



## केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण  
विभाग, जल शक्ति मंत्रालय

भारत सरकार

### **Central Ground Water Board**

Department of Water Resources, River  
Development and Ganga Rejuvenation,  
Ministry of Jal Shakti  
Government of India

## **AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES**

**Arwal District  
Bihar**

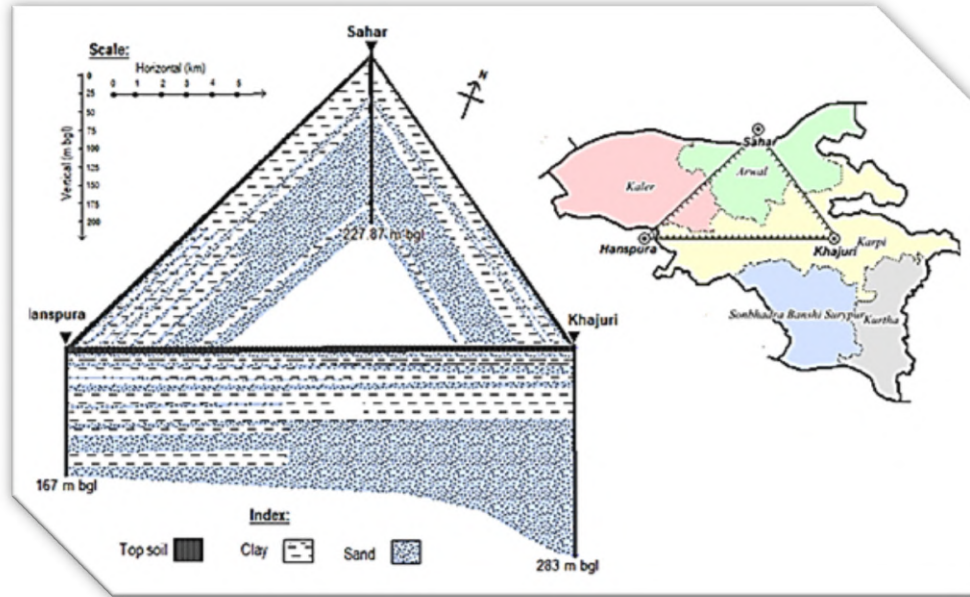
मध्य पूर्वी क्षेत्र, पटना  
Mid Eastern Region, Patna



भारत सरकार  
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# जलभृत मानचित्रण और भूजल प्रबंधन योजना अरवल जिला, बिहार

## Aquifer Mapping and Ground Water Management Plan Arwal District, Bihar



क्षेत्रीय कार्यालय  
मध्य-पूर्वी क्षेत्र, पटना  
**Regional Office**  
Mid-Eastern Region, Patna

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Report on

जलभृत मानचित्रण और भूजल प्रबंधन योजना  
**अरवल जिला, बिहार**  
Aquifer Mapping and Ground Water Management Plan  
**Arwal District, Bihar**

NAQUIM Phase - VI  
AAP - 2018-19

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**Aquifer Mapping and Ground Water Management Plan  
(2018-19)  
Arwal District  
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## 1. INTRODUCTION

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The vagaries of rainfall, inherent heterogeneity of aquifer systems, over exploitation of once copious aquifers, lack of regulation mechanism etc. has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from “Traditional Groundwater Development concept” to “Modern Groundwater Management concept”. Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers. The proposed management plans will provide the “Road Map” for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM (National Aquifer Mapping) is not merely mapping, but reaching the goal-that of ground water management through community participation.

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present studies of Arwal district have been taken up in AAP 2018-19 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Arwal district and other user agencies for its effective implementation.

### 1.1 Objective and Scope

The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization
- Quantification of ground water availability and assessment of its quality to formulate aquifer management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.



The groundwater management plan includes Ground Water recharge, conservation, harvesting, development options and other protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan.

The main activities under NAQUIM are as follows:

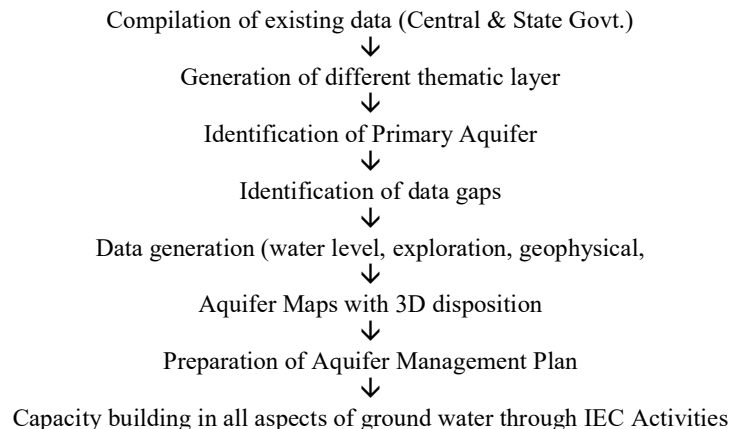
- a). Identifying the aquifer geometry
- b). Aquifer characteristics and their yield potential
- c). Quality of water occurring at various depths
- d). Aquifer wise assessment of ground water resources
- e). Preparation of aquifer maps and
- f). Formulate ground water management plan.

The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a “Road Map” to systematically manage the ground water resources for equitable distribution across the spectrum.

## 1.2 Approach and Methodology

The on-going activities of NAQUIM include hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilization for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:



### 1.3 Area Details

Arwal is one of the 38 districts and the second smallest district of Bihar State covers an area of 638 km<sup>2</sup>. Earlier, it was a part of Jehanabad district and came into existence in August 2001. It lies between longitude of 84° 26' - 84° 52' E and latitudes of 25° 02' - 25° 19' N. It is divided into five (5) administrative block viz Arwal, Kaler, Kurtha, Karpi, Banshi Suryapur (Sonbhadra). District headquarter is located in Arwal block. **(Figure -1)** Sone Rivers forms western boundary of the district and separates it from Rohtas and Bhojpur district. The district shares boundary in the north with Patna, in the east with Jehanabad and in the south with Aurangabad and Gaya district. There is total 65 Gram Panchayats in the district representing 335 villages. Arwal is the only town/urban area in the district.

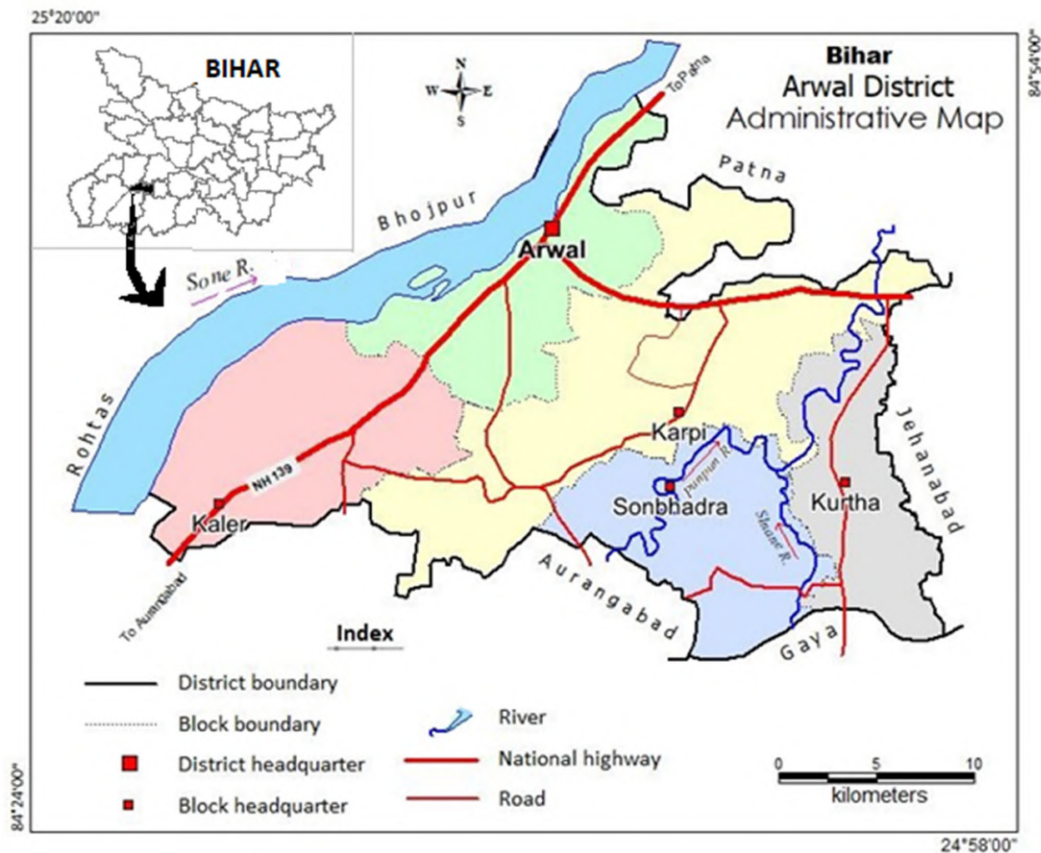


Figure 1: Administrative Map

As per Census -2011, total population of the district was 700843. Urban population is about 7% only. Population growth rate during 2001 census was 29.84 which are reduced to 18.89 during 2011 census. Karpi block have the highest population of 19493 whereas Kurtha block has the lowest (8929).

**Table 1:** Demographic details of Administrative Blocks (2011)

SN	Block	Administrative Area (ha)	Population		
			Rural	Urban	Total
1	Arwal	12182	107837	51849	159686
2	Sonbhadra	8996	78185	0	78185
3	Karpi	19493	192213	0	192213
4	Kurtha	8929	121818	0	121818
5	Kaler	14083	148941	0	148941
<b>Total</b>		<b>63683</b>	<b>648994</b>	<b>51849</b>	<b>700843</b>

Population growth has the direct impact on consumption of water for domestic purpose. As per the recommendation of PHED, domestic consumption of water taken for Ground water estimation is 40 and 135 lit. per day per person for urban and rural area in Bihar state respectively. Population growth rate of 18.89% has been taken for each block and generated demand of water for domestic use for the year 2018 is calculated and given in **table**

**Table 2:** Calculated ground water draft for domestic use in the year 2018

SN	Block	Population (2011)			Projected Population (2018)			Total draft In Ha (2018)
		Rural	Urban	Total	Rural	Urban	Total	Total
1	Arwal	107837	51849	159686	404609	194540	599149	1442.81
2	Sonbhadra	78185	0	78185	293353	0	293353	428.30
3	Karpi	192213	0	192213	721191	0	721191	1052.94
4	Kurtha	121818	0	121818	457066	0	457066	667.32
5	Kaler	148941	0	148941	558833	0	558833	815.90
<b>Total</b>		<b>648994</b>	<b>51849</b>	<b>700843</b>	<b>2435052</b>	<b>194540</b>	<b>2629592</b>	<b>4407.26</b>

<https://slusi.dacnet.nic.in/dmwai/BIHAR/Districts/ARWAL.html>

As per the official websites of 'Jeevan Mission - Har Ghar Jal', the Arwal district has the highest percentage of household connected with tape water supply system (05 Feb. 2021) in Bihar. About 95.3% of total households in the district are already been connected with tape water supply system.

#### 1.4 Brief Description

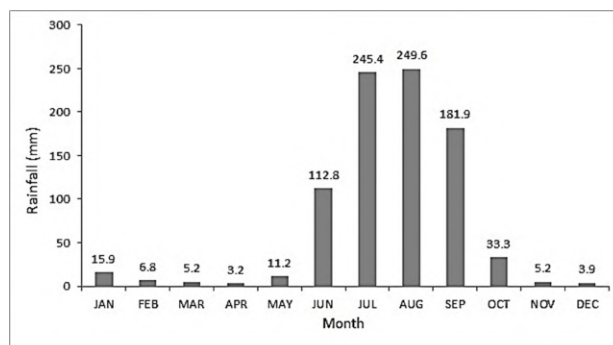
The total geographical area of the district is characterized by the fertile alluvial plain. Roughly, the national highway No. 139 passing through the district is almost following the water divide. The Punpun river with its tributaries drain about 77% area of the district. Western side of NH-139 is drained by river Sone. The maximum and minimum altitude of the district is 64.9 and 95.4 m amsl.

### 1.4.2 Data Adequacy and Data Gap Analysis and Data Generation

Central Ground Water Board has carried out systematic and reappraisal hydrogeological surveys, exploratory drilling under groundwater exploration programme and ground water regime monitoring etc. One exploratory well has been drilled at Khajuri in Karpri blocks. Total 7 (seven) National Hydrograph stations are being monitored four times in a year i.e. during in the month of January, May, August and November. The district has been covered under Hydrogeological survey during the year 1995 as a part of Jehanabad district. One district report has also been published in the year 2004-05. During the study, 06 additional key wells (total 13 wells) have been established to know the ground water behaviour in the district.

### 1.4.3 Rainfall-spatial and Temporal Distribution

Area experiences a tropical monsoon climate. The year may be divided into three seasons. The monsoon season initiates by mid-June and continues till the end of September. **(Figure- 2)** There is slight rainfall in October but November and December are quite dry. The rainy season receives south-west monsoon and accounts for about 85-90% of the total rainfall.



Source: IMD

**Figure 2:** Normal Rainfall

In comparison to normal rainfall (1951-2000) pattern, it is observed that in last five years there is a decrease in rainfall in monsoon season except the year 2016. The rainfall during Rabi season is observed to be decreased over the last five years.

**Table 3:** Rainfall Departure

Year	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D	R/F	%D
2014	27.4	72	24.8	265	8.4	62	0	-100	17.8	59	22.5	-80	107.3	-56	139.6	-44	123.9	-32	12.3	-63	0	-100	1.3	-67
2015	9.4	-41	0	-100	15.4	197	16.1	403	0.6	-95	206.2	83	242.4	-1	234.5	-6	81	-55	0	-100	0	-100	0	-100
2016	3.3	-79	0	-100	4.2	-20	0	-100	7.6	-32	99.3	-12	368.9	50	267.8	7	378.6	108	96.5	190	0	-100	0	-100
2017	0	-100	0	-100	4.3	-17	8.4	163	11.4	2	20.3	-82	292.9	19	101.4	-59	113.1	-38	0	-100	0	-100	0	-100
2018	0	-100	0	-100	0	-100	0	-100	0.9	-92	42.3	-63	156.6	-36	203.6	-18	96.3	-47	0	-100	0	-100	0	-100

Source:-IMD

The district is a part of South West plain of Bihar and is kept in Agro-climatic zone – III B. The table shows that district receives normal annual rainfall of 1027 mm.

**Table 4:** Block wise Normal Rainfall and No. of Rainy Days

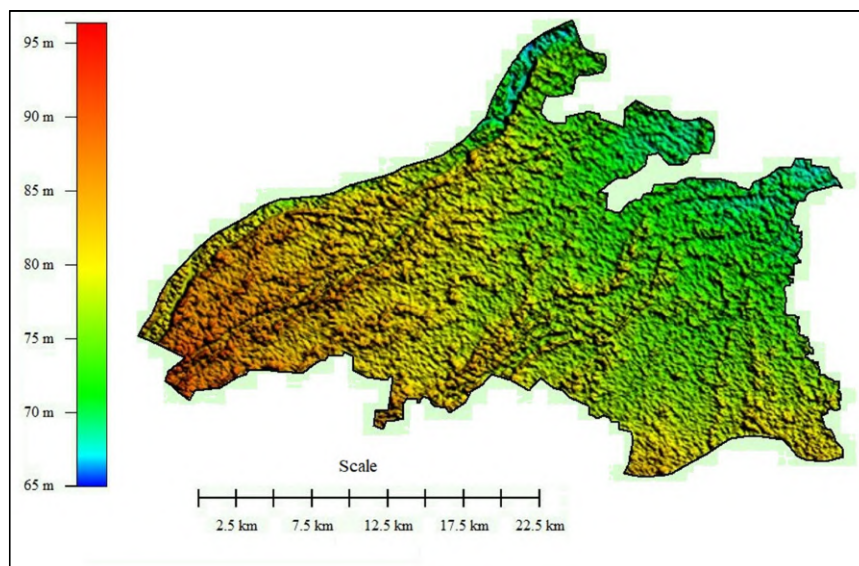
<i>SN</i>	<i>Block</i>	<i>Area (ha)</i>	<i>Normal Annual rainfall (mm)</i>	<i>No of Rainy Days (Nos)</i>
1	Arwal	12246.77	1027	90
2	Kurtha	8650.43	1020	82
3	Karpi	18743.1	1021	85
4	Bansi	9960.24	1019	85
5	Kaler	14646.98	1021	90
<b>Total</b>		<b>64247.52</b>	<b>1027</b>	<b>86</b>

#### **1.4.4 Physiographic setup**

The area is a part of Central South Bihar Plain formed by the sediments deposited by river Sone and Punpun with their tributaries. It is almost flat area with average height of about 78 m. It gently sloped towards north-east direction. Average difference of maximum and minimum height is about 20 m only. The range of the height varies between 64.9 and 95.4 m amsl.

#### **1.4.5 Physiography DEM**

The elevation in the area ranges from 64.9 and 95.4 m above mean sea level (SRTM data with WGS 84 Spheroid).The generated elevation map by SRTM map is given in **figure-3**.

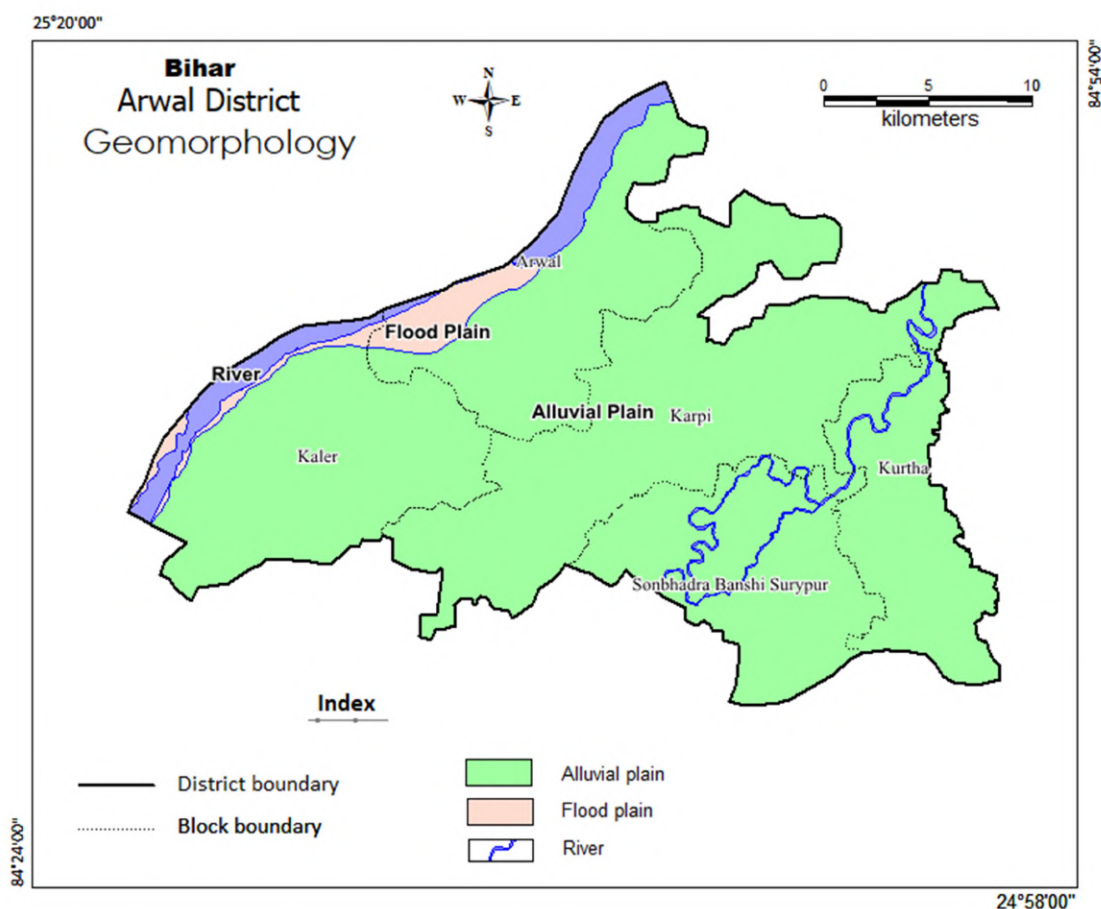


**Figure 3:** Digital Elevation Model of the area based on SRTM Data

### 1.4.6 Geomorphology

Based on map from 'Lgeom', there are only two major types of geomorphic feature in the district:

- (i) *Alluvial plain*: It covers eastern and major part of the district. It can be characterised by the alternating layers of sand, silt and clay. The ground water potential is good in this area.
- (ii) *Flood plain*: It covers western part of the district i.e. neighbouring area of the river Son. The flood plain in the west of river Sone is oxidised clay dominant whereas the east of river Sone is un-oxidised sand and silt dominant.



### 1.4.7 Land Use

The area is dominated by cultivatable land. Only 20% area is not available for cultivation and about 5.5% of the area is fallow land. The Net sown area during the year 2018-19 was about 70% of the area reported. Total 18122 hectare area sown more than once. The cropping intensity during the year reported is about 141%. Land use Statistics of the district is given in **Table-4**.

**Table 5:** Land Use Statistics

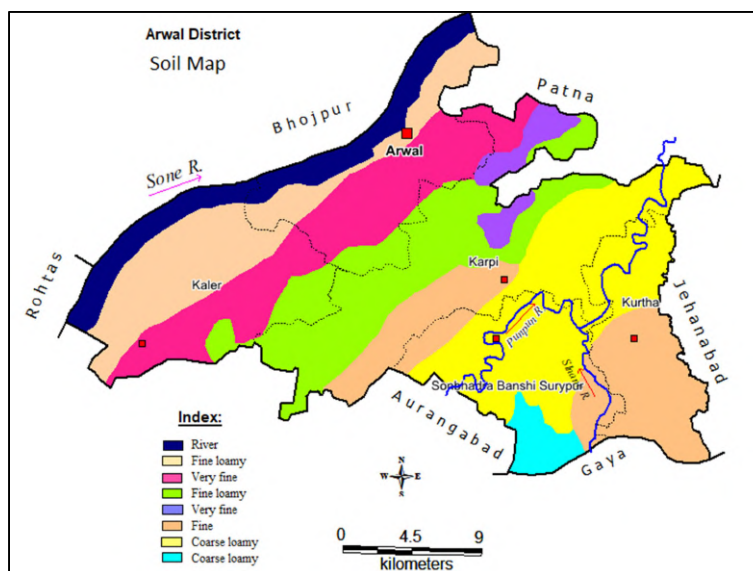
Reporting Area for Land Use Statistics			62631
Classification of Reporting Area	Forests		-
	Not Available for Cultivation	Area Under Non Agricultural Uses	10574
		Barren and Unculturable Land	2180
		<b>Total</b>	12754
	Other Uncultivated Land Excluding Fallow Land	Permanent Pasture and Other Grazing Land	125
		Land Under Misc. Tree Crops and Groves not	942
		Culturable Waste Land	82
		<b>Total</b>	1149
	Fallow Land	Fallow Lands Other Than Current Fallows	1545
		Current Fallow	3465
<b>Total</b>		5010	
Net Area Sown			43718
Cropped Area			61840
Area Sown More Than Once			18122

In Ha

Source: <https://aps.dac.gov.in/>

#### 1.4.8 Soil

The soil type, based on the soil texture, is useful to infer the rate of infiltration. Higher infiltration rate is associated with coarser (or sandy) soil texture whereas in clayey soil it is lower. Therefore proportion of sand, silt, and clay in the soil is major inherent factor affecting infiltration of water.



**Figure 4:** Soil Map

The above soil map (**Figure – 4**) is re-prepared after downloading District Irrigation Plan of Arwal district. The map indicates that soil texture is coarser in the eastern part of the district and it becomes finer towards west.

**Table 6: Soil Profile**

1.5 Soil Profile		source: National Bureau of Land Use Planning , University/KVK/BIRSAC/BAU/RAU				
Name of the State: Bihar						
Name of District: Arwal						
Name of Block	Soil Type		Land Slope			
	Major Soil Classes	Area (ha)	0-3 % (ha)	3-8 % (ha)	8-25 % (ha)	more than 25% (ha)
Arwal	clay	7400				
Kurtha	coarse sand	4000				
Karpi	clay	10900				
Kaler	clay	10400				
<b>Total</b>		<b>32700</b>				

*Source: District Irrigation Plan*

The table also indicates that Kurtha block, located in the eastern part of district, comes under major soil class of ‘coarse sand’.

Hence it may be inferred that infiltration rate is higher in the eastern part of the district as the soil texture is coarser.

#### **1.4.9 Hydrology and drainage**

About 77% of the area of Arwal district is part of Punpun River Sub-basin. Rest 23% is drained by river Sone which flows from south-west to north-east. Roughly, the national highway No. 139, passing through the district is almost following the water divide. Punpun River is a 3<sup>rd</sup> order stream and a tributary of the Ganges. The river Shinane, a tributary of river Punpun, joins near Kurtha. Though Sone and Punpun are perennial in nature, they bear little flow during non-monsoon periods.

#### **1.4.10 Agriculture**

Arwal district is part of Agro-climatic zone - III of Bihar. Fertile alluvial plain of the district coupled with favourable climate boosted agricultural activity. Rice is the main crop of Kharif season. Other Kharif crops are maize and potato grown in the district. Wheat is grown during Rabi season in the 68% of net sown area of the district. Other Rabi crops in the district are Pulses, Linseed, etc. Vegetables are also grown throughout the year. The cropping intensity of the district is 140% (2016-17).

The sowing and harvesting period of some major crops are given in **Table 7**



**Table 7: Sown harvesting Period of Major Crops**

<i>State</i>	<i>Crop</i>	<i>Season</i>	<i>From</i>	<i>To</i>	<i>Period</i>
Bihar	Greengram	Kharif	April (Beg)	July (Beg)	Sowing
	Masur/Lentil	Kharif	June (Mid)	July (Beg)	Sowing
		Kharif	November (Beg)	December (End)	Harvesting
	Rice/Paddy	Kharif	June (Mid)	July (Beg)	Sowing
		Kharif	January (Mid)	July (Beg)	Sowing
		Kharif	November (End)	December (End)	Harvesting
	Pulses	Rabi	January (Beg)	April (Beg)	Sowing
	Masur/Lentil	Rabi	October (Mid)	November (Mid)	Sowing
		Rabi	March (Beg)	March (End)	Harvesting
	Wheat	Rabi	November (Mid)	December (End)	Sowing
Rabi		March (Mid)	April (End)	Harvesting	

<https://nfsm.gov.in/nfmis/rpt/calenderreport>

**Table 8: Area under Major Crops**

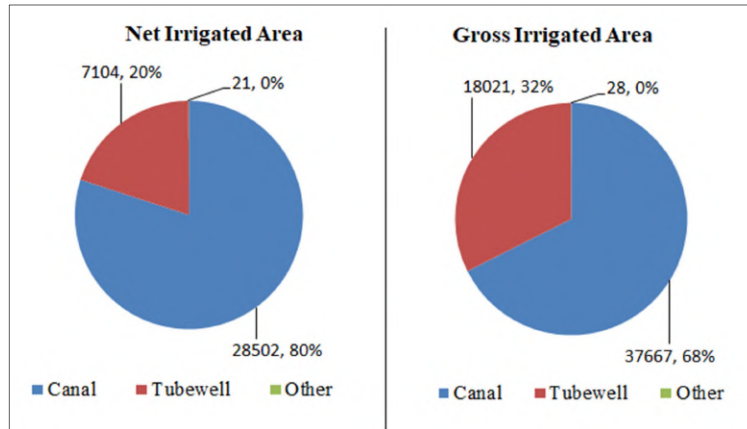
<i>Season</i>	<i>Month</i>	<i>Crop</i>	<i>Area</i>	<i>Net Area Sown</i>	<i>Area Sown More Than Once</i>
Kharif		Rice	175198	205343	81717
		Maize	1175		
		Potato	1662		
		Vegetable	159		
Rabi		Wheat	71130		
		Pulses	23846		
		Gram	7394		
		Linseed	2593		
		Vegetable	319		

*Source: Web Based Land Use Statistics Information System*

The above table shows that the sowing period of Rice, Green gram, Mansur *etc* starts from June (Mid.) depends on the onset of monsoon. Late monsoon may leads to the exploitation of ground water for irrigation purpose.

#### **1.4.11 Irrigation**

There are two major source of irrigation in the district – canal and tube well (ground water) for the year 2018-19. The **figure 5** shows that canal fulfils the major irrigation needs during Kharif and Rabbi Season. About 80% of the net irrigated area is irrigated by canal.

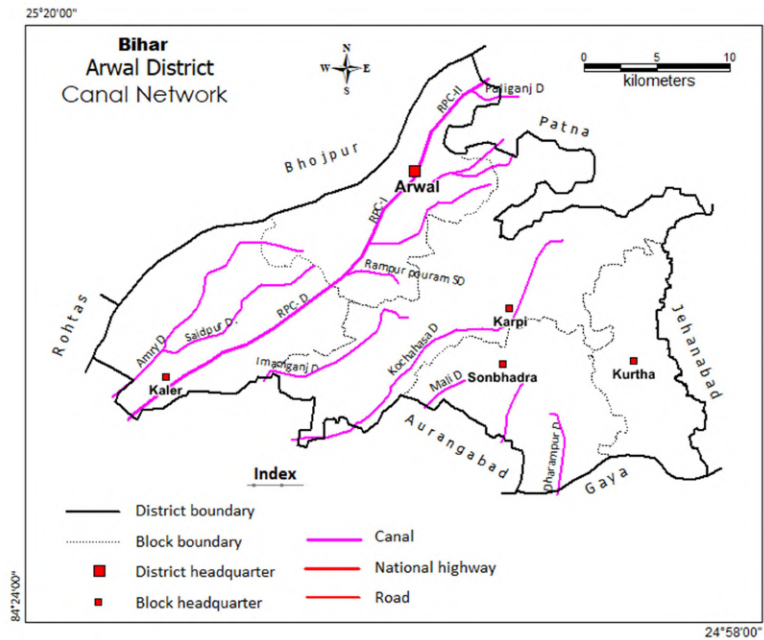


(Value in Hectare)

Source: <https://aps.dac.gov.in/>

**Figure 5:** Area Irrigated (Source Wise) for the year ending 2018-19

Canal in the district is a part of Sone canal system which is one of the oldest irrigation systems of India. It was developed across the Son at Dehri in 1873-74. Water from the Son, fed canal systems on both sides of the river and irrigated a large areas.



**Figure 6:** Canal Network

Its operation schedule for Kharif crops starts from 20 May to 30 October and for Rabbi Crops from 10 December to 10 April.

The Arwal district is irrigated by Eastern Sone High Level Canal. Eastern Sone High Level Canal off-takes from Indrapuri Barrage located 10 km upstream in river Sone from Barun town near Indrpuri, Rohtas.

Current capacity of the canals (Distributary) for Arwal district are given in **table-9**

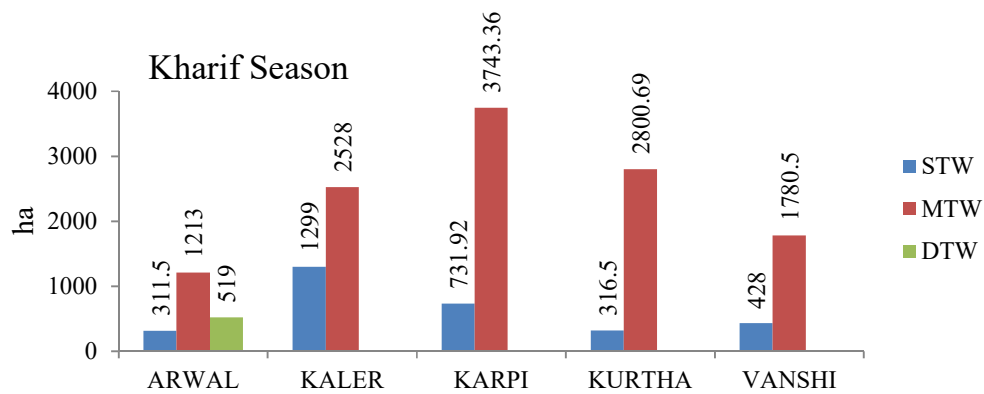
**Table 9:** Capacity of Canal (Distributary)

SN	Canal system	District	Capacity (Cusec)*
1	Mali Disty	Aurangabad/Arwal	325
2	Kochas Disty	Aurangabad/Arwal	300
3	Imamganj	Arwal	200
4	Amra Rajwaha Disty	Arwal	180
5	Aiyara disty	Arwal	320
6	Murka disty	Arwal	58

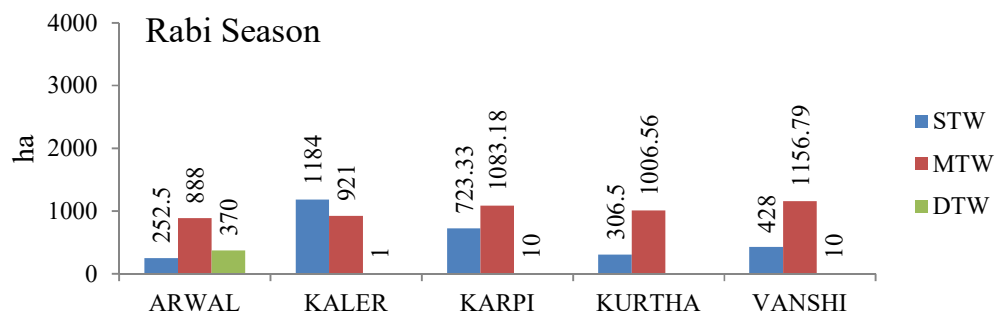
<http://wrd.bih.nic.in/>

\*Cusec = cubic feet per second (roughly 28.3 lit per second)

Tube wells are 2nd largest source of groundwater withdrawal for irrigation in the district. During the year 2012-13 (5th MI Census) the irrigation potential created by the shallow, medium and deep tube well is presented in fig. 7 & 8. The tube wells are categorised based on their depth. Depth of the shallow tube well is down to 35 m bgl, medium tube well is between 35 to 70 m bgl and deep tub well is more than 70 m bgl.



**Figure 7:** Irrigation Potential created by tube well for Kharif season



**Figure 8:** Irrigation Potential created by tube well for Kharif and Rabi season

Kharif season starts from third week of May and lasts till the end of October followed by Rabi season. **Fig. 8** indicates that largest potential created by medium tube wells for Kahrif season as well as in Rabi season except Kaler block where contribution of shallow tube well is higher. In Arwal block potential created by deep tube wells is remarkable. In comparison to the Rabi, larger potential is created for Kharif season.

These figures indicate that by and large ground water extraction from the depth range of 35 to 70 m bgl is higher. Remarkably only in Arwal block deeper aquifer of more than 70 m bgl is also being utilised.

#### ***1.4.12 Climate***

The district comes under the climate type: subtropical monsoon, mild and dry winter, hot summer. District experiences four seasons in a year i.e. cold season starts from late November to the end of February followed by hot season continue to the second week of June. Southwest monsoon sets during second week of June and end in September. The months of October and November are the post monsoon period.

The rainfall during southwest monsoon season constitutes about 90% of the annual normal rainfall. Mean maximum temperature of the district is about 23°C and mean minimum is 9°C. Humidity during southwest monsoon period varies from 75% to 85% and during rest of the year it ranges from 50% to 75%.

## 2. DATA COLLECTION AND GENERATION

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The primary Data such as water level, quality, geophysical data and exploration details available with CGWB has been collected and utilised as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behavior of ground water level and quality of ground water in the district. To understand the sub-surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board. For other inputs such as hydrometeorological, Landuse, cropping pattern etc were collected from concerned state and central govt departments and compiled.

### 2.1 Data collection and Compilation:

The data collection and compilation for various components was carried out as given below

- i. *Hydrogeological Data:* Water level data of 13 key wells and historical water level trend of monitoring wells were collected and compiled representing Aquifer-I.
- ii. *Hydrochemical Data:* To evaluate the quality of ground water, 9 samples were collected from dug wells
- iii. *Exploratory drilling:* Total 4 exploratory wells, located in and around Arwal district have been taken for the present study. The lithologs of total 11 tube wells have been utilised for the preparation of aquifer maps.
- iv. *Hydrometeorological Data:* Rainfall data for the study has been taken for the Indian meteorological Department..
- v. *Land use and cropping pattern data:* The data of land use and cropping pattern obtained from the website [aps.dac.gov.in/](http://aps.dac.gov.in/).

### 2.2 Data Generation

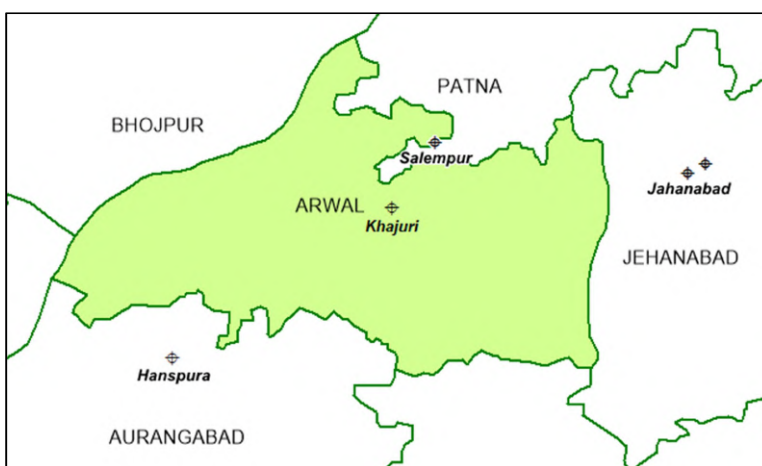
The data has been generated and collected for various components as given below :

**2.2.1 Ground water Monitoring Wells:** Total 13 wells have been monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. The depth of these dug

well varies from 3.78 to 9.13 mbgl. The water level data of 06 (six) piezometers of State Govt. has also been for analysis.

**2.2.2 Ground Water Exploration:** Only one exploratory well has been constructed at Khajuri in Karpi block. Total 4 exploratory wells have been taken to know the aquifer characteristics. The lithology data of Total 13 tube wells has been used to assess the lithological disposition aquifers

Arwal is the second smallest district of Bihar. Maximum radial distance to cross the district is about 46 km only. Therefore lithological information of the neighbouring exploratory wells is also incorporated. Exploratory wells are shown in figure and granular zone tapped / identified is given in **Table 10**



**Figure 9:** Location of Exploratory Wells

**Table 10:** Granular zone tapped

SN	District	Block	Location/	Depth Drilled m bgl.	Granular Zone Tapped /Identified (m)		
					from	to	thickness
1	Patna	Paliganj	Salimpur	229.4	50	56	6
					62	68	6
					86	92	6
					97	107	10
					125	131	6
					145	151	6
					161	167	6
					170	176	6
2	Jehanabad	Jehanabad	Jehanabad	147.3	97	107	10
					113	125	12
					129	140	11
3	Aurangabad	Hanspura	Hanspura	167.75	10	13	3
					20	28	8
					40	43	3
					52	62	10
					80	86	6
					105	112	7

4	Arwal	Karpi	Khajuri	312.37	120	143	23
					10	18	8
					48	55	7
					98	120	22
					125	212	87
					250	270	20
					300	310	10

The area is underlain by thick deposits of quaternary alluvium deposited by the river Ganga and its tributaries flowing from south to north. No basement has been encountered down to the explored depth of 310 m in exploratory drilling. Sub-surface lithology shows that there is alternating layers of sand silt and clay. At Khajuri village in Arwal district about 87 m thick sand layer has been encountered.

**2.2.3 Ground Water Quality:** To assess the quality of ground water, 9 samples were collected and analysed from dug wells representing Aquifer – I

**2.2.6 Thematic Layers:** The following thematic layers were also generated which supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

1. Drainage
2. Geomorphology
3. Elevation
4. Land use
5. Geology & structure etc.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long term scenarios, aquifer wise ground water quality, sub-surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated and as discussed in details.

3.1 Geological set-up

Geologically, the district can be divided as the area of newer alluvium and older alluvium. Newer alluvium covers major part of the district. Older alluvium covers elongated areas in central part of the district and in Kaler and Arwal CD blocks. The younger alluvium consists of sand silt and clay whereas older alluvium consist coarse grain sand and calcium carbonate also.

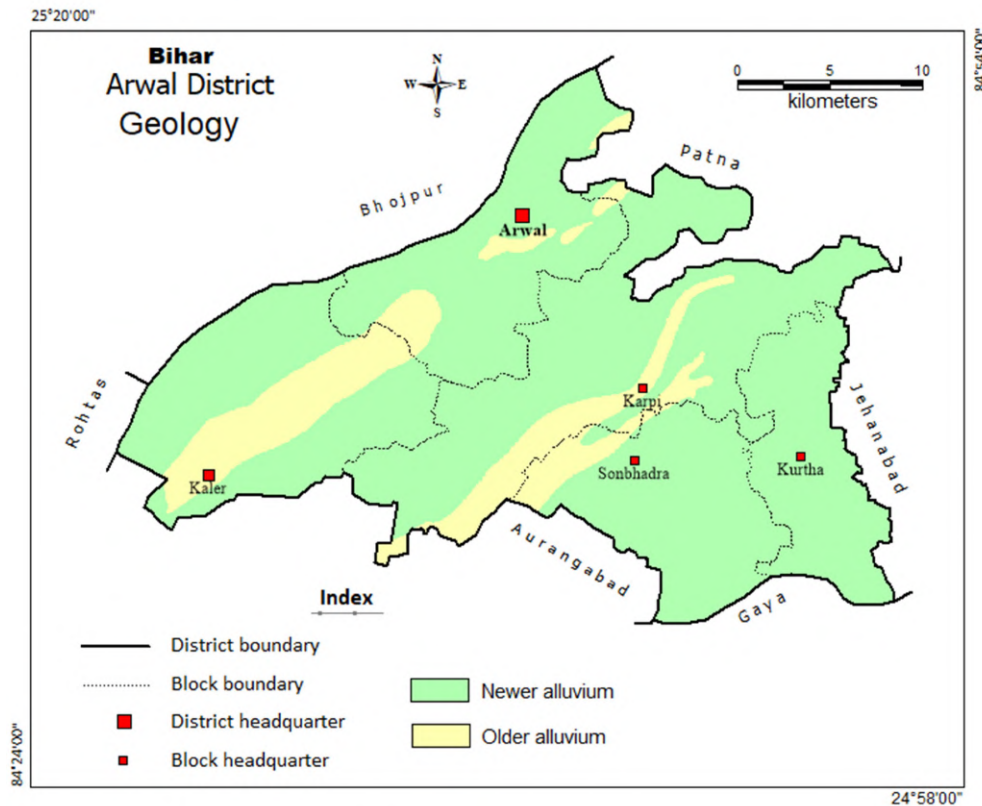


Figure 10: Geological Map



The geological succession is given below

<i>Alluvium</i>	<i>Formation</i>	<i>Age</i>
Newer	Bare, Fatwa and present day deposits	Holocene (present, historical, ancient)
Older	Hajipur, Nawada	Lr. Holocene to Pleistocene

### 3.1 Hydrogeology

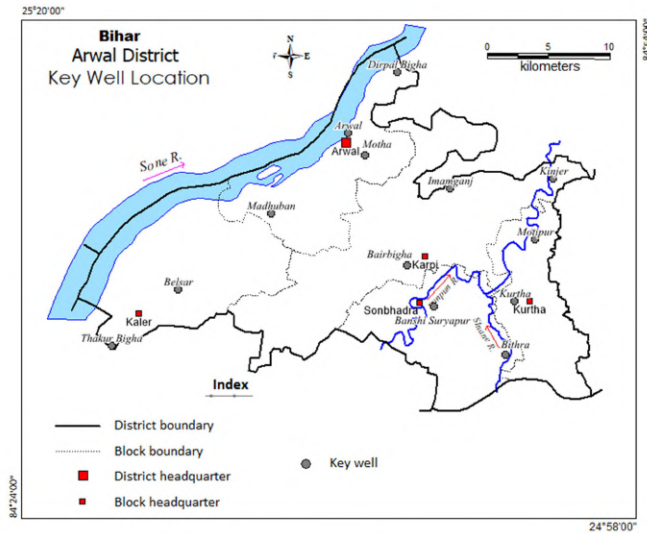
In this chapter, the distribution of groundwater, its seasonal behaviours with time and space has been studied under regional geological condition.

The district is underline by vast tract of flat Indo Gangetic Alluvium of quaternary edge. The alluvial sediments are made up of gavel sands, silt and clay. The gravels and the sand layers are good ground water repositories. Ground water occurs under water table to semi-confined condition in the alluvium formation at shallow depth.

Total 13 Key wells have been establish and periodically monitored for water level, to understand water level behaviour of unconfined aquifer in spatial and temporal domain. In addition, National Hydrograph Network Station (NHNS) are utilised for understanding long-term water level behaviour. Water samples have also been collected during pre-monsoon period. The data has been given in Annexure – I. The Location of key wells and NHNS wells are shown in **Figure 11**

#### 3.1.1 Depth to Water Level

Based on collected field data, maps are prepared in GIS environment, using MapinfoTM and Vertical MapperTM softwares. Data interpolation is done through Natural Neighbour Interpolation method. The data then converted to delineate area in the classes of 0-2, 2-5 and 5-10 m bgl water level and for water level fluctuation 2 meter interval has been taken.

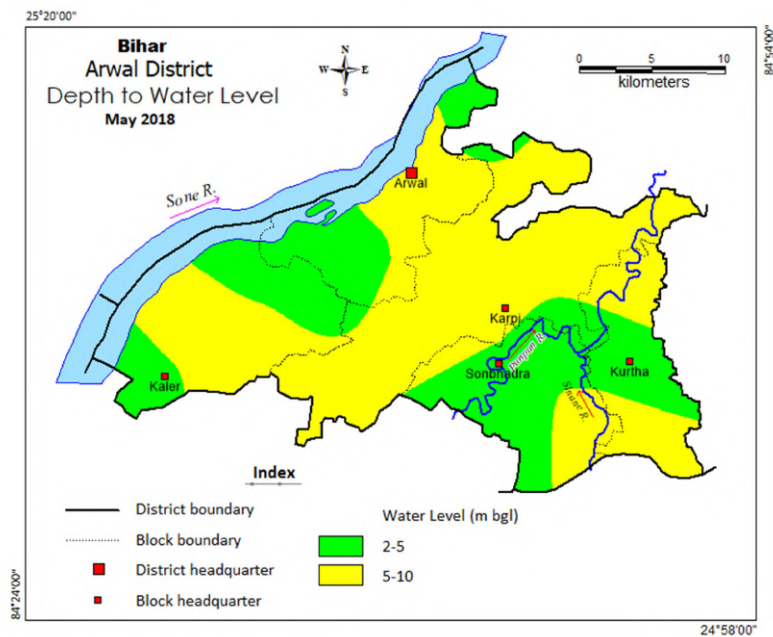


**Figure 11:** Location of Monitoring Wells

*Depth to water level – May 2018*

During pre-monsoon period observed water level ranged from 3.46 to 7.29 m bgl. The average water level calculated to be 5.37 m bgl. Majority of the area is categorized under 5-10 m bgl water level. Major part of the Sonbhadra, central part of Kurtha, bordering area of Arwal and Kaler and some other parts have shown water level between 2 and 5 m bgl. (**Fig.12**).

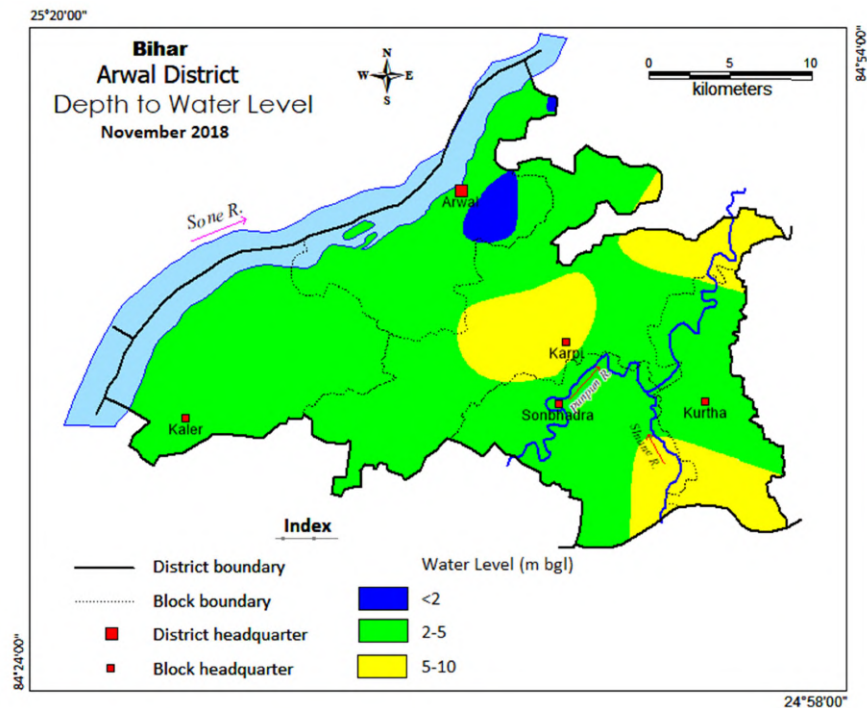
The bordering area of Arwal and Kaler block showing water level between 2 and 5 m bgl, is slightly depressed probably influence local groundwater flow pattern.



**Figure 12:** Depth to water level- May 2018

*Depth to water level – November 2018*

During post-monsoon period, the calculated average water level is 4.01m bgl where water level ranged from 1.42 to 6.7 m bgl. The water level category of 2 to 5 m bgl has covered almost entire district. In southeast and northeast part of the district, water level observed > 5 m bgl. The shallowest category of <2 m bgl observed as pocket in northern part of Arwal district.



**Figure 13:** Depth to water level Nov. 2018

*Water level fluctuation during Nov. 2018 w.r.t. May 2018*

Water level fluctuation has been observed less than 2 m in major part of the district. In a localised area of Arwal and Kurtha block rise of water level is between 2 to 4 m. More than 4 m fluctuation is observed near Arwal town. The decline of water level in central part of the district is due to pumping of key well for irrigation purpose.

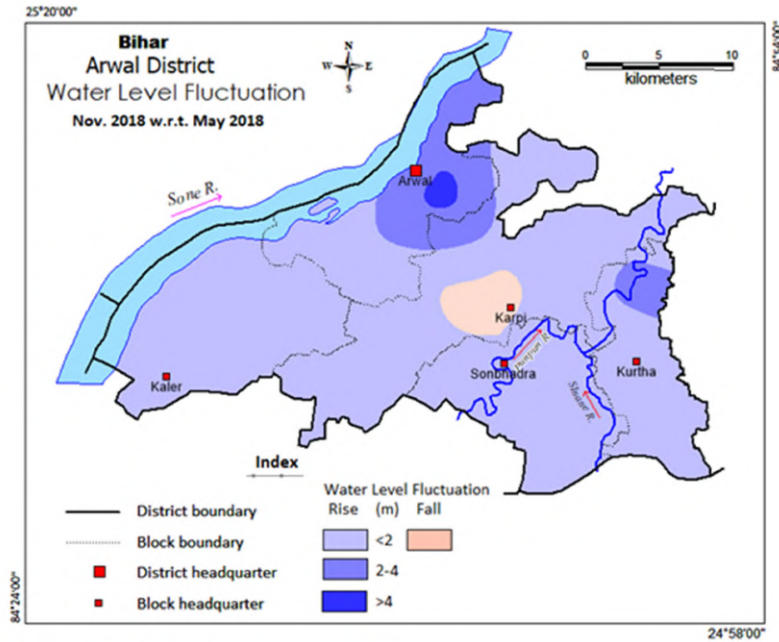


Figure 14: Water level fluctuation map (Nov.2018 w.r.t. May 2018)

### 3.1.2 Water Table Contour

The water table contour from the observed range from 63.71 to 87.06 m amsl has been shown in the Fig. 15. Map reveals that the general flow of groundwater in phreatic aquifer towards north-east direction. The ground water contour is almost following the slope of the area and is seems unaffected by the river and canal (distributary).

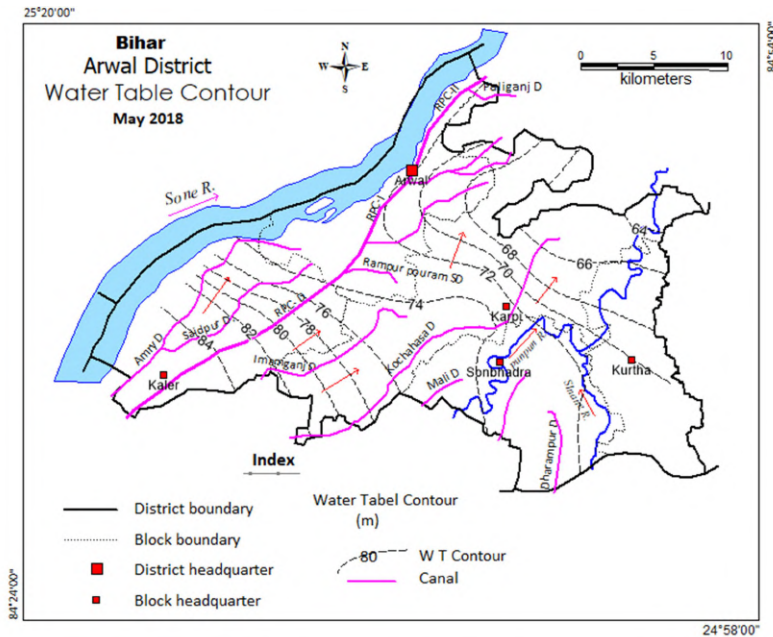
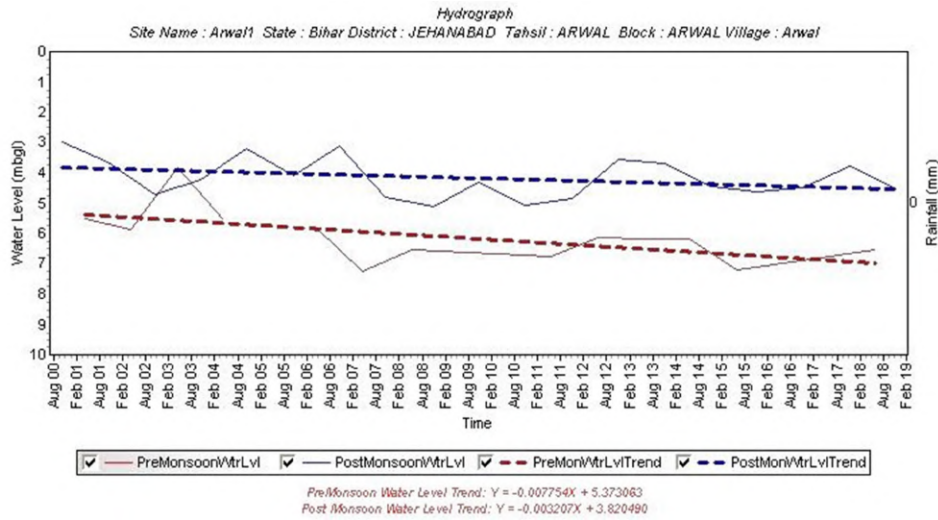


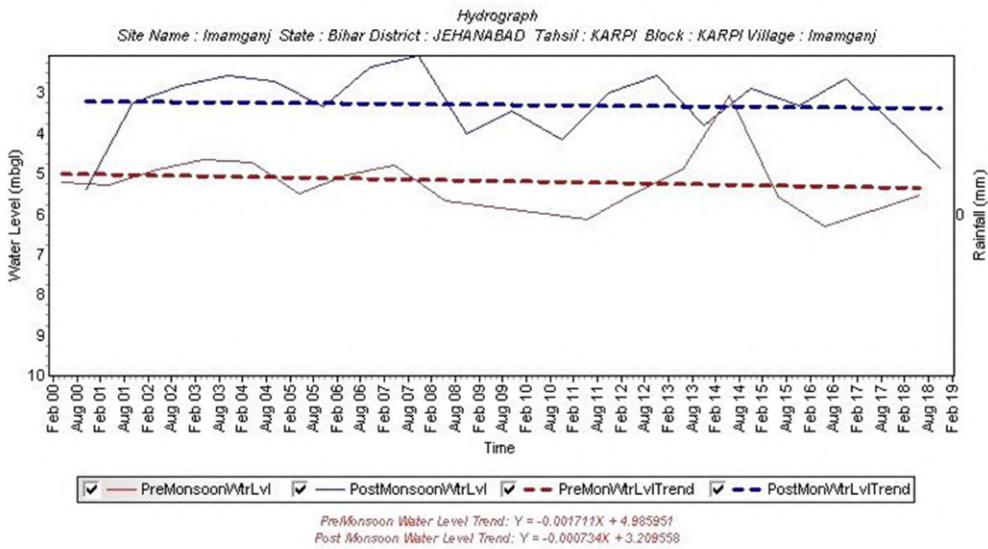
Figure 15: Water table contour

### 3.1.3 Water Level Trend

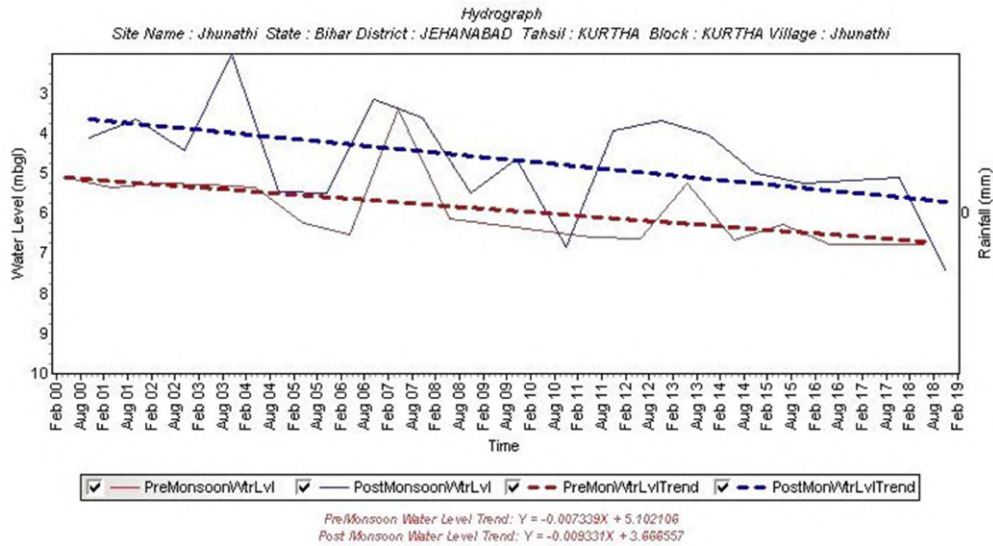
Numbers of dug wells are being monitored four times in a year i.e. in the month of Jan, May, August and November under ‘National Hydrograph Network Station Monitoring’ programme. The month of May and November are the pre and post monsoon period respectively. The long term data of Arwal and Jehanabad district (located nearby) has been taken and prepared the graphs to know the water level trend during pre and post monsoon period for last 10 years (Jan. 2000 to Jan.2019) The graphs have been presented in **Figure 16 to Figure 19**.



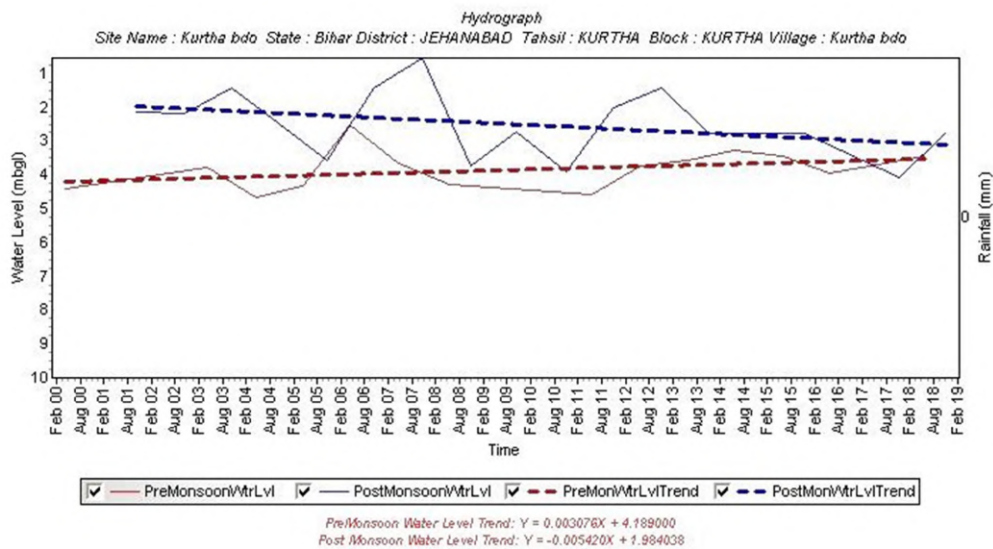
**Figure 16:** Water level trend at Arwal, district Arwal



**Figure 17:** Water level trend at Imamganj, district Arwal



**Figure 18:** Water level trend at Jhunathi, district Jehanabad



**Figure 19:** Water level trend at Kurtha, district Arwal

These graphs reveals that water level is showing falling trend during pre and post monsoon period in last 10 years at the rate up to 0.9 cm per year. However, the falling trend is not significant but it indicates that there is a need of artificial recharge to ground water to prevent the falling trend of water level.

### 3.1.4 Analysis of Hydrograph observed from Automatic Water Level Recorder

To study the hydrograph for each block, daily water level data has been downloaded from the official website of *Water Resource Department, Government of Bihar* for the date till 22 March, 2021 and presented in **Annexure V**. Abnormal and missing data has been omitted while preparation of hydrograph. Summary of the data is given in **Table 11**. Latest data i.e. from 12.11.2017 onwards is available for Arwal blocks. Minimum and maximum water level data in the district recorded to be 0.63 (Sonbhadra) and 11.78 m bgl (Kurtha) on 26 Oct., 2019 and on 12 Aug. 2019 respectively.

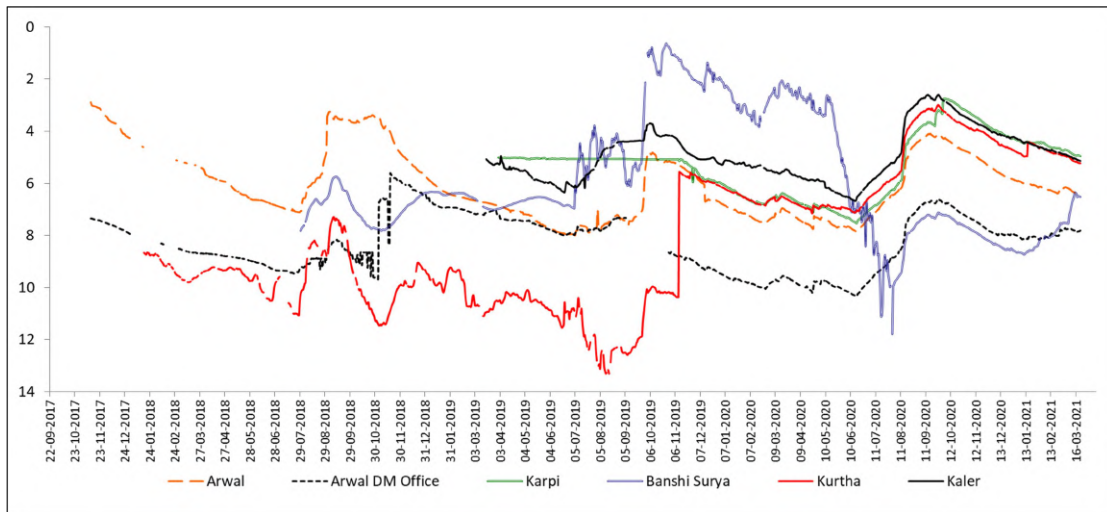
Hydrograph (**Fig. 16**) shows that during the year 2018, rising limb starts from last week of July and continued to the 1st week of September covered about 38 days to reach the peak with the 2.23 m rise of average water level. Same has been observed during 2019 also from 1<sup>st</sup> week of September to 1<sup>st</sup> week of October took almost 30 days with the average rise in water level of 2.20 m. Maximum recharge has been shown with the 3.78 m rise of average level in the year 2020 when normal rainfall (-14%) was observed. However, highly fluctuating hydrograph of Sonbhadra is excluded while calculating district average.

It may also be noticed that there is abrupt rise in water level during last week of September 2019 in Sonbhadra (Banshi Suryapura) and Arwal block and during 2nd week of Oct 2019 in Kurtha block (4.81 m).

Thus the average unit recharge of ground water observed from the Digital Water Level Recorder (DWLR) for the year 2018, 2019 and 2020 is 2.23, 2.20 and 3.78 m respectively. Roughly, the monsoon recharge as reflected in water level, takes place within 30 to 40 days.

**Table 11:** Minimum, maximum and average water level observed by DWLR

<i>Block/Locatio</i>	<i>Arwal</i>	<i>DM Office</i>	<i>Karpi</i>	<i>Sonbhadra</i>	<i>Kurtha</i>	<i>Kaler</i>
<i>Date from which WL Data is available</i>	12 Nov. 17	12 Nov. 17	01 April 19	30 July 18	17 Jan. 18	17 March 19
<i>Minimum</i>	2.89	5.61	2.75	0.63	2.99	2.6
<i>Maximum</i>	7.99	10.33	7.53	11.78	13.3	6.68
<i>Average</i>	6.05	8.27	5.28	5.87	8.06	4.92

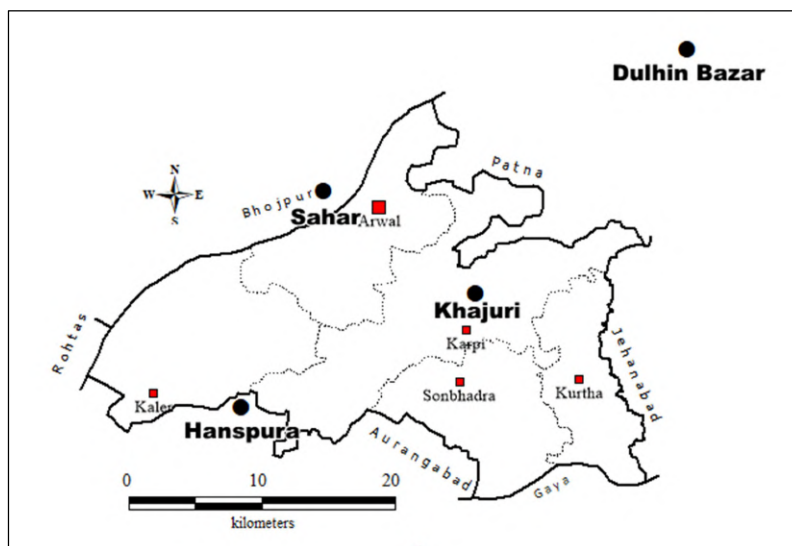


**Figure 20:** Hydrograph of unconfined aquifer (DWLR)

### 2.1.5 Aquifer Characteristics

One Exploratory well has been drilled down to 312 m bgl in the district at Khajuri village, in Karki block. First clay layer encountered from 40 m and total 106 m clay layer has been observed. Total 30 m thickness of aquifer has been tapped from the depth 155 to 267 m bgl.

Arwal district is the second smallest district of the State by area. Therefore neighbouring wells, constructed in other districts, are also taken to study the area. Location of exploratory wells is given in **Figure 21** and the findings of pumping tests is summarised in **Table 12**.



**Figure 21:** Location of pumping test site



**Table 12:** Aquifer parameters

<i>District</i>	<i>Location</i>	<i>Zone tapped (m bgl)</i>	<i>Total length of slotted pipe (m)</i>	<i>Duration of pumping (min.)</i>	<i>Static Water Level (m bgl)</i>	<i>Draw-down (m)</i>	<i>Discharge (lmp)</i>	<i>Transmissivity (m<sup>2</sup>/day)</i>	<i>Storativity</i>
Arwal	Khajuri	155-267	30	1000	9.45	12.29	2029	2139** 2325*	-
Bhojpur	Sahar	182-243	30	1010	10.0	9.98	2528	3248 ** 4645*	-
Aurangabad	Hanspura	105-144	27	1010	7.6	7.22	1930	1106** 1211*	-
Patna	Dulhin Bazar	103-170	21	1000	10.04	10.7	2347	3070** 2511*	2.7 × 10 <sup>-7</sup>

\*\* Jacob-Cooper Straight Line Method \*Theiss Method

The above deep tube wells are constructed by tapping the zone within the depth range of 103 to 267 m bgl. Aquifer Performance Tests (APT) has been conducted at various locations with the discharge varied from 1930 to 2347 lit. per min. Litholog and Electrical logging data indicates that Khajuri, Sahar and Dulhin Bazar have almost identical lithology. Duration of pumping test is about 1000 min.

The deeper zone is about 150 m thick, behaves as confined aquifer. The storativity value calculated to be  $2.7 \times 10^{-7}$  at Dulhin Bazar, Patna.

### 3.2 Ground Water Quality

Water interacts with the soil and rock when flow through it and dissolves chemical constituents under favourable physic-chemical condition. Besides this, anthropogenic activities also affect the quality of ground water. The type of chemical constituents and its amount of mineralisation affects the quality of groundwater for its suitability for drinking, domestic, irrigation and industrial purpose.

To study the groundwater chemistry of the area, chemical sample collected from National Hydrograph Network Station (Dug well zone) during May 2018 has been taken. These samples are analysed in the Chemical laboratory of Central Ground Water Board at Patna. Analytical results of ground water samples are given in **Table 13**. The tables and graphs have been prepared to know its suitability for different purpose discussed below.

#### *Suitability for drinking purpose*

The analytical result, its maximum, minimum and average value against the BIS Standards 2012 for drinking purpose has been shown in the table

**Table 13:** Chemical quality of phreatic aquifer

SN	Block	location	pH	TH	Ca <sup>2+</sup>	Mg <sup>2+</sup>	HCO <sup>3-</sup>	Cl	SO <sub>4</sub> <sup>2-</sup>	NO <sup>3-</sup>	F <sup>-</sup>
1	Arwal	Dipalibibha	7.8	114.9	26	12	129	11	28	26.31	0.23
2	Arwal	Arwal	7.4	244.8	40	35	191	35	28	53.8	0.27
3	Karpi	Imamganj	7.1	234.9	58	22	291	39	51	22.7	0.31
4	Kurtha	Kinjer	7.4	364.7	62	51	301	79	14	74.5	0.34
5	Ratni	Jhunathi	7	340	76	36	326	91	68	46.4	0.77
6	Kurtha	Kurtha	6.9	390	68	53	301	110	15	113.54	0.22
7	Sonbhadra	Bansi	7.2	165	40	16	191	7	18	12.88	0.59
8	Karpi	Bairbiga	6.9	210	48	22	308	43	10	BDL	0.28
9	Arwal	Madhuban	7.1	100	20	12	123	3	9	14.71	0.29
		<i>Minimum</i>	6.9	100	20	12	123	3	9	12.88	0.22
		<i>Maximum</i>	7.4	390	76	53	326	110	68	113.54	0.77
		<i>Average</i>	7	240	49	29	240	46	27	46	0.37
<b>BIS</b>	<i>Acceptable limit</i>		<b>&lt;6.5</b>	<b>200</b>	<b>75</b>	<b>30</b>	<b>200</b>	<b>250</b>	<b>200</b>	<b>NA</b>	<b>1</b>
<b>(2012)</b>	<i>Permissible limit (in the absence of alternate source)</i>		<b>&gt;8.5</b>	<b>600</b>	<b>200</b>	<b>100</b>	<b>600</b>	<b>1000</b>	<b>400</b>	<b>45</b>	<b>1.5</b>

Value in mg/l

From the above table it can be inferred that in general, water is potable. However, out of 9 samples analysed slightly elevated value of Nitrate has been found in 4 samples collected from Arwal, Kurtha and one adjacent location (Jhunathi) falls in Ratni blocks, Jehanabad district

#### *Suitability for domestic purpose*

The term hard and soft as applied to water date from Hippocrates (480-354 BC), the father of medicine, in his treatise on public hygiene. Hardness results from the presence of divalent metallic cation, of which calcium and magnesium are the most abundant in ground water. These ions react with soap. Hard waters are unsatisfactory for household cleansing purposes.

The degree of hardness in water is commonly based on the classification given by Sawyer and Mc Carty, 1967 (Table 2.3). Table 2.3 Total Hardness classification by Sawyer and Mc Carty, 1967

Hardness (mg/l) as CaCO <sub>3</sub>	Water Class
0-75	- Soft
75-150	- Moderate
150-300	- Hard
300-600	- Very hard
>600	- Extremely

In Arwal district, hardness value ranged from 100 to 390 mg/l (as CaCO<sub>3</sub>). Out of 9 samples analysed, 7 are categorised as 'Hard' and rests 2 samples, collected from Arwal block are under 'Moderate' category.

### *Suitability for Irrigation*

The suitability of groundwater for irrigation purpose is based on its chemical characteristics which create soil condition hazardous to crop growth and yield. It depends on the following prevailing criteria:-

Salinity :- Total concentration of soluble salt

Sodicity: Concentration of sodium relative to calcium and magnesium.

Relative proportion of carbonates + bicarbonate to calcium + magnesium.

Based on the above, many methods have been suggested by the scientist/chemist to check its suitability. Some of them are as under:

(i) *Sodium Adsorption Ratio (SAR)*: It is a measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Excessive sodium in irrigation water promotes soil dispersion and structural breakdown but only if sodium exceeds calcium by more than a ratio of about 3:1. Such a relatively high sodium content (>3:1) often results in a water infiltration problem due to soil dispersion and plugging and sealing of the surface pores. In other words higher the SAR lower the rate of infiltration which leads to the problem with crop production.

(ii) *Sodium Soluble Percentage (SSP)*: It is a parameter for classifying irrigation water in terms of soil permeability. Sodium ion in groundwater tends to be exchanged by Mg<sup>2+</sup> and Ca<sup>2+</sup> of clay particles. This exchange process reduces the permeability of soil. Sodium also combines with chloride and carbonates generating salinity and alkalinity in soil.

(iii) *Residual Sodium Carbonate (RSC)*: It indicates the hazardous effect of carbonate and bicarbonate on the quality of water for agricultural purpose. RSC determines how much unreacted Ca and Mg remain available to counteract any Na present. When Na is present, no residual Ca and Mg remains, but residual carbonates are present, the RSC determines how much additional Ca amendments is required to react with the unreacted carbonate to prevent accumulation of sodium carbonate.

(iv) *Kelly's Index*: It is measurement of Na<sup>+</sup> against Ca<sup>2+</sup> and Mg<sup>2+</sup> in meq/l. A Kelley's index more than 1, indicates an excess level of sodium in water.

(vi) *Magnesium Ratio*: In general, Ca<sup>2+</sup> and Mg<sup>2+</sup> maintain a state of equilibrium in water. But the level Mg<sup>2+</sup> will be high if exchangeable Na<sup>+</sup> is present in irrigated soil. In equilibrium, more Mg<sup>2+</sup> tends to make the soil alkaline. Thus it affects the soil quality for crops.

(v) *Permeability Index*: Permeability of soil is greatly influenced by Na<sup>+</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, and Cl<sup>-</sup> contents of soil, and is affected by long-term use of irrigation water, with high salt content.

The above suggested method wise suitability of groundwater of the area for irrigation purpose is given in the table below:-

**Table 14:** Suitability of ground water for irrigation

Block	Location	Sodium Adsorption Ratio	Sodium Soluble Percentage	Residual Sodium Carbonate	Kelley's Index	Magnesium Ratio	Permeability Index
		$\frac{Na}{\sqrt{Ca+Mg/2}}$	$\frac{Na*100}{Ca+Mg+Na}$	$\frac{(HCO_3+CO_3)}{(Ca+Mg)}$	$\frac{Na}{(Ca+Mg)}$	$\frac{(Mg*100)}{(Ca+Mg)}$	$\frac{Na+\sqrt{HCO_3}}{(Ca+Mg+Na)*10}$
Arwal	Dipalibibha	2.90	39	0.9	0.65	43	1
Arwal	Arwal	3.90	17	0.6	0.20	59	1
Karpi	Imamganj	4.90	37	1.0	0.58	38	3
Kurtha	Kinjer	5.90	23	0.7	0.30	58	2
Ratni	Jhunathi	6.90	18	0.8	0.23	44	2
Kurtha	Kurtha	7.90	33	0.6	0.49	56	4
Sonbhadra	Bansi	8.90	17	0.9	0.21	40	1
Karpi	Bairbigha	9.90	41	1.2	0.70	43	3
Arwal	Madhuban	10.90	15	1.0	0.17	50	0
	<i>Minimum</i>	2.9	15	0.6	0.17	38	0
	<i>Maximum</i>	10.9	41	1.2	0.7	59	4
	<i>Average</i>	6.5	27.9	0.86	0.41	47.4	1.8
BIS (2012)	<i>Suitable</i>	<10	<50	1.25	<1	<50	25-75
	<i>Marginal</i>	NA	NA	1.25-2.5	1.2	NA	NA
	<i>Not suitable</i>	>10	>50	>2.5	>2	>50	>75

The above ground water samples collected from phreatic (shallow) aquifer. Based on the various methods and the range of value calculated given in table- indicates that in general, ground water of phreatic aquifer is suitable for irrigation purpose.

### 3.2.3 USSL diagram

The United States Soil Laboratory Staff's (USSLS's) diagram is a plot between sodium hazards (SAR) on the y-axis versus salinity hazard (EC) on the x-axis (log scale) which classifies irrigation water quality into 16 zones to assess the degree of suitability of water for irrigation (**Figure 18**) in which waters have been divided into C1, C2, C3 and C4 types on the

basis of salinity hazard and S1, S2, S3, S4 types on the basis of sodium hazard. This diagram explains the combined effect of sodium hazard and salinity hazard.

Sodium hazard is relative concentration of sodium to calcium and Magnesium and calculated by the following formula:

$$SAR = \frac{Na^+}{\sqrt{\frac{1}{2}(Ca^{2+}+Mg^{2+})}}$$

Although sodium is beneficial to the growth of some plants, but its higher concentrations is toxic to many plants. Excess accumulation of sodium in leaves cause leaf burn, limit the plant growth and calcium and magnesium deficiency through reduced availability and imbalance with respect to sodium.

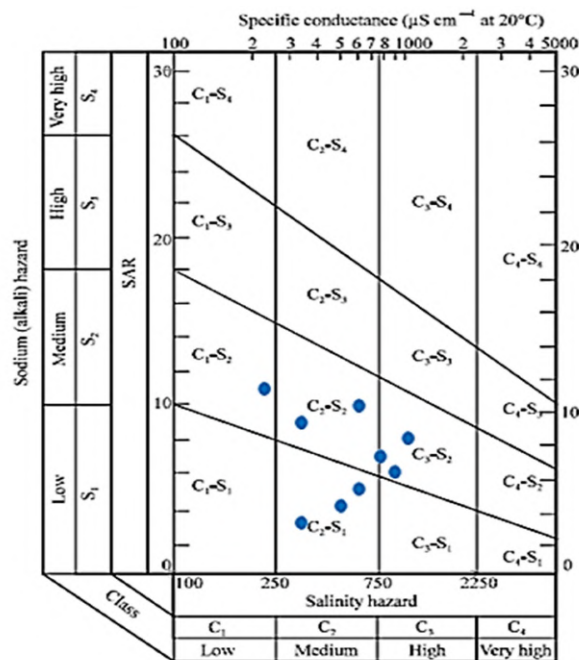


Figure 22: USSL diagram

The salinity hazard classes (After Handa 1969) and the EC value observed has been given below:

Classes	EC (μS/cm)	Water salinity	No. of samples
C <sub>1</sub>	0-250	Low (excellent quality)	1
C <sub>2</sub>	250-750	Medium (good quality)	5
C <sub>3</sub>	750-2250	High (permissible quality)	3
C <sub>4</sub>	2250-6000	Very high	NA

The **Figure 22** shows that out of 9 samples analysed, 8 water samples have fall in medium to high salinity hazard and only one sample has fall in low salinity hazard. Total 3 water sample are fall in 'low' category of SAR and rest are in 'medium' category.

Though the suitability of water for irrigation is determined based on SAR, and Salinity hazard, it is an empirical conclusion. In addition to water quality, other factors like soil type, crop type, crop pattern, frequency and recharge (rainfall), climate, etc. have an important role to play in determining the suitability of water.

### 3. GENERATION OF AQUIFER MAP

#### 3.1 Aquifer Disposition

As per the Annual Action Plan the Central Ground Water Board has been generating depth wise data through groundwater exploration, geophysical survey, drilling and also collecting from other agency etc. The tube wells, drilled by Central Ground Water Board as well as Production Well drilled by Bihar State Authorities also included here These data are further analysed in order to refine sub-surface disposition for the preparation of aquifer maps Since the district is second smallest district of the State and covers an area of 634.23 sq km only therefore tube wells of the bordering area are also incorporated for study.

The cross-sections and fence diagram have been prepared to interpret the aquifer disposition. The location of tube wells are shown on figure 19 which are taken for the various diagram.

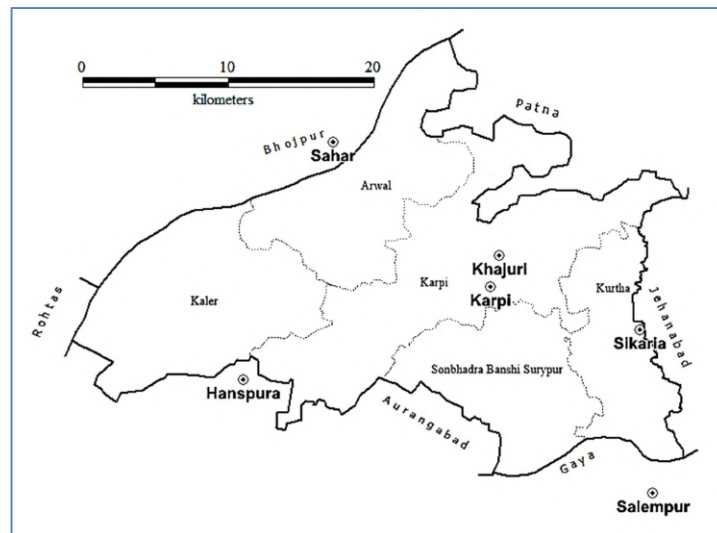


Figure 23: Location of tube wells taken for fence diagram/cross section

#### 3.2 Aquifer Disposition in the area

Based on the available data aquifer geometry on regional scale has been established in Arwal district. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers separated by considerable thickness of clay. Various cross section and fence diagram have been prepared to establish the principal aquifer system. These figures (Fig. 24 to 26) are given below.

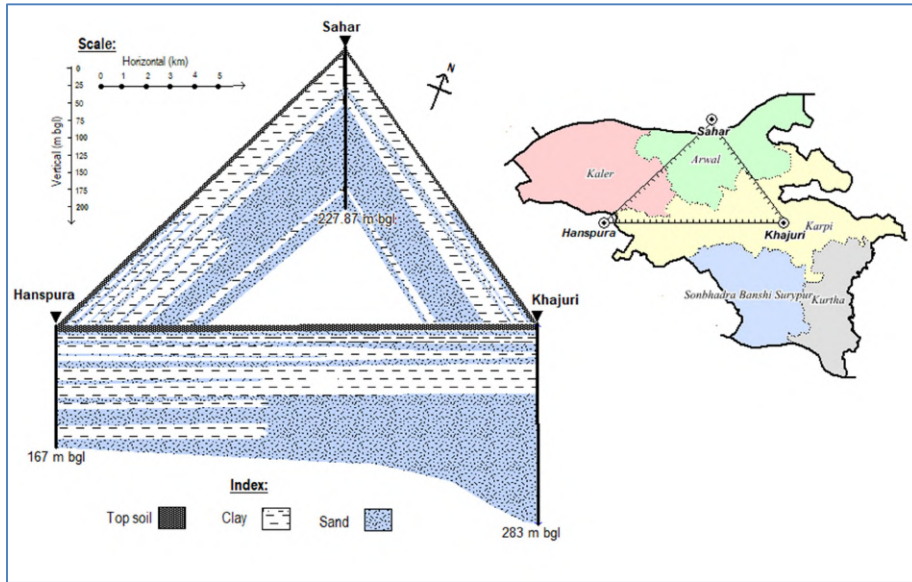


Figure 24: Fence diagram (Sahar-Hanspura-Khajuri)

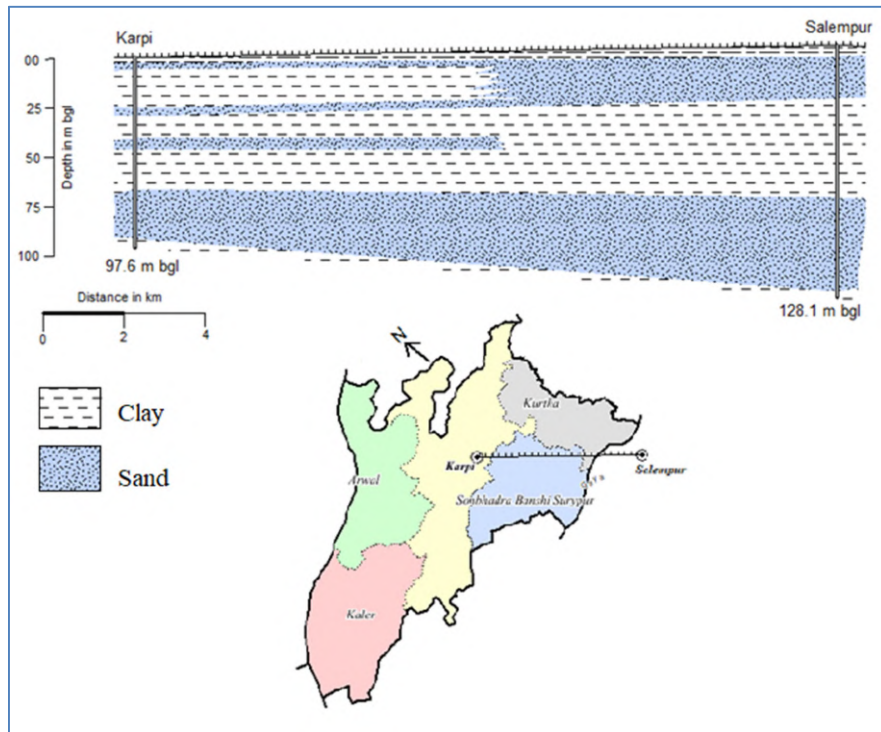


Figure 25: Cross section (Karpri-Salempur)



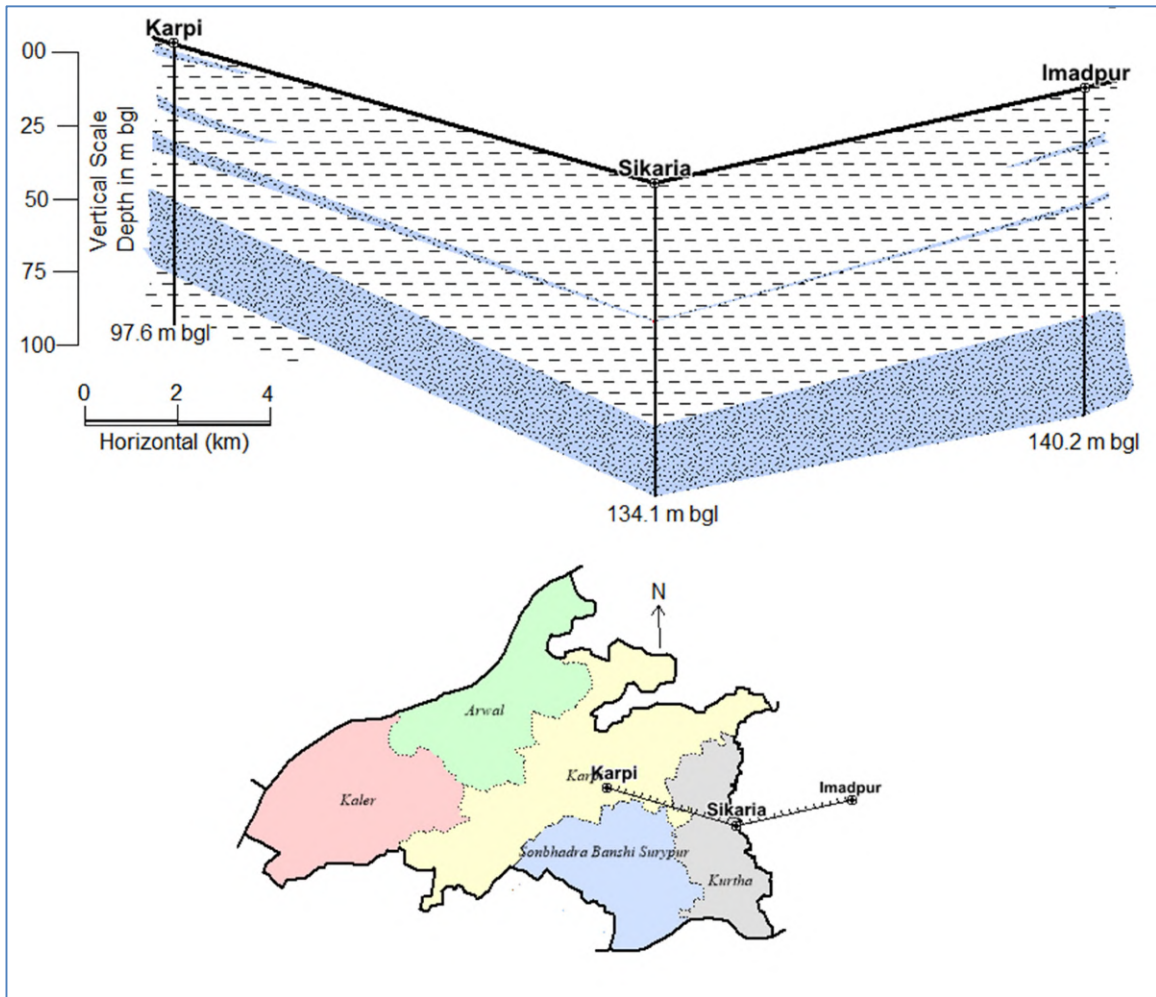


Figure 26: Fence Diagram (Karpi-Sikaria-Imadpur)

### 3.3 Aquifer disposition and its hydraulic characteristics

Based on the above diagrams it may be inferred that the thickness of alluvium is more than 283 m. and can be characterised by the alternating layers of sand, silt and clay. As we move towards Hanspura, distt. Aurangabad, these alternating layers increases. Towards north (Arwal & Karpi blocks) thickness of clay layers up to the depth of ~60 m, gradually increases whereas below 60 m a thick sand layer occurs which continued to the eastern part of the district i.e. in Sonbhadra and Kurtha block also. However in eastern part, thickness of sand layers above 60 m depth has been observed to be less than 1 m (Sikaria).

About 10 m thick clay layers separate the sand layers occur above 60 meter and below 60 m. The upper layers (above 60 m depth) constitute to an aquifer system whereas the lower (below 60 m depth) single layers forms second aquifer system. Therefore in the district there

are two aquifer systems. Upper one occurs from 10 to 60 m. The 2nd aquifer occurs from depth of 60 to 215 m bgl.

Pumping test conducted at Dulhin Bazar (district Patna) where the storativity value has been calculated to be  $2.7 \times 10^{-7}$ . Which indicates that 2<sup>nd</sup> aquifer is confined in nature. The transmissivity value ranges from 1106 to 4645 m<sup>2</sup>/day while conducting pumping test at discharge between 1930 to 2528 lpm after tapping productive zone within depth range between 103 to 267 m bgl.

#### 4. GROUND WATER RESOURCES

Rainfall is the principal source of water to recharge ground water. Major part of the total annual recharge takes place during monsoon period. Besides rainfall, seepage from canal, return flow from irrigation *etc.* also recharge the ground water. On the other hand, besides base flow of ground water and evapotranspiration, ground water extraction carried out for its drinking, domestic, irrigation and industrial purposes.

Thus the methodology for ground water resources estimation is based on the principle of water balance as given below –

$$\text{Inflow} - \text{Outflow} = \text{Change in Storage (of an aquifer)}$$

The equation can be further elaborated as

$$\Delta S = \text{RRF} + \text{RSTR} + \text{RC} + \text{RSWI} + \text{RGWI} + \text{RTP} + \text{RWCS} \pm \text{VF} \pm \text{LF} - \text{GE} - \text{T} - \text{E} - \text{B}$$

Where,

$\Delta S$  – Change in storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels, RC – Recharge from canals, RSWI – Recharge from surface water irrigation, RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks & Ponds, RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

The recharge and extraction of ground water is calculated from the above equation. Stage of development (SOD) is the ratio of ground water recharge and its extraction calculated in percentage. Roughly, stage of development up to 70% is considered as safe.

The assessment of ground water includes assessment of dynamic and in-storage ground water resources. The development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenish able annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

#### 4.1 Dynamic Ground Water Resources

The dynamic Ground Water Resources has been assessed by CGWB, Mid-Eastern Region, Patna in association with Minor Water Resources Department, Government of Bihar based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Arwal district is in **Table-15**.

The assessment of dynamic ground water resources (as on March 2020) has been done.

The result for the Arwal district are given in **Table 15**

**Table 15: Assessment of Dynamic Ground Water Resources (2020)**

S N	Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha )	Recharge from Rainfall- Monsoon Season	Recharge from Other Sources- Monsoon Season	Recharge from Rainfall- Non Monsoon Season	Recharge from Other Sources- Non Monsoon Season	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)
1	Arwal	12182	12182	2925.21	772.99	77.39	640.25	4415.84	441.58	3974.26
2	Bansi Surujpu	8996	8996	1927.41	276.13	57.15	253.71	2514.4	125.72	2388.68
3	Kaler	14083	14083	3381.69	879.16	89.47	789.92	5140.24	514.03	4626.21
4	Karpi	19493	19493	4680.77	606.84	123.84	580.43	5991.88	599.19	5392.69
5	Kurtha	8929	8929	2144.08	175.31	56.72	206.59	2582.7	258.27	2324.43

Value in ham

SN	Assessment Unit Name	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Stage of Ground Water Extraction (%) (Over- Exploited/Critical/Semicritical/Safe/Saline)
1	Arwal	821.34	81.00	453.76	1356.1	509.71	2562.21	34.12	safe
2	Bansi Surujpu	740.22	45.00	106.10	891.32	119.19	1484.27	37.31	safe
3	Kaler	1779.57	108.00	391.29	2278.86	439.54	2299.1	49.26	safe
4	Karpi	1855.62	108.00	331.14	2294.76	371.98	3057.09	42.55	safe
5	Kurtha	1014	63.00	209.87	1286.87	235.75	1011.68	55.36	safe
	<b>Total</b>	<b>6210.75</b>	<b>405</b>	<b>1492.12</b>	<b>8107.91</b>	<b>1676.17</b>	<b>10414.35</b>	<b>43.34</b>	

As per the Ground Water Resource Assessment – 2020, stage of development (SOD) (also called ‘Stage of Ground Water Extraction’) of ground water resources of the district is 43% only. Block wise calculated SOD is ranged from 34.12% (Arwal) to 55.36% (Kurtha).

Therefore, ample scope existed in the district for the further development of ground water up to the safe limit of SOD of 70%.

#### 4.2 Ground Water Extraction from unconfined aquifer

As per the 5th MI Census (2013-14) only one dug well is being used which is located in Arwal district. Block wise and depth wise No. of irrigation dug wells as per 4th MI Census is given in table. It indicates that by 2013-14, during 5<sup>th</sup> MI census, its number is drastically decreased.

**Table 16: Depth wise Block wise No. of dug wells (4th MI Census- 2006-07)**

Block	0-20	20-40	40-60	60-70
Arwal	5	0	0	0
Kaler	9	0	0	0
Karpi	20	0	0	0
Kurtha	4	0	0	0
Vanshi	1	0	0	0
<b>Total</b>	<b>39</b>	<b>0</b>	<b>0</b>	<b>0</b>

As per 5th MI census (2013-14), block wise and depth wise No. of tube wells has been given in Table. Tables shows that majority of the shallow tube wells are in the depth range of 20-35 m. Kaler blocks have highest No. of shallow tube well.

A comparison of 4th and 5th MI census data has also been given in table which indicates that the numbers of shallow tube wells down to the depth of 20 meter are decreased whereas in the depth range of 20 to 35-40 meter is in increased.

**Table 17:** Depth wise and Block wise No. of Tube Well (5th MI Census)

SN	Block	Depth Range (m)									
		0-20	20-35	35-40	40-60	60-70	70-90	90-110	110-130	130-150	>150
		Shallow		Medium			Deep				
1	Arwal	5	99	0	0	0	0	1	0	0	119
2	Kaler	28	265	0	0	0	0	0	0	0	1
3	Karpi	5	146	0	0	0	0	0	0	0	1
4	Kurtha	0	59	0	0	0	0	-	-	-	-
5	Vansi	0	86	0	0	0	0	0	0	2	0
<b>Total</b>		<b>38</b>	<b>655</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>2</b>	<b>121</b>

**Table 18:** Depth wise and Block wise No. of Tube Well in 5th MI Census w.r.t. 4th MI Census

SN	Block	Depth range in m									
		0-20	20-40	40-60	60-70	70-90	90-110	110-130	130-150	>150	
1	Arwal	4	99	0	0	-549	-27	0	0	119	
2	Kaler	-343	233	0	0	-548	-3	0	0	1	
3	Karpi	-579	-38	-4	0	-548	-5	0	0	1	
4	Kurtha	-1064	36	-1	0	-6	-	-	-	-	
5	Vansi	-733	86	0	0	-	-	-	-	-	
		-2715	416	-5	0	-1651	-35	0	0	121	

Above tables shows that no. of irrigational dug wells are decreased. The farmers are drilling deeper for the construction of shallow tube wells. **Table No. 18** also shows that there is no any tube wells within the depth range of 35 to 90 meter which indicates that there may be absence of the productive zone within this depth range for the extraction of ground water or the shallow aquifers are productive enough for irrigation purpose. About 97% of the deep tube wells of the district are reported in Arwal block only.

### 5. GROUND WATER RELATED ISSUES

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Arwal is the second smallest district by area having agrarian based economy. Total geographical area is 634 sq km out of which cultivable area is 495 sq km. District does not have any industry. Arwal is the only town in district. Economy of this district mainly relies on the agriculture. Geologically the district is characterised by the alluvium having alternating layers of sand silt and clay which favours the possibility of surface water irrigation as well as from ground water. One of the objectives of this study is to prepare management plan after identifying ground water related issues in terms of its quantity and quality. Quality of ground water of Arwal district, in general, has been found suitable for domestic and irrigation purposes. The issues related quantity of ground water has been discussed below:

#### 5.1 Identification of issues

The agricultural district of Arwal is a part of fertile Ganga flood plain. Rice, maize, wheat, pulses are the major crops grown in the district. The district has the good network of canal which fulfils the major part of its irrigational demand. Ground water is the second largest source of irrigation being extracted mainly from shallow tube wells. Except Arwal block, depth of the tube wells are less than 35 m bgl. Comparison of the number of shallow tube wells during 5th MI census (year 2013 -14) with respect to 4th MI Census (year 2006-07) shows that the farmers are constructing deeper tube wells for irrigation purpose although deeper tube wells are more expensive.

Long term water level data of phreatic aquifer in last 10 years (2009-18) showing slightly decline trends. Constructing deeper tub wells and declining trend of water level indicate stress on shallow aquifer to fulfil the increasing demand of ground water.

However, as per the Dynamic Ground Water Resources Assessment – 2020, the stage of development (SOD) of ground water of the district is 43.34 % only where the net ground water availability is 2324.43 ham.

In general ground water in phreatic aquifer is found suitable for drinking, domestic and irrigation purpose. Chemical quality of ground water of deeper aquifer is given in Annexure III.

## **5.2 Major Ground Water Issues**

The major issues identified are:

1. The district has a good network of canal but falls in the tail area. The canal irrigation system essentially depends on the availability of surface water. The ground water is a second largest and supplementary source for irrigation. The effect of drought or late monsoon on extraction of ground water for irrigation is yet to be studied. (1 Hectare Meters = 10000Cubic Meters, 1 cubic meter = 1000 lit.)
2. In Dynamic Ground Water Resources Assessment – 2017, the stage of development (SOD) of ground water of the district is 38.56 % only where the net ground water availability is 21195.48 ham. Therefore there is ample scope exists to develop the ground water further up to the safe limit of SOD of 70% to fulfil the demand of ground water for the irrigation purpose.
3. Shifting of number of shallow aquifer to the to the next deeper category and the declining water level of shallow aquifer during last 10 years indicate that there is a need of artificial recharge to ground water for its sustainable use.

## 6. MANAGEMENT STRATEGIES

Following management strategies has been suggested for the district is to address the ground water related issues discussed earlier. Since the ample scope exists for the development of ground water, only supply side management has been discussed in this study. However, it is important to be careful about the indiscriminate waste of water. The shifting of number of shallow aquifer to the next deeper category and the declining water level of shallow aquifer during last 10 years indicates that there is a need of artificial recharge to ground water.

Hence the management strategy for the district is mainly focused on:-

1. *Further development of Ground Water*
2. *Artificial Recharge to Ground Water*

The preparation of above development plan has been explained below:

### 6.1 Further Development of Ground Water:

Ground water can be developed further by constructing additional number of tube well. Based on the MI Census method, cropped area method and crop water requirement method, unit draft of a tube well has been calculated to be 1.69 ham for Arwal district.

The block wise calculated Stage of Development (SOD) in Arwal district ranged from 34 to 55 % only. Therefore by considering the unit draft of 1.69 ham of a tube well, additional number of tube wells may be calculated up to the projected SOD of 70%.

Based on the above, block wise additional number of tube wells has been calculated and given in the table – 19.

**Table 19:** Block-wise Feasible Number of Additional Shallow Tube wells

Sl.	Block	GW Resources Position in Bihar as per GW Resource Estimation - 2017				Calculation for additional TW			
		Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% (Yr-2020)	GW draft at Projected SOD (70%)	Additional Resource Available	Additional Nos. of STW feasible based on GW availability
1	Arwal	5468.21	3974.26	1356.1	509.71	34.12	2781.98	682.57	404
2	Bansi Surujpu	3045.05	2388.68	891.32	119.19	37.31	1672.08	597.41	353
3	Kaler	5965.78	4626.21	2278.86	439.54	49.26	3238.35	948.32	561
4	Karpi	2556.42	5392.69	2294.76	371.98	42.55	3774.88	1245.83	737
6	Kurtha	5435.84	2324.43	1286.87	235.75	55.36	1627.10	461.58	273
7	<b>Arwal</b>	<b>22471.3</b>	<b>18706.27</b>	<b>8107.91</b>	<b>1676.17</b>	<b>43.34</b>	<b>13094.39</b>	<b>3935.71</b>	<b>2329</b>



## 6.2 Artificial Recharge to Ground Water

The artificial recharge plan recommended for the district has been taken from the 'Master Plan for the Artificial Recharge – 2019'. The district area is a part of alluvial plain. Availability of storage space i.e. unsaturated volume is essential for artificial recharge to ground water. The storage space is identified by the post monsoon water level categorised mainly in two categories:

- a) Areas showing water levels between 3 and 6 m bgl and declining trend of  $> 10$  cm /yr;
- b) Areas with Depth-to-Water levels are more than 6 m bgl and showing declining trend.

Storage space available for recharge i.e. net unsaturated volume in identified areas is by computation of average depth of the unsaturated zone below 3 m bgl and then multiplied by the area considered for recharge. Further, norm-based specific yield values, based upon nature of aquifer material, are multiplied to arrive at volume of water required for artificial recharge for each identified area. Gross volume of source water required for artificial recharge is estimated by considering average recharge efficiency of 65%. The volume of source water required for artificial recharge purpose is calculated by multiplying a factor of 1.54 (i.e. reciprocal of 0.65).

The source water i.e. surface water availability with 75% dependability has been utilised from 2<sup>nd</sup> Bihar State Irrigation Commission Report (1994). The commission noted that for South Bihar, rainfall can be directly correlated with river discharge. By considering entire non-monsoon rainfall as committed, excess monsoon rainfall can be safely harnessed to replenish groundwater table without affecting surface water resource. For the present report, 60% of the normal monsoon rainfall for identified feasible areas is considered as available non-committed surface runoff.

As per the above, the total area calculated for artificial recharge in Arwal district is 171.86 sq. km., volume of de-saturated zone is 35.53 mcm, surface water requirement (65% efficiency) is 54.72 mcm and total available surface runoff is 404.15 mcm.

The suggested recharge structures for the district are:

- (a) Nala bunding
- (b) Contour bunding
- (c) Recharge shaft
- (d) Percolation tank
- (e) De-silting of existing tank /pond /talao and
- (f) Injection well in village tank
- (g) Renovation of traditional Ahar-Pyne System (km)

As per the above criteria, no any artificial recharge structure has been worked out for Sonbhadara Banshi Suryapur and Kaler blocks. Emphasis has been given on renovation of old alluvial contour bunding (Ahar - Pyne System), which is very common in South Bihar. Such systems are in existence since long and occasional repairs are undertaken by local farmers.

Based on available literature and previous experiences, unit cost of above structures is also worked out.

As per the above, the block wise number, types of recharge structure with cost worked out has been given in the **tables -20**

**Tables -20** Block-wise and Type-wise Feasible Numbers of various Artificial Recharge Structures

<i>Block</i>	<i>Nala Bunding</i>	<i>Contour Bunding &amp; Trenching</i>	<i>Recharge Shaft</i>	<i>Percolation Tank</i>	<i>De-silting of existing tank /pond /talao</i>	<i>Injection Well in Village Tank</i>	<i>Renovation of traditional Ahar-Pyne System (km)</i>
Arwal	0	0	6	1	12	18	18
Bansi	0	0	0	0	0	0	0
Karpi	0	2	5	0	8	9	9
Kurtha	1	7	7	0	11	14	14
Kaler	0	0	0	0	0	0	0
<b>Total</b>	<b>1</b>	<b>9</b>	<b>17</b>	<b>1</b>	<b>31</b>	<b>41</b>	<b>42</b>
Unit Cost (Lakh)	1	2	5	30	5	4	20
Structure wise total cost (lakh)	<b>1</b>	<b>18</b>	<b>85</b>	<b>30</b>	<b>155</b>	<b>164</b>	<b>840</b>

**Total Cost = Rs 1293.0 Lakh Only**

### **Revival of Urban Water Bodies**

Arwal is the only town/urban area in the district covering an area of 24.4 sq km. Based on norm of at least one surface water bodies in 10 sq. km area, there should be at least two (02) surface water bodies in Arwal urban area. The estimated unit cost of surface water body has been worked out to be Rs. 10 lakh. Therefore cost for the revival of two water bodies will be Rs. 20 lakh.

### **Roof-Top Rain Water Harvesting**

The Arwal has the number of Govt. buildings, institutions, schools, hospitals *etc.* in urban municipal area. These buildings may be adopted for implementation of roof-top rainwater harvesting. As on an average these buildings should have large roof area. Besides Govt. buildings, Arwal town has total 8453 number of residential houses (census 2011). Considering average rainfall of 1000 mm for the district and 80% efficiency of the system with about 100 m<sup>2</sup> of

roof-area, the number of possible rooftop rainwater harvesting structure and Cost Estimate is summarized below

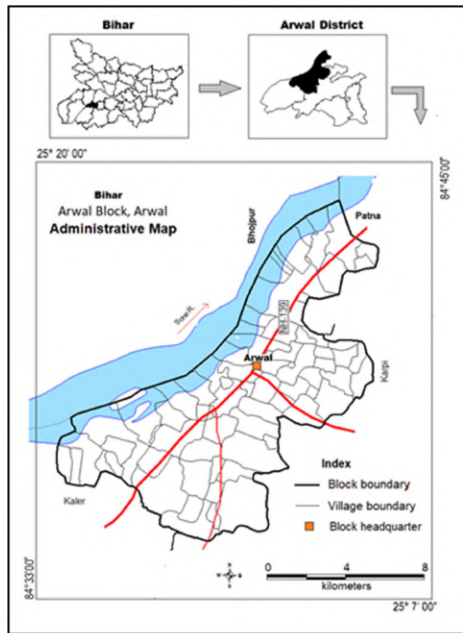
Urban Area (Sq Km)	:	24.4
Estimated Number of Suitable Roof	:	300
Approximate Roof area (m <sup>2</sup> )	:	30000
Total volume of water available (MCM)	:	0.189
<b>Cost Estimate (in lakh Rs.)</b>	<b>:</b>	<b>300</b>

The rooftop rain water harvesting structure should be maintained properly. Entry of Yellow water (urine with or without flush water) brown water (toilet wastewater without urine) grey water (domestic wastewater) and first rainfall must be avoided. Once the ground water is polluted it is difficult to clean it.

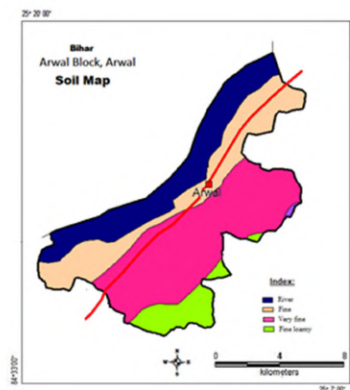
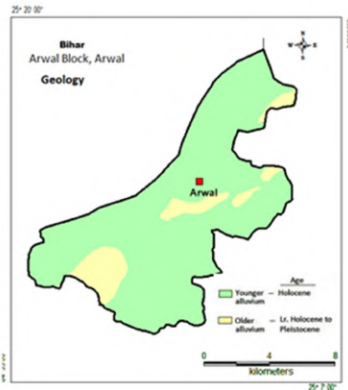
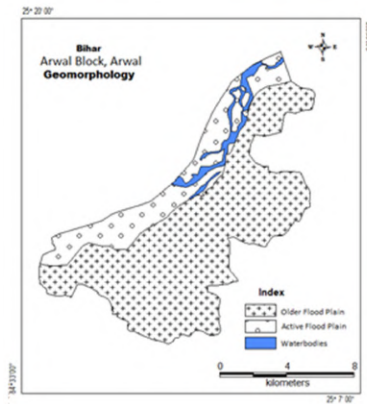
7. BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLANS

7.1 Arwal block

7.1.1 General Information

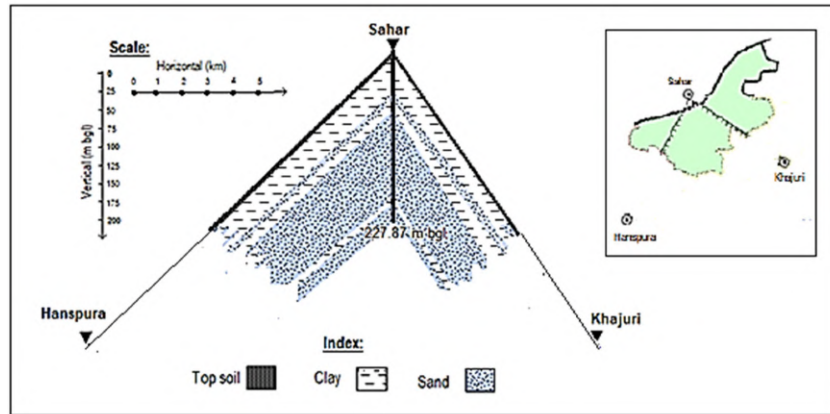


⇒ No. of town	:	1
→ No. of revenue	:	73
⇒ Population	Total :	1,59,686
	Rural :	1,07,837
	Urban :	51,849



1. Geographical Area : 12182 ha
2. Basin/Sub-basin : Lr Ganga / Gandak and
3. Principal Aquifer : Younger and Older
4. Major Aquifer System : Quaternary Alluvium
5. Normal rainfall : 874.4 mm

### 7.1.2 Aquifer Disposition



#### Aquifer Disposition:

#### Two-aquifer system

Depth range

1<sup>st</sup> Aquifer – from 10 to 85 m bgl

2<sup>nd</sup> Aquifer – from 100 to 280 m bgl

Separated by 15 to 30 m clay layer

#### Status of GW Exploration:

At Khajuri (in Karpi block)

#### Depth to Water Level:

Phreatic aquifer:

Pre-monsoon : 4.21 to 6.53 m bgl

Post-monsoon: 1.42 to 4.53 m bgl

#### Aquifer Characteristics :

Discharge : ~ 50 lit. per second

Transmissivity : ~ 2000 m<sup>2</sup>/day } 2<sup>nd</sup> Aquifer

#### CGWB Monitoring Status :

NHS monitoring well: 3

NAQUIM Monitoring Well: 1

#### GW Quality :

Range:

pH: 7.1-7.8, EC:265-387  $\mu\text{s}@25^\circ\text{c}$ , TH: 100-114.9No<sub>3</sub><sup>-</sup>

:14.7-26.3, F: 0.23-0.29

#### Aquifer Potential:

Yield potential: 180 m<sup>3</sup>/hr

### 7.1.3 Aquifer Management Plan

<b>GW Management Issues:</b>	1. Stage of ground water extraction is only 34 % 2. (a) The last 10 years water level data (2000-19) showing declining trend. (b) number of tube wells has been decrease in shallow category and increased in deeper category (5 <sup>th</sup> MI census w.r.t. 4 <sup>th</sup> MI census)
<b>GW Resource:</b>	Net ground water availability: 39.7MCM Gross ground water draft: 13.6 MCM
<b>Existing and Future Water Demand :</b>	Ground Water Extraction for Domestic Use (Ham) : 4.5 MCM Provision for domestic and industrial use for next 25 years: 5.1 MCM
<b>AR &amp; Conservation Possibilities:</b>	Rooftop rainwater harvesting, Renovation of traditional ahar-pyne, Recharge shaft, Percolation tanks, de-silting of existing pond/talab/tank, Injection well in village tank etc.
<b>GW Management Plan :</b>	

#### 1. Possibility for the construction of addition number of tube well

Unit draft of tube well is considered as 1.69 ham

GW Resources Position in Bihar as per GW Resource					Calculation for additional TW		
Estimation - 2017							
Total Annual Recharge	Net Resource	Gross Draft All Uses	Provision for Future Domestic and Industrial Requirement	SOD% 2017	GW draft at Projected SOD (70%)	Additional Resource Available	Additional Nos. of STW feasible based on GW availability
4415.84	3974.26	1356.1	509.71	34.12	2781.98	682.57	404

#### 2. Types and number of the artificial recharge structures with estimated cost.

Block	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank	Renovation of Traditional Ahar-Pyne System (km)
Arwal	6	1	12	18	18

Cost (in lakh)	Recharge Shaft	Percolation Tank	De-silting of existing tank /pond /talao	Injection Well in Village Tank	Renovation of traditional Ahar-Pyne System (km)
Unit cost	5	30	5	4	20
Total cost	<b>30</b>	<b>30</b>	<b>60</b>	<b>72</b>	<b>360</b>

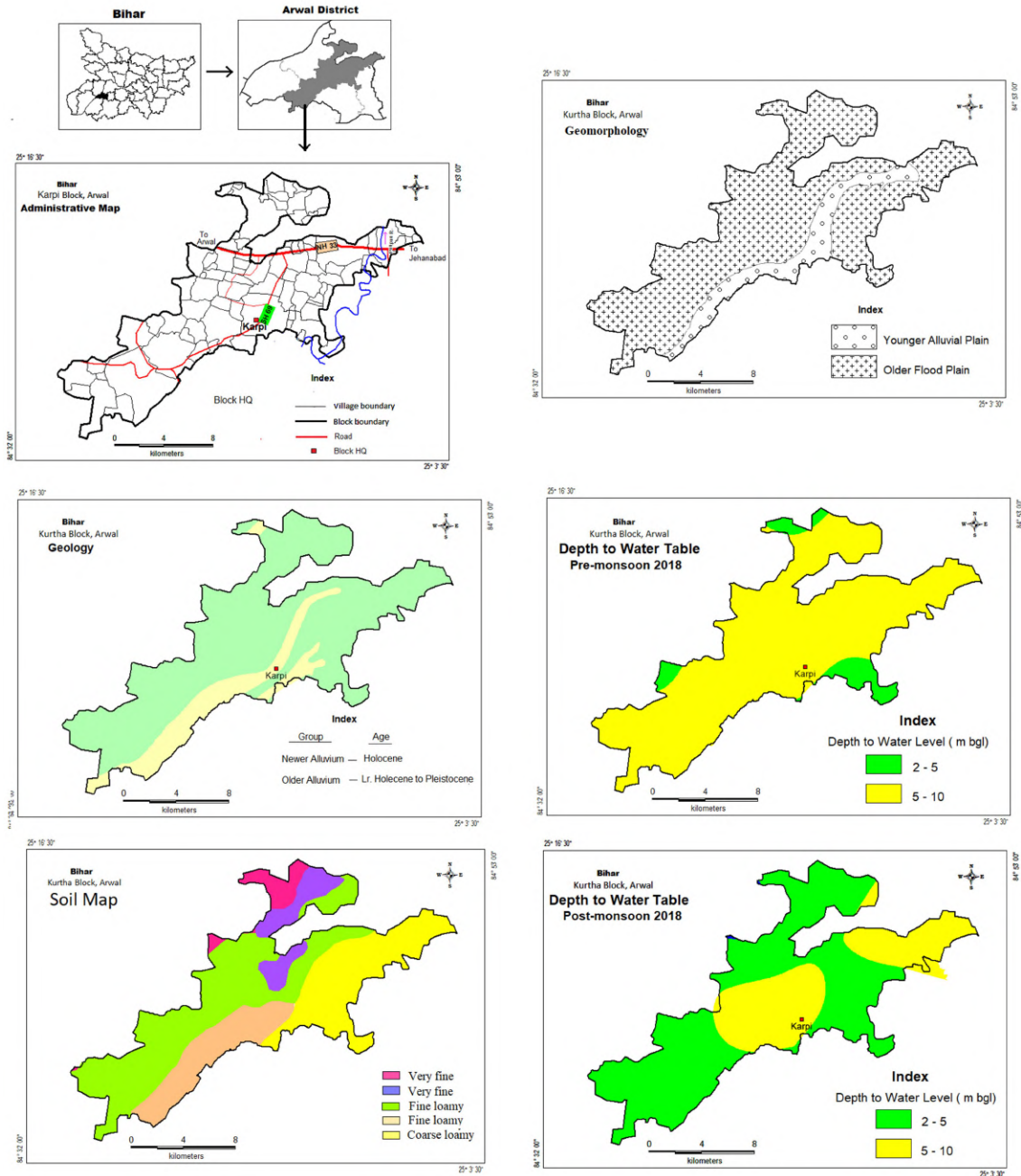
- (1) **Revival of urban water bodies:** As per norm of at least one surface water bodies in 10 sq. km area, there should be at least two (02) surface water bodies in Arwal urban area. The estimated unit cost of surface water body has been worked out to be Rs. 10 lakh. Hence, total cost for the revival of two water bodies will be Rs. 20 lakh.

(2) **Rooftop Rainwater harvesting:** The government buildings having large roof area may be adopted for implementation of roof-top rainwater harvesting. Residential houses may also be considered for roof-top rainwater harvesting. Considering average rainfall of 1000 mm and 80% efficiency of the system with about 100 m<sup>2</sup> of roof area the rooftop rainwater harvesting structure worked out for the Arwal block is given below:

<i>Urban Area (Sq Km)</i>	<i>Estimated Number of Suitable Roof</i>	<i>Approximate Roof area (m<sup>2</sup>)</i>	<i>Total volume of water available (MCM)</i>	<i>Cost Estimate (in lakh Rs.)</i>
24.4	300	30000	0.189	<b>300</b>

## 7.2 Karpi block

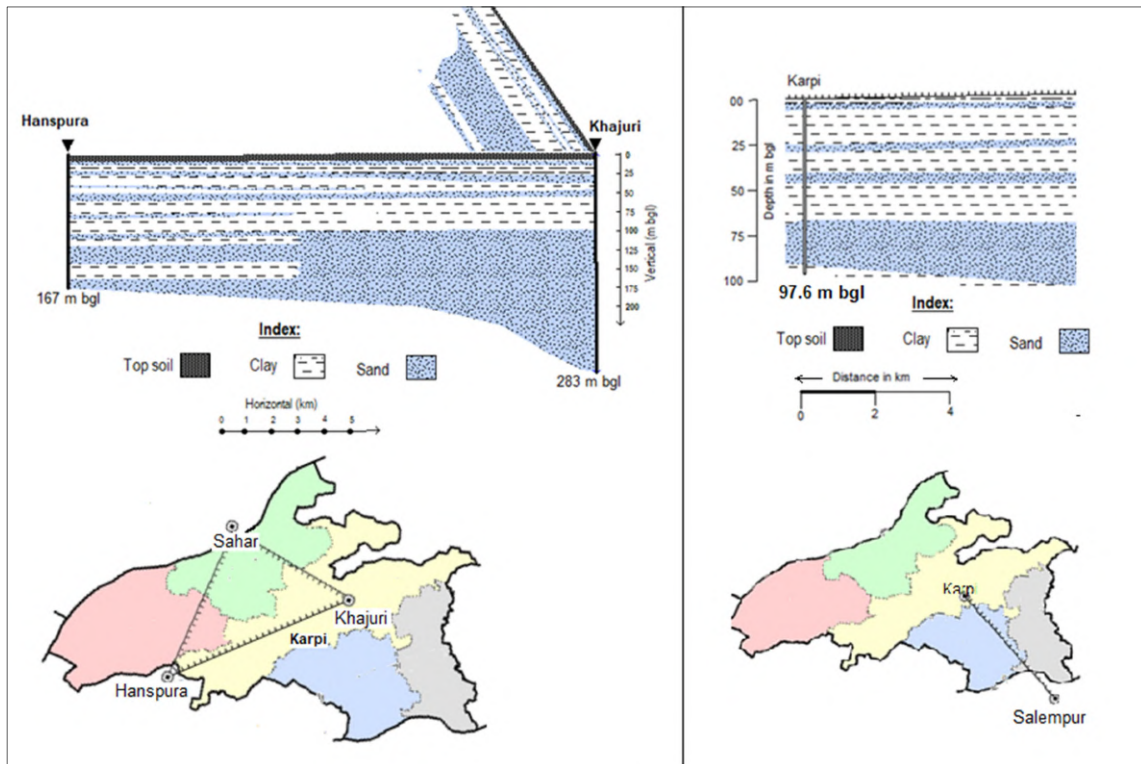
### 7.2.1 General Information



1. Area	:	19493
2. No. of town	:	0
3. No. of revenue village	:	84
4. Population (2011)	Total	1,92,213
	Rural	1,92,213
	Urban	0
5. Normal rainfall (District)	(mm)	874.4
6. Basin / Sub-basin	:	Lr Ganga / Gandak and others



## 7.2.2 Aquifer Disposition



### Aquifer Disposition:

### Two-aquifer system

Depth range

1<sup>st</sup> Aquifer – from 10 to 85 m bgl

2<sup>nd</sup> Aquifer – from 100 to 280 m bgl

Separated by 15 to 30 m clay layer

### Status of GW Exploration:

At Khajuri (in Karpi block)

### Depth to Water Level:

Phreatic aquifer:

Pre-monsoon : 5.52 to 7.29 m bgl

Post-monsoon: 4.89 to 6.65 m bgl

### Aquifer Characteristics :

Discharge : ~ 50 lit. per second

Transmissivity : ~ 2000 m<sup>2</sup>/day } 2<sup>nd</sup> Aquifer

### CGWB Monitoring Status :

NHS monitoring well: 2

NAQUIM Monitoring Well: 1

### GW Quality :

Range:

pH: 6.9-7.4, EC:690-1001  $\mu\text{s}@25^\circ\text{c}$ , TH: 210-265,  $\text{NO}_3^-$  : <74.5, F: 0.28-0.34

### Aquifer Potential:

Yield potential: 180 m<sup>3</sup>/hr

### 7.2.3 Aquifer Management Plan

<b>GW Management Issues:</b>	1. Stage of ground water extraction is only 42.5 % 2. (a) The last 10 years water level data (2000-19) showing declining trend. (b) number of tube wells has been decrease in shallow category and increased in deeper category (5 <sup>th</sup> MI census w.r.t. 4 <sup>th</sup> MI census)
<b>GW Resource:</b>	Net ground water availability: 39.7MCM Gross ground water draft: 13.6 MCM
<b>Existing and Future Water Demand :</b>	Ground Water Extraction for Domestic Use (Ham) : 53.9 MCM Provision for domestic and industrial use for next 25 years: 22.9 MCM
<b>AR &amp; Conservation Possibilities:</b>	Rooftop rainwater harvesting, Renovation of traditional ahar-pyne, Recharge shaft, Percolation tanks, de-silting of existing pond/talab/tank, Injection well in village tank etc.
<b>GW Management Plan :</b>	

#### 1. Possibility for the construction of addition number of tube well

Unit draft of tube well is considered as 1.69 ham

<i>Total Annual Recharge</i>	<i>Net GW Resource</i>	<i>Gross Draft From All Uses</i>	<i>Provision for Future Domestic and Industrial Requirement</i>	<i>SOD% 2017</i>	<i>GW draft at Projected SOD</i>	<i>Additional Resource Available</i>	<i>Unit Draft of STW</i>	<i>Additional Nos. of STW feasible based on GW</i>
2556.42	5392.69	2294.76	371.98	42.55	3774.88	1245.83	1.69	<b>737</b>

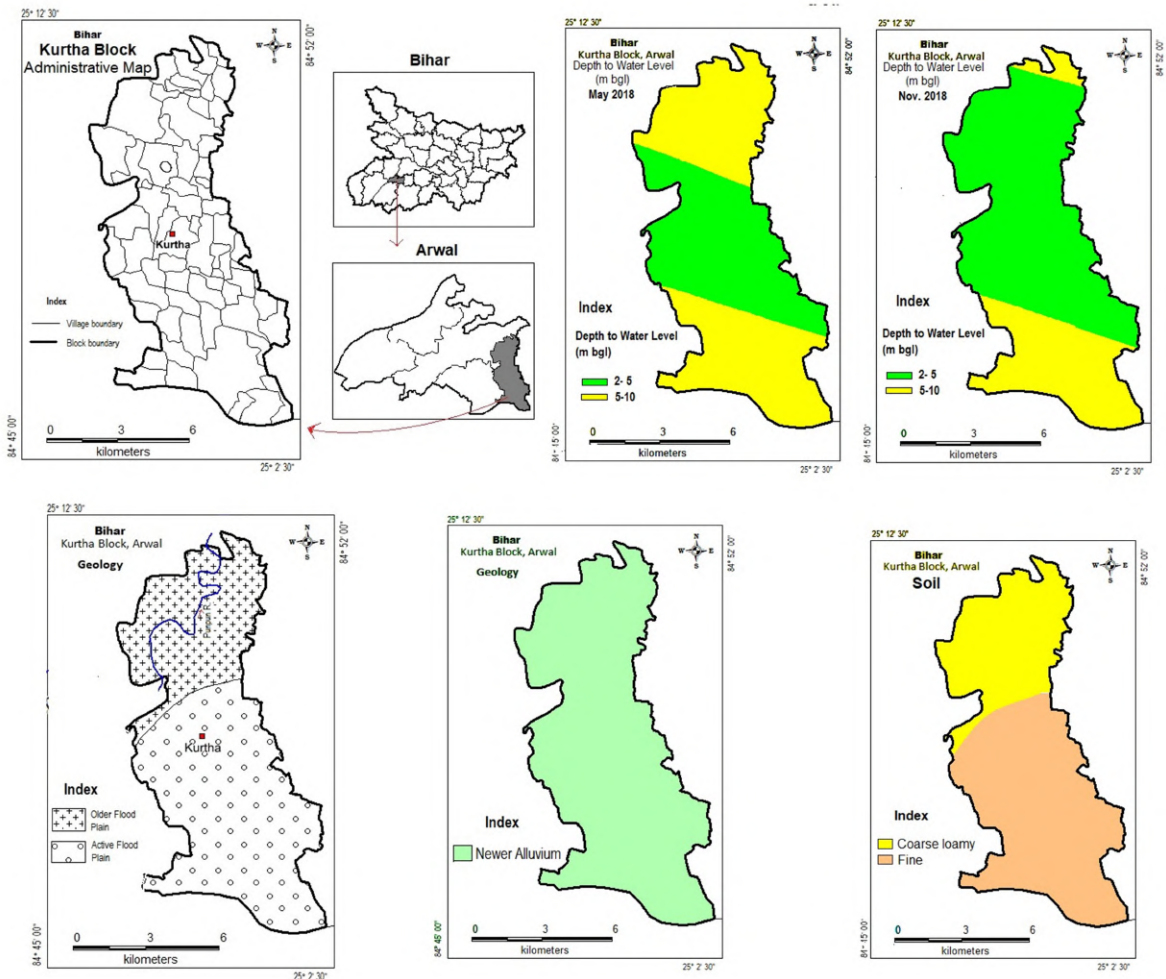
#### 2. Types and number of the artificial recharge structures with estimated cost.

	<i>Contour Bunding &amp; Trenching</i>	<i>Recharge Shaft</i>	<i>De-silting of existing tank /pond /talao</i>	<i>Injection Well in Village Tank</i>	<i>Renovation of traditional Ahar-Pyne System (km)</i>
No. of Structures	2	5	8	9	9
Unit cost (Lakh)	2	5	5	4	20
Total cost (Lakh)	<b>4</b>	<b>25</b>	<b>40</b>	<b>36</b>	<b>180</b>

The total cost for artificial recharge to ground water worked out in Kurtha block is **Rs. 431 Lakh.**

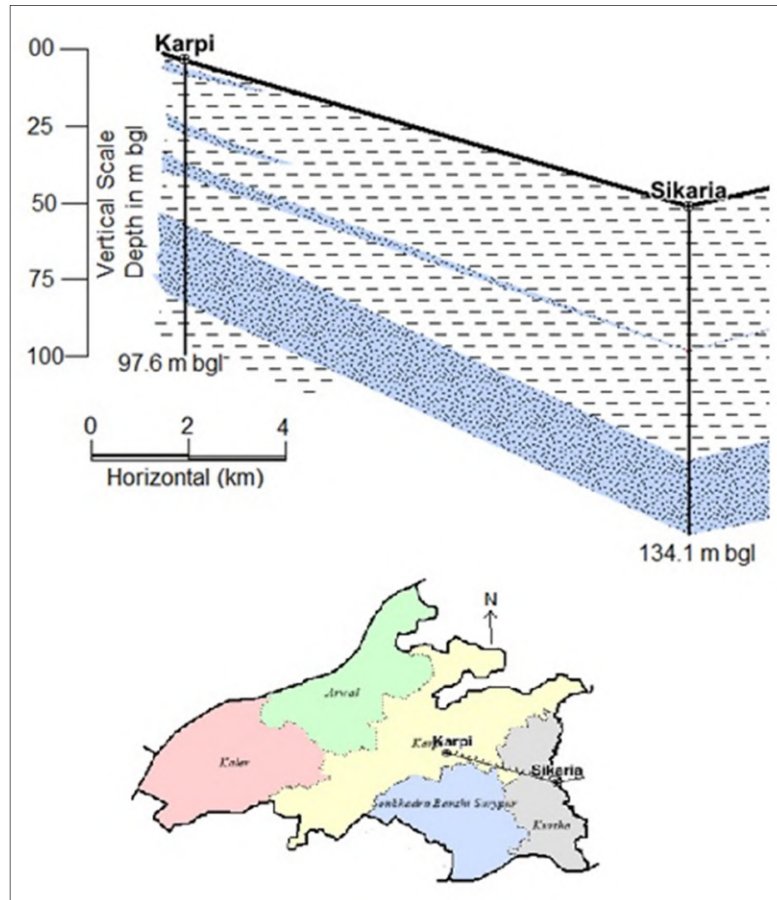
## 7.3 Kurtha block

### 7.3.1 General Information



1. Area	in ha	: 8929
2. No. of town		: 0
3. No. of revenue village		: 72
4. Population (2011)	Total	: 1,21,818
	Rural	: 1,21,818
	Urban	: 0
5. Normal rainfall	(mm)	: 874.4
6. Basin / Sub-basin		: Lr Ganga / Gandak and others

### 7.3.2 Aquifer Disposition



**Aquifer Disposition:**

**Two-aquifer system**

Depth range  
 1<sup>st</sup> Aquifer – from ~20 to ~30 m bgl  
 2<sup>nd</sup> Aquifer – from ~75 to ~134 m bgl  
 Separated by 15 to 30 m clay layer

**Status of GW Exploration:**

At Khajuri (in Karpi block)

**Depth to Water Level:**

Phreatic aquifer:  
 Pre-monsoon : 3.46 to 6.12 m bgl  
 Post-monsoon: 2.72 to 3.74 m bgl

**Aquifer Characteristics :**

Discharge : ~ 50 lit. per second  
 Transmissivity : ~ 2000 m<sup>2</sup>/day } 2<sup>nd</sup> Aquifer

**CGWB Monitoring Status :**

NHS monitoring well: 1  
 NAQUIM Monitoring Well: 1

**GW Quality :**

Range:  
 pH: 6.9-7.4, EC:1001-1143 μs@25°c, TH: 365-390, NO<sub>3</sub><sup>-</sup>:74.5-113.54, F: 0.22-0.34

**Aquifer Potential:**

Yield potential: 180 m<sup>3</sup>/hr

### 7.3.3 Aquifer Management Plan

<b>GW Management Issues:</b>	1. Stage of ground water extraction is only 55 % 2. (a) The last 10 years water level data (2000-19) showing declining trend. (b) number of tube wells has been decrease in shallow category and increased in deeper category (5 <sup>th</sup> MI census w.r.t. 4 <sup>th</sup> MI census)
<b>GW Resource:</b>	Net ground water availability: 23.2 MCM Gross ground water draft: 13.6 MCM
<b>Existing and Future Water Demand :</b>	Ground Water Extraction for Domestic Use (Ham) : 53.9 MCM Provision for domestic and industrial use for next 25 years: 12.8 MCM
<b>AR &amp; Conservation Possibilities:</b>	Rooftop rainwater harvesting, Renovation of traditional ahar-pyne, Recharge shaft, Percolation tanks, de-silting of existing pond/talab/tank, Injection well in village tank etc.
<b>GW Management Plan :</b>	

#### 1. Possibility for the construction of addition number of tube well

<i>Total Annual Recharge</i>	<i>Net Resource</i>	<i>Gross Draft All Uses</i>	<i>Provision for Future Domestic and Industrial Requirement</i>	<i>SOD% 2017</i>	<i>GW draft at Projected SOD</i>	<i>Additional Resource Available</i>	<i>Unit Draft of STW</i>	<i>Additional Nos. of STW feasible based on GW availability</i>
5435.84	2324.43	1286.87	235.75	55.36	1627.10	461.58	1.69	<b>273</b>

#### 1. Types and number of the artificial recharge structures with estimated cost.

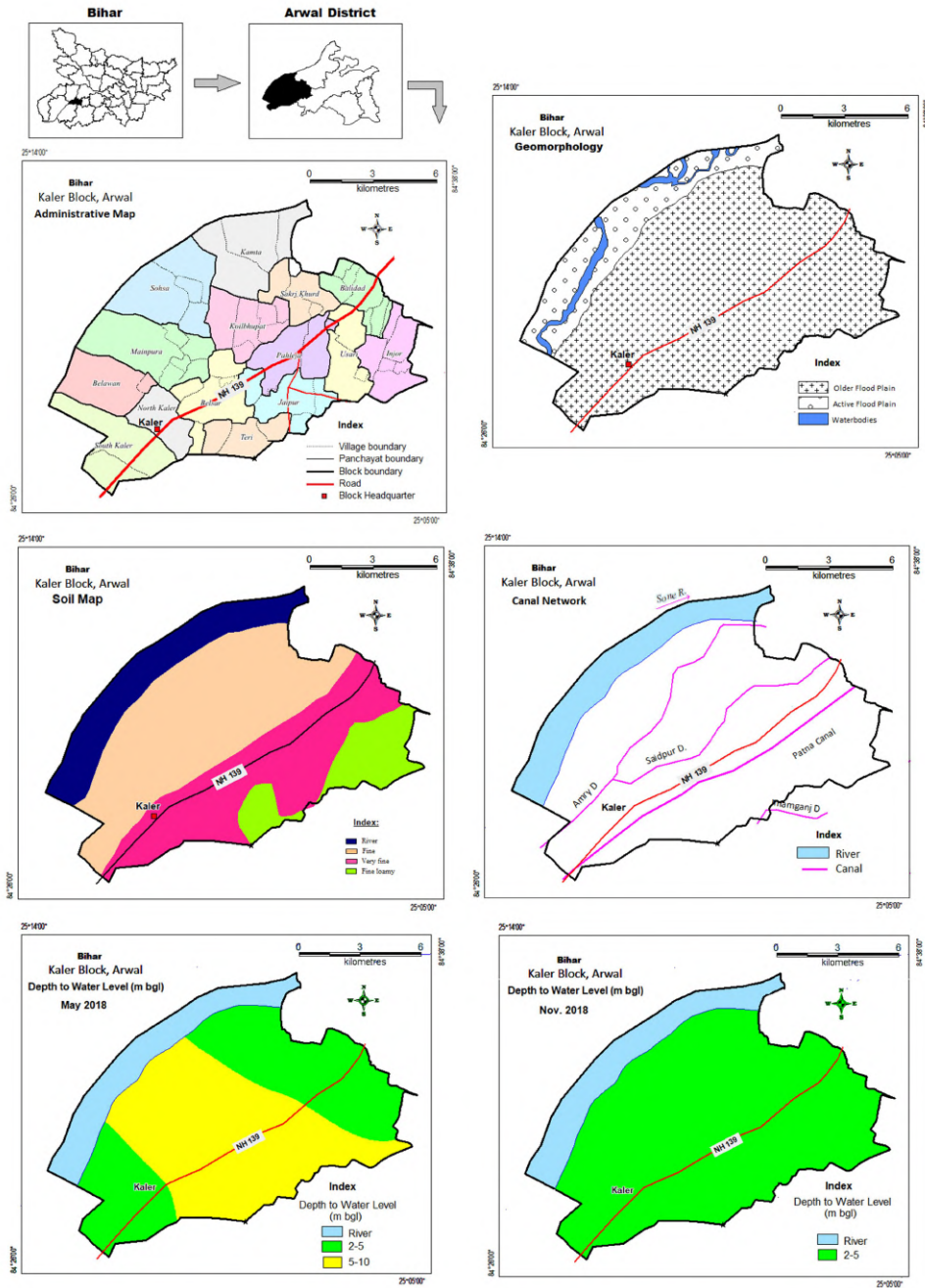
	<i>Nala Bunding</i>	<i>Contour Bunding &amp; Trenching</i>	<i>Recharge Shaft</i>	<i>De-silting of existing tank /pond /talao</i>	<i>Injection Well in Village Tank</i>	<i>Renovation of traditional Ahar-Pyne System (km)</i>
No. of structure	1	7	7	11	14	14
Unit Cost (Lakh)	1	2	5	5	4	20
Total cost (lakh)	<b>1</b>	<b>14</b>	<b>25</b>	<b>55</b>	<b>56</b>	<b>280</b>

The total cost for artificial recharge to ground water worked out in Karpi block is **Rs. 431 Lakh.**

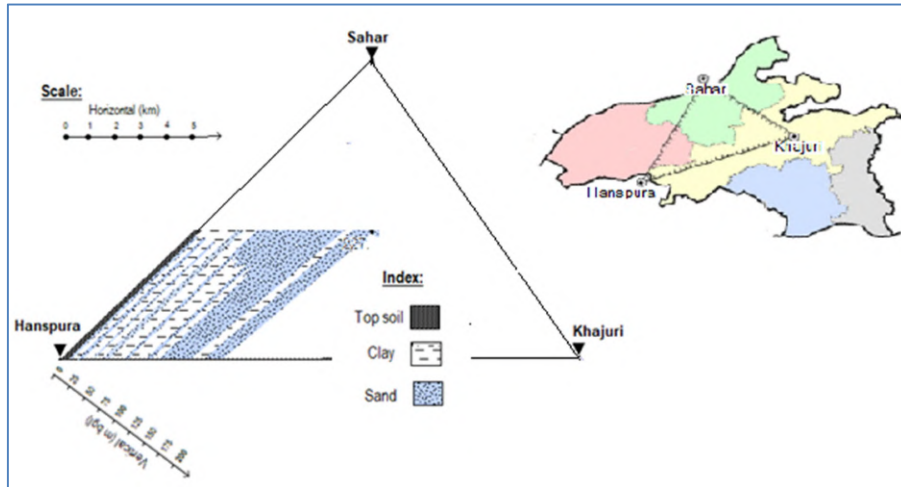
## 7.4 Kaler block

### 7.4.1 General Information

1. Area	in ha.	:	14083
2. No. of town		:	0
3. No. of revenue village		:	60
4. Population	Total	:	1,48,941
	Rural	:	1,48,941
	Urban	:	0
5. Normal rainfall (District)	(mm)	:	874.4
6. Basin / Sub-basin		:	Lr Ganga / Gandak



### 7.4.2 Aquifer Disposition



**Aquifer Disposition:**

Two-aquifer system

Depth range

1<sup>st</sup> Aquifer – from ~10 to ~60 m bgl

2<sup>nd</sup> Aquifer – from ~60 to ~150 m bgl

**Status of GW Exploration (nearby):**

At Hanspura (in Hanspura block of Aurangabad district)

**Depth to Water Level:**

Phreatic aquifer:

Pre-monsoon : 4.54 to 5.28 m bgl

Post-monsoon: 2.88 to 4.03 m bgl

**Aquifer Characteristics :**

Discharge : ~ 34 lit. per second

Transmissivity : ~ 1200 m<sup>2</sup>/day

} 2<sup>nd</sup> Aquifer

**CGWB Monitoring Status :**

NAQUIM Monitoring Well: 2

**GW Quality :**

pH: 7.1, EC:265 μs@25°C, TH: 100, NO<sub>3</sub><sup>-</sup>:14.71, F: 0.29 (one sample only)

**Aquifer Potential:**

Yield potential: ~120 m<sup>3</sup>/hr

### 7.4.3 Aquifer Management Plan

<b>GW Management Issues:</b>	3. Stage of ground water extraction is 49 % only 4. (a) The last 10 years water level data (2000-19) showing declining trend. (b) number of tube wells has been decrease in shallow category and increased in deeper category (5 <sup>th</sup> MI census w.r.t. 4 <sup>th</sup> MI census)
<b>GW Resource:</b>	Net ground water availability: 46.26 MCM Gross ground water draft: 22.8 MCM
<b>Existing and Future Water Demand :</b>	Ground Water Extraction for Domestic Use (Ham) : 3.9 MCM Provision for domestic and industrial use for next 25 years: 4.4 MCM
<b>AR &amp; Conservation Possibilities:</b>	Rooftop rainwater harvesting, Renovation of traditional ahar-pyne, Recharge shaft, Percolation tanks, de-silting of existing pond/talab/tank, Injection well in village tank etc.
<b>GW Management Plan :</b>	

#### 1. Possibility for the construction of addition number of tube well

<i>Total Annual Recharge</i>	<i>Net Resource</i>	<i>Gross Draft All Uses</i>	<i>Provision for Future Domestic and Industrial Requirement</i>	<i>SOD% 2017</i>	<i>GW draft at Projected SOD</i>	<i>Additional Resource Available</i>	<i>Unit Draft of STW</i>	<i>Additional Nos. of STW feasible based on GW availability</i>
5965.78	4626.21	2278.86	439.54	49.26	3238.35	948.32	1.69	<b>561</b>

#### 2. Artificial Recharge

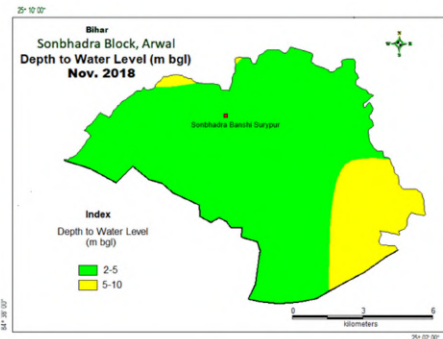
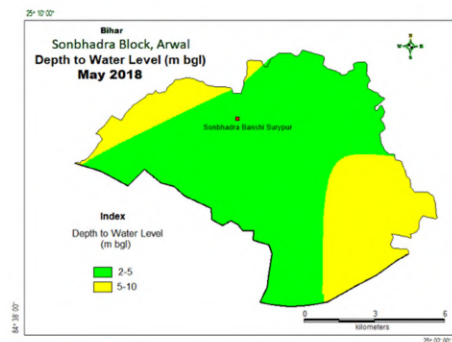
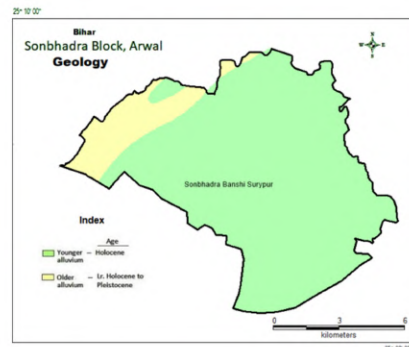
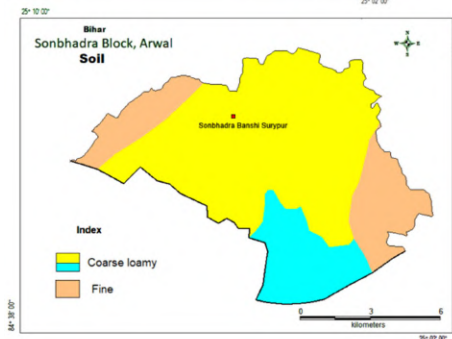
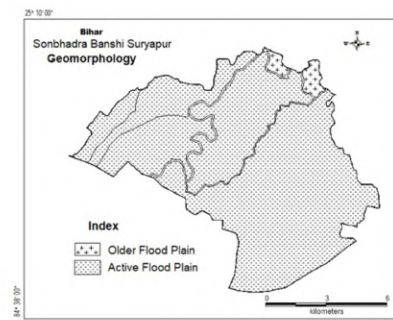
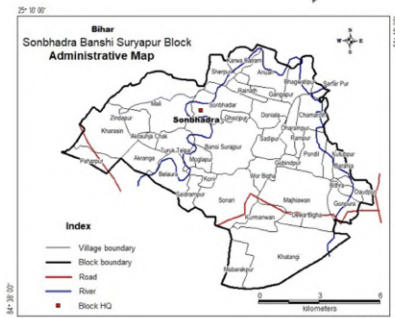
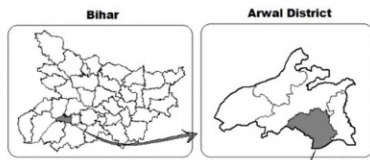
As per the method adopted to calculate number and type of ground water recharge structure, no any recharge structure has been suggested for Kaler block. However, renovation of traditional ahar-pyne, de-silting of existing pond/talab/tank, Injection well in village tank etc may be carried out.



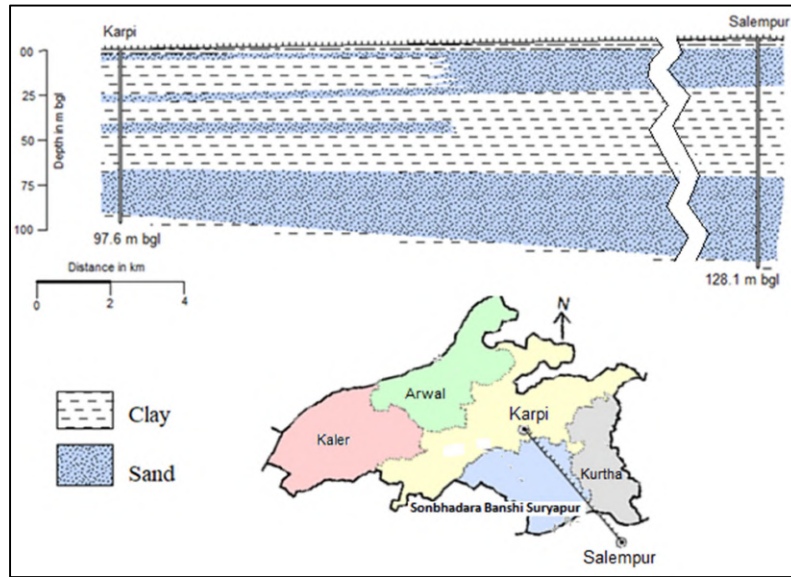
## 7.5 Sonbhadara Banshi Suryapur Block

### 7.5.1 General Information

1. Area	:	8996 ha
2. No. of town	:	0
3. No. of revenue village	:	46
4. Population (2011)	Total :	78,185
	Rural :	78,185
	Urban :	0
5. Normal rainfall (District)	(mm) :	874.4
6. Basin / Sub-basin	:	Lr Ganga / Gandak and others



### 7.5.2 Aquifer Disposition



**Aquifer Disposition:**

Two-aquifer system

Depth range

1<sup>st</sup> Aquifer – from ~10 to ~50 m bgl

2<sup>nd</sup> Aquifer –from ~60 to ~100 m bgl

**Status of GW Exploration (nearby):**

At Khajuri (in Karpi block)

**Depth to Water Level:**

Phreatic aquifer:

Pre-monsoon : 3.98 to 6.72 m bgl

Post-monsoon: 2.31 to 6.7 m bgl

**Aquifer Characteristics :**

Discharge : ~ 34 lit. per second

Transmissivity : ~ 2000 m<sup>2</sup>/day

} 2<sup>nd</sup> Aquifer

**CGWB Monitoring Status :**

NAQUIM Monitoring Well: 2

**GW Quality :**

pH: 7.2, EC:385 μs@25°C, TH: 165, NO<sub>3</sub><sup>-</sup>:12.88, F: 0.59

(one sample only)

**Aquifer Potential:**

Yield potential: ~120 m<sup>3</sup>/hr

### 7.5.3 Aquifer Management Plan

<b>GW Management Issues:</b>	<ol style="list-style-type: none"> <li>1. Stage of ground water extraction is 49 % only</li> <li>2. (a) The last 10 years water level data (2000-19) showing declining trend. (b) number of tube wells has been decrease in shallow category and increased in deeper category (5<sup>th</sup> MI census w.r.t. 4<sup>th</sup> MI census)</li> </ol>
<b>GW Resource:</b>	Net ground water availability: 46.26 MCM Gross ground water draft: 22.8 MCM
<b>Existing and Future Water Demand :</b>	Ground Water Extraction for Domestic Use (Ham) : 3.9 MCM Provision for domestic and industrial use for next 25 years: 4.4 MCM
<b>AR &amp; Conservation Possibilities:</b>	Rooftop rainwater harvesting, Renovation of traditional ahar-pyne, Recharge shaft, Percolation tanks, de-silting of existing pond/talab/tank, Injection well in village tank etc.
<b>GW Management Plan :</b>	

#### 1. Possibility for the construction of addition number of tube well

<i>Block</i>	<i>Total Annual Recharge</i>	<i>Net Resource</i>	<i>Gross Draft All Uses</i>	<i>Provision for Future Domestic and Industrial Requirement</i>	<i>SOD% 2017</i>	<i>GW draft at Projected SOD</i>	<i>Additional Resource Available</i>	<i>Unit Draft of STW</i>	<i>Additional Nos. of STW feasible based on GW availability</i>
Sonbhadra	3045.05	2740.55	883.68	35.91	32.24	1918.38	786.25	1.69	<b>465</b>

#### 2. Artificial Recharge

As per the method adopted to calculate number and type of ground water recharge structure, no any recharge structure has been suggested for Kaler block. However, renovation of traditional ahar-pyne, de-silting of existing pond/talab/tank, Injection well in village tank etc may be carried out.

## Sum-up

The Arwal has been carved out of Jehanabad district in August 2001 as a second smallest district of Bihar covers 638 km<sup>2</sup> area only. It has five administrative blocks i.e. Arwal, Kaler, Karpi, Kurtha and Sonbhadra (Banshi Suryapura). It shares boundary with Patna, Gaya, Jehanabad, Aurangabad, Rohtas and Bhojpur districts of Bihar. River Sone separates it from Bhojpur district while Punpun river crosses the district from south to north. Area is a part of alluvial plain of Ganga gently sloped towards north-east direction.

The district comes under the climate type: subtropical monsoon, mild and dry winter, hot summer. Area experience District experiences four seasons in a year.

Geologically, the district can be divided as the area of younger alluvium and older alluvium. Younger alluvium covers western part along the river Sone and eastern part of the district. Older alluvium covers central part of the district.

As per the Census – 2011, total population in the district is 7, 00,843. This population is projected for the year 2018 to be 26, 29,592 and created total draft of about 4407 ham. About 95% of the total households (highest in the State) covered under '*Jeevan Mission-Har Ghar Jal*' and connected with tape water supply system.

A comparison of actual rainfall of last five years w.r.t. normal rainfall indicates that the actual rainfall during Rabi season is observed to be decreased.

The area is a part of Central South Bihar Plain formed by the sediments deposited by river Sone and Punpun with their tributaries. It is almost flat area with average height of about 78 m. The range of the height varies between 64.9 and 95.4 m amsl. The area is dominated by cultivatable land. Only 20% area is not available for cultivation and about 5.5% of the area is fallow land. The Net sown area during the year 2018-19 was about 70% of the area reported. Soil texture is varies from very fine to coarse loamy. In eastern part, soil texture is coarser. About 77% of the area of Arwal district is part of Punpun River Sub-basin. Rest 13% along the river Sone, is drained by river Sone which flows from south-west to north-east. Though Sone and Punpun are perennial in nature, they bear little flow during non-monsoon periods. Rice is the major crops of Kharif season whereas wheat and pulses in Rabi season. District has good network of canal which fulfil major part of irrigational demand during Rabi and Kharif season. Ground water is the 2<sup>nd</sup> largest and supplementary source of irrigation. It has been seen that the number of shallow tube well in the depth range of 0-20 has been shifted to the next deeper range of 20-40 m bgl during 5<sup>th</sup> MI census when compare with 4<sup>th</sup> MI census..

Central Ground Water Board has carried out systematic and reappraisal

hydrogeological surveys, exploratory drilling under groundwater exploration programme and ground water regime monitoring etc. One exploratory well has been drilled at Khajuri in Karpi blocks. One report of 'Hydrogeological Survey' in 1995 was published. Total 7 (seven) National Hydrograph stations are being monitored four times in a year i.e. during in the month of January, May, August and November. Including 06 newly established key well, total 13 wells have been taken to study ground water behaviour.

Depth to water level in the year 2018 ranged from 3.46 to 7.29 m bgl during pre-monsoon and 1.42 to 6.7 m bgl during post-monsoon period. Post monsoon water level fluctuation w.r.t. pre-monsoon period has been observed less than 2 m in major part of the district. Water table contour ranged from 63.71 to 87.06 m amsl general flow of groundwater in phreatic aquifer towards north-east direction which almost follows general slop of the area. Long term water level trend of phreatic aquifer is showing falling trend up to 9 mm/year during last 10 years. Hydrograph prepared from water level data observed from Automatic Water Level Recorder (2018-20) reveals that monsoon recharge takes place in about 30 days from September to the October. Maximum average water level recharge has been calculated to be 3.78 m in the year 2020. Ground water quality, in general, is potable and suitable for irrigation purpose.

As per Pumping tests conducted in and around Arwal district with the discharge ranging from 1930 to 2528 lpm after tapping productive zone within varying depth between 103 to 267 m bgl of thickness 21 to 30 m shows transmissivity value from 1106 to 4645 m<sup>2</sup>/day.

The exploratory drilling shows that alluvium thickness is more than 283 m bgl. It can be characterized as alternating layer of sand, silt and clay. Based on the cross sections, fence diagram etc. these layers may be grouped into two aquifer system. First aquifer occurs from 10 to 60 m bgl and second one from 60 to 215 m bgl. The second aquifer is confined in nature.

As per the Ground Water Resource Assessment (GWRA) – 2020, stage of ground water extraction of the district is 43.34% only. Block wise calculated SOD is ranged from 20% (Arwal) to 55 % (Kurtha). Therefore, ample scope existed for the further development of ground water upto the calculated SOD of 70%.

There are two major issues has been identified from the study i.e. (i) water level of shallow aquifer is showing declining trend during last 10 years (ii) scope existed for the further development of ground water. To address these issues and as supply side management, block wise number of tube wells have been suggested where the unit draft of tube well is 1.69 ham as well as suitable artificial recharge structures have also been suggested with its estimated cost.

## Annexure I

## Monitoring Wells Details

<i>SN</i>	<i>Block</i>	<i>Village</i>	<i>Longitude</i>	<i>Latitude</i>	<i>Ht. of measuring Point (m agl)</i>	<i>Depth (m bgl)</i>	<i>Dia. (m)</i>	<i>WL May 18 (m bgl)</i>	<i>WL Nov 18 (m bgl)</i>	<i>Elevation (m amsl)</i>	<i>WL Fluctuation (m)</i>
1	Arwal	Arwal	84.6654	25.2503	0.62	6.63	1.22	6.53	4.53	79.1	2
2	Arwal	Dirpal Bigha	84.7056	25.2951	0.5	5.72	1.5	4.21	2.15	76.3	2.06
3	Arwal	Madhuban	84.6027	25.1909	0.73	5.77	1.12	4.47	3.45	77.3	1.02
4	Arwal	Motha	84.6794	25.2338	0.8	4.9	1.64	5.7	1.42	75.1	4.28
5	Kaler	Thakur Bigha	84.4733	25.0936	0.5	6.9	1.3	4.54	2.88	91.6	1.66
6	Kaler	Belsar	84.5272	25.135	0.5	6.3	5.4	5.28	4.03	89.3	1.25
7	Karpi	Bairbigha	84.7133	25.153	0.55	5.95	2.3	5.99	6.63	80.2	-0.64
8	Karpi	Imamganj	84.7484	25.2093	0.28	6.9	0.7	5.52	4.89	71.2	0.63
9	Karpi	Kinjer	84.8324	25.2166	0.67	9.13	1.3	7.29	6.65	71	0.64
10	Kurtha	Kurtha	84.8009	25.1267	1	3.78	1.58	3.46	2.72	74	0.74
11	Kurtha	Motipur	84.8174	25.1724	0.72	6.86	2.33	6.12	3.74	72.8	2.38
12	Banshi	Banshi	84.7355	25.1224	0.1	6	2.4	3.98	2.31	77.4	1.67
13	Banshi	Bithra	84.7939	25.0872	0.6	6.62	2	6.72	6.7	78.3	0.02

## Annexure II

## Chemical Parameter (Phreatic Aquifer)

<i>SN</i>	<i>Location</i>	<i>Latitude</i>	<i>longitude</i>	<i>pH</i>	<i>EC*</i>	<i>TH</i>	<i>Ca<sup>2+</sup></i>	<i>Mg<sup>2+</sup></i>	<i>Na<sup>+</sup></i>	<i>K<sup>+</sup></i>	<i>CO<sub>3</sub><sup>2-</sup></i>	<i>HCO<sub>3</sub><sup>-</sup></i>	<i>Cl</i>	<i>SO<sub>4</sub><sup>2-</sup></i>	<i>NO<sub>3</sub><sup>-</sup></i>	<i>F<sup>+</sup></i>	<i>TDS</i>
1	Dipalibibha	25.2942	84.7028	7.8	387	114.94	26	12	34	6.3	0	129	11	28	26.31	0.23	378
2	Arwal	25.2542	84.6792	7.4	582	244.8	40	35	23	1.24	0	191	35	28	53.8	0.27	449
3	Imamganj	25.2083	84.7667	7.1	691	234.89	58	22	63	1.06	0	291	39	51	22.7	0.31	651
4	Kinjer	25.2125	84.8292	7.4	1001	364.73	62	51	50	31.9	0	301	79	14	74.5	0.34	566
5	Jhunathi	25.2000	84.8875	7	870	340	76	36	35	12.34	0	326	91	68	46.4	0.77	743
6	Kurtha	25.1292	84.8208	6.9	1143	390	68	53	88	8.61	0	301	110	15	113.54	0.22	250
7	Bansi	25.1111	84.6697	7.2	385	165	40	16	16	0.66	0	191	7	18	12.88	0.59	449
8	Bairbigha	25.1483	84.7069	6.9	690	210	48	22	68	1.91	0	308	43	10	BDL	0.28	172
9	Madhuban	25.19026	84.60449	7.1	265	100	20	12	8	5.68	0	123	3	9	14.71	0.29	408

Value in mg/lit.

\*value in  $\mu\text{s/cm}@25^\circ\text{C}$

## Annexure III

## Chemical Parameter (Deeper Aquifer)

SN	Location	Latitude	Longitude	pH	EC*	TH	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	CO <sub>3</sub> <sup>2-</sup>	HCO <sub>3</sub> <sup>-</sup>	Cl	SO <sub>4</sub> <sup>2-</sup>	Value in mg/lit.		
															NO <sub>3</sub> <sup>-</sup>	F <sup>+</sup>	As**
1	Hanspura	25.2942	84.7028	7.34	368.21	28.28	29.79	60.87	14	5					0.81	0.79	0.007
2	Sahar			7.29	461.83	305.76	35.88	65.58	13	8					0.72	0.86	0.003
3	Dulhin Bazar	25.2083	84.7667	7.5	407.9	150.48	36.06	27.8	29	6			18.41		0.68	0.7	0.007
4	Khajuri	25.2125	84.8292	7.38	436.8	266.56	48.61	52.96	18	6		301	40.70		0.79	0.73	0.004

\*value in  $\mu\text{s/cm@25}^\circ\text{C}$  \*\* value in ppb

## Annexure IV

## Litholog

(Wells are located in and around Arwal district)

## Location: Khajuri, Co-ordinate: 84.7372, 25.1819

Depth range (m bgl)		Thickness (m)	Litholog
from	to		
0	10	10	Surface soil, brown color
10	18	8	Fine sand Yellow color
18	28	10	Sandy Clay Yellow color with mix fine sand yellow color
28	31	3	Fine sand Yellow color
31	40	9	Fine to medium sand yellow color
40	48	8	Clay Yellow color
48	55	7	Medium sand yellow color
55	68	13	Clay Yellow color with mix few medium sand yellow color
68	98	30	Sticky Clay grayish & reddish color
98	120	22	Coarse to medium sand yellow color
120	125	5	Fine sand with mix few Clay Yellow color
125	212	87	Sand coarse to Medium Yellow color
212	250	38	Clay Yellow color with mix few fine sand yellow color
270	283	13	Fine sand light yellow color with mix few quartz white color

**Location: Sahar, Bhojpur, Co-ordinate:84.6237, 25.2517**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	6.55	6.55	Soil :Surface soil Yellow color
6.55	52.18	45.63	Sandy Clay :Clay Yellow color with mix few medium sand
52.18	58.69	6.51	Clayey Sand: Medium sand yellow color with mix few Clay Yellow color
58.69	65.21	6.52	Sand: Sand coarse Yellow color
65.21	78.24	13.03	Sandy Clay : Clay Yellow color with mix few medium sand
78.24	195.37	117.13	Sand: Sand Medium to coarse Yellow color
195.37	201.87	6.5	Sandy clay: Clay Yellow color with mix sand medium yellow color
201.87	227.87	26	Sand : Sand coarse yellow color
227.87	286.37	58.5	Sandy clay: Clay brown color with mix few sand fine yellow color
286.37	312.37	26	Clay : Clay brown color

**Location: Hanspura, Aurangabad, Co-ordinate: 84.5623, 25.1048**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	10	10	Surface soil reddish color.
10	13	3	Sand Medium sand yellow color.
13	20	7	Clay grayish color.
20	28	8	Sand Medium sand yellow color.
28	40	12	Clay grayish color.
40	43	3	Sand Medium sand yellow color.
43	52	9	Clay reddish yellow color.
52	62	10	Sand Medium sand yellow color.
62	80	18	Clay reddish yellow color.
80	86	6	Sand Medium sand yellow color.
86	105	19	Clay red color
105	112	7	Sand Medium sand yellow color.
112	120	8	Clay red color.
120	143	23	Sand Medium sand yellow color.

**Location: Karpi, Co-ordinate: 84.5623, 25.1624**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	3.05	3.05	Clay
3.05	6.4	3.35	Fine sand
6.4	25.9	19.5	Clay
25.9	30.5	4.6	Medium sand
30.5	41.2	10.7	Clay



**Location: Sikaria, Co-ordinate: 84.8334, 25.1355**

Depth (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	58.8	58.8	Clay
58.8	59.4	0.6	Coarse sand
59.4	103.6	44.2	Clay
103.6	109.7	6.1	Medium sand
109.7	134.1	24.4	Coarse sand

**Location: Imadpur, Co-ordinate: 84.9250, 25.1538**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	22.9	22.9	Clay
22.9	25.9	3	Medium sand
25.9	48.7	22.8	Clay
48.7	51.2	2.5	Medium sand
51.2	67.1	15.9	Clay
67.1	97.6	30.5	Clay

**Location: Salimpur, Co-ordinate: 84.8421, 25.0349**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	6.1	6.1	Clay
6.1	27.4	21.3	Find sand
27.4	77.7	50.3	Clay
77.7	90.2	12.5	Coarse sand
90.2	99.1	8.9	Clay
99.1	125	25.9	Coarse sand
125	128.1	3.1	Clay

**Location: Ramgarh –I, Co-ordinate: 25.1237, 84.6957**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	33.5	33.5	Clay
33.5	42.7	9.2	Fine sand with pebbles
42.7	48.7	6	Clay
48.7	69	20.3	Coarse sand
69	90	21	Fine sand with clay
90	104.3	14.3	Coarse sand
104.3	108.8	4.5	Medium sand

**Location: Ramgarh -II**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	27.5	27.5	Clay
27.5	36.6	9.1	Clay white
36.6	45.8	9.2	Fine sand with pebbles
45.8	60.8	15	Sand with clay
60.8	64	3.2	Fine sand with kankar
64	97	33	Coarse sand
97	102	5	Clay with fine sand
0	27.5	27.5	Clay

**Location: Gaddopur-I Co-ordinate: 25.2333, 84.71418**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	30.5	30.5	Clay
30.5	39.5	9	Clay and sand
39.5	54.75	15.25	Fine sand with clay
54.75	65.75	11	Fine sand
65.75	99.25	33.5	Coarse sand
99.25	104	4.75	Clay with fine sand

**Location: Gaddopur-II**

Depth range (m bgl)		Thickness (m)	Litholog
<i>from</i>	<i>to</i>		
0	30.5	30.5	Clay
30.5	61	30.5	Clay with fine sand
61	68.5	7.5	Coarse sand
68.5	73	4.5	Clay with fine sand
73	100.5	27.5	Coarse sand
100.5	106	5.5	Medium sand

## Annexure V

## Depth to Water Level (DWLR)

In m bgl

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1	12-11-17	2.89	7.35				
2	13-11-17	2.98	7.35				
3	14-11-17	3.02	7.36				
4	15-11-17	3.03	7.37				
5	16-11-17	3.04	7.38				
6	17-11-17	3.05	7.39				
7	18-11-17	3.05	7.39				
8	19-11-17	3.06	7.4				
9	20-11-17	3.08	7.4				
10	21-11-17	3.1	7.41				
11	22-11-17	3.11	7.42				
12	23-11-17	3.12	7.42				
13	24-11-17	3.15	7.44				
14	25-11-17	3.2	7.45				
15	26-11-17	3.27	7.46				
16	27-11-17	3.32	7.47				
17	28-11-17	3.36	7.48				
18	29-11-17	3.39	7.5				
19	30-11-17	3.41	7.51				
20	01-12-17	3.43	7.52				
21	02-12-17	3.46	7.53				
22	03-12-17	3.5	7.54				
23	04-12-17	3.56	7.56				
24	05-12-17	3.58	7.57				
25	06-12-17	3.61	7.57				
26	07-12-17	3.63	7.59				
27	08-12-17	3.65	7.59				
28	09-12-17	3.66	7.6				
29	10-12-17	3.67	7.62				
30	11-12-17	3.69	7.63				
31	12-12-17	3.69	7.64				
32	13-12-17	3.71	7.66				
33	14-12-17	3.74	7.68				
34	15-12-17	3.76	7.7				
35	16-12-17	3.77	7.72				
36	17-12-17	3.78	7.73				
37	18-12-17	3.82	7.74				
38	19-12-17	3.91	7.75				
39	20-12-17	3.99	7.76				

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
40	21-12-17	4.04	7.78				
41	22-12-17	4.09	7.78				
42	23-12-17	4.1	7.8				
43	24-12-17	4.11	7.81				
44	25-12-17	4.16	7.83				
45	26-12-17	4.19	7.85				
46	27-12-17	4.2	7.87				
47	28-12-17	4.23	7.89				
48	29-12-17	4.25	7.91				
49	30-12-17	4.26	7.93				
50	31-12-17	4.27	7.95				
51	01-01-18	4.28	7.96				
52	02-01-18	4.29	7.98				
53	03-01-18	4.3	8				
54	04-01-18						
55	05-01-18						
56	06-01-18						
57	07-01-18		8.06				
58	08-01-18	4.48					
59	09-01-18						
60	10-01-18						
61	11-01-18						
62	12-01-18		8.12				
63	13-01-18						
64	14-01-18						
65	15-01-18	4.59					
66	16-01-18	4.61					
67	17-01-18					8.66	
68	18-01-18					8.69	
69	19-01-18	4.66	8.18			8.72	
70	20-01-18					8.73	
71	21-01-18					8.65	
72	22-01-18	4.69				8.66	
73	23-01-18					8.68	
74	24-01-18					8.75	
75	25-01-18					8.76	
76	26-01-18					8.74	
77	27-01-18						
78	28-01-18					8.74	
79	29-01-18					8.77	
80	30-01-18	4.77	8.26			8.73	
81	31-01-18					8.7	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
82	01-02-18						
83	02-02-18	4.79				8.74	
84	03-02-18					8.76	
85	04-02-18					8.8	
86	05-02-18		8.3				
87	06-02-18					8.91	
88	07-02-18		8.31			8.97	
89	08-02-18		8.31			9.01	
90	09-02-18		8.33			9.05	
91	10-02-18	4.95	8.34			9.1	
92	11-02-18					9.16	
93	12-02-18						
94	13-02-18					9.19	
95	14-02-18					9.15	
96	15-02-18						
97	16-02-18					9.09	
98	17-02-18	5				9.09	
99	18-02-18					9.12	
100	19-02-18						
101	20-02-18					9.2	
102	21-02-18					9.24	
103	22-02-18		8.43			9.28	
104	23-02-18						
105	24-02-18					9.4	
106	25-02-18					9.46	
107	26-02-18	5.11	8.48			9.49	
108	27-02-18	5.12				9.52	
109	28-02-18					9.54	
110	01-03-18		8.51			9.55	
111	02-03-18		8.52			9.59	
112	03-03-18	5.15	8.52			9.6	
113	04-03-18		8.54				
114	05-03-18	5.2	8.55			9.69	
115	06-03-18					9.7	
116	07-03-18		8.58			9.71	
117	08-03-18	5.21				9.71	
118	09-03-18	5.21					
119	10-03-18	5.22	8.6			9.75	
120	11-03-18	5.23	8.61				
121	12-03-18					9.79	
122	13-03-18		8.62			9.79	
123	14-03-18		8.64			9.79	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
124	15-03-18					9.78	
125	16-03-18					9.76	
126	17-03-18						
127	18-03-18	5.28	8.65			9.69	
128	19-03-18		8.66			9.65	
129	20-03-18		8.65			9.63	
130	21-03-18	5.3				9.62	
131	22-03-18	5.3	8.65			9.62	
132	23-03-18		8.67			9.61	
133	24-03-18	5.32	8.68			9.58	
134	25-03-18					9.54	
135	26-03-18						
136	27-03-18	5.38				9.5	
137	28-03-18		8.69				
138	29-03-18	5.41	8.68			9.45	
139	30-03-18	5.42	8.69			9.43	
140	31-03-18	5.44	8.69				
141	01-04-18	5.48	8.7			9.39	
142	02-04-18	5.57				9.37	
143	03-04-18	5.65	8.69			9.37	
144	04-04-18	5.68	8.69			9.35	
145	05-04-18	5.7	8.69				
146	06-04-18					9.34	
147	07-04-18	5.73	8.7			9.32	
148	08-04-18	5.76	8.71			9.3	
149	09-04-18	5.76	8.71			9.28	
150	10-04-18	5.77	8.71			9.25	
151	11-04-18	5.77	8.71			9.24	
152	12-04-18	5.78	8.72			9.22	
153	13-04-18	5.8	8.72			9.22	
154	14-04-18					9.22	
155	15-04-18	5.82	8.72				
156	16-04-18	5.84	8.73			9.26	
157	17-04-18	5.85	8.73				
158	18-04-18						
159	19-04-18	5.87				9.28	
160	20-04-18		8.74			9.29	
161	21-04-18	5.89				9.3	
162	22-04-18	5.9	8.76			9.31	
163	23-04-18	5.9	8.76			9.31	
164	24-04-18	5.92	8.77			9.33	
165	25-04-18	5.92				9.35	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
166	26-04-18	5.93	8.79			9.34	
167	27-04-18	5.94	8.79			9.34	
168	28-04-18	5.94	8.8			9.33	
169	29-04-18		8.8			9.33	
170	30-04-18		8.79			9.3	
171	01-05-18					9.27	
172	02-05-18					9.25	
173	03-05-18					9.23	
174	04-05-18					9.23	
175	05-05-18	6.1				9.24	
176	06-05-18	6.15	8.82			9.26	
177	07-05-18	6.18	8.83			9.28	
178	08-05-18	6.21				9.3	
179	09-05-18	6.25				9.31	
180	10-05-18	6.26					
181	11-05-18	6.29	8.85			9.27	
182	12-05-18		8.85			9.27	
183	13-05-18	6.32	8.86			9.29	
184	14-05-18	6.32	8.87			9.28	
185	15-05-18		8.87			9.29	
186	16-05-18	6.38	8.87			9.29	
187	17-05-18	6.4	8.87			9.34	
188	18-05-18	6.42				9.41	
189	19-05-18	6.43	8.89			9.45	
190	20-05-18	6.44	8.89			9.49	
191	21-05-18	6.45	8.9			9.5	
192	22-05-18	6.45				9.55	
193	23-05-18	6.45				9.57	
194	24-05-18	6.47				9.59	
195	25-05-18	6.51				9.61	
196	26-05-18	6.54	8.94			9.65	
197	27-05-18	6.56	8.96			9.72	
198	28-05-18					9.75	
199	29-05-18	6.6	8.97			9.74	
200	30-05-18	6.61	8.98			9.73	
201	31-05-18	6.62	8.99			9.74	
202	01-06-18	6.63	8.99			9.68	
203	02-06-18	6.63				9.61	
204	03-06-18	6.63	9.01			9.54	
205	04-06-18	6.63	9.02			9.5	
206	05-06-18	6.63	9.04				
207	06-06-18	6.64	9.04			9.54	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
208	07-06-18	6.64	9.05			9.67	
209	08-06-18	6.64	9.05				
210	09-06-18		9.06			9.85	
211	10-06-18	6.65	9.07			10.02	
212	11-06-18	6.64	9.08			10.07	
213	12-06-18	6.65	9.08			10.15	
214	13-06-18	6.66	9.09			10.17	
215	14-06-18	6.67	9.1			10.19	
216	15-06-18	6.68	9.12				
217	16-06-18	6.7	9.14			10.29	
218	17-06-18	6.71	9.16				
219	18-06-18	6.72	9.17			10.41	
220	19-06-18	6.73	9.19			10.42	
221	20-06-18		9.21			10.43	
222	21-06-18	6.75	9.22			10.44	
223	22-06-18	6.77	9.24			10.5	
224	23-06-18	6.78	9.27			10.5	
225	24-06-18		9.27			10.5	
226	25-06-18	6.8	9.28			10.48	
227	26-06-18	6.81	9.31			10.35	
228	27-06-18	6.83	9.31			10.06	
229	28-06-18	6.83	9.33			9.9	
230	29-06-18	6.84	9.33			9.81	
231	30-06-18	6.86	9.35			9.77	
232	01-07-18	6.86	9.34				
233	02-07-18	6.88	9.35			9.67	
234	03-07-18	6.89	9.35			9.61	
235	04-07-18	6.9	9.35			9.58	
236	05-07-18	6.91	9.36				
237	06-07-18	6.92	9.35				
238	07-07-18	6.93	9.35				
239	08-07-18	6.93	9.35				
240	09-07-18	6.96	9.35				
241	10-07-18	6.97	9.36				
242	11-07-18	6.99	9.36				
243	12-07-18		9.36				
244	13-07-18		9.36				
245	14-07-18		9.37				
246	15-07-18	7	9.37			10.59	
247	16-07-18		9.39			10.62	
248	17-07-18	7.02	9.41			10.66	
249	18-07-18		9.43			10.74	



SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
250	19-07-18	7.04	9.42				
251	20-07-18	6.99	9.43				
252	21-07-18	7.06	9.45			10.99	
253	22-07-18	7.04	9.46			11.01	
254	23-07-18	7.08	9.45			10.99	
255	24-07-18	7.09	9.44			11	
256	25-07-18	7.09	9.41			11	
257	26-07-18	7.1	9.4			11.01	
258	27-07-18	7.1	9.41			11.05	
259	28-07-18	7.11	9.36			11.06	
260	29-07-18	7.11	9.26			10.56	
261	30-07-18	7.06	9.23		7.82	10.25	
262	31-07-18	7.06	9.21		7.74	10.15	
263	01-08-18	6.71	9.21		7.69	10.09	
264	02-08-18	6.59	9.23		7.66	10.08	
265	03-08-18	6.57	9.23		7.61	9.97	
266	04-08-18	6.57	9.19			9.85	
267	05-08-18	6.53	9.1		7.47	9.81	
268	06-08-18	6.36	9.07		7.38	9.18	
269	07-08-18		9.09		7.25	8.89	
270	08-08-18	6.16	9.09		7.13		
271	09-08-18	6.13	9.09		7.03	8.48	
272	10-08-18	6.1	9.09		6.96	8.5	
273	11-08-18	6.1	9.01		6.9	8.44	
274	12-08-18	6.04	8.89		6.84	8.33	
275	13-08-18	6.02	8.89		6.8	8.31	
276	14-08-18	5.98	8.89		6.77	8.26	
277	15-08-18		8.89		6.72	8.25	
278	16-08-18	5.97	8.89		6.67	8.19	
279	17-08-18	5.93			6.62	8.26	
280	18-08-18	5.84	8.89		6.6	8.32	
281	19-08-18	5.82	8.86		6.62	8.36	
282	20-08-18	5.79	8.89		6.66	8.41	
283	21-08-18	5.79	8.89		6.72		
284	22-08-18	5.78	8.89		6.75		
285	23-08-18	5.78	9.31		6.78	8.79	
286	24-08-18	5.68	8.89		6.81		
287	25-08-18	5.65	8.89		6.81	8.77	
288	26-08-18	5.6	9.23		6.77	8.7	
289	27-08-18	5.31	8.89		6.72	8.59	
290	28-08-18	5.14			6.68		
291	29-08-18	5.03	8.89		6.64	8.57	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
292	30-08-18	4.93	9.06		6.62	8.65	
293	31-08-18	4.76	8.89		6.6	8.78	
294	01-09-18	3.43			6.57		
295	02-09-18	3.35	8.56		6.51	8.69	
296	03-09-18	3.26	8.42		6.43	8.21	
297	04-09-18	3.25	8.42		6.3	7.84	
298	05-09-18	3.27	8.42		6.14	7.61	
299	06-09-18	3.35	8.35		6	7.51	
300	07-09-18	3.45	8.27		5.88	7.41	
301	08-09-18	3.5	8.27		5.82	7.33	
302	09-09-18	3.54	8.21		5.78	7.29	
303	10-09-18	3.46	8.19		5.77	7.39	
304	11-09-18	3.42	8.19		5.74	7.43	
305	12-09-18	3.43	8.19		5.73	7.35	
306	13-09-18	3.47	8.16		5.75	7.38	
307	14-09-18	3.51	8.22		5.79	7.41	
308	15-09-18	3.53	8.22		5.82	7.42	
309	16-09-18	3.53	8.22		5.87	7.61	
310	17-09-18	3.56	8.27		5.96	7.52	
311	18-09-18	3.55	8.27		6.04	7.64	
312	19-09-18	3.56	8.27		6.12	7.83	
313	20-09-18	3.51	8.49		6.23	7.9	
314	21-09-18	3.51	8.49		6.25	7.73	
315	22-09-18	3.53	8.49		6.28	7.63	
316	23-09-18	3.54	8.55			7.75	
317	24-09-18	3.53	8.55		6.29	7.86	
318	25-09-18	3.52			6.3		
319	26-09-18	3.52	8.55		6.37	8.19	
320	27-09-18	3.54	8.64		6.45	8.51	
321	28-09-18	3.58			6.55	8.75	
322	29-09-18	3.58	8.64		6.65	8.86	
323	30-09-18	3.62	8.75		6.71	9.01	
324	01-10-18	3.65			6.81	9.18	
325	02-10-18	3.66	8.75		6.84	9.32	
326	03-10-18	3.67	8.92		6.92	9.44	
327	04-10-18	3.67	8.96		7		
328	05-10-18	3.68	8.92		7.04		
329	06-10-18	3.67	8.92		7.07	9.63	
330	07-10-18	3.67	9.03		7.12	9.73	
331	08-10-18	3.59	8.75		7.14	9.89	
332	09-10-18	3.62	8.75		7.18		
333	10-10-18	3.65	9.1		7.21	10.05	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
334	11-10-18	3.69	9.1		7.24	10.11	
335	12-10-18	3.69	8.65		7.26	10.06	
336	13-10-18	3.68	8.65		7.3	10.14	
337	14-10-18	3.68	9.14		7.34	10.3	
338	15-10-18	3.63	8.65		7.41	10.34	
339	16-10-18	3.57	8.65		7.44	10.36	
340	17-10-18	3.51	8.65		7.46	10.4	
341	18-10-18	3.48			7.52	10.5	
342	19-10-18	3.51	8.65		7.58	10.58	
343	20-10-18	3.49	8.65		7.61	10.63	
344	21-10-18	3.47	9.24		7.63	10.58	
345	22-10-18	3.45	8.65		7.63	10.56	
346	23-10-18	3.43	8.65		7.66	10.78	
347	24-10-18	3.44	8.65		7.68	10.83	
348	25-10-18	3.43	9.61		7.73	10.8	
349	26-10-18	3.41	8.65		7.74	10.84	
350	27-10-18	3.38	8.65		7.72	10.95	
351	28-10-18	3.4	9.59		7.7	11.02	
352	29-10-18	3.42	9.62		7.7	11.09	
353	30-10-18	3.47	9.61		7.73	11.21	
354	31-10-18	3.52	9.62		7.74	11.3	
355	01-11-18	3.5	9.63		7.74	11.26	
356	02-11-18	3.48	9.65		7.75	11.34	
357	03-11-18	3.48	9.68		7.77	11.39	
358	04-11-18	3.47	6.71		7.77	11.45	
359	05-11-18	3.51	6.69		7.77	11.45	
360	06-11-18	3.6	6.61		7.8	11.41	
361	07-11-18	3.74	6.61		7.82	11.45	
362	08-11-18	3.79	6.56		7.79	11.41	
363	09-11-18	3.85	6.57		7.77	11.39	
364	10-11-18	3.9	6.59		7.78	11.35	
365	11-11-18	3.87	6.62		7.79	11.39	
366	12-11-18	3.81	6.6		7.77	11.41	
367	13-11-18	3.78	6.6		7.75	11.38	
368	14-11-18	3.79	6.58		7.73	11.28	
369	15-11-18	3.81	6.59		7.71	11.17	
370	16-11-18	3.88	8.35		7.67	11.06	
371	17-11-18	3.96	8.35		7.64	10.98	
372	18-11-18	4.04	5.61		7.63	10.89	
373	19-11-18	4.1	5.64		7.61	10.79	
374	20-11-18	4.2	5.71		7.58	10.69	
375	21-11-18	4.29	5.73		7.55	10.62	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
376	22-11-18	4.38	5.78		7.51	10.55	
377	23-11-18	4.46	5.8		7.48	10.43	
378	24-11-18	4.53	5.8		7.44	10.32	
379	25-11-18	4.59	5.81		7.39	10.2	
380	26-11-18	4.64	5.84		7.35	10.12	
381	27-11-18	4.69	5.89		7.33	10.05	
382	28-11-18	4.74	5.85		7.28	10.01	
383	29-11-18	4.78	5.86		7.25	9.93	
384	30-11-18	4.82	5.91		7.2	9.92	
385	01-12-18	4.86	5.91		7.16	9.88	
386	02-12-18	4.89	5.97		7.12	9.91	
387	03-12-18	4.92	5.99		7.1		
388	04-12-18	4.96	5.99		7.05	9.93	
389	05-12-18	4.98	5.99		7.02	9.87	
390	06-12-18	5	6.02		6.99	9.74	
391	07-12-18	5.04	6.06		6.95	9.78	
392	08-12-18	5.07			6.91	9.85	
393	09-12-18	5.09			6.88		
394	10-12-18	5.13			6.84	9.93	
395	11-12-18	5.18	6.06		6.82	9.98	
396	12-12-18	5.21	6.06		6.81	9.97	
397	13-12-18	5.24	6.13		6.79	9.95	
398	14-12-18		6.13		6.78	9.99	
399	15-12-18	5.27	6.13		6.76	9.97	
400	16-12-18	5.32	6.25		6.74	9.95	
401	17-12-18	5.34	6.26		6.72	9.87	
402	18-12-18	5.37	6.26		6.68	9.72	
403	19-12-18	5.38	6.26		6.65		
404	20-12-18	5.42	6.29		6.62	9.39	
405	21-12-18	5.46	6.32		6.58	9.19	
406	22-12-18	5.49	6.32		6.56	9.05	
407	23-12-18	5.52	6.35		6.54	9.05	
408	24-12-18	5.55			6.5	9.09	
409	25-12-18	5.57	6.36		6.47	9.12	
410	26-12-18	5.58	6.36		6.45	9.16	
411	27-12-18	5.58	6.37		6.42	9.21	
412	28-12-18	5.63	6.44		6.4	9.28	
413	29-12-18	5.65	6.44		6.39	9.3	
414	30-12-18	5.68			6.38		
415	31-12-18	5.72			6.37	9.32	
416	01-01-19		6.44		6.36	9.38	
417	02-01-19	5.78	6.57		6.36	9.45	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
418	03-01-19	5.81			6.36	9.47	
419	04-01-19	5.84	6.57		6.36	9.49	
420	05-01-19	5.87	6.57		6.34	9.56	
421	06-01-19	5.9	6.71		6.33	9.69	
422	07-01-19	5.92	6.72		6.33	9.7	
423	08-01-19	5.95	6.72		6.32		
424	09-01-19	5.97	6.72		6.33		
425	10-01-19	6.01	6.78		6.33	9.67	
426	11-01-19	6.03	6.81		6.33	9.8	
427	12-01-19	6.05	6.81		6.34	9.86	
428	13-01-19	6.07	6.82		6.33	9.91	
429	14-01-19	6.1	6.85		6.33	9.92	
430	15-01-19	6.13	6.85		6.34	9.91	
431	16-01-19	6.16	6.85		6.33	9.87	
432	17-01-19	6.18	6.88		6.34	9.84	
433	18-01-19	6.2	6.91		6.35	9.8	
434	19-01-19	6.23	6.91		6.36	9.84	
435	20-01-19	6.25	6.92		6.4	9.85	
436	21-01-19	6.27	6.93		6.41	9.98	
437	22-01-19	6.28	6.93		6.42	10.12	
438	23-01-19	6.31	6.93		6.46	10.19	
439	24-01-19	6.32	6.95		6.45	10.09	
440	25-01-19	6.33	6.93		6.46	9.95	
441	26-01-19	6.35	6.93		6.46	9.82	
442	27-01-19	6.36	6.92		6.45	9.63	
443	28-01-19	6.39	6.92		6.44	9.47	
444	29-01-19	6.39	6.92		6.42	9.34	
445	30-01-19	6.4	6.92		6.41	9.29	
446	31-01-19	6.42	6.93		6.41	9.24	
447	01-02-19	6.43	6.93		6.4	9.23	
448	02-02-19	6.44	6.93		6.38	9.26	
449	03-02-19	6.45	6.93		6.39	9.33	
450	04-02-19	6.46	6.93		6.39	9.37	
451	05-02-19	6.47	6.93		6.39	9.38	
452	06-02-19	6.48	6.93		6.38	9.39	
453	07-02-19	6.48	6.93		6.39	9.41	
454	08-02-19	6.49	6.93		6.38	9.39	
455	09-02-19	6.5	6.95		6.39	9.34	
456	10-02-19	6.49	6.96		6.38	9.33	
457	11-02-19	6.5	6.96		6.37	9.32	
458	12-02-19	6.52	6.96		6.38	9.36	
459	13-02-19	6.53	6.99		6.38	9.48	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
460	14-02-19	6.54	6.99		6.38	9.64	
461	15-02-19	6.54	6.99		6.38	9.71	
462	16-02-19	6.55	7.01		6.38	9.69	
463	17-02-19	6.55	7.01		6.38	9.77	
464	18-02-19	6.56	7.01		6.39	9.88	
465	19-02-19	6.57	7.04		6.41	10.27	
466	20-02-19	6.58	7.04		6.43	10.58	
467	21-02-19	6.58	7.06		6.44	10.71	
468	22-02-19	6.59	7.07		6.46	10.71	
469	23-02-19	6.6	7.07		6.48	10.73	
470	24-02-19	6.61	7.09		6.5	10.71	
471	25-02-19	6.63	7.11		6.51	10.71	
472	26-02-19	6.62	7.11		6.52	10.75	
473	27-02-19	6.63	7.11		6.54	10.61	
474	28-02-19	6.64	7.17		6.55	10.37	
475	01-03-19	6.64	7.17		6.57	10.29	
476	02-03-19	6.65	7.17		6.59	10.49	
477	03-03-19	6.66	7.17		6.6	10.69	
478	04-03-19	6.66	7.19		6.61	10.69	
479	05-03-19	6.66	7.18		6.64	10.69	
480	06-03-19	6.67	7.17		6.67	10.65	
481	07-03-19	6.68	7.16			10.7	
482	08-03-19	6.68	7.15			10.7	
483	09-03-19						
484	10-03-19						
485	11-03-19						
486	12-03-19						
487	13-03-19	6.72	7.2		6.89	11.09	
488	14-03-19	6.73	7.21		6.91	11.09	
489	15-03-19	6.73	7.15		6.93	11	
490	16-03-19	6.73	7.14		6.94	10.95	
491	17-03-19	6.74	7.13		6.95	10.96	5.07
492	18-03-19	6.75	7.12		6.96	10.92	5.11
493	19-03-19	6.75	7.11		6.98	10.93	5.13
494	20-03-19	6.76	7.1		6.99	10.93	5.17
495	21-03-19	6.77	7.09		6.99	10.84	5.2
496	22-03-19	6.78	7.08		7	10.81	5.22
497	23-03-19	6.78	7.07		7.01	10.84	5.24
498	24-03-19	6.79	7.06		7.01	10.83	5.25
499	25-03-19	6.8	7.05		7.02	10.84	5.28
500	26-03-19	6.81	7.04		7.02	10.74	5.3
501	27-03-19	6.82	7.03		7.02	10.61	5.29

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
502	28-03-19	6.83	7.02		7.01	10.53	5.26
503	29-03-19	6.83	7.01		7	10.51	5.25
504	30-03-19	6.84	7.17		6.99	10.49	5.24
505	31-03-19	6.84	7.17		6.98	10.52	5.23
506	01-04-19	6.86	7.17	5.01	6.98	10.53	5.25
507	02-04-19	6.87	7.17	5.02	6.97	10.49	5.27
508	03-04-19	6.89	7.35	5.03	6.96	10.49	5.23
509	04-04-19	6.9	7.36	5.02	6.96	10.59	4.95
510	05-04-19	6.9	7.36	5.03	6.94	10.6	5.09
511	06-04-19	6.92	7.36	5.03	6.94	10.58	5.21
512	07-04-19	6.92	7.38	5.03	6.92	10.5	5.25
513	08-04-19	6.94	7.38	5.01	6.91	10.44	5.4
514	09-04-19	6.94	7.38	5.01	6.91	10.36	5.42
515	10-04-19	6.97	7.39	5.03	6.89	10.2	5.44
516	11-04-19	6.97	7.39	5.03	6.88	10.16	5.46
517	12-04-19	6.99	7.41	5.02	6.87	10.2	5.46
518	13-04-19	7	7.41	5.02	6.85	10.22	5.45
519	14-04-19	7.02	7.41	5.03	6.84	10.25	5.46
520	15-04-19	7.04	7.42	5.03	6.83	10.28	5.36
521	16-04-19	7.11	7.42	5.03	6.83	10.33	5.46
522	17-04-19	7.04	7.42	5.01	6.82	10.31	5.47
523	18-04-19	7.04	7.43	5.02	6.8	10.26	5.43
524	19-04-19	7.04	7.41	5.02	6.79	10.22	5.41
525	20-04-19	7.04	7.41	5.01	6.77	10.22	5.41
526	21-04-19	7.04	7.41	5.02	6.76	10.26	5.44
527	22-04-19	7.04	7.4	5.01	6.76	10.28	5.45
528	23-04-19	7.04	7.4	5.02	6.75	10.28	5.44
529	24-04-19	7.02	7.4	5.03	6.73	10.26	5.45
530	25-04-19	7.02	7.39	5.02	6.72	10.3	5.46
531	26-04-19	7.07	7.42	5.03	6.71	10.37	5.47
532	27-04-19	7.07	7.42	5.01	6.7	10.39	5.51
533	28-04-19	7.07	7.42	5.01	6.69	10.39	5.53
534	29-04-19	7.11	7.44	5.02	6.68	10.4	5.52
535	30-04-19	7.11	7.44	5.03	6.67	10.44	5.52
536	01-05-19	7.11	7.44	5.02	6.67	10.48	5.53
537	02-05-19	7.18	7.46	5.03	6.66	10.47	5.52
538	03-05-19	7.19	7.44	5.03	6.66	10.41	5.5
539	04-05-19	7.19	7.44	5.04	6.65	10.28	5.5
540	05-05-19	7.19	7.44	5.05	6.63	10.18	5.53
541	06-05-19	7.2	7.44	5.07	6.62	10.12	5.55
542	07-05-19	7.2	7.44	5.06	6.6	10.09	5.58
543	08-05-19	7.2	7.44	5.07	6.59	10.12	5.62

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
544	09-05-19	7.21	7.42	5.07	6.58	10.23	5.67
545	10-05-19	7.24	7.47	5.08	6.58	10.42	5.7
546	11-05-19	7.24	7.47	5.04	6.57	10.54	5.72
547	12-05-19	7.24	7.47	5.05	6.56	10.55	5.76
548	13-05-19	7.29	7.53	5.06	6.57	10.53	5.8
549	14-05-19	7.29	7.53	5.05	6.56	10.5	
550	15-05-19	7.29	7.53	5.04	6.55	10.49	5.86
551	16-05-19	7.35	7.56	5.05	6.54	10.46	5.87
552	17-05-19	7.45	7.57	5.04	6.54	10.46	5.85
553	18-05-19	7.45	7.57	5.03	6.54	10.47	5.85
554	19-05-19	7.45	7.57	5.04	6.53	10.51	5.86
555	20-05-19	7.51	7.61	5.03	6.53	10.55	5.88
556	21-05-19	7.51	7.61	5.05	6.53	10.56	5.89
557	22-05-19	7.51	7.61	5.04	6.53	10.58	5.9
558	23-05-19	7.56	7.63	5.05	6.53	10.57	5.91
559	24-05-19	7.58	7.65		6.53	10.54	5.93
560	25-05-19	7.58	7.65	5.04	6.54	10.63	5.93
561	26-05-19	7.58	7.65	5.04	6.54	10.66	5.94
562	27-05-19	7.63	7.69	5.03	6.54	10.67	5.96
563	28-05-19	7.63	7.69	5.02	6.55	10.71	5.98
564	29-05-19	7.63	7.69	5.04	6.55	10.75	5.97
565	30-05-19	7.69	7.73	5.06	6.56	10.79	5.96
566	31-05-19	7.69	7.74	5.07	6.57	10.76	
567	01-06-19	7.7	7.75		6.59	10.81	5.98
568	02-06-19	7.71	7.76	5.06	6.6	10.83	5.99
569	03-06-19	7.72	7.77	5.06	6.61	10.86	5.96
570	04-06-19	7.74	7.78	5.06	6.62	10.86	5.95
571	05-06-19	7.75	7.79	5.06	6.63	10.87	5.97
572	06-06-19	7.76	7.81	5.05	6.65	10.91	6
573	07-06-19	7.77	7.82	5.04	6.67	11.04	6.02
574	08-06-19	7.78	7.83	5.06	6.67	11.07	6.04
575	09-06-19	7.79	7.84	5.06	6.69	11.1	6.05
576	10-06-19	7.81	7.86	5.05	6.69	11.09	
577	11-06-19	7.84	7.88	5.06	6.7	11.09	6.09
578	12-06-19	7.85	7.9	5.06	6.71	11.1	6.14
579	13-06-19	7.86	7.93	5.06	6.71	11.08	6.16
580	14-06-19	7.87	7.93	5.06	6.73	11.15	6.18
581	15-06-19	7.88	7.94	5.06	6.75	11.23	6.2
582	16-06-19	7.89	7.94	5.06	6.76	11.32	6.21
583	17-06-19	7.9	7.95	5.05	6.79	11.42	6.23
584	18-06-19	7.91	7.96	5.05	6.8	11.51	6.28
585	19-06-19	7.91	7.97	5.05	6.83	11.54	6.3



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586	20-06-19	7.92	7.98	5.06	6.85	11.49	6.32
587	21-06-19	7.92	7.99	5.05	6.87	11.41	6.34
588	22-06-19	7.93	7.99	5.06	6.86	10.56	6.35
589	23-06-19	7.94	8.01	5.05	6.85	10.96	6.2
590	24-06-19	7.95	7.98	5.06	6.84	10.95	5.98
591	25-06-19	7.95	7.96	5.08	6.83	10.91	5.94
592	26-06-19		7.95	5.06	6.83	10.9	5.98
593	27-06-19	7.95	7.93	5.06	6.84	10.93	6.01
594	28-06-19	7.95	7.92	5.06	6.85	11.21	6.04
595	29-06-19	7.95	7.9	5.06	6.87	10.92	
596	30-06-19	7.95	7.91	5.06	6.9	10.94	6.07
597	01-07-19	7.95	7.91	5.06	6.92	10.81	6.1
598	02-07-19	7.95	7.92	5.06	6.93	10.83	6.12
599	03-07-19	7.96	7.95	5.06	6.94	10.79	6.13
600	04-07-19	7.97	7.98	5.06	6.96	10.89	6.16
601	05-07-19	7.99	7.91	5.06	6.15		6.08
602	06-07-19	7.82	7.88	5.06	6.36	11.11	6.15
603	07-07-19	7.81	7.87	5.06	5.77	10.93	6.15
604	08-07-19	7.79	7.66	5.06	5.48	10.73	6.13
605	09-07-19	7.58	7.74	5.06	5.12	10.4	6.09
606	10-07-19	7.61		5.06	5.17	10.74	6.04
607	11-07-19	7.61	7.78	5.06	4.47		6.01
608	12-07-19	7.62	7.78	5.06	4.85	11	5.94
609	13-07-19	7.63	7.78	5.06	5.01	10.81	5.89
610	14-07-19	7.63	7.78	5.06	4.86	11.31	5.87
611	15-07-19	7.64	7.84	5.06	5.15	11.64	5.84
612	16-07-19	7.64	7.84	5.06	5.49	11.88	5.81
613	17-07-19	7.65	7.84	5.06	6.14	11.82	6.18
614	18-07-19	7.66	7.84	5.06	5.46	11.99	5.71
615	19-07-19	7.68	7.84	5.06	5.33	12.07	5.68
616	20-07-19	7.73		5.06	5.36	12.27	5.66
617	21-07-19	7.85	7.84	5.06	5.86		5.65
618	22-07-19	7.89	7.78	5.06	5.49	12.38	5.62
619	23-07-19	7.87	7.78	5.06	4.98	12.25	5.6
620	24-07-19	7.85	7.78	5.06	4.51	12.09	5.56
621	25-07-19	7.82		5.06	4.31		5.51
622	26-07-19	7.82	7.78	5.06	4.33	12.02	5.5
623	27-07-19	7.81		5.06	3.98		5.48
624	28-07-19	7.79	7.78	5.06	4.23	11.85	5.47
625	29-07-19	7.79	7.73	5.06	3.78	11.8	
626	30-07-19	7.78	7.73	5.06	4.01	11.91	5.35
627	31-07-19	7.73	7.71	5.06	4.15	12.46	5.28

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
628	01-08-19	7.67	7.73	5.06	4.42	12.8	5.2
629	02-08-19	7		5.06	5.11		5.14
630	03-08-19	7.71	7.75	5.06	4.99	13	5.12
631	04-08-19	7.69	7.79	5.06	4.88	12.94	
632	05-08-19	7.68	7.82	5.06	4.75	13.11	5.01
633	06-08-19	7.75	7.81	5.06	4.26	12.57	4.95
634	07-08-19	7.65	7.78	5.06	4.43	12.42	4.86
635	08-08-19	7.64		5.06	4.38		4.78
636	09-08-19	7.61	7.75	5.06	4.88	12.58	4.75
637	10-08-19	7.58	7.73	5.06	4.95	13.06	4.7
638	11-08-19	7.55	7.71	5.06	5.23	13.19	4.68
639	12-08-19	7.56	7.69	5.06	5.39	13.3	
640	13-08-19	7.53	7.68		5.15	13.26	4.65
641	14-08-19	7.55	7.67	5.06	4.97		4.65
642	15-08-19	7.52		5.06	4.91	13.16	
643	16-08-19	7.47	7.62	5.06	4.91	13.3	
644	17-08-19	7.47	7.56	5.06	4.94		4.64
645	18-08-19	7.42	7.52	5.06	4.76	12.87	4.63
646	19-08-19	7.39	7.45	5.06	4.5	12.44	
647	20-08-19	7.33	7.41	5.06	4.29	12.4	4.62
648	21-08-19	7.29	7.39	5.06	4.39	12.38	4.6
649	22-08-19	7.27	7.37	5.06	4.42	12.35	4.55
650	23-08-19	7.27	7.36	5.06	4.26	12.33	
651	24-08-19	7.25		5.06	4.33		4.48
652	25-08-19	7.24	7.35	5.06	4.13	12.31	
653	26-08-19	7.21	7.33	5.06	4.09	12.29	4.44
654	27-08-19	7.22	7.33	5.06	4.28		4.42
655	28-08-19	7.26	7.33	5.06	4.38		4.41
656	29-08-19	7.32	7.33	5.06	4.52	12.26	
657	30-08-19	7.38	7.33	5.06	4.56		4.4
658	31-08-19	7.36	7.33	5.06	4.41	12.29	4.4
659	01-09-19	7.35	7.33	5.06	4.65	12.43	4.4
660	02-09-19	7.38	7.33	5.06	4.78	12.49	4.39
661	03-09-19	7.42	7.33	5.06	4.73	12.51	4.39
662	04-09-19	7.42	7.33	5.06	5.35	12.49	4.4
663	05-09-19	7.43	7.33	5.06	5.51	12.49	4.4
664	06-09-19	7.46	7.33	5.06	6	12.52	4.4
665	07-09-19	7.58		5.07	5.93	12.56	4.4
666	08-09-19	7.58		5.07	6.1	12.58	4.4
667	09-09-19	7.6		5.07	5.96	12.52	4.4
668	10-09-19	7.45		5.07	5.86	12.52	4.39
669	11-09-19	7.45		5.07	6.09	12.49	4.38

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
670	12-09-19	7.45		5.07	6.12	12.46	4.38
671	13-09-19	7.45		5.07	5.78	12.38	4.38
672	14-09-19	7.45		5.07	5.51	12.32	4.38
673	15-09-19	7.38		5.08	5.34	12.29	4.38
674	16-09-19	7.33		5.08	5.37	12.27	4.38
675	17-09-19	7.28		5.08	5.3	12.29	4.37
676	18-09-19	7.29		5.08	5.2	12.24	4.38
677	19-09-19	7.25		5.08	5.42	12.13	4.37
678	20-09-19	7.21		5.08	5.5	12.08	4.37
679	21-09-19	7.19		5.08	5.53	11.98	4.37
680	22-09-19	7.15		5.08	5.49	11.95	4.36
681	23-09-19	7.11		5.08	5.31	11.92	4.36
682	24-09-19	7.08		5.08	5.27	11.89	4.36
683	25-09-19	7.09		5.08	5.24	11.89	4.37
684	26-09-19	7.05		5.08	4.89	11.86	
685	27-09-19	6.93		5.08	4.29	11.34	4.36
686	28-09-19	6.51		5.08	3.52	11.02	4.35
687	29-09-19	5.86		5.08	2.76	10.73	4.18
688	30-09-19	5.46		5.08	2.13	10.43	3.97
689	01-10-19	5.23		5.08		10.23	3.98
690	02-10-19	5.03		5.08		10.06	3.78
691	03-10-19	4.82		5.08	0.99	10.19	3.75
692	04-10-19	4.79		5.08	1.15	10.16	
693	05-10-19	4.81		5.08	0.9	10.11	3.71
694	06-10-19	4.85		5.08	0.94	10.07	3.7
695	07-10-19	4.89		5.08	1.03	10.02	3.71
696	08-10-19	4.86		5.08	0.78	9.98	3.72
697	09-10-19	4.82		5.08	0.98	9.95	3.73
698	10-10-19	4.86		5.08	1.12	9.97	3.84
699	11-10-19	4.87		5.08	1.3	9.99	3.97
700	12-10-19	4.9		5.08	1.36	10.01	4.04
701	13-10-19	4.93		5.08	1.5	10.07	4.1
702	14-10-19	5.08		5.08	1.69	10.15	4.13
703	15-10-19	5.11		5.08	1.8	10.19	4.16
704	16-10-19	5.13			1.84	10.16	4.16
705	17-10-19	5.15		5.08	1.68	10.13	4.18
706	18-10-19	5.19		5.08	1.84	10.2	4.2
707	19-10-19	5.2		5.08	1.87	10.21	4.21
708	20-10-19	5.19		5.08	1.42	10.18	4.2
709	21-10-19	5.17		5.08	1.04	10.2	4.18
710	22-10-19	5.19		5.08	0.9	10.21	4.17
711	23-10-19	5.2		5.08	0.84	10.19	4.17

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
712	24-10-19	5.18		5.08	0.78	10.16	4.16
713	25-10-19	5.15		5.08	0.68	10.18	4.14
714	26-10-19	5.13		5.08	0.63	10.21	4.15
715	27-10-19	5.18		5.08	0.71	10.2	4.15
716	28-10-19	5.17		5.08	0.73	10.19	4.16
717	29-10-19	5.16	8.65	5.08	0.75	10.17	4.16
718	30-10-19	5.15	8.68	5.08	0.83	10.19	4.16
719	31-10-19	5.18	8.69	5.08	0.84	10.22	
720	01-11-19	5.18	8.63	5.08	1.01	10.2	4.18
721	02-11-19	5.2	8.68	5.08	1.07	10.23	4.17
722	03-11-19	5.19	8.71	5.08		10.2	4.19
723	04-11-19	5.2	8.72	5.08	1.09	10.27	4.21
724	05-11-19	5.21	8.74	5.08	1.06	10.28	4.23
725	06-11-19	5.23	8.76	5.08	1.11	10.32	4.25
726	07-11-19	5.17	8.77	5.08	1.15	10.35	4.27
727	08-11-19	5.19	8.79	5.08	1.15	10.37	4.29
728	09-11-19	5.23	8.83	5.08	1.17	10.35	4.34
729	10-11-19	5.27	8.87	5.08	1.22	10.37	4.38
730	11-11-19	5.29	8.77	5.15	1.3	5.56	4.42
731	12-11-19	5.33	8.79	5.08	1.28	5.59	4.47
732	13-11-19	5.34	8.8	5.08	1.26	5.6	4.51
733	14-11-19	5.36	8.82	5.08	1.42	5.63	4.56
734	15-11-19	5.39	8.85	5.1	1.49	5.66	4.61
735	16-11-19	5.4	8.87	5.15	1.54	5.68	4.65
736	17-11-19	5.42	8.89	5.18	1.61		4.69
737	18-11-19	5.45	8.93	5.22	1.6	5.71	4.73
738	19-11-19	5.48	8.85	5.17	1.61	5.73	4.76
739	20-11-19	5.5	8.87	5.2	1.63	5.75	4.8
740	21-11-19	5.53	8.89	5.23	1.68	5.76	4.82
741	22-11-19	5.55	8.91	5.28	1.68	5.73	4.85
742	23-11-19	5.57	8.9	5.3	1.78	5.79	4.86
743	24-11-19	5.58	8.88	5.32	1.84	5.8	4.87
744	25-11-19	5.6	8.91	5.35	1.87	5.6	4.9
745	26-11-19	5.63	8.93	5.36	1.91	5.62	4.91
746	27-11-19	5.65	8.94	5.39	1.99	5.66	4.92
747	28-11-19	5.67	8.96	5.96	1.99	5.68	4.95
748	29-11-19	5.69	8.99	5.43	2.03		4.96
749	30-11-19	5.72	9	5.43		5.66	4.98
750	01-12-19	5.7	9.01	5.45	2.04	5.69	5
751	02-12-19	5.74	9.04	5.47	2.07	5.72	5.02
752	03-12-19	5.78	9.07	5.55	2.09	5.74	5.04
753	04-12-19	5.84	9.11	5.59	2.13	5.77	5.06

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754	05-12-19	5.87	9.13	5.65	2.1	5.78	5.07
755	06-12-19	5.9	9.17	5.69	2.14	5.8	5.07
756	07-12-19	5.94	9.2	5.76	2.2	5.85	5.08
757	08-12-19	5.97	9.22	5.81	2.14	5.87	5.08
758	09-12-19	5.99	9.25	5.77	2.2	5.9	5.08
759	10-12-19	5.98	9.24	5.78	2.29	5.92	5.08
760	11-12-19	6.02	9.27	5.83	2.37	5.91	5.08
761	12-12-19	6.05	9.29	5.88	2.47	5.93	5.08
762	13-12-19	6.7	9.31	5.9	1.98	5.94	5.08
763	14-12-19	6.65	9.25	5.86	1.85	5.95	5.08
764	15-12-19	6.67	9.28	5.88	1.6	5.93	5.07
765	16-12-19	6.64	9.23	5.85	1.37	5.9	5.07
766	17-12-19	6.61	9.21	5.83	1.58	5.92	5.06
767	18-12-19	6.63	9.23	5.85	1.71	5.94	5.06
768	19-12-19	6.64	9.25	5.87	1.61	5.95	5.05
769	20-12-19	6.62	9.28	5.88	1.79	5.96	5.04
770	21-12-19	6.64	9.27	5.87	1.72	5.96	5.02
771	22-12-19	6.65	9.29	5.9	1.81	5.98	5.01
772	23-12-19	6.63	9.31	5.9	2.11	5.99	5
773	24-12-19	6.59	9.3	5.89	1.77	5.99	5.03
774	25-12-19	6.61	9.33	5.92	1.94	5.99	5.06
775	26-12-19	6.63	9.35	5.94	1.98		5.11
776	27-12-19	6.65	9.37	5.95	2	6.04	5.15
777	28-12-19	6.67	9.39		2.01	6.06	5.19
778	29-12-19	6.69	9.41	5.97	1.98	6.07	5.22
779	30-12-19	6.7	9.43	5.95	2.03	6.08	5.24
780	31-12-19	6.72	9.45	5.96	1.93	6.1	5.25
781	01-01-20	6.75	9.46	5.98	1.99	6.12	5.26
782	02-01-20	6.77	9.47	6	2.01		5.27
783	03-01-20	6.79	9.49	6.02	2.1	6.15	5.29
784	04-01-20	6.8	9.5	6.03	2.11	6.16	5.27
785	05-01-20	6.82	9.52	6.05	2.18	6.18	5.19
786	06-01-20	6.84	9.53	6.07	2.33	6.19	5.14
787	07-01-20	6.85	9.55	6.09	2.32	6.22	5.11
788	08-01-20	6.87	9.57	6.11	2.24	6.23	5.11
789	09-01-20	6.9	9.59	6.13	2.28	6.25	5.12
790	10-01-20	6.92	9.61	6.15	2.3	6.27	5.13
791	11-01-20	6.93	9.63	6.17	2.38	6.28	5.13
792	12-01-20	6.96	9.65	6.18	2.43	6.29	5.13
793	13-01-20	6.97	9.66	6.2	2.43	6.31	5.15
794	14-01-20	6.99	9.67	6.22	2.49	6.33	5.16
795	15-01-20	6.99	9.69	6.24	2.59	6.34	5.17

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796	16-01-20	7.02	9.7	6.26	2.75	6.35	5.19
797	17-01-20	7.04	9.72	6.28	2.87	6.37	5.21
798	18-01-20	7.02	9.67	6.26	2.89	6.36	5.23
799	19-01-20	7	9.65	6.28	2.92	6.35	5.26
800	20-01-20	7.03	9.67	6.3			
801	21-01-20	7.05	9.62	6.35	2.98	6.35	5.25
802	22-01-20	7.09	9.67	6.41	3.2	6.38	5.26
803	23-01-20	7.11	9.68	6.43	3.02	6.4	5.24
804	24-01-20	7.13	9.7	6.45	2.97	6.42	5.23
805	25-01-20	7.13	9.7	6.45	3.2	6.43	5.22
806	26-01-20	7.1	9.73	6.48	3.3	6.45	5.25
807	27-01-20	7.13	9.75	6.47	3.29	6.47	5.25
808	28-01-20	7.15	9.77	6.49	3.23	6.5	5.23
809	29-01-20	7.15	9.75	6.5	3.01	6.52	5.21
810	30-01-20	7.16	9.76	6.52	2.99	6.55	5.2
811	31-01-20	7.15	9.77	6.55	2.96	6.53	5.26
812	01-02-20	7.17	9.78	6.55	3.01	6.55	5.31
813	02-02-20	7.19	9.79	6.57	3.14	6.58	5.33
814	03-02-20	7.2	9.8	6.6	3.29	6.6	5.32
815	04-02-20	7.22	9.82	6.62	3.36	6.6	5.32
816	05-02-20		9.8	6.63	3.37	6.62	5.3
817	06-02-20	7.25	9.82	6.65	3.41	6.65	5.3
818	07-02-20	7.27	9.8	6.67	3.37	6.64	5.33
819	08-02-20	7.28	9.83	6.63	3.49	6.66	5.38
820	09-02-20	7.31	9.86	6.71	3.62	6.66	5.4
821	10-02-20	7.33	9.85	6.7	3.39	6.68	5.39
822	11-02-20	7.35	9.87	6.72	3.23	6.7	5.38
823	12-02-20	7.37	9.88	6.74	3.22	6.72	5.36
824	13-02-20	7.39	9.9	6.76	3.66	6.75	5.38
825	14-02-20	7.41	9.92	6.78	3.73	6.77	5.37
826	15-02-20	7.42	9.9	6.69	3.74	6.78	5.35
827	16-02-20	7.43	9.95	6.71	3.75	6.79	5.33
828	17-02-20	7.45	9.97	6.73	3.75	6.8	5.32
829	18-02-20	7.47	9.97	6.74	3.83	6.8	5.32
830	19-02-20	7.48	9.99	6.76	3.43	6.8	5.3
831	20-02-20	7.48	9.99	6.77	3.61	6.82	5.31
832	21-02-20	7.48	9.99	6.77			
833	22-02-20	7.51	10.02	6.79			
834	23-02-20	7.51	10.02	6.79			
835	24-02-20	7.51	10.02	6.79	3.28	6.82	5.41
836	25-02-20	7.53	10.02	6.79	3.2	6.83	5.43
837	26-02-20	7.55	10.05	6.81	3.08	6.85	5.44

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838	27-02-20	7.51	10	6.77	3.02	6.74	5.47
839	28-02-20	7.47	9.97	6.73	2.94	6.71	5.51
840	29-02-20	7.44	9.92	6.71	2.88	6.66	5.5
841	01-03-20	7.41	9.88	6.65	2.77	6.66	5.51
842	02-03-20	7.38	9.84	6.62	2.67	6.63	5.52
843	03-03-20	7.36	9.82	6.6	2.68	6.61	5.51
844	04-03-20	7.34	9.8	6.58	2.61	6.6	5.5
845	05-03-20	7.32	9.78	6.57	2.54	6.6	5.53
846	06-03-20	7.3	9.77	6.55	2.54	6.57	5.56
847	07-03-20	7.31	9.76		2.45	6.55	5.55
848	08-03-20	7.28	9.72		2.34	6.52	5.58
849	09-03-20	7.15	9.68	6.51	2.64	6.66	5.58
850	10-03-20	7.21	9.71	6.45	2.64	6.68	5.57
851	11-03-20	7.25	9.73	6.55	2.7	6.68	5.58
852	12-03-20	7.21	9.74	6.57	2.72	6.65	5.6
853	13-03-20	7.22	9.76	6.58	2.65	6.63	5.62
854	14-03-20	7.18	9.71	6.52	2.22	6.57	5.63
855	15-03-20	7.11	9.66	6.47	2.16	6.57	5.61
856	16-03-20	7.01	9.62	6.42	2.1	6.51	5.59
857	17-03-20	6.97	9.59	6.4	2.05	6.5	5.58
858	18-03-20	6.95	9.55	6.38	2.08	6.51	5.54
859	19-03-20	6.97	9.55	6.4	2.2	6.53	5.55
860	20-03-20	6.99	9.56	6.41	2.26	6.55	5.52
861	21-03-20	7.02	9.55	6.43	2.32	6.57	5.48
862	22-03-20	7.05	9.58	6.45	2.35	6.59	5.46
863	23-03-20	7.06	9.6	6.46	2.25	6.6	5.46
864	24-03-20	7.07	9.62	6.48	2.21	6.6	5.48
865	25-03-20	7.09	9.63	6.5	2.18	6.63	5.5
866	26-03-20	7.11		6.52	2.37	6.65	5.52
867	27-03-20	7.13	9.66	6.53	2.49	6.66	5.59
868	28-03-20	7.15	9.69	6.55	2.43	6.69	5.62
869	29-03-20	7.18	9.71	6.57	2.38	6.71	5.64
870	30-03-20	7.21	9.72	6.59	2.61	6.73	5.67
871	31-03-20	7.23	9.75	6.61	2.64	6.73	5.68
872	01-04-20	7.25	9.77	6.63	2.62	6.74	5.68
873	02-04-20	7.27	9.78	6.65	2.58	6.76	5.67
874	03-04-20	7.3	9.81	6.67	2.45	6.77	5.71
875	04-04-20	7.32	9.83	6.69	2.63	6.78	5.71
876	05-04-20	7.33	9.85	6.7	2.76	6.8	5.73
877	06-04-20	7.37	9.87	6.73	2.58	6.81	5.75
878	07-04-20	7.39	9.89	6.75	2.39	6.83	5.74
879	08-04-20	7.41	9.91	6.77	2.32	6.85	5.74

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880	09-04-20	7.43	9.93	6.78	2.53	6.86	5.75
881	10-04-20	7.45	9.94	6.79	2.67	6.88	5.78
882	11-04-20	7.47	9.95	6.78	2.7	6.9	5.8
883	12-04-20	7.49	9.96	6.8	2.66	6.9	5.81
884	13-04-20				2.81	6.92	5.83
885	14-04-20				2.78	6.93	5.82
886	15-04-20	7.52	9.99	6.83	2.78	6.96	5.82
887	16-04-20	7.54	9.99	6.84	2.84	6.98	5.85
888	17-04-20	7.56	9.94	6.86	2.92	6.95	5.85
889	18-04-20	7.55	10.02	6.86	2.7	6.95	5.87
890	19-04-20	7.57	10.05	6.88	2.7	6.97	5.89
891	20-04-20	7.59	10.07	6.89	2.79	6.99	5.89
892	21-04-20	7.61	10.09	6.91	2.56	6.99	5.86
893	22-04-20	7.63	10.11	6.93	2.61	7.03	5.86
894	23-04-20	7.69	10.13	6.96	3.08	7.12	5.86
895	24-04-20	7.72	10.2	7.03	3.16	7.15	5.86
896	25-04-20	7.75	10.06	7.11	2.82	6.85	5.87
897	26-04-20	7.25	9.76	6.79	3.19	6.88	5.88
898	27-04-20	7.29	9.78	6.82	3.2	6.91	5.91
899	28-04-20	7.31	9.79	6.85	3.27	6.91	5.89
900	29-04-20	7.3	9.76	6.83	3.28	6.93	5.87
901	30-04-20	7.32	9.78	6.85	3.31	6.95	5.85
902	01-05-20	7.33	9.79	6.89	3.31	6.96	5.85
903	02-05-20	7.35	9.82	6.91	3.33	6.98	5.88
904	03-05-20	7.38	9.84	6.93	3.11	6.92	5.91
905	04-05-20	7.39	9.86	6.95	3.21	6.86	5.92
906	05-05-20	7.31	9.71	6.89	3.36	6.88	5.92
907	06-05-20	7.33	9.73	6.91	3.35	6.83	5.92
908	07-05-20	7.34	9.73	6.92	3.43	6.83	5.92
909	08-05-20	7.33	9.73	6.91	3.42	6.85	5.93
910	09-05-20	7.35	9.74	6.92	3.35	6.86	5.97
911	10-05-20	7.37			3.4	6.88	6.16
912	11-05-20	7.39	9.75	6.93	2.74	6.89	6.16
913	12-05-20	7.41	9.77	6.95	2.62	6.88	6.18
914	13-05-20	7.43	9.79	6.97	2.65	6.82	
915	14-05-20	7.45	9.82	6.99	2.88	6.84	6.17
916	15-05-20	7.47	9.85	6.99	2.71	6.86	6.2
917	16-05-20	7.52	9.87	7.02	2.82	6.88	6.22
918	17-05-20	7.55			2.97	6.91	6.25
919	18-05-20	7.57	9.9	7.07	2.94	6.93	6.28
920	19-05-20	7.59	9.93	7.05	3.2	6.93	6.28
921	20-05-20	7.61	9.95	7.08	3.33	6.9	6.3



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922	21-05-20	7.62	9.96	7.09	3.57	6.92	
923	22-05-20	7.64	9.97	7.11	3.81	6.93	6.34
924	23-05-20	7.66	9.92	7.12	3.99	6.95	6.36
925	24-05-20	7.68	9.93	7.14	4.05	6.96	6.37
926	25-05-20	7.7	9.95	7.15	4.26	6.96	6.37
927	26-05-20	7.66	9.97	7.17	4.57	6.97	6.39
928	27-05-20	7.68	9.99	7.21	4.62	6.95	6.4
929	28-05-20	7.69	10	7.2	4.72	6.97	6.4
930	29-05-20	7.69	10.02	7.22	4.85	6.99	6.43
931	30-05-20	7.63	10.04	7.24	5.2	6.9	6.44
932	31-05-20		10.06	7.25	5.03	6.92	6.48
933	01-06-20		10.08	7.25	5.33	6.92	6.48
934	02-06-20	7.65	10.09	7.27	5.29	6.93	6.5
935	03-06-20	7.66	10.11	7.29	5.47	6.94	6.5
936	04-06-20	7.67	10.12	7.31	5.77	6.96	6.52
937	05-06-20	7.68	10.13	7.33	5.69	6.95	6.5
938	06-06-20	7.66	10.15	7.3	5.83	6.96	6.52
939	07-06-20	7.65	10.16	7.32	6.18	6.98	6.53
940	08-06-20	7.66	10.15	7.33	6.35	6.98	6.53
941	09-06-20	7.68	10.17	7.35	6.88	6.99	6.55
942	10-06-20	7.7	10.2	7.37	6.91	7.02	6.58
943	11-06-20	7.73	10.23	7.41	7.09	7.05	6.6
944	12-06-20	7.75	10.25	7.43	7.11	7.07	6.62
945	13-06-20	7.77	10.27	7.45	6.63	7.09	6.63
946	14-06-20	7.79	10.28	7.46	7.05	7.11	6.65
947	15-06-20	7.8	10.3	7.48	6.98	7.13	6.66
948	16-06-20	7.83	10.3	7.5	7.13	7.1	6.68
949	17-06-20	7.84	10.32	7.52	7.06	7.11	6.65
950	18-06-20	7.86	10.33	7.53	6.92	7.03	6.55
951	19-06-20	7.8	10.25	7.44	6.78	7.05	6.5
952	20-06-20	7.77	10.22	7.4	6.74	7.07	6.47
953	21-06-20	7.73	10.19	7.38	7	7.02	6.43
954	22-06-20	7.71	10.15	7.35	7.15	6.95	6.4
955	23-06-20	7.68	10.1	7.33	7.05	6.93	6.36
956	24-06-20	7.65	10.06	7.3	7.49	6.9	6.33
957	25-06-20	7.62	10.02	7.28	7.27		
958	26-06-20	7.59	9.99	7.26	6.86	6.83	6.25
959	27-06-20	7.55	9.95	7.22	7.13	6.79	6.21
960	28-06-20	7.51	9.9	7.19	7.27	6.73	6.18
961	29-06-20	7.47	9.87	7.15	8.42	6.7	6.15
962	30-06-20	7.43	9.86	7.11	6.71	6.66	6.12
963	01-07-20	7.4	9.83	7.09	7.22	6.61	6.08

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964	02-07-20	7.35	9.8	7.07	7.41	6.58	6.02
965	03-07-20	7.33	9.77	7.02	7.39	6.55	6
966	04-07-20	7.3	9.72	7	7.14	6.52	5.96
967	05-07-20	7.28	9.7	6.97	7.48	6.5	5.95
968	06-07-20	7.25	9.66	6.96	7.5	6.48	5.91
969	07-07-20	7.23	9.63	6.93	7.24	6.45	5.88
970	08-07-20	7.19	9.6	6.9	7.9	6.43	5.85
971	09-07-20	7.15	9.53	6.88	8.73	6.4	5.83
972	10-07-20	7.12	9.5	6.85	8.41	6.38	5.81
973	11-07-20	7.11	9.47	6.83	8.41	6.37	5.8
974	12-07-20	7.08	9.45	6.84	8.23	6.35	5.77
975	13-07-20	7.05	9.43	6.82	8.3	6.32	5.73
976	14-07-20	7.01	9.41	6.8	8.76	6.3	5.71
977	15-07-20	6.99	9.38	6.77	8.71	6.28	5.68
978	16-07-20	6.93	9.36	6.74	9.41	6.25	5.65
979	17-07-20	6.89	9.33	6.71	10.09	6.21	5.63
980	18-07-20	6.85	9.3	6.66	11.12	6.19	5.6
981	19-07-20	6.81	9.26	6.63	11.08	6.15	5.56
982	20-07-20	6.77	9.25	6.61	10.58	6.11	5.53
983	21-07-20	6.73	9.23	6.58	9.29	6.05	5.48
984	22-07-20	6.7	9.21	6.55	8.99	6.03	5.45
985	23-07-20	6.66	9.18	6.51	8.75	6.03	5.43
986	24-07-20	6.63	9.15	6.47	9.2	5.98	5.4
987	25-07-20	6.61	9.13	6.45	9.36	5.95	5.38
988	26-07-20	6.58	9.1	6.43	8.95	5.93	5.35
989	27-07-20	6.55	9.07	6.4	9.51	5.95	5.33
990	28-07-20	6.53	9.02	6.35	9.71	5.93	5.3
991	29-07-20	6.55	8.95	6.33	9.98	5.9	5.27
992	30-07-20	6.47	8.87	6.28	9.93	5.86	5.23
993	31-07-20					5.85	5.21
994	01-08-20	6.44	8.85	6.25	11.78	5.84	5.23
995	02-08-20	6.45	8.85	6.23	9.96	5.82	5.21
996	03-08-20	6.43	8.84	6.25	9.88	5.8	5.22
997	04-08-20	6.41	8.83	6.21	9.78	5.77	5.18
998	05-08-20	6.38	8.8	6.15	9.73	5.77	5.13
999	06-08-20	6.35	8.77	6.1	9.7	5.73	5.07
1000	07-08-20	6.33	8.73	6.07	9.66	5.7	5.02
1001	08-08-20	6.3	8.71	6.02	9.61	5.66	4.99
1002	09-08-20	6.25	8.61	5.98	9.56	5.65	4.99
1003	10-08-20				9.51	5.58	4.92
1004	11-08-20	6.21	8.55	5.91	9.47	5.55	4.88
1005	12-08-20	6.18	8.51	5.88	9.44	5.51	4.83

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1006	13-08-20	6.13	8.44	5.81	9.24	5.22	4.55
1007	14-08-20	6.02	8.41	5.44	9.03	4.97	4.29
1008	15-08-20	5.91	8.21	5.22	8.84	4.69	3.95
1009	16-08-20	5.76	8.09	5.03	8.39	4.29	3.72
1010	17-08-20	5.32	7.75	4.69	8.25	4.18	3.48
1011	18-08-20	5.13	7.53	4.51	8.14	4.11	3.41
1012	19-08-20	5.03	7.48	4.48	7.96	3.99	3.32
1013	20-08-20	5.03	7.48	4.48	7.92	3.92	3.27
1014	21-08-20	4.82	7.35	4.33	7.9	3.88	3.22
1015	22-08-20	4.78	7.32	4.3	7.9	3.85	3.22
1016	23-08-20	4.75	7.3	4.29		3.77	3.18
1017	24-08-20	4.69	7.28	4.25	7.83	3.75	3.15
1018	25-08-20	4.65	7.25	4.21	7.81	3.71	3.13
1019	26-08-20	4.61	7.21	4.18	7.78	3.66	3.11
1020	27-08-20	4.58	7.19	4.15	7.75	3.61	3.08
1021	28-08-20	4.55	7.16	4.11	7.71	3.58	3.03
1022	29-08-20	4.51	7.13	4.08	7.65	3.55	3.01
1023	30-08-20	4.48	7.11	4.01	7.59	3.51	2.98
1024	31-08-20	4.45	7.07	4.01	7.55	3.48	2.95
1025	01-09-20	4.42	7.01	3.98	7.52	3.48	2.95
1026	02-09-20	4.41	6.98	3.95	7.5	3.41	2.88
1027	03-09-20	4.38	6.93	3.9	7.48	3.38	2.83
1028	04-09-20	4.35	6.88	3.88	7.44	3.35	2.8
1029	05-09-20	4.32	6.85	3.85	7.41	3.31	2.77
1030	06-09-20	4.31	6.83	3.82	7.38	3.28	2.75
1031	07-09-20	4.28	6.8	3.8	7.35	3.28	2.75
1032	08-09-20	4.3	6.81	3.77	7.36	3.25	2.74
1033	09-09-20	4.28	6.77	3.75	7.33	3.22	2.72
1034	10-09-20	4.25	6.74	3.74	7.31	3.25	2.73
1035	11-09-20	4.23	6.75	3.75	7.29	3.21	2.69
1036	12-09-20	4.18	6.74	3.72	7.25	3.19	2.63
1037	13-09-20	4.15	6.75	3.69	7.23	3.15	2.63
1038	14-09-20	4.12	6.73	3.65	7.2	3.16	2.6
1039	15-09-20	4.1	6.71	3.66	7.21	3.13	2.63
1040	16-09-20	4.12	6.73	3.68	7.23	3.15	2.65
1041	17-09-20	4.09	6.7	3.66	7.25	3.15	2.68
1042	18-09-20	4.12	6.66	3.68	7.27	3.18	2.75
1043	19-09-20	4.15	6.68	3.71	7.31	3.12	2.73
1044	20-09-20	4.17	6.7	3.73	7.28	3.19	2.76
1045	21-09-20	4.2	6.72	3.75	7.31	3.21	2.79
1046	22-09-20	4.22	6.75	3.78	7.33	3.24	2.81
1047	23-09-20	4.23	6.77	3.8	7.35	3.2	2.8

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1048	24-09-20	4.2	6.74	3.35	7.29	3.14	2.72
1049	25-09-20	4.16	6.69	3.29	7.23	3.09	2.68
1050	26-09-20	4.13	6.63	3.25	7.18	3.02	2.63
1051	27-09-20	4.09	6.59	3.19	7.12	2.99	2.6
1052	28-09-20	4.12	6.62	3.21	7.14	3.03	2.63
1053	29-09-20	4.16	6.65	3.24	7.18	3.07	2.68
1054	30-09-20	4.17	6.65	3.25	7.17	3.11	2.73
1055	01-10-20	4.21	6.68	3.29	7.19	3.16	2.77
1056	02-10-20	4.25	6.73	3.33	7.22	3.19	2.79
1057	03-10-20	4.28	6.71	2.78	7.2	3.22	2.82
1058	04-10-20	4.29	6.73	2.75	7.22	3.24	2.84
1059	05-10-20	4.26	6.75	2.77	7.24	3.26	
1060	06-10-20	4.29	6.78	2.75	7.21	3.29	
1061	07-10-20	4.31	6.75	2.78	7.23		2.89
1062	08-10-20	4.33	6.77	2.79	7.24	3.35	2.91
1063	09-10-20	4.35	6.75	2.77	7.26	3.37	2.93
1064	10-10-20	4.38	6.77	2.79	7.25	3.39	2.95
1065	11-10-20	4.39	6.79	2.81	7.28	3.42	2.97
1066	12-10-20	4.42	6.82	2.85	7.3	3.45	2.99
1067	13-10-20	4.44	6.85	2.82	7.33	3.48	3.02
1068	14-10-20	4.46	6.88	2.84	7.35	3.51	3.05
1069	15-10-20	4.48	6.89	2.87	7.37		3.09
1070	16-10-20	4.51	6.92	2.88	7.39	3.55	3.12
1071	17-10-20	4.53	6.95	2.91	7.43	3.58	3.15
1072	18-10-20	4.55	6.97	2.93	7.46	3.61	3.18
1073	19-10-20	4.58	6.99	2.95	7.48	3.63	3.21
1074	20-10-20	4.62	7.02	2.97	7.52	3.65	3.23
1075	21-10-20	4.65	7.05	2.99	7.55	3.66	3.26
1076	22-10-20	4.63	7.08	3.01	7.56	3.65	3.28
1077	23-10-20	4.65	7.11	3.05	7.52	3.66	3.33
1078	24-10-20	4.68	7.13	3.08	7.55	3.68	3.35
1079	25-10-20	4.69	7.14	3.11	7.58	3.7	3.36
1080	26-10-20	4.71	7.15	3.13	7.57	3.72	3.38
1081	27-10-20	4.72	7.17	3.14	7.59	3.73	3.39
1082	28-10-20	4.73	7.19	3.16	7.61	3.75	3.41
1083	29-10-20	4.74	7.21	3.17	7.63	3.77	3.42
1084	30-10-20	4.75	7.23	3.18	7.65	3.79	3.44
1085	31-10-20	4.77	7.25	3.2	7.66	3.81	3.46
1086	01-11-20	4.78	7.27	3.22	7.68	3.83	3.48
1087	02-11-20	4.79	7.29	3.24	7.69	3.85	3.49
1088	03-11-20	4.8	7.3	3.26	7.7	3.87	3.51
1089	04-11-20	4.82	7.32	3.28	7.73	3.89	3.53

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1090	05-11-20	4.84	7.33	3.3	7.75	3.91	3.55
1091	06-11-20	4.86	7.35	3.33	7.77	3.88	3.56
1092	07-11-20	4.88	7.37	3.35	7.79	3.91	3.58
1093	08-11-20	4.9	7.39	3.37	7.81	3.93	3.6
1094	09-11-20	4.91	7.39	3.39	7.82	3.95	3.62
1095	10-11-20	4.92	7.41	3.41	7.84	3.97	3.63
1096	11-11-20	4.93	7.44	3.43	7.86	3.98	3.65
1097	12-11-20	4.95	7.46	3.45	7.87	3.96	3.68
1098	13-11-20	4.97	7.48	3.47	7.89	3.95	3.69
1099	14-11-20	4.99	7.49	3.48	7.91	3.92	3.7
1100	15-11-20	5.02	7.51	3.5	7.93	3.95	3.73
1101	16-11-20	5.05	7.53	3.52	7.95	3.97	3.75
1102	17-11-20	5.08	7.55	3.55	7.98	3.98	3.76
1103	18-11-20	5.09	7.58	3.57	7.99	3.99	3.75
1104	19-11-20	5.11	7.6	3.59	8.01	4	3.77
1105	20-11-20	5.13	7.63	3.62	8.04	4.02	3.78
1106	21-11-20	5.15	7.65	3.65	8.07	4.01	3.79
1107	22-11-20	5.17	7.66	3.68	8.08	4.03	3.81
1108	23-11-20	5.2	7.69	3.71	8.11	4.06	3.83
1109	24-11-20	5.22	7.71	3.73	8.13	4.08	3.85
1110	25-11-20	5.25	7.74	3.75	8.15	4.11	3.86
1111	26-11-20	5.28	7.75	3.77	8.16	4.13	3.88
1112	27-11-20	5.3	7.78	3.79	8.18	4.15	3.91
1113	28-11-20	5.32	7.81	3.81	8.2	4.17	3.93
1114	29-11-20	5.34	7.83	3.85	8.21	4.21	3.95
1115	30-11-20	5.38	7.85	3.87	8.23	4.23	3.97
1116	01-12-20	5.37	7.85	3.87	8.24	4.25	3.99
1117	02-12-20	5.39	7.87	3.89	8.27	4.28	4.03
1118	03-12-20	5.42	7.89	3.92	8.29	4.29	4.05
1119	04-12-20	5.44	7.91	3.95	8.33	4.31	4.02
1120	05-12-20	5.47	7.93	3.97	8.35	4.32	4.03
1121	06-12-20	5.49	7.92	3.95	8.31	4.36	4.05
1122	07-12-20	5.51	7.93	3.96	8.33	4.38	4.06
1123	08-12-20	5.55	7.95	3.97	8.35	4.39	4.08
1124	09-12-20	5.56	7.97	3.98	8.36	4.41	4.11
1125	10-12-20	5.58	7.99	4.01	8.38	4.46	4.13
1126	11-12-20	5.59	7.92	4.02	8.39	4.52	4.12
1127	12-12-20	5.61	7.93	4.06	8.41	4.53	4.11
1128	13-12-20	5.63	7.91	4.03	8.43	4.55	4.15
1129	14-12-20	5.65	7.93	4.05	8.45	4.51	4.16
1130	15-12-20	5.66	7.95	4.08	8.47	4.54	4.14
1131	16-12-20	5.68	7.96	4.11	8.49	4.56	

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1132	17-12-20	5.71	7.98	4.13	8.51	4.58	4.17
1133	18-12-20	5.73	7.99	4.15	8.53	4.59	4.18
1134	19-12-20	5.75	7.95	4.17	8.55	4.61	
1135	20-12-20	5.76	7.96	4.19	8.53	4.63	4.21
1136	21-12-20	5.78	7.98	4.21	8.55	4.6	4.23
1137	22-12-20	5.75	7.95	4.18	8.51	4.63	4.21
1138	23-12-20	5.77	7.97	4.21	8.53	4.65	4.23
1139	24-12-20	5.79	7.97	4.23	8.55	4.66	4.25
1140	25-12-20	5.8	7.99	4.25	8.56	4.67	4.28
1141	26-12-20	5.82	7.95	4.27	8.5	4.68	4.25
1142	27-12-20	5.83	7.9	4.29	8.52	4.7	4.22
1143	28-12-20	5.84	7.93	4.25	8.55	4.72	4.23
1144	29-12-20	5.85	7.95	4.27	8.58	4.73	4.21
1145	30-12-20	5.87	7.96	4.28	8.59	4.75	4.23
1146	31-12-20	5.89	7.98	4.29	8.61	4.77	4.25
1147	01-01-21	5.89	7.99	4.32	8.63	4.78	4.27
1148	02-01-21	5.9	7.99	4.33	8.65	4.8	4.28
1149	03-01-21	5.92	8.02	4.35	8.66	4.82	4.3
1150	04-01-21	5.9	8.04	4.36	8.63	4.83	4.32
1151	05-01-21	5.92	8.06	4.37	8.65	4.85	4.32
1152	06-01-21	5.93	8.08	4.38	8.66	4.85	4.33
1153	07-01-21	5.94	8.1	4.4	8.65	4.86	4.35
1154	08-01-21	5.96	8.13	4.42	8.67	4.89	4.38
1155	09-01-21	5.98	8.15	4.43	8.68	4.92	4.41
1156	10-01-21	5.99	8.13	4.45	8.7	4.94	4.43
1157	11-01-21	6.02	8.15	4.47	8.73	4.97	4.46
1158	12-01-21	6.03	8.13	4.46	8.71	4.97	4.43
1159	13-01-21	6.02	8.14	4.45	8.68	4.96	4.42
1160	14-01-21	6.02	8.15	4.42	8.65	4.95	4.41
1161	15-01-21	6.01	8.12	4.39	8.61	4.96	4.43
1162	16-01-21	6.03	8.13	4.41	8.63	4.43	4.43
1163	17-01-21	6.03	8.06	4.41	8.59	4.43	4.45
1164	18-01-21	6.02	8.01	4.43	8.56	4.43	4.46
1165	19-01-21	6.03	8.03	4.44	8.57	4.45	4.48
1166	20-01-21	6.05	8.05	4.46	8.58	4.46	4.49
1167	21-01-21	6.06	8.05	4.45	8.57	4.47	4.5
1168	22-01-21	6.07	8.06	4.46	8.57	4.48	4.52
1169	23-01-21	6.05	8.03	4.45	8.52	4.49	4.53
1170	24-01-21	6.07	8.04	4.46	8.46	4.51	4.55
1171	25-01-21	6.08	8.05	4.45	8.45	4.53	4.55
1172	26-01-21	6.09	8.06	4.44	8.43	4.55	4.56
1173	27-01-21	6.11	8.08	4.42	8.42	4.57	4.57

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1174	28-01-21	6.14	8.09	4.43	8.41	4.58	4.58
1175	29-01-21	6.16	8.13	4.42	8.32	4.59	4.64
1176	30-01-21	6.12	8.16	4.46	8.25	4.66	4.62
1177	31-01-21	6.13	8.11	4.44	8.11	4.61	4.61
1178	01-02-21	6.12	8.1	4.41		4.62	4.62
1179	02-02-21	6.15	8.12	4.46		4.63	4.63
1180	03-02-21	6.11	8.11	4.43		4.64	4.64
1181	04-02-21	6.13	8.12	4.44			4.66
1182	05-02-21	6.16	8.13	4.46	8.12	4.68	4.68
1183	06-02-21	6.18	8.09	4.49	8.02	4.69	4.71
1184	07-02-21	6.21	8.05	4.52	8.05	4.71	4.68
1185	08-02-21	6.22	8.06	4.53	8.05	4.74	4.69
1186	09-02-21	6.23	8.07	4.55	8.06	4.75	4.72
1187	10-02-21	6.25	8.08	4.58	8.08	4.76	4.73
1188	11-02-21	6.26	8.1	4.59	8.09	4.78	4.72
1189	12-02-21	6.25	8.02	4.6	8.06	4.79	4.75
1190	13-02-21	6.27	7.96	4.62	8.05	4.81	4.76
1191	14-02-21	6.28	7.92	4.63	8.02	4.82	4.71
1192	15-02-21	6.29	7.93	4.64	8.03	4.83	4.73
1193	16-02-21	6.31	7.95	4.65	8	4.84	4.75
1194	17-02-21	6.32	7.96	4.63	7.96	4.86	4.76
1195	18-02-21	6.33	7.98	4.64	7.91	4.85	4.78
1196	19-02-21	6.35	7.99	4.65	7.88	4.85	4.79
1197	20-02-21	6.36	8.01	4.65	7.82	4.86	4.81
1198	21-02-21	6.38	8.02	4.66	7.78		
1199	22-02-21	6.39	8.01	4.65	7.75		
1200	23-02-21	6.35	8.01	4.66	7.71	4.88	4.82
1201	24-02-21	6.27	7.92	4.66	7.66	4.88	4.82
1202	25-02-21	6.15	7.78	4.67	7.53	4.89	4.83
1203	26-02-21	6.16	7.79	4.72	7.55	4.91	4.85
1204	27-02-21	6.17	7.81	4.73	7.56	4.92	4.86
1205	28-02-21	6.18	7.83	4.75	7.52	4.93	4.87
1206	01-03-21	6.19	7.81	4.75	7.52	4.93	4.88
1207	02-03-21	6.16	7.76	4.72	7.51	4.94	4.88
1208	03-03-21	6.15	7.72	4.71	7.53	4.95	4.89
1209	04-03-21	6.15	7.75	4.72	7.52	4.96	4.89
1210	05-03-21	6.16	7.76	4.73	7.53	4.98	4.91
1211	06-03-21	6.18	7.75	4.74	7.53	4.96	4.93
1212	07-03-21	6.19	7.75	4.75	7.54	4.98	4.94
1213	08-03-21	6.21	7.72	4.78	7.25	4.99	4.96
1214	09-03-21	6.23	7.73	4.81	7.11	5.02	4.98
1215	10-03-21	6.25	7.74	4.83	6.98	5.06	4.98

SN	Date	Arwal	Arwal (DM Office)	Karpi	Banshi Suryapura	Kurtha	Kaler
1216	11-03-21	6.29	7.76	4.85	6.82	5.09	4.99
1217	12-03-21	6.31	7.78	4.87	6.68	5.11	5.02
1218	13-03-21	6.33	7.79	4.89	6.61	5.14	5.05
1219	14-03-21	6.35	7.81	4.91	6.5	5.15	5.03
1220	15-03-21	6.36	7.81	4.92	6.35	5.16	5.06
1221	16-03-21	6.38	7.85	4.93	6.38	5.18	5.05
1222	17-03-21	6.39	7.83	4.94	6.39	5.16	5.08
1223	18-03-21	6.37	7.86	4.93	6.53	5.19	5.09
1224	19-03-21	6.41	7.84	4.92	6.48	5.21	5.11
1225	20-03-21	6.42	7.85	4.93	6.49	5.22	5.12
1226	21-03-21	6.43	7.82	4.94	6.51	5.23	5.13
1227	22-03-21	6.44	7.81	4.96	6.52	5.23	5.14



**References:**

1. Ground Water Year Book – 2017-18
2. Ground Water Resources and Development Potential of Arwal district, Bihar (2004-05)

*-M.L. Doja, Scientist C*

3. Ground Water Exploration Report – Bihar
4. District Brochure of Arwal District.