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

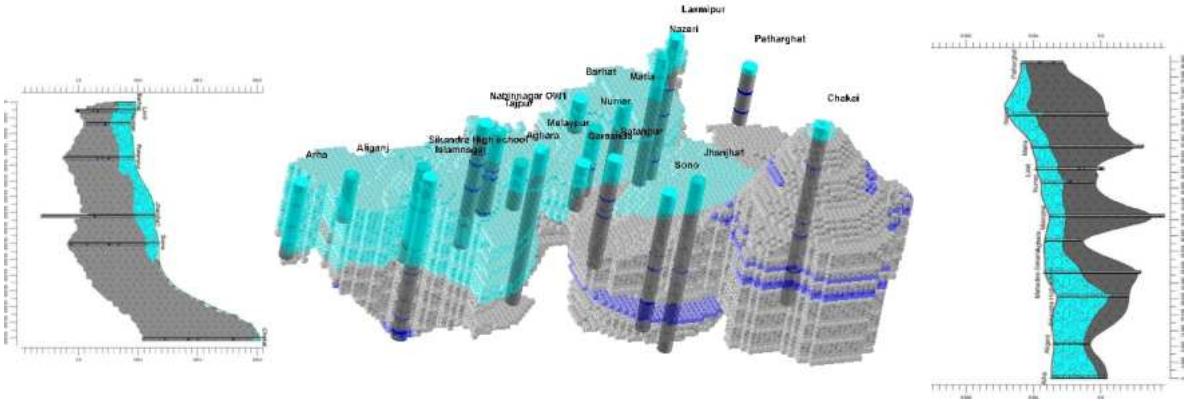
Jamui District
Bihar

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

राष्ट्रीय जलभृत मानचित्रण और प्रबंधन योजना
जमुई जिला, बिहार

NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN IN JAMUI DISTRICT, BIHAR



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Mid-Eastern Region, Patna-Bihar

May, 2022

Contributors Page

Principal Contributor:

Field work, data compilation, analysis, GIS Mapping, 2D/3D- Aquifer Disposition Diagram, Report Writing	**Sanjib Chakraborty, Sc- B**
Chemical Analysis and Diagram	**Manasi Bhattacharya , Sc B**
	Dr. Suresh Kumar, ACH
Supervision	**Dr.I Roy, Sc-C**
Overall Supervision	**A.K. Agarwal, Regional Director**
	Thakur B N Singh, Regional Director

Foreword

Jamui district lies in the southern parts of the Bihar State. Geo-morphologically the district is characterised by undulating terrain surrounded by hill ranges with masses of forest cover and alluvial plains. It is characterised by water scare hard rock terrain and as well as vast alluvial tracts of Jamui terrace in the central and northern parts of the district alongside the Kiul River plain. Hard crystalline Pre-Cambrian Granitic basements to Quaternary younger alluvium comprise the varied geological set up of the district which by and large influences the ground water resources and development. The fissured formation in hard rock area and porous formation in alluvial tracts broadly constitutes the hydrogeological frame work of the district.

Jamui district is principally a rural one and economy is agrarians, however, the agriculture to a greater extent is rainfed. The scope for irrigation is moderate with cropping intensity around 143%. There is scope for irrigation development in the district from surface as well as through ground water irrigation.

In the present study, under NAQUIM activities of Central Ground Water Board, an attempt has been made to study the ground water regime in the district in detail. The generation of 2 D and 3 D aquifer maps in the hard rock and in alluvial terrain has been approached and the respective aquifers have been delineated. Contamination of fluoride in ground water in some pockets of Jamui distrct has also been identified which demands thoughtful attention for effective mitigation measures. Based on the present exercise and from the archive of exploratory drilling data and hydrogeological information in the district an effective management plan has been framed for intervention in drinking domestic and in irrigation sectors. Management intervention through rain water harvesting and artificial recharge has also been advocated for sustainable development in the district.

An admirable effort has been put **by Shri Sanjib Chakraborty, Sc B**, **CGWB, MER, Patna** in data generation, analysis, compilation and in preparation of this report. The report may be a pen sketch for State Ground Water development Authority, other user agencies and stakeholders in ground water and irrigation sectors and may aid as road map to formulate and to execute projects in a comprehensive manner for sustainable development of ground water resources in the district.

Place: Patna **Thakur B N Singh**

Regional Director

CONTENTS

CHAPTER-1

Introduction

Jamui district located in the southern parts of Bihar state is known as a famous religious place for Jains. The 24th Tirthankar the Lord Mahabir was believed to acquire divine knowledge in Jambhiyagram which is developed in recent time as Jamui. The origin of the name Jamui also has been traced as Jambhubani, a copper plate which is kept in Patna Musuem. This plate clarifies that in the 12th century, Jambudani was nothing but today's Jamui. Thus, the two ancient names as Jambhiyagram and Jambubani prove that this district was important as a religious place for Jains and it was also a place of Gupta dynasty in the 19th century.

However, Jamui was formed as a district on 21st February, 1991 as a result of its separation from Munger. Geo-morphologically and geologically the district is characterised by undulating terrain surrounded by hill ranges with masses of forest cover and alluvial plains. The district witnesses water scare hard rock terrain as well as alluvial pain with abundant land and water resources. The varied geological set up of the district influences the land use pattern, agriculture activities and water resource development. The National Aquifer Mapping and Management Programme (NAQUIM) of Central Ground Water Board (CGWB) has been envisaged to focus on the aquifer disposition, occurrences , availability of ground water resources and quality and to formulate management plan of the aquifer system for the sustainable development.

Under the Annual Action Plan of 2019-20 of CGWB, MER, Patna, Aquifer Mapping programme and subsequent formulation of management plan were undertaken in Jamui district, Bihar. The total geographical area of the district is 3098 sq km. The present study includes the entire district comprising a mapable area of 2669 sq km. in 10 administrative blocks.

1.1 Objective

The broad objective of the study is to establish the nature and disposition of the underlying aquifer systems in horizontal and vertical domain, its resources potential in respect of quantity and quality, aquifer characterization, scope for development potential and prepare management plan for drinking and domestic sectors and for agriculture activities.

1.2 Scope of Study

The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) being implemented by CGWB. There are four major activity components viz.: (i) Data collection / compilation (ii) Data gap analysis (iii) Data generation and (VI) Preparation of aquifer maps and management plan.

Data compilation includes collection of maps, reports and information from CGWB archive and concerned agencies, such as the Survey of India, Geological Survey of India, State Govt. Departments etc. Identification of Data Gap includes ascertaining requirement for further data generation (hydro-geological, geophysical, chemical, hydrological, hydro-meteorological etc.) in addition to the existing data in respect of prevailing hydrogeological subsurface geological condition in the area. Data generation includes pre and post monsoon monitoring of aquifer wise water level from the existing network monitoring wells and other available feasible wells, incorporation of observation based on field studies, data collection through ground water exploration work in the study area, collection of water samples etc.

1.3 Approach and Methodology

An approach and methodology adopted to achieve the major objective have been shown below step-wise.

1. Compilation of existing data and reports of CGWB
2. Identification of data gaps
3. Data generation through monitoring of pre and post monsoon water level from the NHNS stations and key observation wells in different aquifers, monitoring of water quality, preparation of lithological logs, yield and aquifer parameter data through ground water exploration activities.
4. Preparation of thematic maps
5. Identification/demarcation of individual aquifer systems in the area from the available lithology, previous literature and observation from field studies etc.
6. Analysis of 5th Minor Irrigation Census Data for block wise compilation of number of STW, MDTW, DTW for assessment of existing draft for irrigation uses. Based on the available cultivable area and irrigation potential created so far, the further area to be brought under irrigation in the district from the available resources has been estimated and accordingly the management plan has been proposed. The scope for rain water harvesting for artificial recharge or conservation is reviewed and accordingly suitable structures are recommended.

1.4 Location, Extent and Accessibility of the study area

The district lies between $24^0$23'15" and $25^0$08'30" North Latitude and $85^0$49'30" and $86^0$38'00" East Longitude, and fall on Survey of India Degree Sheet No. 72/ G, H, K and L. Total geographical area of Jamui district is 3098 sq. km. The district is bordered by Giridih and Deoghar district of Jharkhand in south, its parent district Munger in north, Banka and Nowada district of Bihar lies in the east and west respectively (Fig 1).

The district head quarter is at Jamui and is well connected through road and rail network with the State capital Patna. One can easily reach by road from many major cities of India through NH-333, NH-333A and NH-114A. The distance between the district HQ and State Capital is 151 km.

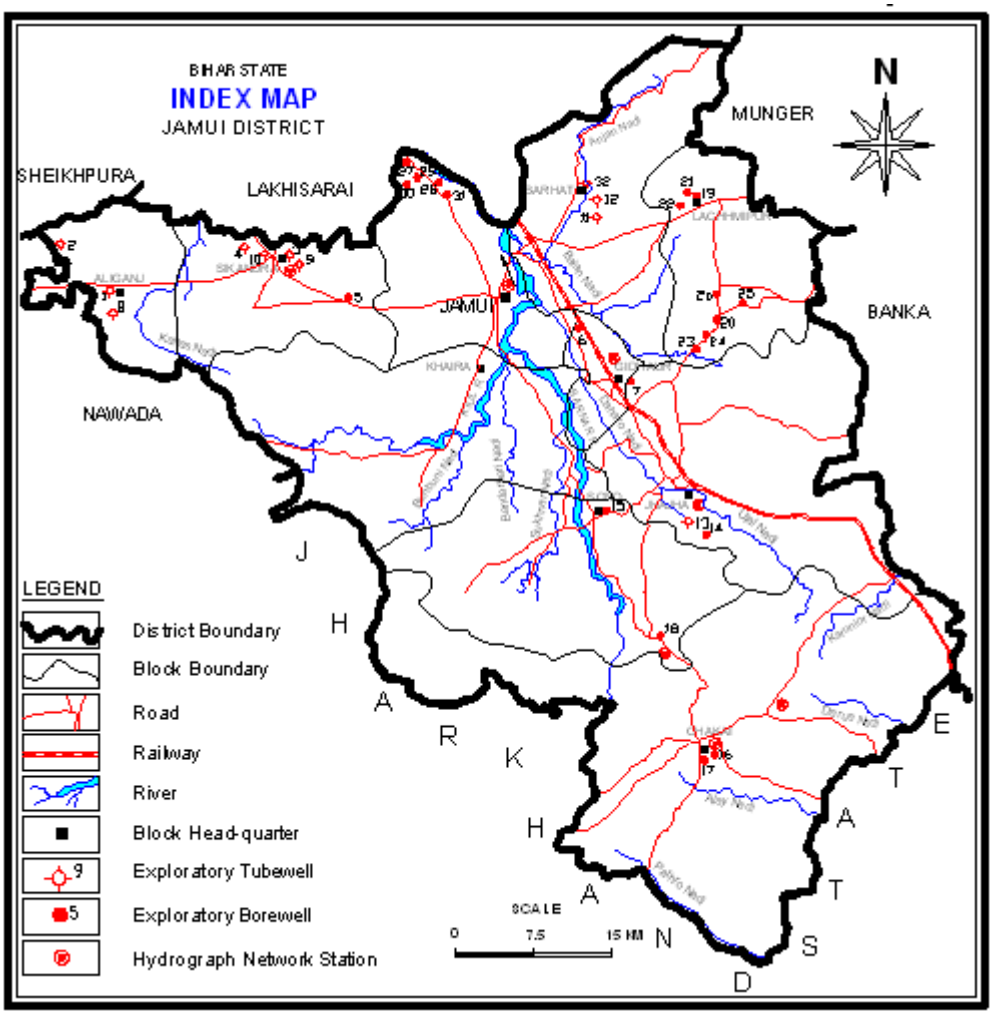


Fig. 1 Administrative map of the Study area

1.5 Administrative Divisions and Demographic Details:

Jamui district have one subdivision, two police subdivisions, 10 blocks , 10 Circles ,16 police stations. 153 Panchayats and 1528 Villages (Table 1.1, 1.2).

Table 1.1: Major Administrative Division

Divisions	Detail
Total Geographical Area	**3098 sq. km.**
No. of Subdivision	**1**
No. of Police Subdivision	**2**
No. of Nagar Parisad & Nagar Panchyat	**2**
No. of Blocks	**10**
No. of Anchal	**10**
No. of Police Station	**16**
No. of village	**1528**
No. of Panchayats	**153**

Table 1.2: Block-wise No. of Panchayats and Villages

Sub division	Block	No. of Panchayat	No. of Village
Jamui	Jamui	12	081
	Khaira	22	120
	Sikandra	14	068
	I. Aliganj	13	069
	Laxmipur	13	082
	Gidhaur	08	020
	Barahat	09	043

Sub division	Block	No. of Panchayat	No. of Village
	Sono	19	250
	Chakai	23	600
	Jhajha	20	197
	Total	**153**	**1530**

Table 1.3: Population Detail in the Study Area

Sl.No.	CD Block/Town	Area in Square Kilometer	No. of Village	Males	Females	Total
1.	Aliganj	172.86	69	70903	65865	136768
2.	Sikandra	184.01	68	76782	71929	148711
3.	Jamui	147.45	98	75254	69503	144757
4.	Barhat	232.12	43	48141	44066	92207
5.	Laxmipur	251.77	82	64688	59461	124149
6.	Jhajha	417.53	202	117663	109195	226858
7.	Gidhour	71.13	20	40720	36838	77558
8.	Khaira	418.74	96	123188	112573	235761
9.	Sono	392.27	250	108515	101930	210445
10.	Chakai	774.05	600	122790	112398	235186
11.	Jamui(NP)	26.45	–	46014	41343	87357
12.	Jhajha(NP)	9.87	–	21406	19240	40646

As per 2011 Census the total population of the district is 1760403 out of which male population is 916064 and female population is 844341. The decadal growth rate (2011) of population over last decade is 25.54%. The population density of the district is 567 person/ km^2. 3050.04 sq km constitutes rural area and 36.32 sq km is urban. Among the total population of 1760403, 7.25% is the urban population and is restricted in two Nagar Parisad, Jamui and Jhanjha and more than 92% comprises rural population (Table 1.3).

1.6 Land use, Agriculture, Iirrigation and Cropping pattern

The geographical, topographical, hydro-geomorphological, socio-economic and cultural features of the district determine the suitability of its land for utilisation. Similarly factors influencing land use pattern are variable as well. The nature of the underlying soils, rainfall pattern, human factors, classes of worker etc to some extent influence the land use pattern in the area. Considerable parts (30%) of the district are under forest cover. Total cropped area is 77500 ha which constitutes 25% of the total geographical area. Besides, barren land and fallow land constitutes a major part. Therefore, the scope of agriculture activities in the district is moderate (Table1.4, fig.2, 3).

Table 1.4-: Details of Land-use pattern in the district

Forest Area			**1**	92855
Land put to non agriculture use	Water	Land area	**2**	39318
		Perennial	**3**	2188
		Temporary	**4**	2845
		Total (2, 3, & 4)	**5**	44*346*
Barren area			**6**	13500
Permanent Pastures & Grazing Land			**7**	166*0*
Land under Misc. Tree crops & Groves not included in net area sown			**8**	2*105*
Culturable Waste Land			**9**	10*305*
Fallow Land		Other Fallow Land	**10**	161*00*
		Current Fallow Land	**11**	6*5300*
		Total	**12**	*.81400*
Total Non-Agricultural Land			**13**	26*1238*
Total Cropped Area			**15**	77500

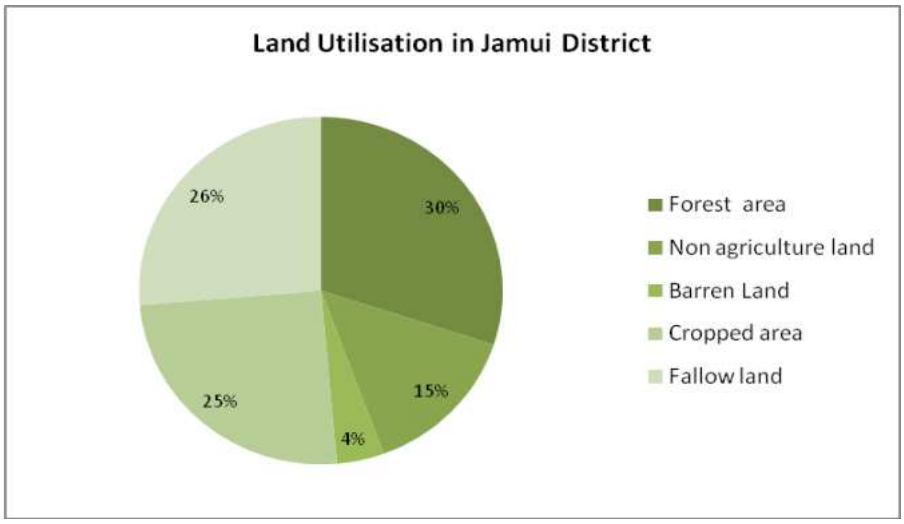


Fig.2 Land Utilization in Jamui District

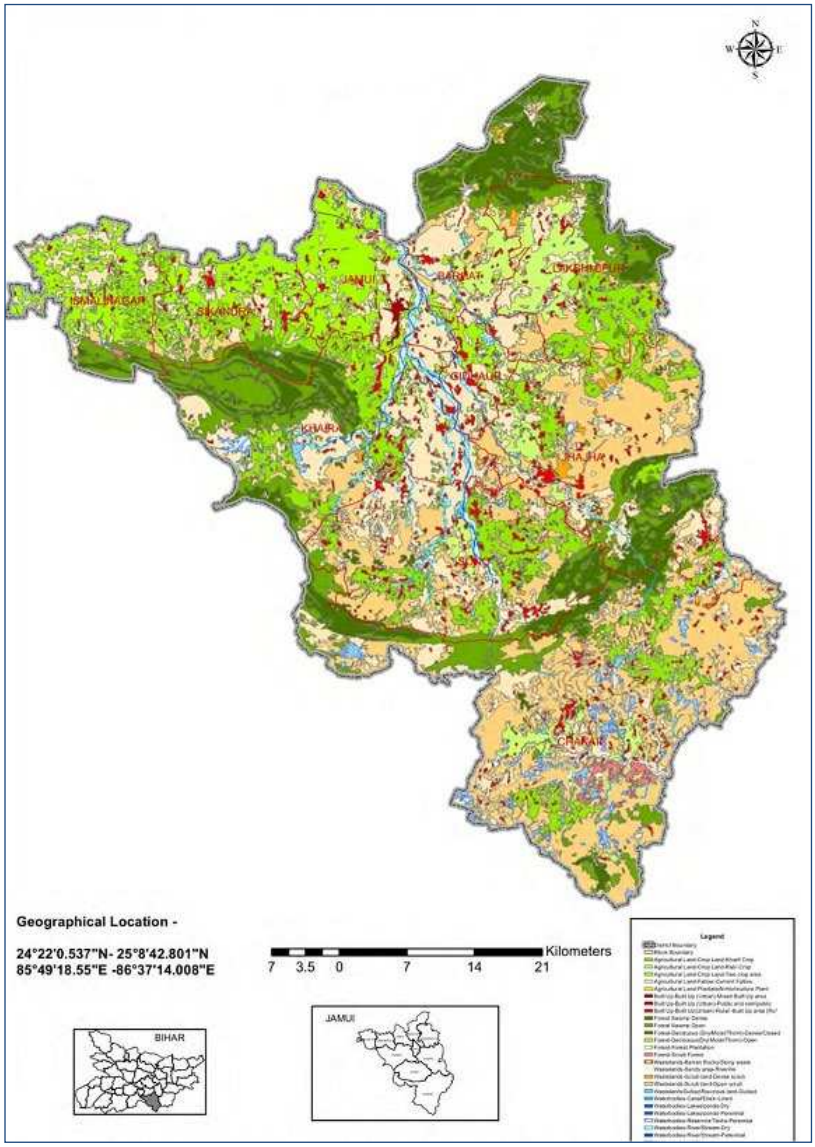


Fig.3 Area under coverage of major land utilization in the district
(source: District Irrigation Plan, Jamui, 2016-20)

Agriculture and Irrigation

Even though, the economy of the district is agrarian in nature,agricultural activities to much extent depends on rain water and kharif cultivation contributes major share of agriculture activities than rabi and summer crops. It indicates the unsuitability of the major area for varied crops throughout the year and also poor irrigation network in the district. It results in low cropping intensity of 125-160 % in the district (Table1.4.,Fig.4).

The cropped area or the cultivable area in the district is 77511 ha which constitute 25% of total geographical area. Out of the total cropped area in the district, 66.7 per cent area (71,099 ha) is covered by cereals crop during Kharif season, 17.3 percent (18,410 ha) during Rabi season and nil during summer season. Coarse cereals occupy a total of 50 ha of land during Kharif season. Therefore, 89500 ha area; 85% of gross cropped area in the district is covered under cereal crops only. In case of pulses, it occupies 7.7 percent (8205 ha) of the gross cropped area of the district. During Kharif season, 0.9 percent of the cropped area of the district is covered by pulses while the same during Rabi and Summer are 3.5 percent and 3.3 percent respectively. 7246 ha area are under pulses during rabi and summer season and mainly depends on irrigation. The area under oilseed is limited to the tune of 0.8 percent (863 ha) of the cropped area of the district. Most of the oilseeds are cultivated during Rabi season. No fibre crops are grown in the district. Horticulture and Plantation, which entirely depends on irrigation,occupies 7.4 percent (7880 ha) of the cropped area. Therefore, it is observed that cereals, pulses, oilseed, horticulture and plantation etc which are grown during Rabi or summer season depends largely on irrigation. Maximum cropping intensity around 160% is reported in Jamui block, followed by Sikandara. Lowest, around 100% is at Chakai block.

Cropped area/cultivable area in the district 77511 ha
Net cropped area 72103 ha
Gross Cropped Area: 103334 ha
Average Cropping Intensity: 143%

Table1.4.Block wise Cultivable/ Net cropped area/ Cropping Intensity (CI) area in Jamui District

Blocks	Cultivable Area (ha)	Net Cropped Area (ha)	Gross Cropped Area (ha)	Cropping Intensity (%)
Sono	8712	8104	11799	146
Sikandra	6988	6500	10269	158
Laxmipur	7340	6828	9740	143
Khaira	9451	8791	13063	149
Jhanjha	7876	7327	10935	149
Jamui	9240	8595	14200	165
Aliganj	4902	4560	6663	146
Gidhaur	6578	6119	8397	137
Chakai	10360	9637	10388	108
Barhat	6065	5642	7880	140
Total	**77511**	**72103**	**103334**	**143**

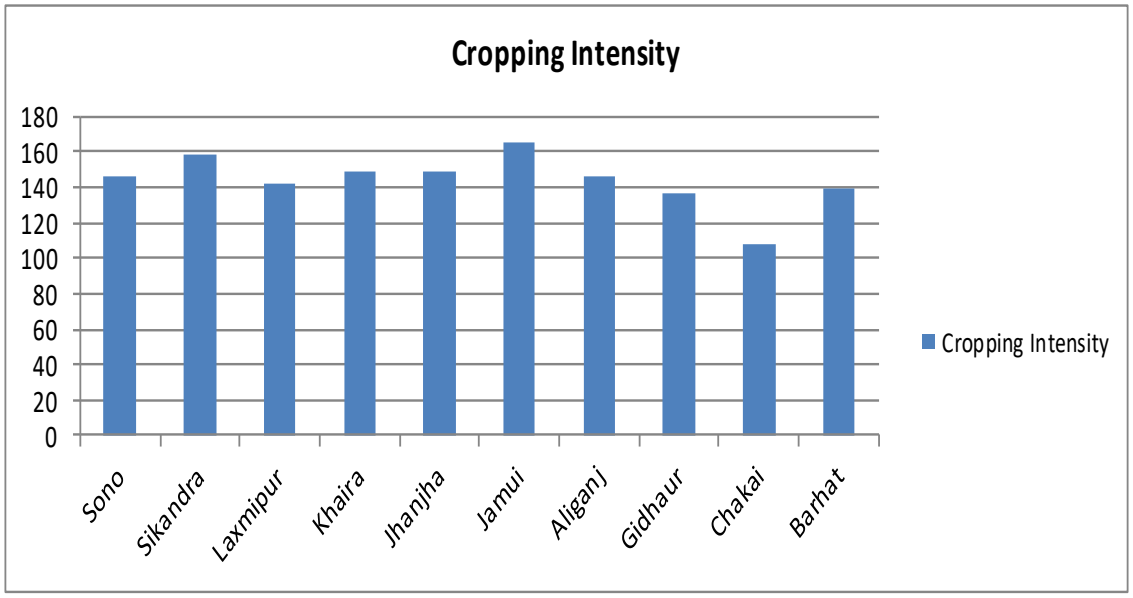


Fig4. Block wise cropping intensity in Jamui District

40-45 % of the cultivable area is brought under irrigation through canals, tanks, open wells tube wells etc. However, surface irrigation network is negligible and only 3% of the total irrigated area. Irrigation through ground water contributes major share, about 80% of the total irrigated area is covered under ground water irrigation. Ground water irrigation is accomplished by shallow, medium and deep tube wells (Table1.5).

Table.1.5 Sources of Irrigation in the district

Sources of irrigation	No	Area ('000 ha)	% of total Irrigated area
Canals	18	0.900	2.36
Tanks	19	0.200	0.52
Open Well		2.880	7.58
Tube wells and bore wells		26.880	70.74
Lift Irrigation			
Micro Irrigation			
Others		12.00	31.58

Source : Agriculture Contingency Plan for District: JAMUI

Table 1.6 Block level statistics number of Shallow tube wells and Depth (as per 5th MI census)

District	Block/Tehsil	No. by the depth of Shallow Tubewells - 0 to 20 mts	No. by the depth of Shallow Tubewells - 20 to 35 mts	Total
Jamui	Aliganj	274	167	441
	Barhat	38	20	58
	Chakai	40	16	56
	Gidhaur	161	296	457
	Jamui	7	142	149
	Jhajha	49	154	203
	Khaira	19	199	218
	Laxmipur	3	3	6
	Sikandara	12	263	275
	Sono	13	46	59
Total		**616**	**1306**	**1922**

As per the report of 5th MI census total number of Shallow tube wells in the district is 1922.

The depth of these tube wells are with 0-35 m depth. Majority of these wells lie in Aliganj, Gidhaur, Sikandara, Khaira block of the district. Jhanjha and Jamui sadar block contain moderate number of STW, whereas number is negligible in other blocks (Table1.6, Fig.5).

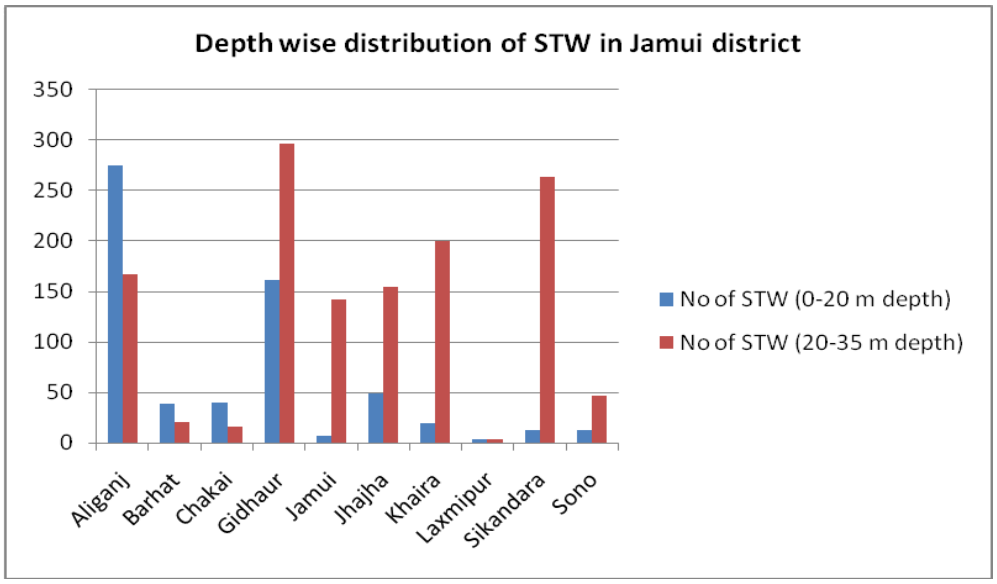


Fig.5 Distribution of STW in Jamui District

Table 1.7 Block level statistics of number of Medium tube wells and depth (as per 5th MI census)

District	Block/Tehsil	No. by the depth of MDTW - 35 to 40 mts	No. by the depth of MDTW - 40 to 60 mts	No. by the depth of MDTW - 60 to 70 mts	Total
Jamui	Aliganj	15	35	11	61
	Barhat		16	2	18
	Chakai	3	29	0	32
	Gidhaur	3	1	107	111
	Jamui	91	771	60	922
	Jhajha	5	46	11	62
	Khaira	8	449	7	464
	Laxmipur		19	1	20
	Sikandara	18	286	10	314
	Sono		50	5	55
Total		**143**	**1702**	**214**	**2059**

As per the report of 5th MI census total number of Medium duty tube wells in the district is

2059. Depth of these tube wells are within 35-70 m depth. Majority of these wells lie in Jamui, Khaira and Sikandara blocks of the district. Number of MDTW in other blocks is limited (Table 1.7. Fig.6)

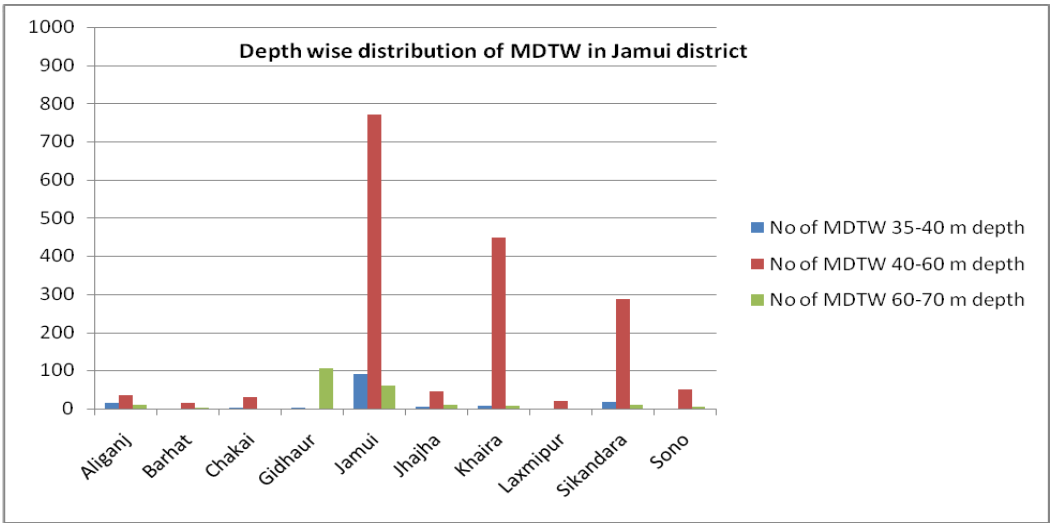


Fig.6 Distribution of MDTW in Jamui District

Table1.8 Block level statistics of number of Deep tube wells in the district (as per 5th MI census)

District	Block/Tehsil	No. by the depth of DTW - 70 to 110 mts	No. by the depth of DTW - 110-150 mts	No. by the depth of DTW >150 m	Total
Jamui	Aliganj			5	5
	Barhat				0
	Chakai				0
	Gidhaur				0
	Jamui	12			12
	Jhajha				0
	Khaira	4	1	1	6
	Laxmipur				0
	Sikandara		2	1	3
	Sono		1	3	4
Total		**16**	**4**	**5**	**25**

As per the report of 5th MI census total number of Deep duty tube wells in the district is 25. Depth of these tube wells are more than 70 m to 150 m depth. There are very limited scope of deep tube well irrigation in the district. Barhat, Laxmipur Chakai blocks etc are not at all suitable for irrigation through DTW (Table 1.8, Fig.7)

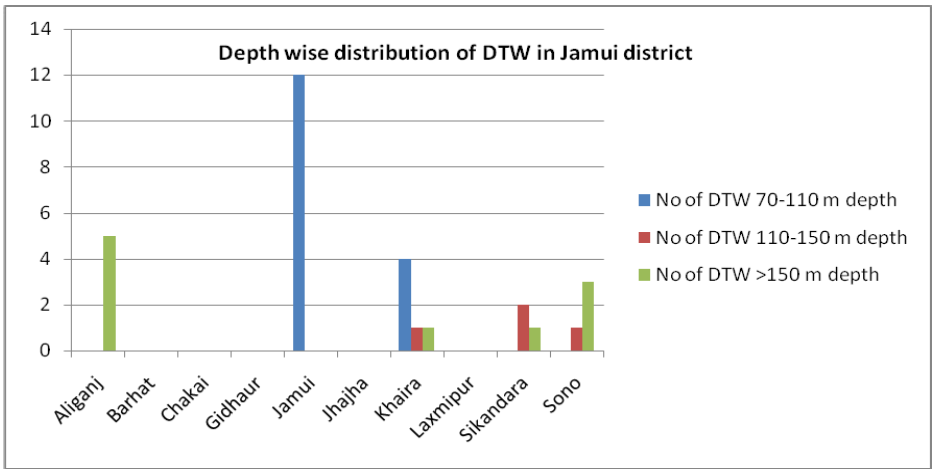


Fig.7 Distribution of DTW in Jamui District

Crops grown and cropping pattern:

Agriculture is one of the principal sources of livelihoods of the people in the area. However, in absence of adequate irrigation network sin the district, the rain fed irrigation is the principal component. There are three major crop season which is followed in the district. The kharif season, rabi and summer crops. Kharif is mostly rain fed whereas the other two are mainly dependent on irrigation. The crops grown are grouped under cereal crops of paddy, wheat, maize etc., pulses, oilseeds, and other miscellaneous crops of horticulture, plantation etc. Among the cereals, the paddy during kharif and wheat during rabi are two principal crops in the district. Besides rice, wheat, maize the other major crops includes potato which constitutes about 3500 ha. Less production of pulses, oilseeds is a concern for future in the district. Therefore, diversification of cropping pattern is needed in the district. Gross area under cereals is 89239 ha, which constitute more than 80% of cropped area, pulses constitute 8205 ha (<10% of cropped area), oil seeds only 873 ha (Fig.8). 36% of cereals crops and 62% of pulses production in the district depends on irrigation. Total irrigated area in the district is 45880 ha whereas rainfed irrigation is 60317 ha (Table 1.9)

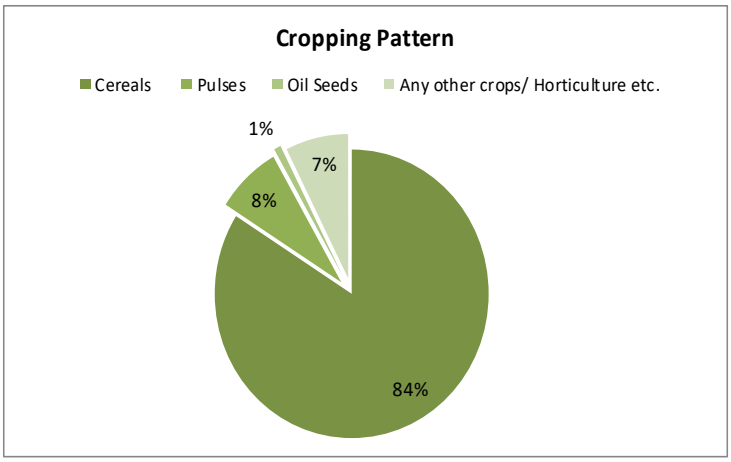


Fig.8 Cropping Pattern

Table.1.9. Area (in ha) under different crops and Irrigation coverage in Jamui district

Block	Cereals		Gross Area under Cereals	Pulses		Gross Area under Pulses	Oil Seeds		Gross Area under Oil seeds	Any other crops/ Horticulture etc.		Total Irrigated Area under different crops	Total Rain fed Area under different crops
	Irrigated	Rain feds		Irrigated	Rain feds		Irrigated	Rain feds		Irrigated	Rain feds	Irrigated	Rain feds
Aliganj	2545	3017	5562	299	334	633	25	15	40	440		3309	3366
Barhat	2166	4776	6942	268	244	512	35	30	65	360		2829	5050
Chakai	2283	9256	11539	812	445	1257	160	0	160	470		3725	9701
Gidhaur	2107	5343	7450	277	210	487	70	0	70	420		2874	5553
Jamui	5815	6270	12085	713	210	923	102	0	102	1160		7790	6480
Jhajha	1527	7230	8757	661	285	946	60	27	87	1140		3388	7542
Khaira	4309	6391	10700	511	538	1049	50	50	100	1220		6090	6979
Laxmipur	1768	6206	7974	499	123	622	20	19	39	1100		3387	6348
Sikandara	6370	2360	8730	524	230	754	40	70	110	410		7344	2660
Sono	3359	6141	9500	565	457	1022	60	40	100	1160		5144	6638
Total	32249	56990	**89239**	5129	3076	**8205**	622	251	**873**	**7880**	0	**45880**	**60317**

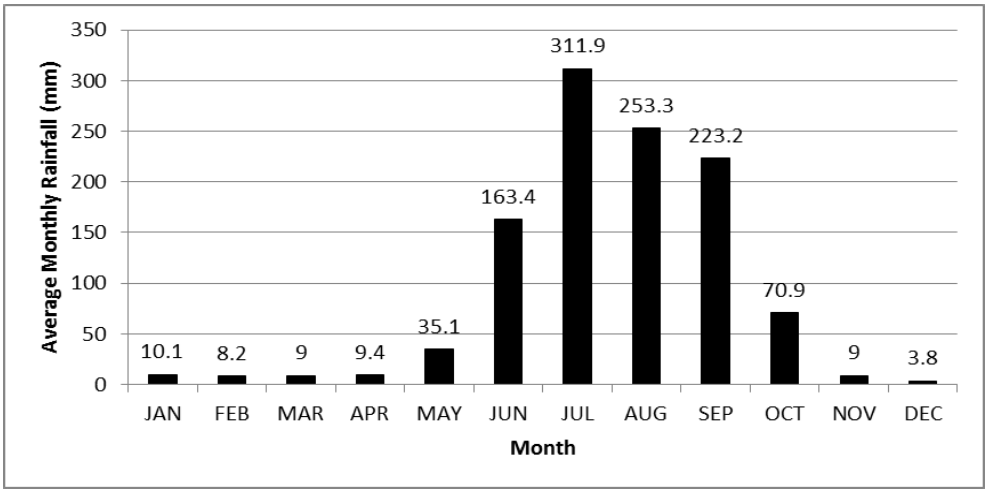
Source: (District Irrigation Plan, Jamui,2016-20)

1.7 Urban areas, industries and mining activities

Urban areas in the study area include 2 Nagar Parisad Jamui and Jhanjha. Sand is one of the major mineral of Jamui district of Bihar. Yellow sand in Kiul river is major source of revenue collection in district as well as soil / clay is actively mined for bricks and pottery industry. The hills of Laxmipur and Khaira are comprised of archaen schists rich in iron rich minerals. Basement rocks of gneissic composition are found in Laxmipur, Sono and Chakai. Mica mines lie in the portion of adjoining Hazaribag district. Beside these there is possibility of availability of lime stone, China clay, Magnese, Graphic Pegmite Termoline quartz etc. in the southern hills of the district. Hilly areas of Jamui are also acquainted with valuable stone like Marble, Topaz, and American diamond, Sfatik, Manic etc. Coals of limited potential are found in hilly area of Barhat block.

1.8 Climate and Rainfall

The average annual rainfall of district is 1107.3 mm. About 80% of the rainfall is received during June to September by south-west monsoon. The climate of Jamui district represents a transition between dry and extreme climates of the northern India and warm and humid of West Bengal. In the summer season the diurnal temperature rises up to 42^0C, while in winter season it drops to as low as 2^0C. Average monthly rainfall in Jamui district and the block wise distribution of total annual rainfall is given in Fig.9 a and b.



(*http://data.gov.in)*

Fig.9a Average Monthly Rainfall in Jamui district, Bihar.

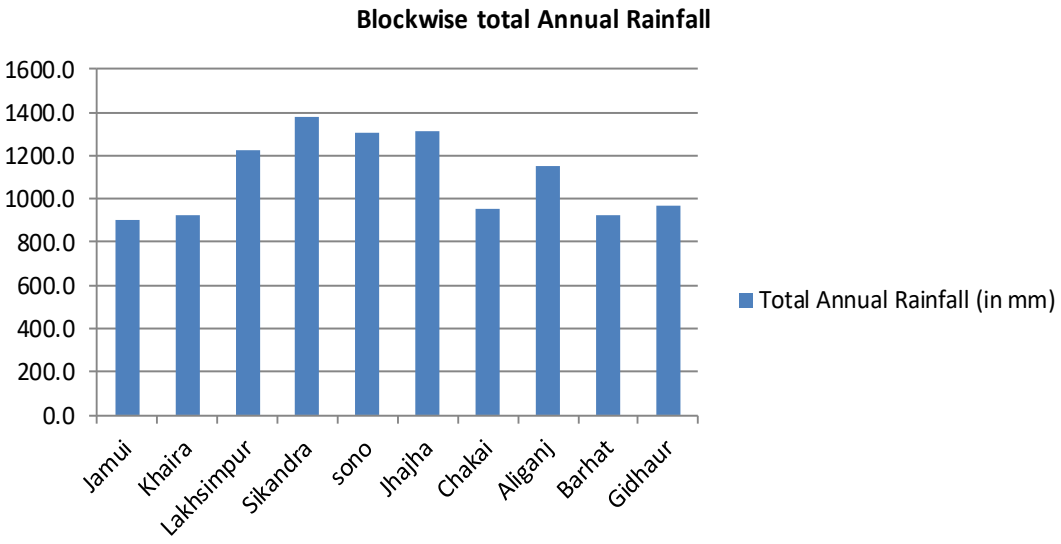


Fig.9b Block wise Rainfall Distribution

1.9 Geomorphology

The State can be broadly subdivided into three major unit's i.e., Northern Mountains, the Gangetic Plains and the Central Highlands. Northern Mountains comprises the Himalayan ranges including their foot hills. The Gangetic plains, situated between the Himalayas and the Deccan plateau, constitute the most fertile plains of the sub-basin ideally suited for intensive cultivation. The central highlands lying to the south of the Gangetic plains consist of mountains, hills and plateaus intersected by valleys and river plains. They are largely covered by forests. Jamui district is mostly characterised by third physical sub-division, i.e., central highlands with Gangetic alluvial plains in northern, north western and north central parts of the district. A sizeable part of the plain in the northern side of the district lies in the Basin of Kiul River and its tributaries. Predominant soil types found in the sub- basin are sandy, loamy, clay and their combinations such as sandy loam, loam, silty clay loam and loamy sand soils.

The district has a diverse geomorphology ranging from hills to flood plains. The major geomorphic units are rocky upland, plateau / pedi-plain and alluvial plain. There are three major hilly tracts, namely, a) the hills of Batia-Jhajha area having strike in east-west direction lying in the northern fringe of Chakai plateau, b) the Gidheshwar hills in the western part of the district and c) the Kharagpur hills lying in north-eastern part of the district with an altitude of 475 m amsl in Barhat block. Hills of the district are considered to be the out –laying extension of Vindhyan ranges. These are moderately dissected structural hills or moderately dissected denudational hills.

Plateau representing oldest table land in the area is Chakai plateau. The pediment pediplain complex with rolling topography has relief up to 300-340 m amsl is the dominant geomorphic landform in the distric. It extends from Batia to the south of Kharagpur hills and comprises residual soil overlain by mixture of sheet wash deposits. Alluvial plain is represented by Jamui terrace in the northern parts of the district. Active flood pain are along the river courses and characterised by younger sediments. It is made up of sediments derived from the denudation of Chakai plateau and Kharagpur hill. The thickness of alluvium in the northern part is about 80 m, while in southern part it reduces to 10 m. Other landforms such as escarpment, in-selberg, valley fills are also present (Fig.10)

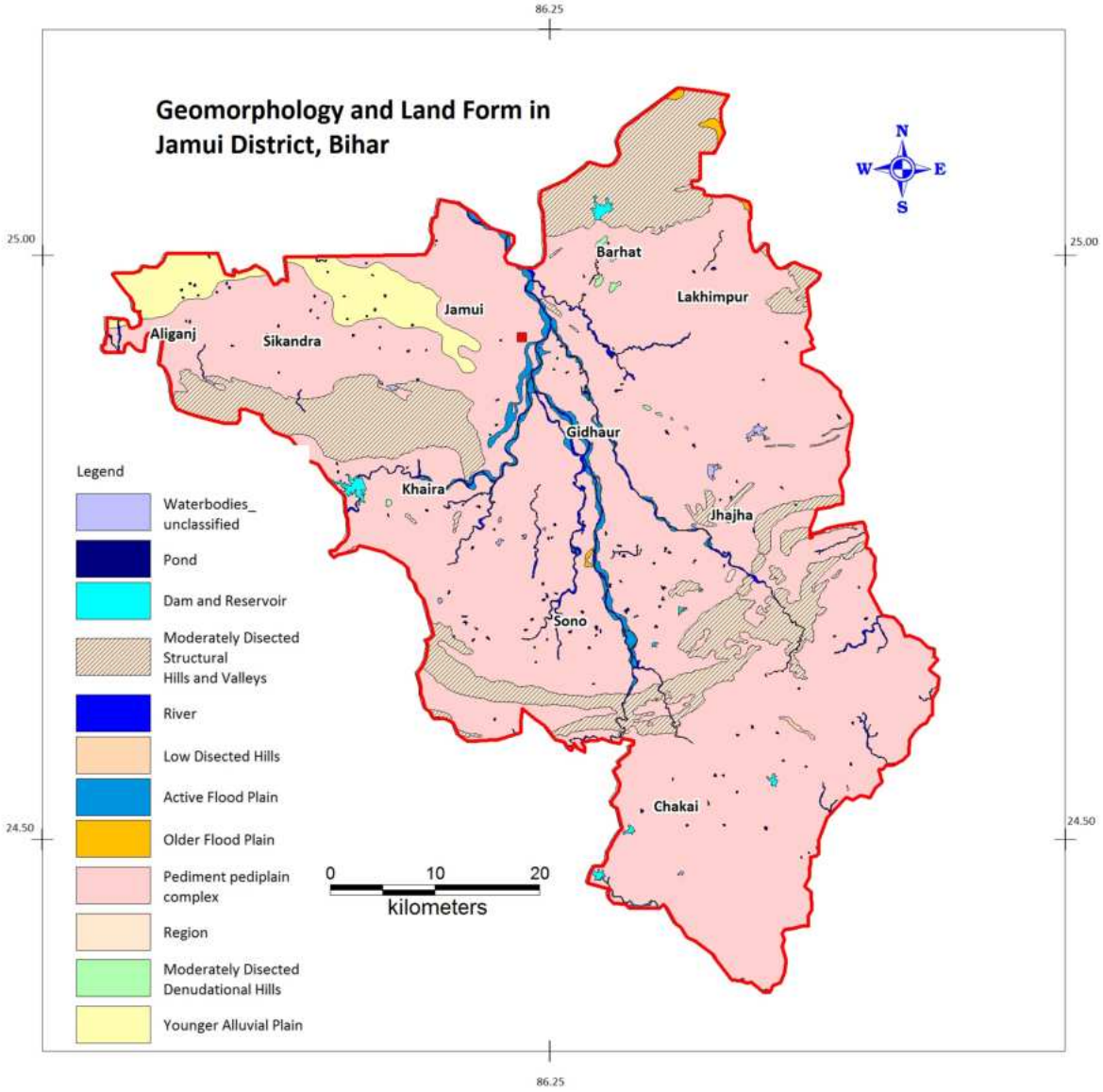


Fig.10 Geomorphic Landform in Jamui District

General slope in the area is from south east to North West towards Jamui terrace. However, intermittent sporadic uplands/hill ranges are found in the western part (Khaira Hill Ranges) and in the north eastern parts in the district as the south ward extension of Khragpur hills. Relief map of the area has been prepared from SRTM data, the elevation varies from maximum of 340 mamsl to 60 mamsl (Fig.11)

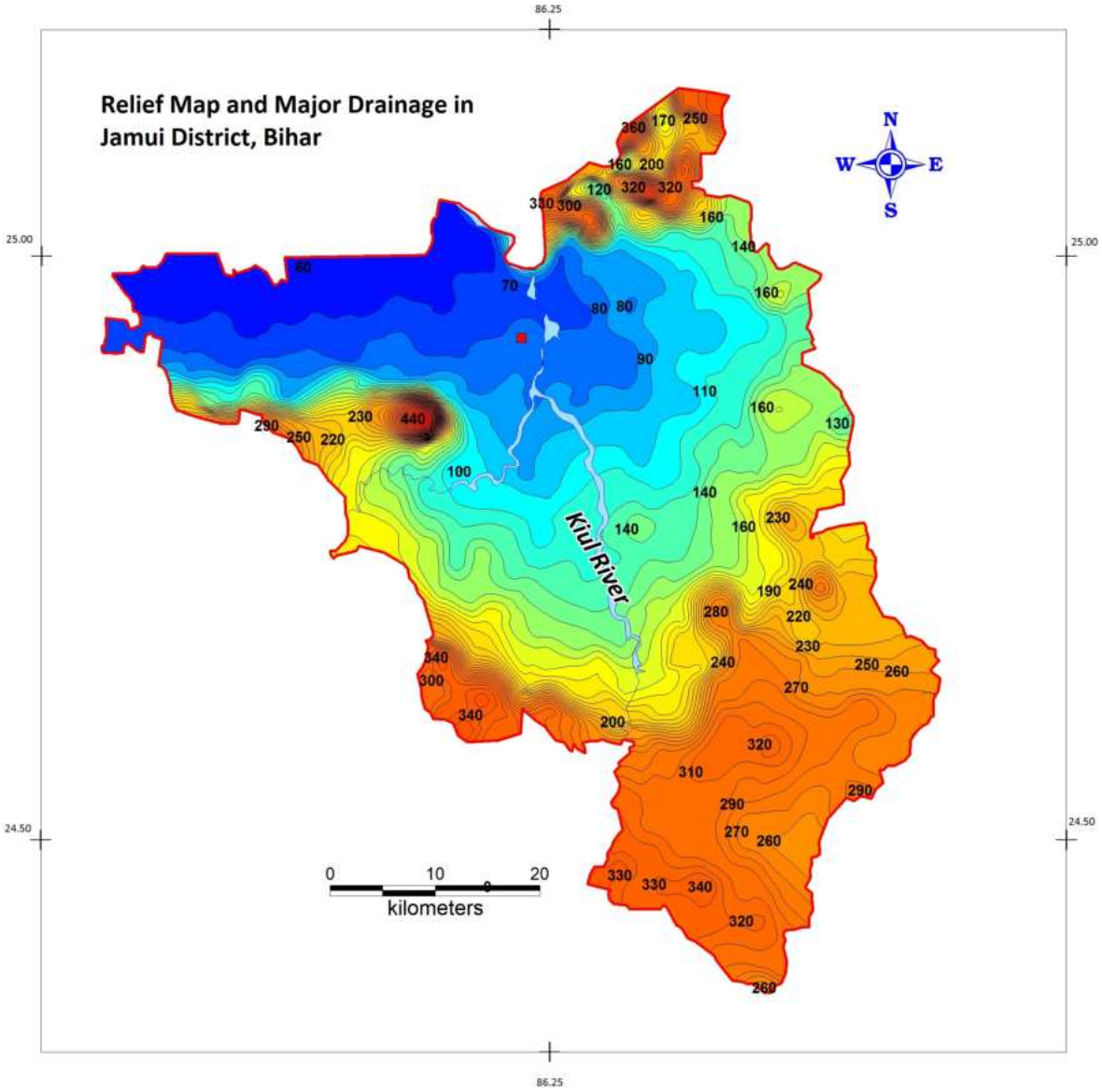


Fig.11 Relief Map of Jamui District

Slope map of the area has been prepared under Arcgis platform using spatial analyst tool (Fig.12). It is understood that, in major parts of the district the slope is 0-3% or 3-5%. However, along the foothill area surrounding the highlands and along the river valley 5-10% slope is witnessed. More than 15% slope is recorded in the hilly tracts and in highlands.

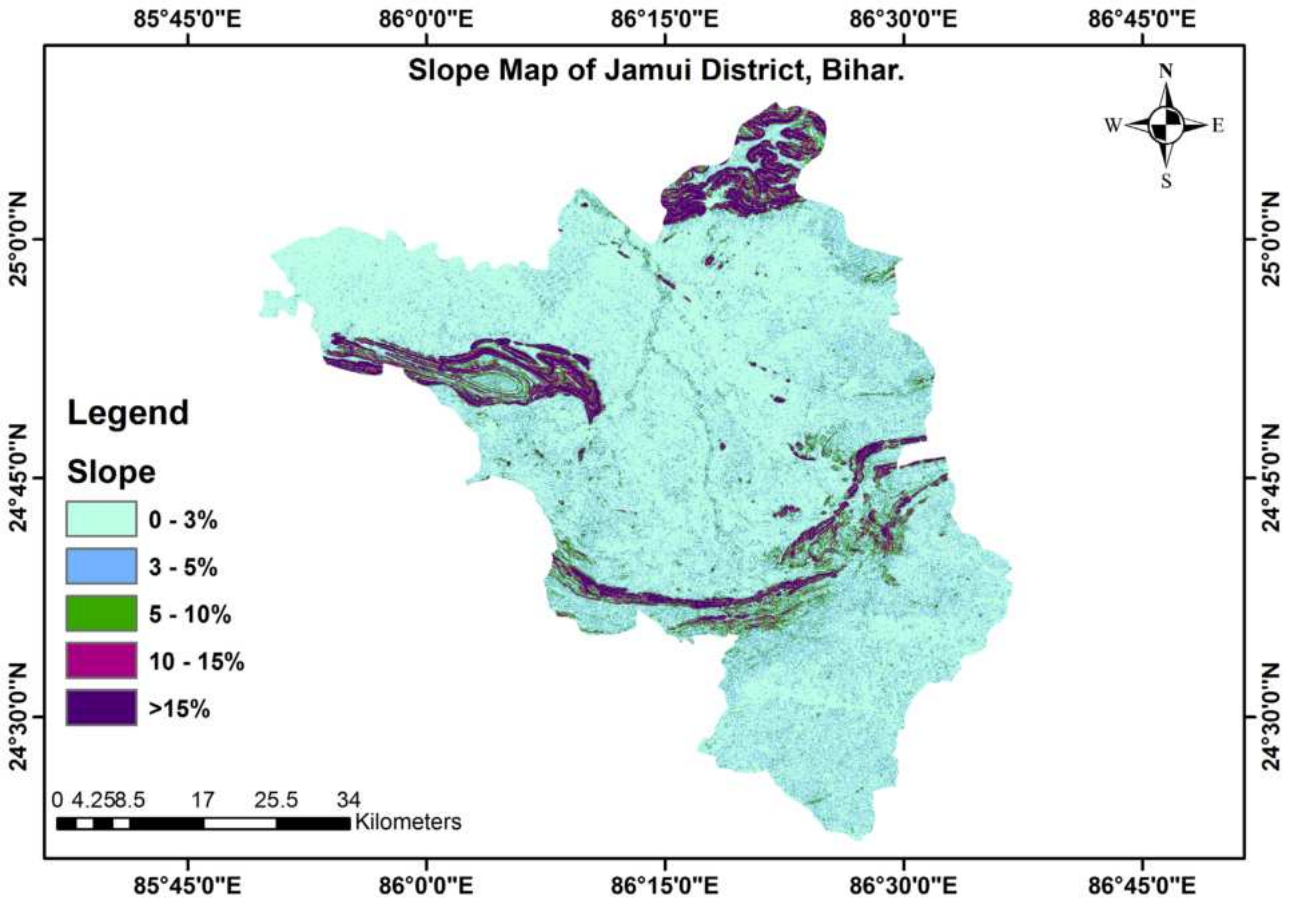


Fig.12 Slope Map of Jamui district

1.10 Drainage and wetlands

Jamui district forms a part of Phalgu-Kiul sub-basin of Ganga Basin (fig13). Catchments of Kiul, Barnar and Ulai rivers form a major part of the district. The principal drainage, the Kiul River originates from northern parts of Chakai plateau flows towards north along the valley towards lowers land of Jamui terrace. Ajay, Pathro and Darua rivers flow towards east, while Kiul, Barnar, Ulal, Nakti and Nagi rivers flow towards north. Rivers are generally ephemeral in nature except the Kiul river, which has meager discharge during lean periods. Kiul river also carries a huge amount of sand which is the main source of building material in the region. Total area of

drainage system with main rivers is 52.18 sq.km. Total length of flow major three rivers Kiul, Barnar and Ulai is 64 km, 52 km and 50 km respectively through Jamui district.

Table 1.10. Major Drainage in the District

Sl. No.	Name of the River	Area drained (Sq. Km)	% Area drained in the District
1.	Agra	0.18	0.0058
2.	Ajay	1.93	0.0622
3.	Anjan	0.24	0.0077
4.	Arghuti	0.35	0.0112
5.	Badua	0.86	0.0277
6.	Bahuar	0.61	0.0196
7.	Balan	0.92	0.0296
8.	Bandarbari	0.81	0.0261
9.	Barnar	3.6	0.4389
10.	Bunbuni	1.04	0.0335
11.	Chilka	0.45	0.0145
12.	Churiya	0.22	0.0071
13.	Darhwa	0.15	0.0048
14.	Gadi	0.40	0.0129
15.	Jalua	0.13	0.0041
16.	Kiul	18.40	0.5939
17.	Nagi	0.80	0.0258
18.	Nakti	2.36	0.0761
19.	Nata	0.36	0.0116
20.	Singarjhor	0.25	0.0080
21.	Sukhnar	2.0	0.0645
22.	Ulai	6.12	0.1975

The total wetland area in the district is 7351 ha, which includes the area contributed by 328 small wetlands (< 2.25 ha) which comprises about 2 per cent of the geographical area of the district. Rivers /streams comprise about 64 per cent of wetland extent of the district that accounts for 4684 ha. The other major wetland types are reservoirs/barrages (1780 ha), tanks/ponds (347 ha) and natural waterlogged (182 ha).

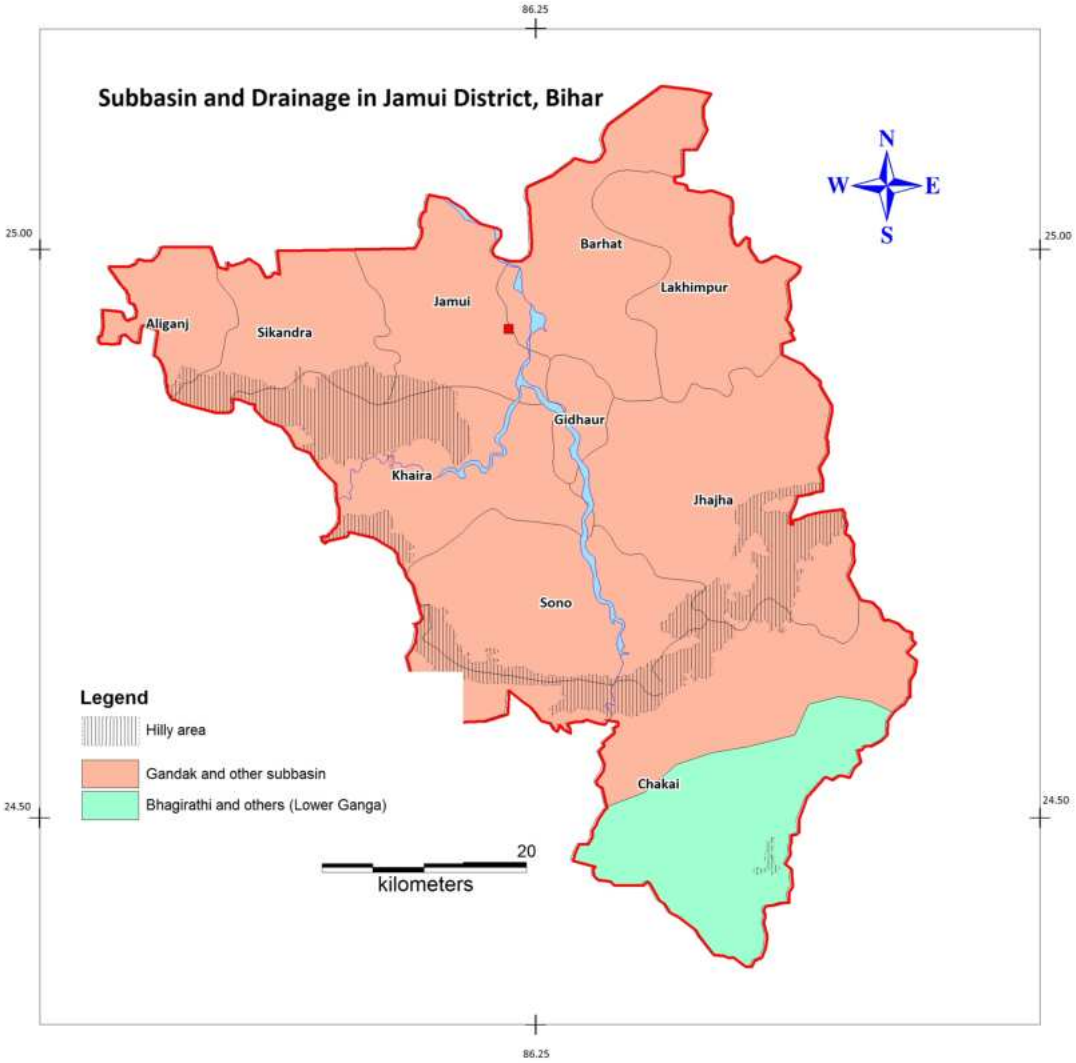


Fig.13 Sub-basin Boundary of Gandak and Lower Ganga

The dominant drainage pattern is dendritic and radial in the hilly and plateau regions, while in the plains it is parallel to sub-parallel. There are linear drainage divide along the outer fringe at the northern extremity of Chakai plateau. The Gidheswar hill ranges in the north western part of the district also serve as a major drainage divide. The detail drainage map has been prepared under Arcgis platform from DEM data using spatial

analyst tool and assigning flow accumulation, flow direction and stream ordering (fig.14). The major streams and rivers are conforming to higher order i.e; 4^{th} or 5^{th} order streams. The lineament patterns are often found to coincide with stream lines of different orders.

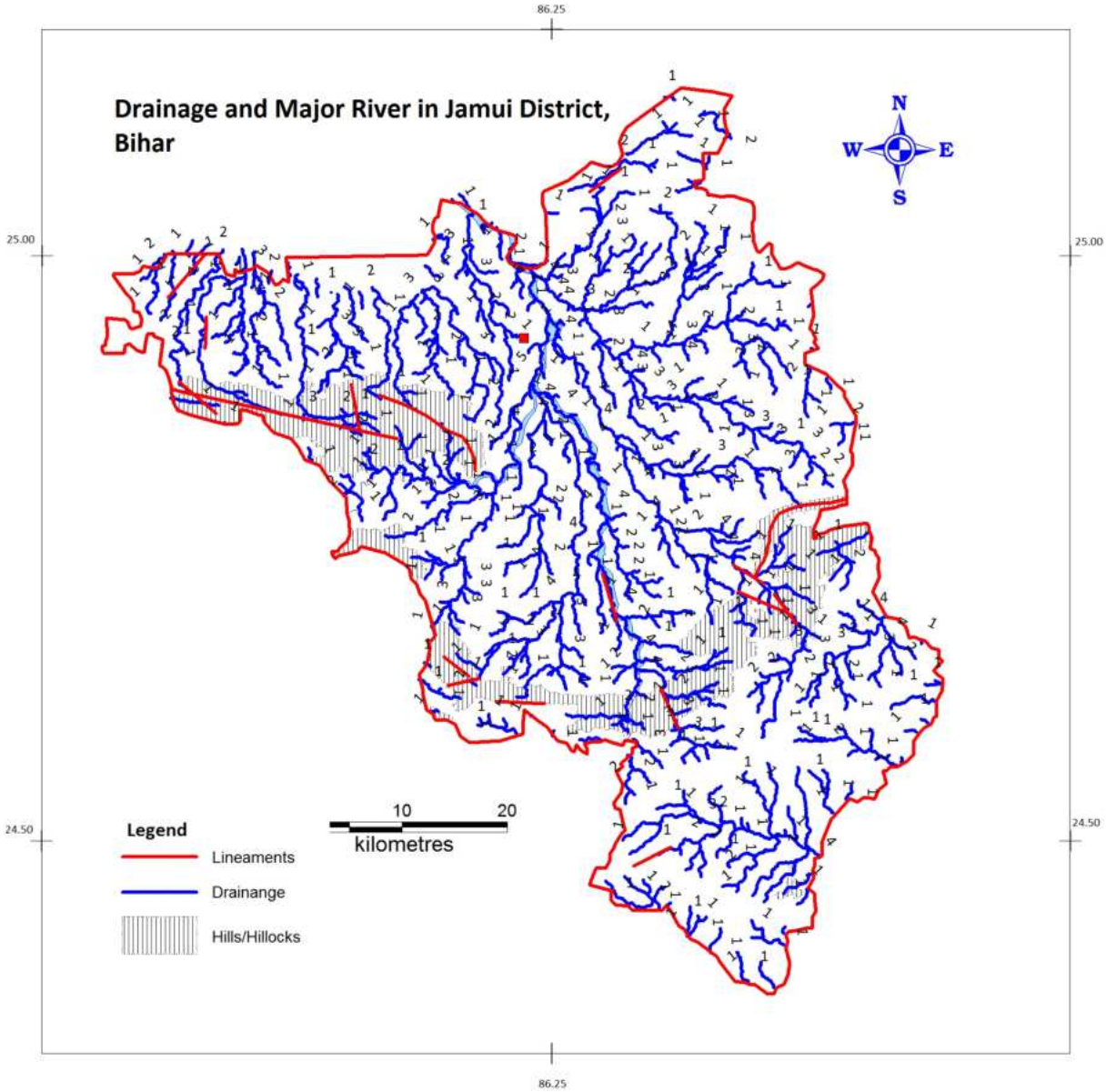


Fig.14 Detail Drainage and lineaments in Jamui district

1.11 Soil Characteristics

The district consists mainly of alfisols and ultisols types of soils formed under different lithological and pedogenic conditions. The alfisols are developed mainly on the marginal alluvial area in the northern fringe of hard rock terrain. It occurs mainly in Jamui, Sikandra and Aliganj blocks. The soil in these blocks are called alluvial soil composed of clay, sand and gravel. The lower horizon is highly ferrugenized. A variant of alfisols soil is red sandy soil occurring mainly in plateau and hilly regions. These soils have poor fertility and are suitable for high land crops. The ultisols occur mainly in Sono and Lakhimpur blocks. It contains argillic horizons and has low base status. Red and yellow soils occur in southern and eastern parts of Jamui town, while light brown to red yellow soil occur in the south of Jamui town in small patches (fig.15).

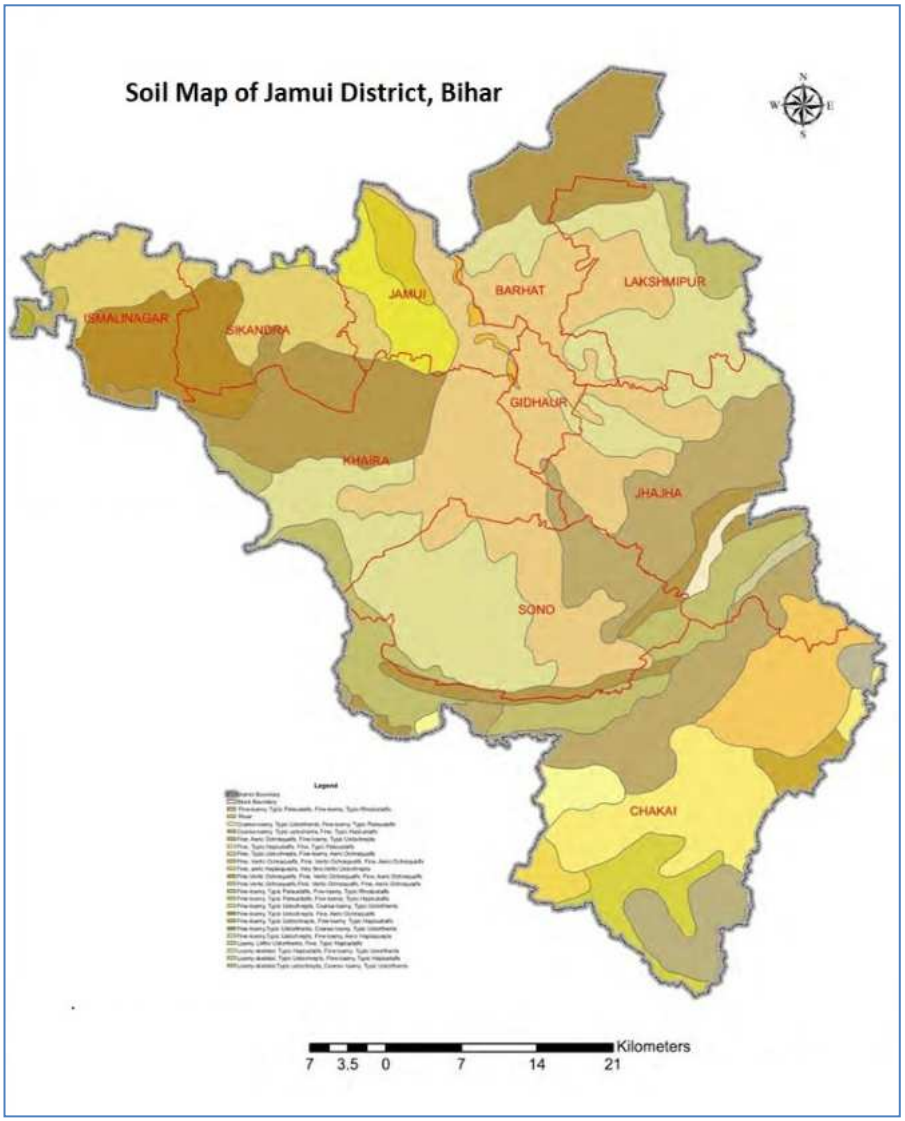


Fig.15 Soil map of Jamui district *(source DIP, Jamui)*

1.12 General Geology

Regional Geology of the area:

Regional Geological Succession

Age	Geology	Occurrences
Quaternary	Alluvial Deposits(sand, clay, silt, rock fragments)	North Bihar Plain & Central Bihar Plain
Tertiary	Sand Stones& Clay Stones	North Champaran Hills
Gondwana	Coal Measures, Forming a series of small outlier basins	Banka District
Vindhyans.	Sandstones,shales,Limestones etc	Parts of Bahbhua and Rohtas Disricts
Satpura	Schist, Phyllite, Quartzite	Part of Aurangabad, Gaya, Nawada,Nalanda,Sheikhpura and Munger District
Proterozoic	Schist,amphibolites,quartzite, granites, dolerites and pegmatites	Nawada, Jamui and Banka
Archaean	Gneisses, Granites, Schists, Phyllites,quartzites,amphibolites & intrusive all metamorphosed sedimentary and igneous rocks	Part of Aurangabad ,Gaya, Nawada ,Jamui, Banka and Bhagalpur

Local Geology

Sporadic occurrence of dolerite, quartz pegmatites veins and quartzites are also found. The domain of Quaternary sediment is represented by Jamui Formation lie in the north central and western parts of the district. Thin deposits of alluvium are found along the course of rivers. The river sand exposed in the river beds of Kiul, Ganga and surrounding areas is the product of the deposition of the sediments brought and deposited in the flood plains of rivers, these alluvium deposits are of Quaternary age.

A comprehensive local stratigraphic sequence of the district can be simplified in the following form for better understanding of the hydrogeology of the area:

Jamui Formation- Upper to Middle Pliestocene

Quatzite, Quartz schist

Phyllite, Mica schist Precambrian

Intrusive of granite and pegmatite

Chotonagpur gneisses and schist

Three lithonits are dominantly encountered in the district:

I. Quaternary Group of sediments
II. Kharagpur Group of rocks
III. Chotanagpur Group of rocks

Quaternary Group of sediments are represented by Jamui Formation which constitute the oldest continental Quaternary deposits in the area and is commonly known as Older alluvium. The district town Jamui and other important towns like Sikandra, Jhanjha and Aliganj is located on older alluvium deposits. The alluvial fills of this sedimentary sequence comprises alternation of medium to coarse sands, clay and gravels at the bottom of the sequence. The thickness of the formation varies between 30-80 m at places.

Kharagpur Group of rock is consist of quartzite, phyllites, schist, quartz veins and laterite. The quartzites mainly constitute the dominant ridges. Phllite and schist, often foliated are associated with quartzite in Kharagpur hills. Quatz veins are found to intrude along the joints of all the rock types . Laterites are found as cap rocks.

Chotanagpur group of rock consist of Chotanagpur gneisses, intrusive granite and the pegmatites. The Chotanagpur gneisses is the dominant country rock covering the more surface area than any other types of rocks. These are complex but fairly weathered. The intrusive granite mostly forms positive /elevated topography in comparison to the gneissic basement rocks. Augen gneiss of K-feldspar phenocryst are common. Pegmatites are another frequent intrusive forming more or less subdued relief in Jamui district. The dimension of pegmatites are thin stringers to about 500 m long to 30 m wide.

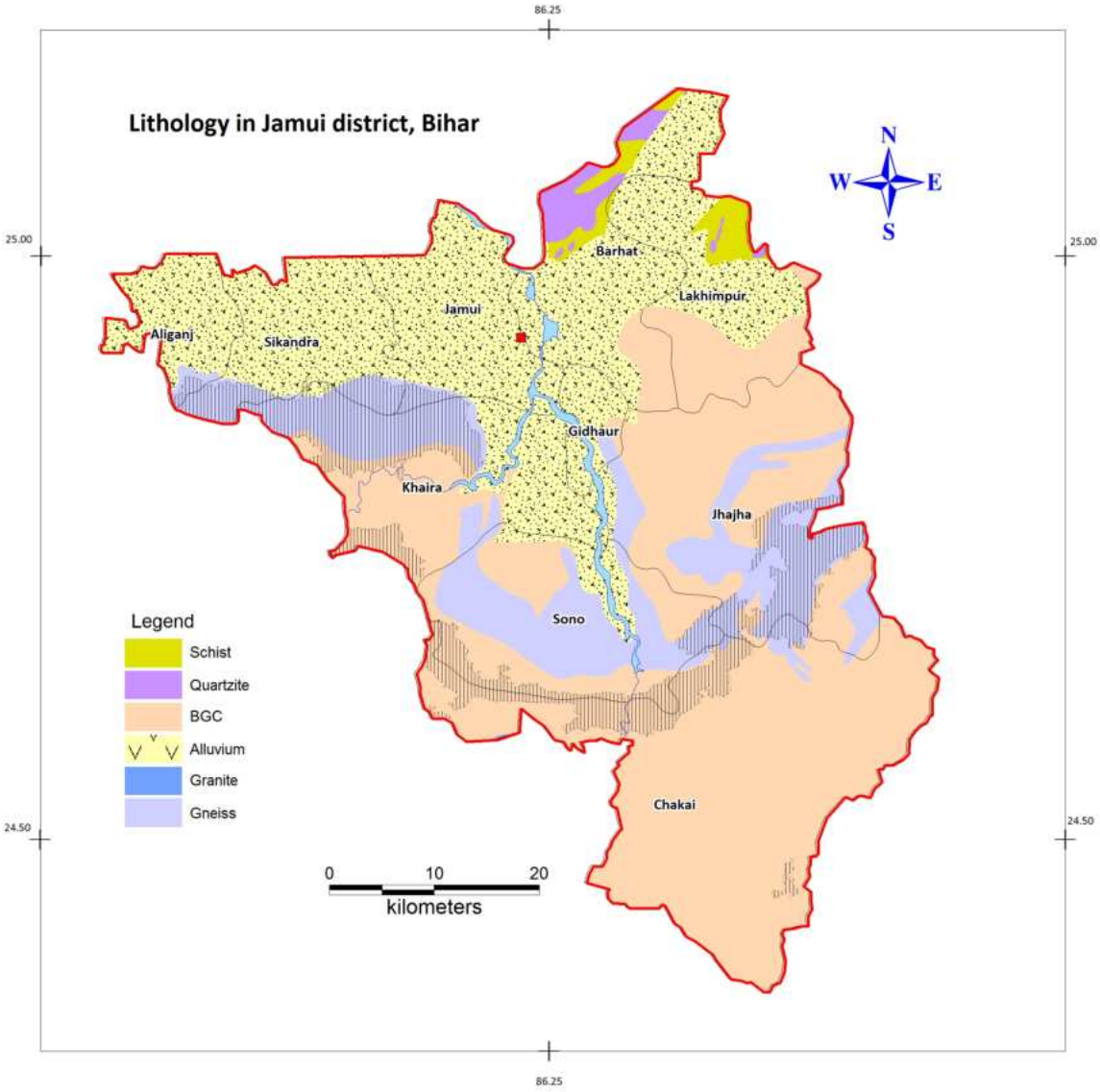


Fig.16 Lithological Disposition In Jamui District

The pre-Quaternary rocks in the area have undergone multiple phases of deformation complex patterns of diastrophic structures. Folds, joints, schistosity/gneissocity, lineaments etc. are common. Two sets of lineaments affecting the pre-quaternary rocks are important in the perspective of ground water exploration and occurrences in the area. The 1st set of lineaments are trending N_S and NW_SE. The 2nd set is trending E_W and ENE_WSW directions.

1.13 Sub-Surface Geology

The subsurface geology of the area has been unearthed from the exploratory bore holes and tube wells data of CGWB. The lithologs of the exploratory bore holes of CGWB in Jamui district has been compiled for preparation subsurface correlation diagram. A considerable area in the district being underlain by hard granitic/gneissic/ quartzite rocks, therefore, in terms of ground water prospects in the district the mapping of the depth of weathered sediments and the incidences of fractures in the bed rock definitely acquire significant roles. Keeping above in mind, the thickness of the alluvium and weathered sediments above the hard rock in the study area has been worked out from the exploratory bore hole data of CGWB and has been utilised in preparation of depth of Hard Rock map of the district (fig17). In major parts of the district depth of hard rock lies within 5 to 35 m depth. However, in the western part around Aliganj, Sikandra and in Khaira block the thickness of alluvium is more. The detail subsurface geology has been discussed in chapter 3 in this report.

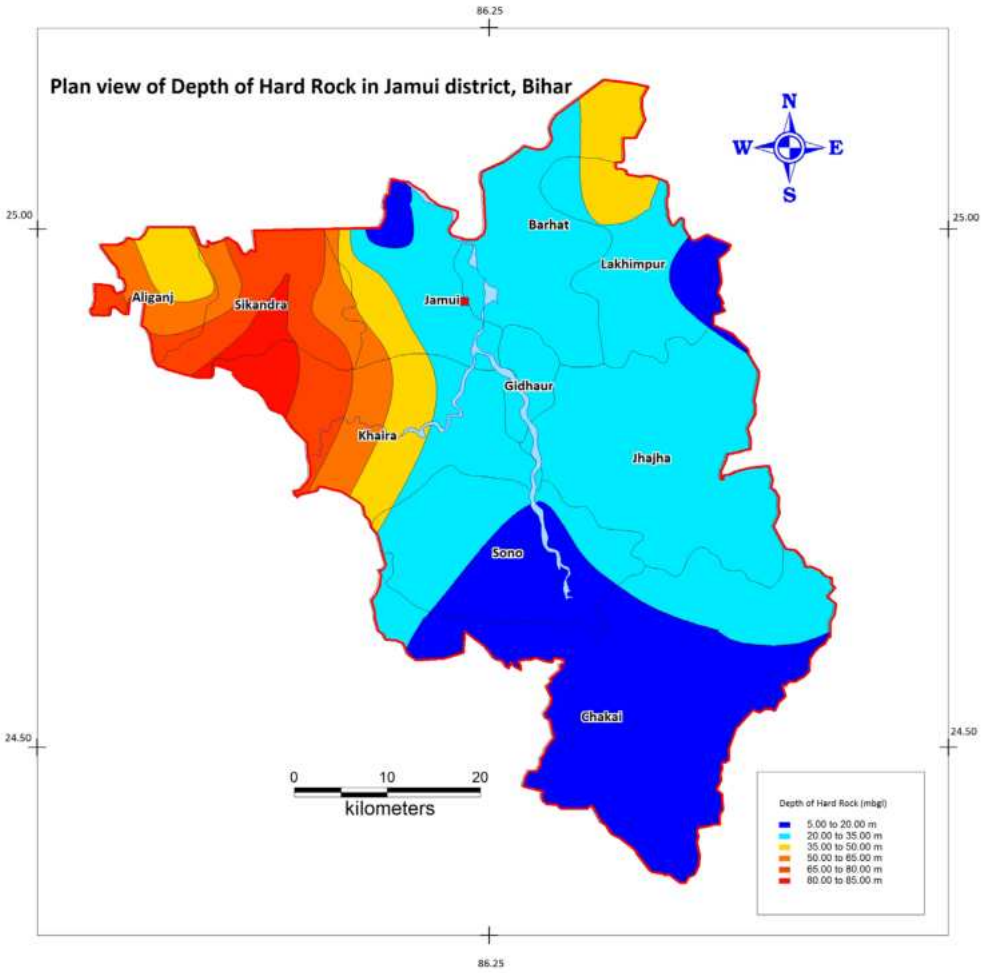


Fig.17 Depth of Occurrences of Hard Rock in Jamui District

CHAPTER-2

Data Collection and Generation

2.1 Hydrogeology

Water Bearing Formations

The terrain condition, geological set up of the area, rainfall pattern, occurrences and movement of ground water through primary or secondary porosity controls the hydrogeological framework of the district. The district of Jamui, thus, can broadly be subdivided into two predominant hydrogeological units:

I. Fissured Formation : Kharagpur and Chotonagpur group of rocks along with the intrusive constitute the fissured aquifers.

II. Porous Formation: The older and recent alluvium of Quaternary group of sediments constitutes the porous formation (Fig.18).

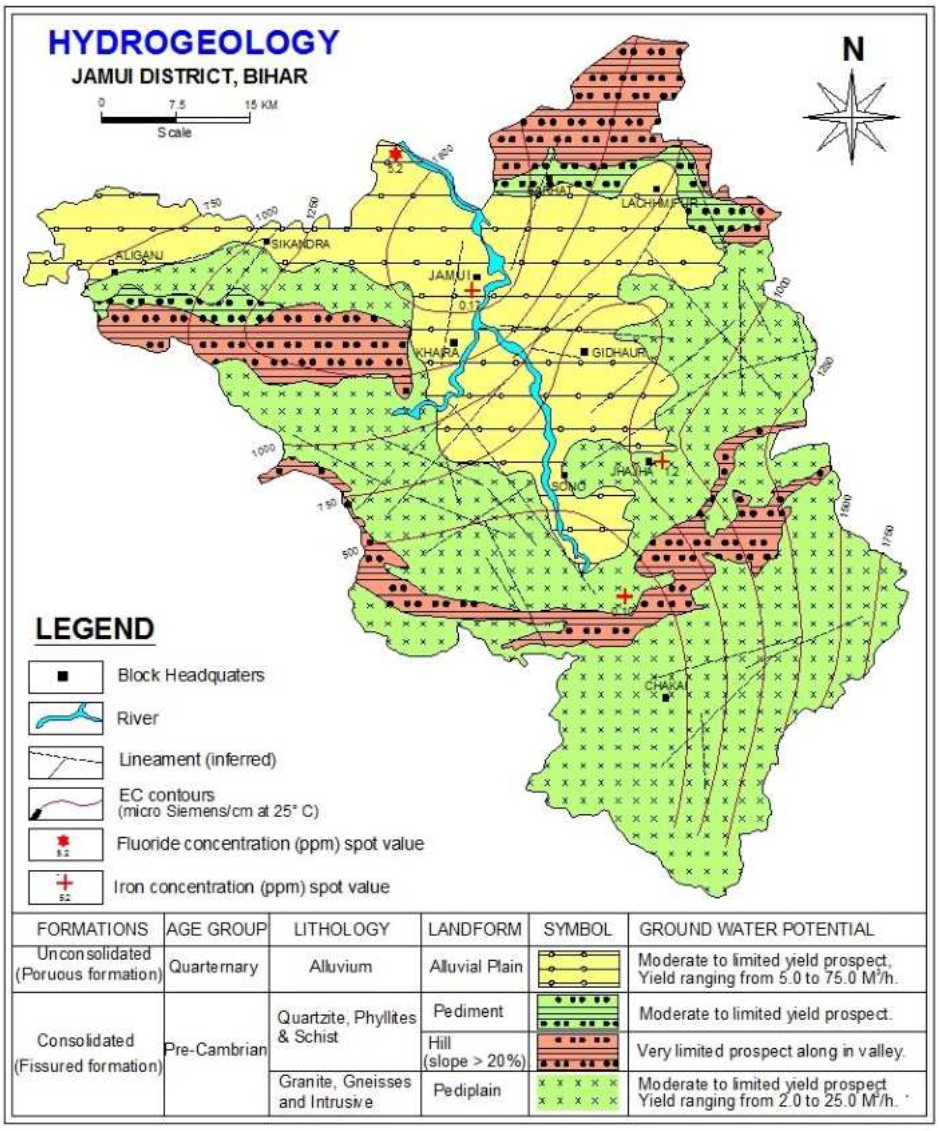
The hard rock / fissured formation: Chakai plateau and Pediplain area in the southern and northern parts of district and the Kharagpur hill tracts belong to this group. It comprises granite gneisses, quartzite and phyllites, while granite gneisses belong to Chotanagpur Gneissic Complex, quartzite and phyllites belong to Kharagpur Formation. The weathered residuum and secondary porosities developed by means of weathering and / or fracturing are main repository of ground water in the hard rock terrain. The granular materials are 5-20 m depth which is underlain by saprolite zone of 0.5-3 m depth. The potentiality of the water bearing formation/aquifers in the area depends on the thickness of the weathered residuum, extent, size, depth, interconnection of the fractures and topographic setup. The intense tectonic movements have resulted in deep seated fractures in the area. The fractures often persists long distance and conform the trend of major lineaments. The lineaments NW-SE and ENE-WSW are more intense. The exploratory drilling data of CGWB reveals that the potential fractures are generally encountered within the depth range of 30-75 m depth, but in few cases deeper fractures are also productive.

Saprolite Zone, the intermediate zone between the weathered mantle and the hard rock, are generally found everywhere. The saprolite zone is potential enough to support shallow wells with small irrigation command in Chakai plateau. The thickness of weathered mantle varies between 4 to as much as 21 m depth and the nature depends on the parent rock. The weathered mantle forms potential ground water repository in the low lying area where they can be effectively developed by large diameter dug wells.

Based on the above observation the aquifers in this hydrogeological unit may be grouped as shallow (1st) and deeper (2nd) aquifers. The shallow aquifers are chiefly constituted by weathered residuum, saprolite zone and shallow fractures within 30-50 m depth. These are generally developed by dug wells or shallow bore wells with limited command area.

The deep seated fractures beyond the depth of 50-60 m can be a sustainable resource for ground water. These fractures are commonly encountered within 75 m depth, but in few cases as deep as 150 m deep fractures have also been reported. These deeper fractures can only be located through detail hydrogeological and geophysical survey.

(II) Porous formation: The Quaternary alluvium constitutes this hydrogeological unit. The alluvial tract is confined to the Jamui terrace with sediment thickness ranging from 35 m to 85 mbgl. The thickness of alluvium varies appreciably all over the marginal alluvial tracts. The variation in thickness of the alluvium is due to uneven bed-rock topography. The mounds and trough in the basement not only controls the thickness but also the nature and grain size of sedimentation. The trough generally host coarser sediments/sands and finer are deposited in the mounds. However, this formation, often constitute the prolific aquifers. Aquifers in this formation may also be grouped as shallow (1st) aquifer within 10-35 m depth which are tapped by dug wells or shallow tube wells and *deeper (2nd)* aquifers beyond the depth of 35 mbgl, which are often tapped by MDTW or DTW. The shallow aquifers are generally unconfined and deeper one is in semi-confined to confined condition.



FORMATIONS	AGE GROUP	LITHOLOGY	LANDFORM	SYMBOL	GROUND WATER POTENTIAL
Unconsolidated (Poruous formation)	Quarternary	Alluvium	Alluvial Plain		Moderate to limited yield prospect, Yield ranging from 5.0 to 75.0 M^3/h.
Consolidated (Fissured formation)	Pre-Cambrian	Quartzite, Phyllites & Schist	Pediment		Moderate to limited yield prospect.
			Hill (slope > 20%)		Very limited prospect along in valley.
		Granite, Gneisses and Intrusive	Pediplain		Moderate to limited yield prospect Yield ranging from 2.0 to 25.0 M^3/h.

Fig.18: Hydro-geological Map of Jamui District, Bihar

2.2 Ground Water Regime, Water Table, Ground Water Movement

Depth to Water Level

The shallow aquifers in the fissured formation/hard rock terrain and in the porous formation are developed by dugwells or shallow bore wells upto the maximum depth of about 30-50 m. The shallow aquifers which are principally developed by dugwells in hard rock area, are represented by the weathered residuum, saprolite zones and shallow fractures in few occasions , whereas in alluvial area is represented by sands of different grain sizes, clay , silts etc. The deeper aquifers (deep seated fractures) in hard rock area is developed by bore wells of 60-150 m depth and in alluvial area by deep tube wells of more than 50-60 m depth. The shallow aquifers irrespective of hard rock or in

the alluvial area are in phreatic condition whereas the deeper aquifers are in semi confined to confined condition in the district.

To study the ground water regime of prevailing aquifer system in the study area, under the data generation activity of NAQUIM , about 25 observation wells representing shallow 1st aquifer (weathered and shallow alluvial wells) and deeper 2nd Aquifer (deeper fractures/ deep bore wells and deep tube wells) have been monitored during the pre and post monsoon period (Table 2.10, Fig.19). The observation wells are private dug wells, mark II tube wells, deep bore/tube wells of PHED, Govt. of Bihar and piezometers of Minor Irrigation Departments, Govt. of Bihar. The depth of the dug well varies from 5.5 m to 17 mbgl. These dug wells are grouped together to represent the 1st aquifer system in the district. The piezometers of Minor Irrigation department, Govt. of Bihar, both in hard rock and in alluvial area lie at the depth of about 50 mbgl. The deep bore/tube wells of PHED, Govt. of Bihar generally are at 80-90 m depth. These two are grouped together to represent the deeper aquifer in the district and are utilized to understand the ground water regime of the deeper aquifers.

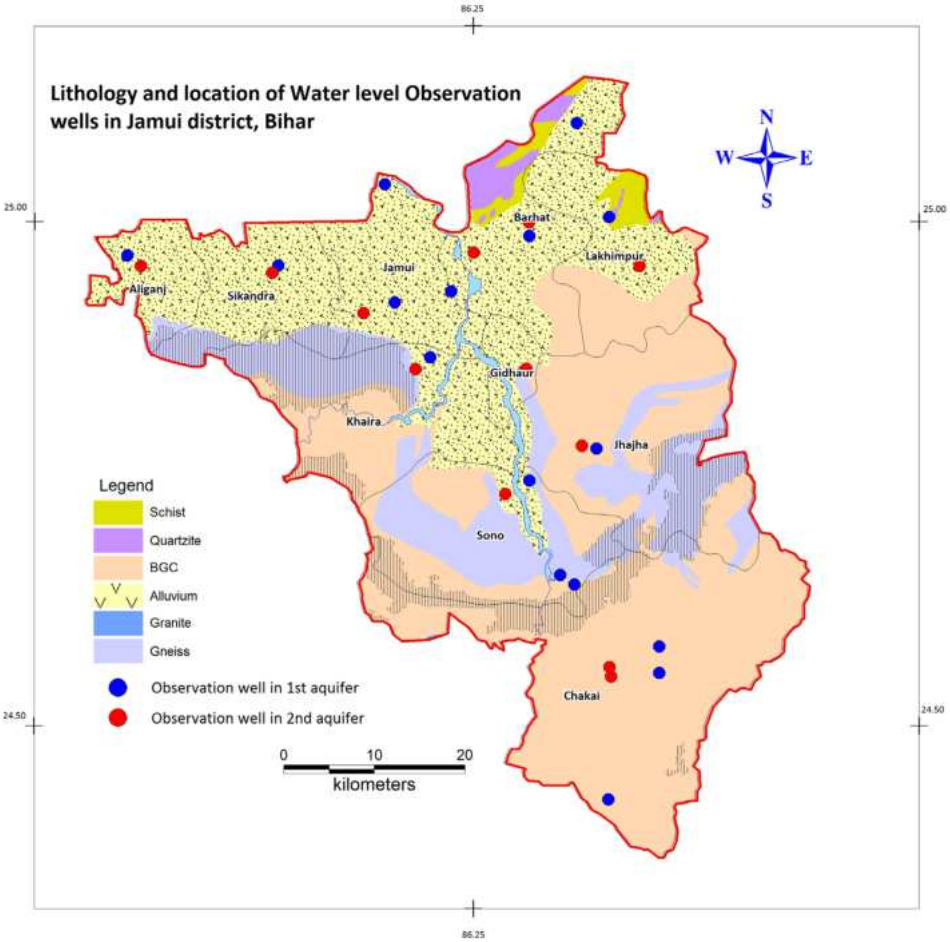


Fig.19 Location of Observation Wells

The depth to water level of ground water in the district would definitely be influenced by the topography, nature of formation, surface water bodies, development scenario etc. The pre-monsoon depth to water level map of the 1st aquifer (fig.20) in the area represents the ground water level of more than 10 mbgl to maximum being 16 m bgl around Chakai, Sono in the south western parts of the district and more than 7 m bgl to 13 mbgl in and around Barhat, Laxmipur block in the north eastern parts of the district. These areas are mainly topographic high and constitute the recharge zone. The pre-monsoon water level lies within the depth range of 4-7 mbgl in the alluvial tract in central and north western parts around Aliganj, Sikandara, parts of Jamui, Jhanjha etc. The post monsoon water level (fig.21) depicts the similar nature with depth to water level lies at 5 mbgl to 11 mbgl in and around Chakai, Sono, Barhat, Laxmipur area and it rests at 0- 5 mbgl around Gidhaur, Aliganj , Sikandara, parts of Jamui, Jhanjha etc in the central and in the north western parts of the district.

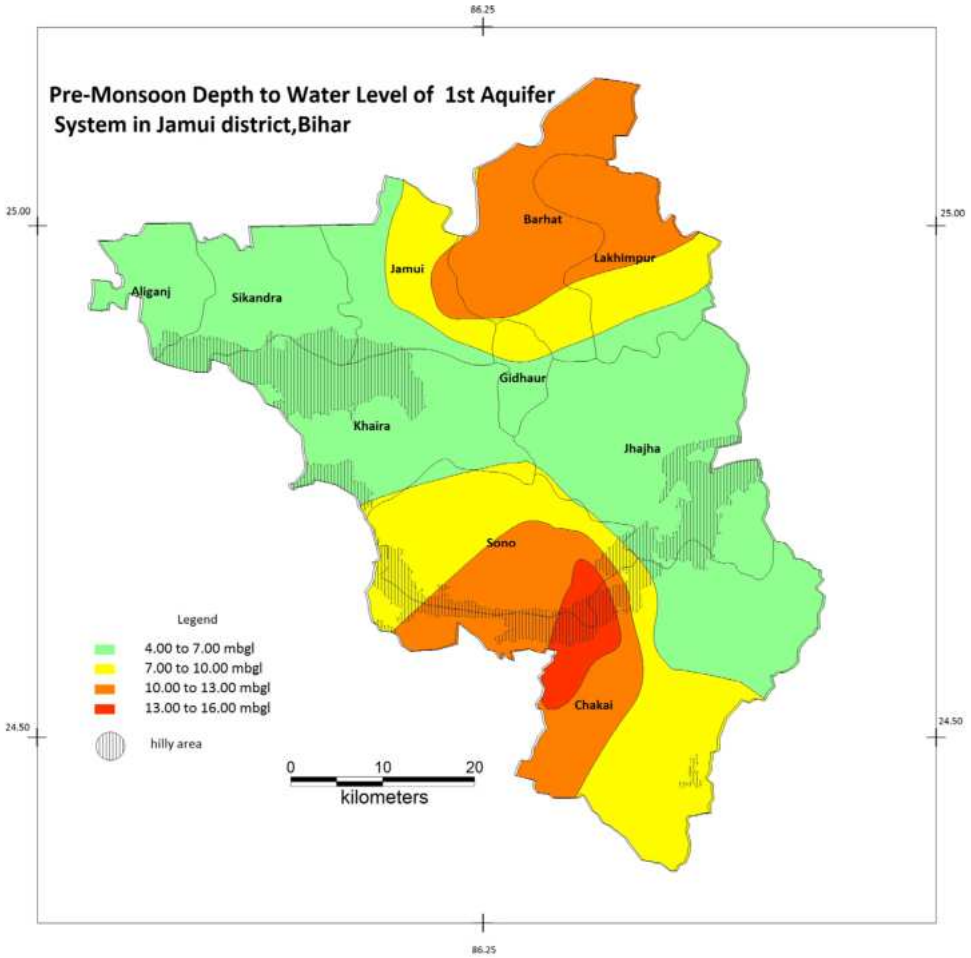


Fig.20 Depth to water level map (1st Aquifer) in Jamui District (Pre-monsoon ,2019)

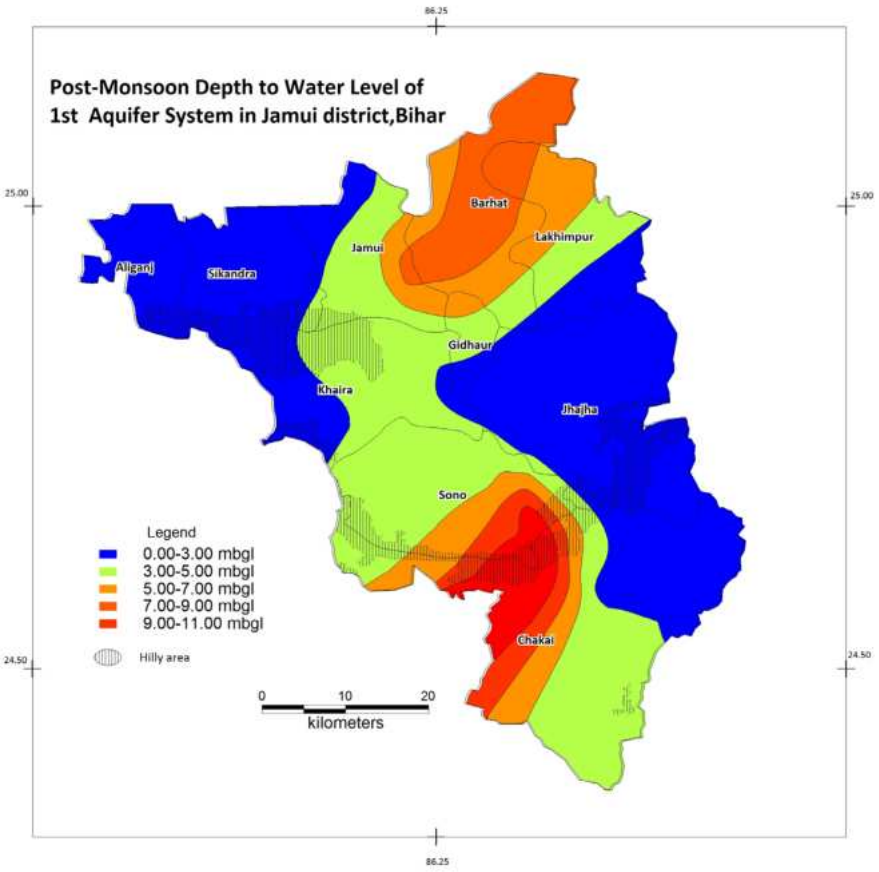


Fig.21 Depth to water level map (1st Aquifer) in Jamui District (Post-monsoon, 2019)

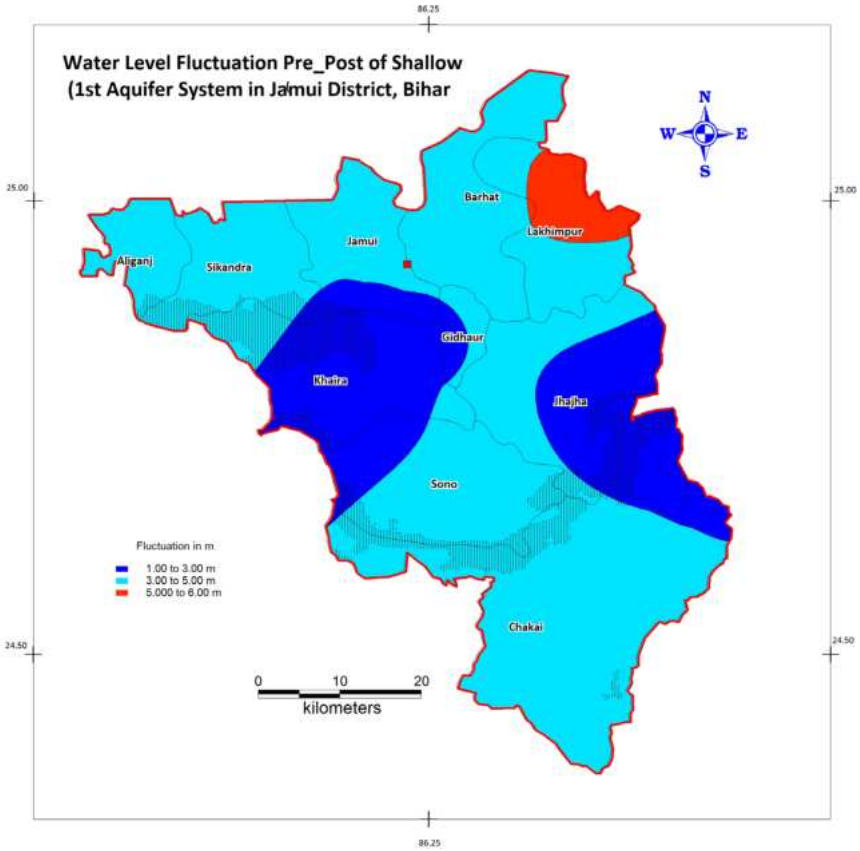


Fig.22. Water Level Fluctuation Map (1st Aquifer) in Jamui District

Ground water level fluctuation, (pre-post, fig.22) of the aquifer system reflects more or less uniform and moderate fluctuation to the tune of 3-5 m in the major parts of the area, whereas 1-3 m and more than 5 m fluctuation is reported in Khaira, Jhanjha area and in parts of Laxmipur block respectively.

Pre-monsoon ground water level in the 2nd Aquifer system (fig.23) measured from the piezomers and deep bore /tube wells revels wide range in the depth of water level from 6 mbgl to 20 mbgl. The comparatively deeper water level of more than 15 m is reported from fractured hard rock aquifers in Barhat and in Laxmipur block. The deeper aquifer in the alluvial area in the district witnesses moderate pre-monsoon water level to the tune of 6 to 12 m bgl. The deeper water level in the hard rock area may be due the less potentiality of the selected fractures. The comparatively deeper water level in the 2nd aquifer system as compared to that of 1st aquifer system particularly in parts of Khaira, Aliganj, Sikandara, Gidhaur, Jamui etc. may be the reflection of higher development scenario through MDTW/DTW in the district. The post monsoon water level in the 2nd aquifer system (fig.24) also represents similar configuration, however, area under deeper water level reduces as compared to the pre-monsoon.

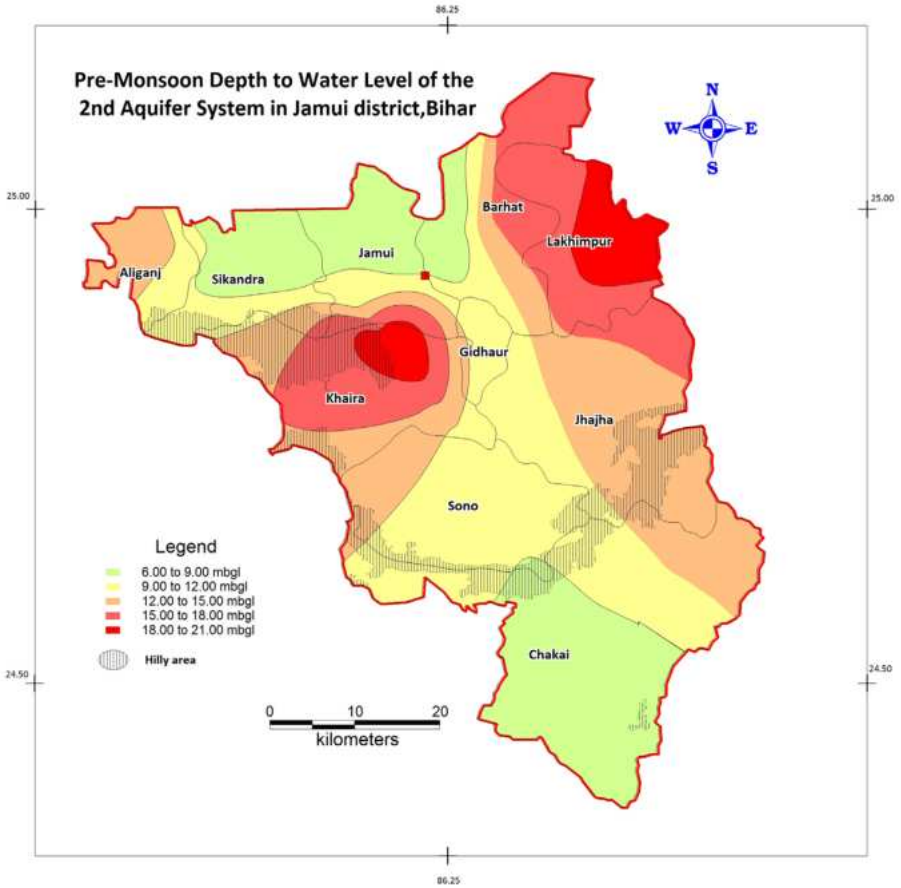


Fig.23 Depth to water level map (2nd Aquifer) in Jamui District (Pre-monsoon, 2019)

In Alluvial terrain around Aliganj , Sikandara , the post monsoon water level, in general, lies within 0-6 mbgl. However, deeper water level of more tha 19 m bgl has been reported in and around Khaira block during post monsoon time.

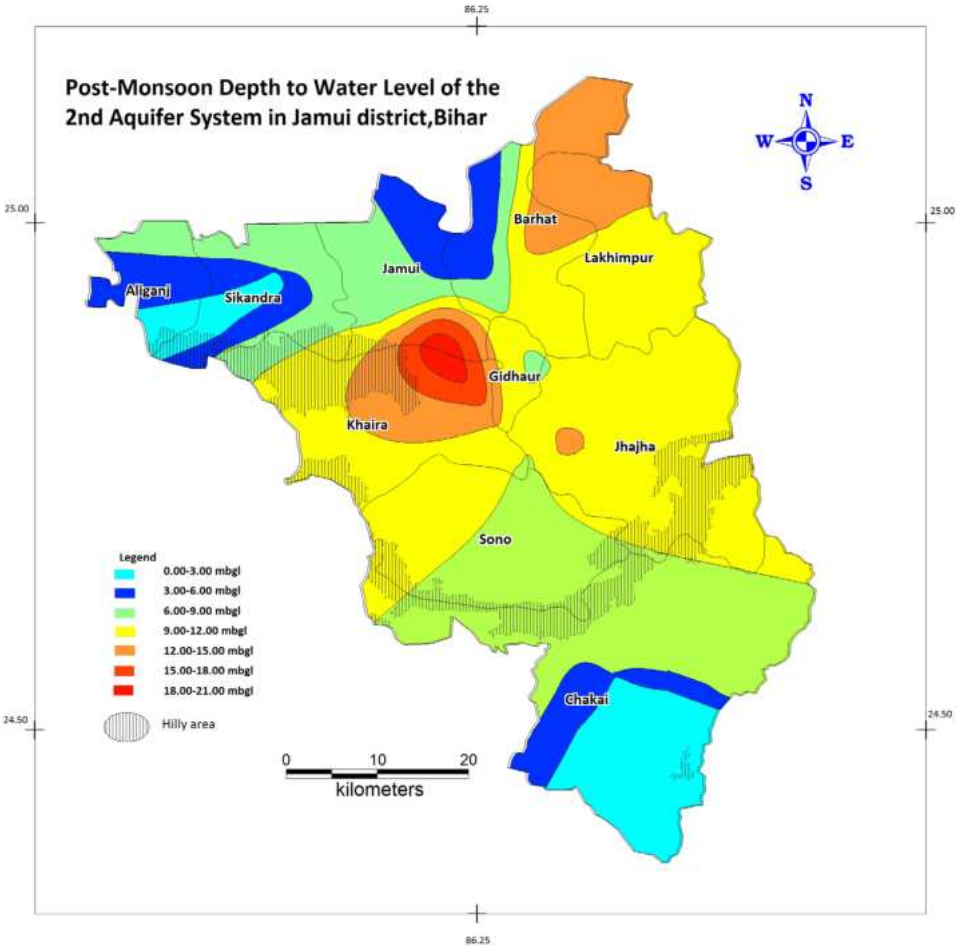


Fig.24 Depth to water level map (2nd Aquifer) in Jamui District (Post-monsoon, 2019)

Fluctuation of water level in the 2nd aquifer system (fig.25) is 0.25 m to 3 m in the major parts of the district, except parts of Aliganj and Sikandara block in alluvial terrain and around Laxmipur block in hard rock aquifer where fluctuation to the tune of 3 m to 6 m has been observed.

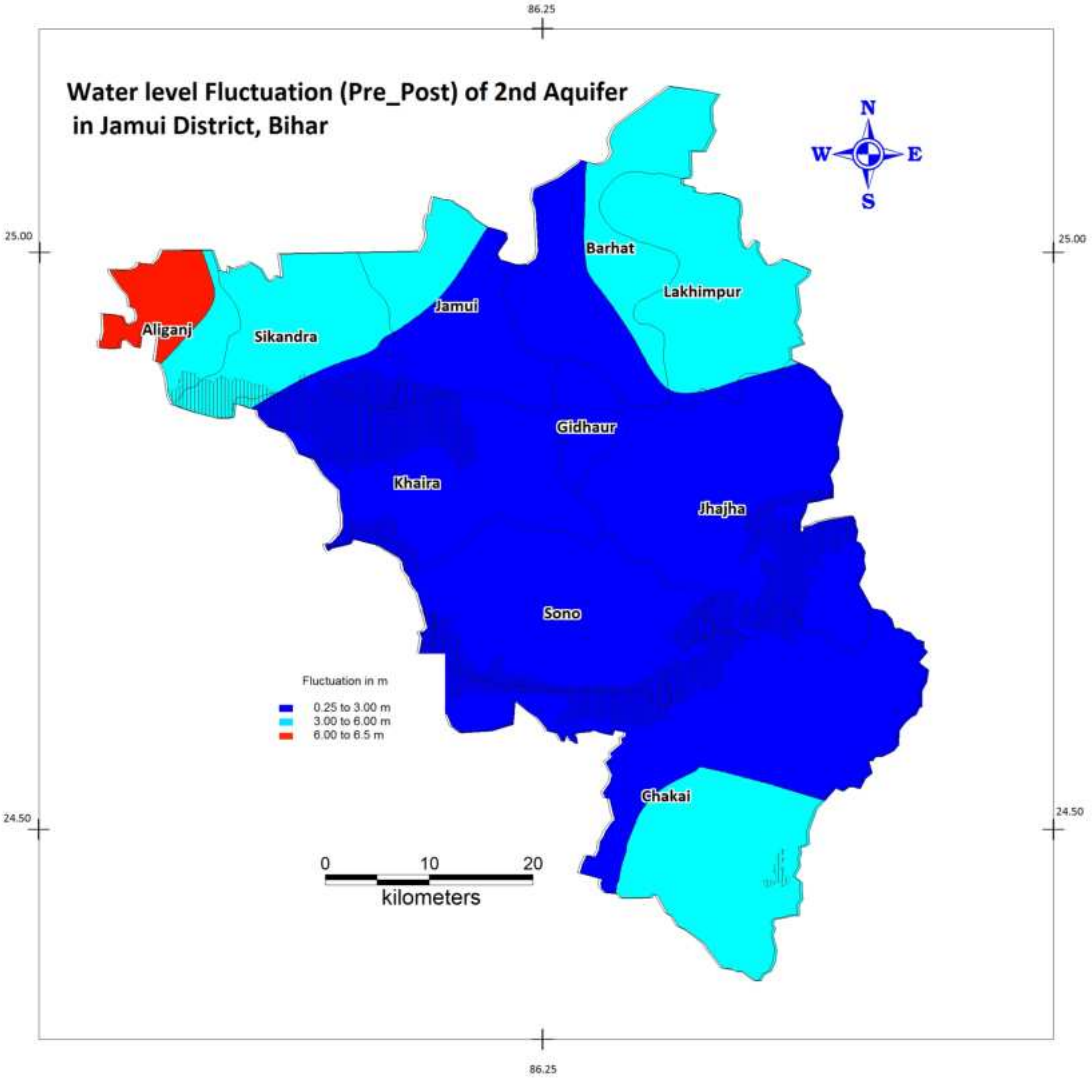


Fig.25. Water Level Fluctuation Map (2nd Aquifer) in Jamui District

Table: 2.10 Detail of Well Inventory Key Observation Stations in Jamui District

Sl No	Village	Block_Name	Type_of_Well	Location	Geology	Latitude	Longitude	Diameter (m)	Depth (mbgl)	MP	Postmonsoon SWL/bgl	Premonsoon/SWL mbgl
1	Purana Khaira	Khaira	DW/ NHNS	Approachable from a link road from Jamui - Khaira road leads to Sikandra. Located before village in front of Bazranf Bali Temple.	Alluvium	24.8658	86.2028	2.5	5.50	0.4	3.4	4.5
2	Aghara	Jamui	DW/ NHNS	RHS of Jamui-Sikandra road near Aghara chowk	Alluvium	24.9206	86.1639	1.8	7.50	0.5	3.8	7.04
3	Chandramandih	Chakai	DW/ NHNS	On Chakai Jasidih Simultala road inside a temple	Hard Rock/ fractured	24.5792	86.453116	2	6.60	0.8	2.3	5.8
3	Chakai	Chakai	DW/ NHNS	Within the compound of DB (I.B.) & starting to Chakai main Market	Hard Rock/ fractured	24.55257	86.453116	1.4	8.50	0.7	3.9	8.8
4	Sikandra	Sikandra	DW/ NHNS	RHS of Jamui Sikandar road, near Lok Janshakti party office	Alluvium	24.9568	86.0368	2	8.40	1.2	1.3	6.15
5	Sono	Sono	DW/ NHNS	in the compound of Shreyash Jaivik Khad Nursery just before Sadashiv Dharmkanta. LHS of road from Sono to Jhajha about 500 m from Sono town.	Hard Rock/ fractured	24.7438	86.31102	2.5	8.50	1	3.4	7.64
6	Jamui	Jamui	DW/ NHNS	In the compound of Jamui Munger Central Co-operative Bank Opp. To Bharat Petroleum Petrol pump and Jamui	Alluvium	24.9316	86.2258	1.22	12.00	0.6	7.6	11.93

Sl No	Village	Block_Name	Type_of_Well	Location	Geology	Latitude	Longitude	Diameter (m)	Depth (mbgl)	MP	Postmonsoon SWL/bgl	Premonsoon/SWL mbgl
				Highway.								
7	Manjhwe	Jamui	DW/ NHNS	Located on Jamui (17 km)-Lakhisarai (7-8 km) road LHS, at just entry of the village.	Alluvium	25.0375	86.1533	2	10.15	0.6	2.6	6.92
8	Laxmipur	Laxmipur	DW/ NHNS	Besides the House of Sh. Arwind Das and apposite to Hanuman Mandir near old Hospital. Appro. 200m east of Laxmipur Chauk.	Hard Rock/ fractured	25.005	86.3983	3.3	12.00	0.2	5.5	10.9
9	Lalmatia	Barhat	DW/ NHNS	Just entrance of village RHS of road of Barhat from Numer	Hard Rock	24.98611	86.3109	3.7	13.00	0.75	7.5	11.26
10	Itwa (Batia)	Sono	DW	About 1.5 km from Batia towards Sono, 50 m before Kalipahari Chawk, opposite to Bank of India, in front of the house of Totan Jadav.	Hard Rock/ fractured	24.6499	86.34485	1.4	13.00	0.4	8.70	13
11	Batia	Sono	DW/ NHNS	Near Shiv Mandir in the Forest Rest house campus.	Hard Rock/ fractured	24.6406	86.3604	1.5	15.80	0.7	11.5	15.07
12	Ambedkar nagar	Jhanjha	DW/ NHNS	In the temple	Hard Rock/ fractured	24.7755	86.38447	1.5	16.80	0.3	1.5	4.47
13	Aliganj	Aliganj	Pz	BDO office	Alluvium	24.95795	86.03		50.00		7.49	14.05
14	Barhat	Barhat	Pz	BDO office	Hard Rock/fractured	24.97	86.25		50.00		4.75	7.17

Sl No	Village	Block_Name	Type_of_Well	Location	Geology	Latitude	Longitude	Diameter (m)	Depth (mbgl)	MP	Postmonsoon SWL/bgl	Premonsoon/SWL mbgl
15	Chakai	Chakai	Pz	BDO office	Hard Rock/fractured	25.5585	86.398677		50.00		6.17	8.4
16	Gidhaur	Gidhaur	Pz	BDO office	Alluvium	24.8546	86.3075		50.00		8.92	10.5
17	Jhajha	Jhanjha	Pz	BDO office	Hard Rock/fractured	24.7783	86.3686		50.00		11.54	11.75
18	Jamui D M Office	Jamui	Pz	Jamui DM House	Alluvium	24.91	86.13		50.00		7.88	10.36
19	Khaira	Khaira	Pz	BDO office	Alluvium	24.8709	86.2081		50.00		19.57	20
20	Lakshmipur	Laxmipur	Pz	BDO office	Hard Rock/fractured	24.78	86.36		50.00		13.42	18.5
21	Sikandra	Sikandra	Pz	BDO office	Alluvium	24.95	86.03		50.00		2.49	6.97
22	Sono	Sono	Pz	BDO office	Hard Rock/fractured	24.7468	86.3049		50.00		8.71	9.83
23	Chakai	Chakai	PHED_DTW	Near Chakai Thana and Hospital	Hard Rock	24.5493	86.400434	0.25	80.00	0.4	2.00	6.5
24	Lalmatia	Barhat	PHED_DTW	At the entrance of village , LHS of Khadigram-Barhat road	Hard Rock/ fractured	24.9876	86.308674	0.25	91.00	0.8	12.30	15.6

Water table and Ground Water Movements

Along with the occurrences of ground water, the movement of water in the aquifer and the gradient of movement are of utmost significance for better understanding the nature of aquifer system in an area. The pre and post monsoon water level data from the shallow aquifer has been utilised to estimate the water table or the head with respect to the reduced level (fig.26). The pre-monsoon water table elevation varies from 300 m above msl to 60 m above msl. The higher water table elevation is observed in the southern parts (300 m amsl, Chakai blolck) and in the north eastern parts (180 mamsl, Barhat block) whereas the lower contour of 60-100 m is in central and in the north western parts; in Khira, Jamui, Sikandara and in Aliganj area. The dominant ground water flow from SE towards NW, however, flow from Barhat area towards Jamui terrace from NE towards SW is also observed. These areas with higher water table head constitute the recharge area for the district. Decrease in hydraulic gradient has been observed from southern parts towards the central part of the district and from north eastern parts towards the central parts of the district. The decrease in hydraulic gradient is also attributed to the increase in the hydraulic conductivity and the potential of the aquifer in central and north western parts of the district. The post monsoon water table contour depicts the similar nature with little flattening of contours (fig27).

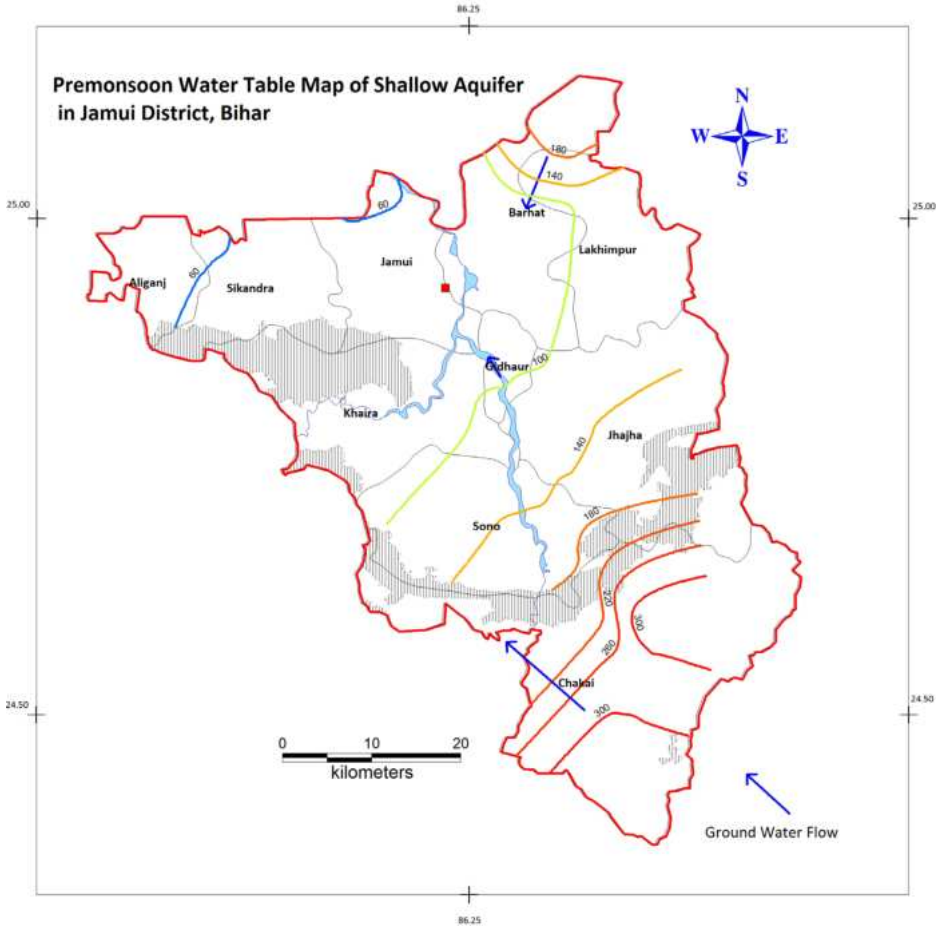


Fig.26 Water table elevation and ground water flow in Jamui District, Pre-monsoon.2019.

Close observation of the pattern of ground water flow around the Kiul river indicates effluent nature of the stream.

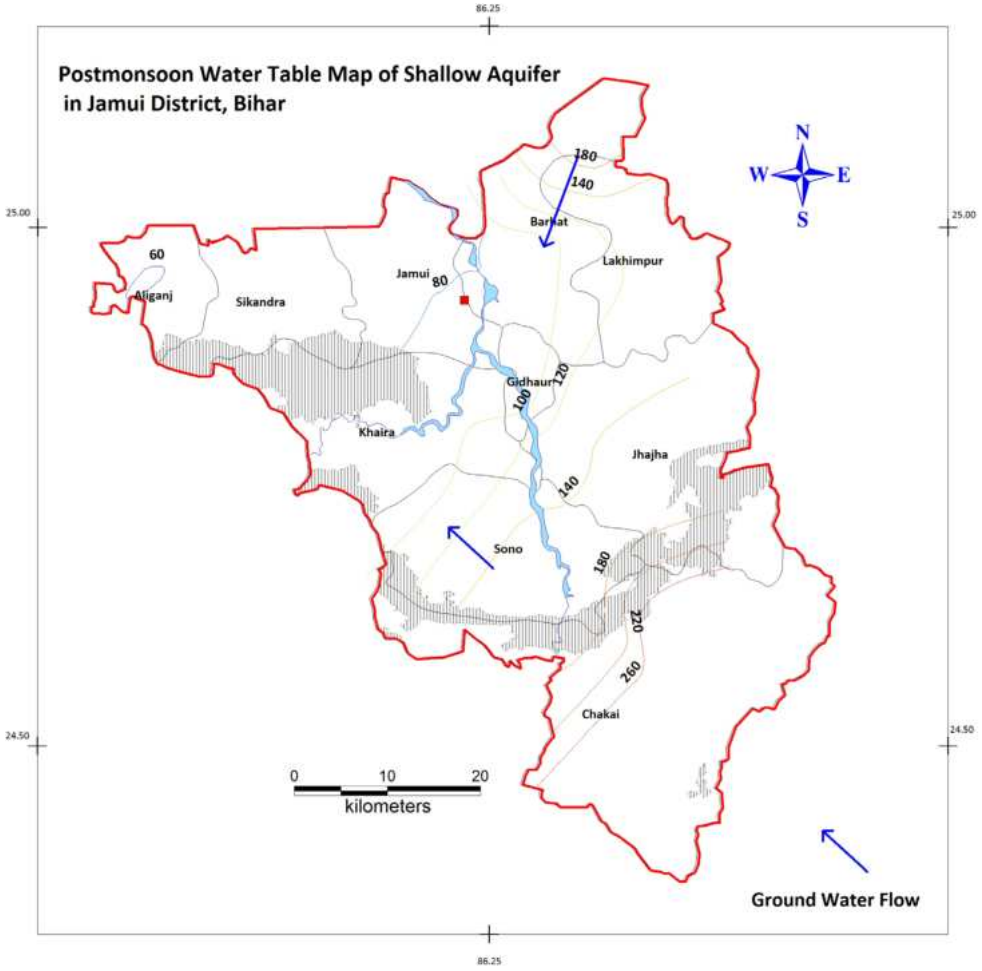


Fig.27 Water table elevation and ground water flow in Jamui District, Post-monsoon.2019.

Long Term Water Level Trend Analysis

The historical data on water level of the observation wells/NHNS wells of CGWB in Jamui district has been analyzed. The observation wells principally represent the shallow/1st aquifer system. The block wise average pre and post monsoon water level for each year has been plotted to find out the long term behavior of water level in the area. The changes in long term water level behaviors over the years are found significant in few parts of the study area. It is observed that the falling trend of 10 cm/year has been reported in the southern parts around Chakai block and in few areas in Jhanjha block. In major parts of the district fall more than 10 cm/yr to 35 cm/yr has been witnessed. Significant fall in ground water regime is however, witnessed around Gidhaur and in other parts of alluvial area in the district. The moderate

changes in long term behaviors of ground water level in the district may be the reflection of increase in ground water draft from shallow aquifers for irrigation uses (Fig.28).

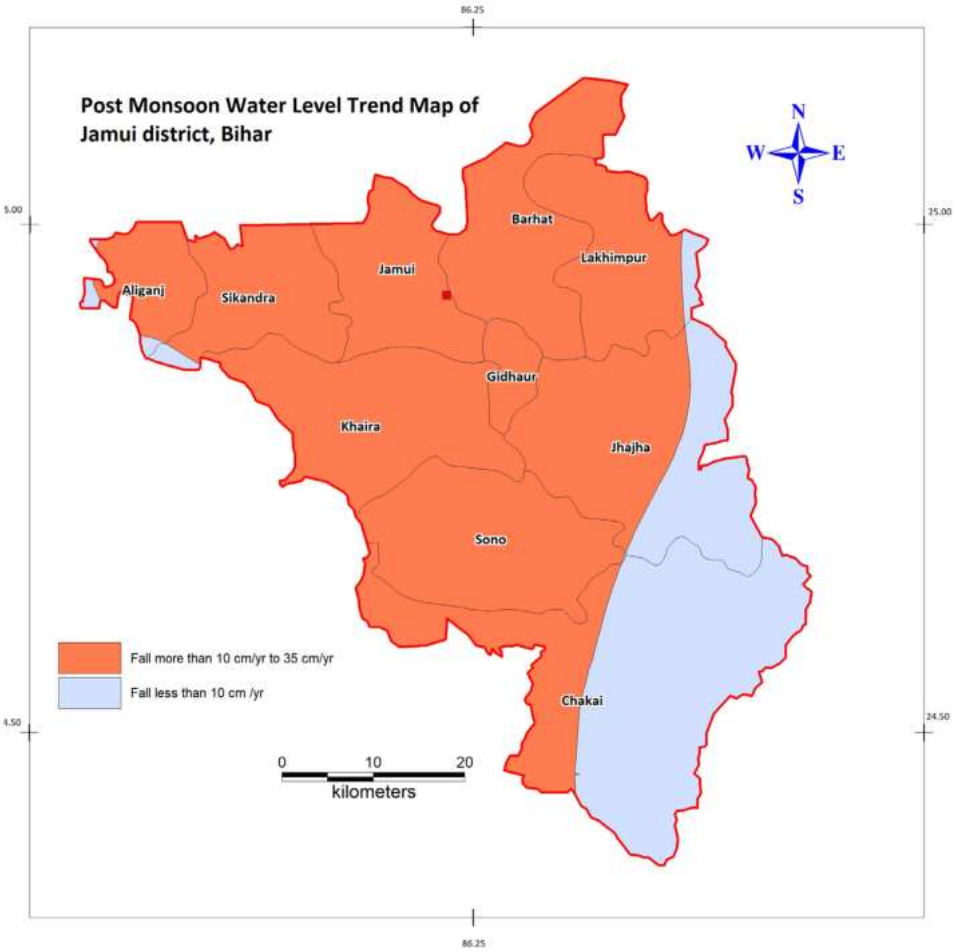


Fig.28 Water level Trend Map in Jamui District

2.3 Exploratory Drilling and Yield

The potentiality of the aquifer l**ar**gely depends on the nature of the underlying formation, extent of the aquifers, scope of recharge and recharge potential and on the aquifer parameters. The occurrence and movement of ground water in the marginal alluvial tract is primarily controlled by primary porosity and the permeability whereas in the fissured formation it depends on the extent of weathering and types and type of interconnection of secondary porosities i.e, joints and fractures. The important hydraulic properties of aquifers are hydraulic conductivity, transmissivity, storativity, specific capacity which has special bearing on the hydrogeological frame work of the district. CGWB has constructed numbers of exploratory and observation wells both in alluvium and hard rock area in the district. The result of exploration with aquifer parameters are given in table 2.20. Exploratory

drilling in alluvium area reveals that, there exist at least two prominent aquifers within the depth of 100 m. The optimum yield of the wells in the marginal alluvium tract is moderate to high and varies from 20.00- 75.00 m^3/hr with reference drawdown of 4-9 m (fig29).

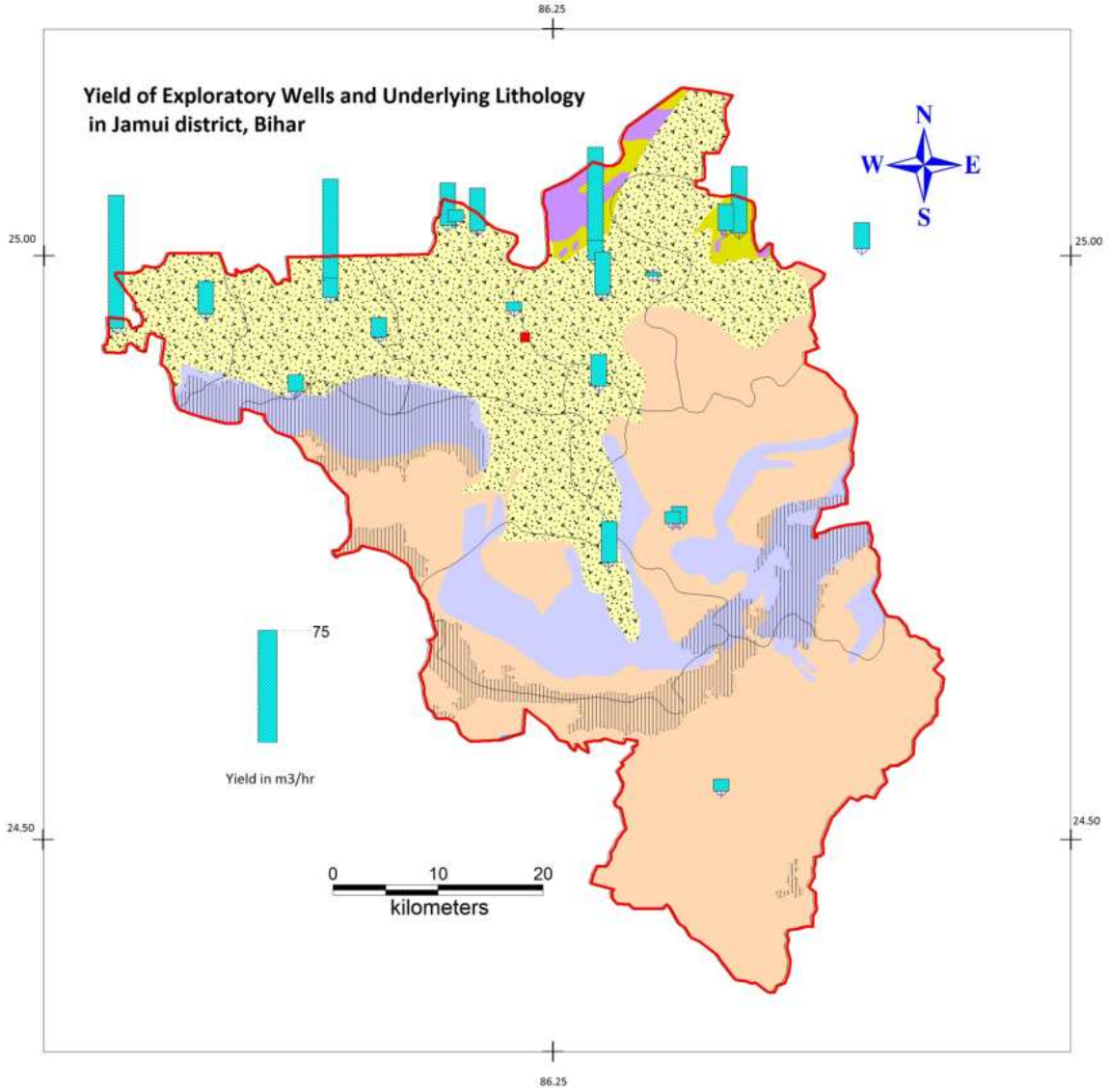


Fig.29 Yield of the Aquifer in Jamui District

Yield in hard rock terrain depend on the potentiality of the fractures , however, satisfactory yield of 5-6 m^3/hr to as much as 30 m^3/hr has been reported in Chakai, Barhat, Laxmipur, Sono etc. Transmissivity of the aquifer is reported low and varies from 450-550 m^2/day in alluvial area and around 30m^2/day in hard rock terrain. Storativity ranges from 6.4x10^{-}4 to 3.02x10^{-}3.

2.20: Yield and Aquifer Potential of Exploratory Wells of CGWB in Jamui district

Sl_No	Name	Block	Latitude	Longitude	Geology	Depth_of_drilling_	Granular_zones/Fractures	Depth of Hard rock	Discharge m^3/hr	SWL_mbgl_	DD_in_m	Sp Capacity m^3/hr/m	Transmissivity m^2/day	Storativity
1	Mahadeo Simaria	Sikandra	24.9302	86.086	Hard Rock	200	38-52/	55	11.37	2.7	21.01	0.54	30	3.5X10-4
2	Sikandra High school	Sikandra	24.9639	86.0403	Alluvium	180	40-42,50-58,75-80/	80	11.04	4.56	10.76	1.02	30	6.4X10-4
3	Islamnagar	Sikandra	24.8833	86.0078	Alluvium/ Hard Rock	180	40-47, 53-63, 65-85/104,147,155,170	85	9.82	5.92	16.47	0.59	11.78	2.17X10-4
4	Chakai	Chakai	24.5417	86.4083	Hard Rock	199	/44-45,105-106,120-121,160-161	14.5	6.9	6.5				
5	Sono	Sono	24.7375	86.3028	Hard Rock	153.44	/67-68,82,83,120-121,147-148	20	23	9.28	16.7	1.38	12.39	5.3X10-3
6	Jhanjha	Jhanjha	24.7708	86.3625	Hard rock	190	/98-99	35	7	8.08				
7	Jhanjha	Jhanjha	24.7708	86.3689	Alluvium	35	12-18,24-27,30-33/	33	10	5			13	
8	Ratanpur	Gidhaur	24.8883	86.293	Hard rock	191	/41-44,54-55,61-62	26	18	4.8				
9	Aliganj	Aliganj	24.95	85.9231	Alluvium	50	10-18, 35-43/	43	18.53	5.24	6.94	2.67	58.13	
10	Arha	Aliganj	24.9378	85.8389	Alluvium	83	43-55,55-67/	70	75.3	2.56	9.05	7.92	464	3.7X10-4
11	Lohanda	Sikandra	24.9722	86.0403	Alluvium	41	28-35/		61.23	4.06	4.4	13.91	535	3.02X10-3
12	Barhat	Barhat	25.0131	86.2908	Hard rock	46		30						
13	Laxmipur	Laxmipur	25.0194	86.425	Hard Rock (Phyllite)	157	/55-56,84-85,135-136	30	37.5	6.1			31	
14	Nazari	Laxmipur	25.0214	86.4126	Hard	142		45	15	5.38	12	1.25	32	

Sl_No	Name	Block	Latitude	Longitude	Geology	Depth_of_drilling_	Granular_zones/Fractures	Depth of Hard rock	Discharge m^3/hr	SWL_m bgl_	DD_in_m	Sp Capacity $m^3/hr/m$	Transmissivity m^2/day	Storativity
					Rock									
15	Matia	Laxmipur	24.9825	86.344	Hard Rock	166		26	2	0				
16	Limli	Barhat	24.9961	86.29	Hard Rock	102.2	/64-66,71.70-73,96-99	33	64	2.1				
17	Malaypur	Jamui	24.9527	86.2132	Hard Rock	170		24	5	3.1				
18	Numer	Barhat	24.9667	86.2967	Hard Rock	73	/39-42	35	24	1.95				
19	Patharghat	Sangrampur	25.006	86.5407	Hard Rock	62.65	/24-28,47-49	6	15	1.9				
20	Tajpur	Jamui	25.0216	86.1786	Hard rock	92.4	/40-43,49-52,88-89	31.5	24.24	7.35				
21	Nabinnagar OW1	Jamui	25.0292	86.1583	Hard Rock	137.8	/30-32,42-45,70-73	12.2	6.4	5.2				
22	Nabinnagar EW	Jamui	25.0258	86.1508	Hard Rock	137.8	/28-30,108-111,120-123,135-137	7	24.24	5.3	22	1.10	7.56	4.89X10-4

2.4 Hydro-geochemistry

Ground water samples have been collected from the existing NHNS in the district during pre-monsoon time for analysis of basic parameters. The detail analysis report is given in Table 2.30. Chemical analysis report of shallow and deeper aquifers reveals that pH value ranges between 7.19-8.72 and EC from 435 to 2830 micro Seimens/cm. The average range of EC in the district around 600-900 micro Seimens/cm, however, in few occasions it is reported more than 2500 micro Seimens/cm, around Sikandara. As per the concentration of chemical constituents given in Table 2.3, the ground water is by and large suitable for drinking and irrigation purposes.

The piper diagram or trilinear diagram (fig.30) is a tool to represent the relative abundance of common ion in a set of sample. The Piper's trilinear diagram (Piper 1944) is most useful to understand the chemical relationships among groundwater. The chemical quality data of the investigated area are used in Piper's trilinear diagram for graphical analysis. The plot of the water samples reveals that the water samples are dominantly Na+K bicarbonate water. Na-Cl type is reported in rare occasions. It reveals that water is mostly of alkalis exceeds alkaline earth in the pre monsoon season

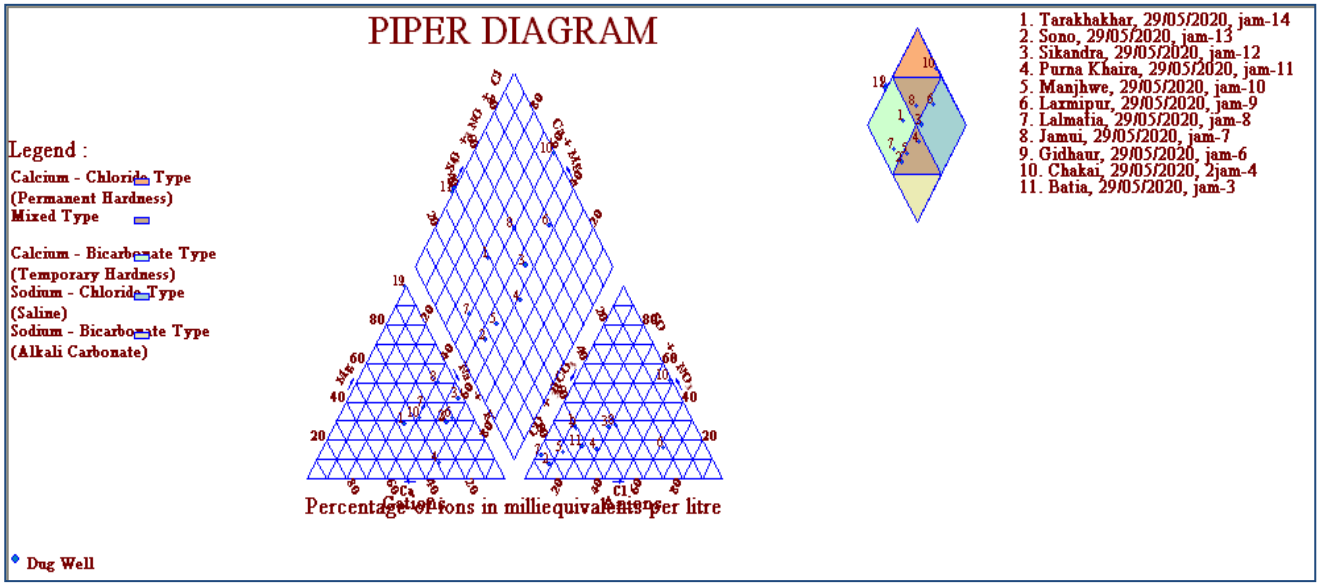


Fig.30 Piper Diagram showing relative abundances of common ion in Water Samples in Jamui District

The USSL diagram best explains the combined effects of salinity hazard and sodium hazards in classification of irrigation water. It is a plot between sodium hazard (SAR) on y axis and salinity hazard (EC) along X axis which allows water to be grouped into 16 classes. In the present sample set the water is C_2S_1 to C_3S_1 type, therefore with low sodium hazard to medium salinity hazard, in few case high salinity hazard has been reported.

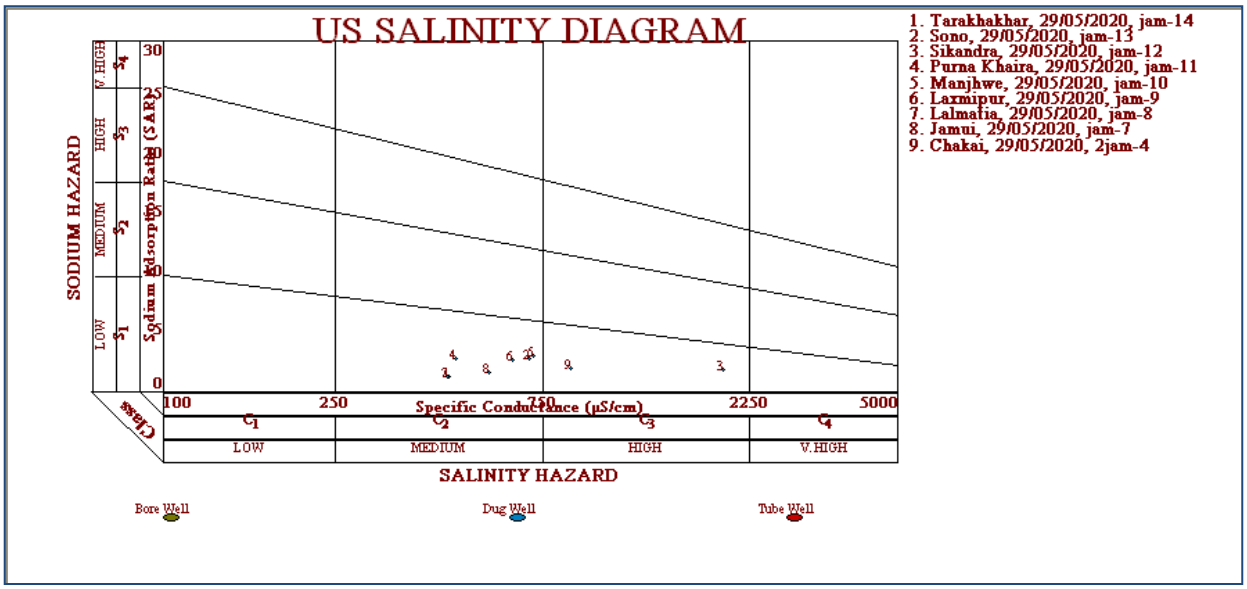


Fig. 31 US Salinity Diagram explains the salinity and Sodium Hazard

Wilcox (1955) used sodium % and specific conductance in evaluating the suitability of groundwater to irrigation. Sodium percentage determines the ratio of sodium to total cations viz., sodium, potassium, calcium and magnesium. All the concentration values are expressed in equivalents per million (epm). Based on the plot (fig.32) the water samples in the district are excellent to good wrt the suitability of ground water irrigation.

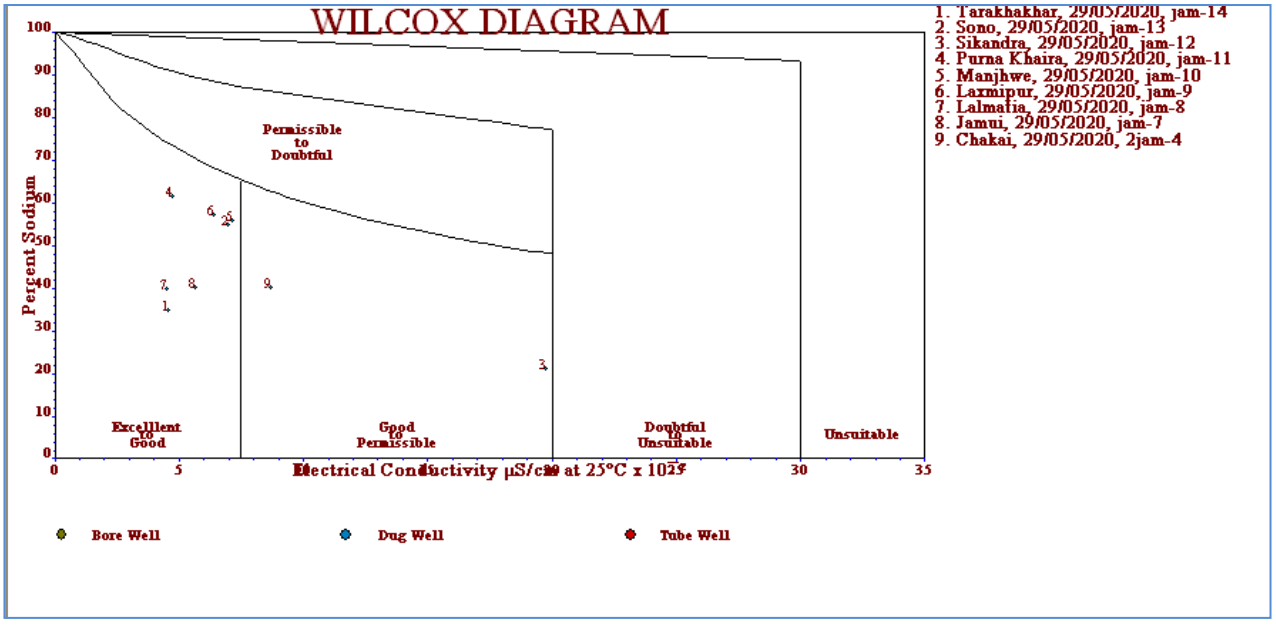


Fig.32 Wilcox Diagram explaining the suitability of Ground Water in Jamui District for Irrigation

The water quality report of Public Health Engineering Department, Govt. of Bihar, reveals that all the 10 blocks in Jamui district has been reported with the concentration of fluoride in ground water more than the permissible limit of 1.5 mg/lit. 1153 habitation in Jamui district has been affected by fluoride contamination in ground water. The other reports on fluoride in ground water in Jamui district reveals that fluoride has been found to be recorded higher than the permissible limit in ground water mostly in granite, granite gneiss terrain. The Pegmatite intrusive areas sometimes are also associated with high F rich ground water. The fluoride rich minerals in the host rocks may be probable source of dissolution of high fluoride in ground water in favourable condition. The weathering and dissolution of fluoride rich mineral i.e fluorite, apatite, sphene, biotite etc. in granite or gneissic terrain under favourable geochemical condition releases fluoride in ground water. The weathered mantle and marginal alluvium sediments adjacent the hard granitic terrain is often reported with higher concentration of Fluoride. The study also reveals that fluoride in ground water more than the permissible limit has been reported both from the shallow and deeper aquifers. Shallow aquifers contribute 23% of the samples more than the permissible limit whereas the deeper one contributes 34% samples. It also says that the ground water from hard rock area is more enriched in fluoride in ground water than in alluvial terrain in Jamui district. Figure 33, shows the depth wise reporting of Fluoride concentration in ground water in shallow dug wells of weathered mantle/alluvium and in fractured aquifers. At the same location both shallow and deeper aquifers are reported with high enrichment of fluoride.

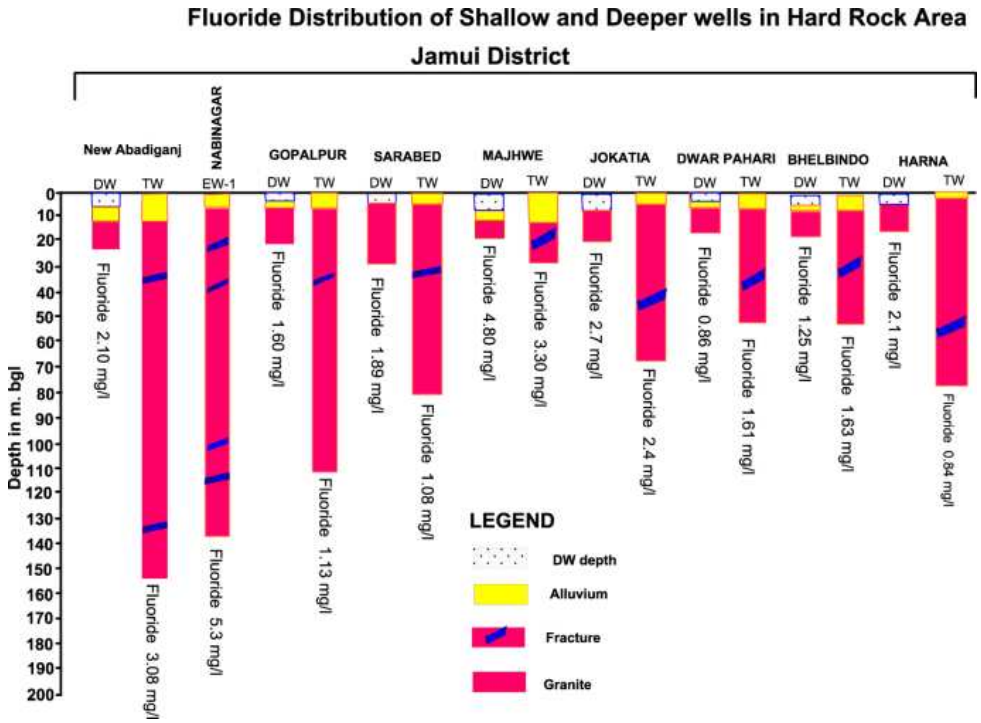


Fig.33 Spatial and Vertical Distribution of F in aquifer in Jamui district.

Table2.30 Chemical analysis report of water sample in Jamui District, Bihar

S.N	Block	Location	Lattitude	Longitude	pH	EC(µs/cm) at 25°C	TDS	TH	Ca2+	Mg2+	Na+	K+	$CO_3$2-	HCO_3-	Cl	SO_4	NO_3	F
									mg /l									
1	Chakai	Chakai	24.55	86.4	7.6	876	569.4	232	42	30.87	72	4.1	0	108	138	78	27	0.41
2	Jhajha	Gidhaur	24.85	86.31	7.2	449	291.85	127	22	17.00	39	1.3	0	152	21	29	32	0.94
3	Jamui	jamui	24.93	86.16	7.5	571	371.15	169	10	35.00	52	1.9	0	154	74	49	3	0.29
4	Lakshmipur	Lalmatia	24.98	86.31	8	455	295.75	112	17	17.00	34	1	0	188	4	27	19	0.88
5	Lakshmipur	Laksmipur	25	86.4	7.4	646	419.9	109	11	19.81	67	1.1	0	62	109	16	29	0.1
6	Jamui	Manjhwe	25.03	86.15	8.3	719	467.35	146	19	23.94	85	1	18	277	29	37	6	2.94
7	Khaira	Purna Khaira	24.87	86.2	7.7	476	309.4	82	25	4.74	61	2	0	156	49	34	1	0.67
8	Sikandra	Sikandra	24.93	86.05	7.6	1977	1285.05	409	9	94.00	88	253	0	502	201	224	31	0.94
9	Sono	Sono	24.74	86.37	8.1	702	456.3	146	19	23.94	81	0.8	0	344	22	19	11	0.66
10	Chakai	Tarakhar	24.58	86.4	8	460	299	152	34	16.00	37	0.9	0	167	19	41	26	0.78

CHAPTER 3

Generation of Aquifer Maps

3.1 Lithological Disposition

In order to frame the aquifer map of the area the detail lithological disposition in the area has been worked out from the available exploration data. The individual lithology, unconsolidated sediments, weathered materials or hard rock with fracture systems has been demarcated and accordingly lithological model, fence, sections are prepared. The lithology model/ sections are interpreted and grouped to generate aquifer map of the area.

The subsurface geology of the area has been unearthed by correlation of subsurface lithological units. The lithologs of the exploratory bore holes of CGWB in Jamui district has been compiled for preparation subsurface correlation diagram. The location map of the bore holes is plotted in fig.34.

A considerable area in the district being underlain by hard granitic/gneissic/ quartzite rocks, therefore, in terms of ground water prospects in the district the mapping of the depth of weathered sediments and the incidences of fractures in the bed rock definitely acquire significant roles. Keeping above in mind, the thickness of the alluvium and weathered sediments above the hard rock in the study area has been worked out from the exploratory bore hole data of CGWB and utilised in lithology model/fence (fig.35a, 35b, 35c) under Rockworks 17 platform. The actual lithology which are encountered (alluvium/weathered sediments/hard rock/ fractures) in each borehole are assigned same G value for the similar items, and thus correlation is done on the basis of modelling the G value. 24 bore hole data within the depth range of 35 m to maximum 190 m has been compiled in the present study. The area being undulating terrain reduced level data wrt msl has been considered for each bore hole which reveals minimum elevation of 62 m amsl in the northern parts of the district to maximum elevation of 306 m amsl in the southern parts of the district around Chakai block. The thickness of alluvium is maximum in alluvial area in Aliganj, Sikandara and in parts of Jamui, Barhat blocks. Maximum alluvium cover of 85 m has been reported in the exploratory bore hole at Islamnagar in Sikandara block, whereas, the bore hole at Sikandara high school and Mahendro Simaria bore hole indicate thickness of 80 m and 55 m respectively. 45 to 70 m thick alluvium is encountered at the bore hole at Aliganj and Arha village in Aliganj block. In parts of Jamui, Barhat and Laxmipur blocks alluvium thickness of 30-45 m has been reported in number of bore holes. In other parts of study area in Chakai, Sono, Gidhaur, Jhanjha blocks and in considerable area in northern parts of Jamui block around Nabin nagar village, western parts of Laxmipur block the thickness of alluvium is very less and unconsolidated sediments mostly comprises weathered

residuum of 6-30 m thick. The exploratory bore hole at Nabinnagar in northern parts of Jamui block and Patharghat bore hole at Sangrampur block in Munger district, bordering the western parts of Laxmipur block is reported with 6-7 m weathered sediments. Thickness of weathered sediments is less than 15-20 m in Chakai and Sono area. Among other controlling factors, the nature of parent rocks controls the extent and depth of weathering. On the basis of factual evidences from the exploratory bore holes data of CGWB in Bihar State, it is reported that the depth of weathered residuum, in general, is less in schist and quartzite area than in gneissic terrain. The Patharghat exploratory bore hole in Sangrampur block in Munger district, bordering Laxmipur block in Jamui district may be a classic signature of the above facts.

Within the bed rocks the occurrences of considerable fractures are common. Areas where the thickness of alluvium or the weathered residuum is meagre, the productive fractures (fractures with sets of interconnections or connection with positive boundaries) are the only source of potential ground water yield. The lithological model diagram and fence demonstrate the occurrences of at least 4-6 sets of fractures which includes both shallow (within 80 m depth) and deep seated fractures. Deep seated fractures are encountered even below 160 mbgl. However, the occurrences of fractures are discontinuous and site specific. The inhomogeneity of occurrences of fractures both laterally and vertically can never be ruled out.

However for better understating of the subsurface disposition of unconsolidated sediment s and bed rock more closed space bore hole data may be required.

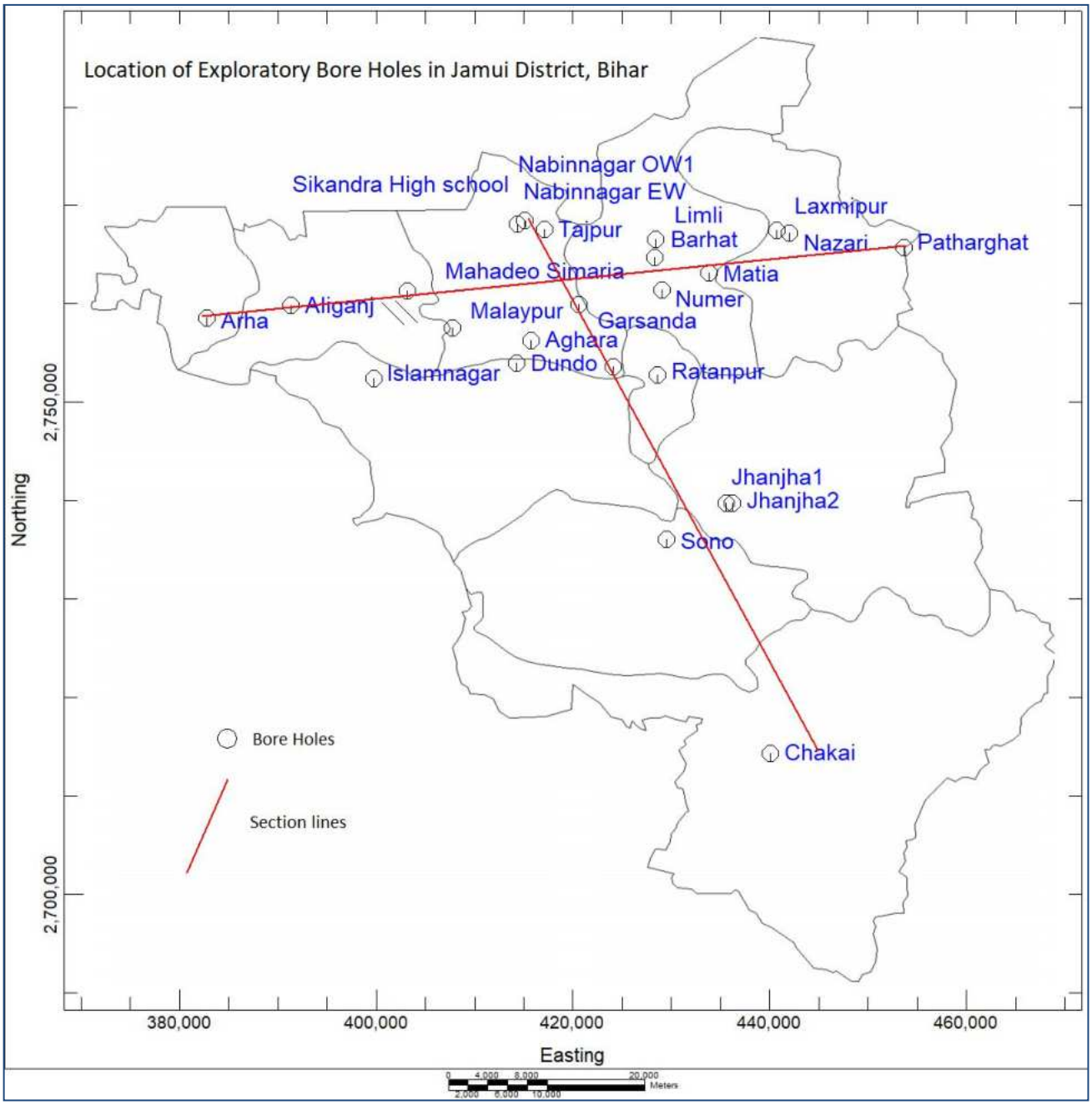


Fig.34 Location of the Bore Holes

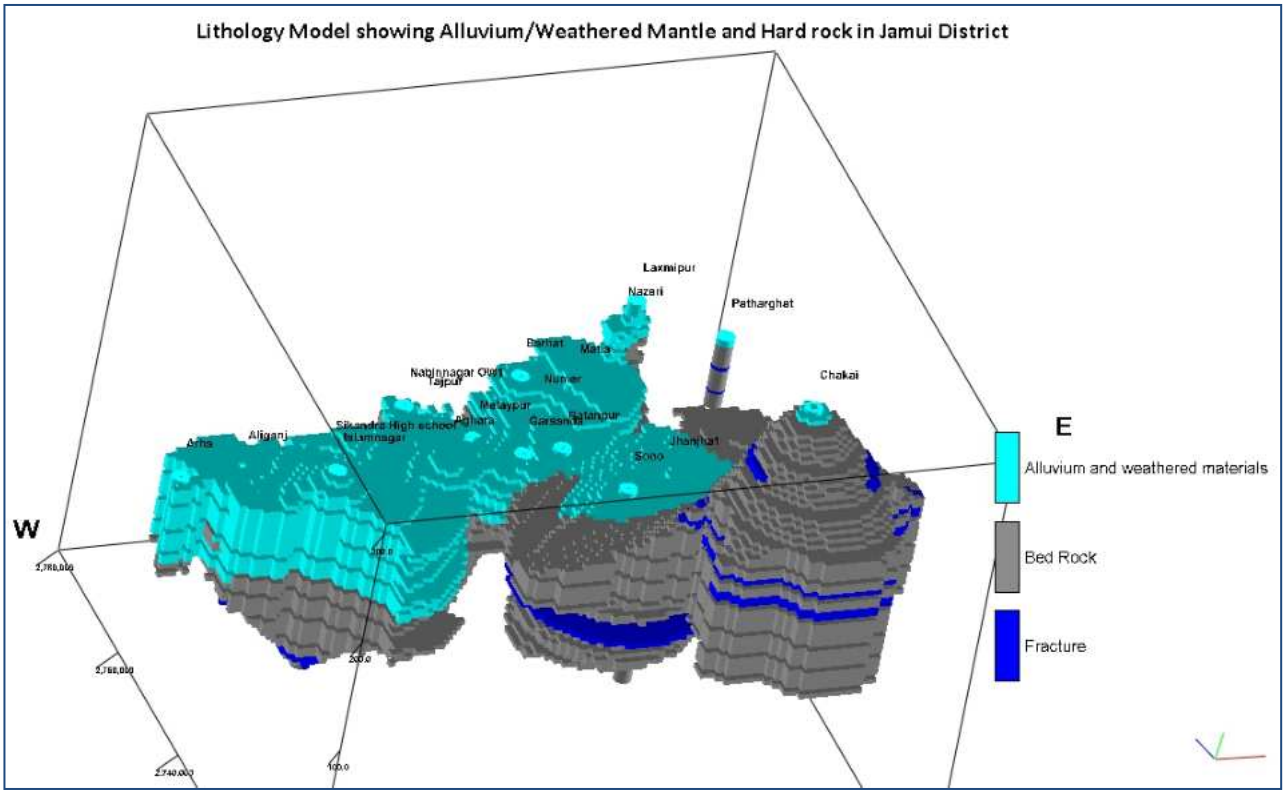


Fig.35a. Lithology Model (I) in Jamui district.

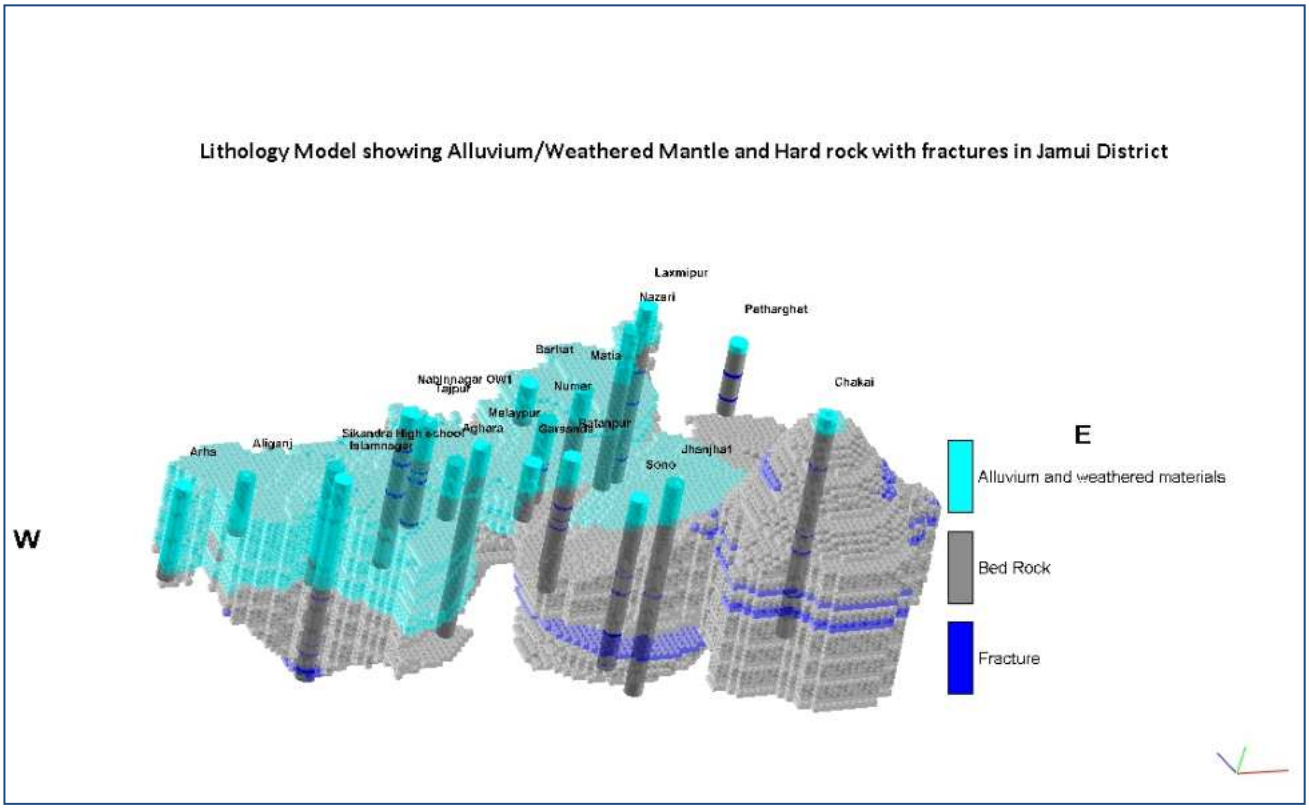


Fig.35b. Lithology Model (II) in Jamui district.

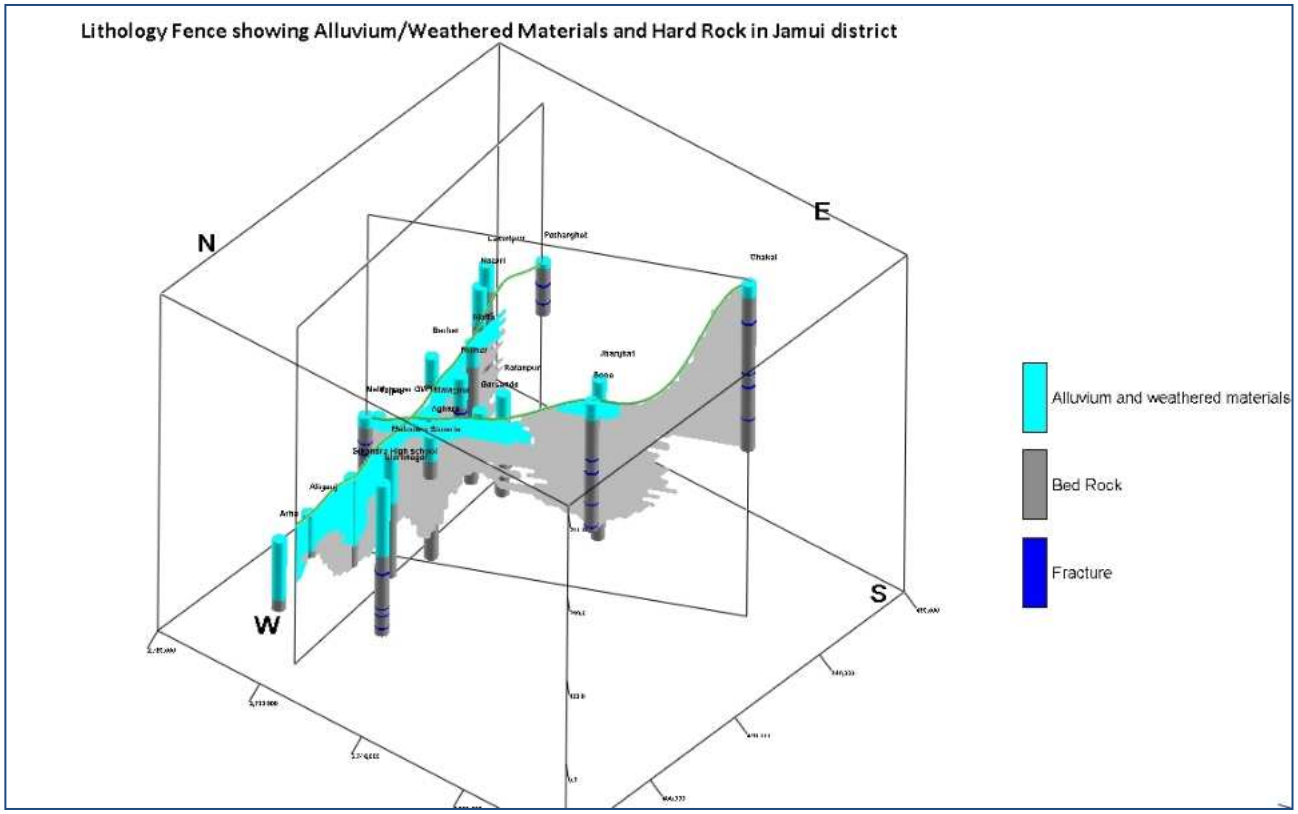


Fig.35c Lithology Fence in Jamui district

Number of sections showing the disposition of alluvial sediments/ weathered materials and bed rock are portrayed in Fig 36, 37. The Arha/Aliganj_Pathargahata (E_W) section reveals that the thickness of the unconsolidated sediments decreases from west towards east. The alluvial sediments are maximum around ALiganj_Sikandara block and from Malaypur area in Jamui block , the considerable decrease of thickness of unconsolidated formation has been observed. The section also depicts the depth of occurrences of fractures in bed rock. Nabinnagar_Chakai or Barhat_Chakai north-south section reveals more or less uniform thickness (20 m) of unconsolidated sediments mostly of weathered materials which gradually decreases south ward in Chakai where thickness of weathered materials are 10-15 m only. However, the fractures are more prominent in north south sections.

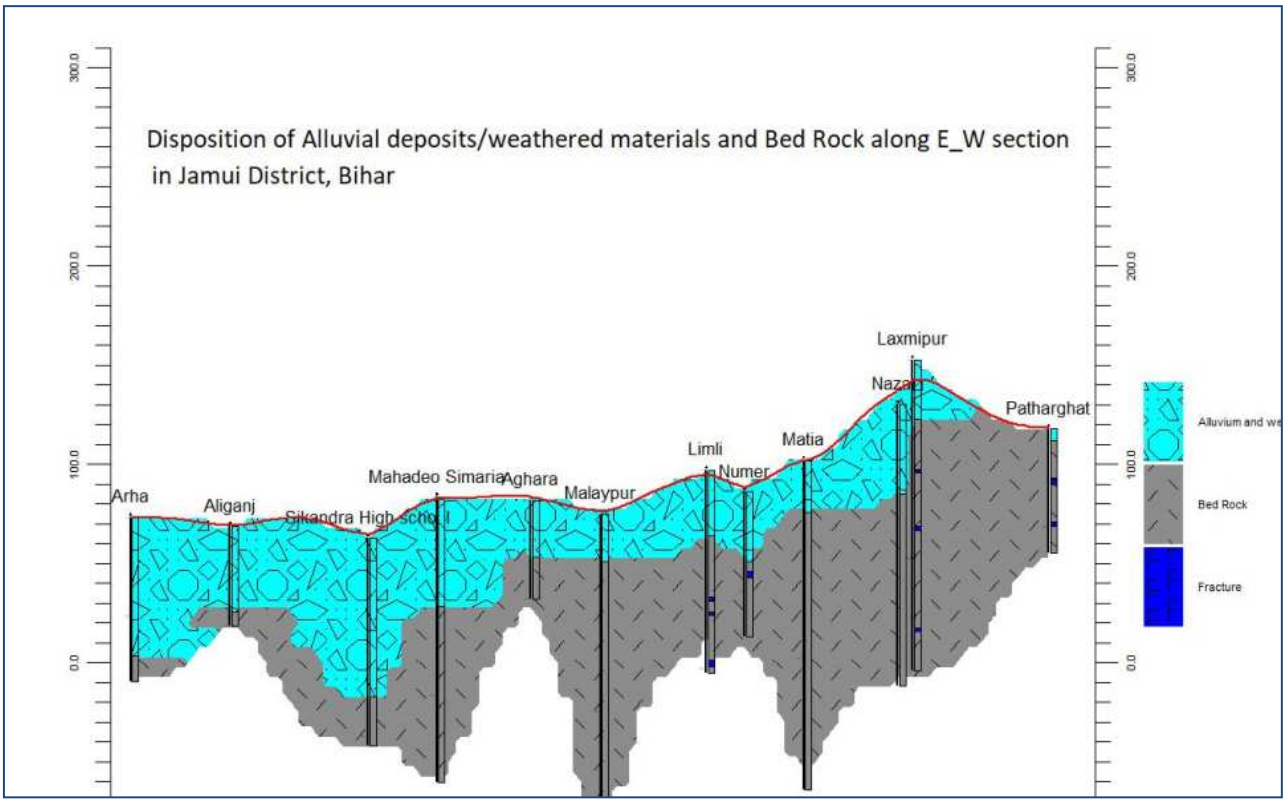


Fig.36 Lithological Disposition along E_W Section

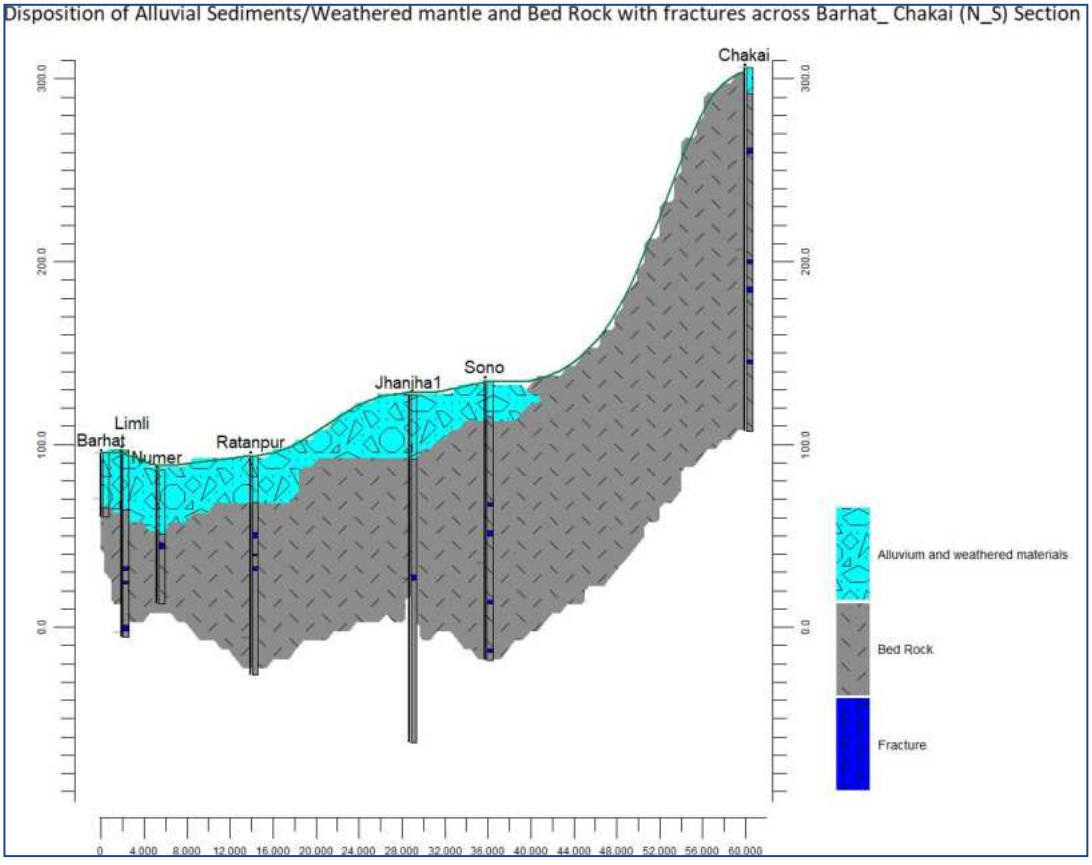


Fig.37 Lithological Disposition along N_S section

More detail lithological disposition has been represented for 3 northern blocks of Jamui district namely Jamui, Barhat and Laxmipur blocks fig.38. The lithological model (fig.39) as well as the lithological sections (fig.40 a to d) reveals that occurrences of yellow surface soil with clay of 10 m thick is predominant around Jamui and Barhat block which pinches out further east in the western part of Laxmipur block. Surface soil, along with underlying coarse to medium sands of limited thickness constitute the alluvial sediments in the area. The average thickness of the unconsolidated sediment is 20-30 m. The weathered granite or quartzite at places along with the alluvial sediments comprises the unconsolidated formation in the area. The thickness of unconsolidated formation is comparatively more in Jamui and Barhat block than in Laxmipur block.

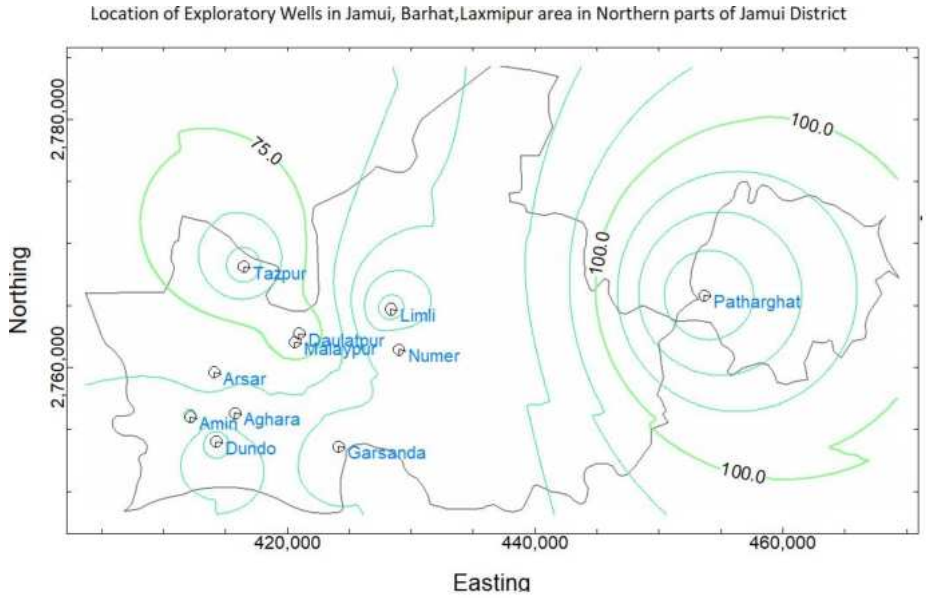


Fig.38Location of Boreholes

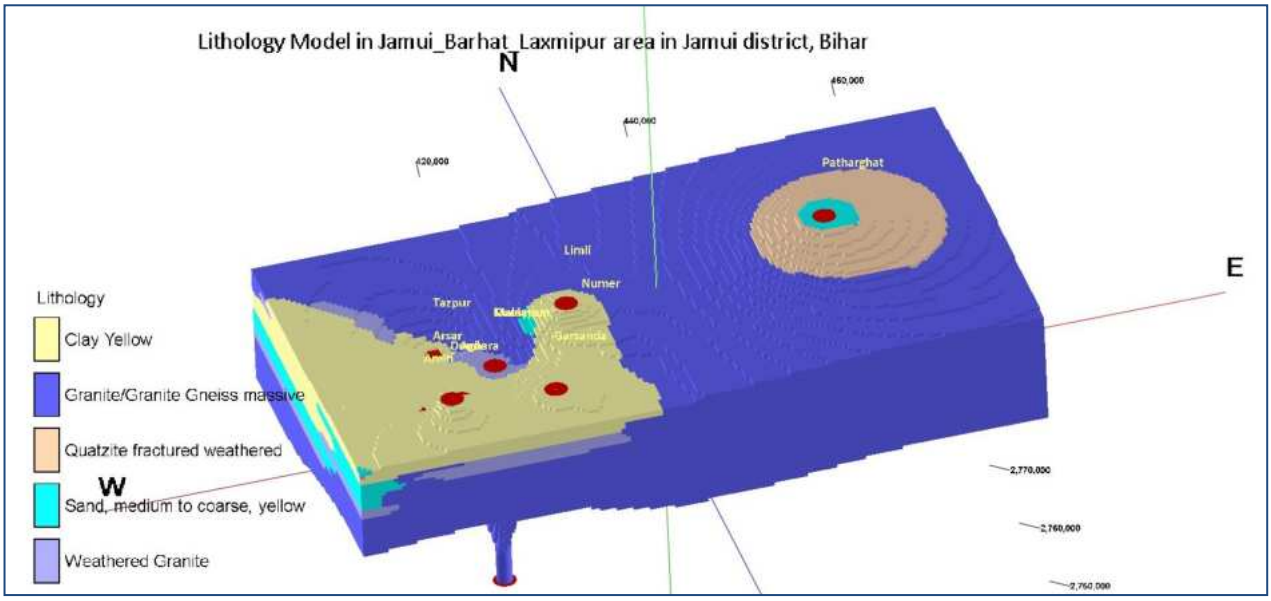


Fig.39 Lithology Model for Northern Blocks in Jamui district

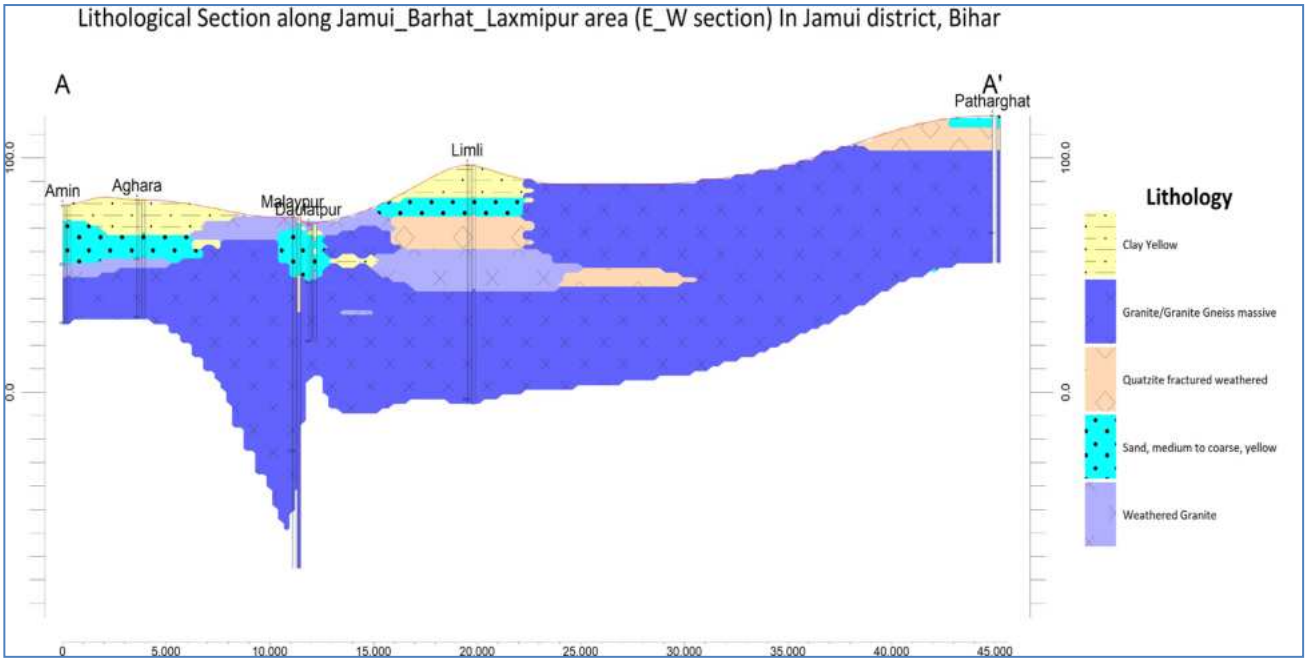


Fig.40a E-W sections depicting lithological disposition in the northern parts of Jamui District

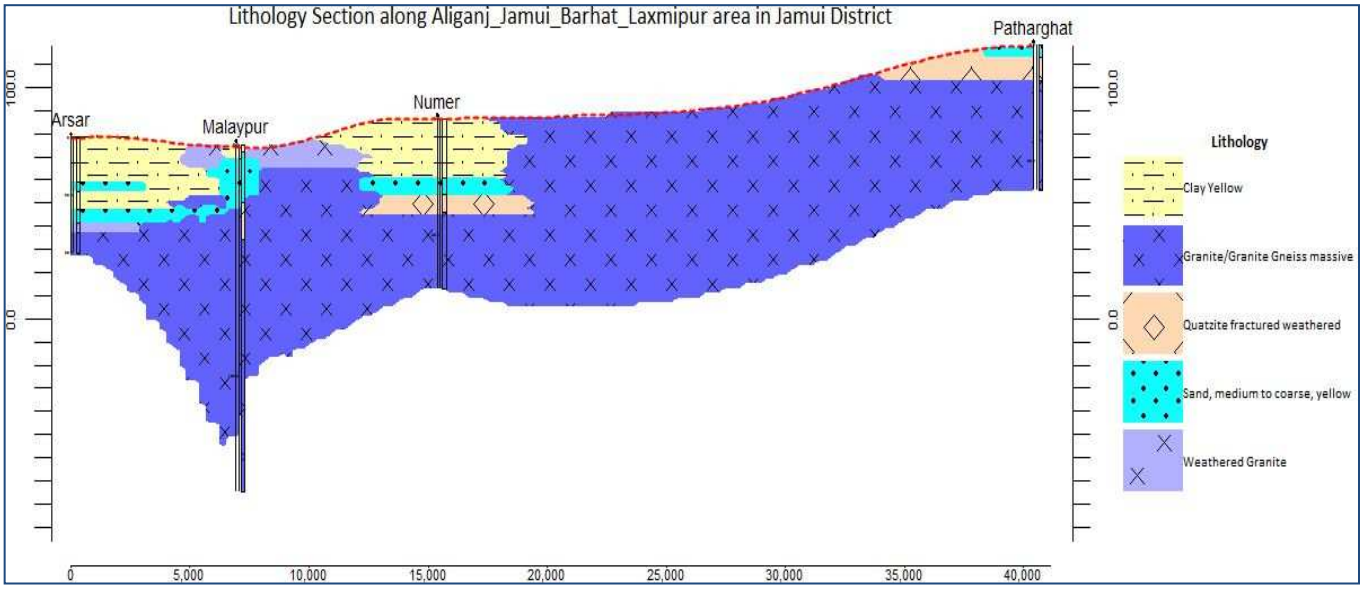


Fig.40 b E-W sections depicting lithological disposition in the northern parts of Jamui District

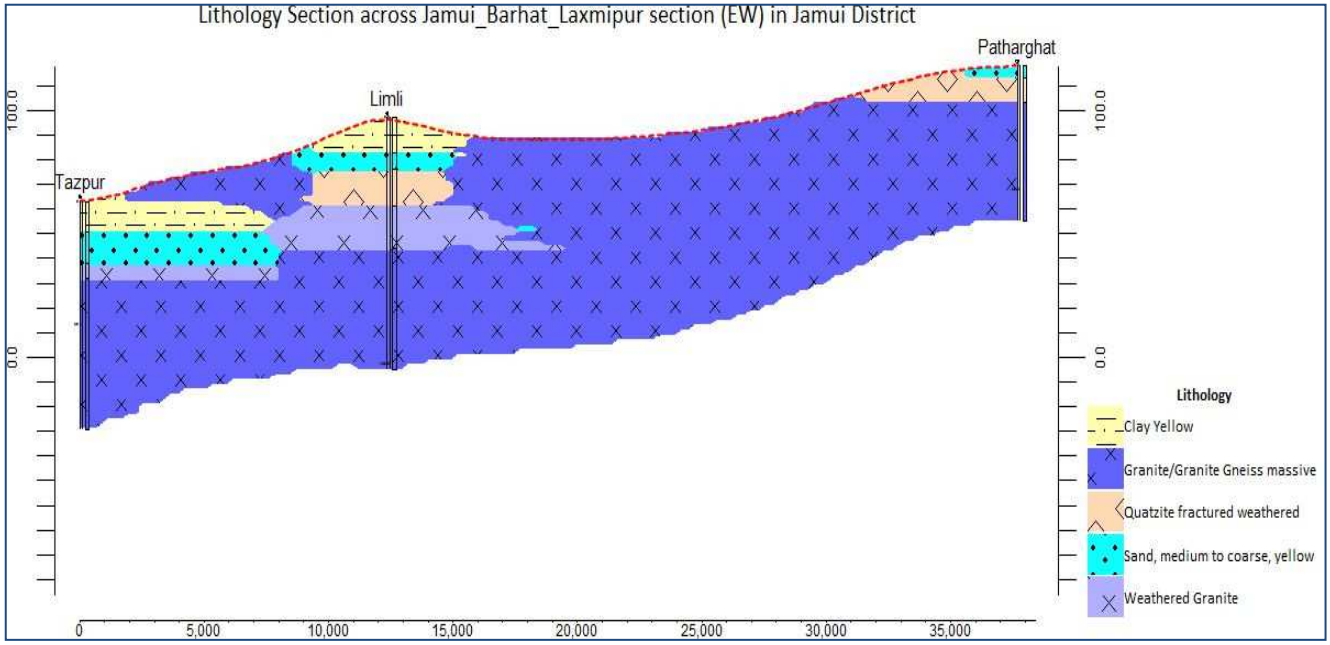


Fig.40c E-W sections depicting lithological disposition in the northern parts of Jamui District

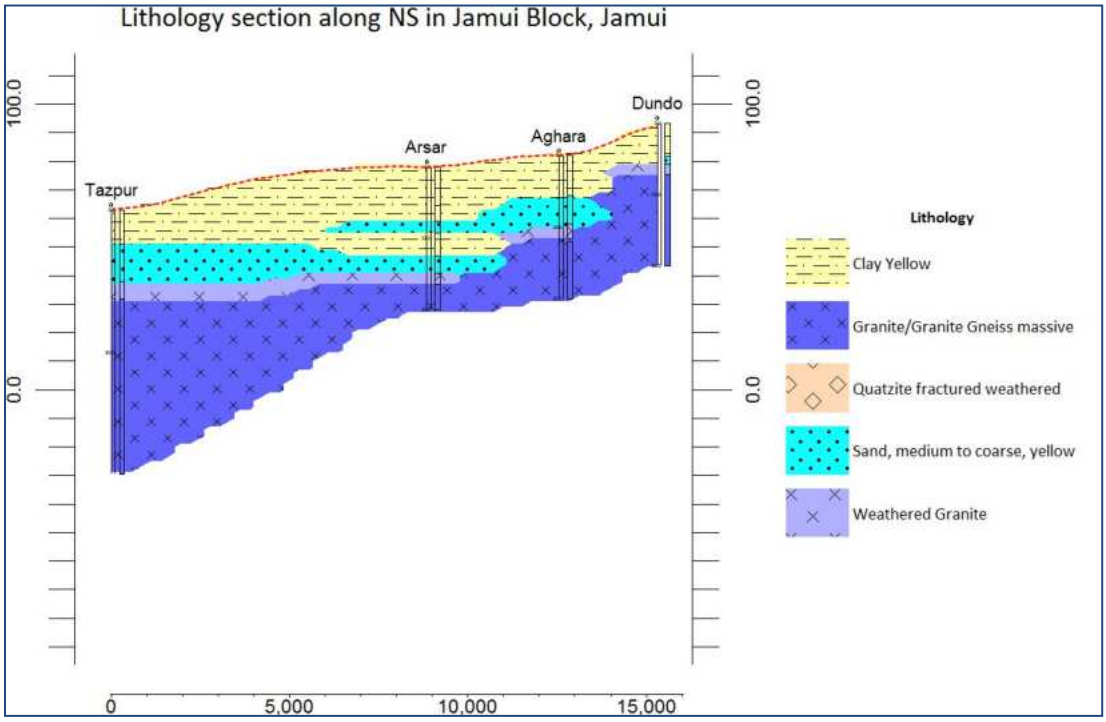


Fig.40 d N_S sections depicting lithological disposition in the northern parts of Jamui District

3.2 Aquifer Disposition

The correlations, interpretation, generalization and subsequent grouping of the granular horizons/unconsolidated sediments and the hard basement rock with secondary porosities leads to differentiate two dominant Aquifer systems in the district. In hard rock dominance area, the unconsolidated sediments comprising the alluvial deposits of limited thickness along with the weathered mantle constitute the 1st Aquifer system and the hard basement rock with secondary porosity constitutes the 2nd Aquifer System (Fig. 41 a & b). The vertical extent of 1st Aquifer system is 20-30 m, which further reduces towards eastern and southern parts of the district. The 2nd aquifer systems depending on the occurrences of potential fractures are explored down to the maximum depth of 200 m in the district. In alluvial blocks the 1st aquifer system consists of granular zones of coarse to medium sands down to maximum depth of 30 mbgl. Below that, the deeper or the 2nd aquifer system continues till the depth of encounter of hard rock. The maximum vertical extent of 2nd alluvial aquifer system in Jamui district lies within 80-90 mbgl.

More detail representation of aquifer dispositions for Jamui, Barhat and Laxmipur blocks in the district reveals the occurrences of surface soil throughout which is followed down by granular zones of alluvial origin. The surface soil and underlying granular zones constitutes the alluvial aquifer. The alluvial aquifer is underlain by weathered mantle which is also considered as part of unconsolidated aquifer system in the area. This unconsolidated aquifer of alluvial sediments and weathered residuum is persistent in these three blocks. However, at Arsar and Tazpur area in Jamui block occurrences of thin persistent aquitard of limited thickness has been observed which pinches out in the west (Fig.42a & b).

3.3 Aquifer Characterization

The transmissivity value in alluvial area varies from 31 m^2/day to 535 m^2/day. The lower transmissivity value indicates limited extent and thickness of the aquifers. Lower value transmissivity around Aliganj may be due to the occurrence of mounds underneath the alluvial cover resulting in lowering of thickness of aquifer. The optimum yield in hard rock terrain varies from 10 to 40 m^3/hr. for drawdown of 30 m. The specific capacity of these wells ranges between 0.54-1.02 m^3/hr/m drawdown in hard rock and 2.67-13.91 m^3/hr/m drawdown in alluvial aquifers. The transmissivity of the aquifer in the hard rock terrain varies from12 m^2/day to 30 m^2/day. The nature and the potentiality of the fracture system influence the value of transmissivity in hard rock terrain. The storativity value indicates the semi confined nature of the aquifers (Table 2.20).

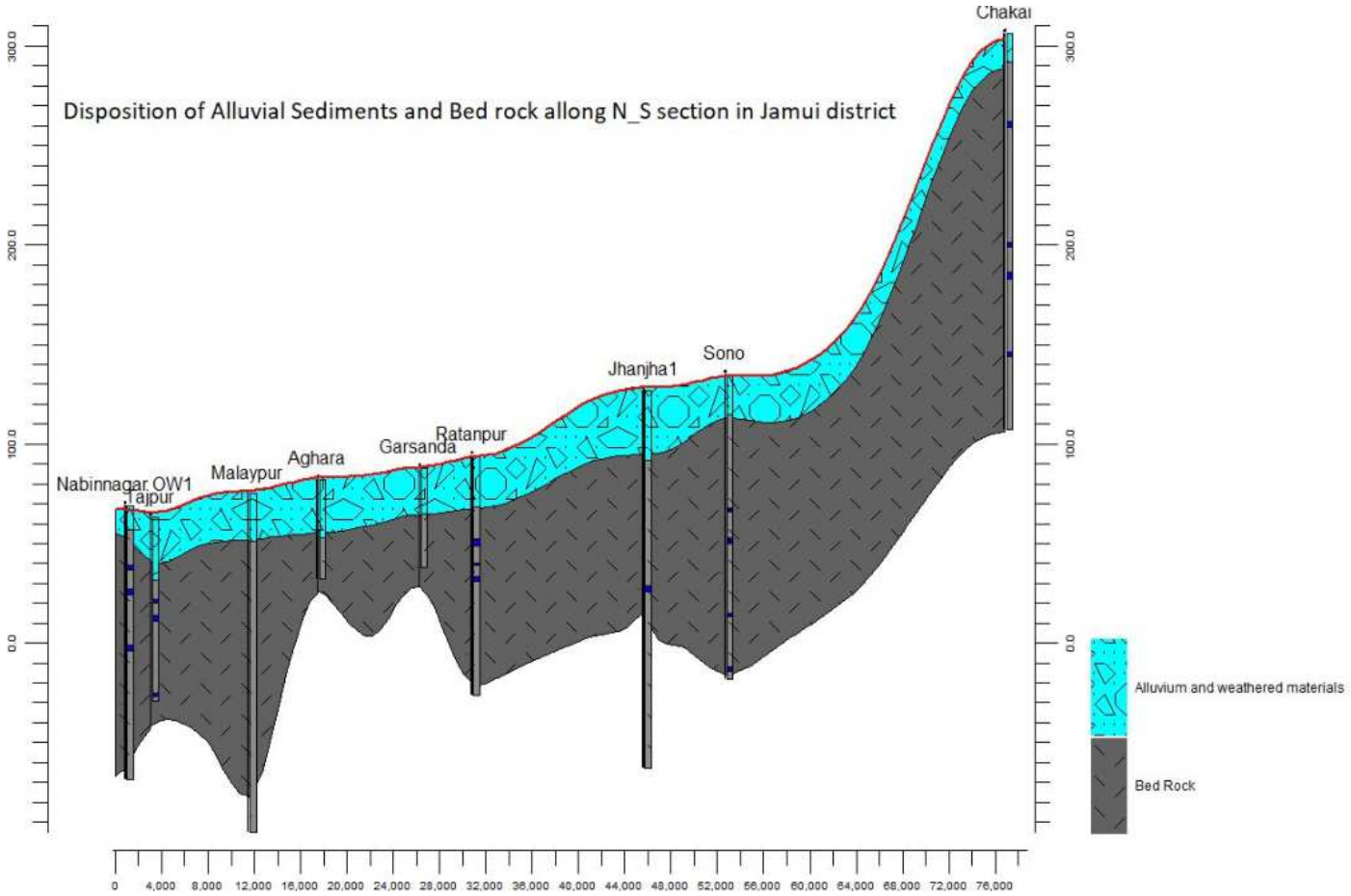
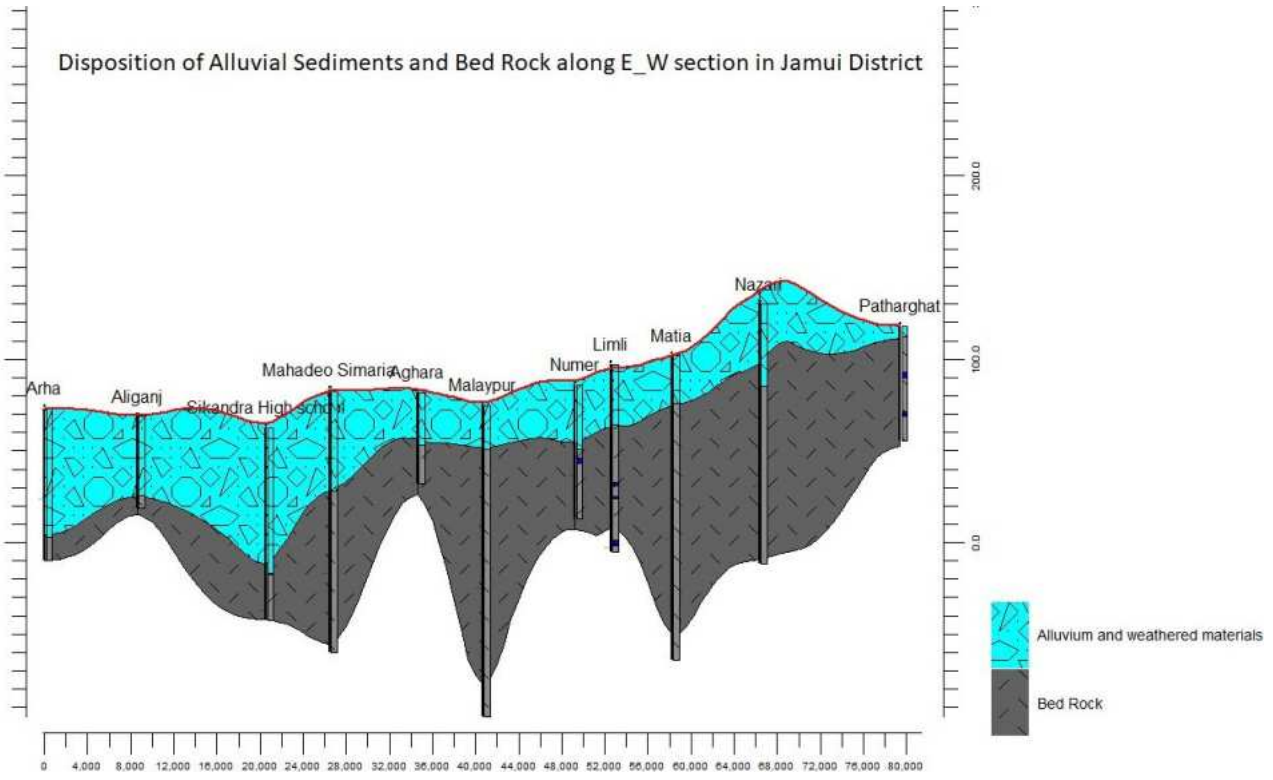


Fig 41 a & b Aquifer Disposition



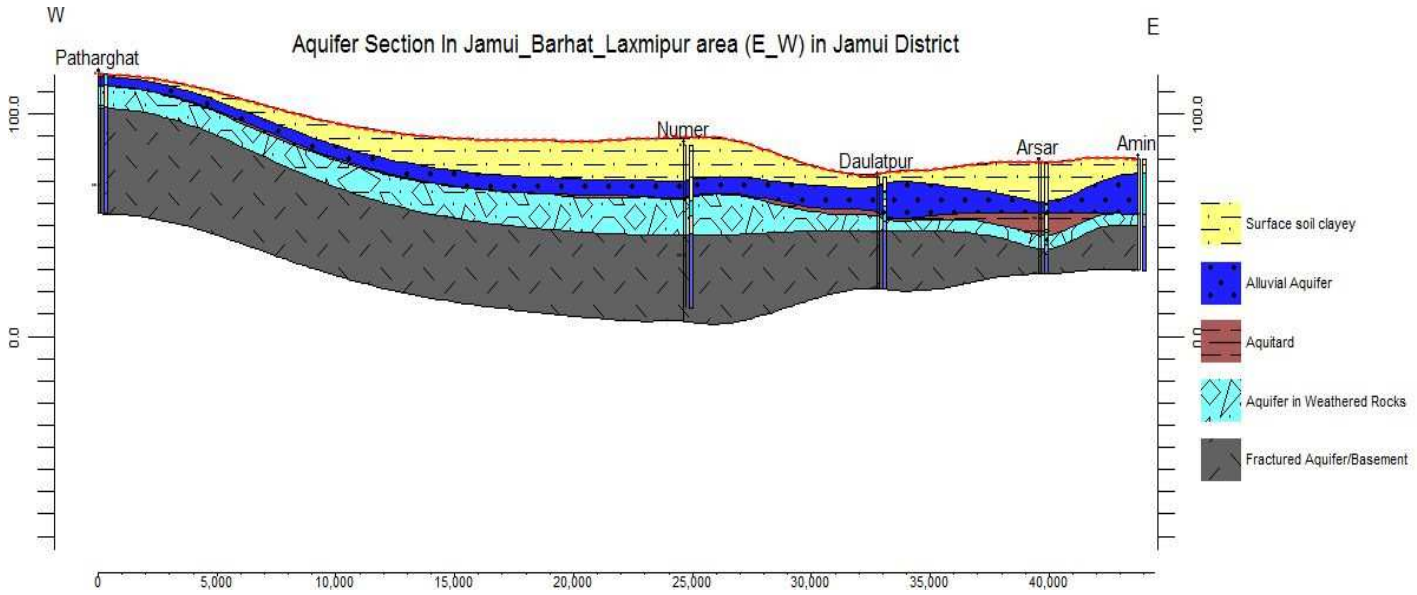
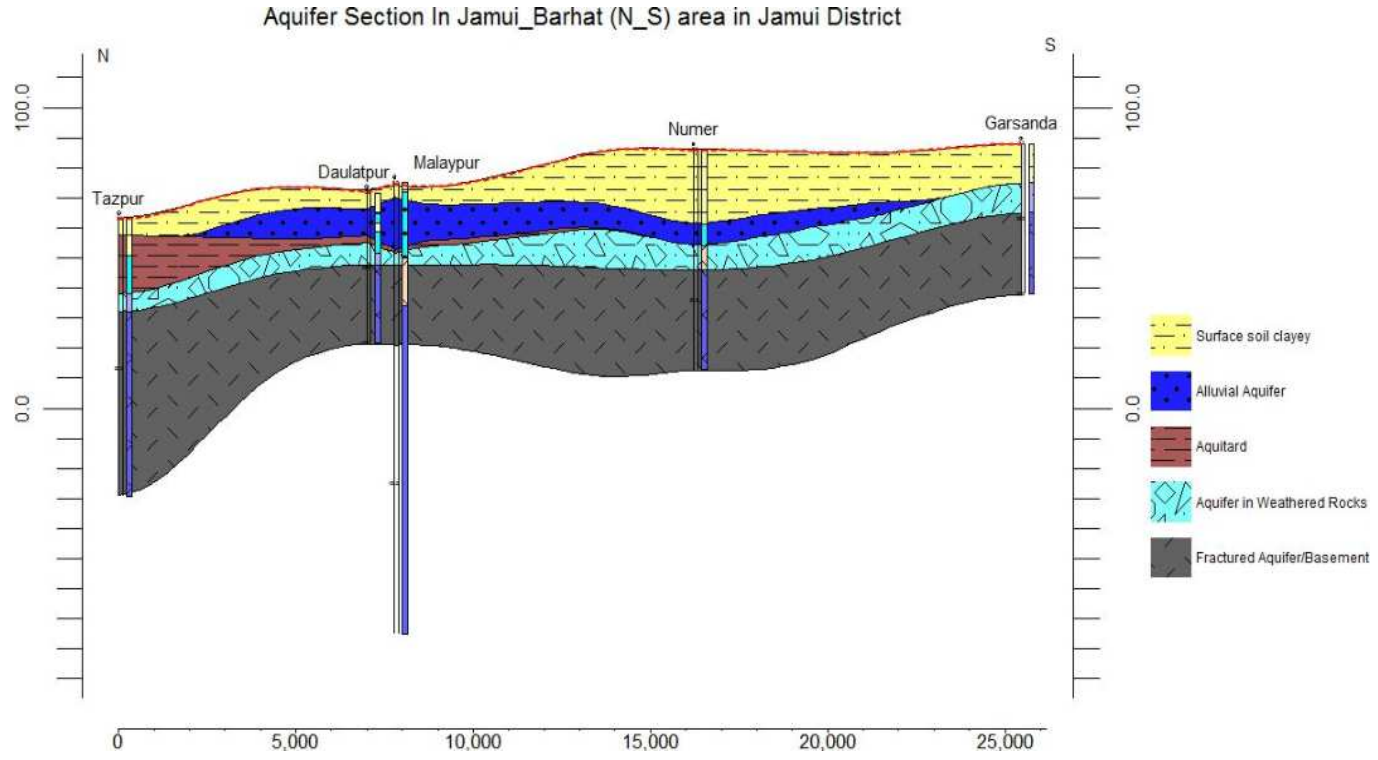


Fig.42 a & b. Aquifer Disposition in northern parts of the district



CHAPTER-4

Ground Water Resources

4.1 Dynamic Ground Water Resource

Dynamic ground water resources for phreatic aquifer in alluvial and in hard rock area in the district has been assessed following the methodology of GEC-2015. The 10 administrative blocks have been taken as the unit of the assessment. Total recharge worthy area in the district is 2551.14 sq. km against total geographical area of 3098.26 sq.km. The hilly area and the area with more than 20% of slope has been identified and not considered as the potential area for recharge of phreatic aquifer. The total annual recharge has been estimated based on the recharge due to rainfall in monsoon and non monsoon seasons and recharge due to other sources like return seepage from surface irrigation networks, return seepage from ground water irrigation or percolation from tanks, ponds etc. As per the norms recommended by GEC-2015, the annual extractable ground water recharge has been estimated after subtracting unaccounted natural discharge, which goes out of the aquifer as base flow etc. The total annual extractable ground water recharges for Jamui district is 36951.44 ha m or 370 mcm. The total annual extraction of ground water in the district is 11806 ham or 118 mcm under irrigation, industrial and domestic draft. Irrigation draft contributes almost 70% of total annual draft in the district. The irrigation draft has been assessed on the basis of 5^{th} MI census data of the shallow, medium and deep tube wells and their unit draft. The ground water for irrigation uses are more in alluvial area, 82% and 78% of total draft for all uses are extracted for irrigation uses in Gidhaur block and Jamui block respectively. In hard rock area irrigation draft is less, about 50% total draft is used for irrigation in area underlain by hard rock. Net ground water availability for future uses in the district is 27193.56 ham or 272 mcm. Therefore, a major share of net ground water availability in the district is still available for future development in the district. The stage of ground water extraction on an average in the district is 34%, lowest being 14% in Barhat block and maximum of 55% in Jamui block. All the blocks are categorised as safe in terms of level of ground water development. Table 4.10 and fig.43 describes the assessment unit wise comparative attributes of ground water resources in the district.

Table 4.10 Dynamic Ground Water Resources in Jamui district, 2017

Assessment Unit Name	Predominant Rock formation	Total area (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)				Net Ground Water Availability for future use	Stage of Ground Water Extraction	Categorization (OE/Critical/Semicritical/Safe)
					Irrigation Use	Industrial Use	Domestic Use	Total Extraction			
Aliganj	Alluvium	17289	17289	4859.90	829.70	52.74	225.14	1107.58	3897.73	22.79	Safe
Barhat	Alluvium / Hard rock	23216	19293	2467.04	175.29	16.35	151.79	343.43	2221.64	13.92	Safe
Chakai	Hard Rock	77404	70131	4701.99	423.00	40.51	387.15	850.66	4101.38	18.09	Safe
Gidhaur	Alluvium	7111	7111	2417.48	832.65	48.02	127.67		1491.60	41.71	Safe
Jamui	Alluvium	17391	13390	4096.95	1800.45	118.67	367.71	2286.84	2042.52	55.82	Safe
Jhajha	Hard Rock	42739	34187	3228.53	1037.20	108.27	611.94	1757.41	1927.12	54.43	Safe
Khaira	Alluvium	41871	31577	6620.07	1274.93	83.15	388.10	1746.18	5124.56	26.38	Safe
Lakhimpur	Hard Rock	25177	17001	1624.02	361.41	28.29	204.37	594.07	1161.95	36.58	Safe
Sikandra	Alluvium / Hard rock	18401	14562	4862.70	866.31	55.56	244.80	1166.67	3854.13	23.99	Safe
Sono	Hard Rock	39227	30573	2072.76	530.57	48.58	365.71	944.86	1370.93	45.58	Safe
		309826	**255114**	**36951.44**	**8131.55**	**600.14**	**3074.38**	**11806.04**	**27193.56**	**34%**	

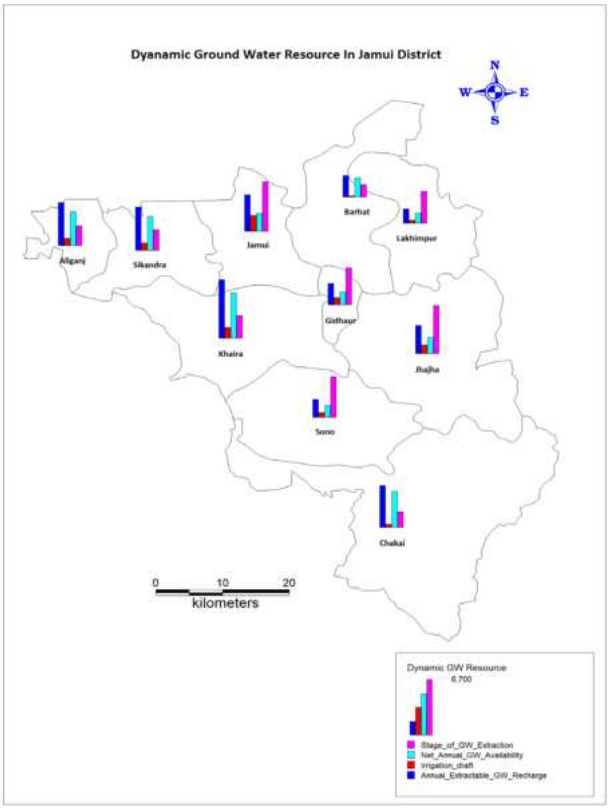


Fig.43 Distribution of Recharge and Draft in Jamui District.

4.2 Static Ground Water Resource

Static /In-storage resource of ground water in the unconfined aquifer below the dynamic zone or below the zone of water level fluctuation till the bottom of the unconfined aquifer has been assessed as per the guidelines proposed by GEC-2015. The depth or the bottom of the unconfined aquifer for different assessment units/ block has been arrived by reconciling the aquifer maps and the available exploration data in the district. Specific yield is considered as 2% for hard rocks area and 6% marginal alluvial area. Total static/In-storage ground water resource in the district has been estimated as 221655 ham or 2217 mcm which is about six times than the total annual extractable resources (table 4.20). However, the static resources are not accountable for development point of view.

Table 4.20 Static/In-storage Ground Water Resources in Jamui district

S.No	Name of the Assessment Unit	Static Resources Area (ha)	Pre-monsoon water level	Bottom of unconfined aquifer (m)	Difference	Specific Yield	Total Static Resources (ha)
1	Aliganj	17289	6.26	30	23.74`	0.06	24626.45
2	Barhat	19293	7.06	30.00 / 20.00	22.94 / 12.94	0.06 / 0.02	9631.45
3	Chakai	70131	9.44	30	20.56	0.02	21628.40
4	Gidhaur	7111	6.17	30	23.83	0.06	10167.31
5	Jamui	13390	6.65	40	33.35	0.06	26793.39
6	Jhajha	34187	6.71	20	13.29	0.02	6815.18
7	Khaira	31577	6.59	50	43.41	0.06	82245.45
8	Lakhimpur	17001	8.99	50	41.01	0.02	10458.17
9	Sikandra	14562	6.57	25.00 / 20.00	18.43 / 13.43	0.06 / 0.02	13399.55
10	Sono	30573	10.35	45	34.65	0.02	15890.32
Total							**221655**

CHAPTER-5

5.1 Major Ground Water Related Issues in the Area

- Among 10 blocks in the district, substantial parts of 6 blocks are underlain by hard rock of granite gneiss, granite, schist, quartzite etc. The occurrence of ground water in these blocks are limited and primarily depends on the thickness of the weathered residuum or the occurrences of shallow or deep seated potential fractures. The existing exploration data in the hard rock terrain of the district reveals that the yield of the wells are often less than 3 lps with specific capacity around 1 m^3/hr/m and transmissivity less than 50 m^2/day. Therefore the potentiality of the aquifers is limited which causes water scarcity in the area particularly during lean period.
- The porous formation which constitutes the Quaternary Alluvium of marginal tract is confined to the Jamui terrace with sediment thickness ranging from 35 to 100 m. The thickness of the alluvium also varies considerably depending upon the bedrock configuration. The area over the mounds in bedrock witnesses less thick alluvium thickness resulting in significant lowering of the potentiality of the alluvial aquifers too.
- As per the 5th MI census data, there are 1922 STW and 2059 MDTW in the district among which about 75% of the STW and 90% MDTW are restricted to the alluvial blocks. The depth of occurrences of majority of these wells is confined within the depth range of 20-60 mbgl causing stress on the particular zone.
- The deep tube wells for irrigation uses of more than 70 m depth are rare in the district.
- Feasibility of STW/MDTW/DTW for irrigation uses is constrained in hard roock terrain. The dug wells sometimes are used in irrigation but with very limited command area.
- Surface Irrigation network in the district is poorly developed, 80% of the total irrigated area are covered under ground water irrigation. Therefore, in absence of proficient surface irrigation network and unsuitability of tube well irrigation in many places resulting in overall poor irrigation development in the district, which registers only 140% of cropping intensity.
- Domestic and industrial draft in the district principally achieved from ground water only. Domestic and industrial draft comprises 30% of the total ground water draft. Domestic water supply, particularly in hard rock area largely depends on the bore wells in fracture zones. Tracing of potential sustainable fracture zone in water scare hard rock terrain often poses difficulties.
- Even in alluvial terrain due to clustering of irrigation tube wells spatially, both laterally and vertically (within a limited depth range) and the absence of thick potential sediments, the alluvial aquifers sometimes are not sustainable which results in long term lowering of post

monsoon water level to the tune of 10 cm/yr to 30 cm /yr particularly in Gidhaur, Jamui and Sikandra blocks.

- The perusal of the relief map of Jamui District reveals that the southern part, western parts and the north of north eastern parts witnesses topographic highlands with elevation of 250-440 mamsl. This high lands tends to merge with topographic low lands /valleys which has elevation of 60-100 amsl. Therefore, the higher gradient/slope in the area impedes ground water to recharge the underlying granular zones rather produce very high runoff which goes off as waste unless arrested by effective harvesting mechanisms.
- Fluoride contamination of ground water above the permissible limit of 1.5 mg/lit has been detected in the aquifers in all the 10 blocks in the district. Fluoride contamination as high as 5.3 mg/lit has been detected in few area. Both the shallow dug well zones and the deeper fractured aquifers are affected with Fluoride contamination in ground water. As per the PHED, Govt. of Bihar, 1153 habitation in Jamui district is affected.

CHAPTER-6

Aquifer Management Plan

On the basis of interpretation and analysis of Aquifer disposition/Aquifer Maps of Jamui district an effective Aquifer Management Plan is proposed to address the above said issues. Attempt has been made to accommodate the issues considering the disposition and potentiality of the underlying aquifers, available resource, existing development, future scope for further development, present irrigation potential from ground water resources in the district, existing cropping pattern , cropping intensity and moreover the quality.

6.1 Ground Water Management Plan for Drinking and Domestic Sectors:

In Bihar, Public Health Engineering Department (PHED), Govt. of Bihar is entrusted with the water supply to the population in rural and urban area. The source of drinking water supply is hand pumps and pipe water supply schemes. The dependence on ponds, river and streams has declined during the last 10 years (2001-2011) from 10.7% to 3.06%. Hand pumps remain the major source of drinking water in rural areas supplying water to 91.4% households (Census 2011). One hand pump is designed for 200-250 population whereas the pipe water supply covers 1000-1500 population. Bihar, however, witnesses very high volume of hand pumps of more than 6, 00,000 in the state. However, the tap water supply based on pipe water supply schemes is not adequate. As per census data only 1.4% of the households used to get tap water in 2001 in rural areas which increased to 2.5% in 2011 (CIMP Report,2013). The percentage share of household using hand pumps and wells as source of drinking water in Jamui district is around 80%. On the other hand the percentage share of households using tap water from WSS as source of drinking water fall much below and stands at 4-6 % for Jamui district (CIMP, Report,2013). It is to be noted that the tube wells within the premises of the individual households are mostly shallow within 30-40 feet depth. Therefore, these are mostly affected by contamination from surface leaching and microbial contamination. It has been estimated that a huge some of investment in the sector of drinking water supply would be required to realize the goal of covering at least 50% of rural population of the State under pipe water supply coverage (CIMP Report,2013).

The pipe water supply scheme in Bihar is categorised under Mini water supply scheme for 1000-1500 population, single village water supply scheme for 5000-15000 population and multi village water supply scheme for more than 50000 population covering number of villages. Each

considers 40 lpcd water supply for drinking and domestic needs. The multi village water supply schemes are designed mainly from surface water sources.

Considering coverage with pipe water supply schemes of 6% population in Jamui district, the water requirement for 50% and 100% coverage has been estimated for individual block. Out of the total population of 1760403, only 105623 has been brought under coverage in the district. With a target to bring 50% of uncovered population under PWSS about 12.74 MCM of resource will be required annually. Almost double the resource will be required to cover the entire population under PWSS (table 6.10). Based on the prevailing hydrogeological condition and the yield of exploratory wells in each block the average discharge of blocks are considered 15 m^3/hr to 30 m^3/hr and accordingly the annual unit draft of one tube well has been arrived for 8 hours running per day. Block wise required number of tube wells thus, estimated for the entire district for 50% and 100% coverage which figures 242 and 481 wells respectively. The block wise required number of tube wells is given in table 6.20.

Both the 1st and the 2nd aquifer in the district may be assigned for the desired requirement of drinking water needs and development plan may accordingly be prepared keeping site specific hydrogeology, yield and potentiality of the water bearing zones. In area of thick alluvial cover the deeper 2nd aquifer system with appropriate granular zones may be tapped for supply of drinking water. In hard rock area the potential fractures with sufficient interconnection may be suitable solution to get the desired discharges. However, keeping the possibility of contamination of fluoride in ground water in the area, water from each drinking water well must be tested before handing over for water supply. The potentiality of the aquifer in Jamui is not much profuse; hence, further development may affect the ground water regime in the area. Therefore, installation of tube wells/bore wells for drinking water, being foremost priority as per National Water Policy, may not be avoided, but keeping in view the significant effects on ground water regime, if any, the installation should always be implemented in phases with precaution. Any installation should always be compensated by construction of suitably design artificial recharge structures in respective aquifers.

It is to mention that, the above requirement is projected based on the feasible capacity of the aquifer in different hydrogeological terrain. In case, the designed discharge is considered less and accordingly lower capacity of the motors is used, the number of tube well required may increase proportionately. **The coverage of population in the district through pipe water supply schemes wherever archived during subsequent years under different plans may be coordinated with above for further development and management.**

Table.6.10.Annual Resource required to cover the population with PWSS in the District

Sl.No.	CD Block/Town	Total population	Population already covered under PWSS (6% of total population)	Population to be covered under PWSS with target of 50% coverage	Annual Resource required to cater the 50% of uncovered population @40lpcd (mcm)	Population to be covered under PWSS with target of 100% coverage	Annual Resource required to cater entire(100%) uncovered population @40lpcd (mcm)
1	Aliganj	136768	8206	64281	0.9385026	128562	1.8770052
2	Sikandra	148711	8923	69894	1.0204524	139788	2.0409048
3	Jamui	144757	8685	68036	0.9933256	136072	1.9866512
4	Barhat	92207	5532	43338	0.6327348	86675	1.265455
5	Laxmipur	124149	7449	58350	0.85191	116700	1.70382
6	Jhajha	226858	13611	106624	1.5567104	213247	3.1134062
7	Gidhour	77558	4653	36453	0.5322138	72905	1.064413
8	Khaira	235761	14146	110808	1.6177968	221615	3.235579
9	Sono	210445	12627	98909	1.4440714	197818	2.8881428
10	Chakai	235186	14111	110538	1.6138548	221075	3.227695
11	Jamui(NP)	87357	5241	41058	1.0490319	82116	2.0980638
12	Jhajha(NP)	40646	2439	19104	0.4881072	38207	0.97618885
	Total	**1760403**	**105623**	**827393**	**12.7387117**	**1654780**	**25.47732485**

Table: 6.20 Development Proposal of TW/BW in the district to cater the drinking water need through PWSS

Sl.No.	CD Block/Town	Geology	Annual Resource required to cater the 50% of uncovered population @40lpcd (mcm)	Annual Resource required to cater entire(100%) uncovered population @40lpcd (mcm)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day running)	No of Tube well/bore wells required to cater 50% target	No of Tube well/bore wells required to cater 100% target
1	Aliganj	Alluvium	0.9385026	1.8770052	0.0876	11	21
2	Sikandra	Alluvium	1.0204524	2.0409048	0.087	12	23
3	Jamui	Alluvium and Hard rock	0.9933256	1.9866512	0.0584	17	34
4	Barhat	Hard rock & Alluvium	0.6327348	1.265455	0.0584	11	22
5	Laxmipur	Hard rock	0.85191	1.70382	0.0438	19	39
6	Jhajha	Hard rock	1.5567104	3.1134062	0.0438	36	71

Sl.No.	CD Block/Town	Geology	Annual Resource required to cater the 50% of uncovered population @40lpcd (mcm)	Annual Resource required to cater entire(100%) uncovered population @40lpcd (mcm)	Unit draft of one TW in MCM (considering average discharge and 8 hrs/day running)	No of Tube well/bore wells required to cater 50% target	No of Tube well/bore wells required to cater 100% target
7	Gidhour	Alluvium	0.5322138	1.064413	0.0584	9	18
8	Khaira	Alluvium and Hard rock	1.6177968	3.235579	0.0584	28	55
9	Sono	Hard rock	1.4440714	2.8881428	0.0438	33	66
10	Chakai	Hard rock	1.6138548	3.227695	0.0438	37	74
11	Jamui(NP)	Alluvium	1.0490319	2.0980638	0.0584	18	36
12	Jhajha(NP)	Hard rock	0.4881072	0.97618885	0.0438	11	22
			Total			242	481

6.2 Ground Water Management Plan for Irrigation Sectors:

Agriculture is one of the principal sources of livelihoods of the people in the area. The major crops in the area are cereals which include paddy, wheat, maize etc. Other major crops are pulses, oilseeds, other horticulture crops, plantations etc. Three crop seasons are predominant in the district kharif, rabi and summer. Major share of kharif cultivation is rain fed although irrigation is provided as per need. It is evident from the table 1.9, that 56% of the total cropped area is rainfed. Area under rainfed cultivation in the district is 60317 ha, whereas irrigated area is 45880 ha. The irrigation facilities are moderate which support the most of the rabi crops, however the area under multiple crops are still limited. The cropping intensity in the district is 143%, with lowest of 108% in Chakai block and maximum of 165% at Jamui block. It is observed that pulses, oilseed cultivation in the district falls much below than cereals crop. Therefore, crop diversification and modification of cropping pattern; (keeping the fundamental crops unchanged) may increase the cropping intensity in a particular block. The reduction in irrigation to water intense cereal crop, say by 10%, reduce exploitation of irrigation water which may be utilized by less water intense crop like pulses, oilseeds which ultimately increases the coverage of irrigation. The tentative water column required for different crops is given in Table 6.3.

Table 6.3 Crop Water Requirements

Crop	Water Requirement (mm)	Crop	Water Requirement (mm)
Rice	1000-2000	Chilies	500
Wheat	450-650	Sunflower	350-500
Sorghum	450-650	Castor	500
Maize	500-800	Bean	300-500
Sugarcane	1500-2500	Cabbage	380-500
Groundnut	500-700	Pea	350-500
Cotton	700-1300	Banana	1200-2200
Soybean	450-700	Citrus	900-1200
Tobacco	400-600	Pineapple	700-1000
Tomato	600-800	Gingerly	350-400
Potato	500-700	Ragi	400-450
Onion	350-550	Grape	500-1200

Table 6.40, indicates that 60% of the total cultivable area in the district has been brought under irrigation facilities by ground water and surface irrigation network. In addition to the existing irrigation facilities in the district 31632 ha area are needed to be brought under assured irrigation in the district. Except, Sikandara block, where the irrigation facilities are adequate, all other blocks need to develop further irrigation network for assured future irrigation. However, the surface irrigation network in the district is poorly developed. Therefore increase in ground water irrigation network with the available resources may be suitable intervention.

Table 6.40. Irrigated area and area to be brought under irrigation

Block	Cultivable area (ha)	Irrigated Area (ha)	Area to be brought under Irrigation (ha)
Aliganj	4902	3309	1593
Barhat	6065	2829	3236
Chakai	10360	3725	6635
Gidhaur	6578	2874	3704
Jamui	9240	7790	1450
Jhajha	7876	3388	4488
Khaira	9451	6090	3361
Laxmipur	7340	3387	3953
Sikandara	6988	7344	-356
Sono	8712	5144	3568
Total	***77512***	***45880***	***31632***

As represented in the table 1.90, it is observed that the area under production of pulses and oilseeds are much below, <10% and around 1-2% of total cropped area respectively. Therefore, further irrigation may be extended for creation of irrigation potentials for pulses/oilseeds. The requirement of water column for these crops may be assumed as 50 cm which is less as compared to the cereals crops. Thus, the volume of additional water required to extend irrigation to the remaining area has been calculated from crop water requirement taking delta factor 0.5 m. In addition to that the water required to cater the drinking water need by PWSS in the district has been added up to arrive at the cumulative demand for management intervention in drinking water and in irrigation sectors (Table 6.50). As per the Dynamic Resource of Ground Water Resource Assessment,2017 in Jamui district, the block wise Net Ground Water Availability is equated with total requirement to estimate the water balance or deficit after the said management intervention. It is observed that, the required intervention in irrigation sector is not satisfied for following four blocks in the district, Gidhaur, Jhanjha, Laxmipur and Sono where the cumulative requirement exceeds availability. Therefore, in these four blocks the area to be brought under irrigation is negotiated on the basis of the availability. 75% of remaining area in Gidhaur, 68% in Jhanjha, 50% in Laxmipur and 61% of the remaining area in Sono block may be brought under assured irrigation. 100% coverage may be achieved in other block with the available resources. In Jamui district, 26229 ha additional irrigation potential may be created. Surface irrigation network or the harvesting of rain water or surface runoff may be practiced in the water deficit blocks for further enhancement of irrigation potential.

The volume of water which will be required to create additional irrigation potential may be accomplished from large diameter dug wells and shallow/medium deep tube wells. The unit draft for one large diameter dug well (LDDW) may be considered as 0.7 ham for 5-7 m^3/hr yield for 8 hr/day run in 120 irrigation days. The unit draft of STW/MDTW is considered 1.44 ham to 2.88 ham based on the prevailing hydrogeological condition in the respective blocks for yield varies from 15 m^3/hr to 30 m^3 / hr for 8 hr/day run for 120 irrigation days. The block wise requirement of LDDW and STW/MDTW has been estimated. 5621 LDDW and 5568 STW/MDTW may be required for the purpose (Table6.60) The required number of LDDW also satisfy proposed command area of one LDDW of 1-2 ha as per guidelines of Manual for Data Collection, 6th MI census,2017-18. However, installation of proposed structures should always be implemented in phases as per the actual site specific feasibility. 3-4 number of LDDW and STW/MDDW in each village in the district would satisfy the requirement. Proposed structures can bring additional 26229 ha irrigation potential in the district. Further, 5758.60 ha area is required to be brought under irrigation in the district. 100% irrigation coverage may be achieved in 5 blocks in the district (table 6.70 & fIg.44).

Table 6.50 Volume of water required for management intervention in drinking and irrigation sectors and water balance /deficit

Block	Area to be brought under Irrigation (ha)	Pulses (Delta factor:50 cm)	Volume of water needed in ham	Annual Resource required to cater entire(100%) uncovered population @40lpcd (ham)	Total volume of water required in irrigation and drinking sectors (ham)	Net Ground Water Availability (ham)	Water Balance /Deficit (ham) after management intervention
Aliganj	1593	0.5	796.5	187.70	984.20	3897.73	2913.53
Barhat	3236	0.5	1618	126.55	1744.55	2221.64	477.09
Chakai	6635	0.5	3317.5	322.77	3640.27	4101.38	461.11
Gidhaur	3704	0.5	1852	106.44	1958.44	1491.601	-466.84
Jamui	1450	0.5	725	0.00	725.00	2042.52	1317.52
Jhajha	4488	0.5	2244	0.00	2244.00	1927.12	-316.88
Khaira	3361	0.5	1680.5	323.56	2004.06	5124.56	3120.50
Lakhimpur	3953	0.5	1976.5	170.38	2146.88	1161.95	-984.93
Sikandra	0	0.5	0	204.09	204.09	3854.13	3650.04
Sono	3568	0.5	1784	288.81	2072.81	1370.93	-701.88

Table: 6.60 Proposed Number of LDDW, STW/MDTW for management intervention in Irrigation sector

Block	Area can be brought under Irrigation with available resources (ha)	Delta factor:50 cm) for Pulses/oilseeds	Volme of water needed in ham	Vol of water needed for 30% -70% irrigation to be provided by LDDW (ham)	Unit Draft LDDW	Vol Water needed for 70% -30% of required irrigation to be provided by STW/MDTW (ham)	Unit draft of STW/ MDTW (ham)	Required no of LDDW	Required no of STW/MDTW
Aliganj	1593	0.5	796.5	238.95	0.7	557.55	2.88	341	194
Barhat	3236	0.5	1618	1132.6	0.7	485.4	1.44	1618	337
Chakai	6635	0.5	3317.5	2322.25	0.7	995.25	1.44	3318	691
Gidhaur	2770.32	0.5	385.16	415.548	0.7	969.612	2.4	594	404
Jamui	1450	0.5	725	217.5	0.7	507.5	2.4	311	211
Jhajha	3036.32	0.5	518.16	455.448	0.7	1062.712	1.44	651	738
Khaira	3361	0.5	1680.5	504.15	0.7	1176.35	1.92	720	613
Laxmipur	1983.52	0.5	991.76	694.232	0.7	297.528	1.44	992	207
Sikandara	-356	0.5		0	0.7	0	2.88	0	0
Sono	2164.24	0.5	1082.12	757.484	0.7	324.636	1.44	1082	225
Total	**26229.4**		**3114.7**	**6738.162**		**6376.538**		**9627**	**3620**

Table.6.70 Percent of area can be brought under irrigation with available resources

Block	Area to be brought under Irrigation (ha)	Area can be brought under irrigation with available resources (ha)	Remaining Area (ha)	% of area which can be brought under irrigation with available resources
Aliganj	1593	1593	0	100
Barhat	3236	3236	0	100
Chakai	6635	6635	0	100
Gidhaur	3704	2770.32	933.68	75
Jamui	1450	1450	0	100
Jhajha	4488	3036.32	1451.68	68
Khaira	3361	3361	0	100
Laxmipur	3953	1983.52	1969.48	50
Sikandara	-356			0
Sono	3568	2164.24	1403.76	61
Total	**31632**	**26229.4**	**5758.6**	**83**

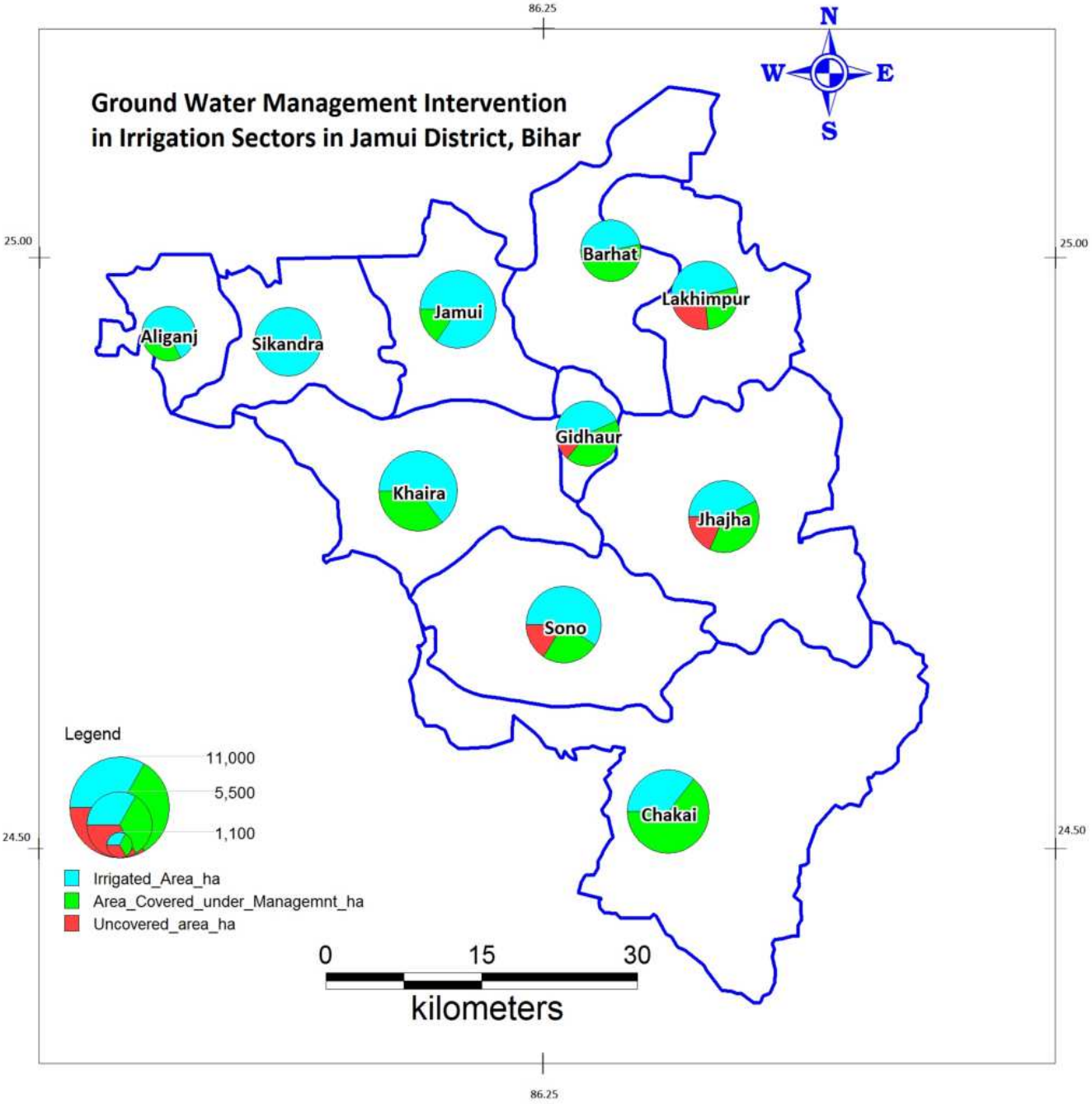


Fig.44. Management Intervention in Irrigation Sector

6.3 Management Interventions through Rain Water Harvesting and Artificial Recharge

The district receives average annual rainfall of 1100 to 1200 mm. However, bulk of the amount is recorded during the 4 monsoon months. Thus, undistributed rainfall causes huge amount of water to drain to the sea. On the other hand, the area being undulating hilly terrain in southern, northern and western parts, high runoff is expected for land slope more than 5%. The non-committed runoff, thus produced, may be diverted for water harvesting either for conservation or for artificial recharge to the depleted aquifer in the area. Combined effect of proliferation of ground water development by stakeholders of various sectors, specially agri-irrigation sector, coupled with deficit rainfall pattern during recent years has already resulted in substantial decline of ground water level in noteworthy area both in hard rock terrain as well as alluvial areas in the district. Central Ground Water Board, MER, Patna has prepared a District wise Master Plan for Artificial Recharge to Ground Water in Bihar State based on 2019 data. The Master Plan broadly identified areas which needs urgent attention. Based in the actual data base, block level plan has been proposed considering the detail variation in lithological characteristics in Jamui district. Based on terrain type of identified areas, various artificial recharge structures have been proposed and a tentative number of each structure has been arrived at. Differences in allotment of volume of ground water resources for different structures the proposed number of structures in this report deviate in few cases from the Artificial Recharge Master Plan, Bihar, 2020.

IDENTIFICATION OF AREAS

Identification of the area suitable for artificial recharge has been done on the basis of depth of post-monsoon water level and ground water level trend. Using GIS tools, post-monsoon (November, 2019) depth-to-water level map and long-term (2007-2017) trend of ground water level map has been superimposed over administrative boundary to identify feasible areas for recharge. The feasible are for recharge are prioritized as under subject to fulfilling the below mentioned conditions (Table. 6.80 ,fig.45),

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 between 6 and 9 m bgl and declining trend;

c) Areas with Depth-to-Water levels > 9 m bgl with or without declining trend.

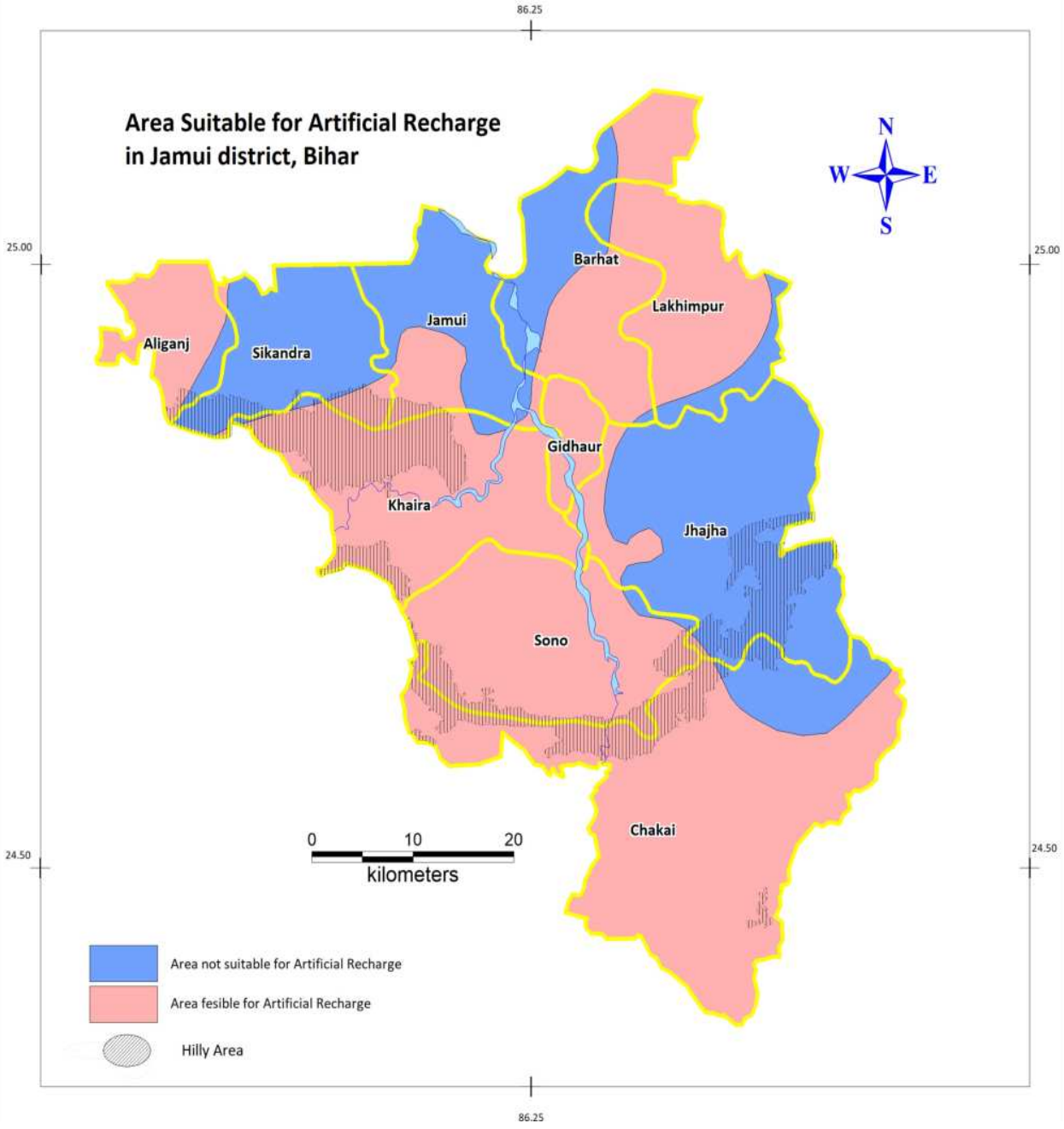


Fig.45 Artificial Recharge Prospect Map in Jamui District

Table 6.80 Area feasible for Artificial Recharge and Surplus runoff

Name of the block	Geographical area (in Sq.Km.)	Hilly area (in sq.km)	Normal monsoon rainfall in m	Area feasible for Artificial recharge in sq km	Volume of Monsoon Runoff Generated on Identified feasible area in MCM	Surplus Runoff Available (MCM)
Aliganj	172.86	0	1.0352	101.3	104.87	62.92
Sikandra	184.01	38.39	1.2183	22.33	27.20	16.32
Jamui	147.45	40	0.7403	48.98	36.26	21.76
Barhat	232.12	39.23	0.8367	182.4	152.61	91.57
Laxmipur	251.77	81.76	1.083	198.5	214.98	128.99
Jhajha	417.53	85.52	1.063	46.24	49.15	29.49
Gidhour	71.13	0	0.8686	54.63	47.45	28.47
Khaira	418.74	102.94	0.8214	348.7	286.42	171.85
Sono	392.27	86.54	1.07	338	361.66	217.00
Chakai	774.05	72.73	0.759	659.6	500.64	300.38
Total	**3098.25**			**2000.68**	**1781.24**	**1068.75**

SUBSURFACE STORAGE AND WATER REQUIREMENT

The available storage column/space (post-monsoon) for has been calculated for respective blocks by computation of average depth of unsaturated zone below 3 m water level in post monsoon time. Total volume of available storage space is calculated by multiplying storage area by specific yield. Considering the efficiency of the structure as 75%, the total water required to fill the storage space has been assessed (Table 6.90).

SOURCE WATER AVAILABILITY

Availability of non-committed source water for the purpose of artificial recharge to groundwater is the primary concern. Following the Master Plan of Artificial Recharge, Bihar,2020, 60% of the normal monsoon rainfall for identified feasible areas is considered as available non-committed surface runoff. The water required to fill the storage space in the identified area has been compared with that of the available non committed runoff and accordingly least of the two volumes has been allocated in different proposed rain water harvesting and artificial recharge structures (Table 6.80)

Table 6.90 Availability of Storage Space for Artificial Recharge

Name of the block	Geographical area (in Sq.Km.)	Area suitable for recharge considering hydrogeological condition	Average post monsoon Piezometric level (mbgl)	Further Storage column available upto 3 m of Piezometric surface (m)	Specific yield	Volume of unsaturated zone available (MCM)	Total storage space available (MCM)	Total surface runoff/water required to fill the space (considering 75% efficiency)
Aliganj	172.86	101.3	6.5	3.5	0.1	354.5500	35.4550	47.1552
Sikandra	184.01	22.33	3.5	0.5	0.1	11.1650	1.1165	1.4849
Jamui	147.45	48.98	5.47	2.47	0.1	120.9806	12.0981	16.0904
Barhat	232.12	182.4	7.5	4.5	0.03	820.8000	24.6240	32.7499
Laxmipur	251.77	198.5	5.5	2.5	0.03	496.2500	14.8875	19.8004
Jhajha	417.53	46.24	4.5	1.5	0.03	69.3600	2.0808	2.7675
Gidhour	71.13	54.63	8.92	5.92	0.1	323.4096	32.3410	43.0135
Khaira	418.74	348.7	3.4	0.4	0.1	139.4800	13.9480	18.5508
Sono	392.27	338	7.5	4.5	0.03	1521.0000	45.6300	60.6879
Chakai	774.05	659.6	3.9	0.9	0.03	593.6400	17.8092	23.6862
Total		2000.68				4450.6352	199.9900	265.9867

The rain water harvesting and artificial recharge proposal for Jamui district has identified total 2000.68 sq. km area suitable for recharge based on the post monsoon water level and long term water level trend. It is observed that 200 MCM is the available storage potential in the district. The volume of water required to fill the available storage space in with 75% efficiency is 266 MCM. The available non committed source water is 1068.75 MCM in the district, which is sufficient to meet the requirement to fill the unsaturated zone.

Considering local hydrogeological diversities, geomorphological set up and relative groundwater potentialities in the district, various types of artificial recharge / conservation structure is possible for augmentation and conservation of ground water resources in alluvial and hard rock terrain. The actual field condition, available area identified for recharge in the particular blocks has been given due importance to decide source water allocation for individual structures in respective blocks. Based on the recharge allocation for individual structures and gross storage capacity the number of proposed structures has been decided (Table 6.12). Block-wise allocation of water for different types of structures and storage Capacity of the structures is given in Table - 6.10 and 6.11.

Table: 6.10 Allocation of water in % for different AR structures

Block	Surplus Runoff Available (MCM)	Total surface runoff/water required to fill the space (considering 75% efficiency)	Allocation of water in percentage of total water required to fill the unsaturated space/available surplus runoff based on terrain condition						
			De-silting of existing tanks /ponds	Injection well in village tanks	Renovation of traditional Ahar-Pyne System	Percolation Tanks	Gulley plugs	Contour Bunding	Check Dam/Nala bunds
Aliganj	62.919456	47.15	60%	10%	30%				
Sikandra	16.3227834	1.4849	60%	10%	30%				
Jamui	21.7559364	16.0904	30%	10%	20%	20%		10%	10%
Barhat	91.568448	32.7499	35%	5%	10%	20%	5%	10%	15%
Laxmipur	128.9853	19.8004	20%	10%	20%	25%		10%	15%
Jhajha	29.491872	2.77	30%			20%		20%	30%
Gidhour	28.4709708	43.0135	60%	10%	30%				
Khaira	171.853308	18.5508	30%	10%	10%	20%		15%	15%
Sono	216.996	60.68	40%	0.000	0.000	30%	10%	10%	10%
Chakai	300.38184	23.6862	0.000	0.000	0.000	40%	10%	20%	30%

6.11 Storage Capacity and tentative dimension of proposed structures

Terrain Type	Recharge Structure Type	Storage Capacity (MCM)	Number of Filling	Dimension
Hard Rock Area	Percolation Tank	0.5	01	100 m x 4.5 m (03 Sq. Km Catchment)
	Gully Plug	0.1	01	10 m x 2 m
	Contour Bunding & Trenching	0.05	03	300 – 400 m
	Check Dam	0.1	02	15 m x 3 m
Alluvial Area	De-silting of existing tank /pond /talao	0.20	02	100 m x 80 m x 6 m
	Injection Well in Village Tank	0.03	02	100 m x 100 m x 3 m Tank with 40 m Boring
	Renovation of traditional Ahar-Pyne System	0.10	01	As per Existing Structure / Km

Besides the traditional recommended rain water harvesting and artificial recharge structures in hard rock and in alluvial terrain 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. These structures, if revitalized

would assist immensely in water conservation as groundwater recharge in in the district. The block wise allocation of source water for Ahar – Pyne renovation has been done, however, based on the actual field data the number of ahar-pyne system to be constructed/renovated may be decided. Desiltation of existing village ponds/ tanks/ talao, particularly in alluvial area has also given due importance. De-silting of *Mauns* (Ox-bow Lake) may also be taken up as a part of augmentation project in the district in suitable location.

The proposed plan envisages utilization of 266 MCM of source water for recharge purpose through different structures. Block wise utilisation of water for each structures and feasible number of structures in each block is given in table 6.12. In hard rock area of Jamui district 92 percolation tanks, 101 gully plugs, 141 contour bunding and trenching and 132 check dam has been proposed. Sono and Chakai in the southern parts of the district have been proposed to hold maximum number of rain water harvesting structures in hard rock area. Hard rock area of Jamui , Barhat and Laxmipur blocks are also proposed for installation of few percolation tank, check dams etc. However, implementation of above structures would be site specific and may be planned in phases to study the impact. Blocks, where both hard rock and alluvium occupy a considerable area the proposed need to be implemented based on the respective terrain condition. In alluvial terrain 244 tanks de-siltation and erection of 246 injections well in village tanks have been proposed. The Ahar- Pyne system renovation should be on the basis of availability of existing structures and on the basis of requirement.

The rapid increase in population in urban area has already put a thrust on the ground water level for domestic and drinking need. The entire urban cluster, Jamui (NP) and Jhanja (NP) has been chosen for implementation of roof top rain water harvesting for conservation or recharge based on the available non committed runoff. Considering average annual rainfall of 1000 mm and 100 sq m roof area with 90% efficiency the volume of water harvested from one structure has been decided.

Table 6.13.Rain water harvesting in urban cluster

Name of the block	Geographical area (in Sq.Km.)	Surplus Runoff Available (MCM)	Volume of water harvested through unit RTRWH of 100 sq m roof area (area*total average annual rainfall * 0.9) in MCM	No of RTRWH structures	Total volume of water harvested in MCM
Jamui(NP)	26.45	4.76	0.009	529	4.76
Jhajha(NP)	9.87	0.71	0.009	79	0.71
Total	**36.32**			**608**	**5.47**

Besides, 5.47 MCM water may be harvested through roof top rain water harvesting structures in Jmaui and Jhanjha urban clusters. 529 RTRWH structures in Jamui NP and 79 structures in Jhanjha NP have been proposed (Table 6.13). In first phase, implementation of roof-top rainwater harvesting covering govt. buildings, institutes, schools, hospitals *etc.* may be planned.

All the blocks in Jamui district have been reported with higher concentration of fluoride in ground water more than the permissible limit. The rain water harvesting structures for artificial recharge in the fluoride affected aquifer may be very effective management intervention to lower the concentration of fluoride through dilution.

6.4 Selection of Tentative Sites for Rain water Harvesting Structures

Although the success of rain water harvesting structures essentially depends on selection of sites, however, the criteria for selection of sites depends on various factors and often become critical. As per the Integrated Mission for Sustainable Development guide lines in Arid and Semi-Arid Regions (ASAR) the check dam usually are preferred in slope <15% , drainage order 1-3, silty loam soil types. Percolation tanks are generally recommended in slope <10%, drainage order 2-4 and on gravelly or sandy soils. Contour bunds are in general in higher slope more than 15% e and are preferred along a particular elevation.

In the present exercise, the administrative blocks, land use pattern, slope map, elevation contour and drainage order maps are superimposed to locate the tentative sites for water harvesting structures; check dam/nala bunds and contour bunds. The feasible number of structures in each block is as per the table 6.12. The check dams are generally recommended on 1st or 2nd order streams. Percolation tanks may be constructed on 3rd or 4th order stream. The precise location of percolation tanks in respective blocks may be decided based on the actual field conditions. Other RWH structures like desilting of tanks, injection wells in village tanks etc., particularly in alluvial area may be positioned based on the existing structures and other feasible conditions.

Superimpositions of proposed locations of check dam/nala bunds and contour bunds with the map of area suitable for recharge in Fig.46, revels that the majority of the structures which are decided based on the overlay of multiple layers are placed in artificial recharge priority area only.

Proposed locations of check dam/nala bunds and contour bunds are as per fig no 47 and 48. The detail village wise location is given in table no 6.13 & 6.14.

Although no check dam and contour bunds are proposed in Sikandra block as in table 6.12, few structures from Jamui block is placed in feasible area in southern parts of Sikandra block.

The recommended sites require actual field verification before implementations.

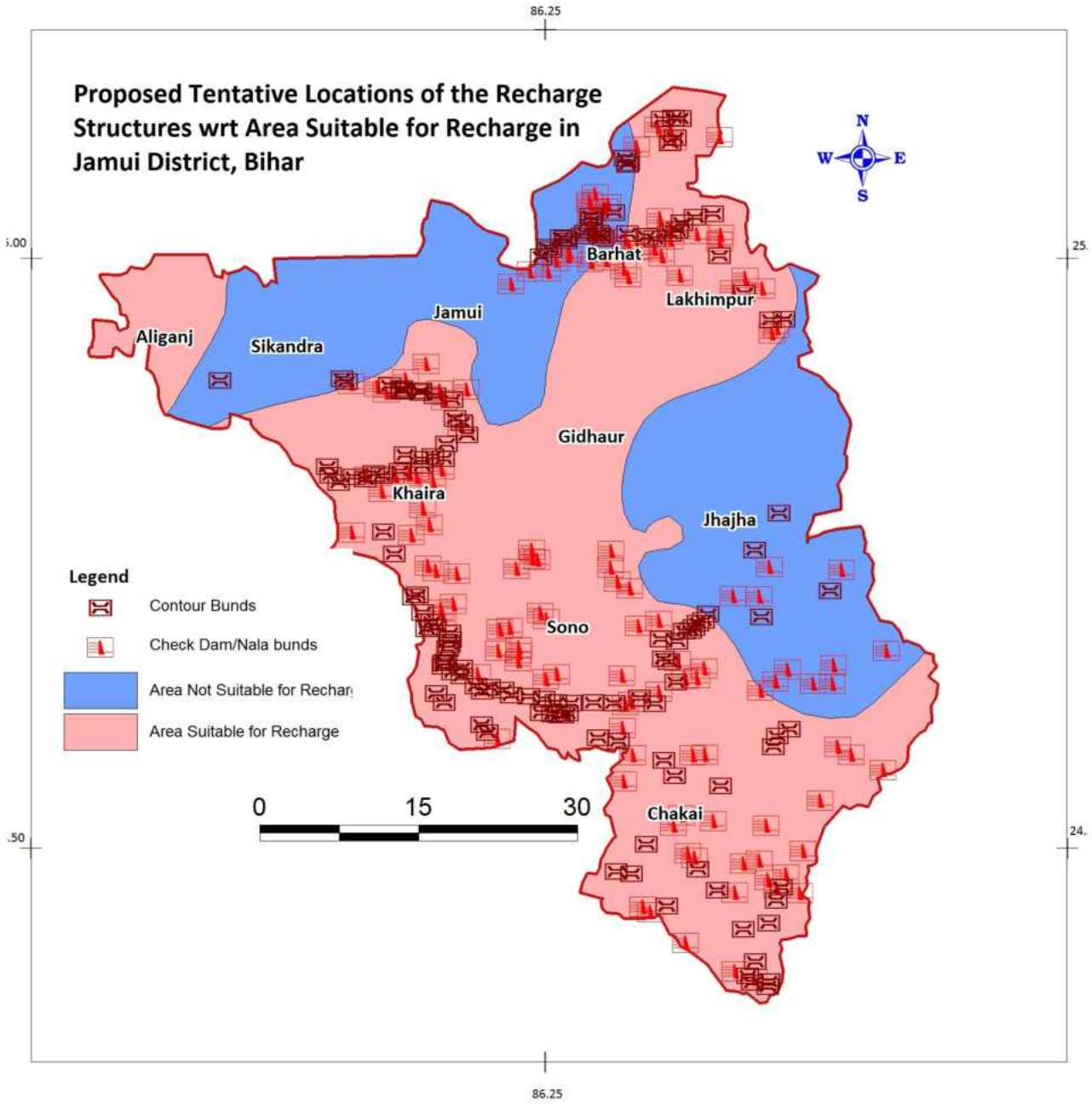


Fig.46. Proposed location of Recharge Structures alongside area identified for Recharge in Jamui District

Table 6.12 Block wise feasible AR structures

Block	Surplus Runoff Available (MCM)	Total surface runoff/water required to fill the space (considering 75% efficiency)	Allocation of water as percentage of total water required to fill the unsaturated space/available surplus runoff based on terrain condition in MCM							Number of feasible structures						
			Desilting of existing tanks /ponds	Injection well in village tanks	Renovation of traditional Ahar-Pyne System	Percolation Tanks	Gully Plug	Contour bunding and trenching	Check Dam/Nala Bunds	Desilting of existing tanks /ponds	Injection well in village tanks	Renovation of traditional Ahar-Pyne System	Percolation Tanks	Gully Plug	Contour bunding and trenching	Check Dam/Nala Bunds
Aliganj	62.92	47.15	28.290	4.715	14.145					71	79	141				
Sikandra	16.32	1.48	0.891	0.148	0.445					2	2	4				
Jamui	21.76	16.09	4.827	1.609	3.218	3.218		1.609	1.609	12	27	32	6	0	11	8
Barhat	91.57	32.75	11.462	1.637	3.275	6.550	1.637	3.275	4.912	29	27	33	13	16	22	25
Laxmipur	128.99	19.80	3.960	1.980	3.960	4.950		1.980	2.970	10	33	40	10	0	13	15
Jhajha	29.49	2.77	0.831	0.000	0.000	0.554		0.554	0.831	2	0	0	1	0	4	4
Gidhour	28.47	43.01	17.083	2.847	8.541					43	47	85	0	0	0	0
Khaira	171.85	18.55	5.565	1.855	1.855	3.710		2.783	2.783	14	31	19	7	0	19	14
Sono	217.00	60.69	24.276	0.000	0.000	18.207	6.069	6.069	6.069	61	0	0	36	61	40	30
Chakai	300.38	23.69	0.000	0.000	0.000	9.474	2.369	4.737	7.106	0	0	0	19	24	32	36
Total number of structures										**244**	**246**	**354**	**92**	**101**	**141**	**132**

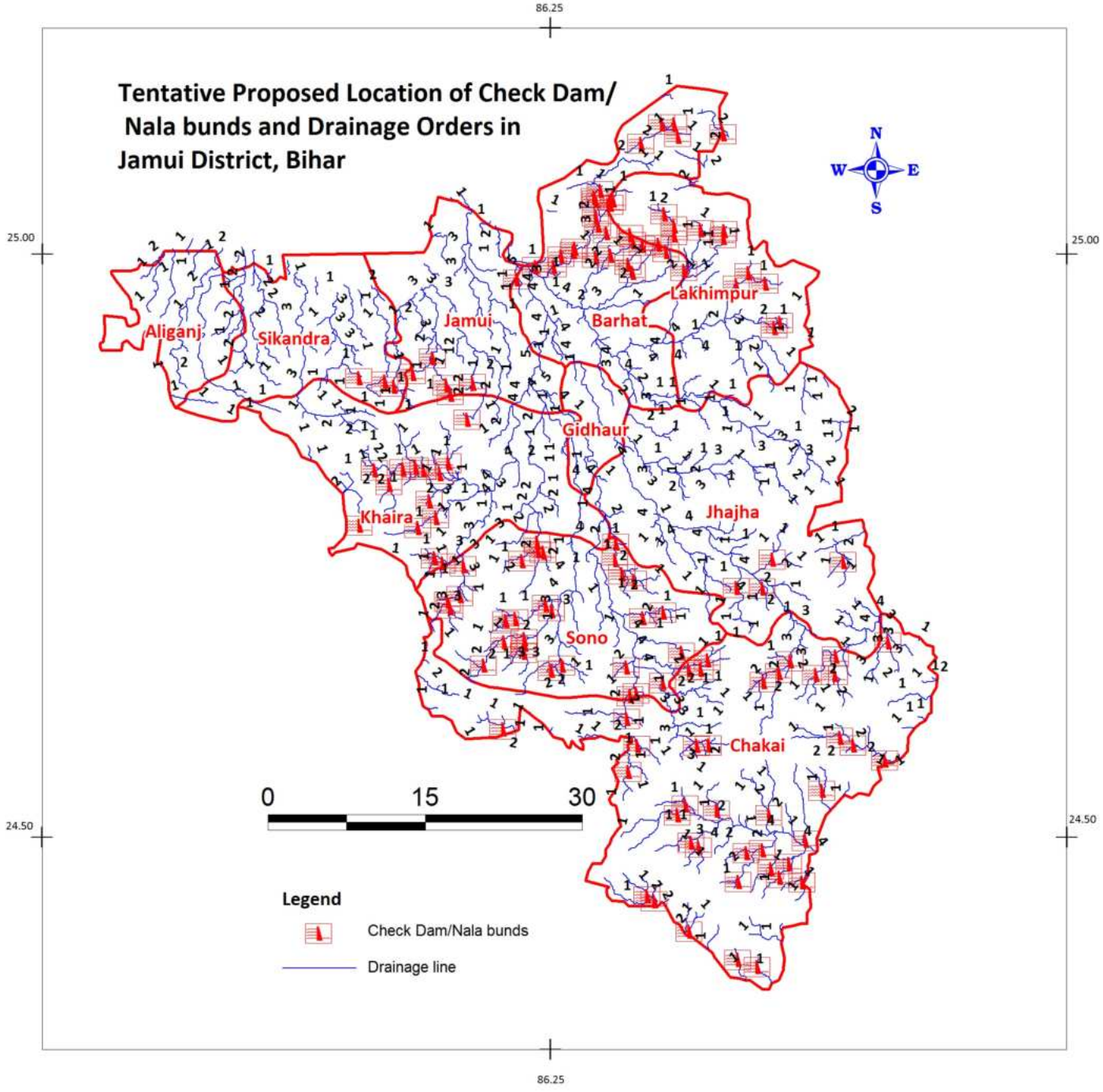


Fig.47 Proposed Locations of Check Dam/Nalabunds in Jamui District

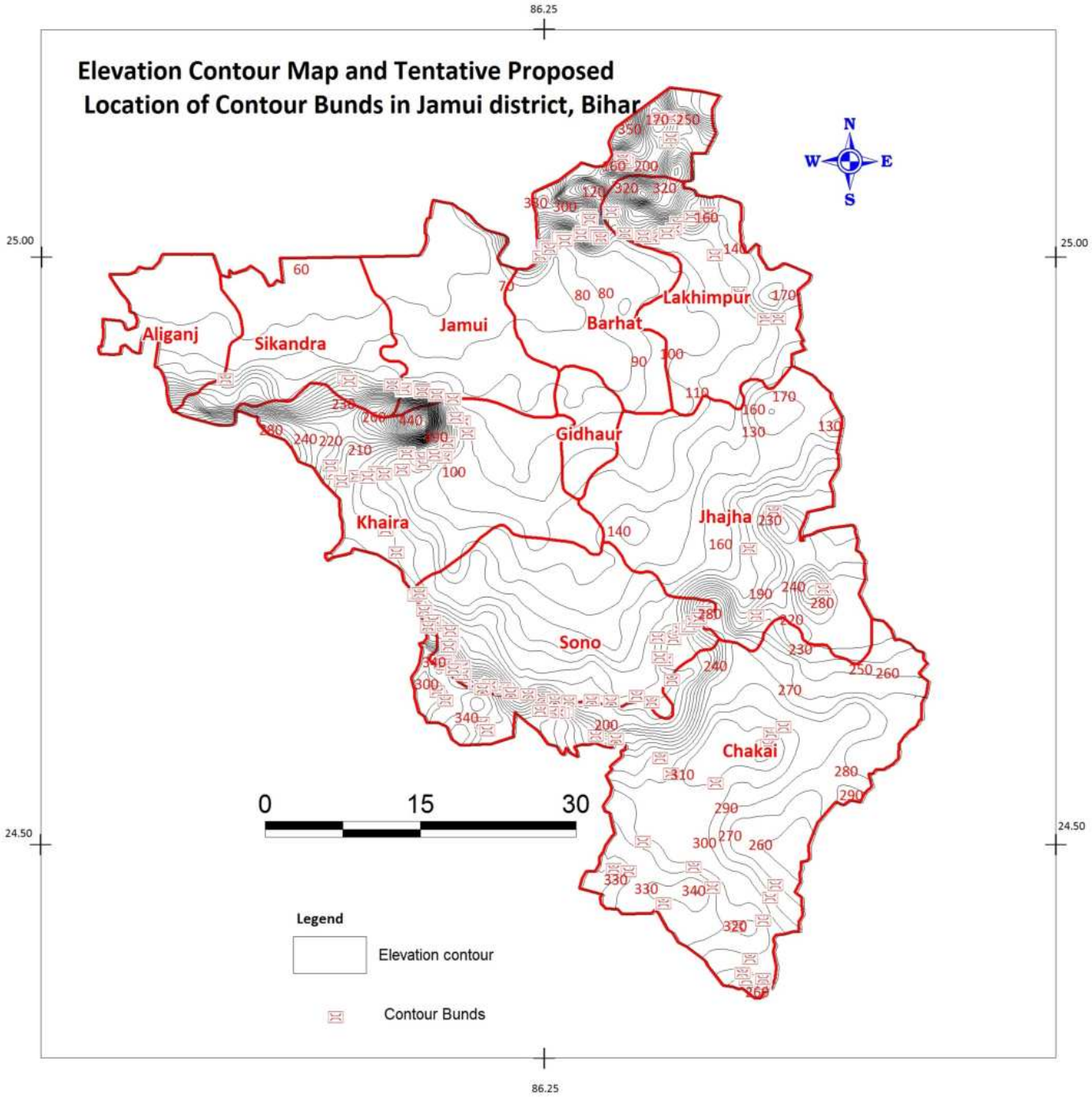


Fig.48 Proposed Locations of Contour Bunds in Jamui District

Table: 6.13 Tentative Location of the proposed Check Dam

Sl no	Village	Block	Latitude	Longitude
1	Tola Domachhorant	Chakai	24.4758	86.4583
2	Tola Nauadih	Chakai	24.4651	86.4274
3	Tola Jalkharia	Chakai	24.4897	86.4353
4	Tola Gadhara	Chakai	24.4946	86.3899
5	Tola Patjori	Chakai	24.4986	86.3832
6	Tola Kasjore	Chakai	24.4529	86.3413
7	Tola Heth Chakai	Chakai	24.526	86.4072
8	Tola Nawada	Chakai	24.522	86.37
9	Tola Mangatadih	Chakai	24.5304	86.3777
10	Tola Noniatari	Chakai	24.6581	86.5194
11	Tola Gharbhasan	Chakai	24.5432	86.5066
12	Tola Pathal Chapti	Chakai	24.6702	86.5688
13	Tola Kandani	Chakai	24.5219	86.4564
14	Tola Jogiatilha	Chakai	24.5002	86.4909
15	Tola Naukadih	Chakai	24.6542	86.4767
16	Tola Jogia	Chakai	24.5816	86.3321
17	Tola Bongi	Chakai	24.5957	86.2053
18	Tola Domohan	Chakai	24.5816	86.3881
19	Tola Gursati	Chakai	24.5819	86.5357
20	Tola Jamha	Chakai	24.569	86.5656
21		Sono	24.7486	86.2383
22		Sono	24.7474	86.2432
23	Tola Chapri	Sono	24.7558	86.2377
24	Tola Cheraiya	Sono	24.7051	86.1532
25	Tola Jhura	Sono	24.7101	86.1649
26	Tola Nainipathar	Sono	24.6994	86.1554
27	Tola Thamhan	Sono	24.6703	86.2065
28	Tola Kaunia	Sono	24.673	86.2255
29	Tola Berbari	Sono	24.6683	86.2258
30	Tola Dhamni	Sono	24.6614	86.225
31	Tola Makarkend	Sono	24.6901	86.2171
32	Tola Kairi	Sono	24.7022	86.2456
33	Tola Sonailtanr	Sono	24.6972	86.2516
34	Tola Bhelsumbhia	Sono	24.6503	86.2611
35	Tola Tetaria	Sono	24.6461	86.2511
36	Tola Naiadih	Sono	24.649	86.3218
37	Tola Binjhi	Sono	24.6243	86.3253
38	Tola Dhodhri	Sono	24.6957	86.3566
39	Tola Kukurbhento	Sono	24.691	86.3373
40	Tola Hariharpur	Sono	24.7232	86.3291
41	Tola Terukha	Sono	24.7286	86.3177
42	Tola Sono	Sono	24.7408	86.3113
43	Tola Sonradih	Sono	24.7549	86.3119
44	Tola Pahar	Chakai	24.655	86.3987
45	Tola Dahiari	Chakai	24.6463	86.3805
46	Tola Karhara Chaupal	Sono	24.7399	86.2235
47	Tola Kusaia	Sono	24.6267	86.331
48	Tola Sarkanda	Sono	24.7356	86.168

Sl no	Village	Block	Latitude	Longitude
49	Tola Barmasia	Sono	24.6355	86.3562
50	Tola Jirhulia	Sono	24.6616	86.3739
51	Tola Charka Pathar	Sono	24.6885	86.2083
52	Tola Asarkho	Sono	24.6506	86.1873
53	Tola Pipra	Jhajha	24.7163	86.4501
54	Tola Kusmha	Jhajha	24.7391	86.5267
55	Tola Narganjo	Jhajha	24.7411	86.4597
56	Tola Parasi	Jhajha	24.717	86.4257
57	Harni	Khaira	24.8238	86.1537
58	Harni	Khaira	24.8146	86.1458
59	Gorhi	Khaira	24.8052	86.0981
60	Tola Kodopathal Kic	Khaira	24.7381	86.1485
61	Tola Kodopathal Kic	Khaira	24.7423	86.1406
62	Mainijor	Khaira	24.7683	86.1253
63	Khalari	Khaira	24.8203	86.1231
64	Karitanr	Khaira	24.8176	86.0842
65	Mainijor	Khaira	24.7768	86.1422
66	Mainijor	Khaira	24.7914	86.136
67	Khalari	Khaira	24.8183	86.1301
68	Sokho	Khaira	24.8185	86.1109
69	Kashmir	Khaira	24.8612	86.1714
70	Jagatpur	Khaira	24.7705	86.07
71	Tola Sukhasan	Lakhimpur	24.944	86.4668
72	Tetaria	Lakhimpur	24.9396	86.4616
73	Tola Alagjara	Lakhimpur	24.9776	86.4529
74	Kala	Lakhimpur	24.9865	86.4371
75	Harchak	Lakhimpur	24.9762	86.4256
76	Anantpur	Lakhimpur	25.0194	86.3667
77	Najari	Lakhimpur	25.0172	86.4131
78	Barhat	Lakhimpur	25.0455	86.3066
79	Barhat	Lakhimpur	25.0492	86.3094
80	Anantpur	Lakhimpur	25.0267	86.3667
81	Anantpur	Lakhimpur	25.0237	86.392
82	Matia	Lakhimpur	25.0194	86.3253
83	Matia	Lakhimpur	25.0111	86.352
84	Najari	Lakhimpur	25.0229	86.4141
85		Barhat	25.106	86.4131
86		Barhat	25.1145	86.3551
87		Barhat	25.1037	86.3704
88		Barhat	25.0975	86.3359
89	Barhat	Barhat	25.0511	86.2917
90	Barhat	Barhat	25.0493	86.2929
91	Barhat	Barhat	25.0277	86.2952
92	Bhaluka	Barhat	25.0079	86.2733
93	Bhaluka	Barhat	25.0048	86.2719
94	Matia	Barhat	25.0136	86.3281
95	Bishunpur	Barhat	25.0015	86.3072
96	Matia	Barhat	25.0102	86.3368
97	Bahera Kita Alaiya	Barhat	24.9872	86.3277
98	Bahera	Barhat	24.9941	86.3236
99	Barhat	Barhat	25.0002	86.2929

Sl no	Village	Block	Latitude	Longitude
100	Bhaluka	Barhat	25.0009	86.2604
101	Amma Sarari	Barhat	24.9812	86.2186
102	Daulatpur	Barhat	24.9921	86.2364
103	Bariarpur	Barhat	24.992	86.2532
104	Tola Bhorbhandari	Barhat	25.1142	86.367
105	Mohanpur	Barhat	25.0048	86.3592
106	Barhat	Barhat	25.0212	86.303
107	Ranhan	Sikandra	24.8893	86.1023
108	Ita Sagar	Sikandra	24.8941	86.0939
109	Bariarpur	Jamui	24.8828	86.1561
110	Maricha	Jamui	24.9137	86.1392
111	Kharui	Jamui	24.8918	86.1768
112	Maricha	Jamui	24.9004	86.1204
113	Harkhar	Sikandra	24.8969	86.0693
114	Tola Dhanwe	Chakai	24.3982	86.4271
115	Tola Mohanpur	Chakai	24.3922	86.4455
116	Tola Dhawatanr	Chakai	24.4688	86.4664
117	Tola Kailidih	Chakai	24.4645	86.4879
118	Tola Kasjore	Chakai	24.4483	86.3483
119	Tola Buchchi	Chakai	24.6469	86.3919
120	Tola Dudhanian	Chakai	24.5886	86.5233
121	Tola Thadhi	Chakai	24.6442	86.4657
122	Ramsinghdih	Chakai	24.6424	86.5007
123	Tola Rupai	Chakai	24.6424	86.5186
124	Tola Bisodah	Chakai	24.6365	86.451
125	Tola Kaunjhi	Chakai	24.5594	86.3234
126	Tola Barakhutia	Chakai	24.6048	86.3224
127	Tola Naiadih	Chakai	24.4223	86.3814
128	Tola Phariatadih	Chakai	24.492	86.4503
129	Tola Thakursair	Chakai	24.4804	86.4753
130	Tola Tarakhar	Chakai	24.5822	86.3993
131	Anantpur	Lakhimpur	25.0372	86.3575
132	Barhat	Barhat	25.0574	86.2973
133	Barhat	Barhat	25.0352	86.2929
134	Gaura	Barhat	24.9887	86.3762
135	Maricha	Jamui	24.8906	86.1519

Table : 6.14 Tentative Location of the proposed Contour Bunds

Sl no	Village	Block	Latitude	Longitude
1	Tola Pataua	Chakai	24.3882	86.4432
2	Tola Badgunda	Chakai	24.3848	86.4576
3	Tola Badgunda	Chakai	24.389	86.4586
4	Tola Karmatanr	Chakai	24.3938	86.4391
5	Tola Silhia	Chakai	24.4533	86.3635
6	Tola Saran Marwa	Chakai	24.4826	86.3162
7	Tola Simradhab	Chakai	24.6336	86.1481
8	Tola Bhadwadih	Chakai	24.6256	86.1557
9	Tola Chatridih	Chakai	24.6071	86.1905
10	Tola Majhladih	Chakai	24.6004	86.1957
11	Tola Durjanpotari	Chakai	24.5883	86.4629
12	Tola Karangarh	Chakai	24.5977	86.4664
13	Tola Tetaria	Chakai	24.6031	86.4778
14	Tola Ghormo	Chakai	24.5551	86.4134
15	Tola Pojha	Chakai	24.5636	86.3706
16	Tola Dhamna	Chakai	24.5769	86.3605
17	Tola Nargi	Chakai	24.4805	86.3305
18	Tola Dulampur	Chakai	24.4058	86.446
19	Tola Gajhi	Chakai	24.4843	86.3925
20	Tola Cheraiya	Sono	24.7023	86.1357
21	Tola Kodopathal Kic	Sono	24.7152	86.1271
22	Tola Nainipathar	Sono	24.6898	86.1471
23	Tola Cheraiya	Sono	24.694	86.1441
24	Tola Pahar	Sono	24.6883	86.1392
25	Tola Pahar	Sono	24.6595	86.155
26	Tola Pahar	Sono	24.6601	86.1571
27	Tola Pahar	Sono	24.64	86.1856
28	Tola Barad Pichra	Sono	24.639	86.1982
29	Tola Pahar	Sono	24.6322	86.2182
30	Tola Nawadih	Sono	24.6287	86.2487
31	Tola Baghakolo	Sono	24.626	86.2601
32	Tola Bandarmara	Sono	24.6252	86.2737
33	Tola Binjhi	Sono	24.6254	86.314
34	Tola Jirhulia	Sono	24.6603	86.3653
35	Tola Ukharia	Sono	24.678	86.3729
36	Tola Jatkatwa	Sono	24.6864	86.3796
37	Tola Tharhi	Sono	24.701	86.4022
38	Tola Amjhari	Sono	24.6869	86.3857
39	Tola Amjhari	Sono	24.6893	86.3884
40	Tola Amjhari	Sono	24.6931	86.3924
41	Tola Amjhari	Sono	24.6957	86.3976
42	Tola Pairamatihana	Sono	24.6628	86.3601
43	Gandar	Sono	24.6298	86.338
44	Tola Thakurkura	Sono	24.626	86.2951
45	Tola Pairamatihana	Sono	24.6796	86.358
46	Tola Patasi	Sono	24.6364	86.2109
47	Tola Asarkho	Sono	24.6552	86.1718
48	Tola Pahar	Sono	24.6792	86.1616
49	Tola Kodopathal Kic	Sono	24.7173	86.1309

Sl no	Village	Block	Latitude	Longitude
50	Tola Dahiari	Chakai	24.6431	86.3717
51	Tola Lilabaran	Jhajha	24.7207	86.5159
52	Tola Asta	Jhajha	24.7867	86.4682
53	Tola Asta	Jhajha	24.7551	86.4454
54	Tola Jurpania	Jhajha	24.6983	86.4519
55	Sokho	Khaira	24.7707	86.0989
56		Khaira	24.7519	86.1092
57	Khalari	Khaira	24.8323	86.1346
58	Khalari	Khaira	24.8271	86.1351
59	Sakdari	Khaira	24.8328	86.155
60	Kashmir	Khaira	24.8531	86.1768
61	Harkhar	Khaira	24.8189	86.0496
62	Kashmir	Khaira	24.8634	86.1723
63	Gorhi	Khaira	24.8202	86.09
64	Harkhar	Khaira	24.8126	86.0573
65	Tola Sukhasan	Lakhimpur	24.9505	86.4603
66	Tola Kamlu	Lakhimpur	24.951	86.4727
67	Harchak	Lakhimpur	24.9731	86.436
68	Anantpur	Lakhimpur	25.0378	86.3899
69	Anantpur	Lakhimpur	25.0326	86.3776
70	Anantpur	Lakhimpur	25.0267	86.3733
71	Matia	Lakhimpur	25.0193	86.3523
72	Matia	Lakhimpur	25.0237	86.3267
73	Barhat	Barhat	25.0289	86.2926
74	Bhaluka	Barhat	25.0121	86.2518
75	Bariarpur	Barhat	25.0037	86.2463
76	Barhat	Barhat	25.0388	86.2921
77		Lakhimpur	25.0406	86.4063
78	Tengahra	Lakhimpur	25.0048	86.4125
79	Matia	Lakhimpur	25.0212	86.3445
80	Anantpur	Lakhimpur	25.0236	86.3666
81	Barhat	Lakhimpur	25.0414	86.3139
82	Ranhan	Jamui	24.8897	86.1163
83	Maricha	Jamui	24.8906	86.1341
84	Maricha	Jamui	24.8891	86.134
85	Maricha	Jamui	24.886	86.1475
86	Maricha	Jamui	24.8923	86.1158
87	Ranhan	Jamui	24.8909	86.1162
88	Bariarpur	Jamui	24.8826	86.1629
89	Ranhan	Sikandra	24.8948	86.1051
90	Basbutti	Sikandra	24.8979	86.0645
91	Bohrama	Sikandra	24.9007	86.0601
92	Dhopdeoghat	Sikandra	24.8993	85.9466
93	Tola Binjha	Chakai	24.4666	86.4103
94	Tola Barhidih	Chakai	24.5057	86.344
95	Tola Harin Singha	Chakai	24.4336	86.4346
96	Tola Pahar	Chakai	24.6166	86.2706
97	Tola Pahar	Chakai	24.6152	86.2664
98	Tola Pahar	Chakai	24.6154	86.2629
99	Tola Pahar	Chakai	24.6161	86.2567
100	Tola Pahar	Chakai	24.6171	86.2462

Sl no	Village	Block	Latitude	Longitude
101	Tola Majhladih	Chakai	24.5959	86.299
102	Tola Mangurakura	Chakai	24.5931	86.3185
103	Tola Nakta	Chakai	24.4386	86.4588
104	Tola Dhawatanr	Chakai	24.4688	86.4701
105	Tola Katiawa	Chakai	24.4582	86.4655
106	Harkhar	Khaira	24.8258	86.0464
107	Karitanr	Khaira	24.8171	86.0716
108	Karitanr	Khaira	24.8155	86.0819
109	Gorhi	Khaira	24.8185	86.0975
110	Sokho	Khaira	24.8223	86.1146
111	Harni	Khaira	24.8346	86.1452
112	Khalari	Khaira	24.8361	86.1189
113		Khaira	24.8451	86.1578
114	Kashmir	Khaira	24.8668	86.1658
115	Tola Pahar	Sono	24.6565	86.1547
116	Tola Pahar	Sono	24.6749	86.1605
117	Tola Pahar	Sono	24.6717	86.1588
118	Tola Pahar	Sono	24.6484	86.1723
119	Tola Murmala	Sono	24.6311	86.2344
120	Tola Nainipathar	Sono	24.6852	86.1608
121	Tola Barmasia	Sono	24.6247	86.3523
122	Tola Pahar	Sono	24.652	86.1635
123	Tola Pahar	Sono	24.6354	86.191
124	Barhat	Barhat	25.0201	86.2646
125	Barhat	Barhat	25.0194	86.2683
126	Bhaluka	Barhat	25.0173	86.2695
127	Bhaluka	Barhat	25.0101	86.2552
128	Barhat	Barhat	25.0243	86.2874
129	Barhat	Barhat	25.0219	86.285
130	Barhat	Barhat	25.0243	86.2996
131	Barhat	Barhat	25.0217	86.3015
132	Barhat	Barhat	25.0197	86.3041
133	Barhat	Barhat	25.0349	86.2931
134	Tola Gurmha	Barhat	25.0824	86.3266
135	Tola Gurmha	Barhat	25.0838	86.3279
136	Tola Musaharitanr	Barhat	25.0876	86.3246
137		Barhat	25.1211	86.3759
138		Barhat	25.1216	86.3698
139		Barhat	25.1005	86.3666
140		Barhat	25.1049	86.371
141		Barhat	25.1209	86.3589

Summary and Findings:

- The district is characterised by undulating terrain surrounded by hill ranges with masses of forest cover and alluvial plains. The district witnesses water scare hard rock terrain as well as alluvial pain with abundant land and water resources.
- Granite, granite gneiss, quartzite, schist, pegmatite of Pre-Cambrian age constitutes the hard rock parts whereas the quaternary sediments is represented by unconsolidated sands, silts and clay.
- Even though, the economy of the district is agrarian in nature the agricultural activity in much extent dependent on kharif cultivation, rabi and summer crops are inadequately cultivated. Cropping intensity is around 140-150%. Crops diversification is also less, cereals crops are the main share, pulses, oil seeds and other horticulture crops are meagre.
- Surface irrigation networks are poorly developed, ground water irrigation are based on STW/ MDTW/DTW. Deep tube wells are rare. The STW and MDTW are concentrated within the depth range of 30-60 m, causing much stress on a particular aquifer.
- In hard rock area the 1st aquifer is represented by weathered residuum and shallow fractures and deep seated potential fractures 75-150 m depth constitutes the 2nd aquifers. Aquifers in alluvial formation may also be grouped as shallow (1st) aquifer within 10-35 m depth which are tapped by dug wells or shallow tube wells and *deeper (2nd)* aquifers beyond the depth of 35 mbgl, which are often tapped by MDTW or DTW.
- The comparatively deeper water level in 2nd aquifer in alluvial area around Khaira, Aliganj, Sikandara, Gidhaur, Jamui may be the signature of higher development by STW/MDTW. Development from dug wells in alluvial area is less. The deeper water level in fractured aquifer depends on the potentiality and interconnection of fracture zones.
- The dominant ground water flow from SE towards NW, however, flow from Barhat area towards Jamui terrace from NE towards SW is also observed. These areas (area with higher water table elevation) constitute the recharge area for the district. Decrease in hydraulic gradient has been observed from southern parts towards the central part of the district and from north eastern parts towards the central parts of the district. The decrease in hydraulic gradient is also attributed to the increase in the hydraulic conductivity and the potential of the aquifer in central and north western parts of the district.
- In major parts of the district, long term water level trend reflects a fall more than 10 cm/yr to 35 cm/yr. However, significant fall in ground water regime of more than 20 cm /yr is found around Gidhaur and in parts of alluvial area in the district. The moderate changes in long term behaviours of ground water level in the district may

be the reflection of increase in ground water draft from shallow aquifers for irrigation.

- The thickness of the alluvium and weathered sediments above the hard rock and the hard rocks with fractures has been demarcated from the exploratory bore hole data of CGWB and utilised in lithology model/fence under Rockworks platform to generate aquifer disposition in the area. The thickness of alluvium is maximum in alluvial area in Aliganj, Sikandara and in parts of Jamui, Barhat blocks. Maximum alluvium cover of 85 m has been reported in the in Sikandara block. In parts of Jamui, Barhat and Laxmipur blocks alluvium thickness of 30-45 m has been reported. In other parts of study area in Chakai, Sono, Gidhaur, Jhanjha blocks and in considerable area in northern parts of Jamui block around Nabin nagar village, western parts of Laxmipur block the thickness of alluvium/weathered mantle is very less. The lithological model diagram and fence clearly demonstrate the occurrences of at least 4-6 sets of fractures which includes both shallow (within 80 m depth) and deep seated fractures. Deep seated fractures are encountered even below 160 mbgl. In general, thickness of the unconsolidated sediments decreases from west towards east. The thickness of weathered mantle gradually decreases towards south and in Chakai area thickness is 10-15 m.
- The optimum yield of the wells in the marginal alluvium tract is moderate to high and varies from 20.00- 75.00 m^3/hr with reference drawdown 4-9 m, where as the yield in hard rock terrain varies from 10 to 40 m^3/hr for drawdown of 30 m. The transmissivity value in alluvial and hard rock area varies from 31 m^2/day to 535 m^2/day and 12 m^2/day to 30 m^2/day respectively. The storativity value indicates the semi confined nature of the aquifers.
- Fluoride contamination of ground water above the permissible limit of 1.5 mg/lit has been detected in the aquifers in all the 10 blocks in the district. Both the shallow dug well zones and the deeper fractured aquifers are affected with Fluoride contamination in ground water. Along with other mitigation measures dilution of concentration of Fluoride by artificial recharge techniques has been proved to be helpful in short term measures.
- Total annual extractable ground water recharges for Jamui district is 370 MCM. The total annual extraction of ground water in the district is 118 MCM under irrigation, industrial and domestic draft. Irrigation draft contributes almost 70% of total annual draft in the district. Net ground water availability for future uses in the district is 272 MCM. The stage of ground water extraction on an average in the district is 34%, lowest being 14% in Barhat block and maximum of 55% in Jamui block. All the blocks are categorised as safe in terms

of level of ground water development. Total static/In-storage ground water resource in the district has been estimated as 2217 mcm which is about six times than the total annual extractable. However, the static resources are not accountable for development point of view.

- 242 tube wells/bore wells are proposed in the district for installation to bring 50% of the population under coverage of pipe water supply scheme. Both the 1st and the 2nd aquifer in the district may be assigned for the desired requirement of drinking water needs and development plan may accordingly be prepared. The indicated numbers are tentative which may vary depending on the designed discharge and capacity of the motors etc. The coverage of population in the district through pipe water supply schemes wherever archived during subsequent years under different plans may be coordinated with above for further development and management**.** However, keeping in view the significant effects on ground water regime, if any, the installation should always be implemented in phases with precaution.
- 60% of the cultivable area in the district has been brought under assured irrigation. To boost crop diversification and to encourage less water intense crops further irrigation may be extended for creation of irrigation potentials for pulses/oilseeds/other horticulture crops. Thus, 26229 ha additional irrigation potential may be created. 75% of remaining area in Gidhaur, 68% in Jhanjha, 50% in Laxmipur and 61% of the remaining area in Sono block may be brought under assured irrigation. 100% coverage may be achieved in other block with the available resources. 5621 LDDW and 5568 STW/MDTW are recommended in the district to achieve the target. 3-4 numbers of LDDW and STW/MDDW in each village in the district would satisfy the requirement.
- Based on deeper post monsoon water level and long term reflection on ground water regime, 2000 sq. km in the district has been identified and prioritized as suitable area for artificial recharge to ground water. 217 MCM available storage space is proposed to be augmented in the district with available non committed runoff. 275 MCM of source water for recharge purpose would be required which are diverted back to the aquifer through different structures. In hard rock area of Jamui district 36 percolation tanks, 40 gully plugs, 84 contour bunding and trenching and 83 check dam has been proposed. In alluvial terrain 198 tanks de-siltation and erection of 288 injections well in village tanks are recommended. The Ahar- Pyne system renovation should be on the basis of availability of existing structures and on the basis of requirement.

- 5.47 MCM water may be harvested through roof top rain water harvesting structures in Jmaui and Jhanjha urban clusters. 529 Roof top rain water harvesting structures in Jamui NP and 79 structures in Jhanjha NP have been proposed.
- Based on the superimposition of different apposite layers like administrative units, slope, elevation, drainage orders, land use pattern etc. tentative suitable sites have been recommended for installation of check dam and contours bunds in Jamui district, Bihar. For other structures actual field inspections and status of the existing structures may be considered.

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