanitation, Govt. of India*



Annexure-IV

Location details of points where VES has been conducted

SL NO	Village	Block	Dist	Latitude (y)	Longitude (X)
1	Kaimnagar	Koilwar	Bhojpur	25.58378	84.73081
2	Dhanupura	Koilwar	Bhojpur	25.57372	84.70350
3	Jamiratola	Udwanthnagar	Bhojpur	25.55508	84.70081
4	Garhna	Arrah	Bhojpur	25.53200	84.66181
5	Karwa	Udwanthnagar	Bhojpur	25.52678	84.68072
6	Khajuatah	Udwanthnagar	Bhojpur	25.50997	84.65586
7	Udwanthnagar	Udwanthnagar	Bhojpur	25.51358	84.63433
8	Daulatpur	Arrah	Bhojpur	25.59161	84.68669
9	Bakuratola	Udwanthnagar	Bhojpur	25.51400	84.68958
10	Lohar Pharna	Barahara	Bhojpur	25.64492	84.70289
11	Bakhorapur	Barahara	Bhojpur	25.67199	84.69202
12	Jadipur	Arrah	Bhojpur	25.60653	84.65642
13	Saraiya	Barahara	Bhojpur	25.65789	84.62772
14	Milki	Barahara	Bhojpur	25.68097	84.62131
15	Dhorge Chakiya	Arrah	Bhojpur	25.57186	84.64575
16	Balua	Arrah	Bhojpur	25.60469	84.60533
17	Dhoboha	Arrah	Bhojpur	25.62136	84.57778
18	Ejira Pipra	Arrah	Bhojpur	25.64214	84.52897
19	Tenua	Arrah	Bhojpur	25.61592	84.54228
20	Chanuwa	Udwanthnagar	Bhojpur	25.56092	84.63097
21	Bishnupur	Udwanthnagar	Bhojpur	25.57025	84.59144
22	Karisath	Udwanthnagar	Bhojpur	25.57394	84.56411
23	Bihiya	Bihiya	Bhojpur	25.58525	84.47186
24	Sasaram	Udwanthnagar	Bhojpur	25.57283	84.49981
25	Malthar	Udwanthnagar	Bhojpur	25.53161	84.62397
26	Ashni	Udwanthnagar	Bhojpur	25.52642	84.58183
27	Kaunra	Jagdishpur	Bhojpur	25.51853	84.55256
28	Bimua	Jagdishpur	Bhojpur	25.50928	84.51886
29	Deotola	Jagdishpur	Bhojpur	25.50689	84.49408
30	Piyaniya	Udwanthnagar	Bhojpur	25.49200	84.65014
31	Jamuaon	Koilwar	Bhojpur	25.47125	84.68392
32	Rampur	Koilwar	Bhojpur	25.47283	84.72814
33	Parura	Sandesh	Bhojpur	25.44700	84.72453
34	Bichhion	Sandesh	Bhojpur	25.43858	84.69592
35	Manihachi(Belour)	Udwanthnagar	Bhojpur	25.43233	84.65483
36	Belour	Udwanthnagar	Bhojpur	25.46447	84.64811
37	Pauna	Sandesh	Bhojpur	25.41211	84.63378
38	Paharpur	Sandesh	Bhojpur	25.39536	84.66372



39	Chela	Sandesh	Bhojpur	25.39342	84.70669
40	Isarpura	Agion	Bhojpur	25.38381	84.61914
41	Narayanpur	Agion	Bhojpur	25.34681	84.60897
42	Nadhi	Agion	Bhojpur	25.31086	84.63400
43	Dundhuva	Agion	Bhojpur	25.32636	84.70425
44	Kehri	Sandesh	Bhojpur	25.35789	84.67536
45	Arra Tier-III	Arrah	Bhojpur	25.56108	84.66381
46	Baruna	Agion	Bhojpur	25.30756	84.59936
47	Guljarpur	Sahar	Bhojpur	25.26803	84.59244
48	Koran Dehri Tola	Sahar	Bhojpur	25.26092	84.63339
49	Dhanchhuha	Sahar	Bhojpur	25.26006	84.55550
50	Kusiar	Sahar	Bhojpur	25.28292	84.53661
51	Kasap	Udwanthnagar	Bhojpur	25.48119	84.60942
52	Dubauli	Udwanthnagar	Bhojpur	25.44347	84.59006
53	Dhamonia	Sandesh	Bhojpur	25.40647	84.57125
54	Sahangi	Garhani	Bhojpur	25.43806	84.55800
55	Manduri	Udwanthnagar	Bhojpur	25.47283	84.55797
56	Bhihiya	Bihiya	Bhojpur	25.55497	84.44039
57	Chakawath	Bihiya	Bhojpur	25.54264	84.40508
58	Bara Karauni	Shapur	Bhojpur	25.61742	84.47264
59	Gaura	Shapur	Bhojpur	25.65742	84.46919
60	Saranpur	Arrah	Bhojpur	25.67231	84.48425
61	Balband	Charpokhri	Bhojpur	25.38339	84.54406
62	Karnauli	Charpokhri	Bhojpur	25.35514	84.53014
63	Bagahi	Charpokhri	Bhojpur	25.31833	84.51850
64	Bagar	Tarari	Bhojpur	25.28861	84.50378
65	Kusiar	Sahar	Bhojpur	25.28453	84.56253
66	Lalgunj	Garhani	Bhojpur	25.41244	84.51964
67	Aer	Garhani	Bhojpur	25.45650	84.51186
68	Kusumha	Jagdishpur	Bhojpur	25.48506	84.51028
69	Boulipur	Jagdishpur	Bhojpur	25.51806	84.44339
70	Hetampur	Jagdishpur	Bhojpur	25.50036	84.41283
71	Karauni	Bihiya	Bhojpur	25.58967	84.45194
72	Belouthi	Shapur	Bhojpur	25.59836	84.41983
73	Itwa(Shapur-Ranisagar)	Shapur	Bhojpur	25.60825	84.37589
74	Mharajgunj	Brahampur	Buxer	25.60922	84.34519
75	Ramgarh	Brahampur	Buxer	25.60722	84.28839
76	Grathakurdh	Brahampur	Buxer	25.59922	84.26422
77	Bharkhar	Brahampur	Buxer	25.57650	84.30122
78	Sajouli	Shapur	Bhojpur	25.61714	84.39097
79	Barauli	Shapur	Bhojpur	25.64322	84.37878
80	Dilmanpur	Shapur	Bhojpur	25.67431	84.35469
81	Isharapur Dehra	Shapur	Bhojpur	25.68756	84.37319
82	Dhabi	Brahampur	Buxer	25.71906	84.36039
83	Pakhrahan	Brahampur	Buxer	25.51686	84.29625
84	Rajpur	Brahampur	Buxer	25.54300	84.29906
85	Kaithi	Brahampur	Buxer	25.55283	84.26769
86	Pakhrahi	Brahampur	Buxer	25.54367	84.31972



87	Khachariwan	Brahampur	Buxer	25.52417	84.26958
88	Baruhan	Brahampur	Buxer	25.50739	84.32556
89	Bharsonda	Bihiya	Bhojpur	25.54561	84.42217
90	Jadhavpur	Bihiya	Bhojpur	25.54411	84.38333
91	Sikariya	Bihiya	Bhojpur	25.54883	84.35825
92	Lagantola(Sajhauili)	Bihiya	Bhojpur	25.57525	84.39592
93	Tier	Bihiya	Bhojpur	25.53867	84.34161
94	Mohuwan	Bihiya	Bhojpur	25.52283	84.39656
95	Sobidumra	Arrah	Bhojpur	25.58839	84.66375
96	Jugaliya	Barahara	Bhojpur	25.62858	84.64075
97	Rampur	Barahara	Bhojpur	25.65683	84.60133
98	Balua	Barahara	Bhojpur	25.65731	84.56578
99	Milki Tola	Barahara	Bhojpur	25.67536	84.62014
100	Buxar	Buxar	Sonpa jalilpur	25.46214	83.85653
101	Buxar	Buxar	Auhauripur	25.47769	83.88117
102	Buxar	Buxar	Chausa	25.51022	83.89872
103	Buxar	Buxar	Kamaria	25.53683	83.91919
104	Buxar	Buxar	Ketpura	25.55242	83.94322
105	Buxar	Buxar	Ahirauli	25.59531	84.00925
106	Buxar	Buxar	Churamanpur	25.58389	84.02281
107	Buxar	Buxar	Dalsagar	25.57600	84.04525
108	Buxar	Simri	Belaur	25.58742	84.06450
109	Buxar	Dumraon	Pratap sagar	25.58608	84.10169
110	Buxar	Simri	Simri	25.65911	84.11894
111	Buxar	Simri	Majhwaria	25.59364	84.12233
112	Buxar	Simri	Nagwan	25.62339	84.12911
113	Buxar	Simri	Rajpur kalam	25.68636	84.12958
114	Buxar	Simri	Tilak raj ki hatta	25.71089	84.13872
115	Buxar	Simri	Rampur mathia	25.59519	84.15447
116	Buxar	Chakki	Chakki 1	25.64147	84.19961
117	Buxar	Chakki	Chakki-2	25.62203	84.21267
118	Buxar	Barhampur	Nawan	25.58489	84.23614
119	Buxar	Barhampur	Jogion	25.58897	84.25461
120	Saran	Chapra	mathwalia	25.79975	84.68839
121	Bhojpur	Koilwar	Bahiara	25.53658	84.75367
122	Bhojpur	Koilwar	Bhaduar	25.56081	84.75667
123	Bhojpur	Koilwar	Koilwar	25.59450	84.75925
124	Saran	Chapra	jp university campus	25.78094	84.77163
125	Bhojpur	Koilwar	Rajapur	25.64997	84.78497
126	Bhojpur	Barhara	Babura	25.66989	84.78567
127	Saran	Chapra	badalpur	25.74478	84.81458
128	Saran	Chapra	salempur	25.73731	84.85917



Aquifer parameters of the study area

Sl. No.	Vill./Loc.	Taluka/Block	Distt.	Lat.	Long.	Depth (in m)	SWL (mbgl)	Discharge (lps)	Drawdown (m)	Transmissivity (m ² /day)	Storativity/S.Yield
1	Brahampur	Brahampur	Buxar	25.6048	84.3166	246	2.97	200	7.04	10980	3x10 ⁻⁴
2	Shahpur	Shahpur	Bhojpur	25.5964	84.3987	303.1	6.93	194.6	4.75	8552	4x10 ⁻⁵
3	Amrahi Nawada	Shahpur	Bhojpur	25.5441	84.5531	224.5	3.09	188.7	8.55	5919	
4	Karnamepur	Shahpur	Bhojpur	25.6542	84.3581	250.8	6.55	194.58	9.91	4461	1.98x10 ⁻³
5	Bharauli	Shahpur	Bhojpur	25.631	84.3801	250.4	4.16	182.79	8.48	8920	2.72x10 ⁻³
6	Nargada Narayanpur	Shahpur	Bhojpur	25.6067	84.4222	250	4.64	188.7	9.62	5529	
7	Paharpur	Shahpur	Bhojpur	25.6494	84.4712	286	5.99	194.62	4.23	8553	7.49x10 ⁻³
8	Bariswan	Shahpur	Bhojpur	25.6265	84.4359	211.9	4.56	189	6.35	10239	4.0x10 ⁻³
9	Arjunpur High School	Simri	Buxar	25.6666	84.1579	250	8.08	180	8.50	9690	1.1x10 ⁻³
10	Churamanpur	Buxar	Buxar	25.5813	84.0306	249.5	7.23	197.3	3.62	7884	1.849x10 ⁻⁵



Annexure-VI

NATIONAL AQUIFER MAPPING (NAM) Exploration Details
(as per 12 point progress format in Aquifer Mapping manual)
FORMAT FOR LITHOLOG

1. FORMAT FOR LITHOLOG

Unique ID	
Village	Brahampur
Taluka/Block	Brahampur
District	Buxar
Toposheet No.	72 C/6
Lat	25.6048
Long	84.3166
RL (m amsl)	
Drilled Depth	246
Casing	208
SWL (m bgl)	7.04
Discharge (lps)	55.56
Date/Year	December 2006

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	22	22	Clay
22	25.2	3.2	Fine Sand
25.2	28.6	3.4	Coarse Sand
28.6	38	9.4	Clay
38	46	8	Fine to Medium Sand
46	56	10	Medium to Coarse Sand
56	65	9	Clay
65	69	4	Fine Sand
69	74	5	Clay
74	90	16	Medium to Coarse Sand
90	98	8	Fine to Medium Sand
98	112	14	Clay
112	118	6	Fine to Medium Sand
118	123	5	Coarse Sand



123	154	31	Fine to Medium Sand
154	163	9	Coarse Sand
163	182	19	Medium to Coarse Sand
182	184	2	Clay
184	192	8	Fine Sand
192	246	54	Medium to Coarse Sand

2. FORMAT FOR LITHOLOG

Unique ID	
Village	Shahpur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/6
Lat	25.5964
Long	84.3987
RL (m amsl)	
Drilled Depth	330
Casing	257
SWL (m bgl)	4.75
Discharge (lps)	54.05
Date/Year	September 2003

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	24	24	Clay
24	36	12	Sandy Clay
36	50	14	Medium to Coarse Sand
50	65	15	Coarse Sand
65	72	7	Clay
72	77	5	Coarse Sand
77	82	5	Clay
82	95	13	Medium to Coarse Sand
95	99	4	Clay
99	106	7	Fine to Medium Sand



106	111	5	Medium to Coarse Sand
111	123	12	Clay
123	135	12	Fine to Medium Sand
135	195	60	Medium to Coarse Sand
195	274	79	Fine to Medium Sand
274	287	13	Sandy Clay
287	295	8	Fine to Medium Sand
295	330	35	Clay

3. FORMAT FOR LITHOLOG

Unique ID	
Village	Amrahi Nawada
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/10
Lat	25.5441
Long	84.5531
RL (m amsl)	
Drilled Depth	248
Casing	180
SWL (m bgl)	8.55
Discharge (lps)	52.41
Date/Year	December 2004

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	22	22	Clay
22	40	18	Fine Sand
40	44	4	Fine to Medium Sand
44	59	15	Medium to Coarse Sand
59	70	11	Sandy Clay
70	85	15	Clay
85	93	8	Fine to Medium Sand
93	120	27	Clay



120	125	5	Fine
125	131	6	Medium to Coarse Sand
131	135	4	Sandy Clay
135	154	19	Medium to Coarse Sand
154	158	4	Sandy Clay
158	168	10	Medium to Coarse Sand
168	248	80	Fine to Medium Sand

4. FORMAT FOR LITHOLOG

Unique ID	
Village	Karnamepur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/6
Lat	25.6542
Long	84.3581
RL (m amsl)	
Drilled Depth	245
Casing	205
SWL (m bgl)	9.91
Discharge (lps)	54.05
Date/Year	August 2005

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	11	11	Clay
11	30	19	Fine to Medium Sand
30	66	36	Coarse Sand
66	115	49	Medium to Coarse Sand
115	128	13	Sandy Clay
128	135	7	Fine Sand
135	160	25	Fine to Medium Sand
160	203	43	Coarse Sand
203	206	3	Sandy Clay



206	213	7	Clay
213	222	9	Sandy Clay
222	245	23	Fine to Medium Sand

5. FORMAT FOR LITHOLOG

Unique ID	
Village	Bharauli
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/6
Lat	25.631
Long	84.3801
RL (m amsl)	
Drilled Depth	250
Casing	218
SWL (m bgl)	4.16
Discharge (lps)	50.77
Date/Year	March 2006

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	13	13	Clay
13	20	7	Sandy Clay
13	44	31	Medium to Coarse Sand
44	69	25	Fine to Medium Sand
69	74	5	Coarse Sand
74	96	22	Medium to Coarse Sand
96	106	10	Fine to Medium Sand
106	112	6	Clay
112	130	18	Sandy Clay
112	134	22	Fine Sand
134	157	23	Fine to Medium Sand
157	163	6	Fine Sand
163	183	20	Fine to Medium Sand



183	204	21	Coarse Sand
204	209	5	Coarse Sand with Gravel
209	230	21	Fine to Medium Sand
230	238	8	Coarse Sand
238	250	12	Fine to Medium Sand

6. FORMAT FOR LITHOLOG

Unique ID	
Village	Nargada Narayanpur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/6
Lat	25.6067
Long	84.4222
RL (m amsl)	
Drilled Depth	250
Casing	234
SWL (m bgl)	4.64
Discharge (lps)	52.41
Date/Year	August 2004

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	6	6	Clay
6	19	13	Sandy Clay
19	35	16	Fine to Medium Sand
35	40	5	Sandy Clay
40	70	30	Medium to Coarse Sand
70	78	8	Fine to Medium Sand
78	92	14	Clay
92	99	7	Fine Sand
99	105	6	Clay
105	142	37	Fine to Medium Sand
142	165	23	Medium to Coarse Sand



165	178	13	Fine Sand
178	225	47	Medium to Coarse Sand
225	231	6	Coarse Sand with Gravel
231	239	8	Medium to Coarse Sand
239	245	6	Coarse Sand with Gravel
245	250	5	Medium to Coarse Sand

7. FORMAT FOR LITHOLOG

Unique ID	
Village	Paharpur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	72 C/6
Lat	25.6494
Long	84.4712
RL (m amsl)	
Drilled Depth	286
Casing	256
SWL (m bgl)	5.99
Discharge (lps)	54.05
Date/Year	April 2004

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	22	22	Clay
22	35	13	Medium to Coarse Sand
35	43	8	Coarse Sand
43	113	70	Medium to Coarse Sand
113	116	3	Clay
116	181	65	Fine to Medium Sand
181	206	25	Coarse Sand
206	213	7	Clay
213	256	43	Fine to Medium Sand
256	286	30	Clay



8. FORMAT FOR LITHOLOG

Unique ID	
Village	Arjunpur High School
Taluka/Block	Simri
District	Buxar
Toposheet No.	72 C/6
Lat	25.6666
Long	84.1579
RL (m amsl)	
Drilled Depth	
Casing	204
SWL (m bgl)	5.99
Discharge (lps)	50
Date/Year	August 2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	15.1	15.1	Sand: fine grey, with clay
15.1	47.12	32.02	Sand, fine grey to light yellow
47.12	75.04	27.92	Sand, fine grey with sub rounded angular transparent heterogeneous rocks chips
75.04	84.5	9.46	Sand coarse with gravels
84.5	131.06	46.56	Sand fine to medium grained
131.06	155.98	24.92	Sand, yellowish to light yellow, coarse
155.98	162	6.02	Sand, grey, fine
162	174	12	Sand, coarse, grey with gravels
174	186	12	Sand fine grained yellow
186	250	64	Sand, grey, coarse with round to sub rounded gravels and feldspar minerals

9. FORMAT FOR LITHOLOG

Unique ID	
Village	Basantpur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.6383
Long	84.5978
RL (m amsl)	60



Drilled Depth	228.6
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	3.04	3.04	Clay
3.04	6.4	3.36	Sandy Clay
6.4	14.06	7.66	Fine Sand
14.06	20.71	6.65	Sandy Clay
20.71	23.77	3.06	Fine Sand
23.77	27.73	3.96	Sandy Clay
27.73	34.74	7.01	Medium to Coarse Sand
34.74	108.2	73.46	Sandy Clay
108.2	114.9	6.7	Medium to Coarse Sand
114.9	128.93	14.03	Clay
128.93	188.97	60.04	Medium to Coarse Sand
188.97	202.38	13.41	Gravel
202.38	221.58	19.2	Clay
221.58	228.6	7.02	Sandy Clay

10. FORMAT FOR LITHOLOG

Unique ID	
Village	Basudeopur
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.5936
Long	84.4939
RL (m amsl)	61



Drilled Depth	91.44
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	3.04	3.04	Clay
3.04	18.28	15.24	Fine Sand
18.28	21.33	3.05	Sandy Clay
21.33	33.52	12.19	Fine Sand
33.52	35.05	1.53	Gravel
35.05	51.81	16.76	Medium to Coarse Sand
51.81	56.88	5.07	Fine Sand
56.88	60.35	3.47	Medium to Coarse Sand
60.35	68.58	8.23	Clay
68.58	73.45	4.87	Medium to Coarse Sand
73.45	91.44	17.99	Clay

11. FORMAT FOR LITHOLOG

Unique ID	
Village	Kataria
Taluka/Block	Piro
District	Bhojpur
Toposheet No.	
Lat	25.3034
Long	84.3458
RL (m amsl)	82
Drilled Depth	80.77
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		



0	12.19	12.19	Clay
12.19	13.71	1.52	Sandy Clay
13.71	16.76	3.05	Coarse Sand
16.76	19.81	3.05	Fine sand
19.81	28.95	9.14	Coarse Sand with Gravel
28.95	30.48	1.53	Fine sand
30.48	41.15	10.67	Clay
41.15	44.02	2.87	Fine sand
44.02	50.29	6.27	Coarse Sand
50.29	53.34	3.05	Fine sand
53.34	74.67	21.33	Coarse Sand with Gravel
74.67	80.77	6.1	Clay

12. FORMAT FOR LITHOLOG

Unique ID	
Village	Sahar
Taluka/Block	Sahar
District	Bhojpur
Toposheet No.	
Lat	25.2512
Long	84.6261
RL (m amsl)	76
Drilled Depth	83.82
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	3.05	3.05	Clay
3.05	27.43	24.38	Clay with Kankar
27.43	36.57	9.14	Clay



36.57	40.23	3.66	Clay with Kankar
40.23	48.76	8.53	Coarse Sand with Gravel
48.76	57.91	9.15	Coarse Sand
57.91	60.96	3.05	Clay
60.96	79.25	18.29	Coarse Sand
79.25	83.82	4.57	Clay

13 FORMAT FOR LITHOLOG

Unique ID	
Village	Chakri
Taluka/Block	Simri
District	Buxar
Toposheet No.	
Lat	25.6146
Long	84.1631
RL (m amsl)	62
Drilled Depth	77
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	5	5	Clay
5	31	26	Fine sand
31	41	10	Clay
41	58	17	Coarse Sand
58	72	14	Coarse Sand with Gravel
72	77	5	Clay



14 **FORMAT FOR LITHOLOG**

Unique ID	
Village	Chanda
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.6254
Long	84.4766
RL (m amsl)	58
Drilled Depth	79
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	5	5	Clay
5	9	4	Sandy Clay
9	30	21	Fine sand
30	71	41	Coarse Sand
71	79	8	Clay

15 **FORMAT FOR LITHOLOG**

Unique ID	
Village	Mangalpur
Taluka/Block	Itarhi
District	Buxar
Toposheet No.	
Lat	25.48769
Long	83.9479
RL (m amsl)	66
Drilled Depth	129
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		



0	23	23	Clay
23	36	13	Fine to Medium Sand
36	67	31	Clay
67	85	18	Coarse Sand
85	100	15	Clay
100	122	22	Coarse Sand
122	129	7	Clay

16 FORMAT FOR LITHOLOG

Unique ID	
Village	Barka Nuawan
Taluka/Block	Buxar
District	Buxar
Toposheet No.	
Lat	25.5495
Long	83.9606
RL (m amsl)	66
Drilled Depth	106
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	55	55	Clay
55	59	4	Clay with Kankar
59	68	9	Fine sand
68	74	6	Medium to Coarse Sand
74	106	32	Coarse Sand



17 FORMAT FOR LITHOLOG

Unique ID	
Village	Bhadwar
Taluka/Block	Brahmpur
District	Buxar
Toposheet No.	
Lat	25.4808
Long	84.3372
RL (m amsl)	66
Drilled Depth	99
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	9	9	Clay
9	18	9	Coarse Sand
18	36	18	Clay
36	45	9	Coarse Sand with Gravel
45	55	10	Clay
55	64	9	Coarse Sand with Gravel
64	70	6	Clay
70	87	17	Coarse Sand with Gravel
87	99	12	Clay

18 FORMAT FOR LITHOLOG

Unique ID	
Village	Chakwath
Taluka/Block	Bihiya
District	Bhojpur
Toposheet No.	
Lat	25.542
Long	84.4163
RL (m amsl)	63



Drilled Depth	94
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	3	3	Clay
3	30	27	Fine to Medium Sand
30	33	3	Clay
33	36	3	Fine Sand
36	42	6	Clay
42	54	12	Coarse Sand
54	58	4	Clay
58	67	9	Coarse Sand
67	70	3	Clay
70	91	21	Coarse Sand
91	94	3	Clay

19 FORMAT FOR LITHOLOG

Unique ID	
Village	Barap
Taluka/Block	Jagdishpur
District	Bhojpur
Toposheet No.	
Lat	25.4265
Long	84.5649
RL (m amsl)	66
Drilled Depth	79
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		



0	30	30	Clay
30	40	10	Fine to Medium Sand
40	42	2	Clay
42	58	16	Coarse Sand
58	75	17	Medium to Coarse Sand
75	79	4	Clay

20 FORMAT FOR LITHOLOG

Unique ID	
Village	Garhani
Taluka/Block	Charpokhari
District	Bhojpur
Toposheet No.	
Lat	25.4119
Long	84.5591
RL (m amsl)	67
Drilled Depth	141
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	53	53	Clay
53	134	81	Medium to Coarse Sand
134	141	7	Clay

21 FORMAT FOR LITHOLOG

Unique ID	
Village	Chakwath
Taluka/Block	Bihiya
District	Bhojpur
Toposheet No.	
Lat	25.542
Long	84.4163
RL (m amsl)	63
Drilled Depth	108



Casing	99
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	2	2	Clay
2	33	31	Clay with Kankar
33	41	8	Medium to Coarse Sand
41	49	8	Coarse Sand
49	72	23	Clay
72	81	9	Medium to Coarse Sand
81	91	10	Clay
91	102	11	Coarse Sand
102	108	6	Clay

22 FORMAT FOR LITHOLOG

Unique ID	
Village	Uttampur
Taluka/Block	Rajpur
District	Buxar
Toposheet No.	
Lat	25.4131
Long	83.9094
RL (m amsl)	69
Drilled Depth	123
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	10	10	Clay
10	24	14	Fine Sand



24	77	53	Clay
77	116	39	Coarse Sand
116	123	7	Clay

23 FORMAT FOR LITHOLOG

Unique ID	
Village	Udwantnagar
Taluka/Block	Udwantnagar
District	Bhojpur
Toposheet No.	
Lat	25.5046
Long	84.6252
RL (m amsl)	62
Drilled Depth	109
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	16	16	Clay
16	22	6	Fine to Medium Sand
22	48	26	Clay
48	62	14	Medium to Coarse Sand
62	67	5	Clay with Kankar
67	74	7	Medium to Coarse Sand
74	79	5	Clay with Kankar
79	103	24	Medium to Coarse Sand
103	109	6	Clay

24 FORMAT FOR LITHOLOG

Unique ID	
Village	Akhgaon
Taluka/Block	Sandesh



District	Bhojpur
Toposheet No.	
Lat	25.471
Long	84.7491
RL (m amsl)	63
Drilled Depth	98
Casing	
SWL (m bgl)	
Discharge (lps)	
Date/Year	

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	23.8	23.8	Clay
23.8	54	30.2	Coarse Sand with Gravel
54	61	7	Clay
61	70	9	Coarse Sand with Gravel
70	98	28	Clay

25 FFORMAT FOR LITHOLOG

Unique ID	
Village	Koilwar
Taluka/Block	Koilwar
District	Bhojpur
Toposheet No.	
Lat	25.5774
Long	84.7917
RL (m amsl)	59
Drilled Depth	104
Casing	102
SWL (m bgl)	8
Discharge (lps)	30.55
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	15	15	Clay
15	30	15	Fine Sand



30	54	24	Medium to Coarse Sand
54	84	30	Fine Sand
84	104	20	Medium to Coarse Sand

26 FORMAT FOR LITHOLOG

Unique ID	
Village	Pachaina
Taluka/Block	Koilwar
District	Bhojpur
Toposheet No.	
Lat	25.6135
Long	84.7749
RL (m amsl)	60
Drilled Depth	96
Casing	96
SWL (m bgl)	7.8
Discharge (lps)	30
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	10	10	Clay
10	30	20	Fine Sand
30	54	24	Medium to Coarse Sand
54	72	18	Medium to Coarse Sand
72	84	12	Fine Sand
84	96	12	Medium to Coarse Sand

27 FORMAT FOR LITHOLOG

Unique ID	
Village	Pachrukhiya
Taluka/Block	Koilwar
District	Bhojpur
Toposheet No.	
Lat	25.6091
Long	84.7783
RL (m amsl)	60
Drilled Depth	102
Casing	102



SWL (m bgl)	8
Discharge (lps)	30.27
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	30	30	Clay
30	42	12	Fine Sand
42	54	12	Medium to Coarse Sand
54	84	30	Fine Sand
84	102	18	Medium to Coarse Sand

28 FORMAT FOR LITHOLOG

Unique ID	
Village	Kajichak
Taluka/Block	Koilwar
District	Bhojpur
Toposheet No.	
Lat	25.6026
Long	84.7829
RL (m amsl)	60
Drilled Depth	102
Casing	102
SWL (m bgl)	7.6
Discharge (lps)	30.55
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	15	15	Clay
15	30	15	Medium to Coarse Sand
30	60	30	Fine Sand
60	78	18	Medium to Coarse Sand
78	90	12	Fine Sand
90	102	12	Medium to Coarse Sand



29 FORMAT FOR LITHOLOG

Unique ID	
Village	Ganj Sripalpur
Taluka/Block	Barhara
District	Bhojpur
Toposheet No.	
Lat	25.6334
Long	84.7389
RL (m amsl)	56
Drilled Depth	101.5
Casing	101.5
SWL (m bgl)	7.6
Discharge (lps)	29.72
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
14	30	14	Fine Sand
30	42	16	Medium to Coarse Sand
42	54	12	Medium to Coarse Sand
54	83.5	12	Fine Sand
83.5	101.5	29.5	Medium to Coarse Sand

30 FORMAT FOR LITHOLOG

Unique ID	
Village	Babura
Taluka/Block	Barhara
District	Bhojpur
Toposheet No.	
Lat	25.681
Long	84.7803
RL (m amsl)	57
Drilled Depth	102
Casing	102
SWL (m bgl)	7.8
Discharge (lps)	30
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		



0	30	30	Clay
30	38	8	Fine Sand
38	72	34	Medium to Coarse Sand
72	102	30	Medium to Coarse Sand

31 FORMAT FOR LITHOLOG

Unique ID	
Village	Karisath
Taluka/Block	Udwanthnagar
District	Bhojpur
Toposheet No.	
Lat	25.5715
Long	84.5512
RL (m amsl)	57
Drilled Depth	105.3
Casing	105.3
SWL (m bgl)	6.06
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	18	18	Clay
18	30.3	12.3	Fine Sand
30.3	63.3	33	Clay
63.3	69.3	6	Coarse Sand
69.3	75.3	6	Fine Sand
75.3	99.3	24	Coarse Sand
99.3	105.3	6	Clay

32 FORMAT FOR LITHOLOG

Unique ID	
Village	Yogibir
Taluka/Block	Bihiya
District	Bhojpur
Toposheet No.	



Lat	25.5613
Long	84.3648
RL (m amsl)	63
Drilled Depth	99
Casing	99
SWL (m bgl)	6
Discharge (lps)	27
Date/Year	2007

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	12	12	Clay
12	33	21	Fine Sand
33	45	12	Coarse Sand
45	51	6	Clay
51	63	12	Coarse Sand
63	87	24	Clay
87	93	6	Coarse Sand
93	99	6	Clay

33 FORMAT FOR LITHOLOG

Unique ID	
Village	Osai
Taluka/Block	Bihiya
District	Bhojpur
Toposheet No.	
Lat	25.5576
Long	84.4123
RL (m amsl)	64
Drilled Depth	102
Casing	102
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	12	12	Clay



12	60	48	Fine Sand
60	78	18	Coarse Sand
78	84	6	Clay
84	96	12	Coarse Sand
96	102	6	Clay

34 FORMAT FOR LITHOLOG

Unique ID	
Village	Ranadih
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.5793
Long	84.414
RL (m amsl)	61
Drilled Depth	108
Casing	108
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	24	24	Clay
24	63	39	Fine Sand
63	81	18	Coarse Sand
81	90	9	Clay
90	102	12	Coarse Sand
102	108	6	Clay

35 FORMAT FOR LITHOLOG

Unique ID	
Village	Kharauni
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.6232



Long	84.4888
RL (m amsl)	59
Drilled Depth	105
Casing	105
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	6	6	Clay
6	30	24	Fine Sand
30	39	9	Clay
39	69	30	Fine Sand
69	102	33	Coarse Sand
102	105	3	Clay

36 FORMAT FOR LITHOLOG

Unique ID	
Village	Bemari
Taluka/Block	Shahpur
District	Bhojpur
Toposheet No.	
Lat	25.622
Long	84.4593
RL (m amsl)	57
Drilled Depth	105
Casing	
SWL (m bgl)	105
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	6	6	Clay
6	30	24	Sandy Clay
30	69	39	Fine Sand



69	99	30	Coarse Sand
99	102	3	Fine Sand
102	105	3	Clay

37 FORMAT FOR LITHOLOG

Unique ID	
Village	Jamira
Taluka/Block	Ara
District	Bhojpur
Toposheet No.	
Lat	25.5533
Long	84.7088
RL (m amsl)	60
Drilled Depth	104.3
Casing	104
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	15	15	Clay
15	30.3	15.3	Fine Sand
30.3	57.3	27	Clay
57.3	69.3	12	Coarse Sand
69.3	81.3	12	Fine Sand
81.3	99.3	18	Coarse Sand
99.3	104.3	5	Clay

38 FORMAT FOR LITHOLOG

Unique ID	
Village	Gothula
Taluka/Block	Ara
District	Bhojpur
Toposheet No.	
Lat	25.5286
Long	84.6934



RL (m amsl)	60
Drilled Depth	105
Casing	105
SWL (m bgl)	6
Discharge (lps)	27.77
Date/Year	2008

Depth range (m bgl)		Thickness (m)	Litholog
From	To		
0	15	15	Clay
15	30	15	Fine Sand
30	63	33	Clay
63	81	18	Coarse Sand
81	87	6	Clay
87	99	12	Coarse Sand
99	105	6	Clay



Annexure-VII

EXPLORATORY WELLS BY CGWB & its Monitoring (BHOJPUR & BUXAR distts.)

I No.	Location	Pz details, if any	Block	District	Long	Lat	Pz Depth (mbgl)	Pz head (W.L. Mar. 2013) (mbmp)	May-13	Aug. 2013	Jan. 2015	Monitoring during pumping test (mbmp)
1	Bariswan	Bariswan Pz1		Bhojpur	84.4492	25.6197	250.7	3.6	5.1		5.76	
		Bariswan Pz2					119.4	H.P. fitted				
		Bariswan Pz3					25.9	5.1			6.33	
2	Shahpur	Shahpur Pz1	Shahpur	Bhojpur	84.3974	25.598	331.8	6.6	6.57	5.06	9.07 (Pz not sure, current Pz's dia. 8")	
		Shahpur Pz2					221.9			filled with soil		
4	Nargada Narayanpur	Nargada Narayanpur Pz1		Bhojpur	84.4445	25.6072	234	4.2	5.5		6.27	
		Nargada Narayanpur Pz2					106	4.47			6.23	
		Nargada Narayanpur Pz3					31	4.52			5.28	
5	Bharauli	Bharauli Pz1		Bhojpur	84.3791	25.6307	250.3	filled with soil		1.93	not getting opened	4.76 (9.8.2006 SDT); 6.2 (6.9.2006 APT)
		Bharauli Pz2					50	filled with soil		1.32	not getting opened	
		Bharauli Pz3					35	4.82	6.07	1.3	7.29	



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6	Karnamepur	Karnamepur, Bhojpur Pz1		Bhojpur	84.3621	25.6553	250	6.5	7.72		7.8	7.44 (4.4.2006 SDT); 7.38 (5.4.2006, APT)
		Karnamepur, Bhojpur Pz2					21				Seal, no place to open	
7	Amrahi Nawada	Amrahi Nawada, Bhojpur		Bhojpur	84.4799	25.5831	249.9	4.2	4.74	2.4	6.85	3.57 (30.12.2005 SDT); 3.69 (12.1.2006 APT)
9	Brahampur	Brahampur, Buxar Pz1	Brahampur	Buxar	84.3057	25.5967	30.5		5.72		not opening	
		Brahampur, Buxar Pz2					170				7.03	
10	Churamanpur	Churamanpur Pz1	Buxar	Buxar	84.031	25.581	181		7.65	5.98		
		Churamanpur Pz2					27			8.07		
		Churamanpur Pz3					221			filled with soil		7.37 (10.8.2010 SDT)



Annexure-VIII

Dynamic Ground Water Resources of Blocks taken under Phase I

SN (Block)	District	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Critical/Over-exploited
1	Bhojpur	Ara	4686	1103	594	489	6872	687	6185	2435	700	3135	50.7	Safe
2	Bhojpur	Barhara	5273	349	668	140	6431	643	5788	1336	349	1686	29.1	Safe
3	Bhojpur	Behea	3550	1023	450	475	5498	550	4948	2504	350	2854	57.7	Safe
4	Bhojpur	Koilbar	2749	605	348	249	3951	395	3555	2317	400	2717	76.4	Safe
5	Bhojpur	Shahpur	3838	570	486	229	5123	512	4611	2183	403	2587	56.1	Safe
6	Bhojpur	Udwantna	3178	2865	548	950	7541	377	7164	2913	238	3150	44	Safe
7	Buxar	Brahampu	4466	783	571	481	6300	630	5670	2335	306	2641	46.6	Safe
8	Buxar	Buxar	3933	2380	530	948	7792	390	7403	2063	451	2514	34	Safe
9	Buxar	Chakki	197	111	25	32	365	37	329	227	64	291	88.5	Safe
10	Buxar	Simari	3970	568	507	170	5215	522	4694	1942	338	2280	48.6	Safe
	Buxar	Total	35840	10357	4727	4163	55088	4743	50347	20255	3599	23855	47.4	Safe



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Arrah

District/ State

Bhojpur/Bihar

Rainfall :

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season . The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm .

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Arrah Block has been assessed as 61. 85 MCM. The gross ground water draft for all uses stands at 31.35 MCM. The stage of Development is 50. 7%.) Annexure-I(

Water level behavior

During 2015 ,the depth to water level varied from 4. 23m to 8.9 m during the pre-monsoon season and from 3.42 to 8.53 m during the post-monsoon season .

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

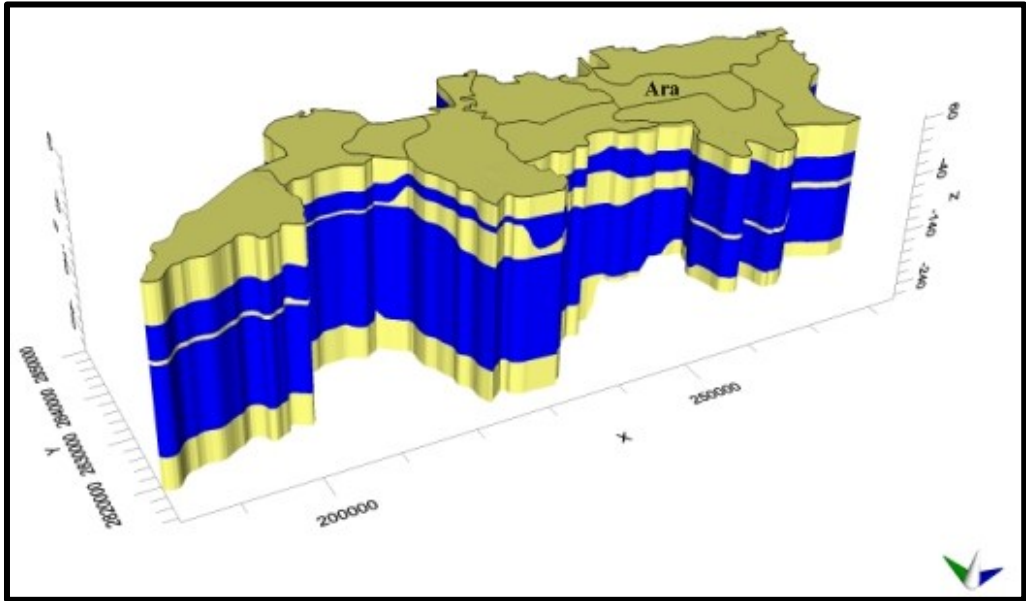


Fig1 :3D view of Aquifer disposition

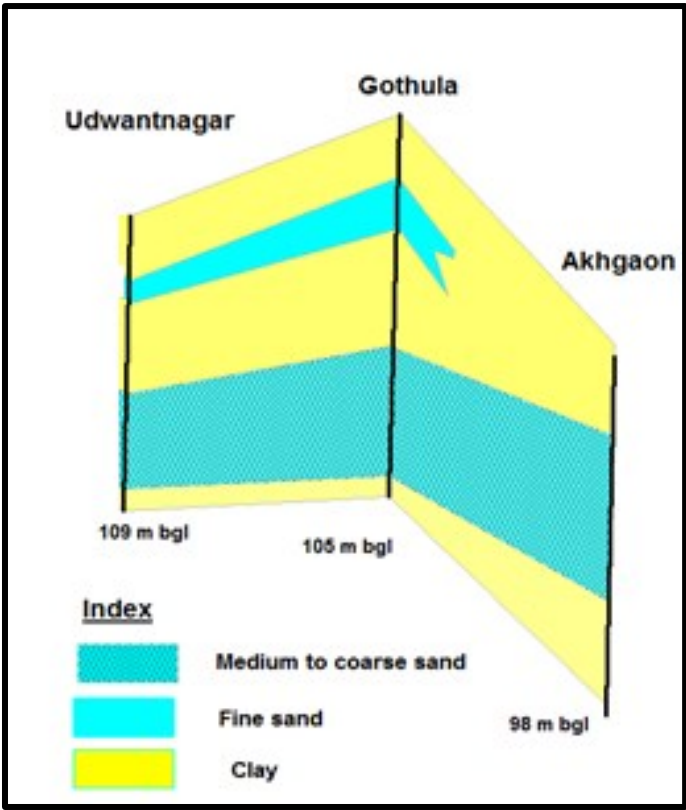


Fig2 :2nD view of Aquifer dispositio

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 50.7%. Thus sufficient scope exists for groundwater development in the Block.



Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination

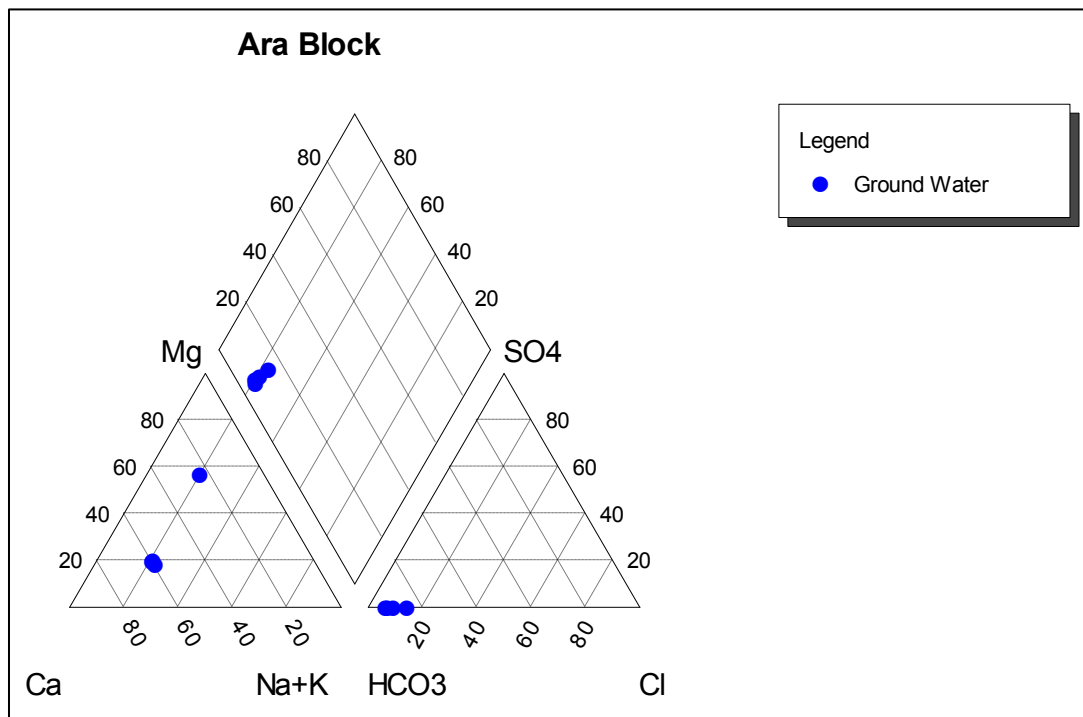
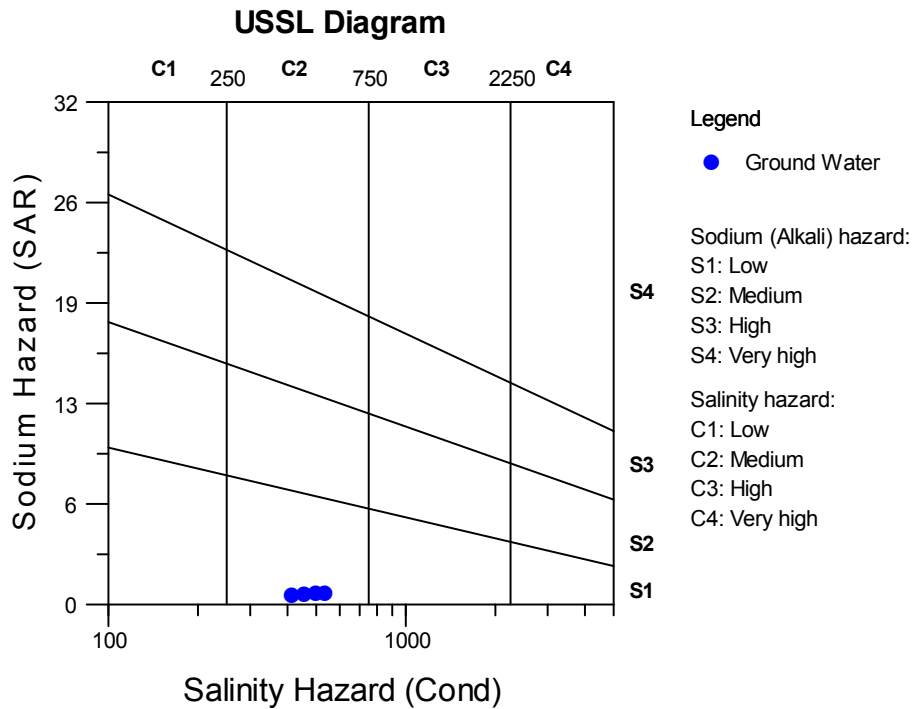


Fig. Diagram Piper



On the basis of USSL diagram ground water of the Ara block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (%)	Category: Safe/Semi-critical/Over-exploited
	Bhojpur		Ara	4686	1103	594	489	6872	687	6185	2435	700	3135	1071	2679	50.7	Safe

Chemical Analysis for groundwater

T. Sh. No.	Sample No.	Location	Block	Source	Long	Lat	pH	EC $\mu\text{S/cm}$ at 25°C	HCO3	Cl	F	NO3	SO4	Total Hardness	Ca	Mg	Na	K	SiO2	TDS
72C10	411/1	Dhanupra	Ara	HP	84.6992	25.5764	6.9	416	226	14	0.31	0	0	160	48	9.6	19	1	27	270.4
72C10	411/2	Chandwa	Ara	DW	84.6372	25.5603	7.2	458	293	14	0.11	0	0	205	28	41	27	1.2	16	297.7
72C10	411/4	Joraupur Milki	Ara	HP	84.5339	25.6008	7.5	500	281	28	0	1.3	0	210	64	12	27	2.5	15	325
72C10	411/14	Abhula tola	Ara	HP	84.6064	25.6561	8.01	536	329	14	0.46	1.4	0	230	68	14	27	1.8	19	348.4



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Barhara

District/ State

Bhojpur/Bihar

Rainfall

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season. The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Barhara Block has been assessed as 57.88 MCM. The gross ground water draft for all uses stands at 16.86 MCM. The stage of Development is 50.7%) annexure-1(

Water level behavior

During 2015, the depth to water level varied from 6.81m to 9.01 m during the pre-monsoon season and from 6.18 to 8.7 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

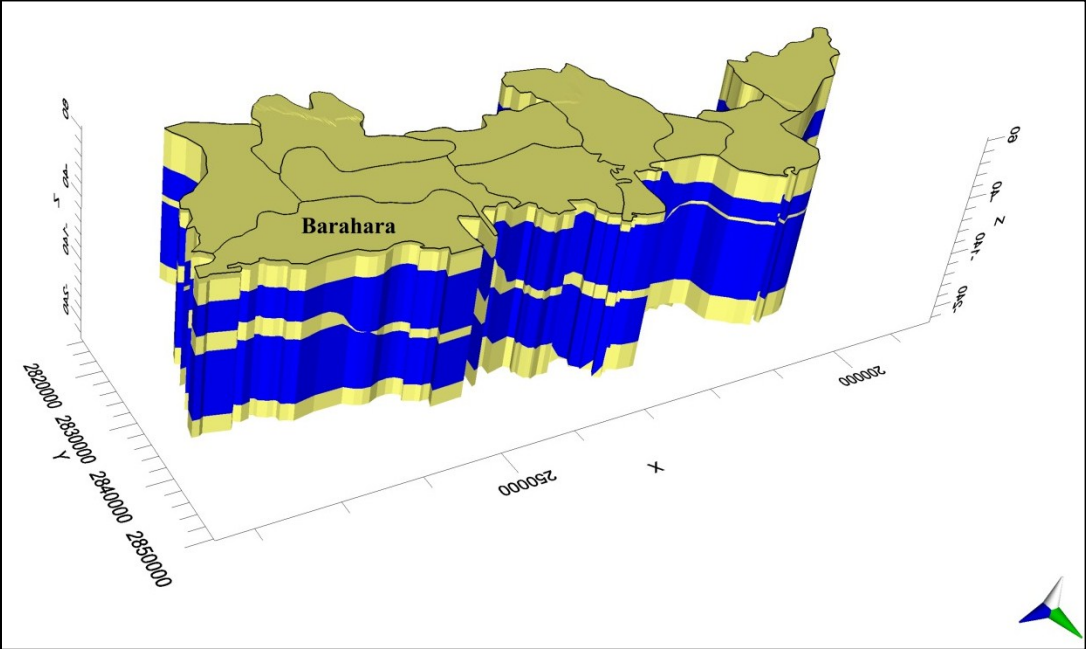


Fig1 :3D view of aquifer disposition

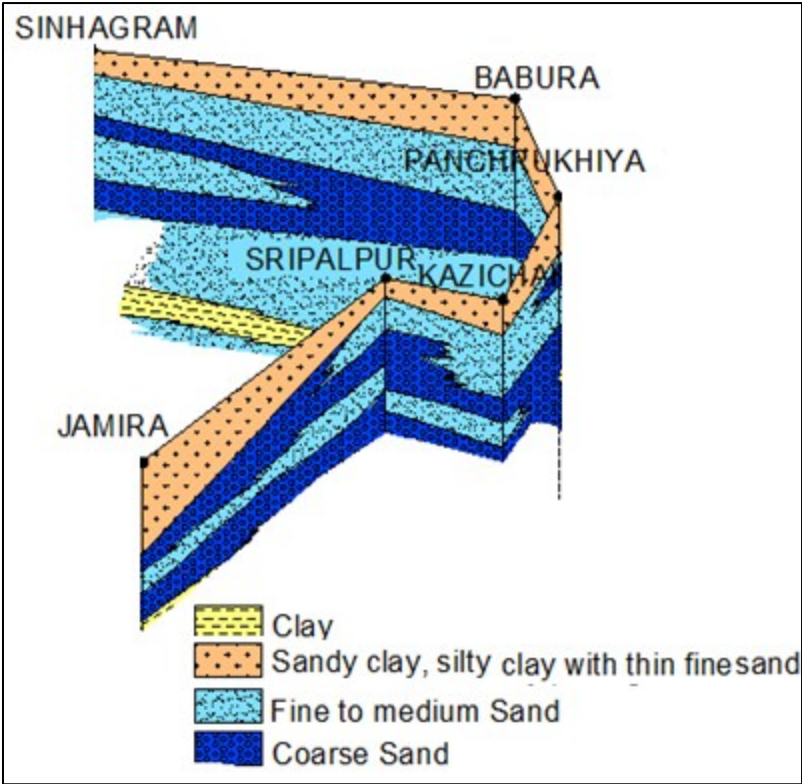


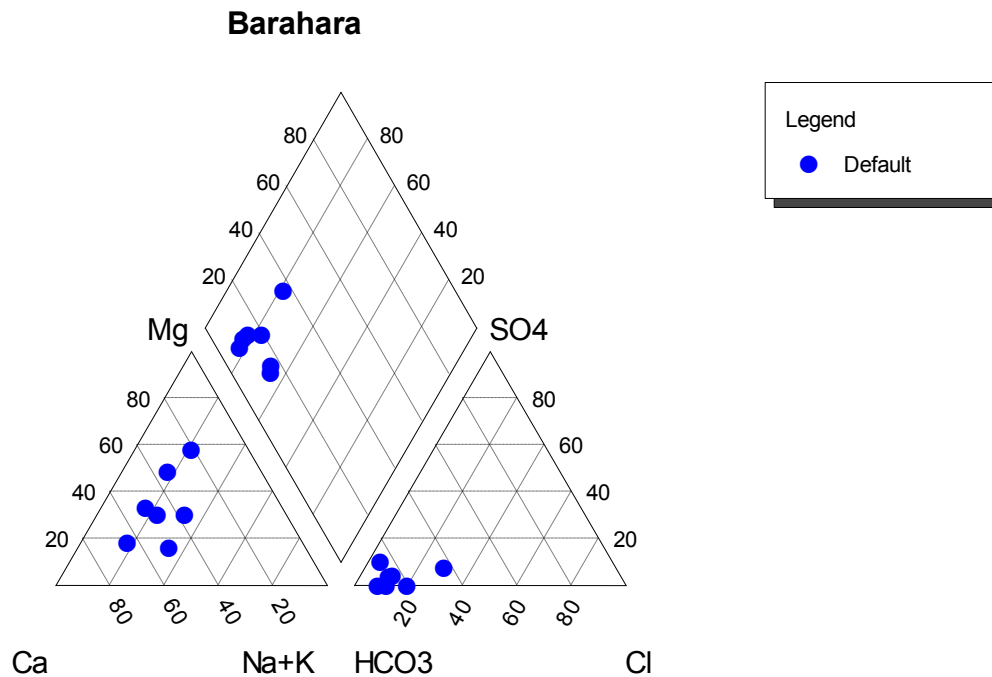
Fig2 :2 D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

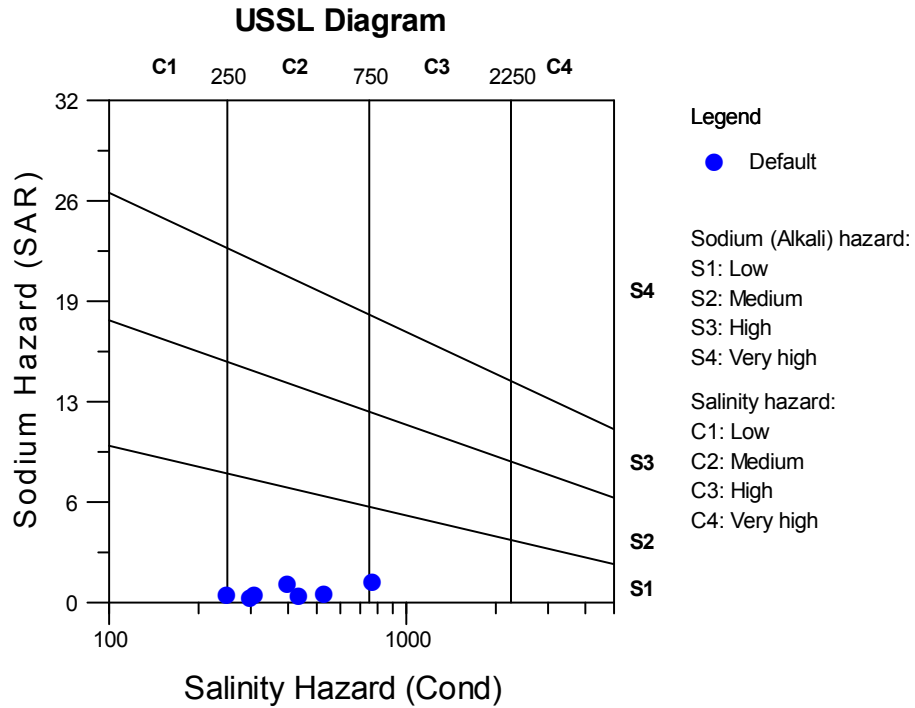


The overall stage of groundwater development in the Block is 50.7%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



Piper plot indicate Ca+Mg+HCO₃ type water. Ground water of the study area are suitable for drinking purpose.



On the basis of USSL diagram ground water of the Barhara block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

Anne- xure- I District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non- monsoon season	Recharge from other sources during non- monsoon season	Total Annual Ground Water Recharge	Provisi- on for Natural Dischar- ge	Net Annual Ground Water Availab- ility	Existing Gross Ground Water Draft for Irrigati- on	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existi- ng Gross Groun- d Wate- r Draft For All Uses (10+ 11)	Alloca- tion for Dome- stic and Indust- rial Requi- remen- t supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Develop- ment (%)	Categ- ory: Safe/S- emi- critica- l/Criti- cal/Ov- er- exploit- ed
Bho- jpur		Barhara	5273	349	668	140	6431	643	5788	1336	349	1686	493	2679	50.7	Safe

Annexure-II

Chemical Analysis of Ground Water Sample

Location	Block	Source	Long	Lat	pH	EC µS/cm at 25°C	HCO3	Cl	F	NO3	SO4	Total Hardness	Ca	Mg	Na	K	SiO2	PO4	TDS
Barahara	Barhara	HP	84.7286	25.6828	7.6	773	415	14	0	0.99	40	265	80	16	52	19	15	0	502.45
Bokharapur	Barhara	DW	84.6928	25.6681	7.4	300	171	14	0.17	0	0	135	32	13	10	4.3	17	0	195
Bahmangawan	Barhara	HP	84.6064	25.6561	8	250	146	21	0.29	0	0	115	28	11	14	2.7	26	0	162.5
Jagatpur	Barhara	HP	84.5981	25.6747	8.01	400	244	21	0.44	1.1	10	165	36	18	36	1.5	32	0	260
Balua	Barhara	HP	84.5564	25.6569	7.9	532	360	21	0.53	0	0	270	44	38	24	3	16	0	345.8
Keshopur Bintoli	Barhara	HP	84.7225	25.6653	8.63	310	116	32	0.67	0	10.8	135	14	24	14	4.6	4.6	0.82	198.4
Farhda	Barhara	HP	84.6556	25.6817	8.01	437	232	18	0	0	7.7	180	56	9.6	14	6.7	3.6	0.72	279.68



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Bihea

District/ State

Bhojpur/Bihar

Rainfall

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season .The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm .

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Bihea Block has been assessed as 49.48MCM. The gross ground water draft for all uses stands at 28.54MCM. The stage of Development is 57.7%) Annexure I.(

Water level behavior

During 2015 ,the depth to water level varied from 6. 2m to 6.54 m during the pre-monsoon season and from 5.57 to 5.68 m during the post-monsoon season .

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

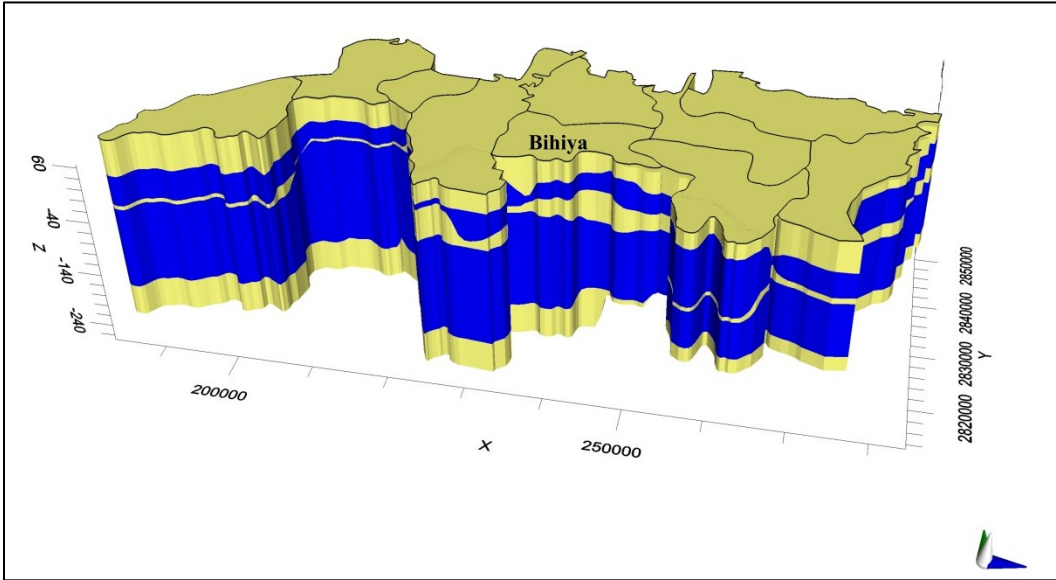


Fig1 :3D View of aquifer disposition

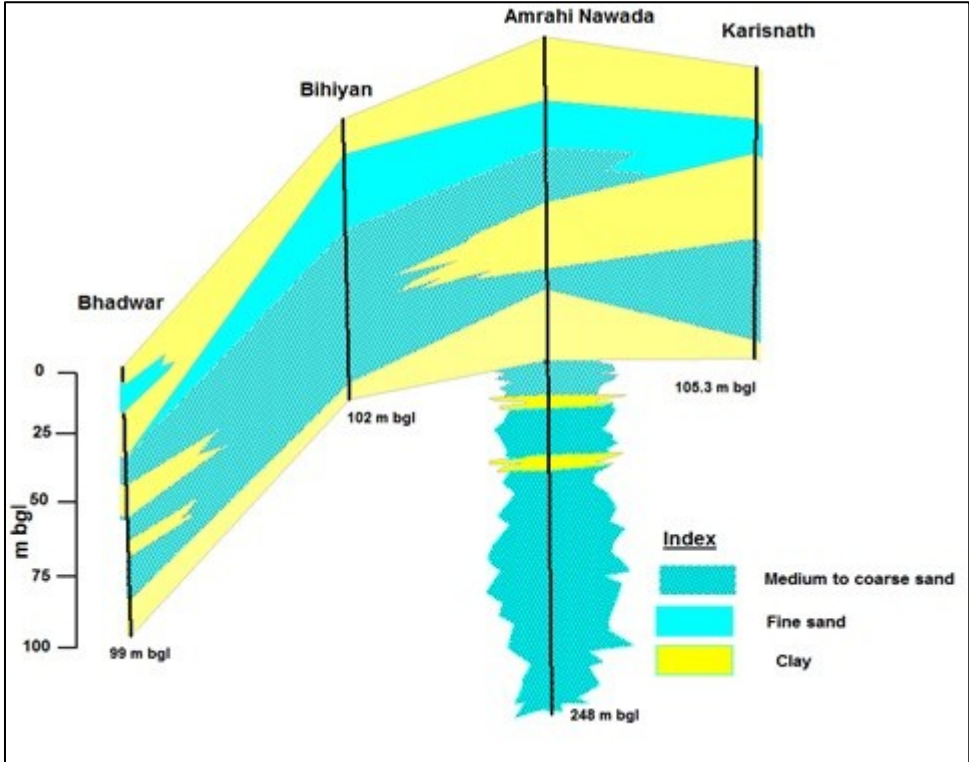


Fig2 :2D viwe of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 57.7%. Thus sufficient scope exists for groundwater development in the Block.

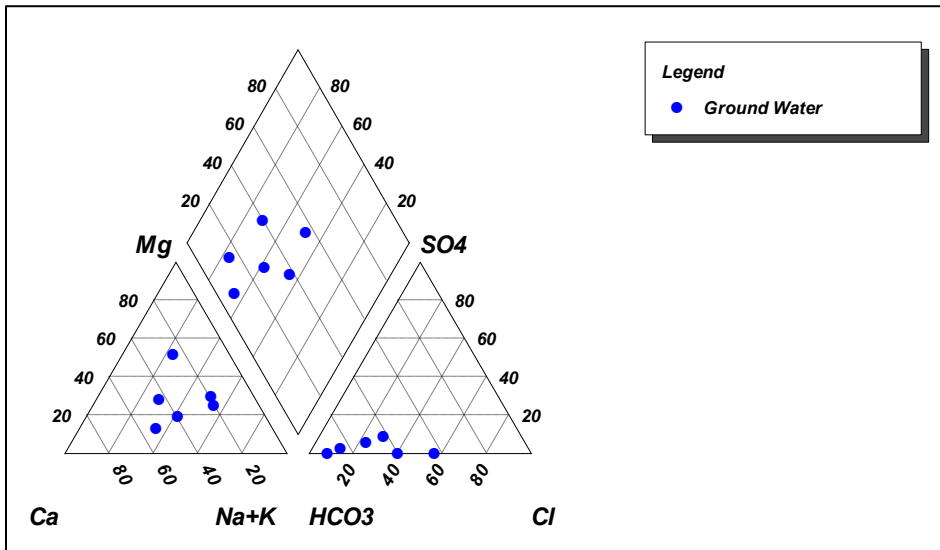
Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for



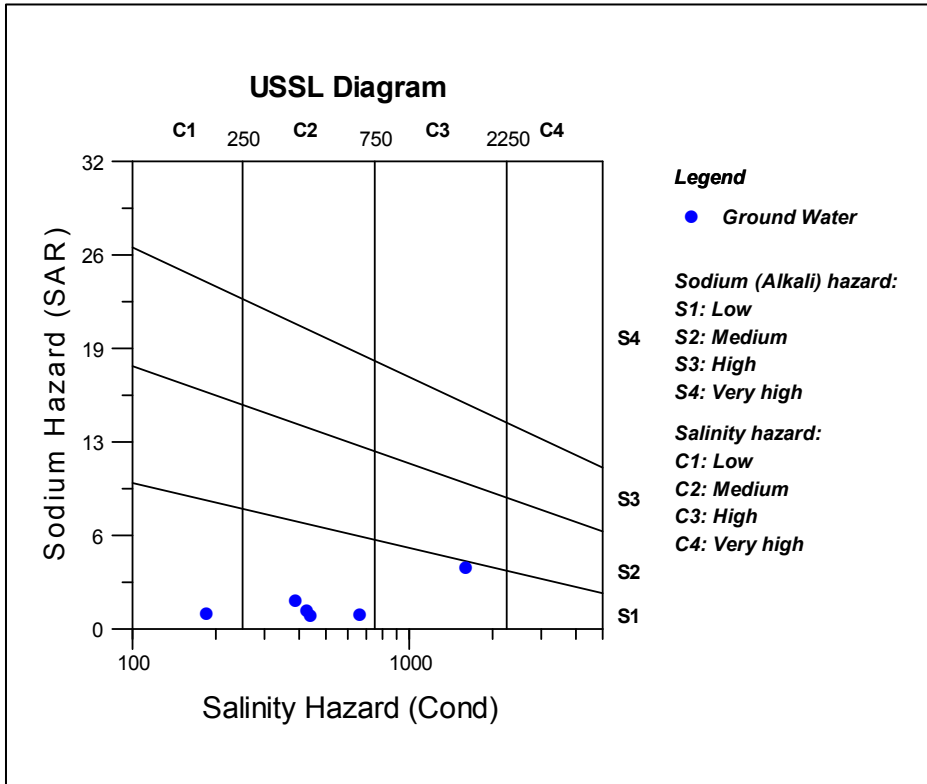
community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



On the basis of piper diagram, ground water of the Bihea block is Ca+Mg+type $_3\text{HCO}$. Ground water of the study area is suitable for drinking purpose.



On the basis of USSL diagram ground water of the Bihea block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non- monsoon season	Recharge from other sources during non- monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation
	Bhojpur		Behea	3550	1023	450	475	5498	550	4948	2504

Chemical Analysis of ground water sample

Sl. No.	Location	Block	Source	Long	Lat	pH	EC μS/cm at 25°C	TDS	Total Hardness	CO3	HCO3	Cl	F	NO3
1	Itwa	Bihia	HP	84.3828	25.6008	7.98	428	273.92	150	0	256	14	0.58	0
3	Bihia (Dogra)	Bihia	DW	84.4706	25.5842	7.98	1608	1029.12	470	0	476	362	0.52	24
4	Philingi Jamua	Bihia	HP	84.4442	25.5647	7.8	441	282.24	165	0	146	57	0.62	32
5	Jataopur	Bihia	HP	84.3925	25.5372	7.9	665	425.6	310	0	390	35	0.72	22
38	Bharauli	Bihia	HP	84.3736	25.6342	8.58	389	248.96	80	15	116	32	0.23	0
39	Majhaoli	Bihia	HP	84.4286	25.5539	8.51	185.7	118.848	75	12	96	18	0.09	0.67



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Koelwar

District/ State

Bhojpur/Bihar

Rainfall

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season. The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Koelwar Block has been assessed as 35.55 MCM. The gross ground water draft for all uses stands at 27.17 MCM. The stage of Development is 50.7%) Annexure I.

Water level behavior

The depth to water level varies from 5.36m to 8.14 m during the pre-monsoon season and from 4.48 to 8.58m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1, 2& 3).

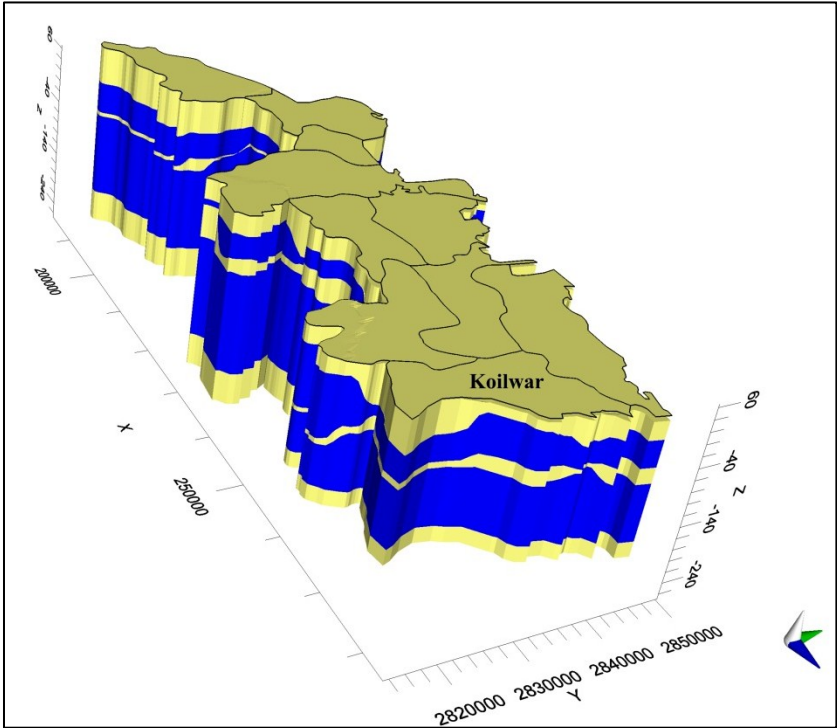


Fig1 :3D View of aquifer disposition

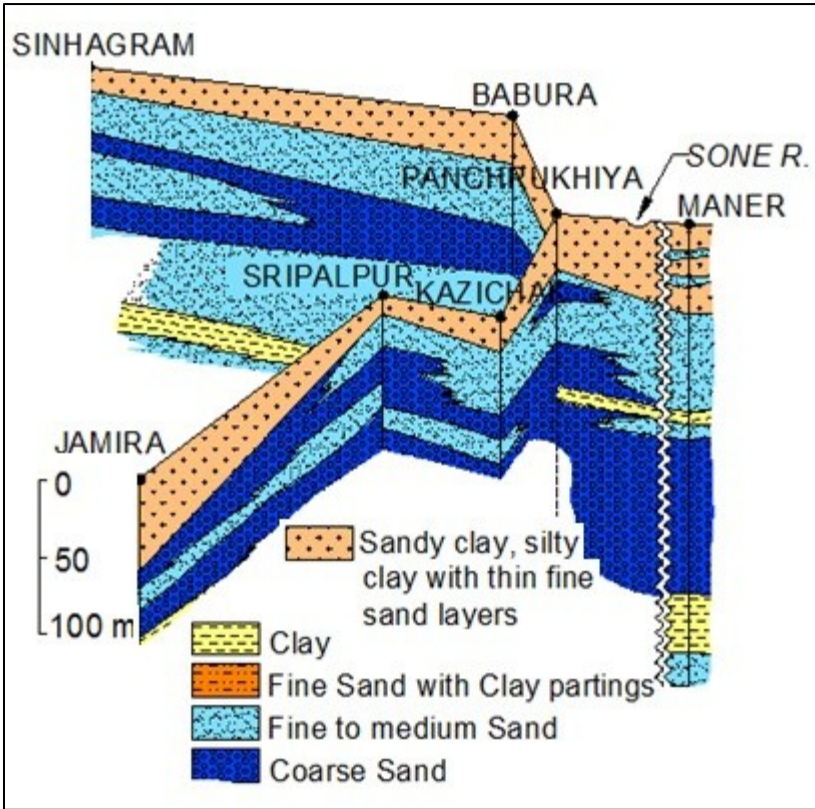
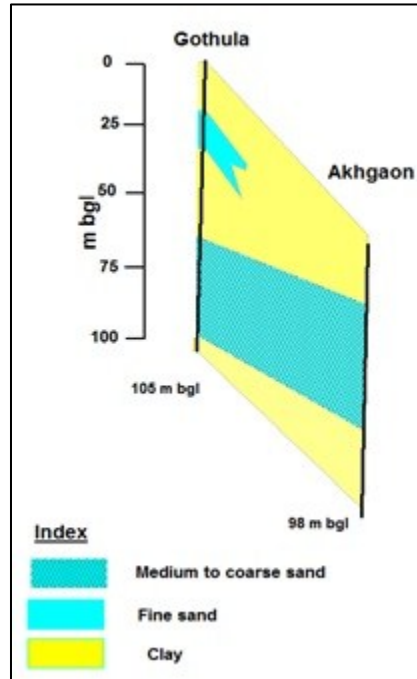


Fig2 :3D View of aquifer disposition



3 Fig: 2D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

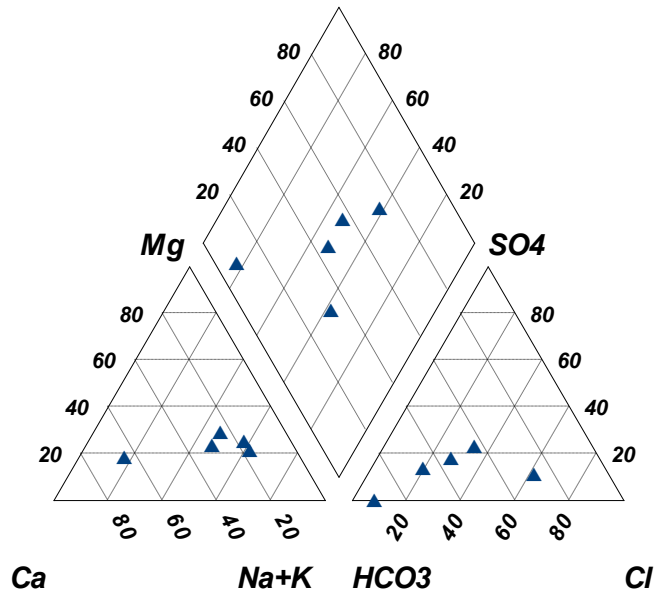
The overall stage of groundwater development in the Block is 50.7%. Thus sufficient scope exists for groundwater development in the Block.

Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

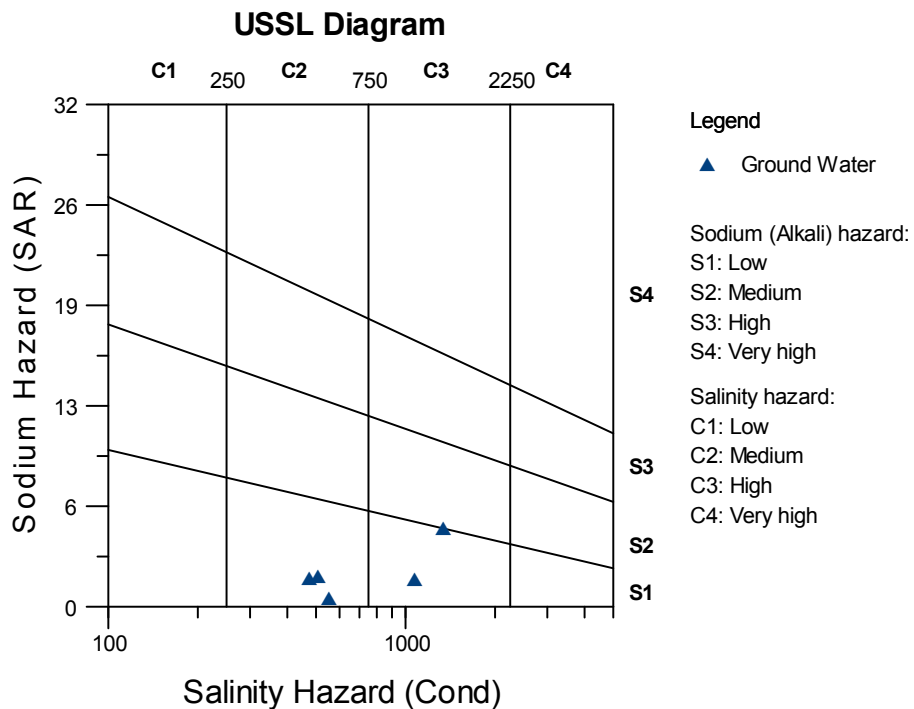


Chemical quality of ground water and contamination



Legend
 ▲ Ground Water

On the basis of piper diagram, ground water of the Koelwar block is Ca+Mg+type₃HCO₃. Ground water of the study area is suitable for drinking purpose.



On the basis of USSL diagram ground water of the Koelwar block is suitable for also irrigation purposes.



4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non- monsoon season	Recharge from other sources during non- monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Ex G Gr w Dr Do c Ind W St
	Bhojpur		Koilbar	2749	605	348	249	3951	395	3555	2317	

Chemical Analysis of Ground water sample

Location	Block	Source	Long	Lat	pH	EC μS/cm at 25°C	CO3	HCO3	Cl	F	NO3	SO4	Total Hardness	Ca
Birampur	Koilwar	DW	84.7247	25.6033	7.98	561	0	244	14	0.14	53	0	220	6
Jogta	Koilwar	DW	84.7093	25.4869	7.68	1360	0	573	780	0.39	16	190	330	5
Sakkadi	Koilwar	DW	84.7564	25.5756	7.6	1088	0	403	71	0.06	41.13	65.4	175	3
Lodhipur	Koilwar	HP	84.7349	25.5106	8.49	481	6	92	43	0.6	39.58	39.5	110	2
Nasratpur	Koilwar	HP	84.7504	25.4516	8.39	515	3	128	39	0.21	41.1	34.2	125	2



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Shahpur

District/ State

Bhojpur/Bihar

Rainfall

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season. The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Shahpur Block has been assessed as 46.11MCM. The gross ground water draft for all uses stands at 25.87MCM. The stage of Development is 56.1% Annexure I.

Water level behavior

The depth to water level varies from 5.09m to 6.57 m during the pre-monsoon season and from 3.26 to 5.28 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1, 2, 3& 4).

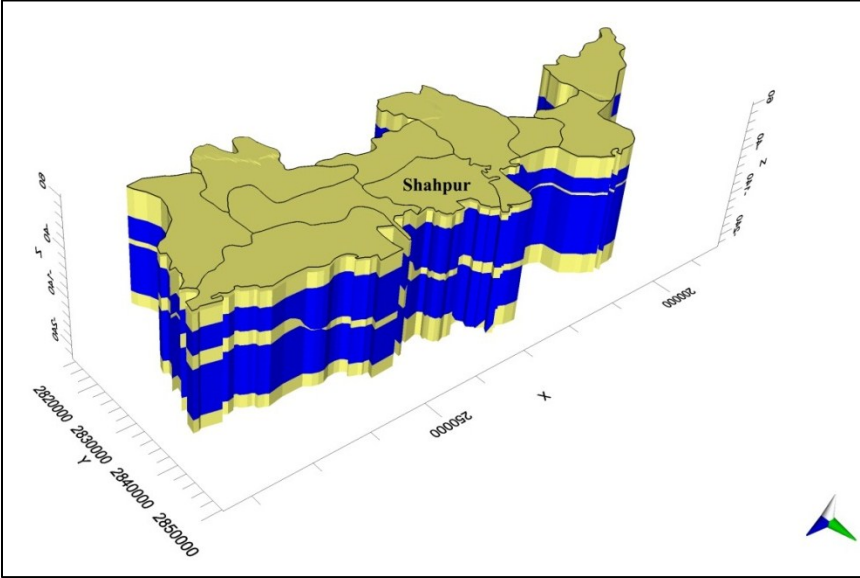


Fig1 :3D View of aquifer disposition

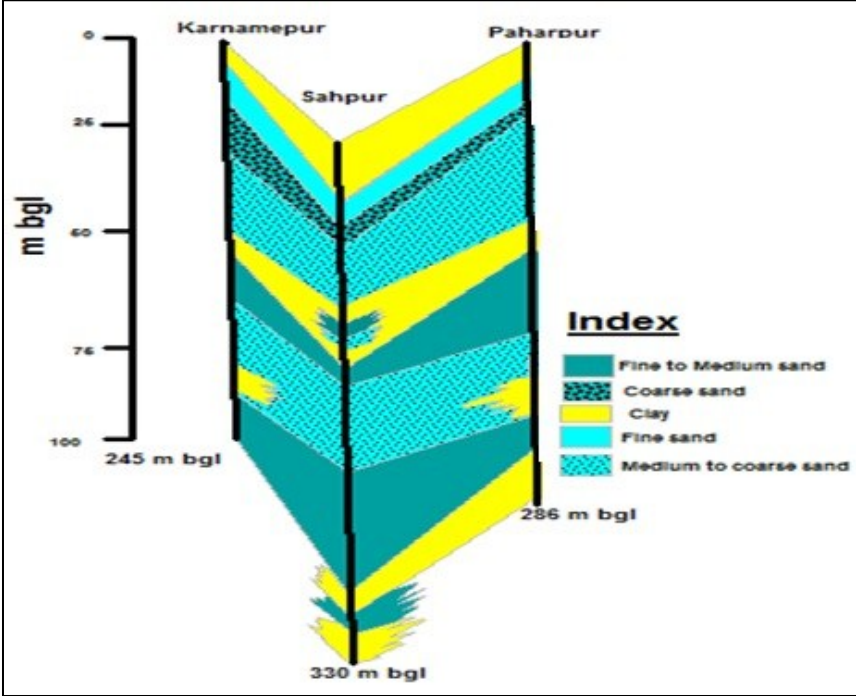




Fig2 :2D View of aquifer disposition

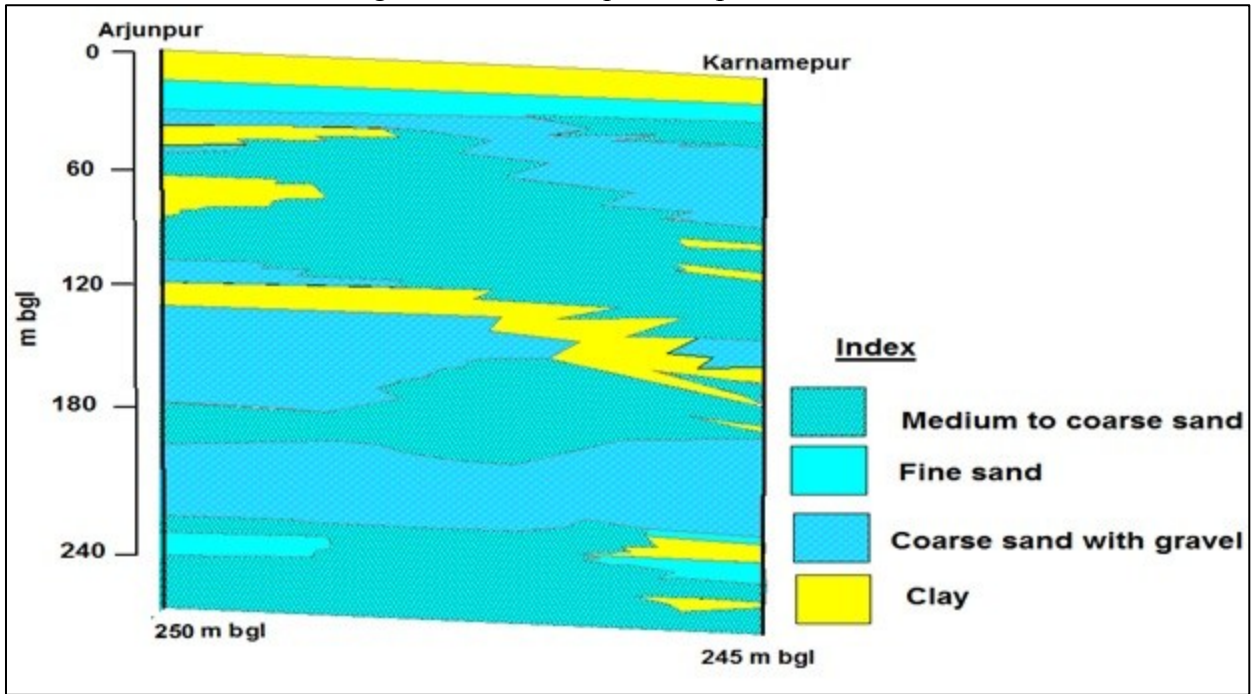


Fig3 :2D View of aquifer disposition

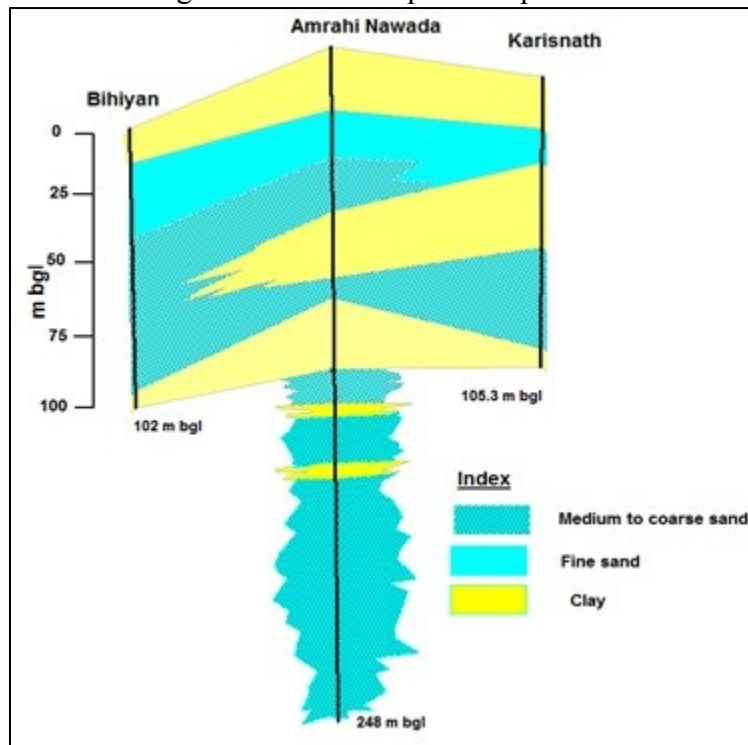


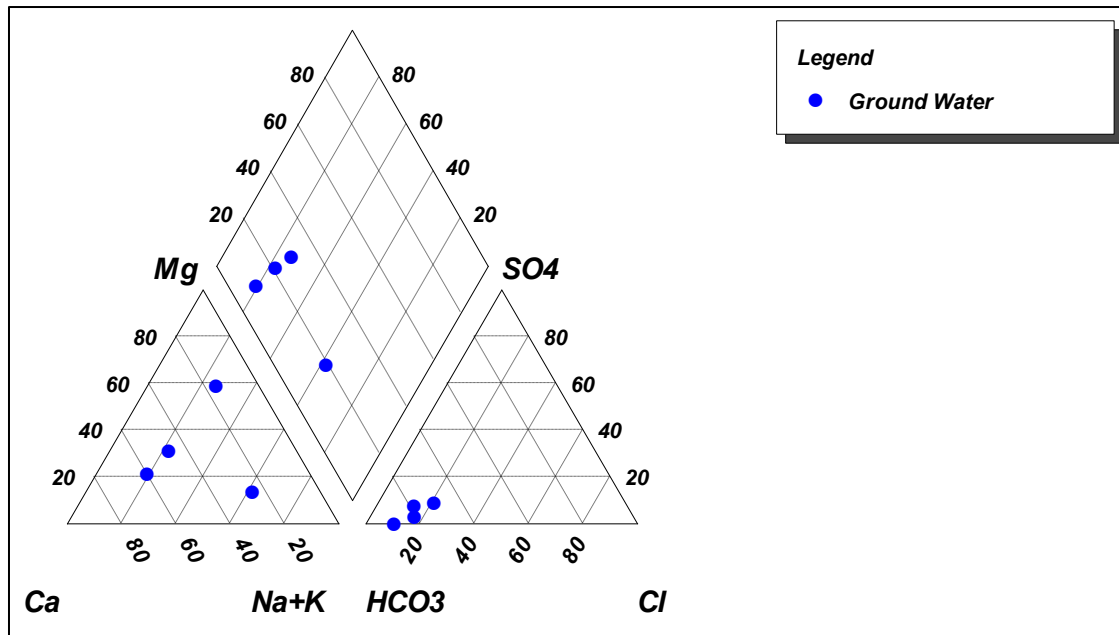
Fig3 :2D View of aquifer disposition



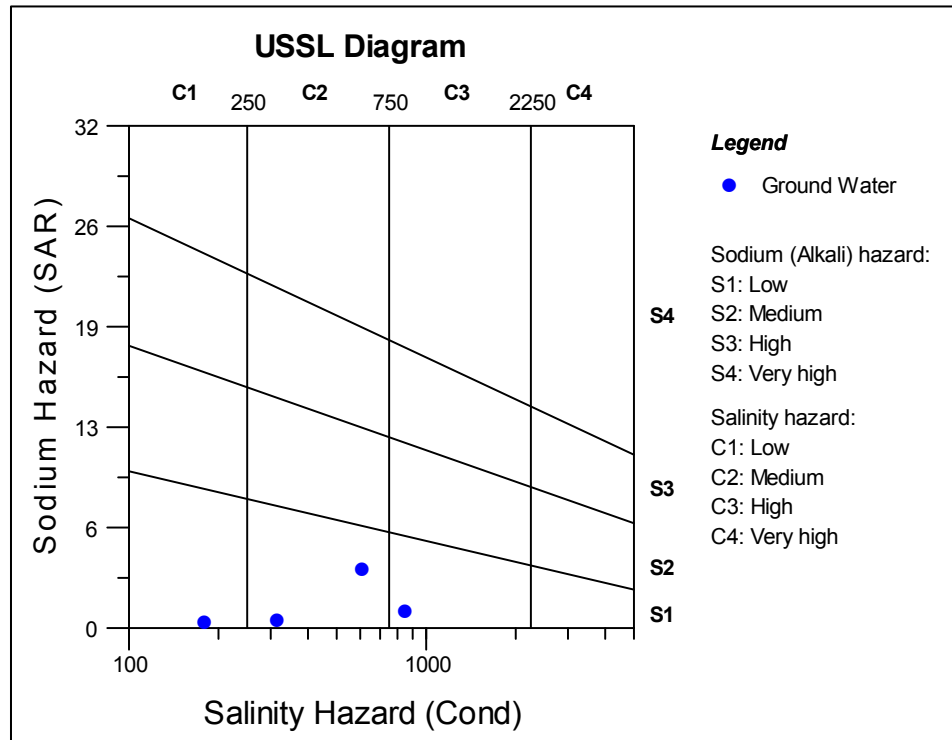
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 56.1%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



On the basis of piper diagram, ground water of the Shahpur block is Ca+Mg+type₃HCO. Ground water of the study area is suitable for drinking purpose.



ble for irrigation On the basis of USSL diagram ground water of the Shah block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Ex C
	Bhojpur		Shahpur	3838	570	486	229	5123	512	4611	2183	

Chemical analysis of ground water sample

Sl. No.	T. Sh. No.	Sample No.	Location	Block	Source	Long	Lat	pH	EC μ S/cm at 25°C	TDS	Total Hardness	CO3	HCO3	Cl
2	72C6		Shapur patti	Shahpur	HP	84.4089	25.5986	7.6	610	0	140	0	354	
20	72C10	411/17	Jhua	Shahpur	HP	84.5133	25.6294	7.8	316	205.4	150	0	201	
36		457	Bara	Shahpur	HP	84.4783	25.6175	7.58	852	545.28	315	0	366	
37		457	Barsaun	Shahpur	HP	84.4392	25.6283	8.42	180	115.2	100	9	104	



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Udwananagar

District/ State

Bhojpur/Bihar

Rainfall

The normal annual rainfall of Bhojpur district is 1080 mm of which 85 % occurs during the monsoon season. The normal rainfall during monsoon season is 923mm and during non-monsoon season is 157mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Udwananagar Block has been assessed as 71.64MCM. The gross ground water draft for all uses stands at 31.50MCM. The stage of Development is 44%) Annexure I.(

Water level behavior

The depth to water level varies from 2.03m to 7.26 m during the pre-monsoon season and from 2.58 to 4.89 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

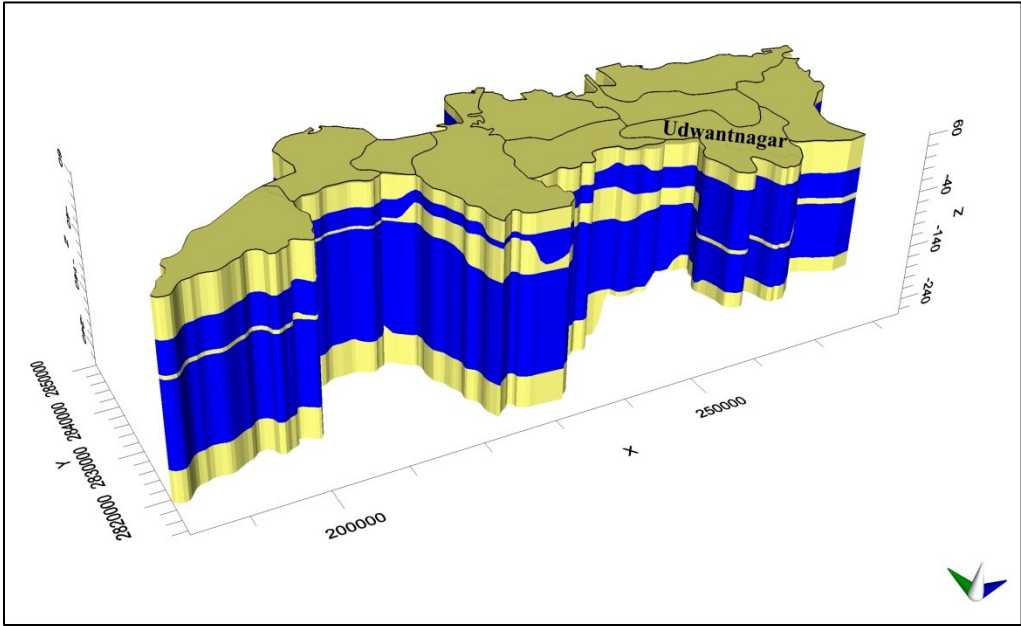


Fig1 :3D View of aquifer disposition

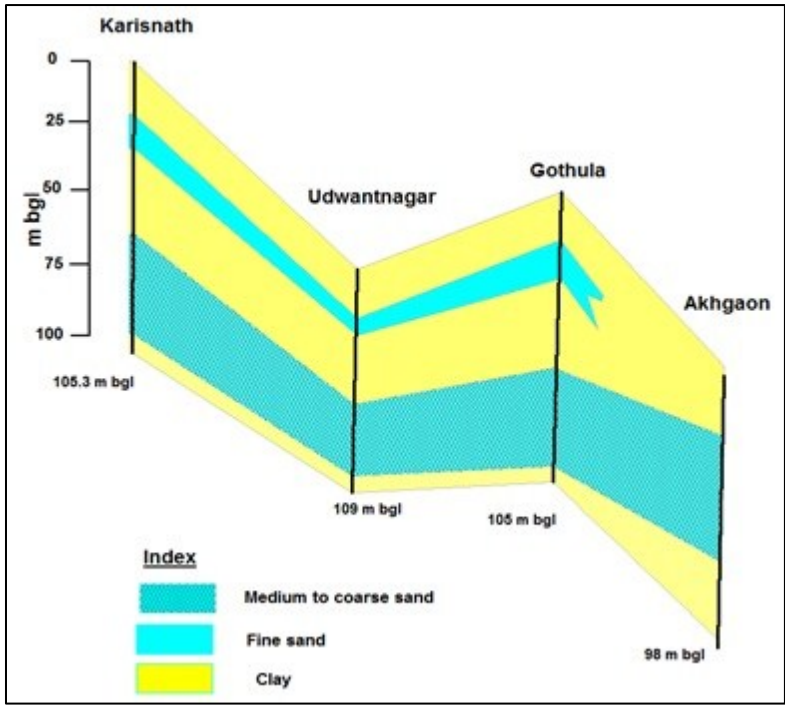


Fig2 :2D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

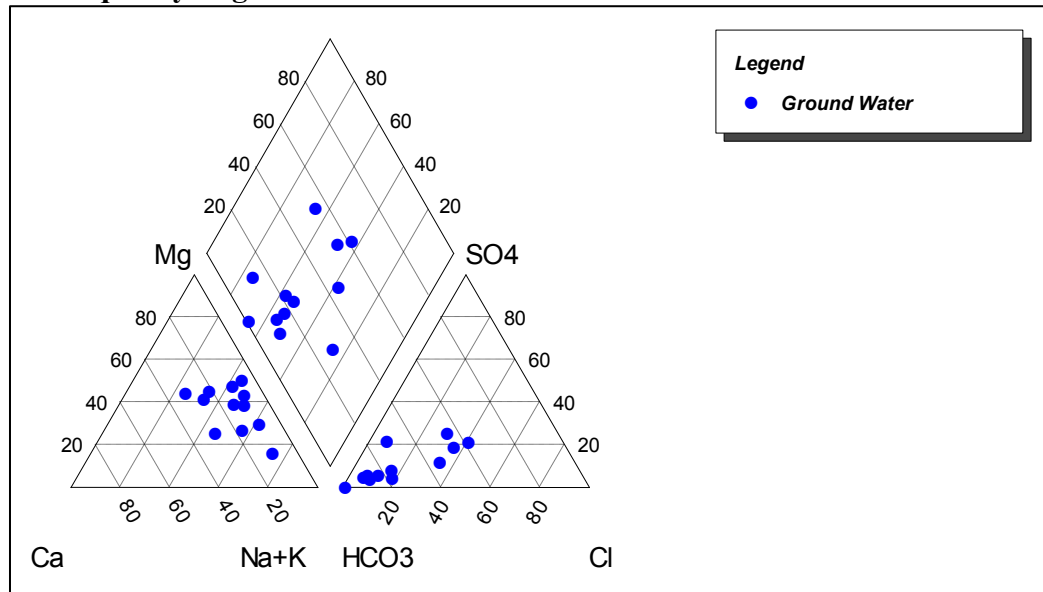
The overall stage of groundwater development in the Block is 44%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd



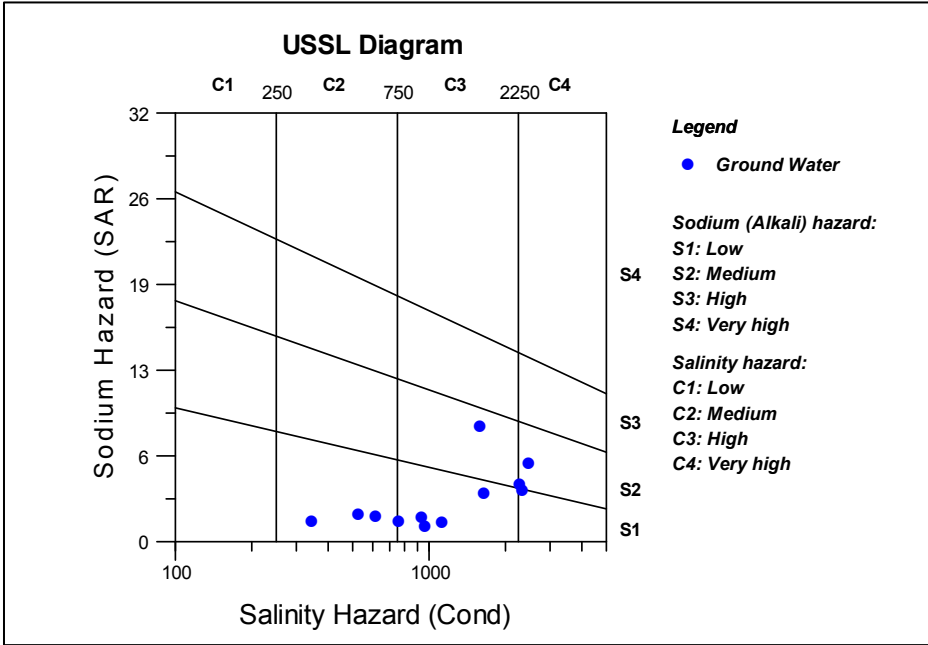
aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



On the basis of piper diagram, block is Ca Uwantnagar ground water of the+Mg+₃HCO type. water of the study area is suitable for drinking purpose Ground.



except few sample On the basis of USSL diagram, ground water of the block is suitable for irrigation purposes also Udwanthnagar.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Annexure-I

Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation
	Bhojpur		Udwantnagar	3178	2865	548	950	7541	377	7164	2913

Annexure-II

Chemical analysis of ground water

Sl. No.	T. Sh. No.	Sample No.	Location	Block	Source	Long	Lat	pH	EC μ S/cm at 25°C	TDS	Total Hardness	CO ₃	HCO ₃	C
21	72C10	399/3	Udwantnagar	Udwantnagar	HP	84.6254	25.5003	7.35	760	494	250	0	760	
22	72C10	399/4	Kasap	Udwantnagar	DW	84.6074	25.4752	7.1	2340	1521	721	0	2340	
23	72C10	399/8	Harnath Kundi	Udwantnagar	DW	84.5739	25.5741	7.3	965	627.25	367	0	965	
25	72C11	397/8	Pinniya	Udwantnagar	DW	84.6533	25.4952	7.9	1590	1033.5	240	0	781	
26	72C11	397/9	Belaur	Udwantnagar	DW	84.6428	25.4509	7.41	1650	1072.5	450	0	781	
27	72C11	397/16	Ekauna	Udwantnagar	DW	84.6436	25.5199	7.66	2471	1606.15	480	0	817	
28	72C11	397/28	Harnath kundi	Udwantnagar	DW	84.5727	25.5725	7.74	2280	1482	610	0	647	
32		457	Udwantnagar	Udwantnagar	HP	84.6252	25.5001	8.72	618	395.52	165	12	317	
33		457	Kasap	Udwantnagar	HP	84.6085	25.4781	8.86	528	337.92	130	15	246	
34		457	Chandwa	Udwantnagar	HP	84.6333	25.55	8.48	345	220.8	95	9	163	
35		457	Chota Sasaram	Udwantnagar	DW	84.5253	25.5697	7.99	1128	721.92	300	0	226	
42		457	Dulapur kosik	Udwantnagar	DW	84.6111	25.5761	8.43	936	599.04	170	9	153	



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Brahampur

District/ State

Buxar /Bihar

Rainfall

The normal annual rainfall of Buxar district is 991 mm of which 86 % occurs during the monsoon season. The normal rainfall during monsoon season is 857mm and during non-monsoon season is 134mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, loam and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Brahampur Block has been assessed as 56.7MCM. The gross ground water draft for all uses stands at 26.41MCM. The stage of Development is 46.6% Annexure I.

Water level behavior

The depth to water level varies from 4.95m to 11.75 m during the pre-monsoon season and from 4.94 to 10.05 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below.

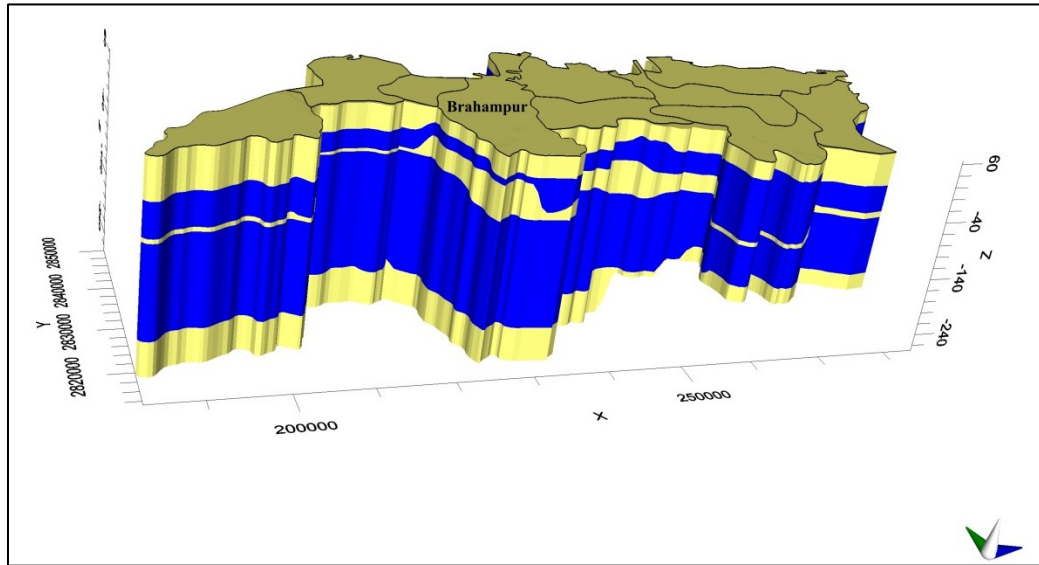


Fig1 :3D View of aquifer disposition

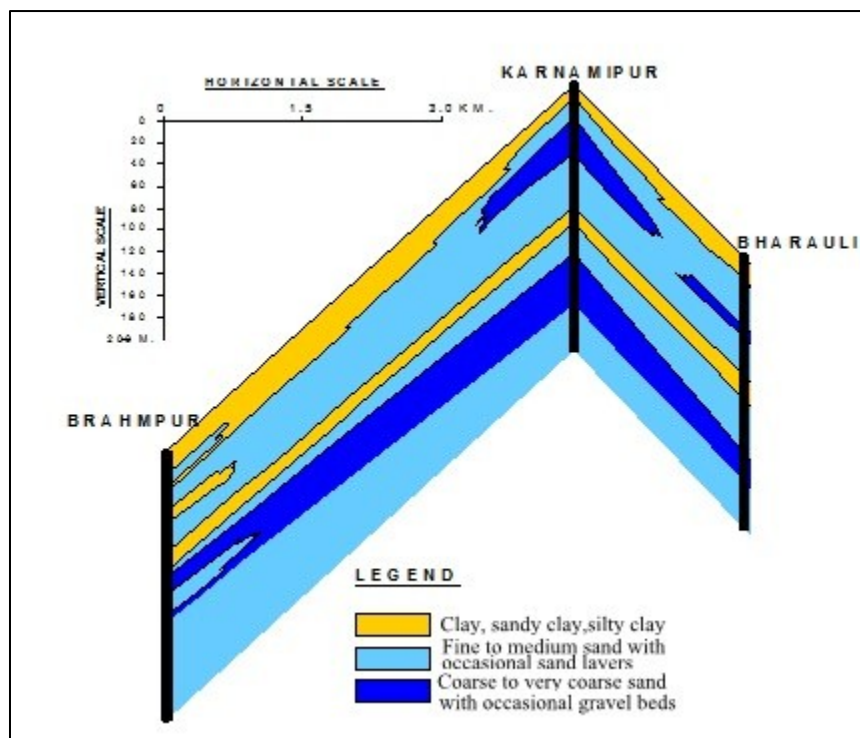


Fig2 :2D view of aquifer disposition

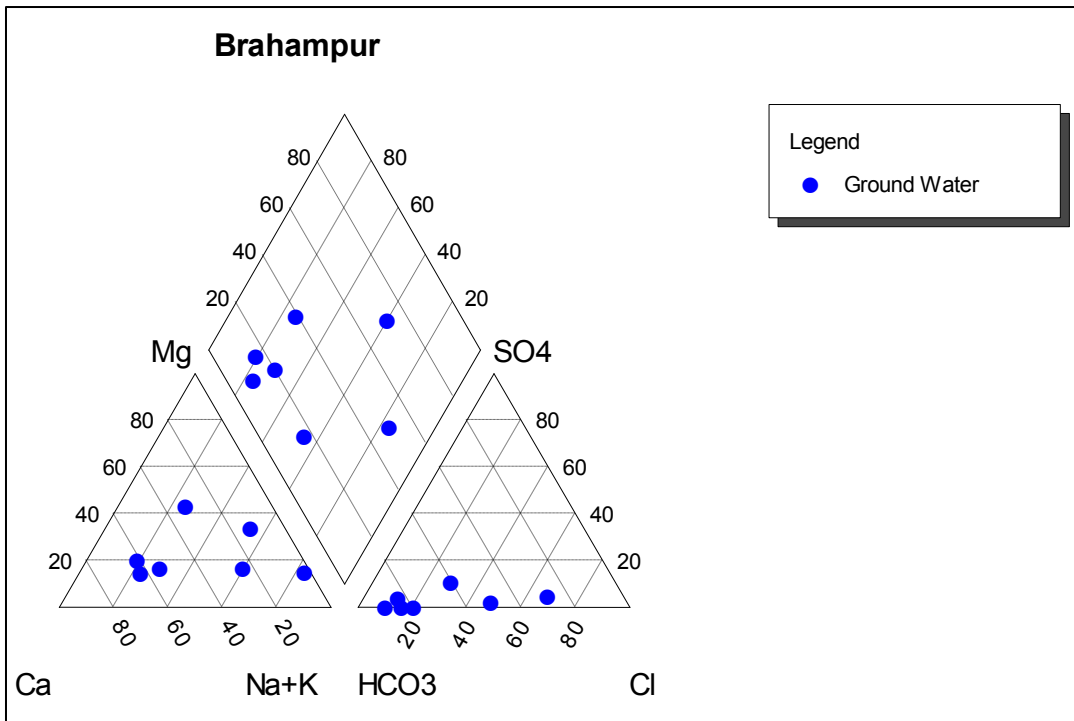
3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 46.6%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is

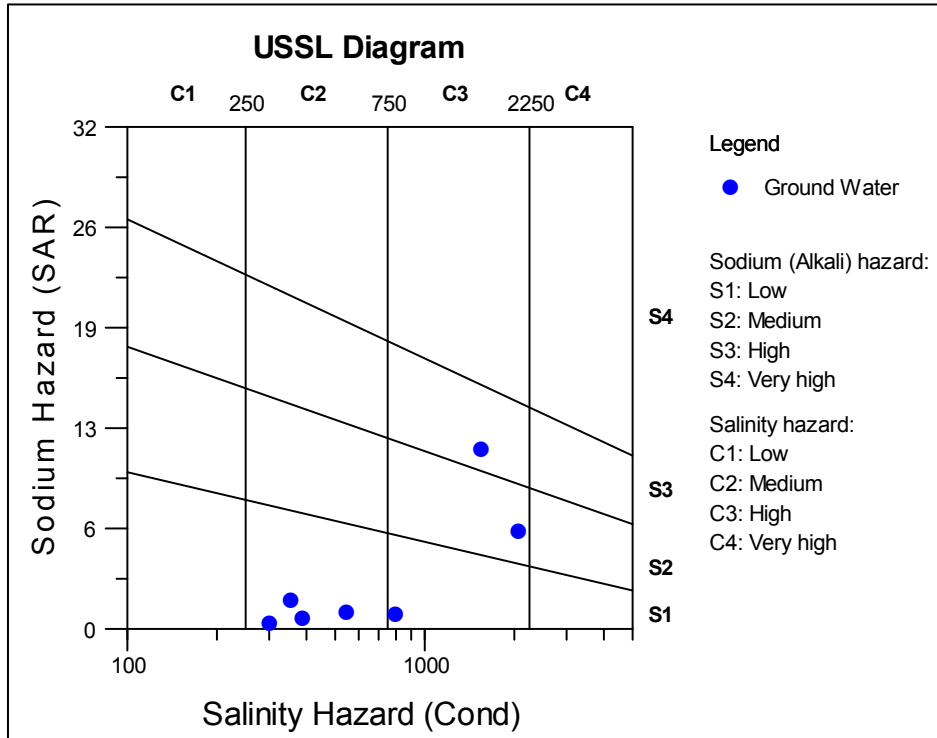


encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



On the basis of piper diagram, Ca ground water of the Brahampur block is $Mg+3HCO$ type. Ground water of the study area is suitable for drinking purpose.



On the basis of USSL diagram ground water of the Brahampur block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non- monsoon season	Recharge from other sources during non- monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Es C G W I F (I
	Buxar		Brahampur	4466	783	571	481	6300	630	5670	2335	306	26

Chemical analysis of ground water sample

Location	Block	Source	Long	Lat	pH	EC μS/cm at 25°C	CO3	HCO3	Cl	F	NO3	SO4	T H
Maharajganj	Brahampur	DW	84.3425	25.6092	8	2077	0	366	525	0.58	54	50	
Ragunathpur	Brahampur	HP	84.3069	25.5608	7.6	548	0	274	42	0.61	12	0	
Jugia Derra	Brahampur	HP	84.2553	25.5931	7.7	390	0	207	14	0.53	1.8	0	
Hathilpur	Brahampur	HP	84.3186	25.6317	7.9	302	0	122	14	0.58	30	0	
Bagen Bazar	Brahampur	HP	84.2928	25.5011	8.63	356	12	153	14	1.11	3.6	5.7	
Khochariwan tola	Brahampur	HP	84.2736	25.5231	7.91	801	0	275	78	0.92	37.1	37.8	
Brahampur	Brahampur	Unconfined	84.3058	25.5956	7.8	1554	0	433.1	244.605	0.06	48.49	14.98	



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Buxar

District/ State

Buxar /Bihar

Rainfall

The normal annual rainfall of Buxar district is 991 mm of which 86 % occurs during the monsoon season .The normal rainfall during monsoon season is 857mm and during non-monsoon season is 134mm .

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Buxar Block has been assessed as 74.03 MCM. The gross ground water draft for all uses stands at 25. 14MCM. The stage of Development is 50. 7%) Annexure 1).

Water level behavior

The depth to water level varies from 4. 78m to 11. 15m during the pre-monsoon season and from 3. 35m to 10.75 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1, 2& 3)).

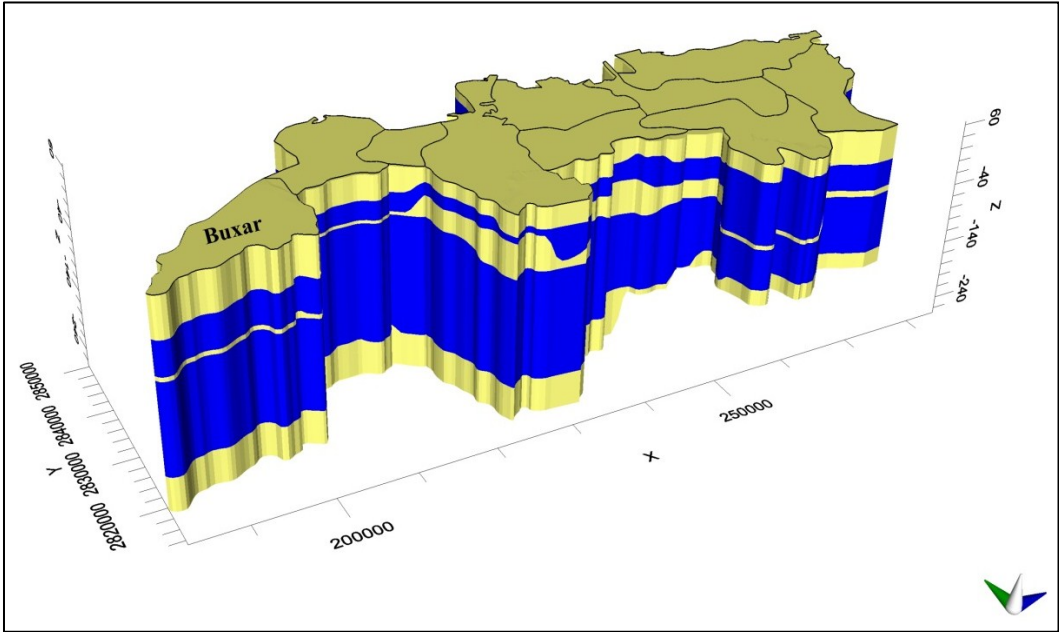


Fig1 :3D View of Aquifer disposition

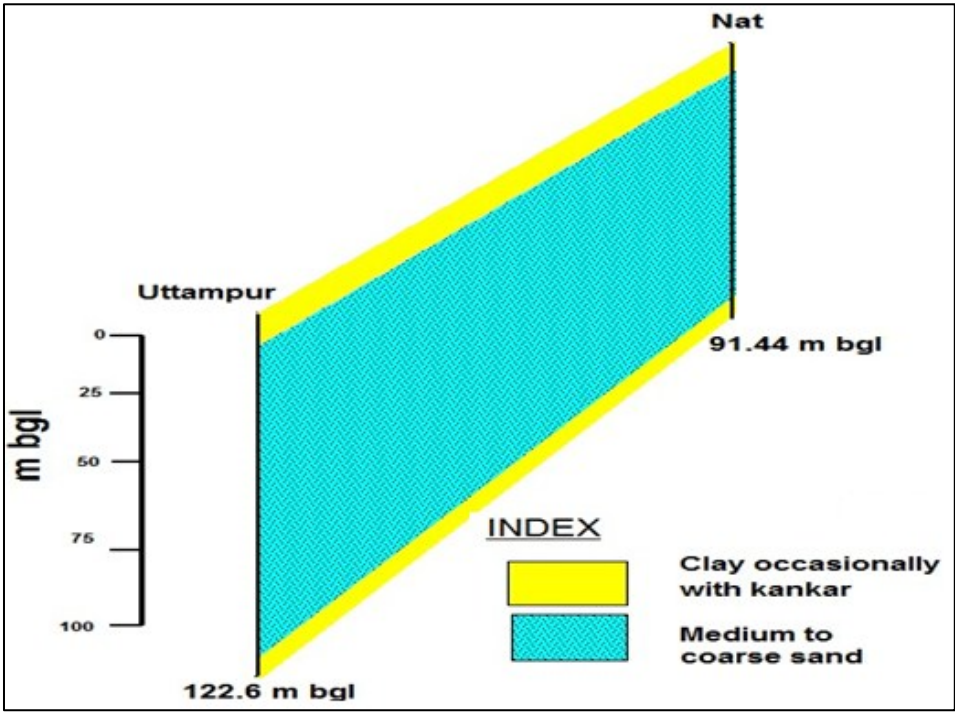


Fig2 :2D View of aquifer disposition

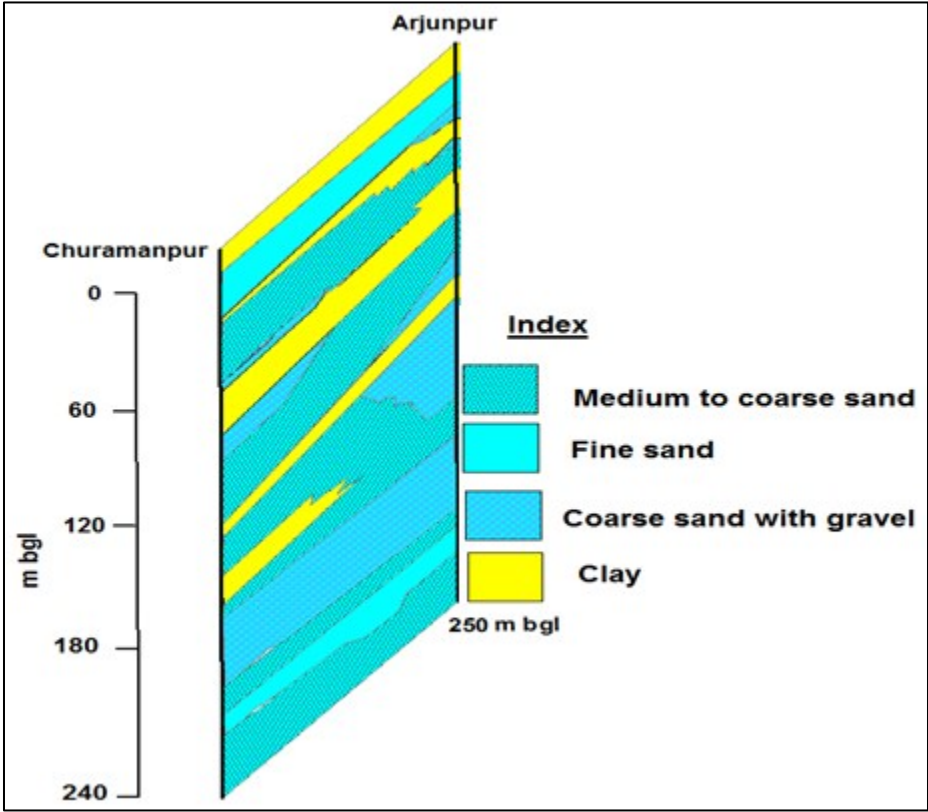


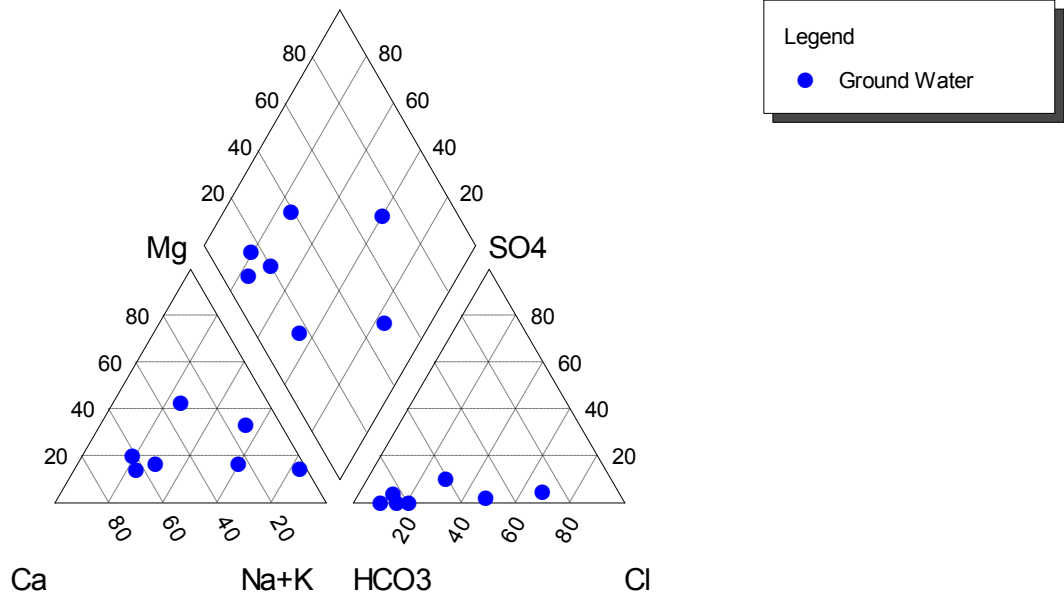
Fig3 :2D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

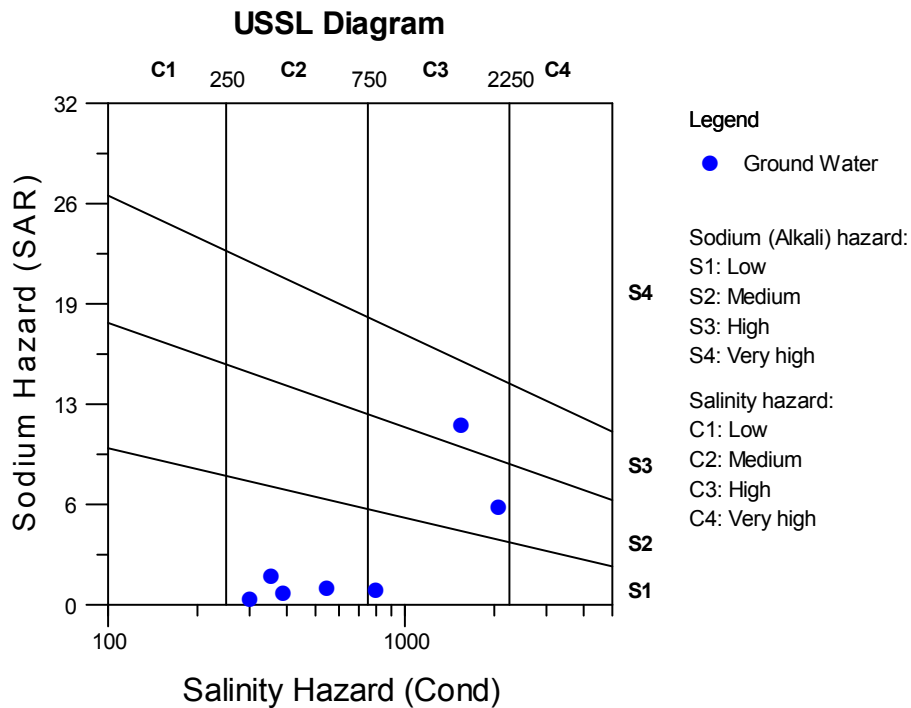
The overall stage of groundwater development in the Block is 50.7%. Thus sufficient scope exists for groundwater development in the Block. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd Aquifer is recommended only for extraction for drinking water supply.



Chemical quality of ground water and contamination



On the basis of piper diagram, Ca ground water of the Buxar block is $Ca+Mg$ type HCO_3 . Ground water of the study area is suitable for drinking purpose.



On the basis of USSL diagram ground water of the Buxar block is suitable for irrigation purposes also.



4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Annexure-1

Dynamic Ground Water Resource

SN (Block)	District	SN (District)	Block	Recharge from Rainfall during monsoon season	Recharge from other sources during monsoon season	Recharge from Rainfall during non-monsoon season	Recharge from other sources during non-monsoon season	Total Annual Ground Water Recharge	Provision for Natural Discharge	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)
	Buxar		Buxar	3933	2380	530	948	7792	390	7403	2063	451	2514

Annexure- II

Chemical analysis of ground water sample

Location	Block	Source	Long	Lat	pH	EC $\mu\text{S/cm}$ at 25°C	CO3	HCO3	Cl	F	NO3	SO4	Total Hard
Maharajganj	Brahampur	DW	84.3425	25.6092	8	2077	0	366	525	0.58	54	50	
Ragunathpur	Brahampur	HP	84.3069	25.5608	7.6	548	0	274	42	0.61	12	0	
Jugia Derra	Brahampur	HP	84.2553	25.5931	7.7	390	0	207	14	0.53	1.8	0	
Hathilpur	Brahampur	HP	84.3186	25.6317	7.9	302	0	122	14	0.58	30	0	
Bagen Bazar	Brahampur	HP	84.2928	25.5011	8.63	356	12	153	14	1.11	3.6	5.7	
Khochariwan tola	Brahampur	HP	84.2736	25.5231	7.91	801	0	275	78	0.92	37.1	37.8	
Brahampur	Brahampur	Unconfined	84.3058	25.5956	7.8	1554	0	433.1	244.605	0.06	48.49	14.98	



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Chakki

District/ State

Buxar /Bihar

Rainfall

The normal annual rainfall of Buxar district is 991 mm of which 86 % occurs during the monsoon season .The normal rainfall during monsoon season is 857mm and during non-monsoon season is 134mm .

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, laom and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Chakki Block has been assessed as 32.9 MCM. The gross ground water draft for all uses stands at 29.1 MCM. The stage of Development is 88.5%) Annexure I.(

Water level behavior

The depth to water level varies from 5. 11m to 7. 05m during the pre-monsoon season and from 5.62 to 5.93 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

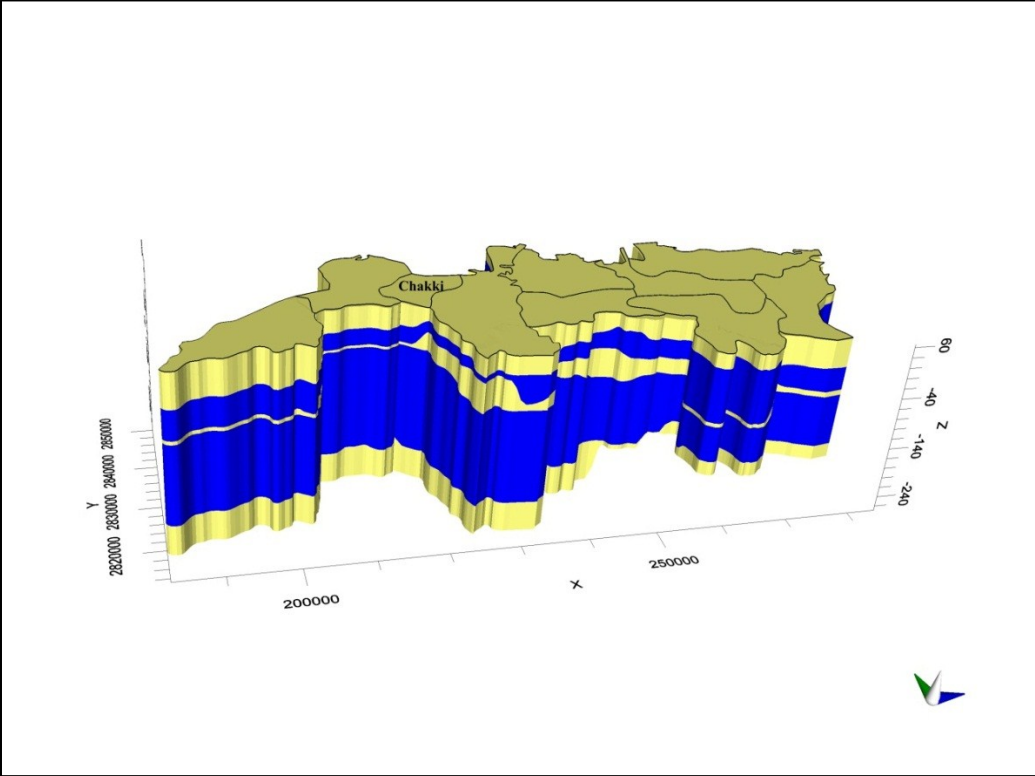


Fig1 :3D View of aquifer disposition

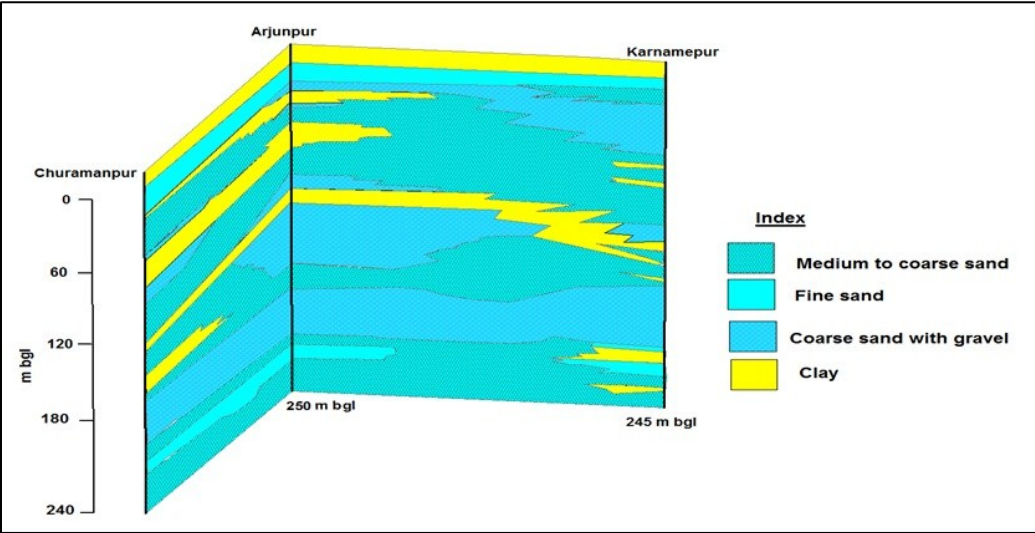


Fig2 :2 D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 88. 5%. Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are vulnerable



to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

<i>SN (Block)</i>	<i>District</i>	<i>SN (District)</i>	<i>Block</i>	<i>Recharge from Rainfall during monsoon season</i>	<i>Recharge from other sources during monsoon season</i>	<i>Recharge from Rainfall during non- monsoon season</i>	<i>Recharge from other sources during non- monsoon season</i>	<i>Total Annual Ground Water Recharge</i>	<i>Provision for Natural Discharge</i>	<i>Net Annual Ground Water Availability</i>	<i>Existing Gross Ground Water Draft for Irrigation</i>	<i>Ex G Gr w Dr Do c Ind W St</i>
	Buxar		Chakki	197	111	25	32	365	37	329	227	



Block wise Aquifer Maps and Management plans

1. Salient Information

Name of the Block and Area (in Km²)

Simri

District/ State

Buxar /Bihar

Rainfall

The normal annual rainfall of Buxar district is 991 mm of which 86 % occurs during the monsoon season. The normal rainfall during monsoon season is 857mm and during non-monsoon season is 134mm.

Agriculture and Irrigation

The Block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice- Wheat, Rice-Gram, Rice- lentil and Rice- Rai. The soils in this zone are sandy loam, clay loam, loam and clay with pH in the range of 6.8-8. The variation of rainfall in this zone is from 990 mm to 1240 mm and the temperature varies from 37.1 to 7.8°C.

Ground water resource availability and extraction

The dynamic ground water resource of Simri Block has been assessed as 46.94MCM. The gross ground water draft for all uses stands at 22.80 MCM. The stage of Development is 48.6%) Annexure I(.

Water level behavior

The depth to water level varies from 5.42m to 10.5 m during the pre-monsoon season and from 4.37 to 8.8 m during the post-monsoon season.

2. Aquifer Disposition

The area is bestowed with two- aquifer system. The section depicting the aquifer disposition is shown below) Fig 1& 2).

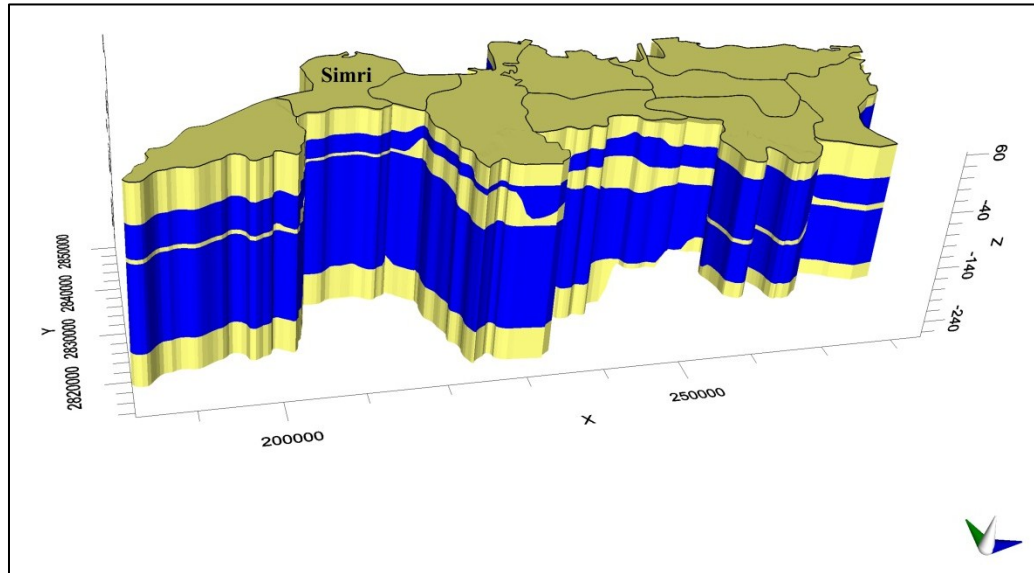


Fig1 :3D View of aquifer disposition

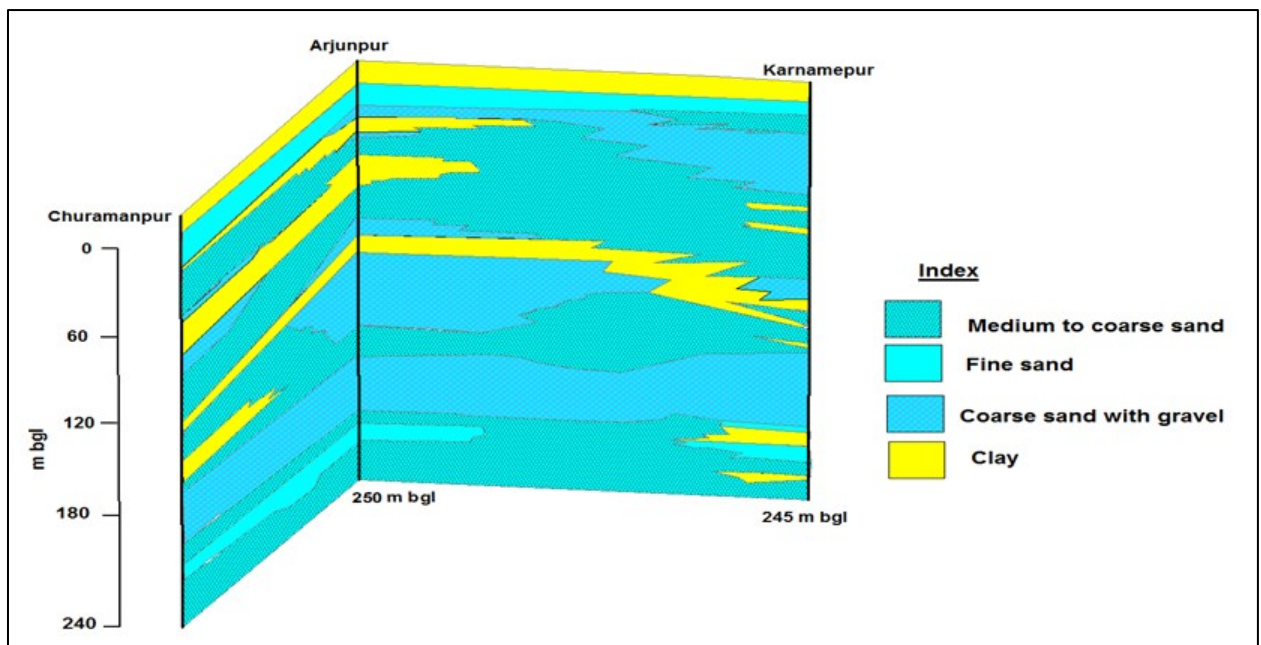


Fig2 :2D View of aquifer disposition

3. Ground water resource, extraction, contamination and other issues

The overall stage of groundwater development in the Block is 48.6%. Thus sufficient scope exists for groundwater development in the Block.

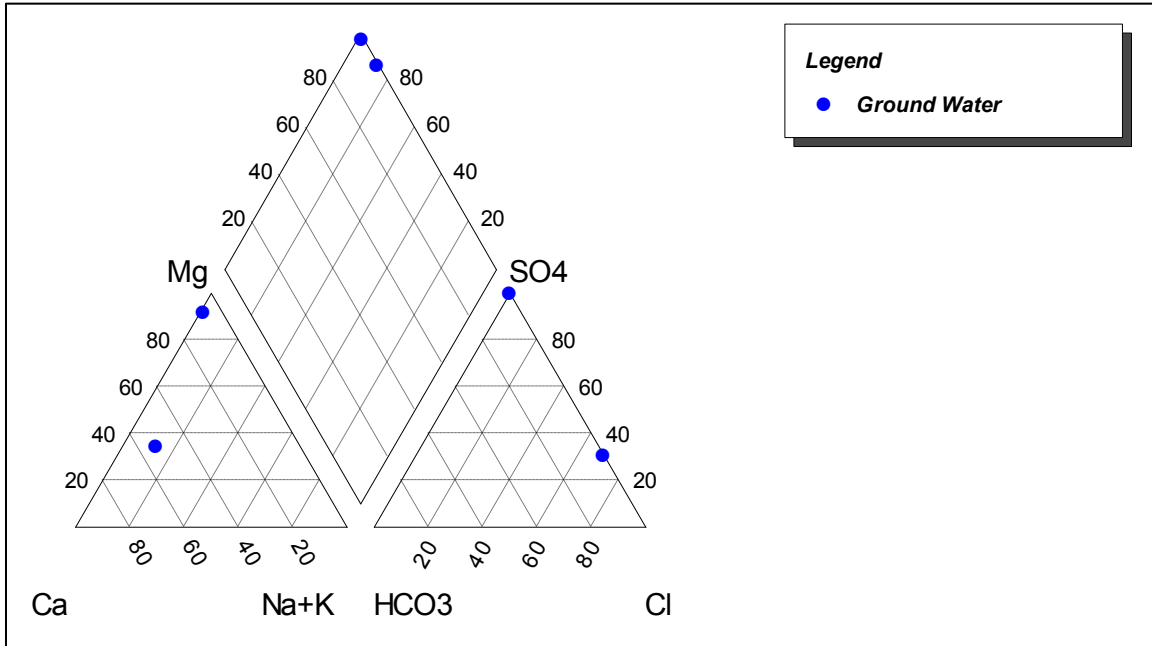
Arsenic contamination of groundwater has been reported from the 1st aquifer in the younger alluvial belt upto the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safe from arsenic contamination. The 2nd aquifer is thus recommended for community drinking water supply. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit, however, these are



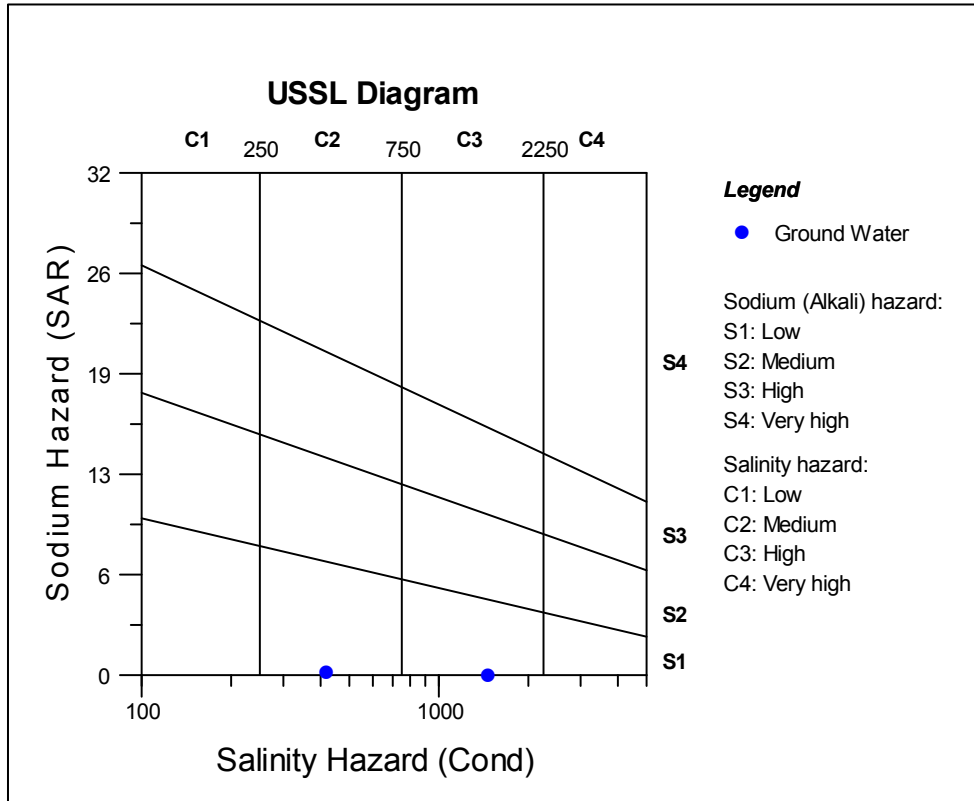
vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energised extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers.

The 2nd Aquifer is recommended only for extraction for drinking water supply.

Chemical quality of ground water and contamination



On the basis of piper diagram, ground water of the Simri block is Ca+Mg+type₃HCO₃. Ground water of the study area is suitable for drinking purpose.



On the basis of USSL diagram ground water of the Buxar block is suitable for irrigation purposes also.

4. Ground water resource enhancement

As the stage of groundwater development is within the safe limits and there is no long-term water level decline in the area, the need for artificial recharge is not felt.

5. Demand side interventions

In view of the issue of arsenic contamination, it is recommended to use the 2nd Aquifer solely for meeting the drinking water supply requirement. Necessary regulations to enforce this recommendation in the arsenic affected Blocks may be made so as to keep the 2nd aquifer safe from arsenic contamination.



Dynamic Ground Water Resource

<i>SN (Block)</i>	<i>District</i>	<i>SN (District)</i>	<i>Block</i>	<i>Recharge from Rainfall during monsoon season</i>	<i>Recharge from other sources during monsoon season</i>	<i>Recharge from Rainfall during non- monsoon season</i>	<i>Recharge from other sources during non- monsoon season</i>	<i>Total Annual Ground Water Recharge</i>	<i>Provision for Natural Discharge</i>	<i>Net Annual Ground Water Availability</i>	<i>Existing Gross Ground Water Draft for Irrigation</i>
	Buxar		Simari	3970	568	507	170	5215	522	4694	1942

Chemical analysis of ground water sample

Sl. No.	T. Sh. No.	Sample No.	Location	Block	Source	Long	Lat	pH	EC μS/cm at 25°C	TDS	Total Hardness	CO ₃	HCO ₃	Cl
51		HNS	Neazipur	Simri	Unconfined	84.1417	25.6792	9.1	1469	63	713.7	42.54	0	
52		HNS	Arjunpur	Simri	Confined	84.1598	25.6741	7.5	420	0	207	7.1	0	

