केंद्रीय 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

JAMTARA DISTRICT, JHARKHAND

राज्य एकक कार्यालय, रांची

State Unit Office, Ranchi

भारतसरकार

Government of India

जल शक्ति मंत्रालय

Ministry of Jal Shakti

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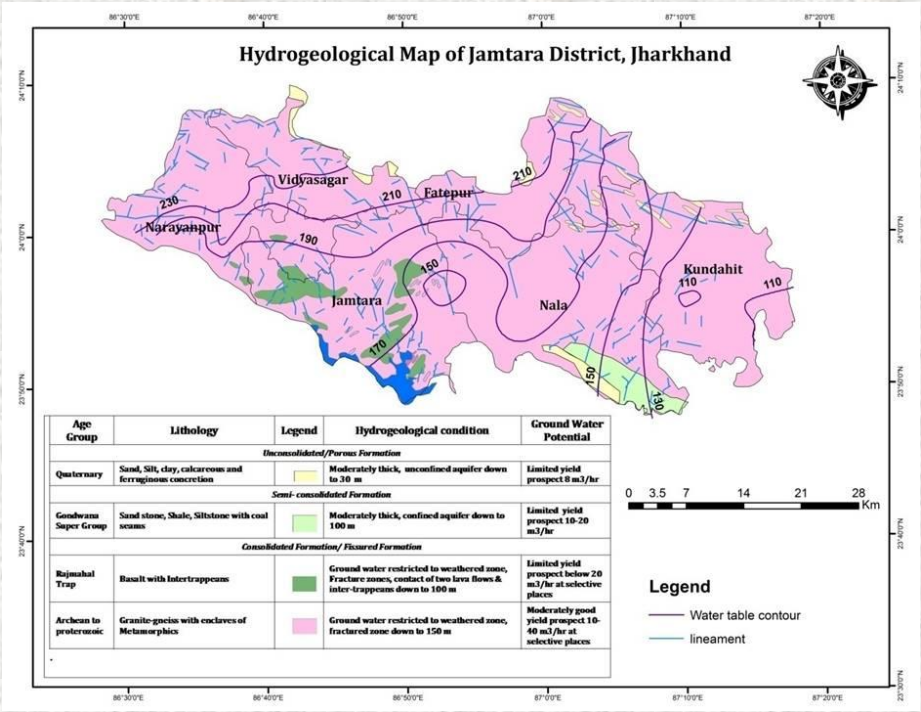
Central Ground Water Board

Aquifer Maps and Ground Water Management Plan of Jamtara district, Jharkhand(2018-19)

जलभृत नक्शे तथा भूजल प्रबंधन योजना

जामताड़ा जिला,झारखण्ड (2018-19)



Age Group	Lithology	Legend	Hydrogeological condition	Ground Water Potential
Unconsolidated/Porous Formation				
Quaternary	Sand, Silt, clay, calcareous and ferruginous concretion		Moderately thick, unconfined aquifer down to 30 m	Limited yield prospect 8 m3/hr
Semi- consolidated Formation				
Gondwana Super Group	Sand stone, Shale, Siltstone with coal seams		Moderately thick, confined aquifer down to 100 m	Limited yield prospect 10-20 m3/hr
Consolidated Formation/ Fissured Formation				
Rajmahal Trap	Basalt with Intertrappeans		Ground water restricted to weathered zone, Fracture zones, contact of two lava flows & inter-trappeans down to 100 m	Limited yield prospect below 20 m3/hr at selective places
Archean to proterozoic	Granite-gneiss with enclaves of Metamorphics		Ground water restricted to weathered zone, fractured zone down to 150 m	Moderately good yield prospect 10-40 m3/hr at selective places

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REPORT ON NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN OF JAMTARA DISTRICT, JHARKHAND 2018 – 19 (PART – I)

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REPORT ON AQUIFER MAPS AND MANAGEMENT PLAN (PART – I) OF JAMTARA DISTRICT, JHARKHAND STATE (2018 - 19)

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(PART – I)

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

1.0 INTRODUCTION:

The vagaries of rainfall, inherent heterogenity & unsustainable nature of hard rock aquifers, over exploitation of once copious aquifers, lack of regulation mechanism etc has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from "**Traditional Groundwater Development concept" to "Modern Groundwater Management concept"**. Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and 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 2018-19, CGWB State Unit Office, Ranchi, has carried out Aquifer mapping and Management Plan in Jamtara district of Jharkhand State with the aim of delianation 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 aredelineation 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:

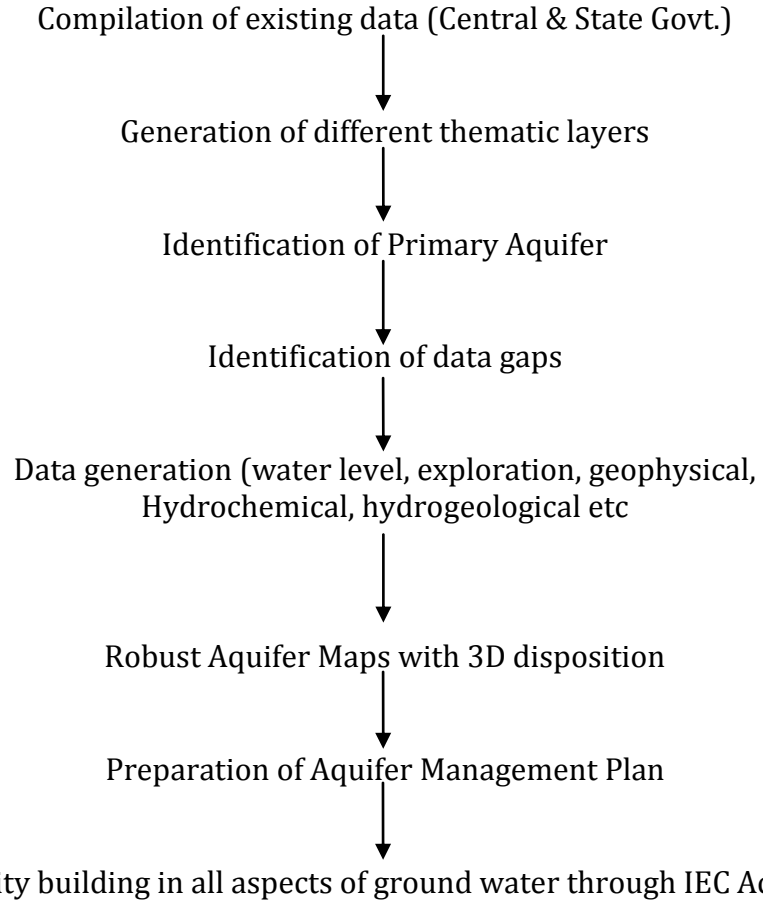
a). Identifying the aquifer geometry
b). Aquifer characteristics and their yield potential
c). Quality of water occurring at various depths
d). Assessment of ground water resources
e). Preparation of aquifer maps and
f). Formulation ground water management plan.

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 Aquifermapping is as given below:



1.3 Area details:

Jamtara is a newly formed district of Jharkhand state. It comes in existence on 26th April 2001. Jamtara district is situated in the North Eastern part of Jharkhand state. Jamtara town is the administrative headquarters of Jamtara district. District is located at lower altitude of Chotanagpur plateau and bounded between 23°10' and 24°05' north latitudes and 86°30' and 87°15' east longitudes respectively. It is a small district of Jharkhand State Comprises only six blocks and surrounded by Deoghar district in north, Dumka and Birbhum district(West Bengal) in the east, Dhanbad and Paschmi Bardhaman district (West Bengal) in the south and Giridih in the west.Chittranjan, Jamtara, Vidyasagar are three railway station (on main line Delhi to Howrah) situated in Jamtara district.

The Jamtara district falls in the survey of India Toposheet Nos. 72L/12, 72L/16, 72P/7204, 73I/09, 73I/13 and 73M/01 (part). Total geographical area of the district is 1804 sq km, and six development blocks, namely Kundahit, Nala, Jamtara, Narayanpur, Karmatar and Fatehpur. It has two municipal corporations Jamtara and Mihijam. It has only one sub division called Jamtara. There are 118 Gram Panchayats and 1164villages in the district.Total population of the district is 791042 includuing rural population of 715296 and urban population of 75746 with the population density of 440/km2 (As per Census 2011). The district administrative unit with geographical area (sq.km) is given in table 1 and base map of Jamtara district is shown in figure 1.

Table 1: The district administrative unit with geographicl area (sq.km)

S.No.	Blocks	Geographical area (sq.km)	No of Villages
1	Fathepur	281.09	179
2	Jamtara	328.75	139
3	Vidyasagar	171.22	151
4	Kundhit	298.74	172
5	Nala	413.84	261
6	Narayanpur	310.065	262
	Total	**1804**	**1164**

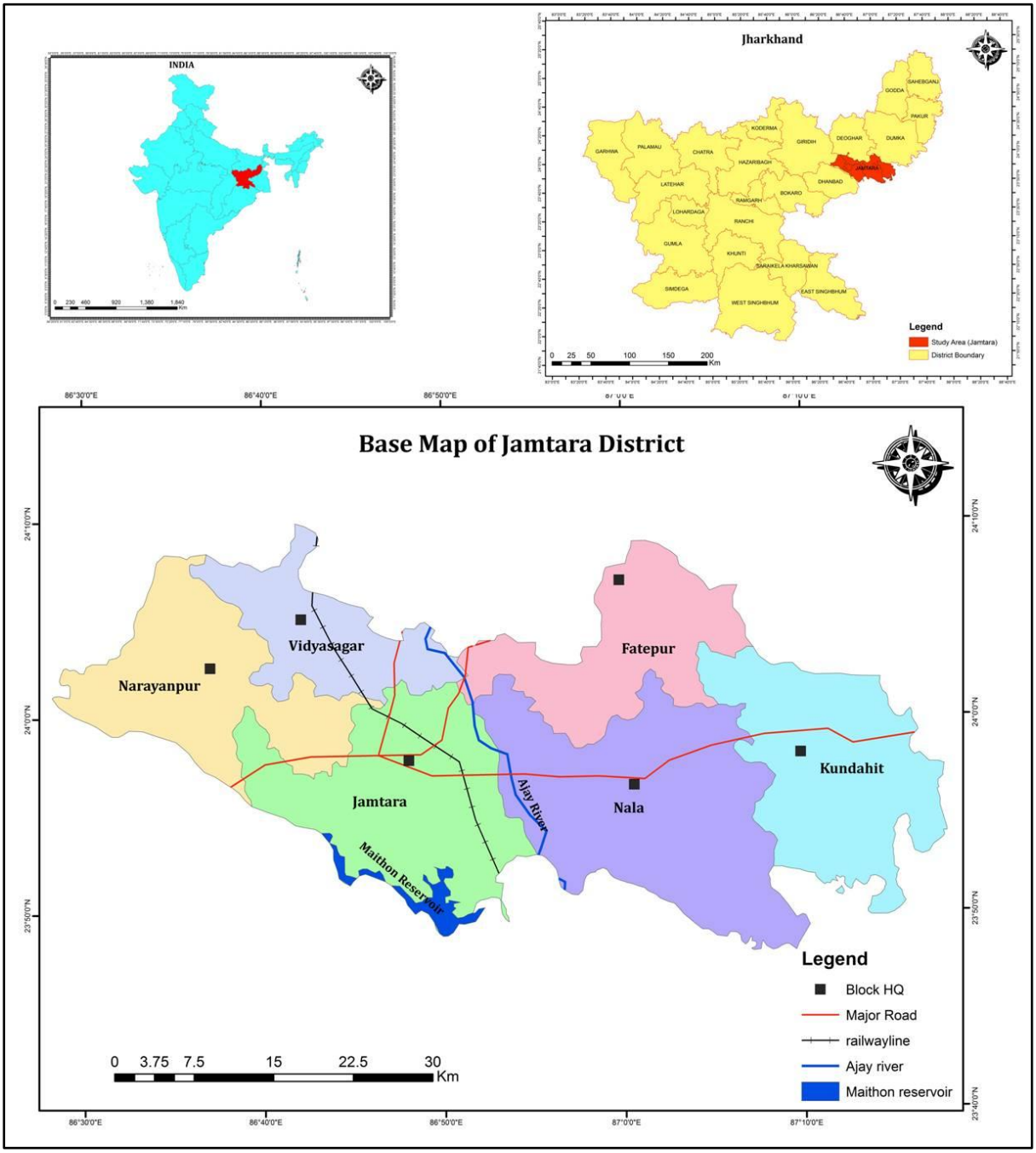


Figure 1: Base map of Jamtara district

1.4 Data Availability, Data Adequacy and Data Gap Analysis

1.4.1Data Availability:-

Central Ground Water Board has carried out exploratory drilling in the district and drilled twenty one exploratory and four observation wells by departmental (12 nos)andthrough outsourcing (09nos) as on March 2019 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, seven numbersof permanent observation well (HNS) of Central Ground Water Board located in the district are being monitored (4 times in a year) bfor ground water regime and to assess the chemical quality of ground water.

1.4.2Data Adequacy and Data Gap Analysis:

The available data of the exploratory wells drilled by Central Ground Water Board, SUO, Ranchi,geophysicalsurvey carried out in the area, ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analyzed for adequacy of the same for the aquifer mapping studies. After taking into consideration, the available data of ground water exploration, geophysical survey, ground water monitoring and ground water quality, the data adequacy is compiled and the summarised details of required, existing and data gap of exploratory wells, ground water monitoring and ground water quality stations is given in table – 2.

Table – 2: Data adequacy and data gap analysis

Exploratory data				**Geophysical data**				**GW monitoring data**				**GW quality data**			
Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation	Req.	Exist.	Gap	Generation
21	16	5	5	13	0	0	14	26	7	19	19	26	7	0	19

Based on the data gap identification, the data generation activity was planned and completed in 2018-19.

1.5 Climate and Rainfall

The climate of Jamtara district can be divided into three distinct seasons in a year, viz. winter, summer and monsoon seasons. Winter commences from late November and continues till the end of February. January is the coldest month of the year. Winter is characterized by heavy dew, thick fog and associated cold wave when mercury drops down to as low as 30^0C to 40^0C. May is the hottest month of the year. The rainy season commences from the middle of June and continues till the end of September. The beginning of monsoon is marked by dust storms, thunder and lightning.

Relative humidity is the lowest during the summer months when it can be as low as 30% in the afternoon. In the night humidity is relatively high.Light north westerly wind prevails during the winter and summer months. Towards the end of the summer season wind begins to blow more and more from directions between north-east and south-east. These wind strengthen and predominately during monsoon. Dust storms occur occasionally in April and May.

District receives an annual rainfall of 1271 mm with 65 to 70 number of rainy days spread across four months with August month receiving most of the rain fall.The district receives a larger share of the annual rainfall mainly by the south west monsoon during the rainy season and from the retreating monsoon during the inter monsoon period which originates in the Bay of Bengal. The district receives most of the annual rainfall during the monsoon period. The average rainfall data (2001-2018) and rainfall departure of last five year data of Jamtara district is given in table 3 and table 4 respectively.

Table- 3Average Rainfall Data of 2001-2018 (Unit -mm) of Jamtara District

Year	Jan.	Feb.	March	Aprill	May	June	July	Agu.	Sept.	Oct.	Nov.	Dec.	Total
mm	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F
2001	0.0	0.0	8.2	1.4	147.8	391.1	169.1	223.5	101.7	209.6	0.0	0.0	1252.4
2002	8.1	5.9	5.1	41.3	87.0	246.5	288.3	246.0	294.5	90.6	0.6	0.0	1313.9
2003	1.2	43.7	27.3	42.5	30.7	196.0	220.9	282.1	164.0	158.2	0.0	0.0	1166.6
2004	10.2	0.0	0.0	162.5	71.5	252.7	208.5	238.7	167.2	215.7	0.0	0.0	1327
2005	46.6	30.2	38.5	27.6	51.6	200.8	472.0	99.4	122.5	199.0	0.0	0.0	1288.2
2006	0.0	0.0	7.0	17.2	65.5	201.2	613.4	261.0	367.0	24.0	2.8	0.0	1559.1
2007	0.0	54.0	16.2	42.2	52.4	145.3	599.2	436.3	393.6	62.2	3.4	0.0	1804.8
2008	8.0	0.0	1.2	33.2	43.5	243.4	605.5	306.0	184.3	18.7	0.0	0.0	1443.8
2009	0.0	3.2	0.0	1.4	87.1	66.9	175.5	231.9	230.1	71.4	0.0	0.0	867.5
2010	0.0	5.3	0.0	3.8	22.1	131.7	171.4	121.0	119.5	78.3	0.0	5.0	658.1
2011	0.0	0.0	45.2	40.8	90.3	448.9	222.0	504.0	200.0	40.9	0.0	0.0	1592.1
2014	9.1	42	20.8	9.3	87.3	166.5	279.1	220	159	11.3	0.0	0.0	1004.4
2015	18	5.7	56.3	42.1	31.1	213.9	578.2	335	87.3	7.3	0.0	0.0	1374.9
2016	13	7.3	5.2	0.8	122	234.3	360.7	342	280	39.3	0.0	0.0	1404.6
2017	0.0	0.0	0.0	0.0	74.2	139.1	455	174	151	227	0.0	0.0	1220.3
2018	0.0	0.0	0.0	129.4	50.5	202.5	266.7	184	177	19	0.0	10	1039.1

Table-4 last five year rainfall departure (%) data of Jamtara District

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP	%DEP
2014	-37	101	12	-43	31	-20	-19	-36	-46	-91	-100	-100
2015	21	-73	205	158	-53	2	67	-2	-71	-94	-100	-100
2016	-13	-65	-72	-95	84	12	4	0	-5	-69	0.0	0.0
2017	0.0	0.0	0.0	0.0	12	-34	31	-49	-49	78	0.0	0.0
2018	0.0	0.0	-100	694	-24	-3	-23	-46	-40	-85	-100	83

1.6 Physiography:

The area is characterized by undulating topography with hills and plain. The district is located in Rajmahal highland. It consists of rolling open land surface with long ridges and intervening depressions. The highest and lowest elevation identified in north western and south eastern part of the district. The area having a relief of above + 354 amsl constitutes scaterred hill features of pre-cambrian rocks. In central part of the district near ajay river basin elevation range occurs between 97-156 above msl. Eastern zone of the district is mostly low land area whereas western part of the district is generallyupland area.The digital elevation model of Jamtara district has been prepared and shown in figure 2.

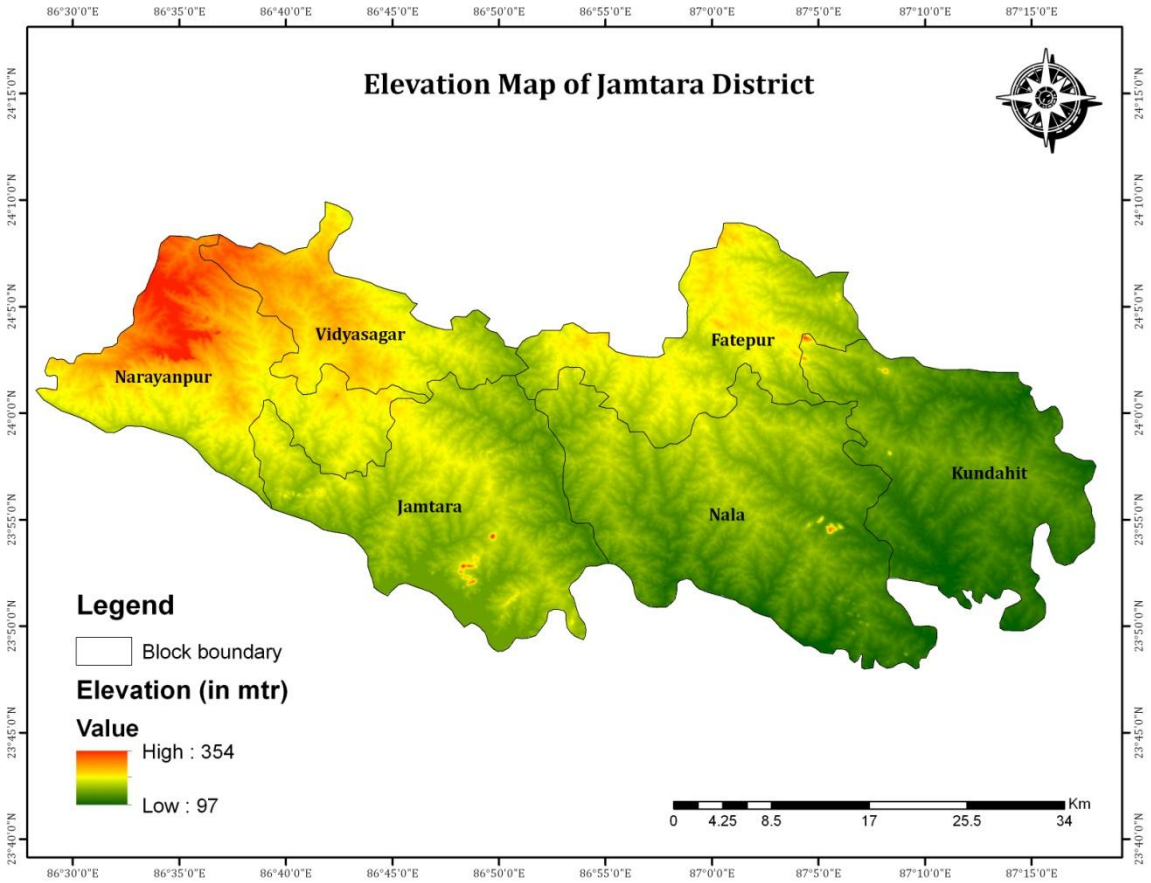


Figure 2 – : Digital elevation model of Jamtara district

1.7 Geomorphology:

Geomorphologically, the district can broadly be divided into three well defined physiographic units (a) Hilly area (b) Rolling velleys and (c) Pediplain flat country. The general slope of the district is from North to South East.The area is characterized by gently undulating topography with isolated hill and hummocks. The lower level in the area is occupied by the granite gneiss of CGC and alluvial plains. The regional slope of the area is towards south east. Block-wise slope of the Jamtara district is given in table-5 and geomorphological map of the area is shown in figure 3.

Table- 5 Block-wise slope of the Jamtara district

Block	Area (in ha)	0-3%	3-8%	8-25%
Karmatanr	9500	8000	1300	200
Nala	17200	6500	10000	700
Fatehpur	10500	5250	5000	250
Kundahit	15500	9300	3875	2325
Narayanpur	17800	8900	7120	1780
Jamtara	18500	14800	2775	925

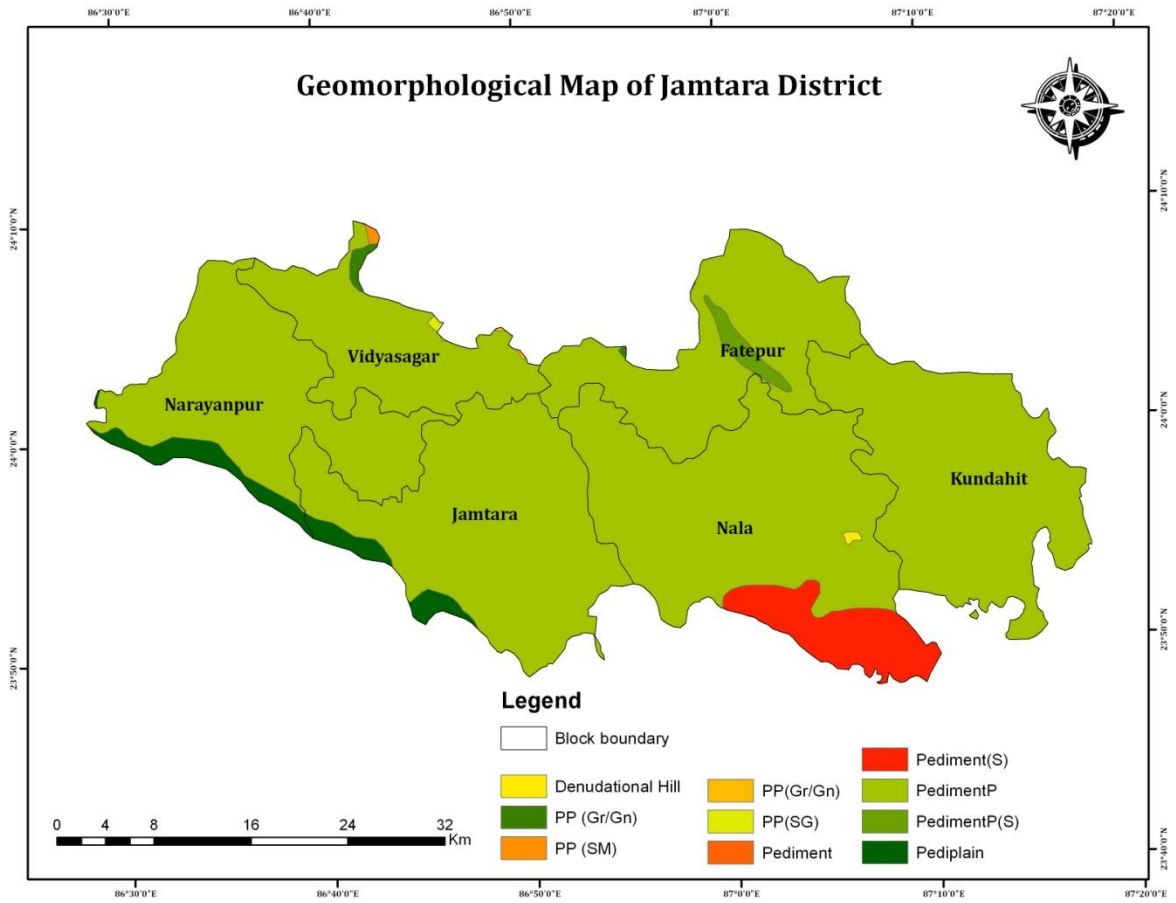


Figure 3 – : Geomophological Map of Jamtara district

1.8 Land Use:

Land is an important resource available to the mankind. Proper planning and utilization of land is important not only in the betterment of an individual, but also contributes to the development of a nation. Landuse planning depends on several factors: climate, soil character, ground water level, water availability, rainfall and terrain condition. The analysis of land use in the present study is based on district statistical magazine, data available at block level and revenue office. Landuse map of the Jamtara district is shown in figure 4 and given in table 6. Following categories of land use have been recognised in the study area.

Agriculture, cropland, Plantation: Agriculture is the main landuse in the area. Most of the first and second order streams in the area are cultivated. Most of the cultivated lands are located towards the central part of the study area. Rice is the principle crop grown in these areas. Other crops include paddy, maize, oilseeds, vegetables etc.These are the lands primarily used for farming and for production of food, fiber, and other commercial and horticultural crops. Cropland includes land under crops (irrigated and unirrigated, fallow, plantations etc.). These are the areas with standing crop as on the date of satellite overpass. Cropped areas appear in bright red to red in color with varying shape and size in a contiguous to noncontiguous pattern. They are widely

distributed in different terrains; prominently appear in the irrigated areas irrespective of the source of irrigation.

Settlement/Build up-Urban: Jamtara block is the largest urban settlement in the area.It is an area of human habitation developed due to non-agricultural use and that has a cover of buildings, transport and communication, utilities in association with water, vegetation and vacant lands.

Barren/Wasteland/ unculturable, barren rocky: Scattered patches of the areas with the bad land topography are also present in the area. Most of the barren land area is present near to the coal mines.

Mining: Abundant coal mining activities is observed in the southern part of the study area. Presently working quarries are opencast mechanised projects. These open cast mining is mostly restricted to the Barakar Formation, towards the southern part of the area.

Rural: Large numbers of small and big rural area are widespred in the district. All the agricultural villages covering 5 hectares area and more are included in this category. These are the built-up areas, smaller in size, mainly associated with agriculture and allied sectors and non-commercial activities with population size less than 5000, generally lack supporting facilities that are unique to urban areas like hospitals, industries (large and medium scale), institutional etc. They appear in dark bluish green in the core built-up area and bluish in the periphery; the size varies from small to big; irregular and discontinuous in appearance; can be seen in clusters con-contiguous or scattered.

Forest: Dense to open mixed jungles are present the study area, especially around the Maithon reservoir. These forested areas usually occupy the high topographic contours. Lodwa forest (Δ326) is an open mixed forest. Durgapur (Δ360) is an example of dense mixed forest.

Open scrub: open scrubs are wide spread towards the south of the Ajay river, They mostly occupy flat to gently undulating area.

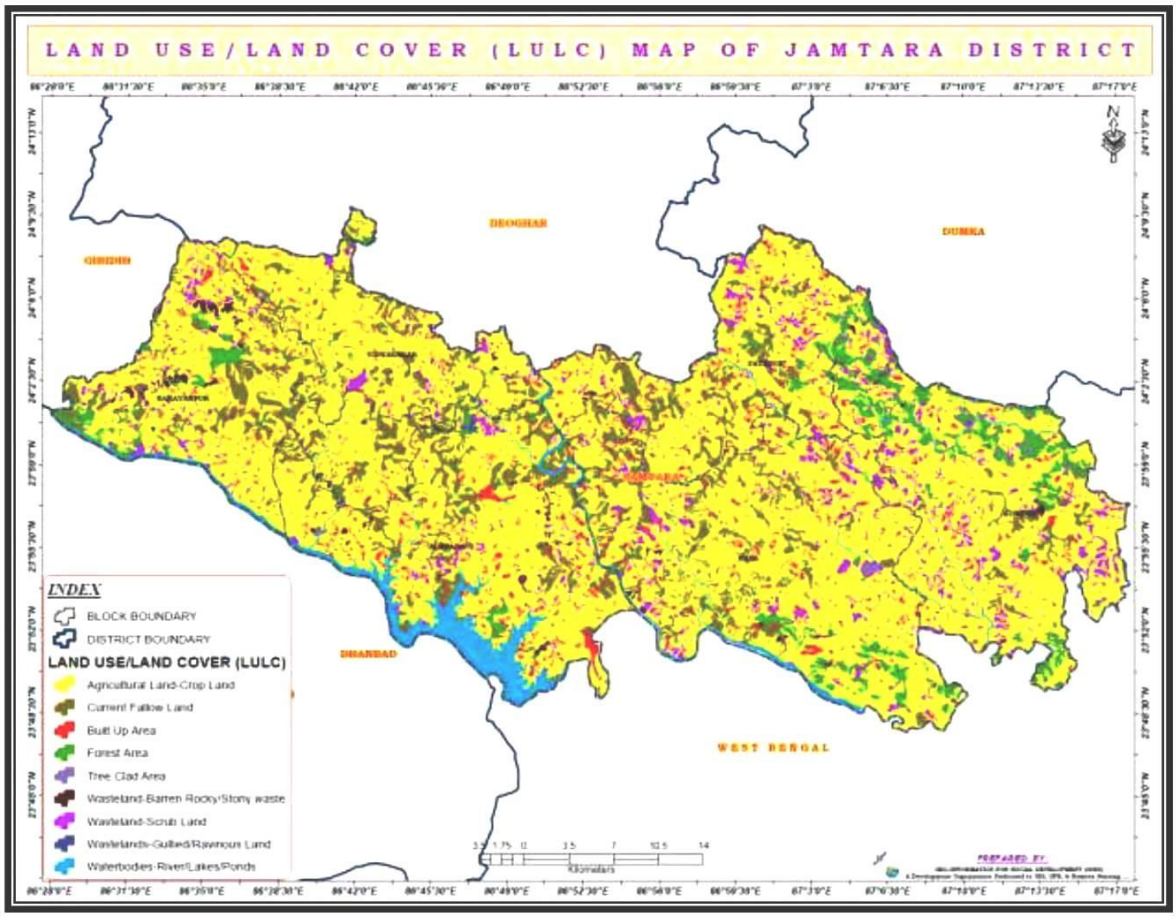


Figure 4– : Land-Use map of Jamtara district

Table 6 - Landuse classification of Jamtara district

BLOCK	Agricultural Land-Crop Land	Built -Up Area	Current Fallow Land	Forest Area	Tree Clad Area	Wasteland-Barren Rocky/Stony waste	Wasteland-Scrub Land	Wastelands-Gullied/Ravinous Land	Waterbodies-River/Lakes/Ponds
Fatehpur	1246.11	1246.1	2718.87	1113.6	74.13	120.87	2281.98	102.0	200.94
Jamtara	22161.9	2054.2	4312.66	330.46	82.48	608.45	1323.08	74.97	4819.4
Kundahit	21967.6	919.86	923.36	3462.2	378.8	108.08	3400.27	162.0	833.38
Nala	30995.7	1746.7	4854.78	1448.2	92.65	246.15	3113.15	98.75	1379.8
Narayanpur	18993.4	1169.8	4022.14	1249.5	20.36	619.53	1777.07	106.5	730.64
Karmatanr	13131.8	731.90	2270.16	127.79	28.56	58.80	869.42	59.75	187.42

1.9 Soil:

Major soil types are Entisols, Inceptisols and Alfisols are common.The soils occurring in different landforms have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar et al. 1996) and three soil orders namely Entisols, Inceptisols and Alfisols were observed in Jamtara district. Inceptisols were the dominant soils covering 50.8 percent of **TGA**(thermogravimetric analysis)followed by Alfisols (39.3 %) and Entisols (6.6 %).

1.10 Hydrology and Drainage:

The Drainage is mainly controlled by South easterly flowing Ajay River and Southerly flowing Barakar River and their tributaries. The drainage pattern is mostly dendritic and drainage density is moderate. Ajay and Barakar rivers are the highest order stream in the area. The drainage of the area is controlled by these two rivers and their tributaries. Ajay River flows from North-West to South-East, while Barakar River flows from North to South. Ajay River originates from Saran (24°29' 00"; 86°18'00") in the south eastern part of Chakai Plateau and flows eastward into Bhagirathi catchments. It enters the study area with a large meandering loop and then follows the straight course and exits near Debkunda in a meandering fashion. Barakar is also a long distance river, originating at the Koderma plateau, and occupies the south-western part of the study area. Maithon Reservoir is constructed over Barakar River. The streams are mostly ephemeral and are active during the rainy season .The drainage pattern is dendritic to sub-dendritc with medium drainage density. Most of the first and second order streams are cultivated. A large number of man-made lakes/ponds are abundant in the area. Near to the mining area, most of the streams are high polluted. The drainage map of Jamtara district is shown in figure 5.

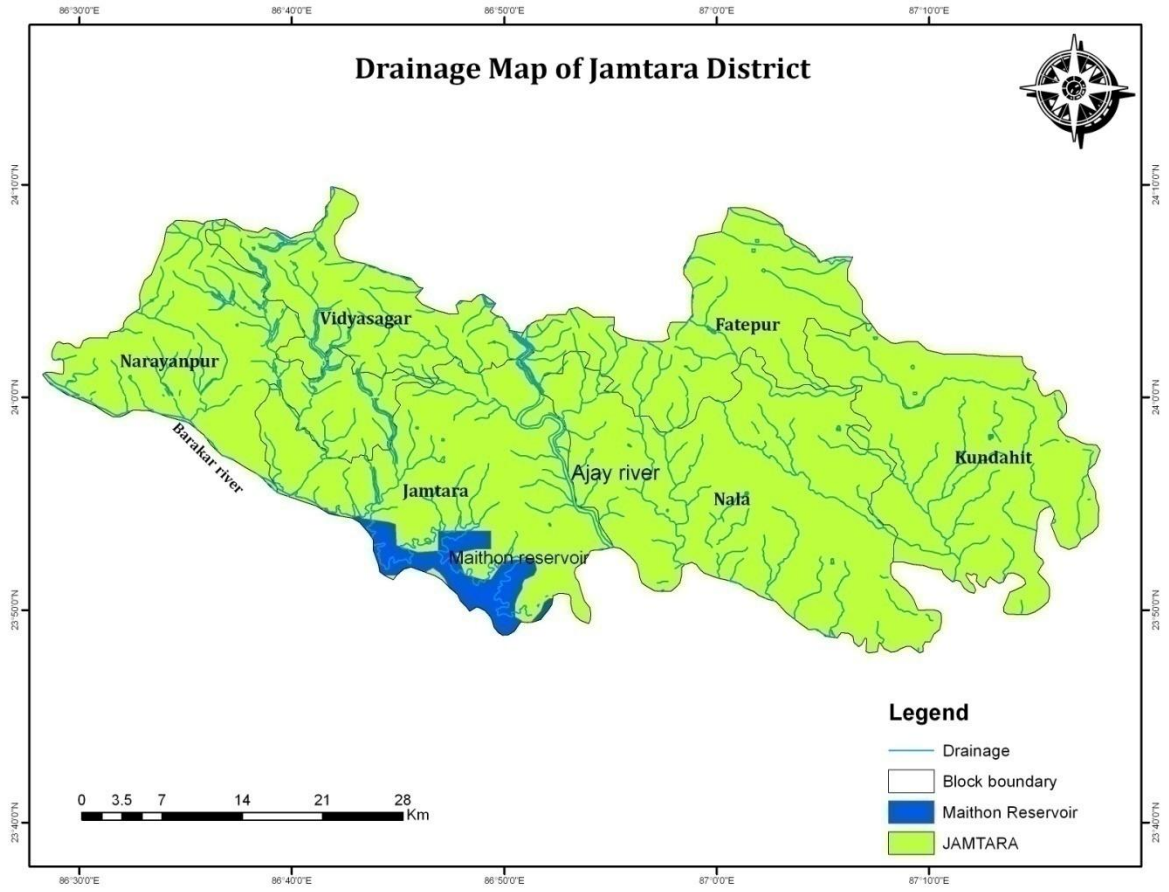


Figure 5–: Drainage Map of Jamtara district

1.11 Agriculture and Irrigation Practice:

Rice is the principal crop grown in the area. Wheat, Barley, Maize, Gram, Mustard, Tur, sugarcane Potato are the other crops in the area. The crops are mainly monsoon dependent**.**The varieties of plantations which are commonly found are Sal, Acacia, Sisoo and Eucalyptus. The floral biodiversity of the area is rich with many flowering and non flowering plants.

District-wise numbers of different types of ground water abstraction structures as per final 5th MI Census are given in Table 6. The Table 6 indicates that Dug wells are the major structure for irrigation in the district. For dug wells, considered unit draft value of varies from 0.075 to 0.3 ham for monsoon and non-monsoon period. Unit drafts of shallow tube-well and deep tube-well are considered 1.2 ham/yr and 16 ham/yr respectively.Block-wise surface water and ground water based irrigation practices is given in table 7.

Table-7.Block-wise surface water and ground water based irrigation practices in Jamtara district

Blocks	Number of Structures			Unit Draft of GW Structures for Irrigation						Sueface Water Scheme		SW Irrigation
				DW		STW		DTW				
	DW	STW	DTW	Mon	NM	Mon	NM	Mon	NM	Sflow	Slift	ham
Fatepur	488	122	8	0.08	0.3	0.3	1.2	4	16	281	469	647
Jamtara	434	12	0	0.08	0.3	0.3	1.2	4	16	395	44	171
Kundahit	556	29	0	0.08	0.3	0.3	1.2	4	16	351	69	188
Nala	561	37	0	0.08	0.3	0.3	1.2	4	16	466	576	831
Narayanpur	1619	8	1	0.08	0.3	0.3	1.2	4	16	555	179	381
Vidyasagar	431	38	1	0.08	0.3	0.3	1.2	4	16	177	72	140

2. DATA COLLECTION AND GENERATION

The primary Data such as water level, quality, geophysical data and exploration details, available with CGWB has been collected and utilised as baseline data. The Central Ground Water Board has established a network of observation wells under National Hydrograph Network programme to study the behavior of ground water level and quality of ground water in the district. To understand the sub–surface geology, identify the various water bearing horizons including their depth, thickness and compute the hydraulic characteristics such as transmissivity and storativity of the aquifers, exploratory drilling programme was carried out by Central Ground Water Board. For other inputs such as hydrometeorological, Landuse, cropping pattern etc were collected from concerned state and central govt departments and compiled. There is no aquifer-wise data available from State or any other agencies.

2.1 Data collection and Compilation: The data collection and compilation for various components was carried out as given below -

i. Hydrogeological Data: Water level data of 19 key wells and historical water level trend of monitoring wells were collected and compiled representing Aquifer-I.

ii. Hydrochemical Data: To evaluate the quality of ground water, 19 samples were collected from dug wells representing shallow aquifer (Aquifer – I)

iii. Geophysical survey**:** 14 VES were carried out to identify the weathered zone resistivity and its thickness as wells as find out deeper fracture zone and different layer of basaltic formation.

iv. Exploratory drilling**:** 21exploratory and6 observation wells drilled in hard rock area of the district through departmental rigs as well as through out sourcing private rig.

v. Hydrometeorological Data: Last ten years (2001 – 2018) monsoon rainfall data for each of the block from the office of District Agriculture Department, Jamtara.

vi. Land use and cropping pattern data**:**Thedata of land use and cropping pattern from the office of Director Statistics, Ranchi.

2.2 Data Generation:

After taking into consideration, the data available with CGWB on ground water monitoring wells (GWMW), ground water quality, geophysical survey and ground water exploration, the data adequacy was compiled and it indicated that exploratory drilling is required at least 5 locations of Jamtara, Nala, Naryanpur, Vidyasagar and Fathepur blocks, of Jamtara district. The requirement, availability and gap of major data inputs i.e., exploratory wells, geophysical data, ground water monitoring wells and ground water quality data are detailed in the table – 2.

2.2.1 Ground water Monitoring Wells: Water level and water quality is being monitored from 27 dug wells (existing NHS 7 well + established -19 well). 19 key wells were established to assess the ground water scenario of shallow aquifer (Aquifer-I) of the area. Location of key wells and exploratory wells are shown in figure 6 and given in *Annexure-II*

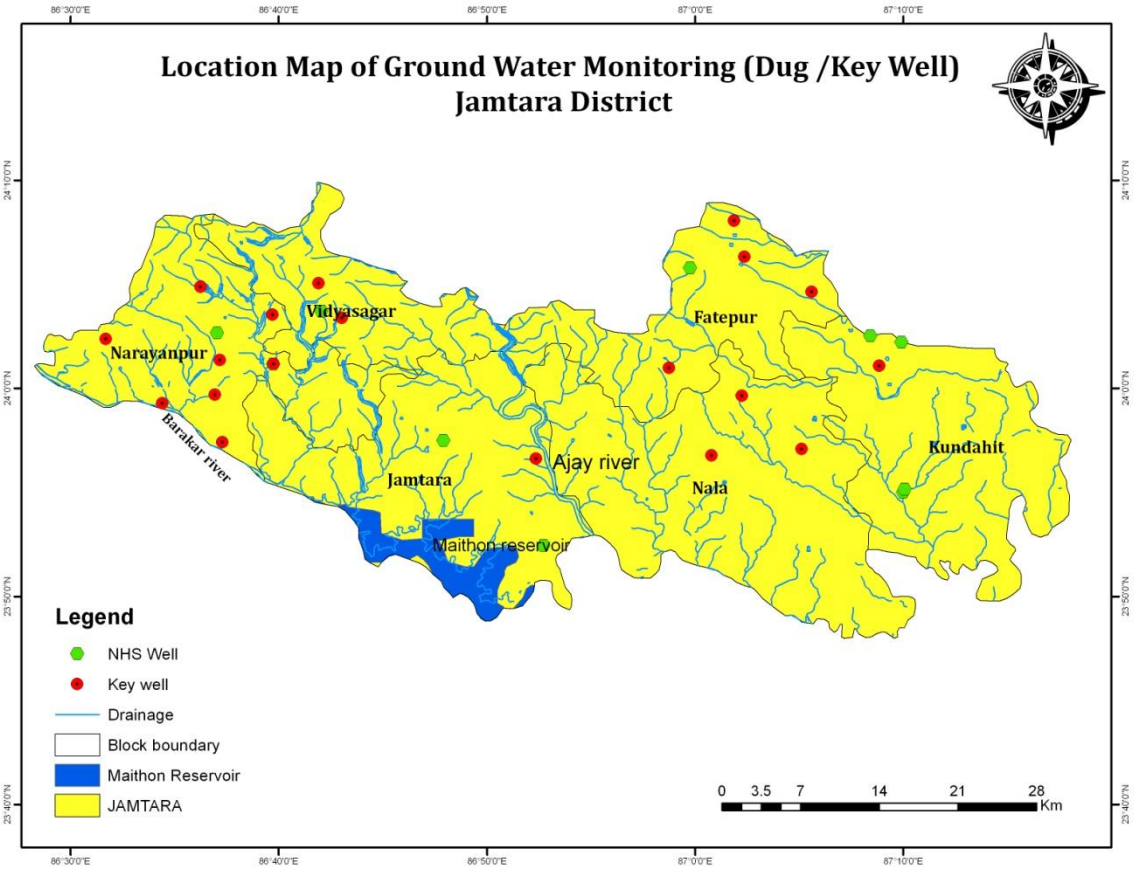


Figure 6–: Location of NHS and key wells in Jamtara district

2.2.2 Ground Water Exploration: In addition to 16 existing bore wells, 5 exploratory &3 obsevatory wells were drilled during 2018-19 in the area. Location and details of exploratory and observation wells are given in *Annexure- I*

2.2.3Ground Water Quality: To assess the quality of ground water, 26 samples were collected from dug wells representing Aquifer – I. Details of water quality result are given inAnnexure- III

2.2.4 Geophysical Survey:A total 8 VES have been conducted in the district during 2018-2019 and 16 VES were conducted earlier which is given in annexure –V. Block wise number of VES conducted in Jamtara district is given below in table –10

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

1. Drainage
2. Geomorphology
3. Geology & structures

The thematic layers such as drainage and geomorphology have been described in Chapter – I.

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

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

3.1 Geological setup

Geologically, Jamtara districtis represented by Chotanagpur Granite-Gneiss of Archaean age to Proterozoic, which are overlain by Gondwana Super Group , Rajmahal basaltic lava flows (Upper Jurrassic to lower cretaceous age) with intertrappean beds and at places Laterites and Alluvium(as per GSI)

The Chotanagpur Gneissic complex is largely represented lithological unit in the area and covers the major part of the district uninterruptedly. They form more or less gently undulating plains and high grounds pediments and buried pediments, seldom giving rise to small hillocks mounds. They are mostly biotite gneisses and granite gneisses and in general coarse grained with porphroblastic texture and traversed by pegmatitite and quartz vein of various dimensions. It contains enclave of amphibolites and mica schists. The Precambrian formations are overlain by Gondwana formations. Gondwanas are represented mainly by Barakar and Talchir formations in the form of a strip running roughly in the NW-SE direction. However an isolated patch of this formation is also found to occur in the central part of the district. A Talchir formation consists of sandsone and shales. Barakar formation consists of white to fawn colored coarse grained sandstone, grits with occasional conglomerstes and carbonaceous shales, thin lenticles and streaks of coal are found in this formation. Common plant fossils occurring in Barakar shales include gangomopteris, cyclipteris, glossoperis indica and vertebraria indica.

The pre-cambrian formations/Gondwana formations are further overlapped by Rajmahal Traps consists of basaltic lava flows with sedimentary intertrappeans. The basaltic rocks are hard and fine to medium grained. Some of the lava flows are vesicular and cavities being filled by calcite and chalcedony. The non vesicular lava flows are hard, tough, compact and fine to medium grained in nature. The vesicular types are comparatively soft and breaks easily. They are greenish to dark in colour with number of flows not clearly delineated in this district. In general the Rajmahal traps show vertical to horizontal joints trending E-W and N-S. Typical columnar joints are also common. These rocks are weathered with characteristic spherical exfoliation which gives rise to large rounded boulders as the out crops. It has been proved that basalts too are productive when either weathered or fractured.

The Laterites are found in patches over Rajmahal traps at few locations. The alluvium patches are generally seen along major streams. Narrow, discontinuous patches of alluvium particularly in granitic country are identified. They comprises medium to

coarse grained sand associated with silt and clay. Occasionally calcareous nodules are also found to occur. They are light grey to brownish colour. The thickness of the alluvium varies from place to place and is largely controlled by topography of the basement crystalliones.

In the district, the rocks are highly deformed and metamorphosed. The exposure of granite and other associated rocks show intricate folding. Based on morphotectonic analysis, the area has undergone several phases of tectonic deformations which leads to various sets of fractures, fissures, faults etc which leads to lineaments. Based on lineament study of the area, various sets of fractures have been identified

The general geological succession as encountered in Jamtara district (As per GSI) is given below in table 7 and geological map of Jamtara district is shown in figure 7.

Table 8 Geological succession of Jamtara district

Lithology	**Formation**	**Age**
Alluvium	Quaternary	Recent
Rajmahal Basalt & Intertrapeans	Rajmahal Trap	Middle Jurrasic to Cretaceous
Silt stone, sandstone and shale with Coal seams	Barakar	Lower Gondwana (Carboniferous to Permian)
Shale, sandstones and Conglomerate	Talchir	
……Unconformity……..		
Granite gneiss, biotite-Gneiss, schists, amphibolites, Hornblend schist, pegmatite, quartz veins	Chotanagpur Granite-Gneissic Complex & Unclassified metamorphics	Archean to proterozoic

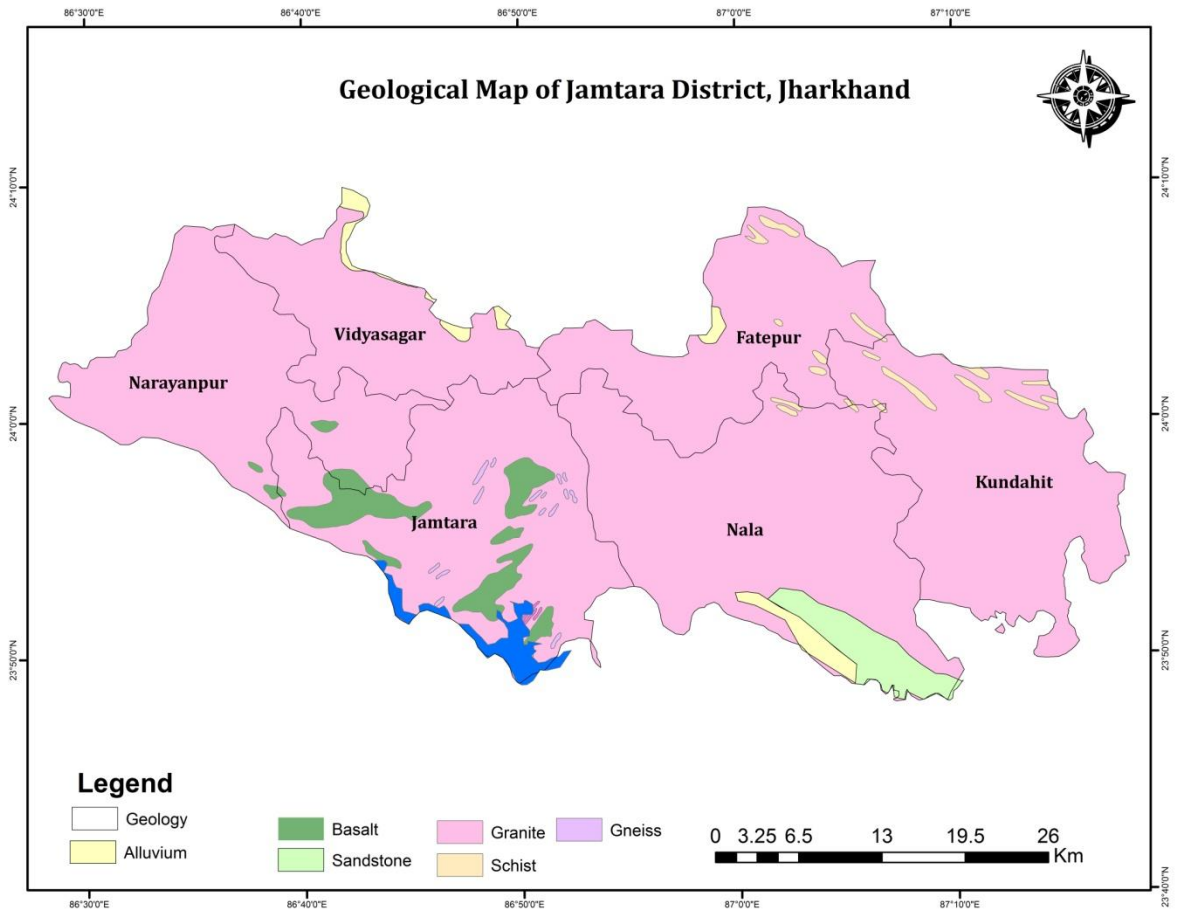


Figure 7–: Geological map of Jamtara district

3.2 Hydrogeology:

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

1. Consolidated or Fissured formations - Precambrians and Rajmahal Trap
2. Semi-Consolidated formations -Gondwanas
3. Unconsolidated or Porous formations - Laterites and Alluvium

In major part of this district, hard rock form the principal aquifers, which includes mainly Chotanagpur gneissic complex, while Rajmahal Traps also found to some extent. However, in isolated areas laterites, as well as alluvial materials along the vicinity of the rivers also form potential aquifers. Hydrogeological Map of Jamtara district is shown in figure 8.

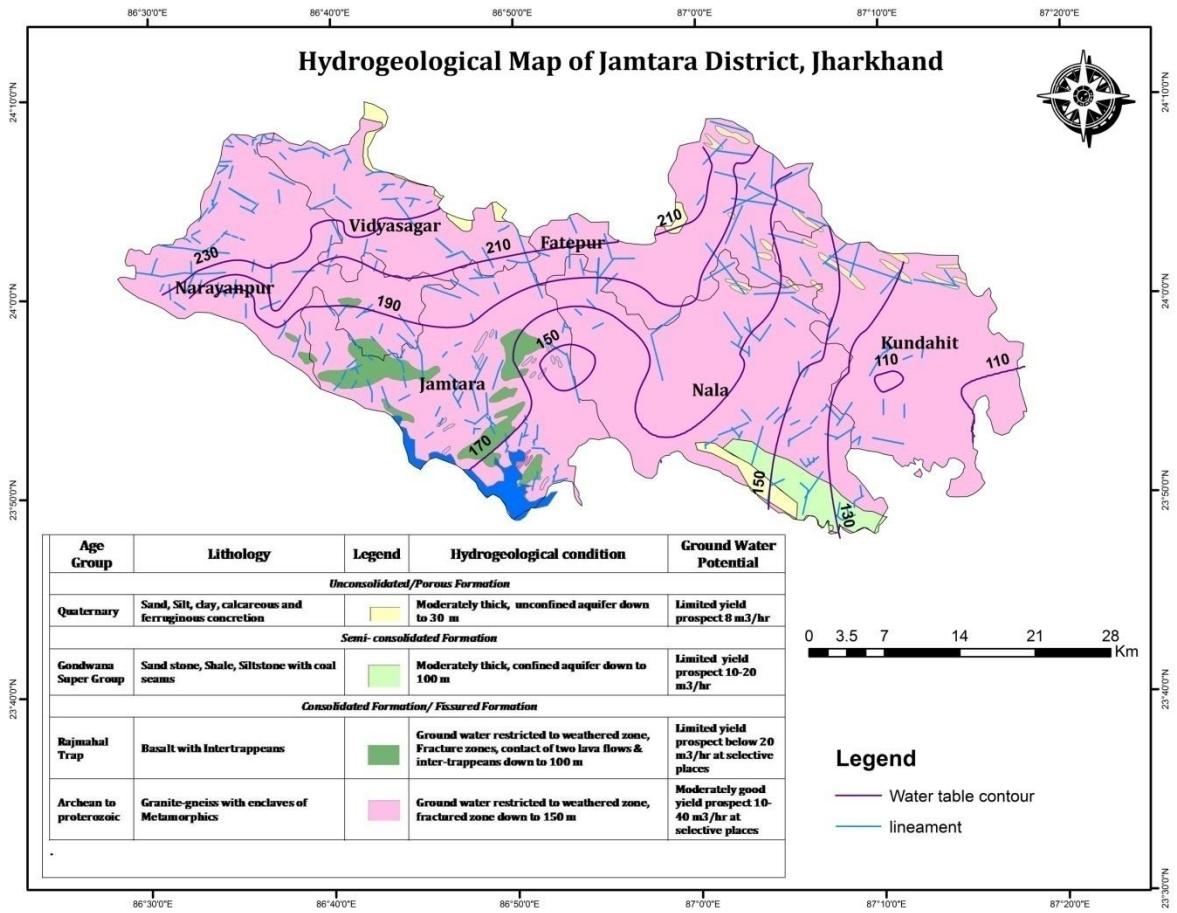


Figure 8 - : Hydrogeological Map of Jamtara district, Jharkhand

3.2.1 Ground Water InAquifer-I (Weathered Granite-Gneiss/Weathered Basalt):

Ground water occurs under phreatic/ unconfined to semi-confined conditions in Aquifer-I which is represented by weathered granite and Weathered Basalt. Ground water occurs in unconfined state in shallow Aquifer-I tapped by alluvium, laterites, weathered graniteand weathered basalt (Upto 30 m depth) , however in some cases depth varies from more than 30m. Yield of the wells in Aquifer-I ranges from 0.8 to 3 lpsin this formation. Weathered zones of granites and gneisses are the most productive zone for ground water development in shallow aquifer. The depth of weathering varies from place to place, which influences the aquifer characteristics. The drinking water and sanitation department has drilled a number of tube wells in Jamtara district having a yield of approximately 80 liter per minute. The dug wells in this formation has a depth to water level range from 4 m to 10 m bgl and the wells can sustain 2 hours of pumping with a yield range of 4000 to 8000 litres per hour.

3.2.2Ground Water In Aquifer-II (Fractured Granite-Gneiss/Fractured Basalt/Sandstone):

Ground water occurs under Semi-confined to confined condition in Aquifer-II represented by Fractured/Jointed granite-gneiss, Fractured Basalt and Sandstones upto the exploreddepth of 200 mtr depth. Generally extent of Aquifer-II in Precambrian formation ranges from 30-140m.Granites and Gneisses are the most predominant rock

types among all other rocks falling under the consolidated unit. Tectonic disturbances in granitic rocks are pronounced and fissures and joints etc are also well developed. These rocks are traversed by numerous veins of quartz and pegmatite. Fracture porosity plays an important role but with varying degree, in different parts of the area depending upon the pattern and intensity of joints and fractures. The potentiality and yielding property of these aquifers vary considerably. Bore wells can be constructed tapping the deep-seated fractures and joints. The semi-consolidated (Gondwana) formation occurs in isolated pockets in the northern part of the district. The rocks are mainly sandstones and shales belonging to the Barakar and Talchir formation. Barakar sandstones are coarse to medium grained, weathered in nature and may be a productive zone for ground water development. Hoever, the exploratory Driliing has not been taken up in Gondwana formation. Yield of the wells in Aquifer-II in granite-gneisses are found to be upto 12.3 lps.

3.2.2.1 Potential Fractures in Aquifer-II

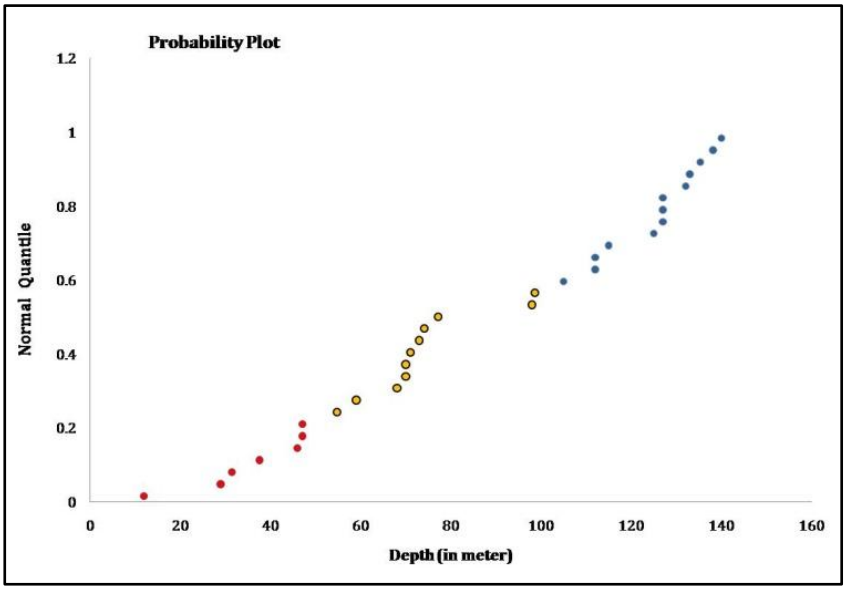
Number of boreholes has been constructed by CGWB in the district under groundwater exploration programme upto maximum depth of 200 m (Table-8). The borehole data reveals that, in general potential fractures are encountered between 30-140 m. The other fractures have also of good potential. Table9- shows the Potential Fracture encountered during Ground Water Exploration in jamtara district.

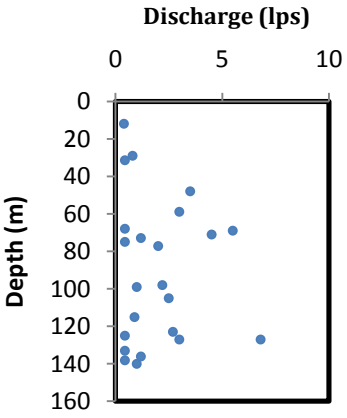
Table-9 Potential Fractures encountered during ground water Exploration in Jamtara district, Jharkhand

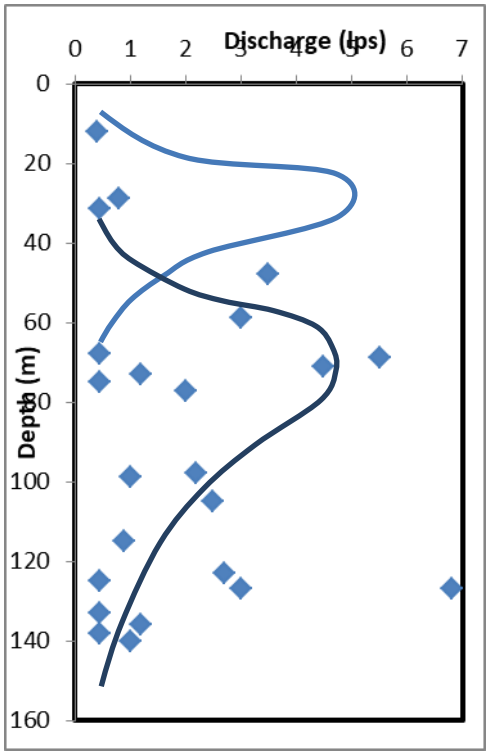
S. No.	Location	Block	Depth Drilled (m)	Major Lithology Encountered	Depth of casing (m)	Potential Fracture Zone (m bgl)	Static Water Level (m bgl)	Discharge (lps)
1	Barmasia	Kundahit	138.5	Granite gneiss	9.58	12.04-013.00, 073.00-74.62, 098.48-099.48, 105.10-106.10, 125.34-126.34, 133.96-135.58	8.16	7.2
2	Panjania	Jamtara	200	Granite gneiss	29.9	71.50 – 72.00, 127.00 – 127.80, 140.10 – 140.80	8.66	12.3
3	Chainpur	Narayan pur	153.6	Granite gneiss	24.5	31.50,77.20,138.20	11.2	3
4	Bhander bera	Nala	123.32	Granite gneiss	21.5	48-49 , 59-60, 69-70	12.89	12
5	Palojori Basti	Fathepur	153.8	Granite gneiss	12.8	123-124, 127-128	6.10	5.7

Statistical Analysis of Fracture System:

Statistical analysis of fracture system represents that there is two aquifer system lies in study area, which is classified by its depth ranges i.e. Aquifer I & II. Depth of aquifer I is generally 0 to 30 mtr which is weathered granite gneiss and aquifer II depth varies from 30 to 140 mbgl which is fractured granite gneiss. Majority of fractures are encountered within 30-140 mbgl in Granite Rocks. Frequency of fractures , depth of occurrence and statistical analysis of fractures system with discharge range of exploratory wells encountered in Jamtara district is shown in figure-9.







Analysis of fracture system

From (m)	To m)	F	CF
0	25	1	1
25	50	3	4
50	75	6	10
75	100	3	13
100	125	4	17
125	150	6	23
150	175	Nil	23

Figure 9: Statistical Analysis of Fracture System

On the basis of field investigations and results of exploratory wells drilled in the district, salient findings are summarized as:-

- Overall in the district the major potential fractures zones are found upto 140m.
- First potential fracture zone encountered in the district widely varies from 12-123 m
- In general in fractured/jointed/fissured formations, discharge of well has been found in the range of 0.45-12.3 lps.

- In central part of the district very less fractures were encountered whereas in eastern, south-western and north-eastern part of the district having 1 to 6 set of fractures has been encountered and these sets of fractures are promising with discharge observed from 3 to 12.3 lps.
- Overall in the district the major potential fractures zones are found upto 140m. At several places fractures between 120-140m have been encountered in which well yielded high discharge, i.e Barmasia(7.2 lps), Panjania(12.3 lps), Palojori(5.7 lps)
- In few occasion 1st potential fractures was encountered beyond 100 m depth (123-127 m) and well has yielded copious amount of discharge e.g Palojori Basti (5.7 lps).
- Some times the potential fractures were encountered at very shallow level 48.00-69.00 m with very high yielding wells. These potential fractures may be tensile in nature occurring at shallow level, which is found to be potential repository of ground water. Some of the exploratory wells encountered upto the depth of 70m which yielded high discharge eg Bhanderbera (12 lps).
- Some of high yielding well where multiple fractures were encountered within 140 m depth are Panjania (12.3 lps), Chainpur (3 lps), Bhanderbera (12 lps), Palojori Basti (5.7lps).

3.3 Geophysical survey:

A total of 08 VES were carried out at 08 locations in the district area of Jamtara under aquifer mapping in Jharkhand state. The VES curves obtained in the area are A, H and HA types *(figure 8).* The interpreted results show three to four geoelectrical layers in the study area.Interpreted results of VES are given in table-10. The geoelectrical characteristics of the weathered and semi-weathered zones are given in table -11. Based on the results of VES carried out in the area, it is observed that out of the 8 VES sites weathered zone is not found at 3 sites namely VES locations 1, 4 and 7. The weathered zone in granite gneiss terrain extends up to 29.20 m depth. The resistivities of the weathered zone varies at 5 sites from 36.5 to 97.5 ohm-m. The semi-weathered zone is delineated at 1, 4 and 7 sites. It extends to a depth in the range of 6.30 to 60.5m. The resistivity of semi weathered zone varies from 139 to 275 ohm-m.

Table-10 Interpreted result of VES data collected from Jamtara district, Jharkhand

VES Nos.	**Individual layer resistivity in ohm-m**					**Individual layer thickness in m**				**H**
	P1	**P2**	**P3**	**P4**	**P5**	**h1**	**h2**	**h3**	**h4**	
Murgabani	54.6	275	3335	-	-	2.16	21.5	-	-	23.66
Fatehpur	273	62.6	1545	-	-	2.89	11.99	-	-	14.88
Kundahit	372	97.5	635	-	-	1.6	16.10	-	-	17.7
Nala	80.6	139	794	4642	-	2.27	6.3	45.5	-	54.10
Jamtara	139	56.5	34385	-	-	1.98	29.20	-	-	31.20
Narayanpur	285	36.5	576	3375	-	0.95	2.10	12.85	--	15.90
Vidyasagar	57.8	182	1124	-	-	2.61	24.8	-	-	27.4
Raghunathpur	218	60.5	208	2469	-	0.75	3.05	24.9	-	28.70

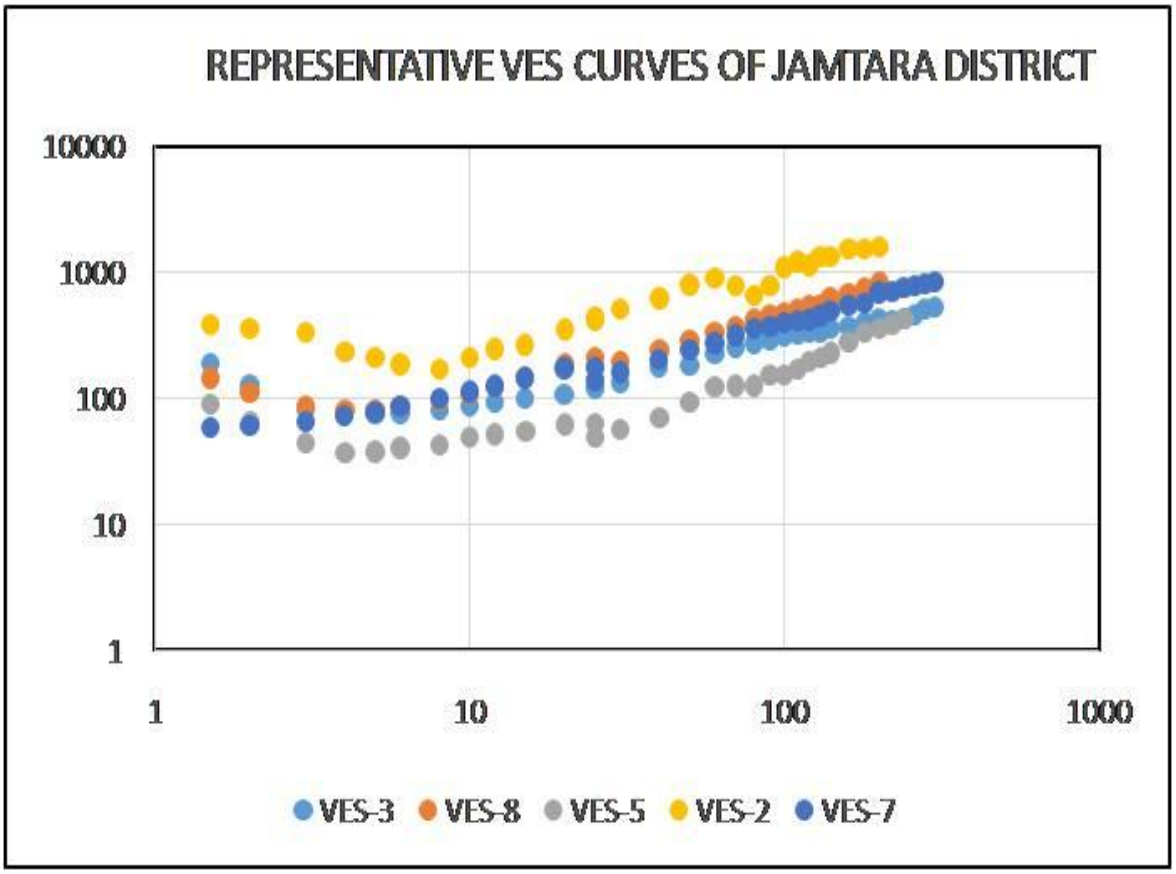


Figure-10 Representative Curve of VES data in Jamtara district, Jharkhand

Table -11: Details of weathered and semi weathered zones and possible presence of thin fractured zones, Jamtara district

VES	Weathered zone			Semi-weathered zone			Fractured zone
	Resistivity (ohm.m)	Thickness (m)	Probable occurrence of weathered zone aquifer up to about (depth in m)	Resistivity (ohm.m)	Thickness (m)	Probable occurrence of semi weathered zone aquifer up to about (depth in m)	Probable occurrence of thin fractured zone aquifer in the depth range (m)
Murgabani	--	--	--	271	21.5	23.66	45-50, 90-100
Fatehpur	62.6	11.99	14.88	--	--	--	70-90
Kundahit	97.5	16.10	17.70	--	--	--	40-50
Nala	--	--	--	139	6.3	8.57	45-55
Jamtara	17.7	1.12	1.98	--	--	--	25.35, 70-90
Narayanpur	36.5	2.10	3.05	--	--	--	20-30, 75-95
Vidyasagar	--	--	--	182	24.8	27.41	110-130
Raghunathpur	60.5	3.05	3.80	--	--	--	120-130

3.4 Ground water Dynamics

3.4.1 Water Level Scenario – Aquifer – I (Shallow Aquifer):

Ground water regime is monitored through 29 dug wells in the study area. With the field data, maps were prepared for visual interpretation of the behavior of the ground water levels. Depths to ground water level were demarcated into various zones in the ranges of less than 2 m, 2-5 m, 5-10 m, 10-20 m. The description of depth to water levels during pre-monsoon and post monsoon is as follows:

Depth to Water level May 2018:

Depth to ground water level during May 2018 ranges from 4.6 mbgl to10.7mbgl. Minimum depth to water level 4.6 mbgl recorded at Bhaiyadih village of Narayanpur block of Jamtara district and maximum depth to water level 10.7 mbgl recorded at Mohanpur village of Narayanpur block of Jamtara district. Depth to water level map May 2018 is shown in *figure-11*

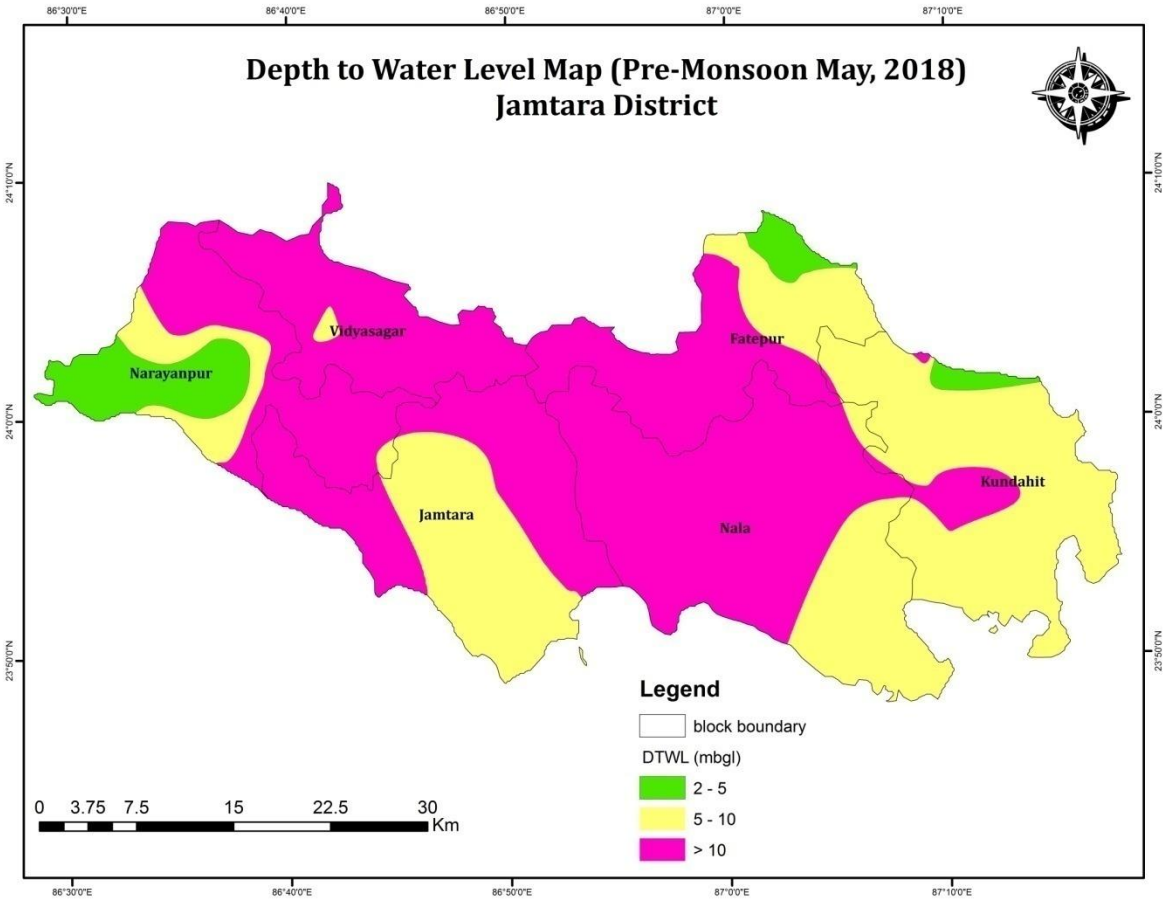


Figure-11–: Pre monsoon (May 2018) depth to water level mapof Jamtara District

Depth to Water level November 2018:

During month of November 2018 (post-monsoon) depth to water level varied from 2.12 m bgl to 7.20 m bgl. Minimum depth to water level 2.12 mbgl recorded at Bhaiyadih

village of Narayanpur block of Jamtara district and maximum depth to water level 7.20 mbgl recorded at at Jasaydih village of Karmatar block of Jamtara district. Depth to water level map November 2018 is shown in*figure12*

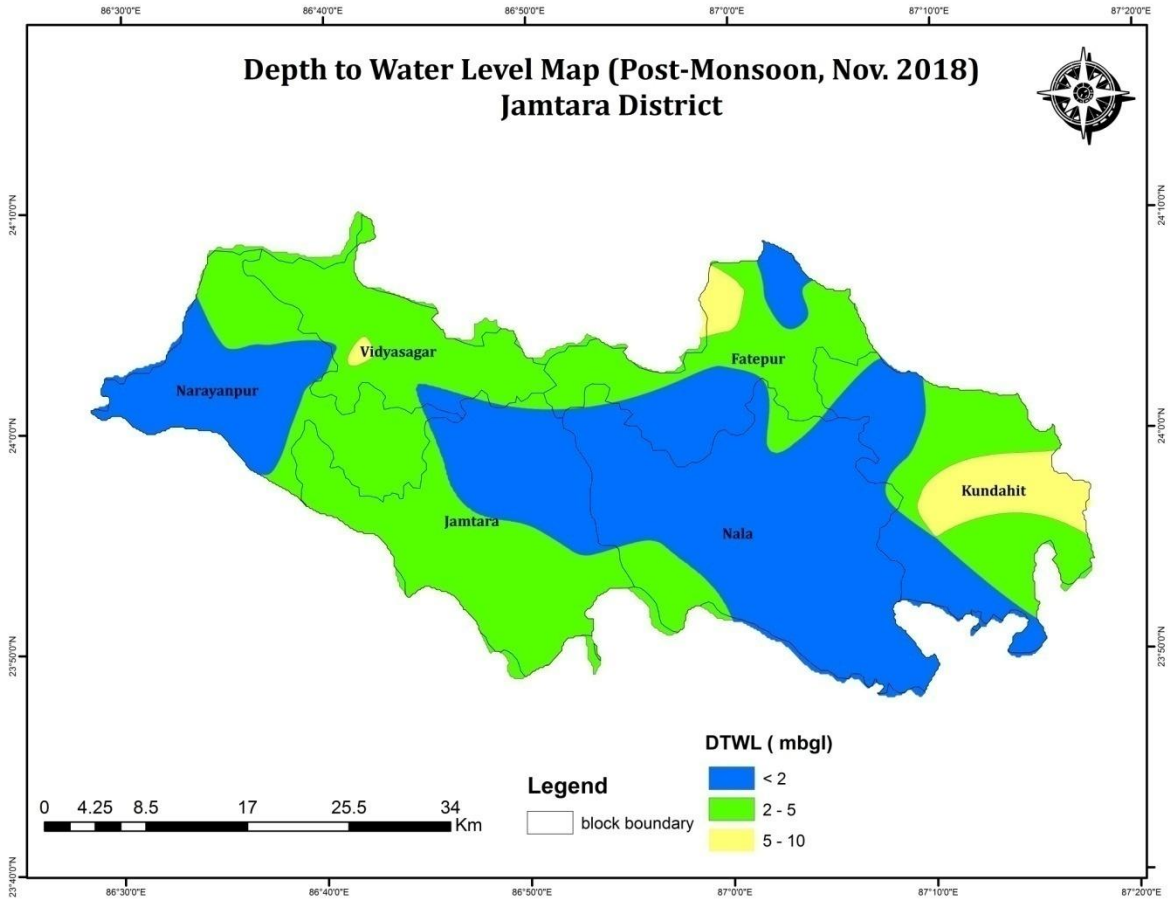


Figure 12–: Post monsoon (May 2018) depth to water level mapof Jamtara District

3.4.2Long Term Water Level Trend (1998-2018): In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data for the period 1998-2018 have been computed and analyzed presented in figure 11 & 12 respectively. The pre monsoon water level trend analysis showing declining trend in Jamtara wells. The post monsoon water level declining trend is observed in Kundhit block.

3.4.3 Hydrograph Analysis

Analysisof two hydrograph network stations, were carried out using GEMS software(Fig-13, 14) andanalysed for the period from 1998-2017. It is observed that the long-term water level trendsduring pre and post-monsoon seasons are declining trend in shallow aquifer-I represented by dug wells.

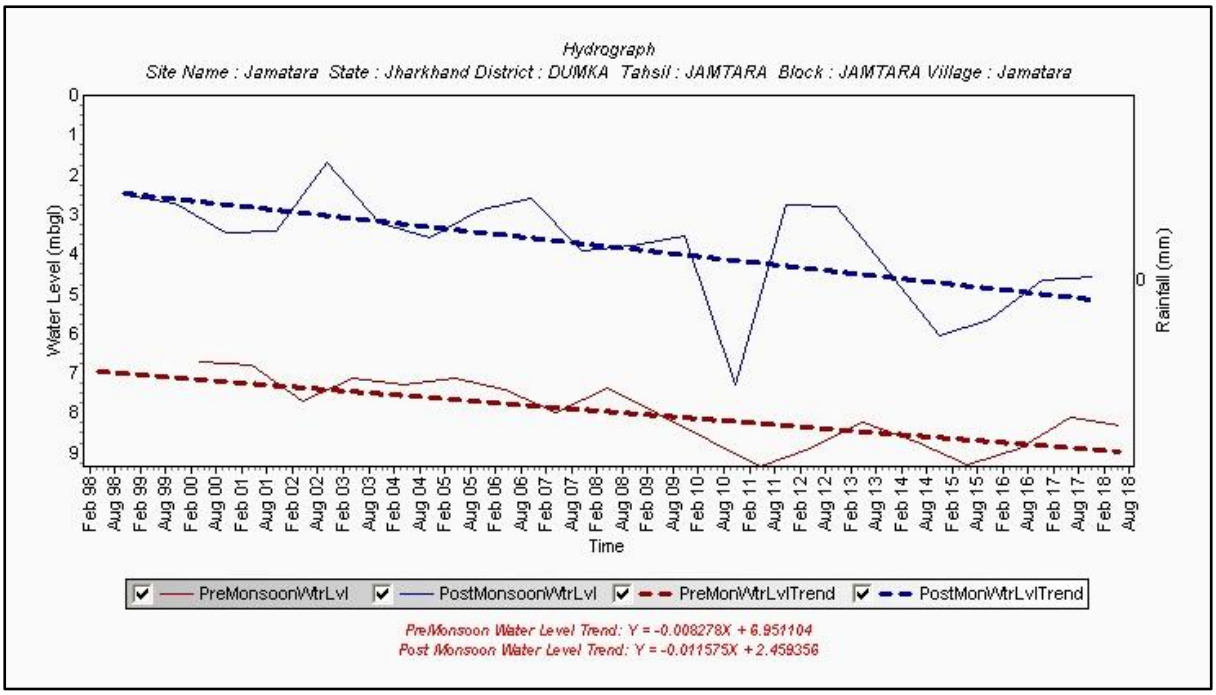


Figure 13 Hydrograph (1998-2018), Jamtara, Jamtara, block, Jamtara, district

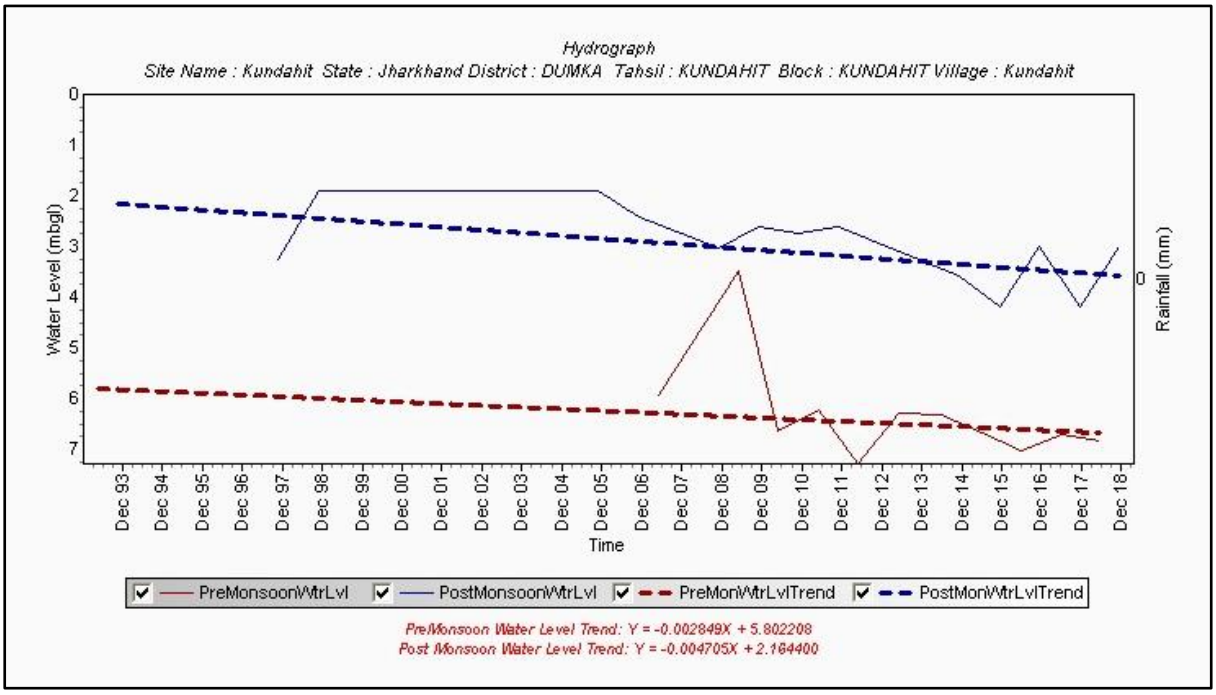


Figure 14- Hydrograph (1998-2017), Kundahit, Kundahit block, Jamtara district

3.5 Ground Water Exploration: The exploratory data particularly includes the information on sub–surface geology, hydrogeological information and geometry of aquifer in hard rocks terrain. Based on exploration data, prepared litholog of exploratory wells&observatory wells, identified the potential fracture zone encountered within 200 m depth in granitic terrain.To assess the potentiality of the deep fractured rock, 21 exploratory wells and 6 observation wells were drilled in Jamtara district.Out of 21 exploratory wells, 14 exploratory wells are drilled by outsourcing and 07 exploratory wells constructed by Central Ground water Board.The drilling results have indicated that granite gneiss of different colour varying from grey to dark grey to pink, having course grained texture sometime porphyritic, are the most dominant rock types met in the area. In the bore wells upper weathered zones are cased and only the fractured zones are tapped in the uncased well. The details of the exploratory and observation wells drilled in Jamtaradistrict are presented in A*nnexure –I*and available lithologs of these wells are represented in A*nnexure –VI*. Location of exploratory wells is shown in figure-15 and Summary of success bore wells drilled in the district is given below in table 12 and Striplog of selected exploratory wells is shown in figure 16.

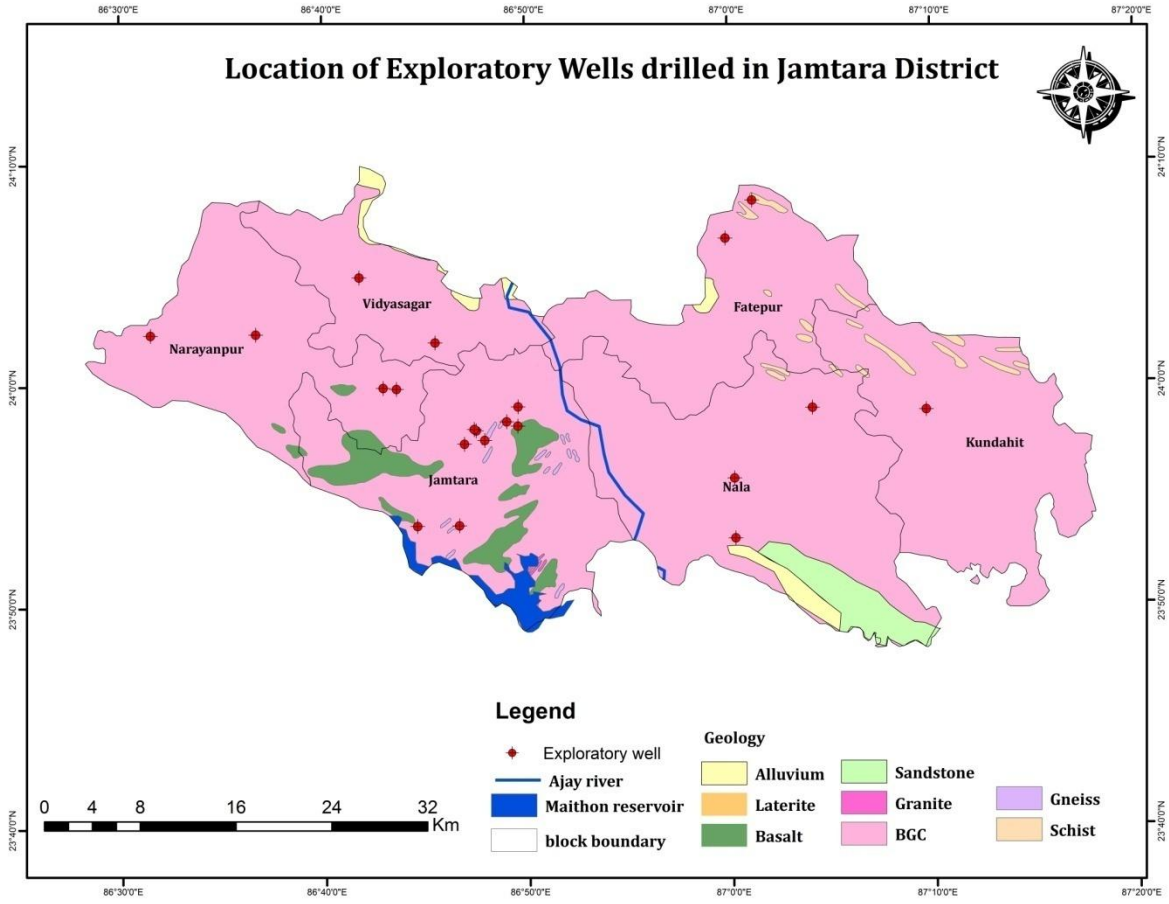
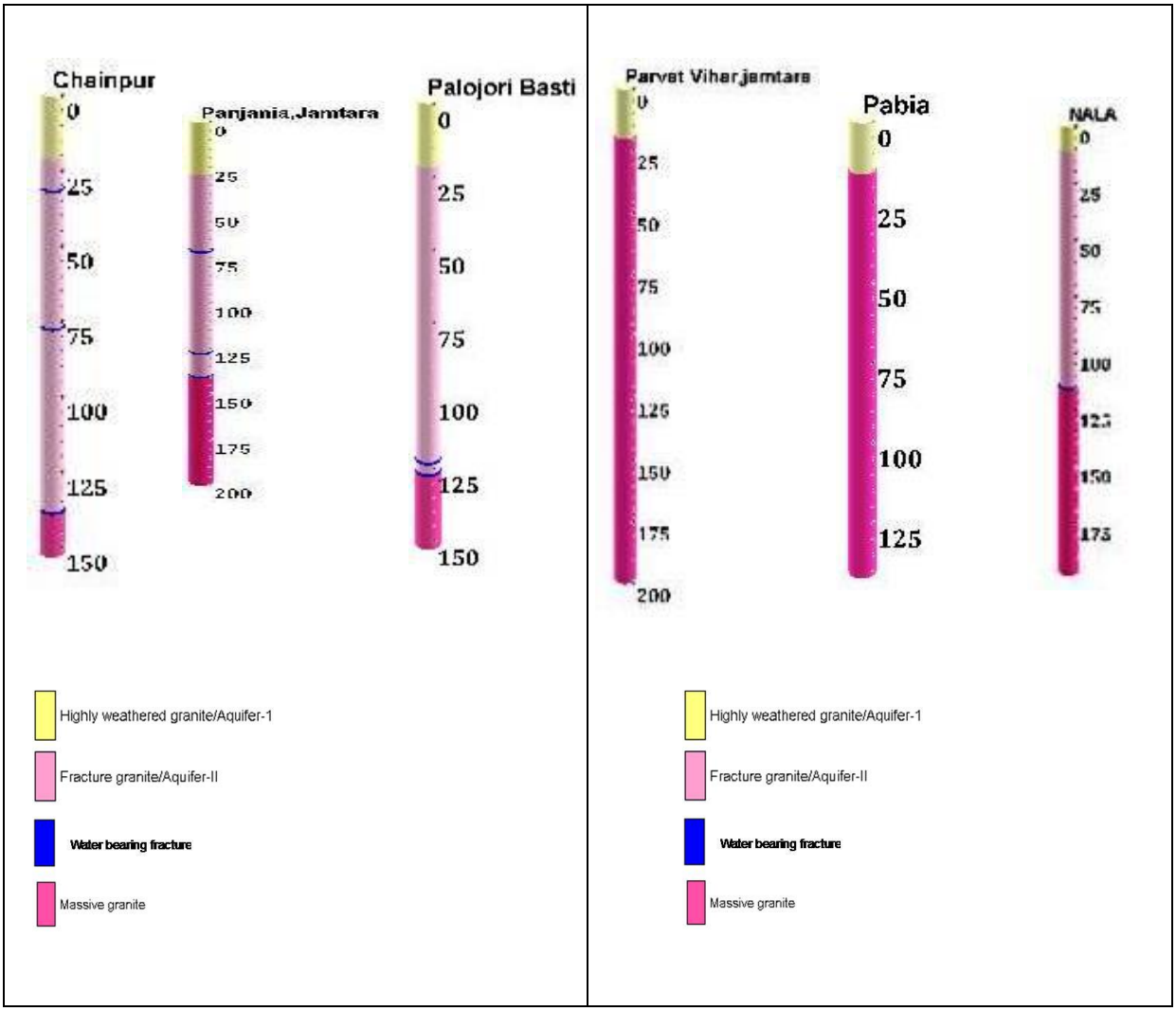


Figure 15: Location of exploratory wells drilled in Jamtara district

Table 12 –: Summary of success bore wells drilled by CGWB in Jamtara district

Location	Depth drilled (mbgl)	Depth of fractured encountered (mbgl)	Discharge (lps)	T (m2/day	S
Barmasia	138.5	12.04-13.00, 73.00-74.62, 98.48-99.48, 105.10-106.10, 125.34-126.34, 133.96-135.58	7.2	-	-
Panjania	200.00	71.50 – 72.00, 127.00 – 127.80, 140.10 – 140.80	12.3	-	-
Bhanderbera	123.32	48-49, 59-60, 69-70	12	-	-
Palojori Basti	153.8	123-124, 127-128	6.10	-	-



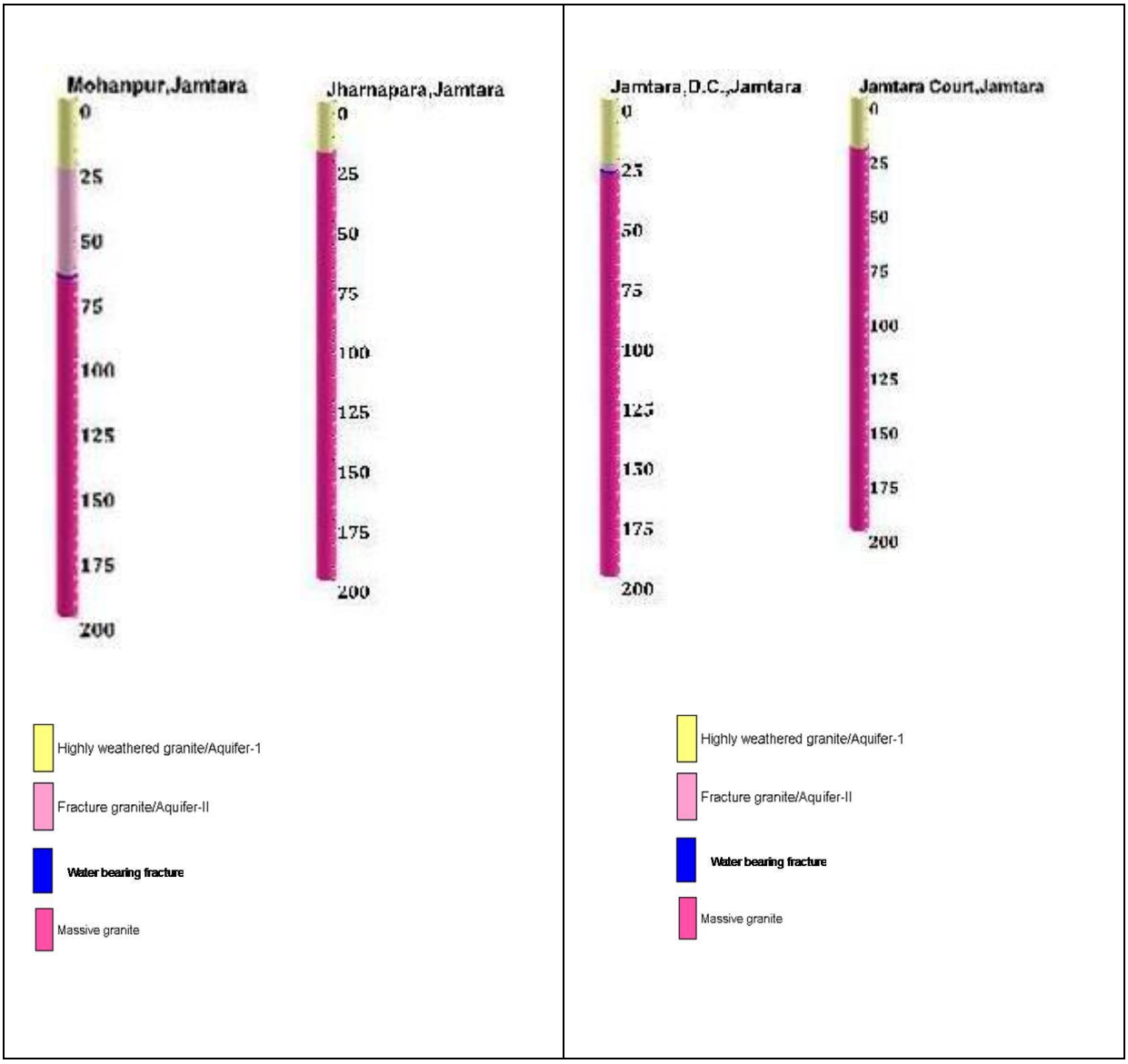


Figure 16.Strip-log of selected exploratory wells drilled in Jamtara district

3.6 Ground Water Quality:

The quality of water plays prominent role in promoting both the standards of agriculture production and human health. To evaluate the quality of ground water, samples have been collected from 29 monitoring wells which includes 10 hydrograph stations (dug wells) and 19 key wells established in the area which represent the quality of phreatic/ shallow zone i.e Aquifer I. however four number of water samples were also colleted through bore wells which represent the Aquifer II (deeper zone). The analytical results of water samples from dug wells and hand pumps are given in Annexure- III. The ground water samples were analyzed for major chemical constituents by using standard procedure at chemical laboratory in CGWB, MER, Patna. These samples have been considered to assess the chemical quality of ground water and its suitability for drinking and irrigational purposes. Since the samples are collected from the dug wells, they represent the quality of Aquifer I (phreatic/ shallow zone) and the bore well samples represent the Aquifer II (deeper zone) quality of ground water.

3.6.1General Range of Chemical Parameters

Evaluation of ground water suitability in relation to its different purposes has been classified for drinking / domestic and irrigation. Water is very essential for life. Many a times it has raw consumption or indirectly (in food). Hence, it should be free from turbidity, odor, bacterial and poisonous contents and also chemically soft, low T.D.S value and other chemical constituents should range within low to tolerable limits. Excessive and longer use of water beyond these limits may endanger to many health problems. An overview of Hydro-chemical data of (phreatic aquifer) hydrograph monitoring wells existing in Jamtaradistrict is tabulated below in table no. and the detail of water quality analysis is given in *Annexure III.* The spot value map of water quality samples more than permissible limit is also shown in *figure17.* Hydro-chemical data of (phreatic aquifer) monitoring wells existing in Jamtara district is tabulated below in *Table 13.*

Table 13 Details of Hydro-chemical data of hydrograph monitoring wells

S.No.	Constituents	Minimum	Maximum	Average	BIS (2012)	
					Desirable	Permissible
1.	pH	7.74	8.21	7.95	6.5-8.5	No relax.
2.	EC	203	1330	558		
3.	TDS (mg/l)				500	2000
4.	HCO3 (mg/l)	49.2	313.65	162	200	600
5.	Cl (mg/l)	3.69	247	58.50	98	1000
6.	TH (as CaCO3) mg/l	75	380	191	300	600
7.	Ca (mg/l)	16	116	43	75	200
8.	Mg (mg/l)	6.07	32.81	17.84	30	100
9.	Na (mg/l)	7.15	105.40	37.69	200	-
10.	K (mg/l)	0.71	76.14	8.15	200	-
11.	NO3 (mg/l)	1.4	144	38.5	45	No relax.
12.	F(mg/l)	0.04	0.79	0.34	1.0	1.5
13.	SO4(mg/l)	6	68	29	200	400

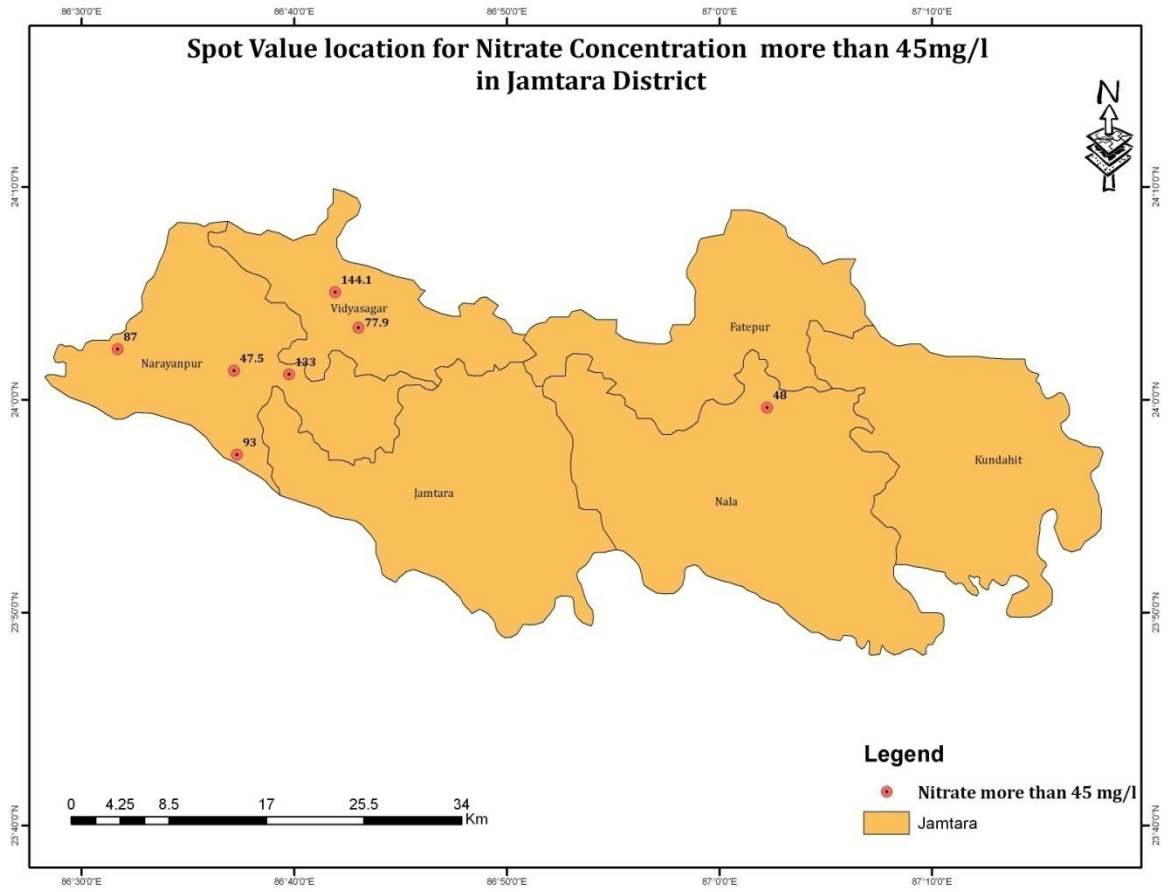


Figure 17 Chemical quality map showing Nitrate concentration more than permissible limit

Hydrogen ion concentration (pH):

The pH of water indicates that whether the water is acidic or alkaline. The hydrogen (pH) is a measure of the hydrogen ion concentration in the water. The measurement scale of pH ranges from 1 to 14 with a pH of 7 indicating as neutral condition environment. The value of pH lower than 7 indicate acidic and more than 7 indicates alkaline. The pH of ground water in Jamtara district ranged in between 7.74 to 8.21. The ground water of the study area can be assessed as slightly alkaline to neutral in nature. Minimum 7.74 PH value observed in Karamatanr village of Vidyasagar block whereas Maximum PH value recorded in lakra kunda village of Nala block of Jamtara district.

Electrical Conductivity (EC):

Electrical conductance is the ability of water to conduct electric current and it depends on, the concentration of ion, nature and types of ions and temperature. BIS has recommended desirable limit for Total Dissolve Solid (TDS) as 500 mg/l corresponding to EC value approximately as 750 µS/cm at 25°C which is extendable to permissible limit as 2000mg/l. TDS corresponding to EC value is about 3000 µS/cm at 25°C in absence of alternate source of water.

The electrical conductivity of ground water in study area ranges in between 230 to 1330µS/cm at 25°C. Based on the electrical conductivity results the ground water in

the study Area is potable. Minimum 230 µS/cm at 25°C EC value observed in babupur village of Kundhit block whereas Maximum 1330 µS/cm at 25°C EC value recorded at Karamatanr village of Vidyasagar block of Jamtara district.

Carbonate and Bicarbonate (Alkalinity):

Presence of alkalinity in water is the capacity to neutralize a strong acid due to the presence of carbonate, bicarbonate and hydroxide of magnesium and calcium. The concentration of bicarbonate ranged in between 49.2 to 313.65 mg/l. Minimum concentration of bicarbonate 49.2 mg/l value has been recorded in Sugapahari village of Vidyasagar block whereas Maximum concentration 313.65 mg/l value has been recorded in Borotanr village of Narayanpur block of Jamtara district.

Chloride:

Chloride in ground water can be geogenic in deep aquifers or caused by industrial or domestic wastes and pollution from brine. The BIS has set 250 mg/l chloride ions as acceptable limit and 1000 mg/l as permissible limit in the absence of alternate source in drinking water. In Jamtara district Chloride concentration ranges in between 3.69 to 247 mg/l. Minimum concentration value of chloride 3.69 mg/l has been recorded in dumariya village of Nala block whereas Maximum concentration value of chloride 247 mg/l has been recorded in Karamatanr village of Vidyasagar block of Jamtara district.

Fluoride:

Fluoride occurs in low concentration in natural water. It is an essential element to maintain normal development of teeth and bones. The consumption of low fluoride concentration prevents the dental caries. The higher concentration of fluoride consumption causes mottling of teeth and skeletal fluorosis. The BIS has set the maximum concentration of fluoride in drinking water is 1.5 mg/l as permissible limit. The fluoride concentration in Jamtara district ranged in between 0.04 to 0.79 mg/l. The maximum concentration of fluoride has been recorded in Chainpur village of Narayanpur block of Jamtara district.

Nitrate:

Nitrate is the end product of oxidation process of nitrogen in the environment and its higher concentration in ground water is an indication of pollution from human and animal wastes, nitrogenous fertilizers and industrial wastes. Nitrate is a non-essential constituent of ground water. The BIS has set a acceptable limit of nitrate concentration in drinking water as 45 mg/l with no relaxation. The consumption of nitrate more than 45 mg/l is harmful for human being, particularly to infants as it may cause blue baby syndrome. In Jamtara district nitrate concentration in ground water ranges in between 1.4 to 144mg/l. The maximum Nitrate concentration has been recorded at Karamatanr village of Vidyasagar block of Jamtara district.

Sulphate :

The concentration of sulphate in drinking water set by BIS as acceptable limit is 250 mg/l and 400 mg/l permissible limit in absence of alternate source. Higher concentrations are undesirable taste because of laxative effects. Sulphates in groundwater are released by natural deposition of calcium sulphate, magnesium sulphate, or sodium sulphate. These natural sources can be applied as soil conditioners.

The ground water of study area recorded sulphate concentration ranges in between 6 to 68 mg/l.

Total Hardness:

As per Bureau of Indian Standard (BIS): 10500-2012 (Drinking Water), the acceptable limit of total hardness is 300 mg/l and permissible limit is 600 mg/l in absence of alternate sources.Total hardness of ground water in the study area ranges in between 75 to 380 mg/l.

Sodium:

Sodium does not find freely in nature because it is very active element. It always combines with other elements. In human body, sodium helps in maintaining water balance. The higher sodium intake may cause congenial heart diseases, hypertension and also kidney problem.In Jamtara district, water samples observed sodium concentration ranges in between 7.15 to 150.40 mg/l.

Potassium:

The common sources of potassium are minerals of igneous, metamorphic and sedimentary rocks. Potassium concentration in water is generally very low. BIS has not given any guideline for potassium concentration in drinking water. In the study area of Jamtara district, Potassium concentration observed in water samples ranged in between 0.71to 76.14 mg/l.

3.6.2 Suitabilityof GroundWaterforDrinking Purposes: -

The suitability of water is evaluated on the basis of electrical conductivity which represents salinity and also the concentration of Fluoride and Nitrate ions. The maximum and minimum values and values exceeding desirable and permissible limit for drinking use of different parameters is given in the Table 14.

The classification of water on the basis of EC it is found that 100 % wells have EC values less than 1500 µS/ cm at 25^0C. Regarding fluoride, in 100% wells its concentration was found less than desirable and permissible limit i.e 1 to 1.5 mg/l for drinking water. The nitrate was observed more than permissible limit of 45 mg/l in 36% wells. Perusal of the analytical data reveals that there is no specific trend observed for distribution of higher values of EC, fluoride and nitrate in the ground water and higher values may be due to local pollution/ geogenic sources. As such in general the quality of ground water in the study area is good and suitable for drinking.

Table 14 Maximum and Minimum and values exceeding Desirable and Permissible limit for drinking use of different parameters

Parameter	pH	TH	Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	NO_3	F	EC	
		mg/l											µS/cm at 25^0C	
RangeofvaluesMax.	9.4	1700	458	276	1250	210	24	1361	1761	1520	620	5.6	Maximum	5620
Rangeofvalues Min.	6.8	10	2	nd	1	nd	0	0	4	0	0	0	Minimum	35

IS:10500drinking water(highest desirablelimit)	6.5-8.5	300	75	30				Bicarbonate alkalinity 200	250	200	45	1	Range of EC	% of samples
IS:10500drinking water(maximum permissiblelimit)	6.5-8.5	600	200	100				600	1000	400	45	1.5	1-1500	100%
%samplesexceedin maxi.desirablelimit	10.5	10.5	15.7	10.5				26	15	0	36	0	>1500-3000	0 %
%samplesexceedin maxi.permissible limit	0	0	0	0				0	0	0		0	>3000	0%

3.6.3 Suitability of ground water of Aquifer–I for irrigation purposes: - Apart from domestic consumption, irrigation is consuming a major share of ground water for agricultural activities. The quality of water used for irrigation is an important factor in productivity and quality of irrigated crops. The suitability of water for irrigation purpose depends upon the Total Dissolved Solid in terms of EC value, concentration of Na, bicarbonate and its relative proportion to Mg and Ca. All these mentioned above either individual or with combination create concentration of Sodium (salinity) bicarbonate and alkalis type of hazard.To better understanding the suitability of ground water for irrigation purpose chemical result of collected water samples have been analyzed and described the different classifications.

3.6.4: Sodium Percentage Classification: -Electrical Conductivity (EC) and sodium concentration are very important in classifying irrigation water. The salts, besides affecting the growth of the plants directly, also affect soil structure, permeability and aeration, which indirectly affect plant growth. Sodium is a major ion used for the classification of irrigation water due to its reaction with soil that reduces its permeability.Classification of ground water of Aquifer - I based on sodium percentis tabulated in table 15. Percentage of Na is generally used for assessing the suitability of water for irrigation purposes. Na is expressed as percent sodium or soluble-sodium percentage (Na %) using Eq.

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

Table 15- : Classification of ground water of Aquifer - I based on sodium percent.

Sl No.	Water class or category	Sodium percent	No. of samples falling	Percentage of samples
1	Excellent	< 20 %	04	21.05 %
2	Good	20 – 40 %	11	57.89 %
3	Permissible	40 – 60 %	04	21.05 %
4	Doubtful	60 – 80 %	Nil	Nil
5	Unsuitable	> 80 %	Nil	Nil

(Where all ions are expressed in epm)

On the perusal of above table-15, 100 % of water samples of aquifer – I (dug wells) falling under excellent to permissible category.

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

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

SAR values can be used to predict the degree to which irrigation water tends to enter into cation exchange section in soil. The higher value of SAR indicates damage of soil. Based on the SAR value the groundwater suitability classification is tabulated in table 16,which is showing that all the water samples (100%) of aquifer– I (dug wells) pertain to excellent class.

Table 16: - Classification of ground water of Aquifer – I based on SAR value

Sl No.	Water class	Type of Water	SAR Value	No. of samples falling	Percentage of samples
1	Excellent	Low sodium water	< 10	19	100
2	Good	Medium sodium water	10 – 18	Nil	Nil
3	Fair	High sodium water	18 – 26	Nil	Nil
4	Poor	Very high sodium water	> 26	Nil	Nil

(Where all ions expressed in epm)

3.6.6 Residual sodium carbonate content (RSC):-Water containing CO2 on way gets saturated with CO2 and forms bicarbonates. The excess bicarbonate of Mg and Ca are precipitated out as carbonates. This produces impermeability to the top soil. Bicarbonate concentration of water has been suggested as additional criteria of suitability for irrigation water. Groundwater samples that had **RSC** indices of positive value imply that the cumulative concentration of $CO3^{-2}$ and $HCO3^{-2}$ is higher than the combined Ca2+ and Mg2+ concentrations. This would indicate that there is a residual carbonate to react with sodium, presenting sodium hazard to the soil when irrigated with such water. Based on the RSC value the groundwater suitability classification is given in table 17.A negative value indicates no residual carbonate. Residual sodium carbonate is determined by using the formula –

$$RSC = (CO_3^{2-} + HCO_3^{2-}) + (Ca^{2+}) + (Mg^{2+}) \quad \ldots\ldots$$

(Where concentration is expressed in epm)

Table- 17: - Classification of ground water of Aquifer – I based on RSC value

Sl No.	RSC (mg/l)	Irrigational suitability	No. of samples falling	Percentage of samples
1	< 1.25	Safe for all type of crops	18	94.73 %
2	1.25 – 2.50	Safe for semi-tolerant to tolerant crops	01	5.26 %
3	> 2.50	Safe with application of gypsum of the rate of 8.5g/ham of irrigation water applied for 1.0 ml/liter RSC	Nil	Nil

(All the values are expressed in epm.)

On the perusal of table 17, about 94.73 %of water samples of aquifer - I are falling under safe for all type of crops category and about 5.26 % of water sample (01 No.) falling under safe for semi- tolerant to tolerant crop. Classification of irrigation water modified Piper's diagram is shown below in figure – 18.

3.6.7 Piper Diagrame for Classification of irrigation Waters

The Piper diagram is used to categorize the type of water. It comprises of three parts: one diamond shaped diagram in the middle and two trilinear diagrams sideways in the bottom. The comparative concentrations of cations (left diagram) and anions (right diagram) in each sample is depicted in the trilinear diagram. For presenting ions in a piper diagram, the cations are clustered into three major divisions: sodium (Na) plus potassium (K), calcium (Ca), and magnesium (Mg). The anions are likewise grouped into three main categories: bicarbonate ($HCO3^{-2}$) plus carbonate ($CO3^{-2}$), chloride (Cl-), and sulfate ($SO4^{-2}$). Each sample is denoted by a point in each trilinear diagram; the type of water samples will make the grade according to the symbolic area in piper diagram.

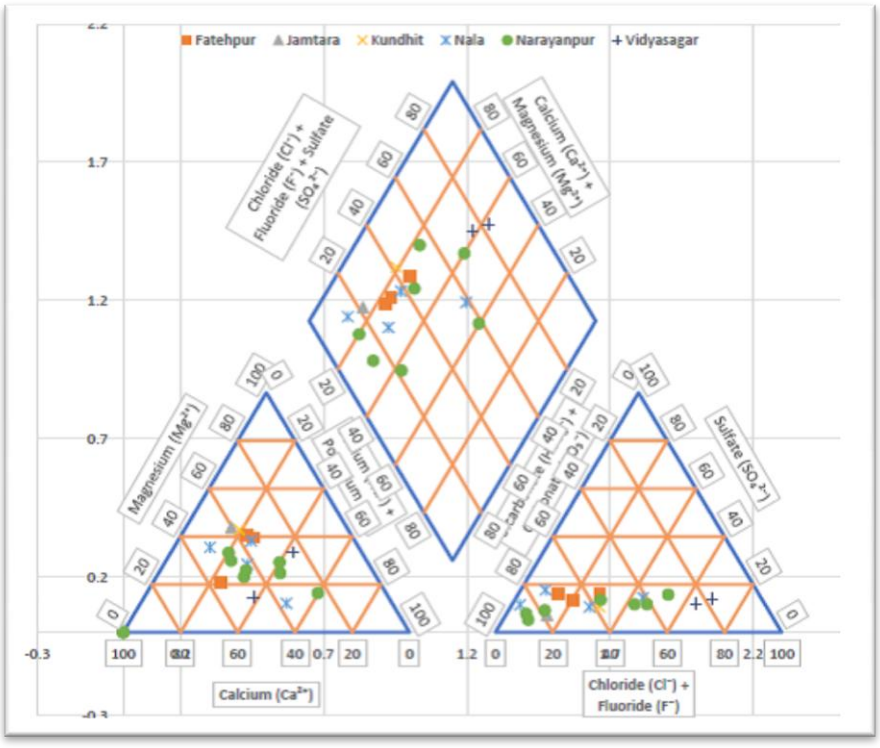


Figure 18: Piper Diagram

Interpretation of Chadha's modified Piper diagram,in shallow aquifer, 65% water sample belong to calcium–magnesium–chloride (Ca–Mg–Cl) type and only 28% water samples belong to calcium-bicarbonate (Ca-HCO3) type.

3.6.8 Suitability of ground water based on Electrical Conductivity (EC): - Wilcox 1948 suggested a water class classification for suitability of water for irrigation. The classification is given below as a table 18.

Table 18 - : - Classification of ground water of Aquifer - I based on electrical conductivity

Sl No.	Water Class	Rages of EC	No. of samples falling	Percentage of samples
1	Excellent	< 250	02	10.52 %
2	Good	250 – 750	14	73.68 %
3	Permissible	750 – 2250	03	15.78 %
4	Doubtful	2250 – 3000	Nil	Nil
5	Unsuitable	> 3000	Nil	Nil

On the perusal of table 18, about 10.52 % of samples falling under excellent class and 73.68 % of water samples of Aquifer – I (dug wells) falling under good and 15.78 % of water sample comes under permissible water class.

3.6.9 Uranium in Ground Water

Uranium is a radioactive heavy metal which is broadly distributed throughout the earth's crust. The presence of Uranium in the ground water causes serioushealth hazards and is a matter of major concern. This study concentrated on contamination of Uranium in shallow groundwater resources of Jharkhand State. In Jamtara district , chemical analysis shows that all the 10 samples from shallow ground water in Jamtara district are under permissible limit of 30 ppb, which generally ranges from 0.23-7.08 ppb(Annexure-VII)

3.7 2-D and 3-D Aquifer Disposition

The 2D & 3-D map in hard rock area of the district showing spatial disposition and vertical extent of Aquifer-I(weathered granite-gneiss/weathered basalt)indicating its depth of weathering while the Aquifer–II (fractured granite-gneiss/fractured basalt/sandstone) showing occurrence of fractured rock thickness is presented in different stratigraphical model (exploded) of hard rock in Jamtara district (figure-19). Based on the drilling data of exploratory wells maximum thickness of Aquifer - I (weathered zone) in hard rock area is 30.0 m. The depth of Aquifer – II (fracture zone) ranges from 30.00 to 140.00 mbgl.Three dimensional sub-surafce Stratigraphical models with Aquifer disposition in hard rock areas of Jamtara district have also been prepared based on exploratory driiling data which is shown in figure 20. A stratigraphical fence diagram is also prepared in the study area and shown in figure 27.

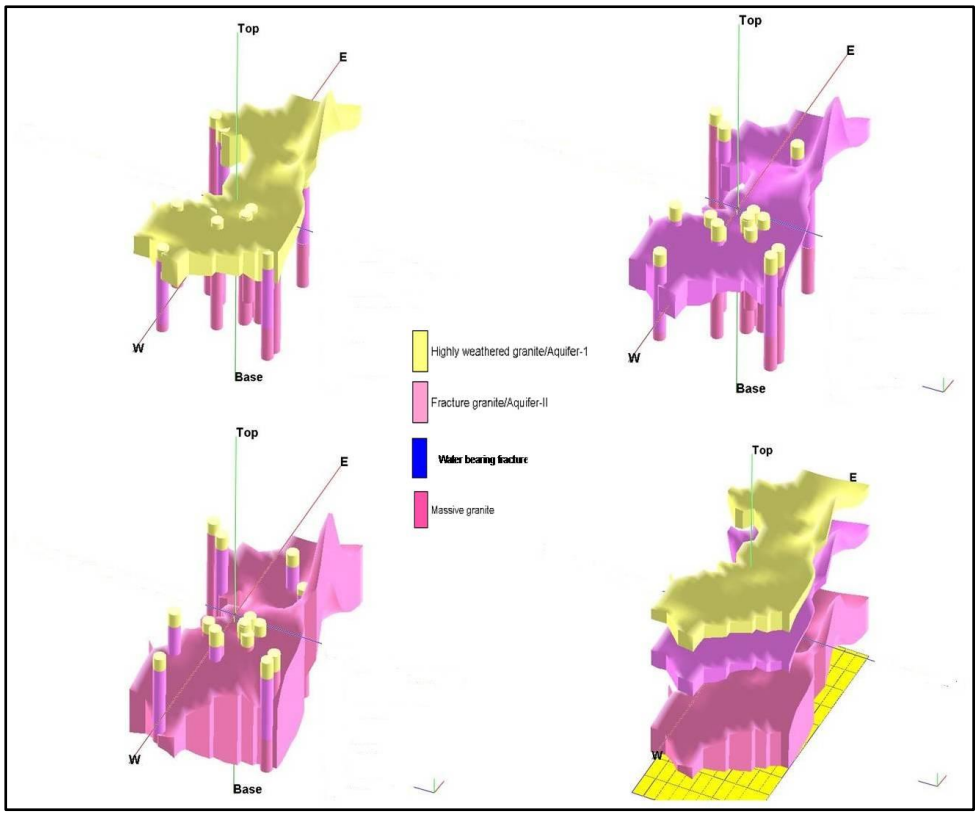


Figure 19: Three-dimensional stratigraphical model (exploded) of Hard rock area of Jamtara district

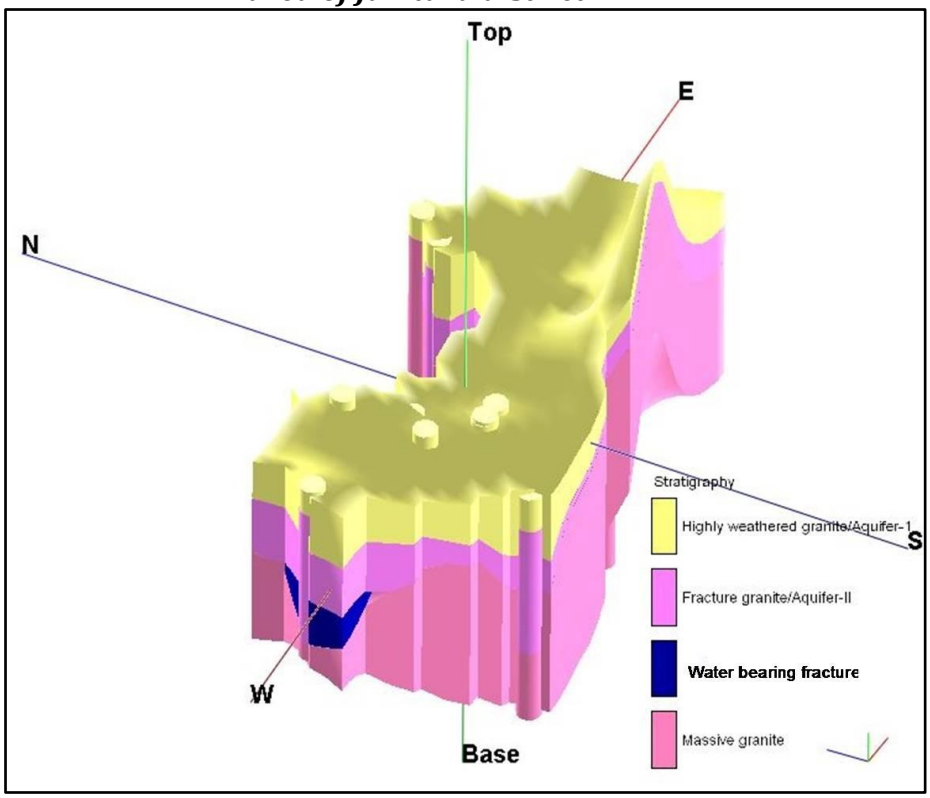


Figure 20:Three dimensional sub-surafce Stratigraphical models with Aquifer Disposition in hard rock areas of Jamtara

3.8 Hydrogeological Cross Section: To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' B-B' and C-C'.

3.8.1 Hydrogeological cross section A-A':

Hydrogeological cross section A-A' represents the area in North-western to eastern part of the district. The data of 5 exploratory wells i.e. Chainpur, Mohanpur, Jamtara D.C., Bhanderbera and Barmasia have been utilised (figure 21). In section A-A' one to five fracture zone has been encountered in different exploratory wells and out of five exploratory wells Barmasia well has got five fracture zone upto depth of 135 mbgl. The discharge range varies from 0.8-12lps. The Aquifer-Ibottom ranges from 21-30m representing weathered Granite-Gneiss/Laterites, while Aquifer-II ranges from 31.50-137 mbgl representing fractured granite gneiss .Hydrogeological cross section of A-A' is shown in figure-22.

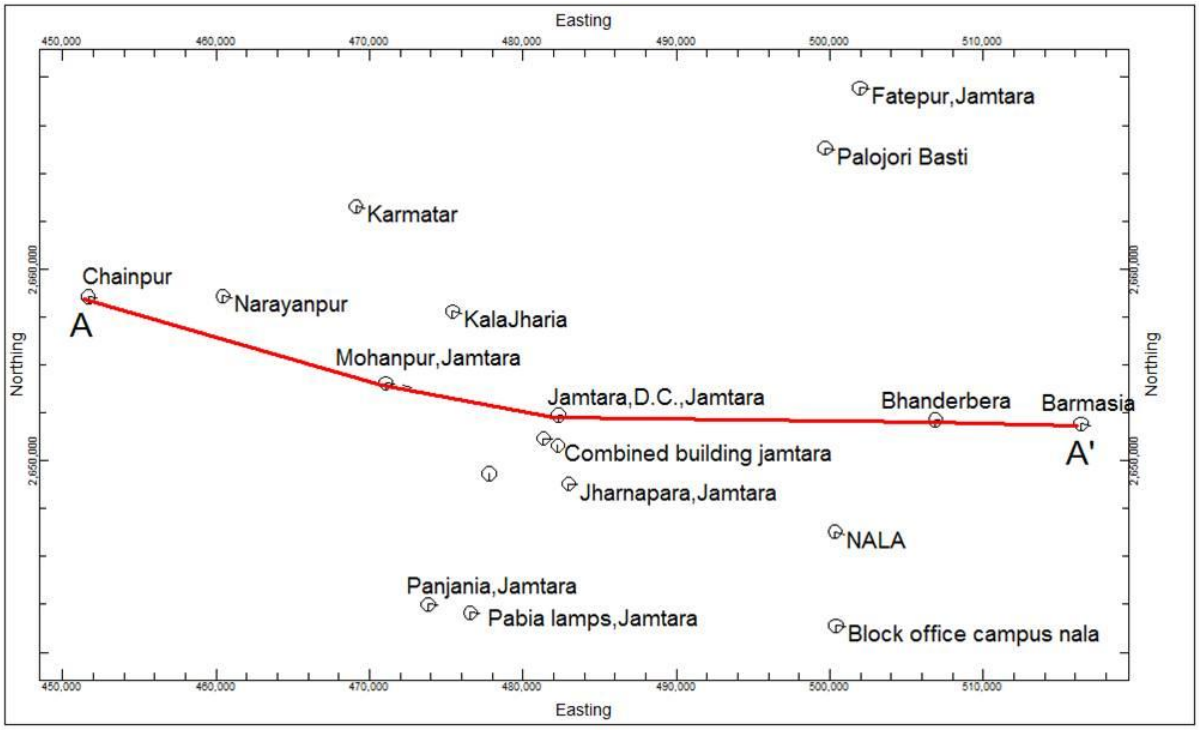


Figure 21: Location of exploratory wells under section A-A'

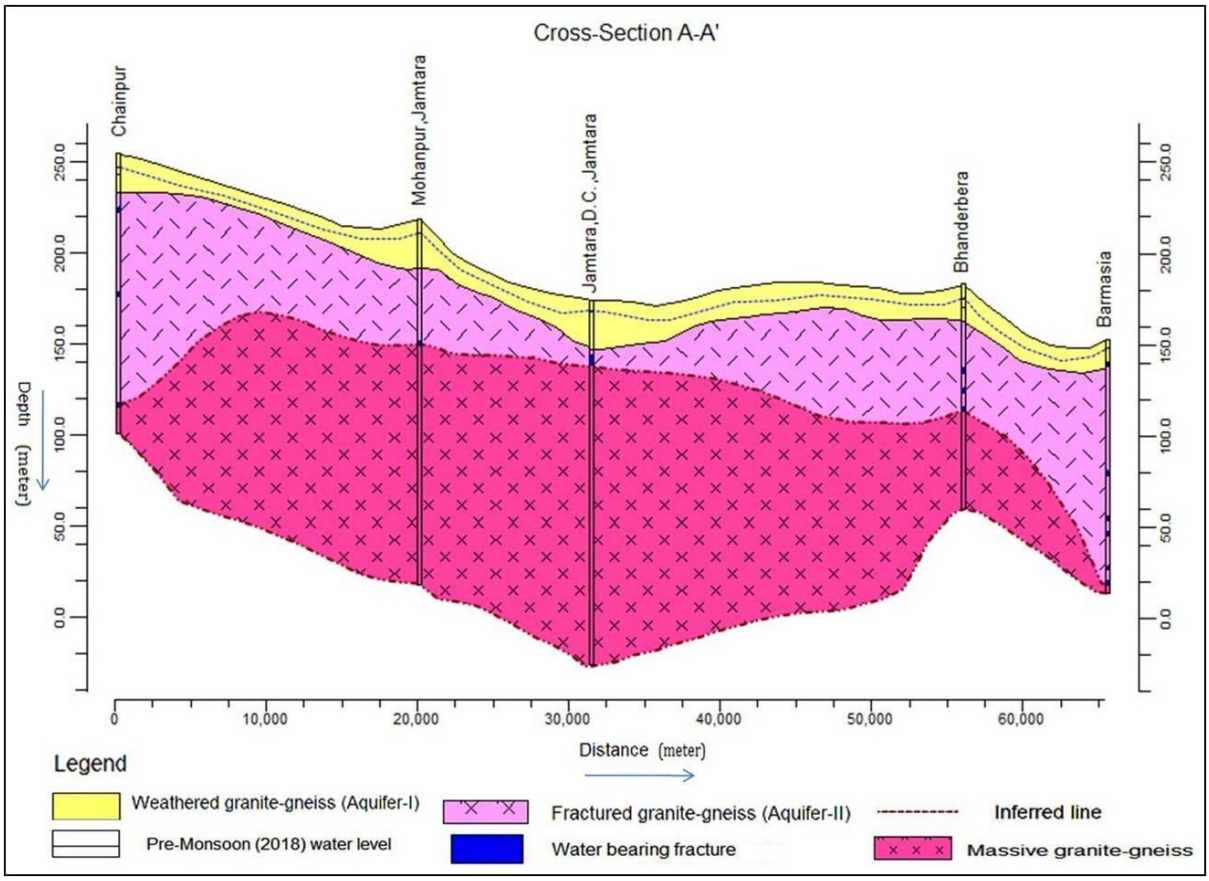


Figure 22-: Hydrogeological cross section along A-A'

3.8.2 Hydrogeological cross section B-B':

Hydrogeological cross section B-B' represents the area in North-eastern to south-western Part of Jamtara district. The data of six exploratory wells i.e. Fatepur, Palojori, Jamtara D.C., Jamtara Block office and Panjania have been utilised (figure 23). Out of six exploratory wells only three exploratory well has got fracture zone upto depth of 140.8 mbgl. The Aquifer- I bottom ranges from13.00-30.00 mbgl representing weathered Granite-Gneiss/Laterites, while Aquifer-II ranges from 30-140.8 mbgl representing fractured granite gneiss. Generally 1-3 fracture zones were encountered. Well yield varies from 0.8 to 12.3lps. The highest discharge i.e 12.3 lps encountered in Panjania well and it is most promising well in Jamtara district.Hydrogeological cross section of B-B' is shown in figure- 24.

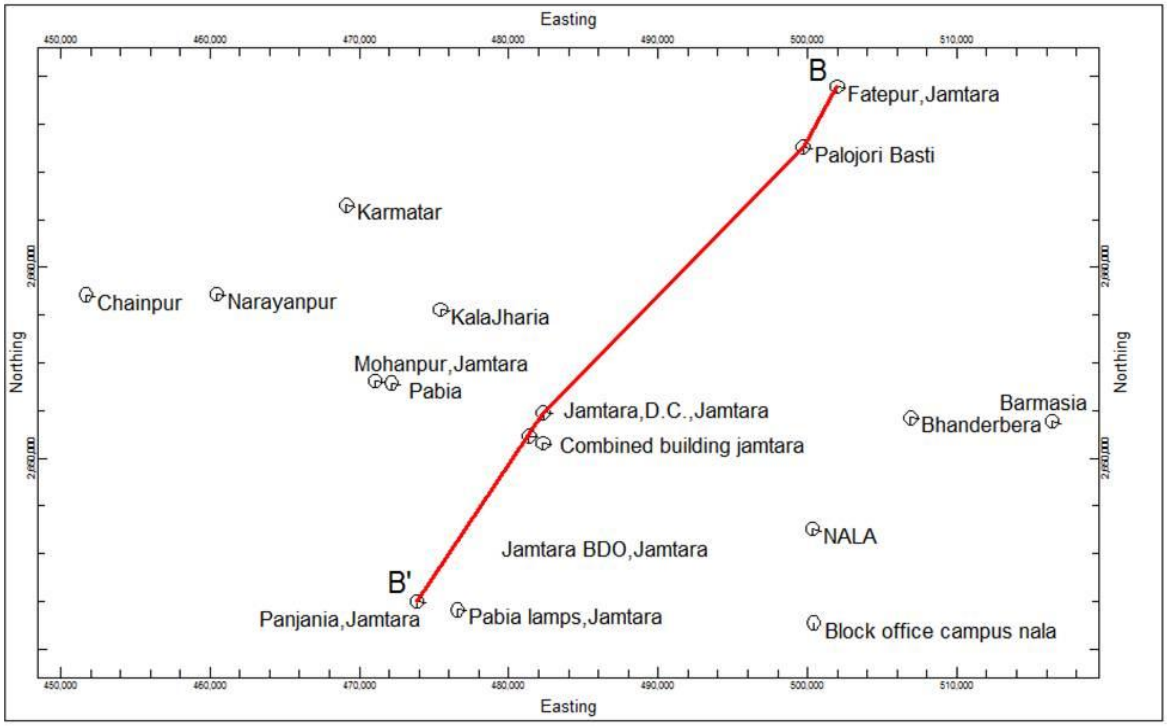


Figure 23: Location of exploratory wells under section B-B'

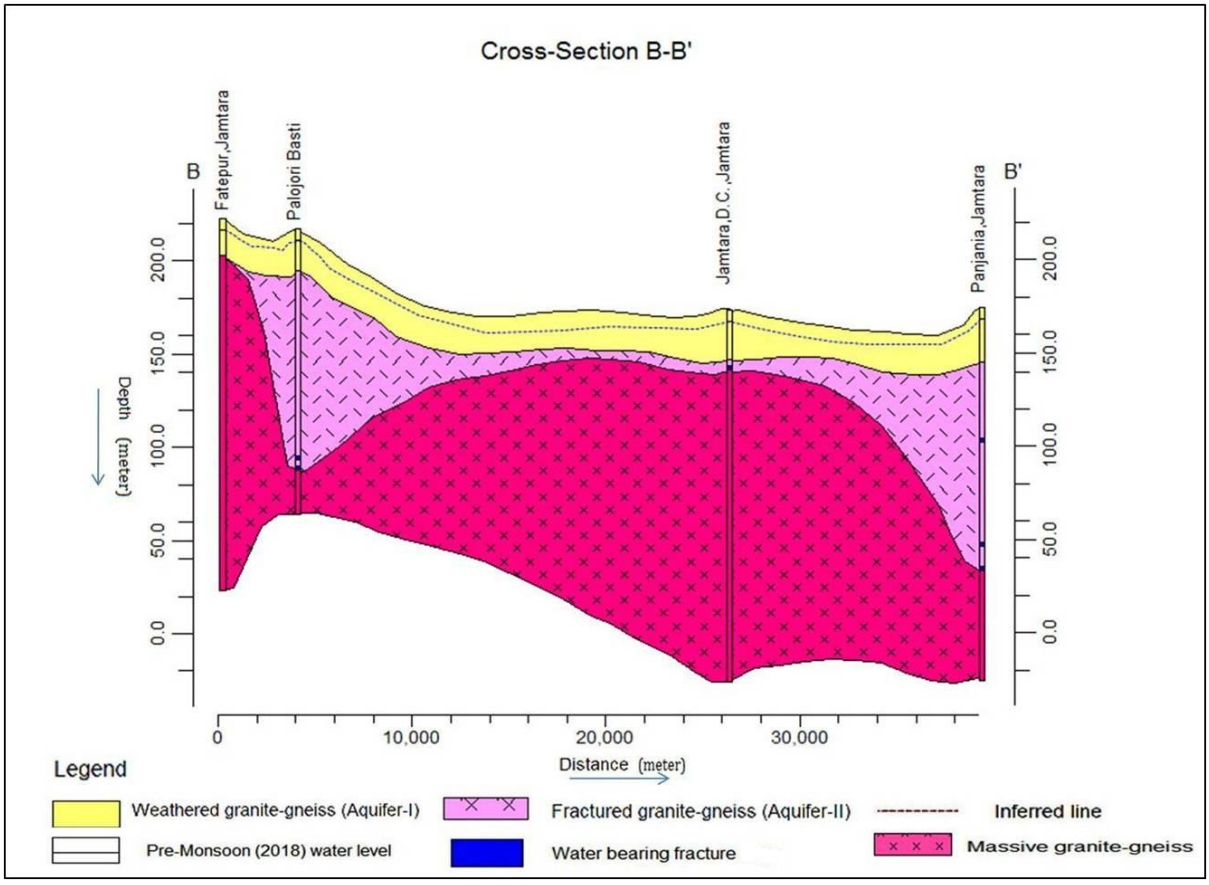


Figure 24-: Hydrogeological cross section along B-B'

3.8.3 Hydrogeological cross section C-C'

Hydrogeological cross section C-C' represents the area in West-northern to South-eastern part of the district. The data of four exploratory wells i.e. Karmatar, Mohanpur, Block office campus and Panjania, Jamtara have been utilised (figure 25). In this area Aquifer-I bottom ranges from 20-29m .In section C-C' out of four exploratory wells, Karmatar well has got three set of fracture in Aquifer II (fractured granite gneiss)upto depth of 136 mbgl. The Aquifer-II ranges from 68-140mtr with discharge upto 12.3 lps. Hydrogeological cross section of C-C' is shown in figure- 26.

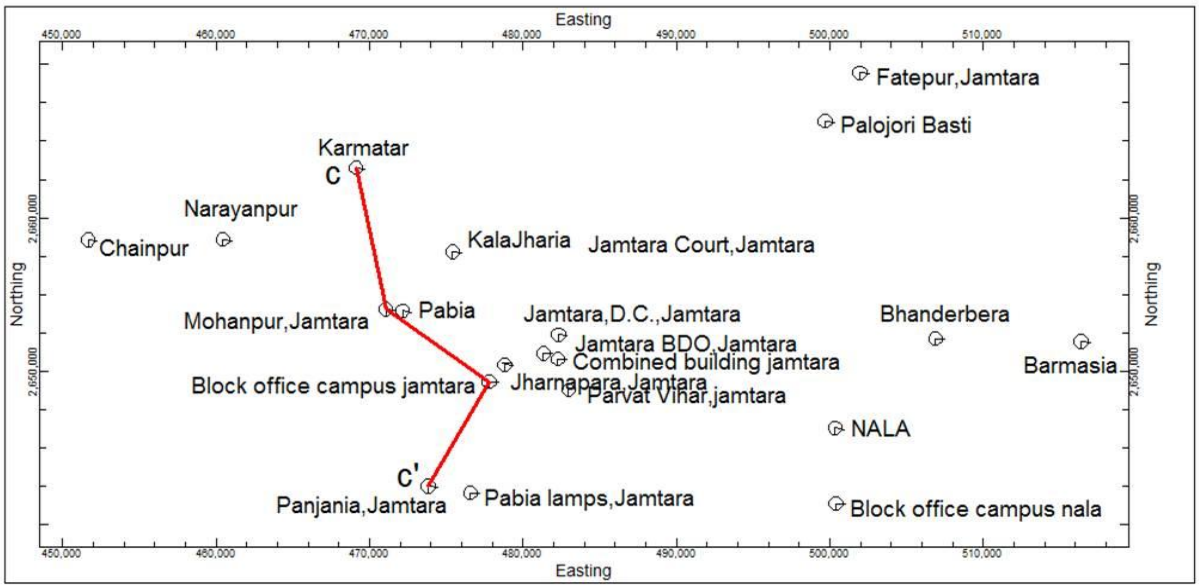
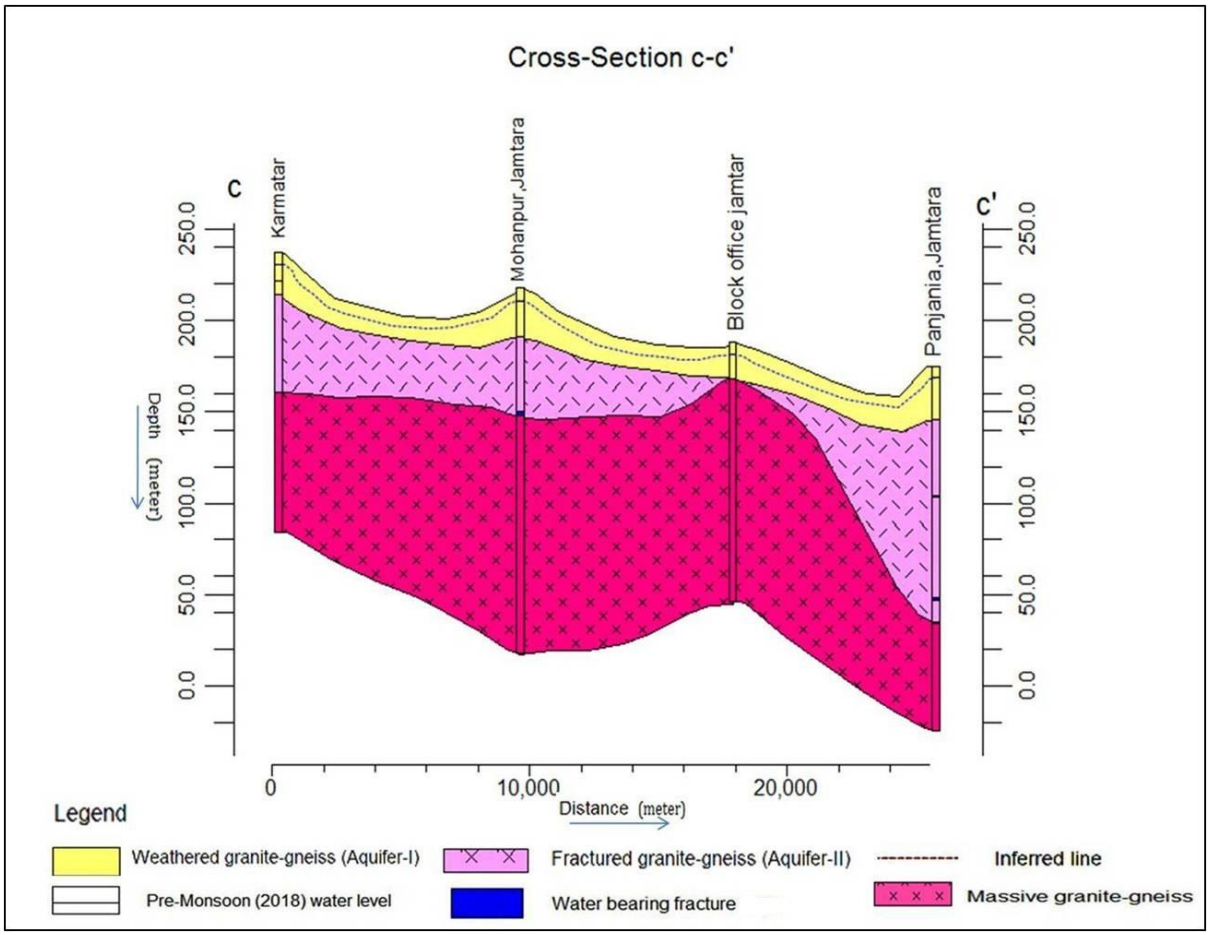


Figure 25: Location of exploratory wells under section C-C'



.Figure 26: Hydrogeological cross section C-C'

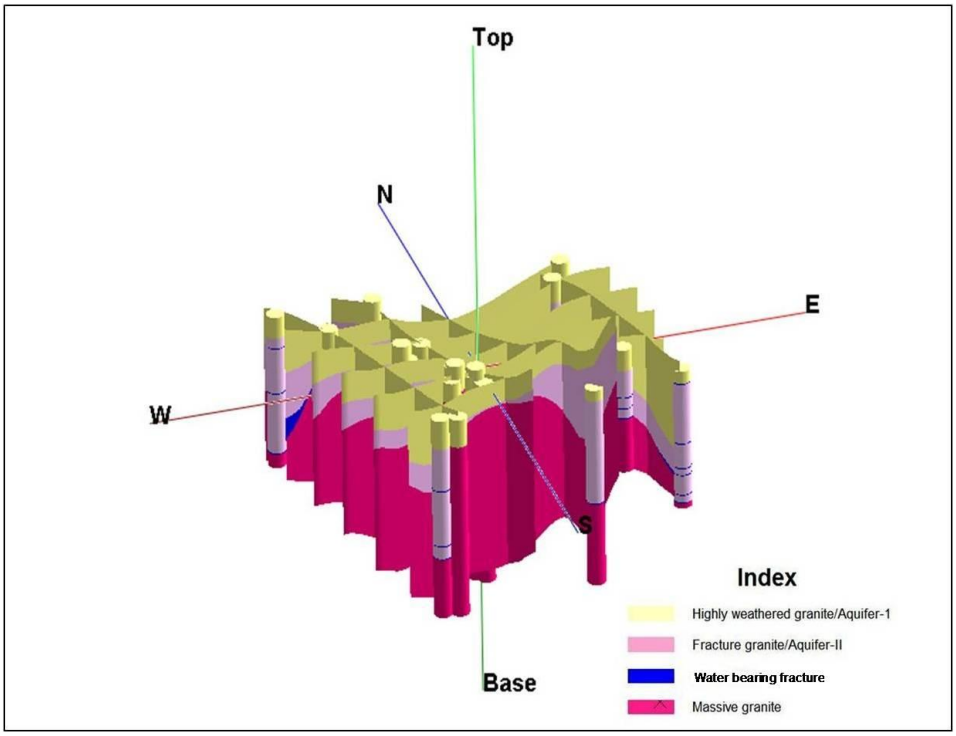


Figure 27: Stratigraphy fence diagram of Hard Rock area of Jamtara District

Hydrogeological cross section of A-A' B-B', C-C', shown in figure- 22, 24 &26 has been prepared based on exploratory well data of CGWB.The inferred imaginary line between fractured rock zone and massive rock zone depicted in Fig 22, 24 &26 are also based on exploratory data. This is a regional model of hydrogeological cross setion. The heterogeneity of hard rock aquifer being high, the hydrogeological cross sections drawn by inferring the continuity of fracture zones in the second aquifer is tentative. Any additional data from the area in future may change the geometry of aquifer that can consider as well.

3.9 Aquifer Characteristics:-

The sustainability of ground water Resources are better understood by the aquifer properties. The table19 depicts the aquifer characterstics in Jamtara district .

Table 19. Aquifer characteristics of Jamtara district

Type of aquifer	Formation	Depth range of the aquifer (mbgl)	SWL (mbgl)		Thickness (m)	Yield (lps)	Aquifer parameter	
			Pre Monsoon (2018)	Post Monsoon (2018)			T (m2/day)	Sy/S
Aquifer - I	Laterites/ Weathered Granite gneiss	3.00 – 29.95	4.6-10.7	2.12-7.20	1 - 5	0 - 3	--	--
Aquifer - II	Fractured Granite gneiss	12 - 140	--	--	0.50 – 2.00	0.45– 12.3	-	-

4. GROUND WATER RESOURCE

Ground Water Resource of the area has been estimated block wise with base year as on March-2017. In the present report GEC 2015 methodology has been used and based on this, assessment has been made using appropriate assumptions. This methodology recommends aquifer wise ground water resource assessment of both the Ground water resources components, i.e., Replenishable ground water resources or Dynamic Ground Water Resources and In-storage Resources or Static Resources. The assessment of ground water includes assessment of dynamic and in-storage ground water resources, but the development planning should mainly depend on dynamic resource only as it gets replenished every year. Changes in static or in-storage resources reflect impacts of ground water mining. Such resources may not be replenishable annually and may be allowed to be extracted only during exigencies with proper recharge planning in the succeeding excess rainfall years.

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

The methodology for ground water resources estimation is based on the principle of waterbalance 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

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Where,
ΔS – Change is storage, RRF – Rainfall recharge,RSTR- Recharge from stream channels
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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 as on 2017 has been assessed by CGWB, SUO, Ranchi in association with State Ground Water Direcorate, Jharkhand based on GEC,

Methodology 2015. The summarized details of Annually Replenishable or Dynamic Ground Water Resources of *Jamtara* district is in Table 20.

Table 20Details of Ground Water Resource of Jamtara District (As on March - 2017)

S.no	Items	Statistics
1	Area in ha	180429
2	Annual Extractable Ground Water Rechargein ham	10616.86
3	Current Annual Ground Water Extraction for irrigationin ham	2060.25
4	Current Annual Ground Water Extraction for domestic in ham	1224.98
5	Current Annual Ground Water Extraction for industrial in ham	4.09
6	Current Annual Ground Water Extraction for All uses in ham	3289.33
7	Annual GW Allocation for for Domestic Use as on 2025 in ham	1225.01
8	Net Ground Water Availability for future usein ham	7327.51
9	Stage of Ground Water Extraction (%)	30.98%

The block wise Dynamic Ground Water Resource of Jamtara District -(As on March - 2017)is given in *Annexure- IV*

4.2 Assessment of In-Storage Ground Water Resources or Static Ground Water Resources (Unconfined Aquifer i.e Aquifer-I)

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

$$SGWR = A *(Z2 - Z1) * SY$$

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

For Aquifer I in hard rock area of Jamtara district

AQUIFER I	
Area (A) (sqkm)	1804.29
Pre-monsoon (average) depth to water level (mbgl) (Z1)	8.36
Bottom of Unconfined Aquifer (mbgl) (Z2)	21.30
Specific yield (Sy)	**2%**
Saturated zone thickness (Z2-Z1) of aquifer (ST)	12.94
SGWR = A *(Z2 - Z1) * SY	466.95 mcm

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

The sum of Annual Extractable Ground Water Recharge and the In storage ground water resources of an unconfined aquifer is the Total Ground Water Availability of that aquifer.

Total Availability (unconfined Aquifer. i.e Aquifer-I) = Annual Extractable Ground Water Recharge + In-Storage Ground Water Resource
Total Availability (Mcm) = *106.16* mcm +466.95 mcm = 573.11 mcm

5. GROUND WATER RELATED ISSUES

Jamtara district is not favoured with surface water irrigation system because of hilly and undulating geographical setting. Due to this, groundwater is being developed to meet more irrigation requirements. The dependence on Ground Water is progressively increasing due to less susceptible to the influences of the changes in the weather phenomenon, however new challenges are threatening the sustainability of the ground water resources. The negative impacts on replenishable ground water resources can be minimized by its proper and planned development. The major emerging problems and issues in ground water resources in Jamtara district canbegrouped intotwo broad categories:

- Problems posed by nature.
- Problems caused by anthropogenic activities
- Other issues (Low Ground Water Extraction)

5.1 PROBLEMS POSED BY NATURE

A variety of nature's factors affect the quantity aspects of ground water over space and time. The major quantity aspects are discussed as follows:

5.1.1 QuantityAspect: (Low Ground Water Potential / Limited Aquifer Thickness / Sustainability)

The occurrence and movement of ground water depends in the hydrogeological characteristics of the sub surface rock formations. Ground water potential at any area mainly depends on the topography, rainfall and geology. Because of varied topography and hydrogeological condition in the district, the ground water potential is not uniform and it changes from one area to another. Entire area of Jamtara district is covered by hard rock or semi-consolidated terrain. The specific yield of the formation varies from 1 to 2%. Therefore the quantity of which can be stored in sub surface as ground water is limited and quantity of water can be extracted from any area which depends on the thickness of aquifer and specific yield of aquifers. Thus the availability of water resources is not uniformly distributed over time. This resource depletes often in summer or lean period.

Central Ground Water Board has constructed 21 exploratory wells in hard area of the district. The percentage of success bore wells (more than 3 lps discharge) is less. Out of 21 exploratory wells only 4 exploratory well having more than 3lps discharge. Average thickness of weathering is 20 m and fracture zone is 1-2 m only.

5.2 PROBLEMS CAUSED BY ANTHROPOGENIC ACTIVITIES

Theareaof interference ofhumanactivitiesmay be broadlygroupedinto:

5.2.1 Quality Aspects:

By and large, ground water in the Jamtara district is potable and is suitable for irrigation as well. However at few localities contamination in ground water do occur. Major Ground water quality issues have been observed in Jamtara district is occurnces of high Nitrate in Narayanpur, Vidyasagar and Nala blocks.

Nitrate

Nitrate generally occurs in trace quantities in surface water but may contain high levels in some groundwater. Nitrate is a non-essential constituent of groundwater and is contributed mostly by agriculture, industrial and municipal (AIM) activities. Concentration of nitrate in excess of 45mg/l in water is harmful for human consumption, particularly for infants as it may cause blue baby disease. The highest desirable and maximum permissible limit of nitrate is 45mg/l (IS: 10500 Drinking water standards). The Concentration of the nitrate above the permissible limit (45.00 mg/l, BIS, IS:10500,1991) is found in Narayanpur, Vidyasagar, Nala and Fathepur blocks of Jamtara district (out of 19 samples 08 samples, high nitrate content are found).

5.2.2 Areas of Intensive Mining Activities

The area is having number of mining activity with the intensive development of ground water. Smooth and unhindered mining operations necessitate heavy ground water pumping and associated activities like washing of coal, milling etc. Main ground water problem in mining area of Stone (Nala,Jamtara, Kundahit and Narayanpur blocks) and coal (Chitra coal mines, Jamtara) is related with the dewatering of shallow and deep aquifer dewatering from open- cast mining of the area. Continued pumping from various coal mines causes depletion of water levels and identified for the problem of depletion in the general water table and decline in the tube well discharge. Underground and opencast excavations behave as large sinks and create hydraulic gradient towards the mine. Mine water is pumped out for trouble free mining operations. Continuous withdrawal of water from Coal mines for their mining activities is causing adverse impact on ground water regime of the area which ultimately results in declining water levels, drying up of wells, dwindling of their discharge and some times land subsidence. Location of stone mining quarry/ area is shown in figure 28.

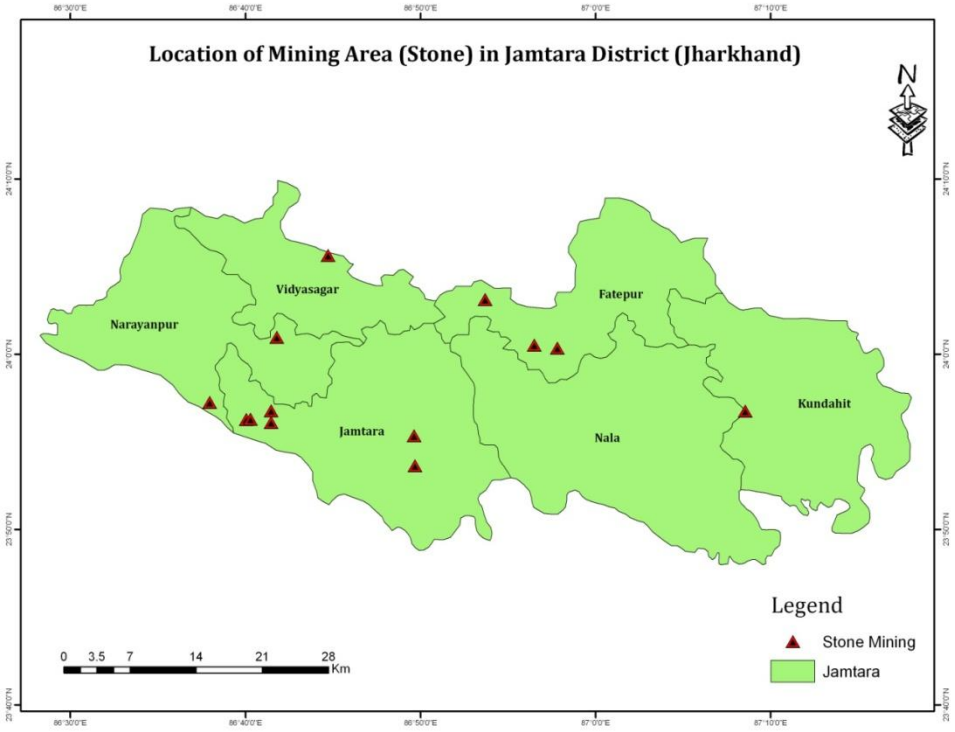

Figure28 Location of Mining area in Jamtara district

The district has total 16 operative and 3 non-operative stone mines. Industrial water supply for these industries seems to be inadequate. As reported, major industrial water requirement is fulfilled from rain water storage in these Mines of these industries. However partial requirement is also met from tube wells drilled in their area. Continued heavy withdrawal of ground water around the industries for water supply may cause adverse effect in ground water regime of the area, including depletion of water table. Detailed studies are required to assess impact of industrial development in ground water regime of the area. Mining Hydrogeological studies are also needed to evaluate impact of pumping from mines of the area.

5.3 Low Ground Water Extraction: One major issue of the area that is low ground water extraction. At present the overall stage of ground water extraction is only around 30.98%. Block wise stage of ground water extraction varies from 17.76 to 50.85 percent. The block wise status of stage of ground water extraction is shown in table21.

Table 21: The block wise status of stage of ground water extraction

Block	Jamtara	Vidyasagar	Nala	Kundhit	Narayanpur	Fathepur
Stage of Development (%)	23.23	39.34	17.76	50.85	40.55	33.37

The study area experiences low ground water extraction, however the eastern part of the district the ground water resources extraction is slightly higher side whereas, central, northern and southern part of the district where ground water resource is underutilized. Ground water related issues and problems are not getting scientific attention of the Government, planners and stakeholders. The plan and policy of the water resources department are mostly related to the surface water only. There is urgent need to pay attention towards ground water also.

6.0 MANAGEMENT STRATEGIES

As discussed in previous chapter, the major ground water related issue in the Jamtara is, Area of intensive Mining, low ground water development owing to many socio-economic and hydrogeological reasons. To overcome these, it is imperative to have a robust ground water resource development plan for the district. Various Management strategies to overcome the ground water related issues are ;

6.1 Proper utilization of Mine Water:

Strict water management practices should be adopted for the stone & coal-mining belt. Abandoned mines can be treated as a big rainwater harvesting and artificial recharge structure. Hence, priority needs to be given for mine water harvesting and sustainable development. In post-mining, the abandoned mine voids should be backfilled to serve as huge groundwater reservoirs and recharge structures. In open cast mines, the permeability of the reclaimed area is usually higher than the in-situ and allows to infiltrate up to 40% of rainfall. These areas can be the major water pockets for future development. Thus, with proper water management, by mining out one resource 'Coal', another valuable resource 'Water' may be generated. Coal mining can be an eco-friendly engineering activity by adopting groundwater resource management.

6.2 Ground Water Utilization in most irrigation deprived areaand low ground water extracted blocks:

The present status of ground water extraction for the whole district is only 30.98%. Although the ground water extraction in eastern part is more, there is ample scope of ground water extraction in the other part of the district. Block-wise balance ground water for future irrigation potential is determined for all availability. The ground water available for future use is divided by an average of depth of irrigation ( ), considering of 0.45 m for Jharkhand, which ultimately gives irrigation potentials. All the six blocks of the Jamtara district having stage of ground water extraction is less than 70% are considered for the further ground water development.

The ground water available for future use is divided by an average depth of irrigation ( ), considering of 0.45for Jharkhand, which ultimately gives irrigation potentials. Considering 70%of future irrigation potential as optimum utilization with 0.3 ha command area for dug well and1.2 ha for shallow bore wells further dividing 50% for dug wells and 50% for bore/tube wells , the number proposed these structures are worked and given in table 22.

Table 22: Future Irrigation Potential & Proposed number of Abstraction Structures based on Stage of Ground Water Extraction70%

Block	Net GW Availability for Future use	future irrigation potential available (ha) considering (Δ) 0.45m	70% of future irrigation potential to be created (ha)	Proposed number of ground water structure (Dug wells)	Proposed number of ground water structure (Shallow TW/BW*)
Fatepur	1089.71	2421.58	1695.10	2825	706

Jamtara	1376.98	3059.96	2141.97	3570	892
Kundahit	399.84	888.53	621.97	1037	259
Nala	2373.21	5273.80	3691.66	6153	1538
Narayanpur	1384.55	3076.78	2153.74	3590	897
Vidyasagar	703.23	1562.73	1093.91	1823	456
Total	**7327.5**	**16283.38**	**11398.36**	**18997**	**4749**

***TW-Tubewell,BW-Borewell**

It is necessary that proposed Additional ground water abstraction structure may be constructed in phases with proper site selection. The results of the first phase of ground water development together with studies of the behavior of ground water regime will guide futher ground water development to achieve 100% utlisation. Dug well, Shallow bore well and tube wells are feasible ground water structures for the district. The additional ground water abstraction structures of 18997 dugwells and 4749 borewells/tubwells would bring an additional area of 11398 ha under assured irrigation.

6.3 Supply side Interventions (Artificial Recharge): At present as per Ground Water Resource Estimation 2017, the stage of ground water extraction is very low i.e**., 30.98%** and all the block of the district comes under safe category. However in some parts of the district long term declining trend has been noticed. Therefore, the ground water development should also be coupled with ground water augmentation, so that there is no stress on ground water regime of the area. The supply side interventions envisages construction of Rainwater Harvesting and Artificial Recharge structures in the areas feasible for construction of recharge structures based on the long term water level scenario and recharge potential of the aquifer.

6.3.1 Artificial recharge to Ground Water Master plan 2020

Recently in 2020, artificial recharge to Ground Water master plan 2020 of Jharkhand state has been prepared. The identification of feasible areas (shown in figure 29) for artificial recharge to ground water in Jamtara district has been carried out based on depth to water level (post-monsoon) and ground water level trend.The area identified for artificial recharge has been made based on post monsoon depth to water level (Nov 2018) more than 3m bgl with declining trend of more than 0.1 m/yr (2009 – 2018). In addition, area with water level more than 9 m bgl in the district has been considered for identifying the area. The volume of unsaturated zone available for recharge in identified areas is determined by computation of average depth of the unsaturated zone below 3 m bgl and then multiplied by area considered for recharge. The computation of unsaturated zone available, surface water requirement and source water availability for Artificial recharge and prposed numbers of different types of artificial recharge structures feasible in Jamtara district has been worked out in table 23 & 24 respectively.

Table 23: Identified Area, Computed Storage Volume and Source Water availability for Artificial Recharge to Ground Water in Jamtara district .

S.No.	Name of District	Area identified for Artificial Recharge (sq.km.)	Volume of unsaturated zone available for recharge (MCM)	Surface Water required at 60% efficiency (MCM)	Source water availability (MCM)	Total Non-committed surplus runoff available (MCM)
1	Jamtara	1374.12	40.12	66.61	419.98	209.99

Table 24: Different types of artificial recharge structures feasible in Jamtara District, Jharkhand.

S.No	District	Number of Structures feasible			
		Nala Bund/Check Dam/Gully Plug	Percolation Tank	RTRWH area 300 to 1000 sq. m.	RTRWH area more than 1000 sq. m
1	Jamtara	1110	177	5118	269

The implementation of water conservation through artificial recharge measures will have a positive impact on drinking water sources of the area. It will ensure that the wells don't go dry during summer/lean/stress period in the areas of implementation and sufficient ground water availability is there in the wells even during the summer season. Thus not only the drinking and domestic water sources will be strengthened but additional irrigation potential can be created through artificial recharge structures.

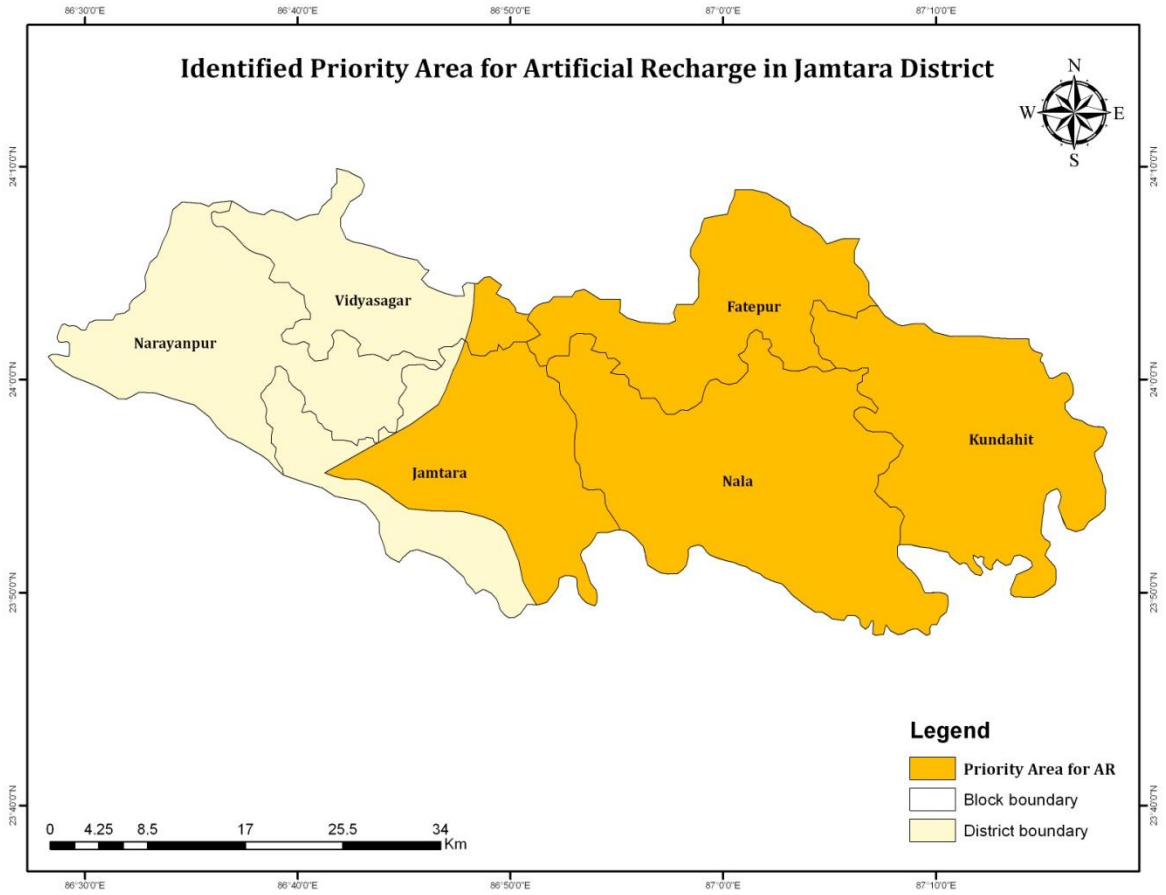

Figure – 29: Identified Priority Area for Artificial Recharge in Jamtara District

6.4 Demand Side Interventions

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

- 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.
- Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.)

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

6.6Water Stress Aspect against future demand (2025, 2030): Demand of water is increasing day by day against the increasing population. The detail demographic particular of the Jamtara district and water requirement for domestic purpose is worked out for the year 2025 and 2030 is presented in table 25,26 and 27 respectively.

Table 25: Detail demographic particular of Jamtara district

Population as per census			
2001		2011	
Rural	Urban	Rural	Urban
597287	55794	715296	75746

Table – 26: Projected population of Jamtara district

Projected population			
2021		2031	
Rural	Urban	Rural	Urban
715315	75781	715335	75817

Table – 27: Requirement of water for domestic use in Jamtara district

	Water requirement (assuming 90 liters per day per person for rural population and 130 liters per day per person for urban population)			
	2021		2031	
	Rural (Litres/day)	Urban (Litres/day)	Rural (Litres/day)	Urban (Litres/day)
	64378350	9851530	64380150	9856210
Total	74229880 litres / day		74236360 litres / day	

On perusal of table – 27, the requirement of water will be 74236360 litres per day in 2030. The demand of water is increasing due to highly increasing population. Thus, recommended for surface water supply from surface water to reduce the stress of ground water.Drinking water & Sanitation Department, Government of Jharkhand, shouldplan to implement Mega water supply scheme from the river Ajayor Masaanjore dam to solve the drinking water problem in Jamtara district.

7.0 Conclusion and Recommendations

7.1 Conclusion

- The district Jamtara is spread over 1804 Sq. km area consisting of 1 subdivision and 6 blocks namely Kundahit, Nala, Jamtara, Narayanpur, Karmatar and Fatehpursituated in the north–eastern part of the Jharkhand state. It is bounded by Deoghar district in north, Dumka and Birbhum district(West Bengal) in the east, Dhanbad and Paschmi Bardhaman district (West Bengal) in the south and Giridih in the west. As per census of 2011, total population of the district is 1313551 with rural population of 1249132 and urban population 64419.

- Aquifer Mapping Study wascarried out inJamtaradistrict, Jharkhand covering 1804 sqkm area throughcollection of various data from state/central govt agencies, Data gap analysis, data generated in-house, data acquired from State/Central Govt. departments. All the available data were integrated to prepare aquifer maps and aquifer management plans of the district.

- Geomorphologically, the district can broadly be divided into three well defined physiographic units (a) Hilly area (b) Rolling velleys and (c) Pediplain flat country. The general slope of the district is from North to South East.The area is characterized by gently undulating topography with isolated hill and hummocks.

- Geologically, the area area mainly exposes rocks of Chotangapur Gneissic complex, Gondwana Supergroup and Rajmahal Traps. The Chotanagpur Gneissic complex(CGC) is largely represented lithological unit in the area. CGC of the Precambrian formations are overlain by Gondwana formations, represented by Barakar, and Talchir formations in the form of a strip running roughly in the NW-SE direction. However an isolated patch of this formation is also found to occur in the central part of the district. The pre-cambrian formations/Gondwana formations are further overlapped by Rajmahal Traps consists of basaltic lava flows with sedimentary intertrappeans. The alluvium patches are generally seen along major streams. Narrow, discontinuous patches of alluvium particularly in granitic country are identified.

- Based on morpho-genetic, geological diversities and relative ground water potentialities of the aquifers, the district can be broadly divided into three Hydrogeological units: a) Consolidated or Fissured formations - Precambrians and Rajmahal Trap, b) Semi-Consolidated formations–Gondwanas, c) Unconsolidated or Porous formations - Laterites and Alluvium. The studies show that the area has undergone several phases of tectonic deformations which lead to various sets of fractures, fissures, faults etc which leads to lineaments. Based on lineament study of the area, various sets of fractures have been identified

- The occurrence and movement of ground water in the area is variable, which is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifer in the area is Chhotanagpur Gnesiss Complex, where the occurrence and movement of ground water primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and

weathering. Ground water occurs under phreatic/ unconfined to semi-confined conditions in Aquifer-I which is represented by weathered granite and Weathered Basalt (Upto 30 m depth) , however in some cases depth varies from more than 30m. Ground water occurs under Semi-confined to confined condition in Aquifer-II represented by Fractured granite-gneiss, Fractured/Vesicular basalt and Sandstone upto the depth of 140 mbgldepth. Discharge of the wells in Aquifer-II range between 0.45-12 lps.

- First potential fracture zone encountered in the district widely varies from 12-123 m. In central part of the district very less fractures were encountered whereas in eastern, south-western and north-eastern part of the district having 1 to 6 set of fractures has been encountered and these sets of fractures are promising with discharge observed from 3 to 12.3 lps.

- Some times the potential fractures were encountered at very shallow level 48.00-69.00 m with very high yielding wells. These potential fractures may be tensile in nature occurring at shallow level, which is found to be potential repository of ground water. Some of the exploratory wells encountered upto the depth of 70m which yielded high discharge eg Bhanderbera (12 lps).At several places fractures between 120-140m have been encountered in which well yielded high discharge, i.e Barmasia(7.2 lps), Panjania(12.3 lps), Palojori(5.7 lps).Some of high yielding well where multiple fractures were encountered within 140 m depth are Panjania (12.3 lps), Chainpur (3 lps), Bhanderbera (12 lps), Palojori Basti (5.7lps).

- Ground Water quality is generally potable,, however Nitrate concentration in four blocks of Jamtara distict i.e Narayanpur, Vidyasagar, Nala and Fathepur are found beyond permissible limit.

- Based on estimation of Ground Water Respurces-2017, the stage of ground water development in Jamtara district is 30.98% and all the block comes under safe category.Therefore there is sufficient scope for further ground water development.

- Three major ground water related issues in Jamtara district are Low ground water development, Low ground water potential and Nitratecontamination(inNarayanpur, Vidyasagar, Nala and Fathepur blocks of Jamtara district.)

7.2. Recommendations

- As the well yield depends on occurrence of potential fractures, therefore before going to any ground water exploration detailed hydrogeological, geophysical studies should be carried out.
- Based on recent Ground water estimation 2017, Ground Water Management strategy suggested that additional 18997 nos Dug well, 4749 nos Shallow bore well/tube wells are feasible ground water structures for the district to enhance the overall ground water development to 70%. The construction of this 23746 additional ground water abstraction structures would bring an additional area of 11398 ha under assured irrigation.

- To suggest a sustainable ground water management plan there are two options- Supply Side Management Options(local water harvesting techniques) &Demand Side Management Options (real water-savings)

- The supply side interventions envisages construction of 1110 nos of Check Dam/Nala bund-, 177 nos of Percolation Tank and 5387 nos building RTRWH 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. It will ensure that the wells don't go dry during summer/lean/stress period in the areas of implementation and sufficient ground water availability is there in the wells even during the summer season. Thus not only the drinking and domestic water sources will be strengthened but additional irrigation potential can be created through artificial recharge structures.

- 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 crop like pulses and horticulture), iii)Promoting treated municipal waste water for irrigation and construction use, and iv)Managing energy and irrigation nexus (provide quality power supply when needed through separate feeders, high voltage distribution lines, solar pumps, etc.)

- The government should encourage and provide incentive the use of drip irrigation and sprinkler system.

- Alternative surface water supply from Ajay river and Masaanjor dam may be provided to reduce the stress of ground water.

- Alternate source of safe drinking water are required to be located in the areas of geogenic polluted areas. Ground water and surface water need to be protected from pollution due to industrial improper sanitation, excessive use of fertilizers. Strict vigilance and legislation should be imposed on industries for the treatment of effluent water.

- The study area requires assured irrigationfor sustainable agriculturalproductivity and to mitigate the effect of persistent drought condition. A special thrust to ground water development for irrigation has to be given in the area where stage of ground water development is less than 60%. Construction of ground water abstraction structures should be permitted as per the scientific feasibility. Distance between these structures and their depth should be decided based on hydrogeological and geomorphologic condition.

- Strict water management practices should be adopted for the stone and coal-mining belt. Abandoned mines can be treated as a big rainwater harvesting and artificial recharge structure. Hence, priority needs to be given for mine water

harvesting and sustainable development. In post-mining, the abandoned mine voids should be backfilled to serve as huge groundwater reservoirs and recharge structures. In open cast mines, the permeability of the reclaimed area is usually higher than the in-situ and allows to infiltrate up to 40% of rainfall. These areas can be the major water pockets for future development. Thus, with proper water management, by mining out one resource 'Coal', another valuable resource 'Water' may be generated. Coal mining can be an eco-friendly engineering activity by adopting groundwater resource management.

- The ground water regimes should be regularly monitored and the distribution of the observation stations should be denser.The main objective of regular monitoring of ground water regimes is to understand the ground water system both in term of quantity and quality. The purpose built piezometers fitted with sophisticated instruments such as Digital Water Level Recorder (DWLR) should be installed in the ground water vulnerable areas for hourly/daily monitoring.

- The public participation is an essential in every ground water management. There is inherent need to educate the people for utilization of ground water resources simultaneously with proficient Rain Water Harvesting and Artificial Recharge. This combined with the political wisdom and community participation focusing on its proper, just and equitable distribution for the area of intensive ground water development can be arrested the declining ground water levels.

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Annexure - I

DETAILS OF EXPLORATORY WELLS DRILLED IN JAMTARA DISTRICT

Sl.No.	Location/	Block	long	lat	Depth Drilled	Length of Casing pipe	Fractured Zone	Static Water level	Discharge	Geology
1	NALA	Nala	87.00	23.928	198.46	10.54	115.00-116.00	6.89	0.9	Granite-Gneiss
2	Bhanderbera	Nala	87.067	23.9810	123.32	21.5	48-49, 59-60, 69-70	12.89	12	Granite-Gneiss
3	Block office campus nala	Nala	87.038	23.5833	150	18.5	-----	-----	Dry	Granite-Gneiss
4	Pabia	Jamtara	86.726	23.9972	142	16.5	-----	-----	Dry	Granite-Gneiss
5	Block office campus jamtara	Jamtara	86.781	23.9555	142	20.5	-----	-----	Dry	Granite-Gneiss
6	Panjania,Jamtara	Jamtara	86.743	23.8938	200	29.95	71.50 – 72.00, 127.00 – 127.80 , 140.10 – 140.80	8.66	12.3	Granite-Gneiss
7	KalaJharia	Jamtara	86.758	24.0319	150	18.22	-----	-----	Dry	Granite-Gneiss
8	Jamtara BDO,Jamtara	Jamtara	86.791	23.9655	200	26.75	-----	-----	Dry	Granite-Gneiss
9	Jharnapara,Jamtara	Jamtara	86.832	23.9508	200	21.6	-		Dry	Granite-Gneiss
10	Jamtara,D.C.,Jamtara	Jamtara	86.826	23.9833	200	27.9	29.50 – 30.00	3.55	0.8	Granite-Gneiss
11	Jamtara Court,Jamtara	Jamtara	86.79	23.9666	200	23.37	-----	-----	Dry	Granite-Gneiss
12	Parvat Vihar,jamtara	Jamtara	86.825	23.9688	200	20.65	-----	-----	Dry	Granite-Gneiss
13	Combined building jamtara	Jamtara	86.816	23.9722	150	27.5	-----	-----	Dry	Granite-Gneiss
14	Pabia lamps,Jamtara	Jamtara	86.675	23.3355	200	28.05	-----	-----	Dry	Granite-Gneiss
15	Palojori Basti	Fathepur	86.997	24.1090	153.8	12.8	123-124, 127-128	6.10	5.7	Granite-Gneiss
16	Fatepur,Jamtara	Fathepur	87.019	24.1375	200	20.37	…….	……..	Dry	Granite-Gneiss
17	Chainpur	Narayanpur	86.524	24.0384	153.6	24.5	31.50-32.50,77.20-78.20,138.20-139.20	11.2	3	Granite-Gneiss
18	Narainpur	Narainpur	86.611	24.0388	150	18.5	-----	-----	Dry	Granite-Gneiss
19	Mohanpur	Narayanpur	86.715	23.9980	200	27.95	68.30 – 70.85	15.25	0.45	Granite-Gneiss
20	Karmatar	Vidyasagar	86.696	24.0813	153.8	22.25	75-76,99-100,136-137	15.10	2.5	Granite-Gneiss
21	Barmasia	Kundahit	87.161	23.9791	138.58	9.58	012.04-013.00, 073.00-074.62, 098.48-099.48, 105.10-106.10, 125.34-126.34, 133.96-135.58	8.16	7.2	Granite-Gneiss

Annexure – II

LOCATION OF KEY WELLS ESTABLISHED UNDER NAQUIM STUDY IN JAMTARA DISTRICT, JHARKHAND,

Sl No	Block	Village	Long	Lat	Source	Pre 2018	post 2018	Geology	MP (magl)	Depth (mbgl)	Diameter (m.)	Owner	Location
1.	Nala	lakra kunda	86.98	24.016	DW	9.5	2.43	Granite	0.7	10.6	8	Sh. Gunpt singh	well situated on Left hand side before 0.5 km road bifurction going to Nala & Kundhit I.e near to Mohanbak mohr)
2.	Nala	dumariya	87.01	23.946	DW	9.6	3.76	Granite	0.6	13	3.6	Sh. Mohit Mondal	Well situated on LHS while coming from lakra kunda around 05 km before to reach nala
3.	Nala	sangajodi	87.09	23.951	DW	9.18	3.31	Granite	0.9	12	2.9	Sh. Shyamal Mistri	In between 7 km from Nala-Kundhit road. Well is situated on RHS of the premises of owner home.
4.	Nala	saharpur	87.04	23.994	DW	9.8	4.2	Granite	0.7	10.6	3.2	Govt.Well	In front of Adhir Mahli house. Well is situated RHS of the road in Kundhit Murgabani road before 10 km reach to murgabani.
5.	fathepur	agariya	87.03	24.134	DW	5.1	3.67	Granite	0.7	8.1	4.3	Sh. Sanatan Pandit	In the back side of Sanatan Pandit house, milestone showing fathepur 5km from Dumka and Nishintpur 21km from Fatehpur
6.	fathepur	baghmara	87.04	24.105	DW	6.4	3.56	Granite	0.5	10.6	2.9	Sh. Utam Das	In front of owner house well situated 4km from Agatiya-Kundhit road or Dhansaniya road opposite to pond
7.	fathepur	pathrabad	87.09	24.077	DW	7.3	4.65	Granite	0.4	8.8	1.8	Govt.Well	Well situated on he RHS of road on pathrabad village, in frontof gram pradhan house
8.	kundhit	babupur	87.15	24.018	DW	6.7	3.09	Granite	0.6	8.1	6.1	Govt.Well	Well situated on the outcut of Babupur village on RHS of the road while coming from fathepur before 7km reach to kundhit, near to SBI sign board and 500m far from Govt school

Sl No	Block	Village	Long	Lat	Source	Pre 2018	post 2018	Geology	MP (magl)	Depth (mbgl)	Diameter (m.)	Owner	Location
													and temple
9.	jamtara	amlachatar	86.87	23.944	DW	9.7	3.05	Granite	0.5	11.7	3	Sh. Bahadur Singh	Well is situated in front of owner house on the RHS of road going to Nala from Amlachatar
10	Narayanpur	Mohanpur	86.66	24.02	DW	10.7	3.67	Granite	0.7	12.2	1.2	Govt.Well	Well is situated on LHS of the Jamtara -Narayanpur road, just 6km before reach to Narayanpur beside hemlal murmu house
11	Narayanpur	Bhaiyadih	86.62	24.023	DW	4.6	2.12	Granite	0.57	6.4	3.2	Sh. Gridhari Mahto	Well situated 400 m before Bhaiyadih vilage on RHS of the road near Ranjit Mandal house and 3km far from Narayanpur town on southern side
12	Narayanpur	Kurtha	86.62	23.995	DW	7.35	3.34	Granite	0.8	9.4	1.3	Sh. Surendra Kisko	Well situated beside owner house in Kurtha village 200 mtr far from panchayat bhawan
13	Narayanpur	Nurgi	86.62	23.957	DW	9.05	4.34	Granite	0.4	9.6	1.2	Govt.Well	Govt well situated at Nurgi village in front of Aseen Ansari house.
14	Narayanpur	Karamdaha	86.57	23.988	DW	7.05	3.21	Granite	0.6	8.3	2.08	Govt.Well	In front of Shiv temple in Karamdaha village
15	Narayanpur	Chainpur	86.53	24.04	DW	6.13	2.14	Granite	0.67	7.1	4.2	Sh.S.C. Dutta	In the premises of owner house in chainpur village northern side of road
16	Narayanpur	Borotanr	86.6	24.081	DW	10.21	4.76	Granite	0.5	12.3	2.3	Sh. Lal Marandi	Well situated on Lahar-Tilabani road just 2km before tilabani.

Sl No	Block	Village	Long	Lat	Source	Pre 2018	post 2018	Geology	MP (magl)	Depth (mbgl)	Diameter (m.)	Owner	Location
17	Narayanpur	Pathrodih	86.66	24.059	DW	8.97	3.5	Granite	0.42	10.61	4.9	Sh. Lorik Roy	Well situated on RHS of the road while entering the village Pathrodih 50 mtr far from hospital, in tha agri field of owner premises
18	Vidyasagar	Karamatanr	86.7	24.084	DW	8.63	5.34	Granite	0.5	10	2.1	Govt.Well	Well is situated 300 mtr before Karmatar Majid and 500 mtr far from hospital
19	Vidyasagar	Sugapahari	86.72	24.056	DW	9.4	4.21	Granite	0.6	10.6	1.8	Sh. Anwar Ansari	In between Karmatar and Jamtara road RHS of the road 1 km far from pindori pathak railway crossing.

Annexure – III

CHEMICAL ANALYSIS RESULT OF WATER SAMPLES COLLECTED TROUGH KEY WELLS UNDER NAQUIM STUDY IN JAMTARA DISTRICT, JHARKHAND

District	Block	Village	pH	EC	TH	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	CO_3^{2-}	HCO_3^{-}	Cl^{-}	SO_4^{2-}	NO_3^{-}	F^{-}	TDS	$PO43^{-}$	S S P%	SAR	RSC	%Na
jamtara	Narayanpur	Kurtha	7.99	221	75	20	6.07	14.20	1.64	ND	116.85	6.1	6	9.6	0.48	144	BDL	29.16	0.71	0.42	30.54
jamtara	Narayanpur	Pathrodih	8.02	292	95	24	8.50	17.87	1.26	ND	92.25	28	17	12.0	0.16	190	BDL	29.03	0.80	-0.09	29.87
jamtara	nala	lakra kunda	8.21	259	100	24	9.72	17.75	1.81	ND	104.55	6.9	20	14.3	0.14	168	BDL	27.84	0.77	-0.29	29.03
jamtara	kundhit	babupur	8.01	203	85	16	10.94	7.15	3.57	ND	67.65	21	10	2.6	0.08	132	0.07	15.46	0.34	-0.59	19.13
jamtara	fathepur	baghmara	7.99	402	165	48	10.94	21.40	3.08	ND	159.90	28	25	15.7	0.19	261	BDL	21.99	0.72	-0.68	23.42
jamtara	Narayanpur	Karamdaha	7.93	303	170	28	12.15	12.62	2.19	ND	172.20	6.7	12	1.4	0.77	197	BDL	18.61	0.50	0.42	20.13
jamtara	Narayanpur	Bhaiyadih	7.96	493	150	40	12.15	34.65	1.17	ND	123.00	42	25	***47.5***	***BDL***	320	BDL	33.43	1.23	-0.98	33.87
jamtara	Narayanpur	Chainpur	7.90	745	208	32	13.36	70.42	36.90	ND	147.60	96	33	***87.0***	0.79	484	BDL	53.14	2.64	-0.28	59.74
jamtara	nala	saharpur	7.91	1158	285	86	17.01	90.98	76.14	ND	246.00	153	68	***48.0***	0.23	753	BDL	40.97	2.34	-1.67	50.88
jamtara	Narayanpur	Borotanr	7.80	605	175	40	18.22	55.23	7.09	ND	313.65	29	29	6.6	0.24	393	BDL	40.70	1.82	1.64	42.46
jamtara	nala	dumariya	7.93	385	185	44	18.23	11.31	1.57	ND	217.71	3.7	23	3.0	0.25	250	BDL	11.73	0.36	-0.13	12.57
jamtara	fathepur	pathrabad	8.00	395	160	30	20.66	24.31	2.10	ND	129.15	37	30	14.7	0.61	257	BDL	24.83	0.84	-1.08	25.77
jamtara	Vidyasagar	Sugapahari	7.89	584	155	26	21.87	51.56	1.50	ND	49.20	113	31	***77.9***	0.30	380	BDL	41.97	1.80	-2.29	42.38
jamtara	Vidyasagar	Karamatanr	7.74	1330	380	116	21.87	105.40	4.35	ND	159.90	247	62	***144.1***	0.04	865	BDL	37.62	2.35	-4.88	38.18
jamtara	Narayanpur	Nurgi	7.78	683	245	40	23.08	59.19	0.71	ND	92.25	87	36	***93.0***	0.75	444	0.11	39.76	1.84	-2.39	39.93
jamtara	fathepur	agariya	8.06	445	190	36	24.30	24.86	2.15	ND	184.50	21	34	16.2	0.07	289	BDL	22.15	0.78	-0.78	23.01
jamtara	nala	sangajodi	8.10	535	205	40	25.52	30.69	3.31	ND	202.95	52	28	3.0	0.22	348	BDL	24.56	0.93	-0.77	25.71
jamtara	jamtara	amlachatar	7.89	570	250	48	31.59	20.25	2.63	ND	301.35	31	22	1.5	0.40	371	BDL	14.97	0.56	-0.06	15.94
jamtara	Narayanpur	Mohanpur	7.91	987	350	86	32.81	46.23	1.62	ND	190.65	103	38	***133.0***	0.38	642	BDL	22.31	1.07	-3.87	22.67

Annexure-IV

DYNAMIC GROUND WATER RESOURCES (2017) JAMTARA DISTRICT, JHARKHAND

Sl. No.	District	Administrative Units	Ground water Assessment Sub- Unit	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
				(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(ham)	(%)
1	Jamtara	Fatepur	Non-Command	1635.47	396.38	149.39	0.00	545.76	149.39	1089.71	33.37
2	Jamtara	Jamtara	Non-Command	1793.70	195.75	220.97	0.00	416.72	220.97	1376.98	23.23
3	Jamtara	Kundahit	Non-Command	813.59	272.25	141.49	0.00	413.74	141.50	399.84	50.85
4	Jamtara	Nala	Non-Command	2885.81	288.00	224.60	0.00	512.60	224.60	2373.21	17.76
5	Jamtara	Narayanpur	Non-Command	2329.04	671.25	273.24	0.00	944.49	273.24	1384.55	40.55
6	Jamtara	Vidyasagar	Non-Command	1159.26	236.63	215.31	4.09	456.03	215.31	703.23	39.34
	District Total			**10616.86**	**2060.25**	**1224.98**	**4.09**	**3289.33**	**1225.01**	**7327.51**	**30.98**

Annexure-V

INTERPRETED RESULT OF VES IN JAMTARA DISTRICT JHARKHAND

S.No.	*Block*	*Village*	*Locaton*	*VES No.*	*Resistivity values for individual layers*					*Thickness of the individual layer in mtr*				*Depth of Bed Rock*	*Expected potential weathered zones in m b.g.l*	*Expected fracture zones in m b.g.l*
					P1	*P2*	*P3*	*P4*	*P5*	*H1*	*H2*	*H3*	*H4*			
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*
1	Kundhit	Kundhit	Inside of the block compound	45	270	80	V.H	-	-	4.0	32.0	-	-	4.0	15-30	-
2	Kundhit	Kundhit	Inside of the block compound	46	270	80	V.H	-	-	4.0	32.0	-	-	4.0	15-30	-
3	Kundhit	Kundhit	Inside of the block compound	47	270	80	V.H	-	-	4.0	32.0	-	-	4.0	15-30	-
4	Kundhit	Kharabani	Middle of the village	48	310	124	V.H.	-	-	1.5	4.5	-	-	6.0	6-0	-
5	Fathepur	Fathepur	Near Dug Well	49	112	56	550	-	-	1.2	10.2	-	-	11.4	11.4	-
6	Fathepur	Fathepur	Near hand pump	50	58	87	280	V.H	-	2.2	10.3	41.8	-	12.5	5-12.5	15-55
7	Fathepur	Fathepur	Near hand pump	51	54	81	525	V.H.	-	2.4	9.0	73.4	-	11.4	11.4	-
8	Kundhit	Baramasiya	South side of village	59	39	95	375	-	-	4	8.0	-	-	12.0	4-12.0	40-100
9	Kundhit	Baramasiya	South side of village	60	170	51	290	-	-	5	10.5	-	-	12.0	5-12.0	-
10	Kundhit	Baramasiya	South side of village	67	170	136	280	-	-	3.0	7.2	-	-	10.2	5-10	-
11	Nala	Nala	Near Adivasi hostel	76	175	105	840	-	-	2.3	11.5	-	-	13.8	6-13.8	-
12	Nala	Nala	Back side of Veternary	78	76	100	V.H	-	-	4.2	13.0	-	-	17.0	4-17.0	-

			hospital													
13	Nala	Nala	Back side of Veternary hospital	79	95	100	V.H	-	-	5.0	14.5	-	-	19.5	4-19.5	-
14	Nala	Nala	Back side of Adivasi hostel	80	290	116	V.H.	-	-	4.0	11.6	-	-	15.6	5.0-15.0	-
15	Nala	Nala	Near forest office	86	64	640	-	-	-	7.5	-	-	-	7.5	7.5	-
16	Jamtara	Jamtara	Near shiv temple	98	7.5	37.5	350	-	-	1.4	28.0	-	-	29.4	10-30	40-50

Annexure-VI

LITHOLOG OF SOME OF THE EXPLORATORY WELLS CONSTRUCTED BY CGWB IN JAMTARA DISTRICT, JHARKHAND

LITHOLOG-1

Chainpur	EW
Village	Middle school chainpur
Block	Narayanpur
District	Jamtara
Latitude	24.0384
Longitude	86.524
Drilled Depth (mbgl)	156.60
Casing depth (m bgl)	24.5
SWL(m bgl)	11.2
Discharge (lps)	3
Date / Year	26.10.2018

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	13.2	13.2	Surface soil – lateritic, yellowish and brown in colour
13.2	24.5	11.3	weathered granite
24.5	31.5	7	Granite gneiss – compact hard, grey in coloured
31.5	32.5	1	Granite gneiss – slightly fractured associated with quartz vein
32.5	77.2	44.7	Granite gneiss – grey associated with quartz veins feldspar pink
77.2	78.2	1	Fractured granite
78.2	138.2	60	Granite gneiss, grey, hard compact
138.2	139.2	1	fractured granite
139.2	153.6	14.4	Granite gneiss, pink, hard compact

LITHOLOG-2

Bhanderbera	EW
Village	Middle school
Block	Nala
District	Jamtara
Latitude	23.9810
Longitude	87.067
Drilled Depth (mbgl)	123.32
Casing depth (m bgl)	21.5
SWL(m bgl)	12.89
Discharge (lps)	12
Date / Year	21.11.2018

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	21.5	21.5	Surface soil – lateritic, yellowish and brown in colour
21.5	48	26.5	Granite gneiss – compact hard, grey in coloured
48	49	1	fractured granite
49	59	10	Granite gneiss, grey, hard compact pink in colour with feldspar
59	60	1	fractured granite
60	69	9	Granite gneiss – compact hard, grey in coloured
69	70	1	fractured granite
70	123.32	53.32	Granite gneiss, pink, hard compact

LITHOLOG-3

Palajori Basti	EW
Village	U.H. school
Block	Fathepur
District	Jamtara
Latitude	24.1090
Longitude	86.997
Drilled Depth (mbgl)	153.80
Casing depth (m bgl)	24.5
SWL(m bgl)	6.10
Discharge (lps)	5.7
Date / Year	14.12.2018

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	12.8	12.8	Surface soil – lateritic, yellowish and brown in colour
12.8	47.12	34.32	Granite gneiss – compact hard, grey in coloured
47.12	48.12	1	fractured granite
48.12	108	59.88	Granite gneiss, grey, hard compact brown in colour
108	109	1	fractured granite
109	123	14	Granite gneiss – compact hard, grey in coloured
123	124	1	fractured granite
124	127	3	Granite gneiss, grey, hard compact
127	128	1	fractured granite
128	153.8	25.8	Granite gneiss – compact hard, grey in coloured

LITHOLOG-4

Karmatar	EW
Village	Kurwa gopalpur high school
Block	Vidyasagar
District	Jamtara
Latitude	24.0813
Longitude	86.696
Drilled Depth (mbgl)	153.80
Casing depth (m bgl)	22.25
SWL(m bgl)	15.10
Discharge (lps)	2.5
Date / Year	29.12.2018

Depth range (m bgl)		**Thickness (m)**	**Litholog**
From	**To**		
0	22.25	22.25	Surface soil – lateritic, yellowish and brown in colour
22.25	75	52.75	Granite gneiss – compact hard, grey in coloured
75	76	1	fractured granite
76	99	23	Granite gneiss, grey, hard compact brown in colour
99	100	1	fractured granite
100	136	36	Granite gneiss – compact hard, grey in coloured
136	137	1	fractured granite
137	153.8	16.8	Granite gneiss, grey, hard compact

Annexure-VII

Chemical analysis results of Ground water Samples for Uranium in Jamtara district

sample no	*Block*	*Well Name*	*Type of Well*	*Lat*	*Long*	**Uranium (ppb)**
1	Jamtara	Jamtara	HP	23.958	86.799	7.08
2	Nala	Nala	HP	24.046	87.153	6.37
3	Mihijam	Mihijam	HP	23.874	86.879	2.00
4	Kundahit	Kundahit	HP	23.917	87.167	0.98
5	Fatehpur	Dhootala	HP	23.919	87.168	0.65
6	Narayanpur	Narayanpur	HP	24.044	86.618	0.63
7	Karmatarn	Jasaydih	DW	24.062	86.701	0.84
8	Fatehpur	Basti Palajori	DW	24.054	87.168	0.37
9	Narayanpur	Mohanpur	DW	24.019	86.663	0.43
10	Fatehpur	Fatehpur	DW	24.096	86.996	0.23