केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

Latehar District

Jharkhand

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

भारतसरकार

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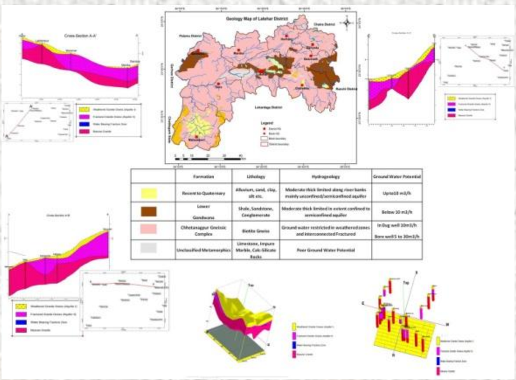
Central Ground Water Board

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN , LATEHAR DISTRICT, JHARKHAND STATE

जलभृत मानचित्र तथा भूजल प्रबंधन योजना

लातेहार जिला, झारखंड



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सितंबर, 2022

State Unit Office, Ranchi

Mid- Eastern Region, Patna,

September 2022

REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF LATEHAR DISTRICT, JHARKHAND, 2020-21

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REPORT ON AQUIFER MAPS AND MANAGEMENT PLAN OF LATEHAR DISTRICT, JHARKHAND STATE (2020 - 2021)

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF LATEHAR DISTRICT, JHARKHAND STATE

1.0 INTRODUCTION

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

During XII five year plan (2012-17) National Aquifer Mapping (NAQUIM) study was initiated by CGWB to carry out detailed hydrogeological investigation. The Aquifer Mapping programme has been continued till 2023 to cover whole country. The present studies of Latehar district have been taken up in AAP 2020-21 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Latehar district and other user agencies for its effective implementation.

1.1 Objective and Scope of the Study:

The major objectives of aquifer mapping are

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

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

The main activities under NAQUIM are as follows:

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

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

1.2 Approach and Methodology:

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

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

Compilation of existing data (Central & State Govt.)

↓

Generation of different thematic layers

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation (water level, exploration, geophysical, hydrochemical, hydrogeological etc.

↓

Aquifer Maps with 3D disposition

↓

Preparation of Aquifer Management Plan

↓

Capacity building in all aspects of ground water through IEC Activties

1.3 Area Details: The district Latehar was taken for aquifer mapping study during 2020-21. The district is spread over 3613 Sq. km of geographical area. Latehar district is situated in the western part of the Jharkhand state. It is bounded in the north by Palamu and Chatra districts, in the south by Gumla and Lohardaga districts in the east by Ranchi and Chatra districts and in the west by Garhwa district and Chattisgarh state. The district is situated between 23^0 19’ 28”and 24^0 02’ 38” North latitude and 83^0 57’ 48” and 84^0 57’ 50” East longitude. The district covers Survey of India toposheets nos. 64 M/14, 64 M/15, 73A/01, 73A/02, 73A/03, 73A/03, 73A/05, 73A/06, 72D/12, 73A/09, 73A/10,72D/16, 73A/13 and 73A/14. The district has two sub-divisions i.e. Latehar and Mahuadar and nine blocks namely – Balumath, Bariyatu, Barwadih, Chandwa, Garu, Herhanj, Latehar, Mahuadar and Manika. Total population of the district is 119370 (as per census of 2011) with rural population 67512 and urban population 51858. The location map of the study area is shown in figure – 1.

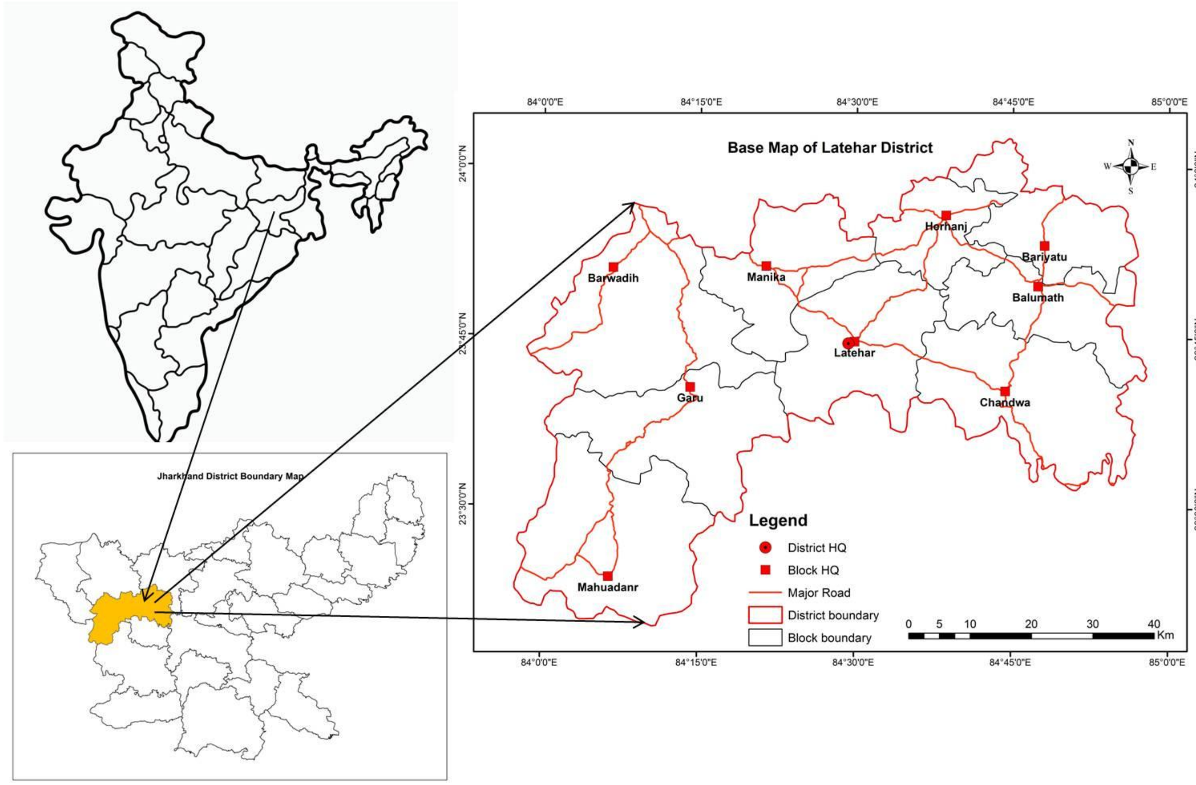


Figure 1: Location map of Latehar district

Table-1: Block wise Area of Latehar District, Jharkhand

Sr. No.	Block	Area in (Hectare)
1	Balumath	35151
2	Bariatu	33740
3	Barwadih	43536
4	Chandwa	58786
5	Garu	22298
6	Herhang	25197
7	Latehar	44884
8	Mahuadanr	63783
9	Manika	33886
Total		**361261**

1.4 Data Availability, Data adequacy and Data Gap analysis

1.4.1 Data Availability: Central Ground Water Board has carried out exploratory drilling in the district and drilled 6 exploratory wells in hard rock formation by departmental rig during the year 1994-1995. In addition 15 exploratory wells and 02 observation wells were drilled in the district in different places during the year AAP 2019 to 2021, through outsourcing (WAPCOS). In addition 11 numbers of permanent observation well (HNS) of Central Ground Water Board located in the district are being monitored for ground water regime and to assess the chemical quality of ground water.

1.4.2 Data Adequacy and Data Gap Analysis: The available data of the Exploratory wells drilled by Central Ground Water Board, Mid–Eastern Region, Patna, geophysical survey carried out in the area, ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analyzed for adequacy of the same for the aquifer mapping studies.

After taking into consideration, the available data of ground water exploration, geophysical survey, ground water monitoring and ground water quality, the data adequacy has been compiled. The summarised details of required, existing and data gap of exploratory wells, ground water monitoring and ground water quality stations are given in table–2.

Table – 2: Data adequacy and data gap analysis

Exploratory data			Geophysical data			GW monitoring data			GW quality data		
Req.	**Exist.**	**Gap**	**Req.**	**Exis.**	**Gap**	**Req.**	**Exist.**	**Gap**	**Req.**	**Exis.**	**Gap**
21	21	0	86	86	0	38	38	0	38	38	0

The data adequacy as discussed above indicates that the existing data is sufficient for preparation of aquifer maps; hence data gap has been identified for Exploratory Wells, Geophysical Survey (VES), Ground Water Monitoring Wells and Ground Water Quality. Based on the data gap identification, the data generation activity was planned and completed in 2019-20. In addition 15 no of EW and 2 no of OW has been drilled through outsourcing through WAPCOS.

1.5 Climate and Rainfall: The district is characterized by humid to sub-humid climate. During summer the hot spell prevails from March to middle of June. Rainy season starts from middle of June to middle & end of October. Winter starts from the middle of November and continues till the end of February. The area consist higher landforms in south and plains in the north, it presents diversities in climatic conditions. The southern portion has cold and mild summer. During winter season the area records 16 to 18 ^{0} C in north and during summer season the temperature increases upto 41^{0}C. The higher areas in south receives anuual rainfall upto 2000 mm. but northern part of the district remain in rain shadow and receive less than 1200 mm rainfall.The average rain fall data for the yearof 2020 is given in table – 3.

Table – 3: Average rainfall (2020) of Latehar district

Sr. No.	Block	Average monsoon rainfall
1	Balumath	1176.8
2	Bariatu	1176.8
3	Barwadih	1086.1
4	Chandwa	1432.31
5	Garu	1194
6	Herhang	1176.8
7	Latehar	2051.4
8	Mahuadanr	1112.8
9	Manika	1932

1.6 Physiography: The major part of the district is covered by hillocks having height up to 1179 m. Landforms developed in the southern part are represented by pediplains. The general slope of the area is east to west. The drainage pattern is mostly dendritic in the plain land area over granite gneiss country rock. In the plateau area somewhere the drainage shows radial pattern. The interesting feature is the presence of few small springs along the edges of the plateau, some 30 to 40 m below the top. The hilly terrains are mostly forest covered. Dense forest areas are marked as Reserve Forests such as Saidup RF, Pundag RF, Baresanr RF, Patki RF, Netarhat RF, Ramandag RF etc.

The Digital elevation model of Latehar district has been presented in Figure-2

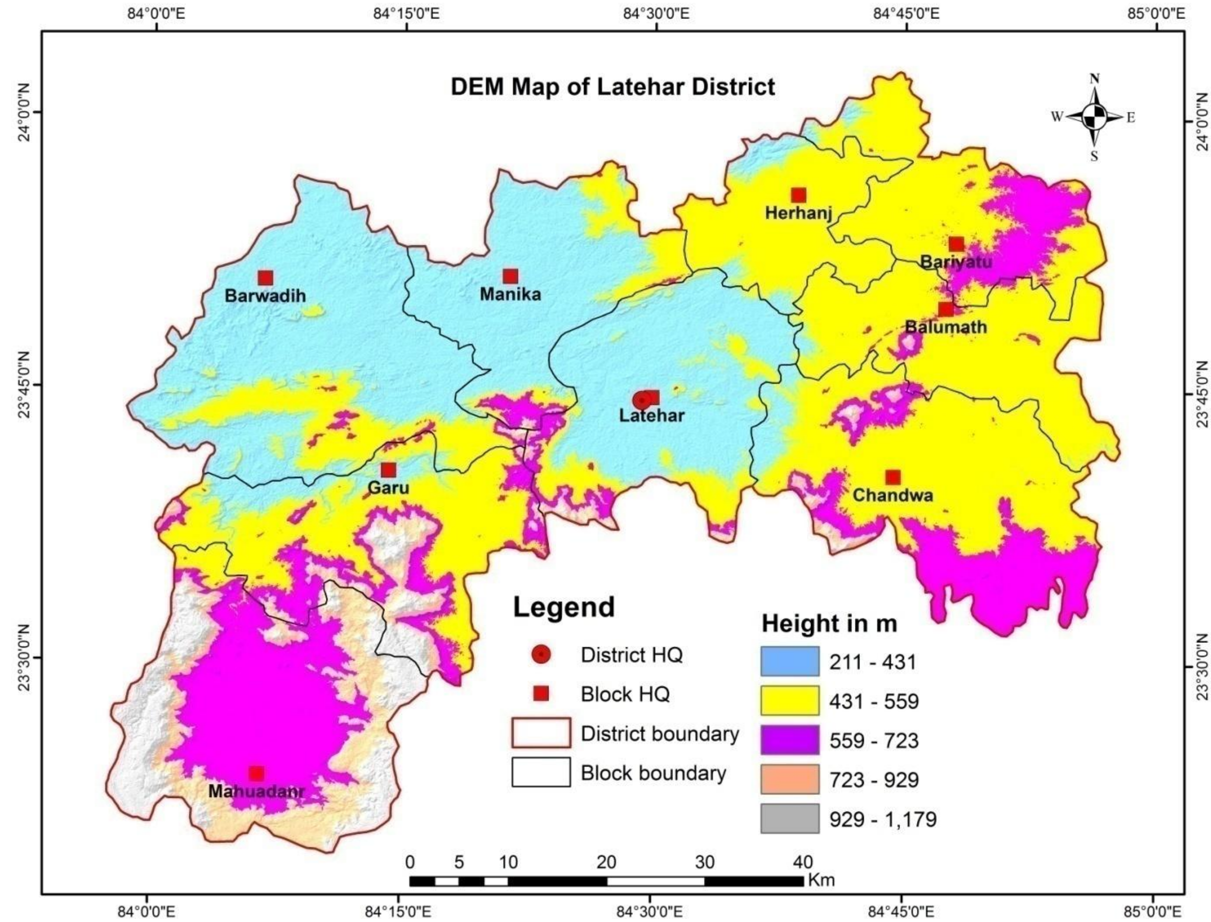


Figure – 2: Digital elevation model of Latehar district

1.7 Geomorphology:

The district has a heterogeneous assemblage of rock formations. Unclassified rocks, Chotanagpur Granite Gneiss and Gondwana are the main lithological formation of the area of which chotanagpur granite gneiss is the most dominant. In general the physiography of the area shows

i) Mountanious tracts of the Chotanagpur Granite Gneiss, with isolated flat topped hills, steeper escarpments and inter-montane valleys.
ii) Plateau consisting of weathered granite gneiss, Gondwana, Laterite, Unclassified rocks and Newer Alluvium.
iii) Alluvium as low tracts found in the immediate vicinity of major rivers as basin-fill deposits

In general the area shows a general slope from East to west. The land surface is rugged and uneven ranging from flat lands to almost steep slopes, though generally the slopes are gradual and have been worked into terraced paddy lands in most of the places.

Based on visual interpretation of Landsat imageries, the various hydrogeomorphic features in the district are:-

i) **Pediment (Gneissic):-** Thes are highly fractured region with gneiss and schist as the underlying rocks.

ii) **Denudational hills (Gneissic):-**These are low hill groups with high rugged topography with gneiss as underlying lithology.

iii) **Low dissected hills (Gneissic):-** The hills of low height mainly composed of gneissic rocks.

iv) **Structural Ridge (Gneissic):-** These are long narrow ridges of low height with gneiss as the dominant rock types.

The geomorphological map of Latehar district have been presented in Fig-3

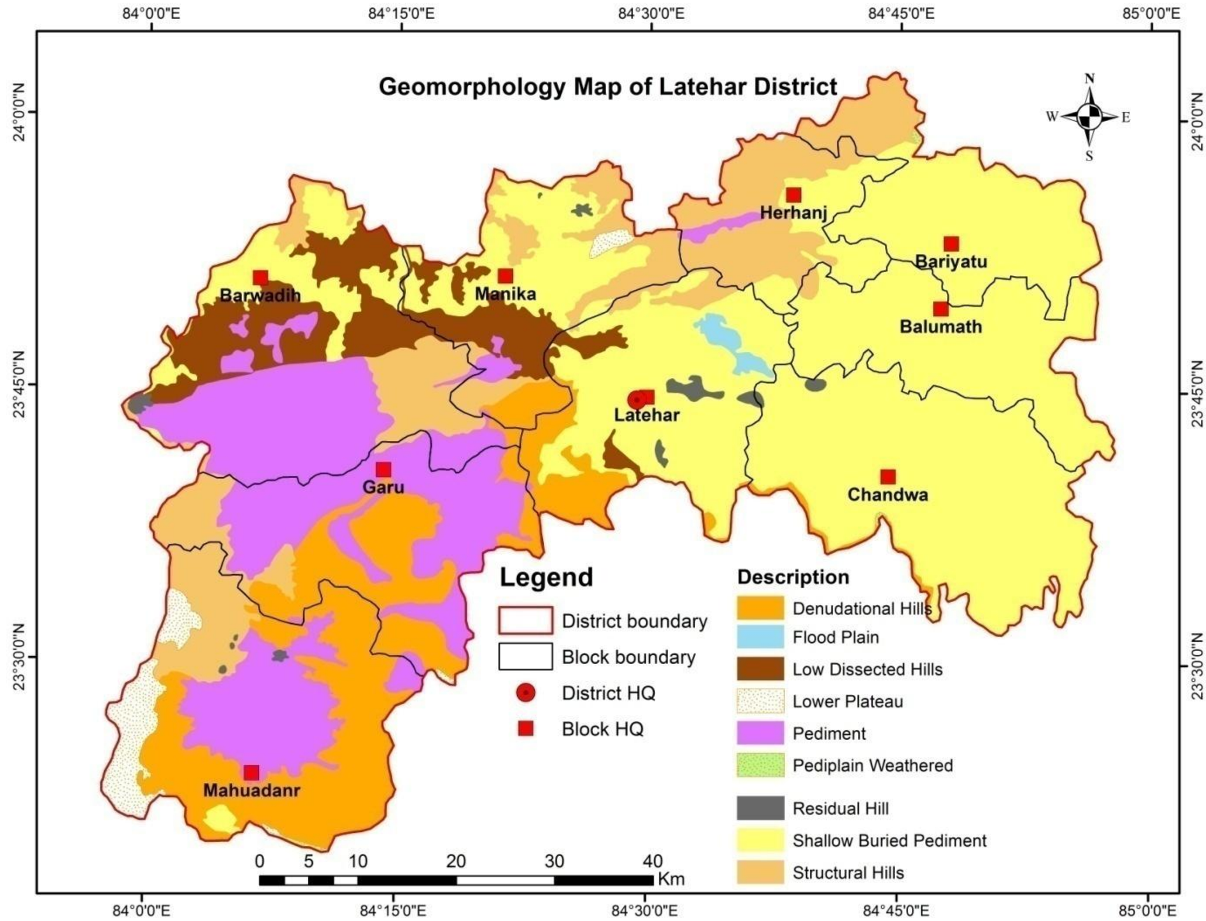


Figure – 3: Geomophology of Latehar district

1.8 Land Use: Geographical features play a major role in information of land use pattern. Out of total geographical area of the district i.e 3613 Sq. km, nearly 18 % area comes under net sown area, 7% under forests and the rest area falls under barren, cultivable waste, pasture and other agricultural use. The land use pattern data of the area for the year 2013 – 14 is given below in table-4. The Land use map of the Latehar district has been prepared and shown in figure – 4.

Table: 4: Land use pattern of Latehar district (2013– 2014) (Sourec: District AGRICULTURE CENSUS OF INDIA (PMKSY DIP Report of Latehar district) hectares)

			Area Under Agriculture					
Sl. No.	Name of Block	Total Geographical area	Gross Crop Area	Net sown area	Area sown more than once	Cropping Intensity	Area under waste Land	Area Under Other Uses
1	Latehar	45359.36	23073.39	23073.39	285	1.0000	1188.13	8098.46
2	Chandwa	58106.55	11214.12	11214.12	271	1.0000	1632.2	4931.48
3	Manika	33805.42	6307	5907.16	221	1.0677	756.77	3297.9
4	Barwadih	45545	13268.8	4994	259	2.6569	854	3351
5	Garu	59906.4	2560	2560	154	1.0000	24884.75	6206.8
6	Mahuadanr	63014	37230	9851.6	208	3.7791	24884.75	4198.13
7	Balumath	93002.75	15799.38	15799.38	402	1.0000	2622.66	6940.54

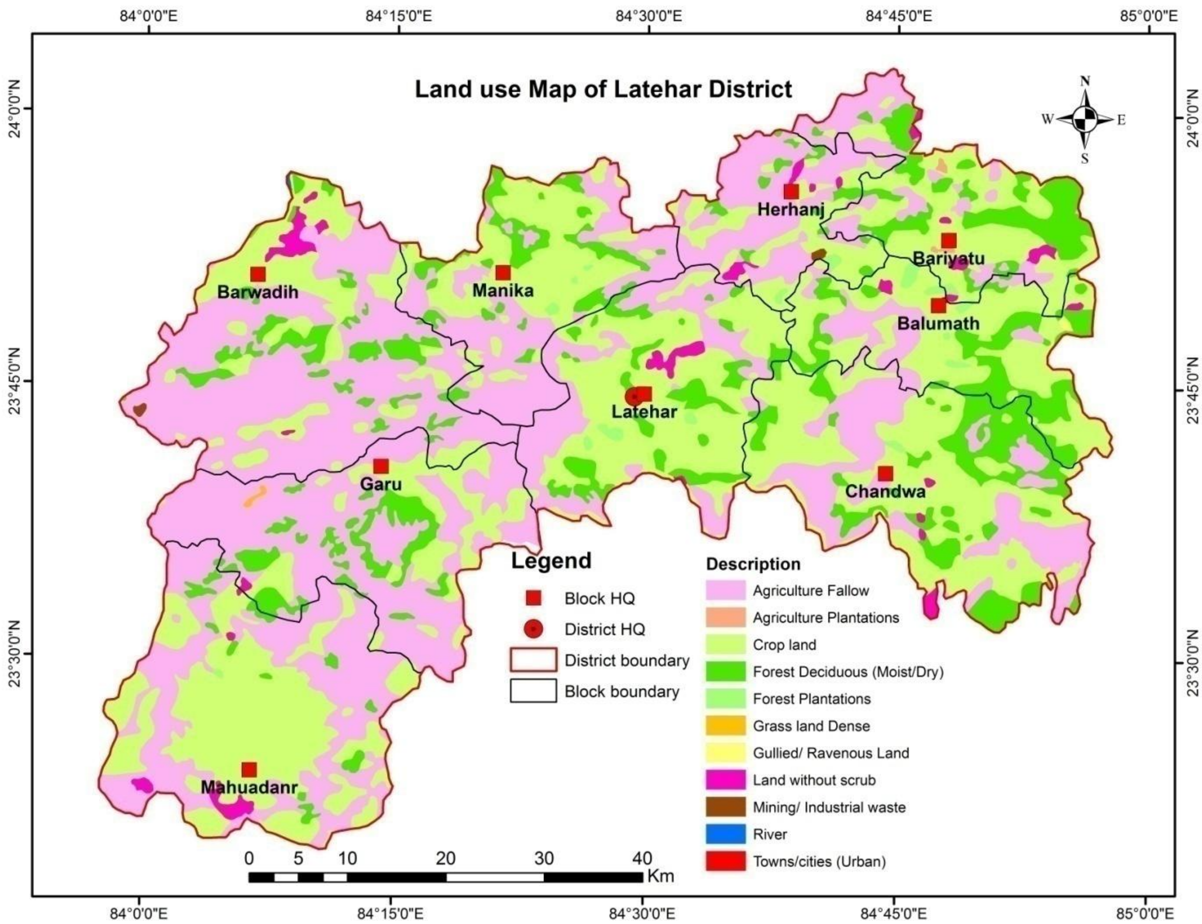


Figure – 4: Land Use Map of Latehar district

1.9 Soils

The soils occurring in different landforms have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar et al. 1996) and three soil orders namely Entisols, Inceptisols and Alfisols were observed in Latehar district (Fig.5). Alfisols were the dominant soils covering 63.7.0 percent of TGA followed by Entisols (28.2 %) and Inceptisols (7.2 %).

Soils of the district and their extent

Map unit	Taxonomy	Area ('00ha)	% of the TGA
15	Loamy-skeletal, mixed, hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Ultic Haplustalfs	641	17.51
16	Fine, mixed, hyperthermic Typic Haplustalfs Loamy, mixed, hyperthermic Lithic Ustorthents	12	0.33
19	Loamy-skeletal, mixed hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Typic Haplustepts	21	0.57
20	Loamy, mixed, hyperthermic Lithic Ustorthents Fine, mixed, hyperthermic Typic Rhodustalfs	70	1.91
21	Coarse loamy, mixed, hyperthermic Typic Ustorthents Fine, mixed, hyperthermic Rhodic Paleustalfs	45	1.23
22	Fine, mixed, hyperthermic Typic Paleustalfs Fine, mixed, hyperthermic Typic Rhodustalfs	157	4.29
24	Fine, mixed, hyperthermic Typic Haplustalfs Fine-loamy, mixed, hyperthermic Typic Haplustepts	78	2.13
34	Fine loamy, mixed, hyperthermic Typic Paleustalfs Fine-loamy, mixed, hyperthermic Typic Rhodustalfs	19	0.52
35	Loamy-skeletal, mixed, hyperthermic Lithic Ustorthents Fine-loamy, mixed, hyperthermic Typic Haplustalfs	311	8.49
36	Fine, mixed, hyperthermic Typic Paleustalfs Fine loamy, mixed, hyperthermic Typic Rhodustalfs	52	1.42
37	Loamy, mixed, hyperthermic Lithic Haplustalfs Fine, mixed, hyperthermic Typic Paleustalfs	901	24.61
38	Fine loamy, mixed, hyperthermic Typic Paleustalfs Fine loamy, mixed, hyperthermic Typic Haplustepts	64	1.75
40	Fine loamy, mixed, hyperthermic Typic Haplustepts Fine loamy, mixed, hyperthermic Typic Haplustalfs	136	3.71
42	Fine, mixed, hyperthermic Typic Rhodustalfs Fine loamy, mixed, hyperthermic Typic Ustorthents	926	25.32
44	Fine, mixed, hyperthermic Aeric Endoaquepts Fine, mixed, hyperthermic Typic Haplustepts	88	2.40
45	Fine, mixed, hyperthermic Aeric Endoaquepts Fine loamy, mixed, hyperthermic Typic Haplustepts	28	0.76
78	Fine, mixed, hyperthermic Typic Paleustalfs Fine loamy, mixed, hyperthermic Ultic Haplustalfs	1	0.03
79	Fine, mixed, hyperthermic Typic Haplustalfs Fine, mixed, hyperthermic Ultic Paleustalfs	66	1.80
81	Fine, mixed, hyperthermic Typic Rhodustalfs Loamy, mixed, hyperthermic Lithic Ustorthents	1	0.03
85	Fine-loamy, mixed, hyperthermic Typic Haplustalfs Fine, mixed, hyperthermic Typic Paleustalfs	2	0.05
86	Fine, mixed, hyperthermic Typic Rhodustalfs Coarse loamy, mixed, hyperthermic Typic Ustorthents	10	0.27
Miscellaneous		32	0.87
Total		3661	100.00

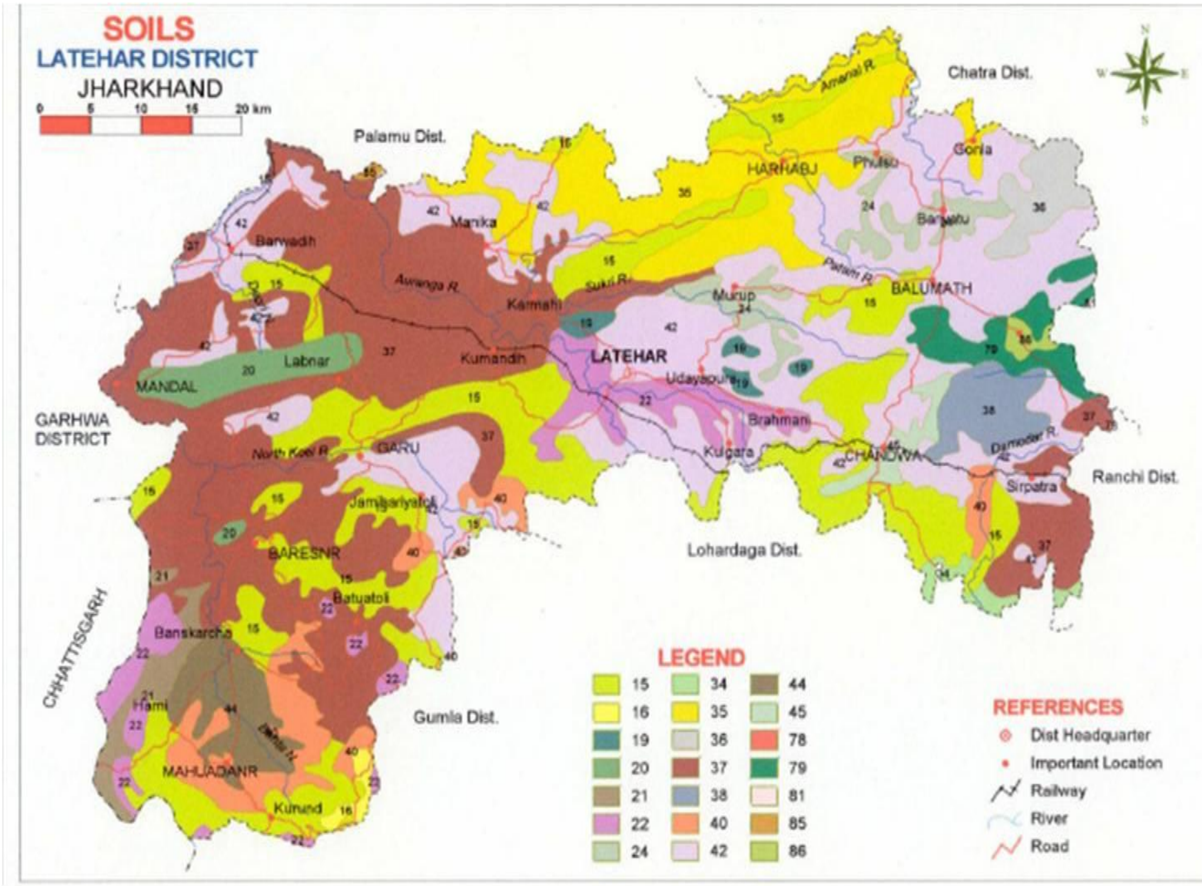


Figure 5 : Soil map (Source) National Bureau of Soil Survey and Land Use Planning (ICAR), Regional Centre, Kolkata And Deptt. Of Soil Science & Agricultural Chemistry, BAU, Ranchi, Jharkhand)

1.10 Hydrology and Drainage:

The North Koel River and its tributaries Burha river, Kudai nala, Kohbarwa nala, Charo nala, Aksi river, Charhu nala etc. contributes to the drainage system of this area. Apart from these tributaries, there are several seasonal streams and nallas which ultimately join the North Koel. Drainage map is given in figure-6.

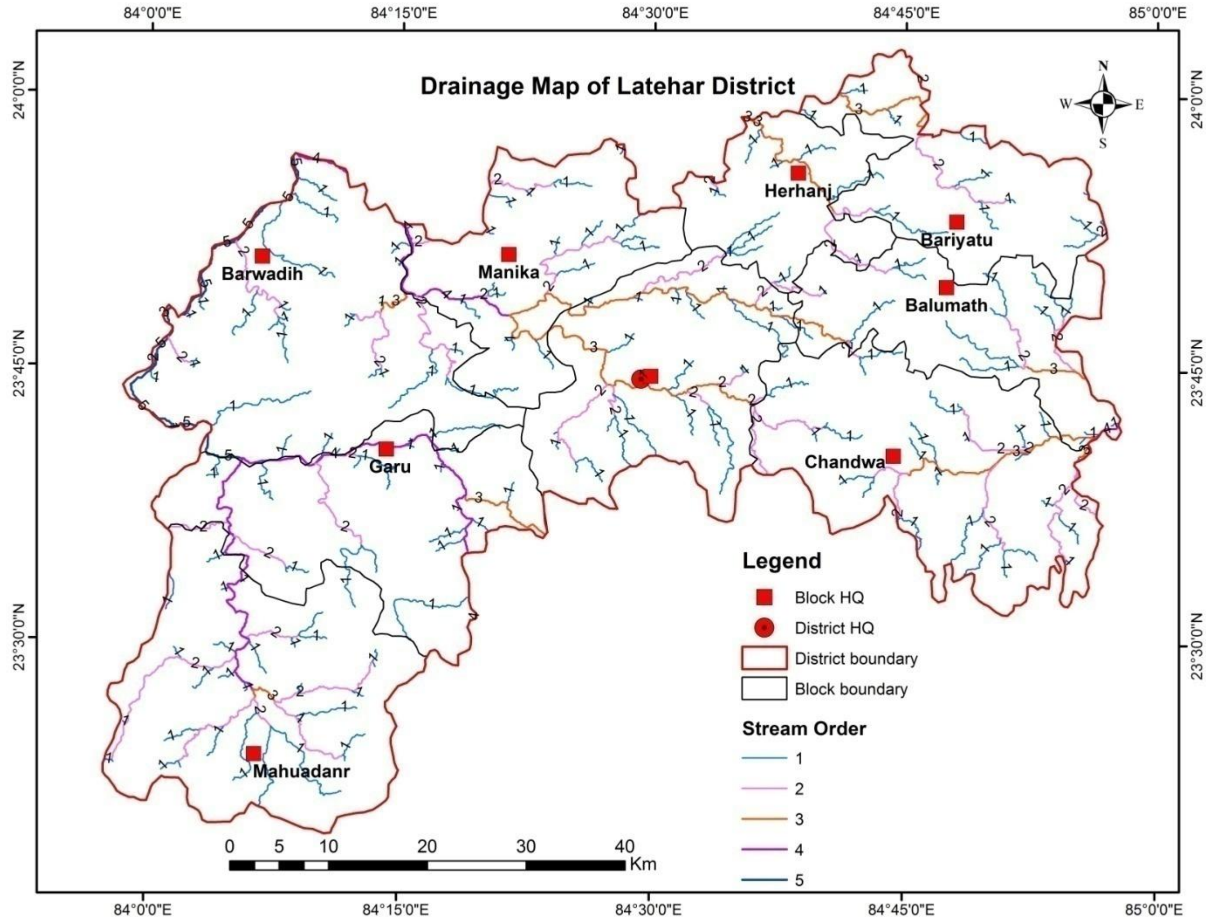


Figure – 6: Drainage Map of Latehar district

1.11 Agriculture and Irrigation Practices:

The local population of the district mostly depends on agriculture and forestry for their sustenance. The agriculture activity of the area is solely dependent upon the monsoon rainfall. Paddy is the main crop of the district. Wheat, Maize, Gram, Mustard oil Potato are other crops grown widely in Latehar and its adjoining areas. Irrigational facilities are not adequate in this district. The most common source is the dug well, but this is not a very dependable source of irrigation. The undulating nature of land makes it possible to store rain water by bunding. Apart from being dependent upon rains, these are by no means adequate. The result is that failure of rains invariably involves failure of crops except in small pockets. Minor irrigation structures like surface water, tanks and ponds are the other source for irrigation. Available source wise irrigation for the 2013-14 is given in table - 5.

Table 5: Block wise number of irrigation structure of Latehar district district (2013-14)

Sl. No.	Name of Block	Canal		Tank		RLI		DTW		STW #		ODW		Others				Total	
														Pucca Check Dam		Well			
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
1	Latehar	31	1573	1	5	27	1538	11350	&	32	&	–	–	8	236	10	20	77	3372
2	Chandwa	44	1769	1	8	9	630	1382	&	3	&	–	–	6	330	10	20	70	2757
3	Balumath	15	801	–	–	–	–	763	&	22	&	–	–	2	100	4	8	21	909
4	Bariyatu	5	430	3	24	6	396	9	&	&	&	–	–	2	100	6	12	22	962

5	Herhanj	3	250	–	–	1	60	&	&	&	&	–	–	–	–	–	–	4	310
6	Manika	21	874	–	–	9	516	555	&	2	&	–	–	9	285	10	20	49	1695
7	Barwadih	28	1132	–	–	14	676	1396	2	1	&	–	–	6	155	10	20	58	1983
8	Garu	5	205	–	–	7	292	953	5	9	&	–	–	19	425	10	20	41	942
9	Mahuadanr	10	276	–	–	16	1076	694	2	&	&	–	–	8	245	10	20	44	1617
Total		**162**	**7310**	**5**	**37**	**89**	**5184**	0	0	0	0	**0**	**0**	**60**	**1876**	**70**	**140**	**386**	**14547**

Source - Executive Engineer M.I., Latehar

1.12 Cropping Pattern:

The major crops cultivated in the area are **paddy, wheat, maize, gram, pulses and vegetable.** But the land available for cultivation is very limited because of the hilly and rugged topography. Area under different crops for the year 2015 – 16 of the district is presented in table – 6.

Table – 6: Cropping pattern of Latehar district (source: DIP reports of PMKSY)

SL.NO.	CROP	KHARIF	RABI
1	Cereals	Rice, Maize	Wheat
2	Pulses	Arhar, Urad, Moong	Gram, Linseed
3	Oilseed	Groundnut, Niger	Mustard, Sunflower
4	Vegetables	Bhindi, Chilli	Potato, Onion, Brinjal, Tomato

1.13 Geological set up

The Chhotanagpur Gneissic Complex (CGC) consists of mainly granite gneiss with enclaves of older meta-sedimentaries and meta-igneous rocks of Archean to Palaeo Proterozoic age. These enclaves are grouped together as ‘Unclassified Metamorphics’. The meta-sedimentaries are represented by mica-schist, quartzite, limestone and calc-silicate rocks. Archaean metasediments is the oldest geological formation in the area and these metasediments were intruded by basic intrusives. The formation of granite is a still later phenomenon. The remnants of the metamorphosed equivalents of the earlier sediments and igneous rocks are observed as numerous inclusions of schists, calc-silicate rock, amphibolite etc., in the granitic mass. These inclusions are usually disposed along the gneissic foliation.

Quartzite also occurs as thick band in the western part and thick bands of calc-silicate are found in southern part**.** The meta-igneous suite is represented by epidiorite, hornblende-talc-schist and amphibolite, which occurs both as thick and thin elongated bands**.** The most prominent country rock, the granite gneiss is exposed all around in the area**.** The archaeans are unconformably overlain by the Gondwana sedimentaries in the small part of the area. Geologically the area is made up of highly metamorphosed and felspathised pre-Cambrian sediments intruded by late to post tectonic pegmatite and quartz veins. The meta-morphites, are represented by mica schist, quartzite, amphibolite, quartz garnet granulite, calc-silicate rocks. These have been extensively granitised to form various types of granite gneisses and hornblende gneiss and even granite. Mica schist is often found as inclusions within the gneiss.

The bauxite bearing areas are popularly known as 'Pat' area of Chhotanagpur plateau topographically comprising rolling plains, mounds, hillocks and low to moderately high isolated flat topped hills rising at places to more than 1125 m above Mean Sea Level (MSL) dissected by wide valleys. The laterite/bauxite is developed over the gneissic country rock belonging to Chhotanagpur Gneissic Complex (CGC). The area surrounding the plateau represents a peneplained of a highly metamorphosed and deformed terrain of Precambrian age. Towards the north- western part of the area as well as to the north eastern part of the area the gneissic rocks are unconformably overlain by grits, felspathic sandstone and calcified and silicified rocks of the Lameta beds of the Cretaceous age followed by basaltic rocks of Upper Cretaceous to Palaeogene age. These are intruded by pegmatite, aplite and quartz veins and younger basic dykes. These are unconformably overlain by sediments of the Lameta Group. Basaltic flows of the Deccan Trap occur in isolated patches below the laterite. Laterite, which is pisolitic and massive type containing pockets of bauxite and aluminous laterite occurs as capping over the plateau and isolated hills. Quartz veins varying in width from few mm to few cm commonly occur within the granitic gneiss.

The general geological succssession is given below:

(Based on compiled Geological Map after GSI)

Lithology	**Formation**		**Age**
Soil and alluvium			Quaternary
Laterite			Cenozoic
Basalt			Upper Cretaceous to Paleogene
Limestone ferruginous grit	Lameta Formation	Gondwana Supergroup	Cretaceous
Feldspathic sandstone	Barakar Formation		Early Permian
Sandstone, shale	Karharbari Formation		
Shale, Sandstone, Siltstone	Talchir Formation		Late Carboniferous to Early Permian
Quartz vein			Proterozoic
Granite gneiss/augen gneiss		Chhotanagpur Granite Gneissic Complex	Archaean to Proterozoic
Calc-silicate rocks		Unclassified Metamorphics	Archaean to Palaeo Proterozoic
Mica schist			
Sillimanite schist			
Hornblende schist, amphibolite			

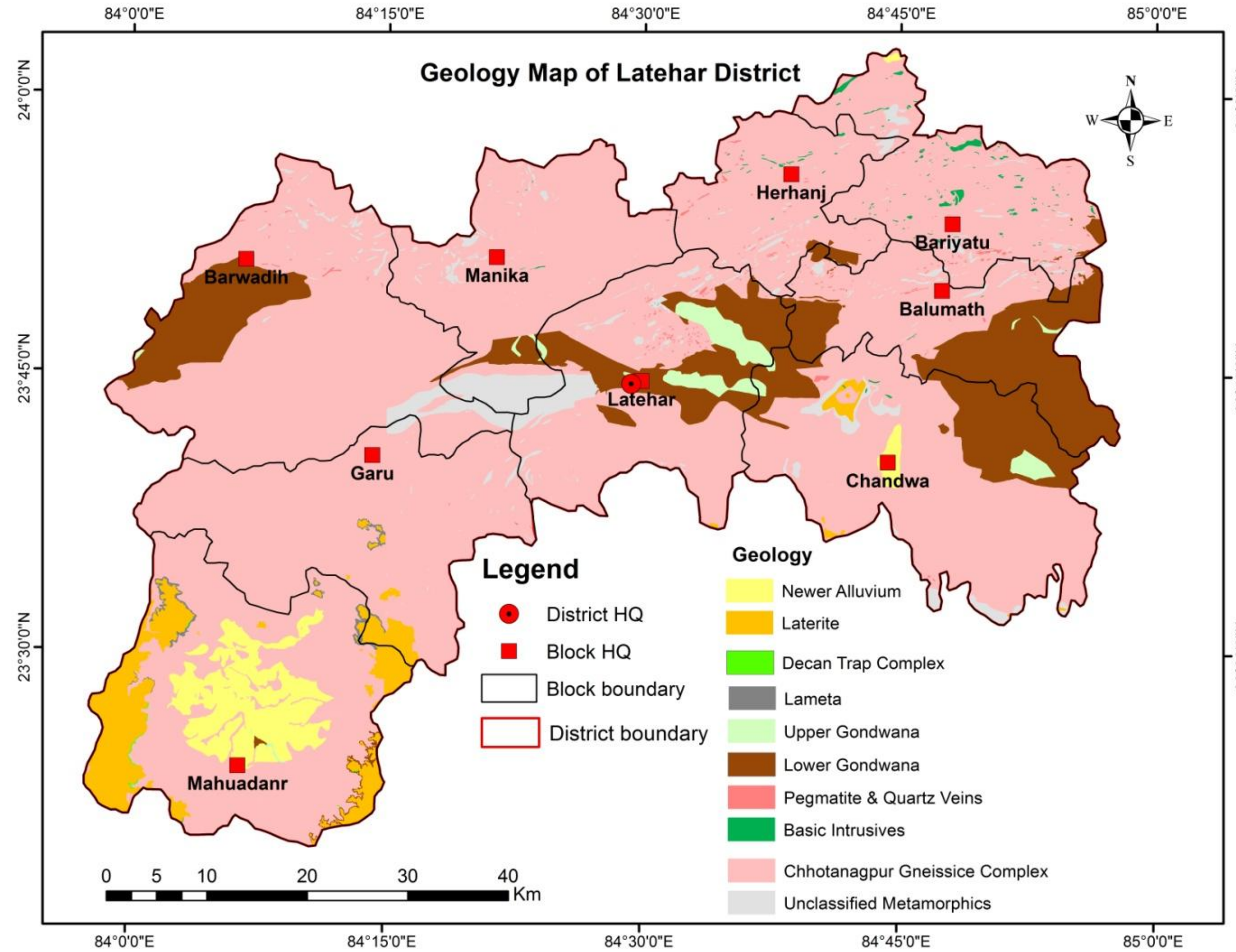


Figure – 7: Geological map of Latehar district (source GSI)

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

2.1 Data collection, Compilation and data Generation

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

2.1.1 Data collection Compilation

i. Hydrogeological Data: Water level data of 38 key wells and historical water level trend of monitoring wells were collected and compiled representing Aquifer-I.

ii. Hydrochemical Data: To evaluate the quality of ground water, 48 samples were collected from dug wells

iii. Exploratory drilling**:** 6 exploratory wells are existing in hard rock area drilled through departmental rigs and 15 exploratory wells and 2 Observations drilled through Outsourcing (WAPCOS)

iv. Hydrometeorological Data: The years (2020) monsoon rainfall data for each of the block from the office of District Agriculture Department, Latehar.

v. Land use and cropping pattern data**:** The data of land use and cropping pattern obtained from the office of Director Statistics, Ranchi.

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

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

The thematic layers such as drainage, geomorphology, DEM and land use have been described in Chapter - I.

2.1.2 Data Generation:

After taking into consideration, the data available with CGWB on ground water monitoring wells (GWMW), ground water quality, geophysical survey and ground water exploration, the data adequacy was compiled. The requirement, availability and gap of major data inputs i.e., exploratory wells, geophysical data, ground water monitoring wells and ground water quality data are detailed in the table – 2.

2.2 Hydrogeology:

The occurrence and movement of ground water in the area is variable, which depends on geomorphology, structure, geological setting, hydraulic properties, tectonic setup etc.

The hydrogeological condition of Latehar is complex due to diverse geological trerrain vide variability of topography, drainage etc. Based on morphogenetic and geological diversities and relative ground water potentialities in the aquifer belonging to different geological formation, the study area can be broadly sub-divided into three hydrogeological unit.

1. Consolidated formation
2. Semi-consolidated formation
3. Uncosolidated formation

The consolidated formation is commonly reffered as hard rocks, the grains of which are firmly held together by cementation, compaction and recrystalization. They do not possess primary porosity. The availability of ground water depends on secondary porosity developed due to weathering and fracturing of these rocks. The chotanagpur gneiss complex, metasedimentaries and other associated rocks of Precambrian age, belongs to consolidated hydrogeological unit. The consolidated formation often turmed as fissured formation.

The unconsolidated formation which forms porous formation is represented by quaternary alluvium. The Gondwana formations represent the semi-consolidated formation. Hydrogeological map of Latehar district has been prepared (Fig-9)

2.2.1 Ground water in Aquifer-I (Weathered Granite Gneisses):-

The Aquifer-I is represented by weathered Granite- Gneisses. Within the depth zone of dug wells, the weathered zone influences to a greater extent in the hard rock formation constituting potential phreatic shallow aquifer. Almost all the rock types in the precambrial formations show the effect of weathering however, degree and intensity varies depending on the structure, chemical and mineralogical composition of the rocks etc. The plateau and pediplain region is occupied by moderately thick weathered residium developed due to mechanical disintegration and chemical decomposition of impervious crystalline rocks. The thickness of weathered zone varies from 5.73-28.15 meter.

2.2.2 Ground Water in Aquifer – II (Fractured Granite Gneisses):

The Chotanagpur granite-gneiss, belonging to Precabmrian age, constitutes the group of Fissured formation hydrogeological units as an Aquifer-II i.e Deeper Aquifer in the area. The aquifers in these rocks lack the primary porosity and occurrence and movement of ground water is to a large extent controlled by the extent and development of secondary porosity like joints, fissure planes etc.These rocks are the part of Chotanagpur Craton of Indian Shield. They contain hard rocks of different age, grade of metamorphism and structure. Many orogenic movements have affected the shields. Some rock types are extensively fractured; while others are almost undisturbed, even though they belong to the same tectonic environment.

The extensive field investigations of deep exploratory wells drilled (up to 200m) by CGWB, Potential fractures have been identified in Precambrian formations. The fractures in granite gneiss at shallow depth are more productive compared to the fractures in amphibolites/ schists. Thus the type of rocks, grade of metamorphism and brittleness are the main geological controls which govern the occurrence and movement of ground water.

The deeper aquifers i. e Aquifer-II in Precambrian rock formation commonly occur within the depth up to 125m with few exceptions where they occur at more than 125m depth (138m, 147m, 167m, 165m, 168m and 182m, depth in the case of borewells at Bandua, Balumath and Maromar respectively). The yield of the deeper aquifers are quite appreciable i.e. upto 49.57 m^3/hr. e.g. Bandua (Manika) Latehar.

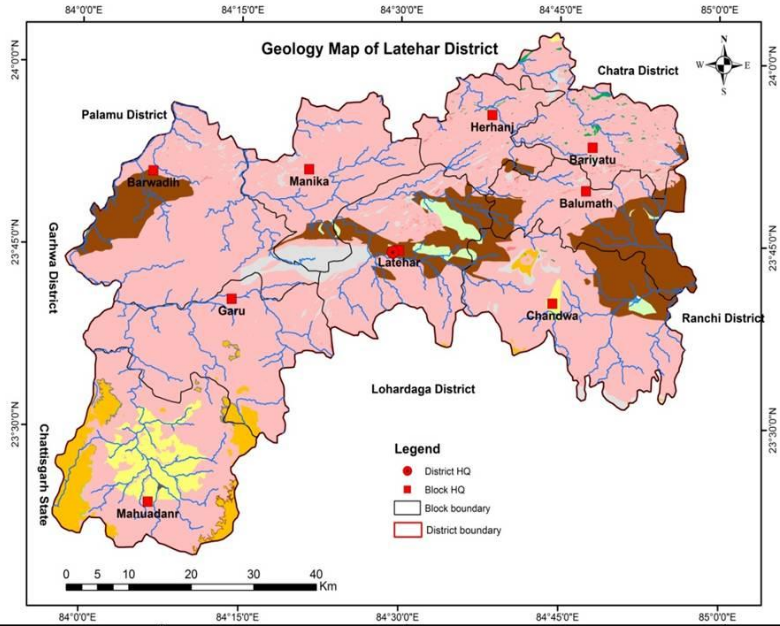
Table-7 Potential Fractures Encountered during ground water Exploration in Latehar district, Jharkhand

Sl.No.	Location	Block	Depth Drilled (mbgl)	Length of Casing pipe (in m)	fracture Tapped(in m)	Static Water level (m bgl)	Discharge (m3/hr.)	Formation
1	Bandua	Manika	187	17.8	18.5-19, 20.5-22, 29-30, 126-127.5, 138.7-138.9	6.5	49.32	Grainite Gneiss
2	Hesla	Chandwa	120	24.4	26-27, 35-36, 50-51, 64-65, 85-86,116-117	13.9	27.82	Grainite Gneiss
3	Maromar	Garu	171	13.3	168-169	21.05	17.28	Grainite Gneiss
4	Hami	Mahuadant	201	28.65	117.2-117.6	6.1	13.6	Grainite Gneiss

Source: CGWB Compile all the wells previous plus NAQUIM plus outsourcing
On the basis of field investigations and results of exploratory wells drilled in the district, salient findings are summarized as:-

- In general in fissured formations, discharge of well has been found upto 49.32 m^3/hr.
- Overall in the district the major potential fractures zones are found between 15-130 m, however other fractures are encountered upto 182 m
- First potential fracture zone encountered in the district widely varies from 11-117 m depth.
- Some of high yielding well where fractures were encountered within 60 m are Hesla-8.18 LPS, 60-120 m depth are Hesla -7.73 LPS, Hami-3.8 LPS, beyond- 120 m depth at Bandua -13.77 LPS

The hydrogeological map of area is prepared and presented in figure -8.



	Formation	Lithology	Hydrogeology	Ground Water Potential
	Recent to Quaternary	Alluvium, sand, clay, silt etc.	Moderate thick limited along river banks mainly unconfined/semiconfined aquifer	Up to10 m3/h
	Lower Gondwana	Shale, Sandstone, Conglomerate	Moderate thick limited in extent confined to semi confined aquifer	Below 10 m3/h
	Chhotanagpur Gneissic Complex	Biotite Gneiss	Ground water restricted in weathered zones and interconnected Fractured	In Dug well below 10m3/h Bore well 5 to 30m3/h
	Unclassified Metamorphics	Limestone, Impure Marble, Calc-Silicate Rocks	Poor Ground Water Potential	

Figure – 8: Hydrogeological Map of Latehar district

2.2.3 Ground water Dynamics:-

2.2.3.1 Ground water Monitoring Wells: 38 key wells were established and 11 NHNS monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. The depth of these dug well varies from 6.5 to 11.80 mbgl. Similarly, the diameters of key wells (dug wells) ranges from 1.80 to 6.35 m. During 2020, the pre monsoon (May) depth to water level in these wells was between 2.60 to 9.86 mbgl. The post monsoon depth to water level (Nov. 2020) in the dug wells ranges from 0.80 to 9.90 mbgl. Average pre-monsoon water level was calculated 7.66 mbgl and in post monsoon 4.48 mbgl respectively. A detail of key wells and water level data is presented in Annexure – I & II. Location of key wells and exploratory wells are shown in figure –9.

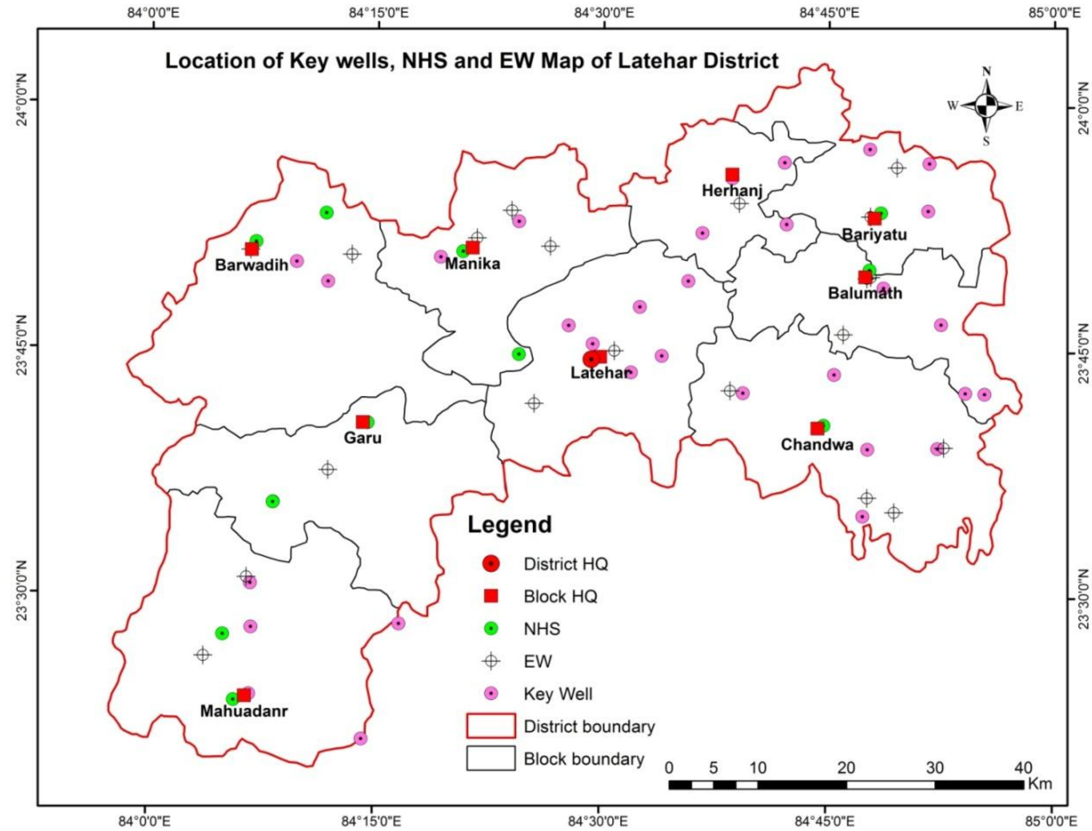


Figure – 9: Location of Key wells NHNS and Exploratory wells

2.2.3.2 Water Level Scenario – Aquifer – I (Shallow Aquifer): water level scenario of shallow aquifer was generated by utilizing water level data of 38 monitoring wells representing shallow aquifer. The pre monsoon (May 2019) depth to water level monitored between 5.85 to 13.20 mbgl and average 9.98m bgl. The post monsoon depth to water level (Nov. 2020) in the dug wells ranges from 0.80 to 9.90 mbgl and average 4.48 m bgl respectively. Pre and post monsoon depth to water level maps were prepared for the year 2019 and 2020 and shown in figure – 10, 11.

The water level monitored during pre and post monsoon period 2019 and 2020 was used to compute the seasonal fluctuation.

2.2.3.3 Water level fluctuation:

The seasonal water level fluctuation was observed between 1.20 to 8.35m for the period between pre monsoon and post monsoon 2020.

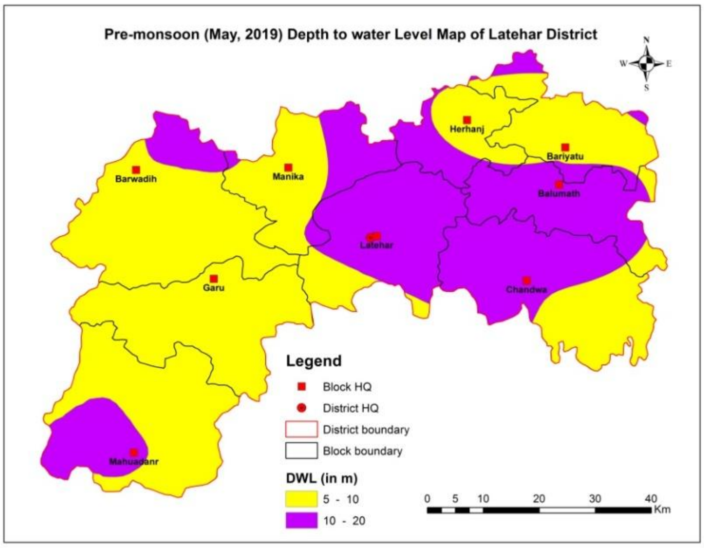


Figure – 10: Pre monsoon (May 2019) depth to water level map of Aquifer – I (shallow aquifer)

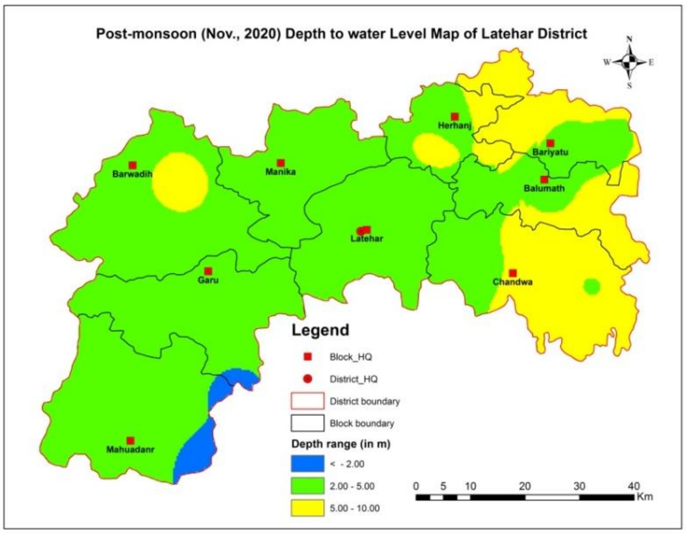


Figure – 11: Post monsoon (Nov. 2020) depth to water level map of Aquifer – I (shallow aquifer)

2.2.3.4 Ten years Long Term Water Level Trend (2010-2019):

In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data for the period 2010-2019 have been computed and analyzed which is presented in table - 8. The pre- monsoon decadal water level trend analysed and observed that out of 6 hydrographs stations 2 wells were declining and 4 well was rising. Post-monsoon decadal water level trend observed 4 station rising and 2 stations falling. The annual decadal water level of the district was observed rising trend in 3 station and declining trend in 3 wells.

Table – 8: Long term water level trend of Latehar district (2010 – 2019)

	Latehar									
			PreMonsoon			PreMonsoon			Annual	
Sl No.	Location	Data Points	Rise (m/year)	Fall (m/year)	Data Points	Rise (m/year)	Fall (m/year)	Data Points	Rise (m/year)	Fall (m/year)
1	Balumath	9		0.0506	10	0.1059		39	0.1509	
2	Manika	10		0.0444	10	0.0165		39	0.0495	
3	Barwadih	9	0.1178		6	0.2896		30	0.2898	
4	Barjatu	8	0.3598		9	0.1897		37	0.2613	
5	Betla	7		0.3455	7	0.2941		30	0.1812	
6	Garu	6	0.0281		6	0.0128		24	0.1176	
7	Chandwa	10	0.243		10	0.0362		38	0.1557	
8	Latehar	10	0.0153		10	0.3206		38	0.1444	

2.2.3.5 Hydrograph Analysis:

Analysis of five (05) hydrograph network stations, were carried out using GEMS software (Figure-12-16) and analysed for the period from 2011-2020. It is observed that the long-term water level trends during pre and post-monsoon seasons are rising in shallow aquifer-I represented by dug wells.

Balumath

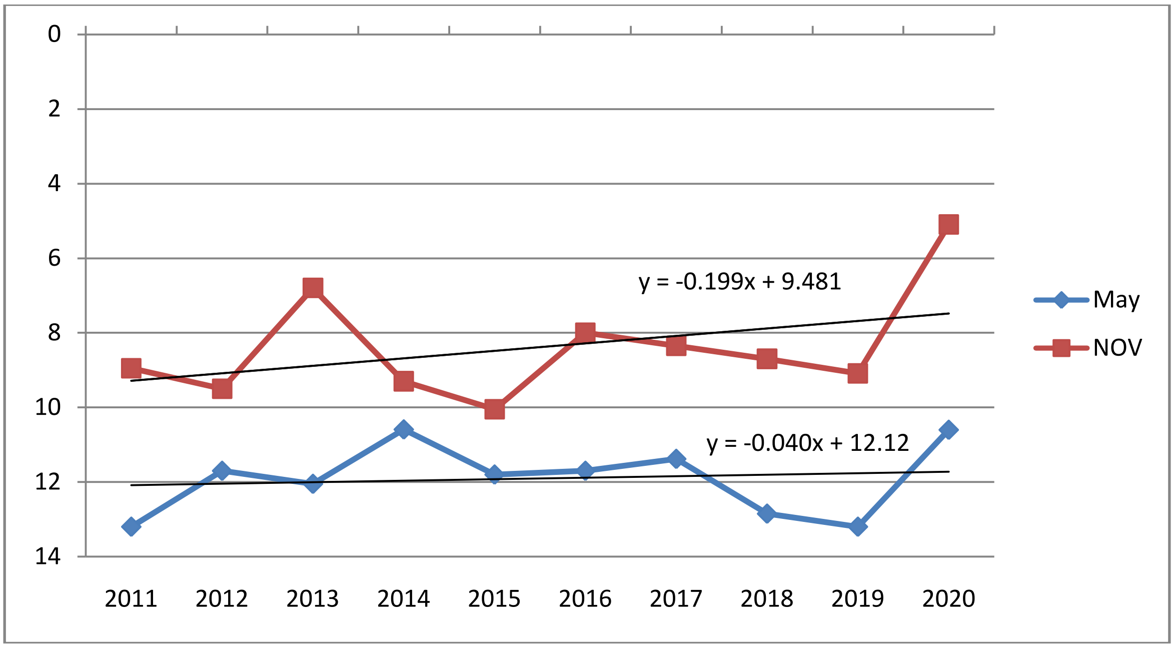


Figure 12: Hydrograph (2011-2020), Balumath, Balumath block, Latehar district

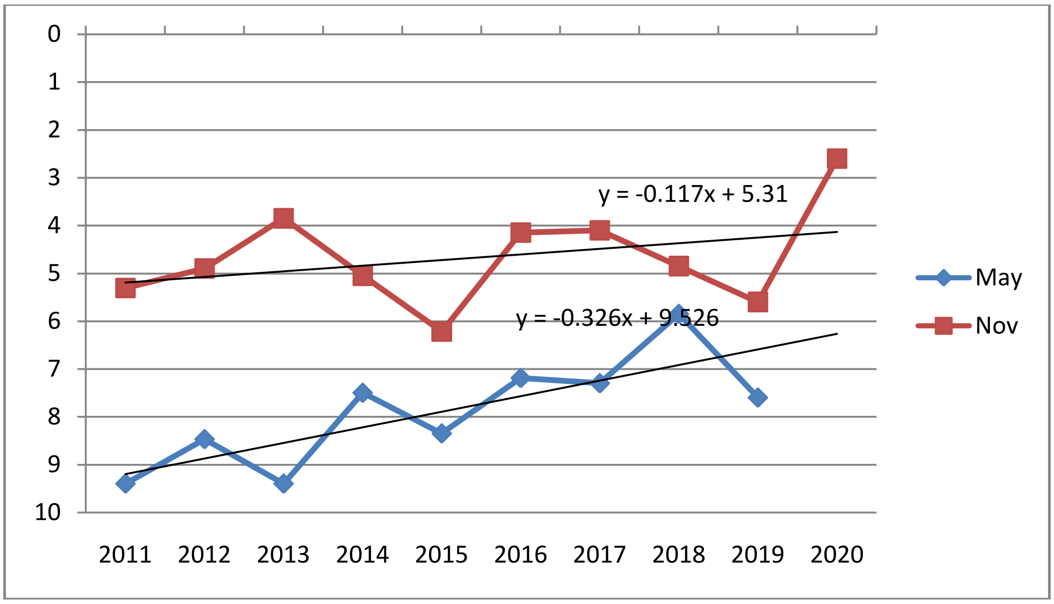


Figure 13: Hydrograph (2011-2020), Bariyatu, Bariyatu block, Latehar district

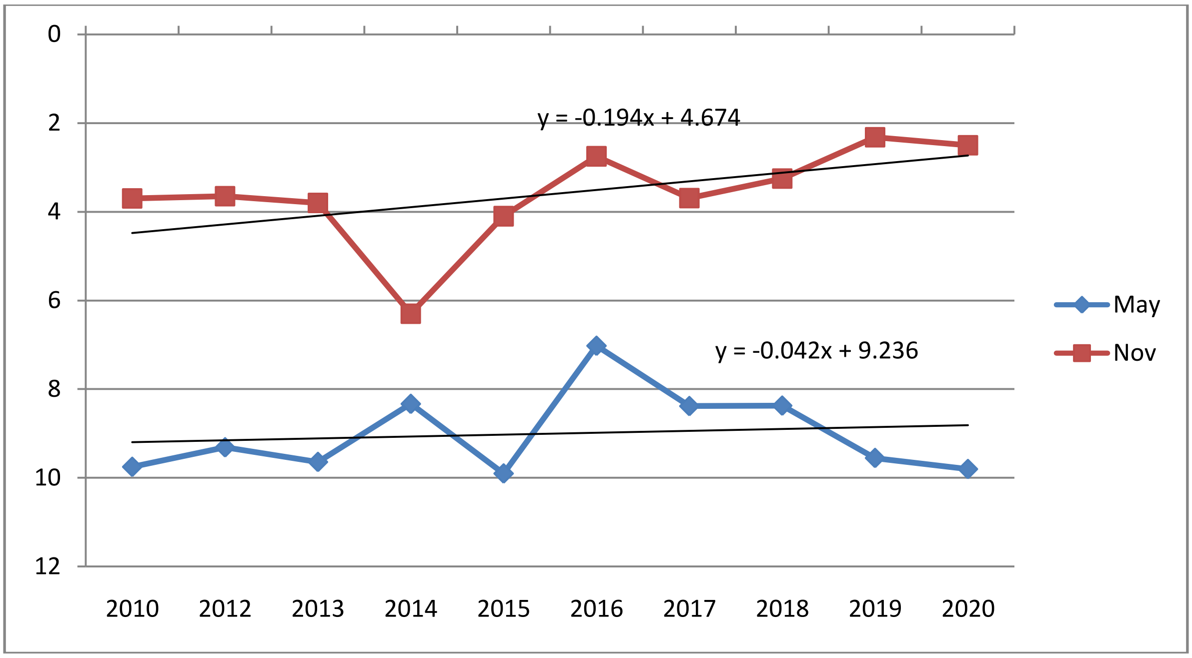


Figure-14: Hydrograph (2011-2020), Barwadih, Barwadihblock, Latehar district

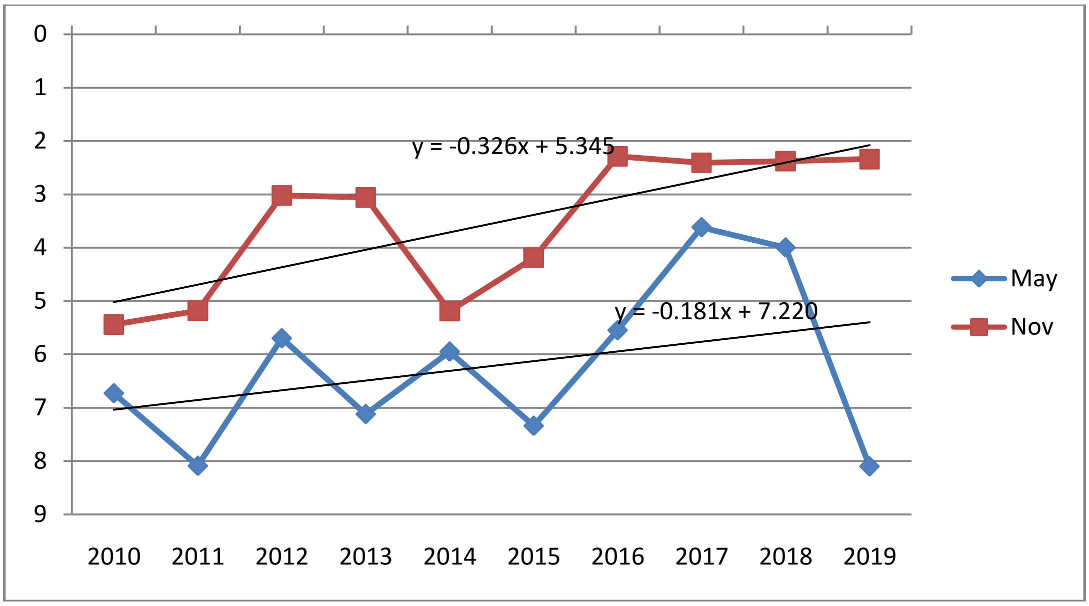


Figure- 15: Hydrograph (2011-2020), Latehar, Latehar block, Latehar district

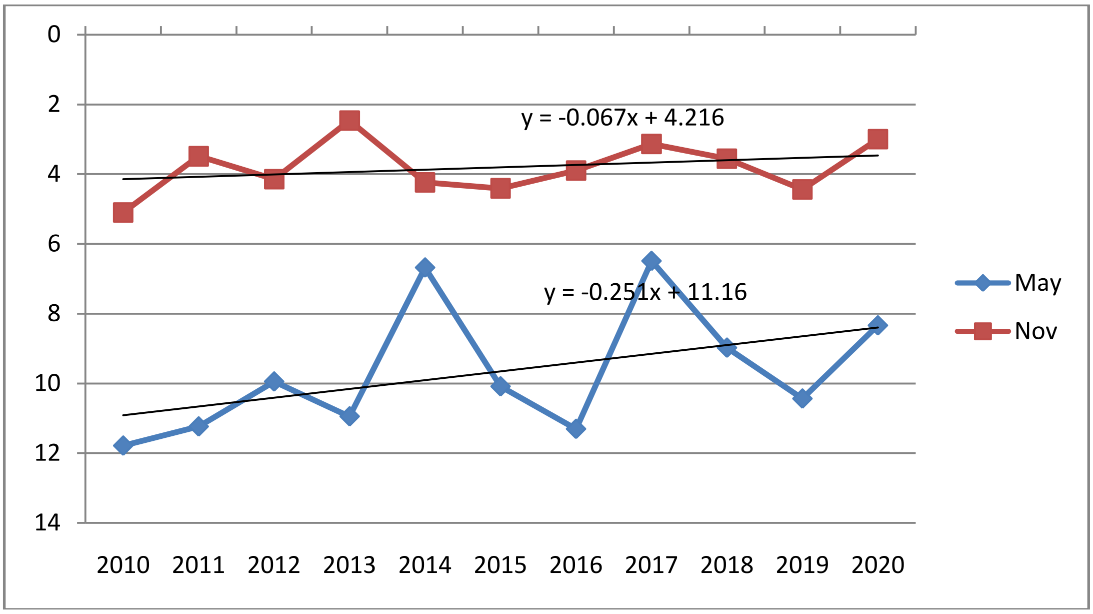


Figure- 16: Hydrograph (2011-2020), Chandwa, Chandwa block, Latehar district

2.3 Geophysical Survey:

at least 86 VES is required in the district each block and 86 nos. of VES have been done by WAPCOS in Latehar district. Latehar district is mostly occupied by Precambrian granite gneiss. The Gondwana sediments (Talchir) occurs in centaral parteast-west. A total of 86 VES were carried out in Latehar district. Based on the interpreted results of 86 VES, it is observed that at 49 VES sites the weathered zone is absent. At 22 VES the weathered zone is having the depths more than 9 meters which can be considered for shallow depths ground water tube wells. At the rest 15 VES the weathered zone is very thin, less than the depth range 9 meter. At 6 VES sites the weathered zone in granite gneiss terrain extends more than the depth 20 m depth. The thickenning of weatherered zone at these sites as well as other sites appears to be structurally controlled. These range of resistivity i.e., 50-150 ohm m at shallow depths (more than 9m) are considered as semi weathered formation aquifer and that of at deeper depths these are considered as less compact formation aquifer. On the basis of these considerations 43 sites are detected to be semi weatherd zones/ Less compact zones which are given in the table. The fractured zones have been delineated at so many sites.These are generally delineated on the basis of curve break techniques and current increase methods. These fracture zones are generally available when the over all resistivity of the curve is little lesser than the very high resistivity. Most of the cases the when the depths of the less compact formation is more or depth to the compact formation is not available, the probability of presence of fractures are more. On the basis of these considerations in 76 nos of VES the fracture zones are detected. In a few cases the fractures may be dry and feeble. Location map of VES is given in figure-17.

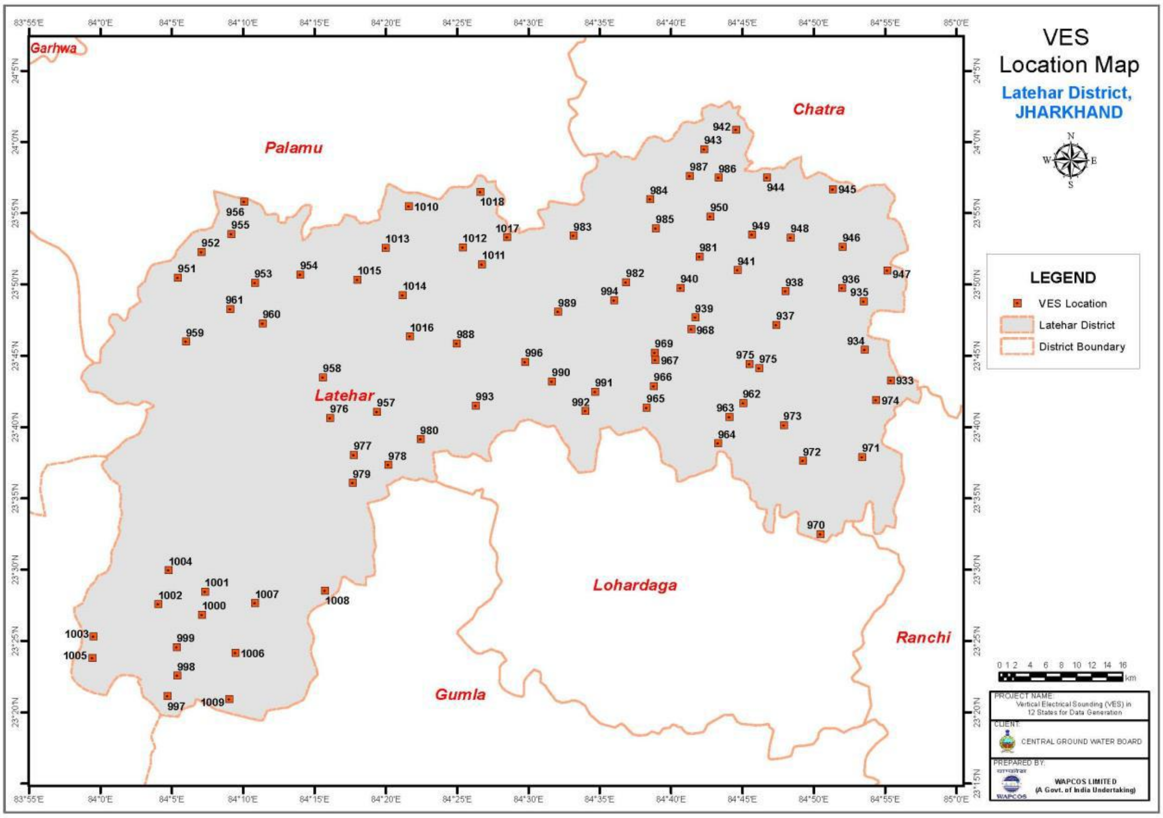


Figure 17: Map of Latehar district showing VES locations

2.4 Ground Water Quality:

The quality of water plays prominent role in promoting both the standards of agriculture production and human health. To evaluate the quality of ground water, samples have been collected from 38 dug wellsand Hand pumps .The analytical results of water samples dug wells are given in Annexure-V. The ground water samples were analyzed for major chemical constituents by using standard procedure at chemical laboratory in CGWB, MER, Patna. These samples have been considered to assess the chemical quality of ground water and its suitability for drinking and irrigational purposes. Since the samples are collected from the dug wells, they represent the quality of Aquifer I (phreatic/ shallow zone)

2.4.1 Chemical Parameters Of Aquifer – I

Evaluation of ground water suitability in relation to its different purposes has been classified for drinking / domestic and irrigation. Water is very essential for life. Many a times it has raw consumption or indirectly (in food). Hence, it should be free from turbidity, odor, bacterial and poisonous contents and also chemically soft, low T.D.S value and other chemical constituents should range within low to tolerable limits. Excessive and longer use of water beyond these limits may endanger to many health problems. The variation range of the concentration in ppm of different chemical constituents and quality parameters of Aquifer I (dug wells samples) in table-9.

The distribution of different constituent in ground water can be described as follows:-

Hydrogen ions activity:

It is expressed in terms of pH and shows the acidity & basicity of the solution. Natural water reacts with H^+ & H^- ions and forms H_3O or ions. The recommended limit (6.5 to 8.5) by BIS, 2012 is base on taste, corrosion and scale formation criteria. The pH value in Aquifer-I ranges from 6.90 to 8.39 mg/l.

Electrical Conductivity:

Generally, the water's electrical conductivity increases in the dry periods because of evaporation and decreases in the rainy days because of the precipitation and also to the surface runoff flow into reservoir. The EC value in Aquifer-I ranges from 39 to 2350 Microsemen at 25^{0c}.

Carbonate & bicarbonate:

Naturally occurring carbondioxide is the foremost source of carbonate and bicarbonate ions in ground water along with the carbon cycle and carbonaceous rocks. Leaching of calcite or dolomite bearing rocks (mainly carbonate) is also a principal source of these ions at places. Carbonate content of the area is not detectable. The bicarbonate concentration ranges between 12.30 to 338.25mg/l.

Chloride:

The chloride anions in a certain water environment are characterized by a high stability. Thus, the concentration of chlorides shows little change after long flow distance because the dissolution of chloride is greater in water and the reaction between Cl- and other ions in stratum is insignificant. The Chloride concentration ranges between 3.54 to 313.11 mg/l.

Fluoride:

Its low solubility in water makes it different form the rest of halogen family. Fluoride geochemistry is mainly governed by fluoride bearing minerals found in Chotanagpur Gneissic complex.The main sources are fluorite (CaF_2), fluorapatite & other minerals present in rocks contributing the ion in water. The Flouride concentration ranges between 0.00 to 2.89 mg/l. Flouride concentration figure is given in figure -16.

Sulphate

Sources of sulphate are minerals pyrite (FeS_2), anhydrite ($CaSO_4$). Under some conditions considerable quantities of sulphate may be obtained from organic Sulphur compounds. The generalized formulae for sulphate reaction ius;

$$SO_4^{2-} + 2CH_2O \rightarrow 2HCO_3^- + H_2S$$

The Sulphate value ranges between 1.16 to 333.22 mg/l.

Sodium

Sources of sodium are halite, sea spray, brines and some silicates. Common sodic silicates include plagioclase. The only common sink for sodium is reverse ion exchange that occurs when highly saline waters come in contact with calcium rich clays.

The Sodium concentration ranges between 0.63 to 285.49 mg/l.

Calcium:

In mineral form, it is found as Calcite, aragonite, gypsum, anhydrite, anorthite, diopside etc. The Calcium concentration ranges between 6 to 168 mg/l.

Magnesium:

The most common source of large quantities of magnesium in natural waters is dolomite. Magnesium is also derived from the silicates olivine, pyroxene and amphibole. The main sink is montmomorillonite. The Magnesium concentration ranges between to 1.21 88.65 mg/l.

Total Hardness:

It is expressed in terms $CaCO_3$ and it is equal to Calcium + Magnesium equivalent per litre. It can be classfied as under:-

Hardness range (mg/l $CaCO_3$) -	Class	
0- 60	-	Soft
61-120	-	Moderately hard
121-180	-	Hard
>180	-	Very Hard

In the study area, the total hardness value ranges from 20 to 785 mg/l.

Table - 9: Ranges of chemical constituents of Aquifer – I

Chemical Constituents and quality parameters	**Aquifer – I (Dug well samples)**
pH	6.90- 8.39
EC (micro siemens/cm at 25^0c)	39 - 2350
TDS (ppm)	25.35 -1527.5
TH as $CaCo_3$ (ppm)	20 -785
Ca (ppm)	6 -168
Mg (ppm)	1.21 – 88.65
Na (ppm)	0.63 – 285.49
K (ppm)	0.07 – 93.79

HCO_3 (ppm)	12.30 – 338.25
Cl (ppm)	3.54 – 313.11
SO_4 (ppm)	1.16 – 333.22
NO_3 (ppm)	1.12 – 70.37
F (ppm)	0.00 -2.89

The ground water of Aquifer – I (shallow aquifers) in the area is alkaline in nature. On the perusal of table - 9, the pH value of the area is 6.90- 8.39. The TDS value is varies between 25.35 to 1527.5 mg/l. Overall values of Calcium and Magnesium varies between 6 to 168 mg/l and 1.21 to 88.65 mg/l in the area respectively. Nitrate concentration is observed between 1.12 to 70.37 mg/l while the Fluoride value varies from 0.00 to 2.89mg/l within the area. Flouride concentration more than permissible limit in the district is given below in the figure: 18.

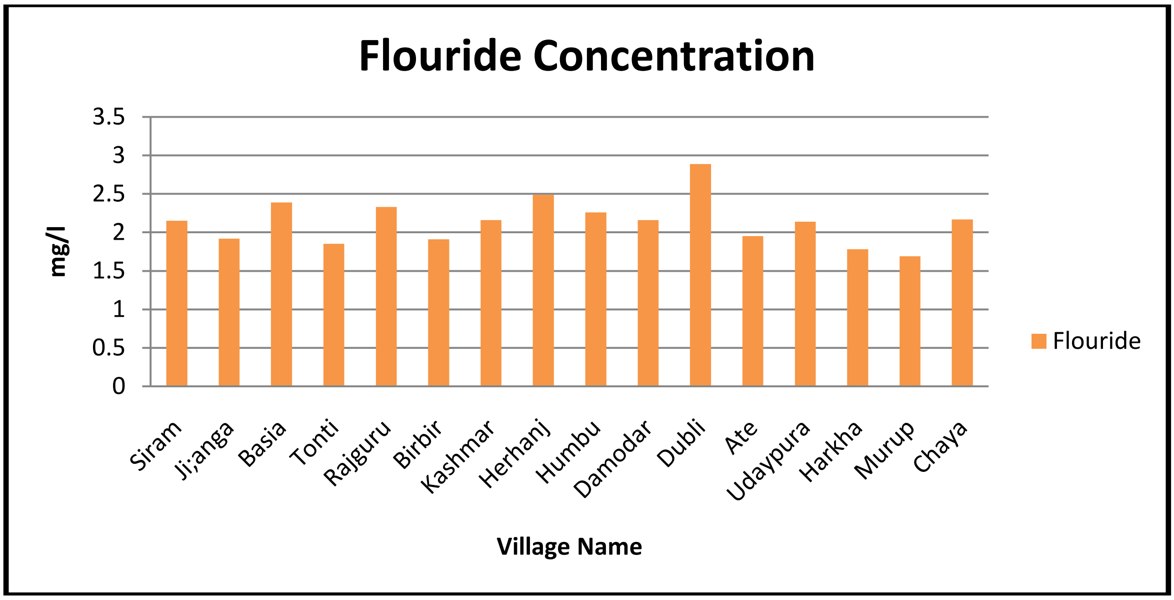


Figure 18. Flouride Concentration in Latehar district

2.4.1.1 Suitability of Ground Water of Aquifer – I for Drinking Purposes

The suitability of ground water for drinking purposes is determined on the basis of drinking water specification adopted by the Bureau of India Standards IS 10500 – 91 Revised 2012 and approved by World Health Organization (WHO). The number of water samples falling under various categories of permissible and desirable limits of various constituents and its percentage are given in table – 10 Aquifer – I.

Table-10: Suitability of ground water of Aquifer- I for drinking purposes

Chemical constituents and quality parameters	Ranges Desirable		No. of samples under desirable limits	No. of samples under permissible limit	No. of samples under excessive limits
	Desirable limit	Permissible limits in the absence of alternate source			
Ph	6.5 to 8.5	No relaxation	38 (100%)	Nil	Nil
TDS (ppm)	500	2000	30 (79%)	8 (21%)	Nil
TH as $Caco_3$ (ppm)	200	600	23 (60%)	14 (37%)	1(3%)
Ca (ppm)	75	200	34 (89%)	4 (11%)	Nil
Mg (ppm)	30	100	37 (97%)	1(3%)	Nil
Cl (ppm)	250	1000	36 (95%)	2(%%)	Nil
SO_4 (ppm)	200	400	35(92%)	3(8%)	Nil
HCO_3 (ppm)	200	600	29 (76%)	9(24%)	Nil
NO_3 (ppm)	45	No relaxation	21(61%)	Nil	15(39%)
F (ppm)	1.0	1.5	22(58%)	Nil	16(42%)

The table - 10 indicates that all the water samples are falling in desirable to permissible category except Nitrate and Flouride. The value of Nitrate observed beyond permissible limit (mg/l) in 15 samples. Similarly, the value of in 16 Samples of Flouride were found within permissible limit.

2.4.1.2 Suitability of Ground Water of Aquifer – I Irrigation Purposes

Apart from domestic consumption, irrigation is consuming a major share of ground water for agricultural activities. The quality of water used for irrigation is an important factor in productivity and quality of irrigated crops. The suitability of water for irrigation purpose depends upon the Total Dissolved Solid in terms of EC value, concentration of Na, bicarbonate and its relative proportion to Mg and Ca. All these mentioned above either individual or with combination create concentration of Sodium (salinity) bicarbonate and alkalis type of hazard.

To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different classifications. Various parameters viz. Total Dissolved Solids (TDS), Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Salt Index (SI), Soluble Sodium Percentage (SSP) & Water Class have been evaluated to assess the suitability of ground water for irrigation purposes.

Sodium Percentage classification: - EC and sodium concentration are very important in classifying irrigation water. The salts, besides affecting the growth of the plants directly, also affect soil structure, permeability and aeration, which indirectly affect plant growth. Sodium is a major ion used for the classification of irrigation water due to its reaction with soil that reduces its permeability. Percentage of Na is generally used for assessing the suitability of water for irrigation purposes. Na is expressed as percent sodium or soluble-sodium percentage (Na %) using Eq.

$$Na\,\% = \left(\frac{Na^{+}+K^{+}}{Ca^{2+}+Mg^{2+}\,Na^{+}\,K^{+}}\right) * 100$$

Table- 11: Classification of ground water of Aquifer - I based on sodium percent

Sl No.	Water class or category	Sodium percent	No. of samples falling	Percentage of samples
1	Excellent	< 20 %	12	32%
2	Good	20 – 40 %	22	58%
3	Permissible	40 – 60 %	2	5%
4	Doubtful	60 – 80 %	2	5%
5	Unsuitable	> 80 %		

(Where all ions are expressed in epm)

On the perusal of table 90% of water samples of aquifer – I (dug wells) falling under excellent to permissible category.

Sodium adsorption ratio (SAR): -In assessment of the quality of water used for irrigation, sodium adsorption ratio (SAR) is a vital parameter. Enhanced salinity decreases the osmotic activity of plants as well as stops water to reach to the branches and leaves of plants resulting in inferior production. Moreover, irrigation water with high sodium and low calcium favors ion exchange by saturation of Na and is detrimental to the soil structure due to scattering of clay particles resulting in minor production because of difficulty in cultivation. The sodium adsorption ration is calculated from the ionic concentration of Sodium, calcium and magnesium according the following relationship:

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

SAR values can be used to predict the degree to which irrigation water tends to enter into cation exchange section in soil. The higher value of SAR indicates damage of soil. Based on the SAR value the groundwater suitability classification is shown in Table-12 which is showing that all the water samples (100%) of aquifer – I (dug wells) pertain to excellent class. In Latehar district all all 38 water samples collected during the field falls in the (0-10) C1 category, ground water is excellent for irrigation.

Table: 12 Sodium Adsorption Ratio

Sodium Hazards Class	SAR (meq/L)	Remarks	Study area quality
C1	0-10	Excellent	All (38 sample)
C2	10-20	Good	-
C3	20-26	Doubtful	-
C4	>26	Unsuitable	-

Residual Sodium Carbonate (RSC)

The potential for a sodium hazard and Residual sodium carbonate (RSC) are directly proportional, and much of the calcium and magnesium are precipitated out of solution when water is supplied to the soil. In study area 38 samples are Safe for all type of for irrigation.

On The perusal of table-13, about 100 % of water samples of Aquifer – I (dug well) falling under good water class.

Table: 13 Residual Sodium Carbonate (RSC)

Parameter	Range	Irrigation Suitability	Sample	Percentage
Residual Sodium Carbonate **(RSC)**	< 1.25	Safe for all type of crops	38	100
	1.25 – 2.50	Safe for semi-tolerant to tolerant crops	Nil	Nil
	>2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC	Nil	Nil

(All the values are expressed in epm)

Suitability of ground water based on Electrical Conductivity (EC):

To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different water class based on Electrical Conductivity (EC), 8 no. (21%) water samples are excellent 21 no. water samples (55%) are good category, 8 no. (21%) water samples are in permissible category and 1 no. water sample is unsuitable which is presented in table – 14.

Table- 14: - Classification of ground water of Aquifer – I based on EC

Sl. No.	Water Class	Rages of EC	No. of samples falling and their percentage
			Aquifer – I
1	Excellent	< 250	8 (21%)
2	Good	250 – 750	21 (55%)
3	Permissible	750 – 2250	8 (21%)
4	Unisuitable	>2250	1(3%)

Piper Diagrame for Classification of Irrigation Water:-

The Piper diagram is used to categorize the type of water. It comprises of three parts: one diamond shaped diagram in the middle and two trilinear diagrams sideways in the bottom. The comparative concentrations of cations (left diagram) and anions (right diagram) in each sample is depicted in the trilinear diagram. For presenting ions in a piper diagram, the cations are clustered into three major divisions: sodium (Na) plus potassium (K), calcium (Ca), and magnesium (Mg). The anions are likewise grouped into three main categories: bicarbonate (HCO_3^{2-}) plus carbonate (CO_3^{2-})), chloride (Cl^-), and sulfate (SO_4^{2-}). Each sample is denoted by a point in each trilinear diagram; the type of water samples will make the grade according to the symbolic area in piper diagram.

Based on the major cation and major anion content in the water samples and plotting them in the trillinear diagram, hydrochemical facies could be identified. In Aquifer I cation chemistry out of 38 samples, 32 samples are no dominant type 4 samples is Calcium dominant and 2 samples are Sodium and Potasium dominant. In anion part 18 samples are Bicarbonate dominant, 6 samples are no dominant (mixed typed) and 4 samples are Chloride dominant. In the dimond part plotted chemical falling 16 samples are Magnesium bicarbonate type (Mg-HCO_3) and 10 samples are mixed type and 2 samples are Sodium Chlorite types. The Diamond part of the Piper Diagram reveals that most of the water samples fall in the hardness region. Figure 19 is given below.

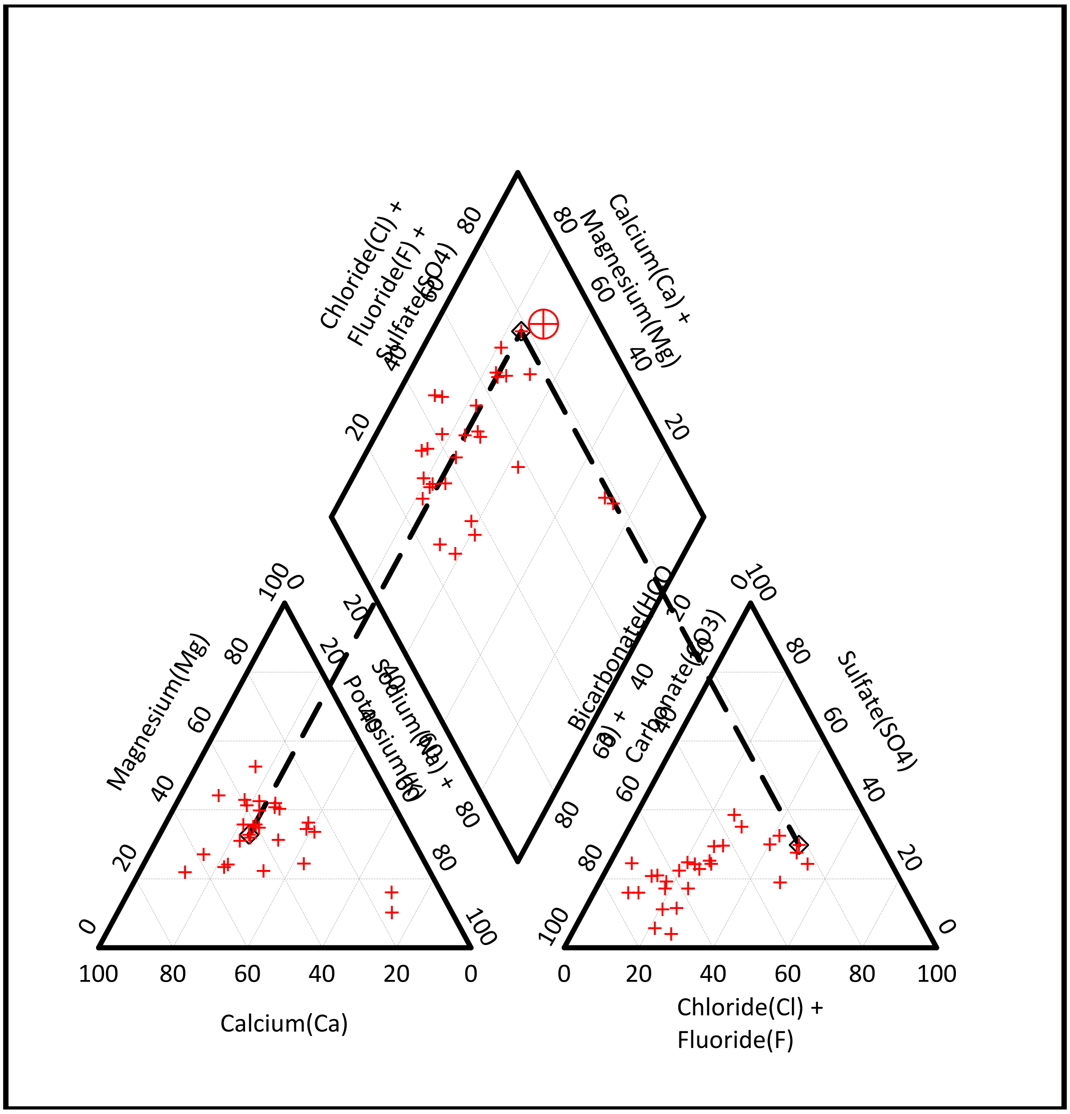


Figure:-19 Piper Diagrame for Aquifer – I

2.5 Ground Water Exploration:

The exploratory data particularly includes the information on sub–surface geology, hydrogeological information and geometry of aquifer in Alluvium as well as in hard rocks. Based on exploration data, prepared litholog of EW & OW, in hard rock area depth of fractured/joints encountered within 200m depth formation has been presented in Annexure III.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

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

3.1 Aquifer Disposition

3.1.1 Hydrogeological Cross Section:-

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A’ (SW to NE direction), B-B’ (E-W direction) and C-C’ (NW to SE Direction). X and Y axis represent Elevation in MSL and Horizontal distance respectively.

3.1.1.1 Hydrogeological cross section A-A’:

Hydrogeological cross section A-A’ represents the area in Western part NE to SE direction of Latehar district. Cross section covers exploratory wells of Hami, Lakhehmpur,Maromar, Manika and Bandua. The Aquifer- I ranges 7.94 – 28.15 m representing weathered Granite gneiss, Granite, while Aquifer-II ranges from 27.89-138.90 m representing fractured granite gneiss. Generally 1-5 fracture zones were encountered. Discharge ranges from 0.25-13.77 LPS . Maximum discharge found at Bandua (13.77 LPS) and minimum at Manika (0.25 LPS).

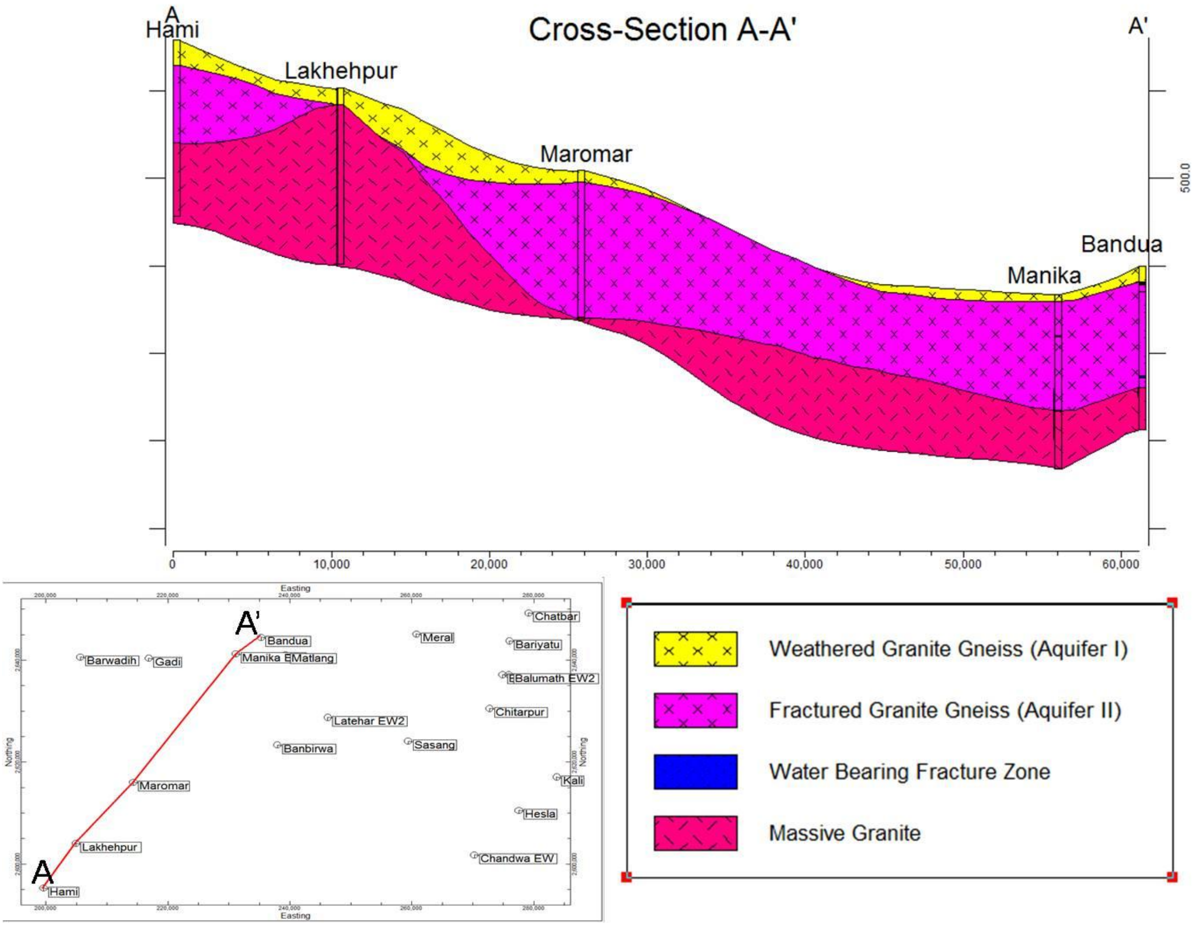


Figure-20: Hydrogeological cross section along A-A'

3.1.1.2 Hydrogeological cross section B-B': -

Hydrogeological cross section B-B' represents the area in E-W direction of Latehar district. Cross section covers exploratory wells of Barwadih, Gadi, Manika, Matlang and Balumath. The Aquifer- I ranges 5.73 – 23.67 m representing weathered Granite gneiss, while Aquifer-II ranges from 11-184 m representing fractured granite gneiss. Generally 0-4 fracture zones were encountered. Discharge ranges from 0.25 LPS- 6.63 LPS. Maximum discharge found at Gadi and minimum at Manika.

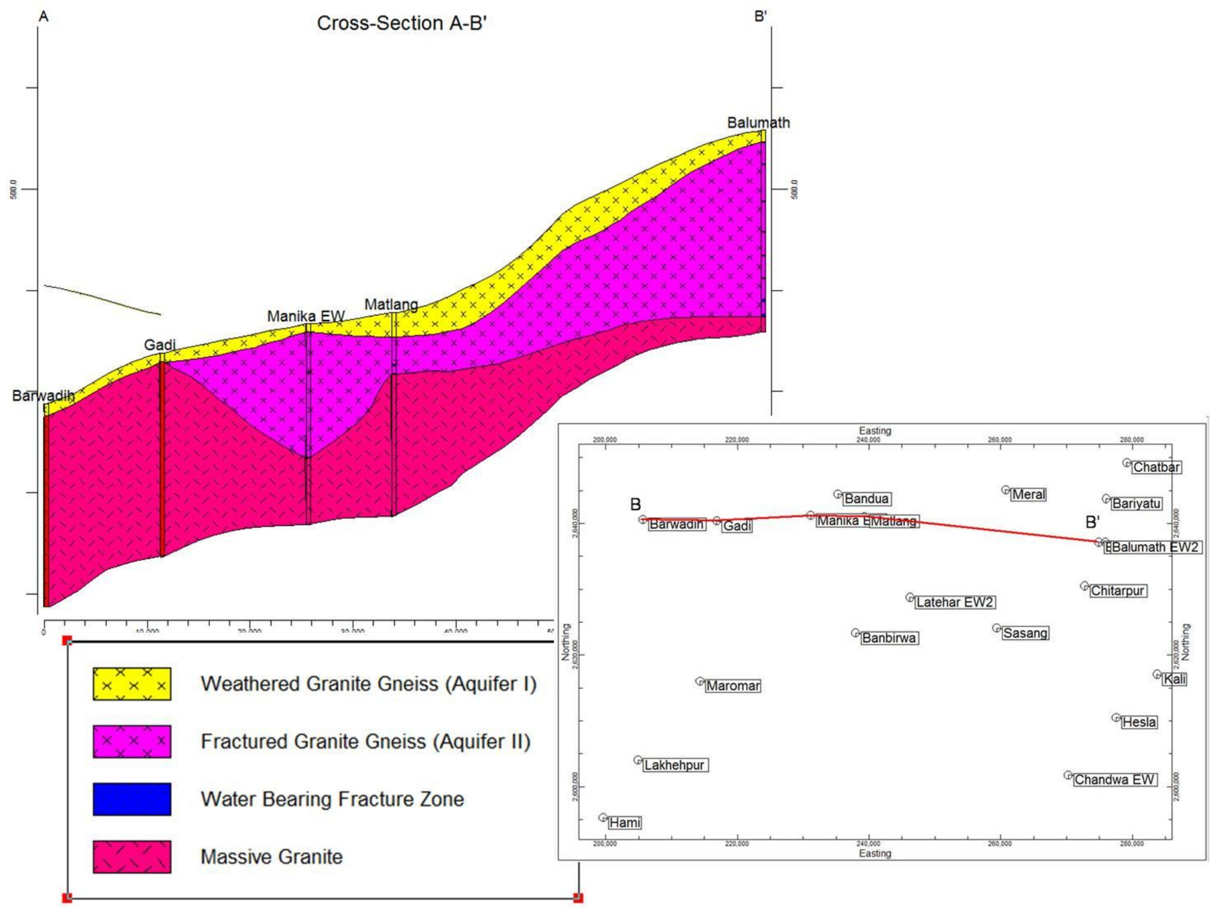


Figure-21: Hydrogeological cross section along B-B'

3.1.1.3 Hydrogeological cross section C-C':-

Hydrogeological cross section C-C' represents the area in NW to SE of Latehar district. Cross section covers exploratory wells of Manika, Latehar, Sasang and Hesla. The Aquifer- I ranges 7.94-23.93 m representing weathered Granite gneiss, while Aquifer-II ranges from 26-133 m representing Fractured in granite gneiss. Generally 0-4 fracture zones were encountered. Discharge ranges from Sepages to 7.73 LPS. Maximum discharges found at Hesla.

.

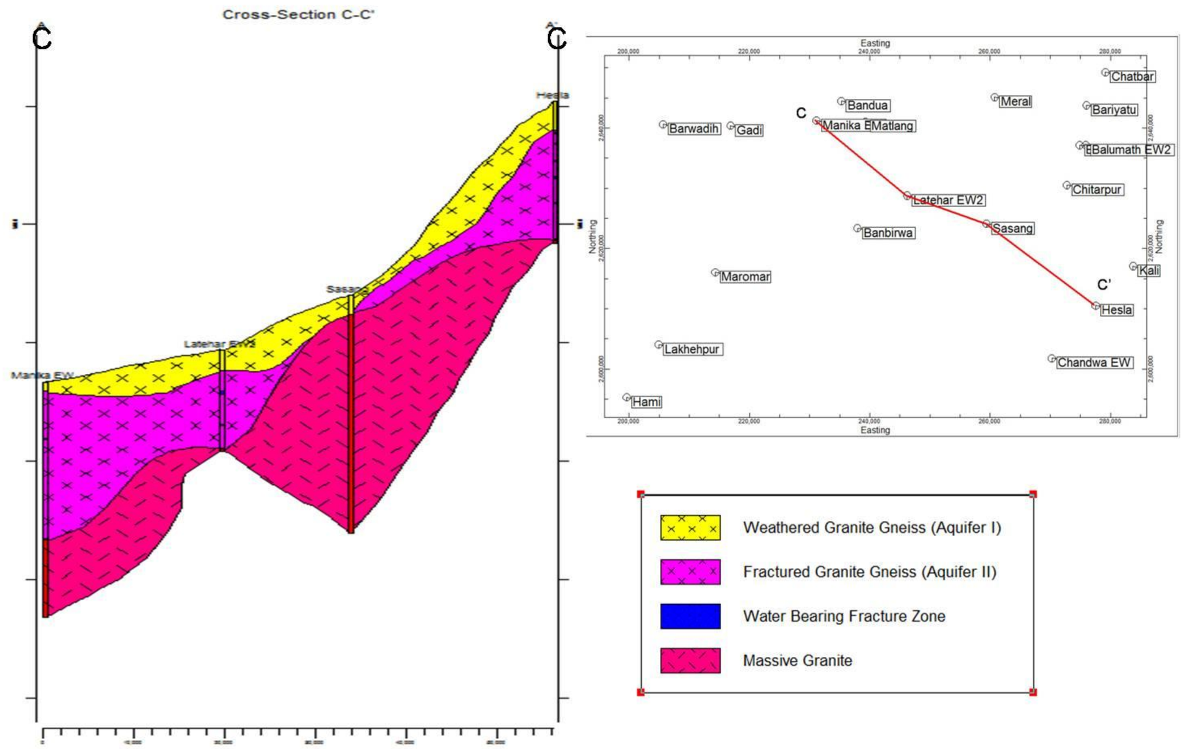


Figure -22: Hydrogeological cross section along C-C'

Hydrogeological cross section of A-A' B-B' & C-C' shown in figure- 20, 21,& 22 has been prepared based on exploratory well data of CGWB.The inferred imaginary line between fractured rock zone and massive rock zone depicted in Fig 20, 21,& 22 are also based on exploratory data. This is a regional model of hydrogeological cross setion. The heterogeneity of hard rock aquifer being high, the hydrogeological cross sections drawn by inferring the continuity of fracture zones in the second aquifer is tentative. Any additional data from the area in future may change the geometry of aquifer that can consider as well.

3.1.2 3-D Aquifer Disposition:

The 3-D map in hard rock area of the district showing spatial disposition and vertical extent of Aquifer-I indicating its depth of weathering while the Aquifer – II showing occurrence of fractured rock thickness is presented in figure – 23 & 24. Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in hard rock area is 28.0 m. The depth of Aquifer – II (fracture zone) ranges from 11 to 184 mbgl.

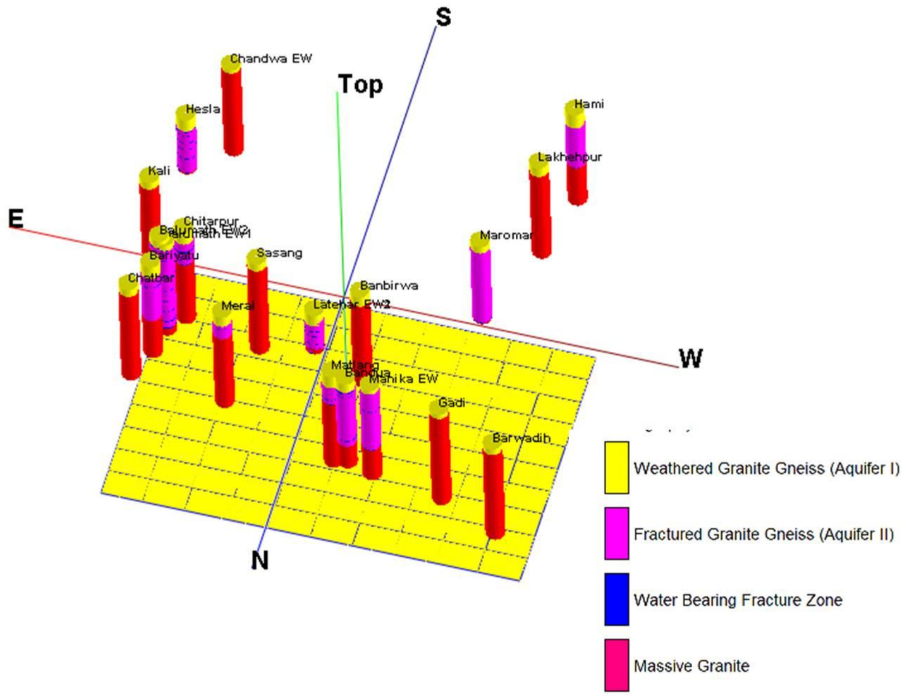


Figure –23: Three dimensional strip-log of EW drilled in Lohardaga district

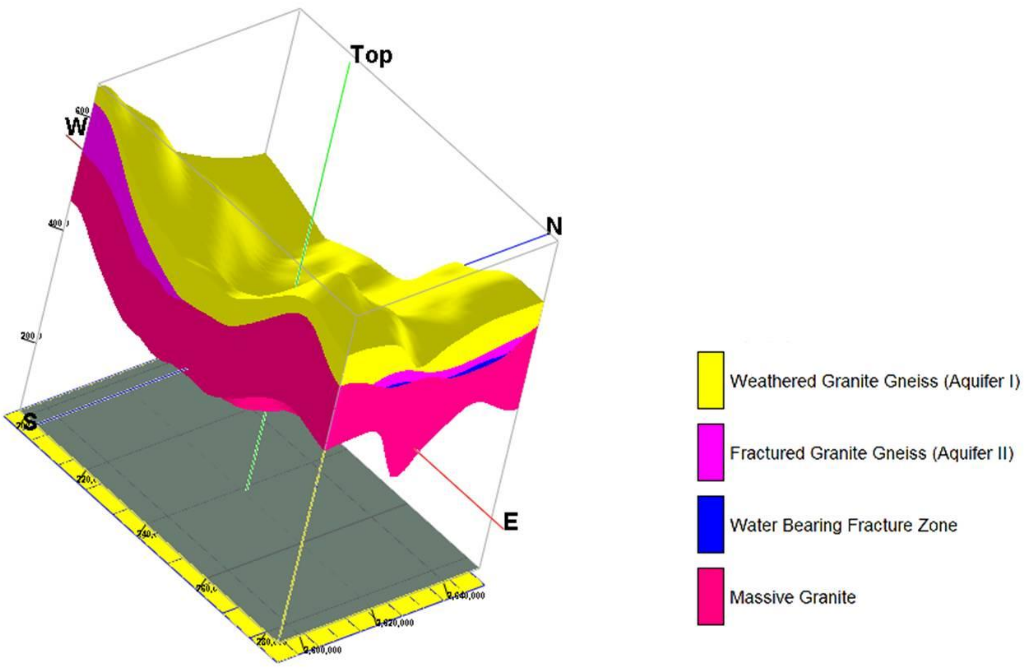


Figure –24: 3D Subsurface lithological models with Aquifer Disposition in Latehar district

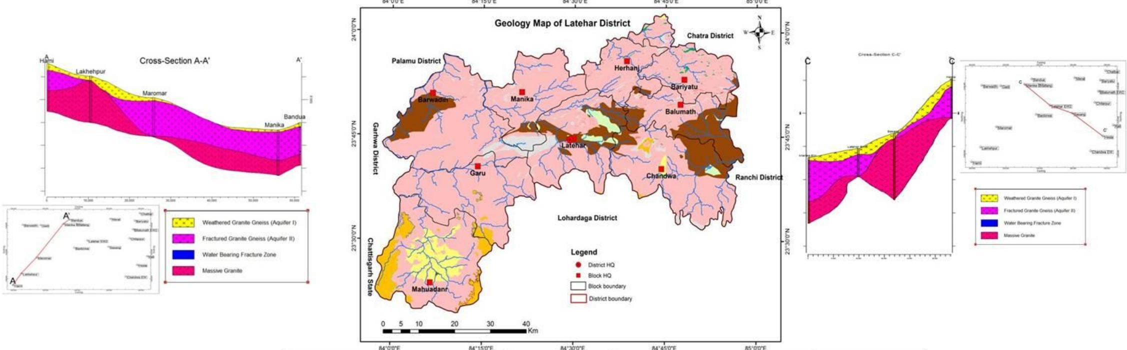
3.2 Aquifer Charcteristics

To know the aquifer Characteristics, Step Drawdown test (SDT) and Aquifer Performamce Tests (APT) were earlier conducted by CGWB is considered. Granite, Granite Gneiss forms the main aquifer of the area and comprises two distinct units viz, weathered zone and hard rock fractured zones. Granite gneiss is hard, compact and does not have primary porosity and hence impermeable. Weathering, jointing and fracturing induces secondary porosity in massive unit of granite gneiss. Average thickness of fractures in Aquifer-II is about 1-2 m. Along with yield potential, the aquifer parameters viz., transmissivity and storativity also form an important aquifer characteristic and provide valuable input on sustainability of the aquifers. The transmissivity of Aquifer-II ranges from 1.67-123.5 m2/day, whereas storativity of the aquifer ranges from 7.33 X10-5 to 5.75x10-4

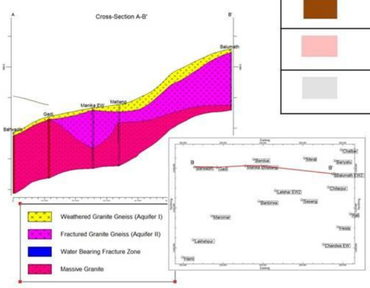
Table 15: Aquifer characteristics in hard rock areas of Latehar district

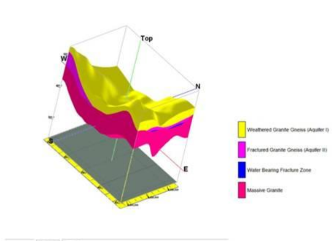
Type of aquifer	Formation	Depth range of the aquifer	SWL (mbgl)		Thickness	Yield (m3/hr)	Aquifer parameter	
			Pre Monsoon (2019)	Post Monsoon (2019)			T (m^2/day)	Sy/S
Aquifer - I	Weathered Granite-Gneiss	5- 28 m	2.60 - 9.85	1.20 - 5.80	5- 10 m	5-10	-	-
Aquifer - II	Jointed/ fractured Granite Gneiss	11-184 m	-	-	1-2 m	Upto 49.5	1.67-123.5	7.33 X10-5 to 5.75x10-4

3.3 Aquifer Maps:- Based on Aquifer Disposition, Aquifer Geometry, Aquifer Characteristics, Aquifer Maps in Latehar district have been prepared as under in Fig-25



	Formation	Lithology	Hydrogeology	Ground Water Potential
	Recent to Quaternary	Alluvium, sand, clay, silt etc.	Moderate thick limited along river banks mainly unconfined/semiconfined aquifer	Up to10 m3/h
	Lower Gondwana	Shale, Sandstone, Conglomerate	Moderate thick limited in extent confined to semiconfined aquifer	Below 10 m3/h
	Chhotanagpur Gneissic Complex	Biotite Gneiss	Ground water restricted in weathered zones and interconnected Fractured	In Dug well 10m3/h Bore well 5 to 30m3/h
	Unclassified Metamorphics	Limestone, Impure Marble, Calc-Silicate Rocks	Poor Ground Water Potential	





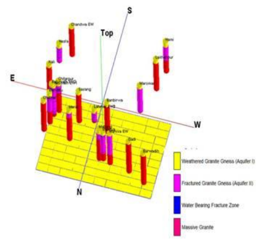


Figure -25 Aquifer maps of Latehar district

4.0 GROUND WATER RESOURCE

Ground Water Resource of the area has been estimated block wise based on as on 2020 water year. 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)

4.1.1 Recharge component

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

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

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, SUO, Ranchi in association with State Ground Water Direcorate, Jharkhand based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of Latehar district is in Table-17. Other details information regarding Dynamic Ground Water Resources of Latehar district is provided in Annexure-VII.

4.1.2 Dynamic Ground Water Resources Availability, Draft and Stage of GW Development 2020

Table- 16: Dynamic Ground Water Resources Availability, Draft and Stage of GW Development 2020

(Figures in hectare meter)

Assessment Unit/ District	Annual Extractable Ground Water Recharge	Current Annual Ground Water Extraction for irrigation	Current Annual Ground Water Extraction for domestic	Current Annual Ground Water Extraction for industrial	Current Annual Ground Water Extraction for All uses	Net Ground Water Availability for future use	Stage of Ground Water Extraction in %	Category
Balumath	2472.12	535.00	117.46	100.00	752.46	1718.85	30.44	safe
Bariatu	1709.51	537.50	79.30	0.00	616.8	1092.16	36.08	safe
Barwadih	2700.59	940.00	139.73	5.28	1085.01	1614.61	40.18	safe
Chandwa	4181.85	771.50	160.35	13.26	945.11	3235.63	22.60	safe
Garu	1042.07	624.00	39.95	0.00	663.95	377.84	63.71	safe
Herhang	1385.06	193.50	45.70	0.00	239.2	1145.55	17.27	safe
Latehar	2625.40	825.50	221.82	0.00	1047.32	1576.53	39.89	safe
Mahuadanr	4368.67	379.00	98.61	0.00	477.62	3890.36	10.93	safe
Manika	1575.36	303.00	116.25	0.00	419.25	1155.31	26.61	safe
Total	22060.63	5109	1019.17	118.54	6246.72	15806.84	28.32	

4.2 Ground Water Resources In-storage – Aquifer-I:-

The computation of the static or in-storage ground water resources is done after delineating the aquifer thickness and specific yield of the aquifer material. The computations can be done as follows:-

SGWR = A *(Z2 - Z1) * SY

Where, SGWR = Static or in-storage Ground Water Resources

A = Area of the Assessment Unit, Z2 = Bottom of Unconfined Aquifer, Z1 = Pre-monsoon water level, SY = Specific Yield in the In storage Zone

Table 17: Assessment of In-storage ground water resource of hard rock

AQUIFER I	
Area (A) (sq km)	3613
Pre-monsoon (average) depth to water level (mbgl) (Z1)	9.98
Bottom of Unconfined Aquifer (mbgl) (Z2)	17.32
Specific yield (Sy)	3%
Saturated zone thickness (Z2-Z1) of aquifer (ST)	7.34
SGWR = A *(Z2- Z1) * SY	mcm
instorage	795.58

4.3 Assessment of Total Ground Water Availability in Unconfined Aquifer (Aquifer-I)

The sum of Annual Extractable Ground Water Recharge and the in storage ground water Resources of an unconfined aquifer are the Total Ground Water Availability of that aquifer.

Total Availability (unconfined Aquifer. i.e Aquifer-I) = Annual Extractable Ground Water Recharge + In-Storage Ground Water Resource

Total Availability (Mcm) = **220.60** *mcm +* **795.58** *mcm =* ***1016.18****mcm*

5. GROUND WATER RELATED ISSUES

The Latehar district forms part of predominantly tribal belt wherein villagers have got very small land holdings and they do not find it economical to engage in agricultural activity in comparison to the earning, they earn by working as labourer in industrial units and Govt. Deprtments. Further, the cultivators are illiterate tribal and are ignorant of improved agricultural practices. By and large the district is not favoured with surface water irrigation system because of hilly and undulating geographical setting. The major ground water related issues are:-

5.1 Low Ground Water Development: One major issue of the area that is low ground water development. At present the overall stage of ground water development is only around 28.32%, based on 2020 GW resource assessment. Block wise stage of ground water development (SOD) varies from 36.93 to 71.08 percent. Graphical presentation of SOD is shown in figure – 26.

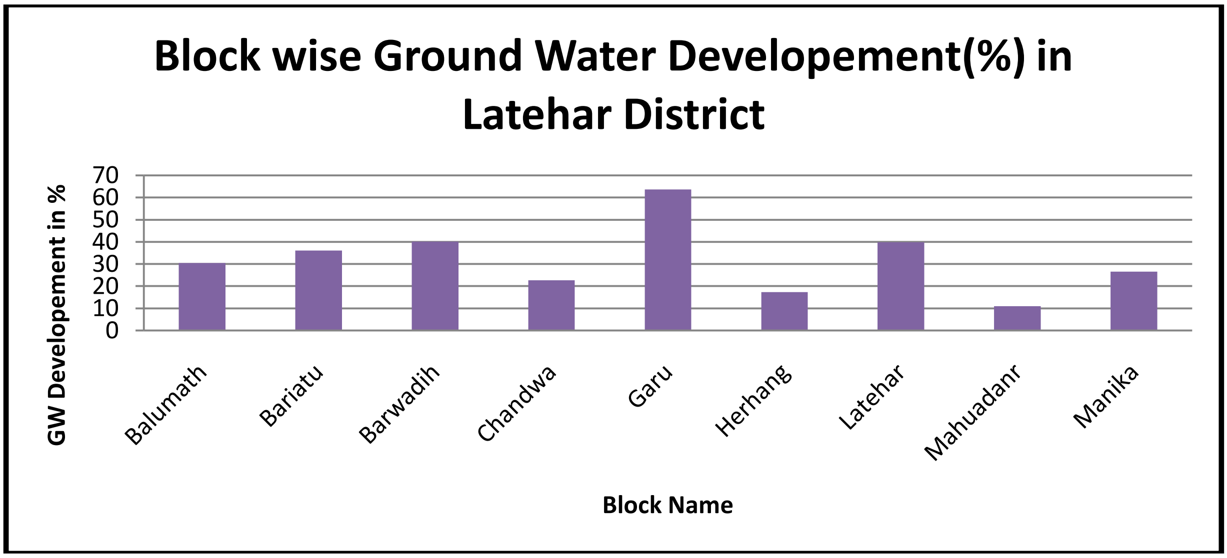


Figure 26 Block wise Ground Water Developement

5.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: Central Ground Water Board has constructed 21 exploratory and 3 observation wells in hard rock area of the district. The successful bore wells have up to 49.5m^3/h discharge. Average thickness of weathering is 1-2 m and secondary porosity i.e. fracture zone is 4-5 m. Transmissivity value is also very low which varies from 1.67 to 123.5 m^2/day in hard rock area. The exploratory drilling results show that fractures generally die down with the depth and below 184 m there is no fracture due to occurrence of massive rocks. The fracture encountered of bore wells drilled in the area is classified and presented below in figure – 27.

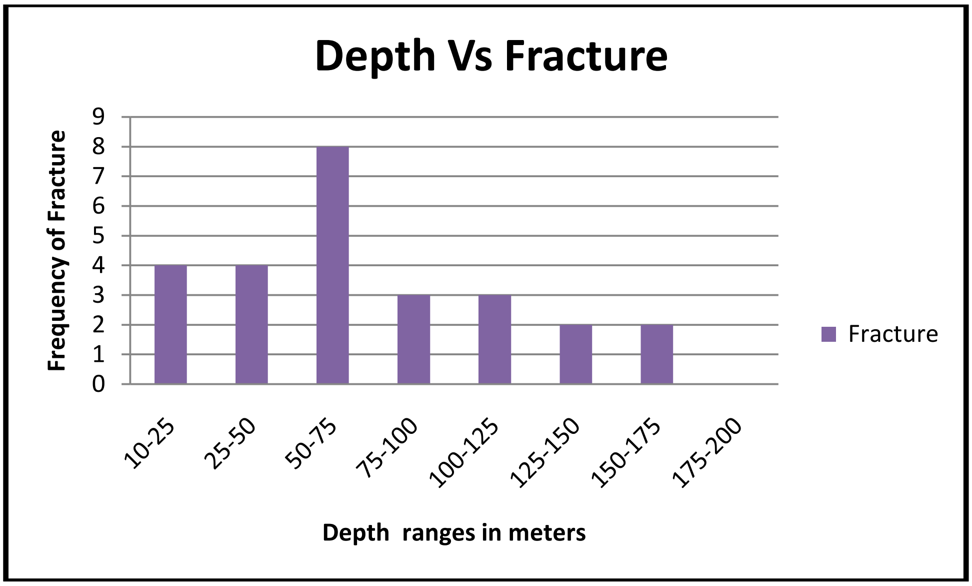


Figure – 27: Depth vs Frequency of fracture encountered in bore wells drilled in Latehar district

5.3 Ground water contamination:-

Analytical result of water samples collected from the district, it is found the Nitrate concentration is beyond permissible limit in 9 samples of shallow aquifer (dug well) Similarly, Fluoride concentration is found beyond permissible limit in 3 samples of shallow aquifer. In addition, very high EC value 1725 µ S/cm has been observed in dug well sample existing at Mohanpur in Mohanpur block. Location details of Nitrate and Fluoride concentration found beyond permissible limit are given in table 20 and 21 respectively and also represented in figure – 26.

5.3.1. Nitrate contamination: -

A variety of chemical constituents including Nitrate can pass through the soil and potentially contaminate ground water. Nitrate comes from the nitrogen, plant nutrient supplied by inorganic fertilizer and animal manure. Beneath agriculture land, nitrate is primary form of Nitrogen. It is soluble in water and can easily pass through soil to the ground water table. Nitrate can persists in ground water for decades and accumulated to high levels as more nitrogen is applied to the land surface every year. Nitrate is one of the most common ground water contaminations in rural areas. It is regulated in drinking water primarily because excess level can cause methemoglobinemia or blue baby disease. Nitrate can be removed from drinking water by distillation, reverse osmosis or ion exchange.

In shallow aquifer of Latehar ditrict 15 water samples out of 38 have been found more than the permissible limit of NO_3 (45mg/l). Location details of NO_3 concentration found beyond permissible limit is given in table 18.

Table 18: Nitrate concentration found beyond permissible limit

Sl. no	Village	Block	Concentration NO_3
1	Siram	Chandwa	54.56
2	Shanti	Chandwa	68.78
3	Jianga	Balumath	67.62
4	Basia	Balumath	70.15
5	Birbir	Bariyatu	70.37
6	Herhanj	Herhanj	51.7
7	Harkha	Latehar	51.53
8	Murup	Latehar	66.57
9	Chaya	Herhanj	63.24
10	Latehar (Karkat)	Latehar	51.5
11	Latehar(in front Of Forest Guest House)	Latehar	68.53
12	Senha	Chandwa	48.75
13	Hotwag	Latehar	51.49
14	Barwadih(NHS)	Barwadih	66.84
15	Ukamar	Barwadih	60.99

5.3.2 Fluoride contamination:

Consumption of water with fluoride concentration above 1.5 mg/l is harmful which results in acute to chronic dental fluorosis where the tooth become coloured from yellow to brown. Skeletal fluorosis which causes weakness and bending of the bones also results due to long term consumption of water containing high fluoride. Presence of low or high concentration of fluoride in groundwater is because of geogenic or anthropogenic causes or a combination of both.

In shallow aquifer 16 samples, out of 38 have F concentration more than the desirable limit of 1.5mg/l. Location details of F concentration found beyond permissible limit is given in table-19 and sample wise Fluoride concentration is shown in figure-28 for shallow aquifer.

Table – 19: Location details of Fluoride concentration found beyond permissible limit

Sl. no	Village	Block	Concentration F
1	Chandwa	Siram	2.15
2	Balumath	Jianga	1.92
3	Balumath	Basia	2.39
4	Bariyatu	Tonti	1.85
5	Bariyatu	Rajguru	2.33
6	Bariyatu	Birbir	1.91
7	Bariyatu	Kashmar	2.16
8	Herhanj	Herhanj	2.49
9	Herhanj	Humbu	2.26
10	Chandwa	Damodar	2.16
11	Chandwa	Dubli	2.89
12	Chandwa	Ate	1.95
13	Latehar	Udaypura	2.14
14	Latehar	Harkha	1.78
15	Latehar	Murup	1.69
16	Herhanj	Chaya	2.17

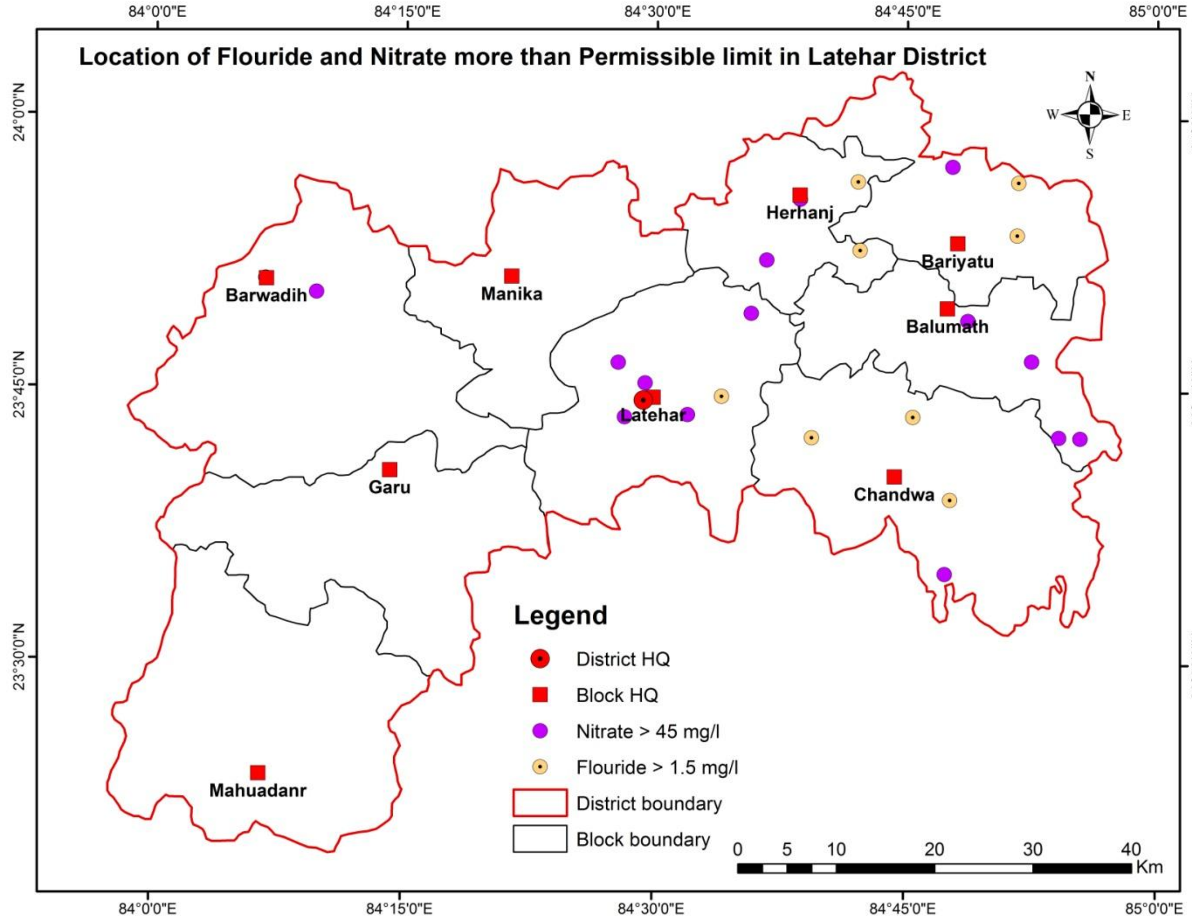


Figure – 28: Location map of NO_3 and F concentration found beyond permissible limit in ground water, Latehar district.

5.3.3 Uranium Contamination

Total 7 samples were analysed for uranium concentration in Latehar district. Uranium concentrations in Latehar district were found to be in the range of 0.50 ppb to 13.75 ppb. Out of 7 samples, at all sample the uranium concentration was found within permissible limit except Lalmatia (Baresad) in Garu Block. The detail results of chemical analysis for uranium are in Annexure-VI.

6.0 MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in the Latehar is low ground water development owing to many socio-economic and hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district.

6.1 Supply side Interventions:

At present as per Ground Water Resource Estimation 2020, the stage of ground water development is low i.e., 28.32% and all nine blocks of the district come under safe category. However in some parts of the district long term declining trend has been noticed. Therefore, the ground water development should also be coupled with ground water augmentation, so that there is no stress on ground water regime of the area.

The supply side interventions envisage Ground Water Resource Development Strategy & construction of Rainwater Harvesting and Artificial Recharge structures in the areas feasible for construction of recharge structures based on the long-term water level scenario and recharge potential of the aquifer.

6.1.1 Ground Water Resource Development Strategy: In view of above, the focus of proposed management plan was to enhance the overall ground water development from the present 28.32% to 70%. Total 3825 dug wells (15-20 m depth; 2 to 4 m diameter @ Rs. 2.50 lakh/dug well) are recommended to be constructed in feasible areas. Similarly, 1434 shallow depth bore wells/tube wells (60 - 100m depth; 100-150 mm dia) are also recommended to be drilled in feasible areas. Proposed number of abstraction structure.

Table – 20: Proposed number of Abstraction Structures

Block	Net GW Availability for Future Development	Development up to the 70%	future irrigation potential available (ha) considering (Δ) 0.45m	70% of future irrigation potential created (ha)	Proposed number of ground water structure (Dug wells) 50%	Proposed number of ground water structure (STW/SBW) 50%
Balumath	1718.85	1203.195	2673.77	1871.64	416	156
Bariatu	1092.16	764.512	1698.92	1189.24	264	99
Barwadih	1614.61	1130.227	2511.62	1758.13	391	147
Chandwa	3235.63	2264.941	5033.20	3523.24	783	294
Garu	377.84	264.488	587.75	411.43	91	34
Herhang	1145.55	801.885	1781.97	1247.38	277	104
Latehar	1576.53	1103.571	2452.38	1716.67	381	143
Mahuadanr	3890.36	2723.252	6051.67	4236.17	941	353
Manika	1155.31	808.717	1797.15	1258.00	280	105
Total	15806.84	11064.788	24588.42	17211.89	3825	1434

It is necessary that proposed Additional ground water abstraction structure may be constructed in three phases with proper site selection through Hydrogeological and geophysical Studies. The results of the first phase of ground water development together with studies of the behavior of ground water regime will guide futher ground water development to achieve 100% utlisation.

6.1.2 Artificial recharge to Groundwater -Master plan 2020

Recently in 2020, artificial recharge to Ground Water master plan 2020 of Jharkhand state has been prepared. The area identified for artificial recharge has been made based on post monsoon depth to water level (Nov 2021) more than 3m bgl with declining trend of more than 0.1 m/yr (2009 – 2018). In addition, area with water level more than 9m bgl in the district has been considered for identifying the area given in figure -28. The volume of unsaturated zone available for recharge in identified areas is determined by computation of average depth of the unsaturated zone below 3 m bgl and then multiplied by area considered for recharge. Based on this master plan, feasible artificial recharge structures including roof rainwater harvesting structures in Latehar district are in Table-21.

Table -21: Artificial recharge structures feasible in Latehar district

Sl. No.	District	Volume of unsaturated zone available for recharge (MCM	Total volume of Available Water for Recharge (MCM)	Percolation Tank	NalaBund/ Check dam / Gully Plug	Recharge Shaft
1	Latehar	1442.72	28.85	127	798	0

Based on the study, 798 No of Nala Bund/Check Dam/Gully Plus and 127 No of Percolation tanks can be constructed in phases with proper site selection.

6.2 Demand side Management:-

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: -

1. Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)
2. Crop choice management and diversification (promote less intensive crops like pulses and horticulture)
3. Promote treated municipal waste water for irrigation and construction use.
4. Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.)

6.3 Ground water management strategy for Nitrate and Fluoride affected areas:

Nitrate and Flouride is the most pollutant in some part of the Lohardaga district Nitrate can be removed from drinking water by distillation, reverse osmosis or ion exchange. several methods are available for the removal of fluoride from groundwater which is insitu or exsitu. To dilute the groundwater contaminated with fluoride, artificial recharge structures can be constructed at suitable places which will decrease its concentration. Rainwater harvesting through existing wells will also prove effective to reduce the groundwater fluoride concentration. Other methods which are conventional treatment methods like adsorption, ion exchange, reverse osmosis etc can be practiced at community level or at households to reduce fluoride concentration before ingestion.

Awareness raising Program /Participatory approach: Peoples should aware about the ground water pollution of Nitrate and Flouride. Management of schemes or project related Nitrate and Flouride removal should be in hand of local peoples, so that peoples will keep the proper maintenance of machines and equipments.

6.4 Stress aspect against future demand (2021, 2031): Demand of water is increasing day by day against the increasing population. The detail demographic particular of the Latehar district and water requirement for domestic purpose is worked out for the year 2021 and 2031 is presented in table – 22, 23 & 24.

6.4.1 Urban Water Supply

Requirement of water for drinking and domestic use will be 88343320 per day in urban area in 2031. Due to increase in population of Latehar district.

6.4.2 Rural Water Supply

Requirement of water for drinking and domestic use will be 796233690 Liter per day in Rural area in 2031. Due to increase in population of Latehar district.

Table 22: Detail demographic particular of Latehar district

Population as per census			
2001		2011	
Rural	Urban	Rural	Urban
534594	26300	675120	51858

Table – 23: Projected population

Projected population			
2021		**2031**	
Rural	Urban	Rural	Urban
2443934	187725	8847041	679564

Table – 24: Requirement of water for domestic use

	Water requirement (assuming 90 liters per day per person for rural population and 130 liters per day per person for urban population)			
	2021		2031	
	Rural (Litres/day)	Urban (Litres/day)	Rural (Litres/day)	Urban (Litres/day)
	219954060	24404250	796233690	88343320
Total	**244358310 litres / day**		**884577010 litres / day**	

On perusal of table – 26, the requirement of water will be 884577010 litres per day in 2031. The demand of water is increasing due to highly increasing of population. Thus, recommended for alternate surface water supply from river to reduce the stress of ground water.

7.0 Sum-up

- The district Latehar is spread over 3612 Sq. km area consisting of 1 subdivision and 09 blocks situated in the western part of the Jharkhand state. It is bounded in the north by Palamu and Chatra districts, in the south by Gumla and Lohardaga districts in the east by Ranchi and Chatra districts and in the west by Garhwa district and Chattisgarh state. As per census of 2011, total population of the district is 119370 with rural population of 67512 and urban population 51858.

- Aquifer Mapping Study was carried in Latehar district, Jharkhand covering an area of 3612 sq.km consisting of 09 blocks through collection of various data from state/Central Govt agencies, data gap analysis, data generated in-house/outsourcing All the available data/ data generated were analysed and integrated to prepare aquifer maps and aquifer management plans of the district.

- The major part of the district is covered by hillocks having height up to 1179 m. Landforms developed in the southern part are represented by pediplains. The general slope of the area is east to west. The drainage pattern is mostly dendritic in the plain land area over granite gneiss country rock. In the plateau area somewhere the drainage shows radial pattern. The interesting feature is the presence of few small springs along the edges of the plateau, some 30 to 40 m below the top. The hilly terrains are mostly forest covered.

- Geologically the study area represents highly deformed Archean gneisses called chotanagpur granite gneissic complex, older meta-sedimentaries. The pre-Cambrian formations are uncomfortably overlain by lower gondawanas comprising Talchirs & Barakar formation. Barakar sandstone and shale contains coal seams found in major coal belt of the area. Recent to Quaternary sediments represented along the river bank.

- Based on morphogenetic and geological diversities and relative ground water potentialities in the aquifer belonging to different geological formation, the study area can be broadly sub-divided into three hydrogeological unit-Consolidated formation (represented by chotanagpur gneiss complex), semi-consolidated formation (represented by Gondwana formations) and Uncosolidated formation weathered granite gneiss & Recent to quaternary alluvium.

- Ground water occurs in consolidated formation under unconfined to semi-confined state in Aquifer-I (upto the depth of 28m). Yield of the wells in Aquifer-I is very poor restricted upto 10 m3/hr weathered Granite-Gneiss and Recent to quaternary alluvium. These aquifers are generally tapped in the dugwells or shallow borewells.

- In fissured formations of the district the major potential fractures zones are found in Aquifer-II between 15-130 m. In general, discharge of well has been found up to 49.32 m^3/hr. The Transmissivity value and Storativity value range from 41.61 m2/dayto 104.45 m^2/day and 7.50×10^{-5} to 5.75×10^{-4} respectively. Ground Water occurs under semi-confined to confined state in Aquifer-II.

- First potential fracture zone encountered in the district widely varies from 11-117 m depth. Some of high yielding well where fractures were encountered within 60 m are Hesla- 8.18 LPS, 60-120 m depth are Hesla -7.73 LPS, Hami-3.8 LPS, beyond- 120 m depth at Bandua -13.77 LPS

- Ground Water quality is generally potable, however high concentration of Flouride was found in 16 number water samples out of 38, and Nitrate concentration was found in 15 numbers water samples out of 38 of Latehar district.
- The stage of ground water development in Latehar district is 28.32%, all nine blocks comes under safe category. Therefore there is sufficient scope for further ground water development.
- Three major ground water related issues in Latehar district are Low ground water development, Low ground water potential and Flouride contamination was found sporadic in 6 blocks blocks and Nitrate in 6 blocks.

- To suggest a sustainable ground water management plan there are two options- Supply Side Management Options & Demand Side Management Options

- The supply side interventions-I envisages Ground Water Management strategy through construction of 3825 dug wells and 1434 shallow bore wells in the feasible areas in the district. Rain water harvesting and artificial recharge to be encouraged in feasible areas for ground water augmentation
- The supply side interventions-II also envisages construction of feasible artificial recharge structures - 127 percolation tank, 798 Nala Bund/Check Dam/Gully Plug Lohardaga district, which is Based on Artificial recharge to Ground Water master plan 2020 of Jharkhand state
- The demand side intervention envisages the real water savings. The main demand side interventions may be-i) Promote improved irrigation technologies (drip or sprinkler irrigation, etc.), ii) Crop choice management and diversification (promote less intensive crops like pulses and horticulture), iii) Promoting treated municipal waste water for irrigation and construction use, and iv) Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.) The government should encourage and provide incentive the use of drip irrigation and sprinkler system.
- Alternative surface water supply in fluoride infested blocks of Latehar district may be extended. In addition a purification/filtration of Flouride/Nitrate may also be adopted.

DETAILS OF KEY WELLS ESTABLISHED FOR NATIONAL AQUIFER MAPPING STUDY OF LATEHAR DISTRICT, 2020 –21

Sl.No.	Village	Block	District	Water Level(BMP)	MP	Depth	Dia	Type of well	Latt.	Long.	Date of Esta.
1	Mochitoli	Chandwa	Latehar	5	0.3	8.2	6.35	DW	23.65194	84.87194	14/12/2020
2	Siram	Chandwa	Latehar	6.3	0.5	9.6	4.5	DW	23.70752	84.92388	14/12/2020
3	Shanti	Chandwa	Latehar	10.2	0.3	11.6	3.7	DW	23.70833	84.90261	14/12/2020
4	Ji;anga	Balumath	Latehar	5.9	0.2	8.2	2.4	DW	23.77819	84.87535	14/12/2020
5	Basia	Balumath	Latehar	4.4	0.5	7	4.5	DW	23.81528	84.81151	14/12/2020
6	Tonti	Bariyatu	Latehar	2.5	0.1	8.8	3	DW	23.89385	84.86049	14/12/2020
7	Rajguru	Bariyatu	Latehar	6.4	0	10.2	4.4	DW	23.94222	84.86167	14/12/2020
8	Birbir	Bariyatu	Latehar	6	0.4	11.3	2	DW	23.95667	84.79578	14/12/2020
9	Kashmar	Bariyatu	Latehar	8.6	0.45	11.2	5.5	DW	23.9427	84.70139	14/12/2020
10	Herhanj	Herhanj	Latehar	3.5	0.9	7.5	3.65	DW	23.92639	84.64361	14/12/2020
11	Humbu	Herhanj	Latehar	5.7	0.5	7.2	3.8	DW	23.87972	84.70376	14/12/2020
12	Damodar	Chandwa	Latehar	5.6	0	9.4	2.5	DW	23.72683	84.75722	14/12/2020
13	Dubli	Chandwa	Latehar	5.8	0	10.2	3.7	DW	23.65081	84.79444	15/12/2020
14	Ate	Chandwa	Latehar	3.3	0.4	6.1	1.9	DW	23.70768	84.65645	15/12/2020
15	Udaypura	Latehar	Latehar	2.7	0.1	10.3	3.05	DW	23.745	84.56639	15/12/2020
16	Harkha	Latehar	Latehar	4.4	0.5	11.8	2.95	DW	23.72806	84.53245	15/12/2020
17	Murup	Latehar	Latehar	3.4	0.4	7.5	2.8	DW	23.82139	84.59543	15/12/2020
18	Chaya	Herhanj	Latehar	7	0.4	10.4	4.65	DW	23.87042	84.61056	15/12/2020
19	Patratu	Latehar	Latehar	3.5	0.4	6.7	2	DW	23.79486	84.54185	15/12/2020
20	Latehar(Karkat)	Latehar	Latehar	5.35	0.5	10.4	2.6	HP	23.75694	84.49	15/12/2020
22	Senha	Chandwa	Latehar	6.6	0.4	11.3	3.1	DW	23.58273	84.78944	15/12/2020
23	Hotwag	Latehar	Latehar	4.4	0.5	9.1	2.2	DW	23.77556	84.46323	16/12/2020
25	Purni Palheya	Manika	Latehar	5.25	0.3	8.1	2.15	DW	23.88111	84.4075	16/12/2020
26	Kutmu	Manika	Latehar	4.56	0.55	9	1.8	DW	23.84417	84.32111	16/12/2020
28	Ukamar	Barwadih	Latehar	5.2	0.2	9.6	3.1	DW	23.83833	84.16167	16/12/2020
29	Chhipadohar	Barwadih	Latehar	5.6	0.15	5.6	2.1	DW	23.81841	84.1966	16/12/2020
32	Netarhat	Mahuadar	Latehar	2	0.5	5.9	2.9	DW	23.47047	84.27781	17/12/2020
33	Chirmunda	Mahuadar	Latehar	1.1	0.3	7.25	4.1	DW	23.35278	84.23729	17/12/2020
34	Mahuadar	Mahuadar	Latehar	3.6	0.3	7.4		DW	23.39793	84.11268	17/12/2020

Sl.No.	Village	Block	District	Water Level(BMP)	MP	Depth	Dia	Type of well	Latt.	Long.	Date of Esta.
35	Bohta	Mahuadar	Latehar	3.5	0.3	8.1		DW	23.46583	84.11444	17/12/2020
36	Aksi	Mahuadar	Latehar	3.56	0	8.85		DW	23.5108	84.11339	17/12/2020
37	Dergaon(Baresard)	Garu	Latehar	3.35	0.5	7.5		DW	23.59346	84.13769	17/12/2020

Hydrogeological Details of Exploratory Borewells in Latehar District

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth/Dia	Granular Zone / fracture Tapped	Static Water level	Discharge	Draw down	Specific Capacity	Formation
				mbgl.	m/mm	m	m bgl.	m^3/hr	m	m^3/hr/m	
1	2	3	4	5	6	7	8	9	10	11	15
1	**Lathehar EW_1**	**Latehar**	$23^0$45'00" $84^0$30'50"	85.45	23.16/203	045-47.14 073-074	4.45	3.06			Gondwana
2	**Latehar EW2**	**Latehar**	$23^0$45'00" $84^0$30'50"	85.24	17.66	035-047 063-064 083-084	4.78	3.3			
3	**Manika EW**	**Manika**	$23^0$51'50" $84^0$21'40"	198.94	7.94/203	047.42-048.42 132.00-133.00	5.7	0.9			Granite Gneiss
4	**Balumath EW-1**	**Balumath**	$23^0$49'30" $84^0$47'35"	199.56	5.73/203	011-012 033-034 070-071 100-101 123-124 146-147 167-169 182-184	3.3	1.5			-do-
5	**Balumath EW 2**	**Balumath**	$23^0$49'35" $84^0$47'50"	199.12	14.38	015-016 030-031	5.7	1.5			
6	**Chandwa** EW	**Chandwa**	$23^0$40'36.62 $84^0$44'21.8"	191.46							

Through Outsource Drilling (WAPCOS)

Sl. No.	Location	Block	Co-ordinate	Depth Drilled m	Casing Depth/ Dia m/mm.	Fractures encountered m	Static Water level m bgl	Discharge (Comp) LPS	Discharge (Pumping Test) m^3/hr	Drawdown m	Specific Capacity $m^3/hr./m$.	T m^2/day	S	Formation
7	Chatbar	Bariyatu	23°56'17.2'' 84°49'33.5''	201	14.5	nil	5.0	0						Granite Gneiss
8	Meral	Herhanj	23°54'03.3'' 84°39'05.0''	201	19.32	26.0-27.0 47.8-48.2	7.05	0						Granite Gneiss
9	Bandua	Manika	23°53'32.2'' 84°23'58"	187	17.8	18.5-19.0 20.5-22.0 29.0-30.0 126-127.5 138.7-138.9	6.50	13.77	23.97	34.70		8.80		Granite Gneiss
10	Matlang	Manika	23°51'20.7'' 84°26'31.7"	201	23.67	51.2-52.6 60.5-61.5	11.82	1.08				6.62(slug)		Granite Gneiss
11	Sasang	Chanduwa	23°42'35.6'' 84°38'31.7"	201	15.8	nil	7.26	0.0135						Granite Gneiss
12	Chitarpur	Balumath	23°46'04.8'' 84°46'02.4''	201	23.90	41.0-44.0 59.0-60 70.0-71.0	13.0	dry						Gondwana
13	Bariyatu	Bariyatu	23°53'17.2'' 84°47'48.3"	201	23.90	45.0-46.0 119-119.2	5.67	2.15	6.516(PYT)	24.16		1.67		Granite Gneiss
14	Kali	Chanduwa	23°39'10.2'' 84°52'43.7"	201	14.13	nil	8.55							Granite Gneiss
15	Hesla-EW	Chanduwa	23°35'13.5'' 84°49'27.5"	120	23.90	26.0-27.0 35.0-36.0 50.0-51.0 64.0-65.0 85.0-86.0 116-117	14.78	7.73	25.27	13.32		123.56	$7.5x10^{-5}$	Granite Gneiss
	Hesla-OW	Chanduwa	23°35'13.5'' 84°49'27.5"	98.5	18.10	44.0-45.5 52.6-52.8 53.0-56.0	14.78	8.19		3.32				Granite Gneiss
16	Gadi	Barwadih	23°50'45.5'' 84°13'23.7"	201	8.35	nil	6.63	0.43						Granite Gneiss

Sl. No.	Location	Block	Co-ordinate	Depth Drilled m	Casing Depth/ Dia m/mm.	Fractures encountered m	Static Water level m bgl	Discharge (Comp) LPS	Discharge (Pumping Test) m^3/hr	Drawdown m	Specific Capacity $m^3/hr./m$.	T m^2/day	S	Formation
17	Barwadih	Barwadih	23°51'01.4'' 84°06'38.6”	201	11.70	nil	6.0	0.2						Granite Gneiss
18	Banbirwa	Latehar	23°41'45.1'' 84°25'32.1"	201	20.53	nil	7.45							
19	Maromar-EW	Garu	23°37'37.3'' 84°11'53.9"	171	12.80	-	17.55	4.8	16.2	8.06		56.13	7.33x 10-5	Granite Gneiss
	Maromar-OW	Garu	$23^0$37'35.9" $84^0$11'53.7"	201	8.64	9.32-10.16	16.38	0.43						Granite Gneiss
20	Lakhehpur	Mahuadant	23°30'06.7'' 84°06'32.6"	201	18.40	nil	8.91							Granite Gneiss
21	Hami-EW	Mahuadant	$23^0$26'11.4" $84^0$03'43.7"	201	28.15	117.2-117.6	6.7	3.16	21.6	32.72		55.91	$5.75x 10^{-4}$	Granite Gneiss
	Hami-OW	Mahuadant	$23^0$26'11.4" $84^0$03'43.7"	201	20.25	27.89-28.49	5.93	3.5						Granite Gneiss

Water quality data of aquifer – I (dug well samples) of aquifer mapping study area of Latehar district

Sl.no.	Block	Location	Latitude	Longitude	Type of well	pH	EC	TDS	F-	Cl-	HCO3-	CO32-	SO42-	NO3-	PO43-	TH	Ca2+	Mg2+	Na+	K+	SiO2
1	Chandwa	Mochitoli	23.6519	84.8719	DW	7.16	274.00	178.10	0.45	7.09	110.70	ND	18.65	36.49	BDL	90.00	24.00	7.29	19.74	1.37	23.29
2	Chandwa	Siram	23.7075	84.9239	DW	6.95	535.00	347.75	2.15	39.00	135.30	ND	55.81	54.56	BDL	215.00	38.00	29.16	21.58	24.96	30.51
3	Chandwa	Shanti	23.7083	84.9026	DW	7.08	1170.00	760.50	0.09	194.98	141.45	ND	120.90	68.78	BDL	155.00	38.00	14.58	189.54	16.90	15.32
4	Balumath	Ji;anga	23.7782	84.8754	DW	7.13	438.00	284.70	1.92	49.63	61.50	ND	28.13	67.62	BDL	175.00	30.00	24.30	21.71	12.24	22.13
5	Balumath	Basia	23.8153	84.8115	DW	7.00	357.00	232.05	2.39	14.18	104.55	ND	13.51	70.15	BDL	150.00	36.00	14.58	19.35	0.95	15.03
6	Bariyatu	Tonti	23.8938	84.8605	DW	7.09	492.00	319.80	1.85	35.63	141.45	ND	48.64	43.04	BDL	195.00	42.00	21.87	19.61	14.70	11.72
7	Bariyatu	Rajguru	23.9422	84.8617	DW	7.25	248.00	161.20	2.33	17.73	98.40	ND	4.49	23.04	BDL	100.00	28.00	7.29	11.27	2.92	15.58
8	Bariyatu	Birbir	23.9567	84.7958	DW	6.98	398.00	258.70	1.91	24.82	86.10	ND	44.37	70.37	BDL	160.00	44.00	12.15	14.29	12.37	19.67
9	Bariyatu	Kashmar	23.9427	84.7014	DW	7.23	412.00	267.80	2.16	17.73	166.05	ND	42.45	19.17	BDL	159.98	34.00	18.22	20.51	8.34	18.20
10	Herhanj	Herhanj	23.9264	84.6436	DW	6.90	760.00	494.00	2.49	41.63	276.75	ND	58.21	51.70	BDL	320.00	48.00	48.60	20.88	11.74	22.73
11	Herhanj	Humbu	23.8797	84.7038	DW	7.88	246.00	159.90	2.26	7.09	98.40	ND	24.34	14.25	BDL	110.00	30.00	8.51	8.52	0.26	13.84
12	Chandwa	Damodar	23.7268	84.7572	DW	6.91	306.00	198.90	2.16	17.73	86.10	ND	31.08	41.39	BDL	140.00	42.00	8.51	8.89	0.25	23.94
13	Chandwa	Dubli	23.6508	84.7944	DW	7.69	485.00	315.25	2.89	27.45	166.05	ND	50.43	39.88	BDL	200.00	46.00	20.66	29.09	2.02	26.59
14	Chandwa	Ate	23.7077	84.6565	DW	7.44	631.00	410.15	1.95	24.82	295.20	ND	51.56	16.27	BDL	204.98	36.00	27.94	58.90	0.72	37.55
15	Latehar	Udaypura	23.7450	84.5664	DW	7.59	473.00	307.45	2.14	28.36	196.80	ND	47.41	5.38	0.24	170.00	28.00	24.30	38.15	17.23	13.63
16	Latehar	Harkha	23.7281	84.5325	DW	7.60	698.00	453.70	1.78	64.44	178.35	ND	97.60	51.53	BDL	210.00	48.00	21.87	50.18	37.80	20.04
17	Latehar	Murup	23.8214	84.5954	DW	7.82	965.00	627.25	1.69	95.72	196.80	ND	155.90	66.57	BDL	385.00	74.00	48.60	49.90	6.08	25.41
18	Herhanj	Chaya	23.8704	84.6106	DW	7.97	742.00	482.30	2.17	46.09	227.55	ND	81.58	63.24	BDL	334.98	68.00	40.09	13.23	7.06	35.11
19	Latehar	Patratu	23.7949	84.5418	DW	8.13	568.00	369.20	0.08	51.72	233.70	ND	33.17	28.58	BDL	175.00	30.00	24.30	54.62	2.62	34.41
20	Latehar	Latehar(Karkat)	23.7569	84.4900	HP	8.01	1040.00	676.00	0.68	95.72	295.20	ND	116.90	51.50	BDL	355.00	62.00	48.60	59.28	9.24	28.41
21	Latehar	Latehar(in front Of Forest Guest House)	23.7256	84.4697	HP	7.94	1269.00	824.85	0.30	109.90	252.15	ND	217.90	68.53	BDL	465.00	98.00	53.46	64.85	6.44	36.30
22	Chandwa	Senha	23.5827	84.7894	DW	8.39	278.00	180.70	0.47	21.27	67.65	15.00	7.85	48.75	BDL	110.00	20.00	14.58	12.91	2.17	20.26
23	Latehar	Hotwag	23.7756	84.4632	DW	7.87	1830.00	1189.50	0.36	307.16	258.30	ND	235.70	51.49	1.97	265.00	48.00	35.24	285.49	13.45	26.81
24	Manika	Manika (NHS)	23.0000	84.0000		7.97	1225.00	796.25	0.17	202.07	159.90	ND	169.82	36.37	BDL	475.00	108.00	49.82	58.46	18.05	15.20
25	Manika	Purni Palheya	23.8811	84.4075	DW	7.91	1064.00	691.60	0.78	138.26	178.35	ND	141.00	41.68	BDL	375.00	82.00	41.31	43.16	4.58	30.91

26	Manika	Kutmu	23.8442	84.3211	DW	8.21	521.00	338.65	0.32	10.64	227.55	ND	63.20	14.35	BDL	215.00	42.00	26.73	15.44	13.60	15.87
27	Barwadih	Barwadih(NHS)	23.8508	84.1108	DW	7.75	2350.00	1527.50	0.81	313.12	338.25	ND	333.22	66.84	BDL	784.81	168.00	88.65	118.78	93.79	2.00
28	Barwadih	Ukamar	23.8383	84.1617	DW	8.08	538.00	349.70	0.27	39.00	159.90	ND	37.16	60.99	BDL	230.00	44.00	29.16	17.40	9.18	19.33
29	Barwadih	Chhipadohar	23.8184	84.1966	DW	8.17	517.00	336.05	0.00	35.45	184.50	ND	21.76	41.90	BDL	235.00	46.00	29.16	13.19	3.36	BDL
30	Barwadih	Betla(NHS)	23.8883	84.1950	DW	7.97	499.00	324.35	0.10	31.91	178.35	ND	65.30	1.37	BDL	200.00	32.00	29.16	21.27	16.10	28.00
31	Mahuadar	Netarhat	23.4686	84.2742	HP	8.32	79.00	51.35	0.37	3.54	36.90	3.00	BDL	BDL	BDL	35.00	8.00	3.65	2.43	0.43	5.09
32	Mahuadar	Netarhat	23.4705	84.2778	DW	8.34	69.00	44.85	0.08	3.54	30.75	3.00	BDL	BDL	BDL	30.00	6.00	3.65	3.07	0.98	1.01
33	Mahuadar	Chirmunda	23.3528	84.2373	DW	8.32	39.00	25.35	0.00	3.55	12.30	3.00	BDL	1.12	BDL	20.00	6.00	1.22	0.63	0.07	0.60
34	Mahuadar	Mahuadar	23.3979	84.1127	DW	7.93	556.00	361.40	0.00	48.37	178.35	ND	54.12	12.17	BDL	200.00	44.00	21.87	25.88	24.68	9.57
35	Mahuadar	Bohta	23.4658	84.1144	DW	8.28	167.00	108.55	0.62	7.09	73.80	ND	1.16	23.36	BDL	75.00	22.00	4.86	6.87	1.17	11.76
36	Mahuadar	Aksi	23.5108	84.1134	DW	8.16	239.00	155.35	0.00	10.64	79.95	ND	17.11	39.10	BDL	95.00	24.00	8.51	10.46	11.34	11.64
37	Garu	Dergaon(Baresard)	23.5935	84.1377	DW	8.06	272.00	176.80	0.05	7.09	159.90	ND	13.21	2.40	BDL	125.00	28.00	13.37	7.52	3.96	14.96
38	Garu	Garu(NHS)			**DW**	8.09	238.00	154.70	0.05	3.55	116.85	ND	17.11	7.40	BDL	105.00	26.00	9.72	6.77	4.75	14.06
					Min	6.90	39.00	25.35	0.00	3.54	12.30	3.00	1.16	1.12	0.24	20.00	6.00	1.22	0.63	0.07	0.60
					Max	8.39	2350.00	1527.50	2.89	313.12	338.25	15.00	333.22	70.37	1.97	784.81	168.00	88.65	285.49	93.79	37.55
					Avg	7.70	590.44	383.78	1.03	56.44	153.91	5.40	70.05	37.90	0.82	206.79	43.18	24.02	37.04	10.72	18.87

Annexure-IV

Sl. No.	*District*	*Block*	*Well Name*	*Type of Well*	*Lat*	*Long*	Uranium (ppb)
1	Latehar	Chandwa	Chandwa	DW	23.675	84.746	0.98
2	Latehar	Latehar	Latehar	DW	23.746	84.408	0.24
3	Latehar	Manika	Manika	DW	23.850	84.346	6.03
4	Latehar	Balumath	Balumath	DW	23.833	84.796	0.31
5	Latehar	Barwadih	Barwadih	DW	23.858	84.117	2.95
6	Latehar	Balumath	Barjatu	DW	23.892	84.808	2.01
7	Latehar	Garu	Garu	DW	23.675	84.242	0.00
8	Latehar	Mahuadanr	Mahuadanr	DW	23.392	84.096	0.00
9	Latehar	Mahuadanr	Aksi	DW	23.459	84.083	1.27
10	Latehar	Garu	Baresad (Lalmatia)	DW	23.593	84.138	42.64
11	Latehar	Barwadih	Betla	DW	23.888	84.194	0.12