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

West Singhbhum District
Jharkhand

मध्य पूर्वी क्षेत्र, पटना

Mid Eastern Region, Patna

भारत सरकार

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Central Ground Water Board

Aquifer Maps and Ground Water Management Plan of West Singhbhum district, Jharkhand

जलभृत नक्शे तथा भूजल प्रबंधन योजना

पश्चिमी सिंहभूम जिला, झारखंड

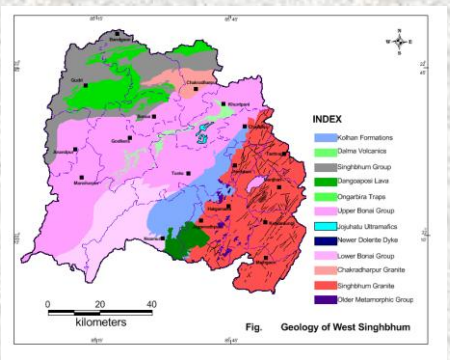

Fig. Geology of West Singhbhum

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अगस्त, 2022

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August 2022

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN,WEST SINGHBHUM DISTRICT, JHARKHAND STATE (2021-22)

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN,WEST SINGHBHUM DISTRICT, JHARKHAND STATE (2021-22)

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN,WEST SINGHBHUM DISTRICT, JHARKHAND STATE (2021-22)

1.0 INTRODUCTION

The vagaries of rainfall, inherent heterogeneity & 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 implementable ground water management plans. This leads to concept of Aquifer Mapping and Ground Water Management Plan programme. 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, which is continued till 2023. In pursuance of AAP 2021-22, CGWB State Unit Office, Ranchi, has carried out Aquifer mapping and Management Plan in West Singhbhum district of Jharkhand State with the aim of delineation and characterization of aquifers and its quantity, quality and sustainability of ground water in aquifers. The study is a part of the fulfilment of National Aquifer mapping and Management Plan. The aquifer maps and management plans will be shared with the Jharkhand Govt 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:

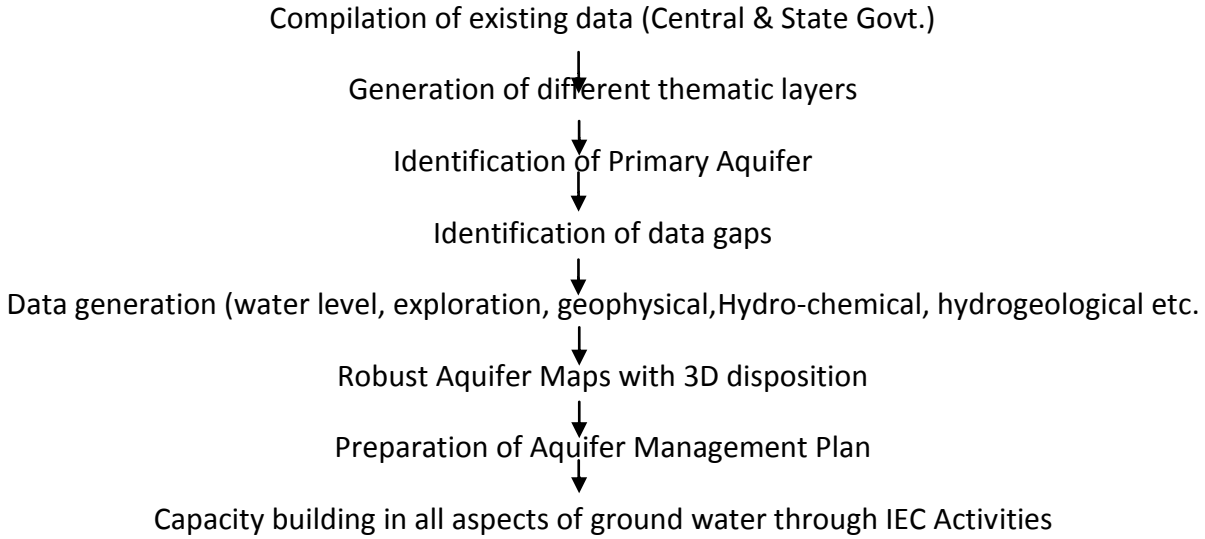
a). Identifying the aquifer geometry
b). Aquifer characteristics and their yield potential
c). Quality of water occurring at various depths
d). Assessment of ground water resources
e). Preparation of aquifer maps and
f). Formulation ground water management plan.

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 in hard rock terrain 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 is as given below:



1.3 Area details:

In 1991 the erstwhile district of Singhbhum was bifurcated to form West and East Singhbhum and subsequently Saraikela-Kharsawan district was carved out in 2001giving the district its present boundaries. Chaibasa, the headquater town is also theheadquater of Singhbhum Division. The district is bounded on the north by Khuntidistrict, on the east by Saraikela-Kharsawan district, on the south by Keonjhar,Mayurbhanj and Sundergarh districts of Odisha and on the west by Simdega districtof Jharkhand. Besides the district headquarter of Chaibasa, other towns in thedistrict are: Chakradharpur, Chiria, Gua, Jhinkpani, Kiriburu, Noamundi. There are18 Development Blocks in the district viz Anandpur, Bandgaon, Chakradharpur,Chaibasa, Goelkera,Gudri,Hatgamharia,Jagannathpur,Jhinkpani,Khuntpani,Kumardungi,Manjhari,Manjhgaon,Manoharpur,Noamundi,Sonua,TantnagarandTonto.Thedistrict has 217 Gram Panchayats and 1697RevenueVillages. According to the 2011 Census, West Singhbhum is the largest district of Jharkhand in terms of area covered (7,224sq.km.),ranks 8th in terms of population (15,02,338) and is 21st in terms of population per sq.km. with 208 persons persq.km as against the state's 414. It has the highest sex ratio in Jharkhand, of 1005 females per 1000 males. Tribals constitute 67.31% of the district's population. The predominant tribe is Ho, while there are significant populations of Mundas, Santhals, Oraons,and Kharias.

The overall Literacy rate is 58.63%; male and female literacy rates stand at 71.13% and 46.25% respectively.The economy of the district mainly depends on cultivation or related work. More than 73% of the total workers are engaged in Primary sector. Bandgaon block has the highest number of villages (216) in the district and Jhinkpani block has the lowest number of villages (27). 18.05 % and 58.63 % of Households of main source of drinking water are from uncovered-well and handpump respectively of the villages.

The district falls on the survey of India Topo-sheet Nos. 73 F/1,2,3,4,5,6,7,8,10,11,12,14,15,16, 73 J 03,04, 73G 13 and 73B16.The district is located between 21^{0}58'12.09"N and 22^{0}52'52.86"N latitude and 84^{0}58'10.96"E and 86^{0}02'52.43"E Longitude. The district administrative unit with geographical area (sq.km) is given in table 1 and base map of the district is shown in figure 1.

Table 1.1: The district administrative units with geographical area (sq.km)

S.No.	Blocks	Geographical area (sq.km)	Population(2011 Census)
1	Anandpur	322.4	44406
2	Bandgaon	474.9	87072
3	Chakradharpur	382.9	197953
4	Chaibasa	211.5	155954
5	Goelkera	562.9	74019

S.No.	Blocks	Geographical area (sq.km)	Population(2011 Census)
6	Gudri	583.4	38282
7	Hatgamaria	307.6	67226
8	Jagannathpur	318.7	99169
9	Jhinkpani	**125.5**	**53792**
10	**Khuntapani**	418.3	83047
11	Kumardungi	295.5	55352
12	Manjhari	318.6	68450
13	Manjhgaon	285.7	72616
14	Manoharpur	975	90142
15	Noamundi	652.6	113333
16	**Sonua**	252.6	77697
17	Tantnagar	200.6	63910
18	**Tonto**	646.2	59918
	Total	**7335**	**1502338**

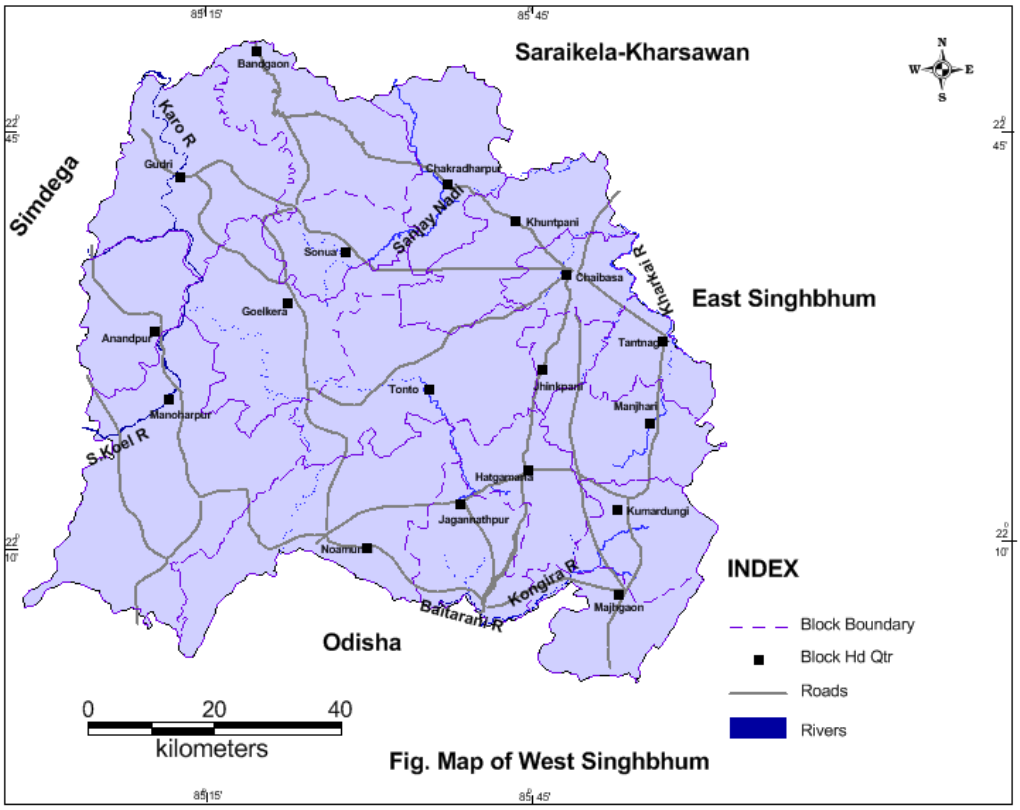


Fig:1. Administrative Map of West Singhbhum District

1.4 Data Availability

Central Ground Water Board has carried out exploratory drilling in the district and drilled twenty six (26) exploratory and twelve (12) observation wells by departmental rigs and drilled twenty six (26) exploratory wells and four (4) observation wells through outsourcing as on March 2022 to know the sub–surface geology, depth and thickness of water bearing formation with their yield and determining the different aquifer parameters and variable lithology in the area. In addition of that, twelve numbers of permanent observation well (HNS) of Central Ground Water Board located in the district are being monitored (4 times in a year) for ground water regime and to assess the chemical quality of ground water. 42 number of observation wells were established during the study for water level monitoring and quality monitoring.

Vertical Electrical Sounding (VES) was carried out at 47 sites covering 11 blocks of the district.

1.5 Climate and Rainfall

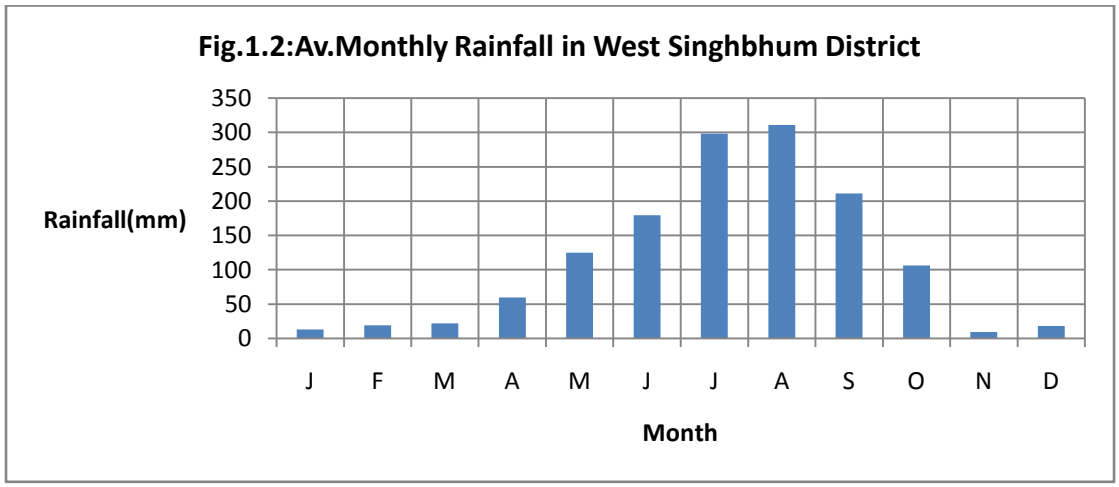
The climate of West Singhbhum district is sub-tropical humid climate. There are three seasons. Summer starts from the month of April and remain upto June. South West Monsoon sets in mid-June and persists upto October. Winter season stars from November and prevails upto March. South-West Monsoon is the principal source of rainfall which contributes around 89 % of the total annual average rainfall of 1372mm. The district occasionally gets rainfall from the Western disturbances during winter. July and August are the wettest months of the year. Summer is hot and maximum temperature may touch 40^0C. December and January are the coldest month with minimum temperature falls below 11 0C.

Table 1.2: Monthly Rainfall in the district

Year/ Month	J	F	M	A	M	J	J	A	S	O	N	D	Total
2012	67.88	24.76	0	36.42	26.68	285.66	239.68	356.47	251.91	62.49	19.57	26.45	1397.97
2013	4.22	10.81	1.88	41.64	143.71	199.29	363.44	286.05	247.72	349.23	0	0	1647.99
2014	0.88	41.74	29.93	5.05	94.12	173.94	430.1	419.81	190.23	60.91	0	0.31	1447.02
2015	8.36	0.88	25.49	96.6	47.55	187.33	407.81	141.47	93.28	37.98	0	20.41	1067.16
2016	8.15	32.41	10.63	0.44	121.29	155.85	227.85	436.91	230.72	22.5	3.15	0	1249.9
2017	1.9	0	24.27	9.61	156.05	148.76	440.78	255.01	138.87	115.55	16.65	0.05	1307.5
2018	0	1.7	1.35	147.51	108.37	175.01	308.64	300.89	229.54	46.4	1.1	75.94	1396.45
2019	0.14	60.67	37.12	93.64	90.78	108.8	212.56	326.86	227.76	176.16	0.7	12.5	1347.69
2020	38.22	15.62	78.23	148.91	121.35	191.44	97.81	428.52	125.1	45.71	11.25	0	1302.16
2021	1.1	1.55	11.74	17.31	340.69	166.24	256.34	157.99	373.85	145.67	40.14	48.36	1560.98
Av	**13.085**	**19.014**	**22.064**	**59.713**	**125.059**	**179.232**	**298.501**	**310.998**	**210.898**	**106.26**	**9.256**	**18.402**	**1372.482**

Table 1.3: Annual Rainfall of the district

Sl.no	Year	Rainfall(mm)	Sl.no	Year	Rainfall(mm)
1	2002	969.48	11	2012	1397.97
2	2003	1194.99	12	2013	1647.98
3	2004	1267.1	13	2014	1446.23
4	2005	1225.83	14	2015	1067.13
5	2006	1712.93	15	2016	1249.89
6	2007	1765.5	16	2017	1307.48
7	2008	1485.38	17	2018	1396.43
8	2009	1449.55	18	2019	1347.68
9	2010	766.34	19	2020	1302.16
10	2011	1885.55	20	2021	1560.98
				Average	**1372.329**



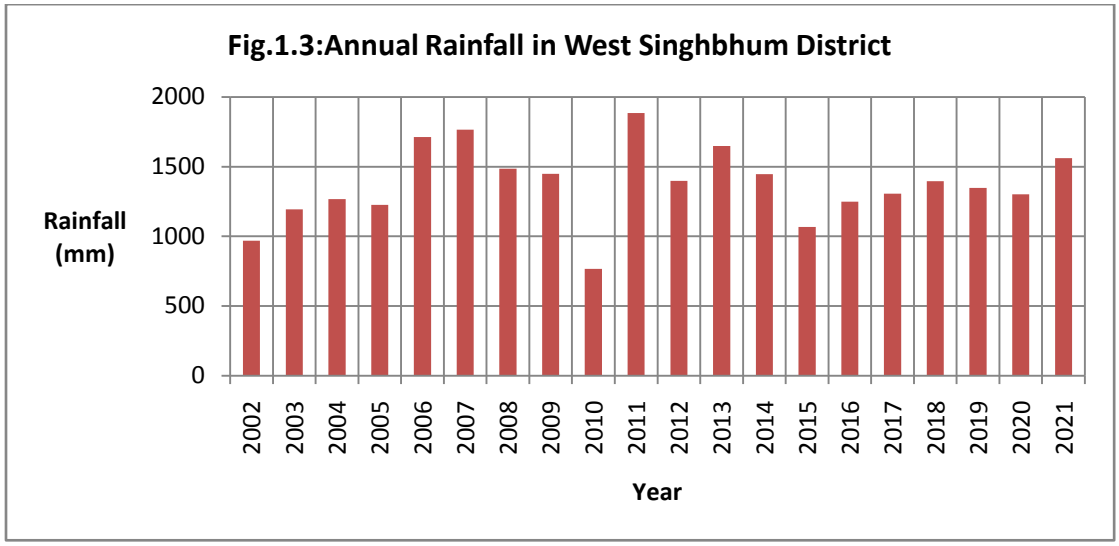


Table 1.4: Rainfall in blocks

Blocks	2015-16	2016-17	2017-18	2018-19	2019-20
Chaibasa	1061	1585.1	1465	1367.4	1252.3
Khuntpani	905	1238.9	1160.2	1087.2	1050.4
Jhinkpani	561.6	774.9	1092	1099.2	1187.1
Tonto	979.5	1115.7	1332.2	1355.3	1463.5
Kumardungi	1004.4	994.8	1201.9	1475.8	1369.1
Manjhari	1025	1116.8	1479	1381.4	1387.4
Manjhgaon	946.2	1239.6	1332.3	1567.6	1175.5
Tantnagar	603.1	850.6	78.2	1262.8	882.4
Jagarnathpur	957	1311.8	1382	1626.8	1591.6
Nowamundi	605	912.6	1535	1222.2	1049.6
Chakradharpur	991.6	1051.6	1174.4	1283.4	1532.4
Bandgaon	1111.6	1035	1353.8	1157.2	1415.6
Sonua	948.2	1326	1278.1	1355	1783.6
Goilkera	970.4	1297.3	1330.3	1309.4	1970.3
Manoharpur	713.2	1315.8	1291.6	1457	1578.6
Hatgamhariya	814	1156.4	1512.6	1507.1	1311.8
Gudri	937.5	1312.6	1267.3	1355	1783.4
Anandpur	792.6	1332.4	1293.8	1457	1560

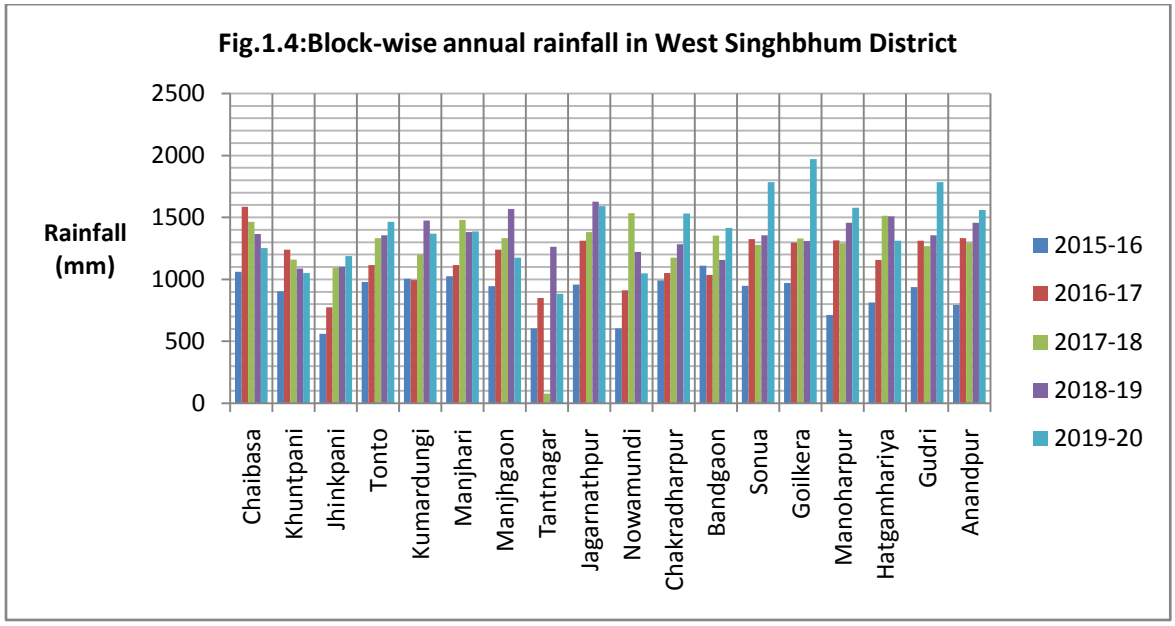
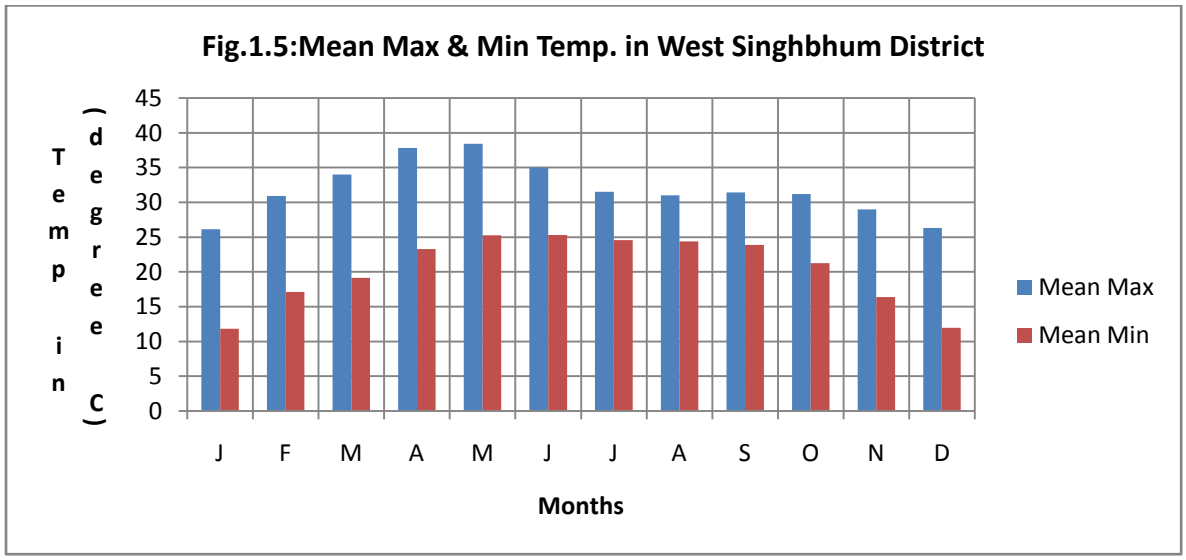


Table 1.5:Mean Max. & Min Temperature(^{0}C) in West –SinghbhumI

Temp/ Months	J	F	M	A	M	J	J	A	S	O	N	D
Av.Max	26.1	30.9	34.01	37.83	38.43	35.03	31.54	31.01	31.44	31.21	28.98	26.33
Av.Min	11.8	17.12	19.16	23.27	25.26	25.31	24.55	24.37	23.88	21.24	16.4	11.97



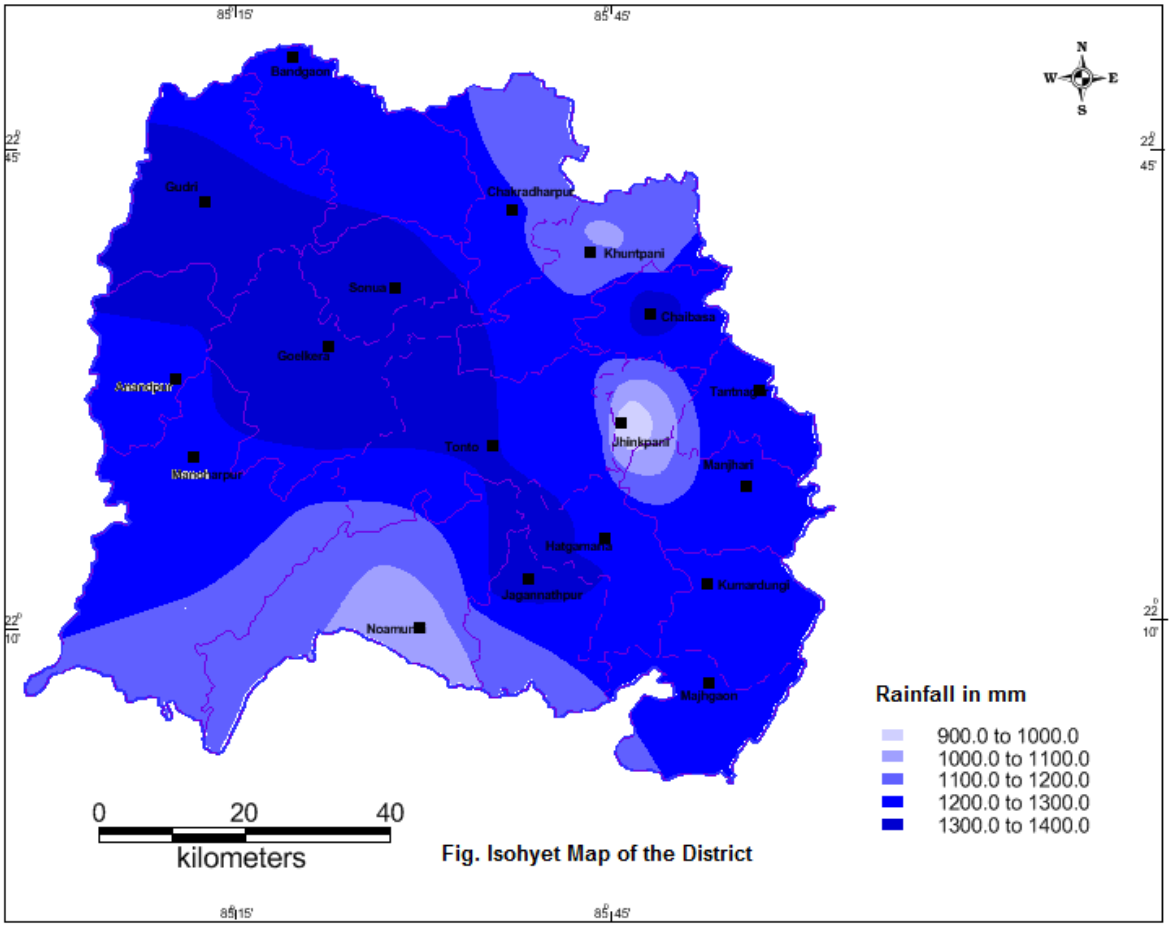


Fig: 1.6 Isohyetal Map

1.6 Physiography:

The area is dominated by hilly ranges, valleys and plateaus. Hilly and steep sloping areas provide dense forest cover. The plain areas have the elevation about300 metres but the hilly areas have about 600 to 950 metres. Singhbhum Group of rocks in the north and Bonai Group of rocks in the south-west form the high hill ranges in the district. The fig 1.7 and fig 1.8 show the land elevation map of the district.

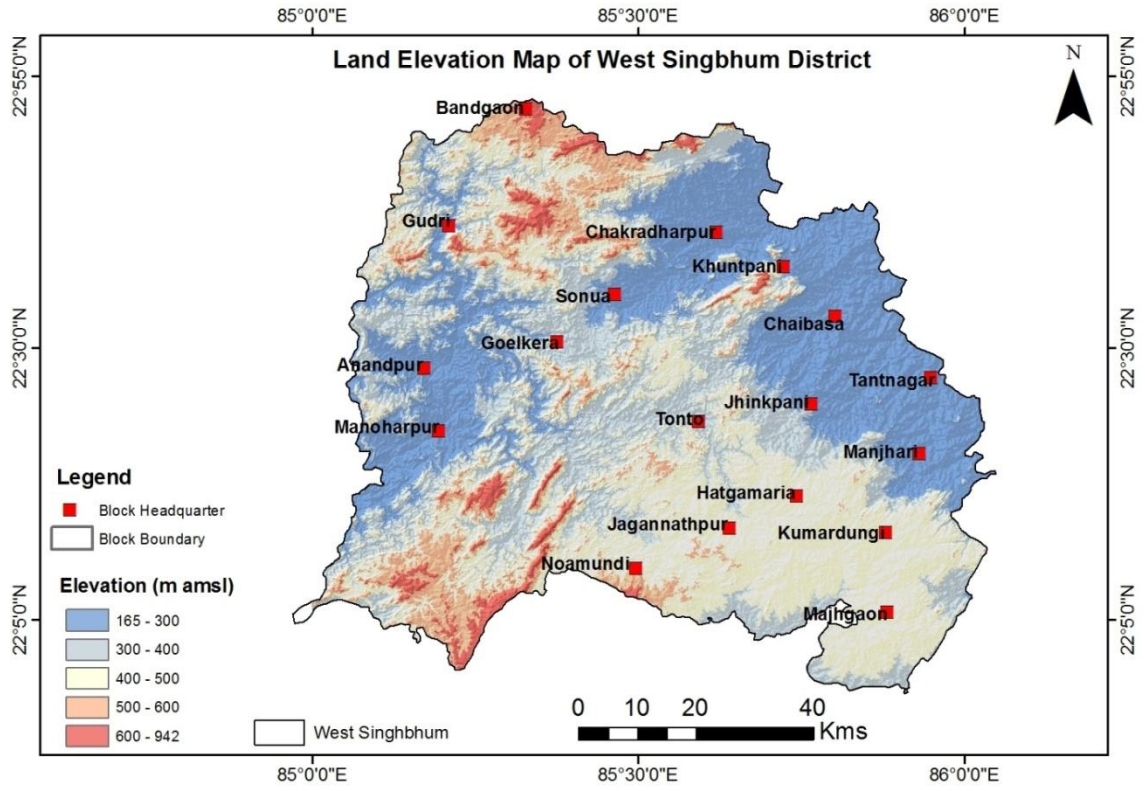


Fig.1.7: Relief Map of the district

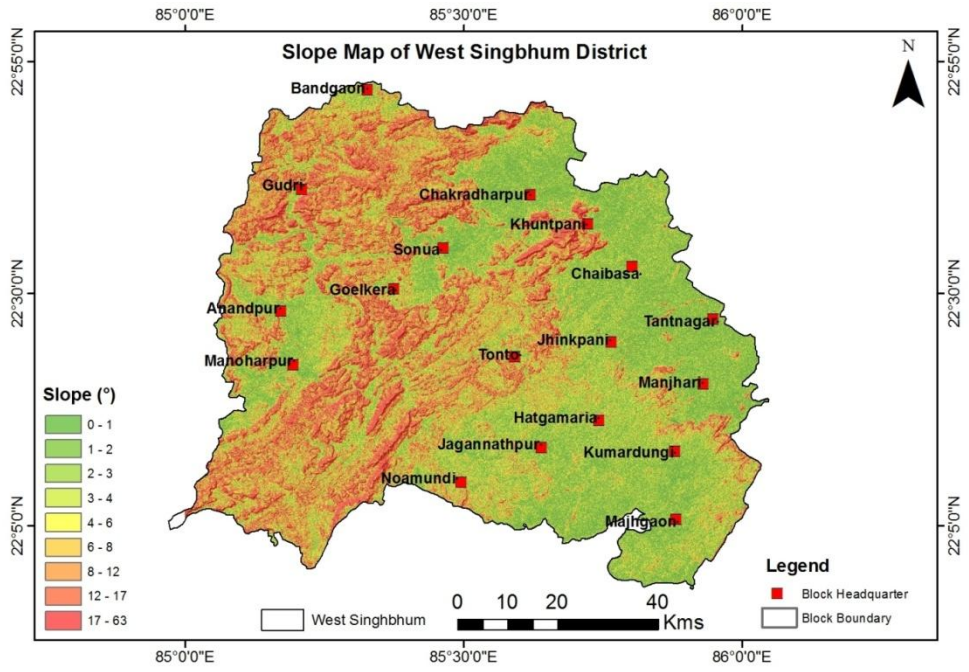


Fig.1.8: Slope map of the district

1.7 Geomorphology:

The area is represented by structural hills, pediplain weathered /buried, denudational hills, dissected pediments, pediment, alluvial plain. Pediplain with thinly discontinuous veneer of soil and alluvium developed on granitic terrain in the east of the district. Few Isolated denudational hills are found in Tantnagar block in the east. Linear alluvial plain occurs all along the major river course. Pediments and dissected pediments are found in patches in the north and west. The geomorphology of the district is shown in the fig.1.9.

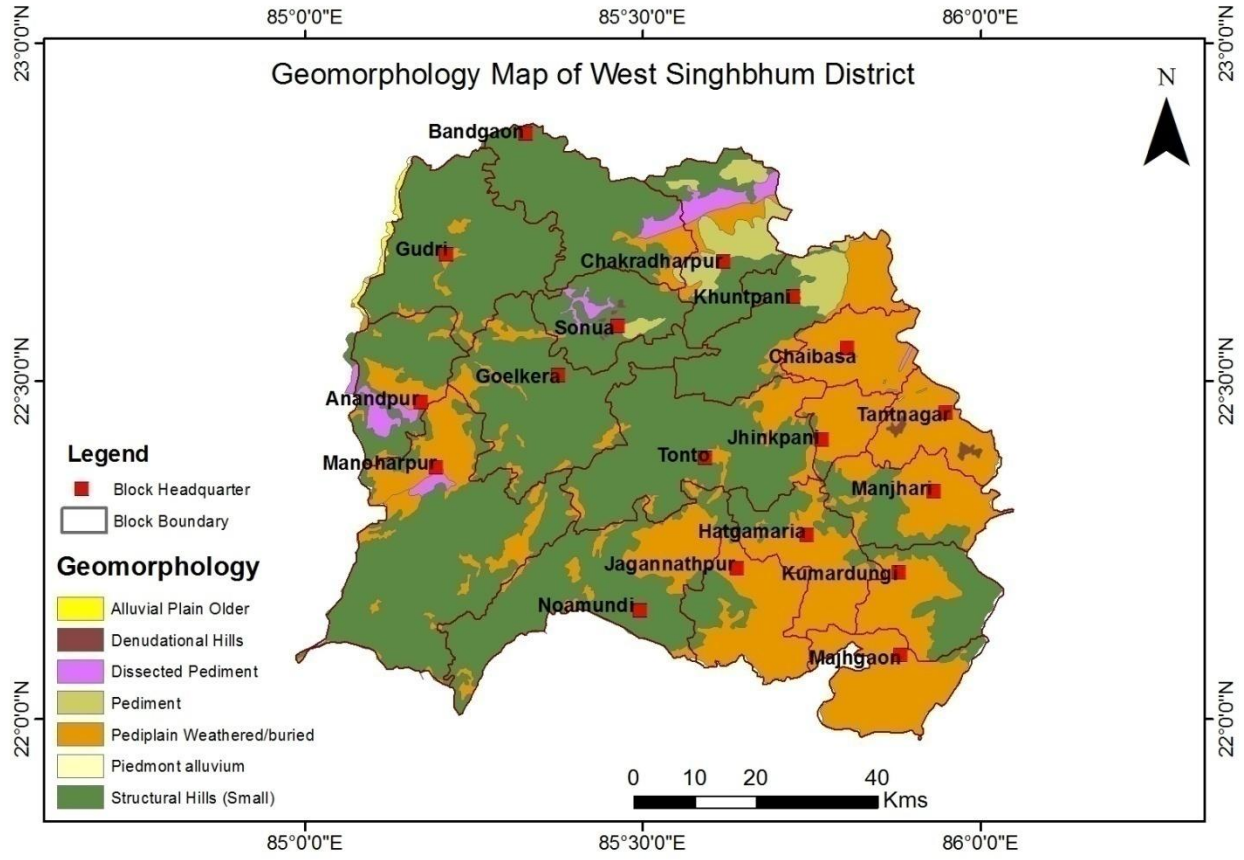


Fig.1.9: Geomorphology of the district

1.8 Land Use:

The fig 1.10 and table 1.6 show the landuse pattern in the district. Crop land and agricultural fallow land constitute the maximum landuse i.e. 48.8 and 30.4 percent of the total area respectively. Town/city (urban area) covers around 0.1 % of the total area.

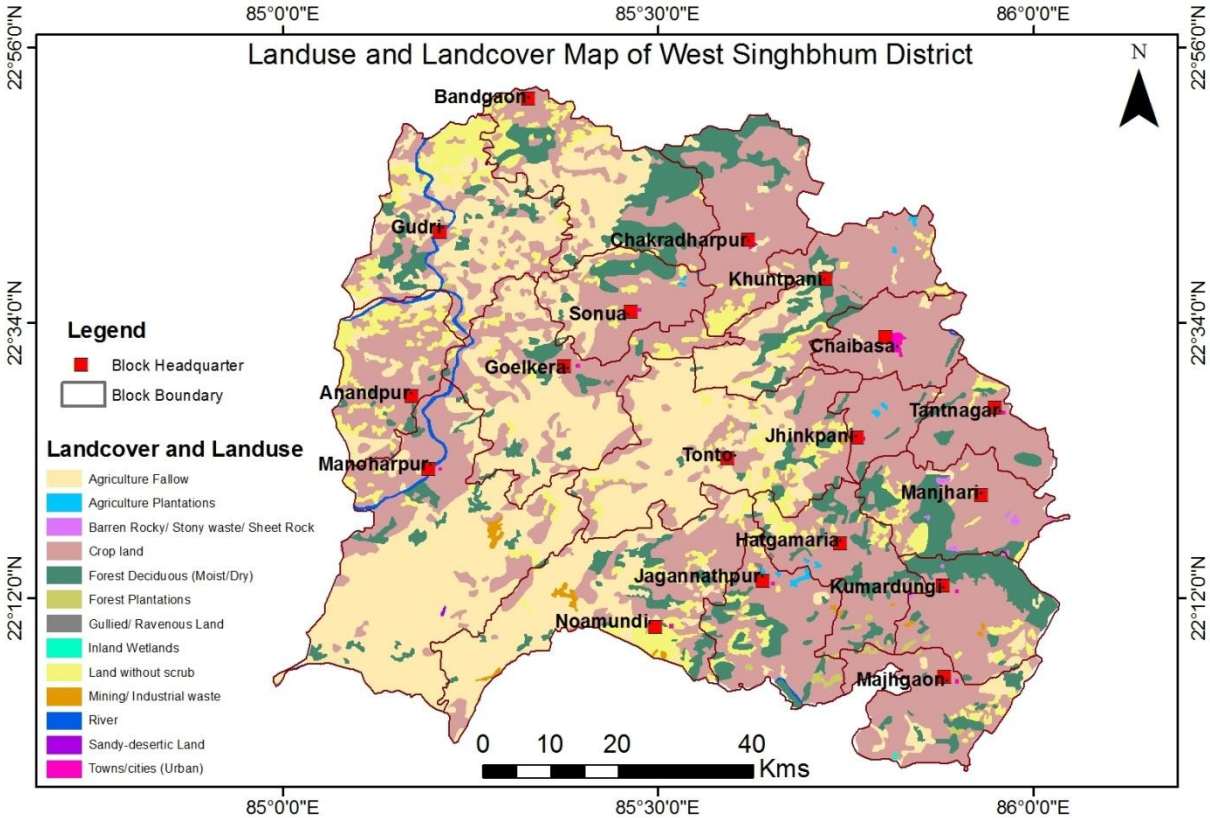


Fig.1.10: Landuse and Landcover Map of the district

Table 1.6: Landuse pattern in the district

Sl.No	Landuse	Area(sq.km)	
1	Agriculture Fallow	2089.3	30.4
2	Agriculture Plantations	9.4	0.1
3	Barren Rocky/ Stony waste/ Sheet Rock	5.9	0.1
4	Crop land	3354.7	48.8
5	Forest Deciduous (Moist/Dry)	785.8	11.4
6	Forest Plantations	18.0	0.3
7	Gullied/ Ravenous Land	3.8	0.1
8	Inland Wetlands	0.6	0.0
9	Land without scrub	543.9	7.9
10	Mining/ Industrial waste	19.8	0.3
11	River	38.9	0.6
12	Sandy-desertic Land	0.6	0.0
13	Towns/cities (Urban)	9.6	0.1
	Total	**6880.2**	**100.0**

1.9 Soil:

The soil of the district is formed from hard rocks, which come under latosol group of soil. Soils developed in the district are very old and due to intensive leaching over the years, soils of the area are of poor fertility status. The soils are old with low base content, low carbon exchange capacity (5-15 dSm-l), acidic in reaction withlowphosphatecontent.73.5% of the total geographic area is very strongly to strongly acidic and 23.4% is moderately to slightly acidic. 67% of the area is rich in organic carbon but the occurrences of other soil fertility parameters are very low 7.

The soil may be further classified in four categories on the basis of colour and fertility'

(a) Rocky soil: - Approximately 20 percent of the area comes under this. lt is not actually under cultivation. This type of soilis found throughout the division, wherever we come down the hills and hillocks and mostly in the southern, western and north-western portions of the division.

(b) Red soil: - After rocky soil comes red soil, which is spread throughout the district. lt covers nearly 35 percent of the soil area. The texture of the soil is sandy and loamy in upland and midland respectively. lts fertility is poor and it is acidic. Only kharif crops and vegetables could grow. ln lowlands or where irrigational facilities are available paddy is also grown.

(c) yellowish grey and grey soil : - Soil in the uplands is yellowish grey in colour while in the lowlands it is only grey Soil in the uplands is less fertile than in the low lands but on the whole this kind of soil is more fertile than red soil. However, this type of soil is deficient in organic matter as well as in other major soil nutrients' At places alkaline patches are also found, locally known as khirnimitti' They donot allow crops to grow.

(d) Blacksoil: - This type of soil is rich in organic matter. lts colour is black, probably due to the deposit of organic matter coming with rainwater from forest. The texture of the soil is loamy and clayey. lt is very fertile and is found only in patches in several villages. Mostly paddy is grown on this soil, but where irrigational facilities are available wheat and gram are also grown.

1.10 Hydrology and Drainage:

Though there are 38 rivers and rivulets passing through or originating inWest Singhbhum district. The major rivers include South Koel, Karo-Koina, Kuju,Kharkai,Sanjai,Roro,Deo,and Baitarini. South-Koel rivers flows in west of the district in south direction. It joins in Sankh river in Odisha to form Brahmani river. Baitarani river flows in west-east direction all along the south boundary of the district. Kharkai river flows in south-north direction in eastern part of the district and join in river Subarnarekha. Major of the rivers and streams are topographically controlled.

The district has number of dams and weir for irrigation purposes. Sonua dam is the biggest dam with storage capacity of 49.22 MCM. The list of dams and weirs given in the table 1.7.

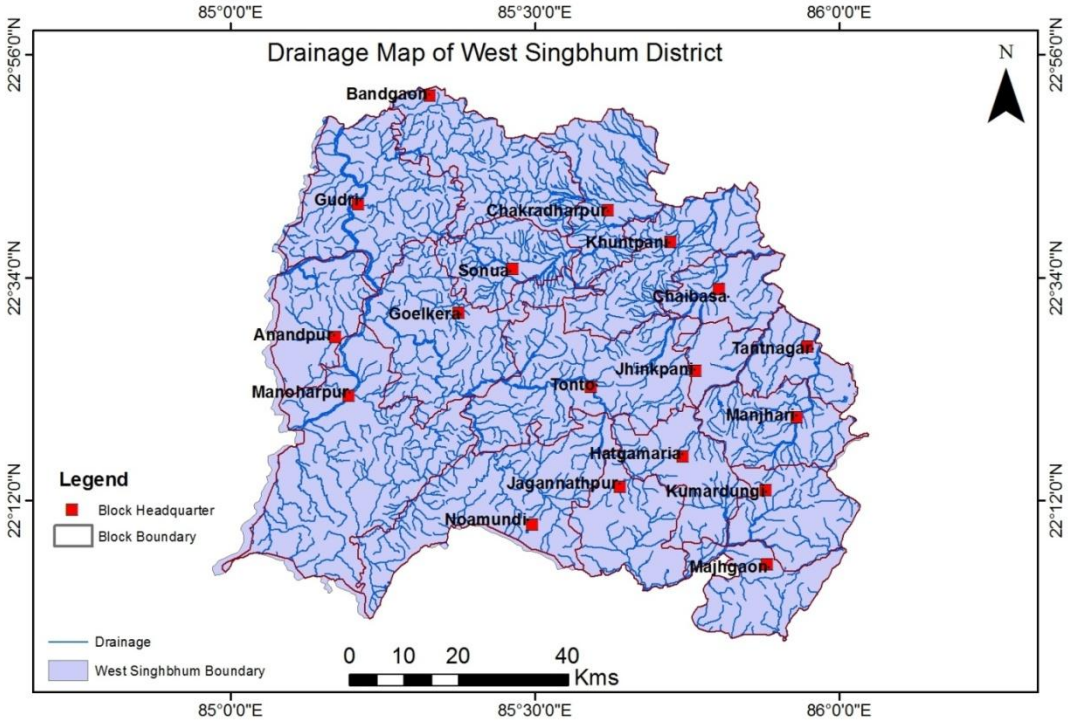


Fig.1.11: Drainage Map of the district

Table 1.7: List of dams and weirs in the district

List of Dams with surrogate information												
Sl. No.	**Name of Dam**	**River**	**Type of Dam**	**Year of completion**	**Catchment Area (Sq.Km.)**	**Length of dam(m)**	**Max height Above foundation(m)**	**Grossstorage capacity(MCM)**	**Livestorage capacity(MCM)**	**Type of spillway**	**Submergence Area(ThHa)**	**Purpose**
1	JenasaiDam		Earthen	1981	25.60	1128	19.21	7.03	6.60		0.13	IR
2	JharjharaDam	Bamini Nalla	Earthen		78	667.1	30.66	22.49	19.84		0.24	IR
3	Nakti Dam	Bijav	Earthen	2010	22.74	678	37.6	11	9.20	CH	0.07	IR
4	Satpotka Dam	Potka	Earthen			128	24.4	10.60	9.30			IR
5	SonuaDam	Sanjav	Earthen	2009	115.20	640.24	39.41	49.22	43.66	CH	0.35	IR
6	TorlowDam	Torlow	Earthen	1990	51.20	2484.8	22.25	15.33	11.76	CH	0.20	IR

List of BWA with surrogate information							
Sl. No.	**NameofB/W/A**	**River**	**Length(m)**	**Height upto crest(m)**	**Catchment area(Th.ha.)**	**Design flood discharge(Cumecs)**	**Purpose**
1	Bijav/VijayWeir	Bijav	63.40	0.76		849.50	IR
2	Brahamani/BamniWeir	BamniNallah	61			566.09	IR
3	PutunggaraWeir	Putungara	45.72			663.26	IR
4	RoroWeir	RoroGara	58.50	5.7912		1387.53	IR
5	SonuaWeir	Sanjav	66	4.05		1303	IR
6	Torlow Weir	Torlo	0			0	IR

1.11 Agriculture and Irrigation Practice:

In the district, out of net sown area of 58992ha, only 14731 ha is covered under irrigation. The cropping intensity in the district is 110%. All these features indicate a poor level of mechanized farming which may also be due to the fact that the district is primarily a monocrop rainfed area with kharif and paddy as the dominant crop.

Table1.8: Crop-wise irrigated Area

CropType	Kharif (Area in ha)			Rabi (Area in ha)			Summer Crop (Area in ha)			Total(Area inha)			Horticulture & Plantation Crops(Area inha)		
	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total	Irrigated	Rainfed	Total
A)Cereals	12784	145736	158520	2595	0	2595	413	0	413	15792	145736	161528			
B)Coarse Cerals	1680	5699	7379	27	0	27	0	0	0	1707	5699	7406			
C)Pulses	0	16342	16342	0	8301	8301	0	0	0	0	24643	24643			
D)Oil Seeds	0	482	482	4857	10355	15212	0	0	0	4857	10837	15694			
E)Fibre	0	0	0	0	0	0	0	0	0	0	0	0			
F)Any other Crops	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	17491
	14464	168259	182723	7479	18656	26135	413	0	413	22356	186915	209271	0	0	17491

1.12 Cropping Pattern

Based on the agro-climatic conditions, the district comes under Sub Zone III. The major fruit crops grown in the district are Mango, Guava, Jack fruit, Citrus, Ber, Amla and Papaya etc. Considering the agro-climatic suitability and future prospects, Government of Jharkhand through the Department of Horticulture, is giving a major thrust for bringing additional area under various P & H crops and enhancing the productivity of existing orchards.

Development of irrigation facilities in the district, has given a boost to vegetable cultivation. The acreage under vegetable crops is increasing year after year due to better returns compared to cereals/pulses. The major vegetable crops grown are potato, cauliflower, cabbage, onion, tomato, chillies, brinjal, bhindi and leafy vegetables. The credit requirement of most of the vegetable crops is expected to be met through crop loan(SAO) /short term credit.

The state has 18,423 sq. km of forest land, which is 23 per cent of the total land area of the State and houses about 200 medicinal plant species, spread over Chotanagpur, Hazaribagh, Palamau, Singhbhum and West Singhbhum (Betla and Netarhat).The climate of the district is most suitable for the cultivation of medicinal and aromatic plants because of presence of large tract of land suitable of cultivation of these herbs. There is a good potential for cultivation & processing of medicinal & aromatic plants in the district as well as theState.

Table 1.9: Crops cultivated during various seasons in West Singhbhum District

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

1.16 Geology

The oldest rocks encountered in the district are of Archaean age represented by Older Metamorphic Group and Gorumahisani Group occurring as enclaves within Singhbhum granite, which is a polyphase, batholithic granite of intrusive nature. The Singhbhum granite covers south-eastern part of the area. The Chakradharpur Granite (Gneiss) is also diphase batholithic migmatitic granite of intrusive nature covering around Chakradharpur town. Newer dolerite of undifferentiated Archaean to Proterozoic age intruded the Singhbhum granite throughout the area in NE-SW and NW-SE directions.

Lower Bonai Group of rocks belonging to Archaean to lower Proterozoic age is next higher group of rocks in the district and a small portion occurs in south-western part while Upper Bonai Group of rocks of Lower Proterozoic age covers more area from south-western border to the east uptoSaraikela.

Singhbhum Group of rocks of lower Proterozoic age covers the northern portion of the district in close association with Dalma Volcanics of same age group. Its boundary with underlying Upper Bonai Group is structurally controlled but ill defined due to close vicinity with Singhbhum Shear Zone. Chhotanagpur Gneissic Complex of Archaean to Proterozoic age and Gangpur Group of rocks of lower Proterozoic age are found in limited occurrences in north-western and western boundaries respectively.

Kolhan Group of rocks, a storehouse of limestone, occurs in south-eastern part of the district adjacent to Singhbhum granite. It extends from Noamundi in SW to Chaibasa in NE.

A small patch of Dangoaposi lava of lower Proterozoic age occurs to the north of Noamundi while Ongarbira traps of same age occur within shale and phyllite of Upper Bonai Group as lenses and patches of various dimensions exposed in between Manoharpur and Chaibasa. The Jojuhatuultramafics of same age occur also within upper Bonai Group of rocks as patches of various dimensions. Soda granite and Arkasani granophyres of Meso Proterozoic age occur as intrusive in the eastern and northern parts of the district respectively.

Laterite capping are plenty over Singhbhum granite as small patches.

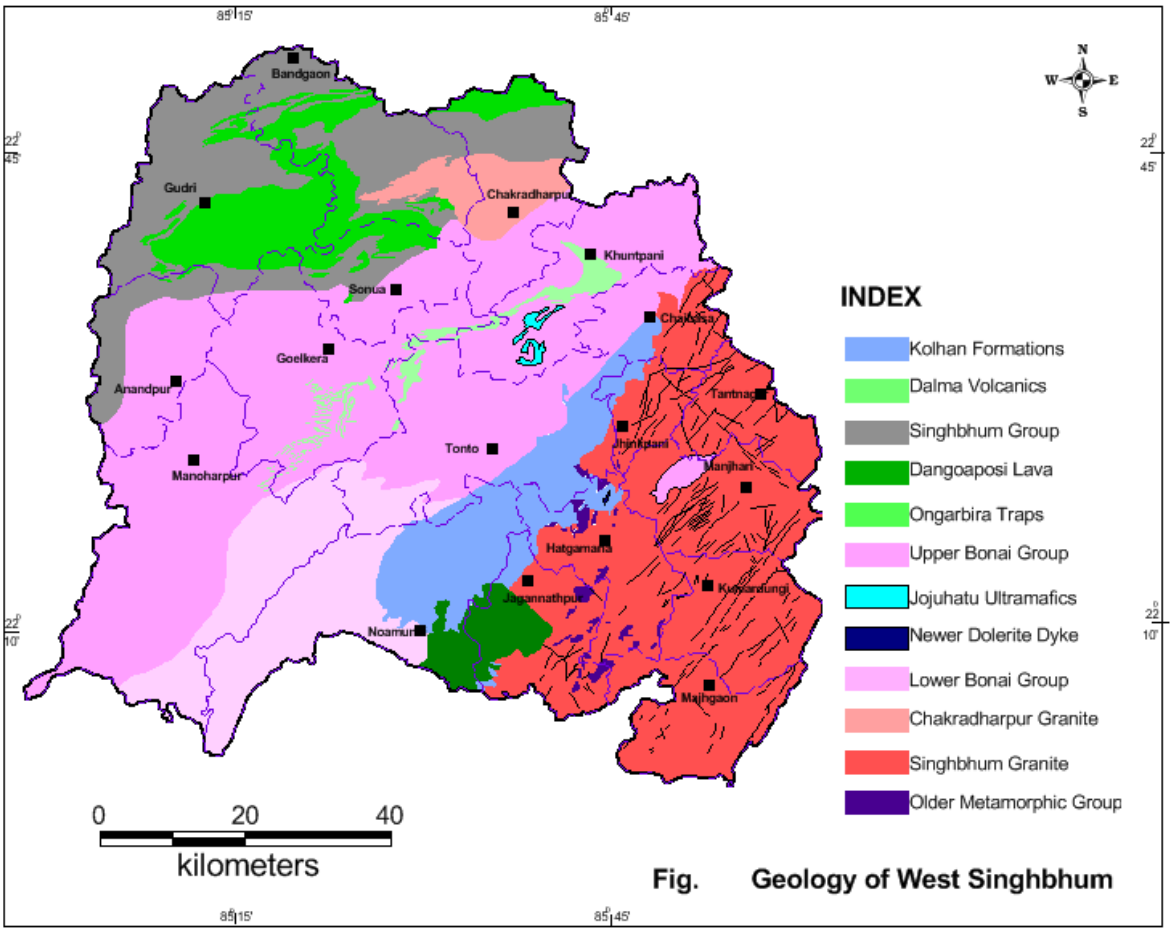


Fig. Geology of West Singhbhum

Fig.1.12: Geology of the district

Table 1.10: General Stratigraphy (based on GSI Geological Map)

Age	Geological Unit	Lithology
Cenozoic (undifferentiated)		Laterite

Middle Proterozoic		Arkasanigranophyres
Lower to Middle Proterozoic	Kolhan Group	Shale & Phyllite Limestone Sandstone & Conglomerate
Lower Proterozoic	Dalma Volcanics	Mafic intrusive Epidiorite, Hbschist, metabasalt, tuffaceous sediments/chlorite schist,agglomerate, phyllite/mica schist, haematite or magnetite qtzite/qtzite Talc,Sericite chlorite phyllite/schist Shale,phyllite,mica schist/chlorite phyllite/carbon phyllite,qtzite,haematite/magnetite,qtzite,cht/cherty rhythmite Ultramafics(gabbro-pyroxenite,peridotite,serpentinite)
	Gangpur Group	Phyllite /mica schist Quartzite
	Singhbhum Group	Metabasic rocks,chlorite phyllite/chlorite schist/muscovite schist Mica schist with Hb schist,tuff,tuffaceous psammopelite,quartzite & chert,Phyllite/carbon phyllite Mica schist with Hb schist,limestone(dolomitic),calc-schist Dangoaposi lava
	Ongarbira Traps	Metabasic rocks Basic lava flow & sub-volcanics
	Upper Bonai Group	Shale,phyllite,mica schist,quartzite,tuffaceous rocks Sandstone Basic volcanic rocks(sheared) with psmmopelite Conglomerate with sandstone/quartzite
	JojuhatuUltramafics	Ultramafic rocks Gabbro & anorthosite
Archaean to Proterozoic	Chhotnagpur Gneissic Complex	Granite Gneiss with porphyroblastic granite gneiss Migmatite
		Newer Dolerite
Archaean to Lr Proterozoic	Lr Bonai Group	Bonai Granite Iron Ore Banded Haematite Quartzite Quartzite Manganeferous Shale,Phyllite Basic metavolcanics/intrusive rocks
Archaean	Gorumahisani Group	Epidiorite,Chlorite,Phyllite Mica schist & phyllite Quartzite,BMQ/BHQ Arkose & Conglomerate
		Chakradharpur Granite
		Singhbhum Granite
	OMG	Orthoamphibolite, High Grade Pellitic schist, Quartzite

2.0 Data Collection and Data Generation

The primal objective ofNational Aquifer Mapping & Management is to collect, generate and collate various types of data - Rainfall, Drainage, Soil, Lithology, Structure, Lineament Mapping, Micro-level hydrogeological data collection, establishment of well inventory, setting up of a monitoring network for effective ground water regime monitoring (level, Quantity & Quality) over space and time, sub-surface information through geophysical investigations and exploratory drilling programme etc., use of remote sensing studies for geomorphological mapping, change analysis interpretation to name a few :

Table – 2.1 NAQUIM Data Collection Status

Sl.No	Item	Sub-Item	CGWB	
1	Groundwater Level monitoring	NHS Phreatic	12	
		Additional Observation Wells phreatic	40	Established During study
2	Groundwater Quality Monitoring stations	Phreatic	42	During study
		Deeper	8	During study
3	Exploratory Well Data		26(in-house)+26 (outsourcing)	
4	Vertical Electrical sounding		47	

2.1 Water Level Measurements : Water level measurements was carried out using the existing National Hydrographs Network stations as well as by establishing a dedicated network of Key Wells (40Dug wells). This involved measurement of water levels of the phreatic aquifer through dug wells only. The highly uneven and rugged topography has restricted the occurrence of ground water in discontinuous patches mainly in topographic lows, intermontene valleys and adjacent to nala and stream courses. Most of the area is inaccessible and has security problem. The work was carried out during Corona pandemic restrictions.

54 number of wells were monitored during the NAQUIM field study during Pre-monsoon (May,2022) and Post-monsoon (Nov,2021) The details of the Key wells with the water level data is given in table 2.2and in Annexure-2.1. Location of monitoring wells is given in fig.2.1.

Table 2.2: Water Level Data of monitoring wells

Sl. No	Well Name	Block	Latitude	Longitude	WL Pre-monsoon(mbgl)	WLPost-monsoon (mbgl)	WL_FLC(m)
1	Bhandgaon	Noamundi	22°05'21''	85°35'40.7''	2.71	1.81	0.9
2	Bandgaon	Bandgaon	22°51'40.2''	85°19'47''	9.48	5.44	4.04
3	Barajamda	Noamundi	22°09'52.4'	85°24'41.2''	2.5	0.9	1.6
4	Chaibasa	Chaibasa	22°32'44''	85°48'18''	13.25	7.73	5.52
5	CKP (Ulidih)	Chakradharpur	22°40'16.8''	85°39'06.4''	7	3.25	3.75
6	Hat Gamhariya	Hatgamhariya	22°15'42''	85°44'09''	9.29	1.92	7.37
7	Hesadih	Bandgaon	22°47'10.8''	85°21'17.7''	4.07	1.65	2.42
8	Jagannathpur	Jagannathpur	22°13'16.3''	85°38'11.7''	8.4	4.9	3.5
9	Jaitgarh	Jagannathpur	22°04'18.4''	85°40'32.6''	4.83	2.62	2.21
10	Jhinkpani	Jhinkpani	22°25'00''	85°46'25''	NA	NA	NA
11	Kereikela	Kereikala	22°42'31''	85°32'21''	6.65	1.7	4.95
12	Khuntpani	Khuntpani	22°37'24.9''	85°43'21''	7.3	2.75	4.55
13	Noamundi	Noamundi	22°09'37.5''	85°30'16.8''	3.6	0.45	3.15
14	Kokcho	Tantnagar	22°28'04.3''	85°54'42.8''	7.1	2.72	4.38
15	Talaburu		22°21'16''	85°44'54''	1.6	1.2	0.4
16	Putida	Chaibasa	22°35'21''	85°45'53''	2.6	1.93	0.67
17	Barananda	Jagnnathpur	22°13'08''	85°36'30''	5.43	1.01	4.42
18	ToretopaNoamundi	Noamundi	22°09'37.9''	85°30'46''	13.36	5.26	8.1
19	Sonua	Sonua	22°34'47.6''	85°27'45.8''	5.62	2.15	3.47
20	Goielkera	Goielkera	22°30'21.7''	85°22'32.5''	13.88	8.1	5.78
21	Toklo	Chakradharpur	22°47'36.1''	85°39'30.4''	7.42	2.07	5.35
22	Jate	Gudri	22°39'22.4''	85°19'19.8''	8.84	4.3	4.54
23	Kumdih	Goelkera	22°32'58''	85°16'04.7''	7.82	5.42	2.4
24	Bila	Goelkera	22°29'53.6''	85°26'54.3''	9.72	3.9	5.82
25	Kuida	Goelkera	22°32'28.2''	85°30'29.6''	7.19	3.88	3.31
26	Bhuta	Chaibasa	22°33'26.1''	85°44'39.2''	5.75	1.65	4.1
27	Taraisol	Goelkera	22°29'30.8''	85°17'50.4''	5.85	4.95	0.9
28	Nandpur	Manoharpur	22°22'36.0''	85°12'53.6''	10.77	4.48	6.29
29	Anandpur	Anandpur	22°27'44.2''	85°10'22.3''	7.2	4.55	2.65
30	Dumirta	Anandpur	22°30'01.9''	85°06'42.0''	7.6	2.4	5.2
31	Pachpahia	Manoharpur	22°18'25.8''	85°09'06.1''	6.88	2.65	4.23
32	Jaraikela	Manoharpur	22°18'32.9''	85°06'57.1''	10.1	9	1.1
33	Lolang	Manoharpur	22°20'23.1''	85°17'54.6''	5.2	3.87	1.33
34	ChhotaNagra	Manoharpur	22°14'21.4''	85°18'31.3''	9.15	7.85	1.3
35	Gamariya	Khuntpani	22°39'13.1''	85°45'05.2''	2	0.75	1.25
36	Barkundia	Chaibasa	22°29'52.1''	85°52'23.6''	9.53	7.6	1.93
37	Kokcho	Tantnagar	22°28'04.3''	85°54'42.8''	7.1	2.72	4.38
38	Tantnagar	Tantnagar	22°27'02.2''	85°56'29.8''	5.37	2.95	2.42

Sl. No	Well Name	Block	Latitude	Longitude	WL Pre-monsoon(mbgl)	WLPost-monsoon (mbgl)	WL_FLC(m)
39	Bingburu	Tantnagar	22°24'59.4''	85°56'14.7''	5.8	2.13	3.67
40	Roladih	Manjhari	22°21'15.2''	85°55'45.9''	5.45	3.1	2.35
41	Barbil	Manjhari	22°17'54.6''	85°55'34.6''	4	1.75	2.25
42	Sirbinja	Kumardungi	22°13'40.2''	85°53'32.2''	7.35	2.95	4.4
43	BaraRaikhaman	Kumardungi	22°07'41.7''	85°54'25.3''	5.15	2.8	2.35
44	Majhgaon	Majhgaon	22°05'29.5''	85°52'48.0''	2.92	1.35	1.57
45	Khairpal	Majhgaon	22°07'07.3''	85°46'39.2''	5.95	2.7	3.25
46	Gumuria	Jagannathpur	22°05'06.5''	85°43'38.1''	3.9	1.75	2.15
47	Siringsia	Tonto	22°21'22.1''	85°42'36.6''	6.66	2.32	4.34
48	Kendoposi	Hatgamhariya	22°17'38.4''	85°44'07.9''	5.33	2.8	2.53
49	Jorapokhari	Jhinkpani	22°24'32.1''	85°45'50''	6.5	2.85	3.65
50	Khunta	Chaibasa	22°30'59.5''	85°45'43.9''	5.27	1.85	3.42
51	Purnapani	Tonto	22°28'20.7''	85°40'02.5''	5.63	2.6	3.03
52	Jhinkpani	Jhinkpani	22°24'55.2''	85°46'01.7''	4.85	1.27	3.58
53	Parlipur		22°30'07.1''	85°13'31.4''	10.4	NA	
54	Narsinghpur		22°09'06.1''	85°43'11.2''	9.1	NA	

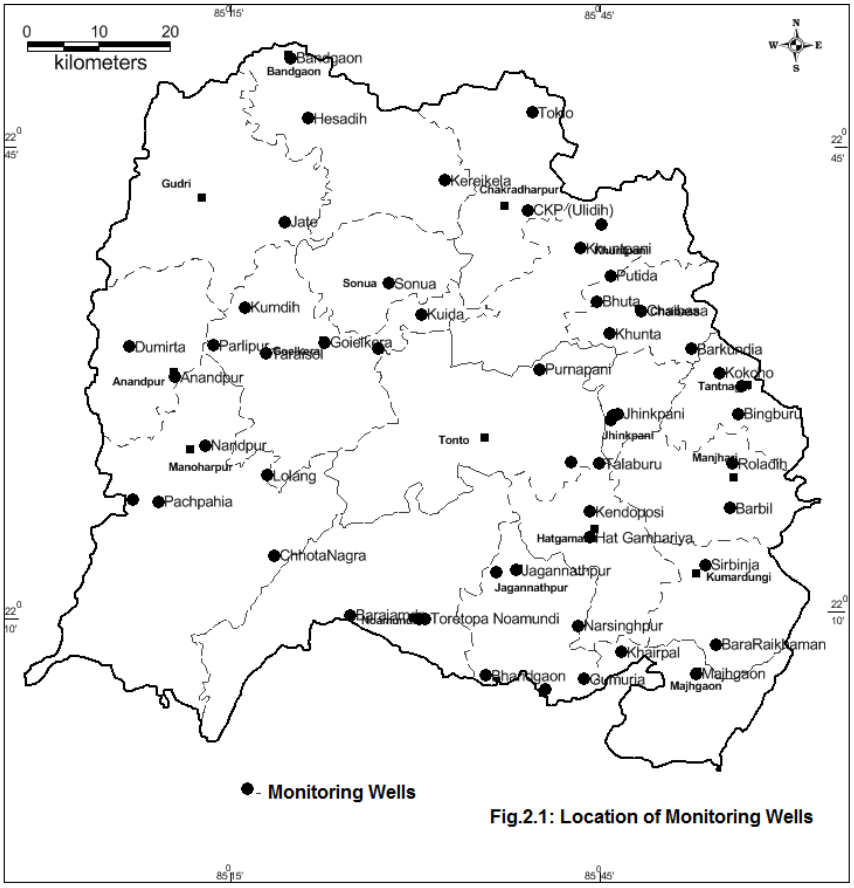


Fig.2.1: Location of Monitoring Wells

Fig 2.1 Location of Monitoring wells

2.1.1 Pre-monsoon depth to water level : Depth to water level in pre-monsoon period varies from 2.0 m bgl (Gamariya in Khuntpani block) to 13.88m.bgl (Goelkera in Goelkera block). The pre-monsoon depth to water level map is shown in fig.2.2. The map shows that western part of the district in Bandgaon, Gudri, Goelkera, Manoharpur water level is deep. The water level is deep may be due to high relief /elevation of surface. Water level is shallow in the east except in patches around Chaibasa and Noamundi. The shallow water level may be due to granitic terrain and low surface elevation. In major part of the district water level varies in the range between 4 to 8m. Water level is shallow in the south in Majhgaon, Jagannathpur and Noamundi blocks due to low surface relief.

2.1.2 Post-monsoon depth to water level: Depth to water level in post-monsoon period varies from0.45 m below ground level (Gamariya in Kuntpani block) to 8.1 (Goelkera in Goelkera block). The post-monsoon depth to water level map is shown in fig.2.3. The map shows that western part of the district in Gudri, Goelkera, Manoharpur water level is deep. Water level is shallow in the east except in patches around Chaibasa ,Jagannathpur and Noamundi. In major part of the district water level varies in the range between 0.45 to 4m.

2.1.3 Fluctuation of water level:

The fig 2.3 shows the seasonal fluctuations in the water level between pre monsoon and post-monsoon periods. The fluctuation in water level ranges between 0.9 m (Taraisol in Goelkerablock) to 8.1 m (Toretopa ,Noamundi block). Major part of the area show rise in water level in between 2 to 6m.

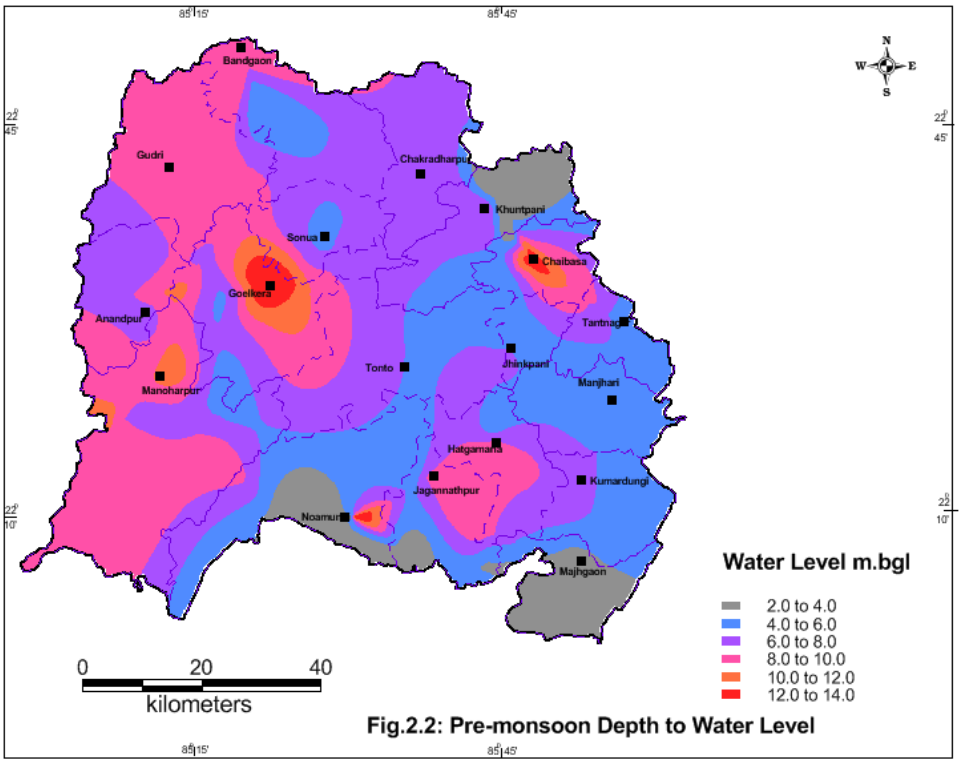


Fig.2.2: Pre-monsoon Depth to Water Level

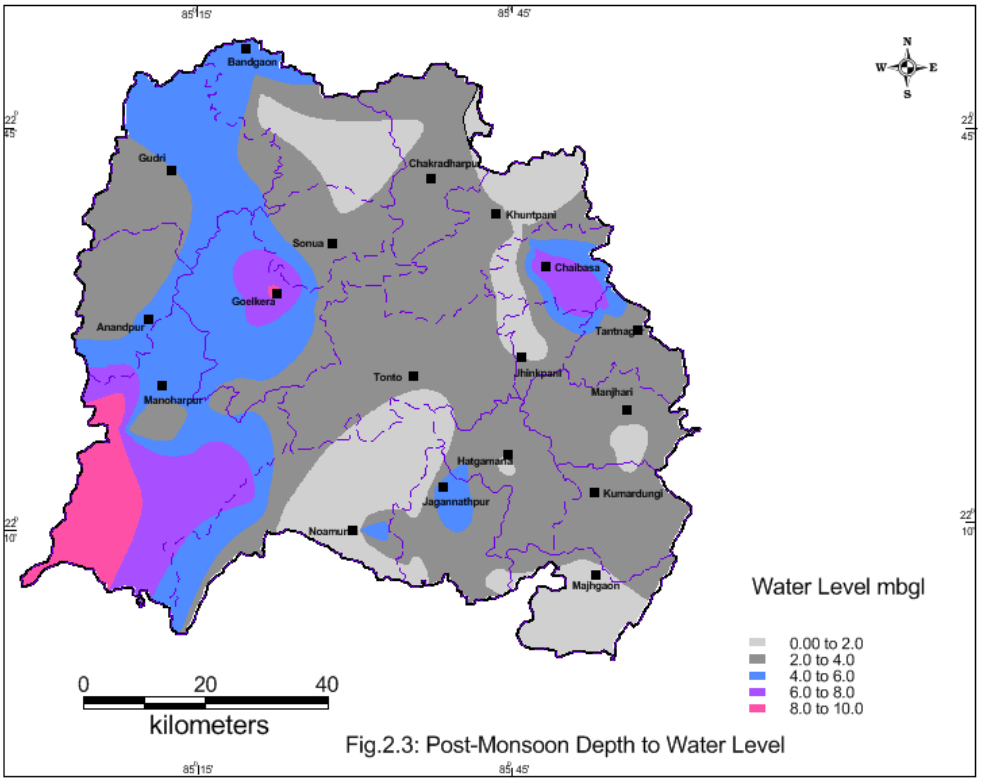


Fig.2.3: Post-Monsoon Depth to Water Level

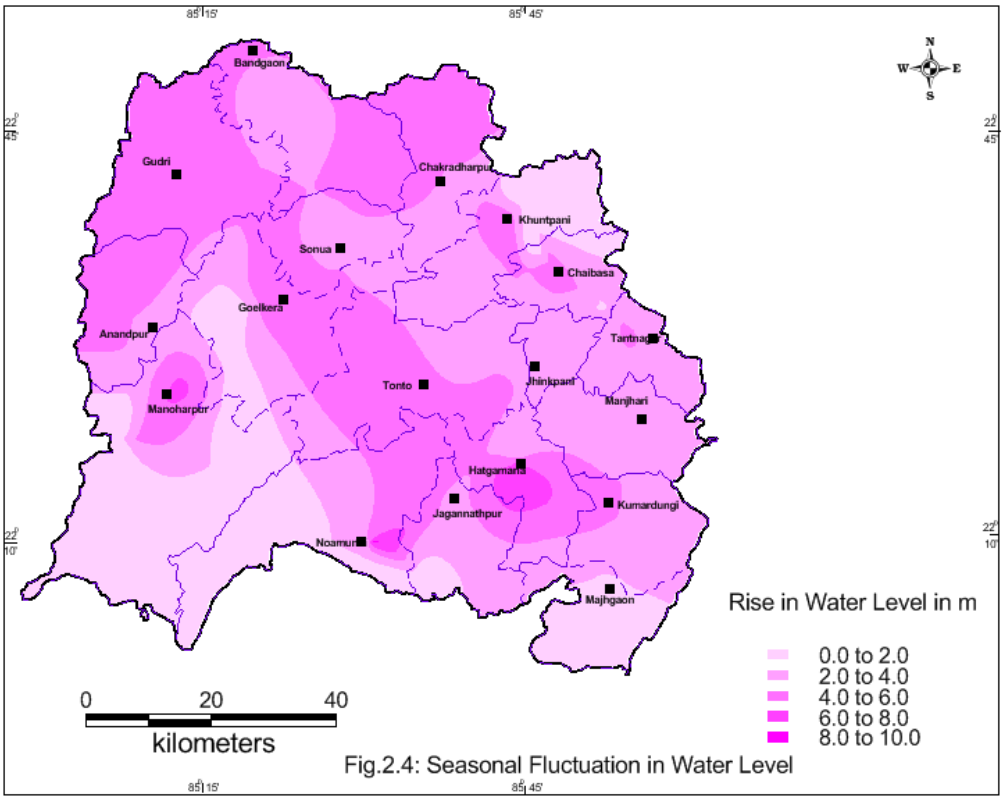


Fig.2.4: Seasonal Fluctuation in Water Level

2.2Groundwater Movement

Major part of the district presents an uneven and rugged topography. The aquifers are highly discontinuous and these discrete aquifers are not hydraulically connected. Water level contour map of the district has been prepared to give a rough picture of water table elevation (fig.2.5). Regional flow direction can not be established for the district.

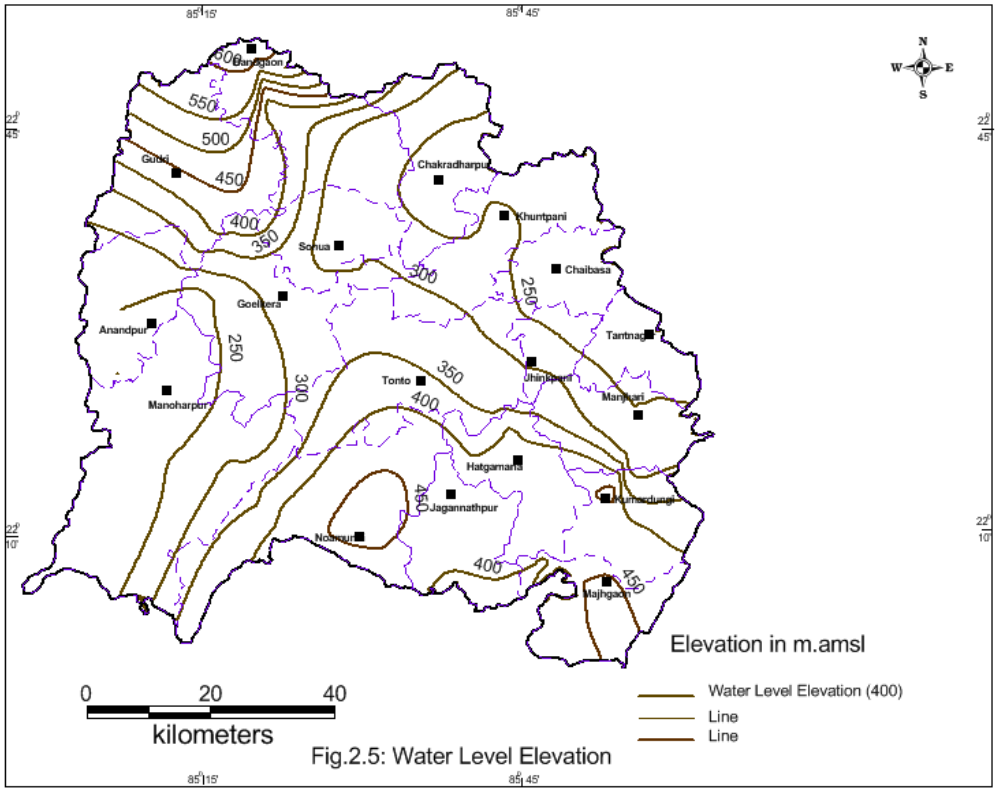


Fig.2.5: Water Level Elevation

2.3 HydrochemicalStudies

Groundwater samples were collected from Dugwells (phreatic aquifers) covering entire district. The samples were analysed for different chemical parameters. The result of the analysis is given in the table 2.2.

2.3.1 Ground Water Suitability for Various Uses:

All the analysed parameters, in all stations fall well within safe limits for drinking as well as irrigation purpose as prescribed by the BIS . The pH value ranges from 7.15 to 8.03 and is within the prescribed limit by BIS. The Electrical Conductivity (EC) value ranges from 103 to 1958 micro- siemens. All of the samples have EC value well within the range. The Cl^- varies from 7.1 mg/l to 309 mg/l. F^- concentration is zero in all samples. The Total dissolved solids(TDS) value ranges from 67 mg/l to 1171 mg/l. Almost all the values of the analysed parameters fall under the safe category for both drinking and irrigation purpose. The iso-conductivity map of phreatic aquifers of the district has been prepared and presented as Fig.2.7. The chloride &nitrate concentration in the study area is shown in Fig. 2.8 & 2.9.

The analysed results are presented in the form of piper tri-linear diagram in order to have an idea about similarity and difference in composition of the ground water in different geological and hydro geological environment. Fig.2.10shows the tri-linear plot of various chemical

parameters. From the figure it may be seen that the ground water in the area is of Ca-HCO_3 type and shows shallow, fresh groundwater in recharge area.

The sodium absorption ratio (SAR) is calculated and is plotted against EC value and is presented in Fig. 2.11as US salinity diagram. The SAR values indicate the degree to which irrigation water tends to enter into cation exchange reaction with soil. High value of SAR indicates a hazard of sodium replacing already absorbed Ca and Mg in the soil, which in turn leads to damaging soil structure. From the figure it may be seen the ground water is falling under medium to high salinity hazard zone.

The predominant USSL classes of the water samples fall within C2S1 and C3S1 classes. The water samples represent Ca-HCO_3type.

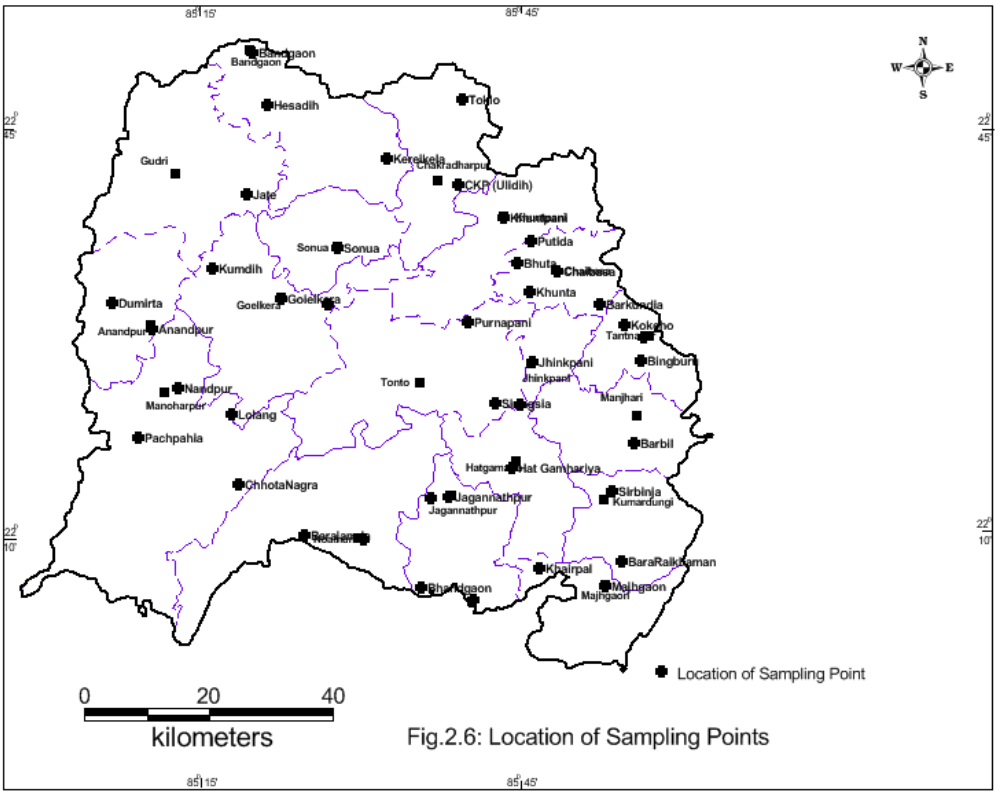


Fig.2.6: Location of Sampling Points

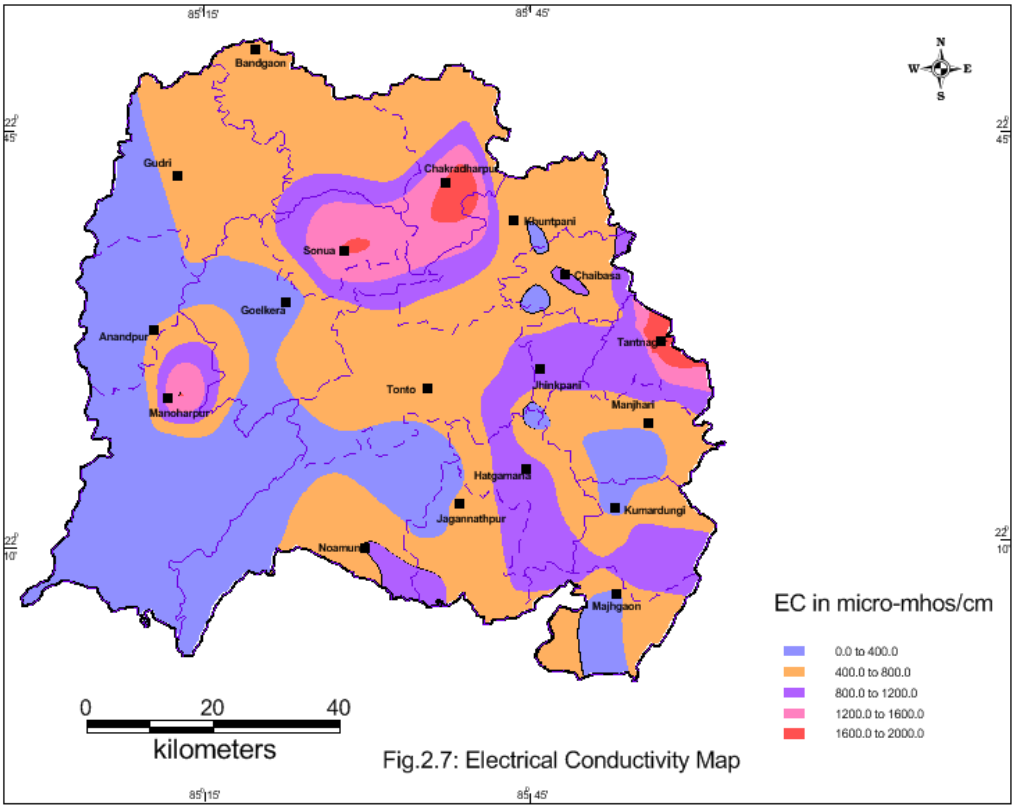


Fig.2.7: Electrical Conductivity Map

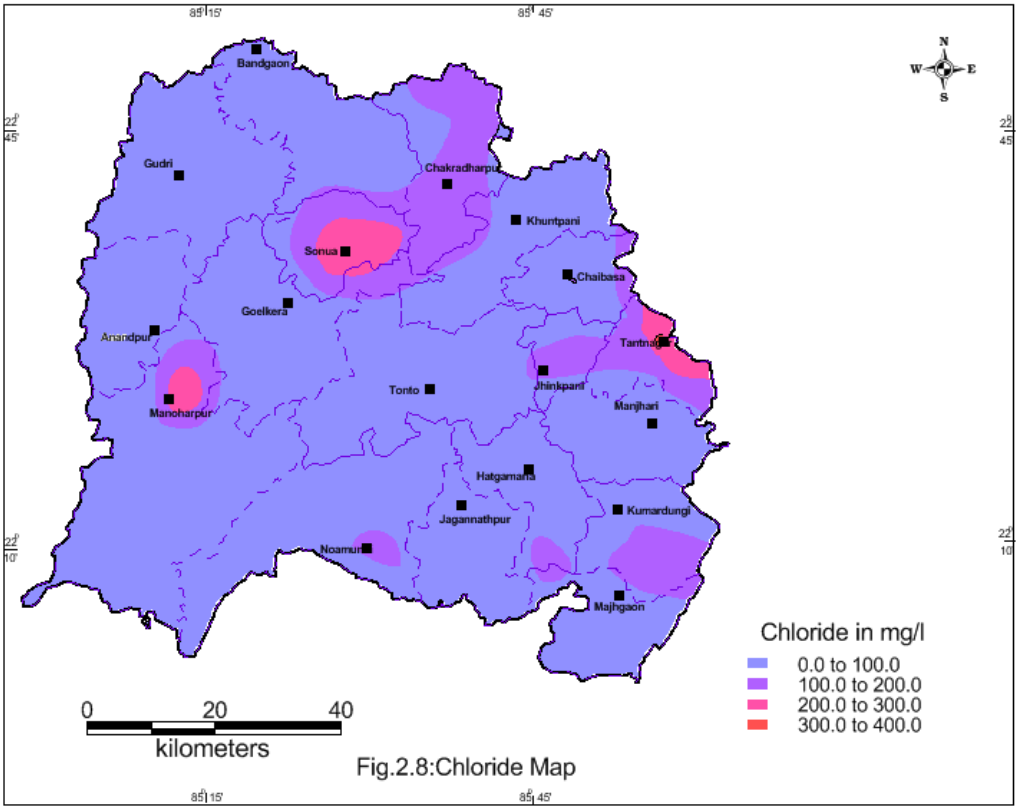


Fig.2.8:Chloride Map

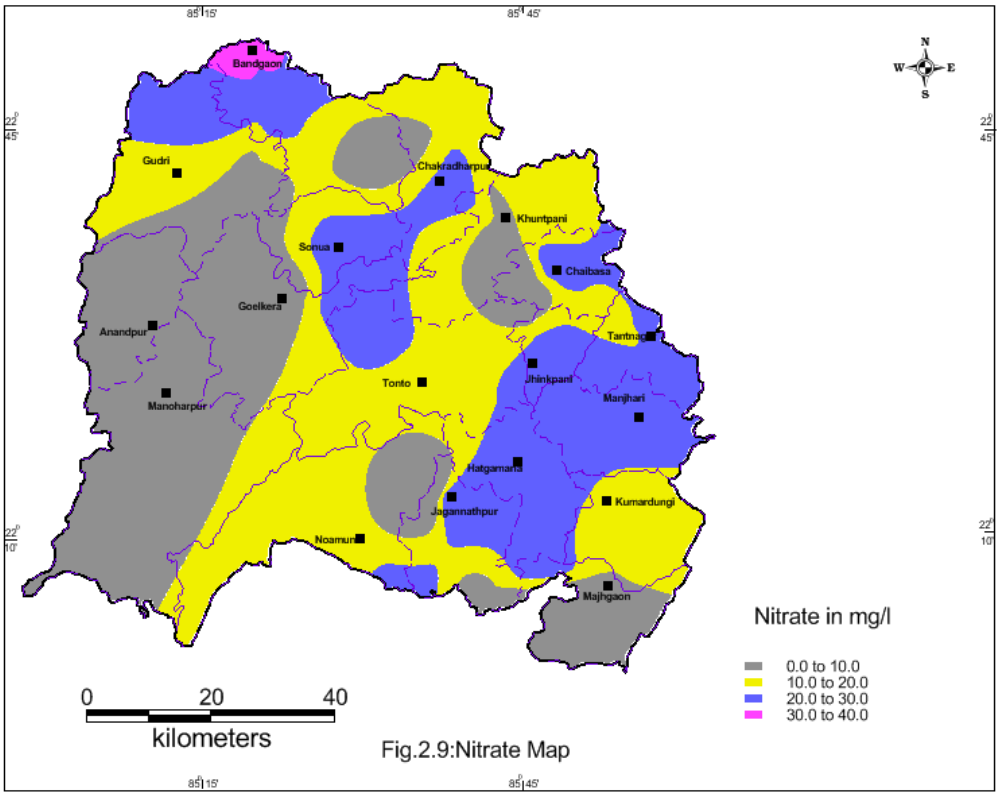
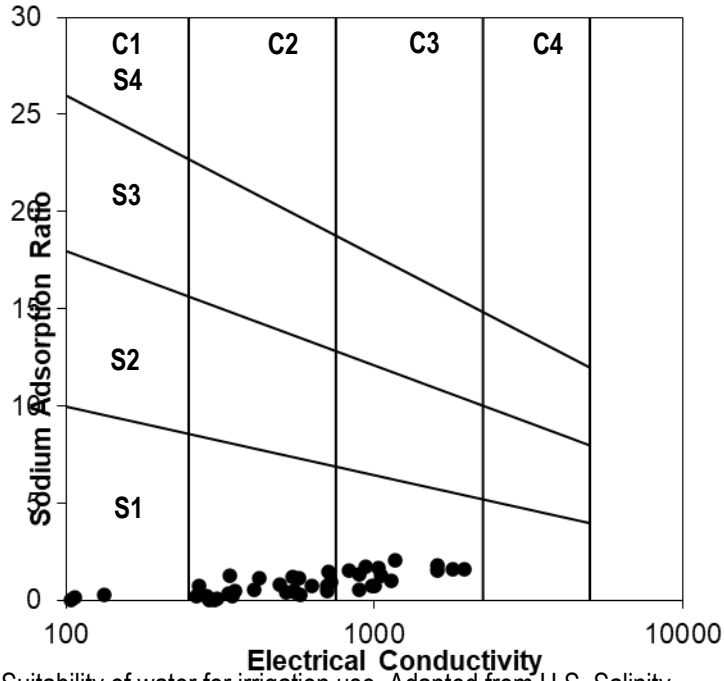


Fig.2.9:Nitrate Map



Suitability of water for irrigation use. Adapted from U.S. Salinity Laboratory Staff (1954).

S1, S2, S3 and **S4** are Low, Medium, High and Very High Sodium

Fig.2.10: US Salinity Plot

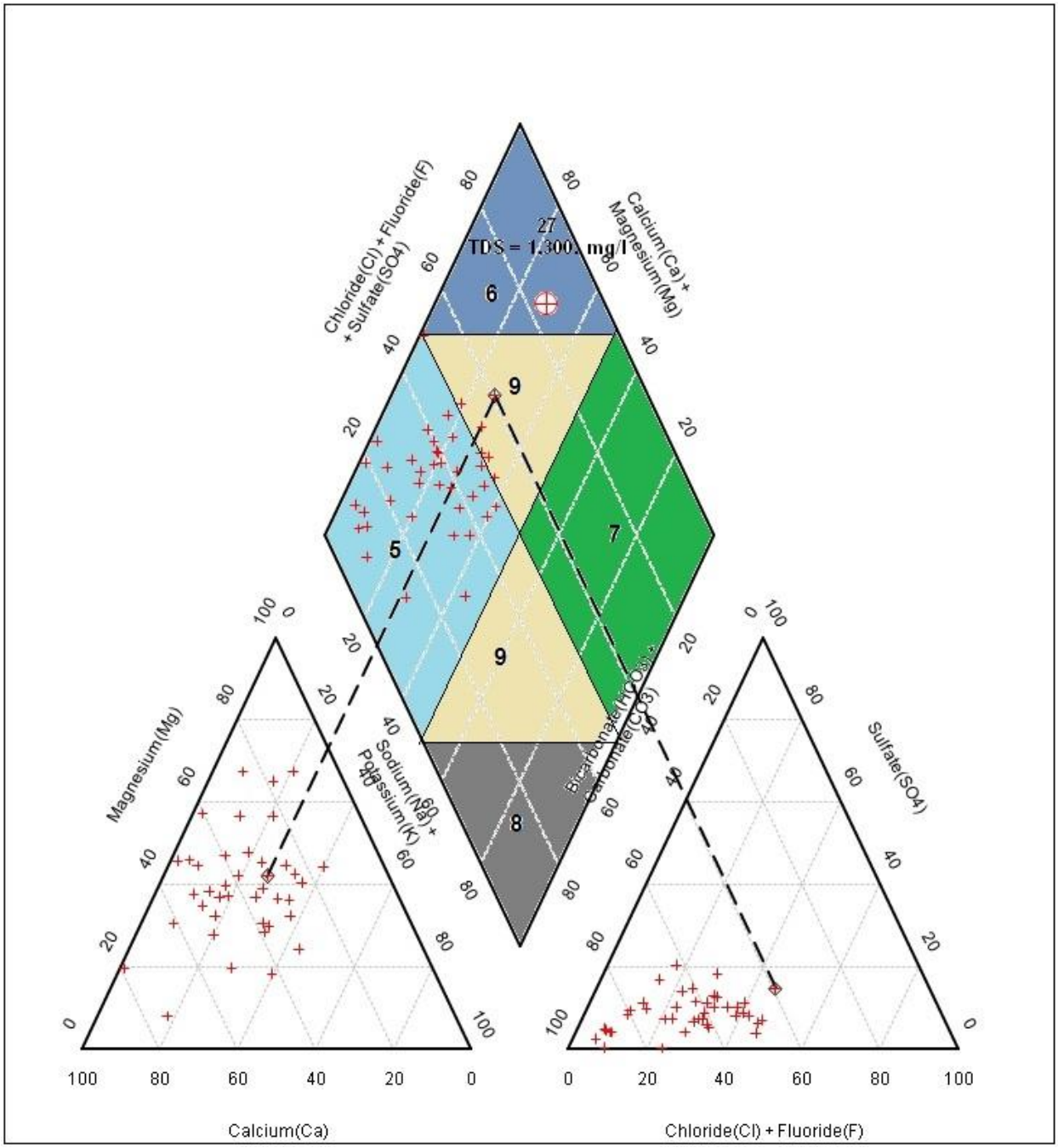


Fig.2.11: Tri-linear Plot of parameters

2.4 Geophysical Studies

Geophysical survey was carried out in 11 blocks of the district. The district is mainly occupied by schist, quartzite, phyllite, granite and patches of basalts (Dalma Lava and Dhanjori Lava). It also encompasses the extreme western part of Singhbhum Shear Zone. A total of 47 VES were carried out in 11 blocks of West Singhbhum district (Figure 2.12).

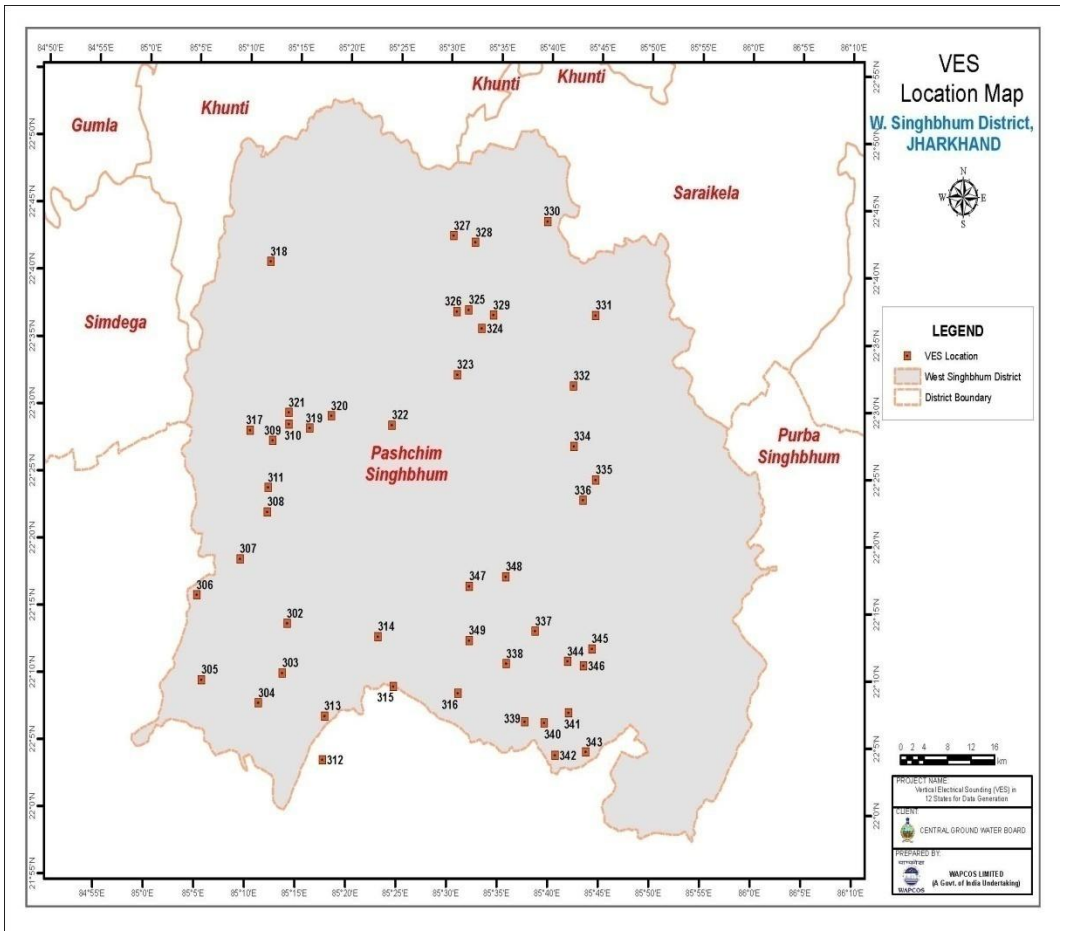


Fig.2.12: Map of West Singhbhum district showing VES location

Interpreted Results of VES

Interpretation of VES are given in Annexure-4. The geo-electrical characteristics of the weathered and semi-weathered zones are given in Table2.3. Based on the results of 47 VES conducted, it can be said that in West Singhbhum district, the weathered zone extends maximum up to 48 m depth and generally within 15 m depth . The resistivity of the weathered zone ranges from 6 to 74 ohm.m. At two sites (VES 323 and VES 331) a highly conductive (about 1 ohm.m resistivity) thick layer is delineated under a 19-24 m thick resistive capping . It extends to depths beyond 100 m. The highly conductive layer could be the carbonaceous shale.

The semi-weathered zone (less compact formation) or a lithounit of moderately higher resistivity extends to a maximum depth of 107 m at VES 312. The resistivity of semi-weathered zone varies from 87 to 275 ohm.m. The fractured zones have been delineated empirically.

Recommendations

On the basis of the interpreted results of the 47 VES conducted in West Singhbhum district, Jharkhand the sites recommended for drilling are given below (Table 2.3).

Table 2.3: The VES sites in West Singhbhum district

VES No.	Weathered zone		Semi weathered zone		Probable occurrences of thin fractured zones in the depth range (m)
	Resistivity (ohm.m)	Depth to the Bottom (m)	Resistivity (ohm.m)	Depth to the Bottom (m)	
303	NA	NA	110 90	8 119	30-45, 95-120
307	NA	NA	132 119	9 45	20-30, 40-45, 50-55, 75-80, 110-160
309	NA	NA	87	29	45-50, 65-70, 110-120, 140-160
313	NA	NA	91	18-52	75-80
315	61	16-64	NA	NA	65-70, 90-95, 150-160
316	50	48	NA	NA	45-55, 75-80, 140-150
325	11	6	91	6-39	40-45, 55-60, 100-120, 160-170
329	52	43	NA	NA	35-40, 45-70, 90-95
330	11 58	6 24	NA	NA	25-30, 35-40, 100-110,
332	31	6	166	6-43	15-35, 45-50, 65-70, 100-110, 130-140
336	NA	NA	178	93	75-80, 130-140
340	59	22	NA	NA	40-50, 70-75
342	10 28	6 25	NA	NA	35-40, 45-50, 120-130
343	6 31	8 19	NA	NA	35-45, 65-70, 85-90, 120-130
345	21	4	208	76	100-120, 150-160
349	NA	NA	57	70	95-100

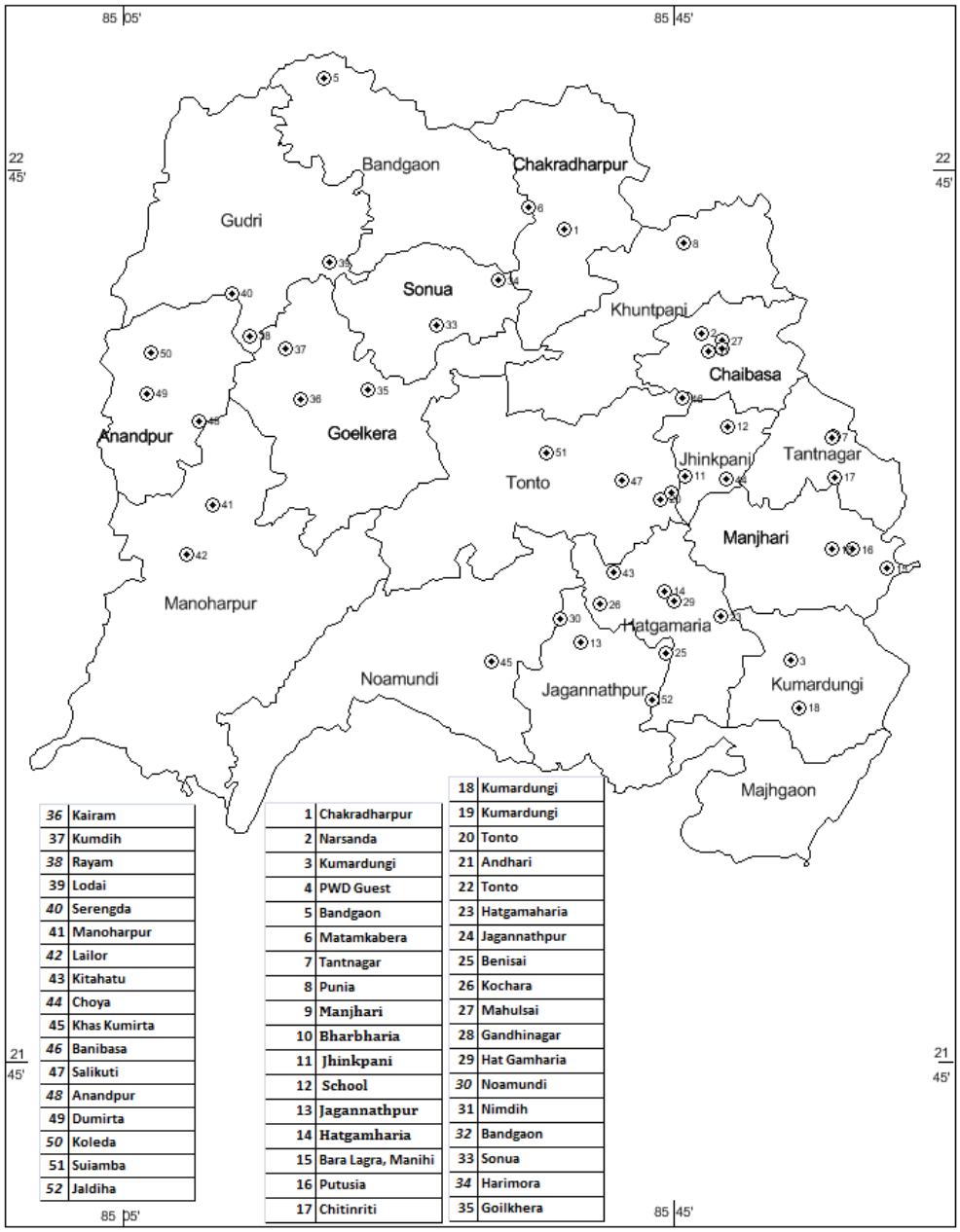
2.5 Exploratory drilling

A total number of 26 exploratory wells, 12 observation wells and 2 piezometers were drilled by CGWB till 2018-19. Most of the wells were drilled in Granitic terrain either in Singhbhum Granite or Chakradharpur Granite.The bore hole drilled by CGWB ranged from 100 to 209 m depth, with yield of wells varies from negligible to maximum discharge of 44 m^3/hr. Two wells drilled in meta-sediments within the depth range of 153m yielded 9 to 16m3/hr. The hydrogeological detail of exploratory is given in Annexure 3.

During the period 2005-06 and 2012-13 , 8 wells were drilled through outsourcing. Out of these 8 wells one well at Harimora drilled in Up. Boanai Group produced yield of 44m^3/hr.

During AAP 2019-20 and 2020-21 a total number of 18 exploratory wells and 3 observation wells were drilled in various geological formations. The wells were in the depth range between 80 and 201m. The details of the exploratory drilling is presented in 2.

Fig 2.13 ;Location of Exploratory Wells in West Singhbhum District



36	Kairam
37	Kumdih
38	Rayam
39	Lodai
40	Serengda
41	Manoharpur
42	Lailor
43	Kitahatu
44	Choya
45	Khas Kumirta
46	Banibasa
47	Salikuti
48	Anandpur
49	Dumirta
50	Koleda
51	Suiamba
52	Jaldiha

1	Chakradharpur
2	Narsanda
3	Kumardungi
4	PWD Guest
5	Bandgaon
6	Matamkabera
7	Tantnagar
8	Punia
9	Manjhari
10	Bharbharia
11	Jhinkpani
12	School
13	Jagannathpur
14	Hatgamharia
15	Bara Lagra, Manihi
16	Putusia
17	Chitinriti

18	Kumardungi
19	Kumardungi
20	Tonto
21	Andhari
22	Tonto
23	Hatgamaharia
24	Jagannathpur
25	Benisai
26	Kochara
27	Mahulsai
28	Gandhinagar
29	Hat Gamharia
30	Noamundi
31	Nimdih
32	Bandgaon
33	Sonua
34	Harimora
35	Goilkhera

3.0 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAP

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, ground water quality, 2-D and 3-D sub-surface disposition of aquifers by drawing fence and lithological sections, yield potential, were generated and as discussed in details

Hydrogeology

The entire West Singhbhum district is covered with hard rocks. The hydrogeology of area depends upon the lithology (rock types). Nature of weathering and hence development of secondary porosity and disposition of fractures depend mainly upon the rock types. Hydrogeology varies from rocks to rocks. Hydrogeology of individual rock or group of rocks is described below.

The entire rocks can be put broadly in to four categories i.e. Crystalline, semi-consolidated clastic sediments, Volcano-sedimentary or meta-sediments and volcanics.

3.1Crystalline Aquifers

Singhbhum Granite and Chakradharpur Granite constitute the crystalline rocks in recognition of their origin from crystallisation of magmas. Granites cover around 1948 sq.km area (26.5% of the district) in the south-eastern part of the district in Jagannathpur, Hatgamaria, Majgaon, Kumardungi, Chaibasa, Tonto, Tantnagar and Manjhari blocks and in the north in Chakradharpur block. Petrographically, Singhbhum granites are biotite granodiorite grading to adamellitic granite; rarely the granodiorite grades to trondhjemite. Xenoliths of older tonalitic gneisses, migmatites and mafic-ultramafic rocks are common within the Singhbhum Granite.A set of dyke swarm, known as Newer Dolerite is present within the Singhbhum Granite but absent in Chakradharpur granite. The dominant trend of the dykes within the Singhbhum Granite is NNE-SSW to NE-SW; subsidiary trends are NW-SE and E-W. The most common rock type is quartz dolerite with local occurrences of norite.

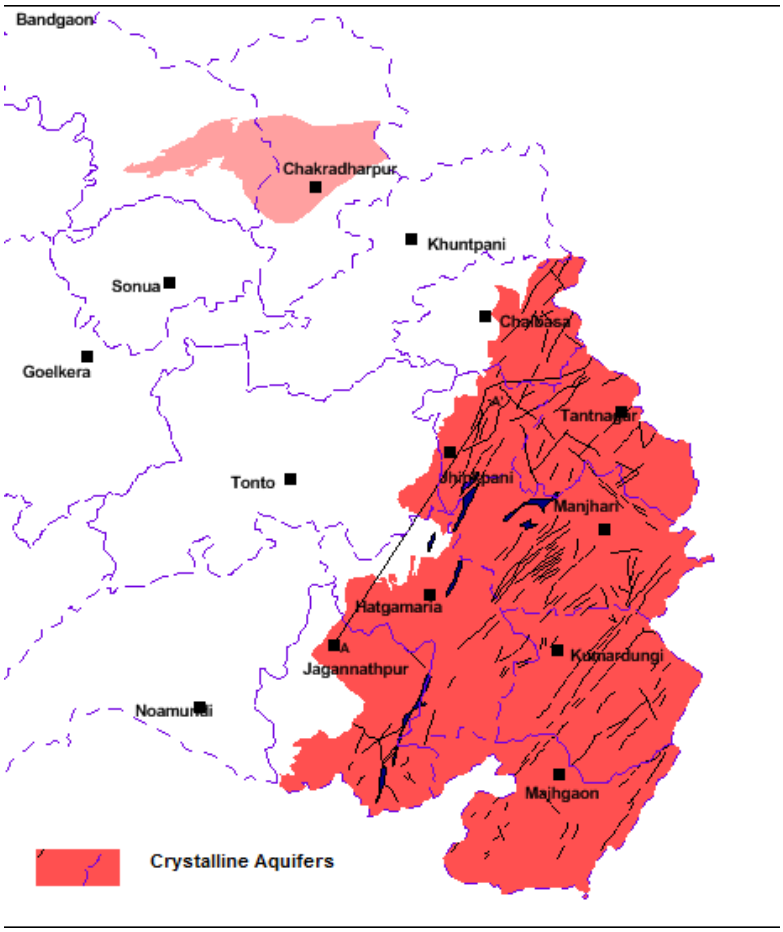


Fig. 3.1:Crystalline Aquifers in West Singhbhum

3.1.1 Aquifer-I

CGWB has drilled 27 exploratory wells and 12 observation wells in the terrain with max drilled depth upto 210m. On the basis of exploration, it has been observed that ground water occurs under phreatic conditions on the top weathered zone. Sandy clays, clayey sand, massive clayey alterites (kaolinitic) with stable primary minerals constitute the weathered zone. The weathered zone has high porosity and low permeability. The depth of weathering varies between 12 to 20 m in Singhbhum Granite and 16m to 24m in Chakradharpur Granite. Exceptionally high depth of weathered zone has been observed at Jaldiha in Jagannathpur block. The weathered zone is a source of water for dug wells and shallow handpumps. The yield of dugwells tapping the weathered zone varies between few cub m to 10m^3/day.

3.1.2 Aquifer-II

Groundwater occurs under confined to semi-confined conditions in deep fractures in massive granites. Persistence of fractures in wells is quite irregular in space and frequency and width of fractures decreases with depth. Productive fractures are common within a depth of 45m, less frequent up to a depth range of 45m to 100m. Deep fractures have been encountered in few wells at Chakradharpur (177-180m), Hatgamaria (114-115m,120-121m) and Kumardungi (107-109m, 111-112m). In none of the wells fractures have been encountered beyond 180m depth. The table.3.1 shows the disposition of few productive well in granitic terrain.

Table 3.1: Exploratory wells in crystalline aquifers

Sl No	Location	Block	Co-ordinate	Depth Drilled m	Length of Casing pipe m	Granular Zone / fracture Tapped m	Static Water level m bgl.	Discharge m^3/hr	Drawdown m
1	Chakradharpur E.W.	Chakradharpur	$22^0$41'00" $85^0$37'00"	209.42	11.5	12.61-25.61 176.94-179.94	6.93	4.3	34.46
	OW_1			99.81	12.6	14.00-23.00 33.32-035.47	6.9	30.6	17.85
	OW_2			107.43	8.1	08.00-023.60	-	-	-
2	Kumardungi EW	Kumardungi	$22^0$12'00" $85^0$53'30"	113	9.75	107-109	8.04	11.3	2.58
	OW 1				16.5	111-112	9.07		1.58
	OW 2				17.5	97-98	9.08		2.58
3	Matamkabera	Bandgaon	$22^0$42'28.8" $85^0$34'22.8"	196.6	25.5	28.5-29.1 181-182	9.6	1.62	
4	Manjhari High School(EW)	Manjhari	$22^0$27'00" $85^0$56'29.76"	153.8	24.0	30.0-30.5 39.0-40.0	9.0	7.92	
	OW			100.4	24.30	30.0-30.5 39.0-39.5	9.0	7.92	
5	BharbhariaTasar Kendra	Manjhari		153.8	16.0	20.0-20.5	8.0	7.38	
6	J.N.V.CampusJhinkpani (EW)	Jhinkpani	$22^0$24'25.2" $85^0$45'46.8"	153.8	16.5	31.5-32 77.6-78.5	14.2	12.24	
	OW			153.8	18.5	31.0-31.5 73.6-74.5	13.5	6.48	
7	Asura High School (EW)	Jhinkpani	$22^0$27'45" $85^0$48'52.92"	153.8	09.02	43.1-44.0		1.62	
8	Jagannathpur (Rassel school)	Jagannathpur	$22^0$13'12" $85^0$38'13.2"	153.8	18.5	20.0-20.		2.796	
9	Putusia	Manjhari	$22^0$19'29"	153.8	10.5	88.84-89		negligi	

Sl No	Location	Block	Co-ordinate	Depth Drilled m	Length of Casing pipe m	Granular Zone / fracture Tapped m	Static Water level m bgl.	Discharge m^3/hr	Drawdown m
			$85^0$57'57"					ble	
10	Chitinriti	Tantnagar	$22^0$24'21" $85^0$56'36"	100.46	21.35	24.26-27.88		25.56	
	OW			100.46	16.63	24.26-31.88		25.56	
11	Kumardungi	Kumardungi	$22^0$08'51" $85^0$54'03"	123	11.25	24-24.5		1.60	
12	Tonto	Tonto	$22^0$22'52" $85^0$43'58"	153.8	24.1	42.12-43.0		2.88	
13	Andhari	Kumardungi	$22^0$08'51" $85^0$54'03"	43.7	24.1	43.12-45		44.28	
	OW			43.70	24.1	43.12-45		44.28	
14	Tonto	Tonto	$22^0$23'17" $85^0$44'49"	153.8	13.5	30.0-31.0 73.60-74.0		4.32	
15	Hatgamaharia	Hatgamaharia	$22^0$14'57" $85^0$48'25"	147.40	26	25.0-25.5,47.0-47.5 114-115,120-121		16.20	
	OW			147.4	25.5	25.0-25.5,47-47.5 114-115,120-121		16.20	
16	Jagannathpur	Jagannathpur	$22^0$14'57" $85^0$48'25"	153.8	18.3	20.26-24.26 35.50-39.50		16.20	
	OW			54.47	18	20.26-24.26 35.50-39.50		6.48	

3.1.3:Aquifer Properties

Crystalline rocks show lots of variation in aquifer properties. The most productivity zones lie within a depth of 45m and with depth discharge of wells reduces with deeper fractures. Percentage of successful wells is more in granitic terrain than other rocks in the district. The discharge of well varies from negligible to 44.28 m^3/hr. The table 3.2 shows the aquifer properties.

Table 3.2: Aquifer Parameters of crystalline aquifers

	Discharge (m^3/hr)	Transmissivity (T) m^2/day	Storativity
Aquifer-II	Negligible-44.28	2-67	$5.6x10^{-1}$ -

3.1.4 Groundwater Quality

Groundwater quality of phreatic aquifer is fresh and all the parameters (analyzed) fall well within the permissible limit. Water is of Ca-HCO3 type and shows shallow, fresh groundwater in recharge area.

3.1.5 Disposition of Aquifers

Section Along A-A'

Section along A-A'(shown in fig.3.1) has been prepared and shown in fig.3.2. The fig shows that Kolhan Sandstone and shale have been deposited on the basement of Older Metamorphic Group and the Singhbhum Granite. Deep fractures exist in the middle of the section at Tonto.

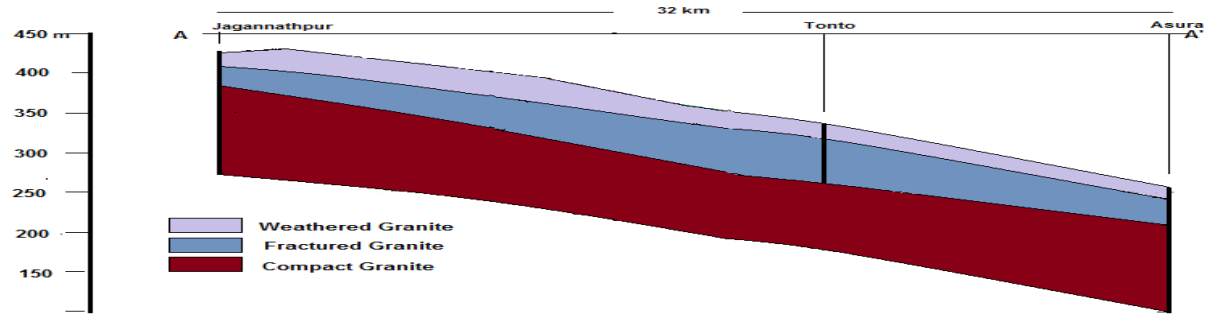


Fig.3.2: Section along Jagannathpur-Asura

3-D Disposition of Aquifers

The fig 3.3 shows the three dimensional disposition of weathered and fractured crystalline aquifers. The thickness of fractured aquifer is more in the east than the west but the thickness of weathered zone is reverse more in the west. Fractures exist at depth of 109m (Kumardungi) and 89m (Putusia).

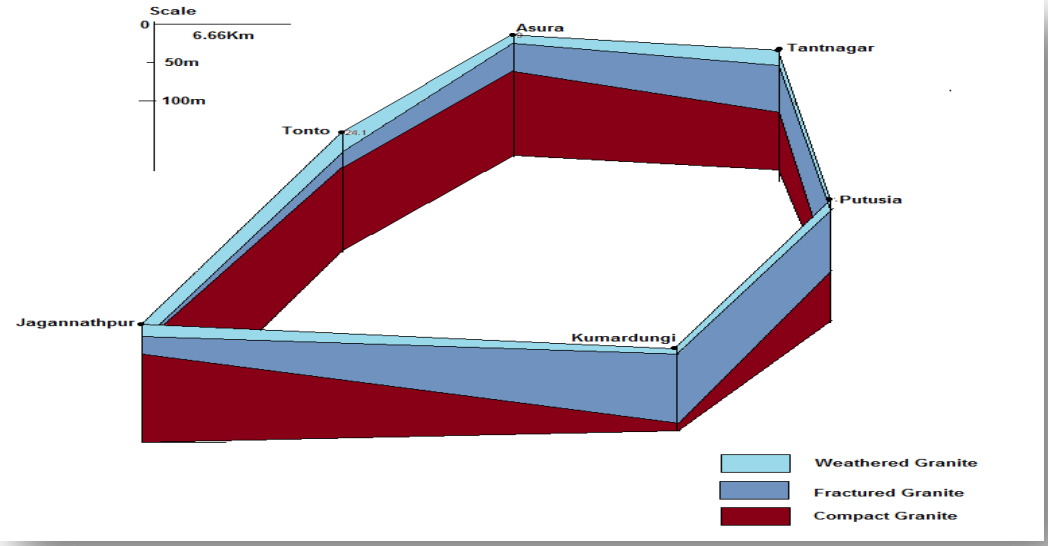


Fig.3.3: 3-D disposition of Aquifers

3.2 Volcano-Sedimentary (or Meta-Sediments) Aquifers

Lower & Upper Bonai and Singhbhum Group of rocks constitute the volcano-sedimentary rocks,derived from the alternation and combination of volcanic and sedimentary events and latter some rocks have been metamorphosed. The rocks include Iron Ore,Banded Haematite Quartzite, Quartzite,Manganeferous Shale, Phyllite, Shale, mica schist, quartzite,tuffaceous rocks, Sandstone,Basic volcanic rocks(sheared) with psmmopelite,Conglomerate with sandstone/quartzite, Metabasic rocks,chlorite phyllite/chlorite schist/muscovite schist,Mica schist with Hb schist, tuff, tuffaceous psammopelite, quartzite & chert, Phyllite/carbon phyllite, limestone(dolomitic),calc-schist and at places with intrusive. The group occupy more than 50% of the area in the district.

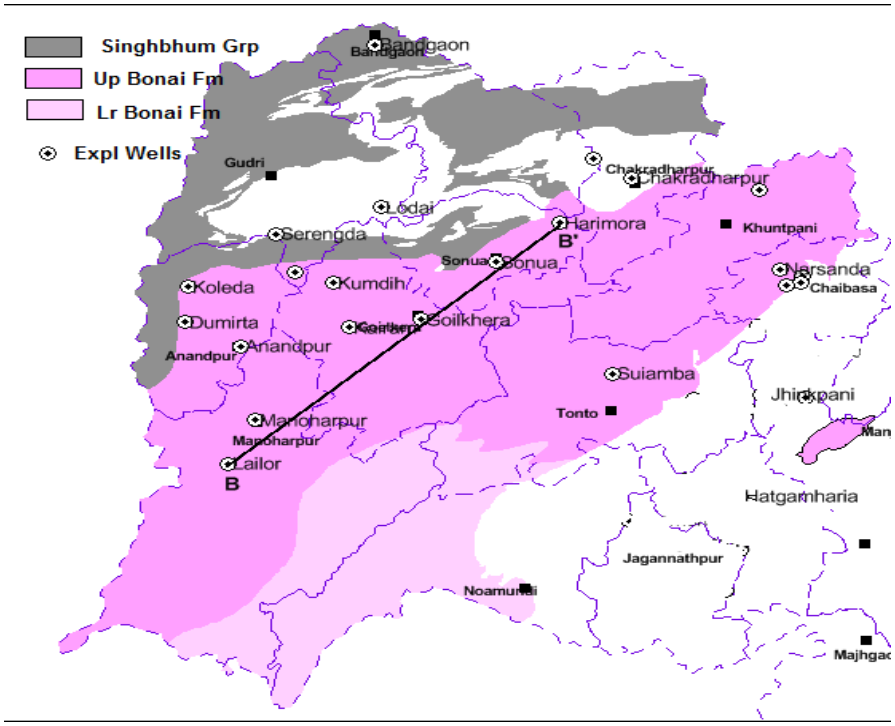


Fig. 3.4: Volcano-sedimentary Aquifer

3.2.1 Aquifer-I

Groundwater occurs under phreatic conditions in porosity both primary and secondary. Primary porosity developed due to unconsolidated nature of sediments i.e. in friable iron ore formations and in valley fills and in secondary porosity due to weathering of country rocks. Depth of phreatic aquifer is in the depth range of 10m to 30m but extend beyond that i.e. in Goelkera it is 64m. The phreatic aquifer sustains dugwells and shallow handpumps.

3.2.2 Aquifer-II

Groundwater occurs under confined conditions in deep-seated rocks involved in faulting and folding. Faulting and folding develop joints and fractures which contribute to secondary porosity and permeability.12 numbers of exploratory wells were drilled in Up Bonai Group and 1 in Singbhum Group with a maximum depth of 200m. The table below shows the disposition of fractures. Fractures are found in the depth range of 14m to 167m. Successful wells with high yield were found in shale and phyllite.

Table 3.3: Disposition of fractures in volcano-sedimentary aquifers

Sl. No.	Location	Block	Depth Drilled	Casing Depth/Dia.	Fractures encountered	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Drawdown	Formation
			m	m/mm	m	mbgl.	m^3/hr	m^3/hr	m	
1	Bandgaon	Bandgaon	200.0	15.25			Dry			Singhbhum Grp
2	Sonua	Sonua	200.0	24.45			3.6			Up Bonai Group
3	Harimora	Sonua	200.0	32.6	32-33.2 56.2-58.2 100.2-101.2		44.28			Up Bonai Group
	OW		200.0	30.2	36.45-37.5 59.2-60.2 104.5-105.5		14.40			Up Bonai Group
4	Goilkhera	Goilkhera	201	37.60	43.0-44.5 52.0-54.0 59.0-60.5 91.0-92.0	23.70	17.28	18	11.68	Shale/phy
	OW	Goilkhera	201	63.52	79.2-79.7 81.6-81.9	24.17	17.28		5.56	Shale/phy
5	Kairam	Goilkhera	201	11.69	14.0-15.0 32.9-33.3	7.8	5.184	7.2	12	Shale/phy
6	Kumdih	Goilkhera	201	21.14	25.0-26.0	5.06	7.74	8.28	10.34	Shale/phy
7	Rayam	Gudri	201	14.74	16.0-16.5 17.5-18.1 22.0-22.5 78.0-79.0	3.31	5.184	7.416	18.53	Shale/phy
8	Manoharpur	Manoharpur	201	15.04	42.0-44.0	9.90	1.548			Shale/phy
9	Lailor	Manoharpur	201	8.64	25.6-26.2	12.22	15.912	18	25.43	Shale/phy
	OW	Manoharpur	127	15.04	54.9-55.3	9.70	43.884		6.19	Shale/phy
10	Anandpur	Anandpur	201	11.39	NIL		0			Shale/phy
11	Dumirta	Anandpur	201	27.24	166.0-167.0	2.49	1.548			Shale/phy
12	Koleda	Anandpur	201	24.8	50.0-50.5 99.0-100.0	9.94	0			Shale/phy
13	Suiamba	Tonto	120	11.39			0			Shale/phy

The yield of well varies between negligible to 44.28 m3/hr. The transmissivity ranges between 6.66 and 102.87m2/day. The storativity ranges between $1.7x10^{-5}$ to $1.97x10^{-5}$.

3.2.3 Disposition of Aquifers

Section Along Lailor-Goilkera-Harimora(BB')

The fig 3.5 shows the section along Lailor-Goilkera-Harimora, the most productive fractured aquifer system. The thickness of fractured aquifer at Lailor is less than at other locations but the well yield was high (16m^3/hr in EW & 44 m^3/hr in OW).The high discharge may be due to its topographical advantage, on the foothill adjoining to a valley fill and may be the fracture system is connected to productive/high storage valley fill. The yield of well at Goilkera was 17 m^3/hr and for Harimora it was 44 m^3/hr. The high yield at Harimora is due to existence of multiple fractures.

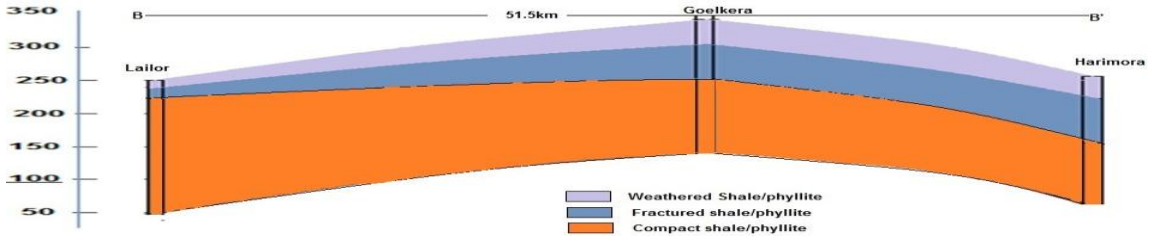


Fig.3.5: Section along Lailor-Goilkera-Harimora

3-D Disposition of Aquifers

The fig 3.6 shows the three dimensional disposition of aquifers. Except wells along the section Lailor-Goilkera-Harimora, the other sections are not so much productive aquifers. In those sections yield of wells ranges between nil to 3 to 5 m^3/hr. The well at Suimba has no fractured aquifer upto drilled depth of 120m.

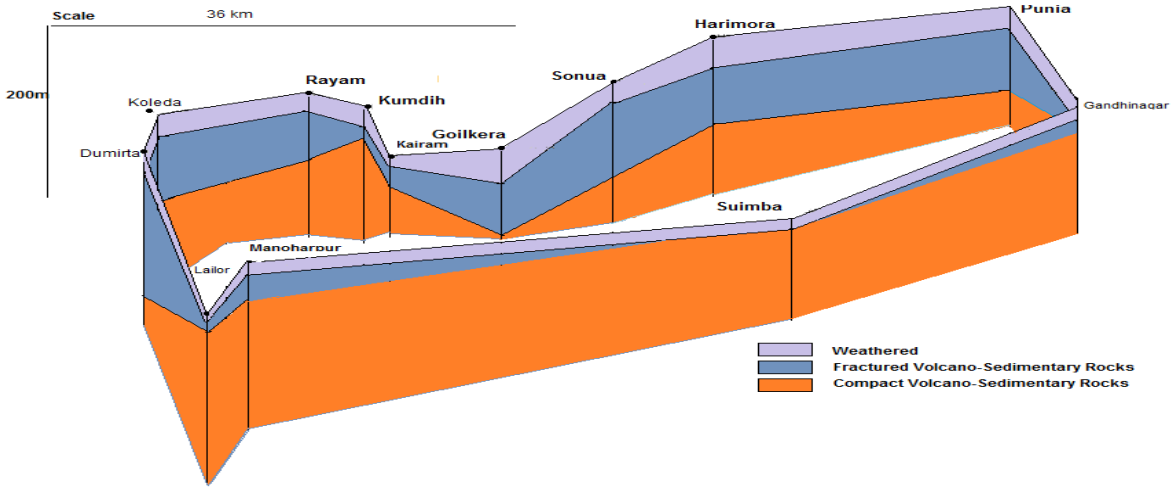


Fig.3.6: 3-D Disposition of Aquifers

3.3 Semi-Consolidated Clastic Sediments(Sedimentary Aquifer)

The Kolhan Group of formations are semi-consolidated and covers around 500 sq.km area in Noamundi, Jagannathpur, Tonto, Jhinkpani and Chaibasa blocks. The Kolhan Group is classified into three Formations. These include the basal Mungra Sandstone Fm., the Jhinkpani Limestone Fm and the Jetia Shale Fm. The Mungra Fm has a maximum thickness of 25m and comprises a conglomeratic and sandstone facies, the latter, in places overlapping on to the basement rocks on the east and also forming several small outliers. The Jhinkpani Fm. Overlies the Mungra Fm and has a maximum thickness of some 20m. The Jhinkpani Fm., in general is divisible into a lower limestone and an upper calcareous shale facies, the contacts being transitional. The limestone facies is divisible into a lower grey and an upper purple limestone and becomes more silicious laterally. In Chaibasa area the limestone contains manganese nodules. This formation passes upwards into the topmost Jetia Shale Fm., in which three facies with gradational boundaries have been identified, comprising a purple shale, calcareous shale and limestone. The Jetia shale Fm.may have a thickness exceeding 200m. The source of sediments of the Kolhans seems to be from both the east and SW and the inputs from the Iron-Ore Formation of the SW is as high as 30% in places.

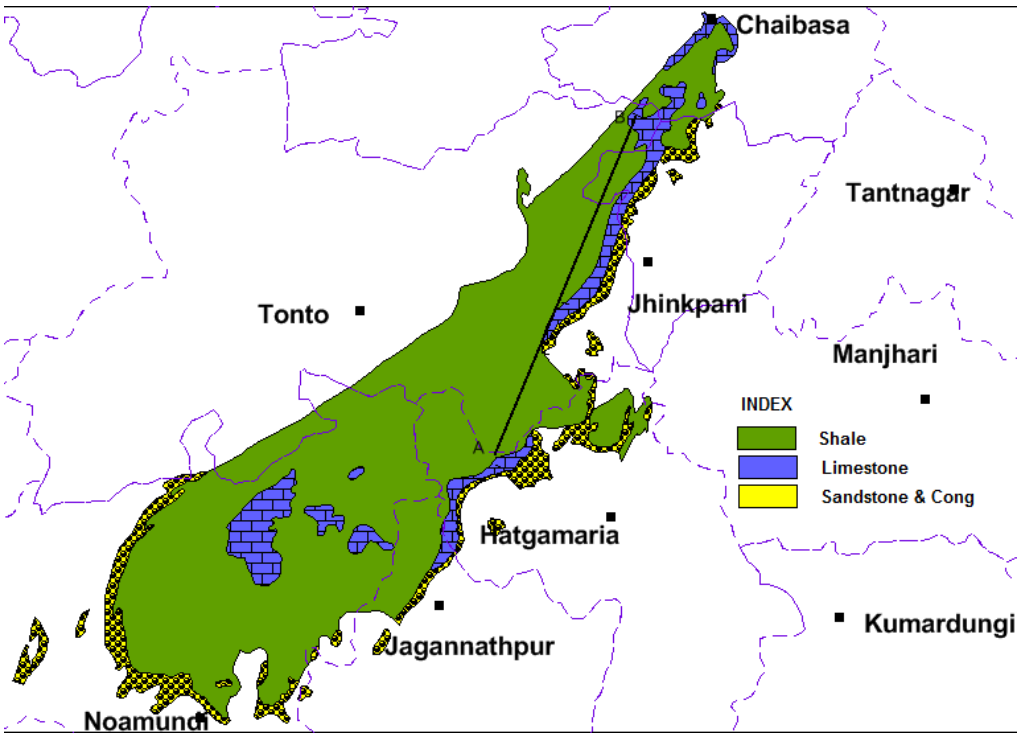


Fig.3.7:Kolhan Group in West Singhbhum district

3.3.1 Aquifer-I

Kolhans constitute a very poor phreatic aquifer system except the area where limestone and sandstone are exposed. Shale is in semi-consolidated form. The vertical hydraulic conductivity is almost negligible. Due to sheet joints/foliated (fissile) nature of shale (upto few meters from surface) , there developed a horizontal hydraulic conductivity and there is seepage of water horizontally which feeds dugwells and shallow handpumps. With increase depth, compaction is more and there is a reduction both in porosity and permeability. Top layer up to depth of around 15m, water occurs under phreatic conditions. The shale zone does sustain borewells. Limestone and sandstone which are in-persistent and exposed in isolated patches form good phreatic aquifer system.

3.3.2 Aquifer-II

Sandstone and conglomerate zone below shale forms good aquifer system. Groundwater occurs under confined conditions. CGWB has drilled one bore well at village Banebasa. The sandstone and conglomerate zone was encountered at 70m below ground level. The well has a very high discharge of 64.5m^3/hr (with compressor) and 21.96 m^3/hr with pump with 10m drawdown. The transmissivity of the aquifer was calculated to be 182.3 m^2/day.

3.3.3 Aquifer disposition

The fig 3.8 shows the disposition of sedimentary aquifer system along Kitahatu-Bamebasa villages. A well was drilled at Kitahatu with DTH methods. Drilling beyond 85m was not possible with DTH methods, a combination drilling methods was required. Kolhan shale, unproductive was encountered throughout. There is no drilling data on Limestone and sandstone. But both constitute productive aquifer systems. Well drilled at Bamebasa encountered productive Kolhan sandstone and conglomerate at 70m.

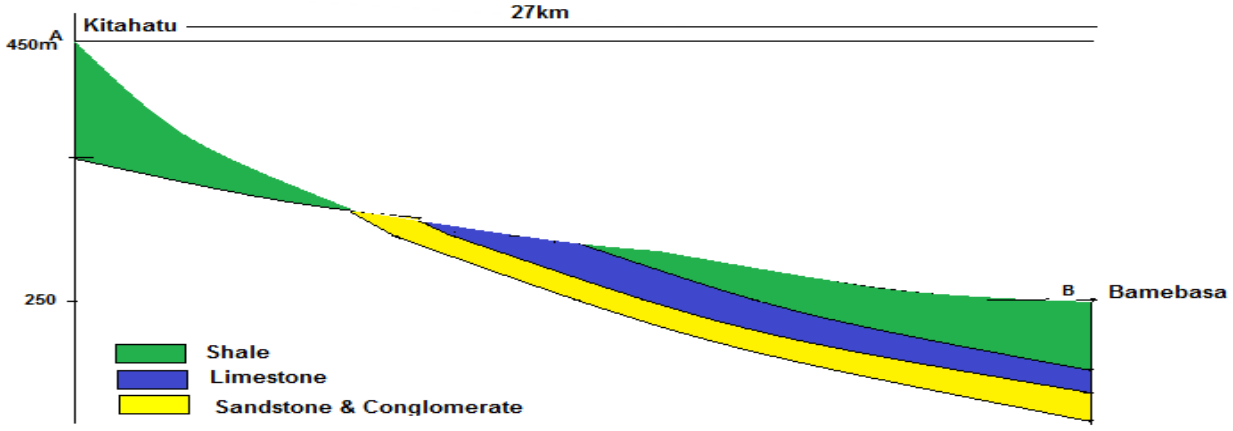


Fig.3.8: Section along Kitahatu-Bamebasa

3.4 Volcanic Aquifers

Dalma volcanic, Dangoaposi lava and Ongarbira traps constitute the volcanics in the district. Volcanics occurs in area in patches in Noamundi, Jagannathpur, Gudri, Bandgaon, Chakradharpur, Sonuaand Tonto blocks and cover around 700 sq.km area. Volcanic aquifers has been less explored.

3.4.1 Aquifer-I

The topmost weathered, jointed/fissured and vesicular layer forms the phreatic aquifer. The thickness of the aquifer is in the range between 7 to 21m. The yield of dug wells depends upon the topography.

Fig.3.9: Volcanic Aquifers in West Singhbhum district

3.4.2 Aquifer-II

Groundwater occurs under confined conditions in deep fractures. CGWB has drilled only 3 borewells in the volcanics. Borewells drilled in Dalma volcanics has yield of 27.8m^3/hr. Fractures were encountered at 11-13m, 57-60m and 70-70.5m. In Dangoaposi lava borewell drilled at Khas Kumirta village has yield of 7.74 m^3/hr. The borewell was drilled on a faulted

contact between the Kolhan basin and Dangaoposi lava. Fractures were encountered at depth ranges of 25-26m and 36-37m

Table 3.4:Disposition of fractures in volcanic aquifers

Sl. No.	Location	Block	Depth Drilled	Casing Depth/Dia.	Fractures encountered	Static Water level	Discharge (Comp)	Discharge (Pumping Test)	Drawdown	Formation
			m	m/mm	m	mbgl.	m^3/hr	m^3/hr	m	
1	Lodai	Gudri	176	6.81	11.0-13.0 57.0-60.0	**5.50**	27.828	18	**20.70**	Tuffaceous psmmopelite
	OW	Gudri	98	10.47	70.0-70.5	**5.21**	27.828		**9.14**	Tuffaceous psmmopelite
2	Serengda	Gudri	201	18.4	21.0-22.0 27.0-27.3 139.0-140.0	**11.34**	5.184	9	**27.71**	Tuffaceous psmmopelite
3	Khas Kumirta	Noamundi	201	21.45	25.0-26.0 36.0-37.0	**5.56**	7.74	7.74	**7.84**	Dangoaposi Lava/Kolhan

3.4.3 Aquifer Properties

The transmissivity of the aquifer varies between 6.10 to 45.52 m^2/day and the storativity of only well was $1.42X10^{-4}$.

3.4.4: Aquifer Disposition

The fig.3.10 shows the section along Serengda-Lodai villages. Fractured aquifer extends upto depth of 140m and 70m at Serengda and Lodai respectively.

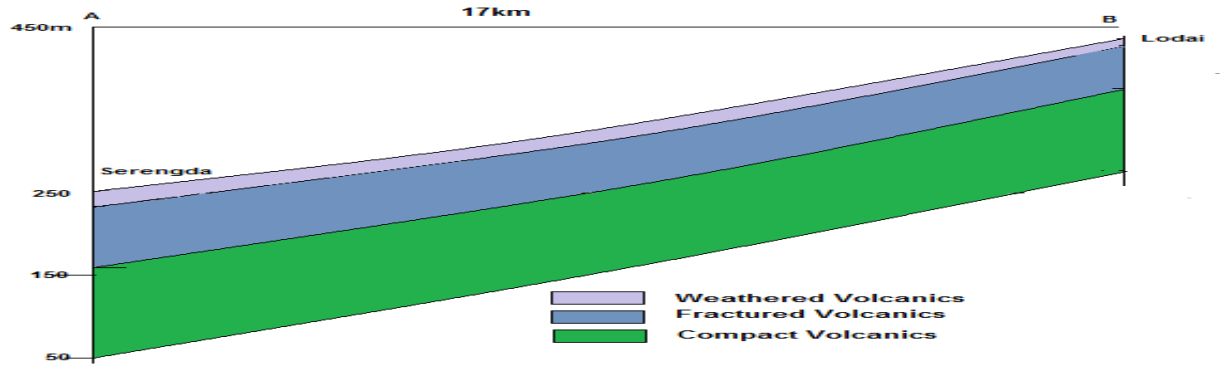


Fig.3.10: Section along Serengda-Lodai

3.5 Hydrogeological Map of West Singhbhum

A consolidated hydrogeological map has been prepared based on the information and data collected and is shown in fig.3.11.

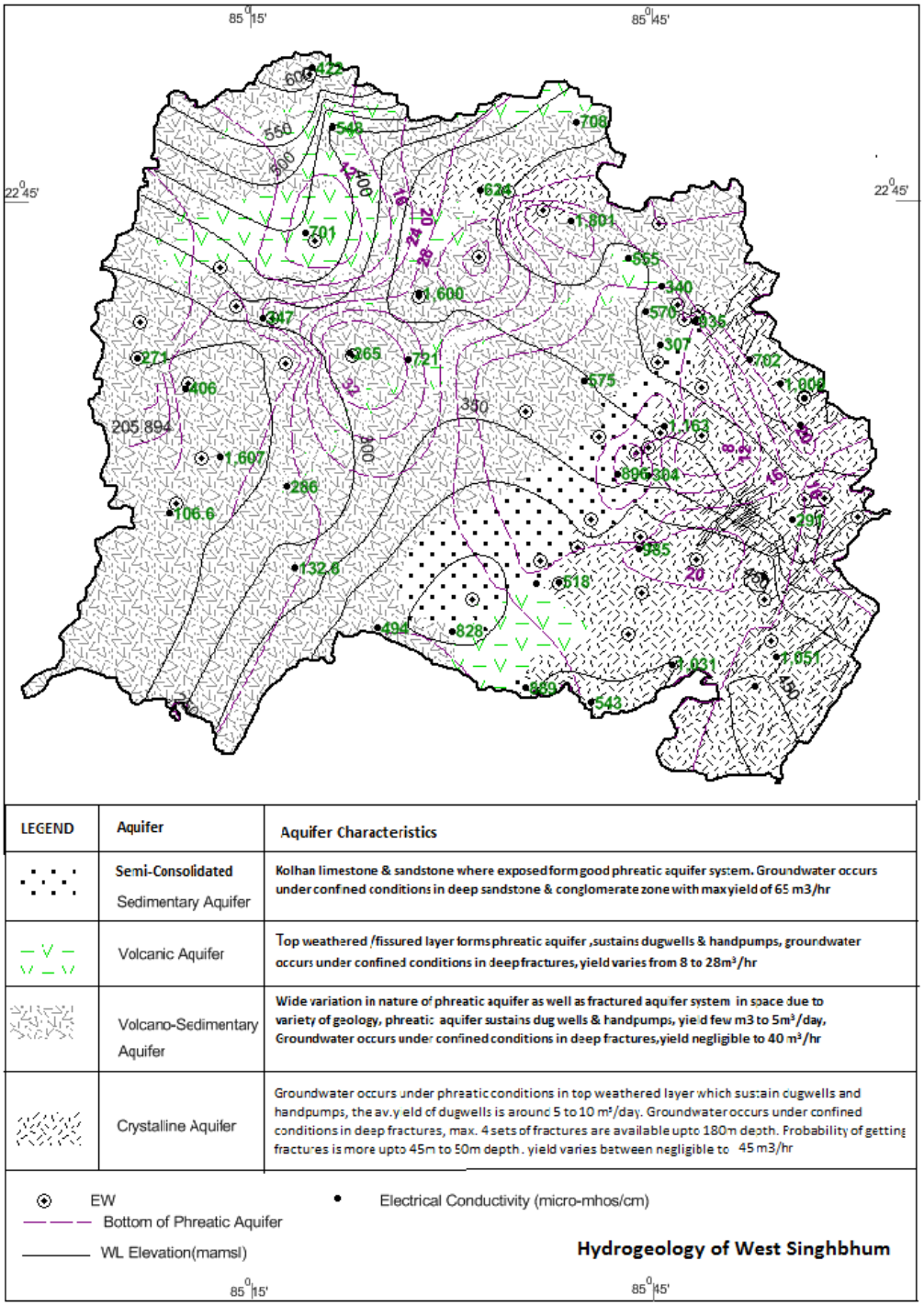


Fig.3.11: Hydrogeological Map of West Singhbhum District

4.0 GROUNDWATER RESOURCE

Ground Water Resource of the area has been estimated block wise 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 DynamicGround Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage groundwater 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: Dynamic Groundwater Resource (Unconfined Aquifer i.e. Aquifer-I)

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

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

The equation can be further elaborated as

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

Where,

ΔS – Change is storage, RRF – Rainfall recharge, RSTR- Recharge from stream channels

RC – Recharge from canals, RSWI – Recharge from surface water irrigation

RGWI- Recharge from ground water irrigation, RTP- Recharge from Tanks& Ponds

RWCS – Recharge from water conservation structures, VF – Vertical flow across the aquifer system, LF- Lateral flow along the aquifer system (through flow),GE-Ground Water Extraction, T- Transpiration, E- Evaporation, B-Base flow

The dynamic Ground Water Resources has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Directorate, Jharkhand based on GEC, Methodology 2015. The summarized detail of Annually Replenishable or Dynamic Ground Water Resources of West Singhbhum district is in Table 4.1.

Table 4.1: Dynamic Groundwater Resource (in ham)

Blocks	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 for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction
Anandpur	984.47	13.50	144.62	0.00	158.12	145.62	825.35	16.06
Bandgaon	4030.20	147.50	109.59	0.00	257.09	110.35	3772.35	6.38
Chaibasa	1950.30	91.00	102.53	0.00	193.52	103.24	1756.07	9.92
Chakradharpur	1682.02	57.50	50.52	0.00	108.02	50.87	1573.65	6.42
Goelkera	5234.24	239.50	133.33	11.82	384.65	134.25	4848.67	7.35
Gudri	2614.44	131.00	95.82	0.00	226.82	96.49	2386.95	8.68
Hatgamaria	1835.85	190.00	326.49	0.29	516.77	328.75	1316.82	28.15
Jagannathpur	2119.04	65.00	212.48	0.00	277.48	213.96	1840.08	13.09
Jhinkpani	4116.89	66.00	97.67	0.00	163.67	98.35	3952.54	3.98
Khuntpani	1198.43	66.00	58.60	0.00	124.60	59.00	1073.43	10.40
Kumardungi	2307.21	190.50	114.90	0.00	305.40	115.70	2001.01	13.24
Majhgaon	1288.56	53.00	84.33	0.00	137.34	84.92	1150.63	10.66
Manjhari	3845.63	20.50	79.07	0.00	99.56	79.62	3745.52	2.59
Manoharpur	3290.89	34.50	90.32	0.00	124.82	90.95	3165.44	3.79
Noamundi	1228.37	170.50	86.07	10.67	267.23	86.67	960.54	21.75
Sonua	2587.30	24.50	88.71	0.00	113.21	89.33	2473.47	4.38
Tantnagar	1530.48	68.50	286.11	0.27	354.88	288.10	1173.61	23.19
Tonto	3181.86	78.50	73.04	0.00	151.54	73.55	3029.81	4.76
Total	**45026.18**	**1707.50**	**2234.19**	**23.05**	**3964.72**	**2249.72**	**41045.94**	**8.81**

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

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

SGWR = A *(Z2 - Z1) * SY

Where, SGWR = Static or in-storage Ground Water Resources
A = Area of the Assessment Unit, Z2 = Bottom of Unconfined Aquifer, Z1 = Pre-monsoon water level, SY = Specific Yield in the In storage Zone

Table 4.2: Static/In-storage Ground Water Resource

Sl. No.	Administrative Units	Pre M WL	Basement Depth	Area	Sp Yield	In Storage Resource	
		m	m	ha		ha-m	bcm
1	Anandpur	5.66	20	24689	0.03	10618.25	0.11
2	Bandgaon	6.88	20	30488	0.03	12000.08	0.12
3	Chaibasa	13.62	16	15172	0.02	722.19	0.01
4	Chakradharpur	7.36	20	24096	0.02	6089.54	0.06
5	Goelkera	4.86	24	45474	0.03	26111.17	0.26
6	Gudri	6.05	18	35212	0.03	12627.73	0.13
7	Hatgamaria	10.72	18	26114	0.02	3800.11	0.04
8	Jagannathpur	9.87	18	23396	0.01	1903.03	0.02
9	Jhinkpani	6.99	12	10059	0.02	1007.91	0.01
10	Khuntpani	8.38	16	30399	0.03	6949.21	0.07
11	Kumardungi	8.70	12	25786	0.02	1701.88	0.02
12	Majhgaon	8.75	12	23963	0.02	1558.55	0.02
13	Manjhari	8.66	12	26602	0.01	889.04	0.01
14	Manoharpur	6.05	20	90561	0.03	37888.91	0.38
15	Noamundi	3.29	24	42221	0.03	26236.97	0.26
16	Sonua	6.40	26	34747	0.03	20431.24	0.20
17	Tantnagar	9.02	18	16503	0.01	1481.97	0.01
18	Tonto	6.44	18	58906	0.03	20421.53	0.20
				584388		**192439.30**	**1.92**

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 (bcm) = 0.45 bcm +1.92bcm = **2.37 b**cm

5.0 GROUNDWATER RELATED ISSUES

The 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. Departments. Further, the cultivators are illiterate tribals 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. At present the overall stage of ground water extraction is only around 8.81%, based on 2020 GW resource assessment. Block wise stage of ground water extraction (SOE) varies from 2.59 % (Manjhari) to 28.15 % (Hatgamaria). Graphical presentation of SOD is shown in figure 5.1.

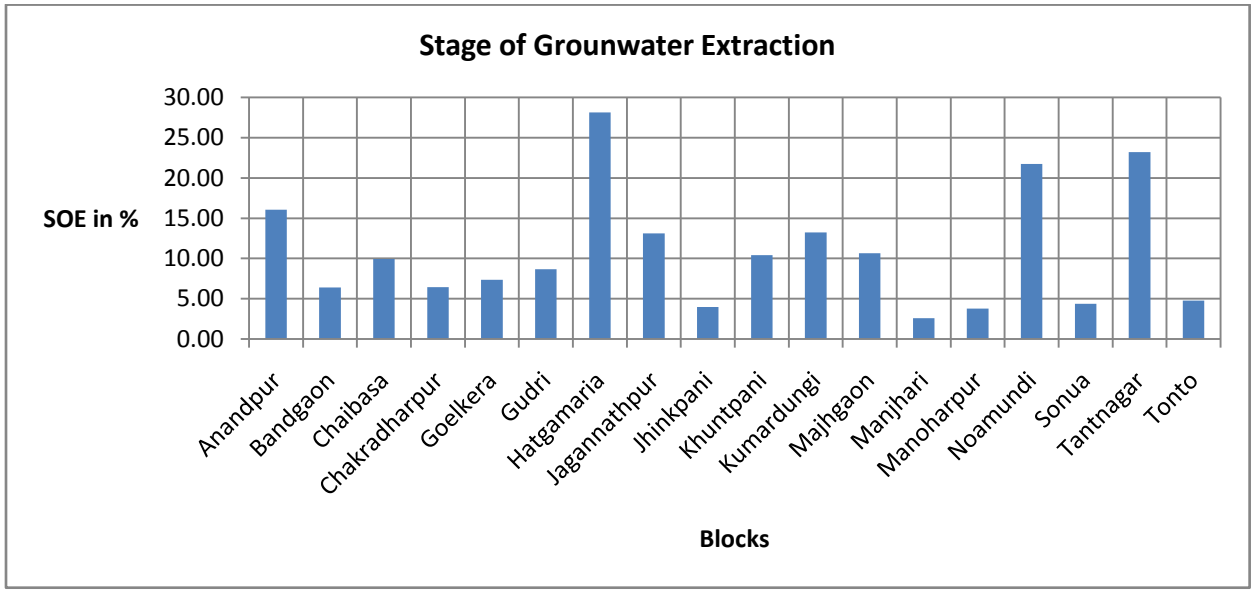


Fig.5.1: Stage of groundwater extraction in blocks

5.2 Low Ground Water Potential / Limited Aquifer Thickness / Sustainability:

Hard rocks in general have low storativity. The entire district is covered with hard rocks. Phreatic aquifers are main repository of groundwater. Out of total area of 7222 sq.km, 1340 sq.km area is hilly where there is no phreatic aquifer and hence no groundwater resource. The thickness of phreatic aquifer is in the range of 10m to 30m. In most of the area phreatic aquifers sustain only dugwells and shallow hand pumps.

Due to heterogeneity of rock types, the persistence of fractures in space is uncertain. Exploratory wells drilled in the district shows that probability of occurrence of productive fractures is more in the depth range upto 45m below ground level. With depth existence of fractures decreases. Beyond 100m fractures are rare.

Overall , it can be said that groundwater resource is limited and not uniformly distributed over the district.

6.0 MANAGEMENT STRATEGIES

The major ground water related issue in the district is low ground water development due to socio-economic and hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district.

6.1 Supply Side Management

6.1.1 Ground Water Resource Development Strategy: In view of above, the focus of proposed management plan was to enhance the overall ground water development from the present 8.81 % to 70%.

Groundwater can be extracted through large diameter dugwells in suitable hydrogeological areas and put to agricultural use. Dug wells can be constructed in granitic terrain, topographically low terrain, all along drainage channels.

The table 6.1 shows (District Irrigation Plan,2017) the water availability, demand & gap for the district. The projected water gap can be reduced by development of groundwater resource.

Table 6.1: Water Demand & Gap

Existing Water Availability (bcm)			Water Demand(bcm)		Water Gap(bcm)	
Stored Surface Water	Ground Water	Total	Present	Projected	Present	Projected (2020)
0.8439	0.331	1.1749	1.712966	1.96565	0.538066	0.79075

6.1.2 Rainwater Harvesting & Artificial Recharge to Groundwater:

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 construction of rainwater harvesting structures i.e. check dams, ponds in suitable areas. The district has suitable topography and good drainage network for construction water storage structures. Water harvesting structures will recharge the underlying aquifer and will ensure that the wells don't go dry during summer/lean/stress period. It will strengthen additional irrigation potential.

An area of 1662 sq.km (Master Plan for Artificial Recharge to Groundwater in India,2019) has been identified in the district i.e. in Chaibasa, Tantnagr, Manjhari, Tonto and Noamundi blocks for rainwater harvesting and artificial recharging to groundwater system. The area has been identified based on Post-monsson,2018 water level and declining trend of water level (2009-

2018). A total 149 Percolation Tanks and 1867 number of Nala bund/Gully Plug/Check Dams have been recommended for construction to harvest and store monsoon runoff.

6.3 Demand Side Management Plan/Interventions

It is always essential to address the issue of constraining demand for groundwater abstraction since this will normally contribute more to achieving the groundwater balance. The concept of real water savings is critical in this regard. The main demand side interventions may be:-

- Promote improved irrigation technologies (drip or sprinkler irrigation, etc.)
- Crop choice management and diversification (promote less intensive crops like pulses and horticulture)
- Promote treated municipal waste water for irrigation and construction use.

7.0 SUM-UP

- The district spreads over 7222 Sq. km area consisting of 18 blocks situated in the south-eastern part of the Jharkhand state with a population of 15 lakhs.
- Aquifer Mapping Study was carried out for the district with data from state/Central Govt agencies, data gap analysis, data generated in-house/outsourcing. All the available data/ data generated were analysed and integrated to prepare aquifer maps and aquifer management plans of the district.
- The district is represented by hilly ranges especially in south-west, north and west, broad intermontanne valleys, uplands, rocky barren lands, rolling topography. The principal rivers are south Koel, Karo, Kharkhai and Baitarani. The district is characterized by humid to sub-humid climate with average annual rainfall of 1372mm.
- Geologically, the area is represented by wide variety of rocks starting from Archaean Older Metamorphic Group/Older Metamorphic Tonalite Group(OMG/OMTG), Singhbhum Granite, Chakradharpur Granite, Bonai Group, Singhbhum Group, Kolhan formations and basic volcanics.
- Based on geological diversities and relative ground water potentialities in the aquifer ,the area can be broadly sub-divided into four hydrogeological unit namely Crystalline aquifers, volcano-sedimentary, semi-consolidated and volcanic aquifers.
- Ground water occurs in consolidated formation 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 granites/weathered volcano-sediments/volcanics. These aquifers are generally tapped with dugwells or shallow handpumps.
- In fissured formations of the district the major potential fractures zones are found in Aquifer-II between 40-100 m. In general, discharge of well has been found in the range of negligible-44 m^3/hr. The Transmissivity value and Storativity value range from 6.10m2/day to 182 m^2/day and $1.42x10^{-4}$ to $1.97x10^{-5}$ respectively. Ground Water occurs under semi-confined to confined state in Aquifer-II.
- Ground Water quality is generally potable and there is no groundwater quality related issues.

- The stage of ground water development is 8.81% and all the block comes under safe category. Therefore there is sufficient scope for further ground water development.
- To suggest a sustainable ground water management plan there are two options-Supply Side Management Options(Ground Water Development strategy and local water harvesting techniques) & Demand Side Management Options (real water-savings).
- The supply side interventions envisages Ground Water Development strategy by construction of additional ground water structure in a sustainable manner
- The supply side interventions also envisages construction of 1867 nos of Check Dam/Nala bund- 149 nos of Percolation Tank, Roof Top Rainwater Harvesting in buildings in the areas feasible for construction of recharge structures based on the long term water level scenario and recharge potential of the aquifer. The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area.
- 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 etc

Annexure-1

Details of NHS & Key Wells in West Singhbhum District

Sl.No	**Well Name**	**Block**	**Latitude**	**Longitude**	**Type of Well**	**Depth of well (bmp)**	**Dia**	**M.P(magl)**	**WLPre-monsoon(mbmp)**	**WLPost-monsoon (mbmp)**	**WL_FLC(m)**
1	Bhandgaon	Noamundi	22°05'21''	85°35'40.7''	Dug Well	11.86	1.82	0.49	3.2	2.3	0.9
2	Bandgaon	Bandgaon	22°51'40.2''	85°19'47''	Dug Well	12.8	2.33	0.6	10.08	6.04	4.04
3	Barajamda	Noamundi	22°09'52.4'	85°24'41.2''	Dug Well	7.09	2.7	0.4	2.9	1.3	1.6
4	Chaibasa	Chaibasa	22°32'44''	85°48'18''	Dug Well	13.9	1.53	0.7	13.95	8.43	5.52
5	CKP (Ulidih)	Chakradharpur	22°40'16.8''	85°39'06.4''	Dug Well	9.05	1.2	0.65	7.65	3.9	3.75
6	Hat Gamhariya	Hatgamhariya	22°15'42''	85°44'09''	Dug Well	12.7	1.9	0.78	10.07	2.7	7.37
7	Hesadih	Bandgaon	22°47'10.8''	85°21'17.7''	Dug Well	8.95	3	0.45	4.52	2.1	2.42
8	Jagannathpur	Jagnnathpur	22°13'16.3''	85°38'11.7''	Dug Well	10.9	2	0.7	9.1	5.6	3.5
9	Jaitgarh	Jagnnathpur	22°04'18.4''	85°40'32.6''	Dug Well	8.85	1.05	0.6	5.43	3.22	2.21
10	Jhinkpani	Jhinkpani	22°25'00''	85°46'25''	Dug Well	7.78	1.6	0.6			0
11	Kereikela	Kereikala	22°42'31''	85°32'21''	Dug Well	11.2	1.7	0.35	7	2.05	4.95
12	Khuntpani	Khuntpani	22°37'24.9''	85°43'21''	Dug Well	12.1	1.6	0.7	8	3.45	4.55
13	Noamundi	Noamundi	22°09'37.5''	85°30'16.8''	Dug Well	13.4	2.3	0.55	4.15	1	3.15
14	Kokcho	Tantnagar	22°28'04.3''	85°54'42.8''	Dug Well	11.4	3.1	0.7	7.8	3.42	4.38
15	Talaburu		22°21'16''	85°44'54''	Dug	6		0.65	2.25	1.85	0.4

Sl.No	Well Name	Block	Latitude	Longitude	Type of Well	Depth of well (bmp)	Dia	M.P(magl)	WLPre-monsoon(mbmp)	WLPost-monsoon (mbmp)	WL_FLC(m)
					Well						
16	Putida	Chaibasa	22°35'21''	85°45'53''	Dug Well	10.9	0.9	0.8	3.4	2.73	0.67
17	Barananda	Jagnnathpur	22°13'08''	85°36'30''	Dug Well	8.8	3	0.62	6.05	1.63	4.42
18	ToretopaNoamundi	Noamundi	22°09'37.9''	85°30'46''	Dug Well	19.15	3.15	0.54	13.9	5.8	8.1
19	Sonua	Sonua	22°34'47.6''	85°27'45.8''	Dug Well	12.1	1.82	0.25	5.87	2.4	3.47
20	Goielkera	Goielkera	22°30'21.7''	85°22'32.5''	Dug Well	17.15	1.35	0.8	14.68	8.9	5.78
21	Toklo	Chakradharpur	22°47'36.1''	85°39'30.4''	Dug Well	12.35	1.2	0.5	7.92	2.57	5.35
22	Jate	Gudri	22°39'22.4''	85°19'19.8''	Dug Well	9.5	2	0.5	9.34	4.8	4.54
23	Kumdih	Goielkera	22°32'58''	85°16'04.7''	Dug Well	9.8	1.75	0.68	8.5	6.1	2.4
24	Bila	Goilkera	22°29'53.6''	85°26'54.3''	Dug Well	10.75	1.9	0.65	10.37	4.55	5.82
25	Kuida	Goilkera	22°32'28.2''	85°30'29.6''	Dug Well	12.55	1.8	0.55	7.74	4.43	3.31
26	Bhuta	Chaibasa	22°33'26.1''	85°44'39.2''	Dug Well	14.35	1.8	0.45	6.2	2.1	4.1
27	Taraisol	Goilkera	22°29'30.8''	85°17'50.4''	Dug Well	7.6		0.6	6.45	5.55	0.9
28	Nandpur	Manoharpur	22°22'36.0''	85°12'53.6''	Dug Well	15.9	2.5	0.7	11.47	5.18	6.29
29	Anandpur	Anandpur	22°27'44.2''	85°10'22.3''	Dug Well	9.5	3	0.6	7.8	5.15	2.65
30	Dumirta	Anandpur	22°30'01.9''	85°06'42.0''	Dug Well	10.1	4.6	0.6	8.2	3	5.2
31	Pachpahia	Manoharpur	22°18'25.8''	85°09'06.1''	Dug Well	12.2	1.9	0.6	7.48	3.25	4.23

Sl.No	Well Name	Block	Latitude	Longitude	Type of Well	Depth of well (bmp)	Dia	M.P(magl)	WLPre-monsoon(mbmp)	WLPost-monsoon (mbmp)	WL_FLC(m)
32	Jaraikela	Manoharpur	22°18'32.9''	85°06'57.1''	Dug Well	12.95	1.7	0.6	10.7	9.6	1.1
33	Lolang	Manoharpur	22°20'23.1''	85°17'54.6''	Dug Well	7.05	1.85	0.7	5.9	4.57	1.33
34	ChhotaNagra	Manoharpur	22°14'21.4''	85°18'31.3''	Dug Well	10.75	1.15	0.75	9.9	8.6	1.3
35	Gamariya	Khutpani	22°39'13.1''	85°45'05.2''	Dug Well	8.8	2.4	0.6	2.6	1.35	1.25
36	Barkundia	Chaibasa	22°29'52.1''	85°52'23.6''	Dug Well	11.1	2.1	0.65	10.18	8.25	1.93
37	Kokcho	Tantnagar	22°28'04.3''	85°54'42.8''	Dug Well	10.5	3.05	0.7	7.8	3.42	4.38
38	Tantnagar	Tantnagar	22°27'02.2''	85°56'29.8''	Dug Well	8.65	3.1	0.45	5.82	3.4	2.42
39	Bingburu	Tantnagar	22°24'59.4''	85°56'14.7''	Dug Well	12.6	1.85	0.6	6.4	2.73	3.67
40	Roladih	Manjhari	22°21'15.2''	85°55'45.9''	Dug Well	11.1	1.6	0.75	6.2	3.85	2.35
41	Barbil	Manjhari	22°17'54.6''	85°55'34.6''	Dug Well	7.1	3	0.5	4.5	2.25	2.25
42	Sirbinja	Kumardungi	22°13'40.2''	85°53'32.2''	Dug Well	10.1	3	0.7	8.05	3.65	4.4
43	BaraRaikhaman	Kumardungi	22°07'41.7''	85°54'25.3''	Dug Well	3.2		0.4	5.55	3.2	2.35
44	Majhgaon	Majhgaon	22°05'29.5''	85°52'48.0''	Dug Well	2.25		0.9	3.82	2.25	1.57
45	Khairpal	Majhgaon	22°07'07.3''	85°46'39.2''	Dug Well	11	1.85	0.7	6.65	3.4	3.25
46	Gumuria	Jagannathpur	22°05'06.5''	85°43'38.1''	Dug Well			0.7	4.6	2.45	2.15
47	Siringsia	Tonto	22°21'22.1''	85°42'36.6''	Dug Well	11.18	3	0.6	7.26	2.92	4.34
48	Kendoposi	Hatgamhariya	22°17'38.4''	85°44'07.9''	Dug	9.27		0.65	5.98	3.45	2.53

Sl.No	**Well Name**	**Block**	**Latitude**	**Longitude**	**Type of Well**	**Depth of well (bmp)**	**Dia**	**M.P(magl)**	**WLPre-monsoon(mbmp)**	**WLPost-monsoon (mbmp)**	**WL_FLC(m)**
					Well						
49	Jorapokhari	Jhinkpani	22°24'32.1''	85°45'50''	Dug Well	6.35		0.5	7	3.35	3.65
50	Khunta	Chaibasa	22°30'59.5''	85°45'43.9''	Dug Well	9.1	3.45	0.6	5.87	2.45	3.42
51	Purnapani	Tonto	22°28'20.7''	85°40'02.5''	Dug Well	8		0.7	6.33	3.3	3.03
52	Jhinkpani	Jhinkpani	22°24'55.2''	85°46'01.7''	Dug Well	10.75	3.2	0.65	5.5	1.92	3.58
53	Parlipur		22°30'07.1''	85°13'31.4''	Dug Well			0.6	11		
54	Narsinghpur		22°09'06.1''	85°43'11.2''	Dug Well	10.45		0.5	9.6		

Annexure-II

: Hydrogeological Details of Exploratory Wells in West Singhbhum District

Wells drilled through Department Rigs

Sl No	Location	Block	Co-ordinate	Depth Drilled (m)	Length of Casing pipe (m)	Granular Zone / fracture Tapped (m)	Static Water level (m bgl.)	Discharge(m^3/hr)	Drawdown (m)	Specific Capacity(m^3/hr/m)	Transmissivity(m^2/day)	Storativity	Dia. of assembly mm	Formation	Year
1	Chakradharpur E.W.	Chakradharpur	$22^0$41'00" $85^0$37'00"	209.42	11.5	12.61-25.61 176.94-179.94	6.93	4.3	34.46	0.124	2	-	203	ChakradharpurGranite	Sep-87
	OW_1			99.81	12.6	14.00-23.00 33.32-035.47	6.9	30.6	17.85	1.71	28	-	203	-do-	
	OW_2			107.43	8.1	08.00-023.60	-	-	-	-	-	-	203	-do-	
2	Narsanda EW	Chaibasa	$22^0$34'00" $85^0$47'00"										203	Kolhan series	Jun-05
3	Kumardungi EW	Kumardungi	$22^0$12'00" $85^0$53'30"	113	9.75	107-109	8.04	11.3	2.58	4.37	67	$5.6x10^{-1}$	203	Granite gneiss	Dec-05
	OW 1				16.5	111-112	9.07		1.58						
	OW 2				17.5	97-98	9.08		2.58						
4	PWD Guest House	Chakradharpur	$22^0$40'59.99" $85^0$37'00.01"	209.42	11.5									Chakradharpur Granite	2016-17
5	Bandgaon Block Office	Bandgaon	$22^0$51'11.99" $85^0$19'35.29"	200	14.6									Singhbhum Group	2016-17
6	Matamkabera	Bandgaon	$22^0$42'28.8" $85^0$34'22.8"	196.6	25.5	28.5-29.1 181-182	9.6	1.62						Chakradharpur Granite	2016-17
7	Tantnagar (Upgraded High	Tantnagar	$22^0$27'03.6" $85^0$56'31.2"	153	20.5	54.7-55.5 85.2-86.2	8.0	9.0						Meta-sediments	2016-17

Sl No	Location	Block	Co-ordinate	Depth Drilled (m)	Length of Casing pipe (m)	Granular Zone / fracture Tapped (m)	Static Water level (m bgl.)	Discharge(m^3/hr)	Drawdown (m)	Specific Capacity(m^3/hr/m)	Transmissivity(m^2/day)	Storativity	Dia. of assembly mm	Formation	Year
	School)														
8	Purnia (Govt.School)	Khuntapani	$22^0$40'04.8" $85^0$45'39.6"	153.8	24	28.9-29.5 59.4-60.0 102-103	11.2	16.20						Meta-sediments	2016-17
	OW			153.8	24	28.9-29.5 59.4-60.0 102-103	10.2	16.20							
9	Manjhari High School(EW)	Manjhari	$22^0$27'00" $85^0$56'29.76"	153.8	24.0	30.0-30.5 39.0-40.0	9.0	7.92						Granite Gneiss	2016-17
	OW			100.4	24.30	30.0-30.5 39.0-39.5	9.0	7.92						Granite Gneiss	
10	BharbhariaTasar Kendra (EW)	Manjhari		153.8	16.0	20.0-20.5	8.0	7.38						Granite Gneiss	2016-17
11	J.N.V.CampusJhinkpani (EW)	Jhinkpani	$22^0$24'25.2" $85^0$45'46.8"	153.8	16.5	31.5-32 77.6-78.5	14.2	12.24						Granite Gneiss	2016-17
	OW			153.8	18.5	31.0-31.5 73.6-74.5	13.5	6.48						Granite Gneiss	
12	Asura High School (EW)	Jhinkpani	$22^0$27'45" $85^0$48'52.92"	153.8	09.02	43.1-44.0		1.62						Granite Gneiss	2016-17
13	Jagannathpur (Rassel school)	Jagannathpur	$22^0$13'12" $85^0$38'13.2"	153.8	18.5	20.0-20.5		2.796						Granite Gneiss	2016-17
14	Hatgamharia (Pry.School)	Hatgamhria	$22^0$16'39" $85^0$44'18.6"	202	12.07			Dry						Granite Gneiss	2016-17
15	Bara Lagra, Manihi	Manjhari	$22^0$18'11" $86^0$00'27"	154.1	9.5			Dry						Granite	2017-18

Sl No	Location	Block	Co-ordinate	Depth Drilled (m)	Length of Casing pipe (m)	Granular Zone / fracture Tapped (m)	Static Water level (m bgl.)	Discharge(m^3/hr)	Drawdown (m)	Specific Capacity(m^3/hr/m)	Transmissivity(m^2/day)	Storativity	Dia. of assembly mm	Formation	Year
16	Putusia	Manjhari	$22^0$19'29" $85^0$57'57"	153.8	10.5	88.84-89		negligible						Granite	2017-18
17	Chitinriti	Tantnagar	$22^0$24'21" $85^0$56'36"	100.46	21.35	24.26-27.88		25.56						Granite Gneiss	2017-18
	OW			100.46	16.63	24.26-31.88		25.56						Granite Gneiss	
18	Kumardungi	Kumardungi	$22^0$08'51" $85^0$54'03"	153.5	11.25			Dry						Granite	2017-18
19	Kumardungi	Kumardungi	$22^0$08'51" $85^0$54'03"	123	11.25	24-24.5		1.60						Granite Gneiss	2017-18
20	Tonto	Tonto	$22^0$22'52" $85^0$43'58"	153.8	24.1	42.12-43.0		2.88						Granite Gneiss	2017-18
21	Andhari	Kumardungi	$22^0$08'51" $85^0$54'03"	43.7	24.1	43.12-45		44.28						Granite Gneiss	2017-18
	OW			43.70	24.1	43.12-45		44.28							
22	Tonto	Tonto	$22^0$23'17" $85^0$44'49"	153.8	13.5	30.0-31.0 73.60-74.0		4.32							2017-18
23	Hatgamaharia	Hatgamaharia	$22^0$14'57" $85^0$48'25"	147.40	26	25.0-25.5 47.0-47.5 114-115 120-121		16.20						Granite Gneiss	2017-18
	OW			147.4	25.5	25.0-25.5 47.0-47.5 114-115 120-121		16.20						Granite Gneiss	
24	Jagannathpur	Jagannathpur	$22^0$14'57" $85^0$48'25"	153.8	18.3	20.26-24.26 35.50-39.50		16.20						Granite Gneiss	2017-18
	OW			54.47	18	20.26-24.26 35.50-39.50		6.48							
25	Benisai	Jagannathpur	$22^0$12'29.988" $85^0$44'20"												2018-19
26	Kochara	Hatgamaharia	$22^0$15'48.07" $85^0$39'37.23"	153.8				0.72						Granite Gneiss	2018-19

Wells drilled through Out-Sourcing

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	Specific Capacity	Transmissivity	Storativity	Dia. of assembly	Formation	Year
				mbgl.	m	m	m bgl.	m^3/hr	m	m^3/hr/m	m^2/day		mm		
27	Mahulsai EW	Chaibasa	$22^0$33'30" $85^0$48'30"	150	20		7.08	dry					203	Granite gneiss	Jul-05
28	P.M College, Gandhinagar, EW	Chaibasa	$22^0$33'00" $85^0$48'28"	150	12.25		6.5	2.52	18				203	Granite gneiss	Mar-05
29	High School Campus EW	Hat Gamharia	$22^0$16'00" $85^0$45'00"	150	22		6.2	1.4					203	Granite gneiss	Mar-05
30	Sildauri Middle School, Campus EW	Noamundi	$22^0$14'50", $85^0$36'45"	150	15.24		9.75	16.2	15.1				203	Granite gneiss	Mar-05
31	DVC Campus, Nimdih, EW	Chaibasa	$22^0$32'50", $85^0$47'30"	126.25	15.75		6.32	16.2	17.5				203	Granite gneiss	Mar-05
32	Bandgaon	Bandgaon	$22^0$51′12″ $85^0$19′35.3″	200.0	15.25			Dry						Singhbhum Group	2012-13
33	Sonua	Sonua	$22^0$34′34″ $85^0$27′46″	200.0	24.45			3.6						Up Bonai Group	2012-13
34	Harimora	Sonua	$22^0$37′35″ $85^0$32′10″	200.0	32.6	32-33.2,56.2-58.2 100.2-101.2		44.28						Up Bonai Group	2012-13
	OW			200.0	30.2	36.45-37.5 59.2-60.2 104.5-105.5		14.40						Up Bonai Group	2012-13

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	Quality	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	m^3/hr./m.	m^2/day		Ec Cl F No3		
35	Goilkhera	Goilkhera	85°22'43.1" 22°30'11.6''	201	37.60	43.0-44.5 52.0-54.0 59.0-60.5 91.0-92.0	23.70	17.28	18	**11.68**		102.87	1.7x 10^{-5}	98.04 15.59 0.06 0.85	Shale/phy	2019-20
	OW	Goilkhera	85°22'43.7" 22°30'11.2''	201	63.52	79.2-79.7 81.6-81.9	24.17	17.28		5.56					Shale/phy	2019-20
36	Kairam	Goilkhera	85°17'49.9" 22°29'35.0''	201	11.69	14.0-15.0 32.9-33.3	7.8	5.184	7.2	12		7.37		112.5 10.63 0.08 2.05	Shale/phy	2019-20
37	Kumdih	Goilkhera	85°16'45.3" 22°32'57.1''	201	21.14	25.0-26.0	5.06	7.74	8.28	**10.34**		9.79		117.9 5.67 0.08 1.56	Shale/phy	2019-20
38	Rayam	Gudri	85°14'08.5" 22°33'50.3''	201	14.74	16.0-16.5 17.5-18.1 22.0-22.5 78.0-79.0	**3.31**	5.184	7.416	**18.53**		6.66		121.4 9.92 0.12 1.70	Shale/phy	2019-20
39	Lodai	Gudri	85°19'58.1" 22°38'47.8''	176	6.81	11.0-13.0 27.0-60.0	**5.50**	27.828	18	**20.70**		**45.52**	**1.42 x10^{-4}**	**133.4 41.83 0.09 1.9**	Tuffaceous psmmopelite	2019-20
	OW	Gudri	85°19'57.3" 22°38'47.3''	98	10.47	70.0-70.5	**5.21**	27.828		**9.14**					Tuffaceous	2019-20

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	Quality	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	m^3/hr./m.	m^2/day		Ec Cl F No3		
															psmmopelite	
40	Serengda	Gudri	85°12'54.4" 22°36'42.0''	201	18.4	21.0-22.0 27.0-27.3 139.0-140.0	**11.34**	5.184	9	**27.71**		**6.10**		**117.6 7.79 0.10 1.6**	Tuffaceous psmmopelite	2019-20
41	Manoharpur	Manoharpur	85°11'29.5" 22°22'29.3''	201	15.04	42.0-44.0	**9.90**	1.548				**0.83(slug)**			Shale/phy	2019-20
42	Lailor	Manoharpur	85°09'35.0" 22°19'08.2''	201	8.64	25.6-26.2	**12.22**	15.912	18	**25.43**		**52.11**	**1.97 x10^{-5}**		Shale/phy	2019-20
	OW	Manoharpur	85°09'34.9" 22°19'08.2''	127	15.04	54.9-55.3	**9.70**	43.884		**6.19**					Shale/phy	2019-20
43	Kitahatu	Hatgamaria	85°40'35.9" 22°17'55.5''	80	Abn			Abn							Kolhan	2019-20
44	Choya	Jhinkpani	85°48'48.0" 22°24'13.8''	201	3.46	4.0-5.0	**-**	0							Singhbhum Granite	2019-20
45	Khas Kumirta	Noamundi	85°31'43.7" 22°11'56.8''	201	21.45	25.0-26.0 36.0-37.0	**5.56**	7.74	7.74	**7.84**		**10.02**		**109.8 2.12 0.06 0.49**	Dangoaposi Lava/Kolhan	2019-20
46	Banibasa	Tonto	85°45'33.1" 22°29'39.5''	90	51.93	70.0-70.84	**19.0**	64.512	21.96	**10**		**182.33**		**250 5.67 0.08 1.30**	Kolhan	2019-20
47	Salikuti	Tonto	85°41'13.5" 22°24'07.1''	75	Abn	65		Abn							Kolhan Shale	2019-20
48	Anandpu	Anandpur	85°10'30.3"	201	11.39	NIL		0							Shale/p	2019-

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	Quality	Formation	Year
				m	m/mm	m	m bgl.	m^3/hr	m^3/hr	m	m^3/hr./m.	m^2/day		Ec Cl F No3		
	r		22°28'08.7''												hy	20
49	Dumirta	Anandpur	85°06'43.7" 22°29'58.9''	201	27.24	166.0-167.0	**2.49**	1.548				**0.669 slug)**			Shale/phy	2019-20
50	Koleda	Anandpur	85°06'58.8" 22°32'41.3''	201	24.8	50.0-50.5 99.0-100.0	**9.94**	0				**2.21(slug)**			Shale/phy	2019-20
51	Suiamba	Tonto	$85^0$35'42.5" $22^0$26'00.0"	120	11.39			0							Shale/phy	2019-20
52	Jaldiha	Jagannathpur	85043'21.9" 22009'22.9"	85	Abn			Abn							Singhbhum Granite	2019-20

Piezometers

Sl No	Location	Block	Co-ordinate	Depth Drilled	Length of Casing pipe	Granular Zone / fracture Tapped	Static Water level	Discharge	Drawdown	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**
EXPLORATORY WELLS DRILLED BY DEPARTMENTAL RIGS															
1	Asura High School (Pz)	Jhinkpani	$22^0$27'43.2" $85^0$48'50.4"	108	14/178			Dry						Granite Gneiss	2016-17
2	Majhgaon Pz	Majhgaon	$22^0$04'07" $85^0$52'55"	29.3	25/178										2017-18

Annexure-III

Quality of Ground Water Sample

						pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	PO_4^{3-}	F^{-}
Sample No.	**Location**	**Block**	**Latitude**	**Longitude**	**Type of Well**		**µS/cm**	**mg/L**												
1	Bandgaon	Bandgaon	22°51'40.2''	85°19'47''	DW	7.63	422	274	135	24	18	30	6.28	0	116	50	14	31	0	0
2	Hesadih	Bandgaon	22°47'10.8''	85°21'17.7''	DW	7.64	548	356	220	46	26	17	6.63	0	207	50	10	26	0.03	0
3	Kereikela	Kereikala	22°42'31''	85°32'21''	DW	7.82	624	406	245	64	21	28	1.84	0	275	32	28	3.34	0.25	0
4	Toklo	Chakradharpur	22°47'36.1''	85°39'30.4''	DW	7.64	708	460	235	54	24	52	2.15	0	195	107	20	15	0	0
5	CKP (Ulidih)	Chakradharpur	22°40'16.8''	85°39'06.4''	DW	7.72	1801	1171	660	132	80	94	24	0	628	188	95	25	0.02	0
6	Sonua	Sonua	22°34'47.6''	85°27'45.8''	DW	7.64	1600	1040	555	80	86	98	23	0	464	252	28	25	0.38	0
7	Jate	Gudri	22°39'22.4''	85°19'19.8''	DW	7.59	701	456	300	72	29	19	4.61	0	390	14	7.97	2.3	0	0
8	Goielkera	Goielkera	22°30'21.7''	85°22'32.5''	DW	7.64	265	172	120	32	9.72	4.825	0.11	0	116	21	0.46	1.1	0	0
9	Kumdih	Goielkera	22°32'58''	85°16'04.7''	DW	7.82	347	226	155	32	18	5.95	0	0	183	11	0.46	3.5	0	0
10	Bila	Goilkera	22°29'53.6''	85°26'54.3''	DW	7.86	721	469	270	44	39	36	3.9	0	268	71	21	22	0	0
11	Bhuta	Chaibasa	22°33'26.1''	85°44'39.2''	DW	7.97	570	371	200	58	13	36	1.29	0	299	18	12	1.36	0	0
12	Nandpur	Manoharpur	22°22'36.0''	85°12'53.6''	DW	7.67	1607	1045	580	108	75	86	22	0	458	263	53	0	0	0
13	Anandpur	Anandpur	22°27'44.2''	85°10'22.3''	DW	7.79	406	264	165	40	16	17	0.6	0	146	46	9.91	1.43	0	0
14	Dumirta	Anandpur	22°30'01.9''	85°06'42.0''	DW	7.62	271	176	90	20	9.72	17	3.88	0	98	28	8.96	6.2	0	0
15	Pachpahia	Manoharpur	22°18'25.8''	85°09'06.1''	DW	7.33	106.6	69	45	10	4.86	2.56	1.3	0	37	11	4.12	0.87	0	0
16	Lolang	Manoharp	22°20'23.1''	85°17'54.6''	DW	7.62	286	186	120	28	12	5.26	1.36	0	146	7.1	5.84	0	0	0

						pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	PO_4^{3-}	F^{-}
Sample No.	**Location**	**Block**	**Latitude**	**Longitude**	**Type of Well**		**µS/cm**	**mg/L**												
		ur																		
17	ChhotaNagra	Manoharpur	22°14'21.4''	85°18'31.3''	DW	7.44	132.8	86	50	18	1.215	4.3	1.32	0	55	11	4.52	0	0	0
18	Barajamda	Noamundi	22°09'52.4'	85°24'41.2''	DW	7.69	494	321	180	36	22	26	6.94	0	171	28	44	19	0	0
19	Bhandgaon	Noamundi	22°05'21''	85°35'40.7''	DW	7.91	889	578	245	56	26	48	68	0	366	64	30	23	0.54	0
20	Jaitgarh	Jagnnathpur	22°04'18.4''	85°40'32.6''	DW	7.84	543	353	180	40	19	38	5.28	0	214	43	26	3.98	0	0
21	Noamundi	Noamundi	22°09'37.5''	85°30'16.8''	DW	7.79	828	538	260	38	40	57	19	0	250	124	32	0	0	0
22	Khuntpani	Khuntpani	22°37'24.9''	85°43'21''	DW	7.68	555	361	240	34	38	15	1.26	0	256	21	24	6.61	0	0
23	Putida	Chaibasa	22°35'21''	85°45'53''	DW	7.61	340	221	100	28	7.29	30	0.86	0	110	36	20	0	0	0
24	Chaibasa	Chaibasa	22°32'44''	85°48'18''	DW	7.63	935	608	305	44	47	71	0	0	311	103	44	25	0	0
25	Barkundia	Chaibasa	22°29'52.1''	85°52'23.6''	DW	7.82	702	456	280	46	40	29	1.57	0	250	78	19	17	0	0
26	Kokcho	Tantnagar	22°28'04.3''	85°54'42.8''	DW	7.86	1000	650	400	86	45	35	15	0	293	138	52	11	0	0
27	Tantnagar	Tantnagar	22°27'02.2''	85°56'29.8''	DW	7.89	1958	1273	715	122	100	97	38	0	458	309	134	23	0	0
28	Bingburu	Tantnagar	22°24'59.4''	85°56'14.7''	DW	7.96	1135	738	440	50	77	47	11	0	409	103	61	25	0	0
29	Barbil	Manjhari	22°17'54.6''	85°55'34.6''	DW	8.03	291	189	140	30	16	0	2.27	0	134	11	11	0	0	0
30	Sirbinja	Kumardungi	22°13'40.2''	85°53'32.2''	DW	7.64	336	218	135	30	15	10	4.83	0	110	43	16	0	0	0
31	BaraRaikhaman	Kumardungi	22°07'41.7''	85°54'25.3''	DW	7.86	1051	683	355	66	46	55	36.9	0	317	138	49	14	0	0
32	Majhgaon	Majhgaon	22°05'29.5''	85°52'48.0''	DW	7.75	353	229	135	8	28	13	5.17	0	116	39	21	3.5	0	0
33	Khairpal	Majhgaon	22°07'07.3''	85°46'39.2''	DW	7.77	1031	670	320	62	40	68	34	0	372	103	35	26	0	0
34	Jagannathpur	Jagnnathpur	22°13'16.3''	85°38'11.7''	DW	7.75	518	337	220	40	29	14	2.89	0	195	25	37	29	0	0
35	Baranand a	Jagnnathpur	22°13'08''	86°36'30''	DW	7.74	103	67	50	16	2.43	0	0.45	0	31	14	4.12	0.23	0	0
36	Siringsia	Tonto	22°21'22.1''	85°42'36.6''	DW	7.85	896	582	355	68	45	22	28.2	0	329	67	57	20	3.75	0
37	Talaburu	Hatgamhariya	22°21'16''	86°44'54''	DW	7.74	304	198	145	24	21	1.2	0.55	0	134	14	16	0	0	0
38	Hat Gamhariy	Hatgamhariya	22°15'42''	85°44'09''	DW	7.76	985	640	405	36	77	33	6.4	0	348	82	66	26	0	0

						pH	EC	TDS	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	PO_4^{3-}	F^{-}
Sample No.	**Location**	**Block**	**Latitude**	**Longitude**	**Type of Well**		**µS/cm**	**mg/L**												
	a																			
39	Khunta	Chaibasa	22°30'59.5''	85°45'43.9''	DW	7.76	307	200	145	30	17	2.53	1.14	0	159	7.1	6.79	0.37	0	0
40	Purnapani	Tonto	22°28'20.7''	85°40'02.5''	DW	7.91	575	374	260	28	46	9.65	0.25	0	305	18	12	0	0	0
41	Jhinkpani	Jhinkpani	22°24'55.2''	85°46'01.7''	DW	7.15	1163	756	345	36	62	87	34	0	354	114	95	27	0	0

Annexure-IV

Details of weathered and semi weathered zones and possible presence of thin fractured zones, West Singhbhum district

VES	Village /Location	General Geology	Weathered zone (WZ) or different lithounit			Semi-weathered (SWZ)/Less compact zone or different lithounit			Fractured zone(FZ)	Recommendations for borehole drilling	Remarks
			Resistivity (ohm.m)	Depth to bottom (m)	Bottom depth of probable WZ aquifer (m)	Resistivity (ohm.m)	Depth to Bottom (m)	Bottom depth of probable SWZ aquifer/ (Depth to compact formation) (m)	Probable occurrence of thin FZ aquifer in the depth range (m)		
302	Morang	Phyllite	15 4 15	1-4 10-53 53-137	137	72	4-10	10 (137)	75-80, 85-90, 110-120, 130-140	140 m	The VES is in shale/ phyllite /slate. The very low resistivity layer in the depth range 10-53 m is probably the carbonaceous shale. Thin fractured zones inferred in the depth range 75-140 m could be tapped
303	Kodilabad	Phyllite-Quartzite	NA	NA	NA	98 53	50 90	90 (90)	30-45, 95-120	120 m	The VES is in shale/ phyllite /slate. The 53 ohm.m resistivity layer in the depth range 50-90 m is probably the weathered phyllite or different lithounit. Thin fractured zones inferred in the depth range 30-120 m could be tapped
304	Thalkabad	Phyllite-Quartzite	44 8	1-3 29-53	29-53	167	3-29	NA (> 53)	85-90, 120-130	130 m	The VES is in Shale/ phyllite/ slate. The 8 ohm.m resistivity layer in the depth range 29-53 m is probably the carbonaceous shale. Thin fractured zones inferred in the depth range 85-130 m could be tapped. The depth to compact formation is expected to be more than 53 m.

305	Tirilpasi	Quartzite	NA	NA	NA	106	1-6	NA (6)	NA	NA	Very High resistivity
306	Digh	Phyllite	NA	NA	NA	134	1-7	NA (7)	NA	NA	Presence of compact formation at about 6 m depth
307	Jumai	Phyllite	86	1-3	NA	132 119	3-9 9-45	up to 45 (45)	20-30, 40-45, 50-55, 75-80, 110-160	160 m	Thin fractured zones may be expected up to 160 m depth
308	Manoharpur	Phyllite	40	6	NA	NA	NA	NA (6)	NA	NA	Very High resistivity
309	Raidih	Phyllite	NA	NA	NA	87	29	29 (29)	45-50, 65-70, 110-120, 140-160	160 m	Fractured zone indications are feeble (Low Priority)
310	Mahuladih	Phyllite	NA	NA	NA	NA	NA	NA (from surface)	NA	NA	Very High resistivity
311	Tartara	Phyllite	43	13	4-13	NA	NA	13 (13)	30-45, 110-120, 130-140	140 m	Fractured zone indications are feeble (Low Priority)
312	Kiriburu	Phyllite-Sandstone	NA	NA	NA	215	24-107	24-107 (107)	85-90	100 m	High Resistivity in the depth range 24-107 m may be associated with different lithounit. Fractured zone indications are feeble (Low Priority)
313	Meghatuburu	Phyllite	NA	NA	NA	91	18-52	18-52 (52)	75-80	100 m	Very high resistivity up to 18 m depth. Carbonaceous shale or a different lithounit is expected in the depth range 18- 52 m.
314	Gua	Phyllite	13	23	up to 23 m	NA	NA	NA (23)	NA	NA	Very high resistivity beyond 23 m depth
315	Badajamda	Kolhans :	61	16-64	16-64	NA	NA	NA (64)	65-70, 90-95, 150-160	100 m	A different lithounit is expected in the depth range 16 to 64 m. The litho-contact may form aquifer.
316	Nowamundi	Kolhans	50	48	2-48	NA	NA	NA (28)	45-55, 75-80, 140-150	100 m	Very high resistivity beyond 48 m depth. The thin fractured zone indication at 140-150 m appears feeble. (Low Priority)
317	Anandpur	Phyllite	NA	NA	NA	241	9	9 (9)	35-40, 65-70, 110-120	120 m	Very high resistivity beyond 9 m depth. The thin fractured zone indications appear feeble. (Low Priority)

318	Gudri	Dalma Lava-Phyllite	74	9	4-9	NA	NA	NA (9)	NA	NA	Very high resistivity beyond 9 m depth
319	Kaida	Phyllite	NA	NA	NA	NA	NA	NA (from surface)	NA	NA	Very high resistivity
320	Jamdih	Phyllite	40	7	0-7	NA	NA	NA (7)	NA	NA	Very high resistivity
321	Goelkheda	Phyllite	NA	NA	NA	224	8-26	NA (26)	35-40, 75-80	40 m	Very high resistivity. The thin fractured zone indications appear feeble. (Low Priority)
322	Lajora	Phyllite	16	12	up to 12 m	90	12-25	12-25 (25)	30-35	40 m	Shallow fractured zone
323	Kuira	Phyllite	39 <1	1-24 24-176	NA	NA	NA	NA (< 176)	NA	NA	The very low resistivity layer could be of carbonaceous shale. There is a possibility of encountering thin fractured zone in the depth range 150-170 m.
324	Kochapur	Phyllite	7	13	up to 13 m	NA	NA	NA (13)	25-30, 35-55, 65-80, 130-160	80 m	The deeper thin fractured zone indications appear feeble. (Low Priority)
325	Harimara	Phyllite	11	1-6	NA	91	6-39	39 (39)	40-45, 55-60, 100-120, 160-170	120 m	The thin fractured zones up to 120 m depth appear to be prominent.
326	Simabanda	Phyllite	9 34	8 24	up to 24	NA	NA	NA (24)	45-55, 130-140	60 m	The thin fractured zone at 45-55 m depth appears to be prominent.
327	Natki	Phyllite-Granite	61	15	up to 15 m	NA	NA	NA (15)	45-55	60 m	The thin fractured zone at 45-55 m depth appears to be prominent.
328	Karaikela	Phyllite-Granite	10	10	up to 10 m	NA	NA	NA (10)	40-55, 130-140	60 m	The thin fractured zone at 40-55 m depth appears to be prominent.
329	Govindpur	Phyllite	52	43	up to 43 m	NA	NA	NA (43)	35-40, 45-70, 90-95	100 m	The weathered zone and fractured zone may hold aquifers
330	Gopinathpur	Singhbhum Granite	11 58	6 24	up to 24 m	NA	NA	NA (24)	25-30, 35-40, 100-110,	110 m	The weathered zone and fractured zone may hold aquifers
331	Basahatu	Sediments & Volcanics	42 < 1	19 19-100	NA	NA	NA	NA (≈ 100)	NA	NA	The layer with very low resistivity represents a different lithounit. Its contact zone with the underlying resistive lithounit may hold aquifer
332	Baralagiya	Phyllite	31	6	NA	166	6-43	43 (43)	15-35, 45-50,	150 m	The thin fractured zone up to 110

									65-70, 100-110, 130-140		m depth appears to be prominent.
334	Ghutuhatu	Kolhans	28	13	up to 13 m	NA	NA	NA (13)	NA	NA	NA
335	Jhinkpani	Singhbhum Granite	32	2	NA	NA	NA	NA (2)	NA	NA	NA
336	Barajhinkpani	Singhbhum Granite	NA	NA	NA	178	93	93 (93)	75-80, 130-140	100 m	The thin fractured zone at 75-80 m depth appears to be prominent.
337	Jagannathpur	Granite	36	6	NA	257	51	51 (51) The depth to compact formation could be taken as 6 m	30-40, 60-70, 130-140	100 m	The thin fractured zone at 30-40 m depth may hold good aquifer
338	Dangua	Dhanjori Lava	42	5	NA	32	9-31	31 (31)	35-50, 55-60, 70-80, 95-100, 130-150, 170-190	100 m	Compaction in the depth range 5-9 m. The thin fractured zones up to 100 m depth is expected to hold good aquifer
339	Boriya	Older Metamorphics	12	14	NA	NA	NA	NA (14)	40-45, 50-55, 110-130	130 m	The fractured zones are feebly reflected (Low Priority)
340	Manikpur	Granite Gneiss	59	22	2-22	NA	NA	22 (22) The max. depth to compact formation could be 35 m	40-50, 70-75	100 m	The thin fractured zone at 40-50 m depth is expected to hold good aquifer
341	Gariyabuba	Granite Gneiss	18	14	3-14	NA	NA	NA (14)	40-45, 70-85	100 m	The thin fractured zones up to 85 m depth is expected to hold aquifer (Low Priority)
342	Jainthgarh	Granite Gneiss	10 28	6 25	up to 25 m	NA	NA	NA (25)	35-40, 45-50, 120-130	50 m	The thin fractured zone at 120-130 m depth is feeble.
343	Mundai	Granite Gneiss	6 31	8 19	up to 19 m	NA	NA	NA (19)	35-45, 65-70, 85-90, 120-130	130 m	WZ indications are feeble
344	Amjara	Granite Gneiss	49	8	NA	275	53	53 (53) Min depth to compact	NA	NA	NA

								formation could be 8 m			
345	Binani	Granite Gneiss	21	4	NA	208	76	76 (76). The depth to compact formation could be less than 76 m	100-120, 150-160	120 m	The thin fractured zones are feeble (Low Priority)
346	Dinnomi	Granite Gneiss	18 64	4 8	up to 8 m	NA	NA	NA (8)	65-75	100 m	Low Priority
347	Duvarsai	Kolhans	NA	NA	NA	261	7	7 (7)	NA	NA	NA
348	Papseya	Phyllite-Kolhan	NA	NA	NA	114	11	11 (11)	45-50, 75-80, 120-130	150 m	The thin fractured zones up to 80 m depth appear to hold aquifer
349	Katgarh	Kolhan-Dhanjori Lava	NA	NA	NA	57	70	70 (70)	95-100	100 m	The thin fractured zones in the depth range 95-100 m depth appear to hold aquifer