केन्द्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

PURULIA DISTRICT
WEST BENGAL

पूर्वी क्षेत्र, कोलकाता

Eastern Region, Kolkata

Government of India
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVENATION

REPORT ON

AQUIFER MAPPING AND MANAGEMENT PLAN OF PURULIA DISTRICT WEST BENGAL

by

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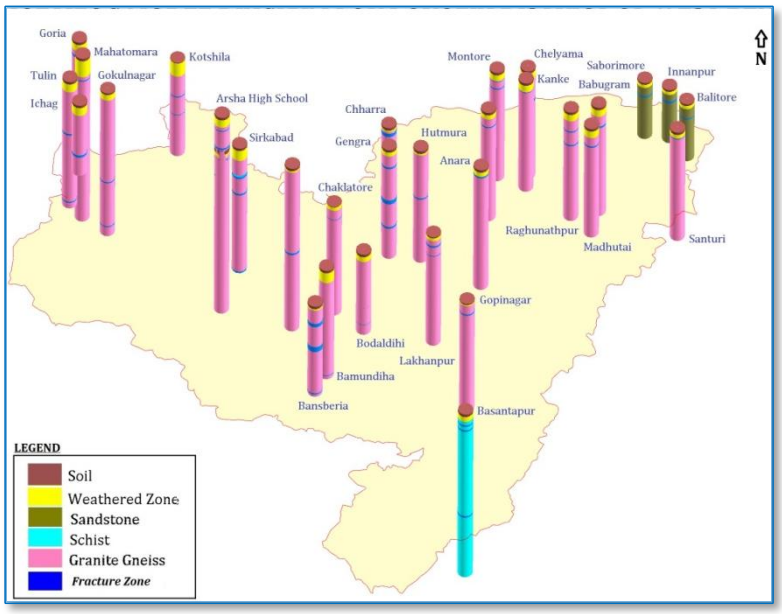

CENTRAL GROUNDWATER BOARD
Eastern Region, Kolkata
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FOREWORD

Purulia District is located in the western part of the State of West Bengal. It is historically tagged as an area with acute water scarcity that affects life and livelihood of the predominantly tribal population, residing in the district.

National Aquifer Mapping(NAQUIM) activities in Purulia District was carried out during the Annual Action Plan(AAP) Period of 2020-21 for deriving the sustainable aquifer management plan. The interim Report for the same was submitted during the Annual Action Plan Period of 2021-22, which in its draft form was presented before the State level Ground Water Co-ordination Committee (SGWCC) under the Chairmanship of The Principal Secretary, Water Resources Investigation & Development Department(WRI & DD), Government of West Bengal on 23.02.2022. Based on the feedbacks and suggestions received in that meeting, few corrections and modifications have been incorporated, which was presented before the National Level Expert Committee(NLEC) and the same was duly approved. The current report is the updated and modified version of the earlier interim report, which is incorporating all the necessary modifications, as suggested by the SGWCC, West Bengal.

This report in its current form is a comprehensive hydrogeological compendium for Purulia district, West Bengal, which includes minute detailing in terms of the suggested and recommended management interventions for aquifer management on short term, intermediate term and long term basis, upto the block level.

It is an outcome of dedicated efforts by our team of Scientists of various disciplines at Central Ground Water Board, Eastern Region, Kolkata. It is very much anticipated that this report will become an important reference tool not only for various user agencies, Engineers, Scientists, Administrators, Planners and others involved in groundwater planning, development and management but also for the common people to make them aware of local groundwater issues and its sustainable management options.

Date : 31.08.2022

31/08/2022

(Dr Anadi Gayen)
Regional Director(I/C),
CGWB, ER, Kolkata

FOREWORD

To understand the nature and occurrences of groundwater, Aquifer geometry, dispositions & 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 2020-2021, Aquifer Mapping studies & Management plan was taken up in Purulia district.

The study under the aegis of NAQUIM includes four major components namely; Data gap analysis, 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 for the study area, Part-II include Block Management Plans and Part-III comprises Data Gap Analysis done for the district. Relevant data in respect of the said subjects have been collected and collated from different Departments and their publications, viz. Public Health Engineering Directorate, State Water Investigation Directorate, 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. Hydrogeological 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 representation in the form of present report is outcome of the efforts given by Miss Monisha Baruah, Scientist-'B'(HG) and Miss Zumchilo T Ezung, Scientist-'B'(HG) under the supervision of Smt. Sandhya Yadav, Scientist-'D'(HG) & OIC(NAQUIM) and Shri. Anirvan Choudhury, Scientist-'B'(HG). The section pertaining to Hydrochemistry has been prepared by Shri A. N. Chowdhury, Assistant Chemist & Dr. Suparna Dutta, Assistant Chemist and her effort is thankfully acknowledged. Geophysical inputs for this report has been provided by Dr. A. K. Sinha, Scientist-'B'(GP).

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 a 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 people to make them aware of local groundwater issues and its sustainable management.

Date : 28.10.2021

(Dr S. K. Samanta)
Regional Director,
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EXECUTIVE SUMMARY

National Aquifer Mapping and Management Plan(NAQUIM) studies in Purulia District West Bengal was taken up during the Annual Action Plan period of 2020-21. The NAQUIM study area comprises of 20 blocks of Purulia districts in West Bengal. The total geographical area is 6,259 sq. km of which mappable area is about 5,627 sq. km.

Climatologically Purulia district represents dry tropical climate characterized by moderately cold winters and scorching summer. Meteorologically it reflects relatively lower precipitation with a comparatively higher evapotranspiration rate. The average annual rainfall varies across the Community Development Blocks, between 1100 – 1500 mm. The normal annual rainfall is in the tune of 1321.9 mm of which 80% is contributed by South-West monsoon. Rainfall is both non-uniform and erratic within the geographic span of the district and even bordering scanty in many localized pockets.

The elevation of the district varies from 63 meters to 712 meters above mean sea level. The general elevation of the land surface ranges between 150 meters to 300 meters. The master slope of the land surface is towards the east and south-east. The district can be sub-divided physiographically into two units. The one is hilly terrain in the western and southern parts, which are the continuation of Chottanagpur Plateau. The other one is the undulating plain with isolated mounds and hills, comprising the rest of the district covering about 80% of the total area. The hilly terrain in the western part has parallel hill ranges roughly trending in NW-SE direction. This includes the Ajodhya hill which is a small plateau with surrounding hills. The highest peak of Ajodhya hills is Chamtaburu (712 mAMSL). In general the topography is undulating. Geomorphologically, the district is represented by pediment-pediplain complex, denudational/residual hills, dissected plateaus, valley fills, isolated hillocks and mounds

The prominent perennial rivers of the district are Kasai, Damodar, Tangon and Subarnarekha. Dwarakeswar and Silai or Sialabati are other rivers of importance. In general, the rivers / streams of the district flow either in easterly or south-easterly directions. The drainage pattern in the district is predominantly dendritic with

occasional radial pattern. The important ephemeral streams of the district are Sahara, Jorh, Bandhu, Nangsai, Vanumata, etc.

Soils in the district are in general of the residual type, derived directly from the weathering of the Pre-Cambrian bed rock, lying at depth underneath. Lateritic soil prevails in the uplands whereas, in the valleys, reddish clay loam or white to reddish clay are common. Texturally sandy loam, reddish loam, white or reddish stiff clay etc are most dominant. Because of the undulating nature of the topography, the soil cover is thin, often skeletal and in general gravelly.

Only 12% of the geographical area is under forest cover, 0.24% constitutes the barren and unculturable land and almost 50% is under net sown area. The forest in general can be classified under Northern tropical Dry Deciduous Forest.

Agriculture is grossly rainfed in absence of adequate potential and sustainable ground water sources. About 40-50 percent of the cultivated land is under single cropbecause of poor land fertility and lack of proper irrigation facility. The proportion of double and triple cropped area is very limited. Paddy is the primary crop grown in the district along with some production of potato, wheat, dal, mustard, maize, maskalai, etc. 3,39,463 hectares of land is under Aman paddy alone as in 2013-2014. This Aman cultivation basically dominates the Kharif season.

Predominantly Precambrian metamorphics of Chottanagpur Gneissic Complex(CGC) represented by granite gneiss, biotite granite gneiss, calc-granulite, ultrabasic, metabasic, meta-sedimentaries, pegmatites and quartz veins covers the area. Gondwana formations are represented by shales and ferruginous sandstones(Barren Measure Formation) along with sandstones, shales and coal seams(Raniganj Formation) are found along the north eastern parts. Unconsolidated formation represented by coarse to fine sand, silt, clay, lithomargic clay, yellow clay, calcareous nodules and laterite. Recent fluvial sediments are found to occur, adjacent to major rivers & streams as discontinuous patches.

The regional structure indicates the presence of isoclinal folds, in which the fold axes are either horizontal or plunging at low angles towards east or west. General E-W strike of the formations is predominant with moderate to steep northerly and southerly dips. Reversals of dips are the manifestations of regional folding and shearing of the concerned rocks locally.

Two prominent shear zones are observed in the district. One of them, known as South Purulia Shear Zone (SPSZ) exists along the boundary between the Singhbhum Group and Gneissic Complex and another Shear Zone (North Purulia Shear Zone, *i.e.,* NPSZ) has been traced further to the north between Jhalda and Ragunathpur.

Groundwater is primarily restricted to the upper weathered mantle, saprolitic zones and in the fractured zones of consolidated Chottanagpur Gneissic Complex(CGC) Formation and in the semi-consolidated Gondwana sedimentaries. The narrow strips of unconsolidated sediments along the major river valleys behave as substantial groundwater repositories as well.

The weathered zone has a maximum thickness 25m. The dug wells from this zone yield up to 3 lps. Potential saturated fractures have been encountered in borewells constructed in CGC upto a depth of 60 mbgl has a cumulative thickness of 2-3 m generally, forming very thin aquifers at different depth levels.

The yield prospect for the aquifers in hard rock is generally very low, and the drawdown is comparatively high. Semi-consolidated Gondwana sedimentaries constitutes the unconfined aquifers within the depth of 12 mbgl. Potential fracture in this zones are encountered within 20 mbgl with moderately low yield prospect and very high drawdown(upto 20m). Analysis of fracture zone, in consolidated formation reveals, that the zone within the range of 0-50 mbgl provides more probability for encountering fractures through drillings and explorations. The aquifers from these shallow fracture zones occur mostly under unconfined or semi-confined conditions. Prolific aquifers, though rare and sporadic are also encountered from the fractures within the depth range of 50-150 mbgl. Yield potential is generally better in the

proximity of the shear zones, though the well collapse phenomenon is also quite common, therein.

The Quaternary sediment column of limited thickness(<3m) occupies the narrow strips of valleys along the major ephemeral rivers. These are thin but potential river bed Phreatic aquifers in otherwise water scarce area.

The stage of ground water development in the district stands at 9.43%, categorized as 'Safe'. The total in-storage for the district is 2,26,620.97 MCM.

The district as a whole is identified as drought prone and water scarce area. Iron and Fluoride are the two most common quality issues in the district. Few samples also show slightly elevated concentration of manganese. Except these there are no major quality issues and most of the water is suitable for potable and irrigation purpose. Gibbs plot of the water samples reveals that the rock water interaction time is appreciable, which indicates that most ground water flows are appreciable within limited areas and the regional ground water flow is relatively slower.

Considering the limited potentialities, attempts are to be made to ensure sustainable drinking water resources. These are to be adopted both through short term and long term measures. Recommended interventions include - Percolation Tanks, Check Dams, Gabion Structures, Sub-Surface Dykes, Re-Excavation of existing tanks with Recharge Shafts, Urban Roof Top Rainwater harvesting. Out of these, based on the earlier recommendations of Master Plan for Artificial Recharge, about 40% Percolation tanks and check dams have already been implemented by the Govt. of West Bengal. The cost of implementation of balance intervention structures is estimated roughly at Rupees 12 crore 40 lakhs only.

CONTRIBUTORS

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PART – I

(National Aquifer Mapping & Management Plan of Purulia District, West Bengal)

Chapter – 1
INTRODUCTION

1.0 INTRODUCTION

Groundwater is one of the prime sources of fresh water contributing significantly for the survival of mankind. However, overexploitation, surface runoff and subsurface groundwater discharge have depleted the fresh groundwater availability considerably. Assessing the groundwater potential zone is extremely important for the protection of water quantity & quality, and the management of groundwater system. In this context, the National Aquifer Mapping & Management Programme (NAQUIM) has been taken up by CGWB under XIIth Plan. As per the annual action plan, groundwater management studies in 20 blocks of Purulia have been taken up by CGWB, ER, Kolkata. In this report the salient features of aquifer geometry, characteristics; ground water occurrences, availability, resource vis-a-vis quality, development & management, scope of ground water etc. of the20 blocks have been covered.

1.1 OBJECTIVE : The broad objective of the study is to establish the geometry of the underlying aquifer systems in horizontal and vertical domain, its resource potential in respect of quality & quantity, aquifer characterization, scope for development potential and prepare aquifer-wise management plans.

1.2 SCOPE OF STUDY : The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) implemented by CGWB. There are four major components of this activity viz.:

(i) Data gap analysis
(ii) Data generation
(iii) Data collection / compilation and
(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 concerned agencies, such as the Survey of India, Geological Survey of India of the

Union Govt. and offices of the Govt. of West Bengal (W.B.), computerization and analyses of all acquired data, and preparation of data bases of different themes. Identification of Data Gap included ascertaining requirement for further data generation in respect of hydro-geological, geophysical, chemical, hydrological, hydro-meteorological studies, etc. Relevant data in respect of the said subjects have been collected from different authorities, 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.

The existing data of hydro-geological data including those of exploratory wells, piezometers, slim holes, etc. by erstwhile E.T.O., CGWB as well as chemical quality data including trace elements in ground water, either by in-situ or out-sourcing, lying in the Central Ground Water Board, Eastern Region have been thoroughly studied. Besides, data have been generated by hydro-geological surveys and collection of water samples, followed by their laboratory analyses for all major parameters including arsenic. Additional data pertaining to sub-surface lithology and aquifer parameters were obtained through in-situ drilling of exploratory wells, pumping tests, etc.

1.3 APPROACH & METHODOLOGY : An approach and methodology adopted to achieve the major objective have been shown below step-wise.

(i) Compilation of existing data
(ii) Identification of data gaps
(iii) Data generation based on data gaps
(iv) Preparation of thematic maps on GIS platform
(v) Preparation of 2D/3D aquifer disposition maps
(vi) Compilation of Block-wise Aquifer Maps and Management Plan

1.4 LOCATION, EXTENT & ACCESSIBILITY : The study area comprises 20 blocks of Purulia district in West Bengal. The present study area covers a total of 6259sq. km. geographical area. It is bounded by the North Latitudes 22° 43′ and 23°42′ & East Longitudes of 85° 49′& 86° 49′ falling in part of Survey of India Degreesheet no.s 73/E, 73/I and 73/J.

The district is bounded on the north by Paschim Barddhaman and Dhanbad (Jharkhand) districts, on the east by Bankura, on the south by Paschim Midnapur and Singbhum (Jharkhand) districts and in the west by Ranchi and Hazaribagh (Jharkhand) districts.

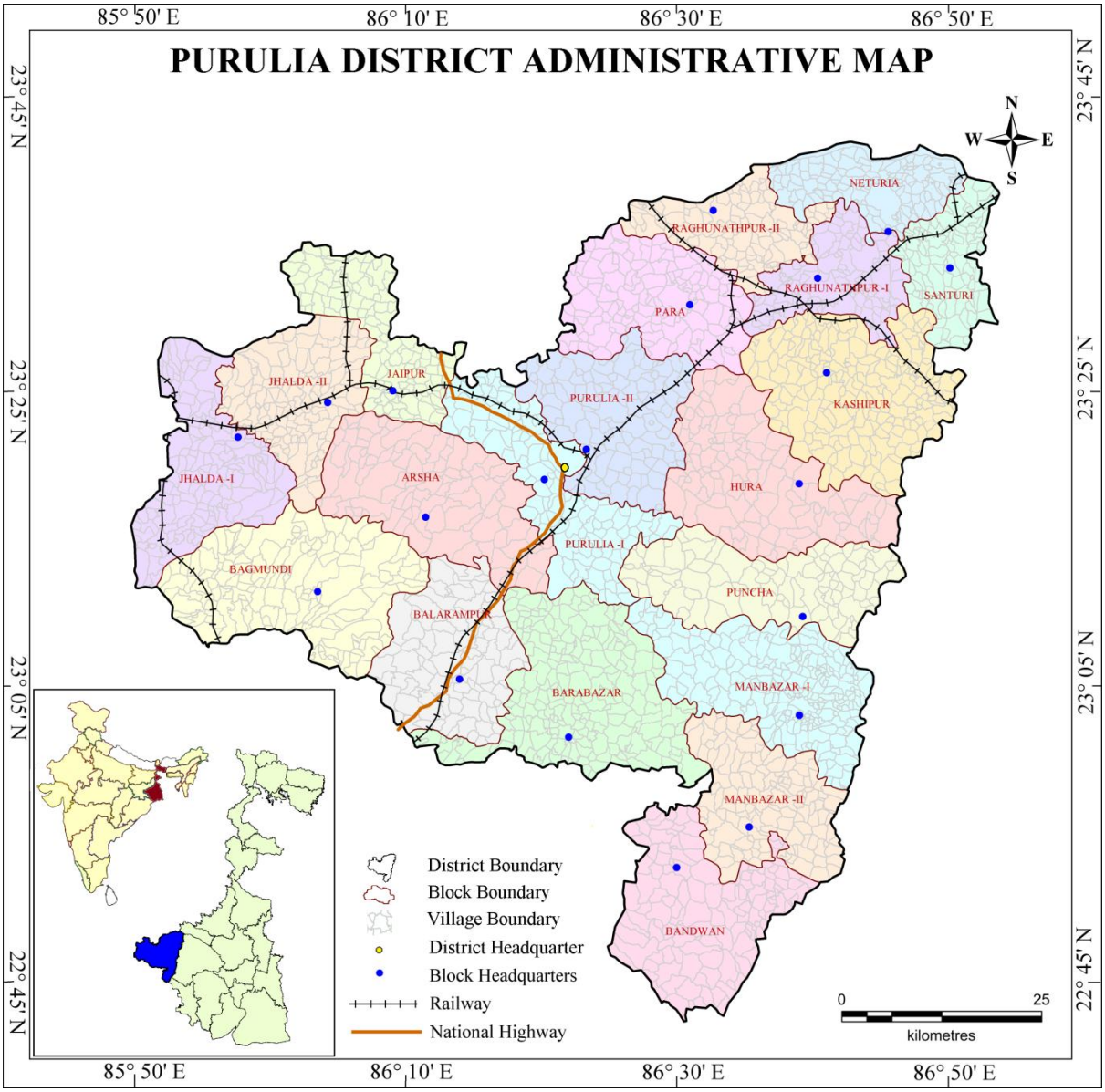


Figure 1.1: Administrative map of Purulia District, West Bengal.

1.5 ADMINISTRATIVE DIVISION AND DEMOGRAPHY : The district with its Headquarter at Purulia has 3 Sub-Divisions, 20 Blocks, 3 Municipal Towns (Jhalda, Purulia and Ragunathpur) and 25 Non-Municipal Towns(Census Towns) with total population of 29,30,115 as per 2011 Census. The administrative detail of the district is presented in table 1.1.

The study area covers a total of 20 Panchayat Samity(Community Development Blocks), 170 Gram Panchayats, 1,942 Gram Sansads, 2,683 Mouzas, 2,459 Inhibited villages, 5,67,824 Households, 3 Municipalities, 47 wards and 25 Census Towns. Distribution of population of the study area is presented in table 1.2.

Table-1.1: Major administrative division of the study area

Sub-Division	C.D. Block/M	Panchayats			Mouzas	Inhabited Villages	House holds	Municipality		Census Town (2011)	Total
		Samity	Gram	Gram Sansad	(2001)	(2011)	(2011)	No.	Ward		
Sadar(West)	**7/ 1**	**7**	**59**	**693**	**930**	**882**	**198703**	**1**	**12**	**6**	**7**
	Arsha	1	8	101	96	95	28868	-	-	-	-
	Baghmundi	1	8	92	142	138	27508	-	-	-	-
	Balarampur	1	7	92	90	89	26255	-	-	1	1
	Barabazar	1	10	122	215	202	32467	-	-	1	1
	Jaypur	1	7	90	113	109	24257	-	-	1	1
	Jhalda-I	1	10	97	143	131	27709	-	-	1	1
	Jhalda(M)	-	-	-	-	-	3676	1	12	-	1
	Jhalda-II	1	9	99	131	118	27963	-	-	2	2
Sadar (East)	**7/ 1**	**7**	**62**	**677**	**971**	**890**	**209758**	**1**	**22**	**5**	6
	Bundwan	1	8	69	135	131	20325	-	-	1	1
	Hura	1	10	107	116	111	28368	-	-	-	-
	Manbazar -I	1	10	114	244	219	31939	-	-	1	1
	Manbazar -II	1	7	75	136	124	20133	-	-	-	-
	Puncha	1	10	97	109	99	25262	-	-	-	-
	Purulia(M)	-	-	-	-	-	23754	1	22	-	1
	Purulia-I	1	8	101	115	105	28228	-	-	1	1
	Purulia-II	1	9	114	116	101	31749	-	-	2	2
Raghunathpur	**6/ 1**	**6**	**49**	**572**	**782**	**687**	**159363**	**1**	**13**	**14**	15
	Kashipur	1	13	137	211	198	40630	-	-	3	3
	Neturia	1	7	73	124	110	18728	-	-	3	3
	Para	1	10	136	135	118	36548	-	-	5	5
	Raghunathpur-I	1	7	89	102	79	22702	-	-	1	1
	Raghunathpur(M)	-	-	-	-	-	4792	1	13	-	1
	Raghunathpur-II	1	6	80	106	90	20847	-	-	1	1
	Santuri	1	6	57	104	92	15116	-	-	1	1
District Total- 3	**20/ 3**	**20**	**170**	**1942**	**2683**	**2459**	**567824**	**3**	**47**	**25**	28

**Source- District Statistical Handbook, 2014*

Table-1.2: Distribution of population in the administrative units of the study area.

Sub-Division/ C.D.Block/ M	Rural Population			Urban Population			Total Population		
	Male	Female	**Total**	Male	Female	**Total**	Male	Female	**Total**
Sadar (W)	**486411**	**466594**	**953005**	**43430**	**40586**	**84016**	**529841**	**507180**	**1037021**
Arsha	78398	76338	154736	-	-	-	78398	76338	154736
Baghmundi	69520	66059	135579	-	-	-	69520	66059	135579
Balarampur	58314	55205	113519	12681	11750	24431	70995	66955	137950
Barabazar	82158	80350	162508	4195	3861	8056	86353	84211	170564
Jaypur	63633	59457	123090	5344	4915	10259	68977	64372	133349
Jhalda-I	65247	62512	127759	4848	4536	9384	70095	67048	137143
Jhalda-II	69141	66673	135814	6312	6030	12342	75453	72703	148156
Jhalda(M)	-	-	-	10050	9494	19544	10050	9494	19544
Sadar (E)	**457709**	**443727**	**901436**	**79285**	**74616**	**153901**	**536994**	**518343**	**1055337**
Bandowan	44686	44250	88936	3112	2881	5993	47798	47131	94929
Hura	72867	70708	143575	-	-	-	72867	70708	143575
Manbazar-I	73172	71378	144550	4867	4654	9521	78039	76032	154071
Manbazar-II	48943	48221	97164	-	-	-	48943	48221	97164
Puncha	62676	61179	123855	-	-	-	62676	61179	123855
Purulia-I	74873	70621	145494	2985	2709	5694	77858	73330	151188
Purulia-II	80492	77370	157862	5970	5656	11626	86462	83026	169488
Purulia(M)	-	-	-	62351	58716	121067	62351	58716	121067
Raghunathpur	**360088**	**342272**	**702360**	**70073**	**65324**	**135397**	**430161**	**407596**	**837757**
Kashipur	88738	85587	174325	13063	12695	25758	101801	98282	200083
Neturia	42707	40430	83137	9603	8687	18290	52310	49117	101427
Para	86423	81574	167997	16883	15741	32624	103306	97315	200621
Raghunathpur-I	49762	46726	96488	11135	10137	21272	60897	56863	117760
Raghunathpur-II	55463	52364	107827	3105	2858	5963	58568	55222	113790
Raghunathpur(M)	-	-	-	13194	12367	25561	13194	12367	25561
Santuri	36995	35591	72586	3090	2839	5929	40085	38430	78515
District Total	**1304208**	**1252593**	**2556801**	**192788**	**180526**	**373314**	**1496996**	**1433119**	**2930115**

**Source- District Statistical Handbook, 2014.*

Table-1.3: Geographical area and Mappable area for the given study area

Block_Name	Geographical Area (Sq.Km)	Mappable Area (Sq.Km)	Normal Rainfall (mm)
Arsha	393	215	1385.72
Bagmundi	450	384	1384.51
Balarampur	316	303	1368.64
Barabazar	456	437	1332.66
Bundwan	379	268	1358.22
Hura	394	378	1354.43
Jaipur	219	162	1351.84
Jhalda-I	309	272	1365.12
Jhalda-II	273	262	1370.54
Kashipur	428	411	1333.21
Manbazar-I	368	353	1341.17
Manbazar-II	282	271	1331.39
Neturia	185	177	1293.27
Para	313	301	1363.80
Puncha	323	310	1334.73
Purulia-I	302	290	1387.95
Purulia-II	312	299	1385.43
Raghunathpur-I	193	185	1322.43
Raghunathpur-II	194	186	1322.24
Santuri	170	163	1301.36
TOTAL	**6259**	**5627**	**1349.43**

1.6 LAND-USE, CROPPING PATTERN AND IRRIGATION :

Land-use: The classification of land utilization in the district is given in Table 1.4. It is evident that 12% of the reporting area is under forest cover, 0.24% constitutes the barren and unculturable land and almost 50% is under net sown area. The forest under Purulia Forest Division falls under Northern tropical Dry Deciduous Forest. The Land use & land cover distribution of the district and the pie diagram depicting land use pattern is given in Table 1.4 & Fig. 1.2 respectively.

Table-1.4: Land use & land cover distribution of Purulia district

Class name	Geographical Area (sq. km.)	Percentage of Total Geographical Area
Deciduous forest	608.87	9.96
Crop land	5255.33	86.00
Built-up land	57.43	0.94
Mixed forest	43.26	0.71
Shrub land	118.49	1.94
Barren land	8.42	0.14
Fallow land	13.56	0.22
Waste land	5.43	0.09

Table-1.5: Block-wise details of Land-use pattern in Purulia district (hectares)

Block	Reporting Area	Forest Area	Area Under Non-Agricultural Waste	Barren and Un-culturable land	Permanent pastures and grazing lands	Land under misc tree crops	Culturable wastes	Fallow land Other than current fallow	Current fallow	Net Sown Area	Cultivable area
	(Ha)										
Arsha	37102	3999	7105	94	240	252	186	96	5443	19687	25664
Bagmundi	42588	15900	5098	59	30	517	205	124	3783	16872	21501
Balarampur	29944	3053	2567	497	-	215	207	163	8390	14852	23827
Bandwan	35003	13619	5468	45	-	-	-	-	5536	10335	15871
Barabazaar	41834	1902	9497	-	-	-	-	-	5965	24470	30435
Hura	39684	4265	6760	-	-	168	306	988	6223	20974	28659
Jhalda I	31730	3026	7573	-	41	230	184	78	4153	16445	21090
Jhalda II	25655	2635	2802	-	-	-	-	-	4023	16195	20218
Joypur	23049	958	4210	-	-	302	-	-	4013	13566	17881
Kashipur	44314	4108	7567	171	44	194	694	457	8450	22629	32424
Manbazaar I	37330	5166	5482	75	-	405	234	-	6163	19805	26607
Manbazaar II	29141	1524	6040	44	27	206	108	250	5408	15534	21506
Neturia	20385	1457	7072	38	-	596	207	-	4360	6655	11818
Para	30773	913	5132	-	-	138	-	-	10002	14588	24728
Puncha	32876	4585	4782	-	-	84	916	84	4739	17686	23509
Purulia I	29495	659	8391	95	-	245	304	640	4700	14461	20350
Purulia II	30927	266	5033	-	-	225	756	129	7960	16558	25628
Raghunathpur I	19767	443	4702	64	258	345	149	71	4450	9285	14300
Raghunathpur II	19767	237	3566	77	-	319	304	305	6350	8609	15887
Santuria	17949	0	3278	221	140	287	294	685	3000	10044	14310
TOTAL	619313	68715	112125	1480	780	4728	5054	4070	113111	309250	436213

*Source- West Bengal Land use Land cover Department

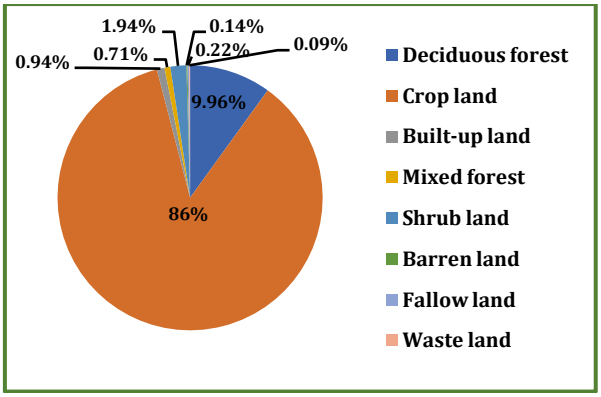


Figure-1.2: Pie Diagram depicting land use pattern of the district (Area in sq.km)

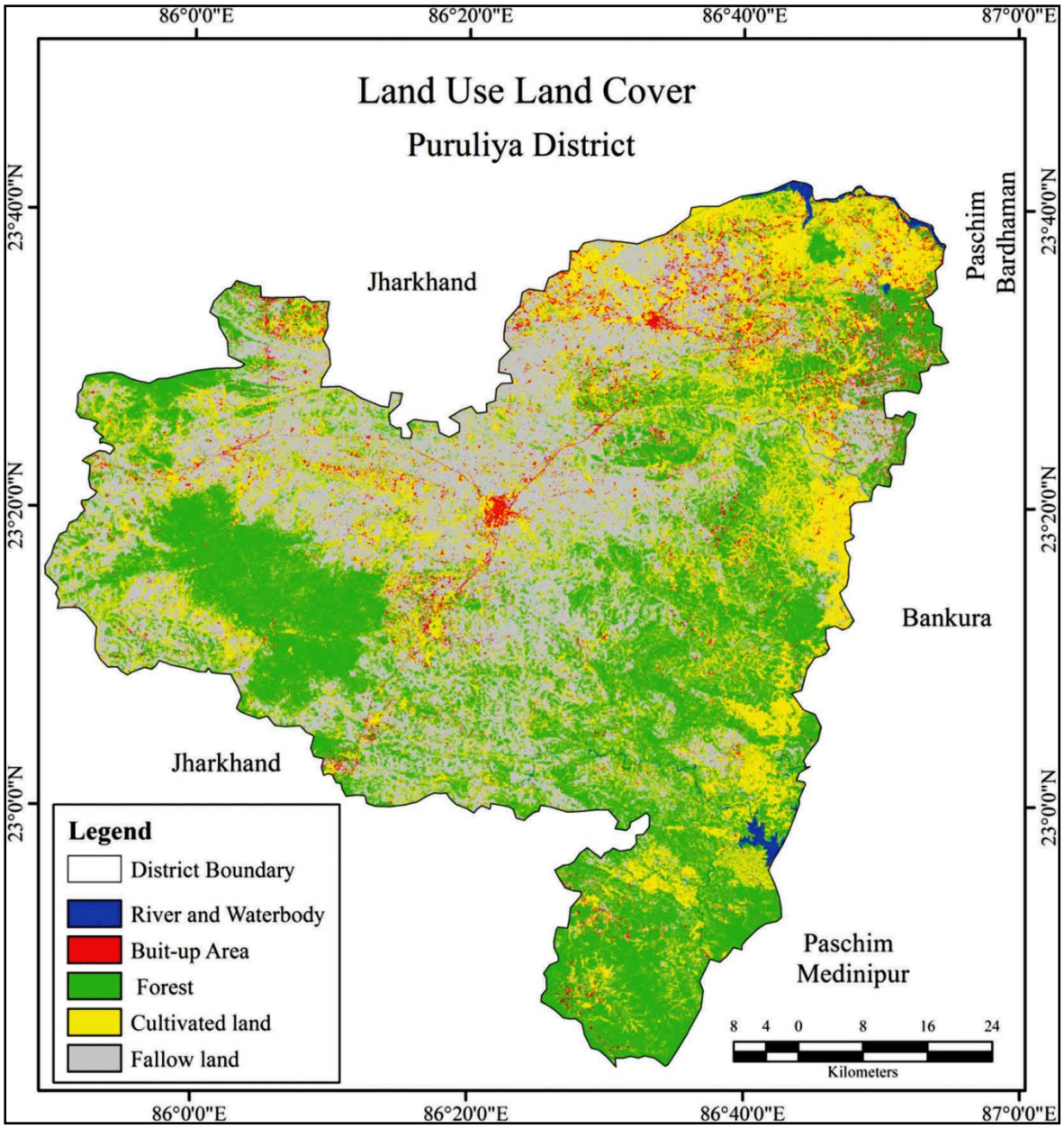


Figure-1.3: Simplified Landuse-Landcover Map of Purulia District, West Bengal

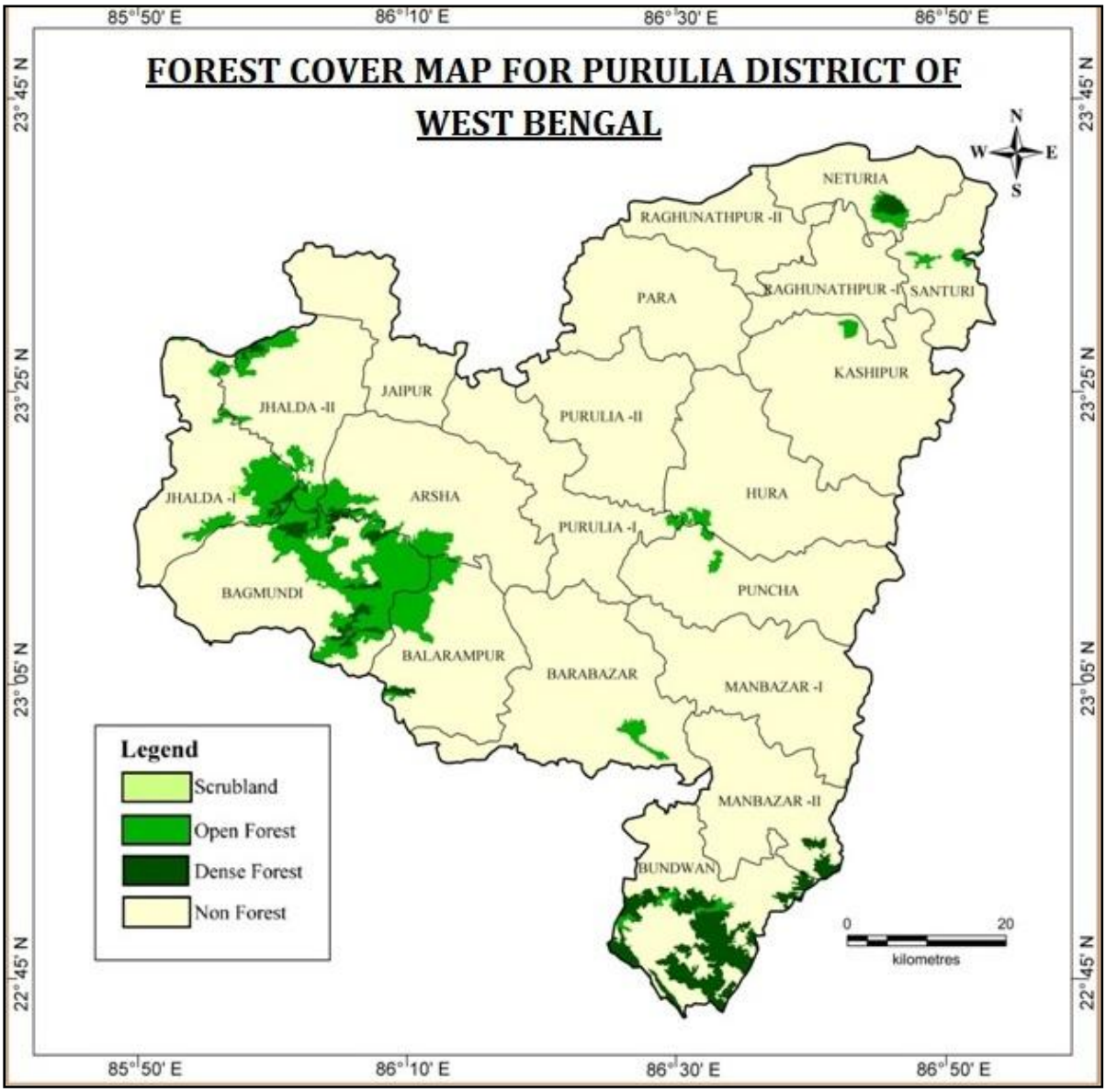


Figure-1.4: Forest Cover map of Purulia District, West Bengal

Cropping pattern: The type of crops grown in the district is a direct influence of relief, soil, slope, climate, irrigation facilities and traditional social conditions. About 40-50 percent of the cultivated land is under single crop (mono cropping system) because of poor land fertility and lack of good irrigation facility. The proportion of double and triple cropped area is very limited. Paddy is the primary crop grown in the district along with some production of potato, wheat, dal, mustard, maize, maskalai, etc. 3,39,463 hectares of land is under Aman paddy alone as in 2013-2014. This Aman cultivation basically dominates the Kharif season. The crops grown in the district are usually rain fed with very low fertilizer consumption.

The overall agricultural production is low to medium. The main causes are its undulating topography, rocky and waste land, scarcity of water and medium to low soil fertility.

Table-1.6: Area, yield and production of major crops in the study area.

BLOCK	AREA/ PROD./ YIELD	CROP TYPE											
		Aus	Aman	Boro	Wheat	Maize	Maskalai	Khesari	Gram	Mustard	Til	Potato	Sugarcane
Arsha	Area	-	39094	17	114	122	686	-	108	108	-	107	150
	Production	-	104.423	0.045	0.27	0.226	0.197	-	0.136	0.077	-	3175	7.467
	Yield	-	2671	2676	2367	1852	288	-	1256	715	-	29672	49783
Baghmundi	Area	-	35241	-	72	268	578	10	-	604	-	-	-
	Production	-	88.37	-	0.17	0.583	0.208	0.006	-	1.115	-	-	-
	Yield	-	2508	-	2367	2174	360	642	-	1846	-	-	-
Balarampur	Area	-	30034	113	125	133	120	-	-	40	102	75	-
	Production	-	74.401	0.334	0.299	0.373	0.024	-	-	0.03	0.052	1475	-
	Yield	-	2477	2952	2389	2805	199	-	-	762	505	19672	-
Barabazar	Area	78	27788	71	25	1347	598	-	-	22	-	59	-
	Production	0.109	64.087	0.204	0.045	2.105	0.134	-	-	0.013	-	1155	-
	Yield	1396	2306	2869	1800	1563	224	-	-	569	-	19572	-
Joypur	Area	-	10593	-	-	274	696	-	-	35	82	27	-
	Production	-	23.025	-	-	0.706	0.23	-	-	0.027	0.041	798	-
	Yield	-	2174	-	-	2576	331	-	-	775	505	29543	-
Jhalda-I	Area	-	19014	256	-	-	-	4	4	30	-	-	-
	Production	-	42.521	0.555	-	-	-	0.001	0.005	0.017	-	-	-
	Yield	-	2236	2169	-	-	-	229	1256	583	-	-	-
Jhalda-II	Area	-	34155	-	216	73	103	47	4	50	-	42	-
	Production	-	85.194	-	0.511	0.158	0.016	0.039	0.005	0.038	-	1149	-
	Yield	-	2494	-	2367	2163	151	839	1256	762	-	27365	-
Bundwan	Area	-	1739	16	9	1636	-	4	-	563	-	372	-
	Production	-	3.533	0.029	0.018	2.286	-	0.001	-	0.622	-	10574	-
	Yield	-	2032	1819	1989	1397	-	266	-	1104	-	28424	-
Hura	Area	-	2233	5	16	-	8380	-	-	188	-	29	-
	Production	-	3.673	0.013	0.032	-	1.593	-	-	0.14	-	864	-
	Yield	-	1645	2651	1981	-	190	-	-	745	-	29802	-
Manbazar-I	Area	-	1740	-	137	194	-	-	-	135	87	217	-
	Production	-	3.542	-	0.268	0.346	-	-	-	0.084	0.038	6111	-
	Yield	-	2035	-	1956	1783	-	-	-	622	434	28161	-
Manbazar-II	Area	-	14351	-	170	1656	41	66	30	600	-	220	-
	Production	-	34.381	-	0.448	3.101	0.012	0.072	0.038	0.345	-	2911	-
	Yield	-	2396	-	2634	1873	295	1088	1256	575	-	13230	-
Puncha	Area	14	1490	-	9	240	452	5	14	164	139	119	4
	Production	0.02	3.103	-	0.02	0.331	0.177	0.004	0.018	0.152	0.081	3551	0.136
	Yield	1396	2083	-	2208	1381	391	799	1256	924	579	29838	33930
Purulia-I	Area	-	34693	-	9	240	616	10	31	306	-	298	7
	Production	-	90.165	-	0.02	0.331	0.119	0.001	0.039	0.198	-	6813	0.345
	Yield	-	2599	-	2208	1381	193	89	1256	648	-	22863	49233
Purulia-II	Area	-	1795	-	90	-	663	-	-	103	-	59	-
	Production	-	2.668	-	0.186	-	0.143	-	-	0.086	-	1544	-
	Yield	-	1486	-	2063	-	215	-	-	836	-	26167	-
Kashipur	Area	-	22061	12	17	4	-	-	-	68	107	22	-
	Production	-	48.385	0.025	0.025	0.005	-	-	-	0.052	0.054	773	-
	Yield	-	2193	2125	1496	1374	-	-	-	772	505	35121	-
Neturia	Area	-	1771	-	1	-	-	-	8	20	-	-	-
	Production	-	3.218	-	0.001	-	-	-	0.01	0.005	-	-	-
	Yield	-	1817	-	914	-	-	-	1256	256	-	-	-
Para	Area	-	14499	-	48	-	-	-	-	54	-	50	-
	Production	-	33.07	-	0.119	-	-	-	-	0.046	-	1349	-
	Yield	-	2281	-	2476	-	-	-	-	852	-	26978	-
Raghunathpur-I	Area	-	1540	-	5	-	29	-	-	51	85	-	-
	Production	-	3.158	-	0.013	-	0.014	-	-	0.078	0.043	-	-
	Yield	-	2051	-	2500	-	477	-	-	1525	505	-	-
Raghunathpur-II	Area	-	6901	26	1	1	22	-	-	2	95	-	-
	Production	-	16.218	0.068	0.002	0.002	0.01	-	-	0.001	0.048	-	-

BLOCK	AREA/ PROD./ YIELD	CROP TYPE											
		Aus	Aman	Boro	Wheat	Maize	Maskalai	Khesari	Gram	Mustard	Til	Potato	Sugarcane
	Yield	-	2350	2608	2007	1569	467	-	-	704	505	-	-
Santuri	Area	-	1542	-	112	-	-	-	-	44	-	30	-
	Production	-	3.001	-	0.205	-	-	-	-	0.025	-	1461	-
	Yield	-	1946	-	1833	-	-	-	-	572	-	48690	-

(Source: District Statistical Handbook, 2014)

***Area** = hectare, * **Production** = thousand million tones, ****Yield**= Kg/hect.*

Irrigation: There are no major/medium irrigation schemes running in the entire district. Irrigation on a large scale is surface water dependent due to the non-availability of adequate ground water owing to its discrete hydrogeological settings. Irrigation plays a major role in district's agriculture though tube wells of various depths.

A total of 12154.12 hectares of land was irrigated from 1379 sources during 2013-2014. The district has a cultural command area of 110041.86 hectares and out of which 86524.94 hectares can be covered by surface water source and the rest 23516.92 hectares by ground water source. 85745.97 hectares of Irrigation Potential can be created in the district. Table 1.7 explains the area irrigated by different sources in the study area. Table 1.8 explains the total culturable command area created so far by groundwater and surface water irrigation schemes. Table 1.9 gives the details of irrigation potential created (IPC) in the district.

Table-1.7: Source of irrigation and area irrigated by different sources(2013-2014).

BLOCKS	Canal	Tank		RLI		ODW		Others		Total	
	Area	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area
Arsha	10984.2	881	3763.71	7	10.57	239	192.2	19	599.3	1146	15549.98
Baghmundi	5627	88	1366.75	6	47.92	129	103.8	41	646.2	264	7791.67
Balarampur	3393.69	130	3736.67	4	61.57	124	99.8	26	300	284	7591.73
Barabazar	6927.81	638	1419.05	12	112.86	186	149.2	62	302.9	898	8911.82
Joypur	600	1568	2866.6	3	66.38	154	124.2	110	715.8	1835	4372.98
Jhalda-I	2585	386	7491.95	13	59.55	156	126	89	970.1	644	11232.6
Jhalda-II	3832	416	7228.65	3	42.21	250	201.8	102	552.2	771	11856.86
Bandowan	1694	376	4833.9	8	58.84	153	122.8	30	624.6	567	7334.14
Hura	1198	663	8397.97	4	11.21	230	185.4	82	3368.1	979	13160.68
Manbazar-I	-	644	6570.42	10	40.92	266	213.6	12	651	932	7475.94
Manbazar-II	1909	471	1322.12	5	67.38	149	119.8	54	787.3	679	4205.6
Puncha	-	652	6342.35	9	70.6	267	214.2	9	565	937	7192.15
Purulia-I	170	295	4606.47	7	27.91	222	179	28	574	552	5557.38
Purulia-II	2378	756	4141.91	8	49.66	233	186.8	46	465	1043	7221.37
Kashipur	2367.4	136	4435.92	14	44.68	284	228.6	46	1924.7	480	9001.3
Neturia	-	487	3303.99	4	13.64	145	116.2	22	372	658	3805.83
Para	2792	379	6132.63	6	-	341	235	25	635	751	9794.63
Raghunathpur-I	-	376	7749.54	4	47	304	243.2	27	1035.5	711	9075.24
Raghunathpur-II	1547	185	1303.94	4	18.89	282	225.6	15	991.7	486	4087.13
Santuri	4117.16	1168	6747.47	4	20.59	183	147.8	24	1121.1	1379	12154.12
TOTAL	**52122.26**	**10695**	**93762.01**	**135**	**872.38**	**4297**	**3415**	**869**	**17201.5**	**15996**	**167373.15**

***RLI**= River Lift Irrigation, **ODW**= Open Dug well.* *(Source: 5th MI Census, West Bengal)*

Table-1.8: Source wise Culturable command area, Purulia district.

BLOCK	Dug well		STW		MTW		DTW		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	
Arsha	60	73.02	1	1	0	0	15	872	602	5401.27	64	1273.02	946.02	6674.29	7620.31
Baghmundi	478	674.57	2	5	3	3	13	717.5	289	2949.8	172	898.44	1400.07	3848.24	5248.31
Balarampur	27	45.7	0	0	0	0	10	1053.2	390	1723.55	6	138	1098.9	1861.55	2960.45
Bandwan	23	23.88	0	0	1	3.9	4	312.5	631	3479.5	29	475.1	340.28	3954.6	4294.88
Barabazar	157	476.31	8	9.7	5	4.03	23	1416.6	805	6133.29	546	3237.98	1906.64	9371.27	11277.91
Hura	99	215.09	0	0	0	0	30	1682.2	889	4328.19	14	245.54	1897.29	4573.73	6471.02
Jhalda-I	646	1388.95	0	0	0	0	20	1645.7	570	3421.45	7	120	3034.65	3541.45	6576.1
Jhalda-II	273	591.31	0	0	0	0	20	1196.6	657	3586.33	5	100	1787.91	3686.33	5474.24
Joypur	278	530.16	1	2	0	0	11	529	282	1150.8	122	373.15	1061.16	1523.95	2585.11
Kashipur	369	663.59	2	3	3	5.5	8	567.8	867	6577.55	314	2557.34	1239.89	9134.89	10374.78
Manbazar-I	82	113.68	3	4	0	0	9	751	436	3969.44	318	2581.17	868.68	6550.61	7419.29
Manbazar-II	18	28.36	1	0.1	0	0	20	659.2	385	2818.15	27	277.23	687.66	3095.38	3783.04
Neturia	54	79.2	4	9.86	0	0	5	195	484	2202.65	102	863.47	284.06	3066.12	3350.18
Para	94	178.08	0	0	0	0	6	407	913	3995.69	10	100.1	585.08	4095.79	4680.87
Puncha	89	174	0	0	0	0	4	610	620	2046.99	10	117.2	784	2164.19	2948.19
Purulia-I	89	125.9	0	0	0	0	15	1206	1241	3503.84	12	168.5	1331.9	3672.34	5004.24
Purulia-II	121	132.96	3	4.4	2	2.05	9	1022.05	943	3678.72	215	1655.41	1161.46	5334.13	6495.59
Raghunathpur-I	1	1.03	0	0	0	0	18	1207.5	448	3830.79	22	210.65	1208.53	4041.44	5249.97
Raghunathpur-II	37	68	2	4.5	0	0	15	649.4	525	1977.76	10	40.21	721.9	2017.97	2739.87
Santuri	54	130.04	1	2.6	0	0	20	1038.2	781	4172.67	11	144	1170.84	4316.67	5487.51
Total	**3049**	**5713.83**	**28**	**46.16**	**14**	**18.48**	**275**	**17738.45**	**12758**	**70948.43**	**2016**	**15576.51**	**23516.92**	**86524.94**	**110041.9**

***RLI**= River Lift Irrigation, **MTW**= Medium Tube-well, **DTW**= Deep Tube-well, **STW**= Shallow Tube-well*

(Source: 5th MI Census, West Bengal)

Table-1.9: Irrigation Potential (IP) created by different sources in Purulia district.

Block Name	Dugwell		STW		MTW		DTW		Surface Flow		Surface Lift		IP (ha.)		Total IP (ha.)
	No.	IP (ha.)	No.	IP (ha.)	No.	IP (ha.)	No.	IP (ha.)	No.	IP (ha.)	No.	IP (ha.)	Ground Water	Surface Water	
Arsha	60	61.45	1	1	0	0	15	1120.52	602	4463.97	64	919.46	1182.97	5383.43	6566.4
Baghmundi	478	834.23	2	7.6	3	3	13	1040	289	1688.66	172	677.35	1884.83	2366.01	4250.84
Balarampur	27	46.37	0	0	0	0	10	715	390	1645.3	6	243	761.37	1888.3	2649.67
Bandwan	23	22.5	0	0	1	3.9	4	320	631	3040.41	29	604.07	346.4	3644.48	3990.88
Barabazar	157	146.82	8	5	5	1.8	23	1367	805	1440.38	546	909.06	1520.62	2349.44	3870.06
Hura	99	215.49	0	0	0	0	30	2149	889	3148.8	14	335.2	2364.49	3484	5848.49
Jhalda-I	646	1359.8	0	0	0	0	20	1420	570	3929.16	7	150	2779.8	4079.16	6858.96
Jhalda-II	273	569.83	0	0	0	0	20	1545	657	3496.49	5	95	2114.83	3591.49	5706.32
Joypur	278	529.56	1	2	0	0	11	880	282	858.25	122	138	1411.56	996.25	2407.81
Kashipur	369	395.31	2	2	3	3	8	640	867	5269.07	314	2137.09	1040.31	7406.16	8446.47
Manbazar-I	82	91.17	3	1.68	0	0	9	660	436	3082.65	318	1578.33	752.85	4660.98	5413.83
Manbazar-II	18	16.2	1	0	0	0	20	1191.1	385	769.51	27	95	1207.3	864.51	2071.81
Neturia	54	55.21	4	2.86	0	0	5	345	484	638.46	102	299.35	403.07	937.81	1340.88
Para	94	178.99	0	0	0	0	6	480	913	3955.21	10	110.1	658.99	4065.31	4724.3
Puncha	89	172.98	0	0	0	0	4	320	620	2057.96	10	95.12	492.98	2153.08	2646.06
Purulia-I	89	127.84	0	0	0	0	15	730	1241	2887.43	12	259.35	857.84	3146.78	4004.62
Purulia-II	121	45.92	3	0.1	2	0	9	641	943	569.17	215	139.39	687.02	708.56	1395.58
Raghunathpur-I	1	2	0	0	0	0	18	1101	448	3058.47	22	195.65	1103	3254.12	4357.12
Raghunathpur-II	37	68	2	4.2	0	0	15	1145	525	1927.69	10	44.33	1217.2	1972.02	3189.22
Santuri	54	150.12	1	2.4	0	0	20	1600	781	4035.13	11	219	1752.52	4254.13	6006.65
Total	**3049**	**5089.79**	**28**	**28.84**	**14**	**11.7**	**275**	**19409.62**	**12758**	**51962.17**	**2016**	**9243.85**	**24539.95**	**61206.02**	**85745.97**

***RLI**= River Lift Irrigation, **MTW**= Medium Tube-well, **DTW**= Deep Tube-well, **STW**= Shallow Tube-well, **IP**= Irrigation potential*

(Source: 5th MI Census, West Bengal)

1.7 URBAN AREA, INDUSTRIES & MINING ACTIVITIES: Purulia has three (3) Municipalities namely Jhalda (M), Purulia (M) and Ragunathpur (M). The urban population as per 2011 census is 373314. The level of urbanization of the district is very low. Only Purulia town has concentrate 32.43% of the total urban population. Levels of urbanization of five blocks namely Ashra, Bagmundi, Hura, Puncha, and Manbazar-II are zero, where not an urban center has been grown. The urban area of these blocks was added only in the last census, i.e., 2011 Census. Purulia-II and Raghunathpur-I blocks

have the highest concentrate of urban population. One of the most important feature that is found in this district is that, the urban populations in some blocks are decreasing. They are Raghunathpur-I & II and Balarampur. Highest negative growth rate was found in Raghunathpur-II (-12.61). The highest rate of urbanization found in Para block (138.14). The urban density of all the blocks is very low and is below the national and state average (328 per sq.km). Four blocks namely, Balarampur, Raghunathpur-I, Para and Neturia blocks have the highest urban density.

All the areas of a district are not uniformly endowed with resource; neither have they had equal potentiality for Industrial developments. An unbalanced growth structure is a common characteristic of present day industrial scenario. Industries thus tend to concentrate around certain centre which are naturally more suited towards development and which have strong forward and backward linkages. The region saw a number of industries being established in the province since the year 2001 owing to the Industry policy of the government of West Bengal.

There are two main industrial areas in Purulia district namely, Purulia IE., Ranibandh & Raghunathpur Industrial Park. There are so far 96 registered industrial units *(Source: District Statistical Handbook of BAES & Economic Review, 2011-12, Govt. of W.B).* The list of Large Scale Industries / Public Sector undertakings includes Ispat Damodar Ltd., Santhaldi Thermal Plant, Bengal arc Steel Pvt. Ltd., Purulia Steel Pvt. Ltd. & Damodar Cement and Slag Ltd. A number of medium and small scale industries have also been established in the region like lac industry and sericulture.

Purulia has wide range of mineral resources. GSI have identified ten types of mineral deposits in this district. Some common minerals include coal, feldspar, limestone, apatite, china clay, quartz, etc. The main mineral resource in the district is Gondwana coal which is being mined at two big collieries namely Ranipur and Parbelia in Santuri block. Other coal mines of importance are Deuli and Bhamuria. Decorative stones/building materials are also being excavated from Deuli, Bero, Dhunia, etc.

Chapter – 2

CLIMATE

2.0 CLIMATE

Climate of the district is probably one of the important factors that have shaped the present day landscape of the area. Purulia has sub-tropical type of climate which is characterized by high evaporation coupled with low precipitation. It is one of the drought prone districts of West Bengal. Winter in the area lasts normally from November to February while the summer lasts from March to June. Monsoon generally lasts from June to September. It has been observed that moderate drought occur once in every 3 years and severe type of drought occur once in every 10 years in the district.

2.1 RAINFALL

The normal annual rainfall for the district is 1321.9 mm. The average annual rainfall of the district ranges from 1100-1500 mm. The rainfall in the area is not uniform each year but is erratic and scanty as a result the Kharif crops fails and drought takes place. Monsoon Lasts from July to September. The main source of rainfall in the district is the South-West monsoon, which accounts for 80% of the total rainfall in the district. The average monthly rainfall graph for Purulia district is shown Figure-2.1 and its corresponding average annual rainfall(2001-19) isohyets zonation is shown in Figure 2.2. The annual rainfall data for a period of 2001 – 2019, along with meteorological analysis have been tabulated and presented in Table -2.1.

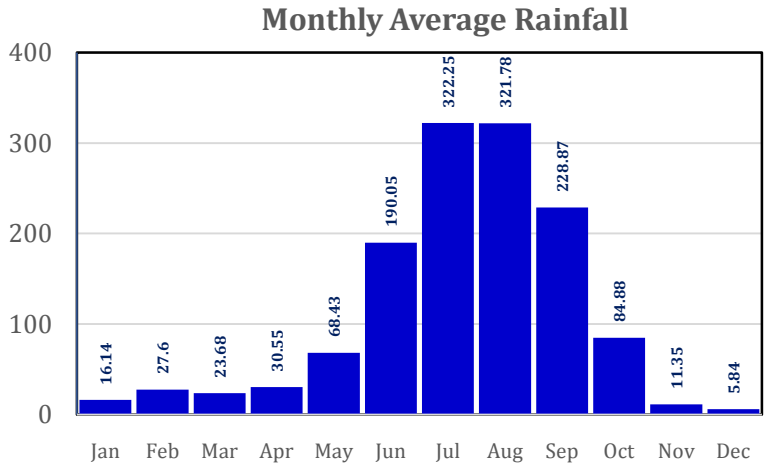


Figure 2.1 : Monthly Average Rainfall(Normal) in Purulia District

Table 2.1 : Normal Annual Rainfall and Meteorological Analysis

Year	RF (mm)	Departure (mm)	Percentage Departure	Analysis
2001	1001.5	-320.4	-24.24	Normal
2002	1193.9	-128.0	-9.68	Normal
2003	1026.8	-295.1	-22.32	Normal
2004	1135.0	-186.9	-14.14	Normal
2005	975.5	-346.4	-26.20	Moderate Drought
2006	1317.9	-4.0	-0.30	Normal
2007	1783.8	461.9	34.94	**Excess Rainfall**
2008	1383.4	61.5	4.65	Normal
2009	1165.8	-156.1	-11.81	Normal
2010	901.3	-420.6	-31.82	Moderate Drought
2011	989.5	-332.4	-25.15	Moderate Drought
2012	1023.1	-298.8	-22.60	Normal
2013	997.5	-324.4	-24.54	Normal
2014	1026.7	-295.2	-22.33	Normal
2015	1208.7	-113.2	-8.56	Normal
2016	1367.9	46.0	3.48	Normal
2017	1565.9	244.0	18.46	Normal
2018	1140.2	-181.7	-13.75	Normal
2019	1219.1	-102.8	-7.78	Normal

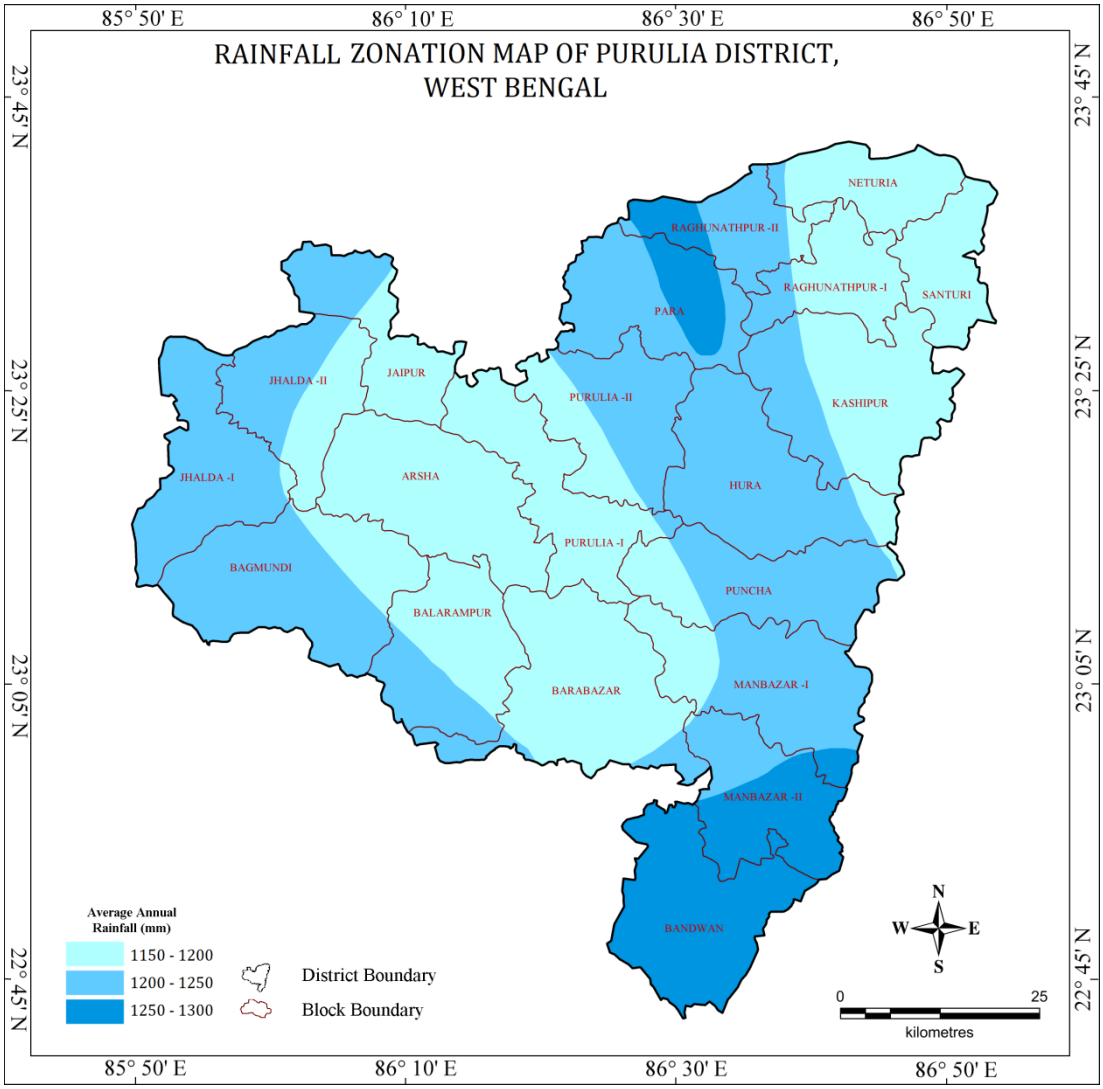


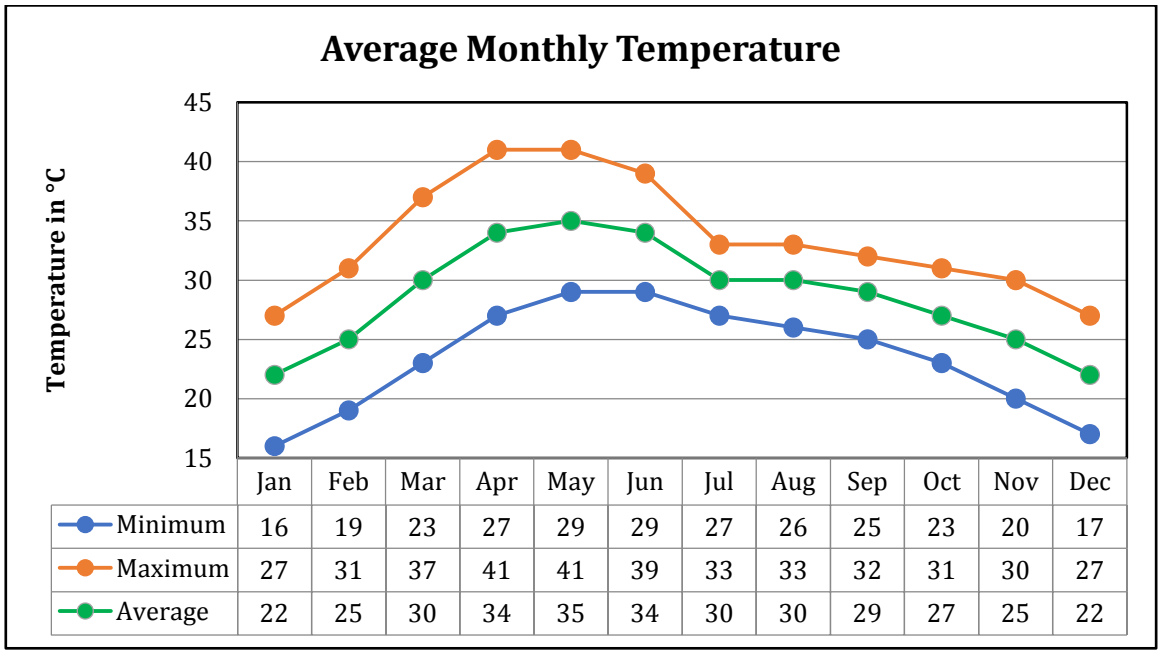
Figure-2.2: Rainfall Isohyet zonation map for Purulia district. *(Source: IMD)*

2.2 TEMPERATURE

Purulia district is characterized by dry tropical climate, marked by a moderately cold winter with night time temperatures reaching around 10°C. Summers are highly oppressive summer and often scorching with day time temperatures reaching above 40°C. Winter which lasts from November to February. Late March signals the advent of summer, which maintains its oppressive spell till June. The maximum and minimum temperature of the district for the preceding 5 years in degree Celsius is given below in table 2.2.

Table 2.2: Maximum and Minimum Temperature of the District

District	Year	Maximum (°C)	Minimum (°C)
PURULIA	2016	32.8	22.9
	2017	33	22.3
	2018	32.75	22.41
	2019	33	24
	2020	32.5	23.8



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	16	19	23	27	29	29	27	26	25	23	20	17
Maximum	27	31	37	41	41	39	33	33	32	31	30	27
Average	22	25	30	34	35	34	30	30	29	27	25	22

Figure-2.3: Average Monthly Temperatures for Purulia district. *(Source: IMD)*

2.3 HUMIDITY AND WIND

The relative humidity is high in monsoon season, being 75% to 85%. But in summer it comes down to 25% to 35%. Dry, hot wind in summer blows across the district with velocity ranging between 5-6 Km/hr.

Chapter – 3

PHYSIOGRAPHY

3.1 PHYISOGRAPHY

Purulia district which is located in the eastern slope of Chottanagpur Plateau is characterized by a hilly terrain. The elevation of the area varies from 63meters to 712 meters above sea level. The general elevation of the land surface ranges between 150 meters to 300 meters. The master slope of the land surface is towards the east and south-east. The elevation map of the study area is shown in Figure-3.1**.**The location and extent of different types of slopes in Purulia district is tabulated in Table -3.1

The district can be sub-divided physiographically into two units. The one is hilly terrain in the western and southern parts, which are the continuation of Chottanagpur Plateau. The other one is the undulating plain with isolated mounds and hills, comprising the rest of the district covering about 80% of the total area.

The hilly terrain in the western part has parallel hill ranges roughly trending NW-SE in Jhalda – Baghmundi-Balarampur area. This includes the Ajodhya hill which is a small plateau with surrounding hills. The highest peak of Ajodhya hills is Chamtaburu (712 m). The prominent hill near Jhalda is Bansa Pahar. The rugged terrain south to south-east of Bundwan is a continuation of the hill ranges from the adjacent Singhbum district in an approximately NW-SE trend. Raika Pahar, ChurniPaharand Gurma Pahar are some of the hills in this part.

The undulating plain covering rest of the district is characterized by high lands alternating with long stretches of low lying areas, where most of the culturable lands are located.

Table 3.1 Location and extent of different land relief types in Purulia District

Class	Slope (%)	Area (Hectares)	Percentage of total area	Location
1	<10	4,89,494	79.49	Erosional Plains of central and eastern parts of Purulia district
2	10-20	90,000	14.62	Lower slopes of plateau fringes & residual hills in the western, south-eastern and north eastern part of the district
3	20-30	35,156	5.71	Upper slopes of plateau region, extreme south western part of the district
4	>30	1,125	0.18	Top of the plateau and eroded steep rock hills of western part and north-eastern part of the district
Total		**6,15,775**	100	

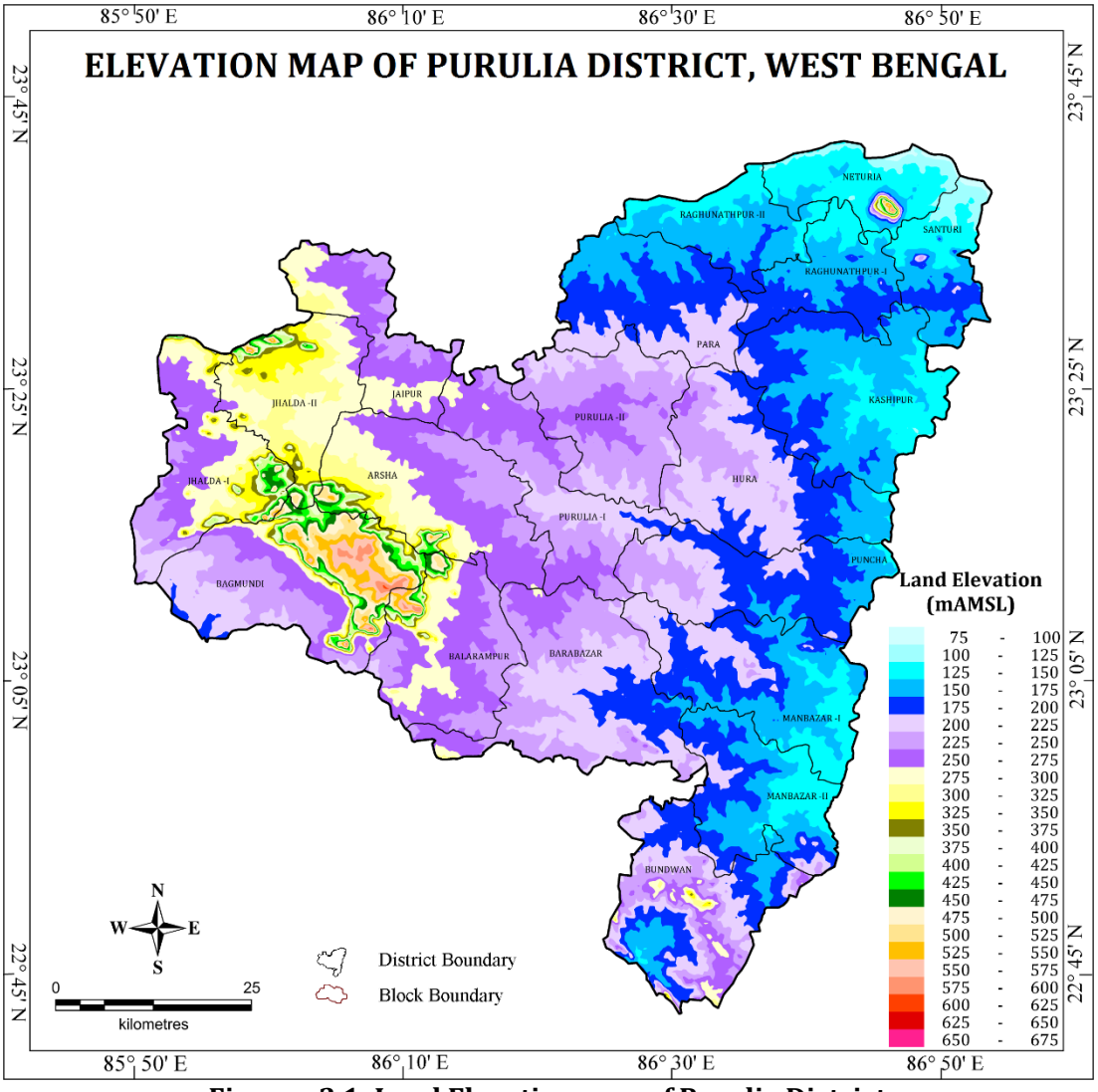


Figure - 3.1: Land Elevation map of Purulia District

3.2 GEOMORPHOLOGY

The study area can be divided into several geomorphic units. The geomorphological map of Purulia district is shown in Figure-3.2. The brief description of each unit is explained below:

- ***Flood Plain:*** Flood plain deposits in the district are found alongside the RiverDamodar in the extreme northern part bordering Santuri, Neturia and Ragunathpur-II blocks. These floodplains act as good aquifers due to their high permeability.

- ***Valley Fills:*** These are accumulation zone of colluvial materials derived from the surrounding uplands. They are characterized by fine loamy to clayey soils and are found as narrow strips along the river channels in the district.

- ***Pediment-pediplain complex:*** Pediplain is a relatively flat surface formed by joining of several pediments. They may have a thin veneer of sediments and are characteristics of semi-arid to arid climates. This landform accounts for almost 80% of the total area in Purulia district.

- ***Low to highly dissected structural hills:*** These are formed due to combined effect of denudation and tectonism.These regions act as runoff zones. This type of landform is found as patches in blocks like Jhalda-I &Jhalda-II, Barabazar, Manbazar-II and Bundwan.

- ***Low to highly dissected denudational hills:*** Denudational hills consist of jointed and fractured granites and gneisses, and are formed due to differential erosion and weathering processes. The presence of fractures, joints and topographic cuts makes infiltration of groundwater possible but with increasing slope the runoff possibility also increases limiting the groundwater recharge process. Therefore, the highly dissected hills with sharp relief, formed due to the severe erosion process have very less groundwater prospect than the low-dissected hills. The Ajodhya hill range and the intermittent valleys are examples of denunational hills. They are characterized by steep to moderately steep relief; rounded to sharp crest and the lithology

comprises of different variants of Chottanagpur Gneissic Complex with enclaves of meta-sedimentaries. This type of landform feature is found in Bundwan, Baghmundi and in some portions of Santuri and Neturia blocks.

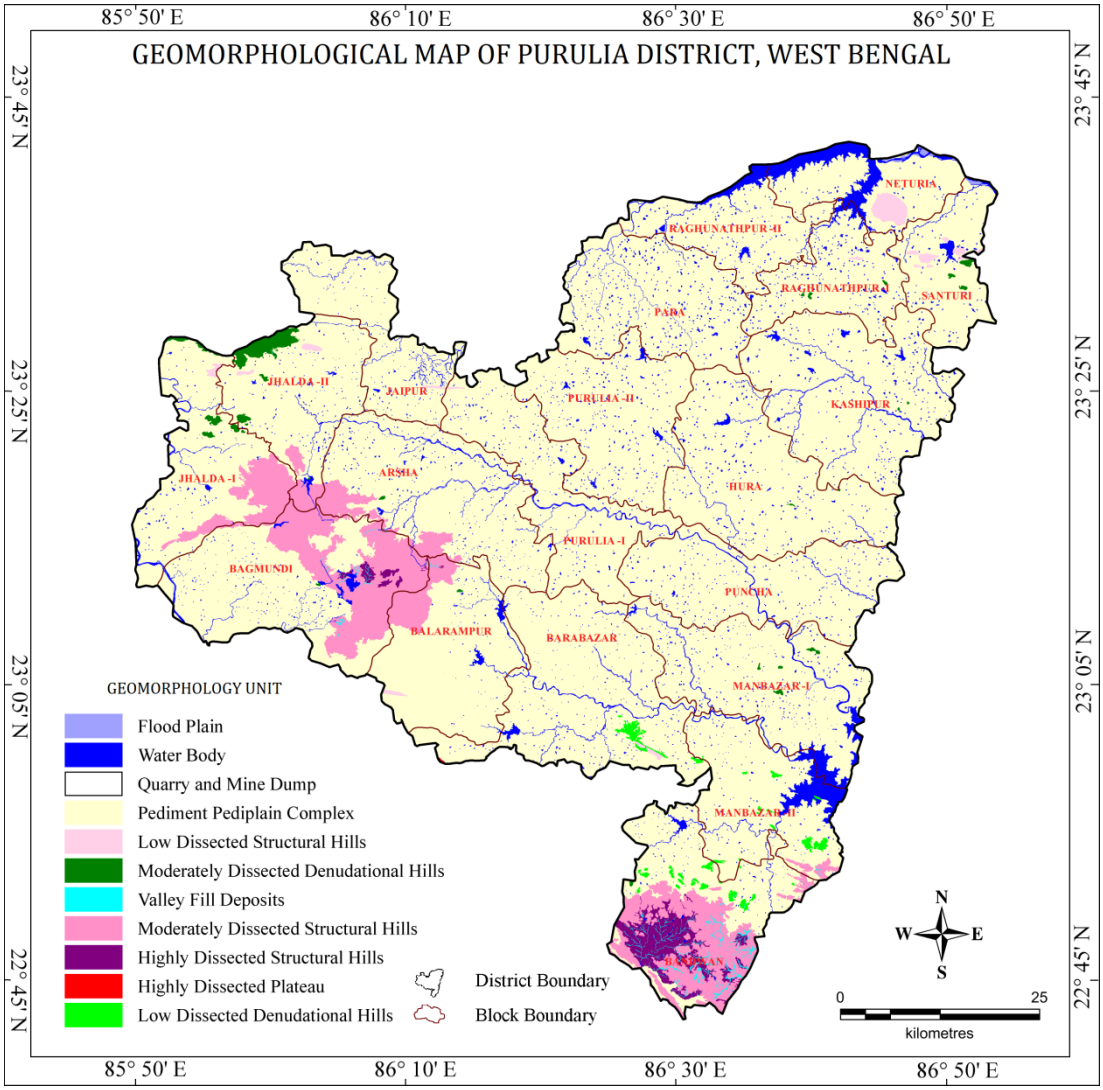


Figure-3.2: Geomorphological map of Purulia District

3.3 DRAINAGE

The river Kasai which flows through the central part of the district, along with Damodar and Subarnarekha are the main perennial rivers, which drain the district. Kasai is the most important river of Purulia which is joined by its major tributary, Kumariin the southern part of the district. Darakeswar and Silai or Sialabati rivers drain small area in the north- eastern and eastern part of the district respectively. In general, the streams of the district flow eitherin easterly or south easterly directions. The drainage pattern developed in the district is also either dendritic or radial pattern. The important

ephemeral streams of the district are Sahara, Jorh, Bandhu, Nangsai, Vanumata, etc. The drainage map of the study area is shown in Figure-3.3.

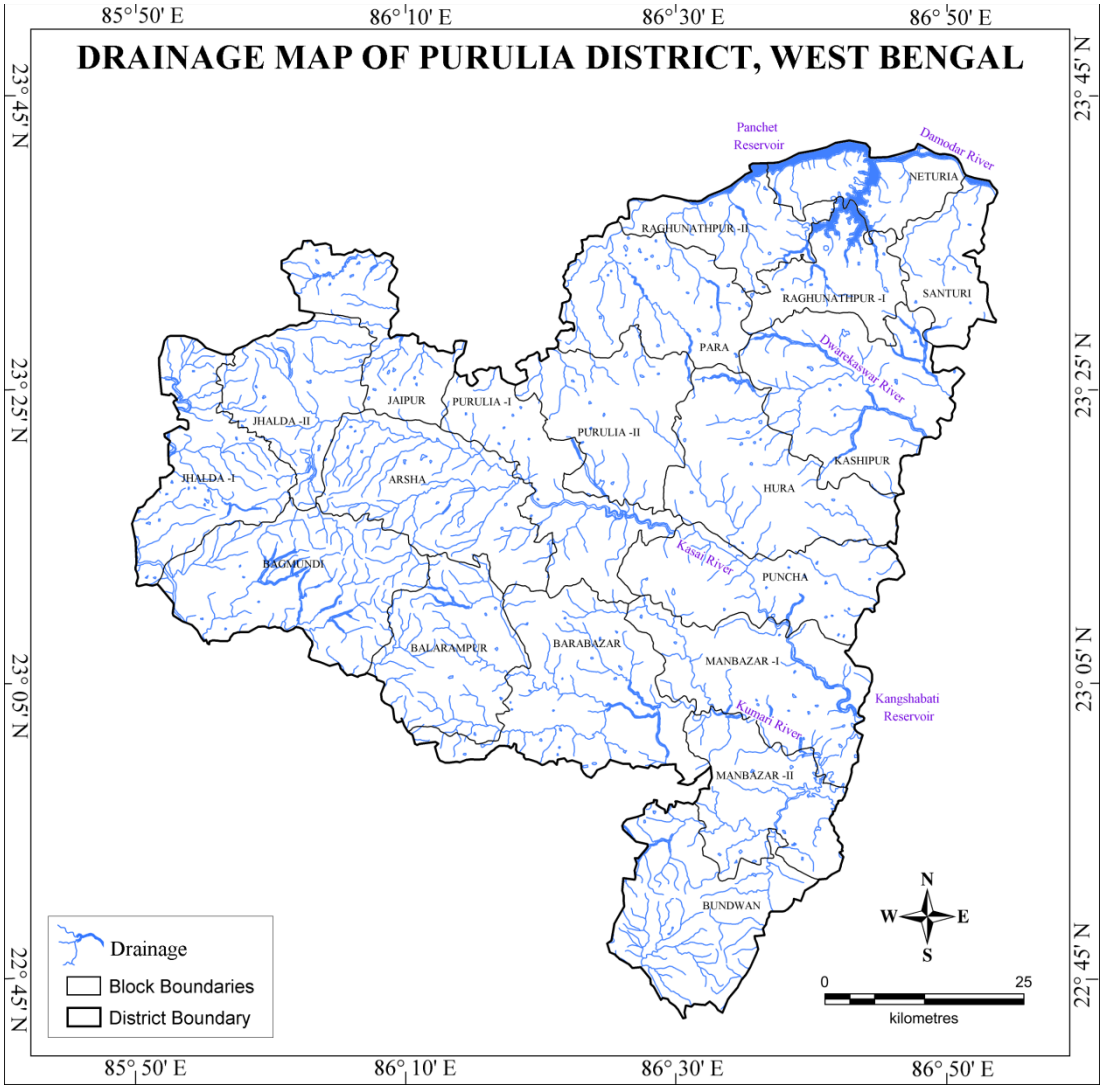


Figure- 3.3: Drainage map of Purulia District

3.4 PEDOLOGY

Soils found in the district are in general of the residual type which is derived directly from the weathering of the Achaean granites, gneisses and schists. Lateritic soil prevails in the uplands whereas, in the valleys, reddish clay loam or white to reddish clay are common. Many textural classes are met with; such as sandy loam, reddish loam, white or reddish stiff clay etc. Because of the undulating nature of the topography, the soil cover is thin and the soil is generally gravelly. The soil in the entire district is found to be acidic in nature. On an average the soil contains 0.04% nitrogen, 0.005% P_2O_5 and 0.01% K_2O. The maximum nitrogen contentof the soil is 0.87% and the minimum is

0.036%. The fertility is also low as the soils contain very little organic matter except in the valley fills and river alluvium. The soil map of the study area is shown in Figure- 3.4. Three main soil groups according to the landscape and its association with rock-types have been identified. The details of the same is shown in Table-3.2.

Table 3.2: Location wise soil distribution

Group	Type	Location	Area (sq. Km)	% of total area
Soils associated with Granite-Gneiss Landscape	Deep, well drained to moderately drained, sandy loamy soil	Gently sloping to undulating plains of Jhalda, Arsa, Bagmundi, Barabazar, Para, Kashipur, Hura and Santuri.	2,744.50	43.84
	Shallow, well drained, gravelly loamy soils	Gently sloping ridges of Bagmundi and subdued ridges of Jhalda, undulating plains of Joypur, Purulia I, Purulia II, Barabazar, Manbazar and Para.	1,577.50	25.20
	Very deep, imperfectly, drained fine soil	Undulating plains of eastern part of Neturia and Santuri, Hura	975.00	15.58
Soils associated with Singhbhum landscape:	Very shallow, semi-white excessively drained gravelly loamy soils	Gently sloping narrow hill slopes of Bundwan	150.00	2.40
	Shallow, moderately well drained, coarse loamy soils	Subdued hill slopes of Bundwan	25.00	0.40
	Deep, moderately well drained, fine loamy soils	Very gently sloping undulating uplands of Bundwan and in small patches in Barabazar	387.50	6.19
Soils associated with Gondwana landscape	Shallow, imperfectly drained, coarse loamy soils	Undulating plains of Raghunathpur block	300.00	4.79
	Shallow, moderately well drained, gravelly loamy soils	Undulating plains of Neturia, Santuri and Raghunathpur I	100.00	1.60
Total			**6259.00**	100

(Source: District Survey Report, Purulia, Feb-2021)

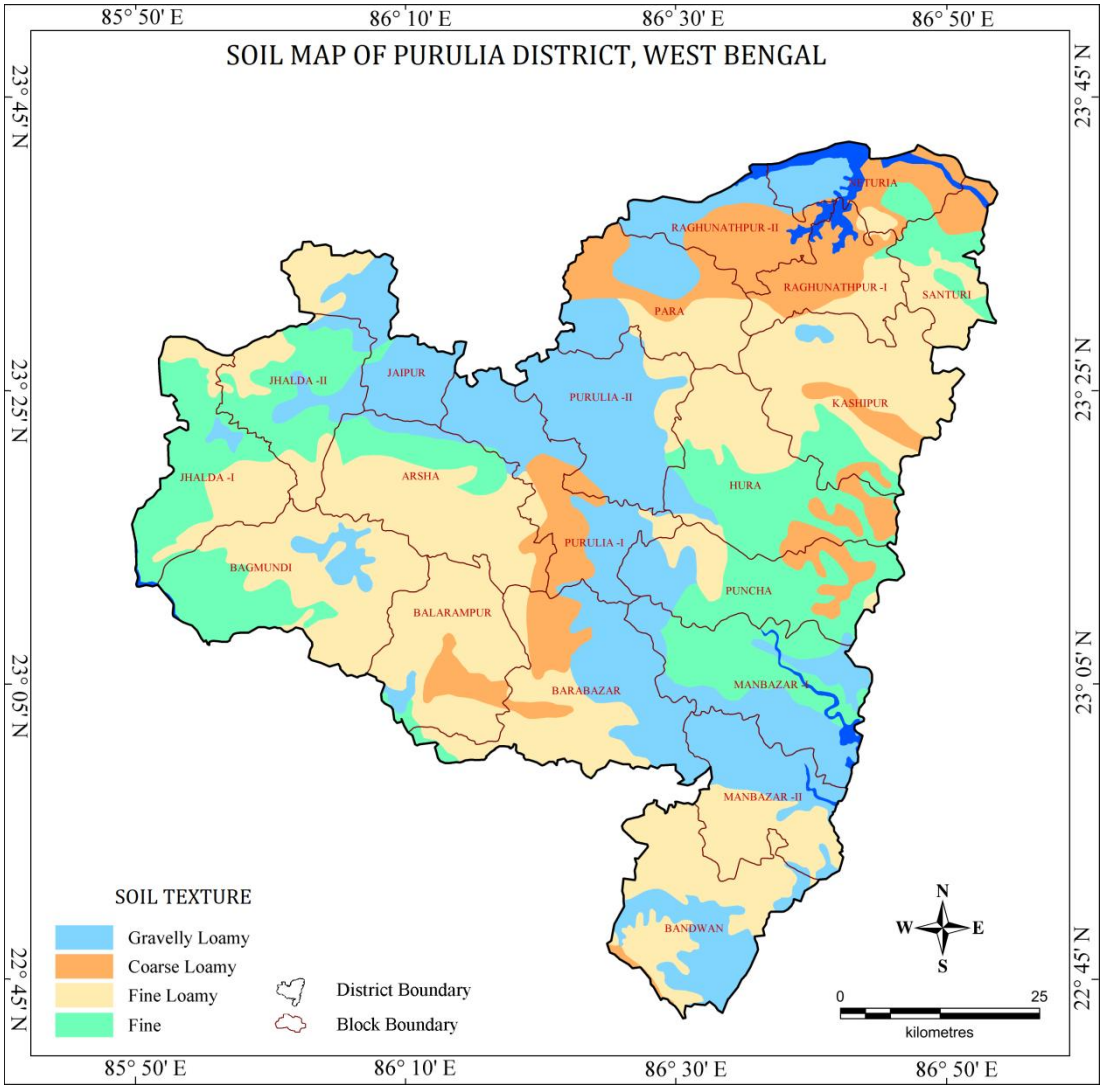


Figure-3.4: Soil map for Purulia District of West Bengal

(Source: District Survey Report, Purulia, Feb-2021)

Chapter – 4

GEOLOGY

4.1 GENERAL GEOLOGY

Purulia district is underlain by Precambrian metamorphics belonging to Chottanagpur Gneissic Complex. Permo-Triassic Gondwana formations occurs in the north eastern parts. Unconsolidated sediments are found to occur, adjacent to major rivers & streams as discontinuous patches. The generalized succession of Purulia district is as follows:

Table 4.1: Stratigraphic Succession of Purulia district

Age	Group Name/Formation		Lithology
Quaternary	Sijua		Coarse to fine sand slit & clay, Lithomargic clay yellow clay, Calcareous modules & laterite.
	~~~~~~~~~~ Unconformity ~~~~~~~~~~		
Triassic	Upper Gondwana		Sandstone (Supra-panchet)
	~~~~~~~~~~ Unconformity ~~~~~~~~~~		
Permian			Sandstone & Shale,
	Lower Gondwana	Panchet	Raniganj formation Sand, shale & coal seams
		Damuda	Barren measures formation Ironstone, shale & ferruginous Sandstone.
	~~~~~~~~~~ Unconformity ~~~~~~~~~~		
Proterozoic	Intrusive granite / Dalma volcanics/Singbhum Granite complex		Pegmatites,granite, quartz &chert veins, epidote-feldspar-quartz veins, aplites& quartz – magnetite veins underlain by Chotanagpur gneissic complex.
Archean	Chottanagpur Gneissic Complex		Chotanagpur Granite Gneiss Porphyroblastic granite – gneiss, biotite - granite composite gneiss, Migmatites, granetiferous granitic gneiss Amphibolites, meta norite, Hornblende-schist.

(Source: GeologicalSurvey of India.)

Metamorphic rocks encompass granite gneiss (Chotanagpur Granite Gneiss Complex), biotite granite gneiss, calc-granulite, ultrabasic, metabasic, meta-sedimentaries, and pegmatite and quartz veins. Geologically the meta- sedimentaries are the older group of rocks here. They comprise of calc- granulite, crystalline limestone, and garnetiferous-sillimanite schist.

Within the vast occurrence of granites and granite gneisses, metabasics occur as intrusive. The rocks of Gondwana i.e. of Permian & Triassic age in the north-eastern part of the district are represented by shales& ferruginous sandstones of the Barren Measure Formation along with sandstones, shales and coal seams of the Raniganj Formation.

The unconsolidated sediments comprising of coarse to fine sand, silt, clay, lithomargic clay, yellow clay, calcareous nodules and laterite play a vital role in forming the unconsolidated sediments.

Rocks with various geological ages ranging from Archeans to Recent that found in the district(Figure-4.1) may be grouped into following categories:

I. Chotanagpur Gneissic Complex:

a) ***Granite gneiss and Migmatite:*** They cover almost 56 percent of the total area of the district and are found in all blocks except the Bundwan& the southern part of Barabazar, Balarampur, Manbazar, north eastern part of Neturia and southern Santuri. These rocks are hard & foliated and can easily be weathered.

b) ***Quartz and Quartz Schists:*** These hard-layered rocks occur mainly in extreme north-western part of Jhalda and as small patches in Barabazar and Para.

c) ***Calc-granulites, calcschists and crystalline limestones:*** These rocks are found in northern part of Jhalda and as small patches in Jaipur and Neturia.

d) ***Mica schist:***These soft and flaky rocks occur in central part of Jhalda II, north of Arsha, southern part of Bagmundi, Balarampur, Barabazar, as patches in Joypur, Purulia II, Para, Kashipore, Santuri, extreme north-western part of Raghunathpur and eastern part of Manbazar.

e) ***Amphibolites and Hornblende schists:*** In Jaypur, Jhalda II, Arsa, Bagmundi, Para, Raghunathpur and Santuri, amphibolites and hornblende schists occur as insignificant patches.

II. Singhbhum Group:

a) Phyllite sand mica schists: Southern part of Balarampur, Barabazar and most part of Bundwan block are covered by these soft flaky rocks.

b) Quartzite: Insignificant patches of quartzite are found in Balarampur and Bundwan.

III. Intrusive Granites:

a) Kuilapal (GRk), Manbhum (GRm) and other Granites: These hard & massive rocks occur mainly in north Jhalda, Joypur , Arsha , Purulia , Para , Raghunathpur, Neturia, Balarampur , Barabazar , Manbazar and as small patches in Bagmundi and in Bundwan blocks.

IV. GondwanaSupergroup Of Sedimentaries With Coal Seams:

a) Clays with caliche concretions: These rocks are soft and unconsolidated and occur as small patches in Hura and Manbazar blocks

b) Red sandstones and red clays: Very insignificant patches of these medium hard to soft layered sedimentary rocks are found mainly in Neturia.

c) Sandstones, clays and shales: These are found in Neturia and Santuri blocks.

d) Coal bearing sandstones and shales: These rocks are considered as a part of Raniganj Formation and found mainly in Neturia and Santuri.

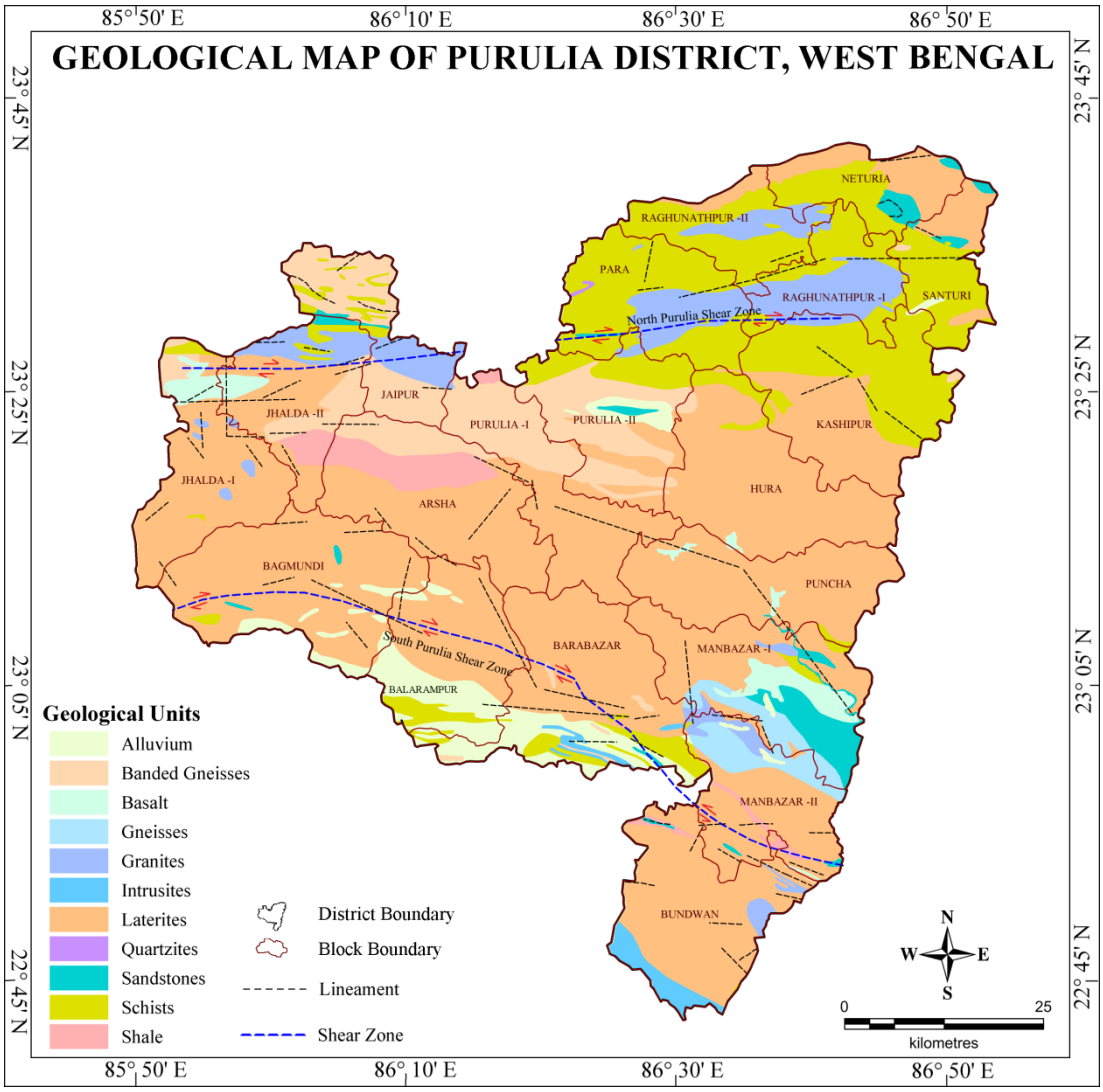


Figure-4.1: Geological map of Purulia district

4.2 STRUCTURAL FEATURES

The regional structure indicates the presence of isoclinal folds, in which the fold axes are either horizontal or plunging at low angles towards east or west. General E-W strike of the formations is predominant with moderate to steep northerly and southerly dips. Reversals of dips are the manifestations of regional folding and shearing of the concerned rocks locally. Well-developed and prominent foliations in the meta-sediments having uniform WNW-ESE strike and with steep dips due north are also noticeable here. Presences of quartzites give the picturesque of weathering and formed low ridges & the intervening valleys which are usually composed of the easily weathered schistose rocks.

The granitic rocks generally form hills and mounds. The porphyritic granite shows planar banding of alternate layer of feldspar phenocrysts and a finer grain assemblage of quartz, feldspar and accessories. It gives supportive evidence to the structural trend of the schistose country rocks. They are often well jointed. Common joints developed in the granite gneiss are as follows:

(i) N-S — Vertical.
(ii) E-W — Dip 15° towards North.
(iii) E-W — Vertical.
(iv) N-S — Dip 35° towards West.
(v) ENE-WSW — Vertical.
(vi) NNE-SSW — Dip 65° towards ESE
(vii) ESE- WNW — Vertical.
(viii) NE-SW — Dip 65° towards SE.

The sedimentary rocks of the Gondwana system such as the sandstones and shales have bedding planes and open joints. Carbonaceous shale are compact but highly jointed. The junction between the Gondwanas and Archeans is marked by the boundary fault.

Two shear zones are observed in the district. One of them, known as South Purulia Shear Zone (SPSZ) exists along the boundary between the Singhbhum Group and Gneissic Complex and another Shear Zone (North Purulia Shear Zone, *i.e.,* NPSZ) has been traced further to the north between Jhalda and Ragunathpur. These shear zones are susceptible to erosional activity. The most prominent rock type observed in the region is an E-W to NE- SW trending porphyritic granite body extending from Tulin in the west to northeast of Bero in the east. To the south of the porphyritic granite body lies a vast area comprising grey granite, granite gneiss, migmatite, basic granulites, charnockite, sillimanite schist and anorthosite.

Chapter – 5

GEOPHYSICAL STUDIES

Geophysical study in field can be broadly divided into two categories, namely surface geophysical investigation or resistivity survey (VES and profiling) and electrical borehole logging.Surface geophysical investigation is the pre-drilling approach and in ground waterexploration it has many objectives depending upon the formation characteristicswhether they are unconsolidated, semi-consolidated or consolidated formations.

In hard rock terrain it is required to identify a) Saturated fractures/joints, faults, shear zones, dykes, quartz veins and reefs which may control the ground water occurrence/movement at varied depths, b) Thickness of the water bearing overburden (weathered residuum), c) depth to the bed rock and resistivity values and d) delineation of water filled cavities in limestone.

Electrical resistivity investigation is also adopted in exploratory drilling program to locate a tube/bore-well site due to its wide simplicity in field proceedings and low cost of operation. It also helps for mapping potential aquifers in buried stream channels and also demarcating the areas suitable for artificial recharge and prone to water logging.

Electrical well logging measures the physical properties of surrounding rocks with a sensor located in a borehole. It is performed by lowering a 'logging tool' - or a string of one or more instruments on the end of a wire-line into a borehole and recording the physical properties using a variety of sensors. Several types of logging methods are available. However the most commonly used is the electrical resistivity method. This method works by characterizing the rock or sediment in a borehole by measuring its electrical resistivity which is the ability to impede the flow of electric current. Resistivity is expressed in ohm meter (Ωm), and is frequently charted on a logarithm scale versus depth because of the large range of resistivity. The natural resistivity in hard rocks are mentioned in Table-5.1.

Table-5.1: Range of resistivity in Hard rocks

LITHOLOGY	RANGE OF RESISTIVITY (IN Ωm)
Highly weathered and fractured granite	220-300
Fractured granite	350-500
Less fractured granite	1000-2000
Fresh and massive granite	>20,000
Laterites (hard)	100-150
Weathered laterite	40-100
Weathered basalt	45-130
Hard and compact	>800

In the present study area, CGWB, ER has carried out geophysical studies using different instruments and methods to pinpoint sites for drilling exploratory wells. The details for each site are discussed thoroughly in the following pages.

5.1 Bodaldih, Barabazar block: The surface resistivity investigation was done using a CRM 500, auto-c, resistivity meter, (Anvic, Pune). One mise-a-la-masse survey was conducted in the borehole where drilling was done and fracture was detected. In mise-a-la-masse survey the one current electrode is kept in infinity and one current electrode is kept inside the borehole at fracture depth. The two potential electrodes are kept radially 5 meters interval in each reading. Different sets of radial readings are taken when current is allowed to pass. These potential values for different positions of electrodes are plotted in centimeter graph paper radially. Equipotential lines are drawn. From the equi-potential line direction, the orientation of fracture is predicted. A rough sketch for the method adopted is shown in Figure-5.1.

To confirm the presence of fracture and the depth of the fracture along the contour orientations, 2 Nos. of VES were conducted in the investigated area using Schlumberger configuration. The maximum current electrode separation was kept at 360 meter to get the maximum depth of investigation. The interpreted results for VES conducted at Bodaldih site is given in Table-5.2.

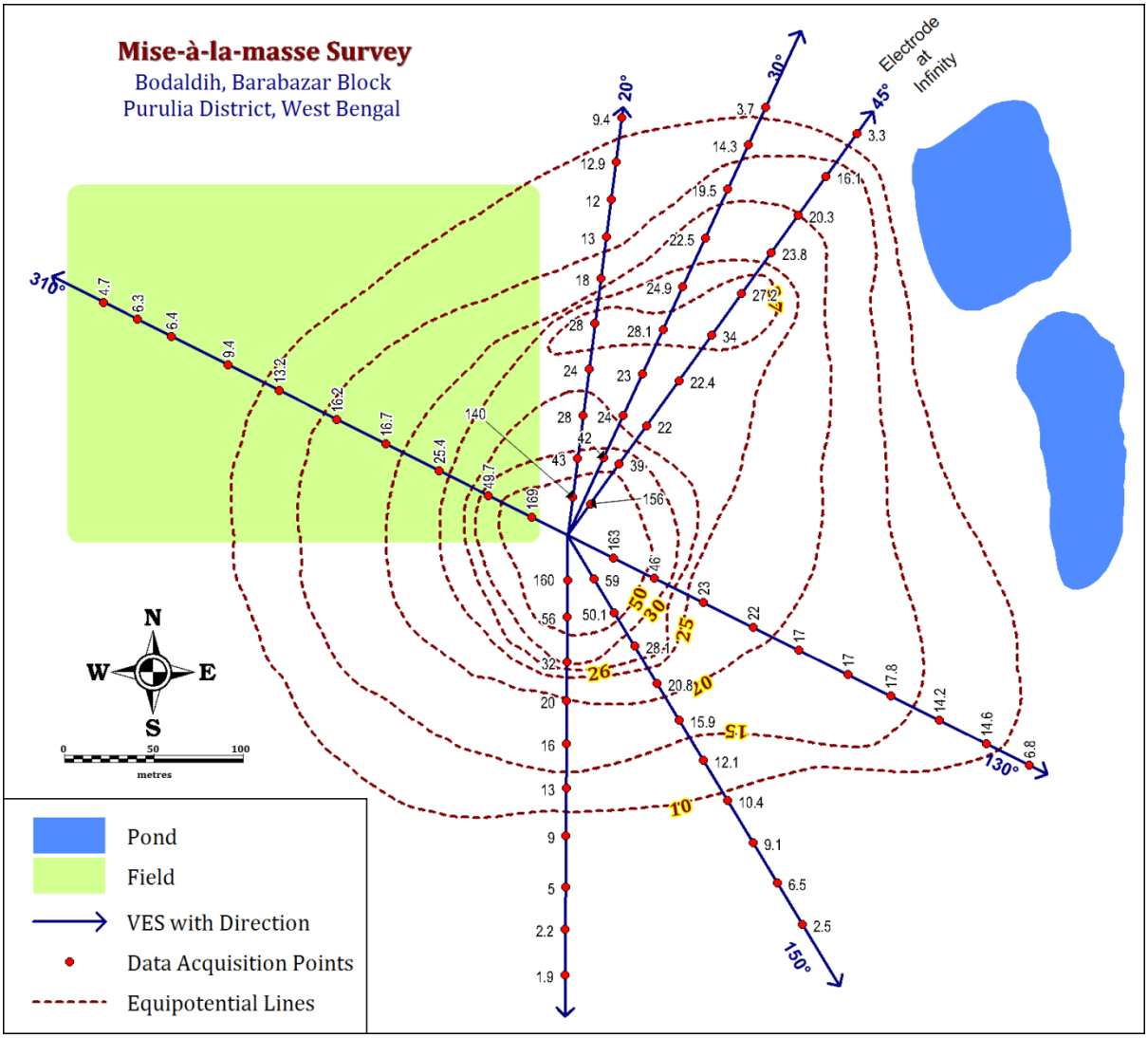


Figure-5.1: Schematic diagram for mise-a-la-masse survey conducted at Bodaldih site, Barabazar block.

Table -5.2: Interpreted VES results of Bodaldih High School, Barabazar block

VES No.	Area/Co ordinate Location	Layer Resistivity and Depth			Lithology	Fractures (mbgl)
		Layer No.	Resistivity (Ωm)	Depth (mbgl)		
VES 1	Along 130° North and 5 metre distance from the existing 1st drilling point (Exploratory well)	1st Layer 2nd Layer 3rd Layer	81 24 1854	0 - 2.0 2.0 – 4.2 4.2 – contd.	Top soil Weathered rock Hard formation	60- 80, 120-160
VES 2	Along 30° North and 5 metre distance from the existing 1st drilling point (Exploratory well)	1st Layer 2nd Layer 3rd Layer 4th Layer	67 44 550 12800	0 - 2.1 2.1 – 5.25 5.25 – 48.5 48.5 - contd.	Top soil Weathered rock Partially fractured Hard formation	60-70, 140-150

Based on the resistivity sounding studies, it is observed that the sub-surface formations may be composed of top soil, weathered/partially weathered rock and hard formation (may be granite). The top soil shows the resistivity order of 67 to 81 Ωm and is detected down to a maximum depth 2.1 mbgl. The second layer of resistivity from 24 to 44 Ωm is assumed to be weathered rock and generally exist within the maximum depth range 2 to 5.25 mbgl. The partially fracture formation of resistivity 550 Ωm is found within the depth range 5.25 to 48.5 mbgl. The weathered formation may provide sufficient water at shallow depths. The consolidated hard formations exhibit resistivity range from 1854 to 12800 Ωm.

The recommendations thus provided through the investigation done at Bodaldih high school site are given in Table-5.3.

Table-5.3: Recommendation of water bearing zones for different locations at Bodaldih High School site as per availability of aquifers.

VES No.	Location	Recommended water bearing depth zone in weathered and fractured formation (mbgl)		Drilling depth (mbgl)
		Weathered/ Partially Weathered formation	Fractured formation	
VES 01	Along 130° North and 5 metre distance from the existing 1st drilling point (Exploratory well)	2.0 – 4.2	60- 80, 120-160	200
VES 02	Along 30° North and 5 metre distance from the existing 1st drilling point (Exploratory well)	2.1 – 5.25 5.25 – 48.5	60-70, 140-150	200

5.2 Ankhro PHC site, Manbazar-II block : Total 3 Nos. of VES was conducted at Ankhro PHC site using Schlumberger configuration. The maximum current electrode separation was kept at 460 meter to get the maximum depth of investigation. The interpreted results for VES conducted at Ankhro PHC site are given in Table-5.4.

Table -5.4: Interpreted VES results of Ankhro PHC site, Manbazar-II block

VES No.	Co-ordinate	Location	Layer Resistivity and Depth			Lithology	Fracture (mbgl)
			Layer No.	Resistivity (Ωm)	Depth (mbgl)		
VES 01	22°54′44.30″ 86°33′3.35″	40 mRHS of the main gate,30m WWN of cement godown, near the wall	1st Layer 2nd Layer 3rd Layer	43 301 VH	0 - 4 4 – 44.85 44.85 – contd.	Top soil Partially weathered Hard formation	120-160
VES 02	22°54′45.73″ 86°33′4.14″	30 m from the back side wall, in between the main hospital building and sub centre	1st Layer 2nd Layer 3rd Layer	57 143 VH	0 – 4.6 4.6 – 16.6 16.6 – contd.	Top soil Partially Weathered Hard formation	-
VES 03	22°54′46.5″ 86°33′2.5″	40 m VES2 along NWW direction.	1st Layer 2nd Layer 3rd Layer	105 68 VH	0 – 2.1 2.1 – 11.97 11.97 – contd.	Top soil Weathered Hard formation	-

Based on the resistivity sounding studies, it is observed that the sub-surface formations may be composed of top soil, weathered/partially weathered rock and hard formation (may be granite). The top soil shows the resistivity order of 43 to 105 Ωm and is detected down to a maximum depth 0 to 4.6 mbgl. The second layer of resistivity, 68 to 301 Ωm is assumed to be made of weathered and partially weathered rock and generally exist down to a maximum depth range 2.1 to 44.85 mbgl. Below this second layer, hard formation layer with higher resistivity order of VH (α) Ωm exist below 21.84 to 32.2 mbgl. The recommendations thus provided through the investigation done at Ankhro PHC site are given in Table-5.5.

Table-5.5: Recommendation of water bearing zones at Ankhro PHC site for different locations as per availability of aquifers.

VES No.	Co-ordinates	Recommended water bearing depth zone in weathered and fracture formation (mbgl)		Drilling depth (mbgl)
		Partially Weathered/Weathered formation	Fractured formation	
VES 01	22°54′44.30″ 86°33′3.35″	4 – 44.85	120-160	200
VES 02	22°54′46.5″ 86°33′2.5″	2.1 – 11.97	--	25
VES 03	22°54′45.73″ 86°33′4.14″	4.6 – 16.6	--	30

5.3 Basantapur PHC site, Manbazar-II block : Total 1 Nos. of VES was conducted in the investigated area (Fig. 2) using Schlumberger configuration (Fig. 3 to 7). The maximum current

electrode separation was kept (AB) 400 meter to get the maximum depth of investigation. The interpreted results for VES conducted at Basantapur PHC site are given in Table-5.6.

Table -5.6: Interpreted VES results of Basantapur PHC site, Manbazar-II block.

VES No.	Area/Co ordinate	Location	Layer Resistivity and Depth			Lithology	Fractures (mbgl)
			Layer No.	Resistivity (Ωm)	Depth (mbgl		
VES 01	22°58′19″ 86°37′09″	20m from NNE of pump house and towards boundary wall	1st Layer 2nd Layer 3rd Layer	22 28 1560	0 - 3.9 3.9 – 16.38 16.38 – contd.	Top soil Weathered rock Hard formation	100-160

Based on the resistivity sounding studies, it is observed that the subsurface formations are comprised of top soil, weathered rock and hard formation (may be granite). In general it is observed that the top soil shows the resistivity order of 22 Ωm and is detected within the depth range of 0 to 3.9 mbgl. The second layer of resistivity 28 Ωm is assumed to be made up of weathered rock and exists within the depth range 3.9 to 16.38 mbgl. Below this second layer, hard formation layer of higher resistivity within the order of 1560 Ωm is assumed to exist below the depth of 16.38 mbgl. The recommendations thus provided through the investigation done at Ankhro PHC site are given in Table-5.7.

Table-5.7: Recommendation of water bearing zones at Basantapur PHC site as per availability of aquifers.

VES No.	Location	Recommended water bearing depth zone in weathered and fracture formation (mbgl)		Drilling depth (mbgl)
		Weathered formation	Fractured formation	
VES 01	20m from NNE of pump house and towards boundary wall	3.9 – 16.38	100-160	180

5.4 Eklabya Model School and Pandit Raghunath Murmu Model School, Manbazar-II block : Total 4 Nos. of VES was conducted in the investigated area using Schlumberger configuration. The maximum current electrode separation was kept at 360 meter to get the maximum depth of investigation. The interpreted results for VES conducted at Eklabya Model School and Pandit Ragunath Murmu Model School PHC site are given in Table-5.8.

Table -5.8: Interpreted VES results of Eklyaba Model School and Pandit Ragunath Murmu Model School, Manbazar-II block.

VES No.	Co- ordinate	Location	Layer Resistivity and Depth			Lithology	Fractures (mbgl)
			Layer No.	Resistivity (Ωm)	Depth (mbgl)		
Eklabya VES 01.	22°57′23.74″ 86°36′30.44″	Closed to school wall	1st Layer 2nd Layer 3rd Layer 4th Layer	32 16 133 VH	0 - 2.0 2.0 – 6.4 6.4 – 21.76 21.76 - contd.	Top soil Weathered rock Partially fractured Hard formation	-
Eklabya VES 02.	22°57′23″ 86°36′30″	Close to the dug well, 15 m SW of VES 1	1st Layer 2nd Layer 3rd Layer 4th Layer	23 12 70 VH	0 – 2.05 2.05 – 6.56 6.56 – 15.11 15.11 - contd.	Top soil Weathered rock Partially fractured Hard formation	-
Pandit VES 01.	22°57′33.93″ 86°36′50.78″	Central point within the School ground	1st Layer 2nd Layer 3rd Layer	24 7 VH	0 – 1.7 1.7 – 9.86 9.86 – contd.	Top soil Highly weathered Hard formation	-
Pandit VES 02	22°57′32.94″ 86°36′51.44″	Back side of the School	1st Layer 2nd Layer 3rd Layer	27 8 VH	0 – 1.9 1.9 – 9.5 9.5 – contd.	Top soil Highly Weathered Hard formation	-

Based on the resistivity sounding studies it is observed that the subsurface formations are comprised of top soil, weathered to highly weathered rock and hard formation (may be granite). In general it is observed that the top soil shows the resistivity order of 24 to 32 Ωm and is detected within the depth range of 1.7 to 2.05 mbgl. The second layer shows resistivity range from 7 to 8 Ωm and from 12 to 16 Ωm. This layer is assumed to be composed of highly weathered rock layer generally exist within the maximum depth range of 1.7 to 9.89 mbgl. The third layer has a resistivity range of 70 to 133 Ωm and exists within the depth range of 6.4 to 21.76 mbgl. The hard formation layer with higher resistivity order is assumed to exist below 9.5 to 21.76 mbgl. The recommendations thus provided through the investigation done at Ankhro PHC site are given in Table-5.9.

Table-5.9: Recommendation of water bearing zones at Eklyaba Model School and Pandit Ragunath Murmu Model School, Manbazar-II block, as per availability of aquifers.

VES No.	Location	Recommended water bearing depth zone in weathered and fracture formation (mbgl)		Drilling depth (mbgl)
		Weathered formation	Partially Fractured formation	
Eklabya VES 01.	Close to the school wall **22°57′23.74″: 86°36′30.44″**	2 -6.4	6.4 -21.76	30
Eklabya VES 02	Close to the dug well, 15 m SW of VES 01. **22°57′23″: 86°36′30″**	2.05 – 6.56	6.56 – 15.11	20

5.5 Sirkabad PHC, Arsha block : Total 5 Nos. of VES was conducted in the investigated area using Schlumberger configuration). The maximum current electrode separation was kept at 660 meters to get the maximum depth of investigation. The interpreted results for VES conducted at Sirkabad PHC, Arsha block site are given in Table-5.10.

Table -5.10: Interpreted VES results of Sirkabad PHC, Arsha block.

VES No.	Co-ordinates	Location	Layer Resistivity and Depth			Lithology	Fractures (mbgl)
			Layer No.	Resistivity (Ωm)	Depth (mbgl)		
VES 01	23°16′30.24″ 86°11′38.32″	Left side of the PHC main gate	1st Layer 2nd Layer 3rd Layer	98 12 17903	0 - 2.5 2.5 – 17.4 17.4 – contd.	Top soil Weathered rock Hard formation	50-60
VES 02	23°16′29.28″ 86°11′37.85″	27 m SSW of VES 1	1st Layer 2nd Layer 3rd Layer	99 21 771	0 – 2.06 2.06 – 26.5 26.5 - contd.	Top soil Weathered rock Hard formation	80-100, 140-160
VES 03	23°16′30.98″ 86°11′38.55″	20 m NNE of VES 2	1st Layer 2nd Layer 3rd Layer	80 5 20752	0 – 4.22 4.22 – 8.81 8.81 – contd.	Top soil Highly weathered Hard formation	40-60, 80-100, 120-140
VES 04	23°16′30.20″ 86°11′41.09″	In front of Quarter no. 14	1st Layer 2nd Layer 3rd Layer	68 17 5498	0 – 1.89 1.89 – 21 21 – contd.	Top soil Weathered rock Hard formation	60-80
VES 05	23°16′32.17″ 86°11′39.87″	Near the old destroyed building	1st Layer 2nd Layer 3rd Layer	63 5 6025	0 – 4.21 4.21 – 9.26 9.26 – contd.	Top soil Highly weathered Hard formation	100-140 & below 200

Based on the resistivity sounding studies, the following observations have been made. The sub-surface formations are assumed to be comprised of top soil, weathered/highly weathered rock and hard formation (may be granite). In general, it is observed that the top soil shows resistivity order of 63 to 99 Ωm and lies within the depth range of 1.89 to 4.22 mbgl. The second layer with resistivity order of 5 to 21 Ωm is assumed to be composed of moderate to highly weathered rock and generally exist within the maximum depth range of 8.81 to 26.5 mbgl. Below this second layer, hard formation layer with higher resistivity order is assumed to exist at a depth

range of 8.81 to 26.5 mbgl. The recommendations thus provided through the investigation done at Sirkabad PHC site, Arsha block are given in Table-5.11.

Table-5.11: Recommendation of water bearing zones at Sirkabad PHC, Arsha block, as per availability of aquifers.

VES No.	Location	Recommended water bearing depth zone in weathered and fracture formation (mbgl)		Drilling depth (mbgl)
		Weathered formation	Fractured formation	
VES 02	23°16′29.28″ 86°11′37.85″	2.06 -26.5	80-100, 140-160	160
VES 03	23°16′30.98″ 86°11′38.55″	--	40-60, 80-100, 120-140	160
VES 05	Near an old and damaged building 23°16′32.17″ 86°11′39.87″	--	100-140 & below 200	260

Chapter – 6
HYDROGEOLOGY

6.1 OCCURRENCE AND MOVEMENT OF GROUNDWATER

The district of Purulia is underlain by pre-Cambrian metamorphics except in a small area in the north eastern part where sedimentary of Gondwana age predominate. At places particularly in the eastern and southern parts- quartzite, slate, phyllite, schist also occurs in patches. Unconsolidated sediments of Recent to Sub-Recent age are restricted to the narrow river channels and to the valleys. The most common rock of widespread occurrence in the district is granites and granite gneiss into which metabasics occur as intrusives.

Groundwater is primarily restricted to the upper weathered mantle, saprolitic zones and in the fractured zones of consolidated Chottanagpur Gneissic Complex Formations and in the semi-consolidated Gondwana sedimentaries. The narrow strips of unconsolidated sediment along the major river valleys behave as groundwater repositories in the study area. Groundwater occurs under water table condition in weathered zones and in the valley sediments. In the deeper fractures zones, ground water generally occurs under semi-confined to confined condition. The topographic slope and direction of flow of the rivers indicates that groundwater movement is from North-West to South-East.

6.2 AQUIFER PROPERTIES AND YIELD, WATER BEARING FORMATIONS

Ground water in the district occurs mainly in (I) weathered zone (II) saprolitic zone (III) Fractured zones of Consolidated Formations (IV) Semi-Consolidated Formations (V) Unconsolidated Formations.

(I)The weathered zone: This zone vary in thickness, attains a maximum thickness of the order of 25m. Ground water occurs under water table condition and groundwater in this zone is mostly developed by a system of open dug wells. At some places these wells go dry during peak summer months. The dug wells from this zone yield up to 2.75 lps.

(II)Saprolitic zone: This zone is sandwiched between weathered mantle and fresh rock mass in granitic terrain. The depth of this zone varies between 10-30 mbgl, with an average thickness of 4m. Ground water occurs under semi confined condition and yield up to 2.5 lps is recorded. Drawdown in the wells tapping in this zone is much less and recovery is also quite fast.

(III)Consolidated Formations: CGC group of rocks represented by granite gneiss, granite, metabasics, metasediments, gabbro, quartzite, etc. form the consolidated Formations of the study area. This CGC covers almost 95% of the study area and forms the crystalline basement. Groundwater in this formation occurs in unconfined condition in the upper weathered and under semi-confined to confined condition in the fractured zones. Study from dug wells within the CGC gives the inference that weathered and shallow fracture zones in general occurs within 15 mbgl.

Electrical resistivity surveys conducted in CGC formations by CGWB suggests that water bearing fracture zones in general are likely to have been formed at two distinctly different depth levels mostly occurring within 80 mbgl, with most potential zones at about 20-35 mbgl and 45-65 mbgl. Bore wells sunk within 80 mbgl are having the prospect of high yield most probably.

As per the exploratory bore well records from CGWB, the fractures encountered from the borewells constructed in CGC upto a depth of 60 mbgl has a cumulative thickness of 2-3 m generally, forming very thin aquifers at different depth levels. Few wells in Barabazar and Jhalda-I blocks have fractures encountered at depths within 200-261.6 mbgl that gives very promiscuous yield. The yield prospect for the aquifers in hard rock is generally very low, mostly less than 5 m^3/hr. The drawdown is very high, ranging from 8-24m.

(IV)Semi-Consolidated Formation: Gondwana sedimentaries occupies not more than 5% of the study area, being limited to Santuri and Neturia blocks which lies in the north-eastern part of Purulia district and adjacent to Damodar River. A number of dug wells exist in this part of the Gondwana basin. This suggests that weathered/fractured sandstones and shales, siltstones etc. constitutes the unconfined aquifers within the

depth of 12 mbgl. Three (3) Exploratory wells have been sunk by CGWB so far in this Formation, two (2) in Neturia and one (1) in Santuri. The maximum depth explored is upto 103.25 mbgl. Potential fracture zones are encountered within the depth zone of 11-36 mbgl. Yield prospect in the Gondwanas is limited, being less than 20 m^3/hr. Drawdown is very high and generally ranges from 15-20m.

(V)Unconsolidated Formation: This Quaternary sediment column of limited thickness (<3m) occupies the narrow strips of valleys along the major ephemeral rivers like Dwarakeswar and Kangsabati. It is composed of assorted mass of gravel, pebble and medium to coarse sand, forming thin but highly potential river bed aquifers under water table conditions. A good number of shallow tube wells have been sunk in the river beds by PHED down to a depth of 8 mbgl to tap the base-flow for domestic supply in the nearby semi-urban areas during lean period. Geoelectric resistivity study along the river beds of Dwarakeswar, Futuari and Darubhanga Rivers near Pirra and Gamarkuri villages reveals the presence of water saturated zones generally occurring within 10 mbgl (few meters below the original river bed). The yield prospect for the river bed aquifers is about 0.01m^3/hr. The nature and occurrence of different sub-units is given in Table-6.1. The discharge, drawdown, Fracture zones, etc for both Aquifer-I & II is given in Table 6.2

Table 6.1 : Aquifer parameters for different litho units in Purulia district

Formation	Aquifer depth ranges (mbgl)	occurrence of fractures (m)	Range of Yield (m^3 /hour)	Aquifer parameter (T in m^2/day)	Storativity (S)	Suitability for Drinking
Weathered Zone	0-25	--	Up to 9.9	--	--	Potable
Saprolite Zone	10-45	--	Up to 9.0	--	--	Potable
Consolidated Formation (Granite & Granite gneiss)	50-230	50 - 60 100 - 150 >200	3.6-9.97 18-28.8	--	--	17 blocks out of 20 are having sporadic occurrence of fluoride in ground water above permissible limit (> 1.5 mg/l)
Semi-Consolidated Formations (Gondwanas)	0-50	24-36	11.88 -19.8	--	--	
Unconsolidated sediment	05-13	--	Up to 72	--	--	Potable

Table 6.2: Geology, Casing depth, Yield, Drawdown and zones tapped for the Aquifers in different blocks of Purulia District

Block	Geology	Casing Depth (mbgl)	Depth range (mbgl)		Fracture Zones		Yield (m^3/hour)		Drawdown (m)	
			Aquifer I	Aquifer II	Aquifer I	Aquifer II	Aquifer I	Aquifer II	Aquifer I	Aquifer II
Jhalda-I	Banded Gneiss &Schists	16.5 – 25.5	0-50	50-200	17.10–25.70 25.70–28.80 28.80-31.80 44.00-47.10	50–68.4 92.80–98.90 98.90–138.60 220.90–227	7.63-19.8	3.24-28.8	5.5-8.7	9.5-12.5
Manbazar-II	Banded Gneiss &Schists/ Phyllites	Upto 13	0-50	50-200	19.60–22.70 28.80–31.80	187.4 - 190.4	7.2	10.8	–	–
Neturia	Sandstone		0-50	50-200	24.44-36.44	–	11.95-19.94	–	15-20	–
Puncha	Banded Gneiss	7.4-18.5	0-50	50-200	16.60 – 19.60 35.00 – 36.00	–	7.92-15.70	–	–	–
Purulia-I	Banded Gneiss & Granites	8-32.5	0-50	50-200	16.60 - 19.60	50.10 - 53.20	0.72-25.2	7.56	–	–
Purulia-II	Banded Gneiss & Granites	8.1-12.3	0-50	50-200	10.4 - 16.50 16.5 - 28.70 28.70 - 40.90	86.70 – 92.80 147.7 - 159.9 159.9 - 200.5	0.72 - 9	1.08 - 10.8	≈ 5	5.75 - 8.13
Raghunathpur-I	Granite/Granite gneiss/Porphyritic granite	7-12.3	0-50	50-200	13.0 - 37.0 31.92 - 34.41 34.46 - 37.45	48.0 - 62.24	1.19 - 9.97	1.76 - 9.97	15 - 24	15 - 18
Raghunathpur-II	Hornblende gneiss/Granite gneiss	7-12.3	0-50	50-200	15.00 -17.10 16.00 - 18 .00 22.5 - 31.00	40.45-59.51	3.49 - 9.97	0.29 - 7.96	9.1 - 13	8.12 - 10.12
Santuri	Granite gneiss	upto 12.5	0-50	50-200	11.0-12.87	–	3.49	–	6	–
Para	Granite gneiss	upto 12.5	0-50	50-200	26.0-28.0	–	4.1	–	15	–
Manbazar	Banded Gneiss	12.00 - 15.00	0-50	50-200	19.6-25.7	--	4.2-8.6	--	4.2-8.7	--
Kashipur	Garnetiferous Schist		0-50	50-200	17.67- 19.0 22.13- 24.61	--	0.18 - 1.19	--	6.4 -10	--
Joypur	Banded Gneiss & Granite Gneiss	10.00 - 15.00	0-50	50-200	21.6-24.2	50.50-53.20 111.2-114.1	4.4	2	--	--
Jhalda-II	Banded Gneiss & Granites	5.4-48.5	0-50	50-200	31.80-37.90	62.30-68.40 95.90-105.00 164.7-193.5	4.68	1.8	--	--
Bundwan	Phyllites	10.00 - 12.00	0-50	50-200	18.2-21.7 31.9-33.7	123.7-125.9 179.2-182.1 187.68-189	7.5-7.2	10.8-12	4.2-8.7	--
Barabazar	Banded Gneiss	12.00 - 32.00	0-50	50-200	16.6-19.6 28.7-31.8 34.9-37.9	16.60 - 19.60 77.60 - 80.6 114.2 - 117.2 120.3- 123.3 126.4- 129.4 242.3-246.3 249.4- 252.4	7.63-19.8	3.6-45	5.5-8.7	5.75-19.4
Balarampur	Banded Gneiss, Granite & Granite Gneiss	17	0-50	50-200	18-23	--	11.56	--	19.1	--
Arsha	Banded Gneiss, Granite & Granite Gneiss	7.4-18.5	0-50	50-200	19.60-22.70 16.60-25.70	53.20 - 56.20 83.70 -86.70 156.4 - 159.4 163 - 166.00 187.4-196.5 227.2 - 229.8	0.36	4.36-17.17	6.4- 8.12	9.5- 19.4
Baghmundi	Granite Gneiss, Metabasic rocks	15-20.5	0-50	50-200	22.30-25.70 30.10-32.30 30.10-32.30	80.10 - 82.60 119 - 121.30 152 - 155.60	5-12.6	4.2-25.9	5.5-9	8.2-13

Table 6.3: Details of exploratory drillings carried out by CGWB, ER, Kolkata in Purulia District

Block / Taluka	Location	Latitude	Longitude	Type of Well	Drill Depth (mbgl)	Well Construction depth (m bgl)	Casing Depth (m bgl)	Major Lithology Encountered	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lpm)	Draw Down (m)	T (m2/day)	S
Arsha	Sirkabad	23.267807	86.19342	EW	233.1	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	19.60-22.70, 53.2-56.2, 144.70-147.70, 153.50-156.90, 227.00-230.00	N/A	577	N/A	N/A	N/A
Arsha	Sirkabad	23.267807	86.19342	OW - I	129.4	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	12.60-18.00, 83.7-86.7	N/A	45	N/A	N/A	N/A
Arsha	Sirkabad	23.267807	86.19342	OW - II	233.1	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	12.60-18.00, 141.00-147.00, 153.00-159.00	N/A	430	N/A	N/A	N/A
Arsha	Arsha	23.322209	86.178185	EW-I	300.2	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	19.60-22.70, 187.4-196.5	N/A	76	N/A	N/A	N/A
Arsha	Arsha	23.322209	86.178185	EW-II	300.2	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	16.60-25.70	N/A	6	N/A	N/A	N/A
Arsha	JHUNJKA	23.275133	86.192385	EW	300.2	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	156.9-159.9, 190.4-192.0	10.7	286	N/A	N/A	N/A
Arsha	JHUNJKA	23.275133	86.192385	OW	300.2	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	47.1-50.1, 102.0-105.0, 156.8-159.9, 163.0-166.0	N/A	336	N/A	N/A	N/A
Balarampur	Salboni (BoreweID)	23.0837	86.2639	EW		183.12	N/A	Meta-sediments	18.0-23.0	N/A	192.6	19.1	N/A	N/A
Barabazar	Bodaldih (OW - I)	23.1508	86.4175	OW - I	118.7	N/A	12	Granite gneiss	114.2-118.50	8.89	750	N/A	N/A	N/A
Barabazar	Bodaldih (OW - II)	23.1508	86.4175	OW - II	118.7	N/A	15	Granite gneiss	114.2-118.50	8.89	750	N/A	N/A	N/A
Barabazar	Shankhari-Bansberia	23.051	86.3571	EW-I	166	N/A	32	Pelitic Schist	77.6-80.6, 159.9-166	9.56	76	N/A	N/A	N/A
Barabazar	Shankhari-Bansberia	23.0516	86.357	EW-II	139.6	N/A	28	Pelitic Schist	28.8-31.8, 34.9-37.9, 132.5-135.5	5.83	426	N/A	N/A	N/A
Barabazar	Shankhari-Bansberia	23.0516	86.357	OW	178.2	N/A	25.2	Pelitic Schist	34.9-37.9, 126.4-129.4, 135.5-138.6	5.25	132	N/A	N/A	N/A
Barabazar	Bamundiha	23.1159	86.3654	EW-I	303.1	N/A	22	Granite gneiss	193-196	23.51	60	N/A	N/A	N/A
Barabazar	Bamundiha	23.1156	86.364	EW-II	264.6	N/A	17.5	Granite gneiss	114.2-117.2, 243.3-246.3, 249.4-252.4, 258.5-261.6	21.12	610	N/A	N/A	N/A
Barabazar	Bamundiha	23.1156	86.364	OW	248.4	N/A	19.6	Granite gneiss	233.1-236.2, 242.3-245.3	24.46	690	N/A	N/A	N/A
Barabazar	Bodaldih	23.1508	86.4175	EW	147.7	N/A	12	Granite gneiss	92.8-95.8, 98.9-102, 132.5-135.5	7.9	720	N/A	N/A	N/A
Hura	Laxmanpur	23.3409	86.5732		220.9	12.6	12.6	Granite gneiss	Not Tapped	N/A	12	N/A	N/A	N/A
Hura	Rakhera	23.2661	86.7493	EW	153.8	12.5	12.5	Granite gneiss	Not Tapped	N/A	60	N/A	N/A	N/A
Jhalda-I	Goria	23.3284	86.2336	EW	190.04	N/A	16.5	SCOI	Not Tapped	N/A	330	N/A	N/A	N/A
Jhalda-I	Goria	23.3284	86.2336	OW	65.3	N/A	18.13	SCOI	Not Tapped	N/A	127.2	N/A	N/A	N/A
Jhalda-I	Ichag	23.3326	85.9251	EW	129.4	N/A	19.5	Granite gneiss	Not Tapped	N/A	108	N/A	N/A	N/A
Jhalda-I	Jhaldah-I, BDO, Office	23.3655	85.9616		200	N/A	25.5	Granite gneiss	Not Tapped	N/A	1530	N/A	N/A	N/A
Jhalda-I	Tulin	23.3776	85.9006	SEW	60	N/A	18.38	Granite gneiss	Not Tapped	N/A	54	N/A	N/A	N/A
Jhalda-II	Mahatomara	23.1236	85.9124	SEW	47.1	N/A	45.5	Basic Granulite	34-42	N/A	78	N/A	N/A	N/A
Jhalda-II	Kotshila EW_III)	23.1055	86.0717	EW_III	111.1	N/A	8.74	Granite gneiss	Not Tapped	N/A	30	N/A	N/A	N/A
Jhalda-II	Kotshila	23.1055	86.0717	EW-I	172.1	N/A	5.4	Granite gneiss	Not Tapped	2.02	30	N/A	N/A	N/A
Jhalda-II	Kotshila	23.1055	86.0717	EW-II	220.9	N/A	12	Granite gneiss	Not Tapped	2.05	N/A	N/A	N/A	N/A

Block / Taluka	Location	Latitude	Longitude	Type of Well	Drill Depth (mbgl)	Well Construction depth (m bgl)	Casing Depth (m bgl)	Major Lithology Encountered	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lpm)	Draw Down (m)	T (m2/day)	S
Jhalda-II	Gokulnagar	23.3328	85.971	EW	300.2	N/A	6.1	Granite gneiss	Not Tapped	N/A	N/A	N/A	N/A	N/A
Jhalda-II	Tulin	23.3776	85.9006	EW-I	141.6	N/A	16.4	Granite gneiss	Not Tapped	5.38	300	N/A	N/A	N/A
Jhalda-II	Tulin	23.3776	85.9007	EW	233.1	N/A	19	Granite gneiss	Not Tapped	5.85	480	N/A	N/A	N/A
Jhalda-II	Mahatomara	23.4236	85.9124	EW	300.3	N/A	48.5	Basic Granulite	Not Tapped	N/A	N/A	N/A	N/A	N/A
Kashipur	Kashipur (Borewell)	23.4245	86.6657	EW		93.39	N/A	Garnetiferous schist	22.13-24.61	N/A	3	N/A	N/A	N/A
Kashipur	Talajuri (Borewell)	23.3959	86.7054	EW		41.1	N/A	Garnetiferous schist	17.67-19.0	N/A	19.8	10	N/A	N/A
Manbazar-I	Gopalnagar	23.1325	86.5879	EW		N/A	N/A	Granite gneiss	Not Tapped	N/A	N/A	N/A	N/A	N/A
Manbazar-I	Mogalda (Borewell)	23.0757	86.6474	EW		183.42	N/A	Granite gneiss		N/A	N/A	N/A	N/A	N/A
Manbazar-I	Manbazar (Borewell)	23.0781	86.6865	EW		150	N/A	Granite gneiss	110-112.00	N/A	398.4	8.675	N/A	N/A
Manbazar-I	GOKIDI	23.060852	86.659518	EW	184.3	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	37.90-39.0, 65.10-67.10	N/A	72	N/A	N/A	N/A
Manbazar-II	BASANTAPUR	22.974015	86.60436	EW	300.2	N/A	N/A	Phyllites and Mica Schists of Singhbum Group	19.60-22.70, 28.80-31.80, 187.4-190.4	4.05	204	N/A	N/A	N/A
Manbazar-II	BASANTAPUR	22.974015	86.60436	OW	300.2	N/A	N/A	Phyllites and Mica Schists of Singhbum Group	19.60-22.70, 28.80-34.90, 126.4-129.4	4.56	266	N/A	N/A	N/A
Neturia	Innanpur (Borewell)	23.682	86.8181	EW		97.74	N/A	Sandstone	28.91-31.91	5.75	332.4	15	N/A	N/A
Neturia	Sarborimore (Borewell)	23.6456	86.7844	EW		103.25	N/A	Sandstone	24.44-36.44	14.32	199.2	20	N/A	N/A
Para	Anara (Borewell)	23.1916	86.3621	EW		81.27	N/A	Granite gneiss	26.0-28.0	N/A	66.6	15	N/A	N/A
Puncha	Lolara	23.1742	86.6618	EW	147.7	18.5	18.5	Granite gneiss	Not Tapped	N/A	132	N/A	N/A	N/A
Puncha	Napara	23.2262	86.6462	EW	184.3	21	21	Granite gneiss	Not Tapped	N/A	200.4	N/A	N/A	N/A
Puncha	Balakdih	23.2209	86.5098	EW		N/A	N/A	Granite gneiss	Not Tapped	N/A		N/A	N/A	N/A
Puncha	Kuruktupa, PHC	23.1478	86.5249	EW		N/A	N/A	Granite gneiss	Not Tapped	N/A		N/A	N/A	N/A
Puncha	Napara	23.221	86.6454	OW	181.3	21		Granite gneiss	Not Tapped	10.05	261.6	N/A	N/A	N/A
Purulia	Chakoltore	23.2425	86.3534	EW		N/A	N/A	Granite gneiss	Not Tapped	N/A		N/A	N/A	N/A
Purulia-I	Charrah	23.3707	86.4193	EW	200	12.5	12.5	Granite	Not Tapped	N/A	12	N/A	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	EW	200.5	N/A	18.4	Granite gneiss	Not Tapped	N/A	108	N/A	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	OW	150.5	N/A	18.5	Granite gneiss	Not Tapped	N/A	108	N/A	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	SEW	60.3	N/A	18.5	Granite gneiss	Not Tapped	N/A	108	N/A	N/A	N/A
Purulia-I	Lalpur	23.3066	86.6248	EW	200.5	N/A	19.5	Granite gneiss	Not Tapped	N/A	54	N/A	N/A	N/A
Purulia-I	Belguma	23.3271	86.3457	EW	300.4	N/A	32.5	Granite gneiss	Not Tapped	12.9	204	N/A	N/A	N/A
Purulia-I	Belguma	23.3271	86.3457	OW	220.9	N/A	20.2	Granite gneiss	Not Tapped	13	156	N/A	N/A	N/A
Purulia-I	Ambagan, PHED	23.3255	86.3497	EW	151.5	N/A	12.5	Granite gneiss	Not Tapped	12.8	264	N/A	N/A	N/A
Purulia-I	Ambagan, PHED	23.3255	86.3497	OW	166	N/A	8	Granite gneiss	Not Tapped	13	420	N/A	N/A	N/A
Purulia-I	PANDRAMA	23.265263	86.321211	EW	300.2	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	16.60-19.60, 50.1-58.2	4.02	126	N/A	N/A	N/A
Purulia-I	PANDRAMA	23.265263	86.321211	OW	263.6	N/A	N/A	Pre-Cambrian Meta-morphics (Chhotonagpur Granite Gneiss)	16.60-19.60, 62.30-65.40, 199.60-202.60, 248.10-251.10	4.17	129	N/A	N/A	N/A
Purulia-II	Gangara	23.3439	86.4241	EW	200.5	12.3	12.3	Granite gneiss	Not Tapped	N/A	180	N/A	N/A	N/A

Block / Taluka	Location	Latitude	Longitude	Type of Well	Drill Depth (mbgl)	Well Construction depth (m bgl)	Casing Depth (m bgl)	Major Lithology Encountered	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lpm)	Draw Down (m)	T (m2/day)	S
Purulia-II	Gangara	23.3439	86.4241	OW	160	12.3	12.3	Granite gneiss	Not Tapped	N/A	150	N/A	N/A	N/A
Purulia-II	Hutmura	23.3524	86.4737	EW	202.5	8.1	8.1	Granite	Not Tapped	N/A	18	N/A	N/A	N/A
Purulia-II	Charrah	23.3707	86.4193	EW	200.5	N/A	9.75	Granite	Not Tapped	N/A	12	N/A	N/A	N/A
Raghunathpur-I	Madhutali (Borewell)	23.5087	86.7232	EW	N/A	54.18	N/A	Granite	31.92-34.41	3.93	19.8	18	N/A	N/A
Raghunathpur-I	Raghunathpur (Borewell)	23.5572	86.6805	EW	N/A	70.35	N/A	Porphyritic granite	13.0-37.0,43.0-62.24	N/A	29.4	18	N/A	N/A
Raghunathpur-I	Raghunathpur (Borewell)	23.5572	86.6805	EW	N/A	71	N/A	Porphyritic granite	Not Tapped	N/A	41.4	15	N/A	N/A
Raghunathpur-I	Babugram (Borewell)	23.583	86.7206	EW	N/A	70.56	N/A	Granite gneiss	34.46-37.45	4.43	166.2	24	N/A	N/A
Raghunathpur-II	Barasoni (Borewell)	23.5584	86.662	EW	N/A	48.75	N/A	Hornblende gneiss		6.29	166.2	9.1	N/A	N/A
Raghunathpur-II	Montore (Borewell)	23.6075	86.5517	EW	N/A	55.18	N/A	Granite gneiss	15.0-17.10,22.5-31.0	3.78	132.6	13	N/A	N/A
Raghunathpur-II	Kanke (Borewell)	23.5909	86.6016	EW	N/A	60.33	N/A	Granite gneiss	16.0-18.0	4.97	58.2	10.12	N/A	N/A
Raghunathpur-II	Chelyama (Borewell)	23.6567	86.583	EW	N/A	72.5	N/A	Granite gneiss	40.15-50.51	N/A	4.8	8.12	N/A	N/A
Santuri	Santuri (Borewell)	23.5505	86.5513	EW	N/A	30.3	N/A	Granite gneiss	11.0-12.57	2.79	58.2	6	N/A	N/A

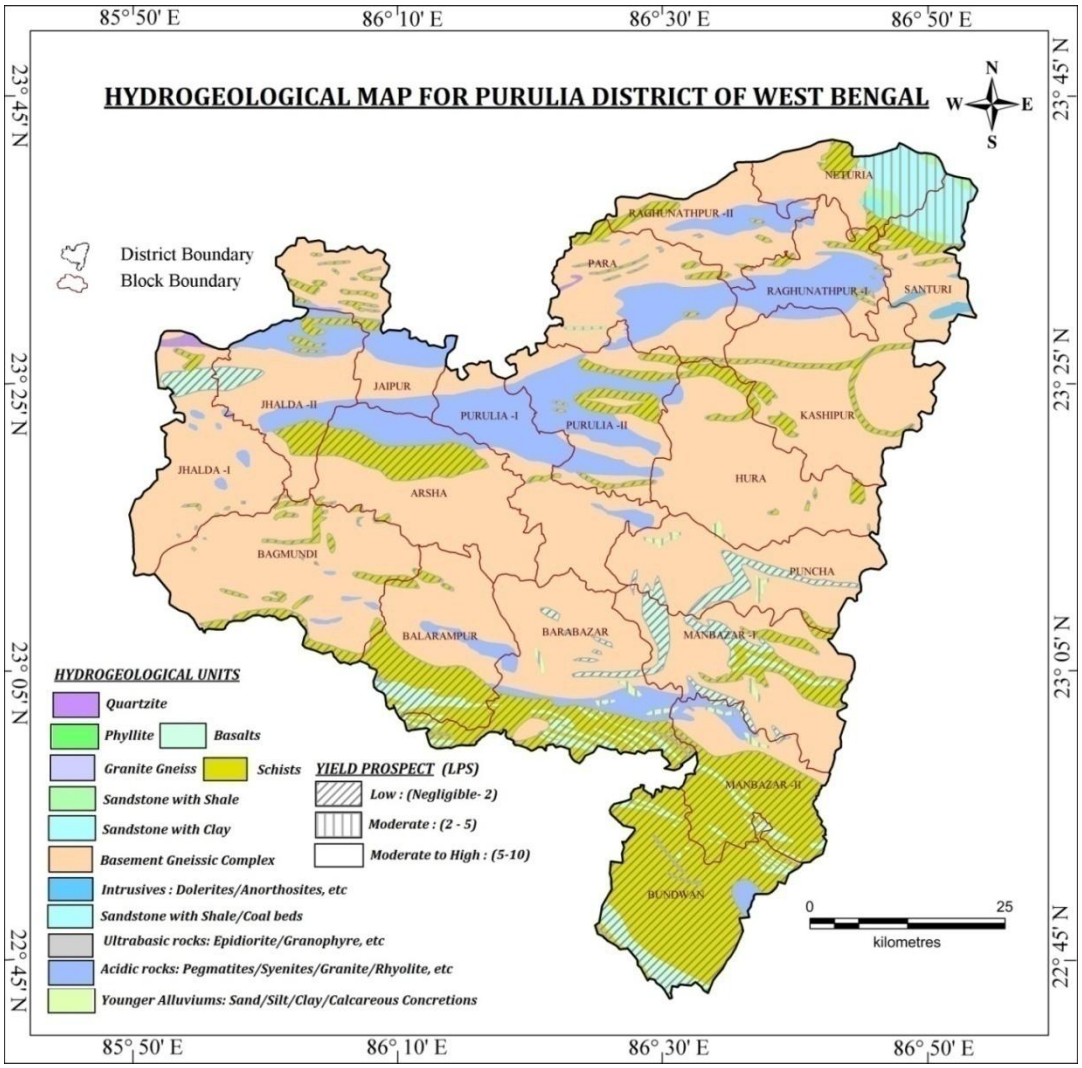


Figure- 6.1: Hydrogeological Map for Purulia District of West Bengal

6.3 FRACTURE ANALYSIS

CGWB has constructed 70 bore wells all over the district so far and out of which 47 wells have been analyzed (39 EW & 8 OW). The number of fractures encountered at specific depth ranges has been identified. As from the analysis, the zone within the range of 0-50 mbgl provides more probability for encountering fractures through drillings and explorations. The aquifers from these shallow fracture zones occur mostly under unconfined or semi-confined conditions. Prolific aquifers are also encountered from the fractures within the depth range of 50-150 mbgl. The fracture analysis details is given in Table-6.3. Map showing the depth to overburden thickness with major shear zones as well as the minor fracture zones and the yield prospect for the study area is given in Figure-6.2 and 6.3.

Table 6.4 : Analysis of fracture zones in different formations

Block	Formation	Fractures Encountered (mbgl)						Yield (m^3/hour)
		Nil	0- 50	50-100	100-150	150-200	> 200	
Arsha	Granite & Granite Gneiss	-	3	1	2	3	-	0.36-1.08
Baghmundi	Granite Gneiss & Schist	-	-	-	-	-	-	-
Balarampur	Meta- sediments	-	1	-		-	-	11.56
Bandwan	Granite gneiss	-		-		-	-	-
Barabazar	Granite Gneiss & Schist	-	3	3	3	2	4	3.6-45
Hura	Granite Gneiss	-		-	1	1	-	0.72-3.6
Jhalda-I	Granite Gneiss & Schist	-	3	3	1	-	1	1.74-45
Jhalda-II	Granite Gneiss & Schist	1	1	2	1	1	-	1.8-28.8
Joypur	Granite Gneiss & Schist	-		-	-	-	-	-
Kashipur	Garnetiferous schist	-	2	-	-	-	-	0.18-1.19
Manbazar-I	Granite Gneiss	-	1	-	1	-	-	22.08
Manbazar-II	Granite Gneiss & Schist	-	2		-	1	-	7.2-10.8
Neturia	Sandstone	-	2	-	-	-	-	11.95-19.94
Para	Granite gneiss	-	1	-	-	-	-	4
Puncha	Granite gneiss	1	2		-	-	-	7.92-15.70
Purulia-I	Granite & Granite Gneiss	-	2	1	-	-	-	0.72-25.2
Purulia-II	Granite & Granite Gneiss	-	3	2	3	3	-	0.72-10.8
Raghunathpur-I	Granite/Granite gneiss/Porphyritic granite	-	3	1	-	-	-	1.19-9.97
Raghunathpur-II	Hornblende gneiss/Granite gneiss	-	4	1	-	-	-	0.29-9.97
Santuri	Granite gneiss	-	1	-	-	-	-	3.49

Discharge is comparatively higher for the wells constructed along the major fracture zones. The probability of occurrence of fracture zones is generally more from the zones between 0 to 50 mbgl. The blocks showing high fracture density Jhalda-I & II, Balarampur, Barabazar, etc, has subsequent bore wells that yield higher than those devoid of proper fracture systems. Geo-physical surveys done in the study area also support these findings as well.

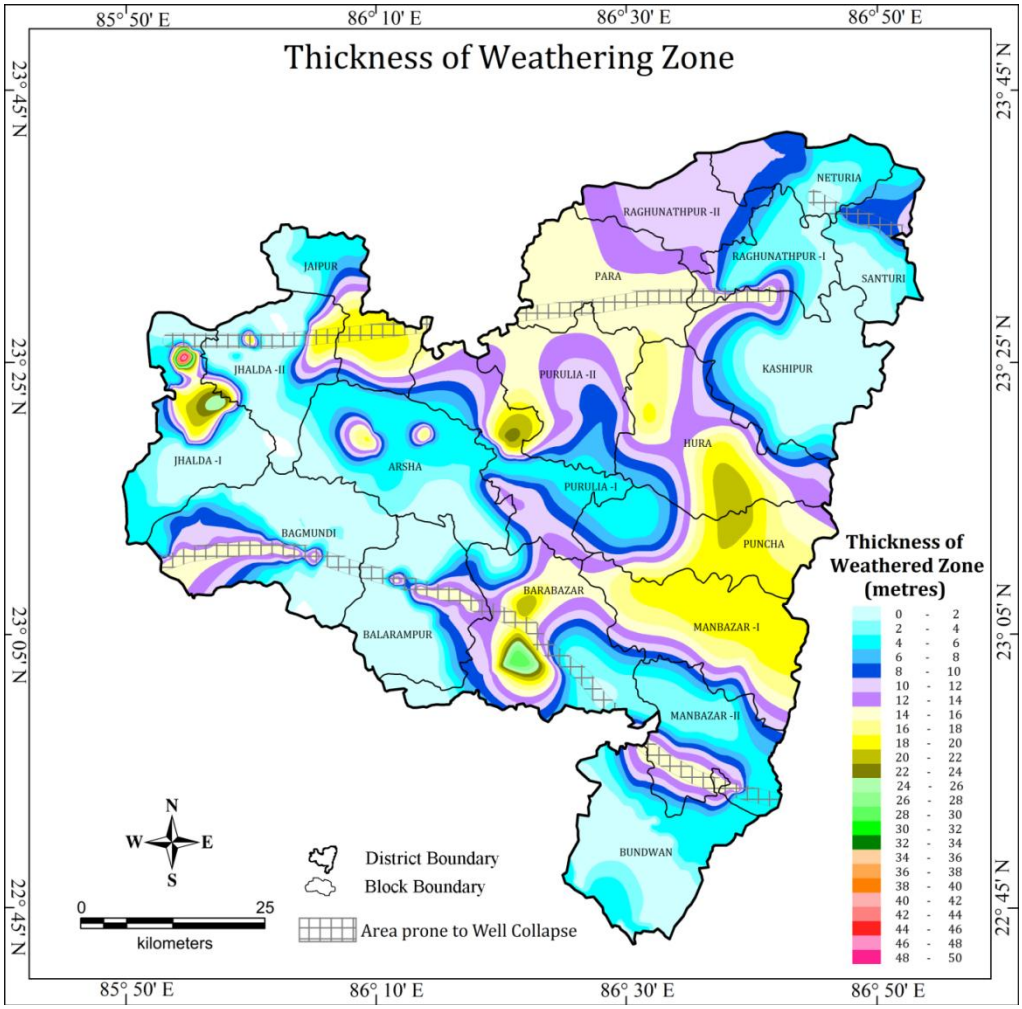


Figure-6.2: Map showing Depth to overburden and area prone to bore well collapse in Purulia district of West Bengal

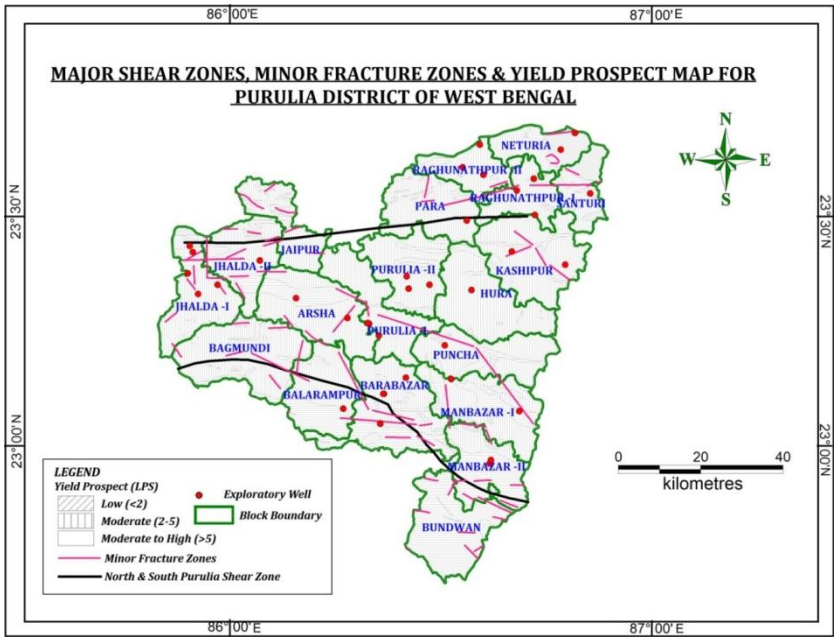


Figure-6.3: Map showing shear zones and fractures in Purulia district of West Bengal

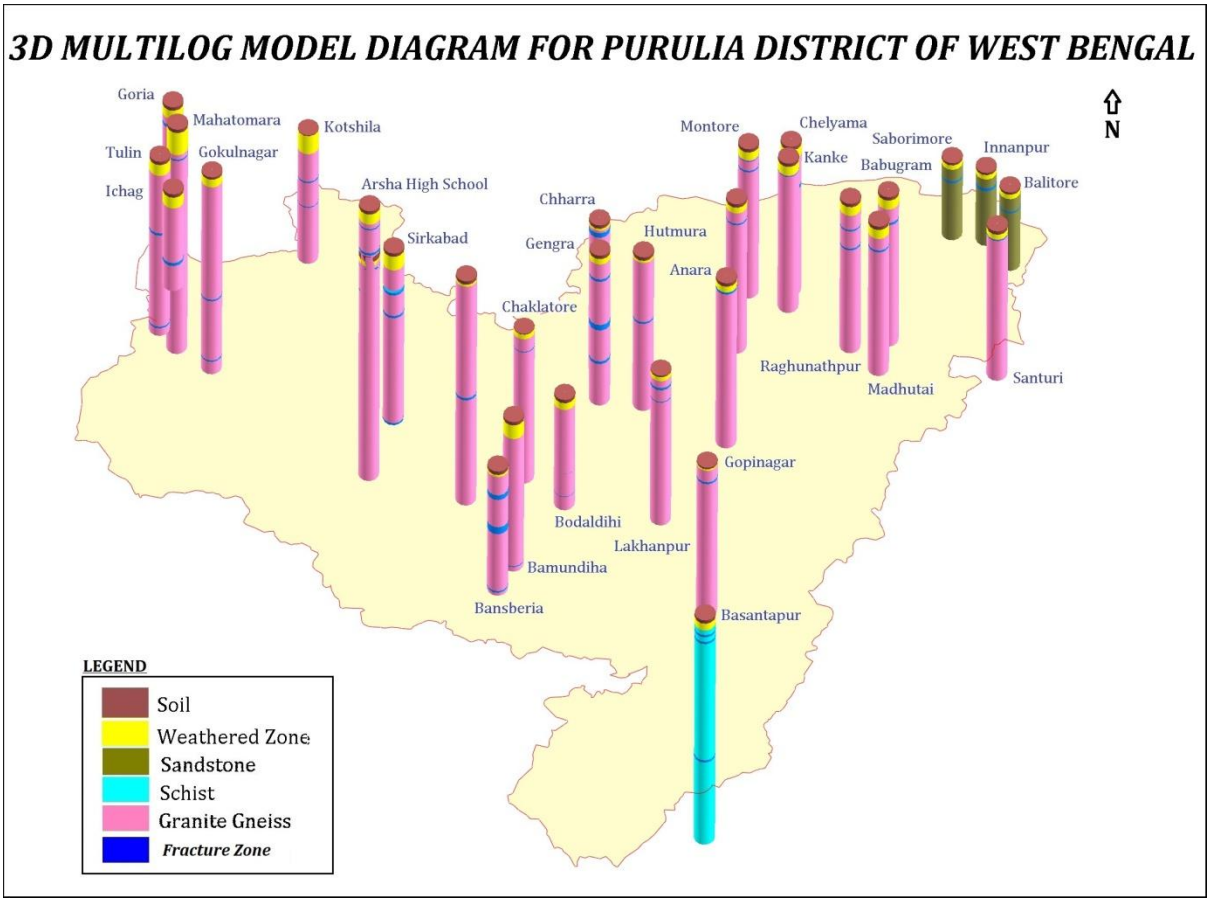


Figure-6.3: 3D Multi-log Model Diagram for the Aquifer Systems in Purulia District of West Bengal

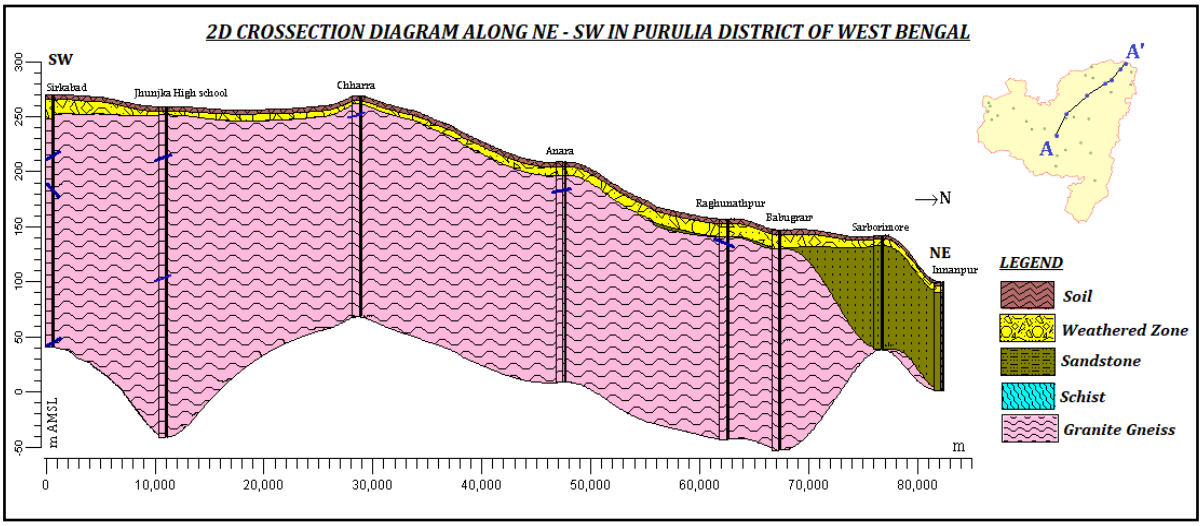


Figure- 6.5: 2D Aquifer Cross-Sectional Diagram along NE – SW in Purulia District of West Bengal

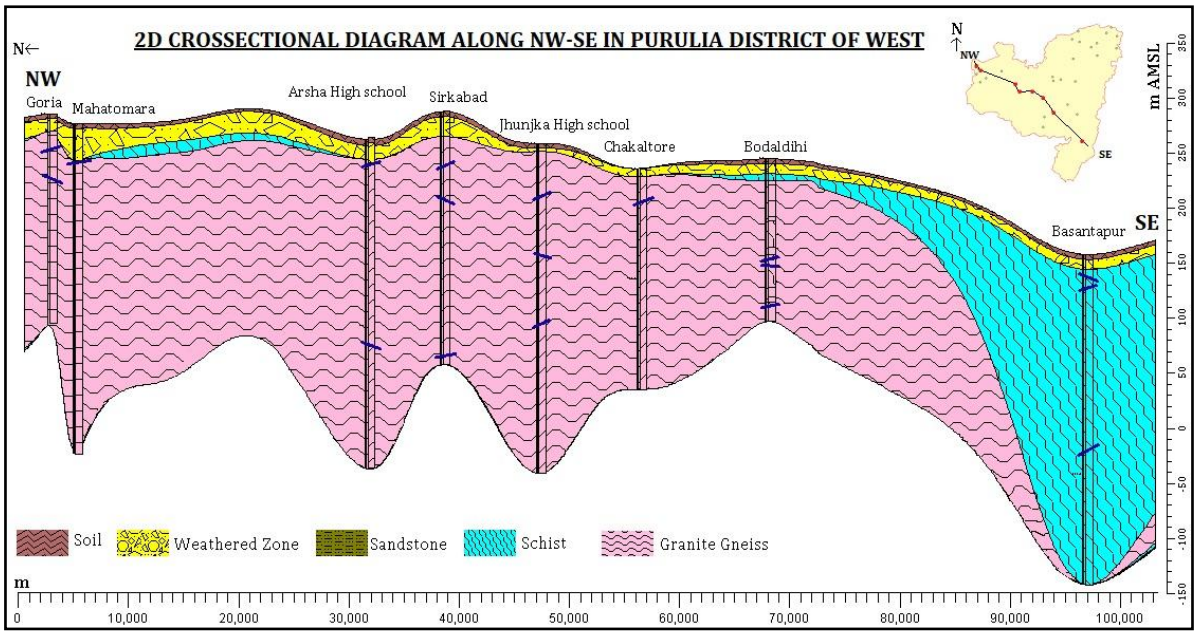


Figure- 6.6: 2D Aquifer Cross-Section Diagram along NW – SE in Purulia District of West Bengal

6.4 GROUND WATER REGIME, DEPTH TO WATER LEVEL, WELLS AND FLUCTUATIONS : Water levelsduring pre-monsoon and post-monsoon periods were studied from 99 NHNS wells, all dug wells tapping the weathered residuum/shallow fractures in CGC and Gondwana Formation. Water level rests mostly at depths ranging from 5 to 8 mbgl during pre-monsoon period, being deeper (8 to 12 mbgl) in some isolated pockets in the northern (south of Damodar River) and southern part of the district. Deepest water level recorded in the district is from Baghmundi block (11.77 mbgl). Water level during the post-monsoon generally occurs within the depth range of 2-5 mbgl, being deeper (5-8 mbgl) mainly in areas adjacent to Damodar River in the north. The water level rises by 2-4 m in most of the areas during pre-monsoon period. Rise with less than 2m takes place in some areas in the northern, western and central parts. The water level fluctuation in the area generally rests between 2-5 m in these shallow Aquifers.

Due to the prevailing Covid-19 Pandemic, the target for establishing key wells tapping groundwater from deeper fractures could not be achieved. Hence, the only data incorporated about water level from the deeper zones are the static water level (SWL) recorded from the exploratory wells drilled by CGWB over the years. The SWL in the area ranges from 4-24.46 mbgl.

Hydrographs for different localities for the past two decades (2001-19)show either rising or nearly steady water level in both pre and post-monsoon periods except in some wells in Baghmundi, Balarampur and bundwan blocks where the declining trend during the post-monsoon is more 14, 13 and 16 cm/year respectively. The decline in water level may be considered not so alarming over the years since the water lever recover appreciably in post-monsoon period to attain a steady state over the years. Long term decline during the pre-monsoon period may be attributed to the increasing water demand in the area, while that during the post-monsoon may be the result of increased practice of groundwater irrigation during September-October months in order to supplement the maximum crop water requirement for Kharif paddy.

Overall, the ground water level condition in the study area do not practically very much over the years and suggest a stable groundwater regime persisting for years. The water level contour maps, water table contour maps and fluctuation maps for both shallow and deeper aquifers are shown in the following pages.

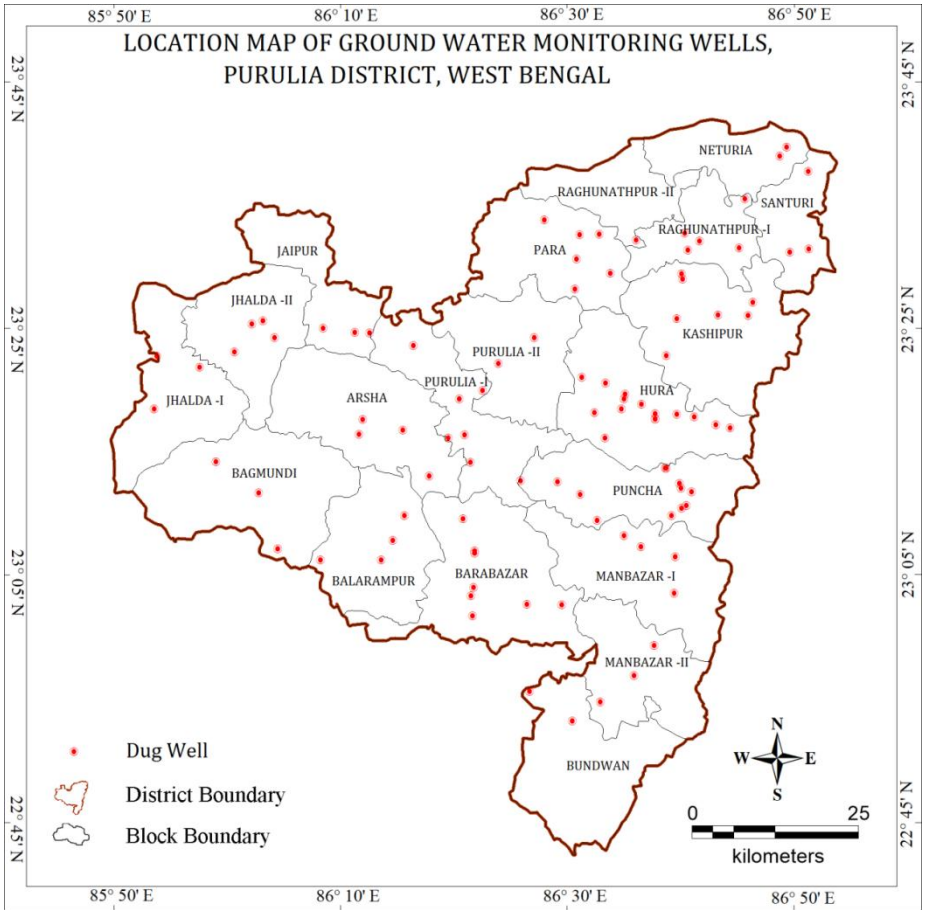


Figure-6.7: Location of Ground water monitoring wells(Phreatic aquifer) in Purulia District, West Bengal

Table-6.5: Water Level and Long term trends (20 years) for Aquifer-I(Phreatic) during Pre-monsoon and post-monsoon season in Purulia district.

Block	Pre-monsoon WL/Trend			Post-monsoon WL/ Trend		
	WL Range (mbgl)	Rise (m/year)	Fall (m/year)	WL Range (mbgl)	Rise (m/year)	Fall (m/year)
Arsha	7.82– 9.59	0.193	--	3.43– 6.29	--	0.103
Baghmundi	5.1– 11.77	0.136	--	2.96– 6.43	--	0.142
Balarampur	3.16-7.08	0.487	--	2.85– 2.92	--	0.137
Bandwan	9.41– 11.68	0.511	--	2.68– 6.61	--	0.167
Barabazar	6.00– 9.11	0.211	--	2.27– 4.29	--	0.078
Hura	2.3-11.60	--	0.217	1.50– 5.73	--	0.065
Jhalda-I	3.50– 8.09	0.361	--	2.49– 5.37	0.055	--
Jhalda-II	8.49 – 8.99	0.361	--	3.54 –4.62	0.025	--
Joypur	2.82 – 7.46	0.363	--	1.66 –4.39	0.096	--
Kashipur	5.17 – 8.56	0.324	--	2.02 –5.09	0.094	--
Manbazar-I	6.03 – 7.99	0.324	--	1.52 –2.97	0.141	--
Manbazar-II	7.17 – 7.18	0.015	--	3.97 –4.23	0.041	--
Neturia	4.26 – 5.96	0.015	--	1.92 –3.64	--	0.038
Para	3.16 – 8.66	0.118	--	2.34 –5.53	--	0.075
Puncha	5.25– 9.98	0.235	--	2.57– 6.52	0.156	--
Purulia-I	4.47– 9.9	--	0.432	1.65– 3.53	--	0.048
Purulia-II	5.77– 6.67	0.583	--	2.49– 4.02	--	0.035
Raghunathpur-I	4.67– 5.91	0.303	--	2.58– 4.41	--	0.067
Raghunathpur-II	4.66– 10.49	--	--	2.80– 6.61	--	0.046
Santuri	3.76– 5.58	0.481	--	3.03– 6.61	--	0.065

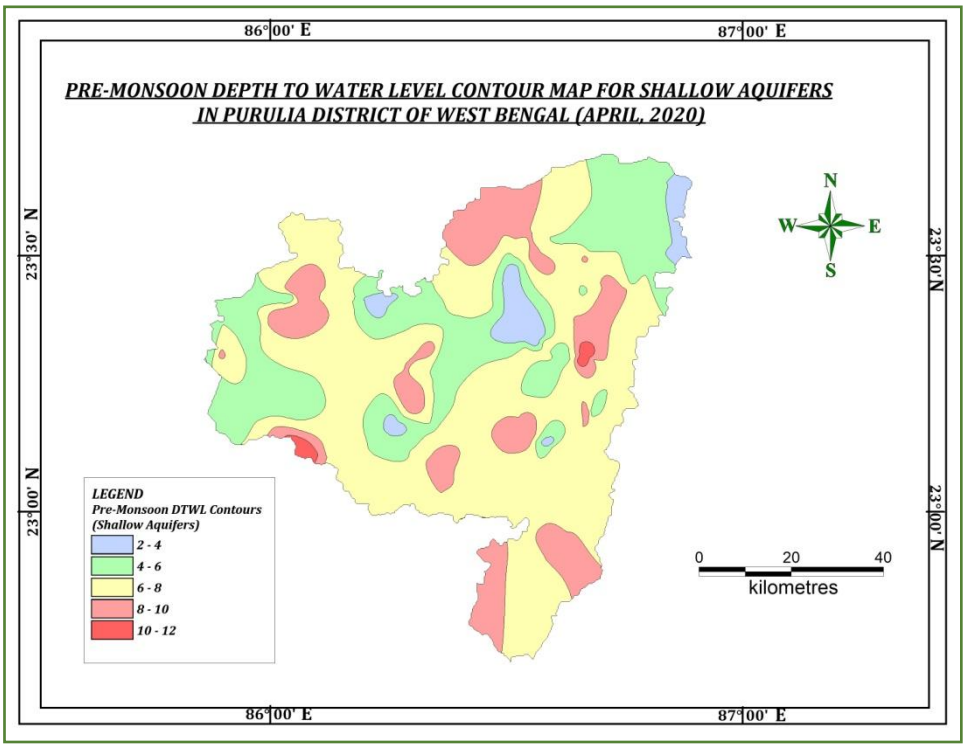


Figure-6.8: Pre-Monsoon Depth to Water Level map for Shallow Aquifers of the study area

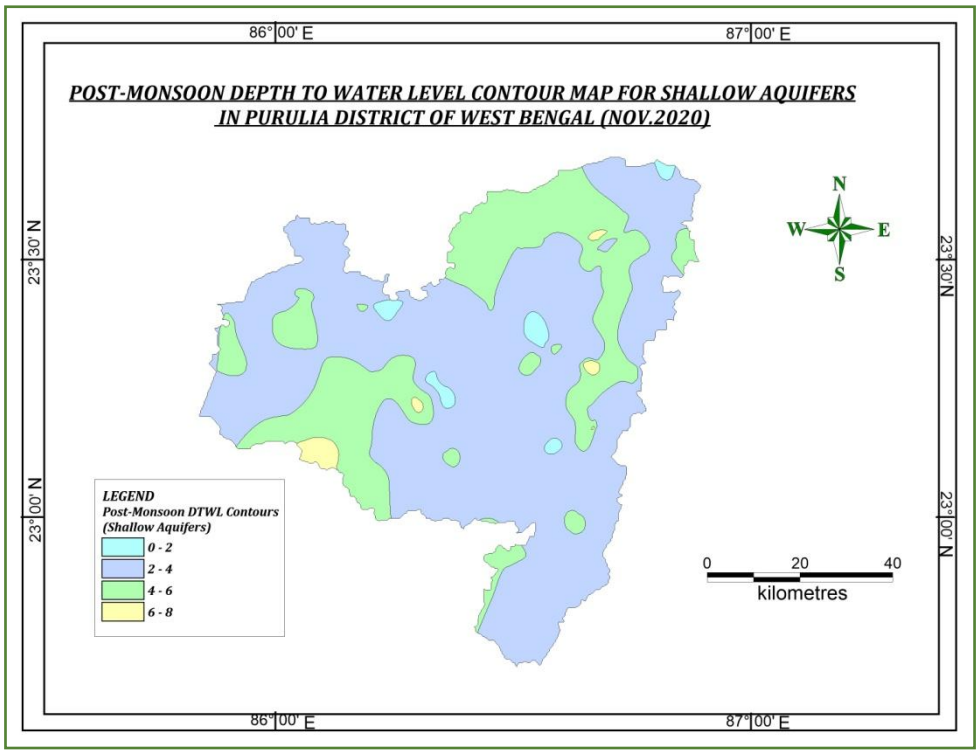


Figure-6.9: Post-Monsoon Depth to Water Level map for Shallow Aquifers of the study area

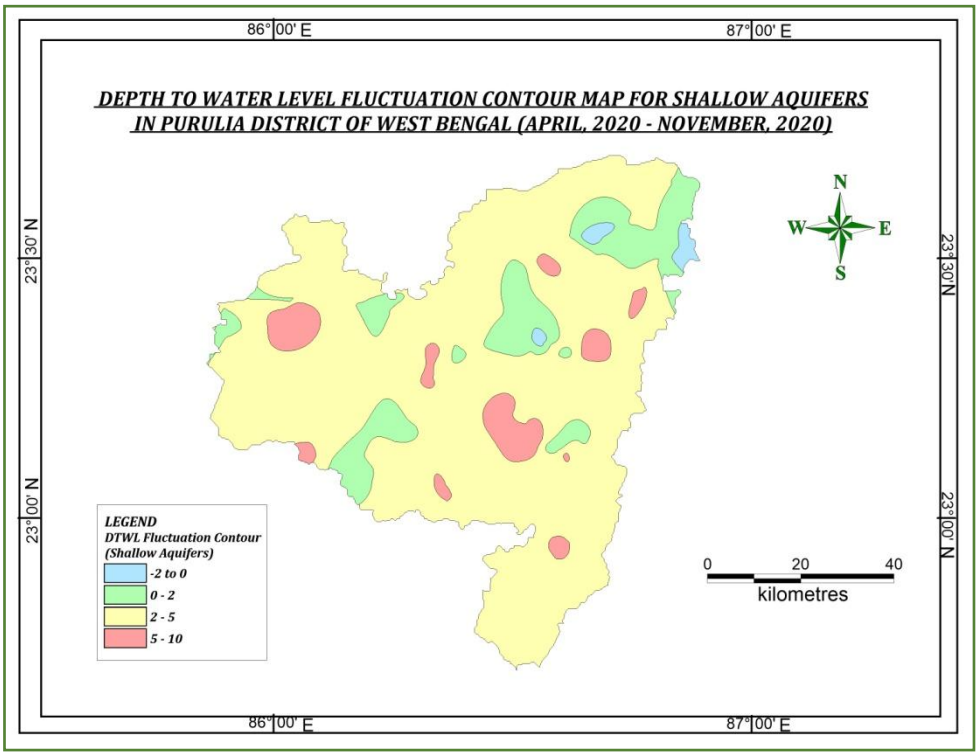


Figure-6.10: Water Level fluctuation map for Shallow Aquifers of the study area

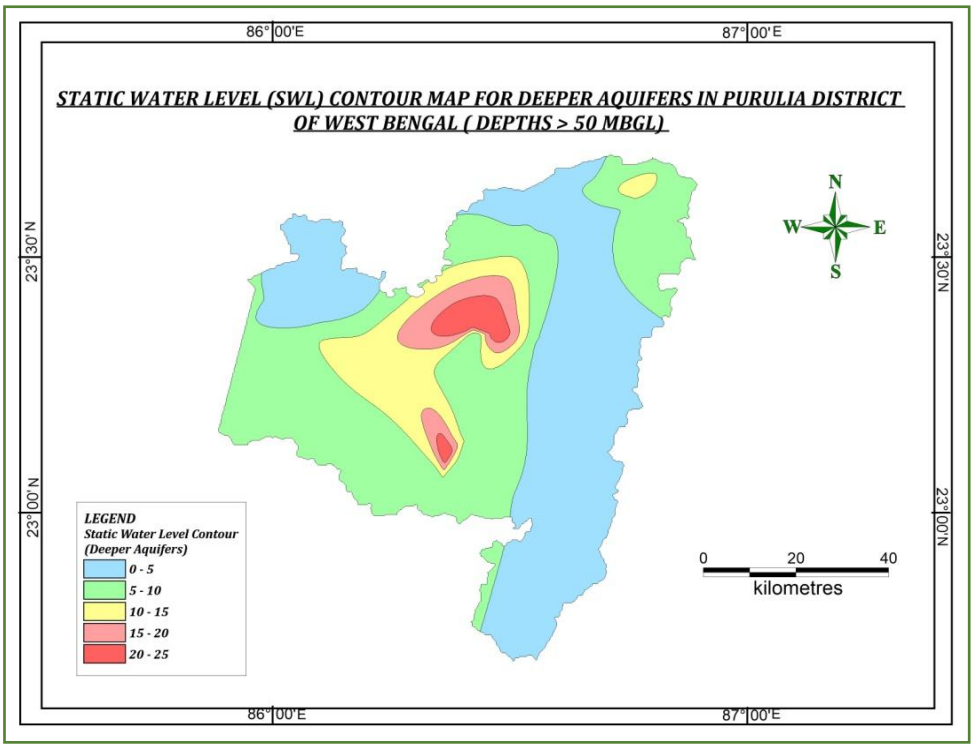


Figure- 6.11: SWL Contour map for the Deeper Aquifers in the study area

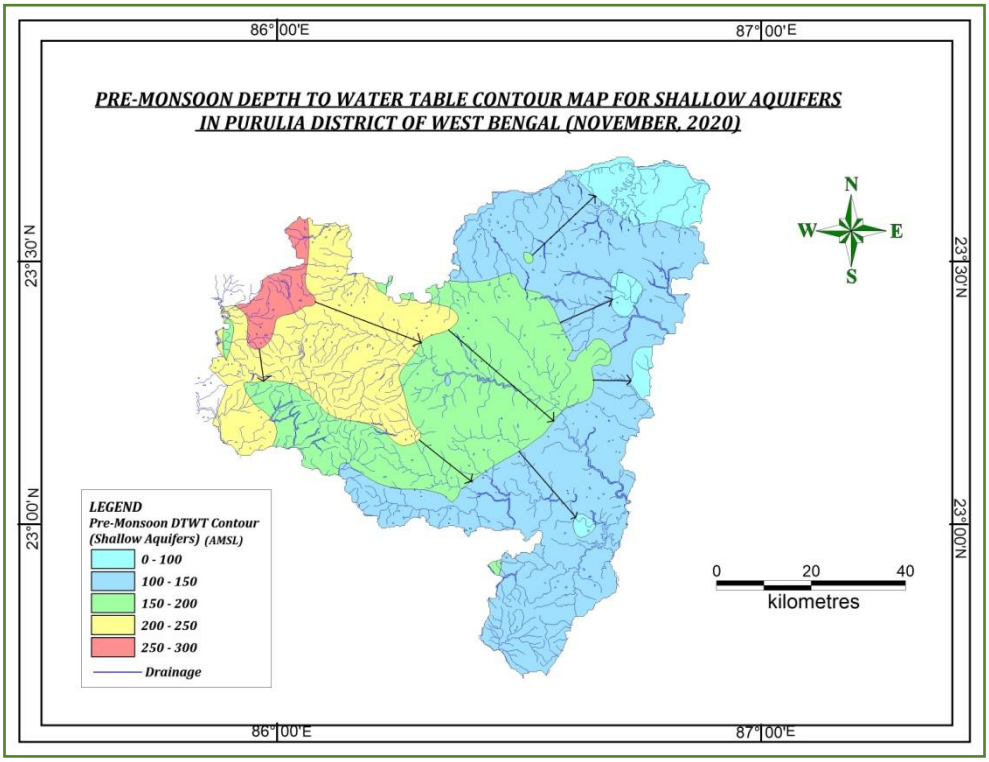


Figure- 6.12: Pre-Monsoon Water Table contour map for Shallow Aquifer of the study area

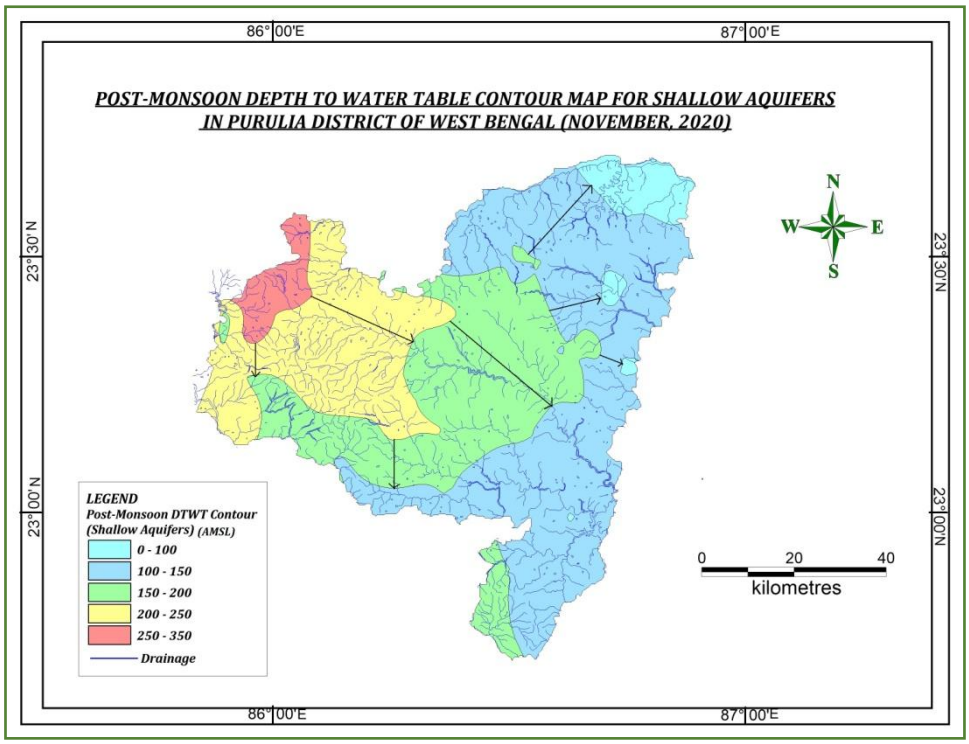
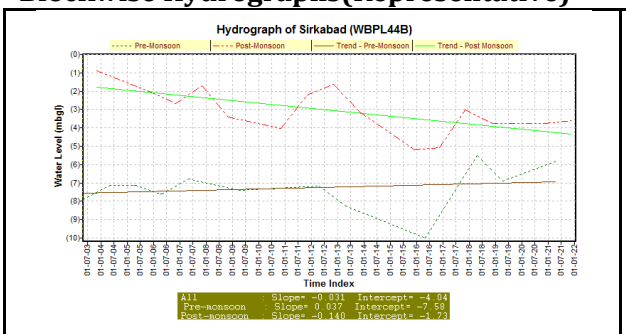


Figure-6.13: Post-Monsoon Water Table contour map for Shallow Aquifer of the study area

Blockwise Hydrographs(Representative)



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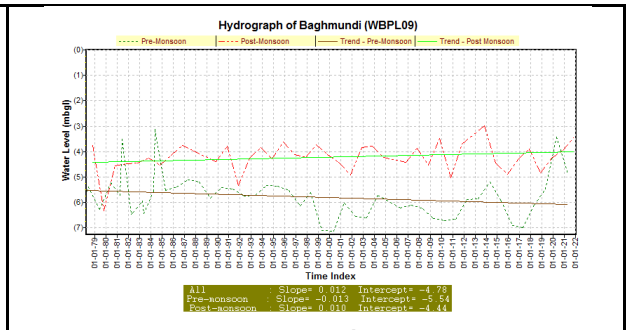
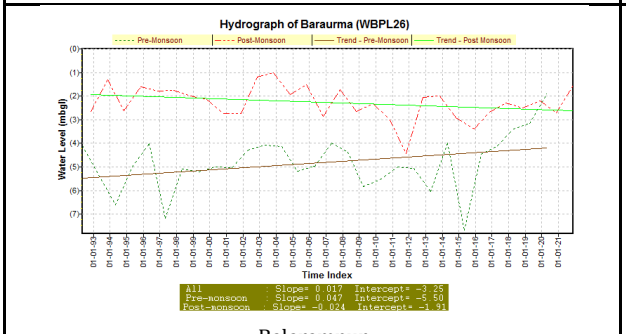


Bagmundi



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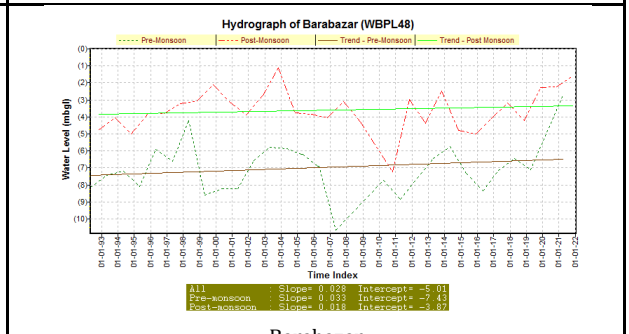

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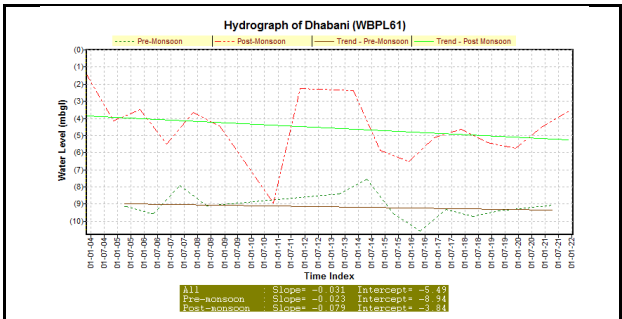
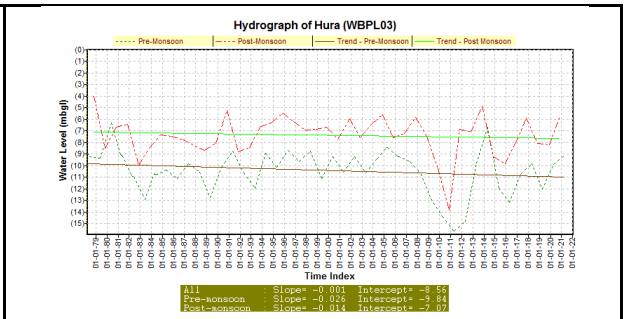


Bundwan



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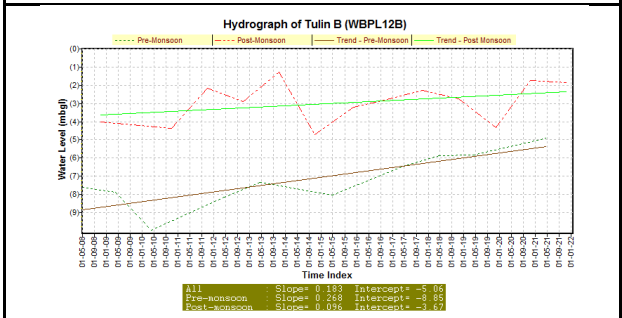

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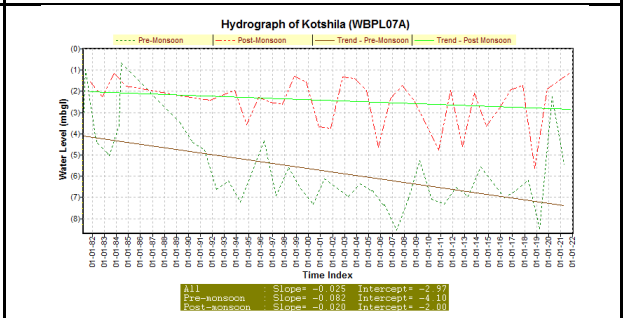

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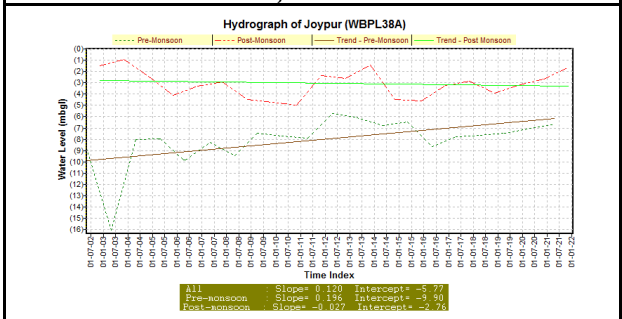

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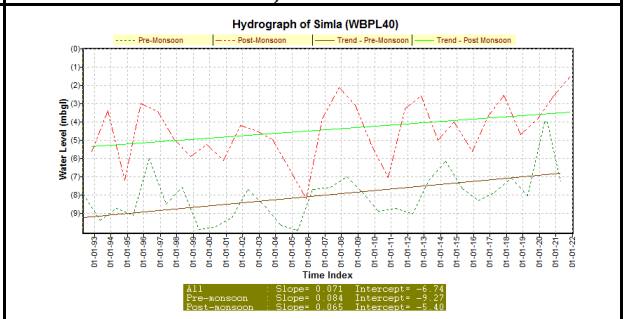
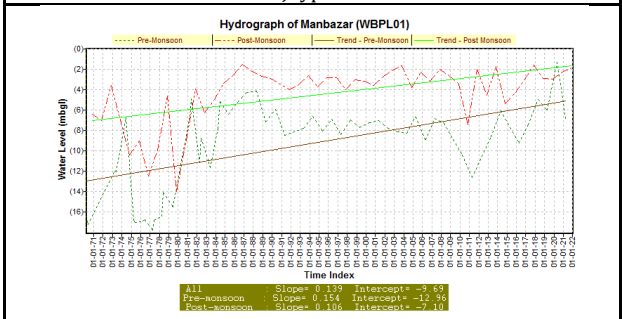


Kashipur



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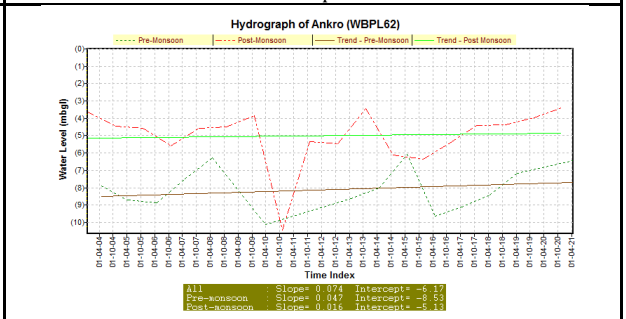

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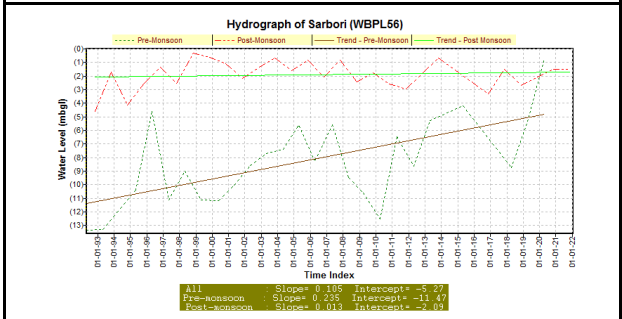
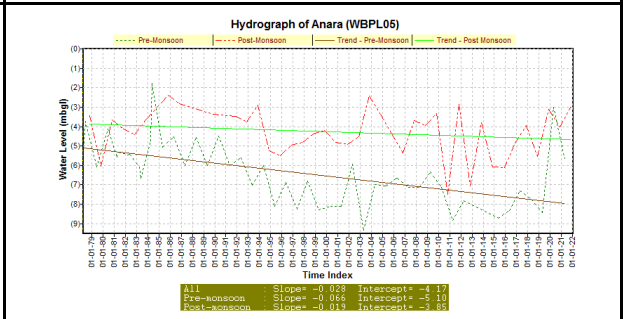


Neturia



Para

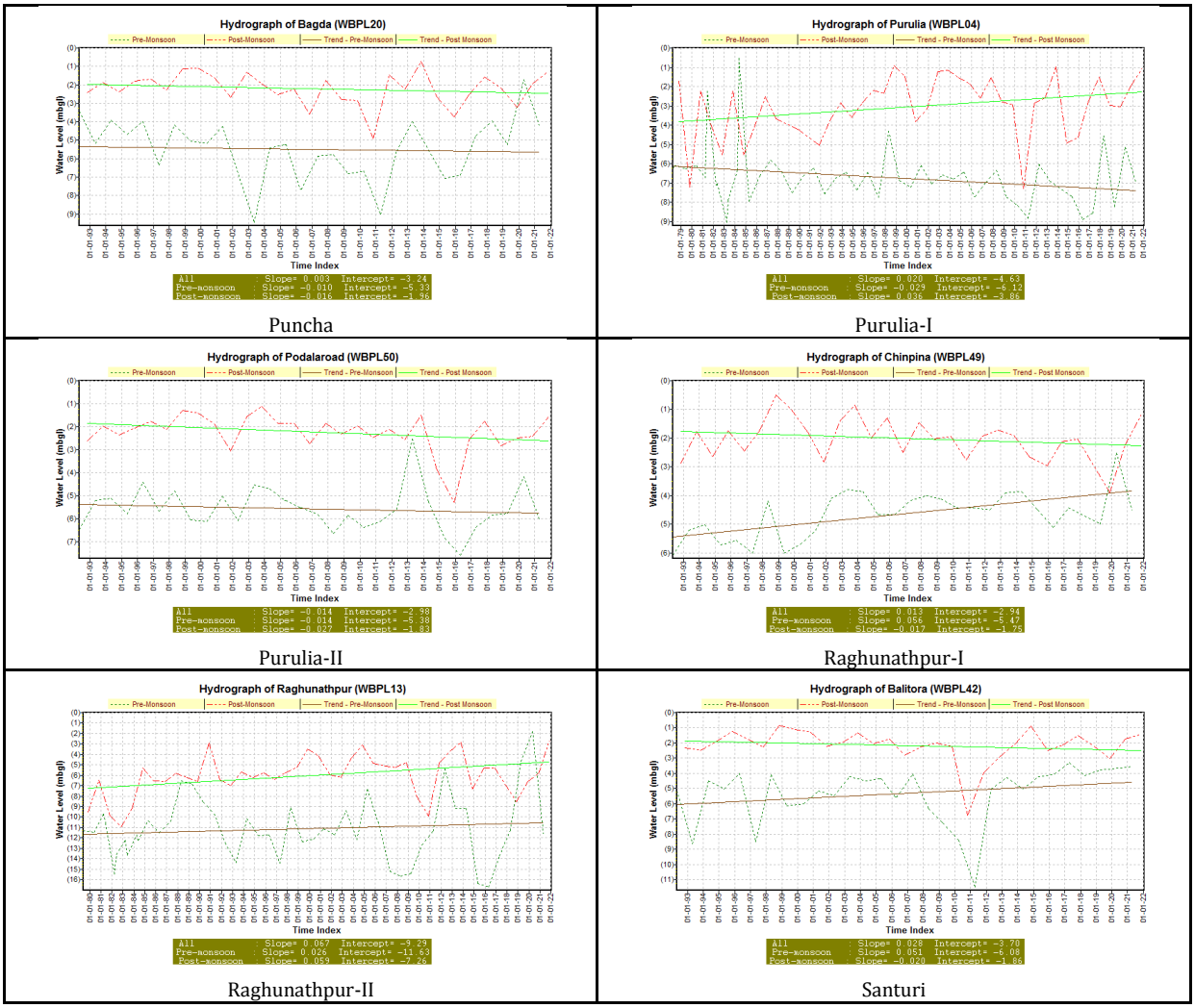


Figure 6.14 : Representative Block wise hydrographs of Purulia District, West Bengal

Table-6.6: Occurrence, potentiality and abstraction structures feasible for the blocks under study area.

Block	Occurrence of Aquifers & its potentiality	Feasibility of GW abstraction structures
Arsha	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5 – 2.75 lps.	Dug well upto 20 mbgl. Bore well 80 mbgl.
Baghmundi	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps.	Dug well upto 20 mbgl. Dug cum bored well at 20-40 mbgl. Bore well 80 mbgl
Balarampur	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50-60 mbgl, yielding 2.5-2.5 lps. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps	Dug well upto 20 mbgl. Dug cum bored well at 20-40 mbgl. Bore well 80 mbgl.
Barabazar	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps.	Dug well upto 20 mbgl. Dug cum bored well at 20- 40 mbgl. Bore well 80 mbgl
Bandwan	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps	Dug well upto 20 mbgl. Dug cum bored well at 20-40 mbgl. Bore well 80 mbgl.
Hura	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps.	Dug well upto 20 mbgl. Dug cum bored well at 20- 40 mbgl. Bore well 80 mbgl.
Jhalda-I	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 80 mbgl.

Block	Occurrence of Aquifers & its potentiality	Feasibility of GW abstraction structures
Jhalda – II	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 60 mbgl.
Puncha	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. Deeper fracture at a depth of 110 m has been encountered, yielding 0.88-2.77 lps. In Gondwana rocks the existence of fractures within the depth of 24-26 mbgl	Dug well upto 20 mbgl, Bore well 80 mbgl.
Purulia –I	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 60 mbgl.
Purulia –II	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 60 mbgl.
Raghunathpur-I	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl Bore well 60 mbgl.
Raghunathpur-II	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 60 mbgl.
Santuri	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps. In Gondwana rocks the existence of fractures within the depth of 24-26 mbgl	Dug well upto 20 mbgl. Dug cum bored well at 20- 40 mbgl. Bore well 60 mbgl.
Manbazar – I	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl Bore well 60 mbgl.
Manbazar - II	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl Bore well 60 mbgl.
Joypur	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl Bore well 60 mbgl.
Neturia	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Dug cum bored well at 20- 40 mbgl. Bore well 60 mbgl.
Kashipur	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Dug cum bored well at 20- 40 mbgl. Bore well 60 mbgl.
Para	Within 20 mbgl saturated weathered zone occurs and potential fracture zone at 50 – 60 mbgl, yielding 2.5-2.75 lps.	Dug well upto 20 mbgl. Bore well 60 mbgl.

Chapter - 7

GROUND WATER RESOURCE ESTIMATION

7.1 DYNAMIC RESOURCE

The present chapter deals with the resources available in the study area. The Dynamic Resource of the area for 2013 has been calculated jointly by CGWB and SWID (State Water Investigation Directorate) using GEC-1997 methodology. The irrigation data available to the 5th Minor Irrigation Census, 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.

7.1.1 Recharge and resource

Rainfall is the principal source of groundwater recharge in the area and a very minor part of it comes from seepage through irrigation canals, rivers and return flow from irrigation. The weathered mantle has a high degree of porosity, as a result of which a substantial part of the total annual precipitation percolates downward and gets stored. The present utilization of groundwater in the study area is mainly for agriculture use and domestic.

7.1.2 Groundwater Draft

Groundwater draft has been computed on the basis of 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 as a whole is 6859.89 ham with Kashipur being the highest with 597.99 Ham.

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 Purulia district (9.43%) is very low as compared to the state average of 42%. 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. This offers a scope for further exploitation of available un-utilized resource in future. The stage of groundwater development map is shown in Plate 7. 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 Purulia district.

Table 7.1 Ground water Recharge, Resource and Stage of Development for Purulia district.

Assessment Units Name / Block	Annual Extractable GW resource (Ham)	Fresh In-storage GW resource (Ham)	Total Availability of Ground Water Resources (Ham)	Gross Ground Water Abstraction for all uses (Draft) (Ham)	Stage of Ground Water Extraction (%)	Category
Arsha	5385.43	8395.00	13780.43	281.19	5.22	Safe
Bagmundi	2789.31	5510.00	8299.31	451.53	16.19	Safe
Balarampur	3251.38	3732.00	6983.38	259.84	7.99	Safe
Barabazar	5414.00	6641.00	12055.00	369.62	6.83	Safe
Bundwan	2951.97	4489.00	7440.97	178.67	6.05	Safe
Hura	3748.66	4433.00	8181.66	453.28	12.09	Safe
Jaipur	1930.32	3168.00	5098.32	445.09	23.06	Safe
Jhalda-I	2714.83	3111.00	5825.83	681.75	25.11	Safe
Jhalda-II	2566.13	6254.00	8820.13	402.48	15.68	Safe
Kashipur	8160.63	13130.00	21290.63	597.99	7.33	Safe
Manbazar-I	4925.41	10152.00	15077.41	278.77	5.66	Safe
Manbazar-II	2527.31	4535.00	7062.31	161.52	6.39	Safe
Neturia	3099.18	7822.00	10921.18	213.36	6.88	Safe
Para	3248.14	2319.00	5567.14	385.34	11.86	Safe
Puncha	4378.48	10474.00	14852.48	258.05	5.89	Safe
Purulia-I	4084.22	4851.00	8935.22	485.81	11.89	Safe
Purulia-II	3846.73	5127.00	8973.73	347.52	9.03	Safe
Raghunathpur-I	2319.96	3065.00	5384.96	230.13	9.92	Safe
Raghunathpur-II	2680.78	2424.00	5104.78	203.41	7.59	Safe
Santuri	2701.21	3204.00	5905.21	174.54	6.46	Safe
Total	**72724.08**	**112836.00**	**185560.08**	**6859.89**	**9.43**	--

7.1.4 Irrigation Potential created and utilized

The net ground water availability for future irrigation use in the district is estimated at 70198.07 Ham. This available balance resource could be utilized efficiently as per feasibility of the area. Presently, irrigation in the district is practiced maximum through surface flows (Table-1.7). It is seen from the table that surface water dependence is 79% whereas the groundwater dependence is 21%. 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 below in Table 7.2.

Table-7.2 Irrigation potential created and actual area irrigated with groundwater in the study area (Source: 5th MI census)

Block	Irrigation potential created (HaM)	Actual/net area irrigated (Ha)	Achievement (%)
Arsha	6566.40	15549.98	42
Bagmundi	4250.84	7791.67	5 5
Balarampur	2649.67	7591.73	35
Barabazar	3870.06	8911.82	43
Bundwan	3990.88	7334.14	54
Hura	5848.49	13160.68	44
Jaipur	2407.81	4372.98	55
Jhalda-I	6858.96	11232.60	61
Jhalda-II	5706.32	11856.86	48
Kashipur	8446.47	9001.30	94
Manbazar-I	5413.83	7475.94	72
Manbazar-II	2071.81	4205.6	49
Neturia	1340.88	3805.83	35
Para	4724.30	9794.63	48
Puncha	2646.06	7192.15	37
Purulia-I	4004.62	5557.38	72
Purulia-II	1395.58	7221.37	19
Raghunathpur-I	4357.12	9075.24	48
Raghunathpur-II	3189.22	4087.13	78
Santuri	6006.65	12154.12	49
Total	**85745.97**	**167373.15**	**51**

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.

As per 5th MI Census record, there are a total of 17276 water bodies in the district out of which 1212 are for non-irrigation purpose, 13882 water bodies are in use for irrigation and 970 are defunct.

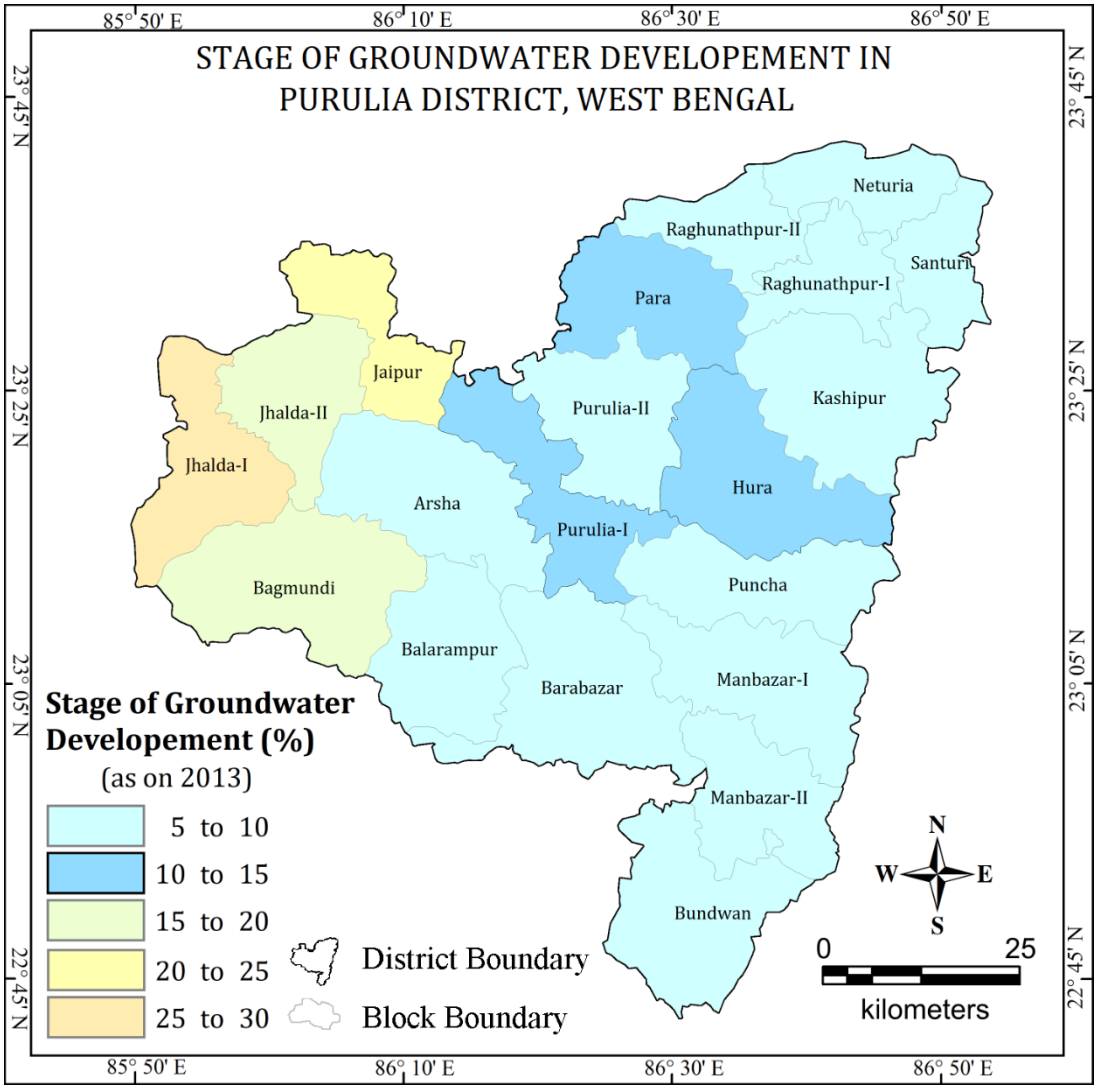


Figure 7.1 : Stage of Ground Water Development in different CD Blocks of Purulia District

7.2 STATIC WATER RESOURCE/IN-STORAGE

Computation of in-storage is essential not only for estimation of emergency storage available for utilization in case of natural extremities like drought conditions but also for assessment of storage depletion in over-exploited areas for sensitizing stakeholders about the damage done to environment. The in-storage for the blocks under study area is listed in Table-7.3 (as of 2013).

Table-7.3 In-storage of groundwater for the study area (Purulia)

Sl. No	Block	Area (Ha)	Average Pre-Monsoon WL (mbgl)	Bottom of the aquifer (m)	Total saturated thickness (m)	Average Specific Yield	In-storage Resource (HaM)
1	Arsha	37504	6.1	20.0	13.9	0.04	20852.22
2	Baghmundi	42795	6.36	20.0	13.6	0.02	8755.86
3	Balarampur	30088	4.72	20.0	15.3	0.02	9194.89
4	Bandwan	35125	5.74	25.0	19.3	0.02	13530.15
5	Barabazar	41806	5.86	20.0	14.1	0.02	11822.74
6	Hura	38221	6.42	20.0	13.6	0.02	7785.62
7	Jhalda-I	31897	7.05	20.0	13.0	0.02	6195.99
8	Jhalda-II	25661	6.59	20.0	13.4	0.03	10323.42
9	Joypur	23047	5.69	20.0	14.3	0.02	6596.05
10	Kashipur	45131	6.47	20.0	13.5	0.04	24424.90
11	Manbazar-I	38132	6.36	20.0	13.6	0.04	20804.82
12	Manbazar-II	28581	7.78	20.0	12.2	0.02	6985.20
13	Neturia	20365	3.3	20.0	16.7	0.05	17004.78
14	Para	31259	6.14	20.0	13.9	0.01	4332.50
15	Puncha	33011	5.08	20.0	14.9	0.04	19700.96
16	Purulia-I	29540	6	20.0	14.0	0.02	8271.20
17	Purulia-II	31010	6.19	20.0	13.8	0.02	8564.96
18	Raghunathpur-I	21477	5.56	20.0	14.4	0.02	6202.56
19	Raghunathpur-II	19767	5.17	20.0	14.8	0.03	8794.34
20	Santuri	17969	5.58	20.0	14.4	0.03	6477.82
	TOTAL	**622386**					**226620.97**

Chapter - 8

GROUND WATER QUALITY

8.1 MAJOR ION CHEMISTRY AND HYDRO-GEOCHEMICAL FACIES

The geochemical evolution of groundwater can be understood by plotting the concentrations of major cations and anions in the Piper tri-linear diagram. For demarcating the hydro-chemical facies existing in the phreatic and fractured aquifer in the study area, Piper (1953) and the modified Piper diagram by Chadha (1999) were used. The sample plotting falls in different areas are:

- The Piper's tri-linear diagram (Figure-8.1) for phreatic aquifer shows that 45% of groundwater samples fall into No dominant cation type. Whereas 46% of the samples fall into the Magnesium Type and remaining 9% samples in Sodium and Potassium type in the cation facies. Hence, the plotting on the Piper diagram for the samples from the study area shows dominance of Magnesium and mixed cation.
- Regarding anions, 38% of samples fall into HCO_3– type, 45% is Cl- type and rest 17% samples fall in 'no dominant' type of anion facies for phreatic aquifer.

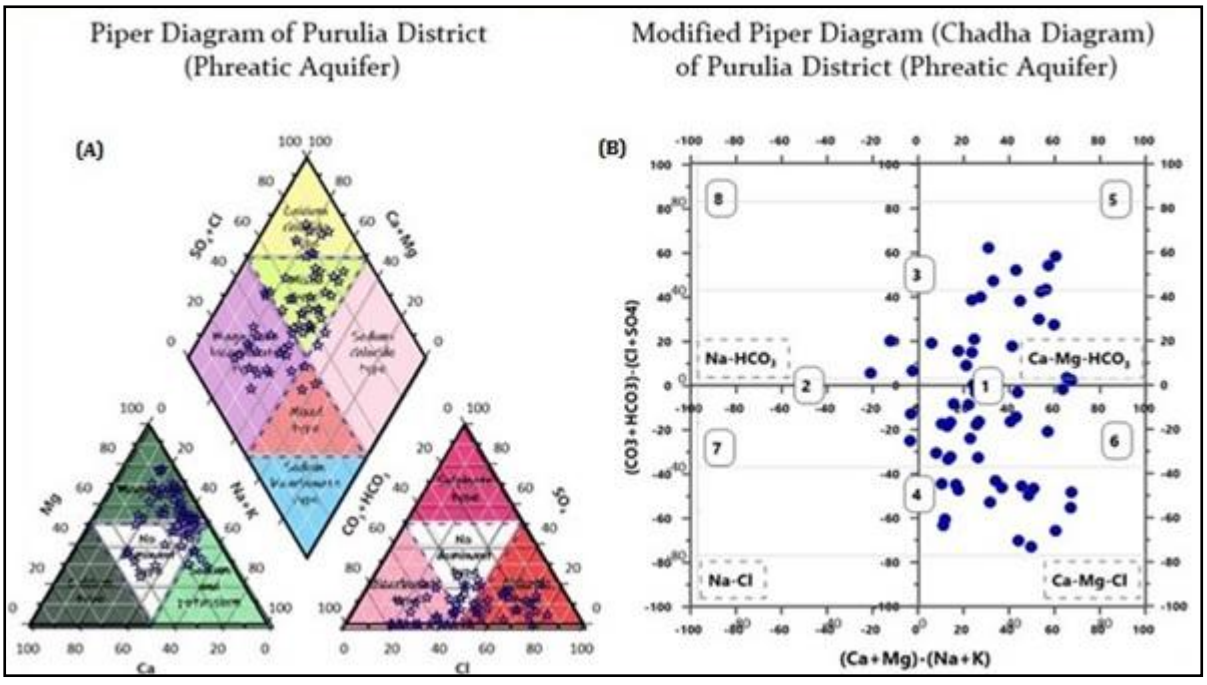


Figure-8.1: (A) Piper tri-linear diagram for hydro-geochemical facies (B) Groundwater samples from phreatic aquifers of the Study Area plotted on modified Piper diagram (Chadha, 1999)

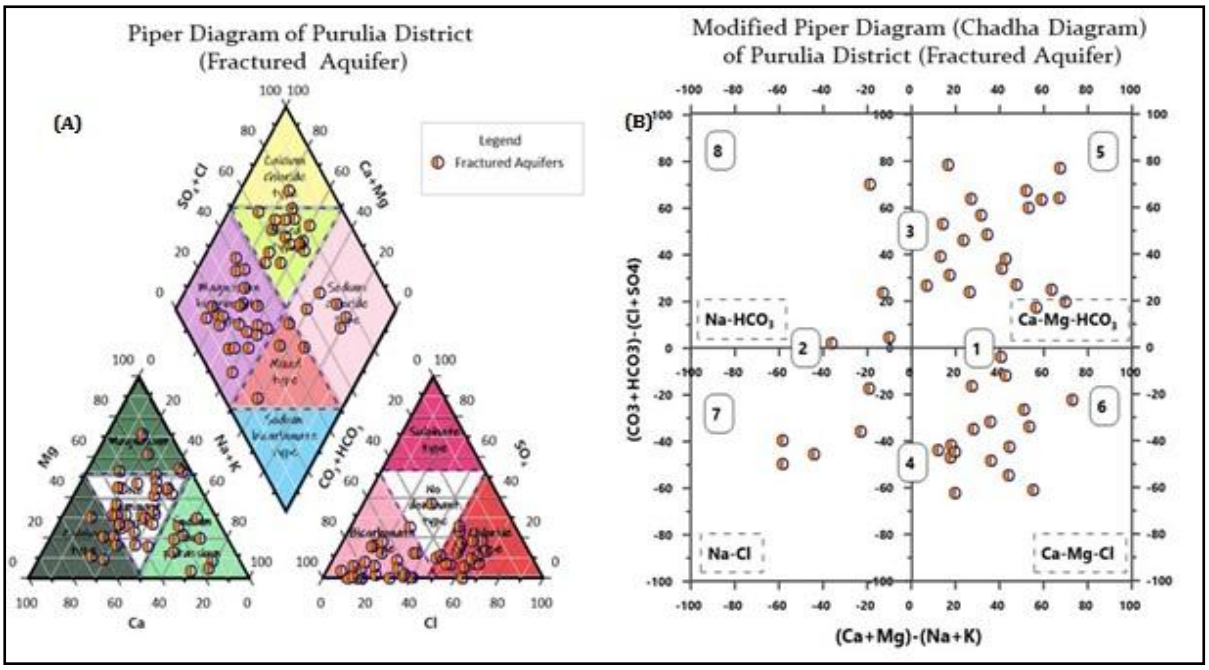


Figure-8.2: (A) Piper tri-linear diagram for hydro-geochemical facies (B) Groundwater samples from fractured aquifers of the Study Area plotted on modified Piper diagram (Chadha, 1999)

- The Piper's tri-linear diagram (Figure-8.2) for fractured aquifer reveals that 91% of the groundwater samples fall in the fields of 'alkaline earth exceeds alkalies' and remaining 9% fall in the fields of 'alkalies exceed alkaline earth'. 60% of groundwater sample fall in the 'strong acids (SO_4 + Cl) exceeds weak acids (CO_3 + HCO_3)', 40% fall in 'Weak acids (CO_3 + HCO_3) exceed strong acids (SO_4 + Cl)'.

Facies classification (Piper Tri-linier Diagram) indicates that maximum groundwater samples belong to Ca-Mg-Cl type and Ca-Mg-HCO3 type in phreatic aquifer as well as fractured aquifer.

The above analysis indicates that the hydro-chemical characteristics of groundwater in the phreatic aquifers show considerable variations, which could be attributed to various factors such as the composition of the litho units, soil type and even water contamination. The Ca-Mg-HCO_3 and Ca-Mg-Cl type water indicates water type with temporary hardness. Phreatic and fractured, both types of aquifer revealed similar types of ionic dominance and facies.

Table-8.1: Characteristics of groundwater samples in different zones derived from Chadha's diagram.

Chemical facies	Characteristics
Ca-Mg-HCO3 type of recharge waters	water type with temporary hardness
Ca-Mg-Cl Type of reverse ion-exchange waters	water type with temporary hardness
Na-Cl type of end-member waters (seawater intrusion)	water type with permanent hardness
Na-HCO_3 type of base ion-exchange waters	water type which causes foaming

8.2 ROCK-WATER INTERACTION

Rock-water interaction has been assessed by using Gibbs Diagram (Gibbs, 1970), which is a widely used method to establish the relationship of water composition and source conditions/characteristics. Three distinct fields such as precipitation dominance, evaporation dominance and rock-water interaction dominance areas are shown in the Gibbs diagram (Figure 8.3 & 8.4). The distribution of samples in the rock dominance region of the plot in the Gibbs diagram suggests that the major ion chemistry of groundwater is controlled by chemical weathering of rock forming minerals in both phreatic and fractured aquifer (Figure-8.3)

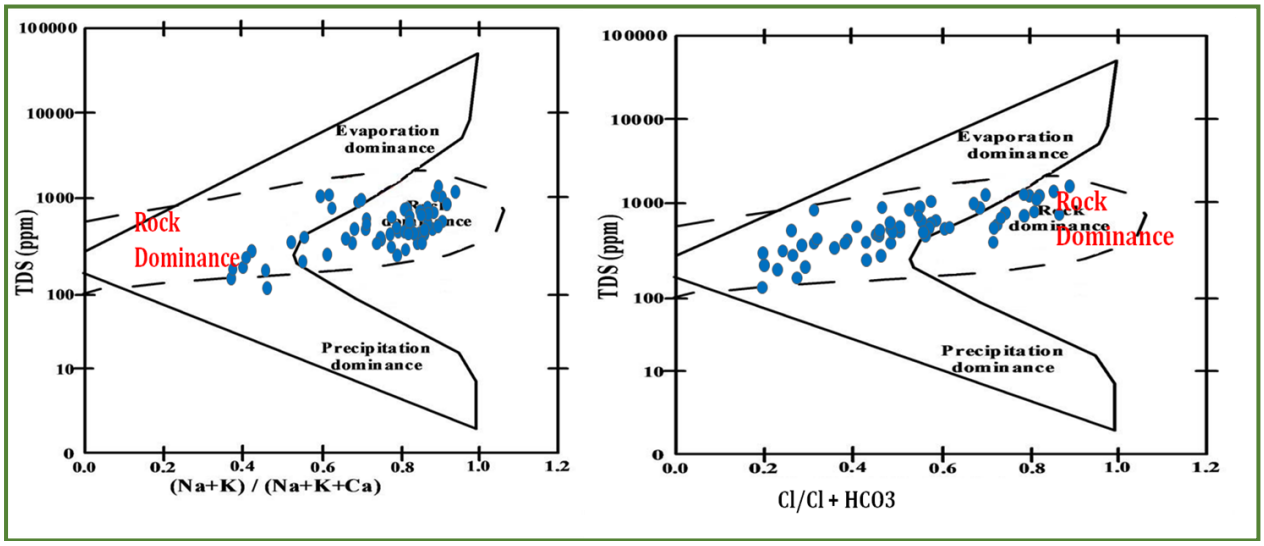


Figure-8.3: Gibbs diagram for controlling factor of groundwater quality for Phreatic aquifer

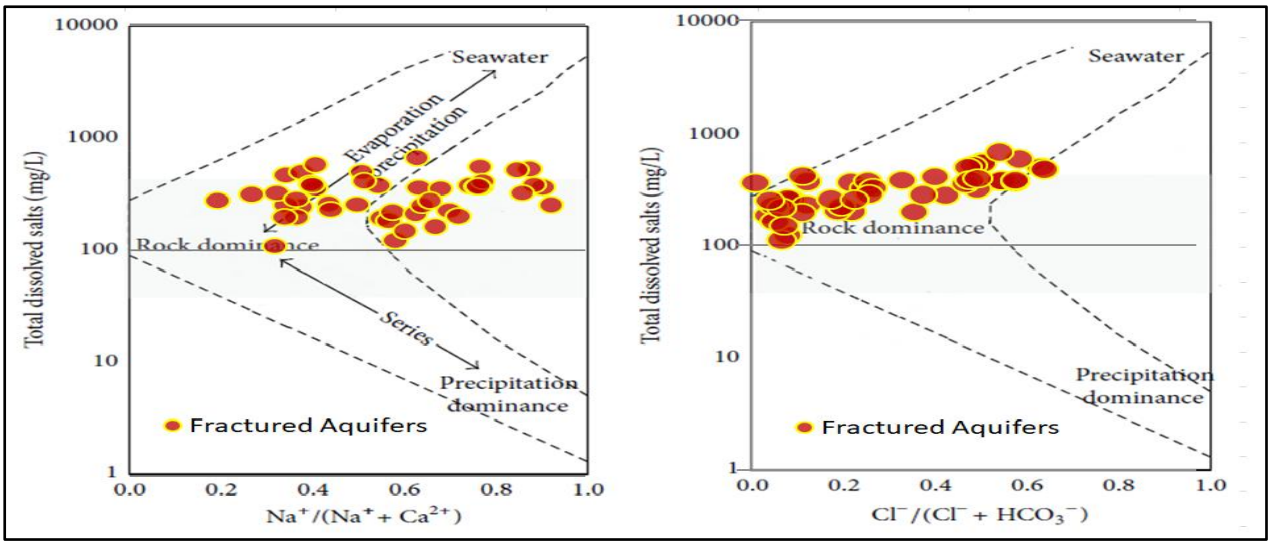


Figure-8.4: Gibbs diagram for controlling factor of groundwater quality for fractured aquifer

8.3 WATER QUALITY ASSESSMENT

Since groundwater is intensively used for irrigation and drinking purposes, an effort has been made to evaluate the suitability of groundwater for drinking and irrigation uses.

Suitability for Drinking Uses: The analytical results of physical and chemical parameters of groundwater were compared with the standard guideline values as recommended by Bureau of Indian Standard (BIS, 2012) for drinking and public health purposes (Table-8.2). The table shows the acceptable limits and Permissible limits of various chemical parameters. Except for few samples, the concentration of cations, such as Na^{+}, Ca^{2+}, and Mg^{2+}, are all within the permissible limits.

To ascertain the suitability of groundwater for any purposes, it is essential to classify the groundwater depending upon their hydro-chemical properties based on their TDS values. 40% of the sample from phreatic aquifer is found to have TDS concentration more than the BIS's (2012) acceptable limit of 500 mgL^{-1}. However, all the samples were found well within the Permissible limit of 2000 mgL^{-1} in both phreatic and fractured aquifers.

Table-8.2: Hardness Classification of groundwater of the study area

Water Class	TH as $CaCO_3$ in mg/L	% of Samples (Phreatic aquifer)	% of Samples (Fractured aquifer)
Soft	<75	3.7	0
Moderately Hard	75–150	18.3	42.5
Hard	150–300	38	48.9
Very Hard	>300	40	8.5

The total hardness (TH) varies from 55-880 mgL^{-1} indicating soft to very hard water types. Alkaline earth elements i.e., Ca^{2+} and Mg^{2+} mostly contribute to more Hardness in drinking water. This justifies with the water type as attributed by Piper diagram. 6.67% of water sample in phreatic aquifer has TH beyond the BIS (2012) Permissible limit of 600 mgL^{-1} for drinking purpose. Presence of higher concentration of Magnesium has also been noticed in the study area.

As per hardness classification, the fractured aquifer exhibits moderate to very hard water quality. However, all the samples were well within the maximum Permissible limit of 880 mg/L.

Table-8.3: Spatial Variation of Ionic Concentration in Study Area (Phreatic Aquifer and Fractured Aquifer)

Constituents (mg/L)	Acceptable Limit	Permissible Limit	Sample Exceeding Acceptable Limit (%)	Sample Exceeding Permissible Limit (%)	Max	Min	Sample Exceeding Acceptable Limit (%)	Sample Exceeding Permissible Limit (%)	Max	Min
Aquifer Type			**Phreatic Aquifer**				**Fractured Aquifer**			
pH	6.5-8.5	No Relaxation	-	-	8.4	7.5	-	-	8.3	6.6
EC (µS/cm)	-	-	-	-	2548.0	153.0	-	-	1318.0	181.0
Total Dissolved Solid (mg/L)	500	2000	40	-	1415.7	91.8	13.0	-	668.4	110.3
Total Alkalinity (as $CaCO_3$) (mg/L)	200	600	20	-	470.0	55.0	4.3	-	284.9	70.0
Chloride (mg/L)	250	1000	26.7	-	556.6	10.6	2.2	-	266.3	10.6
Nitrate (mg/L)	45	No Relaxation	16.7	-	279.1	Traces	-	-	42.0	Traces
Sulfate (mg/L)	200	400	1.7	-	204.8	Traces	-	-	109.7	Traces
Fluoride (mg/L)	1	1.5	1.7	1.7	1.9	Traces	13.0	2.2	1.6	Traces
Sodium (mg/L)	-	-	-	-	192.5	8.2	-	-	156.5	8.3
Potassium (mg/L)	-	-	-	-	65.1	0.4	-	-	6.6	1.1
Calcium (as Ca) (mg/L)	75	200	-	-	70.0	8.0	6.5	-	102.0	4.0
Magnesium (as Mg) (mg/L)	30	100	75	18	202.9	4.9	26.1	-	48.5	3.6
Total Hardness (as $CaCO_3$) (mg/L)	200	600	70	6.67	880.0	55.0	34.8	-	360.0	75.0
Iron (Fe) (mg/L)	1	No Relaxation	12	-	23.5	Traces	15.2	-	3.3	Traces

NOTE : *It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'Acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'Permissible limit' in the absence of alternate source' in column 4, above which the sources will have to be rejected.*

- Sporadic occurrences of Nitrate in water have been detected from few wells in the study area in phreatic aquifer especially. The average NO_3^- values range between Traces to 279 mg/L.

- Ca^{2+}concentrations is also found within the highest permissible limits (BIS:2012), with the value range of 8 to70 mg/L in phreatic aquifer and 4 to 102 mg/L in fractured aquifers. 18% of the samples in phreatic aquifer exhibits Mg^{2+} concentration exceeding the maximum permissible limits. The relative concentrations of major cations and anions in both the aquifers have been displayed as Box and Whisker Plot in Figure-8.5.

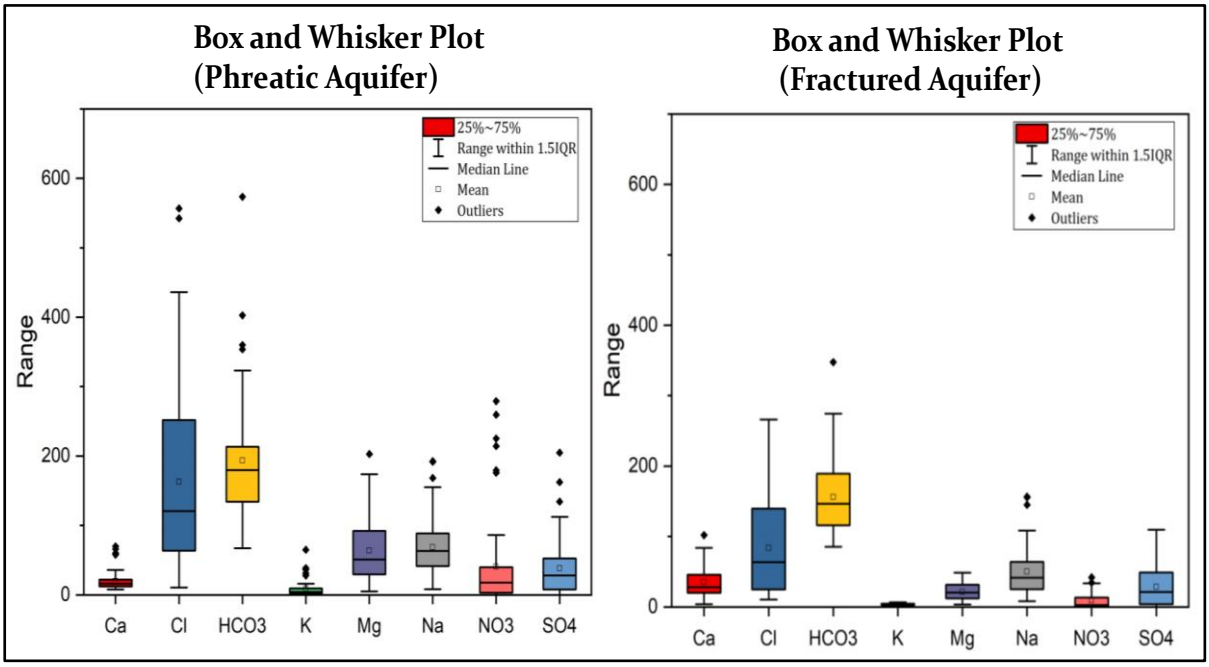


Figure-8.5: Box and Whisker Plot sowing Spatial Distribution of Major Cations and Anions in the study area in Phreatic and Fractured Aquifer

Distribution of Iron and Fluoride in the study area: Iron concentrations in the water samples of the study area ranged between Traces-23.5 & Traces-3.3 in phreatic and fractured aquifer respectively. As per BIS, 2012 the permissible limit of iron is 1.0 mgL^{-1} beyond which water is not considered as suitable for drinking purposes without prior

treatment. In the study area 12% & 15.2% samples were detected with Iron concentration more than permissible limit in phreatic and fractured aquifer respectively. High iron content in drinking water can cause diabetes, hemochromatosis, stomach problems, and nausea. It can also damage the liver, pancreas, and heart.

Fluoride is one of the main trace elements in groundwater which generally occurs as a natural constituent. Bedrock containing fluoride minerals is the main source of Fluoride in groundwater. The concentration of fluoride in groundwater in the study area has been observed to be above the permissible limit of 1.5 mg/L. High fluoride concentration in phreatic aquifer have been reported at Jhapra, Para block (1.9 mgL^{-1}) and in fractured aquifer from Jhujhka, Arsa block (1.63 mgL^{-1}).

Assessment for Co-occurrence of Uranium and other Trace Metals in Groundwater of Purulia District

- All the samples were found within the prescribed standards as per WHO, 2012 for Uranium.
- High concentration of Iron has been detected in few pockets with concentration more than 10 mg/L at some places.
- 43% of samples show manganese contamination well beyond the acceptable Limit and 30% of the samples exceeds the Permissible Limit as per BIS, 2012.
- Zinc, Chromium, Copper, Arsenic and Lead are within permissible limit.

Suitability for Irrigation Uses : In the present study the suitability of the groundwater for irrigation is assessed by considering the irrigation indexes like Conductivity (EC), Soluble Sodium Percentage (SSP), Sodium Adsorption Ratio (SAR), Residual Sodium Carbonate (RSC), Magnesium Hazard (MH) and Permeability Index (PI) along with the USSL salinity and Wilcox diagrams and the result has been summarized in Table-8.4.

USSL diagram has been used for studying the quality of groundwater suitability for irrigation purpose. The SAR and EC values of water samples of the study area were plotted in the form of a graphical representation (Figure-8.6B) and it has been found that all the samples fall in the low to medium category in salinity hazard group and low

in sodium hazard group in both the phreatic and fractured aquifers. The ground water from the study area is thus suitable for the irrigation purpose.

Similar results are found in Wilcox diagram plot, for classifying water for irrigation suitability. In this diagram, the EC was plotted against the percentage of Na. According to Wilcox classification, 93% of the water samples from the study area belong to the 'excellent to good' and 'good to permissible' category in phreatic aquifer. Remaining 7% groundwater samples falls in the 'doubtful to unsuitable' category {Figure-8.6 (A)}.

For fractured aquifer, the Irrigation suitability analysis revealed that the groundwater in Purulia is mostly found within the category of 'Excellent to Good' and 'Good to permissible' zone.

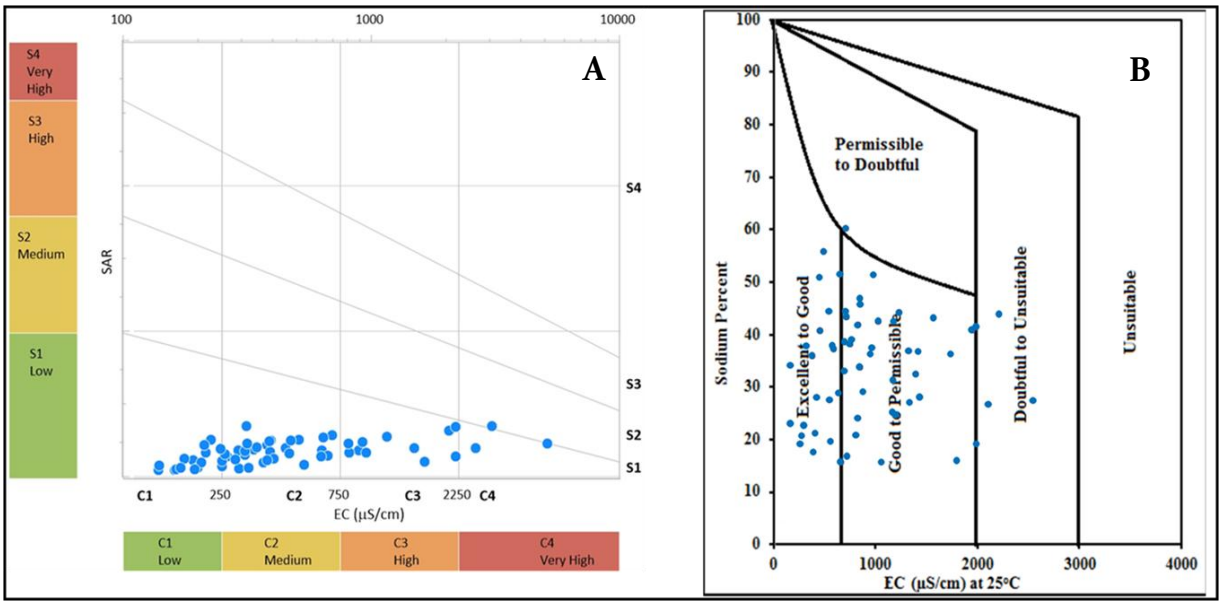


Figure-8.6: (A) Wilcox Diagram and (B) United States Salinity Laboratory (USSL) Diagram for assessing the Irrigation water quality of Phreatic Aquifer

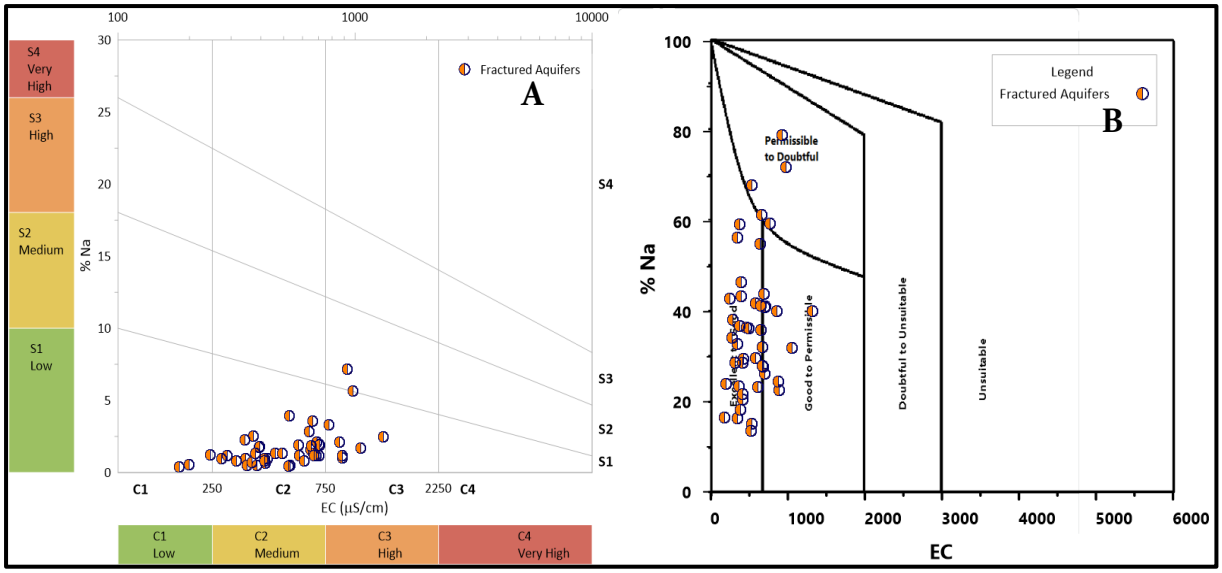


Figure-8.7: (A) Wilcox Diagram and (B) United States Salinity Laboratory (USSL) Diagram for assessing the Irrigation water quality of Fractured Aquifer

Table-8.4: Summarized result for various indices to assess the suitability of the groundwater for irrigation

Indices	Range	Water Class	Maximum	Minimum	Average	Maximum	Minimum	Average
Type of Aquifer			Phreatic Aquifer			Fractured Aquifer		
SAR	< 10	Excellent	3.5	0.4	1.7	7.2	0.4	1.8
	10 to 18	Good						
	18 to 26	Moderate						
	> 26	Unsuitable						
SSP	< 50	Good	60.4	16.3	34.3	79.3	13.5	37.6
	> 50	Unsuitable						
RSC	< 1.25	Good	1.0	-15.6	-3.0	2.0	-5.1	-0.9
	1.25 to 2.50	Moderate						
	> 2.50	Unsuitable						
MH	< 50	Good	94.9	36.4	79.8	92.9	12.0	50.5
	> 50	Unsuitable						
PI	> 75	Good	102.5	25.1	58.0	105.7	36.1	68.5
	25 to 75	Moderate						
	< 25	Unsuitable						
KI	<1	Suitable	1.5	0.2	0.5	3.8	0.1	0.8
	>1	Unsuitable						

Chapter - 9

GROUNDWATER RELATED ISSUES AND PROBLEMS

9.1 DROUGHT & WATER SCARCITY

Purulia has a long history of water scarcity. The district as a whole is identified as drought and water scarce area. Because of the complex hydrogeological set up, the area experiences limited scope for large-scale ground water development. Moreover, most of the open wells go dry with the advent of summer season leading to an acute water crisis. There are several factors which are mainly responsible for the water scarcity of Purulia. The gap between demand and supply of water is widening day by day due to rapid growth of population. Both physical and economic water scarcity are observed in Purulia. Physical water scarcity is inadequate water resources to meet a country's or regional demand, including the water needed to fulfill the demand of ecosystems to function effectively (UNDP, 2006). Arid regions frequently suffer from physical water scarcity. Economic water scarcity is caused by a lack of investment in infrastructure or technology to draw water from rivers, aquifers or other water sources, or insufficient human capacity to satisfy the demand for water.

9.2 GROUND WATER QUALITY PROBLEMS (GEOGENIC)

Fluoride is common in semi-arid climate with crystalline igneous rocks and alkaline soils. In Indian continent, the higher concentration of fluoride in groundwater is associated with igneous and metamorphic rocks. The chief sources of fluoride in groundwater are the fluoride-bearing minerals, such as fluorite (fluorspar), fluor-apatite, cryolite, biotite, muscovite, lepidolite, tourmaline and hornblende series minerals. In water, fluoride is strongly reactive or exists in free state, eventually precipitating as fluorite (main solid phase with the fluoroapatite, $Ca_5 [PO_4]_3[F,Cl]$) [2,3]. Fluoride content in groundwater usually depends on rock type, interaction period with host rock, as well as the dissolution kinetics for fluorite, apatite or silicate minerals.

Fluoride (F^-) is an essential micronutrient for human beings, serving to strengthen the apatite matrix of skeletal tissues and teeth (*Maithani et al. 1998*). On the other hand, due to excessive fluoride intake, tooth enamel loses its luster. Besides skeletal and dental fluorosis, excessive consumption of fluoride may lead to muscle fiber degeneration, low hemoglobin levels, excessive thirst, headache, skin rashes, nervousness, depression, etc. (*Ayoob and Gupta 2006*).

Iron and Fluoride are the two most common quality issues in the district. PHED, Gov. of WB have analyzed 24,076 ground water sources (2018-19) from both dug well and bore

wells, out of which 478 sources have Fluoride concentration above 1.5 mg/L and 4809 sources have Iron concentration above the permissible limit of 1 mg/L .

The fluoride concentration in dug wells varies from 0.25 to 1.495 mg/l as per the rapid assessment report of Fluoride Task Force, Government of West Bengal. Drinking water sources tapped from bore wells in fractured granitic rocks within the depth of 50 m are also found to have fluoride contamination. The granitic rocks having fluor-apatite veins may enhance the level of fluoride in ground water as such. In Purulia district 17 blocks out of 20 (except Jhalda-II, Manbazar-II and Bundwan blocks), are having sporadic occurrence of fluoride in ground water above permissible limit (> 1.5 mg/l). The maximum fluoride concentration in ground water is recorded from Joypur block (1.47 to 7.70 mg/l). High fluoride concentration is also reported from the northern and central part of the study area where the weathered mantle and saprolitic zone are produced from the parent rock of granite and granite gneiss. Low concentration of fluoride is reported from the regions dominated by the parent **rock of mica-schist.**

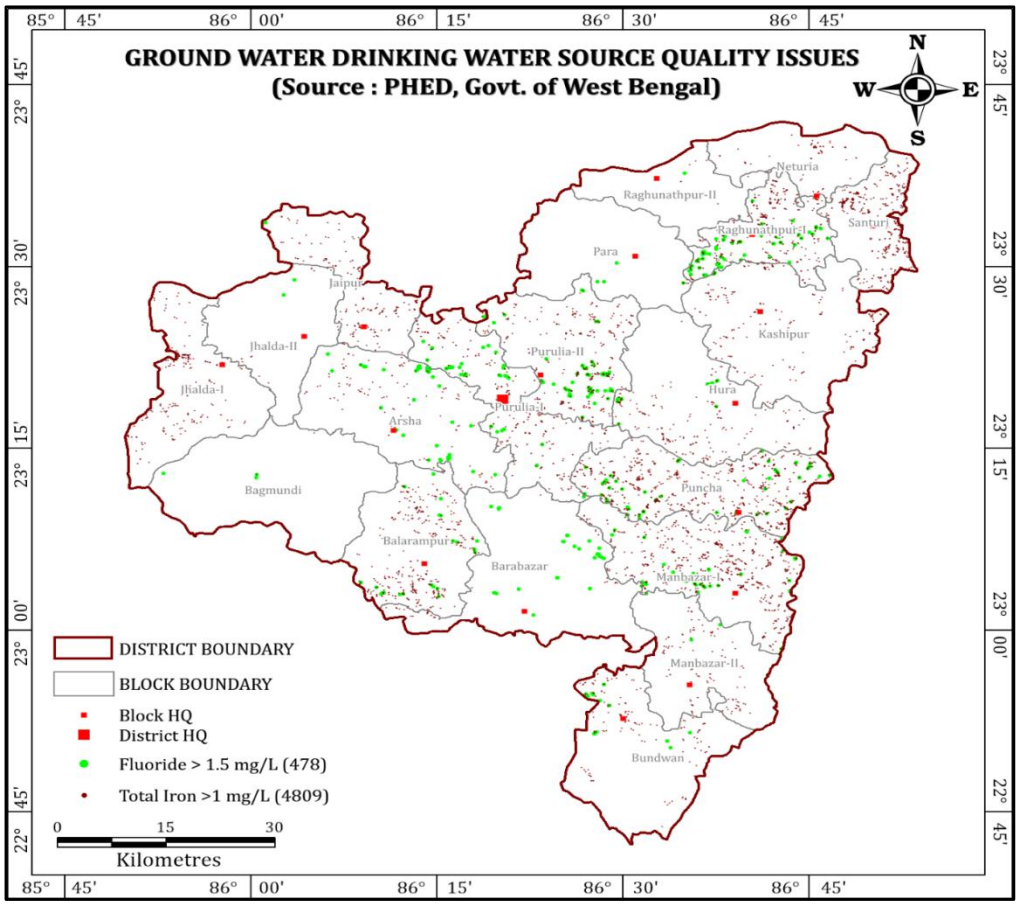


Figure-9.1: Chemical quality map (Fluoride & Iron Spot values) for Purulia district.

Table 9.1: Status of Fluoride concentration, village and number of persons affected in Purulia district

Block	Maximum concentration of Fluoride(mg/l)	No. of affected Villages	No. of Persons affected by Fluorosis
Arsha	2.92	2	198
Baghmundi	2.38	1	14
Balarampur	2.12	1	94
Barabazar	2.08	2	76
Hura	2.1	2	216
Jhalda-i	4.93	3	242
Joypur	7.7	2	277
Kashipur	2.78	5	135
Manbazar-I	2.73	13	415
Neturia	1.77	3	345
Para	2.34	3	205
Puncha	2.41	7	358
Purulia-I	3.53	6	428
Purulia-II	2.54	16	466
Raghunathpur-I	4.3	3	207
Raghunathpur-II	1.74	2	288
Santuri	2.38	2	246
DISTRICT TOTAL		**73**	**4210**

(Source : Fluoride Task Force, Govt. of West Bengal, Rapid Assessment-2016)

9.3 OTHER MAJOR ISSUES

The yield of wells constructed is generally low in the district and for water supply, PHED depends on tapping the alluvial zones (River valleys, channel bars and valley fills) for sustainable water supply. Because of uncertainty of encountering saturated fractures, bore wells are limited. Dug wells are mostly used for abstraction through manual means. Because of this, crop production is limited to mainly lentils that too are limited only in the rain fed areas. This results in Low Stage of ground Water Development.

Chapter - 10

GROUNDWATER DEVELOPMENT AND MANAGEMENT

Groundwater development in an area is regarded as an index of groundwater use in different sectors like domestic, agricultural, industrial and mining, etc. The level of development in hard rock areas is generally low owing to the limited availability and restricted occurrence of groundwater under favorable hydro-geological settings. Chronic water scarcity over an area often prevents expansion of agricultural and economic growth. In such a situation, strategic use of groundwater resource is essentially needed for its sustainability. And in this, the role of management occupies a primary role that would be an obvious practice in groundwater sectors.

10.1 RURAL AND URBAN WATER SUPPLY SCHEMES

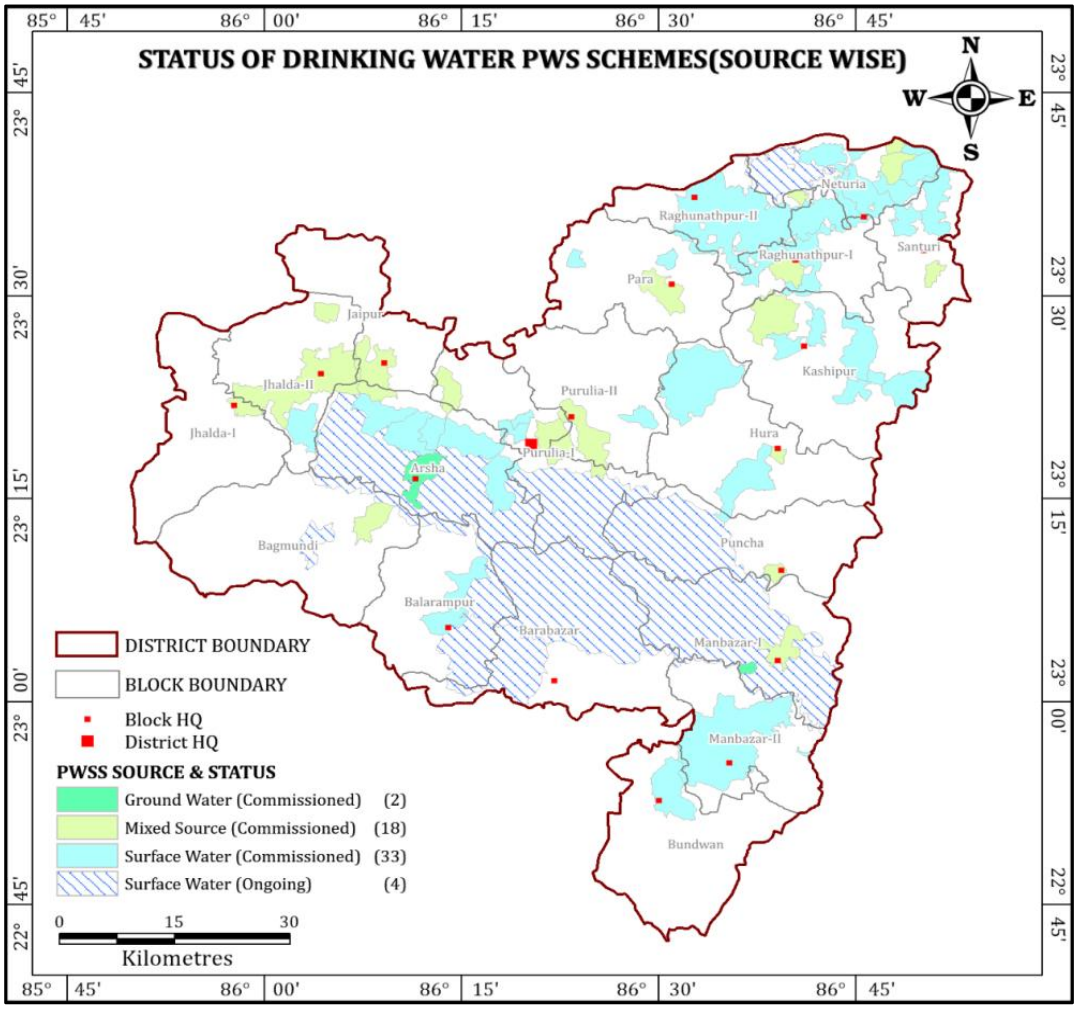


Figure-10.1: Status of Piped Water Supply Schemes in Purulia District

Groundwater availability as a source of drinking water supply is a perpetual crisis for hard rock areas. A large number of privately owned dug wells are available along with very limited Gov.dug wells in both rural and urban areas. A number of hand pumps (Mark-II) have been installed by the Panchayat and PHED for the benefit of the local public. But this does not suffice the need of the people in general and still proves inadequate. Moreover, many of the wells run dry or give insufficient discharge during lean periods due to depressed water level. At present there are 53 Commissioned Schemes, out of which 2 are groundwater based, 33 are surface water based and 18 mixed source type. Additional 4 Schemes are ongoing all of which are surface water based.

10.2 FUTURE GROUND WATER DEVELOPMENT AND MANAGEMENT

The net availability of ground water for future irrigation development in the district ranges from 1406.58 to 5013.36 ham (see **C**hapter-5). The level of groundwater development is at an average of 9.4%, categorized "Safe". Therefore, despite of the area's adverse hydro-geological constraint, there is still some scope for further utilization of groundwater through construction of new abstraction structures for irrigation.

Development of groundwater in the study area can be done by constructing large diameter dug wells of 15-20m depth tapping the weathered residuum for both domestic as well as agri-irrigation purposes. Bore wells of 50 - 60 m depth in hard rock terrain may sustain a yield 1- 2.5 lps. Bore wells tapping intermediate fracture zones encountered at 100-150 m depth, may yield around 15 lps (Ankhro, manbazar-II). At places, deeper fractures encountered within around 230 m may have cumulative yield upto 8 lps. Selection of site may be done in a scientifically, especially with the help of geophysical survey. Considering the limited potentialities, attempts are to be made to augment ground water resources. It has been observed that by constructing suitable rainwater harvesting structures at feasible locations across existing streams, the base flow could be arrested. This will prevent lowering of water level in the nearby dug wells/tube wells. In unconsolidated alluvial areas, dug wells and shallow tube-wells may yield up to 20 m^3 / hr with a reasonable drawdown.

The surface water which flows through streams/nallahs can be conserved with the help of check dams giving due consideration to farmers' land, local hydrogeological and terrain condition. In undulating terrain gully plugs can be feasible on cultivated lands to conserve water and there by soil moisture can be increased. Check-dams on sloppy streambed are to be supported by Gabion structures on upstream side to control the velocity of water. Dry dug wells after cleaning can be used for artificial recharge. However before recharging the water is to be sand filtered. Sub-surface dykes below the streams/nallahs, flowing over plain terrain and ephemeral in nature are feasible.

For exclusively drinking purposes, special care is to be taken for fluoride infested area, where F concentration is above permissible limit (>1.5 mg/l). Considering long term solution of fluoride contamination of drinking water, piped water supply tapping sub-surface sources of water in the river beds of the Damodar, Barakar, Kumari, Dwarkeswar, Silabati, Kasai etc. may be thought of. In some cases where surface / sub-surface water is not available in sufficient quantity, groundwater from unaffected mouzas may be considered as source. Wherever such water source is also inadequate to meet up the demand, Pond based water supply (rain water harvesting) or groundwater based water supply with fluoride removal plant may be taken up.

10.3 ARTIFICIAL RECHARGE AND RAINWATER HARVESTING

The district wise Master Plan has been prepared for the state of West Bengal. Accordingly, the feasible area for recharge in different parts of Purulia district has been identified. Considering the local hydrogeological conditions in the district the following recharge structures are being proposed mainly for hard rock terrain. The suitable structures are as follows:-

i) Percolation Tank
ii) Check dam
iii) Gabion structures/contour bunds
iv) Sub-surface dykes
v) Dug well recharge/recharge shaft

It is recommended that farm ponds/percolation pond, nala bund, gully plug and contour bund may be constructed as rainwater harvesting structures in different

hydrogeological set-up where water scarcity is felt. However, in the area where percolation tanks are not feasible for all practical implementation the provisions may be substituted by construction of new tanks or desiltation of existing tanks. In connection to this, it is to be mentioned that there are already 15 no.s existing irrigation reservoirs (constructed during 1999) situated at different blocks of the district which are already approved for re-excavation of silted materials for creation of additional surface storage and recharge to the ground water.

Augmentation of water through conservation structures in such water deficit terrains needs to be executed more in various mini water sheds in the district for mitigating the water problem. The increment in groundwater and additional surface water storage, the moisture content of the soil along the area of influence could help in thriving of plantations.

A pilot study was carried out by CGWB along with State Water Investigation Directorate (SWID), Government of West Bengal along the channel bars of Subarnarekha River near Tulin, Jhalda-I, Block, Purulia. Both Sounding (Schlumberger) and Profiling (Wenner) were carried out. This gave a bigger prospect for harnessing the Potential of Valley Fills & Channel Bars. The findings are-

Valley fills prospect: Geographical area around 13.93 Sq Km. The average thickness of valley fills is around 2- 3 m. Assumed Specific Yield to be around 0.12. Assumed annual average saturation volume is 70%. The Utilizable resource available is computed to be at 0.004 MCM. Expected average yield of large Diameter Dug wells is around 1.8 m^3/hour with a drawdown of 0.5–1 m, with 5-6 hours of pumping.

Channel Bars: Geographical area around 10.65 Sq Km. The average thickness of Channel Bars & Active Flood Plains is around 5-7 m. Assumed Specific Yield to be around 0.16. Assumed annual average saturation volume is 85%. The Utilizable resource available is computed to be at 0.01 MCM. Expected average yield of Collector Wells is around 36 m^3/hour with a drawdown of 2-3 m, with 8-10 hours of pumping. With construction of sub-surface dykes at appropriate downstream sides, the yield potential is expected to increase further.

Under Central Sector Scheme (CSS) of Artificial Recharge under VII & IX Plan, Artificial Recharge Structures constructed and completed in Purulia district and the details are given below (Table-10.1).

Apart from this scheme, a study conducted by CGWB at Purulia Ramkrishna Mission Vidyapith has established that conservation of rainwater from hostels and staff quarters' rooftops as well as from land surface can harvest a huge amount of rainwater. From 6 nos. hostels and from 14 nos. staff quarters' rooftops, about 5974 m^3 water and from part of land surface of the institute 30,624 m^3 of rain water is expected to be available. However, considering the storage capacity of ponds and also evaporation losses (30%) about 1,56,623 m^3 water (considering all types of losses) can be conserved to cater a huge amount of water requirement for the Vidyapith.

Overall, emphasize should be given on rain water harvesting with suitable structures. Conservation of rainwater can be done both from the rooftop and from the lands. The water that can be available from rooftops can be stored in cemented and PVC tanks. Before conserving, the water should be sand filtered. The rain water available from any land surface can be stored in any ponds and in this case, sites as well as design of ponds are to be finalized considering local hydrogeological and terrain condition.

Table-10.1: Artificial Recharge Structures constructed and completed in Purulia district.

Title of Scheme	Type/No. Of Structure	Approved cost(Rs)	Implementing Agency	Amount utilized	Remarks
Under VII Plan period					
Study of Artificial Recharge at Tulin, Jhalda-I block	Sub Surface Dyke: 5	0.38 Lakhs	SWID, Govt. Of West Bengal	0.38 Lakhs	The impact of sub-surface dykes across the nala course in water scarce hard rock terrain has been studied and an average increment of 0.15 m of ground water level per year was found. Within a catchment area of 2 sq.km with only 1.654 MCM water retention capacity and base flow of 0.50 MCM, it has been estimated that dynamic utilizable ground water potential of 0.21 mcm in respect of mini-watershed in Tulin area has been created after the construction of these sub-surface dykes.
Under IX Plan period					
Integrated approach of Artificial Recharge of Ground Water for improvement in the watershed management in the water scarce area	Farm Pond:13 Sub Surface Dyke: 8 Re-excavation of pond: 15 Percolation Tank: 15 Contour bund: 1.2 km Monitoring well: 5	50.44 Lakhs	SWID, Govt of West Bengal	50.44 Lakhs	Out of 12 nos. Of blocks covered under different types of artificial recharge schemes. 6 nos. blocks have been taken into consideration for impact assessment in the first phase for the period 2001-2005 and the resulted impact of arresting surface run off and sub-surface run off reflect the increment of ground water level to the tune of 0.01-2.82 m during post-monsoon period.

10.4 STRATEGIES FOR WATER CONSERVATION, RAINWATER HARVESTING & ARTIFICIAL RECHARGE – BASED ON NON-COMMITTED RUNOFF (CGWB)

Based on component wise distribution of non-committed surface runoff, a number of different structures were recommended under Master plan for Artificial Recharge during 2013 and 2019. The status for the same along with their cost of construction and area identified for recharge is given through the following table.

Table-10.2: Area suitable for recharge, Structures proposed and cost of construction in Purulia district

Block	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	Check Dam	Gabion / Contour Bund	Sub surface dykes	Dug Well Recharge	Percolation Tanks	Check Dam	Gabion / Contour Bund	Sub surface dykes	Dug Well Recharge	
Baghmundi	97.47	11	35	88	44	9	132	52.5	44	44	9.9	8.772
Balarampur	167.25	20	60	151	75	15	240	90	75	75	16.5	15.052
Barabazar	37.51	4	14	34	17	3	48	21	17	17	3.3	3.376
Jhalda-I	6.04	4	28	69	35	7	108	42	34.5	35	7.7	0.544
Jhalda-II	77.10	9	3	9	4	1	12	4	4.5	4	1.1	6.939
Joypur	9.66	1	2	5	3	1	12	3	2.5	3	1.1	0.870
Kashipur	25.41	1	9	23	11	2	36	13.5	11.5	11	2.2	2.287
Raghunathpur-I	50.77	3	18	46	23	5	72	27	23	23	5.5	4.570
Santuri	22.25	6	8	20	10	2	36	12	10	10	2.2	2.002
TOTAL	**493.46**	**59**	**177**	**445**	**222**	**45**	**696**	**265**	**222**	**222**	**49.5**	**44.412**

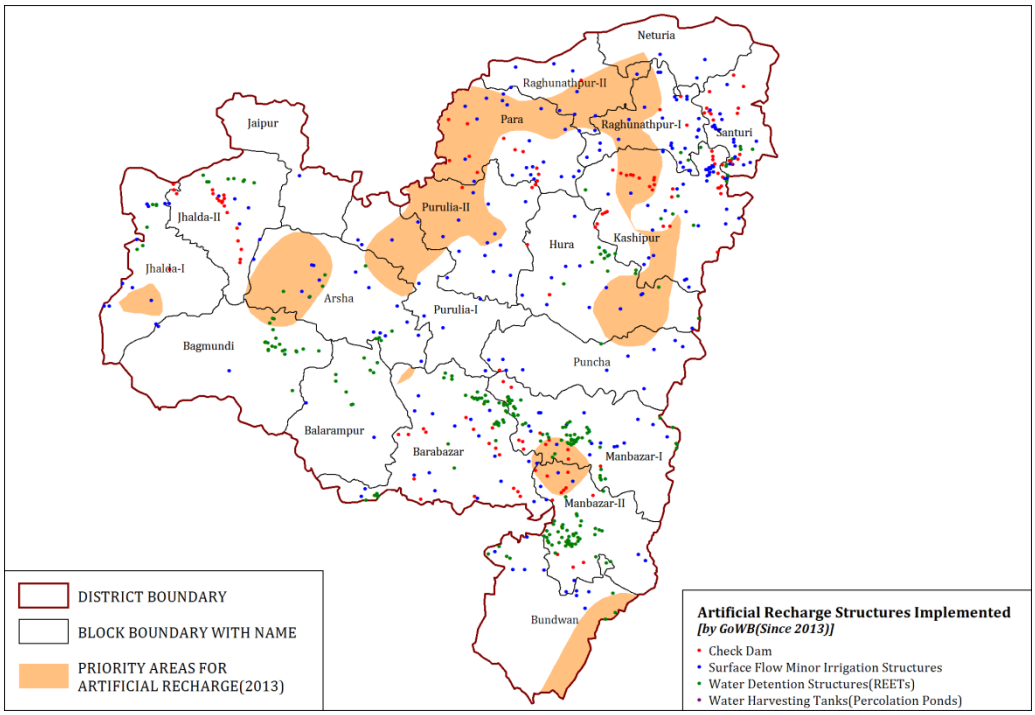


Figure-10.2: Artificial Recharge Map & Structures Implemented by Govt. of West Bengal for Purulia district of West Bengal

Interventions worked out under NAQUIM Studies : During the course of NAQUIM Studies, it was seen that the district is chronically drought affected and there is a perennial scarcity of drinking water in the district. A perusal of the drinking water supply schemes – both existing as well as proposed, gives an enormous thrust on surface water based piped water supply schemes. This is to ensure sustainable source, since ground water yield potential is highly uncertain and of moderate nature. With this in the backdrop, the first step was to identify the recharge and discharge areas in the district from the topographic and geomorphologic perspective. The resultant map for the district is shown in figure 10.3.

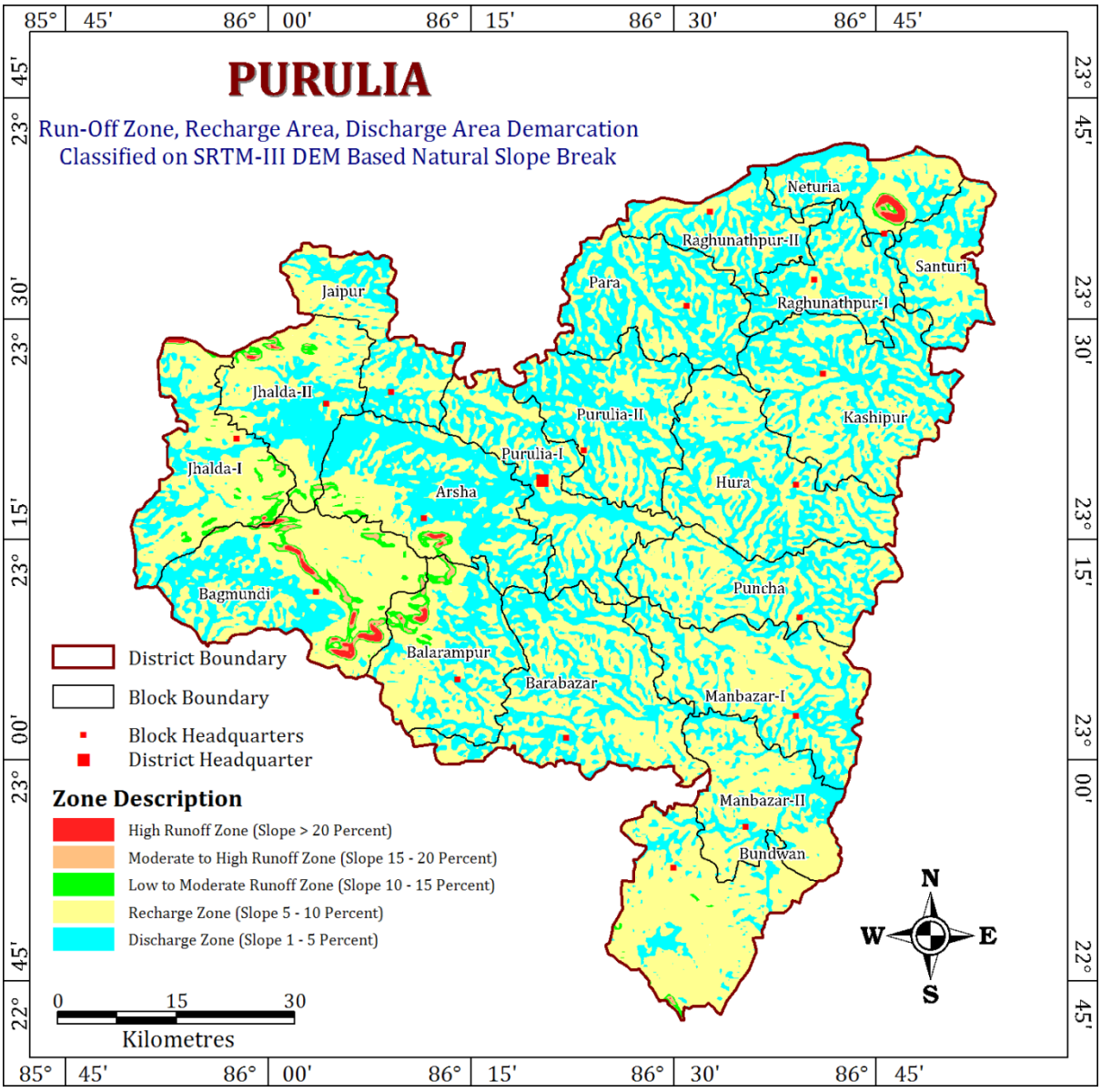


Figure 10.3 : Demarcated Run-off zones, recharge and discharge zones in Purulia District

Aquifer management Strategies :

- In unconsolidated alluvial areas, open wells/ dug wells and shallow tube-wells may yield upto 20 m^3 / hr with a reasonable drawdown.
- Construction of large diameter dug wells of 15-20m depth tapping the weathered residuum is feasible for domestic as well as agri-irrigation purposes.
- Bore wells of 50 - 60 m depth in hard rock terrain may sustain a yield 1- 2.5 lps.
- Bore wells tapping intermediate fracture zones encountered at 100-150 m depth, may yield around 5 lps.
- At places, deeper fractures encountered within around 230 m may have cumulative yield upto 8 lps.

Table 10.3 : Demand and Supply Side Intervention Strategies

Sl No	Issues	Demand Side	Supply Side
1	Hard Rock Area with Low Yield Prospect	Scientific investigation for sustainable source finding Equitable and rational water budgeting	Minimize Conveyance Loss Dependence on Ground Water to be reduced. Tapping Channel Bars and Valley fills
2	Low Stage of Ground Water Development	Scientific investigation for sustainable source finding	Efforts to identify sustainable source and efficient conveyance systems
3	Fluoride & Iron Infestation	Identify pockets of infestations Alternate source findings	Installation of Iron and Fluoride removal units in water supply systems Increase quality monitoring frequency Seal affected sources
4	Chronic Drought Prone Area	Demarcate all unclassified water bodies Ensure adequate surface storage	More emphasis on Water Conservation Structures Rejuvenation of traditional water bodies Artificial Recharge, if necessary

Ground Water Development Strategies :

- For exclusively drinking purposes, special care is to be taken for fluoride infested area, where Fluoride concentration is above permissible limit.
- Considering long term solution of fluoride contamination of drinking water, piped water supply tapping sub-surface sources of water in the river beds of the Damodar, Barakar, Kumari, Dwarkeswar, Silabati, Kasai etc. as well as tapping of smaller valley fills may be thought of, at least seasonally.
- In some cases where surface / sub-surface water is not available in sufficient quantity, groundwater from unaffected mouzas may be considered as source.

- Wherever such water source is also inadequate to meet up the demand, Pond based water supply (rain water harvesting) or groundwater based water supply with fluoride removal plant may be taken up

Status of Piped Water Supply Schemes(PWSS) :

- At present there are 53 Commissioned Schemes
- 2 are Ground water based
- 33 are Surface water based
- 18 are mixed source types
- Additional 4 Schemes are ongoing – all are surface water based
- Thus the main thrust area for Aquifer management Plan in Purulia District will be to ensure sustainability of Drinking water sources

Water Quality Issue of Sources of PWSS :

- Iron and Fluoride are the burning quality issues in the district
- PHED, GoWB analyzed 24,076 Ground water sources(2018-19) – both dug well and bore wells
- 478 sources have Fluoride concentration above 1.5 mg/L
- 4,809 sources have Iron concentration above the permissible limit of 1 mg/L

SUGGESTED WATER CONSERVATION STRUCTURES FOR INTERVENTION

Gabion Structures :

- Based on component wise distribution of non-committed surface runoff 626 Gabion Structures could be taken up in lower order streams / nallahs, in the hilly parts of the District
- Till date Gabions have not been attempted in the district.
- Entire balance of 626 Gabion Structures remains to be constructed, from the amply available local geomaterials

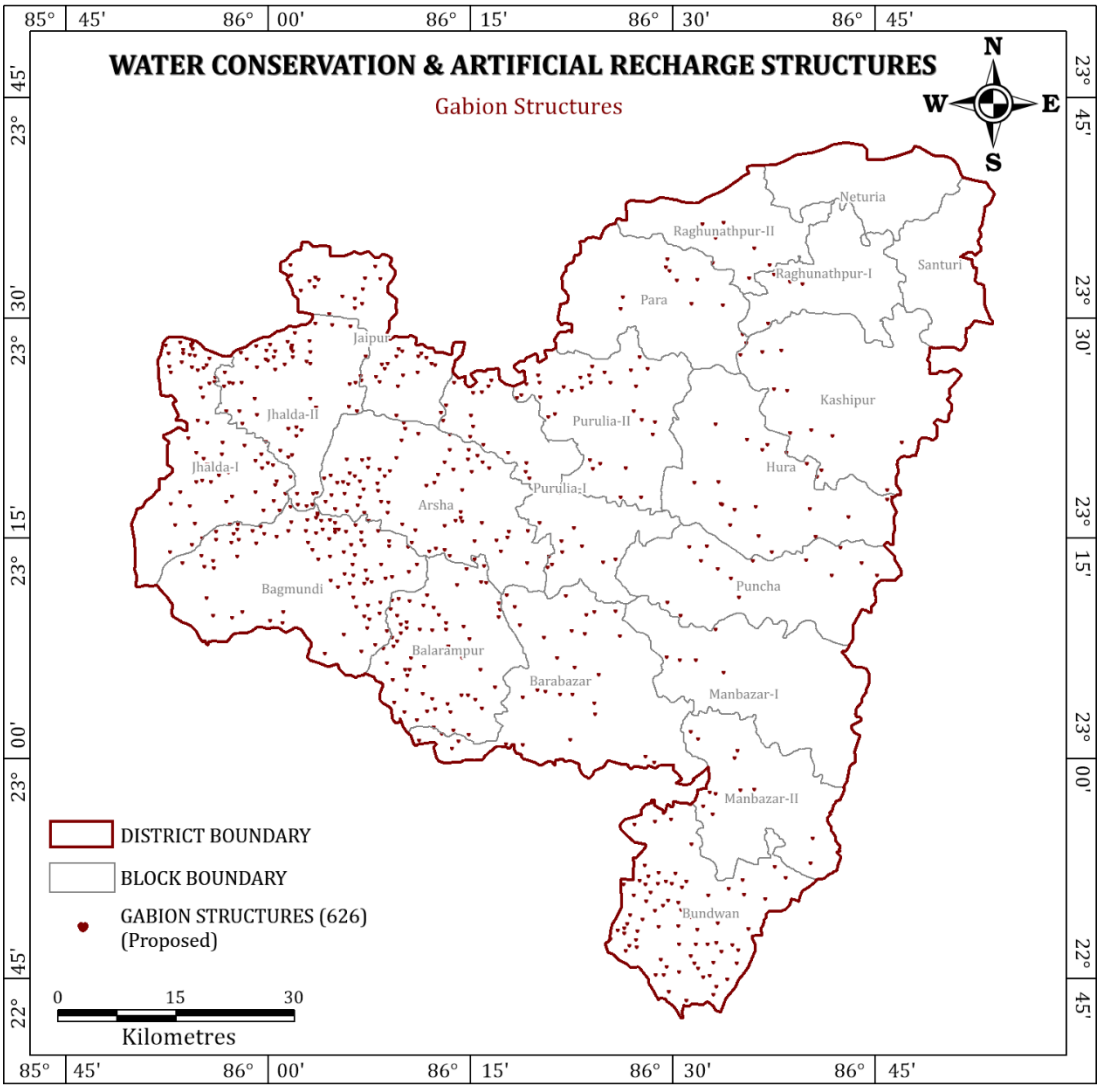


Figure : 10.4 :Suggested Gabion Structures in Purulia District, West Bengal

Check Dams :

- Based on component wise distribution of non-committed surface runoff 214 Check Dams could be taken up
- GoWB have already constructed 140 Check Dams in the District under Jaltirtha & WBADMIP Schemes
- Balance of 74 Check Dams remains to be constructed

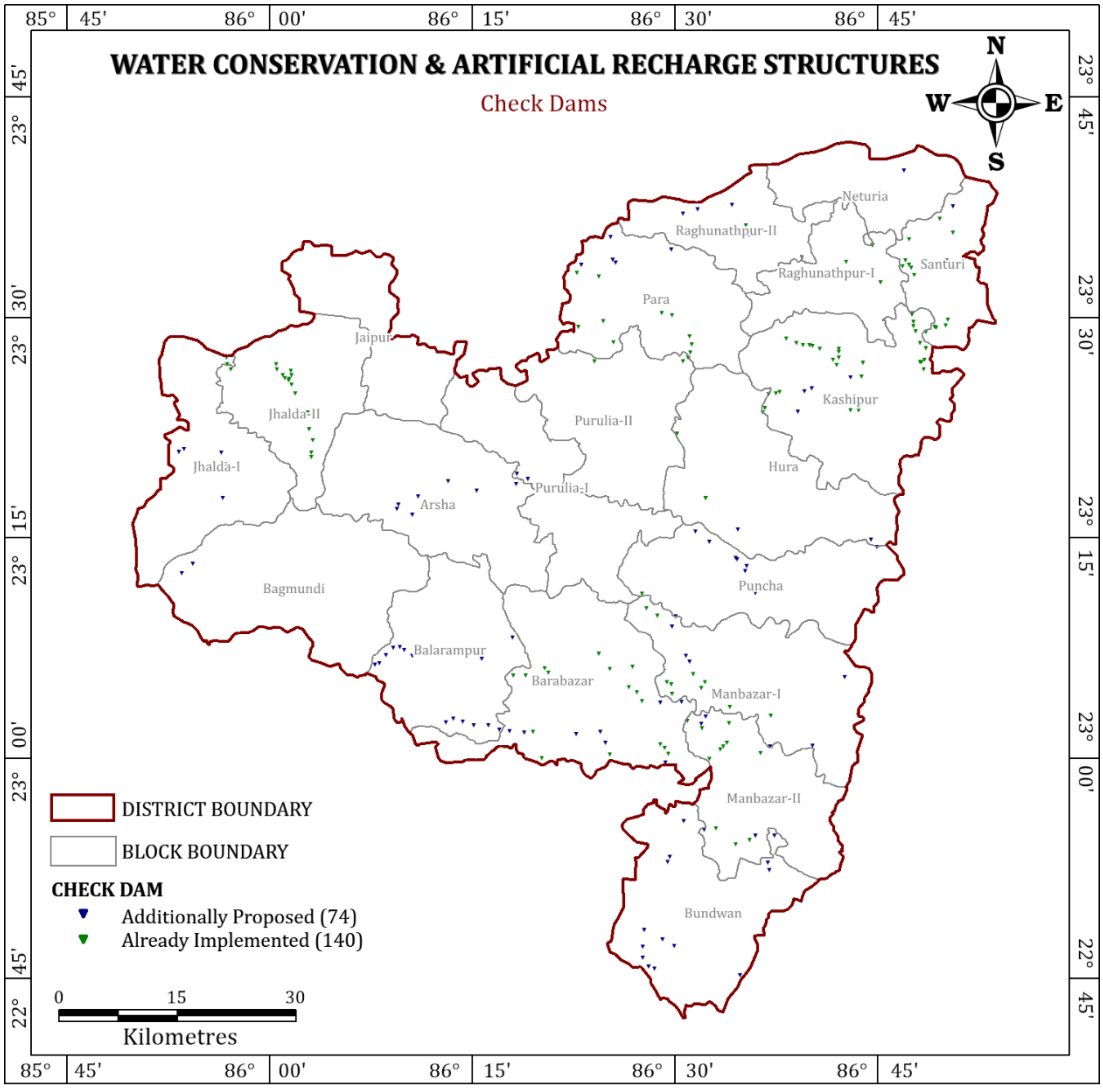


Figure : 10.5 : Suggested Check Dams in Purulia District, West Bengal

Percolation Tanks:

- Based on component wise distribution of non-committed surface runoff 433 Percolation Tanks could be taken up.
- GoWB have already constructed 369 Percolation Tanks in the District under Jaltirtha & WBADMIP Schemes.
- Balance of 64 Percolation Tanks remains to be constructed.
- Around 29 MCM additional GW resource could be augmented.

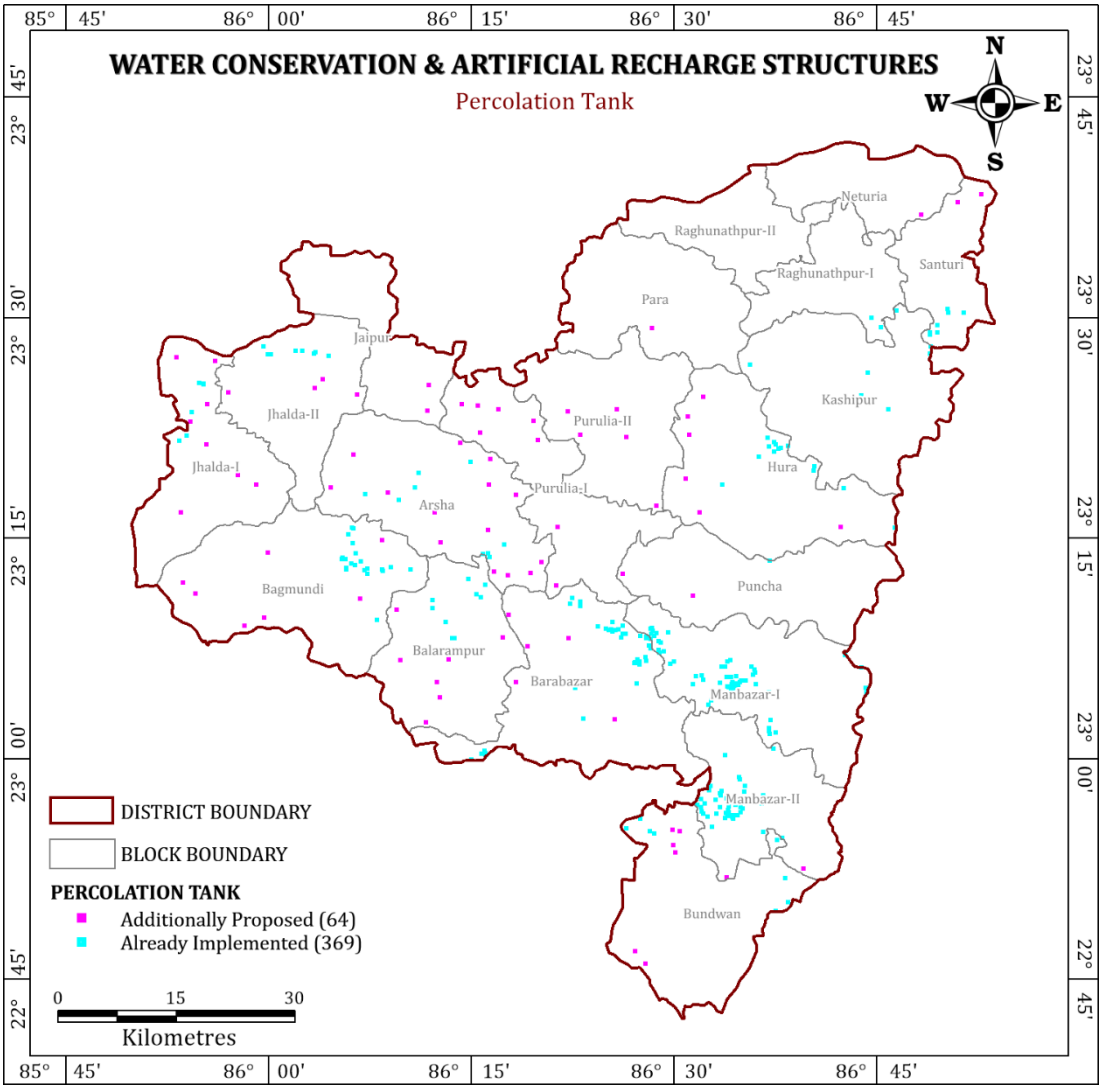


Figure : 10.6 : Suggested Percolation Tanks in Purulia District, West Bengal

Channel Bars and Valley Fills :

- Valley Fills and Channel bars are the most understated and underutilized units for PWSS.
- In this district the average thickness of these units are around 5 metres.
- PHED, GoWB, utilize these units for PWSS
- Based on component wise distribution of non-committed surface runoff 111 shallow Sub-surface Dykes can be constructed in these units to restrict and retain the surface run-off as well as that of the infiltrated sub-surface runoff.

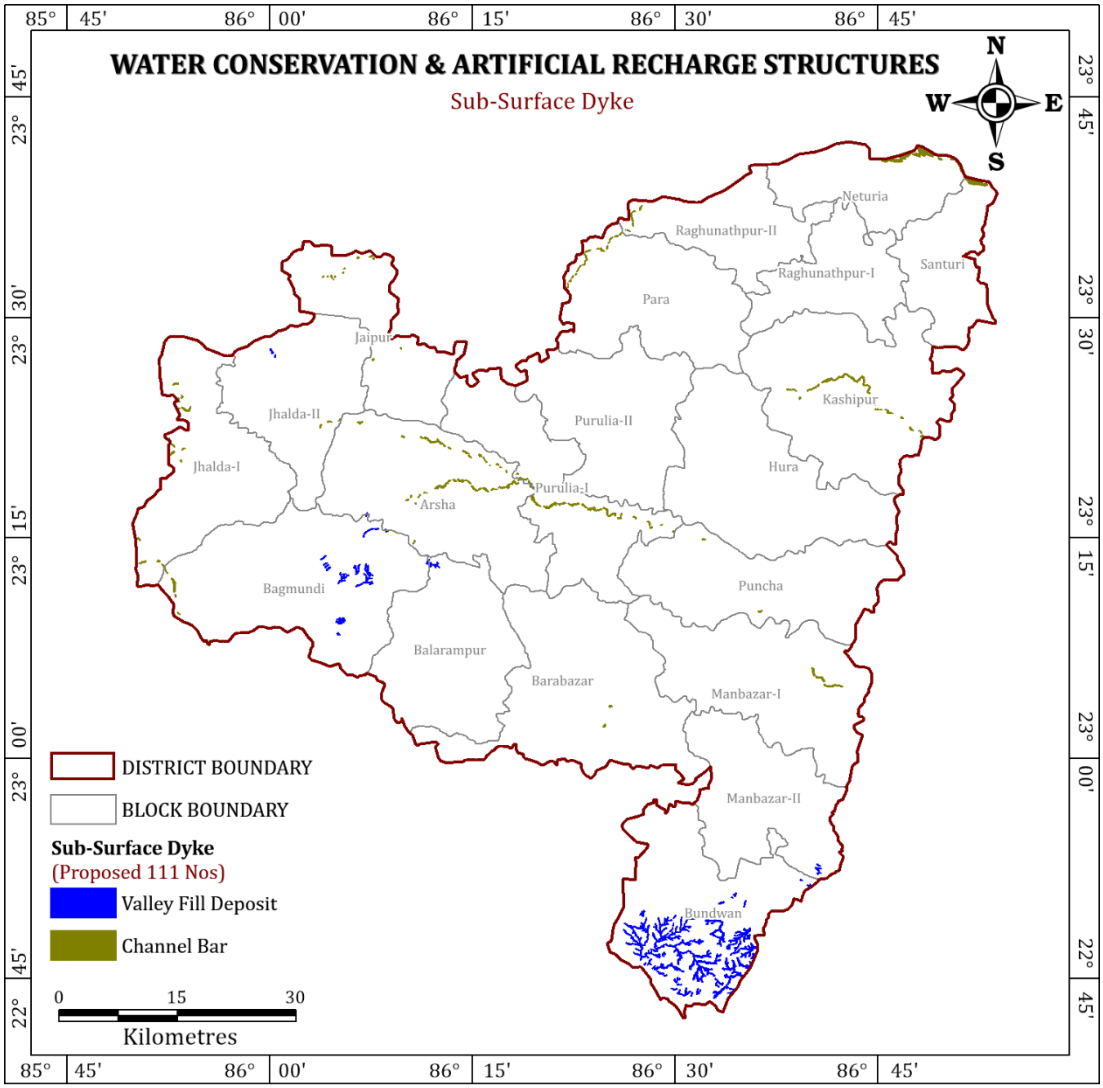


Figure : 10.7 : Suggested Locations for utilization of Channel bars & Valley Fills in Purulia District, West Bengal

Pinpointing Sites for Sub-Surface Dykes through Surface Geophysical Investigations :

- A pilot study was carried out in the channel bars of Subarnarekha River near Tulin, Jhalda-I, Block, Purulia.
- Both Sounding(Schlumberger) and Profiling(Wenner) was carried out.
- Results were interpreted, in sync with existing ground water exploration data.
- Effective site for construction of sub-surface dyke could be pinpointed in the extreme SSE corner of the area.

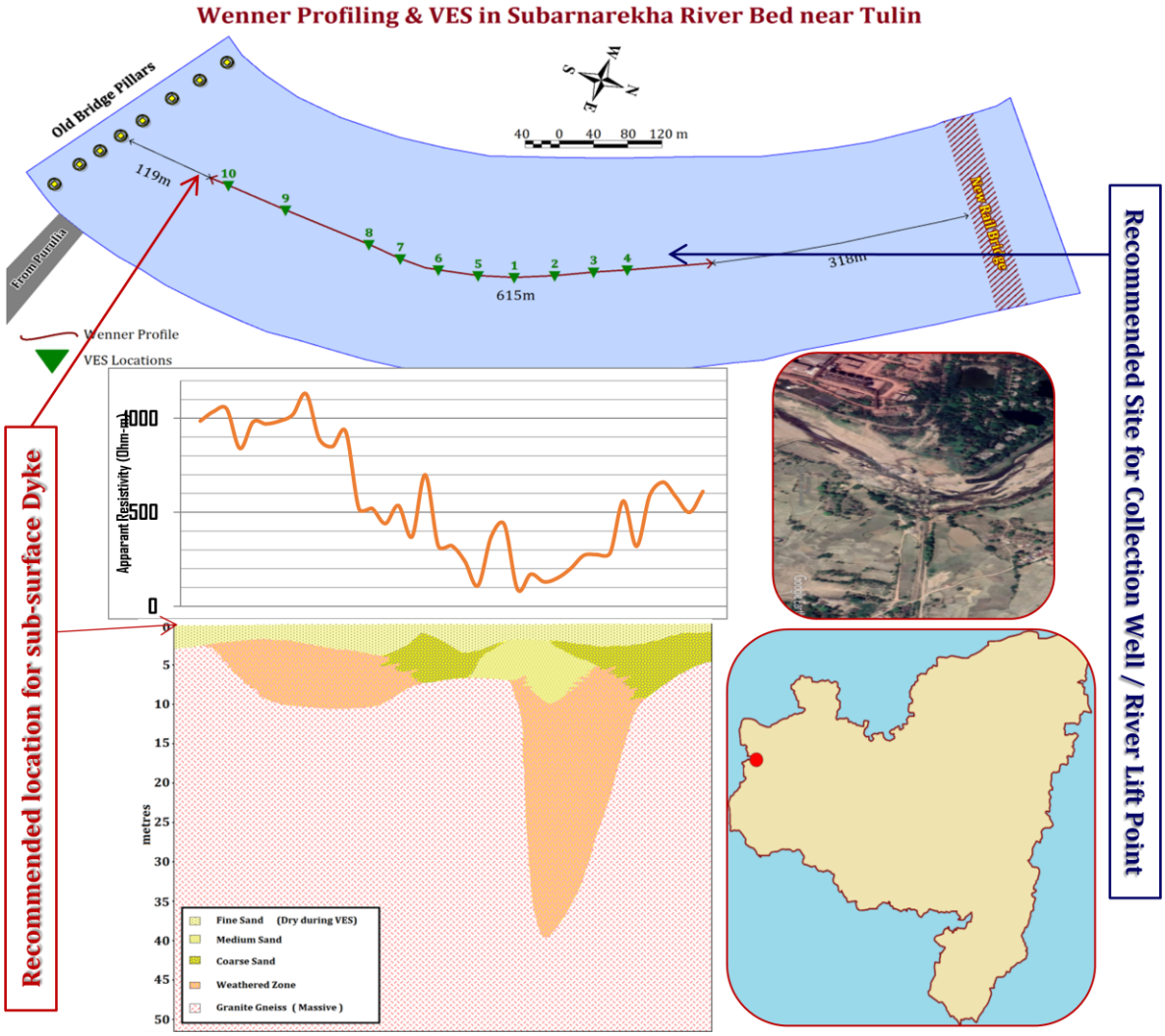


Figure : 10.8 : Details of Site of Pilot Study for Locating sites for Subsurface Dyke and River Lift Point in Purulia District, West Bengal

Yield Potential of the Valley Fills Deposits :

- Geographical area around 13.93 Sq Km
- The average thickness of valley fills is around 2- 3 m
- Assumed Specific Yield to be around 0.12
- Assumed annual average saturation volume of 70%
- The Utilizable resource available is computed to be at 0.004 MCM
- Expected average yield of Large Diameter Dug wells is around 1.8 m^3/hour with a drawdown of 0.5–1 m, with 5-6 hours of pumping.

Yield Potential of the Channel Bars

- Geographical area around 10.65 Sq Km
- The average thickness of Channel Bars & Active Flood Plains is around 5-7 m
- Assumed Specific Yield to be around 0.16
- Assumed annual average saturation volume of 85%
- The Utilizable resource available is computed to be at 0.01 MCM
- Expected average yield of Collector Wells is around 36 m^3/hour with a drawdown of 2-3 m, with 8-10 hours of pumping.

Re-Excavation of the Existing Tanks(REET):

- A lot of existing tanks and ponds as well as a huge number of unclassified water bodies exists in the District.
- Experience of RRR Schemes have shown very encouraging results in hard rock areas, Pan India
- Based on component wise distribution of non-committed surface runoff 157 Existing Tanks and Ponds can be desilted and fitted with shallow recharge shafts to facilitate additional infiltration

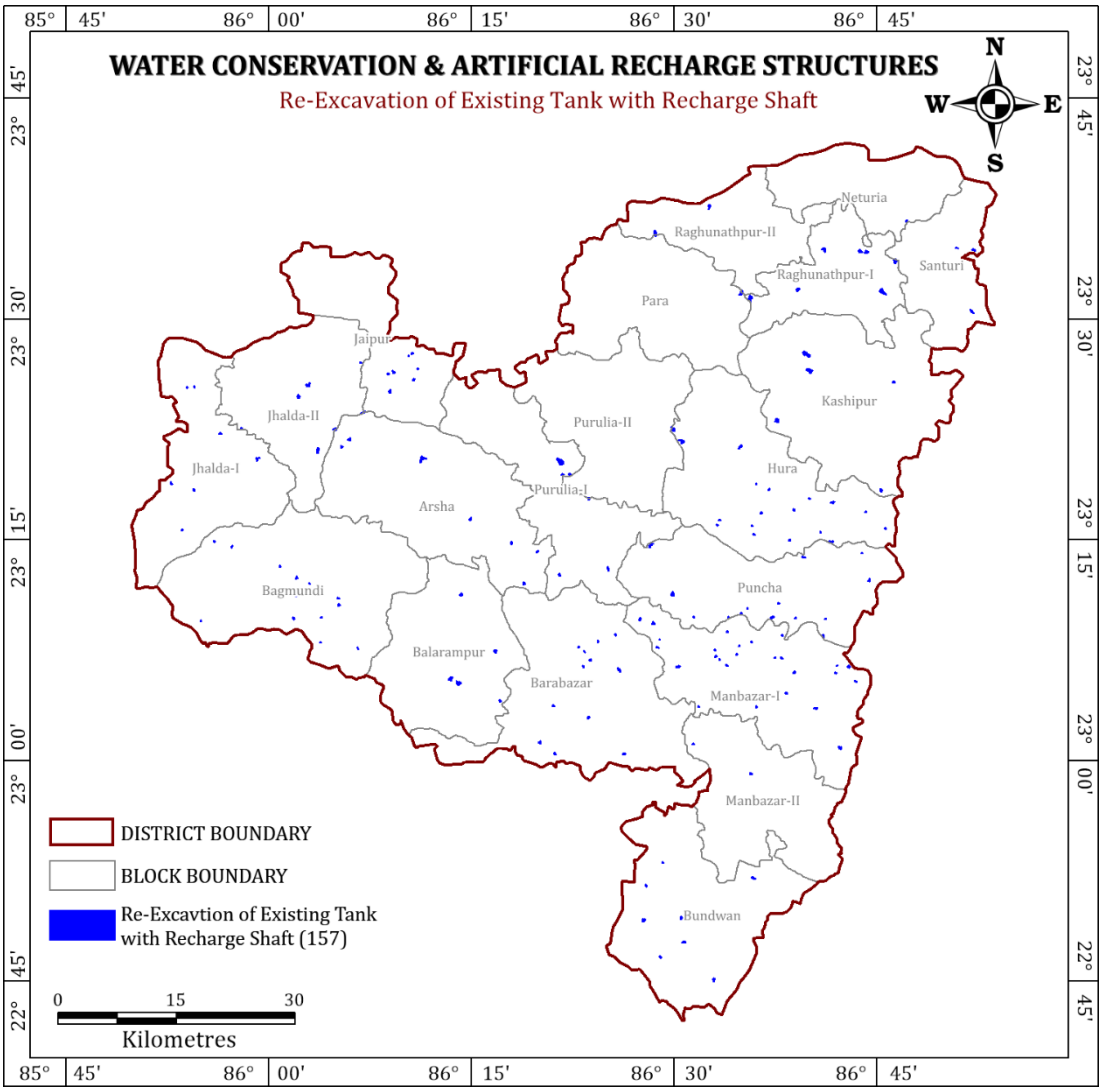


Figure : 10.9 : Suggested Locations REET in Purulia District, West Bengal

Urban Roof Top Rain Water Harvesting :

- A total of 9 urban classified areas exists in the District.
- 2 are Municipalities and remaining 7 are Census Towns
- As a pilot measure, only municipal areas have been proposed to be experimented with urban Roof Top rain Water harvesting Measures
- Based on component wise distribution of non-committed surface runoff about 20 such RTRWH is proposed -equally distributed in the Municipalites of Purulia & Raghunathpur

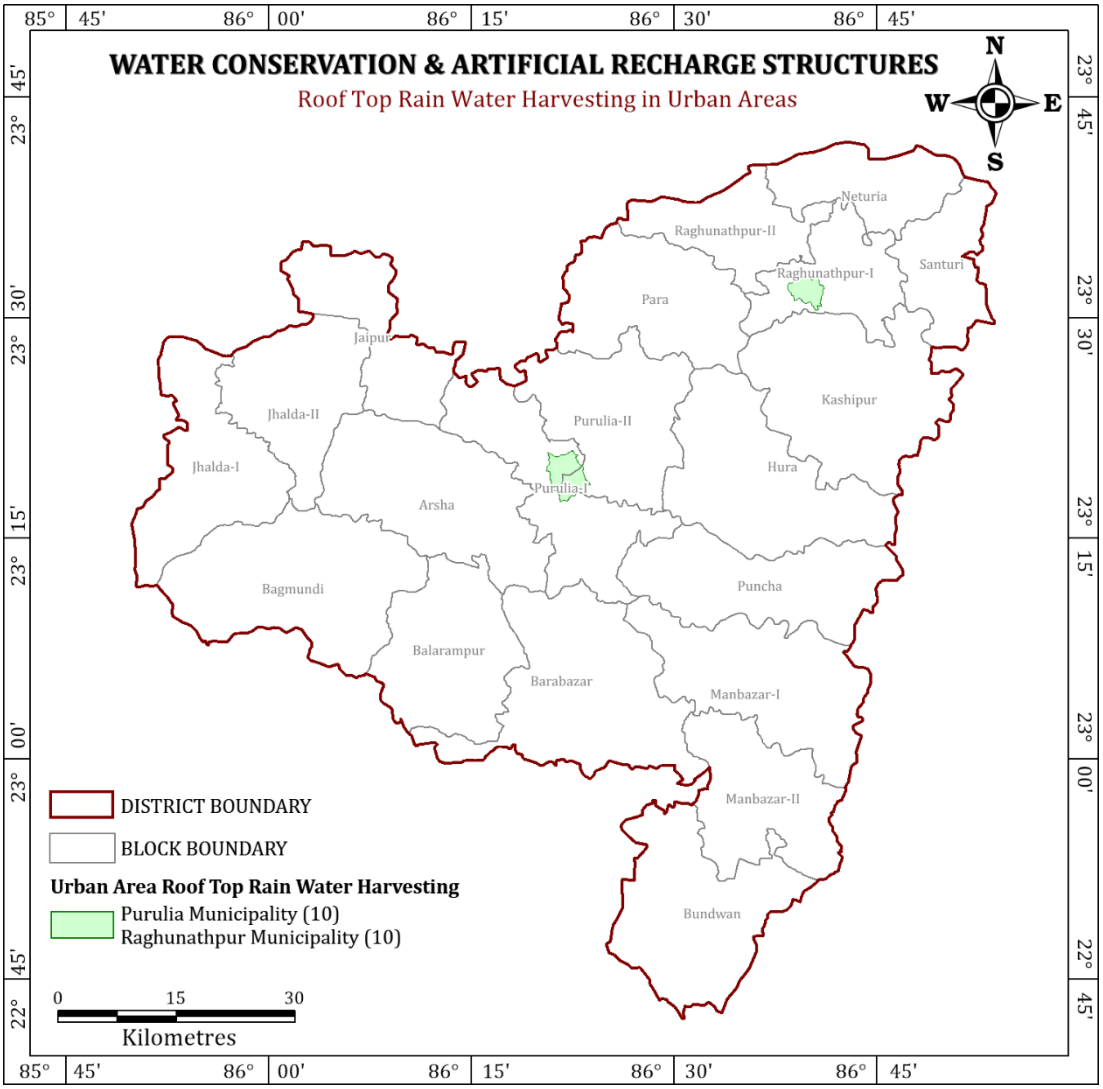


Figure : 10.10 : Suggested Locations urban RTRWH in Purulia District, West Bengal

In addition to the above, around 251 Surface Flow Minior Irrigation Structures(Equivalent Ponds) havbe been already constructed in the District, which is already augmenting the recharge phenomenon.

Table – 10.4 : District wise summary of water conservation structures and their cost implications

Sl	Structures	Recommended (Nos)	Implemented (Nos)	Balance (Nos)	Unit Cost (Rs.)	Total (Rs.)
1	Percolation Tank	433	369	64	800,000	51,200,000
2	Check Dam	214	140	74	200,000	14,800,000
3	Gabion Structures	626	0	626	25,000	15,650,000
4	Sub-Surface Dykes	111	0	111	150,000	16,650,000
5	REET with RS	157	0	157	150,000	23,550,000
6	Urban RTRWH	20	0	20	110,000	2,200,000
	District Total	**1561**	**509**	**1052**		**12,40,50,000**

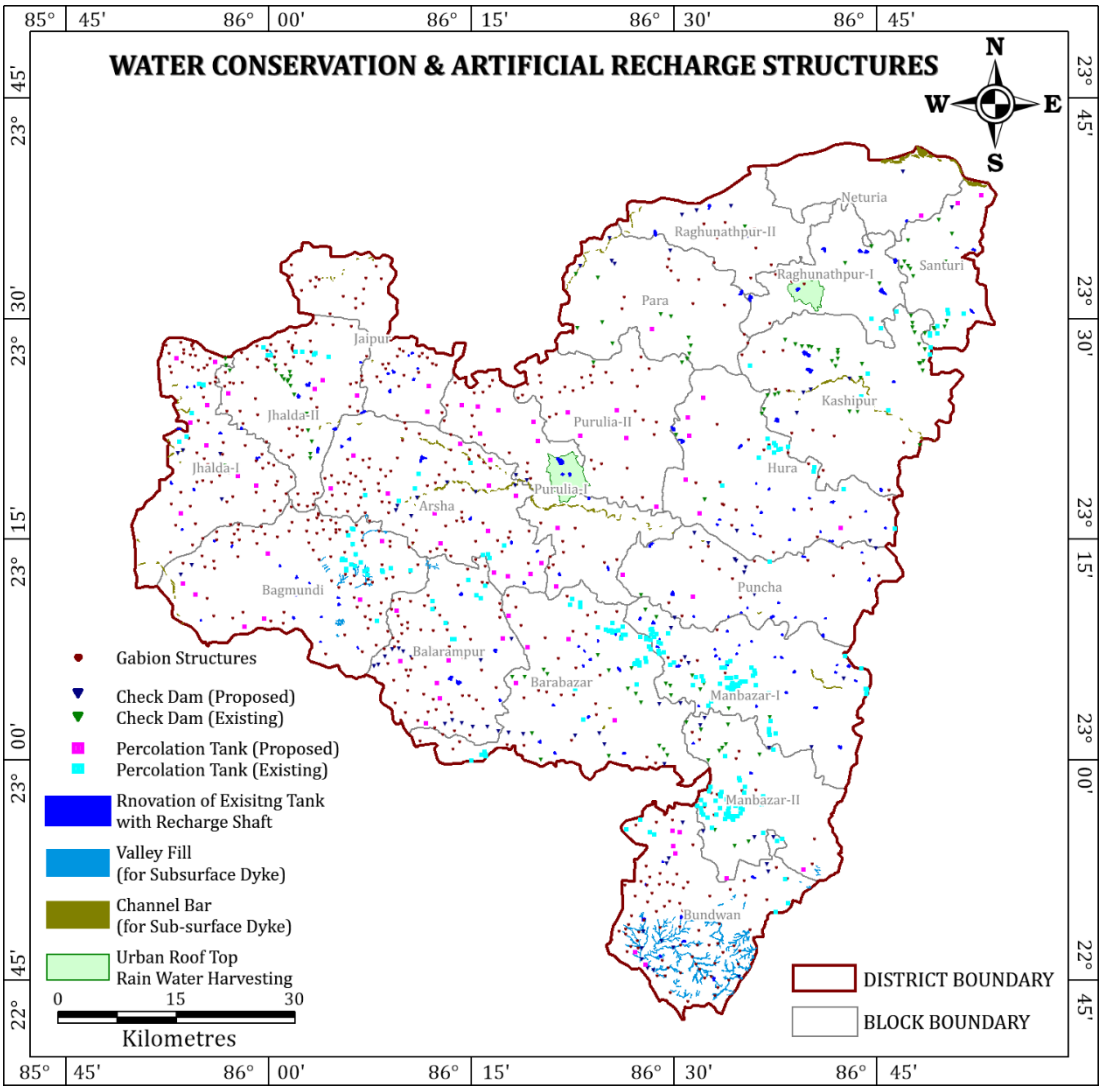


Figure 10.11 : Composite layout of recommended water conservation structures

PART – II

(**Blockwise Aquifer Management Plans**)

[National Aquifer Mapping & Management Plan of Purulia District, West Bengal]

SALIENT INFORMATION

Block Name: **Arsha**

Geographical area (sq. km): **393**

Mappable area (sq. km): **215**

District: **Purulia**

State: **West Bengal**

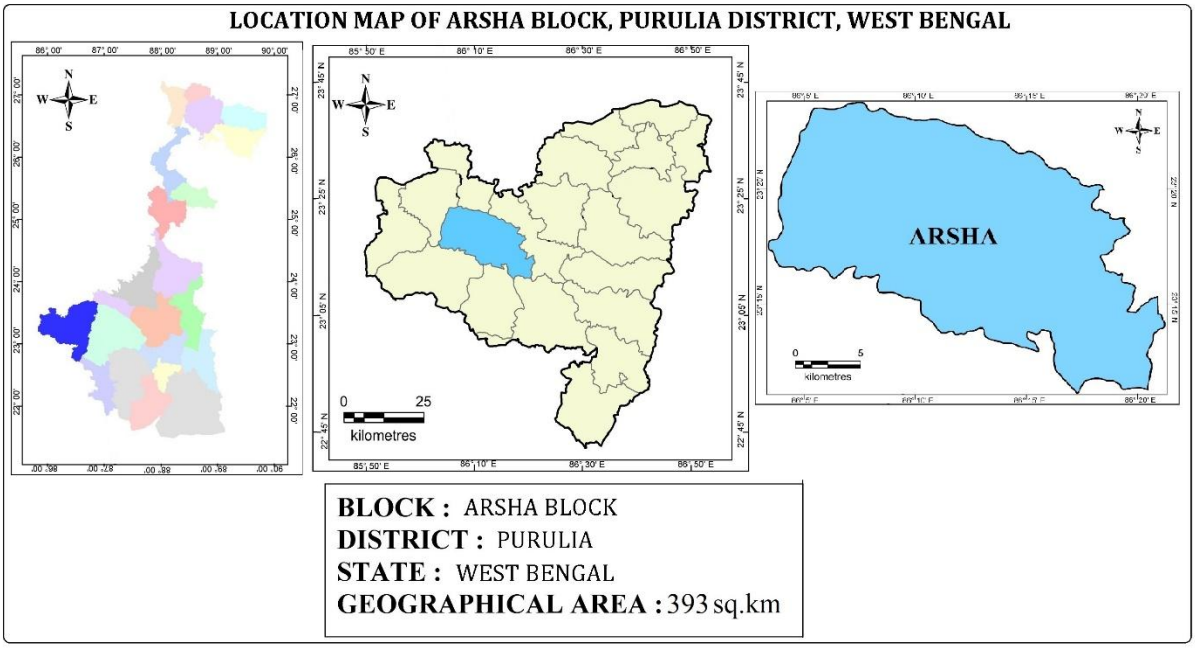


Figure 11.1.1: Location Map of Arsha Block

Population (as on 2011):

Table 11.1.1: Details of population in Arsha block.

Rural	Urban	Total
154736	**--**	154736

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.1.2: Details of Annual Rainfall for the last five years in Arsha block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Arsha	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.1.3: Salient Land use features of Arsha block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Arsha	39300	25664	7620.31	18043.69	3999

Ground Water Resource:

Table 11.1.4: Details of Ground WaterResource Availability and Utilization in Arsha Block.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**5668.87**
Annual Extractable Ground Water Resource (HaM)	**5385.43**
Gross Ground Water Abstraction for all uses (HaM)	**281.19**
Net Ground Water Availability for future use (HaM)	**5013.36**
Stage of Ground Water Development (%)	**5.22**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**326.47**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**20852.22**

Disposition of Aquifers:

Theprincipal aquifer systems encountered in this Block are**Banded Gniessic complex(BG01)** and **Gneiss(GN02).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl.

Aquifer-II(Deeper aquifer) ranges between 50-250 mbgl. Both aquifers are fresh in nature.

Table 11.1.5: Details of aquifer disposition (fractured Aquifer) in ArshaBlock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Arsha	Banded Gneiss, Granite & Granite Gneiss	15-50	50-200	19.60-22.70 16.60-25.70	53.20 - 56.20, 83.70 -86.70, 156.4 - 159.4, 163 - 166.00, 187.4-196.5,227.2 - 229.8

Table 11.1.6: Aquifer-wise depth range and parameters (fractured Aquifer)in ArshaBlock

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Arsha	Aquifer I	15-50	0.36	6.4- 8.12	--	--
	Aquifer II	50-200	4.36-17.17	9.5- 19.4	--	--

Table 11.1.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Arsha	Phreatic	7.82– 9.59	0.193	--	3.43– 6.29	--	0.103

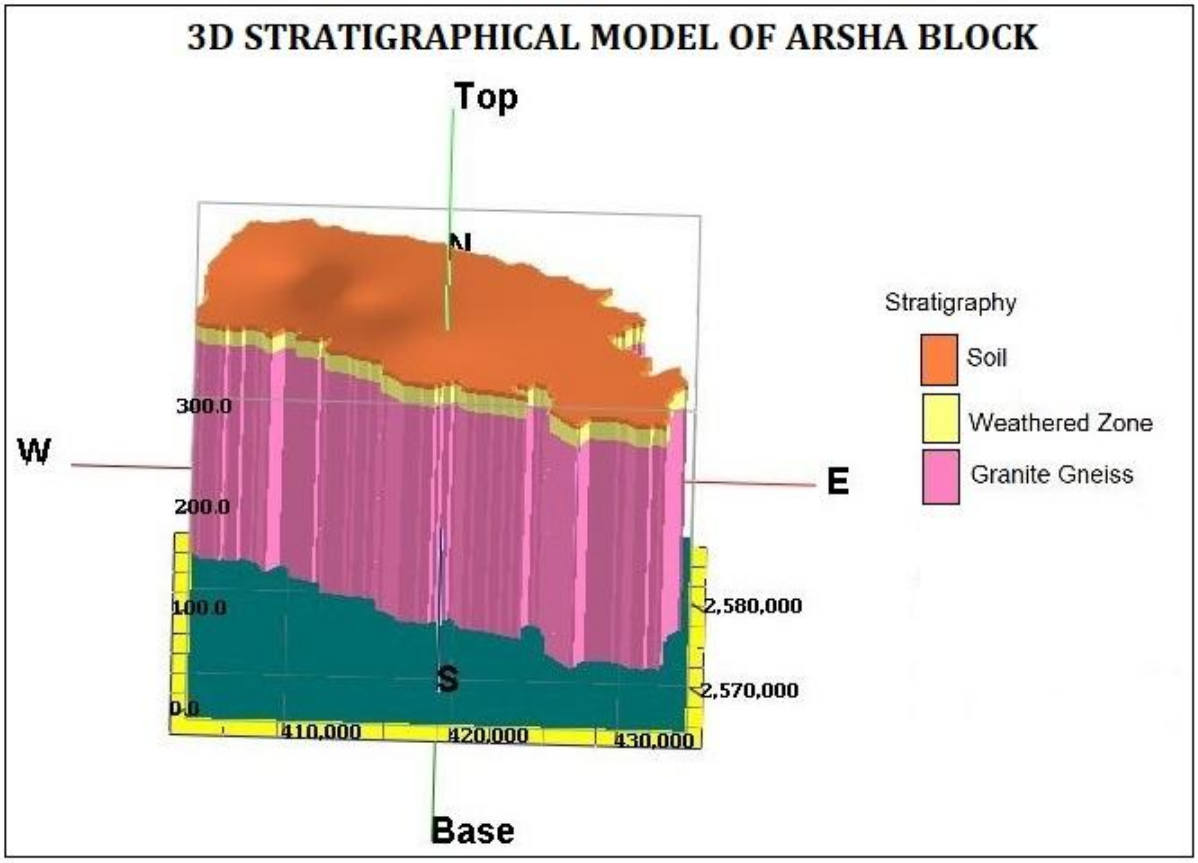


Figure11.1.2: 3-DimensionalAquifer disposition model in ArshaBlock

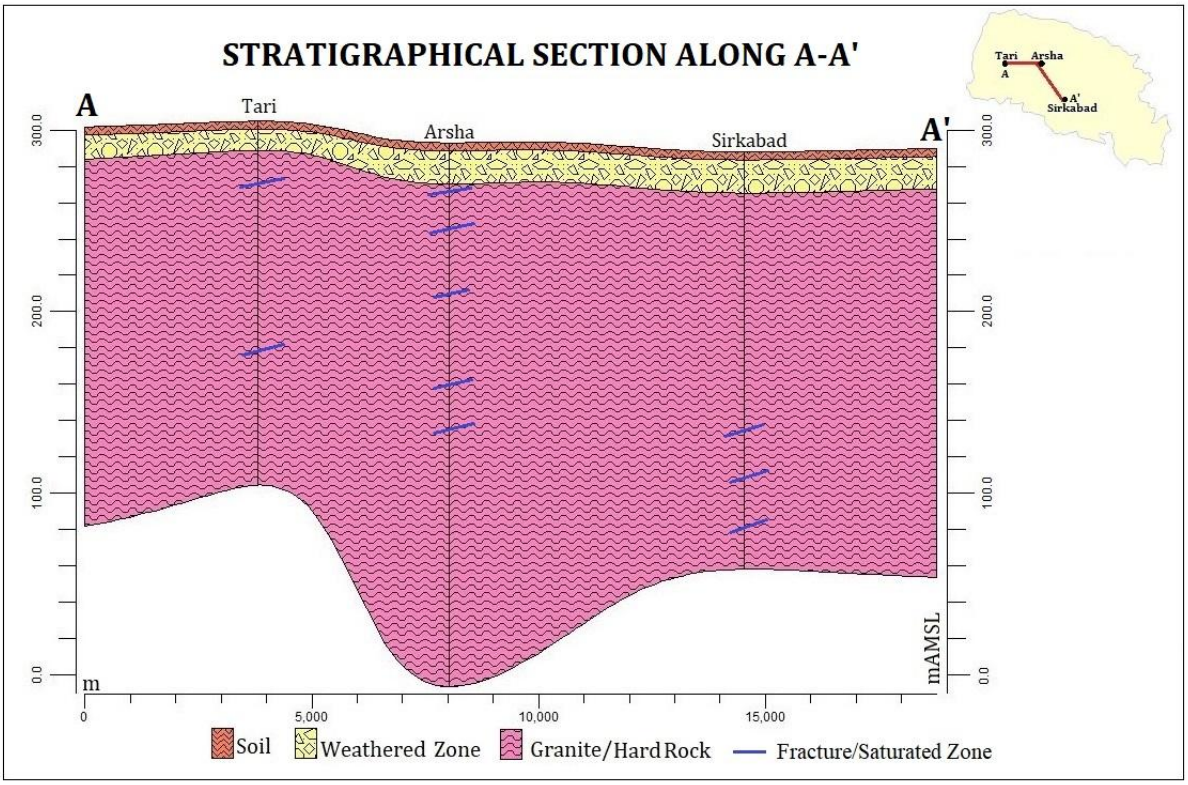


Figure11.1.3: 2-Dimensional Section in Arsha Block

Ground water quality and issues:

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

Table 11.1.8 Range of chemical parameters in Arsha 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)
Arsha	Phreatic	7.89-8.07	260-1984	12-94	10-60	0.10-0.94	2-9	0.03-0.07	105-865
	Fractured	7.81-8.29	416-884	19-76	22-196	0.43-1.62	1-12	Traces	155-335

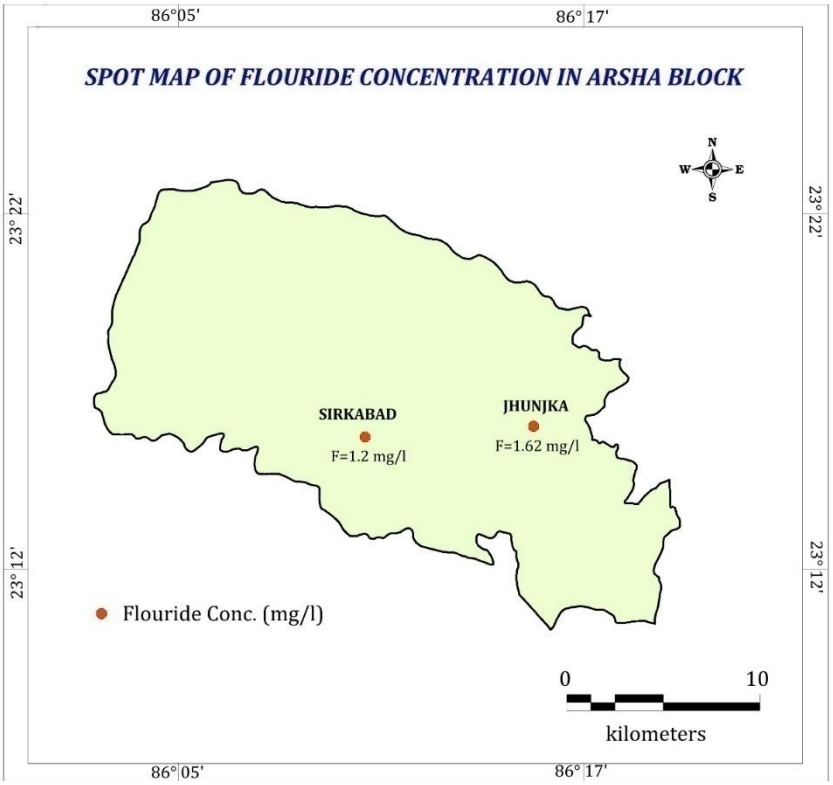


Figure11.1.4: Spot map of fluoride concentration in groundwater for Arsha Block

Fluoride concentration of 1.62 mg/l which is above the permissible limit is reported in two samples collected from exploratory drilling in this block. More intensive sampling from this block is recommended.

Aquifer Management Plan:

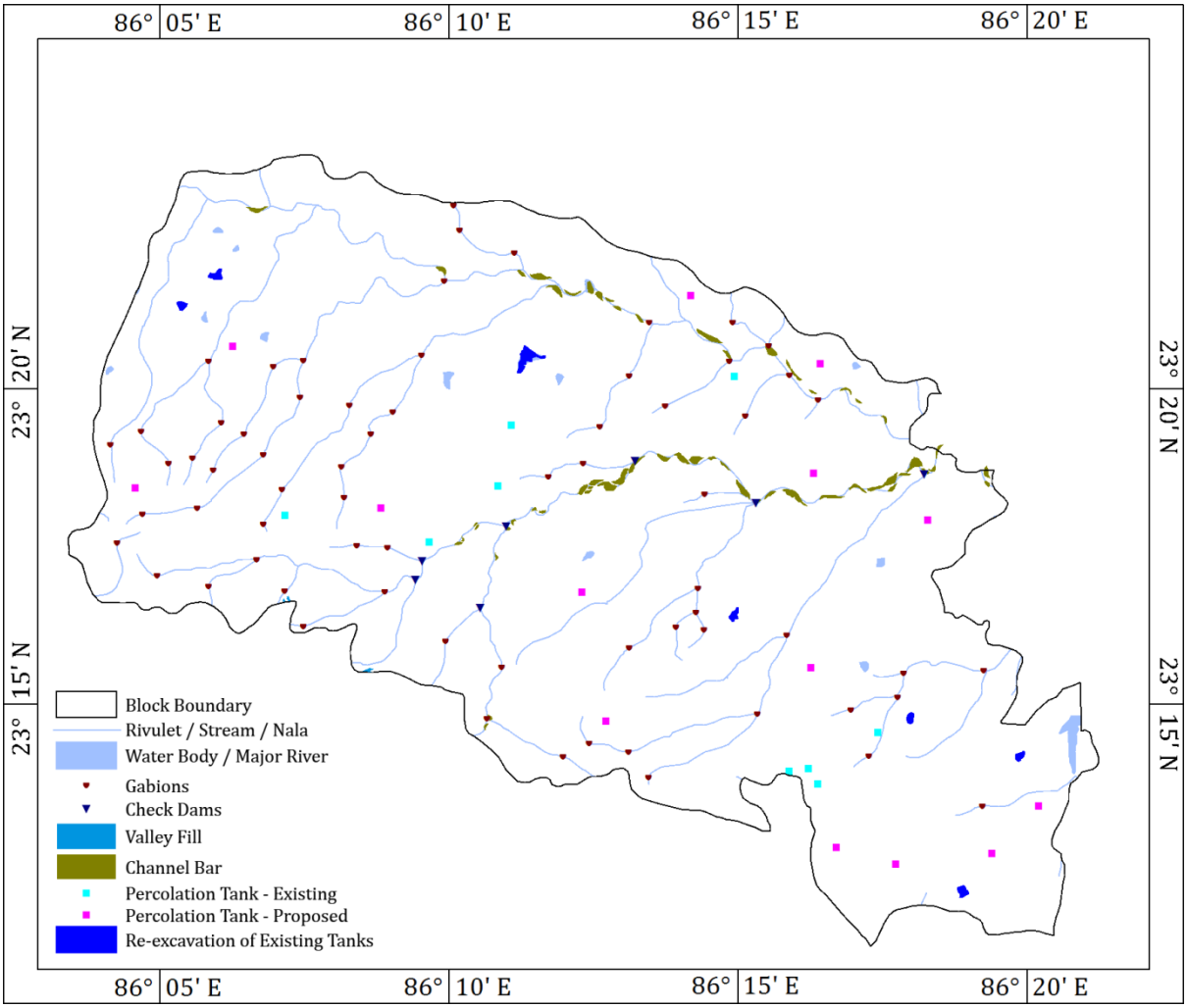


Figure11.1.5: AQM-Recommended Water Conservation Structures in Arsha Block

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SALIENT INFORMATION

Block Name: **Bagmundi**

Geographical area (sq. km): **450**

Mappable area (sq. km): **384**

District: **Purulia**

State: **West Bengal**

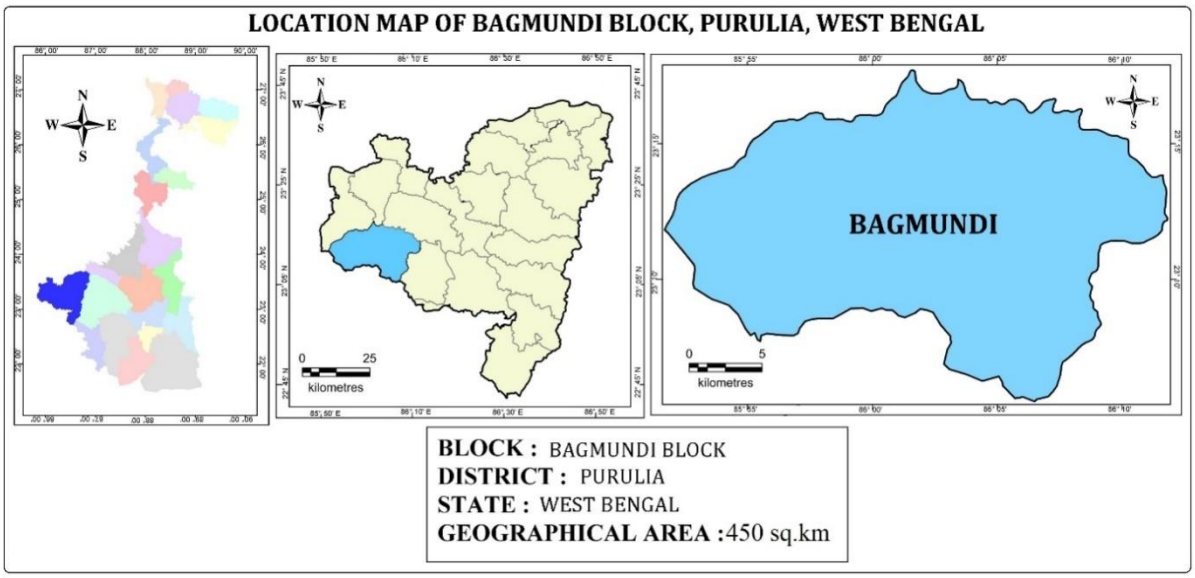

Figure 11.2.1: Location Map of Bagmundi Block

Population (as on 2011):

Table 11.2.1: Details of population in Bagmundi block.

Rural	Urban	Total
135579	**--**	135579

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.2.2: Details of Annual Rainfall for the last five years in Bagmundi block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Bagmundi	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.2.3: Salient Land use features ofBagmundi block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Bagmundi	45000	21501	5248.31	16252.69	15900

Ground Water Resource:

Table 11.2.4: Details of Ground Water Resource Availability and Utilization in Bagmundi Block.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3099.23**
Annual Extractable Ground Water Resource (HaM)	**2781.31**
Gross Ground Water Abstraction for all uses (HaM)	**451.53**
Net Ground Water Availability for future use (HaM)	**2258.66**
Stage of Ground Water Development (%)	**16.19**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**284.25**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**8755.86**

Disposition of Aquifers:

Theprincipal aquifer systems encountered in this block are **Granite (GR01)** and **Gneiss (GN02).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.2.5: Details of aquifer disposition in Bagmundi (fractured aquifer) Block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Bagmundi	Granite Gneiss, Metabasic rocks	15-50	50-200	22.30-25.70 30.10-32.30 30.10-32.30	80.10 - 82.60 119 - 121.30 152 - 155.60

Table 11.2.6: Aquifer-wise depth range and parameters in Bagmundi(fractured aquifer) Block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Bagmundi	Aquifer I	15-50	5-12.6	5.5-9	--	--
	Aquifer II	50-200	4.2-25.9	8.2-13	--	--

Table 11.2.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Bagmundi	Phreatic	5.1– 11.77	0.136	--	2.96– 6.43	--	0.142

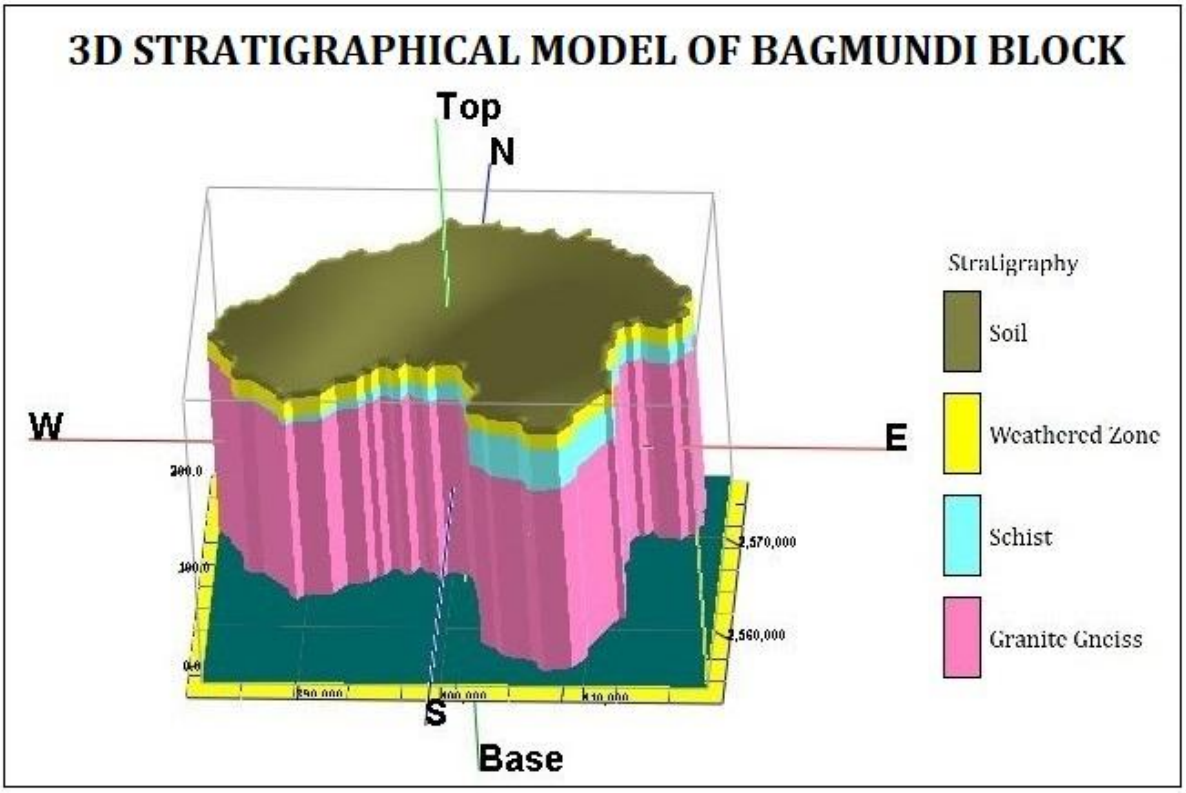

Figure11.2.2: 3-DimensionalAquifer disposition model in Bagmundi Block

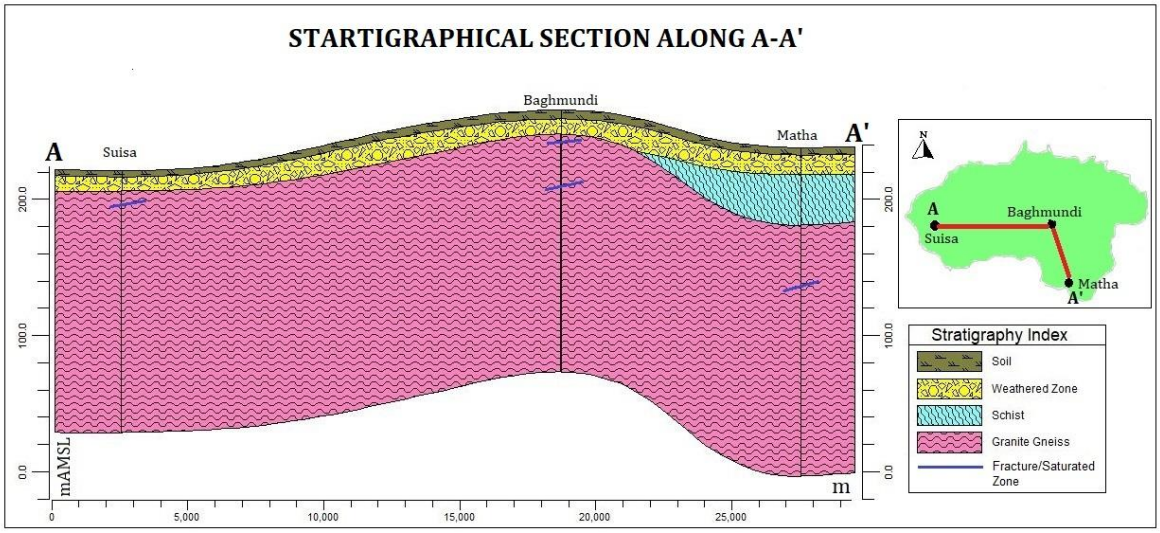

Figure11.2.3: 2-Dimensional Section in Bagmundi Block

Ground water quality and issues:

Based on two NHS, the range of chemical parameter for the block is given below.

Table 11.2.8 Range of chemical parameters in Bagmundi 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)
Bagmundi	Phreatic	7.81-7.85	250-1386	11-89	18-266	1.17-0.28	5-43	BDL	105-465

Aquifer Management Plan:

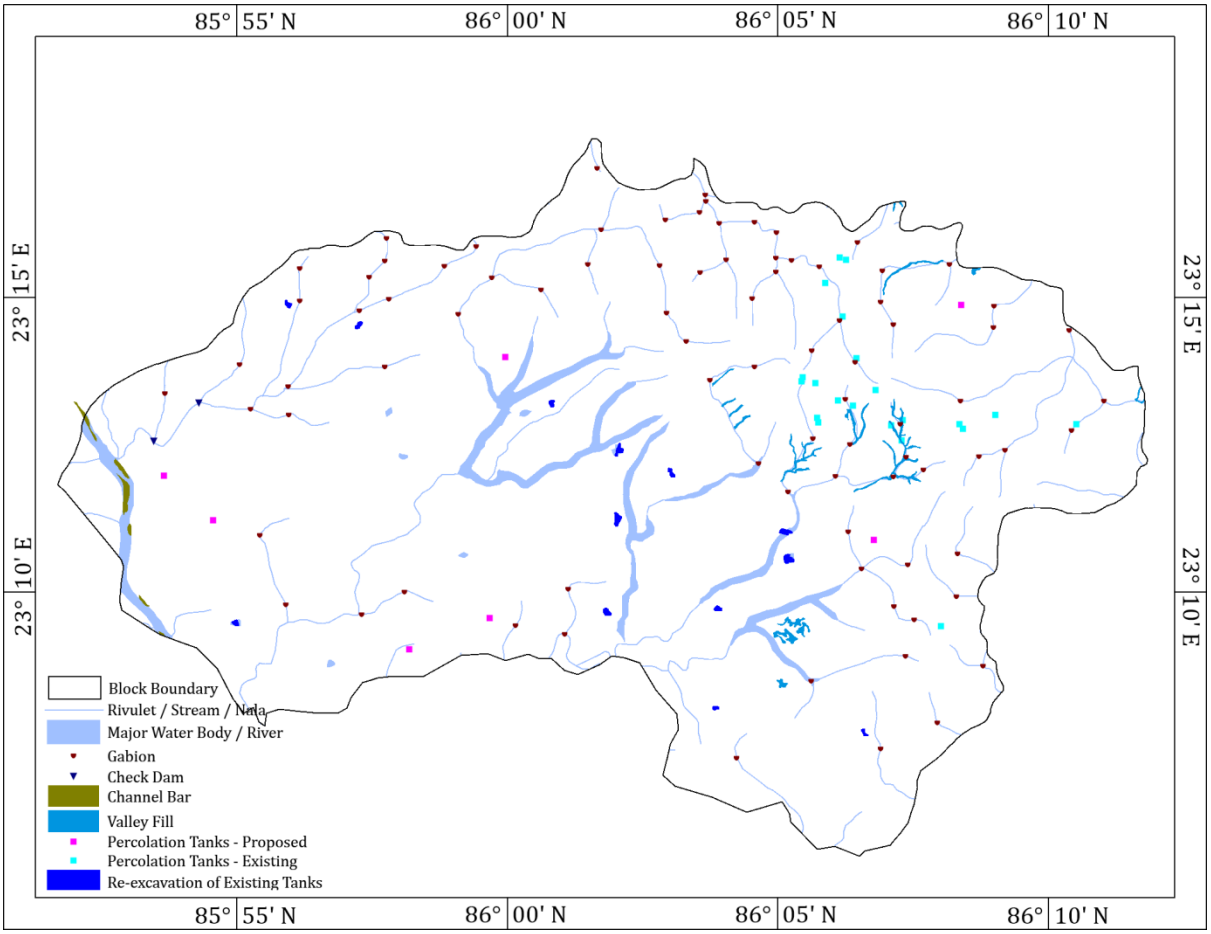

Figure 11.2.4: AQM-Recommended Water Conservation Structures in Bagmundi Block

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SALIENT INFORMATION

Block Name: **Balarampur**

Geographical area (sq. km): **316**

Mappable area (sq. km): **303**

District: **Purulia**

State: **West Bengal**

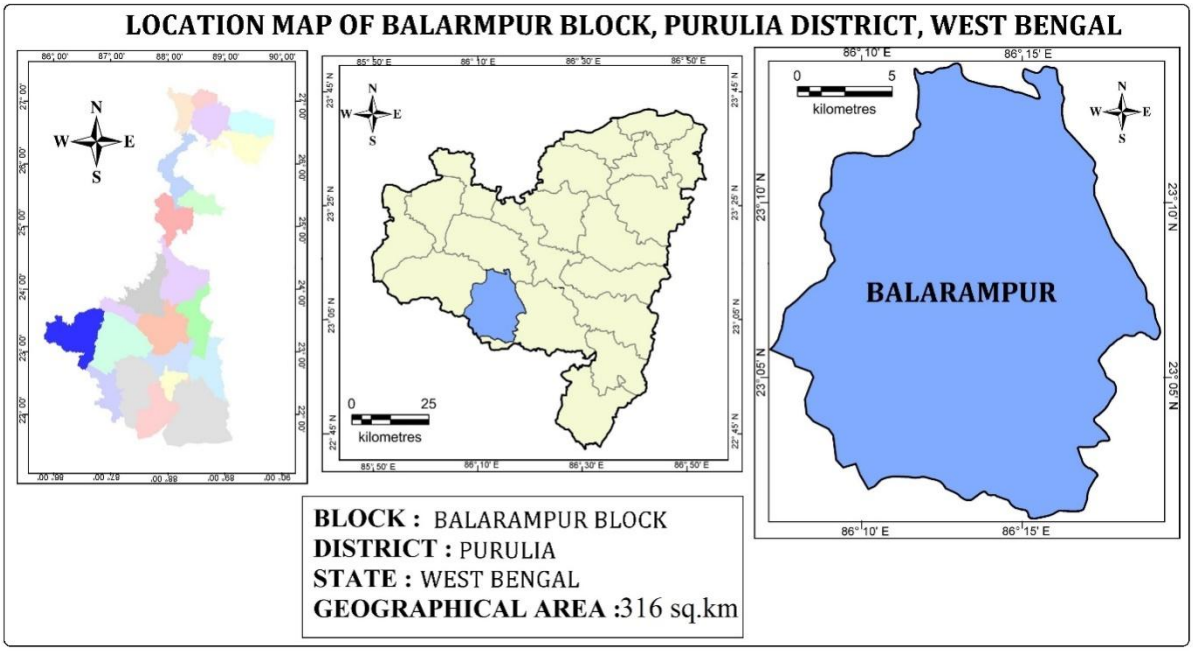

Figure 11.3.1: Location Map of Balarampur Block

Population (as on 2011):

Table 11.3.1: Details of population in Balarampur block.

Rural	Urban	Total
113519	24431	137950

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.3.2: Details of Annual Rainfall for the last five years in Balarampur block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Balarampur	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.3.3: Salient Land use features of Balarampur block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Balarampur	31600	23827	2960.45	20866.55	3053

Ground Water Resource:

Table 11.3.4: Details of Ground Water Resource Availability and Utilization in Balarampur Block.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3612.65**
Annual Extractable Ground Water Resource (HaM)	**3251.38**
Gross Ground Water Abstraction for all uses (HaM)	**259.84**
Net Ground Water Availability for future use (HaM)	**2908.43**
Stage of Ground Water Development (%)	**7.99**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**298.55**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**9194.89**

Disposition of Aquifers:

Theprincipal aquifer systems encountered in this Block are **Banded Gniessic complex (BG01)** and **Schist (SC01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.3.5: Details of aquifer disposition (fractured aquifer) in BalarampurBlock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Balarampur	Banded Gneiss&Schist	15-50	50-200	18-23	110-113, 111-112, 147-149, 80.11-82.31

Table 11.3.6: Aquifer-wise depth range and parameters (fractured aquifer) in BalarampurBlock

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Balarampur	Aquifer I	15-50	11.56	19.1	--	--
	Aquifer II	50-200	--	--	--	--

Table 11.3.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Balarampur	Phreatic	3.16-7.08	0.487	--	2.85– 2.92	--	0.137

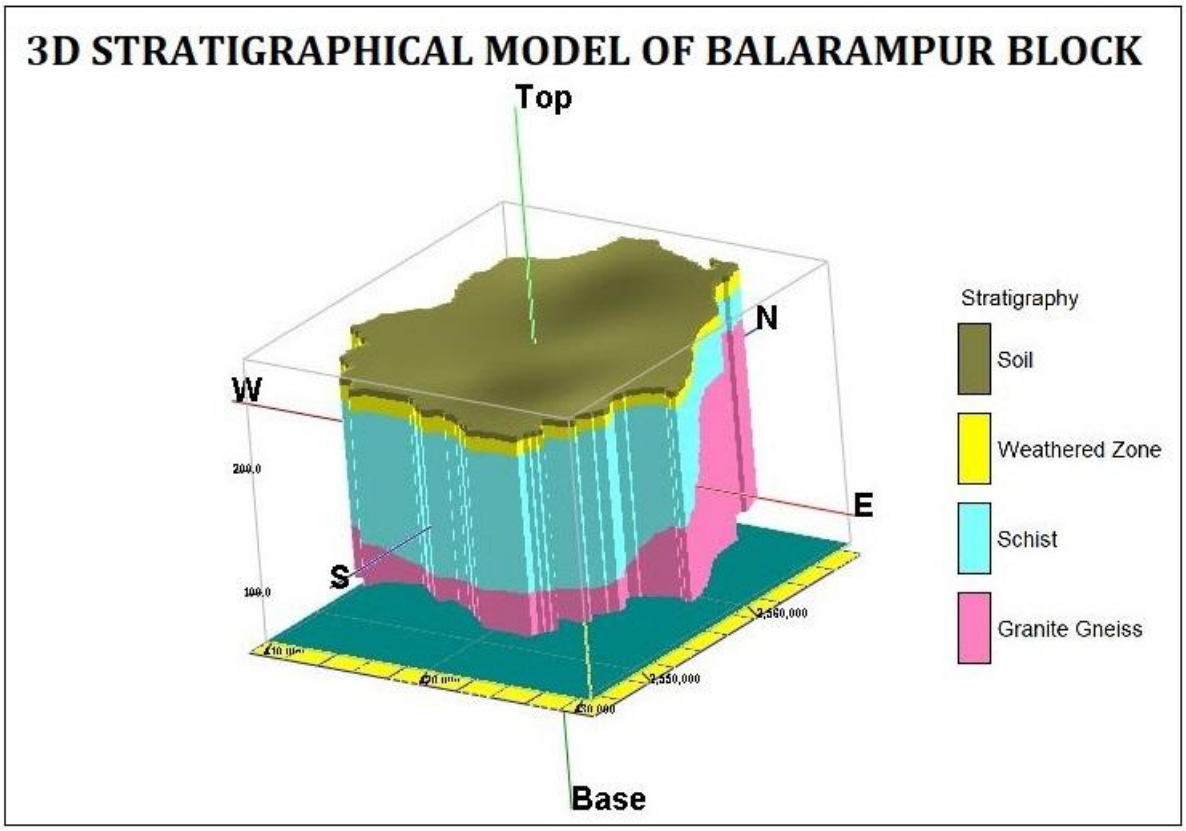

Figure 11.3.2: 3-Dimensional Aquifer disposition in Balarampur Block

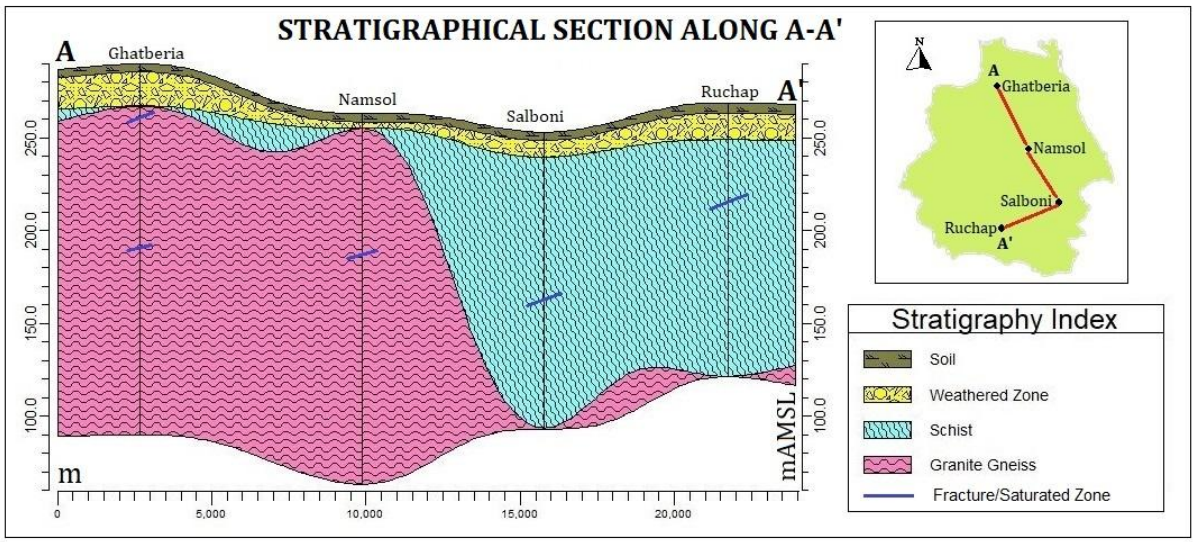

Figure 11.3.3: 2-Dimensional Section in Balarampur Block

Ground water quality and issues:

Based on two NHS (dugwells), the range of chemical parameter for the block is given below

Table 11.3.8 Range of chemical parameters in Balarampur 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)
Balarampur	Phreatic	7.64-7.94	286-535	15-54	28-96	0.37-0.66	BDL-41	BDL	115-150

Aquifer Management Plan:

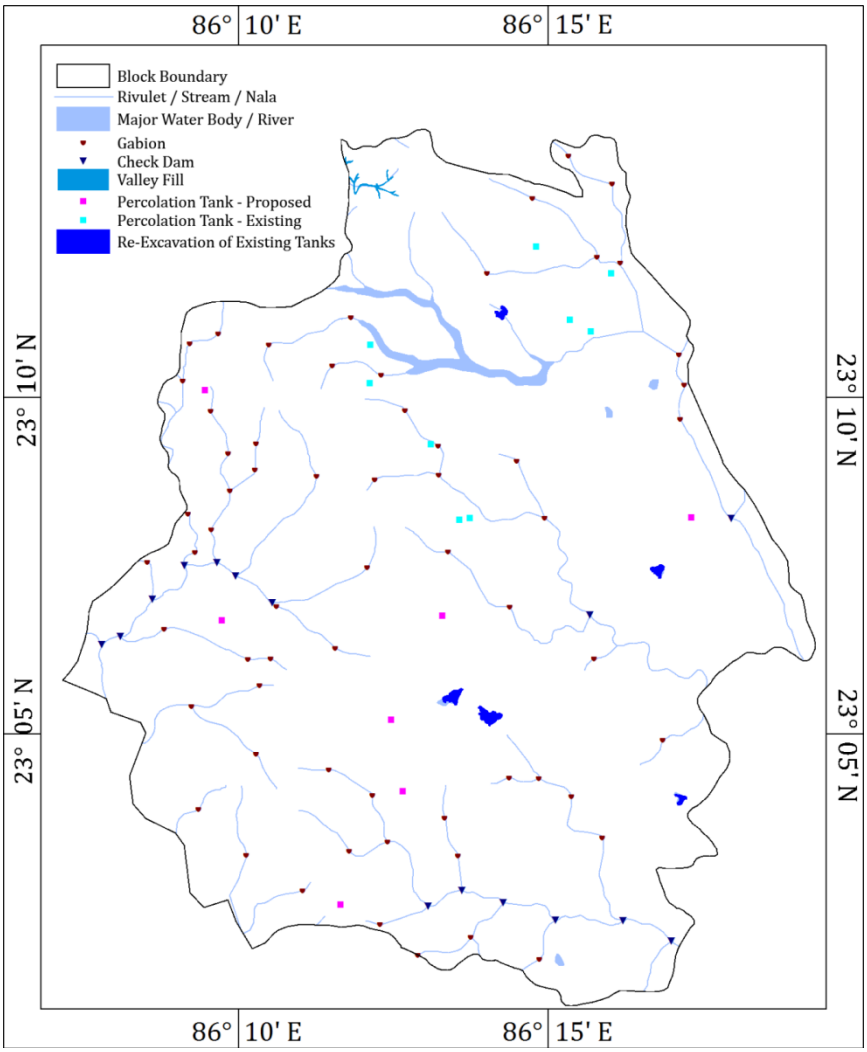

Figure 11.3.4 : AQM-Recommended Water Conservation Structures in Balarampur Block

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SALIENT INFORMATION

Block Name: **Barabazar**

Geographical area (sq. km): **456**

Mappable area (sq. km): **435**

District: **Purulia**

State: **West Bengal**

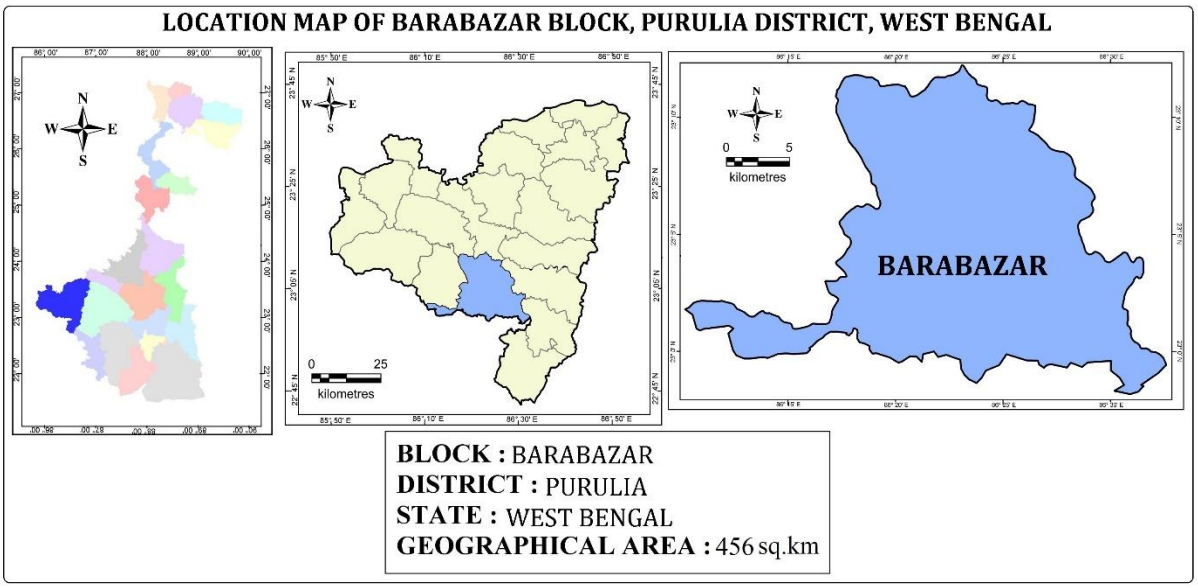

Figure 11.4.1: Location Map of Barabazar Block

Population (as on 2011):

Table 11.4.1: Details of population in Barabazar block.

Rural	Urban	Total
162508	8056	170564

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.4.2: Details of Annual Rainfall for the last five years in Barabazar block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Barabazar	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.4.3: Salient Land use features of Barabazar block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Barabazar	45600	30435	11277.91	19157.09	1902

Ground Water Resource:

Table 11.4.4: Details of Ground Water Resource Availability and Utilization in BarabazarBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**6015.56**
Annual Extractable Ground Water Resource (HaM)	**5414**
Gross Ground Water Abstraction for all uses (HaM)	**369.62**
Net Ground Water Availability for future use (HaM)	**4940.99**
Stage of Ground Water Development (%)	**6.83**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**371.41**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**11822.74**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is**Banded Gniessic complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-280 mbgl. Both aquifers are fresh in nature.

Table 11.4.5: Details of aquifer disposition (fractured aquifer) in BarabazarBlock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Barabazar	Banded Gneiss	15-50	50-255	16.6-19.6 28.7-31.8 34.9-37.9	16.60 - 19.60, 77.60 - 80.6, 114.2 - 117.2, 120.3- 123.3, 126.4- 129.4 ,242.3-246.3, 249.4- 252.4

Table 11.4.6: Aquifer-wise depth range and parameters (fractured aquifer) in BarabazarBlock

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Barabazar	Aquifer I	15-50	7.63-19.8	5.5-8.7	--	--
	Aquifer II	50-200	3.6-45	5.75-19.4	--	--

Table 11.4.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Barabazar	Phreatic	6.00– 9.11	0.211	--	2.27– 4.29	--	0.078

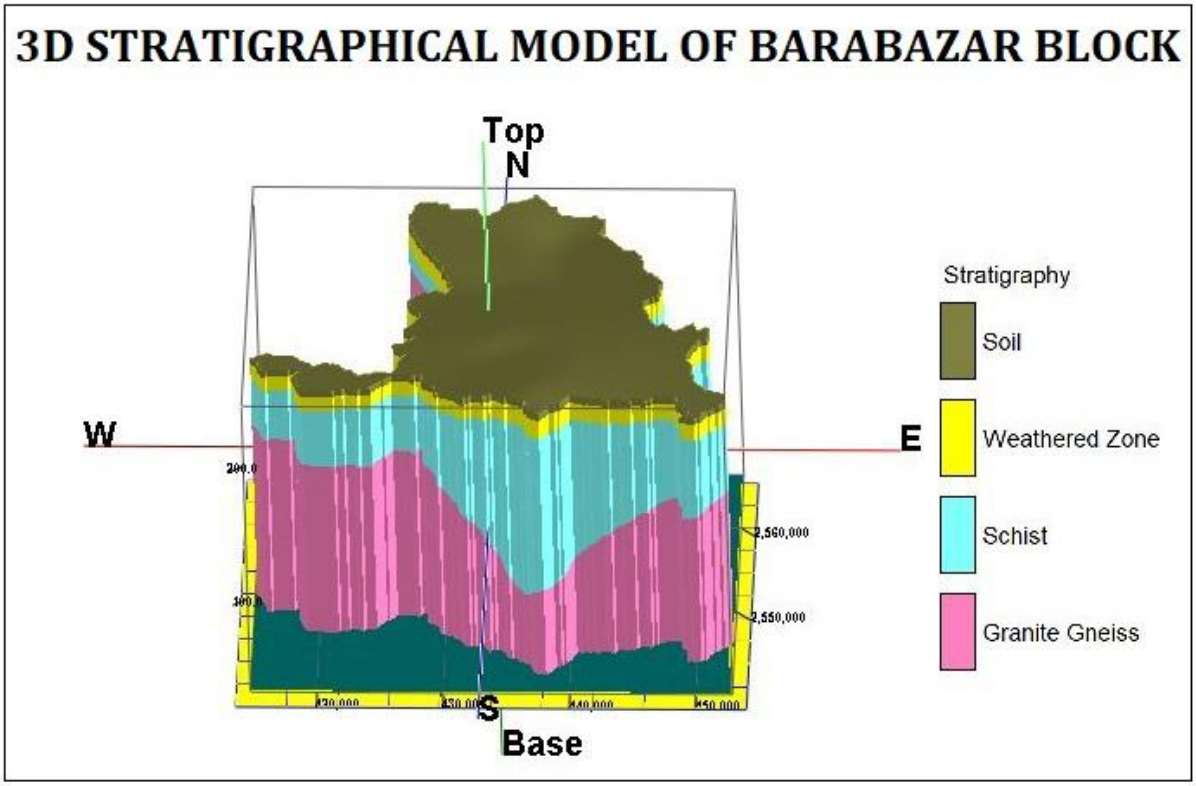

Figure 11.4.2: 3-Dimensional Aquifer disposition in Barabazar Block

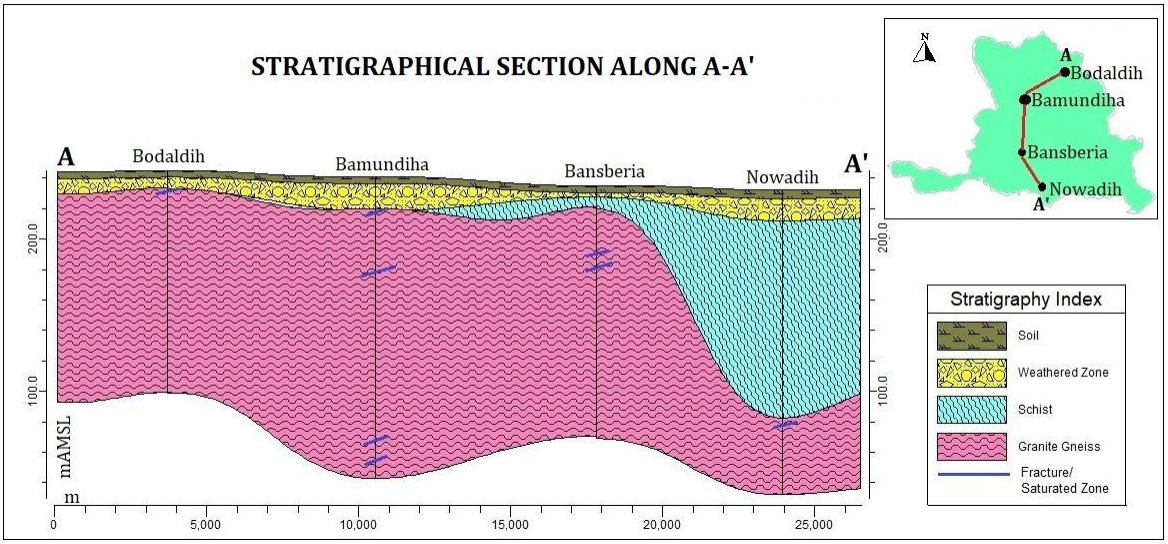

Figure 11.4.3: 2-Dimensional Section in Barabazar Block

Ground water quality and issues:

Based onfour NHS (Dug-wells), the range of chemical parameter for the block is given below.

Table 11.4.8 Range of chemical parameters in Barabazar 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)
Barabazar	Phreatic	7.74-8.08	311-1728	29-106	50-312	0.08-0.64	3-40	0.01-0.39	105-540

Aquifer Management Plan:

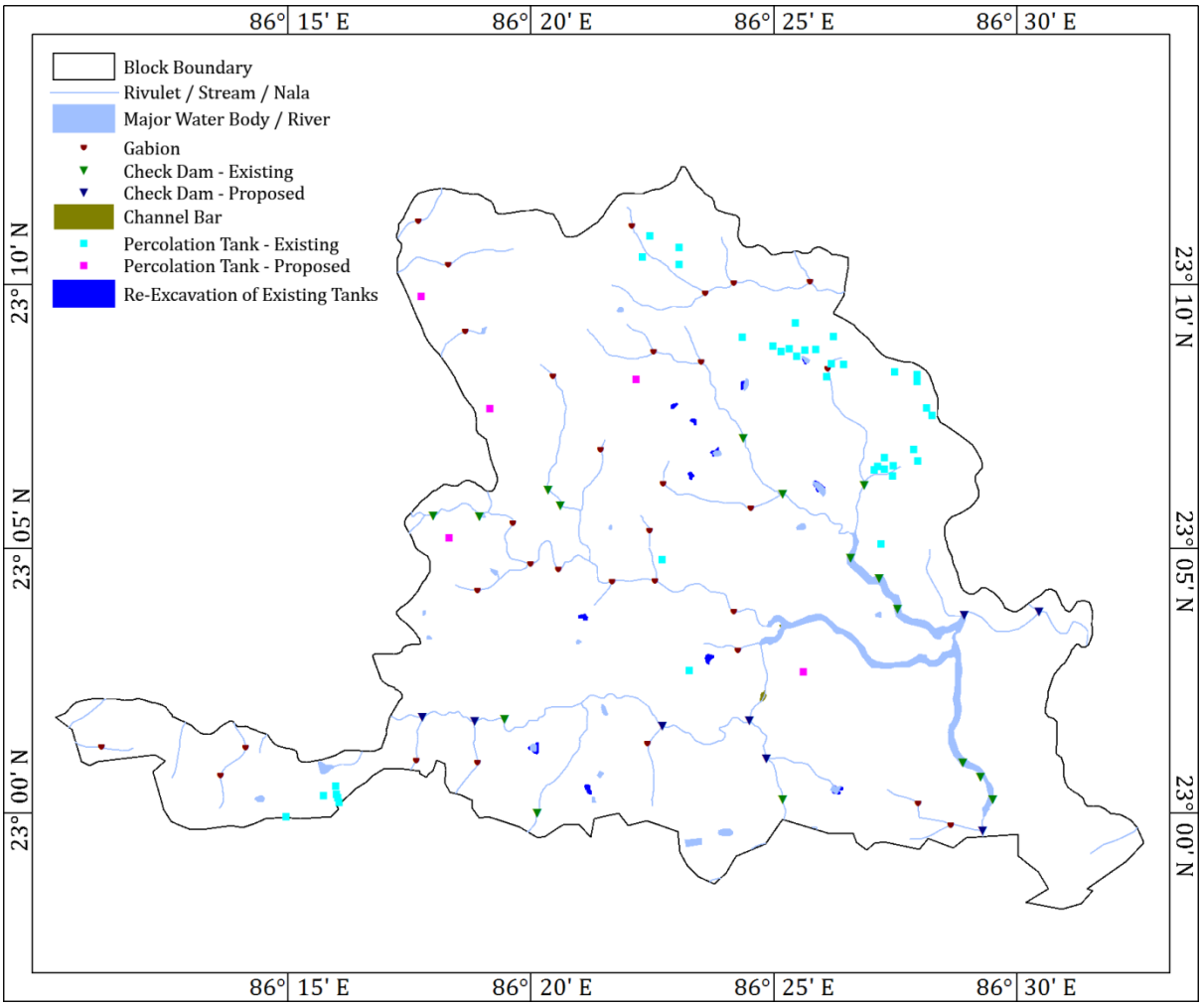

Figure 11.4.4 : AQM-Recommended Water Conservation Structures in Barabazar Block

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SALIENT INFORMATION

Block Name: **Bundwan**

Geographical area (sq. km): **379**

Mappable area (sq. km): **268**

District: **Purulia**

State: **West Bengal**

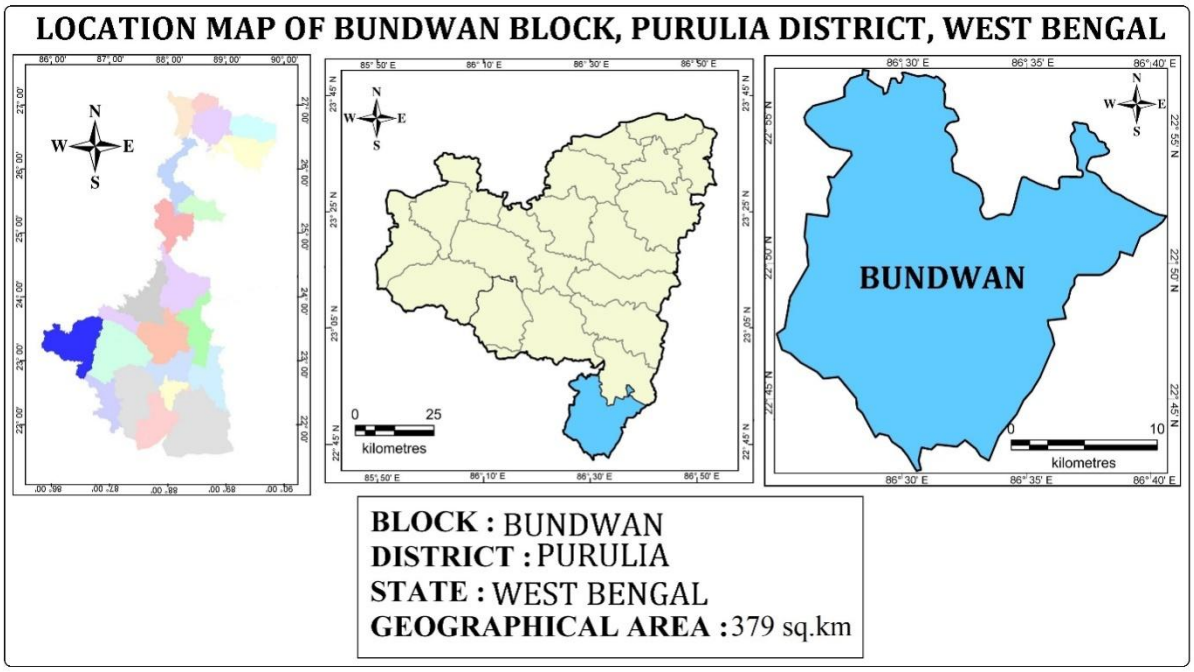

Figure 11.5.1: Location Map of Bundwan Block

Population (as on 2011):

Table 11.5.1: Details of population in Bundwan block.

Rural	Urban	Total
88936	5993	94929

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.5.2: Details of Annual Rainfall for the last five years in Bundwan block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Bundwan	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.5.3: Salient Land use features of Bundwan block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Bundwan	37900	15871	4294.88	11576.12	13619

Ground Water Resource:

Table 11.5.4: Details of Ground Water Resource Availability and Utilization in BundwanBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3279.97**
Annual Extractable Ground Water Resource (HaM)	**2951.97**
Gross Ground Water Abstraction for all uses (HaM)	**178.67**
Net Ground Water Availability for future use (HaM)	**2714.41**
Stage of Ground Water Development (%)	**6.05**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**211.56**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**13530.15**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Schist** and the major aquifer is Phyllite **(SC02).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.5.5: Details of aquifer disposition in Bundwan (fractured aquifer) Block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Bundwan	Phyllites	15-50	50-200	18.2-21.7 31.9-33.7	123.7-125.9, 179.2-182.1, 187.68-189

Table 11.5.6: Aquifer-wise depth range and parameters (fractured aquifer) in BundwanBlock

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Bundwan	Aquifer I	15-50	7.5-7.2	4.2-8.7	--	--
	Aquifer II	50-200	10.8-12	--	--	--

Table 11.5.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Bundwan	Phreatic	9.41– 11.68	0.511	--	2.68– 6.61	--	0.167

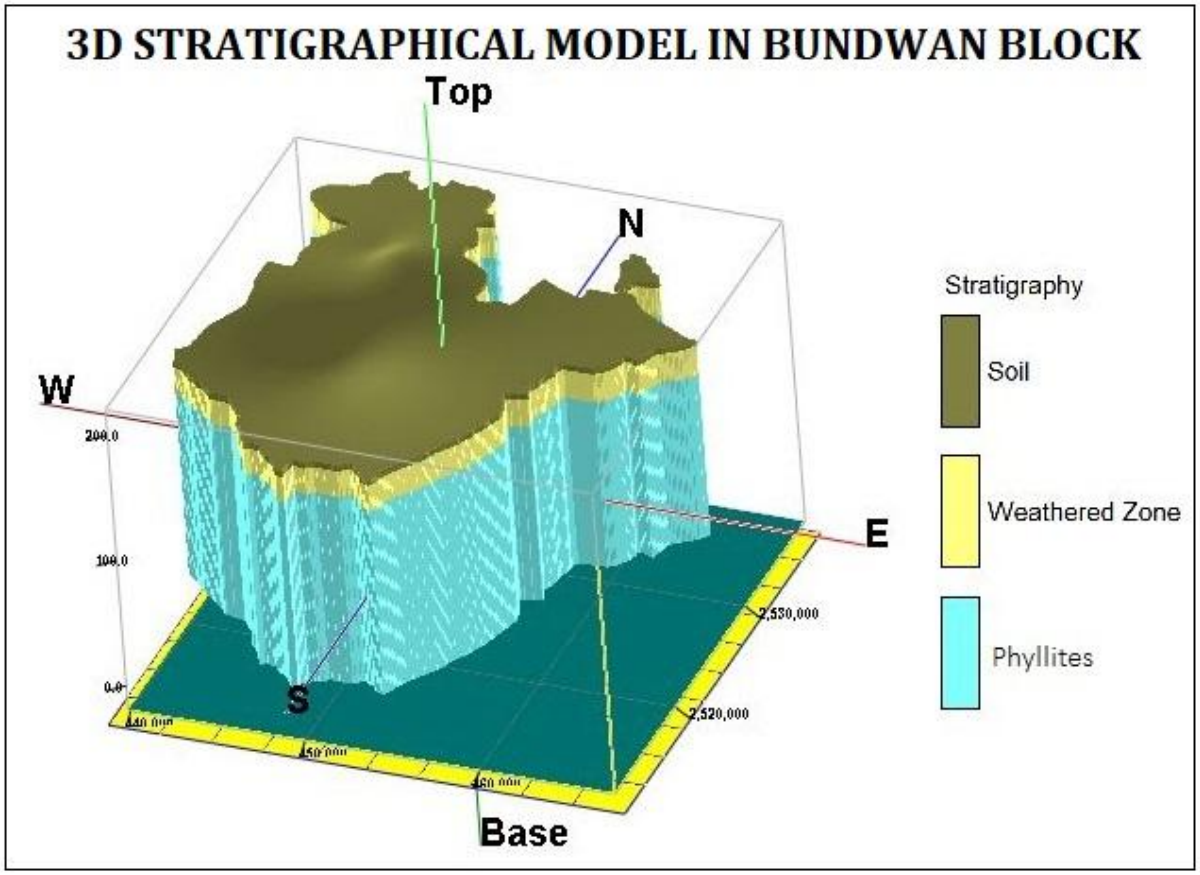

Figure 11.5.2: 3-Dimensional Aquifer disposition in Bundwan Block

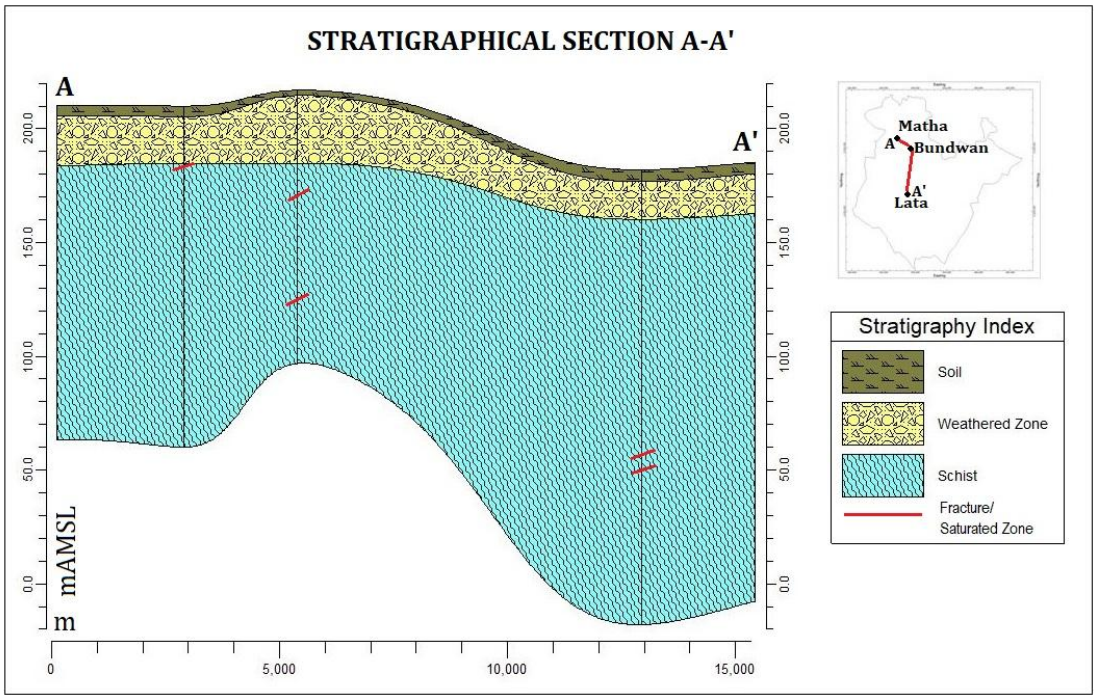

Figure 11.5.3: 2-Dimensional Section in Bundwan Block

Ground water quality and issues:

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

Table 11.5.8 Range of chemical parameters in Bundwan 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)
Bundwan	Phreatic	7.74-8.08	311-1728	29-106	50-312	0.08-0.64	3-40	0.01-0.39	105-540

Aquifer Management Plan:

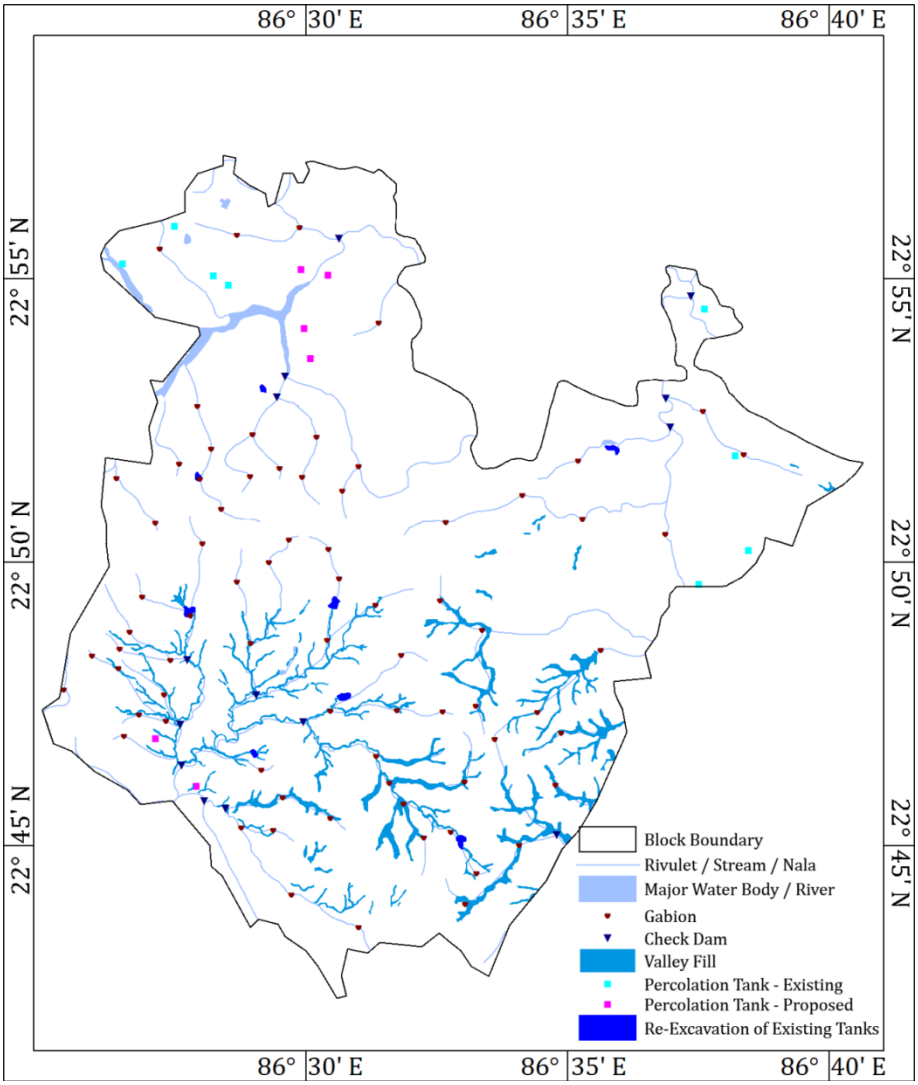

Figure 11.5.4 : AQM-Recommended Water Conservation Structures in Bundwan Block

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SALIENT INFORMATION

Block Name: **Hura**

Geographical area (sq. km): **394**

Mappable area (sq. km): **379**

District: **Purulia**

State: **West Bengal**

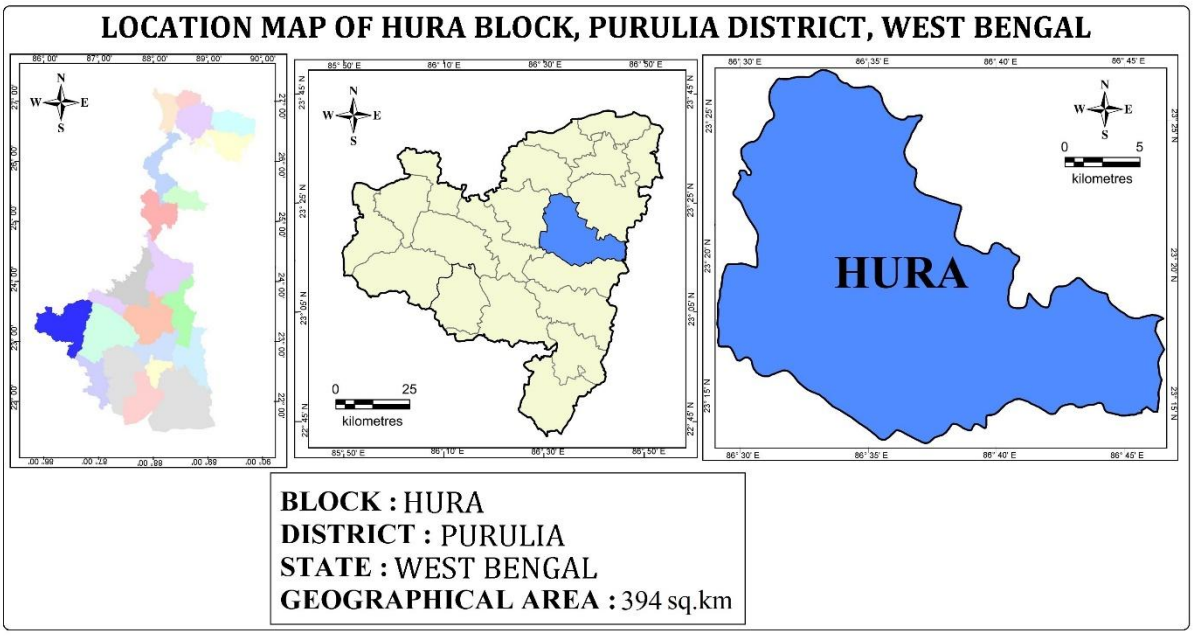

Figure 11.6.1: Location Map of Hura Block

Population (as on 2011):

Table 11.6.1: Details of population in Hura block.

Rural	Urban	Total
143575	**--**	143575

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.6.2: Details of Annual Rainfall for the last five years in Hura block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Hura	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.6.3: Salient Land use features of Hura block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Hura	39400	28659	6471.02	22187.98	4265

Ground Water Resource:

Table 11.6.4: Details of Ground Water Resource Availability and Utilization in HuraBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**4615.18**
Annual Extractable Ground Water Resource (HaM)	**3748.66**
Gross Ground Water Abstraction for all uses (HaM)	**453.28**
Net Ground Water Availability for future use (HaM)	**3205.70**
Stage of Ground Water Development (%)	**12.09**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**322.16**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**7785.62**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01)**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.6.5: Details of aquifer disposition (fractured aquifer) in HuraBlock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Hura	Banded Gneiss	15-50	50-200	36.4-39.1	132.6-135.1, 167.3-169.8, 154.2-159.1, 121.5-123.6

Table 11.6.6: Aquifer-wise depth range and parameters (fractured aquifer) in Hura Block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Hura	Aquifer I	15-50	3.96-5.4	3.5-4.4	--	--
	Aquifer II	50-200	2.88-5.76	6.1-7.7	--	--

Table 11.6.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Hura	Phreatic	2.3-11.60	--	0.217	1.50– 5.73	--	0.065

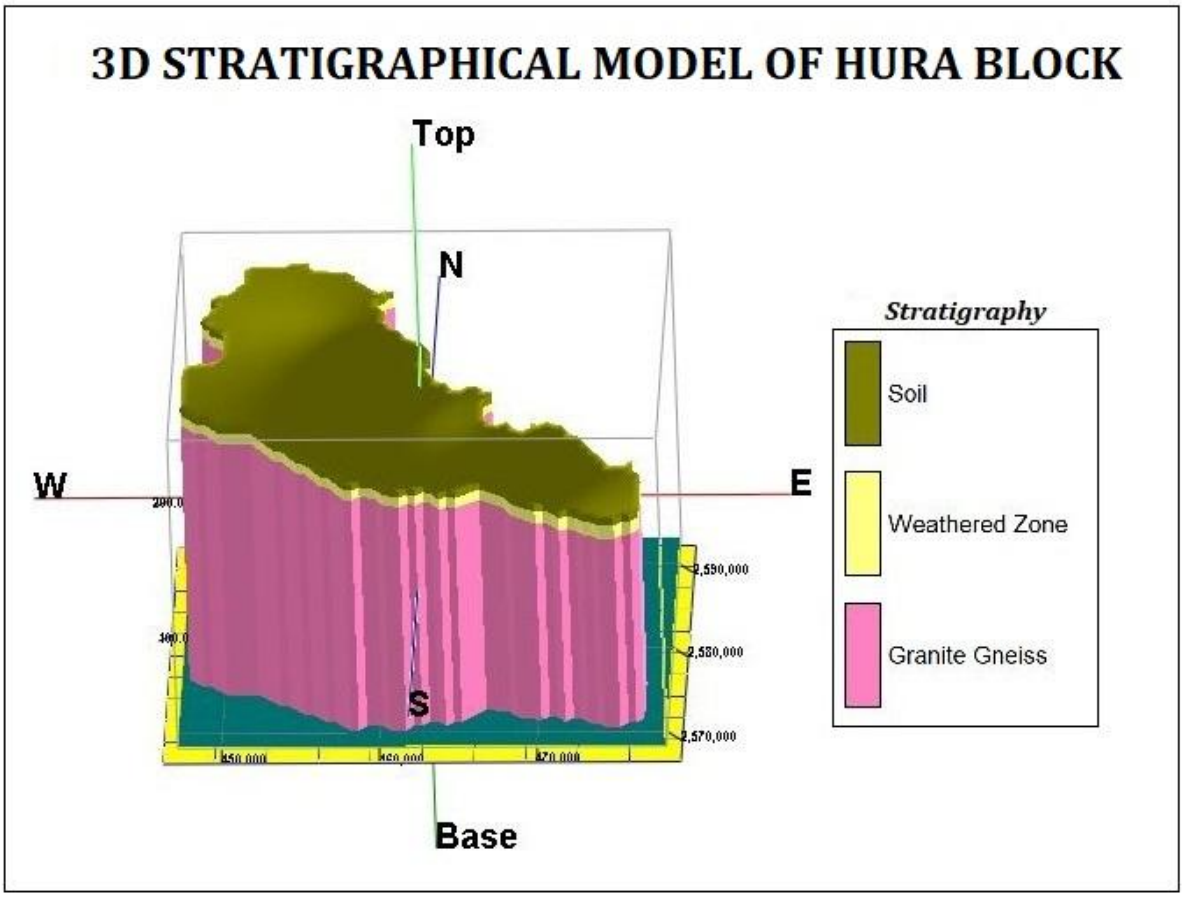

Figure 11.6.2: 3-Dimensional Aquifer disposition in Hura Block

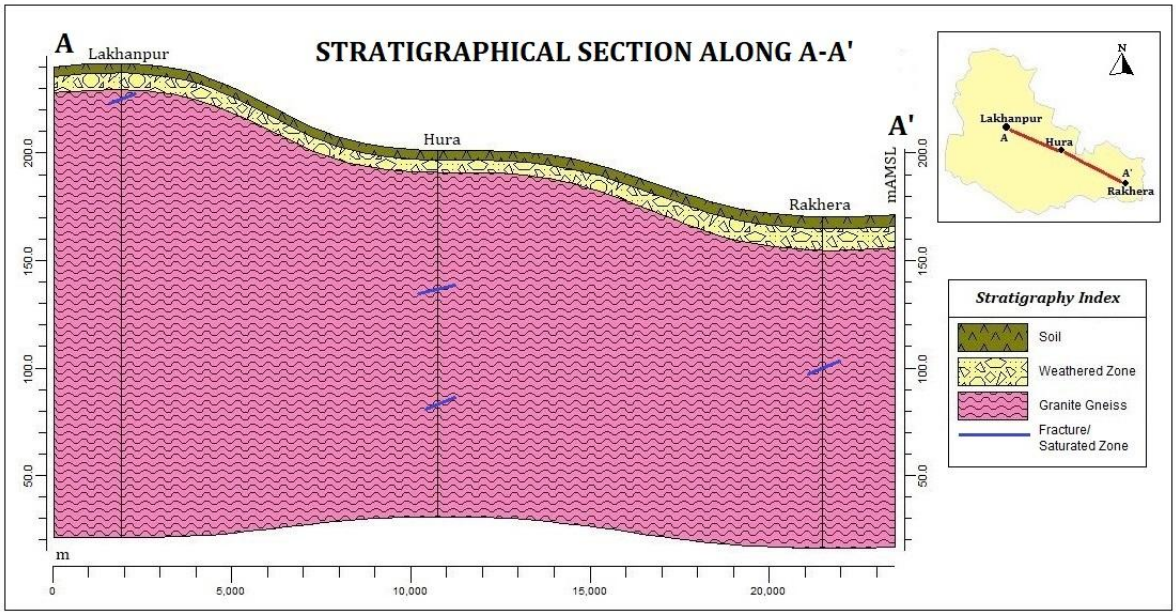

Figure 11.6.3: 2-Dimensional Section in Hura Block

Ground water quality and issues:

Based on seven NHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.6.8 Range of chemical parameters in Hura 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)
Hura	Phreatic	7.77-8.24	153- 1430	8-88	14-266	0.12-0.28	BDL-86	0.01-0.04	65-530

Aquifer Management Plan:

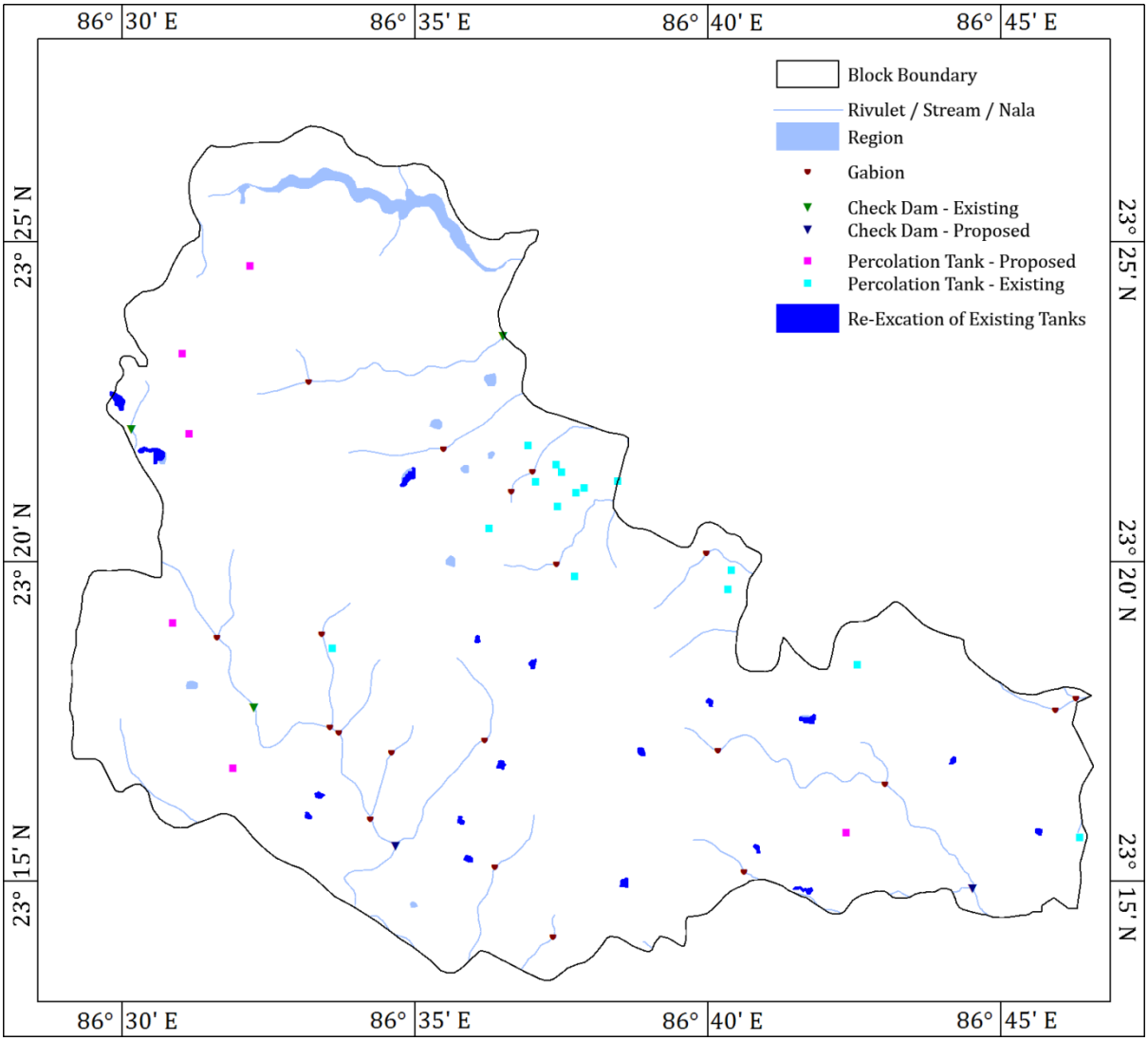

Figure 11.6.4 : AQM-Recommended Water Conservation Structures in Hura Block

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SALIENT INFORMATION

Block Name: **Jaipur**

Geographical area (sq. km): **219**

Mappable area (sq. km): **162**

District: **Purulia**

State: **West Bengal**

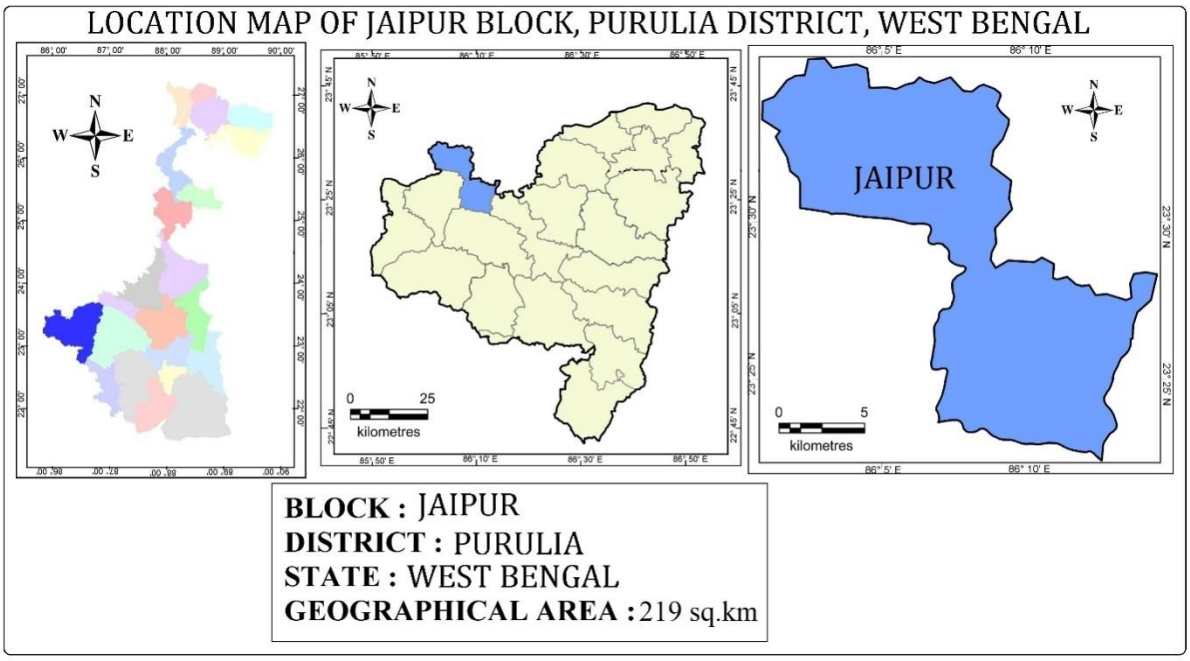

Figure 11.7.1: Location Map of Jaipur Block

Population (as on 2011):

Table 11.7.1: Details of population in Jaipur block.

Rural	Urban	Total
123090	10259	133349

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.7.2: Details of Annual Rainfall for the last five years in Jaipur block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Jaipur	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.7.3: Salient Land use features of Jaipur block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Jaipur	21900	17881	2585.11	15295.89	958

Ground Water Resource:

Table 11.7.4: Details of Ground Water Resource Availability and Utilization in JaipurBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**2144.80**
Annual Extractable Ground Water Resource (HaM)	**1930.32**
Gross Ground Water Abstraction for all uses (HaM)	**445.09**
Net Ground Water Availability for future use (HaM)	**1406.58**
Stage of Ground Water Development (%)	**23.06**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**282.54**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**6596.05**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.7.5: Details of aquifer disposition (fractured aquifer) in JaipurBlock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Jaipur	Banded Gneiss & Granite Gneiss	15-50	50-200	21.6-24.2	50.50-53.20, 111.2-114.1

Table 11.7.6: Aquifer-wise depth range and parameters (fractured aquifer) in Jaipur Block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Jaipur	Aquifer I	15-50	4.4	--	--	--
	Aquifer II	50-200	2	--	--	--

Table 11.7.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Jaipur	Phreatic	2.82 – 7.46	0.363	--	1.66 –4.39	0.096	--

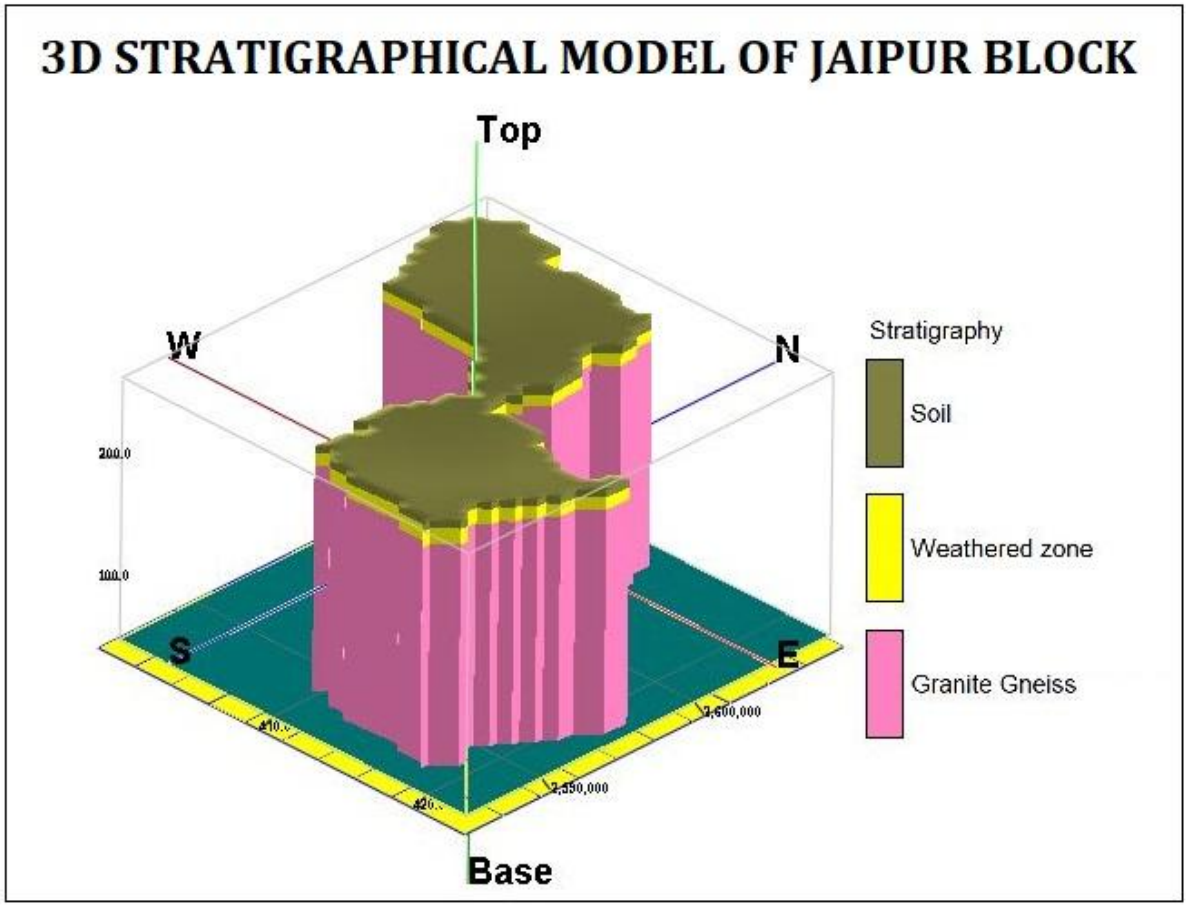

Figure 11.7.2: 3-Dimensional Aquifer disposition in Jaipur Block

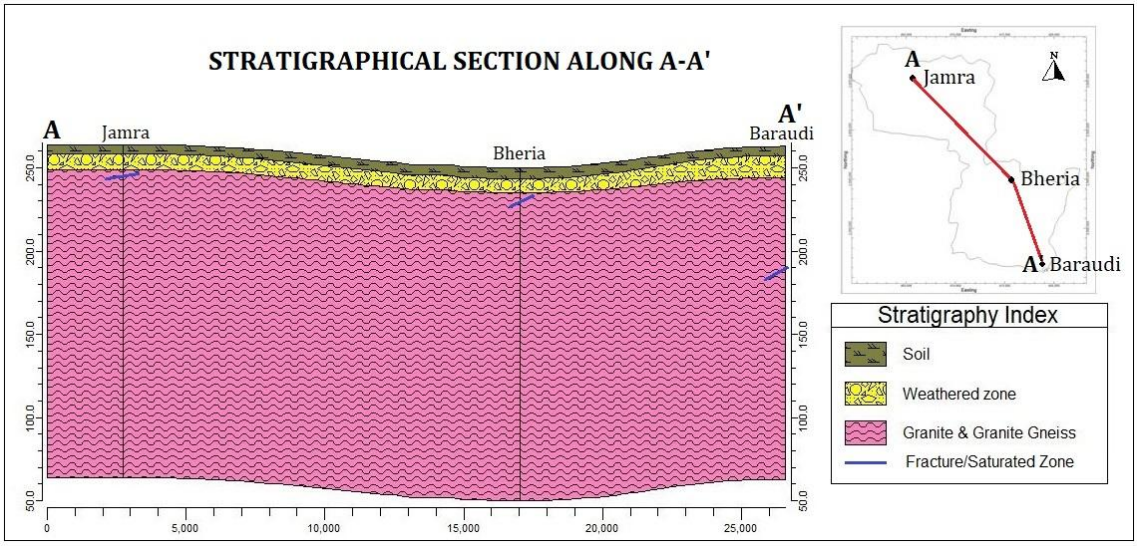

Figure 11.7.3: 2-Dimensional Section in Jaipur Block

Ground water quality and issues:

Based on twoNHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.7.8 Range of chemical parameters in Jaipur 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)
Jaipur	Phreatic	7.78-7.97	441-2208	45-193	35-436	0.37-0.62	BDL-225	BDL	140-575

Aquifer Management Plan:

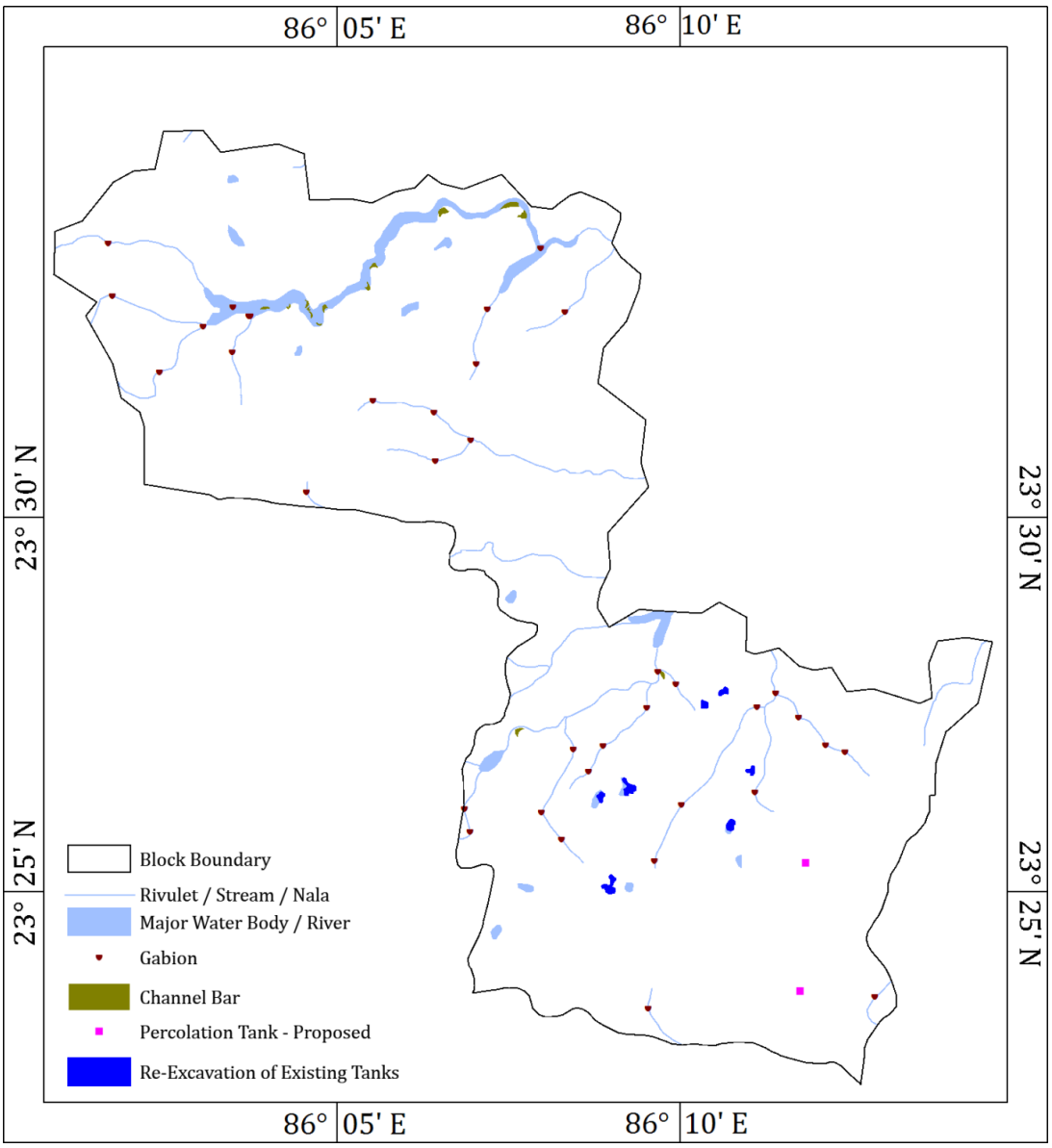

Figure 11.7.4 : AQM-Recommended Water Conservation Structures in Jaipur Block

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SALIENT INFORMATION

Block Name: **Jhalda-I**

Geographical area (sq. km): **309**

Mappable area (sq. km): **272**

District: **Purulia**

State: **West Bengal**

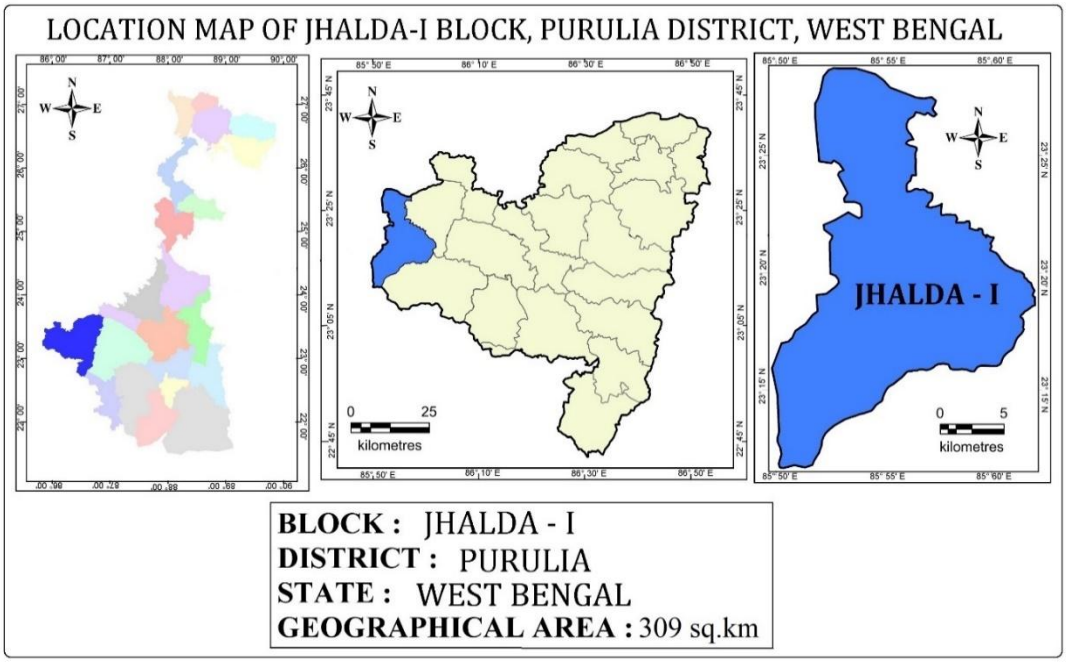

Figure 11.8.1: Location Map of Jhalda-IBlock

Population (as on 2011):

Table 11.8.1: Details of population in Jhalda-Iblock.

Rural	Urban	Total
127759	9384	137143

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.8.2: Details of Annual Rainfall for the last five years in Jhalda-I block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Jhalda-I	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.8.3: Salient Land use features of Jhalda-I block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Jhalda-I	30900	21090	6576.10	14513.9	3026

Ground Water Resource:

Table 11.8.4: Details of Ground Water Resource Availability and Utilization in Jhalda-IBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3016.48**
Annual Extractable Ground Water Resource (HaM)	**2714.83**
Gross Ground Water Abstraction for all uses (HaM)	**681.75**
Net Ground Water Availability for future use (HaM)	**1939.06**
Stage of Ground Water Development (%)	**337.77**
Category	**25.11**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**Safe**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**6195.99**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-230 mbgl. Both aquifers are fresh in nature.

Table 11.8.5: Details of aquifer disposition (fractured aquifer) in Jhalda-Iblock

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Jhalda-I	Banded Gneiss Complex	15-50	50-230	17.10–25.70, 25.70–28.80, 28.80-31.80, 44.00-47.10	50–68.4, 92.80–98.90, 98.90–138.60, 220.90–227

Table 11.8.6: Aquifer-wise depth range and parameters (fractured aquifer) in Jhalda-I block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Jhalda-I	Aquifer I	15-50	7.63-19.8	5.5-8.7	--	--
	Aquifer II	50-200	3.24-28.8	9.5-12.5	--	--

Table 11.8.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Jhalda-I	Phreatic	3.50– 8.09	0.361	--	2.49– 5.37	0.055	--

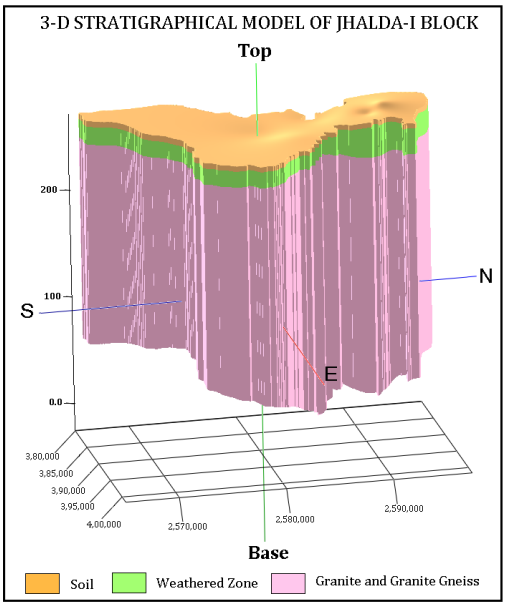

Figure 11.8.2: 3-Dimensional Aquifer disposition in Jhalda-I Block

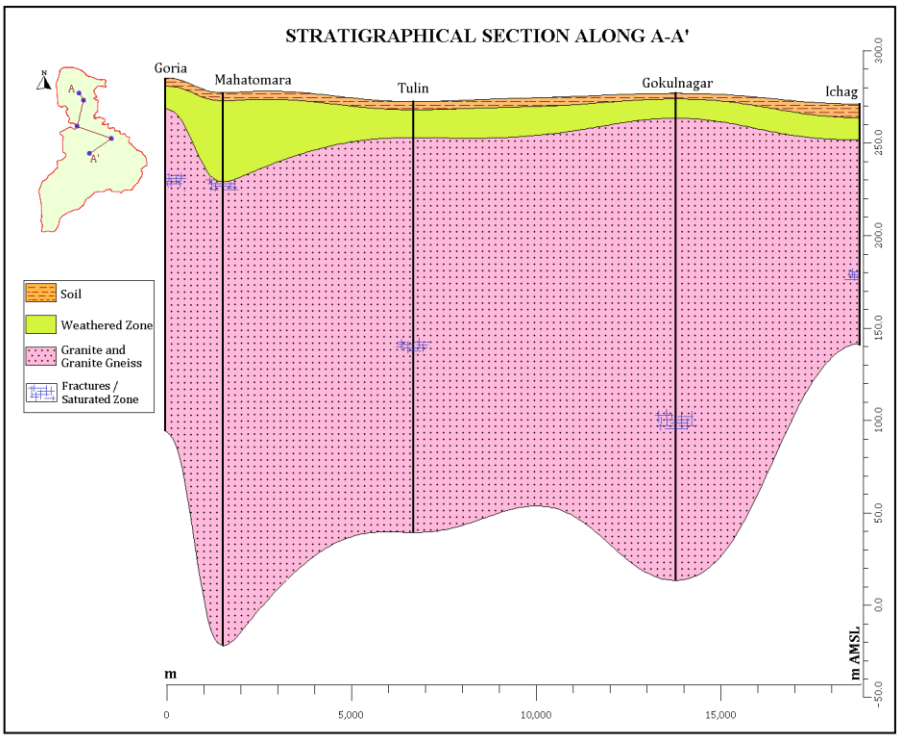

Figure 11.8.3: 2-Dimensional Section in Jhalda-I Block

Ground water quality and issues:

Based on four NHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.8.8 Range of chemical parameters in Jhalda-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)
Jhalda-I	Phreatic	7.88-8.36	543-1221	25-122	67-305	0.21-0.84	5-26	0.01-0.04	210-345

Aquifer Management Plan:

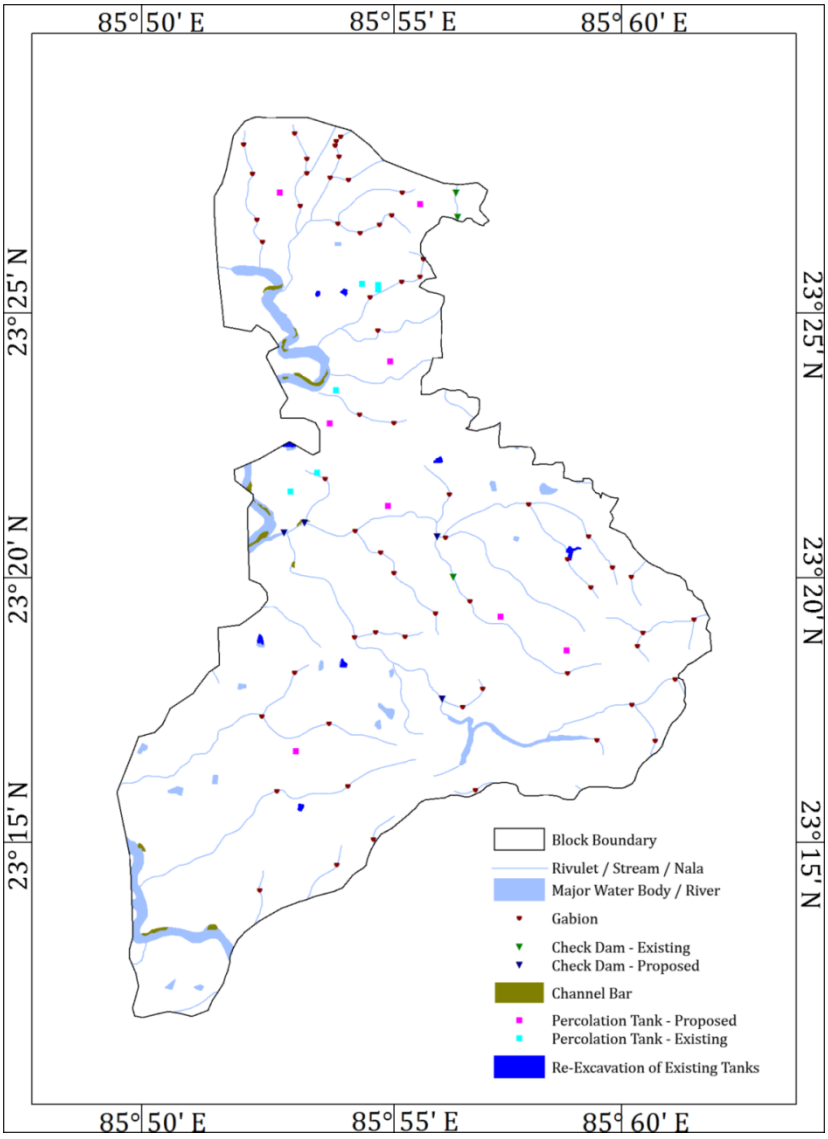

Figure - 11.8.4 : AQM-Recommended Water Conservation Structures in Jhalda-I Block

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SALIENT INFORMATION

Block Name: **Jhalda-II**

Geographical area (sq. km): **273**

Mappable area (sq. km): **262**

District: **Purulia**

State: **West Bengal**

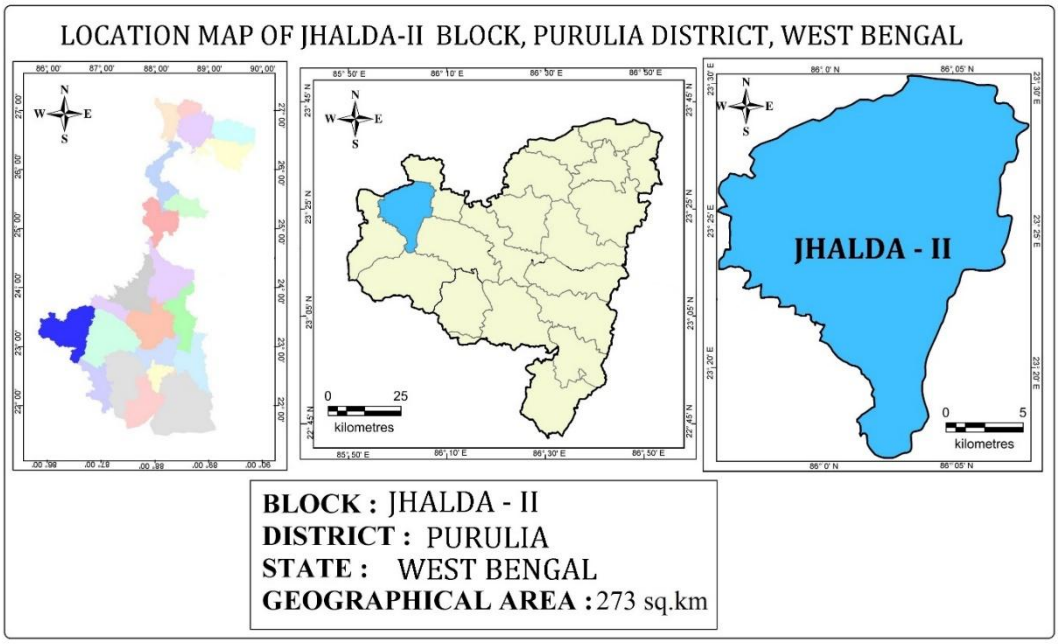

Figure 11.9.1: Location Map of Jhalda-IIBlock

Population (as on 2011):

Table 11.9.1: Details of population in Jhalda-IIblock.

Rural	Urban	Total
135814	12342	148156

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.9.2: Details of Annual Rainfall for the last five years in Jhalda-II block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Jhalda-II	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.9.3: Salient Land use features of Jhalda-II block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Jhalda-II	27300	20218	5474.24	14743.76	2635

Ground Water Resource:

Table 11.9.4: Details of Ground Water Resource Availability and Utilization in Jhalda-IIBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**2851.26**
Annual Extractable Ground Water Resource (HaM)	**2566.13**
Gross Ground Water Abstraction for all uses (HaM)	**402.48**
Net Ground Water Availability for future use (HaM)	**2076.60**
Stage of Ground Water Development (%)	**15.68**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**312.73**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**10323.42**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.9.5: Details of aquifer disposition in Jhalda-II (fractured aquifer) block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Jhalda-II	Banded Gneiss & Granites	15-50	50-200	31.80-37.90	62.30-68.40, 95.90-105.00, 164.7-193.5

Table 11.9.6: Aquifer-wise depth range and parameters in Jhalda-II (fractured aquifer) block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Jhalda-II	Aquifer I	15-50	4.68	--	--	--
	Aquifer II	50-200	1.8	--	--	--

Table 11.9.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Jhalda-II	Phreatic	8.49 – 8.99	0.361	--	3.54 –4.62	0.025	--

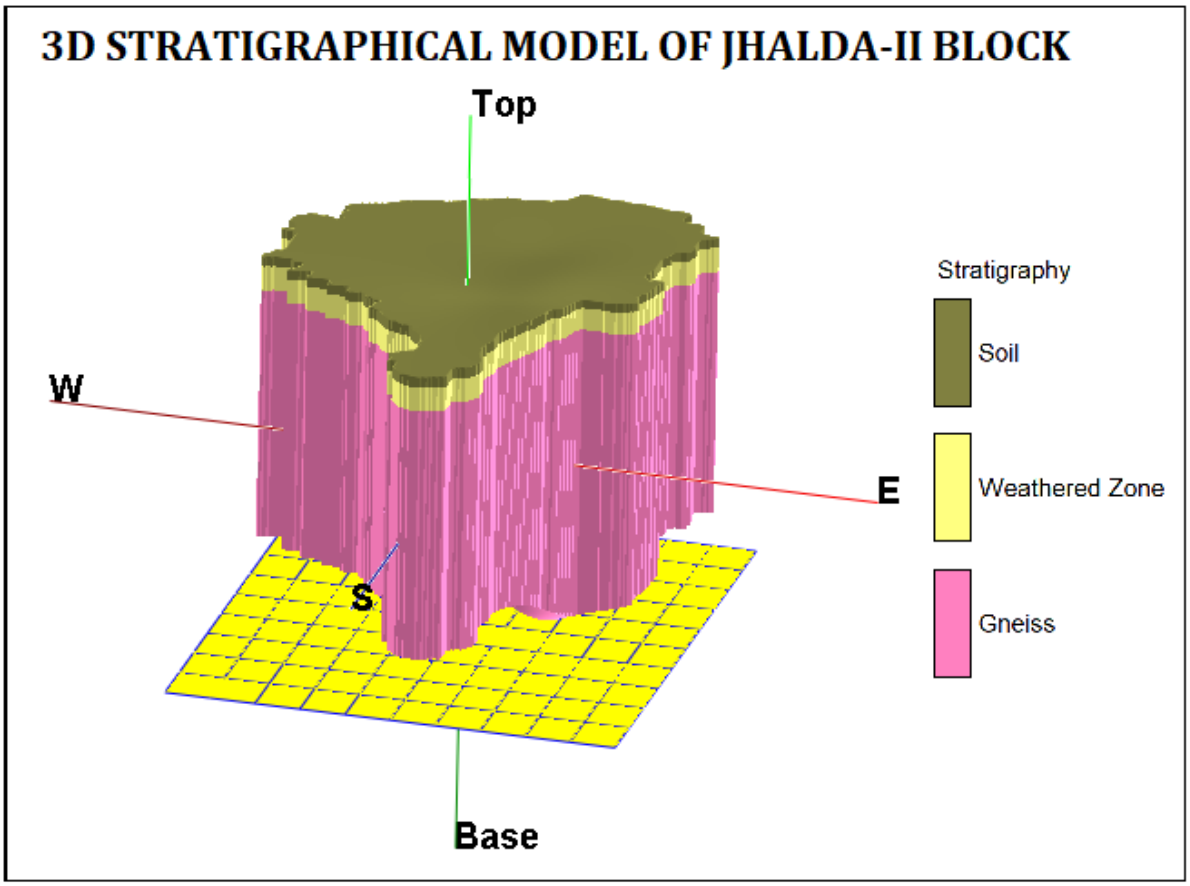

Figure 11.9.2: 3-Dimensional Aquifer disposition in Jhalda-IIBlock

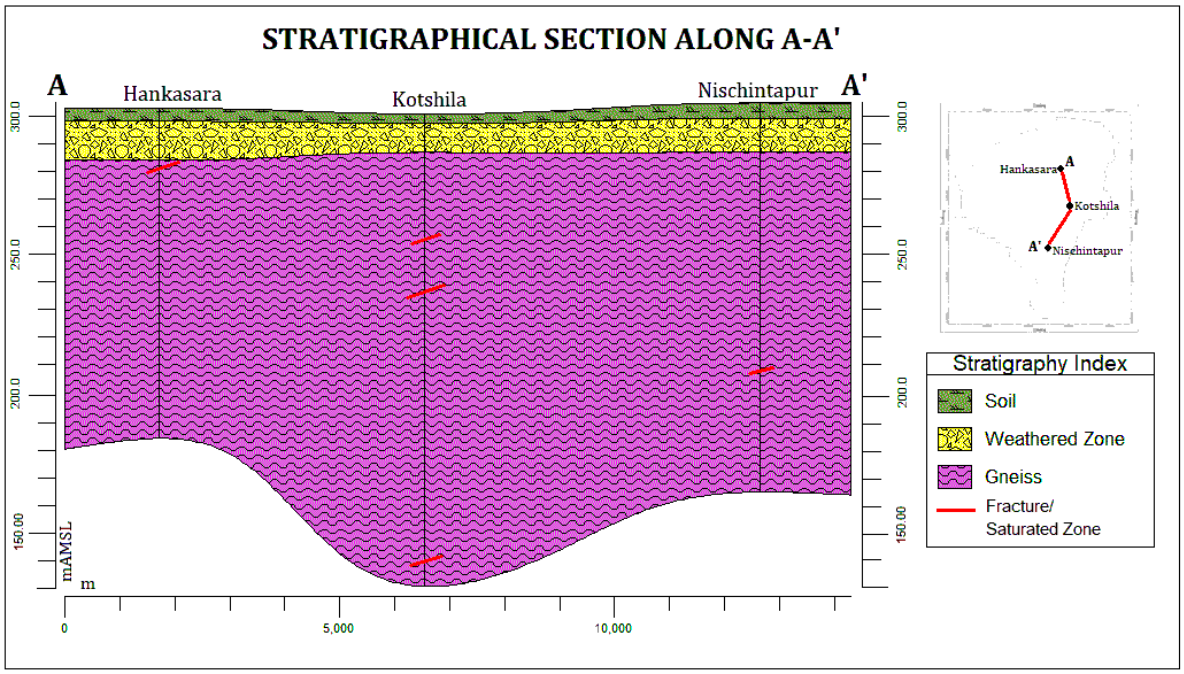

Figure 11.9.3: 2-Dimensional Section in Jhalda-II Block

Ground water quality and issues:

Based on four NHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.9.8 Range of chemical parameters in Jhalda-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)
Jhalda-II	Phreatic	7.88-8.36	543-1221	25-122	67-305	0.21-0.84	BDL-57	0.01-0.04	210-345

Aquifer Management Plan:

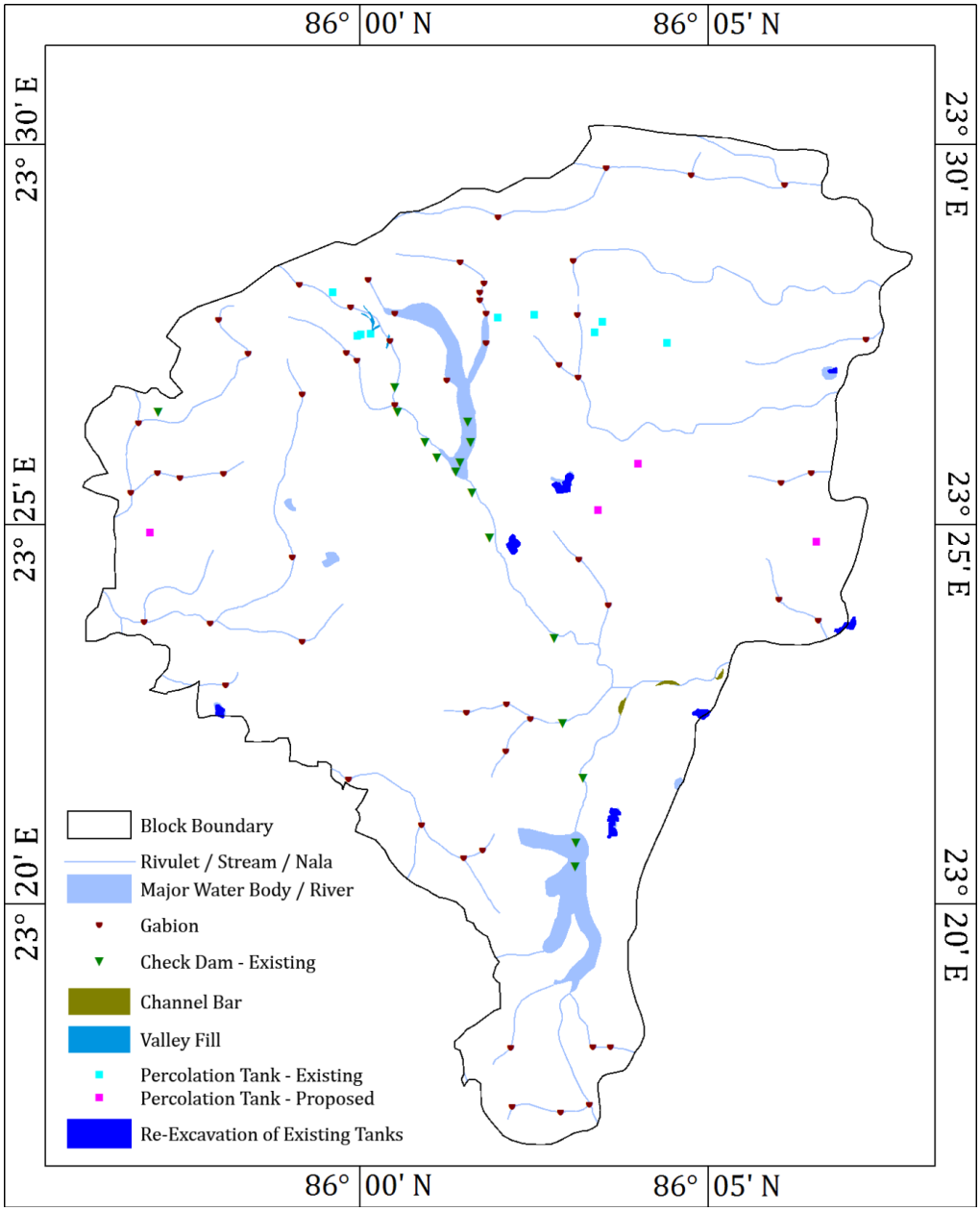

Figure - 11.9.4 : AQM-Recommended Water Conservation Structures in Jhalda-I Block

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SALIENT INFORMATION

Block Name: **Kashipur**

Geographical area (sq. km): **428**

Mappable area (sq. km): **411**

District: **Purulia**

State: **West Bengal**

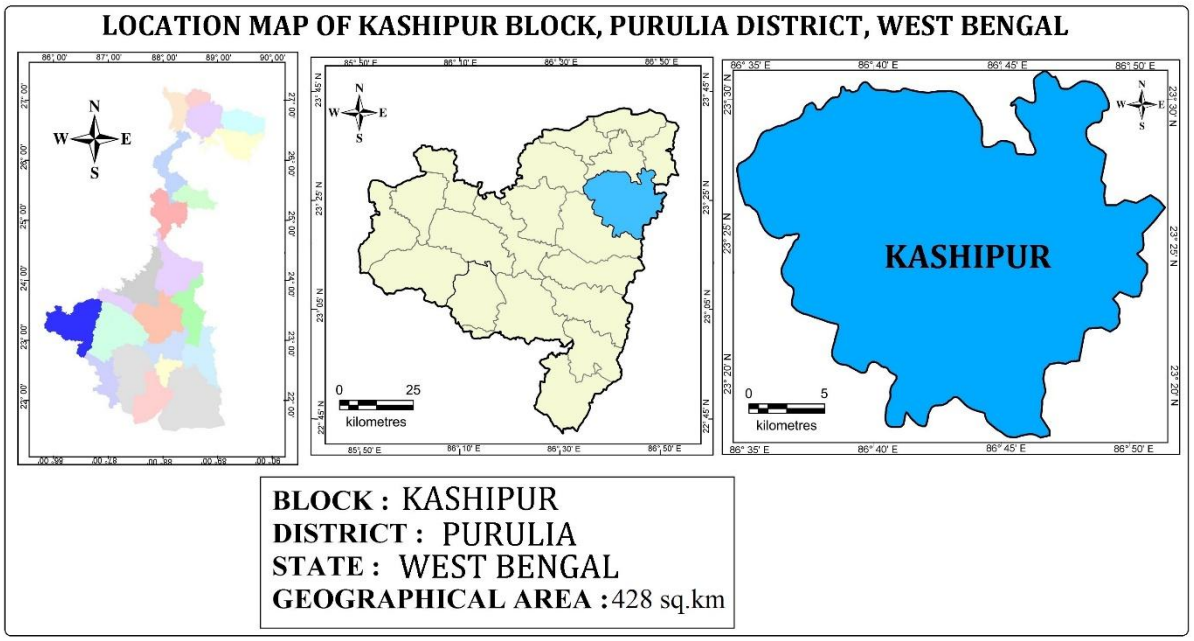

Figure 11.10.1: Location Map of KashipurBlock

Population (as on 2011):

Table 11.10.1: Details of population in Kashipurblock.

Rural	Urban	Total
174325	25758	200083

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.10.2: Details of Annual Rainfall for the last five years in Kashipur block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Kasipur	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.9.3: Salient Land use features of Kashipur block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Kashipur	42800	32424	10374.78	22049.22	4108

Ground Water Resource:

Table 11.10.4: Details of Ground Water Resource Availability and Utilization in KashipurBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**9067.37**
Annual Extractable Ground Water Resource (HaM)	**8160.63**
Gross Ground Water Abstraction for all uses (HaM)	**597.99**
Net Ground Water Availability for future use (HaM)	**7431.02**
Stage of Ground Water Development (%)	**7.33**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**472.81**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**24424.90**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Schist (SC01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. Aquifer is fresh in nature.

Aquifer-II(Deeper aquifer) were reported dry during exploratory drilling

Table 11.10.5: Details of aquifer disposition in Kashipur (fractured aquifer) block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Kashipur	Garnetiferous Schist	15-50	50-200	17.67- 19.0, 22.13- 24.61, 41.62-42.83	--

Table 11.10.6: Aquifer-wise depth range and parameters in Kashipur(fractured aquifer) block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Kashipur	Aquifer I	15-50	0.18-1.19	6.4-10	--	--

Table 11.10.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Kashipur	Aquifer I	5.17 – 8.56	0.324	--	2.02 –5.09	0.094	--

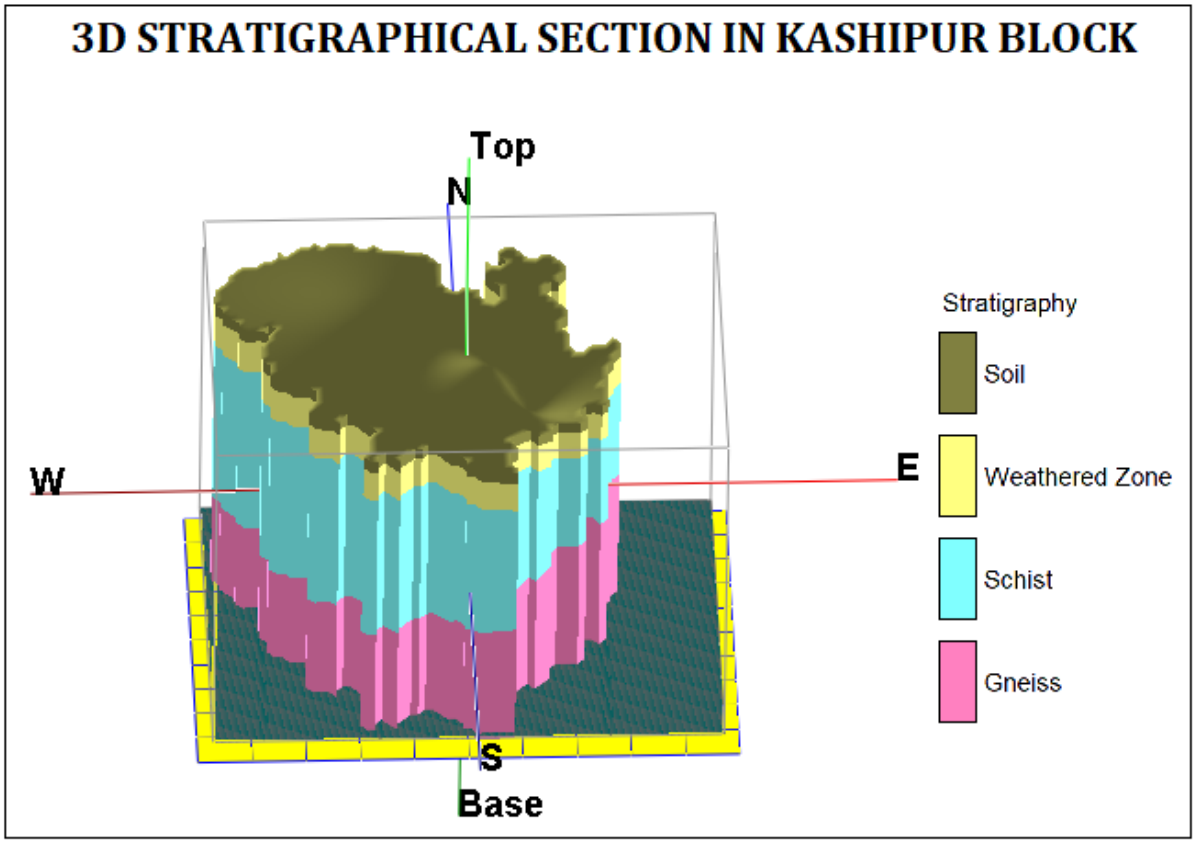

Figure 11.10.2: 3-Dimensional Aquifer disposition in Kashipur Block

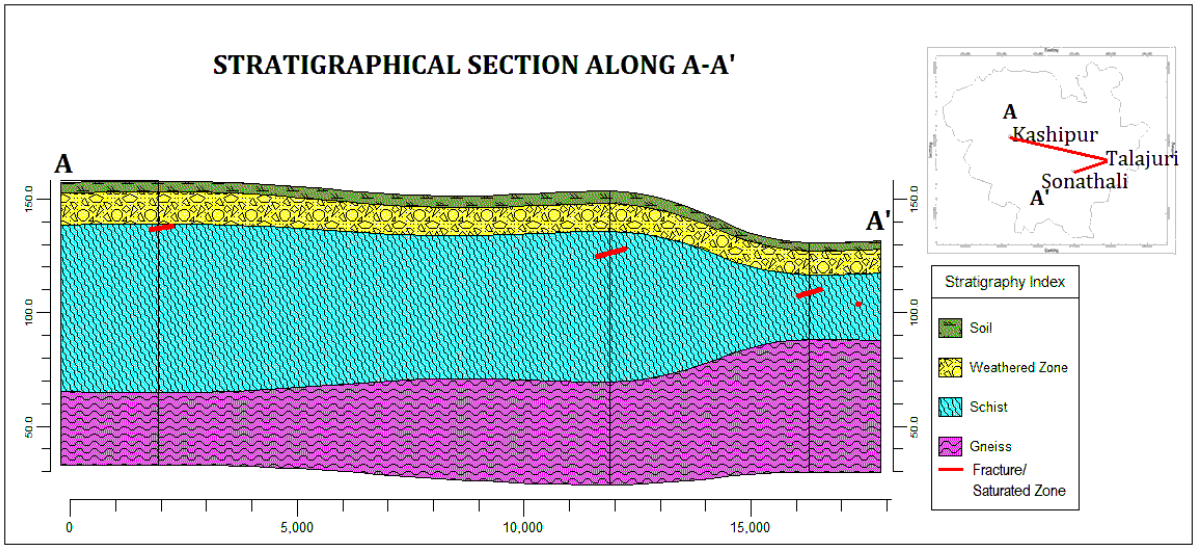

Figure 11.10.3: 2-Dimensional Section in Kashipur Block

Ground water quality and issues:

Based on fiveNHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.10.8 Range of chemical parameters in Kashipur 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)
Kashipur	Phreatic	7.74-8.23	863-2548	49-168	145-542	0.12-0.76	3-279	0.01-0.51	295-880

Aquifer Management Plan:

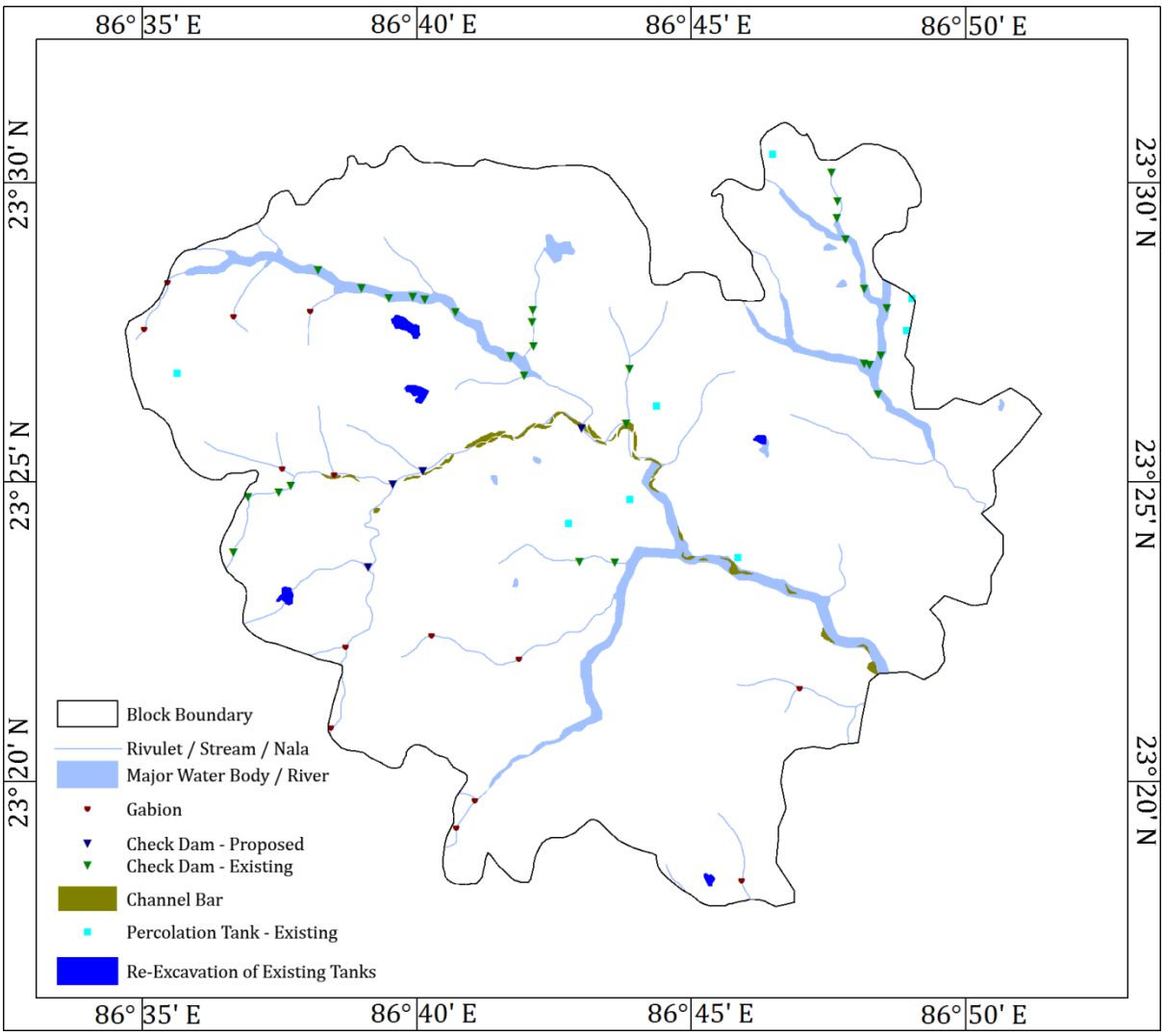

Figure - 11.10.4 : AQM-Recommended Water Conservation Structures in Kashipur Block

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SALIENT INFORMATION

Block Name: **Manbazar-I**

Geographical area (sq. km): **368**

Mappable area (sq. km): **353**

District: **Purulia**

State: **West Bengal**

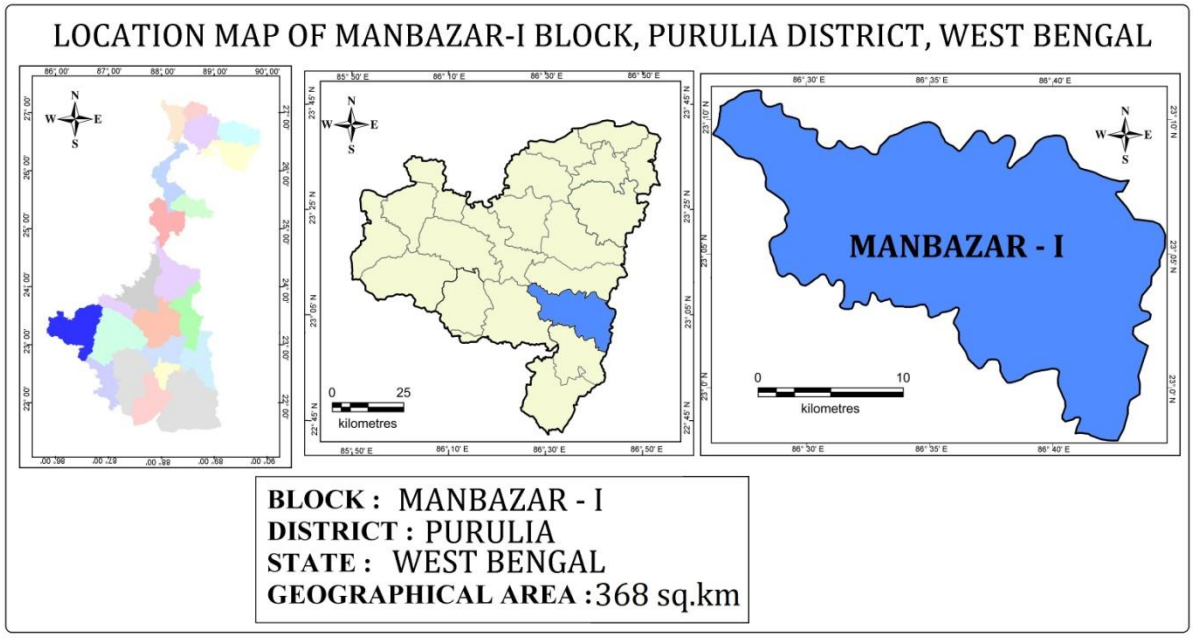

Figure 11.11.1: Location Map of Manbazar-IBlock

Population (as on 2011):

Table 11.11.1: Details of population in Manbazar-Iblock.

Rural	Urban	Total
144550	9521	154071

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.11.2: Details of Annual Rainfall for the last five years in Manbazar-I block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Manbazar-I	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.11.3: Salient Land use features of Manbazar-I block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Manbazar-I	35300	26607	7419.29	19187.71	37330

Ground Water Resource:

Table 11.11.4: Details of Ground Water Resource Availability and Utilization in Manbazar-I Block.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**5472.68**
Annual Extractable Ground Water Resource (HaM)	**4925.41**
Gross Ground Water Abstraction for all uses (HaM)	**278.77**
Net Ground Water Availability for future use (HaM)	**4556.85**
Stage of Ground Water Development (%)	**322.56**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**5.66**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**20804.82**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is**Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.11.5: Details of aquifer disposition in Manbazar-I block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Manbazar-I	Banded Gneiss	15-50	50-200	19.6-25.7	--

Table 11.11.6: Aquifer-wise depth range and parameters in Manbazar-I block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Manbazar-I	Aquifer I	15-50	4.2-8.6	4.2-8.7	--	--

Table 11.11.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Manbazar-I	Aquifer I	6.03 – 7.99	0.324	**--**	1.52 –2.97	0.141	**--**

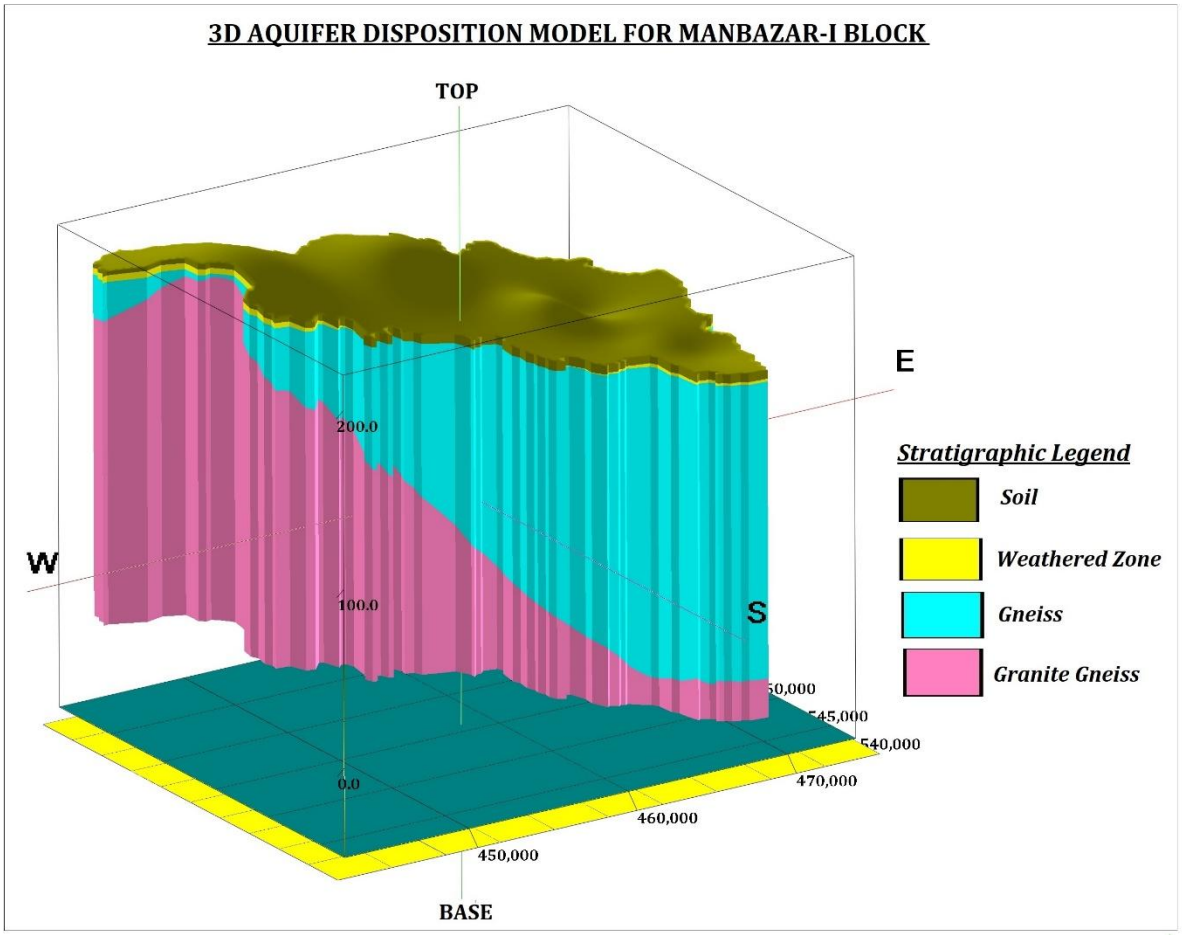

Figure 11.11.2: 3-Dimensional Aquifer disposition in Manbazar-I Block

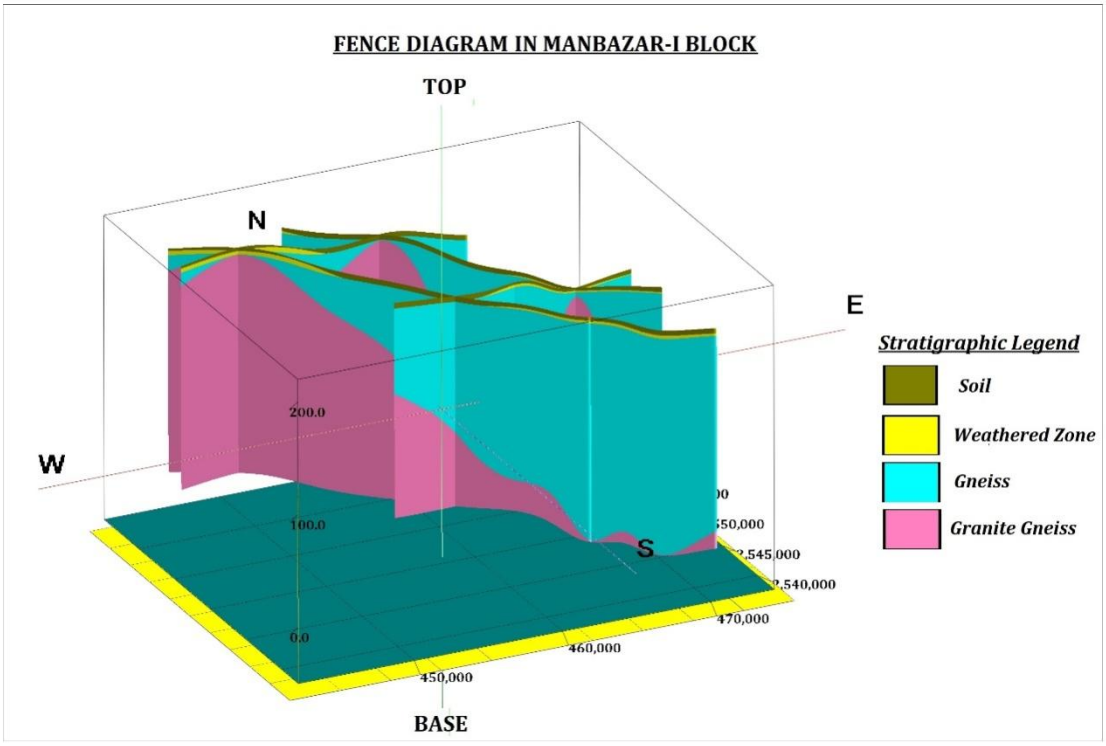

Figure 11.11.3: Fence diagram in Manbazar-I Block

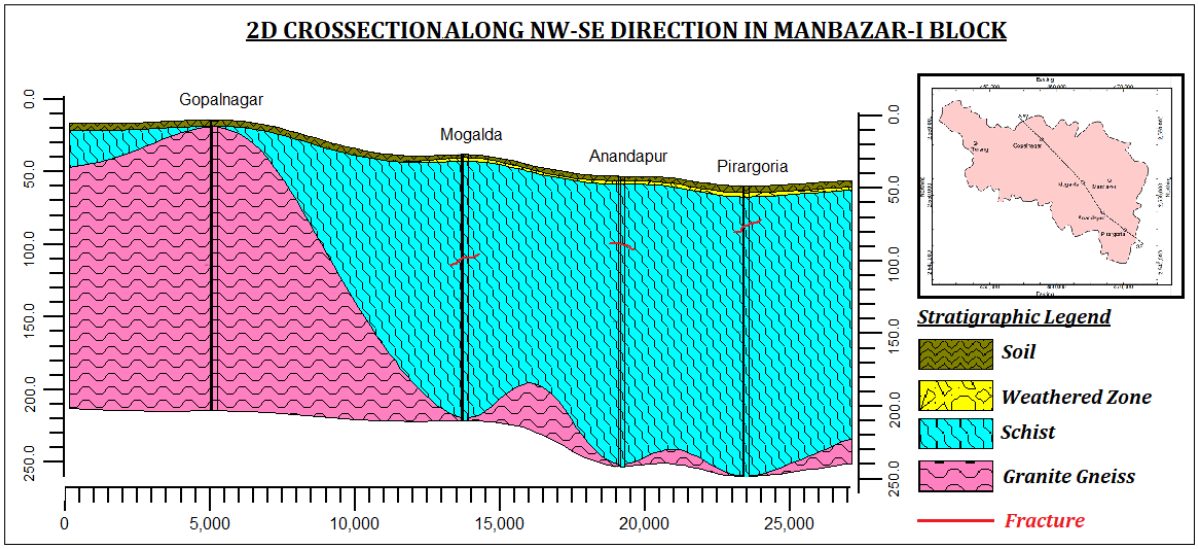

Figure 11.11.4: 2-Dimensional Section in Manbazar-I Block

Ground water quality and issues:

Based on twoNHS (dugwells) one exploratory well and one observation well, the range of chemical parameters for the block is given below.

Table 11.11.8 Range of chemical parameters in Manbazar-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)
Manbazar-I	Phreatic	8.05-8.35	694-958	63-91	103-113	0.24-0.52	BDL-41	0.01-0.04	130-290
	Fractured	7.98-8.01	432-434	26-38	57-106	0.50-0.61	3-9	Traces	95-180

Aquifer Management Plan:

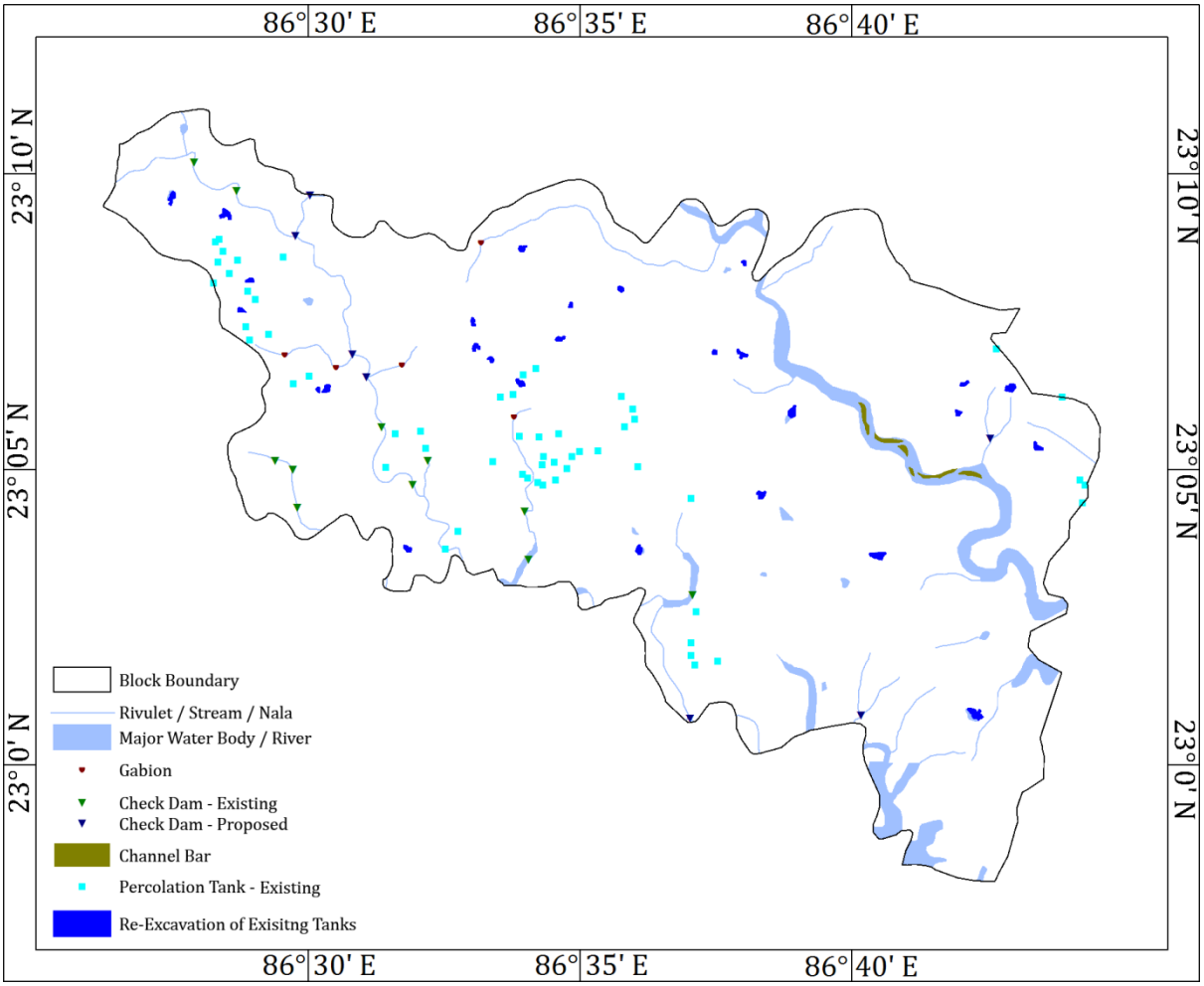

Figure - 11.11.5 : AQM-Recommended Water Conservation Structures in Manbazar-I Block

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SALIENT INFORMATION

Block Name: **Manbazar-II**

Geographical area (sq. km): **282**

Mappable area (sq. km): **271**

District: **Purulia**

State: **West Bengal**

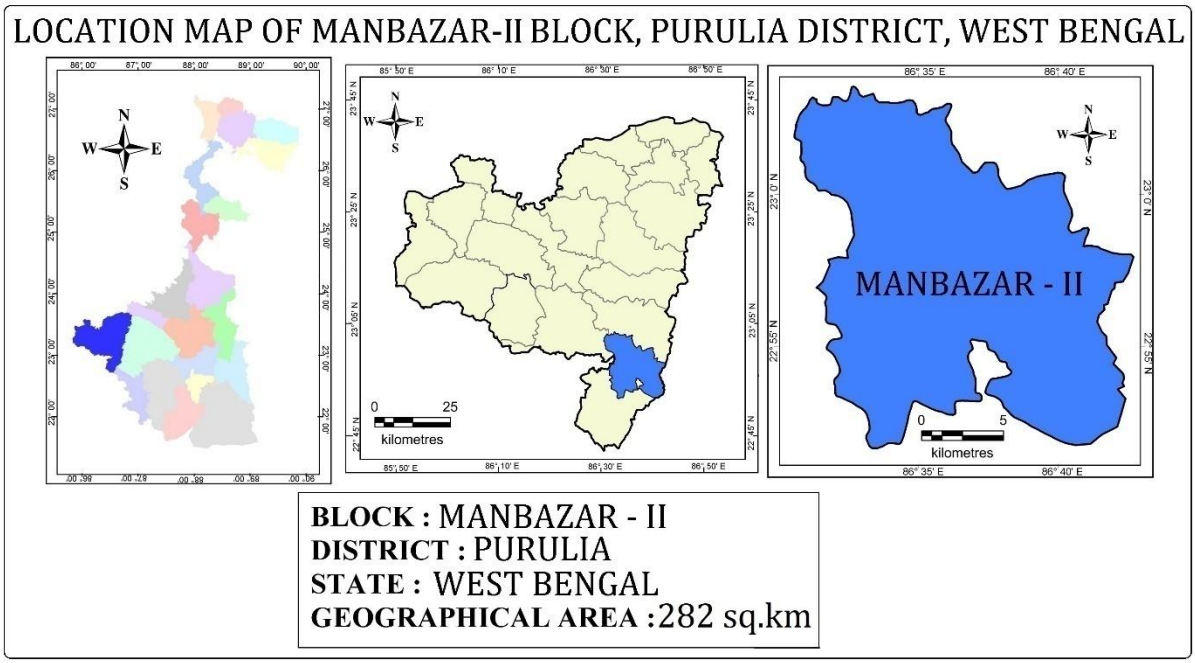

Figure 11.12.1: Location Map of Manbazar-IIBlock

Population (as on 2011):

Table 11.12.1: Details of population in Manbazar-IIblock.

Rural	Urban	Total
97164	--	97164

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.12.2: Details of Annual Rainfall for the last five years in Manbazar-II block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Manbazar-II	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.12.3: Salient Land use features of Manbazar-II block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Manbazar-II	28200	21506	3783.04	17722.96	1524

Ground Water Resource:

Table 11.12.4: Details of Ground Water Resource Availability and Utilization in Manbazar-IIBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**2660.33**
Annual Extractable Ground Water Resource (HaM)	**2527.31**
Gross Ground Water Abstraction for all uses (HaM)	**161.52**
Net Ground Water Availability for future use (HaM)	**2305.80**
Stage of Ground Water Development (%)	**6.39**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**215.51**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**6985.20**

Disposition of Aquifers:

Theprincipal aquifer systems encountered in this block is **Banded Gneissic Complex (BG01) and Schist (SC01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.12.5: Details of aquifer disposition (fractured aquifer) in Manbazar-II block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Manbazar-II	Banded Gneiss &Schists/ Phyllites	15-50	50-200	19.60–22.70 28.80–31.80	187.4 - 190.4

Table 11.12.6: Aquifer-wise depth range and parameters (fractured aquifer) in Manbazar-II block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Manbazar-II	Aquifer I	15-50	7.2	--	--	--
	Aquifer II	50-200	10.8	--	--	--

Table 11.12.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Manbazar-II	Phreatic	7.17 – 7.18	0.015	**--**	3.97 –4.23	0.041	**--**

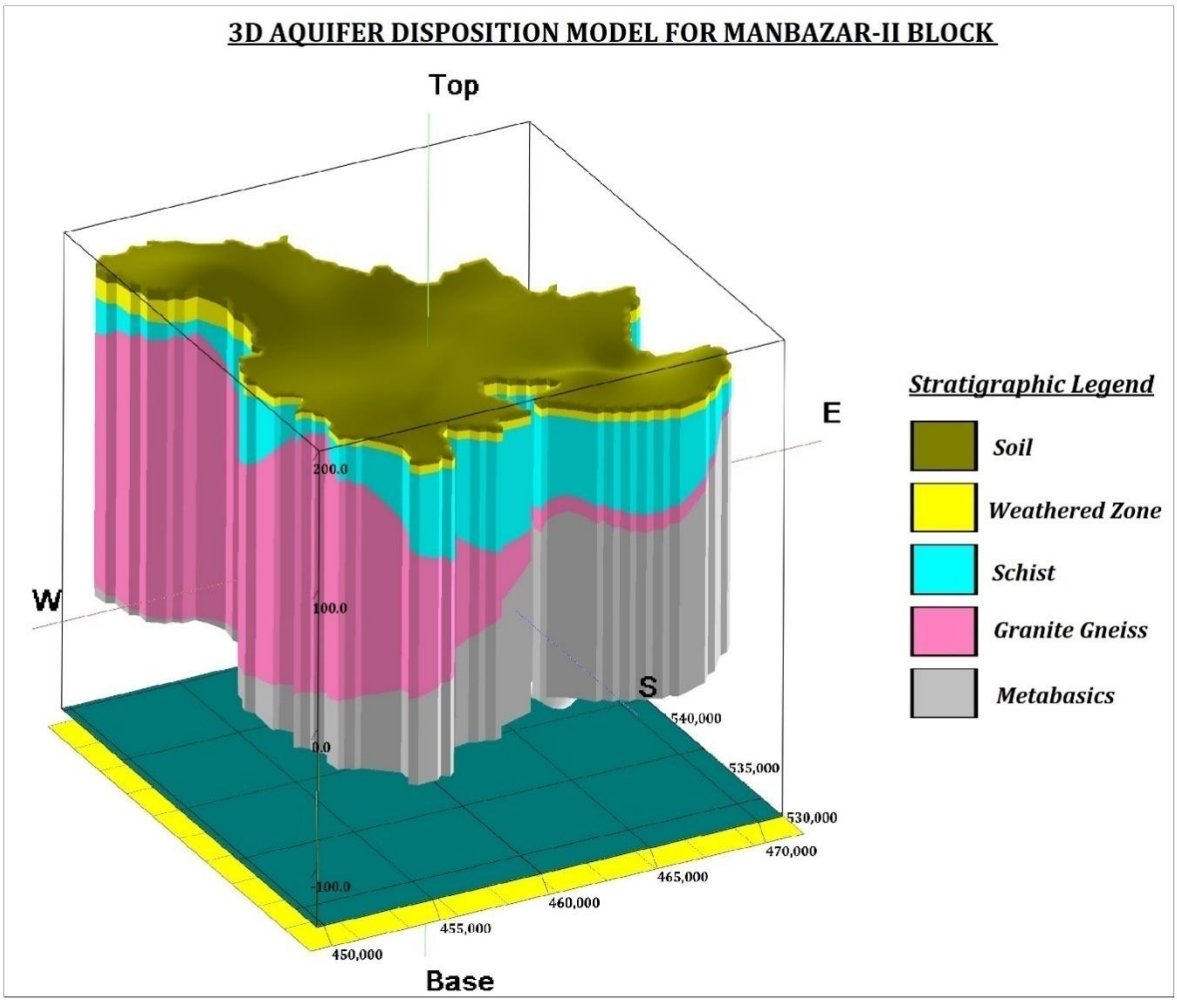

Figure 11.12.2: 3-Dimensional Aquifer disposition in Manbazar-II Block

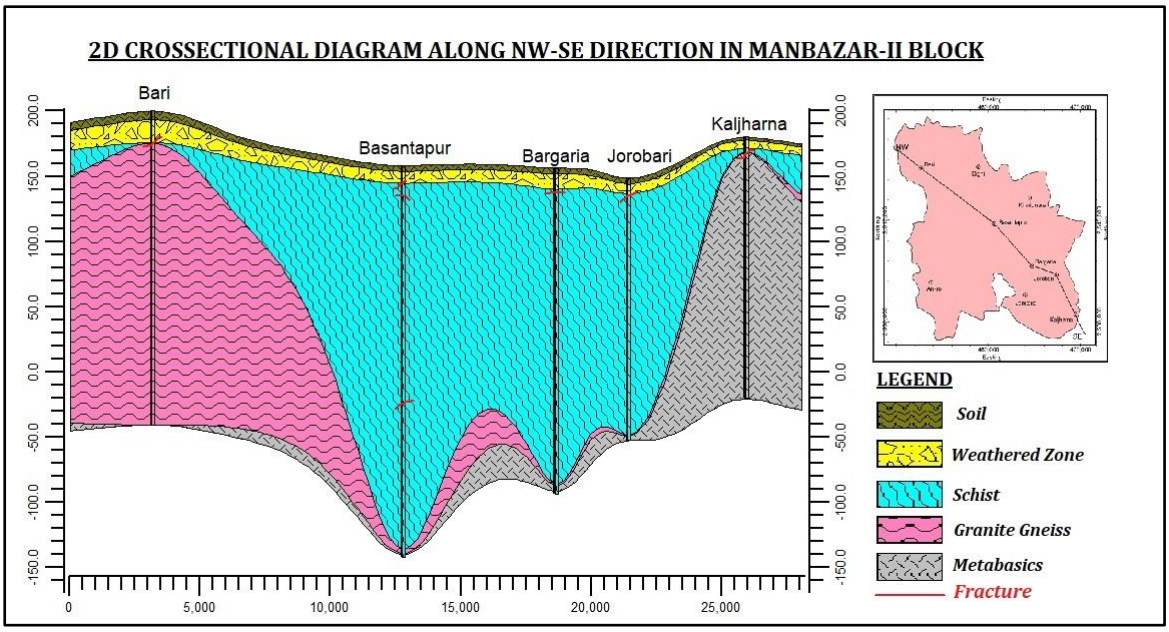

Figure 11.1.3: 2-Dimensional Section in Manbazar-II Block

Ground water quality and issues:

Based on two NHS (dugwells), the range of chemical parameter for the block is given below.

Table 11.12.8 Range of chemical parameters in Manbazar-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)
Manbazar-II	Phreatic	8.05-8.20	561-758	48-72	60-124	0.36-0.45	BDL-4	0.36-0.45	175-245
	Fractured	7.58-8.36	361-584	25-38	35-57	0.51-0.84	1-9	Traces	120-215

Aquifer Management Plan:

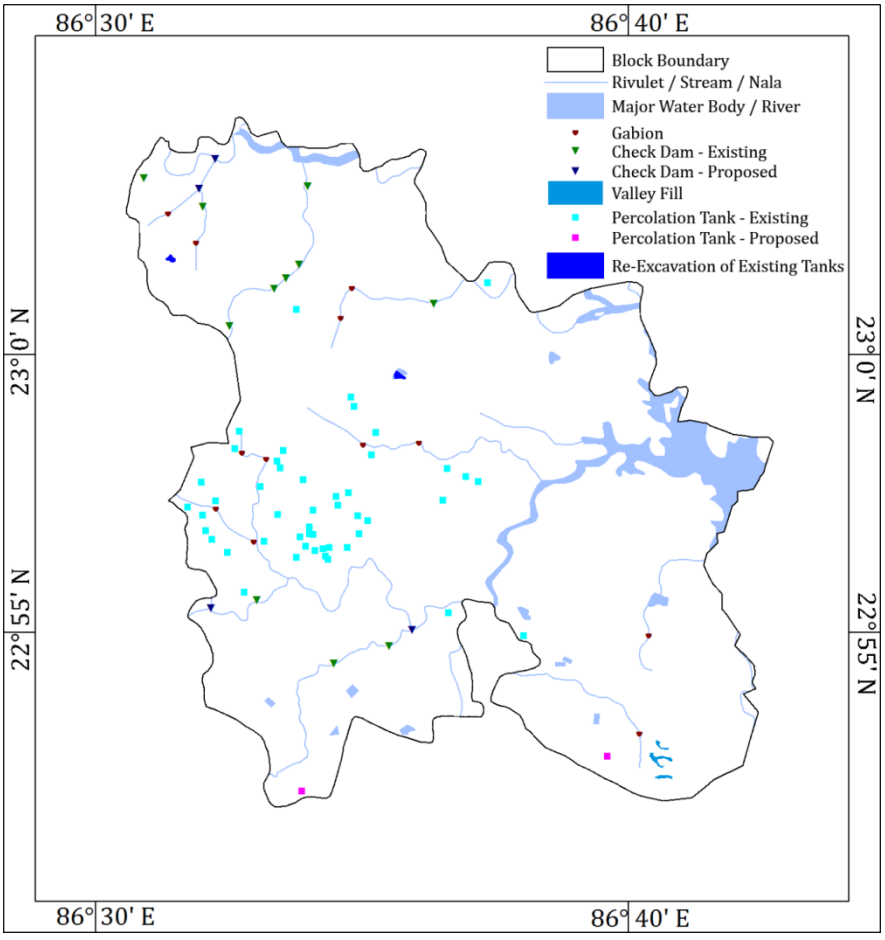

Figure - 11.12.4 : AQM-Recommended Water Conservation Structures in Manbazar-II Block

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SALIENT INFORMATION

Block Name: **Neturia**

Geographical area (sq. km): **185**

Mappable area (sq. km): **177**

District: **Purulia**

State: **West Bengal**

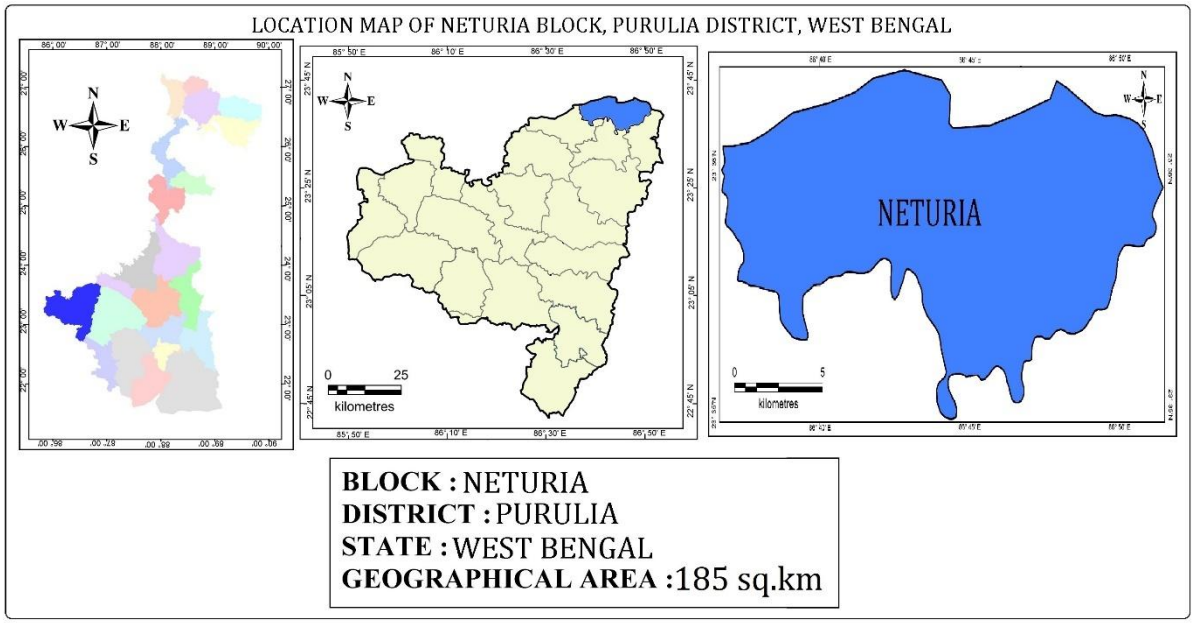

Figure 11.13.1: Location Map of Neturia Block

Population (as on 2011):

Table 11.13.1: Details of population in Neturiablock.

Rural	Urban	Total
83137	18290	101427

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.13.2: Details of Annual Rainfall for the last five years in Neturia block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Neturia	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.13.3: Salient Land use features of Neturia block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Neturia	18500	11818	3350.18	8467.82	1457

Ground Water Resource:

Table 11.13.4: Details of Ground Water Resource Availability and Utilization in NeturiaBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3443.53**
Annual Extractable Ground Water Resource (HaM)	**3099.18**
Gross Ground Water Abstraction for all uses (HaM)	**213.36**
Net Ground Water Availability for future use (HaM)	**2822.03**
Stage of Ground Water Development (%)	**6.88**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**229.15**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**17004.78**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Sandstone (ST06).**

Phreatic aquifer: Ranges between 2-10 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 10-50 mbgl. Aquifer is fresh in nature.

Deeper exploratory drilling has not been carried out in this block.

Table 11.13.5: Details of aquifer disposition in Neturia (fractured aquifer) block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Neturia	Sandstone	10-50	50-200	24.44-36.44	--

Table 11.13.6: Aquifer-wise depth range and parameters in Neturia (fractured aquifer) block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Neturia	Aquifer I	10-50	11.95-19.94	15-20	--	--
	Aquifer II	50-200	--	--	--	--

Table 11.13.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Neturia	Phreatic	4.26 – 5.96	0.015	**--**	1.92 –3.64	**--**	0.038

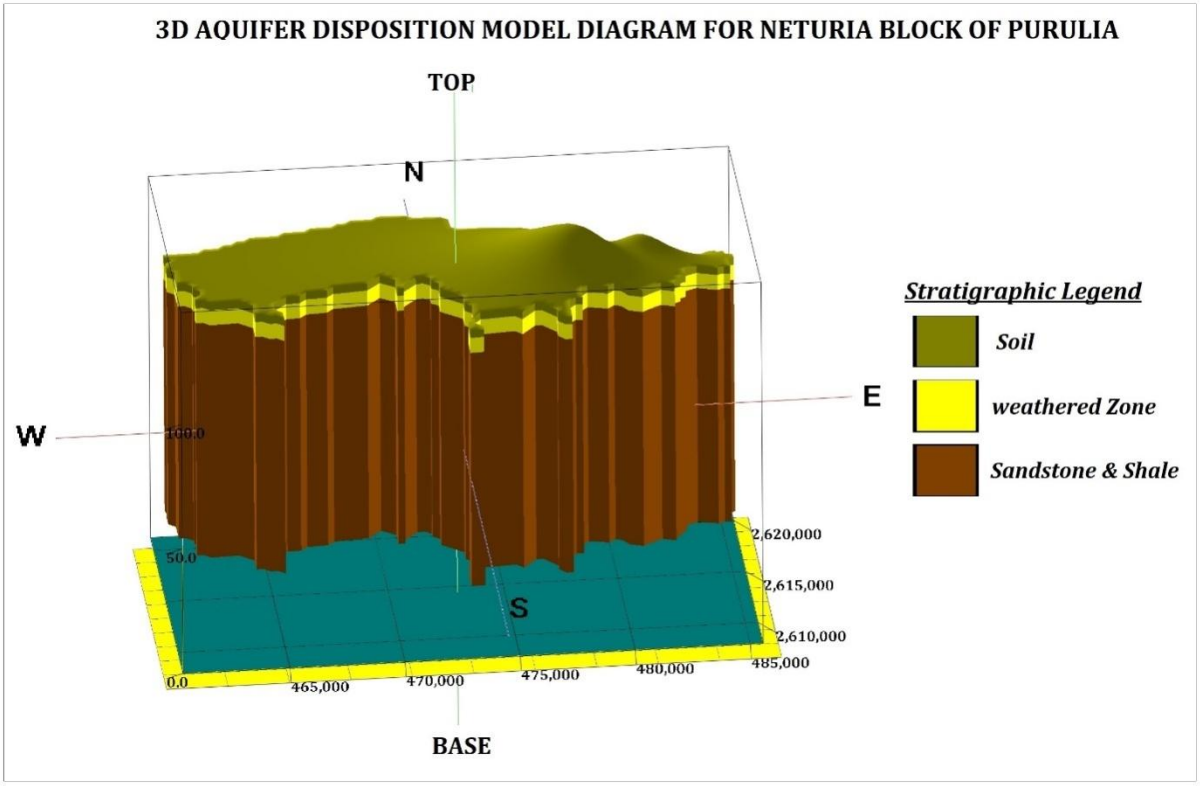

Figure 11.13.2: 3-Dimensional Aquifer disposition in Neturia Block

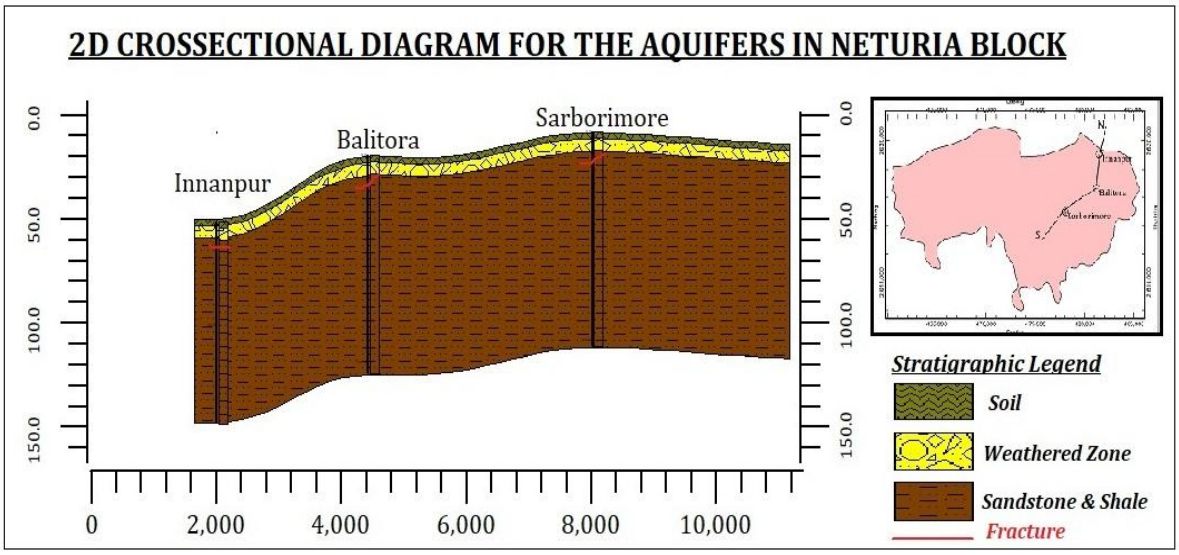

Figure 11.13.3: 2-Dimensional Section in Neturia Block

Ground water quality and issues:

Based on two NHS (dugwells), the range of chemical parameters for the block is given below.

Table 11.13.8 Range of chemical parameters in Neturia 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)
Neturia	Phreatic	7.81-7.98	623-645	41-50	53-85	0.17-0.37	29-36	0.01-0.08	145-225

Aquifer Management Plan:

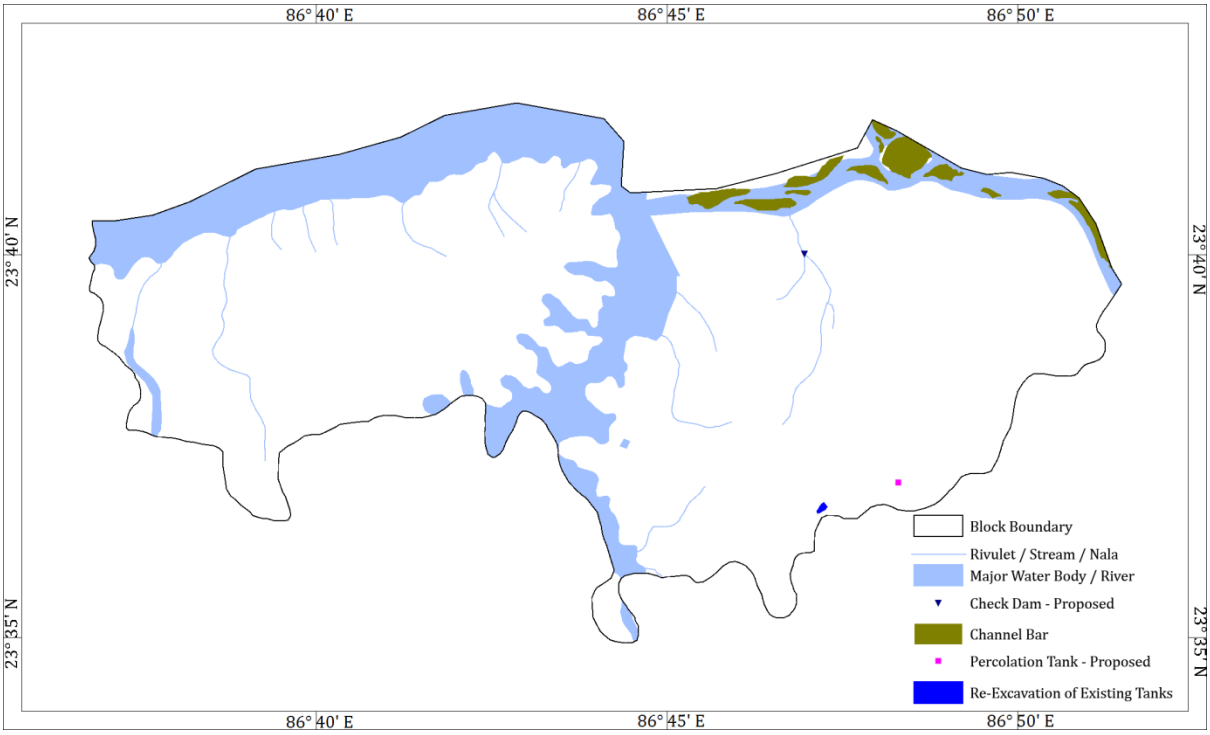

Figure - 11.13.4 : AQM-Recommended Water Conservation Structures in Neturia Block

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SALIENT INFORMATION

Block Name: **Para**

Geographical area (sq. km): **313**

Mappable area (sq. km): **301**

District: **Purulia**

State: **West Bengal**

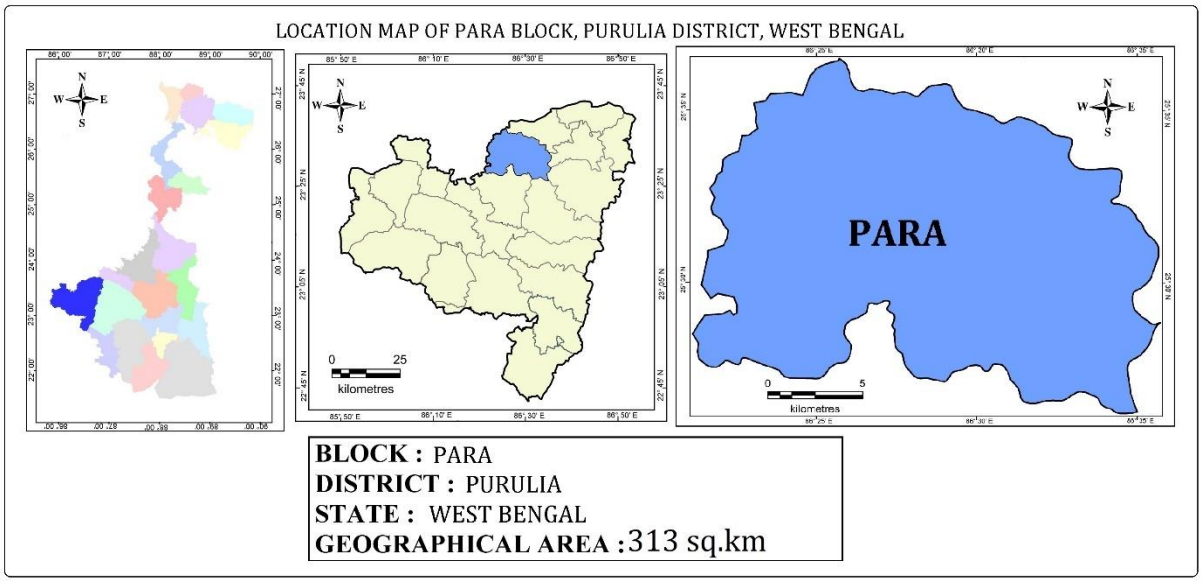

Figure 11.14.1: Location Map of ParaBlock

Population (as on 2011):

Table 11.14.1: Details of population in Parablock.

Rural	Urban	Total
167997	32624	200621

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.14.2: Details of Annual Rainfall for the last five years in Para block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Para	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.14.3: Salient Land use features of Parablock

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Para	31300	24728	4680.87	20047.13	913

Ground Water Resource:

Table 11.14.4: Details of Ground Water Resource Availability and Utilization in ParaBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3609.05**
Annual Extractable Ground Water Resource (HaM)	**3248.14**
Gross Ground Water Abstraction for all uses (HaM)	**385.34**
Net Ground Water Availability for future use (HaM)	**2739.92**
Stage of Ground Water Development (%)	**11.86**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**441.42**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**4332.50**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. This aquifer is fresh in nature.

Deeper exploratory drilling has not been carried out in this block.

Table 11.14.5: Details of aquifer disposition in Para (fractured aquifer) block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Para	Granite Gneiss	15-50	50-200	26.0-28.0	--

Table 11.14.6: Aquifer-wise depth range and parameters in Para (fractured) block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Para	Aquifer I	15-50	4.1	15	--	--
	Aquifer II	50-200	--	--	--	--

Table 11.14.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Para	Phreatic	3.16 – 8.66	0.118	**--**	2.34 –5.53	**--**	0.075

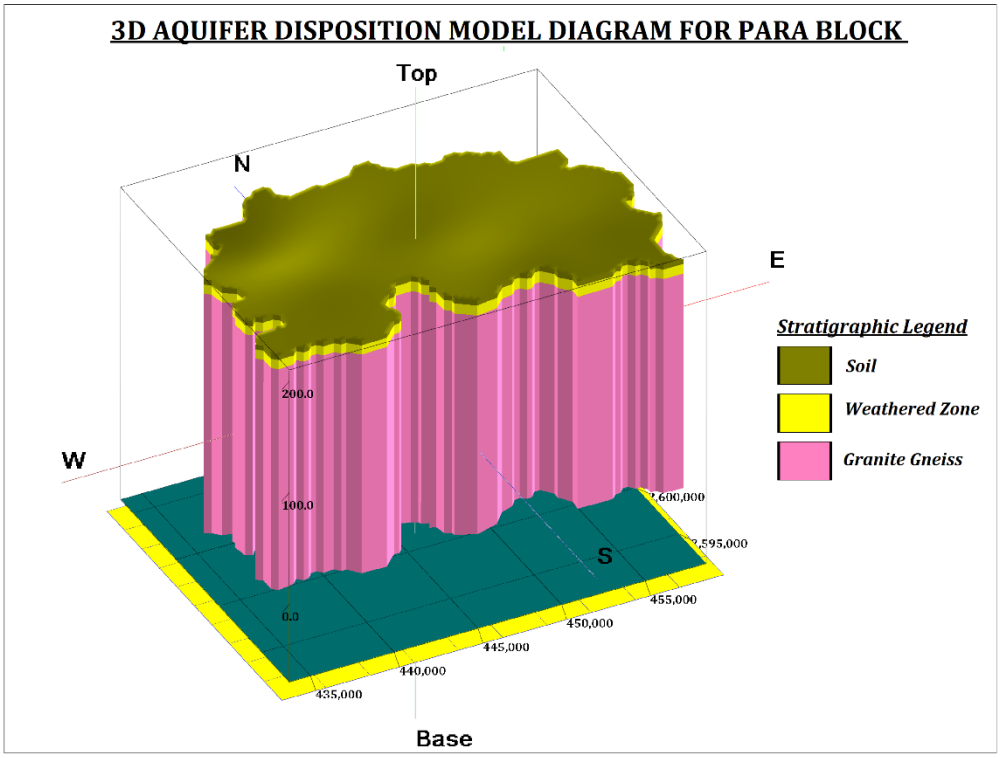

Figure 11.14.2: 3-Dimensional Aquifer disposition in Para Block

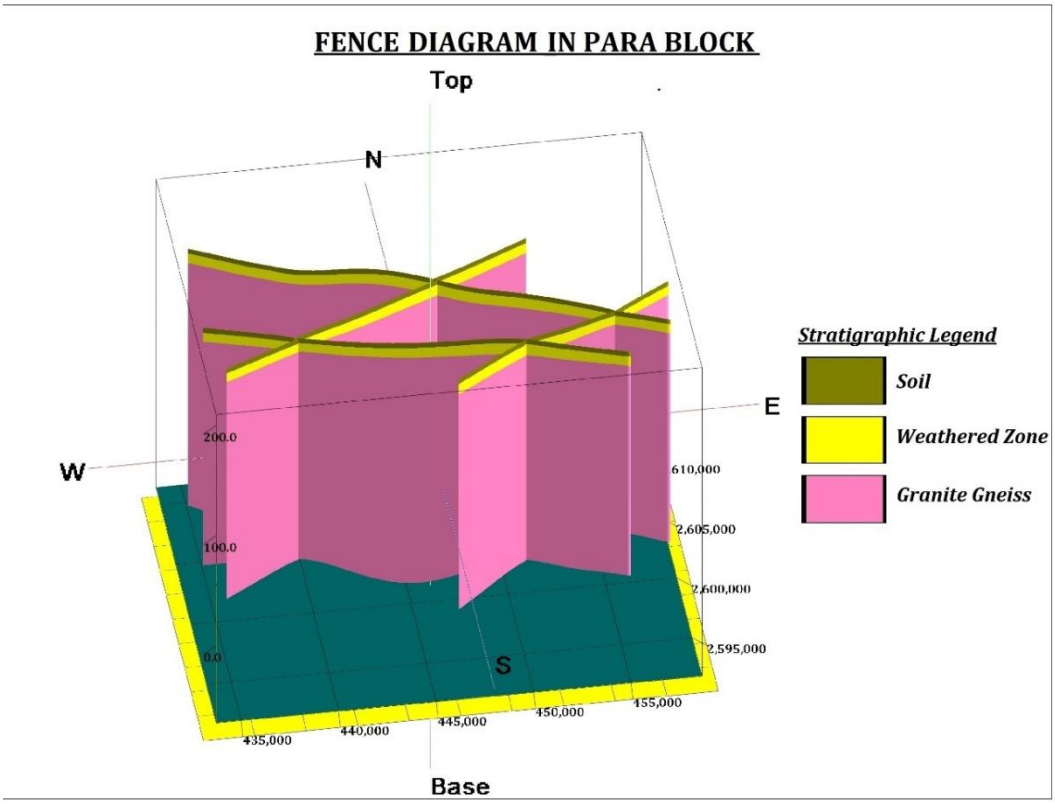

Figure 11.14.3: LithologicalFence Diagram in Para Block

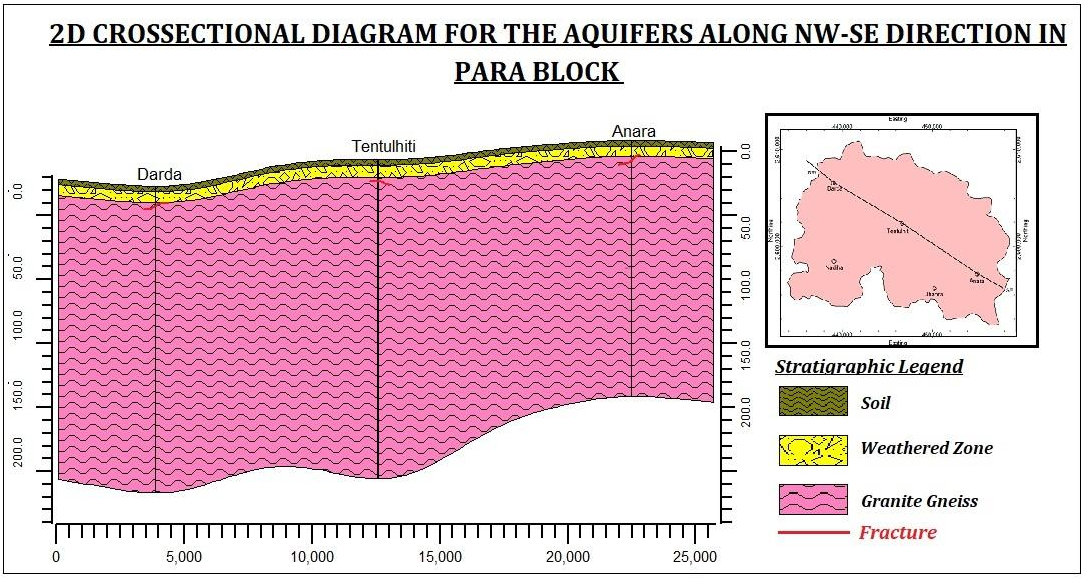

Figure 11.14.4: 2-Dimensional Section in Para Block

Ground water quality and issues:

Based on fourNHS (dugwells), the range of chemical parameters for the block is given below.

Table 11.14.8 Range of chemical parameters in Para 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)
Para	Phreatic	7.83-8.32	800-1410	42-114	110-174	0.08-0.41	BDL-179	0.02-0.04	230-445

Aquifer Management Plan:

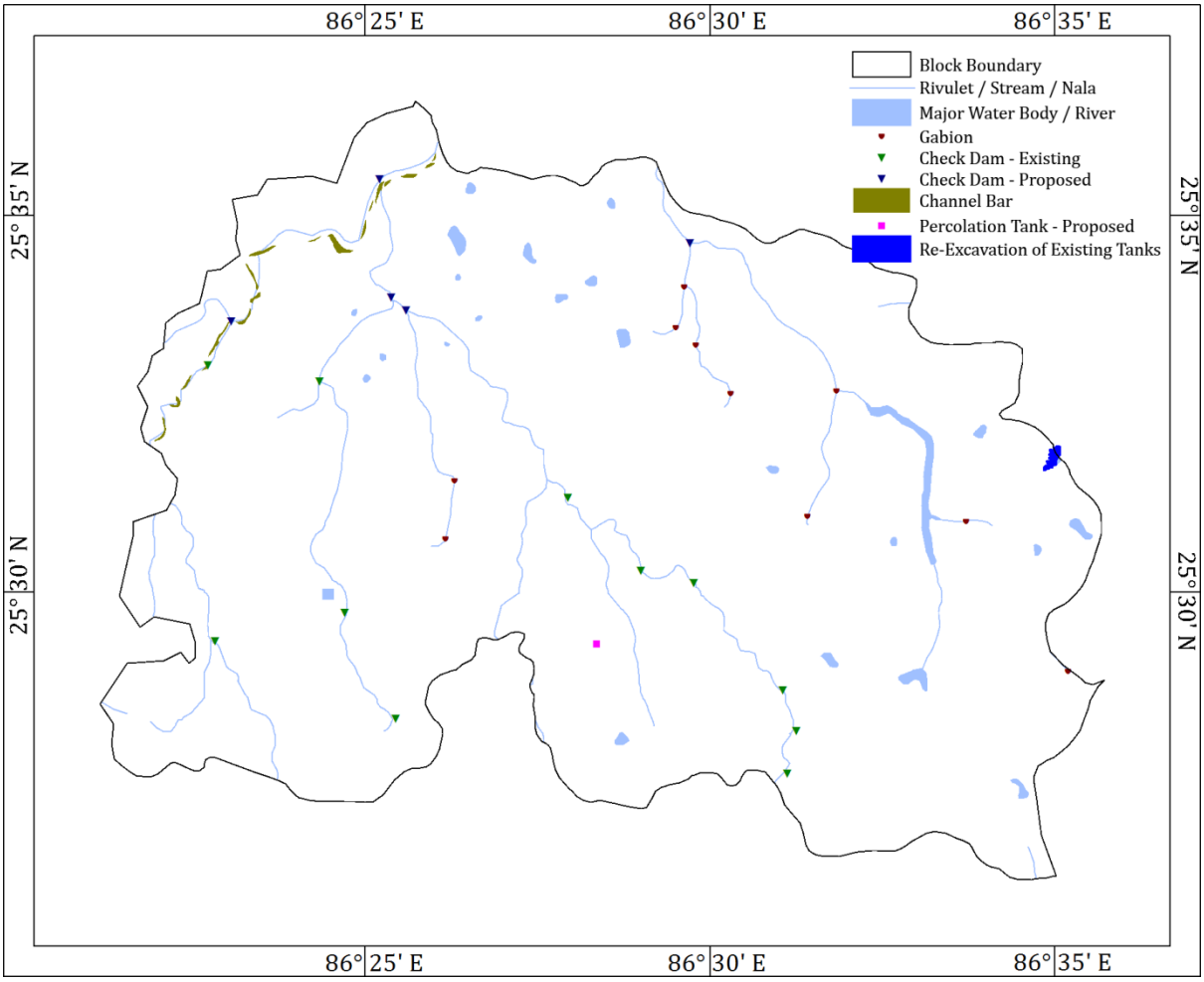

Figure - 11.14.5 : AQM-Recommended Water Conservation Structures in Para Block

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SALIENT INFORMATION

Block Name: **Puncha**

Geographical area (sq. km): **323**

Mappable area (sq. km): **310**

District: **Purulia**

State: **West Bengal**

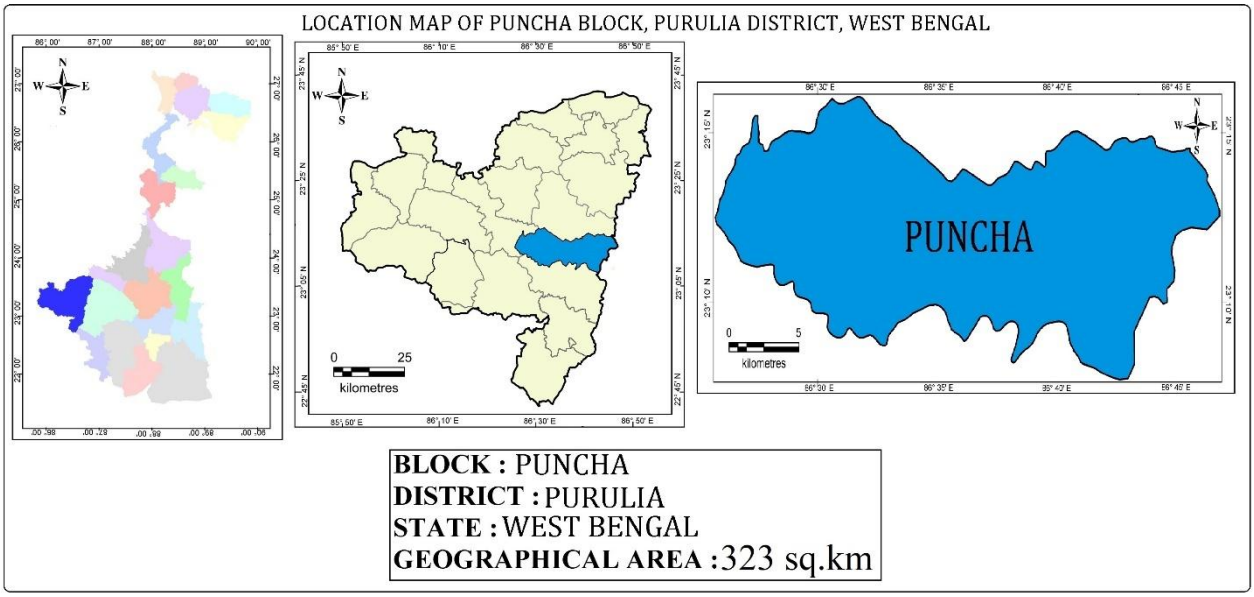

Figure 11.15.1: Location Map of Puncha Block

Population (as on 2011):

Table 11.15.1: Details of population in Puncha block.

Rural	Urban	Total
123855	--	123855

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.15.2: Details of Annual Rainfall for the last five years in Puncha block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Puncha	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.15.3: Salient Land use features of Punchablock

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Puncha	32300	23509	2948.19	20560.81	4585

Ground Water Resource:

Table 11.15.4: Details of Ground Water Resource Availability and Utilization in PunchaBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**4608.93**
Annual Extractable Ground Water Resource (HaM)	**4378.48**
Gross Ground Water Abstraction for all uses (HaM)	**258.05**
Net Ground Water Availability for future use (HaM)	**4044.35**
Stage of Ground Water Development (%)	**5.89**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**273.33**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**19700.96**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 15-50 mbgl. **Aquifer-II(Deeper aquifer)** ranges between 50-200 mbgl. Both aquifers are fresh in nature.

Table 11.15.5: Details of aquifer disposition in Puncha (fractured aquifer) block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Puncha	Banded Gneiss	15-50	50-200	16.60 – 19.60 35.00 – 36.00	80.11-82.63

Table 11.15.6: Aquifer-wise depth range and parameters in Puncha (fractured aquifer) block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Puncha	Aquifer I	15-50	7.92-15.70	--	--	--
	Aquifer II	50-200	--	--	--	--

Table 11.15.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Puncha	Phreatic	5.25– 9.98	0.235	**--**	2.57– 6.52	0.156	**--**

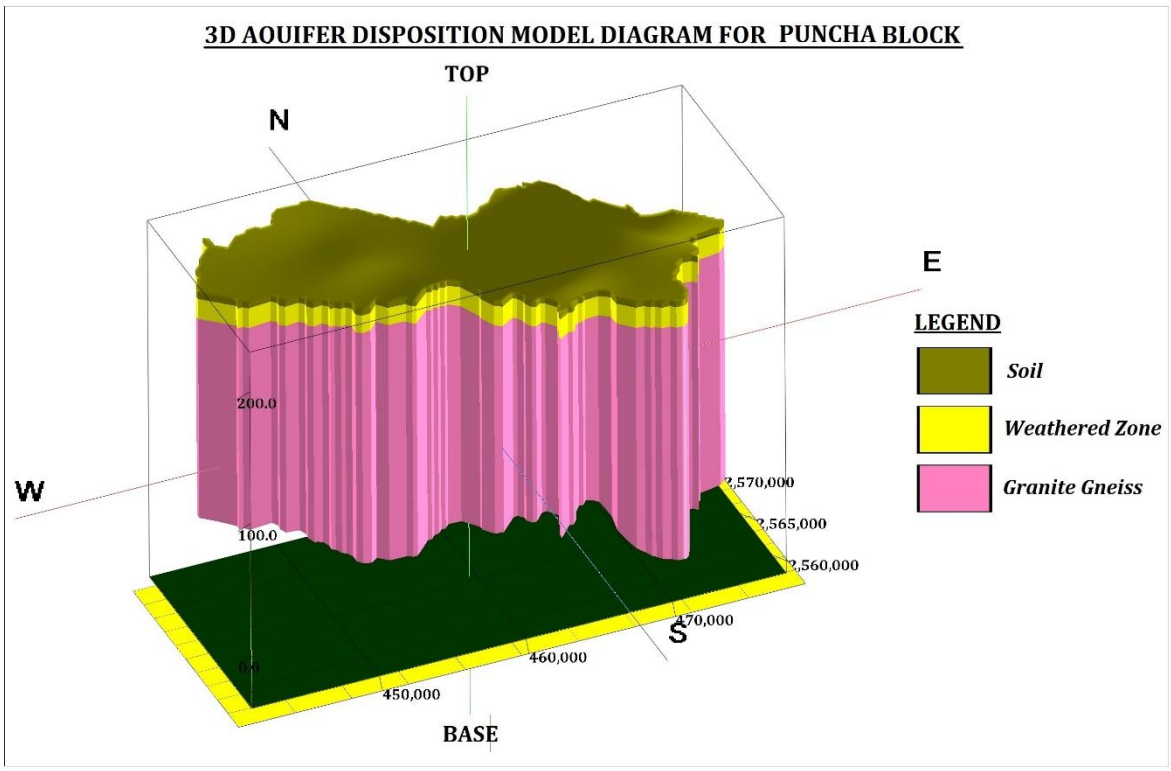

Figure 11.15.2: 3-Dimensional Aquifer disposition in Puncha Block

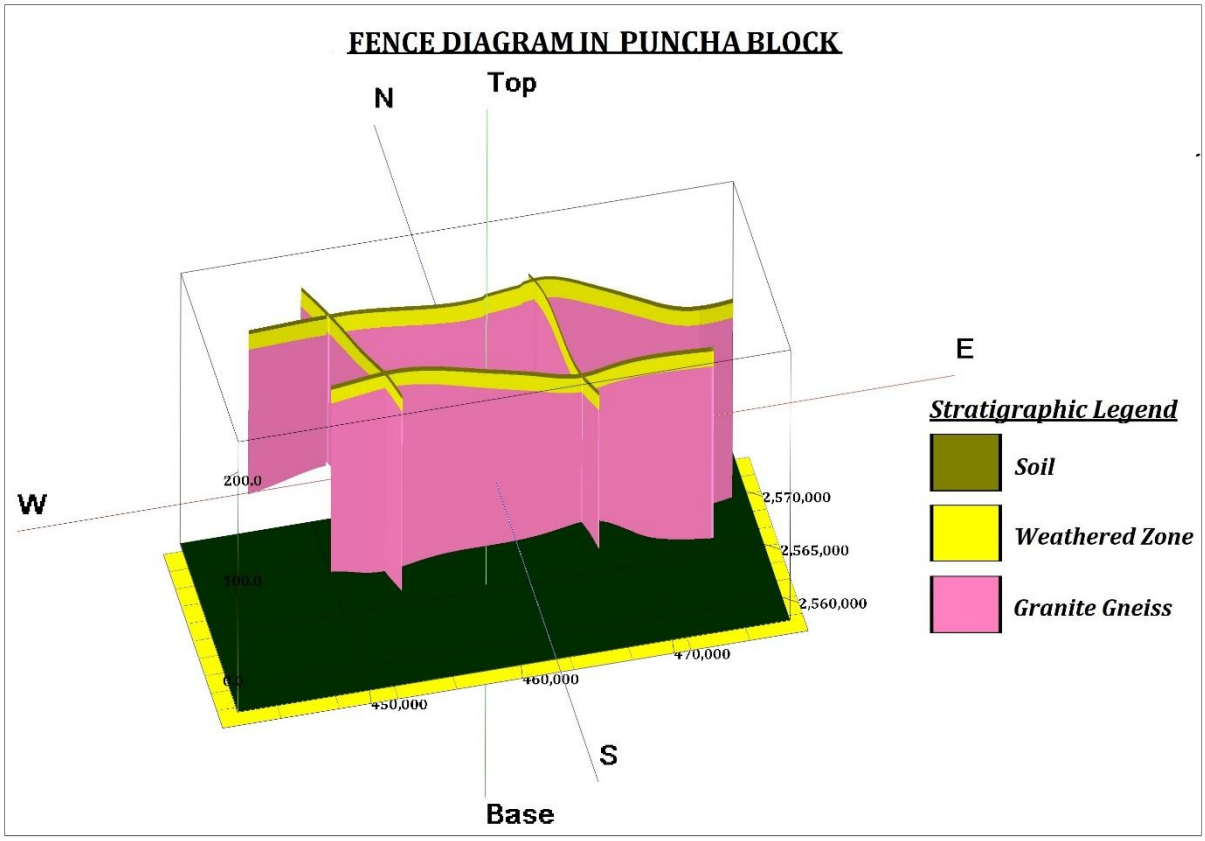

Figure 11.15.3: Lithological Fence Diagram in Puncha Block

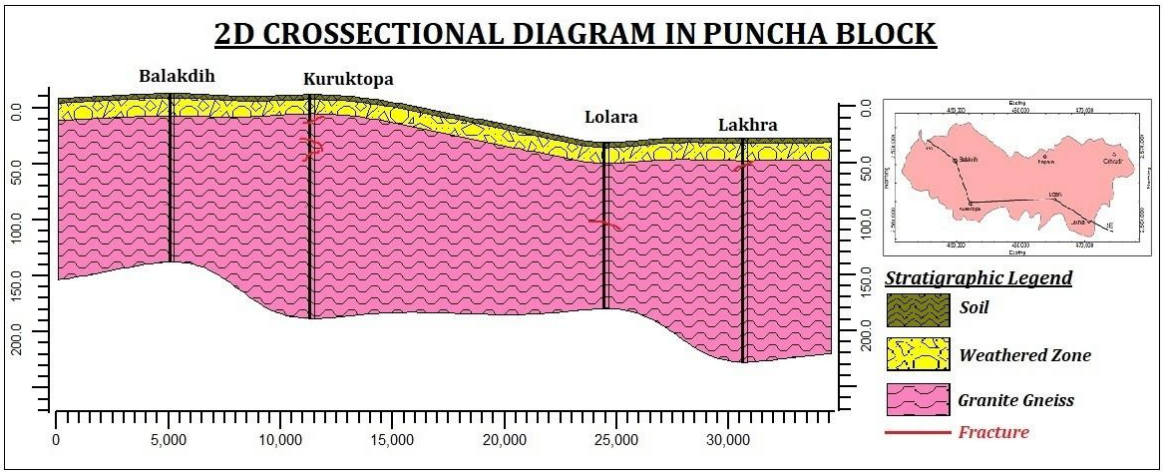

Figure 11.15.4: 2-Dimensional Section in Puncha Block

Ground water quality and issues:

Based on fiveNHS (dugwells), three exploratory well and one observation well, the range of chemical parameters for the block is given below.

Table 11.15.8 Range of chemical parameters in Puncha 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)
Puncha	Phreatic	7.87-8.03	155-1985	13-192	11-379	0.14-0.31	BDL-176	0.01-0.06	55-735
	Fractured	6.76-8.29	246-1057	24-70	14-213	0.34-0.69	BDL-42	0.48-0.98	75-335

Aquifer Management Plan:

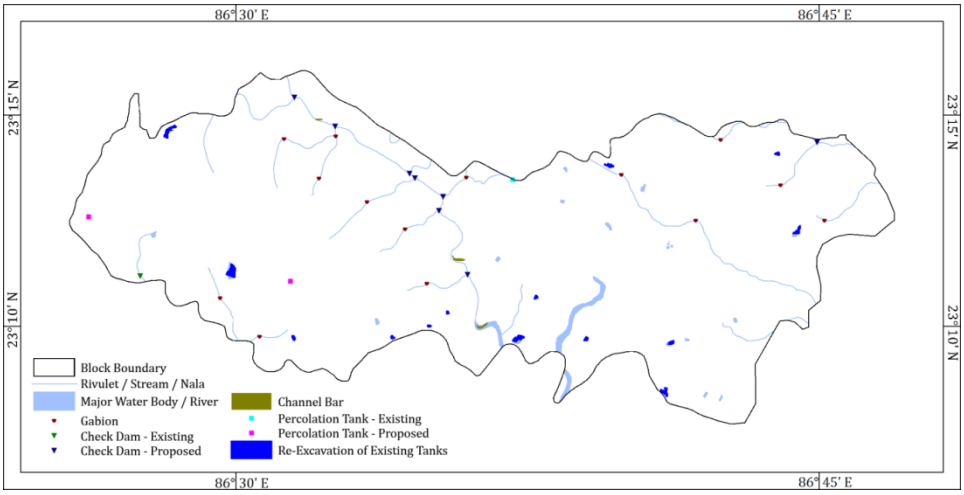

Figure - 11.15.5 : AQM-Recommended Water Conservation Structures in Puncha Block

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SALIENT INFORMATION

Block Name: **Purulia-I**

Geographical area (sq. km): **302**

Mappable area (sq. km): **290**

District: **Purulia**

State: **West Bengal**

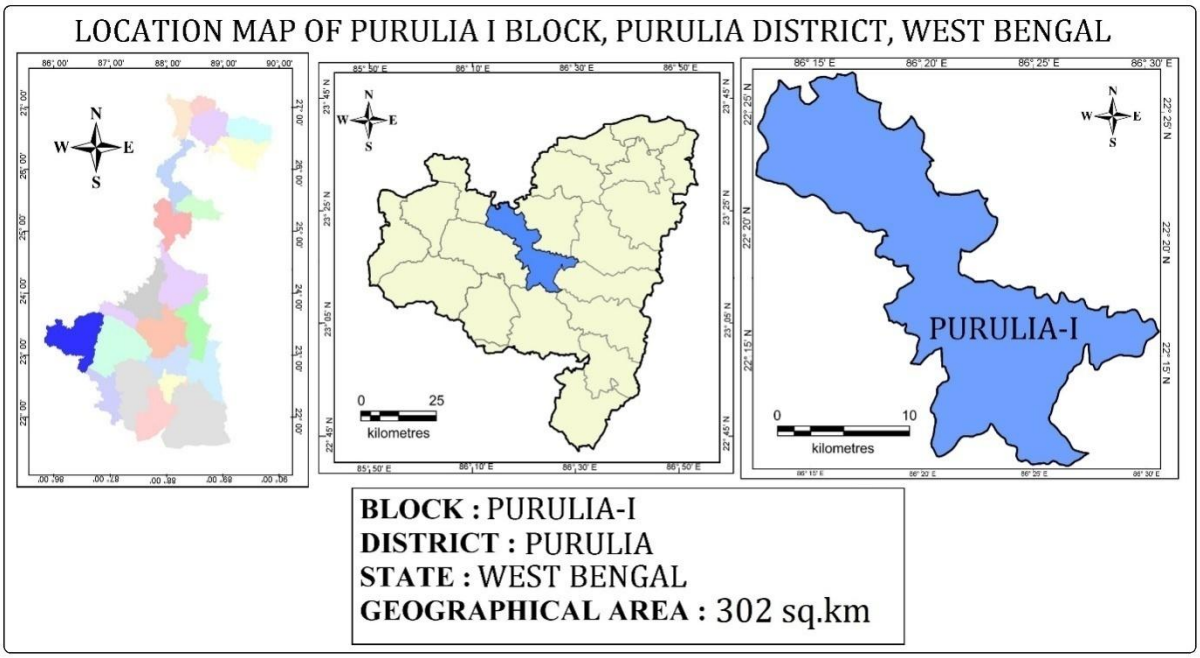

Figure 11.16.1: Location Map of Purulia-IBlock

Population (as on 2011):

Table 11.16.1: Details of population in Purulia-Iblock.

Rural	Urban	Total
145494	5694	151188

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.16.2: Details of Annual Rainfall for the last five years in Purulia-I block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Purulia-I	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.16.3: Salient Land use features of Purulia-Iblock

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Purulia-I	30200	20350	5004.24	15345.76	659

Ground Water Resource:

Table 11.16.4: Details of Ground Water Resource Availability and Utilization in Purulia-IBlock.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**4538.02**
Annual Extractable Ground Water Resource (HaM)	**4084.22**
Gross Ground Water Abstraction for all uses (HaM)	**485.81**
Net Ground Water Availability for future use (HaM)	**3430.15**
Stage of Ground Water Development (%)	**11.89**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**604.47**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**8271.20**

Disposition of Aquifers:

Theprincipal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells.This aquifer is usually found within the weatheredor saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)**ranges between15-50 mbgl.**Aquifer-II (Deeper aquifer)**ranges between50-200 mbgl.Both Aquifersare freshin nature.

Table 11.16.5: Details of aquifer disposition (fractured aquifer) in Purulia-I block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Purulia-I	Banded Gneiss & Granites	15-50	50-200	16.60 - 19.60	50.10 - 53.20

Table 11.16.6: Aquifer-wise depth range and parameters (fractured aquifer) in Purulia-I block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Purulia-I	Aquifer I	15-50	0.72-25.2	0.72-25.2	--	--
	Aquifer II	50-200	50.10 - 53.20	7.56	--	--

Table 11.16.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Purulia-I	Phreatic	4.47– 9.9	--	0.432	1.65– 3.53	--	0.048

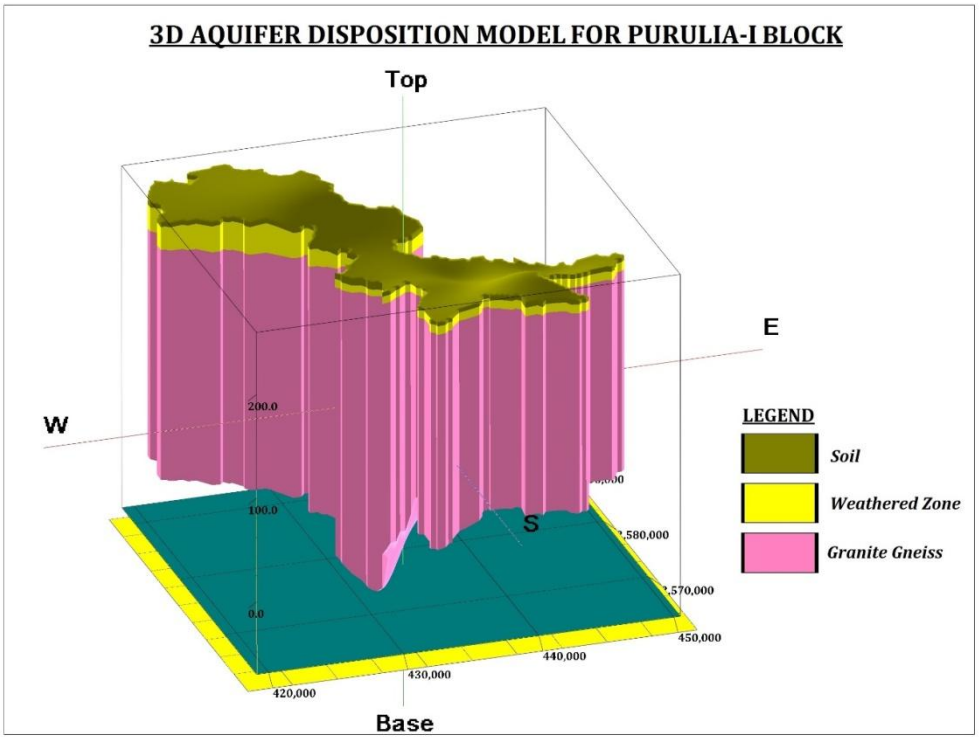

Figure 11.16.2: 3-Dimensional Aquifer disposition in Purulia-IBlock

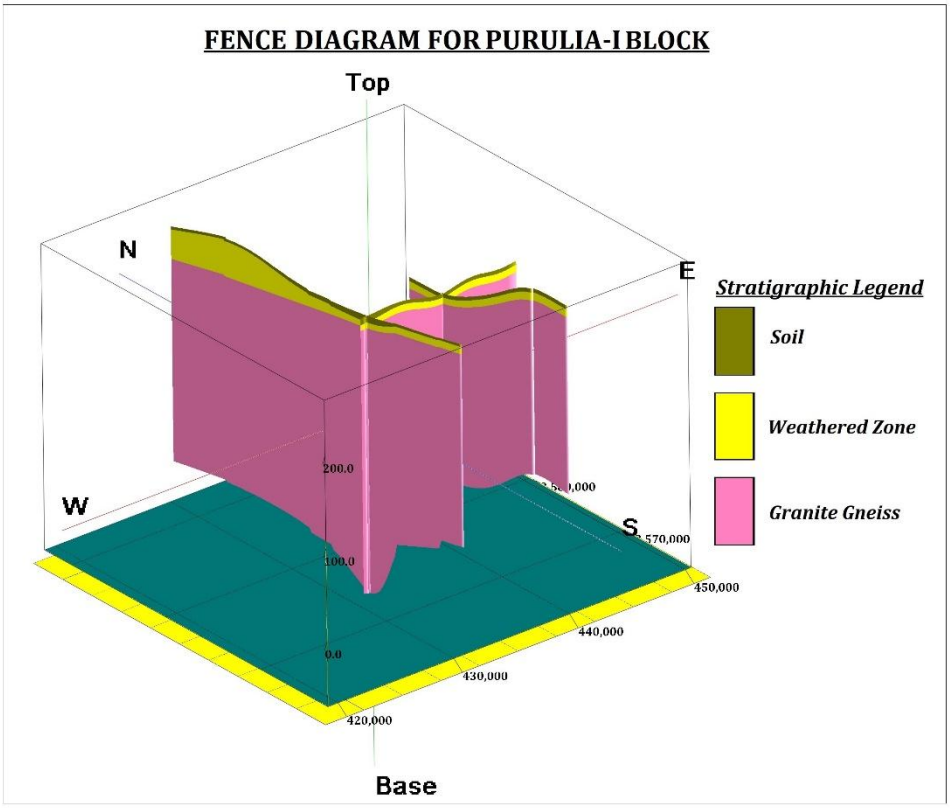

Figure 11.16.3: Fence diagram in Purulia-I Block

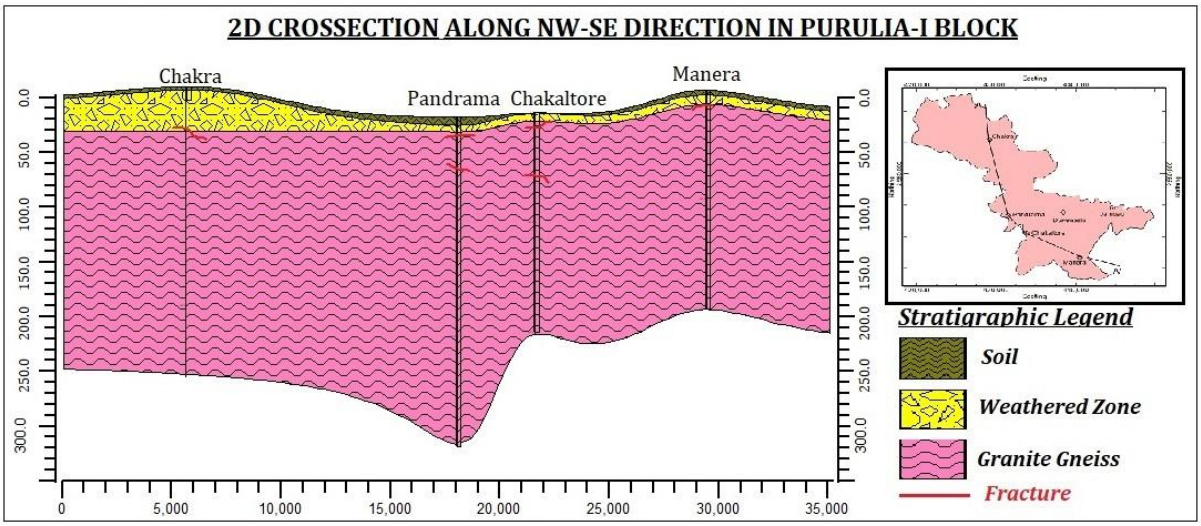

Figure 11.16.4: 2D section in Purulia-I Block

Ground water quality and issues:

Based on five NHS (dugwells), six exploratory well and three observation well, the range of chemical parameters for the block is given below.

Table 11.16.8 Range of chemical parameters in Purulia-IBlock

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)
Purulia-I	Phreatic	7.54-8.15	364-1560	29-133	32-347	0.13-0.68	1-73	BDL-0.03	125-440
	Fractured	7.17-8.27	386-774	26-93	18-140	0.36-0.81	BDL-27	0.06-0.43	90-245

Aquifer Management Plan:

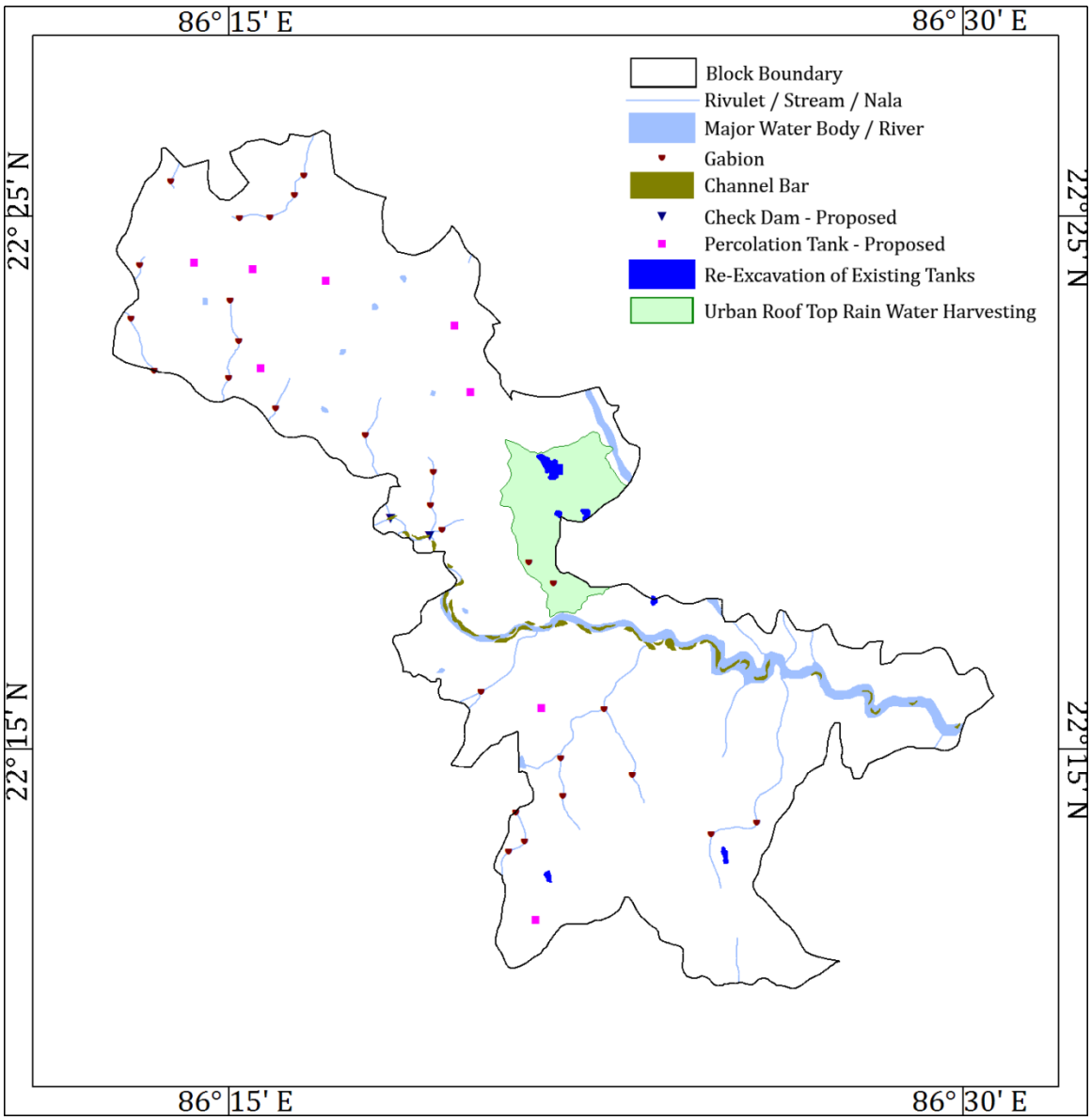

Figure - 11.16.5 : AQM-Recommended Water Conservation Structures in Purulia-I Block

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SALIENT INFORMATION

Block Name: **Purulia-II**

Geographical area (sq. km): **312**

Mappable area (sq. km): **299**

District: **Purulia**

State: **West Bengal**

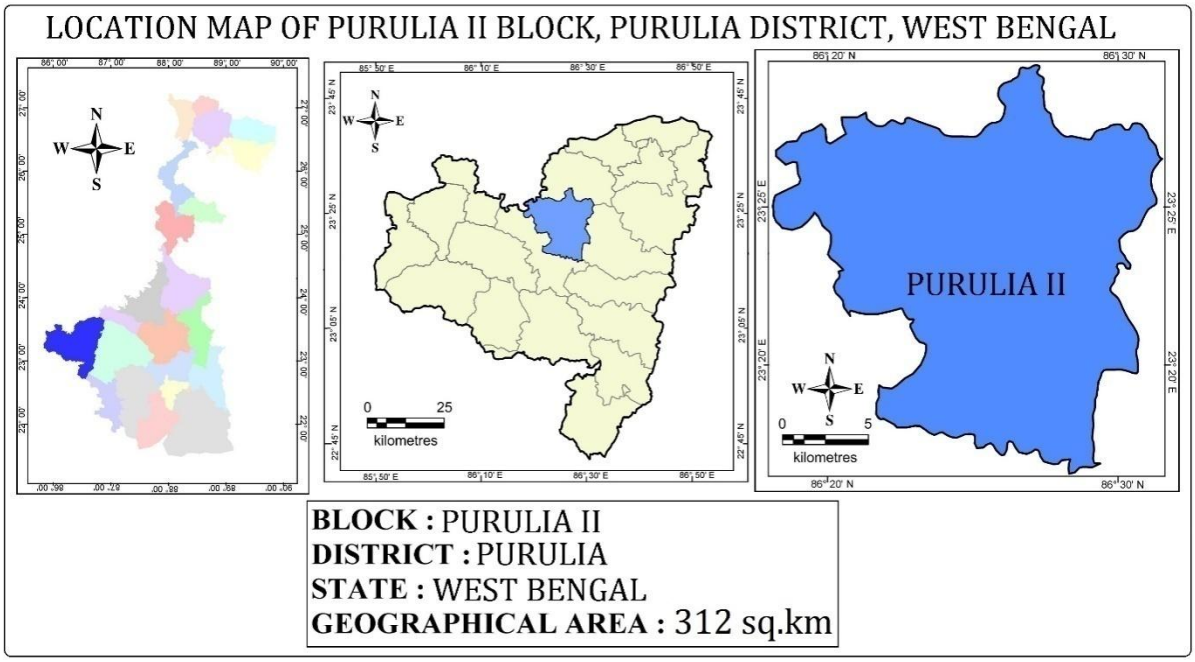

Figure 11.17.1: Location Map of Purulia-II Block

Population (as on 2011):

Table 11.17.1: Details of population in Purulia-II block.

Rural	Urban	Total
157862	11626	169488

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.17.2: Details of Annual Rainfall for the last five years in Purulia-II block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Purulia-II	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.17.3: Salient Land use features of Purulia-II block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Purulia-II	31200	25628	6495.59	19132.41	266

Ground Water Resource:

Table 11.17.4: Details of Ground Water Resource Availability and Utilization in Purulia-II Block.

(As on 31.03.2013)

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**4274.14**
Annual Extractable Ground Water Resource (HaM)	**3846.73**
Gross Ground Water Abstraction for all uses (HaM)	**347.52**
Net Ground Water Availability for future use (HaM)	**3398.78**
Stage of Ground Water Development (%)	**9.03**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**360.75**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**8564.96**

Disposition of Aquifers:

The principal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 10-50 mbgl. **Aquifer-II (Deeper aquifer)** ranges between 50-200 mbgl. Both Aquifers are fresh in nature.

Table 11.17.5: Details of aquifer disposition (fractured aquifer) in Purulia-II block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Purulia-II	Banded Gneiss & Granites	10-50	50-200	10.4 - 16.50 16.5 - 28.70 28.70 - 40.90	86.70 – 92.80 147.7 - 159.9 159.9 - 200.5

Table 11.17.6: Aquifer-wise depth range and parameters (fractured aquifer) in Purulia-II block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Purulia-II	Aquifer I	10-50	0.72 - 9	≈ 5	--	--
	Aquifer II	50-200	1.08 - 10.8	5.75 - 8.13	--	--

Table 11.17.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Purulia-II	Phreatic	5.77– 6.67	0.583	**--**	2.49– 4.02	**--**	0.035

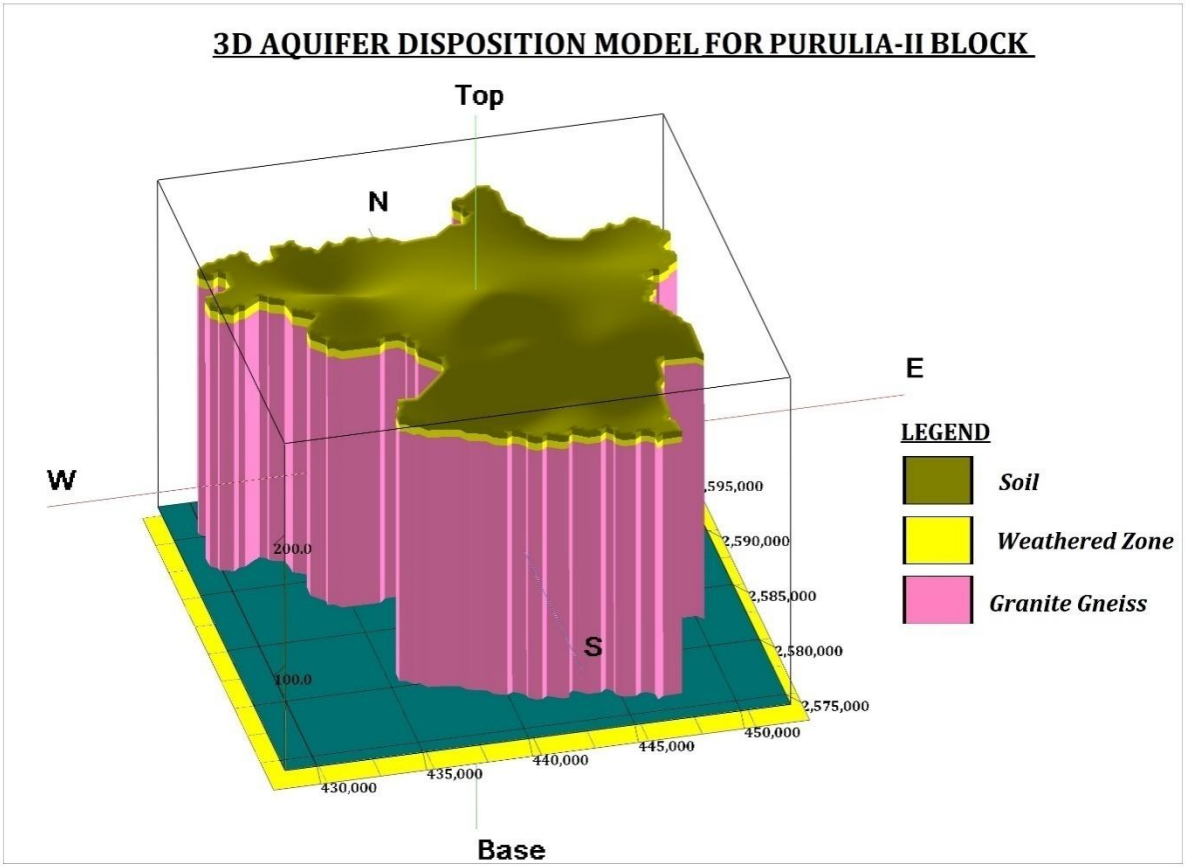

Figure 11.17.2: 3-Dimensional Aquifer disposition in Purulia-II Block

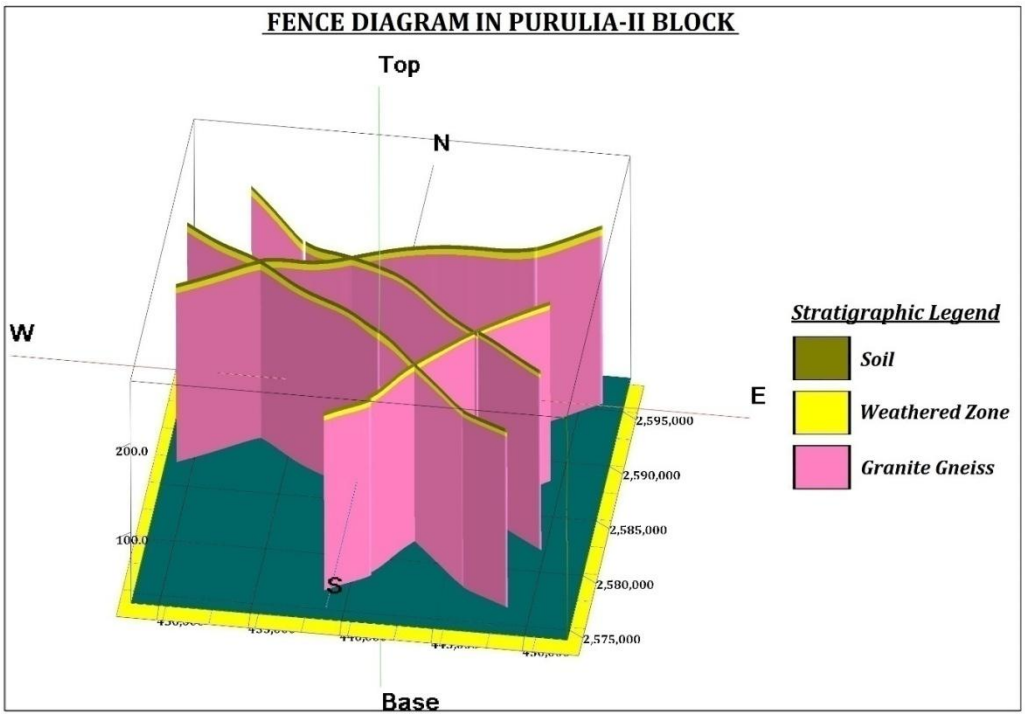

Figure 11.17.3: Fence diagram in Purulia-II Block

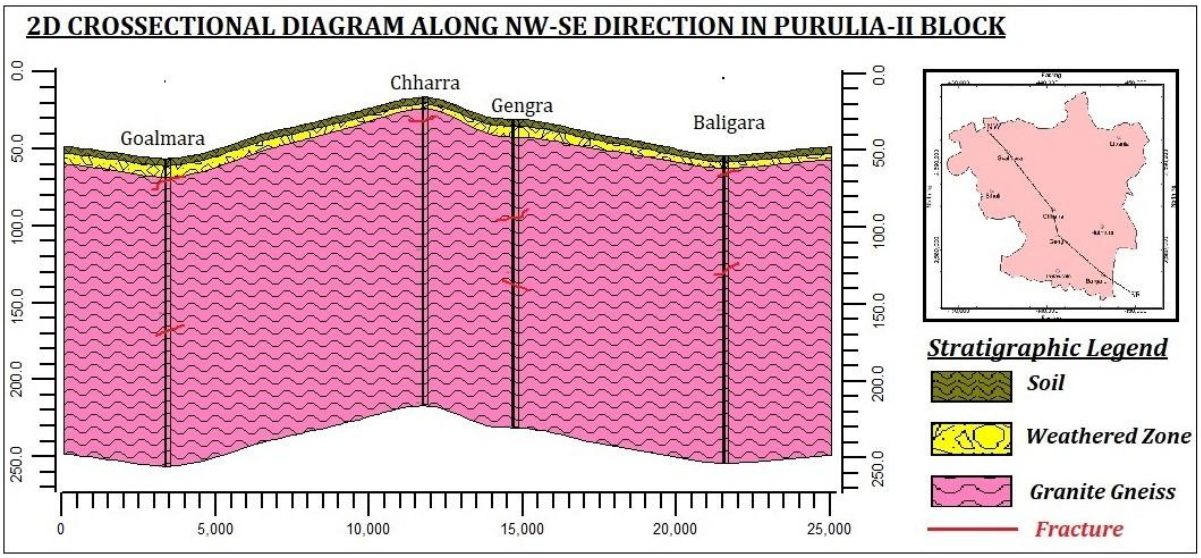

Figure 11.17.4: 2-Dimensional Section in Purulia-II Block

Ground water quality and issues:

Based on five NHS (dugwells), two exploratory well and one observation well, the range of chemical parameters for the block is given below.

Table 11.17.8 Range of chemical parameters in Purulia-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)
Purulia-II	Phreatic	7.81-8.30	685-2108	53-121	64-415	0.08-0.73	18-259	0.01-0.30	250-730
	Fractured	7.52-8.03	397-1318	36-109	50-230	0.27-0.29	BDL	0.01-0.58	140-360

Aquifer Management Plan:

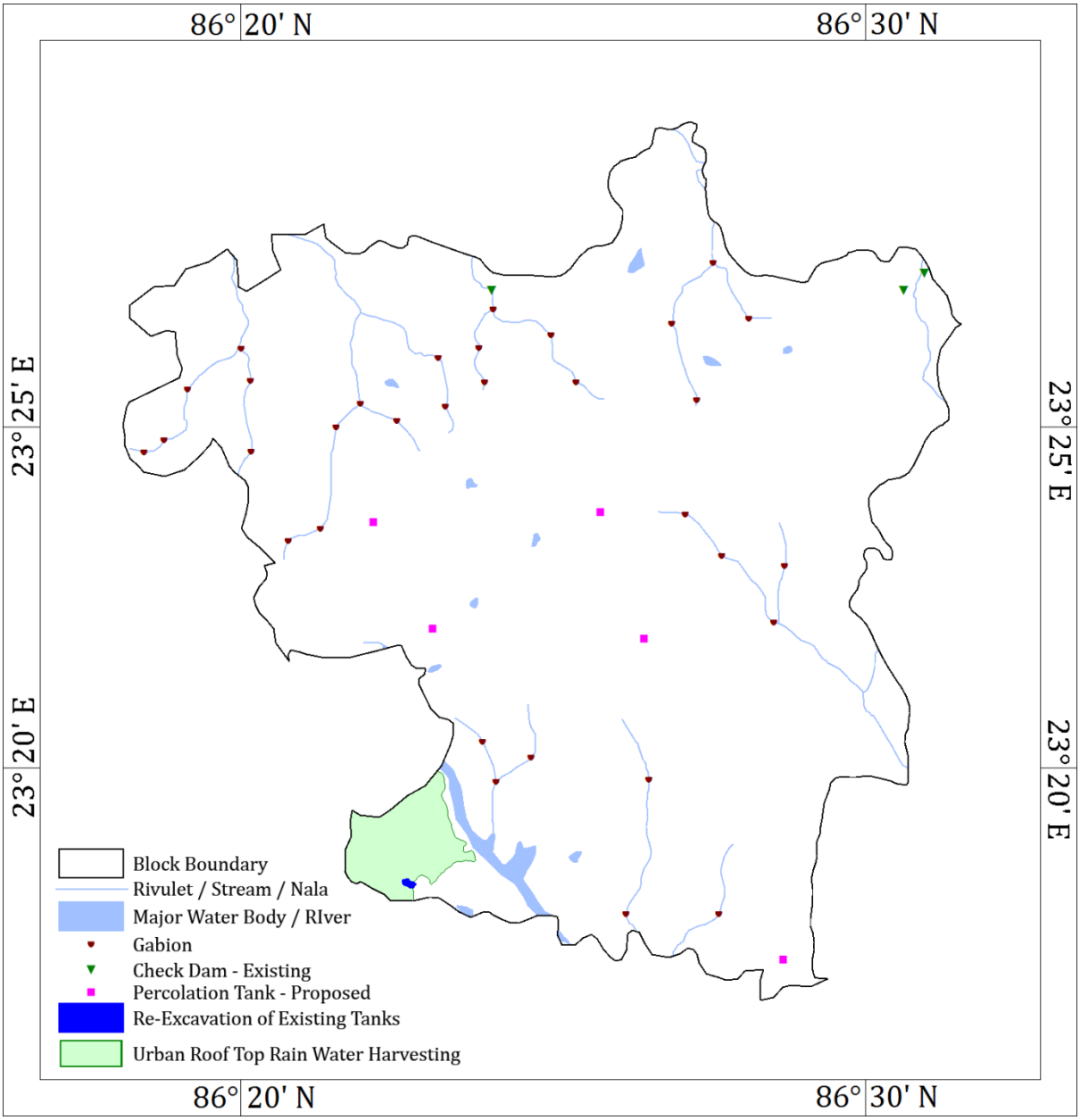

Figure - 11.17.5 : AQM-Recommended Water Conservation Structures in Purulia-II Block

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SALIENT INFORMATION

Block Name: **Raghunathpur-I**

Geographical area (sq. km): **193**

Mappable area (sq. km): **185**

District: **Purulia**

State: **West Bengal**

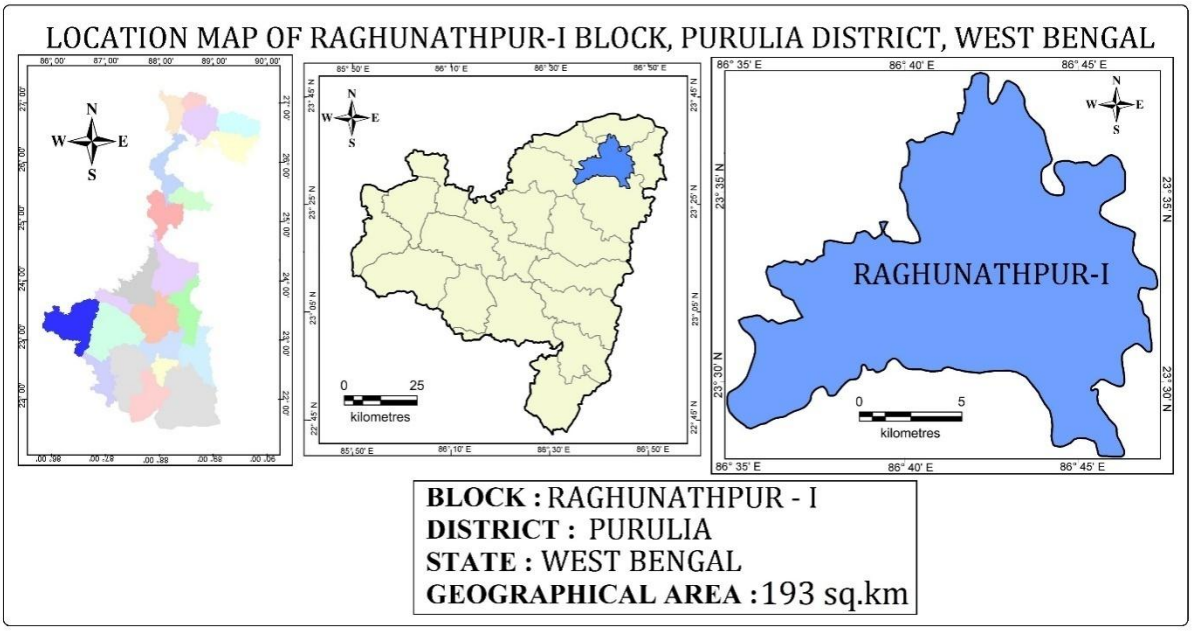

Figure 11.18.1: Location Map of Raghunathpur-I Block

Population (as on 2011):

Table 11.18.1: Details of population in Raghunathpur-I block.

Rural	Urban	Total
96488	21272	117760

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.18.2: Details of Annual Rainfall for the last five years in Raghunathpur-I block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Raghunathpur-I	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.18.3: Salient Land use features of Raghunathpur-I block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Raghunathpur-I	19300	14300	5249.97	9050.03	443

Ground Water Resource:

Table 11.18.4: Details of Ground Water Resource Availability and Utilization in Raghunathpur-I

Block.(As on 31.03.2013).

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**2577.73**
Annual Extractable Ground Water Resource (HaM)	**2319.96**
Gross Ground Water Abstraction for all uses (HaM)	**230.13**
Net Ground Water Availability for future use (HaM)	**2001.37**
Stage of Ground Water Development (%)	**9.92**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**317.79**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	6202.56

Disposition of Aquifers:

The principal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 10-40 mbgl. **Aquifer-II (Deeper aquifer)** ranges between 40-200 mbgl. Both Aquifers are fresh in nature.

Table 11.18.5: Details of aquifer disposition (fractured aquifer) in Raghunathpur-I block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Raghunathpur-I	Granite/Granite gneiss/Porphyritic granite	10-40	40-200	13.0 - 37.0 31.92 - 34.41 34.46 - 37.45	48.0 - 62.24

Table 11.18.6: Aquifer-wise depth range and parameters (fractured aquifer) in Raghunathpur-I block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Raghunathpur-I	Aquifer I	10-40	1.19 - 9.97	15 - 24	--	--
	Aquifer II	40-200	1.76 - 9.97	15 - 18	--	--

Table 11.18.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Raghunathpur-I	Phreatic	4.67– 5.91	0.303	--	2.58– 4.41	--	0.067

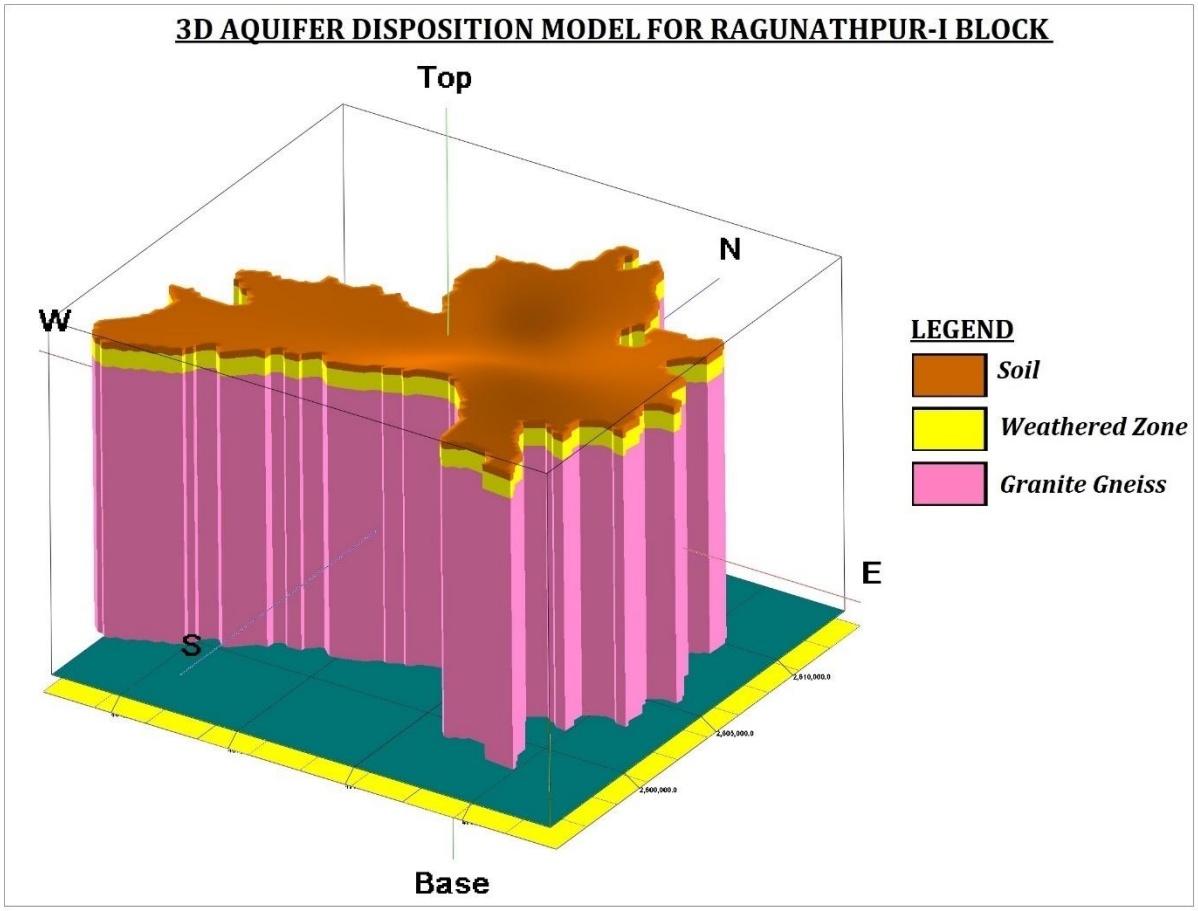

Figure 11.18.2: 3-Dimensional Aquifer disposition in Raghunathpur-I Block

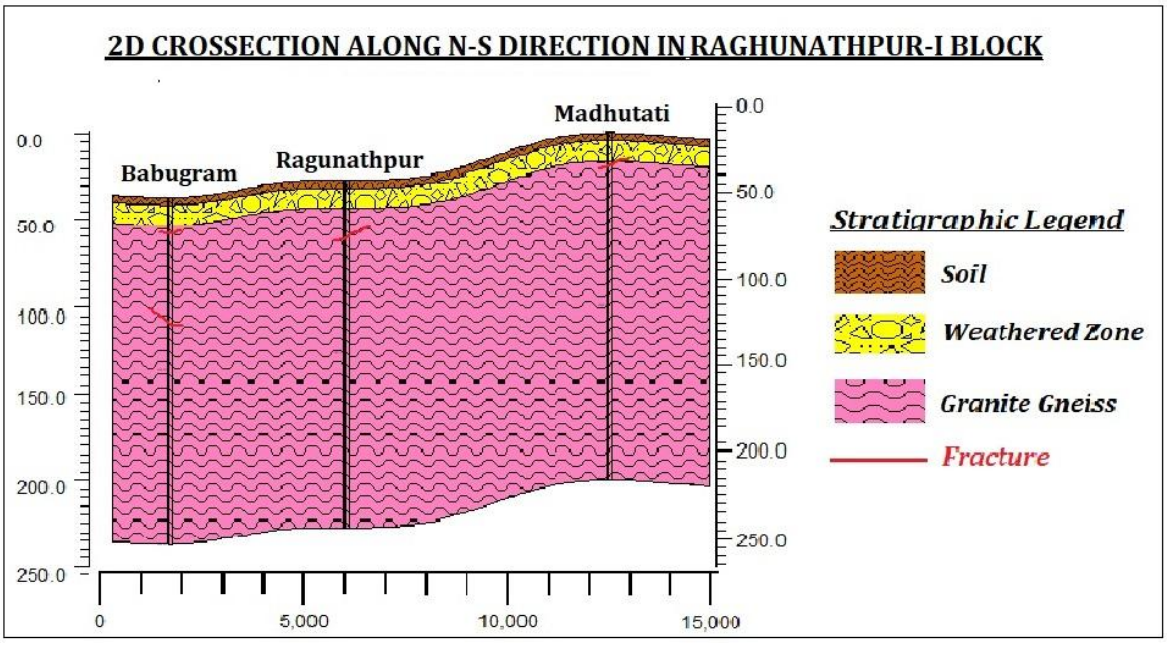

Figure 11.18.3: 2-Dimensional Section in Raghunathpur-I Block

Ground water quality and issues:

Based on NHS (dugwells), the range of chemical parameters for the block is given below.

Table 11.18.8 Range of chemical parameters in Raghunathpur-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)
Raghunathpur-I	Phreatic	7.98	435	54	46	0.06	BDL	0.07	115

Aquifer Management Plan:

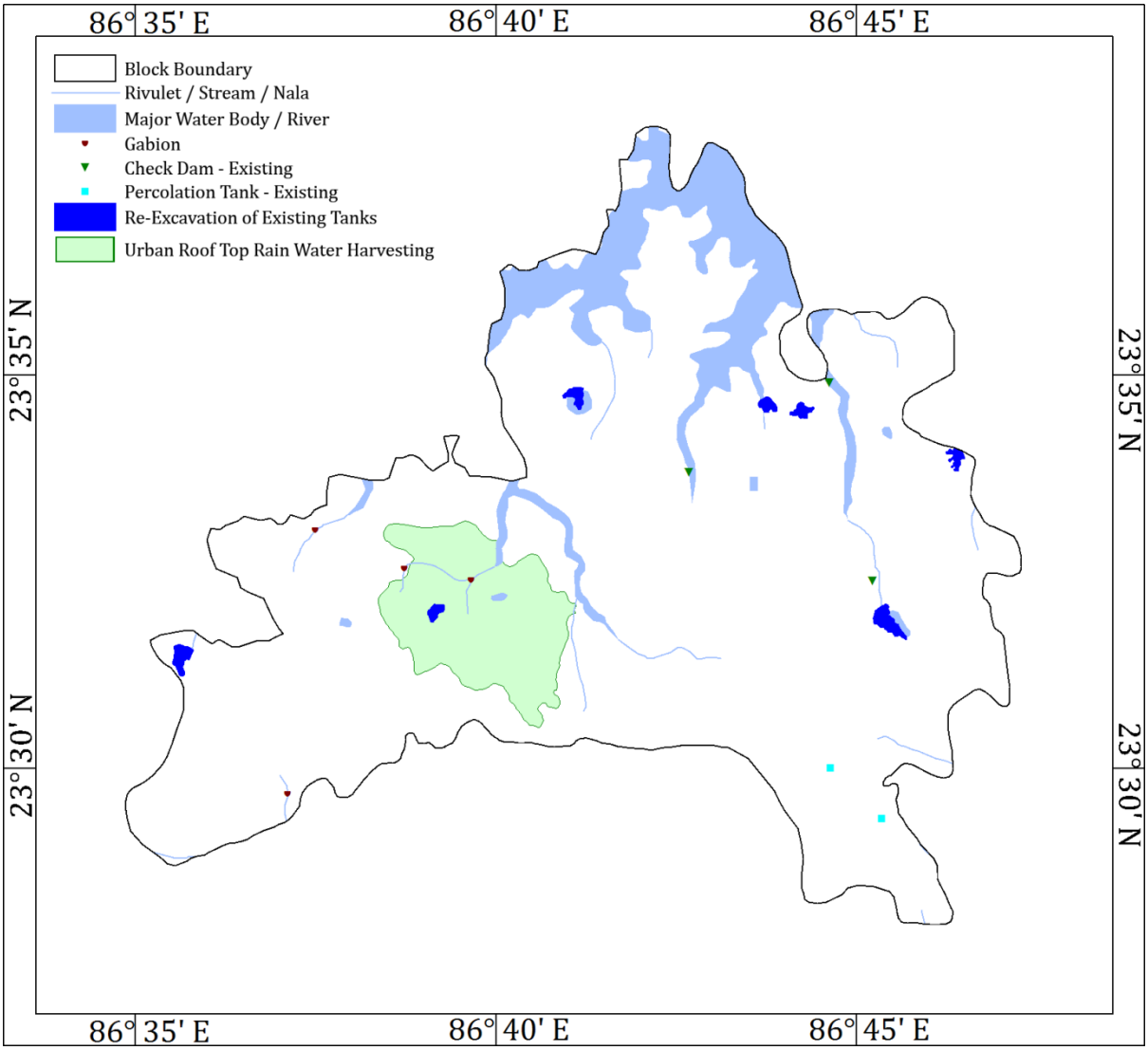

Figure - 11.18.4 : AQM-Recommended Water Conservation Structures in Raghunathpur-I Block

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SALIENT INFORMATION

Block Name: **Raghunathpur-II**

Geographical area (sq. km): **194**

Mappable area (sq. km): **186**

District: **Purulia**

State: **West Bengal**

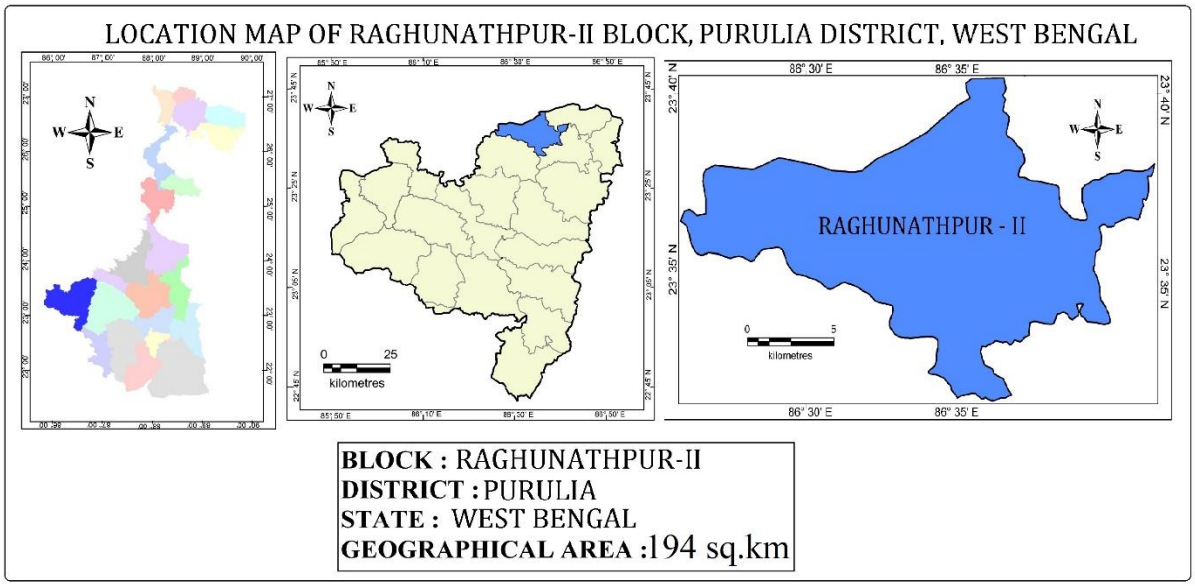

Figure 11.19.1: Location Map of Raghunathpur-II Block

Population (as on 2011):

Table 11.19.1: Details of population in Raghunathpur-II block.

Rural	Urban	Total
107827	5963	113790

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.19.2: Details of Annual Rainfall for the last five years in Raghunathpur-II block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Raghunathpur-II	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.19.3: Salient Land use features of Raghunathpur-II block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Raghunathpur-II	19400	15887	2739.87	13147.13	237

Ground Water Resource:

Table 11.19.4: Details of Ground Water Resource Availability and Utilization in Raghunathpur-II

Block. (As on 31.03.2013).

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**2978.64**
Annual Extractable Ground Water Resource (HaM)	**2680.78**
Gross Ground Water Abstraction for all uses (HaM)	**203.41**
Net Ground Water Availability for future use (HaM)	**2407.55**
Stage of Ground Water Development (%)	**7.59**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**250.83**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**8794.34**

Disposition of Aquifers:

The principal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 10-40 mbgl. **Aquifer-II (Deeper aquifer)** ranges between 40-200 mbgl. Both Aquifers are fresh in nature.

Table 11.19.5: Details of aquifer disposition (fractured aquifer) in Raghunathpur-II block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Raghunathpur-II	Hornblende gneiss/Granite gneiss	10-40	40-200	15.00 -17.10 16.00 - 18 .00 22.5 - 31.00	40.45-59.51

Table 11.19.6: Aquifer-wise depth range and parameters (fractured aquifer) in Raghunathpur-II block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Raghunathpur-II	Aquifer I	10-40	3.49 - 9.97	9.1 - 13	--	--
	Aquifer II	40-200	0.29 - 7.96	8.12 - 10.12	--	--

Table 11.19.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Raghunathpur-II	Phreatic	4.66– 10.49	--	--	2.80– 6.61	--	0.046

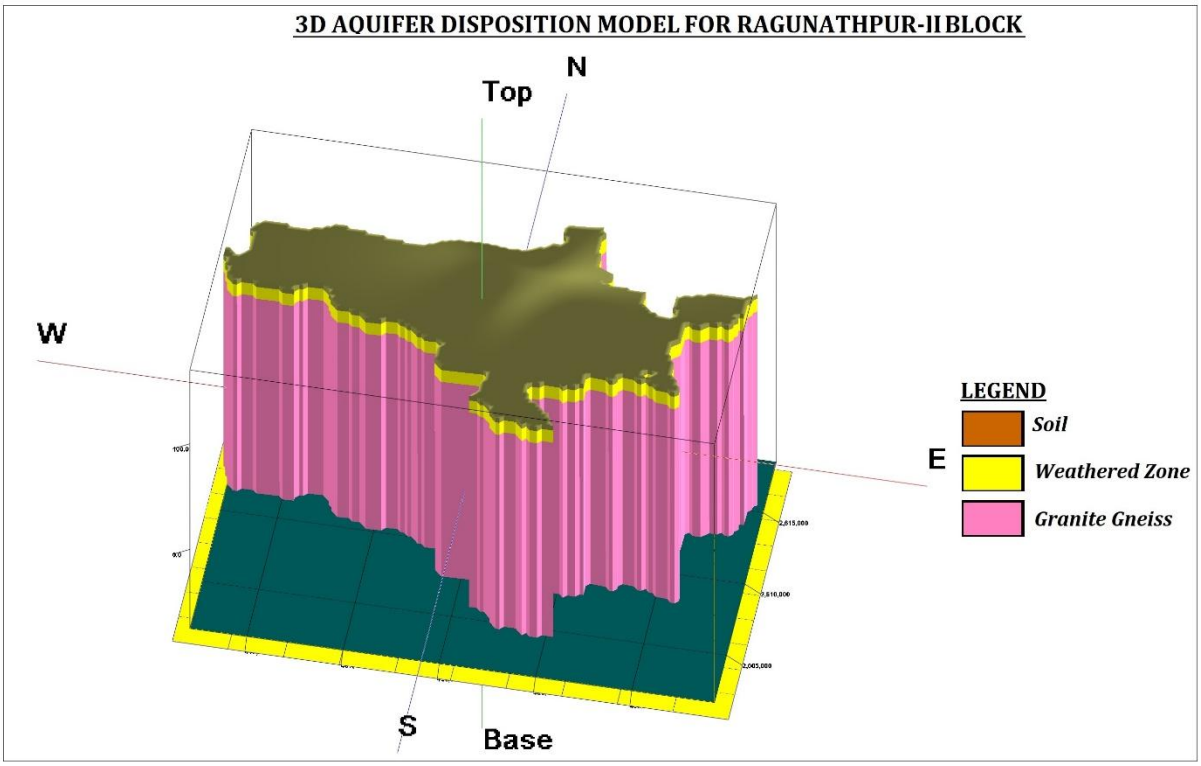

Figure 11.19.2: 3-Dimensional Aquifer disposition in Raghunathpur-II Block

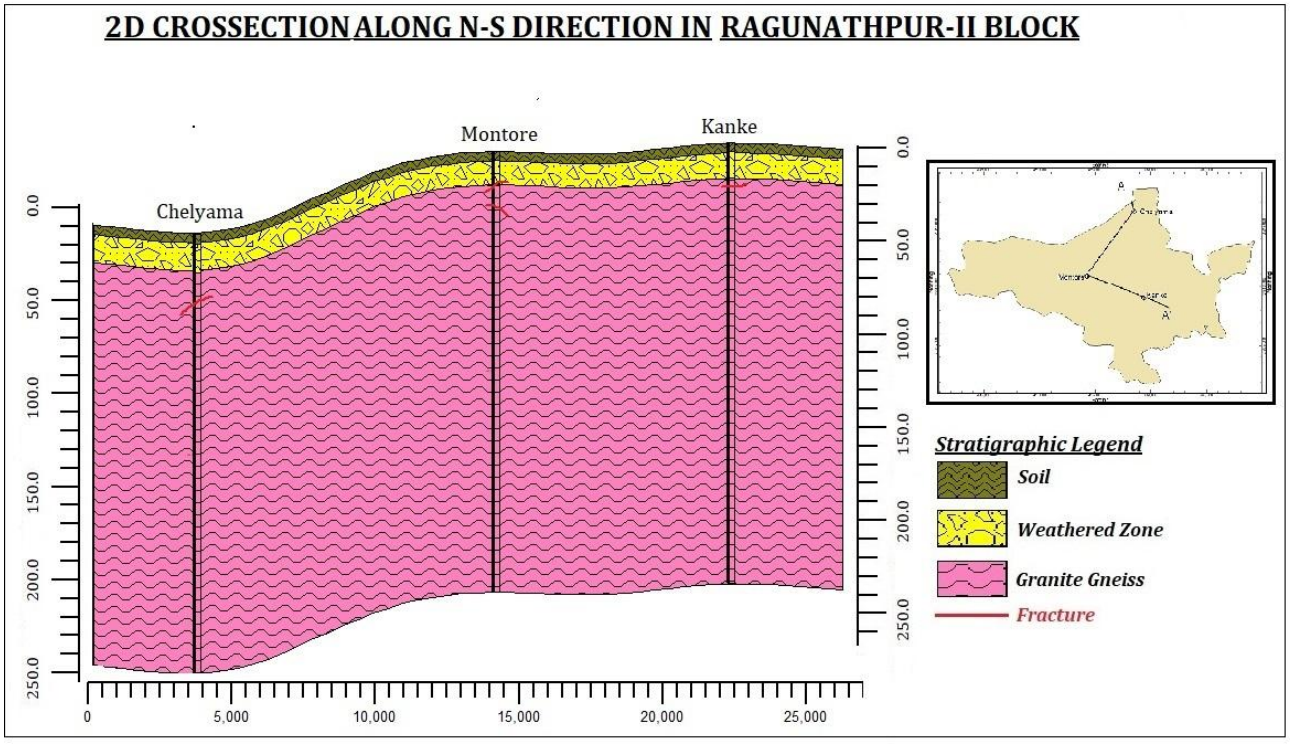

Figure 11.19.3: 2-Dimensional Section in Raghunathpur-II Block

Ground water quality and issues:

Based on NHS (dugwells), the range of chemical parameters for the block is given below.

Table 11.19.8 Range of chemical parameters in Raghunathpur-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)
Raghunathpur-II	Phreatic	7.97	1016	97	163	0.56	7	BDL	285

Aquifer Management Plan:

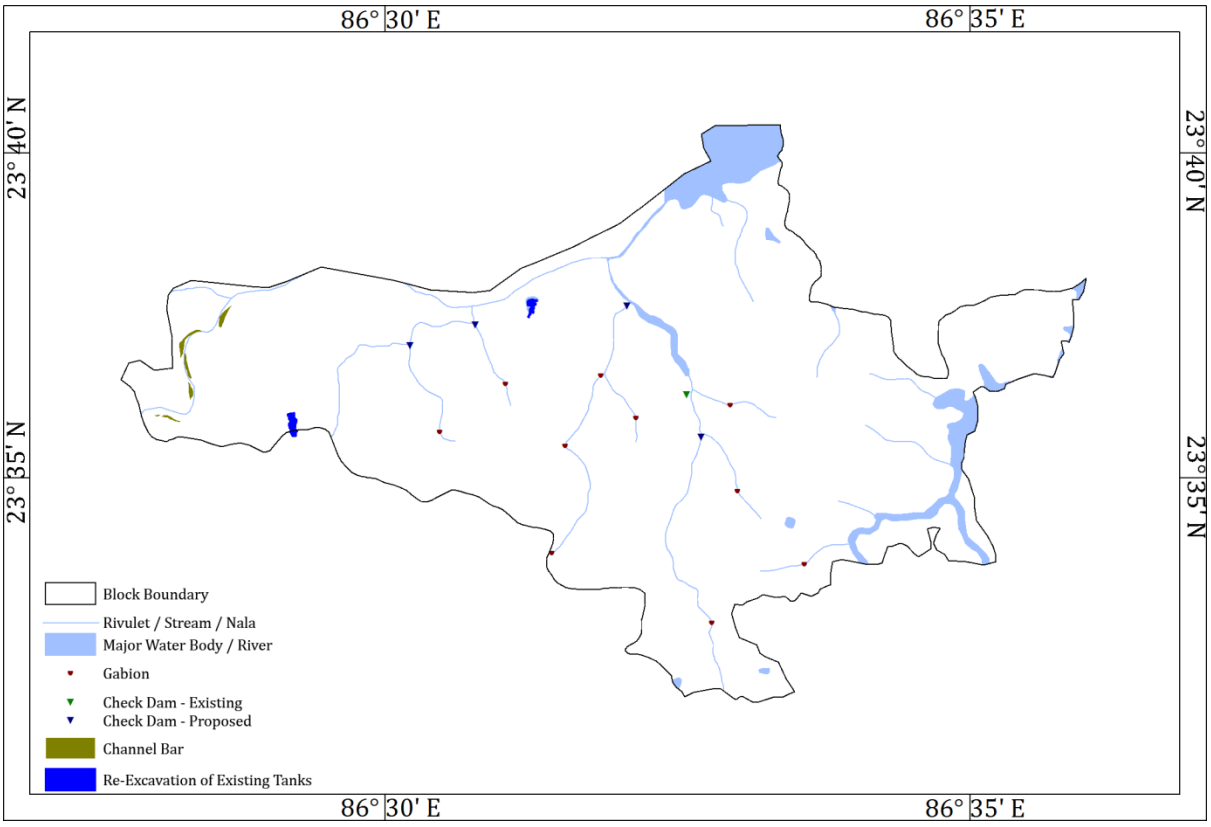

Figure - 11.19.4 : AQM-Recommended Water Conservation Structures in Raghunathpur-II Block

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SALIENT INFORMATION

Block Name: **Santuri**

Geographical area (sq. km): **170**

Mappable area (sq. km): **163**

District: **Purulia**

State: **West Bengal**

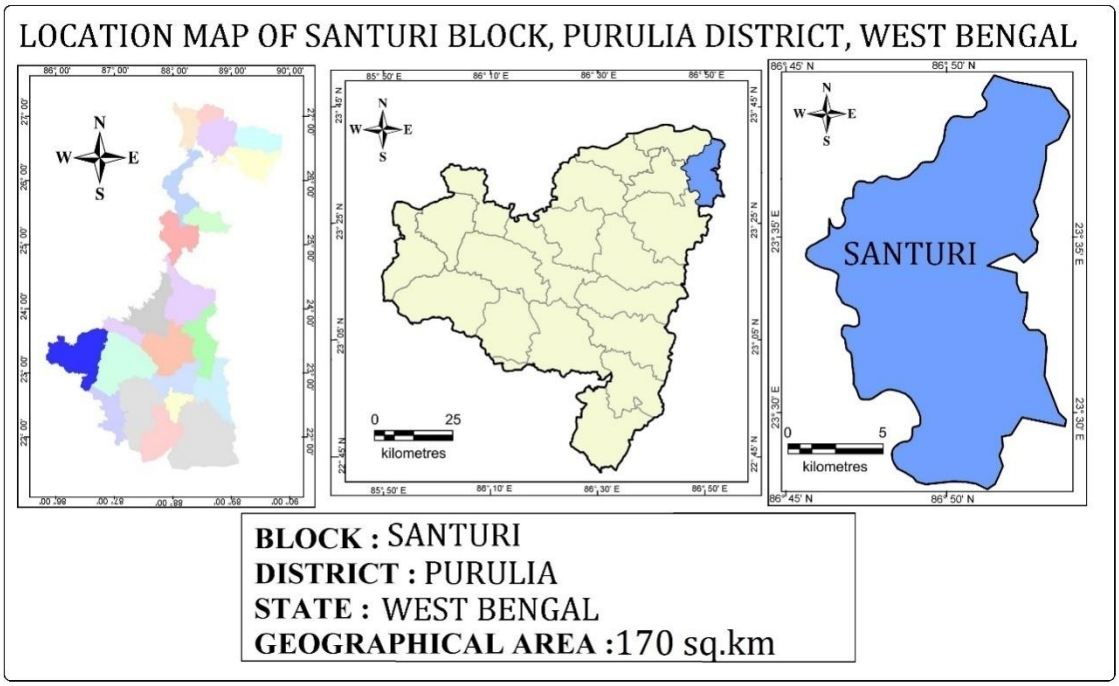

Figure 11.20.1: Location Map of Santuri Block

Population (as on 2011):

Table 11.20.1: Details of population in Santuri block.

Rural	Urban	Total
72586	5929	78515

Rainfall: Average annual rainfall for the period 2015 -19 is 1300.36 (in mm)

Table 11.20.2: Details of Annual Rainfall for the last five years in Santuri block.

Block	District Normal	District Actual (Annual)				
		2015	**2016**	**2017**	**2018**	**2019**
Santuri	1321.9	1208.7	1367.9	1565.9	1140.2	1219.1

Agriculture& Irrigation (area in ha):

Table 11.20.3: Salient Land use features of Santuri block

Name of the Block	Geographic Area	Cultivable area	Total CCA	Area to be brought under CCA	Forest Land
Santuri	17000	14310	5487.51		--

Ground Water Resource:

Table 11.20.4: Details of Ground Water Resource Availability and Utilization in Santuri Block. (As on 31.03.2013).

Dynamic Ground Water Resources	
Annual Replenishable Ground Water Resource (HaM)	**3001.34**
Annual Extractable Ground Water Resource (HaM)	**2701.21**
Gross Ground Water Abstraction for all uses (HaM)	**174.54**
Net Ground Water Availability for future use (HaM)	**2477.70**
Stage of Ground Water Development (%)	**6.46**
Category	**Safe**
Annual GW Allocation for Domestic and Industrial use as on 2025 (HaM)	**175.91**
In-storage Ground Water Resources	
In-storage Resource beneath Ground Water Fluctuation Zone upto a depth of 300 mbgl (HaM)	**6477.82**

Disposition of Aquifers:

The principal aquifer system encountered in this block is **Banded Gneissic Complex (BG01).**

Phreatic aquifer: Ranges between 2-15 mbgl and tapped by dugwells. This aquifer is usually found within the weathered or saprolite zone.

Fractured aquifer: **Aquifer-I (Shallow aquifer)** ranges between 10-50 mbgl. **Aquifer-II (Deeper aquifer)** ranges between 50-200 mbgl. Both Aquifers are fresh in nature.

Table 11.20.5: Details of aquifer disposition (fractured aquifer) in Santuri block

Block	Geology	Depth range (mbgl)		Fracture Zones	
		Aquifer-I	**Aquifer-II**	**Aquifer-I**	**Aquifer-II**
Santuri	Granite gneiss	10-40	50-200	11.0-12.87	--

Table 11.20.6: Aquifer-wise depth range and parameters (fractured aquifer) in Santuri block

Block	Aquifer Type	Depth Range (mbgl)	Discharge (m^3/hr)	Drawdown (m)	T (m^2/day)	S
Santuri	Aquifer I	10-40	3.49	6	--	--
	Aquifer II	40-200	--	--	--	--

Table 11.20.7: Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends.

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		WL Range (mbgl)	Rise (m/year)	Fall (m/year)	**WL Range (mbgl)**	Rise (m/year)	Fall (m/year)
Santuri	Phreatic	3.76– 5.58	0.481	**--**	3.03– 6.61	**--**	0.065

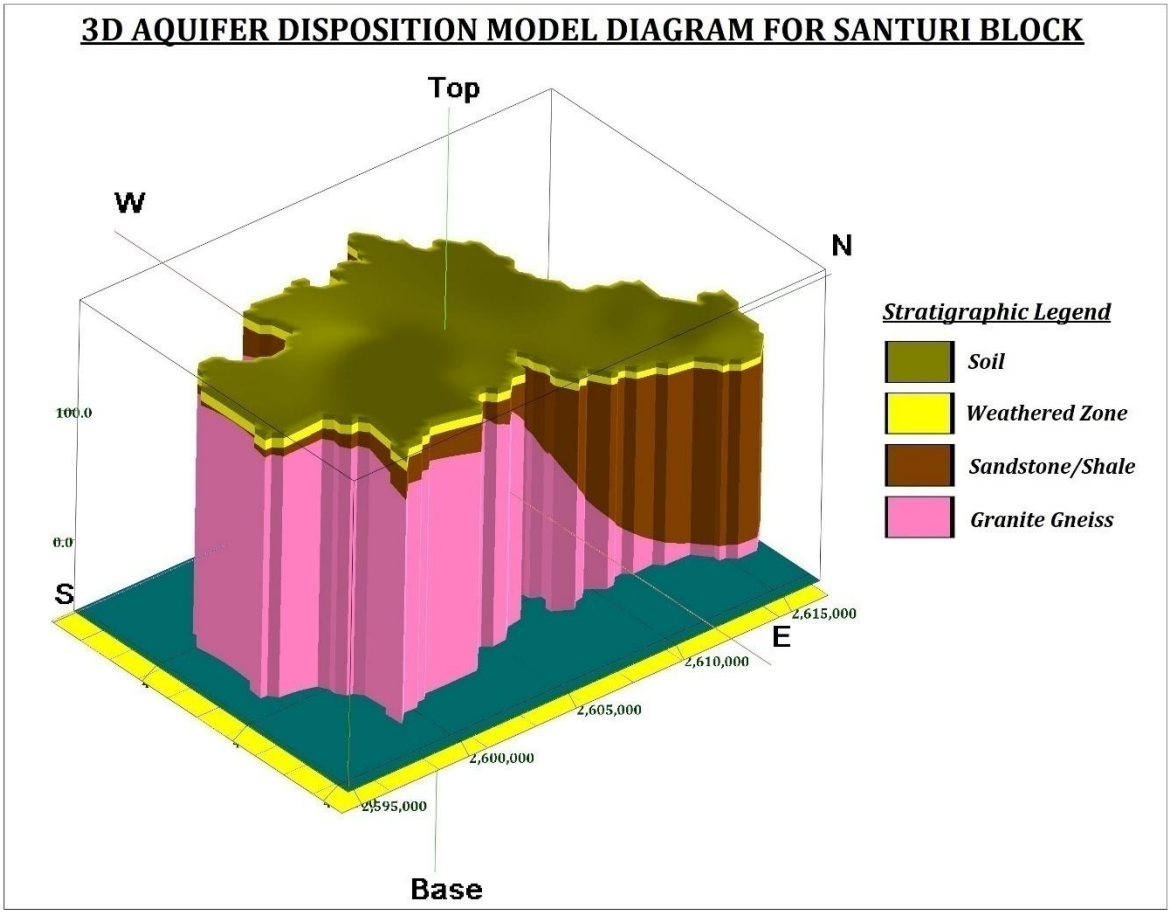

Figure 11.20.2: 3-Dimensional Aquifer disposition in Santuri Block

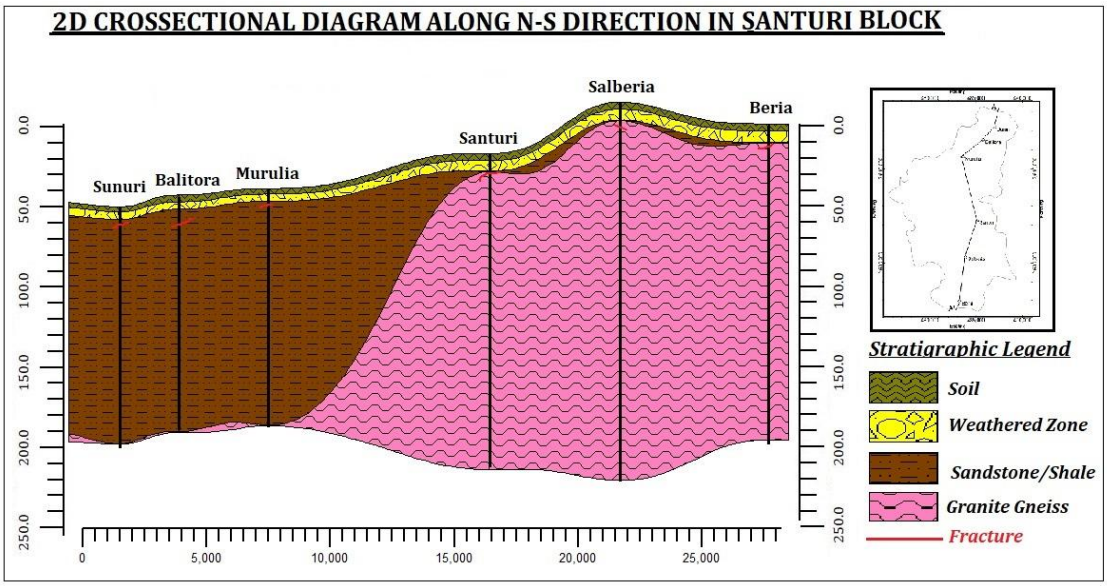

Figure 11.20.3: 2-Dimensional Section in Santuri Block

Ground water quality and issues:

Based on two NHS (dugwells), the range of chemical parameters for the block is given below.

Table 11.20.8 Range of chemical parameters in Santuri 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)
Santuri	Phreatic	7.60-7.90	375-937	15-79	57-142	0.24-0.86	BDL-3	0.02	165-300

Aquifer Management Plan:

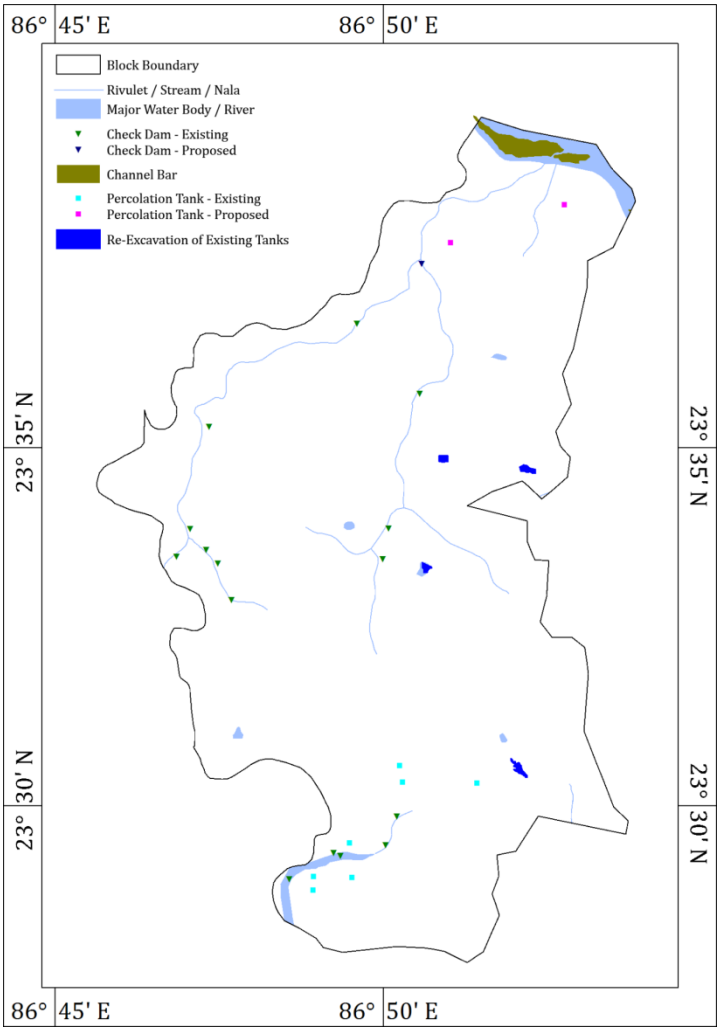

Figure - 11.20.4 : AQM-Recommended Water Conservation Structures in Raghunathpur-II Block

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PART – III

(Data Gap Analysis)

Chapter – 12
Data Gap Analysis(2020-21)

Location : The study area comprises of 20 blocks of Purulia district of West Bengal covering a total geographical area of 6259 sq. km. It is bounded by the North latitudes of 22˚43' and 23˚42' and East longitudes of 85˚49'& 86˚49'. The study areafall in part of Survey of India toposheet no.s73E/15, 73E/16, 73I/2, 73I/3, 73I/4, 73I/6, 73I/7, 73I/8, 73I/10, 73I/11, 73I/12, 73I/14, 73I/15, 73J/5, 73J/6, 73J/9and73J/10.

Data Availability : The available CGWB in-house Exploration data and existing NHS wells for monitoring water level in different blocks along with the toposheet no.s within the study area have been compiled, tabulated and plotted. The data insufficiency within the study area is thereby identified and given for recommendations.

Data gap analysis for Exploratory Wells : In hard rock areas 5 Exploratory Wells and 5 Observation Wells should be constructed at suitable locations, preferably one in central quadrant and one each in the four corner quadrants for establishing aquifer geometry and determining aquifer parameters. The locations of EW/OW in corner quadrants have been changed in the adjacent Toposheets in order to insure uniform distribution in the study area.

In this chapter, the existing exploratory well data in Purulia have been plotted in the respective toposheets and block map. In order to reduce the gap rationally in exploration data, 56 additional wells (includes all EW along with their subsequent OW) of 200 meters depth have been recommended. The map of existing exploratory wells and their details is furnished in Figure1.1 and Table 1.1. The map of the proposed wells and the list including the location and coordinate details is furnished in Figure 1.2 and Table 1.2 respectively.

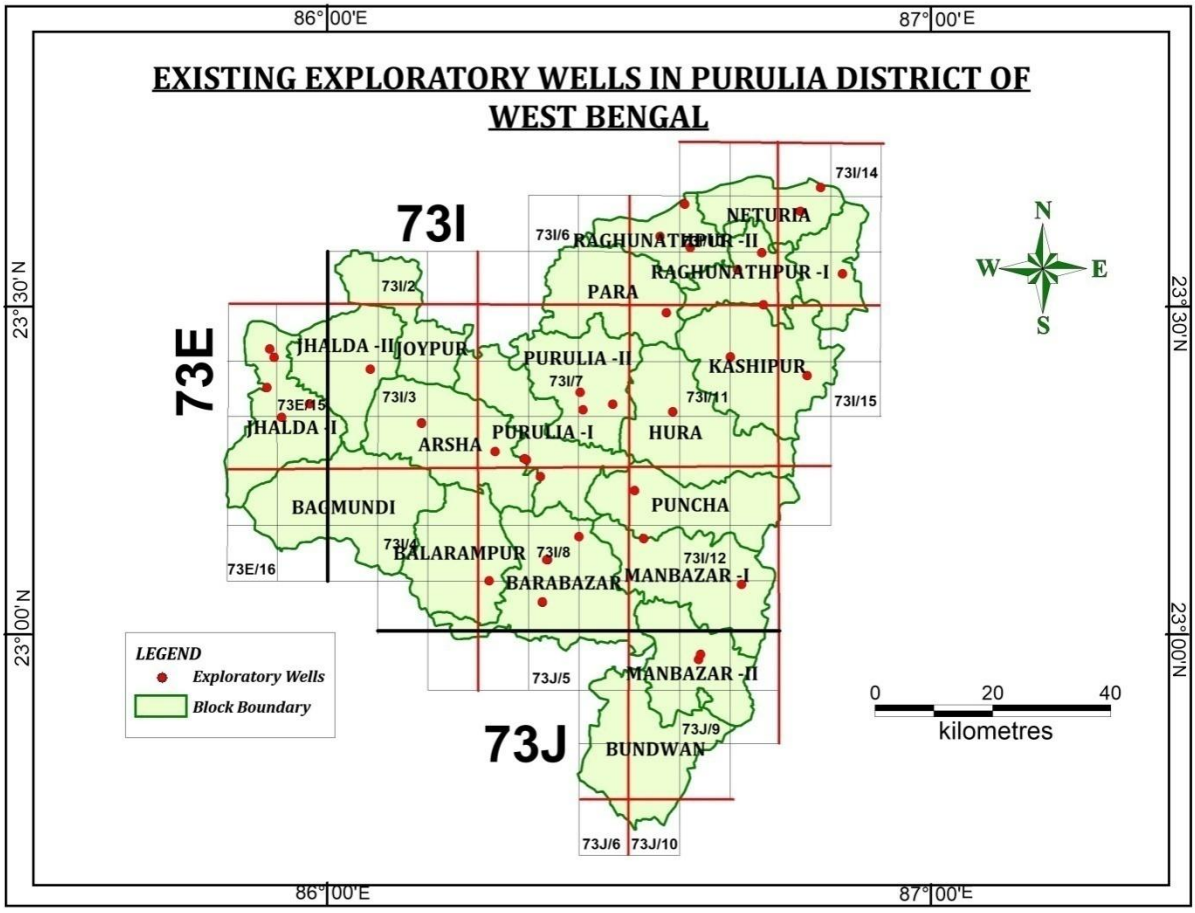

Figure-12.1: Map of existing Exploratory wells in Purulia district of West Bengal

Table-12.1: Details of existing exploratory wells (In-house) in the study area

Block / Taluka	Location	Latitude	Longitude	Formation	Type of Well	Depth drilled (m bgl)	Depth of Well Constructed (m bgl)	Casing Depth for Hard Rock (m bgl)	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lps)	T	S
Arsha	Sirkabad	23.26807	86.19342	Granite gneiss	EW	233.1	18	18.5	19.60-22.70, 53.2-56.2, 144.70-147.70, 153.80-156.90, 227.00-230.00	N/A	9.62	N/A	N/A
Arsha	Sirkabad	23.26807	86.19342	Granite gneiss	OW - I	129.4	18	18.5	12.60-18.00, 83.7-86.7	N/A	0.75	N/A	N/A
Arsha	Sirkabad	23.26807	86.19342	Granite gneiss	OW - II	233.1	18	18.5	12.60-18.00, 141.00-147.00, 153.00-159.00	N/A	7.17	N/A	N/A
Arsha	Arsha	23.322209	86.178135	Granite gneiss	EW-I	300.2	18	18.5	19.60-22.70, 187.4-196.5	N/A	1.27	N/A	N/A
Arsha	Arsha	23.322209	86.178135	Granite gneiss	EW-II	300.2	18	18.5	16.60-25.70	N/A	0.10	N/A	N/A
Arsha	Jhunjka	23.275133	86.192385	Granite gneiss	EW	300.2	12	12.5	156.9-159.9, 190.4-192.0	10.7	4.77	N/A	N/A
Arsha	Jhunjka	23.275133	86.192385	Granite gneiss	OW	300.2	12.5	12.5	47.1-50.1, 102.0-105.0, 156.8-159.9, 163.0-166.0	N/A	5.60	N/A	N/A
Balarampur	Salboni (Borewell)	23.0837	86.2689	Meta-sediments	EW		183.42	N/A	18.0-23.0	N/A	3.21	N/A	N/A
Barabazar	Bodaldih (OW - I)	23.1508	86.4175	BG01	EW	147.7	11.7	9.75	10.5-13.50, 13.50-16.50, 92.80-98.50, 98.90-102	N/A	12.00	N/A	N/A
Barabazar	Bodaldih (OW - I)	23.1508	86.4175	BG01	OW - I	200.5	12	12	16.6-19.6, 120.3-123.3	6.96	0.48	N/A	N/A
Barabazar	Bodaldih (OW - II)	23.1508	86.4175	BG01	OW - II	118.7	15	15	114.2-117.2	8.89	12.50	N/A	N/A
Barabazar	Shankhari-Bansberia	23.051	86.3571	SC01	EW-I	166	32	32	77.6-80.6, 159.9-163	9.56	1.27	N/A	N/A
Barabazar	Shankhari-	23.0516	86.357	SC01	EW-II	139.6	28	28	28.7-31.8, 34.9-37.9,	5.83	7.10	N/A	N/A

Block / Taluka	Location	Latitude	Longitude	Formation	Type of Well	Depth drilled (m bgl)	Depth of Well Constructed (m bgl)	Casing Depth for Hard Rock (m bgl)	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lps)	T	S
	Bansberia								132.5-138.6				
Barabazar	Shankhari-Bansberia	23.0516	86.357	SC01	OW	178.2	25.2	25.2	34.9-37.9, 126.4-129.4, 135.5-138.6	5.25	2.20	N/A	N/A
Barabazar	Bamundiha	23.1159	86.3654	BG01	EW-I	303.1	22	22	193-194	23.54	1.00	N/A	N/A
Barabazar	Bamundiha	23.1156	86.364	BG01	EW-II	264.6	17.5	17.5	242.3-246.3, 249.4-252.4, 258.5-261.6	21.12	10.17	N/A	N/A
Barabazar	Bamundiha	23.1156	86.364	BG01	OW	248.4	19.6	19.6	233.1-236.2, 242.3-245.3	24.46	11.50	N/A	N/A
Barabazar	Bodaldih	23.1508	86.4175	BG01	EW	147.7		12	92.8-95.8, 98.9-102, 132.5-135.5	7.9	12.00	N/A	N/A
Bundwan	Ankro	22.912512	86.549559	Phyllites & schists	EW	136	6	6.5	132.5-135.5	3.17	10.12	N/A	N/A
Bundwan	Ankro	22.912512	86.549559	Phyllites & schists	OW	135	6	6.5	41.00-44.00, 59.30-62.30 114.20-117.20 132.50-135.50	2.8	12.02	N/A	N/A
Hura	Lakhanpur	23.3409	86.5732	BG01	EW	220.9	12.6	12.6	N/A	N/A	0.20	N/A	N/A
Hura	Rakhera	23.2661	86.7483	BG01	EW	153.8	12.5	12.5	22-70-25.70 86.70-89.80	N/A	1.00	N/A	N/A
Jhalda-I	Goria	23.3284	86.2336	SC01	EW	190.04	16	16.5	N/A	N/A	5.50	N/A	N/A
Jhalda-I	Goria	23.3284	86.2336	SC01	OW	65.3	17.63	18.13	N/A	N/A	2.12	N/A	N/A
Jhalda-I	Ichag	23.3326	85.9251	BG01	EW	129.4	19	19.5	92.80-95.90	N/A	1.80	N/A	N/A
Jhalda-I	Jhaldah-I, BDO, Office	23.3655	85.9616	BG01	EW	200	25	25.5	16.60-18.60 28.80-31.80 123.3-126.4	N/A	0.70	N/A	N/A
Jhalda-I	Tulin	23.3776	85.9006	BG01	SEW	60	17.88	18.38	N/A	N/A	0.90	N/A	N/A
Jhalda-I	Tulin	23.3776	85.9006	BG01	EW-I	141.6	15.9	16.4	22.70-25.70 44.00-47.10 50.20-53.20 74.50-77.60 80.60-83.70 105.0-108.1	5.38	5.00	N/A	N/A
Jhalda-I	Tulin	23.3776	85.9007	BG01	EW-II	233.1	18.5	19	13.50-16.60 62.30-65.40 95.90-98.90	5.85	8.00	N/A	N/A
Jhalda-I	Mahatomara	23.4236	85.9124	BS01	EW	300.3	48	48.5	Dry Well	N/A	0.00	N/A	N/A
Jhalda-I	Mahatomara	23.4236	85.9124	BS01	SEW	47.1	44.5	45.5	37.90-41.00	N/A	1.50	N/A	N/A
Jhalda-II	Kotshila EW_III)	23.4055	86.0717	BG01	EW_III	111.1	5.4	8.74	N/A	N/A	0.50	N/A	N/A
Jhalda-II	Kotshila	23.4055	86.0717	BG01	EW-I	172.1	4.9	5.4	50.10-53.20 62.30-65.40	2.02	0.50	N/A	N/A
Jhalda-II	Kotshila	23.4055	86.0717	BG01	EW-II	220.9	11.5	12	Dry Well	2.05	N/A	N/A	N/A
Jhalda-II	Gokulnagar	23.3528	85.971	BG01	EW	300.2		6.1	Dry Well	N/A	N/A	N/A	N/A
Kashipur	Kashipur (Borewell)	23.1245	86.6687	Garnetiferous schist	EW	N/A	93.39	N/A	22.13-24.61	N/A	0.05	N/A	N/A
Kashipur	Talajuri (Borewell)	23.3959	86.7954	Garnetiferous schist	EW	N/A	41.1	N/A	17.67-19.0	N/A	0.33	N/A	N/A
Manbazar-I	Gopalnagar	23.1325	86.5879	BG01	EW	200.5	6.8	7.3	22.70-25.70	N/A	0.64	N/A	N/A
Manbazar-I	Mogalda (Borewell)	23.0757	86.6474	Granite gneiss	EW	N/A	183.42	N/A	N/A	N/A	N/A	N/A	N/A
Manbazar-I	Manbazar (Borewell)	23.0781	86.6865	Granite gneiss	EW	N/A	150	N/A	110-112.00	N/A	6.64	N/A	N/A
Manbazar-I	Golkidih	23.060852	86.659518	Granite gneiss	EW	184.3	21	21.5	37.90-39.0, 65.10-67.10	N/A	1.20	N/A	N/A
Manbazar-I	Golkidih	23.060852	86.659518	Granite gneiss	OW	220.9	24	24.5	193.5-196.5	N/A	1.22	N/A	N/A
Manbazar-II	Basantapur	22.974015	86.60436	Schists	EW	300.2	N/A	N/A	19.60-22.70, 28.80-31.80, 187.4-190.4	4.05	3.40	N/A	N/A
Manbazar-II	Basantapur	22.974015	86.60436	Schists	OW	300.2	N/A	N/A	19.60-22.70, 28.80-34.90, 126.4-129.4	4.56	4.43	N/A	N/A
Manbazar-II	Bari hospital	23.013975	86.538016	Schists	EW	245.3	11.6	12.1	31.80-34.90	N/A	0.80	N/A	N/A
Neturia	Innanpur (Borewell)	23.682	86.8181	Sandstone	EW	N/A	97.74	N/A	28.91-31.91	5.75	5.54	N/A	N/A
Neturia	Sarborimore (Borewell)	23.6456	86.7844	Sandstone	EW	N/A	103.25	N/A	24.44-36.44	14.32	3.32	N/A	N/A
Para	Anara (Borewell)	23.4916	86.5621	Granite gneiss	EW	N/A	81.27	N/A	26.0-28.0	N/A	1.11	N/A	N/A
Puncha	Lohara	23.1742	86.6618	BG01	EW	147.7	18.5	18.5	98.90-102.0	N/A	2.20	N/A	N/A
Puncha	Napara	23.2262	86.6462	BG01	EW	184.3	20.5	21	25.70-28.80 92.80-95.90 169.1-172.1	N/A	3.34	N/A	N/A
Puncha	Balakdih	23.2209	86.5098	BG01	EW	200.5	5.5	6	Dry Well	N/A	N/A	N/A	N/A
Puncha	Kuruktupa, PHC	23.1478	86.5249	BG01	EW	200.5	8.3	8.8	16.60-19.60 34.90-37.90 41.00-44.00	N/A	0.75	N/A	N/A

Block / Taluka	Location	Latitude	Longitude	Formation	Type of Well	Depth drilled (m bgl)	Depth of Well Constructed (m bgl)	Casing Depth for Hard Rock (m bgl)	Zone tapped/ Fractures encountered (mbgl)	S.W.L. (m bgl)	Discharge (lps)	T	S
Puncha	Napara	23.221	86.6454	BG01	OW	181.3	21	21	117.2-120.3 144.7-147.7 147.4-150.8 166-169 169-172.10	10.05	4.36	N/A	N/A
Purulia	Chakoltore	23.2425	86.3534	BG01	EW	200.5	11.7	12.2	13.50-16.60 80.60-83.70	N/A	0.50	N/A	N/A
Purulia-I	Charrah	23.3707	86.4193	GR02	EW-II	200	12.5	12.5	71.50-74.50	N/A	0.20	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	BG01	EW	200.5	17.9	18.4	22.70-25.70 53.20-56.20 74.50-77.60 135.5-138.60	N/A	1.80	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	BG01	OW	150.5	18	18.5	37.90-41.00 53.10 -56.20 132.5-135.5	N/A	1.80	N/A	N/A
Purulia-I	Ladurkha	23.3521	86.5309	BG01	SEW	60.3	18	18.5	53.20-56.20	N/A	1.80	N/A	N/A
Purulia-I	Lalpur	23.3066	86.6248	BG01	EW	200.5	18.5	19.5	41.00-44.00 56.20-59.30 59.30-62.30 120.3-123.3	N/A	0.90	N/A	N/A
Purulia-I	Belguma	23.3271	86.3457	BG01	EW	300.4	32.5	32.5	50.30-56.10	12.9	3.40	N/A	N/A
Purulia-I	Belguma	23.3271	86.3457	BG01	OW	220.9	20.2	20.2	50.30-53.10 80.80-83.90	13	2.60	N/A	N/A
Purulia-I	Ambagan, PHED	23.3255	86.3437	BG01	EW	151.5	12.5	12.5	77.60-80.60	12.8	4.10	N/A	N/A
Purulia-I	Ambagan, PHED	23.3255	86.3437	BG01	OW	166	8	8	154.90-156.90	13	7.00	N/A	N/A
Purulia-I	Pandrama	23.265263	86.321211	Granite gneiss	EW	300.2	13.5	14	16.60-19.60, 50.1-53.2	4.02	2.10	N/A	N/A
Purulia-I	Pandrama	23.265263	86.321211	Granite gneiss	OW	263.6	13.5	14	16.60-19.60, 62.30-65.40, 199.60-202.60, 248.40-251.40	4.17	2.15	N/A	N/A
Purulia-II	Denagar	23.3439	86.4241	BG01	EW	200.5	11.8	12.6	31.80-34.90 141.6-144.7 150.8-153.8	N/A	3.00	N/A	N/A
Purulia-II	Denagar	23.3439	86.4241	BG01	OW	160	11.8	12.3	25.70-28.80	N/A	2.50	N/A	N/A
Purulia-II	Hutmura	23.3524	86.4737	GR02	EW	202.5	7.6	8.1	95.90-98.90	N/A	0.30	N/A	N/A
Purulia-II	Charrah	23.3707	86.4193	GR02	EW	200.5	9.27	9.75	N/A	N/A	0.20	N/A	N/A
Raghunathpur-I	Madhutali (Borewell)	23.5037	86.7232	GR02	EW	N/A	54.18	N/A	31.92-34.41	3.93	0.33	N/A	N/A
Raghunathpur-I	Raghunathpur (Borewell)	23.5572	86.6805	Granite	EW	N/A	70.35	N/A	13.0-37.0,48.0-62.24	N/A	0.49	N/A	N/A
Raghunathpur-I	Raghunathpur (Borewell)	23.5572	86.6805	Porphyritic granite	EW	N/A	71	N/A	N/A	N/A	0.69	N/A	N/A
Raghunathpur-I	Babugram (Borewell)	23.583	86.7206	Porphyritic granite	EW	N/A	70.56	N/A	34.46-37.45	4.43	2.77	N/A	N/A
Raghunathpur-II	Barasoni (Borewell)	23.5584	86.662	Hornblende gneiss	EW	N/A	48.75	N/A	N/A	6.29	2.77	N/A	N/A
Raghunathpur-II	Montore (Borewell)	23.6075	86.5517	Granite gneiss	EW	N/A	55.18	N/A	15.0-17.10,22.5-31.0	3.78	2.21	N/A	N/A
Raghunathpur-II	Kanke (Borewell)	23.5909	86.6016	Granite gneiss	EW	N/A	60.33	N/A	16.0-18.0	4.97	0.97	N/A	N/A
Raghunathpur-II	Chelyama (Borewell)	23.6567	86.593	Granite gneiss	EW	N/A	72.5	N/A	40.45-59.51	N/A	0.08	N/A	N/A
Santuri	Santuri (Borewell)	23.5505	86.8543	Granite gneiss	EW	N/A	30.3	N/A	11.0-12.87	2.79	0.97	N/A	N/A

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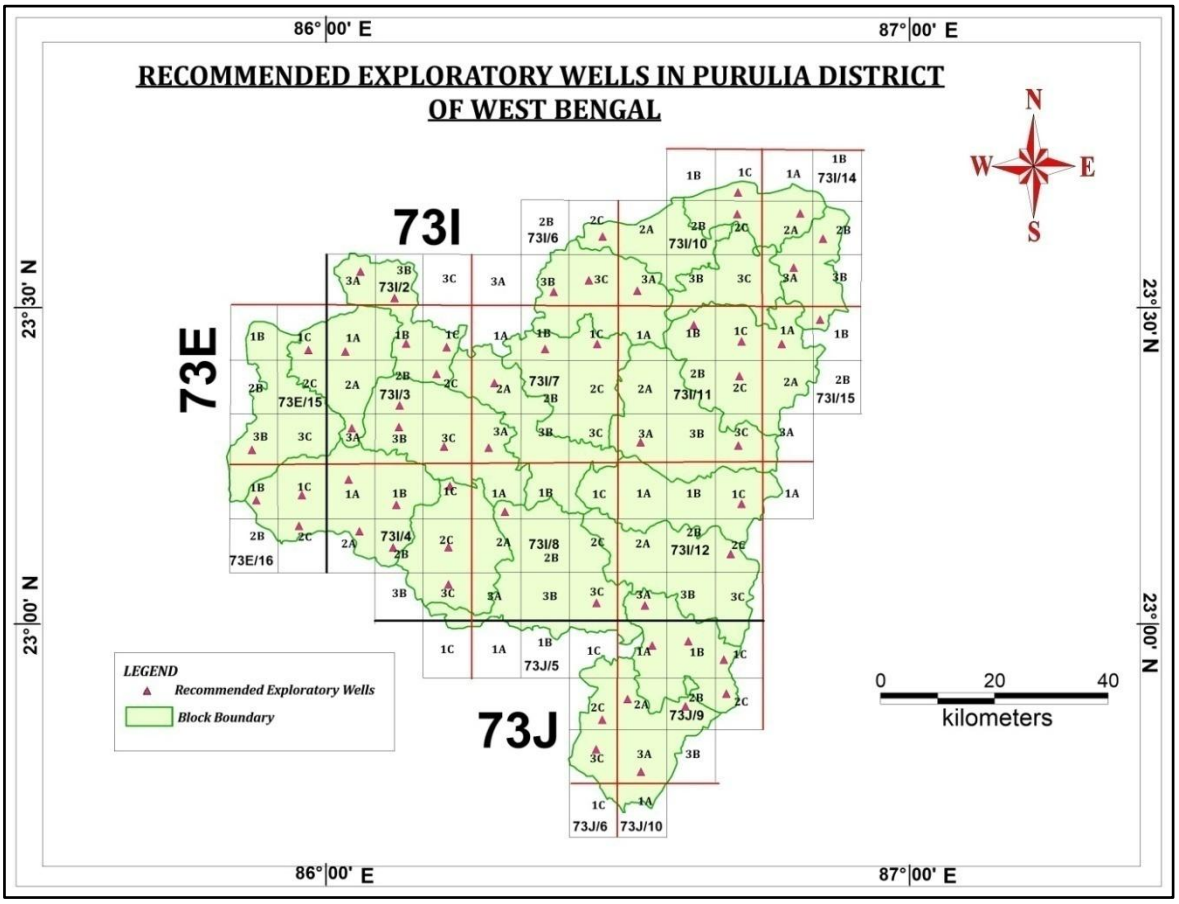

Figure – 12.2: Map of proposed exploratory wells in the study area.

Table-12.2 : Details of proposed exploratory wells in Purulia district of West Bengal.

SL No.	Block	Village	Latitude	Longitude	Toposheet No.	Quadrant	Rock Type	Proposed Drill Depth (mbgl)
1	Arsha	Palpal	23.3127	86.125418	73 I/3	3B	Hard Rock	200
2	Arsha	Jhujhka	23.28028	86.27926	73 I/7	3A	Hard Rock	200
3	Arsha	Mankiari	23.34672	86.126812	73 I/3	2B	Hard Rock	200
4	Arsha	Gurahata	23.28209	86.203036	73 I/3	3C	Hard Rock	200
5	Bagmundi	Gagi	23.19745	85.880944	73 E/16	1B	Hard Rock	200
6	Bagmundi	Dugdha	23.15732	85.954379	73 E/16	2C	Hard Rock	200
7	Bagmundi	Chorda	23.22989	86.038969	73 I/4	1A	Hard Rock	200
8	Bagmundi	Banshidi	23.12317	86.115193	73 I/4	2B	Hard Rock	200
9	Bagmundi	Sarmali	23.20532	85.959491	73 E/16	1C	Hard Rock	200
10	Bagmundi	Gobaria	23.18999	86.121235	73 I/4	1B	Hard Rock	200
11	Bagmundi	Sankupi	23.14885	86.058024	73 I/4	2A	Hard Rock	200
12	Balarampur	Parbad Kashitanr	23.21964	86.212797	73 I/4	1C	Hard Rock	200
13	Balarampur	Biramdih	23.06512	86.210008	73 I/4	3C	Hard Rock	300
14	Balarampur	Kana	23.12355	86.210472	73 I/4	2C	Hard Rock	200
15	Barabazar	Kudlung	23.03609	86.463778	73 I/8	3C	Hard Rock	200
16	Barabazar	Raygara	23.1796	86.307147	73 I/8	1A	Hard Rock	200
17	Bundwan	Beko	22.87302	86.616226	73 J/9	2B	Hard Rock	200
18	Bundwan	Kuriapara	22.85168	86.474004	73 J/5	2C	Hard Rock	200
19	Bundwan	Madhuban	22.76972	86.540002	73 J/9	3A	Hard Rock	200
20	Bundwan	Senkebasa	22.80497	86.463313	73 J/5	3C	Hard Rock	200
21	Bundwan	Chilla	22.88407	86.517228	73 J/9	2A	Hard Rock	200
22	Hura	Keshargarh	23.2888	86.539538	73 I/11	3A	Hard Rock	200

Sl. No.	Block	Village	Latitude	Longitude	Toposheet No.	Quadrant	Rock Type	Proposed Drill Depth (mbgl)
23	Hura	Shamukgarya	23.2838	86.706858	73 I/11	3C	Hard Rock	200
24	Joypur	Dambera	23.55773	86.059419	73 I/2	3A	Hard Rock	200
25	Joypur	Ritudi	23.44445	86.137502	73 I/3	1B	Hard Rock	200
26	Joypur	Koshangi	23.51617	86.117982	73 I/2	3B	Hard Rock	200
27	Joypur	Agharpur	23.43847	86.207219	73 I/3	1C	Hard Rock	200
28	Joypur	Upar Kahan	23.39655	86.190022	73 I/3	2C	Hard Rock	200
29	Jhalda-I	Pareshya	23.27697	85.873971	73 E/15	3B	Hard Rock	200
30	Jhalda-II	Bararola	23.4319	86.033856	73 I/3	1A	Hard Rock	200
31	Jhalda-II	Gobindapur	23.31094	86.045011	73 I/3	3A	Hard Rock	200
32	Jhalda-II	Haratan	23.43413	85.970646	73 E/15	1C	Hard Rock	200
33	Kashipur	Kusumgora/ Ranjandi	23.39272	86.708718	73 I/11	2C	Hard Rock	200
34	Kashipur	Mahulkoka	23.44382	86.781224	73 I/15	1A	Hard Rock	200
35	Kashipur	Jorapukur /Sitarampur	23.47342	86.630634	73 I/11	1B	Hard Rock	200
36	Kashipur	Aguibad	23.44779	86.712436	73 I/11	1C	Hard Rock	200
37	Manbazar-I	Dhadika	23.11298	86.693844	73 I/12	2C	Hard Rock	200
38	Manbazar-II	Chandanpur	22.96864	86.559523	73 J/9	1A	Hard Rock	200
39	Manbazar-II	Shusina	22.94645	86.682225	73 J/9	1C	Hard Rock	200
40	Manbazar-II	Olgara	22.97533	86.621338	73 J/9	1B	Hard Rock	200
41	Manbazar-II	Kararbaid	23.03155	86.546974	73 I/12	3A	Hard Rock	200
42	Manbazar-II	Sankura	22.89261	86.686408	73 J/9	2C	Hard Rock	200
43	Neturia	Bhurkunrabari	23.68238	86.706393	73 I/10	1C	Hard Rock	200
44	Neturia	Mahuda	23.64826	86.705	73 I/10	2C	Hard Rock	200
45	Neturia	Bonra	23.64937	86.812828	73 I/14	2A	Hard Rock	200
46	Para	Pirma	23.54407	86.450764	73 I/6	3C	Hard Rock	200
47	Para	Charpatya	23.5256	86.390807	73 I/6	3B	Hard Rock	200
48	Para	Sanar	23.5273	86.53396	73 I/10	3A	Hard Rock	200
49	Puncha	Chakia	23.19169	86.712436	73 I/12	1C	Hard Rock	200
50	Purulia-I	Belkundi	23.38186	86.289021	73 I/7	2A	Hard Rock	200
51	Purulia-II	Chitarpoka	23.43564	86.37547	73 I/7	1B	Hard Rock	200
52	Purulia-II	Raghudi	23.44382	86.465172	73 I/7	1C	Hard Rock	200
53	Ragunathpur-II	Santaldih	23.61248	86.474468	73 I/6	2C	Hard Rock	200
54	Santuri	Gorsika	23.48174	86.846757	73 I/15	1B	Hard Rock	200
55	Santuri	Madhukunda Alias Mokura	23.60923	86.85187	73 I/14	2B	Hard Rock	200
56	Santuri	Malibana	23.5639	86.801673	73 I/14	3A	Hard Rock	200

Ground Water Monitoring Data : For 1st aquifer (un-confined/Phreatic), one open/dug wellsis recommended for each quadrant of a toposheet. For 2nd aquifer (fractured zone) the OW constructed may be used as piezometers for GW monitoring.Topo-sheetsatspatial scale of 5' x 5' grids have been considered for plotting and analysis of the gap in the study area.

Presently in Purulia there are 102 existing NHS wells (101 Dug wells & 1 bore well) which are monitored four times a year. Figure 12.3 and Table 12.3 shows the distribution of NHS wells in the study area. A total of 42 wells tapping Aquifer-I are thereby recommendedfor bridging the data gap.For 2nd Aquifer, the Observation wells (OW) recommended along with the Exploratory wells may be used aspiezometers for

GW monitoring. Figure 12.4 and Table 12.4 presents the recommended NHS wells in different parts of the study area.

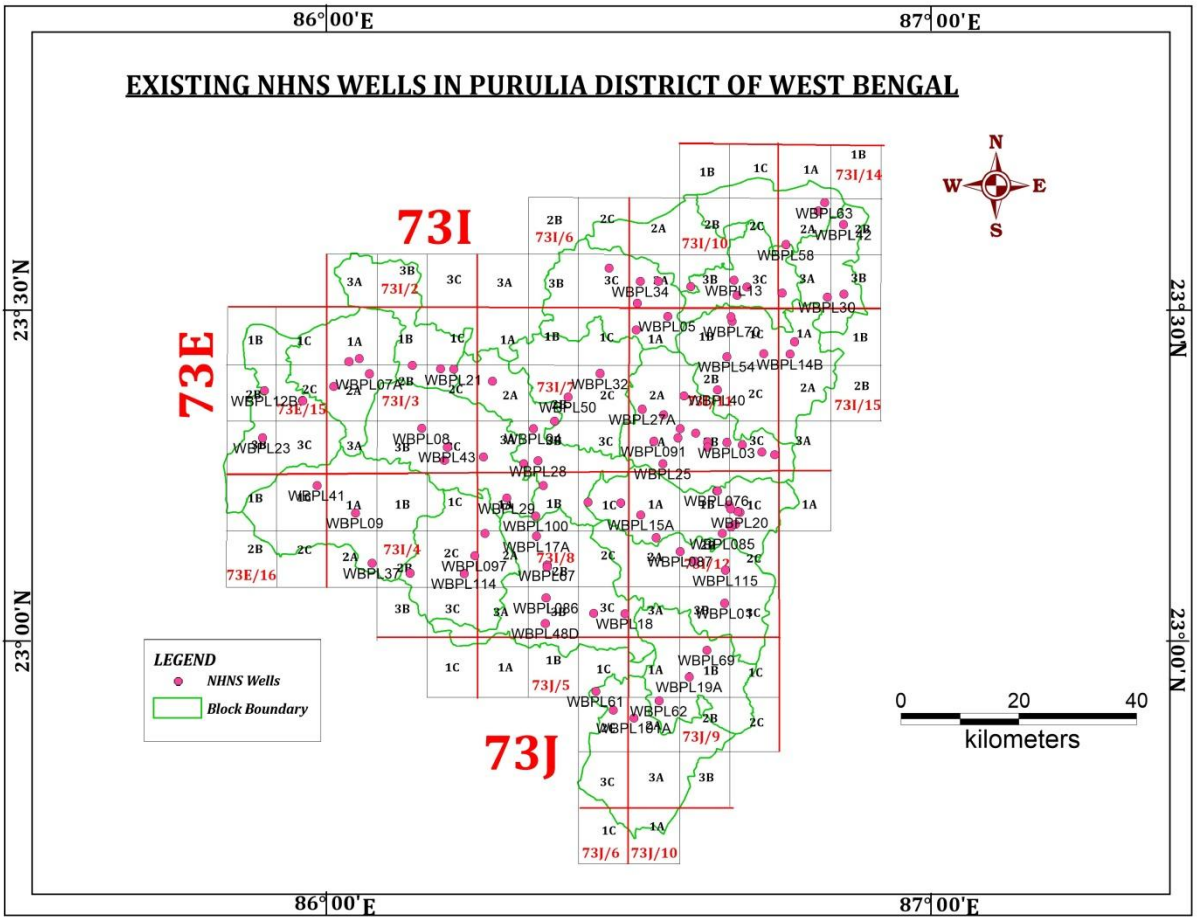

Figure-12.3: Map showing existing NHS wells in Purulia district of West Bengal

Table-12.3: List of details of Existing NHS wells in Purulia district of West Bengal.

Sl No.	Block	Village	Well no.	Well Type	MP	Latitude	Longitude	RL	Location
1	Arsha	Arsha	WBPL08	Dug	0.32	23.322406	86.158107	332.3	Within the Forest Beat office & opp. to Arsha P.S.
2	Arsha	Kantadihi	WBPL29	Dug	0.51	23.217356	86.298971	206.65	Inside sub-health centre appraochable from Arsha.
3	Arsha	Aharrah	WBPL43	Dug	0.84	23.29433	86.200712	226.33	Located at Aharaha more at Hari Mandir opp. to U.B.I.
4	Arsha	Sirkabad	WBPL44B	Dug	0.5	23.274027	86.1956	227.99	About 50 m North West of PHC main building within open field. Located backside of OPD buiding &water supply for domestic use.
5	Arsha	Hansla More	WBPL096	Dug	0.64	23.279444	86.259949	206.96	RHS of Tawna More - Arsha road, adjacent the house of Baridas Kaibarta. About 6 km from Pandrama
6	Baghmundi	Mathbura	WBPL37	Dug	0.87	23.119536	86.075843	193.21	Inside Forest Range Office, Rd approaching Balarampur.
7	Baghmundi	Korenge	WBPL41	Dug	0.68	23.236565	85.985109	198.29	Backside of the Hospital.
8	Bagmundi	Baghmundi	WBPL09	Dug	0.86	23.195178	86.048332	197.77	In Baghmundi P.S. adjacent to Shiva Temple.
9	Balarampur	Baraurma	WBPL26	Dug	0.72	23.164166	86.262704	205.17	Inside school compound.
10	Balarampur	Namsole	WBPL097	Dug	0.62	23.130699	86.245471	199.98	LHS of Tawna - Balarampur Rd., infront of of Sub - health centre . About 3 km from Baraumra towards Balarampur
11	Balarampur	Dava	WBPL098A	Dug	0.55	23.104257	86.139284	154.92	LHS of Balarampur - Baghmundi Rd., adjacent to the house of Surya Kanta Kumar,about 7 km before Matha.
12	Balarampur	Balarampur	WBPL114	Dug	0.45	23.103991	86.228201	215.62	*Location not listed*
13	Banduan	Likimore	WBPL082	Dug	0.6	22.898297	86.475194	137.51	Govt. well. LHS of Rd. 2.5 km before Banduan. Near Bus stand. Near house of Satish Singh Sardar.
14	Banduan	Banduan	WBPL101A	Dug	0.8	22.886412	86.509212	152.29	RHS of Banduan - Manbazar Rd., compound of Hotel Samarat
15	Barabazar	Takariya	WBPL17A	Dug	0.6	23.159087	86.348147	204.03	On Rd.to Barabazar near the house of Sri Kandru Mahato.
16	Barabazar	Sindri	WBPL18	Dug	0.64	23.043614	86.494011	131.77	Near Primary Health Centre on Manbazar-Purulia Raod.
17	Barabazar	Barabazar	WBPL48D	Dug	0.7	23.028913	86.362132	145.31	Inside hospital compound, located in front of " Indoor Patient" near pump house.

Sl No.	Block	Village	Well no.	Well Type	MP	Latitude	Longitude	RL	Location
									Sardardih more Old KSP Well.
18	Barabazar	Bamundiha	WBPL67	Dug	0.7	23.11644	86.36552	170.5	Within P.H.C. on Purulia - Manbazar road.
19	Barabazar	Bamundiha	WBPL68	DUG	0.5	23.113518	86.365424	191.17	Within P.H.C. on Purulia - Manbazar road.
20	Barabazar	Purihasa	WBPL086	Dug	0.5	23.067356	86.363933	162.03	RHS of Purulia - Barabazar road, before reaching Barabazar 1.50 m north from Hari mandir, infront of house of Guru Mahato, 750 m from Kumari river Bridge.
21	Barabazar	Aga Jhore	WBPL099	Dug	0.65	23.044452	86.442333	134.12	RHS of Purulia - Manbazar Rd. , near the house of Sahadeb Mahato, about 5 km before Sindri
22	Bundwan	Dhabani	WBPL61	Dug	0.55	22.926845	86.446175	162.18	Near house of Sufi singh at Sardar Para, EHS of road from Bandwan to Barabazar, 8.5 km from Bandwan, at the end of village
23	Hura	Hura	WBPL03	Dug	1.06	23.301122	86.662737	145.27	In the compound of Police Station
24	Hura	Keshargarh	WBPL25	Dug	0.6	23.269088	86.556936	159.17	Appraoch from Kulgura on Purulia-Hura road, about 8km South of Kulgura and 10m SW of Janata Clothes Store.
25	Hura	Ludurka	WBPL27A	Dug	0.68	23.351291	86.523225	174.6	Inside Pandeya line hotel, after crossing Primary Health Centre and Reliance Petrol Pump; way to Purulia.
26	Hura	Bishpuria	WBPL39	Dug	0.65	23.282697	86.741533	103	Inside Bispuria Library-Sahitya Sadan, on Purulia-Bankura Road.
27	Hura	Katagora	WBPL64	Dug	0.5	23.294402	86.630873	177.1	Within P.H.C. campus. On Lalgon - Manbazar road.
28	Hura	Katagora	WBPL65	BW	0.5	23.294402	86.630873	177.1	Within P.H.C. campus. On Lalgon - Manbazar road.
29	Hura	Lalpur	WBPL074	Dug	0.73	23.301914	86.631246	189.32	Behind Dayal Onkareswar Shivalay Mandir. RHS of road from Lalpur to Bagda. Tekchongora village.
30	Hura	Katagora	WBPL075	Dug	0.45	23.294404	86.630853	175.75	Owner - Sristi Dhar Mahato. LHS of road from Lalpur to Bagda.
31	Hura	Raheradhi	WBPL076	Dug	0.83	23.228441	86.645938	168.19	RHS of road towards Bagda 1km. Beffore Napara. Near the residence of Ashok Dutta (Owner of dugwell), Satyajit Mess.
32	Hura	Kulgara	WBPL080	Dug	0.65	23.322035	86.585376	180.97	*Location not listed*
33	Hura	Duriakata	WBPL084	Dug	0.5	23.297736	86.688512	143.61	RHS of Bispuria - Hura road, about 3 - to 4 km from Bispuria, " Dikse" Shop, Hura G.P. country Liquor shop of Mihir Mandi.
34	Hura	Kulabahal	WBPL091	Dug	0.65	23.303131	86.541829	164.73	RHS of Keshargarh - Ludhurka road via Ground More. Back side of the house of Bairav, Judhistir and Arun Mahato
35	Hura	Kumardihi	WBPL108	Dug	0.8	23.236871	86.720188	121.87	in the house of Nirbakar Mondal.LHS of the road towards Puruliya after crosing Birpuria near telephone tower
36	Hura	Mongalpur	WBPL111	Dug	1	23.314907	86.610959	150.33	Inside compound of new line hotel of Ripon Ghosh.LHS of road towards Puruliya & 2 km from Lalpur more
37	Hura	Asanboni	WBPL112	Dug	0.7	23.308029	86.581673	170.69	opposite H/O Swapan Mahato near Primary school RHS of the road to Keshargarh
38	Hura	Gurda More	WBPL113	Dug	0.3	23.343019	86.557895	163.05	Puruliya-Hura road LHS of road towards Puruliya and by the side of Yadav hotel
39	Hura	Khairapihira	WBPL116	Dug	0.72	23.37112	86.591574	211	*Location not listed*
40	Jaypur	Narayanpur	WBPL21	Dug	0.64	23.411132	86.211051	211.12	At the entrance of P.W.D. I.B. at Narayanpur, left side on the paddy field.
41	Jhalda - II	Durgu	WBPL088	Dug	0.5	23.385372	86.012713	252.85	4 to 5 km towards Jhalda from Kotsila, LHS of road, adj. To Photo Binding of Sunil Kumar.
42	Jhalda-I	Tulin	WBPL12B	Dug	0.58	23.379209	85.938152	196.78	On the way to JOYSIYSRAM HIGH SCHOOL before crossing the railway level crossing in the house of Shaktipada Mahato at Uppur para.
43	Jhalda-I	Jhalda	WBPL22A	Dug	0.75	23.364384	85.960959	270.35	Located in Satyabala Vidyapith (High School) on Tulin road. Depth - 9.00 m bmp; Dia - 3.73 m. M.P. 0.75 m agl. Changed on 4/02 by A.K.Chatterjee.
44	Jhalda-I	Jhargo	WBPL23	Dug	0.65	23.308233	85.89469	208.23	On Jhalda-Bagmundi Rd,inside village, 50m N of Ananda Marg School.
45	Jhalda-I	Jhalda	WBPL73	Dug	0.5	23.363472	86.961469	224.6	Adjacent to the hostel building of Satya Vama Vidyapith.
46	Jhalda-II	Kotshila	WBPL07A	Dug	0.75	23.404287	86.071455	248.17	Inside BDO Office compound. On Purulia-Ranchi road.
47	Joypur	Joypur	WBPL38A	Dug	0.62	23.417232	86.143009	214.21	Located in the Police Station Compound near bus stand opposite to U.B.I. Just left side after entrance. Depth - 13.00 m bmpdia - 1.23 m M.P. 0.62 m agl
48	Joypur	Joypur Forest More	WBPL092	Dug	0.65	23.411831	86.189568	222.98	LHS of Purulia - Jhalda road, back side of Shrinibas Dhaba and Karmokar Cement Centre. Joypur about 5 km
49	Kashipur	Gaurandih	WBPL14B	Dug	0.6	23.434316	86.767264	119.12	In the residence of Shri Sushil Patra, which is opposite to Gaurandih Junior High School.
50	Kashipur	Indrabil	WBPL24	Dug	1	23.452539	86.774899	109.45	Approach from Kashipur & inside the house of Gurupada just entering in the village. In the residence of Gurupada Bauri.
51	Kashipur	Simla	WBPL40	Dug	0.64	23.380268	86.646979	142.22	On Kashipur-Hura Rd., within Majura-Amdiha High School.
52	Kashipur	Kapasitha	WBPL53B	Dug	0.77	23.434846	86.72364	97.63	In the compound of Ma Manikeswari light house(r) Owner Pvt Shri Jadhubir Mahato.
53	Kashipur	Napara	WBPL54	Dug	0.75	23.430372	86.662776	120.8	Inside Forest guard's Quarter at Nawapara on Kashipur-Hura Road.
54	Kashipur	Rangani	WBPL70	Dug	0.8	23.483566	86.671395	111.34	Opposite to vetanary hospital on Adra - Kashipur road.
55	Kashipur	Palash Kola	WBPL104	Dug	0.62	23.490689	86.670035	131.88	LHS of Adra - Kashipur Rd. near the house of Shibram Dubey, Just entrance of Kashipur Rd. from Adra
56	Kotshila	Nowahatu	WBPL093	Dug	0.66	23.427401	86.054567	269.41	RHS of Kotshila - Barurula road, at the farm of Lalbahadur Rajwar. Barurala about 5 km
57	Kotshila	Ukma	WBPL094	Dug	0.64	23.423116	86.037756	267.74	RHS of Bararula - Durgu road, back side of Shiva Mandir. Durgu about 5 km
58	Manbazar	Gopalnagar	WBPL087	Dug	0.4	23.137127	86.585397	109.89	On Manbazar - Purulia road, after crossing Goplanagar village, besides Gopalnagar Siva mandir & Kali Mandir.
59	Manbazar-I	Sindurpur	WBPL102	Dug	0.64	23.121968	86.609792	126.24	RHS of Jitujuri - Kunda - Purulia Rd., near the house of Budheswar Mahato. After 1 km from Jitjuri
60	Manbazar-I	Manbazar	WBPL01	Dug	0.7	23.059361	86.659135	114.22	Inside Manbazar Police Station.
61	Manbazar-I	Budpur	WBPL115	Dug	0.7	23.108825	86.66023	83.52	*Location not listed*

Sl No.	Block	Village	Well no.	Well Type	MP	Latitude	Longitude	RL	Location
62	Manbazar-II	Ankro	WBPL62	Dug	0.58	22.912271	86.550649	121	In the premises of PHC, near pump house behind main hospital building.Ankro village is 6 km from Bandwan on Manbazar road.
63	Manbazar-II	Khariduyara	WBPL69	Dug	0.7	22.988664	86.629541	103.69	Within P.H.C. campus. On Barabazar - Manbazar road.
64	Neturia	Sarbori	WBPL56	Dug	0.8	23.619641	86.814248	81.16	Inside commercial check post on Raghunathpur-Barakar Rd.
65	Neturia	Gobag	WBPL58	Dug	0.73	23.591949	86.762734	102.58	Located at the entrance of the village adj. to Purulia-Bankura Rd. in front of Haradhan Garai's Cycle reparing Shop.
66	Nituria	Nituria	WBPL63	Dug	1.08	23.662027	86.824667	56.29	In the campus of Shiva Temple. Opposite to Nituria Police Station. (new well from Nov 2010)
67	Para	Anara	WBPL05	Dug	0.84	23.491296	86.56469	153.21	Inside the compd of 33 KV sub-station, just after the Chapuri gate on Raghunathpur-Purulia road.
68	Para	Para	WBPL33A	Dug	3.74	23.510533	86.515082	159.05	LHS of road from Para to Dubra, near bus stand, adjacent to the house of Subhash Modak, in front of the shop Gauri Sankar Sweets.
69	Para	Dubra	WBPL34	Dug	1	23.543654	86.520021	128.35	Within Dubra market, adj. to Dubra Readymade Store & Anil Tailoring Shop on Raghunathpur Santaldih Road and adj to M.M.Cloth store and oppo. to Ice Cream Factory on Dubrá-Samtaldih road.
70	Para	Jhapra	WBPL46	Dug	0.49	23.470346	86.513335	147.56	Within High School compd on Raghunathpur-Purulia Rd.
71	Para	Deuli	WBPL55A	Dug	0.55	23.56329	86.468192	112.58	Located in the house of Shri Gour Mahato. Just opposite to Tarun Granthagar (Library) on Santaldih road. Depth - 10.50 mdia - 1.50 m M.P. 0.55 m agl.
72	Para	Kashiberia	WBPL083	Dug	0.7	23.544095	86.549105	123.16	Govt. well near Keshiberia School. RHS of Rd. towards Babugram. 3 km from Dubra.
73	Puncha	Kenda	WBPL15A	Dug	0.95	23.192502	86.520363	187.17	In the residence of Shri Sukhdeb Mahato opposite to Pally Seva Sangha at Sardardih more
74	Puncha	Bagda	WBPL20	Dug	0.67	23.195973	86.684726	139.65	Just behind primary health centre. On Hura-Manbazar Rd.
75	Puncha	Panipathar	WBPL071	Dug	0.95	23.210134	86.487155	172.6	On the midway from Purulia to Manbazar, 17 km from Chakaltore. Near Panipathar more Bus stand behind M.K.Xerox & Photo printing and New Era Machines.
76	Puncha	Chakgopalpur/Kapara	WBPL077	Dug	0.9	23.228124	86.647035	143.68	Govt. well (LDW-1960). Adjacent to the house of Sapan Mahato. RHS of road towards Bagda.
77	Puncha	Kulgara	WBPL079	Dug	0.8	23.328183	86.586637	168.68	Behind bela Sriti Path mondir. Near the Signboard Kulgara Sankaryacharya Mission Vidyamandir. RHS of road towards Keshargar.
78	Puncha	Puncha	WBPL085	Dug	0.7	23.164032	86.655195	126.35	Inside Puncha Police Station.
79	Puncha	Damodarpur	WBPL089	Dug	0.67	23.207322	86.666415	142.99	LHS of road from Lalpur to Bagdah infront of the house of Abhiram Sais
80	Puncha	Loulara	WBPL090	Dug	0.58	23.173953	86.66955	157.42	LHS of Bagdah - Puncha road infront of the house of Sukumar Banerjee, about 4 km from Bagdah
81	Puncha	Matha	WBPL103	Dug	0.57	23.158048	86.545636	154.77	RHS of Banduan Kendra Rd., near the house of Atul Ch. Mahato
82	Puncha	Taltal	WBPL107	Dug	0.5	23.211415	86.433191	175.32	LHS of Manbazar - Puncha Road near open ground of Hat Bazar after Panipathar. 200m away from Kali Mandir.
83	Puncha	Dadki	WBPL110	Dug	1	23.177938	86.67714	138.79	In front of H/o Devnath Dutta L.H.S. Of road towards Purcha 2.5 km before Purcha P.S
84	Purulia	Sankhari	WBPL100	Dug	0.68	23.056084	86.360455	169.1	LHS of Bamundiha - Barabazar Rd. near the house of Bhuson Mahto, about 3 km before Barabazar
85	Purulia - I	Imundi	WBPL66	Dug	0.75	23.393683	86.275304	218.47	On Purulia - Jhalda road. Opposite to the approach road for Gourinath Dham Rly. Stn.
86	Purulia - I	Pandrama	WBPL095	Dug	0.66	23.268935	86.327106	181.63	LHS of Purulia - Arshar road, opposite side of health centre and adjacent of Smriti Bedi mother of Dulal Mahato.3 km from Tawna More.
87	Purulia - I	Dhobakata	WBPL106	Dug	0.69	23.333432	86.377485	171.81	LHS of Bankura - Purulia By-pass, after crossing the flyover Railway track , near the house of Sarbeswar Kalindi at Harijan colony
88	Purulia-I	Purulia(Belguma)	WBPL04	Dug	0.65	23.321875	86.343006	183.99	Just left side of the entrance of Agri. Irrigation Office at Belguma, Purulia.
89	Purulia-I	Tamna	WBPL28	Dug	0.3	23.273642	86.350964	153.25	At Tamna more within the House of Subal Adhikari & back side of Hotel.
90	Purulia-I	Chakaltore	WBPL45	Dug	0.94	23.236235	86.359198	163.22	Inside Primary Health Centre.
91	Purulia-II	Kustar	WBPL32	Dug	0.49	23.404799	86.453162	200.26	Within Health Centre, at its entrance adj. to Doctors' Quarter near outdoor. On Raghunathpur-Purulia road.
92	Purulia-II	Podakaroad	WBPL50	Dug	0.43	23.369513	86.400155	199.97	On Puruliá-Raghunathpur Rd,near the house of Anil Bauri Harijan Para.
93	Raghunathpur-I	Bero	WBPL31A	Dug	0.35	23.525901	86.754148	124.77	On Saltora-Raghunathpur road, near bus stand 10 K.m. from Raghunathpur towards Saltora at Kharbora, near Bauri para. Depth - 9.00 m bmpdia - 2.40 m.M.P. 0.35 m agl.
94	Raghunathpur-I	Naduara	WBPL47	Dug	0.2	23.522744	86.67948	118.36	Inside Raghunathpur I.T.I compd. on Raghunathpur-Adra road.
95	Raghunathpur-I	Chinpina	WBPL49	Dug	0.69	23.535127	86.696097	106.55	By the side of Purulia-Bankura rd just at the entrance of the village from Raghunathpur & adj.to Hari Mandir & house of Badal Bauri.
96	Raghunathpur-I	Babugram	WBPL52	Dug	0.72	23.53613	86.603018	132.41	Inside Babugram Primary Health Centre, near Doctors' Quarter on Raghunathpur-Santaldih road.
97	Raghunathpur-II	Raghunathpur	WBPL13	Dug	0.71	23.545405	86.674557	113.59	In the compound of P.W.D.I.B.
98	Rampur	Dangardi	WBPL19A	Dug	0.78	22.948402	86.600192	133.69	Opposite to Dangardi Junior Basic School, adjacent to H/O Abani Mahato.Located on the left side of road from Dangardi to Sindri, 250 m from Dangardi more on Manbazar to Bandwan road, 1 km before Rampur.
99	Santuri	Leadson	WBPL30	Dug	0.63	23.519919	86.823932	131.95	On Saltora-Raghunathpur road & adj.to the house oæ Atika Mondal.12 km from Saltora towards Raghunathpur(r) Behind Mihijam Clinic.
100	Santuri	Balitora	WBPL42	Dug	0.61	23.629301	86.855553	57.99	On Neturia-Saltora Rd, at the Bus Stand near house of Shri Gouri Pada Mitra.
101	Santuri	Santuri	WBPL105	Dug	0.34	23.524307	86.856579	128.33	LHS of Raghunathpur - Bankura Rd., back side of Telephone Tower, near Tarun Sangha and Police station, after Leadason
102	Tuncha	Damodarpur	WBPL109	Dug	0.6	23.201558	86.668829	142.61	RHS of road towards Purcha 7 near house compound of Dwga Charam Mahato & opp I.C.D.S. Center

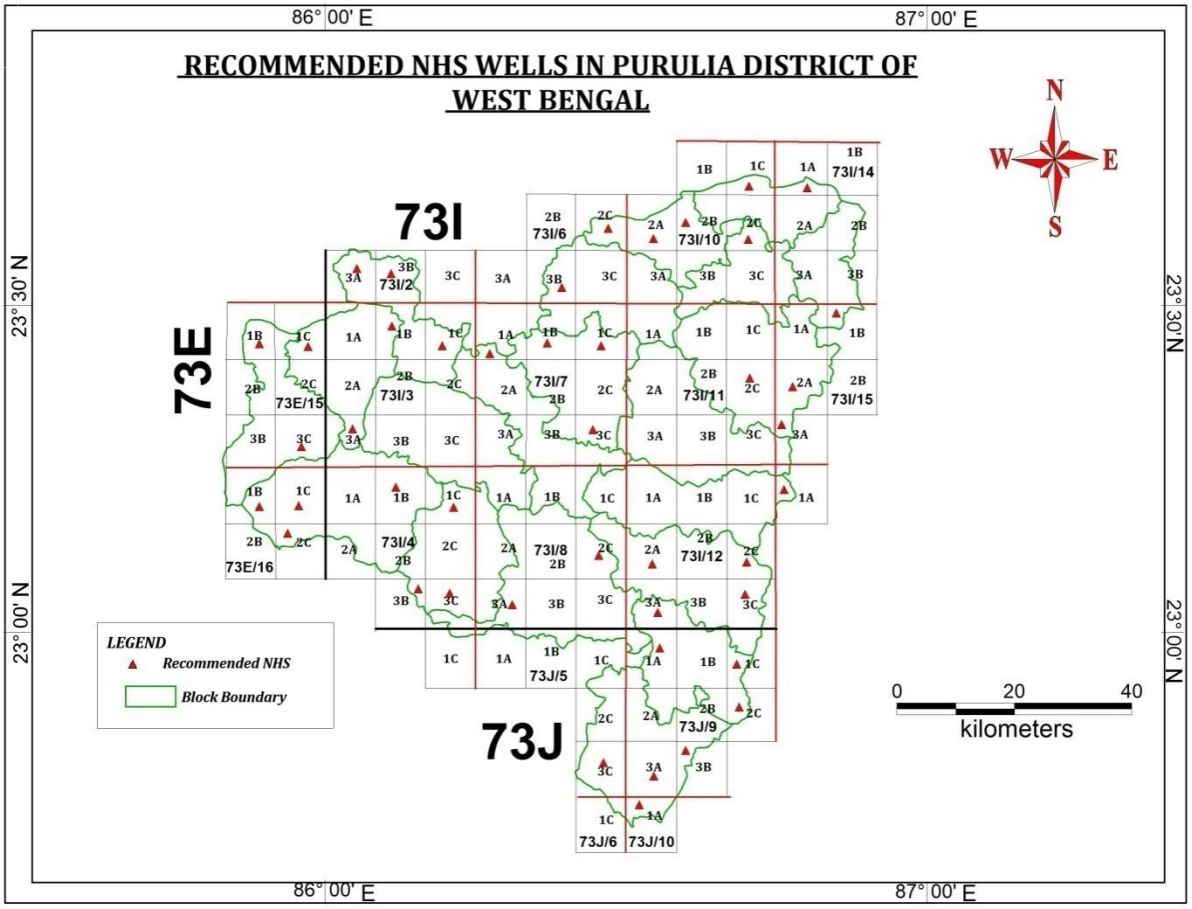

Figure-12.4: Map showing recommended NHS wells in Purulia district of West Bengal.

Table-12.4 : Details of proposed NHS wells in Purulia district of West Bengal.

Sl. No	Block	Location	Latitude	Longitude	Toposheet No.	Quadrant No.
1	Manbazar-II	Kutni	22.979	86.556	73J/9	1A
2	Manbazar-II	Durgadi	22.953	86.686	73J/9	1C
3	Manbazar-II	Sankura	22.89	86.688	73J/9	2C
4	Bundwan	Madhuban	22.779	86.546	73J/9	3A
5	Bundwan	Churku	22.816	86.599	73J/9	3B
6	Bundwan	Digha	22.783	86.524	73J/10	1A
7	Bundwan	Dangarjuri	22.802	86.465	73J/5	3C
8	Jhalda-I	Piprajara	23.441	85.891	73E/15	1B
9	Jhalda-II	Lakshmipur	23.436	85.972	73E/15	1C
10	Jhalda-I	Luskudih-Dantia	23.283	85.959	73E/15	3C
11	Baghmundi	Suisa	23.192	85.899	73E/16	1B
12	Baghmundi	Karihensa	23.195	85.953	73E/16	1C
13	Baghmundi	Kantadih	23.151	85.936	73E/16	2C
14	Joypur	Dambera	23.559	86.051	73I/2	3A
15	Joypur	Sidhu	23.546	86.109	73I/2	3B
16	Jhalda-II	Damra	23.467	86.11	73I/3	1B
17	Joypur	Selani	23.441	86.193	73I/3	1C
18	Jhalda-II	Baradi	23.311	86.043	73I/3	3A

Sl. No	Block	Location	Latitude	Longitude	Toposheet No.	Quadrant No.
19	Baghmundi	Ajhodya Hill	23.22	86.119	73I/4	1B
20	Balarampur	Kana	23.129	86.213	73I/4	1C
21	Balarampur	Baraha Chatarma	23.066	86.154	73I/4	3B
22	Balarampur	Jagadih	23.057	86.208	73I/4	3C
23	Ragunathpur-II	Nabagram	23.618	86.469	73I/6	2C
24	Para	Tetalta	23.527	86.396	73I/6	3B
25	Puruli-I	Gondhudi	23.427	86.273	73I/7	1A
26	Puruli-II	Chainpur	23.442	86.368	73I/7	1B
27	Puruli-II	Ragudih	23.438	86.459	73I/7	1C
28	Puruli-II	Dubcharka	23.311	86.445	73I/7	3C
29	Barabazar	Ulda	23.12	86.454	73I/8	2C
30	Barabazar	Ramkanali	23.042	86.311	73I/8	3A
31	Neturia	Kalipathar	23.68	86.706	73I/10	1C
32	Ragunathpur-II	Sagarka	23.601	86.547	73I/10	2A
33	Ragunathpur-II	Barra	23.626	86.599	73I/10	2B
34	Ragunathpur-I	Salanchi	23.601	86.704	73I/10	2C
35	Kashipur	Kusumgora/ Ranjandi	23.387	86.705	73I/11	2C
36	Manbazar-I	Bagdega	23.105	86.541	73I/12	2A
37	Manbazar-I	Dhadika	23.107	86.699	73I/12	2C
38	Manbazar-II	Nalkundi	23.033	86.552	73I/12	3A
39	Manbazar-I	Udaypur	23.059	86.699	73I/12	3C
40	Neturia	Saltore	23.677	86.802	73I/14	1A
41	Santuri	Gorsika	23.488	86.849	73I/15	1B
42	Kashipur	Paharpur	23.376	86.777	73I/15	2A
43	Kashipur	Hadalda	23.32	86.757	73I/15	3A
44	Puncha	Chorrdi	23.219	86.763	73I/16	1A

Groundwater quality data : The norms for data required for groundwater quality is similar to that of Ground Water Monitoring. Water samples collected from every existing NHS stations as well as from the recommended NHS wells could be utilized for quality analysis.

Geophysical data : It is recommended that 2 to 3 Profiling/VES/TEM soundings upto 200 meterinterpretation depth should be carried out in each of the nine quadrants of thetoposheet totalling to 18 to 27 nos. in each sheet to decipher aquifer geometry.A total of 249VES is recommended to carry out in the study area. The recommendation for VES is presented in Figure 12.5 &Table 12.5.

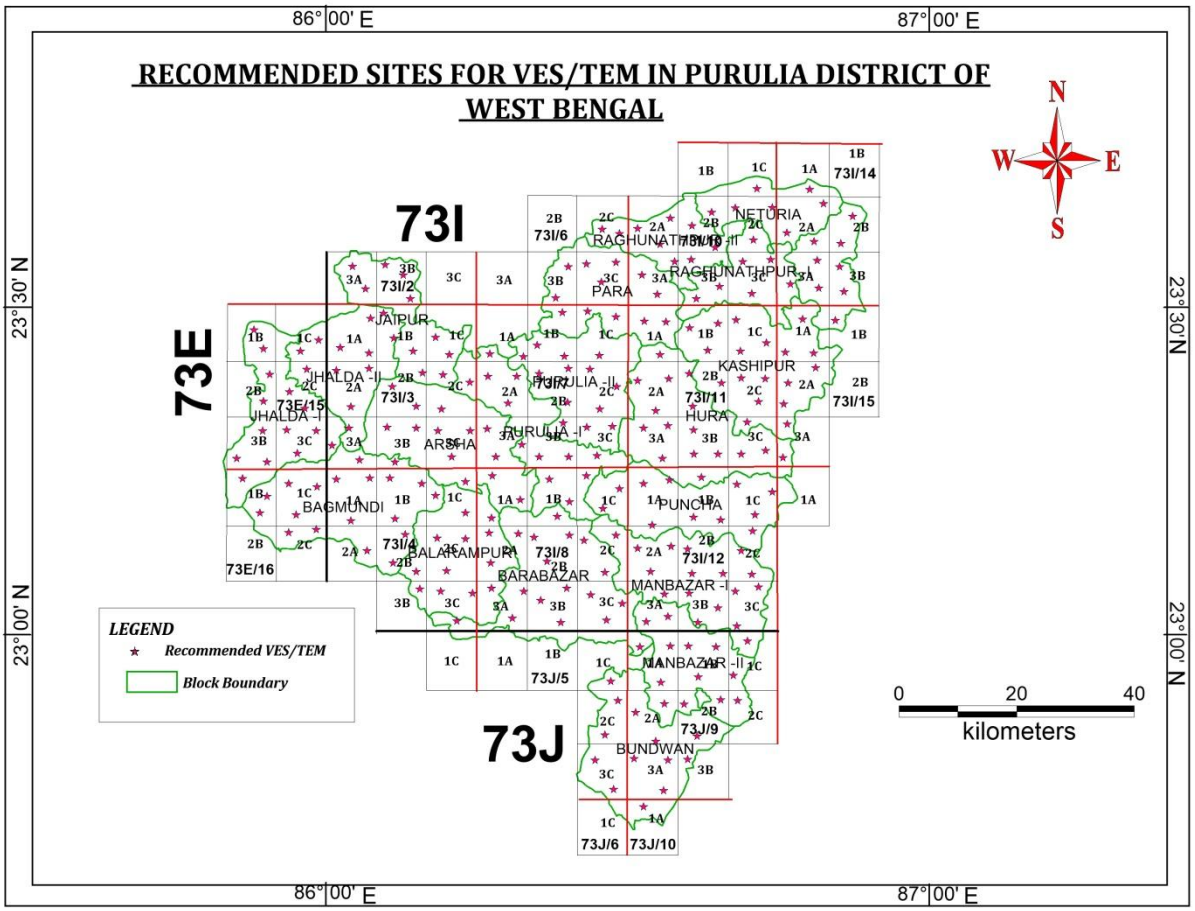

Figure-12.5: Map showing recommended sites for VES/TEM in Purulia district of West Bengal

Table-12.5: List of recommended VES to be carried out in Purulia district of West Bengal.

Sl. No.	Toposheet No.	Quadrant	No. of VES	Aquifer Type
1	73J/5	1C	1	Aquifer-I, Aquifer-II
2	73J/5	2C	3	Aquifer-I, Aquifer-II
3	73J/5	3C	2	Aquifer-I, Aquifer-II
4	73J/9	1A	3	Aquifer-I, Aquifer-II
5	73J/9	1B	3	Aquifer-I, Aquifer-II
6	73J/9	1C	2	Aquifer-I, Aquifer-II
7	73J/9	2A	3	Aquifer-I, Aquifer-II
8	73J/9	2B	3	Aquifer-I, Aquifer-II
9	73J/9	2C	1	Aquifer-I, Aquifer-II
10	73J/9	3A	3	Aquifer-I, Aquifer-II
11	73J/9	3B	1	Aquifer-I, Aquifer-II
12	73J/10	1A	1	Aquifer-I, Aquifer-II
13	73E/15	1B	2	Aquifer-I, Aquifer-II
14	73E/15	1C	2	Aquifer-I, Aquifer-II
15	73E/15	2B	2	Aquifer-I, Aquifer-II
16	73E/15	2C	3	Aquifer-I, Aquifer-II
17	73E/15	3B	3	Aquifer-I, Aquifer-II
18	73E/15	3C	3	Aquifer-I, Aquifer-II
19	73E/16	1B	3	Aquifer-I, Aquifer-II
20	73E/16	1C	3	Aquifer-I, Aquifer-II

Sl. No.	Toposheet No.	Quadrant	No. of VES	Aquifer Type
21	73E/16	2C	2	Aquifer-I, Aquifer-II
22	73I/2	3A	2	Aquifer-I, Aquifer-II
23	73I/2	3B	3	Aquifer-I, Aquifer-II
24	73I/3	1A	3	Aquifer-I, Aquifer-II
25	73I/3	1B	3	Aquifer-I, Aquifer-II
26	73I/3	1C	2	Aquifer-I, Aquifer-II
27	73I/3	2A	3	Aquifer-I, Aquifer-II
28	73I/3	2B	3	Aquifer-I, Aquifer-II
29	73I/3	2C	3	Aquifer-I, Aquifer-II
30	73I/3	3A	3	Aquifer-I, Aquifer-II
31	73I/3	3B	3	Aquifer-I, Aquifer-II
32	73I/3	3C	3	Aquifer-I, Aquifer-II
33	73I/4	1A	3	Aquifer-I, Aquifer-II
34	73I/4	1B	3	Aquifer-I, Aquifer-II
35	73I/4	1C	3	Aquifer-I, Aquifer-II
36	73I/4	2A	1	Aquifer-I, Aquifer-II
37	73I/4	2B	3	Aquifer-I, Aquifer-II
38	73I/4	2C	3	Aquifer-I, Aquifer-II
39	73I/4	3B	1	Aquifer-I, Aquifer-II
40	73I/4	3C	3	Aquifer-I, Aquifer-II
41	73I/6	2C	2	Aquifer-I, Aquifer-II
42	73I/6	3B	2	Aquifer-I, Aquifer-II
43	73I/6	3C	3	Aquifer-I, Aquifer-II
44	73I/7	1A	2	Aquifer-I, Aquifer-II
45	73I/7	1B	3	Aquifer-I, Aquifer-II
46	73I/7	1C	3	Aquifer-I, Aquifer-II
47	73I/7	2A	3	Aquifer-I, Aquifer-II
48	73I/7	2B	3	Aquifer-I, Aquifer-II
49	73I/7	2C	3	Aquifer-I, Aquifer-II
50	73I/7	3A	3	Aquifer-I, Aquifer-II
51	73I/7	3B	3	Aquifer-I, Aquifer-II
52	73I/7	3C	3	Aquifer-I, Aquifer-II
53	73I/8	1A	3	Aquifer-I, Aquifer-II
54	73I/8	1B	3	Aquifer-I, Aquifer-II
55	73I/8	1C	3	Aquifer-I, Aquifer-II
56	73I/8	2A	3	Aquifer-I, Aquifer-II
57	73I/8	2B	3	Aquifer-I, Aquifer-II
58	73I/8	2C	3	Aquifer-I, Aquifer-II
59	73I/8	3A	3	Aquifer-I, Aquifer-II
60	73I/8	3B	3	Aquifer-I, Aquifer-II
61	73I/8	3C	3	Aquifer-I, Aquifer-II
62	73I/10	1C	1	Aquifer-I, Aquifer-II
63	73I/10	2A	3	Aquifer-I, Aquifer-II
64	73I/10	2B	2	Aquifer-I, Aquifer-II
65	73I/10	3A	3	Aquifer-I, Aquifer-II
66	73I/10	3B	3	Aquifer-I, Aquifer-II
67	73I/10	3C	3	Aquifer-I, Aquifer-II
68	73I/11	1A	3	Aquifer-I, Aquifer-II
69	73I/11	1B	3	Aquifer-I, Aquifer-II
70	73I/11	1C	3	Aquifer-I, Aquifer-II
71	73I/11	2A	3	Aquifer-I, Aquifer-II
72	73I/11	2B	3	Aquifer-I, Aquifer-II

Sl. No.	Toposheet No.	Quadrant	No. of VES	Aquifer Type
73	73I/11	2C	3	Aquifer-I, Aquifer-II
74	73I/11	3A	3	Aquifer-I, Aquifer-II
75	73I/11	3B	3	Aquifer-I, Aquifer-II
76	73I/11	3C	3	Aquifer-I, Aquifer-II
77	73I/12	1A	3	Aquifer-I, Aquifer-II
78	73I/12	1B	3	Aquifer-I, Aquifer-II
79	73I/12	1C	3	Aquifer-I, Aquifer-II
80	73I/12	2A	3	Aquifer-I, Aquifer-II
81	73I/12	2B	3	Aquifer-I, Aquifer-II
82	73I/12	2C	3	Aquifer-I, Aquifer-II
83	73I/12	3A	3	Aquifer-I, Aquifer-II
84	73I/12	3B	3	Aquifer-I, Aquifer-II
85	73I/12	3C	3	Aquifer-I, Aquifer-II
86	73I/14	1A	1	Aquifer-I, Aquifer-II
87	73I/14	2A	3	Aquifer-I, Aquifer-II
88	73I/14	2B	2	Aquifer-I, Aquifer-II
89	73I/14	3A	3	Aquifer-I, Aquifer-II
90	73I/14	3B	2	Aquifer-I, Aquifer-II
91	73I/15	1A	3	Aquifer-I, Aquifer-II
92	73I/15	1B	1	Aquifer-I, Aquifer-II
93	73I/15	2A	3	Aquifer-I, Aquifer-II
94	73I/15	3A	2	Aquifer-I, Aquifer-II

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ANNEXURES

Annexure – 1 : Chemical parameters for Phreatic Aquifers assessed from various sampling points in Purulia district of West Bengal (Source: NABL Laboratory, CGWB, ER, Kolkata)

Sl. no.	Block	Location	Lat	Long	Date of Sampling	Well Type	Well ID	Lab Code	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Total Alk as $CaCO_3$	Cl	NO_3	SO_4	F	TDS	Fe
1	Arsha	Arsha	23.3228	86.1581	18.06.2019	Dug Well	WBPL008	C - 597/19	8.07	576	190	16	36	43	16.0	0	220	180	78	BDL	7	0.31	332	0.04
2	Arsha	Kantadihi	23.2175	86.2989	30.05.2019	Dug Well	WBPL029	C - 613/19	7.89	1984	865	60	174	94	7.6	0	214	175	557	4	62	0.10	1089	0.05
3	Arsha	Sirkabad	23.2747	86.1942	29.05.2019	Dug Well	WBPL044B	C - 622/19	7.96	833	215	10	46	82	10.5	0	299	245	117	9	BDL	0.94	458	0.03
4	Arsha	Hansla More	23.3272	86.1717	19.06.2019	Dug Well	WBPL096	C - 646/19	8.00	260	105	14	17	12	1.8	0	128	105	21	2	BDL	0.64	147	0.07
5	Baghmundi	Korenge	23.2364	85.9850	01.06.2019	Dug Well	WBPL041	C - 620/19	7.81	250	105	16	16	11	1.8	0	128	105	18	5	BDL	1.17	147	0.04
6	Bagmundi	Baghmundi	23.1950	86.0681	30.05.2019	Dug Well	WBPL009	C - 598/19	7.85	1386	465	22	100	89	27.9	0	214	175	266	43	88	0.28	765	BDL
7	Balarampur	Namsole	23.1306	86.2456	19.06.2019	Dug Well	WBPL097	C - 647/19	7.94	286	115	24	13	15	1.6	0	122	100	28	BDL	BDL	0.37	157	0.01
8	Balarampur	Dava	23.1042	86.1392	19.06.2019	Dug Well	WBPL098	C - 648/19	7.64	535	150	18	26	54	4.1	0	67	55	96	41	34	0.66	314	0.01
9	Barabazar	Takariya	23.1600	86.3200	28.05.2019	Dug Well	WBPL017A	C - 603/19	7.86	701	200	12	41	62	15.1	0	165	135	96	24	63	0.64	415	0.04
10	Barabazar	Sindri	23.0600	86.4800	20.06.2019	Dug Well	WBPL018	C - 604/19	7.74	740	225	10	49	63	2.7	0	159	130	138	40	26	0.47	426	0.04
11	Barabazar	Barabazar	23.0000	86.3800	29.05.2019	Dug Well	WBPL048	C - 624/19	8.08	1728	540	58	96	106	65.1	0	403	330	312	37	24	0.34	943	0.01
12	Barabazar	Bamundiha	23.2389	86.3536	27.06.2019	Dug Well	WBPL068	C - 633/19	7.84	311	105	22	12	29	1.6	0	116	95	50	3	BDL	0.08	188	0.39
13	Bundwan	Dhabani	22.9000	86.4900	20.06.2019	Dug Well	WBPL061	C - 629/19	8.08	709	305	8	69	24	9.5	0	207	170	99	40	17	0.27	393	0.01
14	Hura	Keshargarh	23.2689	86.5561	20.06.2019	Dug Well	WBPL025	C - 610/19	8.24	1430	530	14	120	88	14.9	0	360	295	252	39	43	0.16	791	0.01
15	Hura	Ludurka	23.3478	86.5422	20.06.2019	Dug Well	WBPL027A	C - 611/19	7.77	153	65	14	7	8	1.6	0	67	55	14	4	8	0.12	99	0.02
16	Hura	Bishpuria	23.2861	86.7231	31.05.2019	Dug Well	WBPL039	C - 618/19	7.82	1047	485	16	108	42	2.1	0	171	140	266	17	37	0.19	592	0.03
17	Hura	Lalpur	23.2806	86.7611	01.06.2019	Dug Well	WBPL074	C - 635/19	8.02	683	220	12	46	59	9.2	0	177	145	96	34	39	0.28	403	0.04
18	Hura	Raheradhi	23.2744	86.6408	19.06.2019	Dug Well	WBPL076	C - 636/19	8.04	392	165	12	33	19	4.4	0	183	150	25	BDL	23	0.17	228	0.04
19	Hura	Duriakata	23.2986	86.6625	29.05.2019	Dug Well	WBPL084	C - 639/19	8.15	414	160	36	17	29	1.2	0	201	165	35	7	BDL	0.24	248	0.04
20	Hura	Kulabahal	23.2997	86.5422	30.05.2019	Dug Well	WBPL091	C - 643/19	8.13	967	220	22	40	85	38.7	0	195	160	138	86	22	0.26	552	0.02
21	Jaypur	Narayanpur	23.4100	86.2000	01.06.2019	Dug Well	WBPL021	C - 606/19	7.97	441	140	12	27	45	0.4	0	159	130	35	BDL	43	0.37	259	0.01
22	Jhalda - II	Durgu	23.3653	85.9756	29.05.2019	Dug Well	WBPL088	C - 641/19	7.94	1153	440	14	98	67	4.5	0	134	110	280	84	BDL	0.16	630	0.02
26	Jhalda - II	Kotshila	23.4175	86.1417	20.06.2019	Dug Well	WBPL007A	C - 596/19	7.69	838	290	10	64	67	3.7	0	116	95	174	8	67	0.23	464	0.01
23	Jhalda-I	Tulin	23.3797	85.8983	30.05.2019	Dug Well	WBPL012B	C - 599/19	7.88	1221	345	16	74	122	8.5	0	128	105	305	16	57	0.24	678	0.01
24	Jhalda-I	Jhalda	23.4472	86.0336	20.06.2019	Dug Well	WBPL022A	C - 607/19	7.95	844	220	18	43	85	1.8	0	171	140	156	17	47	0.24	473	0.03
25	Jhalda-I	Jhargo	23.3083	85.8944	31.05.2019	Dug Well	WBPL023	C - 608/19	8.36	543	230	22	43	25	2.8	27	159	175	67	26	BDL	0.21	299	0.02
27	Joypur	Joypur	23.4172	86.1428	31.05.2019	Dug Well	WBPL038A	C - 617/19	7.78	2208	575	14	131	193	27.9	0	134	110	436	225	112	0.62	1222	0.01
28	Kashipur	Gaurandih	23.4339	86.7667	19.06.2019	Dug Well	WBPL014B	C - 601/19	7.75	1943	540	18	120	168	9.3	0	146	120	326	279	74	0.41	1085	0.02
29	Kashipur	Indrabil	23.4114	86.7825	20.06.2019	Dug Well	WBPL024	C - 609/19	8.23	1325	525	20	115	88	7.2	0	573	470	145	20	BDL	0.16	745	0.07
30	Kashipur	Simla	23.3956	86.6497	30.05.2019	Dug Well	WBPL040	C - 619/19	7.83	1195	475	12	108	71	4.4	0	104	85	372	3	26	0.27	660	0.51
31	Kashipur	Napara	23.4239	86.6664	30.05.2019	Dug Well	WBPL054	C - 626/19	7.74	863	295	14	63	49	12.9	0	195	160	113	43	66	0.12	481	0.01
32	Kashipur	Palash Kola	23.4908	86.6700	19.06.2019	Dug Well	WBPL104	C - 650/19	7.83	2548	880	18	203	155	2.9	0	122	100	542	214	205	0.76	1416	0.03
33	Kotshila	Ukma	23.3981	86.0606	30.05.2019	Dug Well	WBPL094	C - 644/19	8.21	698	210	16	41	76	4.6	0	177	145	128	5	27	0.84	406	0.04
34	Manbazar - I	Sindurpur	23.1219	86.6097	19.06.2019	Dug Well	WBPL102	C - 649/19	8.35	958	290	30	52	63	31.3	24	214	215	113	41	51	0.52	527	0.04
35	Manbazar-I	Manbazar	23.0600	86.6500	20.06.2019	Dug Well	WBPL001	C - 593/19	8.05	694	130	14	23	91	1.0	0	220	180	103	BDL	15	0.24	381	0.01

Annexure – 1 : Chemical parameters for Phreatic Aquifers assessed from various sampling points in Purulia district of West Bengal (Source: NABL Laboratory, CGWB, ER, Kolkata)

Sl. no.	Block	Location	Lat	Long	Date of Sampling	Well Type	Well ID	Lab Code	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Total Alk as $CaCO_3$	Cl	NO_3	SO_4	F	TDS	Fe
36	Manbazar-II	Ankro	22.9100	86.5700	19.06.2019	Dug Well	WBPL062	C - 630/19	8.05	561	175	8	38	48	3.8	0	238	195	60	4	BDL	0.45	307	0.15
37	Manbazar-II	Khariduyara	22.9892	86.6300	20.06.2019	Dug Well	WBPL069	C - 634/19	8.20	758	245	16	50	72	2.8	0	256	210	124	BDL	BDL	0.36	421	0.02
38	Neturia	Gobag	24.0189	87.2925	19.06.2019	Dug Well	WBPL058	C - 628/19	7.81	645	145	22	22	50	36.4	0	116	95	85	36	47	0.17	368	0.08
39	Nituria	Nituria	23.6622	86.8247	19.06.2019	Dug Well	WBPL063	C - 631/19	7.98	623	225	20	43	41	2.9	0	201	165	53	29	35	0.37	347	0.01
40	Para	Anara	23.4914	86.5647	01.06.2019	Dug Well	WBPL005	C - 595/19	7.83	820	230	10	50	76	1.9	0	207	170	110	28	47	0.08	449	0.02
41	Para	Para	23.5106	86.5153	02.06.2019	Dug Well	WBPL033A	C - 616/19	8.25	1322	395	18	85	103	9.0	0	268	220	170	179	BDL	0.24	728	0.02
42	Para	Deuli	23.5633	86.4681	20.06.2019	Dug Well	WBPL055A	C - 627/19	8.09	800	340	18	72	42	1.5	0	183	150	138	31	39	0.19	454	0.03
43	Para	Kashiberia	23.5442	86.5492	29.05.2019	Dug Well	WBPL083	C - 638/19	8.32	1410	445	66	68	114	11.4	0	354	290	174	BDL	162	0.41	812	0.04
44	Puncha	Kenda	23.1931	86.5183	01.06.2019	Dug Well	WBPL015A	C - 602/19	7.90	476	115	12	21	63	7.7	0	183	150	64	BDL	9	0.18	288	0.06
45	Puncha	Bagda	23.1958	86.6847	01.06.2019	Dug Well	WBPL020	C - 605/19	7.87	650	280	18	57	22	5.6	0	214	175	103	BDL	21	0.18	356	0.02
46	Puncha	Kulgara	23.1639	86.6553	31.05.2019	Dug Well	WBPL079	C - 637/19	7.77	155	55	14	5	13	1.0	0	79	65	11	BDL	BDL	0.18	92	0.04
47	Puncha	Puncha	23.1589	86.6517	29.05.2019	Dug Well	WBPL085	C - 640/19	8.03	1985	590	24	129	192	4.7	0	281	230	369	83	134	0.14	1106	0.01
48	Puncha	Damodarpur	23.1989	86.6667	29.05.2019	Dug Well	WBPL089	C - 642/19	7.90	1791	735	26	163	65	3.8	0	153	125	379	176	74	0.31	980	0.02
49	Purulia - I	Purulia (Belguma)	23.3281	86.3608	20.06.2019	Dug Well	WBPL004	C - 594/19	7.54	364	125	8	26	29	5.7	0	159	130	32	1	10	0.16	208	0.03
50	Purulia - I	Tamna	23.2736	86.3511	20.06.2019	Dug Well	WBPL028	C - 612/19	7.96	1159	395	12	89	82	2.9	0	153	125	252	73	36	0.23	640	0.02
51	Purulia - I	Chakaltore	23.2364	86.3592	29.05.2019	Dug Well	WBPL045	C - 623/19	7.98	542	205	16	40	36	1.8	0	153	125	82	21	18	0.68	308	0.03
52	Purulia - I	Imundi	23.3936	86.2753	18.06.2019	Dug Well	WBPL066	C - 632/19	7.95	1560	440	14	98	133	38.4	0	299	245	347	33	13	0.13	859	BDL
53	Purulia - I	Pandrama	23.2664	86.3228	01.06.2019	Dug Well	WBPL095	C - 645/19	7.90	820	325	18	68	47	3.5	0	116	95	167	35	48	0.23	457	0.02
54	Purulia - II	Dhobakata	23.3333	86.3775	02.06.2019	Dug Well	WBPL106	C - 652/19	8.15	1168	330	30	62	112	3.1	0	281	230	191	17	53	0.38	641	0.01
55	Purulia - II	Kustar	23.4047	86.4531	26.06.2019	Dug Well	WBPL032	C - 615/19	8.30	685	250	14	52	53	7.9	0	323	265	64	18	BDL	0.08	407	0.30
56	Purulia - II	Podalaroad	23.3772	86.4056	28.05.2019	Dug Well	WBPL050	C - 625/19	7.81	2108	730	70	135	121	8.0	0	201	165	415	259	30	0.73	1161	0.01
57	Raghunathpur-I	Bero	23.5289	86.7544	29.05.2019	Dug Well	WBPL031A	C - 614/19	7.98	435	115	12	21	54	2.4	0	146	120	46	BDL	39	0.06	263	0.07
58	Raghunathpur-ii	Raghunathpur	23.9669	87.0183	19.06.2019	Dug Well	WBPL013	C - 600/19	7.97	1016	285	10	63	97	1.4	0	201	165	163	7	91	0.56	557	BDL
59	Santuri	Balitora	23.6294	86.8558	01.06.2019	Dug Well	WBPL042	C - 621/19	7.60	937	300	16	63	79	2.6	0	183	150	142	3	95	0.86	513	0.02
60	Santuri	Santuri	23.5247	86.8567	02.06.2019	Dug Well	WBPL105	C - 651/19	7.90	375	165	22	27	15	4.1	0	116	95	57	BDL	18	0.24	213	0.02

Annexure – 2 : Decadal water level data (2010 to 2019)from various NHNSstationsthat has been utilized for preparing Depth to Water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

Sl. no.	Block	Location	Lat	Long	Date of Sampling	Well ID	Lab Code	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Total Alk as $CaCO_3$	Cl	NO_3	SO_4	F	TDS	Fe
1	Arsa	Arsa	23.3231	86.1157	24.10.2020	EW 01	C - 792/20	8.34	860	255	74	17	76	3.5	0	98	80	192	BDL	75	0.81	498	2.03
2	Arsa	Arsa	23.3231	86.1157	24.10.2021	EW 02	C - 793/20	8.30	884	335	80	33	41	5.5	0	98	80	196	BDL	52	0.43	468	0.21
3	Arsa	Jhujhka	23.2807	86.2794	09.01.2021	EW	C - 806/20	8.40	651	215	44	26	53	4.8	0	122	100	68	BDL	110	1.62	380	BDL
4	Arsa	Jhujhka	23.2807	86.2794	29.01.2021	OW	C - 810/20	8.36	584	215	56	18	38	5.4	0	177	145	58	BDL	72	1.23	357	0.57
5	Arsa	Sirkabad	23.2757	86.1943	25.08.2019	EW	C - 52/20	7.81	418	180	32	24	19	3.6	0	226	185	28	1	BDL	1.21	247	BDL
6	Arsa	Sirkabad	23.2757	86.1943	08.09.2020	OW 01	C - 785/20	8.23	428	155	54	5	28	3.0	0	165	135	22	12	31	0.51	256	BDL
7	Arsa	Sirkabad	23.2757	86.1943	12.09.2020	OW 02	C - 786/20	8.27	416	160	36	17	28	3.1	0	183	150	22	12	32	0.48	262	BDL
8	Barabazar	Bamundiha	23.1159	86.3654	10.01.2020	EW 01	C - 1224/19	7.83	979	125	44	4	145	4.6	0	134	110	152	28	94	0.00	553	BDL
9	Barabazar	Bamundiha	23.1167	86.3635	01.02.2020	EW 02	C - 1232/19	8.25	928	90	22	9	156	3.2	0	134	110	152	BDL	108	0.00	532	BDL
10	Barabazar	Bamundiha	23.1159	86.3654	16.03.2020	OW	C - 525A/20	7.96	927	90	28	5	157	2.6	0	159	130	167	BDL	64	0.00	521	1.87
11	Barabazar	Bodaldih	23.1508	86.4175	21.02.2018	OW 01	C - 23/19	6.64	316	130	32	12	25	6.6	0	183	150	35	9	3	0.07	202	BDL
12	Barabazar	Bodaldih	23.1508	86.4175	03.07.2019	OW 02	C - 653/19	7.74	279	105	22	12	27	4.8	0	153	125	25	3	10	0.14	196	BDL
13	Barabazar	Shankhari - Bansberia	23.0510	86.3570	25.08.2019	EW 01	C - 1070/19	7.86	351	155	10	32	13	1.3	0	189	155	14	BDL	BDL	0.00	186	BDL
14	Barabazar	Shankhari - Bansberia	23.0512	86.3572	16.10.2019	EW 02	C - 1077/19	7.63	181	100	6	21	8	1.3	0	116	95	14	3	BDL	0.00	124	BDL
15	Barabazar	Shankhari - Bansberia	23.0512	86.3572	10.12.2019	OW	C - 1092/19	7.92	199	75	22	5	10	1.1	0	98	80	11	2	BDL	0.02	110	BDL
16	Hura	Ladhurka	23.3521	86.5309	08.02.2018	EW 01	C - 1566/17	8.12	705	210	22	38	64	5.1	0	110	90	145	13	22	0.00	399	1.26
17	Hura	Ladhurka	23.3521	86.5309	15.02.2018	EW 02	C - 1567/17	7.12	690	195	20	35	67	5.3	0	104	85	142	14	25	0.00	391	0.72
18	Hura	Ladhurka	23.3521	86.5309	21.02.2018	EW 03	C - 1568/17	7.15	710	205	20	38	63	5.1	0	98	80	149	14	21	0.00	396	1.68
19	Hura	Lakhanpur	23.3409	86.5732	24.05.2018	EW	C - 110/18	7.78	315	120	34	9	20	4.2	0	85	70	53	12	15	0.80	199	0.80
20	Hura	Lalpur	23.3066	86.6248	15.03.2018	EW	C - 29/18	8.08	185	155	28	21	17	2.7	0	116	95	43	11	1	0.77	118	0.83
21	Hura	Rakhera-Bishpuria	23.2661	86.7483	12.09.2018	EW	C - 1051/18	8.24	531	320	40	53	19	4.6	0	220	180	85	2	1	0.44	340	0.33
22	Jhalda I	Goria	23.3284	86.2336	18.05.2017	EW	C - 536/17	7.79	378	185	34	24	49	3.4	0	348	385	15	4	10	1.32	179	0.78
23	Jhalda I	Ichag	23.3326	85.9251	06.09.2017	EW	C - 1310/17	8.14	372	80	22	6	51	4.0	0	201	165	18	BDL	4	0.08	237	0.82
24	Jhalda I	Jhalda	23.3655	85.9616	10.12.2018	EW	C - 1476/17	8.20	344	80	18	9	46	2.2	0	128	105	35	1	14	0.00	217	3.34
25	Jhalda I	Mahatomara	23.4236	85.9124	16.04.2017	EW 01	C - 2/17	6.68	910	215	74	7	27	5.0	0	67	55	120	2	14	1.4	583	1.47
26	Jhalda I	Mahatomara	23.4236	85.9124	16.04.2017	EW 02	C - 3/17	7.34	626	230	60	19	14	3.8	0	116	95	96	BDL	6	1.21	400	1.38
29	Jhalda I	Tulin	23.3776	85.9006	24.12.2017	EW 02	C - 1477/17	8.01	395	105	30	7	41	2.2	0	146	120	43	1	9	0.86	234	BDL
30	Jhalda I	Tulin	23.3776	85.9006	25.11.2016	EW 02	C - 41/16	7.68	273	90	10	16	20	2.2	0	140	120	11	34	1	0.39	175	0.11
27	Jhalda II	Kotshila	23.4055	86.0717	28.10.2016	EW	C - 38/16	7.98	769	205	20	38	43	3.1	0	116	95	113	33	35	0.8	492	0.11
28	Jhalda II	Kotshila	23.4055	86.0717	28.10.2016	OW	C - 38/16	7.68	756	185	6	41	57	4.8	0	159	130	43	33	34	0.5	484	0.12
31	Manbazar I	Gopalnagar HS	23.1325	86.5879	31.01.2019	EW	C - 1145/18	7.98	368	150	12	29	20	1.7	0	195	160	21	1	8	0.72	214	0.92

Annexure – 2 : Decadal water level data (2010 to 2019)from various NHNSstationsthat has been utilized for preparing Depth to Water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

Sl. no.	Block	Location	Lat	Long	Date of Sampling	Well ID	Lab Code	pH	EC	TH	Ca	Mg	Na	K	CO_3	HCO_3	Total Alk as $CaCO_3$	Cl	NO_3	SO_4	F	TDS	Fe
32	Puncha	Kurukthupa	23.1478	86.5249	31.01.2019	EW	C - 1146/18	8.29	246	75	16	9	24	2.6	0	122	100	14	BDL	10	0.69	151	0.48
33	Puncha	Loulara	23.1742	86.6618	12.10.2018	EW	C - 1053/18	8.25	465	285	42	44	44	3.5	0	275	225	46	8	BDL	0.62	298	0.48
34	Puncha	Napara	23.2210	86.6454	19.11.2018	EW	C - 1055/18	8.03	883	355	84	35	61	3.1	0	201	165	202	2	BDL	0.34	565	0.77
35	Puncha	Napara	23.2210	86.6454	30.11.2018	OW	C - 1057/18	6.76	1057	335	102	19	70	4.0	0	134	110	213	42	49	0.52	582	0.98
36	Purulia I	Ambagan	23.3255	86.3437	31.07.2016	EW	C - 23/16	7.68	665	130	12	24	93	4.0	0	110	90	113	26	41	0.51	426	0.09
37	Purulia I	Ambagan	23.3255	86.3437	31.07.2016	OW	C - 23/16	7.63	774	135	26	17	89	4.7	0	165	135	124	27	22	0.8	495	0.21
38	Purulia I	Belguma	23.3271	86.3457	30.04.2016	EW	C - 003/16	7.96	639	140	24	19	77	3.4	0	189	155	74	24	35	0.6	409	0.10
39	Purulia I	Belguma	23.3271	86.3457	30.04.2016	OW	C - 003/16	7.65	530	90	14	13	86	3.2	0	153	125	64	24	29	0.4	339	0.13
40	Purulia I	Chaklatore	23.2425	86.3534	31.01.2019	EW	C - 1238/18	8.12	460	140	20	22	36	2.1	0	226	185	18	6	12	0.81	254	0.43
41	Purulia I	Chhara	23.3707	86.4193	19.01.2018	EW	C - 1555/17	7.17	493	160	20	27	39	5.6	0	110	90	74	22	24	0.66	293	0.36
42	Purulia I	Chhara	23.3707	86.4193	13.04.2018	EW 02	C - 30/18	7.81	386	215	46	24	26	1.6	0	177	145	71	10	1	0.47	247	0.22
43	Purulia I	Pandrama	23.2676	86.3153	05.12.2020	EW	C - 800/20	8.27	684	245	62	22	41	4.0	0	122	100	135	BDL	58	0.53	396	0.06
44	Purulia I	Pandrama	23.2676	86.3153	22.12.2020	OW	C - 805/20	8.25	673	245	62	22	41	4.0	0	92	75	140	BDL	58	0.52	383	0.31
45	Purulia II	Gengara	23.3439	86.4241	19.06.2018	EW	C - 679/18	8.03	397	140	4	32	48	2.3	0	195	160	50	BDL	BDL	0.27	254	0.50
46	Purulia II	Gengara	23.3439	86.4241	03.07.2018	OW	C - 689/18	7.92	359	140	36	12	36	2.8	0	177	145	60	BDL	4	0.26	230	0.01
47	Purulia II	Hutmura	23.3524	86.4737	30.07.2018	EW	C - 690/18	7.52	1318	360	64	49	109	3.7	0	201	165	230	BDL	4	0.29	844	0.58

Annexure – 3 : Decadal water level data (2010 to 2019)from various NHNSstationsthat has been utilized for preparing Depth to Water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR 2010_19	NOV 2010_19
1	Arsha	Arsha	23.322406	86.158107	332.3	WBPL08	0.32	Within the Forest Beat office & opp. to Arsha P.S.	0.71	-0.83
2	Arsha	Kantadihi	23.217356	86.298971	206.65	WBPL29	0.51	Inside sub-health centre appraochable from Arsha.	-0.67	-0.36
3	Baghmundi	Mathbura	23.119536	86.075843	193.21	WBPL37	0.87	Inside Forest Range Office. Rd approaching Balarampur.	-3.13	-1.88
4	Baghmundi	Korenge	23.236565	85.985109	198.29	WBPL41	0.68	Backside of the Hospital.	-0.52	0.25
5	Bagmundi	Baghmundi	23.195178	86.048332	197.77	WBPL09	0.86	In Baghmundi P.S. adjacent to Shiva Temple.	0.82	-0.17
6	Balarampur	Namsole	23.130699	86.245471	199.98	WBPL097	0.62	LHS of Tawna - Balarampur Rd., infront of of Sub - health centre . About 3 km from Baraumra towards Balarampur	0.29	0.2
7	Balarampur	Dava	23.104287	86.139284	154.92	WBPL098A	0.64	LHS of Balarampur - Baghmundi Rd., adjacent to the house of Surya Kanta Kumar,about 7 km before Matha.	0.23	-3.76
8	Balarampur	Baraurma	23.164166	86.262704	205.17	WBPL26	0.72	Inside school compound.	1.95	0.56
9	Barabazar	Bamundiha	23.11644	86.36552	170.5	WBPL67	0.7	Within P.H.C. on Purulia - Manbazar road.	-1.59	-0.03
10	Barabazar	Bamundiha	23.113518	86.365424	191.17	WBPL68	0.5	Within P.H.C. on Purulia - Manbazar road.	-0.86	0.44
11	Barabazar	Purihasa	23.067356	86.363933	162.03	WBPL086	0.5	RHS of Purulia - Barabazar road, before reaching Barabazar 1.50 m north from Hari mandir, infront of house of Guru Mahato, 750 m from Kumari river Bridge.	-1.04	-0.06
12	Barabazar	Aga Jhore	23.044452	86.442333	134.12	WBPL099	0.65	RHS of Purulia - Manbazar Rd. , near the house of Sahadeb Mahato, about 5 km before Sindri	0.11	0.98
13	Barabazar	Takariya	23.159837	86.348147	204.03	WBPL17A	0.6	On Rd.to Barabazar near the house of Sri Kandru Mahato.	0.03	-0.52
14	Barabazar	Sindri	23.043614	86.494011	131.77	WBPL18	0.64	Near Primary Health Centre on Manbazar-Purulia Raod.	0.69	0.55
15	Barabazar	Barabazar	23.028913	86.362432	145.31	WBPL48D	0.54	Inside hospital compound, located in front of " Indoor Patient" near pump house. Sardardih more Old KSP Well.	0.16	1.99
16	Bundwan	Dhabani	22.926845	86.446175	162.18	WBPL61	0.55	Near house of Sufi singh at Sardar Para, EHS of road from Bandwan to Barabazar, 8.5 km from Bandwan, at the end of village	-0.23	-0.62
17	Hura	Hura	23.301122	86.662737	145.27	WBPL03	1.06	In the compound of Police Station	-0.06	0.26
18	Hura	Katagora	23.294402	86.630873	177.1	WBPL65	0.5	Within P.H.C. campus. On Lalgon - Manbazar road.	-5.29	-0.55
19	Hura	Lalpur	23.301914	86.631246	189.32	WBPL074	0.73	Behind Dayal Onkareswar Shivalay Mandir. RHS of road from Lalpur to Bagda. Tekchongora village.	-0.09	0.47
20	Hura	Raheradhi	23.228441	86.645938	168.19	WBPL076	0.83	RHS of road towards Bagda 1km. Beffore Napara. Near the residence of Ashok Dutta (Owner of dugwell), Satyajit Mess.	-0.75	0.22
21	Hura	Duriakata	23.297736	86.688712	143.61	WBPL084	0.5	RHS of Bispuria - Hura road, about 3 - to 4 km from Bispuria, " Dilse" Shop, Hura G.P. country Liquor shop of Mihir Mandi.	-0.52	-0.53
22	Hura	Kulabahal	23.303131	86.541829	164.73	WBPL091	0.65	RHS of Keshargarh - Ludhurka road via Ground More. Back side of the house of Bairav, Judhistir and Arun Mahato	-0.64	0.02
23	Hura	Keshargarh	23.269088	86.556936	159.17	WBPL25	0.6	Appraoch from Kulgura on Purulia-Hura road, about 8km South of Kulgura and 10m SW of Janata Clothes Store.	0.61	0.19
24	Hura	Ludurka	23.351291	86.523225	174.6	WBPL27A	0.68	Inside Pandeya line hotel, after crossing Primary Health Centre and Reliance Petrol Pump; way to Purulia.	3.64	0.4
25	Hura	Bishpuria	23.282697	86.741533	103	WBPL39	0.65	Inside Bispuria Library-Sahitya Sadan, on Purulia-Bankura Road.	-0.39	-0.95
26	Jaypur	Narayanpur	23.411132	86.211051	211.12	WBPL21	0.64	At the entrance of P.W.D. I.B. at Narayanpur, left side on the paddy field.	0.71	0.03
27	Jhalda - II	Durgu	23.385372	86.012713	252.85	WBPL088	0.5	4 to 5 km towards Jhalda from Kotsila, LHS of road, adj. To Photo Binding of Sunil Kumar.	-0.4	-0.09
28	Jhalda-I	Tulin	23.379209	85.898152	196.78	WBPL12B	0.58	On the way to JOYSIYSRAM HIGH SCHOOL before crossing the railway level crossing in the house of Shaktipada Mahato at Uppur para.	1.84	-1.38
29	Jhalda-I	Jhalda	23.364384	85.960959	270.35	WBPL22A	0.75	Located in Satyabala Vidyapith (High School) on Tulin road. Depth - 9.00 m bmp; Dia - 3.73 m. M.P. 0.75 m agl. Changed on 4/02 by A.K.Chatterjee.	1.21	0.24
30	Jhalda-I	Jhargo	23.308233	85.89469	208.23	WBPL23	0.65	On Jhalda-Bagmundi Rd,inside village, 50m N of Ananda Marg School.	-0.25	1.53
31	Jhalda-II	Kotshila	23.404287	86.071455	248.17	WBPL07A	0.75	Inside BDO Office compound. On Purulia-Ranchi road.	-1.99	1.03
32	Joypur	Joypur Forest More	23.411831	86.189568	222.98	WBPL092	0.65	LHS of Purulia - Jhalda road, back side of Shrinibas Dhaba and Karmokar Cement Centre. Joypur about 5 km	0.18	-1.76
33	Joypur	Joypur	23.417232	86.143009	214.21	WBPL38A	0.62	Located in the Police Station Compound near bus stand opposite to U.B.I. Just left side after entrance. Depth - 13.00 m bmpdia - 1.23 m M.P. 0.62 m agl	-0.23	0.22
34	Kashipur	Rangani	23.483566	86.671395	111.34	WBPL70	0.8	Opposite to vetanary hospital on Adra - Kashipur road.	-0.68	-0.4
35	Kashipur	Palash Kola	23.490689	86.670035	131.88	WBPL104	0.62	LHS of Adra - Kashipur Rd. near the house of Shibram Dubey. Just entrance of Kashipur Rd. from Adra	-0.62	0.04

Annexure – 3 : Decadal water level data (2010 to 2019)from various NHNSstationsthat has been utilized for preparing Depth to Water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR 2010_19	NOV 2010_19
36	Kashipur	Gaurandih	23.434316	86.767264	119.12	WBPL14B	0.6	In the residence of Shri Sushil Patra, which is opposite to Gaurandih Junior High School.	-0.86	1.26
37	Kashipur	Indrabil	23.452539	86.774899	109.45	WBPL24	1	Approach from Kashipur & inside the house of Gurupada just entering in the village. In the residence of Gurupada Bauri.	1.84	1.24
38	Kashipur	Simla	23.380268	86.646979	142.22	WBPL40	0.64	On Kashipur-Hura Rd., within Majura-Amdiha High School.	-0.15	0.55
39	Kashipur	Kapasitha	23.434846	86.72364	97.63	WBPL53B	0.77	In the compound of Ma Manikeswari light house(r) Owner Pvt Shri Jadhubir Mahato.	-0.95	-1.34
40	Kashipur	Napara	23.430372	86.662776	120.8	WBPL54	0.75	Inside Forest guard's Quarter at Nawapara on Kashipur-Hura Road.	-0.01	0.4
41	Kotshila	Nowahatu	23.427401	86.054567	269.41	WBPL093	0.66	RHS of Kotshila - Barurula road, at the farm of Lalbahadur Rajwar. Barurala about 5 km	-2.08	0.88
42	Kotshila	Ukma	23.423116	86.037756	267.74	WBPL094	0.64	RHS of Bararula - Durgu road, back side of Shiva Mandir. Durgu about 5 km	2.16	0.58
43	Manbazar	Gopalnagar	23.137127	86.585397	109.89	WBPL087	0.4	On Manbazar - Purulia road, after crossing Goplanagar village, besides Gopalnagar Siva mandir & Kali Mandir.	0.01	0.03
44	Manbazar - I	Sindurpur	23.121968	86.609792	126.24	WBPL102	0.64	RHS of Jitujuri - Kunda - Purulia Rd., near the house of Budheswar Mahato. After 1 km from Jitjuri	-0.23	0.19
45	Manbazar-I	Manbazar	23.059361	86.659135	114.22	WBPL01	0.7	Inside Manbazar Police Station.	2.43	0.74
46	Manbazar-II	Khariduyara	22.988664	86.629541	103.69	WBPL69	0.7	Within P.H.C. campus. On Barabazar - Manbazar road.	-0.11	0.42
47	Manbazar-II	Ankro	22.912271	86.550649	121	WBPL62	0.58	In the premises of PHC, near pump house behind main hospital building.Ankro village is 6 km from Bandwan on Manbazar road.	1.4	1.55
48	Neturia	Sarbori	23.649641	86.814248	81.16	WBPL56	0.8	Inside commercial check post on Raghunathpur-Barakar Rd.	2.75	0.16
49	Neturia	Gobag	23.591949	86.762734	102.58	WBPL58	0.73	Located at the entrance of the village adj. to Purulia-Bankura Rd. in front of Haradhan Garai's Cycle reparing Shop.	-0.26	-0.49
50	Nituria	Nituria	23.662027	86.824667	56.29	WBPL63	1.08	In the campus of Shiva Temple. Opposite to Nituria Police Station. (new well from Nov 2010)	-0.16	-0.12
51	Para	Anara	23.491296	86.56469	153.21	WBPL05	0.84	Inside the compd of 33 KV sub-station, just after the Chapuri gate on Raghunathpur-Purulia road.	-0.66	1.96
52	Para	Kashiberia	23.544095	86.549105	123.16	WBPL083	0.7	Govt. well near Keshiberia School. RHS of Rd. towards Babugram. 3 km from Dubra.	-0.43	0.28
53	Para	Para	23.510533	86.515082	159.05	WBPL33A	0.8	LHS of road from Para to Dubra, near bus stand, adjacent to the house of Subhash Modak, in front of the shop Gauri Sankar Sweets.	-0.24	-0.01
54	Para	Dubra	23.543654	86.520021	128.35	WBPL34	1	Within Dubra market, adj. to Dubra Readymade Store & Anil Tailoring Shop on Raghunathpur Santaldih Road and adj to M.M.Cloth store and oppo. to Ice Cream Factory on Dubrá- Samtaldih road.	-0.18	-0.62
55	Para	Jhapra	23.470346	86.513335	147.56	WBPL46	0.49	Within High School compd on Raghunathpur-Purulia Rd.	1.62	0.78
56	Para	Deuli	23.56329	86.468192	112.58	WBPL55A	0.55	Located in the house of Shri Gour Mahato. Just opposite to Tarun Granthagar (Library) on Santaldih road. Depth - 10.50 mdia - 1.50 m M.P. 0.55 m agl.	-0.55	0.57
57	Puncha	Panipathar	23.210134	86.487155	172.6	WBPL071	0.95	On the midway from Purulia to Manbazar, 17 km from Chakaltore. Near Panipathar more Bus stand behind M.K.Xerox & Photo printing and New Era Machines.	-0.92	0.63
58	Puncha	Chakgopalpur/Napara	23.228124	86.647035	143.68	WBPL077	0.9	Govt. well (LDW-1960). Adjacent to the house of Sapan Mahato. RHS of road towards Bagda.	-0.34	-2.11
59	Puncha	Kulgara	23.328183	86.586637	168.68	WBPL079	0.8	Behind bela Sriti Path mondir. Near the Signboard Kulgara Sankaryacharya Mission Vidyamandir. RHS of road towards Keshargar.	0.62	0.43
60	Puncha	Puncha	23.164032	86.655195	126.35	WBPL085	0.7	Inside Puncha Police Station.	-1.19	0.51
61	Puncha	Loulara	23.173953	86.66955	157.42	WBPL090	0.58	LHS of Bagdah - Puneha road infront of the house of Sukumar Banerjee, about 4 km from Bagdah	-1.1	-1.49
62	Puncha	Matha	23.158048	86.545656	154.77	WBPL103	0.57	RHS of Banduan Kendra Rd., near the house of Atul Ch. Mahato	-3.54	0.5
63	Puncha	Kenda	23.192502	86.520563	187.17	WBPL15A	0.95	In the residence of Shri Sukhdeb Mahato opposite to Pally Seva Sangha at Sardardih more	-1.21	-0.24
64	Puncha	Bagda	23.195973	86.684726	139.65	WBPL20	0.67	Just behind primary health centre. On Hura-Manbazar Rd.	0.84	-0.74
65	Purulia	Sankhari	23.056084	86.360455	169.1	WBPL100	0.68	LHS of Bamundiha - Barabazar Rd. near the house of Bhuson Mahto, about 3 km before Barabazar	-2.04	0.6
66	Purulia - I	Dhobakata	23.333432	86.377485	171.81	WBPL106	0.69	LHS of Bankura - Purulia By-pass, after crossing the flyover Railway track , near the house of Sarbeswar Kalindi at Harijan colony	0.58	1.17
67	Purulia - I	Imundi	23.393683	86.275304	218.47	WBPL66	0.75	On Purulia - Jhalda road. Opposite to the approach road for Gourinath Dham Rly. Stn.	0.5	0.31
68	Purulia - I	Pandrama	23.268935	86.327106	181.63	WBPL095	0.66	LHS of Purulia - Arshar road, opposite side of health centre and adjacent of Smriti Bedi mother of Dulal Mahato.3 km from Tawna More.	0.1	0.95
69	Purulia-I	Purulia(Belguma)	23.321875	86.343006	183.99	WBPL04	0.65	Just left side of the entrance of Agri. Irrigation Office at Belguma, Purulia.	-0.74	0.35

Annexure – 3 : Decadal water level data (2010 to 2019)from various NHNSstationsthat has been utilized for preparing Depth to Water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR 2010_19	NOV 2010_19
70	Purulia-I	Tamna	23.273642	86.350964	153.25	WBPL28	0.3	At Tamna more within the House of Subal Adhikari & back side of Hotel.	0	0.15
71	Purulia-II	Kustar	23.404799	86.453162	200.26	WBPL32	0.49	Within Health Centre, at its entrance adj. to Doctors' Quarter near outdoor. On Raghunathpur-Purulia road.	0.04	0.15
72	Purulia-II	Podalaroad	23.369513	86.400155	199.97	WBPL50	0.43	On Puruliá-Raghunathpur Rd,near the house of Anil Bauri Harijan Para.	0.08	0.21
73	Puruliya-I	Chakaltore	23.236235	86.359198	163.22	WBPL45	0.94	Inside Primary Health Centre.	-0.96	0.27
74	Raghunathpur-I	Bero	23.525901	86.754148	124.77	WBPL31A	0.35	On Saltora-Raghunathpur road, near bus stand 10 K.m. from Raghunathpur towards Saltora at Kharbora, near Bauri para. Depth - 9.00 m bmpdia - 2.40 m.M.P. 0.35 m agl.	-0.24	-1.49
75	Raghunathpur-I	Naduara	23.522744	86.67948	118.36	WBPL47	0.2	Inside Raghunathpur I.T.I compd. on Raghunathpur-Adra road.	4.13	0.66
76	Raghunathpur-I	Chinpina	23.535127	86.696097	106.55	WBPL49	0.69	By the side of Purulia-Bankura rd just at the entrance of the village from Raghunathpur & adj.to Hari Mandir & house of Badal Bauri.	-0.62	-1.67
77	Raghunathpur-I	Babugram	23.53613	86.603018	132.41	WBPL52	0.72	Inside Babugram Primary Health Centre, near Doctors' Quarter on Raghunathpur-Santaldih road.	0.36	0.41
78	Raghunathpur-II	Raghunathpur	23.545405	86.674557	113.59	WBPL13	0.71	In the compound of P.W.D.I.B.	7.46	-0.71
79	Rampur	Dangardi	22.948402	86.600192	133.69	WBPL19A	0.78	Opposite to Dangardi Junior Basic School, adjacent to H/O Abani Mahato.Located on the left side of road from Dangardi to Sindri, 250 m from Dangardi more on Manbazar to Bandwan road, 1 km before Rampur.	-0.83	0.33
80	Santuri	Santuri	23.524307	86.856579	128.33	WBPL105	0.34	LHS of Raghunathpur - Bankura Rd., back side of Telephone Tower, near Tarun Sangha and Police station, after Leadason	0.91	-2.35
81	Santuri	Leadson	23.519919	86.828932	131.95	WBPL30	0.63	On Saltora-Raghunathpur road & adj.to the house oæ Atika Mondal.12 km from Saltora towards Raghunathpur(r) Behind Mihijam Clinic.	1.08	0.17
82	Santuri	Balitora	23.629301	86.855853	57.99	WBPL42	0.61	On Neturia-Saltora Rd, at the Bus Stand near house of Shri Gouri Pada Mitra.	1.96	-0.3

Annexure – 4 : Annual water level data (2019)from various NHNSstationsthat have been used for preparing the Depth to water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR_19	NOV_19
1	Arsha	Kantadihi	23.164166	86.262704	205.17	WBPL29	0.72	Inside sub-health centre appraochable from Arsha.	9.59	6.29
2	Arsha	Sirkabad	23.380268	86.646979	142.22	WBPL44B	0.64	About 50 m North West of PHC main building within open field. Located backside of OPD buiding &water supply for domestic use.	6.88	4.51
3	Arsha	Hansla More	23.279444	86.259949	206.96	WBPL096	0.64	RHS of Tawna More - Arsha road, adjacent the house of Baridas Kaibarta. About 6 km from Pandrama	7.82	4.86
4	Baghmundi	Mathbura	23.404799	86.453162	200.26	WBPL37	0.49	Inside Forest Range Office, Rd approaching Balarampur.	11.77	6.43
5	Baghmundi	Korenge	23.417232	86.143009	214.21	WBPL41	0.62	Backside of the Hospital.	5.1	2.96
6	Balarampur	Baraurma	23.308233	85.89469	208.23	WBPL26	0.65	Inside school compound.	3.16	2.2
7	Balarampur	Namsole	23.130699	86.245471	199.98	WBPL097	0.62	LHS of Tawna - Balarampur Rd., infront of of Sub - health centre . About 3 km from Baraumra towards Balarampur	5.48	2.24
8	Balarampur	Dava	23.104287	86.139284	154.92	WBPL098A	0.64	LHS of Balarampur - Baghmundi Rd., adjacent to the house of Surya Kanta Kumar,about 7 km before Matha.	7.08	5.97
9	Barabazar	Takariya	23.545405	86.674557	113.59	WBPL17A	0.71	On Rd.to Barabazar near the house of Sri Kandru Mahato.	6	3.12
10	Barabazar	Sindri	23.434316	86.767264	119.12	WBPL18	0.6	Near Primary Health Centre on Manbazar-Purulia Raod.	6.39	2.72
11	Barabazar	Barabazar	23.274027	86.1956	227.99	WBPL48D	0.6	Inside hospital compound, located in front of " Indoor Patient" near pump house. Sardardih more Old KSP Well.	7.09	2.27
12	Barabazar	Bamundiha	22.912271	86.550649	121	WBPL67	0.58	Within P.H.C. on Purulia - Manbazar road.	8.54	4.15
13	Barabazar	Bamundiha	23.662027	86.824667	56.29	WBPL68	1.08	Within P.H.C. on Purulia - Manbazar road.	8.27	4.29
14	Barabazar	Purihasa	23.067356	86.363933	162.03	WBPL086	0.5	RHS of Purulia - Barabazar road, before reaching Barabazar 1.50 m north from Hari mandir, infront of house of Guru Mahato, 750 m from Kumari river Bridge.	9.11	4.86
15	Barabazar	Aga Jhore	23.044452	86.442333	134.12	WBPL099	0.65	RHS of Purulia - Manbazar Rd. , near the house of Sahadeb Mahato, about 5 km before Sindri	6.3	2.79
16	Bundwan	Dhabani	23.430372	86.662776	120.8	WBPL61	0.75	Near house of Sufi singh at Sardar Para, EHS of road from Bandwan to Barabazar, 8.5 km from Bandwan, at the end of village	9.41	5.76
17	Hura	Hura	23.301122	86.662737	145.27	WBPL03	1.06	In the compound of Police Station	12	8
18	Hura	Keshargarh	23.364384	85.960959	270.35	WBPL25	0.75	Appraoch from Kulgura on Purulia-Hura road, about 8km South of Kulgura and 10m SW of Janata Clothes Store.	4.84	2.58
19	Hura	Ludurka	23.452539	86.774899	109.45	WBPL27A	1	Inside Pandeya line hotel, after crossing Primary Health Centre and Reliance Petrol Pump; way to Purulia.	2.57	2.02
20	Hura	Bishpuria	23.543654	86.520021	128.35	WBPL39	1	Inside Bispuria Library-Sahitya Sadan, on Purulia-Bankura Road.	6.82	4.08
21	Hura	Matipur	23.591949	86.762734	102.58	WBPL065	0.73	Within P.H.C. campus. On Lalgon - Manbazar road.	11.55	3.22
22	Hura	Lalpur	23.11644	86.36552	170.5	WBPL074	0.7	Behind Dayal Onkareswar Shivalay Mandir. RHS of road from Lalpur to Bagda. Tekchongora village.	5.88	2.11
23	Hura	Raheradhi	23.113518	86.365424	191.17	WBPL076	0.5	RHS of road towards Bagda 1km. Beffore Napara. Near the residence of Ashok Dutta (Owner of dugwell), Satyajit Mess.	6.98	2.97
24	Hura	Duriakata	23.297736	86.688712	143.61	WBPL084	0.5	RHS of Bispuria - Hura road, about 3 - to 4 km from Bispuria, " Dilse" Shop, Hura G.P. country Liquor shop of Mihir Mandi.	7.88	4.37
25	Hura	Kulabahal	23.303131	86.541829	164.73	WBPL091	0.65	RHS of Keshargarh - Ludhurka road via Ground More. Back side of the house of Bairav, Judhistir and Arun Mahato	7.39	4.74
26	Hura	Kumardihi	23.286871	86.720188	121.87	WBPL108	0.8	in the house of Nirhakar Mondal.LHS of the road towards Puruliya after crosing Birpuria near teliphone tower	7.84	4.44
27	Hura	Mongalpur	23.314907	86.610959	150.33	WBPL111	1	Inside compound of new line hotel of Ripon Ghosh.LHS of road towards Puruliya & 2 km from Lalpur more	4.94	3.09
28	Hura	Asanboni	23.308029	86.581673	170.69	WBPL112	0.7	opposite H/0 Swapan Mahato near Primary school RHS of the road to Keshargarh	6.38	2.77
29	Hura	Gurda More	23.343019	86.557895	163.05	WBPL113	0.3	Puruliya-Hura road LHS of road towards Puruliya and by the side of Yadav hotel	2.3	1.5
30	Jaypur	Narayanpur	23.043614	86.494011	131.77	WBPL21	0.64	At the entrance of P.W.D. I.B. at Narayanpur, left side on the paddy field.	2.82	1.66
31	Jhalda - II	Durgu	23.385372	86.012713	252.85	WBPL088	0.5	4 to 5 km towards Jhalda from Kotsila, LHS of road, adj. To Photo Binding of Sunil Kumar.	8.99	1.52
32	Jhalda-I	Tulin	23.404287	86.071455	248.17	WBPL12B	0.75	On the way to JOYSIYSRAM HIGH SCHOOL before crossing the railway level crossing in the house of Shaktipada Mahato at Uppur para.	5.83	4.34
33	Jhalda-I	Jhalda	22.948402	86.600192	133.69	WBPL22A	0.78	Located in Satyabala Vidyapith (High School) on Tulin road. Depth - 9.00 m bmp; Dia - 3.73 m. M.P. 0.75 m agl. Changed on 4/02 by A.K.Chatterjee.	4.75	2.49
34	Jhalda-I	Jhargo	23.195973	86.684726	139.65	WBPL23	0.67	On Jhalda-Bagmundi Rd,inside village, 50m N of Ananda Marg School.	8.09	5.37
35	Joypur	Joypur	23.510533	86.515082	159.05	WBPL38A	0.8	Located in the Police Station Compound near bus stand opposite to U.B.I. Just left side after entrance. Depth - 13.00 m bmpdia - 1.23 m M.P. 0.62 m agl	7.46	3.16
36	Joypur	Joypur Forest More	23.411831	86.189568	222.98	WBPL092	0.65	LHS of Purulia - Jhalda road, back side of Shrinibas Dhaba and Karmokar Cement Centre. Joypur about 5 km	5.48	4.39
37	Kashipur	Gaurandih	23.195178	86.048332	197.77	WBPL14B	0.86	In the residence of Shri Sushil Patra, which is opposite to Gaurandih Junior High School.	7.87	2.02

Annexure – 4 : Annual water level data (2019)from various NHNSstationsthat have been used for preparing the Depth to water Level Maps in Purulia district of West Bengal (Source: RODC, CGWB, ER, Kolkata)

SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR_19	NOV_19
38	Kashipur	Indrabil	23.411132	86.211051	211.12	WBPL24	0.64	Approach from Kashipur & inside the house of Gurupada just entering in the village. In the residence of Gurupada Bauri.	5.17	2.22
39	Kashipur	Simla	23.119536	86.075843	193.21	WBPL40	0.87	On Kashipur-Hura Rd., within Majura-Amdiha High School.	8.02	3.84
40	Kashipur	Kapasitha	23.028913	86.362432	145.31	WBPL53B	0.54	In the compound of Ma Manikeswari light house(r) Owner Pvt Shri Jadhubir Mahato.	8.56	5.73
41	Kashipur	Napara	23.535127	86.696097	106.55	WBPL54	0.69	Inside Forest guard's Quarter at Nawapara on Kashipur-Hura Road.	5.86	2.38
42	Kashipur	Rangani	23.294402	86.630873	177.1	WBPL70	0.5	Opposite to vetanary hospital on Adra - Kashipur road.	7.32	3.85
43	Kashipur	Palash Kola	23.490689	86.670035	131.88	WBPL104	0.62	LHS of Adra - Kashipur Rd. near the house of Shibram Dubey, Just entrance of Kashipur Rd. from Adra	8.37	5.09
44	Kotshila	Nowahatu	23.427401	86.054567	269.41	WBPL093	0.66	RHS of Kotshila - Barurula road, at the farm of Lalbahadur Rajwar. Barurala about 5 km	8.71	4.21
45	Kotshila	Ukma	23.423116	86.037756	267.74	WBPL094	0.64	RHS of Bararula - Durgu road, back side of Shiva Mandir. Durgu about 5 km	4.3	2.73
46	Manbazar	Gopalnagar	23.137127	86.585397	109.89	WBPL087	0.4	On Manbazar - Purulia road, after crossing Goplanagar village, besides Gopalnagar Siva mandir & Kali Mandir.	3.18	2.67
47	Manbazar-I	Manbazar	23.059361	86.659135	114.22	WBPL01	0.7	Inside Manbazar Police Station.	6.03	2.97
48	Manbazar-I	Sindurpur	23.121968	86.609792	126.24	WBPL102	0.64	RHS of Jitujuri - Kunda - Purulia Rd., near the house of Budheswar Mahato. After 1 km from Jitjuri	7.99	2.83
49	Manbazar-II	Ankro	23.56329	86.468192	112.58	WBPL62	0.55	In the premises of PHC, near pump house behind main hospital building.Ankro village is 6 km from Bandwan on Manbazar road.	7.17	3.97
50	Manbazar-II	Khariduyara	23.294402	86.630873	177.1	WBPL69	0.5	Within P.H.C. campus. On Barabazar - Manbazar road.	7.18	4.23
51	Neturia	Sarbori	23.53613	86.603018	132.41	WBPL56	0.72	Inside commercial check post on Raghunathpur-Barakar Rd.	5.32	2.05
52	Neturia	Gobag	23.434846	86.72364	97.63	WBPL58	0.77	Located at the entrance of the village adj. to Purulia-Bankura Rd. in front of Haradhan Garai's Cycle reparing Shop.	5.96	3.64
53	Nituria	Nituria	23.649641	86.814248	81.16	WBPL63	0.8	In the campus of Shiva Temple. Opposite to Nituria Police Station. (new well from Nov 2010)	4.26	1.92
54	Para	Anara	23.491296	86.56469	153.21	WBPL05	0.84	Inside the compd of 33 KV sub-station, just after the Chapuri gate on Raghunathpur-Purulia road.	8.43	3.1
55	Para	Para	23.519919	86.828932	131.95	WBPL33A	0.63	LHS of road from Para to Dubra, near bus stand, adjacent to the house of Subhash Modak, in front of the shop Gauri Sankar Sweets.	6.56	3.75
56	Para	Dubra	23.525901	86.754148	124.77	WBPL34	0.35	Within Dubra market, adj. to Dubra Readymade Store & Anil Tailoring Shop on Raghunathpur Santaldih Road and adj to M.M.Cloth store and oppo. to Ice Cream Factory on Dubrá- Samtaldih road.	8.43	4.95
57	Para	Jhapra	23.629301	86.855853	57.99	WBPL46	0.61	Within High School compd on Raghunathpur-Purulia Rd.	3.16	2.34
58	Para	Deuli	23.369513	86.400155	199.97	WBPL55A	0.43	Located in the house of Shri Gour Mahato. Just opposite to Tarun Granthagar (Library) on Santaldih road. Depth - 10.50 mdia - 1.50 m M.P. 0.55 m agl.	8.66	5.53
59	Para	Kashiberia	23.544095	86.549105	123.16	WBPL083	0.7	Govt. well near Keshiberia School. RHS of Rd. towards Babugram. 3 km from Dubra.	8.05	4.41
60	Puncha	Kenda	23.379209	85.898152	196.78	WBPL15A	0.58	In the residence of Shri Sukhdeb Mahato opposite to Pally Seva Sangha at Sardardih more	7.74	3.3
61	Puncha	Bagda	23.159837	86.348147	204.03	WBPL20	0.6	Just behind primary health centre. On Hura-Manbazar Rd.	5.25	3.22
62	Puncha	Panipathar	23.393683	86.275304	218.47	WBPL071	0.75	On the midway from Purulia to Manbazar, 17 km from Chakaltore. Near Panipathar more Bus stand behind M.K.Xerox & Photo printing and New Era Machines.	7.89	2.57
63	Puncha	Chakgopalpur/Napara	23.228124	86.647035	143.68	WBPL077	0.9	Govt. well (LDW-1960). Adjacent to the house of Sapan Mahato. RHS of road towards Bagda.	6.54	3.92
64	Puncha	Kulgara	23.328183	86.586637	168.68	WBPL079	0.8	Behind bela Sriti Path mondir. Near the Signboard Kulgara Sankaryacharya Mission Vidyamandir. RHS of road towards Keshargar.	7.14	4.97
65	Puncha	Puncha	23.164032	86.655195	126.35	WBPL085	0.7	Inside Puncha Police Station.	7.2	5.73
66	Puncha	Damodarpur	23.207322	86.666415	142.99	WBPL089	0.67	LHS of road from Lalpur to Bagdah infront of the house of Abhiram Sais	8.51	4.62
67	Puncha	Loulara	23.173953	86.66955	157.42	WBPL090	0.58	LHS of Bagdah - Puneha road infront of the house of Sukumar Banerjee, about 4 km from Bagdah	9.02	6.52
68	Puncha	Matha	23.158048	86.545656	154.77	WBPL103	0.57	RHS of Banduan Kendra Rd., near the house of Atul Ch. Mahato	9.98	3.01
69	Puncha	Damodarpur	23.201558	86.668829	142.61	WBPL109	0.6	RHS of road towards Purcha 7 near house compound of Dwga Charam Mahato & opp I.C.D.S. Center	9.44	3.41
70	Puncha	Dadki	23.177938	86.67714	138.79	WBPL110	1	In front of H/o Devnath Dutta L.H.S. Of road towards Purcha 2.5 km before Purcha P.S	7.2	3.75
71	Purulia	Sankhari	23.056084	86.360455	169.1	WBPL100	0.68	LHS of Bamundiha - Barabazar Rd. near the house of Bhuson Mahto, about 3 km before Barabazar	9.9	3.53
72	Purulia - I	Imundi	22.926845	86.446175	162.18	WBPL66	0.55	On Purulia - Jhalda road. Opposite to the approach road for Gourinath Dham Rly. Stn.	4.93	2.12
73	Purulia - I	Pandrama	23.268935	86.327106	181.63	WBPL095	0.66	LHS of Purulia - Arshar road, opposite side of health centre and adjacent of Smriti Bedi mother of Dulal Mahato.3 km from Tawna More.	7.2	1.7
74	Purulia - I	Dhobakata	23.333432	86.377485	171.81	WBPL106	0.69	LHS of Bankura - Purulia By-pass, after crossing the flyover Railway track , near the house of Sarbeswar Kalindi at Harijan colony	4.47	2.46

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SL. NO	BLOCK	VILLAGE	LATITUDE	LONGITUDE	RL	WELL-ID	MP	LOCATION	APR_19	NOV_19
75	Purulia-I	Purulia(Belguma)	23.321875	86.343006	183.99	WBPL04	0.65	Just left side of the entrance of Agri. Irrigation Office at Belguma, Purulia.	8.22	3.05
76	Purulia-I	Tamna	23.269088	86.556936	159.17	WBPL28	0.6	At Tamna more within the House of Subal Adhikari & back side of Hotel.	4.8	2.33
77	Purulia-I	Chakaltore	23.236565	85.985109	198.29	WBPL45	0.68	Inside Primary Health Centre.	5.59	1.65
78	Purulia-II	Kustar	23.217356	86.298971	206.65	WBPL32	0.51	Within Health Centre, at its entrance adj. to Doctors' Quarter near outdoor. On Raghunathpur-Purulia road.	6.67	4.02
79	Puruliya-ii	Podalaroad	23.470346	86.513335	147.56	WBPL50	0.49	On Puruliá-Raghunathpur Rd,near the house of Anil Bauri Harijan Para.	5.77	2.49
80	Raghunathpur-I	Bero	23.273642	86.350964	153.25	WBPL31A	0.3	On Saltora-Raghunathpur road, near bus stand 10 K.m. from Raghunathpur towards Saltora at Kharbora, near Bauri para. Depth - 9.00 m bmpdia - 2.40 m.M.P. 0.35 m agl.	5.91	4.41
81	Raghunathpur-I	Naduara	23.29433	86.200712	226.33	WBPL47	0.84	Inside Raghunathpur I.T.I compd. on Raghunathpur-Adra road.	4.67	3.95
82	Raghunathpur-I	Chinpina	23.236235	86.359198	163.22	WBPL49	0.94	By the side of Purulia-Bankura rd just at the entrance of the village from Raghunathpur & adj.to Hari Mandir & house of Badal Bauri.	4.99	3.89
83	Raghunathpur-I	Babugram	23.522744	86.67948	118.36	WBPL52	0.2	Inside Babugram Primary Health Centre, near Doctors' Quarter on Raghunathpur-Santaldih road.	5.77	2.58
84	Raghunathpur-II	Raghunathpur	23.322406	86.158107	332.3	WBPL13	0.32	In the compound of P.W.D.I.B.	4.66	6.61
85	Rampur	Dangardi	23.192502	86.520563	187.17	WBPL19A	0.95	Opposite to Dangardi Junior Basic School, adjacent to H/0 Abani Mahato.Located on the left side of road from Dangardi to Sindri, 250 m from Dangardi more on Manbazar to Bandwan road, 1 km before Rampur.	9.07	3.26
86	Santuri	Leadson	23.351291	86.523225	174.6	WBPL30	0.68	On Saltora-Raghunathpur road & adj.to the house oæ Atika Mondal.12 km from Saltora towards Raghunathpur(r) Behind Mihijam Clinic.	5.58	3.68
87	Santuri	Balitora	23.282697	86.741533	103	WBPL42	0.65	On Neturia-Saltora Rd, at the Bus Stand near house of Shri Gouri Pada Mitra.	3.76	3.03
88	Santuri	Santuri	23.524307	86.856579	128.33	WBPL105	0.34	LHS of Raghunathpur - Bankura Rd., back side of Telephone Tower, near Tarun Sangha and Police station, after Leadason	3.76	4.28