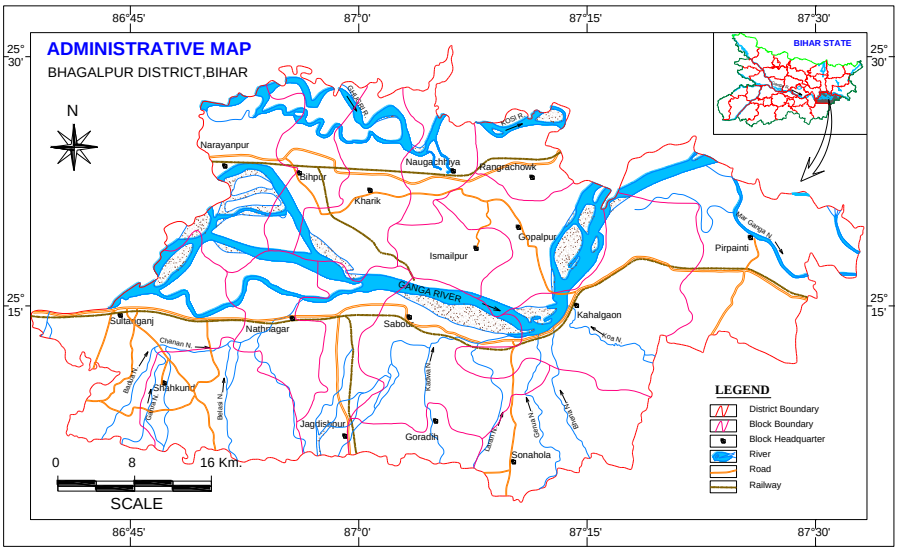
भूजल सूचना पुस्तिका

भागलपुर जिला, बिहार

Ground Water Information Booklet

Bhagalpur District, Bihar State



केन्द्रीय भूमिजल बोर्ड
जल संसाधन मंत्रालय
(भारत सरकार)
मध्य-पूर्वी क्षेत्र
पटना

Central Ground water Board
Ministry of Water Resources
(Govt. of India)
Mid-Eastern Region
Patna

सितंबर 2013

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PREPARED BY	**-**	**Shri S. Sahu Sc. B**
UNDER SUPERVISION OF	**-**	**Shri A.K.Agrawal, Scientist'D'**
CARTOGRAPHY	**-**	**Shri Lokendra Kumar, D/Man Gd-II**
UPDATED BY	**-**	**Shri S.N.Dwivedi & Dr. Fakhre Alam, STA (Hg)**

GROUNDWATER INFORMATION BOOKLET
BHAGALPUR DISTRICT, BIHAR

DISTRICT AT A GLANCE

Sl. No.		Statistics
1.	**GENERAL INFORMATION**	
	I. Geographical Area (Sq. Km.)	2,570 km²
	Administrative Divisions	Bhagalpur, Kahalgaon, Naugachhia
	No. of Panchayats/Villages	
	II. Population (As per 2011 Census)	Rural: 2432126 Urban: 600100
	III. Average Annual Rainfall (mm)	1148.52
2	**GEOMORPHOLOGY**	
	Major Physiographic Units	1. Flat Indo-Gangetic Alluvium Tract 2. Marginal Alluvium Tract
	Major Drainages	Ganga, Kosi, Bhadua, Koa, Garha, Chandan, Kadwa
3	**LAND USE**	
	a) Forest Area	Nil
	b) Net Area Sown	1850 sq.km
	c) Cultivable Area	1930 sq. km
4	**MAJOR SOIL TYPES**	Vertisols, inceptisols, entisols.
5	**AREA UNDER PRINCIPAL CROPS**	
6	**IRRIGATION BY DIFFERENT SOURCES (Areas and Number of Structures)**	
	Dugwells	2244
	Tubewells/Borewells (STW)	10598
	Tanks/ponds	6
	Canals	3
	Other Sources	3 - 15
	Net Irrigated Area	666 sq. km (35 % of net sown area)
	Gross Irrigated Area	790 sq. km
7	**NUMBER OF GROUND WATER MONITERING WELLS OF CGWB (2011)**	
	No. of Dugwells	09
	No. of Piezometers	Nil
8	**PREDOMINANT GEOLOGICAL FORMATIONS**	1. Quaternary Formations 2. Basement Pre-cambrian Granitic Gneiss with few exposures as Inliers.
9	**HYDROGEOLOGY**	
	Major water bearing formations	Alluvium

	Pre-monsoon Depth to water level during 2011	2.5 – 10.69 m bgl
	Post-monsoon Depth to water level during 2011	1.53 – 8.04 m bgl
	Long term water level trend in last 10 yrs(2002 – 2011) in m/yr	No significant decline
10	**GROUND WATER EXPLORATION BY CGWB (As on 31-03-2013)**	
	No. of well drilled (EW,OW, PZ, SH, Total)	EW=12, OW=1, PZ=7
	Depth Range (m)	61 – 294 m bgl
	Discharge (m^3/hr)	1. 20 – 50 m^3/hr for STW within 50 m bgl 2. 50 – 200 m^3/hr for DTW beyond 100 m bgl.
	Storativity (s)	-
	Transmissitivity (m^2/day)	100 – 600 m^2/day, 4208 at Rampur.
11	**GROUND WATER QUALITY**	Good for drinking and irrigation
	Presence of Chemical constituents more than the permissible limit (e.g.EC, F, As, F)	Few patches are identified to be contaminated with Arsenic.
	Type of Water	Potable
12	**DYNAMIC GROUND WATER RESOURCES (as on 31st March 2009) In ha m.**	
	Annual Replenishible Ground Water Resources	69583
	Net Annual Ground Water Draft	22941
	Projected Demand for Domestic and Industrial Uses up to 2025	7665
	Stage of Ground Water Development	33%
13	**AWARENESS AND TRAINING ACTIVITY**	
	One day Training Programme Organized	
	Date	08.03.2007
	Place	Hotel Rajhans International, Bhagalpur
	No. of Participants	110
14	**GROUND WATER CONTROL AND REGULATION**	
	No. of OE Blocks	Nil
	No. of Critical Blocks	Nil
	No. of Blocks Notified	Nil
15	**MAJOR GROUND WATER PROBLEMS AND ISSUES**	Arsenic pollution of ground water along the banks of river Ganga
	Note: Latest available data may be incorporated	

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1.0 INTRODUCTION

1.1 Location, Area and Administrative Details

The district Bhagalpur is located in the eastern part of the state and extends between the north latitudes of 25^0-03'-40" and 25^0-30'-00" and east longitudes of 86^0-30'-00" and 87^0-29'-45" falling in the Survey of India toposheet no. 72 K and O. The district forms a part of the mid-Gangetic alluvium plain covering an area of 2570 km^2. It is bounded by the district Munger in the west, Sahebganj and Katihar in the east, Madhepura and Purnea in the north and Banka in the south. Bhagalpur Sadar, Kahalgaon and Naugachhia are the three sub-divisions of the district with a total of sixteen community development blocks namely Pirpainti, Kahalgoan, Sanhaula, Sabour, Nathnagar, Jagdishpur, Sultanganj purushottam (thana road), Sahkund, Bihpur, Navgachia, Gopalpur, Kharik, Narayanpur, Gauradih, Ismailpur and Rangrachowk (Plate 1). As per the 2011 Census, the total population of the district stands at 3032226. The density of population is 743 per km^2.

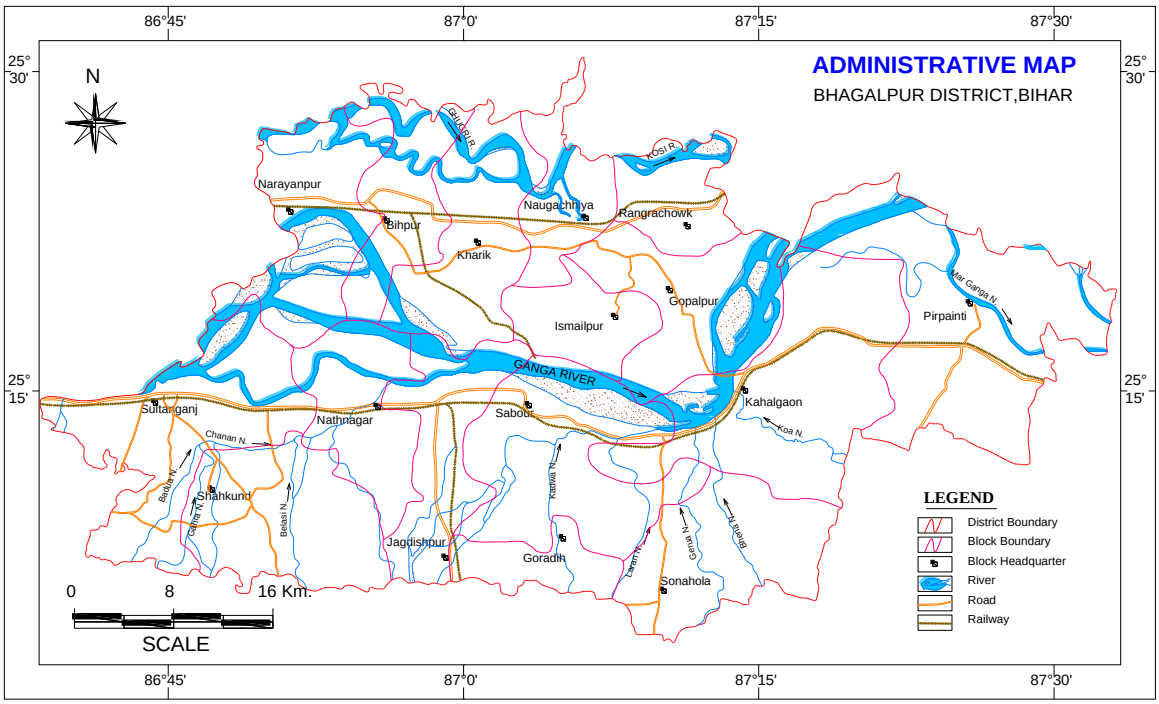

Figure 1: Administrative map of Bhagalpur district, Bihar with block boundaries road (rail) networks.

1.2 Basin/Sub-Basin and Drainage

The part of the district towards the south of the river Ganga falls in the Badua- Koa Sub-Basin (Plate 2) and the area to north of Ganga falls in the Baghmati - Kosi sub-basin. These two sub-basins are parts of Mid-Ganga basin in Bihar. The district is principally drained by the river Ganga, which enters the district at Sultanganj. The northern boundary of the district is marked by the river Kosi (Ghugri) known to be heavily laden with silt and sand. The river Ganga has two

major tributaries joining from south; Badua and Koa. Apart from these, a number of ephemeral streams such as Gahra, Chanan, Kadwa, Gerua and Bhena from Chotnagpur plateau join the mighty Ganga.

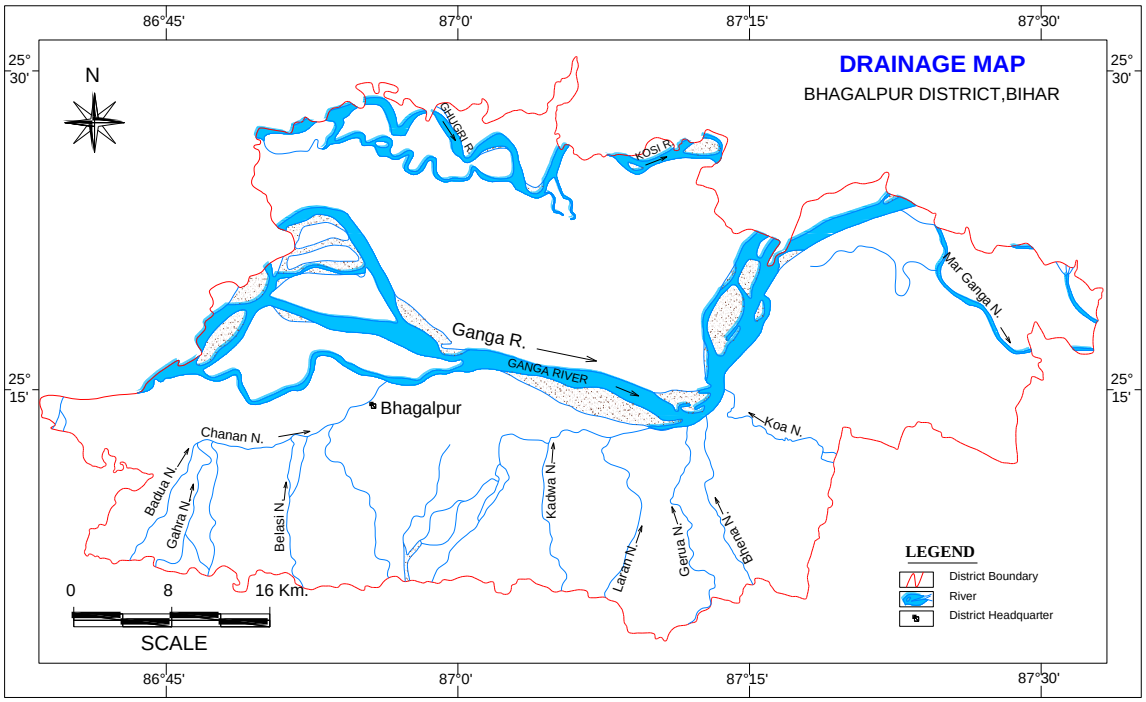

Figure 2: Drainage map of Bhagalpur district, Bihar.

1.3 Agriculture and Irrigation practices

Though Bhagalpur has an agro-based economy, agriculture is largely restricted only to khariff season due to lack of adequate irrigation facilities. Paddy, maize and lentils are the important crops of the district. A large ground water resource in the district has been remained untapped.

1.4 Studies/ activities carried out by CGWB

The exploratory drilling in Bhagalpur district has been carried out at 20 sites (including 8 Slim Hole) down to depth varying from 61.00 m to 294 m. However, no exploratory drilling in the area lying to the north of Ganga River has been carried out. Central Ground Water Board has a set up of 11 dug wells in the district as Hydrograph Network Stations from which water level data are collected four times in every year in order to study the general ground water trend in the district. Recently water samples have also been collected from the district in order to study the Arsenic contamination in the ground water.

2.0 CLIMATE AND RAINFALL

In general a warm and humid climate prevails in the district. Winter starts from November and extends up to February. Temperature usually does not drop below 15^0 C but during the coldest months (late December to early January) temperature even comes down to 8^0 C. During this period, wind blows from northwest and west. The summer period begins from March with the peak temperature of 40 – 45^0 C in May. The month of March and April are the driest months of the year with the relative humidity of 50 – 55 % in the morning and 35 – 40 % in the afternoon.

The humidity increases in May and June to 80 % or more. About 80 % of the rainfall is under the influence of southwest monsoon, which normally breaks in the second fortnight of June. The monsoon lasts till the later part of the September. Generally the eastern and northeastern part of the district receives higher amount of rainfall. The annual normal rainfall in the district remains above 1148 mm.

3.0 GEOMORPHOLOGY AND SOIL TYPES

3.1 Geomorphology

Geomorphologically, the district Bhagalpur forms a part of the Mid-Ganga Foreland Basin. The north and central Bhagalpur towards the north and south of Ganga respectively forms a flat Indo-Gangetic alluvium tract (parts of the North Bihar Plains and Central Bihar Plains respectively). The southern part of the district forms a marginal alluvial tract. The general elevation of the alluvium tract remains within 45 m above mean sea level (amsl). The master slope of region at both north and south is towards the river Ganga. There are some detached hard rock bodies of pre-cambrian age, which stand out as prominent peaks (inliers) within the alluvial plains. Among these, the highest one is at Shahkund with a height of 143 m.

3.2 Soils

The soils in the district are mainly derived from the older and newer alluvium. These alluvial plain soils are light grey to dark grey in colour, rather heavy and texturally fine in nature. The pH values range from neutral to acidic and the acidity of the soil gradually increases from north to south. The hilly soils are acidic with low nitrogen, medium to high potash.

The soils derived from older alluvium are mainly loamy in character with moderate to heavy texture and well drained. In low lands these are poorly drained with heavy texture. These soils comprise an association of vertisols, entisols, alfisols, and ultisols. Black soils found in Shahkund, Sonhaulia, and Sultanganj belong to vertisols category. Sandy soils (Diara soils) derived from younger alluvium are light textured, well drained. These are moderate to highly

fertile calcareous soils and found along the banks/course of the river Ganga. These comprise the soil association of inceptisols and entisols.

4.0 GROUND WATER SCENARIO

4.1 Water bearing formations

The sand layers in the Quaternary Alluvium (both newer and older) form the main source of ground water in the district. Based on the strata logs and hydrogeological properties, the aquifer system in the district can be divided into two categories;

I The shallow aquifers within 50 m depth.

II The deep aquifers within 50 – 200 m depth.

In shallow aquifers, the ground water occurs under unconfined condition and in deeper aquifers under semi-confined to confined conditions. The shallow aquifers consisting of fine to medium sand with clay, silt and kankars are the main sources of ground water in the marginal alluvial tract in the south Bhagalpur. In general the thickness of these aquifers varies from 13 to 18 m, being more at central parts than the eastern and western parts of the marginal alluvium. The thickness of the aquifer is controlled by the geometry of the underlying basement rock. The deeper aquifers mainly consist of sand, gravel and calcareous nodules with alternating layers of clay. The exploration data reveals the presence of four to five major aquifers with cumulative thickness 20 to 85 m. These aquifers thin out towards Sultanganj in the western part since clay dominancy increase.

The composition of the aquifer is not homogeneous at many places. These are very often mixed with silt and little clay, which impedes their water yielding capacity. The yield of these zones varies between 14.30 m^3/hr at Rampur to 202.70 m^3/hr at Madarganj with reference draw down of 6 – 27m.

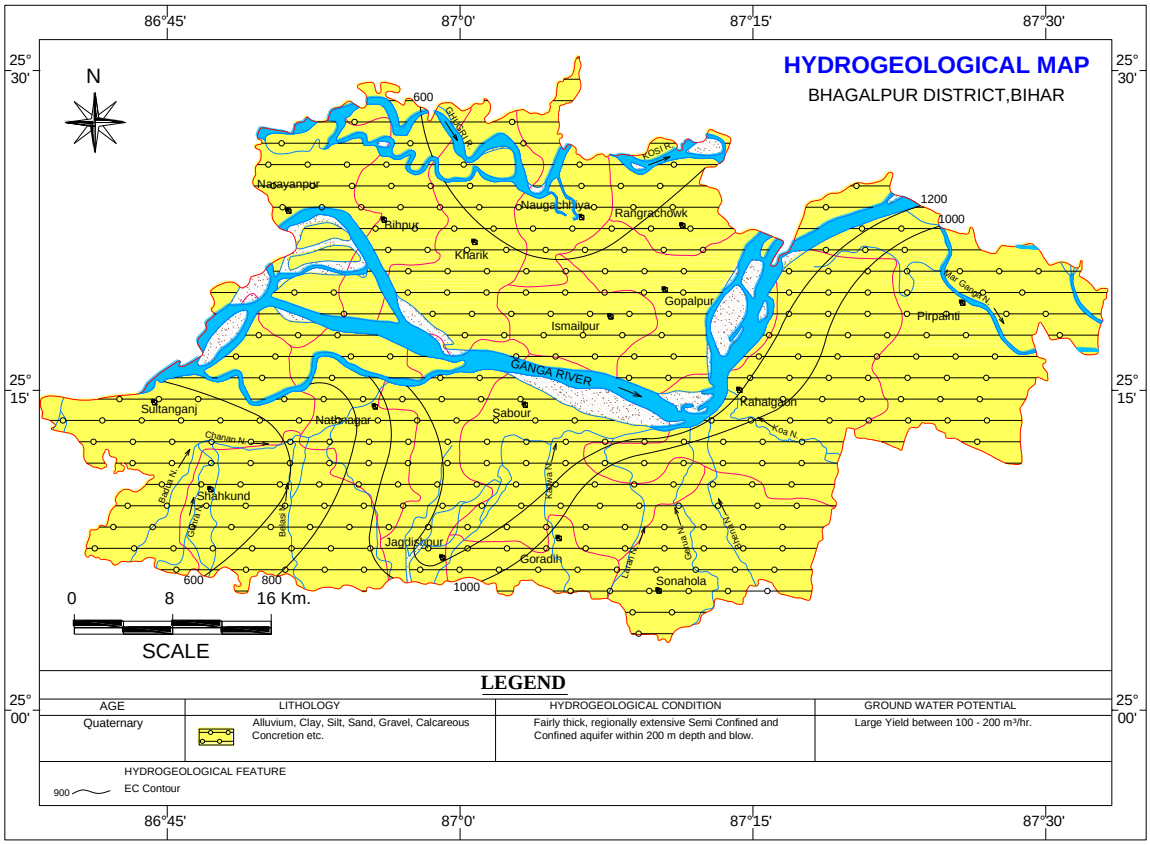

Figure 3: Hydrogeological map of Bhagalpur district, Bihar showing Quaternary Alluvium with their yield potential. Electrical conductivity of groundwater has been represented by contours.

4.2 Depth to Water Level

The pre-monsoon water level data of the year 2011 (Fig. 4) reveals that the depth to water level in the district remain within 2.5 – 10.69 m bgl, with the deepest of 10.69 m bgl and the shallowest of 2.5 m bgl. In post-monsoon, the depth to water level (Fig. 5) in the district comes to be within 1.53 – 8.04 m bgl. The pre and post-monsoon water level data indicates that the water level in the district has registered a rise of 0.77 to 5.14 m within the season. The pre and post-monsoon depth to water level contours has been prepared and produced in Fig. 4 and 5 respectively.

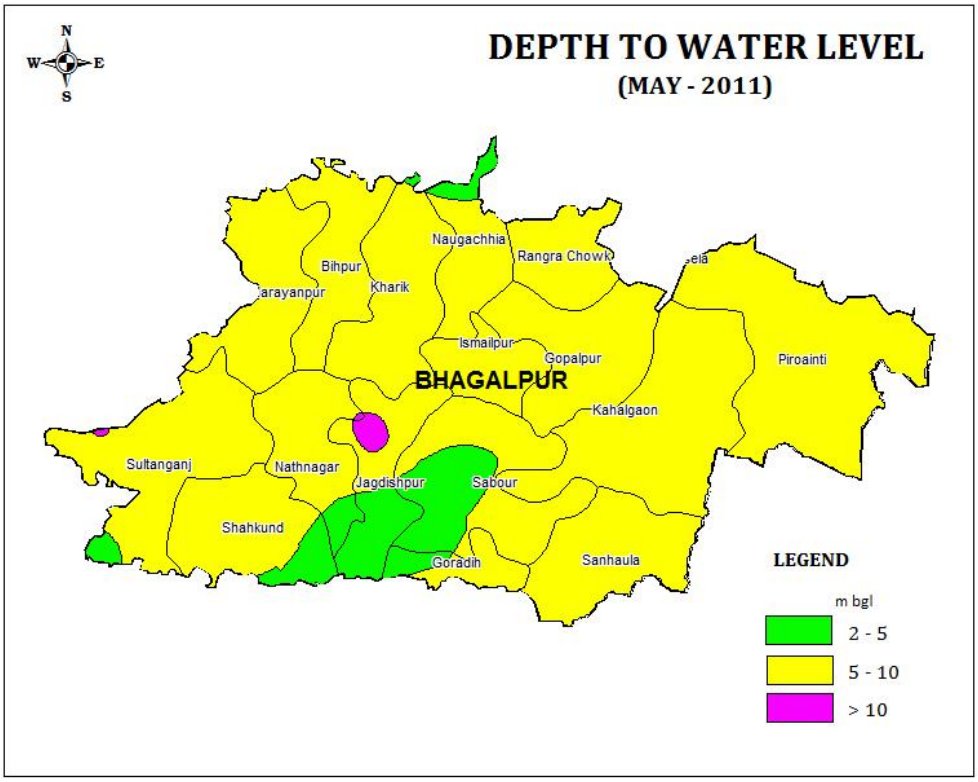

Figure 4: Pre- monsoon 2011 depth to water level contours in Bhagalpur district, Bihar.

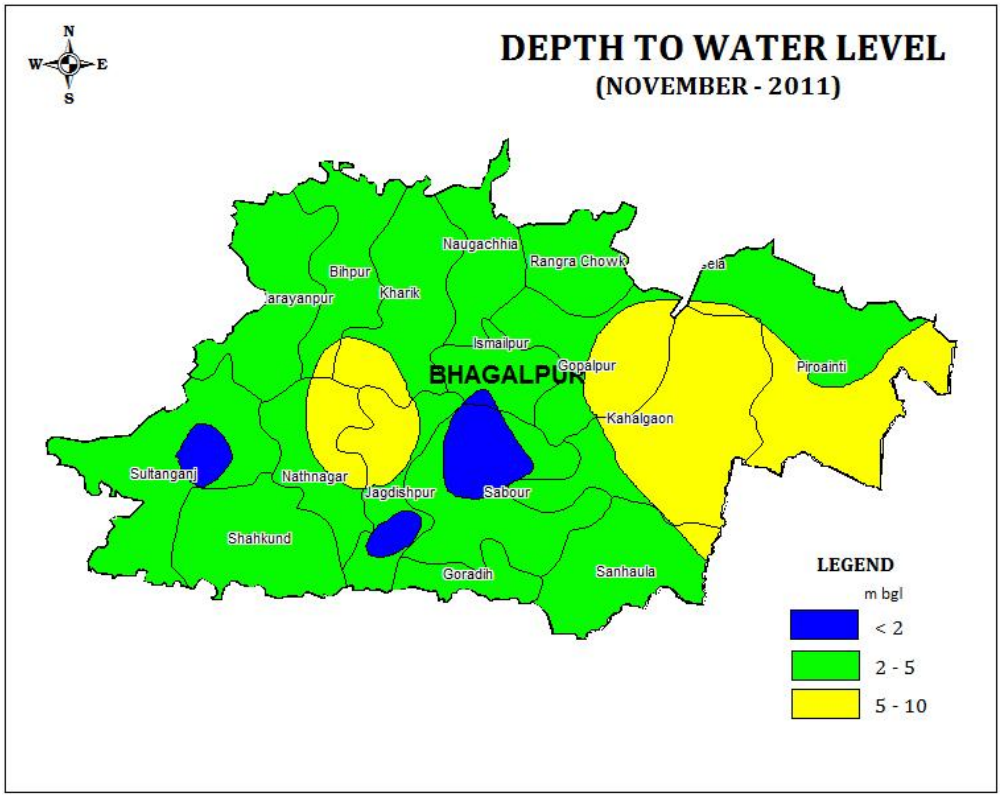

Figure 5: Post- monsoon 2011 depth to water level contours in Bhagalpur district, Bihar.

4.3 Ground Water Quality

The following informations regarding the quality aspects of the ground water in Bhagalpur district has been gathered from the partial and complete analysis of water samples collected from the district. The study of this analytical data reveals that in general the quality of ground water is for drinking and irrigation purposes.

Electrical conductance	: 450 to 1400 micromhos/cm at 25^0C
pH	: 7.0 to 8.05
Total Dissolved Solids	: 145 to 826 ppm
Total Hardness as $CaCO_3$	: 70 to 488 ppm
Calcium	: 12 to 158 ppm
Magnesium	: 9.7 to 60 ppm
Sodium	: 14 to 189 ppm
Potassium	: 0.18 to 4.0 ppm
Chloride	: 10.6 to 200 ppm
Carbonate	: NIL
Bicarbonate	: 122 to 634 ppm
Sulphate	: Less than 2 to 40 ppm
Iron	: Less than 0.1 to 1.40 ppm
Fluoride	: 0.01 to 1.80 ppm
Nitrate	: Less than 1 to 50 ppm
Silica	: 12 to 40 ppm

4.3.1 Arsenic in ground water

Bhagalpur is one of the districts in the state of Bihar, which affected by arsenic contamination in ground water. The ground water in the blocks namely Sultanganj, Nathnagar and Jagdispur, has been reported to be containing arsenic more than the permissible limit of 50 mg/L (as per WHO norm). PHED, Govt of Bihar has conducted a blanket testing for arsenic in the state. The hand pumps where arsenic concentration was found to be more than 50 mg/L during blanket testing were marked with red paint. Arsenic occurs sporadically in hand pumps and it largely depends on the depth of the hand pump and from which formation it taps water. A sudden surge in arsenic concentration in the tube wells is found between the depth range of 12 and 40 m. After 40 m there is a drastic decline in arsenic concentration. In dug wells arsenic concentration is reported as below detection limit (BDL).

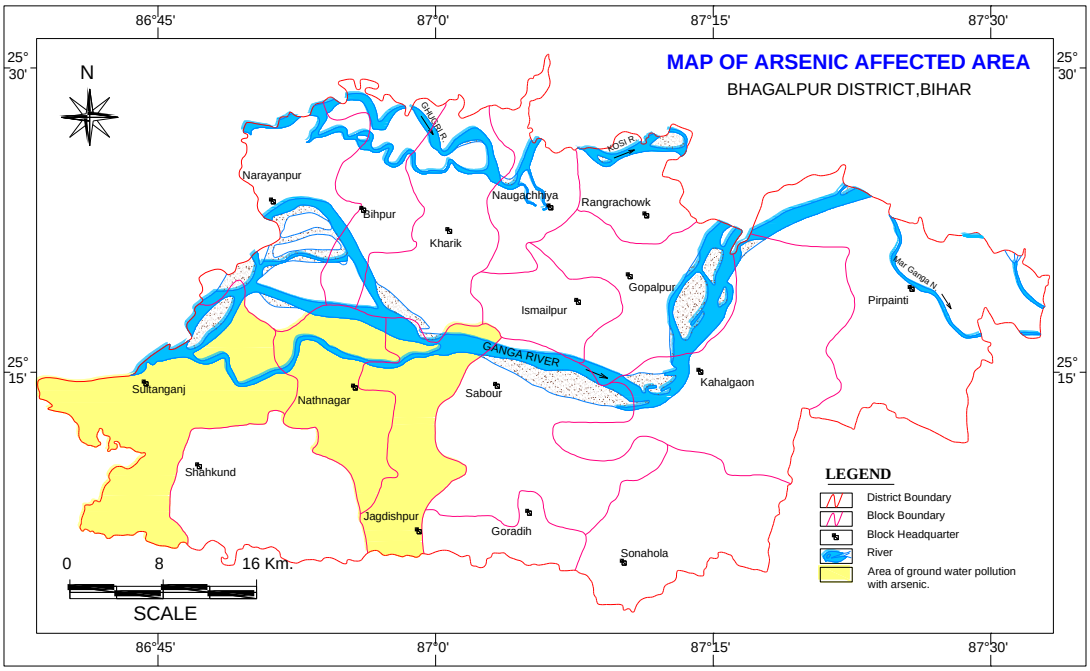

Figure 6: Map of Bhagalpur district, showing areas affected with groundwater arsenic along river Ganga

4.4 Ground Water Resource of Bhagalpur (As per 31st march 2009)

Table 1: Ground Water Resource of the district as on 31st March 2009 (in hectare meters)

Sl.No	Assessment Unit/District	Net Annual Ground water Availability	Existing Gross Ground Water Draft for Irrigation	Existing Gross Ground water Draft for Domestic and Industrial Water Supply	Existing Gross Ground Water Draft For all Uses (10+11)	Allocation for Domestic and Industrial Requirement supply upto year 2025	Net Ground Water Availability for future irrigation development (9-10-13)	Stage of Ground Water Development (12/9)*100 (%)
1	2	9	10	11	12	13	14	15
1	Bihpur	4303	1547	170	1717	264	2492	39.9
2	Gopalpur	3620	912	134	1046	208	2500	28.9
3	Goradih	3653	895	197	1092	307	2452	29.9
4	Ismailpur	2162	270	66	336	102	1789	15.6
5	Jagdishpur	2951	608	1285	1893	2150	192	64.2
6	Kahalgong	7930	999	607	1606	964	5968	20.3
7	Kharik	3653	1099	180	1279	280	2274	35.0
8	Narayanpur	3802	571	144	715	223	3008	18.8
9	Nathnagar	3160	1165	214	1379	332	1662	43.6
10	Naugacchia	3099	1316	383	1699	350	1433	54.8
11	Pirpainti	9189	2065	384	2449	598	6527	26.7
12	Rangrachowk	3186	547	127	675	198	2441	21.2
13	Sabour	3138	782	192	974	298	2058	31.0
14	Shahkund	4984	2447	269	2716	418	2119	54.5
15	Sonhaulla	4872	1577	264	1841	411	2884	37.8
16	Sultanganj	5881	1171	354	1525	561	4149	25.9
	Total	**69583**	**17971**	**4970**	**22941**	**7665**	**43947**	**33.0**

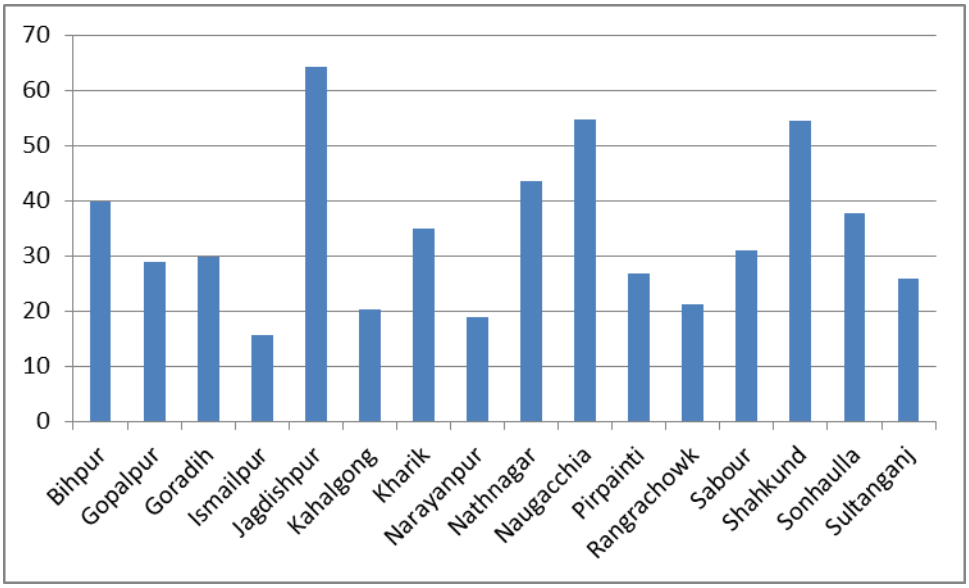

Figure 7: Map showing stage of groundwater development of Bhagalpur district, Bihar.

4.5 Status of ground water development

As far as stage of ground water development is concerned, all the blocks in the district fall under safe category as per the norms of GEC, 1997. The block Ismailpur and Narayanpur are having significantly low stage of ground water development i.e. 15.6 and 18.8 % respectively. Only 4 blocks, which possess more than 40 % stage of ground water development, are Jagdispur (64.2 %), Naugacchia (54.8 %), Nathnagar (43.6 %) and Shahkund (54.5 %). Thus the district possesses a good ground water potential for further utilization in irrigation purposes.

Number of dug wells used in irrigation for kharif and rabi are 2244 and 2720 respectively (as per 1993 well census). A total of 10598 shallow tube wells utilized for irrigation out of which 319 were electric operated, 10172 were diesel engine operated and rest were either solar or man/animal operated. Though a total of 146 deep tube wells were found but most of them were defunct due to unavailability of power. The rest are working for few hours because of power crunch.

As per available statistics, area irrigated by different sources constitute only 35.01 % of the total cultivated area, out of which only 9.48 % is served by surface water and the rest 25.53 % is served by ground water.

It is imperative that optimum utilization of water resources, both surface as well as ground water is vital for the integrated and intensive agricultural development of the district. Proper management is therefore essential pre-requisite for agro-economic development of the district.

5.0 GROUND WATER MANAGEMENT STRATEGY

5.1 Ground water Development

As per the resource evaluation (31st march 2009) the average stage of ground water utilisaton in the district is less than 33 %, which means none of the blocks in the district comes under semi-critical/critical or over exploited category. The present infrastructural facilities yield 15370.4 ha m of ground water for irrigation and there is a vast surplus replenishable ground water potential of 45118.5 ha.m to be tapped.

Depending on the ground water yield potential, the district can be divided into three parts;

1) *High potential zone*

The areas bordering the south of Ganga from Sultanganj to Ghogha and north of Ganga from Bihpur to Nuagachia belong to this zone.In this zone a tube well drilled down to 160 – 200 m bgl can yield 150 – 200 m^3/hr for a reference Drawdown of 4 to 8 m.

2) *Medium potential zone*

The central Bhagalpur with yield potential from 50 to 100 m^3/hr for drawdown of 6 – 15 m belongs to this zone. The depth of the tube well should be within 50 to 100 m bgl.

3) *Low potential zone*

The marginal alluvium tract with yield potential less than 50 m3/hr for draw down of 6 – 20 m comes under this zone. The well should be within 50 m bgl tapping 10 to 15 m of the saturated zone.

5.2 Design and construction of Tube Wells

(a) *Shallow tube wells*- along diara areas and marginal alluvium tracts.

Table 2 Proposed Model for Shallow Tube Wells

Depth of well	: 30 to 50 m bgl
Diameter of well assembly (casing/screen)	: 76 to 102 mm
Length of screen	: Less than 15 m
Slot size	: 1/64'' (0.04 cm) to 1/32'' (0.08 cm)

(b) Deep tube wells

The proposed model design of tube wells in Bhagalpur district is given in the following table;

Table 3 Proposed Model of Deep Tube Wells

Sl. No	Discharge (m^3/hr)	Depth of the well (m bgl)	Proposed well assembly	
			Dia. Of pipe	Length (m)
1	100	100	Housing – 12”	25 – 30
			Slot pipe – 6”	24
			Blank pipe – 6”	46 - 51
2	150	150	Housing – 14”	30
			Slot pipe – 8”	30
			Blank pipe – 8”	90
3	200	200	Housing – 14”	35
			Slot pipe – 8”	50
			Blank pipe – 8”	115

The slot size should be recommended depending on the grain size of the granular zones as given below;

Table 4 Slot opening size in different size of formation sands

Fine sand	: 1/64” (0.04 cm) to 1/32” (0.08 cm)
Medium to coarse sand	: 1/16” (0.15 cm)
Gravel	: 1/8” to 1/16”

Both the shallow as well deep tube wells should be artificially packed with gravels of size ranging within 2 – 3 – 4 mm and a bail plug of 2 – 5 m should be provided in order to the yield and life of the well.

5.3 Water Conservation and artificial recharge:

One artificial recharge structure has been constructed in the combined building, Bhagalpur by Ground Water Investigation Department, Bihar under technical guidance of Central Ground Water Board, MER, Patna.

6.0 GROUND WATER RELATED ISSUES AND PROBLEMS:

Ground water in the blocks Sultanganj, Nathnagar and Jagdispur has been reported to be polluted with arsenic.

7.0 MASS AWARENESS AND TRAINING PROGRAMME:

A one day training programme on **water conservation and artificial recharge to groundwater** was organized at the district headquarter, Bhagalpur, in 2007. Participation of

more than 200 trainees from universities (faculties and students), NGOs, and construction companies was registered in the training programme

8.0 AREA NOTIFIED BY CENTRAL GROUND WATER AUTHORITY/ STATE GROUND WATER AUTHORITY

Since all blocks of the district come under safe category from ground water development point of view, hence no area is notified either by Central ground water authority or State ground water authority till date.

9.0 RECOMMENDATIONS

- Though there has been a considerable development in ground water potential demarcation in the Younger Alluvium belt in the northern part of the district, a lot is yet to be done in the southern Older Alluvium areas.
- There is ample scope of large- scale ground water development in the area to meet the requirement for agriculture sector. Exploitation of ground water can be done through Shallow tube wells and bamboo boring to meet the requirement of small and marginal farmers while deep tube wells can be operated through farmers cooperative.
- Energisation of pump needs to be taken which can help in increasing irrigation potential and cropping intensity.
- Drinking water demand in the arsenic affected areas can be met from the deeper aquifers (depth more than 80 m).