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जल शक्ति मंत्रालय
भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development & Ganga Rejuvenation Ministry of Jal Shakti
Government of India

Report on

NATIONAL AQUIFER MAPPING AND MANAGEMENT PLAN

Jhargram District West Bengal

पूर्वी क्षेत्र, कोलकाता
Eastern Region, Kolkata

Technical Report: For Official use

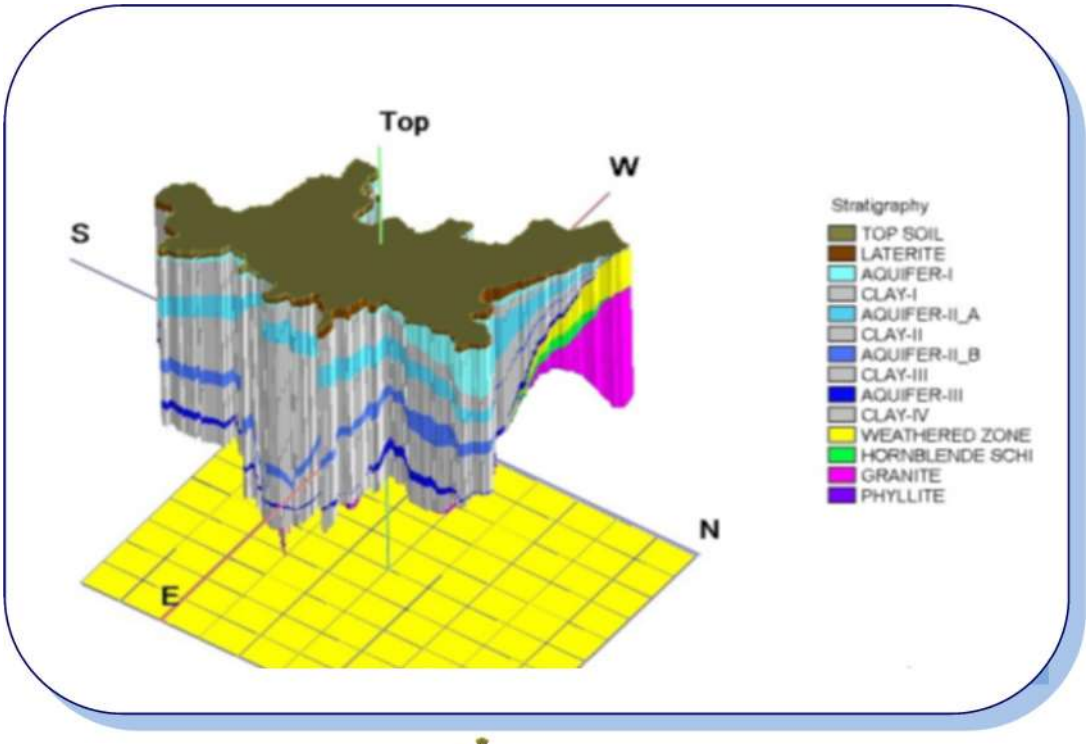
Government of India
MINISTRY OF JAL SHAKTI
Department of Water Resources, River Development & Ganga Rejuvenation

Report
On

NATIONAL AQUIFER MAPPING & MANAGEMENT PLAN

In

Parts of Jhargram District, West Bengal



Central Ground Water Board
Eastern Region, Kolkata
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CONTRIBUTORS

Data Acquisition	**:**	Sh**.** Bibhuti Bhushan Sahoo Sc B (Hg)
	:	Awadhesh Kumar STA (Hg)
Data Processing	**:**	Awadhesh Kumar STA (Hg)
	:	Sh. Rajesh Kumar Sahoo AHG
Data Compilation & Editing	**:**	Awadhesh Kumar STA (Hg)
Data Interpretation	**:**	Awadhesh Kumar STA (Hg)
GIS & Thematic Map Preparation	**:**	Sh. Anirvan Chowdhury, Sc D
	:	Sh. Rajesh Kumar Sahoo AHG
	:	Mahasweta Mukherjee YP
	:	Rajyashree Nandi YP
Report Compilation	**:**	Sh. Awadhesh Kumar STA (Hg)
	:	Sh. Rajesh Kumar Sahoo AHG
Chemical Analysis	**:**	Sh. P. Antapally, ACH
Geophysical Study	:	Dr. A. K Sinha, Sc D
	:	Sh. S. Sarkar, Sc D
Report Scrutiny	**:**	Dr. Indranil Roy Sc D
Technical Guidance	**:**	Dr. Indranil Roy Sc D
Overall Supervision	**:**	**Dr. Anadi Gayen, Regional Director**

FOREWORD

To understand the nature and occurrences of groundwater, aquifer geometry, aquifer disposition & characteristics, and management of groundwater resource, National Aquifer Mapping & Management Programme (NAQUIM) has been taken up by CGWB under XIIth Plan. During the Annual Action Plan 2022-2023, Aquifer Mapping studies & Management plan was taken up in Bankura District, West Bengal.

The study under the aegis of NAQUIM includes four major components namely; Data generation, Data collection & compilation and preparation of Aquifer maps and Aquifer Management Plan.

This report is presented in three parts, where Part-I embodies general report of the study area, Part-II includes Block wise Management Plans and Part-III comprises Data Gap Analysis done for the district. Relevant data in respect of the said subjects have been collected from different departments and their publications, , viz. Public Health Engineering Dept., State Water Investigation Dept., Agri.-Irrigation Dept., Bureau of economics & Statistics, Land & Land Reforms Dept., Data of Indian Meteorological Dept., National Bureau of Soil Survey & Land Use Planning, etc. of Govt. of India have also been used. Hydro-geological data is sourced from the scientific studies of CGWB pertaining to groundwater explorations, hydrogeological surveys, chemical analysis and outsourcing explorations being taken up for data generation.

Compilation of this report, evaluation of data and preparation of relevant maps, 2D cross-sections & 3D models of aquifers and their reproduction in the form of present report is the outcome of effort given by Sh. Awadhesh Kumar, Senior Technical Assistant (Hydrogeology) and Sh. Rajesh Kumar Sahoo, AHG, under the supervision of Mrs Sandhya Yadav, Scientist-'E' & Dr Indranil Roy Scientist-'D' (OIC NAQUIM). The section pertaining to Hydrochemistry has been contributed by Shri P. Antapally, Assistant Chemist, Sh. Rinkumoni Barman, STA (Chemist), his effort is thankfully acknowledged.

Effective method of dissemination of the existing technical information to different user agencies is an important aspect of NAQUIM, which plays a very vital role in the safe and optimal development of groundwater resources in our country. In this regard, Central Ground Water Board has taken up great initiative in incorporating NAQUIM project since 2012 to fulfill this directive. It is much anticipated that, this report will become an important tool not only for various user agencies, Engineers, Scientists, Administrators, Planners and others involved in groundwater planning, development and management but also to the common public to make them aware of local groundwater issues and its sustainable management.

(Dr Anadi Gayen)
Regional Director

EXECUTIVE SUMMARY

The total geographical area encompassed under the project is 3037.5 sq. km. The Mappable area for the same is about 1824 sq. km. The study area comprises of 06 blocks and 02 blocks previously done in AAP-2018-2019. The study area can be located in Survey of India Toposheet No.- 73J/9, 73J/10, 73J/12, 73J/14, 73J/15, 73J/16, 73N/2, 73N /3, 73N/4 AND 73O/1.

The district head quarter of Jhargram District is at Jhargram, with single Municipality is at Jhargram. The total population of the study area is **1136548** (Male: **574747** & Female: **561801**) as per 2011 Census with rural population accounting for almost 96.52% and the rest 3.48 % as urban population. The study area experiences moderate climatic condition with cold dry winter, hot humid summer and prolonged rainy season. The weather is extremely humid and tropical. Temperatures can reach as high as 46 ° C in the hot and dry months of May and June but can plummet to 4° C in the chilly nights of December and January. The average annual rainfall of Jhargram (Jhargram Forest Division) is about 1400 mm. The rainy season spreads over June to September due to southwest monsoon and the highest rainfall occurs in July and August. The rainfall starts decreasing from October and dry winter sets in. The dry season lasts until May. However, during this time this division gets some sporadic showers. The study is classified into seven units such as Badlands, flood plains; Para deltaic fan surface, pediments and Pedi plains, ridges and hills and upland plains. Upland plain is spread out all over the area and more than 60 % area of Jhargram, 80 % area of Jamboni with good ground water potentiality. Badlands topography is found in Binpur-I, where the ground water potentiality is low. Flood plains areas exhibit an excellent ground water potentiality which found along three main channels in the Kangsabati Command area. The area covered by low ridges and hills Binpur-II with low ground water potentiality. The major soils types of this area are Lateritic soil the top most surface soil, Red soil and alluvial soil comprising older alluvium.

The Principal crops grown in the district are Bhadoi / Kharif followed by winter crop and Rabi crop which is followed by summer crop. The standard crop cycles in major part of NAQUIM area is Aus Paddy / Aman Paddy / Maskalai (Black Gram) / Kharif Vegetables (Rainy Season)–Mung / Masur / Mustard/ Potato / Rabi Vegetables (Winter Season) Boro Paddy/Ground Nut/Summer Vegetables/Til (Summer Season); whereas for some localized areas situated in sporadic manner, a single crop like Betel-vine /flower plants/Sugarcane are grown which occupies agricultural field for

the whole year. The district has vast irrigation potential, which is yet to be fully utilized. The crops grown are mainly rain-fed. The Kharif, Rabi and Boro paddy and vegetables are grown mostly by ground water through DTW and STW. There are a total of 61224 tanks, 4632 RLI, 157, HDTW, 17, MDTW 219, LDTW 66, ODW4564, and 1041 others as sources for irrigation in the district. There is a number of Micro and large-scale industrial infrastructure developed in Jhargram, Sankrail, and industrial belt is the centre for small and medium scale industrial development. Gopiballavpur Chandan super Cement industries, Jhargram Paper Mill ltd, Jhargram, UAL Bengal (Utkal Asbestors) Industries Ltd, Aryavatra Steel pvt Ltd, Jhargram is growing fast with numbers of sponge Iron Company, alloy industry, plastic industry has come up in the study area.

The most area of the Jhargram district characterized by the various litho units of different geological age A. hard crystalline rocks occur around Binpur-II in the extreme north western part of the district, where ground water occurs under water table condition in weathered residuum of the hard rocks and the interconnected fracture, fissures, joints etc. The thickness of the weathered zone varies from a very thin veneer to as much as 15-20 m., B. The upland region in the north western, northern, and south western part of the district is characterized by the occurrence of laterite and lateritic soils at the top underlain by a thick sequence of clay, silt, sand, and gravel down to the depth of 250 mbgl. In the shallow phreatic aquifers, ground water occurs under water table condition in this upland tract whose pre-monsoon depth to water level ranges from 2.25 mbgl to 12.5 mbgl during pre-monsoon period. C. The block areas of Nayagram, Sankrail, Gopiballavpur-I and Gopiballavpur-II are mainly covered by recent alluvium deposits. Very significant and promising water bearing formations occur in Jamboni and Gopiballavpur-I & II Block within the depth range of 120-180 m. Ground water here occurs both in water table and confined conditions. The yield potential and aquifer characteristics are different in different hydrogeological units in Jhargram district is as follows;

a) In hard rock area (in Binpur II block) fractures encountering in the depth zones 20 to 85 mbgl yields 5 to 7 lps of water. Transmissivity (T) & Storage co-efficient (S) values determined as 40 m^2/day & 5.83 x 10^{-3} respectively.

b) In the alluvium areas around Thakurpara (Binpur-II Block), Manikpara (Jhargram Block), Tube wells constructed within depth of 70 to 250 mbgl yielding 7 to 10 lps. Transmissivity and storage co-efficient values determined as 43m^2/day and 9.6 x 10-5 respectively.

c) In younger alluvium formation yield of well varies from 30 to 50 lps with T & S as 3847 m^2/days and 3.87 x 10^{-3} respectively.

d)In Tertiary sedimentary formation (within the depth of 22 to 80 mbgl) yield of the wells varies from 20 to 44 lps with T determined as 2370 m^2/day.

In the present study area, CGWB, ER has conducted surface geophysical survey. However, a total of 18 TEM (Transient Electromagnetic Exploration) and 10 VES (Vertical Electrical Sounding) done in study area. Based on interpretation of TEM data carried out in Gopiballavpur –I & II block of Jhargram district reveals that northern part of the block close to Kangsabati River occupied the hard formation and eastern part of the block is occupied by the semi consolidated formation. The western and southern part of the block is covered by Alluvium which is close to the Subarnarekha River. The ground water occurrence confined to the sand formation in alluvium and fractured rock.

As per the computation, the net ground water availability for recharge for Jhargram district is estimated at 64992 Ham, while the total extraction for all uses is estimated at 23432Ham. The stage of ground water development in the district stands at 26.82%, deemed as 'Safe'. At present, all the 08 blocks in the study area are 'Safe' category.

From the chemical analysis of the samples collected from the study revealed that the ground water quality in the area is suitable for drinking purposes with a few locations having, higher concentration of Fluoride (F) exceeding the permissible limit of 1.5 mg/L was found in few pockets and maximum Iron (Fe) concentration. In respect of suitability assessment for Irrigation water, the ground water of majority of the study area was in suitable category. Facies classification of the area indicates that maximum groundwater samples belong to Ca-Mg-HCO3and Ca-Mg-Cl type (as high as 32% locations), which indicates, water type with temporary hardness.

At present, all the 08 blocks in the study area are under 'Safe' category and there is large scope for ground water development in agricultural, domestic and industrial sectors through different structures considering optimum command area of the abstraction structures. However, effective water management technique is proposed for planning and management of resources in the district. Conservation through rainwater harvesting structures is suggested for all the blocks in view of better ground water sustainability in the study area. Recharge structures like Percolation tank, REET with RS and Injection Wells have been proposed in the recharge priority areas

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PART-I

NAQUIM REPORT IN PARTS OF JHARGRAM DISTRICT, WEST BENGAL, INDIA

CHAPTER-1

1. INTRODUCTION

In XII five-year Plan, National Aquifer Mapping (NAQUIM) had been taken up by CGWB to carry out detailed hydrogeological investigation on Toposheet scale of 1:50,000. The NAQUIM has been prioritised to study Over-exploited, Critical and Semi-Critical Talukas as well as the other stress areas recommended by the State Govt. 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 vagaries of rainfall, inherent heterogeneity & unsustainable nature of hard rock aquifers, over exploitation of once copious alluvial aquifers, lack of regulation mechanism 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. 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. The aquifer maps and management plans in parts of Jhargram district will be shared with the administration of West Bengal, India for its effective implementation.

1.1 Objective and Issues

The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain and characterize them, so as to work out the development potential and prepare block wise aquifer maps and finally to formulate aquifer-wise and block wise ground water management plan with respect to issues concerned i.e. (i) Water scarcity in the District, (ii) Quantity and Quality of groundwater resources, (iii) Salinity as well as Iron & Fluoride contaminations within the available limited aquifers, (vi) Rejuvenation of the major source of groundwater.

1.2 Scope of Study

The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) being implemented by CGWB. There are four major activities components viz. (i) data collection / compilation (ii) Data gap analysis (iii) Data generation (iv)Preparation of aquifer maps and management plan to achieve the primary objective. Data compilation included collection, and wherever required procurement, of all maps from concern agencies, such as the Survey of India, Geological Survey of India, State Governments etc. computerization and analysis of all acquired data, and preparation of a knowledge based. Identification of Data Gap included ascertaining requirement of further data generation in respect of Hydrogeological, Geophysical, Chemical, Hydrological, Hydro-meteorological studies, etc. Data generation includes those of hydrometeorology, chemical quality of groundwater, litho-logs and aquifer parameters. Generation of groundwater chemical quality data was accomplished by collection of water samples and their laboratory analyses for all major parameters, and some of the heavy metals. Additional data pertaining to sub-surface lithology and aquifer parameters were obtained through drilling of additional exploratory wells and slim holes, pumping tests at drilling sites. As per the revised annual action plan groundwater management studies in parts of Jhargram districts covering an area of 1824 square kilometre was taken up by CGWB, ER, Kolkata. In this report the salient features of aquifer geometry, characteristics, ground water occurrences, availability, and resource vis-a-vis quality, development & management, scope of ground water have been covered.

1.3 Approach and methodology

A stepwise approach and methodology adopted to achieve the major objective have been shown below.

i) Compilation of existing data.

ii) Identification of data gap.

iii) Data generation based on data gap.

iv) Preparation of thematic maps on GIS platform.

v) Preparation of 2D/3D aquifer disposition maps.

vi) Compilation of Aquifer data collection from different sources and preparation of block-wise Aquifer Maps and Aquifer / Ground Water Management Plan

1.4 Location, Extent and Accessibility of the NAQUIM area.

Jhargram; district possesses a geographical area of 3037.55 sq. Kms., the NAQUIM area of 1824 sq. km including 1 sub-division (Jhargram), 08 Blocks i.e., Jhargram, Jamboni, Binpur-I, Binpur-II, Gopiballavpur-I, Gopiballavpur-II, Sankrail and Nayagram and 79 Grampanchayat, 2995 villages (District Statistical handbook, West Bengal).

Jhargram district of West Bengal is bounded between North latitudes 22˚47'58.48" and 21˚51'54.92" & East longitudes of 86˚33'29.12" & 87˚15'29.50" in Survey of India Toposheet nos. 73J/9, 73J/10, 73J/12, 73J/14, 73J/15, 73J/16, 73N/2, 73N /3, 73N/4 AND 73O/1. These portions of NAQUIM area have been considered for Data gap Analysis and NAQUIM studies. The study area forms part of lower deltaic region of Bengal Basin and the Marginal areas between the platform area of Chhotonagpur plateau and the alluvium plain. The whole NAQUIM area is well connected with the State Capital Kolkata by road and rail. The network of major roads and railway line are shown in **(Figure-1.1)**

1.5 Administrative Divisions

This NAQUIM area of 1824 sq. km. covering 06 administrative blocks is situated in Jhargram district. Details of administrative divisions in the NAQUIM area are given in Table- 1.1.

Table 1.1: Details of Administrative Divisions in NAQUIM Area

Block (Municipality)	Co-ordinate bound	Geographic Area (Sq. Km)	Sub Division	No. of Gram Panchayat / Ward	Gram Sansad	Inhabited Villages	No. of Mouza	Households	Literacy Rate (%)
Binpur-I	22^0 28'31.368", 22^0 3'52.752" N $86^0$53'34.08", $87^0$07'32.304" E	357.6	Jhargram	10	115	427	553	33936	69.74%
Binpur-II	22^0 31'51.096"' 22^0 47'55.968" N $86^0$33'37.692", 86058'19.704" E	583.5	Jhargram	10	128	401	470	38681	70.46%
Jamboni	22^0 18'0.468"' 220 34'15.132" N $86^0$45'0.972", 86057'5.184" E	318.1	Jhargram	10	85	281	338	25773	72.63%
Jhargram & Jhargram (M)	22^0 15'30.96", $22^0$30'13.572" N $86^0$54'18.108", $87^0$15'38.34" E	532.2	Jhargram	13	129	489	604	37864	72.33%
Sankrail	22^0 5'30.984"' 22^0 20'4.128" N $87^0$0'57.204", $87^0$13'53.076" E	276.8	Jhargram	10	87	247	287	25795	73.35%
Nayagram	21^0 51'52.092"' 220 11'06.18" N $86^0$57'0.672", 87014'9.564" E	501.4	Jhargram	12	104	294	336	32074	63.70%
Gopiballavpur-I	22^0 5'09.924", 220 14'08.736" N $86^0$43'4.368", 86059'11.724" E	275.8	Jhargram	7	80	199	216	22943	65.44%
Gopiballavpur-II	22^0 10'29.028", 220 8'41.436" N $86^0$47'43'152", 87003'17.028" E	192.2	Jhargram	7	78	175	192	23226	71.40%
Total		**3037.55**	**Jhargram**	**79**	**806**	**2513**	**2996**	**240292**	**70.92 %**

Source: DCHB, West Bengal 2011

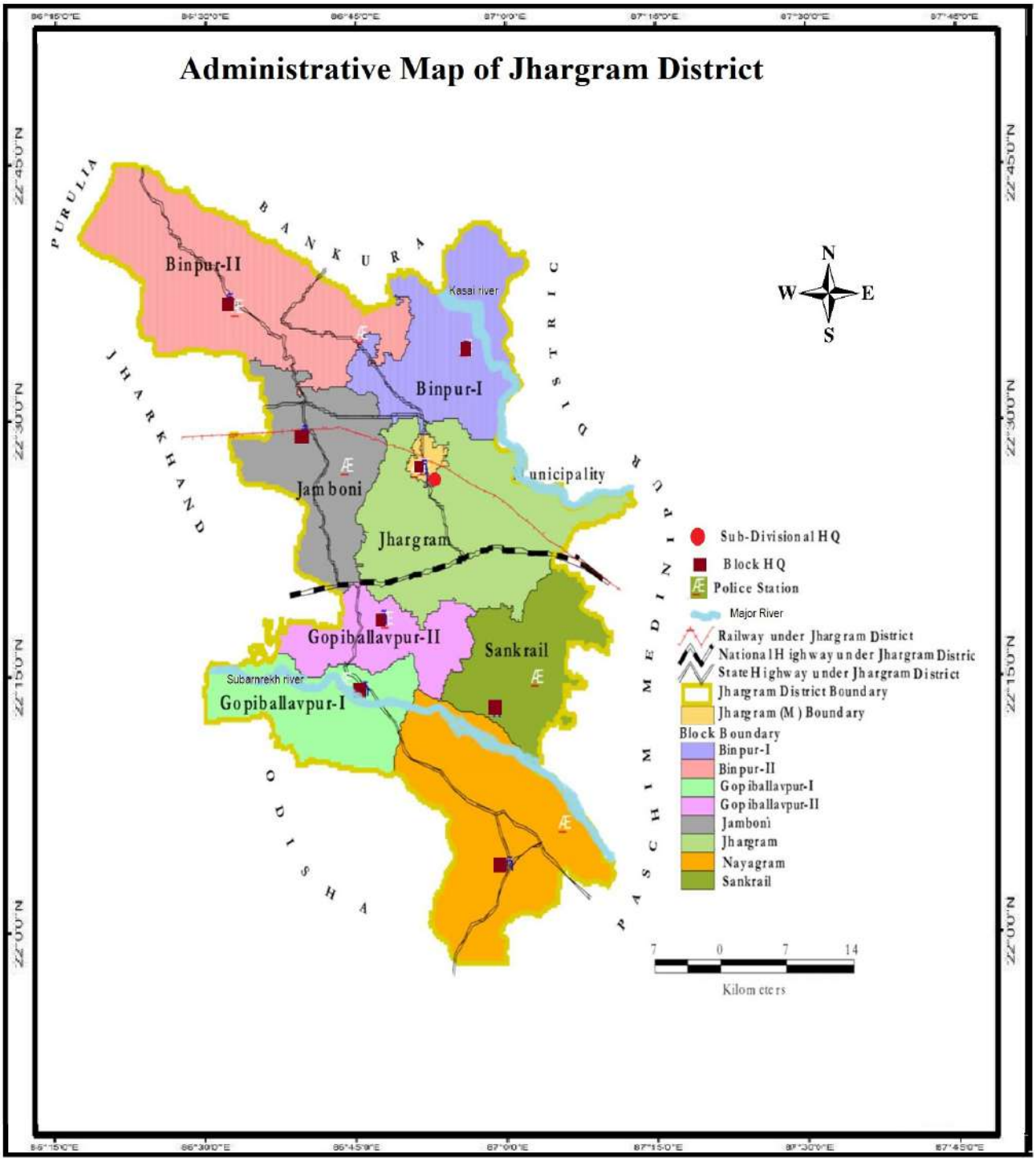


Figure-1.1: Location and Administrative Map of Jhargram districts, West Bengal.

1.6 Demographic Details

Total population of the NAQUIM area as per the 2001 Census was **954879** and as per 2011 census it is **1136548** (Male: **574747** & Female: **561801**). As per the latest Census 2011, in NAQUIM area rural population is **1136548** which constitutes more than 96.52% of the total population and urban population and 3.48% was urban population. 20.11% of the total population belonged to schedule casts and 29.37 % belonged to schedule tribes of the total population (Table - 1.2 & 1.3). The density of population in rural area i.e. excluding the municipalities is 370 persons/sq. km. The Highest population density of 530 persons/sq. km. is recorded in Gopiballavpur – II block and lowest density of 280 persons/sq. km. is recorded in Nayagram block. The percentage of decadal variation for the last decade i.e. 2001-2011 is 12.13%. Sex ratio as per the Census 2011 is 959/1000.

Table 1.2: Decadal Change in Population in the Administrative Blocks under NAQUIM

Block	2001			2011			Decadal Variation (%)			Urban Pop. (%)	
	Total	Rural	Urban	Total	Rural	Urban	Total	Rural	Urban	2001	2011
Binpur-I	139148	139148		156153	156153		12.2	12.22	--	--	--
Binpur-II	145971	140723	5248	164522	158798	5724	12.7	12.83	9.07	3.59	3.48
Jamboni	101718	101718		113197	113197		11.3	11.28		--	--
Jhargram & Jhargram(M)	153331	153331	53145	231809	170097	61712	10.9	10.92	16.12	34.66	26.62
Sankrail	102634	102634		115418	115418		12.5	12.45	--	--	--
Nayagram	123937	123937		142199	142199		14.7	14.73	--	--	---
Gopiballavpur- I	94834	94834		108254	108254		14.2	14.15	--	--	--
Gopiballavpur-II	93306	93306		104996	104996		12.5	12.53	--	--	--
Total	**954879**	**954879**	**58393**	**1136548**	**1069112**	**67436**	**12.1**	**12.13**	**15.48**	**6.12**	**5.93**

Source: DCHB, West Bengal 2011

Table 1.3: Distribution of Population in the NAQUIM area (as per Census 2011)

Sub-Div. / C.D. Block / Municipality	Rural Population			Urban Population			Total Population					Population Density (/Sq Km)
	Male	Female	Total	Male	Female	Total	Male	Female	Total	SC	ST	
Jhargram Sub-Division												
Binpur-I	78929	77224	156153	--	--	--	78929	77224	156153	39064	43962	440
Binpur-II	79793	79005	158798	2861	2863	5724	82654	81868	164522	25947	65722	280
Jamboni	57607	55590	113197	--	--	--	57607	55590	113197	20484	32369	360
Jhargram/ Jhargram(M)	85970	84127	170079	30876	30836	61712	116846	114963	231809	31136	44702	330
Sankrail	58240	57178	115418	--	--	--	58240	57178	115418	21004	28825	370
Nayagram	71537	70662	142199	--	--	--	71537	70662	142199	28899	56887	280
Gopiballavpur- I	55475	52779	108254	--	--	--	55475	52779	108254	29423	36819	390
Gopiballavpur-II	53459	51537	104996	--	--	--	53459	51537	104996	32553	24562	530
Total	**541010**	**528102**	**1069094**	**33737**	**33699**	**67436**	**574747**	**561801**	**1136548**	**228510**	**333848**	**370**

Source: DCHB, West Bengal 2011

1.7: Land use and Land Cover, Agriculture and Cropping Pattern

Jhargram district covers an area of 3,037.55sq. km. out of which 268249 hectares is agricultural land and 59497 hectares is under forest coverage. Most of the land under Jhargram, Binpur-I, Binpur-II & Sankrail blocks are non-agricultural land and in the rest blocks i.e., Jamboni, Gopiballavpur-I, Gopiballavpur-II and Nayagram there are agricultural land. There is total 2995 villages exist out of total 3021 Mouza. Total 66583.81 acres of vested lands were distributed out of total 214595.08 acres of vested land among the landless for agricultural purpose. 24430.02 acres of lands were recorded among Bargadars. 183.26 acres of lands were distributed among landless under NGNB scheme for residential purpose. LULC pattern and map of district Jhargram have been shown in **Fig: 1.5** and Land use Statics is summarised in **table: 1.4**

Table 1.4: Land Use Statistics of Jhargram district (2018–2019)

Net Cropped Area	168448 ha
Area under non-agricultural use	38927 ha
Area under Forest	73647 ha
Area under current fallow (2016-17)	3377 ha
Cultivable waste land	21417 ha
Gross cropped area	229713 ha
Area cultivated more than once	70495 ha
Cropping intensity	136 %
Annual Action Plan, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 - 2019	

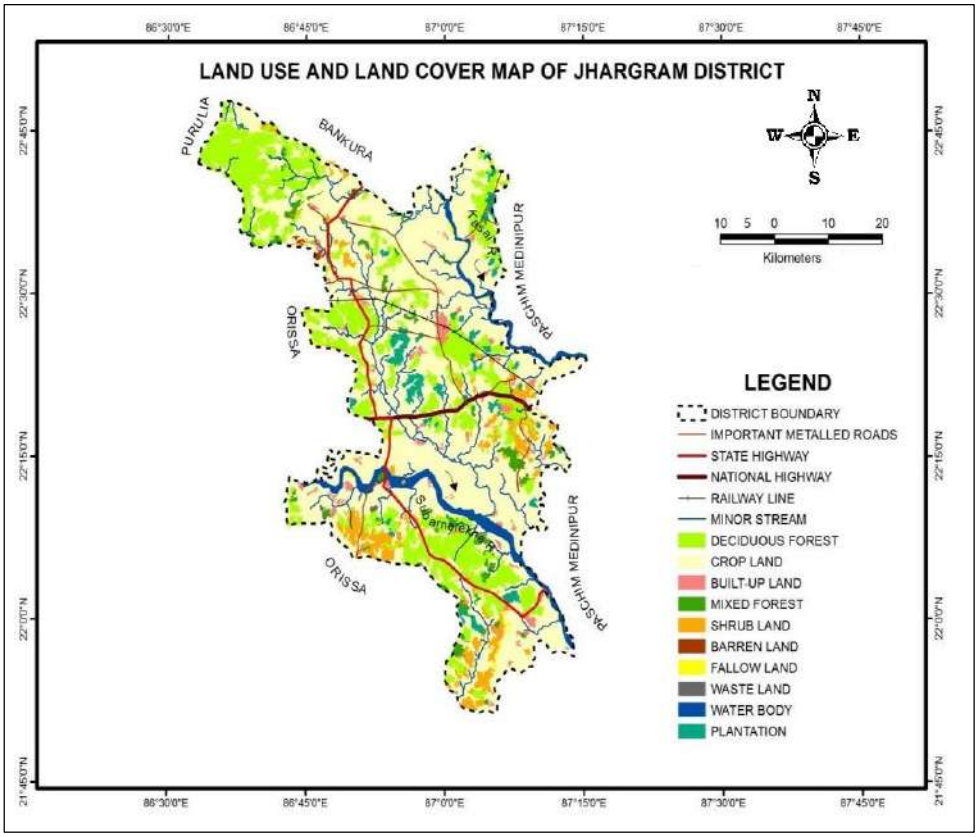


Figure1.2: Land use Land cover Map of NAQUIM Area in parts of Jhargram District.

1.8 Agriculture:

Land use in Jhargram from its origin is dominated by agricultural activities after forest cover. 268249 hectares is agricultural land. The same trend is observed in Jhargram the greatest share of its land belongs to agricultural practices currently. Jhargram is a developing district of West Bengal. So, its agriculture is under-developed. Aus., Aman & Boro paddy are the principal agricultural crops produced in the district. Apart from these many other different crops are grown in the district such as wheat, sugarcane, pulses, oil seeds as, mustard, groundnut, vegetables as potato, tomato, cabbage, cauliflower, brinjal, cucurbits, onions etc. Fruits such as watermelon mango, banana, guava etc., are also found to grown in the district (Annual Action Plant, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 - 2019) .Net cropped area of the district is about 168448 hectares and Gross cropped area is 227921 hectares (DDMP Jhargram, 2018).

1.9 Cropping Pattern

Main cropping pattern of the NAQUIM area is Bhadoi / Kharif followed by winter crop and Rabi crop which is followed by summer crop. The standard crop cycles in major part of NAQUIM area is Aus Paddy / Aman Paddy / Maskalai (Black Gram) / Kharif Vegetables (Rainy Season)–Mung / Masur / Mustard/ Potato / Rabi Vegetables (Winter Season) Boro Paddy/Ground Nut/Summer Vegetables/Til (Summer Season); whereas for some localized areas situated in sporadic manner, a single crop like Betel-vine /flower plants/Sugarcane are grown which occupies agricultural field for the whole year.

Table - 1.5: Block wise Area, Production & Yield data of major crops grown in NAQUIM Area (2013-14)

Name of Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Binpur-I	1959	4.536	2316	9944	17.577	1768	12040	37.964	3153	7	0.016	2216	1448	25.123	17.35	261	0.225	864	0	0	0	684	0.667	975	1564	0.892	571	2289	37.640	16444	0	0	0
Binpur-II	535	1.239	2316	2219	1.022	461	8335	25.927	3111	0	0	0	511	6.423	12.57	0	0	0	0	0	0	46	0.042	907	1132	1.110	981	1893	37.180	19641	0	0	0
Jamboni	0	0	0	2487	0.631	254	7019	19.273	2746	0	0	0	507	7.443	14.68	90	0.088	972	110	0.156	1416	620	0.677	1092	1271	1.164	916	280	5.195	18552	0	0	0
Jhargram	121	0.224	1854	5299	4.635	875	18987	65.627	3456	12	0.027	2216	0	0	0	10	0.011	1069	0	0	0	399	0.341	855	974	0.602	618	5235	135.76	25934	0	0	0
Sankrail	1372	2.738	1996	17403	36.526	2099	14225	44.560	3133	24	0.053	2216	983	14.027	14.27	1	0.001	1007	20	0.044	2213	61	0.044	723	317	0.251	791	2	0.038	18765	0	0	0
Nayagram	7259	16.306	2246	15912	30.519	1918	22354	86.159	3854	0	0	0	467	8.084	17.31	0	0	0	0	0	0	1799	1.857	1032	248	0.235	947	5	0.105	21050	0	0	0
Gopiballavpur - I	648	1.092	1685	1937	1.965	1014	874	2.672	3057	143	0.329	2298	0	0	0	0	0	0	0	0	0	2567	2.942	1146	64	0.053	824	3308	126.78	38326	0	0	0
Gopiballavpur - II	2773	6.276	2263	30753	65.765	2138	951	2.935	3087	562	1.617	2877	0	0	0	552	0.912	1653	0	0	0	559	0.410	733	1276	1.138	892	5024	191.90	38197	0	0	0
	14807	32.706		168096	308.386		126738	440.251		758	2.064		3916	61.1		914	1.237		130	0.2		6967	7.128		13860	8.466		18041	534.72		1300	286.803	

Sources 1) B. A. E & S., Govt. of W.B., 2) Directorate of Agri., Govt. of West Bengal

1.10. Irrigation

The Jhargram District faces both flood & Drought. Most of blocks are under drought prone area of about 114099 hectares. The average rainfall of the district for last 10 years is 1609.46 mm. but it is the experience of the people that the district faces scattered & uneven distribution of rainfall almost in all year & the monsoon showers come always in late. Currently Government attempts to minimize the drawbacks agricultural issues by certain extent advancement in the economic condition, education, technology manures, pesticides, irrigation facilities etc. As a result of such initiatives reduction of irrigation water availability became low. Prudent and effectual water management with special reference to watershed development and micro irrigation system was implemented to the thrust areas with low production due to nutrient deficiency of low yielding wheat in irrigated medium land under micro farming situation and irrigated up land to assess the effect of different seed treatment measures of cucurbits during Rabi season (Annual Action Plant, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 – 2019).

Table 1.6: Basic irrigation statistics of Jhargram

Net Irrigated Area (2016-17)	**61224 hectares**
% Of irrigation	**36.34 %**
***Source**: Annual Action Plant, Seva Bharat Krishi Vigyan Kendra, ICAR 2018*	

Table 1.7: Sources of irrigation and irrigation potential (in hectare)

Sources of irrigation	Area (Ha)	Total Nos
HDTW	155	17
MDTW	3680	219
LDTW	599	66
STW	25710	10695
RLI	4548	157
ODW	1898	4564
Others	4021	1041
Tanks	2780	4632
Canal	17833	
GREOSS TOTAL	**61224**	**21391**

CHAPTER-2

HYDROMETEOROLOGY

2.1 CLIMATE

The weather, like much of Bengal, is extremely humid and tropical. Temperatures can reach as high as 46 ° C in the hot and dry months of May and June but can plummet to 4° C in the chilly nights of December and January. The average annual rainfall of Jhargram (Jhargram Forest Division) is about 1400 mm. The rainy season spreads over June to September due to southwest monsoon and the highest rainfall occurs in July and August. The rainfall starts decreasing from October and dry winter sets in. The dry season lasts until May. However, during this time this division gets some sporadic showers.

2.2 Rainfall

The NAQUIM area receives plenty of rainfall. The normal annual rainfall is about 1541 mm. Rainfall in the 4 months of south-west monsoon from June to September contributes around 75 % of total annual rainfall and more than 80 % rainfall occurs from June to October. Pre-monsoon showers are occasionally received in March, April and May.

Average annual rainfall for last 10 years (2008 to 2017) considering 5 nos. of rain gauge stations from 2008 to 2010 and then 4 nos. of stations up to 2017 is 1441.8 mm. Month wise rainfalls for 2008–18 of NAQUIM area is presented in Table: 2.2.

2.3 Temperature

The minimum and maximum temperatures generally vary from 9^0C in winter to 38^0C in summer. During summer temperature shoots up to 42^0C and the highest temperature recorded so far has been 47^0C. December and January are coolest months with normal temperatures around 9 - 10^0C and lowest temperature recorded ever is 5^0C.

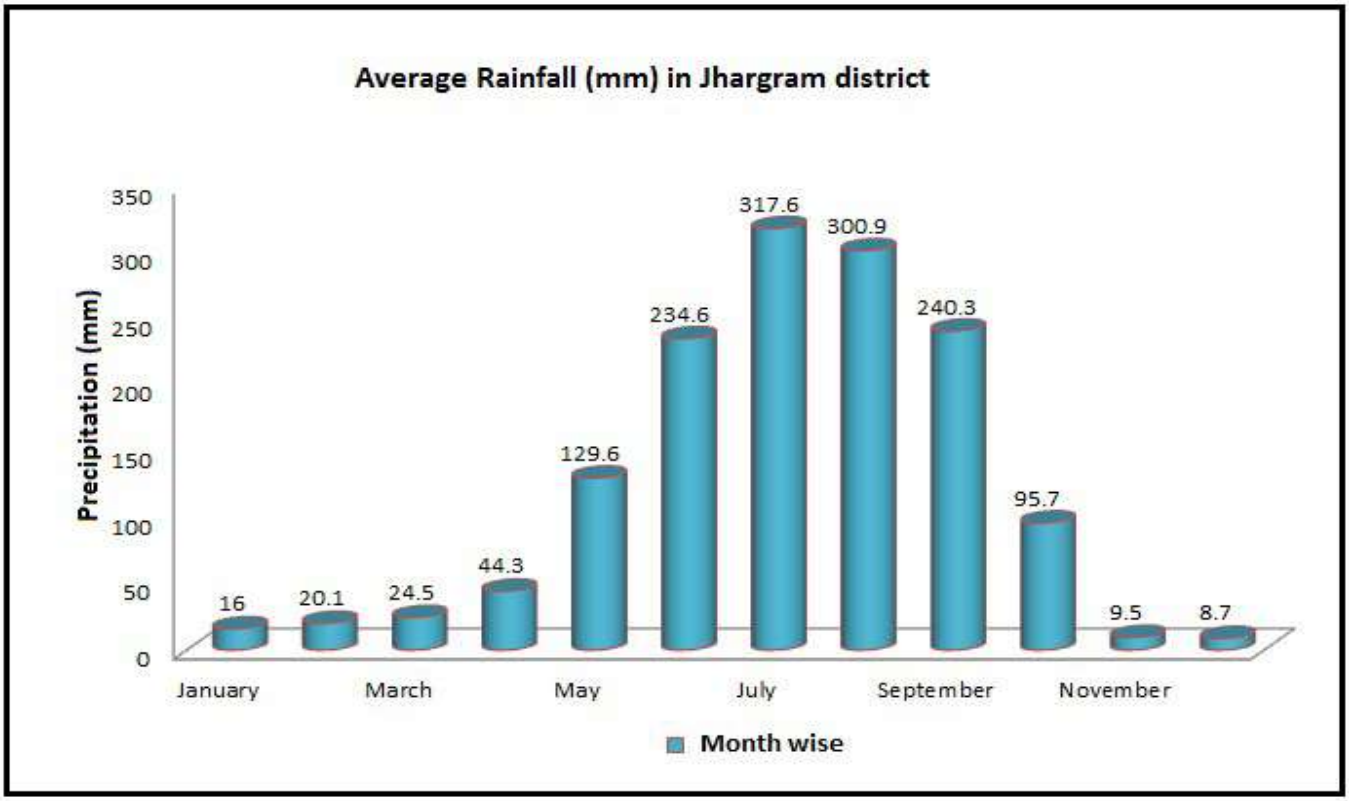


Figure: 2.1 Average Rainfall of Jhargram District

Table 2.1: Station wise Monthly Actual Rainfall for the year 2021 in NAQUIM area

STATION	YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
Jhargram	**2021**	**0.0**	**0.0**	**0.0**	**0.0**	**356.7**	**484.4**	**459.4**	**196.6**	**646.8**	**204.8**	**14.4**	**85.8**	**2448.9**
Binpur-II	**2021**	**0.0**	**0.0**	**0.0**	**0.0**	**303.4**	**289.6**	**442.0**	**272.2**	**392.2**	**37.2**	**3.2**	**65.4**	**1805.2**
AVERAGE														

Table 2.2: Month wise Rainfall data, Jhargram District (2008-18)

STATION	YEAR	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEP	OCT	NOV	DEC	TOTAL
Jhargram (Block - Jhargram, Adjacent to Gopiballavpur – II)	**2008**	39.6	7.8	36.8	47.4	152.4	749.0	186.4	367.3	320.6	58.0	0.0	0.0	**1965.3**
	2009	3.0	0.0	1.6	0.0	250.6	96.6	208.2	353.8	215.4	90.1	41.8	0.0	**1261.1**
	2010	0.0	1.0	29.4	1.6	172.6	45.6	189.8	115.6	181.2	47.0	0.8	18.8	**803.4**
	2011	6.4	7.8	110.0	96.4	84.0	503.6	125.4	463.4	369.6	3.1	0.0	0.0	**1769.7**
	2012	35.2	46.0	6.0	96.8	57.2	119.4	372.0	251.8	214.4	50.0	35.0	65.4	**1349.2**
	2013	1.2	16.6	4.6	97.6	316.8	155.0	499.4	445.8	260.4	467.0	0.0	0.0	**2264.2**
	2014	0.0	39.8	16.2	6.0	123.2	150.8	278.6	270.4	154.2	57.0	0.0	0.0	**1096.2**
	2015	35.6	5.2	18.8	163.8	89.8	119.2	362.2	222.0	197.8	35.8	0.0	13.4	**1263.6**
	2016	19.4	69.6	14.3	14.6	145.2	222.4	222.8	308.0	198.8	73.0	0.0	0.0	**1288.1**
	2017	0.8	0.0	108.0	19.4	165.6	88.8	424.2	251.4	171.0	143.4	25.6	9.6	**1407.8**
	2018	0.0	0.0	0.0	126.6	69.6	235.6	289.9	546.2	192.9	105.4	0.0	32.6	**1598.8**
AVERAGE														**1460.673**

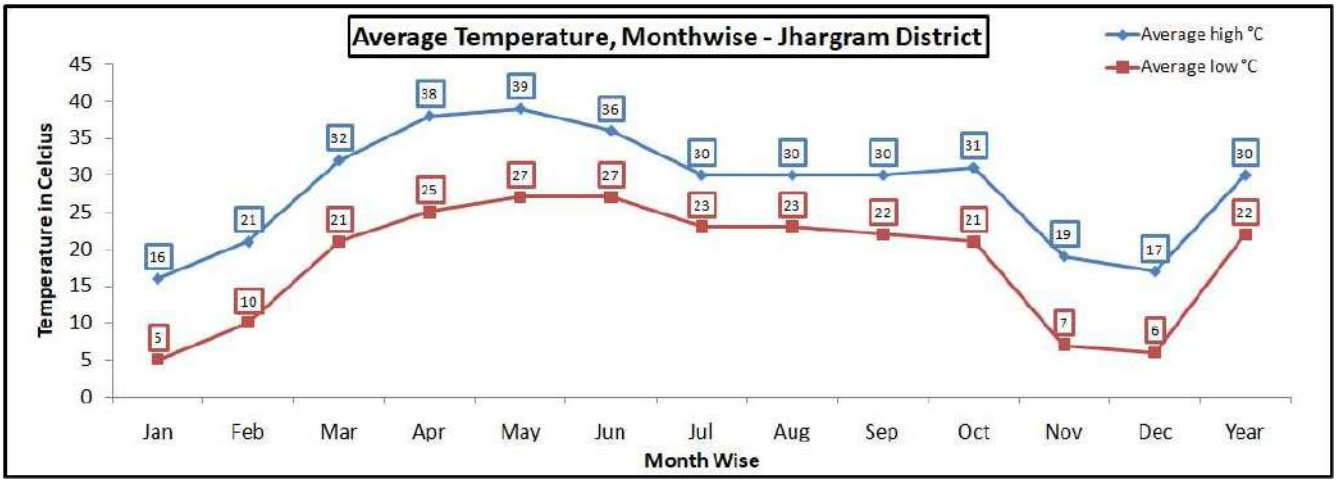


Figure: 2.2-month wise average temperature of Jhargram District

Source: Annual Action Plant, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 - 2019

Table2.3: Highest and Lowest Temperature (^{0}C) recorded at 3 stations in

Station	Highest Temperature (^{0}C)	Lowest Temperature (^{0}C)
Jhargram	41.5	6.0

Table2.4: Maximum and Minimum Temperature recorded in NAQUIM Area

Station	**Jhargram**	
Month	**Max**	**Min**
January	27.0	10.8
February	31.2	15.2
March	31.8	19.5
April	38.0	24.4
May	38.9	24.2
June	36.0	25.7
July	32.1	25.2
August	33.1	25.5
September	34.6	25.2
October	36.3	23.0
November	29.3	15.9
December	27.5	11.5

Source: Annual Action Plant, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 - 2019

CHAPTER-3
GEOMORPHOLOGY

3.1 Physiography

The present NAQUIM area is a moderately high to low alluvial plains covered with Quaternary Alluvium sediments (Older Alluvium for major part and Recent Alluvium for minor portion) originated from fluvial deposition and both Older and Recent alluvial lands are subjected to inundation and forming an extensive flood plain.

Jhargram district is a part of Chotonagpur plateau, the geomorphological point of view Jhargram can be conveniently divided into three Physiographic Units viz., (a) Plains, (h) Piedmont and (c) Hills and alluvial plain deposits. The district gradually slopes down towards east; hilly terrain occurs in the north-western portion of the district (Development & Planning Department). The geological formation of Jhargram is mainly lateritic, which occupies the central as well as the southern parts of this area, whereas the eastern part gradually gives way to the alluvium of the Lower Ganga plain. The plains command the largest area followed by the Piedmont and the hills.

On the other hand, the minor fraction of current NAQUIM area comprising Gopiballavpur–I and Gopiballavpur– II blocks of Jhargram district presents a topography flatter than the rugged topography of the platform area in the west and north-west and rolling plains consisting of laterite covered areas but underlain by deposits of Older Alluvium, which gradually merge into flat alluvial plain to the east and south-east.

Geomorphologically the study area is classified into seven units such as Badlands, flood plains; Para deltaic fan surface, pediments and Pedi plains, ridges and hills and upland plains. Upland plain is spread out all over the area and more than 60 % area of Jhargram, 80 % area of Jamboni with good ground water potentiality. Badlands topography is found in Binpur-I, where the ground water potentiality is low. Flood plains areas exhibit an excellent ground water potentiality which found along three main channels in the Kangsabati Command area. The area covered by low ridges and hills Binpur-II with low ground water potentiality, Geomorphological map of the Jhargram District is shown in **Fig. 3.1** and the Elevation map shown in **Fig. 3.2.**

3.2 Drainage

In Jhargram the river system includes river Kangsabati popularly known as Kasai, river Subarnarekha and river Dulung which is the tributary of river Subarnarekha, Tarafeni and

several rivulets viz., 'Deb', 'Palpala', Rangium', 'Kupon' etc. Most of the above river's flow from west to east as the western side of the division is having higher altitude as Jhargram has a gently sloping plain of low relief excepting the small north-western section where the low hills rise rather suddenly from the lateritic plain (Das and Das, 2015). Kangsabati enters Jhargram from its north in between Binpur I and Binpur II and flows towards east along the eastern border of Jhargram Block. Subarnarekha River enters the area from Jharkhand in the west and flows between Gopiballavpur I and Gopiballavpur II. With a southerly direction Dulung meets Subarnarekha River as a tributary. The Tarafeni River originates in the northwest portion of this division near Patagarh in Banspahari Range. It runs towards east within the jurisdiction of Belpahari and Binpur police Stations and finally has fallen into the Kangsabati river. The Kasai/ Kangsabati valley drains the northern and north-eastern part, while the southern half is drained by the river Subarnarekha and the south-western part of Nayagram is drained by the Muralinadi, a tributary of Jamir Anadi. Subarnarekha & Kasai drainage basins contain within themselves a few secondary drainage basins, which are drained by their respective tributary streams. The Kasai has two prominent tributaries namely the Tarafeni in the north and the Kalighai in the east. Similarly, the Dulung basin forms a part of the Subarnarekha valley. There are also numerous small tributaries to the south of Subarnarekha. Towards the north of this area, the plains rise gradually along the Dulung basin and Kasai-Tarafeni basin. Besides there are a few scattered plains developed on the narrow valleys in the hilly region at varying heights. It is a zone of accumulation. Drainage map of Jhargram district is shown in **Fig.3.3**

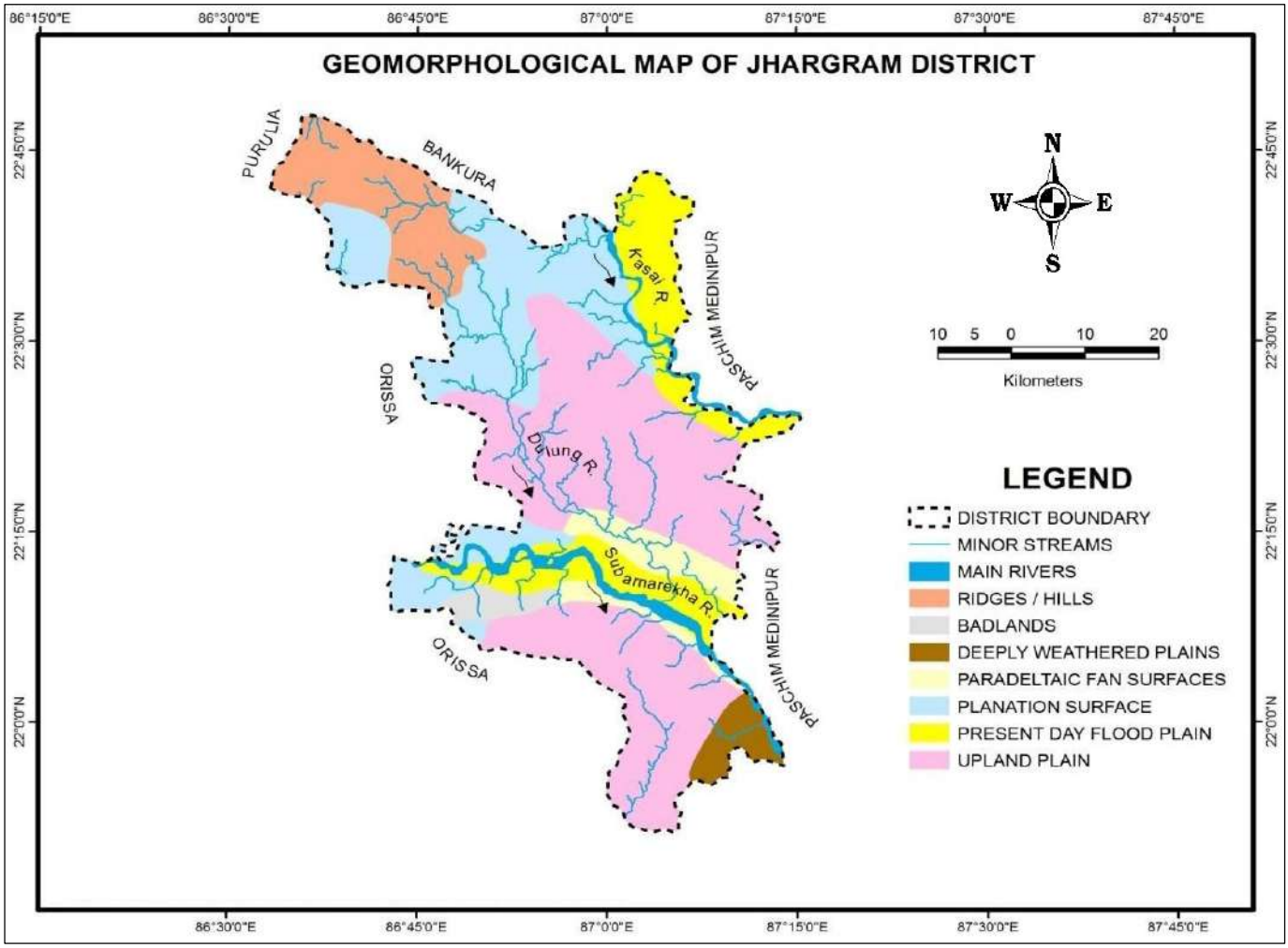


Figure 3.1: Geomorphological Map of Jhargram District.

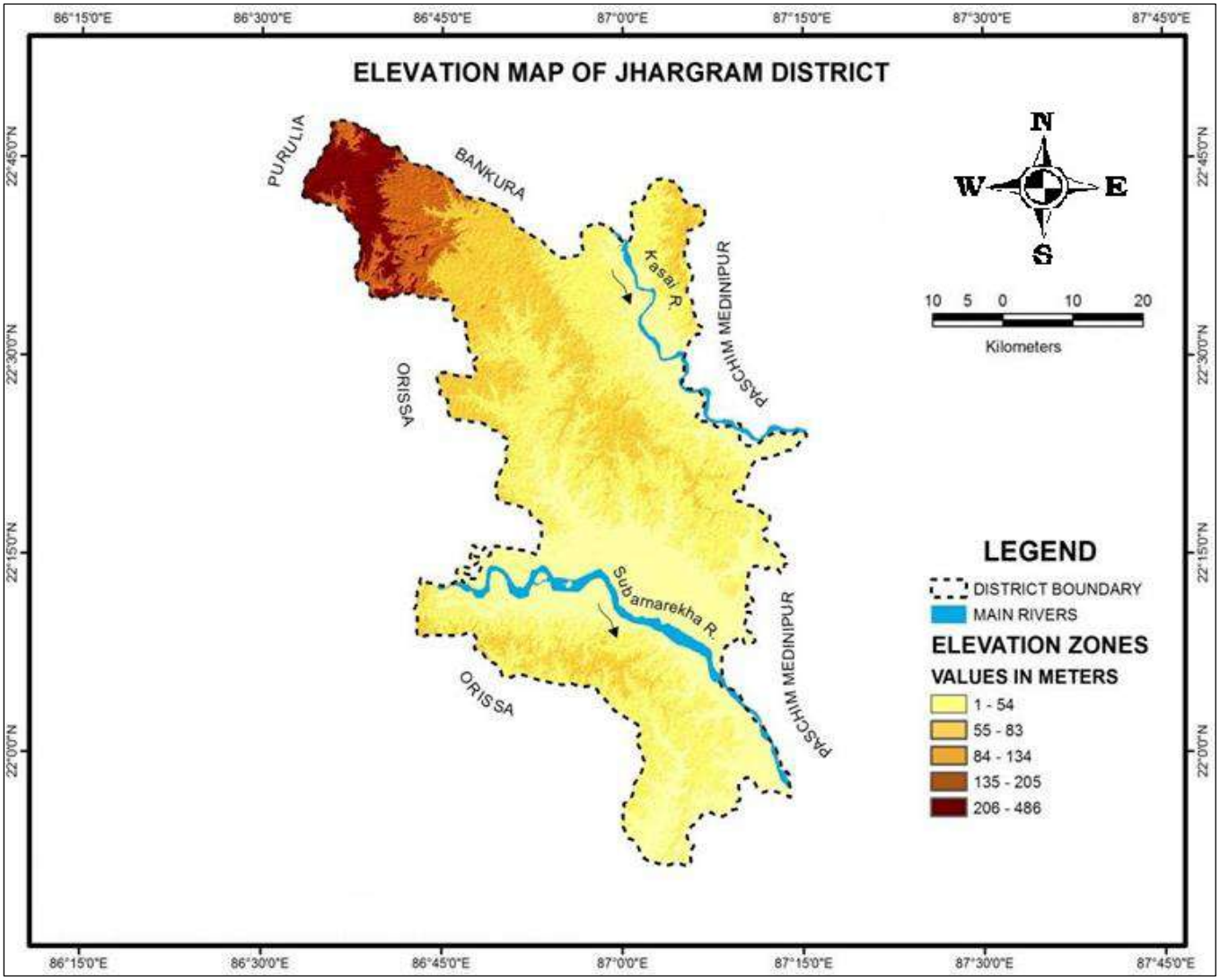


Figure 3.2: Elevation Map of NAQUIM Area in parts of Jhargram District

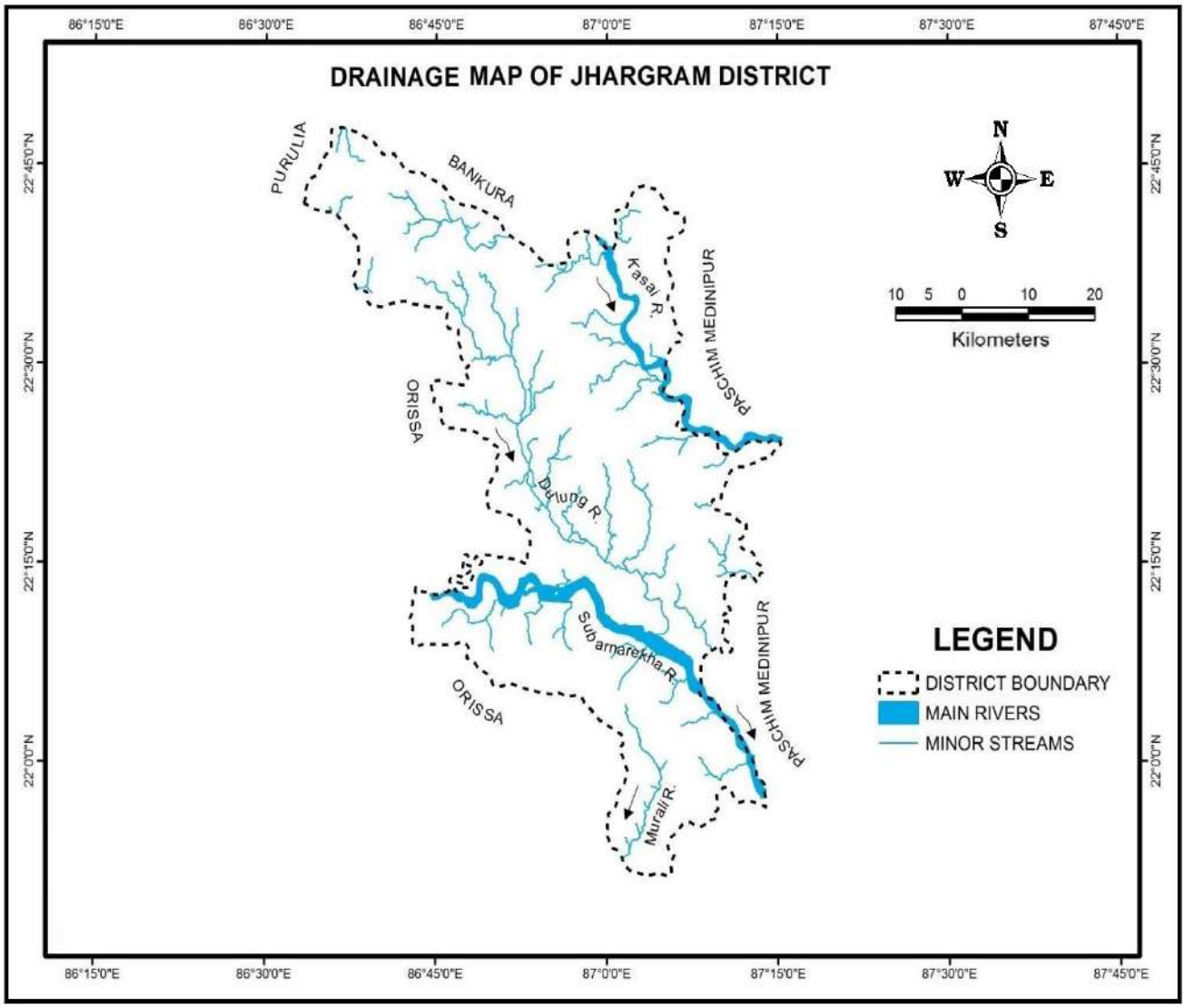


Figure 3.3: Drainage system in the NAQUIM area (Jhargram

3.3 Soil Type

Jhargram district is fundamentally shielded with unfertile hard laterite rocks and/or soil. The other than lateritic soil, the district soil can be broadly classified into four categories, viz., red sandy, red gravelly, older and newer alluvium. The most major soil type of the district is lateritic in Jhargram along with existence of newer alluvial patches near the river basins which tumble over in the wet season. The lateritic soils are slightly acidic with pH range 5.5 to 6.5 and poor in calcium, organic matter, and available phosphates and in bases. Laterite soil has a little water holding capacity. In some portions of the district red gravelled and sandy soils appear with few patches of older alluvium. The red soils are poor in organic matter and available plant nutrients and course textured with pH around 6.0 to 6.6. In the alluvial tract three types of soils are abundant e.g., clayey soil is known as 'etel'; the loam soil, known as 'doash'/ 'dorash'/'doesta' and sandy loam soil which is known as 'beledoash of alluviums ranges from pH 6.0 to 8.0 i.e., marginally acidic and to some extent alkaline(shodhganga.in flibnet.ac.in./bitstream/).

In the lateritic tracts of Jhargram subdivision the soils are mostly loam and sandy loam, having the same name as the alluvial portion, but their colour is reddish-brown, and they are inferior in fertility to the corresponding types of soil in the alluvial tract (O'Malley, 1995). Soil map of the Jhargram district is shown in **Fig 3.4** and block wise soil characteristics tabulated in **Table:3.2**

Table 3.1: Soil type with Soil Reaction Classes of Jhargram

Soil Type	Soil Reaction Classes
lateritic soils	pH 5.5 to 6.5
Red soils	pH 6.0 to 6.6
Alluvium	pH 6.0 to 8.0

Table: 3.2 Soil characteristics of Jhargram district

Block	Net Cultivated Area (Ha)	SOIL TYPE				TEXTURAL AREA (ha)					LAND SITUATION		
		Predominant type	% Of Total Area	Other Type	% Of Total Area	Sandy	Sandy Loam	Loam	Clay Loam	Clay	Low	Medium	High
Jhargram	25424	Lateritic	90	Alluvium	10	1745	18515	3719	1445	-	3063	9349	13013
Nayagram	22826	Lateritic	90	Alluvium	10	5408	14754	1312	1352	-	2961	8490	11375
Sankrail	21153	Lateritic	80	Alluvium	20	4173	14313	1343	1324	-	4833	8868	7452
Jamboni	20450	Lateritic	85	Alluvium	15	6664	12629	1157	607	-	9884	9959	
Binpur-I	20052	Lateritic	70	Alluvium	30	3845	11228	3390	1589	-	4354	9629	6069
Binpur-II	21870	Lateritic	95	Alluvium	5	4566	16098	1206	2387	-	6855	12628	
Gopiballavpur-I	15265	Lateritic	60	Alluvium	40	2502	7255	3751	1757	-	4222	5497	5546
Gopiballavpur-II	15566	Lateritic	55	Alluvium	45	1249	10243	2325	1749	-	1553	8279	5733
District Total	**162606**					**30152**	**105035**	**18203**	**3506**	-	**23980**	**66851**	**71775**

Source (Annual Action Plant, Seva Bharati Krishi Vigyan Kendra, ICAR 2018 - 2019)

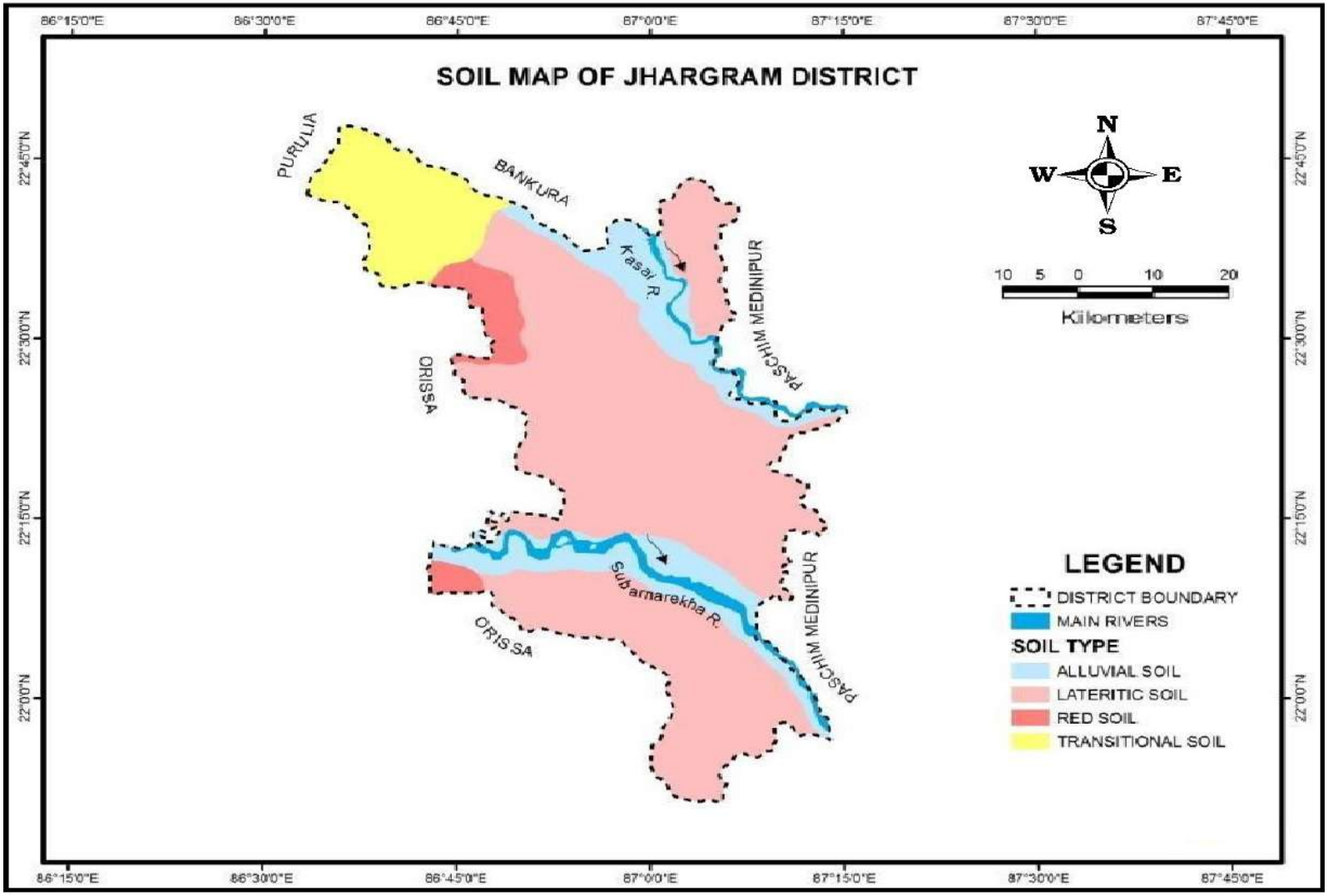


Figure 3.4: Soil map of NAQUIM area in Jhargram districts

CHAPTER-4

GEOLOGY

4.1 REGIONAL GEOLOGY

There are various types of rocks to be noticed in the area. Laterites cover major part of the area. Only in the extreme north-west of Binpur, distribution of rocks offers a complex picture. The oldest outcrops are of the Archaean era and the alluvium is of recent origin. In the north- west of Binpur, micaceous schists crop up from beneath the laterite flats in a stream near the village of Silda, and about 13 km further west a low ridge raises from the lateritic plain. The ridge is formed of grey and bluish grey micaceous schists with bands of gneiss below. It has close similarity with the rocks found, in the Silda village. To the west of this ridge there is a group of hills of irregular shape which have no general bearing but occur rather in isolated masses separated by valleys.

The area is covered mostly by Quaternary sediments, except in the north-western parts where older rocks are exposed. The older rocks in the area belonging to Palaeoproterozoic age group are represented by (i) Singhbhum group consisting of mica schist, phyllites, garnet-staurolite schist and quartzite, (ii) Dalma volcanics, consisting of carbon-phyllites, volcanics, pyroclastic, epidiorites and hornblende-schist in the north-western part of the district, around Silda, Jamboni area adjacent to Purulia district, and (iii) Younger intrusive belonging to Mesoproterozoic age, consisting of Kuilapal granite and quartz tourmaline rocks. Cainozoic laterites in the north-western and south-western parts of the district represent hard crust at the top, followed by a layer of nodular lateritic mass that grades down through a lithomarge (saprolite zone). There are numerous exposures of laterite in the area giving rise to bi- or tri-profile sequence indicating “in-situ” nature. The Cainozoic gravel bed (Tertiary gravel bed) constitutes gravels and pebbles of quartz, which are occasionally embedded in the laterites.

4.2 SUBSURFACE GEOLOGY:

The Precambrian rocks are highly deformed resulting with both planer and linear structures chiefly along NE-SW directions. The zone of weathering in this hard rock terrain consists of loose regolithic materials which become more compact downward till the fresh hard rock is met. The phyllites and mica schists are highly foliated, striking generally along NE direction. Few parallel and sub parallel quartzite bands stand out as prominent ridges in the area.

The north western and south western part of the area is essentially upland region characterized by occurrence of laterites and lateritic soils at the top. The lateritic sequence shows the development of sand and clay horizons which are rather discontinuous in nature.

The laterite sequence is sometime underlain by a gravel horizon. Laterites are porous, pitted and in most cases typified by pisolitic structures and are either in situ or secondary. The lateritic sequence containing sand, clay and gravel has predominantly yellow and brown colour and is underlain by a thick grey coloured sequence of sand, silt, clay of tertiary age.

The subsurface lithology is correlated based on the available lithological logs (table 5.5) of the exploration carried out in different parts of the upland tracts. It reveals that beneath the lateritic mental these occurs a thick sequence of clay, silt, sand and gravel down to the depth of 200-250 m. The laterite sequence is considered to belong to Pleistocene period. From the upland to the eastern plains, the base of lateritic section lies at about 54 m at Gopiballavpur, 55 m at Jhargram, 56 m at Dahijhuri, about 46 m at Pukuria, around 60 m at Salboni. The hard crust of laterite is well developed at Jhargram and Sankrail and its pinches towards east. The general succession shows in **Table 4.1** and the geologicall Map of the NAQUIM area has been presented in **Fig. 4.1**

Table: 4.1 General Geological Succession of the Jhargram District

Age	Formation	Lithology
Recent Quaternary	Younger Alluvium Older Alluvium	Alluvium, Pale greyish white silt, sandy clay, sand course to medium brown to greyish in colour.
  Pleistocene	 Unconformity	Laterites, brown sandy clays, brown to reddish brown sand, mottled and variegated clays.
Upper Tertiary Mid Pliocene	 Unconformity	Sandstone, fine to medium ferruginous with sticky grey clay, bluish clay with bivalve fossils etc.
Precambrian		Phyllites, Mica Schists, Quartzite, Hornblende, Schists, dolerites, epidiorites etc.

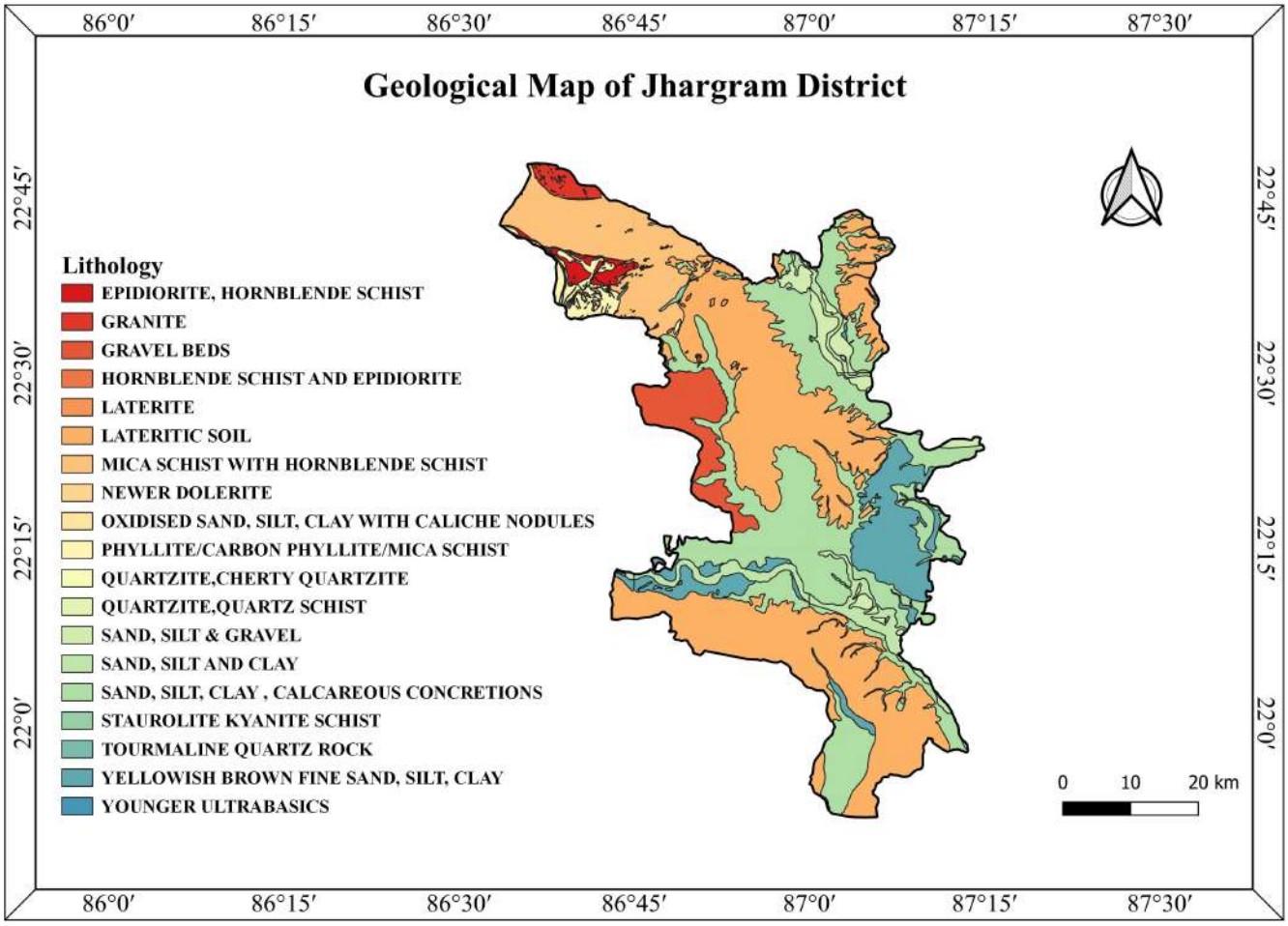


Figure 4.1: Geological Map of Jhargram District (source: Geological survey of India)

CHAPTER: 5

HYDROGEOLOGY

Hydrogeological condition of Jhargram district can be divided into two broad divisions as (i) Fissured/Fractured formation (ii) Porous formation

5.1 Hydrogeological condition of Fissured / Fractured Formation

In NAQUIM area hard crystalline rocks occur around Binpur-II in the extreme north western part of the district, where ground water occurs under water table condition in weathered residuum of the hard rocks and the interconnected fracture, fissures, joints etc. The thickness of the weathered zone varies from a very thin veneer to as much as 15-20 m.

Depth to water level in the zone of weathered and fractured rocks varies from 2 mbgl to 13 mbgl during pre-monsoon period. Ground water in this unit forms limited ground water development scope and is mainly tapped by dug wells, dug cum bore wells and bore wells. However, the deeper fractures are also potential for ground water development and are mainly developed by bore well. Ground Water exploration carried by CGWB in this unit reveals the existence of fractures within depth of 85 mbgl with the yield of the well ranging from 5 to 7 lps.

5.2 Hydrogeological condition of porous formations

The porous formations are very extensive both laterally and vertically and can be sub divided into two categories a) Older Alluvium and upper Tertiaries and b) Recent Alluvial plains in the eastern part of the district.

5.2.1 Older Alluvium and Tertiary Region

The upland region in the north western, northern, and south western part of the district is characterized by the occurrence of laterite and lateritic soils at the top underlain by a thick sequence of clay, silt, sand, and gravel down to the depth of 250 mbgl. In the shallow phreatic aquifers, ground water occurs under water table condition in this upland tract whose pre-monsoon depth to water level ranges from 2.25 mbgl to 12.5 mbgl during pre-monsoon period.

The block areas of Nayagram, Sankrail, Gopiballavpur-I and Gopiballavpur-II are mainly covered by recent alluvium deposits. Very significant and promising water bearing formations occur in Jamboni and Gopiballavpur-I & II Block within the depth range of 120-180 m. Ground water here occurs both in water table and confined conditions.

5.2.2 Alluvial plains in the eastern part

Sankrail, and southern part Nayagram, and South-eastern part of Gopiballavpur-I & II blocks are mainly covered by recent alluvium deposits. Very significant and promising water bearing formations occur in Nayagram-Sankrail Block within the depth range of 130-185 m. Ground water here occurs both in water table and confined conditions.

5.3 Aquifer Characteristics:

The yield potential and aquifer characteristics are different in different hydrogeological units

a) In hard rock area (in Binpur II block) fractures encountering in the depth zones 20 to 85 mbgl yields 5 to 7 lps of water. Transmissivity (T) & Storage co-efficient (S) values determined as 40 m^2/day & 5.83 x 10^{-3} respectively.
b) In the alluvium areas around Thakurpara (Binpur-II Block), Manikpara (Jhargram Block), Tube wells constructed within depth of 70 to 250 mbgl yielding 7 to 10 lps. Transmissivity and storage co-efficient values determined as 43m^2/day and 9.6 x 10^{-5} respectively.
c) In younger alluvium formation yield of well varies from 30 to 50 lps with T & S as 3847 m^2/days and 3.87 x 10^{-3} respectively.
d) In Tertiary sedimentary formation (within the depth of 22 to 80 mbgl) yield of the wells varies from 20 to 44 lps with T determined as 2370 m^2/day.

5.4 Depth to water level:

During the NAQUIM study 31 key wells have been established. Water levels in those key wells have been monitored during pre and post monsoons periods.

The depth to water level in the hard rock terrain varied from 2.75 mbgl at Bhandarpur to 12.67 mbgl at Jinaguri in Binpur-II block during pre -monsoon period while during post monsoon period it varied from 1.60 mbgl at Jaspur to 10.2 mbgl at Tentudanga.

The depth to water level during pre-monsoon period in areas underlain by older alluvium varied in range of 3.57 mbgl 17.9 m bgl in Jamboni, Jhargram, Sankrail, Gopiballavpur-I & II and some part of Binpur-I block. During post monsoon period, it varies 2.51 m bgl at Rajdihi to 10.25

m bgl at Nekrasuli. Depths to Water Level map and Water Table map have been prepared and presented in **Figure no: 5.2 to Figure no 5.5**, below is given the Water Level pre & Post Monsoon details in **Table no 5.1.**

Table: 5.1 Water levels of key wells of Jhargram District

Sl. No	Sample Code/ Well No	Location	State/ District	Block	Type of sample	Latitude	Longitude	MP	Pre WL _mbgl	Post WL _mbgl
1	KWJH-1	Pachakhali	Jhargram	Jhargram	DW	22.482057	87.003893	0.8	4.09	3.55
2	KWBPI-2	Chandrapur, High School	Jhargram	Binpur-I	DW	22.560413	87.018747	0.65	7.29	5.35
3	KWBPI-3	Chandrapur, High School	Jhargram	Binpur-I	TW	22.560413	87.018747	0.5	7.51	5.07
4	KWBPII-4	Raghunathpur	Jhargram	Binpur-II	Sub TW	22.578109	86.967803	0.63	7.5	4.62
5	KWBPII-5	Bhandarpur	Jhargram	Binpur-II	DW	22.58191	86.948418	0.3	2.25	1.75
6	KWBPII-6	Jinaguri	Jhargram	Binpur-II	Mark-II	22.58068	86.897502	0.5	12.67	8.15
7	KWBPII-7	Laldanga	Jhargram	Binpur-II	Mark-II	22.606738	86.90037	0.5	12.14	8.55
8	KWBPI-8	Silda Range Office	Jhargram	Binpur-I	Sub TW	22.561447	86.913205	0.5	11.04	8.67
9	KWBPI-9	Jashpur Pr. School	Jhargram	Binpur-I	DW	22.536659	86.963263	0.8	3.08	1.6
10	KWBPI-10	Tentudanga Harimandir	Jhargram	Binpur-I	DW	22.505027	87.030901	0.85	10.88	9.35
11	KWJH-11	Rajdihi	Jhargram	Jhargram	DW	22.456603	87.025869	0.65	4.15	2.51
12	KWJH-12	Burisol Pr. School	Jhargram	Jhargram	DW	22.515703	86.863547	0.65	5.65	3.85
13	KWJH-13	Nakdihi	Jhargram	Jhargram	DW	22.502746	86.863547	0.9	8	7.3
14	KWJH-14	Jamboni WBSEDCL	Jhargram	Jhargram	DW	22.450682	86.897239	0.8	3.57	3.35
15	KWJH-15	Tanga High School	Jhargram	Jhargram	DW	22.439869	86.944913	0.7	5.05	3.47
16	KWJH-16	Murakati Jr. Pr. School	Jhargram	Jhargram	DW	22.441264	86.843788	0.7	4.4	3.65
17	KWJH-17	Anguiboni High School	Jhargram	Jhargram	DW	22.307689	86.947749	0.95	11.98	11.5
18	KWJH-18	Salboni	Jhargram	Jhargram	DW	22.381824	87.02144	0.8	9.63	5.4
19	KWJH-19	Indraboni	Jhargram	Jhargram	DW	22.394412	87.106278	0.3	6.82	3.3
20	KWJH-20	Shahid Matangini	Jhargram	Jhargram	Mark-II	22.391867	87.200447	0.6	8.49	5.6
21	KWSK-21	Nekrasuli	Jhargram	Sankrail	Mark-II	22.263727	87.188809	0.5	17.9	16.3
22	KWSK-22	Benageria	Jhargram	Sankrail	DW	22.207536	87.162954	0.6	5.04	3.3
23	KWSK-23	Ragra RNM Academy	Jhargram	Sankrail	Sub TW	22.182046	87.06654	0.4	6.6	5.77
24	KWSK-24	Baharadari	Jhargram	Sankrail	Sub TW	22.190062	87.06654	0.3	6.35	5.95
25	KWNG-25	Nayagram Police station	Jhargram	Nayagram	Sub TW	22.036599	87.170911	0.4	6.89	7.4
26	KWNG-26	Kuldiha Kisku Bhawan	Jhargram	Nayagram	Sub TW	21.908791	87.055285	0.5	7.82	6.6
27	KWNG-27	Chhota Dhonsola	Jhargram	Nayagram	Mark-II	21.99015	87.04288	0.5	9.88	5.25
28	KWNG-28	Rangiam	Jhargram	Nayagram	DW	22.040985	87.098304	0.5	6.17	4.6
29	KWBPII-29	Kodpura Adivasi Mission HS	Jhargram	Binpur-II	Mark-II	22.625853	86.729563	0.5	10.47	8.33
30	KWBPII-30	Tongaveda Kali Mandir	Jhargram	Binpur-II	DW	22.693387	86.703743	0.8	6.25	3.5
31	KWBPII-31	Jamtolgoda CRPF Camp	Jhargram	Binpur-II	Mark-II	22.72831	86.675031	0.6	8.11	5.55

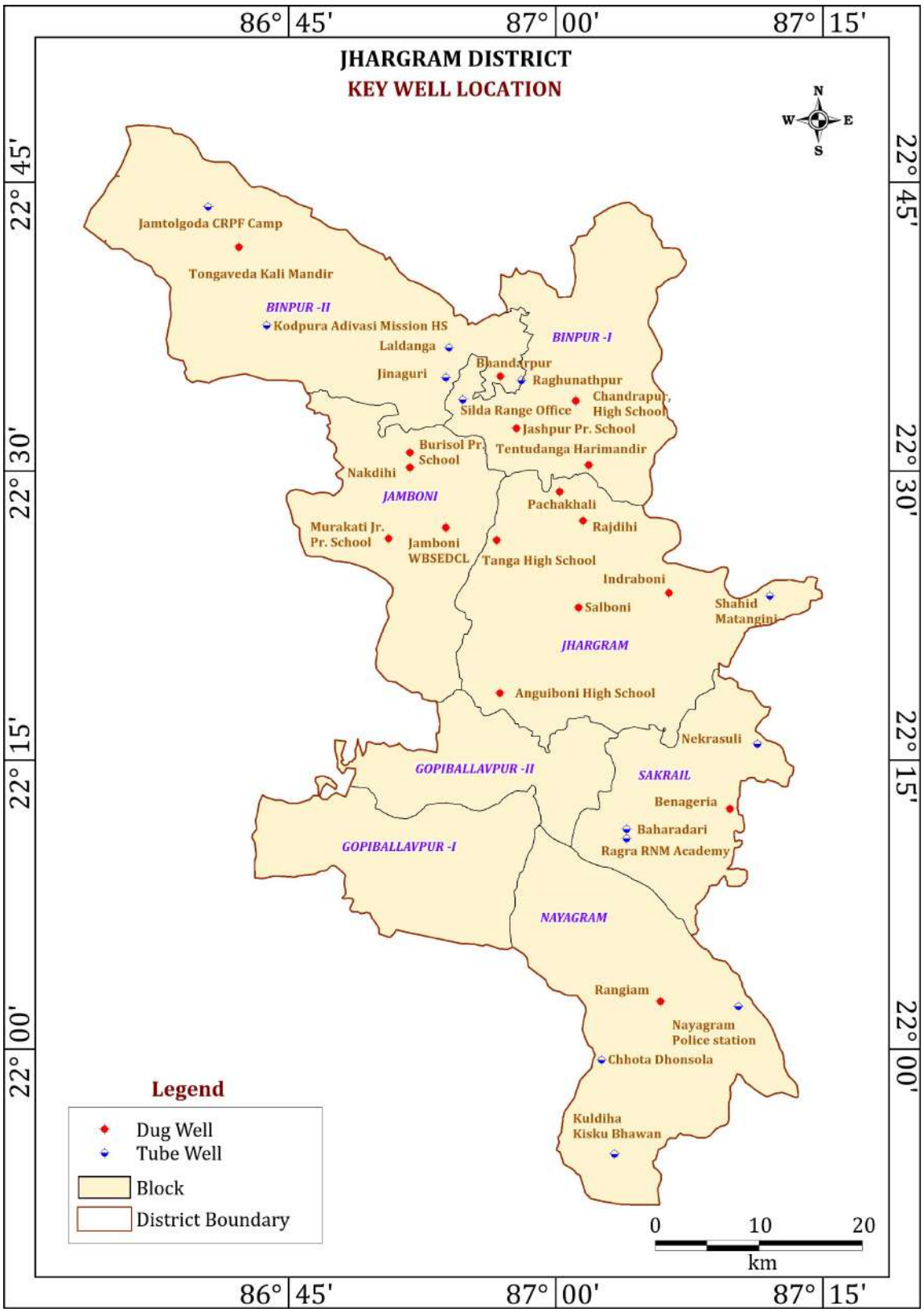


Figure 5.1: **Key well locations of Jhargram District**

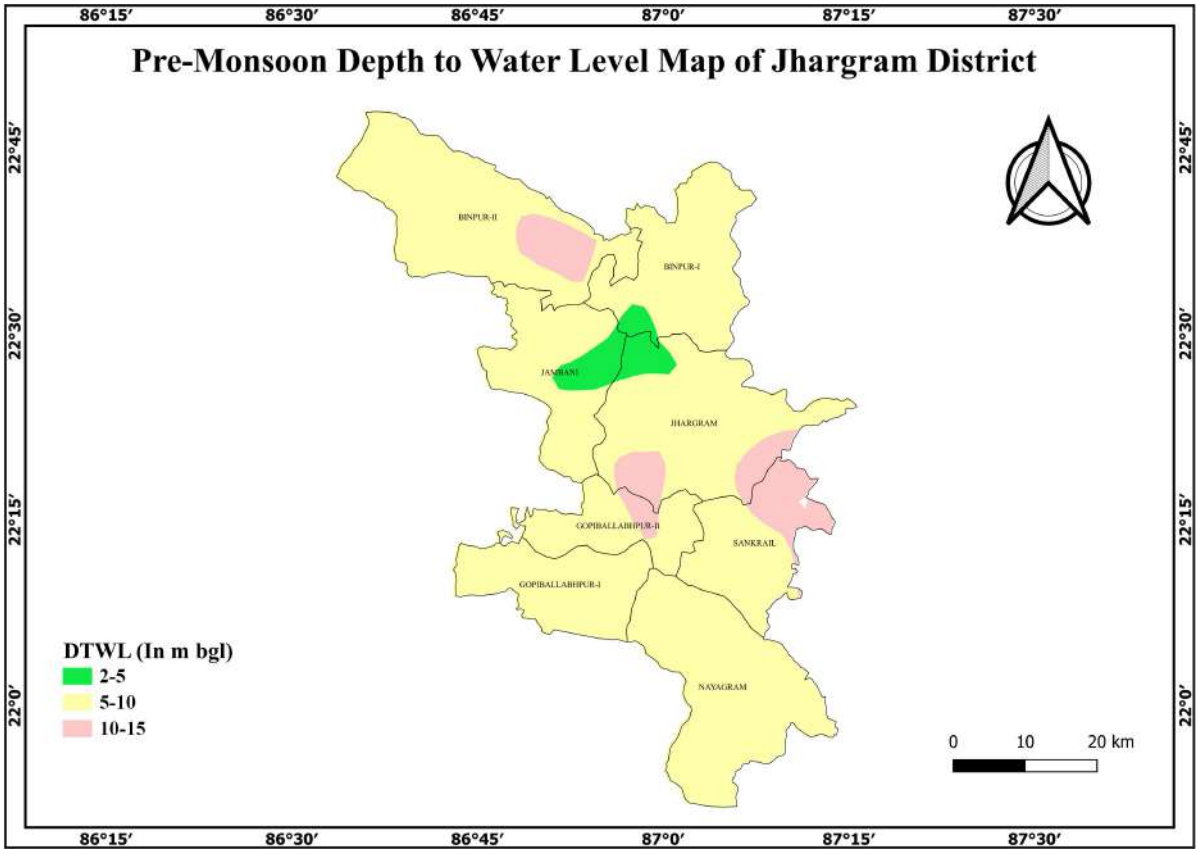


Figure: 5.2 Pre-Monsoon Depths to Water Level for Jhargram District

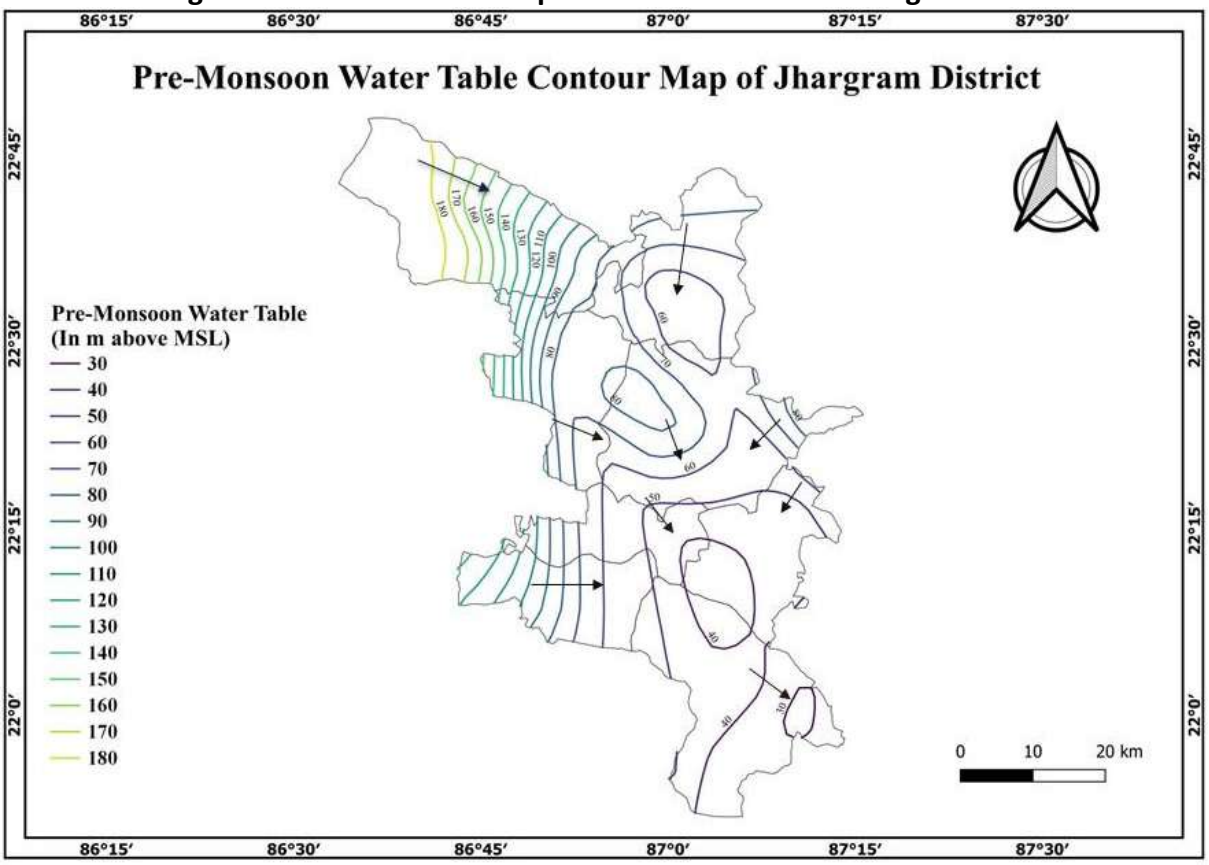


Figure5.3: Pre-Monsoon Depth to Water Table map of Jhargram District

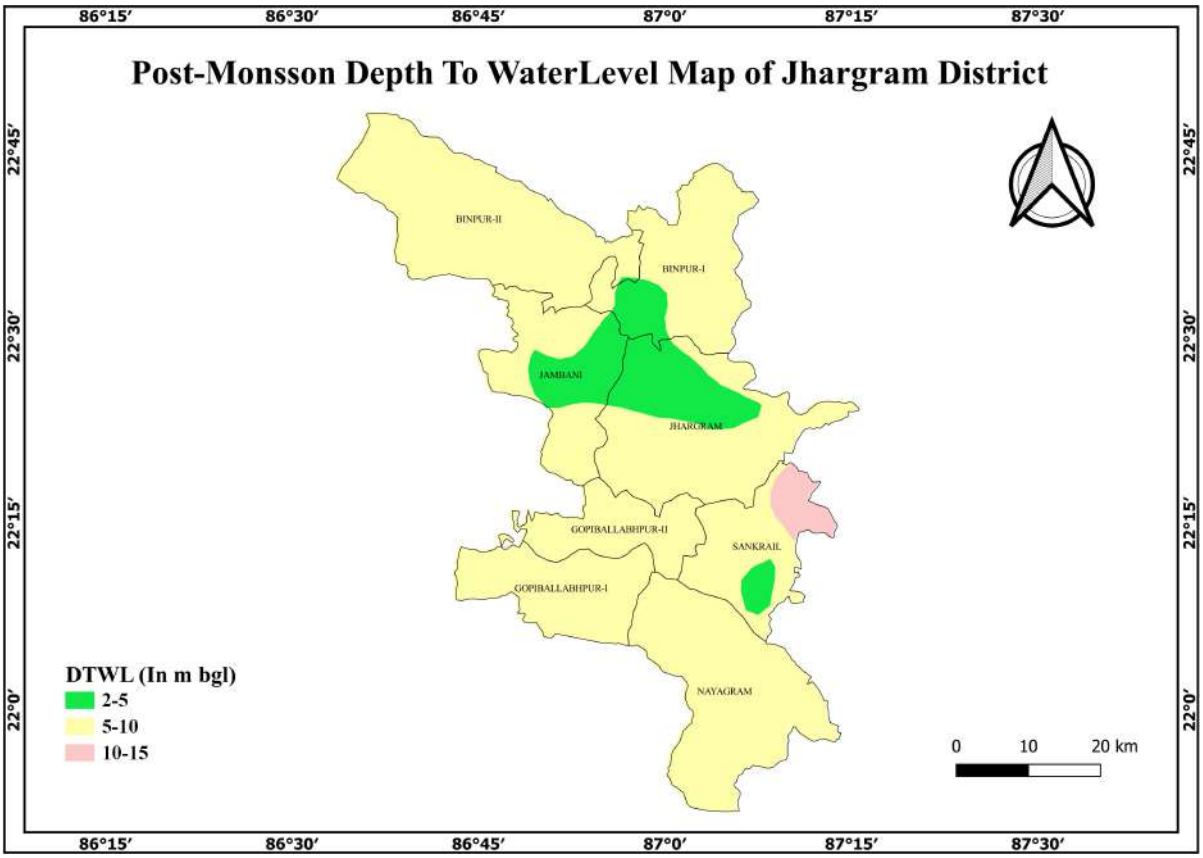


Figure 5.4: Post-Monsoon Depth to Water Level for Jhargram District

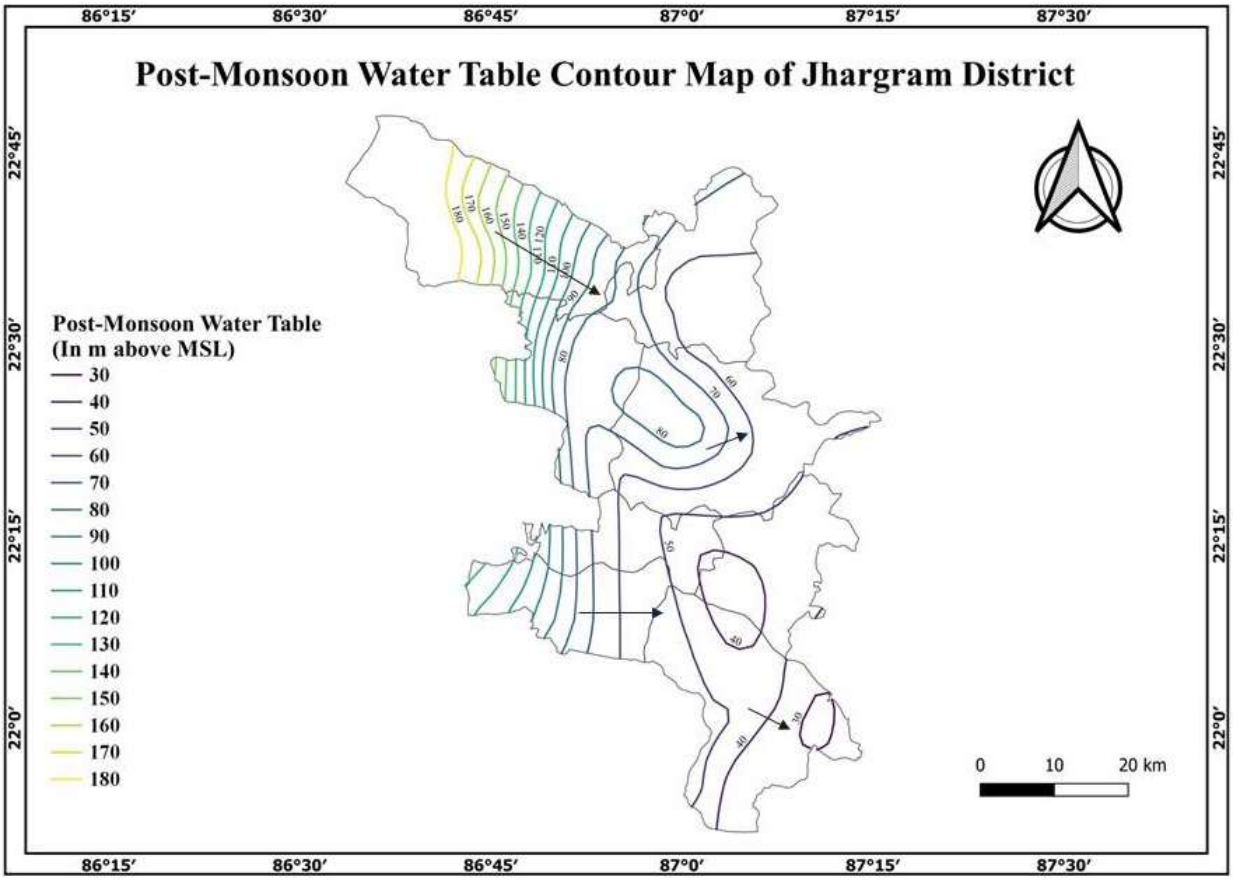


Figure5.5: Post-Monsoon Depth to Water Table map of Jhargram District

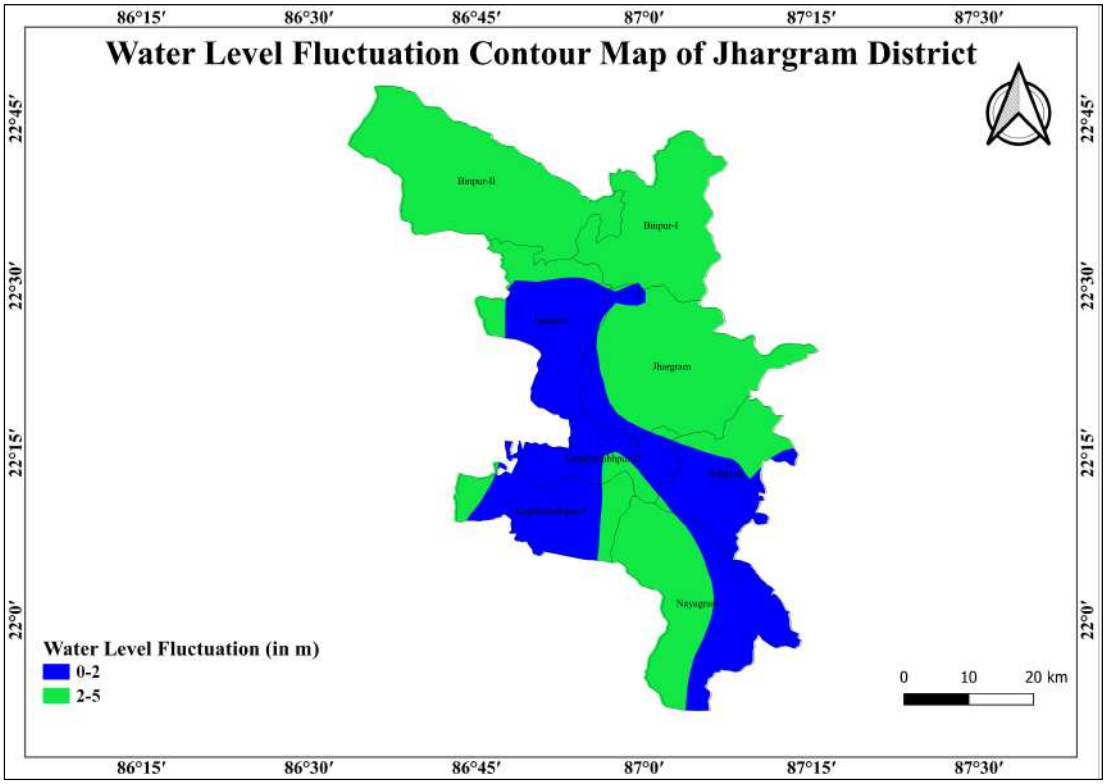
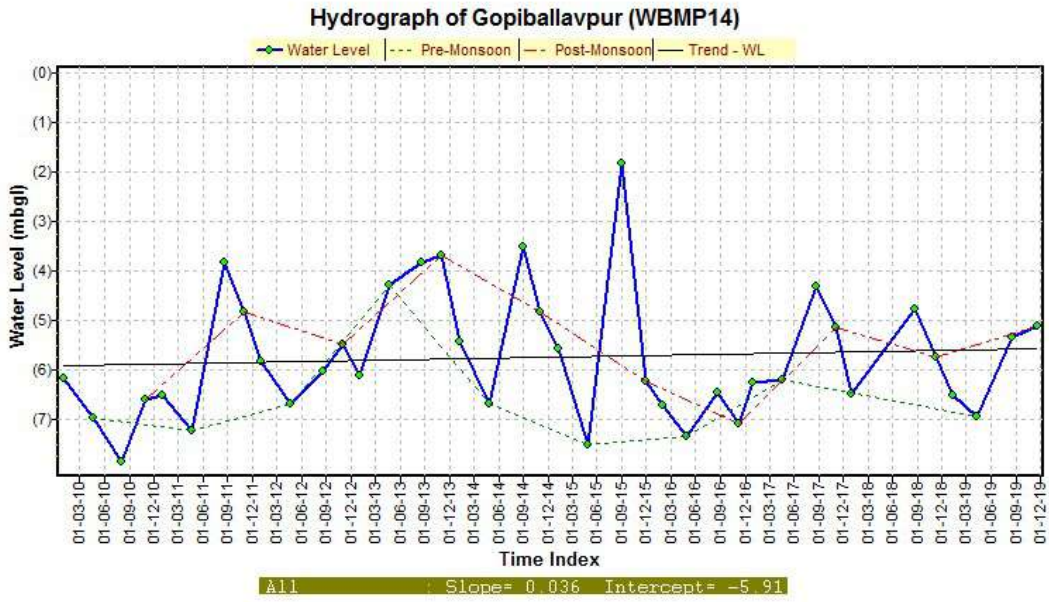


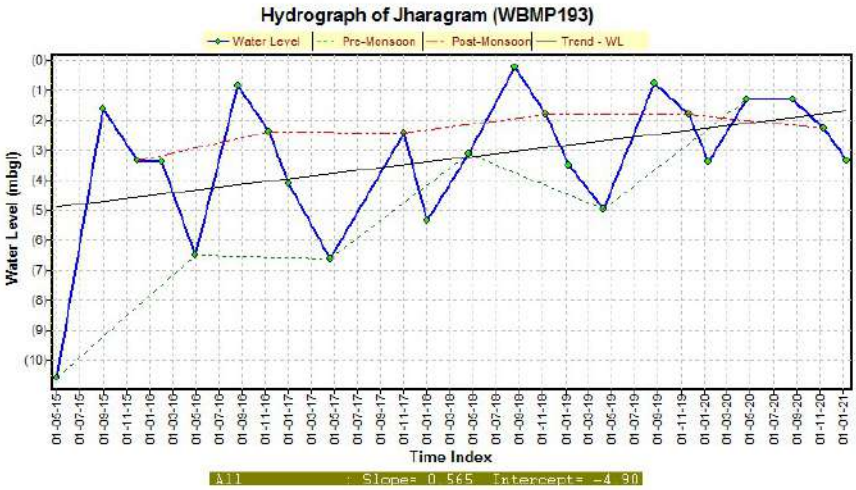
Figure 5.6: Water Level fluctuation map for Jhargram District

Hydrograph of Long-Term water level trend

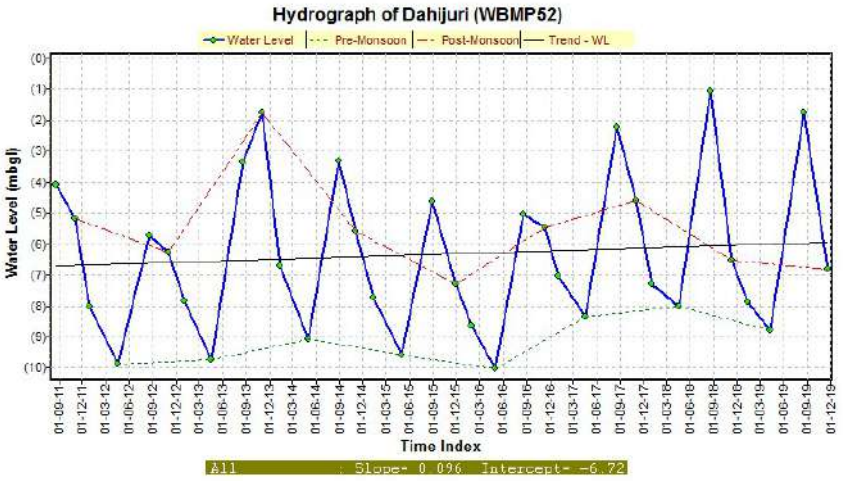
Figure 5.7 Hydrographs showing long term (decadal) Fluctuation



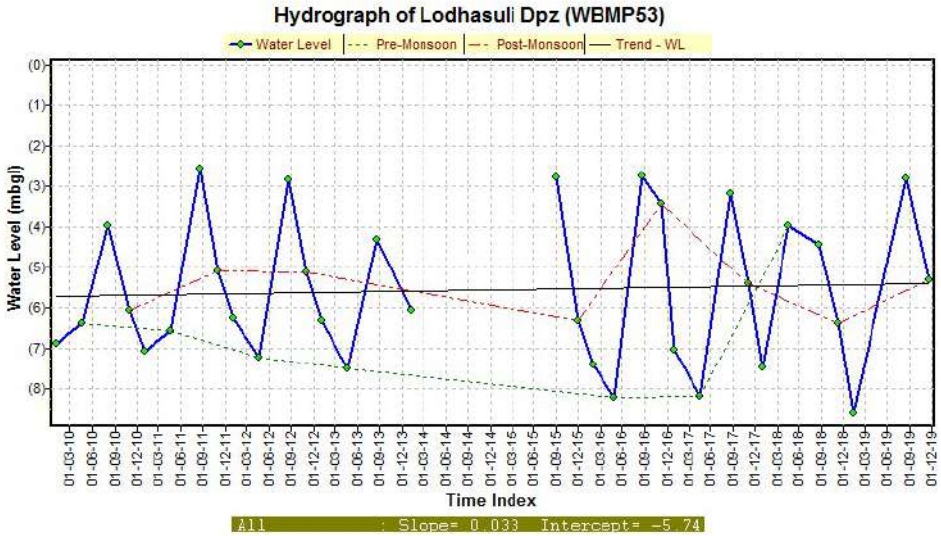
Decadal Long term Water Level Trend of Gopiballavpur (Well No. WBMP14), Block Gopiballavpur-I



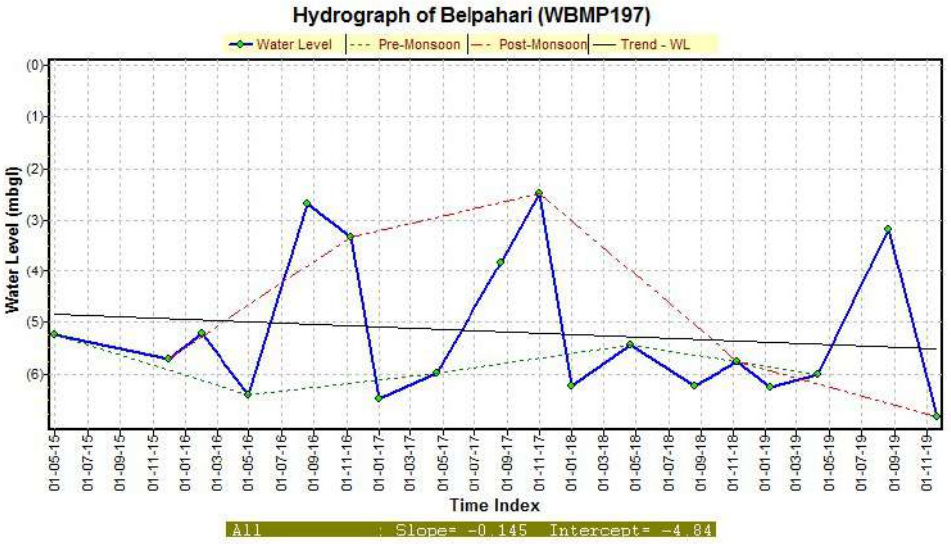
Decadal Long term Water Level Trend of Jhargram(Well No. WBMP193), Block Jhargram



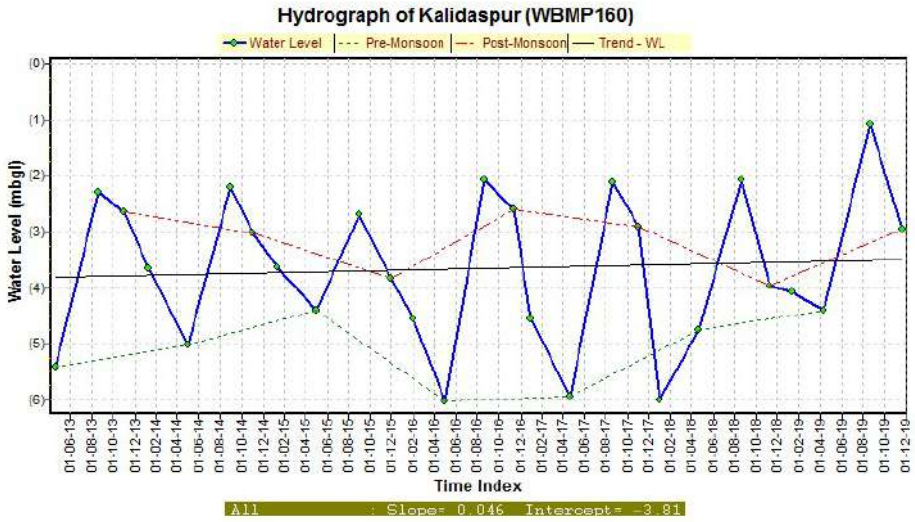
Decadal Long term Water Level Trend of Dahijuri (Well No. WBMP52), Block Binpur-I



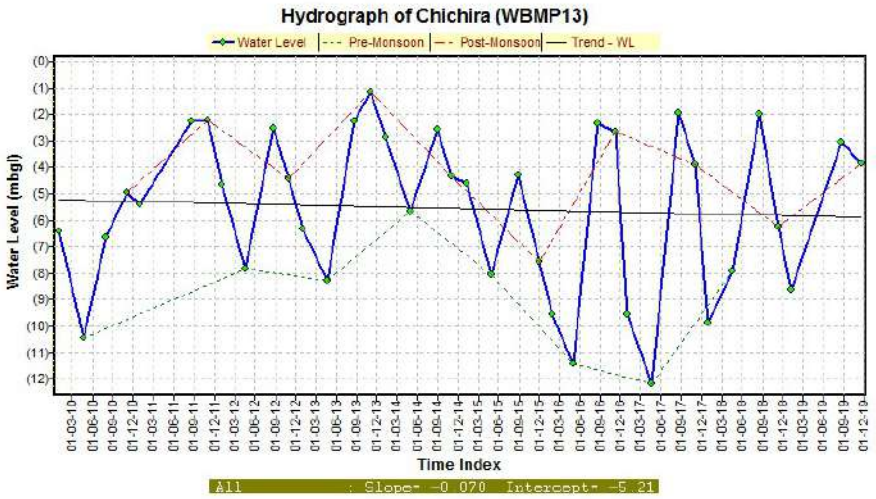
Decadal Long term Water Level Trend of Lodhasuli(Well No. WBMP53), Block Jhargram



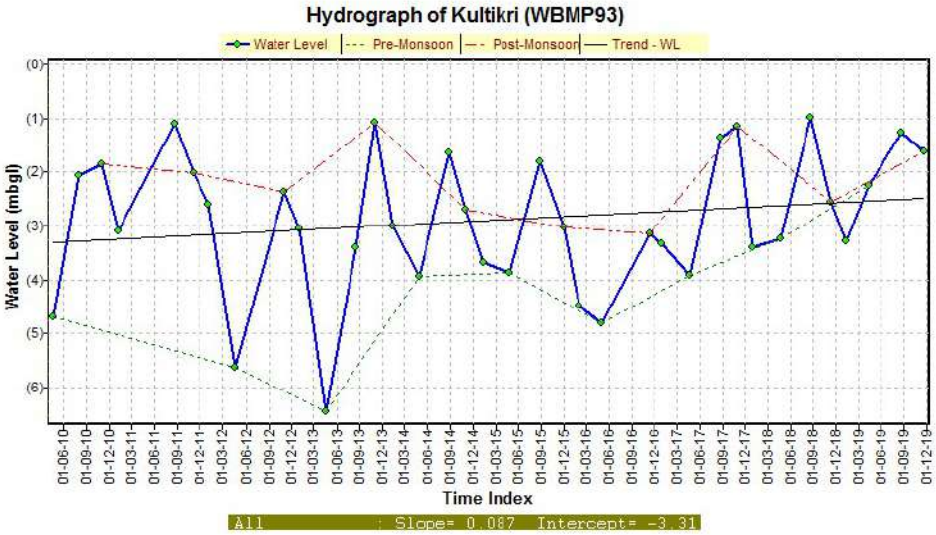
Decadal Long term Water Level Trend of Belpahari (Well No WBMP197), Block Binpur-II



Decadal Long term Water Level Trend of Kalidaspur (Well No. WBMP160), Block Jamboni



Decadal Long term Water Level Trend Chichira (Well No WBMP13), Block Jamboni



Decadal Long term Water Level Trend Kultikri (Well No. WBMP93), Block Sankrail

5.5 Pre monsoon and Post Monsoon Long Term analysis:

Long term trend analysis of pre and post monsoon water level has been done with the water level data of hydrograph stations in the NAQUIM study area for the last decade (2012-2021). The long-term analysis of water levels in various blocks of the NAQUIM area is calculated based on average rise/ fall of all the hydrograph station in the study area is summarized in **Table no 5.2** and **Table no 5.3** respectively.

It appears from the table that out of eight blocks the Belpahari in Binpur II block showing falling trend at the rate of 2.310 cm/year during pre-monsoon and 0.214 cm/year in post monsoon period.

Maximum blocks are showing rise trend in both the seasons.

Table 5.2: Long Term Water Level Trend Analysis for the Pre-monsoon (2012-21)

Block	Location	Well no	No of Data	Rise	Fall	Intercept
Jhargram	Balivasa	WBMP190	2	0.127	-	10.672
Gopiballavpur-II	Beliaberia	WBMP92A	3	0.216	-	10.807
Binpur-II	Belpahari	WBMP159	2	-	2.310	3.411
Binpur-II	Belpahari	WBMP197	6	0.247	-	6.910
Binpur-II	Binpur	WBMP46	4	0.668	-	8.844
Jamboni	Chichira	WBMP13	8	0.195	-	8.850
Binpur-I	Dahijuri	WBMP52	10	0.394	-	10.398
Jamboni	Dharsa	WBMP225	2	2.200	-	20.352

Block	Location	Well no	No of Data	Rise	Fall	Intercept
Jamboni	Gidhni	WBMP47	9	0.761	-	7.360
Gopiballavpur	Gopiballavpur	WBMP14	8	-	0.093	6.134
Jamboni	Guthia	WBMP211	4	0.403	-	4.788
Binpur-I	Harda	WBMP127	6	-	0.093	12.506
Jamboni	Hijli	WBMP186	6	0.740	-	9.429
Jhargram	Jhargram	WBMP193	6	1.557	-	14.461
Jhargram	Jhargram	WBMP135	3	-	0.140	10.242
Jamboni	Kalidaspur	WBMP160	8	0.292	-	6.154
Jamboni	Kapcita	WBMP212	4	0.856	-	9.594
Jamboni	Kapgari	WBMP187	4	1.609	-	17.129
Binpur-II	Khurchiboni	WBMP207	4	1.439	-	13.422
Sankrail	Kultikri	WBMP93	9	0.328	-	5.619
Jhargram	Lodhasuli	WBMP206	4	0.050	-	6.203
Jhargram	Lodhasuli DPz	WBMP53	6	0.501	-	8.499
Binpur-II	Malabati	WBMP189	5	0.175	-	3.925
Jamboni	Nunia	WBMP198	6	0.994	-	11.458
Jamboni	Parihati (Hattala)	WBMP150	5	0.440	-	8.224
Jhargram	Raghunathpur	WBMP133	3	-	0.750	10.102
Jhargram	Rashmandal	WBMP12	3	-	0.129	4.764
Jhargram	Rashmandal	WBMP12A	6	0.028	-	5.329
Sankrail	Sankrail	WBMP94	7	0.385	-	15.056
Jhargram	Sevayatan	WBMP196	6	1.147	-	15.525
Binpur-II	Silda	WBMP29	4	0.688	-	6.959
Gopiballavpur-II	Topsia	WBMP137	4	0.175	-	11.181
Gopiballavpur-II	Topsia	WBMP219	3	2.570	-	30.031
Jamboni	Tulibarh	WBMP185	6	0.941	-	13.436

Table 5.3: Long Term Water Level Trend Analysis for the Post-monsoon (2012-21)

Block	Location	Well no	No of Data	Rise	Fall	Intercept
Jhargram	Balivasa	WBMP190	8	0.173	-	5.169
Gopiballavpur-II	Beliaberia	WBMP92A	5	1.307	-	18.407
Binpur-II	Belpahari	WBMP159	8	0.04	-	2.745
Binpur-II	Belpahari	WBMP197	7	-	0.214	3.445
Binpur-II	Binpur	WBMP46	7	-	0.183	3.745
Jamboni	Chichira	WBMP13	10	0.081	-	4.346
Binpur-I	Dahijuri	WBMP52	10	0.087	-	5.562
Jamboni	Dharsa	WBMP225	2	0.69	-	8.357
Jamboni	Gidhni	WBMP47	10	-	0.009	1.77
Gopiballavpur	Gopiballavpur	WBMP14	10	-	0.003	5.283
Jamboni	Guthia	WBMP211	7	0.097	-	2.534
Binpur-I	Harda	WBMP127	8	-	0.381	5.633
Jamboni	Hijli	WBMP186	8	0.443	-	6.376
Jhargram	Jhargram	WBMP193	7	0.249	-	3.881
Jhargram	Jhargram	WBMP135	5	-	0.705	6.615
Jamboni	Kalidaspur	WBMP160	9	-	0.027	2.978
Jamboni	Kapcita	WBMP212	6	-	0.096	3.572

Block	Location	Well no	No of Data	Rise	Fall	Intercept
Jamboni	Kapgari	WBMP187	8	0.587	-	10.164
Binpur-II	Khurchiboni	WBMP207	7	0.16	-	2.686
Sankrail	Kultikri	WBMP93	10	0.056	-	2.417
Jhargram	Lodhasuli	WBMP206	7	1.017	-	12.137
Jhargram	Lodhasuli DPz	WBMP53	8	0.074	-	5.558
Binpur-II	Malabati	WBMP189	7	0.091	-	2.554
Jamboni	Nunia	WBMP198	7	0.221	-	5.524
Jamboni	Parihati (Hattala)	WBMP150	7	-	0.183	1.591
Jhargram	Raghunathpur	WBMP133	4	-	0.254	6.541
Jhargram	Rashmandal	WBMP12	2	0.91	-	12.39
Jhargram	Rashmandal	WBMP12A	8	-	0.163	3.713
Sankrail	Sankrail	WBMP94	10	-	0.357	7.075
Jhargram	Sevayatan	WBMP196	7	0.31	-	7.264
Binpur-II	Silda	WBMP29	5	0.096	-	3.829
Gopiballavpur-II	Topsia	WBMP137	9	-	0.039	8.026
Gopiballavpur-II	Topsia	WBMP219	6	0.543	-	13.596
Jamboni	Tulibarh	WBMP185	8	0.223	-	7.519

Table: 5.4 Status of Groundwater Development in Jhargram district (Block wise)

Block	Tentative Aquifer Zones in mbgl from existing bore holes	Geology	Aquifer Potentiality, Structures Feasible
Binpur-I	9-14, 22-29.5, 31-55, 55-66, 80-85, 92-120, 158-187	Older alluvium/ Tertiary alluvium underlain by Granite Gneiss. Tertiary aquifer encountered from 0-30 m bgl. Most parts of Binpur II is covered by Granite Gneiss.	Upper aquifer within 40mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 15-25m³/hr. MDTW tapping granular zone of 30-40m within depth of 300mbgl yield 50-100m³/hr. Dug well. Dug cum bore well & bore wells are suitable with yield of 5-10m³/hr.
Binpur-I			
Jamboni	27-30, 33-36, 63-69, 72-78, 81-87, 99-102,129-132.	Older alluvium/Tertiary alluvium underlain by Granite Gneiss. Tertiary aquifer encountered from 0-30m bgl.	Upper aquifer within 40mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 15-25 m³/hr. MDTW tapping granular zone of 30-40m within depth of 200mbgl yield 50-100 m³/hr. In hard rock areas Dug well. Dug cum bore well & bore wells are suitable with yield of 5-10 m³/hr.

Block	Tentative Aquifer Zones in mbgl from existing bore holes	Geology	Aquifer Potentiality, Structures Feasible
Jhargram	41-46, 66-74, 80-88, 113-143, 210-218, 240-250	Older Alluvium underlain by tertiary sediments. Tertiary aquifer exists below 40-60m bgl.	Upper aquifer within 30mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 20-40m³/hr. MDTW tapping granular zone of 30-40m within depth of 300mbgl yield 50-100m³/hr. Dug well are also suitable in shallow aquifer having yield of 5-10m³/hr.
Sankrail	2-7, 13-30, 45-48, 51-60, 63-66, 81-96, 100-120, 170-210.	Quaternary alluvium underlain by tertiary sediments. Tertiary aquifer exists below 55-74 mbgl.	Upper aquifer within 40mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 15-25 m³/hr. HDTW tapping granular zone of 30-40m within depth of 200mbgl yield 50-100 m³/hr.
Nayagram	7-15, 30-34, 40-46, 51-96, 112-120, 134-140.	Quaternary alluvium underlain by tertiary sediments. Tertiary aquifer exists below 85-110 mbgl.	Upper aquifer within 40mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 15-25 m³/hr. HDTW tapping granular zone of 30-40m within depth of 200mbgl yield 75-150 m³/hr.
Gopiballavpur-I	7-15, 30-34, 40-46, 51-96, 112-120, 158-187.	Quaternary alluvium underlain by tertiary sediments. Tertiary aquifer exists below 80-100 m bgl.	Upper aquifer within 30 mbgl is under unconfined condition and lower aquifer below 50m is under Confined condition. LDTW tapping granular zone of 12 to 15m within depth of 50m bgl capable of yield 20-30 m³/hr. MDTW tapping granular zone of 30-40m within depth of 300mbgl yield 50-100 m³/hr.
Gopiballavpur-II			

Source (*Ground Water information Booklet, CGWB****)***

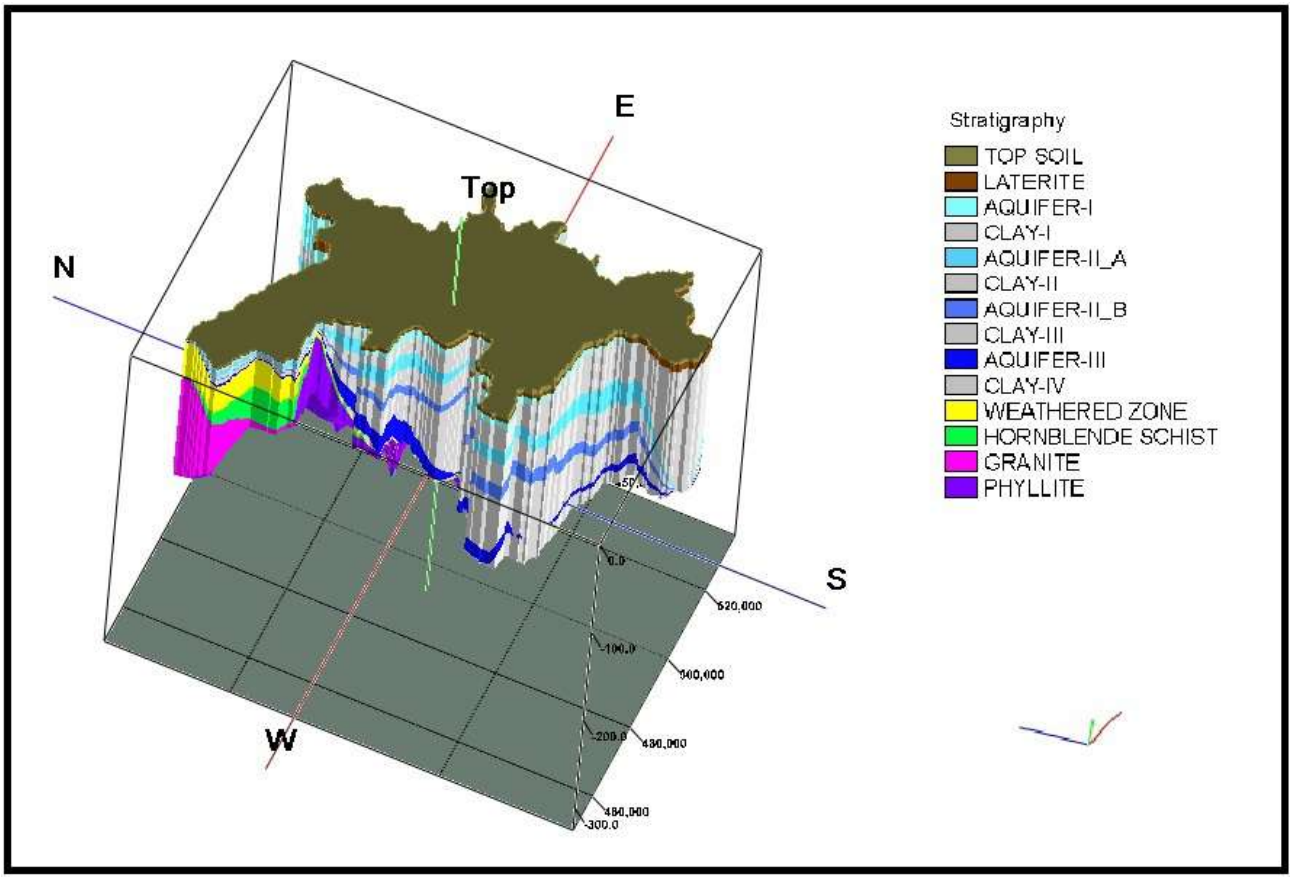


Figure 5.8: 3-D West view Aquifer Disposition of Jhargram district

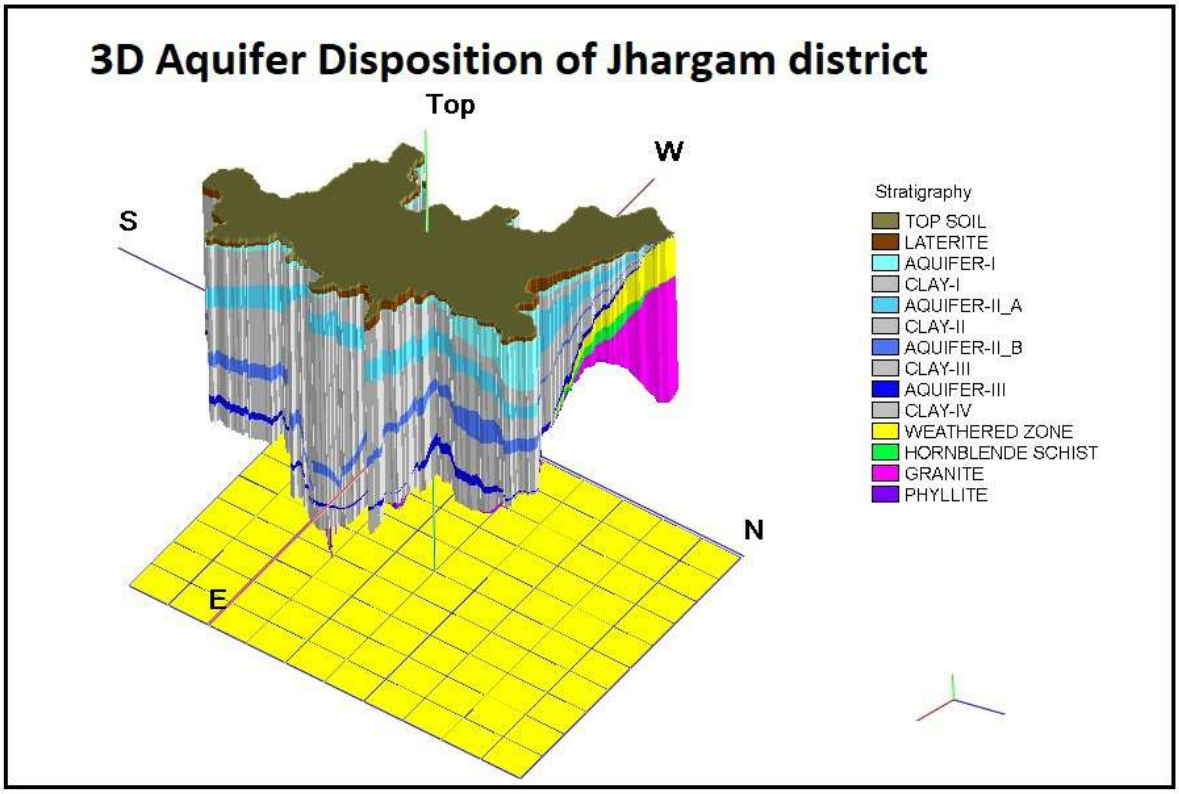


Figure 5.9: 3-D East view Aquifer Disposition of Jhargram district

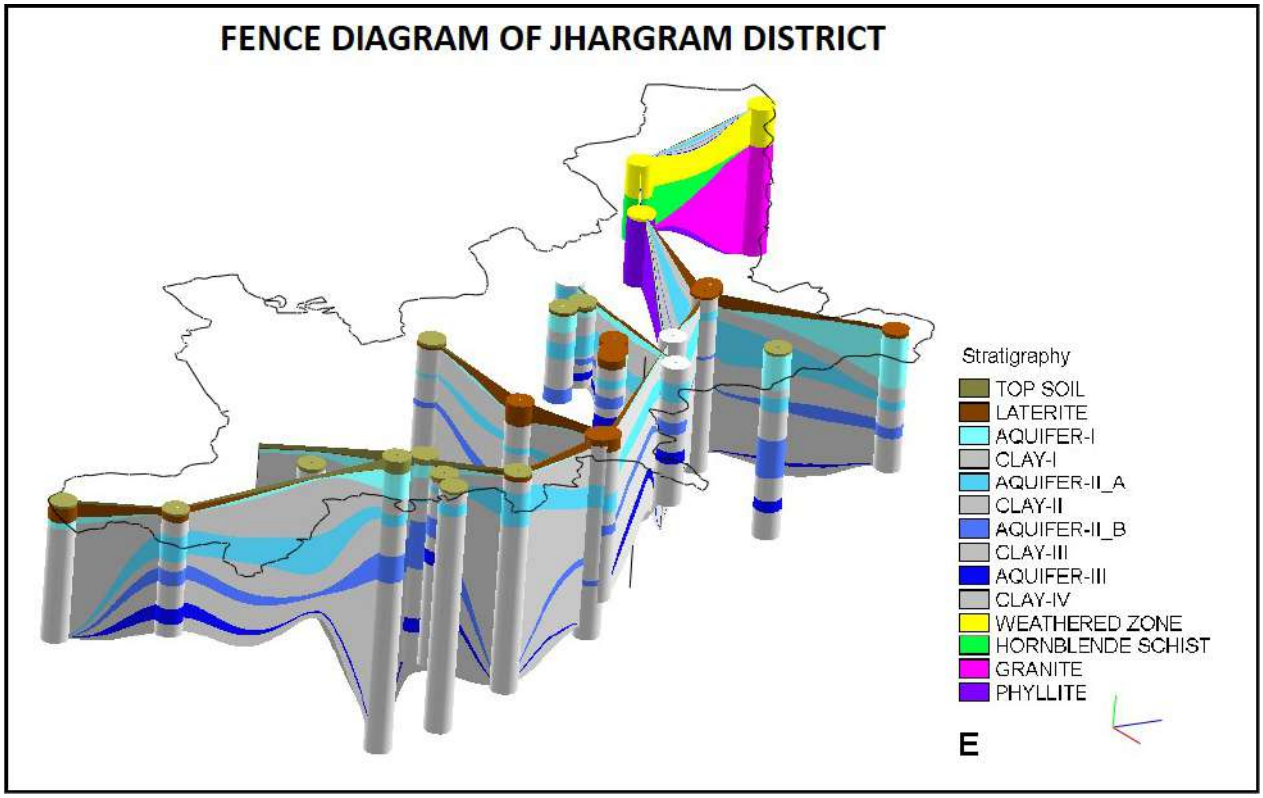


Figure 5.10: Fence diagram of Jhargram District

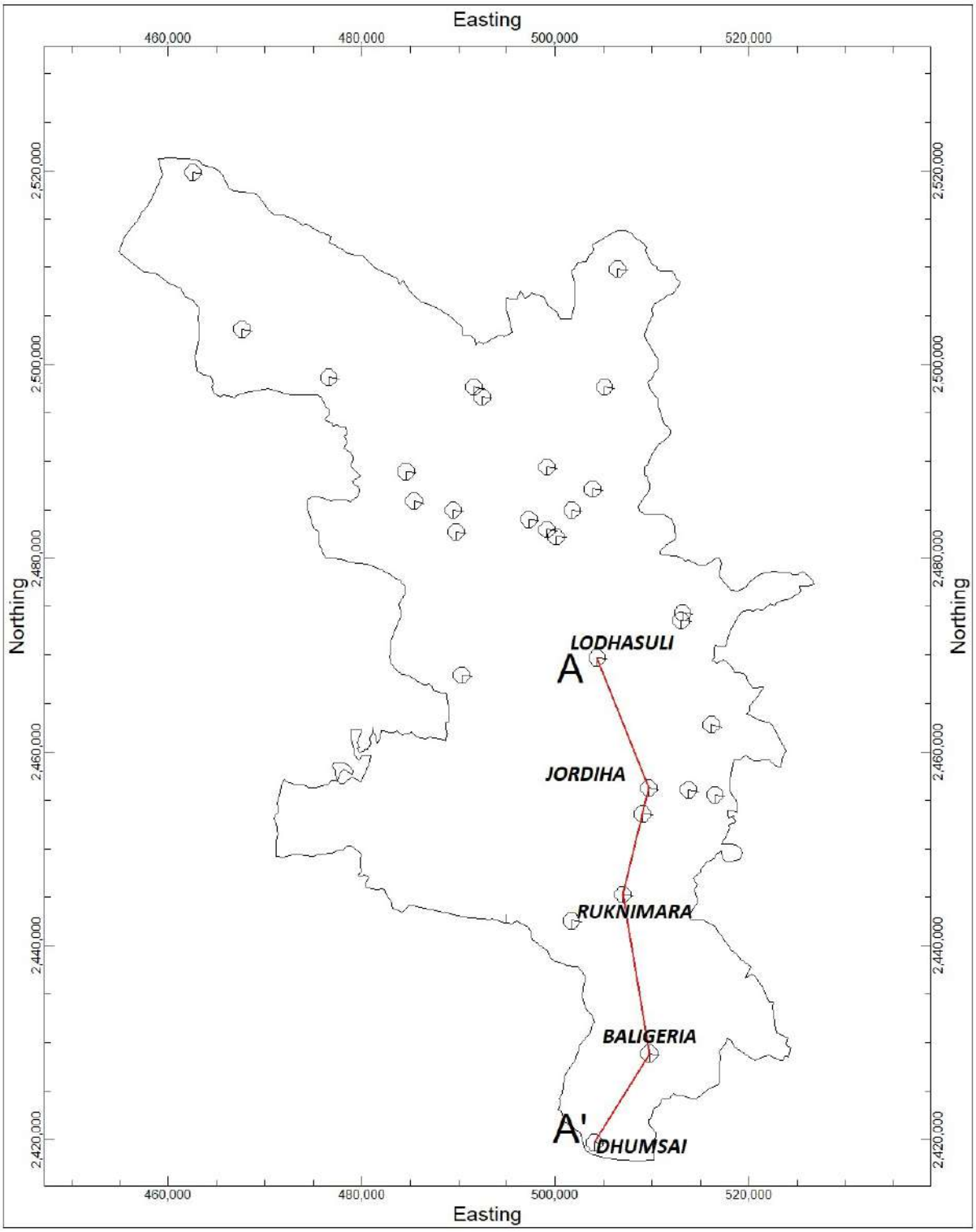


Figure 5.11: 2-D section lines along the study area

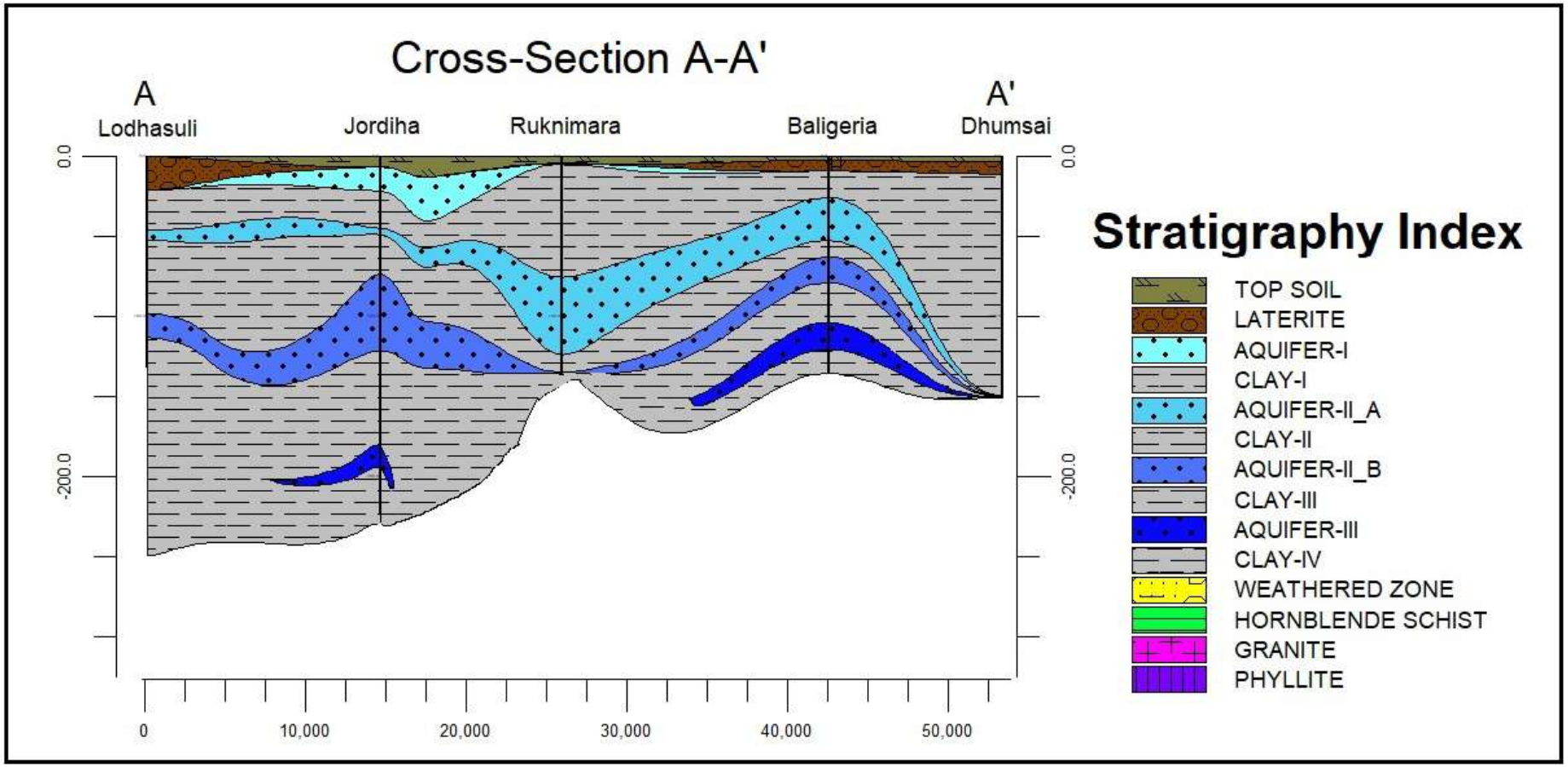


Figure.5.12 2-D Aquifer Disposition along S centre section of Jhargram District

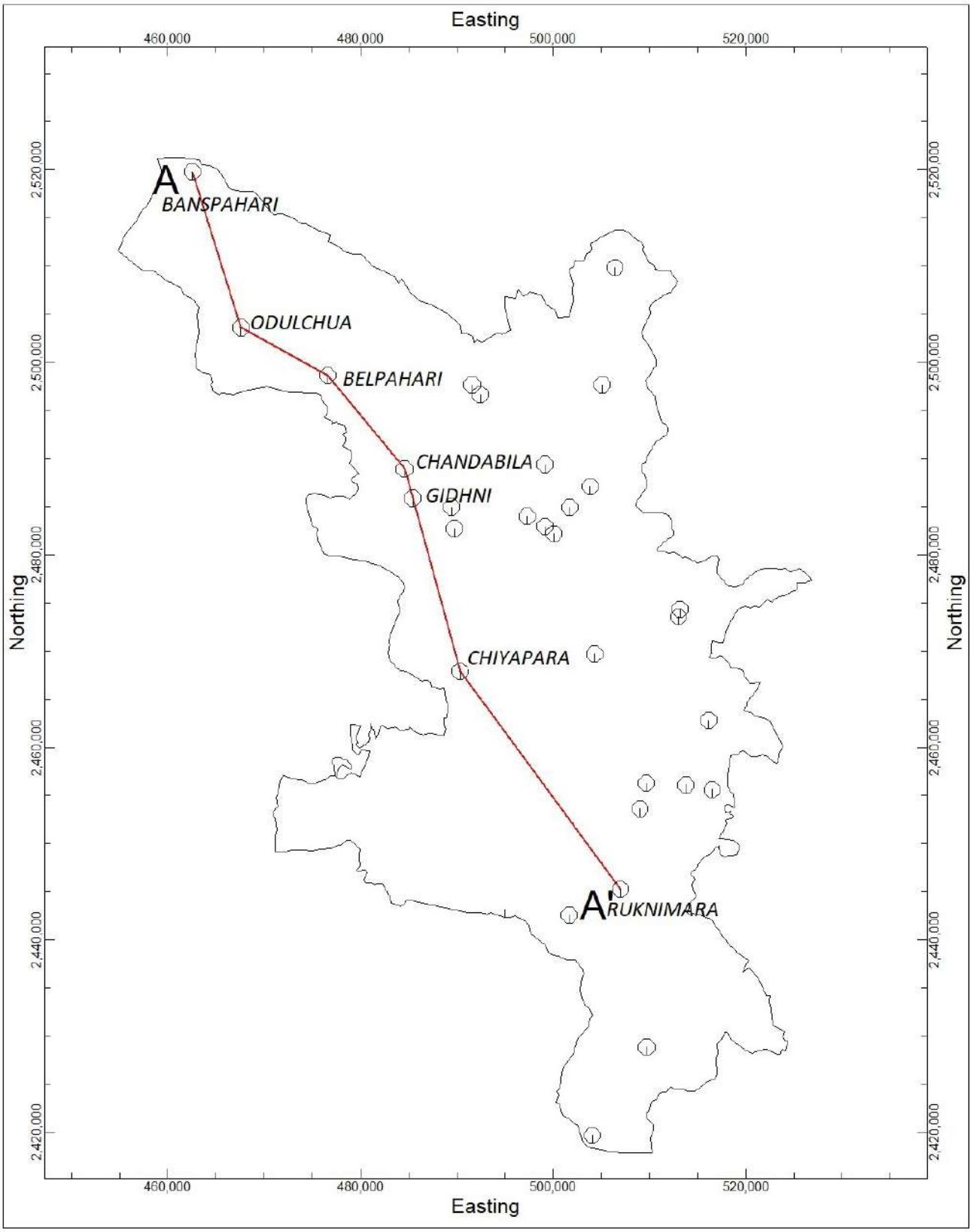


Figure 5.13: 2-D section lines along the study area

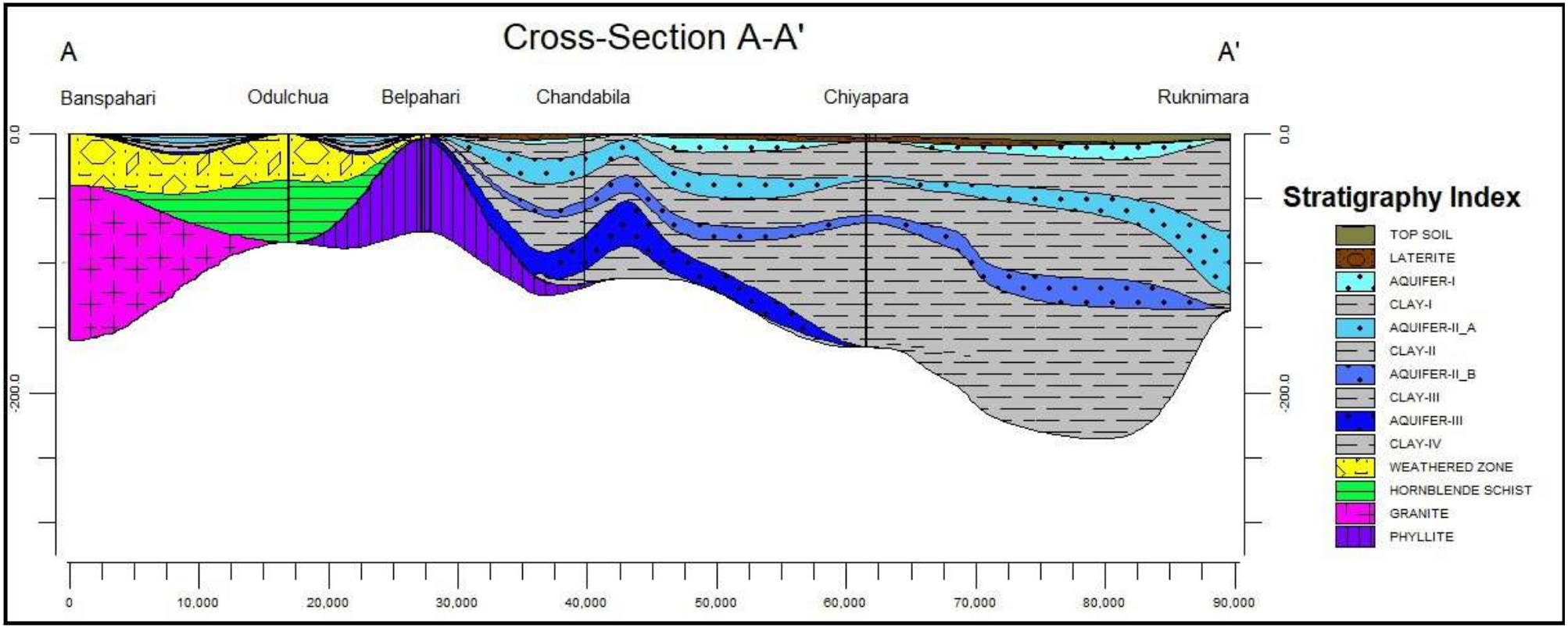


Figure 5.14. 2-D Aquifer Disposition along N-S section of Jhargram District

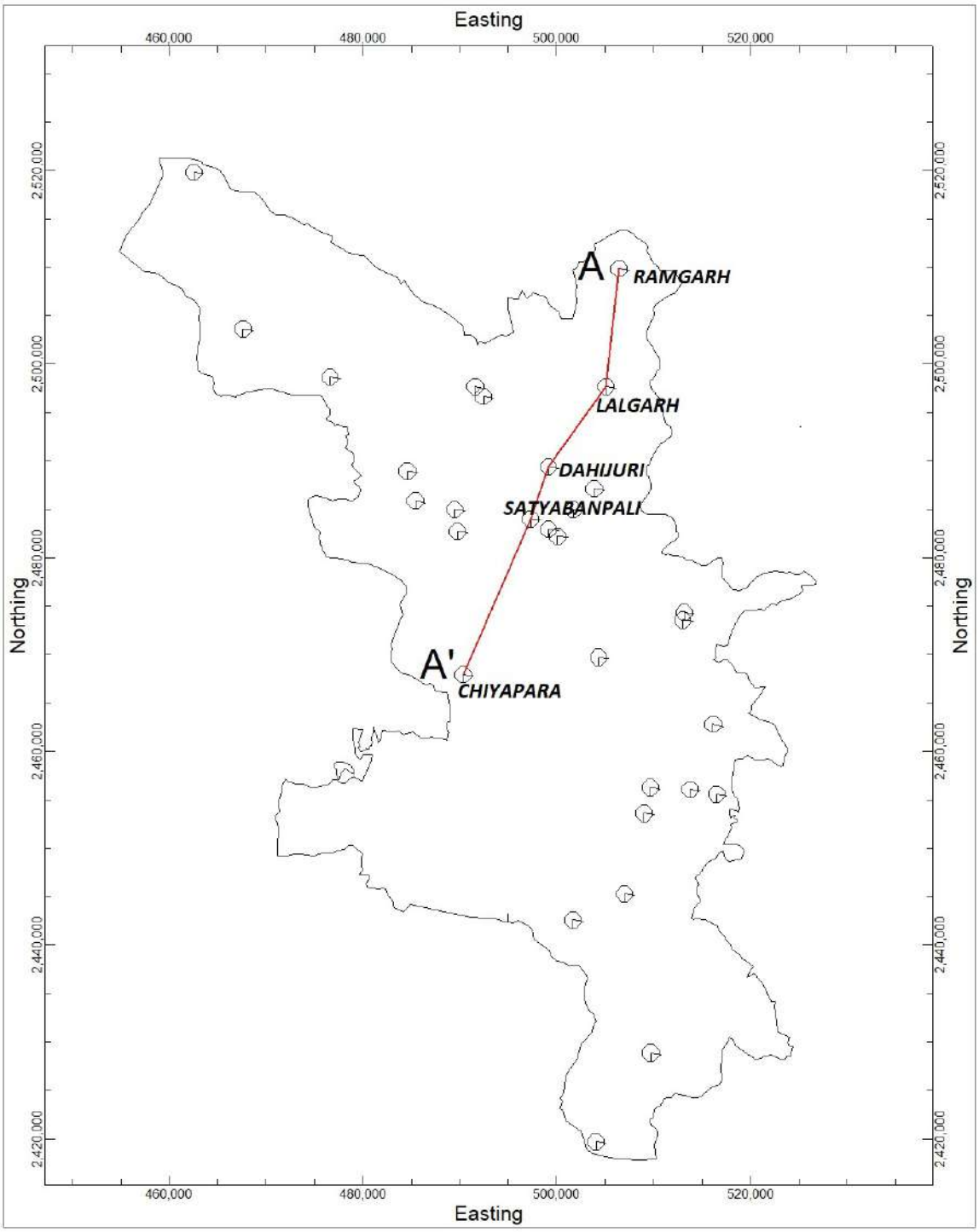


Figure 5.15: 2-D section lines along the study area

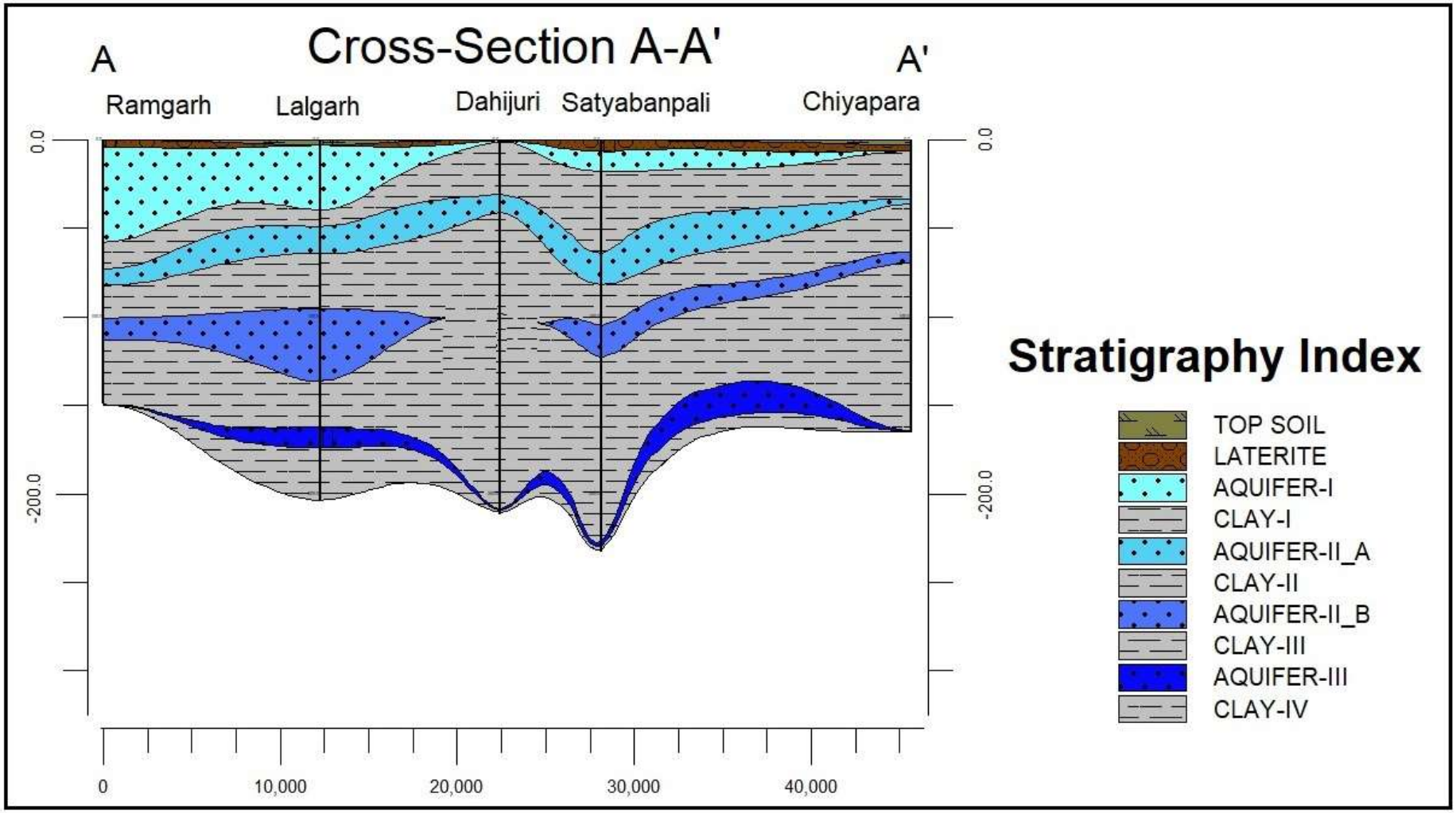


Figure 5.16: 2-D Aquifer Disposition along NE-SW section of Jhargram District

Table 5.5: Exploratory data for Jhargram district

SL No	State	District	Block_Taluka Mandal_Firka	Village	Type of Well	Latitude	Longitude	Elevations	Depth drilled (m bgl)	Depth of Well-Constructed (m bgl)	Major Lithology Encountered	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lpm)	Drawdown (m)	T (m2/day)	S
1	West Bengal	Jhargram	Binpur-I	Binpur	SEW-I	22.5931	86.9247	157.5	157.5	114	Quaternary / Tertiary Sediments	48.00-63.00, 81.00-87.00, 105.00-111.00		46.2			
2	West Bengal	Jhargram	Binpur-I	Binpur	SEW-II	22.5931	86.9247	145.5	145.5	121.5	Quaternary / Tertiary Sediments	33.00-45.00, 100.50-103.50, 109.50-118.50		566.4	3.59		
3	West Bengal	Jhargram	Binpur-II	Chakdoba	EW-I	22.6439	86.8786	122.25	122.25		Quaternary / Tertiary Sediments	Fracture zone: 70.57-72.09	5.63	37.8			
4	West Bengal	Jhargram	Binpur-II	Chakdoba	EW-II	22.6439	86.8786	122.45	122.45		Quaternary / Tertiary Sediments	Fracture zone: 13.81-14.33 mbgl.	Dry				
5	West Bengal	Jhargram	Binpur-II	Thakurpara	DEW	22.6439	86.895	205.29	205.29	200	Tertiary Sediments	90.00-96.00, 111.00-114.00, 180.00-183.00, 189.00-197.00		600	24.24	43	9.6 x 10-5
6	West Bengal	Jhargram	Binpur-II	Bhulaveda	EW-I	22.69722222	86.69722222	122.25	122.25		Quaternary / Tertiary Sediments	18.9-20.4, 33-34.5, 41.75-47.85,60-61.6, 64-66.15, 72.1-75.1, 76.6-81.2, 82.7-84.25, 85.75-87.15,105.5-107, 114.7-116.25	2.45	<60			

7	West Bengal	Jhargram	Binpur-II	Bhulaveda	EW-II	22.69722222	86.69722222	122.25	122.25		Quaternary / Tertiary Sediments	34.25-38.7, 53.95-58.45, 64-66,72-73.5, 75.1-76.65, 79.75-82.80, 93.40-95.95, 108-109, 114.7-116.2		162.6	0.33		
8	West Bengal	Jhargram	Binpur-II	Oroli	EW	22.74444444	86.625	122.25	122.25		Quaternary / Tertiary Sediments	28.35-38.85 (highly fractured), 40.35-52.4 (moderately fractured), 75.1-78.1 (moderately fractured), 82.7-88.7 (slightly fractured), 88.7-90.25(moderately fractured), 91.75-94.85 (moderately fractured), 99.35-103.8 (slightly fractured), 108.35-109.85 (moderately fractured), 112.9-117.5 (moderately fractured)	2.49	360	18.96 (after 420 min of pumping)	43.32	
9	West Bengal	Jhargram	Binpur-II	Pachapani	EW-I	22.77722222	86.65777778	100	100		Quaternary / Tertiary Sediments	23.40-29.55 (moderately fractured),31.05-39.70(slightly fractured), 39.7-53.35(slightly fractured), 55.20-66.05 (slightly fractured)		19.8			

10	West Bengal	Jhargram	Binpur-II	Pachapani	EW-I	22.77722222	86.65777778	58.85	58.85		Quaternary / Tertiary Sediments	5.2-6.7 (moderately fractured), 8.25-10.90(highly fractured), 14.4-31(moderately fractured), 34.6-37.15(moderately fractured), 40.15-43.15 (moderately fractured)		15			
11	West Bengal	Jhargram	Binpur-II	Odalchua	EW-I	22.6375	86.68666667	84.25	84.25		Quaternary / Tertiary Sediments	Highly fractured zones in the depth span of 3.7-5.2, 9.8-14.3, 24.9-26.45, 40.2-41.7, 49.3-50.8, 55.9-59.95, 66-75.1, 78.1-81.2, 82.7-84.25	5.83	347.34	15.41	22.6	5.86 x10-4
12	West Bengal	Jhargram	Binpur-II	Odalchua	OW	22.6375	86.68666667	84.25	84.25		Quaternary / Tertiary Sediments	Highly fractured zones in the depth span of 5.2-8.2, 17.45-23.45, 24.95-26.55, 41.8-44.8, 46.3-66.05, 67.6-69.1, 70.6-72.2, 73.75-75.25, 79.8-81.3	4.94		6.98	18.46	
13	West Bengal	Jhargram	Binpur-II	Odalchua	EW-II	22.6375	86.68666667	84.25	84.25		Quaternary / Tertiary Sediments	Highly fractured zones in the depth span of 5.3-21.9, 37.5-41.7, 44.7-49.3, 56.9-61.45, 62.95-64.5, 72.1-84.25	2.47	388.2	12.91	20.26	
14	West Bengal	Jhargram	Jhargram	Asimulsuli	SPz	22.305	87.0617	250.54	250.54		Quaternary Sediments	44.0-50.0, 98.0-104.0					
15	West Bengal	Jhargram	Jhargram	Asimulsuli	DPz	22.305	87.0617	200	200	144	Tertiary Sediments	137.0-143.0					

16	West Bengal	Jhargram	Jhargram	Shaktinagar	EW	22.3219	87.0839	252.22	252.22	252	Quaternary / Tertiary Sediments	41.0-46.0, 66.0-74.0, 80.0-88.0, 210.0-218.0, 245.0-250.0	11.07	349.8	4.62	225.1	4.0x10-2
17	West Bengal	Jhargram	Jhargram	Shaktinagar	OW	22.3219	87.0839	223.8	223.8	219	Quaternary / Tertiary Sediments	41.0-46.00, 66.0-74.0, 81.0-89.0, 209.0-217.0					
18	West Bengal	Jhargram	Jhargram	Manikpara	EW	22.3389	87.1136	178.8	178.8	142	Quaternary / Tertiary Sediments	69.0 - 81.0, 113.0 - 139.0	18.39	437.4	3.54	275.75	2.68 x 10 -4
19	West Bengal	Jhargram	Jhargram	Manikpara	OW	22.3389	87.1136	145.82	145.82	141	Quaternary / Tertiary Sediments	65-77, 114-138	16.13		1.67		
20	West Bengal	Jhargram	Jhargram	Dholkat Pukuria	EW	22.305	87.0925	169.05	169.05	160	Quaternary / Tertiary Sediments	47.0 – 59.0,81.0 – 84.0, 89.0- 95.0, 146.0-158.0	10.59	124.8	7.97	37.7	29.5 x 10 -5
21	West Bengal	Jhargram	Jhargram	Dholkat Pukuria	OW	22.305	87.0925	141.5	141.5	96	Quaternary / Tertiary Sediments	47-59, 82-85, 88-94	10.53		0.51		
22	West Bengal	Jhargram	Jhargram	Saptabanpalli	EW	22.305	87.1125	241.94	241.94	118	Quaternary / Tertiary Sediments	71.0 - 81.0, 103.0 - 115.0	16.33	283.2	3.02	139.93	
23	West Bengal	Jhargram	Jhargram	Saptabanpalli	OW	22.305	87.1125	125	125	120	Quaternary / Tertiary Sediments	74-80, 108-117	16.13		1.84	135.08	2.947x10 -4

CHAPTER 6

GEOPHYSICS

6.1 Geophysical Studies:

A total eighteen (18) numbers of TEM surveys have been carried out in Jhargram district of West Bengal at eight locations namely Dhansol, Dhankamra, Kanargaon, Hathibari and Sasra in block Gopiballavpur-I and Rantua, Sardiha and Ashui in block Gopiballavpur-II. The location map is shown in **Figure-6.1**. The interpreted layer parameter is given in **Table-6.1** and inferred geology is given in **Table-6.2**

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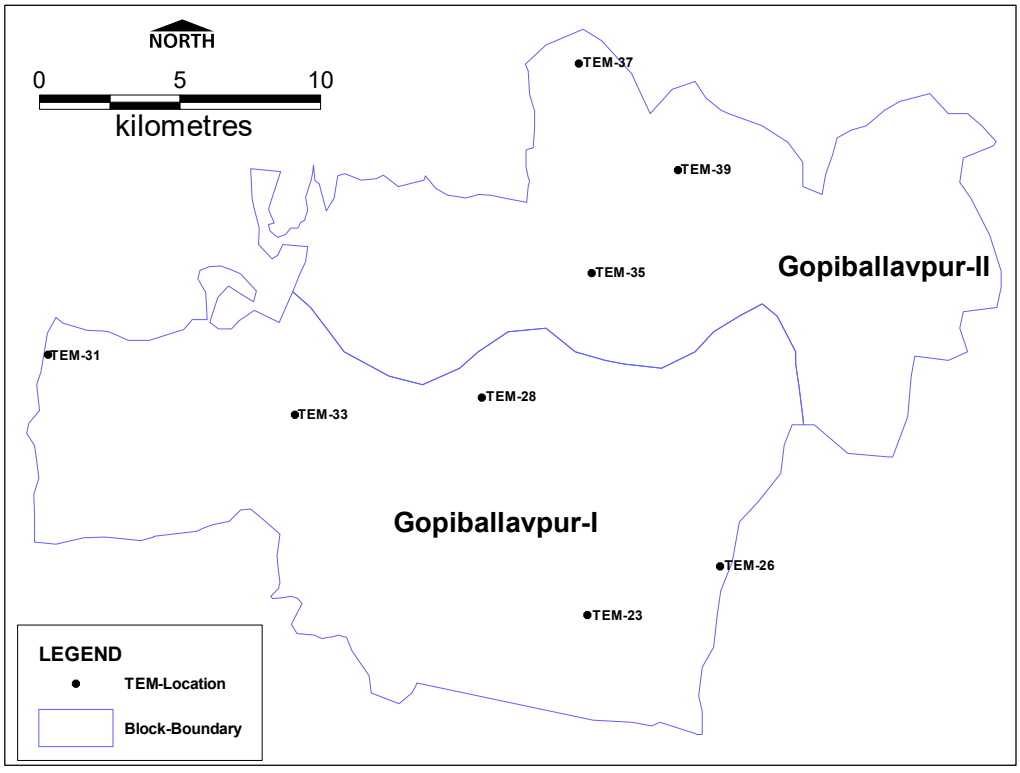


Figure-6.1: TEM location in Jhargram district

Table-6.1 Interpreted layer parameters of TEM curves carried out in Jhargram district.

S.No.	TEM No.	District	Location	Respective layer Resistivity in (Ohm-m)				Respective layer Depth in (m)		
				ρ_1	ρ_2	ρ_3	ρ_4	D_1	D_2	D_3
1	TEM-23	Jhargram	Dhansol-1	12	48	17	8	1	6.7	45
2	TEM-24	Jhargram	Dhansol-2	8.5	75	15	9	1	6.7	45
3	TEM-25	Jhargram	Dhansol-3	12	33	15	9	1	6.7	45
4	TEM-26	Jhargram	Dhankamra-1	10	110	21	6.5	1	6.7	45
5	TEM-27	Jhargram	Dhankamra-2	321	1150	19	6.8	1	6.7	43
6	TEM-28	Jhargram	Kamargaon-1	28	162	11	15	1	6.8	45
7	TEM-29	Jhargram	Kamargaon-2	36	462	12	16	1	6.7	45
8	TEM-30	Jhargram	Kamargaon-3	12	48	12	15	1	6.7	44
9	TEM-31	Jhargram	Hathibari-1	200	3000	40	22	1	6.7	45
10	TEM-32	Jhargram	Hathibari-2	120	3500	16	25	1	6.8	44
11	TEM-33	Jhargram	Sasra-1	15	570	14	18	1	6.8	46
12	TEM-34	Jhargram	Sasra-1	280	1600	16	21	1	6.6	44
13	TEM-35	Jhargram	Rantua-1	23	600	41	13	1	6.8	45
14	TEM-36	Jhargram	Rantua-2	17	1800	59	14	1	6.7	44
15	TEM-37	Jhargram	Sardiha-1	320	2400	12	17	1	6.7	45
16	TEM-38	Jhargram	Sardiha-2	195	2700	13	21	1	6.9	44
17	TEM-39	Jhargram	Ashui-1	6.5	82	10	13	1	6.7	45
18	TEM-40	Jhargram	Ashui-2	160	200	8.5	12	1	6.6	44

Table-6.2 Stratigraphy of TEM curves carried out in Jhargram district.

Location	Depth1	Depth2	Stratigraphy
Dhansol-1	0	1	Top Soil
	1	6.7	Medium Sand
	6.7	45	Fine Sand
	45	100	Clay
Dhansol-2	0	1	Top Soil
	1	6.7	Medium Sand
	6.7	45	Fine Sand
	45	100	Clay
Dhansol-3	0	1	Top Soil
	1	6.7	Fine to Medium Sand
	6.7	45	Fine Sand
	45	100	Clay
Dhankamra-1	0	1	Top Soil
	1	6.7	Medium to Coarse Sand
	6.7	45	Fine Sand
	45	100	Clay
Dhankamra-2	0	1	Top Soil
	1	6.7	Coarse Sand
	6.7	43	Fine Sand
	43	100	Clay
Kanargaon-1	0	1	Top Soil
	1	6.8	Medium to Coarse Sand
	6.8	45	Very Fine Sandy Clay
	45	100	Fine Sand
Kanargaon-2	0	1	Top Soil
	1	6.7	Coarse Sand
	6.7	45	Very Fine Sandy Clay
	45	100	Fine Sand
Kanargaon-3	0	1	Top Soil
	1	6.7	Medium Sand
	6.7	44	Very Fine Sandy Clay
	44	100	Fine Sand
Hathibari-1	0	1	Top Soil
	1	6.7	Coarse Sand (Unsaturated)
	6.7	45	Fine to Medium Sand
	45	100	Fine Sand
Hathibari-1	0	1	Top Soil
	1	6.8	Coarse Sand (Unsaturated)
	6.8	44	Fine Sand
	44	100	Fine to Medium Sand
Sasra-1	0	1	Top Soil
	1	6.8	Coarse Sand (Unsaturated)
	6.8	46	Sandy Clay
	46	100	Fine Sand

Sasra-2	0	1	Top Soil
	1	6.6	Coarse Sand (Unsaturated)
	6.6	44	Sandy Clay
	44	100	Fine Sand
Rantua-1	0	1	Top Soil
	1	6.8	Coarse Sand (Unsaturated)
	6.8	45	Fine to Medium Sand
	45	100	Fine Sand
Rantua-2	0	1	Top Soil
	1	6.7	Coarse Sand (Unsaturated)
	6.7	44	Fine to Medium Sand
	44	100	Fine Sand
Sardiha-1	0	1	Top Soil
	1	6.7	Coarse Sand (Unsaturated)
	6.7	45	Sandy Clay
	45	100	Fine Sand
Sardiha-2	0	1	Top Soil
	1	6.9	Coarse Sand (Unsaturated)
	6.9	44	Sandy Clay
	44	100	Fine Sand
Ashui-1	0	1	Top Soil
	1	6.6	Coarse Sand (Unsaturated)
	6.6	45	Fine to Medium Sand
	45	100	Sandy Clay
Ashui-2	0	1	Top Soil
	1	6.6	Coarse Sand (Unsaturated)
	6.6	44	Fine to Medium Sand
	44	100	Sandy Clay

1. Dhansol, Gopiballavpur-I, Jhargram (TEM-23)

A total three (3) numbers of TEM (TEM-23 to TEM-25) has been carried out in Dhansol village area of Gopiballavpur-I block in Jhargram district, West Bengal at interval of 40 m. The interpretation of all the three TEM's are showing four layers earth model in the alluvium terrain. The interpretation of TEM-23 curve is shown in **Figure-6.2**. The first layer is having resistivity value 12 Ohm-m and thickness of 1 m is sandy clay formation as top soil. The second layer with resistivity value 48 Ohm-m and depth up to 6.7 m is indicative of fine to medium grained sand formation. The third layer is having resistivity value 17 Ohm-m and depth up to 45m shows the formation as fine-grained sand. The fourth and last layer with resistivity value 8 Ohm-m is indicative of clay formation extended up to depth of investigation as 100 m. This location is suitable for tapping fresh ground water up to depth of 45 m.

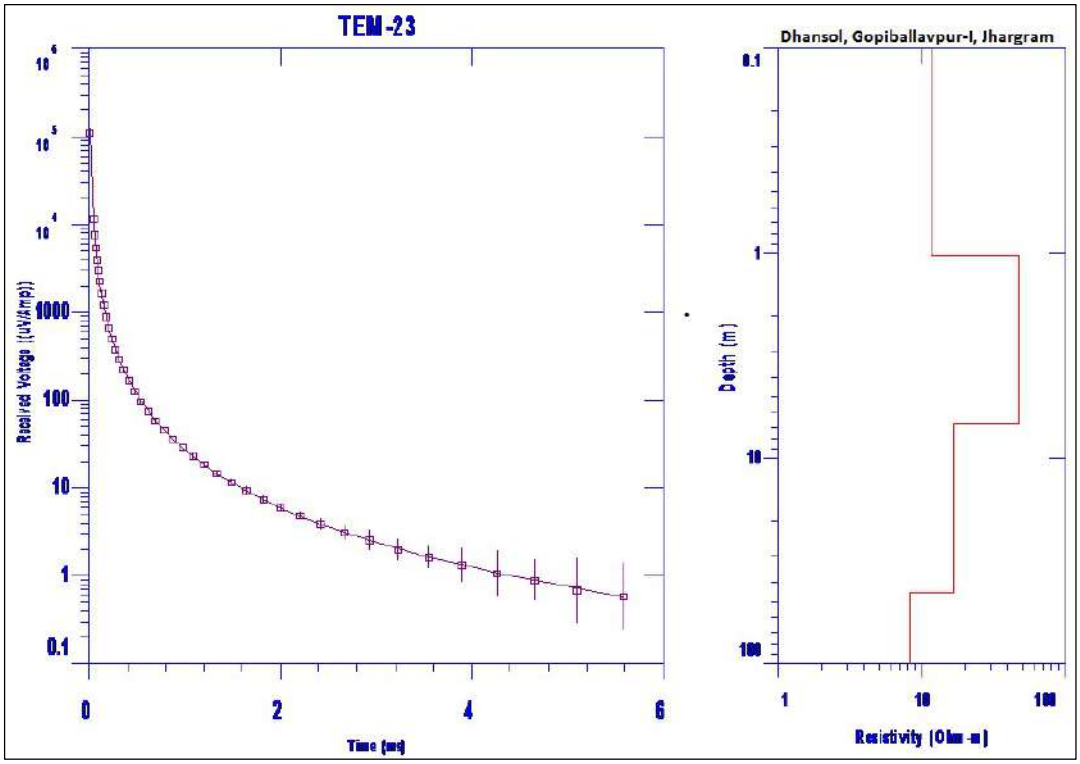


Figure-6.2: Interpretation of TEM-23 curve at Dhansol, Gopiballavpur-I, Jhargram.

2. Sasra, Gopiballavpur-I, Jhargram (TEM-33)

A total two (2) numbers of TEM (TEM-33 to TEM-34) has been carried out in Sasra village area of Gopiballavpur-I block in Jhargram district, West Bengal at interval of 40 m. The interpretation of all the two TEM's are showing four layers earth model in the alluvium terrain. The interpretation of TEM-33 curve is shown in **Figure-6.3**. The first layer is having resistivity value 15 Ohm-m and thickness of 1 m is sandy clay formation as top soil. The second layer with resistivity value 570 Ohm-m and depth up to 6.8 m is indicative of unsaturated coarse grained sand formation. The third layer is having resistivity value 14 Ohm-m and depth up to 46 m shows the formation as sandy clay. The fourth and last layer with resistivity value 18 Ohm-m is indicative of fine-grained sand formation extended up to depth of investigation as 100 m. This location is suitable for tapping fresh ground water up to depth of 100 m.

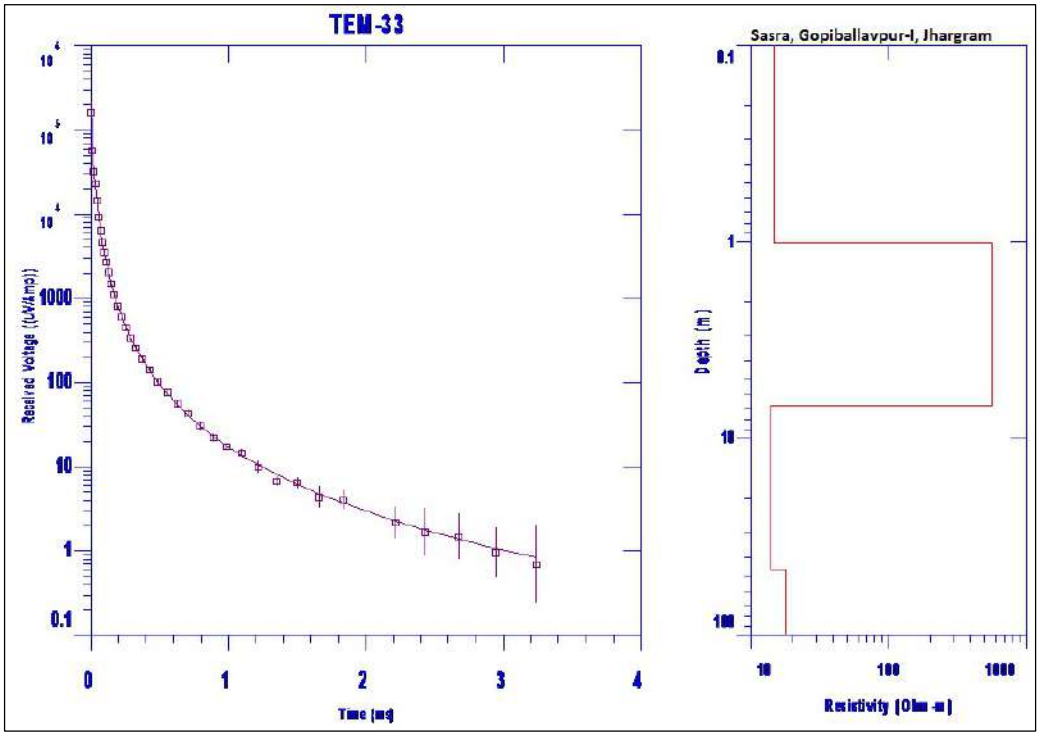


Figure-6.3: Interpretation of TEM-33 curve at Sasra, Gopiballavpur-I, Jhargram.

3. Rantua, Gopiballavpur-II, Jhargram (TEM-35)

A total two (2) numbers of TEM (TEM-35 to TEM-36) has been carried out in Rantua village area of Gopiballavpur-II block in Jhargram district, West Bengal at interval of 40 m. The interpretation of all the two TEM's are showing four layers earth model in the alluvium terrain. The interpretation of TEM-35 curve is shown in **Figure-6.4**. The first layer is having resistivity value 23 Ohm-m and thickness of 1 m is sand formation as top soil. The second layer with resistivity value 600 Ohm-m and depth up to 6.8 m is indicative of unsaturated coarse grained sand formation. The third layer is having resistivity value 41 Ohm-m and depth up to 45m shows the formation as fine to medium grained sand. The fourth and last layer with resistivity value 13 Ohm-m is indicative of sandy clay formation extended up to depth of investigation as 100 m. This location is suitable for tapping fresh ground water up to depth of 45 m.

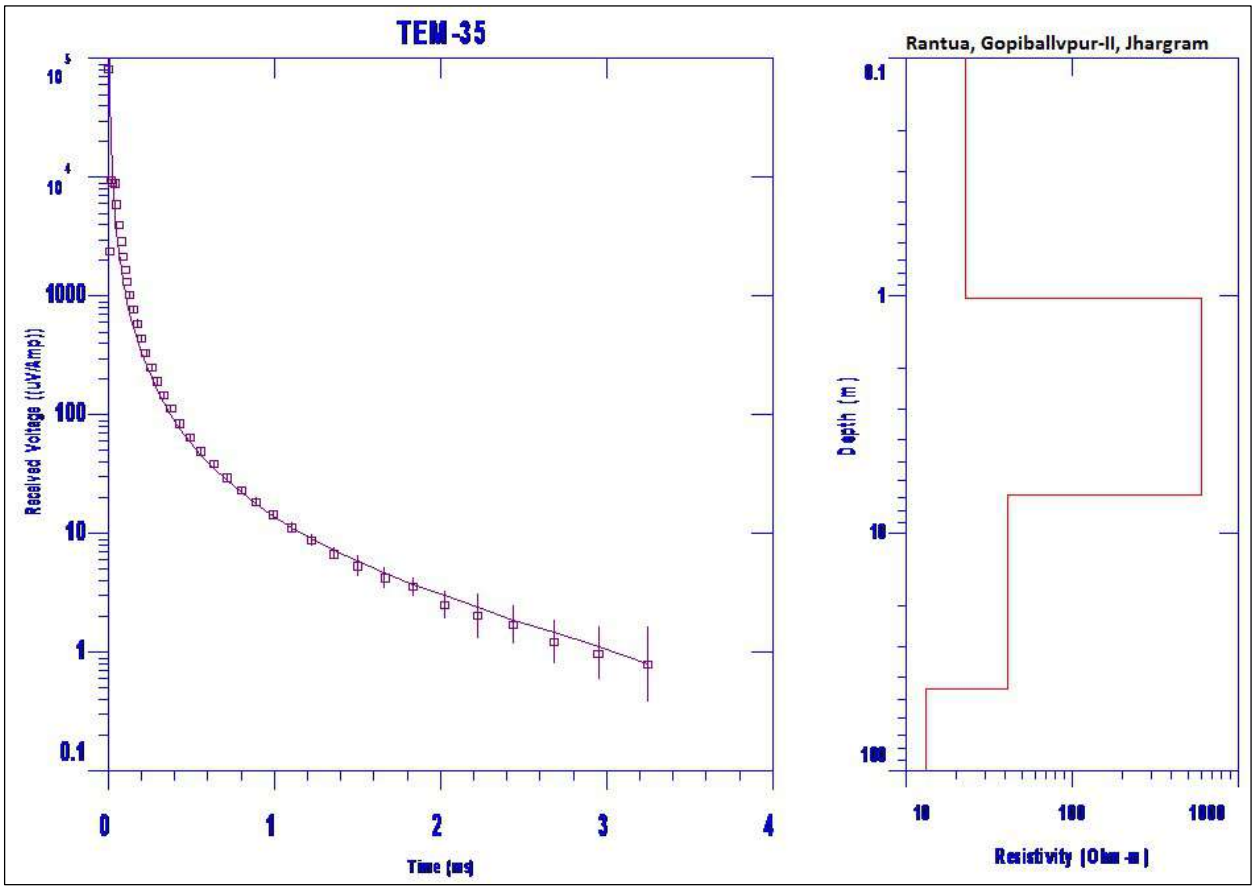


Figure-6.4: Interpretation of TEM-35 curve at Rantua, Gopiballavpur-II, Jhargram

4. Sardiha, Gopiballavpur-II, Jhargram (TEM-37)

A total two (2) numbers of TEM (TEM-37 to TEM-38) has been carried out in Sardiha village area of Gopiballavpur-II block in Jhargram district, West Bengal at interval of 40 m. The interpretation of all the two TEM's are showing four layers earth model in the alluvium terrain. The interpretation of TEM-37 curve is shown in **Figure-6.5** the first layer is having resistivity value 320 Ohm-m and thickness of 1 m is sand formation as top soil. The second layer with resistivity value 2400 Ohm-m and depth up to 6.7 m is indicative of unsaturated coarse grained sand formation. The third layer is having resistivity value 12 Ohm-m and depth up to 45m shows the formation as sandy clay. The fourth and last layer with resistivity value 17 Ohm-m is indicative of fine sand formation extended up to depth of investigation as 100 m. This location is suitable for tapping fresh ground water up to depth of 100 m.

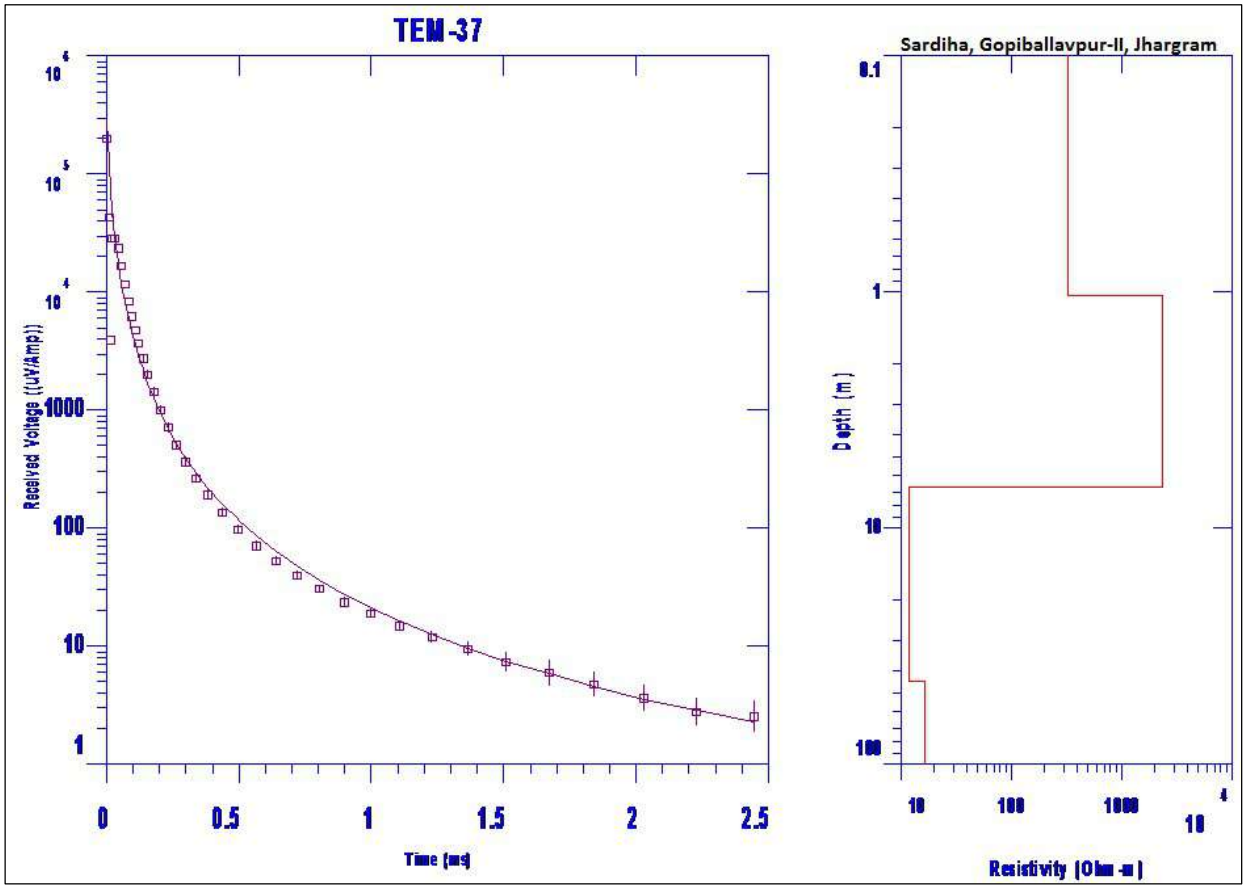


Figure-6.5: Interpretation of TEM-37 curve at Sardiha, Gopiballavpur-II, Jhargram.

A total **18** VES were conducted on Kasai basin, Medinipur district, West Bengal, covering an area of 10 Sq. Km. for tracing out the thickness of top unsaturated sand layer, saturated sand layer and depth to the clay horizon for sinking tube wells for drinking water supply purpose.

10 VES has been conducted in and around Binpur-ll block for selection of exploratory drilling sites at Odalchua for identify the potential granular zones in the Jhargram district.

CHAPTER- 7

GROUND WATER RESOURCE ESTIMATION

7.1 Dynamic water resource

The present chapter deals with the resources available in the study area. The Dynamic Resource of the area for 2022 has been calculated jointly by CGWB and SWID (State Water Investigation Directorate) using GEC-2015 methodology. The irrigation data available to the 5th Minor Irrigation Census (yet to be published), block wise demographic data of 2011 Census, CGWB water level data, cropping pattern, annual monsoon rainfall and normal rainfall provided the basic input for calculating the resources of the state. Block wise (Groundwater assessment unit) geographical area, area under different hydro-geological sub-provinces (sub-units), area under command and non-command, poor ground water quality area and ground worthy recharge area has also been considered. Gross current draft for all uses, recharge from rainfall, recharge from other sources like tanks, ponds, canal seepages, return flow from ground water and surface irrigation has all been considered. The number of abstraction structures and their unit draft has been taken into account for computation of irrigation draft. The projected population of 2025 (based on census 2011) and per capita consumption (60 lpcd) have been considered for computation and 70 % of the obtained figure is taken as the domestic and industrial draft.

As per the computation, the net ground water availability for recharge for Jhargram district is estimated at 64992 Ham, while the total extraction for all uses is estimated at 23432.1Ham. The categorization of the blocks has been done based on their Stage of Development and long-term water level trend.

7.1.1 Ground water recharge and resource

Recharge from ground water irrigation through a system of abstraction structures like deep tube wells, shallow tube wells and dug wells, surface water irrigation by surface lift and flow modes and rainfall has been separately calculated for both monsoon and non-monsoon periods. The annual recharge for this district is relatively high and the maximum recharge is from monsoon rainfall.

7.1.2 Ground water draft

Groundwater draft has been computed based on quantum of water likely to be used for domestic, irrigation and industrial purposes. The estimate is done by projecting the population and the number of ground water abstraction structures. The total extraction for the blocks is 23432.1Ham.

Table 7.1 Ground water Recharge, Resource and Stage of Development of Jhargram district

Name of the Block	Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)	Annual Extractable Ground Water Recharge (Ham)	Total Extraction	Annual GW Allocation for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%	Categorization (OE/ Critical/ Semi critical/Safe)
Binpur- I	12323.2	1232.33	11090.87	5787.3	407.1	6490.37	52.18076	Safe
Binpur- II	17066.6	1706.67	15359.96	818.03	423.64	14515.52	5.32573	Safe
Jamboni	10969.2	1096.92	9872.26	1452.75	291.06	8406.89	14.71548	Safe
Jhargram	16899.8	1689.98	15209.82	2404.51	537.42	12780.52	15.80893	Safe
Sankrail	9303.08	930.31	8372.77	5142.92	302.15	3215.22	61.42436	Safe
Nayagram	14813.2	1481.31	13331.87	567.27	383.75	12742.62	4.254992	Safe
Gopiballavpur-I	6484.23	921.51	8293.66	5105.56	281.4	3172.56	61.55979	Safe
Gopiballavpur-II	9215.17	648.43	5835.8	2153.77	283.4	3668.3	36.90617	Safe
Total	97074.5	9707.46	87367.01	23432.11	2909.92	64992	26.82	Safe

7.1.3 Stage of development and category

The unit of assessment is categorized for groundwater development based on two criteria; Stage of ground water development and long-term water level trends. The level of ground water development in Jhargram district is 26.82%. All the blocks in the district are under 'Safe' category as their stage of groundwater development is < 70% and there is steady water level over the years. The following table gives an account of the groundwater recharge, their draft, and allocation of resource for future use, stage of development and categorization of the blocks in Jhargram district.

7.1.4 Irrigation Potential created and utilized

The net ground water availability for future use in the district is estimated at **64992** Ham. This available balance resource could be utilized efficiently as per feasibility of the area. Presently, irrigation in the district is practiced maximum through shallow tube wells. Since these blocks falls under 'Safe' category, there is further scope for expansion of ground water irrigation through

additional irrigation potential with available resource. The irrigation potential created and the net irrigated area through means of various abstraction structures are given table 7.2 (2017-18)

Table 7.2 Irrigation potential created in Jhargram District

	Block	Irrigation potential Created (Ham)	Actual/ Net area irrigated (Ha)	Irrigation met through Ground Water (%)
1	Bnpur- I	13816.5	13100.03	95
2	Bnpur- II	1938.67	1276.02	66
3	Jamboni	2710.48	2235.65	82
4	Jhargram	4468.98	4087.40	91
5	Sankrail	10836.89	8731.99	81
6	Nayagram	2583.47	2368.25	92
7	Gopiballavpur-I	7439.25	5459.80	73
8	Gopiballavpur-II	5201.34	4571.22	88

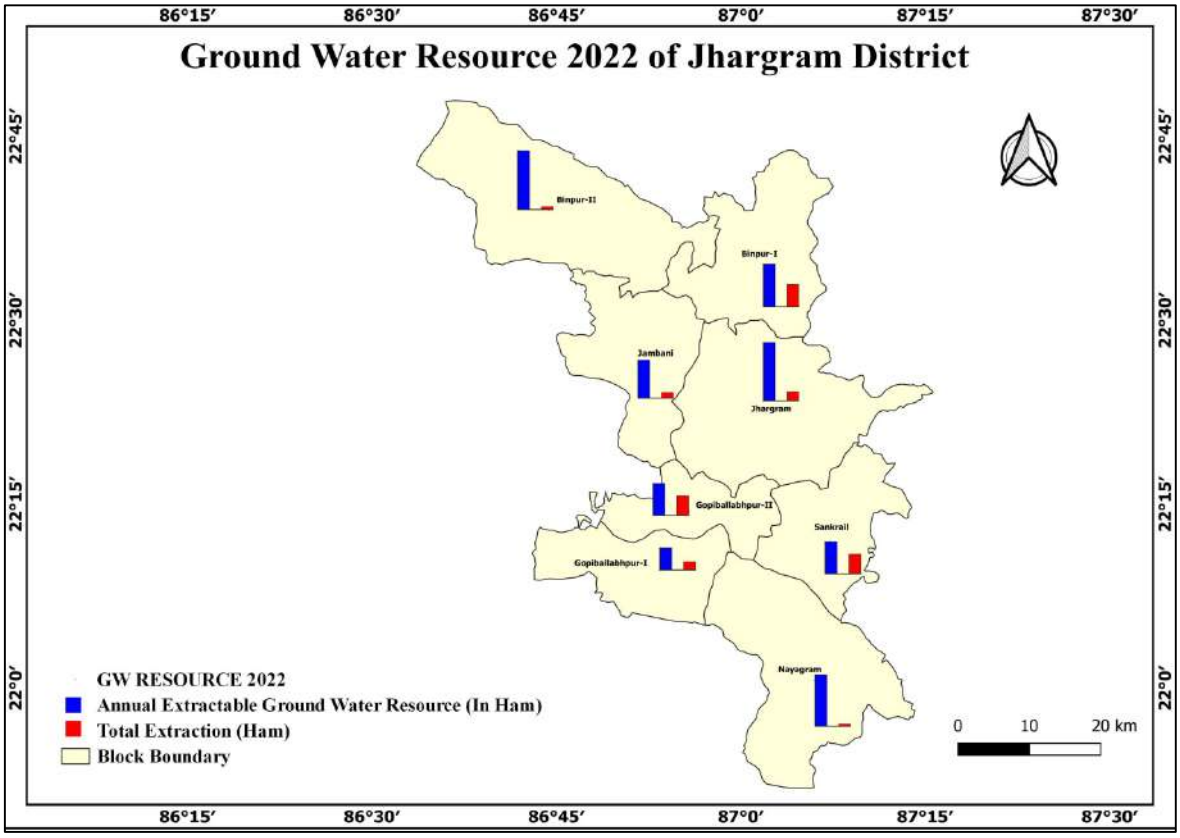


Figure: 7.1 Ground water resource 2022 of Jhargram district

Apart from common abstraction structures like dug wells, shallow tube wells and deep tube wells, there are number of surface water bodies in use for irrigation in this district.

CHAPTER - 8
HYDROCHEMISTRY

8.1 General range of Chemical parameter in the area

During the NAQUIM study of Jhargram district the water samples collected from the key wells (dug wells and tube wells) for analysis. The samples were analysed in the CGWB, Eastern Region, Kolkata, chemical laboratory, and the results are given in **Table: 8.1.** The chemical constituents present in ground water in the area is presented table below.

From the perusal of the range of chemical Parameters it is obvious that Fe content is beyond permissible limit of 1 mg/l in many places of the NAQUIM study areas in northern part of the Jhargram, Binpur-II block showing the maximum Iron (Fe) concentration at Jinaguri location 13.38 mg/l, Kodupura location 11.84 mg/l and at Rangiam in Nayagram block showing marginal high value 1.65 mg/l. show in **Figure 8.4**

n some parts of the area in Nayagram, Binpur-II fluoride (F) content is marginally higher than the permissible limit of 1.5 mg/l. Fe-content of ground water at some places are high like Rangiam in Nayagram Block is 2.14 mg/l, Kudupara, Binpur -II block is 3.04 mg/l, **Figure 8.2** showing the distribution of Fluoride.

Electrical Conductivity data showing the eastern marginal part of the all blocks except Binpur-II block showing the high concentration of EC, shows in **Figure 8.3.**

From the piper diagram it can be inferred that the groundwater is dominated by the HCO_3^- + CO_3^{2-} anion with no dominant cation. Overall, the groundwater is Magnesium bicarbonate type, which indicates the presence of calcite and dolomite mineral in the subsurface. During infiltration of rain water, the carbonate minerals might get dissolved, resulting in dissolution of calcium, magnesium, and bicarbonate to the groundwater, presented in **Figure 8.5.**

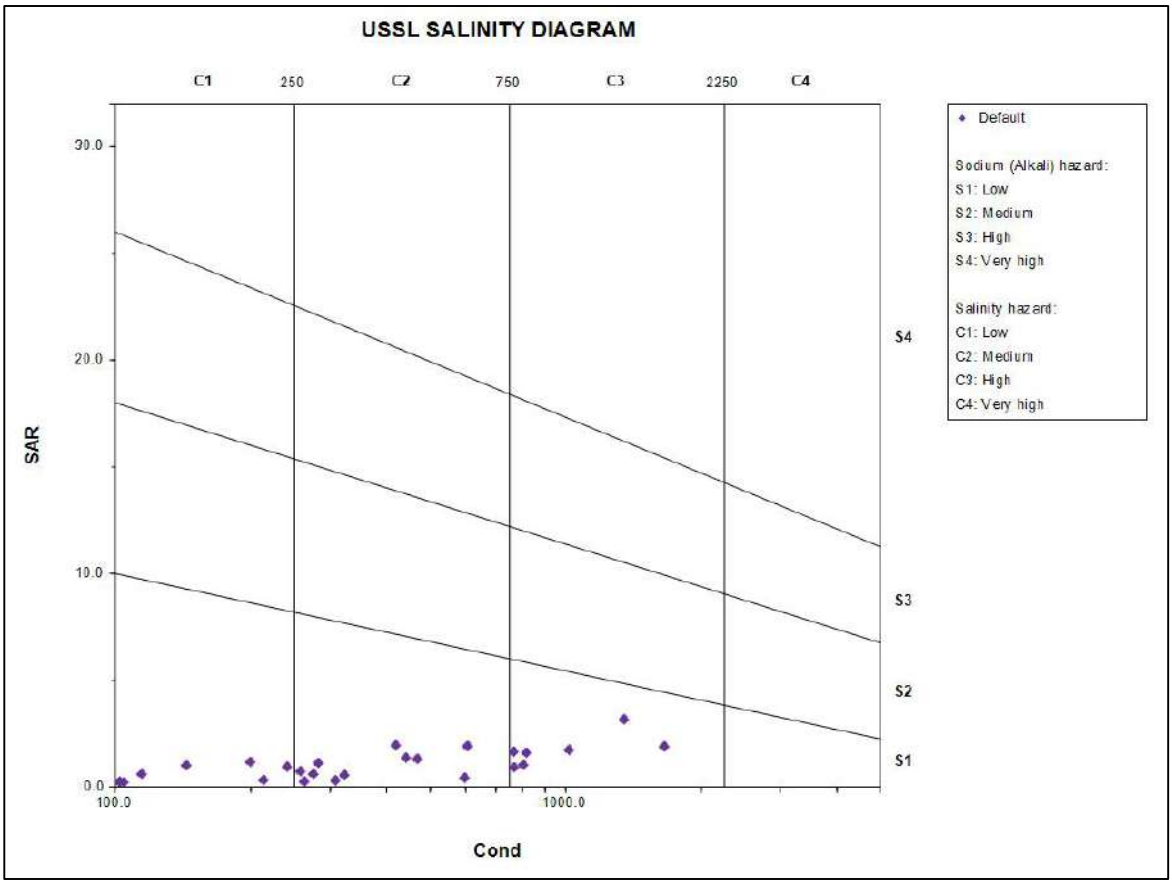


Figure: 8.1 USSL Salinity diagram of Jhargram District

A graphical classification of water which is given by the U.S. Salinity Laboratory is used for classification of irrigation water (Wilcox, 1958; Richards, 1954). It is based on SAR and electrical conductivity

The USSL diagram reveals that all the samples fall in the low sodium hazard zone whereas most of the sample falls in the medium hazard zone in terms of the salinity hazard. The diagram also shows that 7 numbers of the sample falls in the high salinity hazard zone.

Overall, the quality of the groundwater in the district is found to be suitable for drinking except for few locations where Fe and F content is higher than the permissible limit. In terms of the irrigation the quality of the water is found to be suitable, however the water could be utilised for irrigation after treatment of the water for salinity for better production of crops represented in **Figure 8.1.**

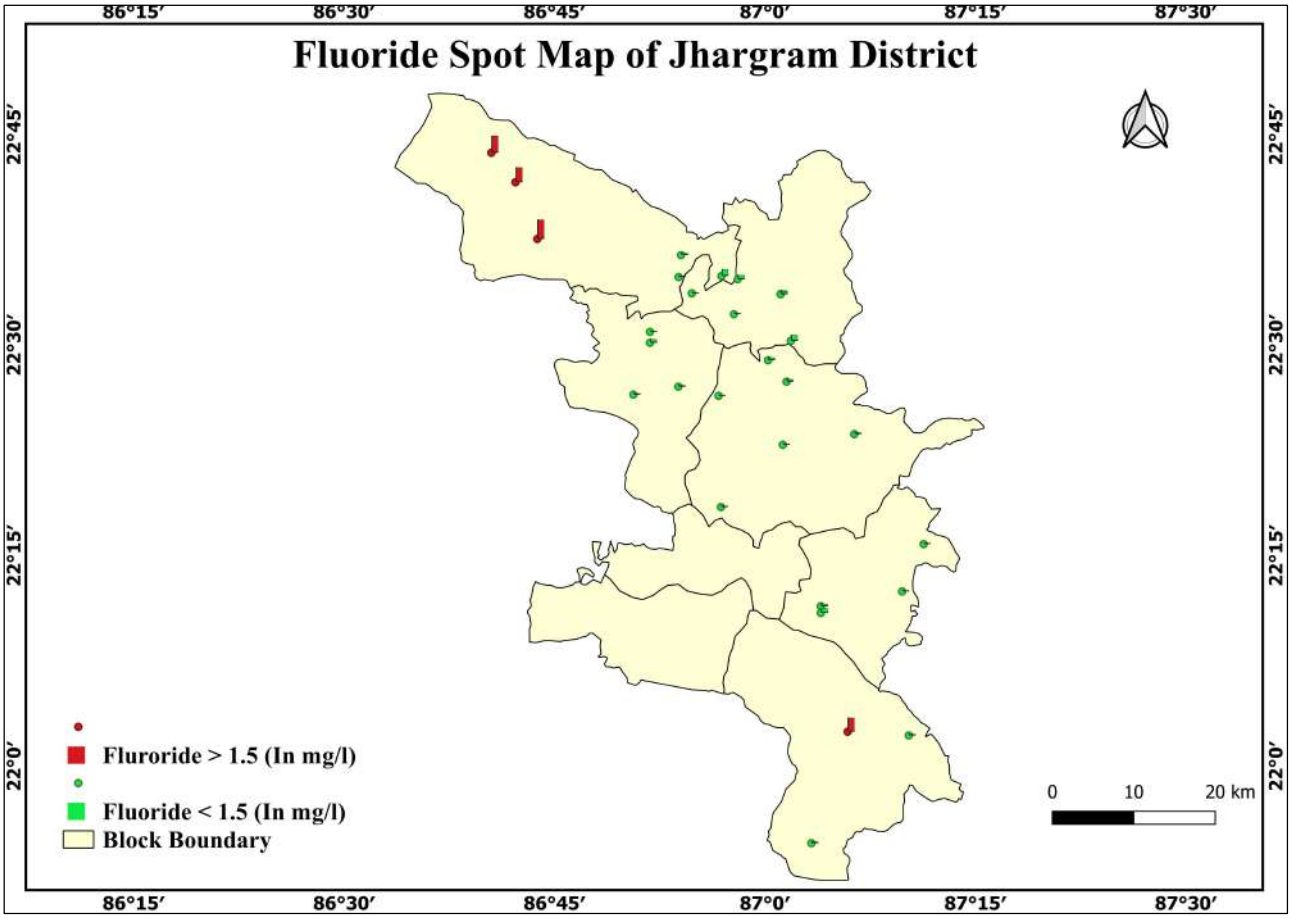


Figure: 8.2 Fluoride Spot Map of Jhargram District

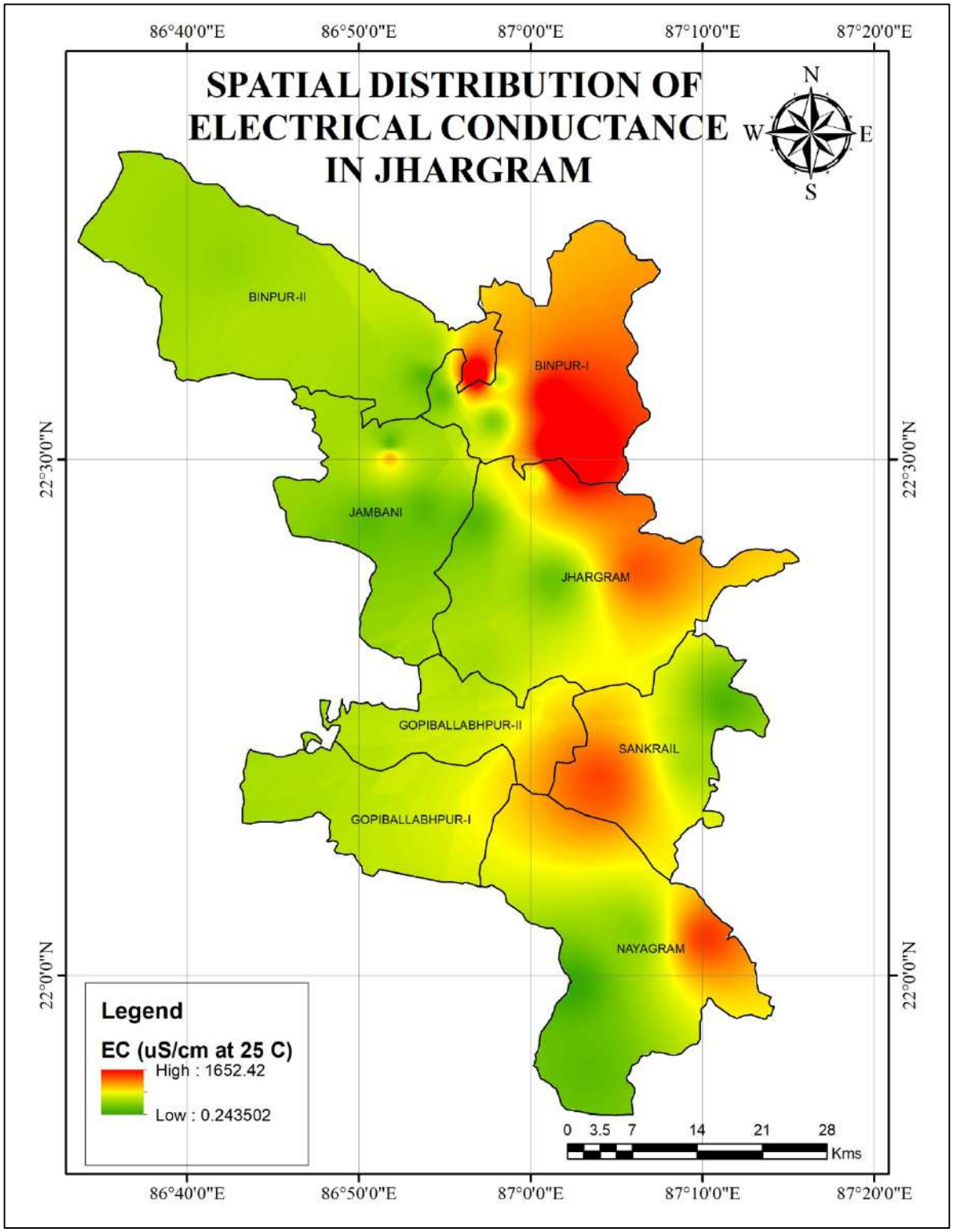


Figure: 8.3: Spatial distribution map of Electrical Conductivity, Jhargram District

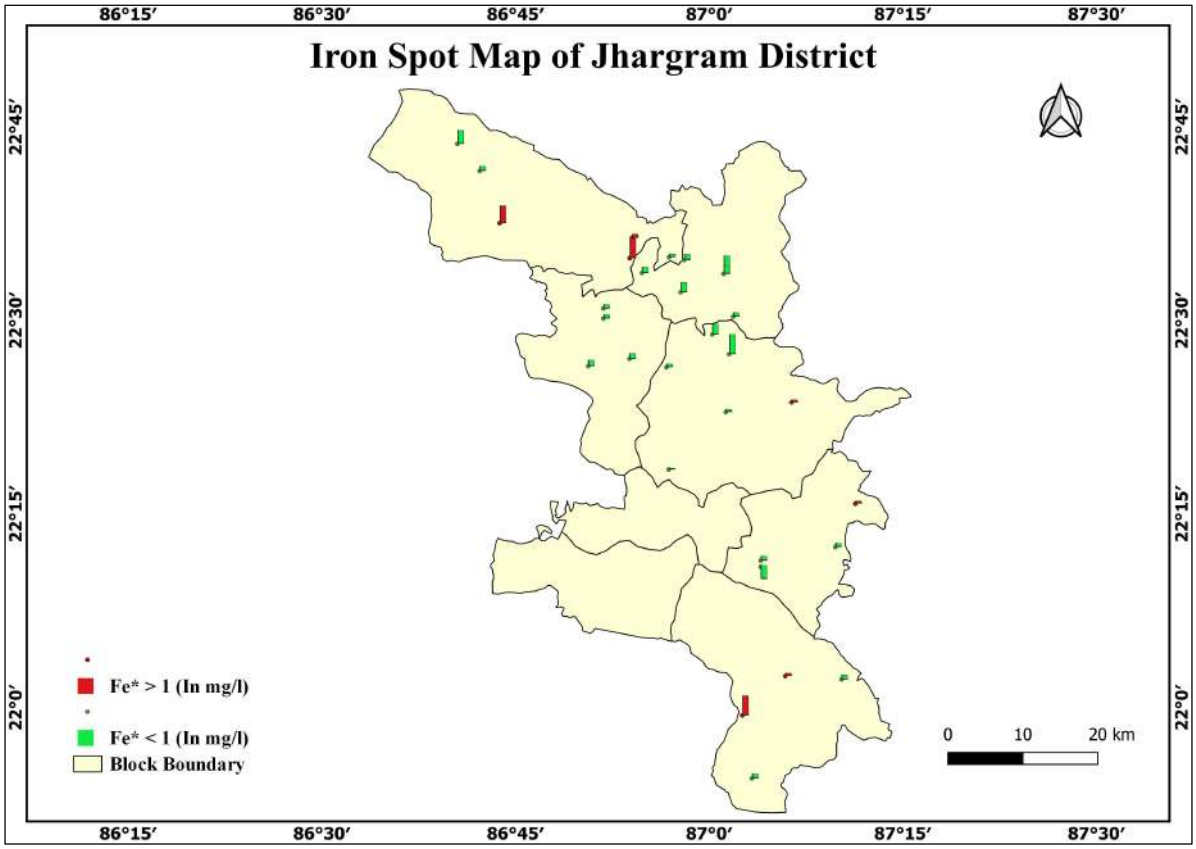


Figure: 8.4: Iron Spot map of Jhargram District

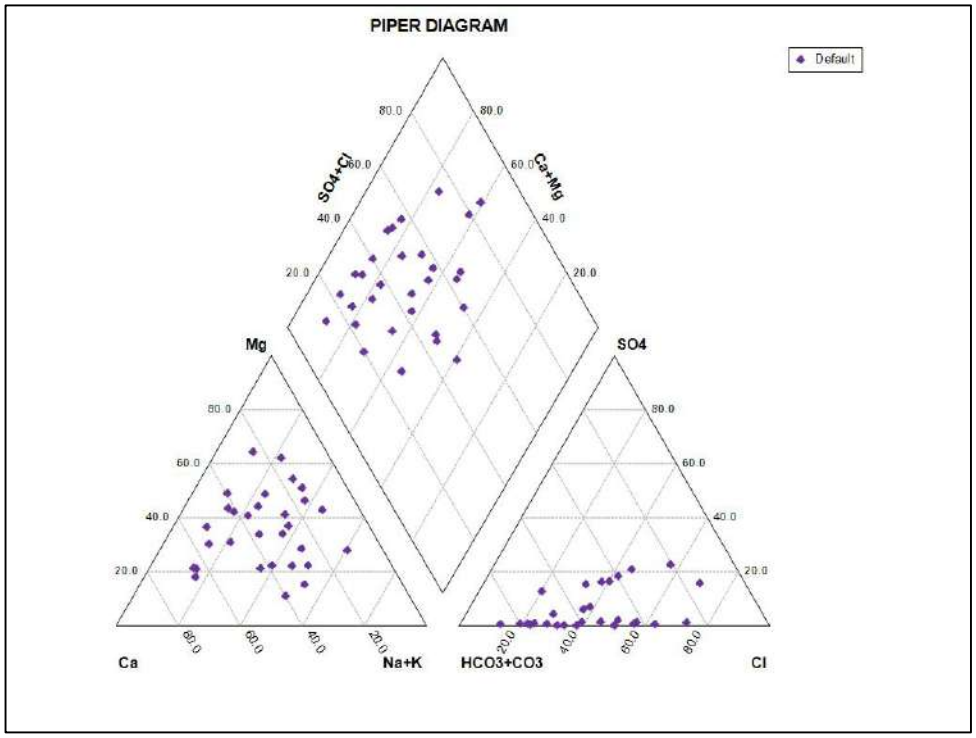


Figure 8.5: Piper Diagram of Jhargram District

8.2 Suitability for drinking purpose

The statistically summarized analysed groundwater data are presented in **Table 7.1.** The data reveals that the pH of the area is within the BIS permissible range of 6.5-8.5. The average pH of the Jhargram district is 7.28 with a maximum of 8.0 and a minimum of 7.14**.** The mean conductance of the study area as evaluated was found to be 876 µS/cm at 25°C, the conductance varies from a minimum of 96 µS/cm at 25°C to a maximum of 1657µS/cm at 25°C **(Figure 7.3)**. The total alkalinity (TA), Cl^- SO_4^{2-} and NO_3^- concentration was found to be much below the permissible limit prescribed by the BIS. The TA varies from 15 to 310 mg/L, Cl^- varies from 11 to 284 mg/L, SO_4^{2-} varies from 0 to 152.4 mg/L and NO_3^- varies from 0 to 63.2 mg/L

Table 8.1: Statistical summarized result of the analysis

	Unit	Min	Max	Mean	BIS Limit
pH		6.56	8.00	7.28	6.5-8.5
Conductance	µS/cm at 25°C	96	1657	876.5	–
CO32-	mg/L	–	–	–	–
HCO3-	mg/L	18	378	198	–
TA as CaCO3	mg/L	15	310	162.5	600.00
Cl-	mg/L	11	284	147.5	1000.00
SO42-	mg/L	0.0	152.4	76.2	400.00
NO3-	mg/L	0.0	63.2	31.6	45.00
F-	mg/L	0	3	1.5255	1.50
TH as CaCO3	mg/L	40	465	197.43	600.00
Ca2+ as Ca	mg/L	6	54	30	200.00
Mg2+ as Mg	mg/L	2	53	27.5	100.00
Na+	mg/L	2.2	111.8	57	–
K+	mg/L	0.7	61.8	31.25	–
TDS	mg/L	50	542	296	2000.00
Fe	mg/L	0	13	6.78	1.00

The TDS of most of the locations are confined within the range of 200 mg/L- 400 mg/L with patches of the area showing TDS in the higher range of 800 mg/L - 1600 mg/L **(Table:7.2),** although the TDS is within the permissible range of drinking water. Except for the Fe the concentration of all the analysed parameter is found to be much below the BIS permissible limit. The Fe concentration varies from a minimum of 0.0 to 13.0 mg/L with an average of 6.78 mg/L and the high concentration of Fe was detected in Jinaguri, Tikadera and Kodupura locations in Binpur-II block and, Indrabani location, Jhargram and Nekrasuli in Sankrail block of the Jhargram district **(Figure 8.4**) which mainly confined in the part of Northern and southern part of the district.

Table 8.2 Chemical analysis data of Jhargram district

SN	Block	Location	Well ID	Source	pH	EC µS/cm at 25°C	TH as $CaCO_3$	Ca^{2+} as Ca	Mg^{2+} as Mg	Na^{+}	K^{+}	Cl^{-}	TA as $CaCO_3$	CO_3^{2-}*	HCO_3^{-}*	SO_4^{2-}*	NO_3^{-}*	F^{-}*	TDS*	Fe*
							mg/l													
1	Jhargram	Pachakhali	KWJH-1	DW	6.56	420	90	24	7	42.0	7.3	57	75	0	92	33.5	1.6	0.09	228	0.49
2	Binpur-I	Chandrapur, High School	KWBPI-2	DW	7.56	1019	290	54	38	67.5	17.5	117	200	0	244	67.8	31.9	0.14	542	0.87
3	Binpur-I	Chandrapur, High School	KWBPI-3	TW	7.72	469	135	22	19	34.4	3.0	53	115	0	140	11.5	16.7	0.08	246	0.36
4	Binpur-II	Raghunathpur	KWBPII-4	Sub TW	7.72	323	115	28	11	13.5	1.7	25	125	0	153	1.0	1.8	0.16	175	0.27
5	Binpur-II	Bhandarpur	KWBPII-5	DW	7.83	1349	240	28	41	111.8	97.6	142	310	0	378	88.2	7.8	0.29	747	0.14
6	Binpur-II	Jinaguri	KWBPII-6	Mark-II	7.57	80.7	30	6	4	3.3	1.4	11	25	0	31	0.0	0.0	0.02	44	13.38
7	Binpur-II	Laldanga	KWBPII-7	Mark-II	7.41	263.2	110	26	11	5.8	0.8	21	100	0	122	0.4	3.1	0.06	143	2.47
8	Binpur-I	Silda Range Office	KWBPI-8	Sub TW	7.55	114.7	40	6	6	8.6	1.3	18	30	0	37	0.7	6.6	0.02	69	0.27
9	Binpur-I	Jashpur Pr. School	KWBPI-9	DW	7.27	199.8	50	12	5	18.9	1.1	43	35	0	43	0.5	2.6	0.02	109	0.46
10	Binpur-I	Tentudanga Harimandir	KWBPI-10	DW	7.27	1657.0	465	48	84	93.3	61.8	284	145	0	177	152.4	63.2	0.23	894	0.17
11	Jhargram	Rajdihi	KWJH-11	DW	7.55	442.3	100	22	11	31.1	27.9	53	105	0	128	12.7	8.4	0.08	244	0.96
12	Jamboni	Burisol Pr. School	KWJH-12	DW	7.60	90.9	35	6	5	4.5	1.0	14	20	0	24	0.0	9.8	0.01	55	0.17
13	Jamboni	Nakdihi	KWJH-13	DW	7.91	597.3	240	26	43	14.7	0.9	64	195	0	238	0.0	3.2	0.13	296	0.17
14	Jamboni	Jamboni WBSEDCL	KWJH-14	DW	7.66	96	40	8	5	2.5	1.1	11	30	0	37	0.0	3.5	0.03	53	0.24
15	Jhargram	Tanga High School	KWJH-15	DW	7.51	81.7	35	10	2	2.5	0.1	14	20	0	24	0.0	1.4	0.01	46	0.14

16	Jamboni	**Murakati Jr. Pr. School**	**KWJH-16**	**DW**	7.34	102.3	40	12	2	3.1	0.7	18	20	0	24	0.3	7.4	0.02	59	0.27
17	Jhargram	**Anguiboni High School**	**KWJH-17**	**DW**	7.07	282.6	80	20	7	22.6	1.2	50	15	0	18	15.2	37.3	0.02	164	0.05
18	Jhargram	**Salboni**	**KWJH-18**	**DW**	7.16	144	40	12	2	14.2	4.8	21	35	0	43	0.9	14.9	0.02	96	0.11
19	Jhargram	**Indraboni**	**KWJH-19**	**DW**	7.26	767	190	36	24	51.7	35.5	99	105	0	128	61.7	50.7	0.04	437	1.49
20	Jhargram	**Shahid Matangini**	**KWJH-20**	**Mark -II**	7.63	606	160	14	30	54.9	8.1	57	205	0	250	1.6	0.0	0.06	318	4.01
21	Sankrail	**Nekrasuli**	**KWSK-21**	**Mark -II**	7.70	76.8	35	10	2	2.2	1.0	11	15	0	18	0.6	12.1	0.02	50	1.43
22	Sankrail	**Benageria**	**KWSK-22**	**DW**	7.28	275.7	95	14	15	13.4	0.7	60	30	0	37	1.2	12.2	0.01	139	0.17
23	Sankrail	**Ragra RNM Academy**	**KWSK-23**	**Sub TW**	7.80	768.7	275	22	53	34.2	2.8	67	225	0	275	13.6	21.6	0.18	382	0.65
24	Sankrail	**Baharadari**	**KWSK-24**	**Sub TW**	7.63	806.2	265	24	50	38.3	23.3	99	150	0	183	54.6	28.1	0.08	429	0.20
25	Nayagram	**Nayagram Police station**	**KWNG-25**	**Sub TW**	8.00	818.5	250	22	47	57.7	4.3	53	245	0	299	44.5	3.6	0.03	415	0.20
26	Nayagram	**Kuldiha Kisku Bhawan**	**KWNG-26**	**Sub TW**	7.36	104.5	45	12	4	3.2	0.9	14	30	0	37	0.6	7.6	0.04	64	0.20
28	Nayagram	**Rangiam**	**KWNG-28**	**DW**	7.62	213.7	80	16	10	6.4	2.1	18	80	0	98	0.9	0.6	2.14	113	1.65
29	Binpur-II	**Kodpura Adivasi Mission HS**	**KWBPII-29**	**Mark -II**	7.80	308.5	135	24	18	7.7	0.4	14	130	0	159	0.7	1.0	3.04	163	11.84
30	Binpur-II	**Tongaveda Kali Mandir**	**KWBPII-30**	**DW**	7.69	241	75	20	6	18.4	1.5	43	45	0	55	1.2	9.5	2.28	133	0.20
31	Binpur-II	**Jamtolgoda CRPF Camp**	**KWBPII-31**	**Mark -II**	7.72	258.1	85	18	10	15.3	1.8	18	105	0	128	0.9	0.0	2.63	142	0.65

CHAPTER-9

GROUNDWATER RELATED ISSUES AND PROBLEMS

9.1 Ground Water Problem Encountered

The area under study is unique in its diversity of geological formations. Ground water problem in the areas is distinct from the nature of the terrain as well as of water scarcity. The acuteness of the problem is witnessed during summer. Due to varying degree of weathering the thickness of weathered residuum is variable limiting the construction of dug wells in many areas. Topology occupied by buried pediments is the favourable areas for construction of dug wells in the hard rock terrain.

There are many areas like Pachapani, Chakdoba, Banspahari, Bhulaveda Balichuan which face acute water scarcity particularly during summer. Geophysical resistivity survey in these areas did not bring out any prospect for ground water exploration.

Apart from this hard rock terrain the study areas in in general face water scarcity during pre-monsoon period. The area where water scarcity has been witnessed in the study area are Chantola, Jaspur, Murakati, Bengaria, Rangiam, Chainsol, sijua, Sumitrapur, Topsia, Barunachak, Nohatikuri, Kapcita, Chandabila, Nekrasuli etc. water column in dug wells inventories in the above area was between 3.0 m to 14.0 m.

Ground water quality problem has been witnessed at Kodupura, Jinagua, Laldanga, Tungaveda, Jamtogola of Binpur-II block, Indraboni, Sahid Matagni, of Jhargram Block, Nekrasuli in Sankrail Block Rangiam in Nayagram Block.

The fluoride content in ground water of these areas varied from 2.14- 3.04 mg/l. High Iron (Fe) content in the range of 1.43 mg/l to 13.38 mg/l occur in ground water of the above-mentioned areas.

CHAPTER-10

GROUND WATER DEVELOPMENT AND MANAGEMENT

Groundwater development and management involves the planning implementation, and operation necessary to provide safe and reliable ground water. For assessing development potentialities of and aquifer, the following information is required;

i. Geometry of the reservoir defining dimensions and boundaries
ii. Condition at the boundaries in particular the source of recharge;
iii. Lithology and aquifer characteristics;
iv. Hydrodynamic condition- whether phreatic, confined, or semi-confined;
v. Order of magnitude of the reservoirs,
vi. Average natural recharge and discharge and
vii. Quality of water.

10.1 Urban and Rural water supply schemes:

Urban and rural water supply scheme for drinking and domestic purpose is mainly looked after by PHED, local municipality and Gram Panchayat of Jhargram. The water supply to both urban and rural areas is achieved through construction of various ground water structures depending upon the requirement and feasibility. Deep tube wells, shallow tube wells and rig wells are commonly used for water supply to rural area.

10.2 Ground water for Irrigation:

Ground water development for irrigation in the study area is affected by various ground water structures namely dug wells, Shallow tube wells, medium tube wells and deep tube wells. Of these the majority of ground water irrigation is performed by a battery of shallow tube wells. As per the minor irrigation census maximum ground water development done in Binpur-I and Sankrail block where the actual area irrigated **15055.31** ha and **12310.67** ha respectively; least groundwater development for irrigation was witness in Binpur-II block (most of the area is occupied by hard rock formation.

Below the **table 10.1 &10.2** is showing the Block level irrigation potential in the study area.

Table: 10.1 Block level Summary on Irrigation Potential during 2017-2018

Sl. No.	Block Name	Dug well		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Ground Water	
		No.	*IPC (ha.)*	*No.*	*IPC (ha.)*	*No.*	*IPC (ha.)*	*No.*	*IPC (ha.)*	*No*	*IPC (ha.)*
1	**BINPUR I**	49	243.63	1531	6120.55	719	7251.20	91	1439.93	2390.00	15055.31
2	**BINPUR II**	1	2.87	120	681.37	121	1132.45	4	175.34	246.00	1992.03
3	**GOPIBALLAVPUR I**	34	123.31	1375	6863.56	69	493.01	29	302.43	1507.00	7782.31
4	**GOPIBALLAVPUR II**	67	311.64	523	2989.17	320	2479.08	15	306.20	925.00	6086.09
5	**JAMBONI**	6	13.00	334	1740.43	178	979.47	18	554.02	536.00	3286.92
6	**JHARGRAM**	39	165.53	466	2230.62	355	2081.02	24	713.01	884.00	5190.18
7	**NAYAGRAM**	165	1032.95	21	217.33	82	1839.95	2	60.48	270.00	3150.71
8	**SANKRAIL**	46	264.06	1374	8678.13	256	2184.37	76	1184.11	1752.00	12310.67
	TOTAL: -	**407**	**2156.99**	**5744**	**29521.17**	**2100**	**18440.55**	**259**	**4735.52**	**8510.00**	**54854.23**

Table: 10.2: Block level Summary on Culturable Command Area (CCA) during 2017-2018

Sl. No.	Block Name	Dug well		Shallow Tubewell		Medium Tubewell		Deep Tubewell		Ground Water	
		No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No	CCA (ha.)
1	**BINPUR I**	49	126.20	1531	3950.93	719	4555.72	91	1823.22	2390	10456.07
2	**BINPUR II**	1	1.40	120	350.94	121	573.14	4	75.00	246	1000.48
3	**GOPIBALLAVPUR I**	34	69.18	1375	3605.21	69	233.77	29	688.14	1507	4596.30
4	**GOPIBALLAVPUR II**	67	181.89	523	1667.24	320	1436.47	15	371.82	925	3657.42
5	**JAMBONI**	6	11.74	334	1078.43	178	773.67	18	397.42	536	2261.26
6	**JHARGRAM**	39	67.09	466	1294.96	355	1277.97	24	574.08	884	3214.10
7	**NAYAGRAM**	165	431.78	21	89.46	82	1015.68	2	42.80	270	1579.72
8	**SANKRAIL**	46	142.03	1374	5201.43	256	1452.45	76	1742.38	1752	8538.29
	TOTAL: -	**407**	**1031.31**	**5744**	**17238.60**	**2100**	**11318.87**	**259**	**5714.86**	**8510**	**35303.64**

Table: 10.3 Block level Summary on IPC & IPU during 2017-2018

Block	CCA	Season Wise Irrigation Potential Created (IPC)					Season Wise Actual Area Irrigated During 2017-2018 (IPU)					Achievement
		Kharif	Rabi	Perennial	Others	Total	Kharif	Rabi	Perennial	Others	Total	
BINPUR I	9686.35586	6080.41	3148.083026	411.53532	4176.500076	13816.53	5798.762	2920.803	357.96066	4022.503123	13100.02846	94.81418388
BINPUR II	974.223241	901.5562	682.771677	0.25	354.094486	1938.672	530.7386	493.8676	0.1	251.3128401	1276.019067	65.81922206
GOPIBALLAVPUR I	4275.12275	3294.633	2281.987992	362.0008168	1500.631507	7439.253	2599.891	1594.615	271.0657356	994.2284315	5459.801016	73.39178966
GOPIBALLAVPUR II	3091.54007	2580.936	1271.297728	22.53122	1326.57501	5201.34	2316.045	1112.367	10.64	1132.169696	4571.221751	87.88546448
JAMBONI	1883.33504	1001.227	651.20321	31.25	1026.787993	2710.468	859.3028	502.8447	16	857.5001617	2235.647666	82.48198166
JHARGRAM	2762.37481	1920.437	794.567903	70.54534	1683.430535	4468.981	1812.898	678.7654	38.84266	1556.894814	4087.401357	91.46159309

NAYAGRAM	1271.06683	1127.063	464.470751	2.96306	988.9773006	2583.474	1045.063	398.7145	2	922.4773006	2368.25476	91.669382
SANKRAIL	7658.54632	3422.958	2624.110317	1586.05711	3203.768766	10836.89	2827.457	2135.722	1090.95416	2677.859217	8731.992322	80.5765203
Grand Total	31602.5649	20329.22	11918.4926	2487.132867	14260.76567	48995.61	17790.16	9837.699	1787.563216	12414.94558	41830.3664	85.37574171

10.3 Future Ground Water Development and Management:

The district has net available ground water resource as **64992 hams.** and the average stage of development is 26.82%.

In deciding the mode of future groundwater development in the study are the following aspect have been taken in to consideration.

The area barring the hard rock terrain of Binpur-II block is suitable for construction of dug wells, shallow wells medium duty tube wells. Dugwell and dug cum bore wells are suitable and feasible in hard rock terrain.

The feasibility of a particular ground water structures will depend on local hydro geological setup and requirement of water to be used. Shallow tube wells are mainly suitable for private use as it involves farmer's participation in a cooperative manner and requires less expenditure on maintenance. The same applies to dug-wells in the study area.

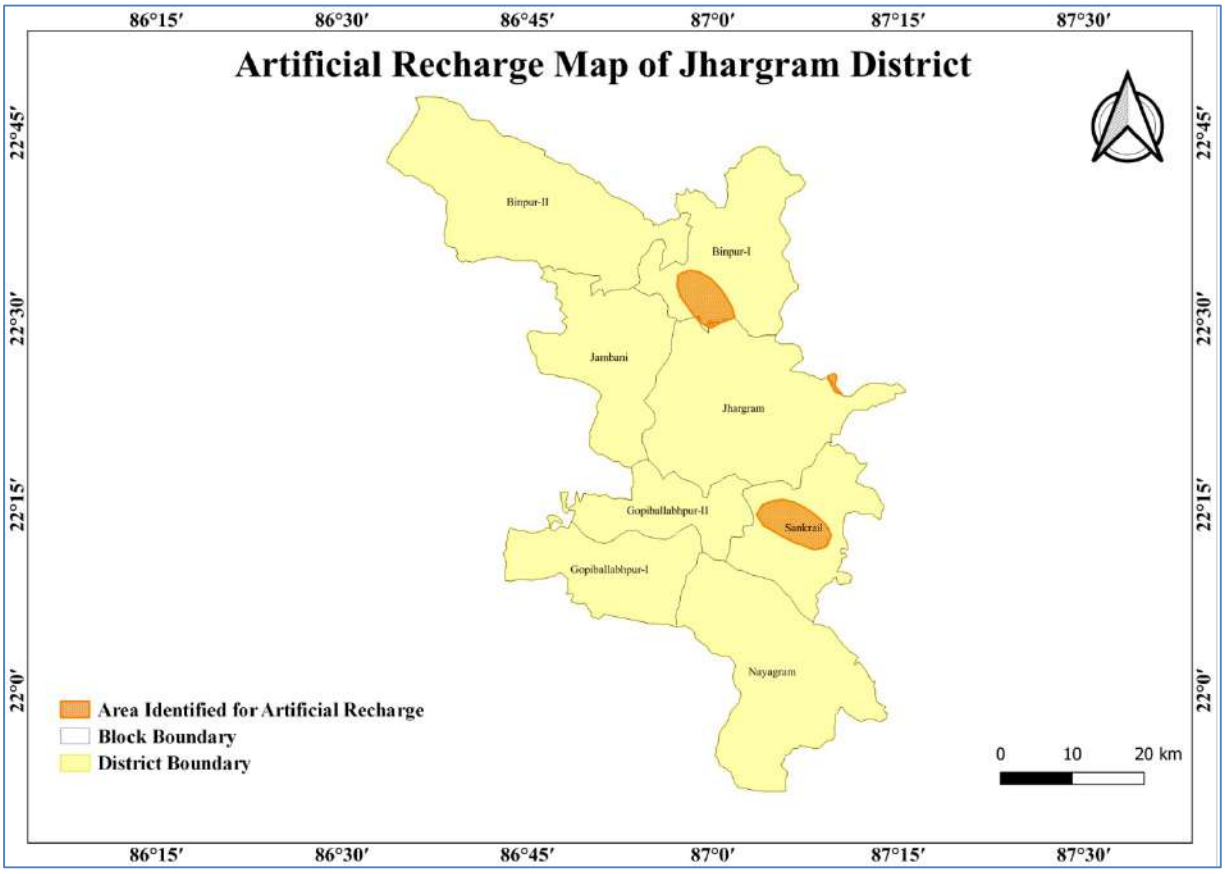
The discharges of deep tube wells are quite less than the discharge of deep tube wells in other alluvium areas. Ground water development through medium duty deep tube wells may be done. But these tube wells involve high cost for construction and maintenance and are thus maintain by government.

In the water scarce hard rock terrains of Binpur-II block, large diameter Dug well and Radial Dug well especially in Laterite terrains, may be constructed in suitable areas as the offer storage. As the previously geophysical resistivity survey in this terrain reveled presence of weathered layers of thickness 5-8m at place like Banspahari, Chakdoba, Pachapani etc. these areas are suitable for construction of dug wells, and for semi weathered layer 4.5 to 32.5 m, which allows construction of dug cum bore well in addition to dug wells for future ground water development and management.

10.4 Scope for Artificial recharge to Ground water:

Artificial recharge is always site specific. As far as possible, the site for recharge should be a plain area, hydrogeologically feasible and should have ample scope for groundwater development. The non-committed rainwater should be used for recharge. Care should be taken so that recharged water does not drain out under natural conditions into streams/ Nallah. And, the post-monsoon water level should be more than 6mbgl.

In the present study area, only 03 blocks are feasible, the recharge structures feasible and their cost of constructions, utilizable surface run-offs for the blocks under study



are given in the table below. (Table10.4)

Figure 10.1 Area feasible for Artificial Recharge Map of Jhargram District

Table 10.4 Feasible structures and their cost of constructions in lakhs for the blocks in study area (CGWB, ER)

District	Block	Formation type	Area feasible for AR (Sq.km)	Number of Proposed Recharge Structures							Cost of Recharge structures (Rs. In lakhs)							Availability of surface non committed monsoon run off (MCM)
				Percolation Tanks	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub surface dykes	Dug Well Recharge	Percolation Tanks	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub surface dykes	Dug Well Recharge	
Jhargram	Bnpur- I	Alluvium	40.9	12	25	12	0	0	0	0	96	100	36	0	0	0	0	12.28
Jhargram	Jhargram	Alluvium	1.01	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0.31
Jhargram	Sankrail	Alluvium	46.79	14	28	14	0	0	0	0	112	112	42	0	0	0	0	14.04
Total			**88.76**	**26**	**54**	**26**	**0**	**0**	**0**	**0**	**208**	**216**	**78**	**0**	**0**	**0**	**0**	**26.63**

PART – II

BLOCK MANAGEMENT PLANS

CHAPTER-11

11.1 SALIENT INFORMATION

Block Name: ***Binpur-I***

Geographical area (sq. km): **357.6**

Mappable area (sq. km): **321**

District: **Jhargram**

State: **West Bengal**

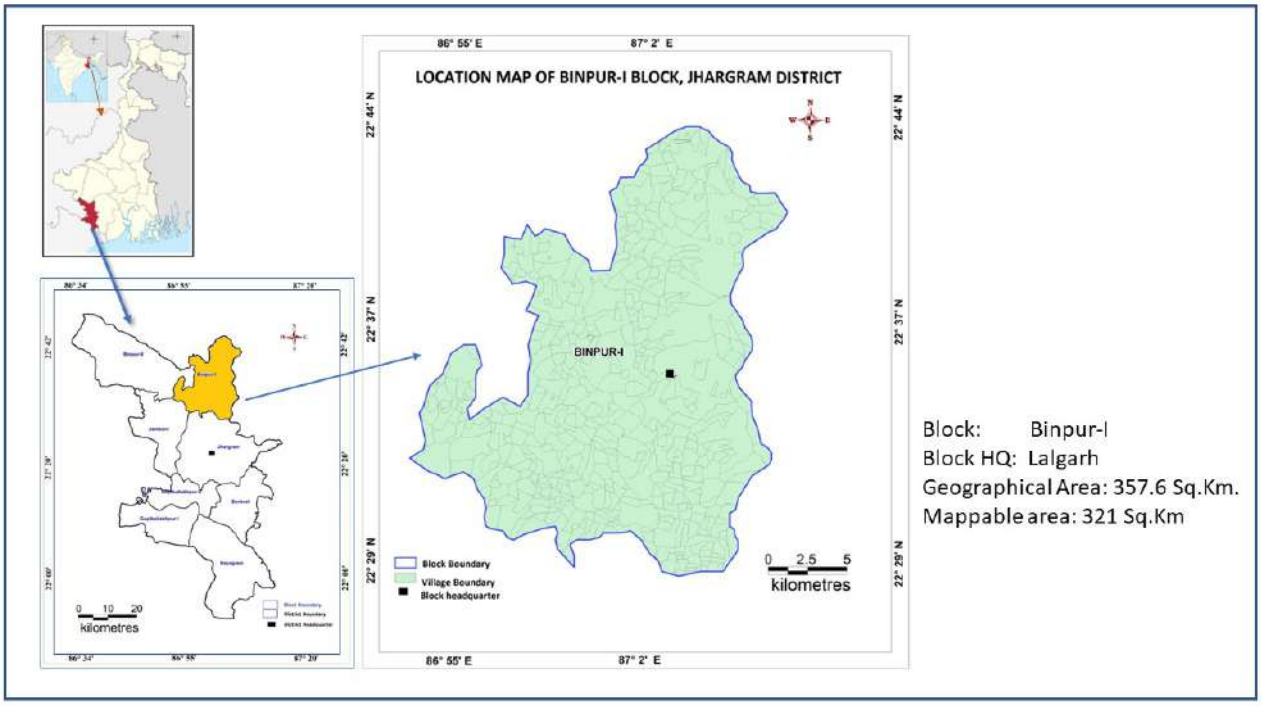


Figure10.1.1: Location Map of Binpur-I Block

Population (as on 2011):

Table 11.1.1: Details of population in Binpur-I block.

Rural	Urban	Total	Population Density per Sq.km
156153	-	156153	440

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.1.2: Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BINPUR-I	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture & Irrigation (area in ha):

Table 11.1.3: Salient Land use features of Binpur-I block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
BINPUR-I	35969	7245	1903	34736	12257	155	22479	4342

Table 11.1.4: Crop pattern of Binpur-I block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
BINPUR-I	1959	4.536	2316	9944	17.577	1768	12040	37.964	3153	7	0.016	2216	1448	25.123	17.35	261	0.225	864	0	0	0	684	0.667	975	1564	0.892	571	2289	37.640	16444	0	0	**0**

Table 11.1.5: Crop water requirement of Binpur-I block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
BINPUR-I	**Cereals**	24205	17705	0.28328	1000	0.29928	0.28328	0.01600
	Coarse Cereals	120	120	0.00060	1000	0.00560	0.00060	0.00500
	Pulses	350	350	0.00088	1500	0.00463	0.00088	0.00375
	Oil Seeds	4460	4460	0.01115	1500	0.01490	0.01115	0.00375
	Fibre	0	0	0.00000	200	0.00080	0.00000	0.0080
	Other Crops	5601	5274	0.03164	1874	0.04289	0.03164	0.01124

Table 11.1.6 Command area (ha) of Binpur-I block

Block Name	Dugwell		Shallow Tubewell		Medium Tubewell		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
BINPUR-I	49	12.20	1531	3950.93	719	4555.72	92	1823.22	144	1438	54	860.09	10456.07	2298.89	12754.96

Disposition of Aquifers:

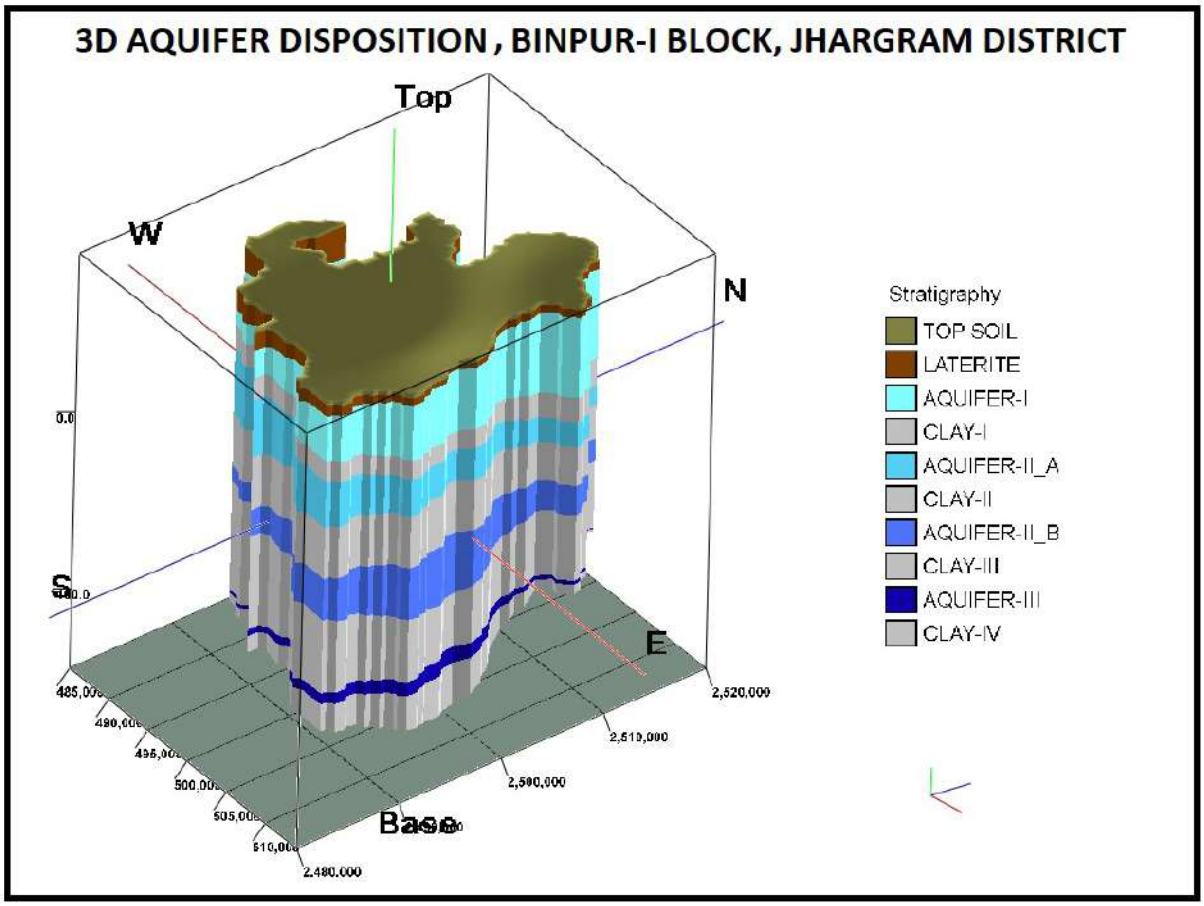


Figure11.1.2: 3-Dimensional Aquifer disposition in Binpur-I Block

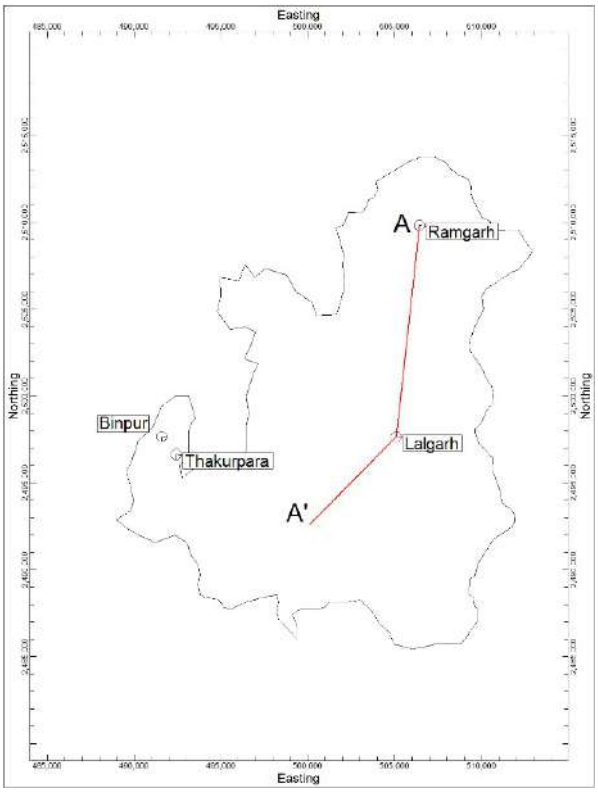


Figure 11.1.3: 2-D section lines along the study area

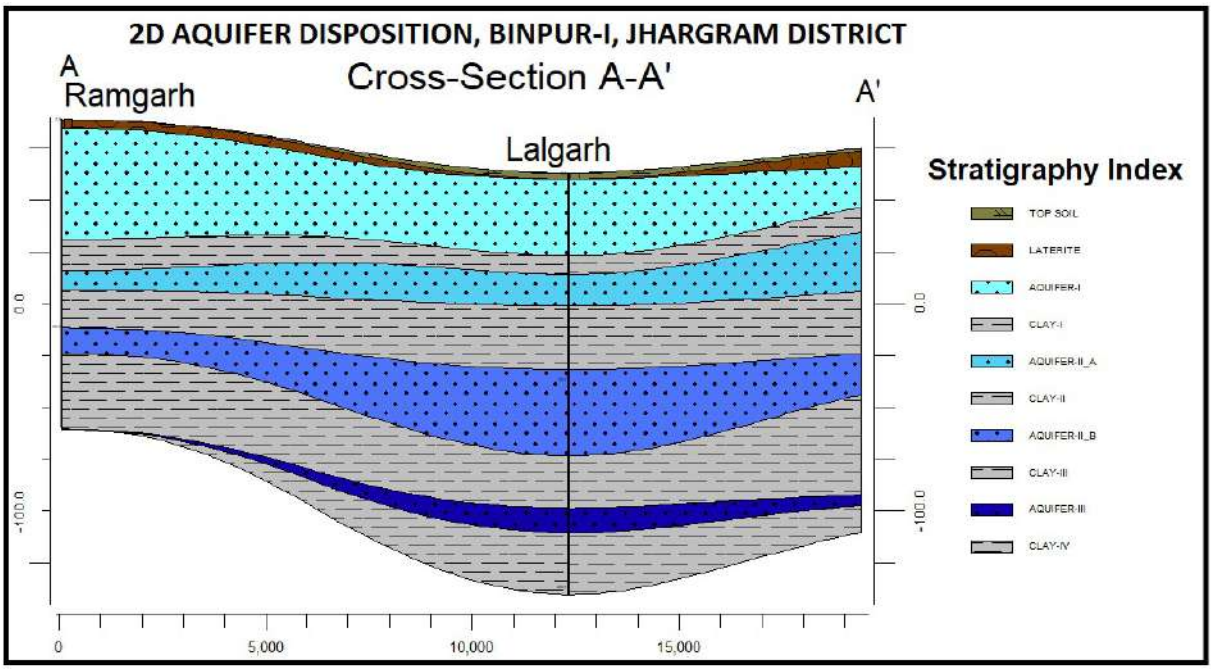


Figure11.1.4: 2-Dimensional Section in Binpur-I Block

The principal aquifer systems encountered in this block is hard rock. Two aquifers are encountered in this block. The range of **Aquifer-I** is also known as Shallow aquifer/ weathered zone. The top layer is varying 41 to 111 m bgl, potential granular zone1 varied from 33 m bgl to 45 mbgl and potential granular zone 2 varies from 48 m bgl to 63 m bgl.

The range of **Aquifer-II** is also known as fracture zone where the interconnected fracture (secondary porosity of the rock) is responsible for the presence of GW. Fractures encountered at a depth of 81 mbgl & 118 mbgl. The potential granular zone1 varied from 81m bgl to 87 mbgl and potential granular zone 2 varies from 105mbgl to 111 m bgl.

Table 11.1.7: Details of aquifer disposition in Binpur-I Block

Blocks (dominant in hard rock)	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I weathered Zone	Aquifer-II Fracture zone					
BINPUR-I	2	12-37	(Up to 11m)	63	43,30	46-566	--	10.8	--	--

Table 11.1.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
BINPUR-I	8.0- 13.5	--	0.093	3.31-12.6	0.087	--

Ground water quality and issues:

Based on three NHS key wells, four exploratory wells and three observation wells, the range of chemical parameter for the block is normal range as given below.

Table 11.1.9: Range of chemical parameters in Binpur-I Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
BINPUR-I	Aquifer-I	7.27-7.56	199.8--1657	18.9-93.3	43-284	0.02-0.23	2-9	0.27-0.36	109-894
	Aquifer-II	7.55- 7.72	114.7-469	8.6.34.4	18-53	0.02-0.08	6.6-16.7	0.17-0.87	69-246

Ground Water Resource

Table 11.1.10: Details of Ground Water Resource Availability and Utilization in Binpur-I Block.

Name of the Block	**BINPUR-I**
Total Annual Ground Water Recharge (Ham)	12323.19
Total Natural Discharges (Ham)	1232.33
Annual Extractable Ground Water Recharge (Ham)	11090.87
Total Extraction	5787.3
Annual GW Allocation for Domestic Use as on 2025	407.1
Net Ground Water Availability for future use	6490.37
Stage of Ground Water Extraction (%)	52.18
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan

Ground Water Management Plan for drinking purpose:

The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541 mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 18.28%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.
- In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.
- Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered.

Management Intervention through Harvesting of Surface Runoff and Artificial Recharge:

It has been estimated that the utilizable surface runoff produced in the block is **12.283** MCM. This surface runoff is proposed to be utilized to recharge the shallow aquifer (weathered zone) in the block. As per the available storage space, **12.283** MCM water is required to fill the shallow

aquifers in block. Therefore, 12 Percolation tanks, 25 REET with RS and 12 injections well structures are recommended in the block.

Figure11.1.5: Area Feasible for Artificial Recharge of groundwater for Bankura-I Block

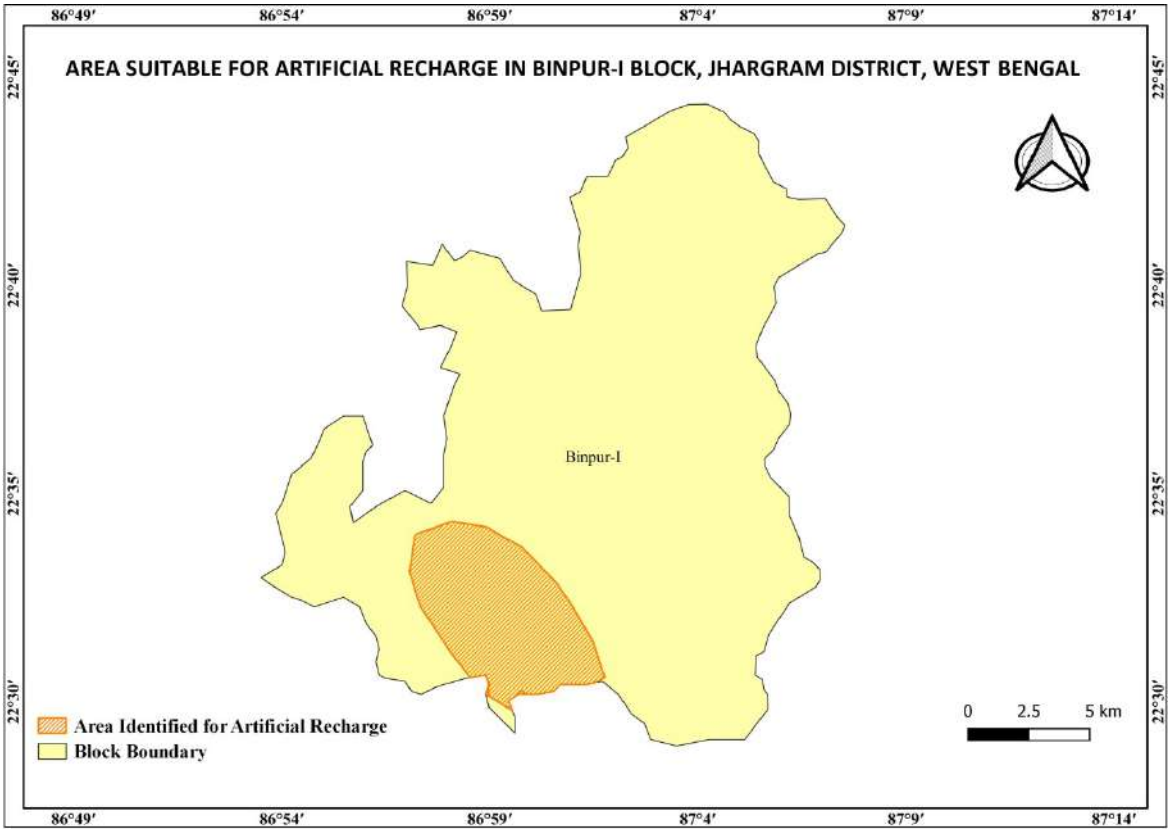


Table 11.1.11: Detail of structures recommended in feasible area of artificial recharge for Binpur-I Block.

Name of the Block	Utilizable Surface Run Off	Allocation of Utilizable Recourse (MCM)							Structures Feasible							Cost of Structures (in lakhs)							
		Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	TOTAL
BINPUR-I	12.283	6.141	2.457	3.685	0	0	0	0	12	25	12	0	0	0	0	96.0	100.0	36.0	00	0	0	0	232

11.2 SALIENT INFORMATION

Block Name: **Binpur-II**

Geographical area (sq. km): **583.5**

Mappable area (sq. km): **518**

District: **Jhargram**

State: **West Bengal**

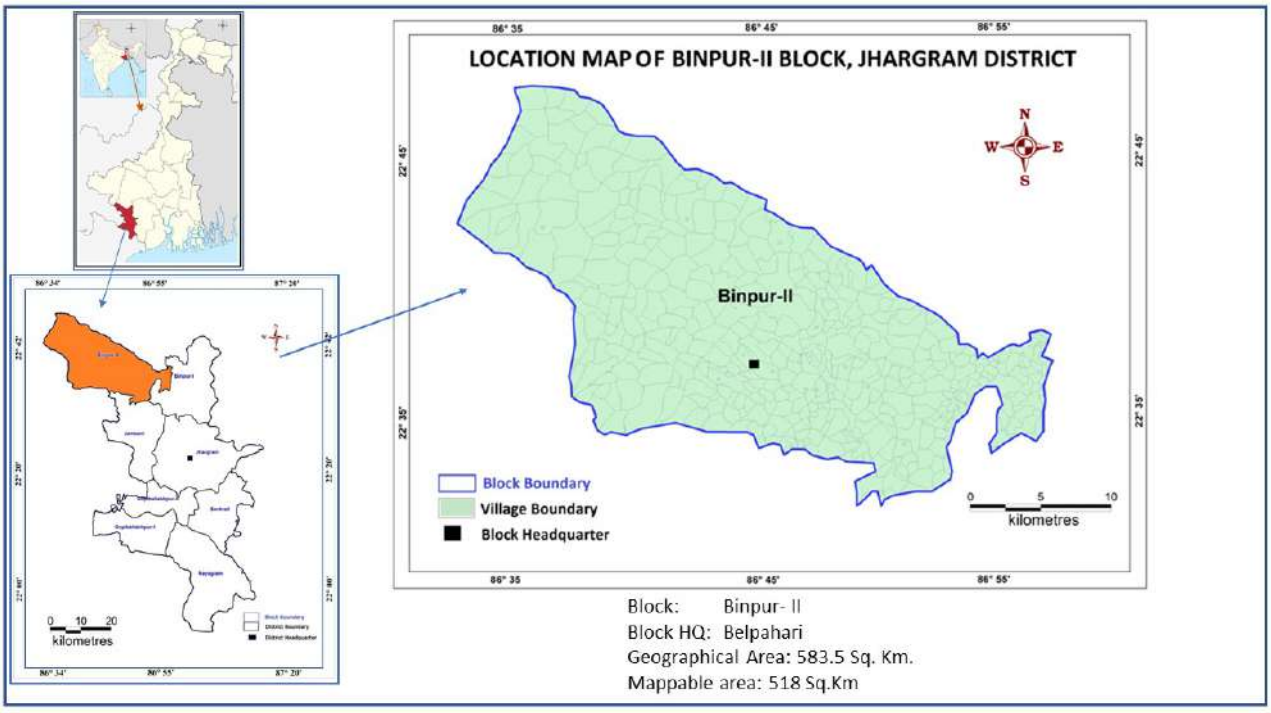


Figure 11.2.1: Location Map of Binpur-II Block

Population (as on 2011):

Table 11.2.1: Details of population in Binpur-II block.

Rural	Urban	Total	Population Density per Sq km
158798	5724	164522	280

Table 11.2.2 Detail of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
BINPUR-II	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.2.3: Salient Land use features of Binpur-II block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
BINPUR-II	58345	23974	2081	24195	573	102	23622	4203

Table 11.2.4: Crop pattern of Binpur-II block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
BINPUR-II	535	1.239	2316	2219	1.022	461	8335	25.927	3111	0	0	0	511	6.423	12.57	0	0	0	0	0	0	46	0.042	907	1132	1.110	981	1893	37.180	19641	0	0	0

Table 11.2.5: Crop water requirement of Binpur-II block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
BINPUR-II	**Cereals**	18661	4110	0.06576	2000	0.09776	0.06576	0.03200
	Coarse Cereals	375	375	0.00188	4000	0.02188	0.00188	0.02000
	Pulses	673	673	0.00168	5000	0.01418	0.00168	0.01250
	Oil Seeds	1727	1727	0.00432	5000	0.01682	0.00432	0.01250
	Fibre	97	97	0.00039	200	0.00119	0.00039	0.00080
	Other Crops	2662	2627	0.01576	4904	0.04519	0.01576	0.02942

Table 11.2.6: Command area (ha) of Binpur-II block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
BINPUR-II	1	1.4	120	350.94	121	573.14	4	75.0	13	82.95	27	278.37	1000.48	361.32	1361.80

Disposition of Aquifers:

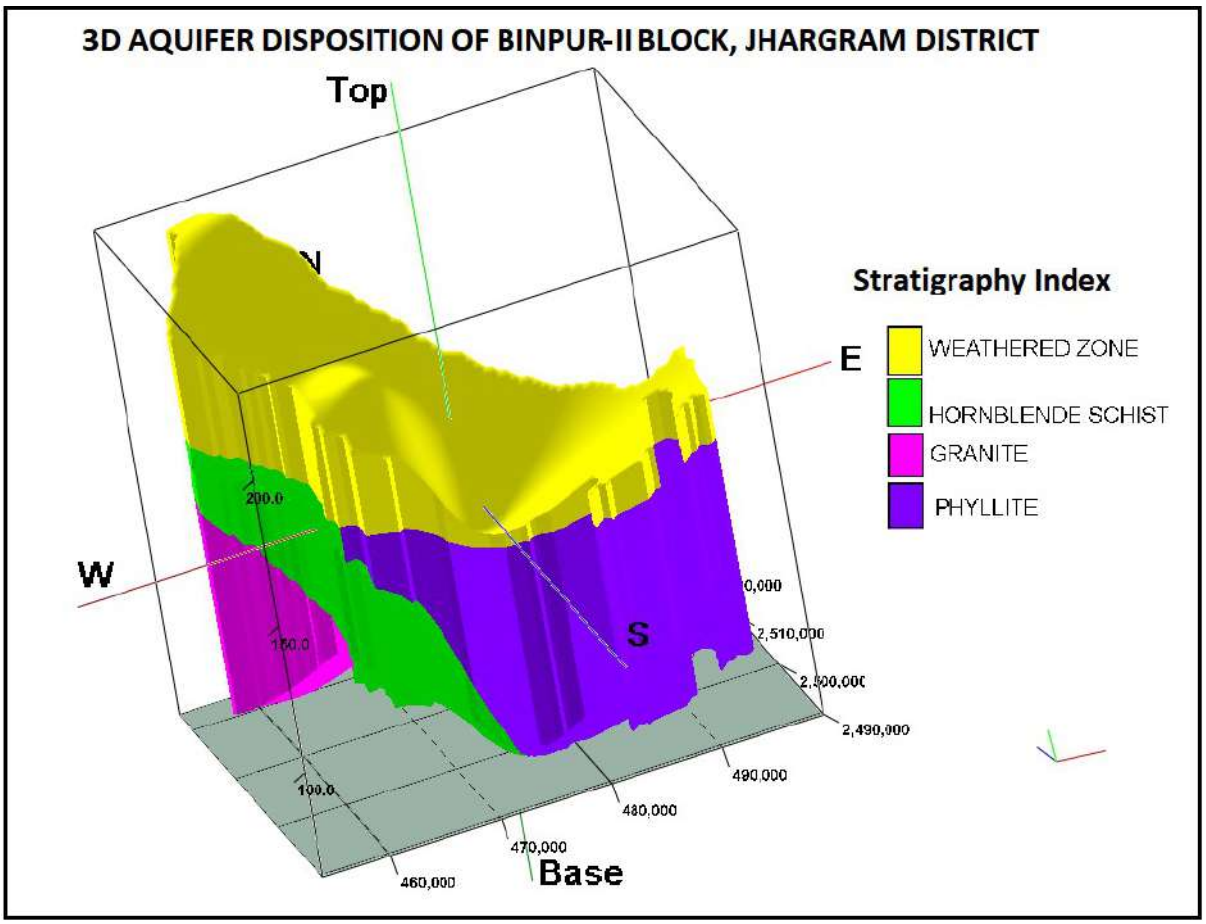


Figure11.2.2: 3-Dimensional Aquifer disposition in Binpur-II Block

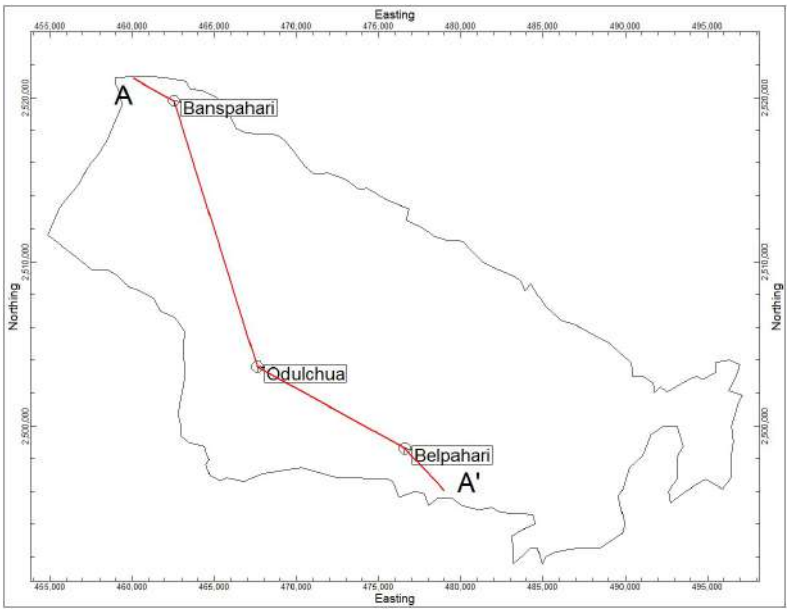


Figure: 11.2.3-2D section lines along the study area

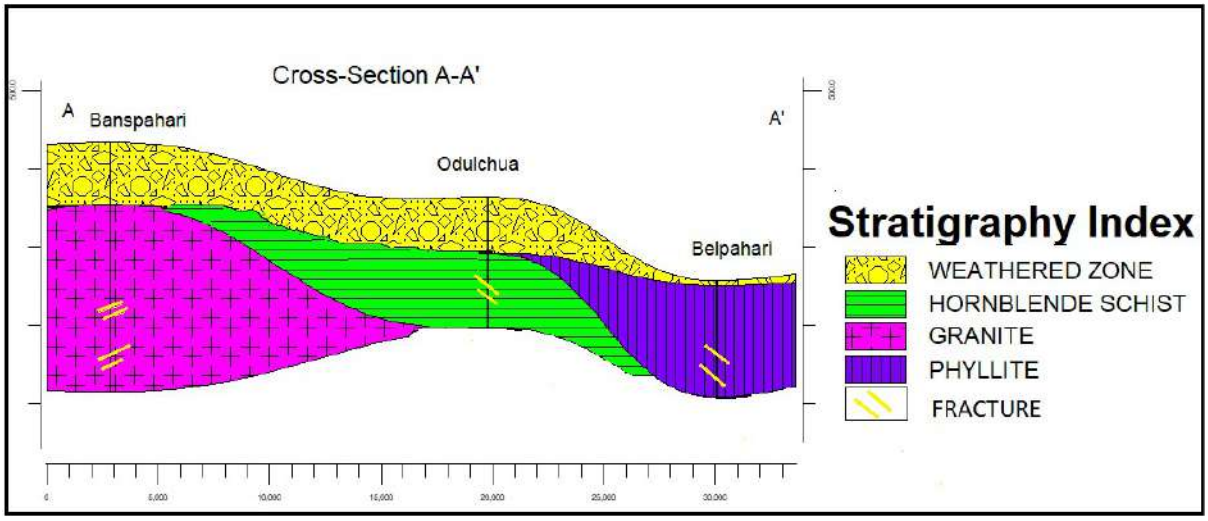


Figure11.2.4: 2-Dimensional Section in Binpur-II Block

The principal aquifer systems encountered in this block is hard rock.

Two aquifers are encountered in this block. The range of **Aquifer-I** is also known as Shallow aquifer/ weathered zone within 40 mbgl. With tapping the granular zone of 12 to 15 capable of yield 15-25 m3/hr.

The range of **Aquifer-II** is also known as fracture zone where the interconnected fracture (secondary porosity of the rock) is responsible for the presence of GW. Fractures encountered at a depth of 65 mbgl & 120 mbgl.

Table 11.2.7: Details of aquifer disposition in Binpur-II Block

Blocks (dominant in hard rock)	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I weathered Zone	Aquifer-II Fracture zone					
BINPUR-II	2	12-15	(Up to 12m)	30-50	65-120	250-417	--	7.3	--	--

Table 11.2.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
BINPUR-II	5.33-10.29	0.247	--	1.29-8.9	0.096	--

Ground water quality and issues:

Based on five NHS, three key wells, the range of chemical parameter for the block is given below.

Table 11.2.9: Range of chemical parameters in Binpur-II Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
BINPUR-II	Aquifer-I	7.69-7.83	241-1349	18.4-111.8	43-142	0.29-2.28	7.8-9.5	0.20-2.47	44-747
	Aquifer-II	7.41-7.80	80.7-323	3.3-15.3	11-25	2.63-3.04	0.0-3.1	11.84-13.38	143-175

As per PHED report Fluoride and Iron concentration is above the permissible limit this block. More intensive sampling from this block is recommended.

Ground Water Resource:

Table 11.2.10: Details of Ground Water Resource Availability and Utilization in Binpur-II Block.

Name of the Block	***BINPUR-II***
Total Annual Ground Water Recharge (Ham)	16899.8
Total Natural Discharges (Ham)	1689.98
Annual Extractable Ground Water Recharge (Ham)	15209.82
Total Extraction	2404.51
Annual GW Allocation for Domestic Use as on 2025	537.42
Net Ground Water Availability for future use	12780.52
Stage of Ground Water Extraction (%)	15.81
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541 mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 15.81%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area. Owing to its distinct hydrogeology, it is evident that very less cultivable command area is created by both surface as well as groundwater.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.

In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.

Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered

11.3. SALIENT INFORMATION

Block Name: **Jamboni**

Geographical area (sq. km): **318.1**

Mappable area (sq. km): **251**

District: **Jhargram**

State: **West Bengal**

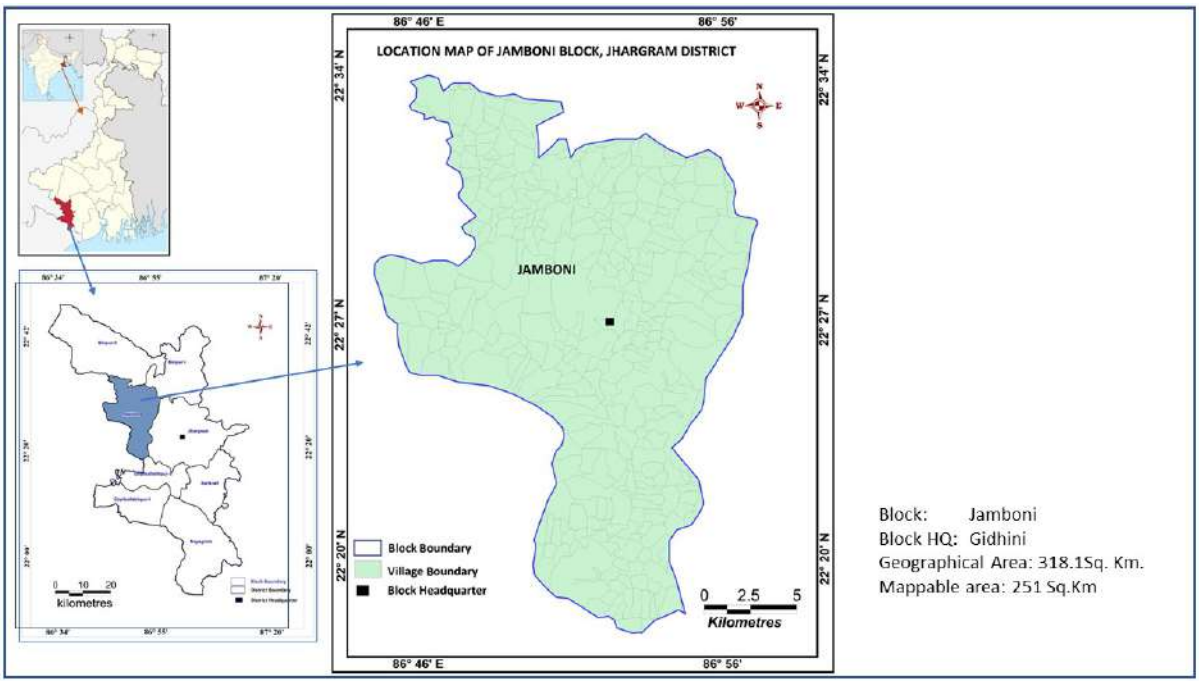


Figure 11.3.1: Location Map of Jamboni Block

Population (as on 2011):

Table 11.3.1: Details of population in Jamboni block.

Rural	Urban	Total	Population Density per Sq.km
113197	-	113197	360

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.3.2: Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Jamboni	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.3.3: Salient Land use features of Jamboni block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
JAMBONI	31822	7052	1901	26197	6446	133	19751	3118

Table 11.3.4: Crop pattern of Jamboni block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
JAMBONI	0	0	0	2487	0.631	254	7019	19.273	2746	0	0	0	507	7.443	14.68	90	0.088	972	110	0.156	1416	620	0.677	1092	1271	1.164	916	280	5.195	18552	0	0	0

Table 11.3.5: Crop Water Requirement of Jamboni block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
JAMBONI	Cereals	20007	2650	0.04240	2000	0.07440	0.02686	0.01532
	Coarse Cereals	250	250	0.00125	2000	0.01125	0.00125	0.01000
	Pulses	160	160	0.00040	4000	0.01040	0.00040	0.01000
	Oil Seeds	2054	2054	0.00514	4000	0.01514	0.00514	0.00040
	Fibre	15	15	0.00006	100	0.00046	0.00006	0.00040
	Other Crops	3711	3276	0.011966	3761	0.04222	0.01966	0.02257

Table11.3.6: Command area (ha) of Jamboni block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
JAMBONI	6	11.74	334	1078.43	178	773.67	18	397.42	17	329.56	82	2448.15	2261.26	2777.71	5038.97

Disposition of Aquifers:

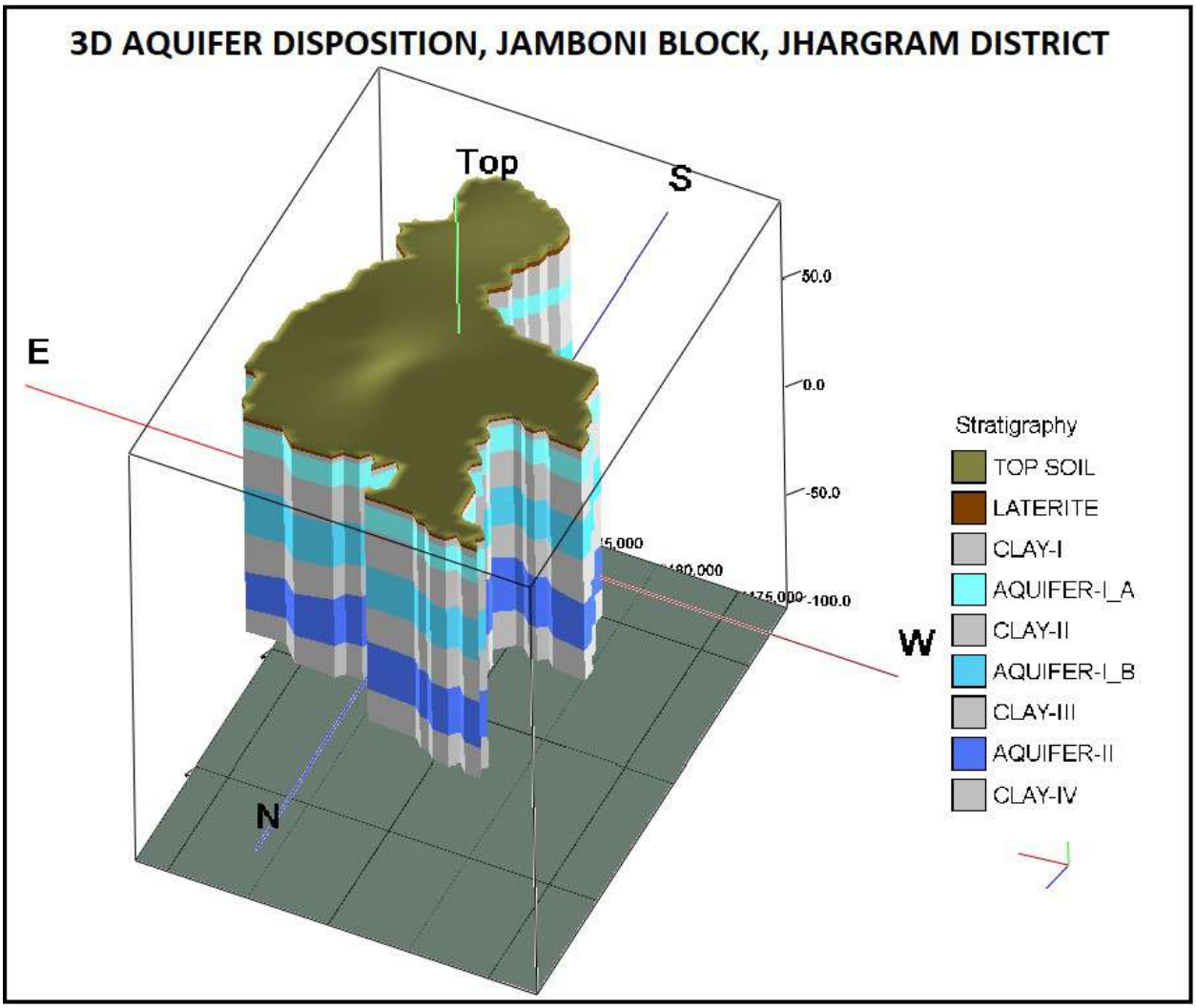


Figure 11.3.2: 3-Dimensional Aquifer disposition in Jamboni Block

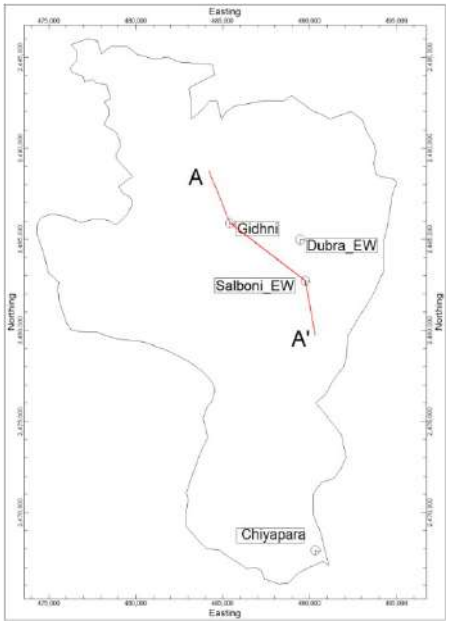


Figure: 11.3.3: 2D section lines along the study area

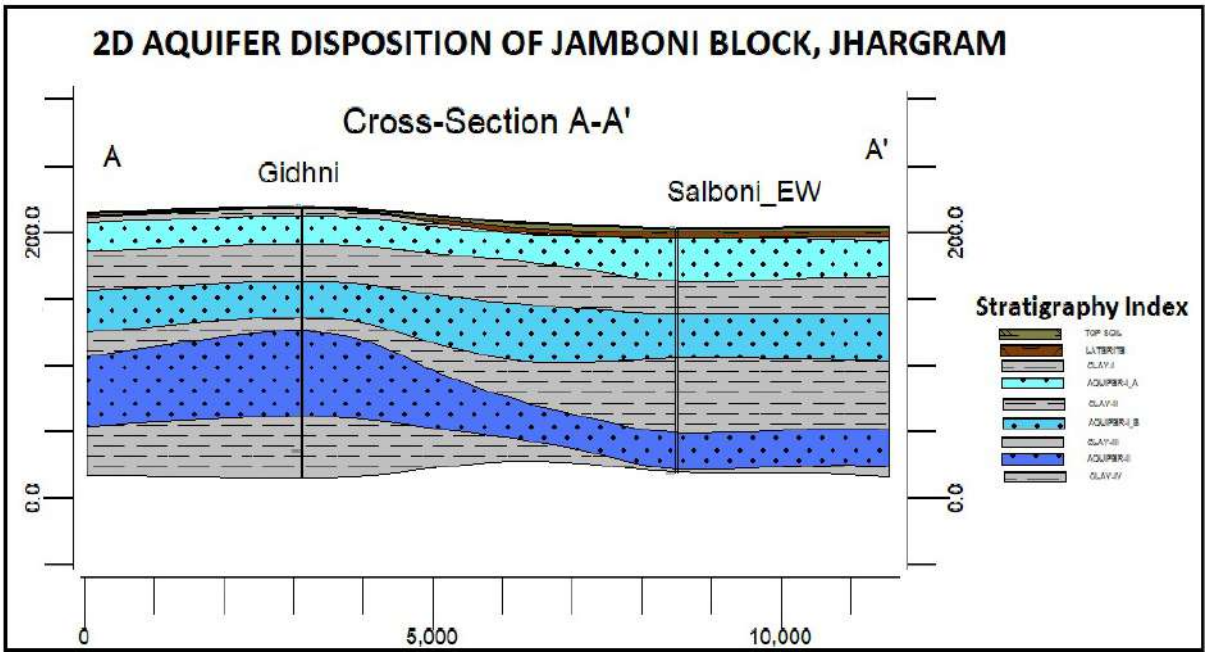


Figure 11.3.4: 2-Dimensional Section in Jamboni Block

Two aquifers are encountered in Jamboni block.

The range of **Aquifer-I** is also known as Shallow aquifer/ weathered zone. The casing depth is here up to 40mbgl. The water bearing zone varied between 12-15 mbgl.

The range of **Aquifer-II** is also known as fracture zone where the interconnected fracture (secondary porosity of the rock) is responsible for the presence of GW. Fractures encountered at a depth of 50 mbgl.

Table 11.3.7: Details of aquifer disposition in Jamboni Block

Blocks (dominant in hard rock)	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I weathered Zone	Aquifer-II Fracture zone					
JAMBONI	2	12-15	(up to 20m)	30-40	50	800	--	-	--	--

Table 11.3.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
JAMBONI	2.2-6.02	0.292	-	2.6-3.82	-	0.027

Ground water quality and issues:

Based on four NHS, four exploratory wells and three observation wells, the range of chemical parameter for the block is given below.

Table 11.3.9: Range of chemical parameters in Jamboni Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
JAMBONI	Aquifer-I	**7.60-7.91**	96-597	2.5-14.7	11-64	0.01-0.03	3.2-9.8	0.17-0.27	55-296
	Aquifer-II	**7.34-7.70**	96-597	2.5-14.7	11-64	0.01-0.03	3.2-9.8	0.17-0.27	55-296

Ground Water Resource:

Table 11.3.10: Details of Ground Water Resource Availability and Utilization in Jamboni Block.

Name of the Block	**JAMBONI**
Total Annual Ground Water Recharge (Ham)	10969.18
Total Natural Discharges (Ham)	1096.92
Annual Extractable Ground Water Recharge (Ham)	9872.26
Total Extraction	1452.75
Annual GW Allocation for Domestic Use as on 2025	291.06
Net Ground Water Availability for future use	8406.89
Stage of Ground Water Extraction (%)	14.72
Categorization (OE/Critical/ Semi-Critical/ Safe)	Safe

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 14.72%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area. Owing to its distinct hydrogeology, it is evident that very less cultivable command area is created by both surface as well as groundwater.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.
  In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.
  Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered.

11.4: SALIENT INFORMATION

Block Name: ***JHARGRAM***

Geographical area (sq. km): **532.2**

Mappable area (sq. km): **489**

District: **Jhargram**

State: **West Bengal**

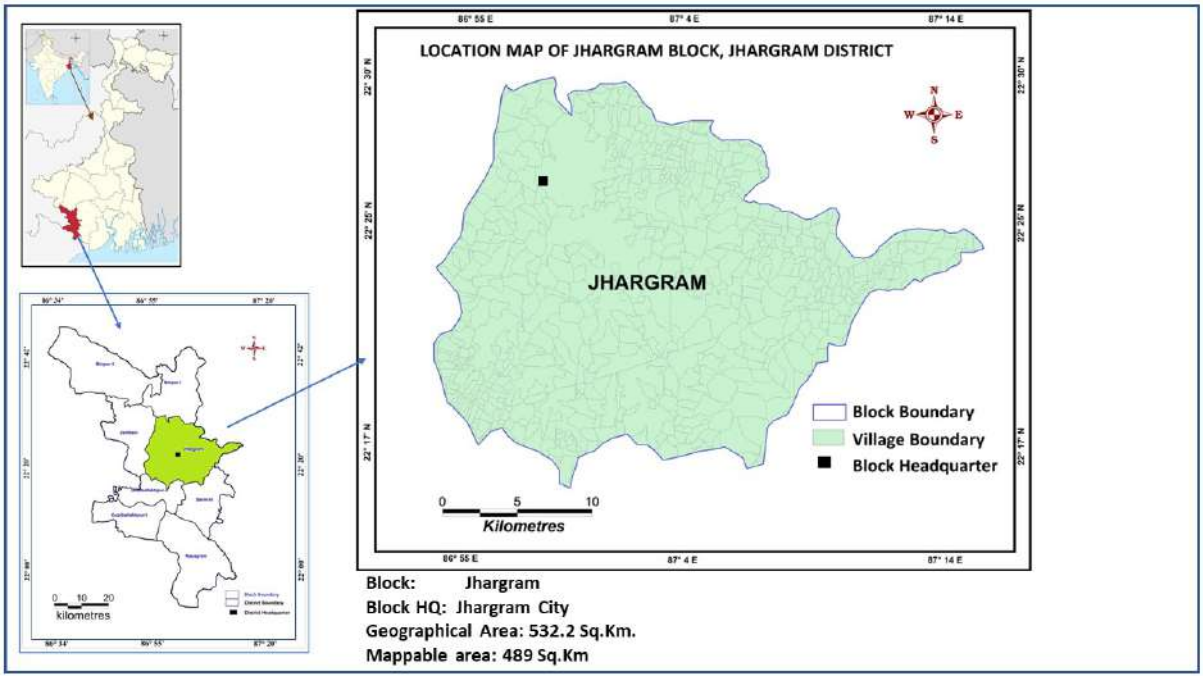


Figure 11.4.1: Location Map of Jhargram Block

Population (as on 2011):

Table 11.4.1: Details of population in Jhargram block.

Rural	Urban	Total	Population Density per Sq.km
170097	**61712**	**231809**	330

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.4.2: Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
JHARGRAM	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha)

Table 11.4.3: Salient Land use features of Jhargram block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
JHARGRAM	51844	13033	4930	32300	6673	126	25627	5254

Table 11.4.4: Crop pattern of Jhargram block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
JHARGRAM	121	0.224	1854	5299	4.635	875	18987	65.627	3456	12	0.027	2216	0	0	0	10	0.011	1069	0	0	0	399	0.341	855	974	0.602	618	5235	135.76	25934	0	0	0

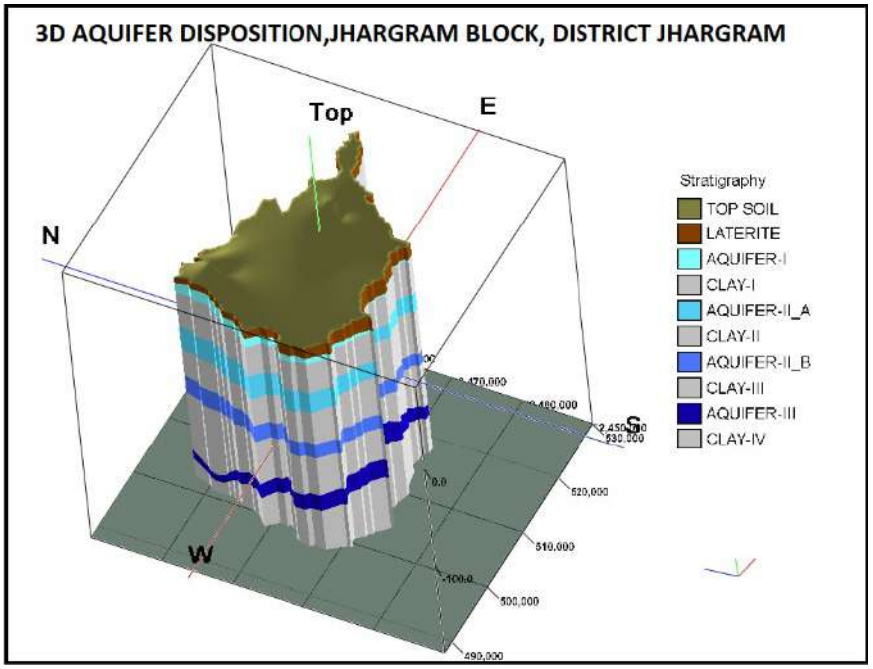
Table 11.4.5: Crop water requirement of Jhargram block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
JHARGRAM	**Cereals**	23096	14650	0.23440	1000	0.25040	0.23440	0.01600
	Coarse Cereals	350	350	0.00175	1000	0.00675	0.00175	0.00500
	Pulses	271	271	0.00068	2000	0.00568	0.00068	0.00500
	Oil Seeds	2278	2278	0.00570	2000	0.01070	0.00570	0.00500
	Fibre	40	40	0.00016	200	0.00096	0.00016	0.00080
	Other Crops	6265	5756	0.03454	3733	0.05693	0.03545	0.02240

Table 11.4.6: Command area (ha) of Jhargram block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
JHARGRAM	39	67.09	466	1296	355	1277.97	24	574.08	29	483	32	1119.54	3214.10	1557.96	4772.06

Disposition of Aquifers:



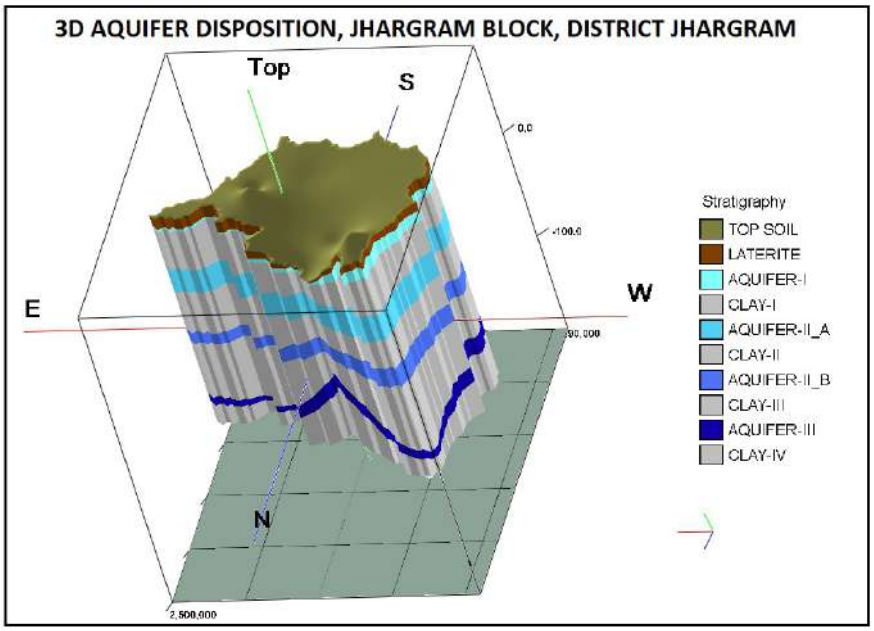


Figure 11.4.2: 3-DimensionalAquifer disposition in Jhargram Block

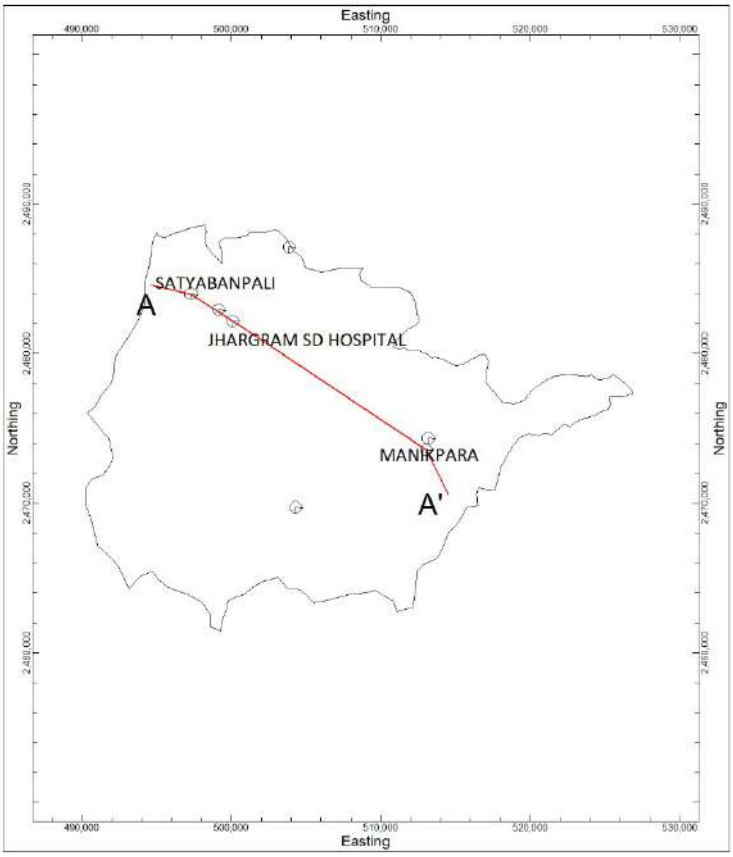


Figure: 11.4.3: 2D section lines along the study area

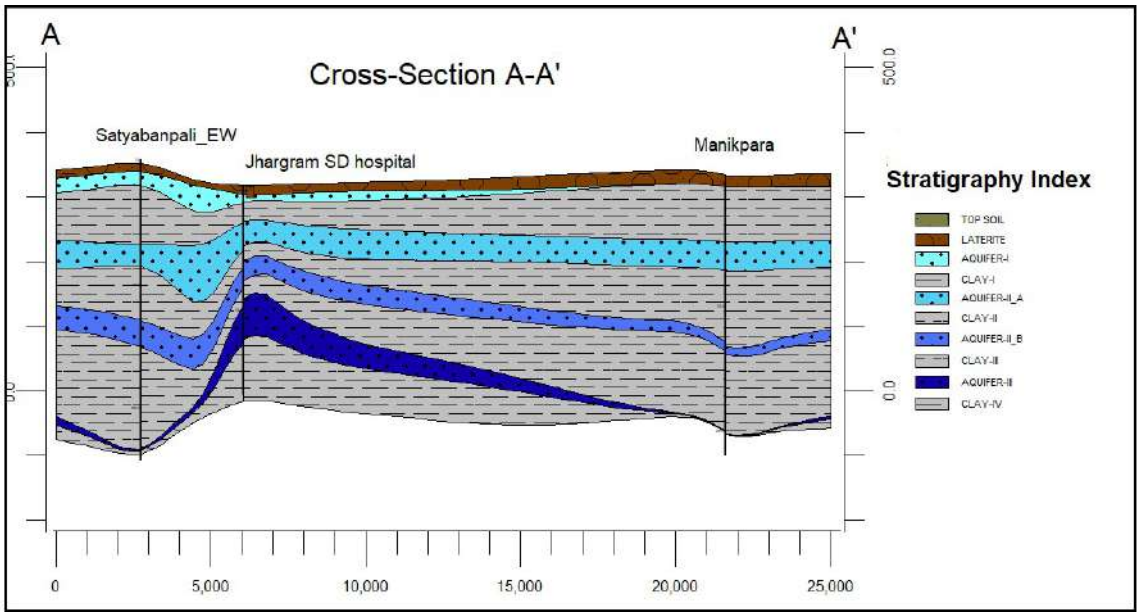


Figure 11.4.4: 2-Dimensional Section in Jhargram Block

The principal aquifer systems encountered in this block is Tertiary Aquifer.
Two aquifers are encountered in this block. The range of **Aquifer-I** is also known as Shallow aquifer/ weathered zone. The casing depth is here up to 17mbgl. The water bearing zone varied between 4-8 mbgl.

The range of **Aquifer-II** is also known as fracture zone where the interconnected fracture (secondary porosity of the rock) is responsible for the presence of GW. Fractures encountered at a depth of 32 mbgl & 45 mbgl.

Table 11.4.7: Details of aquifer disposition in Jhargram Block

Blocks	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I	Aquifer-II					
JHARGRAM	2	12-15	(up to 15m)	30	50	640	--	-	--	--

Table 11.4.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
JHARGRAM	4.07-5.60	0.028	-	3.2-4.6	-	0.163

Ground water quality and issues:

Based on four NHS, four exploratory wells and three observation wells, the range of chemical parameter for the block is given below.

Table 11.4.9: Range of chemical parameters in Jhargram Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
JHARGRAM	Aquifer-I	6.56-7.63	81-767	2.5-54.9	14-99	0.01-0.09	1.6-50.7	0.11-4.01	46-437
	Aquifer-II	6.56-7.63	81-767	2.5-54.9	14-99	0.01-0.09	1.6-50.7	0.11-4.01	46-437

Ground Water Resource:

Table 11.4.10: Details of Ground Water Resource Availability and Utilization in Jhargram Block.

Name of the Block	**JHARGRAM**
Total Annual Ground Water Recharge (Ham)	16899.8
Total Natural Discharges (Ham)	1689.98
Annual Extractable Ground Water Recharge (Ham)	15209.82

Total Extraction	2404.51
Annual GW Allocation for Domestic Use as on 2025	537.42
Net Ground Water Availability for future use	12780.52
Stage of Ground Water Extraction (%)	15.81
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

- The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541 mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.
- The block shows a falling trend of 0.254 m/year during post-monsoon. For monitoring of change in ground water regime in the area, cost of construction of Observation well should be included.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 15.81%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area. Owing to its distinct hydrogeology, it is evident that very less cultivable command area is created by both surface as well as groundwater.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.
  In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.
  Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered

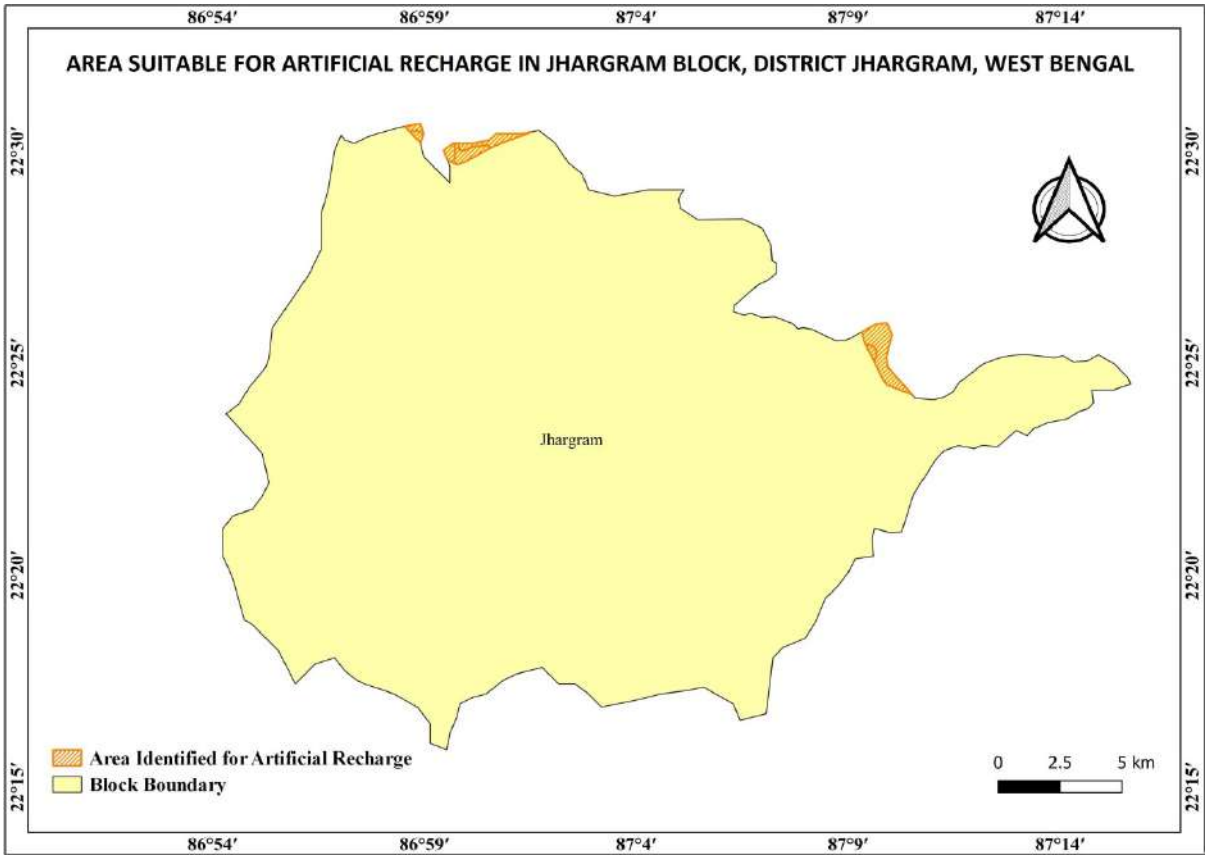


Figure11.4.5: Area Feasible for Artificial Recharge of groundwater for Jhargram Block

Table 11.4.11 Details of structures recommended in feasible area of artificial recharge for Jhargram Block.

Name of the Block	Utilizable Surface Run Off	Allocation of Utilizable Recourse (MCM)							Structures Feasible							Cost of Structures							
		Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	TOTAL
JHARGRAM	0.306	0.153	0.061	0.092	0	0	0	0	0	1	0	0	0	0	0	0	4.0	0	0	0	0	0	4.00

11.5 SALIENT INFORMATION

Block Name: **Sankrail**

Geographical area (sq. km): **276.85**

Mappable area (sq. km): **259**

District: **Jhargram**

State: **West Bengal**

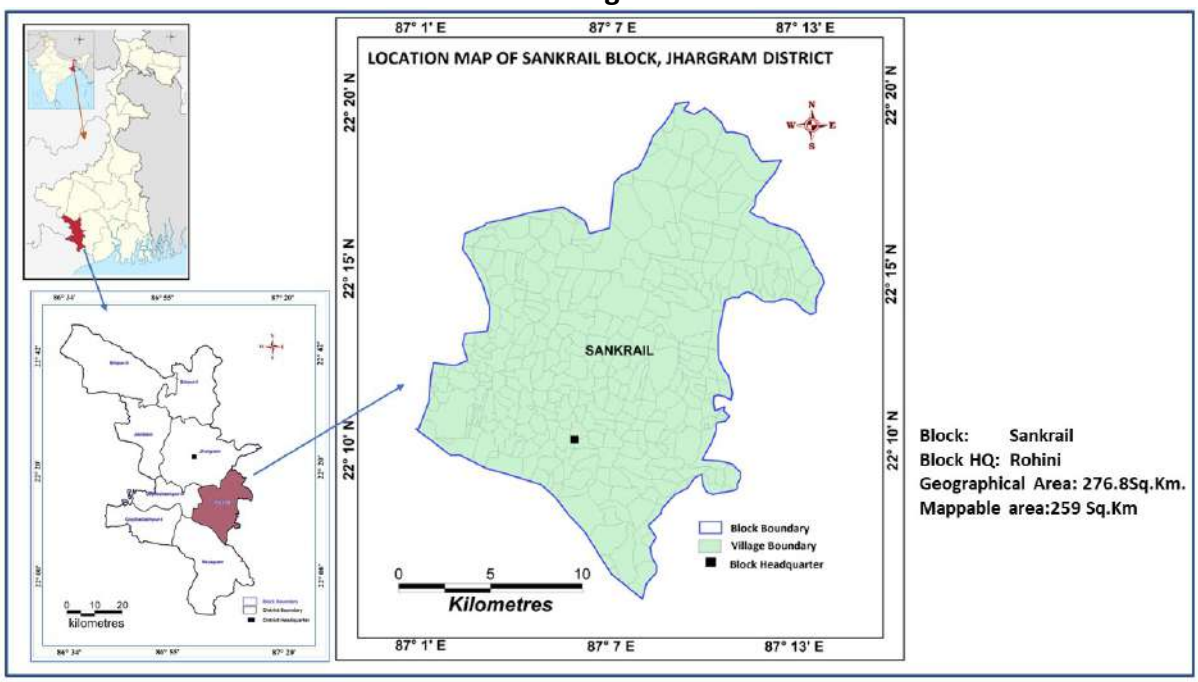


Figure 11.5.1: Location Map of Sankrail Block

Population (as on 2011):

Table 11.5.1: Details of population in Sankrail block.

Rural	Urban	Total	Population Density per Sq.km
83834	-	83834	415

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.5.2: Total Annual Rainfall details for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
SANKRAIL	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.5.3: Salient Land use features of Sankrail block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
SANKRAIL	27680	2379	2017	27683	7430	137	20253	3031

Table 11.5.4: Crop pattern of Sankrail block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
SANKRAIL	1372	2.738	1996	17403	36.526	2099	14225	44.560	3133	24	0.053	2216	983	14.027	14.27	1	0.001	1007	20	0.044	2213	61	0.044	723	317	0.251	791	2	0.038	18765	0	0	0

Table 11.5.5: Crop water requirement of Sankrail block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
SANKRAIL	**Cereals**	19657	10352	0.16563	2000	0.19763	0.16563	0.03200
	Coarse Cereals	75	65	0.00033	2000	0.01033	0.00033	0.01000
	Pulses	1392	1392	0.00348	2000	0.00848	0.00348	0.00500
	Oil Seeds	1514	1514	0.00379	2000	0.00879	0.00379	0.00500
	Fibre	55	55	0.00022	100	0.00062	0.00022	0.00040
	Other Crops	4990	4477	0.02686	2554	0.04219	0.02686	0.01532

Table 11.5.6: Command area (ha) of Sankrail block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
SANKRAIL	46	142.03	1374	5201.43	256	1452.45	76	1742.38	7	25.15	95	395.07	8538.29	420.22	8958.51

Disposition of Aquifers:

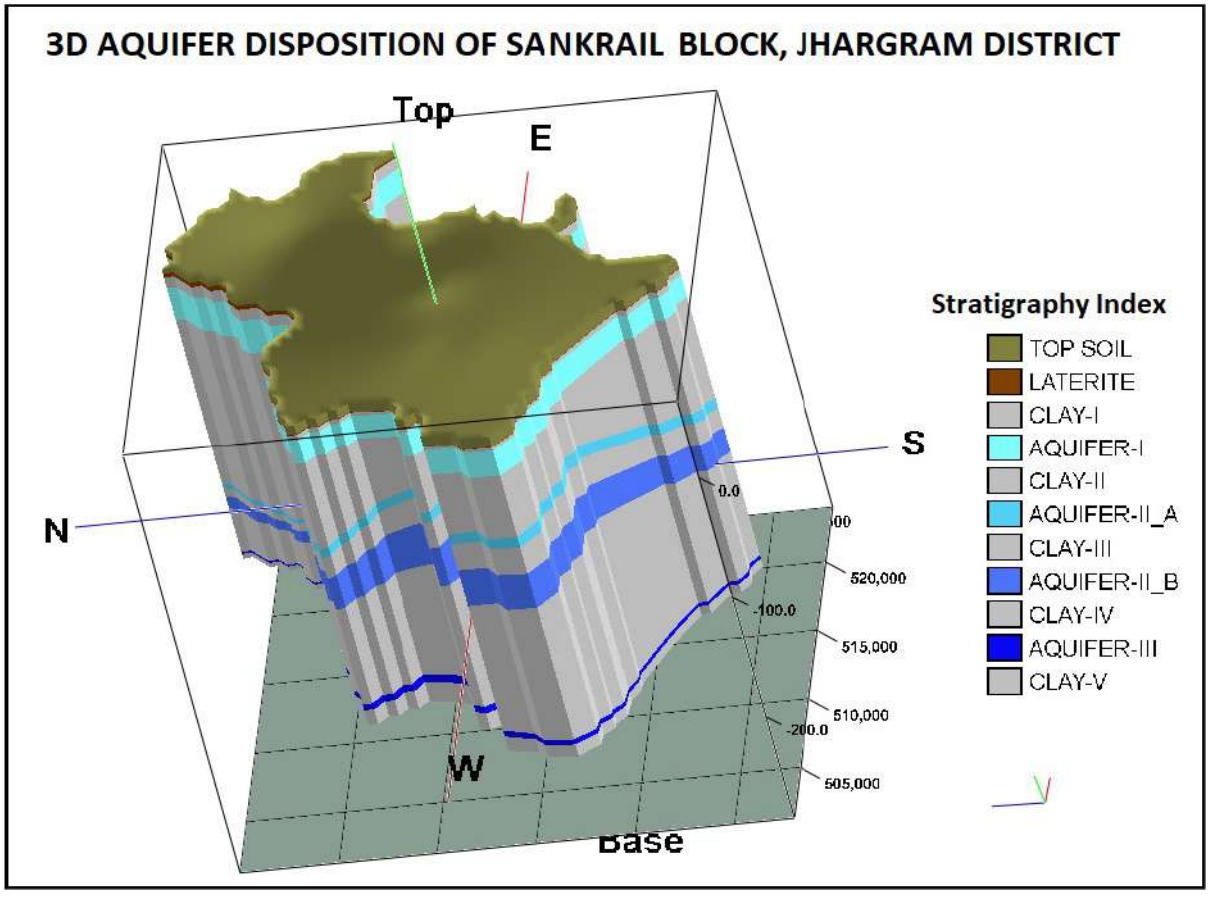


Figure 11.5.2: 3-Dimensional Aquifer disposition in Sankrail Block

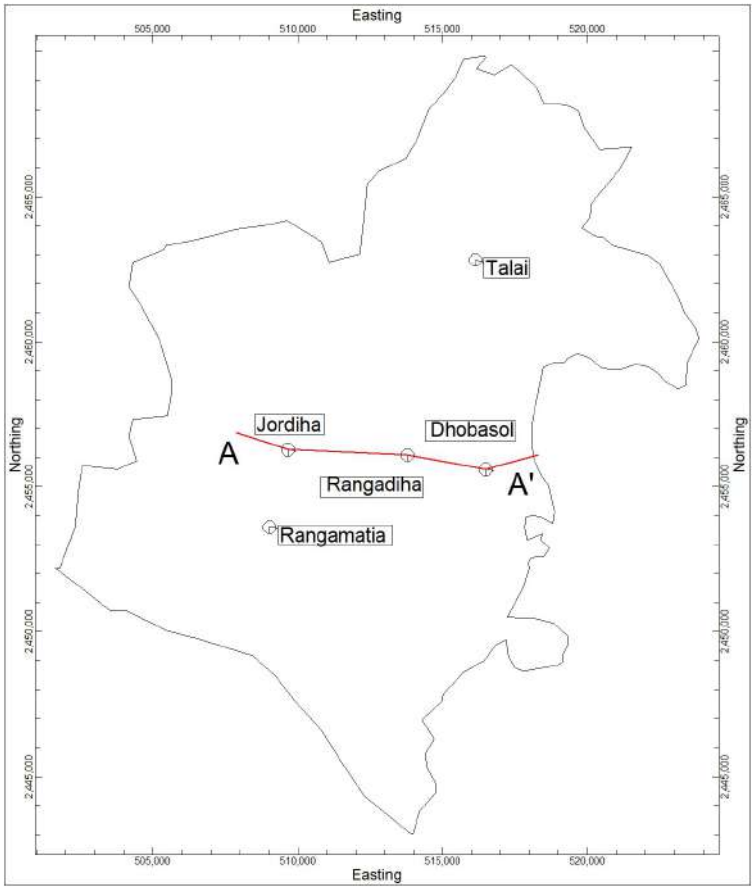


Figure: 11.5.3: 2D section lines along the study area

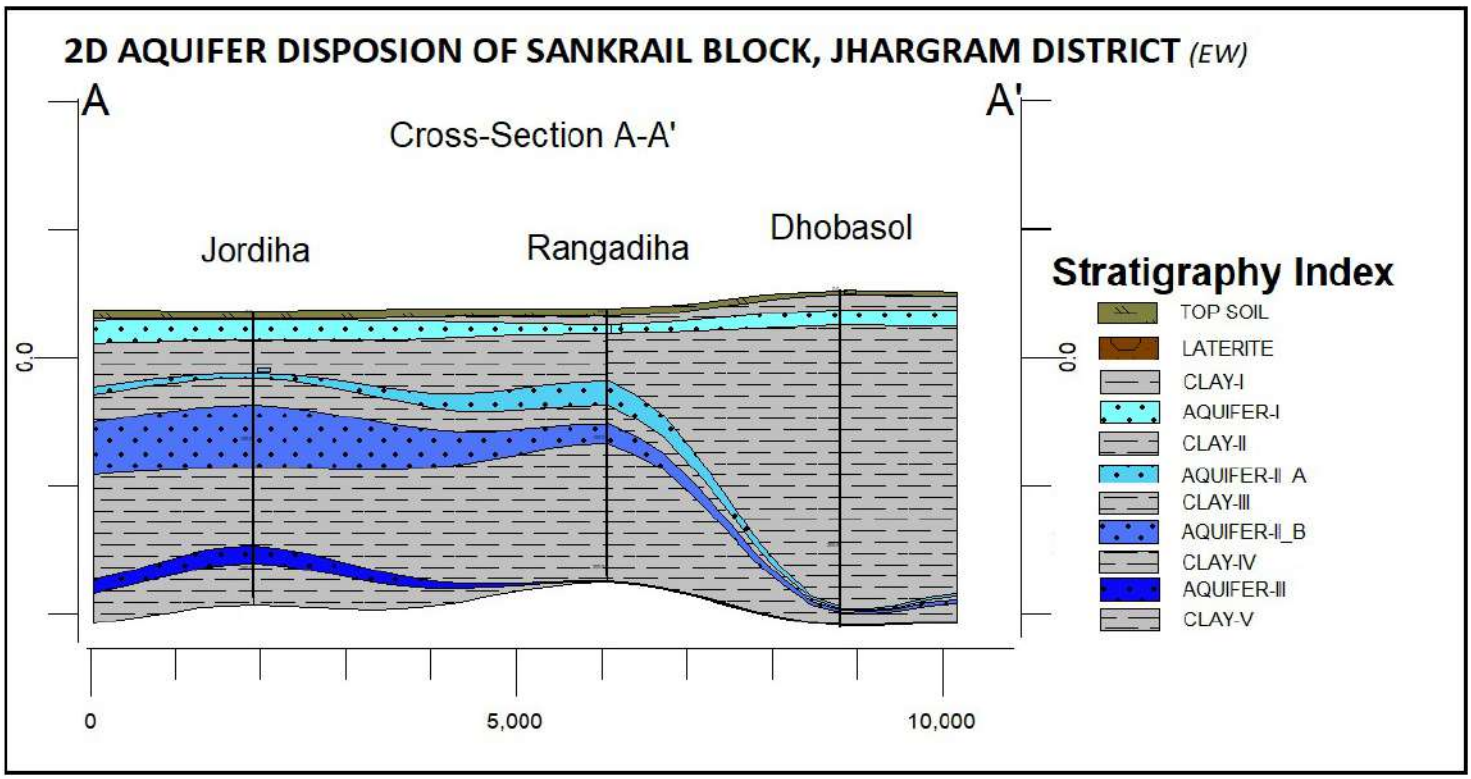


Figure11.5.4: 2-Dimensional Section in Sankrail Block (EW)

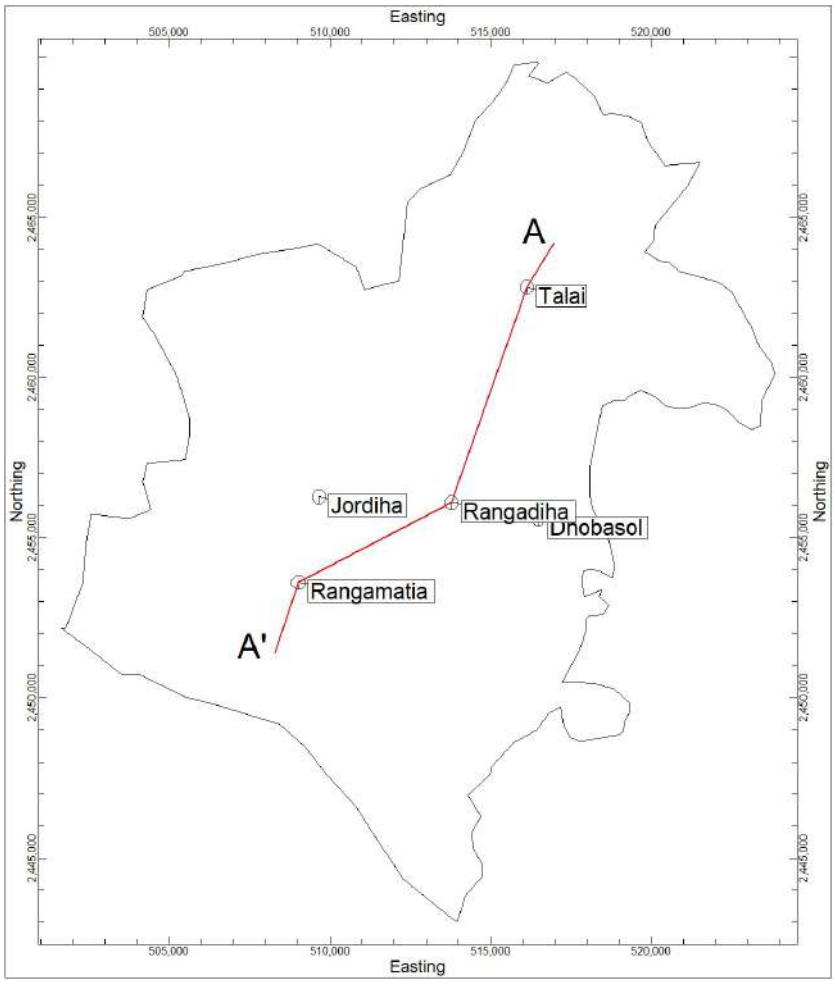


Figure: 11.5.5: 2D section lines along the study area

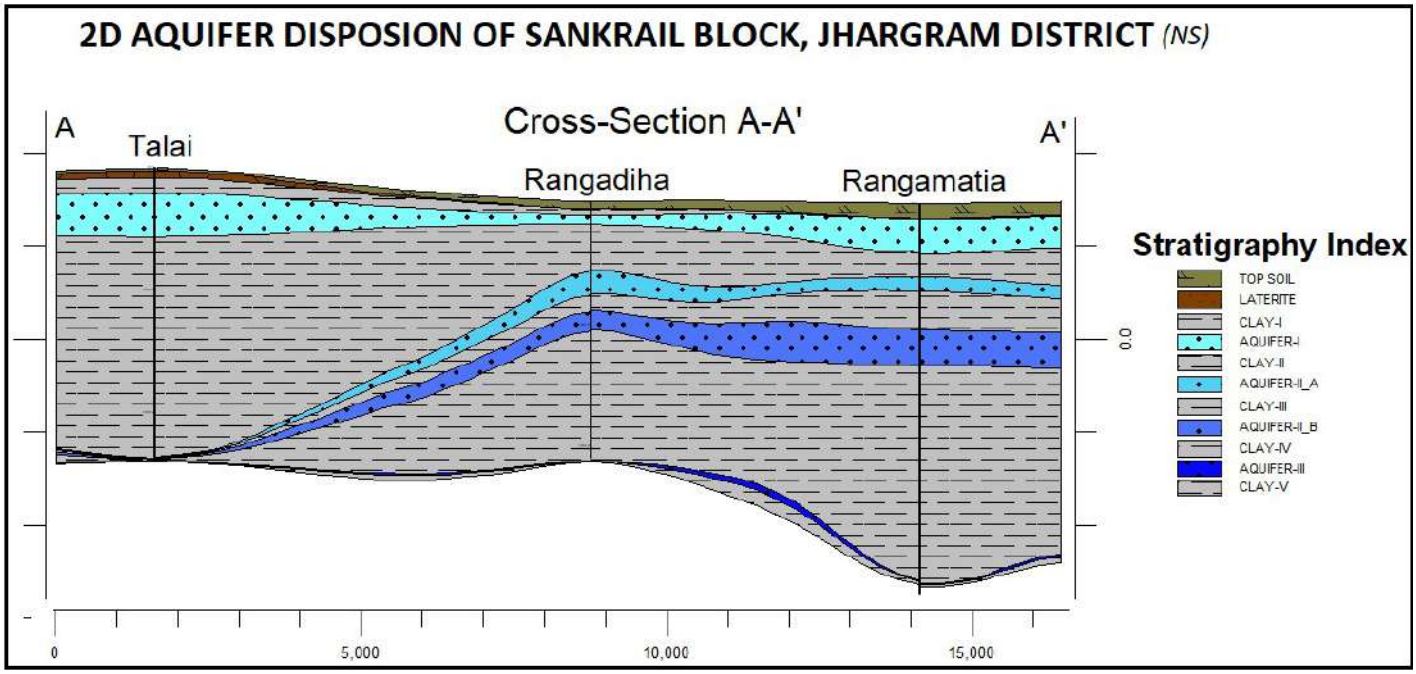


Figure11.5.6: 2-Dimensional Section in Sankrail Block (NS)

Three aquifers are encountered in this block.

The range of **Aquifer-I** is also known as Shallow aquifer/ tertiary alluvium. The casing depth is here up to 40mbgl. The water bearing zone varied between 12-15 mbgl.

The range of **Aquifer-II** is also known as Granular zone where the tertiary alluvium Granular zone at a depth of 51mbgl & 69mbgl.

The range of **Aquifer-III** presence at a depth of 158 mbgl & 187 mbgl.

Table 11.5.7: Details of aquifer disposition in Sankrail Block

Blocks	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I	Aquifer-II & III					
SANKRAIL	3	12-15	(Up to 15m)	40	51-96, 158-187	500-1600	--	-	--	--

Table 11.5.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
SANKRAIL	12-14.5	0.385	---	2.88-10.70	--	0.357

Ground water quality and issues:
Based on four NHS, Key wells/exploratory wells and observation wells, the range of chemical parameter for the block is given below.

Table 11.5.9: Range of chemical parameters in Sankrail Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
SANKRAIL	Aquifer-I	7.28-7.70	76.8-275.7	2.2-13.4	11-60	0.01-0.02	12.1-12.2	0.17-1.43	50-139
	Aquifer-II	7.63-7.80	768.7-806.2	13.4-34.2	67-99	0.08-0.18	21.6-28.1	0.20-0.65	382-429

As per PHED report Fluoride/Iron concentration is above the permissible limit this block. More intensive sampling from this block is recommended.

Ground Water Resource:

Table 11.5.10: Details of Ground Water Resource Availability and Utilization in Sankrail Block.

Name of the Block	**SANKRAIL**
Total Annual Ground Water Recharge (Ham)	9303.8
Total Natural Discharges (Ham)	930.31
Annual Extractable Ground Water Recharge (Ham)	8372.77
Total Extraction	5142.92
Annual GW Allocation for Domestic Use as on 2025	302.15
Net Ground Water Availability for future use	3215.22
Stage of Ground Water Extraction (%)	61.42
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541 mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 61.4%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area. Owing to its distinct hydrogeology, it is evident that very less cultivable command area is created by both surface as well as groundwater.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.
  In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.

Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered

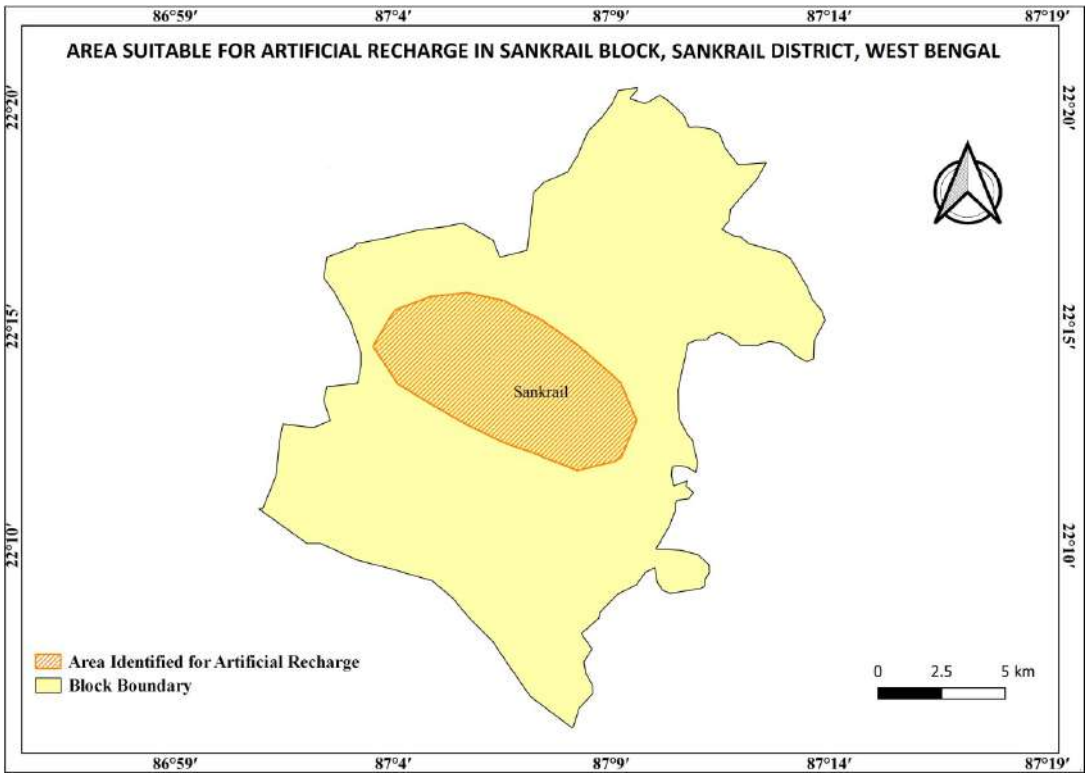


Figure11.5.7: Area Feasible for Artificial Recharge of groundwater for Sankrail Block

Table 11.5.11 Details of structures recommended in feasible area of artificial recharge for Sankrail Block.

Name of the Block	Utilizable Surface Run Off	Allocation of Utilizable Recourse (MCM)							Structures Feasible							Cost of Structures							
		Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	Percolation Tank	REET with RS	Injection Well	Check Dam	Gabion/ Contour Bund	Sub-Surface Dyke	Dug Well Recharge	TOTAL
SANKRAIL	14.040	7.02	2.808	4.212	0	0	0	0	14	28	14	0	0	0	0	112.0	112.0	42.0	00	00	00	00	266

Management Intervention through Harvesting of Surface Runoff and Artificial Recharge:

It has been estimated that the utilizable surface runoff produced in the block is **14.040** MCM. This surface runoff is proposed to be utilized to recharge the shallow aquifer (weathered zone) in the block. As per the available storage space, **14.040** MCM water is required to fill the shallow aquifers in block. Therefore, **14 percolation Tanks** 28 REET with RS and **14** Injection well recharge structures are recommended in the block.

11.6 SALIENT INFORMATION

Block Name: ***Nayagram***

Geographical area (sq. km): **308**

Mappable area (sq. km): **308**

District: **Jhargram**

State: **West Bengal**

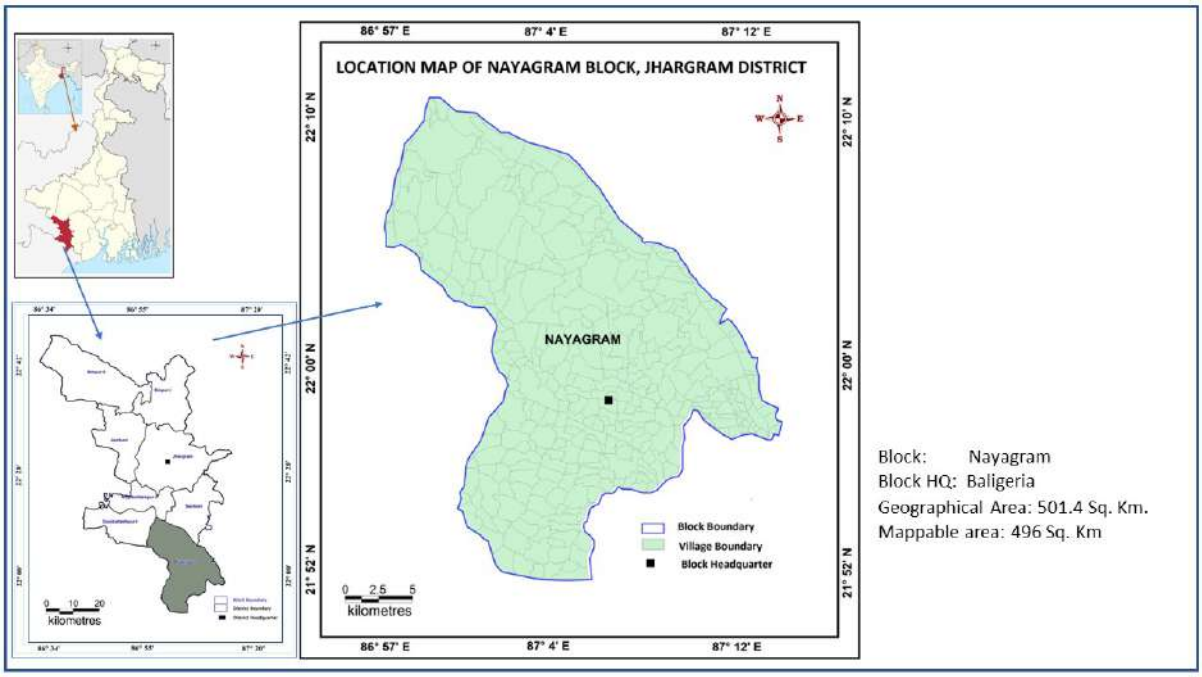


Figure 11.6.1: Location Map of Nayagram Block

Population (as on 2011):

Table 11.6.1: Details of population in Nayagram block.

Rural	Urban	Total	Population Density per Sq.km
156522	-	156522	508

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.6.2 Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Nayagram	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.6.3: Salient Land use features of Nayagram block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
Nayagram	49900	14285	4191	31226	8341	136	22885	8539

Table 11.6.4: Crop pattern of Nayagram block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
NAYAGRAM	7259	16.306	2246	15912	30.519	1918	22354	86.159	3854	0	0	0	467	8.084	17.31	0	0	0	0	0	0	1799	1.857	1032	248	0.235	947	5	0.105	21050	0	0	0

Table 11.6.5: Crop water requirement of Nayagram block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
NAYAGRAM	**Cereals**	25313	3139	0.05109	2000	0.08309	0.05109	0.03200
	Coarse Cereals	295	0	0.00000	2000	0.01000	0.00000	0.01000
	Pulses	547	200	0.00050	4000	0.01050	0.00050	0.01000
	Oil Seeds	2185	985	0.00246	4000	0.01246	0.00246	0.01000
	Fibre	50	0	0.00000	100	0.00040	0.00000	0.00040
	Other Crops	2836	822	0.00493	5985	0.04084	0.00493	0.03591

Table 11.6.6: Command area (ha) of Nayagram block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
NAYAGRAM	165	431.78	21	89.46	82	1015.68	2	42.80	3	9.35	39	1593.20	1579.72	1602.55	3182.27

Disposition of Aquifers:

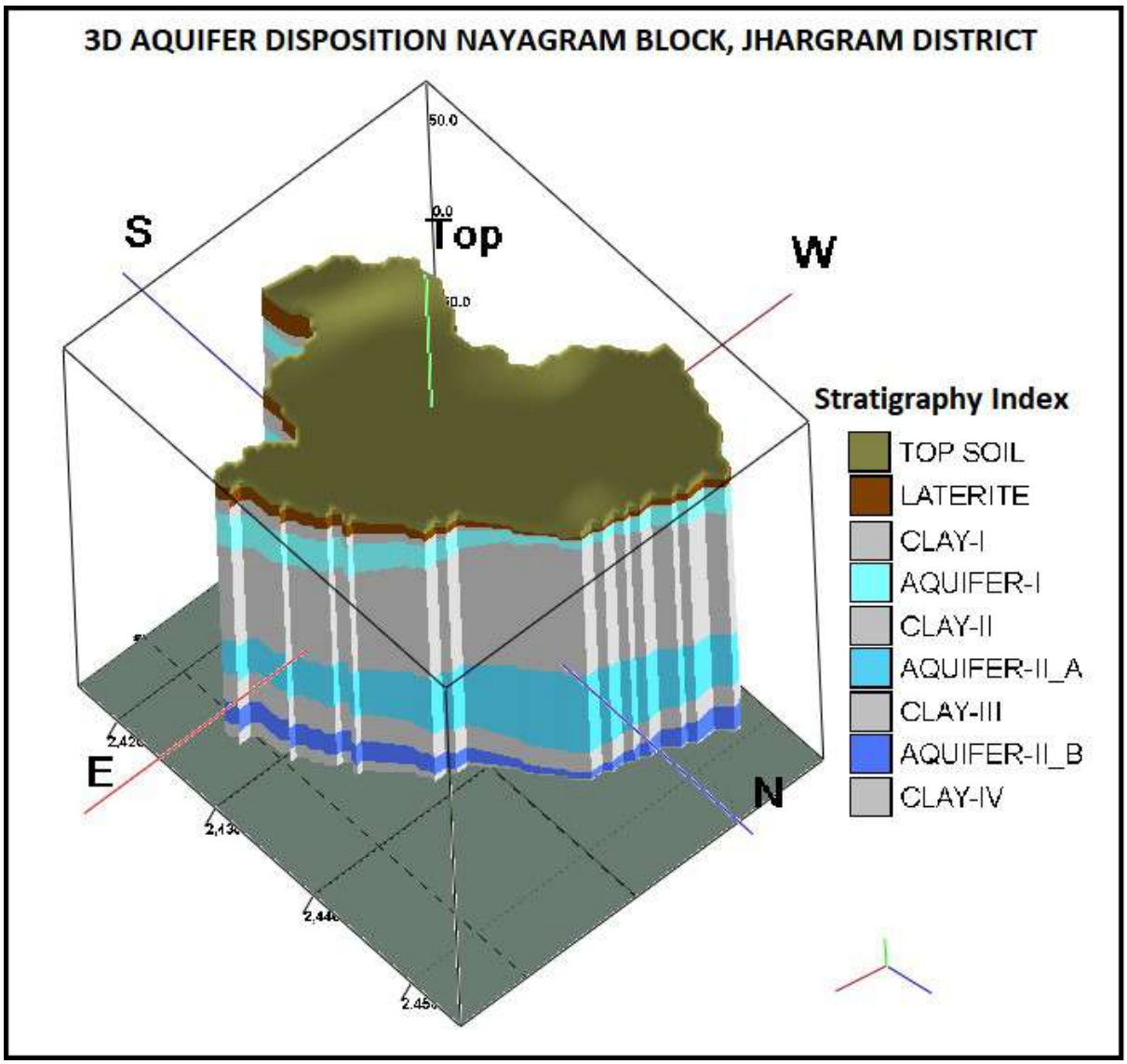


Figure 11.6.2: 3-DimensionalAquifer disposition in Nayagram Block

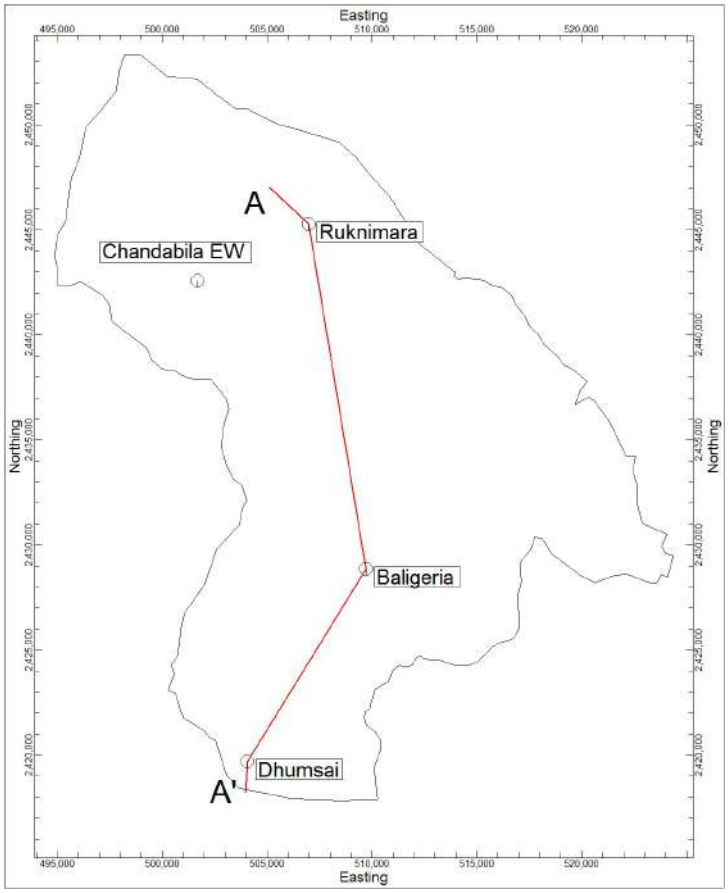


Figure: 11.6.4: 2D section lines along the study area

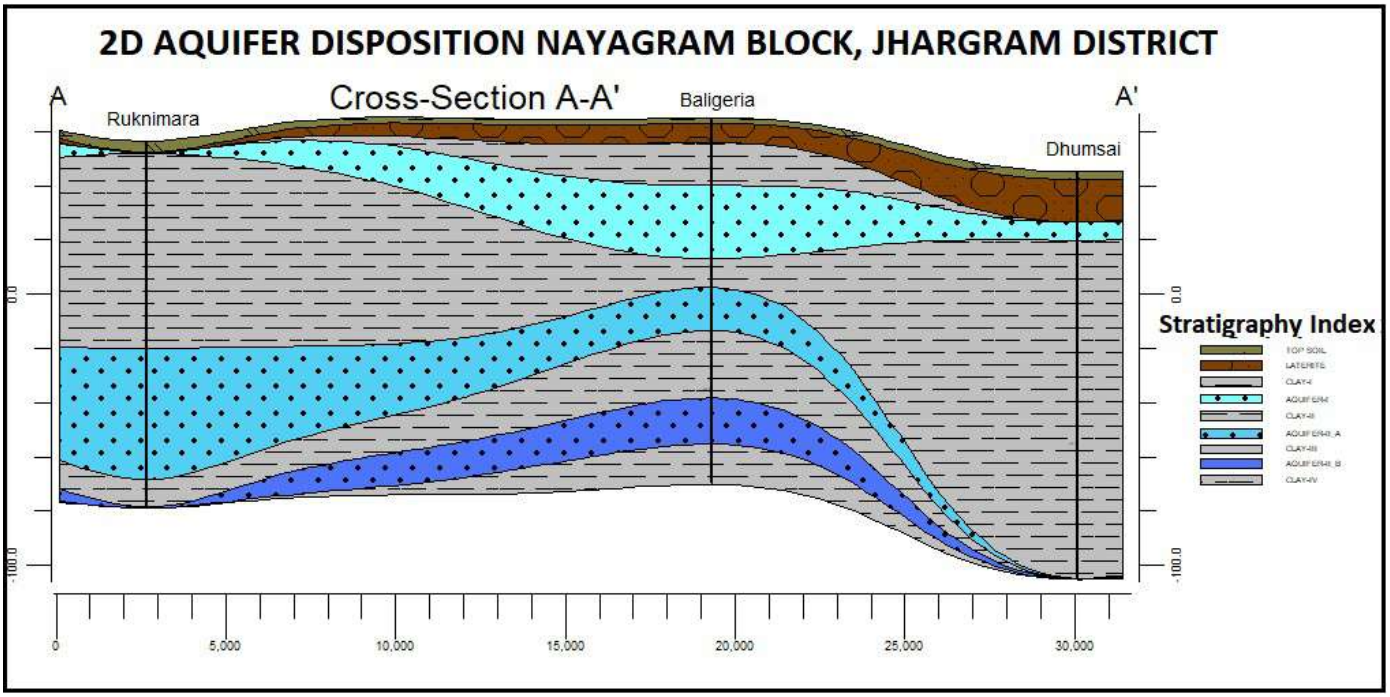


Figure 11.6.5: 2-Dimensional Section in Nayagram Block

The principal aquifer systems encountered in this block is Alluvium.

Two aquifers are encountered in this block.

The range of **Aquifer-I** is also known as Shallow aquifer. The casing depth is here up to 15mbgl. The water bearing zone varied between 12-15 mbgl.

The range of **Aquifer-II** is also known as fracture zone where the Granular zone is responsible for the presence of GW. Fractures encountered at a depth of 51-96 mbgl.

Table 11.6.7: Details of aquifer disposition in Nayagram Block

Blocks	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I Granular Zone	Aquifer-II Granular zone					
NAYAGRAM	**2**	12-15	(up to 15m)	30-40	51-96	415	--	-	--	--

Table 11.6.8: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
NAYAGRAM	N/A	N/A	N/A	N/A	N/A	N/A

Ground water quality and issues:

Based on four NHS, exploratory wells and observation wells, the range of chemical parameter for the block is given below.

Table 11.6.9: Range of chemical parameters in Nayagram Block

Block	Aquifer Type	pH	EC (µS/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Fe (mg/l)	Measured Hardness (mg/l)
NAYAGRAM	Aquifer-I	7.36-8.0	104.5-818.5	3.2-57.7	14-53	0.03-2.14	0.6-3.6	0.20-1.65	64-415
	Aquifer-II	7.36-8.0	104.5-818.5	3.2-57.7	14-53	0.03-2.14	0.6-3.6	0.20-1.65	64-415

Ground Water Resource:

Table 11.6.10: Details of Ground Water Resource Availability and Utilization in Nayagram Block.

Name of the Block	NAYAGRAM
Total Annual Ground Water Recharge (Ham)	**14813.18**
Total Natural Discharges (Ham)	**1481.31**
Annual Extractable Ground Water Recharge (Ham)	**13331.87**
Total Extraction	**567.27**
Annual GW Allocation for Domestic Use as on 2025	**383.75**
Net Ground Water Availability for future use	**12742.62**
Stage of Ground Water Extraction (%)	**4.26**
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	**Safe**

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

- The block has two commissioned public water supply schemes by PHED. There is one ongoing as well. However, there is still recorded deficit in supply of drinking water as the schemes do not reach to every mouza in the block. Therefore, there should be a general practice of conservation through rainwater harvesting, considering an adequate normal monsoon rainfall of 1541 mm which the block receives. The conserved rainwater can be utilized for drinking purpose by filtering through Horizontal Roughing Filters. The water from the lands can be channeled to ponds for recharge in the weathered zones and this water can be tapped through open dug wells for domestic and drinking purpose.

Ground Water Management Plan for irrigation purposes:

- Although ground water development in the block is low with stage of ground water development at 4.26%, further development should be done in planned manner to harness the additional available resource for site specific sustainable development.
- In view of low yield of the area, large diameter dug wells with adequate storage are another viable option for irrigation in favorable condition, thus creating a small command area. Owing to its distinct hydrogeology, it is evident that very less cultivable command area is created by both surface as well as groundwater.
- Modern methods of irrigation like sprinkler and drip irrigation methods are encouraged.
- Crops with low water requirement should be preferred.
  In view of adequate rainfall in the area, excavation of tanks with large catchment areas, construction of check dam, nallah bunds, sub-surface dykes along the stream channels at suitable locations can be implemented to raise ground water level as well as to augment irrigation facilities.
  Irrigation by surface water may be increased. In addition to surface lift from canal & surface flows, rain water harvesting may also be considered.

11.7 SALIENT INFORMATION

Block Name: *Gopiballavpur-I*
Geographical area (sq. km): 279
Mappable area (sq. km): 219
District: Jhargram
State: West Bengal

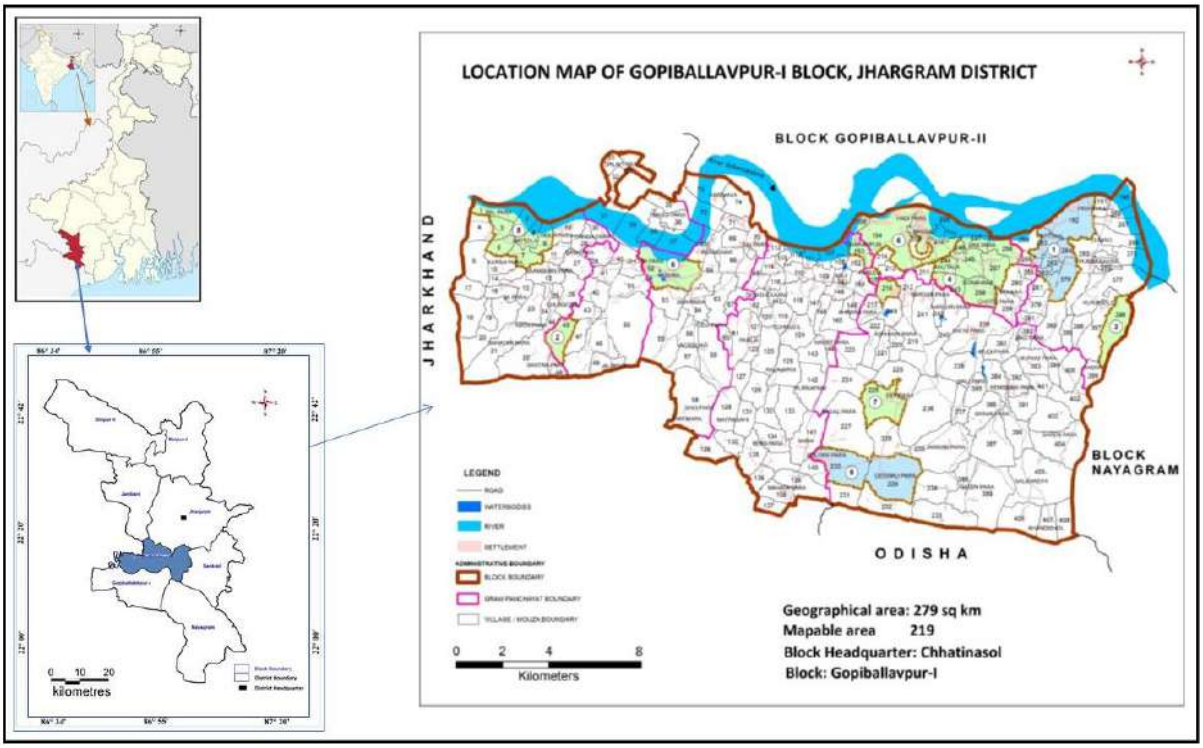


Figure 11.7.1: Location Map of Gopiballavpur-I Block

Population (as on 2011):

Table 11.7.1: Details of population in Gopiballavpur-I block.

Rural	Urban	Total	Population Density per Sq.km
108254	-	108254	392

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table11.7.2 Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Avg. Annual Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GOPIBALLAVPUR-I	1465.17	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.7.3: Salient Land use features of Gopiballavpur-I block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping
GOPIBALLAVPUR-I	27662	5170	3826	19876	4797	1

Table 11.7.4: Crop pattern of Gopiballavpur-I block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
GOPIBALLAVPUR-I	648	1.092	1685	1937	1.965	1014	874	2.672	3057	143	0.329	2298	0	0	0	0	0	0	0	0	0	2567	2.942	1146

Table 11.7.5: Crop pattern of Gopiballavpur-I block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)
GOPIBALLAVPUR-I	Cereals	13760	6260	0.10016	1000	0.11616
	Coarse Cereals	105	105	0.00053	1000	0.00553
	Pulses	425	425	0.00771	3000	0.00856
	Oil Seeds	3085	3085	0.00771	3000	0.01521
	Fibre	75	75	0.00030	200	0.00110
	Other Crops	2426	2380	0.01428	1887	0.02560

Table 11.7.6: Culturable Command area (ha) of Gopiballavpur-I block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
GOPIBALLAVPUR-I	34	69.18	1375	3605.21	69	233.77	29	688.14	19	118.67	33	97.44	4596.30	215.11	4812.41

Table 11.7.7: Command area (ha) of Gopiballavpur-I block

Name of Block	Canal Area	Tank		DTW		STW		RLI		ODW		Others		Total	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
GOPIBALLAVPUR-I	1123	654	48	7	30	1238	2530	16	1123	654	48	7	30	1238	2530

(Source: Bureau of Applied Economics & Statistics, Govt. of WB as on 2013-14)

Disposition of Aquifers:

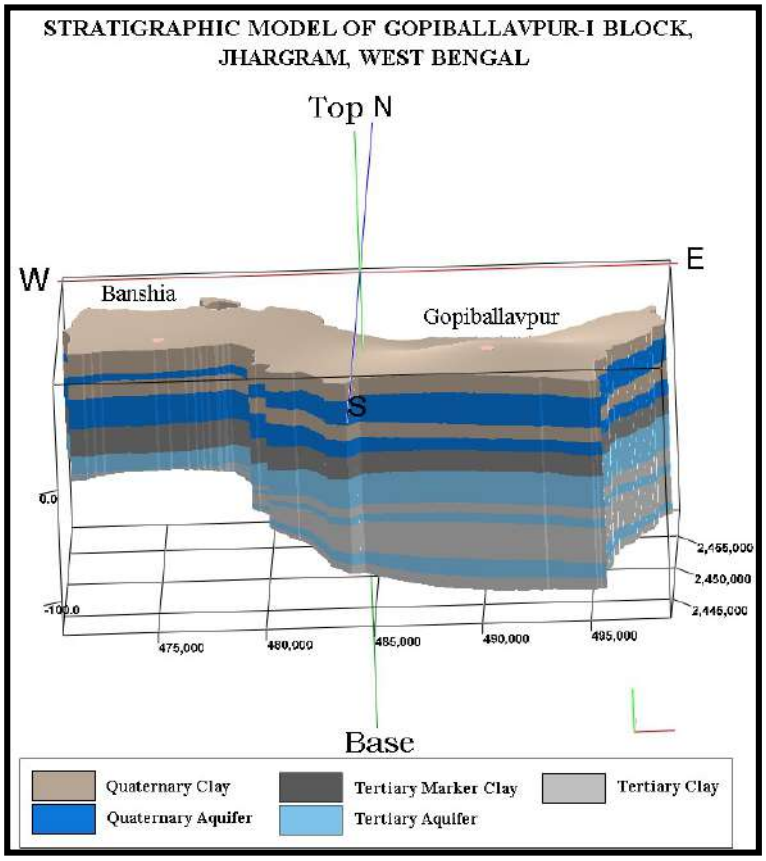


Figure 11.7.2: 3-DimensionalAquifer disposition in Gopiballavpur-I Block

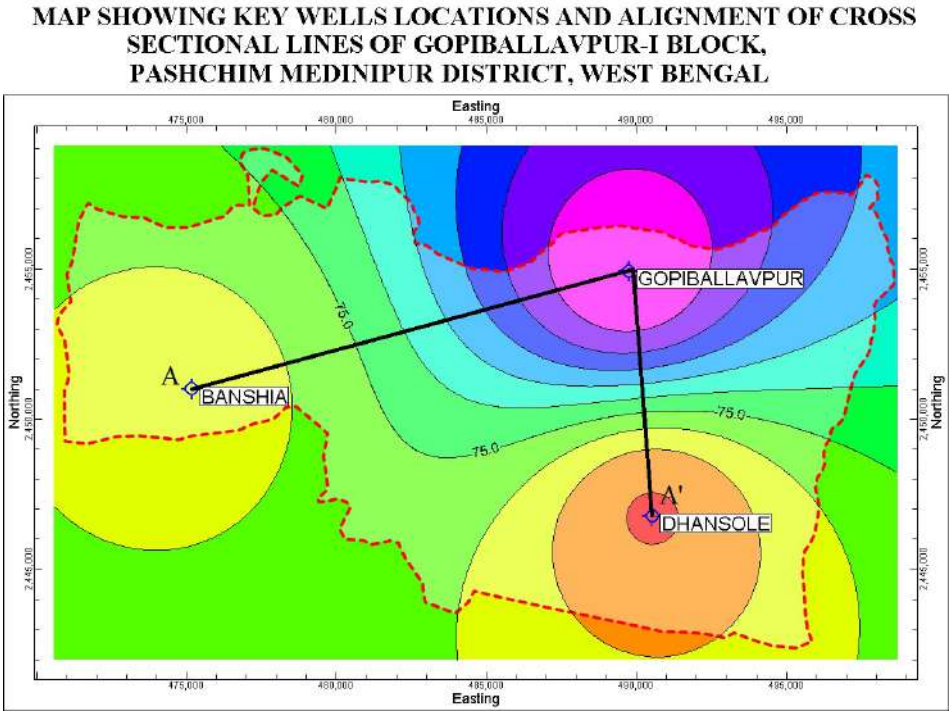


Figure: 11.7.3: 2D section lines along the study area

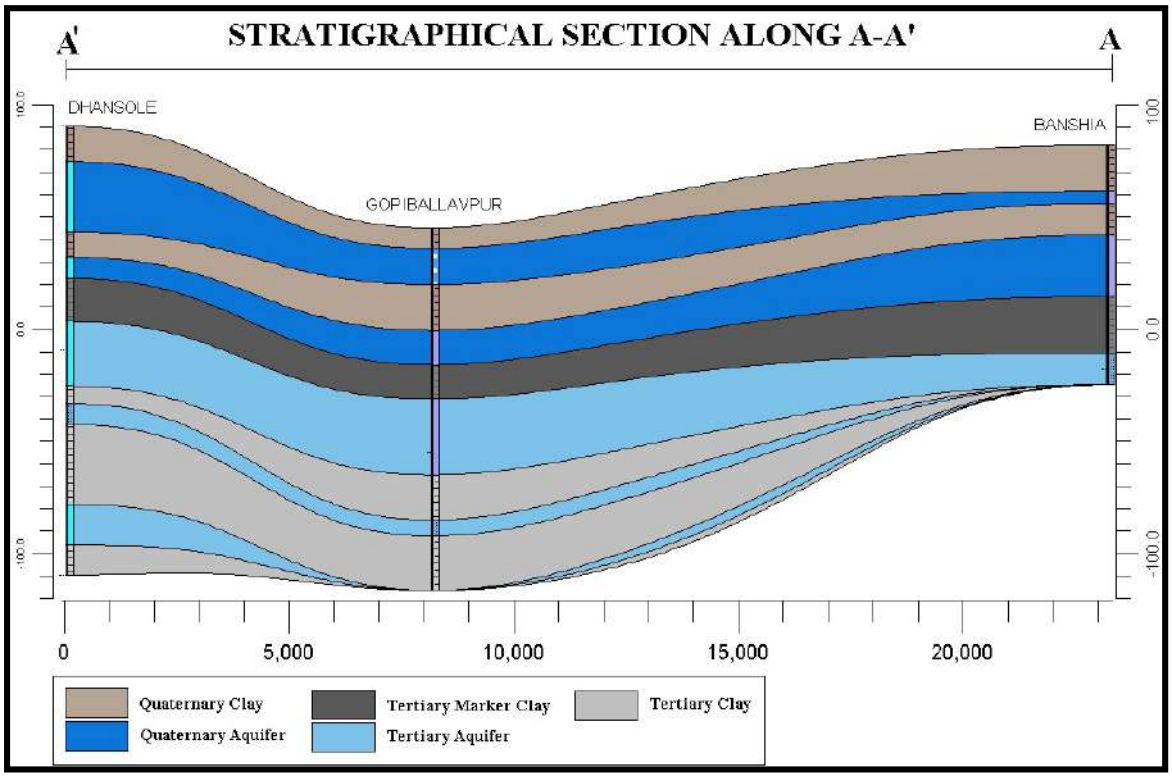


Figure 11.7.4: 2-Dimensional Section in Gopiballavpur-I Block

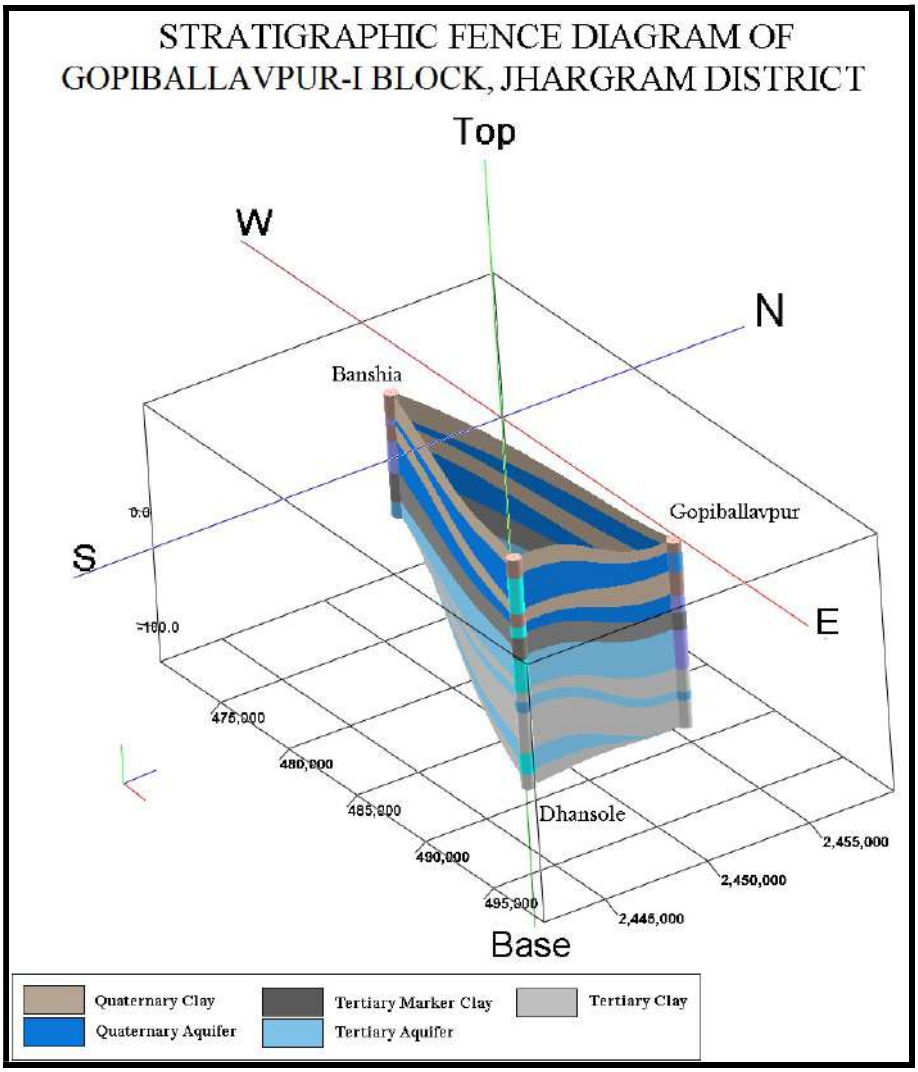


Figure 11.7.5: Stratigraphical Fence Diagram of Gopiballavpur-I Block viewed from South-East

As per data collected, there are two aquifer groups: Aquifer Group–I (Quaternary) and Aquifer Group–II (Tertiary) in Gopiballavpur-I Block

Aquifer Group – I: Group – I Aquifers are formed by Quaternary sediments i.e., upper litho-system on top of the stratigraphic succession. Group– I contain 2 nos. of individual aquifers (QT-Aq–1 & QT-Aq–2), which exist consistently throughout the block. These two aquifers are having different thickness. Cumulative thickness of these two aquifers of Group – I is ranging from 31.39– 40.71 m, which is conspicuously high and occurring within the depth span of 9.10 – 67.82 m bgl. Available Chemical data show that ground water is neutral and all physicochemical properties and chemical constituents including EC (371µs/cm), Fluoride (0.60mg/lt), Nitrate (6 mg/lt) and Iron (0.50 mg/lt) are well within maximum permissible limit.

Aquifer Group – II: Group – II Aquifers are formed by Tertiary sediments i.e. lower litho system, which are also frequently explored and tapped by tube wells as they are substantially thick (7.10-33.80 m), prolific and consistent and occurring up to 186.78 m bgl. Thus, the drinking water and irrigation water demands are also partly fulfilled by the Group-II aquifers. As per collected data of Gopiballavpur-I block, up to the explored depth of 200.02 m three Group-II aquifers have been identified, which are designated by TR-Aq-1, TR-Aq-2 and TR-Aq-3. Within the depth of 100 m bgl, only one Tertiary aquifer is to be encountered. Ground water from these aquifers is fresh (EC: 279-469 µs/cm) and potable as all chemical constituents including Iron (0.332–0.82 mg/lt) are within the maximum permissible limit.

Table 11.7.8: Details of aquifer disposition in Gopiballavpur-I Block

Blocks	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I	Aquifer-II					
GOPIBALLAVPUR-I	2	33- 45	(Up to 48.00)	5.50–31.39	9.32-27.50	Aq-1 375.1 Aq-2 1139.6	--	14.10	--	--

Table 11.7.9: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
GOPIBALLAVPUR-I	10.15 to 16.29	0.020	--	3.33 to 9.93	--	0.056

Ground water quality and issues:

As per the Laboratory Analysis report and spot analysis report by portable kit in field the ground Water available in both Aquifer Group–I and Group–II is mostly fresh (EC in Gr-I: 371 and in Group–II: 279 - 469 µs/cm), potable and free from any contamination as all the chemical constituents are well within maximum permissible limit throughout the block and so should be considered fit for drinking and domestic purposes.

Iron (Fe) concentration in ground water from both the Group-I and Group-II aquifers is above desirable limit (up to 0.3 mg/l) but within maximum permissible limit (Gr-I aquifer: 0.50 mg/l), whereas in Group-II aquifers: 0.332 to 0.82 mg/l). So, the iron removal plants should be installed in the water supply schemes where the concentration is more than 0.3 mg/l (desirable limit) for making the extracted ground water potable before starting its community supply.

Table 11.7.10: Range of chemical parameters in Gopiballavpur-I Block

VILLAGE	Type	Latitude	Longitude	pH	EC	TDS	TH (as Ca-)	Ca^{+2} (as	Mg^{+2} (as Mg)	Na^{+}	K^{+}	CO_3^{-2}	HCO_3^{-1}	TA	Cl^{-}	NO_3^{-1}	SO_4^{-2}	F^{-}	PO_4^{-}	SiO_2	Fe
GOPIBALLAVPUR	DW	22.21054	86.89526	7.65	371	250.98	145	29	18	25	3.59	0	156	127	30	6	18	0.60	0.10	26.0	0.50

Ground Water Resource:

Table 11.7.11: Details of Ground Water Resource Availability and Utilization in Gopiballavpur-I Block.

Name of the Block	*GOPIBALLAVPUR-I*
Total Annual Ground Water Recharge (Ham)	9215.17
Total Natural Discharges (Ham)	921.51
Annual Extractable Ground Water Recharge (Ham)	8293.66
Total Extraction	5105.56
Annual GW Allocation for Domestic Use as on 2025	281.4
Net Ground Water Availability for future use	3172.56
Stage of Ground Water Extraction (%)	61.56
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan:

Ground Water Management Plan for drinking purpose:

- As per ground water policy, drinking is the priority in using ground water.

Normally the development of deeper Tertiary Aquifers is recommended for drinking water. However, as the Tertiary aquifers are deep-seated and the construction of drinking water tube wells tapping only these deeper aquifers is costly, it may be recommended that the drinking water tube wells could also be constructed by tapping the Quaternary aquifers in a limited manner, if necessary, when there is no quality problem. As an alternative, the drinking water tube wells may be constructed by tapping the deepest/lowermost Group-I (quaternary) aquifer and shallowest/ uppermost Group-II (Tertiary) aquifer jointly or in future 40% of the drinking water tube wells should be constructed solely by tapping the Group-I aquifers and 60% tube wells solely by tapping Group-II aquifers. Tube wells should be constructed by taking utmost care after ascertaining the presence and the position of potential aquifers

containing fresh sweet water, checking the salinity (EC value) of individual granular zones (i.e. aquifers) and taking precise decision on the well length and well pipe assembly on the basis of lithology and electrical log. After construction of tube wells and before commissioning of any scheme for starting supply of drinking water from deep tube wells, a long duration pumping with constant discharge and a rigorous water quality testing through chemical analysis are mandatory in order to find out the well characteristics & performances and aquifer parameters & performances and to determine the EC values and Iron, Arsenic, Fluoride and Nitrate contents.

Status of existing drinking water supply schemes:

As per status of Water Supply Schemes by PHED, Govt. of WB, in Gopiballavpur-I block a population of 33912 out of total population 108254, 215 Mouza out of total 216 Mouza and 98 habitations from total 199 inhabited villages are so far covered by drinking water.

Ground Water Management Plan for irrigation purposes:

- It is recommended that deeper Tertiary aquifers should be kept intact for drinking water and only the deeper/second aquifer of Group-I in Quaternary formation should be exploited for irrigation. Planning should also be made to construct new surface water bodies following various methods of collection of rain water and then to use these surface water sources for fulfilling the major part of annual demand of irrigation water.
- Old surface water bodies like small streams, canals (khal), lake, ponds etc. may be re-excavated, rejuvenated and used in a larger scale for irrigating the cultivated land.
- Irrigation by advanced techniques like sprinkler, drip etc. and land-shaping like ridge/broad-bed and furrow, construction of farm ponds etc. may also be adopted. Crops consuming lesser irrigation water like Mustard, Groundnut, Potato, Pulses and Vegetables may be cultivated in an enhanced magnitude and simultaneously the 'Boro' paddy cultivation must be reduced day by day for saving the ground water for future.
- Conjunctive use of ground water and surface water may be practiced for irrigation, where it seems obligatory to use ground water as a complementary part for irrigation.
- Regular monitoring of iron (Fe) is a must since long term use of iron rich ground water for irrigation may reduce the soil fertility and hamper the crop yield in future.

11.8 SALIENT INFORMATION

Block Name: *Gopiballavpur-II*

Geographical area (sq. km): 195

Mappable area (sq. km): 145

District: Jhargram

State: West Bengal

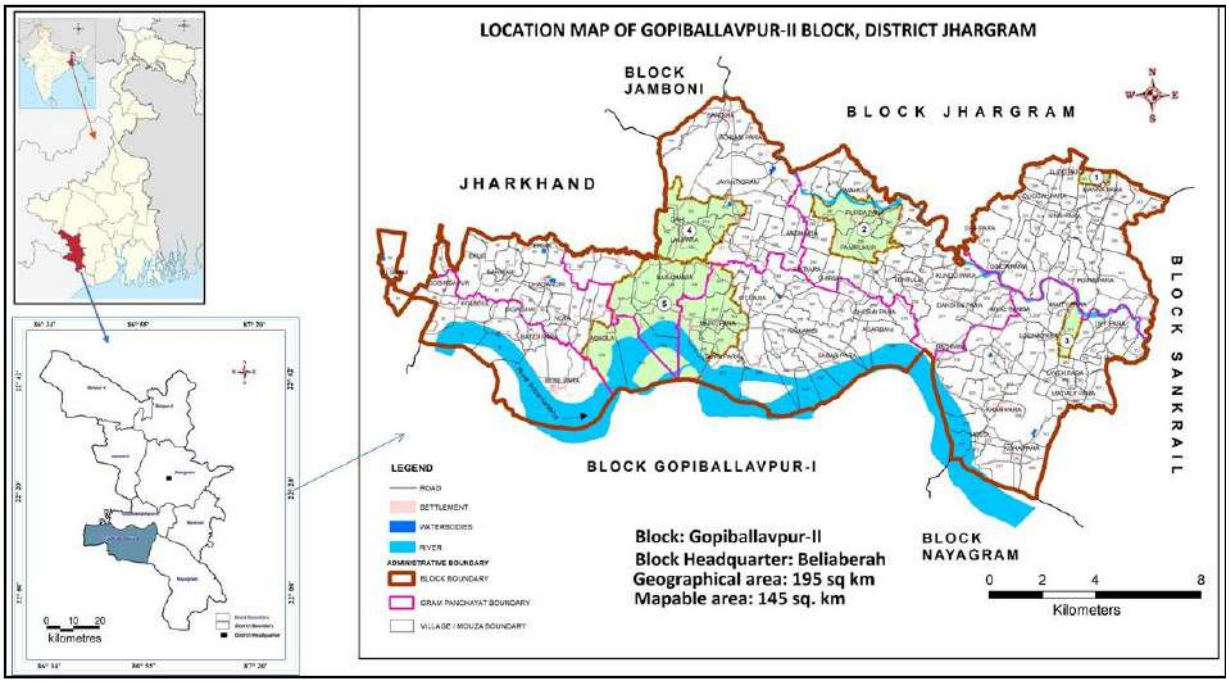


Figure 11.8.1: Location Map of Gopiballavpur-II Block

Population (as on 2011):

Table *11.8.1*: *Details of population in Gopiballavpur-II block.*

Rural	Urban	Total	Population Density per Sq.km
156522	-	156522	508

Rainfall: Average annual rainfall for the period 2008 -18 is 1460.67 (in mm)

Table 11.8.2 Details of total Annual Rainfall for the last Eleven years at Jhargram station.

Block Name	Normal Rainfall	Rainfall										
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GOPIBALLAVPUR-II	**1541**	1965.3	1261.1	803.4	1769.7	1349.2	2264.2	1096.2	1263.6	1288.1	1407.8	1598.8

Agriculture& Irrigation (area in ha):

Table 11.8.3: Salient Land use features of Gopiballavpur-II block

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Gross cropped area	Area shown more than once	Cropping intensity (%)	Net area sown	Area under other use
GOPIBALLAVPUR-II	19217	3853	568	19013	4726	133	14287	3853

Table 11.8.4: Crop pattern of *Gopiballavpur-II* block

Block	Aus			Aman			Boro			Wheat			Jute			Musur			Khesari			Mustard			Til			Potato			Sugarcane		
	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield	Area	Prod.	Yield
Gopiballavpur-II	2773	6.276	2263	30753	65.765	2138	951	2.935	3087	562	1.617	2877	0	0	0	552	0.912	1653	0	0	0	559	0.410	733	1276	1.138	892	5024	191.90	38197	0	0	0

Table 11.8.5: Crop pattern of Gopiballavpur-II block

Block	Crop	Area sown (ha)	Irrigated area (ha)	Crop water demand (BCM)	Area to be Irrigated (ha)	Water potential required (BCM)	Existing Water Potential (BCM)	Water Potential to be created (BCM)
Gopiballavpur-II	Cereals	15850	5525	0.08840	1000	0.10440	0.0884	0.01600
	Coarse Cereals	30	30	0.00015	500	0.00265	0.00015	0.00250
	Pulses	285	285	0.0071	1500	0.00446	0.00071	0.00375
	Oil Seeds	1940	1940	0.00485	1500	0.00860	0.00485	0.00375
	Fibre	20	20	0.00008	200	0.00088	0.00008	0.00080
	Other Crops	888	888	0.00533	2447	0.02001	0.00533	0.01468

Table 11.8.6: Command area (ha) of Gopiballavpur-II block

Block Name	Dug well		Shallow Tube well		Medium Tube well		Deep Tube well		Surface Flow		Surface Lift		CCA (ha.)		Total CCA (ha.)
	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	No.	CCA (ha.)	Ground Water	Surface Water	
GOPIBALLAVPUR-II	67	181.89	523	1667.24	320	1436.47	15	371.82	0	0.00	49	1975.07	3657.42	1975.07	5632.49

Table 11.8.7: Command area (ha) of Gopiballavpur-II block

Name of Block	Canal Area	Tank		DTW		STW		RLI		ODW		Others		Total	
		No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
GOPIBALLAVPUR-II	-	125	200	4	125	400	4000	6	120	400	55	-	-	935	4500

(Source: Bureau of Applied Economics & Statistics, Govt. of WB as on 2013-14)

Disposition of Aquifers:

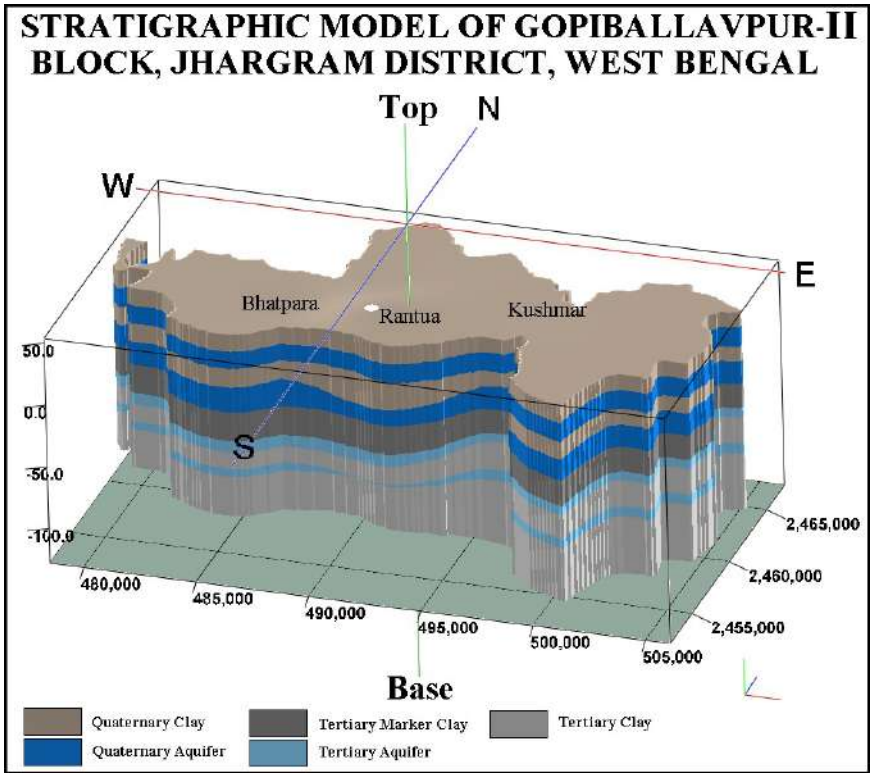


Figure 11.8.2: 3-DimensionalAquifer disposition in Gopiballavpur-II Block

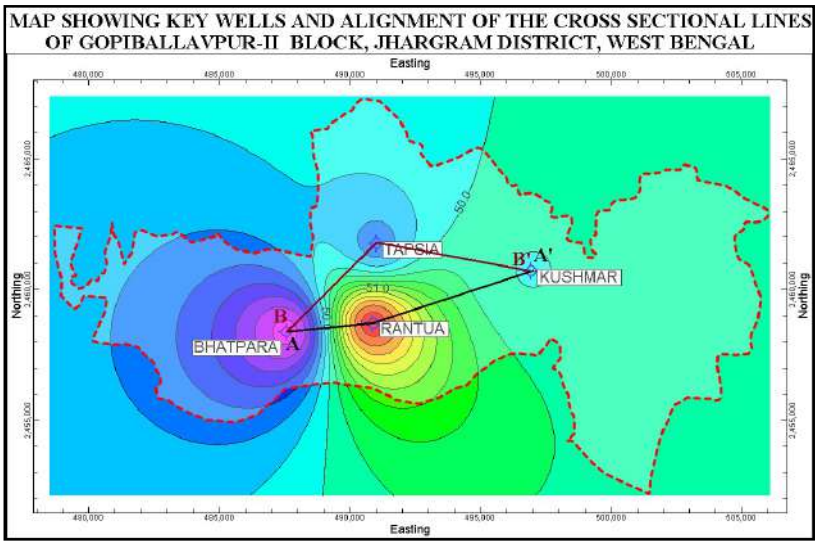


Figure: 11.8.3: 3-D section lines along the study area

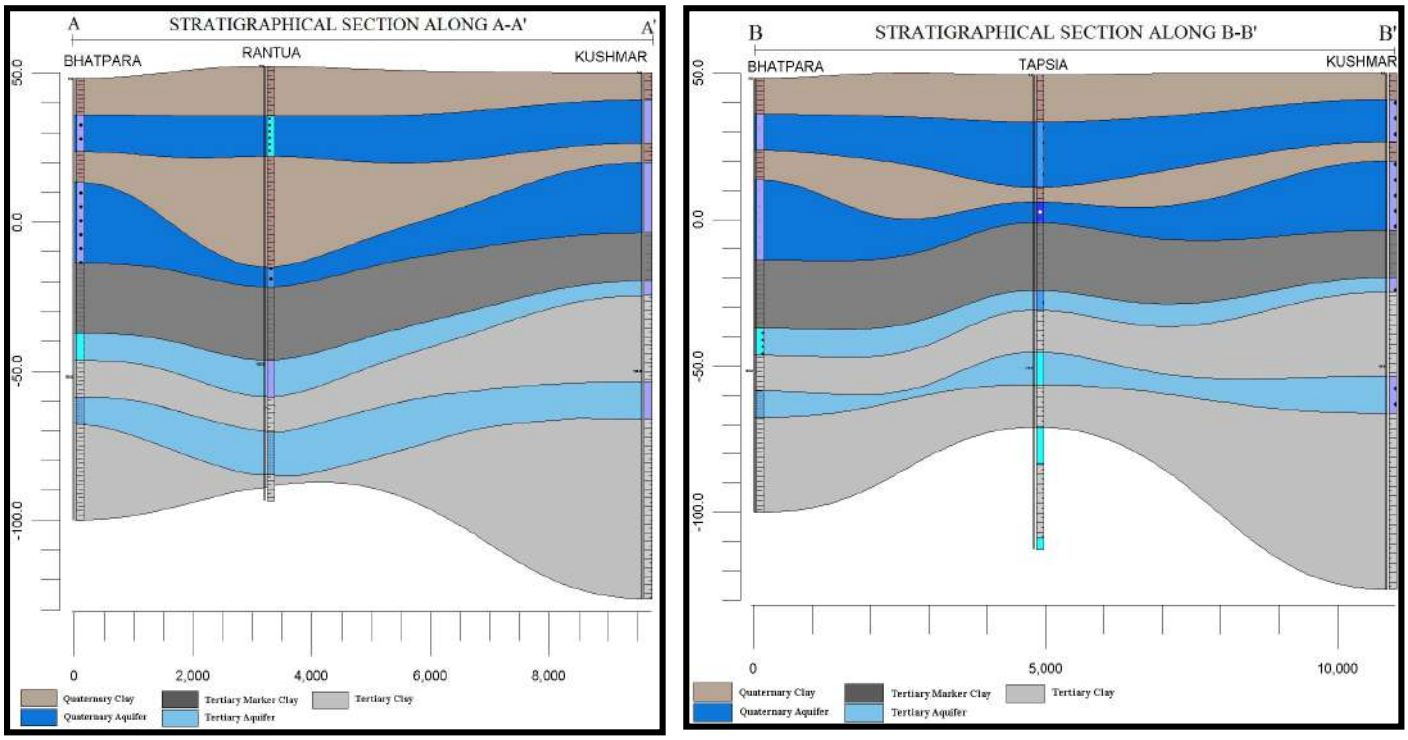


Figure 11.8.4: A &B : 2-Dimensional Cross Section in Gopiballavpur-II Block

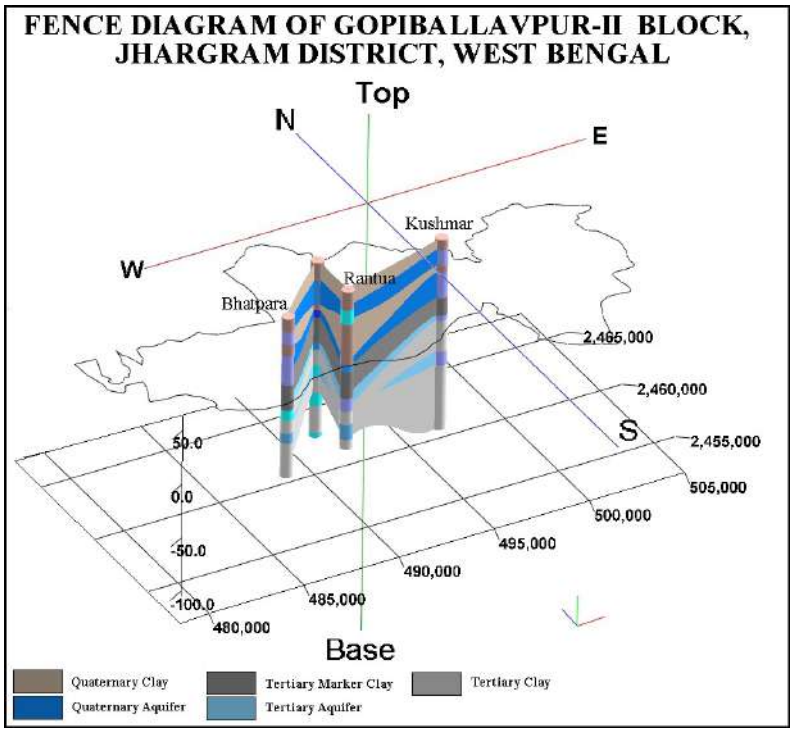


Figure 11.8.5: Stratigraphical Fence Diagram of Gopiballavpur-II Block viewed from North

The principal aquifer systems encountered in this block is Semi consolidated rock.

Two aquifers are encountered in this block.

Aquifer Group – I: Group – I Aquifers are formed by Quaternary sediments i.e., upper litho-system on top of the stratigraphic succession. Group– I contain 2 nos. of individual aquifers (QT-Aq–1 & QT-Aq–2), which exist consistently throughout the block. These two aquifers are having different thickness. In Rantua-Topsia area, the upper aquifer i.e., QT-Aq–1 is much thicker than the lower one i.e., QT-Aq–2. Cumulative thickness of these two aquifers of Group – I is ranging from 20.10 – 39.73 m, which is noticeably high and occurring within depth span of 9.00 – 74.20 m bgl. Ground water is neutral and all physicochemical properties and chemical constituents including EC (399 – 710 µs/cm), Fluoride (0. 9 – 0.51 mg/l), Nitrate (1 - 7 mg/l) and Iron (0.01 mg/l) are well within maximum permissible limit.

Aquifer Group - II: Group – II Aquifers are formed by Tertiary sediments i.e., lower litho-system, which are also frequently explored and tapped by the tube wells as they are of moderate thickness (4.94 – 14.20 m) but prolific and consistent throughout the block and occurring up to 132.71 m bgl. Thus, the drinking water and irrigation water demands are also partly fulfilled by the Group-II aquifers. As per collected data of Gopiballavpur-II block, up to the explored depth of 176.35 m three Group-II aquifers have been identified, which are designated by TR-Aq-1, TR-Aq-2, and TR-Aq-3. Within the depth of 100

m bgl, generally only one Tertiary aquifer i.e., the uppermost one is supposed to be encountered with an exception at Rantua, where this aquifer occurs within depth range 98.75 – 111 m bgl. Ground water from these aquifers is fresh (EC: 341 - 808 µs/cm) and potable as all chemical constituents including Iron (0.0 – 0.05 mg/l), Fluoride (0. 0 – 0.41 mg/l) and Nitrate (0.0 mg/l) are well within the desirable limit (0.3 mg/l).

Table 11.8.8: Details of aquifer disposition in Gopiballavpur-II Block

Blocks	No. of Aquifers	Water bearing zone	Casing depth	Aquifer Thickness (m)		Discharge (lpm)	T (m^2/day)	SWL (mbgl)	Drawdown (mbgl)	S
				Aquifer-I	Aquifer-II					
GOPIBALLAVPUR-II	2	Aq1- 20-39 Aq-2-30-74	(Up to 16m)	9-16	30-67	357.1-1197	--	11.06	8.94-14.26	--

Table 11.8.9: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends

Block	Pre-monsoon Trend			Post-monsoon Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
GOPIBALLAVPUR-II	8.62- 16.15	0.068	--	3.64-11.15	0.171	0.292

Ground water quality and issues:

As per the Laboratory Analysis report ground Water available in both Aquifer Group–I and Group–II is mostly fresh (EC in Group-I: 399 -710 and in Group–II: 341 - 808 µs/cm), potable and free from any contamination as all the chemical constituents are well within maximum permissible limit throughout the block and so should be considered fit for drinking and domestic purposes.

Table 11.8.10: Range of chemical parameters in Gopiballavpur-II Block

VILLAGE	Type of Well	pH	EC (µs/ cm) 25^0C	TDS	TH (as Ca-CO3)	Ca+2 (asCa)	Mg+2 (as Mg)	Na+	K+	CO3-2	HCO3-1	TAas Ca -CO3	Cl-	NO3-1	SO4-2	F-	PO4-	SiO2	Fe
Topsia	**DW**	**7.81**	**399**	**261.27**	**172**	**37**	**19**	**23**	**3.19**	**0**	**159**	**130**	**75**	**1**	**6**	**0.51**	**0.45**	**12.00**	
Beliaberia	**Cyclin TW**	**7.47**	**710**	**428.37**	**241**	**65**	**19**	**43**	**1.99**	**0**	**299**	**245**	**28**	**7**	**69**	**0.09**	**0.00**	**13.00**	**0.01**

As per available chemical data, Iron (Fe) concentration in ground water from both the Group-I and Group-II aquifers is below desirable limit (up to 0.3 mg/lt) (Gr-I aquifer: 0.01 mg/lt), whereas in Group-II aquifers: 0.05 mg/l). However, the iron removal plants should be installed in the water supply schemes were the

Concentration is more than 0.3 mg/l (desirable limit) for making the extracted ground water potable before starting its community supply.

Ground Water Resource:

Table 11.8.11: Details of Ground Water Resource Availability and Utilization in Gopiballavpur-II Block.

Name of the Block	*GOPIBALLAVPUR-II*
Total Annual Ground Water Recharge (Ham)	6484.23
Total Natural Discharges (Ham)	648.43
Annual Extractable Ground Water Recharge (Ham)	5835.8
Total Extraction	2153.77
Annual GW Allocation for Domestic Use as on 2025	283.4
Net Ground Water Availability for future use	3668.3
Stage of Ground Water Extraction (%)	36.90617
Categorization (OE/CRITICAL/ SEMI-CRITICAL/ SAFE)	Safe

Aquifer Management Plan

Ground Water Management Plan for drinking purpose:

As per ground water policy, drinking is the priority in using ground water.

Normally the development of deeper Tertiary Aquifers is recommended for drinking water. However, as the Tertiary aquifers are deep-seated and the construction of drinking water tube wells tapping only these deeper aquifers is costly, it may be recommended that the drinking water tube wells could also be constructed by tapping the Quaternary aquifers (when there is no quality problem) in a limited manner, if extremely necessary. As an alternative practice, the drinking water tube wells may be constructed by tapping the deepest/lowermost Group-I (quaternary) aquifer and shallowest/ uppermost Group-II (Tertiary) aquifer jointly or in future 40% of the drinking water tube wells should be constructed solely by tapping the Group-I aquifers and 60% tube wells solely by tapping Group-II aquifers. Tube wells should be constructed by taking utmost care after ascertaining the presence and the position of potential aquifers containing fresh sweet water, checking the salinity (EC value) of individual granular zones (i.e., aquifers) and taking precise decision on the well length and well pipe assembly based on lithology and electrical log. After construction of tube wells and before commissioning of any scheme for starting supply of drinking water from deep tube wells, a long duration pumping with constant discharge and a rigorous water quality testing through chemical analysis are mandatory in order to find out the well characteristics & performances and aquifer parameters & performances and to determine the EC values and Iron, Arsenic, Fluoride and Nitrate contents.

Status of existing drinking water supply schemes:

As per status of Water Supply Schemes by PHED, Govt. of WB, in Gopiballavpur-II block a population of 16938 out of total population 104996, 175 mouzas out of total 192 mouzas and 48 habitations from total 175 inhabited villages are so far covered by drinking water.

Ground Water Management Plan for irrigation purposes:

- It is recommended that deeper Tertiary aquifers should be kept intact for drinking water and preferably only the deeper i.e., second aquifer of Group-I in Quaternary formation should be exploited for irrigation. Planning should be made to construct various kinds of surface water bodies for collection of rain water and then to use these surface water sources for fulfilling the major part of annual demand of irrigation water.
- Old surface water bodies like small streams, canals (khal), lake, ponds etc. may be re-excavated, rejuvenated and used in a larger scale for irrigating the cultivated land.
- Irrigation by advanced techniques like sprinkler, drip etc. and land-shaping like ridge/broad-bed and furrow, construction of farm ponds etc. may also be adopted. Crops consuming lesser irrigation water like Mustard, Groundnut, Potato, Pulses and Vegetables may be cultivated in an enhanced magnitude and simultaneously the 'Boro' paddy cultivation must be reduced day by day for saving the ground water for future.
- Conjunctive use of ground water and surface water may be practiced for irrigation, where it seems obligatory to use ground water as a complementary part for irrigation.
- Regular monitoring of iron (Fe) is a must since long term use of iron rich ground water for irrigation may reduce the soil fertility and hamper the crop yield in future.

PART-III

CHAPTER-12

DATA GAP ANALYSIS

CHAPTER-12

DATA GAP ANALYSIS FOR AQUIFER MAPPING PROGRAMME IN JHARGRAM DISTRICT

(AAP 2021-2023)

The study area comprises of 6 blocks out of 8 blocks of Jhargram district. The present study area covers a total of 1824 sq. km. (Except Two Blocks i.e., Gopiballavpur–I & II) geographical area. It is bounded by the North latitudes 22˚47'58.48" and 21˚51'54.92" & East longitudes of 86˚33'29.12" & 87˚15'29.50" in Survey of India Toposheet nos. 73J/9, 73J/10, 73J/12, 73J/14, 73J/15, 73J/16, 73N/2, 73N /3, 73N/4 AND 73O/1. Data Gap in terms of exploratory wells (EW), water level monitoring stations (key wells), geophysical studies viz. Vertical Electrical Sounding (VES), additional water quality monitoring stations etc. to study the aquifers in the area has been tabulated quadrant wise in different Toposheet.

12.1. Data Gap for Exploratory Wells

Exploratory wells constructed by Central Ground Water Board, Eastern Region, Kolkata has been considered for the study. After plotting the existing exploratory wells and following the guidelines it is seen that a total of 26 Exploratory wells (EW), 08 Observation wells (OW) and 5 well fields are required in the study area.

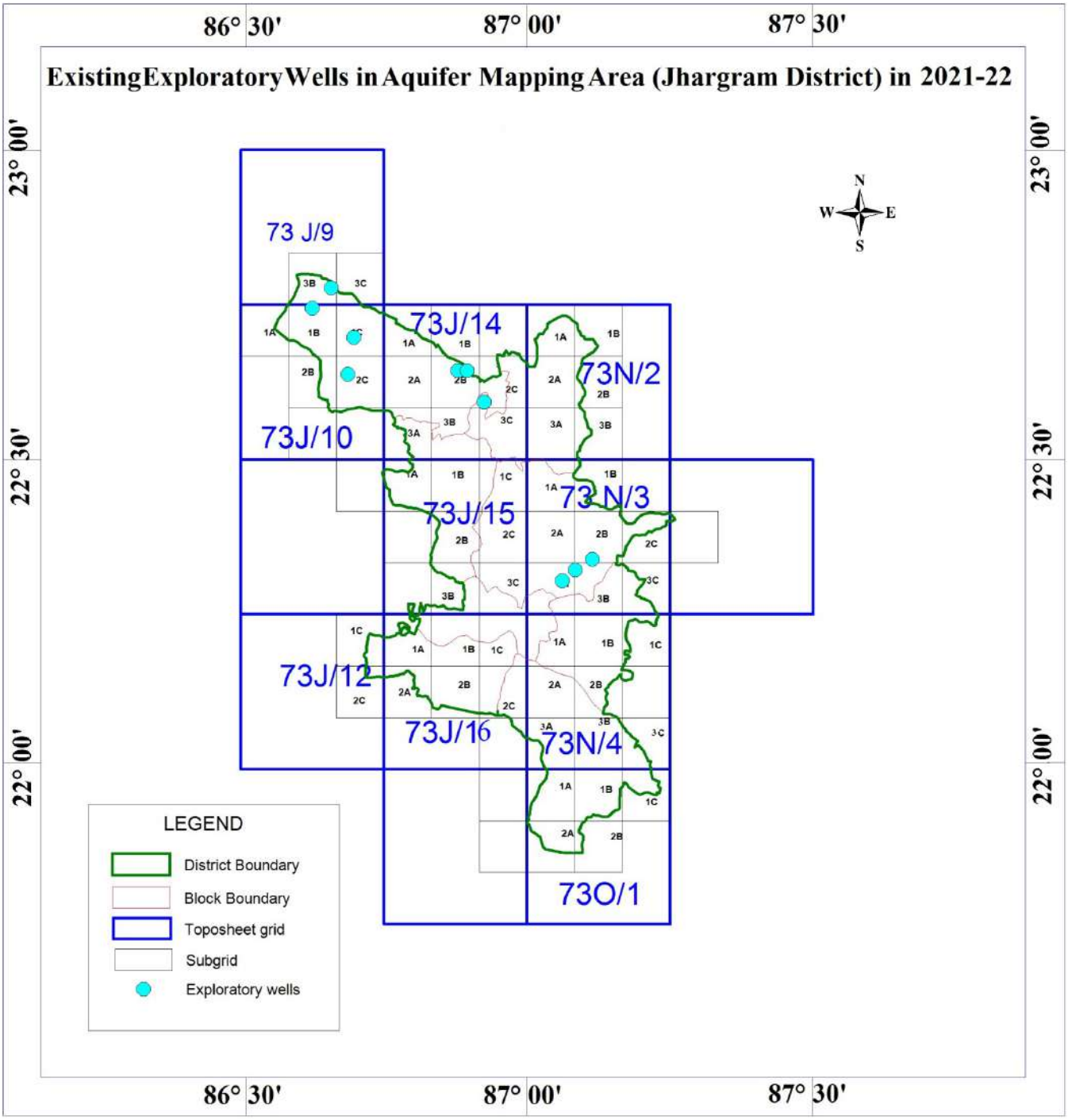


Figure 12.1: Map of existing exploratory wells in the study area.

Table 12.1: Table suggesting extra Exploratory wells and their depths for the study area

Toposheet No.	Quadrant	No. of Additional EW/OW required	Depth of Drilling (Meters)
73J /9	3C	1 EW	200
73J /12	1C	1 EW	200
73J /14	1A	1 EW	200
	2B	2OW	200
		1WELL FIELD	
	3A	1 EW	200
	3C	1EW	200
73J /15	1A	1 EW	200
	1C	2 EW	200
	2B	2EW,	200
		2OW	200
		1WELL FIELD	
73J /16	1A	1EW	200
	1C	1EW	200
	2B	2EW	200
		2EW,	200
		1WELL FIELD	
73N /2	1A	1EW	200
	3A	1EW	200
73N/3	1A	1EW	200
	2B	1EW	200
		2OW	200
		1WELL FIELD	
	3C	1EW	200
73N/4	1A	1EW	200
	2B	1EW	200
		2OW	200
		1WELL FIELD	200
	3A	1EW	200
	3C	1EW	200
73O/1	1A	1EW	200

12.2. Data Gap for Monitoring stations (Key wells)

Monitoring wells in terms of key wells were plotted for data gap analysis. The NHS monitoring wells of CGWB) has been for the study. It has been found that an extra of 75 wells tapping Aquifer- I, 27 wells tapping Aquifer-II are required for future monitoring.

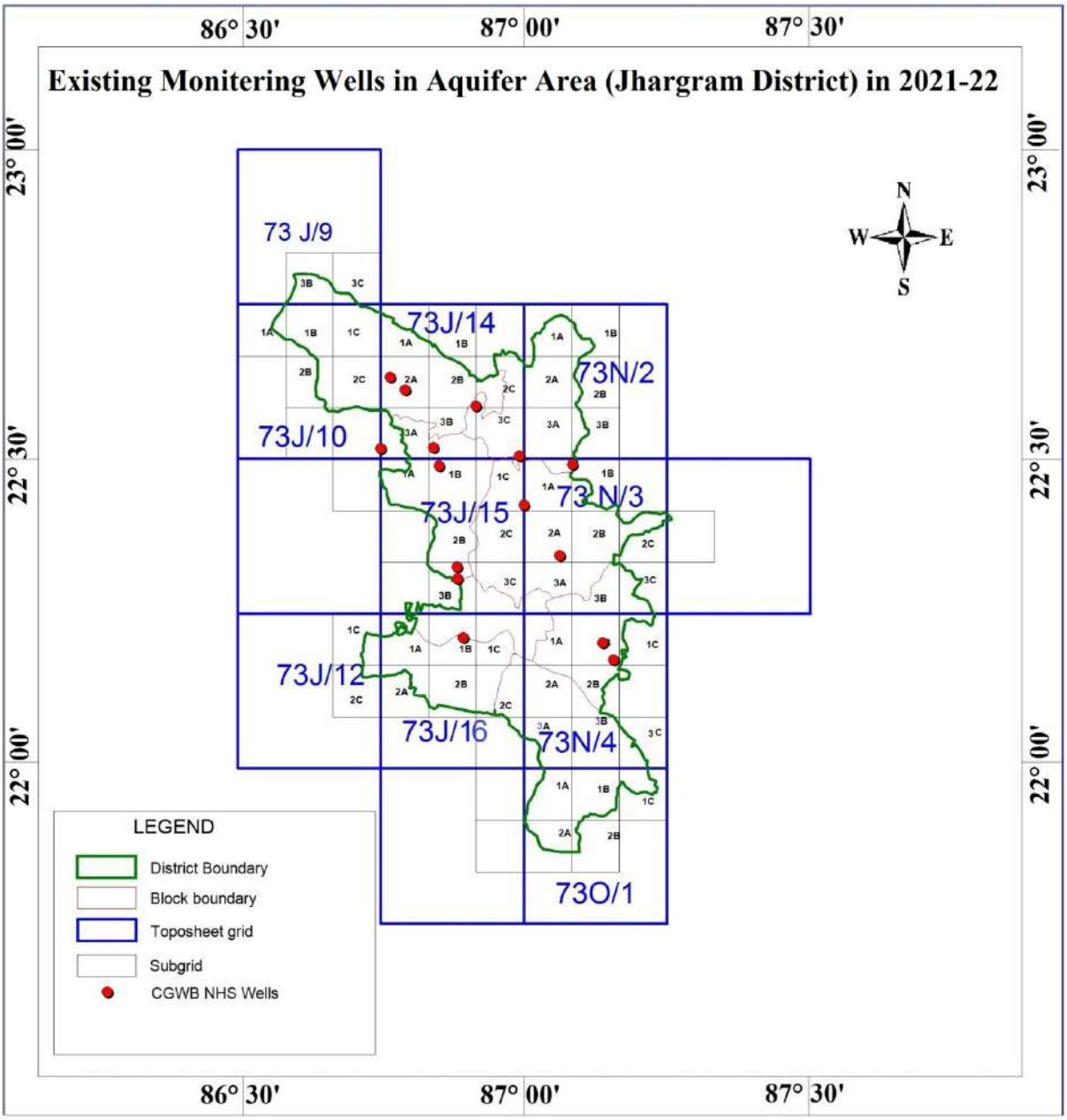


Figure 12.2.1: Map of existing Key Wells in the study area

Table 12.2.1: Table suggesting aquifer wise extra key-wells for the study area

Toposheet No.	Quadrant	No. of Additional Key Wells required Aquifer wise
73J /9	3B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
73J /10	1B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73J /12	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
73J /14	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
73J /15	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73J /16	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
73N /2	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73N/3	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
73N/4	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0

	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
73O/1	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0

12.3: Data Gap for Ground Water Quality Monitoring stations

Water quality monitoring stations are required to study the chemical property of groundwater viz. pH, EC, TDS, Total Hardness, F, Na, K, As, Fe, Cl etc. It has been found that an extra of 75 wells tapping Aquifer- I, 27 wells tapping Aquifer-II are required for future monitoring.

Table 12.3.1: Table suggesting aquifer wise extra water quality monitoring stations for the study area

Toposheet No.	Quadrant	No. of Additional Water Quality stations required Aquifer wise
73J /9	3B	Aquifer I: 1, Aquifer II: 1, , Aquifer III: 0
73J /10	1B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	1C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73J /12	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
73J /14	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
73J /15	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73J /16	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0

	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	1C	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
73N /2	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
73N/3	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2A	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	2C	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
73N/4	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 1, Aquifer II: 1, Aquifer III: 0
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2B	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	3B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	3C	Aquifer I: 1, Aquifer II: 0, Aquifer III: 0
73O/1	1A	Aquifer I: 2, Aquifer II: 1, Aquifer III: 0
	1B	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0
	2A	Aquifer I: 2, Aquifer II: 0, Aquifer III: 0

12.4. Data Gap for Geophysical studies (TEM/VES)

CGWB has not carried out any VES in the study area. A total of 34 VES is suggested to carry out in the study area. The detail of numbers of VES required is explained quadrant wise in the following table 4below.

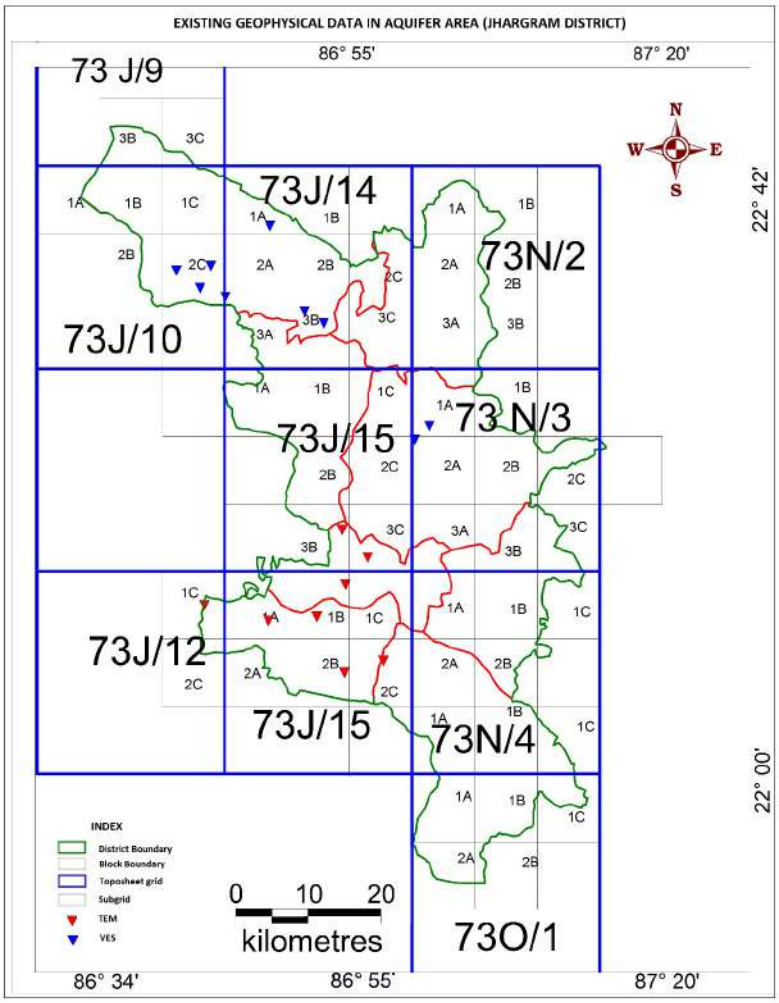


Figure 12.4.1: Map of existing Geophysical TEM-VES in the study area

Table 12.4.1: Table suggesting no. of VES stations for the study area

Toposheet No.	Quadrant	No. of VES required within the quadrant
73J /9	3B	2
	3C	2
73J /10	1A	
	1B	2
	1C	2
	2B	
	2C	-
73J /12	1C	-
	2C	-
	3C	-
73J /14	1A	-
	2A	2
	2B	3
	2C	

	3A	-
	3B	
	3C	
73J /15	1A	2
	1B	2
	1C	2
	2B	3
	2C	-
	3A	-
	3B	--
	3C	2
73J /16	1A	-
	1B	-
	1C	-
	2B	-
	2C	-
73N /2	1A	2
	1B	2
	2A	-
	2B	-
	3A	-
	3B	-
73N/3	1A	2
	1B	-
	2A	2
	2B	2
	2C	-
	3A	2
	3B	
	3C	
73N/4	1A	2
	1B	-
	1C	-
	2A	1
	2B	2
	3A	-
	3B	-
	3C	-
73O/1	1A	2
	1B	2
	1C	-
	2A	-
	2B	-

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