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

GUMLA DISTRICT
JHARKHAND

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

भारत सरकार

Government of India

जल शक्ति मंत्रालय

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जल संसाधन नदी विकास एवं गंगा संरक्षण विभाग

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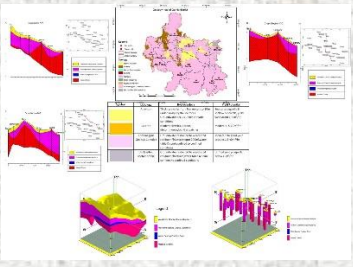
Central Ground Water Board

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

जलभृत नक्शें तथा भूजल प्रबंधन योजना

गुमला जिला, झारखण्ड



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REPORT ON AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF GUMLA DISTRICT, JHARKHAND, 2021-22

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REPORT ON AQUIFER MAPS AND MANAGEMENT PLAN OF GUMLA DISTRICT, JHARKHAND STATE (2021 - 2022)

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN OF GUMLA 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 Gumla district have been taken up in AAP 2021-22 as a part of NAQUIM Programme. The aquifer maps and management plans will be shared with the administration of Gumla 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.

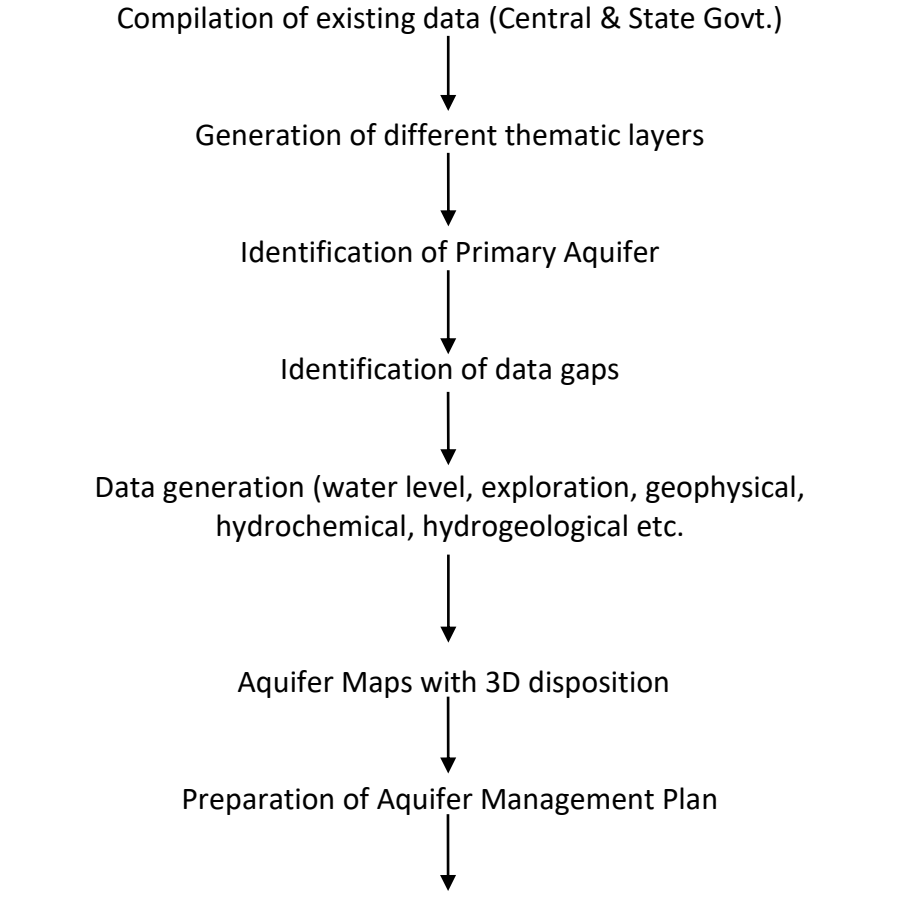
The demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and

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 Aquifer mapping is as given below:



1.3 Area Details: The district Gumla was taken for aquifer mapping study during 2021-22. The district is spread over 5347 Sq. km of geographical area. Gumla district is situated in the western part of the Jharkhand state. The district is bounded in the north by the Lohardaga and Latehar districts, in the east by Ranchi district, in the south by Simdega district and in the west by the Chhatisgarh state. The district is situated between 220 42’ 45” and 23^0 36’ 30” N latitude and 840 02’ 00” and 850 01’ 00” E longitude. Gumla district came into existence after Ranchi district split into three districts namely Ranchi, Gumla and Lohardaga way back in 1983. The Gumla district comes under the south Chhotanagpur division. It has one sub-division i.e. Gumla Sadar sub – division. Further, the sub – division is devided into 11 blocks namely – Gumla, Palkot, Chainpur, Dumri, Bishunpur, Raidih, Ghaghra, Sisai, Basia

Bharno and Kamdara (Fig. 1). 12 th block as Albert Ekka (Jari) has been created during 2011. which contains 951 villages spread over in 159 Gram Panchayats (Fig-1). According to 2011 census, the total population of the district is 1025213 (Male- 514390 and Female-510823) constituting 3.10 % of the total population of Jharkhand. The rural and urban population of the district is 960132 and 65081 respectively.

The location map of the study area is shown in figure – 1.

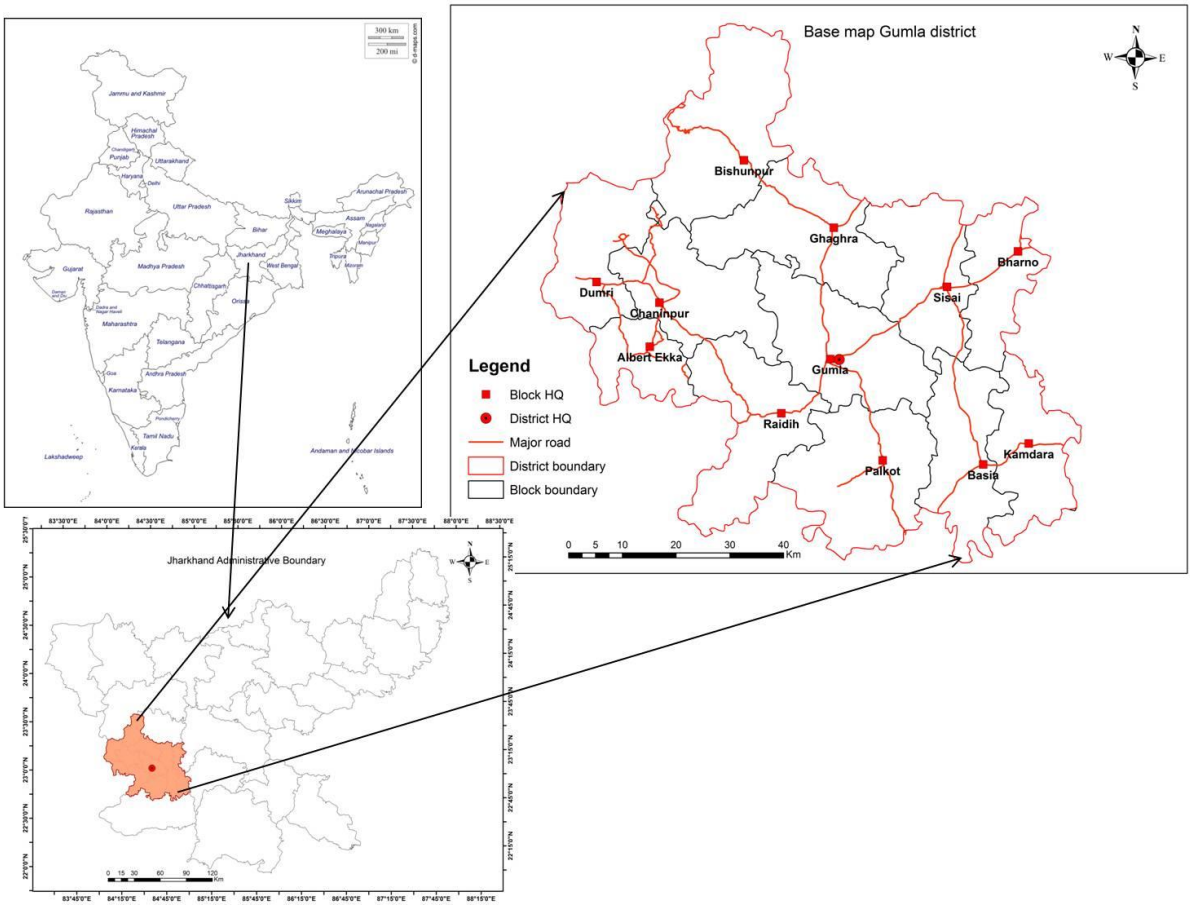


Figure 1: Location map of Gumla district

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

Sr. No.	Block	Area in (Hectare)
1	Albert ekka	20901
2	Basia	40276
3	Bharno	30185
4	Bishunpur	61035
5	Chainpur	50344
6	Dumri	37163
7	Ghaghra	53014
8	Gumla	53974
9	Kamdara	36468
10	Palkot	57735
11	Raidih	51096
12	Sisai	42535
Total		**534726**

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 20 exploratory and 3 observation wells in hard rock formation by departmental rig during the year 1997-2005. In addition 28 exploratory and 6 Observation wells drilled through outsourcing (WAPCOS). In addition 17 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**
45	48	0	54	27	27	55	58	0	55	58	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 2020-21.

1.5 Climate and Rainfall:

The Gumla district enjoys a healthy climate through out the year. Normal atmospheric temperature in the area often goes up to 42^0 c in summer and it goes down to about 4^0 c during winter. The climate of the area could be divided into three district season. The winter commences from November and extends to middle of March, December being the coldest month. The winter season is characterized by heavy dew thick fog and cold wave. The rainy season last up to middle of October. The area is free from hot winds and dust storm. The monsoon sets in by the middle of June and continues till the middle of October. The area receives rain fall mainly by North-west monsoon during rainy season and from retreating monsoon during inter-monsoon period, which originates in the bay of Bengal. The average annual rainfall varies between 1400-1600 mm. Rainfall is the only sources of replenishment of ground water in the district.

Table – 3: Average Annual Rainfall (2020-21) of Gumla district

Sr. No.	Block	Average annual rainfall in (mm)
1.	Albert Ekka(Jari)	1252.6
2.	Basia	761.8
3.	Bharno	-
4.	Bishunpur	911.6
5.	Chainpur	-
6.	Dumari	688.6
7.	Ghaghara	1290
8.	Gumla	843.8
9.	Kamdara	795.2
10.	Palkot	886.6
11.	Raidih	1398.4
12.	Sisai	-

1.6 Physiography: The chotanagpur plateau is a region of large physical inequalities and presents a rich panorama of topographical features. The general configuration of the region varies from valley fills, pedeplains to structural ridges. In Gumla district three well marked erosion surfaces are clearly discernible. The lowest erosion surface i.e. 400 metres erosion surface is the surface carved out by Sankh river and its tributaries. This erosion surface occurs on the western portion of the district. The 600 metres erosion surface covers a vast tract of central part of the district and is mainly carved out by south Koel and its tributaries. The area is relatively flat. The South Koel river has its revinous course all along its valley. The 1000 metre erosion surface lies mainly in north western and northern part of the Gumla district. The large difference in relief bring about strong contrast in climate, natural vegetation, surface drainage, under ground water and soil profile. In the pat region the rivers are long, deep and with terrace but in pediplain area they are wide with gentle slopes in Figure-2

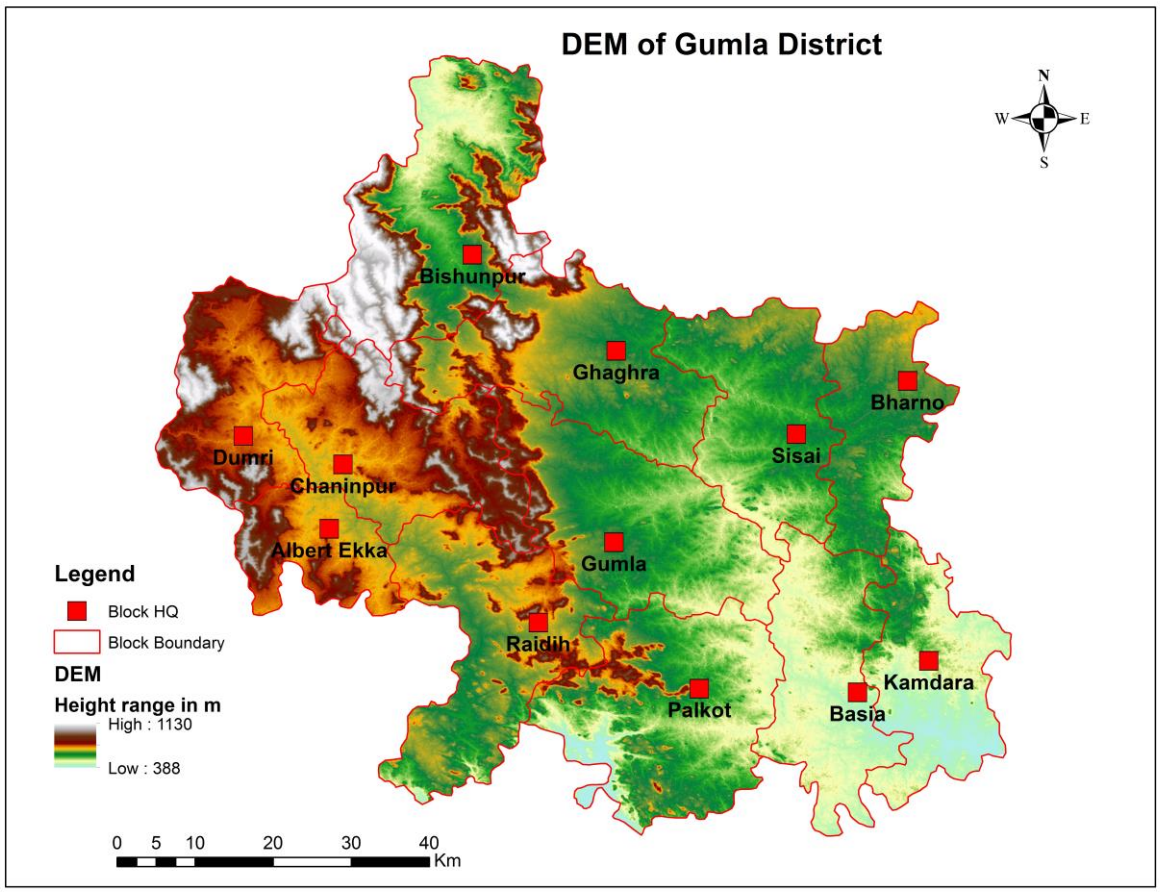


Figure – 2: Digital elevation model of Gumla district

1.7 Geomorphology:

Gumla district is a part of the Chhotanagpur plateau which is situated in the western part of the plateau. The terrain is highly undulating in nature. The plateaus are covered with laterite having the average thickness of 50m. In some places the laterites are enriched with aluminium and contain huge amount of bauxite. The average elevation of the district vary between 610 to 640 masl . The Gumla district is divisible into following physiographic unit on the basis of lardforms, geological and structural control in the area:-

1. Burried Pediment
2. Pedeplain
3. Dissected Pediment
4. Denudational hills / inselbergs
5. Lateritic capping
6. Valley fill
7. Dissected Pediplain
8. Denudational hills
9. Structural ridges

1. **Burried Pediment** : The pediments are gently sloping flat platforms extending from foot of the hills and ridges outward towards the nearest major drainage axis. Their slope lie generally between 1^0 and 7^0. Basically it is a rock out surface but in the

tropics and subtropics it is generally buried under the cover of transported material coming from the hills. Beyond the pediment the rock platform in deeply buried under transported debris and alluvium. These are broad gently sloping erosional surface having detritus. Thickness of over burden is considerably high. The underlying lithology is mainly of granites and granite-gneiss. The underlying basement is highly rugged.

2. **Pediplain**:-Pediplains consist of a series of dissected pediments. They are formed due to the parallel retreat of slopes . Such retreat depends on the spacing of streams and bed rock structure and occur mainly on upper and middle slopes. Headward extension of the basal slope has consumed the scarp, leaving residual rock standing above as inselbergs. The underlying lithology is mainly of granites and granite-gneiss. They have generally undulating erosional surface.

3. **Dissected Pediment**: This is also a pediment but are heavily dissected. It is Dissected by numerons streams flowing across it. Thickness of weathered material is also more and topography is much more rugged . Ravinous lands are also found in Pockets.

4. **Denudational hills / inselbergs**: there are numerous large and small isolated hills scattered throughout the district. Their height varies from 70 m to more than 300m from the Surrounding plains. All of them are made up of granites and granite-gneiss. Almost all of them hills are devoid of vegetation except the higher ones. Run off is very high and regolith is absent thus the hills like a dome. Since they are highly jointed and foliated, boulder,cobbles and pebbles are also present within the foot hills. The larger hills have well defined pediment which is totally covered by veneer of sediments which comes from uplands and also laid down by streams. Soil is gravelly and highly ferruginous. Inselbergs are residual structural features evolved from differential chemical weathering in the ground water zone and subsequent stripping of weathered mantle.

5. **Lateritic Capping** : Laterite is porous, pitted, clay like rock with red brown, grey and mettled colours depending upon the composition. Generally it has a hard protective, limonic crust on the exposed surface which is generally irregular and rough. It is composed mainly of hydrated oxides of iron and alumina. These occurs mainly as capping of high lands and hills. The laterite cap varies considerable in thickness and may be up to 50 or 60 m. These lateritic capping are developed mainly on metamorphic rock. Water potential of this litho unit is poor to moderate.

6. **Valley fill**: These are relatively low lying area between uplands. These valley fills constitute boulders, cobbles, pebbles gravels, sand, silt and clay. The sediments are poorly sorted. The unconsolidated sediments filling the valley comes from the adjoining high lands through fluvial action of streams. They represents 400 metres erosion surface. These valleys are undulating and gently wide. They show scattered broad river terrace often with wide alluvial flats with mounds and hillocks ranging in width from 2 to 5 Km, on both sides of rivers, where the rocks are found to be highly weathered.

7. **Dissected Pediplain**: This geomorphic unit lies in the eastern and western part of the district and has an elongation roughly to N-S direction. The soil cover in this area is of considerable thickness as compared to other geomorphic unit of the area. These are

undulating erosional surface with high intensity of pegmatite veins in the granites and grantie gneiss which is the underlying litho-logy of the unit. Stream course in the area have ravenous course. The stream incision is deep at places. Wherever such incision occurs the underlying lithology is exposed. The granite-gneiss are weathered up to a considerable extent. The materials of this geomorphic unit are contributed by neighbouring uplands and streams. The soil cover is mainly of ferruginous nature.

8. **Denudational Hills**: There are numerous large and small isolated hills scattered throughout the district. Their height varies from 70 metres to more than 300 metres from surrounding plains. Almost all of them are made up of granites, phyllites and quartzites. Majority of the hills are devoid of vegetation cover except the highest ones. Runoff is unchecked and regolith is missing. The soil in the foot hill region is gravelly and is highly ferruginous and is un-suitable for cultivation. Their thickness and extension varies from place to place. Relief from surrounding plain is moderate to low. Ground water prospects of the area is poor.

9. **Structural Ridge**: Structural ridges are those hilly areas which show a preferred orientation, in conformity to prevailing geological structure. Such ridges are found along the southern and south-eastern part of the district. Moderate reliefs presence of forest are characteristic feature runoff is very high. All this Structural ridges are composed mainly of mica schist, physlites and quartzites. Ground water potential of this geomorphic unit is poor.

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

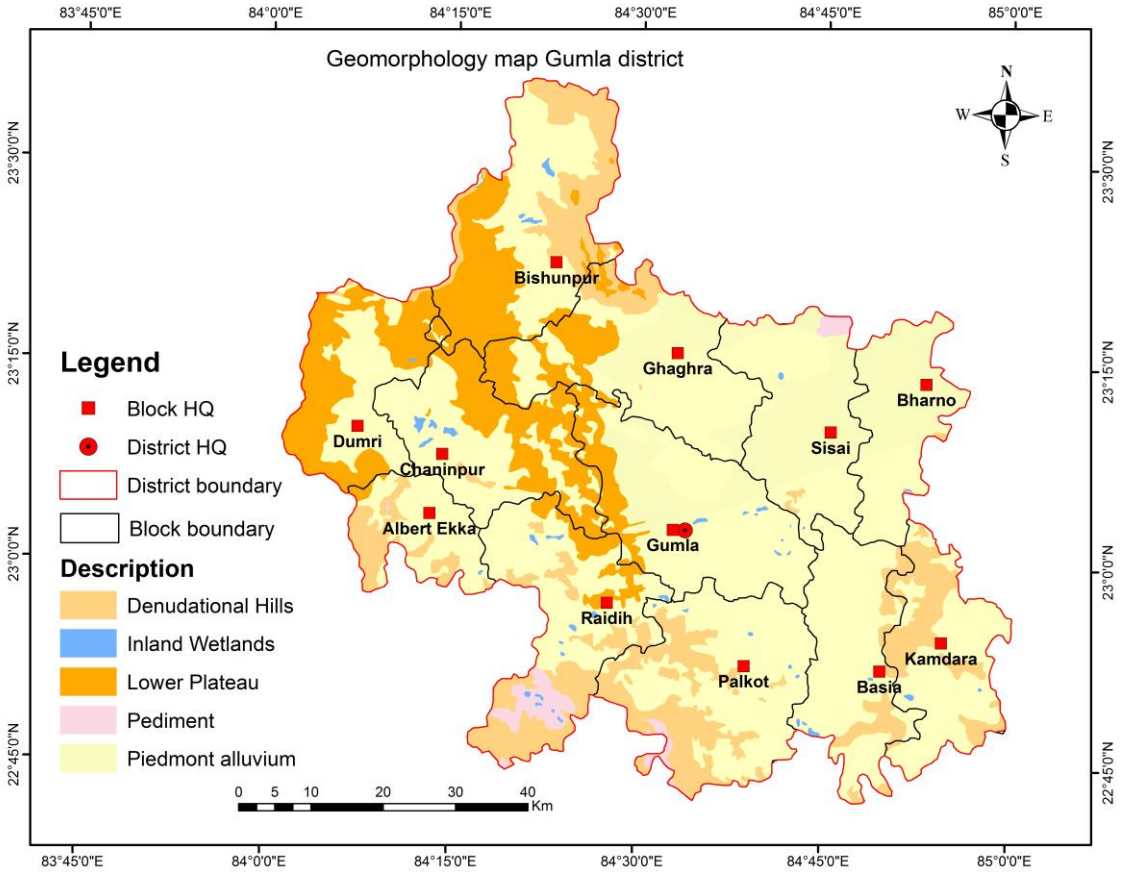


Figure – 3: Geomophology of Gumla district

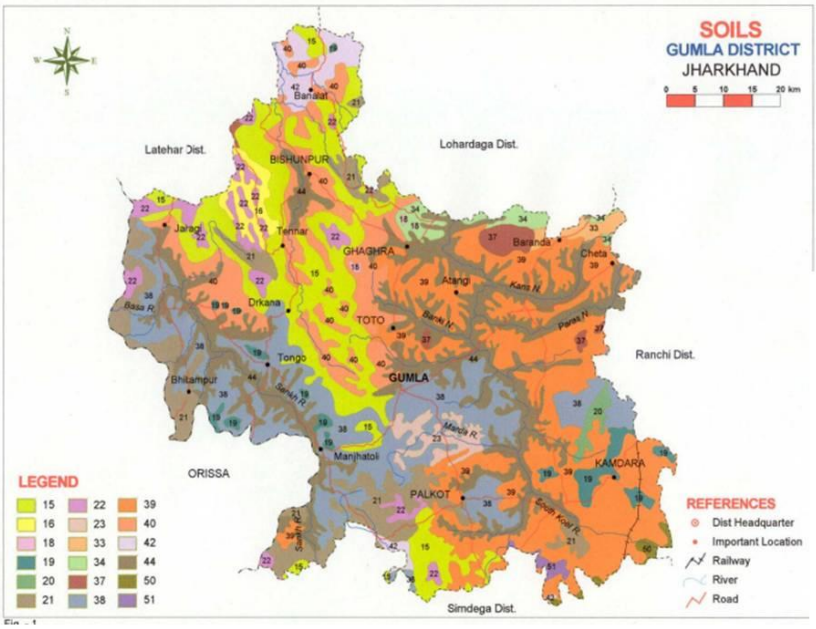
1.8 Land Use: Geographical features play a major role in information of land use pattern. Out of total geographical area of the district i.e 5347 Sq. km, nearly 24 % area comes under net sown area, 25% under forests and the rest area falls under barren, cultivable waste, pasture and other agricultural use. The land use pattern data of the area for the year 2013 – 14 is given below in table-4.

Table: 4: Land use pattern of Gumla district (2015– 2016) (Source: Gumla DIP report of PMKSY area in hectares)

Block Name	Forest	Uncultivabale Land	Cultural Waste	Permanent Pasture	Net Sown Area
Albert Ekka(Jari)	5933.20	261.57	165.07		6484.35
Basia	5356.71	2517.02	3285.51		13017.71
Bharno	1675.75	3849.99	2029.61		8948.48
Bishunpur	34131.85	658.14	2944.85	213.12	7307.93
Chainpur	17029.86	4009.23	3023.62		6169.19
Dumari	8899.80	392.36	247.60		9726.52
Ghaghara	10976.50	4363.26	2137.16	233.67	12898.16
Gumla	9158.78	2793.71	1904.85	142.34	16074.53
Kamdara	4385.88	2593.41	1445.04		11881.76
Palkot	15254.04	7860.12	4401.08	59.98	10297.96
Raidih	19320.44	2890.87	2116.77	484.61	8198.00
Sisai	5593.81	4462.65	3398.28		17921.00

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 Gumla district (Fig.4) Alfisols were the dominant soils covering 42.80 percent of TGA followed by Inceptisols (40.3 %) and Entisols (16.2 %).



Map unit	Taxonomy	Area ('00ha)	% of the TGA
15	Loamy-skeletal, mixed, hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Ultic Haplustalfs	748	14.06
16	Fine, mixed, hyperthermic Typic Haplustalfs Loamy, mixed, hyperthermic Lithic Ustorthents	65	1.22
18	Loamy, mixed, hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Typic Haplustalfs	5	0.09
19	Loamy-skeletal, mixed hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Typic Haplustepts	102	1.92
20	Loamy, mixed, hyperthermic Lithic Ustorthents Fine, mixed, hyperthermic Typic Rhodustalfs	30	0.56
21	Coarse loamy, mixed, hyperthermic Typic Ustorthents Fine, mixed, hyperthermic Rhodic Paleustalfs	399	7.50
22	Fine, mixed, hyperthermic Typic Paleustalfs Fine, mixed, hyperthermic Typic Rhodustalfs	153	2.88
23	Fine-loamy, mixed, hyperthermic Typic Haplustepts Fine-loamy, mixed, hyperthermic Typic Haplustalfs	76	1.43
33	Fine, mixed, hyperthermic Typic Paleustalfs Fine, mixed, hyperthermic Typic Rhodustalfs	37	0.70
34	Fine loamy, mixed, hyperthermic Typic Paleustalfs Fine-loamy, mixed, hyperthermic Typic Rhodustalfs	66	1.24
37	Loamy, mixed, hyperthermic Lithic Haplustalfs Fine, mixed, hyperthermic Typic Paleustalfs	59	1.11
38	Fine loamy, mixed, hyperthermic Typic Paleustalfs Fine loamy, mixed, hyperthermic Typic Haplustepts	811	15.24
39	Fine, mixed, hyperthermic Rhodic Paleustalfs Fine-loamy, mixed, hyperthermic Typic Haplustepts	1097	20.62
40	Fine loamy, mixed, hyperthermic Typic Haplustepts Fine loamy, mixed, hyperthermic Typic Haplustalfs	492	9.25
42	Fine, mixed, hyperthermic Typic Rhodustalfs Fine loamy, mixed, hyperthermic Typic Ustorthents	122	2.29
44	Fine, mixed, hyperthermic Aeric Endoaquepts Fine, mixed, hyperthermic Typic Haplustepts	982	18.46
50	Loamy, mixed, hyperthermic Lithic Ustorthents Fine loamy, mixed, hyperthermic Typic Haplustepts	20	0.38
51	Fine loamy, mixed, hyperthermic Typic Haplustepts Loamy, mixed, hyperthermic Lithic Ustorthents	17	0.32
Miscellaneous		39	0.73
Total		5320	100.00

Figure 4 : Soil map of Gumla District

(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:

Gumla district covers the south - western part of Chhotanagpur plateau. The district is forming two sub basins i.e. the North Koel sub – basin of Ganga basin and the Sankh sub basin of Brahmni basin. The entire district is highly dissected by rivers of varying magnitudes, new drainage basins were formed when the region was elevated during recent past. The nucleous of the drainage area is located on an elevated tract for Ranchi plateau. (Fig. 5)

The south koel originates from a place called Piska near Ranchi and has its course traverses in the Ranchi, Gumla and Simdega districts. Several feeders of South Koel river have their source on the western side of the north – south up-wrap. It flows from north to south having meandering coarse excavating even straight valleys in the western part of the areas whereas in the northern part south-koel meanders from west to east. The entire catchment basin of the South- koel is wide and extensive which incorporates the most populous region. In the lower reaches of the river sand banks are formed due to large amount of silt brought down by the rivers Dendritic drainage pattern, a typical of hard rock terrain is developed over the area. However redial drainage pattern is developed locally in some areas where streams and tributaries emanated from the local mounds and raised ground. All these drainage is characterized by rapid surface run – off.

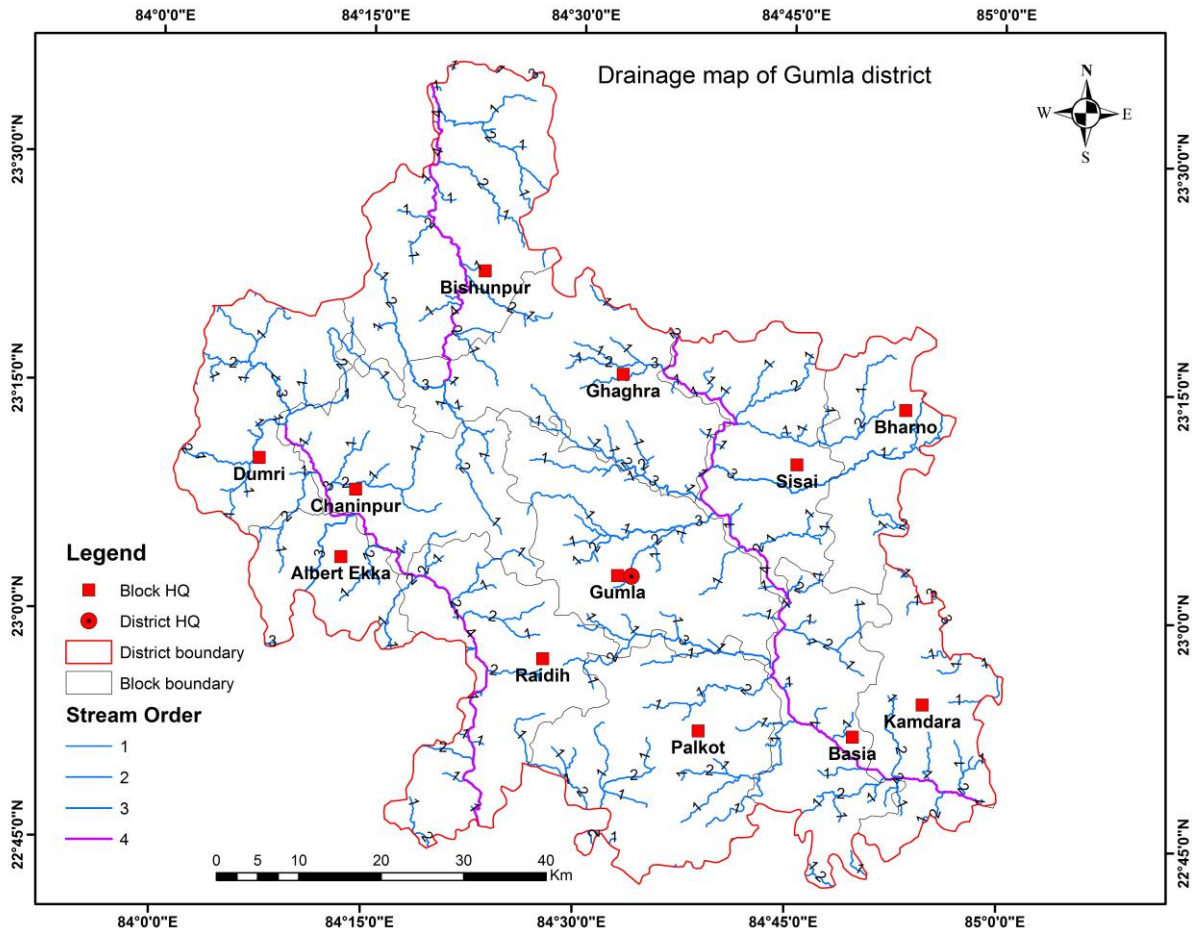


Figure – 5: Drainage Map of Gumla district

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 Gumla 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 Gumla district (2013-14)

Sl. No	Block	Surface water			Ground water			Other sources
		Canal	Tank	LI	DW	STW	DTW	
1	Albert Ekka(Jari)			2	431	1	1	11
2	Basia				1314	5	1	0
3	Bharno			76	1082	1	0	0
4	Bishunpur			29	694	20	4	76
5	Chainpur			40	430			34
6	Dumari			24	217			16
7	Ghaghara			17	1486	5	1	46
8	Gumla			8	401	10	4	24
9	Kamdara			21	467	0		55
10	Palkot			7	500	2		55
11	Raidih			0	604	1		0
12	Sisai			12	887	1		77
				160	**6117**	**40**		**394**

Source: 5th MI Census of India

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 Gumla district (2015-16)

Sl.			Kharif (area in ha)			Rabi (area in ha)			Summer (area in ha)			Total (area in ha)		
No.	Block	Crop Type	Irrigated	rainfed	Tolal	Irrigated	rainfed	Tolal	Irrigated	rainfed	Tolal	Irrigated	rainfed	Tolal
1	Gumla	Cereals	2856	14997	17853	713	167	880	60	0	60	3629	15164	18793
		Coarse Cereals	75	674	749	0	0	0	0	0	0	75	674	749
		Pulses	76	1449	1525	261	1044	1305	33	0	33	370	2493	2863
		Oil Seeds	29	550	579	636	159	795	0	0	0	665	709	1374
		Cereals	2110	12958	15068	521	114	635	12	0	12	2643	13073	15715
2	Raidih	Coarse Cereals	54	397	451	0	0	0	0	0	0	54	397	451
		Pulses	127	1685	1812	148	672	820	20	0	20	294	2358	2652
		Oil Seeds	22	526	548	391	86	477	0	0	0	413	612	1025
3	Chainpur	Cereals	2541	14397	16938	592	113	705	0	0	0	3133	14510	17643
		Coarse Cereals	49	491	540	0	0	0	0	0	0	49	491	540

Sl.			Kharif (area in ha)			Rabi (area in ha)			Summer (area in ha)			Total (area in ha)		
No.	**Block**	**Crop Type**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**
		Pulses	153	1552	1705	263	988	1250	10	0	10	426	2539	2965
		Oil Seeds	12	573	585	876	179	1055	0	0	0	888	752	1640
4	Dumri	Cereals	1574	10536	12110	535	125	660	0	0	0	2109	10661	12770
		Coarse Cereals	45	513	558	0	0	0	0	0	0	45	513	558
		Pulses	96	974	1070	109	463	572	8	0	8	213	1437	1650
		Oil Seeds	14	346	360	366	70	436	0	0	0	380	416	796
5	Jari	Cereals	756	6114	6870	360	90	450	0	0	0	1116	6204	7320
		Coarse Cereals	18	276	294	0	0	0	0	0	0	18	276	294
		Pulses	52	688	740	140	495	635	5	0	5	197	1184	1380
		Oil Seeds	12	183	195	531	109	640	0	0	0	543	292	835
6	Palkot	Cereals	1864	16776	18640	540	95	635	18	0	18	2422	16871	19293
		Coarse Cereals	66	667	733	0	0	0	0	0	0	66	667	733
		Pulses	56	1819	1875	198	744	942	40	0	40	294	2563	2857
		Oil Seeds	13	637	650	721	169	890	0	0	0	734	806	1540
7	Basia	Cereals	1092	12554	13646	413	67	480	0	0	0	1504	12622	14126
		Coarse Cereals	40	531	571	0	0	0	0	0	0	40	531	571
		Pulses	55	1314	1369	231	774	1005	22	0	22	308	2088	2396
		Oil Seeds	27	418	445	722	158	880	0	0	0	749	576	1325
8	Kamdara	Cereals	1797	10180	11977	433	102	535	0	0	0	2230	10282	12512
		Coarse Cereals	36	485	521	0	0	0	0	0	0	36	485	521
		Pulses	43	1397	1440	193	728	921	35	0	35	272	2124	2396
		Oil Seeds	16	378	394	623	128	750	0	0	0	638	506	1144
9	Sisai	Cereals	1848	12368	14216	568	108	676	92	0	92	2508	12476	14984
		Coarse Cereals	67	676	743	0	0	0	0	0	0	67	676	743
		Pulses	72	1370	1442	200	851	1050	94	0	94	366	2220	2586
		Oil Seeds	29	449	478	752	133	885	0	0	0	781	582	1363
10	Bharno	Cereals	1074	8686	9760	502	103	605	80	0	80	1656	8789	10445
		Coarse Cereals	43	565	608	0	0	0	0	0	0	43	565	608
		Pulses	74	986	1060	129	632	761	83	0	83	287	1617	1904

Sl.			Kharif (area in ha)			Rabi (area in ha)			Summer (area in ha)			Total (area in ha)		
No.	**Block**	**Crop Type**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**	**Irrigated**	**rainfed**	**Tolal**
		Oil Seeds	11	357	368	472	104	575	0	0	0	483	460	943
11	Ghaghra	Cereals	1677	15090	16767	564	141	705	58	0	58	2299	15231	17530
		Coarse Cereals	94	844	938	0	0	0	0	0	0	94	844	938
		Pulses	106	2012	2118	245	922	1167	62	0	62	413	2934	3347
		Oil Seeds	11	559	570	743	142	885	0	0	0	755	700	1455
12	Bishunpur	Cereals	2316	16984	19300	593	158	750	0	0	0	2909	17142	20050
		Coarse Cereals	64	856	920	0	0	0	0	0	0	64	856	920
		Pulses	69	1665	1734	201	671	872	12	0	12	282	2336	2618
		Oil Seeds	21	670	691	760	167	927	0	0	0	781	837	1618

(Area in ha)

1.13 Geological set up

In general The Gumla district forming South –Western part of the chotanagpur plateau is predominated by chotanagpur granite-gneiss of archean age, which forms the basement in the area. Patches of mica schist occurs within the granitic and gneissic bodies. Laterities of early tertiary are found to cap over granites and gneisses in highland areas. Recent to sub recent alluvial sediments are found to occur along present day river channel. Structurally & tectonically the archean complex have been affected by eastern ghat oroganic movement giving rise to the sets of major fractures and lineaments.

The generalized geological succession of the district is given below: -

Geological Formation	**Age**
Alluvium	Recent to sub-Recent
Laterite	Early Tertiary
----------Unconformity----------	
Schist and Phyllite Quartzites, Chotanagpur Granite and Granite Gneiss	Proterozoic to Archaean

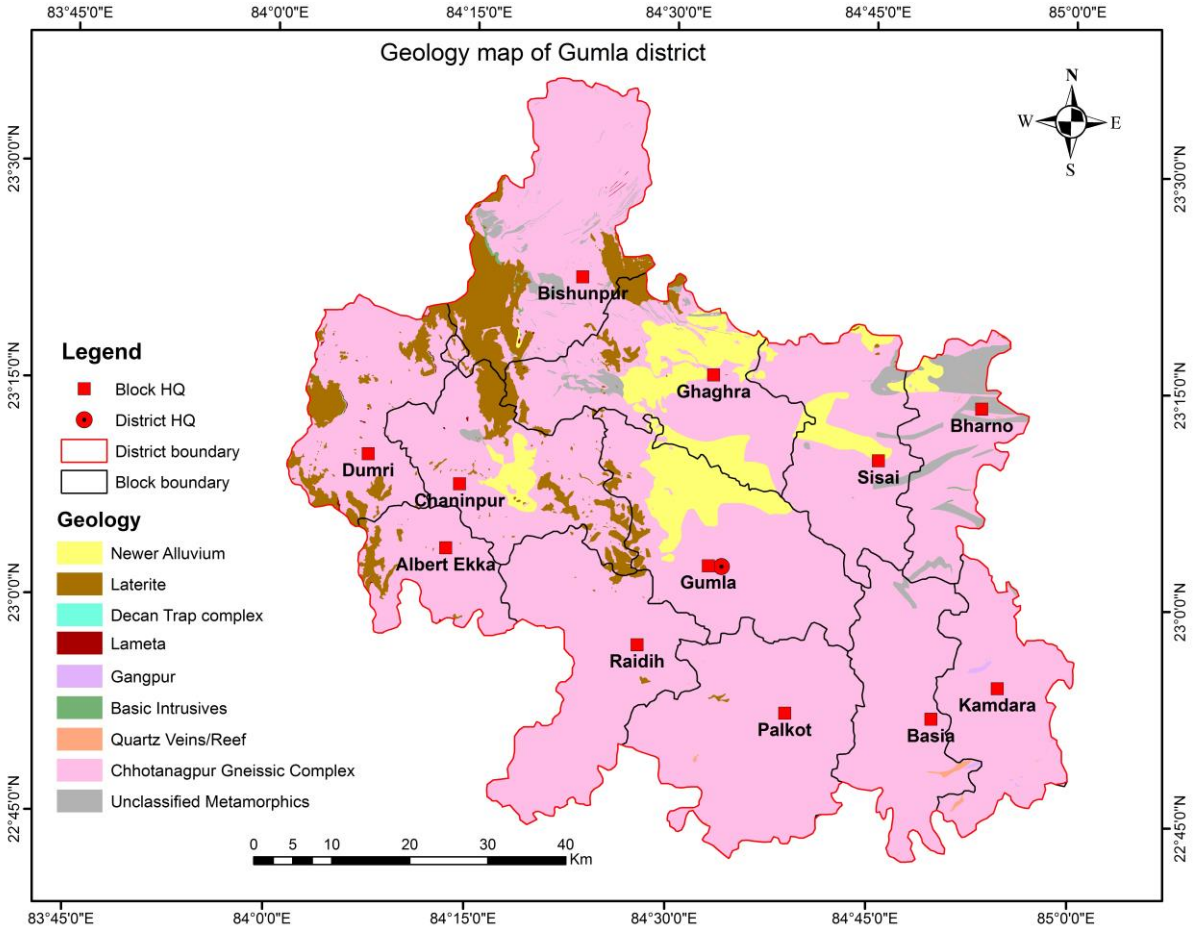


Figure – 6: Geological map of Gumla district (source GSI)

Chotanagpur Granites and Granite-gneiss

Major Part of the district is underlain by Chotanagpur granite-gneiss of Archean age which forms the basement rocks. It occurs as large batholithic mass. The granite-gneiss is foliated whereas granites are massive, but foliation is sometimes seen in granitic rocks also, both the rock unit have same mineral composition. The minerals are quartz, feldspar and biotite. The gneisses are banded showing prominent foliation. Pegmatitic veins are seen intruded all along the granitic terrain. They are emplaced in tensional fractures and often show chilling and alteration effect in the contact. The granites which generally stand out as hills and mounds with numerous heaped up boulders testifying to their highly jointed character.

Mica-Hornblende Schist & Phylites

In a limited area exposure of mica hornblende schist and phyllites are seen which is generally composed of muscovite biotite, hornblende with feldspar and quartz. The mica hornblend schist show pronounced foliation in the form of well developed axial plane schistosity plane show parallel trend with the gneisses. The schistose rocks are folded.

Laterites

Early tertiary laterites occur in the area over topographic highs of uplands. They do not have large areal extension and are localised in nature. They are porous, pitted, clay like rock with red, brown and grey colours, often mottled. Generally it has a hard protective cover of limonetic crust. It is composed mainly of hydrated oxides of iron and alumina.

Recent Alluvium

These are found to occurs as terrace deposits comprising of coarse sand and gravels mixed with sandy silt and silty clay with some pebbles of laterites and granite-gneiss.

Structural features

Structurally and tectonically the archean complex of chotanagpur plateau is a product of satpura orogenic cycle having regional E-W strike which has giving rise to sets of major fractures and a series of synformal and antiformal structures. All pronounced vertical to sub-vertical gneissic foliation. The mica schist also show well developed foliation/schistosity in the form of axial plane. The trend of the foliation varies from E-W in the northern part of the district where as in the southern part it trends in ENE-WSW direction.

Joints parallel to foliation are common in gneissic rocks where as sheet jointing are common in granites which generally stands out as hills and mounds with numerous heaped up boulders testying to their highly jointed character. Two sets of joints trending NW-SE and NNE- SSW are discrenable with steep dip of 50 to 88^0 in NE or SE direction near simdega. At many places it has been observed that the quartz-veins are off set by these structures. Significantly dykes are uncommon in the area. More or less these structures control the drainage of the area.

2.0 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 & Data Generation

2.1.1 Data collection Compilation

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

i. Hydrogeological Data: Water level data of 57 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, 57 samples were collected from dug wells

iii. Exploratory drilling**:** 48 exploratory and 10 observation wells are existing in hard rock area and 17 exploratory well and 4 observation well were drilled through departmental rigs and 31 exploratory wells and 6 Observations drilled through Outsourcing (WAPCOS).

iv. Hydrometeorological Data: Last five years (2016-2020) monsoon rainfall data for each of the block from the office of District Agriculture Department, Gumla.

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 is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is Chhotanagpur Gnesiss Complex, where the occurrence and movement of ground water primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and weathering. Based on morpho-genetic, geological diversities and relative ground water potentialities of the aquifers, the district can be broadly divided into two Hydrogeological units: Consolidated or Fissured formations, and unconsolidated or porous formations.

1. Consolidated or Fissured formations - Precambrians formation
2. Unconsolidated or Porous formations - Laterites and Alluvium

In major part of this district, hard rock form the principal aquifers, which includes mainly Chotanagpur gneissic complex, However, laterites at isolated patches as well as alluvium al materials along the vicinity of the rivers also form potential aquifers.

Hydrogeological map of Gumla district has been prepared (Fig-7)

2.2.1 *Ground water in Aquifer-I (Weathered Granite Gneisses, Laterites and alluvium): -*

The Aquifer-I is represented by weathered Granite- Gneisses, Laterites and alluvium. 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. Laterites occur as cappings over granite-gneiss. Ground water occurs within the weathered residuum at favorable locations.The average thickness of the weathered residuum of the districtvariesfrom 10-50m. Besides, the patches of laterite deposits contain goodamount ofground water within its primary porosityin the western part of the district. The valley has beenformed mainly by South Koel and its tributaries like Sankh.Ground water also occurs in the unconsolidated sediments deposited by theserivers. Potential aquifer exists at shallow to moderate depth. Ground water occurs in unconfined to semi-confined state in Aquifer-I (upto the depth of 30m). Yield of the wells in Aquifer-I is very poor restricted to 5-10 m3/hr in laterites/weathered Granite-Gneiss. These aquifers are generally tapped by the dugwells or shallow borewells.

2.2.2 *Ground Water in Aquifer – II (Fractured Granite Gneiss): -*

The Chotanagpur granite-gneiss, belonging to Precambrian 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. Based on exploratory drilling by CGWB, Moderate to good yield has been obtained in the wells upto the depth of 200m.

2.2.2.1 Potential Fractures: Potential Fractures have been identified based on exploratory drilling in Gumla district as under Table-7

Table-7.Potential Fractures identified based on exploratory drilling in Gumla district

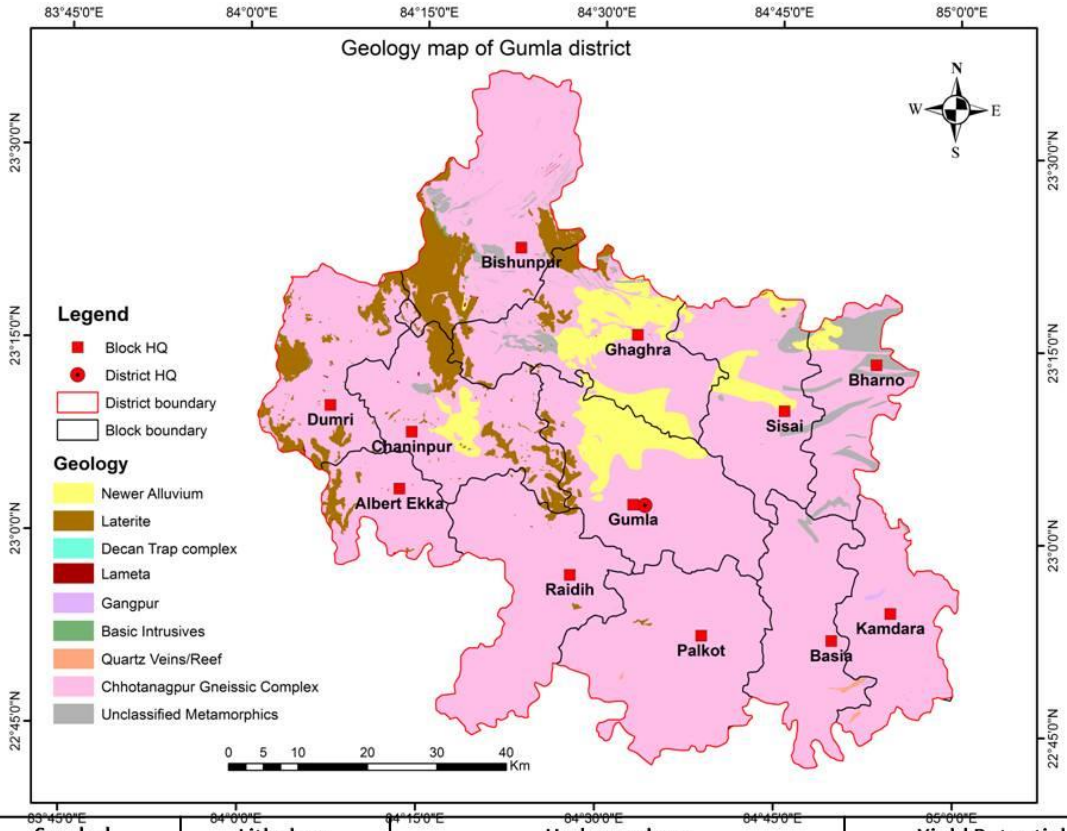
Sl.No.	Location/	Block	Latitude	Longitude	Depth Drilled	Casing Depth/Dia. (m/mm)	Fractures encountered (m)	Discharge (m3/hr.)	Formation
1	Nimtoli	Gumla	23^{0}04'00"	84^{0}32'00"	90	-	-	10.8	Granite Gneiss
2	Natapole	Chainpur	23^{0}04'05"	84^{0}19'10"	60.4	-	-	36	Granite Gneiss
3	Salegutu	Kamdara	22^{0}50' 50"	84^{0}55' 10"	55.91	-	-	9	Granite Gneiss
4	BajarHat, Toto	Gumla	23^{0}08'10"	84^{0}32'00'	161.82	24	67-68, 112-113	15.69	Granite Gneiss
5	Murgu	Sisai	23^{0}11'40"	84^{0}41'25"	132.39	22.57	25-28, 85-88	24	Granite Gneiss
6	Chainpur	Chainpur	23°08'15.7''	84°14'21.3"	144	24.39	67.5-68.5, 118.2-119.2	43.884	Granite Gneiss
7	Kumhari	Basia	22°57'00"	84°49'00''	90.46			21.39	Granite Gneiss
8	Lawakera	Basia	22°54'24.7"	84°46'59.7"	131	20.72	124.5-126.0	43.884	Granite Gneiss
9	Bishunpur	Bishunpur	23°22'41.1"	84°22'54.5"	203	32.92	91-93, 96-96.5	27.828	Granite Gneiss
11	Nawadih	Dumri	23°09'46.5"	84°08'18.3"	148	18.74	23.2-23.4, 45.5-45.9, 66.0-67.0	43.884	Granite Gneiss

Source: CGWB

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 43 m^3/hr.
- Overall in the district the major potential fractures zones are found between 20-120 m.
- First potential fracture zone encountered in the district widely varies from 17-148 m depth.
- The potential fractures were encountered below 100m with very high yielding wells (Murgu- 24 m3/hr, Bishunpur- 27 m3/hr, Nawadih- 43 m3/hr
- The potential fractures were encountered between 100-125m with very high yielding wells (Bazar Hat Toto-15.69 m3/hr, Chainpur-43.88m3/hr, Lawakera-43.88 m3/hr).

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



Symbol	Lithology	Hydrogeology	Yield Potential
	Alluvium	Thickness varies from few meters to 20m underlain by crystalline rocks. Groundwater occurs under phreatic conditions	Supports dugwells & shallow tubewells, yield varies from 1-5 m^3/hr
	Laterite	Moderately thick, porous, discontinuous,found as patches	Moderate, 5-10m^3/hr
	Chotanagpur Gneissic Complex	Groundwater restricted to weathered residuum/fractures(upto 200m),water table & semi-confined to confined conditions	Moderate to good yield prospecs, 5-40m^3/hr
	Unclassified Metamorphic	Groundwater restricted to weathered residuum/fractures,water table & semi-confined to confined conditions	Limited yield prospects, below 10m^3/hr

Figure – 7: Hydrogeological Map of Gumla district

2.2.3 Ground water Dynamics:-

2.2.3.1 Ground water Monitoring Wells: 44 key wells were established and 13 NHNS monitored to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. The depth of these dug well varies from 3.15 to 12.50 mbgl. Similarly, the diameters of key wells (dug wells) ranges from 2.10 to 4.50m. During 2021, the pre monsoon (May) depth to water level in these wells was between 0.30 to 10.00 mbgl. The post monsoon depth to water level (Nov. 2021) in the dug wells ranges from 0.25 to 6.64 mbgl. Average pre-monsoon water level was calculated 5.04 mbgl and in post monsoon 3.72 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 –8.

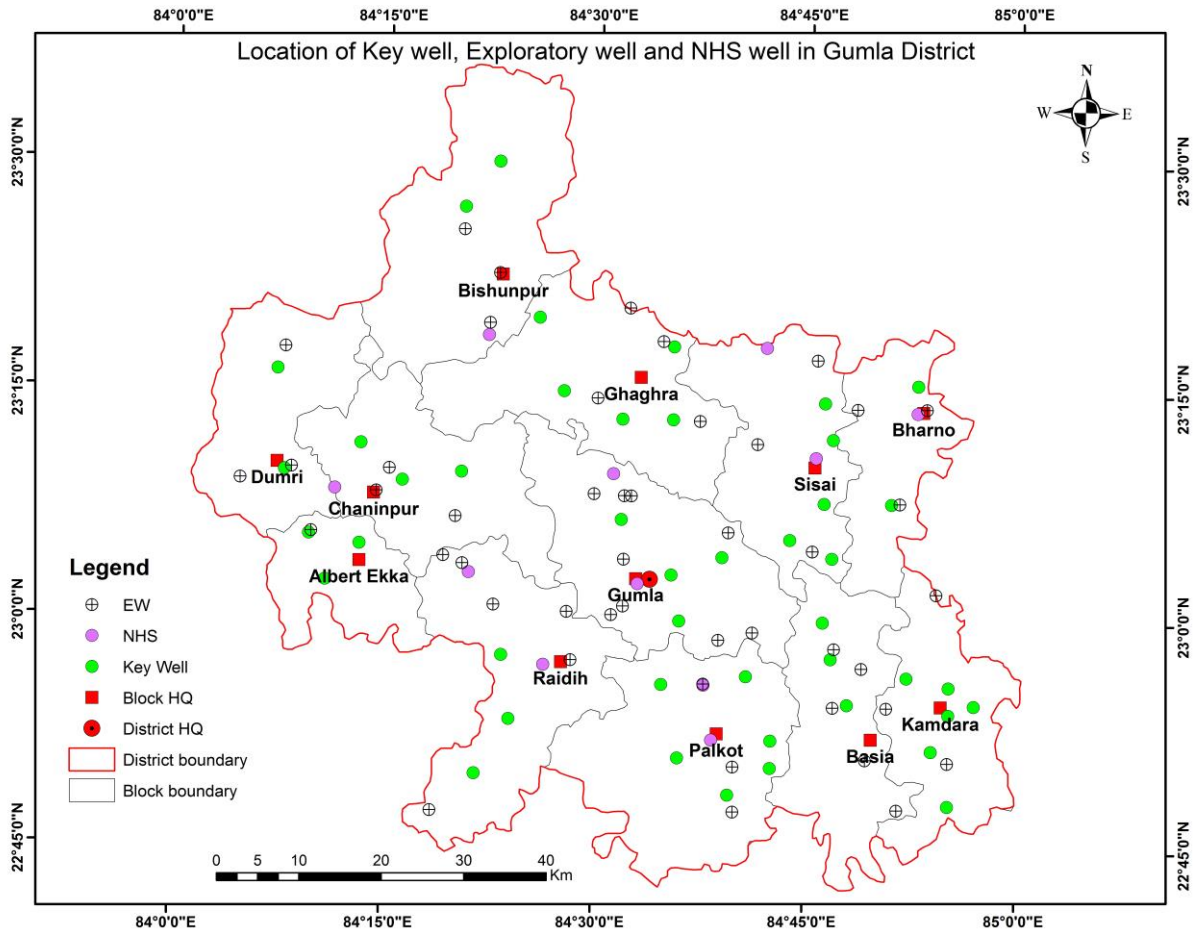


Figure –8: Location of Key wells NHNS and Exploratory wells

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 57 monitoring wells representing shallow aquifer. The pre monsoon (May 2021) depth to water level monitored between 0.30 to 10.00 mbgl and average 5.04 m bgl. The post monsoon depth to water level (Nov. 2021) in the dug wells ranges from 0.25 to 6.64 mbgl and average 3.72 m bgl respectively. Pre and post monsoon depth to water level maps were prepared for the year 2021 and shown in figure – 09, 10.

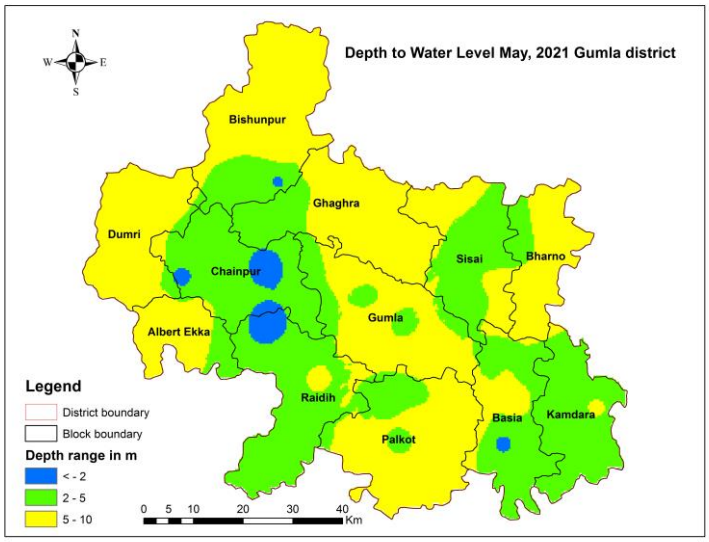


Figure – 09: Pre monsoon (May 2021) depth to water level map of Aquifer – I (shallow aquifer)

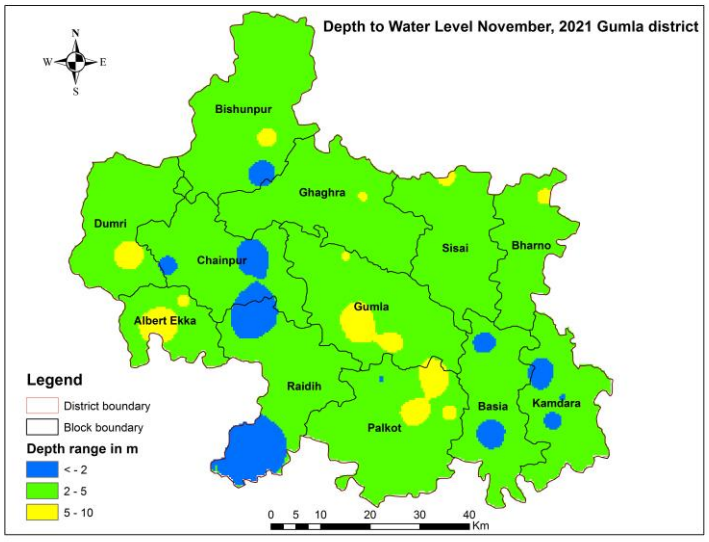


Figure – 10: Post monsoon (Nov. 2021) depth to water level map of Aquifer – I (shallow aquifer)

The water level monitored during pre and post monsoon period 2021 was used to compute the seasonal fluctuation.

2.2.3.3 Water level fluctuation:

The seasonal water level fluctuation was observed between 0.35 to 6.45m for the period between pre monsoon and post monsoon 2021.

2.2.3.4 Ten years Long Term Water Level Trend (2011-2021):

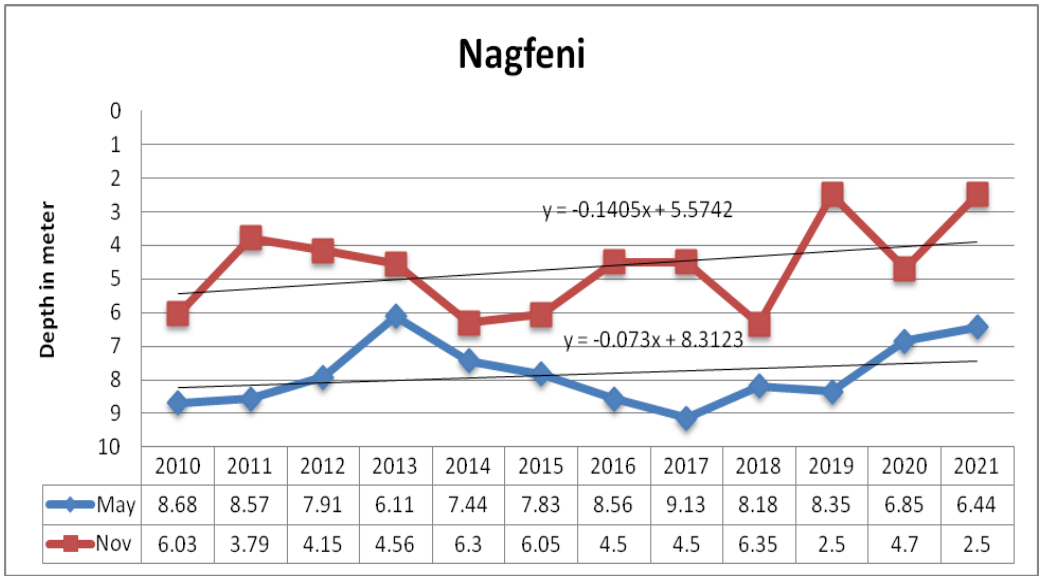
In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data for the period 2011-2021 have been computed and analyzed which is presented in table - 8. The annual decadal water level of the district was observed rising trend in 3 stations and declining trend in 4 staqtions.

Table:8 Last ten years long term water level trend of Gumla district (2011 – 2020)

	Gumla	Annual	
Sl No.	Location	Rise (m/year)	Fall (m/year)
1	Nagfeni		0.0509
2	Gumla		0.0579
3	Palkot		0.041
4	Baisia		0.2239
5	Baghma		0.0403
6	Raidih	0.2202	
7	Gumla1	0.0409	
8	Kasir		0.0245
9	Anjam gram	0.3746	
10	Chainpur1	0.0366	
11	Sisai		0.0216
12	Bharno bdo		0.0999
13	Ghagra	0.0984	

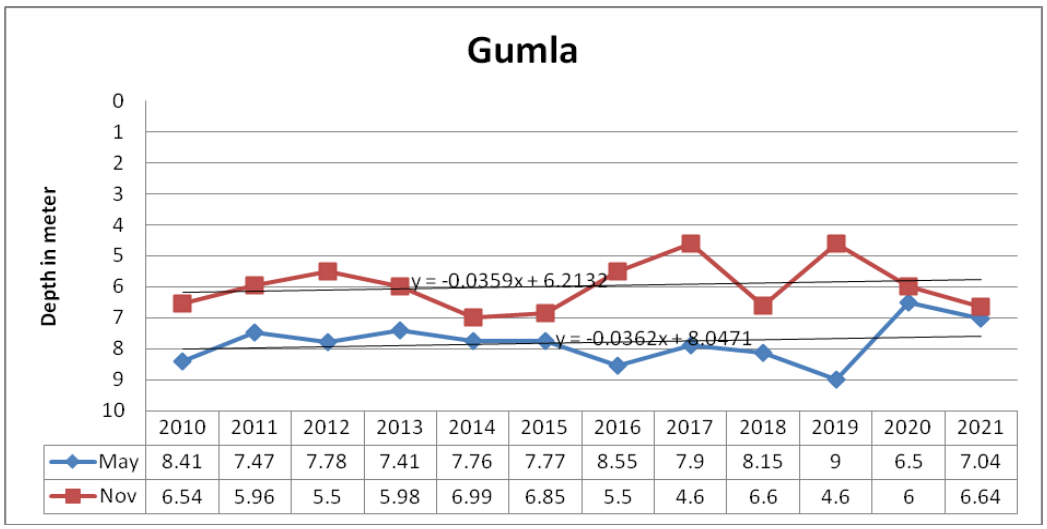
2.2.3.5 Hydrograph Analysis:

Analysis of five (05) hydrograph network stations, were carried out using Excel software (Figure-11-15) and analysed for the period from 2010-2021. It is observed that the long-term water level trends during pre and post-monsoon seasons are declining trend in one station and four station are rising in shallow aquifer-I represented by dug wells.



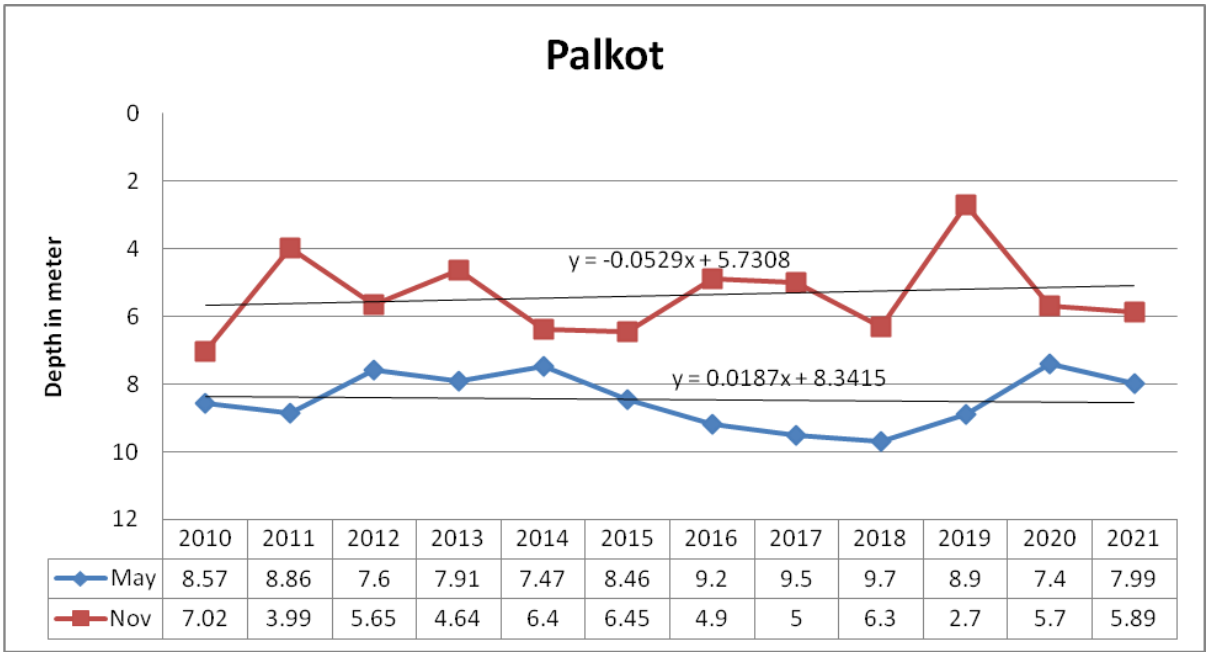
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
May	8.68	8.57	7.91	6.11	7.44	7.83	8.56	9.13	8.18	8.35	6.85	6.44
Nov	6.03	3.79	4.15	4.56	6.3	6.05	4.5	4.5	6.35	2.5	4.7	2.5

Figure 11: Hydrograph (2010-2021), Nagfeni, Gumla



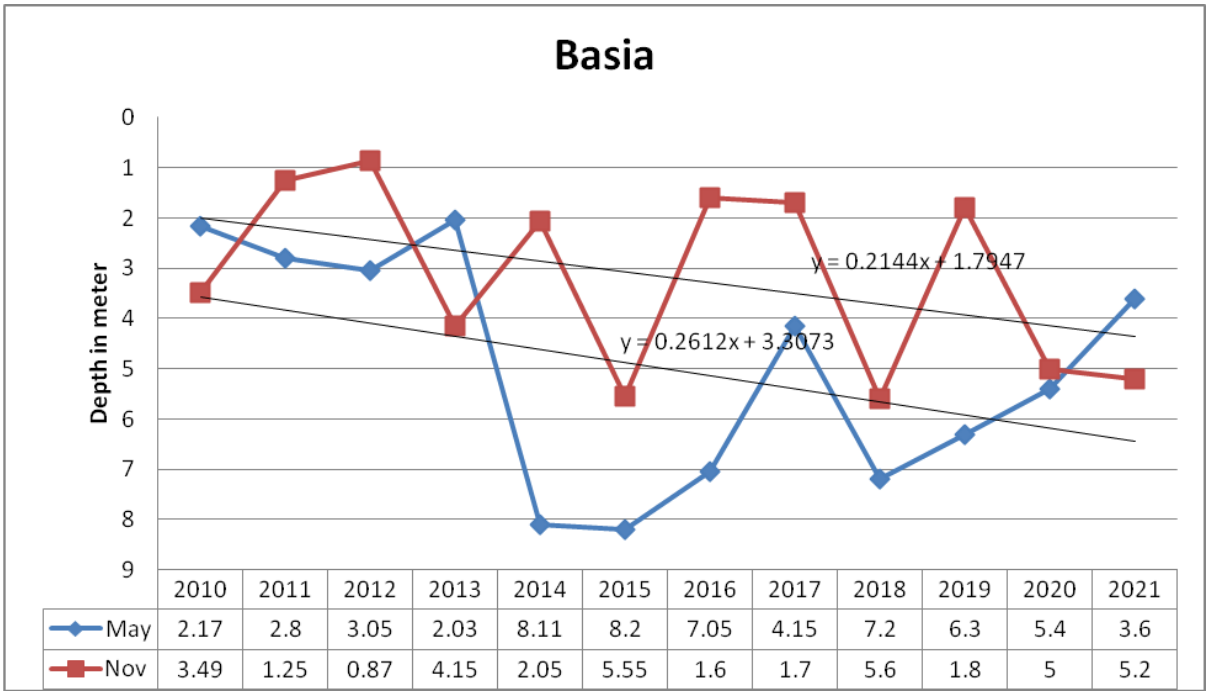
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
May	8.41	7.47	7.78	7.41	7.76	7.77	8.55	7.9	8.15	9	6.5	7.04
Nov	6.54	5.96	5.5	5.98	6.99	6.85	5.5	4.6	6.6	4.6	6	6.64

Figure-12: Hydrograph (2012-2021), Gumla block, Gumla district



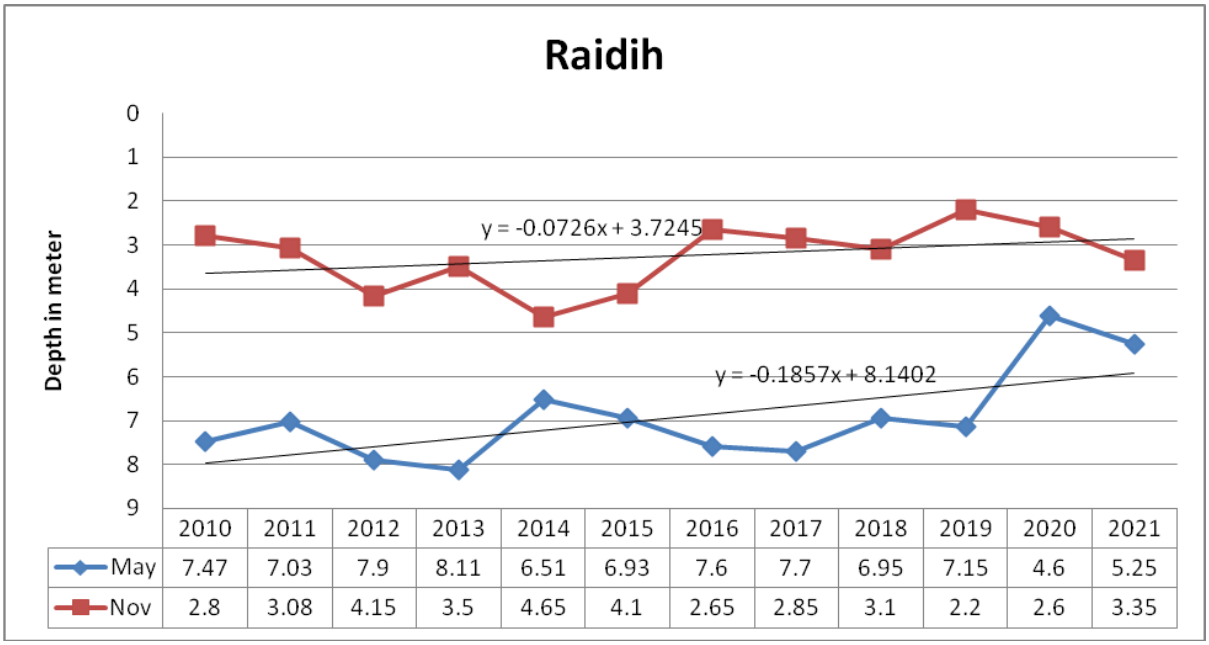
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
May	8.57	8.86	7.6	7.91	7.47	8.46	9.2	9.5	9.7	8.9	7.4	7.99
Nov	7.02	3.99	5.65	4.64	6.4	6.45	4.9	5	6.3	2.7	5.7	5.89

Figure- 13: Hydrograph (2012-2021), Palkot, Palkot block, Gumla district



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
May	2.17	2.8	3.05	2.03	8.11	8.2	7.05	4.15	7.2	6.3	5.4	3.6
Nov	3.49	1.25	0.87	4.15	2.05	5.55	1.6	1.7	5.6	1.8	5	5.2

Figure- 14: Hydrograph (2010-2021), Gumla , Gumla block, Gumla district



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
May	7.47	7.03	7.9	8.11	6.51	6.93	7.6	7.7	6.95	7.15	4.6	5.25
Nov	2.8	3.08	4.15	3.5	4.65	4.1	2.65	2.85	3.1	2.2	2.6	3.35

Figure- 15: Hydrograph (2010-2021), Raidih, Raidih block, Gumla district

2.3 Geophysical Survey:

150 VES is required in the district each block and 143 nos. of VES have been done by WAPCOS in Gumla district. The district has 12 blocks, and geophysical surveys were carried out in all blocks.

Interpreted Results of VES

In hard rock terrain the subsurface parameters changes with small distances. No boreholes were found exactly at the same spot of VES. Still the VES interpreted results are compared with the available nearby boreholes. At 5 nos. of VES sites i.e., VES 118, 157, 183, 229 and 239 the borehole sites are available within one km. Based on the interpreted results of 143 VES, it is observed that at 96 VES sites the weathered zone is absent. At 21 VES the weathered zone is having the depths more than 9 meters which can be considered for shallow depths to ground water. At the rest 26 VES the weathered zone is very thin, less than the depth range 9 meter. At 4 VES sites the weathered zone in granite gneiss terrain extends more than 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 basis of these considerations 44 sites are detected to be semi weatherd zones/ Less compact zones which are given in the table. The fractured zones have been delineated at several 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 89 nos of VES the fracture zones are detected. In a few cases the fractures may be dry and feeble.

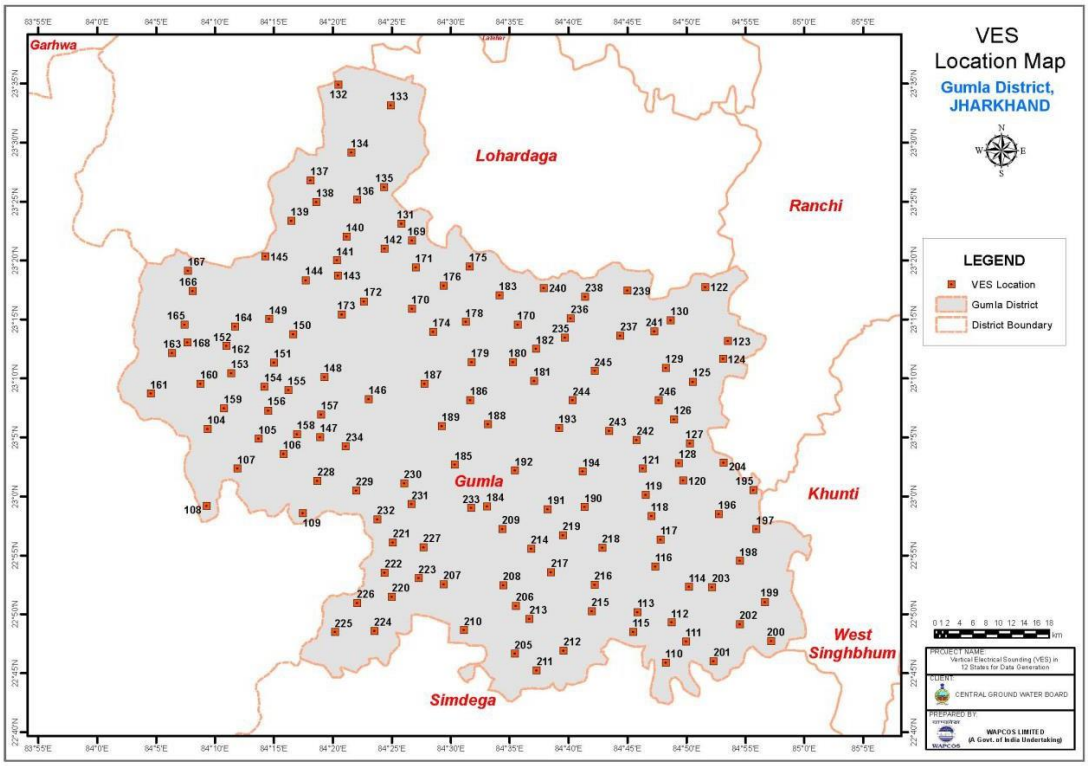


Figure 16: Map of Gumla district showing VES locations

Based on the results of the VES conducted, it can be said that in Gumla district the weathered zone in granite gneiss terrain extends maximum up to 33 m depth. The resistivity of the weathered zone ranges from 15 to 70 ohm.m. Out of 27 VES sites at 8 VES sites the depth to the bottom of the weathered zone exceeds 10 m. The semi-weathered zone extends to a maximum depth of 94m at VES 115. The resistivity of semi weathered zone varies from 88 to 258 ohm.m. The fractured zones have been delineated empirically.

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 57 dug wells. The analytical results of water samples dug wells are given in Annexure-IV. 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) and four no. of bore wells.

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 7.63 to 8.23 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 69 to 1584 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 18.30 to 451.40 mg/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 7.10 to 227.20 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 0.94 mg/l.

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 is;

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

The Sulphate value ranges between 0.00 to 94.98mg/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 1.22 to 85 mg/l.

Calcium:

In mineral form, it is found as Calcite, aragonite, gypsum, anhydrite, anorthite, diopside etc. The Calcium concentration ranges between 6 to 136 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 montmorillonite. The Magnesium concentration ranges between 1.10 to 102.06 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 595 mg/l.

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

Chemical Constituents and quality parameters	**Aquifer – I (Dug well samples)**
pH	7.63-8.23
EC (micro siemens/cm at 25^0c)	69 - 1584
TDS (ppm)	44.85-1029.6
TH as $CaCo_3$ (ppm)	20-595
Ca (ppm)	6-136
Mg (ppm)	1.10-102.06
Na (ppm)	1.22-85
K (ppm)	0.01-29.84
HCO_3 (ppm)	18.3-451.40
Cl (ppm)	7.10-227.20
SO_4 (ppm)	0.00 – 94.98
NO_3 (ppm)	0-98
F (ppm)	0.00-0.94

The ground water of Aquifer – I (shallow aquifers) in the area is alkaline in nature. On the perusal of table - 11, the pH value of the area is 7.63-8.23. The TDS value is varies between 44.85 to 1029.60 mg/l. Overall values of Calcium and Magnesium varies between 6 to 136 mg/l and 1.10 – 102.06 mg/l in the area respectively. Nitrate concentration is observed between 0.00 to 98 mg/l while the Fluoride value varies from 0.00 to 0.94 mg/l within the area.

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

The suitability of ground water for drinking purposes is determine 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 for 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	57 (100%)	Nil	Nil
TDS (ppm)	500	2000	57 (100%)	Nil	Nil
TH as $Caco_3$ (ppm)	200	600	57 (100%)	Nil	Nil
Ca (ppm)	75	200	57 (100%)	Nil	Nil
Mg (ppm)	30	100	56 (98%)	Nil	1(2%)
Cl (ppm)	250	1000	57 (100%)	Nil	Nil
SO_4 (ppm)	200	400	57 (100%)	Nil	Nil
HCO_3 (ppm)	200	600	57 (100%)	Nil	Nil
NO_3 (ppm)	45	No relaxation	45 (79%)	Nil	12(21%)
F (ppm)	1.0	1.5	57(100%)	Nil	Nil

The table - 10 indicates that all the water samples are falling in desirable to permissible category except Nitrate & Mg. The value of Nitrate observed beyond permissible limit (mg/l) in 12 samples. Similarly, the value of in 1 Sample of Magnesium were found beyond permissible limit.

2.4.1.2 Suitability of Ground Water of Aquifer – I for 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 equation.

Sodium Percentage (Na %) $\quad \dfrac{(Na^+ + K^+) \times 100}{(Ca^{2+} + Mg^{2+} + Na^+ + K^+)}$ $\quad$ Wilcox (1955)

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 %	10	17%
2	Good	20 – 40 %	36	63%
3	Permissible	40 – 60 %	10	17%
4	Doubtful	60 – 80 %	1	2%
5	Unsuitable	> 80 %		Nil

(Where all ions are expressed in epm)

On the perusal of table 98% of water samples of aquifer – I (dug wells) falling under permissible and 2% 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:

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

where Na^+, Ca^{2+} and Mg^{2+} are in meq/l.

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 Gumla district all all 57 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 (57 sample)
C2	10-20	Good	-
C3	20-26	Doubtful	-
C4	>26	Unsuitable	-

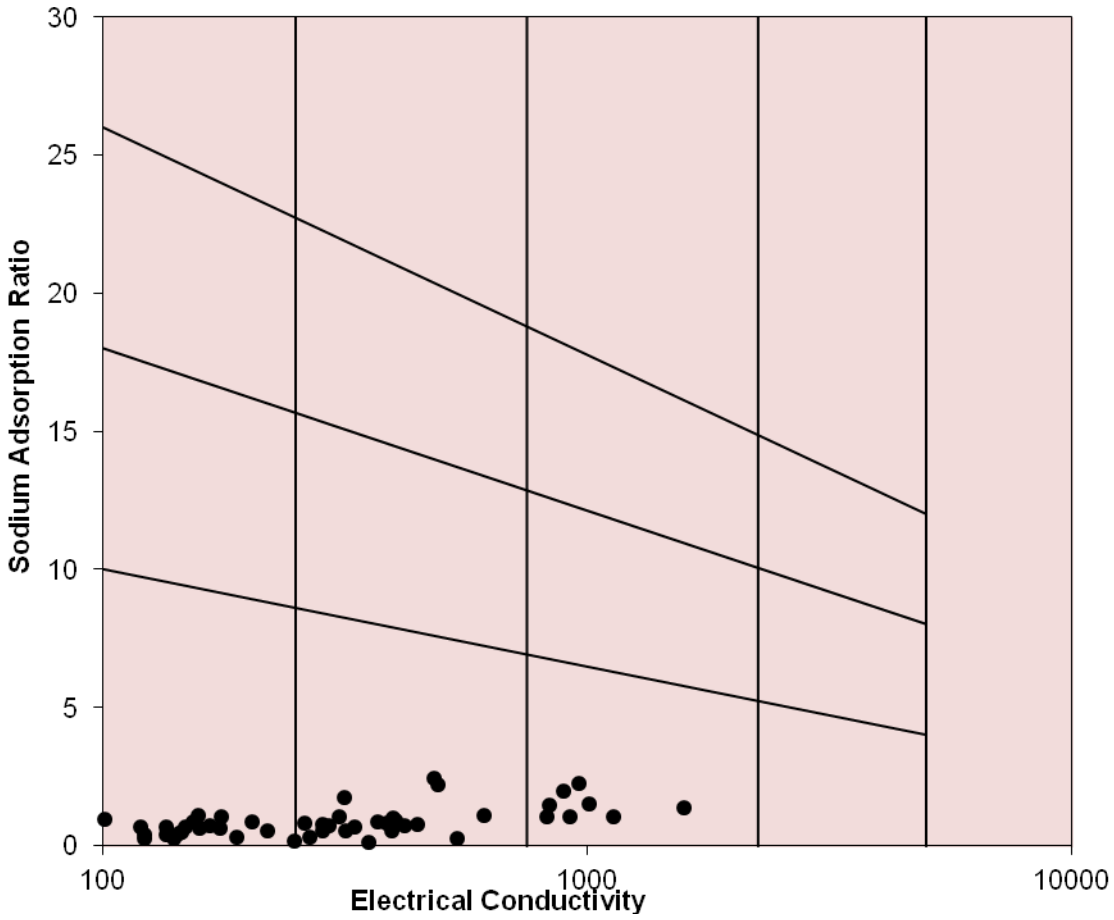


Figure:-17 U.S. salinity Hazards for Aquifer – I

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. Calculation of RSC is given below.

Residual sodium carbonate (RSC)	$(HCO_3^- + CO_3^{2-}) - (Ca^{2+} + Mg^{2+})$	Eaton (1950); Richards (1954)	

In study area 57 water samples of shallow Aquifer-(dug wells) collected for analysis and are safe for all type of crops for irrigation.

On The perusal of table-13, about 98 % of water samples of Aquifer – I (dug well) falling under good water class and 2%fall in the semi-tolerant to tolerant classes.

Table: 13 Residual Sodium Carbonate (RSC)

Parameter	Range	Irrigation Suitability	Sample	Percentage
Residual Sodium Carbonate **(RSC)**	< 1.25	Safe for all type of crops	56	100
	1.25 – 2.50	Safe for semi-tolerant to tolerant crops	1	
	>2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC		

(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) 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	28 (49%)
2	Good	250 – 750	21 (37%)
3	Permissible	750 – 2250	8 (14%)
4	Unisuitable	>2250	Nil

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 samples, 22 sample is no dominant type 8 samples are Sodium and

Potassium dominant 25 samples are calcium dominant and 2 sampes are magnesium dominant. In anion part 25 samples are Bicarbonate dominant, 10 samples are Chloride dominant and 22 samples are no dominant. In the dimond part plotted samples falling 30 Magnesium bicarbonate type 3 samples are Sodium Chloride type 3 samples are Sodium bicarbonate mixed type (Na-HCO_3) and 21 sample is mixed type Calcium chloride type.

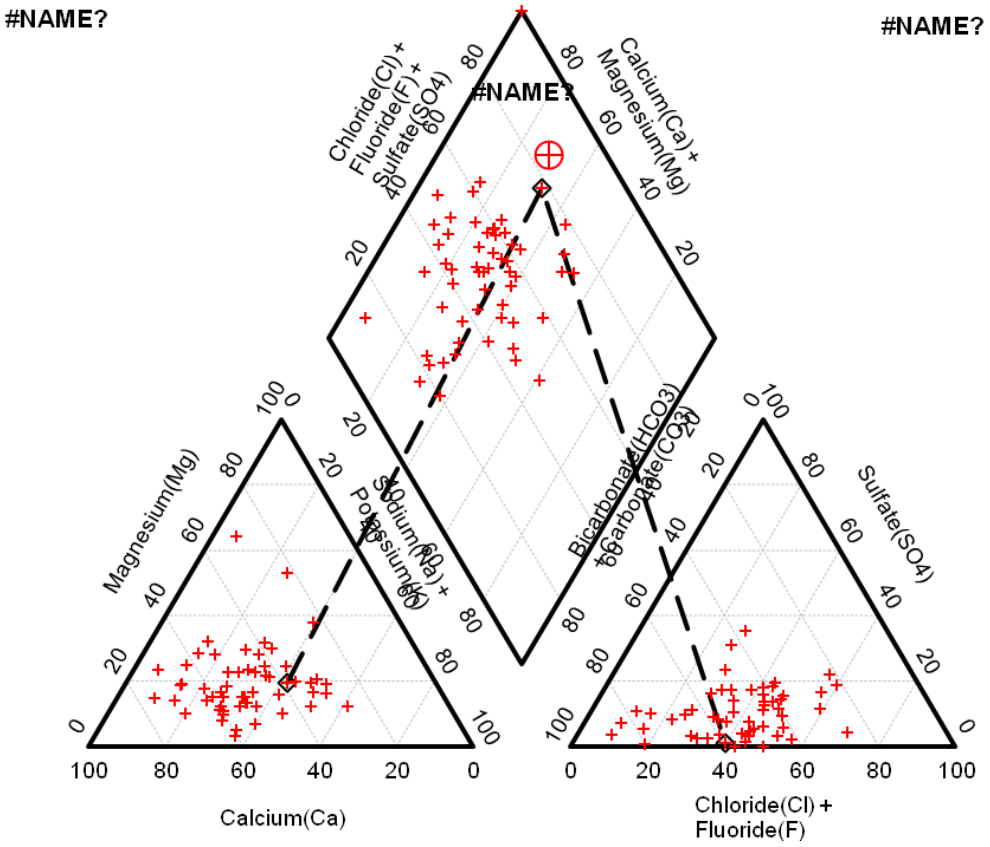


Figure:-18 Piper Diagrame for Aquifer – I

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**.

3.0 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 which has been 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' (NW to SE direction), B-B' (N-S direction) and C-C' (West to East 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 Central part NW to SE direction of Gumla district. Cross section covers exploratory wells of Lohra, Chainpur, Kashir Karaundi, Baghama and Karicuan. The Aquifer- I ranges 1.82-50.54m representing weathered Granite gneiss, while Aquifer-II ranges from 1.82-160.2 m representing fractured granite gneiss. Generally 1-5 fracture zones were encountered. Maximum discharge found at Chainpur (43.88 m^3/hr).

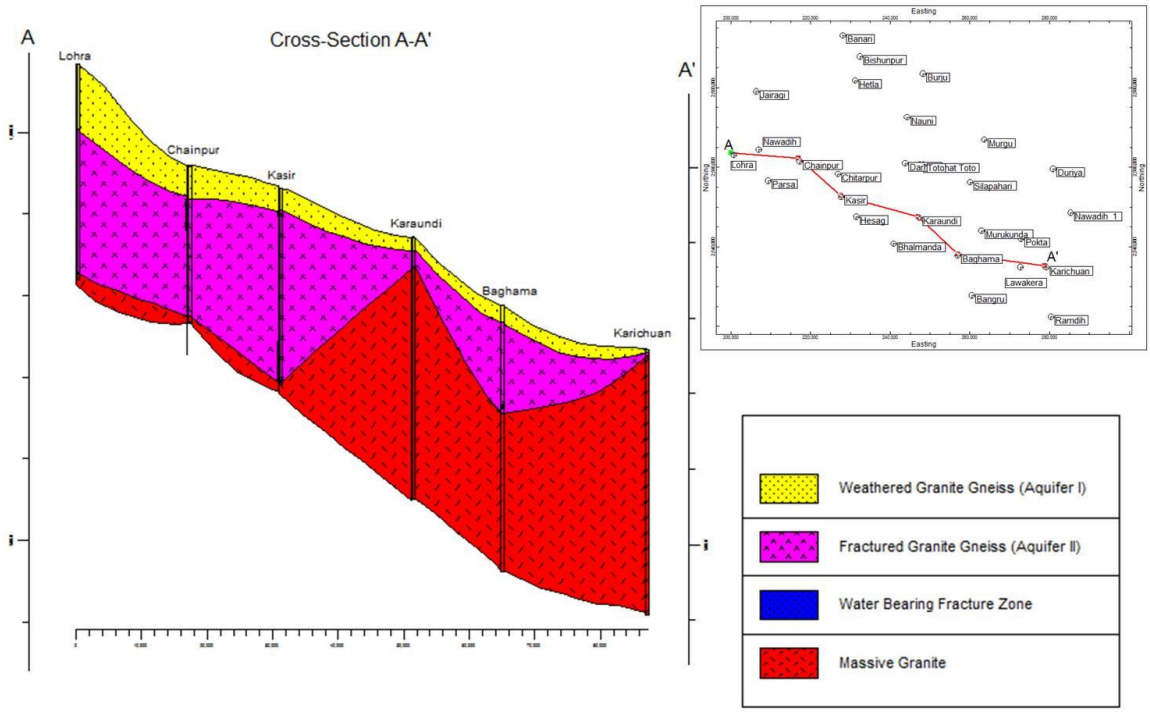


Figure-19: Hydrogeological cross section along A-A'

3.1.1.2 Hydrogeological cross section B-B': -

Hydrogeological cross section B-B' represents the area in NE and SW direction in north-east part of Gumla district. Cross section covers exploratory wells of Banari, Bishunpur, Burju, Murgu,Duriya ans Nawadih The Aquifer- I ranges 2.43-32.92m representing weathered Granite gneiss, while Aquifer-II ranges from 32.92-167.5m representing fractured granite gneiss. Generally 1-3 fracture zones were encountered. Discharge ranges from 1-43.88 m^3/hr. Maximum discharge found at Nawadih 43.88 m3/hr.

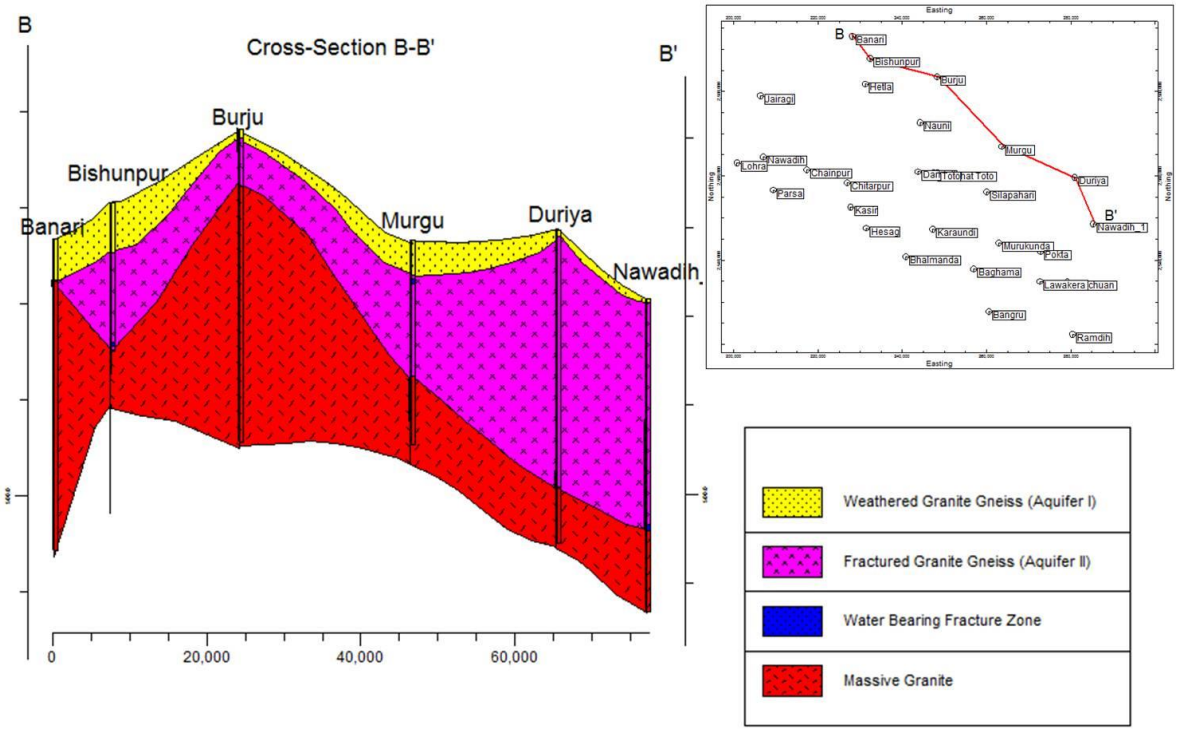


Figure-20: Hydrogeological cross section along B-B'

3.1.1.3 Hydrogeological cross section C-C':-

Hydrogeological cross section C-C' represents the area in North to South of Gumla district. Cross section covers exploratory wells of Burju,Toto,Karaundi, Baghama and Bangru. The Aquifer- I ranges 6-13 m representing weathered Granite gneiss, while Aquifer-II ranges from 13.1-82.5 m representing Fractured in granite gneiss. Generally 0-4 fracture zones were encountered. Discharge ranges from 0.46 -5.85 m^3/hr. Maximum discharges found at Karaundi-5.85m3/hr.

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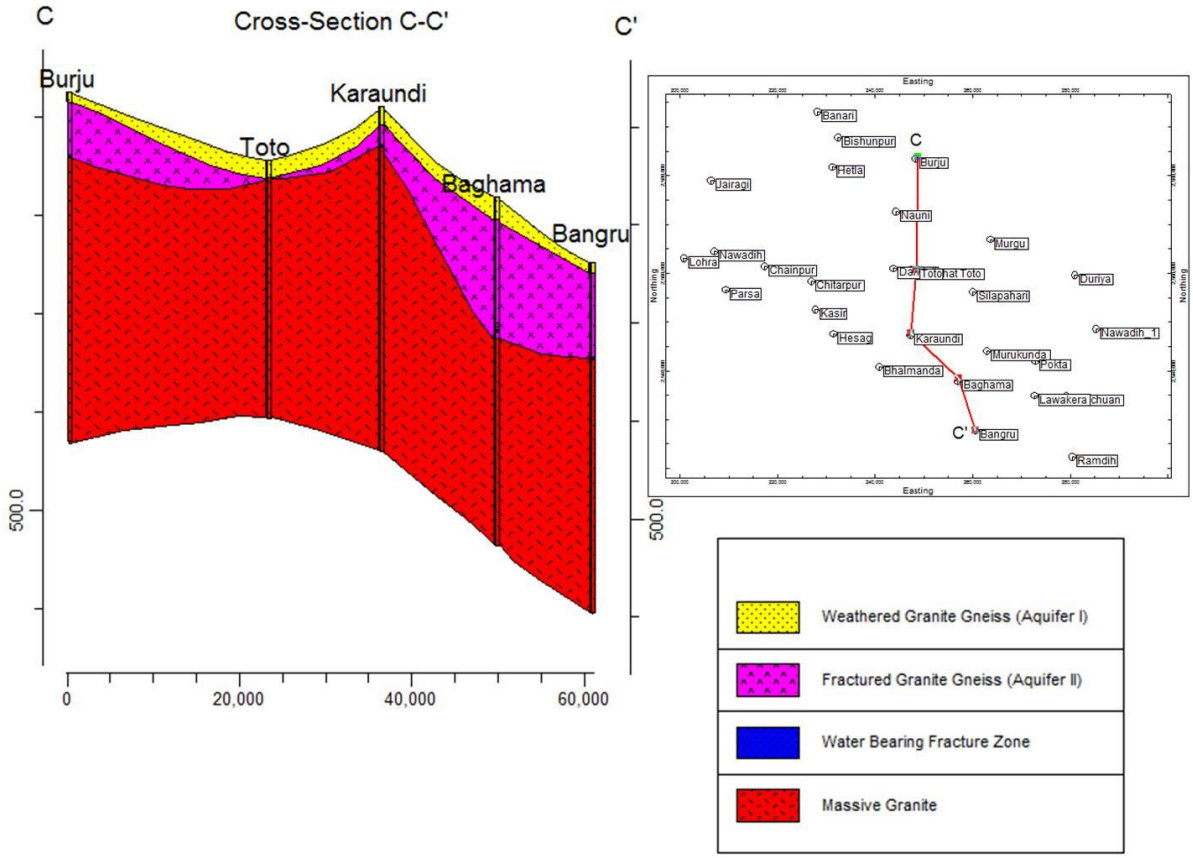


Figure -21: Hydrogeological cross section along C-C'

Hydrogeological cross section of I, II, &III shown in figure- 19, 20, 21 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 19, 20, 21 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 – 20. Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in hard rock area is 30.0 m. The depth of Aquifer – II (fracture zone) ranges from 13.00 to 140.00 mbgl.

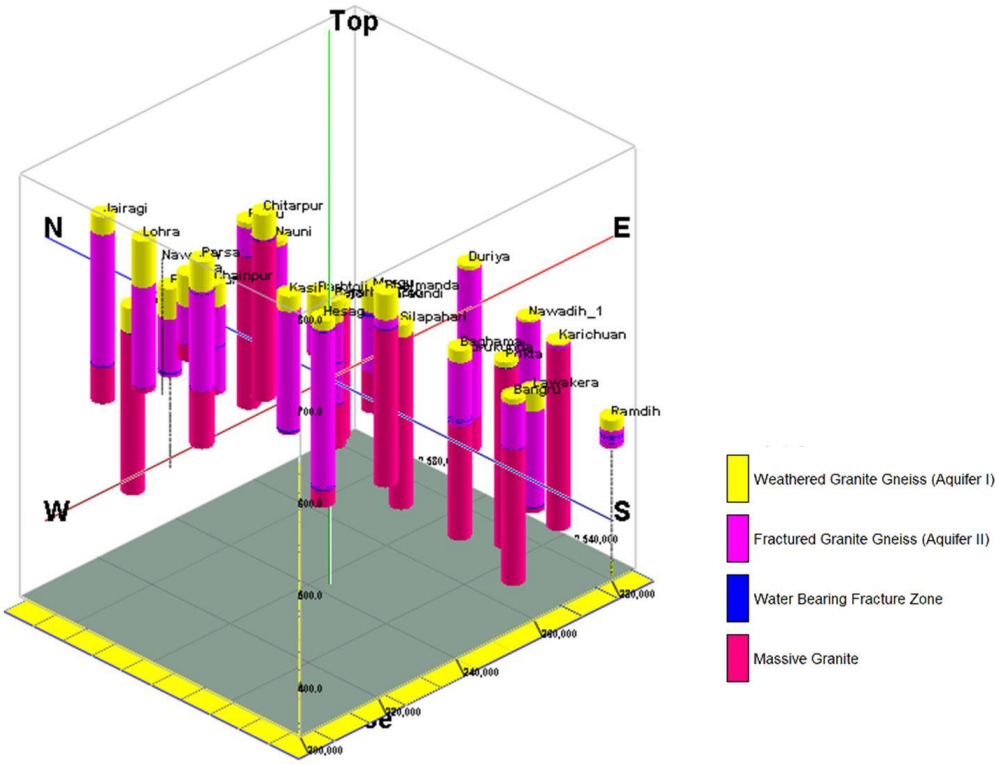


Figure –22: Three dimensional strip-log of EW drilled in Gumla district

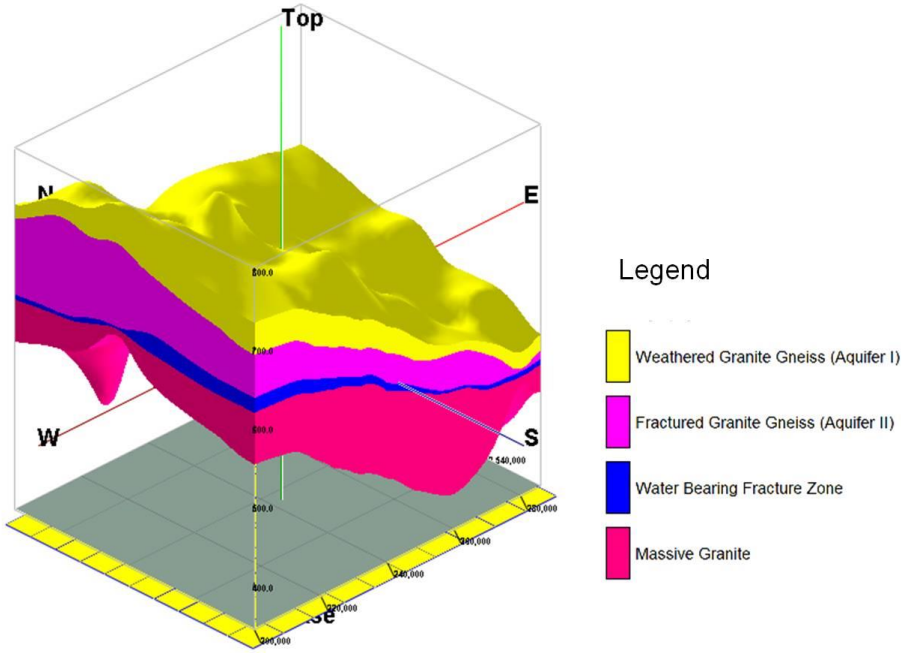


Figure –23: 3D subsurface lithological models with Aquifer Disposition in Gumla district

3.2 Aquifer Characteristics: -

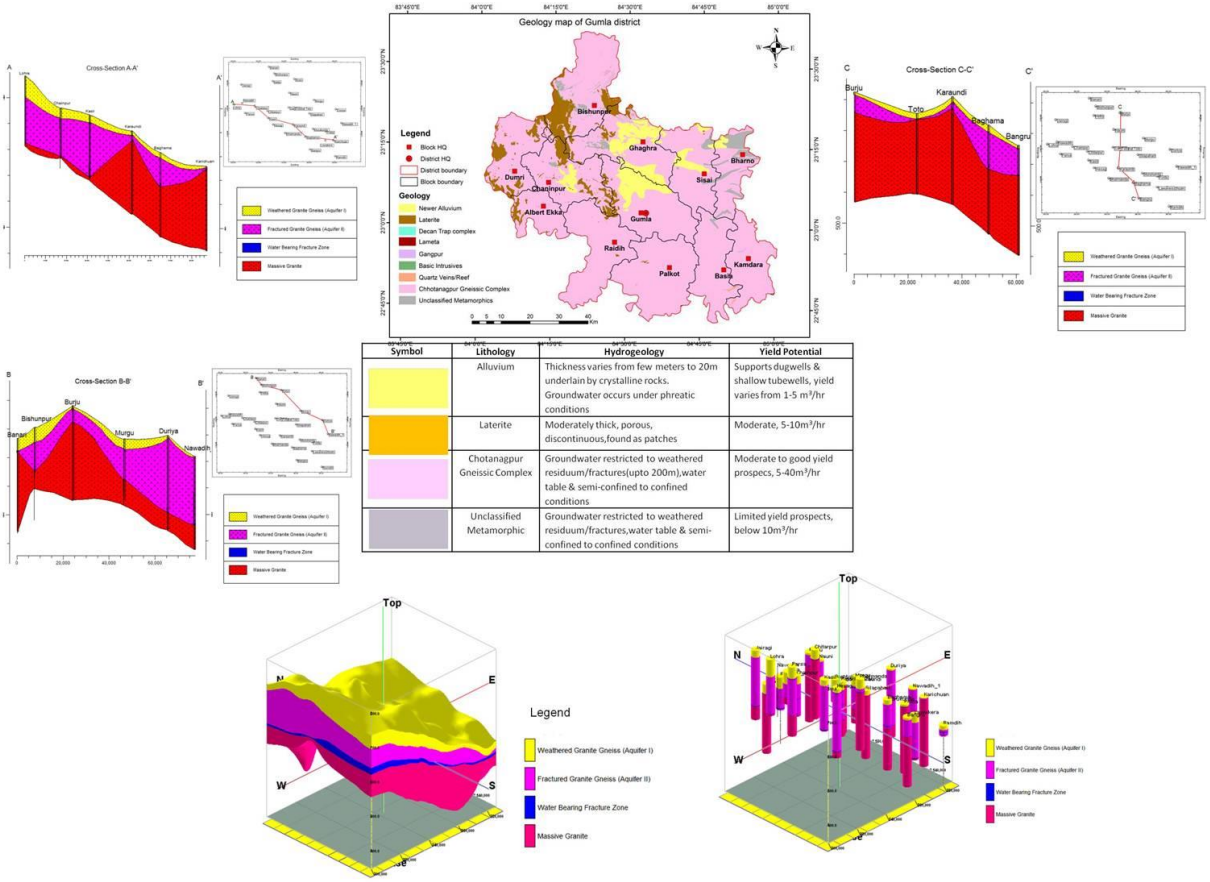
To know the aquifer Characteristics, Step Drawdown test (SDT) and Aquifer Performamce Tests (APT) conducted by CGWB has been considered. Granite, Granite Gneiss forms the main aquifer of the area and comprises two distinct units viz, weathered zone and hard rock fractured zones. Granite gneiss is hard, 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 0.90 – 125.75 m^2/day, whereas storativity of the aquifer ranges from $1.82x10^{-4}$ to $5.64x10^{-6}$.

Table 15: Aquifer characteristics in hard rock areas of Gumla 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	1.82-50.14 m	0.30 – 10.00m	0.25 – 6.64m	5- 10 m	5-10	-	-
Aquifer - II	Jointed/ fractured Granite Gneiss	35-160.2 m	-	-	2-3 m	Upto 43.88	0.90 - 125.73	$1.82x10^{-4}$ - $5.64x10^{-6}$

3.3 Aquifer Maps

Based on Aquifer Disposition, Aquifer Geometry, Aquifer Characteristics, Aquifer Maps of Gumla district have been prepared as under



Symbol	Lithology	Hydrogeology	Yield Potential
	Alluvium	Thickness varies from few meters to 20m underlain by crystalline rocks. Groundwater occurs under phreatic conditions	Supports dugwells & shallow tubewells, yield varies from 1-5 m^3/hr
	Laterite	Moderately thick, porous, discontinuous,found as patches	Moderate, 5-10m^3/hr
	Chotanagpur Gneissic Complex	Groundwater restricted to weathered residuum/fractures(upto 200m),water table & semi-confined to confined conditions	Moderate to good yield prospecs, 5-40m^3/hr
	Unclassified Metamorphic	Groundwater restricted to weathered residuum/fractures,water table & semi-confined to confined conditions	Limited yield prospects, below 10m^3/hr

Figure -24 Aquifer maps of Gumla 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)

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

4.1.1 Recharge Component

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

Where,
ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels
RC – Recharge from canals, RSWI – Recharge from surface water irrigation
RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks & Ponds
RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow), GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

4.1.2 Ground Water Availability, Draft and Stage of GW development

Dynamic Ground Water Resource of Gumla district area has been estimated block wise with base year as on March-2020, based on GEC 2015 methodology. The dynamic Ground Water Resources as on 2020 has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Directorate, Jharkhand. Out of Annual Extractable ground water recharge of 17052 Ham, current annual ground water extraction is only for 680 ham. The stage of ground water development is 14.79%. The Block wise details of Annually Replenishable or Dynamic Ground Water Resources of Loharadaga district is as under: - Table-18.

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

Sl. No.	Adm Units	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	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
		(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Albert Ekka	1069.38	276.5	40.81	0	317.31	41.09	751.79	29.67
2	Basia	2603.39	322.125	106.53	0	428.65	107.27	2174	16.47
3	Bharno	1342.32	10.875	84.16	0	95.02	84.74	1246.72	7.08
4	Bishunpur	3196.66	402.5	82.23	0.351	485.08	82.8	2711.01	15.17
5	Chainpur	2250.95	174.75	74.68	0	249.43	75.2	2001	11.08
6	Dumri	1845.43	130.125	64.84	0	194.95	65.29	1650.03	10.56
7	Ghaghra	5318.11	645.5	160.86	6.07	812.45	161.98	4504.54	15.28
8	Gumla	2972.64	553.25	226.21	3.60	783.06	227.78	2188.01	26.34
9	Kamdara	2169.00	403.875	127.34	0	531.21	128.22	1636.91	24.49
10	Palkot	3138.77	206.25	106.70	0	312.95	107.44	2825.08	9.97
11	Raidih	3208.91	262.875	94.27	0	357.14	94.93	2851.11	11.13
12	Sisai	4098.21	400.875	154.18	0	555.05	155.25	3542.09	13.54
Total		**33213.77**	**3789.5**	**1322.81**	**10.021**	**5122.3**	**1331.99**	**28082.29**	**15.42**

4.2 Assessment of In-Storage Ground Water Resources or static Ground Water Resources (Unconfined Aquifer i.e. 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)	5347
Pre-monsoon (average) depth to water level (mbgl) (Z1)	5.05
Bottom of Unconfined Aquifer (mbgl) (Z2)	16.96
Specific yield (Sy)	3%
Saturated zone thickness (Z2-Z1) of aquifer (ST)	11.91
SGWR = A *(Z2 - Z1) * SY	mcm
instorage	1910.48 mcm

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) = **332.13** *mcm +* **1910.48** *mcm =* ***2242.61*** *mcm*

5. GROUND WATER RELATED ISSUES

The Gumla 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 extraction due to various socio-hydrogeological reasons. At present the overall stage of ground water extraction is only around 15.42 % Block wise stage of ground water extraction varies from 7.08 (Bharno)-29.67 (Albert Ekka) percent.
Graphical presentation of SOD is shown in figure – 25.

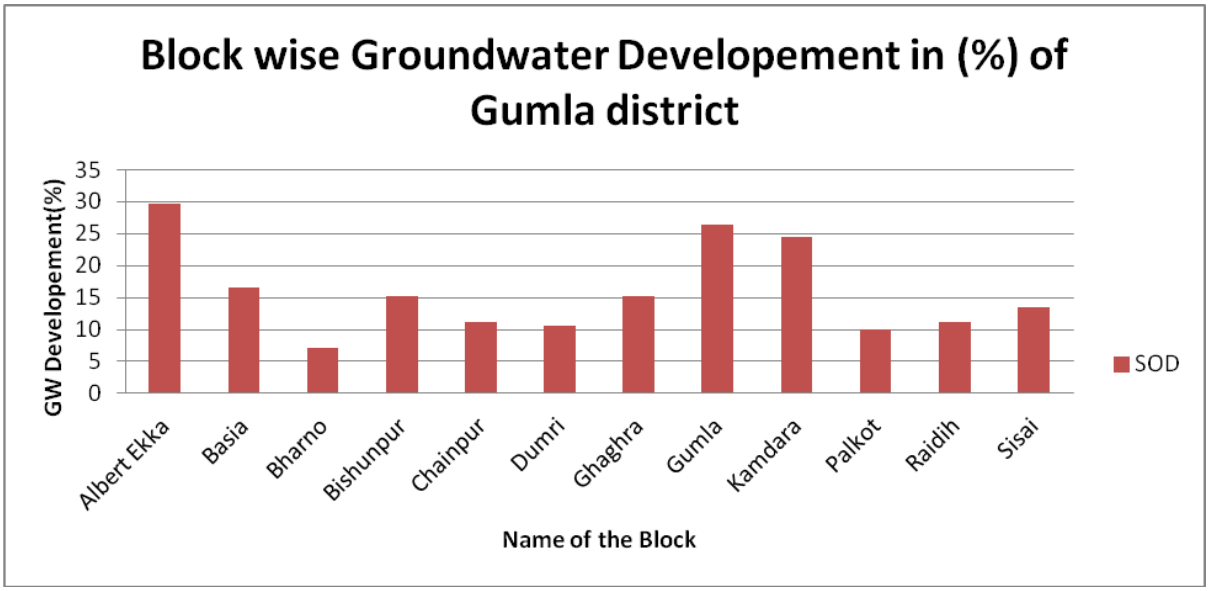


Figure 25 Block wise Ground Water Developement

5.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability: The occurrence and movement of ground water depends in the hydrogeological characteristics of the sub surface rock formations. Ground water potential at any area mainly depends on the topography, rainfall and geology. Because of varied topography and hydrogeological condition in the district, the ground water potential is not uniform and it changes from one area to another. The majority of the area of Gumla district is covered by hard rock. Therefore, the quantity of which can be stored in sub surface as ground water is limited and quantity of water can be extracted from any area which depends on the thickness of aquifer and specific yield of aquifers. Thus, the availability of water resources is not uniformly distributed over time. This resource depletes often in summer or lean period.Central Ground Water Board has constructed exploratory wells at 48 locations in hard area of the district. The percentage of successful bore wells (more than 3 lps discharge) is less. Average thickness of weathering is 17 m and fracture zone is 2-3 m only.

The fracture encountered of bore wells drilled in the area is classified and presented below in figure – 26.

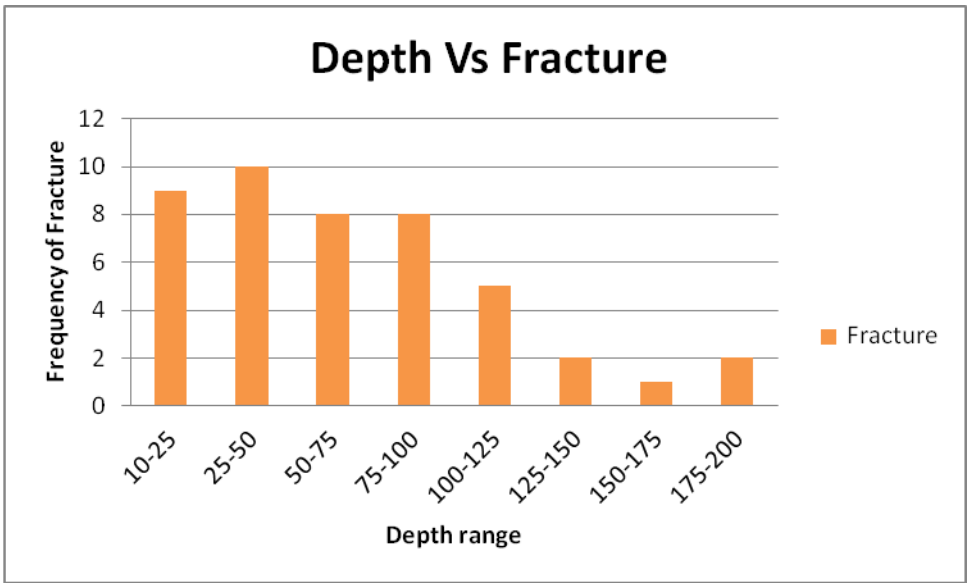


Figure – 26: Depth vs Frequency of fracture encountered in bore wells drilled in Gumla district

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 13 samples of shallow aquifer (dug well). In addition, high EC value 1584 µ S/cm has been observed in dug well sample existing at Pandariya village in Gumla block. Location details of Nitrate is given in table 21 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 Gumla ditrict 13 water samples out of 57 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 20.

Table 18: Nitrate concentration found beyond permissible limit

S.no	BLOCK	LOCATION	NO3-
1	Kamdara	RHSnear Temple,Thana road kamdara	70
2	Kamdara	LHS from Bakashpur mor to Tetartoli road before starting Tetartoli village	50
3	Bharno	In the village of Duria about 10 km from Darha to Dorma road	47
4	Sisai	In the agriculture field of Bachan Oraon	49
5	Gumla	In the village of Pandaria	74.86
6	Ghaghra	LHS of road near Primary health centre Gamharia	70.03
7	Bishunpur	In the village of Baratoli	78.18
8	Dumri	RHS, Dumri to A.Ekka road, Tetartoli near 0 mile stone tetartoli	72.25
9	Albert Ekka	Albert Ekka to chainpur road RHS starting village chatkpur	69
10	Basia	Basia	77
11	Palkot	Baghma	49
12	Sisai	Sisai	98
13	Bishunpur	Bishunpur	77

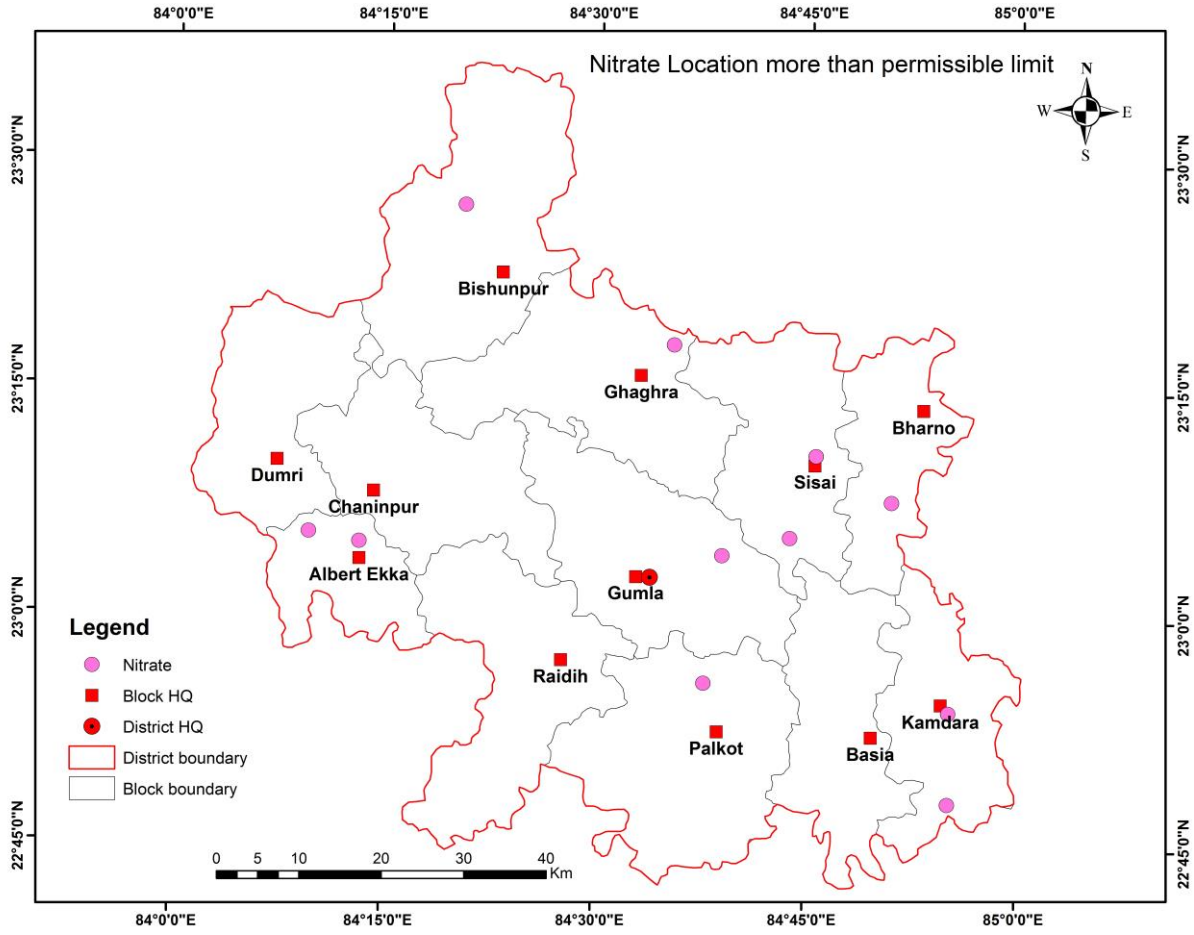


Figure – 27: Location map of NO_3 concentration found beyond permissible limit in Ground water, Gumla district.

5.3.2 Uranium Contamination

Total 14 samples were analysed for uranium concentration in Gumla district. Uranium concentrations in Gumla district were found to be in the range of -0.01 ppb to 1.86 ppb. Out of 14 samples, at all sample the uranium concentration was found within permissible limit. The detail results of chemical analysis for uranium are in Annexure-VI.

6. MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in Loharadaga, low ground water development and low ground water potential 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. Various Management strategies to overcome the ground water related issues are;

6.1 Supply side Interventions:

At present as per Ground Water Resource Estimation 2020, the stage of ground water extraction is very low i.e., 15.42% and all the block of the district comes 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:

The present status of ground water extraction for the whole district is only 15.42%. Therefore, there is ample scope of ground water extraction in the district. Block-wise balance ground water for future irrigation potential is determined for all availability. Considering the net ground water availability for future use, unit draft of different structures like Dug wells/Shallow Tubewell/Borewell, feasible structure has been determined for further ground water development in the district.

Table – 19: Proposed number of Abstraction Structures

Block	Net GW Availability for Future use	future irrigation potential available (ha) considering (Δ) 0.45m	70% of future irrigation potential to be created (ha)	Proposed number of ground water structure (Dug wells)	Proposed number of ground water structure (Shallow TW/BW*)
Albert Ekka	751.79	1670.64	1169.45	260	49
Basia	2174.00	4831.11	3381.78	752	141
Bharno	1246.72	2770.49	1939.34	431	81
Bishunpur	2711.01	6024.47	4217.13	937	176
Chainpur	2001.00	4446.67	3112.67	692	130
Dumri	1650.03	3666.73	2566.71	570	107
Ghaghra	4504.54	10010.09	7007.06	1557	292
Gumla	2188.01	4862.24	3403.57	756	142
Kamdara	1636.91	3637.58	2546.30	566	106
Palkot	2825.08	6277.96	4394.57	977	183
Raidih	2851.11	6335.80	4435.06	986	185
Sisai	3542.09	7871.31	5509.92	1224	230
Total	**28082.29**	**62405.09**	**43683.56**	**9707**	**1820**

*TW-Tubewell, BW-Borewell

It is necessary that proposed Additional ground water abstraction structure may be constructed in phases with proper site selection through hydrogeological and geophysical survey. 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 identification of feasible area for artificial recharge to ground water in Gumla district has been carried out based on depth to water level (post-monsoon) and ground water level trend. The computation of unsaturated zone available, surface water requirement and source water availability for Artificial recharge and proposed numbers of different types of artificial recharge structures feasible in Gumla district has been worked out. Based on the study 2639 No of Nala Bund/Check Dam/Gully Plus and 421 No of Percolation tanks can be constructed in phases in feasible area after proper site selection. In addition, Roof Top rainwater harvesting system may also be installed in buildings. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area. It will ensure that the wells don't go dry during summer/lean/stress period in the areas of implementation and sufficient ground water availability is there in the wells even during the summer season. Thus, not only the drinking and domestic water sources will be strengthened but additional irrigation potential can be created through artificial recharge structures.

Table -20: Artificial recharge structures feasible in Gumla 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	Gumla	655.47	32.64	421	2639	0
Total Structures				**421**	**2639**	**0**

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 affected areas

Nitrate and Flouride is the most pollutant in some part of the Gumla district Nitrate can be removed from drinking water by distillation, reverse osmosis or ion exchange.

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 Gumla district and water requirement for domestic purpose is worked out for the year 2031 and 2031 is presented in table – 21,22,23.

6.4.1 Urban Water Supply

Requirement of water for drinking and domestic use will be 13176670 litres per day in urban area in 2031.

6.4.2 Rural Water Supply

Requirement of water for drinking and domestic use will be 134582940 Liters per day in rural area in 2031.

Table 21: Detail demographic particular of Gumla district

Population as per census			
2001		2011	
Rural	Urban	Rural	Urban
792686	39761	960132	65081

Table – 22: Projected population

Projected population			
2021		**2031**	
Rural	Urban	Rural	Urban
1198227	81219	1495366	101359

Table – 23: 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)
	107840430	10558470	134582940	13176670
Total	**118398900 litres / day**		**147759610 litres / day**	

On perusal of table – 24, the requirement of water will be 147759610 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

1. The district Gumla is spread over 5347 Sq. km area consisting of 12 blocks situated in the South Western part of the Jharkhand state. As per census of 2011, total population of the district is 1025213 with rural population of 960132 and urban population 65081.

2. Gumla district covers the south-western part of Chhotanagpur plateau. The topography of the district is undulating and rugged. District has a number of small hill blocks covered with forests. It is drained by the tributaries of two major river of the state viz. North Koel & South Koel.

3. Gumla district occupies the south western part of the Chotanagpur Plateau. The district is underlain by Chotanagpur Granite-gneiss of Archean age forming the basement rock. Patches of mica schists also occur within the granite and gnessic country rocks. Laterites of Pleistocene age is found to occur as cap over granite gneiss in plateau region. Recent alluvium sediments are found to occur along the present-day river channels.

4. Based on morpho-genetic, geological diversities and relative ground water potentialities of the aquifers, the district can be broadly divided into two Hydrogeological units: Consolidated or Fissured formations (Precambrians), and unconsolidated or porous formations (Laterites& Alluvium).

5. Ground water occurs under unconfined to semi-confined state in Aquifer-I (upto the depth of 30m). Yield of the wells in Aquifer-I is very poor restricted upto 10 m3/hr in laterites/weathered Granite-Gneiss. These aquifers are generally tapped in the dugwells or shallow borewells.

6. In fissured formations of the district the major potential fractures zones are found in Aquifer-II between 35-130 m. In general, discharge of well has been found in the range of 1-13 LPS. Ground Water occurs under semi-confined to confined state in Aquifer-II.

7. Ground Water quality is generally potable, except few patches of high Nitrate in Ground Water.

8. The stage of ground water development in Gumla district is 15.42% and all the block comes under safe category. Therefore, there is sufficient scope for further ground water development.

9. The major ground water related issues in Gumla district are Low ground water development, Low ground water potential/ sustainability etc.

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

11. The supply side interventions-I envisages Ground Water Management strategy through construction of 9707 dug wells and 1820 shallow bore wells in the feasible areas in the district in phases. Rain water harvesting and artificial recharge to be encouraged in feasible

areas for ground water augmentation. In additional purification/filtration of Fluoride may also be adopted.

12. The supply side interventions-II also envisages construction of feasible artificial recharge structures – 421 percolation tank, 2639 Nala Bund/Check Dam/Gully Plug in Gumla district, which is Based on Artificial recharge to Ground Water master plan 2020 of Jharkhand state

13. 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.

WATER LEVEL DATA OF KEY & NHNS WELLS OF NAQUIM STUDY AREA OF GUMLA DISTRICT, JHARKHAND, 2021-22

Sl. No	DW no.	Distric	Block	Village	Type of Well	May 2021 DWL mbgl	Nov 2021 mbgl	Fluctuation
1	DW1	Gumla	Kamdara	Kuda Sarnatoli	DW	5.8	4.35	1.45
2	DW2	Gumla	Kamdara	Kamdari	DW	2.05	1.85	0.2
3	DW3	Gumla	Kamdara	Kotbo Saraktoli	DW	4.6	3.1	1.5
4	DW4	Gumla	Kamdara	Kajra	DW	2.9	0.9	2
5	DW5	Gumla	Basia	Pokta	DW	5.2	3.6	1.6
6	DW6	Gumla	Basia	Mamarla	DW	2.5	0.8	1.7
7	DW7	Gumla	Basia	Ambatoli Banagutu	DW	6	4.7	1.3
8	DW8	Gumla	Basia	Kaliga	DW	1.4	1	0.4
9	DW9	Gumla	Basia	Basia	DW	3.6	5.2	
10	DW10	Gumla	Kamdara	Tetartoli	DW	2.7	2.7	0
11	DW11	Gumla	Kamdara	Bakashpur more	DW	4	1.7	2.3
12	DW12	Gumla	Palkot	Nathpur Duratoli	DW	7.7	5.2	2.5
13	DW13	Gumla	Palkot	Palkot	DW	7.99	5.89	2.1
14	DW14	Gumla	Palkot	Baghma	DW	3.8	4.1	
15	DW15	Gumla	Palkot	Marda	DW	8.6	6.2	2.4
16	DW16	Gumla	Palkot	Gurma	DW	2.85	1.9	0.95
17	DW17	Gumla	Raidih	Raidih	DW	5.25	3.35	1.9
18	DW18	Gumla	Raidih	Birkera	DW	4.4	3	1.4
19	DW19	Gumla	Raidih	Konkel	Dw	4.45		
20	DW20	Gumla	Bharno	Samsera	DW	6.1	5.25	0.85
21	DW21	Gumla	Bharno	Bharno	DW	6.97	4.17	2.8
22	DW22	Gumla	Bharno	Duria	DW	5.6	4.6	1
23	DW23	Gumla	Sisai	Charda	Dw	2.55	2	0.55
24	DW24	Gumla	Sisai	Burh	DW	3.2	4.1	

Sl. No	DW no.	Distric	Block	Village	Type of Well	May 2021 DWL mbgl	Nov 2021 mbgl	Fluctuation
25	DW25	Gumla	Sisai	Jatnitoli	DW	6.6	4.5	2.1
26	DW26	Gumla	Sisai	Thethai Tanger	DW	10	5	5
27	DW27	Gumla	Sisai	Sisai	DW	3.6	4	
28	DW28	Gumla	Sisai	Samal	DW	2.3	4.4	
29	DW29	Gumla	Bharno	Nagfeni	DW	6.44	5.24	1.2
30	DW30	Gumla	Gumla	Pandaria	DW	5	4	1
31	DW31	Gumla	Gumla	Dhodhara	DW	4.1	3	1.1
32	DW32	Gumla	Gumla	Bairtoli Chotaloro	DW	4.45	4.45	0
33	DW33	Gumla	Gumla	Kharke	DW	6.52	5.07	1.45
34	DW34	Gumla	Gumla	Barkadih Barkatoli	DW	5.4	4.15	1.25
35	DW35	Gumla	Ghaghra	Ghagra	DW	7.644	5.144	2.5
36	DW36	Gumla	Ghaghra	Gamharia	DW	5.8	3	2.8
37	DW37	Gumla	Ghaghra	Shivsereng	DW	5.8	2.9	2.9
38	DW38	Gumla	Ghaghra	Sirkot	DW	6	3.1	2.9
39	DW39	Gumla	Ghaghra	Adar	DW	1.7	0.85	0.85
40	DW40	Gumla	Ghaghra	Pouri	DW	5.3	4.95	0.35
41	DW41	Gumla	Bishunpur	Bishunpur	DW	6.2	5.6	0.6
42	DW42	Gumla	Bishunpur	Baritoli	DW	8	3	5
43	DW43	Gumla	Bishunpur	Banalat	DW	5.5	2.5	3
44	DW44	Gumla	Gumla	Tainsera	DW	7.25	5.65	1.6
45	DW45	Gumla	Palkot	Jaldega	DW	4.39	4.39	0
46	DW46	Gumla	Palkot	Keuind toli	DW	6.3	4	2.3
47	DW47	Gumla	Gumla	Gumla1	DW	7.04	6.64	0.4
48	DW48	Gumla	Raidih	Katkaya	DW	4.8	3	1.8
49	DW49	Gumla	Raidih	Kashir	Dw	0.25	0.3	
50	DW50	Gumla	chainpur	Chainpur1	DW	0.6	1.05	
51	DW51	Gumla	chainpur	Darkana Kurumgarh	DW	0.9	1.4	
52	DW52	Gumla	chainpur	Dahudar Gaon	DW	3.85	3.7	0.15

Sl. No	DW no.	Distric	Block	Village	Type of Well	May 2021 DWL mbgl	Nov 2021 mbgl	Fluctuation
53	DW53	Gumla	chainpur	Auratoli	DW	3.55	2.5	1.05
54	DW54	Gumla	Dumri	Ambatoli Rajauri	DW	9.35	2.9	6.45
55	DW55	Gumla	Dumri	Dumri	DW	8.55	6.1	2.45
56	DW56	Gumla	Dumri	Tetartoli	DW	5.7	4.3	1.4
57	DW57	Gumla	Albert Ekka	Vikhampur	DW	7.6	6.15	1.45
58	DW58	Gumla	Albert Ekka	Chatakpur	DW	5.9	5.2	0.7

Annexure - II

Hydrogeological Details of Exploratory Borewells in Gumla District

Wells drilled through Department Rigs

Sl. No.	Location/	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge	D/Dn	Specific Capacity	T	S	Dia. of assembly	Formation	Year
				m	m/mm	m.	m. bgl.	m^3/hr.	m.	m^3/hr./m.	m^2/day		mm.		
1	Nimtoli EW	Gumla	$23^0$04'00" $84^0$32'00"	90	-	-	8	10.8	14	0.77	28.97	-	203	Granite Gneiss	1977
2	Natapole EW	Chainpur	$23^0$04'05" $84^0$19'10"	60.4	-	-	5.1	36	13.78	2.61	66	-	203	Granite Gneiss	1978
3	Hanslala EW	Raidih	$23^0$00'20" $84^0$31'10"	90	-	-	7.7	3.6	14.95	0.24	2.84	-	203	Granite Gneiss	1978
4	Chaha EW	Chainpur	23^0 07' 30" 84^0 20' 15"	91	-	-	4.75	1.8	14.55	0.12	2.9	-	203	Granite Gneiss	1978
5	Chuglu EW	Gumla	23^0 07' 30" $84^0$30' 40"	90.7	-	-	7.5	1.8	16.55	0.1	0.9	-	203	Granite Gneiss	1979
6	Salegutu EW	Kamdara	$22^0$50' 50" $84^0$55' 10"	55.91	-	-	8.21	9	10	0.9	11.3	-	203	Granite Gneiss	1977
7	Kashitoli EW	Raidih	$23^0$00'30" $84^0$28'00'											Granite Gneiss	
8	BajarHat,TOTO EW	Gumla	$23^0$08'10" $84^0$32'00'	161.82	24	67-68 112-113	5.64	15.69	29.4	0.533673	14.61	5.64x10-6		Granite Gneiss	2006
9	Karaundi EW	Gumla	$23^0$00'55" $84^0$32'00"	199.92	10.2	22-23	5.85	3.6						Granite Gneiss	2006

Sl. No.	Location/	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge	D/Dn	Specific Capacity	T	S	Dia. of assembly	Formation	Year
				m	m/mm	m.	m. bgl.	m^3/hr.	m.	m^3/hr./m.	m^2/day		mm.		
10	Silapahari EW	Gumla	$23^0$05'50" $84^0$39'25"	199.92	13	--	6.1	3.6						Granite Gneiss	
11	Bhalmanda EW	Raidih	$22^0$57'20" $84^0$28'20'	199.92	28	38-39	5.65	4.3						Granite Gneiss	2006
12	Murukunda EW	Gumla	$22^0$59'16.656" $84^0$41'13.38"	199.92	19	17-19 119.60-120.60								Granite Gneiss	2006
13	Korekora EW	Sisai	$23^0$04'40" $84^0$45'25"	199.92		--	7.1	3.6						Granite Gneiss	2006
14	Keondtoli(Pojenga school) EW	Palkot	$22^0$47'30" $84^0$40'00"	184.68		--		3.6						Granite Gneiss	2007
15	Bharno block office,Ew	Bharno	$23^0$14'03.58" $84^0$53'27.03"	200			2.63	5.4	20.16	0.27	5.65	3.9x10 -5		Granite gneiss	2005

Wells drilled through Outsourcing

Sl. No.	Location/	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge	D/Dn	Specific Capacity	T	S	Dia. of assembly	Formation	Year
				m	m/mm	m.	m. bgl.	m^3/hr.	m.	m^3/hr./m.	m^2/day		mm.		
16	Kasir EW	Raidih	$23^0$03'34.61" $84^0$20'32.52"	150	16.49	146-148	4.95	5.08	4.95					Granite Gneiss	2005

Sl. No.	Location/	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge	D/Dn	Specific Capacity	T	S	Dia. of assembly	Formation	Year
				m	m/mm	m.	m. bgl.	m^3/hr.	m.	m^3/hr./m.	m^2/day		mm.		
17	Murgu EW	Sisai	$23^0$11'40" $84^0$41'25"	132.39	22.57	25-28 85-88	5.6	24	6.1					Granite Gneiss	2005
18	Toto EW	Gumla	$23^0$08'10" $84^0$32'30'	150	10.4	-	7.9							Granite Gneiss	2005

Through Outsource Drilling (WAPCOS)

Sl. No.	Location	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Drawdown	Specific Capacity	T	S	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	m^3/hr./m.	m^2/day			
19	Parsa	Jari	23°05'34.1" 84°09'45.8"	203	32.61	35.0-36.0,140.8-141.5	8.43	0.468			-	0.27			2020
20	Ramdih	Basia	22°47'42.7" 84°51'36.4"	175	11.58	17-18,18.5-19,20-20.6,24.5-25.1,29-30.1	5.48	64.512	5.25	21.48		15.2			2020
	OW	Basia	22°47'43.7" 84°51'36.4"	203	18.58	20.5-21.1,22-22.6,25-26,27.8-28.5	5.09	7.74		5.63					2020
21	Lawakera	Basia	22°54'24.7" 84°46'59.7"	131	20.72	124.5-126.0	3.85	43.884	2.15	8.43		19.46			2020
22	Pokta	Basia	22°58'15.8' 84°47'01.8"'	203	6	6.0-07.0	5.34	1.548	Slug Test			1.69			2020
23	Duriya	Bharno	23°07'50.5" 84°51'35.4"	203	4.01	166.5-167.5	9.18	1.548	Slug Test	NA		0.9		Granite Gneiss	2020
24	Banari	Bishunpur	23°25'31.0" 84°20'21.4"	203	28.65	27-28	10.07	0	Slug Test	NA		1.04		Granite Gneiss	2020
25	Bishunpur	Bishunpur	23°22'41.1" 84°22'54.5"	203	32.92	91-93,96-96.5	2.96	27.828	1.66	32.85		3.13		Granite Gneiss	2020
26	Helta	Bishunpur	23°19'24.1" 84°22'16.2"	93	33.41	74.9-75.3	18	43.884	5	7.3		125.73	$3.18 x10^{-4}$		2020

Sl. No.	Location	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Drawdown	Specific Capacity	T	S	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	$m^3/hr./m.$	m^2/day			
	OW	Bishunpur	23°19'24.1" 84°22'16.2"	98	34.14	74.0-74.3,76.1-76.3	17.99	43.884		1.73					2020
27	Chitrapur	Chainpur	23°06'39.9" 84°19'59.8"	203	26.82	28.0-29.0	3.92	0.1332				0.68			2020
28	Chainpur	Chainpur	23°08'15.7" 84°14'21.3"	144	24.39	67.5-68.5,118.2-119.2	3.99	43.884	18.9	26.64		39.98	$1.34 x10^{-4}$		2020
	OW	Chainpur	23°08'15.7" 84°14'21.3"	134	24.39	25.0-26.0,125.5-126.0	3.66	64.512		4.17					2020
29	Bhathouli	Chainpur	23°09'45.8" 84°15'15.8"	203	14.2			0							2020
30	Nawadih	Dumri	23°09'46.5" 84°08'18.3"	148	18.74	23.2-23.4,45.5-45.9,66.0-67.0	6.6	43.884	5	19.99		45.26	$1.82 x10^{-4}$		2020
	OW	Dumri	23°09'46.5" 84°08'18.3"	117	19.47	21.8-22.2	5.71	64.512		9.07					2020
31	Lohra	Dumri	23°08'59.4" 84°04'39.7"	165	50.14	159.5-160.2	15.45	27.828	1.87	11		4.49			2020
32	Jai ragi	Dumri	23°17'39.6" 84°07'45.0"	203	19.5	162.0-193.7	2.91	0.0486	Slug Test			0.52			2020
33	Tilsiri	Ghagra	23°13'07.4" 84°37'18.6"	203	12.28	NA	NA	0	NA	NA		NA		Granite Gneiss	2020
34	Nauni	Ghagra	23°14'33.1" 84°30'00.4"	149	6	80	21.05	64.512	4.5	8.06		56.13		Granite Gneiss	2020
	OW	Ghagra	23°14'33.1" 84°30'00.4"	158	6	10,150.5-151.5		53.532						Granite Gneiss	2020
35	Burju	Ghagra	23°20'30.1" 84°32'.01.4"	203	6	37-37.5	4.66	5.184	2	37.81		0.87		Granite Gneiss	2020
36	Happamuni	Ghagra	23°18'19.7" 84°34'38.2"	203	1.85	NA	NA	0	NA	NA		NA		Granite Gneiss	2020
37	Charka tangar	Gumla	22°58'46.0" 84°38'48.6"	203	3.71	NA	NA	0	NA	NA		NA		Granite Gneiss	2020
38	Darh toli	Gumla	23°08'16.1" 84°29'50.5"	67	29.68	63.4-63.9	7.23	27.972		17.75		46.59			2020
	OW	Gumla	23°08'15.9" 84°29'50.5"	203	33.6	67.5-68.4	5.2	0.468	5	5.78					2020

Sl. No.	Location	Block	Co-ordinate	Depth Drilled	Casing Depth/ Dia.	Fractures encountered	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Drawdown	Specific Capacity	T	S	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	$m^3/hr./m.$	m^2/day			
39	Nawadih	Kamdara	23°01'54.3" 84°54'15.0"	203	2.43	146-150	1.95	0.1332				0.68			2020
40	Karichuan	Kamdara	22°54'24.6" 84°50'47.5"	203	1.82	5.2-5.6	18.6	2.808	Slug Test			0.23			2020
41	Bangru	Palkot	22°50'27.2" 84°39'57.6"	203	6	55-55.9	1.87	0.468	Slug Test			0.75			2020
42	Baghama	Palkot	22°55'52.6" 84°37'46.6"	203	13.1	73.0-73.4,75.3-75.8,77.2-77.4,78-78.6,82.5-82.7	5.6	5.184	2.15	8.22		8.96			2020
43	Hesag	Raidi	23°00'54.1" 84°22'47.3"	203	10.36	12.0-13.0,181.5-182.2,184-185		0							2020
44	Katasaru(Kondra)	Raidi	22°47'19.3" 84°18'30.8"	203	14.02		3.27	5.184	2.15	37.63		1.13			2020
45	Mangalo	Sisai	23°14'00.9" 84°48'31.3"	203	6		12.46	1.548				2.42			2020
46	Pahamu	Sisai	23°17'12.5" 84°45'37.9"	203	6.7		3.61	0.1332				0.23			2020

Wells drilled through Department Rigs

Sl No	Location	Block	Co-ordinate	Depth Drilled	Casing Depth	Fracture Tapped	Static Water level	Discharge	Draw-down	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				m	m	m	m bgl	m^3/hr	m	$m^3/hr/m$	m^2/day		mm		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
47	Kumhari EW	Basia	22°57'00" 84°49'00"	90.46			5.44	21.39					203	Granite Gneiss	1977
48	Konbir EW	Basia	22°51'00" 84°49'20"	83.19			4.73	9					203	Granite Gneiss	1977
	OW	Rania	22°51'00" 84°49'25"	90.00									203	Granite Gneiss	1977

Annexure - III

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

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
1	Kamdara	Near Railway crossing Pokla	22.91	84.95	7.91	285	185.25	90	24	7.29	11.5	20.9	0	103.7	31.95	8.09	2.99	0.63	0.51
2	Kamdara	RHSnear Temple,Thana road kamdara	22.9	84.92	7.85	492	319.8	115	30	9.72	54	12	0	61	74.55	70	30	0.87	0.47
3	Kamdara	In the campus of Sh santial	22.93	84.92	7.96	158	102.7	50	16	2.43	10	3.62	0	54.9	14.2	11	2.06	0.04	0
4	Kamdara	about 5km from Turbul chowk to Govindpur road in the campus of Mashidash barla	22.94	84.87	8.01	83	53.95	25	6	2.43	6.82	0.98	0	18.3	10.65	6.6	5.42	0.02	0
5	Basia	In the village Pokta, RHS,about 5 km from kummar	22.96	84.78	8.14	120	78	40	12	2.43	9.5	0.34	0	24.4	17.75	20.03	2.59	0	0
6	Basia	Starting of village Mamarla RHS, IN THE OPEN PADDY FIELD	23	84.77	7.96	122	79.3	45	14	2.43	6.31	1.7	0	24.4	17.75	17.37	4.39	0	0
7	Basia	Govt,RHS,about 2km from Kumhari to Basia road	22.91	84.8	7.93	145	94.25	50	12	4.86	8.23	2.9	0	36.6	14.2	13	9.94	0	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
8	Basia	LHS,Konbir to Kolebira road near culvert and Kaliga signboard	22.84	84.71	7.82	369	239.85	130	44	4.86	22	5.24	0	79.3	39.05	45	23.9	0.34	0
9	Kamdara	LHS from Bakashpur mor to Tetartoli road before starting Tetartoli village	22.8	84.92	8.05	308	200.2	100	36	1.1	23	3.8	0	61	21.3	50	34.5	0.23	0
10	Kamdara	LHS near Bakashpur mor, bakshpur mor to tetartoli road	22.86	84.9	8.16	85	55.25	20	6	1.215	9	1.5	0	24.4	7.1	9.2	5.64	0.13	0
11	Palkot	RHS in the village of Nathpur uratoli, about 7 km from Konbir to Palkot road	22.87	84.71	8.2	157	102.05	40	10	3.645	16	1.86	0	18.3	28.4	27	2.32	0.11	0
12	Palkot	In the premises of Ranthu Gop about 7 km from Baghama to Basia road (poltry farm house is there)	22.94	84.68	8.04	166	107.9	55	18	2.43	12	0.94	0	42.7	21.3	16	2.03	0.07	0
13	Palkot	In the village of Gurma RHS from road	22.93	84.58	8.23	101	65.65	25	6	2.43	11	0.3	0	21	10	6	0.42	0.09	0
14	Raidih	Near Birkera chowk, in front of primary school Birkera	22.89	84.4	7.93	76	49.4	25	8	1.215	6.01	0.02	0	24.4	10.65	0	0	0	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
15	Raidih	LHS, near mile stone 0 konkel	22.83	84.36	7.82	85	55.25	40	12	2.43	1.22	0.06	0	24.4	14.2	0	0	0	0
16	Bharno	LHS, in the village entrance open ground	23.26	84.88	7.99	90	58.5	40	10	3.645	2.81	0.74	0	30.5	14.2	0	1.79	0	0
17	Bharno	In the village of Duria about 10 km from Darha to Dorma road	23.13	84.85	8.19	261	169.65	90	24	7.29	18	2.46	0	73.2	17.75	47	10	0.03	0
18	Sisai	LHS, about 150 m near Barha 9km mile stone	23.24	84.77	7.73	82	53.3	35	10	2.43	2.43	0.02	0	24.4	14.2	0	0	0	0
19	Sisai	In front of Primary School Burh , about 5km from Barha	23.2	84.78	7.92	69	44.85	30	8	2.43	2.29	0.01	0	24.4	10.65	0	0	0	0
20	Sisai	RHS after crossing Jatnatoli chowk towards Gunatoli	23.13	84.77	7.84	144	93.6	55	18	2.43	7.56	0.54	0	48.8	17.75	8.3	2.13	0	0
21	Sisai	Backside of primary school ,Thethai Tangar near telephone tower	23.07	84.78	8.19	315	204.75	75	18	7.29	35	4.9	0	67.1	53.25	30	2.51	0.08	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
22	Sisai	In the agriculture field of Bachan Oraon	23.09	84.73	7.94	330	214.5	120	38	6.075	16.55	7.62	0	79.3	31.95	49	17	0.13	0
23	Gumla	In the village of Pandaria	23.07	84.65	7.93	1584	1029.6	595	70	102.1	76.3	26	0	384.3	227.2	74.86	94.98	0.31	0
24	Gumla	In the village of near Primary School Dhodhara	23.05	84.59	7.85	249	161.85	105	34	4	3.47	2.7	0	73.2	28.4	15.7	7.56	0	0
25	Gumla	LHS about 5km from Gumla to LOhardaga road	23.11	84.53	7.94	122	79.3	45	14	2.43	3.84	3.06	0	30.5	10.65	17.37	3.36	0	0
26	Gumla	In the village of Barkatoli	23.22	84.53	8.21	219	142.35	80	22	6.075	11	5.2	0	42.7	24.85	30.9	14.78	0	0
27	Ghaghra	LHS of road near Primary health centre Gamharia	23.3	84.59	7.63	921	598.65	340	82	32.81	44	19.21	0	201.3	131.4	70.03	52.23	0.46	0
28	Ghaghra	In the campus of the Assembly of God Church	23.25	84.46	8.08	268	174.2	115	36	6.075	7.17	3.2	0	97.6	21.3	17.11	11.33	0.32	0
29	Ghaghra	LHS of road Ghagra to Sasantoli	23.22	84.59	8.13	395	256.75	160	56	4.86	15.4	5.4	0	97.6	56.8	19.57	19.23	0.28	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
30	Ghaghra	LHS in Pouri village about 5km from Adar	23.33	84.43	7.91	189	122.85	65	22	2.43	5.4	11.35	0	48.8	24.85	16	3.39	0	0
31	Bishunpur	In the village of Baratoli	23.45	84.34	7.95	482	313.3	95	26	7.29	55	23	0	115.9	39.05	78.18	30.5	0.49	0
32	Bishunpur	LHS, Banalat village Market	23.5	84.38	8.13	445	289.25	155	34	17.01	22.37	13.8	0	213.5	24.85	0.71	11.64	0.61	1.3
33	Gumla	In the GumlaPalkot road about 8km from Gumla LHSend of Tainsera village	23	84.6	7.81	137	89.05	45	16	1.215	7.1	3.6	0	30.5	10.65	12.5	11.64	0	0
34	Palkot	In the village of Jaldega in the campus of Lalmohan Mato after crossing weekly marketbefore bridge	22.85	84.6	7.95	1130	734.5	425	136	20.66	50	24.12	0	451.4	124.3	4.3	12.65	0.87	0.47
35	Palkot	In the village of Keundtoli in the campus of Samual Tirkey	22.81	84.66	8.07	203	131.95	55	18	2.43	14.39	11.5	0	61	31.95	0	5.05	0	0
36	Raidih	LHS about 3km from Raidih	22.96	84.39	8.06	354	230.1	160	20	26.73	3.72	2.2	0	176.9	10.65	10.35	5.64	0	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
37	Chainpur	In the entrance of village after crossing bridge RHS, near Kurumgarh Thana signboard	23.16	84.34	8.08	293	190.45	95	24	8.505	15.97	10.3	0	115.9	14.2	19.83	12.22	0.13	0
38	Chainpur	Near Trijunction of Dahutargaon(in the campus of Boniphus Tirkey)	23.15	84.27	8.16	135	87.75	40	6	6.075	9.78	3.6	0	36.6	24.85	0.5	2.03	0	0
39	Chainpur	In the village of Auratoli	23.19	84.22	8.14	402	261.3	135	30	14.58	24.65	9.12	0	97.6	56.8	19.52	22.18	0.52	0
40	Dumri	in the village of Ambatoli	23.27	84.12	8.19	834	542.1	260	84	12.15	54.61	29.84	0	396.5	53.25	10.96	2.69	0.94	0.56
41	Dumri	Near Trijunction (Dumri,Chainpur, A.Ekka) Dumri to albert ekka road LHS Harsari Pakaritoli	23.16	84.13	8.14	420	273	145	50	4.86	19.88	15.36	0	207.4	14.2	5.74	14.16	0	0

S.no	BLOCK	LOCATION	Lat	Long	pH	EC	TDS	TH	Ca	Mg	Na	K	CO32-	HCO3-	Cl-	NO3-	SO42-	F	PO43-
42	Dumri	RHS, Dumri to A.Ekka road, Tetartoli near 0 mile stone tetartoli	23.09	84.16	7.93	824	535.6	295	98	12.15	41.47	20.14	0	335.5	28.4	72.25	36.73	0.79	0
43	Albert Ekka	About 200m RHS from Vikhampur chowk to albert Ekka block road to chainpur	23.04	84.18	7.91	135	87.75	50	14	3.645	6.41	2.12	0	30.5	17.75	18.73	3.04		
44	Albert Ekka	Albert Ekka to chainpur road RHS starting village chatkpur	23.08	84.22	7.92	318	206.7	160	42	13.37	15.87	2.16	0	97.6	31.95	69	11.84		
45	Basia	Basia	23.18	84.76	7.91	963	626	270	70	23	85	21	0	110	178	77	75	0.78	0.12
46	Palkot	Palkot	22.87	84.64	8.17	154	100	45	12	3.65	13	3.22	0	55	21	2.62	0.58	0.05	0
47	Palkot	Baghma	22.93	84.63	7.93	398	259	135	42	7.29	27	4.5	0	43	64	49	34	0.13	0
48	Raidih	Raidih	22.95	84.44	7.84	385	250	140	42	8.51	22	2.66	0	73	50	35	30	0.23	0
49	Bharno	Bharno	23.23	84.88	8.17	176	114	45	12	3.65	16	8.1	0	24	28	24	7.32	0	0
50	Sisai	Sisai	23.18	84.76	7.92	1008	655	335	104	18	63	23	0	195	128	98	74	0.68	0.98
51	Bharno	Nagfeni	23.3	84.70	7.96	175	114	60	16	4.86	11	0.98	0	24	18	39	7	0	0
52	Gumla	Kharke	23.16	84.52	8.13	538	350	225	70	12	9.2	15	0	122	85	20	27	0.12	0
53	Ghaghra	Adar	23.31	84.37	7.76	285	185	90	24	7.29	17	9.1	0	116	21	6.03	11	0.15	0
54	Bishunpur	Bishunpur	23.7	84.38	7.82	613	398	195	72	3.65	35	26	0	110	82	77	36	0.58	0
55	Gumla	Gumla 1	23.04	84.55	8.19	148	96	45	16	1.22	10	6.05	0	43	21	5.2	4.9	0	0
56	Raidih	Kashir	23.05	84.35	8.14	140	91	60	20	2.43	4.5	0.8	0	24	11	21	18	0	0
57	Chainpur	Chainpur 1	23.14	84.19	7.83	893	580	260	76	17	74	19	0	268	110	30	42	0.74	0

Annexure-IV

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

sl.no.	District	Block	Well Name	Type of Well	Uranium (ppb)
1	Gumla	Gumla	Anjan gram	D/W	-0.01
2	Gumla	Bishunpur	Bishunpur	D/W	0.00
3	Gumla	Palkot	Baghima	H/P	0.02
4	Gumla	Sisai	Sisai	D/W	0.04
5	Gumla	Kashir	Kashir	D/W	0.04
6	Gumla	Nagfeni	Nagfeni	H/P	0.13
7	Gumla	Ghaghra	Ghaghra	H/P	0.15
8	Gumla	Palkot	Palkot	H/P	0.17
9	Gumla	Basia	Basia	D/W	0.19
10	Gumla	Bharno	Bharno	D/W	0.29
11	Gumla	Raidih	Raidih	D/W	0.30
12	Gumla	Chainpur	Chainpur	H/P	0.33
13	Gumla	Gumla	Gumla	H/P	0.99
14	Gumla	Ghaghra	Adar	H/P	1.86