



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

**IN PARTS OF LAKHISARAI DISTRICT,
BIHAR**

मध्य पूर्वी क्षेत्र, पटना
Mid Eastern Region, Patna

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Introduction

Lakhisarai district in Bihar lies in the southern parts of the State and on the south bank of River Ganga. Lakhisarai district was carved out of erstwhile Munger district on 3rd July 1994. Earlier it was a sub-division within Munger District. It is located in southern part of Bihar state and extends from 25° 01' to 25° 22' North Latitude and 85° 50' to 86° 17' East Longitudes with a geographical area of 1228 km². It has 06 developmental blocks comprising 476 villages with its headquarters at Lakhisarai. The district forms a part of Phalgu-Kiul sub-basin of Ganga Basin. The district comprises catchments of Ganga and Kiul river systems. The district is having moderate to low drainage density with dendritic and radial patterns dominating in the hilly regions, while parallel to sub-parallel drainage pattern in the plains. The Ganga, Kiul and Harohar are the three main rivers flowing through the district. Geo-morphologically and geologically the district is characterized by rocky uplands of Kachua and Kajra hillocks, pediplain complex, older alluvial plain and flat younger alluvial plain. The district is rural one and people are largely depending on agriculture. The district represents water scarce hard rock terrain as well as alluvial plain with abundant land and water resources. The fissured formation in hard rock area and porous formation in alluvial tracts broadly constitutes the hydrogeological frame work of the district. So far, the scope for irrigation development in the district is moderate.

Total geographical area of the district is 1228 sq km. National Aquifer Mapping in parts of Lakhisarai district was undertaken by CGWB, MER, Patna during 2016-2017 under phase III where 972 sq km comprising 4 administrative blocks was covered.

Under the Annual Action Plan of 2019-20 of CGWB, MER, Patna, aquifer mapping program and subsequent formulation of management plan were undertaken in the remaining 2 blocks comprising an area of 255 sq km.

The present report is a compilation of block wise picture of geology, geomorphology, water level, ground water development, aquifer disposition and management plan for further sustainable development of water resources in the district. In absence of sufficient exploratory well data in the district, the aquifer dispositions of the adjacent blocks have been presented. There exists further scope for detail aquifer disposition in prevalence of sufficient lithological data.

Existing and future water demand	3214.82 Ham/244.11 Ham (annual GW allocation for domestic as on 2025)
Water level behaviour	Pre-monsoon SWL- 5-10 mbgl Post-monsoon SWL- 2.0-5.0 mbgl

2. Aquifer Disposition

Number of Aquifers	01; up to the explored depth of 59.5m
Aquifer disposition and basic characteristics	1 st Aquifer from 36m to 58m, fine to medium sand mostly phreatic, at the depth of 59.50 m hard rock encountered

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

GW Resource/Categorization	Stage of extraction : 82.41%; Semi critical
Availability	
Chemical quality of ground water and contamination	Potable Arsenic and fluoride concentration was found more than permissible limit in the surrounding block of Halsi. Barhariya, Surajgarha and Pipriya block of Lakhisarai has been reported arsenic contamination from 16 PPB to 50 PPB respectively.

4. Supply Side Interventions

Ground Water Development Strategies-	Ground water development about 80%. Therefore further indiscriminate uses have been restricted. DTW for irrigation uses from 2 nd aquifer has been recommended. At initial phases 20-30 DTW with unit draft of 4-5 ham is proposed
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Aquifer wise space available for recharge and proposed interventions	As per ARMP, 2020, 4537 ha area has been identified as recharge worthy area. 1 Percolation tanks, 6 gully plugs, 8 contour bunding, 10 recharge shafts, 17 de-siltation of tanks and 23 injection wells have been recommended.
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5. Demand side interventions

Advanced Irrigation Practices

Project based drip/sprinkler irrigation, lining of field channels etc.

Change in cropping pattern

Less water intensive crop like pulses, oilseeds may be encouraged.

Alternate water sources

Conjunctive uses of groundwater/surface water sources,

Regulation and Control

Capacity building for awareness generation for Arsenic and fluoride contamination.

1.0 General Information

1.	Total area		151.06 sq km
2.	Total number of Panchayat		10
3.	Total number of villages		76
4.	Population (Census 2011)	Total	139018
		Rural	139018
		Urban	0
5.	Normal annual rainfall		1108.6 mm
6.	Basin / Sub-basin		Ganga Basin / Phalgu- Kiul Sub basin
7.	Location		
	Latitude		24.975 to 25.084
	Longitude		85.887 to 86.142

Halsi is an administrative block in Lakhisarai district of Bihar state in India. The Halsi comes under south circle of the Lakhisarai district, having a geographical area of 151.06 Sq. Km. It is located in southern part of Bihar state and extends between North latitude 24.975 to 25.084 and East Longitude 85.887 to 86.142. The block is bounded by Jamui district in the east, Sikandra and Aliganj block of Jamui district in the south, Chewara block of Sheikhpura district in the west and in the north, it is bounded by Ramgarh Chowk block. (Fig-1).



Fig-1 Administrative Map of Halsi Block, Lakhisarai District

1.1 Basic demographic detail of Halsi block (Census 2011)

There are 75 revenue villages under Halsi block. The block consists of 10 Gram Panchayats, 76 villages and 18,096 households. Total population of Halsi block is 139018 as per Census 2011 Data. Sex ratio in Halsi block is 929 per 1000 male. Literacy rate in Halsi block is 59.35%. Partabpur is most populated village in Halsi block and less populated village is Kusokhar. There are no town in Halsi sub-district.

Table 1A- Population of Halsi block

S.No	Block	No of Panchayat	No. of village	Population			
				M	F	CH	Total
1	Halsi	10	76	60118	55879	23021	139018

1.2 Rainfall and Temperature

Normal annual rainfall of Halsi block is 1108.6 mm of which 83.88% occurs during the monsoon season. The normal rainfall during monsoon season is 930.00 mm and during non-monsoon season is 178.60 mm. The variation of rainfall in this zone is from 1108.6 mm to 1104.5 mm and the temperature varies from 6° to 43°.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Halsi block, 63% of total population is non workers. It is evident from below diagram that 10% of the total population in the block is engaged in agriculture, 7% are cultivator, 1% comprises household industrial workers, 17% are marginal workers and 7% comprises other workers, (Fig-2).

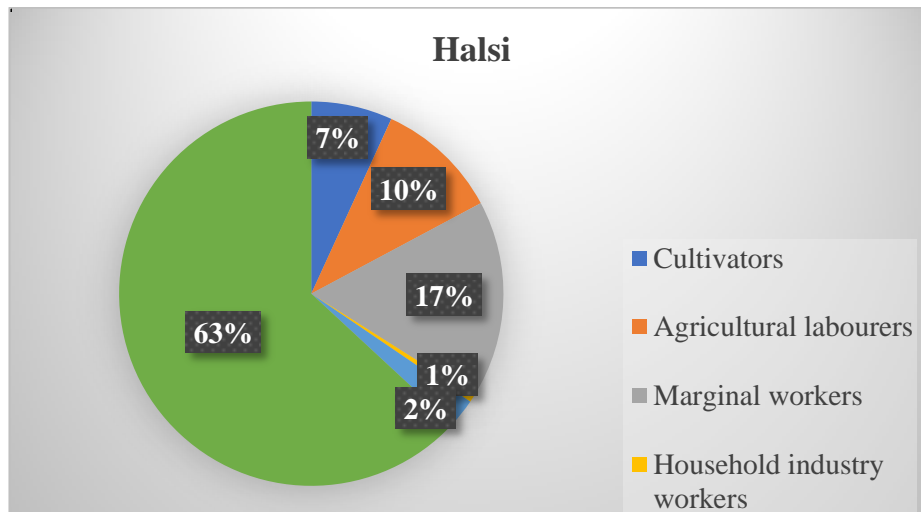


Fig 2- Distribution of persons engaged in Halsi block

Source- Census 2011

1.4 Soil

Halsi block contains mainly calcareous sandy soils, Coarse loamy soils, fine loamy soils, Clayey soils with pH in the range of 6.8-8.0 (Fig-3)



Fig -3 Soil Map of Halsi block, district Lakhisarai, Bihar

1.5 Physiographic, Basin/sub-basin, and Drainage:

In this block Kiul river flows from east of the block boundary of Lakhisarai district and forms a part of Phalgu-Kiul sub-basin of Ganga Basin. The block comprises catchments of Ganga and Kiul river systems. The block is having moderate to low drainage density with dendritic and radial patterns dominating in the hilly regions, while parallel to sub-parallel drainage pattern in the plains. The Ganga, Kiul and Harohar are the three main rivers flowing through the area. The Ganga flowing to the east touches the northern border while Kiul river flowing to the north almost bisects the district and joins the river Ganga in the north. The block having average elevation of 47m. The entire blocks are with land slope of 0-3%.

1.6 Geomorphology

The block has a diverse landscape ranging from hills to flood plains. The major geomorphic units are rocky upland; Padi plain, alluvial plain and flood plains. The Rocky Upland area comprises series of hills namely Kachhua and Kajra hills. The altitude of hills varies from 90 to 150m amsl. It comprises mainly quartzite, phyllite and schist of Kharagpur formation. Older Alluvial Plain forms a major part of the block. It comprises sediments deposited by Ganga River and also the sediments derived from the denudation of Chota Nagpur plateau and Kharagpur hills. This is also known as marginal alluvial plain due to its limited thickness. However, the thickness of the alluvium ranges from 45 to 70m in the interfluvium of Kiul and Harohar rivers. (Fig- 4).

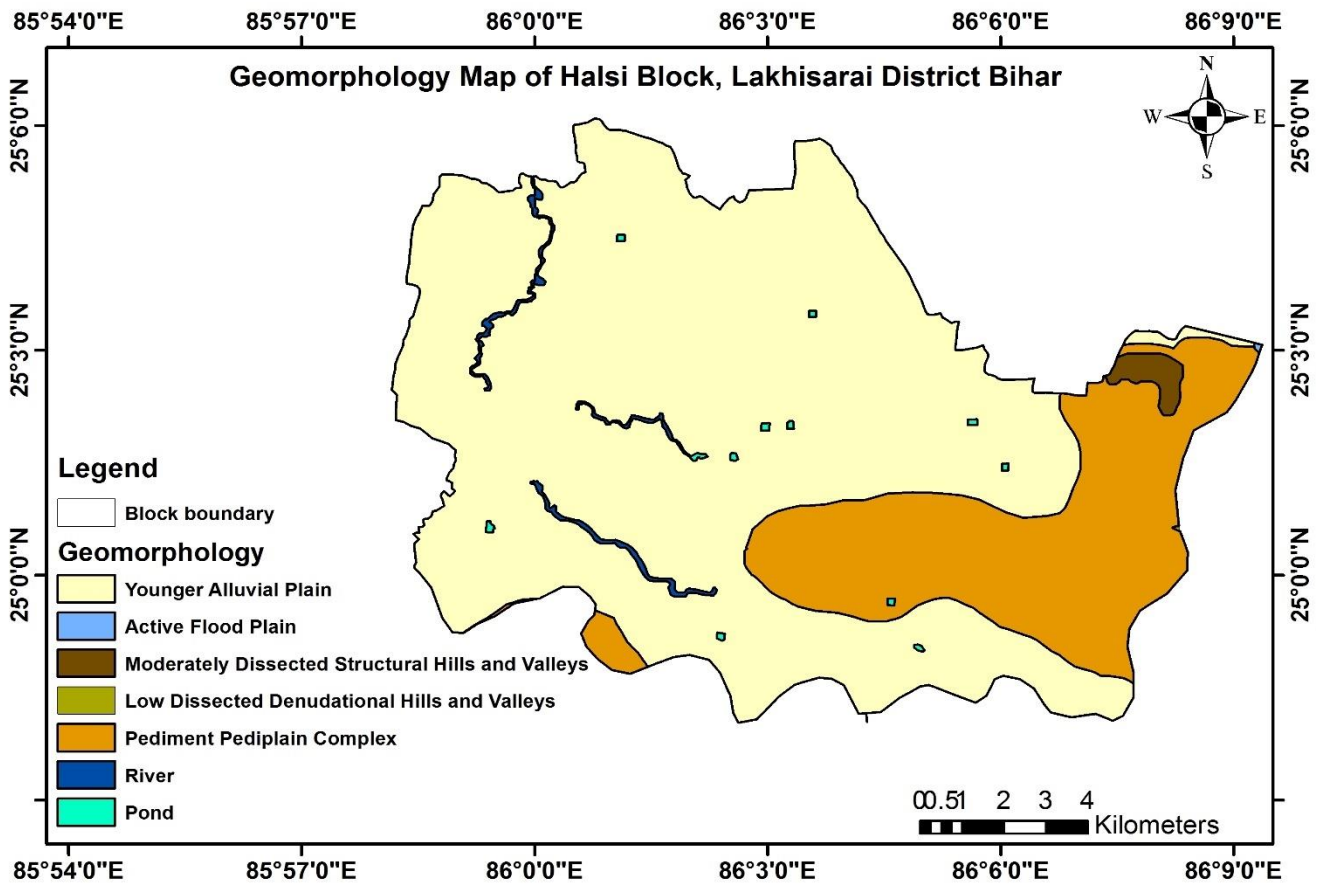


Fig 4- Geomorphology Map of Halsi block

1.7 Land use pattern

Total geographic area of the Halsi block is 15106 ha among which net sown area 10187 ha and gross cropped area is 17823 ha. Therefore, area under multiple cultivation is 7636 ha. It is evident that net sown area comprises 67.43% of total geographical area in the block and 50.54% area under multiple cultivation. The cropping intensity of the block is 174.96% (Table 1C).

Table 1 C- Details of Land use pattern of block (area in ha)

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under waste land	Area under other uses
Halsi	15106	17823	10187	7636	174.96 %	-	-	-

(DIP 2016)

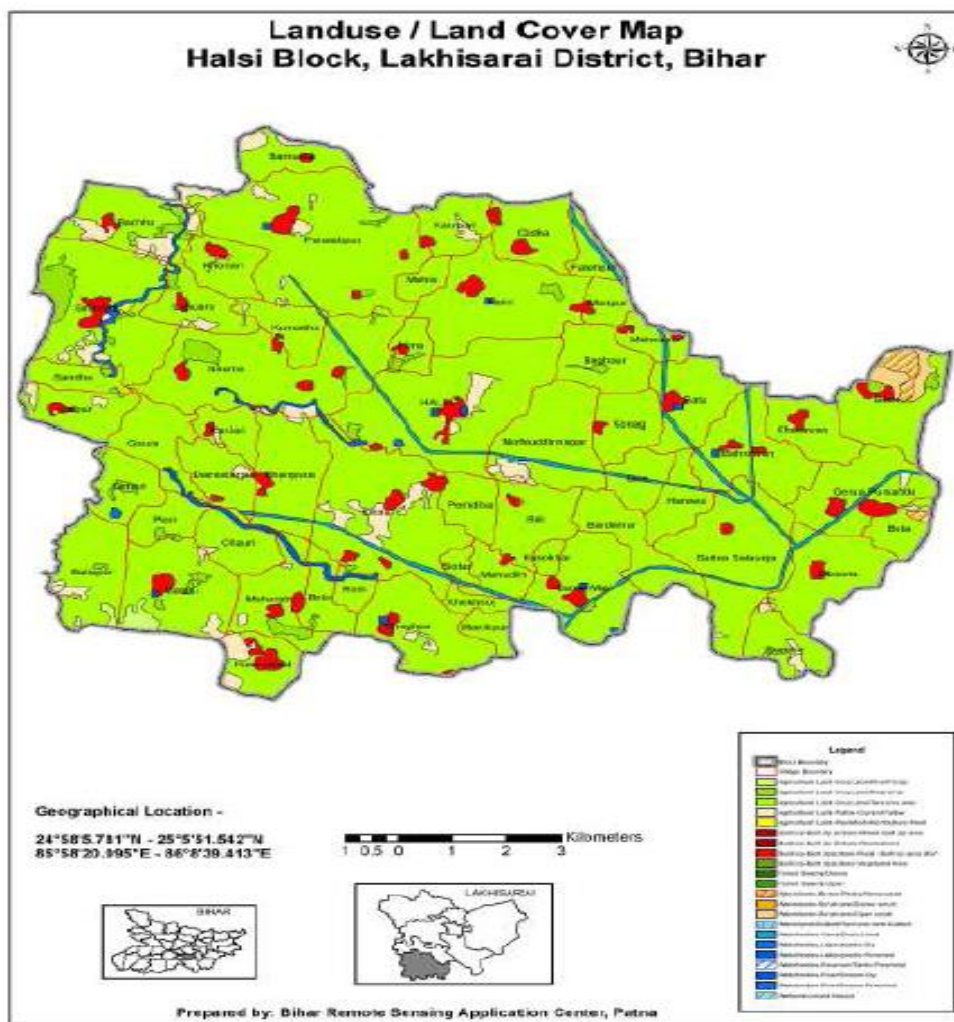


Fig 5- LULC Map of Halsi block

1.8 Agriculture and Irrigation

Halsi block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. The gross irrigated area is 52.65 Sq. km (DIP- 2016). The irrigation by surface water canals is provided in Halsi block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5thMI Census are presented in (Figure-6).

Table 1D- of MI structure in Halsi block

DW	STW	MTW				DTW
		35-40m	40-60m	60-70m	TOTAL	
29	23	89	956	7	1052	12

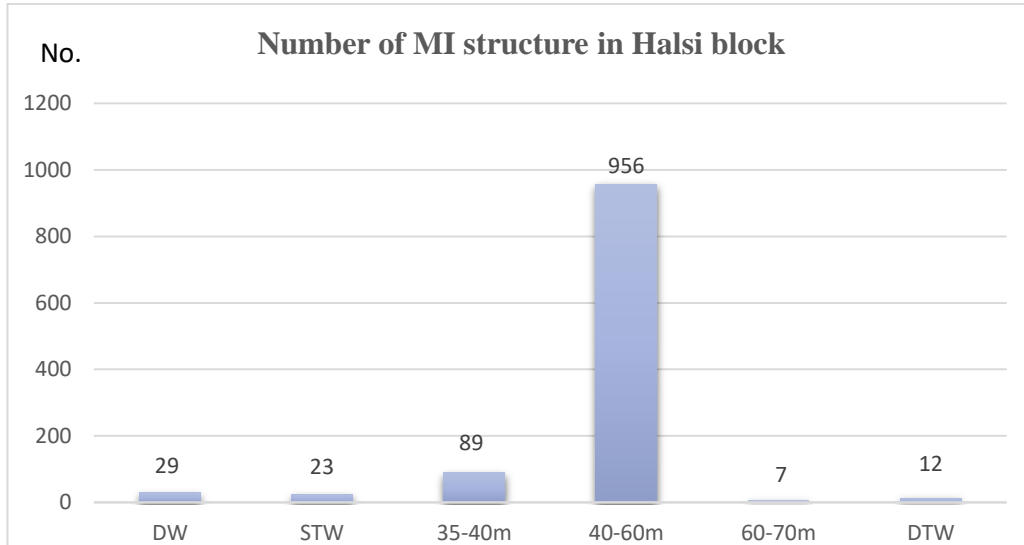


Fig 6- No. of MI structure in Halsi block

2.0 Geology

The block comprises unconsolidated and consolidated formation of Quaternary and Precambrian age. Unconsolidated formation forms a major part of the block. It comprises sediments deposited by Ganga River and also the sediments derived from the denudation of Chota Nagpur plateau and Kharagpur hills. It consists of clay, silt and sand. Consolidated formation are found to occur in sparse area in eastern parts of the block. The consolidated formation is part of Chotonagpur Gneissic complex.

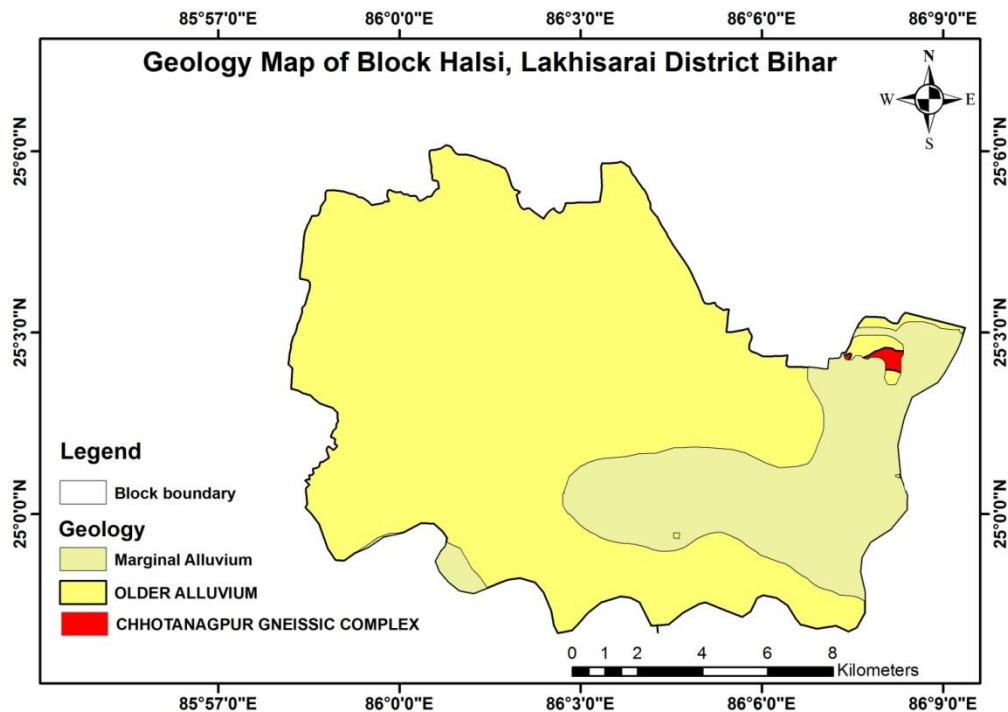


Fig 7- Geology Map of Halsi block, District Lakhisarai, Bihar

3.0 Hydrogeology

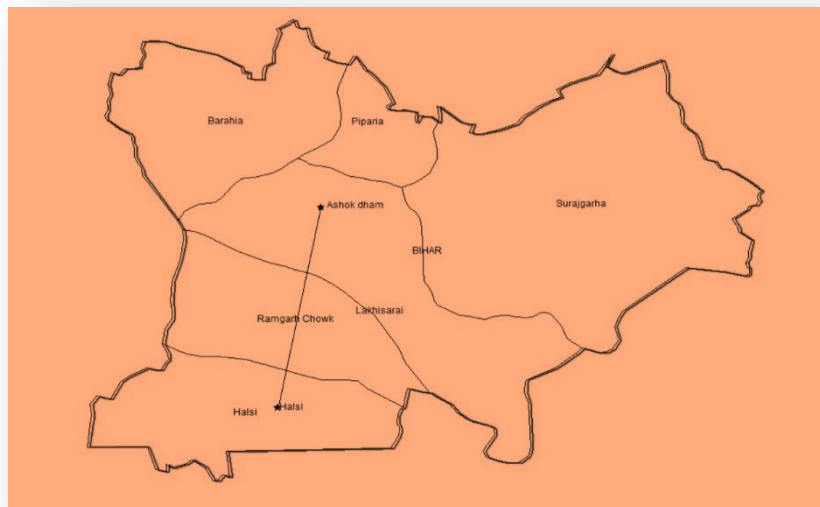
The block is divided into two parts (a) unconsolidated / porous formations (b) hard rock/ fissured formation.

(a) Porous Formation: The Quaternary alluvium constitutes this hydrogeological unit. The alluvium comprises clay, silt and sand of various thicknesses. Aquifers in this formation occur under unconfined to semi-confined conditions. Yield ranging from 10 to 100 m³/hr.

(b) The hard rock / fissured formation: It comprises rocks of Chotanagpur Gneissic Complex (CGC) and Kharagpur formation. They are composed mainly of granite gneisses, quartzites and phyllites. The water holding capacity of the fissured formation depends on occurrences of potential fractures/joints etc.

3.1 Aquifer Disposition

Lithological log of Halsi and Ashok dham exploratory well has been compiled, analysed and lithological cross section across Halsi and Ashok dham (North-west) section has been prepared. The lithological disposition in Halsi block reveals single aquifer system down to the explore depth of 59.50m below from ground level. The aquifer is overlain by significant thick clay layer from 0.00 to 36.00m. The aquifer are appreciably thick and the thickness of granular zone is about 22 m in Halsi exploratory well and 35m in Ashok dham exploratory well. Two intermediate clays of 8 to 15m thick have been encountered within the sandy aquifer layer in Ashok dham well. Hard crystalline granitic basement rock has been encountered at 60m in Halsi and 116m in Ashok dham area. The lithological disposition across Halsi-Ashoke dham is given in (fig 8).



Section showing Aquifer disposition in the block

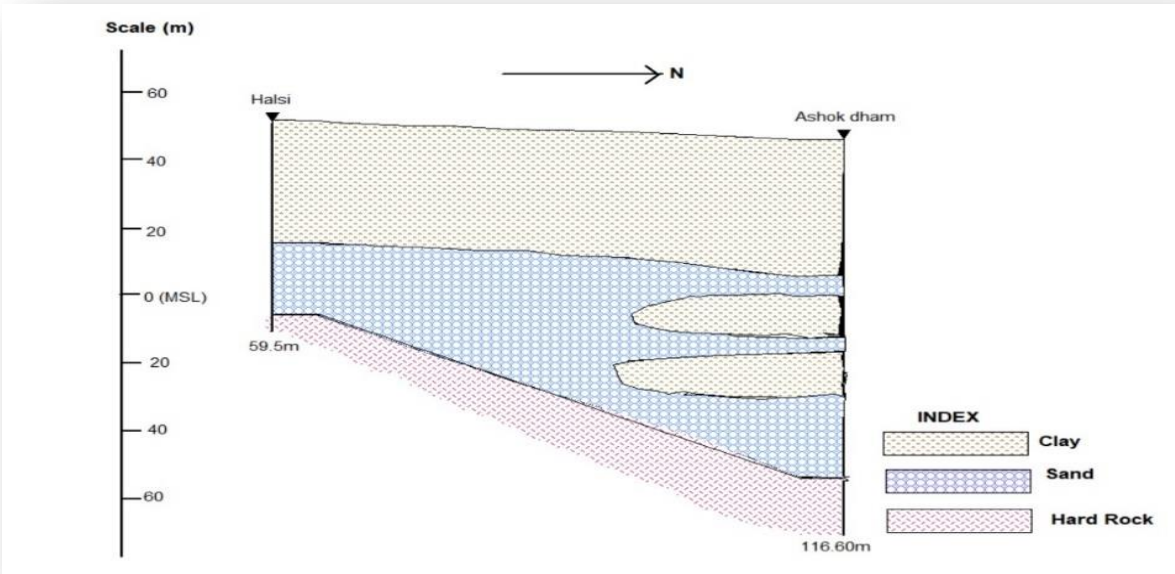


Fig 8- Lithological disposition across Halsi-Ashoke Dham Area

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells in and around the area, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar.

In existing network monitoring wells depth to water level varies from 5 to 10 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 2 to 5 mbgl.

Water level measured in piezometer of minor irrigation department 7.67 mbgl during pre-monsoon season and in post monsoon season water level is 4.53 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 3.14m in this block.

Table 3A- Water level in Halsi block

SI No	Block _Name	Type_of _Well	Location	Latitude	Longitu de	RL(m)	Depth (mbgl)	Pre- monsoon SWL/bg l	Post- monsoon/SWL mbgl	Flauctutati on(m)	Pre Water Table (m amsl)	Post W ater Table (m amsl)
1	Halsi	Pz	BDO Office	25.029	86.0489	47	50.00	7.67	4.53	3.14	39.33	42.47

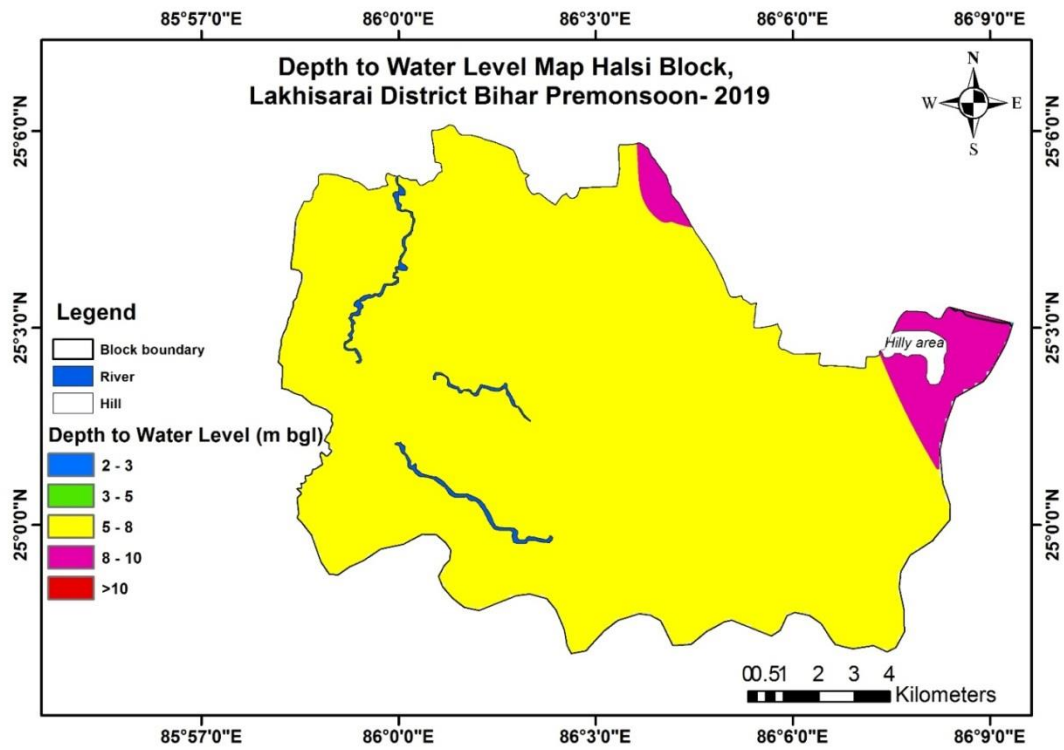


Fig 9- Pre-monsoon (2019) water level Map of Halsi Block

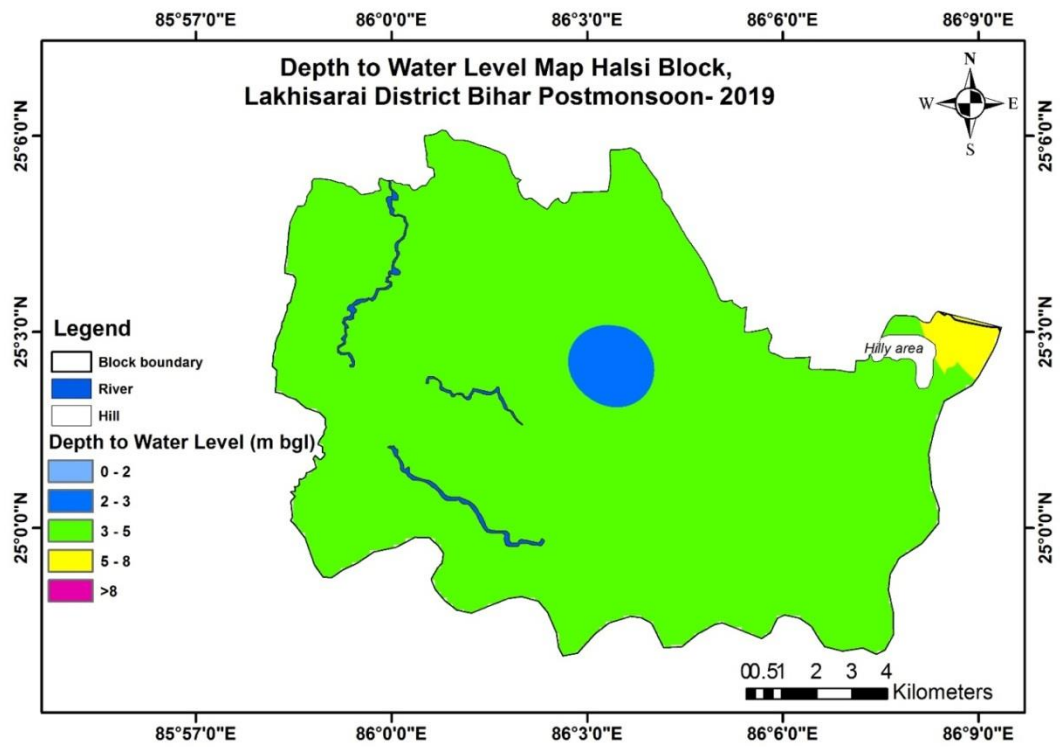


Fig 10- Post-monsoon (2019) water level Map of Halsi Block

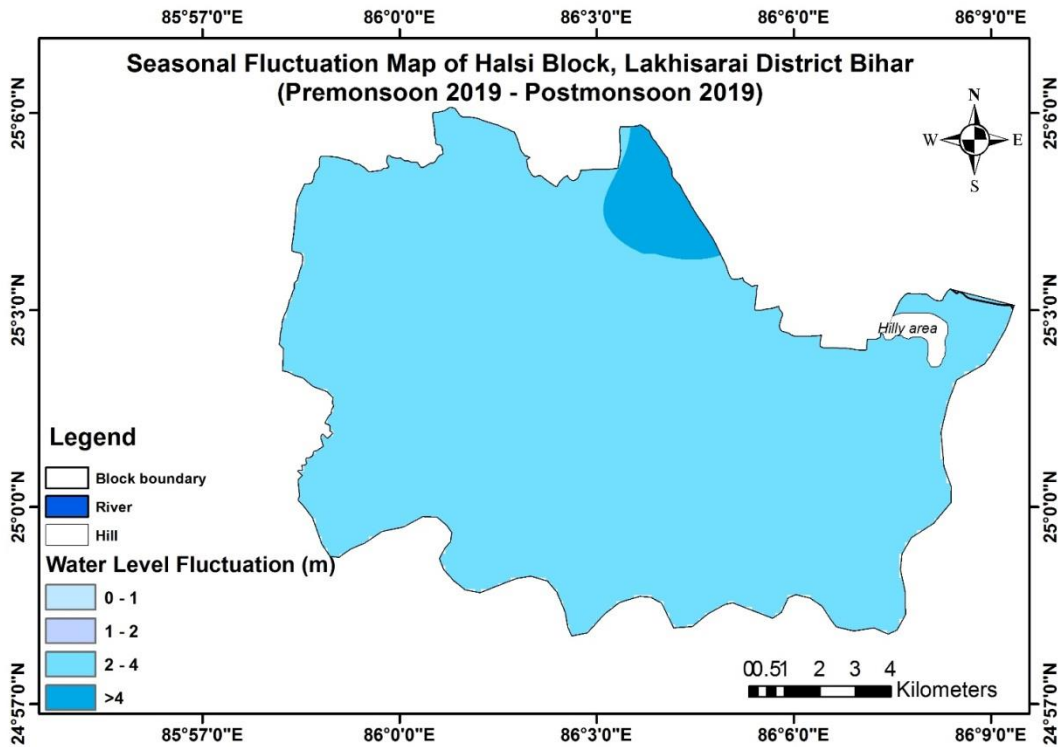


Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Halsi Block

3.3 Aquifer properties

Ground water exploration has been carried out in Halsi block to assess the ground water potentiality.. Halsi block has two (2) wells as one exploratory tube well has been constructed in the block with maximum explored depth of 59.5m and one is observatory well has been constructed in the block with maximum depth of 55.4m. Reported discharge is 237.36 m³/hr with drawdown 6.48 m. estimated aquifer property shows that area have a transmissivity value of 1238.4 m²/day with storativity value of 2.08x10⁻⁴.

3.4 Water table contour

The water table contour map of Halsi block shows the height of water table during pre-monsoon season varies from 40.37 m to 45.40 m and during post monsoon season height of water table varies from 41.30m to 46.40m above from mean sea level. As shown in map, ground water flow direction is towards NW direction in this block (fig-12).

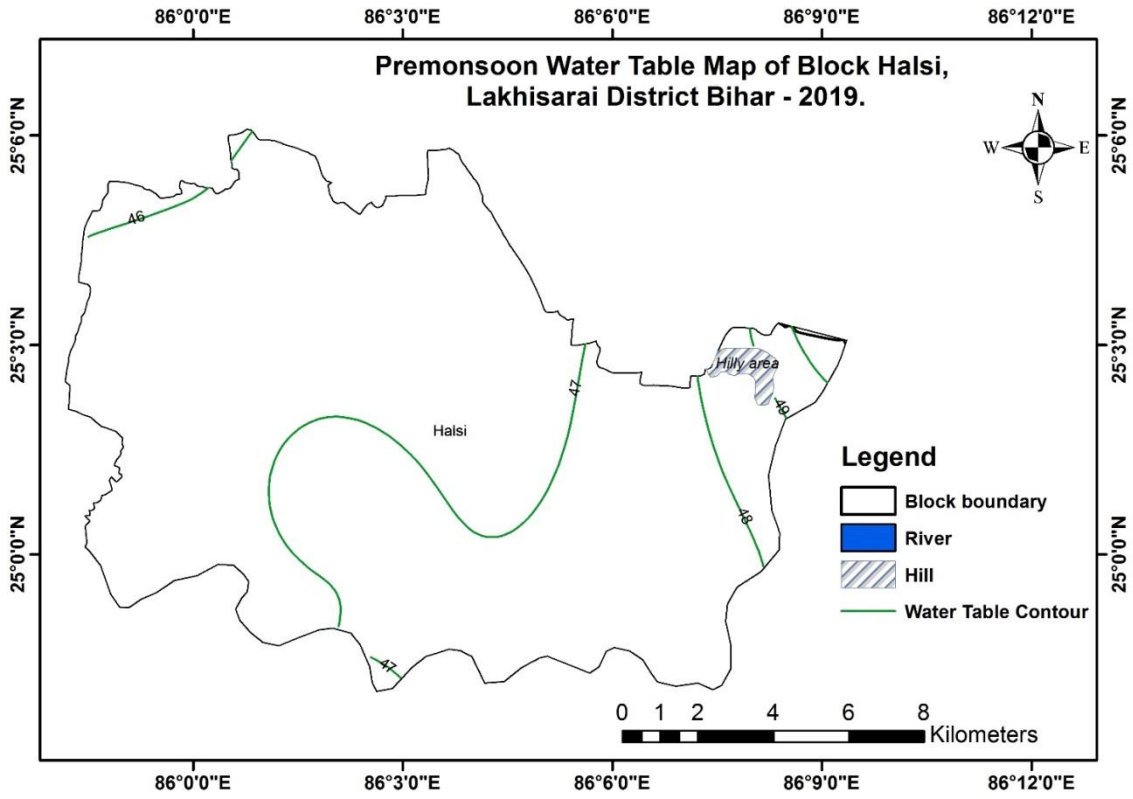


Fig 12: Pre-monsoon (2019) water table contour Map of Halsi Block

4.0 Ground Water Resource Availability and Extraction

Total annual ground water recharge is 4334.62 Ham and total natural discharge is 433.47 Ham. Total extraction for uses is 3215 ham. The stage of ground water extraction is 82.41%, and comes under semi-critical category.

Table 4A: Dynamic Ground Water Resource (as on 22nd March, 2021)

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi critical/Safe /Saline)
HALSI	15106	13419	4334.62	433.47	3901.15	2907.5	90.00	217.32	3214.82	244.11	659.54	82.41	semi_critical

4.1 Chemical Analysis

Central Ground Water Board, Mid-Eastern Region is doing ground water sampling from these blocks to monitor the ground water quality. The chemical quality of ground water is good and suitable for irrigation and other purposes, in general, with exception to arsenic and fluoride contaminations in some of the villages. Arsenic concentration was found more than permissible limit in the surrounding block of Halsi. Barhariya, Surajgarha and Pipriya block of Lakhisarai has been reported arsenic contamination from 16 PPB to 50 PPB respectively. Therefore, every ground water base water supply in the block is recommended for chemical analysis for Arsenic before supply to the villagers. Sporadic occurrences of F in ground water above 1 ppm has been reported from few area.

5.0 Management Plan

5.1. Supply side intervention in Agriculture, Irrigation and Drinking water

The overall stage of groundwater development in the Block is 82.41% and the block has been categorized as semi critical. Total annual extraction exceeds for 70% development of total annual extractable ground water resources in the block by 485 ham. Therefore, further development from shallow aquifer may be attempted judiciously to restrict further stress on the aquifer. Arsenic contamination of groundwater has been reported at the adjacent block from the 1st aquifer in the younger alluvial belt down to the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safer from arsenic contamination. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit; however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energized extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd aquifer is thus recommended for community drinking water supply. As per the MI census data 12 DTW are, at present in this block. Considering the unit draft of one DTW as 4.8 ham, additional 20-30 DTW may be safely constructed in the district, which may increase the development at 85%. Otherwise the deeper aquifer may be protected for drinking water supply. Every installation of ground water may be compensated with suitable design rain water harvesting structure to augment the resource in the depleted aquifer.

Table 5A Availability/Deficit in resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70% development (Ham)
Halsi	15106	13419	3901	3215	2730	-485

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 175 %. It reveals that considerable cropped area is under assured irrigation coverage. Installation of 20-30 no of DTW for irrigation uses will further create irrigation potential of 500-600 ha. Therefore the cropping intensity of around 180% may be achieved.

5.2 Supply Side Management intervention through Artificial Recharge and rain water harvesting

The block receives 1104.5 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. 4537 ha rea has been identified as recharge worthy area in the block. Contour bunding, check dam, gully plug, percolation tank, recharge shafts, de-siltation of existing tanks, injection well village tanks etc. are some suitable structures in the area. Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

Table 5.B Proposed number of AR structures in the block

Recharge worthy area in ha	Gully Plug	Contour Bunding & Trenching	Nala Bunding	Recharge Shaft	De-silting of existing tank/pond/talao	Injection well in Village Tank
4537	6	8	1	10	17	23

5.3 Demand Side Interventions

In view of the moderate to higher development of ground water further unplanned development may be restricted in the block. Considering the moderate potentiality of the area water intensive crop may to some extent be replaced by less water consuming crop. Therefore pulses, oilseeds other horticulture crops etc as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

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

In addition to that, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested for arsenic contamination. Domestic arsenic removal technique may be adopted for short term measures whereas for long term intervention commercial arsenic removal plan may be installed. Domestic fluoride removal technique may be adopted for short term measures where fluoride contamination in ground water has been reported.

Capacity building for awareness generation among the stake holders and end users may be suitable for effective management of water resources and to mitigate the water contamination in ground water.

Post-monsoon SWL- 2.0-5.0 mbgl

2. Aquifer Disposition

Number of Aquifers

02 Aquifers; up to the explored depth of 116.60m

Aquifer disposition and basic characteristics

1st Aquifer or dug well zone, shallow within 10 m depth, mostly phreatic. Surface clay capping of 25-30 m , 2nd aquifer thick, about 50 m in Ramgarh Chowk , confined to semi confined in nature; hard rock encountered at 70-80 m depth.

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

GW Resource/Categorization

Safe; development 44%

Availability

Chemical quality of ground water and contamination

Potable
Arsenic and fluoride concentration was found more than permissible limit in the surrounding block of Halsi. Barhariya, Surajgarha and Pipriya block of Lakhisarai has been reported arsenic contamination from 16 PPB to 50 PPB respectively.

4. Supply Side Interventions

Ground Water Development Strategies-

Number of STW/MDTW and DTW may be proposed for irrigation uses-
STW-188, DTW-0

Aquifer wise space available for recharge and proposed interventions

As per ARMP, 2020, for Munger district 4789 ha is suitable or recharge in Ramgarh Chawk
Percolation tanks, desilting of existing tanks, check dam , recharge shafts, injection wells etc. are some suitable structures in the area

5. Demand side interventions

Advanced Irrigation Practices

Project based drip/sprinkler irrigation, lining of field channels etc.

Change in cropping pattern

Water intense and Less water intensive crop like pulses, oilseeds may be encouraged.

Alternate water sources

Conjunctive uses of groundwater/surface water sources,

Regulation and Control

Capacity building for awareness generation for fluoride contamination.

1.0 General Information

1. Total area		: 104 sq km
2. Total number of Panchayat		: 08
3. Total number of villages		: 31
4. Population (Census 2011)	Total	: 101893
	Rural	: 71006
	Urban	: 30887
5. Normal annual rainfall		: 1108.6 mm
6. Basin / Sub-basin		: Ganga Basin / Phalgu-Kiul Sub basin
7. Location		
Latitude		: 25.033 to 25.174
Longitude		: 85.948 to 86.164

Ramgarh Chowk is a town and Block in Lakhisarai district of Bihar state in India. The Ramgarh Chowk comes under west circle of the Lakhisarai district, having a geographical area of 104 Sq. Km. It is located in southern part of Bihar state and extends from between North latitude 25.033 to 25.174 and East Longitude 85.948 to 86.164. The block is bounded by Barahia in the east, Halsi in the south, Sheikphura and Chewara in the west and in the north, it is bounded by Lakhisarai block. (Fig-1).

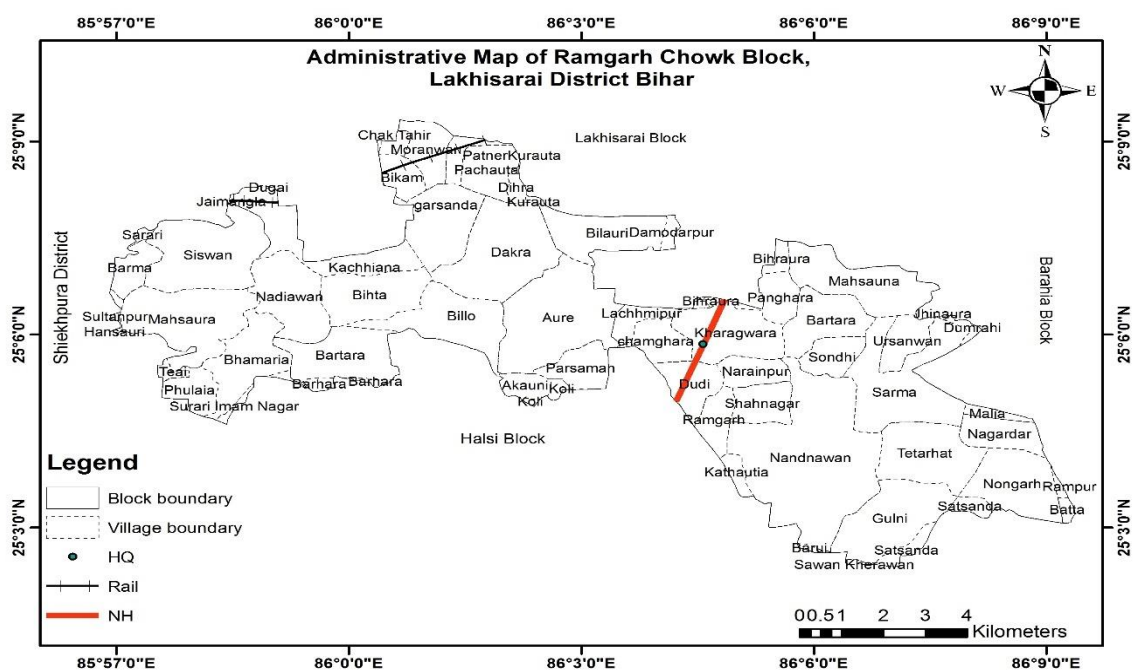


Fig-1 Administrative Map of Ramgarh Chowk Block, Lakhisarai District

1.1 Basic demographic detail of Ramgarh Chowk block (Census 2011)

As per census 2011 the total population of Ramgarh Chowk block is 101893 among which 30887 people live in urban area that is 30.31% of total population (Table 1A). Therefore, the block is a rural one.

Table 1A- Population of Ramgarh Chowk block

S.no	Block	No of Panchayat	No. of village	Population			
				M	F	CH	Total
1	Ramgarh Chowk	8	31	44056	41049	16788	101893

The block consists of 08 Gram Panchayats, 31 villages and 13,910 households.

1.2 Rainfall and Temperature

Normal annual rainfall of Ramgarh chowk block is 1108.6 mm of which 83.88% occurs during the monsoon season. The normal rainfall during monsoon season is 930.00 mm and during non-monsoon season is 178.60 mm. The variation of rainfall in this zone is from 1108.6 mm to 1104.5 mm and the temperature varies from 6° to 43°.

1.3 Distribution of persons engaged in agriculture and other workers/ non workers in the block

In Ramgarh chowk block, 53% of total population is non workers. It is evident from below diagram that 11% of the total population in the block is engaged in agriculture, 7% are cultivator, 2% comprises household industrial workers, 17% are marginal workers and 2% comprises other workers, (Fig-2).

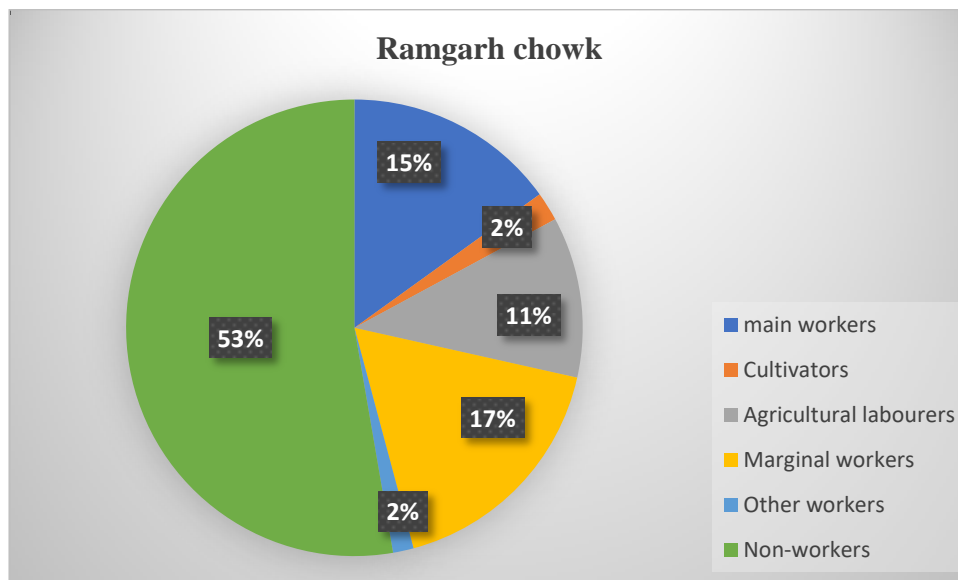


Fig 2- Distribution of persons engaged in Ramgarh Chowk block

Source- Census 2011

1.4 Soil

Ramgarh Chowk block contains Alluvium and Granite and Gneiss, Alluvium part contains mainly sandy loam, Clay loam, loam, Clay. Major soil classes of this zone are Alluvium, Granite Gneiss with pH in the range of 6.8 – 8.0 (Fig-3).

		Soil Type	Land Slope				
S.No	Block	Major Soil Classes	Area (ha)	0-3% ha	3-8% ha	8-25% ha	>25%
1	Ramgarh Chowk	sandy loam, Clay loam, loam, Clay.	10427	600	-	-	-

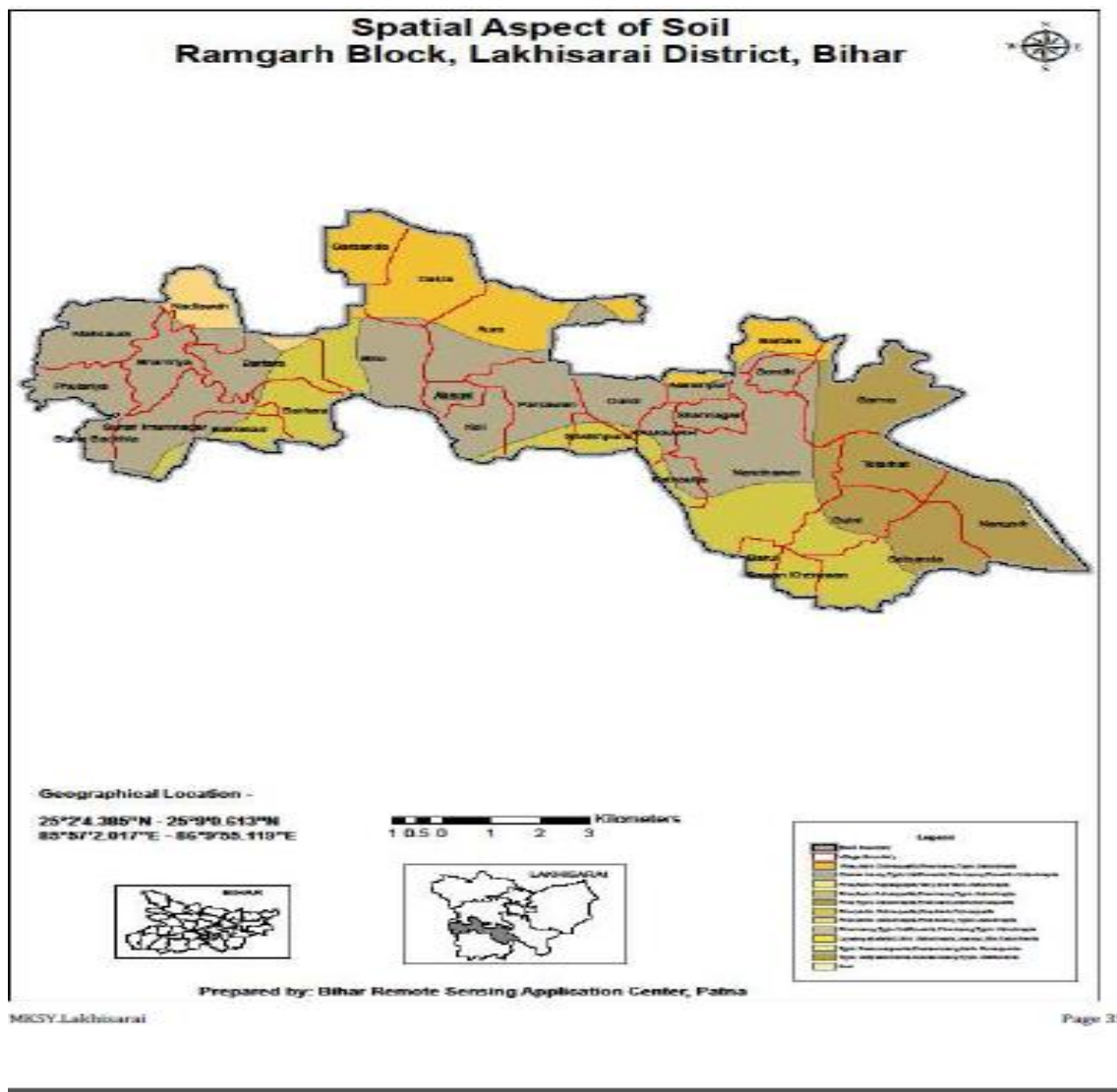


Fig -3 Soil Map of Ramgarh Chowk block, district Lakhisarai, Bihar

Source- (DIP 2019)

1.5 Physiographic, Basin/sub-basin, and Drainage:

The Kiul river flows through the east of the block boundary. The area forms a part of Phalgu-Kiul sub-basin of Ganga Basin. The block comprises catchments of Ganga and Kiul river systems. The block is having moderate to low drainage density with dendritic and radial patterns dominating in the hilly regions, while parallel to sub-parallel drainage pattern in the plains. The Ganga, Kiul and Harohar are the three main rivers flowing through the area. The Ganga flowing to the east touches the northern border while Kiul river flowing to the north almost bisects the district and joins the river Ganga in the north. The average elevation is 50 m. The entire blocks are with land slope of 0-3%.

1.6 Geomorphology

The major parts of the block comprise alluvial plain. Few parts have landscapes of moderately dissected structural hills and valleys, pediment pediplain complex. Older Alluvial Plain forms a major part of the block. It comprises sediments deposited by Ganga River and also the sediments derived from the denudation of Chota Nagpur plateau and Kharagpur hills. This is also known as marginal alluvial plain due to its limited thickness. Sediments of sand silt and clay which occurs in the interfluvium of Kiul and Harohar rivers in the eastern parts of the block forms major hydrogeological units of block.

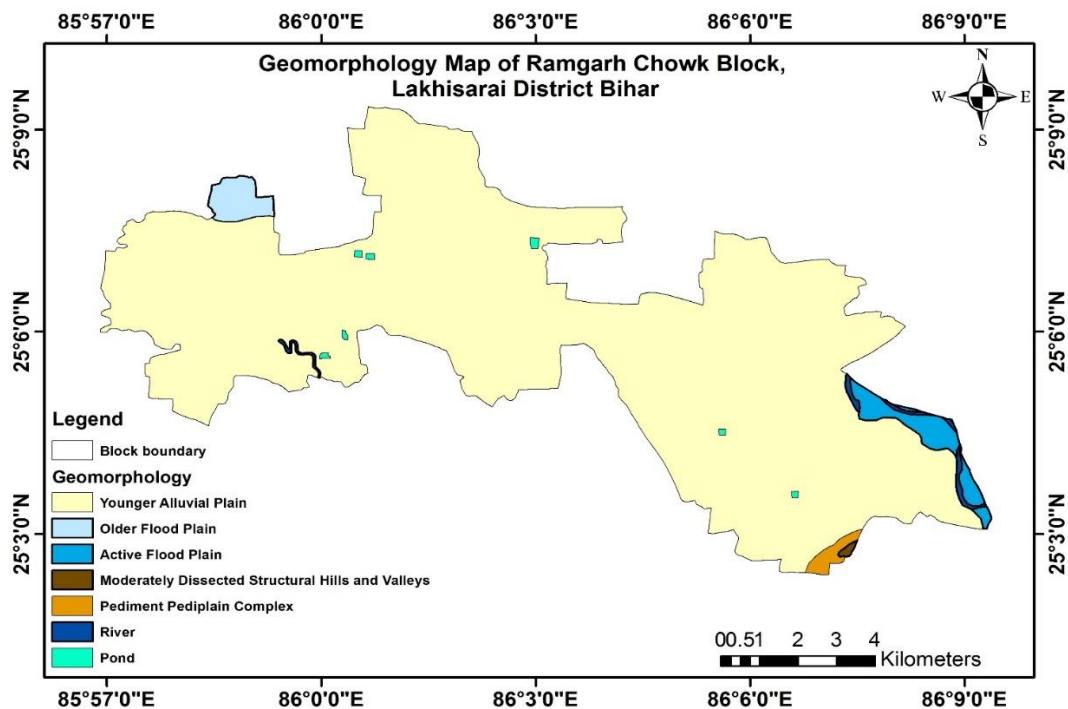


Fig 4- Geomorphology Map of Ramgarh chowk block

1.7 Land use pattern

Total geographical area is 6543 ha, gross cropped area 9154 ha with net sown area as 5678 ha and area sown more than once is 3476 ha. Total geographical area of district is 129317 ha with area under forest is 12065 ha, area under agriculture use is 82485ha, area under wasteland 14259 and area under other uses as 11397 ha (DIP 2016). The overall cropping intensity in the block is 161.22%.

Name of the block	Total Geographical area	Gross cropped area	Net sown area	Area sown more than once	Cropping intensity	Area under forest	Area under waste land	Area under other uses
Ramgarh chowk	6543	9154	5678	3476	161.22 %	-		-

Table 1 C- Details of Land use pattern of block (area in ha)

Source- DIP (2019)

1.8 Agriculture and Irrigation

Ramgarh chowk block falls in the Agro-climatic Zone III B. The cropping sequence followed in this zone is Rice – Wheat, Rice – Gram, Rice – Lentil, Rice – Rai. The gross irrigated area is 39.01 Sq. km (Dip 2016).

The irrigation by surface water canals is provided in Ramgarh chowk block, besides a large area is irrigated by ground water irrigation by tube wells and large diameter dug wells. Majority of the ground water structures are fitted with diesel-operated pumps. The numbers of irrigation structure as per 5th MI Census are presented in (Figure-6).

Table 1D- of MI structure in Ramgarh chowk block

STW	MDTW	MDTW	MDTW	TOTAL MDTW	DTW
	(35-40m)	(40-60m)	(60-70m)		
17	193	94	1	288	30

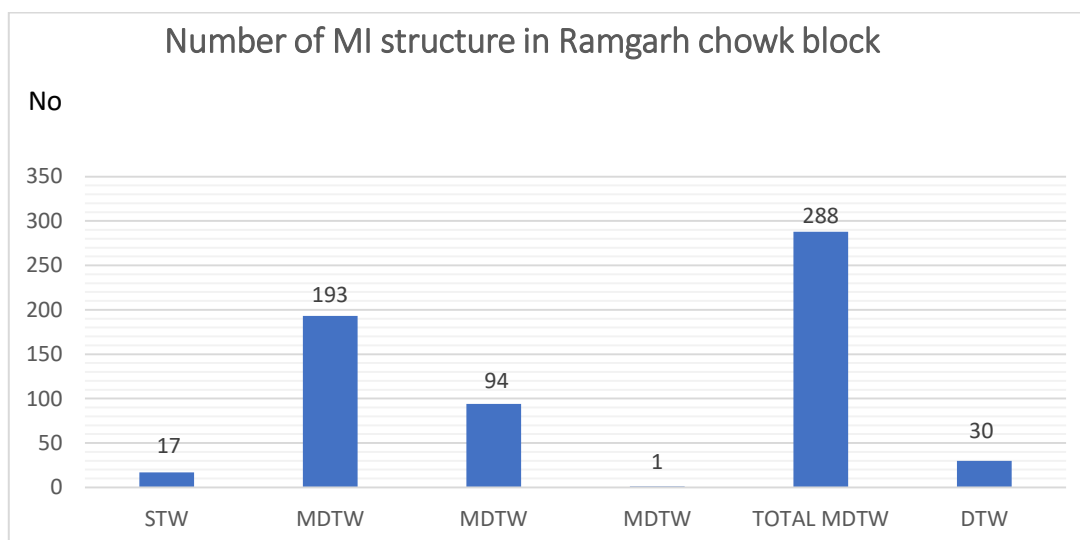


Fig 6- No. of MI structure in Ramgarh Chowk block

2.0 Geology

The block comprises unconsolidated and consolidated formation of Quaternary and Precambrian age. Unconsolidated formation forms a major part of the block. It comprises sediments deposited by Ganga River and also the sediments derived from the denudation of Chota Nagpur plateau and Kharagpur hills. It consists of clay, silt and sand. The Rocky Upland area comprises series of Kachhua and Kajra hills. It comprises mainly quartzite, phyllite and schist of Kharagpur formation (Fig -7).

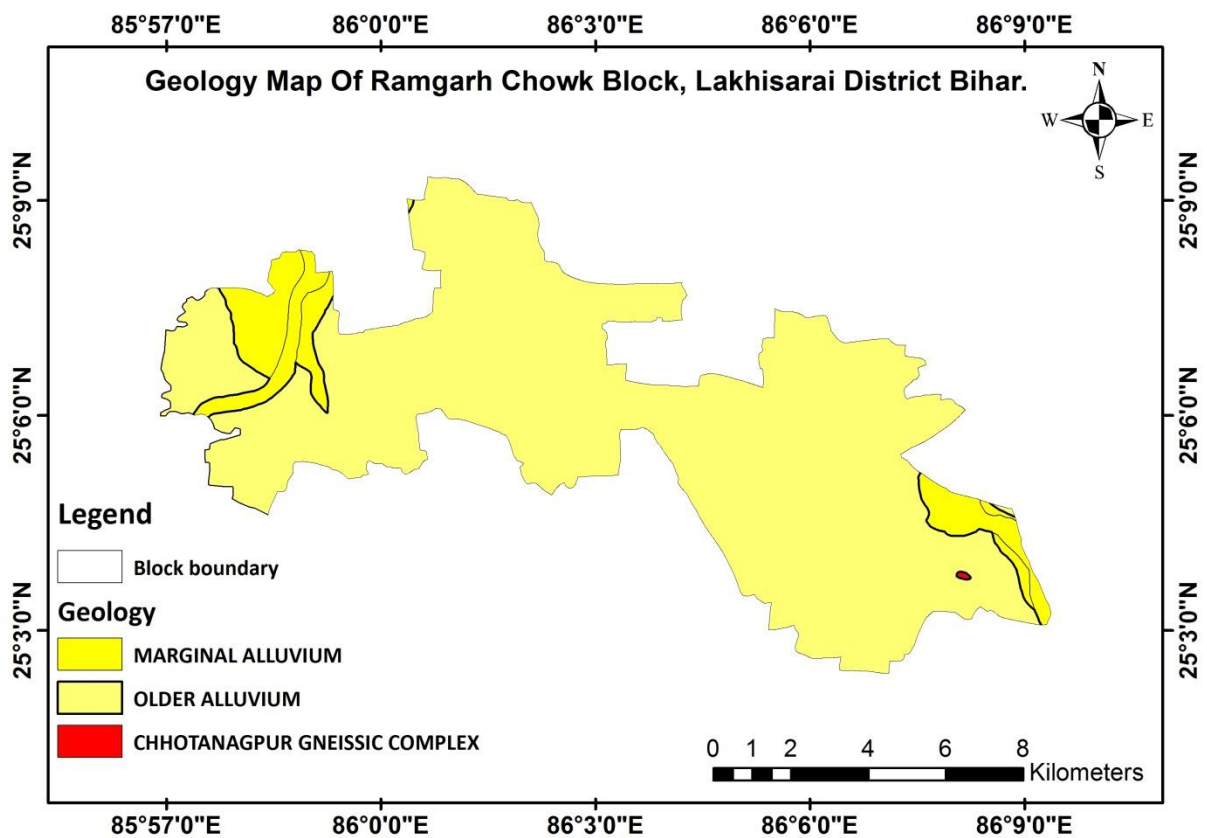


Fig.5 Geology Map of Ramgarh chowk block, District Lakhisarai, Bihar

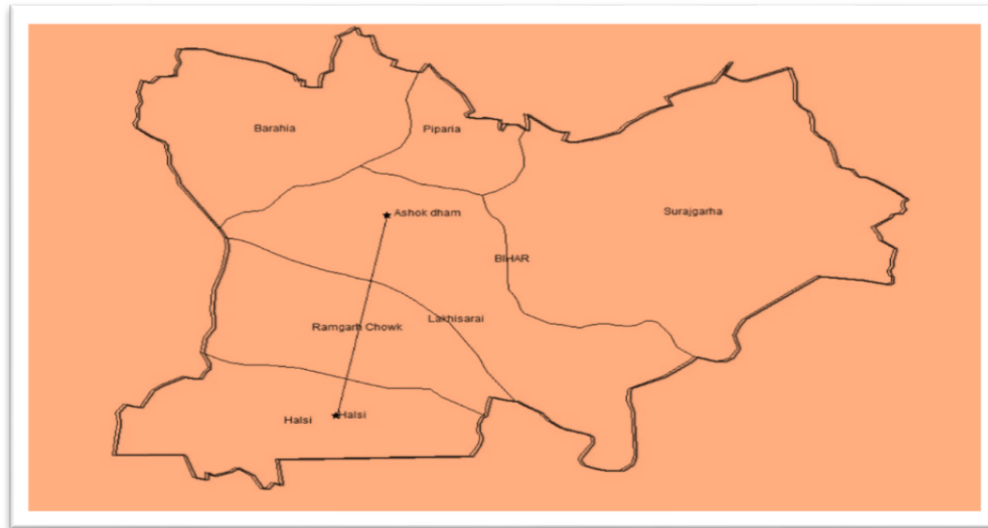
3.0 Hydrogeology

The block is divided into two parts (a) hard rock/ fissured formation (b) unconsolidated / porous formations. The hard rock / fissured formation occupies little area. It comprises rocks of Chotanagpur Gneissic Complex (CGC) and Kharagpur formation. They are composed mainly of granite gneisses, quartzites and phyllites.

(b) Porous Formation: The Quaternary alluvium constitutes this hydrogeological unit. The alluvium comprises clay, silt and sand of various thicknesses. Aquifers in this formation occur under unconfined to semi-confined conditions. Yield ranging from 10 to 100 m³/hr.

3.1 Aquifer Disposition

Using the lithology of exploratory wells drilled at Halsi and Ashok dham, a cross section has been prepared. Cross section shows one aquifer layers in Halsi exploratory well. The aquifer is about 23 m thick at Halsi and about 30 m thick at Ashok dham. However, in Ramgarh block the thickness of aquifer is more; about 50 m. The aquifer are overlain by thick clay and fine sands layer 25-30 m thick. Hard rock is expected to be encountered beyond 75 mbgl in Ramgarh block. The coarse sands layer is often underlain by hard crystalline granitic rock. Section depicting the aquifer is shown below (fig 8).



Section showing Aquifer disposition in the block

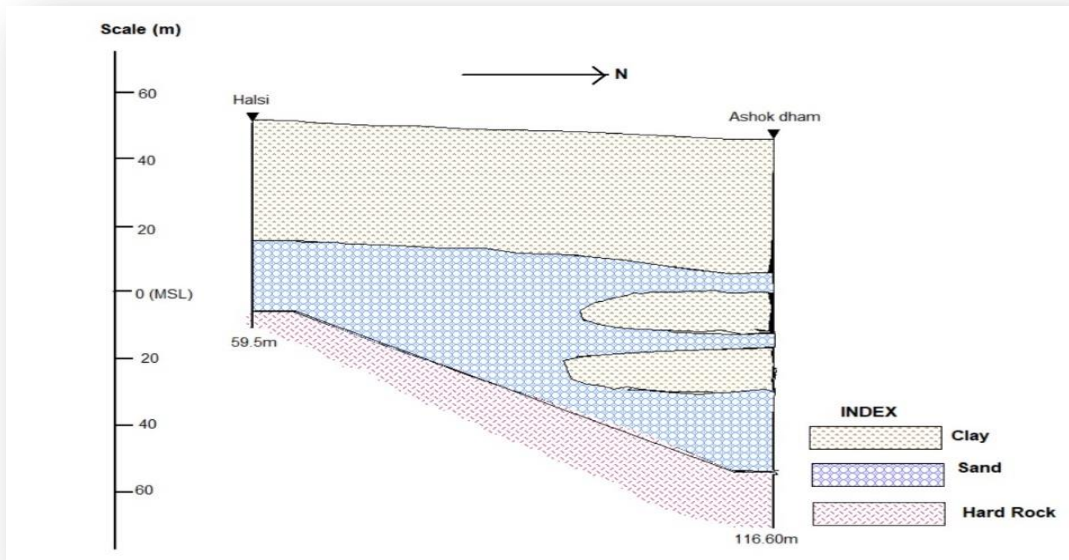


Fig 8- Diagram showing Aquifer disposition in Ramgarh chowk block

3.2 Water Level Behaviour

The Ground water regime of the block has been monitored from the existing network monitoring wells in and around the area, piezometer of minor irrigation department (MID) Government of Bihar and deep tube well of PHED Government of Bihar. In existing network monitoring wells depth to water level varies from 5 to 10 mbgl during pre-monsoon season. In post monsoon season, the depth to water level varies from 2 to 5 mbgl.

Water level measured in bore well of PHED (Government of Bihar) 9.27 mbgl during pre-monsoon season and post monsoon season water level lies at 2.51 mbgl.

The water level fluctuation between pre-monsoon and post-monsoon ranges from 1.73 m to 6.76 m in this block.

Table 3A- Water level in Ramgarh chowk block

Sl No	Block_Name	Type_of_Well	Location	Latitude	Longitude	RL(m)	Depth (mbgl)	Pre-monsoon SWL/bgl	Post-monsoon/SWL mbgl	Flauctutation(m)	Pre Water Table (m amsl)	Post Water Table (m amsl)
2	Ramgarh Chowk	Pz	BDO Office	25.0978	86.08	56	50.00	9.27	2.51	6.76	46.73	53.49

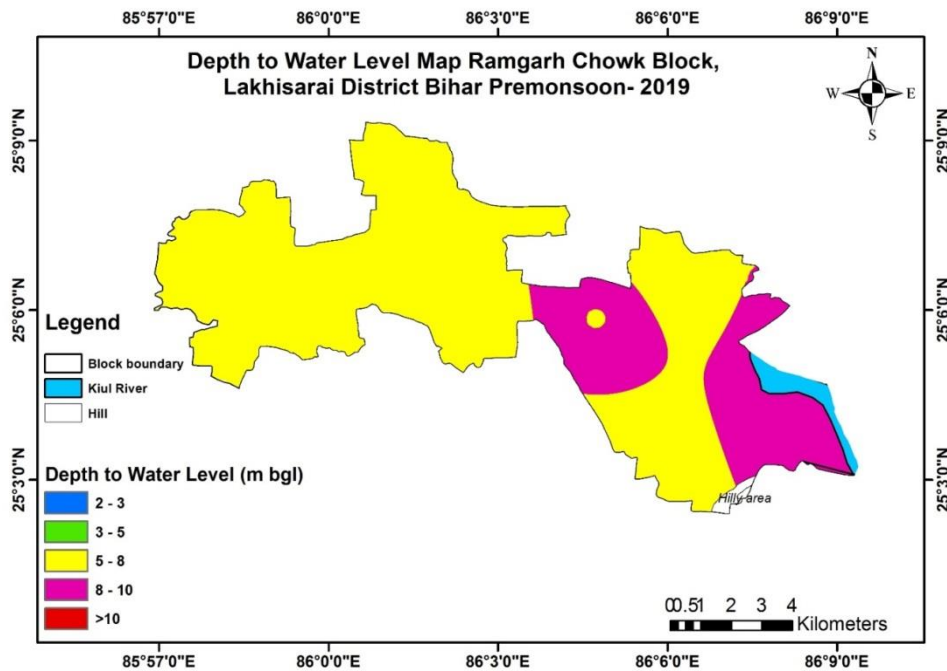


Fig 9- Pre-monsoon (2019) water level Map of Ramgarh chowk Block

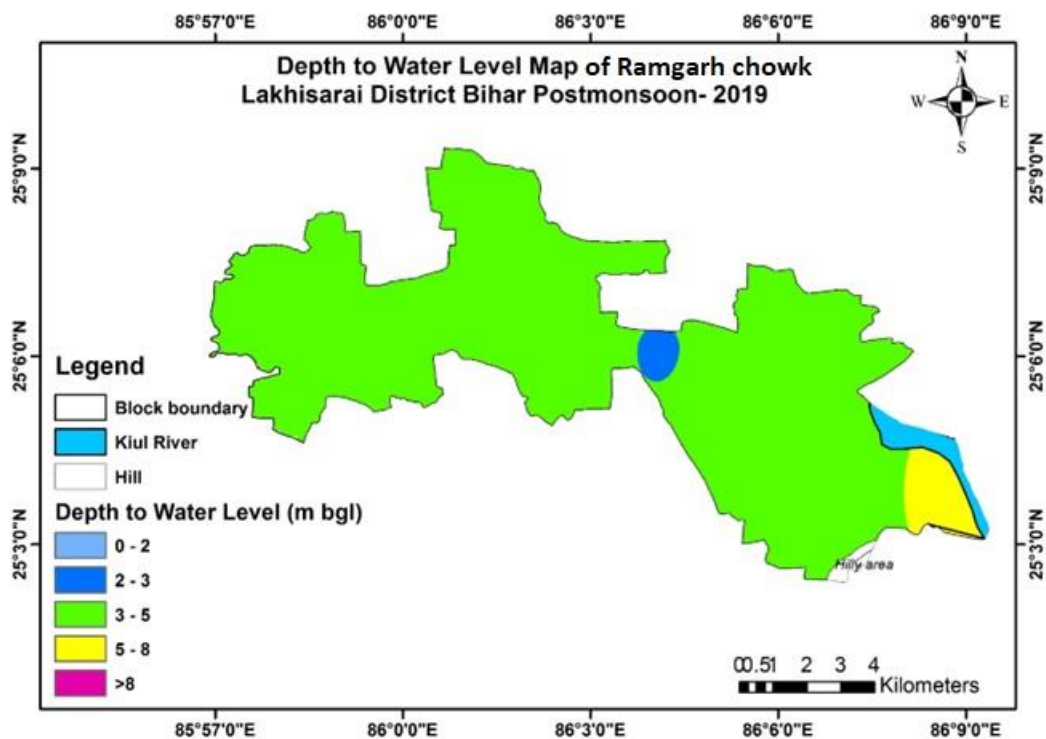


Fig 10- Post-monsoon (2019) water level Map of Ramgarh chowk Block

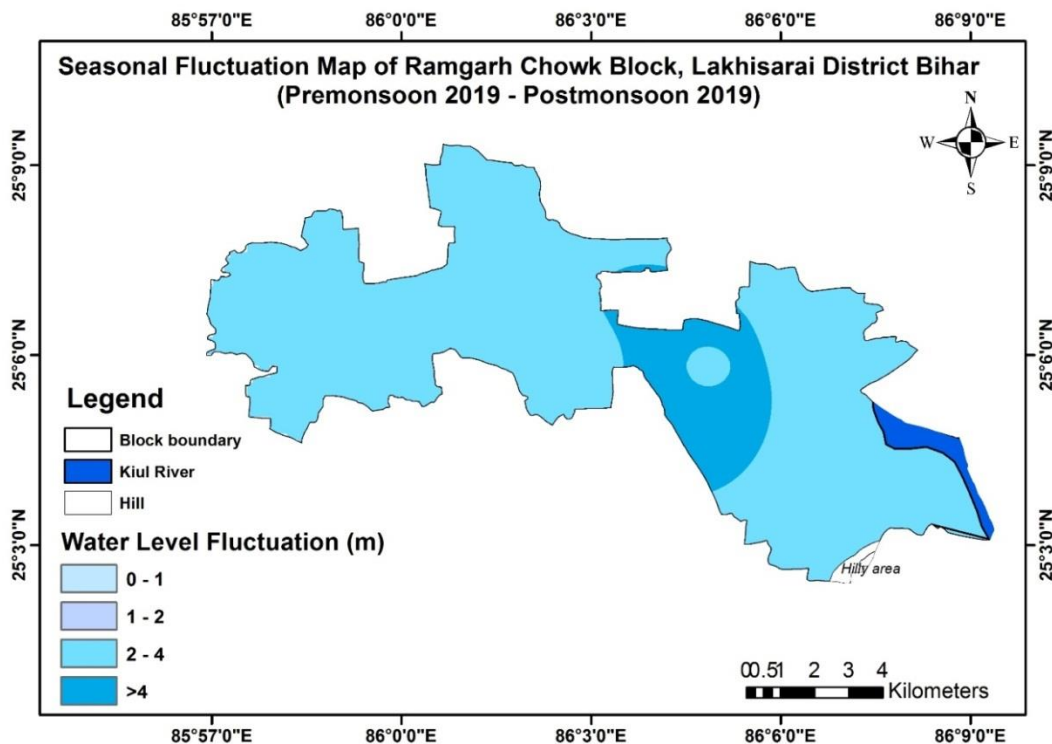


Fig 11- Water level Fluctuation Map (pre-monsoon- post monsoon 2019) of Ramgarh chowk Block

3.3 Aquifer properties

Ground water exploration has been carried out in Halsi block to assess the ground water potentiality.. Halsi block has two (2) wells as one exploratory tube well has been constructed in the block with maximum explored depth of 59.5m and one is observatory well has been constructed in the block with maximum depth of 55.4m. Reported discharge is 237.36 m³/hr with drawdown 6.48 m. estimated aquifer property shows that area have a transmissivity value of 1238.4 m²/day with storativity value of 2.08x10⁻⁴.

3.4 Water table contour

The water table contour map of Ramgarh chowk block shows the height of water table during pre-monsoon season varies from 40.37 m to 45.40 m and during post monsoon season height of water table varies from 41.30m to 46.40m above from mean sea level. As shown in map, ground water flow direction is towards NE direction in this block (fig-12).

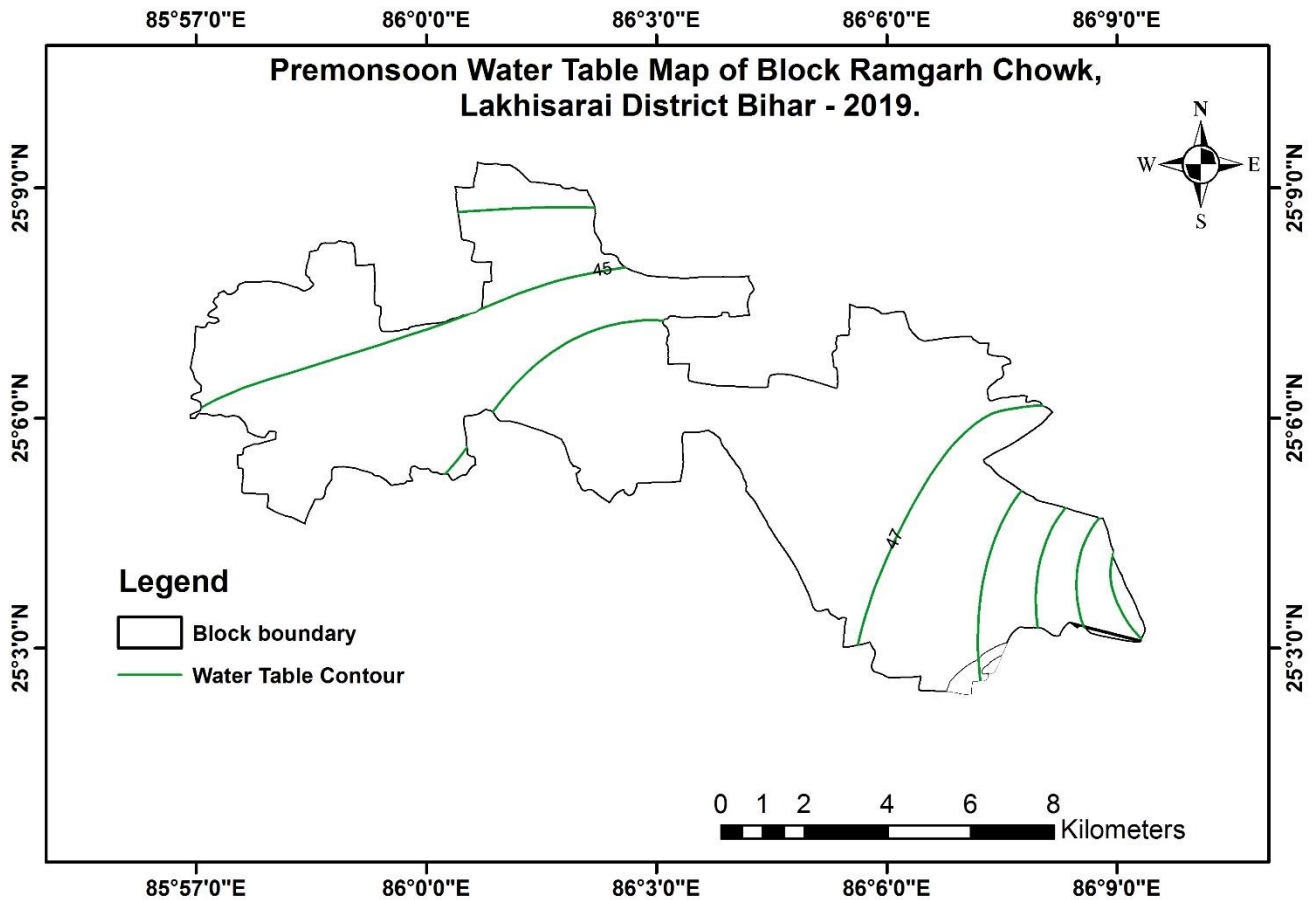


Fig 12: Pre-monsoon (2019) water table contour Map of Ramgarh chowk Block

4.0 Ground Water Resource Availability and Extraction

The total annual ground water recharge is 2506.21 Ham total natural discharge is 250.62 Ham. The stage of ground water extraction is 44.90%, and comes under safe category.

Table 5A: Dynamic Ground Water Resource (as on 22nd March, 2021

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area(Ha)	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Resource (Ham)	Ground Water Extraction for Irrigation Use (Ham)	Ground Water Extraction for Industrial Use (Ham)	Ground Water Extraction for Domestic Use (Ham)	Total Extraction (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
RAMGARH CHOWK	10427	9255	2506.21	250.62	2255.59	680	27.00	305.82	1012.83	343.53	1205.05	44.90	safe

4.1 Chemical Analysis

Central Ground Water Board, Mid-Eastern Region is doing ground water sampling from these blocks to monitor the ground water quality. The chemical quality of ground water is good and suitable for irrigation and other purposes, in general, with exception to arsenic and fluoride contaminations in some of the villages. Arsenic concentration was found more than permissible limit in the surrounding block of Halsi. Barhariya, Surajgarha and Pipriya block of Lakhisarai has been reported arsenic contamination from 16 PPB to 50 PPB respectively. Therefore, every ground water base water supply in the block is recommended for chemical analysis for Arsenic before supply to the villagers. Sporadic occurrences of F in ground water above 1 ppm has been reported from few area.

5.0 Management Plan

5.1. Supply side intervention in Agriculture, Irrigation and Drinking water

The overall stage of groundwater development in the Block is 44.90% and the block has been categorized as Safe as per the Dynamic Ground Water assessment-2020. Therefore, there lies ample scope for further ground water exploration in the block. Total annual ground water exploration in the block is 1012.83 ham. Additional 566 ham may be exploited further in the block for safe development of 70% of total annual extractable resource. At present 300 STW and MDTW and 30 DTW are in operation in the district. The additional resource may be utilized to install 188 STW/MDTW in the block which will create additional irrigation potential. Considering the occurrences of hard rock at the depth around 80-90 mbgl no DTW are further recommended for irrigation uses.

Arsenic contamination of groundwater has been reported at the adjacent block from the 1st aquifer in the younger alluvial belt down to the depth of 60m. Ground water exploration has revealed that the 2nd aquifer which is encountered below the clay layer separating the 1st and the 2nd aquifer is safer from arsenic contamination. Even in the 1st aquifer, the concentration of arsenic below the depth of 60 m has been found within the permissible limit; however, these are vulnerable to contamination with further groundwater development as they are part of the same contaminated aquifer. It is therefore recommended to develop the groundwater from the lower parts of the 1st aquifer only through hand-pumps. Energized extraction should be discouraged as this would accelerate the vertical mixing with the arsenic contaminated layers. The 2nd aquifer is thus recommended for community drinking water supply. Every installation of ground water may be compensated with suitable design rain water harvesting structure to augment the resource in the depleted aquifer.

Table 5A Availability/Deficit in resource for 70% development

Assessment Unit Name	Total Area of Assessment Unit (Ha)	Recharge Worthy Area (Ha)	Annual Extractable Ground Water Resource (Ham)	Total Extraction (Ham)	Draft for 70% development (Ham)	Additional resource available for 70% development (Ham)
Ramgarh Chawk	10427	9255	2255.59	1012.83	1578.91	566

Additional resource available for 70% development (Ham)	Resource allocated for development by STW /MDTW(Ham)	Resource allocated for development by DTW (Ham)	Unit draft of STW/MDTW (Ham)	Unit draft of DTW (Ham)	No. of STW proposed	No. of DTW proposed
566	566	nil	3		188	

From the existing land/agriculture and irrigation data it is understood that the block is principally agricultural depending. However, the average cropping intensity is recorded as 161 %. Installation of 188 STW/MDTW in the block will further create irrigation potential of 1000 to 1500 ha. Therefore the cropping intensity of around 180%-190% may be achieved.

5.2 Supply Side Management intervention through Artificial Recharge and rain water harvesting

The block receives 1104.5 mm of annual rainfall on an average but most of rain water goes as run off. Construction of suitable artificial recharge structure will help to reduce the run off as well as it also recharges the aquifers and maintain the soil moisture of the area. 4789 ha area has been identified as recharge worthy area in the block. Contour bunding, check dam, gully plug, percolation tank, recharge shafts, de-siltation of existing tanks, injection well village tanks etc. are some suitable structures in the area. Before construction of these recharges' structures, selection of suitable site is required for getting better benefits from these structures.

Table 5.B Proposed number of AR structures in the block

Recharge worthy area in ha	Percolation Tank	Gully Plug	Contour Bunding & Trenching	Nala Bunding	Recharge Shaft	De-silting of existing tank/pond/talao	Injection well in Village Tank
4789	1	7	8	1	10	18	24

5.3 Demand Side Interventions

In view of the status of present ground water development further development may be promoted in the block for further irrigation coverage. Considering the moderate to higher potentiality of the area water intensive crop as well less water crops may be practiced in the area. Therefore pulses, oilseeds other horticulture crops etc as per the local requirement may be encouraged. This may create further irrigation potential in the block. Suitable crop rotation may be practiced.

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

In addition to that, before using of ground water from shallow or deep tube wells for drinking, domestic and irrigation purpose should be tested for arsenic contamination. Domestic arsenic removal technique may be adopted for short term measures whereas for long term intervention commercial arsenic removal plan may be installed. Domestic fluoride removal technique may be adopted for short term measures where fluoride contamination in ground water has been reported.

Capacity building for awareness generation among the stake holders and end users may be suitable for effective management of water resources and to mitigate the water contamination in ground water.