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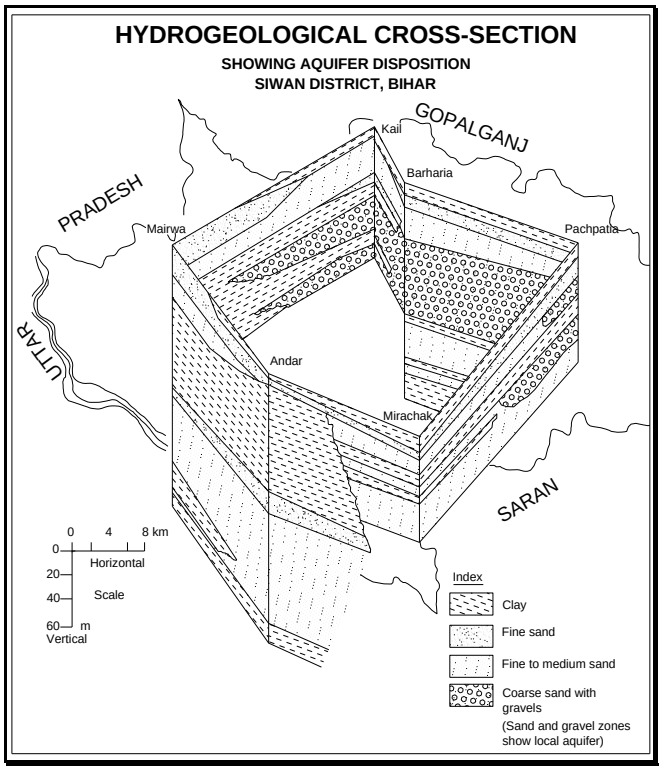
Ministry of Jal Shakti

Department of Water Resources, River Development and Ganga Rejuvenation

AQUIFER MAPPING AND MANAGEMENT PLAN
IN
SIWAN DISTRICT, BIHAR



Central Ground Water Board

Mid-Eastern Region

Patna

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REPORT ON AQUIFER MAPPING AND MANAGEMENT PLAN IN SIWAN DISTRICT, BIHAR (AAP 2022-23)

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Chapter 1: Introduction

The state of Bihar is located ineastern region of India and is a completely land locked state in a subtropical region of the temperate zone. Bihar has three parts on the basis of physical and structural conditions: the Southern Plateau Region, the Indo-Gangetic Plain, and the Siwalik Region in the northern part of the state. The naturally fertile Indo-Gangetic plain is an asset of the state and the backbone of agricultural and industrial development.The Indo-Gangetic plain in Bihar consists of a thick alluvial mantle of drift origin overlying in most part, the Siwalik and older tertiary rocks. The soil is mainly young loam, rejuvenated every year by constant deposition of silt, clay and sand brought by streams and floods in Bihar.Siwan district is the westernmost part of the state and is a part of the Indo-Gangetic plain and is drained by several other small rivers. Geological set up and paleo-depositional history of the area controls the occurrence and distribution of the sediments, thus, the aquifer disposition in the area.

The National Aquifer Mapping and Management Programme (NAQUIM) of Central Ground Water Board (CGWB) has been envisaged to focus on the aquifer geometry, occurrences, availability of ground water resources and quality and to formulate management plan of the individual aquifer system for the sustainable development. The proposed management plans will provide the "Road Map" for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus, the focus of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation.

Under the Annual Action Plan of 2022-23 of CGWB, MER, NAQUIM studywas undertaken in Siwan district, Bihar. The present study includes a mappable area of 2223 sq kms covering 19 blocks. The aquifer maps and management plans will be shared with the administration of Siwan district and other user agencies for its effective implementation.

1.1. Objective

The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain, its resource potential in respect of quantity and quality, aquifer characterization, scope for development potential and preparation of aquifer-wise management plan for drinking and domestic sectors and for agriculture activities.

1.2. Scope of the 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 (iv) Preparation of aquifer maps and management plan to achieve the primary objectives. Data compilation includes collection, and wherever required procurement, of all maps and data from concerned agencies, such as the Survey of India, Geological Survey of India, State Governments etc., computerization and analysis of all acquired data, and preparation of a data base. Collection and compilation of lithologs, wells assembly, electrical log reports and yield test data of the tube wells of PHED, Govt. of Bihar and Agri-Irrigation Department of Govt. of Biharis vital in accomplishing the work. 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, spot measurements of electrical conductivity of the water samples from the 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

- Compilation of existing data and reports of CGWB.
- Identification of data gaps.
- 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, spot measurement of conductivity, exploratory drilling for study of subsurface geology, preparation of lithological logs, yield and aquifer parameter data through construction of tube wells.
- Collection, compilation, and analysis of lithologs, electrical logs and yield data of the water supply wells of PHED, Govt of Bihar and Agri-Irrigation Department, Govt. of Bihar.
- Preparation of thematic maps on GIS platform.

- Identification/demarcation of individual aquifer systems in the area from the available lithologs, electrical logs, previous literature, and observation from field studies etc.
- Preparation of 2D/3D aquifer disposition maps in Rockworks Platform.
- Analysis of 2D and 3D maps, assessment of existing draft and resource of individual aquifer systems. Considering the demand and supply status in drinking, domestic, industrial and agriculture sectors the suitable management plan has been designed. The scope for rainwater harvesting for artificial recharge or conservation is reviewed and accordingly suitable structures are recommended.

1.4. Area Details

The study area lies in the Indo-Gangetic Plains of Bihar and forms the western part of the state (*Fig.1*). It covers a mappable area of 2223 sq.kms. and consists of 19 blocks namely, Andar, Barharia, Basantpur, Bhagwanpur Hat, Darauli, Daraundha, Goriakothi, Guthani, Hasanpura, Hussainganj, LakriNabibganj, Maharajganj, Mairwa, Nautan, Pachrukhi, Raghunathpur, Siswan, Siwan, Ziradei. The study area geographically lies between 25.58^{o} N to 26.23^{o} N latitude and 84.10^{o} E to 84.47^{o} E longitude. The area is covered in Survey of India toposheet nos. 72B/11,72B/12, 72B/16, 72B/4, 72B/7, 72B/8, 72C/1, 72C/5. It is bounded in the North by Gopalganj district, on the east by Saran district and on the west and south by two districts of U.P. viz. Deoria and Balia respectively.

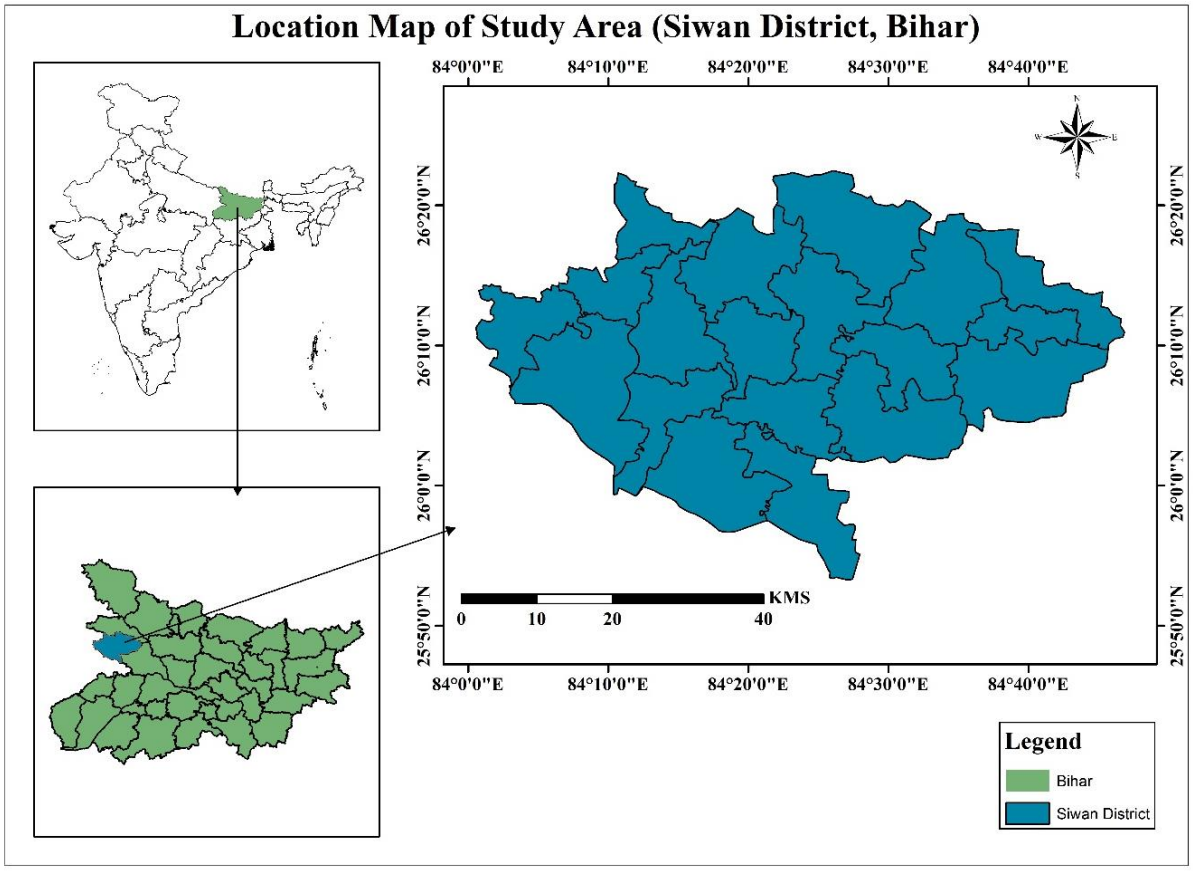

Fig. 1: Study area Map (Siwan district,Bihar)

1.5. Administrative and Demographic details

Siwan town is the administrative headquarters of this district. Siwan district is a part of Saran Division since 1972. There are two sub-divisions in the Siwan district- Siwan subdivision and Maharajganj subdivision.

According to the 2011 census, Siwan district has a population of 3703626 (*Table 1*). The district has a population density of 1,495 inhabitants per square kilometer (3,870/sq mi). Its population growth rate over the decade 2001-2011 was 22.25%. The block-wise demographic details of Siwan district are given in detail in Table 1. Siwan has a sex ratio of 984females for every 1000 malesand a literacy rate of 71.59%.

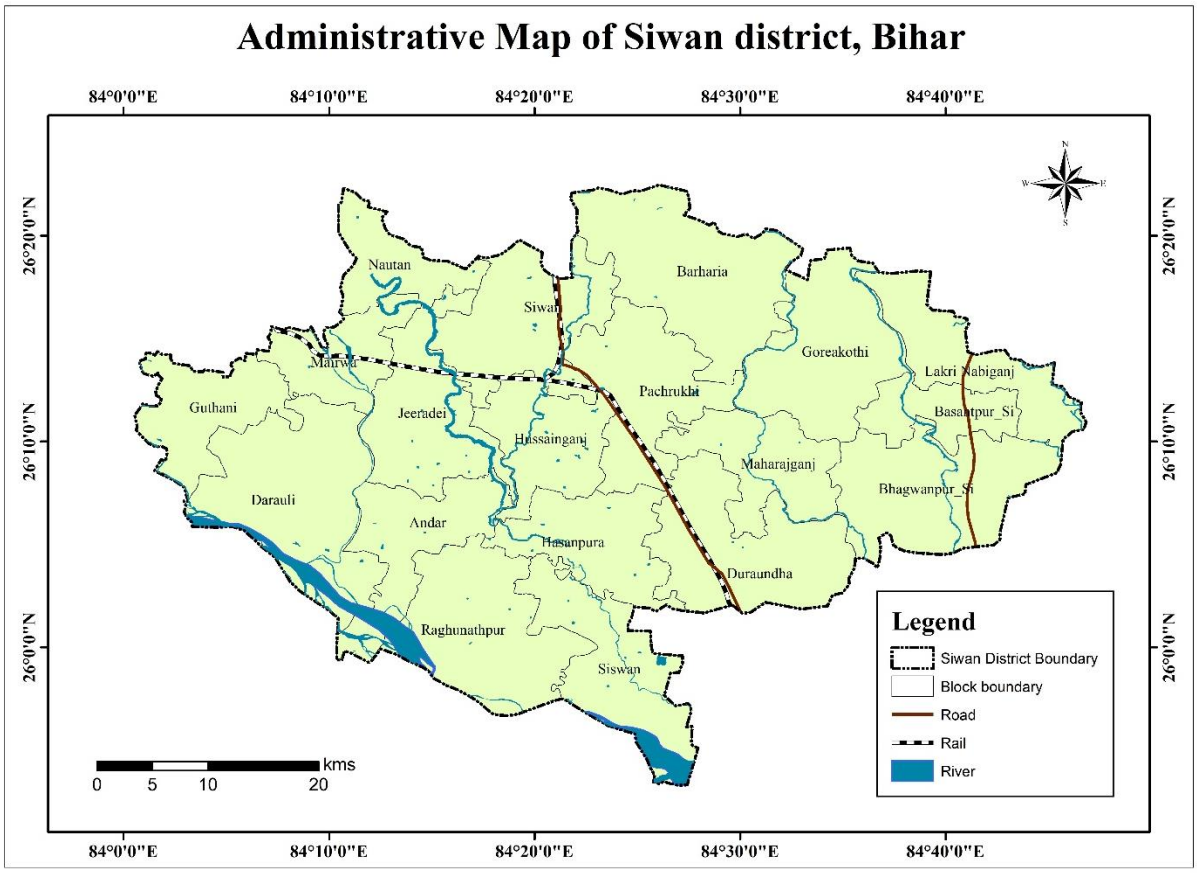

Fig. 2: Administrative map of Siwan district, Bihar

Table 1: Block-wise Demographic details of Siwan district (As per census 2011)

Sl.No.	Block	No.of Panchayat	No.of villages	Population				No.of households	No.of members
				Male	Female	Children	Total		
1	Andar	11	69	54471	55556	17572	127599	17691	127599
2	Barharia	30	142	164179	197113	55477	416769	52271	416769
3	Basantpur	9	41	53735	51496	18414	123645	17061	123645
4	Bhagwanpur Hat	20	134	111578	109073	36560	257211	35669	257211
5	Darauli	16	82	87634	86783	27237	201654	27111	201654
6	Daraundha	17	107	85712	87488	28876	202076	26822	202076
7	Goriakothi	22	84	111167	112542	37862	261571	36982	261571
8	Guthani	12	106	64275	73880	20178	158333	21530	158333
9	Hasanpura	14	65	73069	76511	25645	175225	23488	175225
10	Hussainganj	16	46	93003	89791	31412	214206	28123	214206
11	LakriNabibganj	11	39	63670	65229	2894	131793	21051	131793
12	Maharajganj	16	67	81731	84204	28648	194583	27580	194583
13	Mairwa	8	54	45747	44187	14421	104355	15521	104355
14	Nautan	9	47	45856	44858	14945	105659	14102	105659
15	Pachrukhi	18	76	101688	100071	34349	236108	33000	236108
16	Raghunathpur	16	118	78000	79694	25230	182924	25470	182924
17	Siswan	13	90	77683	76270	25160	179113	27095	179113
18	Siwan	19	81	105022	100895	34913	240830	31371	236830
19	Ziradei	16	82	81467	82285	26220	189972	25117	192672
	TOTAL	293	1530	1579687	1617926	506013	3703626	507055	3702326

1.6. Climate and Rainfall

Table 2: Month wise departure from Normal Rainfall, Siwan district (Source:IMD)

YEAR	JAN		FEB		MAR		APR		MAY		JUN		JUL		AUG		SEPT		OCT		NOV		DEC	
	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP	R/F	%DEP
2017	0.2	-99	0.0	-100	12.3	27	11.6	21	88.2	221	61.3	-55	260.5	-23	171.6	-40	81.9	-66	0.5	-99	0.0	-100	0.0	-100
2018	0.0	-100	0.0	-100	0.0	-100	0.0	-100	69.4	152	32.4	-76	209.6	-38	238.7	-17	76.2	-68	0.0	-100	0.0	-100	0.0	-100
2019	7.9	-20	13.3	29	2.0	-65	1.8	-79	12.7	-58	63.2	-56	714.2	122	82.4	-71	413.5	89	16.4	-66	0.0	-100	26.5	236
2020	5.7	-42	20.1	95	30.3	441	44.9	435	69.6	129	323.4	125	521.1	62	130.6	-54	246.2	12	1.1	-98	0.4	-96	0.0	-100
2021	0.0	-100	0.0	-100	0.0	-100	0.0	-100	262.0	762	386.2	169	229.7	-29	361.3	28	154.1	-30	235.8	388	0.0	-100	25.3	220

The climate of Siwan district is semi-arid with very hot summer and equally cold winter season. During the summer months i.e., April-May, the maximum temperature goes beyond 46^{o}C and in winter months of Dec-Jan, it is around 4^{o}C. In the month of May and June, the natives of the district experience ‘loo. The average annual rainfall is 1245 mm and the average monthly rainfall is 103.75mm considering that the district has approximately 54 rainy days in a year. About 89% of rainfall occurs from June to September. During monsoon surplus water is available for deep percolation to ground water.

1.7. Physiographic setup

The entire district is usually flat alluvial tract. The uniformity in flatness is disturbed quite often with marshy lands, natural depressions etc.Devoid of much relief features, this plain exhibits widely scattered palaeolevees, backswamps, relict palaeochannels aggraded to different degrees, meander belts with relict meander scrolls and ox-bow lakes. The average elevation varies between 55-67 m above msl. There is gradual slope from north west to south east. The area is principally drained by Ghaghra, Gandak and its tributaries.The area lies to the North of Ganga Riverand forms a part of Ghaghara - Gandak doab region.

1.8. Geomorphology

The district forms a part of the vast alluvial terrain of Gandak and Ghaghra sub-basins forming a part of Indo-Gangetic alluvium consisting of a thick pile of unconsolidated quaternary sediments. They are recent to sub-recent deposits underlain by erosional basement of Vindhyan formation of pre-cambrian age. The thickness of alluvium is still not yet confirmed through bore-holes. These quaternary sediments consist of sequences of finer clastics like clay and silts with various grades of sand and gravel associated with Kankar. The lithological characteristics are mainly governed by the depositional environments namely distance from the provenance, agencies of deposition and the medium of transport. Marked lateral and vertical variations is texture and composition of sediments support these propositions. The Gangetic alluvial deposits can be sub-divided into two types viz. newer alluvium and older alluvium. The older alluvium of pleistocence age in the area is rather dark in colour occupies the higher ground and generally rich in kankar which are concretion of nodules of impure calcium carbonate ranging in size from small grains to loose lumps whereas the newer alluvium of recent age occupying the lower grounds constituting of a thick sequence of clay, silt and sand with occasional kankar. The entire district is underlain by flat alluvial formations of considerable thickness. The uniformity of flatness is quite often disturbed by marshy lands and natural depressions etc. along rivers and stream courses various topography has developed. Broadly the entire tract can be divided as under:

(a) **Alluvial low tracts** – They are usually found in the immediate vicinity of the major river Ghaghra which is subjected to periodical submergence by flood water.

(b) **Upland Tracts** – They are usually found away from the major river Ghaghra, thus being immense to its influence.

(c) **Diara Land** – They are found on the beds of major rivers Ghaghra which are nothing but heap of sands brought by rivers during flood gradually rise as water lying stagnant, spreads a thin layer of clay and silt over sand. There is a gradual slope from north-western to southeastern part of the district, where Mairwa which is the highest part in the district being 65.830 m above MSL and GangpurSiswan being the lowest point 56.90 m above MSL.

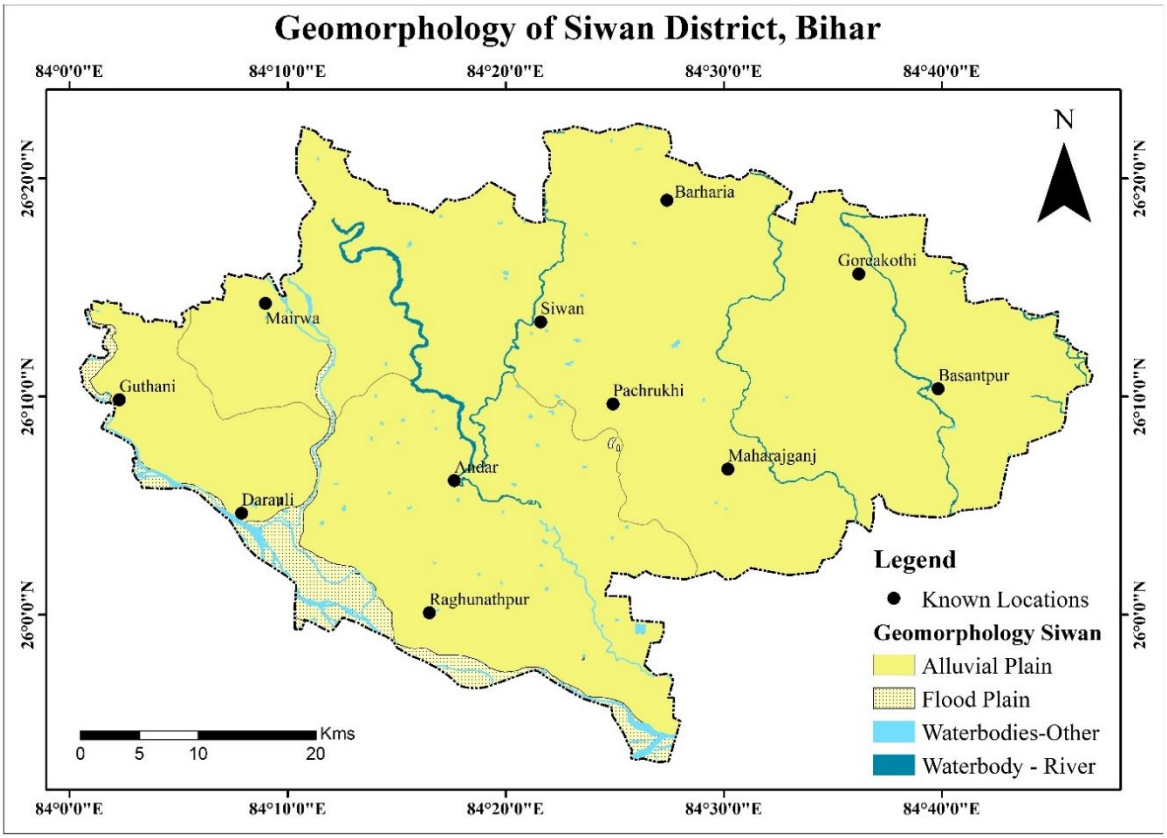

Fig. 3: Geomorphology of Siwan district, Bihar

1.9. Land Use Land Cover

Table 3: Block wise Land Use, Land cover details of Siwan district, Bihar.

Sl.No.	Name of the Block	Total Geographical Area(ha)	Total Area under Agriculture	Area Under Forest	Area Under Wasteland	Area under Other Uses
1.	Andar	11826	13840	0	311.4	275
2.	Barharia	17732	33484	0	753.39	990
3.	Basantpur	6220	11724	0	263.79	358
4.	Bhagwanpur Hat	14943	27124	0	610.29	1266
5.	Darauli	12431	31120	0	700.2	1011
6.	Daraundha	17278	27094	0	609.615	1347
7.	Goriakothi	13798	24612	0	553.77	1370
8.	Guthani	9171	17278	0	388.755	530
9.	Hasanpura	8490	9670	0	217.575	165
10.	Hussainganj	9699	17148	0	385.83	966
11.	LakriNabibganj	9521	17728	0	398.88	931
12.	Maharajganj	11542	20526	0	461.835	1343
13.	Mairwa	7977	12420	0	279.45	603
14.	Nautan	6462	22500	0	506.25	750
15.	Pachrukhi	12437	28542	0	642.195	746
16.	Raghunathpur	15589	37064	0	833.94	588
17.	Siswan	11579	22446	0	505.035	1576
18.	Siwan	12909	21000	0	472.5	1648
19.	Ziradei	12703	13750	0	309.375	1053
	TOTAL	222307	409070	0	9204.075	17516

(Source: DAP,PPR,District Statistical office/lus.dacnet.nic.in)

Table 4: Block wise Agricultural details of Siwan district, Bihar.

Sl.No.	Name of the Block	Area Under Agriculture			
		Gross Cropped Area	Net Sown Area	Area Sown more than once	Cropping Intensity (%)
1.	Andar	6920	6228	692	137
2.	Barharia	16742	15067.8	1674.2	137
3.	Basantpur	5862	5275.8	586.2	137
4.	Bhagwanpur Hat	13562	12205.8	1356.2	137
5.	Darauli	15560	14004	1556	137
6.	Daraundha	13547	12192.3	1354.7	137
7.	Goriakothi	12306	11075.4	1230.6	137
8.	Guthani	8639	7775.1	863.9	137
9.	Hasanpura	4835	4351.5	483.5	137
10.	Hussainganj	8574	7716.6	857.4	137
11.	LakriNabibganj	8864	7977.6	886.4	137
12.	Maharajganj	10263	9236.7	1026.3	137
13.	Mairwa	6210	5589	621	137
14.	Nautan	11250	10125	1125	137
15.	Pachrukhi	14271	12843.9	1427.1	137
16.	Raghunathpur	18532	16678.8	1853.2	137
17.	Siswan	11223	10100.7	1122.3	137
18.	Siwan	10500	9450	1050	137
19.	Ziradei	6875	6187.5	687.5	137
	TOTAL	204535	184082	20453.5	137

(Source: DAP,PPR,District Statistical office/lus.dacnet.nic.in)

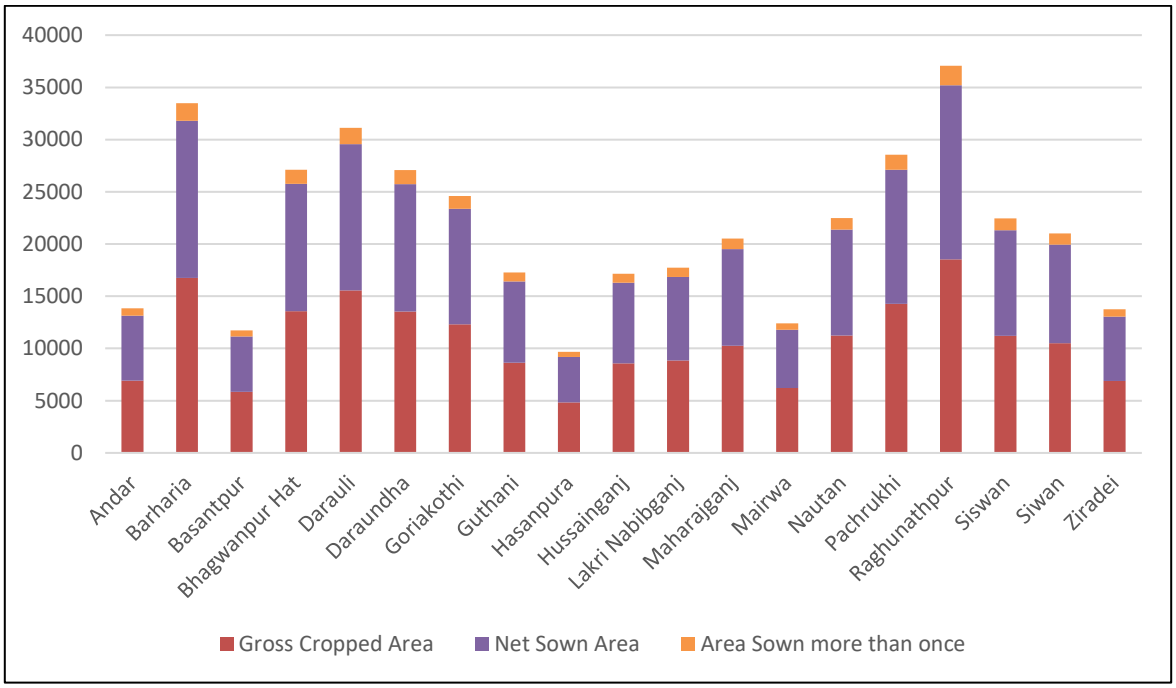

Fig. 4: Graphical representation of block wise agricultural area in Siwan district, Bihar

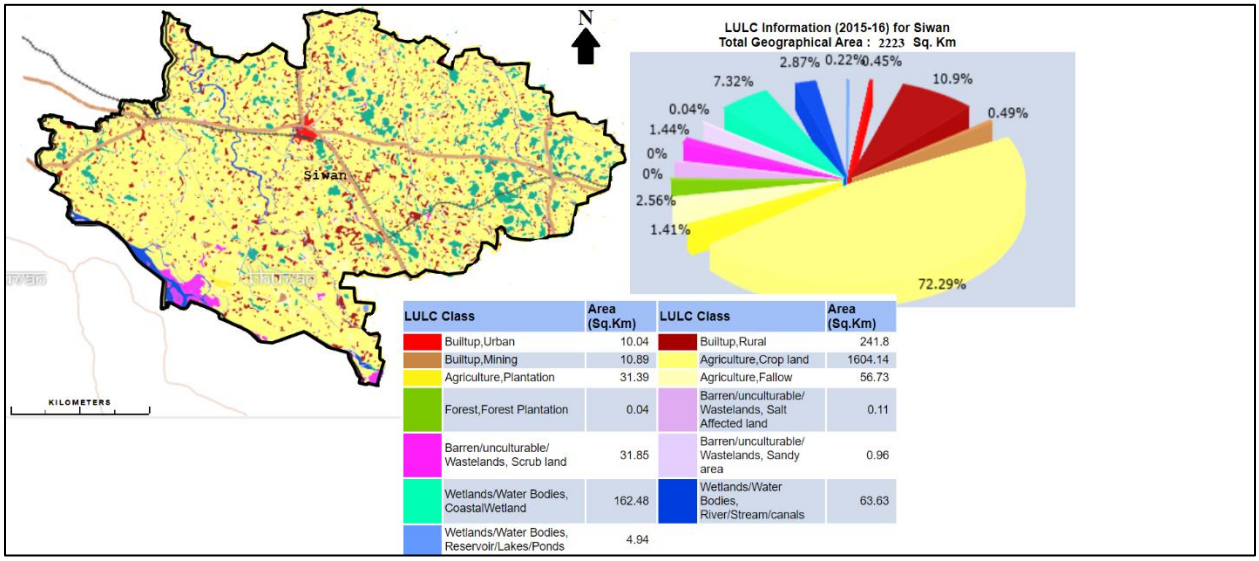

Fig. 5: LULC map of Siwan district (Source: https://bhuvan.nrsc.gov.in)

1.10. Soil

Siwan district falls in an area that holds an intermediate position between the Khader plains of West Bengal and Bhanger Plains of Uttar Pradesh. Bhanger or Banger is the old form of

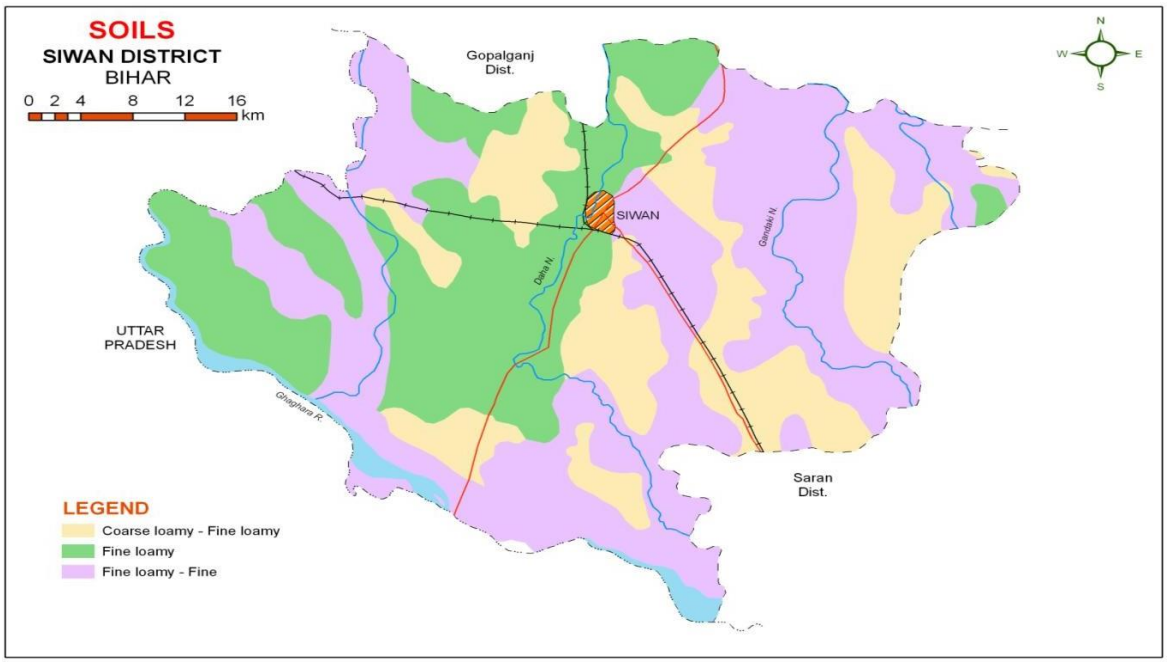

Fig. 6: Soil Map of Siwan district (Source: NBSS & LUP, Kolkata, and Agriculture Contingency Plan, Siwan district, Bihar by NICRA, ICAR)

alluvium soil, which is inclusive of heavy soil that constitutes more proportion of clay.As compared to this, the Khader is the new form of alluvium soil that has resulted from river deposits. There are both kinds of soil found in Siwan but there is limited availability of the newly formed Khader soil. Khader soil is limited to vicinity of rivers, and is consistently renewed by fresher deposits. The Khader soil is mainly present around the 'Diara' or boundary areas of rivers in Siwan. The local terms used for Khader soil is 'Domat' while that for Bhanger is 'Balsundari'. The Bhanger soil is inclusive of 'Kankars', which are nodular segregations of lime carbonate.At many places, the soil is sulfurous.

As per the data of Krishi Vigyan Kendra (ICAR), Siwan the soil type of Siwan district is Sandy loam, Saline soil and Alkaline soil. Sandy loam covers the majority of the district.Sandy soils are known to allow water to move rapidly through them, whereas loamy soils hold water. Thus, the combination of these two soils is very nutritious and fertile for plants to grow.

1.11. Hydrology and Drainage

This district falls in the Indo Gangetic plain covering part of Gandak and Ghagra sub-basin of Ganga basin. The district is mainly drained by river Ghaghra which is called Saryu in Uttar Pradesh. The river originates from the lower Himalaya in U.P. travelling south-easterly and entering in the district at Guthni. Besides the river Ghaghra there are many ephemeral streams. These are Gandak, Nikri, Jharhi, Daha and Dhamhi (*Fig.7*). Apart from these sources there are many Jhills and Tals also. During the process of shifting of course these rivers leave behind cut off, meanders, abandoned channels and a number of marshes locally known as chaurs. The chaurs are also responsible for water logging in the area with the onset of monsoon and contract to become localised during summer. Apart from this drainage system there is a very good network of canal system also in this district.

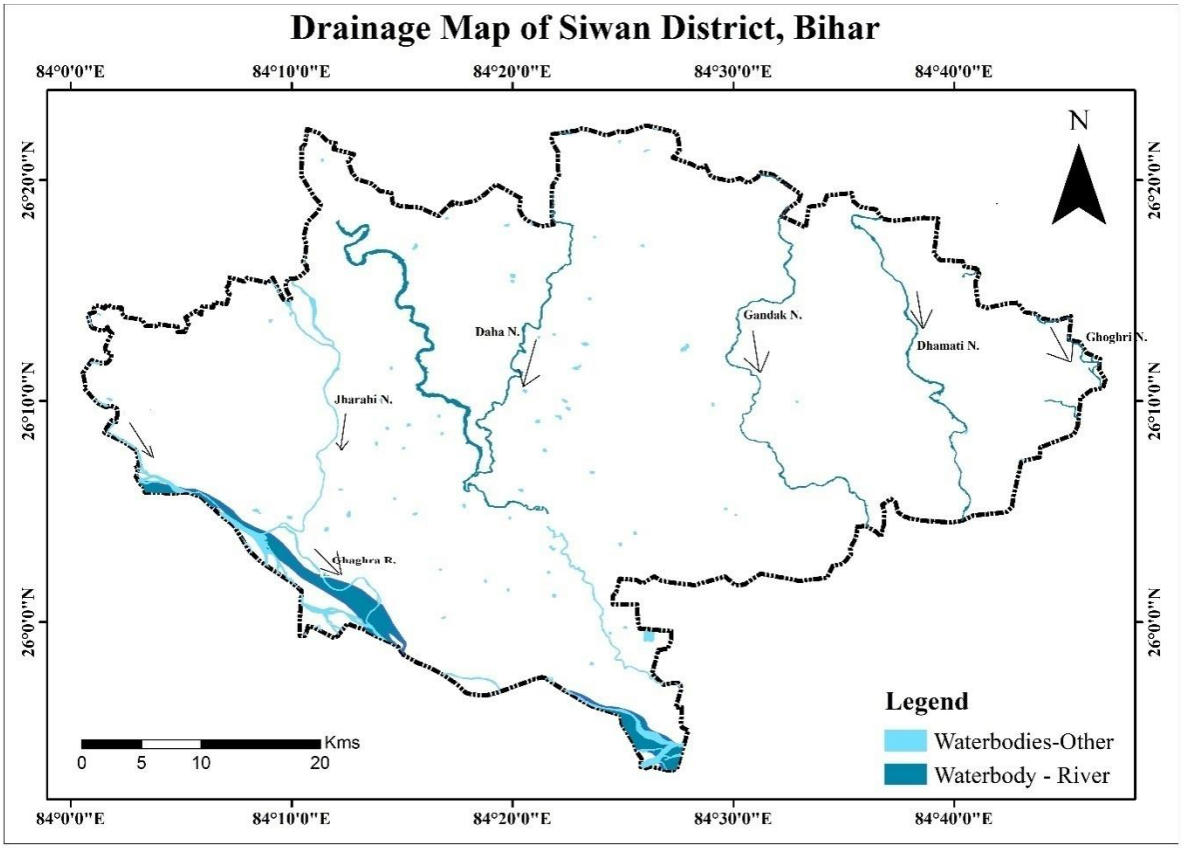

Fig. 7: Major rivers flowing through Siwan district

1.12. Agriculture

Agriculture is the main activity conducted in the district for general living. There are mainly two agricultural seasons in the district – Kharif and Rabi. The major crops grown in the district includes foodgrains (cereals like wheat, maize; millets;pulses), commercial crops (Sugarcane, Tobacco), fiber crops (cotton/kapas, jute), oilseeds (castor seeds,groundnut, flaxseed, rapeseed and mustard).

Table 5: Crop production statistics of Siwan district, Bihar

State/Crop/District	Year	Season	Area (Hectare)	Production (Tonnes)	Yield (Tonnes/Hectare)
Arhar/Tur	2019-20	Kharif	1103	1699	1.54
Bajra	2019-20	Kharif	80	90	1.13
Barley	2019-20	Rabi	128	175	1.37
Coriander	2019-20	Whole Year	11	9	0.82
Garlic	2019-20	Whole Year	127	193	1.52
Ginger	2019-20	Whole Year	5	9	1.80
Gram	2019-20	Rabi	225	164	0.73
Linseed	2019-20	Rabi	28	24	0.86
Maize	2019-20	Autumn	11604	19281	1.66
		Rabi	4970	17693	3.56
		Summer	1173	3742	3.19
		Total	17747	40716	2.29
Masoor	2019-20	Rabi	455	424 Bales	0.93Bales/Hectare
Mesta	2019-20	Kharif	14	29	2.07
Moong (Green Gram)	2019-20	Kharif	16	10	0.63
		Summer	943	193	0.20
		Total	959	203	0.21
Onion	2019-20	Rabi	664	6627	9.98
Other Rabi pulses	2019-20	Rabi	18	18	1.00
Other Kharif pulses	2019-20	Kharif	111	84	0.76
Peas & beans (Pulses)	2019-20	Rabi	770	802	1.04
Potato	2019-20	Rabi	3757	42725	11.37
		Winter	1608	23229	14.45
		Total	5365	65954	12.29
Ragi	2019-20	Kharif	535	434	0.81
Rapeseed &Mustard	2019-20	Rabi	2030	2755	1.36
Rice	2019-20	Autumn	27672	37891	1.37
		Winter	50406	99743	1.98
		Total	78078	137634	1.76
Sannhamp	2019-20	Kharif	43	35	0.81
Sesamum	2019-20	Kharif	7	6	0.86
Small millets	2019-20	Kharif	159	120	0.75
Sugarcane	2019-20	Whole Year	2716	133375	49.11
Tobacco	2019-20	Whole Year	93	163	1.75
Turmeric	2019-20	Whole Year	16	18	1.13
Urad	2019-20	Kharif	118	107	0.91
Wheat	2019-20	Rabi	90625	187401	2.07

1.13. Irrigation

As per the available statistics, area irrigated by different sources e.g., canal, tube wells, dug wells etc. contributes to only 59% of the total cultivated area in Siwan district. The operation of canals in the western and northern part of the district has greatly enhanced the irrigation facilities but still the tail end area is deprived of canal water. At some places deep tubewells and shallow tubewells also help in irrigation up to some extent. As per the 5th MI census, the irrigation details of Siwan district are given in the tables below.

Table 6: Irrigation Area by sources Siwan district, Bihar (Area in ha)

Area irrigated by Groundwater schemes					**Area irrigated by Surface water schemes**					**Area irrigated by total Minor Irrigation schemes**				
Kharif	Rabi	Perennial	Other	Total	Kharif	Rabi	Perennial	Other	Total	Kharif	Rabi	Perennial	Other	Total
37693.86	34723.3	19448.31	18753.62	110619.09	421	402	300	162	1285	38114.86	35125.3	19748.31	18915.62	111904.09

Table 7: Block wisenumber of Shallow TW, Medium TW, Deep TW in Siwan District as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Andar	0	36	8
Barharia	0	415	0
Basantpur	0	61	0
Bhagwanpur Hat	0	567	0
Darauli	0	37	0
Daraundha	0	1	0
Goriakothi	0	29	0
Guthani	0	34	0
Hasanpura	0	386	0
Hussainganj	0	453	1
LakriNabibganj	0	4	0
Maharajganj	0	3	0
Mairwa	0	20	0
Nautan	0	251	1
Pachrukhi	0	6	1
Raghunathpur	0	18	0
Siswan	0	7	0
Siwan	10	7	0
Ziradei	0	2	1
TOTAL	**10**	**2337**	**12**

1.13. Slope

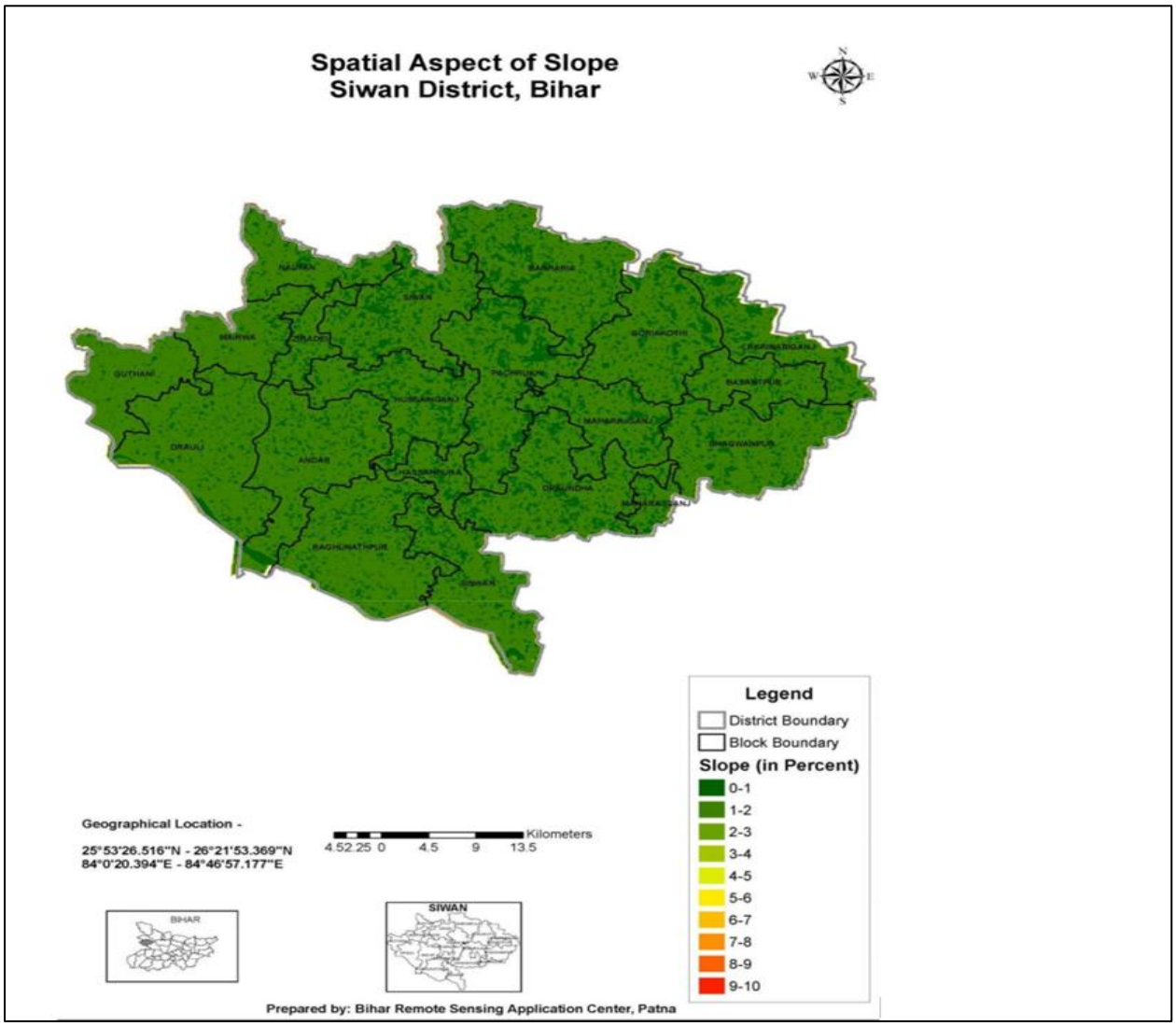

Fig. 8: Slope Map of Siwan district (Source: District Irrigation Plan, Siwan)

The district has a uniformly low slope of less than 3% and there are no hilly areas. It is more or less flat. Thus, the entire district has good potential of rainwater percolation.

Chapter 2: Data collection and Generation

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

2.1. Hydrogeological Data

Hydrogeological data of the district was collected from CGWB reports, BDRs and unpublished reports. Water level data collected from the National Hydrograph Network Stations (NHNS) of CGWB in the Siwan District. Data of 18 monitoring wells were collected and historical water level trend compiled representing phreatic aquifer (Aquifer-1). 10 new key wells were also established in blocks lacking NHNS and water level data was collected from these wells also to see the trend in seasonal water level fluctuation.

2.2. Hydrochemical data

Groundwater quality of an area is a function of physical and chemical parameters that are greatly influenced by geological formations and anthropogenic activities. Quality of ground water is as much demanding as its quantity. Suitability of ground water for drinking and irrigational purpose is important for its safe and effective use. The concentration of the major ions and other dissolved ions in ground water are function of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulate are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality. Ground water samples of 27 well locationshave been analysed in the Chemical lab of CGWBto assess the chemical quality of Aquifer-1 in this area.

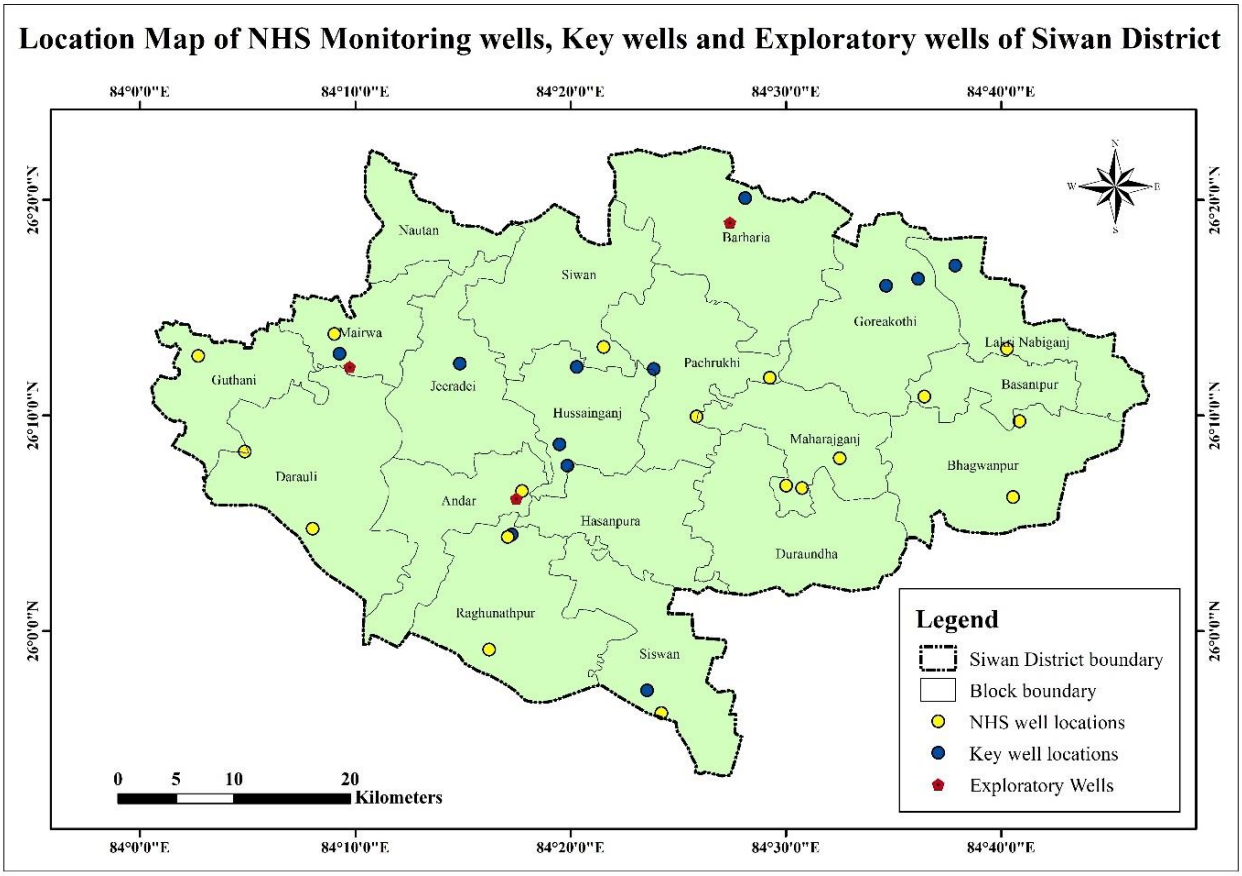

Fig. 9: Base map of Siwan district, Bihar showing NHNS well location, Key well location and Exploratory well locations.

2.3. Exploratory Drilling

A total of 03 exploratory wells and03 observation wells are existing in alluvium terrain of Siwan district through departmental rigs.

The details of exploratory wells are given in AnnexureIII.

2.4. Thematic Layers

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

1. Soil Map
2. Drainage Map
3. Geomorphology
4. Slope
4. Land use
5. Geology

The thematic layers such as drainage, geomorphology, Slope, and land use has been described in Chapter 1.

Chapter 3: Data Interpretation, Integration and Aquifer Mapping

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various aquifer characteristic maps on hydrogeology, aquifer wise water level scenario both current and long-term scenarios, aquifer wise ground water quality, 2-D and 3-D sub-surface disposition of aquifers by drawing lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated and are discussed in detail.

3.1. Geology

The entire district is underlain by a thick pile of unconsolidated sediments of Quaternary period. Geological Survey of India (GSI) has given classification of Quaternary alluvium based on topography, drainage and nature of alluvial deposits.The cover sediments of this vast terrain were earlier classified into two units – the Older Alluvium and the Newer Alluvium. The former, comprising thick beds of clay interbedded with sand and silt with reddish brown cover sediment, was generally supposed to be restricted to relatively high grounds. Ubiquitous “kankar” concretions and/or iron nodules are common constituents of the Older Alluvium. The Newer Alluvium, composed of grey to whitish grey sand and silt deposits, was described as restricted along the river channels and of clay in the backswamp areas without any significant kankar or ferruginousconcretions. Within the GandakGhagra ‘Doab’ region in the western part, the Hajipur formation crops out in patches and comprises yellowish brown to grayish brown compact clay with iron and calcareous concretions. The caliche nodules present in the unit often form long continuous bands.

Table 8: General Geology and stratigraphic succession of Siwan district, Bihar (GSI)

Geological Age	Geomorphic Unit	Geological Unit(North Bihar Plain)
Late Holocene	Present flood plain	Kamala formation ≡ Diara formation
Middle Holocene	Older flood plain	Ganga-Kosi≡Vaishali formation ≡ Betiah formation ≡ Bhat Alluvium
Early to Middle Holocene	Relict dissected alluvial fan,	Purnia formation, Bare formation

	olderflood plain	
Pleistocene	Relict older alluvial surface Older alluvial surface Older alluvial surface High level terrace	Hajipur formation Mohanpur formation Madhubani formation Ganauli formation
----------Unconformity----------		

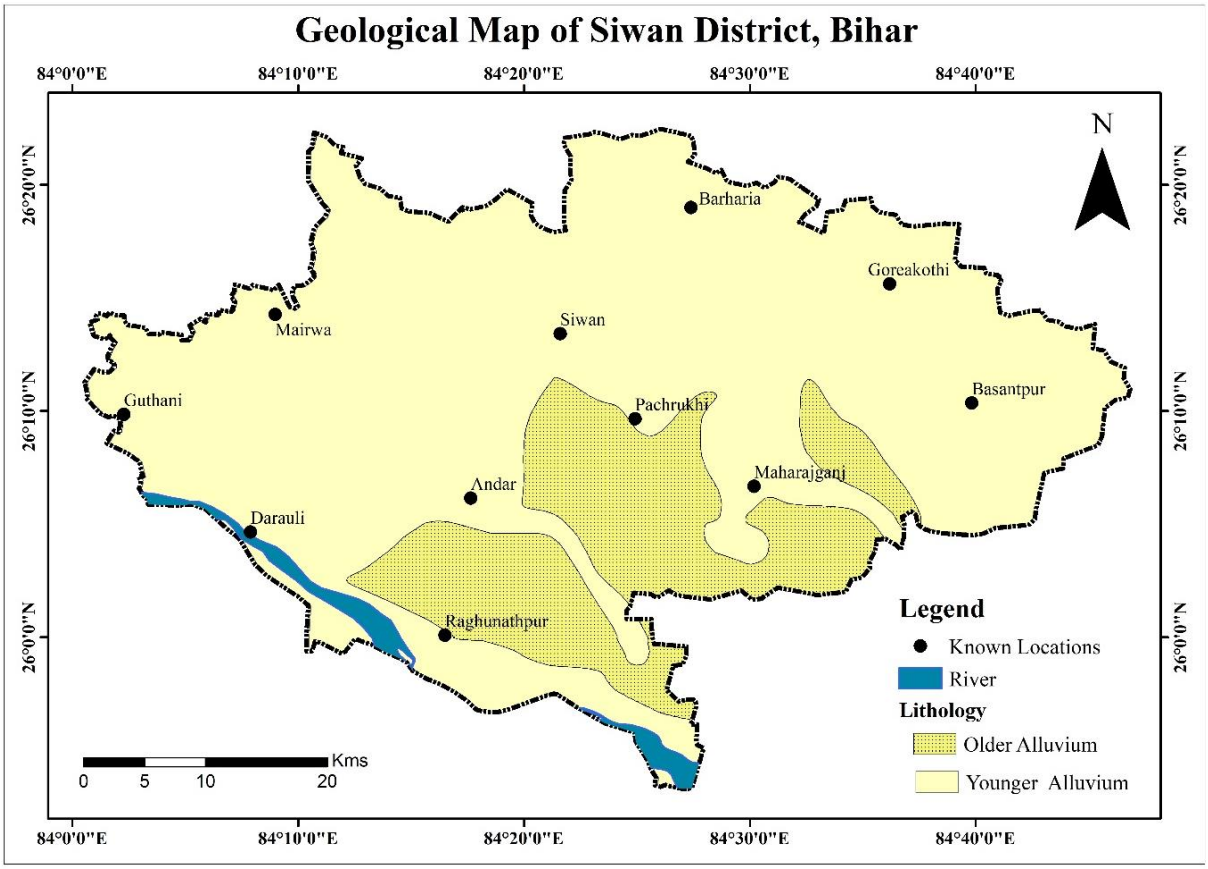

Fig. 10: Geological Map of Siwan district, Bihar

The sub-surface lithology of the alluvial tract is known down to 200 mbgl from the lithological logs of bore holes drilled under exploratory wells construction programme of erstwhile ETO and State Tubewells Corporation. The depositional nature of sediments beyond 200 mt is still remaining unascertained. Recent geophysical traverses brought to the light that alluvial basin is very thick and is of the order of 1000 mt to 2700 mt. The

transmissivity of this sand/Gravel bed is calculated to be 3000 m^2 /day under confined condition. At Barharia the aquifer below 50 mt is proved to be in leaky artisan condition with a transmissivity value of 2000 m^2 /day.

3.2. Hydrogeology

Rainfall in the primary source of ground water recharge. Out of the total rainfall which falls within the Gandak and Gharghra sub-basins of the district, a part of it directly evaporates from the land surface, partly it is absorbed by the vegetation and partly reaches the rivers and ponds as surface run-off. The remaining 20% to 30% rain water goes to the ground water body. Influent seepage from irrigation also contributes to the ground water body in the district.The sand layers of the quaternary alluvial sequence form the major repository of ground water in the district which occur under unconfined condition in shallow zone and semi-confined to confined condition in the deeper zone. The thickness of the aquifer in the district varies from 15 mt to 90 mt which is mainly controlled due to the irregular sloping nature of the bed on which sediments rest. The composition of the sediment is not uniform thus the aquifers are of heterogeneous in character. In general, sand layer predominant in the district barring the clay bed which gradually thickness in South. These granular zones yield 150 m^3/hr to 250 m^3/hr for a draw-down of 4.7 mt to 8.00 mt as observed from the state tubewells.

The cross sections and 3D-model indicates that there are number of sand layers alternating with clay layers. There is also intercalation of gravel mixed with coarse sand which occurs at some places between the sand and clay layers. The gravel layer thickens in the northern and north-eastern part of the district in Barharia and Goriakothi blocks. Though sand is the main repository of underground water, this gravel mixed with coarse sand has high water holding potential. High discharge from wells drilled at Barharia by CGWB (194.4 m^3/hr) has been observed. The gravel layer thins out in the southern part of the district.

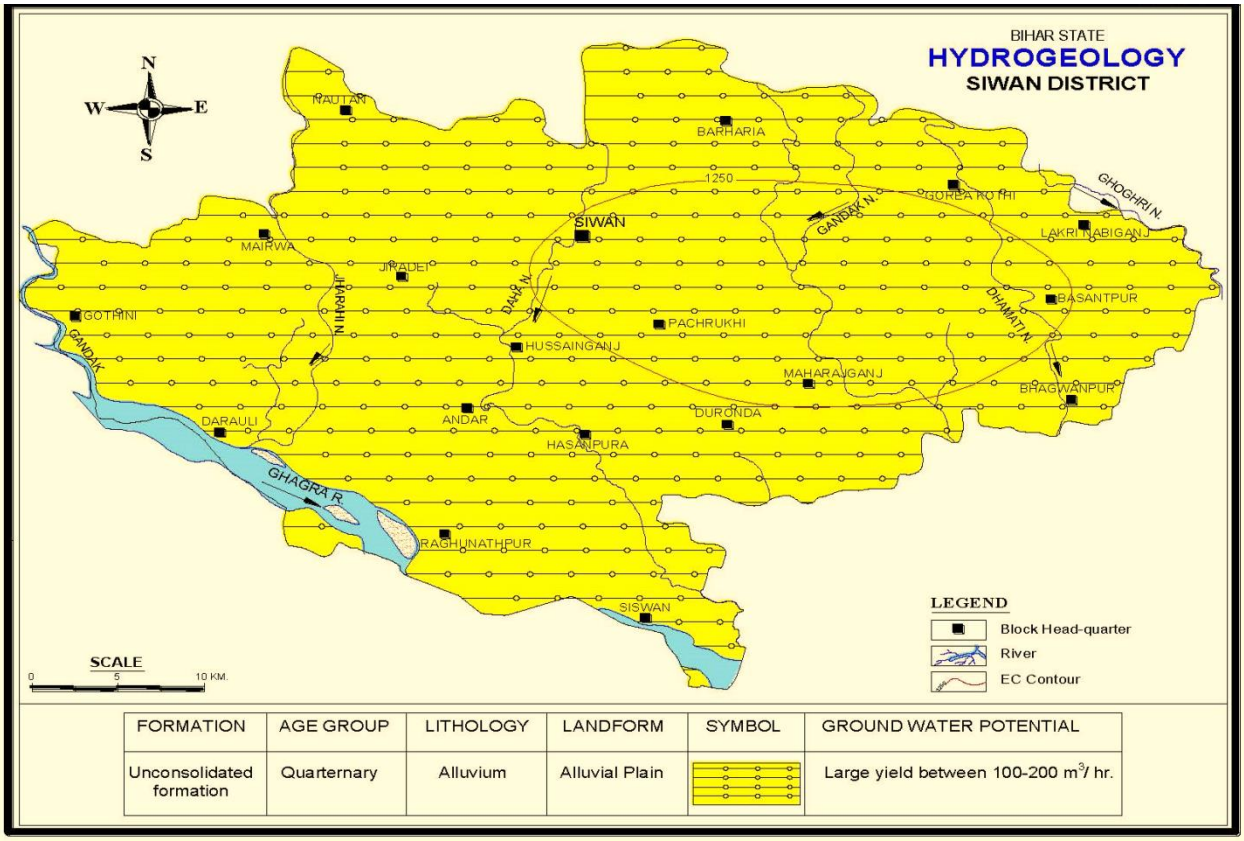

Fig. 11: Hydrogeological map of Siwan District (CGWB District Brochure 2013)

3.3. Groundwater Dynamics

Water Level Scenario – Aquifer – I (Shallow Aquifer):Water level scenario of shallow aquifer was generated by utilizing water level data of 18 monitoring wells and 10 key wells representing shallow aquifer. The pre monsoon (May 2022) depth to water level (*Fig.12*) monitored between 2.5 to 5.86mbgl and average of 4.31m bgl. The post monsoon (November 2022) depth to water level (*Fig.13*)varies between as shallow as 1.45 mbgl to a depth of 5.3 mbgl and average of 2.76 mbgl. Deeper ground water levels were not observed in the district. The water table contour map clearly shows that the overall flow direction of groundwater in the district is from northwest to southeast direction (*Fig.14* and *15*). Highest fluctuation of water level (2.54m) is observed in Deoria in Guthani block. The seasonal water level fluctuation in the district does not exceed beyond 4m (*Fig.16*).

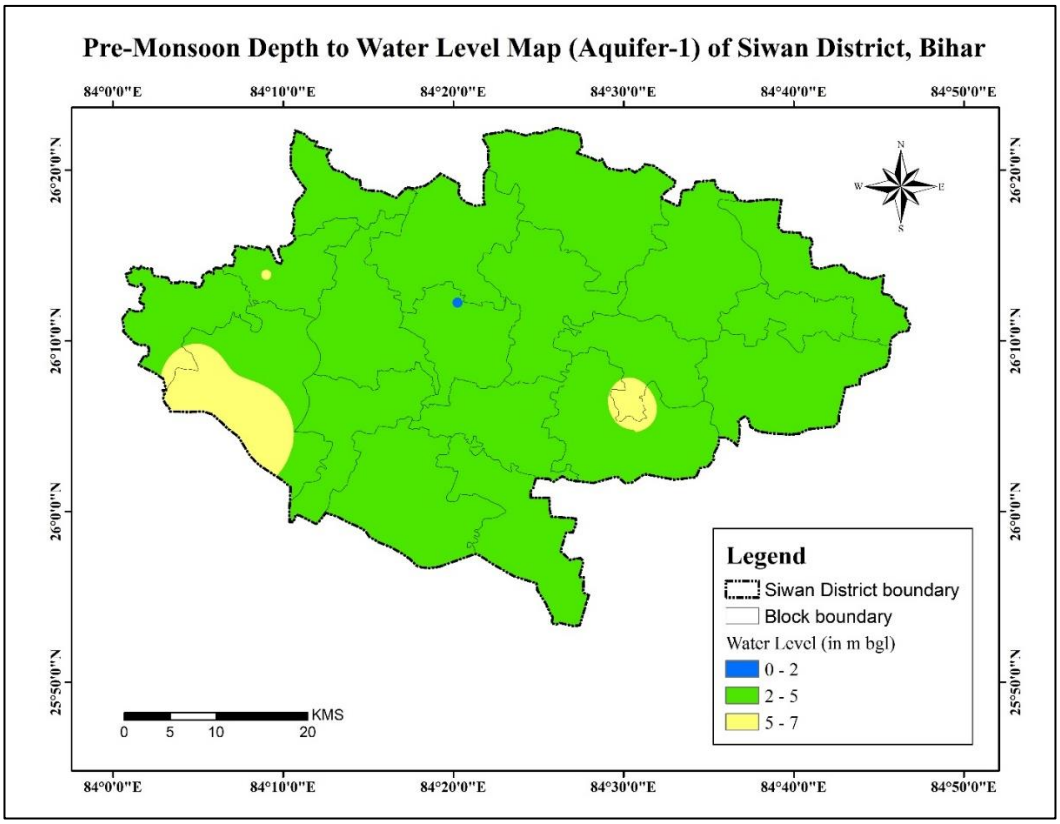

Fig. 12: Pre-Monsoon Depth to Water level (Aquifer-1) of Siwan District, Bihar

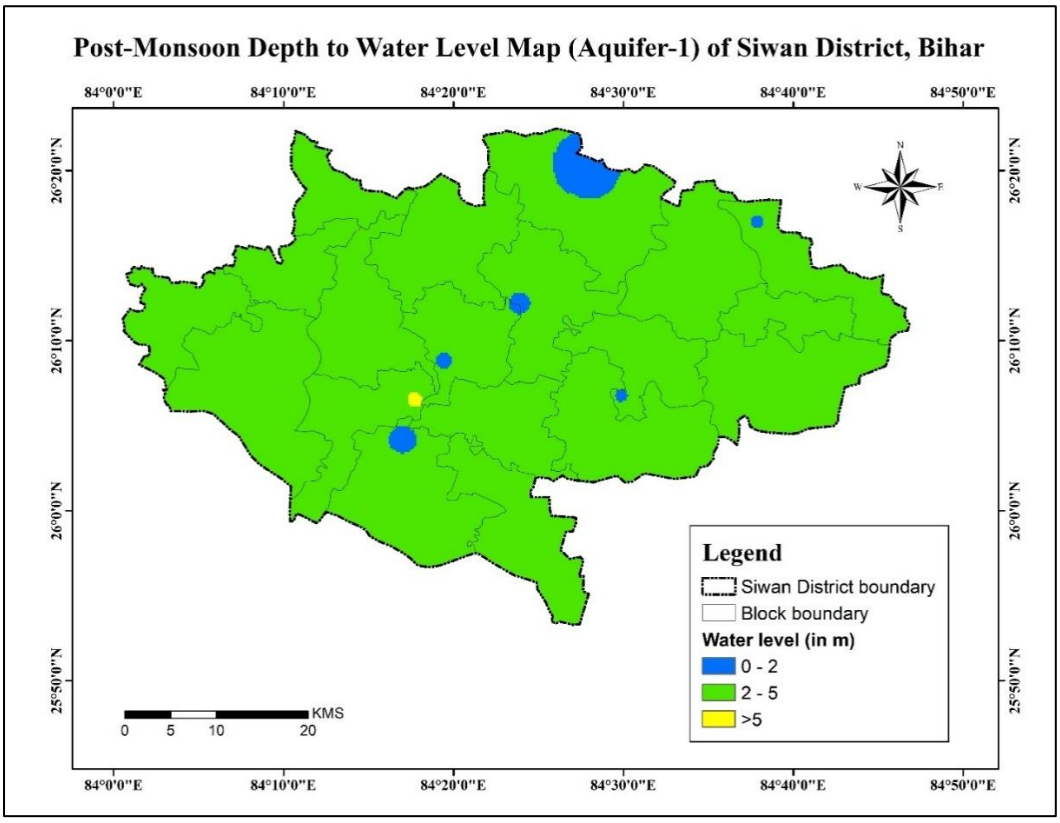

Fig. 13: Post-Monsoon Depth to Water level (Aquifer-1) of Siwan District, Bihar

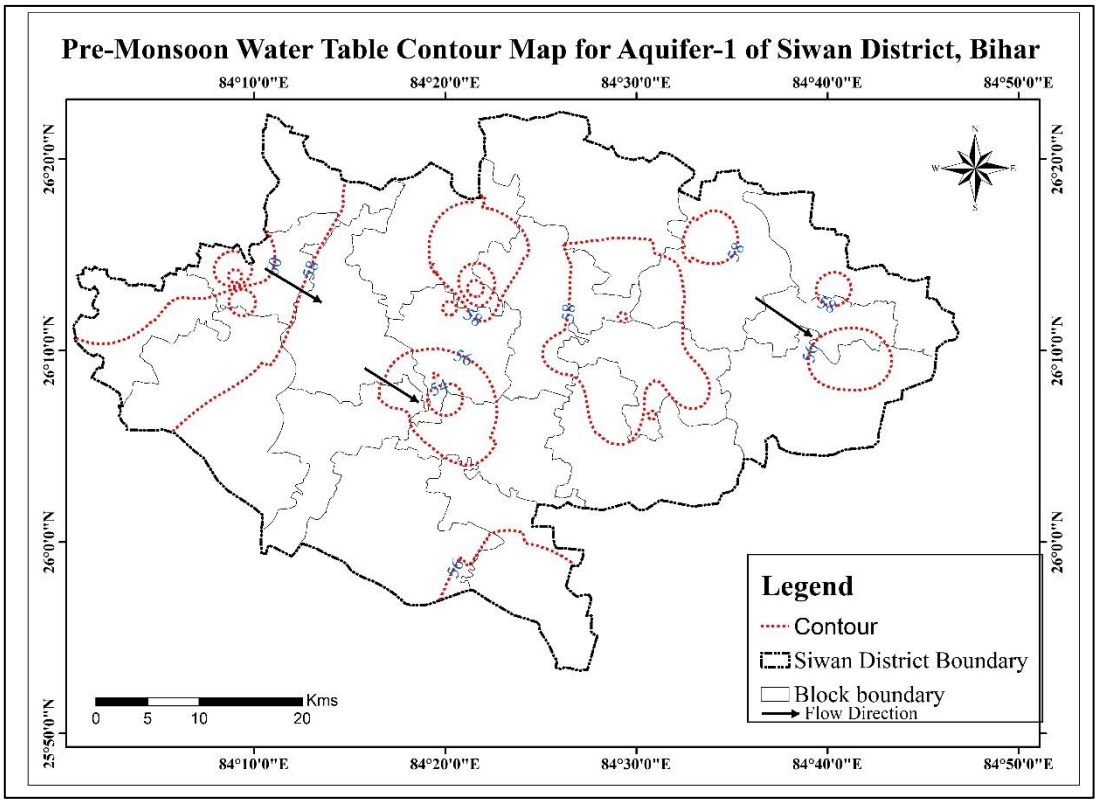

Fig. 14: Pre-Monsoon water table contour Map (Aquifer-1) of Siwan District, Bihar

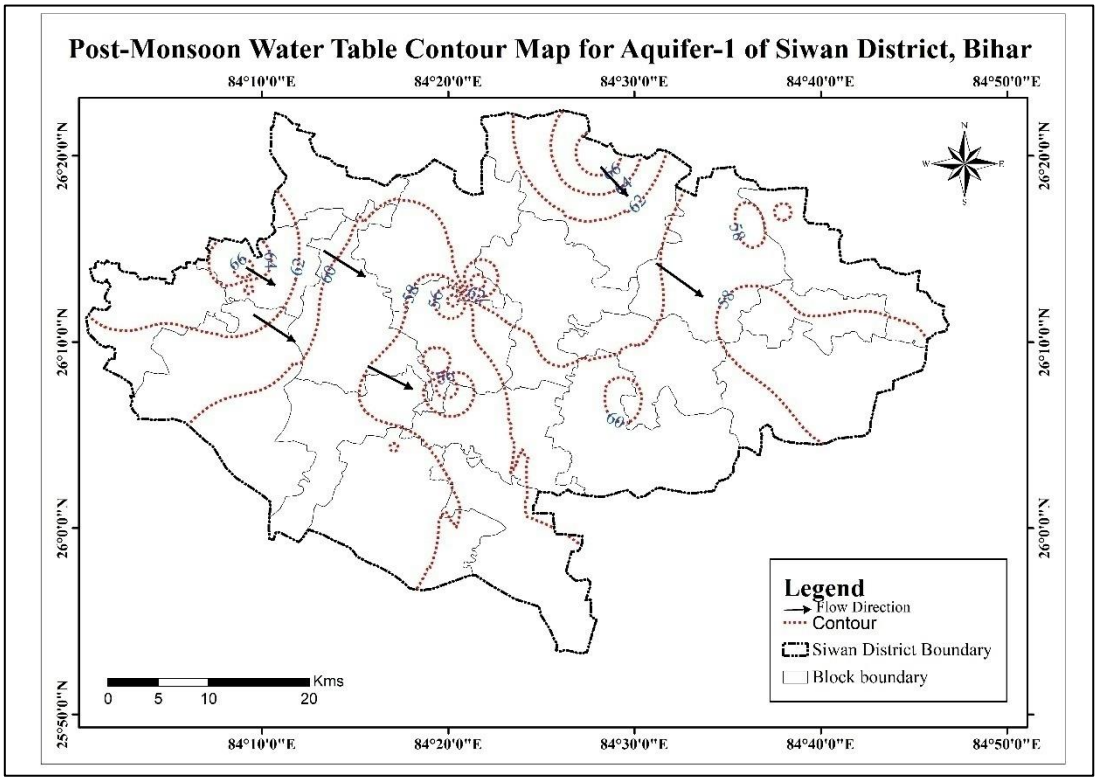

Fig. 15: Post-Monsoon water table contour Map (Aquifer-1) Siwan District, Bihar

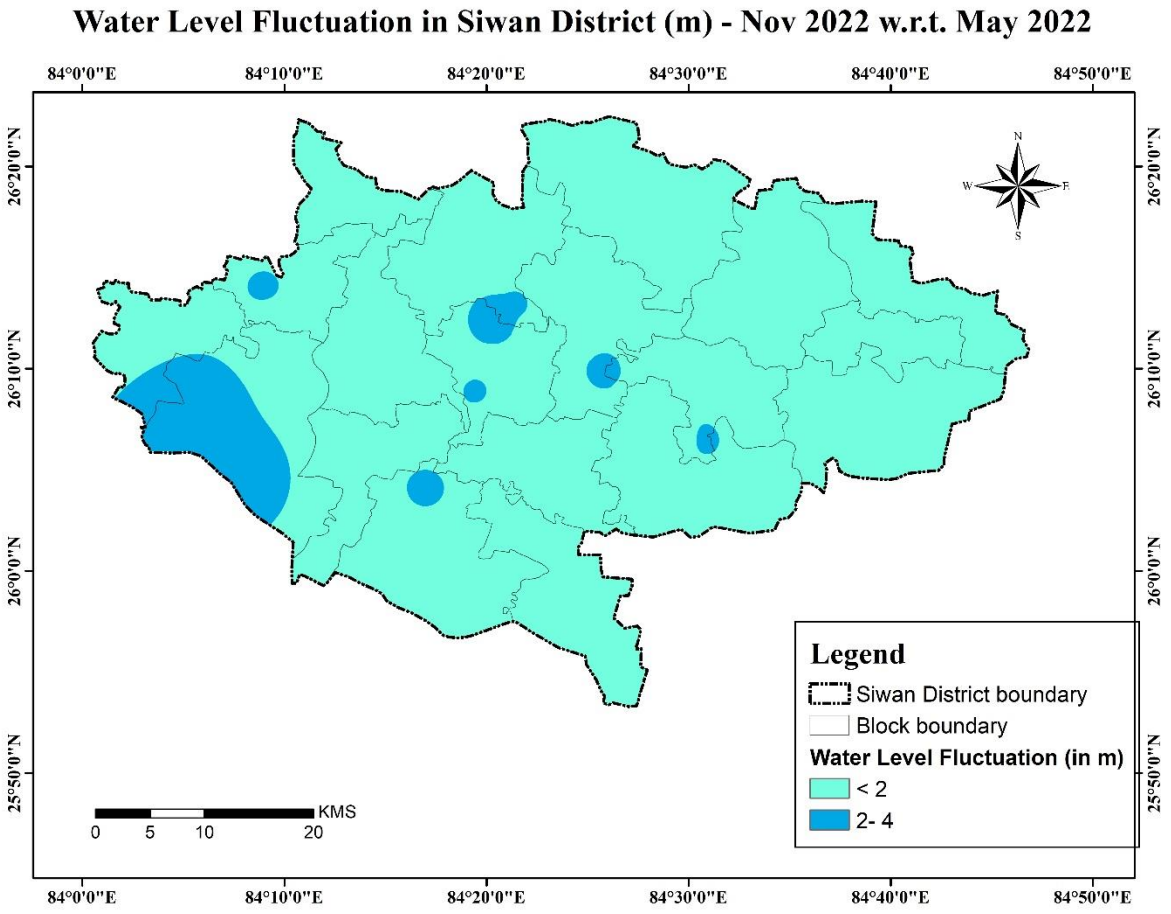

Fig. 16: Seasonal Fluctuation in Water Level in Siwan district

3.4. Hydrograph Analysis (Water level trend)

Analysis of two hydrograph network stations located at Mairwa and Siwan were carried out using GEMS software and analyzed for the period from 2010-2019 (*Fig.17, Fig.18*). It is observed that the long-term water level trends during pre- and post-monsoon seasons are declining**.**

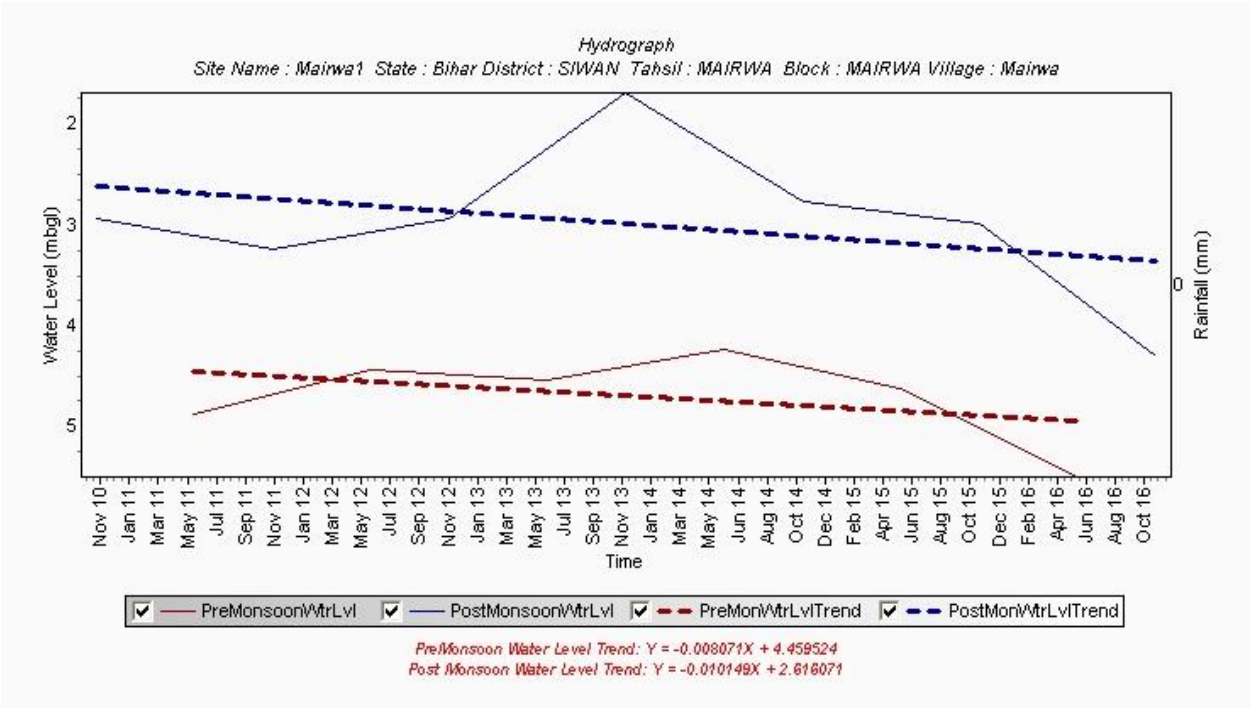

Fig. 17: Water Level trend at Mairwa, Siwan district

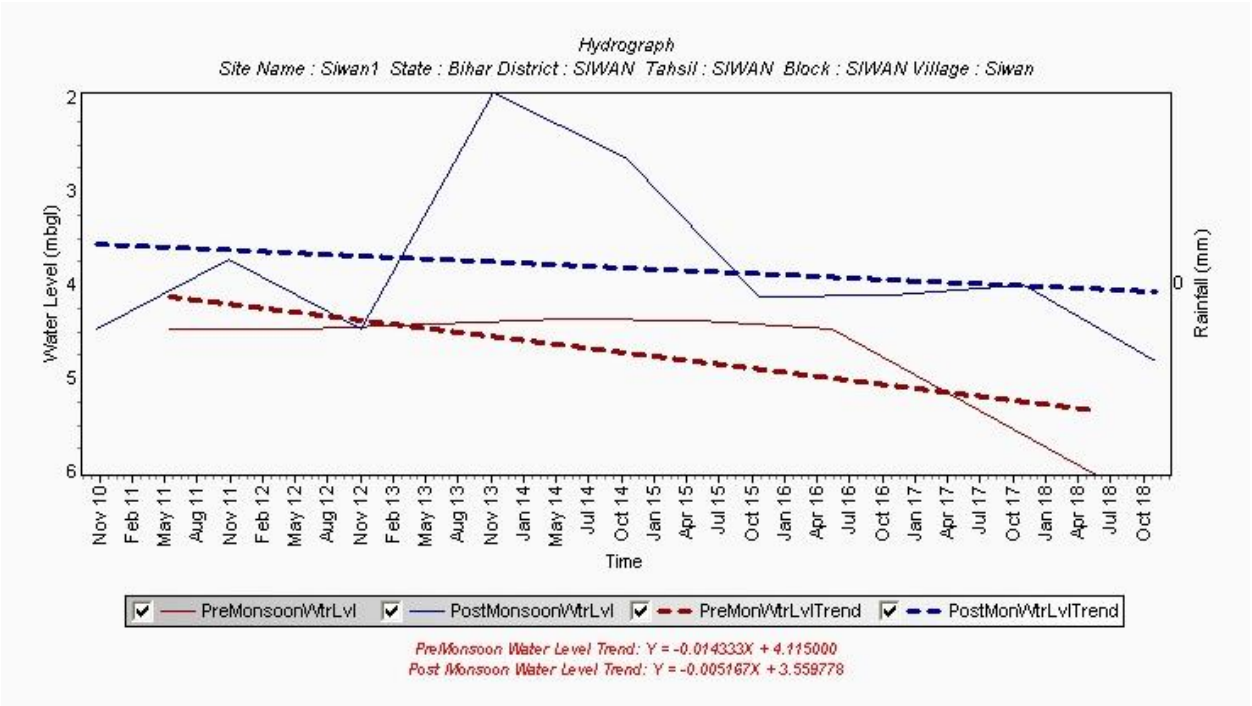

Fig. 18: Water Level trend at Siwan, Siwan district

3.5. Groundwater Exploration

Under exploratory programme CGWB has drilled 3exploratory wells and 3 observation wells down to a depth of 200 m (*Fig.19*). The drilling data indicate the presence of 3 to 4 m water bearing granular zones at different depths. The well yield varies from 160-194 m^3/hr (Annexure III). The fence diagram prepared using available bore hole data reveals that finer clastic are predominant in the northern part gradually decreases towards the southern part. The clay bed is thin in the northern part and it increases towards south and it is about 80.00 m thick at Andar. The aquifer performance test reveals that the transmissivity varies between 2000 and 3800 m^2/day whereas storativity value range between $1.1X10^{-3}$ and $3.3X10^{-4}$. The above findings show that Siwan district is having prolific aquifer.

In Siwan district, shallow tubewells of 50 m depth taping 10-20 m granular zones can be constructed for a yield of 30-50 m^3/hr. The deep tubewell of 100-200 m can also be constructed for a yield of 150-250 m^3/hr.

Pumping test carried out at Andar and Barharia reveal that is the Southern part of the district the aquifers are in the perfect confined condition with storage co-efficient value of $3.3X10^{-4}$ whereas the aquifer in the northern part is in leaky artisan condition. The hydraulic properties of the granular zones are given in Annexure. The study of this annexure reveals that the quaternary sediments of Siwan district are good repository of ground water. The wide range of hydraulic conducting value indicates that the aquifer in the area is quite heterogeneous both vertically and laterally. Shallow tubewells constructed by State Govt. in the area yielded as high as 134 m3 /hr to 175 m3 /hr for a drawdown of 3.35 mt to 7.00 mt. The deep tubewells constructed by CGWB at Andar, Barharia and Mairwa yielded 161 m^3/hr to 195 m^3/hr for a draw down 7.00 mt to 12.0 mt. The yield of dug wells depends upon the thickness of aquifer tapped, diameter of wells, depth of wells, nature of lining and discharge of wells at which they are pumped. The ground water hydraulics largely depend upon the nature of sediments i.e., gain size and sorting and is depositional setup. Occurrence and movement of ground water in this hydrogeological unit is controlled by primary porosity of the sediment. In the entire district, ground water occurs under both phreatic and confined condition and at some places they are also found to be under semiconfined condition.

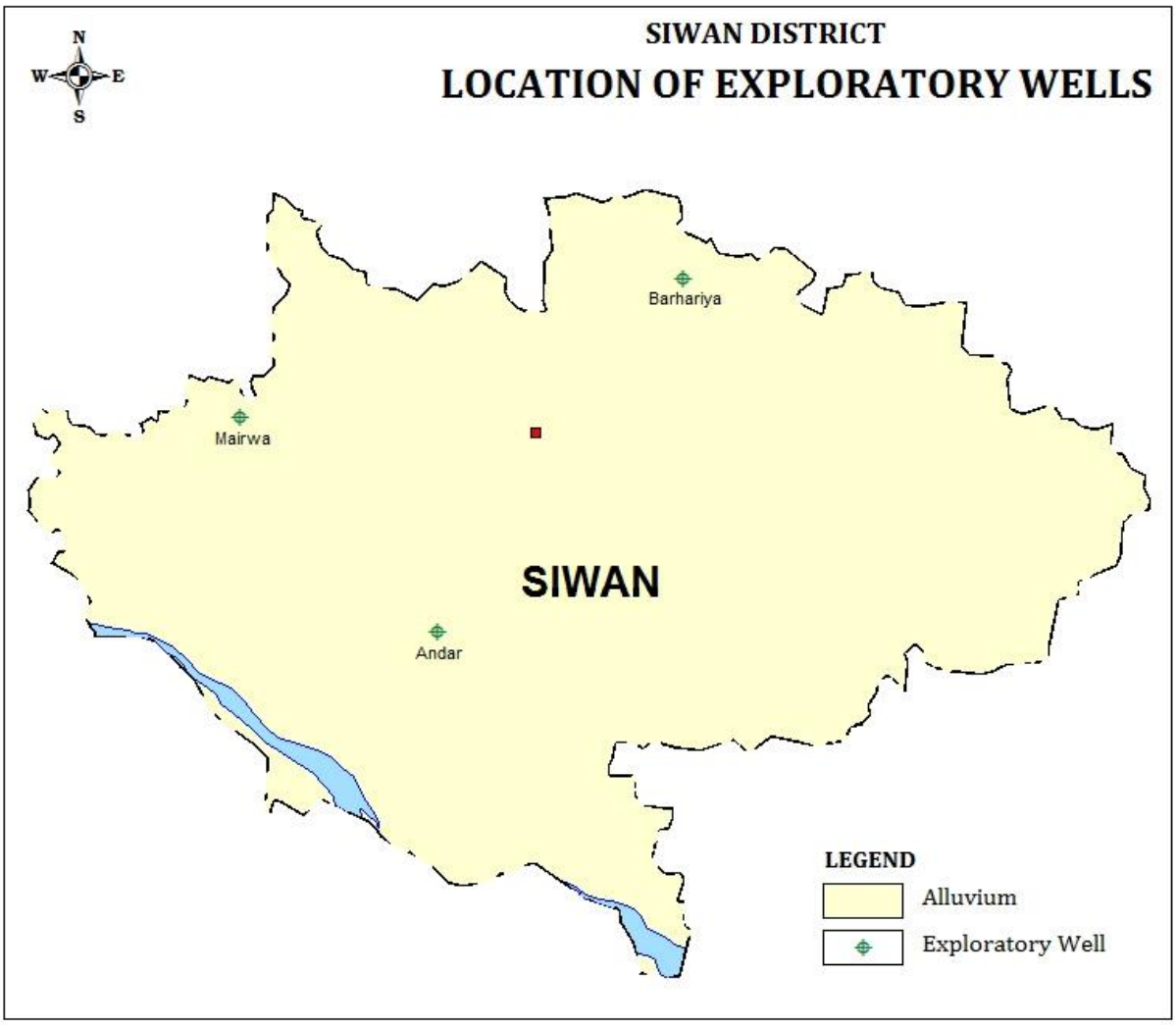

Fig. 19: Location of exploratory wells drilled by CGWB in Siwan district, Bihar.

3.6. Groundwater Quality

The quality of ground water of an area is derived from both physical and chemical parameters that are mainly influenced by geological formations of that area and may also get affected by anthropogenic activities such as over exploitation, industrial density etc. Availability of ground water supply as well as the quality of the same for drinking or irrigation purposes is always a major concern. Suitability of ground water for drinking and irrigation purpose is important for its safe and effective use. The dissolved ions in different amount in ground water are function of the availability of the constituents in the aquifer matrices and their solubility. Rocks, through which water circulates, are composed of minerals and amorphous solids, which in turn are composed of chemical elements that greatly affect the ground water quality.

Total 27 ground water samples have been collected in pre monsoon season 2022 from Shallow tubewells (Aquifer-I). These water samples have been analysed in chemical laboratory of CGWB, MER,Patna for various basic parameters. As can be seen by the analysis results, pH values of the collected water samples vary between 6.63 and 7.76 with an average value of 7.02. From the pH value range, it can be observed that the groundwater samples were slightly acidic to mild basic in nature but all remained well within the acceptable limit. Electrical Conductivity is an important measure in the determination of ground water quality. It is the ability of water to pass an electric current. It is influenced by the presence of dissolved cations (Na^+, K^+, Ca^{2+}, Mg^{2+}, Fe, Al^{3+} etc.) and anions (Cl^-. NO_3^-, PO_4^{3-}, SO_4^{2-} etc.). The electrical conductivity (EC) values range between 411-4570 µs/cm with an average value of 1041.37 µs/cm. The large variations in EC values can be primarily attributed to geochemical processes that prevail in the region. Similarly, Total dissolved solids (TDS) values range from 267.2 to 2970.5 mg/L. The maximum value of EC and thus TDS is observed at Surwal Colony, Ziradei block, Siwan district. Agricultural runoff may be the main contributor, flushing high nutrients into water bodies that often carry a higher concentration of dissolved solids, which influence the conductivity of water. High nitrate concentration suggests that there may be anthropogenic or natural activities such as over use of fertilizers, manure, liquid waste discharged from septic tanks etc.

The TDS is made up of inorganic salts and small amount of organic matter. The common inorganic salts found in water generally includes calcium, magnesium, sodium, potassium as cations and carbonates, bicarbonates, chlorides, sulphates, nitrates as anions. These minerals can also come from anthropogenic sources such as urban and agricultural runoff, wastewater discharge, industrial effluent etc.

The total load of dissolved solids in water is determined theoretically by taking into account the EC of that particular water body. It is calculated as the formula given in Equation 1.

$$\mathbf{TDS = EC * 0.65\ mg\ L^{-1}} \text{ ……... (Equation 1)}$$

where EC is in µS/cm at 25º C.

Table 9: Relationship between TDS and Salinity

TDS (mg/L)	Degree of Salinity
0-1000	Fresh, Non-Saline
1001-3000	Slightly Saline
3001-6000	Moderately Saline
6001-10,000	Highly Saline
10,001-35,000	Excessively Saline
>35000	Brine

Table 10: Frequency Distribution of TDS in Siwan district

Salinity as per T.D.S range	No. of Samples	Percentage
Fresh, non-saline (0-1000 mg/l)	22	81.5
Slightly saline (1001-3000 mg/l)	05	18.5

As can be seen in chemical analysis results, Ca^{2+} and Mg^{2+} are the major dominant cation as compared to alkali metal ions. Ca^{2+} concentration ranges between 40 mg/L and 586 mg/L with an average of 123.03 mg/L. Results revealed that Na^{+} concentration ranges between 5.03 mg/L and 312 mg/L with an average of 44.86 mg/L. The bicarbonate ion concentrations were in the range of 183 mg/L to 1610.4 mg/L, with an average value of 428.35 mg/L. Only 01 sample out of the total collected samples was found to have alkalinity (bicarbonate concentration) above the permissible limit of 600 mg/L (*Table 11*).

Table 11: Distribution of Ground Water Samples in Different Alkalinity Ranges

Alkalinity Range (mg/l)	Percentage
0 - 600	96.29
> 600	3.71

In none of the analysed samples Carbonate alkalinity has been detected. Analysis results reveal that only 02 samples of the study area have Nitrate concentration above acceptable limit of 45 mg/L.

None of the total samples analysed has shown Uranium concentration above acceptable limit.

Most of the samples according to their chemical quality parameters value as per Annexure Vmay be categorized as safe for drinking purpose.

Classification of ground water geo-chemistry:

The determination of groundwater facies helps in evaluation of groundwater quality. It can be done by plotting the percentage of selected chemical constituents in Modified Piper diagram (Chadha's plot) which is a simplified version of Piper plot. The plot is prepared by using percentage of major cations data on X axis and major anions in Y axis (*Fig.20*).

It can be observed that almost all of the water samples collected from Siwan district are of Ca/Mg-HCO_3 type. The study suggested that the area of study is dominated by HCO^{3-}anion , and alkaline earth metals (Ca^{2+} and Mg^{2+}) dominating over alkali metals (Na^{+} and K^{+}).The Ca - HCO3 water is primarily a result of dissolution of carbonate minerals, and the origin of water is mainly due to rainfall-derived recharge, over decades to centuries, whereby surface water charged with atmospheric and biogenic CO_2 infiltrates into the subsurface. Presence of low Cl^{-} &SO_4^{2-}ions in comparison with HCO_3^{-} indicates low residence time.

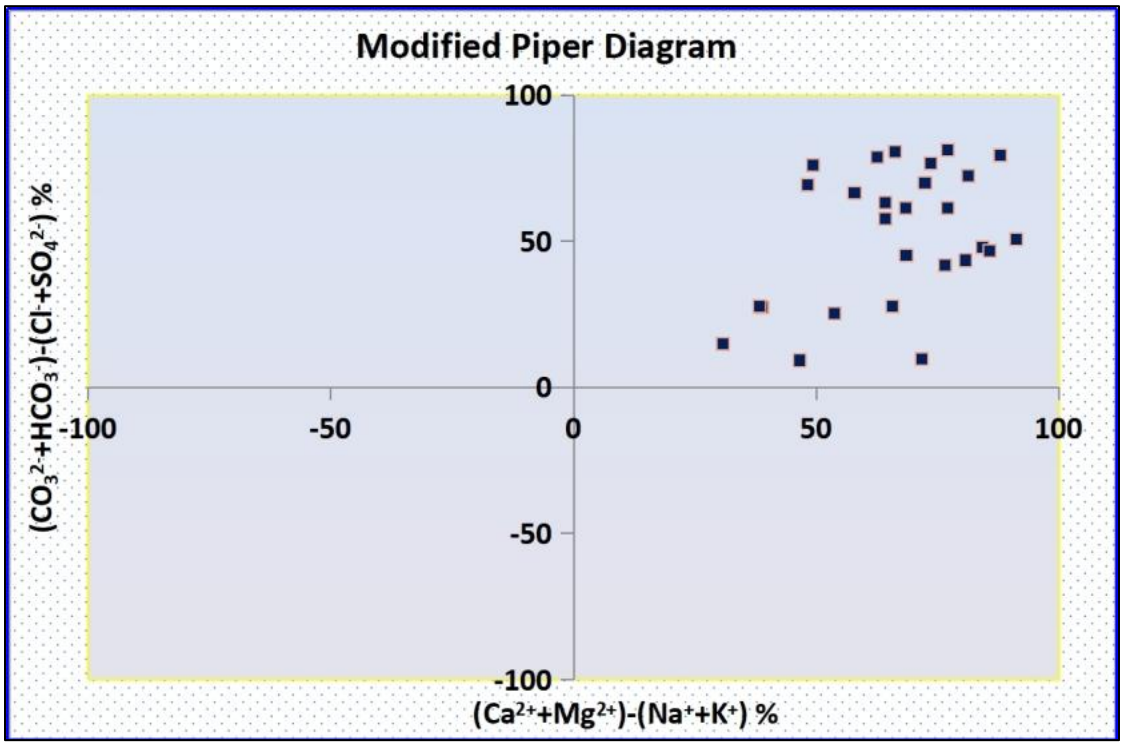

Fig. 20: Modified Piper plot of water samples collected from Siwan district.

Suitability of ground water for Irrigation

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

Salinity: - Total concentration of soluble salt (Higher the TDS high will be salinity)

Sodicity: Concentration of sodium relative to calcium and magnesium (sodium percent)

The United States Soil Laboratory Staff's (USSL's) diagram classifies the water quality into 16 zones to assess the degree of suitability of water for irrigation. In Figure 20, waters has been divided into C1, C2 C3 and C4 types on the basis of salinity hazard and S1, S2, S3, S4 types on the basis of sodium hazard. The classification of irrigation water with respect to SAR is primarily based on soil quality. Sodium-sensitive plants may, however, suffer injury as a result of sodium accumulation in the plant tissue when exchangeable sodium values are lower than those effective in causing deterioration of the physical condition of the soil.

US Salinity plot (*Fig.21*), shows that most of the groundwater samples were in the C2-S1 category and C3-S1 category, only 01 samples was in C4-S2 category. The C2-S1 category suggests that the groundwater has less sodium content and medium salinity thus can be used for irrigation purpose. C3-S1 category suggests that samples have high salinity and low sodium hazard, C4-S2 type suggests groundwater to be highly saline, so it is not fit to be used for irrigation. Most of the samples in the study area were found suitable for irrigation.

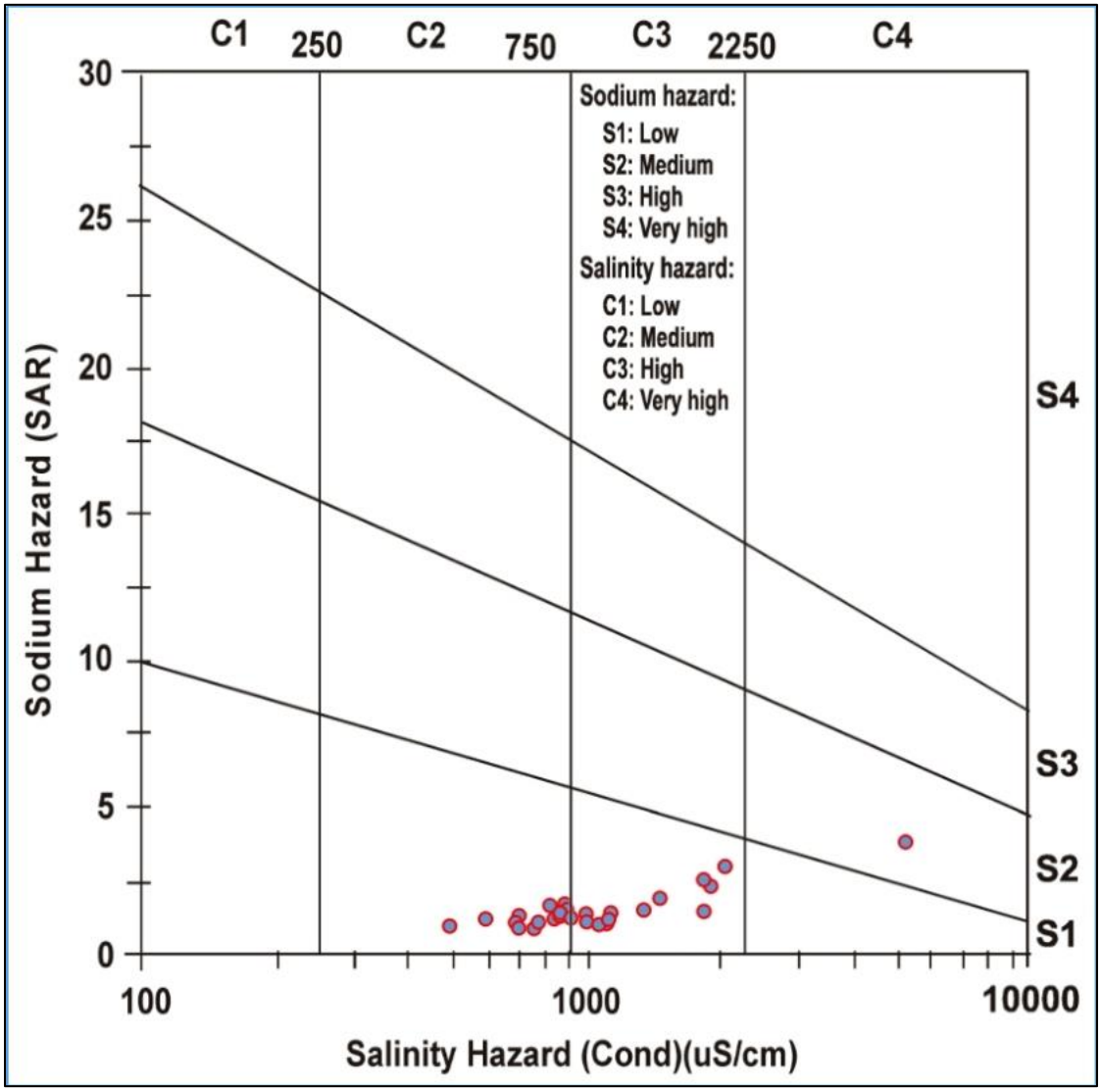

Fig. 21: USSL Plot for water samples collected from Siwan district.

Wilcox plot (*Fig.22*) between Sodium percent and Salinity, illustrates that majority of the samples were in the category of excellent to good, followed by only few in good to permissible category for irrigation. Only 01 sample falls in Unsuitable for irrigation category and the main reason behind this may be its high salinity.

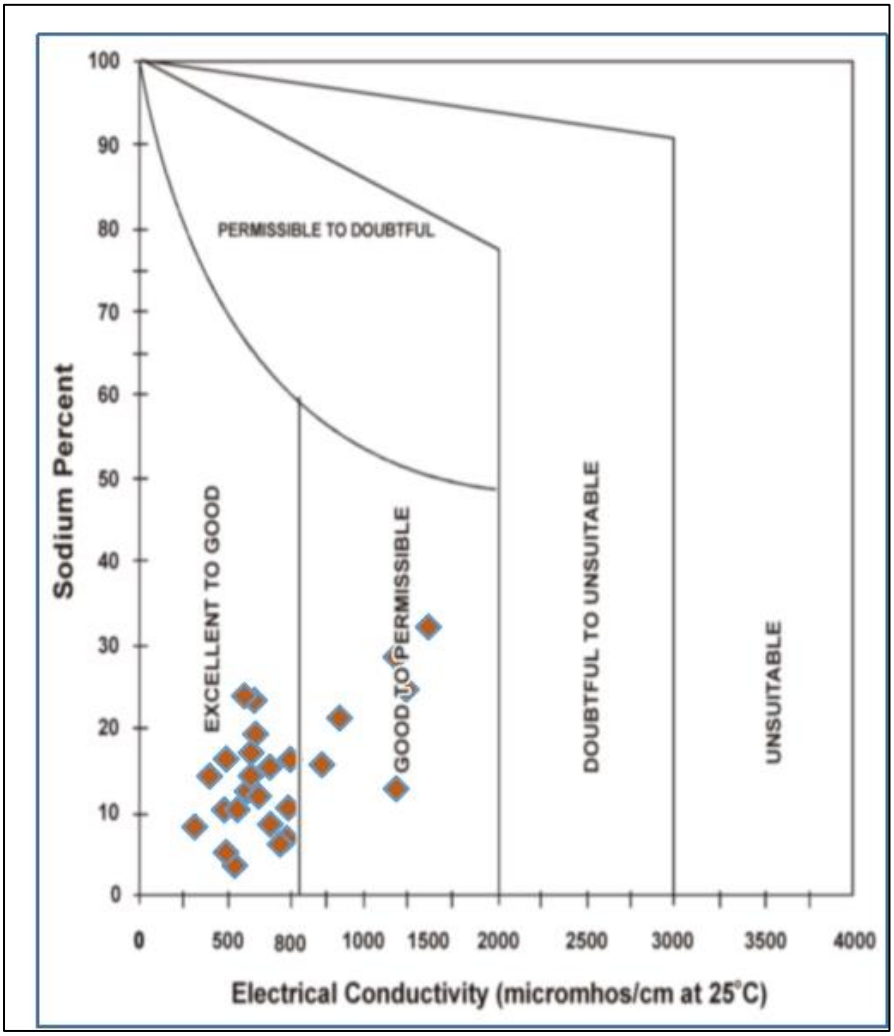

Fig. 22: Wilcox Plot of water samples collected from Siwan district.

A statistical evaluation of ground water samples has been displayed in *table 12*, as can be seen from the table, the SAR and Percent Sodium value collectively suggests that most of the samples are excellent followed by good for irrigation.

Table 12: Classification of groundwater samples of Siwan district for Irrigation purposes

Parameter	Range	Classification	% Of samples
SAR value	<10	Excellent	100
	10-18	Good	0
	18-26	Doubtful	0

	>26	Unsuitable	0
% Sodium	<20	Excellent	70.37
	20-40	Good	29.63
	40-60	Permissible	0
	60-80	Doubtful	0
	>80	Unsuitable	0

In *table 13*, statistical results of chemical variables of all the samples analysed with their comparison to the BIS 2012, acceptable limit is given.

Table 13: Statistical results of the studied chemical parameters, Siwan district

Parameter	Minimum value	Maximum value	Average value	BIS 2012, acceptable limit
pH	6.63	7.76	7.02	6.5-8.5
TDS (mg/L)	267.15	2970.5	676.89	500
HCO_3^- (mg/L)	183	1610.4	428.35	200
Cl^- (mg/L)	10.65	312.4	60.61	250
NO_3^- (mg/L)	0.47	250	18.33	45
SO_4^{2-} (mg/L)	5.6	300	52.32	200
F^- (mg/L)	0.66	1.16	0.89	1
Ca^{2+} (mg/L)	40	586	123.03	75
Mg^{2+} (mg/L)	13.36	46.17	23.13	30
TH (mg/L)	175	1575	402.77	200

The chemical quality data for all parameters analysed has been enclosed in Annexure – V.

3.7. Aquifer Disposition

Cross-sections (2-D) and 3-D models are prepared to identify spatial disposition and vertical extent of Aquifer. The tube wells, drilled by Central Ground Water Board as Exploratory Well and Production Well as well as the tube wells drilled by Bihar State Development Authority before 1986 are also included here for the 2-D diagrams. The location of these wells are shown in *Fig.23*.However, map is prepared based on limited field data and is subject to change with incorporation of more data points.

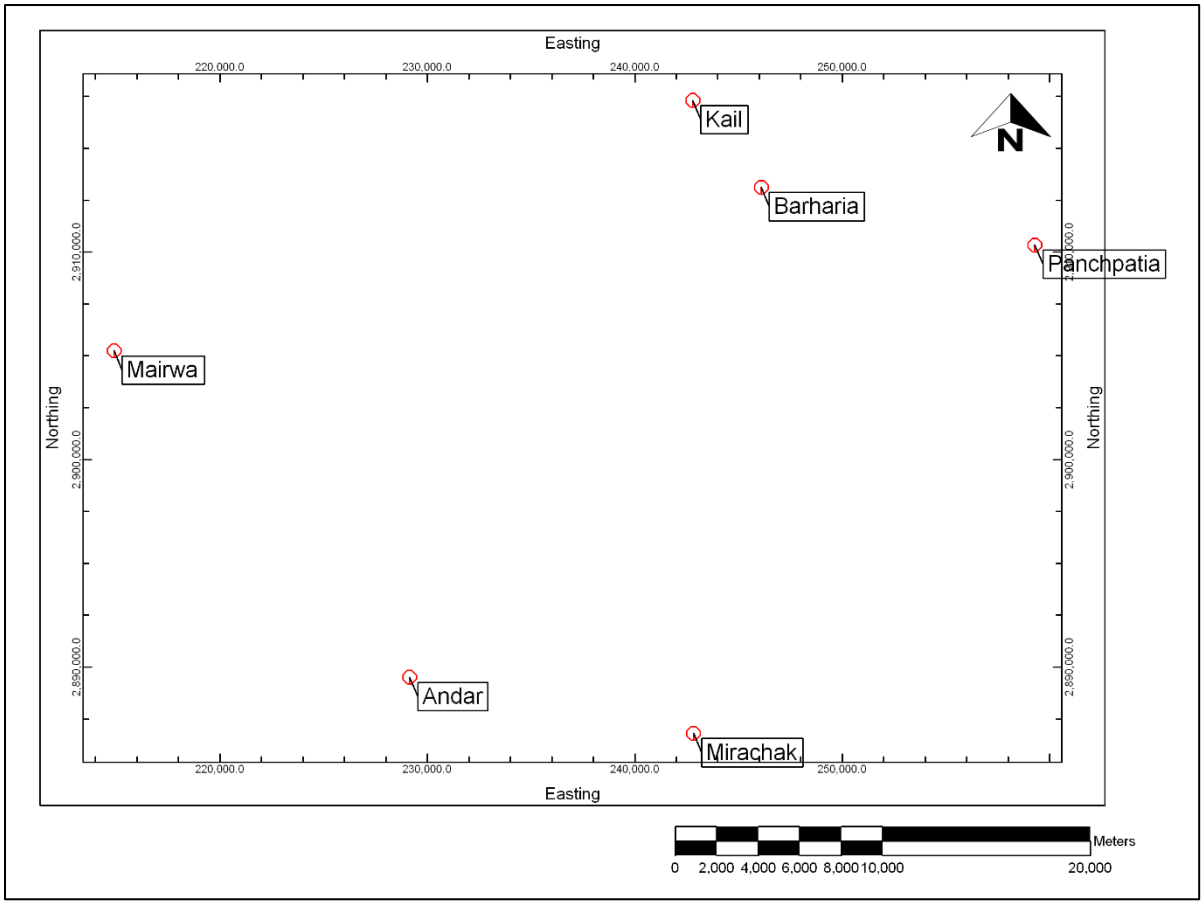

Fig. 23: Locations of Wells in Siwan district for preparation of 2D and 3D diagrams

Preparation of litholog is one of the important components of ground water exploration being carried out by Central Ground Water Board (CGWB). The drilled cuttings are collected at regular intervals or whenever there is any change in lithology during exploratory drilling. This data has been collected from the previous reports of CGWB as well as State agencies and new

data are also generated to fill-up the data gap. Various cross sections and fence diagram has been prepared with the help of lithology to know the aquifer disposition of the area.

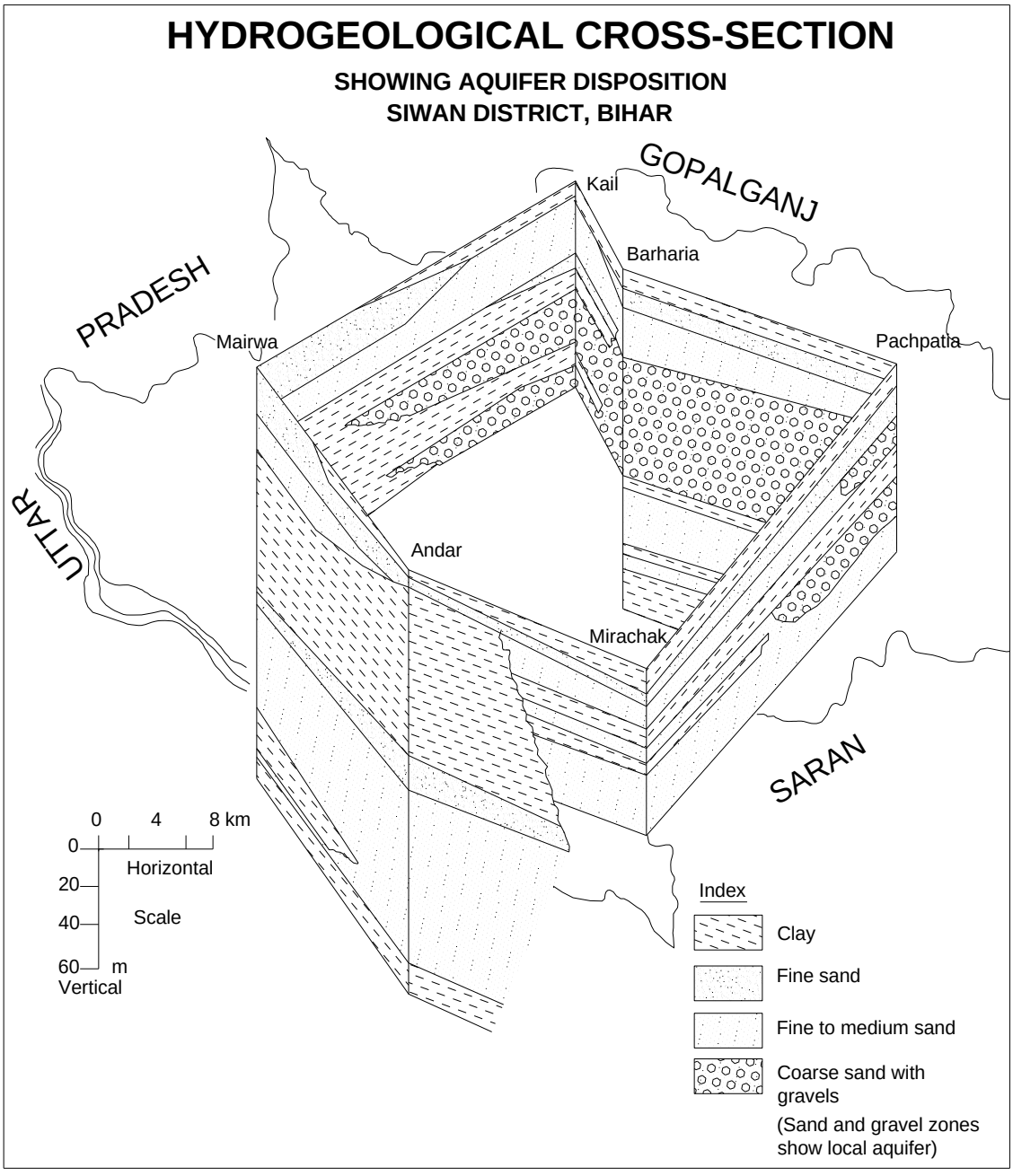

Fig. 24: Fence-diagram showing aquifer disposition in Siwan district (Bihar Exploration Report 2012).

An attempt has been made to establish the aquifer geometry on regional scale in Siwan district to cover all administrative blocks as per the available data. Principal aquifers in the area have been delineated by grouping the fine to medium sand, coarse sand and gravelly sand as aquifers

separated by considerable thickness of clay. These cross sections/fence diagrams are given below along with the map to locate the area concerned (*Fig. 25- 29*).

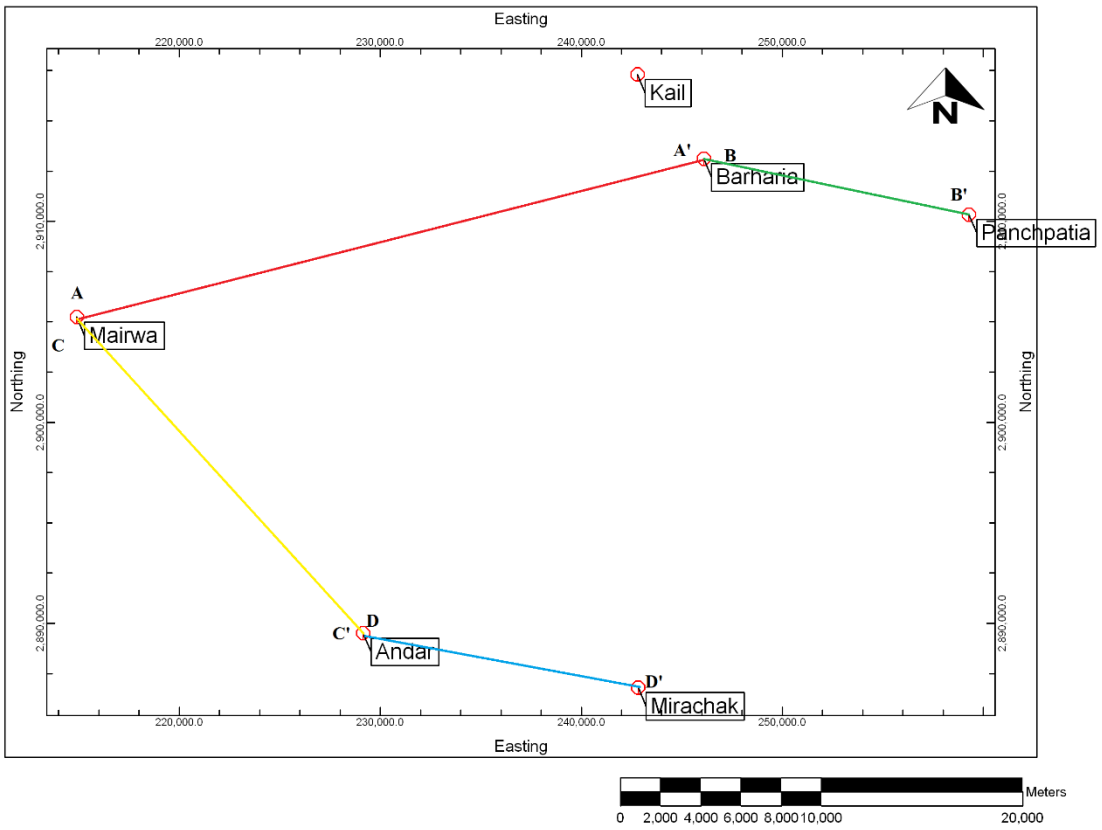

Fig. 25: Directions along which cross-sections (2D plots) are prepared.

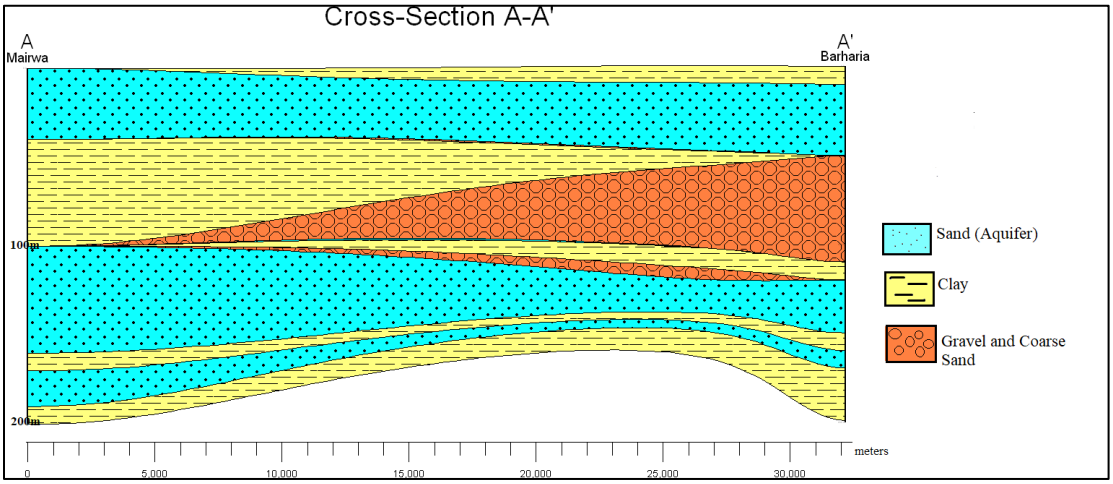

Fig. 26: Cross-section along AA'

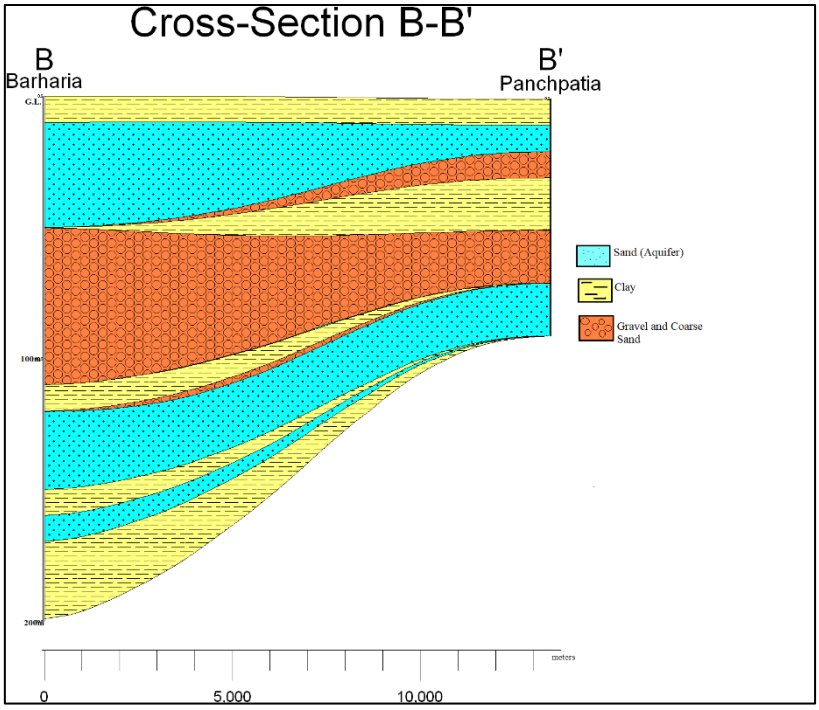

Fig. 27: Cross-section along BB'

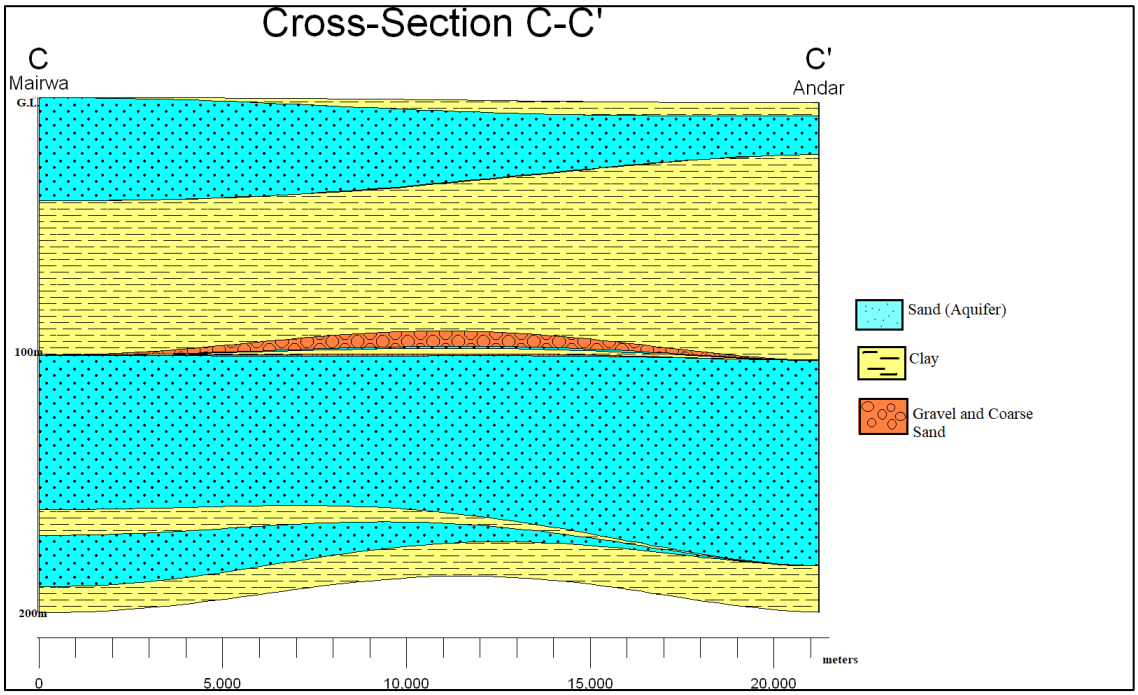

Fig. 28: Cross-section along CC'

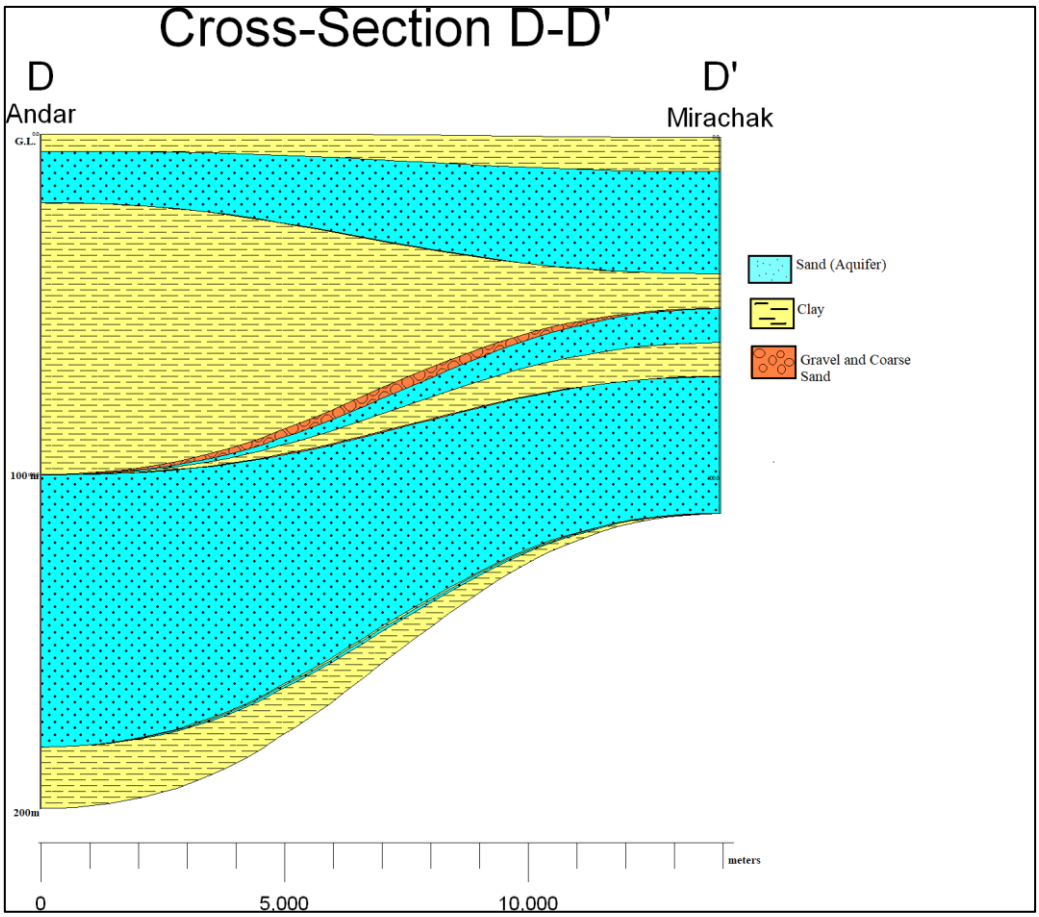

Fig. 29: Cross-Section along DD'

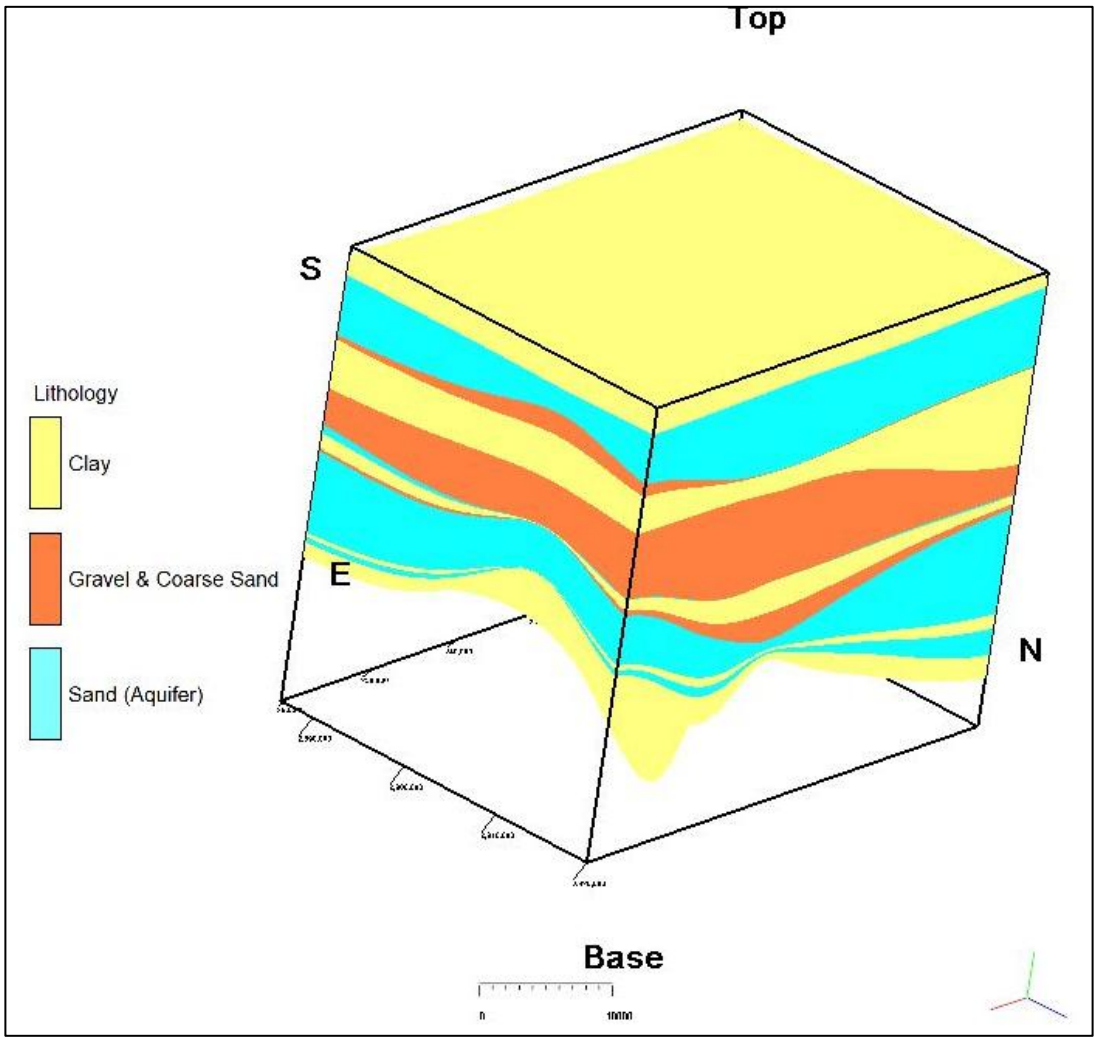

Fig. 30: 3-D Disposition of Aquifers in Siwan district

Characterization of aquifer upto ~200 m bgl in the study area has been arrived at by convergence of the observations from the study of the different lithological sections, fence diagrams, geo-electrical sections, sections based on lithologs and overall lithological model of the area. All these figures reveal the presence of a thick pile of alluvial sediments with alternation of various grades of sand with clay and silt. The area is characterized by occurrence of thicksands of various grades forming aquifers. A layer of gravel with coarse sand also exists which is prominent towards the northern and north-eastern part of the district.

All the cross-sections, fence diagram, 3D model (*Fig.30*) indicates that there are mainly two principal aquifer systems below the top aquitard layer (water table aquifer) upto 200 m depth

separated by clay. In Mairwa block, Aquifer-I occurs under unconfined condition, while towards Mirachak in Daraunda district, Aquifer-I occurs under semi-confined condition. Aquifer-II occurs throughout under confined condition overlain by a thick layer of clay (50-60 m thick). In the northern part of the district Aquifer-I and Aquifer-II are separated by a relatively thicker layer of gravel and coarse sand alongwith a thin layer of clay. Thus, in the northern part of the district in Barharia and Goriakothi blocks, Aquifer-II occurs within semi-confined condition. The gravel layer mixed with coarse sand contributes to high discharge of wells in this area. Aquifer-I is 20-30 m thick and occurs within a depth of 40 m in the district. Aquifer-II is about 30-40 m thick and occurs beyond the depth of 100 m. The confining clay layer is nearly 30-60 m thick,its thickness varying atplaces.

Chapter 4: Groundwater Resource

Ground Water Resource of the area has been estimated block wise based on for base year as on 2022. In the present report GEC 2015 methodology has been used and based on the assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., Replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage ground water resources, but the development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

4.1. Assessment of Annually Replenishable or Dynamic Ground Water Resources (Unconfined Aquifer i.e., Aquifer-I)

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

Inflow – Outflow = Change in Storage (of an aquifer).

The equation can be further elaborated as:

ΔS= RRF+RSTR+RC+RSWI+RGWI+RTP+RWCS±VF ± LF -GE-T-E-B

Where, ΔS – Change is storage,

RRF – Rainfall recharge,

RSTR- Recharge from stream channels,

RC – Recharge from canals,

RSWI – Recharge from surface water irrigation,

RGWI- Recharge from ground water irrigation,

RTP- Recharge from Tanks & Ponds,

RWCS – Recharge from water conservation structures,

VF – Vertical flow across the aquifer system,

LF- Lateral flow along the aquifer system (through flow),

GE-Ground Water Extraction,

T- Transpiration,

E- Evaporation,

B-Base flow

The dynamic Ground Water Resources has been assessed by CGWB, MER, Patna in association with Minor Water Resources Department, Government of Bihar based on GEC, Methodology 2015. The salient features of Dynamic Ground Water Resources of Siwan district (as on 31st March, 2022) are given in table.

As per Ground Water Resource Estimation (GWRE) 2022, all the blocks in Siwan district, are safe assessment units.

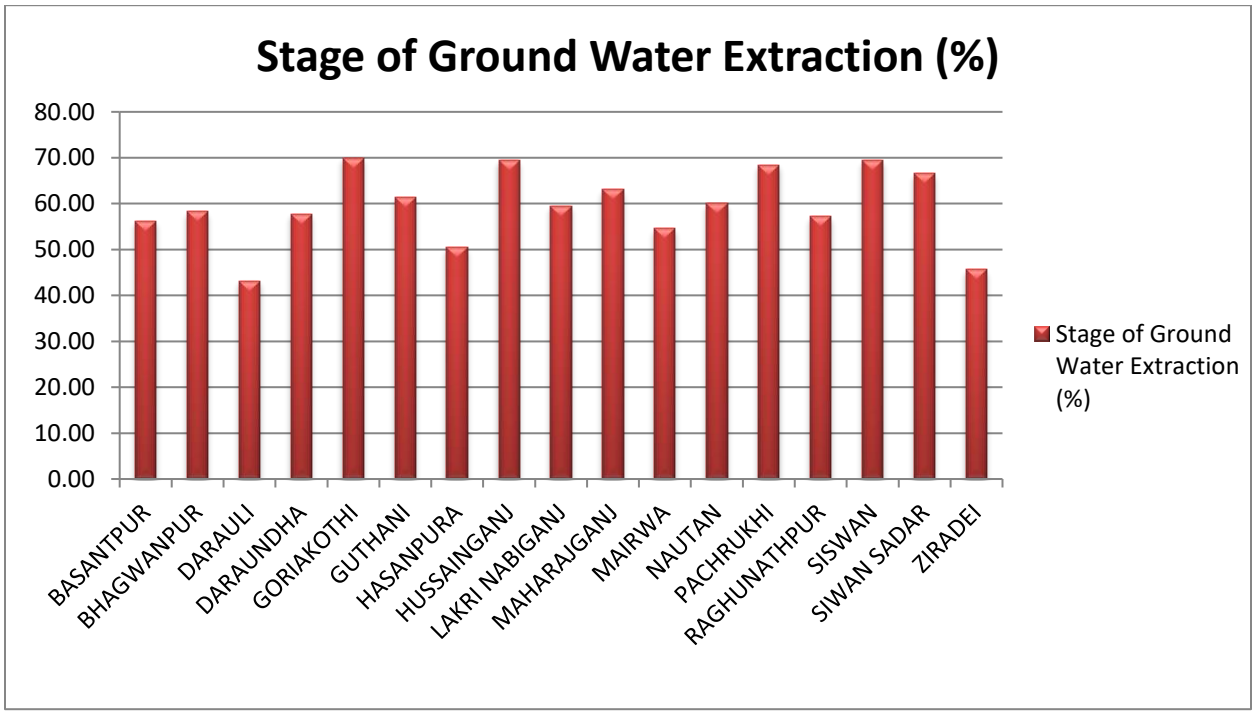

Fig. 31: Block-wise stage of groundwater extraction in Siwan district, Bihar

Table 14: Dynamic Groundwater Resource (till 2022) of Siwan district, Bihar

Block	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	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semicritical/Safe/Saline)
ANDAR	4105.60	1980.40	0.00	342.97	2323.37	372.62	1752.58	56.59	safe
BARHARIA	6876.39	3682.19	0.00	1001.50	4683.68	1088.11	2106.10	68.11	safe
BASANTPUR	2528.31	1092.66	0.00	328.01	1420.67	356.37	1079.28	56.19	safe
BHAGWANPUR	5540.43	2538.00	0.00	687.79	3225.79	747.27	2255.16	58.22	safe
DARAULI	8365.94	3069.53	0.00	543.49	3613.02	590.49	4705.92	43.19	safe
DARAUNDA	5359.85	2557.62	0.00	539.88	3097.51	586.57	2215.65	57.79	safe
GORIAKOTHI	5521.17	3162.40	0.00	697.32	3859.73	757.63	1601.13	69.91	safe
GUTHANI	3770.81	1913.64	0.00	399.47	2313.12	434.02	1423.14	61.34	safe
HASANPURA	3472.53	1287.08	0.00	466.26	1753.34	506.58	1678.87	50.49	safe
HUSSAINGANJ	3752.16	2034.51	0.00	569.79	2604.30	619.06	1098.59	69.41	safe

LAKRI NABIGANJ	3403.01	1624.04	0.00	401.79	2025.84	436.54	1342.42	59.53	safe
MAHARAJGANJ	3898.86	1802.69	12.00	646.99	2461.68	702.94	1381.23	63.14	safe
MAIRWA	3564.71	1542.76	0.00	406.25	1949.01	441.39	1580.56	54.68	safe
NAUTAN	2753.05	1370.63	0.00	282.76	1653.38	307.22	1075.21	60.06	safe
PACHRUKHI	4297.85	2306.76	4.80	628.90	2940.47	683.29	1302.99	68.42	safe
RAGHUNATHPUR	5082.27	2414.70	0.00	491.55	2906.24	534.06	2133.52	57.18	safe
SISWAN	4068.01	2344.78	0.00	479.89	2824.67	521.39	1201.84	69.44	safe
SIWAN	5748.29	2965.70	2.40	858.39	3826.49	932.62	1847.57	66.57	safe
ZIRADEI	5667.60	2550.8	162.00	510.43	2585.12	554.57	1752.58	56.59	safe

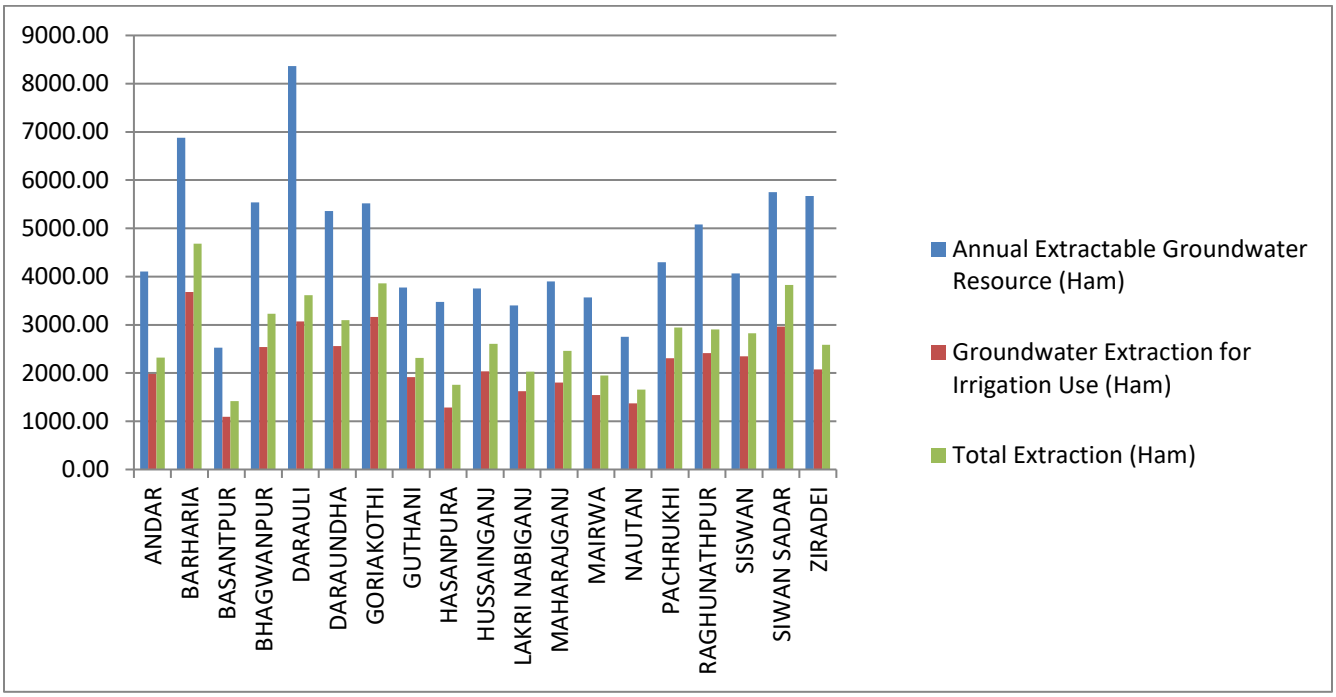

Fig. 32: Block wise Net Resources vis-a-vis Gross Draft

Chapter 5: Groundwater Related Issues

Moderate Stage of Groundwater Development: The aquifers are highly potential and prolific in nature. Siwan district has a medium stage of groundwater extraction of 59.32% and all the blocks lie in safe category as per GWRE 2022. Thus, the groundwater development potential of the district is high.

Declining Water Level: The hydrographs show that the long-term water level trend is declining. Thus, arises the need for artificial recharge.

Apart from these, there are no major groundwater related issues in the district.

Chapter 6: Groundwater Management Plan

6.1. Groundwater resource development strategy

The district has a medium stage of groundwater extraction 59.32%. Few blocks like Darauli, Ziradei, Hasanpura, Mairwa have low groundwater development. The focus of proposed management plan is to enhance the overall ground water development up to 70% in most of the blocks.

On the basis of Ground Water Resource Estimaton-2022additional number of shallow tubes well for alluvium area for each block has been calculated within the safe limit of the Stage of Development upto 70% by considering unit draft for each tube well 1.63 ha m. As per the calculation, a total of 9291 number of tube wells can be constructed to fulfil the future demand of ground water. The block wise additional number of tubewell is given in *Table 15*.

The crop water requirement in alluvial terrain for various crops as norm fixed by the Agricultural University Pusa, Samastipur District, Bihar is as follows:

For Paddy, depth of water applied is 0.80m and for wheat and other Rabi crops depth of water applied is 0.35m. Thus, average water application is 0.575m and considering that 70% field application efficiency, the net irrigation requirement will be 0.575×0.70 = 0.402m. Therefore,

Irrigation Potential = Utilizable ground water resource/0.402

Thus, the total future irrigation potential feasible (area) in Siwan district after enhancing the overall ground water development up to 70% in each block is 37900.78 Ha (*Table 16).*

Table 15: Additional Number of Shallow tube wells feasible based on Groundwater availability.

Block	Total Annual Recharge	Annual Extractable groundwater resource (Ham)	Gross Draft all uses (Ham)	Annual GW Allocation for Domestic Use as on 2025 (Ham)	Stage of Development (SOD)% 2022	Category	Projected SOD%	Groundwater Draft at Projected SOD(Ham)	Additional Resource available (Ham)	Unit Draft of STW	Additional Nos. of STW feasible based on GW availability
ANDAR	4561.77	4105.60	2323.37	372.62	56.59	safe	70	2873.92	859.06	1.63	527
BARHARIA	7640.43	6876.39	4683.68	1088.11	68.11	safe	70	4813.473	974.81	1.63	598
BASANTPUR	2809.23	2528.31	1420.67	356.37	56.19	safe	70	1769.817	402.12	1.63	246
BHAGWANPUR	6014.01	5540.43	3225.79	747.27	58.22	safe	70	3878.301	914.86	1.63	561
DARAULI	8955.21	8365.94	3613.02	590.49	43.19	safe	70	5856.158	1919.29	1.63	1177
DARAUNDHA	5955.39	5359.85	3097.51	586.57	57.79	safe	70	3751.895	1021.39	1.63	626
GORIAKOTHI	5964.95	5521.17	3859.73	757.63	69.91	safe	70	3864.819	898.72	1.63	551
GUTHANI	4115.97	3770.81	2313.12	434.02	61.34	safe	70	2639.567	697.22	1.63	427
HASANPURA	3858.38	3472.53	1753.34	506.58	50.49	safe	70	2430.771	535.18	1.63	328
HUSSAINGANJ	4169.07	3752.16	2604.30	619.06	69.41	safe	70	2626.512	506.59	1.63	310
LAKRI NABIGANJ	3665.77	3403.01	2025.84	436.54	59.53	safe	70	2382.107	584.36	1.63	358

MAHARAJGANJ	4332.07	3898.86	2461.68	702.94	63.14	safe	70	2729.202	466.72	1.63	286
MAIRWA	3960.79	3564.71	1949.01	441.39	54.68	safe	70	2495.297	628.02	1.63	385
NAUTAN	2999.21	2753.05	1653.38	307.22	60.06	safe	70	1927.135	518.70	1.63	318
PACHRUKHI	4775.39	4297.85	2940.47	683.29	68.42	safe	70	3008.495	606.07	1.63	371
RAGHUNATHPUR	5646.96	5082.27	2906.24	534.06	57.18	safe	70	3557.589	990.62	1.63	607
SISWAN	4520.01	4068.01	2824.67	521.39	69.44	safe	70	2847.607	699.01	1.63	428
SIWAN SADAR	6188.14	5748.29	3826.49	932.62	66.57	safe	70	4023.803	791.87	1.63	485
ZIRADEI	6297.33	5667.60	2585.12	554.57	45.61	safe	70	3967.32	1145.71	1.63	702
										TOTAL	**9291**

Table 16: Estimation of Area (in Ha) which can be irrigated with the additional GW resource available.

Block	Additional Resource available (Ham)	Net Irrigation Requirement (m)	Further irrigation potential feasible (in Ha)
ANDAR	859.06	0.4	2147.65
BARHARIA	974.81	0.4	2437.018
BASANTPUR	402.12	0.4	1005.308
BHAGWANPUR	914.86	0.4	2287.148
DARAULI	1919.29	0.4	4798.23
DARAUNDHA	1021.39	0.4	2553.463
GORIAKOTHI	898.72	0.4	2246.803
GUTHANI	697.22	0.4	1743.058
HASANPURA	535.18	0.4	1337.948
HUSSAINGANJ	506.59	0.4	1266.47
LAKRI NABIGANJ	584.36	0.4	1460.908
MAHARAJGANJ	466.72	0.4	1166.795
MAIRWA	628.02	0.4	1570.058
NAUTAN	518.70	0.4	1296.738
PACHRUKHI	606.07	0.4	1515.163
RAGHUNATHPUR	990.62	0.4	2476.553
SISWAN	699.01	0.4	1747.533
SIWAN SADAR	791.87	0.4	1979.668
ZIRADEI	1145.71	0.4	2864.275
TOTAL			**37900.78**

6.2. Water Conservation and Artificial Recharge (AR)– Supply Side Interventions

Although, all the 19 blocks are in safe category, artificial recharge should beencouraged to arrest the decline of ground water level caused by the increasing demand of ground water.

By considering entire non-monsoon rainfall as committed, excess monsoonrainfall can be safely harnessed to replenish groundwater table without affecting surface waterresource. For the present calculation for artificial recharge, 60% of the normal monsoon rainfallfor identified feasible areas is considered as available non- committed surface runoff.

Table 17: Identified Area, Computed Storage Volume and Source Water availability for Artificial Recharge to Ground Water in Siwan district (ARMP 2020)

District	Area	Area Identified for AR	Volume of Desaturated Zone	Source Water Requirement	Total Surplus Runoff Available
	(sq.km.)	(sq.km.)	(MCM)	(MCM)	(MCM)
Siwan	2223.07	481.47	19.72	30.38	1497.40

Table 18: Types and Number of different Artificial recharge structures proposed for Siwan district (ARMP 2020)

Nala Bunding	Lateral Recharge Shaft	Recharge Shaft	De-silting of existing tank /pond /talab	Injection Well in Village Tank
1	5	9	17	23

Siwan town is the only urban area in the district, thus rooftop rainwater harvesting is proposed for Siwan district.As the entire district is covered by alluvial formation contour bunding and recharge ponds are most suitable structure in the rural areas of the blocks.

6.3. Demand Side Interventions

It is always essential to address the issue of constraining demand for groundwater abstraction since this will normally contribute more to achieving the groundwater balance.

The concept of real water savings is critical in this regard. The main demand side interventions may be: -

- Modern irrigation practices like drip water irrigation system; sprinklers can be implemented for creating efficiency in irrigation methods applied.
- Crop choice management and diversification.
- Conjunctive use of surface water as well as ground water for irrigation.
- Shallow aquifers are usually polluted by various geogenic and anthropogenic activities. Thus, deeper aquifers may be tapped for getting pollutant free water for drinking purposes.
- Special attention should be given towards the already existing structures which have become defunct. These structures unit can be rehabilitated so that it creates a confidence among the beneficiaries and it can help to boost the overall productivity through multiple cropping pattern.
- To keep in view the efficiency and proper discharge, minimum standard for well spacing should be maintained. For this a minimum distance for shallow wells should be kept 150 mt whereas for deep tubewells it should be 600 mt.

Table 19: Proposed model of tubewell in Siwan District (Source: District Report)

Sl.No.	Discharge (m^3/hr)	Proposed Depth of wells (m)	Proposed Well Assembly		H.P. of suitable pump
			Dia of the pipe	Length	
1	150	100	306mm Housing 153mm slotted pipe 153mm blank pipe	25 24 51	22
2	200	120	357mm Housing 204mm slotted pipe 204mm blank pipe	30 30 60	35
3	250	180	357mm Housing 204mm slotted pipe 204mm blank pipe	35 35 110	42

Chapter 7: Blockwise Groundwater Management Plan of Siwan district

7.1. Andar Block

General Information:

Total Geographical Area (hectares): 11826
Total Population (as per census 2011): 127599

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Andar	6920	6228	692	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Andar	0	36	8

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
ANDAR	4105.60	1980.40	0.00	342.97	2323.37	372.62	1752.58	56.59	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Details of Exploratory Wells drilled by CGWB

Location	**Depth Drilled (m bgl)**	**Granular Zones (m bgl)**	**Static Water Level (m bgl)**	**Discharge (m^3/hr)**	**Drawdown (m)**	**Specific Capacity (m^3/hr/m)**	**Transmissivity (m^3/day)**	**Storativity**
ANDAR	198	102-108 126-132 150-156 174-186	2.27	160.72	7.09	22.66	3820	3.30×10^{-4}

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Andar	Andar	26.1083	84.2958	5.5	56.07	5.3	56.27

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4561.77
Annual Extractable GW resource (Ham):4105.60
Gross Draft all uses (Ham): 2323.37
Annual GW allocation for domestic use os on 2025 (Ham): 372.62
Stage of GW development (SOD) %: 56.59

GW draft at projected SOD (Ham): 2873.92
Additional Resource available (Ham): 859.06
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **527**
Further irrigation potential feasible (in Ha): 527.0307

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.2. Barharia Block

General Information:

Total Geographical Area (hectares): 17732
Total Population (as per census 2011): 416769

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Barharia	16742	15067.8	1674.2	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Barharia	0	415	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
BARHARIA	6876.39	3682.19	0.00	1001.50	4683.68	1088.11	2106.10	68.11	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). Aquifer-I and Aquifer-II are separated by a relatively thicker layer of gravel and coarse sand alongwith a thin layer of clay. Aquifer-II occurs within semi-confined condition. The gravel layer mixed with coarse sand contributes to high discharge of wells in this area.

Details of Exploratory Wells drilled by CGWB

Location	**Depth Drilled (m bgl)**	**Granular Zones (m bgl)**	**Static Water Level (m bgl)**	**Discharge (m^3/hr)**	**Drawdown (m)**	**Specific Capacity (m^3/hr/m)**	**Transmissivity (m^3/day)**	**Storativity**
BARHARIA	200	41-47 54-66 72-97 116-127	2.01	194.4	11.87	16.38	2009	1.10×10^{-3}

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Barharia	Chhattisi	26.3347	84.4684	2.5	56.07	1.66	67.08

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 7640.43
Annual Extractable GW resource (Ham):6876.39

Gross Draft all uses (Ham): 4683.68
Annual GW allocation for domestic use os on 2025 (Ham): 1088.11
Stage of GW development (SOD) %: 68.11
GW draft at projected SOD (Ham): 4813.473
Additional Resource available (Ham): 974.81
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **598**
Further irrigation potential feasible (in Ha): 598.0411

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.3. Basantpur Block

General Information:

Total Geographical Area (hectares): 6220
Total Population (as per census 2011):123645

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Basantpur	5862	5275.8	586.2	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Basantpur	0	61	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
BASANTPUR	2528.31	1092.66	0.00	328.01	1420.67	356.37	1079.28	56.19	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Basantpur	Chimanpur	26.2183	84.6711	4.64	58.45	3.7	59.39

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2809.23
Annual Extractable GW resource (Ham):2528.31
Gross Draft all uses (Ham): 1420.67
Annual GW allocation for domestic use os on 2025 (Ham): 356.37
Stage of GW development (SOD) %: 56.19
GW draft at projected SOD (Ham): 1769.817
Additional Resource available (Ham): 402.12
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **246**
Further irrigation potential feasible (in Ha): 246.7012

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.4. Bhagwanpur Block

General Information:

Total Geographical Area (hectares): 14943
Total Population (as per census 2011):257211

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Bhagwanpur Hat	13562	12205.8	1356.2	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Bhagwanpur Hat	0	567	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
BHAGWANPUR	5540.43	2538.00	0.00	687.79	3225.79	747.27	2255.16	58.22	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Bhagwanpur Hat	Malmalia Chowk	26.1622	84.6808	4.4	54.42	2.55	56.27
Bhagwanpur Hat	Sarripatti	26.1036	84.6758	3.8	56.85	2.7	57.95

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 6014.01
Annual Extractable GW resource (Ham):5540.43
Gross Draft all uses (Ham): 3225.79
Annual GW allocation for domestic use os on 2025 (Ham): 747.27
Stage of GW development (SOD) %: 58.22
GW draft at projected SOD (Ham): 3878.301
Additional Resource available (Ham): 914.86
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **561**
Further irrigation potential feasible (in Ha): 561.2632
No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.5. Darauli Block

General Information:

Total Geographical Area (hectares): 12431
Total Population (as per census 2011):201654

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Darauli	15560	14004	1556	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Darauli	0	37	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
DARAULI	8365.94	3069.53	0.00	543.49	3613.02	590.49	4705.92	43.19	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Darauli	Darauli	26.0791	84.1336	5.86	56.62	3.65	58.83

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 8955.21
Annual Extractable GW resource (Ham):8365.94
Gross Draft all uses (Ham): 3613.02
Annual GW allocation for domestic use os on 2025 (Ham): 590.49
Stage of GW development (SOD) %: 43.19
GW draft at projected SOD (Ham): 5856.158
Additional Resource available (Ham): 1919.29
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **1177**
Further irrigation potential feasible (in Ha): 1177.48

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.6. Daraundha Block

General Information:

Total Geographical Area (hectares): 17278
Total Population (as per census 2011):202076

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Daraundha	13547	12192.3	1354.7	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Daraundha	0	1	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
DARAUNDA	5359.85	2557.62	0.00	539.88	3097.51	586.57	2215.65	57.79	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5955.39
Annual Extractable GW resource (Ham):5359.85
Gross Draft all uses (Ham): 3097.51
Annual GW allocation for domestic use os on 2025 (Ham): 586.57
Stage of GW development (SOD) %: 57.79
GW draft at projected SOD (Ham): 3751.895
Additional Resource available (Ham): 1021.39
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **626**
Further irrigation potential feasible (in Ha): 626.6166

Artificial Recharge (AR) structures suggested for this block as per ARMP 2020:

Nala Bunding	Lateral Recharge Shaft	Recharge shaft	De-silting of existing Tank/pond	Injection well in village tank
11	1	2	4	5

7.7. Goriakothi Block

General Information:

Total Geographical Area (hectares): 13798
Total Population (as per census 2011):261571

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Goriakothi	12306	11075.4	1230.6	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Goriakothi	0	29	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
GORIA KOTHI	5521.17	3162.40	0.00	697.32	3859.73	757.63	1601.13	69.91	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Goriyakothi	Tarwara	26.1958	84.4875	3.96	60.04	2.95	61.05
Goriyakothi	ShadipurNayatola	26.267	84.5774	3.1	59.15	2.34	59.91

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5964.95
Annual Extractable GW resource (Ham):5521.17
Gross Draft all uses (Ham): 3859.73
Annual GW allocation for domestic use os on 2025 (Ham): 757.63
Stage of GW development (SOD) %: 69.91
GW draft at projected SOD (Ham): 3864.819
Additional Resource available (Ham): 898.72
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **551**
Further irrigation potential feasible (in Ha): 551.3626

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.8. Guthani Block

General Information:

Total Geographical Area (hectares): 9171
Total Population (as per census 2011):158333

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Guthani	8639	7775.1	863.9	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Guthani	0	34	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
GUTHANI	3770.81	1913.64	0.00	399.47	2313.12	434.02	1423.14	61.34	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:

The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Guthani	Chitakahl	26.2127	84.045	4.31	61.22	3.1	62.43
Guthani	Deoria	26.1388	84.0811	5.24	59.37	2.7	61.91

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4115.97
Annual Extractable GW resource (Ham):3770.81
Gross Draft all uses (Ham): 2313.12
Annual GW allocation for domestic use os on 2025 (Ham): 434.02
Stage of GW development (SOD) %: 61.34
GW draft at projected SOD (Ham): 2639.567
Additional Resource available (Ham): 697.22
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **427**
Further irrigation potential feasible (in Ha): 427.7442

Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

Lateral Recharge Shaft	Recharge shaft	De-silting of existing Tank/pond	Injection well in village tank
1	2	3	4

7.9. Hasanpura Block

General Information:

Total Geographical Area (hectares): 8490
Total Population (as per census 2011):175225

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Hasanpura	4835	4351.5	483.5	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Hasanpura	0	386	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
HASANPURA	3472.53	1287.08	0.00	466.26	1753.34	506.58	1678.87	50.49	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 3858.38
Annual Extractable GW resource (Ham):3472.53
Gross Draft all uses (Ham): 1753.34
Annual GW allocation for domestic use os on 2025 (Ham): 506.58
Stage of GW development (SOD) %: 50.49
GW draft at projected SOD (Ham): 2430.771
Additional Resource available (Ham): 535.18
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **328**
Further irrigation potential feasible (in Ha): 328.3307

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.10. Hussainganj Block

General Information:

Total Geographical Area (hectares): 9699
Total Population (as per census 2011):214206

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Hussainganj	8574	7716.6	857.4	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Hussainganj	0	453	1

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
HUSSAINGANJ	3752.16	2034.51	0.00	569.79	2604.30	619.06	1098.59	69.41	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Hussainganj	KhanpurKhairanti	26.1444	84.3247	3.86	56.07	1.45	59.42
Hussainganj	Baghauni	26.1279	84.3307	4.8	52	4.46	52.34
Hussainganj	Reneua	26.2042	84.338	4.05	53.47	1.86	55.66

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4169.07
Annual Extractable GW resource (Ham):3752.16
Gross Draft all uses (Ham): 2604.30
Annual GW allocation for domestic use os on 2025 (Ham): 619.06
Stage of GW development (SOD) %: 69.41
GW draft at projected SOD (Ham): 2626.512
Additional Resource available (Ham): 506.59
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **310**
Further irrigation potential feasible (in Ha): 310.7902

Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

Lateral Recharge Shaft	Recharge shaft	De-silting of existing Tank/pond	Injection well in village tank
1	1	3	4

7.11. Lakri Nabibganj Block

General Information:

Total Geographical Area (hectares): 9521
Total Population (as per census 2011):131793

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
LakriNabibganj	8864	7977.6	886.4	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
LakriNabibganj	0	4	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
LAKRI NABIGANJ	3403.01	1624.04	0.00	401.79	2025.84	436.54	1342.42	59.53	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Nabibganj	Barwadumri	26.2826	84.6311	3.63	56.07	1.9	60.24

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 3665.77
Annual Extractable GW resource (Ham):3403.01
Gross Draft all uses (Ham): 2025.84
Annual GW allocation for domestic use os on 2025 (Ham): 436.54
Stage of GW development (SOD) %: 59.53
GW draft at projected SOD (Ham): 2382.107
Additional Resource available (Ham): 584.36
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **358**
Further irrigation potential feasible (in Ha): 358.5049

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.12. Maharajganj Block

General Information:

Total Geographical Area (hectares): 11542
Total Population (as per census 2011):194583

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Maharajganj	10263	9236.7	1026.3	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Maharajganj	0	3	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
MAHARAJGANJ	3898.86	1802.69	12.00	646.99	2461.68	702.94	1381.23	63.14	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Maharajganj	Maharajganj	26.1125	84.5002	3.2	59.89	1.76	61.33
Maharajganj	Patrehi	26.1336	84.5416	4.01	58.47	3.21	59.27

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4332.07
Annual Extractable GW resource (Ham):3898.86
Gross Draft all uses (Ham): 2461.68
Annual GW allocation for domestic use os on 2025 (Ham): 702.94
Stage of GW development (SOD) %: 63.14
GW draft at projected SOD (Ham): 2729.202
Additional Resource available (Ham): 466.72
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **286**
Further irrigation potential feasible (in Ha): 358.5049

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.13. Mairwa Block

General Information:

Total Geographical Area (hectares): 7977
Total Population (as per census 2011): 104355

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Mairwa	6210	5589	621	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Mairwa	0	20	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
MAIRWA	3564.71	1542.76	0.00	406.25	1949.01	441.39	1580.56	54.68	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by a 50m thick aquitard (clay layer).

Details of Exploratory Wells drilled by CGWB

Location	**Depth Drilled (m bgl)**	**Granular Zones (m bgl)**	**Static Water Level (m bgl)**	**Discharge (m^3/hr)**	**Drawdown (m)**	**Specific Capacity (m^3/hr/m)**	**Transmissivity (m^3/day)**	**Storativity**
MAIRWA	200	50-70 115-155 174-189	-	-	-	-	-	-

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Mairwa	Guthani More	26.2297	84.1505	5.1	65	3	67.1
Mairwa	Shitalpura	26.2145	84.1545	3.97	56.07	2.2	61.74

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 3960.79
Annual Extractable GW resource (Ham):3564.71
Gross Draft all uses (Ham): 1949.01
Annual GW allocation for domestic use os on 2025 (Ham): 441.39
Stage of GW development (SOD) %: 54.68
GW draft at projected SOD (Ham): 2495.297

Additional Resource available (Ham): 628.02
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **385**
Further irrigation potential feasible (in Ha): 385.2902

No Artificial Recharge (AR) structure suggested for this block as per ARMP 2020.

7.14. Nautan Block

General Information:

Total Geographical Area (hectares): 6462
Total Population (as per census 2011):105659

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Nautan	11250	10125	1125	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Nautan	0	251	1

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)

NAUTAN	2753.05	1370.63	0.00	282.76	1653.38	307.22	1075.21	60.06	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 2999.21
Annual Extractable GW resource (Ham):2753.05
Gross Draft all uses (Ham): 1653.38
Annual GW allocation for domestic use os on 2025 (Ham): 307.22
Stage of GW development (SOD) %: 60.06
GW draft at projected SOD (Ham): 1927.135
Additional Resource available (Ham): 518.70
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **318**
Further irrigation potential feasible (in Ha): 318.2178

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.15. Pachrukhi Block

General Information:

Total Geographical Area (hectares): 12437
Total Population (as per census 2011):236108

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Pachrukhi	14271	12843.9	1427.1	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Pachrukhi	0	6	1

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
PACHRUKHI	4297.85	2306.76	4.80	628.90	2940.47	683.29	1302.99	68.42	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by a thick aquitard (clay layer).

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Pachrukhi	Sadikpur	26.1658	84.4308	4.89	58.2	2.75	60.34
Pachrukhi	Hardiya	26.2027	84.3977	3.52	56.07	1.81	60.69

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4775.39
Annual Extractable GW resource (Ham):4297.85
Gross Draft all uses (Ham): 2940.47
Annual GW allocation for domestic use os on 2025 (Ham): 683.29
Stage of GW development (SOD) %: 68.42
GW draft at projected SOD (Ham): 3008.495
Additional Resource available (Ham): 606.07
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **371**
Further irrigation potential feasible (in Ha): 371.819

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.16. Raghunathpur Block

General Information:

Total Geographical Area (hectares): 15589
Total Population (as per census 2011):182924

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Raghunathpur	18532	16678.8	1853.2	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Raghunathpur	0	18	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/ Saline)
RAGHUNATHPUR	5082.27	2414.70	0.00	491.55	2906.24	534.06	2133.52	57.18	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by a thick aquitard (clay layer).

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Raghunathpur	Jamanpura	26.0727	84.2847	3.8	57.77	1.5	60.07
Raghunathpur	Murarpatti	25.9858	84.2702	4.93	56.64	3.1	58.47

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 5646.96
Annual Extractable GW resource (Ham):5082.27
Gross Draft all uses (Ham): 2906.24
Annual GW allocation for domestic use os on 2025 (Ham): 534.06
Stage of GW development (SOD) %: 57.18
GW draft at projected SOD (Ham): 3557.589
Additional Resource available (Ham): 990.62
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **607**
Further irrigation potential feasible (in Ha): 607.7429

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.17. Siswan Block

General Information:

Total Geographical Area (hectares): 11579
Total Population (as per census 2011):179113

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Siswan	11223	10100.7	1122.3	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Siswan	0	7	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
SISWAN	4068.01	2344.78	0.00	479.89	2824.67	521.39	1201.84	69.44	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by aquitard (clay layer) of varying thickness.

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Siswan	Bhagar	26.1105	84.5125	5.61	55.65	3.17	58.09
Siswan	Gangapur Siswan	25.9366	84.4036	3.85	54.67	2	56.52

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 4520.01
Annual Extractable GW resource (Ham):4068.01
Gross Draft all uses (Ham): 2824.67
Annual GW allocation for domestic use os on 2025 (Ham): 521.39
Stage of GW development (SOD) %: 69.44
GW draft at projected SOD (Ham): 2847.607
Additional Resource available (Ham): 699.01
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **428**
Further irrigation potential feasible (in Ha): 428.8423

Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

Lateral Recharge Shaft	Recharge shaft	De-silting of existing Tank/pond	Injection well in village tank
1	2	4	5

7.18. Siwan Block

General Information:

Total Geographical Area (hectares): 12909
Total Population (as per census 2011):240830

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Siwan	10500	9450	1050	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Siwan	10	7	0

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
SIWAN	5748.29	2965.70	2.40	858.39	3826.49	932.62	1847.57	66.57	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterization:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by a thick aquitard (clay layer).

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Siwan	Siwan	26.2197	84.3588	4.53	62.83	2.5	64.86

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 6188.14
Annual Extractable GW resource (Ham):5748.29
Gross Draft all uses (Ham): 3826.49
Annual GW allocation for domestic use os on 2025 (Ham): 932.62
Stage of GW development (SOD) %: 66.57
GW draft at projected SOD (Ham): 4023.803
Additional Resource available (Ham): 791.87
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **485**
Further irrigation potential feasible (in Ha): 485.808

No Artificial Recharge (AR) structures suggested for this block as per ARMP 2020.

7.19. Ziradei Block

General Information:

Total Geographical Area (hectares): 12703
Total Population (as per census 2011):189972

Agricultural details (Area under agriculture):

Block	Gross Cropped Area (Ha)	Net Sown Area (Ha)	Area sown more than once (Ha)	Cropping Intensity (%)
Ziradei	6875	6187.5	687.5	137

Number of Shallow TW, Medium TW, Deep TW as per 5th MI Census

Block	Number of Shallow Tubewells (<35m)	Number of Medium Tubewells (35m-70m)	Number of Deep Tubewells (>70m)
Ziradei	0	2	1

Dynamic Groundwater Resource (till 2022)

Block	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 for Domestic Use as on 2025	Net Ground Water Availability for future use (Ham)	Stage of Ground Water Extraction (%)	Categorization (Over-Exploited/Critical/Semi-critical/Safe/Saline)
ZIRADEI	5667.60	2550.8	162.00	510.43	2585.12	554.57	1752.58	56.59	safe

Aquifer Disposition:
Water Quality:
The water is potable in nature.

Aquifer Characterisation:
The block possesses potential shallow aquifers within 40 mbgl (unconfined aquifer-I).High potential (deeper) aquifers exist within 100-200 m depth (Aquifer-II). The two aquifers are separated by a thick aquitard (clay layer).

Water Level Data of 2022:

Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
Ziradei	Surwal	26.2068	84.2476	3.94	56.07	2.43	59.15

Groundwater Management Plan:

The block lies in **safe** category as per stage of development of groundwater resources (GWRA 2022).

Additional No. of STW feasible in the block (at a projected stage of development of 70%) and the additional area that can be irrigated based on groundwater availability:

Total Annual Recharge: 6297.33
Annual Extractable GW resource (Ham):5667.60
Gross Draft all uses (Ham): 2585.12
Annual GW allocation for domestic use os on 2025 (Ham): 554.57
Stage of GW development (SOD) %: 45.61
GW draft at projected SOD (Ham): 3967.32
Additional Resource available (Ham): 1145.71
Unit draft of STW: 1.63
Additional Nos. of STW feasible based on GW availability: **702**
Further irrigation potential feasible (in Ha): 702.8896

Artificial Recharge (AR) structures suggested for this block as per ARMP 2020:

Lateral Recharge Shaft	Recharge shaft	De-silting of existing Tank/pond	Injection well in village tank
1	2	3	5

ANNEXURE-I

NHNS location data of Siwan district, Bihar

Sl.No.	Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
1.	Andar	Andar	26.1083	84.2958	5.5	56.07	5.3	56.27
2.	Basantpur	Chimanpur	26.2183	84.6711	4.64	58.45	3.7	59.39
3.	Basantpur	Hardia	26.1813	84.6072	4.25	56.1	4.05	56.3
4.	Bhagwanpur Hat	Malmalia Chowk	26.1622	84.6808	4.4	54.42	2.55	56.27
5.	Bhagwanpur Hat	Sarripatti	26.1036	84.6758	3.8	56.85	2.7	57.95
6.	Darauli	Darauli	26.0791	84.1336	5.86	56.62	3.65	58.83
7.	Goriyakothi	Tarwara	26.1958	84.4875	3.96	60.04	2.95	61.05
8.	Guthani	Chitakahl	26.2127	84.045	4.31	61.22	3.1	62.43
9.	Guthani	Deoria	26.1388	84.0811	5.24	59.37	2.7	61.91
10.	Maharajganj	Maharajganj	26.1125	84.5002	3.2	59.89	1.76	61.33
11.	Maharajganj	Patrehi	26.1336	84.5416	4.01	58.47	3.21	59.27
12.	Mairwa	Guthani More	26.2297	84.1505	5.1	65	3	67.1
13.	Pachrukhi	Sadikpur	26.1658	84.4308	4.89	58.2	2.75	60.34
14.	Raghunathpur	Jamanpura	26.0727	84.2847	3.8	57.77	1.5	60.07
15.	Raghunathpur	Murarpatti	25.9858	84.2702	4.93	56.64	3.1	58.47
16.	Siswan	Bhagar	26.1105	84.5125	5.61	55.65	3.17	58.09
17.	Siswan	Gangapur Siswan	25.9366	84.4036	3.85	54.67	2	56.52
18.	Siwan	Siwan	26.2197	84.3588	4.53	62.83	2.5	64.86

ANNEXURE-II

Key well data of Siwan district, Bihar

Sl.No.	Block	Location	Latitude	Longitude	WL May 2022 (m bgl)	RL May 2022 (in m)	WL Nov 2022 (m bgl)	RL Nov 2022 (in m)
1	Nabibganj	Barwadumri	26.2826	84.6311	3.63	56.07	1.9	60.24
2	Hussainganj	Reneua	26.2042	84.338	4.05	53.47	1.86	55.66
3	Goriakothi	ShadipurNayatola	26.267	84.5774	3.1	59.15	2.34	59.91
4	Pachrukhi	Hardiya	26.2027	84.3977	3.52	56.07	1.81	60.69
5	Goriakothi	Mirzapur	26.2724	84.6022	4.18	56.07	3.75	56.32
6	Barharia	Chhattisi	26.3347	84.4684	2.5	56.07	1.66	67.08
7	Hussainganj	KhanpurKhairanti	26.1444	84.3247	3.86	56.07	1.45	59.42
8	Hussainganj	Baghauni	26.1279	84.3307	4.8	52	4.46	52.34
9	Ziradei	Surwal	26.2068	84.2476	3.94	56.07	2.43	59.15
10	Mairwa	Shitalpura	26.2145	84.1545	3.97	56.07	2.2	61.74

ANNEXURE-III

Details of Exploratory Wells drilled by CGWB in Siwan district, Bihar

Location	**Depth Drilled (m bgl)**	**Granular Zones (m bgl)**	**Static Water Level (m bgl)**	**Discharge (m^3/hr)**	**Drawdown (m)**	**Specific Capacity (m^3/hr/m)**	**Transmissivity (m^3/day)**	**Storativity**
ANDAR	198	102-108 126-132 150-156 174-186	2.27	160.72	7.09	22.66	3820	3.30×10^{-4}
BARHARIA	200	41-47 54-66 72-97 116-127	2.01	194.4	11.87	16.38	2009	1.10×10^{-3}
MAIRWA	200	50-70 115-155 174-189	-	-	-	-	-	-

ANNEXURE-IV

Lithological logs of Exploratory Wells

1. Location: Mairwa, Block: Mairwa

Coordinates: 26.2386, 84.1461

Depth Drilled:200 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	**To**		
0	20	20	Fine Sand
20	40	20	Fine to Medium Sand
40	100	60	Clay
100	110	10	Fine Sand
110	160	50	Fine to Medium Sand
160	170	10	Clay
170	190	20	Fine to Medium Sand
190	200	10	Clay

2. Location: Andar, Block: Andar

Coordinates: 26.0994, 84.2919

Depth Drilled:198 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0	5	5	Clay
5	20	15	Fine Sand
20	100	80	Clay
100	120	20	Fine Sand
120	180	60	Fine to Medium Sand
180	198	18	Clay

3. Location: Mirachak, Block: Daraunda

Coordinates: 26.0775, 84.4291

Depth Drilled:110 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0	10	10	Clay
10	20	10	Fine Sand
20	40	20	Fine to Medium Sand
40	50	10	Clay
50	60	10	Fine to Medium Sand
60	70	10	Clay
70	110	40	Fine to Medium Sand

4. Location: Panchpatia, Block: Goriakothi

Coordinates: 26.2927, 84.5891

Depth Drilled:90 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0	10	10	Clay
10	20	10	Fine Sand
20	30	10	Coarse Sand mixed with Gravel
30	50	20	Clay
50	70	20	Coarse Sand mixed with Gravel
70	90	20	Fine to Medium Sand

5. Location: Barharia, Block: Barharia

Coordinates: 26.3155, 84.4566

Depth Drilled:200 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	To		
0	10	10	Clay
10	20	10	Fine Sand
20	50	30	Fine to Medium Sand
50	110	60	Coarse Sand mixed with Gravel
110	120	10	Clay
120	150	30	Fine to Medium Sand
150	160	10	Clay
160	170	10	Fine Sand
170	200	30	Clay

6. Location: Kail, Block: Barharia

Coordinates: 26.3527, 84.4227

Depth Drilled:130 m

Depth (in m bgl)		Thickness (in m)	Lithology
From	**To**		
0	10	10	Clay
10	40	30	Fine to Medium Sand
40	50	10	Fine Sand
50	60	10	Clay
60	100	40	Coarse Sand mixed with Gravel
100	115	15	Clay
115	130	15	Coarse Sand mixed with Gravel

ANNEXURE-V

Results of chemical analysis of Groundwater collected from Siwan district (May 2022)

S.no	BLOCK	LOCATION	Lat	Long	Source	pH	EC	TDS	TH	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	NO_3^{-}	SO_4^{2-}	F^{-}	$PO4^{3-}$	SiO_2	U (in ppb)
1	Ziradei	Surwal Colony	26.20698	84.24928	Tubewell	6.96	4570	2970.5	1575	586	27	312	12.4	0	1610	312.4	250	300	0.87	0	10	6.32
2	Raghunathpur	Jawanpura	26.07803	84.28502	Tubewell	6.98	1248	811.2	475	146	27	64	2.8	0	451	99.4	28	77	0.67	0	35	8.12
3	Siswan	Siswan	25.94514	84.38801	Tubewell	6.77	942	612.3	425	126	27	15	2.85	0	415	21.3	0.6	86	0.85	0	41	12.6
4	Barharia	Barharia	26.31136	84.46027	Tubewell	6.82	714	464.1	310	84	24	20	4.84	0	378	14.2	0.95	33.55	0.81	0	14	16.3
5	Goreakothi	Mirzzapur	26.27073	84.60599	Tubewell	6.77	845	549.25	340	102	21	29	4.75	0	451	17.75	0.6	13.78	0.73	0	34	5.12
6	Nabirganj	Nabirganj-DighwaDubauli Rd.	26.23827	84.70591	Tubewell	6.94	755	490.75	270	72	22	40	3.62	0	384	10.65	0.67	26.81	0.9	0	28	9.23
7	Hussainganj	KhanpurKhairati	26.14493	84.32691	Tubewell	6.9	698	453.7	230	60	19	35	3.37	0	317	18	1.17	21	1	0	28	7.98
8	Hussainganj	Hussainganj, Renewa	26.20028	84.2525	Tubewell	6.79	963	625.95	370	122	16	32	8.5	0	451	36	6.35	32	1.07	0	34	8.56
9	Bhagwanpur	Malmaliachok	26.16188	84.67839	Tubewell	7.46	497	323	175	40	18.225	15	0.06	0	183	14.2	0.47	35	0.66	0	23	4.32
10	Basantpur	Basantpur	26.16983	84.66770	Tubewell	7.66	763	496	285	88	15.795	33	3.38	0	353.8	35.5	17	7.79	1.06	0	14	1.92
11	Tarwara	Barharia	26.19913	84.48810	Tubewell	7.25	1633	1061	590	160	46.17	97	3.32	0	530.7	170.4	2.36	116	1.03	0	25	6.54
12	Siwan	Haradia	26.20179	84.3989	Tubewell	7.76	593	385	240	74	13.365	22	3.53	0	274.5	17.75	12.27	34	0.8	0	16	2.98

13	Siwan	Bhada Khurd, Mahajanmistri Mandir	26.22169	84.31937	Tubewell	7.31	736	478	305	86	21.87	24	3.86	0	353.8	24.85	0.93	33	0.9	0	23	7.53
14	Mairwa	Mairwa, Near Petrol pump	26.22945	84.15019	Tubewell	6.98	1575	1024	660	216	29.16	46	6.8	0	488	142	55	123	0.83	0	29	10.3
15	Mairwa	Mairwa, Shitalpura	26.25155	84.19572	Tubewell	7.3	642	417	300	90	18.225	5.03	2.32	0	274.5	24.85	21	37	1.02	0	34	4.63
16	Guthani	Chitakal	26.18432	84.06035	Tubewell	7.03	411	267	180	50	13.365	6.85	2.81	0	213.5	14.2	1.53	7.58	1.16	0	12	7.92
17	Guthani	Deoria	26.13938	84.08064	Tubewell	7.13	848	551	375	110	24.3	17	2.35	0	353.8	71	8.95	13.5	1	0.12	17	8.56
18	Darauli	Mairwa-Darauli Rd.	26.08329	84.12958	Tubewell	7.11	582	378	250	64	21.87	13	3.23	0	305	14.2	10	5.6	0.94	0	23	3.62
19	Ander	Ander	26.10437	84.29775	Tubewell	7.09	737	479	285	84	18.225	28	3.69	0	378.2	21.3	1.75	6.6	0.76	0	27	4.56
20	Raghunathpur	Murarpatti	25.99382	84.27988	Tubewell	6.77	1761	1145	565	166	36.45	136	2.9	0	591.7	188.15	17	90	0.78	0	19	6.37
21	Siswan	Bhagar	25.95137	84.37166	Tubewell	6.85	904	588	415	124	25.515	13	2.77	0	396.5	17.75	2.02	89	0.91	0	32	8.23
22	Siswan	Gangpur-Siswan	25.95393	84.39361	Tubewell	7.06	657	427	275	76	20.655	14	4.16	0	305	10.65	2.33	43	0.81	0	39	5.62
23	Maharajganj	Maharajganj-Pansouli	26.10805	84.49904	Tubewell	6.85	1573	1022	520	156	31.59	104	4.5	0	585.6	166.85	0.55	34.41	0.89	0	34	3.14
24	Panchrukhi	Sadikpur	26.16551	84.43053	Tubewell	7.12	592	385	260	76	17.01	5.5	3.8	0	305	14.2	0.56	8.4	0.9	0	27	9.56
25	Siwan	Siwan	26.22859	84.35917	Tubewell	6.72	952	619	410	124	24.3	22	5.17	0	396.5	74.55	16	27	1.01	0	38	8.74
26	Basantpur	Chimapura	26.23416	84.5919	Tubewell	6.63	780	507	330	88	26.73	22	1.84	0	402.6	14.2	9.02	22.79	0.96	0.17	17	6.15
27	Bhagwanpur	Sarripatti	26.10364	84.6781	Tubewell	6.7	1146	745	460	152	19.44	41	5	0	414.8	71	28	89	0.74	0	13	3.85

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Disclaimer

The Report has been prepared based on the available data, observations from fields and discussion with the local farmers. Additional data, incorporated in future, may change the understanding of hydrogeological scenario of the area.