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

North 24 Parganas, South 24 Parganas & Howarh Districts West Bengal

पूर्वी क्षेत्र, कोलकाता

Eastern Region, Kolkata

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

REPORT ON

AQUIFER MAPPING AND MANAGEMENT PLAN IN PARTS OF NORTH 24 PARGANAS, SOUTH 24 PARGANAS & HOWRAH DISTRICTS, WEST BENGAL

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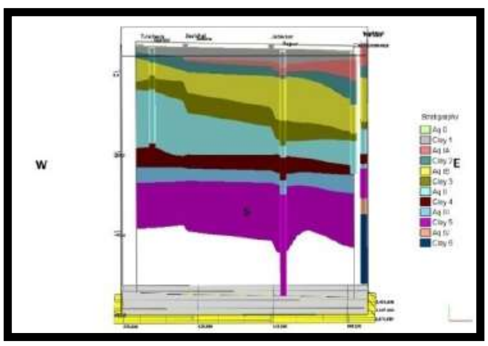

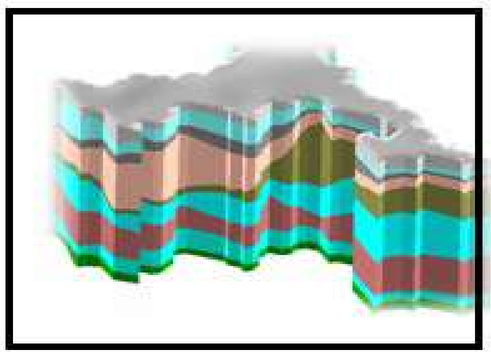

Central Groundwater Board

Eastern Region, Kolkata

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Report on Aquifer Mapping Studies in districts (pts.) of N. 24 Parganas, S. 24 Parganas & Howrah West Bengal

1.0 INTRODUCTION

Groundwater is one of the prime sources of fresh water contributing significantly for the survival of mankind. However, overexploitation, surface runoff, 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 revised Action Plan under NAQUIM, ground water management studies in 46 blocks of seven districts namely Murshidabad (3 blocks), Barddhaman (8 blocks), Birbhum (1 block), Nadia (9 blocks), North 24 Parganas (13 blocks), South 24 Parganas (9 blocks) and Howrah (3 blocks) district in West Bengal, covering an area of approximately 8904 sq. km. was 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. in 9 blocks of South 24 Parganas District and 3 blocks of Howrah District 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 resources potential in respect of quality & quantity, aquifer characterization, scope for development potential and prepare aquifer-wise management plan.

1.2 Scope of Study

The scope of the present study is broadly within the framework of National Aquifer Mapping & Management Programme (NAQUIM) being implemented by CGWB. There are four major 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 and 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 and Accessibility of the study area

The study area **(Plate 1.4a)** comprises 25 blocks of three districts namely South 24 Parganas, Howrah and North 24 Parganas districts in West Bengal. The present area covers a total area of 3834.59 sq km.

The study area is located in the southern part of the State and mainly located in the lower deltaic region of Bengal Basin. This area covers 3834.59 sq kms in 25 blocks (North 24 Parganas - 13 blocks, South 24 Parganas - 9 blocks and Howrah -3 blocks). Most of this part of study area i.e. part of North & South 24 Parganas districts are in the Eastern part of Bhagirathi- Ichhamati in lower delta interfluves and areas of Howrah district is in the Western part of Bhagirathi river. The area extends between North latitudes 23°07'48.1” and 22°54'33.6” and East longitudes 87°56'30.5” and 89°04'07.7”. The study area partly falls in the Survey of India Degree Sheet no.79B.This area is located near the State Capital Kolkata and is well connected by rail & roads. Some parts of the area fall in coastal plains of West Bengal. The international boundary between India and Bangladesh is running just beside a part of the study area mainly in the eastern boundary by the river Ichhamati.

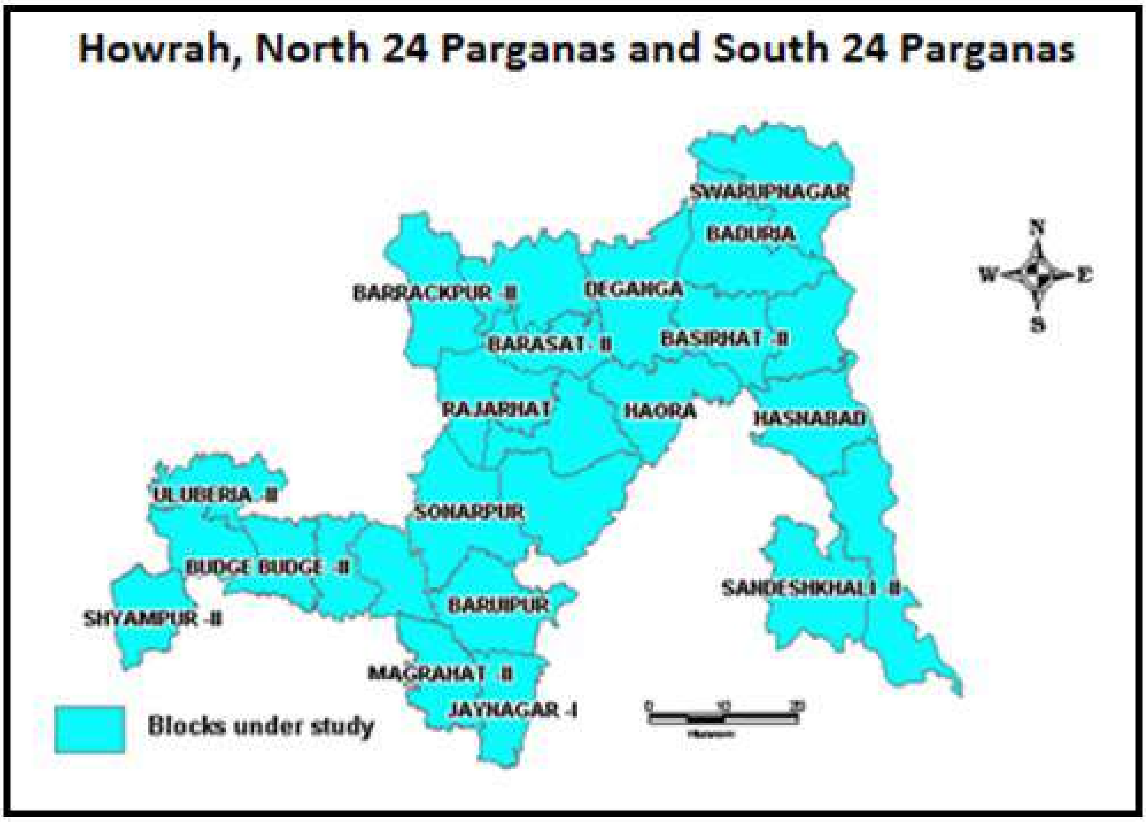

Plate 1.4a: 25 blocks of S. 24 Parganas, N. 24 Parganas & Howrah Districts

1.5 Administrative Divisions and Population

As the study area scattered in three zones, the administrative divisions and population have been presented in area wise as discussed above.

1.5.1 Sub-Area A covering parts of North 24 Parganas, South 24 Parganas and Howrah districts:

This Sub-Area covers 25 blocks (North 24 Parganas district - 13 blocks), South 24 Parganas district - 9 blocks and Howrah district -3 blocks) for an area of 3834.59 sq km. Details of administrative divisions are summarized in Table1.5 a.

Table 1.5a.: Administrative units of the Area A

Sr. No.	District	Block	Geographical area** in Sq Km	Name of Sub-division	Number of Panchayat samity	Number of Gram Panchayat	Gram Samsad
1	**Howrah**	**Shyampur II**	117.00	Uluberia	1	8	147
2	**Howrah**	**Uluberia II**	80.98	Uluberia	1	8	134
3	**Howrah**	**Uluberia I**	102.35	Uluberia	1	9	145
	Howrah Total		**300.33**		**3**	**25**	**426**
4	**N 24 Parganas**	**Deganga**	211.06	Barasat	1	13	223

5	**N 24 Parganas**	**Haora**	166.16	Basirhat	1	8	139
6	**N 24 Parganas**	**Basirhat II**	135.86	Basirhat	1	9	155
7	**N 24 Parganas**	**Swarupnagar**	224.17	Basirhat	1	10	204
8	**N 24 Parganas**	**Barasat II**	106.36	Barasat	1	7	133
9	**N 24 Parganas**	**Barasat I**	175.07	Barasat	1	9	201
10	**N 24 Parganas**	**Baduria**	210.60	Basirhat	1	14	211
11	**N 24 Parganas**	**Basirhat I**	125.58	Basirhat	1	7	119
12	**N 24 Parganas**	**Rajarhat**	167.99	Barasat	1	6	125
13	**N 24 Parganas**	**Barrackpur II**	168.09	Barrackpore	1	6	131
14	**N 24 Parganas**	**Hingalganj**	230.00	Basirhat	1	9	137
15	**N 24 Parganas**	**Sandeshkhali II**	191.91	Basirhat	1	8	107
16	**N 24 Parganas**	**Hasnabad**	169.96	Basirhat	1	9	146
	North 24 Parganas Total		**2282.81**		**13**	**115**	**2031**
17	**S 24 Parganas**	**Baruipur**	170.21	Baruipur	1	9	307
18	**S 24 Parganas**	**Sonarpur**	205.41	Baruipur	1	11	156
19	**S 24 Parganas**	**Budge Budge II**	108.19	Alipore	1	11	150
20	**S 24 Parganas**	**Bhangar II**	143.07	Baruipur	1	10	159
21	**S 24 Parganas**	**Bhangar I**	192.82	Baruipur	1	9	161
22	**S 24 Parganas**	**Bishnupur II**	10041	Alipore	1	11	167
23	**S 24 Parganas**	**Bishnupur I**	9310	Alipore	1	11	168
24	**S 24 Parganas**	**Magrahat II**	127.14	Diamond Harbour	1	14	214
25	**S 24 Parganas**	**Jaynagar I**	111.10	Baruipur	1	12	188
	South 24 Parganas Total		**1251.45**		**9**	**98**	**1670**
Total Study area			**3834.59**		**25**	**238**	**4127**

** Area considering Map Info Tab file (Source: District Statistical Handbook, 2014)

In Sub-Area A of study area covering 3834.59 sq km, there are 25 Panchyat Samity, 238 Gram Panchyat and 4127 Gram Samsad.

Distribution of population of the districts of Howrah, North 24 Parganas and South 24 Parganas are presented in **Table 1.5b.1, Table 1.5b.2 and Table1.5b.3.**

Table 1.5b.1: Population distribution in administrative units of Howrah district

Distribution of Rural and Urban Population by sex in parts of Howrah district (census 2011)									
Sub-Division / C.D.Block / M.C./ M	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Uluberia Sub-Division	**225391**	**215658**	**441049**	**196656**	**187690**	**384346**	**422047**	**403348**	**825395**
Uluberia-I	94250	90531	184781	15559	15052	30611	109809	105583	215392
Uluberia-II	41288	39505	80793	56556	54250	110806	97844	93755	191599
Shyampur-II	89853	85622	175475	10618	10071	20689	100471	95693	196164
Uluberia(M)	-	-	-	113923	108317	222240	113923	108317	222240
District Total	**225391**	**215658**	**441049**	**196656**	**187690**	**384346**	**422047**	**403348**	**825395**

Table 1.5b.2: Population distribution in administrative units of North 24 Parganas district

Distribution of Rural and Urban Population by sex in parts of North 24 Parganas district (Census 2011)									
Sub-Division / C.D.Block / M.C./ M	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Barasat Sub-Division	**392810**	**370497**	**763307**	**566736**	**552015**	**1118751**	**959546**	**922512**	**1882058**
Barasat-I	90238	84988	175226	60681	58721	119402	150919	143709	294628
Barasat-II	98235	90689	188924	6018	5976	11994	104253	96665	200918
Barasat(M)	-	-	-	140822	137613	278435	140822	137613	278435
Madhyamgram(M)	-	-	-	98864	97263	196127	98864	97263	196127
Deganga	158216	151334	309550	4938	4725	9663	163154	156059	319213
Rajarhat	46121	43486	89607	51502	48784	100286	97623	92270	189893
Rajarhat-Gopalpur(M)	-	-	-	203911	198933	402844	203911	198933	402844
Barrackpur Sub-Division	**26701**	**25173**	**51874**	**1303517**	**1254603**	**2558120**	**1330218**	**1279776**	**2609994**
Garulia(M)	-	-	-	44825	40511	85336	44825	40511	85336
North Barrackpur(M)	-	-	-	66924	65882	132806	66924	65882	132806
Barrackpur(M)	-	-	-	78349	74434	152783	78349	74434	152783
Titagarh(M)	-	-	-	62735	53806	116541	62735	53806	116541
Khardah(M)	-	-	-	54879	53617	108496	54879	53617	108496
BarrackpurII	26701	25173	51874	84581	80716	165297	111282	105889	217171
Panihati(M)	-	-	-	189446	187901	377347	189446	187901	377347
New Barrackpur(M)	-	-	-	38239	38607	76846	38239	38607	76846
Kamarhati(M)	-	-	-	170293	159918	330211	170293	159918	330211

Baranagar(M)	-	-	-	126187	119026	245213	126187	119026	245213
Dum Dum(M)	-	-	-	58566	56220	114786	58566	56220	114786
South Dum Dum(M)	-	-	-	202214	201102	403316	202214	201102	403316
North Dum Dum(M)	-	-	-	126279	122863	249142	126279	122863	249142
Bidhannagar Sub-Division	**-**	**-**	**-**	**109665**	**106944**	**216609**	**109665**	**106944**	**216609**
Bidhannagar(M)	-	-	-	109014	106500	215514	109014	106500	215514
Nabadiganta Industrial Township	-	-	-	651	444	1095	651	444	1095
Basirhat Sub-Division	**830206**	**790773**	**1620979**	**145938**	**141414**	**287352**	**976144**	**932187**	**1908331**
Baduria	141944	136100	278044	3697	3578	7275	145641	139678	285319
Baduria(M)	-	-	-	26799	25694	52493	26799	25694	52493
Haroa	111080	103321	214401	-	-	-	111080	103321	214401
Swarupnagar	129255	122460	251715	2255	2105	4360	131510	124565	256075
Hasnabad	100795	96219	197014	3224	3024	6248	104019	99243	203262
Taki(M)	-	-	-	19562	18701	38263	19562	18701	38263
Hingalganj	81413	78056	159469	7524	7552	15076	88937	85608	174545
SandeshkhaliII	81921	79055	160976	-	-	-	81921	79055	160976
BasirhatI	76930	73590	150520	10787	10306	21093	87717	83896	171613
BasirhatII	106868	101972	208840	8867	8423	17290	115735	110395	226130
Basirhat(M)	-	-	-	63223	62031	125254	63223	62031	125254
District Total	**1249717**	**1186443**	**2436160**	**2125856**	**2054976**	**4180832**	**3375573**	**3241419**	**6616992**

Table 1.5b.3: Population distribution in administrative units of South 24 Parganas district

Distribution of Rural and Urban Population by sex in parts of South-24 Parganas district (census 2011)									
Sub-Division / C.D.Block / M.C./ M	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Alipore Sub-Division	**244870**	**233748**	**478618**	**370163**	**352450**	**722613**	**615033**	**586198**	**1201231**
BishnupurI	104530	99855	204385	14187	13793	27980	118717	113648	232365
Bishnupur-II	71223	67756	138979	38380	37172	75552	109603	104928	214531
Budge-Budge-II	69117	66137	135254	29453	27427	56880	98570	93564	192134
Budge-Budge(M)	-	-	-	39510	37327	76837	39510	37327	76837
Maheshtala(M)	-	-	-	229693	218624	448317	229693	218624	448317
Pujali(M)	-	-	-	18940	18107	37047	18940	18107	37047
Baruipur Sub-Division	**607140**	**576445**	**1183585**	**371518**	**360326**	**731844**	**978658**	**936771**	**1915429**
Sonarpur	89706	86007	175713	22532	21618	44150	112238	107625	219863
JaynagarI	111367	105462	216829	23599	22723	46322	134966	128185	263151
Baruipur	161643	154164	315807	59557	57755	117312	221200	211919	433119
BhangarI	117229	111299	228528	10473	10169	20642	127702	121468	249170
BhangarII	127195	119513	246708	-	-	-	127195	119513	246708
Jaynagar-	-	-	-	13234	12688	25922	13234	12688	25922

Majilpur(M)									
Baruipur(M)	-	-	-	26718	26410	53128	26718	26410	53128
Rajpur-Sonarpur(M)	-	-	-	215405	208963	424368	215405	208963	424368
D.Harbour Sub-Division	**112441**	**106063**	**218504**	**44127**	**42113**	**86240**	**156568**	**148176**	**304744**
MograhatII	112441	106063	218504	44127	42113	86240	156568	148176	304744
District Total	**964451**	**916256**	**1880707**	**785808**	**754889**	**1540697**	**1750259**	**1671145**	**3421404**

Table1.5b.4: Districtwise distribution of Population

District	Rural Population			Urban Population			Total Population		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Howrah	225391	215658	441049	196656	187690	384346	422047	403348	825395
North 24 Parganas	1249717	1186443	2436160	2125856	2054976	4180832	3375573	3241419	6616992
South 24 Parganas	964451	916256	1880707	785808	754889	1540697	1750259	1671145	3421404
Study area A in total	**2439559**	**2318357**	**4757916**	**3108320**	**2997555**	**6105875**	**5547879**	**5315912**	**10863791**

In the present area, total population is 10863791 of which Rural population is 4757916 and Urban is 6105875.

1.6 Landuse, Irrigation and Cropping pattern

Out of the total area concerned about 63.23 % area is occupied by cultivable land, about 0.26% area is occupied by current waste land and the negligible area is under forest land. The details of land use pattern in each block is shown in **Table-1.6 a**.

Table-1.6 a: Salient features of Landuse, 2016-17

SI. No (1)	Name of the Block (2)	Area(ha), under reporting (3)	Cultivable Area (ha) (4)	Area under pasture & orchard (ha) (5)	Cultivable Waste Land (ha) (6)	Forest Land (ha) (7)
1	Shyampur II	11700	8700	-	-	Nil
2	Uluberia I	8098	6000	73.9766	-	Nil
3	Uluberia II	10235	5000	-	-	Nil
4	Deganga	21106	12000	1130	25	-
5	Haroa	16616	9100	251	50	-
6	Basirhat II	13586	8595	526	50	-
7	Swarupnagar	22417	13120	655	237	-
8	Barasat I	10536	6320	306	160	-
9	Barasat II	17507	9730	251	152	-
10	Baduria	21060	12390	1255	213	-
11	Basirhat I	12558	7400	827	387	-
12	Rajarhat	16799	3958	458	15	-
13	Barrackpur II	16809	2227	90	100	-
14	Hingalganj	23000	14200	93	75	-
15	Sandeshkhali II	19191	7730	86	162	32

16	Hasnabad	16996	11020	1032	240	-
17	Baruipur	17021	11705	150	-	-
18	Sonarpur	20541	8413	224	-	-
19	Budge Budge II	10819	2025	468	-	-
20	Bhanger I	19282	12071	100	-	-
21	Bhanger II	14307	11773	109	5	-
22	Bishnupur I	10041	9608	256	-	-
23	Bishnupur II	9310	7067	50	-	-
24	Magarhat II	12712	11591	146	-	-
25	Jaynagar I	11110	9380	119	-	-

Irrigation plays an important role for crop production and intensity of crops. The cultivable land in the study area, about 33.23% is rain-fed, andin the rest area crop production is solely dependent of surface water and ground water irrigation systems. 46.40% of cultivable area has been irrigated through ground water & surface water. Ground water irrigation is created by deep tube well and shallow' tube wells. Irrigation by surface water is done through River Lift Irrigation, whereas irrigation by water conservation structures (tanks etc.) is covering an area of about 15% of the total irrigated area. In **Table 1.6 b.1, Table 1.6 b.2 and Table 1.6 b.3**, block wise details of irrigation have been tabulated.

The majority of the study area is covered under "Bagri" area which is located in the eastern part of Bhagirathi River. Rice forms the principal crop of the study area. Other crops with a substantial production include wheat, jute, oil seeds, vegetables and sugar cane.

Table 1.6b.1: Block wise details of Irrigation in South 24 Parganas district

Sl. No.	Block	Dug well		Shallow tube well		Deep tube well		Surface flow		Surface lift		CCA in ha		Total CCA in ha
		No.	CCA in ha	No.	CCA in ha	No	CCA in ha	No	CCA in ha	No	CCA in ha	Surface Water	Ground water	
1	**Baruipur**	0	0	912	3019.39	13	260	0	0	178	1628.63	3279.39	1628.63	4908.02
2	**Sonarpur**	0	0	355	582.77	4	80	2	8	641	2007.73	662.77	2015.73	2678.5
3	**Budge Budge II**	0	0	1	2	5	100	370	1474.47	5	14.82	102	1489.29	1591.29
4	**Bhangar II**	0	0	1933	2541.5	2	35	4	181.41	79	1940.33	2576.5	2121.74	4698.24
5	**Bhangar I**	0	0	2823	5465.05	3	60	0	0	53	1662.68	5525.05	1662.68	7187.73
6	**Bishnupur II**	0	0	2	32	6	120	0	0	534	2566.34	152	2566.34	2718.34
7	**Bishnupur I**	0	0	7	37.3	1	20	99	2770.31	674	1987.25	57.3	4757.56	4814.86
8	**Magrahat II**	0	0	0	0	2	40	0	0	288	1722.5	40	1722.5	1762.5
9	**Jaynagar I**	0	0	4	34	4	110	109	5844.98	27	224	144	6068.98	6212.98
	Total	0	0	6037	11714.01	40	825	584	10279.17	2479	13754.28	12539.01	24033.45	36572.46

Table 1.6b.2: Block wise details of Irrigation in North 24 Parganas district

Sl. No.	Block	Dug well		Shallow tube well		Deep tube well		Surface flow		Surface lift		CCA in ha		Total CCA in ha
		No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	Surface Water	Ground water	
1	**Deganga**	0	0	4686	7491.15	9	360	0	0	0	0	7851.15	0	7851.15
2	**Haora**	4	6.01	1591	2891.52	6	240	0	0	4	98.55	3137.53	98.55	3236.08
3	**Basirhat II**	2	5.23	2094	4906.37	6	239	0	0	46	97.2	5150.6	97.2	5247.8
4	**Swarupnagar**	0	0	4331	6374.04	14	540	2	41.56	29	1111.65	6914.04	1153.21	8067.25
5	**Barasat II**	1	2.69	2164	3795.82	26	1020	0	0	4	8.97	4818.51	8.97	4827.48
6	**Barasat I**	4	47.92	1033	1624.61	21	739.25	0	0	26	216.32	2411.78	216.32	2628.1
7	**Baduria**	0	0	5086	5821.46	36	1315.02	0	0	1	12.35	7136.48	12.35	7148.83
8	**Basirhat I**	0	0	1614	2615.74	3	120	0	0	8	52.67	2735.74	52.67	2788.41
9	**Rajarhat**	0	0	362	757.94	9	340	0	0	0	0	1097.94	0	1097.94
10	**Barrackpur II**	0	0	13	35.93	13	518.5	0	0	10	159.23	554.43	159.23	713.66
11	**Hingalganj**	0	0	0	0	0	0	412	422.74	15	285.97	0	708.71	708.71
12	**Sandeshkhali II**	3	9.02	763	2199.8	2	80	287	569.05	30	574.56	2288.82	1143.61	3432.43
13	**Hasnabad**	0	0	577	786.56	0	0	76	79.62	352	306.18	786.56	385.8	1172.36
		14	70.87	24314	39300.9	145	5511.77	777	1112.97	525	2923.65	44883.58	4036.62	48920.2

Table 1.6b.3: Block wise details of Irrigation in Howrah district

Block	Dug well		Shallow tube well		Deep tube well		Surface flow		Surface lift		CCA in ha		Total CCA in ha
	No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	No.	CCA in ha	Surface Water	Ground water	
Shyampur II	0	0	0	0	1	40	13	593.87	426	4551.35	5145.22	40	5185.22
Uluberia II	0	0	2	14.89	1	40	22	942.17	212	459.52	1401.69	54.89	1456.58
Uluberia I	0	0	1	2.3	0	0	55	2190.54	178	1966.39	4156.93	2.3	4159.23
	0	0	3	17.19	2	80	90	3726.58	816	6977.26	10703.84	97.19	10801.03

1.7 Urban areas, Industries and Mining activities

Urban areas in the study area include 26 municipalities: 6 in S 24 Parganas District, viz. Maheshtala, Budge Budge, Pujali, Jaynagar-Majilpur, Baruipur and Rajpur-Sonarpur, 1 in Howrah district, viz. Ulubaria and, 19 in N 24 Parganas District, viz., Barasat, Madhyamgram, Rajarhat-Gopalpur, Garulia, N. Barrackpore, Barrackpore, Titagarh, Khardah, Panihati, New Barrackpore, Baranagar, Dum Dum, S. Dum Dum, N. Dum Dum, Bidhannagar, Nabadiganta Industrial Township, Baduria, Taki and BasirhatMining activities are virtually absent in this area.

2.0 CLIMATE

The climate of the area is characterized by hot and humid climate with adequate rainfall mainly derived from south-west monsoon, which starts from mid-June and continue upto September. Generally, 85 percent of the rainfall is received during the monsoon period. Pre-monsoon showers are occasionally received in the month of March, April and May.

2.1 Rainfall

Month wise average rainfall for the year 2012 – 2016in three districts in study area have been tabulated and presented in **Table-2.1** below.

2.2 Temperature

The winter season sets in around middle of November when both maximum and minimum temperature begins to drop steadily and attain their respective lowest values in the month of January. The temperature starts rising in the month of February. May is the hottest month of the year.

3.0 PHYSIOGRAPHY

3.1 Geomorphology

The northern and western parts of the area comprising North 24 parganas and Howrah districts is characterized by a part of alluvial tract of Lower Ganga Basin, which shows gentle southerly slope with some local elevations and depressions. This flat alluvial plain is dissected by numerous meandering rivers and streams, viz. Hugli, Bidyadhari, Raimangala, etc. with dendritic drainage pattern. A small portion is flood plain near adjoining parts of banks of major river. Within flat topography, vast fields are often found submerged. In the south in N 24 parganas, there are some marshy lands which are mostly converted into paddy fields and also residential localities, eg. Salt Lake City and NewTown Complex. In the southern part of this Sub-Area, i.e. in S 24 Parganas District, there are numerous islands with creeks forming different stages of fluvio-tidal & marine coastal facies, which are represented by mangrove marsh and tidal beaches respectively;

the elevation of this part lies between 2.5 m to 4.0 m above m.s.l.

In the area under study in S 24 Parganas District, elevation varies from 15m in the north west (BarrackporeII Block) to (-) 0.01 m towards southeast (Hingalganj block);the average slope of the area is 0.065 m /Km.

Geomorphology of the present area has been shown in Plate 3.1.

Table-2.1: Average monthly &annual rainfall in different sub areas for the period 2012 -16 (in mm)

Districts	year	January	February	March	April	May	June	July	August	September	October	November	December
Howrah													
	2012	81	14.5	0	34.4	18.3	226.5	240.8	155.2	256.7	111.9	26.3	40.3
	2013	5.8	9.6	9.9	40.2	99.4	228.1	310.2	550	249.1	352.6	0	0
	2014	0.1	54.2	19.5	0	103.6	161.8	224.9	362.6	280.4	24	0	1.2
	2015	9.8	4.2	10	101.1	68.3	227.9	854.4	180.8	202.2	25.7	0	6
	2016	0.4	104.1	8.8	0	52	119	334.6	309.5	214.1	74.4	59	0
Average 5 yrs		**19.42**	**37.32**	**9.64**	**35.14**	**68.32**	**192.66**	**392.98**	**311.62**	**240.5**	**117.72**	**17.06**	**9.5**
North 24 Parganas													
Districts	**year**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
	2012	43.3	15.6	0	98.5	87.2	147.6	248.7	211.8	254.2	115.2	55.5	14
	2013	4.3	10.1	18.2	57.6	214.9	350.3	282.5	373.7	178.8	337.4	0	0
	2014	0	25.3	19.9	0	112.6	237.9	343.4	262.6	222.8	42.7	0	2.5
	2015	26.3	1.8	36.7	131.2	33.2	261.9	662.1	324.1	180.2	42.5	0	15
	2016	0.7	84.4	37.8	2.5	146	225.8	427.1	473.4	135	111.3	30.7	0
Average 5 yrs	**2014**	**14.92**	**27.44**	**22.52**	**57.96**	**118.78**	**244.7**	**392.76**	**329.12**	**194.2**	**129.82**	**17.24**	**6.3**
South 24 Parganas													
Districts	**year**	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
	2012	44.8	18.1	5.5	42.8	42.8	139.7	345.4	327.8	317.5	67.3	38.9	34.2
	2013	2.8	6.8	3.1	46.7	202.7	354.1	363.3	619.6	312.2	388.7	0.1	0
	2014	0	49.8	20.2	0	190.3	214.2	323.2	352.6	317.9	109.7	0.5	1
	2015	10.9	5.7	15.5	69.1	35.9	264.3	754.6	351.5	196.4	23.5	2.8	7.6
	2016	7.2	63.3	1.6	7.6	100.4	181.9	472.4	534.5	221.6	93.9	54	0
Average 5 yrs	**2014**	**13.14**	**28.74**	**9.18**	**33.24**	**114.42**	**230.84**	**451.78**	**437.2**	**273.12**	**136.62**	**19.26**	**8.56**

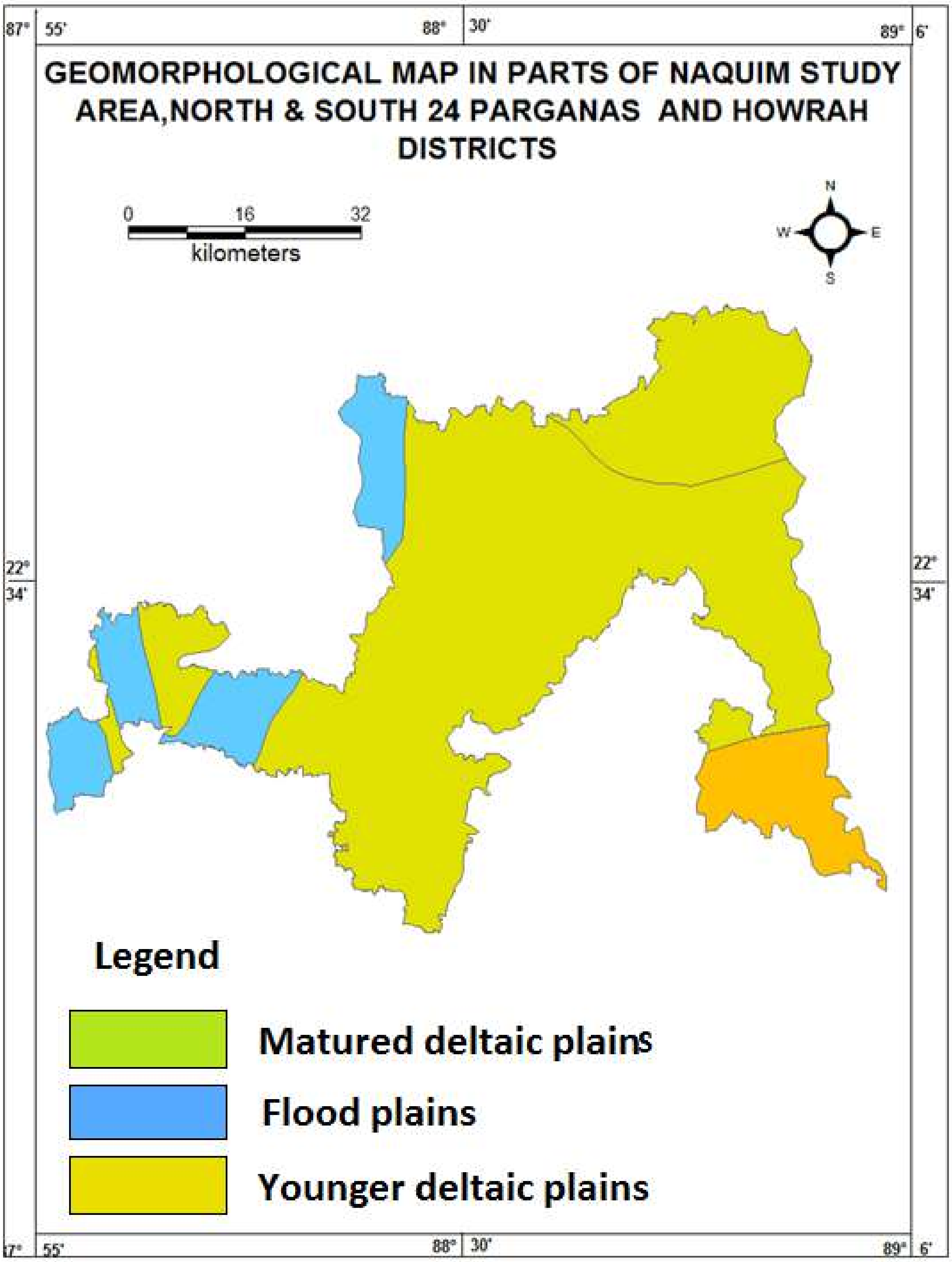

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Plate-3.1: Geomorphology in study area

3.2 Drainage

The whole area is drained by the river system of Hugly/Gangadrainage system. Other important rivers are Thakuran, Matla, Guasuba, Haribhairga, Raimangala in S 24 Parganas District. The Drainage Map of the study area is shown in **Plate-3.2.1.** Water bodies in the area have been shown in Plate – 3.2.2

Plate 3.2.2: Water bodies in study area

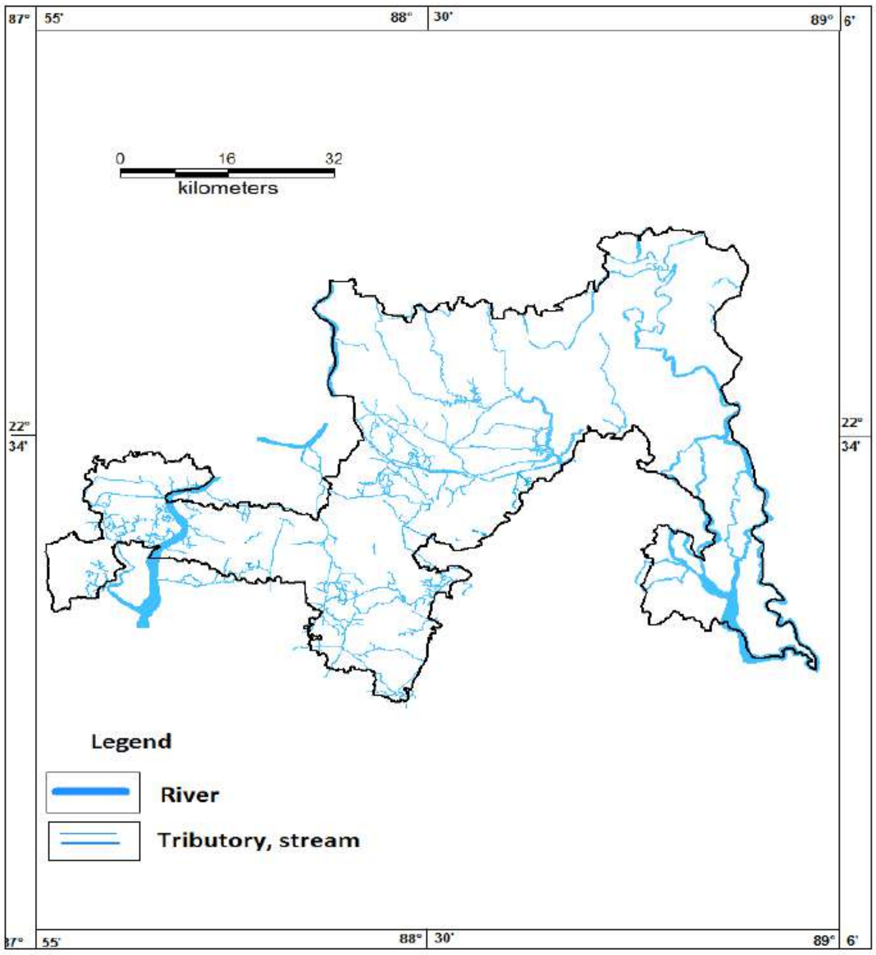
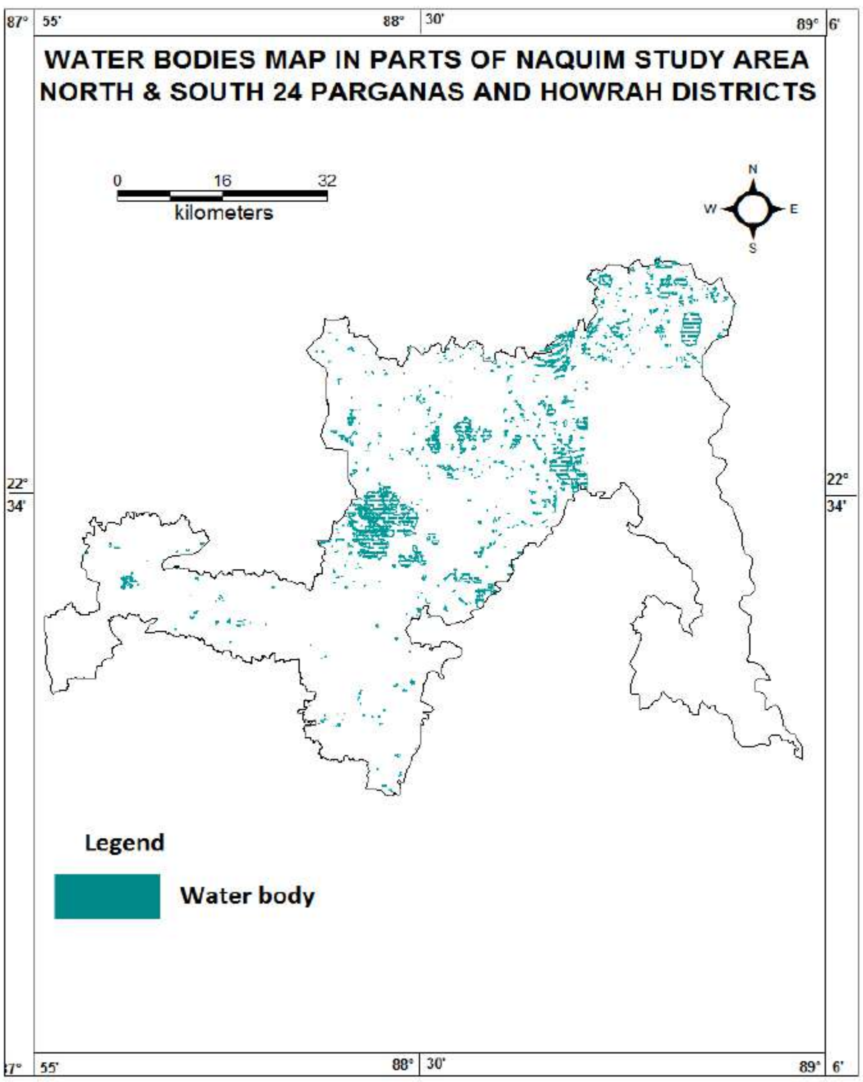


Plate-3.2.1: Drainage in 25 blocks in N 24 Parganas, S 24 parganas & Howrah Districts



3.3 Soil Characteristics

Major part of the area is covered by poorly drained, fine loamy soils (fine loam), exceptinga small part in the north-western part, which is covered by deep moderately well drained sandy soils.However, the detailed Soil Map of this area is shown in Plate-3.3.

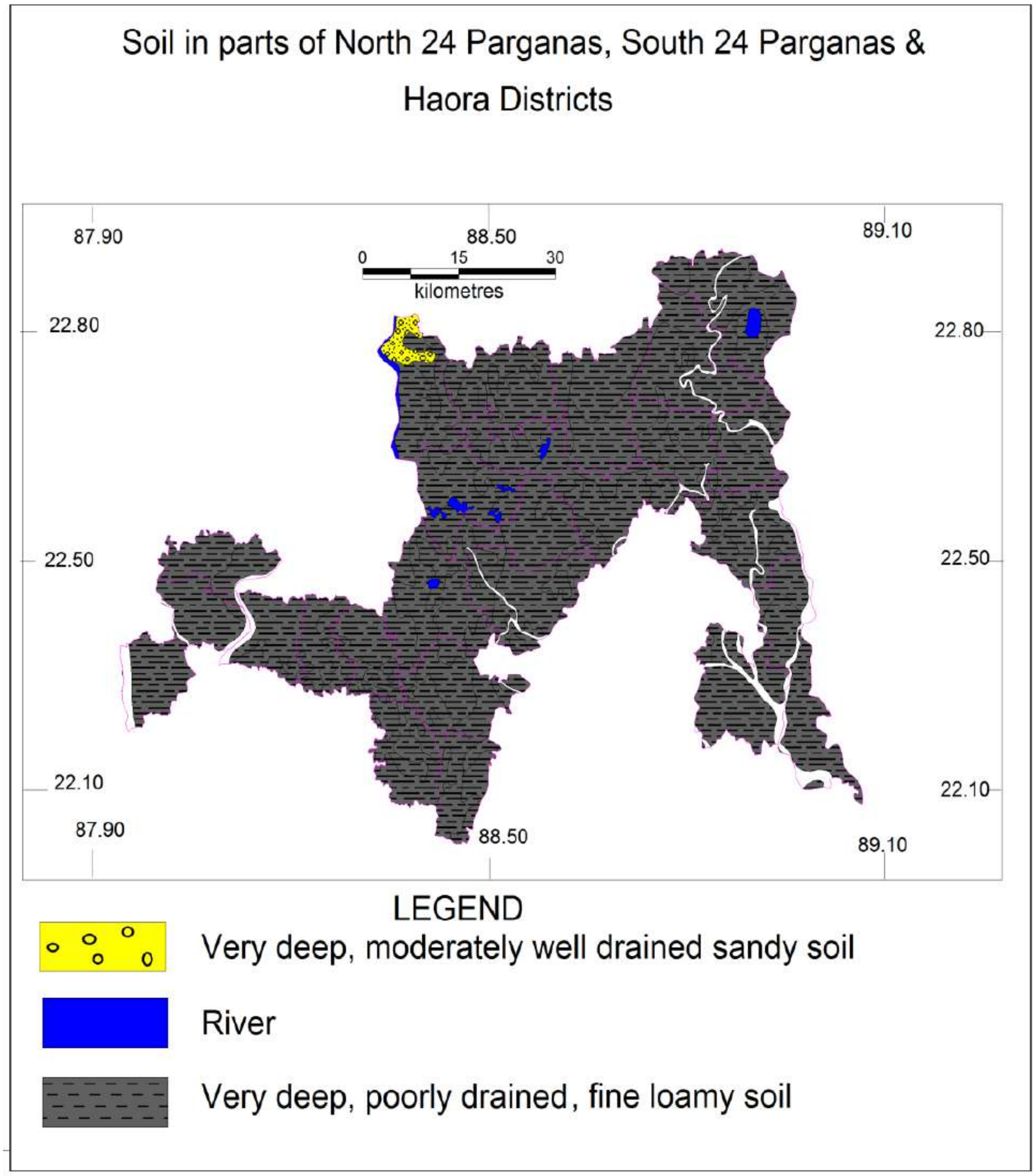


Plate-3.3: Soil Map in parts of N. Parganas, S. 24 Parganas & Howrah districts

4.0 GEOLOGY

4.1 General geology

The area under study is mostly covered by a huge thickness of Quaternary deposits, Recent to Sub-Recent Alluvium of the Ganga River system consists of clay, silt, sand and gravel; these deposits are characteristically grey, fine to coarse, and very often highly micaceous and their composition is mainly quartzo-feldspathic. Thick column of these Recent Alluvium are encountered in the eastern part of Bhagirathi (Hughly) River covering present parts of study area in Nadia-N 24 Parganas and S 24 Parganas Districts.

The geology of the whole study area has been shown in plate **Plate-4.1**.

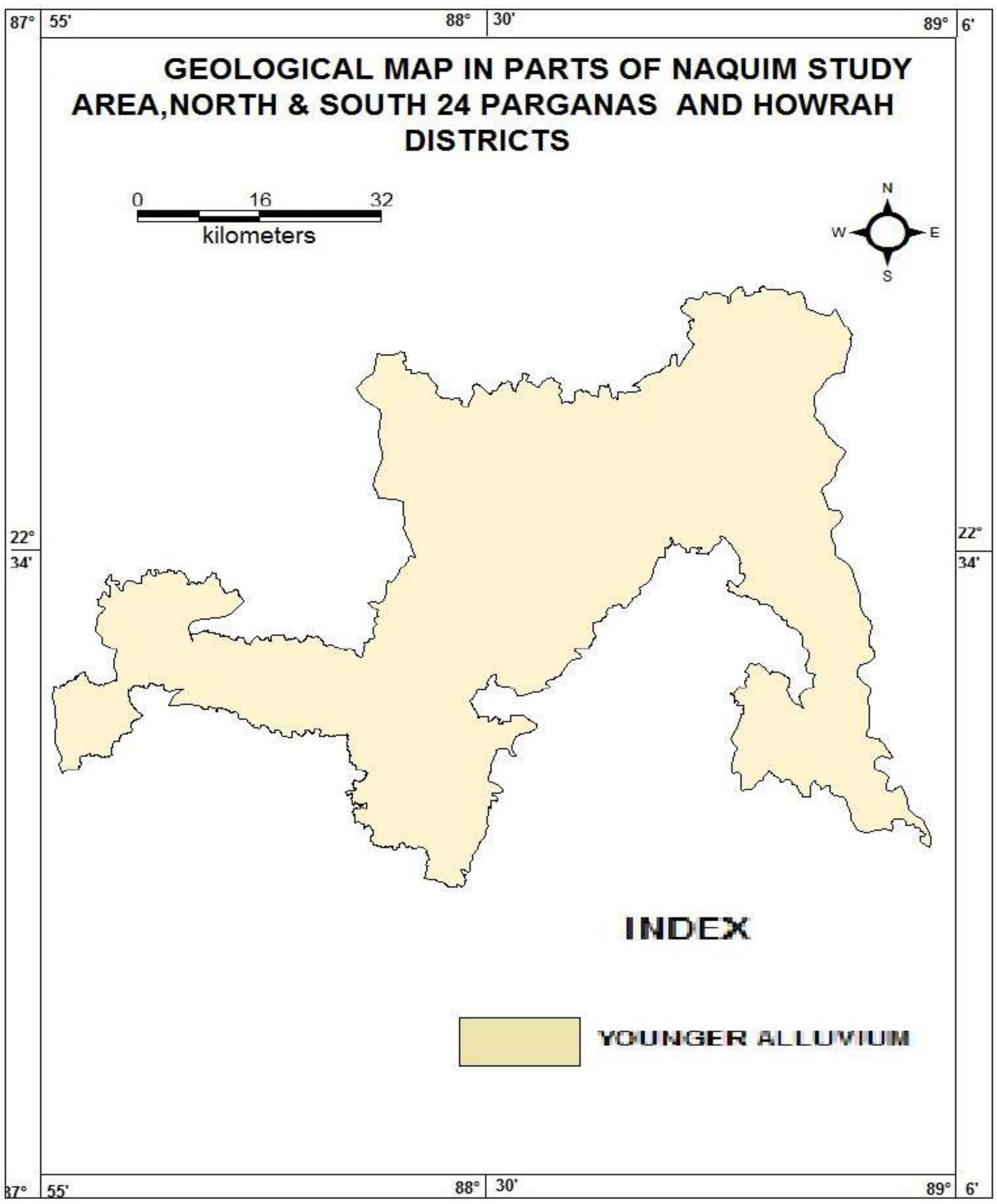


Plate-4.1: Geology in study area

5.0 HYDROGEOLOGY

5.1 Water bearing formations of parts of North 24 parganas district

Blocks under study area of North 24 pargana district are Swarupnagar, Baduria, BarasatI,BarasatII,Rajarhat,BasirhatI,Basirhat,BarrackporeII,Deganga,Haroa,Hasnabad,Hingalganj and SandseshkhaliII. From the drilling data of CGWB and other central and stateGovt. organizations three prominent aquifers have been found in North 24 Parganas. All the aquifers are regionally extensive, but their thickness varies from one place to another.

The aquifers in the study area belong to unconsolidated sediments of Quaternary sediments deposited by the Hugli-Bhagirathi river system and consists of a succession of coarse to fine grained sand, along with their various admixtures with localized patches of gravel. Regional sub-surface correlation has been attempted from the panel tree diagram of the entire study area (**Fig5.1.1**). The top surface is composed of a Sandy Clay to Clay layers, thickness of which varies from3 to 40m. The thickness of top clay layer increases towards Southern part of the study area. In general, three principal aquifer systems separated by clay beds of variable thickness exist in major part of the study area but in northern part of Barrackpore II block a localized aquifer has been encountered ranging from 0 to 5mbgl.The aquifer has been interpreted as flood plain deposit along the palaeo-channels of Hugli river and termed as **Zero-Aquifer**. This is sporadically contaminated by arsenic.

First aquifer system ranges from depth 0 -185 mbgl and mainly overlain by a 0-10 m thick Sandy clay layer in northern part and thick clay of nearly 30 to 40m in southern part. 1st Aquifer (Aquifer I Group) is intercalated with a number of sandy clay and clay layers of varying thickness and for convenience & explanation, it is separated into Aquifer IA &Aquifer IB, though both of them joins together somewhere and behaves a single aquifer system. Pumping test analysis data also reveal the interconnection of Aquifer IA and Aquifer IB as observed in Bhatpara (Kanchrapara), BarrackporeII area and both the aquifers has almost same values of aquifer parameters. This aquifer is fresh mainly in the north and it becomes brackish/saline towards south.

Aquifer IA occurs within the depth of 80mbgl. Aquifer IB is encountered below 80mbgl upto a maximum depth of 185 mbgl) and is separated from the upper Aquifer IA by clay beds of varying thickness and of considerable aerial extent. The aquifers of Aquifer I Group have also been found to be sporadically contaminated by arsenic.

Second Aquifer system (Aquifer II) occurs within the depth of 185 to 250mbgl. Aquifer II is completely separated from Aquifer I by thick regionally extensive clay bed (in general

15 to 50m thick) and the thickness of clay is more towards the south. Two to three aquifers exist within this aquifer system separated by a number of clay beds. The change in lithology, both vertically & laterally is very common towards the south due to lower deltaic deposits (as observed in Hasnabad, Hingalganj and Sandeshkali blocks). All these aquifers within this Aquifer II are interconnected and behave like a single aquifer system.

The 3rd group of aquifers (Aquifer III) ranges from depth, 264–371mbgl and it is separated from aquifer II by a thick regionally extensive clay layer. Two to three aquifer units are recognized within this aquifer system. These aquifer units are locally separated by 5 to 30m thick clay layers. These aquifers mainly consist of fine to medium sands in places enriched with gravels.

General disposition of aquifers has been shown in Fig. 5.1.1.

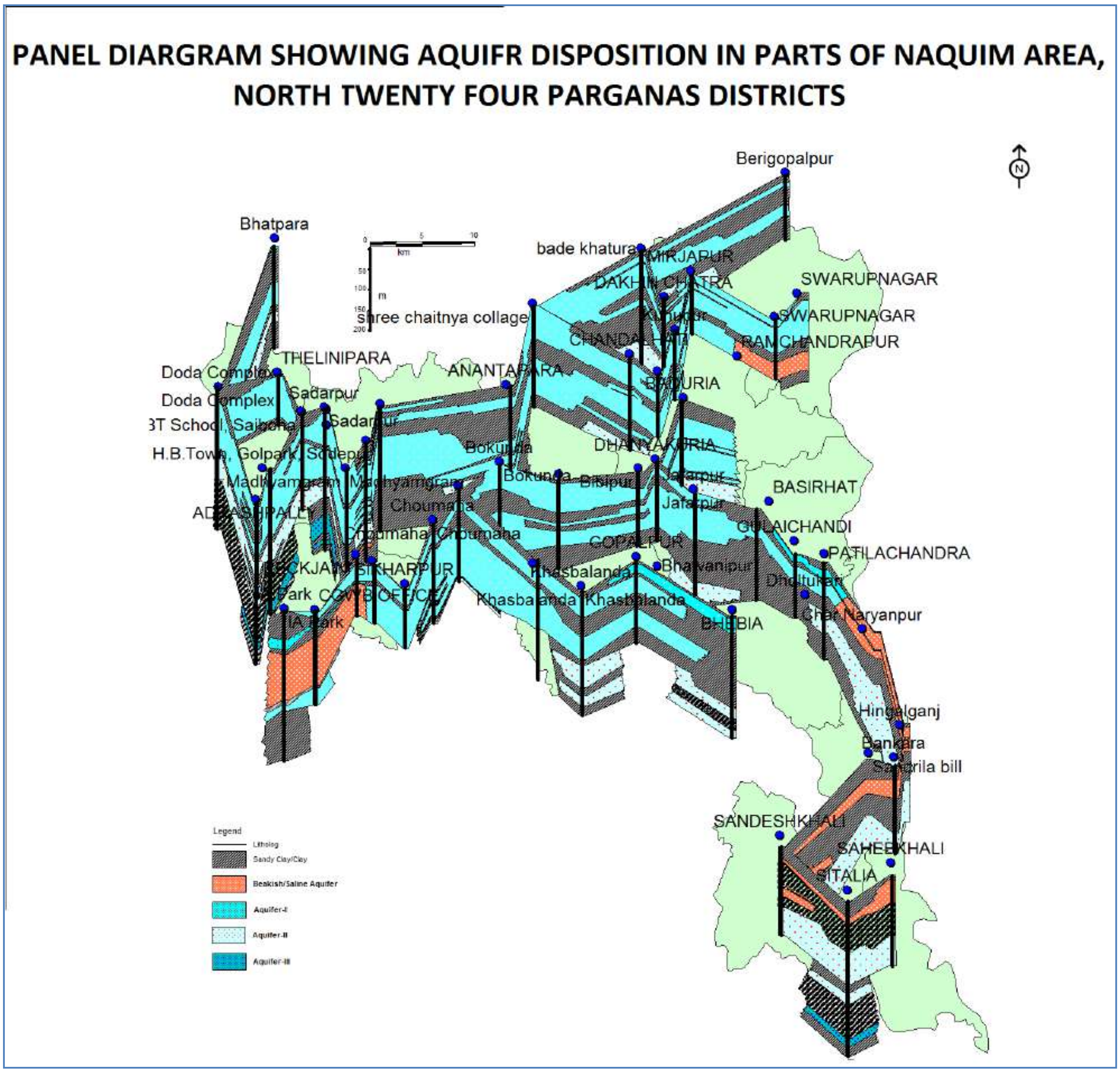


Fig 5.1.1: General disposition of aquifers in 13 blocks of North 24 Parganas district

5.2 Water bearing formations of South 24 Parganas district & Howrah district:

Hydrogeological survey has been done in Bhangar I, Bhangar II, Baruipur, Sonarpur, Jaynagar I, MagrahatII,Bishnupur I, Bishnupur II, Budge Budge II blocks of South 24 Parganas district and Uluberia I, Uluberia II and Shyampur II blocks of Howrah district. From the drilling data of CGWB and other central and State Govt. organizations, three prominent aquifers have been interpreted in both South 24 Parganas and Howrah districts. All the aquifers are regionally extensive, but their thickness varies from one place to another. Beside these, one locally extensive aquifer has been encountered in parts of Baruipur block just below the ground along old river channel. This is inferred to be flood plain deposit in origin and Arsenic concentration here is more than permissible limit. This aquifer is named as **Zero Aquifer.**

Parts of South 24 Parganas district:

In South 24 Parganas, the 1st aquifer group (Aquifer I) ranges within depth range of 10 – 200mbgl and overlain by a 10-15 m thick clay layer. This aquifer group is divided in to two sub aquifers in the study area of South 24 Parganas namely, Aquifer IA (10 – 65 mbgl) and Aquifer IB (65 – 200mbgl). These two sub aquifers are separated by a sticky clay layer of thickness 10-20 m in the study area but in Barrackpore II block, exploration data has revealed that these two aquifers are interconnected.

Ground water in Aquifer IA is,in general, fresh in current study areas but in some places it's arsenic concentration is above .01mg/litre.Aquifer IB is again divided into smaller aquifers by intercalations of clay layers and these intercalations increasetowards southern part of the study area(Baruipur, Jaynagar I, Magrahat II block). Quality wise in Bhangar II block and eastern part of Bhangar I block ground water in this aquifer is fresh but towards the western and southern part of the study area i.e, in Sonarpur, Baruipur, Bishnupur I, Bishnupur II blocks,Jaynagar I and Magrahat II blocks, quality of water is turned to brackish/saline. In the north-western part of Sonarpur block, this aquifer bears fresh ground water in Jadavpur–GangulyBagan area.

The 2ndaquifer group (i.e., Aquifer II) is encountered within a depth of 205– 300mbgl. This aquifer group is also divided into individual aquifers by clay layers and the litho-logical change in vertical succession is dominant towards south. The thickness as well as depth of the aquifers also increases towards the south of the present area.

Apart from the above said 2 aquifer groups, deep drilling up to a depth up to 500-600mbgl, reveals the presence of other thick aquifers e.g. at Goalberia, Balbalia, Kashipur, Kuarali, Rajpur. But due to lack of deep proper drilling data, correlation of these aquifers could not be possible.

Parts of Howrah district:

In Howrah district, the 1st aquifer (Aquifer I) is encountered within 20 – 135 m bgl in Uluberia I, Uluberia II and Shyampur II block and brackish /saline in nature. This is divided in to two major Sub-divisions, i.e. from 20- 80mbgl and 95 – 135 mbgl. The 2nd aquifer (Aquifer II) ranges from 155 - 285 mbgl and has clay layers dividing this aquifer group into smaller aquifer zones. Ground water in this aquifer is fresh. The shallow Aquifer IA does not exist in the study blocks of Howrah district. After considering all the log data, chemical and geophysical data it has been interpreted that the 1st aquifer or the Aquifer I is the extension of Aquifer IB in South 24 parganas and the 2nd fresh aquifer (i.e. Aquifer II) is the extension of Aquifer II in South 24 parganas.

The disposition of aquifers in the blocks of South 24 Parganas & Howrah districts together has been shown in **Fig 5.2.1.**

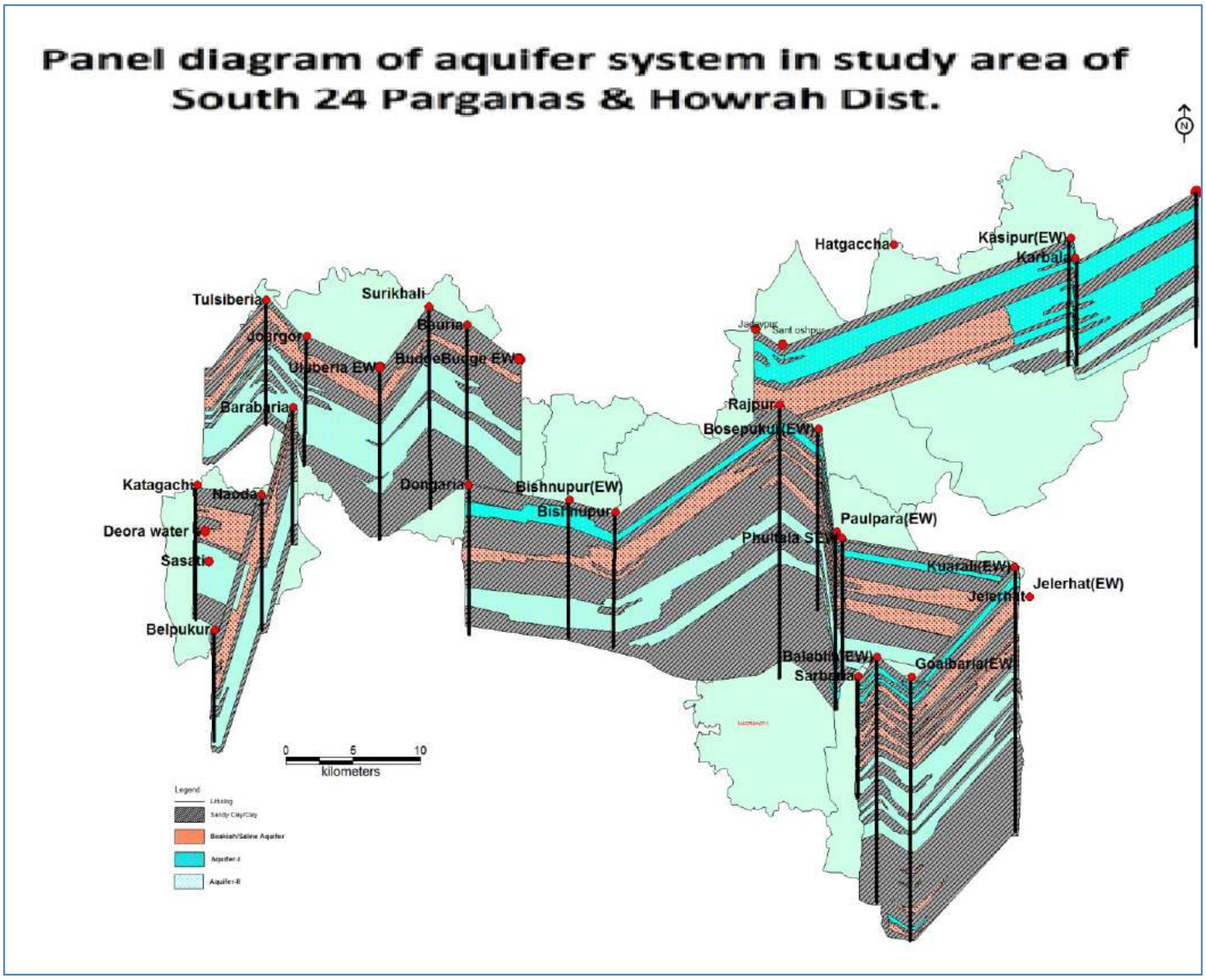
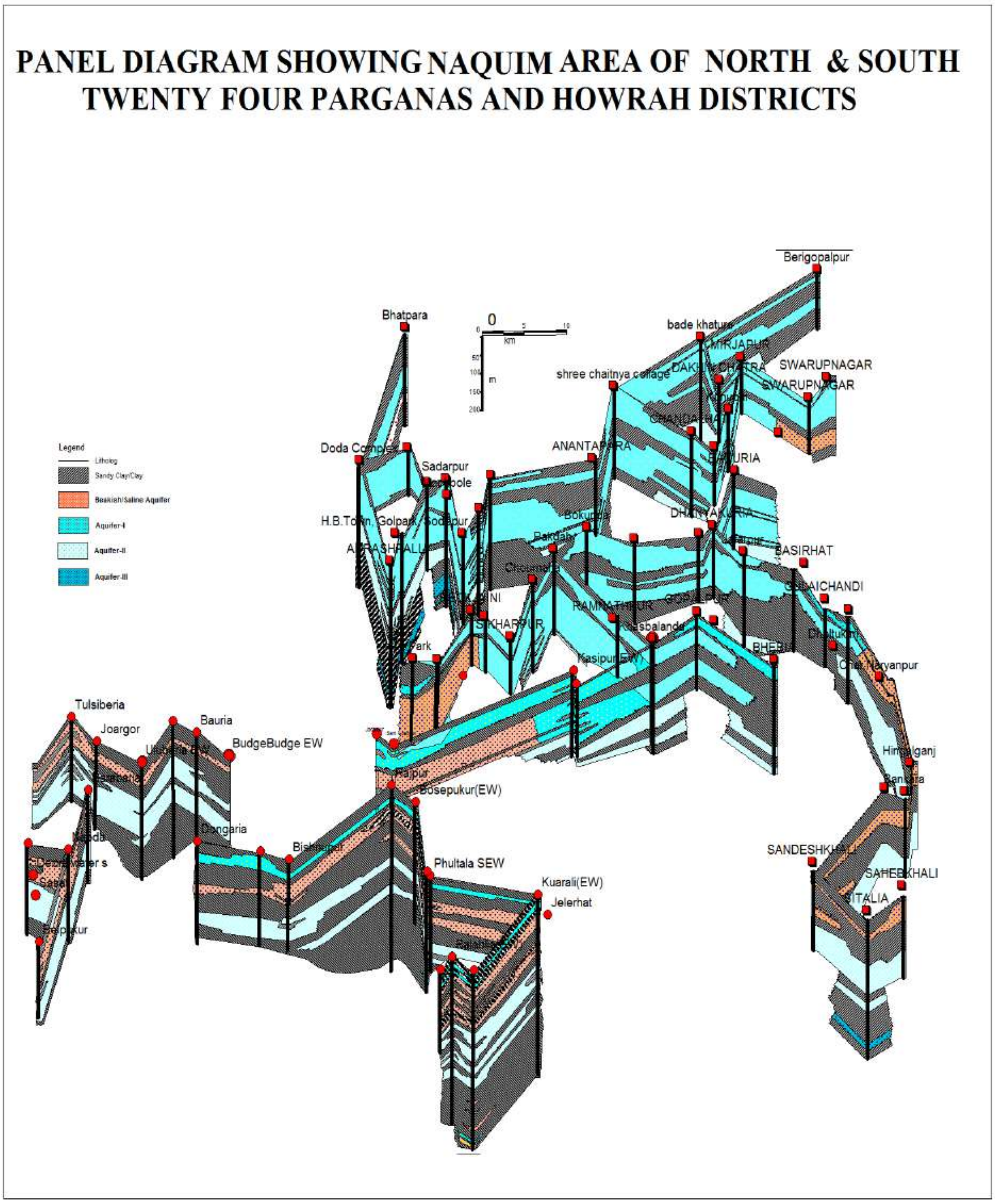


Fig 5.2.1: Disposition of Aquifers in 12 blocks of South 24 Parganas and Howrah districts

From available exploration data, chemical data and micro level hydro-geological survey, the saline and fresh water interface has been interpreted and shown in Fig 5.2.2. Three North-South cross sections have been prepared for better understanding of variations in aquifer thickness, depth and quality and shown in **Fig 5.2.3, 5.2.4 and 5.2.5**. Further study in the southern most part beyond the boundary of the whole study area might reveal the nature and continuity of this saline zone towards coastal area and may help understanding the reason behind the occurrence of the brackish/saline zone in that particular aquifer.

Fig 5.2.2: Occurrence of aquifers and variations in their quality in study area comprising N 24 Parganas, S 24 parganas and Howrah districts



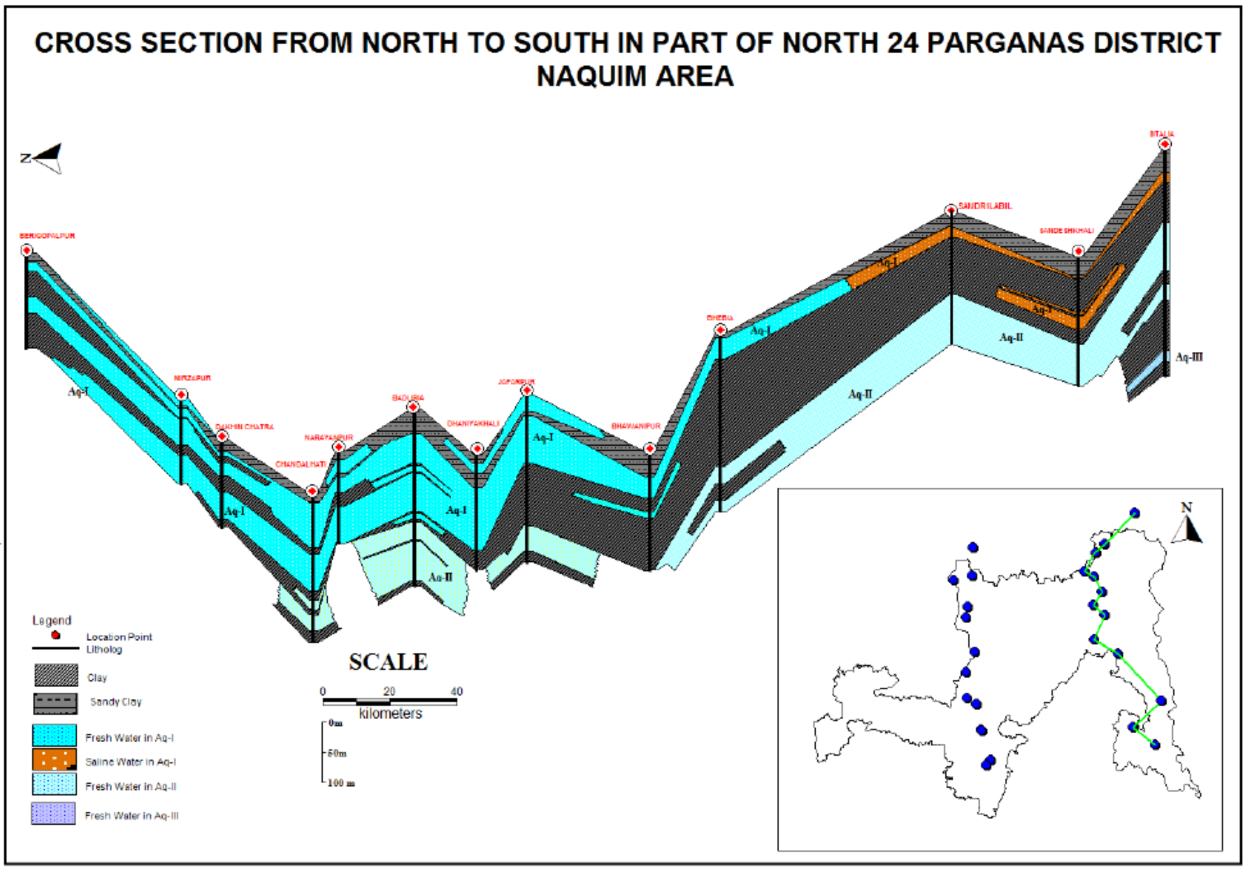


Fig 5.2.3 : North-South cross section-1 in N 24 Parganas district

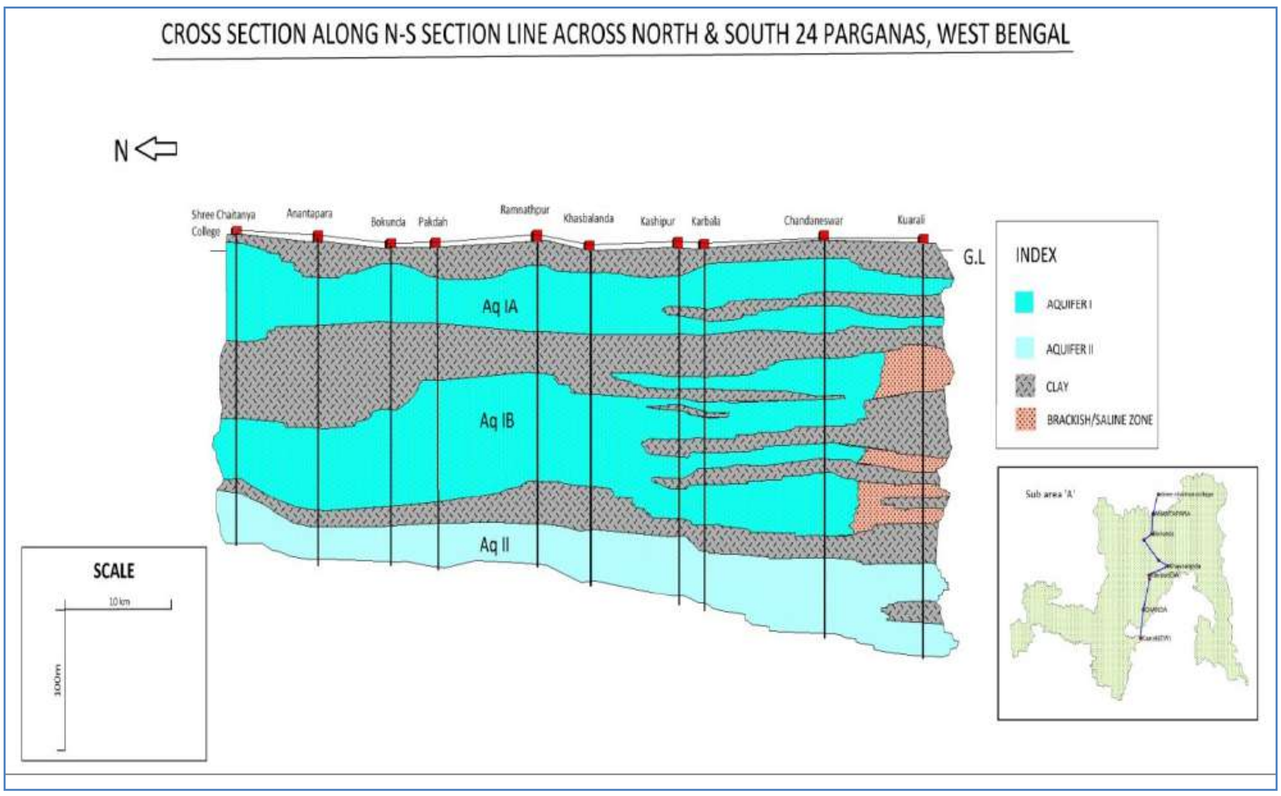


Fig 5.2.4 : North-South cross section-2 in N 24 Parganas & S 24 parganas districts

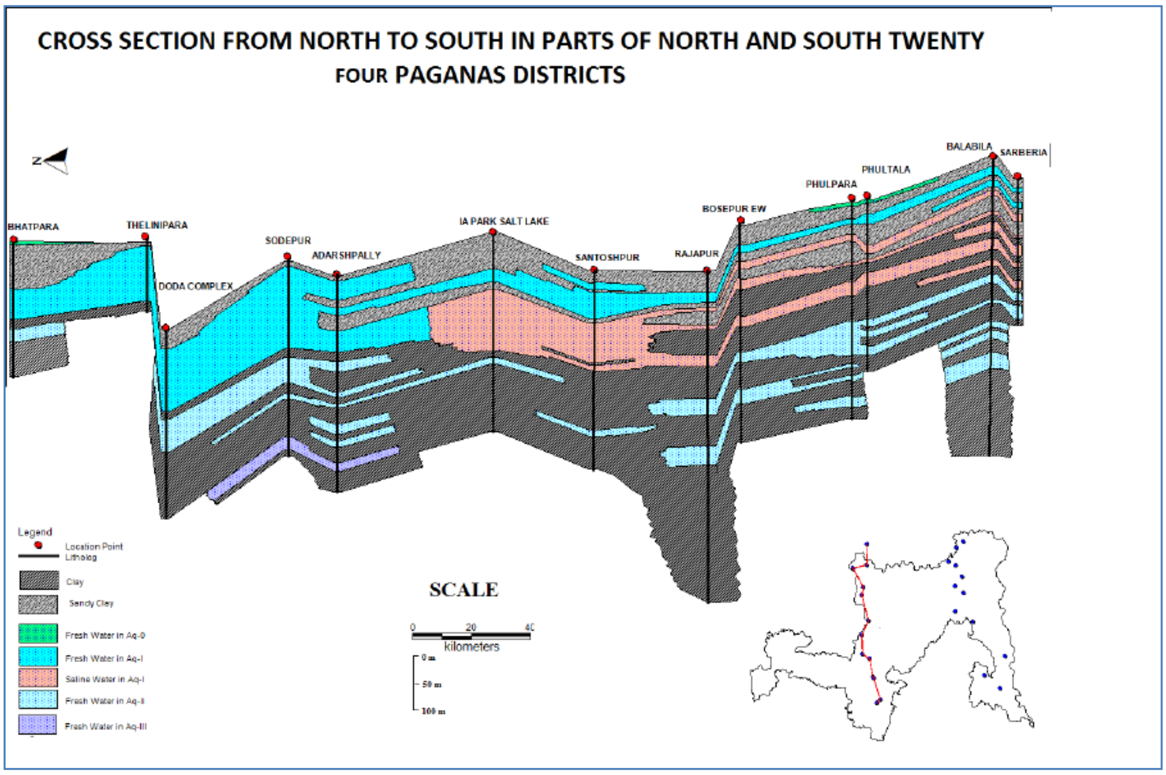


Fig 5.2.5 : North-South cross section-3 in N 24 Parganas & S 24 parganas districts

5.3 Aquifer wise groundwater regime, depth to water level:

During aquifer mapping and detailed hydro-geological survey of 25 blocks of North 24 Parganas,South 24 Parganas and Howrah districts under AAP 2016-17, a total of 162 numbers of key wells have been established in the study area for aquifer wise water level monitoring and sampling. These are mostly tube wells fitted with submersible pumps, piezometers and, a very few are dug wells(mainly in Howrah district). Out of these 71 key wells, are tube wells tapping the 1st aquifer; among these in 23 wells, shallow Aquifer IA has been tapped and the depth range of these wells varies from 4.00 - 101mbgl, and in the remaining 48 key wells, Aquifer IB has been tapped and the depth range of these wells varies from 55 -152mbgl. In the present study, the deeper fresh water bearing Aquifer II is represented by 91 key wells whose depth varies from 120 -300mbgl.

5.3.1 First Aquifer (Aquifer IA& IB)

The shallow aquifer / first Aquifer Group (Aquifer I) is represented by two aquifers, which is separated by distinct clay layer in most of the study area especially towards south; though in blocks of Baduria, Basirhat, Swarupnagar, Aquifer IA & IB are found to be separated by sandy clay layer which could be better described as an aquitard. The results of pumping test conducted in Barrackpur II block, confirms that both these aquifer units are interconnected. The thickness of both the aquifers and confining layer in between, are increasing towards south. Because of this reason both aquifer IA & IB have been considered to be a single aquifer system.

The pre monsoon depth to water level of first aquifer in the study area is represented in Fig 5.3.1.1, showingdepth to water level ranging from 0.74 mbgl to 25.2mbgl. The depth to water level in the surrounding areas of KMC i.e, the western part of blocks of Rajarhat, Barrackpur II, Sonarpur & Baruipur shows depth range of 10 – 25mbelow ground level which might be due to heavy withdrawal of ground water for irrigation purpose and /or domestic usage because of requirement for huge population inhabiting in KMC and adjoining areas.The minimum depth to water level has been encountered in the northern part of Bishnupur I block ranging within0.74- 2.00 mbgl. In major part of the study area, the depth to water level ranges within 2 – 10 mbgl.

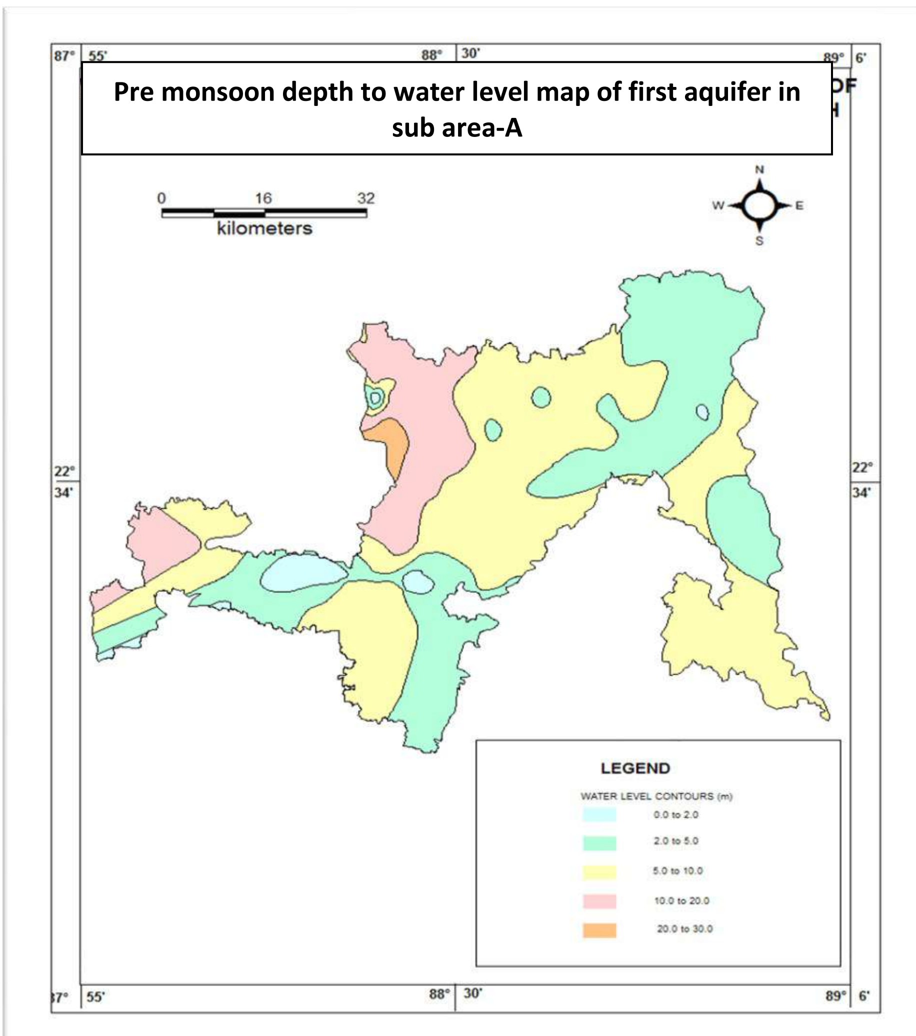


Fig 5.3.1.1: Pre-monsoon depth to water level in first aquifer

The depth to water level map of first aquifer during post monsoon is shown in Fig 5.3.1.2. In post monsoon the depth to water level ranges from 0.32 to 19.38 m bgl. Deeper water level within 10 -15 m bgl has been encountered in the north of Barackpur

II block and western parts of Barasat I , Barasat II and Basirhat II blocks; shallow water level ranging within 0.32 - 2 m bgl has been witnessed in blocks of Magrahat II, Jaynagar I , Bishnupur I, Bishnupur II , Budge Budge II and part of Bhangar I & Bhangar II.

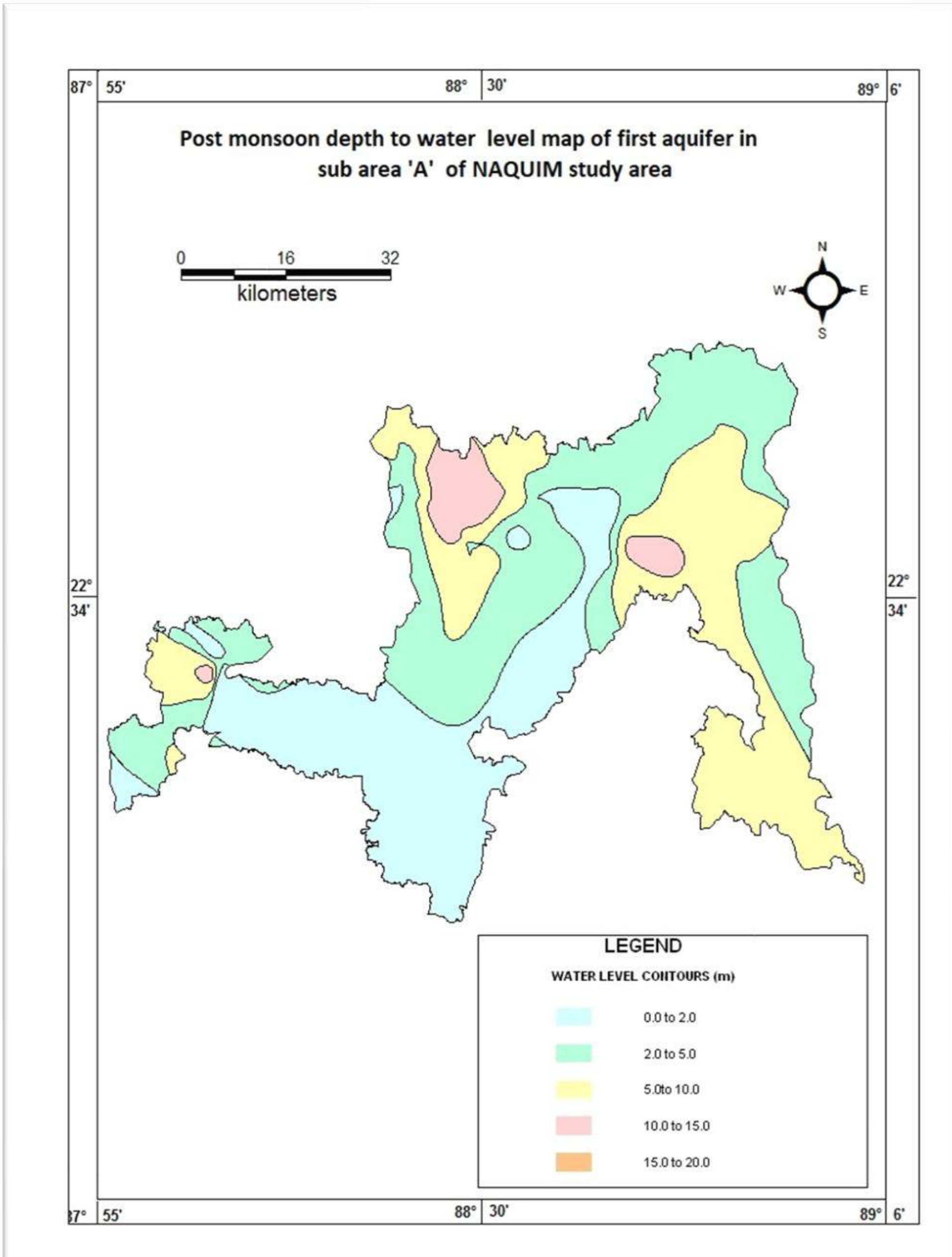


Fig 5.3.1.2: Post monsoon depth to water level map of first aquifer

5.3.2 Second Aquifer (Aquifer II)

The deeper aquifer II ranges from 120mbgl to 300mbgl and it shows varying depth and thickness throughout the area. This aquifer is fresh water bearing except in Barasat I block where entrapped (?) salinity has been encountered at Sethpukur within 248-258mbgl. In blocks of Hasnabad,BarrackpurII,Haroa, Uluberia II &Shyampur II blocks, a 12-30m thick clay layer has been encountered which is separating Aquifer II Group in to two aquifer units.

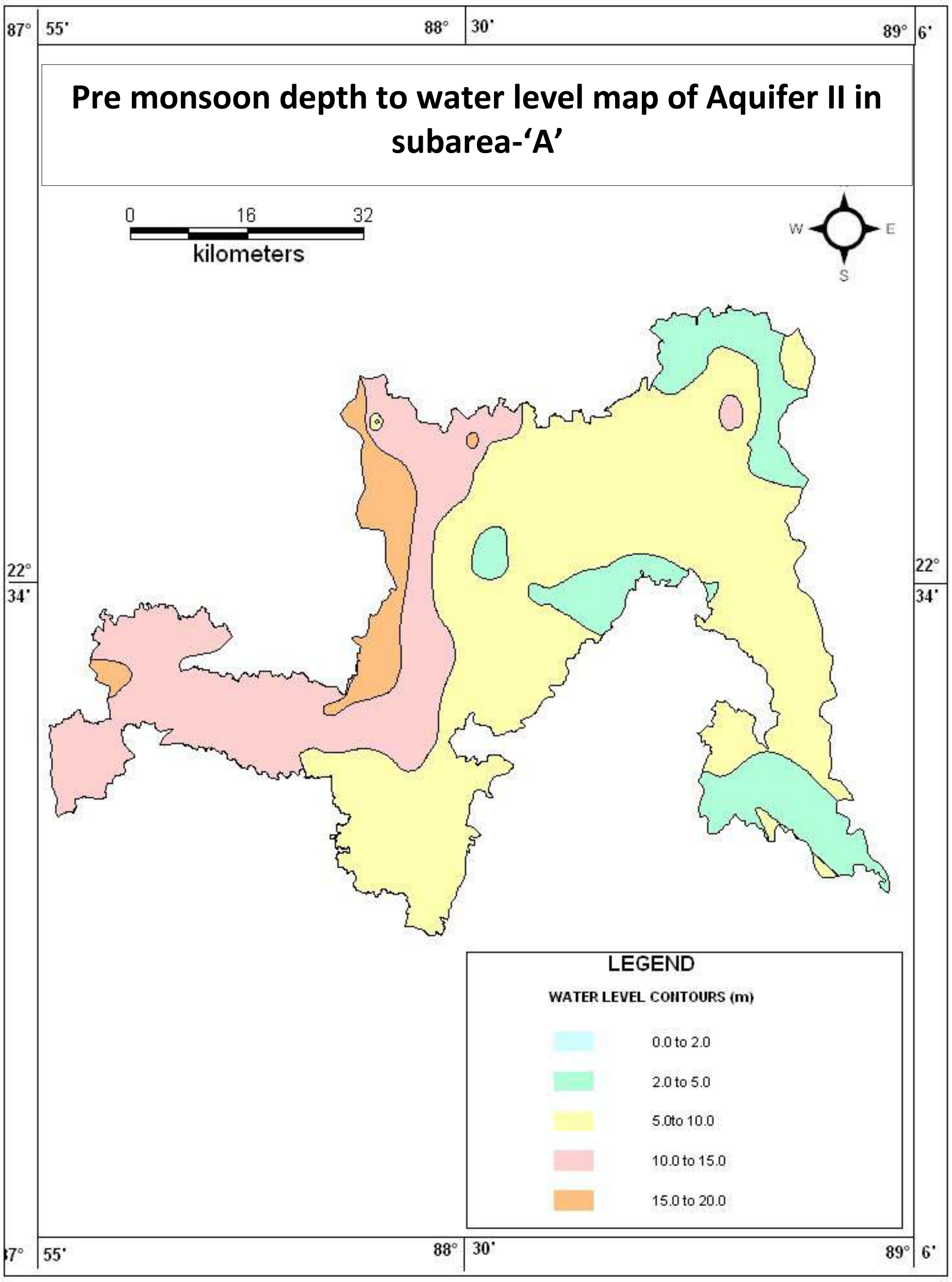


Fig 5.3.2.1: Pre monsoon depth to water level map of Aquifer II

The pre monsoon depth to water level map (Fig 5.3.2.1) for Aquifer II shows a wide range varying from 2.2 -18.9 mbgl. A wide area surrounding KMC shows deeper water level, 10 to 20 mbgl in average, in western parts of blocks of Barrackpur II, Rajarhat, Sonarpur, Bhangar I & Bhangar II and, entire blocks of Bishnupur I, Bishnupur II, Budhe Budge II, Uluberia I, Uluberia II and Shyampur II blocks. This is due to huge population residing in thearea causing heavy withdrawal of ground water for drinking and domestic purpose as this aquifer system contains fresh water. In the remaining part of the study area, the range of water level varies between 2 to 10 mbgl.

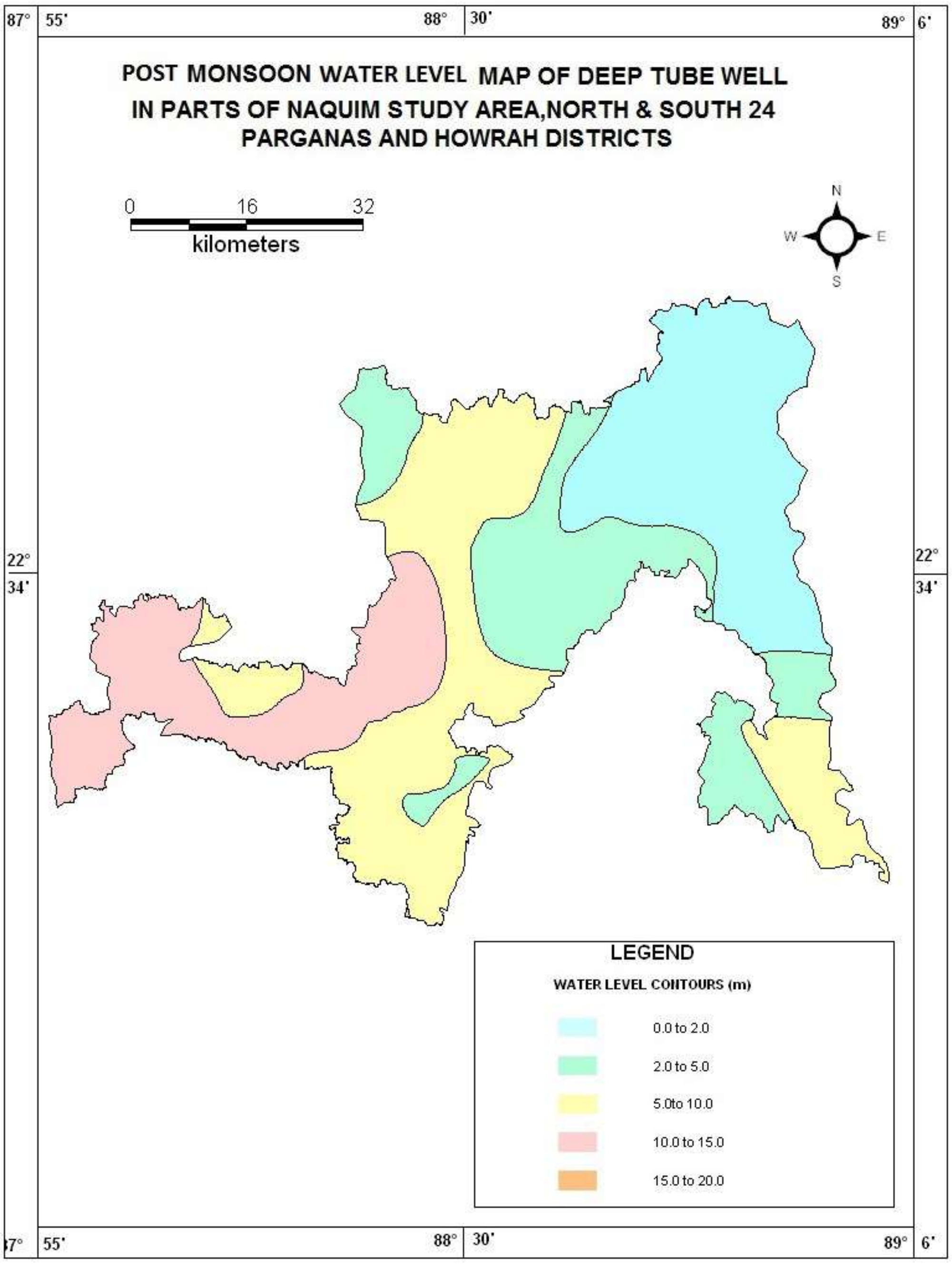


Fig 5.3.2.2: Pre monsoon depth to water level map of Aquifer II

The post monsoon depth to water level of Aquifer II for the entire study area shown in **Fig 5.3.2.2** indicates that the depth to water level ranges from 0.2 to18.22mbgl. Depth to water level is deeper, within 10-15mbgl, in the western part of blocks of Rajarhat, Sonarpur, Baruipur, and almost entire blocks of Uluberia I , Uluberia II and Shyampur II in Howrah district. Water levelis shallow, ranging from 0.2 m bgl to 2 m bgl,in the north-eastern part of the study area covering blocks of Swarupnagar, Baduria, Basirhat I, Basirhat II and Hasnabad blocks.

5.3.3 Aquifer wise occurrence and movement of groundwater:

The pre monsoon water table map representing the shallow aquifer has been shown in **Fig 5.4.1**. The water table contour here ranges from – 16m to 9.5 m (with respect to mean sea level). The general water table flow is towards southeast of the sub area. But in some places troughs have been formed locally due to anthropogenic activities. A huge depression in water table has been formed adjacent to the KMC area in Rajarhat, Barrackpur II and Sonarpur blocks because of high draft in this populated zone. A smaller trough has been formed comprising areas in the northwestern part of Barrackpur II, eastern part of Bishnupur I and southern part of Sonarpur blocks. The water table also shows a depression in the western part of Uluberia I, Uluberia II and Shyampur II blocks indicating high draft in this region too.

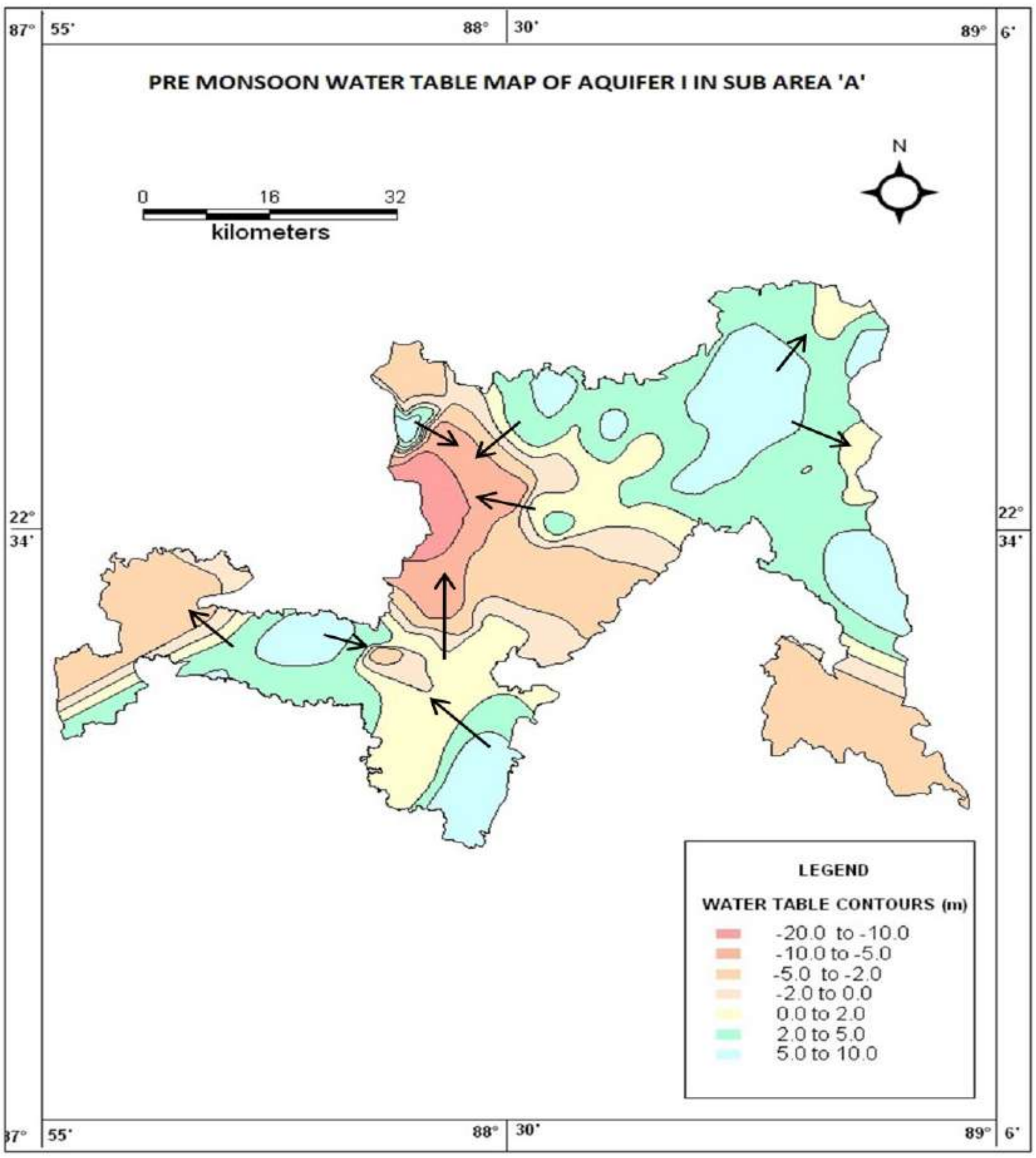


Fig 5.4.1 : Ground water flow of water in shallow aquifer during pre-monsoon

Fig 5.4.2 represents post monsoon water table contour of the shallow aquifer which ranges from-8 m to 9.6 m. The regional ground water flow is towards southeast but the huge trough in parts of Rajarhat, Sonarpur, Barrackpur II, Barasat I and western part of Bhangar I & Bhangar II blocks near KMC area still exists in post monsoon period too. Some smaller troughs have also been formed in the north eastern part of the study area near the boundary of Baduria & Swarupnagar blocks and in the southern part of Uluberia II block of Howrah district.

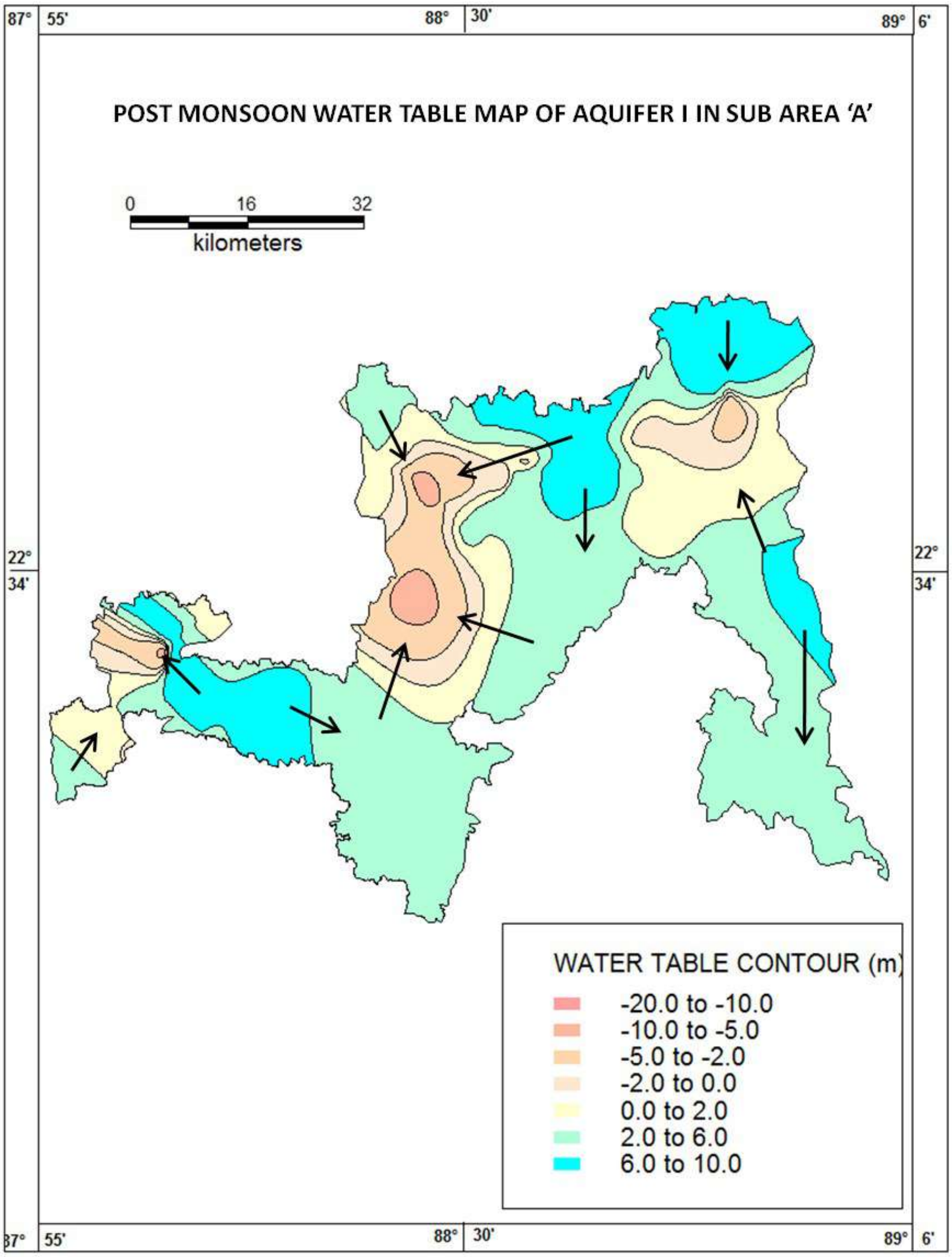


Fig 5.4.2 : Ground water flow of water in shallow aquifer during post monsoon

The hydrogeological map shown in Fig 5.4.3 represents the pre monsoon piezometric surface map of the deeper Aquifer II which has a depth range of 120-300 m bgl in North 24 Parganas, 205-300 m bgl in South 24 parganas and 155 – 280 m bgl in Howrah. The piezometric surface of Aquifer II ranges from -12m to 6.3 m in pre monsoon period in the study area and the overall slope is towards southeast. A number of troughs have been formed, out of which one is adjacent to the KMC area and it is significantly extensive covering blocks / municipalities of Rajarhat, Sonarpur, Baruipur, parts of blocks of Barrackpur II, Barasat I, Bishnupur I, Bishnupur II, Bhangar I & Bhangar II. This indicates heavy fresh ground water withdrawal from the deeper aquifer in KMC and surrounding areas for drinking and household purpose. Beside this some smaller areas in Swarupnagar & Baduria blocks, northeastern part of Hingalganj block and western part of Uluberia I & Uluberia II blocks are also affected by lowering of piezometric head in this aquifer in pre monsoon period.

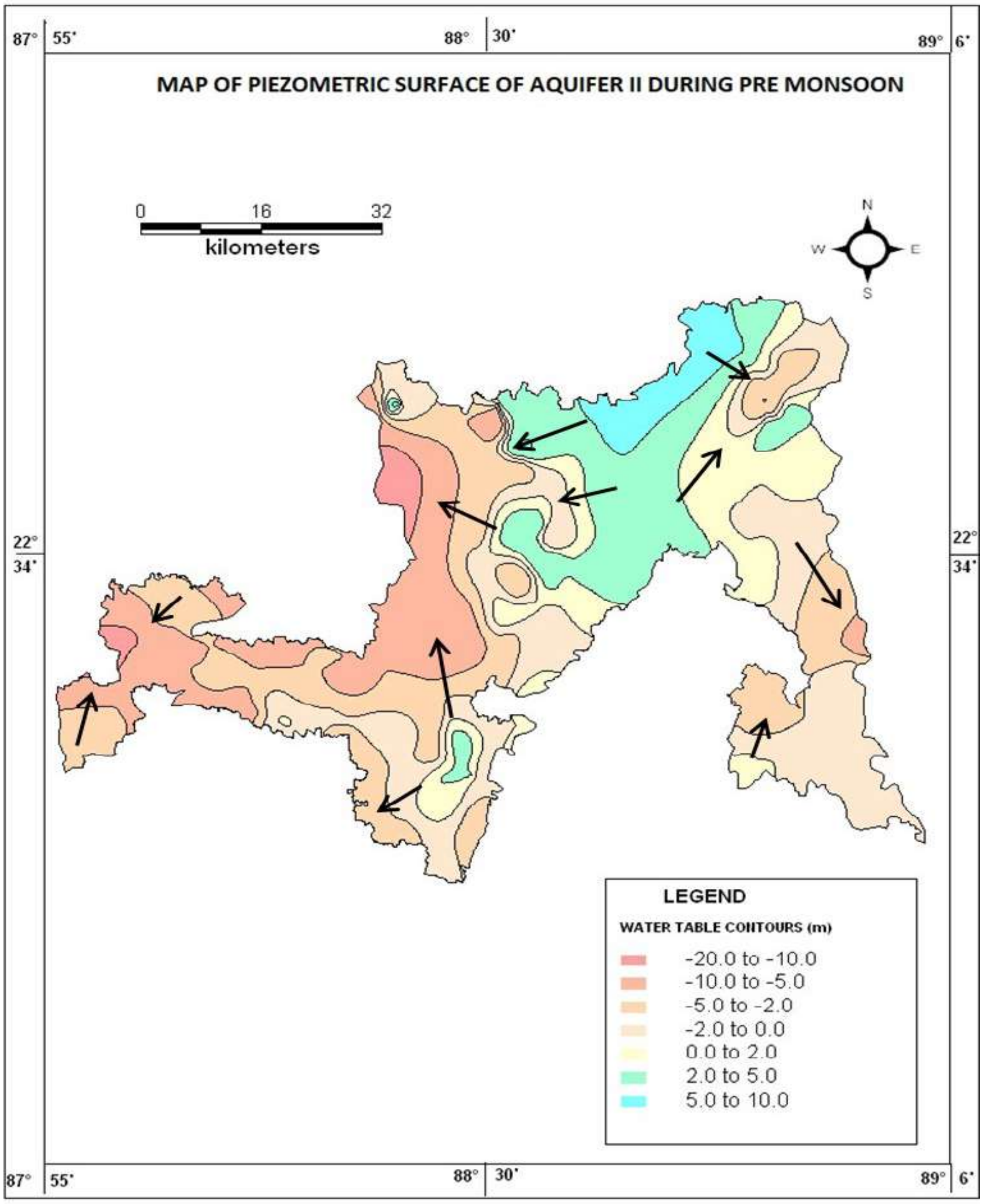


Fig 5.4.3 : Pre monsoon piezometric surface map of Aquifer II

Fig 5.4.4 represents the post monsoon peizometric surface map of deeper fresh aquifer (Aquifer II). The peizometric surface ranges within 11-12 m. Therefore, in post monsoon there is an increase in hydraulic head.In blocks of Deganga, Baduria, Swarupnagar & eastern part of Barasat II block, the piezometric surface is high and it is gradually sloping towards southeast of the study area. It is visualized that a trough is formed surrounding KMC area in Sonarpur, Bishnupur I and Rajarghat blocks but the area of the trough has been decreased in post monsoon compared to pre monsoon. Other than this, in southern part of Basirhat II block and eastern part of Haroa block of N 24 Parganas and blocks of Uluberia I & Uluberia II block, the pressure head is very low to the tune of - 2m to -10 m.

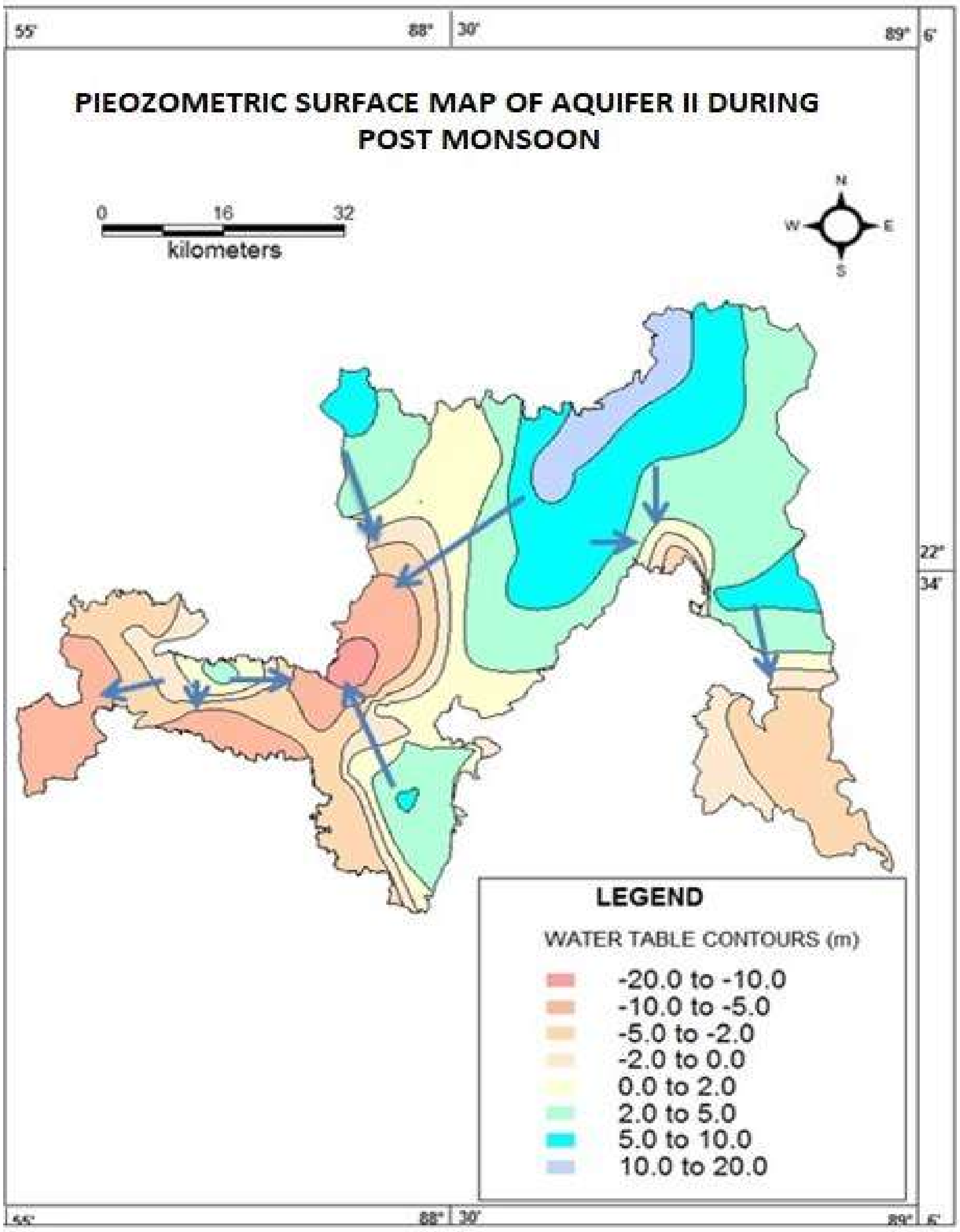


Fig 5.4.4: Post monsoon piezometric surface map of Aquifer II

5.3.4 Pre-monsoon & Post-monsoon long term trend:

The long term trend analysis of depth to water level for last 10 years (from 2008-2017) based on data of National Hydrograph Network Station (NHNS), reveals an overall falling trend in both pre-monsoon and post-monsoon in maximum blocks of study area.
For Aquifer I, all the blocks in North 24 Parganas& South 24 Parganas, except Basirhat II, Deganga Hasnabad and Bhangar II, show falling water level trend during pre-monsoon, with -0.5 m/yr being the lowest one in Jaynagr I block. In Bhangar II block, highest rising trend of water level to the tune of .09 m /yr has been encountered in pre monsoon. In post monsoon, the water level for last 10 years exhibitfalling trend in all the blocks,excepting blocks of Bhangar II & Budge Budge II, ranging from -1.08 m/yr to -.092 m/yr in Jaynagar I & Sandeshkhali II blocks respectively. The water level trend of Aquifer I isshown in **Table 5.5.1**.
As the blocks under study of Howrah do not have unconfined aquifer and the first aquifer has quality problems, monitoring wells and data of wells tapping the first aquifer for a continuous period of 10 years are very much limited. So it was not possible to determine block wise water level trend for first aquifer in blocks of Uluberia I, Uluberia II and Shyampur II blocks.
The water level trend of Aquifer II for last 10 years is given in Table no 5.5.2 and it shows rising trend in area covering blocks of Hasnabad, Hingalganj, Bhangar II and Magrahat II during pre monsoon; the highest rising trend of 0.34 m/year is encountered in Hingalganj block, where as in Uluberia I block the trend is lowest (-1.39m/yr). In postmonsoon, all the blocks showfalling water level trend except Bhangar II &Magrahat II blocks: -3.84m/yr being the lowest in Hasnabad II block and 0.42m/yr being the highest in Bhangar II block.

Table 5.5.1: Details of Aquifer Wise Pre-monsoon and Post-monsoon long term water level trends (2008 to 2017) in Aquifer I

SI. No.	Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
			Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
1.	Barrackpore-II	I	-	2.26	-	2.98
2	Baduria	I	-	4.78	-	6.02
3	Barasat-I	I	-	5.08	-	10.75
4	Barasat-II	I	-	12.86	-	19.87
5	Basirhat-I	I	-	9.37	-	7.11
6	Basirhat-II	I	6.34	-	-	3.05

7	Denganga	I	6.34	-	-	7.58
8	Rajarhat	I	-	5.37	-	576
9	Swarupnagar	I	-	7.59	-	8.54
10	Haroa	I	-	8.86	-	7.90
11	Hasnabad	I	0.132	-	-	0.261
12	Hingalganj	I	-	0.341	-	-
13	Sandeshkhali-II	I	-	0.416	-	.092
14	Baruipur	I	-	17.85	-	60.5
15	Sonarpur	I	-	33.8	-	48.9
16	Bhangar I	I	-	10.66	-	12.86
17	Bhangar II	I	9.40	-	34.78	-
18	Budgebudge II	I	-	0.4	12	-
19	Joynagar I	I	-	50.3	-	108.3

Table 5.5.2: Block-wise Pre- and Post-monsoon long term water level trend for during 2008-2017 in Aquifer II

SI. No.	Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
			Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
1.	Hasnabad	II	.106	-	-	3.84
2	Hingalgunj	II	.342	-	-	-
3	Baruipur	II	-	36.47	-	26.76
4	Bhanger-I	II	-	14.46	-	30.56
5	Bhangar II	II	1.85	-	42.57	-
6	Sonarpur	II	-	31.38	-	35.5
7	Bishnupur-I	II	-	56.5	-	81.83
8	Jaynagar I	II	-	34.65	-	13.5
9	Magrahat II	II	8.7	-	39.5	
10	BudgeBudgeII	II	-	68.6	-	196.95
11	Uluberia I	II		139.65		9.15
12	Shyampur II	II		43		57.1

5.4 Aquifers with yield prospects:

From the study of exploration data of CGWB & the litho charts of state govt. tube wells, mainly three aquifer groups have been delineated down to a maximum depth of 434mbgl at Kashipur, Bhangar II block in the present area. The first aquifer group exists within the depth of 225 mbgl with yield potential to the tune of 11.95 to 136.8 m^3/hr. The Transmissivity of the first aquifer system varies within 260.78 -2921.92 m^2/day. The second aquifer group exists in the depth span of 123-300 mbgl,with yield potential to the tune of 21 to 208.08 m^3/hr. The Transmissivity of the second aquifer system varies from 695.71– 3962 m^2/day. The third aquifer has been encountered at a depth of 264 -393

mbgl; data is very much limited. The deepest 4th aquifer has been encountered only at one place Kashipur, Bhangar II block at a depth of 394 -434mbgl where drilling has been done upto 607.5mbgl; no other data is available regarding this aquifer. Aquifer wise parameters in the study area are given in the following**Table-5.6.1 and Table 5.6.2.**
Aquifer ‘0’ has been encountered locally and sporadically in parts of Barrackpore-II&Baruipur blocks . This aquifer is mostly tapped by dug wells and shallow wells.

Table- 5.6.1: Aquifer-wise parameters in North 24 Parganas, South 24 Parganas and Howrah districts

Sl. No.	Name of Block	Aquifer I				Aquifer II				Aquifer III	Remarks
		Depth Range (IA/IB), mbgl	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (IIA/IIB), mbgl	Discharge (m^3/hr) with DD	T (m^2/day)	S	Depth Range, mbgl	
1	Hingalganj	10-85	-	-	-	123-250	81(0.35 DD)	1125.77		337-357	1st aquifer saline
2	SandeshkhaliII	30-124	-	-	-	123-250	81(0.35 DD)	1125.77		337-357	1st aquifer saline
3	Hasnabad	4-85	**28.80**			2A 119-252 2B 280-300	81(0.35 DD)	1125.77			1st aquifer saline in half part with saline fresh interface
4	BarrackporeII	**IA** 10-67 **IB** 60-174	**40.44 (2.61 DD*)**	**1628.6**	**0.029**	2A 146-225 2B 237-254	41.22 (0.91 DD)	1618	6.5 X 10^{-4}	325-360	'0' Aquifer present as levees(0-6 m)
5	Barasat-I	**IA** 0-93 **IB** 76-193	**59.2 (7.59 DD)**	**645.275**	-	186 - 245	21(2.65 DD)	1711		264 -371	2nd Aquifer is saline (248-258) entrapped (?) salinity in Sethpukur
6	**Barasat-II**	**IA** 0-60 **IB** 61-225	**91.72 (7.1 DD)**	**2021**		220-245	27(16 DD)	3891	3.8*10^{-1}		
7.	**Rajarhat**	**IA** 5 – 62 **IB** 54-219	**62.04(1.84 DD)**	**2003**	**2.04 * 10^{-5}**	184-245			-	**-**	
8.	**Haroa**	**IA** 7 – 61 **IB** 71-170	**44.94(0.24 DD)**	**822.42**	-	2A 182-236 2B 256 - 281	41.34(0.075)	2269	-	**-**	
9.	**Basirhat-II**	**IA** 0 - 69 **IB** 45-161	**26.47**	-	-	220 - 264			-	**-**	
10.	**Basirhat-I**	**IA** 3 - 38	-	-	-	119 - 175			-	**-**	

		IB 32-85									
11.	**Deganga**	**IA** 0 - 85 **IB** 83-194	**64.8 (2.29 DD)**	**2921.915**	**$2.29*10^{-4}$**	212 - 245	39.61	3962	$4.86*10^{-6}$	-	
12.	**Baduria**	**IA** 10-105 **IB**85 -185	**36 (2.12 DD)**	**729.14**	-	223 - 287	-	-	-	-	
13.	**Swarupnagar**	**IA** 0 - 113 **IB**106-191	-	-	-	223 - 296	-	-	-	-	IB aquifer (106-191) is saline due to entrapped salinity
	Baruipur	**IA**20- 60 **IB** 65-100,105-140, 150-200	**IA** 11.95 **IB** 129.52	-	-	215 - 295 218 - 270	86.76	1727	$9 * 10^{-5}$	305-393	Presence of Aquifer ‘0’ in parts of this block. Aquifer IB is brackish/saline.
	BhangarI	**IA**10-35,45 -65 **IB**75-130 , 140-200	-	-	-	205 - 250, 265 - 285 220-270	110.37	-	-	-	Fresh and Saline water interface present in Aquifer IB
	BhangarII	**IA**10 – 45 ,55-65 **IB**90-100 , 110-135 ,145-160, 175-195	**IB**86.4 (DD 0.76m)	**2670.4**	-	195 - 210, 212-270 215-285	126 (DD 1.22m)	695.71	$8.13x10^{-3}$	-	All the aquifers are found to be fresh water bearing
	Sonarpur	**IA**20-35,40-60 **IB** 70 -85, 90-	-	-	-	210 - 300 211 - 295	-	-	-	305-358	A fresh – brackish/saline water interface of

		140, 150-190									Aquifer IB is present
	Bishnupur I	**IA**45- 70 **IB**85-130 , 140-150	-	-	-	215 -275 145 - 190, 195- 280	-	-	-	-	Aquifer IB is brackish, other aquifers are fresh
	Bishnupur II	**IA**15 - 60 **IB**115-140, 155-175	-	-	-	150- 195, 205-275	-	-	-	-	Aquifer IB is brackish, other aquifers are fresh
	Jaynagar I	**IA**10 –30 , 45-55 **IB** 70 –85 , 95 –145 ,155-200	- **IB**136.8 (DD 0.90m)	-	-	215 - 295 218 - 270	208.08 (DD 15.25m)	1309	-	317-387	Aquifer IB is saline water bearing
	MagrahatII	**IA**6-45 **IB** 95-140 , 150-165	-	-	-	205 - 250, 265 - 285 220-270	-	-	-	-	Aquifer IB is bearing brackish/saline water
	Budge Budge II	**IA**35-65 **IB**150- 175	**IA** 18	-	-	195 - 210, 212-270 215-285	90	-	-	-	Aquifer IB is brackish in nature
	Uluberia I	**IB** 20-80, 95 - 135	-	-	-	210 - 300	-	-	-	-	Aquifer IB is brackish in nature
	Uluberia II	**IB** 20 -80,95 - 135	-	-	-	211 - 295	-	-	-	-	Aquifer IB is brackish in nature.
	Shyampur II	**IB** 30 -80, 90 - 130	**IB** 39.71 (DD 9.79m)	260.78	-	215 -275	39.96 (DD 5.61 m)	-	-	-	Aquifer IB is brackish in nature

6.0 GROUND WATER RESOURCES, DRAFT, SOD & CATEGORY

Dynamic Ground water resources of the area under study have been calculated on the basis of GEC (1997) methodology by CGWB and State Water Investigation Department (SWID) for the year as on 31.03. 2013.The block wise computed data of dynamic ground water resources, as on 31st March 2013 is given in Table 6.0.1. The Static Ground Water Resources (blockwise) have been presented in Table 6.0.1. 9 blocks have been categorized as safe blocks and one block is categorized as Semi-critical block.

Table-6.0.1: Block wise dynamic ground water resources as on 31st March'13

Sr. No.	District	Block	Net GW availability in ham	Gross GW draft in Ham	SOD in %	Long term Water Level trend in Cm/Yr (Rising - & Falling +)		Category	GW available for Future GW use in ham
						Pre monsoon	Post monsoon		
1	N 24 Parganas	Deganga	10330.71	7539.03	58.12	-6.34	7.58	Safe	2634.59
2	N 24 Parganas	Haora	6870.18	2767.50	40.28	8.86	7.90	Safe	3998.54
3	N 24 Parganas	Basirhat II	6240.37	3626.70	58.12	-6.34	3.05	Safe	2502.97
4	N 24 Parganas	Swarupnagar	11932.64	9068.13	75.99	7.59	8.54	Safe	2735.22
5	N 24 Parganas	Barasat II	6024.29	4113.88	68.29	12.86	19.87	Safe	1813.94
6	N 24 Parganas	Barasat I	6990.09	3100.19	44.35	5.08	10.75	Safe	3533.29
7	N 24 Parganas	Baduria	10879.60	8530.20	78.41	4.78	6.02	Safe	2181.07
8	N 24 Parganas	Basirhat I	6294.76	3334.39	52.97	9.37	7.11	Safe	2811.52
9	N 24 Parganas	Rajarhat	4433.07	1915.16	43.20	5.37	5.76	Safe	2186.20
10	N 24 Parganas	Barrackpur II	4773.23	4608.11	96.54	2.26	2.98	Semi Critical	-
North 24 Parganas Unconfined area Total			**169094 ha**						

11	N 24 Parganas	Hingalganj	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as**28ham**. GW flow through the block in a section of maximum length of **9.3 km** is **6125** m^3/day towards south*
12	N 24 Parganas	Sandeshkhali II	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 752.29ham. GW flow through the block in a section of maximum length of **20.4 km** is **17111.11** m^3/day towards east*
13	N 24 Parganas	Hasnabad	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as **15.23ham**. GW flow through the block is found to be in two prominent directions: in sections of maximum lengths of **17.2 km**and **7.9 km**are**7222.2**m^3/day **and 54000** m^3/day**towards south & west** respectively*
North 24 Parganas Confined area Total			**59187 ha**
1	Howrah	Shyampur II	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 17.784ham. GW flow through the block in a section of maximum length of 15.16 km is 3790 m^3/day northwesterly*
2	Howrah	Uluberia II	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as **12.438**ham. GW flow through the block in a section of maximum length of **11.43 km** is **5733** m^3/day towards northwest*
3	Howrah	Uluberia I	Fresh GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 23.09 ham. GW flow through the block in a section of maximum length of **10.62 km is 11977** m^3/day westerly*
Howrah confined area Total			**30033 ha**
1	S 24 Parganas	Baruipur	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 25.05ham. GW flow through the block is prominent in to two directions.Sections of maximum length of **15.96 km&13.3 km are 10400**m^3/day **& 10000** m^3/day towards NE & NW respectively*
2	S 24 Parganas	Sonarpur	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 27.93ham. GW flow through the block in a section of maximum length of 19.95km is 65000 m^3/day north - westerly*
3	S 24 Parganas	Budge Budge II	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 7.53ham. GW flow through the block in a section of maximum length of 13.15km is 22471 m^3/day towards south*
4	S 24 Pargana	Bhangar II	GW occurs under Confined Condition. Hence Change in storage of Ground water has been

	s		calculated as 21.17ham. GW flow through the block in a section of maximum length of 13.33 km is 2857 m^3/day north westerly*
5	S 24 Parganas	Bhangar I	GW occurs under Confined Condition. Hence, Change in storage of Ground water has been calculated as 28.54ham. GW flow through the block in a section of maximum length of 17.29 km is 4333 m^3/day towards southwest*
6	S 24 Parganas	Bishnupur II	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 9.98ham. GW flow through the block in a section of maximum length of 10.10 km is 9500 m^3/day towards south east*
7	S 24 Parganas	Bishnupur I	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 10.76ham. GW flow through the block is prominent in two directions: in sections of maximum length of 11.9 km& 3.9 km are 12000 m^3/day & 3000 m^3/day towards NE & West respectively*
8	S 24 Parganas	Magrahat II	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 8.49ham. GW flow through the block in a section of maximum length of 17.29 km is 19500 m^3/day westerly*
9	S 24 Parganas	Jaynagar II	GW occurs under Confined Condition. Hence Change in storage of Ground water has been calculated as 21.50ham. GW flow through the block in a section of maximum length of 15.96 km is 10400 m^3/day towards south east *
	South 24 Parganas Total		**125145 ha**
Total Study area			**383459 ha**

*Ground water flow for confined aquifer has been calculated considering post monsoon water level data from the water table map of confined aquifer (**Plate 6.0.1**)

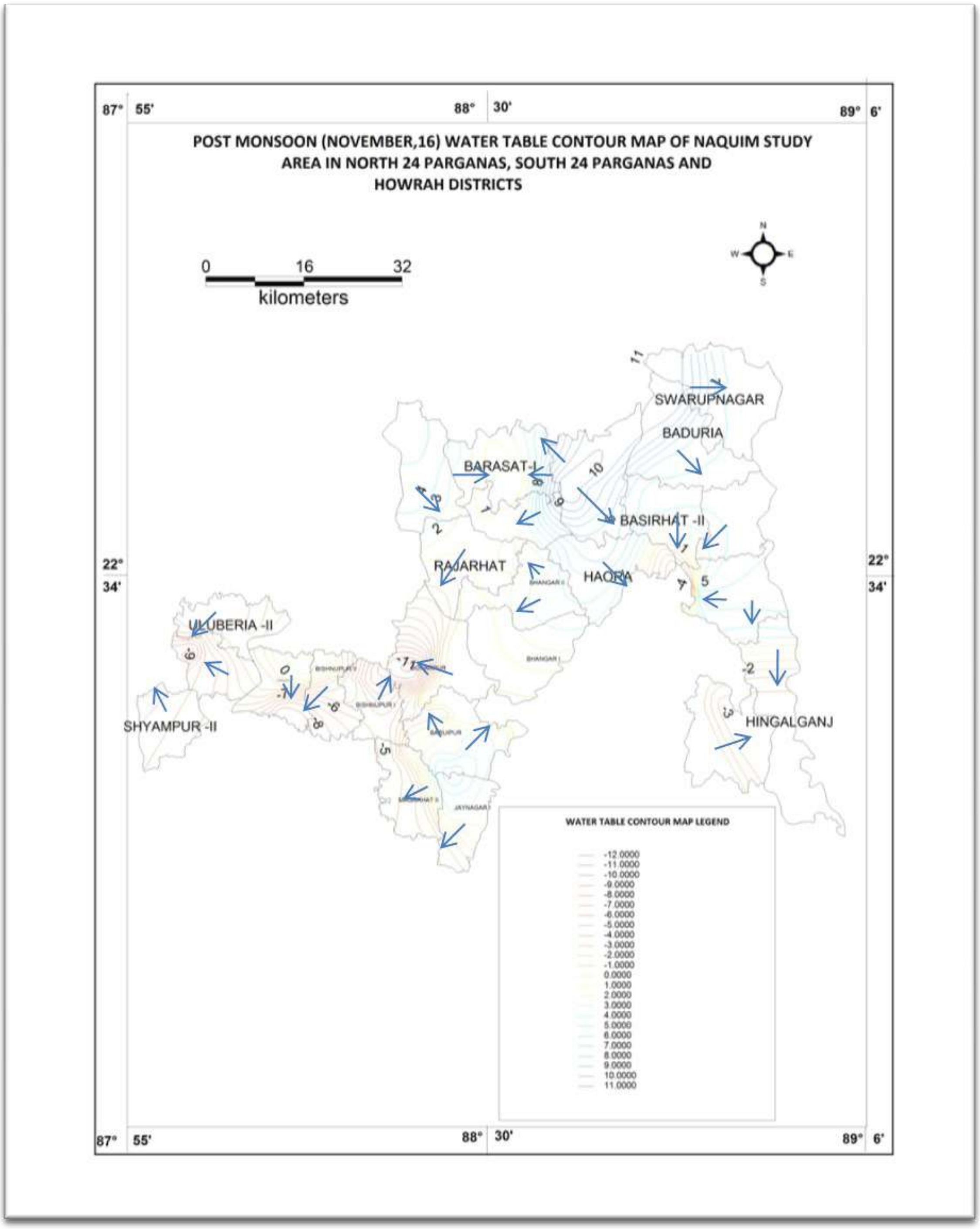


Fig. 6.0.1 Ground water flow of confined aquifer for study area

Table 6.0.2: In-Storage Ground Water Resources (ham) of unconfined in North 24 Parganasdistrict

Sr. No.	Block	Area in ha	Bottom of the unconfined aquifer (mbgl)	Average Pre-monsoon Water Level (mbgl)	Average specific yield of the area	Thickness of the Saturated Zone of the Un-Confined aquifer below WLF zone (m)	Volume of Saturated Zone of the Unconfined aquifer below WLF zone (ham)	Static / In-Storage Ground Water Resources (ham)
1	Barrackpore-II	16809	67	11.36	0.2	55.64	935252.76	187050.55
2	Barasat I	10636	93	7.2	0.2	85.8	912568.8	182513.8
3	Barasat II	17507	60	6.93	0.2	53.07	929096.5	185819.3
4	Rajarhat	16799	62	11.85	0.2	50.15	842469.85	168493.97
5	Haroa	16616	61	5.45	0.2	55.55	923018.80	184603.76
6	Basirhat II	13586	69	3.92	0.2	65.08	884176.88	176835.38
7	Basirhat I	12558	38	6	0.2	32.00	401856.00	80371.20
8	Deganga	21106	85	5.86	0.2	79.14	1670328.84	334065.77
9	Baduria	21060	105	4.49	0.2	100.51	2116740.60	423348.12
10	Swarupnagar	22417	113	4.15	0.2	108.85	2440090.45	488018.09
Total(ham)								2456097.46
in MCM								24560.97

On the basis of ground water resource calculation (2013) and long term water level trend, all 9 blocks of present area i.e. Barasat I,Barasat II, Rajarhat, Haroa, Basirhat II, Basirhat I,Deganga,Baduria and Swarupnagar have been categorized as Safe blocks except Barrackpore-II, which has been categorized as Semi-Critical block. Unconfined fresh water resource does not exist in 15 blocks: 3 blocks i.e. Hingalganj, SandeshkhaliII&Hasnabad in North 24 Parganas, 3 blocks i.e. ShyampurII, UluberiaII &Uluberia I in Howrah and 9 blocks i.e. Baruipur,Sonarpur,Budge Budge II,Bhangar II,Bhangar I, Bishnupur II,Bishnupur I, Magrahat II&Jaynagar I in South 24 Parganas. So, dynamic Ground Water Resource could not be estimated for these blocks.The Category of blocks with quality problems is shown in Plate **6.0.3**

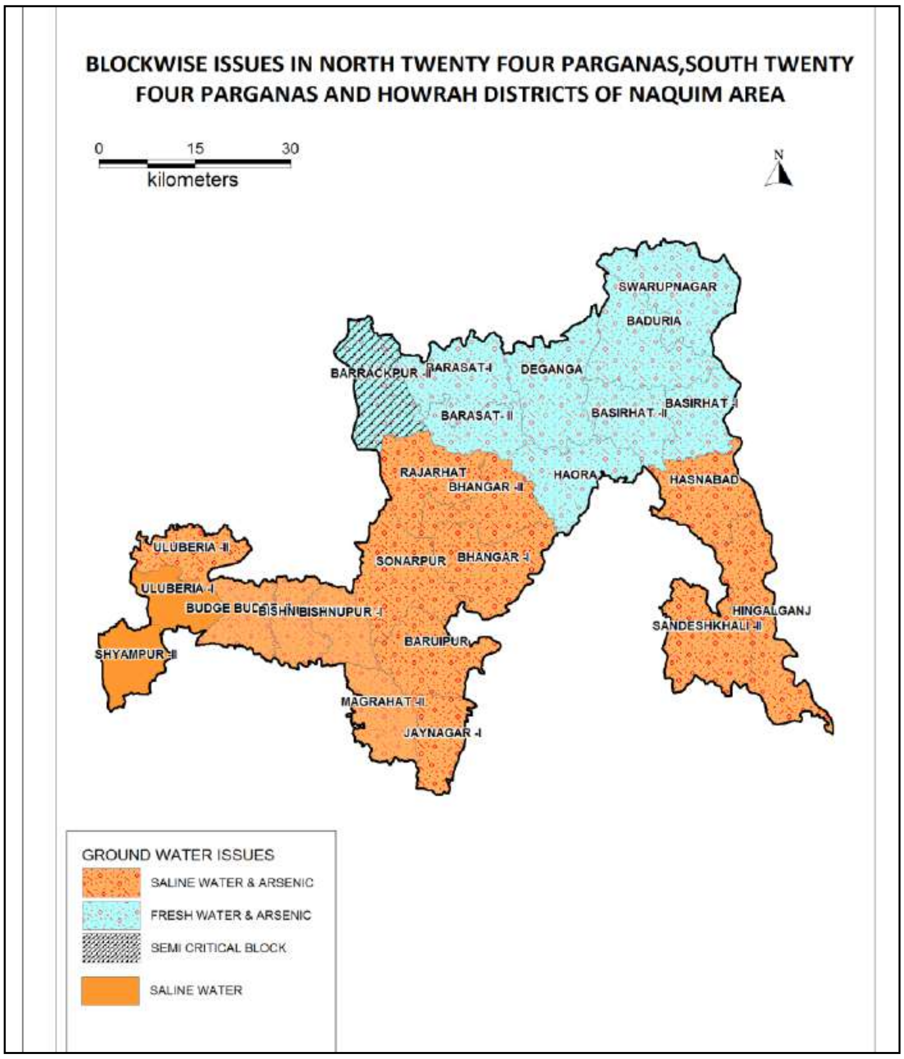


Plate 6.0.3: Categorization of blocks & quality problems in North 24 Parganas, South 24 Parganas and Howrah districts

Table 6.0.3: Calculation of Change in storage in confined aquifer in study area (Pre to Post monsoon 2016)

Sr no.	District	Block	Area in ha	Fluctuation of Water level (Pre to post) in metre	Average Storativity of confined aquifer	Change in Storage in ham
1	N 24 Parganas	Deganga	21106	2.5	0.0008	42.21
2	N 24 Parganas	Haora	16616	1.9	0.0008	25.26
3	N 24 Parganas	Basirhat II	13586	2	0.0008	21.74
4	N 24 Parganas	Swarupnagar	22417	2.1	0.0008	37.66
5	N 24 Parganas	Barasat II	10636	2.2	0.0008	18.72
6	N 24 Parganas	Barasat I	17507	2.1	0.0008	29.41
7	N 24 Parganas	Baduria	21060	2.4	0.0008	40.44

8	N 24 Parganas	Basirhat I	12558	1.9	0.0008	19.09
9	N 24 Parganas	Rajarhat	16799	2.2	0.0008	29.57
10	N 24 Parganas	Barrackpur II	16809	2.1	0.0008	28.24
11	N 24 Parganas	Hingalganj	23000	2	0.0008	36.8
12	N 24 Parganas	Sandeshkhali II	19191	49	0.0008	752.29
13	N 24 Parganas	Hasnabad	16996	1.12	0.0008	15.23
North 24 Parganas Confined area Total			228281			
1	Howrah	Shyampur II	11700	1.90	0.0008	17.78
2	Howrah	Uluberia II	8098	1.92	0.0008	12.44
3	Howrah	Uluberia I	10235	2.82	0.0008	23.09
Howrah Confined area Total			30033			
1	S 24 Parganas	Baruipur	17021	1.84	0.0008	25.054
2	S 24 Parganas	Sonarpur	20541	1.70	0.0008	27.94
3	S 24 Parganas	Budge Budge -ii	10819	0.87	0.0008	7.53
4	S 24 Parganas	Bhangar -ii	14307	1.85	0.0008	21.17
5	S 24 Parganas	Bhangar -i	19282	1.85	0.0008	28.54
6	S 24 Parganas	Bishnupur -ii	9310	1.34	0.0008	9.98
7	S 24 Parganas	Bishnupur -i	10041	1.34	0.0008	10.76
8	S 24 Parganas	Magrahat -ii	12714	0.835	0.0008	8.49
9	S 24 Parganas	Jaynagar -i	11110	2.42	0.0008	21.51
South 24 Parganas Confined area Total			125145			

7.0 HYDROCHEMISTRY

7.1 Quality of ground water in shallow and deeper aquifer:

Ground water samples were collected during pre-monsoon period from the National Hydrograph Stations falling in the study area and those have been analyzed in the departmental Chemical Laboratory and by outsourcing from important laboratory of Govt. of India. Chemical quality of ground water occurring in shallow and deeper aquifers does vary significantly. Ground water in Aquifer IA is generally $NaHCO_3$ type in North 24 Parganas excepting a few places, NaCl type in South 24 Parganas and Howrah districts. Ground water in 1Baquifer is, in general, NaCl, $NaHCO_3$, $CaHCO_3$,$MgHCO_3$type in different blocks of North 24 Pgs, NaCl type in South 24 Pgs. Generally, ground watering 2[nd]aquiferis $NaHCO_3$ type in North 24 Parganas, $NaHCO_3$and NaCl type in South 24 Parganas (vide Fig 7.1.1) and $NaHCO_3$ and NaCl types in Howrah (vide Fig-7.1.2).

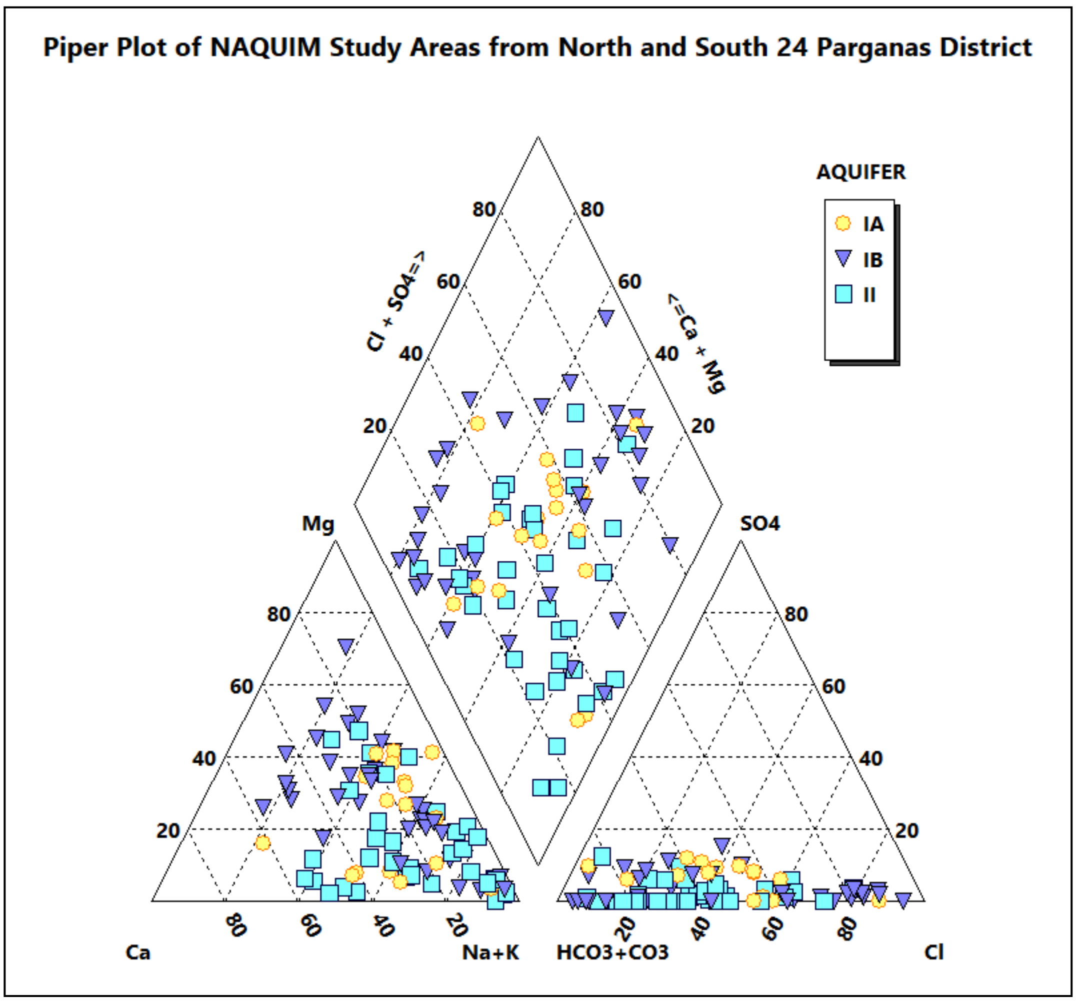


Fig-7.1.1: Ground water type(Piper plot) of Aquifer IA,Aquifer IB& Aquifer II in North & South 24 Parganas

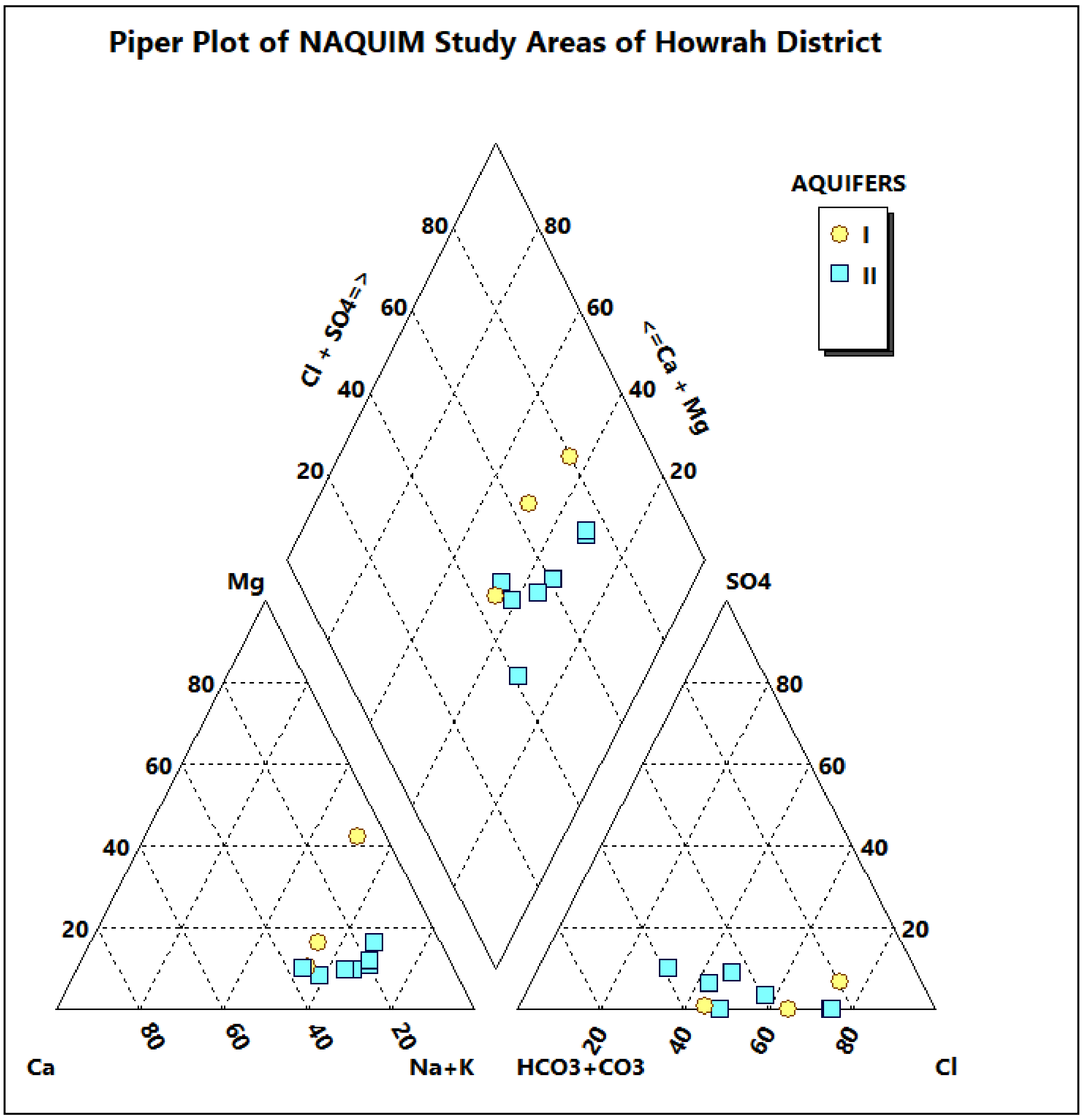


Fig-7.1.2: Ground water type (Piper plot) of Aquifer IB& Aquifer II in Howrah

7.2 Quality of Shallow and Deeper Aquifer Water for irrigation:

On the basis of Fig 7.2.1 it can be stated that in districts of North 24 Parganas & South 24 Parganas, Salinity Hazard in Aquifer I is medium to very high, whereas Sodium Hazard level is low to medium in maximum parts excepting in some cases where ground water in Aquifer IB show very high Sodium Hazard. Ground water samples collected from Aquifer II are, in general, show low to medium salinity hazard level and low to medium sodium hazard level, excepting a few cases. The samples of Aquifer IA is having medium to high salinity hazard level and low sodium hazard level in these blocks.

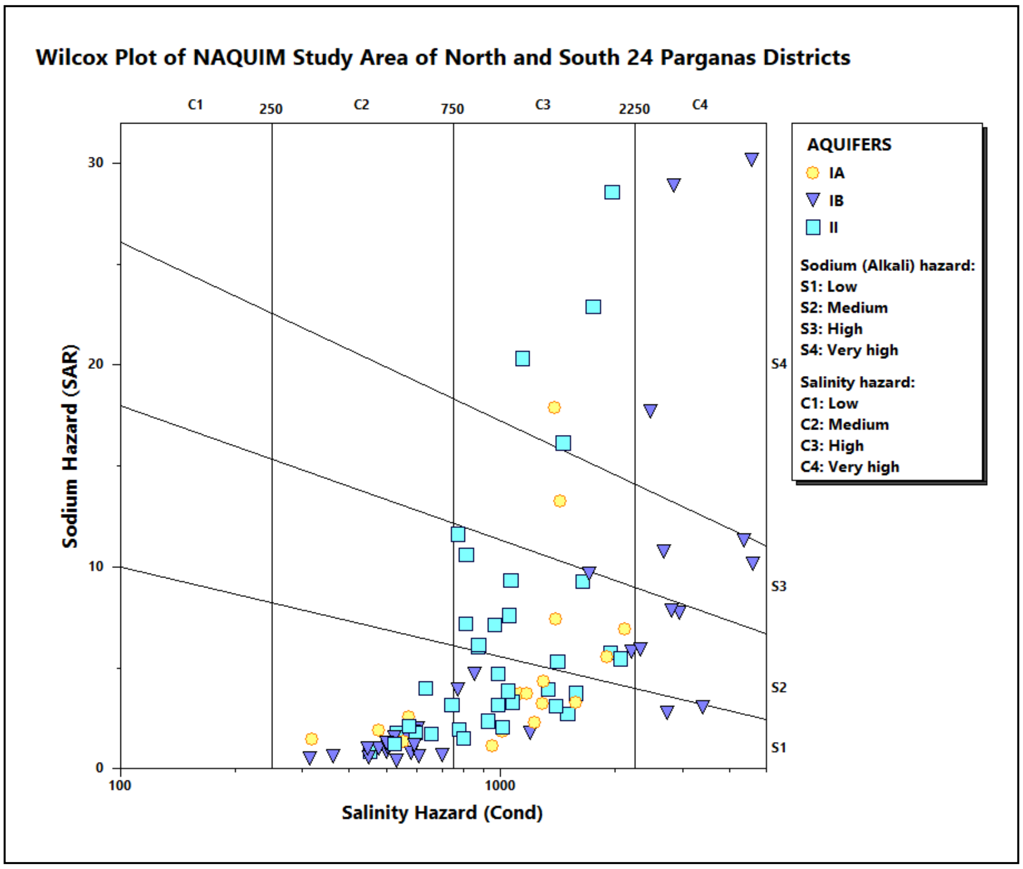


Fig-7.2.1: Ground water type (Wilcox plot) of Aquifer IA, Aquifer-IB & Aquifer II in North & South 24 Parganas

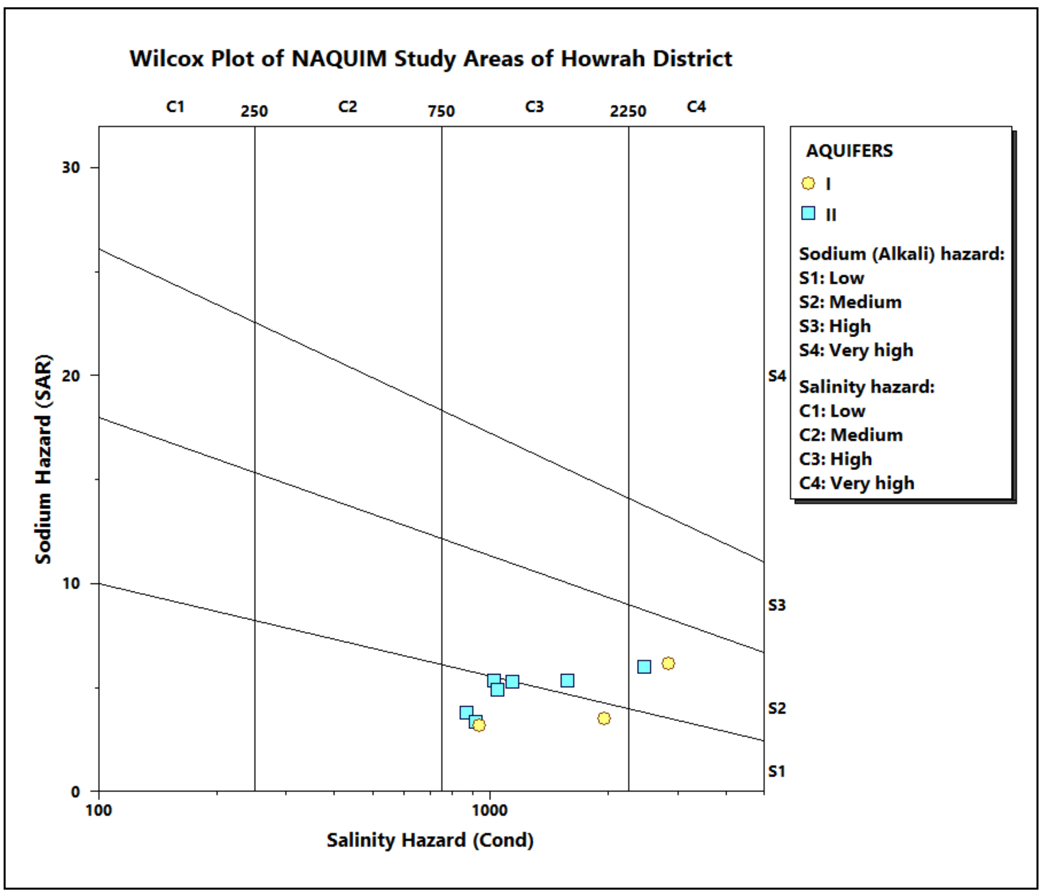


Fig-7.2.2: Ground water type (Wilcox plot) of Aquifer-I & Aquifer II in Howrah District

In Fig 7.2.2, graphical representation of sodium hazard and salinity hazard of limited number of samples collected from Uluberia I,Uluberia II and Shyampur II blocks have been shown. Samples collected from Aquifer I show high to very high salinity hazard level and low to medium sodium hazard level.Water samples from Aquifer II show high salinity hazard and low to medium sodium hazard levels.

7.3 General range of chemical parameter in the area:

From the analytical results as available so far from the laboratory on the basis of analysis of 89 nos. of samples aquifer wise range of parameters are given below:

7.3.1 Aquifer IA:

pH of ground water, in general, varies between 7.25 and8.43and, EC ranges between 14 and 7164 (μS/cm (Table 7.3.1.). TDS ranges from 357.62mg/1 to 1266.68mg/1. Concentrations of Na and K range from 29.7 to 131.8 mg/l and 0.56 to 77.98mg/1, respectively. Mg is encountered sporadically from less than12.15to 38.82mg/1. CO_3 varies between 7.25 and 8.43. $HCO_3$is encountered in the range of7.25 and 8.43 mg/1and Cl is mostly in the range of28.36 to 387.54mg/1.SO_4 concentrations vary from 4.95 to 79.95 mg/l.

7.3.2 Aquifer IB:

pH of ground water, in general, varies between 7.33 and8.83and, EC ranges between 315 and 5472 (μS/cm (Table 7.3.2.). TDS ranges from 201.3 mg/1 to 3079.3 mg/1. Concentrations of Na and K range from 13.5 to 968.6 mg/1 and from 0.891 to 115.6 mg/1, respectively. Mg is available sporadically from less than 8.5 to 150.6 mg/1. CO_3 is ranging from 5.99 to 83.9 mg/l. $HCO_3$is present in the range of 79.3 to 902.8 mg/1and Cl mostly varies within the range of 7.09 -1350.8 mg/1.F ranges from0.13-1.28 mg/1.SO_4 concentrations are varying from 5.35 to 119.9mg/l.

7.3.3 Aquifer II

pH of water, in general, varies between 7.26 and8.73and, EC ranges between 454 and 2072 (μS/cm (Table 7.3.3.). TDS ranges from 292 mg/1 to 1581 mg/1. Concentrations of Na and K range from 26.4 to 463.7 mg/1 and from 0.23 to 195.9 mg/1, respectively. Mg is encountered sporadically from less than 2.43 to 72.8 mg/1. CO_3 is ranging from 14.98 to 41.96 mg/l. $HCO_3$is present in the range of 164.7 to 677.1 mg/1and Cl is mostly found in the range of 14.18 to 482.6 mg/1.SO_4 concentrations are varying from 2.29 to 54.9 mg/l.

Table-7.3.1 Aquifer wise chemical parameters in parts of North24 Parganas, South 24 Parganas and Howrah(Aquifer-IA)

Location	District	Water Type	pH	EC	TDS	Ca	Mg	Na	K	Cl	HCO_3	CO_3	SO_4	F	NO_3	Hardness	SiO_2	Ca+Mg	Na+K	CO_3+HCO_3
Bhebia	N 24 Parg	Na-HCO3	9.03	1384	842.50	11.99	6.07	304.36	2.54	170.18	445.33	62.94	-	0.19	2.56	55	35	1.10	13.30	9.39
BishnupurGhoshpara	N 24 Parg	Na-HCO3	8.32	574	362.69	17.99	24.29	70.60	3.43	81.544	176.91	5.99	26.87	0.64	0.12	145	25.17	2.9	3.15	3.09
ChakJagatdal	S 24 Parg	Na-Cl	7.46	1907	1129.12	117.99	19.45	245.01	34.99	387.54	414.82	-	53.96	0.37	5.90	375	9.6	7.49	11.55	6.79
DaulatabadGhature More	S 24 Parg	Ca-HCO3	7.31	951	556.77	123.9	19.45	52.00	0.55	113.77	317.22	-	48.96	0.07	3.11	390	-	7.79	2.27	5.19
kharibariChowmaha	N 24 Parg	Na-HCO3	8.39	480	305.33	13.99	26.72	51.87	5.24	28.36	219.61	8.99	14.89	0.29	0.08	145	24	2.90	2.39	3.89
Kheyadaha	S 24 Parg	Na-Cl	8.12	1228	492.91	23.99	36.3955	75.50	13.35	174.96	213.51	-	0	0.28	17.80	210	19.67	4.19	3.62	3.49
Krishnarampur	S 24 Parg	Na-Cl	7.65	1289	587.45	29.99	38.82	112.60	16.73	187.46	250.11	-	4.94	0.66	15.90	235	26.97	4.69	5.32	4.09
Kultukari	S 24 Parg	Na-HCO3	7.25	1438	885.96	15.99	6.07	245.01	77.98	159.99	616.14	-	-	1.20	3.66	65	-	1.29	12.65	10.09
MallikpurHaldarpara	S 24 Parg	Na-Cl	7.88	7167	2203.13	79.99	100.69	480.52	109.57	1200.1	292.8	-	-	0.51	28.18	465	22.92	12.27	23.70	4.79
Natapukur	S 24 Parg	Na-HCO3	7.58	1129	728.02	101.99	12.15	150.01	0.79	117.32	530.7	-	-	0.62	0.36	305	20	6.09	6.54	8.69
Nityanandkathi	N 24 Parg	Mg-HCO3	8.3	554	357.62	27.99	24.29	40.16	24.383	7.09	268.42	5.99	24.54	-	8.22	170	33	3.39	2.37	4.59
Notagacchi	S 24 Parg	Na-Cl	7.65	1400	812.74	49.99	18.23	240.01	0.09	263.10	390.42	-	-	-	2.51	200	-	3.99	10.44	6.39
Rajarhat	N 24 Parg	Na-Cl	8.43	1293	794.98	7.99	70.45	175.31	8.49	219.81	298.92	41.96	65.65	0.64	-	310	38	6.19	7.84	6.29
Samalia	S 24 Parg	Na-Cl	7.48	2124	1266.68	121.99	13.37	300.01	12.99	373.32	549.03	-	79.94	0.82	8.10	360	20	7.19	13.38	8.99
SodpurPanihati	N 24 Parg	Na-HCO3	8.32	319	207.70	13.99	10.93	29.71	12.42	31.91	109.81	-	17.54	0.43	0.48	80	23	1.59	1.61	1.79
Tarulia	N 24 Parg	Mg-HCO3	8.06	1009	651.59	39.99	53.44	75.16	44.47	113.45	420.93	-	38.18	0.11	6.95	320	21.94	6.39	4.40	6.89
Thakdari	N 24 Parg	Na-HCO3	8.11	1170	639.53	37.99	35.22	131.87	11.57	138.27	347.72	-	40.18	0.87	1.300	240	29.3	4.79	6.032	5.69
Uttar Durgapur	S 24 Parg	Na-Cl	7.65	1572	887.88	117.99	12.15	140.01	42.98	270.21	396.52	-	59.96	0.34	1.17	345	-	6.88	7.18	6.49

Table-7.3.2. Aquifer wise chemical parameters in parts of North 24 Parganas, South 24 Parganas and Howrah (Aquifer-IB)

Location	District	Water Type	pH	EC	TDS	Ca	Mg	Na	K	Cl	HCO_3	CO_3	SO_4	F	NO_3	Hardness	SiO_2	Ca+Mg	Na+K	CO_3+HCO_3
Atbelia	N 24 Parg	Ca-HCO3	8.46	503	321.35	53.99	19.43	29.01	3.03	17.72	305.02	-	-	1.18	3.63	215	6.55	4.29	1.34	4.99
Bhasilia	N 24 Parg	Mg-HCO3	8.23	364	244.06	25.99	21.86	17.69	4.60	7.09	201.31	-	12.68	0.20	0.10	155	30.49	3.09	0.88	3.29
Bilkanda	N 24 Parg	Na-HCO3	8.17	604	367.98	15.99	30.36	59.95	3.71	46.09	298.92	-	0	0.46	0.51	165	28	3.29	2.70	4.89
Bodra	S 24 Parg	Ca-Cl	7.33	1195	592.95	85.99	20.66	72.00	19.99	245.32	231.85	-	2.29	-	-	300	4.27	5.99	3.64	3.79
Chakla	N 24 Parg	Mg-HCO3	8.44	450	270.67	23.99	30.36	18.21	5.24	7.09	237.91	11.99	-	0.31	0.50	185	32	3.69	0.92	4.29
Chandipur	N 24 Parg	Mg-HCO3	8.45	480	299.43	21.99	30.36	30.46	4.97	10.63	274.51	11.99	-	0.58	0	180	25.14	3.59	1.45	4.89
Chatra,dantarKhana More	N 24 Parg	Ca-HCO3	8.3	581	339.52	51.99	20.64	26.52	2.379	49.63	256.21	-	-	0.39	0.37	215	30.56	4.29	1.21	4.19
Dharmtala	N 24 Parg	Na-Cl	7.88	5472	3079.32	167.99	150.61	757.90	18.48	1350.80	902.86	-	32.57	0.24	2.60	1040	44	20.77	33.44	14.79
Dudgaya-Paltadana	N 24 Parg	Mg-HCO3	8.33	561	343.53	33.99	25.50	46.87	6.29	28.36	256.21	5.99	25.78	0.16	0	190	16	3.79	2.20	4.39
Duttapara	N 24 Parg	Na-Cl	7.98	2684	1467.36	65.99	36.44	438.78	7.19	684.26	286.72	-	10.85	0.63	5.33	315	42	6.29	19.27	4.69
Duttapukur	N 24 Parg	Mg-HCO3	8.35	447	253.99	15.99	27.93	28.70	3.37	14.18	231.81	11.98	0	0.24	0	155	14.43	3.09	1.33	4.19
Garanberia	S 24 Parg	Na-HCO3	7.52	1708	1127.73	49.9973	8.50	280.01	80.97	159.99	701.55	-	95.93	0.72	6.07	160	17	3.19	14.25	11.49
Gobberia	N 24 Parg	Na-Cl	8.33	4554	2633.33	15.99	37.65	968.65	7.29	1201.9	530.73	-	49.42	0.32	9.86	195	18	3.89	42.32	8.69
Ichapur	N 24 Parg	Ca-HCO3	8.43	315	201.39	31.99827	13.36	13.56	3.68	21.27	158.61	8.99	-	0.13	0.66	135	14.11	2.69	0.68	2.89
Jhurli	N 24 Parg	Na-HCO3	8.34	772	480.93	21.99	25.50	113.55	4.09	60.27	347.72	11.98	5.35	0.27	3.03	160	27	3.19	5.04	6.09
Jujhargachia	N 24	Na-	8.18	591	346.99	23.99	25.50	54.03	3.69	46.09	286.72	-	-	0.25	1.02	165	16.96	3.29	2.44	4.69

	Parg	HCO3																		
Kadampukur	N 24 Parg	Na-Cl	7.98	2943	1607.90	83.99	77.73	407.88	13.48	570.81	616.14	-	32.569	0.24	0.60	530	43	10.58	18.08	10.09
Kanchpukur	S 24 Parg	Na-Cl	8.32	1043		31.99	19.41	95.80	22.89	200.52	109.81	47.95	-	0.43	-	160	29.7	3.19	4.75	3.39
Karaidanga	S 24 Parg	Na-Cl	7.35	2817	1642.17	117.99	27.95	365.02	155.96	771.53	256.21	-	16.98	0.10	-	410	29	8.18	19.86	4.19
KhalisadiMore	N 24 Parg	Mg-HCO3	8.26	524	324.76	15.99	27.93	45.17	6.19	35.45	237.91	-	16.46	0.44	0.43	155	31	3.09	2.12	3.89
KhashBalanda	N 24 Parg	Na-Cl	7.89	4598	2537.04	135.99	110.52	659.23	7.49	1336.62	305.02	-	63.40	0.39	-	795	34.72	15.88	28.86	4.99
Mallikpur	N 24 Parg	Na-Cl	7.89	3401	1261.35	121.99	67.93	168.70	55.78	750.99	79.30	-	0.06	0.62	10.90	585	34.05	11.67	8.76	1.29
Mandalghanti	N 24 Parg	Na-HCO3	8.31	852	523.49	21.99	24.29	134.15	4.24	102.81	292.82	11.98	32.42	0	4.21	155	13	3.09	5.94	5.19
Mazimpur	N 24 Parg	Mg-HCO3	8.3	533	346.56	13.99	51.01	15.59	14.84	60.27	237.91	-	10.23	0.78	8.38	245	25.48	4.89	1.057	3.89
Naopara	N 24 Parg	Na-Cl	8.02	2203	1194.46	59.99	66.80	274.41	6.34	592.08	201.31	-	23.58	0.38	0.68	425	45.98	8.49	12.09	3.29
Natundiara	S 24 Parg	Na-Cl	7.41	2472	1509.13	43.99	9.72	498.02	0.91	394.65	664.94	-	119.92	1.28	4.50	150	30	2.99	21.68	10.89
Nutanpukur	N 24 Parg	Ca-HCO3	7.95	608	378.91	69.99	19.43	23.33	2.16	77.99	189.11	-	21.15	0.83	12.40	255	35.37	5.09	1.07	3.09
Purbakamarpukuria	S 24 Parg	Na-Cl	7.66	2326	1306.46	121.99	29.17	280.01	78.97	597.31	231.81	-	34.97	-	1.20	425	20	8.48	14.20	3.79
Raghabpur	S 24 Parg	Na-Cl	7.66	2745	949.77	79.99	72.79	142.00	37.99	422.42	237.91	-	-	0.740	15.70	500	31.33	9.98	7.14	3.89
Sadarpur	N 24 Parg	Mg-HCO3	8.38	594	349.64	37.99	27.93	38.98	1.57	77.99	158.61	5.99	43.25	0.48	1.35	210	18.98	4.19	1.73	2.79
Sanakdaha	N 24 Parg	Mg-HCO3	8.34	506	335.33	23.99	20.64	29.96	34.49	14.18	262.31	5.99	-	0.26	5.68	145	42	2.89	2.18	4.49
Sandal Bill	N 24 Parg	Na-HCO3	8.83	2849	1626.03	11.99	10.93	574.83	3.899	421.90	835.75	83.92	-	0.61	18.50	75	23	1.49	25.10	16.49
Setpur	N 24	Ca-	8.46	502	335.39	35.99	18.21	38.77	7.99	24.81	256.21	8.99	-	0.34	0	165	47	3.29	1.89	4.498

	Parg	HCO3																		
Swarupdah	N 24 Parg	Na-Cl	7.88	4364	2414.93	97.99	97.16	661.83	10.79	1286.99	292.82	-	41.17	0.30	0	645	38	12.88	29.06	4.79
Titagarh	N 24 Parg	Ca-HCO3	8.24	702	457.04	67.99	38.87	27.87	2.20	53.18	323.32	-	30.45	0.78	1.47	330	35.86	6.59	1.26	5.29

Table-7.3.3: Aquifer wise chemical parameters in parts of North24 Parganas.South 24 Parganas and Howrah Districts (Aquifer-II)

Location	District	Water Type	pH (lab)	EC.	TDS	Ca	Mg	Na	K	Cl	HCO_3	CO_3	SO_4	F	NO_3	Hardness	SiO_2	Ca+Mg	Na+K	CO_3+HCO_3
Amulia (Bargachia)	N 24 Parg	Mg-HCO3	8.36	454	291.71	27.99	26.72	26.40	6.34	14.18	244.01	17.98	2.29	0.50	-	180	27	3.59	1.31	4.59
Atakhali	N 24 Parg	Na-HCO3	8.3	874	585.67	13.99	21.86	154.55	6.94	92.18	341.62	-	41.83	0.07	6.84	125	38.56	2.49	6.90	5.59
Bankra	N 24 Parg	Na-HCO3	8.67	1144	751.19	7.99	2.42	255.36	3.19	74.45	567.34	41.96	-	0.64	0.78	30	35	0.59	11.18	10.69
Basirhat	N 24 Parg	Na-HCO3	8.34	1066	688.64	19.99	10.93	208.56	3.14	141.81	390.42	20.98	6.74	0.25	8.58	95	37.56	1.89	9.15	7.09
Bhaduria	N 24 Parg	Na-HCO3	8.71	775	515.27	5.99	6.07	168.35	2.99	35.45	427.03	17.98	-	0.20	7.31	40	17.48	0.79	7.39	7.59
Bisweshwarpur	S 24 Parg	Na-Cl	7.26	1953	1219.37	81.99	10.94	208.01	195.94	412.42	384.32	-	54.96	0.070	4.71	250	15	4.99	14.05	6.29
ChakBarali	S 24 Parg	Ca-Cl	7.56	1502	895.71	103.99	21.88	116.00	116.97	330.65	305.02	-	17.98	-	0.97	350	-	6.99	8.03	4.99
ChakJagatdal	S 24 Parg	Ca-HCO3	7.74	928	537.73	97.99	6.01	88.00	0.23	124.44	347.72	-	7.19	-	0.78	270	-	5.39	3.83	5.69
Chhayani	S 24 Parg	Na-HCO3	7.52	747	469.99	63.99	2.431	94.00	0.52	63.99	359.92	-	23.98	-	0.93	170	-	3.39	4.10	5.89
DakhinDurgamandap	N 24 Parg	Na-Cl	8.08	1650	987.28	27.99	29.15	292.51	7.69	319.08	414.82	-	24.83	0.15	4.20	190	28	3.79	12.92	6.79
DakshinGouripur	S 24	Na-Cl	7.59	207	1581.3	107.9	15.8	228.01	118.9	842.6	323.3	-	49.9	0.07	2.57	335	17	6.68	12.96	5.29

	Parg			2	3	9	0		6	3	2		6						
Daudpur	N 24 Parg	Na-HCO3	8.36	1756	1122.16	23.99	-	406.92	4.94	269.45	597.84	26.97	2.47	0.55	3.24	60	29.56	1.19	17.82	10.69
Dhamakhali	N 24 Parg	Na-HCO3	8.73	877	504.42	5.99	20.64	140.25	5.89	124.09	280.61	17.98	6.51	0.41	0.26	100	18.05	1.99	6.25	5.19
Hariharpur	N 24 Parg	Na-HCO3	8.51	969	659.38	25.99	18.21	193.21	4.048	81.54	475.83	11.98	8.63	0.08	8.74	140	21	2.79	8.50	8.19
Jafarpur	N 24 Parg	Na-HCO3	8.43	638	423.12	13.99	20.64	99.92	5.08	53.18	286.72	17.98	-	-	0.19	120	44	2.39	4.47	5.29
Jalassi	S 24 Parg	Na-Cl	7.35	1335	737.84	69.99	26.7	152.00	41.98	266.65	280.61	-	6.29	0.07	1.96	285	-	5.69	7.68	4.59
Kadamgachi	N 24 Parg	Na-HCO3	8.41	534	346.20	25.99	24.29	50.89	4.5	38.99	256.21	17.98	-	0.30	0.54	165	33	3.29	2.32	4.79
Korakati	N 24 Parg	Na-HCO3	8.5	1969	1244.97	9.99	6.072	463.72	4.79	326.17	591.74	32.97	12.59	0.50	4.25	50	36	0.99	20.29	10.79
Krishnarampur	S 24 Parg	Na-Cl	7.69	1414	820.05	69.99	15.80	188.01	39.98	273.76	378.22	-	-	0.04	0.96	240	-	4.79	9.20	6.19
Madhyaraipur	S 24 Parg	Na-HCO3	7.73	989	624.75	49.99	8.50	136.00	22.99	110.21	366.02	-	27.98	0.17	1.06	160	44	3.19	6.50	5.99
Mallikpur	N 24 Parg	Na-HCO3	8.39	600	386.10	39.99	24.29	56.63	2.199	95.72	219.61	-	6.13	0.36	0.70	200	25.42	3.99	2.51	3.59
Mangalgachi (DakhinRanigachi)	N 24 Parg	Na-HCO3	8.31	576	338.89	21.99	25.50	60.28	6.14	38.99	268.41	14.98	-	0.14	0.40	160	12.15	3.19	2.77	4.89
Manipur	N 24 Parg	Na-HCO3	8.25	1054	662.35	17.99	19.43	194.61	7.64	134.72	384.32	29.97	-	0.08	13.03	125	22	2.49	8.66	7.297
Moukhali	S 24 Parg	Ca-HCO3	7.85	778	443.52	77.99	10.94	68.00	0.60	106.66	274.51	-	9.99	0.05	1.01	240	-	4.79	2.97	4.49
NayeberMore,Palpara	S 24 Parg	Na-HCO3	7.69	1079	649.14	95.9	4.86	121.00	0.49	174.21	378.22	-	17.98	-	1.70	260	1.3	5.19	5.27	6.19
Nimpith	S 24 Parg	Na-HCO3	7.43	1403	1096.6	85.99	30.38	130.00	72.98	295.10	677.14	-	44.97	0.03	2.94	340	20	6.79	7.52	11.09
Padmapukur	S 24	Na-	7.66	104	635.60	57.99	13.3	124.00	26.99	174.2	384.3	-	-	-	3.93	200	-	3.99	6.08	6.29

	Parg	HCO3		8			7			1	2									
Panithar	N 24 Parg	Na-Cl	8.28	1583	875.05	29.99	72.87	165.20	12.29	244.63	420.92	23.97	-	0.25	43.66	375	33.72	7.49	7.50	7.69
PurbaJaynagar	N 24 Parg	Mg-HCO3	8.23	658	443.43	27.99	35.22	57.61	10.79	14.18	317.22	-	37.77	0.37	32.62	215	32.6	4.29	2.78	5.19
Rampur	N 24 Parg	Na-HCO3	8.42	1465	896.08	9.99	10.93	309.66	12.99	187.9	536.83	23.97	-	0.21	4.32	70	18	1.39	13.80	9.59
Sandeshkhali.f	N 24 Parg	Na-HCO3	8.66	813	517.08	3.99	18.21	152.00	5.79	95.73	335.52	17.98	-	0.55	0.05	85	25	1.69	6.76	6.09
SardarparaMetiari	S 24 Parg	Ca-HCO3	7.38	800	477.94	89.99	6.07	54.00	31.99	78.21	353.82	-	-	-	0.99	250	-	4.99	3.16	5.79
Swarupnagar	N 24 Parg	Na-HCO3	8.66	815	488.04	9.99	4.85	162.75	4.09	63.81	359.92	17.98	-	0.43	0.79	45	10.81615	0.89	7.18	6.49
Tentulia	N 24 Parg	Mg-HCO3	8.51	527	322.86	21.99	31.57	37.62	7.10	35.45	244.01	14.98	-	0.31	0.3	185	30	3.69	1.81	4.49
Tona	S 24 Parg	Ca-Cl	7.41	1015	588.10	97.99	2.43	74.00	54.98	255.99	164.71	-	-	-	1.38	255	-	5.09	4.62	2.69
Wari	S 24 Parg	Na-HCO3	7.58	987	588.93	51.99	25.52	111.00	0.79	99.55	433.13	-	29.98	-	5.07	235	-	4.69	4.84	7.09

Block wise Management Plan in parts of North 24 Parganas District

8.0 Block wise Management Plan in parts of North 24 Parganas District

8.1 BARRACKPORE-II BLOCK

8.1.1 Salient Information:

Block Name: BarrackporeII

Area (in Ha):**16809**

District: **N. 24 Parganas**

Population (as on 2011):

Table8.1.1.- Details of Population in Barrackpore-II block:

Rural	Urban	Total
51874	**2558120**	**2609994**

Rainfall:District Average annual rainfall (**North 24 Parganas** district)for the period 2012 -16 (in mm):1555.76

Table-8.1.2. Details of Annual Rainfall since last five year:

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Barrackpore-II	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

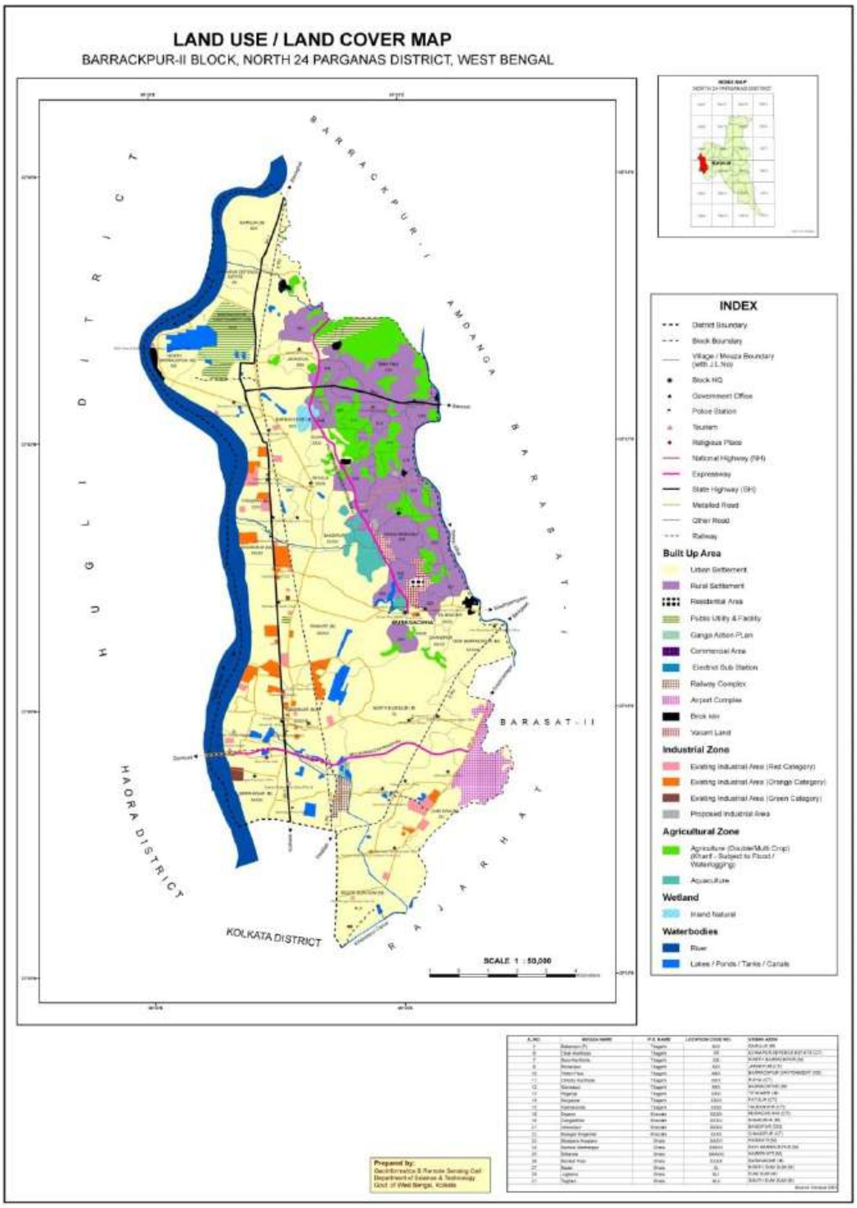
Table-8.1.3–Salient Landuse features of block:

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Barrackpore-II	**16809**	**2227**	**90**	**100**	**-**

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.1.4-Details of aquifer wise resource availability and draft (in MCM) in block:

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	**47.7323**	**0.28**	**-**	**46.0811**
Static Resource	**1870.50**	**-**	**-**	**-**



(Source: Land & Land Reforms Dept., Govt. of W. B.)

Fig-8.1.1: Land use Land cover map of the Barrackpore-II block

8.1.2 Disposition of Aquifers:

In BarrackporeII Block, there are fouraquifer systems or groups.

- **Zero aquifer** is encountered due to formation of sand dunes along the Ganga River. Generally, the range of Zero aquifer is **0m to 5m**.In this aquifer, sometimes, arsenic is available in ground water, so may not be suitable for drinking purpose. This aquifer has been named so, because it is not extended vertically & laterally throughout the block.
- Aquifer I has two parts: at the top,Aquifer IA ranges from **10m to 67m**and at bottom Aquifer IB ranges between **60m to 174m**and in both these parts arsenic contaminations of ground water has been encountered.

- Within Second Aquifer, Aquifer II, two parts have been encountered: 2A between **146m and 225m**and 2B between **237m and 254 m**; the second one i.e. bottom part or the 2B is fresh and Arsenic free.
- The deepest aquifer i.e. Aquifer III is encountered between **325 m and 360 m**, which is also fresh and Arsenic free.

Table-8.1.5- Details of aquifer disposition depth range in block

Block	Depth range of Aquifer in m bgl			
Barrackpore-II	0 Aquifer	Aquifer I	Aquifer II	Aquifer III
	0-5	1A 10-67 1B 60-174	2A 146-225 2B 237-254	325-360

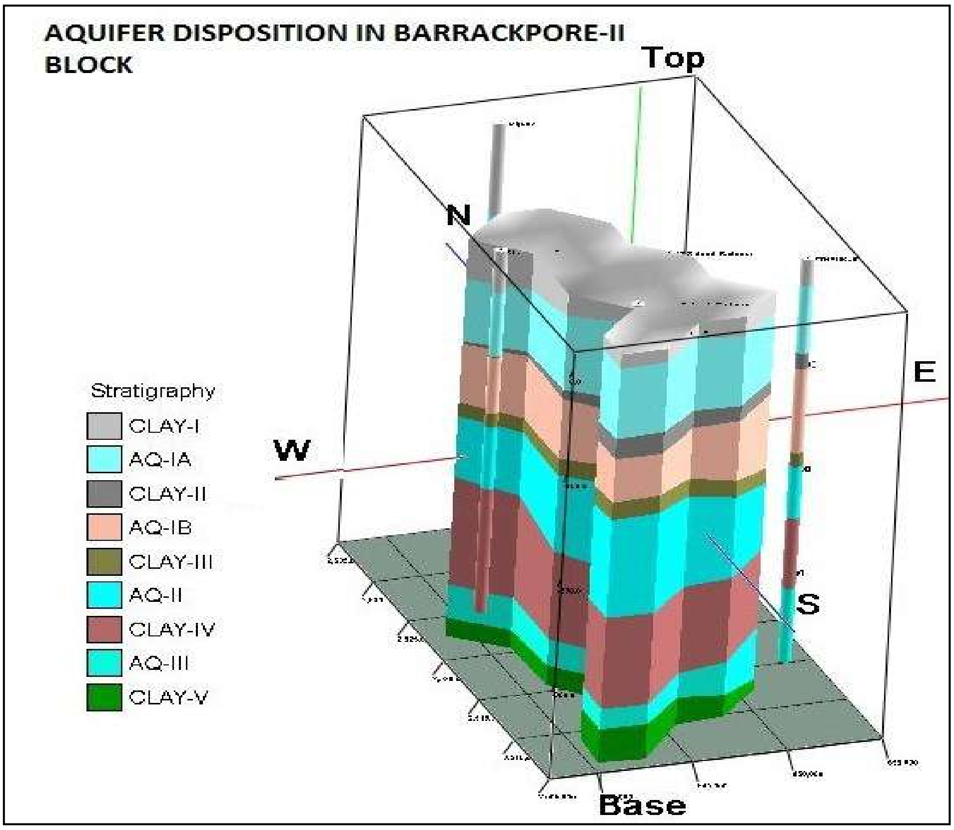


Fig-8.1.1: 3D aquifer disposition in BarrackporeII block

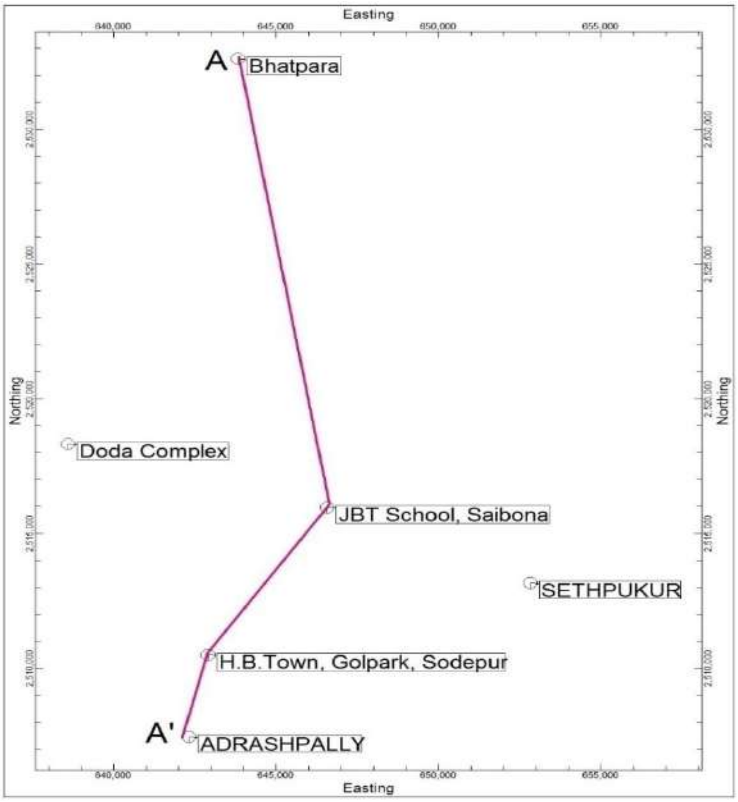


Fig.-8.1.2: N-S section index line in Barrackpore-II block

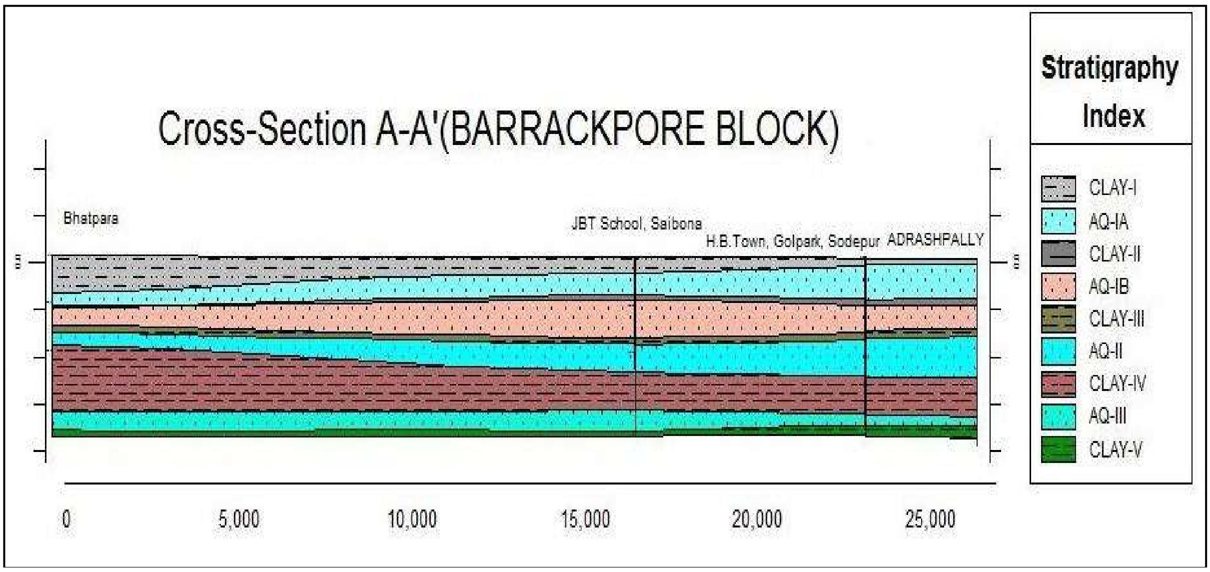


Fig.-8.1.3: N-S section in BarrackporeII block

Table- 8.1.6-Details of Aquifer Wise Water Level Ranges & seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (m/year)	Fall (m/year)	Water Level Range (m bgl)	Rise (m/year)	Fall (m/year)
Barrackpore-II	I	0.74 - 25.2	-	2.26	6.15 - 24.7	-	2.98
Barrackpore-II	II	13.11 - 22.65	-	-	6.1 – 15.2	-	-

Table-8.1.7-Aquifer wise (maximum) thickness

Block	Area (sq km)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)	Thickness of the Granular Zone in 3rd aquifer (m)
Barrackpore-II	16809	1A 57 1B 114	2A 79 2B 17	35

Table-8.1.8-Aquifer-wise depth range and parameters

Name of Block	Aquifer I				Aquifer II				Aquifer III		
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)
Barrackpore-II	**1A 10-67 1B 60-174**	**40.44**	**1628.6**	**0.029**	**2A 146-225 2B 237-254**	**41.22**	**1618**	**6.5 X 10^{-4}**	**325-360**	**-**	**-**

8.1.3 Ground Water Resource and Extraction:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'13

Table-8.1.9-Availability of Ground Water resource in block

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Barrackpore-II	47.7323	46.0811	96.54	Semi-critical	56.2894

Static (in-storage) Resources: 1870050.00 Ham.

8.1.4 Ground water contamination &other Issues:

Chemical Quality of Ground Water &contamination: Based onKey well data, block wise Average data of chemical parameter is given below. For Arsenic data,3 to 4 Ground Water monitoring station data of CGWB have been considered.

Table-8.1.10-Aquifer wise averageconcentration of chemical parameter of block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/cm)	Na(mg/l)	Cl(mg/l)	F(mg/l)	NO_3(mg/l)	Measured Hardness(mg/l)
Barrackpur II	**IA**	**0.001**	**8.32**	**309**	**29.71**	**31.90**	**0.43**	**0.48**	**80**

Barrackpore-II	**IB**	**0.017**	**8.43**	**2203**	**13.56**	**21.27**	**0.13**	**0.66**	**135**

Table-8.1.11- Data of arsenic affected tube wells

Sl. No.	Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (mg/l)						
			<& =0.01		>0.01 &<=0.05		>0.05		Max.Concentration (mg/l)
			%	Nos.	%	Nos.	%	Nos.	
9	Barrackpore II	951	33.86	322	65.51	623	0.42	4	0.13

(Source – PHED, Govt. of West Bengal)

8.1.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes:

- The block is under Semi Critical category and as per ground water policy priorityshould have to be given for drinking purpose.
- As per PHED, Govt. of West Bengal37234 population with 4 villages**(Talbandha** (CT)**,Muragachha** (CT)**,Bara Kanthalia,Jugberia)** is under risk zone and in these villages no water supply schemeexists.
- Based on CGWB data **9 tube wells** is required for water supply in all the four villages.
- Detailed recommendation is as follows.

Table-8.1.12 - Recommendation for water supply in Arsenic affectedpopulation

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Suggestions for providing water supply to the risk population
Barrackpore II	4	37234	Potential arsenic free aquifers encountered within depths of **146m – 225m & 237m - 254m**, separated from the upper aquifers system by thick clay layer of 10 to 30 m, third aquifer depth range of**325m to 360** m.

Table- 8.1.13 -Village wise cost estimate of Tube wells for water supply

Block	Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in m^3 @70lpcd	Projected Water Requirement for Human Population in m^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle m^3 @20lpcd	projected Water Requirement for cattle m^3 @20lpcd	Total Water Requirement/day as on 2011 in m^3	Total Water Requirement/day as on 2021 in m^3	Discharge	hours	Discharge of one TW in m^3/day after 8 hours of pumping	No of TW	Cost of the well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Barrackpur II	Talbandha (CT)	17802	19945	1246.14	1396.15	1780	1845	35.6	36.9	1281.74	1433.05	41.22	8	329.76	4	80
Barrackpur II	Muragachha (CT)	13249	14844	927.43	1039.08	1325	1373	26.5	27.47	953.93	1066.55	41.22	8	329.76	3	60
Barrackpur II	Bara Kanthalia	2782	3117	194.74	218.19	278	288	5.56	5.76	200.3	223.95	41.22	8	329.76	1	20
Barrackpur II	Jugberia	3401	3810	238.07	266.7	340	352	6.8	7.05	244.87	273.75	41.22	8	329.76	1	20
Barrackpur II		**37234**	**41716**	**2606.38**	**2920.12**	**3723**	**3859**	**74.46**	**77.18**	**2680.84**	**2997.3**	**164.88**	**32**	**1319.04**	**9**	**180**

- For monitoring ofchange in ground water regime in the area, cost of construction of Observation well should also be included.
- In the initial stageof development of drinking water management plan, 25 % wells could be constructed.Based on result, the whole plan may be implemented.
- Phase wise drilling could be started for accurate results.

Management Plan forirrigation:

Table: 8.1.14 - Water level scenario for irrigation

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Remarks for GW Management Plan
Barrackpore-II	16809	7570	713.66.	6856.34	96.54	F*- 2.26	F-2.98	12.265	8.63	Block is semi critical; so,regular monitoring of GW Regime should be done&Boro cultivation should be restricted

***F-Falling**

Management options for irrigation:

- Barrackpore II block is semi critical and stage of Ground Water development is 90%, so as such source from unconfined aquifer can not be recommended for Irrigation; other alternate surface water source of irrigation like river, canal and water bodies can be used. Additional water conserving structure may also be constructed.Sand duneareas are very productive so, in these areas artificial recharge is very useful for ground water recharge and this may also be useful for dilution of arsenic contamination.
- Modern technologies like Sprinkler, Drip irrigation and mixing of aquifers with fresh and arsenic infested ground water in appropriate ratios under direct supervision of a scientist might be beneficial for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic content should be preferred.
- Artificial recharge should be implemented in arsenic affected zone for dilution, in unconfined aquifer.
- As the shallow aquifer is arsenic affected, during summer due to base flow ground water flows into the river or other surface water bodies. Therefore, these surface water bodies should be tested before use.
- Regular monitoring of Arsenic concentration in ground water and produced crops is also necessary.
- R & D study is required in arsenic affected area, so we can get new solutions in future.

Table-8.1.15 -Management Plan for Irrigation in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Barrackpur II	-	As	Rice,mustard,cabbage, Jute, wheat, cauliflower,brinjal,okra, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio/drip for vegetable,flowers

Table-8.1.16 -Details of crops under practice in Barrackpore block

Name of Block		Barrackpur-II
Aman	Area*	122
	Prod.*	0.322
	Yield*	2640
Boro	Area	514
	Prod.	1.515
	Yield	2947
Jute	Area	30
	Prod.*	0.513
	Yield**	17.090
Mustard	Area	6
	Prod.	0.006
	Yield	1018
Potato	Area	15
	Prod.	0.287
	Yield	19114
Sugarcane	Area	1
	Prod.	0.081
	Yield	81190

***Area in ha, Production in 000' MT and Yield in kg./ha**

(Source: Department of Economics and Statistics, Govt. of west Bengal)

Management Plan for Industrial Purpose:

- The block is under semi critical condition and is situated on eastern side of the Ganga River; a large numbers of industries are there.All these industries, whether existing/ new/ under expansion and drawing/ proposing to withdraw ground water through energized means shall need to obtain NOC for ground water withdrawal from the State Ground water Authority.
- All industries abstracting ground water > 500 m^3/day should mandatorily implement artificial recharge measures as per norms and these units are requiredto make 90 % quantum of recharge to that of ground water withdrawal by them.
- The competent authority shouldissue NOC and monitor its compliance. Arsenic free water supply following technologies should be applied-
- Arsenic free aquifer should have to be tapped and proper cement sealing technique should be applied during construction of tube wells.
- Regular Field monitoring is necessary for Arsenic concentration in tube wells.

Proposed Artificial Recharge Structures in the Study area:

Table-8.1.17 -Area suitable for recharge in the study area

District	Block Name	Block Area (in ha)	Area(in ha) suitable for recharge (having DTW 3m& more in postmonsoon and showing 2m/yr or morelong term falling trend)
NORTH 24 PARGANAS	Barrackpore-II	**16809**	**9667**

Table-8.1.18 -Surface runoff component calculation bsed on methodology by Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc(sub-tracting amount of e-flow)= Vf
Barrackpur II	Sandy/Clay Loam	1.1728	1305.9128	979.43	489.7173	293.83038

A* – Area; C** - Run off coefficient of Normal Monsoon Rainfall depending on soil

Table-8.1.19 -Details of structures proposed & cost estimate involved

Block	Block Area	Area suitable for recharge (area showing water level of shallow more than 3m in post-monsoon and having 20 cm/yr falling trend)	Soil type	Amount of water for artificial recharge and conservation (Ham) (1)	Irrigation cum recharge Tank -35 % of Col. 1 (2)	Re-excavation of existing tanks with Recharge shaft -35 % of 1 for Aq-I (3)	Injection Well for recharging deeper aquifers - 20 % of 1 (4)	Farm Pond- 10 % of 1 (5)	Nos. of Irrigation cum recharge Tank @ 50 Ham per unit	Nos. of Re-excavation of existing tanks with Recharge shaft @ 10 Ham per unit	Nos. of injection well suggested @ 30 Ham per unit	Nos. of Farm Pond @ 10 Ham per unit (10)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of Irrigation cum recharge Tank @ Rs 8 lakh per unit	Cost of injection well @ Rs 15 lakh per unit	Cost of Farm Pond @ Rs 8 lakh per unit	Remarks
Barrackpur II	16809	9677	Sandy/Clay Loam	293.83	102.84	102.84	58.77	29.38	2	10	2	10	80	16	30	80	Total cost of structures proposed – Rs 206 lakh In levees deposit Tank is suitable structure;

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Irrigation cum recharge tank – size 100m*100m*5m, Filling -10 times, capacity – 50 Ham; for recharge and irrigation
- Farm pond- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

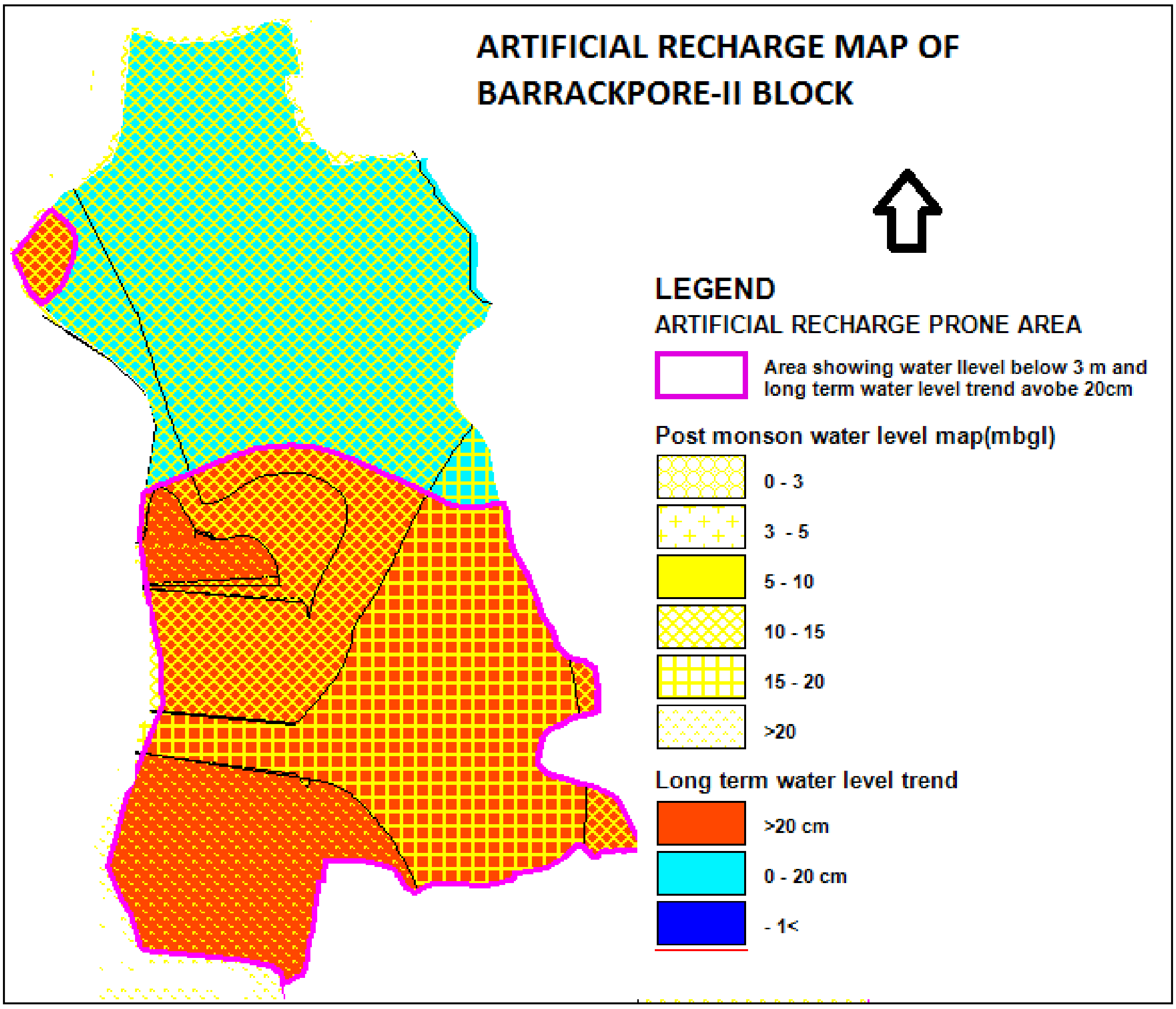


Fig-8.1.4: Area for artificial recharge in Barrackpore-II block

8.2 BADURIA BLOCK

8.2.1 Salient Information:

Block Name: Baduria

Area (in Ha):**21060**

Population (as on 2011):

District – N 24 Parganas

Table-8.2.1 - Details of Population in Baduria block

	Rural	Urban	Total
BADURIA	278044	7275	285319
BADURIA(M)	-	52493	52493

Rainfall: Average annual rainfall (**N 24 Parganas** district)for the period 2012 -16 (in mm):1555.76

Table-9.2.2 -Details of Annual Rainfall since last five year (mm)

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Baduria	**1623.6**	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

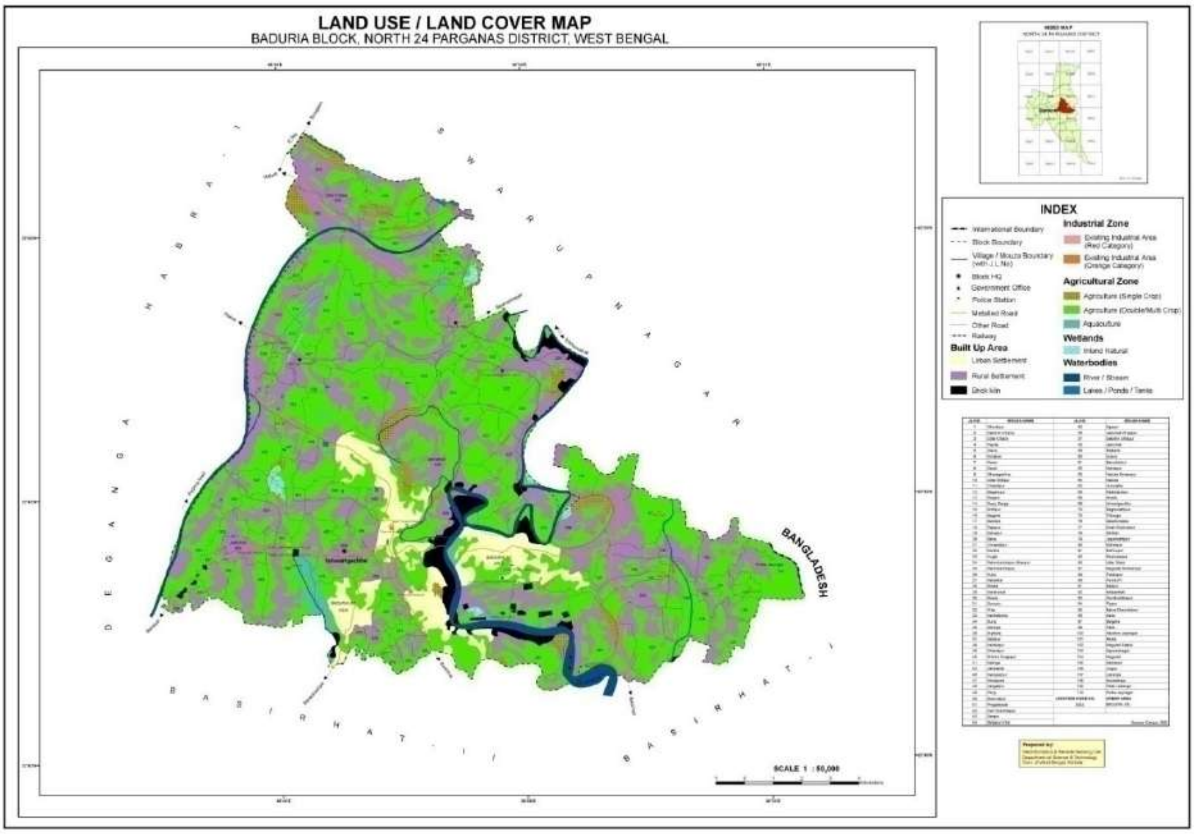
Table- 8.2.3–Salient Landuse features of block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Baduria	21060	12390	1255	213	-

Aquifer wise GroundWaterResourceavailability& extraction:

Table-8.2.4 -Details of aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	**108.7960**	**0.4043**	-	**85.3020**
Static Resource	4233.4812	-	-	-



(Source: Land & Land Reforms Dept., Govt. of W. B.)

Fig-8.2.1:Land use Land cover map of the Baduria block

8.2.2 Disposition of Aquifer:

In Baduria Block, there are two aquifer groups:

- WithinAquifer I Group, AquiferIA layer ranges between 10m and 105 m andAquiferIB layerranges between **85m and 185m**; both these aquifers are contaminated by arsenic.
- Aquifer II Group also has two aquifers: Aquifer IIA from depths **223&287 m** andAquifer IIB between **237m and 254m**, which is fresh and Arsenic free.

Table- 8.2.5 -Details of aquifer disposition depth range in block

Block	Depth range of Aquifers in mbgl		
	‘0’ Aquifer	Aquifer I	Aquifer II
BADURIA	-	1A 10 - 105 1B 85 - 185	223 - 287

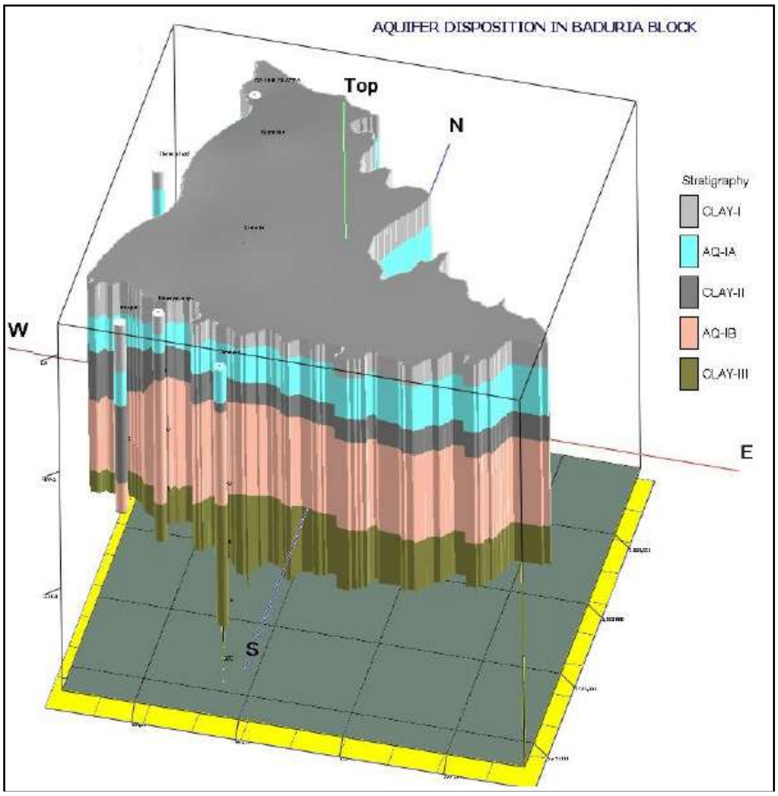


Fig-8.2.1: 3D aquifer disposition in Baduria block

Fig-8.2.2: N-S section index line in Baduria block

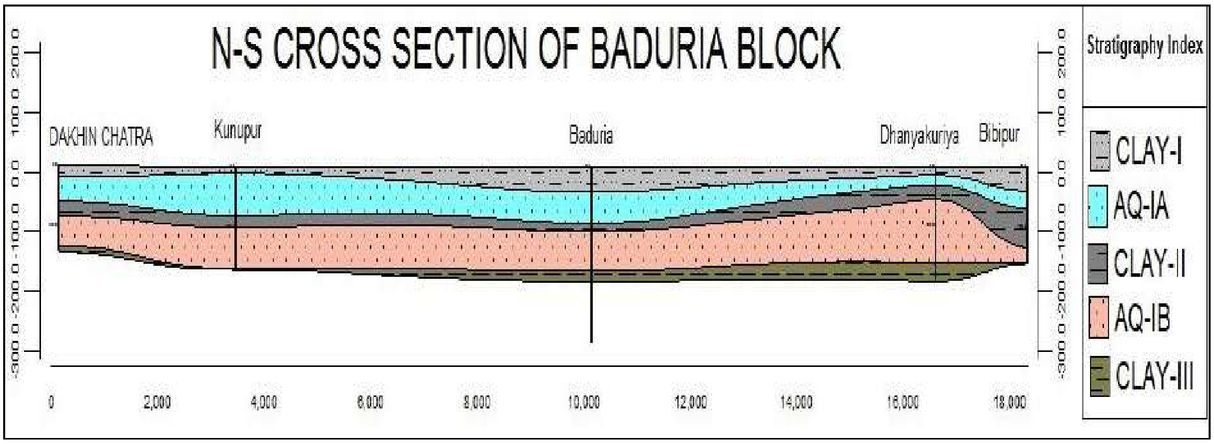


Fig-8.2.3: N-S Section in Baduriablock

Table-8.2.6 -Details of Aquifer Wise Water Level Ranges& seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m	Rise (cm/year)	Fall (cm/year)
Baduria	I	2.81-5.52	-	4.78	2.68-3.05	-	6.02
Baduria	II	4.2-5.35	-	-	3.6-6.1	-	-

Table-8.2.7 -Aquifer wise (maximum) thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Baduria	21060	1A 95 1B 105	64

Table- 8.2.8-Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Baduria	**1A 10 - 105** **1B 85 - 185**	**36**	**729.14**	**0.029**	**223 - 287**	**39.61**	**3962**	**4.86×10^{-6}**

8.2.3 Ground Water Resource, Extraction, Contamination &other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.2.9 -Availability of Ground Water resource in block

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development(%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Baduria	10879.60	8530.20	78.41	Safe	6.92

Static (in-storage) Resources: 423348.12 Ham.

8.2.4 Chemical Quality of Ground Water & Contamination

On the basis of Key well data blocks wise average data of chemical parameters is given below. For Arsenic data 3 to 4 Ground Water monitoring station data of CGWB has been considered.

Table-8.2.10 -Aquifer wise average chemical parameter of block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/cm)	Na(mg/l)	Cl(mg/l)	F(mg/l)	NO_3(mg/l)	Hardness(mg/l)
Baduria	I	0.00015	8.58	581	99.41	23.04	0.39003	3.65522	110
	II	0.0085	8.71	658	168.36	35.45	0.20001	7.31043	40

Table- 8.2.11 - Status of Arsenic affected tube wells

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max. Concentration (mg/l)
		%	No.	%	No.	%	No.	
Baduria	2461	26.62	655	34.17	841	39.21	965	1.33

(Source - PHED, Govt. of West Bengal)

8.2.5 Ground Water Resource Enhancement& Management Plan

Ground Water Management Plan for drinking purposes:

- To get rid of top arsenic contaminated ground water of Aquifer I, deeper arsenic free aquifer has to be tapped with proper cement sealing in clay between the above two layers; also arsenic removal plant might be installed for supply of water.
- Regular field monitoring is necessary to moinitor arsenic concentration in ground water in tube wells.
- As per WBPHED Data, 6883 population in 2 villages (**Salua, Rasui**) is under risk zone where no water supply scheme exists.
- Estimate cost for construction of tube wells based on CGWB data and using cement sealing technique for projected population in 2021 is given in Table 9.2.13 below. In this block for supply of arsenic free water, 2 wells are needed.

Table-8.2.12 -Details of Arsenic infested population in Block

Sl. No.	Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Suggestions for providing water supply to the risk population
1	Baduria	2	6883	Potential arsenic free aquifers in the depth rangeof 223-287mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m.

Table-8.2.13 - Village wise estimated cost of construction of Tube wells for Human and Cattle population

Block	Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of the Observation well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh) as per EFC
Baduria	Salua	4237	4747	296.59	332.29	424	440	8.48	8.79	305.07	341.08	**45**	**8**	360	1	20
Baduria	Rasui	2646	2965	185.22	207.55	265	275	5.3	5.49	190.52	213.04	**45**	**8**	360	1	20
Baduria		**6883**	**7712**	**481.81**	**539.84**	**689**	**714**	**13.78**	**14.28**	**495.59**	**554.12**	45	8	360	**2**	**40***

*For monitoring ofground water, cost of construction of observation well, if needed, should be included in the expenditure.

Management Plan for irrigation:

- To improve irrigation efficiency modern technologies like Sprinkler, Drip irrigation should be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be helpful in saving ground water resource.
- Preference should be adopted for cultivation crops with low water requirment.
- Crops consuming low arsenic should be cultivated.
- Artificial recharge is must in arsenic affected zone for dilution of Arsenic concentration in unconfined aquifer.
- As the shallow aquifer is contaminated, during summer ground water flows into the river or other surface water bodies by base flow. Therefore, water of these surface water bodies should be analysed before use.
- Regular monitoring of arsenic concentration in crop is necessary.
- R & D study is necessary in arsenic infested area for geting better solutions.
- Ground water management plan (vide Table 8.2.15) has been prepared in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV).

Table-8.2.14 - Irrigation scenario in Baduria block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Remarks for GW Management Plan
Baduria	21060	12390	7148.83	5241.17	78.41	F- 4.78	F - 6.02	4.49	3.42	-

Table-8.2.15 -Ground Water Management Plan for Irrigation

Block	Ground water availability (Ham)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m) used	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Baduria	2181.07	As	Wheat,rice,mustard,cabbage, cauliflower,brinjal, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil, flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio/drip for vegetable,flowers

Table-8.2.16 -Details ofcrops in regular practice

Name of Block		Baduria
Aus	Area	927
	Prod.	2.459
	Yield	2652
Aman	Area	7011
	Prod.	18.912
	Yield	2697
Boro	Area	4461
	Prod.	14.664
	Yield	3287
Wheat	Area	331
	Prod.	0.950
	Yield	2871
Maskalai	Area	58
	Prod.	0.040
	Yield	696
Khesari	Area	50
	Prod.	0.035
	Yield	709
Mustard	Area	2495
	Prod.	3.340
	Yield	1339
Til	Area	803
	Prod.	0.709
	Yield	882
Potato	Area	2062
	Prod.	76.770
	Yield	37231

***Area in ha, Production in 000' MT and Yield in kg./ha**

(Source: Department of Economics and Statistics, Govt. of West Bengal)

Table-8.2.17 -Area wise current practice of crops in Baduria Block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		**Boro Cultivation(Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**Sugarcane(water column requirement =0.5 m)**		**Total Area covered(A)**
%	Area	%	Area	%	Area	**%**	**Area(ha)**	
35.4	3629	43.5	4461	21.2	2170	0	0	10260

(Source: Department of Economics and Statistics, Govt. of West Bengal)

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of water required by major crops in current practice, divided by area of cultivation has been consideredto get the required factor (0.7) for determination of **water requirement**by just multiplying this factor with the remaining cultivable area in the block. Using 60 % of this **water requirement,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.2.18) so that the maximum area of the remaining cultivable area could be covered& with an intention to save 40 % of ground water available.

Table-8.2.18 -Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block:

Water requirement in ham based on weighted average of water required by all crops divided by total area of cultivation (1)	Considering 60% water in ham (60% of Col 1) or the actual ground water available for cultivation, whichever is less (2)	Rabi Crops Cultivation (Wheat, Mustard and oil seeds water column requirement=0.21 m)		Boro Cultivation (Water column requirement- 1.2 m)		Vegetable (water column requirement Potato=0.6m)		Sugarcane (water column requirement =0.5 m)		Total Area covered (A)	Remaining Cultivable area (5241.17-A)
		% of water	Area(ha)	% of water	Area(ha)	% of water	Area(ha)	% of water	Area(ha)		
3668.819	2181.07	35	3635	35	636	30	1091	0	0	5362	-120.83
3668.819	2181.07	30	3116	40	727	30	1091	0	0	4934	207.17
3668.819	2181.07	15	1558	70	1272	15	545	0	0	3375	1866.17

In this case, actually ground water available for future irrigation is 2181.07 ham**; e**fforts have been made to encourage farmers to cultivate wheat and other Rabi crops and reduce boro cultivation. Therefore, in this block, more or less boro in 35%, Rabi crops in 35% and vegetables in 30% of the remaining cultivable area i.e. 5241.17 hacould be irrigated.

And, in this block, for boro Rice, rabi and vegetables almost 35%, 35 % and 30 % of 2181.07 ham water respectively may be used to irrigate remaining cultivable area of 5241.17 ha in a better way.

Proposed Artificial Recharge Structures in the Study area

Table-8.2.19 -Area suitable For Artificial Recharge and Proposed Interventions

District	Block Name	Area (in ha)	Total Area suitable for recharge (Considering area having DTW 3m and more in postmonsoon and showing 2m/yr or more long term water level falling trend) (in ha)
NORTH 24 PARGANAS	Baduria	21060	4421

Table-8.2.20 - Surface runoff component based on method of Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc(sub-tracting amount of e-flow)= Vf
Baduria	Sandy/Clay Loam	1.17	5812.40	4359.30	2179.65	1307.79

A* – Area; C** - Run off coefficient of Normal Monsoon Rainfall depending on soil

Based onsoil characteristic, slope, rainfall data and long term trendof ground water, surface run off component has been calculated and then, nos. of structures are proposed. Top part of Baduria Block is sandy in nature, so irrigation cum recharge tank is a suitable structure.

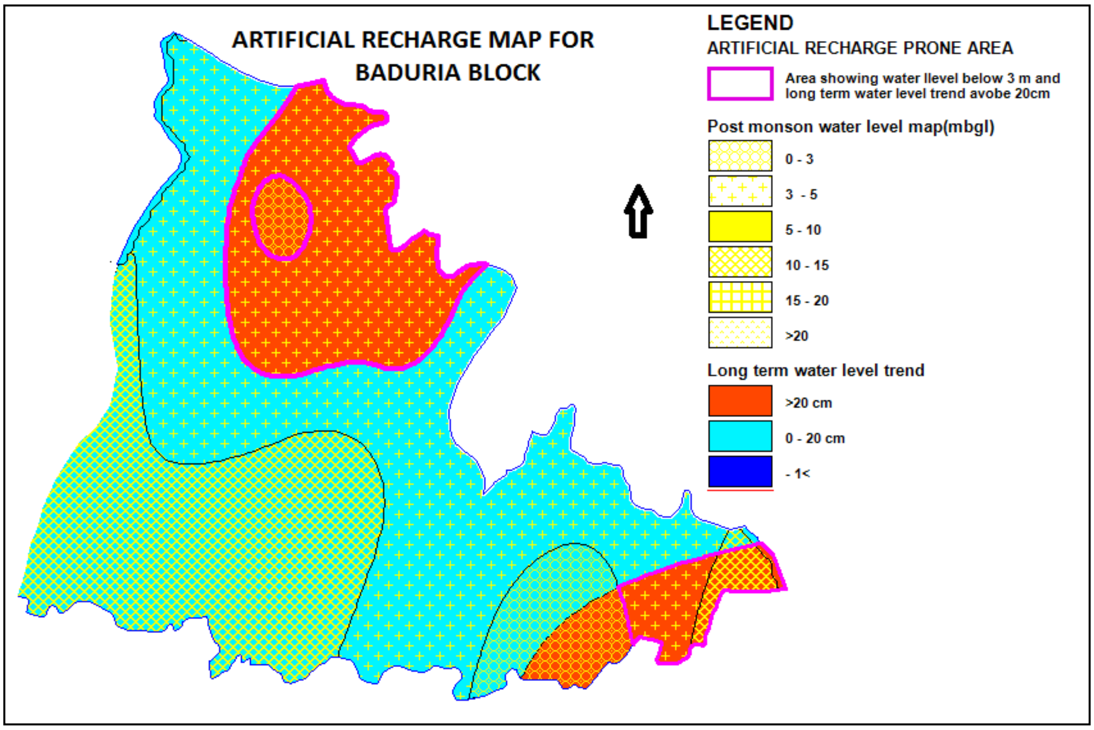


Fig-8.2.5: Area suitable for Artificial Recharge in Baduria block

Table-8.2.21 - Proposed artificial recharge & conservation structures

Block (1)	Block Area (2)	Area suitable for recharge (Considering area having DTW above 3m in post monsoon and showing 2m/y falling trend) (3)	Soil type (4)	Amount of water for artificial recharge and conservation (Ham) (5)	Source water allocation for with Artificial recharge in Ham - 70 % of Col. 5 (6)	Irrigation cum recharge Tank -35 % of Col. 5 (7)	Re-excavation of existing tanks with Recharge shaft - 35 % of Col. 5 (8)	Injection Well for recharging deeper aquifers - 20 % of Col. 5	Farm Pond- 10 % of Col. 5	Nos. of Irrigation cum recharge Tank -@ 50 Ham per unit	Nos. of Re-excavation of existing tanks with Recharge @ 10 Ham per unit	Nos. of Injection Well @ 30 Ham per unit	Nos. of Farm Pond @ 10 Ham per unit	Cost of Irrigation cum recharge Tank @ Rs 8 lakh per unit	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of Injection Well @ Rs 15 lakh per unit	Cost of Farm Pond @ Rs 8 lakh per unit	Remarks
Baduria	21060	4421	Sandy/Clay Loam	1307.79	915.45	457.73	457.73	392.34	46	9	46	13	5	72	368	195	40	Total cost of proposed structures – Rs 675 lakh

8.3 BARASAT-I BLOCK

8.3.1 Salient Information:

Block Name: Barasat-I

Area (in Ha):17507

District: North Twenty Four Parganas

State: West Bengal

Population (as on 2011):

Table- 8.3.1 -Details of Population in Barasat-I block

Rural	Urban	Total
175226	119402	294628

Rainfall: Average annual rainfall (**North Twenty Four Parganas** district)for the period 2012 -16 (in mm):1555.76

Table-9.3.2: Details of District annual Rainfall for last five years

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Barasat-I	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

Table-8.3.3 –Salient Landuse features of block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Barasat-I	17507	6320	306	160	-

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.3.4: Details of aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	69.9009	0.294	-	31.0019
Static Resource	1825.138	-	-	-

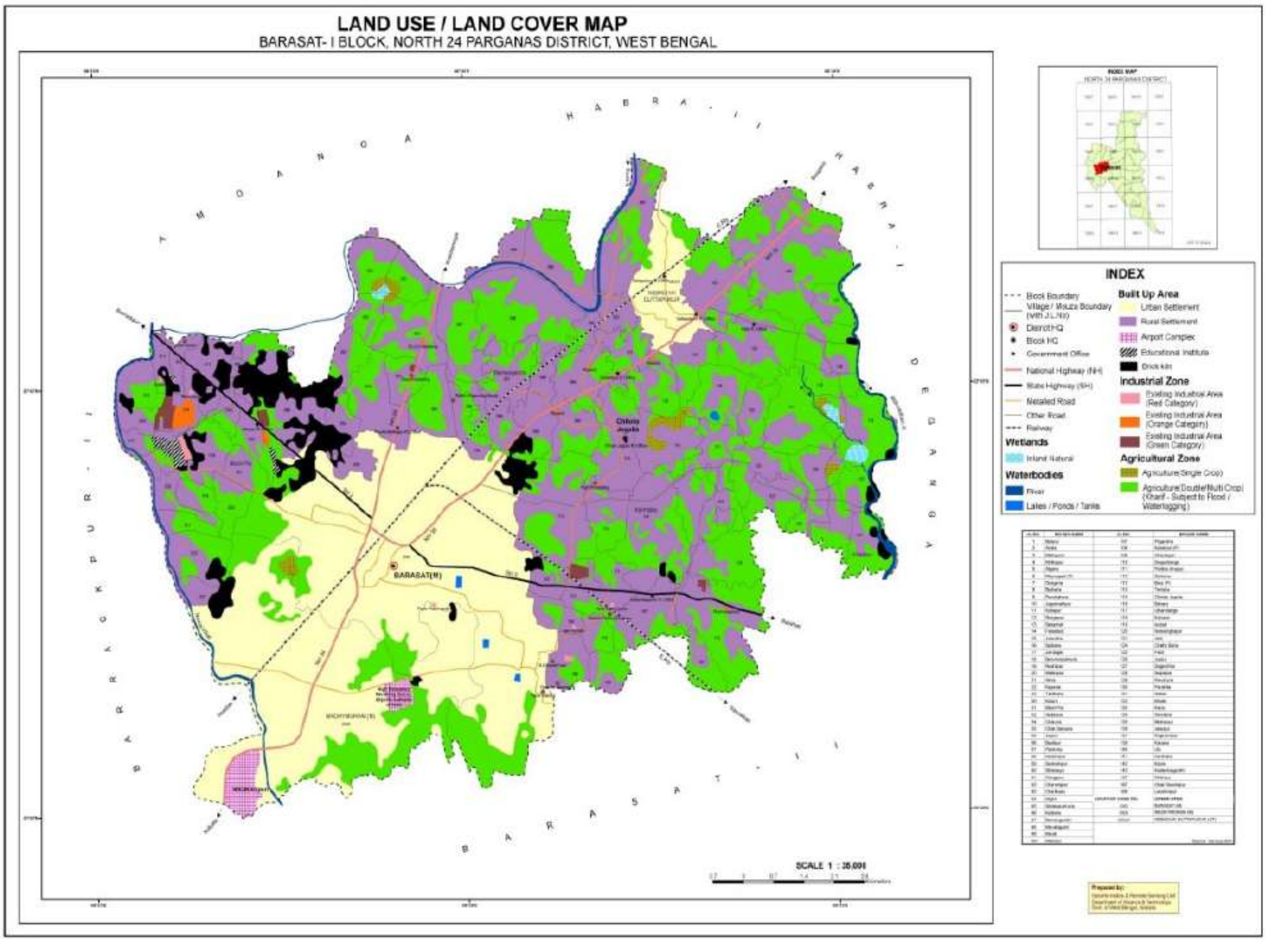
8.3.2 Disposition of Aquifers:

In Barasat-Iblock, three aquifer systems exist:

- Aquifer I Group has 2 aquifers: Aquifer IA ranges between **0m and 93 m**, and Aquifer IB ranges from **76m to 193m;** ground water inboth these aquifers arecontaminated by arsenic.
- The range of Aquifer II is from **186m to 255m**, ground water of this aquifer is fresh.
- Aquifer III ranges from **264 m to 371 m,** which is also fresh and arsenic free.

Table- 8.3.5 -Details of aquifer disposition depth range in block

Block	Depth range of Aquifer in m bgl		
BARASAT-I	Aquifer I	Aquifer II	Aquifer III
	1A 0-93 1B 76-193	186 - 245	264 -371



Source: Land & Land Reforms Dept., Govt. of W.B.)

Fig.8.3.1 Land use Land cover map of Barasat-I block

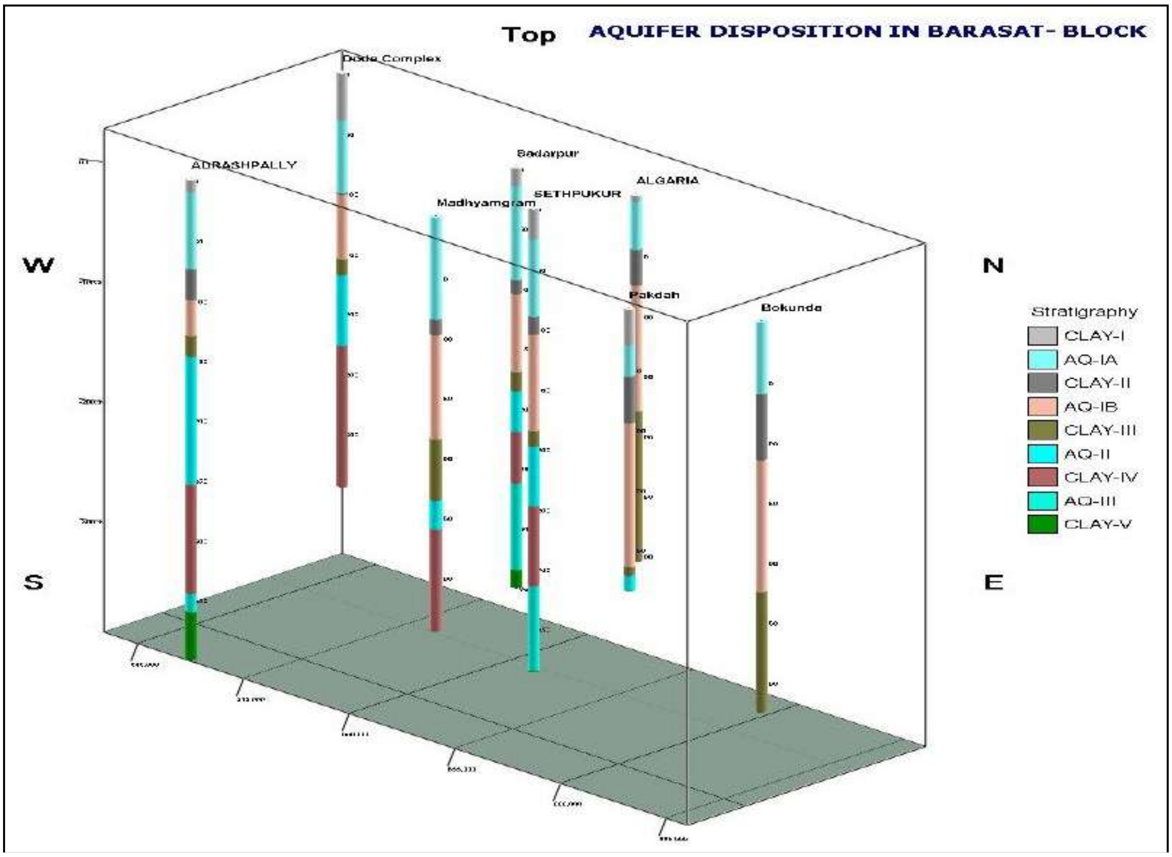


Fig-8.3.2: Stratigraphic logs of Barasat-I block

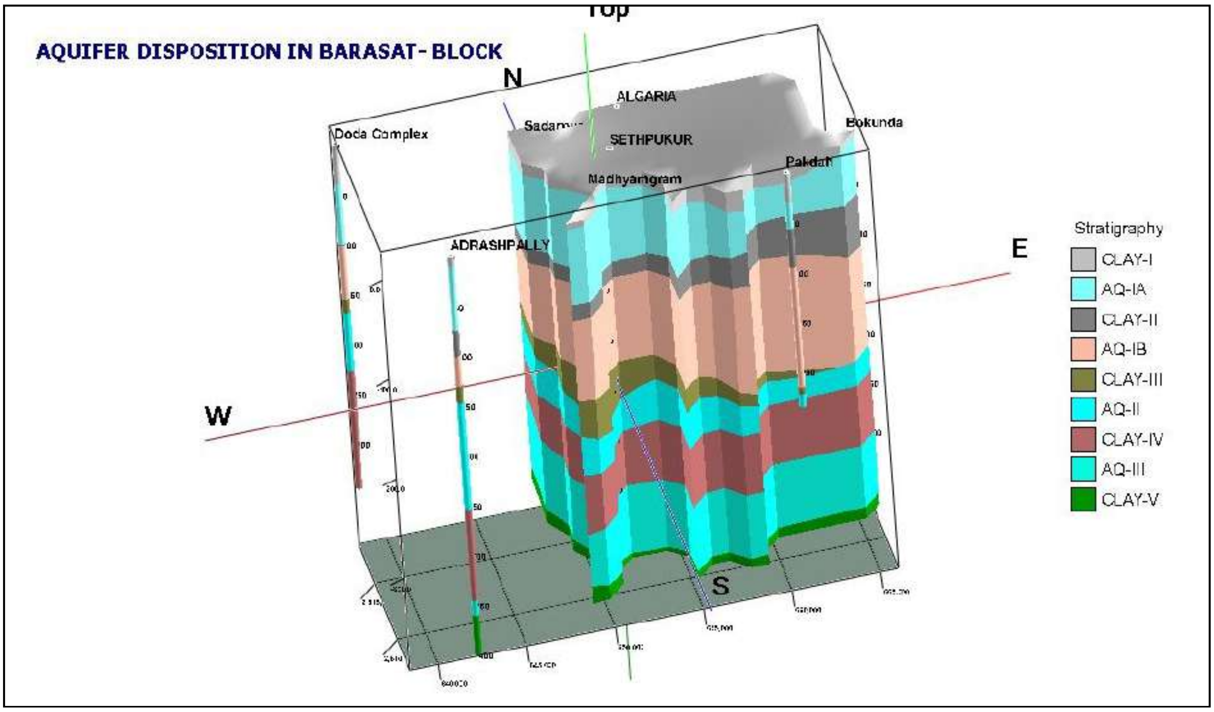


Fig- 8.3.3: Aquifer disposition in Barasat-I block

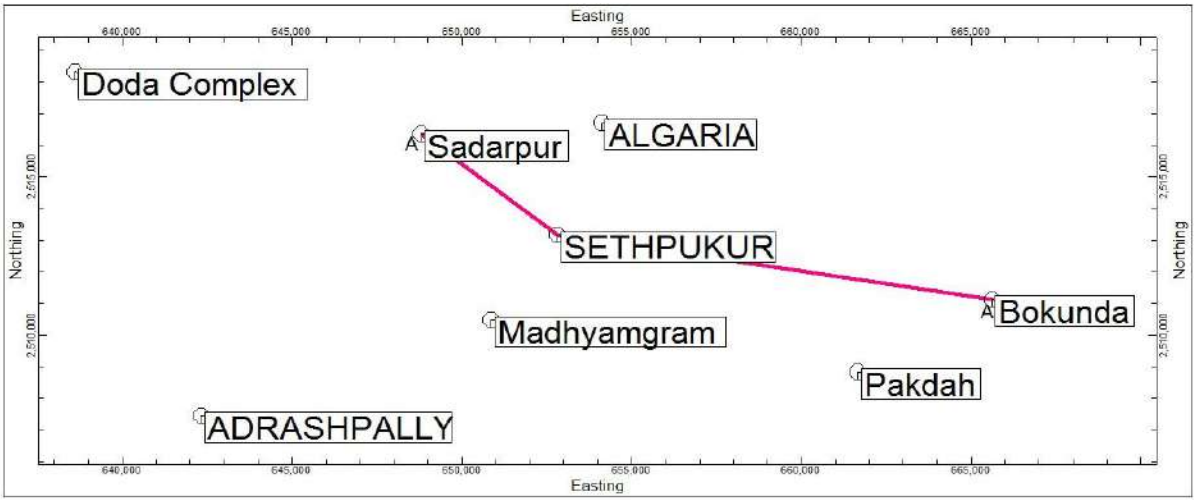


Fig.8.3.4: N-S Section Index line in Barasat-I block

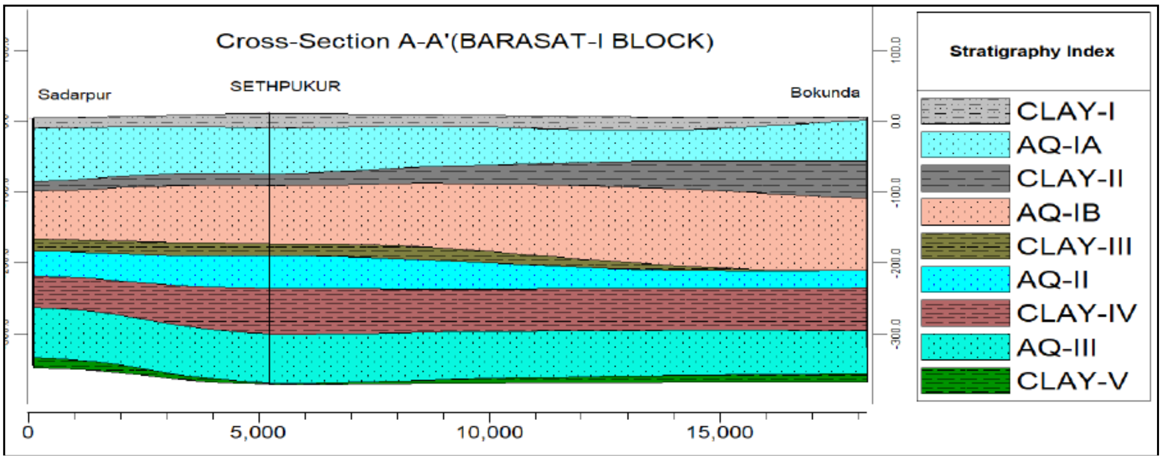


Fig-8.3.5: N-S Section in Barasat-I block

Table- 8.3.6:Aquifer Wise Water Level Ranges & seasonal longterm water level trends (2006 to 2017)

Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
I	5.9 - 11.81	-	5.08	2-15.91	-	10.75
II	5.71 - 15.7	-	-	4.9-10.3	-	-

Table-8.3.7: Aquifer wise maximum thickness:

Block	Area (sq km)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)	Thickness of the Granular Zone in 3rd aquifer (m)
Barasat-I	17507	1A 0-93 1B 76-193	186 - 245	107

Table-8.3.8: Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer				3rd Aquifer		
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)
Barasat-I	1A 0-93 1B 76-193	59.2	645.28	0.029	186 - 245	21	1711	$3.8*10^{-1}$	264 -371	-	-

8.3.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.3.9: Availability of Ground Water resource in Block

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Barasat-I	**6990.09**	**3100.19**	**44.35**	**Safe**	**14.66**

Static (in-storage) Resources: 300420.12 Ham

8.3.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data block wise Average data of chemical parameter is given below.

Table-9.3.10:Aquifer wise average chemical parameter of block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/cm)	Na(mg/l)	Cl(mg/l)	F(mg/l)	NO_3 (mg/l)	Measured Hardness(mg/l)
Barasat - I	IA	-	8.39	480	51.87	28.36	0.29	0.08	145
	IB	0.0025	8.33	620	46.87	28.36	0.16	0	190
	II	0.0055	8.41	534	50.89	39.00	0.30	0.54	165

8.3.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- Aquifer I is contaminated by arsenic; tube well should have to be constructed by using proper cement sealing in the impervious clay, which occurs above the aquifer with potable water, and tapping the said aquifer zone only.
- Regular Field monitoring is necessary for determination of arsenic concentration in ground water of tube wells.
- As per PHED Data, Govt. of West Bengal31398 populationin 7 villages (**Khilkapur, Barbaria, Saibana, Faldi Ula, Kanthalia,Kadambagachhi**) is under risk zone, where no water supply scheme is exists.
- Efforts have been made to estimate the construction of tube wells yielding arsenic free ground water; for this CGWB tube well data (Discharge, T, S) for projected population of 2021. A total of 16 wells are needed for water supply schemes in uncovered area of the block.

Table-9.3.11: Details of Arsenic infested population in Barasat-I block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Barasat I	7	31398	Potential arsenic free aquifers are encountered in the depth rangeof 186-245 mbgl, but the aquifer is brackish. It is expected that the aquifer remained entrapped for long time without flushing. Construction of tube well has not been proposed.

Table - 8.3.12: Village wise number and cost for construction of Tube wells calculated based on Human and Cattle population

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of tube wells of 300 m depth (approx) 10*6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Khilkapur	4501	5043	315.07	353.01	450	466	9	9.33	324.07	362.34	21	8	168	2	40
Barbaria	4764	5338	333.48	373.66	476	493	9.52	9.87	343	383.53	21	8	168	2	40
Saibana	516	578	36.12	40.46	52	54	1.04	1.08	37.16	41.54	21	8	168	1	20
Faldi	3595	4028	251.65	281.96	360	373	7.2	7.46	258.85	289.42	21	8	168	2	40
Ula	4058	4547	284.06	318.29	406	421	8.12	8.42	292.18	326.71	21	8	168	2	40
Kanthalia	5724	6413	400.68	448.91	572	593	11.44	11.86	412.12	460.77	21	8	168	3	60
Kadambagachhi	8240	9232	576.8	646.24	824	854	16.48	17.08	593.28	663.32	21	8	168	4	80
	31398	**35179**	**2197.86**	**2462.53**	**3140**	**3255**	**62.8**	**65.1**	**2260.66**	**2527.63**	**21**	**8**	**168**	**16**	**320**

For monitoring of the ground water regime, if needed, cost of construction of observation well should be included.

Management Plan forirrigation:

Table- 8.3.13 – Irrrrigation scenario in Barasat I block

***F-Falling**

Management options:

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Barasat-I	**17507**	**6320**	**4827.4**	**4902.52**	**78.41**	***F- 5.08**	**F-10.75**	**9.026**	**8.6**

- To enhance irrigation efficiency, technologies like Sprinkler, Drip irrigation should be adopted; blending of fresh and arsenic contaminated ground water may be used in appropriate ratio for irrigation purpose.
- Crops with less requirement of water should be preferred.
- Crops consuming low arsenic content may be cultivated.
- Artificial recharge is needed in arsenic infested areas for dilution of ground water in unconfined aquifer.
- As the shallow aquifer is arsenic infested, in summer ground water flows into the river or other surface water bodies. Therefore, analysis of water is necessary before use.
- Regular monitoring of arsenic accumulation in crop is also necessary.
- Continuous R & D study should be carried out to get better solution.

Table-8.3.13 Ground Water Management Plan for Irrigation in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Barasat I	3533.29	As	wheat,rice,mustard, vegetables , lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio/drip for vegetable, flowers

Table-8.3.14:Details of Regular practice crops in the block

Name of Block		Barasat-I
Aman	Area	3010
	Prod.	7.470
	Yield	2482
Boro	Area	1642
	Prod.	5.089
	Yield	3099
Jute	Area	1308
	Prod.*	19.581
	Yield**	14.970
Musur	Area	114
	Prod.	0.063
	Yield	554
Khesari	Area	17
	Prod.	0.015
	Yield	897
Mustard	Area	1733
	Prod.	2.107
	Yield	1216
Til	Area	478
	Prod.	0.523
	Yield	1095
Potato	Area	49
	Prod.	1.689
	Yield	34473

***Area in ha, Production in 000' MT and Yield in kg./ha**

(Source: Dept. of Economics & Statistics, Govt. of West Bengal)

Table-8.3.15 -Area wise percentage of current practice of crops in Barasat-I block

Area wise Current Practice of Crops								
Rabi Crops (Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation (Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses (water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
54.82	2211	40.71	1642	1.21	49	3.25	131	4033

(Source: Dept. of Economics & Statistics, Govt. of West Bengal)

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of water required by major crops in current practice, divided by area of cultivation has been considered to get the required factor (0.6) for determination of water requirement by just multiplying this factor with the remaining cultivable area in the block. Using 60 % of this water requirement, an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 9.3.16) so that the maximum area of the remaining cultivable area may be covered; in this way 40 % of water could be saved.

Table-8.3.16: Future Water allocation for remaining cultivable area considering SOD,Soil conditions and cropping pattern of the block

Water requirement in ham based on weighted average of water required by all crops divided by total area of cultivation (1)	Considering 60% water and 40 % for future irrigation(ham) (2)	Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Total Area covered(A)	Remaining Cultivable area (4902.52-A)
		%	Area (ha)	%	Area(ha)	%	Area (ha)		
2941.512	1764.91	65	5042.6	20	294.15	15	441.23	5777.98	-875.46
2941.512	1764.91	30	2521.3	40	588.30	30	882.46	3992.06	910.47
2941.512	1764.91	40	3361.73	30	441.23	30	882.46	4685.42	217.1

In this case, actually ground water available for future irrigation is 3533.29Ham:water recommended for utilisation is 1764.91ham& the remaining water could be saved as conservation measure.

And, in this block, for boro Rice, rabi and vegetables 30%, 40 % and 30 % of 1764.91 ham water respectively may be used to irrigate part (4685.4 ha) of remaining cultivable area of 4902.52 ha in a better way.

Proposed Artificial Recharge Structures in the Study area:

Table-8.3.18-Area suitable for recharge in the study area:

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having DTW above 3m in postmonsoon and showing 2m/y falling trend)(in ha)
NORTH TWENTY FOUR PARGANAS	Barasat-I	17507	15330

Table- 8.3.19: Estimation of Surface runoff component by method of Dhruvanarayana,1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc(sub-tracting amount of e-flow)= Vf
Barasat-I	Sandy/Silty Loam	1.17	4447.26	3335.44	1667.72	1000.63

A* - area, C** - Run off coefficient from Normal Monsoon Rainfall

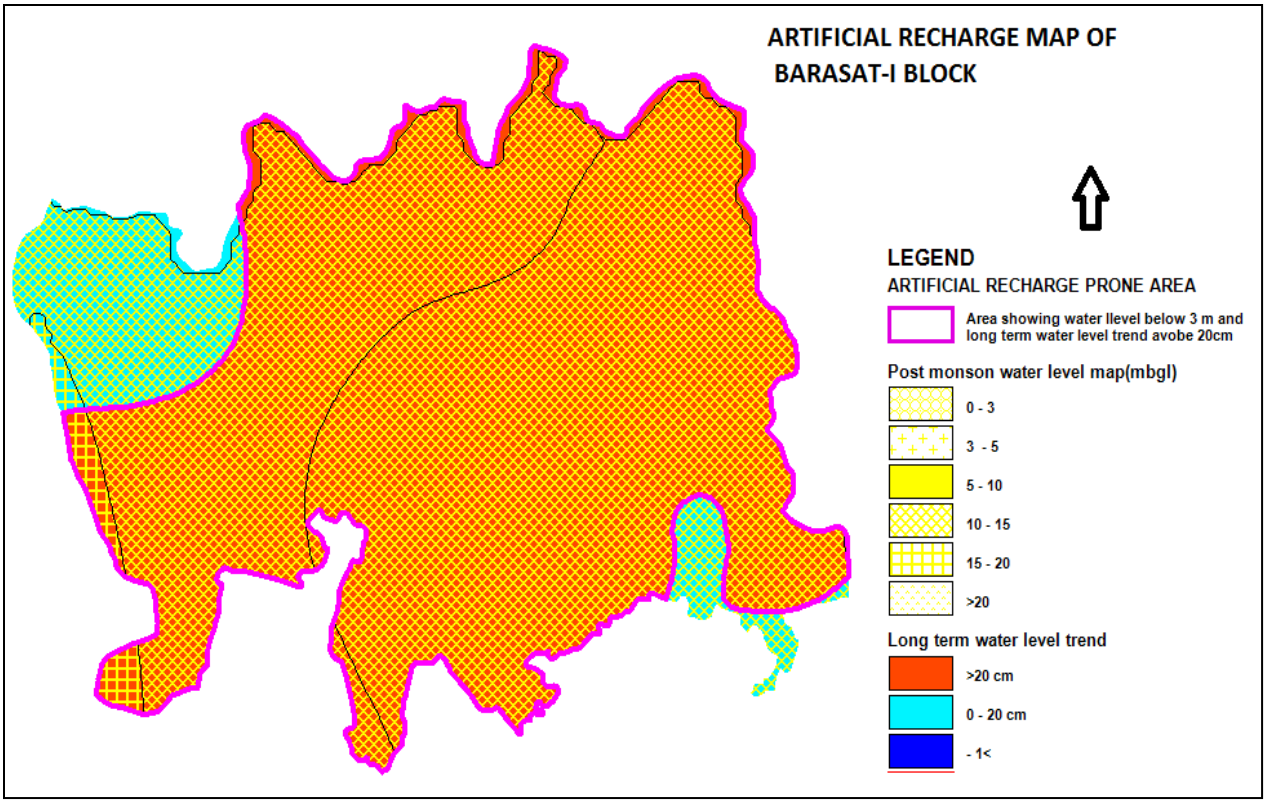


Fig-8.3.6: Area suitable for artificial Recharge in Barasat-I block

Table-8.3.20 - Proposed Recharge and conservation structures

Block (1)	Block Area (2)	Area suitable for recharge (Considering area having DTW above 3m in post monsoon and showing 2m/y or more falling trend) (3)	Soil type (4)	Amount of water for artificial recharge and conservation (Ham) (5)	Source water allocation for with Artificial recharge in Ham - 70 % of Col. 5 (6)	Irrigation cum recharge Tank -35 % of Col. 5 (7)	Re-excavation of existing tanks with Recharge shaft - 35 % of Col. 5 (8)	Injection Well for recharging deeper aquifers - 20 % of Col. 5 (9)	Farm Pond- 10 % of Col. 5 (10)	Nos. of Irrigation cum recharge Tank -@ 50 Ham per unit (11)	Nos. of Re-excavation of existing tanks with Recharge @ 10 Ham per unit (12)	Nos. of Injection Well @ 30 Ham per unit (13)	Nos. of Farm Pond @ 10 Ham per unit (14)	Cost of Irrigation cum recharge Tank @ Rs 8 lakh per unit (15)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit (16)	Cost of Injection Well @ Rs 15 lakh per unit	Cost of Farm Pond @ Rs 8 lakh per unit	
Barasat I	14990	9230	Sandy/ Silty Loam	1000.63	700.44	350.22	350.22	200.13	100.6	7	35	7	10	56	333.37	105	80	Total estimated cost of proposed structures= Rs. 574.37 lakh;

8.4 BARASAT-II BLOCK

8.4.1 Salient Information

Block Name: Barasat-II

Area (in Ha): 10636

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table- 8.4.1 -Details of Population in Barasat-II block

Rural	Urban	Total
188924	11994	200918

Rainfall: Average annual rainfall (**N. 24 Parganas**district) for the period 2012 -16 (in mm):1555.76

Table-8.4.2 -Details of Annual Rainfall for last five years (in mm)

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Barasat-II	**1623.6**	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

Table-8.4.3 - Salient Landuse features of block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Barasat-II	**10636**	**9730**	**251**	**152**	**-**

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.4.4: Details of aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	**60.2429**	**0.19**	**-**	**41.1388**
Static Resource	**1858.193**	**-**	**-**	**-**

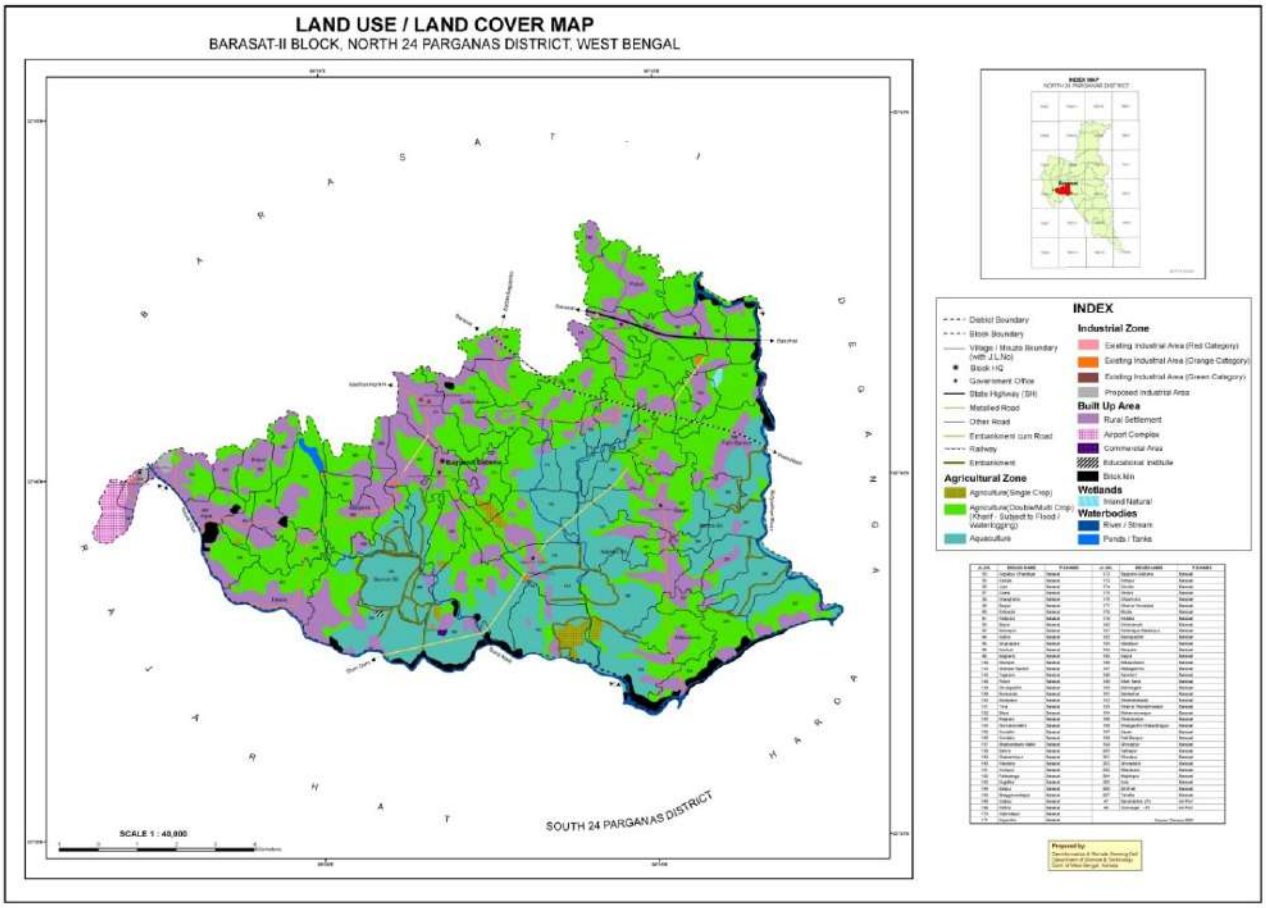
8.4.2 Disposition of Aquifer:

In Barasat-II Block, two aquifer systems are encountered:

- In AquiferI Group, Aquifer IA ranges between 0**m and 60 m**and Aquifer IB occurs within **61 m - 225 m,** and both these aquifers show arsenic contamination in ground water.
- Aquifer II ranges between **220m and 245m**, which is fresh and arsenic free.

Table- 8.4.5:Aquifer disposition in block

Block		
BARASAT-II	Aquifer I	Aquifer II
	1A 0-60 1B 61-225	220-245



(Source: Land & Land Reforms Dept., Govt. of W.B.)

Fig.-8.4.1.Land use Land cover map of the Barasat-II block

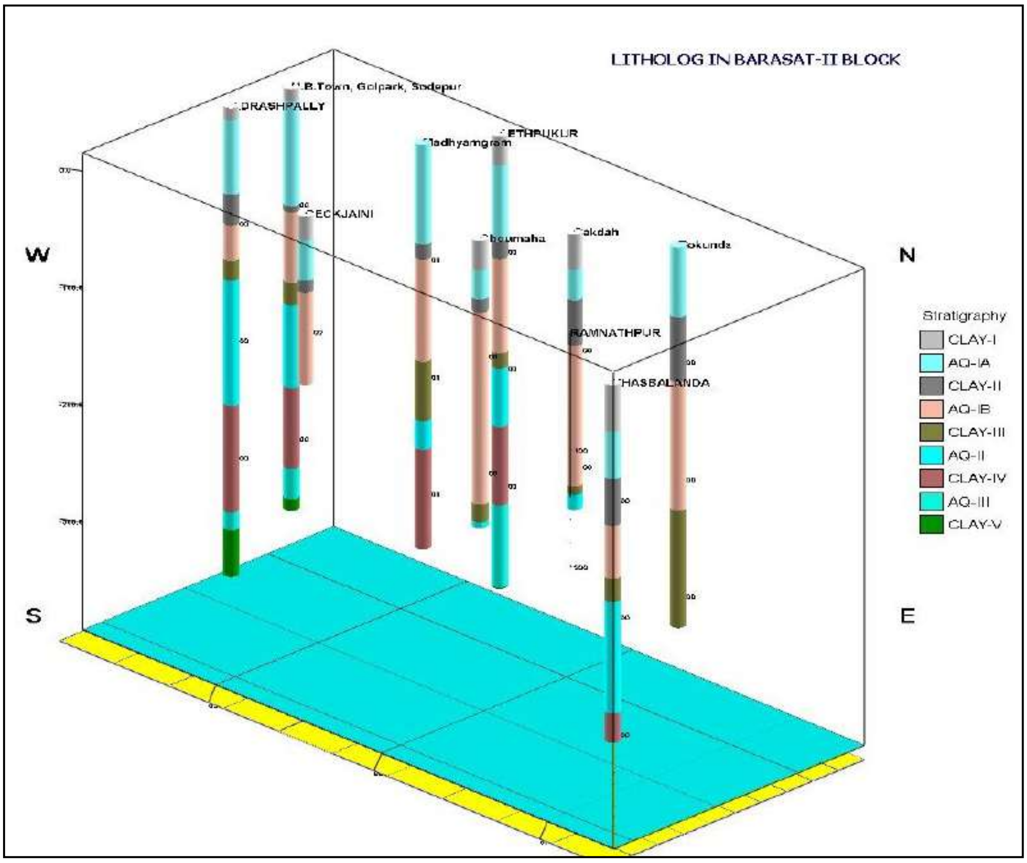


Fig-8.4.2: Stratigraphic logs of Barasat-II block

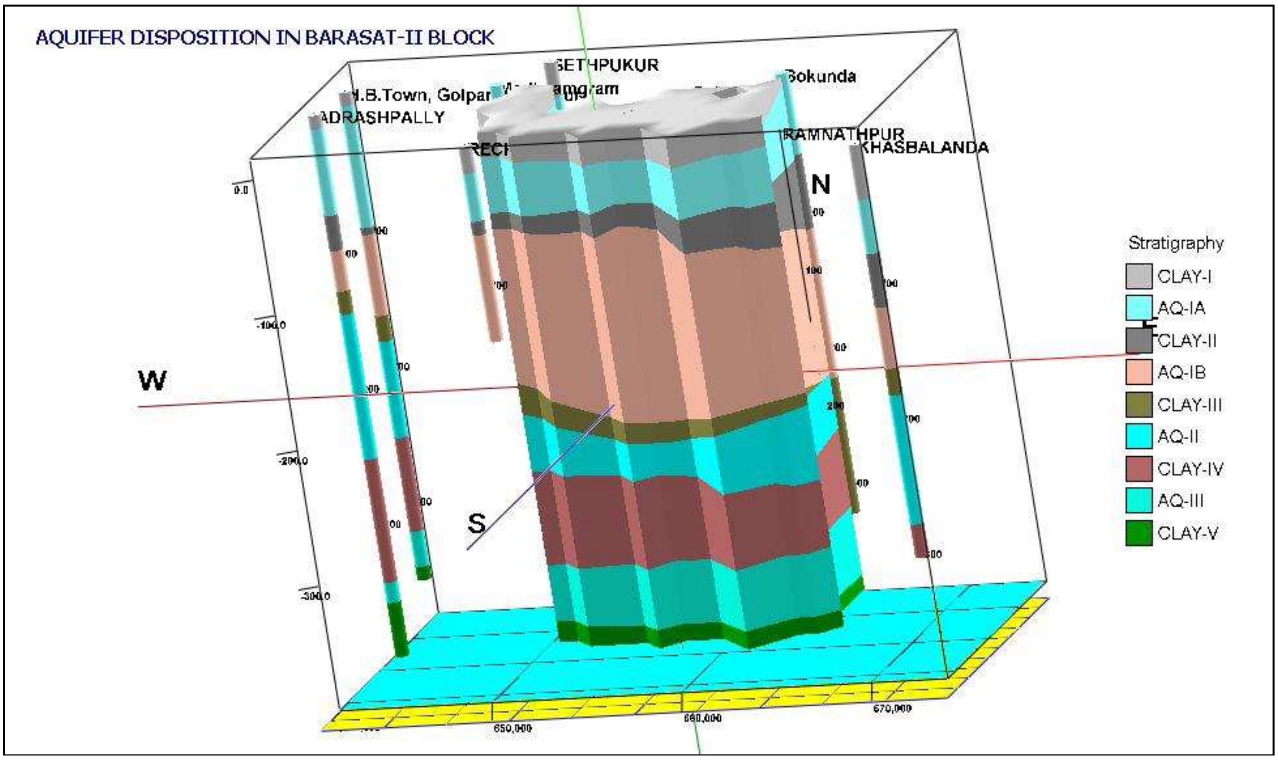


Fig- 8.4.3:Aquifer disposition in Barasat-IIblock

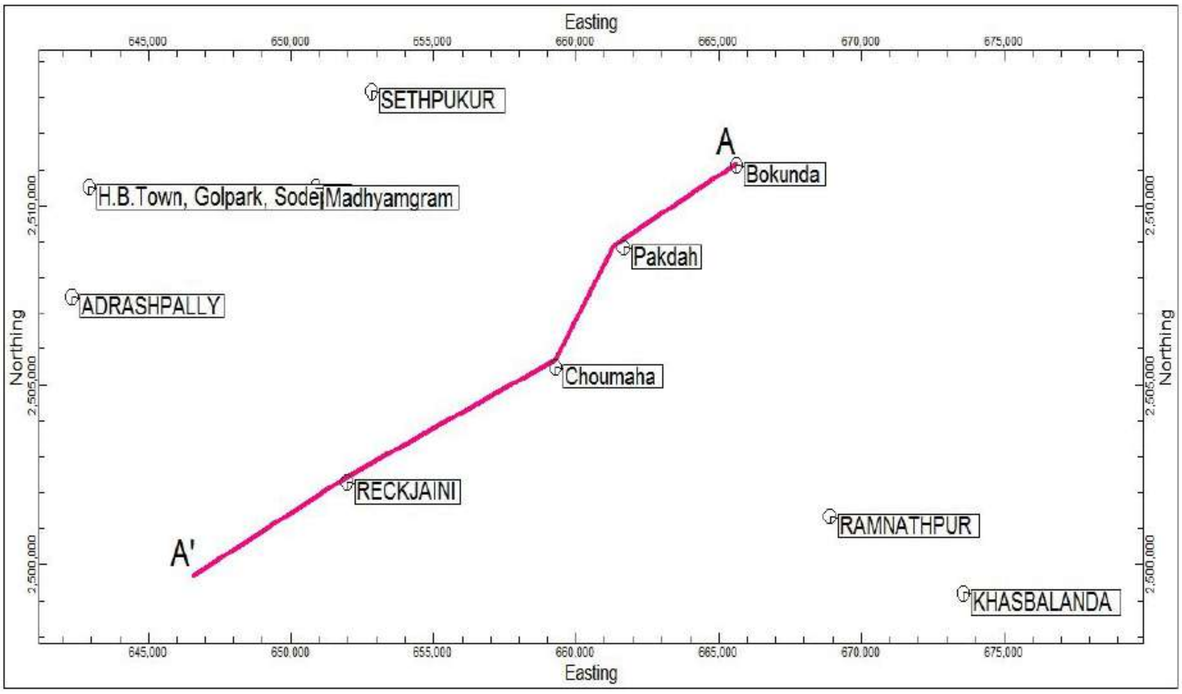


Fig.-8.4.4: NW-SE section index line in Barasat-II block

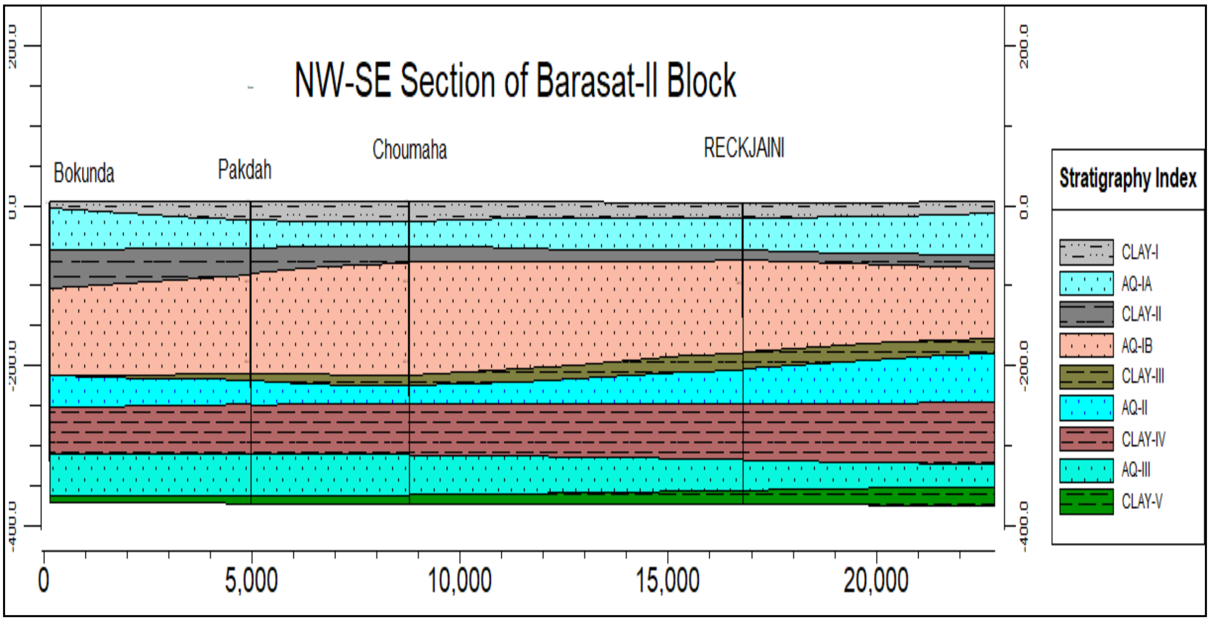


Fig-8.4.5 NW-SEsection in Barasat-IIblock

Table-8.4.6 -Aquifer Wise Water Level Ranges &seasonal long term water level trends (2006 to 2017)

SI. No.	Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
			Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
1.	**Barasat-II**	**I**	**3.21-4.95**	**-**	**12.86**	**2.00 -15.91**	**-**	**19.87**
3	**Barasat-II**	**II**	**---**	**-**	-	**---**	**-**	**-**

Block	Area (sq km)	Thickness of the Granular Zone in Aquifer I (m)	Thickness of the Granular Zone in Aquifer II (m)
Barasat-II	**17507**	**1A 60** **1B 164**	**25**

Table-8.4.7 - Aquifer wise maximum thickness

Table- 8.4.8 -Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Barasat-II	1A 0-60 1B 61-225	91.72	2021	0.029	220-245	27	3891	$3.8*10^{-1}$

8.4.3 Ground Water Resource, Extraction, Contamination & Other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.4.9:Availability of Ground Water resource in block

Block	Net ground water availability (MCM)	Gross ground water draft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Barasat-II	**6024.29**	**4113.88**	**68.29**	**Safe**	**3.9655**

Static (in-storage) Resources: 112890.50 Ham.

8.4.4 Chemical Quality of Ground Water & Contamination:

Based on 2 to 3 Key well data blocks wise Average data of chemical parameter is given below. For Arsenic data 3 to 4 Ground Water monitoring station data of CGWB is considered.

Table-8.4.10 - Aquifer wise average chemical parameter of block

Block	Aquifer Type	As(mg/l)
Barasat-II	IA	**0.125**
	IB	**0.0517**

Table-8.4.11 -Arsenic affected Risk Population

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max. concentration
		%	No.	%	No.	%	No.	
Barasat II	1147	57.19	656	26.94	309	15.87	182	0.95

(Source – PHED, Govt. of West Bengal)

8.4.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- In first aquifer Arsenic is present so for removal of Arsenic, followingtechnologies should be applied-
- Tap Arsenic Free aquifer with proper cement sealing along with in supply tube well Arsenic removal plant should be installed.
- Regular Field monitoring is necessary for Arsenic concentration in tube wells.
- As per PHED, Govt. of West Bengaldata **38827** population with 16 villages (**Banubankra(P),Shankar Gachhi,Tegharia,Gobindapur,Simulia,Mudia,Mahishgadi,Bardeshia,Shanberiabada ,Khamar, Rameshwarpur,Chakshason,Ghosalpur,Majlishpur,Kola,Bil Bheli,Tehatta**) is under risk zone where no water supply scheme is exist.
- Based on CGWB well data (Discharge, T, S) number and cost for construction of well is given for future population of 2021.
- In this block total 17 wells are needed in villages, where supply scheme does exist.

Table-8.4.12 -Arsenic infested population in block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Barasat II	16	38827	Potential arsenic free aquifers in the depth span of 220-245 mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m.

Table- 8.4.13 -Village wise Estimate for cost of construction of Tube wells for supply of arsenic free ground water

Block	**Village Name**	**Population 2011**	**Projected Population 2021 (decadal growth rate 12.04%)**	**Present Water Requirement for Human Population in M^3 @70lpcd**	**Projected Water Requirement for Human Population in M^3 @70lpcd**	**Cattle 2011**	**Projected Cattle 2021**	**Present Water Requirement for cattle M^3 @20lpcd**	**projected Water Requirement for cattle M^3 @20lpcd**	**Total Water Requirement/day as on 2011 in M^3**	**Total Water Requirement/day as on 2021 in M^3**	**Discharge**	**hours**	**Discharge of one TW in M^3/day after 8 hours of pumping**	**No of TW**	**Cost of the Observation well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC**
Barasat-II	Banubankra (P)	141	158	9.87	11.06	14	15	0.28	0.29	10.15	11.35	27	8	216	1	20
Barasat-II	Shankar Gachhi	1883	2110	131.81	147.7	188	195	3.76	3.9	135.57	151.6	27	8	216	1	20
Barasat-II	Tegharia	3833	4294	268.31	300.58	383	397	7.66	7.94	275.97	308.52	27	8	216	1	20
Barasat-II	Gobindapur	3416	3827	239.12	267.89	342	355	6.84	7.09	245.96	274.98	27	8	216	1	20
Barasat-II	Simulia	2394	2682	167.58	187.74	239	248	4.78	4.95	172.36	192.69	27	8	216	1	20
Barasat-II	Mudia	3317	3716	232.19	260.12	332	344	6.64	6.88	238.83	267	27	8	216	1	20
Barasat-II	Mahishgadi	6468	7247	452.76	507.29	647	671	12.94	13.41	465.7	520.7	27	8	216	2	40
Barasat-II	Bardeshia	1226	1374	85.82	96.18	123	128	2.46	2.55	88.28	98.73	27	8	216	1	20
Barasat-II	Shanberiabada	3298	3695	230.86	258.65	330	342	6.6	6.84	237.46	265.49	27	8	216	1	20
Barasat-II	Khamar Rameshwarpur	3363	3768	235.41	263.76	336	348	6.72	6.97	242.13	270.73	27	8	216	1	20
Barasat-II	Chakshason	507	568	35.49	39.76	51	53	1.02	1.06	36.51	40.82	27	8	216	1	20
Barasat-II	Ghosalpur	1412	1582	98.84	110.74	141	146	2.82	2.92	101.66	113.66	27	8	216	1	20
Barasat-II	Majlishpur	2614	2929	182.98	205.03	261	271	5.22	5.41	188.2	210.44	27	8	216	1	20
Barasat-II	Kola	1636	1833	114.52	128.31	164	170	3.28	3.4	117.8	131.71	27	8	216	1	20
Barasat-II	Bil Bheli	486	545	34.02	38.15	49	51	0.98	1.02	35	39.17	27	8	216	1	20
Barasat-II	Tehatta	2833	3174	198.31	222.18	283	293	5.66	5.87	203.97	228.05	27	8	216	1	20
Barasat-II		**38827**	**43502**	**2717.89**	**3045.14**	**3883**	**4025**	**77.66**	**80.5**	**2795.55**	**3125.64**	**27**	**8**	**216**	**17**	**340**

- For monitoring of the ground water regime, the cost of observation well, if needed, should also be included.
- In the initial stageof development, 25 % wells should be constructed. Based on result, the rest of the plan may be implemented.

Management Plan forirrigation:

Table-8.4.14 - Irrigation details in Barasat II

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Basirhat II	10636	9730	2628.1	3691.9	68.29	F- 12.86	F-19.87	9.65	8.6

Measures recommended:

- Modern technologies like Sprinkler, Drip irrigation and fresh and arsenic contaminated ground water in suitable ration may be used for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low Arsenic should be preferred.
- Artificial recharge is recommended in Arsenic infested zone for dilution of Arsenic content in unconfined aquifer.
- As the shallow aquifer is arsenic infested, during summer due to base flow ground water flows into the river or other surface water bodies. Therefore, these surface water bodies should be tested before use.
- Regular monitoring of Arsenic concentration in crop is also necessary.
- R & D study is necessary in arsenic affected area, so we can get new solutions in future.

Table- 8.4.14 - Water column suggested for crops in consultation with Bidhan Chandra KrashiVidhyalaya (BCKV)

Block	Ground water availability (Ham)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Barasat II	1813.94	As	wheat,rice, mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water: in appropriate ratio/drip for vegetable,flowers

Table-8.4.15 -Crops in regular practice

Name of Block		Barasat-II
Aus	Area	14
	Prod.	0.031
	Yield	2228
Aman	Area	4262
	Prod.	9.429
	Yield	2212
Boro	Area	2167
	Prod.	6.084
	Yield	2807
Wheat	Area	262
	Prod.	0.557
	Yield	2127
Jute	Area	3124
	Prod.*	43.205
	Yield**	13.83
Musur	Area	162
	Prod.	0.173
	Yield	1071
Gram	Area	4
	Prod.	0.004
	Yield	918
Mustard	Area	1437
	Prod.	1.806
	Yield	1256
Til	Area	58
	Prod.	0.062
	Yield	1075
Potato	Area	194
	Prod.	4.836
	Yield	24927

(Area in Ha, Production in 000' MT and Yield in kg./Ha, (Courtesy: Department of Economics

Table-8.4.16 - Crop area under regularcultivation in Barasat-II block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
41	1757	50.6	2167	4.5	194	3.9	166	4284

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of water required by major crops in current practice, divided by area of cultivation has been considered to get the required factor (0.7) for determination of **water requirement** by just multiplying this factor with the remaining cultivable area in the block. The main objective is to irrigate cultivable area with proper cropping pattern. Different options have been tried as follows:

Table-8.4.17:. Future Water allocation for remaining cultivable area considering SOD,soil conditions and cropping pattern of the block

Water requirement to cover entire remaining area (ham)	Actual Water availabilit y for future irrigation(ham)	Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation (Water column requirement- 1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses (water column requireme nt =0.11 m)		Total Area covered(A)	Remaini ng Cultivab le area (3691.9 - A)
		%	Area(ha)	%	Area(ha)	%	Area(h a)	%	Area (ha)		
2584.33	1813.94	30	2591	40	605	25	756	5	825	4777	-1085.1
2584.33	1813.94	30	2591	40	605	30	907	0	0	4103	- 411.1
2584.33	1813.94	40	3455	45	680	15	453.49	0	0	4588	-896.1

Based onTable 8.4.17,best option by using better allocation of water is to allocate available water: 30 % each for rabi &vegetables &40 % for boro in the remaining cultivable area.

Proposed Artificial Recharge Structures in the Study area:

Table-8.4.19: Area suitable for recharge in the study area

District	Block Name	Area (in ha)	**Area suitable for recharge, considering Post monsoon DTW of 3m& more and & long term falling trend of 0.2m/y and more** (in ha)
NORTH TWENTY FOUR PARGANAS	Barasat-II	10636	4536

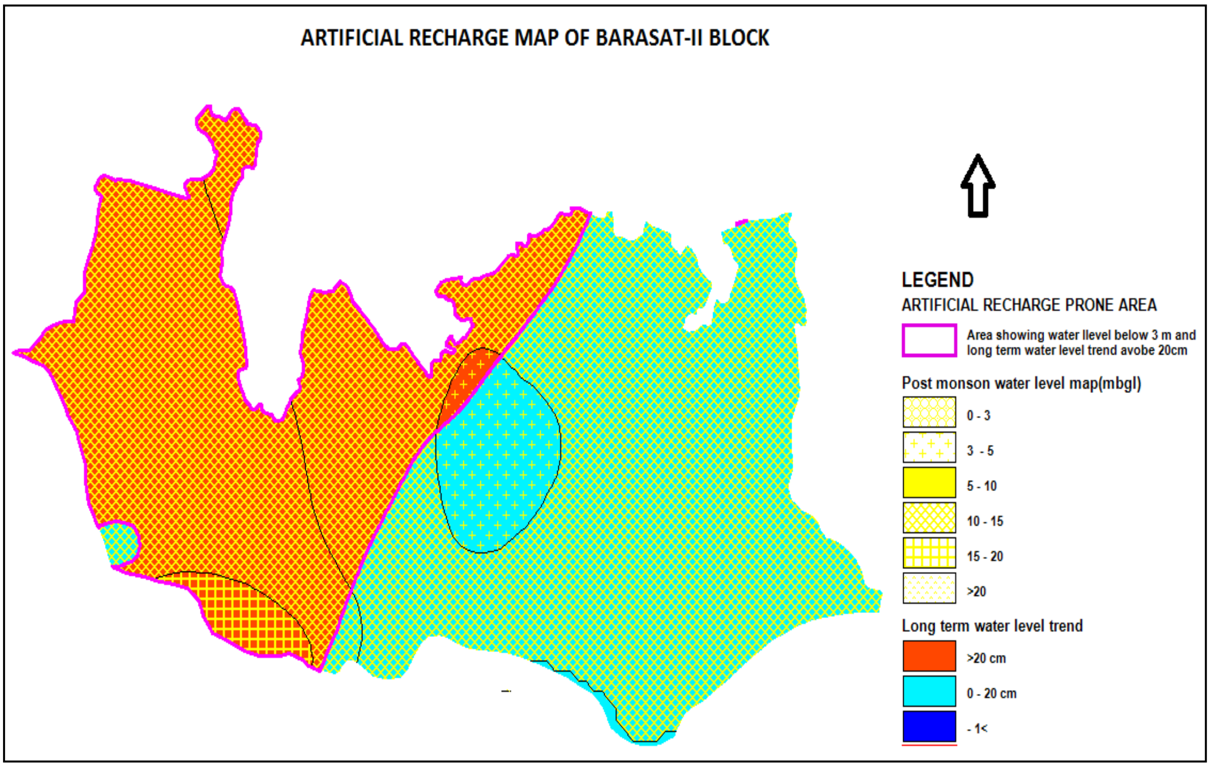


Fig-8.4.6: Area suitable for Artificial Recharge in Barasat-II block

Table- 8.4.20: Estimation of Surface runoff component based on Dhruvanarayana (1993) method

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc(sub-tracting amount of e-flow)= Vf
Barasat-II	Silty Clay	1.17	3993.97	2995.48	1497.74	898.64

A* - area, C** - Run off coefficient from Normal Monsoon Rainfall

On the basis of soil characteristic, Slope, Rain fall data and Long term trend number of structures are calculated and given below

Table-8.4.21 - Proposed Recharge & Conservation structures in Barasat II block

Block Area (1)	Area suitable for recharge (2)	Soil type (3)	Amount of water for artificial recharge and conservation (Ham) (4)	Source water allocation for with Artificial recharge in Ham - 70 % of Col. 4 (5)	Irrigation cum recharge Tank - 50 % of Col. 5 (6)	Re-excavation of existing tanks with Recharge shaft - 50 % of Col. 5 (7)	Injection Well for recharging deeper aquifers - 20 % of Col. 5 (8)	Farm Pond- 10 % of Col. 4 (9)	Nos. of Irrigation cum recharge Tank - @ 50 Ham per unit (10)	Nos. of Re-excavation of existing tanks with Recharge @ 10 Ham per unit (11)	Nos. of Injection Well @ 30 Ham per unit (12)	Nos. of Farm Pond @ 10 Ham per unit (13)	Cost of Irrigation cum recharge Tank @ Rs 8 lakh per unit (14)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit (15)	Cost of Injection Well @ Rs 15 lakh per unit (16)	Cost of Farm Pond @ Rs 8 lakh per unit (17)	Remarks
10636	4536	Sandy /Silty Clay	898.64	629.05	314.53	314.53	179.73	89.86	6	31	6	9	60	248	90	72	Total estimated cost for proposed structures =Rs 470 lakh

8.5 BASIRHAT-I BLOCK

8.5.1 Salient Information:

Block Name: Basirhat-I

Area (in Ha):12558

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table-8.5.1: Details of Population in Basirhat-I block

Rural	Urban	Total
150520	21093	171613

Rainfall: Average annual rainfall (**North Twenty Four Parganas** district) for the period 2012 -16 (in **mm):1555.76**

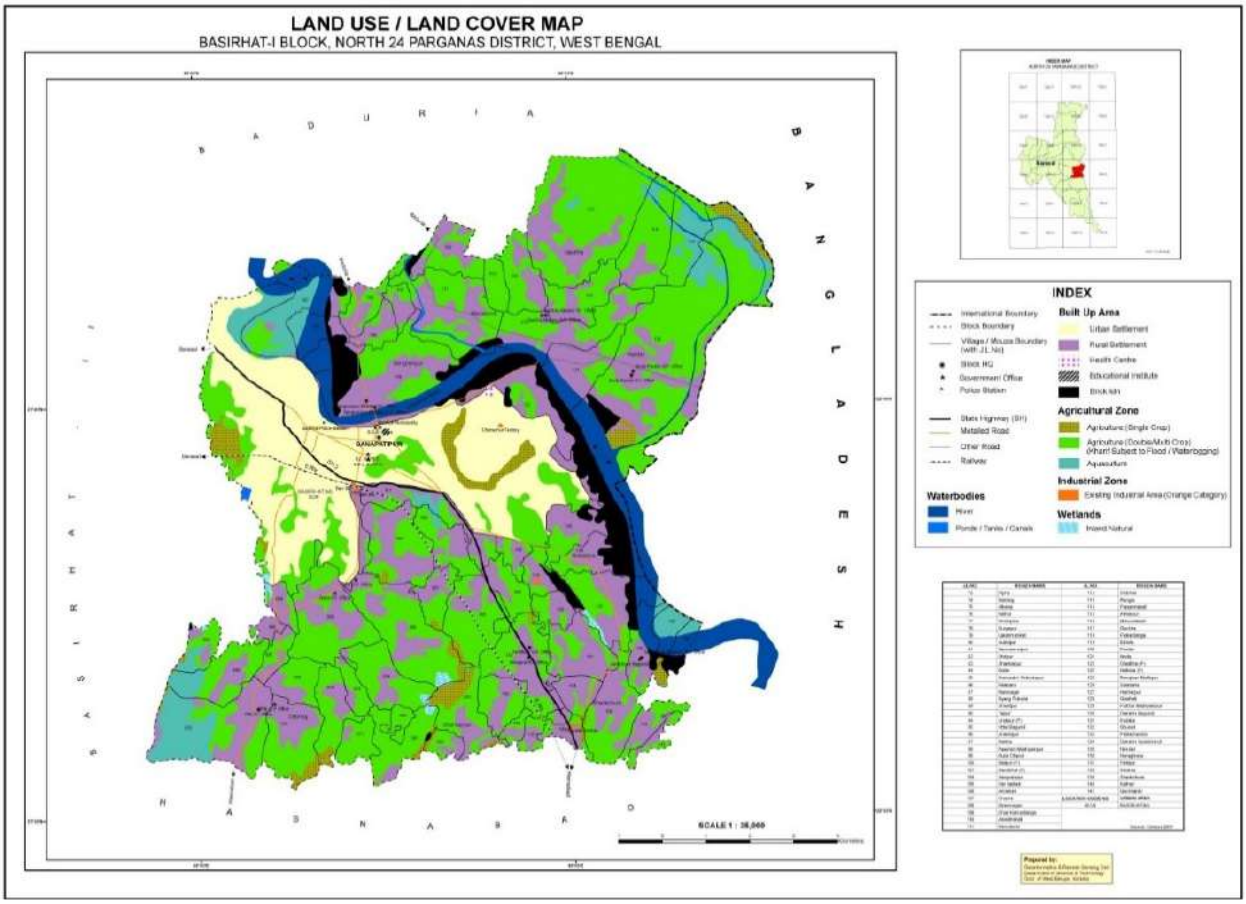
Table-8.5.2 -Details of District Annual Rainfall for last five years (in mm)

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Basirhat-I	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

Table-8.5.3 -Salient Landuse features in block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Basirhat-I	12558	7400	827	387	-



(Source – Land & Land Reforms Dept., Govt. of West Bengal)

Fig.-8.5.1: Land use& Land cover map of the Basirhat-I block

8.5.2 Disposition of Aquifer:

In BasirhatI Block, two Aquifer Groups are explored:

- Aquifer I: Aquifer IA ranges within **3 -38 m**, and Aquifer IB ranges between **32 m and 85 m**; both these aquifers are separated by distinct clay layer and are contaminated by arsenic.
- Aquifer II: it ranges between **119 m &175m**, and is fresh and arsenic free.

Table-8.5.4 - Aquifer disposition in block

Block	Depth range of Aquifer in m bgl	
BASIRHAT-I	1st Aquifer	2nd aquifer
	1A 3 - 38 1B 32-85	119 - 175

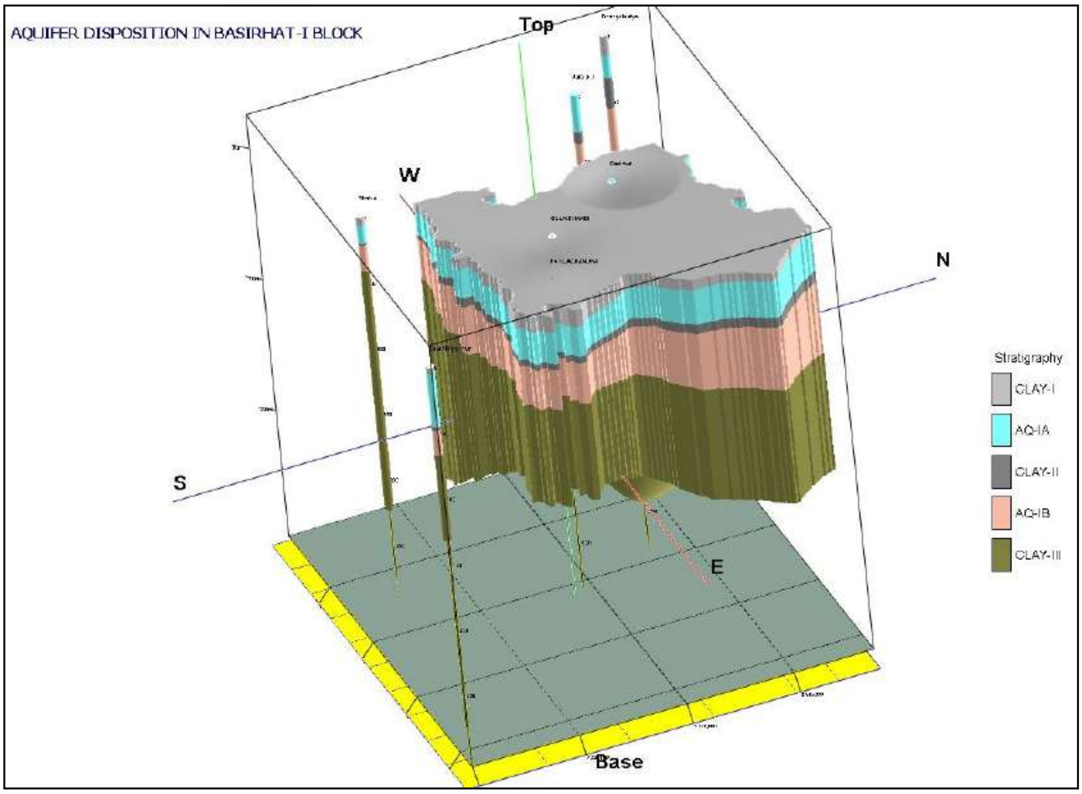


Fig-8.5.2: Aquifer disposition of Basirhat-I block

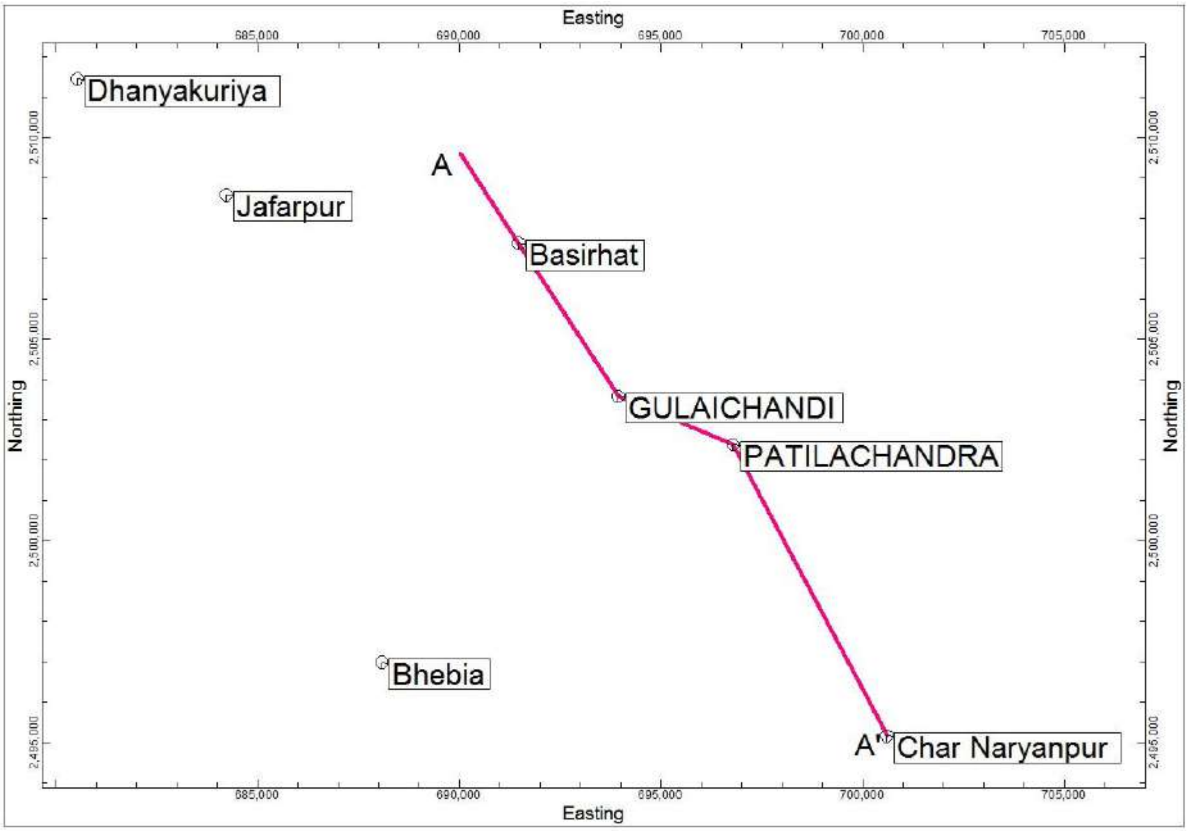


Fig.-8.5.3: NW-SE section index line in Barsirhat-I block

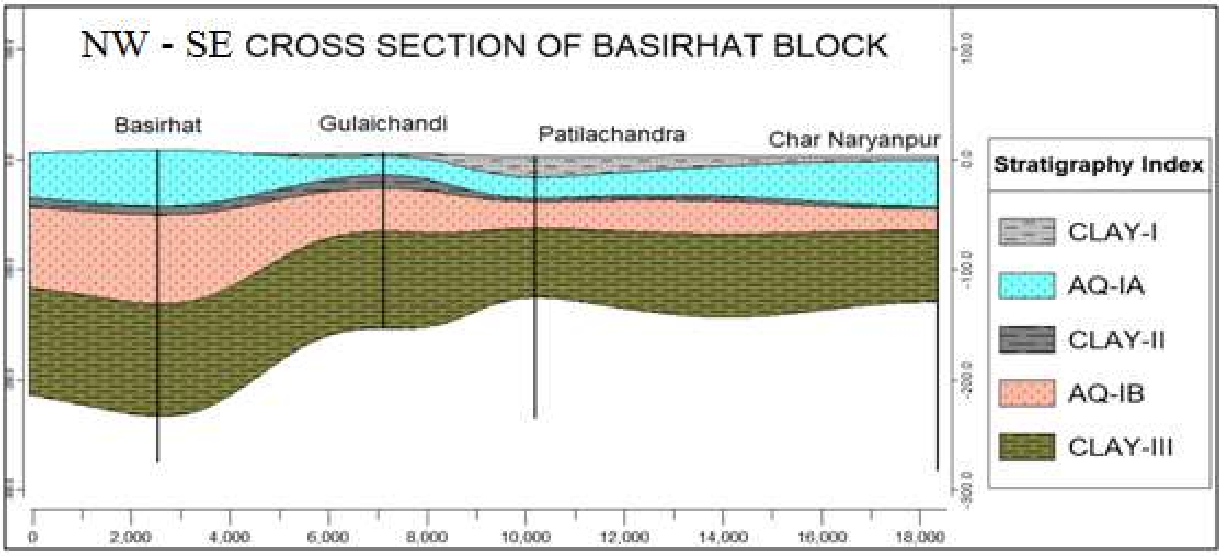


Fig-8.5.4: NW-SE section in Basirhat-I block

Table-8.5.5 - Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
Basirhat-I	I	**1.75-7.66**	**-**	**9.37**	**7.14**	**-**	7.11
Basirhat-I	II	**4 - 6.47**	-	-	**3.9- 6.1**	-	-

Table-8.5.6-Aquifer wise maximum thickness of aquifers:

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Basirhat-I	**12558**	**1A 35** **1B 53**	**56**

Table- 8.5.7 Aquifer-wise depth range and parameters (based on CGWB exploration data)

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Basirhat-I	**1A 3 - 38** **1B 32-85**	**44.94**	**44.94**	**0.029**	**119 - 175**	**39.61**	**3962**	**4.86×10^{-6}**

8.5.3 Ground Water Resource, Extraction, Contamination &other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.5.8:Availability of Ground Water resource in block

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Basirhat-I	**6294.76**	**3334.39**	**52.97**	Safe	**6.12**

Static (in-storage) Resources: 80371.20 Ham.

8.5.4 Chemical Quality of Ground Water & Contamination:

Based onground water quality data of key wells of the current year, average data of chemical parameters are given below. For Arsenic contamination, data of hydrograph monitoring stationsof CGWB have been considered.

Table-8. 5.9 -Aquifer wise average chemical parameter of block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/cm)	Na(mg/l)	Cl (mg/l)	F (mg/l)	NO3(mg/l)	Measured Hardness(mg/l)
Basirhat-I	**IB**	0.0695	-	-	-	-	-	-	-
	II	0.008	8.51	969	193.21	81.55	0.080	8.74	140

Table-8.5.10:Arsenic affected Risk Population

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max.concentration
		%	No.	%	No.	%	No.	
Basirhat I	1326	80.02	1,061	12.37	164	7.62	101	0.53

(Source- PHED, Govt. of West Bengal)

8.5.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- In Aquifer Group I, ground water is contaminated by arsenic. Therefore, for drinking purpose tube well should be constructed by tapping arsenic free aquifer with proper cement sealing in the clay zone above the aquifer to be tapped; for pipe water supply Arsenic Removal Plant should be installed.
- Regular Field monitoring is necessary for determination of arsenic concentration in ground water.
- As per PHED, Govt. of West Bengaldata, 6883 population in 4 villages (**Jirakpur (P),Dandirhat (P),Nalkora (P),Gachharati**) is under risk zone where no potable water supply scheme exists.
- Cost Estimation has been made for construction of suitable tube wells following above technique for projected population in 2021.
- In this block, total 6 wells are needed where supply scheme donot exists. To arrive at the needed data, CGWB exploratory well data have been considered.

Table-8.5.11-Details of Arsenic infested population in Basirhat-I block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Basirhat I	4	10365	Potential arsenic free aquifers in the depth rangeof 119-175mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m

Table- 8.5.12:Village wise number and cost estimate for construction of Tube wells

Block	**Village Name**	**Population 2011**	**Projected Population 2021 (decadal growth rate 12.04 %)**	**Present Water Requirement for Human Population in M^3 @70lpcd**	**Projected Water Requirement for Human Population in M^3 @70lpcd**	**Cattle 2011**	**Projected Cattle 2021**	**Present Water Requirement for cattle M^3 @20lpcd**	**projected Water Requirement for cattle M^3 @20lpcd**	**Total Water Requirement/day as on 2011 in M^3**	**Total Water Requirement/day as on 2021 in M^3**	**Discharge**	**hours**	**Discharge of one TW in M^3/day after 8 hours of pumping**	**No of TW**	**Cost of the Observation well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC**
Bashirhat-I	Jirakpur (P)	1580	1770	110.6	123.9	158	164	3.16	3.28	113.76	127.18	21	8	168	1	20
Bashirhat-I	Dandirhat (P)	6387	7156	447.09	500.92	639	662	12.78	13.25	459.87	514.17	21	8	168	3	60
Bashirhat-I	Nalkora (P)	948	1062	66.36	74.34	95	98	1.9	1.97	68.26	76.31	21	8	168	1	20
Bashirhat-I	Gachharati	1450	1625	101.5	113.75	145	150	2.9	3.01	104.4	116.76	21	8	168	1	20
Bashirhat-I		**10365**	**11613**	**725.55**	**812.91**	**1037**	**1075**	**20.74**	**21.51**	**746.29**	**834.42**	**84**	**32**	**672**	**6**	**120**

For monitoring of the ground water regime, cost of construction of if observation well, if needed, should be included in expenditure**.**

Management Plan forirrigation:

Table- 8.5.13 - Irrigation scenario in block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Basirhat -I	**12558**	**7400**	**2788.41**	**4611.59**	**52.97**	**F- 9.37**	**F-7.11**	**5.154**	**7.14**

Measures recommended:

- To improve the irrigation efficiency, modern technologies like Sprinkler, Drip irrigation, etc. to be applied; blending of fresh and arsenic contaminated ground water may be applied in appropriate ratio for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water to be preferred.
- Artificial recharge is must in arsenic infested zone for dilution of arsenic concentration in ground water.
- As the shallow aquifer is arsenic affected, during summer ground water flows into the river or other surface water bodies by base flow. Therefore, these surface water bodies should be analysed before use.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.5.13- Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Basirhat I	2811.52	As	wheat,rice,mustard, vegetables lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable (0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water: in suitable ratio/drip for vegetable,flowers

Table-8.

Name of Block		Basirhat-I
Aus	Area	108
	Prod.	0.303
	Yield	2805
Aman	Area	4018
	Prod.	11.849
	Yield	2949
Boro	Area	1453
	Prod.	4.672
	Yield	3216
Wheat	Area	563
	Prod.	1.660
	Yield	2948
Jute	Area	2972
	Prod.*	50.465
	Yield**	16.98
Musur	Area	81
	Prod.	0.078
	Yield	962
Maskalai	Area	29
	Prod.	0.020
	Yield	692
Khesari	Area	11
	Prod.	0.012
	Yield	1078
Mustard	Area	741
	Prod.	1.138
	Yield	1536
Til	Area	194
	Prod.	0.189
	Yield	972
Potato	Area	115
	Prod.	3.645
	Yield	31692

5.14:Crops in regular practice

Area in Ha., Production in 000' MT and Yield in kg./Ha.

Table-8.5.15: Area of current practice of crops in Basirhat-I block

Area wise Current Practice of crops								
Rabi Crops (Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation (Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
47	1498	45.6	1453	3.6	115	3.8	121	3187

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of water required by major crops in current practice, divided by area of cultivation has been considered to get the required factor (0.7) for determination of **water requirement** by just multiplying this factor with the remaining cultivable area in the block. Using 60 % of this **water requirement,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.5.16) so that the maximum area of the remaining cultivable area may be covered; in this way 40 % of water could be saved.

Table-8.5.16 - Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Water requirement to cover entire remaining area (ham)	Considering 60% water and 40 % for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses(water column requirement =0.11 m)		Total Area covered(A)	Remaining Cultivable area (4611.59-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
3228.113	1936.9	30	2767	35	565	30	968	5	11	4311	300.59
3228.113	1936.9	40	3689	35	565	15	484	10	194	4932	-320.41
3228.113	1936.9	35	3228	35	1130	20	387	10	194	4939	-327.41

Based onTable-8.5.16, out of 4611.59 ha area 4311 ha area could be covered by better water allocation; also, 2811.52 – 1936.9 ham could be saved by this way. And, in this block, for boro Rice, rabi and vegetables 35%, 30 % and 30 % of 1936.9 ham water respectively may be used for irrigation for cultivationin a better way.

Proposed Artificial Recharge Structures in the Study area:

Table-8.5.17 -Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Total Area suitable for recharge (in ha)
North Twenty Four Parganas	Basirhat-I	**12558**	10380

Table- 8.5.19: Calculation of Surface runoff on the basis of Runoff co efficient from Dhruvanarayana,1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Basirhat-I	**Sandy/Clay Loam**	**3471.488**	**2603.616**	**1301.808**	**781.0848**

A* - area, C - run off coefiiceent from Normal Monsoon Rainfall**

Table-8.5.20: Cost estimate of proposed structures in block

Block (1)	Block Area (2)	Area suitable for recharge (Considering area having DTW above 3m in post monsoon and showing 2m/y falling trend) (3)	Soil type (4)	Amount of water for artificial recharge and conservation (Ham) (5)	Source water allocation for with Artificial recharge in Ham - 70 % of Col. 5 (6)	Irrigation cum recharge Tank -35 % of Col. 5 (7)	Re-excavation of existing tanks with Recharge shaft - 35 % of Col. 5 (8)	Injection Well for recharging deeper aquifers - 20 % of Col. 5 (9)	Farm Pond- 10 % of Col. 5 (10)	Nos. of Irrigation cum recharge Tank -@ 50 Ham per unit (11)	Nos. of Re-excavation of existing tanks with Recharge @ 10 Ham per unit (12)	Nos. of injection well suggested @ 30 Ham per unit (13)	Nos. of Farm Pond @ 10 Ham per unit (14)	Cost of Irrigation cum recharge Tank @ Rs 8 lakh per unit (15)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit (16)	Cost of Injection Well @ Rs 15 lakh per unit	Cost of Farm Pond @ Rs 8 lakh per unit	Remarks
Basirhat I	12558	10380	Sandy/ Clay Loam	781.08	546.76	273.38	273.38	156.22	78.11	5	27	5	8	40	216	75	64	Total estimated cost of proposed structures is Rs 395 lakh

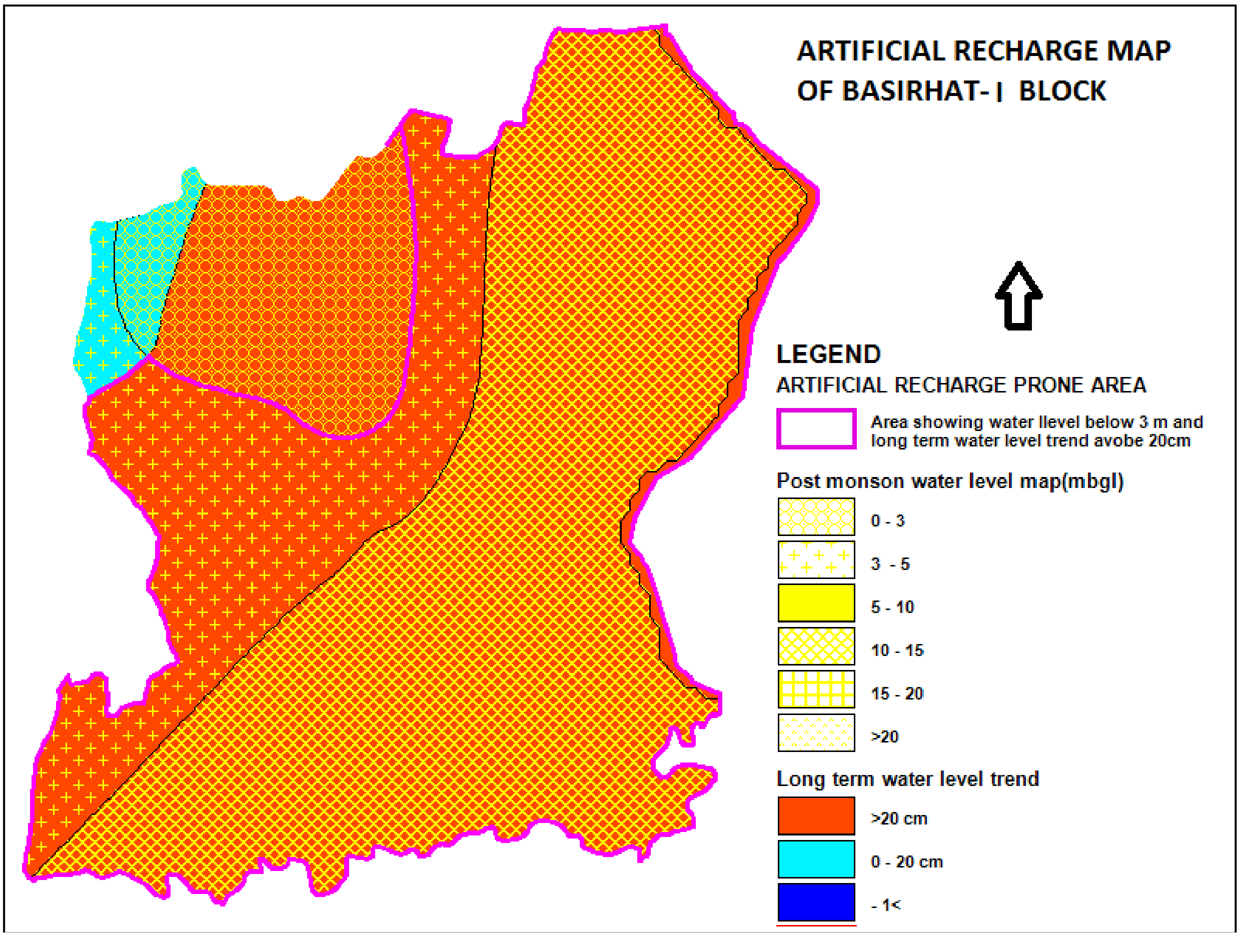


Fig-8.5.6: Area suitable for Artificial Recharge in Basirhat-I block

8.6 BASIRHAT-II BLOCK

8.6.1 Salient Information:

Block Name: Basirhat-II

Area (in Ha):**13586**

District: **North Twenty-Four Parganas**

State: West Bengal

Population (as on 2011):

Table-8.6.1: Population in Basirhat-II block

	Rural	Urban	Total
BasirhatII	208840	17290	226130
Basirhat(M)	-	125254	125254

Rainfall: District Average annual rainfall (North Twenty Four Parganas district)for the period 2012 -16 (in mm):**1555.76**

Table-8.6.2 -Details of Annual Rainfall for last five years (in mm)

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Basirhat-II	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

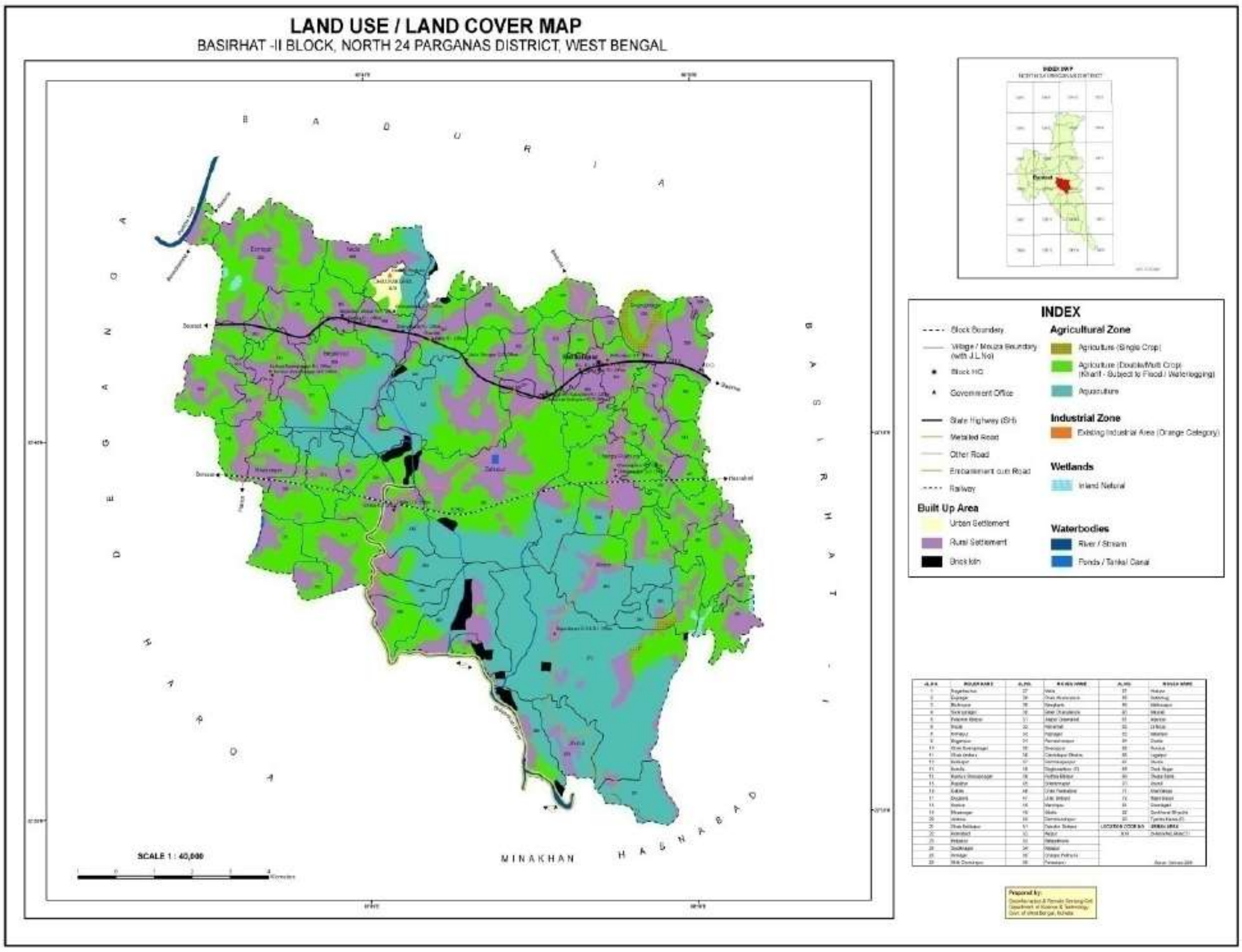
Table- 8.6.3 – SalientLanduse features of block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Basirhat-II	13586	8595	526	50	-

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.6.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	62.40	0.22	-	36.27
Static Resource	1768.35	-	-	-



(Source – Land & Land Reforms Dept., Govt. of West Bengal)

Fig.8.6.1 -Land use& Land cover map of the Basirhat-II block

8.6.2 Disposition of Aquifer:

In Basirhat-II block, two aquifer systems are encountered

- Two aquifers are there in Aquifer I: the range of aquifer IA: **0m to 69 m;** aquifer IB**: 45 m to 161 m,** with arsenic contamination.
- The range of 2nd aquifer is **220 m to 264 m**, which is fresh and arsenic free.

Table- 8.6.5 - Aquifer disposition in block

Block	Depth range of Aquifer in m bgl	
BASIRHAT-II	1st Aquifer	2nd aquifer
	1A 0 - 69 1B 45-161	220 - 264

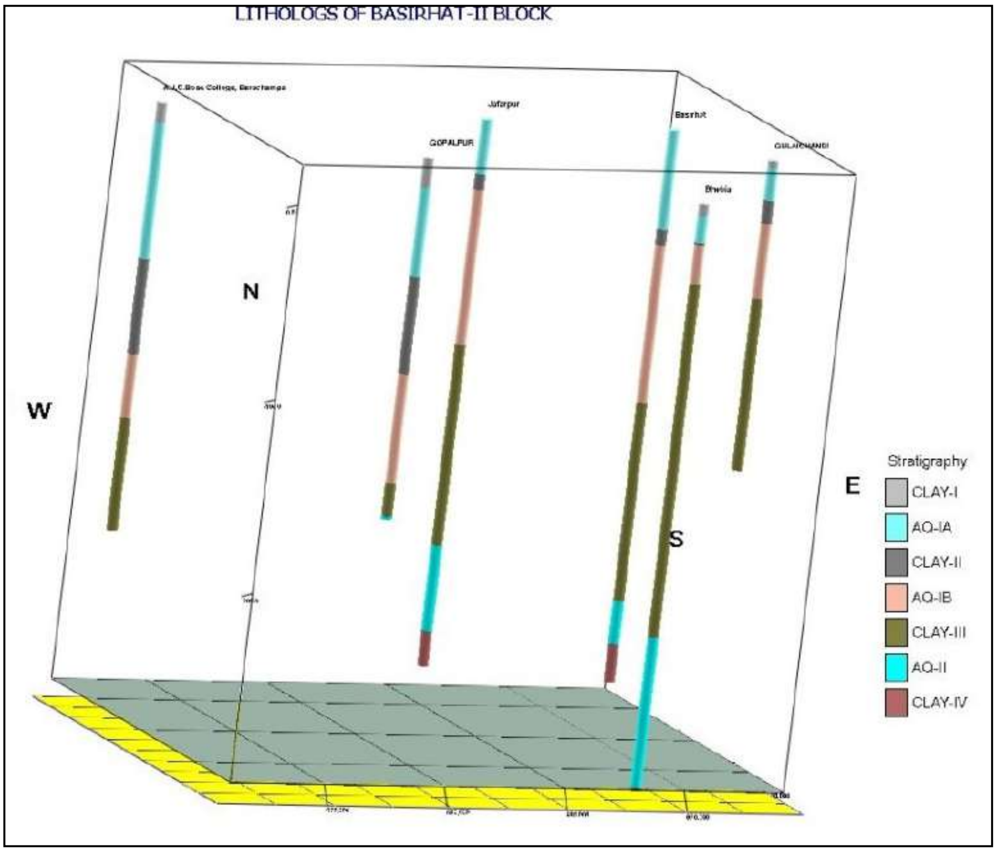


Fig-8.6.2: Stratigraphic logs in Basirhat-II block

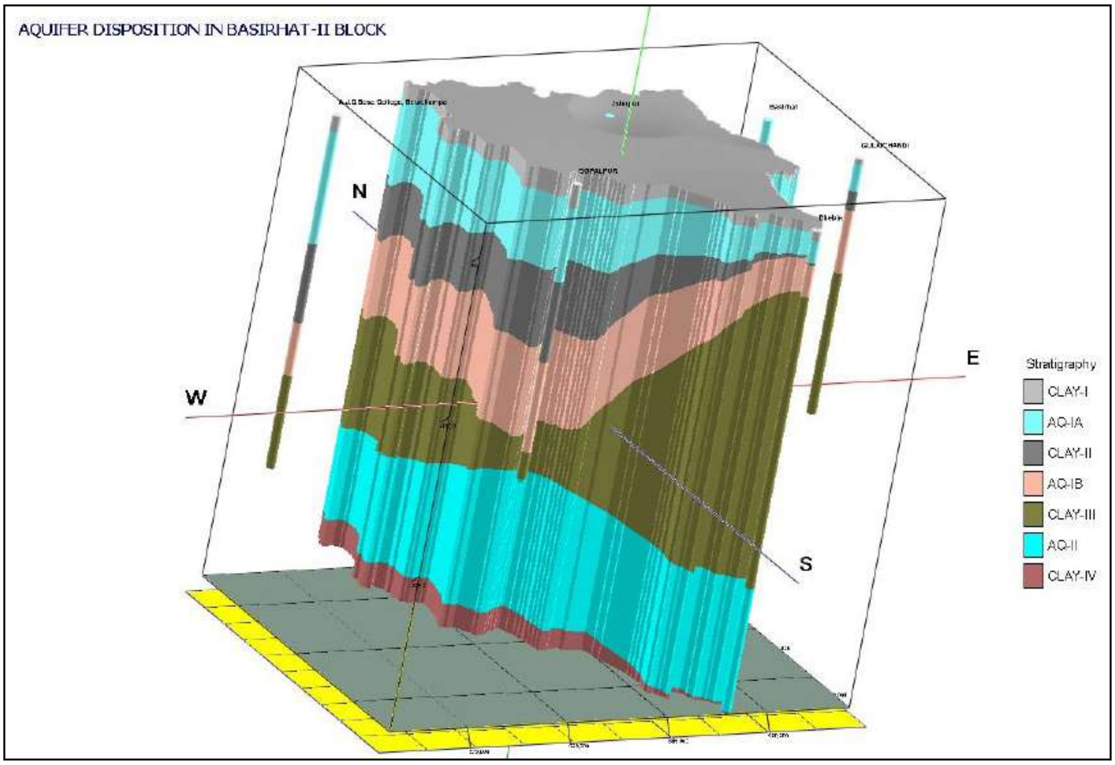


Fig-8.6.3: Aquifer disposition of Basirhat-II block

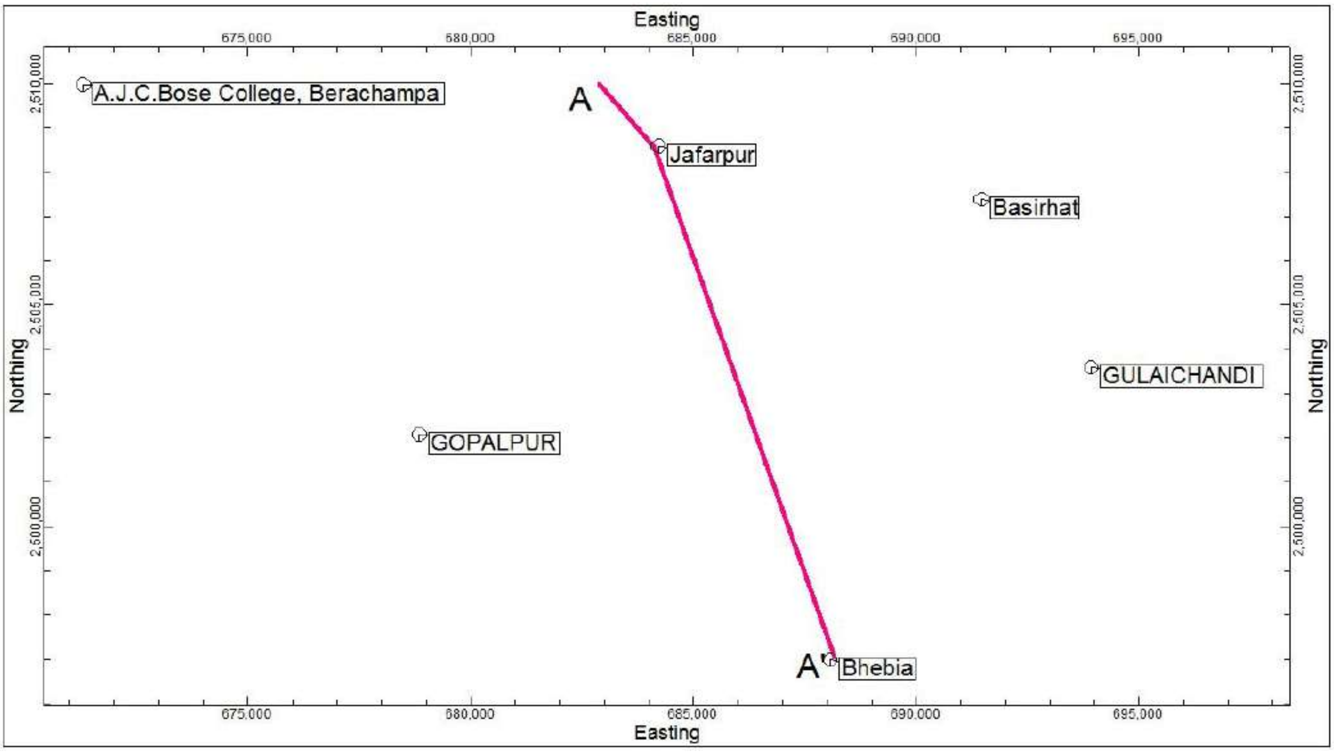


Fig.-8.6.4: N-S section index line in Basirhat II block

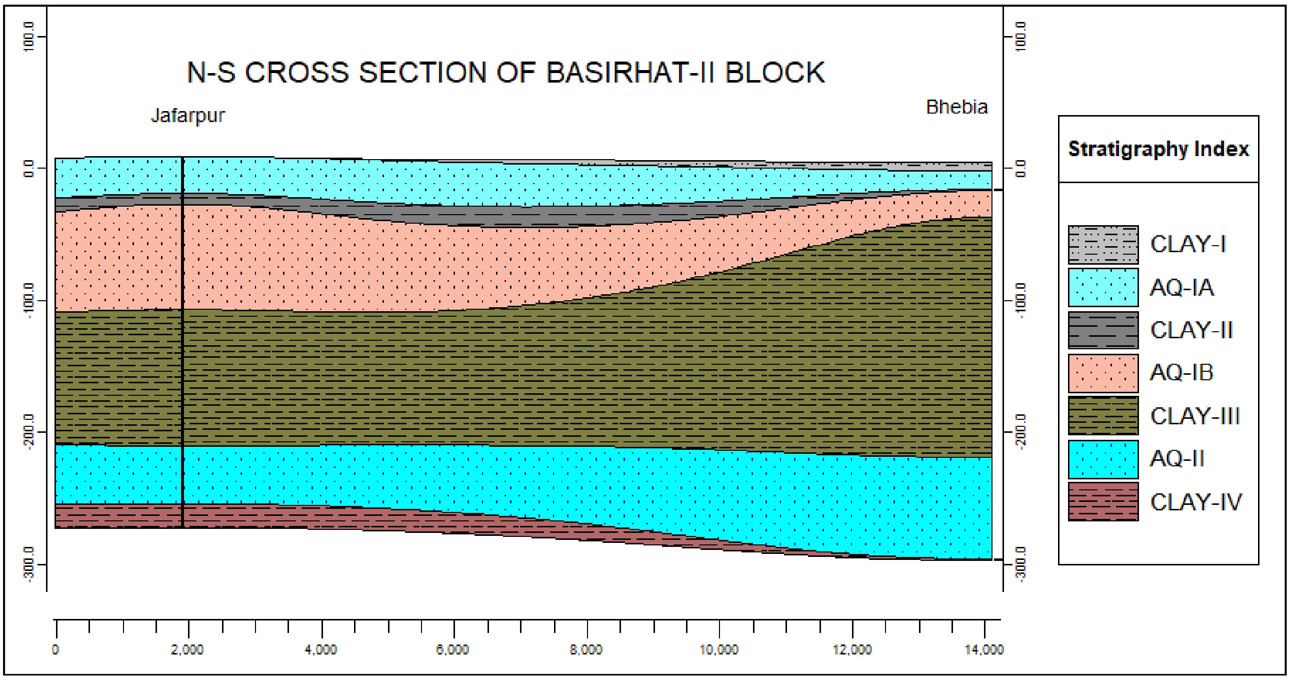


Fig-8.6.5:N-S Cross section in Basirhat-II block

Table-8.6.6 -Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
Basirhat-II	I	**3.21-4.95**	6.34	-	**3.1- 10.14**	-	3.05
Basirhat-II	II	**5.4- 6.35**	-	-	**4.2 – 6.1**	-	-

Table- 8.6.7 - Aquifer wise maximum thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Basirhat-II	**13586**	1A 69 1B 116	44

Table- 8.6.8 - Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Basirhat-II	1A 0 - 69 1B 45-161	26.47	44.94	0.029	220 - 264	39.61	3962	$4.86 * 10^{-6}$

8.6.3 Ground Water Resource, Extraction, Contamination & other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.6.9: Availability of Ground Water resource in block

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Basirhat-II	**6240.37**	**3626.70**	**58.12**	Safe	4.55

Static (in-storage) Resources: 176835.38 Ham.

8.6.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data of current AAP, block wise average data of chemical parameter are given below. For arsenic data, hydrograph monitoring station have been considered.

Table-8.6.10 -Aquifer wise average chemical parameters of block

Block	Aquifer Type	As (mg/l)	pH	EC (Us/Cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Measured Hardness (mg/l)
Basirhat-II	IB	0.0025	8.34	772	113.56	60.27	0.27	3.03	160
Bashirhat II	II	0.0023	8.43	638	99.926	53.18	0	0.19	120

Table-8.6.11 -Arsenic affected Risk Population

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max.concentration (mg/l)
		%	No.	%	No.	%	No.	
Basirhat II	1573	77.56	1,220	11.82	186	10.62	167	0.63

(Source- PHED, Govt. of West Bengal)

8.6.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

Measures recommended

- In Aquifer I, arsenic is present so for removal of Arsenic, following technologies should be applied-
- Tap Arsenic Free aquifer with proper cement sealing along with in supply tube well Arsenic removal plant should be installed.
- Regular Field monitoring is necessary for Arsenic concentration in tube wells.
- As per WBPHED Data 16402 population with 4 villages (**KachuaSwarupnagar, ChakKhamarpara,PurbbaBibipur,DhopaBaria**) is under risk zone where no water supply scheme exists.
- Based on CGWB wells data (Discharge, T,S), number and cost estimate for construction of these wells have been given for projected population in 2021.In this block, a total of 6 wells are needed where supply scheme does not exist.

Table-8.6.12 -Arsenic infested population in Basirhat-II block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Recommendation for providing water supply to the risk population
Basirhat II	5	16402	Potential arsenic free aquifers in the depth rangeof 220-264mbgl, separated from the upper aquifers system by clay layer of 10 to 30 m thickness.

Table-8.6.13:Village wise nos. and cost estimate for construction of Tube wells

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of the Observation well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Kachua Swarupnagar	8383	9392	586.81	657.44	838	869	16.76	17.37	603.57	674.81	27	8	216	3	60
Chak Khamarpara	11	12	0.77	0.84	1	1	0.02	0.02	0.79	0.86	27	8	216	1	20
Purbba Bibipur	361	404	25.27	28.28	36	37	0.72	0.75	25.99	29.03	27	8	216	1	20
Dhopa Baria	2499	2800	174.93	196	250	259	5	5.18	179.93	201.18	27	8	216	1	20
	11254	**12608**	**787.78**	**882.56**	**1125**	**1166**	**22.5**	**23.32**	**810.28**	**905.88**	**108**	**32**	**864**	**6**	**120**

- For monitoring of the ground water regime, cost of construction of observation wells, if needed, should be included in the expenditure.
- In the initial stage of development of drinking water management plan, 25 % wells may be constructed. Based on the result whole plan could be implemented.

Management Plan for irrigation:

Table-8. 6.14 - Irrigation scenario in Basirhat II block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Basirhat-II	**13586**	**8595**	**5247.8**	**3347.2**	**58.12**	**R- 6.34**	**F-3.05**	**4.36**	**7.14**

Measures Recommended

- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation etc. should be applied, blending of fresh and arsenic contaminated ground water for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from irrigation water should be preferred.
- Artificial recharge may be implemented in arsenic infested area for dilution of contamination in unconfined aquifer.
- As the shallow aquifer is contaminated by arsenic, during summer ground water flows into the river or other surface water bodies by base flow. Therefore, these surface water bodies should be analysed before use.
- Regular monitoring of arsenic concentration in crop is also necessary.
- R & D study is necessary to get better solutions to tackle contamination by arsenic.

Table-8. 6.15 - Recommended water column for irrigation in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Basirhat II	2502.97	As	wheat, rice, mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat, mustard, lentil, flowers, vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water: in suitable ratio& drip for flowers & vegetables

Table-8.6.16 -Crops in regular practice

Name of Block		Basirhat-II
Aus	Area	10
	Prod.	0.026
	Yield	2633
Aman	Area	5518
	Prod.	15.492
Boro	Area	2715
	Prod.	8.886
	Yield	3273
Wheat	Area	57
	Prod.	0.154
	Yield	2700
Jute	Area	2746
	Prod.*	61.895
	Yield**	22.54
Musur	Area	317
	Prod.	0.277
	Yield	873
Maskalai	Area	3
	Prod.	0.002
	Yield	692
Gram	Area	11
	Prod.	0.010
	Yield	918
Mustard	Area	2368
	Prod.	3.459
	Yield	1461
Til	Area	25
	Prod.	0.028
	Yield	1127
Potato	Area	142
	Prod.	3.528
	Yield	24844

(Area in Ha, Production in 000' MT and Yield in kg./Ha

(Source – Deptt. of Economics and Statistics,Govt. of W.B.)

Table-8.6.17: Area of crops in Basirhat-IIblock

Area wise Current Practice of crops								
Rabi Crops(Wheat,Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
43.5	2450	48.2	2715	2.5	142	5.9	331	5638

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of water required by major crops in current practice, divided by area of cultivation has been considered to get the required factor (0.7) for determination of **water requirement** by just multiplying this factor with the remaining cultivable area in the block. Using 60 % of this **water requirement,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.6.16) so that the maximum area of the remaining cultivable area may be covered; in this way 40 % of water could be saved.

Table-8.6.18: Water allocation for remaining cultivable area considering cropping pattern of the block

Present water availability(Ham)	Considering 60% water and 40 % for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses(water column requirement =0.11 m)		Total Area covered (A)	Remaining Cultivable area (3347.2-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
2343.04	1405.8	30	2008	35	410	30	703	5	8	3129	218.2
2343.04	1405.8	40	2678	45	527	15	351	0	0	3556	-208.8
2343.04	1405.8	15	1004	70	820	15	351	0	0	2175	1172.2

Based onTable 8.6.18, out of 3347.2 ha an area of 3129 ha area could be covered by better allotment of water and in this way, 1097 ham of water could be saved as a measure of conservation.

Table-8. 6.19 -Area suitable for artificial recharge in the block

District	Block Name	Area (in ha)	Area suitable for recharge (Considering area having postmonsoon DTW of 3m and more & showing 2m/y and above falling trend)(in Ha)
NORTH 24 PARGANAS	Basirhat-II	**13586**	**5740**

Table-8.6.20: Estimation of Surface runoff component based on method of Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Basirhat-II	**Sandy/Clay Loam**	**3528.0756**	**2646.057**	**1323.0284**	**793.81701**

A* - area, C** - run off coefiicient from Normal Monsoon Rainfall

Based onsoil characteristic, slope, Rainfall data and Long term trendof ground water a number of structures are calculated and given below.

Table-8.6.21 - Proposed nos.& cost estimate of artificial recharge and conservation structures

Block (1)	**Block Area (2)**	**Area suitable for recharge (Considering area having DTW above 3m in post monsoon and showing 2m/y falling trend) (3)**	**Soil type (4)**	**Amount of water for artificial recharge and conservation (Ham) (5)**	**Source water allocation for with Artificial recharge in Ham -70 % of Col. 5 (6)**	Irrigation cum recharge Tank -35 % of Col. 5 (7)	Re-excavation of existing tanks with Recharge shaft - 35 % of Col. 5 **(8)**	Injection Well for recharging deeper aquifers - 20 % of Col. 5 (9)	Farm Pond- 10 % of Col. 5 (10)	**Nos. of** Irrigation cum recharge Tank -**@ 50 Ham per unit (11)**	**Nos. of** Re-excavation of existing tanks with Recharge **@ 10 Ham per unit (12)**	**Nos. of injection well suggested @ 30 Ham per unit (13)**	**Nos. of** Farm Pond @ **10 Ham per unit (14)**	**Cost of** Irrigation cum recharge Tank **@ Rs 8 lakh per unit (15)**	**Cost of REET with Recharge Shaft @ Rs 8 lakh per unit (16)**	**Cost of** Injection Well **@ Rs 15 lakh per unit**	**Cost of** Farm Pond **@ Rs 8 lakh per unit Remarks**	**Remarks**
Basirhat II	**13586**	**5740**	**Sandy/Clay Loam**	**793.82**	**555.67**	**277.84**	**277.84**	**158.76**	**79.38**	**6**	**28**	**16**	**8**	**48**	**224**	**240**	**64**	**Total estimated cost of proposed structures = Rs 576 lakh**

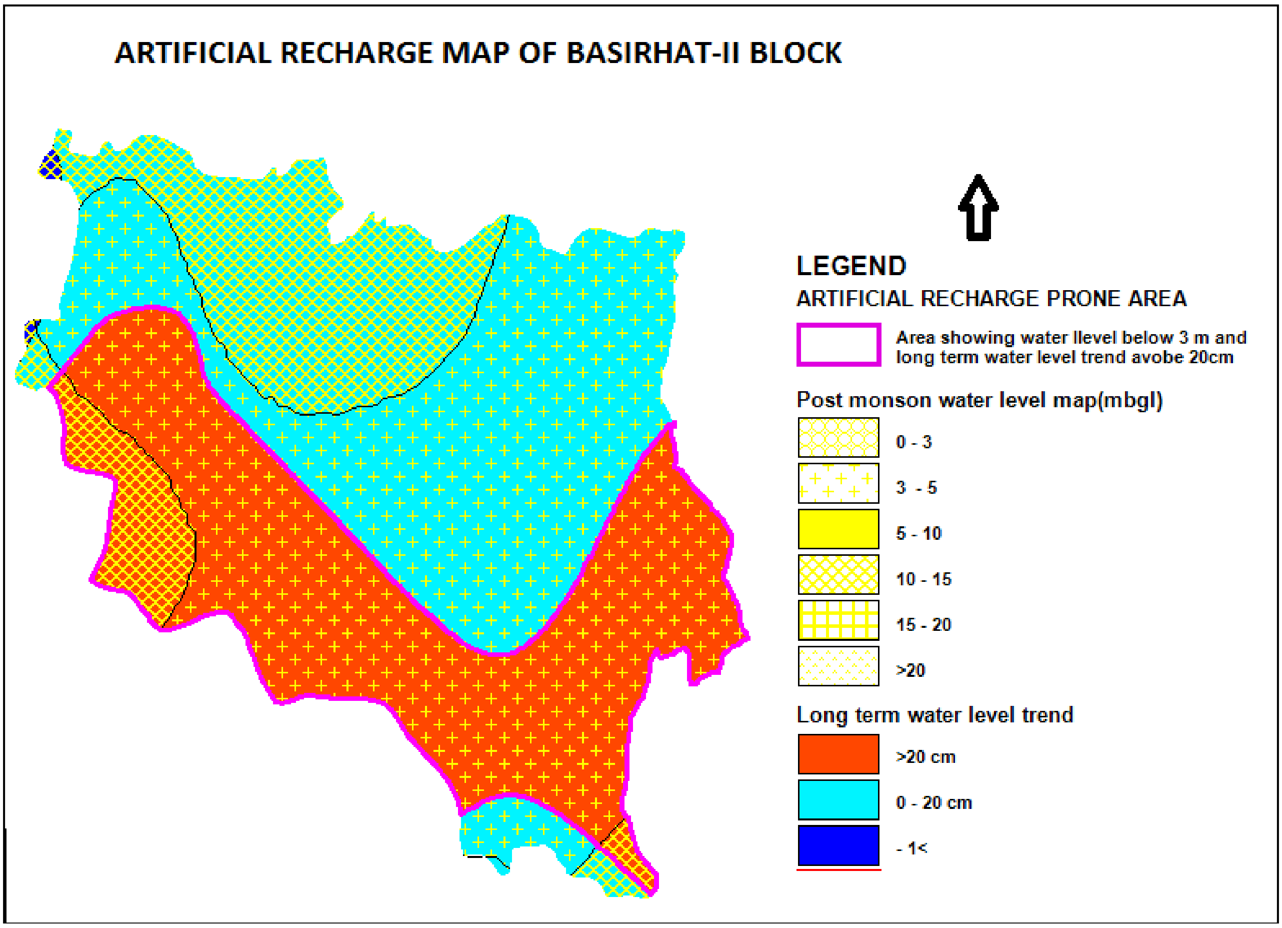


Fig-8.6.6:Area suitable for Artificial Recharge in Basirhat-II block

8.7 DEGANGA BLOCK

8.7.1 Salient Information:

Block Name: Deganga

Area (in Ha):**21106**

District: **North Twenty-Four Parganas**

State: **West Bengal**

Population (as in 2011):

Table-8.7.1 -Details of Population in Deganga block

Rural	Urban	Total
309550	9663	319213

Rainfall: Average annual rainfall (**North 24 Parganas** district)for the period 2012 -16 (in mm):**1555.76**

Table-8.7.2 -Annual Rainfall for last five years (in mm)

Block	District Normal	District Actual (Annual)				
		2012	2013	2014	2015	2016
Denganga	**1623.6**	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in Ha):

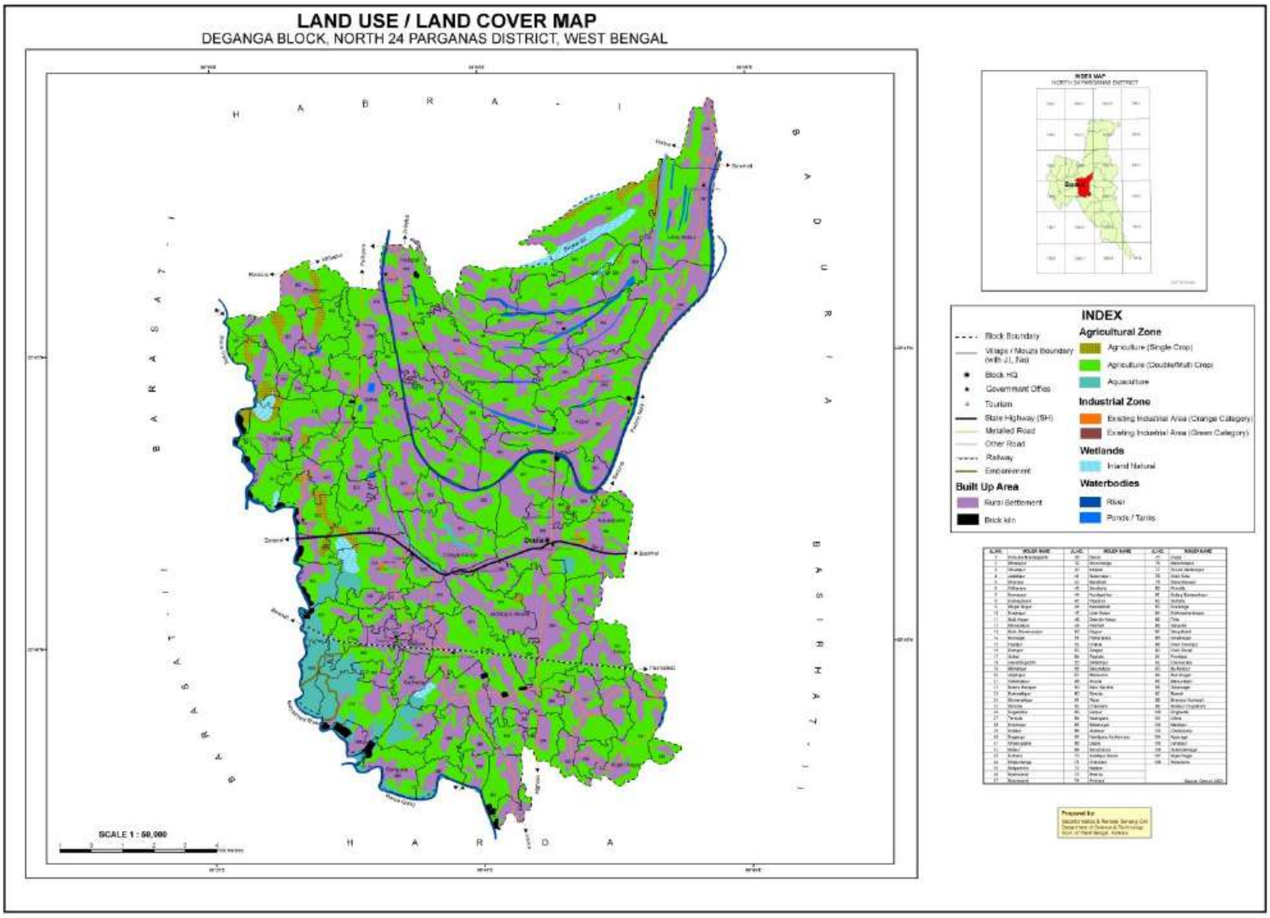
Table- 8.7.3–SalientLand use features inblock

Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Deganga	**21106**	**12000**	**1130**	**25**	**-**

Aquifer Wise Ground Water Resource Availability & Extraction:

Table- 8.7.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Extraction (for Aquifer I)
Dynamic Resource	103.3071	0.42	75.3903
Static Resource	3340.6577	-	-



(Source - Land& Land Reforms Dept., Govt. of W.B.)

Fig. 8.7.1: Landuse and land cover map of Deganga block

8.7.2 Disposition of Aquifer:

In Deganga Block, two aquifer systems are encountered:

- Aquifer I Group; in this group, IA: **0m - 85 m, IB: 83 m - 194 m**; both are contaminated by arsenic.
- Aquifer II Group: **212 m - 245m**, and it is fresh and arsenic free.

Table- 8.7.5 - Aquifer disposition in block

Block	Depth range of Aquifer in m bgl	
DENGANGA	Aquifer I	Aquifer II
	1A 0 - 85 1B 83-194	212 - 245

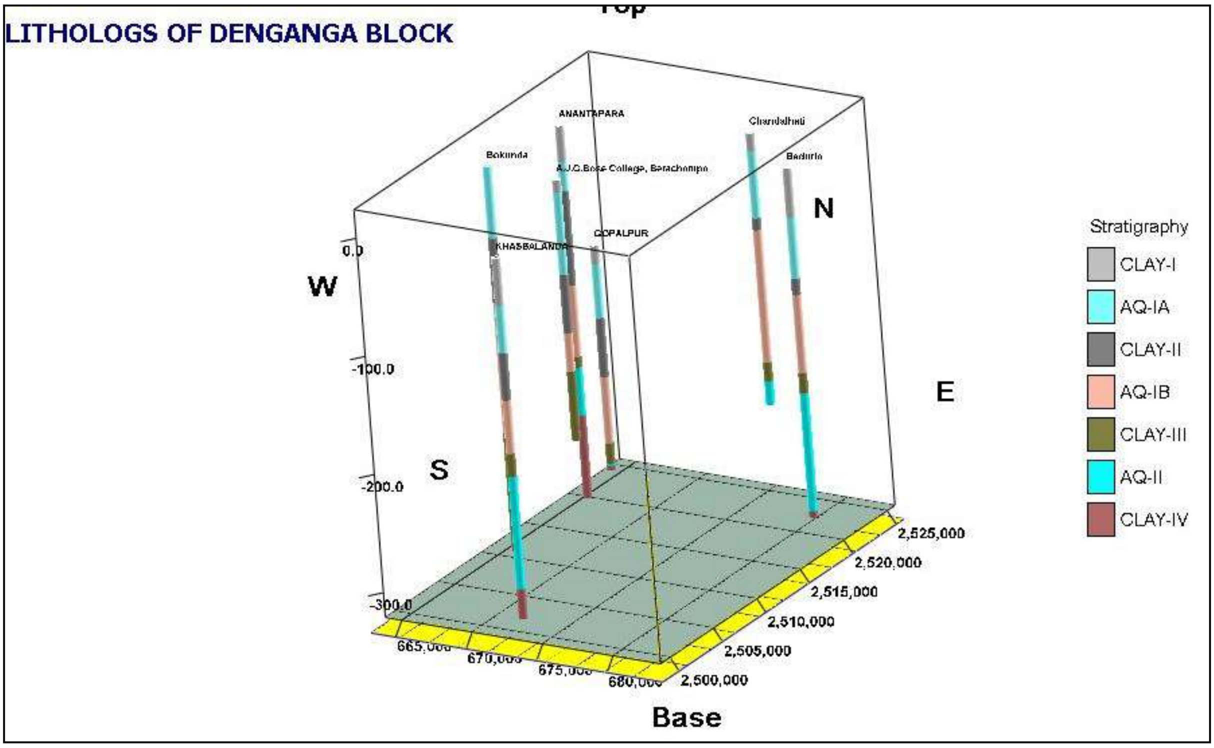


Fig.8.7.2: Stratigraphic logsin Deganaga block

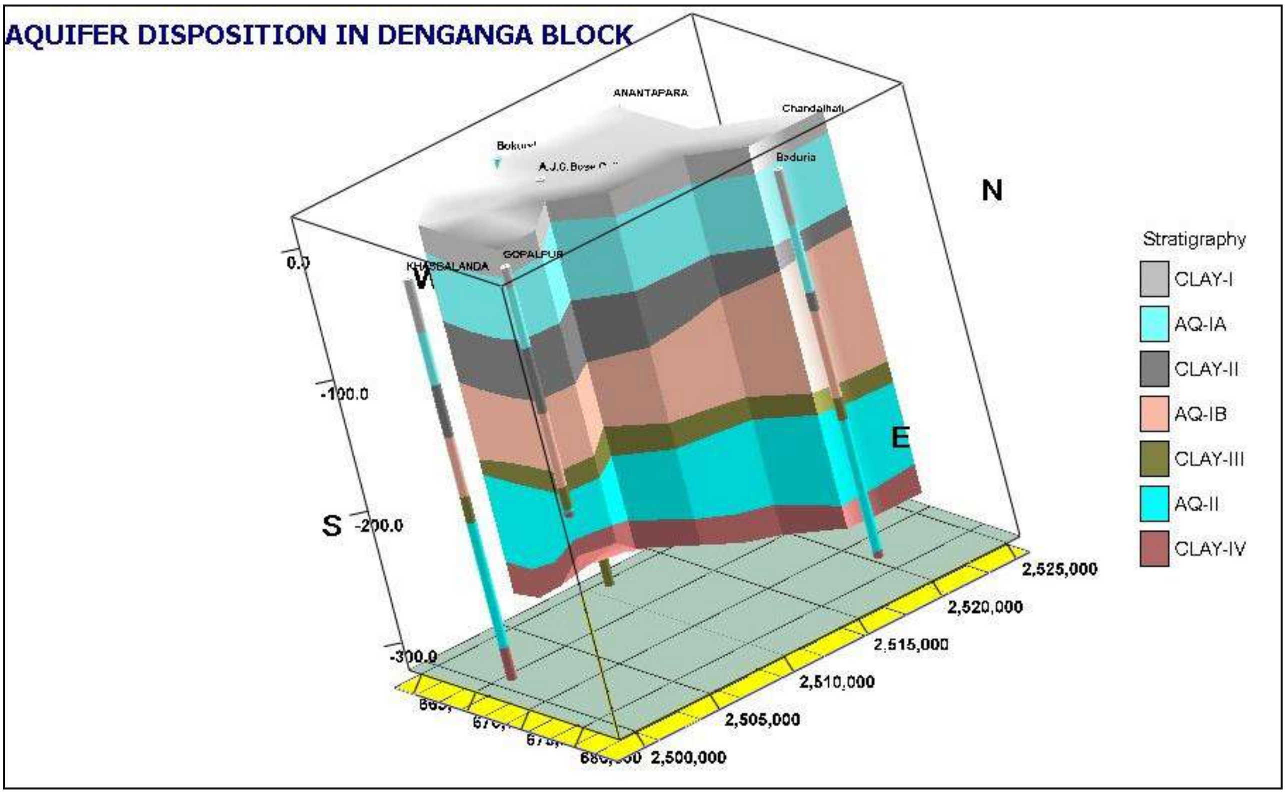


Fig. 8.7.3: 3D aquifer disposition in Deganga block

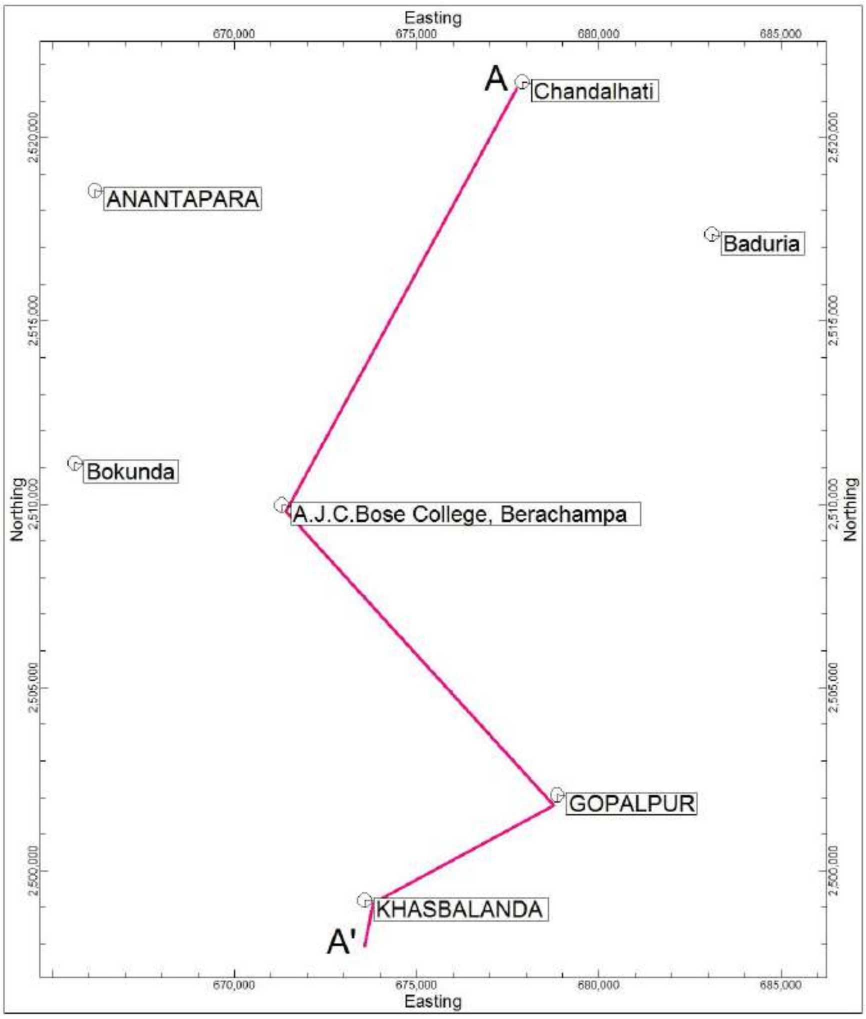


Fig. 8.7.4: N-S section index line in Deganga block

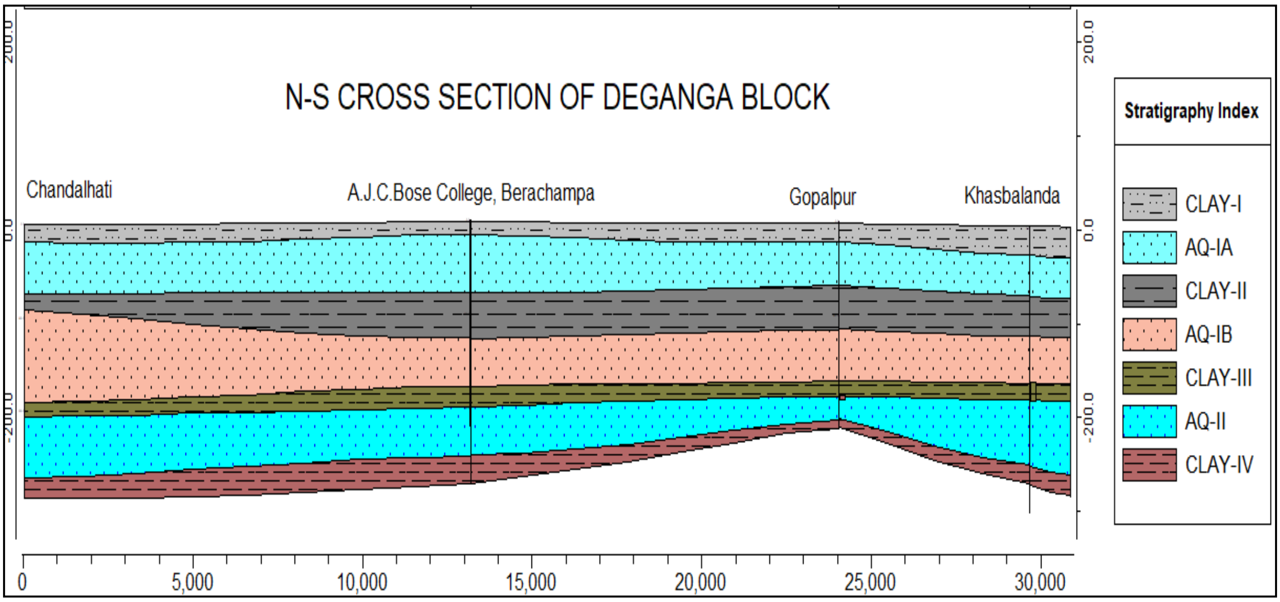


Fig8.7.5:N-S section in Deganga block

Table- 8.7.6 -Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

SI. No.	Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
			Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
1.	**Deganga**	I	**4.6-5.94**	**6.34**	-	**0.83-11.8**	-	**7.58**
2.	**Deganga**	II	**5.2-6.58**	-	-	**3.2-7.3**	-	-

Table-8.7.7-Aquifer wise maximum thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Deganga	21106	1A 85 1B 111	33

Table- 8.7.8- Aquiferwise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Denganga	1A 0 - 85 1B 83-194	64.8	2921.915	$2.29*10^{-4}$	212 - 245	39.61	3962	$4.86*10^{-6}$

8.7.3 Ground Water Resource, Extraction, Contamination &other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.7.9 -Ground Water resource in block

Block	Netground Water availability (MCM)	Gross ground Water draft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years (MCM)
Deganga	**10330.71**	**7539.03**	**58.12**	Safe	6.4572

Static (in-storage) Resources: 334065.77 Ham.

8.7.4 Chemical Quality of Ground Water & Contamination

Based ondata of Key wells of current year in this block average data of chemical parameter is given below. For Arsenic data, data of hydrograph stations of the area have been considered.

Table-8.7.10 -Aquifer wise average chemical parameter of block

Block	Aquifer Type	As(mg/l)	pH	EC (Us/Cm)	Na(mg/l)	Cl (mg/l)	F (mg/l)	NO3(mg/l)	Measured Hardness(mg/l)
Deganga	IB	0.003	8.23	450	17.69	7.09	0.20	0.1	155
Deganga	II	0.001	8.36	454	26.40	14.18	0.50	0	180

8.7.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- To cater potable water, modern technique, i.e.cement sealing to be applied; also arsenic removal plant should be installed.
- Regular Field monitoring of arsenic concentration in ground water in tube wells is required.
- As per PHED, Govt. of West Bengal data,22136 population in 4 villages (**Tentulia, Khejurdanga, Alipur Chandpur**) is under risk zone where no water supply scheme exists.
- Based on CGWB wells data (Discharge, T, S), nos. & cost for construction of wells required for projected population in 2021 has been estimated.
- In this block, a total of **6 wells** are needed in villages, where supply scheme does not exist.

Table-8.7.11- Details of Arsenic infested population in Deganga block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Recommendation for providing water supply to the risk population
Deganga	4	22136	Potential arsenic free aquifers within depth span of 212-245 m, separated from the upper aquifers system by thick clay layer of 10 to 30 m.

Table- 8.7.12: Estimation of Village wise number and cost for construction of Tube wells (based on CGWB exploratory well)

Block	**Village Name**	**Population 2011**	**Projected Population 2021 (decadal growth rate 12.04 %)**	**Present Water Requirement for Human Population in M^3 @70lpcd**	**Projected Water Requirement for Human Population in M^3 @70lpcd**	**Cattle 2011**	**Projected Cattle 2021**	**Present Water Requirement for cattle M^3 @20lpcd**	**projected Water Requirement for cattle M^3 @20lpcd**	**Total Water Requirement/day as on 2011 in M^3**	**Total Water Requirement/day as on 2021 in M^3**	**Discharge**	**hours**	**Discharge of one TW in M^3/day after 8 hours of pumping**	**No of TW**	**Cost of the Observation well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC**
Deganga	Tentulia	1185	1328	82.95	92.96	119	123	2.38	2.47	85.33	95.43	39.61	8	316.88	1	20
Deganga	Khejurdanga	4370	4896	305.9	342.72	437	453	8.74	9.06	314.64	351.78	39.61	8	316.88	1	20
Deganga	Alipur	7801	8740	546.07	611.8	780	809	15.6	16.17	561.67	627.97	39.61	8	316.88	2	40
Deganga	Chandpur	8780	9837	614.6	688.59	878	910	17.56	18.2	632.16	706.79	39.61	8	316.88	2	40
Deganga		**22136**	**24801**	**1549.52**	**1736.07**	**2214**	**2295**	**44.28**	**45.9**	**1593.8**	**1781.97**	**158.44**	**32**	**1267.52**	**6**	**120**

Management Plan for irrigation

Table - 8.7.13: Irrigation Scenario in Deganga block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Deganga	21106	12000	7851.15	4148.85	96.54	R- 6.34	F-7.58	5.22	3.72

Measures recommended

- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration in unconfined aquifer.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analyzed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8. 7.14 - Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management (considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Deganga	2634.59	As	wheat,rice,mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio &drip for vegetable& flowers

Table-8.7.15 - Crops in current practice

Name of Block		Deganga
Aus	Area	450
	Prod.	1.172
	Yield	2604
Aman	Area	8622
	Prod.	21.270
	Yield	2467
Boro	Area	8827
	Prod.	30.47
	Yield	3452
Wheat	Area	1184
	Prod.	3.146
	Yield	2657
Jute	Area	5068
	Prod.*	118.845
	Yield**	23.45
Musur	Area	137
	Prod.	0.155
	Yield	1131
Mustard	Area	2941
	Prod.	4.814
	Yield	1637
Til	Area	879
	Prod.	1.195
	Yield	1359
Potato	Area	1398
	Prod.	63.363
	Yield	45324

(Area in hectare, Production in Thousand MT and Yield in kg./hect.)

(Courtesy: Department of Economics and Statistics, Govt. of W. B.)

Table-8.7.15: Area of crops in current practice in Deganga block

Area wise Current Practice of crops								
Rabi Crops Cultivation (Wheat, Mustard and oil seeds water column requirement=0.21)		**Boro Cultivation (Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**Pulses (water column requirement =0.11 m)**		**Total Area covered(A)**
%	Area	%	Area	%	Area	%	Area	
32.6	5004	57.4	8827	9.1	1398	0.9	137	15366

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, it is 0.8and for determination of water requirement in the area this factor i.e. 0.8 is multiplied with the remaining cultivable area in the block. Using 60 % of this water requirement**,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.7.16) so that the maximum area of the remaining cultivable area may be covered; in this way 40 % of water could be saved. Main aim is to reduce area of boro cultivation and increase of rabi crops.

Table-8.7.16 -Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Present water availability (Ham)	Considering 60% water and 40 % for future irrigation(ham)	Rabi Crops Cultivation (Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation (Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses (water column requirement =0.11 m)		Total Area covered(A)	Remaining Cultivable area (4148.85-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
3319.08	1991.45	35	3319	40	664	20	664	5	905	5552	-1403.15
3319.08	1991.45	40	3793	40	664	15	498	0	0	4955	-806.15
3319.08	1991.45	25	2373	45	747	30	997	0	0	4117	31.85

Based on Table-8.7.16, out of 4148.85 ha, an area of 4117 Ha could be covered by better option of water allotment and by this an amount of 643.14 Ham could be saved as a measure of water conservation.

Proposed Artificial Recharge Structures in the block:

Table-8.7.18 -Area suitable for artificial recharge in the study area

District	Block Name	Area (in ha)	Area suitable for recharge, considering area having post monsoon DTW of 3m and more &showing 2m/yr falling trend(in Ha)
NORTH 24 PARGANAS	Deganga	**21106**	2051

Table- 8.7.19 - Estimation of Surface runoff component based on method of Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Deganga	**Sandy/Clay Loam**	**5629.44**	**4222.08**	**2111.04**	**1266.62**

A* - area, C - run off coefficient from Normal Monsoon Rainfall**

Based on soil characteristic, slope, normal monsoon rainfall and long term trend, number of suitable structures and cost have been calculated and are given in Table 8.7.20.

Table-8.7.20: Proposed structures & cost estimate in block

Block (1)	Block Area (2)	Area suitable for recharge, considering area having Post monsoon DTWof 3m & morein and showing 0.20 m/y falling trend in shallow aquifer (3)	Soil type (4)	Amount of water for artificial recharge and conservation (Ham) (5)	Source water allocation for Artificial recharge - 70 % of Col. 5 (6)	Source water allocation for irrigation cum recharge Tank - 50% of Col. 6 (7)	Source water allocation for REET with recharge Shaft- 50% of Col. 6 (8)	Source water allocation for Injection for Injection wells - 20% of Col. 5 (9)	Source water allocation for Farm Ponds -10% of Col. 5 (10)	Nos. of irrigation cum recharge Tank suggested @ 50 Ham per unit	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit	Nos. of injection well suggested @ 30 Ham per unit	Nos. of FarmPonds suggested @ 30 Ham per unit	Cost of irrigation cum recharge Tank @ Rs 8 lakh per unit	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of injection well @ Rs 3 lakh per unit	Cost of Farm Ponds @ Rs 8 lakh per unit	Remarks
Deganga	21106	2051	Sandy/Clay Loam	1266.62	886.64	443.32	443.32	379.99	122.66	9	44	13	4	72	352	39	32	In parts, water level is shallow; injection well is suitable structure; total tentative cost of structure = 495 lakh

***REET – Reexcavation of existing tank**

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Irrigation cum recharge tank – size 100m*100m*5m, Filling -10 times, capacity – 50 Ham; for recharge and irrigation
- Farm pond- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

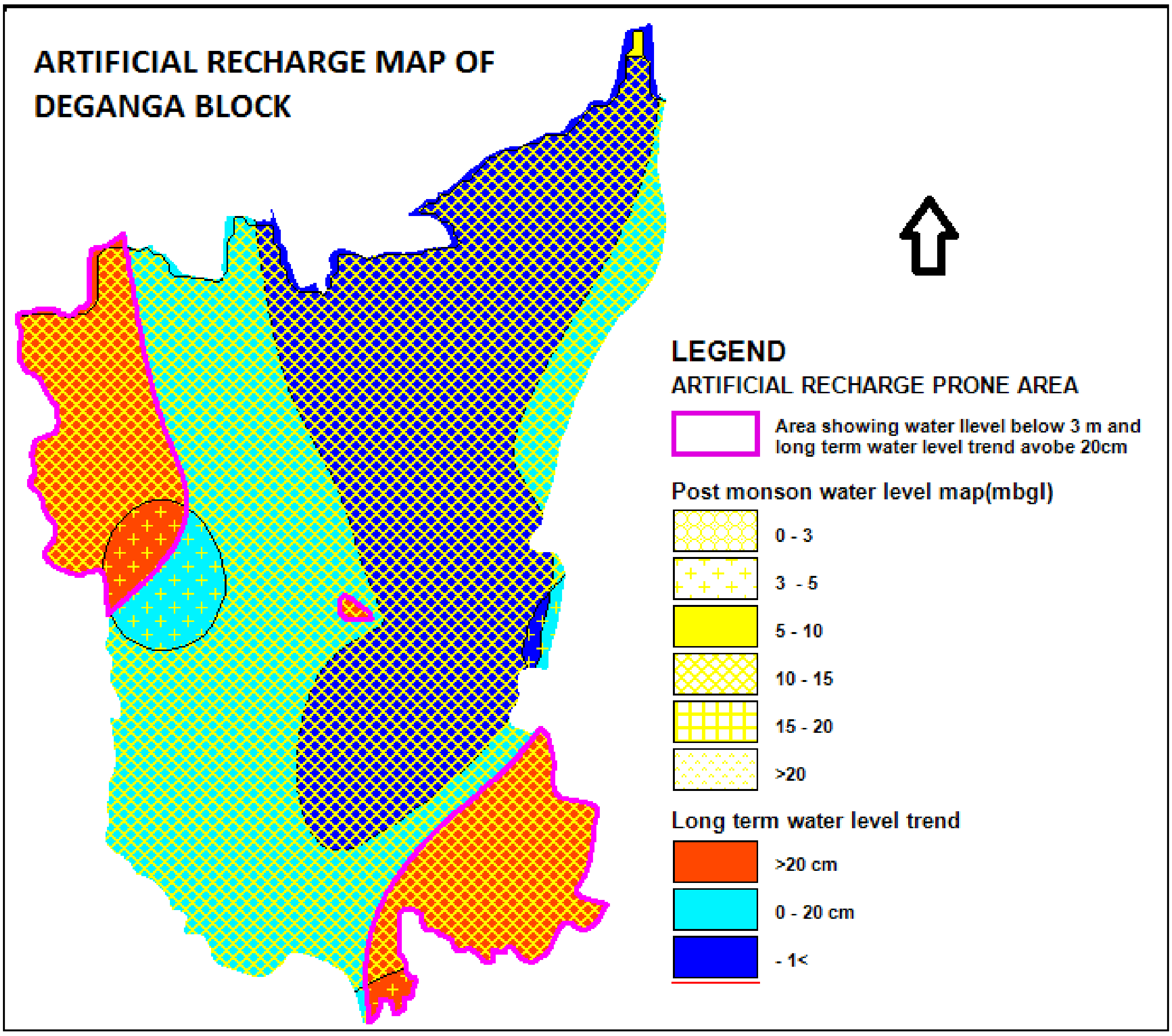


Fig-8.7.6: Area suitable for Artificial Recharge in Degangablock

8.8 RAJARHAT BLOCK

8.8.1 Salient Information:

Block Name: Rajarhat

Area (in Ha):**16799**

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table-8.8.1 - Details of Population in Rajarhat block

Rural	Urban	Total
-	402844	402844

Rainfall: Average annual rainfall (**North 24 Parganas** district)for the period 2012-16(in mm):1555.76

Table-8.8.2 -Rainfall for last five years

District	District Normal	District Annual (in mm)				
		2012	2013	2014	2015	2016
North 24 Parganas	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

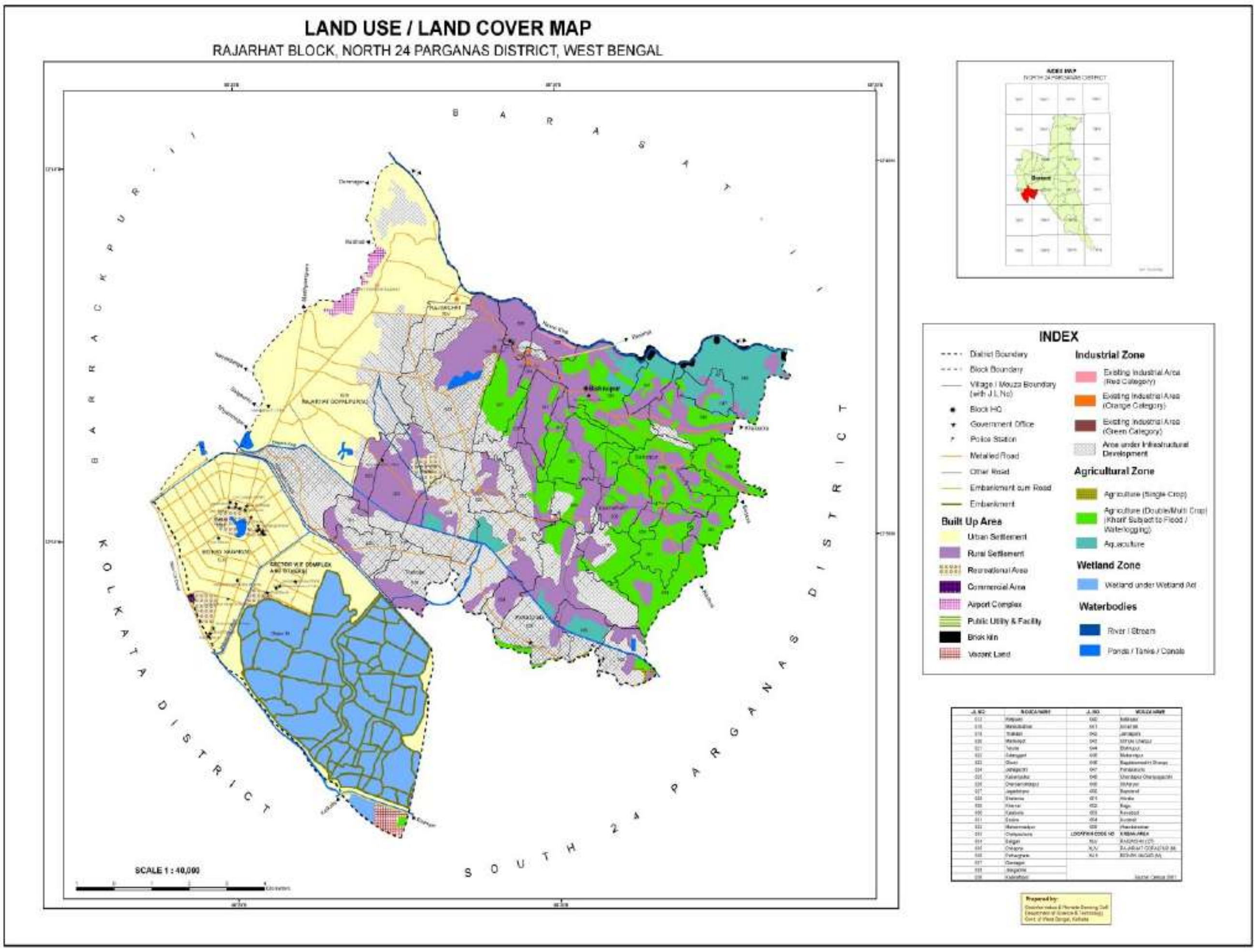
Table- 8.8.3–Salient Land use features in Rajarhat block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Rajarhat	**16799**	**3958**	**458**	**15**	**-**

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.8.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Extraction (for Aquifer I)
Dynamic Resource	44.3307	0.30	19.15
Static Resource	1684.94	-	-



(Courtsey: Land & land Reforms Dept., Govt. of W. B.)

Fig.9.8.1: Land use& Land cover map of Rajarhat block

8.8.2 Disposition of Aquifer

In Rajarhat Block, two aquifer systems are explored.

- Aquifer I: aquifer IA between 5 m & 62 m, aquifer IB within 54 - 219 m**;** both having Arsenic contamination.
- Aquifer II ranges from 184m to 245m, which is fresh and Arsenic free.

Table- 9.8.5 -Details of aquifer disposition in block

Block	Depth range of Aquifer in m bgl	
Rajarhat	Aquifer I	Aquifer II
	1A 5 – 62 1B 54-219	184-245

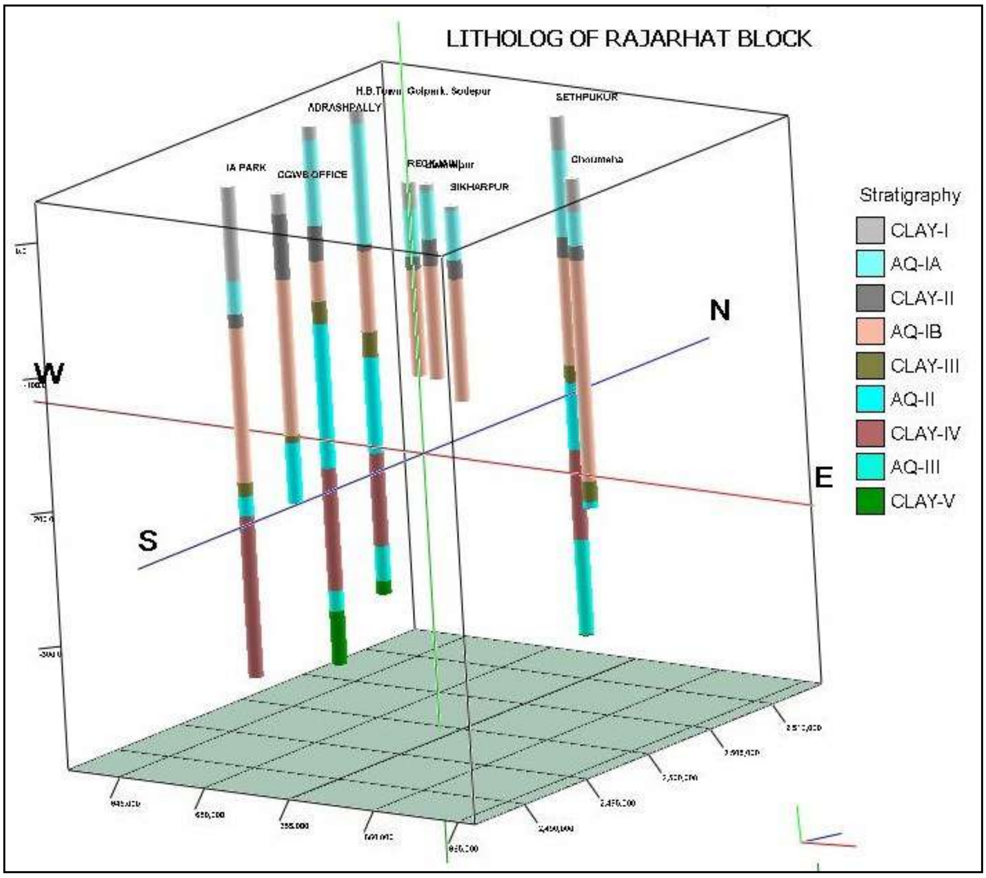


Fig-8.8.2: Stratigraphic logs in Rajarhat block

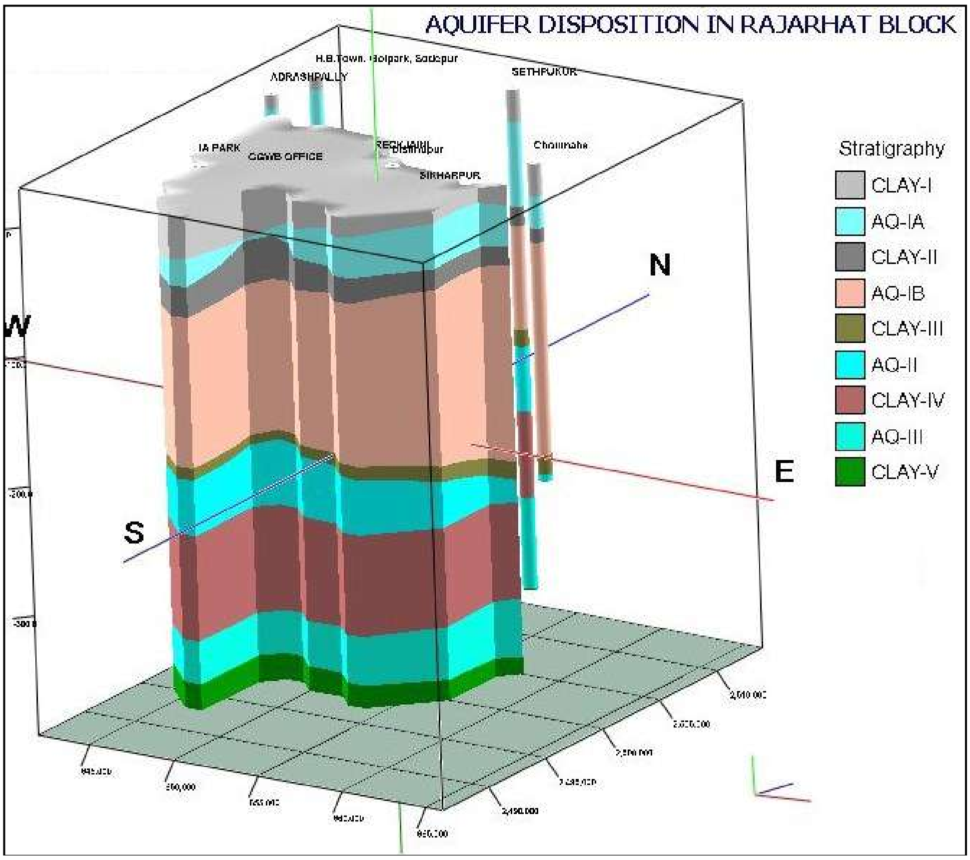


Fig-8.8.3: 3 D aquifer disposition in Rajarhat block

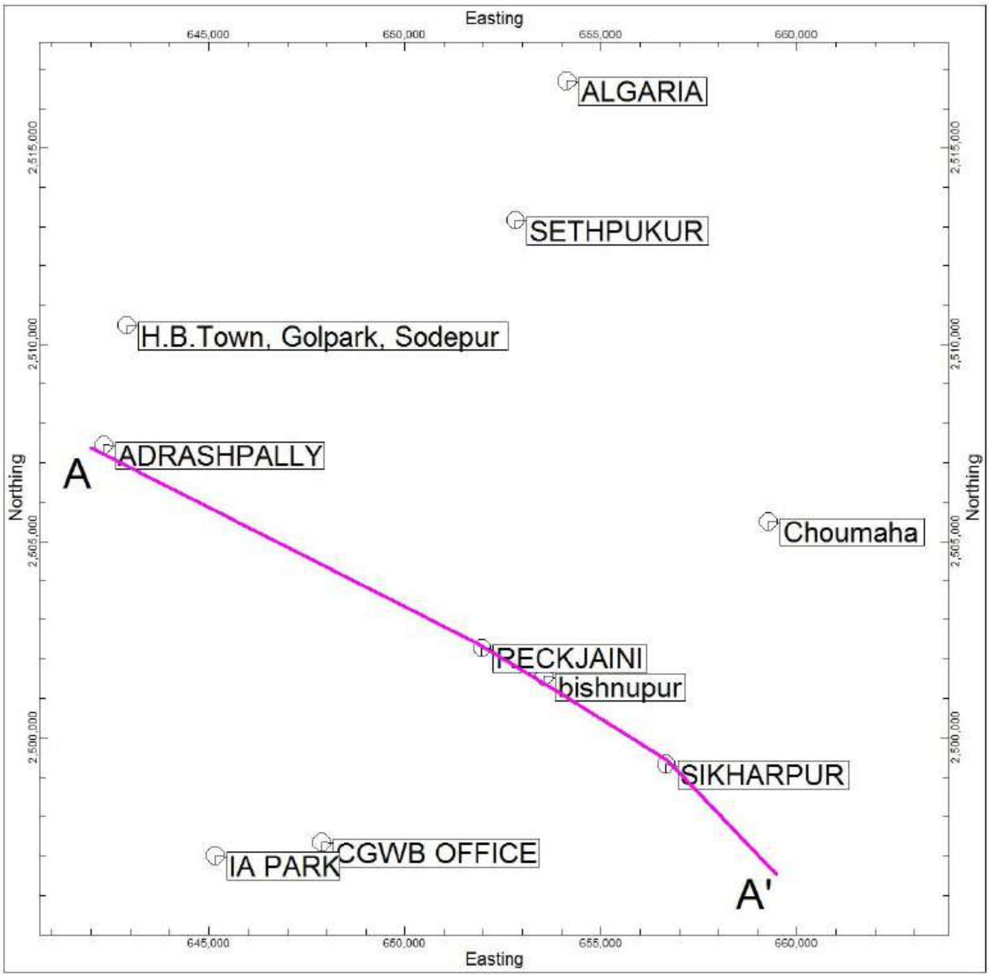


Fig.8.8.4: NW-SE section index line in Rajarhat block

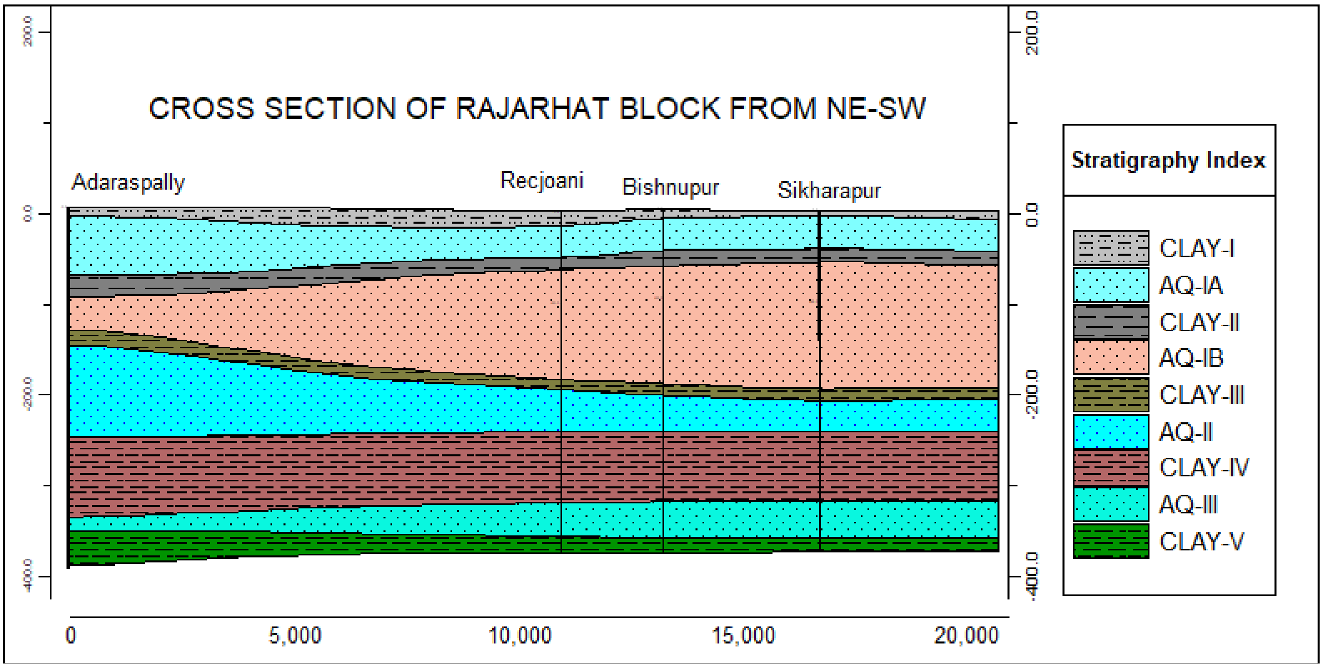


Fig-8.8.5: NW-SE cross section in Rajarhat block

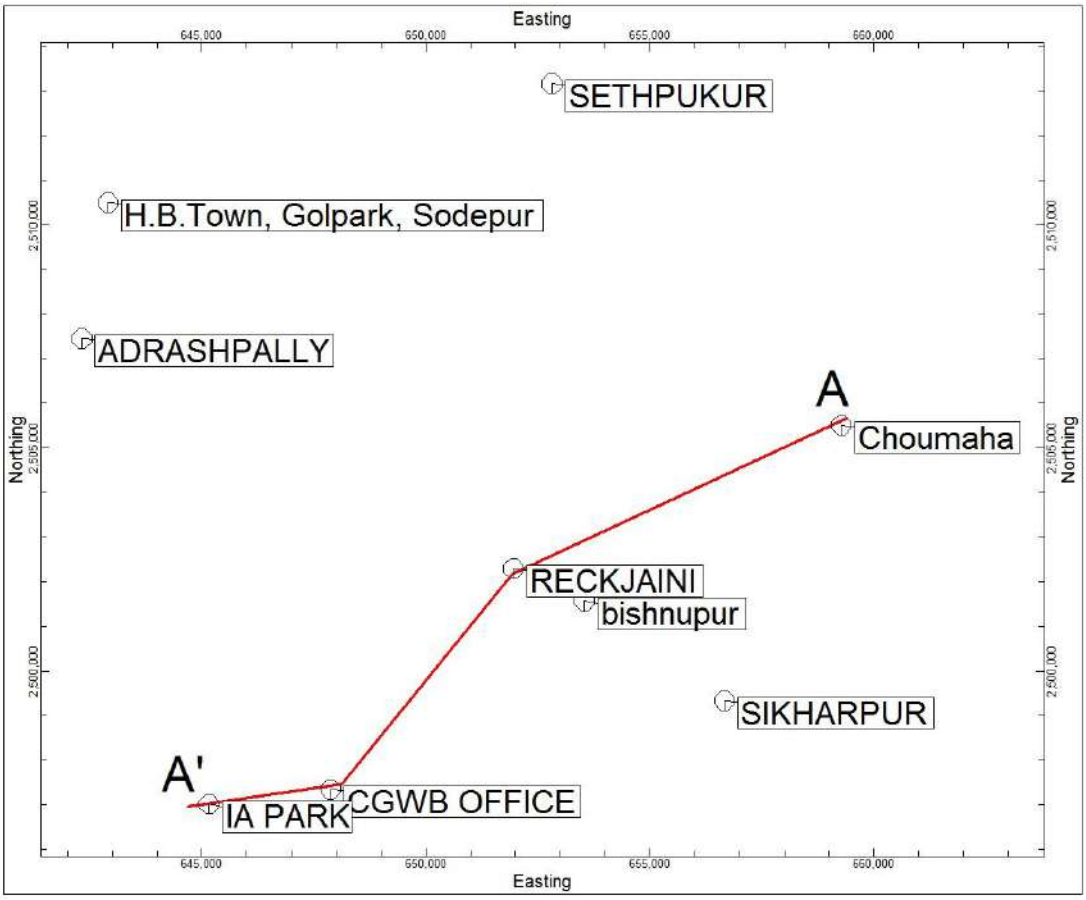


Fig. 8. 8.6: NE-SW section index line in Rajarhat block

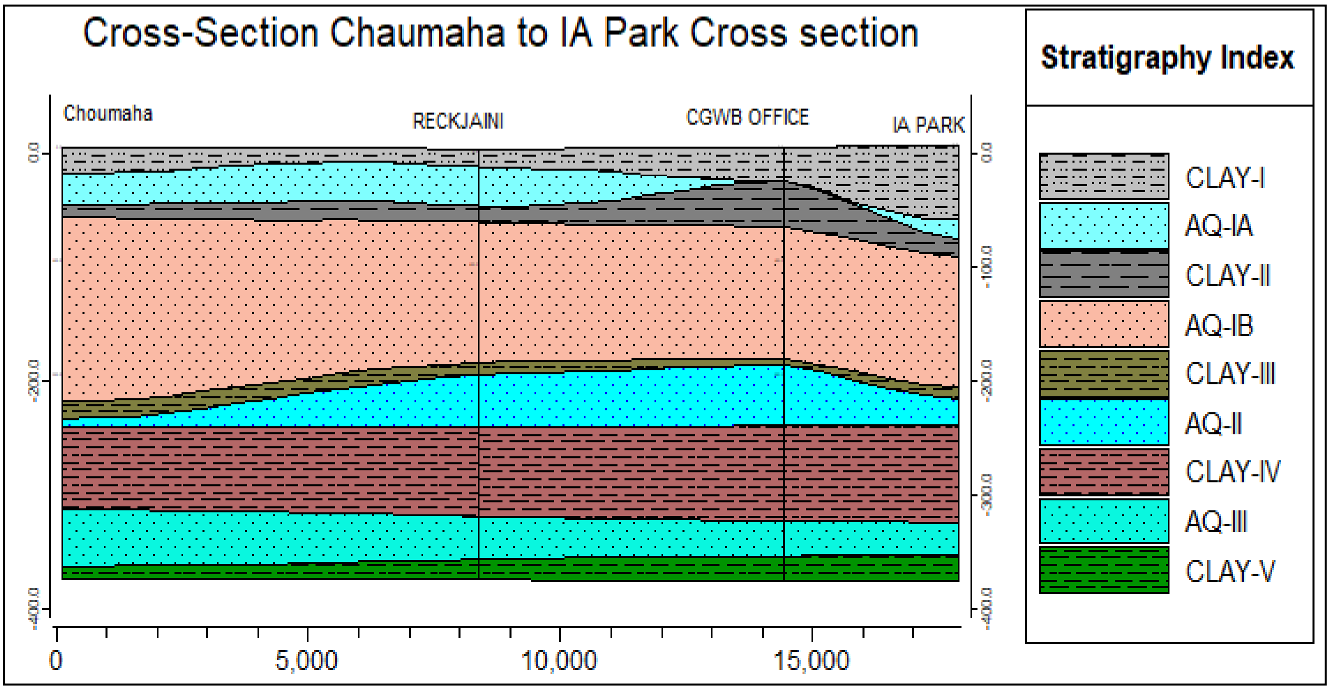


Fig-8.8.7:NE-SW cross section in Rajarhat block

Table- 8.8.6: Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

SI. No.	Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
			Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
1.	**Rajarhat**	I	**6.3-16.24**	-	**5.37**	**4.52-6.77**	-	**5.76**
2.	**Rajarhat**	II	**7.82 - 8.1**	-	-	**6.3-14.1**	-	-

Table-8. 8.7:Aquifer wise maximum thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Rajarhat	16799	1A 57 1B 165	61

Table-8. 8.8: Aquifer-wise depth range and parameters (based on CGWB exploration data)

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Rajarhat	1A 5 – 62 1B 54-219	62.04	2003	$2.04 * 10^{-5}$	184-245	41.22	1618	6.5×10^{-4}

8.8.3 Ground Water Resource, Extraction, Contamination &other Issues:

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources as on 31st March'13

Table-8.8.9 -Availability of Ground Water resource in Block

Block	Net ground Water availability	Gross ground Water draft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Rajarhat	4433.07	1915.16	43.20	Safe	13.63

Static (in-storage) Resources: 168493.97 Ham.

8.8.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data blocks wise average data of chemical parameters are given below. For ground water by arsenic, data of hydrograph stations of CGWB has been considered.

Table-8. 8.10 -Aquifer wise average chemical parameters in block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Measured Hardness (mg/l)
Rajarhat	IA	0.382	8.43	1170	175.31	219.82	0.64	0	310
Rajarhat	IB	0.018	8.46	503	29.01	17.73	1.18	3.63	215
	II	0.003	-	-	-	-	-	-	-

Table- 8.8.11 -Arsenic affected Risk Population

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max.concentration
		%	No.	%	No.	%	No.	
Rajarhat	**1044**	**59.58**	**622**	**31.80**	**332**	**8.62**	**90**	**0.41**

(Source: PHED, Govt. of W. B.)

8.8.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- To cater potable water in the arsenic infested area, construction of tube wells has to be constructed by cement sealing against clay layer above the fresh ground water bearing aquifer i.e. the 2nd Aquifer between **184m to 245m. A**rsenic removal plant should also be installed.
- Regular monitoring of arsenic concentration in ground water in tube wells should also be conducted.
- As per PHED, Govt of West Bengal, 110063 population in 20 villages is under risk zone where no water supply scheme exists.
- Attempt has been made to determine the nos. of tube wells and cost of construction of these wells for projected population in 2021.
- In this block a total of 32 tube wells are needed to cover pipe water supply in uncovered area.

Table- 8.8.12 -Arsenic infested population in Rajarhatblock

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Recommendation on providing water supply to the risk population
Rajarhat	20	110063	Potential arsenic free aquifers in the depth span of 184-245 mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m; third aquifer or Aquifer III is expected to be at a depth of 300 m.

Table- 8.8.13 -Estimation of Village wise nos. of required tube wells& tentative cost of construction

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement /day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of the well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Akandakeshari	2847	3190	199.29	223.3	285	295	5.7	5.91	204.99	229.21	41.34	8	330.72	1	20
Bagdobamachhi Bhanga	4483	5023	313.81	351.61	448	464	8.96	9.29	322.77	360.9	41.34	8	330.72	1	20
Baligari	4193	4698	293.51	328.86	419	434	8.38	8.69	301.89	337.55	41.34	8	330.72	1	20
Bishnupur	12660	14184	886.2	992.88	1266	1312	25.32	26.25	911.52	1019.13	41.34	8	330.72	3	60
Chandapur Champagachhi	6431	7205	450.17	504.35	643	667	12.86	13.33	463.03	517.68	41.34	8	330.72	2	40
Chhapna	2519	2822	176.33	197.54	252	261	5.04	5.22	181.37	202.76	41.34	8	330.72	1	20
Dharsamoktarpur	2566	2875	179.62	201.25	257	266	5.14	5.33	184.76	206.58	41.34	8	330.72	1	20
Ganragari	1907	2137	133.49	149.59	191	198	3.82	3.96	137.31	153.55	41.34	8	330.72	1	20
Ghuni	24249	27169	1697.43	1901.83	2425	2514	48.5	50.27	1745.93	1952.1	41.34	8	330.72	6	120
Jamalpara	2694	3018	188.58	211.26	269	279	5.38	5.58	193.96	216.84	41.34	8	330.72	1	20
Jatragachhi	6890	7720	482.3	540.4	689	714	13.78	14.28	496.08	554.68	41.34	8	330.72	2	40
Kadampukur	1981	2220	138.67	155.4	198	205	3.96	4.1	142.63	159.5	41.34	8	330.72	1	20
Kalikapur	1666	1867	116.62	130.69	167	173	3.34	3.46	119.96	134.15	41.34	8	330.72	1	20
Kasinathpur	2166	2427	151.62	169.89	217	225	4.34	4.5	155.96	174.39	41.34	8	330.72	1	20
Mahammadpur	4141	4640	289.87	324.8	414	429	8.28	8.58	298.15	333.38	41.34	8	330.72	1	20
Mobarekpur	3628	4065	253.96	284.55	363	376	7.26	7.53	261.22	292.08	41.34	8	330.72	1	20
Panapukuria	2522	2826	176.54	197.82	252	261	5.04	5.22	181.58	203.04	41.34	8	330.72	1	20
Raigachhi (CT)	8245	9238	577.15	646.66	825	855	16.5	17.1	593.65	663.76	41.34	8	330.72	2	40
Sulanggari	13496	15121	944.72	1058.47	1350	1399	27	27.99	971.72	1086.46	41.34	8	330.72	3	60
Umarhati	779	873	54.53	61.11	78	81	1.56	1.62	56.09	62.73	41.34	8	330.72	1	20
	110063	**123318**	**7704.41**	**8632.26**	**11008**	**11411**	**220.16**	**228.21**	**7924.57**	**8860.47**	**41.34**	**8**	**330.72**	**32**	**640**

- For monitoring of the ground water regime, cost of construction of observation well, if needed, should also be included in the expenditure.
- In the initial stage, 25 % wells should be constructed. Based onthe result, whole plan could be implemented.

Management Plan for irrigation

Table-8. 8.14 - Irrigation scenario in the block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Rajarhat	16799	3958	1097.94	2860.06	43.2	*F- 5.37	F-5.76	12.2	5.64

*F - falling

Measures Recommended

- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration in unconfined aquifer.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analyzed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.8.15 – Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Rajarhat	2186.2	As,Salinity	wheat,rice,mustard, vegetables lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable (0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil ,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio for vegetable,flowers

Table-8. 8.16 - Crops in regular practice

Name of Block		Rajarhat
Aus	Area*	750
	Prod.*	1.732
	Yield*	2309
Aman	Area	1748
	Prod.	4.237
	Yield	2424
Boro	Area	1114
	Prod.	3.656
	Yield	3282
Wheat	Area	40
	Prod.	0.098
	Yield	2442
Jute	Area	118
	Prod.*	2.130
	Yield**	18.05
Musur	Area	34
	Prod.	0.032
	Yield	952
Mustard	Area	477
	Prod.	0.610
	Yield	1278
Til	Area	195
	Prod.	0.224
	Yield	1148
Potato	Area	25
	Prod.	0.549
	Yield	21976

*Area in hectare, Production in Thousand MT and Yield in kg./hect.
(Courtesy: Department of Economics and Statistics, Govt. of West Bengal)

Table-8.8.17 -Area of crops in Rajarhat block

Area wise Current Practice of crops								
Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		**Boro Cultivation(Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**pulses(water column requirement =0.11 m)**		**Total Area covered(A)**
%	Area	%	Area	%	Area	%	Area	
37.8	712	59.1	1114	1.3	25	1.8	34	1885

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, it is 0.8and for determination of water requirement in the area this factor i.e. 0.8 is multiplied with the remaining cultivable area in the block. Total water required is 2288.05 Ham; but practically as per Ground Water Assessment less i.e. 2186.2 Ham water is available. Now using 60 % of water available i.e. 2186.2 Ham**,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.8.17) so that the maximum area of the remaining cultivable area may be covered; in this way 40 % of water could be saved.

Main aim is to reduce area of boro cultivation and increase of rabi crops.

Table-8.8.17 -Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Present water availability(ham)	Considering 60% water and 40 % for future irrigation (ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses(water column requirement =0.11 m)		Area to be covered (A)	Remaining Cultivable area (2860.06 - A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
2186.2	1311.72	40	2498.51	45	491.90	10	218.62	5	596.23	3805.26	-945.20
2186.2	1311.72	40	2498.51	50	546.55	5	109.31	5	596.23	3750.60	-890.54
2186.2	1311.72	35	2186.2	55	601.21	10	218.62	0	0	3006.03	-145.97

Based on Table8.8.17, in 2860.06 ha area, irrigation may be done in 35:55:10 ratio of irrigation water in Rabi, Boro and Vegetables.

Proposed Artificial Recharge Structures in the study area:

Table-8.8.19 -Area suitable for recharge in the study area

District	Block Name	Area (in ha)	Area in hasuitable for recharge (Considering area having DTWfor shallow aquifer more than 3m in post-monsoon and showing falling trend of 2m/yr and above)
NORTH 24 PARGANAS	Rajarhat	**16799**	**9132**

Table-8.8.20 – Estimation of Surface runoff component after Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Rajarhat	**Clay/Silty Loam**	**1624.67984**	**1218.51**	**609.25494**	**365.552964**

A* - Area, C** - run off coefiicient from Normal Monsoon Rainfall

Table-8.8.21 – Possible Recharge & conservation structures in block

Based on soil characteristic, slope, and rainfall nos. of possible structures have been assessed.

Block (1)	Block Area (2)	Area suitable for recharge (3)	Soil type (4)	Amount of water for artificial recharge and conservation (Ham) (5)	Source water allocation for allocation for Artificial recharge - 70 % of Col. 5 (6)	Source water allocation for irrigation cum recharge Tank - 50% of Col. 6 (7)	Source water allocation for REET with recharge Shaft- 50% of Col. 6 (8)	Source water allocation for Injection for Injection wells - 20% of Col. 5 (9)	Source water allocation for Farm Ponds - 10 % of Col. 5 (10)	Nos. of irrigation cum recharge Tank suggested @ 50 Ham per unit	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit	Nos. of injection well suggested @ 30 Ham per unit	Nos. of FarmPonds suggested @ 10 Ham per unit	Cost of irrigation cum recharge Tank @ Rs 8 lakh per unit	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of injection well @ Rs 15 lakh per unit	Cost of Farm Ponds @ Rs 8 lakh per unit	Remarks
Rajarhat	**16799**	**9132**	**Clayey /Silty Loam**	**365.55**	**255.89**	**127.94**	**127.94**	**73.11**	**36.56**	**3**	**13**	**2**	**4**	**24**	**104**	**30**	**32**	**-**

***REET – Reexcavation of existing tank**

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Irrigation cum recharge tank – size 100m*100m*5m, Filling -10 times, capacity – 50 Ham; for recharge and irrigation
- Farm pond- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

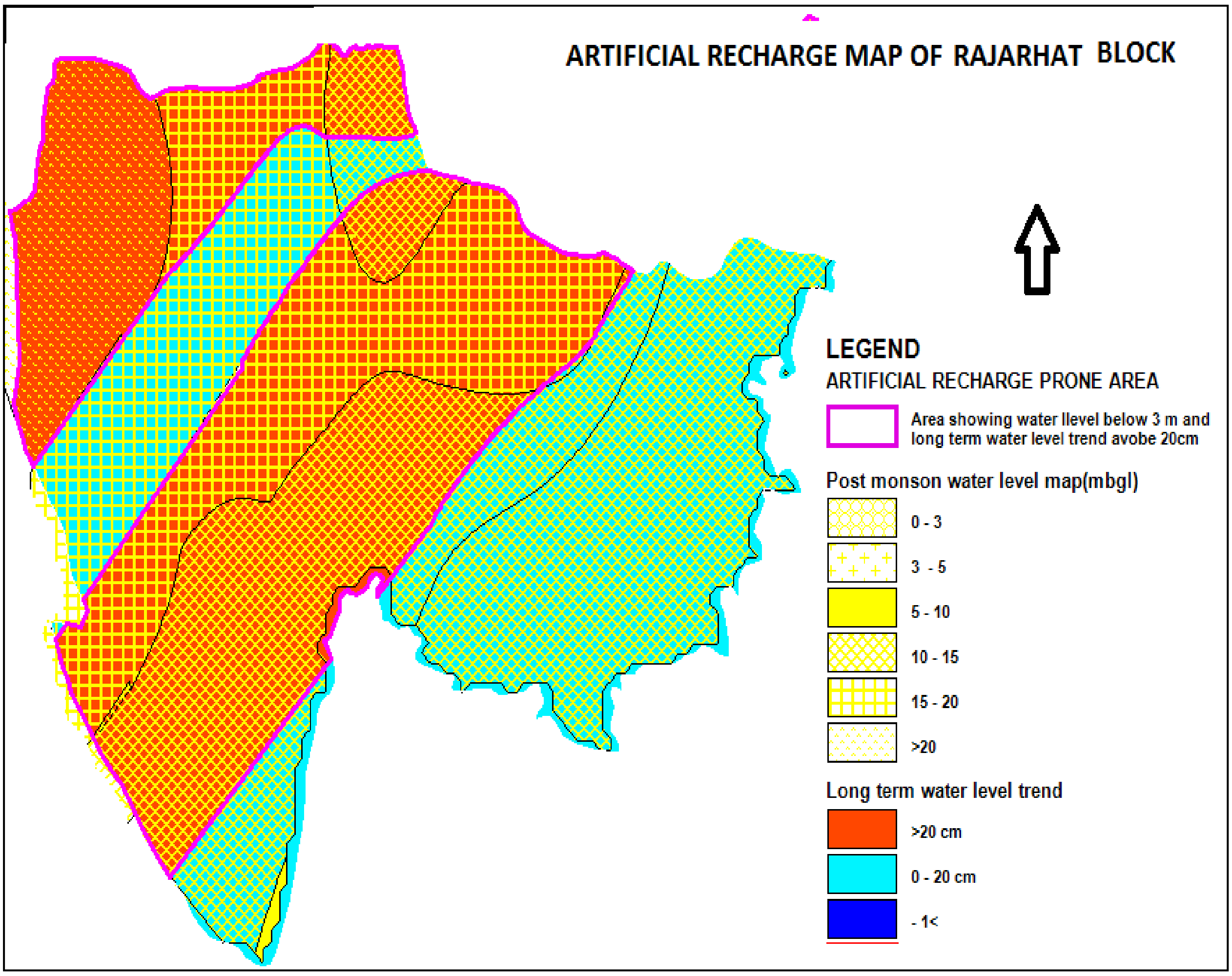


Fig-8.8.8: Area suitable for Artificial Recharge in Rajarhat block

8.9 SWARUPNAGAR BLOCK

8.9.1 Salient Information:

Block Name: Swarupnagar

Area (in Ha):22417

District: North Twenty Four Parganas

State: West Bengal

Population (as on 2011):

Table- 8.9.1:Population in Swarupnagar block

Rural	Urban	Total
251715	4360	256075

Rainfall: Average annual rainfall (**North 24 Parganas** district)for the period 2012 -16 (in mm):1555.76

Table-8.9.2- Annual Rainfall for last five years

Block	District Normal	District Annual (in mm)				
		2012	2013	2014	2015	2016
Swarupnagar	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

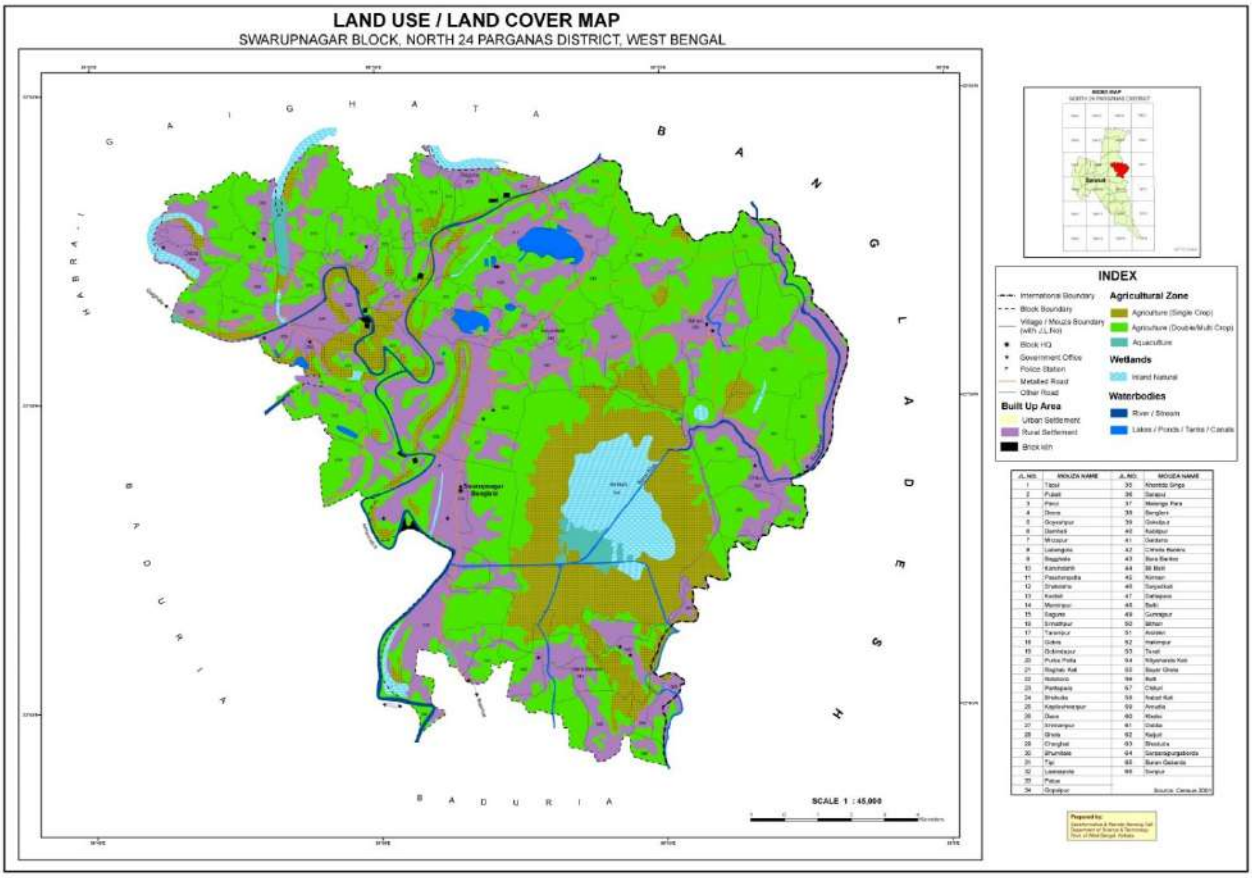
Table- 8.9.3– Salient Landuse features of block

SI. No	Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
1.	**Swarupnagar**	**22417**	**13120**	**655**	**237**	**-**

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.9.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Extraction (for Aquifer I)
Dynamic Resource	119.3264	0.38	90.6813
Static Resource	4880.1809	-	-



(Source: Land & Land Reforms Dept., Govt. of W. B.)

Fig.-8.9.1: Land Use& Land Cover Map of Swarupnagar block

8.9.2 Disposition of Aquifer:

In Swarupnagar block, two aquifer systems are encountered

- Aquifer I –aquifer IA:**0m - 113 m**; aquifer IB: **106 m - 191 m**;both of these are contaminated by arsenic.
- Aquifer II ranges between **223 m and 296 m**, which is fresh and arsenic free.

Table- 8.9.5 - Depth range in block

Block	**Depth range of Aquifer in mbgl**			
SWARUPNAGR	1st Aquifer	2nd aquifer	3rd aquifer	Remarks
	1A 0 - 113 1B 106 - 191	223 - 296	-	1B aquifer is saline due to entrapped salinity(depth 106-191)

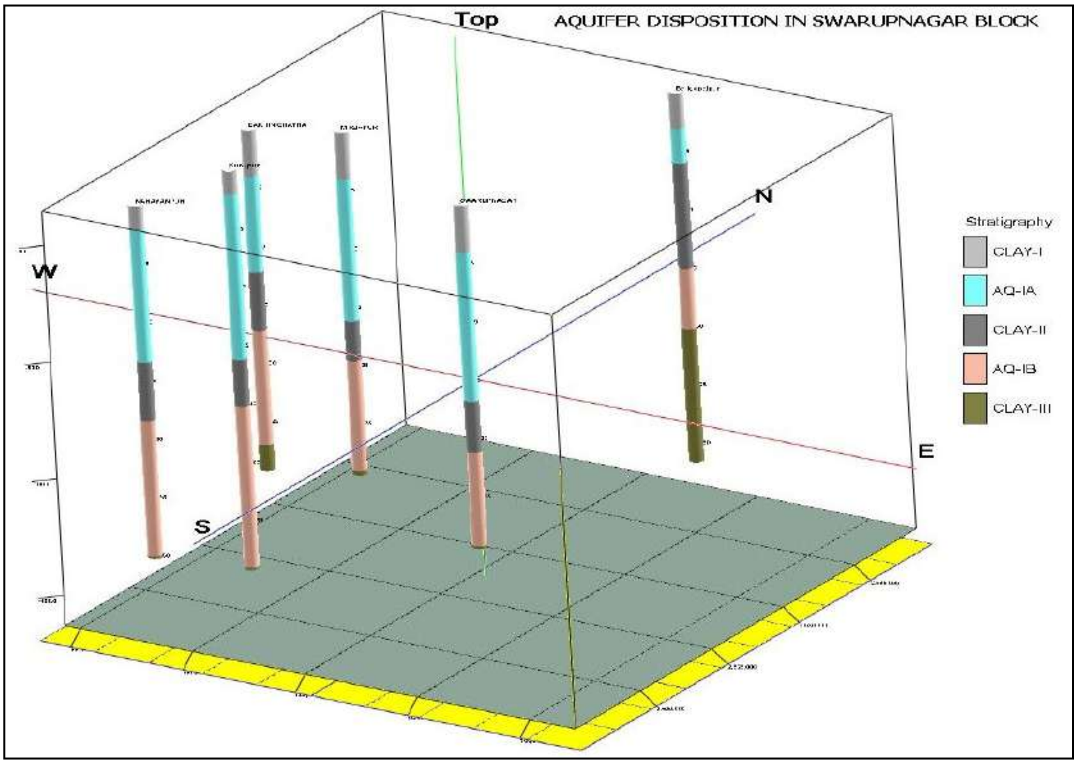


Fig.8. 9.2: Stratigraphic logs in Swarupnagar block

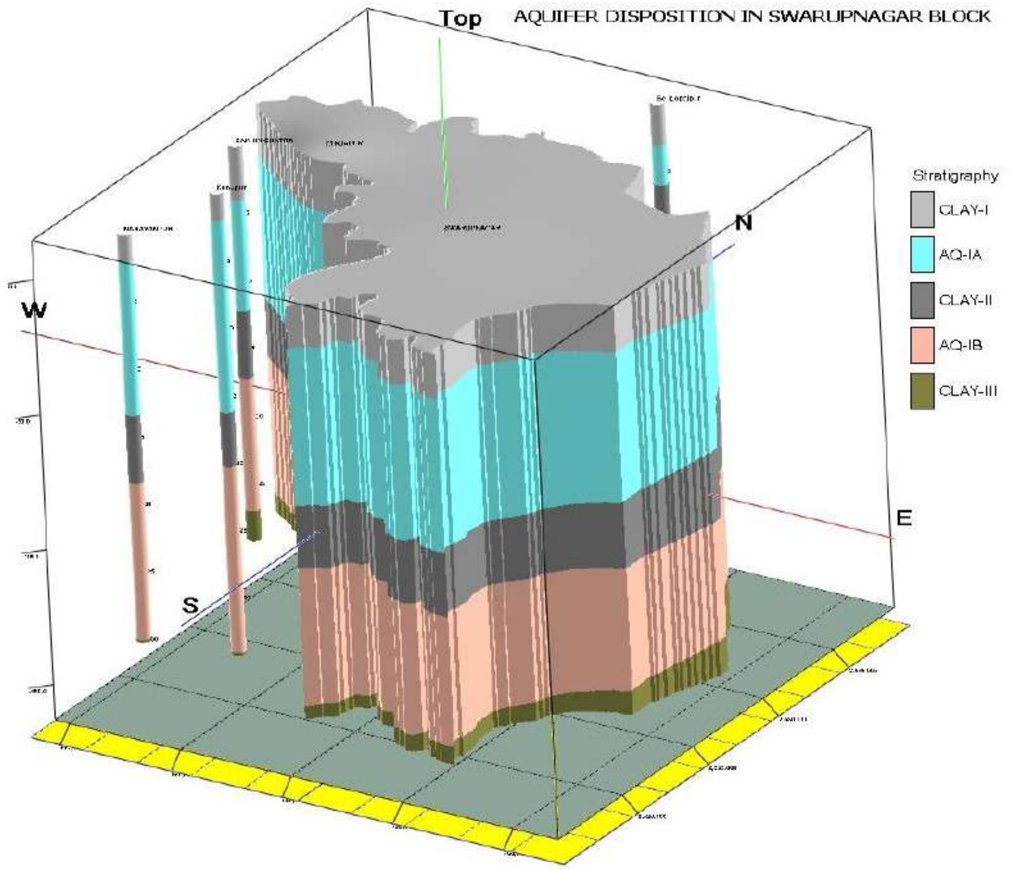


Fig.8. 9.3:3 D aquifer disposition of Swarupnagar block

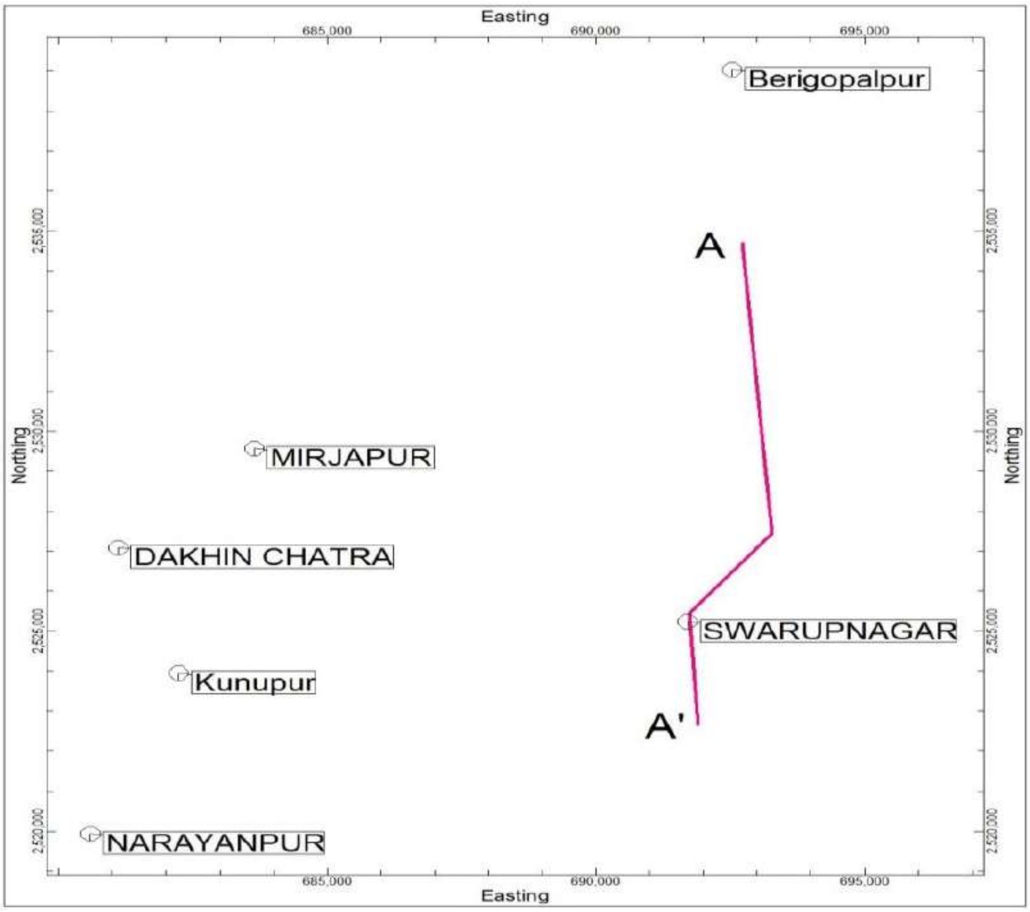


Fig.8.9.4 - N-S section index line in Swarupnagar block

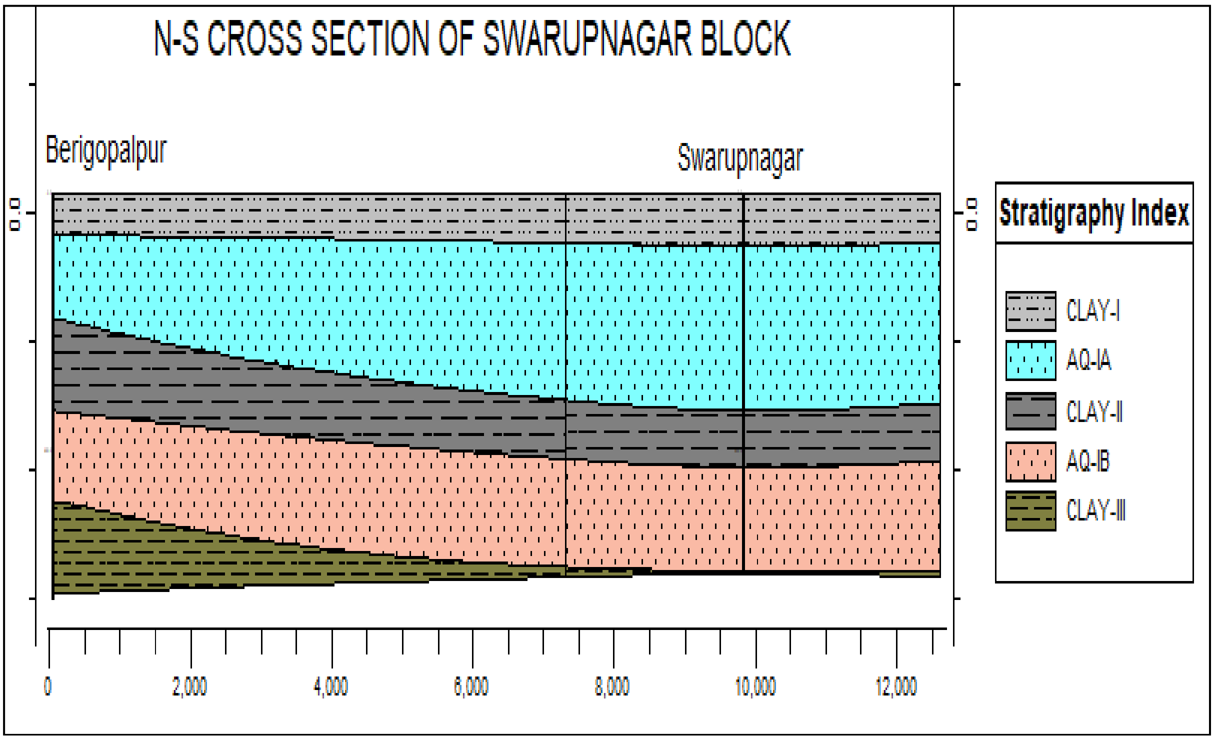


Fig.8.9.5: N-S cross section of Swarupnagar block

Table- 8.9.6 -Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

SI. No.		Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
				Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year	Fall (cm/year)
1.		Swarupnagar	I	3.6-4.85	-	7.59	3.57-9.42	-	8.54
2.		Swarupnagar	II	4-11.13	-	-	3.2 – 5.3	-	-

Table- 8.9.7 - Aquifer wise maximum thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Swarupnagar	22417	1A 113 1B 85	73

Table-8. 9.8– Aquifer wise Statement

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Swarupnagar	1A 0 - 113 1B 106 - 191	64.8	2921.92	$2.29*10^{-4}$	223 - 296	39.61	3962	$4.86*10^{-6}$

8.9.3 Ground Water Resource, Extraction, Contamination &other Issues:

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table-8.9.9 -Availability of Ground Water resource in block

Block	Net ground water availability (MCM)	Gross ground water draft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years (MCM)
Swarupnagar	11932.64	9068.13	75.99	Safe	5.3142

Static (in-storage) Resources:488018.09Ham.

8.9.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data in block wise average data of chemical parameters is given below. For arsenic, data of hydrograph stations of CGWB has been considered.

Table-8. 9.10 -Aquifer wise average chemical parameter of block

Block	Aquifer	As (mg/l)	pH	EC (µs/Cm)	Na (mg/l)	Cl (mg/l)	F(mg/l)	NO3(mg/l)	Measured Hardness(mg/l)
Swarupnagar	**IA**	**0.067**	**8.3**	**554**	**40.162**	**7.09**	**0**	**8.22**	**170**
Swarupnagar	**IB**	**0.12**	**7.98**	**2684**	**438.77**	**684.27**	**0.63**	**5.33**	**315**
Swarupnagar	**II**	**0.0015**	**8.66**	**527**	**162.76**	**63.82**	**0.43**	**0.79**	**45**

Table-8. 9.11 - Arsenic affected Risk Population

<table>
<tr><th rowspan="3">Name of arsenic affected block</th><th rowspan="3">No. of Tube well analysed</th><th colspan="7">Arsenic Concentration (in mg/l)</th></tr>
<tr><th colspan="2"><& =0.01</th><th colspan="2">>0.01 &<=0.05</th><th colspan="2">>0.05</th><th rowspan="2">Max.concentration</th></tr>
<tr><th>%</th><th>No.</th><th>%</th><th>No.</th><th>%</th><th>No.</th></tr>
<tr><td>Swarupnagar</td><td>1363</td><td>15.33</td><td>209</td><td>28.83</td><td>393</td><td>55.83</td><td>761</td><td>0.67</td></tr>
</table>

(Source – PHED, Govt. of West Bengal)

8.9.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- In AquiferI, ground water is contaminated with arsenic. Therefore, to cater potable water, modern technique, i.e., cement sealing to be applied; also arsenic removal plant should be installed.
- Regular Field monitoring of arsenic concentration in ground water in tube wells is required.

- PHED Data, Govt. of West Bengal show that 18835 population in 5 villages (Diara, Charghat,Gokulpur,BilBalli and Sarparajpurgabarda) is under risk zone where no pipe water supply scheme exist.
- Based on CGWB welldata (eg. Discharge, etc.), number of tube wells for PWSS and cost of construction of these wells have been attempted; a total of 6 **wells** are needed in those villages. Villagewise cost estimate has been tabulated in Table 8.9.13.

Table-8.9.12 - Arsenic infested population in Swarupnagar block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Swarupnagar	5	18835	Potential arsenic free aquifers in the depth span of 223-296mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m, First aquifer is Arsenic rich with inland salinity on the depth range of 106-191 mbgl

Table- 8.9.13 – Estimation of village wise required number of tube wells and cost for construction

Block	Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement /day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	Hours of run	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of the Observation well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Swarupnagar	Diara	2794	3130	195.58	219.1	279	289	5.58	5.78	201.16	224.88	45	8	360	1	20
Swarupnagar	Charghat	6819	7640	477.33	534.8	682	707	13.64	14.14	490.97	548.94	45	8	360	2	40
Swarupnagar	Gokulpur	6638	7437	464.66	520.59	664	688	13.28	13.77	477.94	534.36	45	8	360	1	20
Swarupnagar	Bil Balli	1807	2025	126.49	141.75	181	188	3.62	3.75	130.11	145.5	45	8	360	1	20
Swarupnagar	Sarparajpur gabarda	777	871	54.39	60.97	78	81	1.56	1.62	55.95	62.59	45	8	360	1	20
Swarupnagar	Total	**18835**	**21103**	**1318.45**	**1477.21**	**1884**	**1953**	**37.68**	**39.06**	**1356.13**	**1516.27**	**45**	**8**	**360**	**6**	**120**

- For monitoring of the ground water regime if observation well is needed then cost of construction of the same should also be included in the expenditure.
- In the initial stage of development, 25 % wells could be constructed& based on result whole plan should be implemented.

Management Plan for irrigation:

Table - 8.9. 14 – Irrigation scenario in block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon DTW in mbgl
Swarupnagar	**22417**	**13120**	**8067.25**	**5052.75**	**75.99**	**F- 7.59**	**F-8.54**	**4.024**	**5.77**

Measures Recommended

- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration in unconfined aquifer.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analyzed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.9.15 – Recommended water column in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability(Ham)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Swarupnagar	2735.22	As	wheat,rice,mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio for vegetable,flowers

Table-8.9.16 - Crops in practice

Name of Block		Swarupnagar
Aus	Area*	2121
	Prod**.	5.572
	Yield***	2627
Aman	Area	8769
	Prod.	20.013
	Yield	2282
Boro	Area	8122
	Prod.	26.564
	Yield	3271
Wheat	Area	673
	Prod.	1.759
	Yield	2613
Jute	Area	5048
	Prod.*	119.890
	Yield**	23.75
Musur	Area	391
	Prod.	0.341
	Yield	873
Maskalai	Area	85
	Prod.	0.059
	Yield	692
Gram	Area	36
	Prod.	0.033
	Yield	918
Mustard	Area	2608
	Prod.	4.222
	Yield	1619
Til	Area	556
	Prod.	0.627
	Yield	1127
Potato	Area	1292
	Prod.	40.692
	Yield	31495

*Area in Ha, **Yield in kg/Ha, ***Production in Thousand MT(Source: Department of Economics and Statistics, Govt. of W. B.)

Area and percentage wise area of crops in practice in block is given in Table-8.9.17.

Table-8.9.17 - Area &percentage of area of crops in practice in Swarupnagar block

Area wise Current Practice of crops								
Rabi Crops Cultivation(Wheat,Mustard and oil seeds water column requirement=0.21)		**Boro Cultivation(Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**Pulses(water column requirement =0.11 m)**		**Total Area covered(A)**
%	Area	%	Area	%	Area	%	Area	
27.88	3837	59.01	8122	9.39	1292	3.72	512	13763

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of cropsin current practice divided by area of cultivation, has been estimated; in this case, it is 0.8and for determination of water requirement in the area this factor i.e. 0.8 is multiplied with the remaining cultivable area in the block. Total water required calculated (5052.75*0.8) is 4042.2 Ham. As a principle, using 60 % of required water calculated i.e. 2425.32 Ham**,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.9.17) so that the maximum area of the remaining cultivable area could be covered; in this way as a matter of principle, 2735.22 – 2425.32 i.e. 309.9 Ham of water could be saved.

Main aim is to reduce area of boro cultivation and increase of rabi crops.

Table-8.9.18. Future Water allocation for remaining cultivable area considering SOD, Soil conditions and cropping pattern of the block

Calculated Water required (ham)	Considering 60% water and 40 % for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses(water column requirement =0.11 m)		Total Area could be covered(A)	Remaining Cultivable area (5052.75-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
4042.2	2425.32	45	5197.11	30	606.33	20	808.44	10	2204.84	8816.72	-3763.97
4042.2	2425.32	40	4619.66	45	909.50	15	606.33	0	0	6135.49	-1082.74
4042.2	2425.32	30	3464.74	50	1010.55	17	687.17	3	661.45	5823.91	- 771.16

Based onTable-8.9.18, in 5052.75 ha area irrigation water can be utilized in 30:50:17:3 ratio for Rabi, Boro, vegetables & Pulses and maximum area could be covered.

Proposed Artificial Recharge Structures in the block

Table-8.9.19 - Area suitable for recharge in the block

District	Block Name	Area (in ha)	Area in hasuitable for recharge(Considering area having DTW of 3m& more in post monsoon and showing long term falling trend of 2m/yr)& more
NORTH TWENTY FOUR PARGANAS	Swarupnagar	22417	6672

Table- 8.9.20: Estimation of Surface runoff component after Dhruvanarayana,1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Swarupnagar	Sandy/Clay Loam	6154.85	4616.14	2308.07	1384.84

A* - area, C - run off coefficient from Normal Monsoon Rainfall**

On the basis of soil characteristic, Slope &Rain fall data, possible structures are given below:

Table- 8.9.21: Estimation of nos. of recharge & conservation structures & cost estimate

Block (1)	**Block Area (2)**	**Area suitable for recharge (3)**	**Soil type (4)**	**Amount of water for artificial recharge and conservation (Ham) (5)**	**Source water allocation for with Artificial recharge in Ham - 70 % of Col. 5 (6)**	Irrigation cum recharge Tank - 35 % of Col. 5 (7)	Re-excavation of existing tanks with Recharge shaft -35 % of Col. 5 **(8)**	Injection Well for recharging deeper aquifers - 20 % of Col. 5 (9)	**Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit (10)**	**Nos. of** Irrigation cum recharge Tank **suggested @ 50 Ham per unit**	**Nos. of injection well suggested @ 30 Ham per unit**	**Cost of REET with Recharge Shaft @ Rs 8 lakh per unit**	**Cost of Percolation tank @ Rs 8 lakh per unit**	**Cost of injection well @ Rs 15 lakh per unit**	**Remarks**
Swarupnagar	**22417**	**6672**	**Sandy/ Clay Loam**	**1384.84**	**969.39**	**484.69**	**484.69**	**415.45**	**48**	**10**	**14**	**384**	**80**	**210**	**In this block, top soil is Sandy in nature so recharge pit is most suitable structure.**

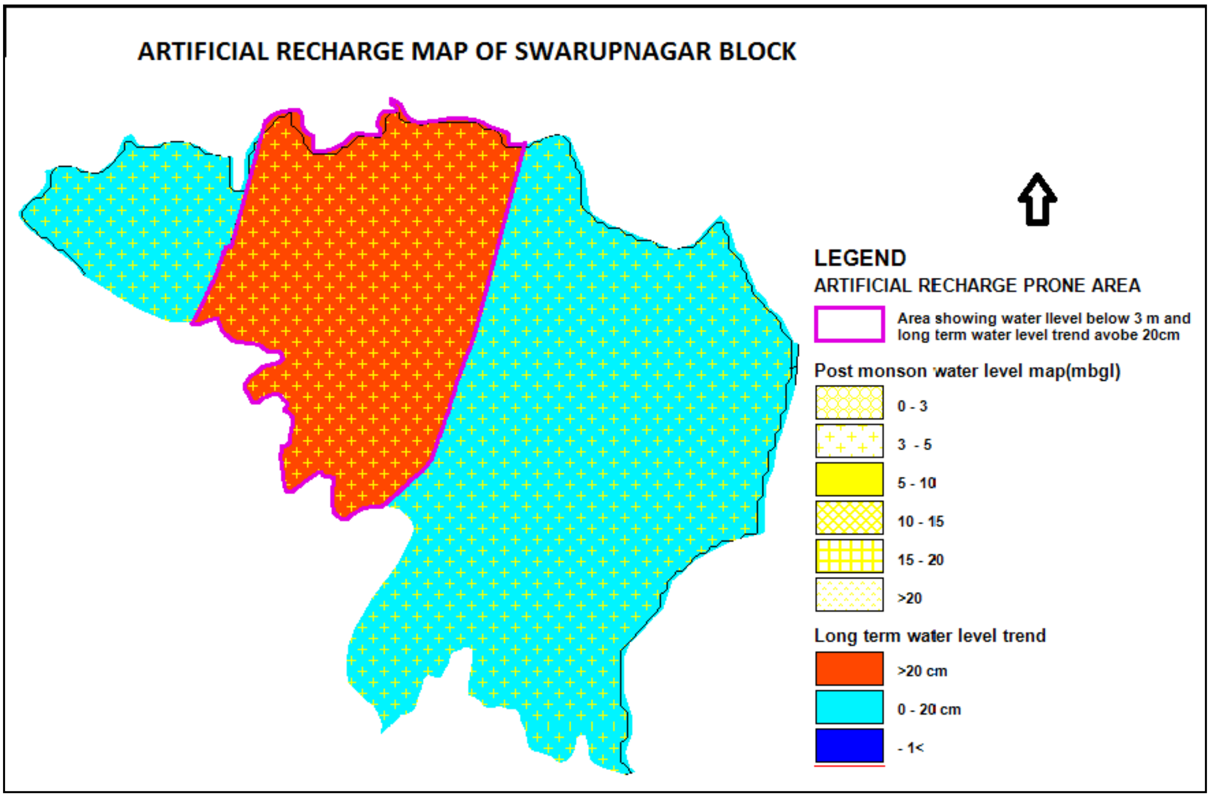


Fig.-8.9.6: Area suitable for Artificial Rechargein Swarupnagar block

8.10 HAROA BLOCK

8.10.1 Salient Information:

Block Name: Haroa

Area (in Ha):**16616**

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table- 8.10.1 - Population in Haroa block

Rural	Urban	Total
214401	-	214401

Rainfall: Average annual rainfall (**North Twenty Four Parganas** district)for the period 2012 -16 (in mm): 1555**.76**

Table-8.10.2 - Annual Rainfall for last five years

Block	District Normal	District Annual (in mm)				
		2012	2013	2014	2015	2016
Haroa	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

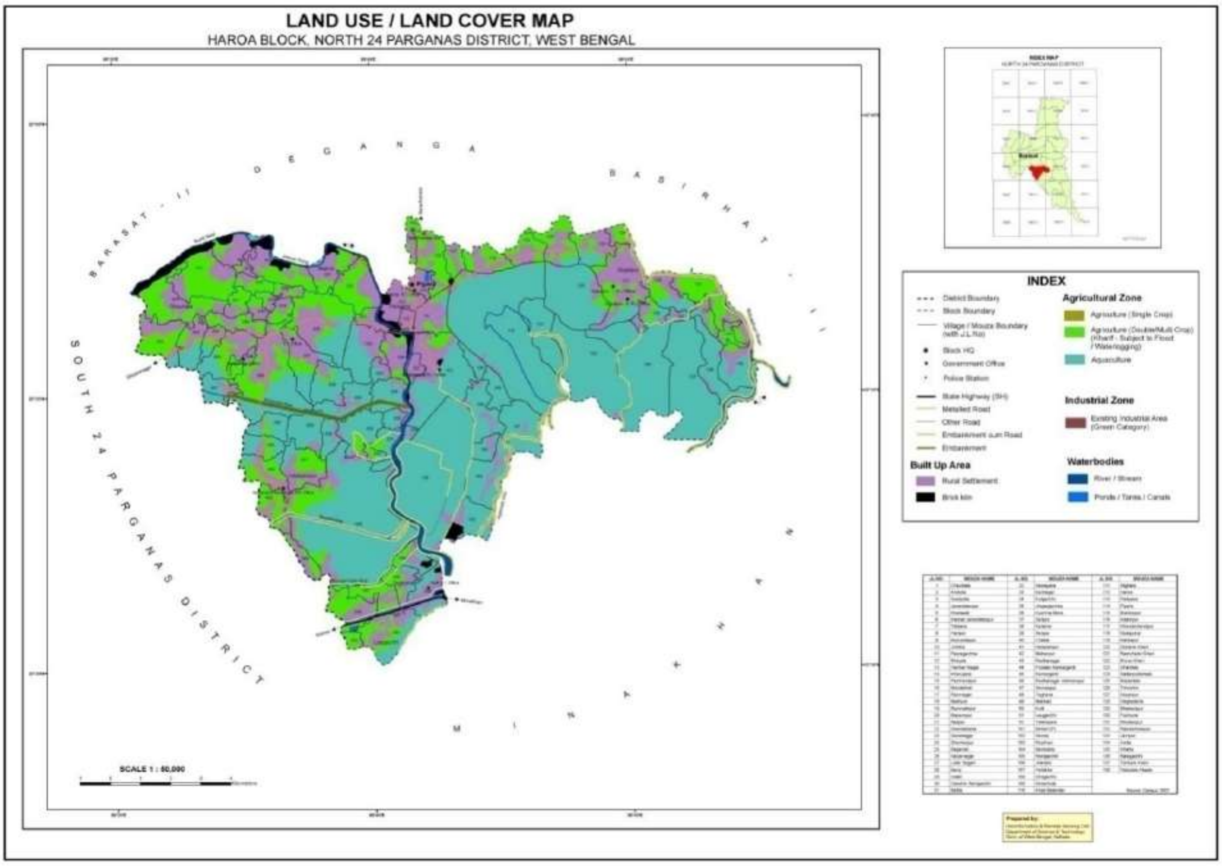
Table- 8.10.3 –Salient landuse features in block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Haroa	**16616**	**9100**	**251**	**50**	**-**

8.10.2 Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.10.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III	Extraction (for Aquifer I)
Dynamic Resource	68.7018	0.25	-	27.6750
Static Resource	1846.0376	-	-	-



(Source- Land & Land Reforms Dept., Govt. of W. B.)

Fig. 8.10.1: Land use & Land cover map of Haroa block

8.10.3 Disposition of Aquifers

In Haroa Block, two aquifer systems are explored

- There are two aquifers in Aquifer I Group: Aquifer IA ranges between 7 m and 61 m and Aquifer IB ranges from 71 m to 170 m; ground water in Aquifer IB is contaminated by arsenic.
- There are two aquifers in Aquifer II Group: range of Aquifer IIA is between 182 m to 236m; Aquifer IIB ranges from 256 m to 281 m, ground water in both these aquifers are fresh and Arsenic free.

Table- 8.10.5 - Aquifer disposition in block

Block	Depth range of Aquifer in m bgl	
HAROA	1st Aquifer	2nd aquifer
	1A 7 – 61 1B 71-170	2A 182-236 2B 256 -281

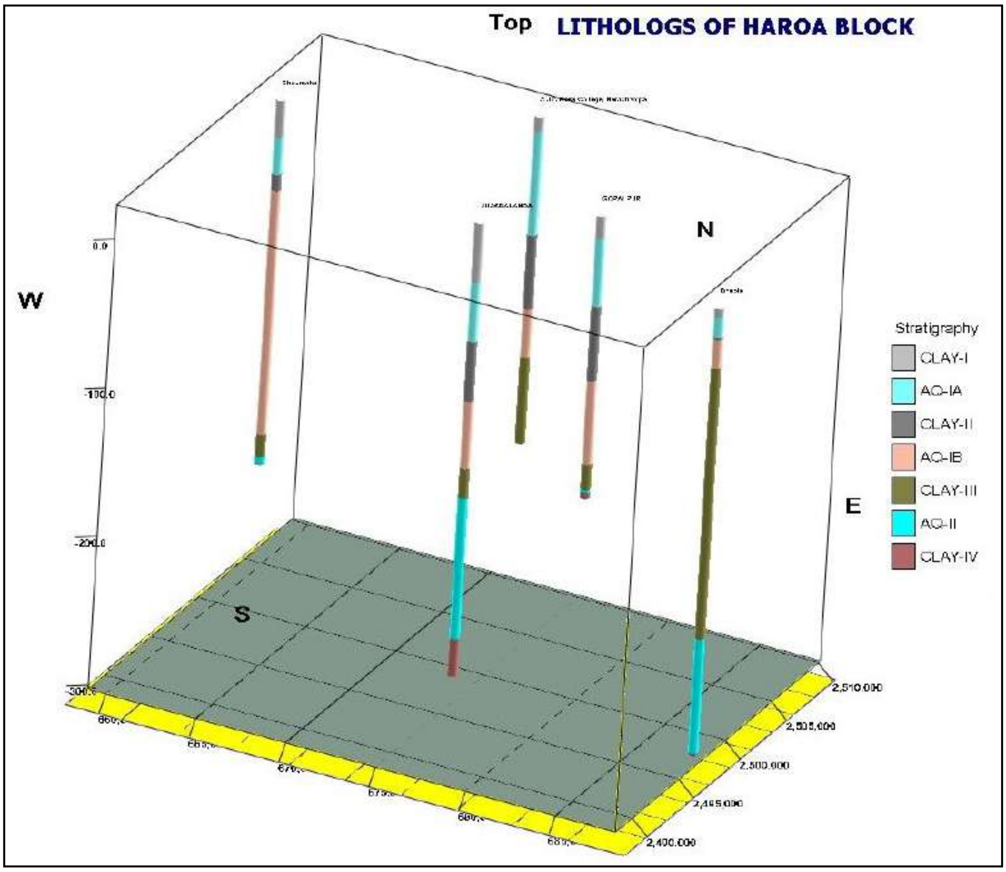


Fig-8.10.2: Stratigraphic Log in Haroa block

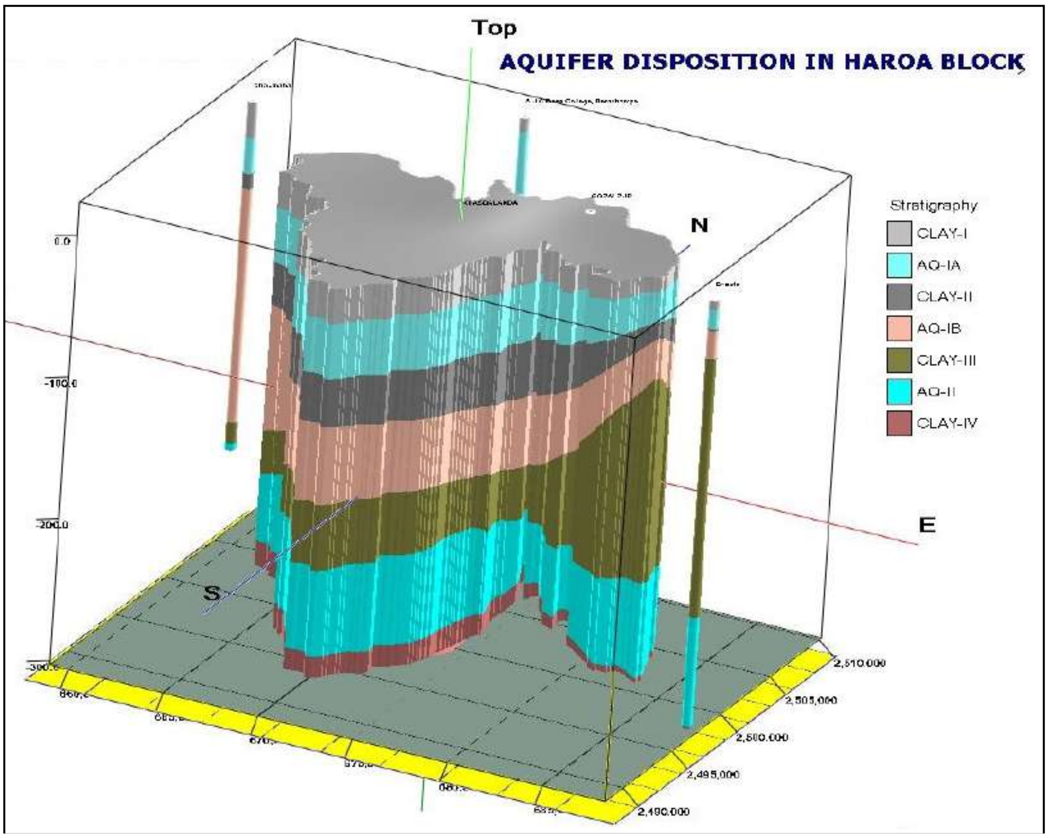


Fig-8.10.3: 3 D aquifer disposition in Haroa block

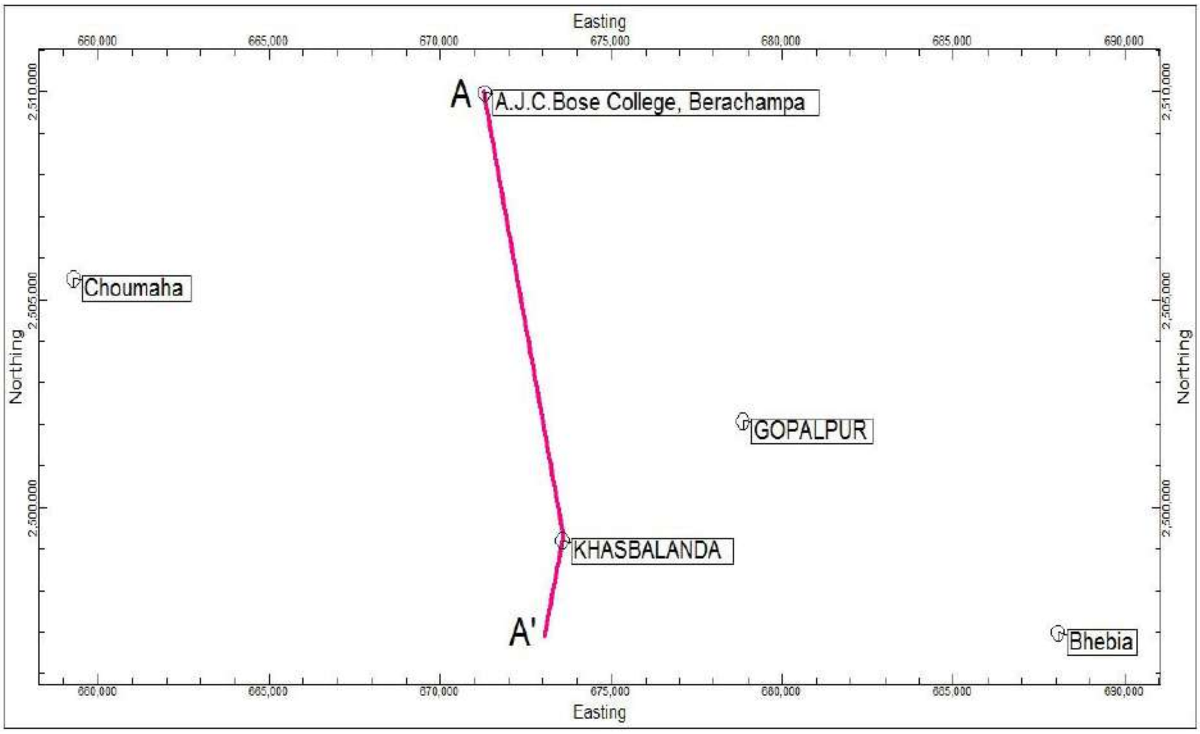


Fig. 8.10.4: N-S section index line in block

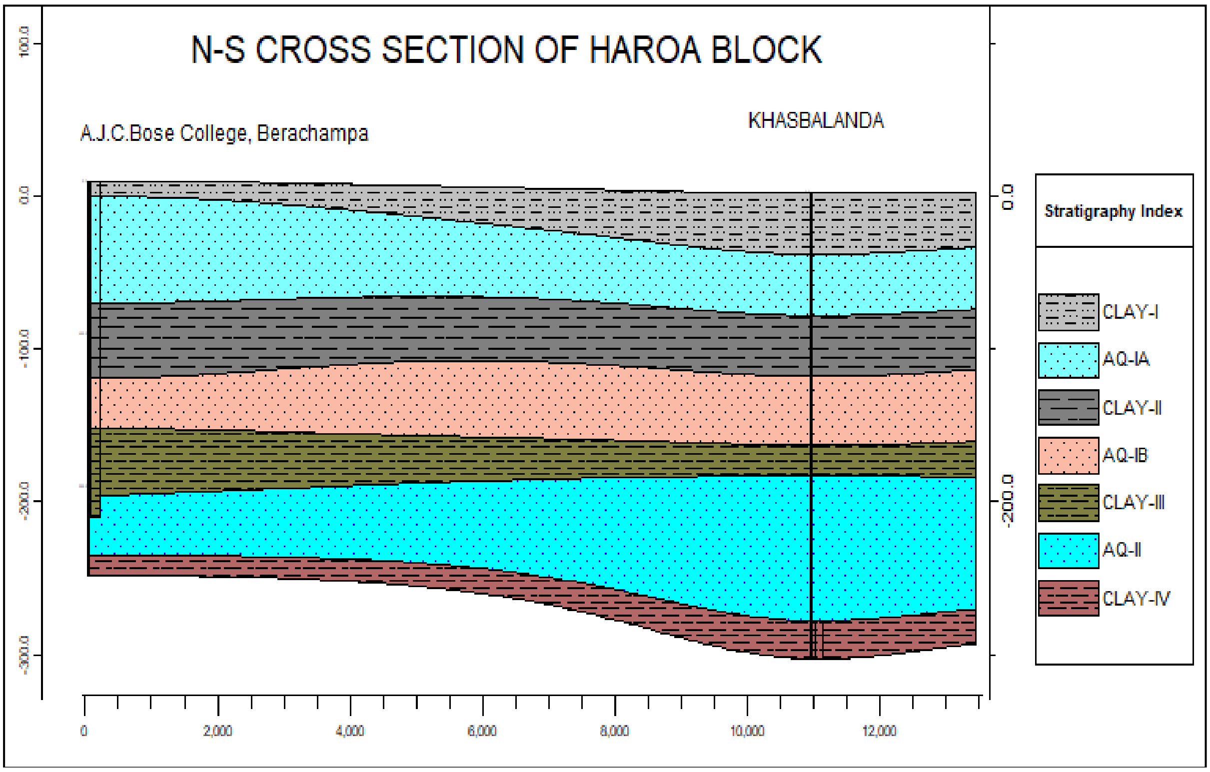


Fig- 8.10.5: N-S section in block

Table- 8.10.6 - Aquifer Wise Water Level Ranges& season along term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
Haroa	I	3.8-7.17	-	8.86	2.74-3.5	-	7.90
Haroa	II	3.9 - 6.69	-	-	4 – 6.5	-	-

Table-8.10.7 -Aquifer wise maximum thickness

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Haroa	16616	1A 54 1B 99	2A 54 2B 25

Table –8.10.8 - Aquifer-wise Statement

8.10.4 Ground Water Resource, Extraction, Contamination &other Issues:

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Haroa	1A 7 – 61 1B 71-170	44.94	822.42	$2.29*10^{-4}$	2A 182-236 2B 256 -281	41.34	2269	$4.86*10^{-6}$

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources as on 31st March'13

Table- 8.10.9 - Availability of Ground Water resource in Block

Static (in-storage) Resources: 184603.76 Ham.

8.10.5 Chemical Quality of Ground Water & Contamination

Block	Netground Wateravailability (MCM)	Grossground Waterdraft (MCM)	Stage of development (%)	Category	Provision for domestic and industrial requirement supply upto next 25 years(MCM)
Haroa	6870.18	2767.50	40.28	Safe	4.2804

Based on Key well data of the blocks, Average data of chemical parameter in ground water is given below. For Arsenic contamination, ground water in selective monitoring stations of CGWB has been analysed.

Table-8.10.10 - Aquifer wise average chemical parametersin block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/Cm)	Na (mg/l)	Cl(mg/l)	F (mg/l)	NO_3 (mg/l)	Measured Hardness (mg/l)
Haroa	**IB**	0.009	8.18	591	54.03	46.09	0.25	1.02	165
Haroa	**II**	0.002	8.31	4598	60.28	38.99	0.14	0.40	160

Table- 8.10.11 -Arsenic affected Risk Population

Name of arsenic affected block	No. of Tube well analysed	Arsenic Concentration (in mg/l)						
		<& =0.01		>0.01 &<=0.05		>0.05		Max.concentration
		%	No.	%	No.	%	No.	
Haroa	**1092**	**62.64**	**684**	**28.21**	**308**	**9.16**	**100**	**0.73**

(Source – PHED, Govt. of W. B.)

8.10.6 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking purposes

- In AquiferI, ground water is contaminated with arsenic. Therefore, to cater potable water, modern technique, i.e. cement sealing to be done; also arsenic removal plant should be installed.
- Regular Field monitoring of arsenic concentration in ground water in tube wellsis required.
- As per WBPHED Data 145349 population with 70 villages are under risk zone where no water supply scheme is exist.
- Based on CGWB wells data, viz. discharge, T, etc. number of wells and cost for construction of wells have been estimated for population in 2021 (vide Table 8. 10.13)
- In this block total 73 wells are needed in villages, where supply scheme does not exist.

Table-8. 10.12 - Arsenic infested population in Haroa block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Haroa	70	145349	Potential arsenic free aquifers in the depth span of 182-236mbgl& 256 – 281 mbgl, separated from the upper aquifers system by thick clay layer of 10 to 30 m.

Table 8.10.13 – Proposed structures & cost estimate in block

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement /day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Behari (P)	405	454	28.35	31.78	41	43	0.82	0.85	29.17	32.63	41.34	8	330.72	1	20
Chauhata	2764	3097	193.48	216.79	276	286	5.52	5.72	199	222.51	41.34	8	330.72	1	20
Andulia	2685	3008	187.95	210.56	269	279	5.38	5.58	193.33	216.14	41.34	8	330.72	1	20
Goalpota	2596	2909	181.72	203.63	260	270	5.2	5.39	186.92	209.02	41.34	8	330.72	1	20
Janarddanpur	1979	2217	138.53	155.19	198	205	3.96	4.1	142.49	159.29	41.34	8	330.72	1	20
Khalisadi	2906	3256	203.42	227.92	291	302	5.82	6.03	209.24	233.95	41.34	8	330.72	1	20
Kismat Janarddanpur	610	683	42.7	47.81	61	63	1.22	1.26	43.92	49.07	41.34	8	330.72	1	20
Talbaria	1771	1984	123.97	138.88	177	183	3.54	3.67	127.51	142.55	41.34	8	330.72	1	20
Haripur	6315	7075	442.05	495.25	632	655	12.64	13.1	454.69	508.35	41.34	8	330.72	2	40
Mukundapur	1756	1967	122.92	137.69	176	182	3.52	3.65	126.44	141.34	41.34	8	330.72	1	20
Jhinkia	1234	1383	86.38	96.81	123	128	2.46	2.55	88.84	99.36	41.34	8	330.72	1	20
Payragachha	687	770	48.09	53.9	69	72	1.38	1.43	49.47	55.33	41.34	8	330.72	1	20
Bhayda	3933	4407	275.31	308.49	393	407	7.86	8.15	283.17	316.64	41.34	8	330.72	1	20
Harihar Nagar	310	347	21.7	24.29	31	32	0.62	0.64	22.32	24.93	41.34	8	330.72	1	20
Kharupala	6003	6726	420.21	470.82	600	622	12	12.44	432.21	483.26	41.34	8	330.72	1	20
Parchandpur	1072	1201	75.04	84.07	107	111	2.14	2.22	77.18	86.29	41.34	8	330.72	1	20
Mondalhat	810	908	56.7	63.56	81	84	1.62	1.68	58.32	65.24	41.34	8	330.72	1	20
Ramnagar	1079	1209	75.53	84.63	108	112	2.16	2.24	77.69	86.87	41.34	8	330.72	1	20

Mathura	1201	1346	84.07	94.22	120	124	2.4	2.49	86.47	96.71	41.34	8	330.72	1	20
Ramnathpur	1208	1353	84.56	94.71	121	125	2.42	2.51	86.98	97.22	41.34	8	330.72	1	20
Bakjuri	2184	2447	152.88	171.29	218	226	4.36	4.52	157.24	175.81	41.34	8	330.72	1	20
Akandabaria	2629	2946	184.03	206.22	263	273	5.26	5.45	189.29	211.67	41.34	8	330.72	1	20
Garainagar	1010	1132	70.7	79.24	101	105	2.02	2.09	72.72	81.33	41.34	8	330.72	1	20
Shankarpur	4364	4889	305.48	342.23	436	452	8.72	9.04	314.2	351.27	41.34	8	330.72	1	20
Baganati	1440	1613	100.8	112.91	144	149	2.88	2.99	103.68	115.9	41.34	8	330.72	1	20
Nazarnagar	3064	3433	214.48	240.31	306	317	6.12	6.34	220.6	246.65	41.34	8	330.72	1	20
Baroj	1488	1667	104.16	116.69	149	154	2.98	3.09	107.14	119.78	41.34	8	330.72	1	20
Indali	858	961	60.06	67.27	86	89	1.72	1.78	61.78	69.05	41.34	8	330.72	1	20
Dakshin Ranigachhi	706	791	49.42	55.37	71	74	1.42	1.47	50.84	56.84	41.34	8	330.72	1	20
Baltia	612	686	42.84	48.02	61	63	1.22	1.26	44.06	49.28	41.34	8	330.72	1	20
Nawapara	468	524	32.76	36.68	47	49	0.94	0.97	33.7	37.65	41.34	8	330.72	1	20
Kalinagar	1477	1655	103.39	115.85	148	153	2.96	3.07	106.35	118.92	41.34	8	330.72	1	20
Kulgachhi	849	951	59.43	66.57	85	88	1.7	1.76	61.13	68.33	41.34	8	330.72	1	20
Jhujargachha	1056	1183	73.92	82.81	106	110	2.12	2.2	76.04	85.01	41.34	8	330.72	1	20
Kuchhia Mora	1846	2068	129.22	144.76	185	192	3.7	3.84	132.92	148.6	41.34	8	330.72	1	20
Kalianai	679	761	47.53	53.27	68	70	1.36	1.41	48.89	54.68	41.34	8	330.72	1	20
Serpur	130	146	9.1	10.22	13	13	0.26	0.27	9.36	10.49	41.34	8	330.72	1	20
Chatra	704	789	49.28	55.23	70	73	1.4	1.45	50.68	56.68	41.34	8	330.72	1	20
Narayanpur	3106	3480	217.42	243.6	311	322	6.22	6.45	223.64	250.05	41.34	8	330.72	1	20
Meherpur	2373	2659	166.11	186.13	237	246	4.74	4.91	170.85	191.04	41.34	8	330.72	1	20
Radhanagar	3420	3832	239.4	268.24	342	355	6.84	7.09	246.24	275.33	41.34	8	330.72	1	20
Puratan Kamarganti	1680	1882	117.6	131.74	168	174	3.36	3.48	120.96	135.22	41.34	8	330.72	1	20
Kamarganti	9555	10705	668.85	749.35	956	991	19.12	19.82	687.97	769.17	41.34	8	330.72	2	40
Radhanagar Abhirampur	3237	3627	226.59	253.89	324	336	6.48	6.72	233.07	260.61	41.34	8	330.72	1	20
Samaspur	1458	1634	102.06	114.38	146	151	2.92	3.03	104.98	117.41	41.34	8	330.72	1	20

Tegharia	1728	1936	120.96	135.52	173	179	3.46	3.59	124.42	139.11	41.34	8	330.72	1	20
Makhali	1539	1724	107.73	120.68	154	160	3.08	3.19	110.81	123.87	41.34	8	330.72	1	20
Kulti	3008	3370	210.56	235.9	301	312	6.02	6.24	216.58	242.14	41.34	8	330.72	1	20
Laugachhi	4540	5087	317.8	356.09	454	471	9.08	9.41	326.88	365.5	41.34	8	330.72	1	20
Telenipara	567	635	39.69	44.45	57	59	1.14	1.18	40.83	45.63	41.34	8	330.72	1	20
Samla	1976	2214	138.32	154.98	198	205	3.96	4.1	142.28	159.08	41.34	8	330.72	1	20
Roykhan	2007	2249	140.49	157.43	201	208	4.02	4.17	144.51	161.6	41.34	8	330.72	1	20
Bantosha	758	849	53.06	59.43	76	79	1.52	1.58	54.58	61.01	41.34	8	330.72	1	20
Ranigachhi	5947	6663	416.29	466.41	595	617	11.9	12.34	428.19	478.75	41.34	8	330.72	1	20
Jhanjha	1527	1711	106.89	119.77	153	159	3.06	3.17	109.95	122.94	41.34	8	330.72	1	20
Haldaha	1353	1516	94.71	106.12	135	140	2.7	2.8	97.41	108.92	41.34	8	330.72	1	20
Dihigachhi	559	626	39.13	43.82	56	58	1.12	1.16	40.25	44.98	41.34	8	330.72	1	20
Sonarhula	265	297	18.55	20.79	27	28	0.54	0.56	19.09	21.35	41.34	8	330.72	1	20
Mallickpur	1499	1679	104.93	117.53	150	155	3	3.11	107.93	120.64	41.34	8	330.72	1	20
Adampur	2353	2636	164.71	184.52	235	244	4.7	4.87	169.41	189.39	41.34	8	330.72	1	20
Khordachandpur	1065	1193	74.55	83.51	107	111	2.14	2.22	76.69	85.73	41.34	8	330.72	1	20
Goalpukur	3065	3434	214.55	240.38	307	318	6.14	6.36	220.69	246.74	41.34	8	330.72	1	20
Kalikapur	4378	4905	306.46	343.35	438	454	8.76	9.08	315.22	352.43	41.34	8	330.72	1	20
Gobaria Abad	6643	7443	465.01	521.01	664	688	13.28	13.77	478.29	534.78	41.34	8	330.72	2	40
Ramchakir Gheri	185	207	12.95	14.49	19	20	0.38	0.39	13.33	14.88	41.34	8	330.72	1	20
Munsi Gheri	3314	3713	231.98	259.91	331	343	6.62	6.86	238.6	266.77	41.34	8	330.72	1	20
Sadarpurbehala	2094	2346	146.58	164.22	209	217	4.18	4.33	150.76	168.55	41.34	8	330.72	1	20
Batagachhi	678	760	47.46	53.2	68	70	1.36	1.41	48.82	54.61	41.34	8	330.72	1	20
Tentulia Abad	816	914	57.12	63.98	82	85	1.64	1.7	58.76	65.68	41.34	8	330.72	1	20
Nebutala Abada	1768	1981	123.76	138.67	177	183	3.54	3.67	127.3	142.34	41.34	8	330.72	1	20
	145349	**162849**	**10174.43**	**11399.43**	**14542**	**556**	**290.84**	**301.46**	**10465.27**	**11700.89**	**2893.8**	**560**	**23150.4**	**73**	**1460**

- For monitoring of the ground water regime if observation well is needed then cost of construction of the same should also be included in the expenditure.
- In the initial stage, 25 % wells should be constructed. Based on result whole plan should be implemented.

Management Plan forirrigation:

Table- 8.10.14 – Irrigation scenario in the block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Remarks for GW Management Plan
Haroa	16616	9100	3236.08	5863.92	40.28	F- 8.86	F-7.9	5.57	2.74	-

Measures recommended

- This block comes under Sunderban area so there is management plan is different. Numerous creeks and rivulets traverse it.
- To ensure food security in the present changing climatic condition, expansion of irrigation network and harnessing of new water sources are essential.
- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration in unconfined aquifer.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analyzed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.10.15 – Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability(Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Haora	3998.54	As	wheat,rice,mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-0.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2), pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio for vegetable,flowers

Table-8.10.16 – Cropping pattern in block

Name of Block		Haroa
Aus	*Area	73
	*Prod.	0.192
	*Yield	2627
Boro	Area	1653
	Prod.	5.02
	Yield	3037
Wheat	Area	78
	Prod.	0.211
	Yield	2700
Maize	Area	9
	Prod.	0.023
	Yield	2526
Mustard	Area	837
	Prod.	1.222
	Yield	1461
Til	Area	198
	Prod.	0.223
	Yield	1127
Potato	Area	191
	Prod.	6.881
	Yield	36024
Sugarcane	Area	13
	Prod.	1.055
	Yield	81190

(Source - Department of Economics and Statistics, Govt. of West Bengal)

*Area in hectare, Production in Thousand MT and Yield in kg./hect.

Percentage wise crop covering block is given Table-8.10.16.

Table-8.10.16 - Percentage of area of different crops in Haroa block

Area wise Current Practice of crops										
Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		**Boro Cultivation(Water column requirement-1.2 m)**		**Vegetable (water column requirement Potato=0.6m)**		**Pulses(water column requirement =0.11 m)**		**Sugarcane(water column requirement =0.5 m)**		**Total Area covered(A)**
%	Area	%	Area	%	Area	%	Area	**%**	**Area(ha)**	
37.4	1113	55.5	1653	6.7	200	0	0	0.4	13	2979

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, it is 0.7and for determination of water requirement in the area this factor i.e. 0.7 is multiplied with the remaining cultivable area in the block. Total water required calculated (5863.9*0.7) is 4104.73 Ham. As a principle, using 60 % of required water calculated i.e. 2462.84 Ham**,** an attempt has been made to change the cropping pattern in a nos. of possible ways (vide Table 8.9.17) so that the maximum area of the remaining cultivable area could be covered; in this way as a matter of principle, 3998.54 – 2462.84 i.e. 1535.70 Ham of water could be saved.

Main aim is to reduce area of boro cultivation and increase of rabi crops. An attempt has been made to show changed cropping pattern in **Table-8.10.17.** It appears that water allocation in the ratio of 35:45:20:5 for Rabi, Boro, Vegetables and Sugarcane is most appreciable to cover maximum area.

Table-8.10.17- Future Water allocation for remaining cultivable area

Present water required(ham)	Considering 60% water and 40 % for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Sugarcane(water column requirement =0.5 m)		Total Area covered (A)	Remaining Cultivable area (5863.92 -A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)		
4104.73	2462.84	30	3518.34	40	820.95	25	1026.18	5	246.28	5611.75	252.17
4104.73	2462.84	40	4691.12	45	923.57	15	615.71	0	0	6230.4	-366.48
4104.73	2462.84	35	4104.73	45	924	20	616	5	246.28	5891.01	-27.09

Space Available for Recharge and Proposed Interventions:

Table- 8.10.18 -Area suitable for recharge in the block

District	Block Name	Area (in ha)	Area suitable for recharge(Considering area having DTW of 3m and more in shallow aquifer in post-monsoon and showing falling trend of 2m/yr & more) (in Ha)
NORTH TWENTY FOUR PARGANAS	Haroa	16616	7386

Table- 8.10.19 – Estimation of Surface runoff component after Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Haroa	Silty Clay	6403.488	4802.616	2401.308	1440.7848

A* - area, C - run off coefficient from Normal Monsoon Rainfall**

Based on soil characteristic, Slope, Rainfall data and Long term trend, number of possible recharge and conservation structures have been estimated and shown in Table 8.10.20.

Table- 8.10.20 – Estimation of nos. of different structures & cost estimate

Block Area (1)	Area suitable for recharge (2)	Soil type (3)	Amount of water for artificial recharge and conservation (Ham) (4)	Source water allocation for Artificial recharge in Ham: 70 % of Col. 4 (5)	40% of column 5 for REET with recharge shaft for Aq-I (6)	60% of column G for Conservation structures like Farm Pond/Irrigation pond/Series of Check Dam with Sluice systems (7)	30% of col. 5 for injection well Aq-II (8)	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit	Nos. of Farm Pond/Irrigation pond suggested @ 50 Ham per unit	Nos. of injection well suggested @ 30 Ham per unit	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of Percolation tank @ Rs 8 lakh per unit	Cost of injection well @ Rs 15 lakh per unit	Remarks
16616	7386	Silty Clay	1440.78	1008.55	403.42	605.13	432.23	40	12	14	320	96	210	In this block Soil type is clay in nature.In half part of the block fisheres ponds exist so farm pond is suitable structure

***REET – Reexcavation of existing tank**

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Farm pond- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

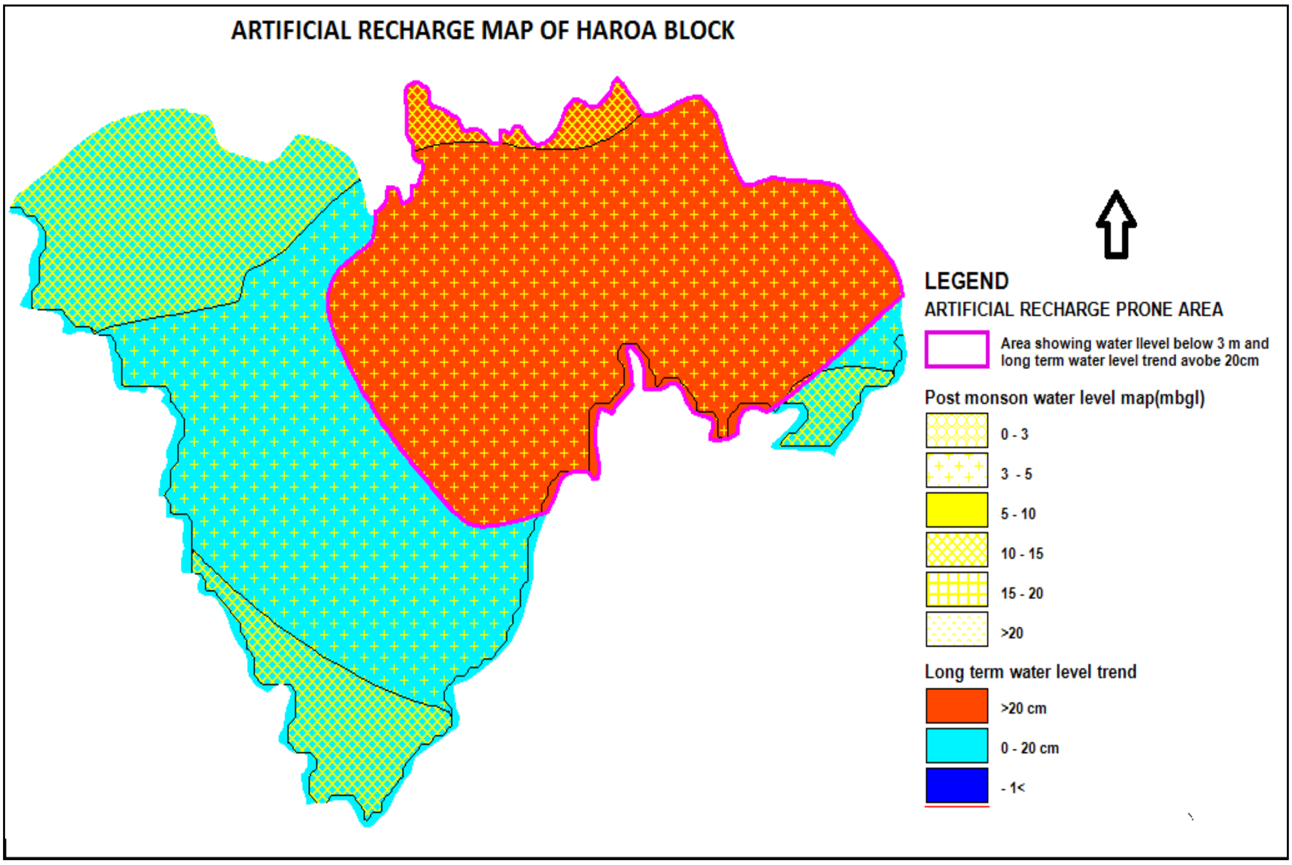


Fig.-8.10.6 – Area of Artificial Recharge in Haroa block

8.11 HASNABAD BLOCK

8.11.1 Salient Information

Block Name: Hasnabad

Area (in Ha):**16996**

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table- 8.11.1 - Population in Hasnabad block

Rural	Urban	Total
197014	6248	203262

Rainfall: Average annual rainfall (**North Twenty-Four Parganas** district)for the period 2012 -16 (in mm): 1555.76

Table-8.11.2 - Annual Rainfall for last five years

Block	District Normal	District Annual (in mm)				
		2012	2013	2014	2015	2016
Hasnabad	**1623.6**	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

Table- 8.11.3 –Salient Landuse features in block

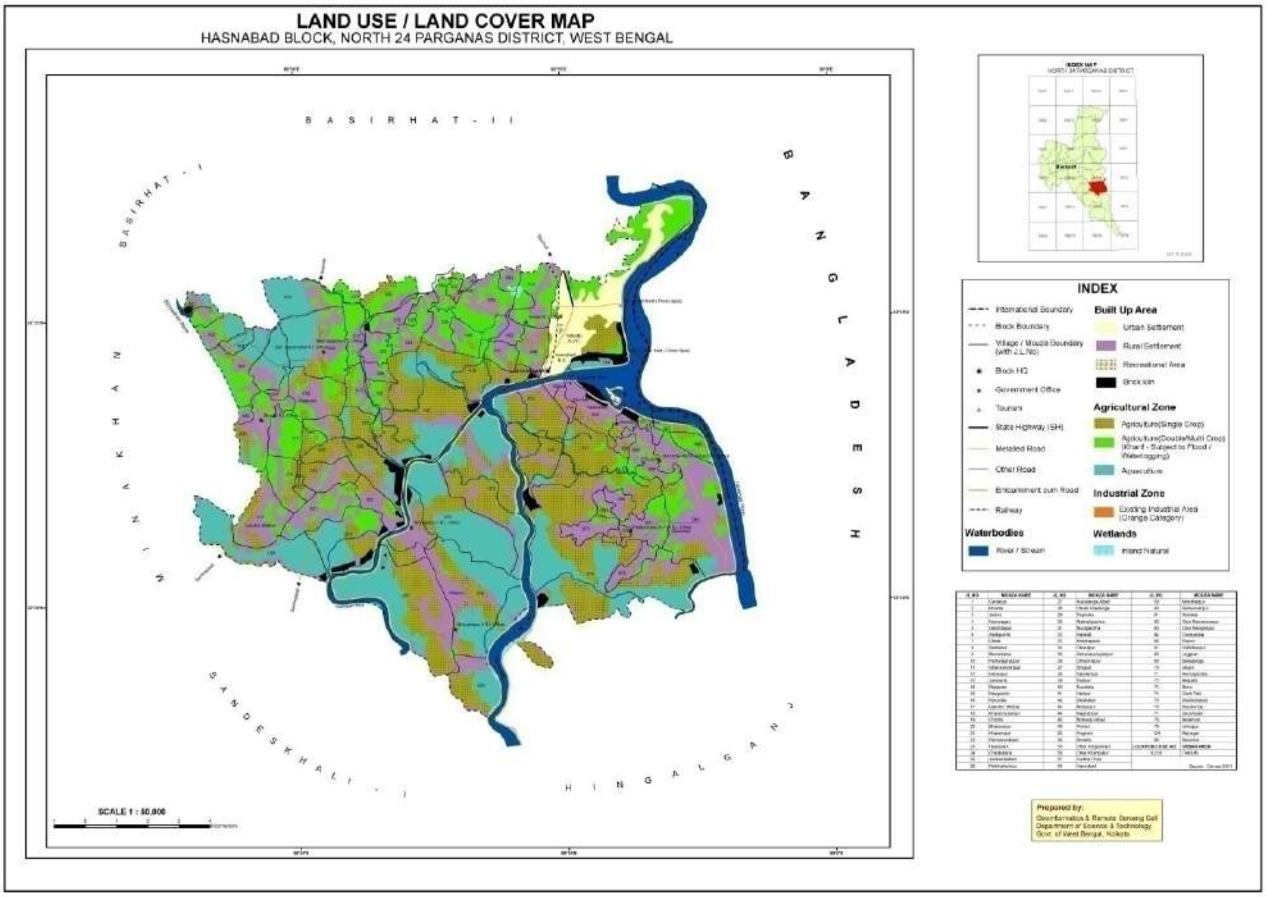
Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Hasnabad	16996	11020	1032	240	-

8.11.2 Aquifer Wise Ground Water Resource Availability & Extraction:

No unconfined aquifer exists in this block so resource has not been calculated as per GEC-97. Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.11.4 - Dynamic resource in Aquifer II

Resource Availability	**Aquifer II (in ham)**
Dynamic Resource	15.23



(Source – Land & Land Reforms Dept., Govt. of West Bengal)

Fig. 8.11.1: Landuse& land cover map of Hasanabad block

8.11.3 Disposition of Aquifer

In Hasnabad block, two aquifer groups are explored

- There is one aquifer in Aquifer I Group: Range - 4 m to 85 m& ground water in it is contaminated with arsenic.
- There are two aquifers in Aquifer II Group: Range of aquifer IIA -119 m to 252 m, aquifer IIB -280 m to 300 m; this is fresh and Arsenic free.

Table- 8.11.5 -Aquifer disposition in block

Block	Depth range of Aquifer in m bgl		
HASANABAD	1st Aquifer (Aquifer I)	2nd aquifer(Aquifer II)	Remarks
	4-85	IIA: 119-252 IIB: 280-300	Aquifer I is saline; saline fresh interface inferred

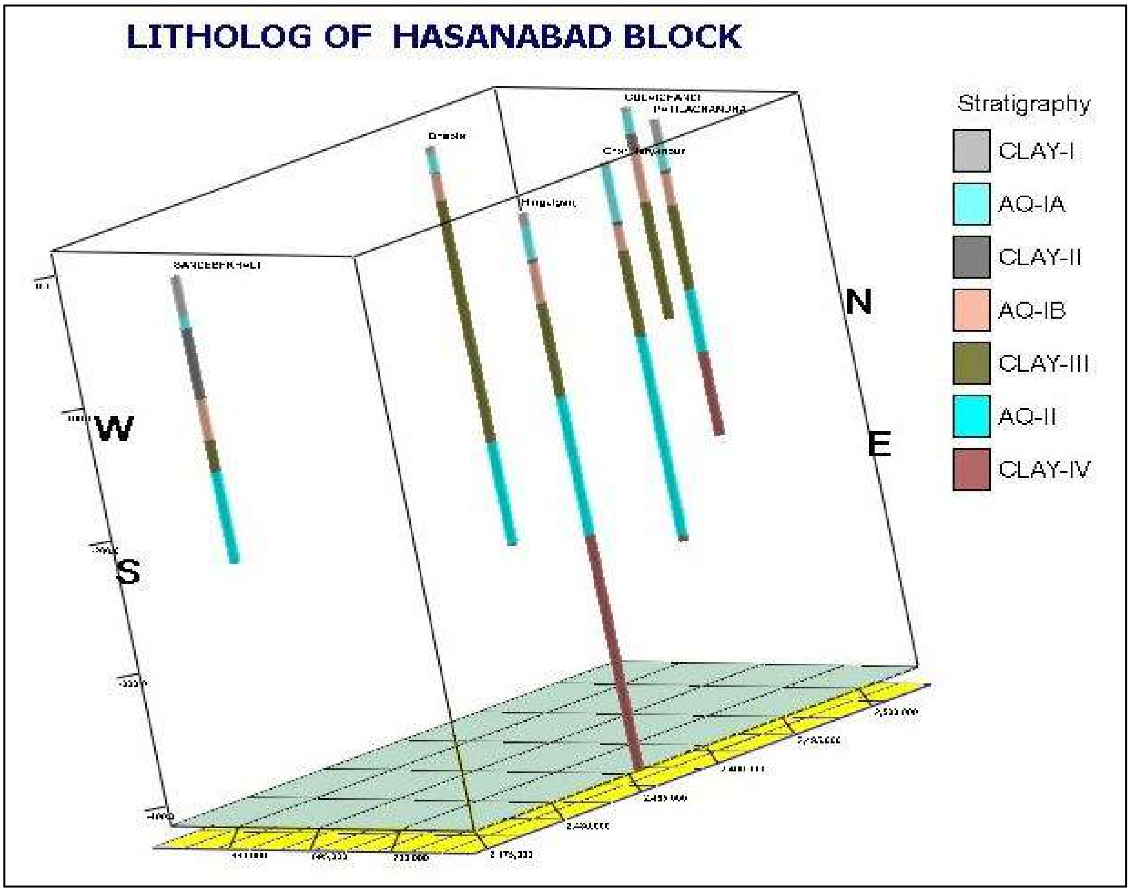


Fig. 8.11.2: Stratigraphic Logsin Hasanabad block

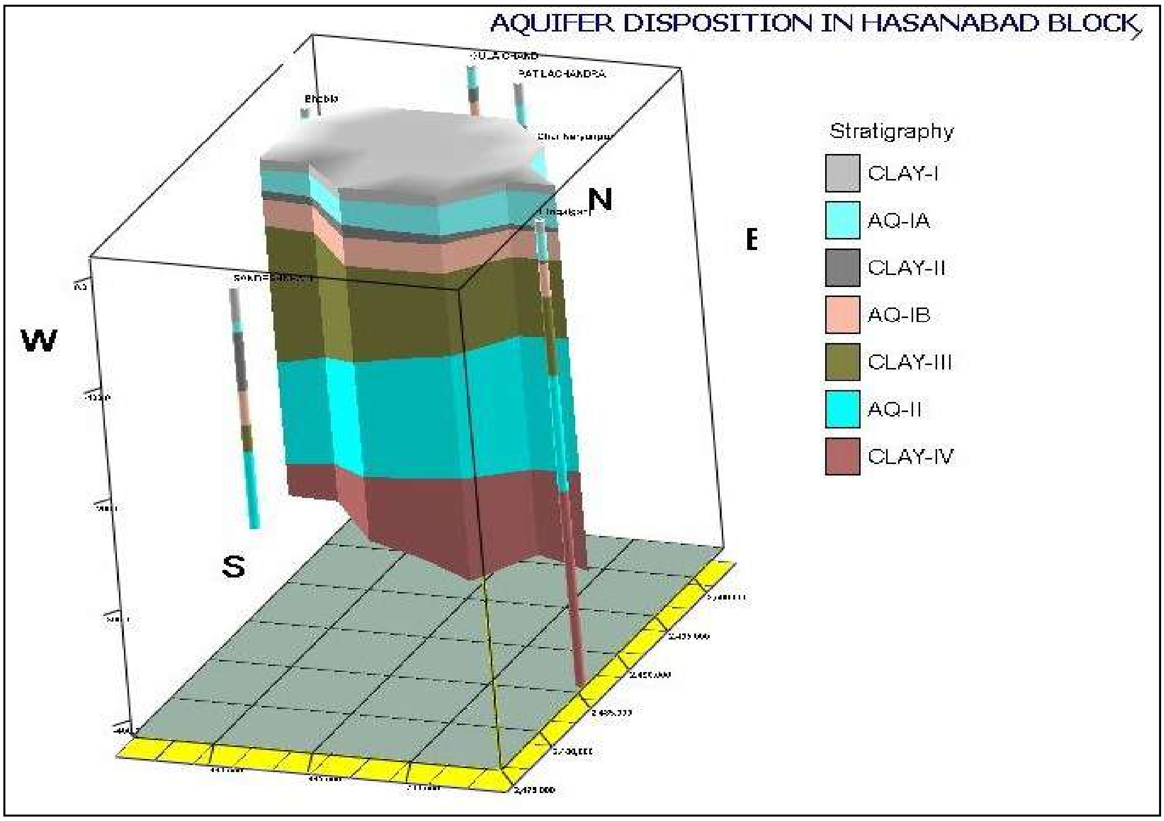


Fig-8.11.3: 3 D aquifer disposition in Hasanabadblock

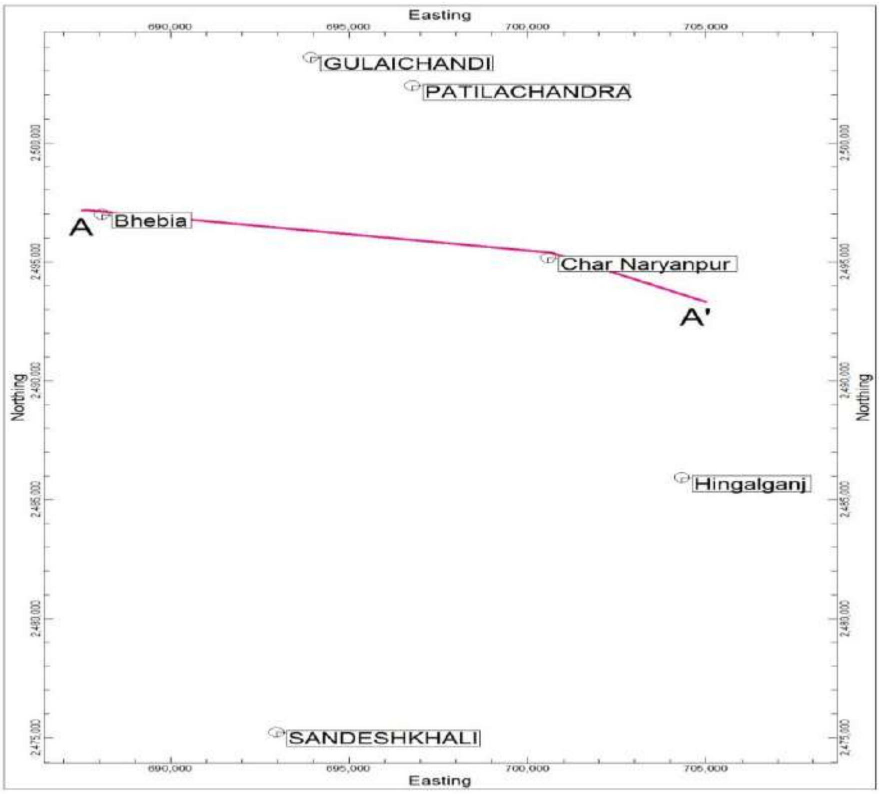


Fig. 8.11.4: NW-SE section index line in Hasanabadblock

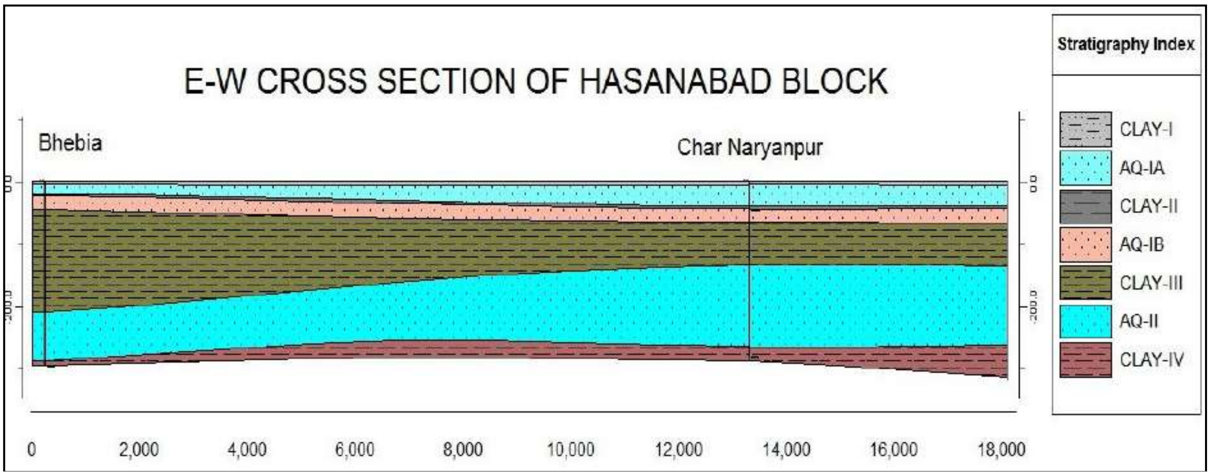


Fig. 8.11.5: NW-SE section in Hasanabadblock

Table- 8.11.5 - Aquifer Wise Water Level Ranges & seasonal long term water level trends (2006 to 2017)

Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
		Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
Hasnabad	I	2.4	0.132	-	2.74	-	0.261
Hasnabad	II	5.01- 6.5	0.106	-	3.2 -5.5	-	3.84

Table –8.11.6Aquifer wise maximum thickness

Block	Area (sq km)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)
Hasnabad	16996	81	2A - 133 2B - 20

Table- 8.11.7 -Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer			
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S
Hasnabad	4-85	28.8	822.42	0.029	2A 119-252 2B 280-300	81	1125.77	$4.86*10^{-6}$

8.11.4 Ground Water Resource

Aquifer Wise Resource Availability & Extraction:

Dynamic ground water resources have not been assessed as the block falls under confined condition. However ground water flow for the confined aquifer has been assessed using Q=TIL Method. The total Ground water flows have been assessed to be7222.2m^3/day towards south and 54000m^3/dayt owards west.

Table-8.11.8 -Availability of Ground Water resource in block

Dynamic resource (Aquifer II) – 15.23 Ham

8.11.5 Chemical Quality of Ground Water & Contamination:

Based on Key well data blocks wise average data of chemical parameter is given below. For Arsenic data, data of ground water in selective monitoring stations of CGWB have been considered.

Table-8.11.9 -Aquifer wise average chemical parameter in the block

Block	Aquifer	As (mg/l)	pH	EC (µs/Cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Hardness (mg/l)
Hasnabad	Aquifer IA	0.124	9.03	1384	304.37	170.18	0.19	2.56	55
	Aquifer II	0.022	-	-	-	-	-	-	-

8.11.6 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking

- In Aquifer I, ground water is contaminated with arsenic. Therefore, to cater potable water, technique of cement sealing to be applied; also arsenic removal plant should be installed.

- Regular Field monitoring of arsenic concentration in ground water in tube wells is required.
- PHED, Govt of West Bengal Data depict that **50257** population in 18 villages (**Konanagar,Gobindapur,Kharampurabad,Chimta,Kharampur,Nawapara,ChakkUliadanga,Tegharia,Makhalgachha,Sundaria,ChakKhanpukur,PurbbaChak,Monoharpur,Rameswarpur,Chanpatala,Barunhat,Kharur,Rajnagar**) is under risk zone where no water supply scheme exists.
- Based on CGWB wells data, it has been estimated that in this block a total of 19 wells are needed for projected population in 2021, where no supply scheme exists. The cost estimate for the construction of these wells has been shown in Table 8.11.11.

Table-8.11.10- Details of Arsenic infested population in Hasanabd block

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Hasnabad	18	50257	Fresh aquifers occur at different depth; in general, it existswithin 123-250 mbgl. The upper aquifer within 130mbgl is brackish & clay layer separates these two aquifers In this block. CGWB exploration depicts that fresh aquifers also exist within 430-480 mbgl. Hence, site specificaquifer disposition is required for assembly design.

Table 8.11.11: Village wise requirement of nos. of arsenic free tube wells & cost estimate of construction

For monitoring of the ground water regime, if Observation well is needed then cost of construction of the same should also be included in the

Village	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of the Observation well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Konanagar	2829	3170	198.03	221.9	283	293	5.66	5.87	203.69	227.77	81	8	648	1	20
Gobindapur	1458	1634	102.06	114.38	146	151	2.92	3.03	104.98	117.41	81	8	648	1	20
Kharampurabad	3114	3489	217.98	244.23	311	322	6.22	6.45	224.2	250.68	81	8	648	1	20
Chimta	2490	2790	174.3	195.3	249	258	4.98	5.16	179.28	200.46	81	8	648	1	20
Kharampur	5714	6402	399.98	448.14	571	592	11.42	11.84	411.4	459.98	81	8	648	1	20
Nawapara	2772	3106	194.04	217.42	277	287	5.54	5.74	199.58	223.16	81	8	648	1	20
Chakk Uliadanga	859	962	60.13	67.34	86	89	1.72	1.78	61.85	69.12	81	8	648	1	20
Tegharia	1594	1786	111.58	125.02	159	165	3.18	3.3	114.76	128.32	81	8	648	1	20
Makhalgachha	2610	2924	182.7	204.68	261	271	5.22	5.41	187.92	210.09	81	8	648	1	20
Sundaria	1335	1496	93.45	104.72	134	139	2.68	2.78	96.13	107.5	81	8	648	1	20
Chak Khanpukur	1886	2113	132.02	147.91	189	196	3.78	3.92	135.8	151.83	81	8	648	1	20
Purbba Chak	296	332	20.72	23.24	30	31	0.6	0.62	21.32	23.86	81	8	648	1	20
Monoharpur	762	854	53.34	59.78	76	79	1.52	1.58	54.86	61.36	81	8	648	1	20
Rameswarpur	3463	3880	242.41	271.6	346	359	6.92	7.17	249.33	278.77	81	8	648	1	20
Chanpatala	367	411	25.69	28.77	37	38	0.74	0.77	26.43	29.54	81	8	648	1	20
Barunhat	16635	18638	1164.45	1304.66	1664	1725	33.28	34.5	1197.73	1339.16	81	8	648	2	40
Kharur	1068	1197	74.76	83.79	107	111	2.14	2.22	76.9	86.01	81	8	648	1	20
Rajnagar	1005	1126	70.35	78.82	101	105	2.02	2.09	72.37	80.91	81	8	648	1	20
	50257	**56310**	**3517.99**	**3941.7**	**5027**	**1979**	**100.54**	**104.23**	**3618.53**	**4045.93**	**1458**	**144**	**11664**	**19**	**380**

Management Plan for irrigation:

Table 8.11.12 – Irrigation scenario in block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Remarks for GW Management Plan
Hasnabad	16996	11020	1172.36	9847.64	-	R- 0.132	F-0.106	12.265	8.63	-

Measures recommended

- This block comes under Sunderban area so there is management plan is different. Numerous creeks and rivulets traverse it.
- To ensure food security in the present changing climatic condition, expansion of irrigation network and harnessing of new water sources are essential.
- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analysed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.11.13 – Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability(Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Hasnabad	-	Salinity	wheat, rice, mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-.12)	wheat, mustard, lentil, flowers, vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio for vegetable,flowers

Table-8.11.14– Crops in practice in block

Name of Block		Hasnabad
Aus	*Area	1
	*Prod.	0.003
	*Yield	2627
Aman	Area	10128
	Prod.	23.983
	Yield	2368
Boro	Area	1795
	Prod.	6.169
	Yield	3437
Wheat	Area	15
	Prod.	0.040
	Yield	2700
Jute	Area	1161
	Prod	18.739
	Yield	16.14
Musur	Area	28
	Prod.	0.024
	Yield	873
Mustard	Area	2946
	Prod.	4.303
	Yield	1461
Til	Area	143
	Prod.	0.161
	Yield	1127
Potato	Area	419
	Prod.	12.542
	Yield	29934

*Area in hectare, Production in Thousand MT and Yield in kg./hect.
(Source - Department of Economics and Statistics, Govt. of West Bengal)

Table-8.11.15 - Area wise percentage of current practice of crops in Hasnabad block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
58.1	3104	33.6	1795	7.8	419	0.5	28	5346

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, it is 0.6 and for determination of water requirement in the area this factor i.e. 0.6 is multiplied with the remaining cultivable area in the block. Total water required calculated (9847.64*0.6) is

5908.58 Ham. But, there is no unconfined aquifer in this block & no water is available as such to irrigate the remaining land.

An attempt has been made (vide Table- 8.11.16**)** to estimate the surface runoff component in the block after **Dhruvanarayana, 1993** studying slope, soil type, rainfall, etc**.**

Table- 8.11.16 – Estimation of Surface runoff component after Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Hasnabad	**Silty Clay**	**7754.55**	**5815.91**	**2907.96**	**1744.77**

A* - area, C - run off coefiiceent from Normal Monsoon Rainfall**

There is no unconfined aquifer & as such there is no dynamic resource available in this block. To cover the still uncovered area by cultivation, it should be our endeavour not to practice boro rice further and to increase other crops including rabi.

From the available surface water run off component (Table 8.11.16), 60 % i.e. 1046.86 Ham may be allotted for further cultivation in the remaining 9847.64 Ha of cultivable land. An attempt has been made to show changed cropping pattern inTable-8.11.17**.** It appears thatwater allocation in the ratio of 100:0 for Rabi &Vegetables is most appreciable to cover maximum area.

Table-8.11.17. Future Water allocation for remaining cultivable area from surface run off component estimated after Dhruvanarayana 1993

Present water availability(ham) from Surface Run off Component	Considering 100% water for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Vegetable (water column requirement Potato=0.6m)		Total Area covered(A)	Remaining Cultivable area (9847.64-A)
		%	Area(ha)	%	Area(ha)		
1046.86	1046.86	100	4985	0	0	4985	4862.64
1046.86	1046.86	50	2493	50	872	3365	6482.64
1046.86	1046.86	20	997	80	1396	2393	7454.64

Based ontable-8.11.17, it is suggested that out of 9847.64 ha area 4985 ha area could be covered by above said allocation. For covering remaining area, treated brackish/saline surface water may be used.

Proposed Artificial Recharge Structures in the study area

Table- 8.11.18 - Area suitable for recharge in the study area**:**

District	Block Name	Area (in sq. km)	Total Area suitable for recharge (sq km.)
NORTH TWENTY FOUR PARGANAS	Hasnabad	16996	6394

Only 40 % water is used for artificial recharge& conservation i.e. 697.91 Ham, because 60 % water has already been suggested for use in irrigation of the remaining cultivable land. Based on soil characteristic, Slope, Rainfall data and Long term trend number of structures are calculated and given in **Table- 8.11.19**.

Table- 8.11.19- Estimation of nos & types of artificial & conservation structures proposed

***REET – Reexcavation of existing tank**

Block (1)	Block Area (2)	Area suitable for recharge (Considering area having Post monsoon DTW 3m & above and showing long term falling trend of 2m/yr. & more) (3)	Soil type (4)	Considering 40 % water for artificial recharge and conservation (Ham) (5)	Source water allocation for with Artificial recharge in Ham (5)70 % of Col. 5 (6)	Source water allocation for irrigation cum recharge Tank - 50% of Col. 6 (7)	Source water allocation for REET with recharge Shaft- 50% of Col. 6 (8)	Source water allocation for Injection for Injection wells - 20% of Col. 5 (9)	Source water allocation for Farm Ponds - 10% of Col. 5 (10)	Nos. of irrigation cum recharge Tank suggested @ 50 Ham per unit (11)	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit (12)	Nos. of injection well suggested @ 30 Ham per unit (13)	Nos. of FarmPonds suggested @ 10 Ham per unit (14)	Cost of irrigation cum recharge Tank @ Rs 8 lakh per unit	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of injection well @ Rs 15 lakh per unit	Cost of Farm Ponds @ Rs 8 lakh per unit	Remarks
Hasnabad	16996	6394	Silty Clay	697.91	488.53	^244.27	244.27	139.58	69.79	5	24	5	7	40	192	75	56	This block comes under Sunderban delta area so in river tributaries series of check dam with sluices structures are suitable.

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Irrigation cum recharge tank – size 100m*100m*5m, Filling -10 times, capacity – 50 Ham; for recharge and irrigation
- Farm pond- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

^ By this amount of 244.27 Ham of water, after subtracting 48.85 Ham as annual evaporation loss and with an average crop water requirement of 0.6m, an additional area of 325.7 Ha could be irrigated. Thus, finally total area irrigated is 4985 + 325.7 i.e. 5310.7 Ha.

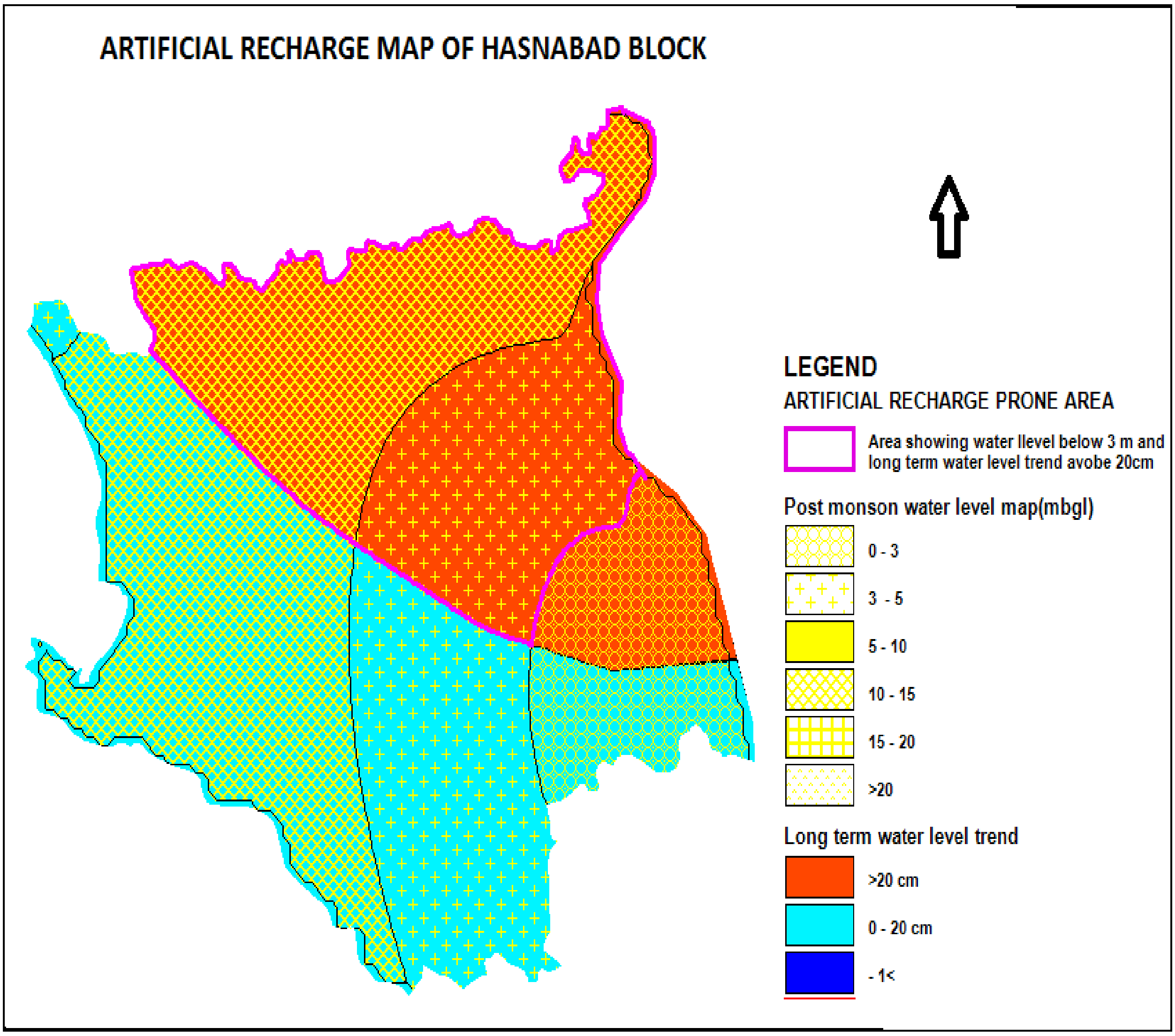


Fig.-8.11.6: Artificial Recharge map of Hasnabad block

Special measures recommended in Sunderban area of Hasanabad Block for management of surface water&Ground Water

Problems:

- Fresh water aquifer has been encountered in deeper aquifers of this block, whereas saline/brackish water inferred in shallow aquifers.
- Freshwater is a scarce resource in Sundarban area. Numerous creeks and rivulets traverse in the block. The block receives a huge amount of precipitation monsoon months.
- The salt water intrusion into groundwater aquifers often takes place.
- This situation may further worsen with current climate change and rising sea level conditions.
- In this area extreme cyclonic activities take place regularly.

Interventions recommended:

- Conjunctive use of surface water and ground waters may be helpful for sustainable water resource management in Sundarbans.

- Sluice gate, which can regulate the water from the back flow during high tide, should be constructed across river, canal and creeks, etc.
- Large scale rainwater harvesting, rejuvenation and re -connection of disconnected river channels, artificial recharge within shallow aquifers to bring down its salinity, de-salination of shallow groundwater may be some of the major policy options to meet the water demand in the Sundarbans eco regime in future.
- Assurance of an ecological flow (e-flow) in the river channels are the major solution for this water starved region.
- Switching to treated surface water rather than extensive deep groundwater exploitation may be other sustainable alternative for drinking water supply in the Sundarbans .
- deepening of existing ponds to increase
- their water holding capacity
- Deepening of existing ponds to increase their water holding capacity
  The harvested rainwater may be utilised for domestic use after proper treatment.
- Regular studies are needed for better management options for surface water and groundwater in the fragile ecosystem of Sundarbans.

8.12 HINGALGANJ BLOCK

8.12.1 Salient Information

Block Name: Hingalganj

Area (in Ha):23000

District: **North Twenty Four Parganas**

State: West Bengal

Population (as on 2011):

Table-8.12.1 -Population in Hingalganj block

Rural	Urban	Total
159469	15076	174545

Rainfall: Average annual rainfall (**North Twenty Four Parganas** district)for the period 2012 -16 (in mm): 1555.76

Table – 8.12.2 – District Annual Rainfall for last five years

Block	District Normal	District Annual (in mm)				
		2012	2013	2014	2015	2016
Hingalganj	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in Ha):

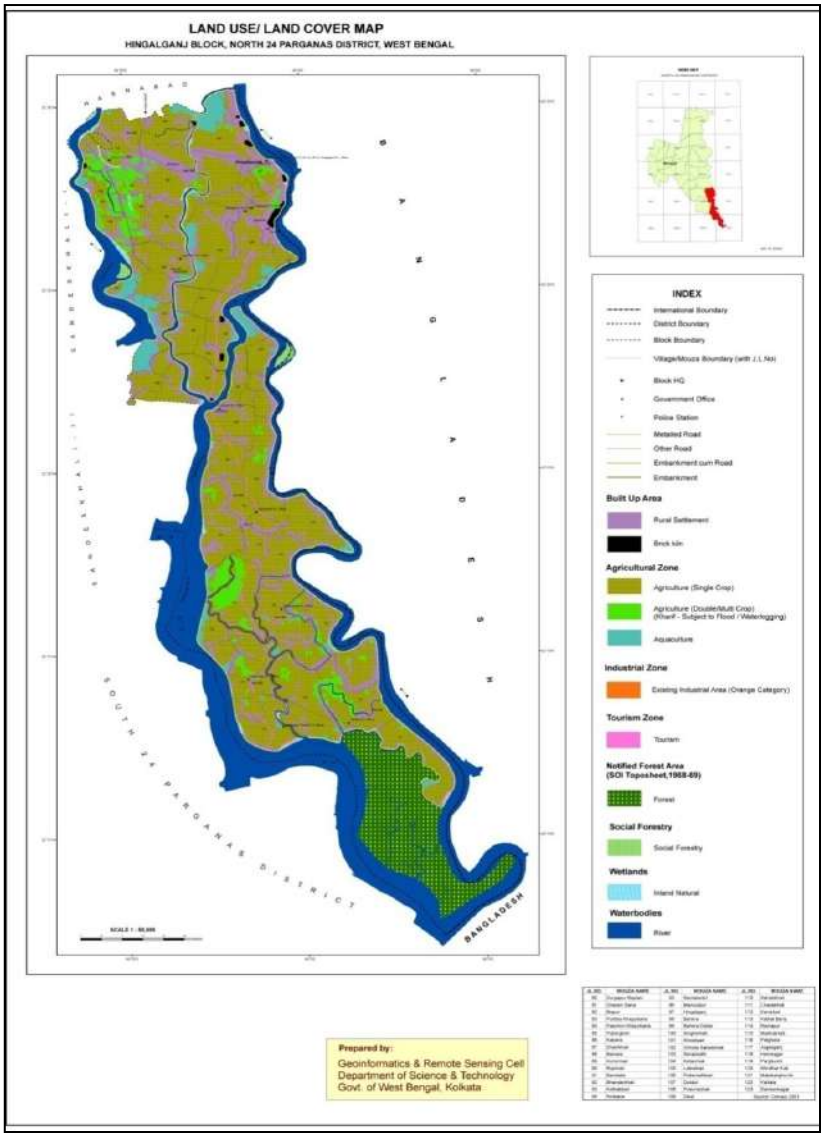
Table –8.12.3- Salient Landuse features in block

Name of the Block	Geographic Area	Cultivable Area	Area under pasture & orchard	Cultivable Waste Land	Forest Land
Hingalganj	23000	14200	93	75	-

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.12.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	**Aquifer I**	**Aquifer II**	**Remarks (for Aquifer I)**
Dynamic Resource	**-**	**0.28**	**Dynamic resource is not calculated for unconfined aquifer due to salinity**



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig. 8.12.1: Landuse& Land cover map of Hingalganj block

8.12.2 Disposition of Aquifers

In Hingalganj Block, there are three aquifer systems:

- The range of 1st aquifer (Aquifer I) is **30m to 124 m,** ground water in this aquifer is contaminated by arsenic.
- The range of 2nd aquifer (Aquifer II) is **123 m to 250m**, which is fresh and Arsenic free.
- The range of 3rd aquifer (Aquifer III)is **337 m to 357 m**. This is also fresh.

Table- 8.12.5 - Aquifer disposition in block

Block	Depth range of Aquifer in m bgl			
HINGALGUNJ	1st Aquifer	2nd aquifer	3rd aquifer	Remarks
	30-124	123-250	337-357	1st aquifer saline

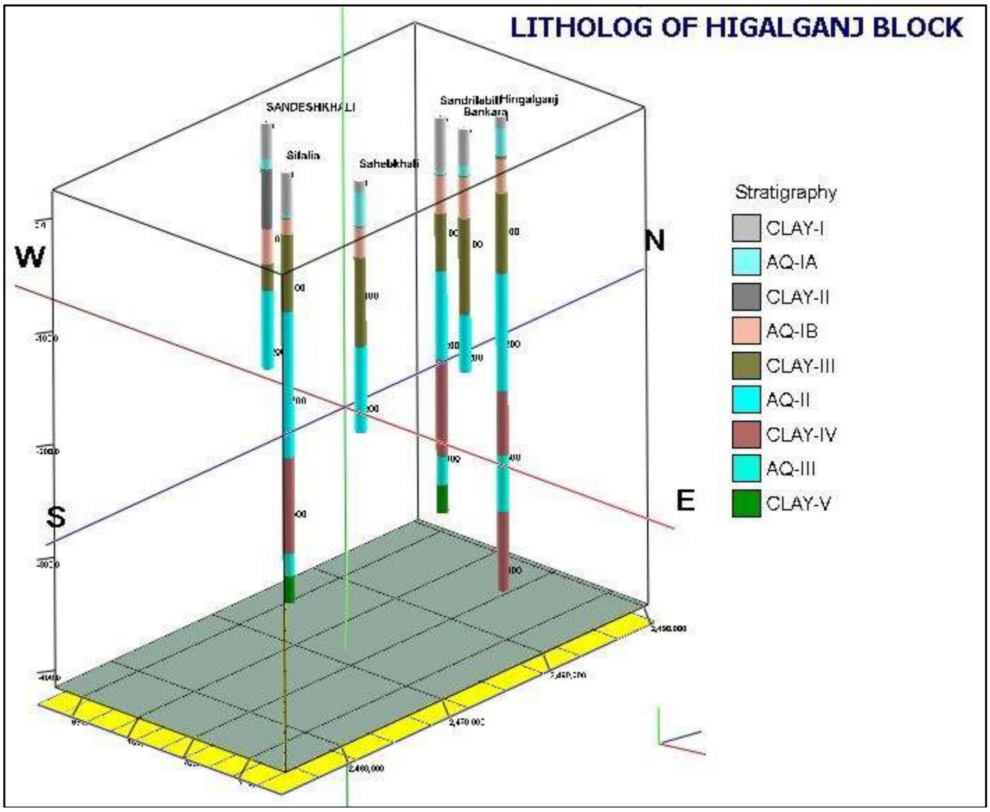


Fig. 8.12.2: Stratigraphic logsin Hingalganj block

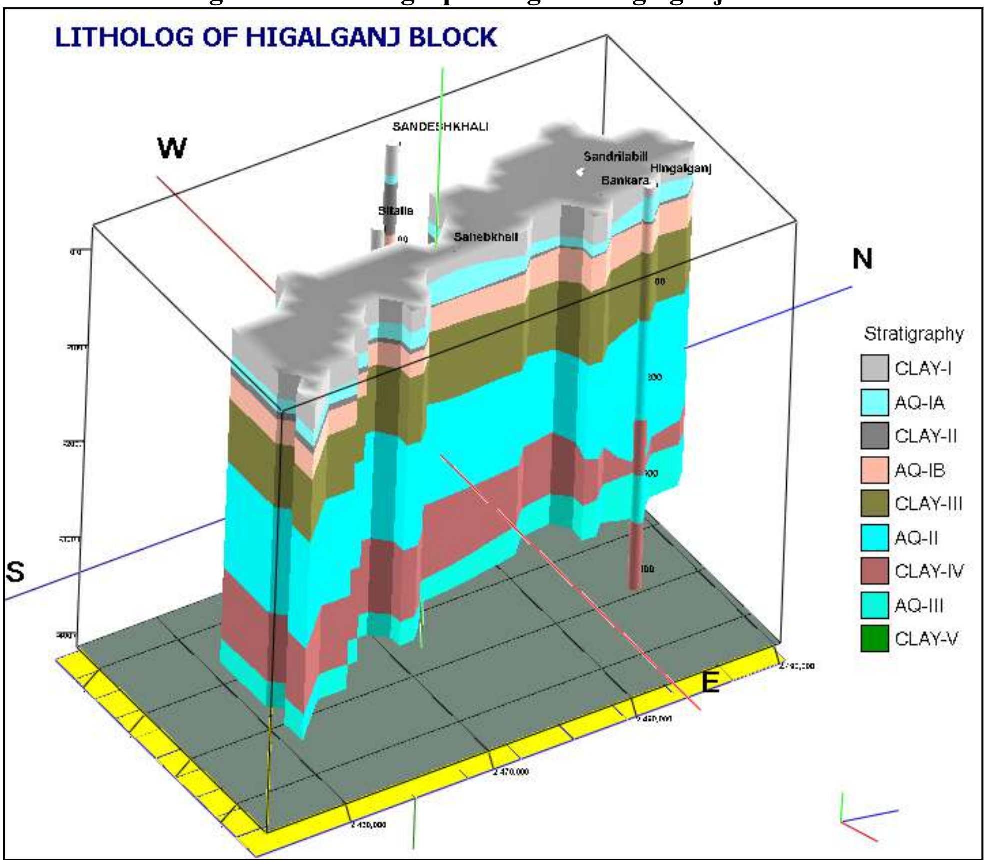


Fig. 8.12.3: 3 D aquifer disposition in Hingalganj block

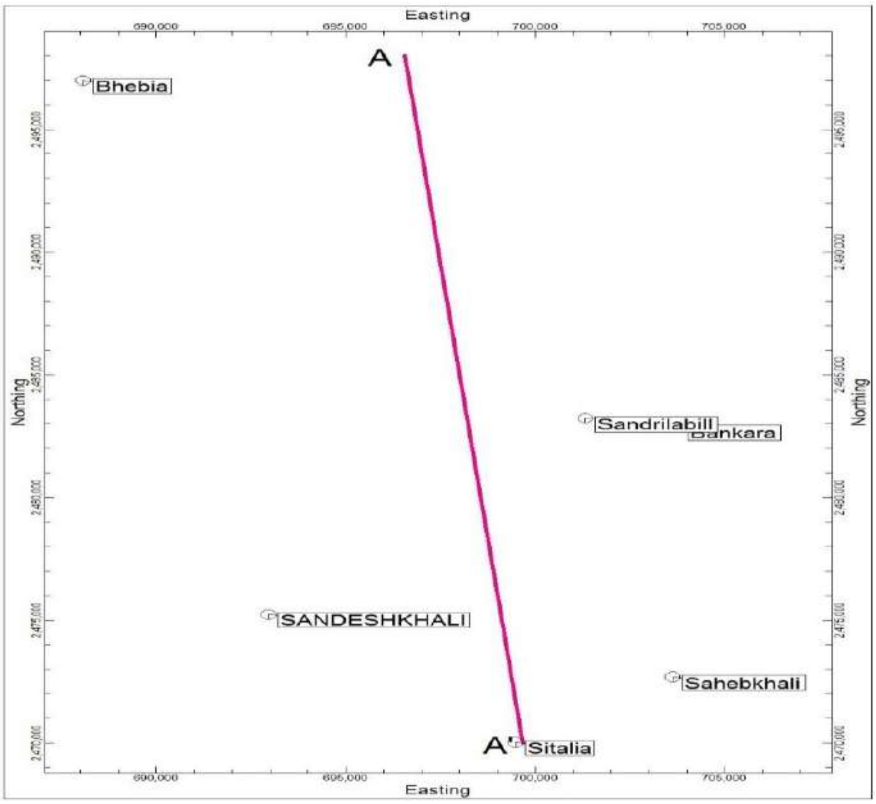


Fig. 8.12.4: N-S section index Line in Hingalganj block

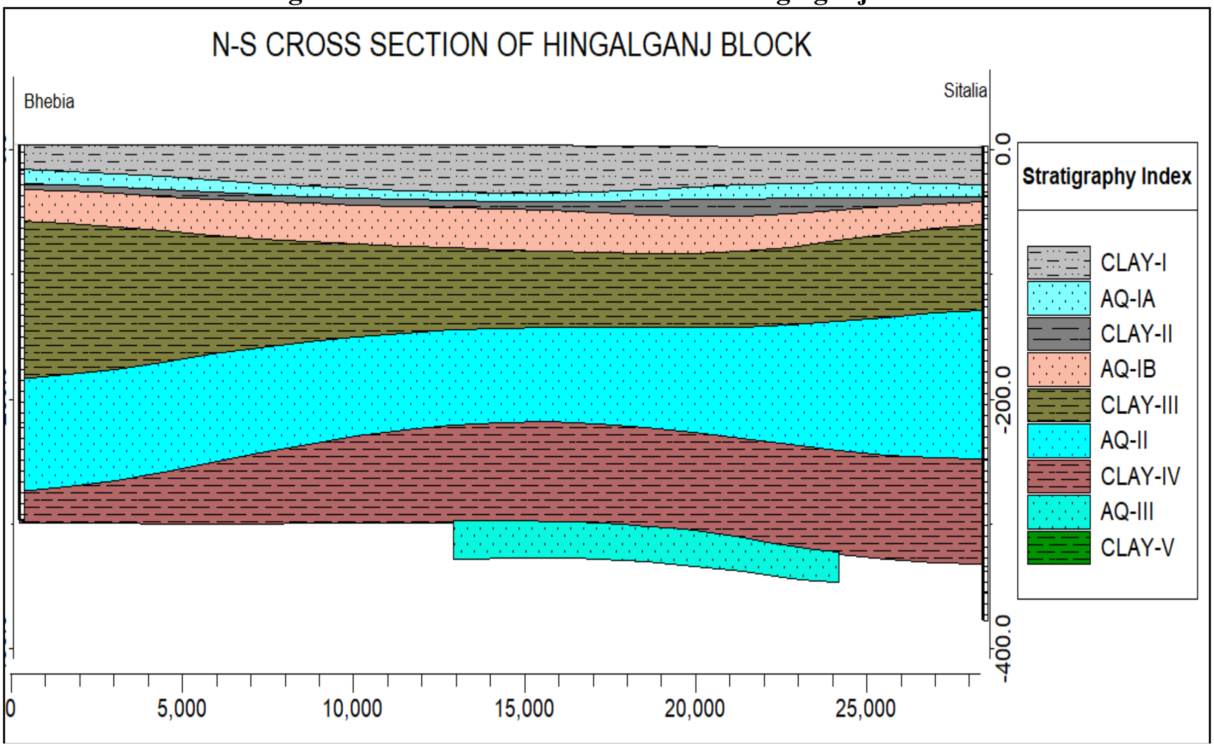


Fig.8.12.5: N-S cross section in Hingalganj block

Table- 8.12.6 - Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

SI. No.	Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
			Water Level Range (	Rise (cm/year)	Fall (cm/year)	Water Level Range (m	Rise (cm/year	Fall (cm/year)
1.	Hingalganj	I	2.4 – 4.3	-	0.341	2.74–4.1	-	-
2.	Hingalganj	II	6.44-9.87	-	-	5.2- 6.7	-	-
3	Hingalganj	III	-	-	-	-	-	-

Table- 8.12.7 -Aquifer wise maximum Thickness-

Block	Area (sq km)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)	Thickness of the Granular Zone in 3rd aquifer (m)
Hingalganj	23000	94	127	20

Table- 8.12.8 -Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer				3rd Aquifer		
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)
Hingalganj	10-85	44.94	822.42	0.029	123-250	81	1125.77	$4.86*10^{-6}$	337-357	-	-

8.12.3 Ground Water Resource, Extraction, Contamination &other Issues

Aquifer Wise Resource Availability & Extraction: Dynamic ground water resources have not been assessed for Aquifer I as it is under confined condition, and it is salinity infested. However, ground water flow for the confined aquifer has been assessed using Q=TIL Method. The total Ground water flow is 6125 m^3/day towards south.

Table-8.12.9 -Availability of Ground Water resource in block (Ham)

Resource Availability	Aquifer I	Aquifer II	Aquifer III
Dynamic Resource	-	28	-

8.12.4 Chemical Quality of Ground Water & Contamination

Based on Key well data blocks wise Average data of chemical parameter is given below. For contamination of ground Water by arsenic, data of 3 to 4 monitoring stations of CGWB have been considered.

Table-8.12.10 -Aquifer wise average chemical parameter in the block

Block	Aquifer Type	As (mg/l)	pH	EC (µs/Cm)	Na (mg/l)	Cl (mg/l)	F (mg/l)	NO_3 (mg/l)	Measured Hardness(mg/l)
Hingalganj	IB	-	8.83	2849	574.83	421.90	0.61	18.50	75
Hingalganj	II	0.008	8.67	1144	255.36	74.45	0.64	0.78	30

8.12.5 Ground Water Resource Enhancement& Management Plan

Ground Water Management Plan for drinking

- In Aquifer I, ground water is contaminated by arsenic; so, for construction of tube wells Arsenic free aquifer should be tapped with proper cement sealing in the upper clay layer.
  - Arsenic removal plant should be installed.
- Regular Field monitoring is necessary for determination of arsenic concentration in ground water.
- As per PHED Data, Govt. of West Bengal,6883 population in 14 villages (**Bhandarkhali,Kothabbari,Ambaria, Sarapkathi,Ketarchak,Lebukhali,Deuli,Sahebkhali,Ramapur,Madhabkati,Jogesganj,Hemnagar,Shridhar Kati,Malekanghumti**) is under risk zone where no water supply scheme exists.
- Based on CGWB wells data, viz. discharge, etc. nos. and cost for construction of well have have been estimated for future population in 2021.
- In this block total 14 wells are needed for supply of arsenic free potable ground water.

Table-8.12.11 - Arsenic infested population in Hingalganj block

Sl. No.	Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.
Hingalganj	14	58642	In general, fresh aquifers exist in depth span 123-250 mbgl. The upper aquifer within 130 mbgl is brackish & clay layer separates these two aquifers

Table- 8.12.12 – Estimation of Village wise number and cost for construction of Tube wells

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of well of 300 m depth (approx) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Bhandarkhali	5832	6534	408.24	457.38	583	604	11.66	12.09	419.9	469.47	81	8	648	1	20
Kothabbari	1625	1821	113.75	127.47	163	169	3.26	3.38	117.01	130.85	81	8	648	1	20
Ambaria	2749	3080	192.43	215.6	275	285	5.5	5.7	197.93	221.3	81	8	648	1	20
Sarapkathi	1636	1833	114.52	128.31	164	170	3.28	3.4	117.8	131.71	81	8	648	1	20
Ketarchak	994	1114	69.58	77.98	99	103	1.98	2.05	71.56	80.03	81	8	648	1	20
Lebukhali	2677	2999	187.39	209.93	268	278	5.36	5.56	192.75	215.49	81	8	648	1	20
Deuli	2549	2856	178.43	199.92	255	264	5.1	5.29	183.53	205.21	81	8	648	1	20
Sahebkhali	5792	6489	405.44	454.23	579	600	11.58	12	417.02	466.23	81	8	648	1	20
Ramapur	6357	7122	444.99	498.54	636	659	12.72	13.19	457.71	511.73	81	8	648	1	20
Madhabkati	4304	4822	301.28	337.54	430	446	8.6	8.91	309.88	346.45	81	8	648	1	20
Jogesganj	7082	7935	495.74	555.45	708	734	14.16	14.68	509.9	570.13	81	8	648	1	20
Hemnagar	3960	4437	277.2	310.59	396	410	7.92	8.21	285.12	318.8	81	8	648	1	20
Shridhar Kati	7687	8613	538.09	602.91	769	797	15.38	15.94	553.47	618.85	81	8	648	1	20
Malekanghumti	5398	6048	377.86	423.36	540	560	10.8	11.2	388.66	434.56	81	8	648	1	20
	58642	**65703**	**4104.94**	**4599.21**	**5865**	**6080**	**117.3**	**121.6**	**4222.24**	**4720.81**	**81**	**8**	**648**	**14**	**280**

For monitoring of the ground water regime if observation well is needed then cost of construction of the same should also include in the expenditure.

Management Plan for irrigation:

Table- 8.12.13 – Irrigation scenario in the block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl
Hingalganj	23000	14200	708.71	13491.29	-	F-0.341	-	-	-

Measures recommended

- This block comes under Sunderban area so there is management plan is different. Numerous creeks and rivulets traverse it.
- To ensure food security in the present changing climatic condition, expansion of irrigation network and harnessing of new water sources are essential.
- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analyzed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table- 8.12.14– Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability(Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Hingalganj	-	Salinity	wheat, rice, mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable (0.15-0.2),pulse(0.1-.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water in appropriate ratio for vegetable,flowers

Table-8.12.15 – Crops in practice in block

Name of Block		Hingalganj
Aus	*Area	2094
	**Prod.	5.501
	***Yield	2627
Aman	Area	10132
	Prod.	19.915
	Yield	1966
Boro	Area	385
	Prod.	1.236
	Yield	3210
Wheat	Area	124
	Prod.	0.335
	Yield	2700
Jute	Area	12
	Prod.*	0.244
	Yield**	20.36
Khesari	Area	4
	Prod.	0.003
	Yield	791
Til	Area	1
	Prod.	0.001
	Yield	1127
Potato	Area	1
	Prod.	0.021
	Yield	20580

*Area in hectare, **Production in Thousand MT and ***Yield in kg./hect.

(Source -Department of Economics and Statistics, Govt. of West Bengal)

Table – 8.12.16–Crop area percentage in Hingalgunj block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
24.3	125	74.8	385	0.2	1	0.8	4	515

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, it is 0.9 and for determination of water requirement in the area this factor i.e. 0.9 is multiplied with the remaining cultivable area in the block. Total water required calculated (13491.29*0.9) is 12142.16 Ham. But, there is no available resource as such.

An attempt has been made (vide Table- 8.12.17**)** to estimate the Surface runoff component in the block after **Dhruvanarayana, 1993** studying slope, soil type, rainfall, etc**.**

Table- 8.12.17 – Estimation of Surface runoff component after Dhruvanarayana, 1993

Block	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (RnXAXC) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc	60% of Vnc (considering e-flow)= Vf
Hingalganj	**Silty Clay**	**9992.256**	**7494.192**	**3747.096**	**2248.2576**

There is no unconfined aquifer. To cover the remaining cultivable area, it should be our endeavour not to practice boro rice further, but to increase other crops including rabi.

From the available surface water run off component (Table 8.12.17), 60 % i.e. 1348.95456 Ham may be allotted for further cultivation in the remaining cultivable land i.e. 13491.29 Ha. An attempt has been made to show changed cropping pattern in **Table-8.12.18.** It appears thatwater allocation in the ratio of 90:10 for Rabi & Vegetables is most appreciable to cover maximum area.

Table-8.12.18 – Crop Water allocation for remaining cultivable area

Present water availability(ham)	Considering 100% water for future irrigation(ham)	Rabi Crops Cultivation(Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Total Area covered(A)	Remaining Cultivable area (13491.29-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)		
1348.9	1348.9	90	5781	0	0	10	225	6006	7485.29
1348.9	1348.9	50	3211.67	0	0	50	1124.08	4335.75	9155.54
1348.9	1348.9	25	1605.83	0	0	75	1686.13	3291.96	10199.33

Based on Table 8.12.18, out of 13491.29 ha area 6006 ha area could be covered by 90:10 water allocation.

Proposed Artificial Recharge Structures in the study area:

Table- 8.12.18 - Area suitable for recharge in the study area:

District	Block Name	Area (in ha)	Area in ha suitable for water conservation (Considering area having DTW of 3m)
NORTH TWENTY FOUR PARGANAS	Hingalganj	**23000**	**20560**

Only 40 % water of the estimated surface run off component could be used for construction of artificial recharge and conservation structures, because 60 % water has already been allocated for use for irrigation of the part of remaining cultivable land.

Now, based on soil characteristic, slope, rainfall data and long term trend number of different structures are given in Table 8.12.19.

Table-8.12.19 – **Estimation of nos.& type of artificial & conservation structures proposed**

Block (1)	Block Area (2)	Area suitable for recharge (3)	Soil type (4)	Considering 40 % water for artificial recharge and conservation (Ham) (5)	Source water allocation for REET with recharge Shaft- 30 % of Col. 5 (6)	Source water allocation for Farm Ponds / irrigation ponds/ series of check dams with sluices - 70% of Col. 5 (8)	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit (9)	Nos. of Farm Pond/Irrigation pond/Series of Check Gate along with Sluice systems suggested @ 50 Ham per unit (11)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit	Cost of Farm Pond/Irrigation pond/Series of Check Gate along with Sluice systems @ Rs 8 lakh per unit	Remarks
Hingalganj	**23000**	**20560**	**Silty Clay**	**899.30**	**269.8**	**629.5**	**27**	**13**	**216**	**104**	**This block comes under Sunderban delta area; creek development may be suitable option.**

***REET – Reexcavation of existing tank**

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Farm pond/ irrigation pond/ check dams with sluices- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only
- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping
- ^ By this amount of 179.86 Ham of water, after subtracting 35.97 Ham as annual evaporation loss and with an average crop water requirement of 0.6m, an additional area of 159.88 Ha could be irrigated. Thus, finally total area irrigated is 6006 + 159.88 i.e. 6165.88 Ha.
- **For covering remaining area, treated saline surface water could be used.**

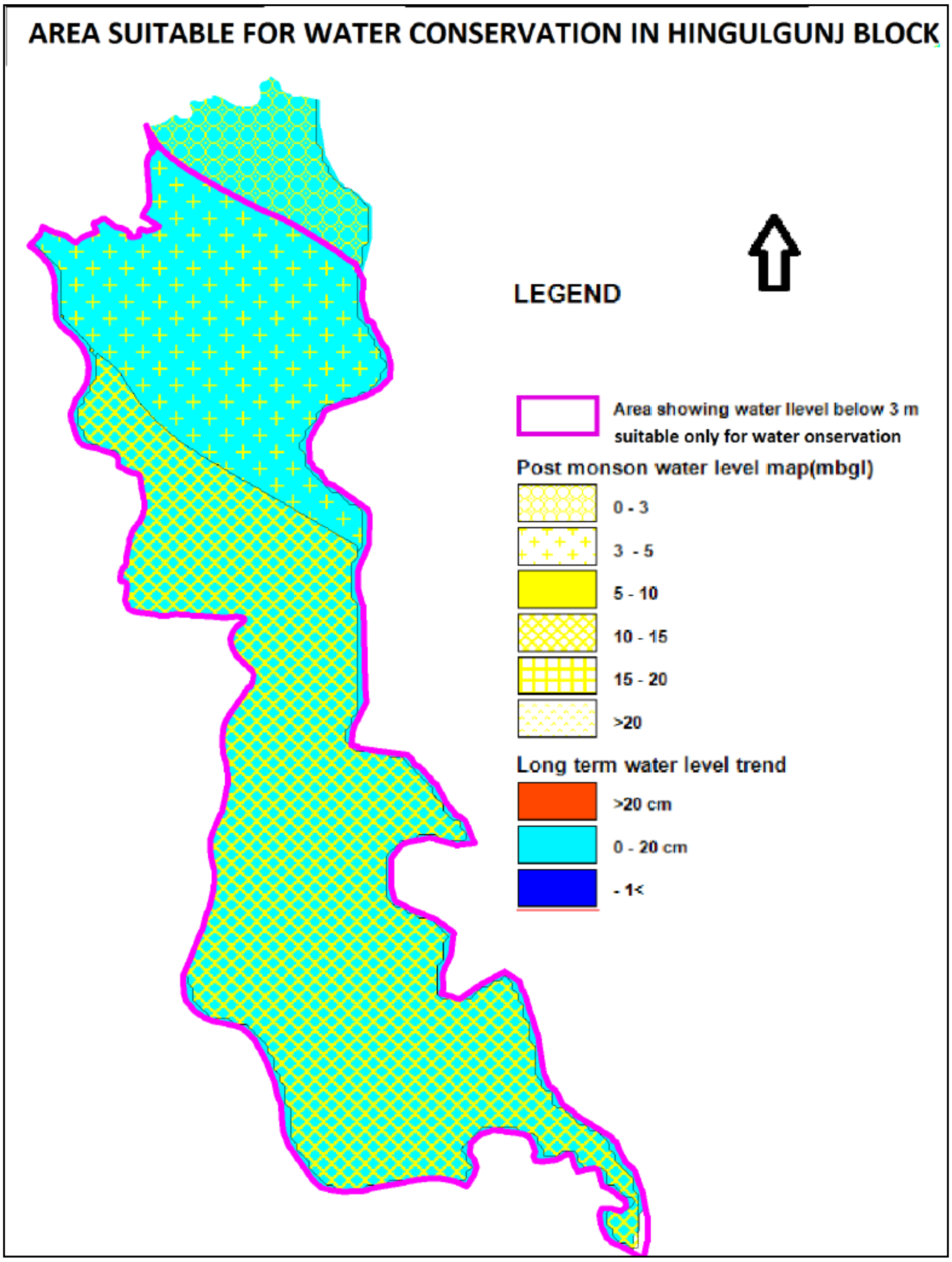


Fig.-8.12.19: Artificial Recharge area in Hingalgunjblock

Special measures recommended in Sunderban area of Hingalganj block for management of surface water & ground water

Problems in Sunderban area of Hingalganjblock

- the lowest values have been
- observed in the southern blocks, due to existence of saline water in shallow aquifers
- Fresh water aquifer has been observed in deeper level in this block, whereas saline/brackish water found in shallow aquifers.

- Freshwater is a scarce resource in the Sundarban. Numerous creeks and rivulets traverse in the block. The block receives a huge amount of precipitation during the monsoon months.
- roof-top rainwater harvesting in this region has potential to supply
- additional
- Conjunctive use of surface water and ground
- waters may be helpful for sustainable water resource management in Sundarbans.
- The salt water intrusion into groundwater often takes place due to influent discharge
- of the river
- The salt water intrusion into groundwater often takes place due to influent discharge of the river.
- This situation may further worsen with current climate change and rising sea level conditions.
- In this area, extreme cyclonic activities take place regularly.

Intervention for surface water & Ground Water management-

- Conjunctive use of surface water and ground waters may be helpful for sustainable water resource management in Sundarbans.
- Sluice gate should be constructed between the junction of river, Canal and estuaries, which can regulate the water from the back flow during high tide.
- Large scale rainwater harvesting, rejuvenation and re -connection of disconnected river channels, artificial recharge within shallow aquifers to bring down its salinity, de-salination of shallow groundwater may be some of the major policy options to meet the water demand in the Sundarbans eco region.
- Switching over to treated surface water rather than expensive exploitation from deep ground water aquifers may be a sustainable alternative for drinking water supply in the Sundarbans .
- deepening of existing ponds to increase
- their water holding capacity
- Regular studies are needed for better management options for balanced Surface and groundwater management.

8.13 SANDESHKHALI-II BLOCK

8.13.1 Salient Information

Block Name: Sandeshkhali-II

Area (in Ha):**19191**

District: **North Twenty-Four Parganas**

State: West Bengal

Population (as on 2011):

Table-8.13.1 - Population in Sandeshkhali-II block

Rural	Urban	Total
160976	**-**	**160976**

Rainfall: District Average annual rainfall (**North Twenty Four Parganas** district) for the period 2012 -16 (in mm):**1555.76**

Table-8.13.2 - Annual Rainfall for last five years

Block	**District Normal**	**District Annual (in mm)**				
		2012	**2013**	**2014**	**2015**	**2016**
Sandeshkhali-II	1623.6	1291.6	1827.8	1269.7	1715	1674.7

Agriculture & Irrigation (area in ha):

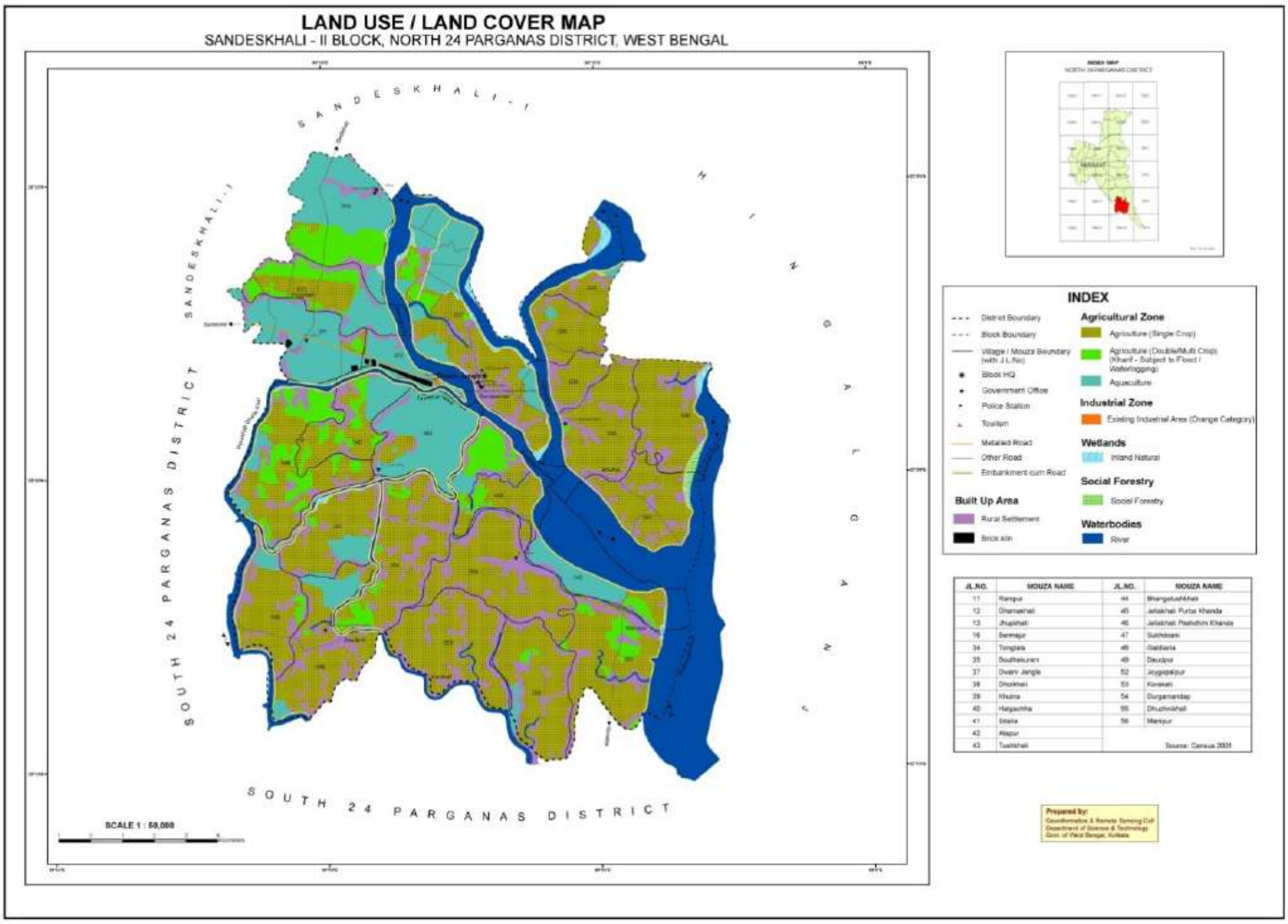
Table- 8.13.3 – Salient Landuse features in block

Name of the Block	**Geographic Area**	**Cultivable Area**	**Area under pasture & orchard**	**Cultivable Waste Land**	**Forest Land**
Sandeshkhali-II	**19191**	7730	86	162	32

Aquifer Wise Ground Water Resource Availability & Extraction:

Table-8.13.4 - Aquifer wise resource availability and draft (in MCM) in block

Resource Availability	**Aquifer I**	**Aquifer II**	**Extraction (for Aquifer I)**
Dynamic Resource	**-**	**7.52**	**Saline water dynamic resource is not calculated for unconfined aquifer**



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig.8.13.1: Landuse & Land cover map of Sandeshkhali-IIblock

8.13.2 Disposition of Aquifer

In Sandeshkhali-II block, three aquifer systems are explored:

Aquifer Group I (Aquifer I): range -**30 m to 124 m,** ground water is contaminated by arsenic.

Aquifer Group II (Aquifer II), range - **123 m to 250m**, which is fresh and arsenic free.

Aquifer Group III (Aquifer III), range -**337 m to 357 m**. This is also likely to be fresh.

Table-8.13.5- Aquifer disposition in block

Block	Depth range of Aquifer in m bgl			
SANDESHKHALI-II	1st Aquifer	2nd aquifer	3rd aquifer	Remarks
	30-124	123-250	337-357	1st aquifer saline

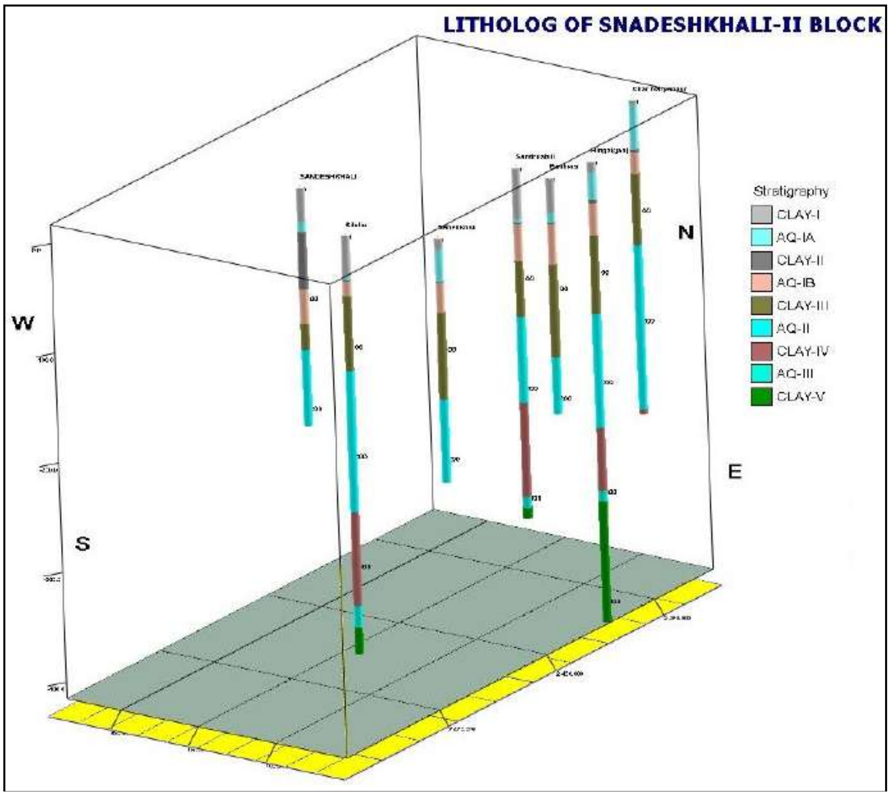


Fig.8.13.2: Stratigraphic Logs in Sandeshkhali-II block

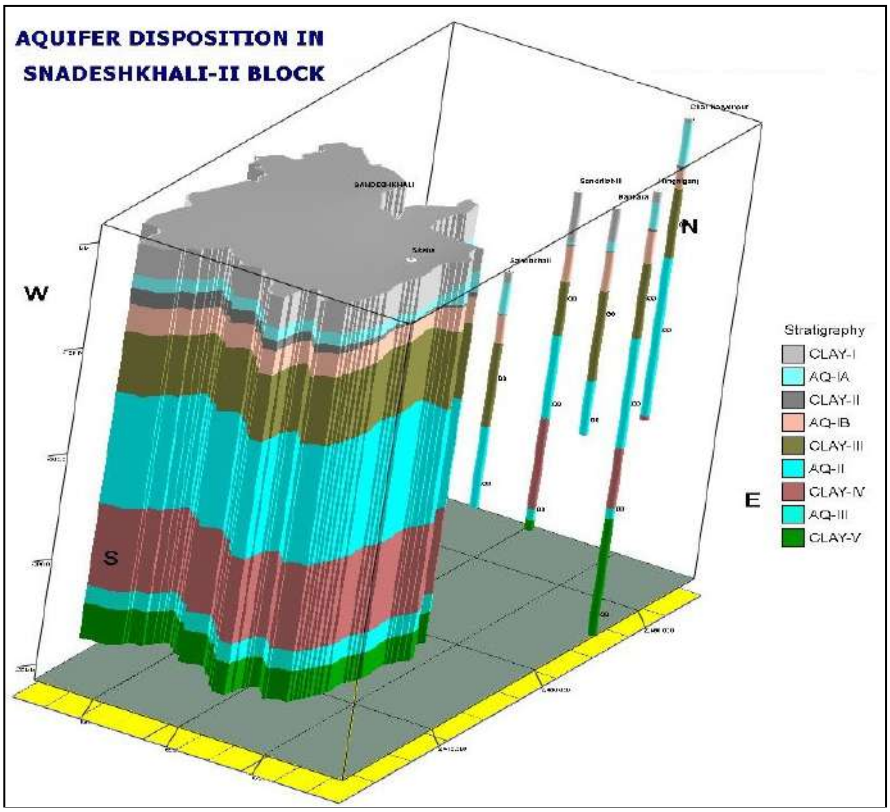


Fig. 8.13.3: Aquifer disposition in Sandeshkhali-II block

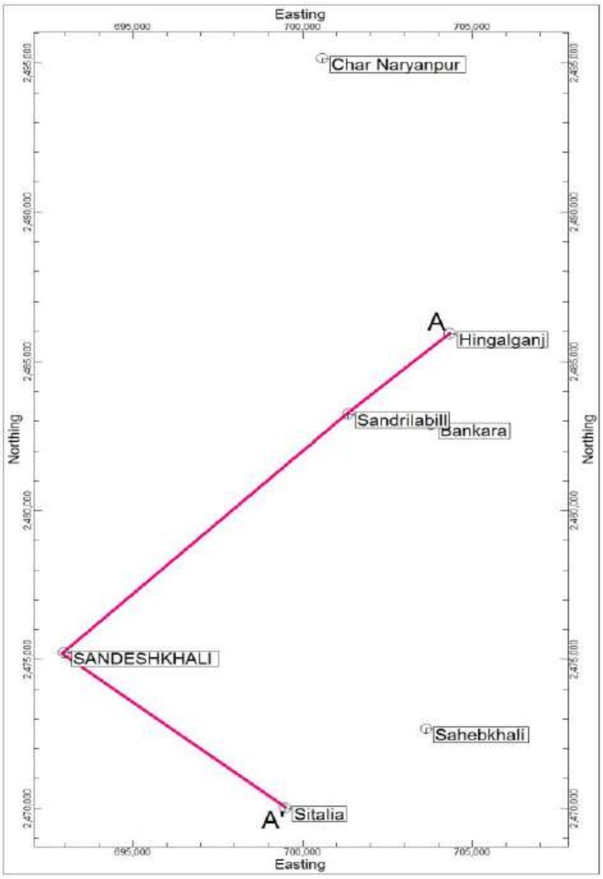


Fig. 8.13.4: NE-SW-SE section index line in Sandeshkhali-II

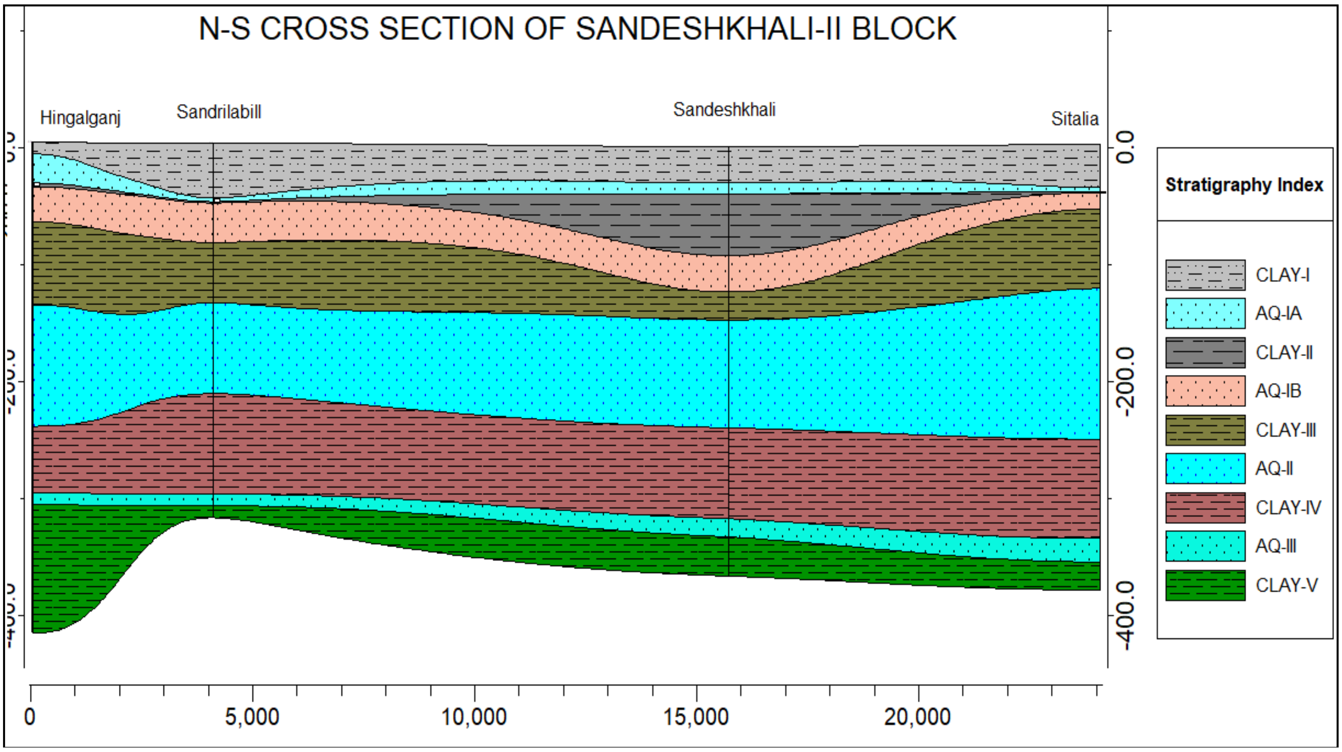


Fig.8.13.5: NE-SW-SEsection in Sandeshkhali-II

Table- 8.13.6 - Aquifer Wise Water Level Ranges & Seasonal long term water level trends (2006 to 2017)

SI. No.	Block	Aquifer	Pre-monsoon Trend			Post-monsoon Trend		
			Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)	Water Level Range (m bgl)	Rise (cm/year)	Fall (cm/year)
1.	**Sandeshkhali-II**	**I**	**6.56-7.67**	**-**	**0.416**	**2.74**	**-**	**0.092**
2.	**Sandeshkhali-II**	**II**	**3.7 - 5.74**	**-**	-	**5.2 -9.5**	**-**	**-**
3	**Sandeshkhali-II**	**III**	**---**	**-**	-	**---**	**-**	**-**

Table-8.13.7 - Thickness of Aquifer (Maximum) in block

Block	Area (ha)	Thickness of the Granular Zone in 1st aquifer (m)	Thickness of the Granular Zone in 2nd aquifer (m)	Thickness of the Granular Zone in 3rd aquifer (m)
Sandeshkhali-II	**19191**	**94**	**127**	**20**

Table- 8.13.8- Aquifer-wise depth range and parameters

Name of Block	1st Aquifer				2nd Aquifer				3rd Aquifer		
	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	S	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)
Sandeshkhali-II	30-124	-	-	-	123-250	81	1125.77	-	337-357	-	-

8.13.3 Ground Water Resource, Extraction, Contamination & other Issues:

Aquifer Wise Resource Availability & Extraction:

There is no unconfined aquifer in this block and the sub-surface ground water regime, as a whole, is under confined condition. Dynamic ground water resource has been assessed for Aquifer II only. However, ground water flow for the confined aquifer has been assessed using Q=TIL Method. The total Ground water flow is 17111.11m^3/daytowards east.

Table-8.13.9 -Availability of Ground Water resource in block

Resource Availability	Aquifer I	Aquifer II	Aquifer III
Dynamic Resource	**-**	**7.52**	**-**

8.13.4 Chemical Quality of Ground Water & Contamination:

Based on Key well data average data of chemical parameter are given below.

Table-8.13.10 -Aquifer wise average chemical parameter of block

Block	Aquifer Type	pH	EC (µs/Cm)	Na(mg/l)	Cl(mg/l)	F(mg/l)	NO_3(mg/l)	Measured Hardness(mg/l)
Sandeshkhali-ii	IB	8.33	4554	968.65	1201.9	0.32	9.86	195
Sandeshkhali-ii	II	8.3	4554	154.56	92.18	0.07	6.84	125

8.13.5 Ground Water Resource Enhancement& Management Plan:

Ground Water Management Plan for drinking

- In Aquifer I, ground water is contaminated by arsenic; so, for construction of tube wells arsenic free aquifer should be tapped with proper cement sealing in the upper clay layer.
- Arsenic removal plant should be installed.
- Regular Field monitoring is necessary for determination of arsenic concentration in ground water.

- As per data of PHED, Govt of West Bengal, **72577**populationin 11 villages (**Rampur,Dhamakhali,Jhupkhali,Khulna,Hatgachha,Tushkhali,Bhangatushkhali,JeliakhaliPurbaKhanda,Sukhdoani,Daudpur,Dhuchnikhali**) is under risk zone where no water supply scheme exist.
- On te basis of CGWB wells data, i.e. discharge, etc. nos. of wells required and cost for construction of these wells have been estimated for population in 2021.
- In this block total **11 wells** needed.

Block	Number of Villages to be covered by water supply schemes	Population in risk zone (as per Census 2011) to be covered by water supply schemes.	Comments on providing water supply to the risk population
Sandeshkhali II	11	**72577**	In general, fresh aquifers exist in the depth span of 123-250mbgl. The upper aquifer within 130 mbgl is brackish. Third aquifer exist in the depth range of 337 – 357 mbgl

Table-8.13.11 - Arsenic infested population in Sandeshkhali-II block

Table- 8.13.12 - Village wise number and cost for construction of tube wells

Village Name	Population 2011	Projected Population 2021 (decadal growth rate 12.04%)	Present Water Requirement for Human Population in M^3 @70lpcd	Projected Water Requirement for Human Population in M^3 @70lpcd	Cattle 2011	Projected Cattle 2021	Present Water Requirement for cattle M^3 @20lpcd	projected Water Requirement for cattle M^3 @20lpcd	Total Water Requirement/day as on 2011 in M^3	Total Water Requirement/day as on 2021 in M^3	Discharge	hours	Discharge of one TW in M^3/day after 8 hours of pumping	No of TW	Cost of well of 300 m depth (approx.) 6" dia @ Rs. 20 lakhs (In lakh)as per EFC
Rampur	8612	9649	602.84	675.43	861	893	17.22	17.85	620.06	693.28	81	8	648	1	20
Dhamakhali	2807	3145	196.49	220.15	281	291	5.62	5.83	202.11	225.98	81	8	648	1	20
Jhupkhali	7908	8860	553.56	620.2	791	820	15.82	16.4	569.38	636.6	81	8	648	1	20
Khulna	5958	6675	417.06	467.25	596	618	11.92	12.36	428.98	479.61	81	8	648	1	20
Hatgachha	5960	6678	417.2	467.46	596	618	11.92	12.36	429.12	479.82	81	8	648	1	20
Tushkhali	9645	10806	675.15	756.42	965	1000	19.3	20.01	694.45	776.43	81	8	648	1	20
Bhangatushkhali	7346	8230	514.22	576.1	735	762	14.7	15.24	528.92	591.34	81	8	648	1	20
Jeliakhali Purba Khanda	5084	5696	355.88	398.72	508	527	10.16	10.53	366.04	409.25	81	8	648	1	20
Sukhdoani	4481	5021	313.67	351.47	448	464	8.96	9.29	322.63	360.76	81	8	648	1	20
Daudpur	7510	8414	525.7	588.98	751	778	15.02	15.57	540.72	604.55	81	8	648	1	20
Dhuchnikhali	7266	8141	508.62	569.87	727	754	14.54	15.07	523.16	584.94	81	8	648	1	20
	72577	**81315**	**5080.39**	**5692.05**	**7259**	**7525**	**145.18**	**150.51**	**5225.57**	**5842.56**	**81**	**8**	**648**	**11**	**220**

Management Plan forirrigation

Table 8.13.13 – Irrigation scenario in the block

Name of Block	Geographical area in ha	Cultivable area in ha	Net irrigated area in ha	Area to be irrigated in ha	SOD in %	Pre monsoon WL Trend 2016 in cm/yr	Post monsoon WL Trend 2016 in cm/yr	Average Pre monsoon WL in mbgl	Average Post monsoon WL in mbgl	Remarks for GW Management Plan
Sandeshkhali-II	19191	7730	3432.43	4297.57		*F-0.4167	F-0.092	7.115	-	

***F- Falling**

Measures recommended

- This block comes under Sunderban area so there is management plan is different. Numerous creeks and rivulets traverse it.
- To ensure food security in the present changing climatic condition, expansion of irrigation network and harnessing of new water sources are essential.
- To improve irrigation efficiency, modern technologies like Sprinkler, Drip irrigation are to be applied; blending of fresh and arsenic contaminated ground water in appropriate ration may be done for irrigation purpose.
- Crops with low water requirement should be preferred.
- Crops consuming low arsenic from ground water should be preferred.
- Artificial recharge is must in arsenic affected zone for dilution of arsenic concentration.
- As the shallow aquifer is arsenic affected, ground water flows into the river or other surface water bodies during summer by base flow. Therefore, these surface water bodies should be analysed before use.
- Regular monitoring of arsenic concentration in crop is also needed.
- R & D study is necessary in arsenic affected area to get better solutions.

Table-8.13.14 – Recommended water column for crops in consultation with experts of Bidhan Chandra Krashi Vidhyalaya (BCKV)

Block	Ground water availability (Ham,)	Quality	Major crops/vegetables/ fruits/flowers currently in practice	Water column depth(m)	Crops suggested for better management(considering ground water quality & quantity)	Water column depth(m) recommended	Remarks e.g. Irrigation techniques etc
Sandeshkhali II	-	Salinity	wheat,rice,mustard, vegetables, lentil	Wheat(0.3-0.35),rice(1.2-1.4),Vegetable(0.15-0.2),pulse(0.1-.12)	wheat,mustard,lentil,flowers,vegetables	Wheat(0.2-0.25),mustard(0.2),pulse(0.08-0.12),flowers(0.12-0.16)	Conjunctive use of fresh and contaminated water: in appropriate ratio for vegetable,flowers

Table-8.13.15: Crops in practice in block

Name of Block		Sandeshkhali-II
Aus	*Area	1936
	*Prod.	5.086
	*Yield	2627
Aman	Area	5008
	Prod.	3.837
	Yield	766
Boro	Area	1042
	Prod.	2.193
	Yield	2105
Til	Area	2
	Prod.	0.002
	Yield	1127
Potato	Area	29
	Prod.	0.925
	Yield	31913

(Source: Department of Economics and Statistics,Govt. of West Bengal)

*Area in hectare, Production in Thousand MT and Yield in kg./hect.

Table-8.13.16 - Area wise percentage of crops in Sandeshkhali-II block

Area wise Current Practice of crops								
Rabi Crops(Wheat, Mustard and oil seeds water column requirement=0.21) Cultivation		Boro Cultivation(Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		pulses(water column requirement =0.11 m)		Total Area covered(A)
%	Area	%	Area	%	Area	%	Area	
0.2	2	97.1	1042	2.7	29	0	0	1073

For recommendation of future irrigation and area of crops to be irrigated, statistically weighted average of the area, determined by water column by major groups of crops in current practice divided by area of cultivation, has been estimated; in this case, boro is to be curtailed from planning, instead vegetables and rabi are to be encouraged and as a matter of fact total water column required for these crops are assumed to be 0.5 m. This factor i.e. 0.5 is multiplied with the remaining cultivable area in the block. Total water required calculated (4297.57*0.5) is 2148.79 Ham. But, there is no available resource as such, because there is no unconfined aquifer.

An attempt has been made (vide Table- 8.13.17**)** to estimate the Surface runoff component in the block after **Dhruvanarayana, 1993** studying slope, soil type, rainfall, etc**.**

Table- 8.13.17 – Estimation of Surface runoff component after Dhruvanarayana, 1993

Block	Major type of soil available in that block	Normal Monsoon rainfall in m'Rn'	Total volume of surface runoff available Annually 'Vt' (RnXA*XC**) Ham	75% of 'Vt' = V	50% of V (Non committed)= Vnc
Sandeshkhali-II	**Silty Clay**	**5439.45**	**4079.59**	**2039.80**	**1223.88**

A* - area, C - run off coefiiceent from Normal Monsoon Rainfall**

There is no unconfined aquifer. To cover the remaining cultivable area, it should be our endeavour not to practice boro rice further, but to increase other crops including rabi.

From the available surface water run off component (Table 8.13.17), 60 % i.e. 734.32 Ham may be allotted for further cultivation in the remaining cultivable land i.e. 4297.57 Ha. An attempt has been made to show changed cropping pattern in **Table-8.13.18.** It appears thatwater allocation in the ratio of 90:10 for Rabi & Vegetables is most appreciable to cover maximum area.

Table-8.13.18 - Future Water allocation for remaining cultivable area

Present water availability(ham)	Considering 100% water for future irrigation(ham)	Rabi Crops Cultivation (Wheat, Mustard and oil seeds water column requirement=0.21)		Boro Cultivation (Water column requirement-1.2 m)		Vegetable (water column requirement Potato=0.6m)		Total Area covered(A)	Remaining Cultivable area (4297.57-A)
		%	Area(ha)	%	Area(ha)	%	Area(ha)		
734.32	734.32	90	3147	0	0	10	122	3269	1028.5
734.32	734.32	40	1399	45	275	15	184	1858	2439.5
734.32	734.32	15	525	70	428	15	184	1137	3160.5

Based onTable- 8.13.16,out of 4297.57 ha area 3269 ha area should be covered by above given allocation. For covering remaining cultivable area treated saline/ brackish surface water may be used.

Proposed Artificial Recharge Structures in the Study area

Table- 8.13.19 -Area suitable for recharge in the block:

District	Block Name	Area (in ha)	Area in hasuitable for conservation (Considering area having DTW of 3m bgl & more)
NORTH TWENTY FOUR PARGANAS	Sandeshkhali-II	**19191**	**19191**

Remaining 40 % estimated surface run off component could be used for construction of artificial recharge and conservation structures, because 60 % of the said amount has already been allotted for irrigation purpose.

Based on soil characteristic, slope, rainfall data and long term trend, number of structures and cost associated have been given in Table 8.13.20 below.

Table-8.13.20 – Estimation of nos.& cost of construction of artificial recharge & conservation structures

Block (1)	Block Area (2)	Area suitable for recharge (3)	Soil type (4)	40 % of surface run off component for artificial recharge and conservation structures (Ham) (5)	Source water allocation for REET with recharge Shaft- 50% of Col. 6 (6)	Source water allocation for Farm Ponds/ irrigation ponds/ series of check dams with sluices - 30% of Col. 5 (7)	Nos. of REET with Recharge Shaft suggested @ 10 Ham per unit (8)	Nos. of Farm Pond /Irrigation pond /Series of Check Gate along with Sluice systems suggested @ 50 Ham per unit (9)	Cost of REET with Recharge Shaft @ Rs 8 lakh per unit (10)	Cost of Farm Pond/Irrigation pond/Series of Check Gate along with Sluice systems @ Rs 8 lakh per unit (11)	Remarks
Sandesh khali II	19191	19191	Silty Clay	489.55	146.9	342.7	15	7	120	56	This block comes under Sunderban delta area; series of check dams with sluices across creeks are suitable structures.

*REET – Reexcavation of existing tank

- ***REET – Re-excavation of existing tanks, size 100m*100m*5m, Filling -2 times, capacity – 10 Ham, for recharge and irrigation
- Farm pond/ irrigation pond/ check dams with sluices- size 100m*100m*5m, Filling -2 times, capacity – 10 Ham; for fishing only

- Injection wells - dia. -10"*6"; Depth - 300 m / 200m / 100m, Capacity -30 Ham, for recharge in to deeper zones as well as for pumping

^ By this amount of 102.81 Ham of water, after subtracting 20.56 Ham as annual evaporation loss and with an average crop water requirement of 0.6m, an additional area of 137.08 Ha could be irrigated. Thus, finally total area irrigated is 3269 + 137.08 i.e. 3406.08 Ha.

For covering remaining area, treated saline surface water could be used.

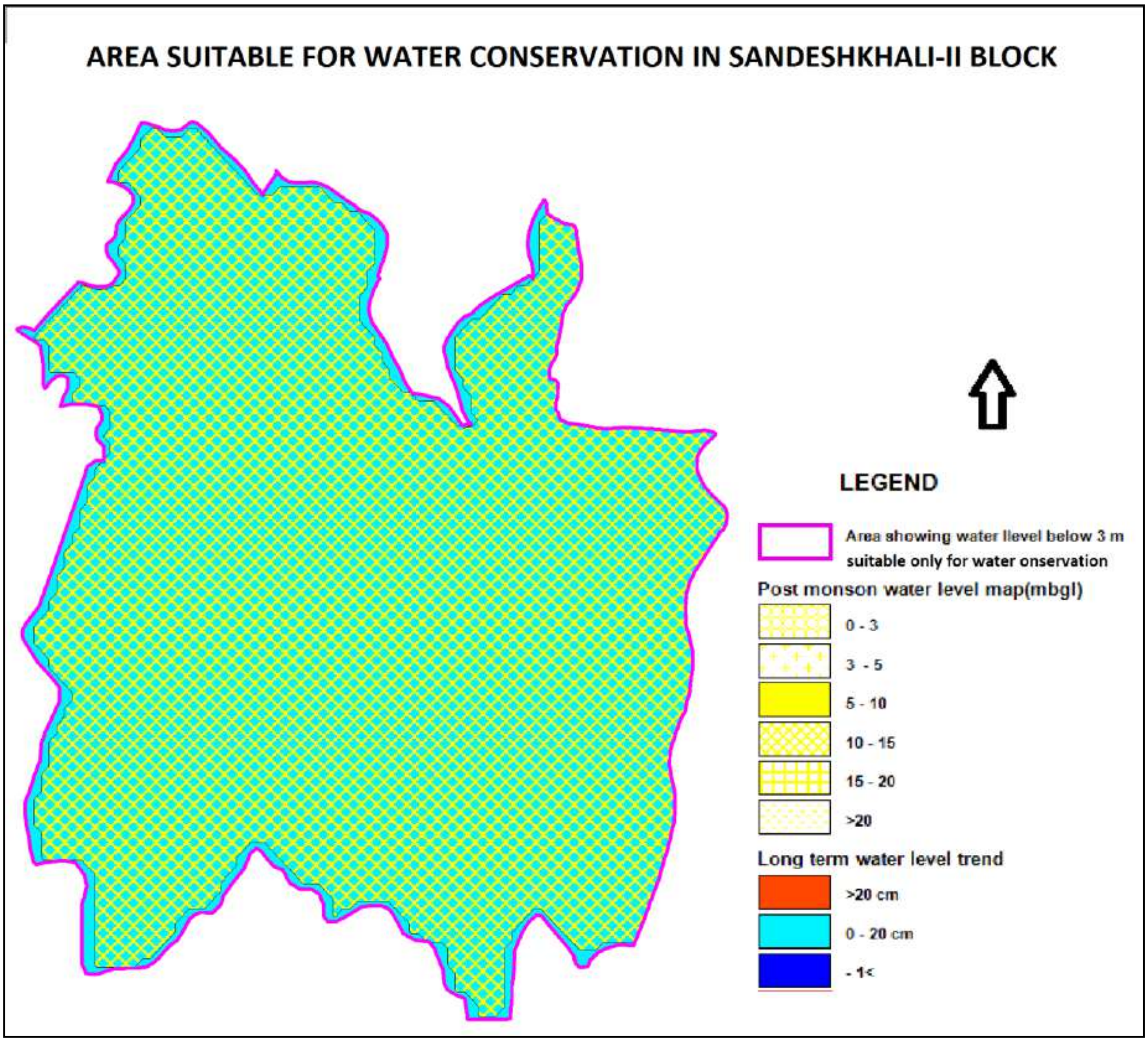


Fig.-8.13.6: Area of artificial recharge in Sandeshkhali-II block

Special measures recommended in Sunderban area of Hingalganj block for management of surface water & ground water

Problems in Sunderban area of Hingalganj block

- Fresh water aquifer has been encountered in deeper level in this block, whereas saline/brackish water found in shallow aquifers.
- Freshwater is a scarce resource in the Sundarban. Numerous creeks and rivulets traverse in the block. The block receives a huge amount of precipitation during the monsoon months.
- The salt water intrusion into groundwater often takes place due to influent discharge of the river.

- This situation may further worsen with current climate change and rising sea level conditions.
- In this area, extreme cyclonic activities take place regularly.

Intervention for surface water & Ground Water management-

- Conjunctive use of surface water and ground waters may be helpful for sustainable water resource management in Sundarbans.
- Sluice gate should be constructed between the junction of river, Canal and estuaries, which can regulate the water from the back flow during high tide.
- Large scale rainwater harvesting, rejuvenation and re -connection of disconnected river channels, artificial recharge within shallow aquifers to bring down its salinity, de-salination of shallow groundwater may be some of the major policy options to meet the water demand in the Sundarbans eco region.
- Switching over to treated surface water rather than expensive exploitation from deep ground water aquifers may be a sustainable alternative for drinking water supply in the Sundarbans .
- Regular studies are needed for better management options for balanced Surface and ground water management.

Block wise Management Plan in parts of South 24 Parganas District

Block wise Management Plan in parts of South 24 Parganas District

8.14 Baruipur

8.14.1 Salient Information

Block Name: Baruipur

Area(in km^2):170.21

District: South 24 Parganas

State: West Bengal

Population (as on 2011)**:**

Total	433119
Rural	315807
Urban	117312

Approximate Decadal Growth Rate from 2001-2011: 23.2%

Rainfall: Average annual rainfall (as in the district) for the period 2012 -16 (in mm): 1756.1

Land use:

Major features of land cover have been shown in Fig 8.14.1

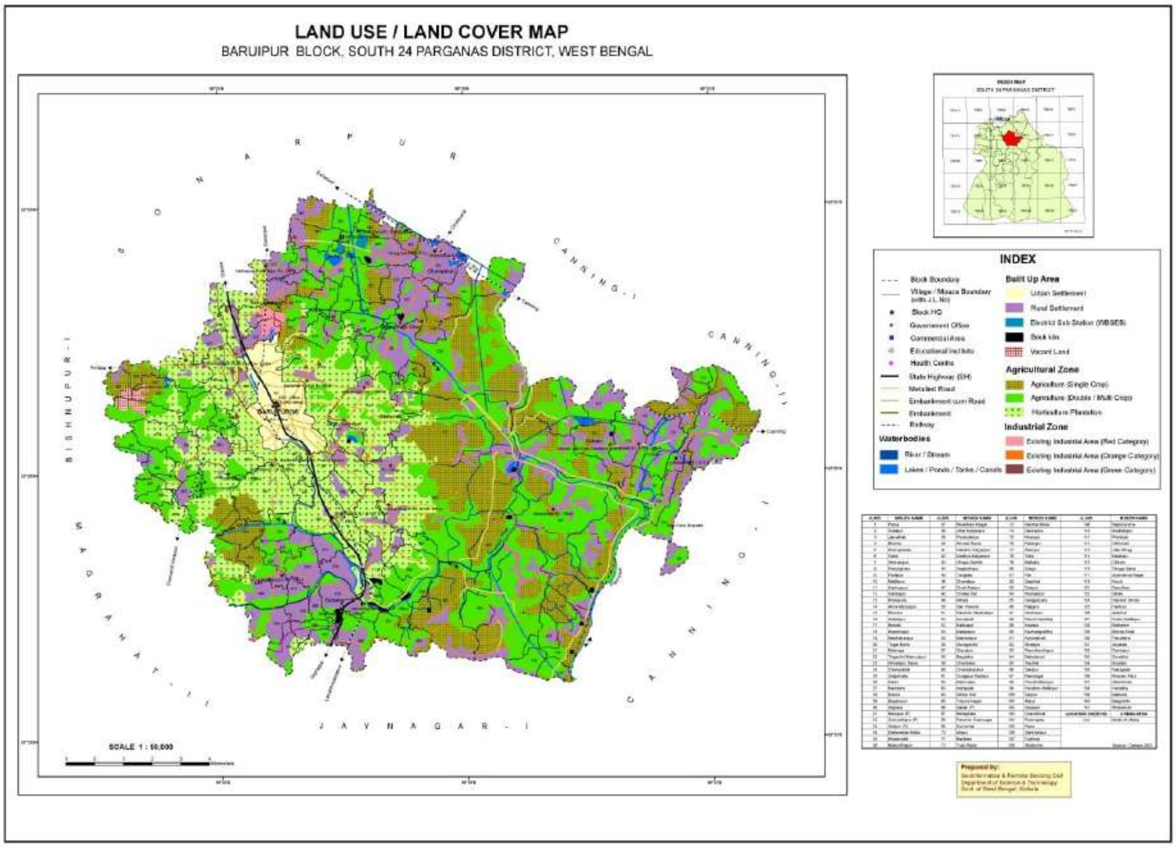
Table 8.14.1 – Salient use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard(ha)	Industrial Area(ha)	Lakes / Ponds / Tanks/ Canal (ha)
Baruipur	17021	11705	4684	66.02	301.55

8.14.2 Aquifer disposition & Characteristic:

Table 8.14.2 - Aquifer disposition in block

Name of Block	Aquifer IA		Aquifer IB		Aquifer II		
	Depth Range (m bgl)	Discharge (m^3/hr)	Depth Range (m bgl)	Discharge (m^3/hr)	Depth Range (m bgl)	Discharge (m^3/hr)	T (m^2/day)
Baruipur	20 - 60	11.95	65 - 100, 105 - 140, 150 - 200	129.52	215 - 295	86.76	1727



(Source: Land & Land Reforms Dept., Govt. of West Bengal)

Fig. 8.14.1: Land use& land cover in Baruipur block

8.14.3 Aquifer Wise Ground Water Resource Availability (in MCM):

No unconfined aquifer exists in this block, so resource has not been calculated as per GEC-97. Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.14.3 - Dynamic resource in Aquifer

Resource Availability	**Aquifer II (in ham)**
Dynamic Resource	25.05

8.14.4 Seasonal long term water level trends of Aquifer II (2008 to 2017):

Block	**Aquifer**	**Pre-monsoon Trend**		**Post- monsoon Trend**	
		Rise (cm/year)	**Fall (cm/year)**	**Rise (cm/year)**	**Fall (cm/year)**
Baruipur	I*	-	17.85	-	60.5
Baruipur	II	-	36.47	-	26.76

*Combined trend of Aquifer IA & IB

8.14.5 Quality of Ground Water & Contamination:

Table 8.14.4 – Range of Chemical Parameters:

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Baruipur	Nil to 0.012 (Aq IA)	160-260 (Aq II)	747-1079(Aq II)	Nil	0.93-1.7 (Aq II)

Table 8.14.5: Percentage of contaminated tube wells:

Blocks	% of tube wells with Arsenic <0.01 mg/l	% of tube wells with Arsenic 0.01 - 0.05 mg/l	% of tube wells with Arsenic > 0.05 mg/l	Total Tube well	Max concentration (mg/l)
Baruipur	84.61	3.30	12.02	1423	2.56

(Source – PHED, Govt. of West Bengal)

Out of 1423 shallow tube wells, arsenic in ground water within 0.01 - 0.05 mg/lhas been encountered in 47 tube wells and As> 0.05mg/l has been found in 171 tube wells.

Contamination of aquifers by arsenic and salinity:

In Baruipur block, Aquifer IA is occurring at a depth of 20- 60 mbgl and sporadic occurrence of Arsenic contamination in ground water has been encountered in ground water of this aquifer. Aquifer IB is separated from Aquifer IA by a 5-15m thick clay layer and occurs within depth of 65-200 mbgl. This aquifer is brackish to saline in nature, the salinity increases towards south of the block.

Aquifer II is fresh ground water bearing and occurs at a depth range of 215-295m bgl.

8.14.6 Present water supply scenario:

19 Gram Panchayats and the Baruipur Municipality provide water from deep tube wells for drinking purpose; during survey most of them have been found defunct. Still a population of 17259 (Nov, 2017) is not covered by any water supply scheme in Baruipur block. Hence, tube wells, tapping the fresh deeper aquifer with proper cement sealing in thick clay bed above the fresh water bearing aquifer is recommended for water supply in uncovered area.

8.14.7 Managementplan for domestic usage

a. Construction of tube wells

From exploration, it has been visualized that arsenic free deeper aquifer within depth range from 215 to 295 m bgl are potential to yield to the tune of 25 lps and can cater to the need of rural water supply. The demand for potable water vis-à-vis availability of arsenic free ground water from the deeper aquifers has been calculated for Baruipur block of South 24 Parganas district for drinking and domestic purpose & is given in the table below. Considering human drinking and domestic demand of water @70 lpcd & projected population up to 2027 (Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells having size of 10” X 6 “ and depth of 300 m has been calculated and shown in Table 8.14.6. **It has been found that 2 tube wells tapping Aquifer II can cater the need of water for drinking for 23677 people living in risk zone by 2027.** The tube wells should be constructed by tapping the fresh deeper aquifer which is separated from top arsenic contaminated and saline aquifers by a persistent clay blanket and cement sealing should be done in this clay layer to prevent vertical movement of water from top to below.

Table 8.14.6 – Estimation of requirement of tube wells for potable water supply

Block	Population in risk zone where no water supply scheme exists till now (As per census 2011)	Population Growth rate (%) per year as per Census 2011	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027	Discharge per Tube Well tapping suitable aquifer (lps)	Total discharge per day assuming 8 hours run (lpd)	Number of tube wells needed to cater the requirement	Cost of construction of tube well sof 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakhs as per approved bid
Baruipur	17259	2.32	23677	1657391.731	25	720000	2	36

b. Roof top rain water harvesting may be implemented in this block to tackle the following:

- declining depth to water level,
- Salinity in ground water.
- Chemical parameter above permissible limit, viz. fluoride, iron and arsenic.
- To prevent contamination from various other sources.

Proper purification of ground water should be done before using for domestic reason.

8.14.8 Management plan for irrigation

Drilling data available from CGWB indicates the occurrence of fresh ground water bearing aquifer below 215m. Aquifer IA is arsenic infested and IB is brackish/ saline in Baruipur block. The ‘Adi Ganga’in the southern part of the block is a prominent source of water. Besides, there are Piyali canal on the north and Uttarbhag-Garia canal on the western part of the block. Now, out of 17021 ha geographical area of Baruipur block, 11705 ha area is cultivable. Of this,1628.63 ha Culturable Command Area (CCA)can be irrigated by surface water and 3279.39 ha CCA can be irrigated by ground water.

The data of 4th MI census for CCA in Baruipur block is given Table 8.14.7.

Table 8.14.7 - CCA & different sources of irrigation

Block	Total CCA (Ha)	No of STW	CCA (Ha)	No of DTW	CCA (Ha)	Surface Flow	CCA (Ha)	Surface lift	CCA (Ha)
Baruipur	4908.02	912	3019.39	13	260	0	0	178	1628.63

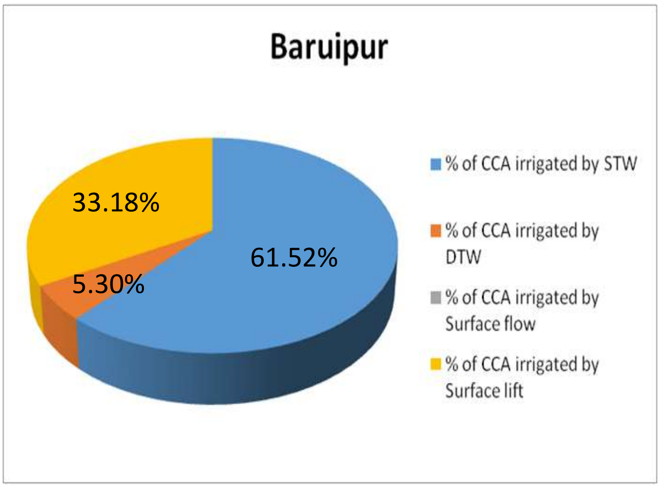


Fig. 8.14.2: Percentage of CCAs covered by different sources of irrigation

1. Data indicates that almost 61.5 % & 33 % of the CCA can be irrigated by shallow tube well & surface lift respectively. This actually clarifies the declining trend of post monsoon water level of shallow aquifer.
2. As discussed above the shallow aquifer is arsenic affected in places, so the high draft from this aquifer can result in the spreading of arsenic contamination in ground water which is then used for irrigation. In this way it can enter into the food cycle and cause health hazards.
3. 6796.98 ha of cultivable area is yet to be covered by irrigation schemes.

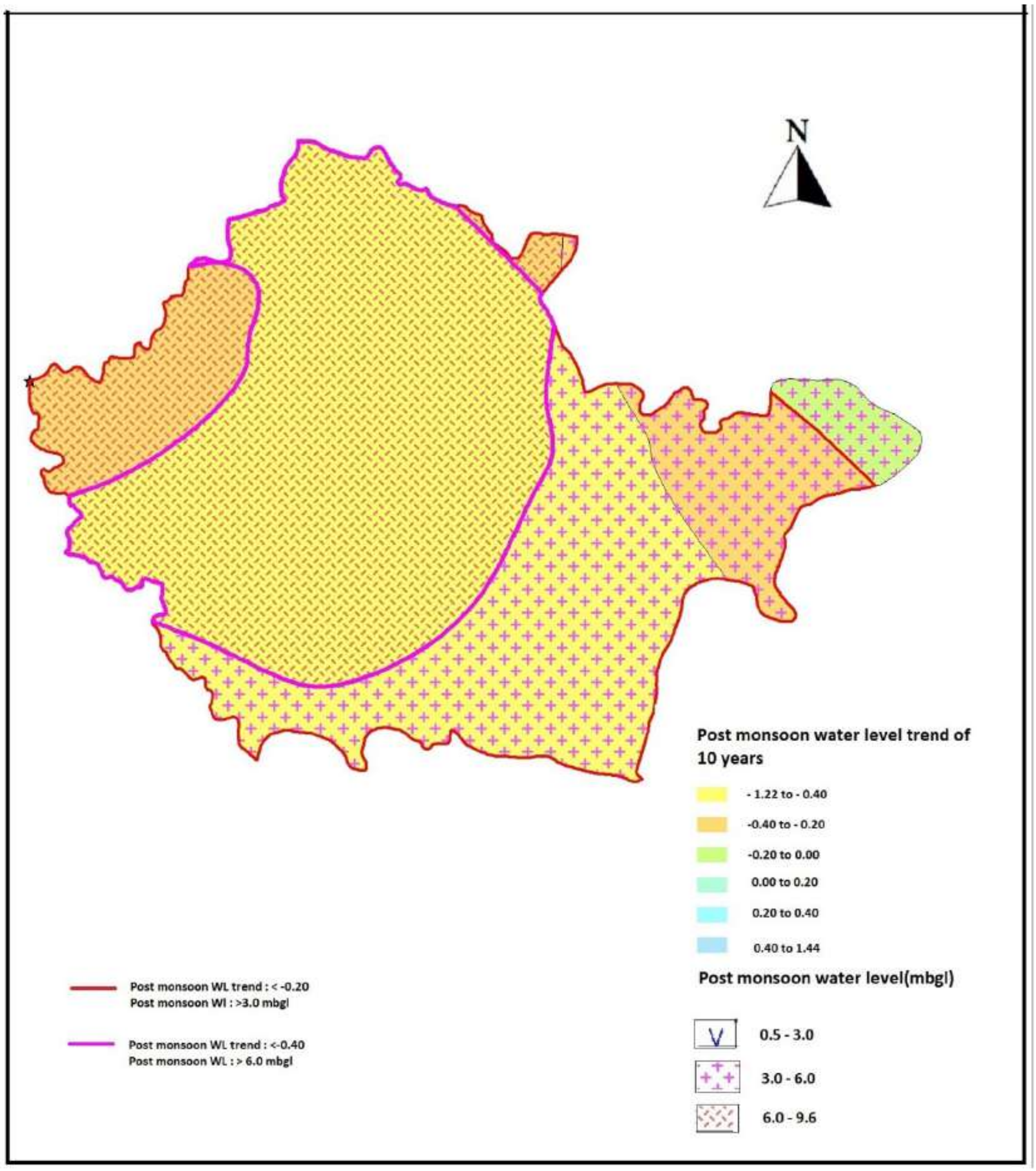


Fig. 8.14.3: Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Baruipur block

Measures for improvement of hydrogeological scenario, irrigation activity and quality of ground water

1.From the census data it is clear that the major part of irrigation water is being withdrawn mainly from shallow aquifer present in this block. This has gradually created very critical hydrogeological scenario in Baruipur block

Fig.14.2. indicates that more than 90% of Baruipur block is having post monsoon declining water level trend in the range of -0.20 to -1.22 m /year where post monsoon water level is greater than 3 m bgl and this area is marked by red line. The area enclosed by pink boundary is having a very critical hydrogeological condition. Here the range of post monsoon water level of shallow aquifer is 6 to 9.6 mbgl and the water level trend is declining below -0.40 m/yr upto -1.22m/yr.

So **to improve the ground water condition of shallow aquifer the following steps** can be taken:-

- **Increase of surface water usage in irrigation which may either be from existing water bodies or by rain water harvesting and gradually lowering down the usage of ground water.**
- **Implementing modern irrigation practices like drip water irrigation system, sprinklers to avoid excess water loss and eventually less water withdrawal from ground.**
- **Use of drum seeders for direct sowing of pre germinated seeds will reduce the water requirement for transplantation**
- **Cultivation of low water requiring crops**
- **Artificial recharge by harvesting the rainwater must be given importance as this will help in increase of water level in the shallow aquifer.**

2. **The shallow aquifer is arsenic contaminated in this block (>.01 mg/l). So to prevent the consumption of food with high arsenic concentration and remove excess arsenic from ground water** in economically feasible way, the following technologies can be adopted:

- **Lowering of arsenic concentration by dilution with arsenic free water**
- **Artificial recharge may be considered which will eliminate the problem of both declining water level and arsenic contamination**
- **Cultivation of arsenic resistant crops**
- **Flower cultivation may be considered in arsenic affected areas**
- **Usage of harvested rainwater**

3. In above discussion, it has been observed that an area of 6796.98 ha(4th MI census) cultivable land is not covered by any irrigation schemes. Rainwater harvesting should be considered for solving this problem partially or fully (depending on the rainfall and other factors) because construction of more tube wells for irrigation will worsen the ground water situation.

The approximate **surface runoff** has been calculated taking into consideration all the factors like environmental flow, water required for natural flow to drainage, committed purposes (already existing water bodies in that area. The 'total cultivable area' and 'Normal annual rainfall' are considered for the calculation. The runoff co-efficient for annual normal monsoon rainfall has been used (Dhruvanarayana,1993) along with soil type, land use and slopeof the area as criteria. After calculation it has been found that **annually 2750 ham (Table- 8.14.9) will be available amount of water approximately which can be utilised in future conservation structures and for artificial recharge**.

The details of the calculation are given below:

Table -8.14.9 – Estimation of Surface Run off component

Block	Normal annual rainfall in m'Rn'	Total cultivable area (ha) 'A'	Run off co efficient'C'	Major type of soil occurring in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Baruipur	2.088	11705	0.5	Clay loam	12220.02	9165.015	4582.508	2749.505 or 2750(approx.)

The major crops, vegetables, fruits, flowers, spices, cultivated in Baruipur block are as follows:

Crops	Boro, Aman, Khesari ,Musur
Fruits	Guava, Banana, Mango, Litchi, Cherry(karamcha)
Vegetables	Tomato, cabbage, cauliflower

Baruipur is well known for orchards along paleo-channels which is the source of growing economy of the area and also one of the reasons of declining water level trend in this block. The horticulture plantation requires 0.65 m, rabi crops like wheat, mustard requires 0.35m and boro requires 1.2m depth of water approximately. The water requirement for kharif crops (aman) is fulfilled by monsoon rain fall mainly. So the **harvested rain water may be used for cultivation in the remaining 6796.98 ha land**. Due to high rate of decline of water level, boro cultivation is not suggested in this block.

The possible coverage of cultivable land with the harvested surface runoff has been calculated for irrigation in the remaining 6796.98 ha area considering different types of agricultural pattern and given in Table 8.14.10.

Table 8.14.10 – Utilisation of cultivable land by change in cropping pattern in Baruipur block

Harvested surface Runoff 'vf' (ham)	Horticulture plantation Water depth = 0.65m		Vegetables Water depth = 0.45m		Rabi crops (wheat, mustard, khesari etc) Water depth= 0.35m		Total area covered 'A'(ha)	Land Required to store harvested Run off (vf)	Remaining cultivable land
	%	Area covered (ha)	%	Area covered (ha)	%	Area covered (ha)		Area (ha)	
2750	100	4230.77	-	-	-	-	4230.77	1008	1558.21
2750	50	2115.38	50	3055.55	-	-	5170.93	1008	718.05
2750	50	2115.38	25	1527.77	25	1964.29	5607.44	1008	181.54

Now, to store 2750 ham harvested surface runoff, 1008 ha area with 3m of depth (considering 10% more volume to accommodate excess water and avoid spill over) will be sufficient. This 1008 ha can be obtained from the remaining cultivable land.

If we use all the harvested water in horticulture then only 62% of the remaining area can be irrigated, whereas if we use 50% of harvested runoff in horticulture and 25% each in cultivation of vegetables and rabi crops then 82.5% of the remaining area can be irrigated. In this way proper management of the available water is possible to increase the production.

This harvested rain water can be used in fish farming which will also be beneficial for the land owners.

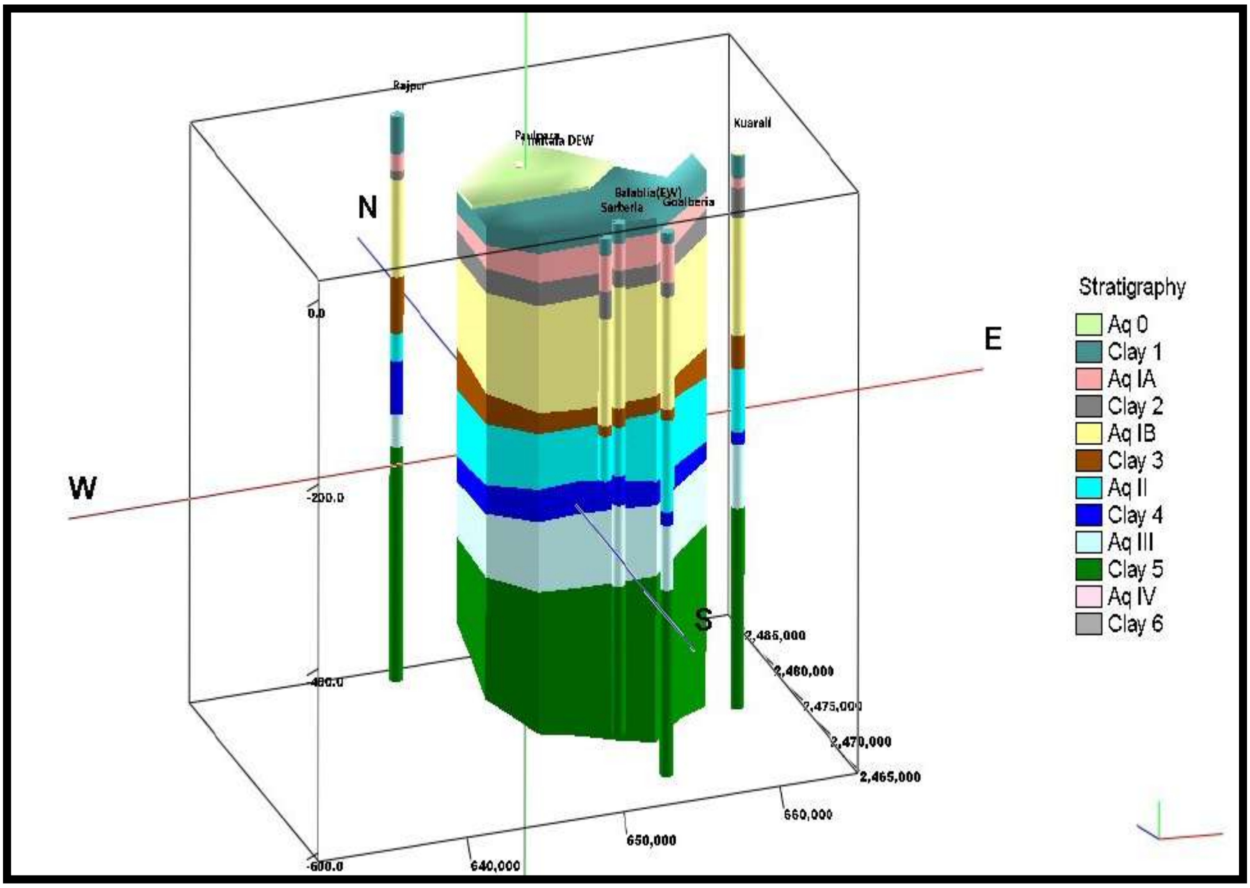


Fig. 8.14.3: 3D aquifer disposition in Baruipur block

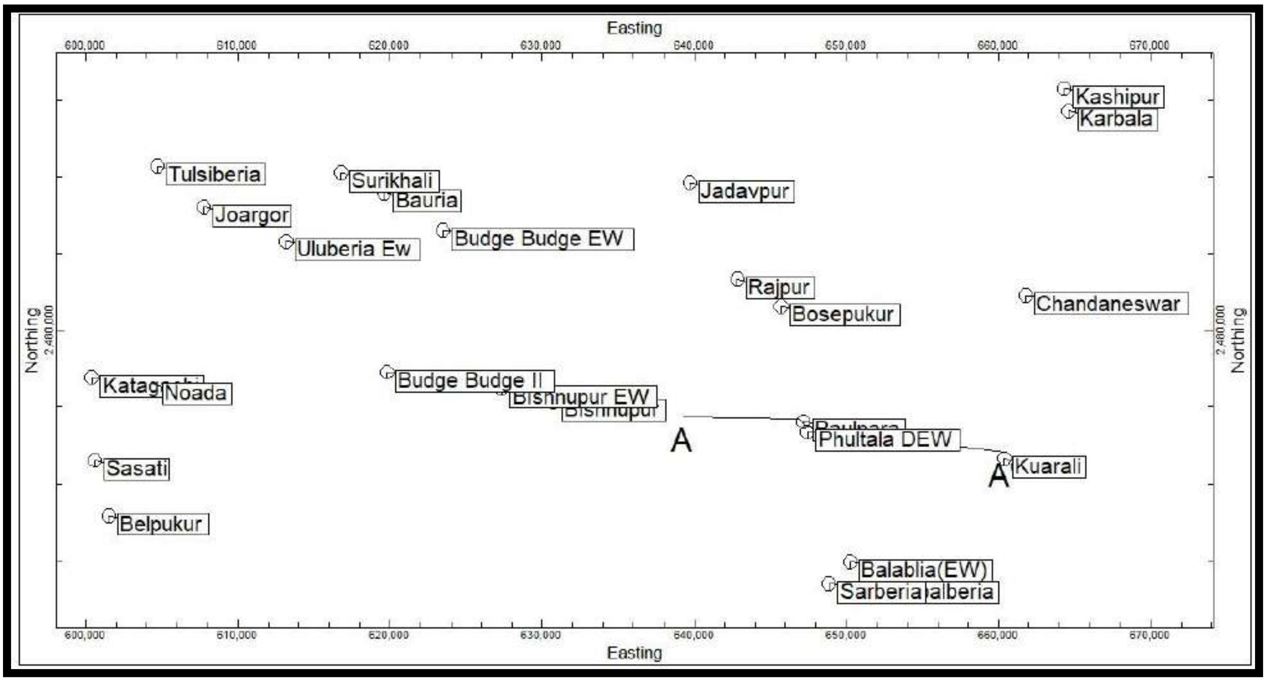


Fig. 8.14.4: W-E cross section index line in Baruipur block, South 24 Parganas district

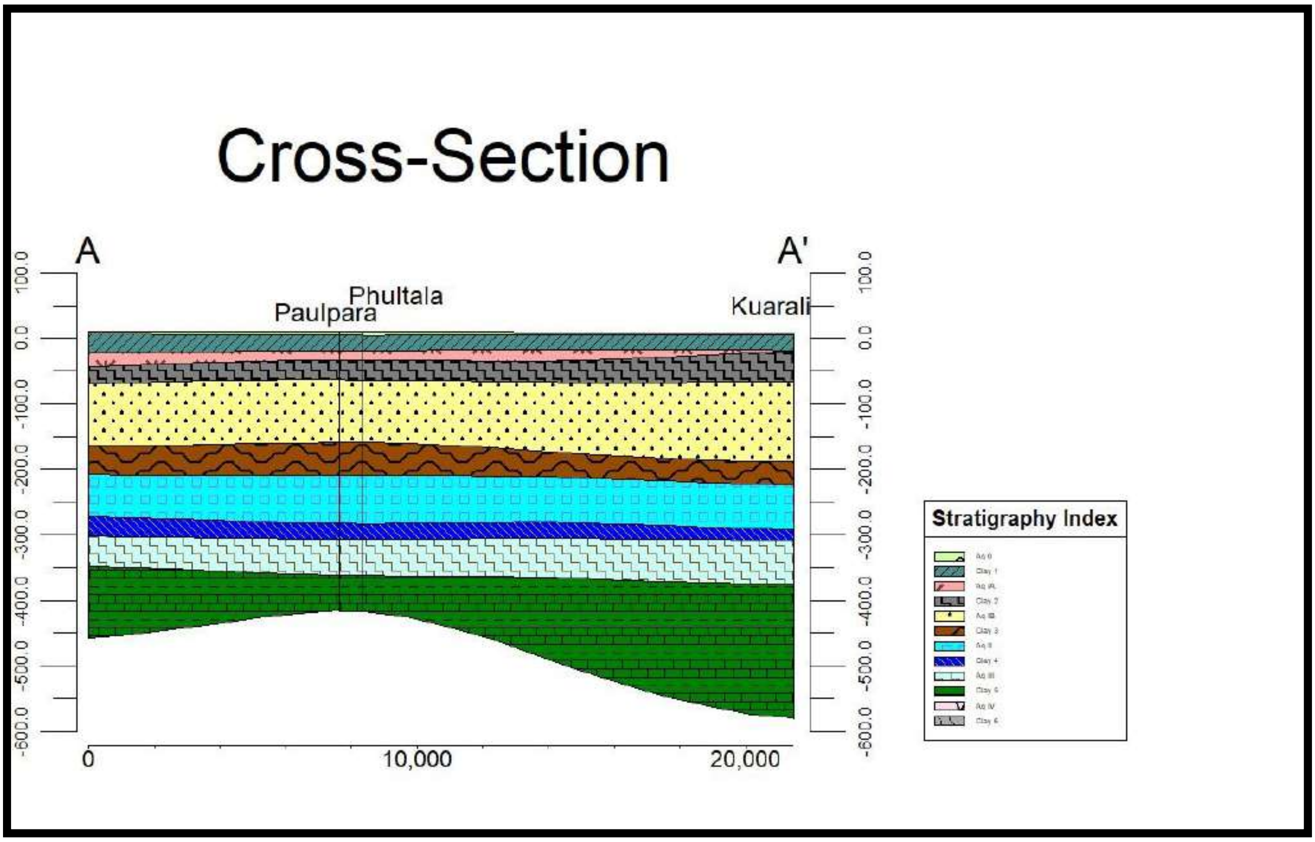


Fig 8.14.4: Cross section in Baruipur block, South 24 Parganas district

8.15 Bhangar I

8.15.1 Salient Information

Block Name: Bhangar I

Area(in km^2): 192.82

District: South 24 Parganas

State: West Bengal

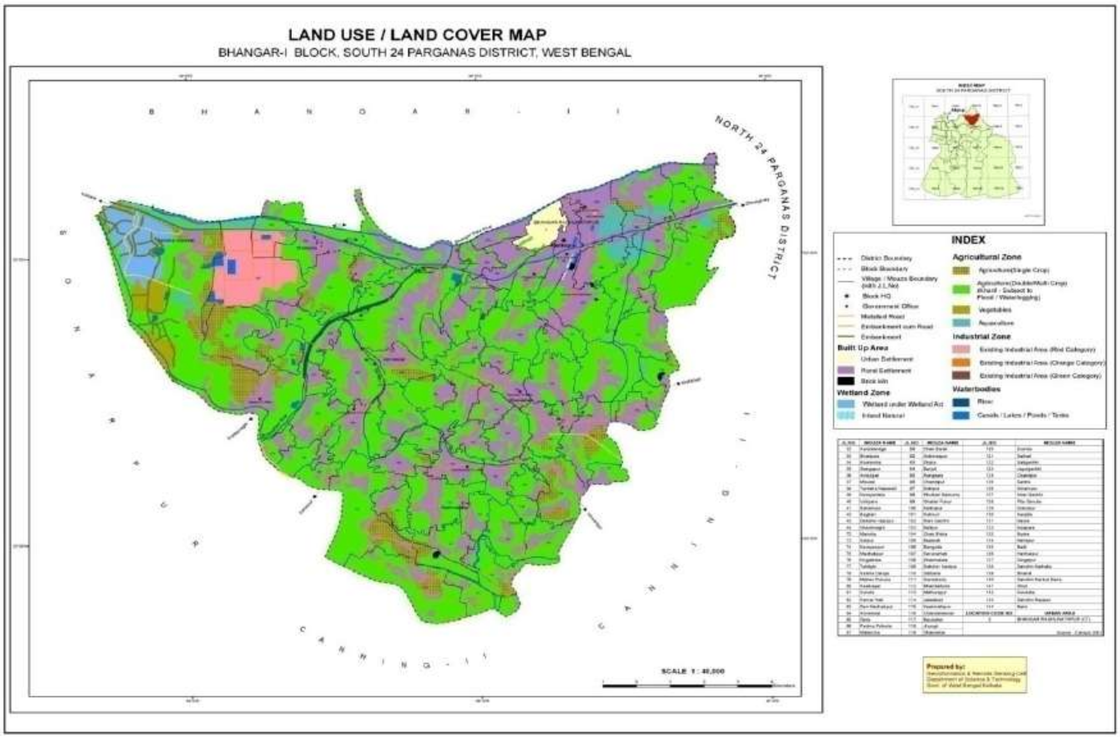
Population(as on 2011):

Total	249170
Rural	228528
Urban	20642

Approximate Decadal Growth Rate from 2001-2011: 20.4%

Rainfall: Average annual rainfall (district) for the period 2012 -16 (in mm): 1756.1

Land use:



(Source- Land & Land Reforms Dept., Govt of West Bengal)

Fig 8.15.1: Land use & Land cover map of Bhangar I block

Table 8.15.1 – Salient Land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Aquaculture (ha)	Industry (ha)	Canal / Lakes / Ponds / Tanks (ha)
Bhanger I	19282	12071	322.73	427.84	243.89

8.15.2 Aquifer disposition & Characteristic:

Table 8.15.2 – Aquifer wise depth ranges & parameters

Name of Block	Aquifer IA		Aquifer IB		Aquifer II		
	Depth Range (mbgl)	Discharge (m^3/hr)	Depth Range (mbgl)	Discharge (m^3/hr)	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)
Bhangar I	10 to 35, 45 - 65	-	75 to 130, 140 - 200	-	218 - 270	**110.37**	**-**

8.15.3 Aquifer Wise Ground Water Resource Availability & Extraction:

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97. Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.15.3 – Ground water resource

Resource Availability	Aquifer II(ham)
Dynamic Resource	28.54

8.15.4 Seasonal long term water level trends (2008 to 2017)

Table 8.15.4 - Seasonal long term water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Bhangar I	I*	-	10.66	-	12.86
Bhangar I	II	-	14.46	-	30.56

*Combined trend of Aquifer IA & IB

8.15.5 Chemical Quality of Ground Water &Contamination

Table 8.15.5 - Range of chemical parameters:

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Bhangar I	Nil to 0.012(Aq IA)	300-410(AqIB) 160-350(Aq II)	1195-3401 (Aq IB) 800-1502(Aq II)	0-0.1(Aq IB) 0.00(Aq II)	0.00(AqIB) 0.97-0.99(AqII)

Table 8.15.6 – Percentage tube wells with ground water contamination

Blocks	Arsenic (<0.01 ing/1) in percentage	Arsenic (>0.01- <0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max ppm
Bhangar I	78.45	13.19	8.19	1160	0.82

(Source –PHED, Govt. of West Bengal)

In Bhangar I block, two prominent aquifers have been identified using exploration data of CGWB and other state govt. organisations. Aquifer I is divided into two parts (Aquifer IA & IB) by a thick clay layer of 5 to10m. Aquifer IA is occurring at a depth 10mbgl to 65 mbgl and Aquifer IB is occurring at a depth of 75mbgl to 200mbgl.The deeper Aquifer II is occurring at a depth range of 218mbgl to 270mbgl. Aquifer IB is brackish to saline in the western part of the block and a fresh - saline water interface has been inferred in the central part of block expl. data, hydrogeological studies, and micro level data collected from the block.

As per PHED, Govt. of West Bengal data, out of 1160 tube wells, arsenic within the range of 0.01mg/l to 0.05mg/l has been encountered in ground water of shallow aquifer of 153 tube wells and more than 0.05mg/l is found in 95 tube wells. The maximum arsenic level found in this block is 0.82 mg/l.

8.15.6 Present water supply scenario

A population of 3711(Nov,2017) is still not covered by any water supply scheme in Bhangar I block by PHED. Hence the tube wells, tapping the fresh deeper aquifers with proper cement sealing against thick clay bed will produce arsenic free fresh ground water to villages, yet to be covered by water supply scheme of PHED.

8.15.7 Management plan for domestic usage:

a. Construction of tube wells

As evidenced from the exploration, arsenic free fresh deeper aquifer ranging from depth of 218 to 270 m bgl are potential to yield to the tune of 30.6 lps and can cater to the need of rural water supply. The demand for arsenic free potable water and availability of ground water from the deeper aquifers has been calculated for Bhangar I block of South 24 Parganas district for drinking and domestic purpose & the same is given in table below. Considering human drinking and domestic demand of water @70 lpcd & projected population up to 2027 (Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells with 10 inch X 6 inch dia and depth of 300 m (max.) has been calculated and shown in Table 8.15.7. It has been found that water from **a single tube well tapping Aquifer II**

can cater the need of water for drinking and domestic purpose for 4921 people living in risk zone (by 2027). Withdrawal from Aquifer IB may be avoided to stop the spreading of saline water in the whole block. The tube well should be constructed by tapping the fresh deeper aquifer which is separated from top arsenic bearing & saline aquifers by a persistent clay blanket; cement sealing should be done against this clay layer to prevent vertical movement of water from top aquifers to bottom inside well.

Table 8.15.7 – Estimation of nos. of wells required and cost of construction

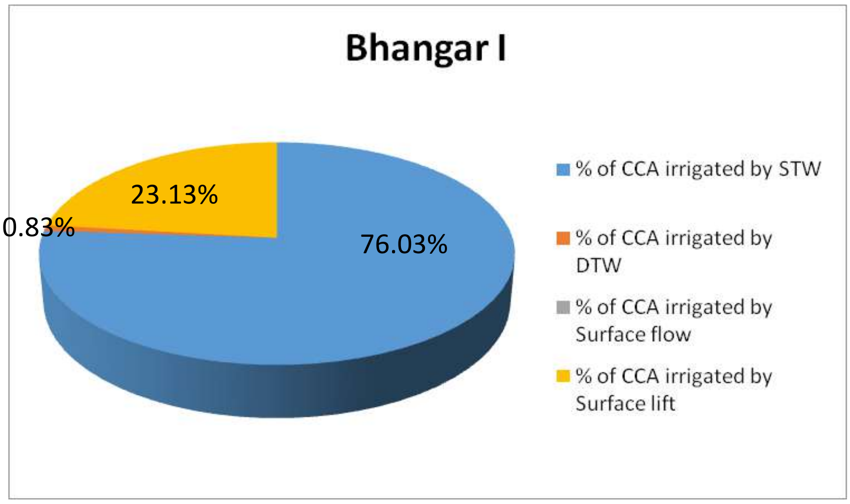
Block	Population in risk zone where no water supply scheme exists till now (As per census 2011)	Growth rate (%) per year as per Census 2011	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027	Discharge of tube wells tapping suitable aquifer (lps)	Total discharge per day assuming 8 hours run (lpd)	Number of Tube wells needed to cater the requirement	Cost of the tube well of 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakhs as per latest approved bid
Bhangar I	3711	2.04	4921	344436.002	30.6	881280	1	18

8.15.8 Management plan for irrigation

Drilling data available from CGWB and other state govt. departments indicates the occurrence of fresh ground water bearing aquifer below 220m. In some places Aquifer IA is arsenic infested and Aquifer IB is brackish/saline in parts of the block. The main source of irrigation in this block is canals and shallow tube wells. Now out of 19282 ha geographical area of Bhangar I block, 12071 ha is cultivable. Of this 1662.68ha could be covered by surface water irrigation scheme and 5525.05ha by ground water scheme. The data of 4th MI census for Culturable Command Area in Baruipur block is given in Table 8.15.8.

Table8.15.8 –Nos. of sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA (Ha)	No of DTW	CCA (Ha)	Surface Flow	CCA (Ha)	Surface lift	CCA (Ha)
Bhangar I	7187.73	2823	5465.05	3	60	0	0	53	1662.68



Problems

1. As almost 76% of the total irrigated area is covered by STW irrigation scheme, The arsenic contamination in Bhangar I block may spread due to the high draft of shallow ground and enter in to the food chain.
2. 4883.27 ha area is still not

Fig 8.15.2:Percentage of CCAs covered by different sources of irrigation
In Bhangar I block

Fig 8.15.3 represents combined map of post monsoon depth to water level (Nov, 2016) and 10 yrs water level trend (2007-2016) of Aquifer IA in Bhangar I block. The water level trend is positive in the northwestern side varying from 0.40 to 1.44 m/yr and gradually decreasing towards north east below -0.20 m/yr. Though the trend is below 1.20m/yr in the northeastern side of the block but the post monsoon depth to water level is within 3 m bgl in this area. So it can be said that the huge draft of ground water is not affecting the shallow aquifer as it is happening in adjoining Baruipur block. **Artificial recharge may be considered in the northwestern part of the block where post monsoon depth to water level is ranging from 3 m bgl to 6 m bgl**.

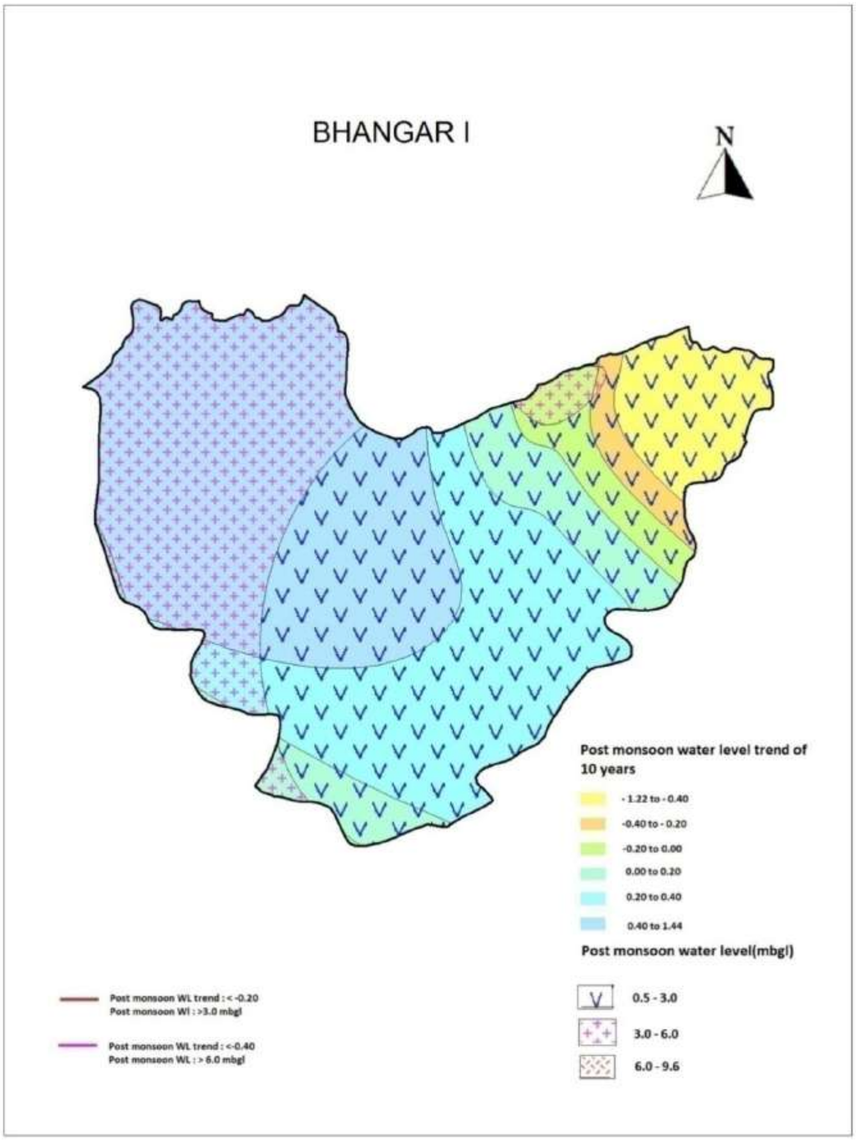


Fig. 8.15.3: Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Bhangar I block

Solutions:

1. The shallow aquifer is arsenic contaminated in Bhangar I block(>.01mg/l). So,**to prevent the consumption of food with high arsenic concentration and toremove excess arsenic from ground water** in economically feasible way, the following technologies can be adopted:
    - **Lowering of arsenic concentration by dilution with arsenic free water**
    - **Artificial recharge may be considered which will eliminate the problem of both declining water level and arsenic contamination**
    - **Cultivation of arsenic resistant crops**
    - **Flower cultivation may be considered in arsenic affected areas**
    - **Usage of harvested rainwater**

2. An area of 5525.05ha cultivable land is not covered by any irrigation schemes. Rainwater harvesting can be considered for solving this problem partially or fully (depending on the rainfall and

other factors). The approximate **surface runoff** has been calculated taking into consideration all the factors as described under management plan as described for Baruipur block above. After calculation it has been found that **annually 2268.38 ham will be available approximately which can be used for throughout the year in conservation structures and for artificial recharge**.

The details of the calculation are given in Table 8.15.9.

Table –8.15.9 – Estimation of surface run off component in block

Block	Normal annual rainfall in m(50 yrs data from IMDB) 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana, 1993 'C'	Major type of soil occuring in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
BhangarI	2.088	12071	0.4	Sandy & clay loam	10081.6992	7561.274	3780.637	2268.382

The major crops, vegetables, fruits, flowers, spices growing in Bhangar I block are:

Crops	Aman, Aus, Boro paddy, wheat, musur, rapeseed, Jute , mustard ,sesame, potato and khesari
Vegetables	Cabbage, Cauliflower, Lady's Finger, Cucurbits, Radish, Beans
Fruits	Guava, Banana, Mango, Litchi
Spices	Chilli, Turmeric, Ginger
Flower	Marigold, Tuberose, Ornamental Plants

Cultivation of kharif crops are suggested in the remaining land as the water requirement for kharif crops(aman rice,musur,jute) is fulfilled by monsoon rain fall mainly but if irregularities in rainfall occur then irrigation is needed. For fruits and vegetables 0.65 m 0.45 m respectively are average water requirement. For irrigation of Rabi crops like wheat, mustard, sesame, potato, khesarietc. the maximum depth of water required is 0.35m. So, the **2268 ham harvested run off can irrigate approximately 5040 ha area (considering average 0.45m water depth for irrigation of rabi crops, fruits, flowers and vegetables) which is almost 91% of the remaining cultivable land. The remaining 485 ha can be used to store the harvested rainwater**.

8.16 Bhangar II

8.16.1 Salient Information

Block Name: Bhangar II

Area(in Km^2):143.07

District: South 24 Parganas

State: West Bengal

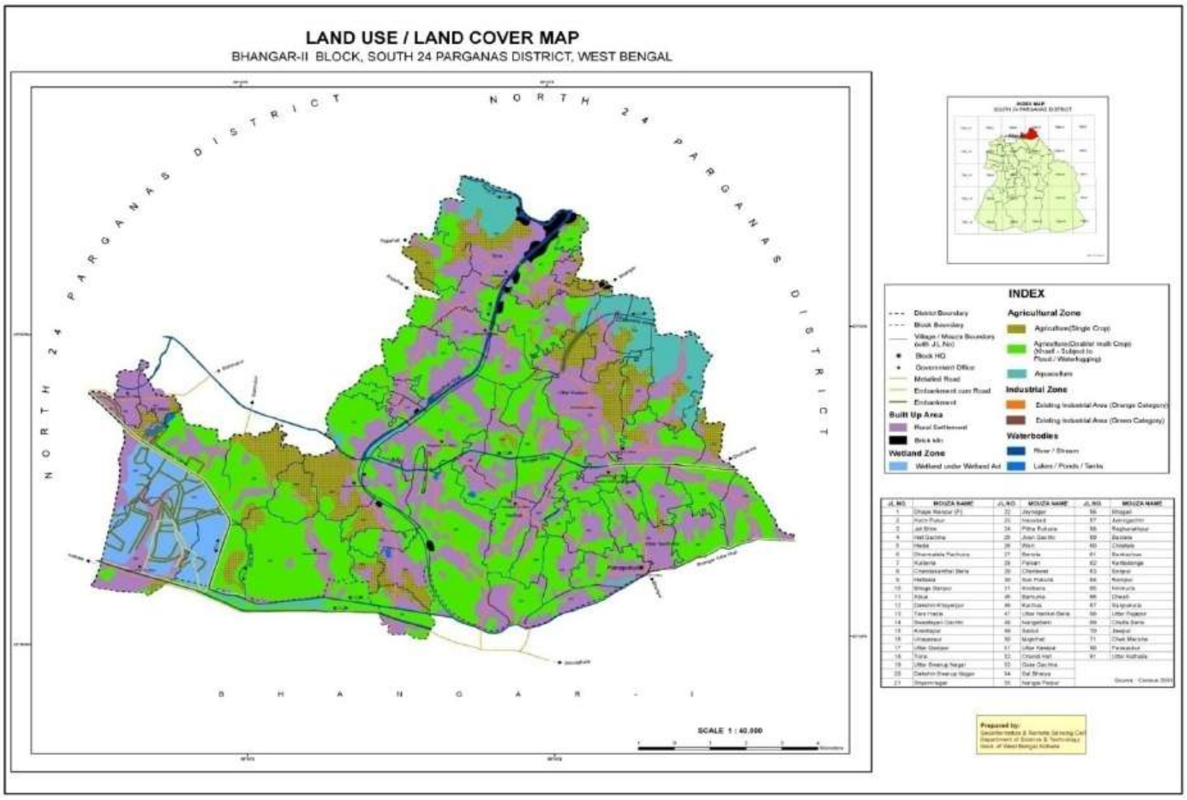
Population(as on 2011):

Total	246708
Rural	246708

Approximate Decadal Growth Rate from 2001-2011: 20.4%

Rainfall: Average annual rainfall (in district)for the period 2012 -16 (in mm):1756.1

Landuse:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig. 8.16.1: Land use &Land cover map of Bhangar II block

Table 8.16.1 – Salient Land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Aquaculture (ha)	Forest Land (ha)	River & Canal/Lakes/Ponds/Tanks (ha)
Bhanger II	14307	11773	757.65	Nil	355.85

8.16.2 Aquifer disposition & Characteristic

Table 8.16.2 – Aquifer wise depth ranges & parameters

Name of Block	Aquifer IA		Aquifer IB			Aquifer II	
	Depth Range (mbgl)	Discharge (m^3/hr)	Depth Range (mbgl)	Discharge (m^3/hr)	T (m^2/day)	Depth Range (m bgl)	Discharge (m^3/hr)
Bhangar II	10 - 45, 55-65	-	90 - 100, 110-135, 145 - 160, 175-195	86.4	2670.4	205 - 250, 265 - 285	126

8.16.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97.Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.16.3 – Ground water resources

Resource Availability	Aquifer II (ham)
Dynamic Resource	21.17

8.16.4 Seasonal long term water level trends of Aquifer II (2008 to 2017):

Table 8.6.4 – Pre monsoon & post monsoon water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Bhangar II	I*	9.40	-	34.78	-
Bhangar II	II	1.85	-	42.57	-

*combined average trend of Aq IA & IB

8.16.5 Chemical Quality of Ground Water & Contamination

Table 8.16. 5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Bhangar II	Nil to 0.014(Aq IA)	305(AqIA) 255-755(Aq II)	1129(Aq IA) 1043-1149 (Aq IB) 800-1502(Aq II)	0.62(Aq IA) 0.43(Aq IB) 0-0.13(Aq II)	0.36(AqIA) 1.38-5.07(AqII)

Only one sample result is available for each of Aq IA & IB

Table 8.16.6 – Percentage tube wells showing ground water contamination by arsenic

Blocks	Arsenic (<0.01 ing/1) in percentage	Arsenic (>0.01-<0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max ppm
Bhangar II	63.02	25.42	11.56	1306	0.76

(Source – PHED, Govt. of West Bengal)

In Bhangar II block two prominent aquifers have been identified from the exploration data of CGWB and other state govt, organisations. Aquifer I is divided into two parts(Aquifer IA & IB) by a thick clay layer of 20-25m. Aquifer IA is occurring at a depth 10mbgl to 65 mbgl and Aquifer IB is occurring at a depth of 90mbgl to 195mbgl.The deeper Aquifer II is occurring at a depth range of 205mbgl to 285mbgl. All the three aquifers are fresh water bearing but sporadic occurrence of arsenic has been found in Aquifer IA in this block.

As per PHED chemical analysis data of 1306 tube wells, arsenic within the range of 0.01 mg/l to 0.05mg/l in shallow ground water has been observed in 332 tube wells and As concentration more than 0.05mg/l is found in 151 tube wells.

8.16.6 Present water supply scenario

A population of 160820(Nov,2017) is still not covered by any water supply scheme in this block. Hence the tube wells, tapping the fresh deeper aquifers with proper cement sealing against thick clay bed will produce arsenic free fresh ground water to villages, yet to be covered by water supply scheme of PHED.

8.16.7 Management plan for domestic usage

a. Construction of wells

As evidenced from the exploration, arsenic free deeper aquifers ranging from 90 to 195mbgland 205 to 285mbgl are potential to yield to the tune of 24 lps& 35 lps respectively and can cater to the need of rural water supply. The demand for potable water vis-à-vis availability of arsenic free ground water from the deeper aquifers has been calculated for Bhangar II block of South 24 Parganas district for drinking and domestic purpose & is given in the Table 8.16.7. Considering human drinking and domestic demand of water @70 lpcd& projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells having size 10-inch X 6 inch with depth 300(max. depth considered)mbgl has been calculated and shown in the given Table 8.16.7. It has been found that water from **a total of 15 tube wells tapping Aquifer II can cater the need of water for drinking and domestic purpose for 213236 people living in risk zone(by 2027)**.Withdrawal from Aquifer IB should be done with caution as the same aquifer is becoming brackish/ saline in south of the block; so, there is a chance for ingression of saline water. The tube wells should be constructed by tapping the aquifers which is separated from top arseniferous aquifers by a persistent clay blanket. Provision for sealing the top arseniferous aquifers with proper cement sealing against clay layer above should be kept in order to prevent the vertical percolation of arseniferous water from the top contaminated aquifer.

Table- 8.16.7 – Estimation of requirement of wells for water supply

Block	Population in risk zone without water supply scheme till now(As per census 2011)	Growth rate(%) per year (Census 2011)	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in lt projected till 2027	Discharge per Tube well tapping suitable aquifer (lps)	Total discharge per day assuming 8 hours run(lpd)	Number of Tubewells needed to cater the requirement	Cost of the tube well of 300 m depth (approx) & 10"x6" dia @ Rs.18 lakhs as per latest approved bid
Bhangar II	160820	2.04	213236	14926488.23	35	1008000	15	270

b. Rooftop rainwater harvesting is strongly recommended in this block as the drinking and domestic water requirement is too high. The govt. schools, hostels, panchayat office, clubs or some village houses can be chosen for this purpose .an example is given below:

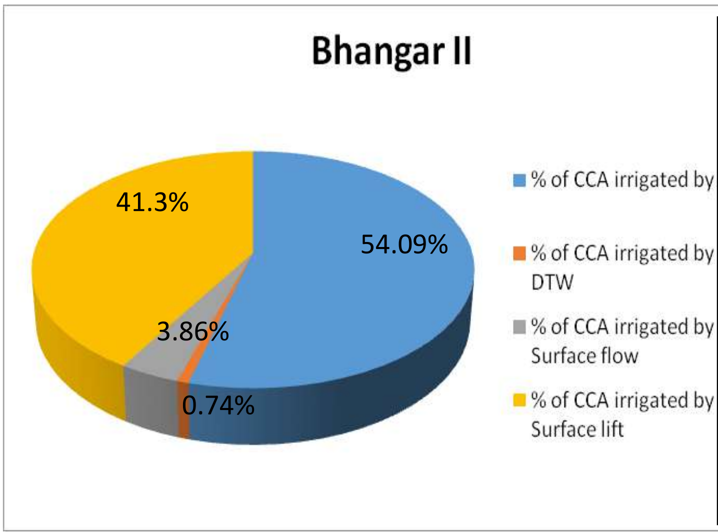
Ifthe roof area/catchment area is 500 sqm, for annual rainfall of 2.088 m in Bhangar II block, the harvested water will be- 500 X 1.75 X 0.8 (runoff coefficient for metal sheets being 0.7-0.9) or, 700 cu.m or 700000 litres, which can cater drinking and domestic needs of almost 27 persons for whole year considering proper conservation of the water. Therefore, **if rooftop rainwater harvesting can be implemented in this block together with installation of deep tube wells, it will solve the problem of ever increasing fresh water demand. Proper purification is needed after rainwater harvesting for domestic usage and consumption**.

8.16.8 Management Plan for irrigation

Irrigation facility is mainly available through canals and shallow tube wells in Bhangar II block. Drilling data available from CGWB and other state govt. departments indicates the occurrence of fresh ground water bearing aquifer below 90m in Aquifer IB & Aquifer II. The shallow aquifer is arsenic affected.Now out of 14307ha geographical area of Bhangar II block, 11773 ha area is cultivable. Of this 2121.74ha area is irrigated by surface water scheme and 2576.5 ha area is irrigated by ground water scheme. The data of 4th MI census for Culturable Command Area in Bhangar II block is given in Table8.16.8.

Table 8.16.8 – Nos. of sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA(Ha)	No of DTW	CCA(Ha)	Surface Flow	CCA(Ha)	Surface lift	CCA(Ha)
Bhangar II	4698.24	1933	2541.5	2	35	4	181.41	79	1940.33



Problems

1. In Bhangar II block 54% of CCA is covered by STW and 41% is covered by surface lift from canals. As arsenic contamination has been found in places within the shallow aquifer, there should be restricted use of shallow ground water and alternative water resources should be explored.
2. 7074.76 ha area is still not covered by any irrigation scheme.

In Fig 8.16.2, combined map of post monsoon depth to water level (Nov, 2016) and 10 yrs water level trend(2007-2016) of Aquifer IAin Bhangar II block have been shown. In the east, water level trend gradually declining beneath -0.20 m/yr, but the depth to water level is within 3 mbgl here. Whereas in the western part of the block adjacent to KMC, in last 10 years post monsoon water level trend is positive but the depth to water level is below 3 m from ground level. **Artificial recharge may be considered in the western part of the block where post monsoon depth to water level is ranging from 3 m bgl to 6 m bgl**.

Solutions:

1. To **restrict the use of arsenic contaminated shallow ground water for irrigation activity, the following steps can be taken**:

- **Irrigation by surface water may be increased. In addition to surface lift from canal & ponds along with rain water harvesting may also be considered.**
- **Implementing modern irrigation practices like drip water irrigation system, sprinklers, to avoid excess water loss**
- **Implementation of subsurface irrigation system through porous pipes to avoid evaporation**

- **Cultivation of low water requiring and arsenic resistant crops**
- **Increase of cultivation of Kharif crops like aman, jute etc. to cater monsoon rainfall (depending on the soil pattern of that area) in irrigation**
- **Artificial recharge may be considered in places where high arsenic value is encountered (mainly in the western part of Bhangar II), which will dilute the arsenic concentration and also increase the water level.**
- **Aquifer IB is bears fresh water in this block; precaution should be taken during withdrawing water from this aquifer for irrigation: heavy withdrawal may cause the intrusion of saline water in it from adjacent areas.**

In the above discussion it has been observed that an area of **7074.76 ha** cultivable land is not being irrigated by any irrigation scheme. Rainwater harvesting can be considered for solving this problem partially or fully (depending on rainfall and other factors). The approximate **surface run off** has been calculated taking into consideration all factors as described under management plan of Baruipur block. After calculation it has been found that **annually 2212.38 ham** (Table 8.16.9) **will be available approximately which can be used for farming throughout the year by storing it in conservation structures**.

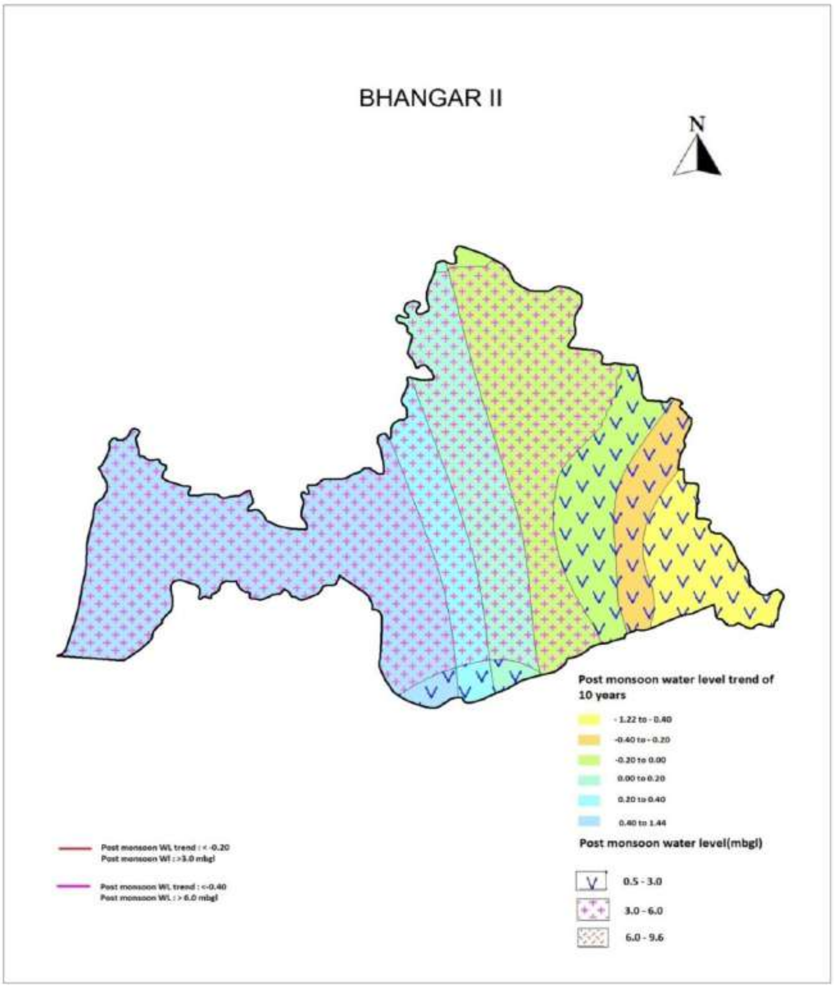


Fig. 8.16.2:Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Bhangar II block

Table 8.16.9 – Estimation of Run off Component

Block	Normal annual rainfall in m(50 yrs data from IMDB) 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana, 1993 'C'	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (RnXAXC) ham	75% (deducting runoff to existing drainage) of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc (deducting e-flow)= Vf (ham)
BhangarII	2.088	11773	0.4	Alluvial soil	9832.8096	7374.607	3687.304	2212.38

The major crops, vegetables, fruits, flowers, spices irrigated in Bhangar II block are:

Crops	aman, aus, boro paddy, wheat, musur, jute, mustard,sesame, potato and khesari
Vegetables	cabbage, cauliflower, lady's finger, cucurbits, radish, beans
Fruits	Guava, Banana, Mango, Litchi
Spices	Chilli, Turmeric, Ginger
Flower	Marigold, Tuberose, Ornamental Plants

The water requirement for kharif crops (aman, musur, jute) is mainly fulfilled by monsoon rain fall. For other crops, viz. for fruits 0.65 m and for vegetables 0.45 m are average water requirement. For irrigation of Rabi crops like wheat, mustard, sesame, potato, khesari etc. average 0.35m depth of water is required(Boro cultivation is not suggested as the water requirement is high). So, for irrigation of crops and vegetables in the remaining 7074.76 ha cultivable land, total water requirement will be to the tune of 0.45 X 7074.76ha i.e. 3183.64 ham approximately (Average 0.45 m water requirement is considered for all crops in the area). Now, **2212.38 ham water conserved by rainwater harvesting can irrigate 4916.84 ha i.e. 69% of the remaining cultivable land in Bhangar II block. The 2157.92 ha which could not be irrigated can be used for storing the harvested surface runoff**.

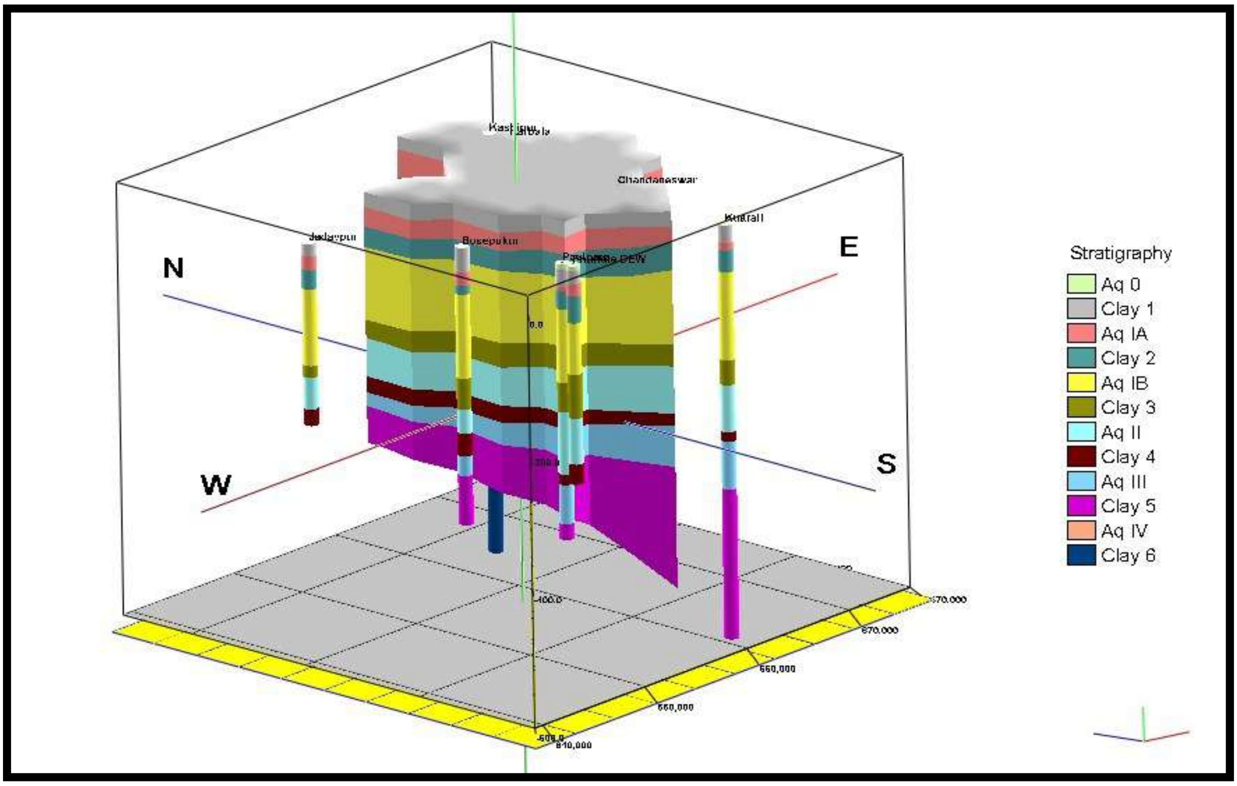


Fig 8.16.3: 3D disposition of aquifers in Bhangar I &Bhangar II blocks

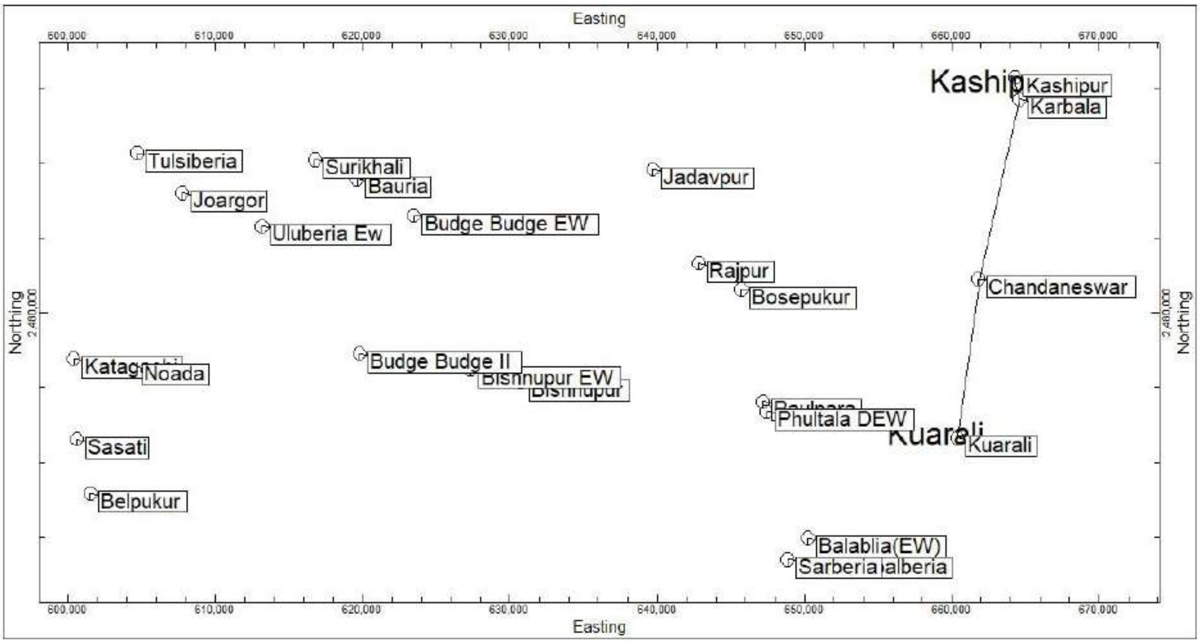


Fig 8.16.4: N-S cross section index line in Bhangar I & Bhangar II blocks, South 24 Parganas District

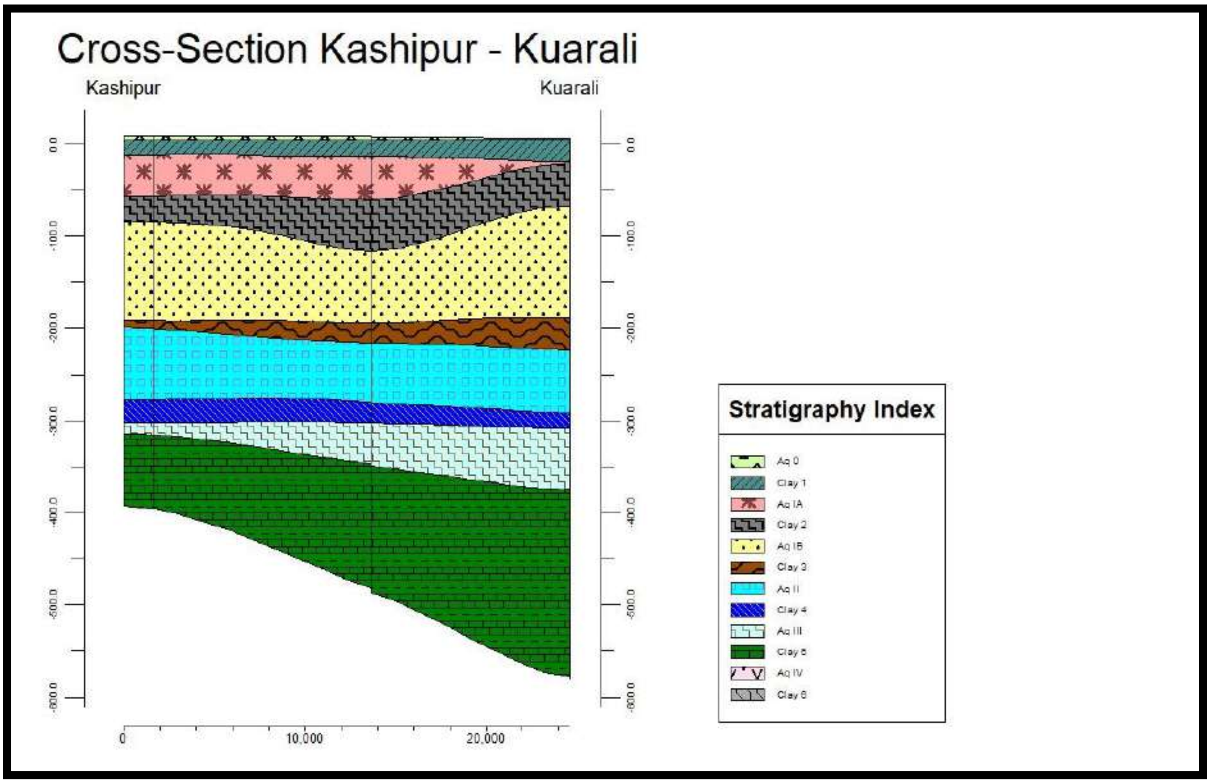


Fig 8.16.5: Cross section of Bhangar I & Bhangar II blocks, South 24 Parganasdistrict

8.17 Sonarpur

8.17.1 Salient Information

Block Name: Sonarpur

Area (in km^2): 205.41

District: South 24 Parganas

State: West Bengal

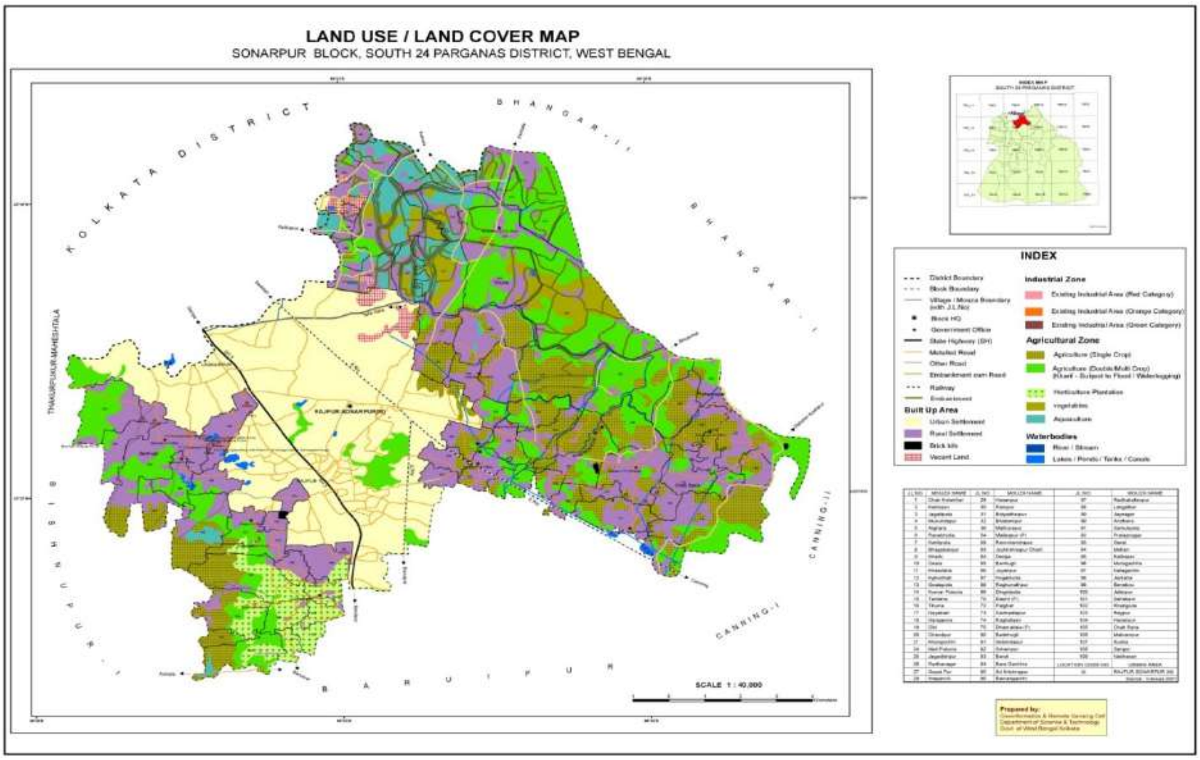
Population(as on 2011):

Total	**219863**
Rural	**175713**
Urban	**44150**

Approximate Decadal Growth Rate from 2001-2011: 31.3%

Rainfall: Average annual rainfall (as in the district)for the period 2012 -16 (in mm):1756.1

Land use:



(Source- Land & Land Reforms Dept., Govt of West Bengal)

Fig 8.17.1: Land use & Land cover map of Sonarpur block

Table 8.17.1 – Salient Land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard (ha)	Aquaculture (ha)	Lakes/Ponds/Tanks/Canals(ha)
Sonarpur	20541	8413	625.766	772.9	71.55

8.17.2 Aquifer disposition & Characteristic

Table 8.17.2 – Aquifer wise depth ranges & parameters

Name of Block	Aquifer IA	Aquifer IB	Aquifer II
	Depth Range (m bgl)	Depth Range (mbgl)	Depth Range (mbgl)
Sonarpur	20 - 35, 40 - 60	70 - 85, 90- 140, 150-190	220 - 270

8.17.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97 .Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table - 8.17.3 – Ground water resources

Resource Availability	Aquifer II(ham)
Dynamic Resource	27.94

8.17.4 Seasonal long term water level trends (2008 to 2017):

Table-8.17.4 – Seasonal water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Sonarpur	I	-	33.8	-	48.9
Sonarpur	II	-	31.38	-	35.5

8.17.5 Chemical Quality of Ground Water & Contamination

Table 8.17.5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Sonarpur	Nil to 0.015(Aq IA)	200-375(Aq IA) 150(Aq IB) 270-455(Aq II)	1228-1907(Aq IA) 2472-7000 (Aq IB) 928-1068(Aq II)	0-0.37(Aq IA) 1.28(Aq IB) 0.00(Aq II)	2.51-17.8 (Aq IA) 4.5 (Aq IB) 0.78-2.34 (Aq II)

Table - 8.17.6- Percentage of tube wells showing As-contamination in ground water

Blocks	Arsenic (<0.01 ing/1) in percentage	Arsenic (>0.01- <0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total nos. of Tube well	Max contamination (mg/l)
Sonarpur	57.56	38.90	3.54	820	2.72

(Source- PHED, Govt. of West Bengal)

In Sonarpur block Aquifer IA is occurring at a depth of 20- 60 mbgl and sporadic occurrence of arsenic in ground water has been found in this aquifer. Aquifer IB is separated from Aquifer IA by a 10-15m thick clay layer and within depth range of 70-190 mbgl. This aquifer is brackish to saline in nature except in the North western part of the block where the aquifer is bearing fresh water in Jadavpur, Ganguly Bagan area. Aquifer II is fresh water bearing and occurring at a depth range of 220-270mbgl.

As per PHED chemical analysis data of 820 tube wells, arsenic within the range of 0.01 mg/l to 0.05mg/l in shallow ground water has been observed in 319 tube wells which is almost 39% and As concentration more than 0.05mg/l is found in 29 tube wells. The maximum arsenic level found in this block is 2.72mg/l, which is maximum in the district as well.

8.17.6 Present water supply scenario

A population of 11103 (Nov,2017) is still not covered by any water supply scheme in Sonarpur block by PHED. Hence the tube wells, tapping the fresh deeper aquifer with proper cement sealing against thick clay bed can produce arsenic free fresh ground water and the same may be used for water supply in villages, yet to be covered by scheme of PHED.

8.17.7 Management plan for domestic usage:

a. Construction of wells

As evidenced from the exploration, arsenic free fresh deeper aquifer ranging from 220 to 270mbgl are potential to yield to the tune of 24 lps and can cater to the need of rural water supply. The demand for potable water and availability of arsenic free ground water from the deeper aquifers has been calculated for Sonarpur block of South 24 Parganas district for drinking and domestic purpose & is given in the table below. Considering human drinking and domestic demand of water @70 lpcd &

projected population up to 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells with 10 inch X 6 inch dia. and 300 m depth m bgl has been calculated and shown in Table 8.17.7. It has been found that water from approximately **2 tube wells tapping Aquifer II can cater the need of water for drinking and domestic purpose for 16669 people living in risk zone(by 2027)**. The tube wells should be constructed by tapping the fresh deeper aquifer which is separated from top arseniferous & saline aquifers by a persistent clay blanket and cement sealing should be done against this clay layer to prevent vertical movement of water from top aquifers.

Table 8.17.7 – Estimation of required tube wells for water supply & cost of construction

Block	Population in risk zone where no water supply scheme exists (As per census 2011)	Growth rate (%) per year as per Census 2011	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027	Discharge per tube well tapping suitable aquifer (lps)	Total discharge per day assuming 8 hours run (lpd)	Number of tube wells needed to cater the requirement	Cost of the tube well of 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakh as per latest aproved bid
Sonarpur	11103	3.13	16669	1166854.945	24	691200	2	50

b. **Roof top rain water harvesting** may be implemented in Sonarpur block where no water supply scheme has been applied. Other than this it is effective in the following situations also:

- Areas with problems of ground water salinity which is prevalent in this block.
- Areas where ground water has high concentration of harmful chemical constituents such as fluoride, iron and arsenic.
- Areas where water sources are contaminated due to pollution from various sources.

Proper purification of this harvested water should be done before using in domestic and drinking purpose.

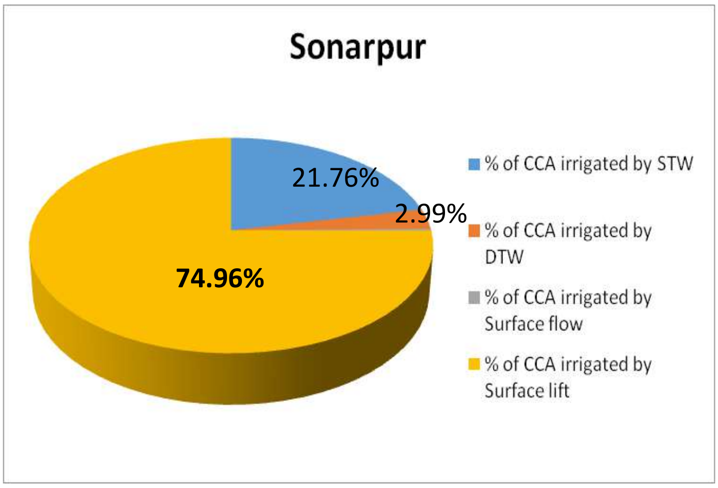
8.17.8 Management Plan for irrigation

Drilling data available from CGWB indicates occurrence of fresh ground water bearing aquifer below 220m. Aquifer IA is arsenic affected and IB is brackish/saline in the maximum part of the block.

Now, out of 20541 ha geographical area of Sonarpur block, 8413ha area is cultivable. Of this,2015.73ha CCA can be irrigated by surface water schemes and 662.77ha CCA can be irrigated by ground water schemes. The data of 4th MI census for Culturable Command Area in Bhangar II block is given below:

Table 8.17.8 – Nos. of sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA(Ha)	No of DTW	CCA(Ha)	Surface Flow	CCA(Ha)	Surface lift	CCA(Ha)
Sonarpur	2678.5	355	582.77	4	80	2	8	641	2007.73



Problems

1. The decreasing post monsoon water level trend and increasing depth to water level in the southern part of the block has created a stressful ground water condition of Sonarpur block.
2. The shallow aquifer is arsenic affected and the highest concentration of arsenic in South 24 Parganas has been encountered in Sonarpur block (2.72 mg/lt)
3. 5734.5 ha of cultivable area is not covered by any irrigation schemes.

Fig 8.17.2 represents combined map of 10 years post monsoon wa monsoon depth to water level map (Nov,2016) of shallow aquifer of Sonarpur block. Towards south in adjoining Baruipur block, water level trend is gradually decreasing: it ranges between -0.20m/year and -1 m/year, but depth to water level is below 6 m from ground level in this area. Except some portion in the western side, the depth to water level is higher than 3mbgl in the whole block.

Solution

1. The critical hydrogeological condition in the southern part of Sonarpur may be the result of heavy groundwater draft from shallow aquifer for irrigation in Baruipur block which is adjacent to this block. So the possible solutions for Baruipur block shall solve the declining water level problem of the southern part of Sonarpur. Besides, artificial recharge of shallow Aquifer IA must be implemented where post monsoon water level trend is below -0.20 m/yr and depth to water level is more than 3 mbgl (area bounded by red line in Fig 8.17.2). **Shallow injection wells, percolation tanks (where soil permeability is good) and recharge shafts may be constructed for artificial recharge of the shallow aquifer**.

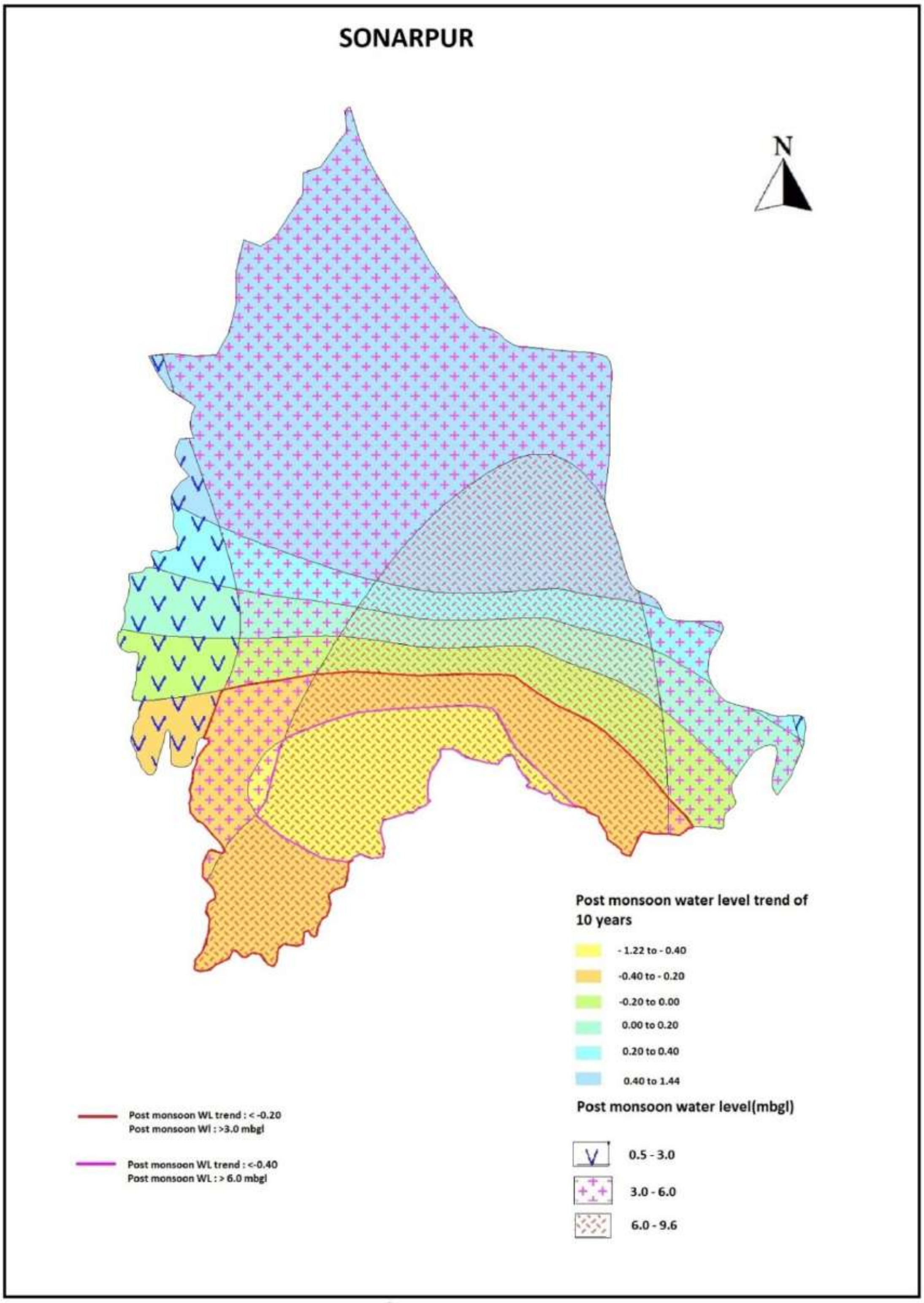


Fig 8.17.2: Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Sonarpur block

2. To deal with the **high amount of arsenic contamination in Sonarpur block in shallow ground water the following steps** must be considered:

- **Artificial recharge in the contaminated parts of the aquifer will dilute the arsenic concentration.**
- **Cultivation of flowers with shallow ground water which is arsenic contaminated and using the water from surface lift irrigation scheme to grow other crops.**
- **Using alternative water sources for cultivation of crops like harvested rain water.**
- **Cultivation of arsenic resistant crops.**

In the above discussion it has been observed that an area of **5734.5 ha cultivable land is not being irrigated** due to unavailability of water. Rainwater harvesting can be considered for solving this problem partially or fully (depending on the rainfall and other factors). The approximate surface runoff has been calculated taking into consideration all the factors as described under management plan of Baruipur block above. After calculation it has been found that **annually 1580.97 ham** (Table 8.17.9) **will be available approximately which can be used for farming throughout the year by storing it in conservation structures**.

The detail of the calculation is given below:

Table 8.17.9 – Nos. of sources & corresponding CCAs

Block	Normal annual rainfall in m(50 yrs data from IMDB) 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana,1993 'C'	Major type of soil occurring in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Sonarpur	2.088	8413	0.4	Sandy loam & clay loam	7026.5376	5269.903	2634.952	1580.971

The major crops, vegetables, fruits, flowers, spices grown in Sonarpur block are :

Crops	Aman, Khesari
Fruits	Guava, Banana, Mango, Litchi
Flower	Marigold, Tuberose, Ornamental Plants

The water requirement for kharif crops is fulfilled by monsoon rainfall; due to natural vegaries if rainfall does no occur, then irrigation is needed. For fruits & flowers 0.65 m is the average water requirement. ForRabi crops like (Khesari) average 0.35m depth of water is required. As the cultivation of fruits and flowers are more dominant in this block and more profitable, 50% of water may be used for cultivation of these and 50% may be used for rabi crops. So, **the area covered with**

1580.97 ham harvested surface run off will be 3474.66ha as per the above distribution, i.e. almost 60% of the remaining cultivable land. More area can be irrigated if the whole amount of harvested rainwater is used only in rabi crop cultivation. The remaining area may be used for conservation of the harvested water.

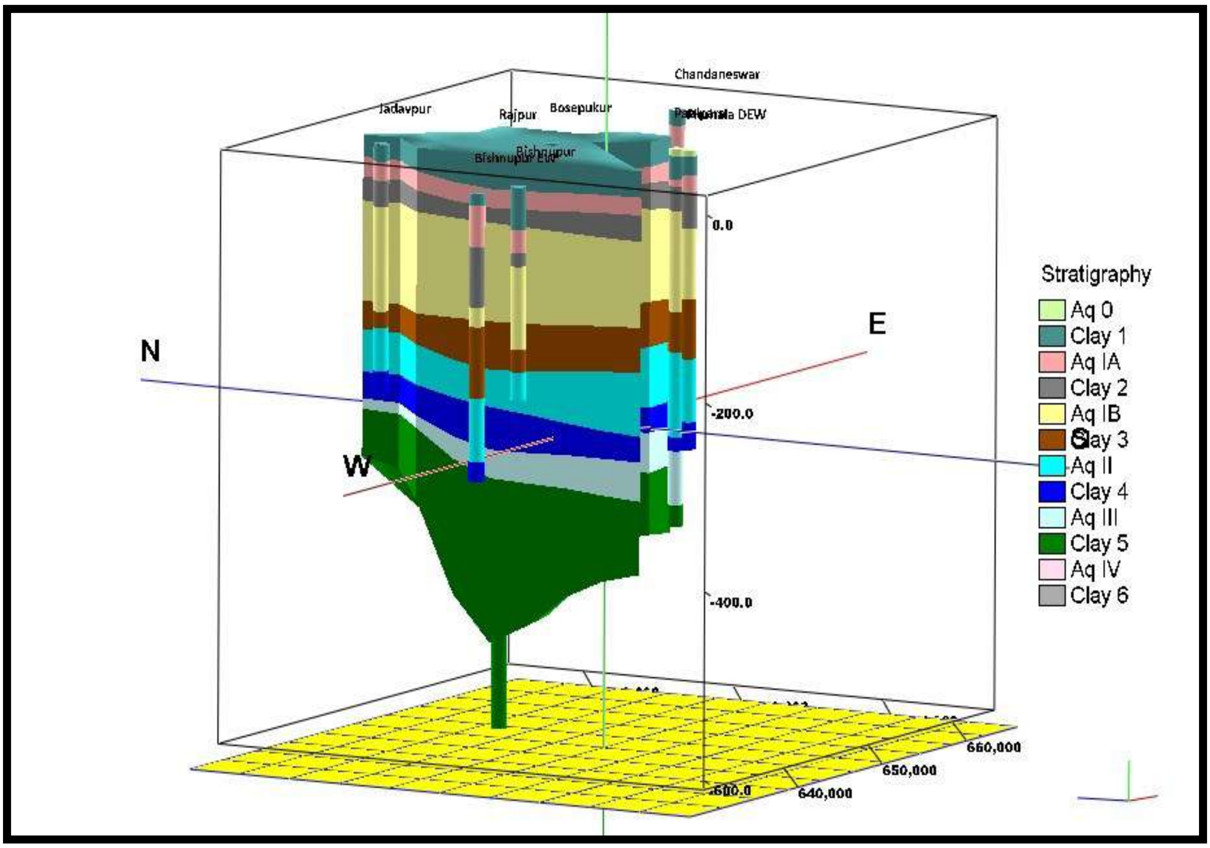


Fig 8.17.3: 3D aquifer disposition in Sonarpur block, South 24 Parganas district

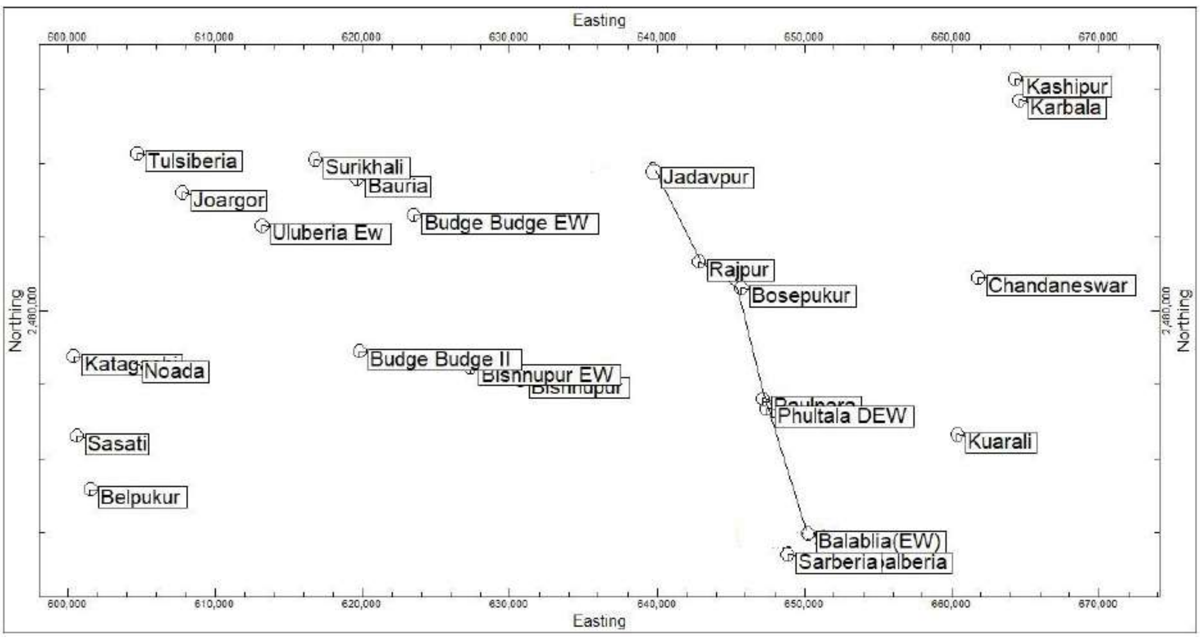


Fig 8.17.4: NNW- SSEsection index line in blocks of Sonarpur &Baruipur, South 24 Parganas district

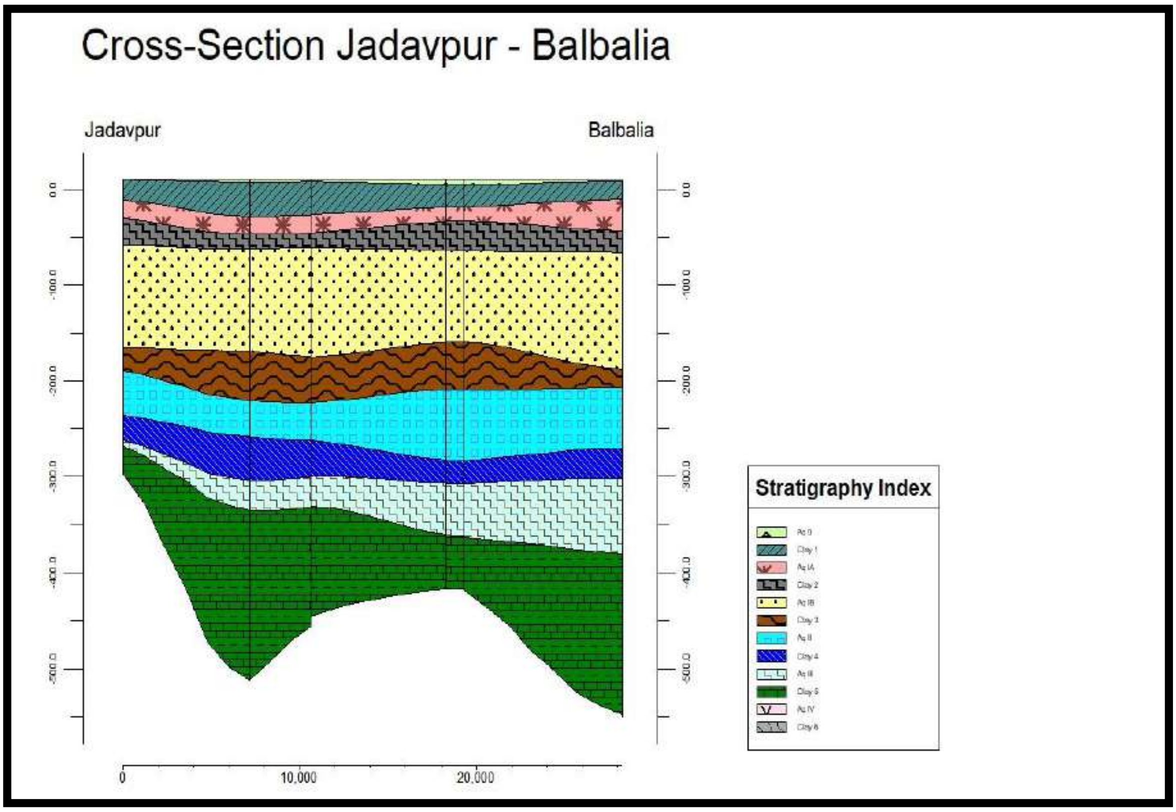


Fig 8.17.5: NNW- SSEsection in blocks of Sonarpur &Baruipur, South 24 Parganas district

8.18 Bishnupur I & Bishnupur II

8.18.1 Salient Information

Block Name: Bishnupur Iand Bishnupur II

Area(in km^2): Bishnupur I – 100.41

Bishnupur II - 93.10

District: South 24 Parganas district

State: West Bengal

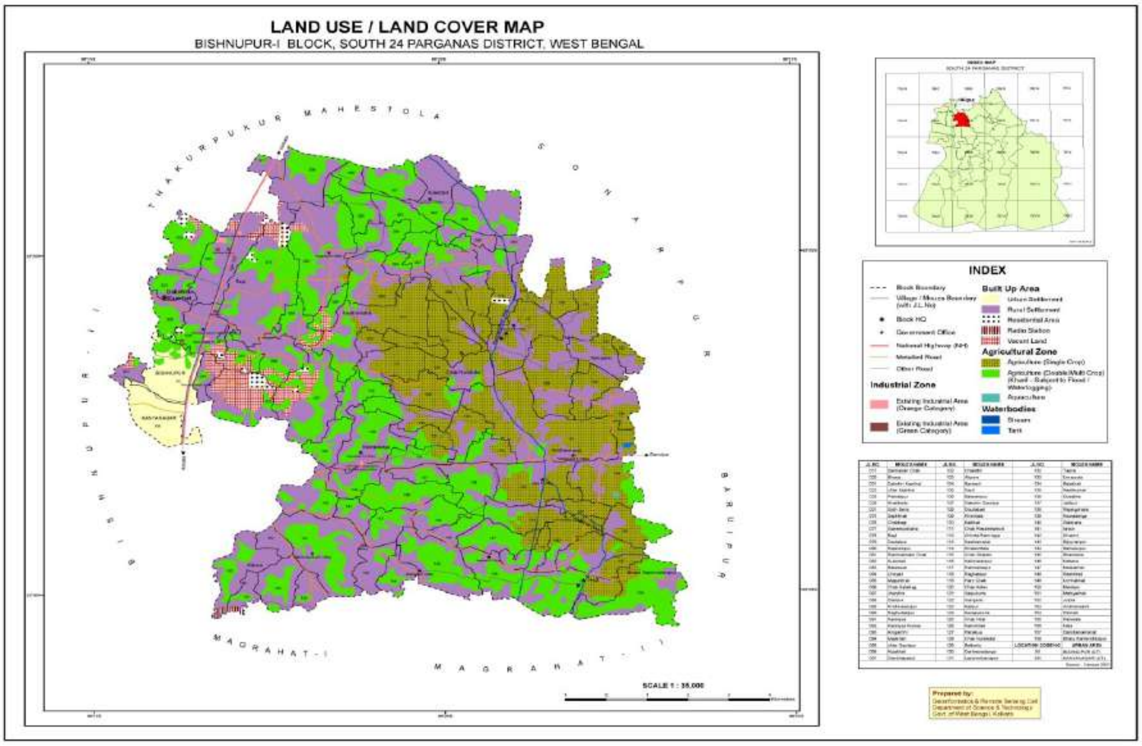
Population(as on 2011):

Bishnupur I:		Bishnupur II:	
Total	232365	Total	214531
Rural	204385	Rural	138979
Urban	27980	Urban	75552

Approximate Decadal Growth Rate from 2001-2011 of both the blocks is: 12.6%

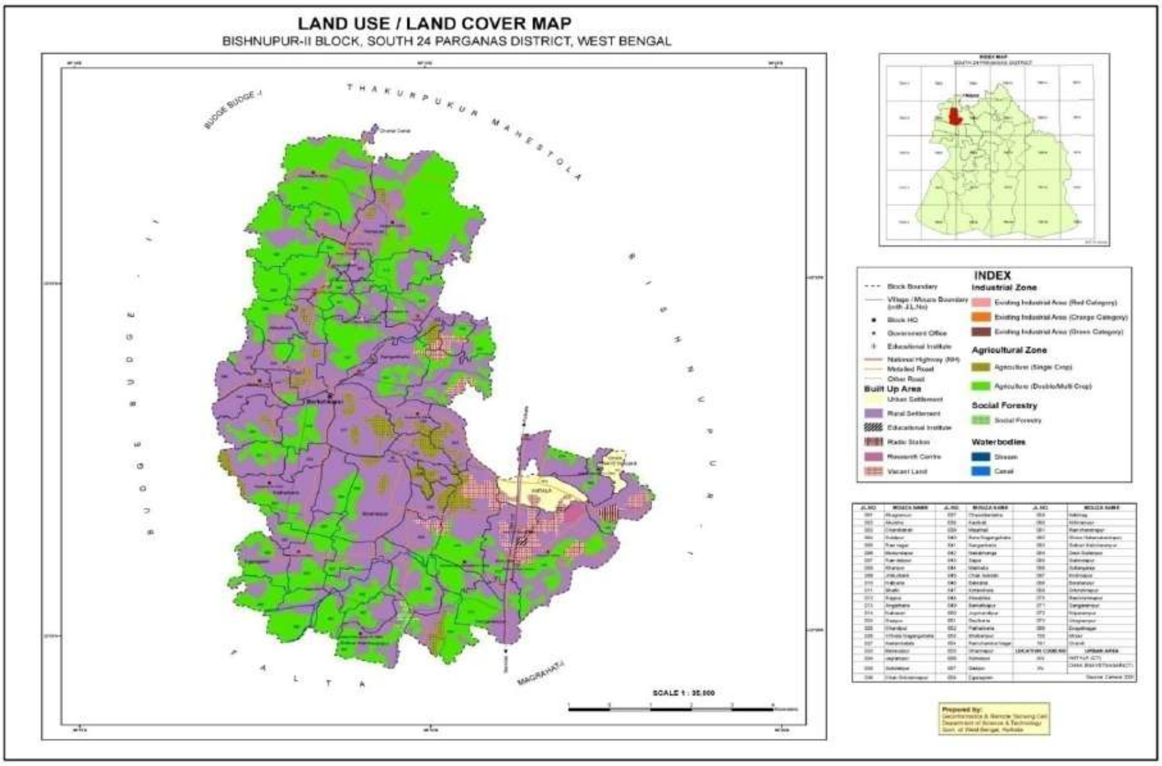
Rainfall: Average annual rainfall (as in the district)for the period 2012 -16 (in mm): 1756.1

Landuse:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.18.1: Land use & Land cover map of Bisnupur I block



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.18.2: Land use & Land cover map of Bisnupur II block

Table 8.18.1 – Salient land use features in blocks of Bishnupur I & Bishnupur II

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard(ha)	Industry(ha)	Tank/Canal (ha)
Bishnupur I	10041	9608	Nil	3.78	3.09
Bishnupur II	9310	7067	24.59	3.30	0.34

8.18.2 Aquifer disposition & Characteristic:

Table 8.18.2 – Aquifer wise depth ranges

Name of Block	Aquifer IA	Aquifer IB	Aquifer II
	Depth Range (mbgl)	Depth Range (m bgl)	Depth Range (m bgl)
Bishnupur I	45- 70	85 -130, 140 -150	195 - 210,212-270
Bishnupur II	15 - 60	115-140, 155-175	215-285

8.18.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97 .Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.18.3 – Aquifer wise ground water resources

Block	Resource Availability	Aquifer II(ham)
Bishnupur I	Dynamic Resource	10.76395
Bishnupur II	Dynamic Resource	9.98032

8.18.4 Seasonal long term water level trends (2008 to 2017)

Table 8.18.4 - Seasonal water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Bishnupur I	II	-	56.5	-	81.83

Long term trend data is not available separately for Bishnupur II block; data of adjacent blocks have been used for Bishnupur II.

8.18.5 Chemical Quality of Ground Water & Contamination

Table -8.18.5: Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Bishnupur I	Data not available	949.77(Aq IB) 240-335(Aq II)	1289(Aq IA) 2745 (Aq IB) 1414-2072(Aq II)	0.66(Aq IA) 0.74(Aq IB) 0.04-0.07(Aq II)	15.9(AqIA) 15.7(Aq IB) 0.96-2.57(AqII)
Bishnupur II	0.00-.083	360-390(AqIA)	951-2124(Aq IA)	.07-.82(Aq IA)	3.11-8.1(Aq IA)

Table - 8.18.6-Percentage of tube wells showing As-contamination in ground water

(Source – PHED, Govt. of West Bengal)

Blocks	Arsenic (<0.01 ing/1) in percentage	Arsenic (>0.01- <0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max ppm
Bishnupur I	92.58	6.99	0.44	458	0.24
Bishnupur II	99.68	0.00	0.32	317	0.08

In Bishnupur I &Bishnupur II blocks, Aquifer IA is occurring at a depth of 45- 70 mbgl and 15-60 mbgl respectively. According to data from PHED, Govt. of West Bengal, out of 458 tube wells only 6.99% are found to be contaminated with As with a range between 0.01mg/l to 0.05 mg/l and only 0.44% contains more than 0.05mg/l arsenic in ground water in Bishnupur I.In Bishnupur II block, out of 317 tubewells only 1 Tube well has shown arsenic contamination of more than 0.05mg/l.

Aquifer IB is ranging from 85-150 mbgl and 115 – 175 mbgl in Bishnupur I and Bishnupur II block respectively. During hydrogeological survey it has been found that in both these blocks, the ground water withdrawing from Aquifer IB is brackish in nature. This aquifer group is mainly divided in to 2 aquifers by a 10-15 m thick clay layer in both the blocks.

Aquifer II is fresh water bearing and occurring at a depth range of 195 – 270 mbgl and 212-285mbgl in Bishnupur I and Bishnupur II respectively(vide Fig. 8.18.4 &Fig. 8.18.5).

8.18.6 Present water supply scenario

A population of 10823 in Bishnupur I and 15519 in Bishnupur II blocks (Nov,2017) are still not covered by any water supply scheme of PHED. Hence the tube wells, tapping the fresh deeper aquifer with proper cement sealing against thick clay bed can produce arsenic free fresh ground water to villages, yetto be covered by water supply scheme of PHED.

8.18.7 Management plan for domestic usage

a. Construction of wells

As evidenced from the exploration, arsenic free fresh deeper aquifer (Aquifer II) is potential to yield to the tune of 24 lps and can cater to the need of rural water supply in these 2 blocks. The demand for potable water and availability of arsenic free ground water from the deeper aquifers has been calculated for Bishnupur I and II block of South 24 Parganas district for drinking and domestic purpose & is given in Table 8.18.7. Considering human drinking and domestic demand of water @70 lpcd & projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells having size 10 inch X 6 inch with depth 300(max. depth considered) mbgl has been calculated and shown in the given table. It has been found that water from approximately **1 tube well in Bishnupur I and 2 tubewells in Bishnupur II tapping Aquifer II can cater to the needs of water for drinking and domestic purpose for 12999 &18639 people living in risk zones of Bishnupur I & Bishnupur II blocks respectively (up to 2027)**. The tube wells should be constructed by tapping the fresh deeper aquifer which is separated from top arseniferous & saline aquifers by a persistent clay blanket and cement sealing should be done against this clay layer to prevent vertical movement of water from top aquifers.

Table 8.18.7 – Estimation of nos. of tube wells & construction cost

Block	Population in risk zone where no water supply scheme exists (census 2011)	Growth rate(%) per year as per Census 2011	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027	Discharge per tube well tapping suitable aquifer (lps)	Total discharge per day assuming 8 hours run (lpd)	Number of Tube wells needed to cater the requirement	Cost of the tube well of 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakh) as per latest approved bid
Bishnupur I	10823	1.26	12999	909938.8329	24	691200	1	18
Bishnupur II	15519	1.26	18639	1304752.91	24	691200	2	36

Before making the tube wells the water level trend of deeper aquifer in that area should be monitored and if it is showing a declining trend then **other options like roof top rainwater harvesting , treatment of saline water, installation of RO plants may be implemented in that particular area to fulfil the drinking water requirement**. In Bishnupur II block, some Govt. Reservoirs are present for drinking water supply.

8.18.8 Management Plan for irrigation

- Very few numbers of drillings have been done by CGWB in these two blocks. Data from CGWB exploration and and other organizations as well as hydrogeological surveys indicate occurrence of fresh ground water bearing aquifer below 200m approximately in both the blocks. Aquifer IA is arsenic affected and Aquifer IB is brackish/saline in the blocks. In **Bishnupur I** block, most of the cultivable land is irrigated by different canals, the main one is Magrahat basin canal as there is no river present in this block. In **Bishnupur II** block, agriculture is mainly dependent upon rain water and in some mouzas there is system of irrigation through Canal.
- Out of 10041 ha geographical area of **Bishnupur I** block, 9608 ha area is cultivable. Of this 4757.56 ha area is irrigated by surface water and only 57.3 ha area is irrigated by ground water. So, the remaining 4793.14 ha cultivable area is needed to be irrigated.

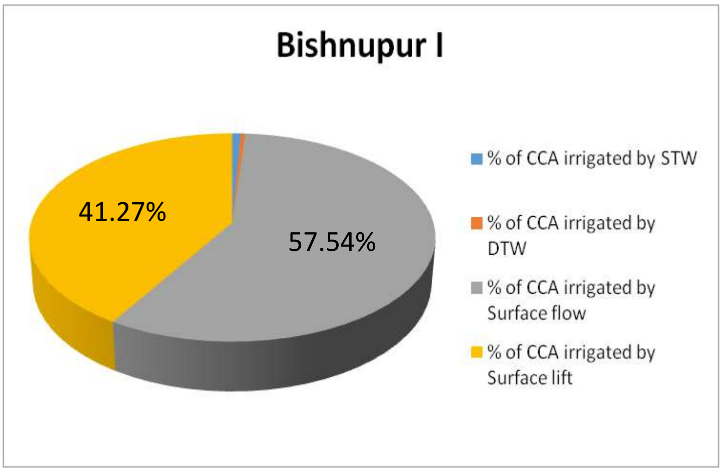


Fig. 8.18.2a – Percentage of CCAs of different sources of irrigation

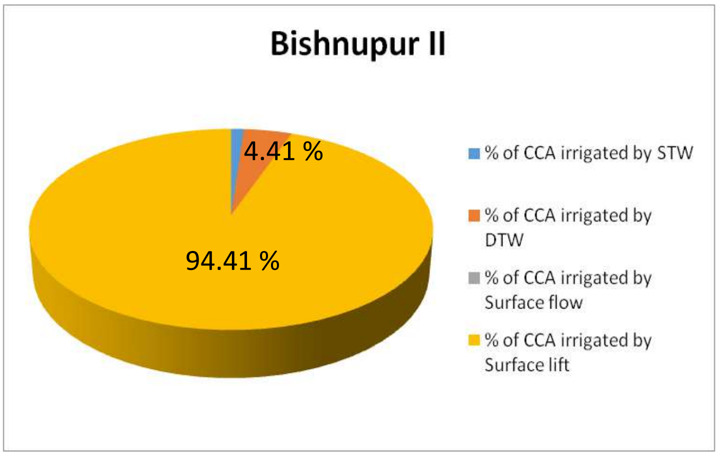


Fig.8.18.2b – Percentage of CCAs of different sources of irrigation

In **Bishnupur II,** block total cultivable area is 7067 ha of which 152 ha is cultivated by ground water and 2566.34 ha area is cultivated by surface water. 4348.66 ha area is still remaining to get cultivated. The data of 4th MI census in both the blocks is given below:

Table 8.18.8 – Nos. of irrigation sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA (Ha)	No of DTW	CCA (Ha)	Surface Flow	CCA (Ha)	Surface lift	CCA (Ha)
Bishnupur I	4814.86	7	37.3	1	20	99	2770.31	674	1987.25
Bishnupur II	2718.34	2	32	6	120	0	0	534	2566.34

Problems & solutions:

1. Fig 8.18.3 represents combined map of post monsoon water level trend of 10 years (2007-2016) and post monsoon depth to water level (Nov, 2016) of Aquifer IA in Bishnupur I &Bishnupur II blocks. The water level trend is declining below -0.20m/yr in the central and southern part of both

the blocks. The post monsoon depth to water level is more than 3mbgl and water level trend is below -0.20m/yr in the southern part of the block shown by red line. This area is mainly used for single and multi-crop cultivation and rural settlement. But as the census data indicates very low usage of shallow ground water in both the blocks, so this critical hydrogeological condition may be the outcome of high ground water draft in nearby areas including adjacent Baruipur block. To solve this problem,**artificial recharge must be considered in both the blocks through percolation tanks, recharge shafts, injection wells etc**.

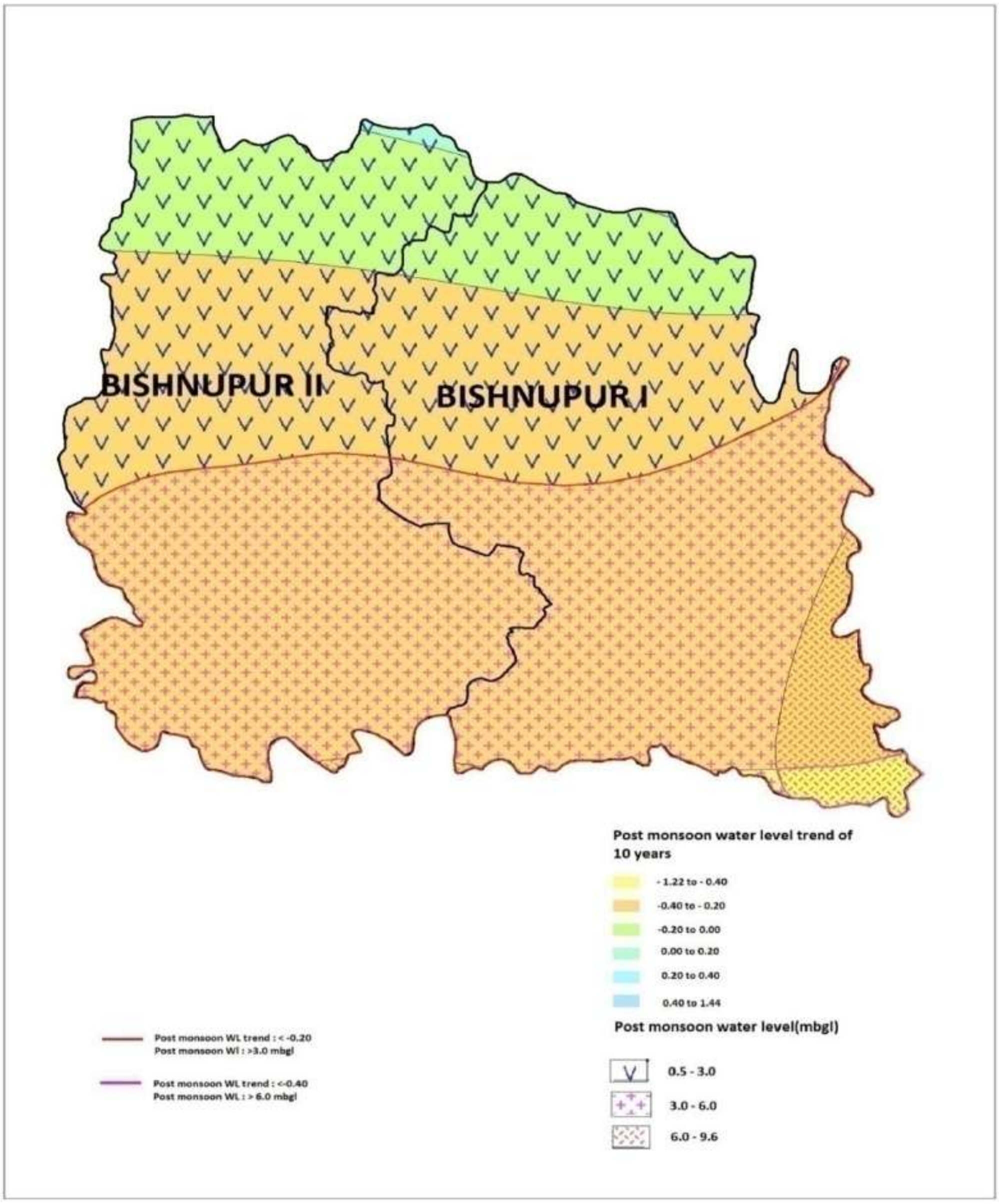


Fig 8.18.3: Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Bishnupur I & Bishnupur II blocks

2. Arsenic contamination has been found in some samples of shallow aquifer in both the blocks. As shallow ground water is used in small quantity for irrigation, there is less chance of arsenic contamination in the crops grown here. **To avoid intake of arsenic** in any other way, the following measures can be taken :

- **Consumption of ground water from tube wells tapping the shallow aquifer should be avoided totally**
- **Artificial recharge may be implemented in areas where arsenic concentration is high**
- **Where there is no other option, proper water treatment should be done before consumption of shallow ground water**

3. In the above discussion it has been observed that an area of 4793.14ha & 4348.66 ha of cultivable land is yet to be irrigated in Bishnupur I & Bishnupur II blocks by irrigation scheme. **To maximize the usage of available water the following methods can be used for irrigation:**

- **Implementing modern irrigation practices like sub surface irrigation, drip irrigation, sprinklers to avoid excess water loss.**
- **Cultivation of low water requiring and arsenic resistant crops**
- **Cultivation of kharif crops in the remaining area i.e, Aman which is the major crop produced in these blocks**
- **Direct sowing of seeds through drum seeders can save 50% of the water required otherwise**

Rainwater Harvesting:

Rainwater harvesting can be considered for irrigation in remaining 4793.14 ha & 4348.66 ha cultivable land in Bishnupur I &Bishnupur II blocks. Surface runoff has been calculated taking into consideration all the factors like e-flow, water required for natural flow to drainage, committed purposes (already existing water bodies in that area). The 'total cultivable area' and 'Normal annual rainfall' have taken in to account for calculation. Runoff co-efficient of annual normal rainfall is taken from table by 'Dhruvanarayana,1993'. After calculation it has been found that annually 2708.3 ham&1992.05 ham (Table - 8.18.9) are available approximately in Bishnupur I &Bishnupur II blocks respectively which can be used for farming by storing it in conservation structures.

Table 8.18.9 – Estimation of surface run off component in block

Block	Normal annual rainfall in m(50 yrs data from IMDB) 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana,1993 'C'	Major type of soil occuring in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow) = Vf (ham)
Bishnupur I	2.088	9608	0.6	Clay	12036.9024	9027.677	4513.838	2708.303
Bishnupur II	2.088	7067	0.6	Clay	8853.5376	6640.153	3320.077	1992.046

The major crops, vegetables, fruits, flowers, spices grown in Bishnupur I & Bishnupur II blocks are :

Bishnupur I	
Crops	Boro and Aman (Boro cultivation is done in larger area of this block)
Flowers	Marigold, Tuberose, Ornamental Plants
Bishnupur II	
Crops	Aman & Boro (in this block aman cultivation is more than boro cultivation) and small quantity of Aus cultivation
Flowers	Marigold, Tuberose, Ornamental Plants

Maximum kharif crop cultivation is suggested in remaining cultivable land in both the blocks as the water requirement could be fulfilled by monsoon rainfall only. Though boro cultivation is done maximum in Bishnupur I block but the water requirement is huge in boro cultivation. **So a combined cultivation of boro, mustard, pulses, vegetables & flower is suggested in these 2 blocks.**

The **possible coverage of cultivable land with the harvested surface runoff has been calculated for irrigation** in the remaining cultivable area considering different types of agricultural pattern and **given in the table below**.

Table 8.18.10 - Allotment of irrigation water & possible change in cropping pattern in block

Block	Harvested surface Runoff 'vf' (ham)	Boro cultivation Water depth= 1.2m		Vegetables /Flowers Water depth= 0.45m		Rabi crops(mustard, khesari etc) Water depth= 0.35m		Total area covered 'A'(ha)	Land Required to store harvested Runoff(vf)*	Remaining cultivable land (ha)
		%	Area covered (ha)	%	Area covered (ha)	%	Area covered (ha)		Area (ha)	
Bishnupur I	2708.303	60	1354.15	40	2407.38	-	-	3761.53	993.04	38.57
Bishnupur II	1992.046	40	664	40	1770.66	20	1138.28	3572.94	730.42	45.3

*Considering 10% more volume to avoid spill over

The above distribution of available harvested surface runoff has been done based on the crop pattern, benefit to cost ratio of crops and maximum land coverage. The storage of runoff can be done in the remaining cultivable land and calculated in the above table considering 3m depth. Fish farming can be done here during the time of storage.

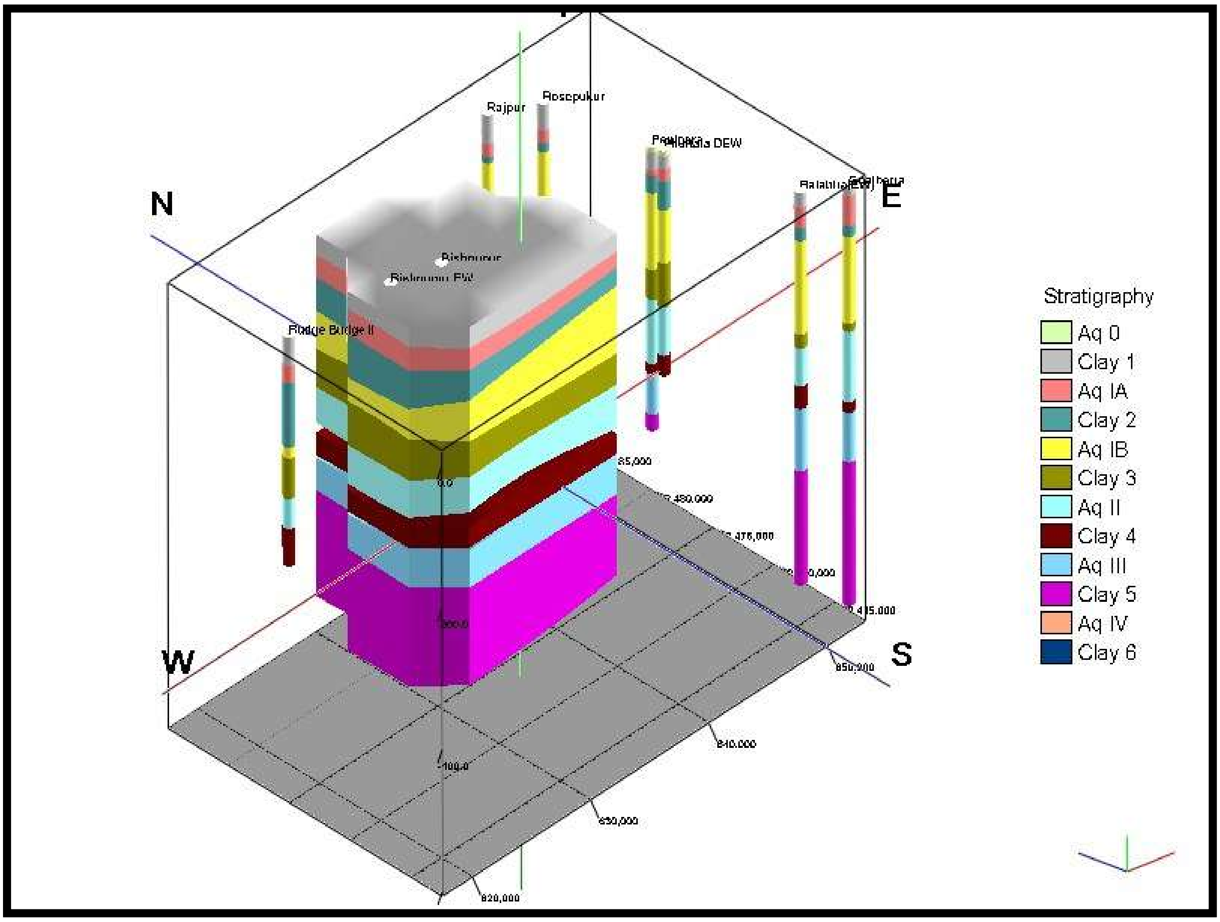


Fig 8.18.4: 3D aquifer disposition in Bishnupur I & Bishnupur II blocks

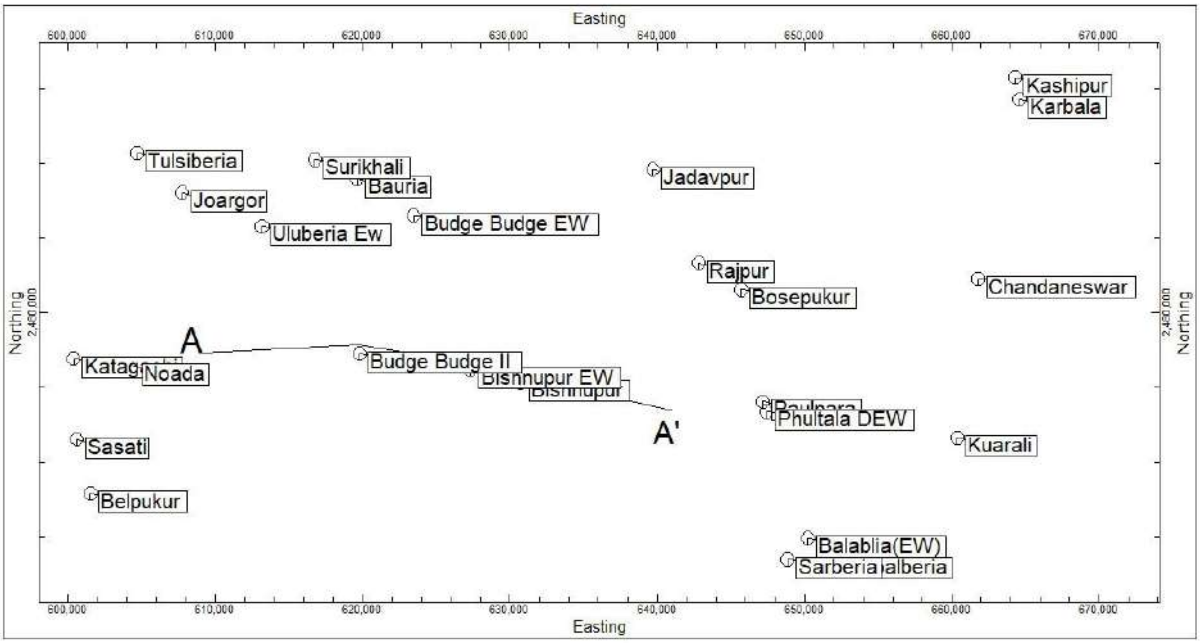


Fig 8.18.5: W-E sectionindex line in blocks of Bishnupur I & Bishnupur II, South 24 Parganas district

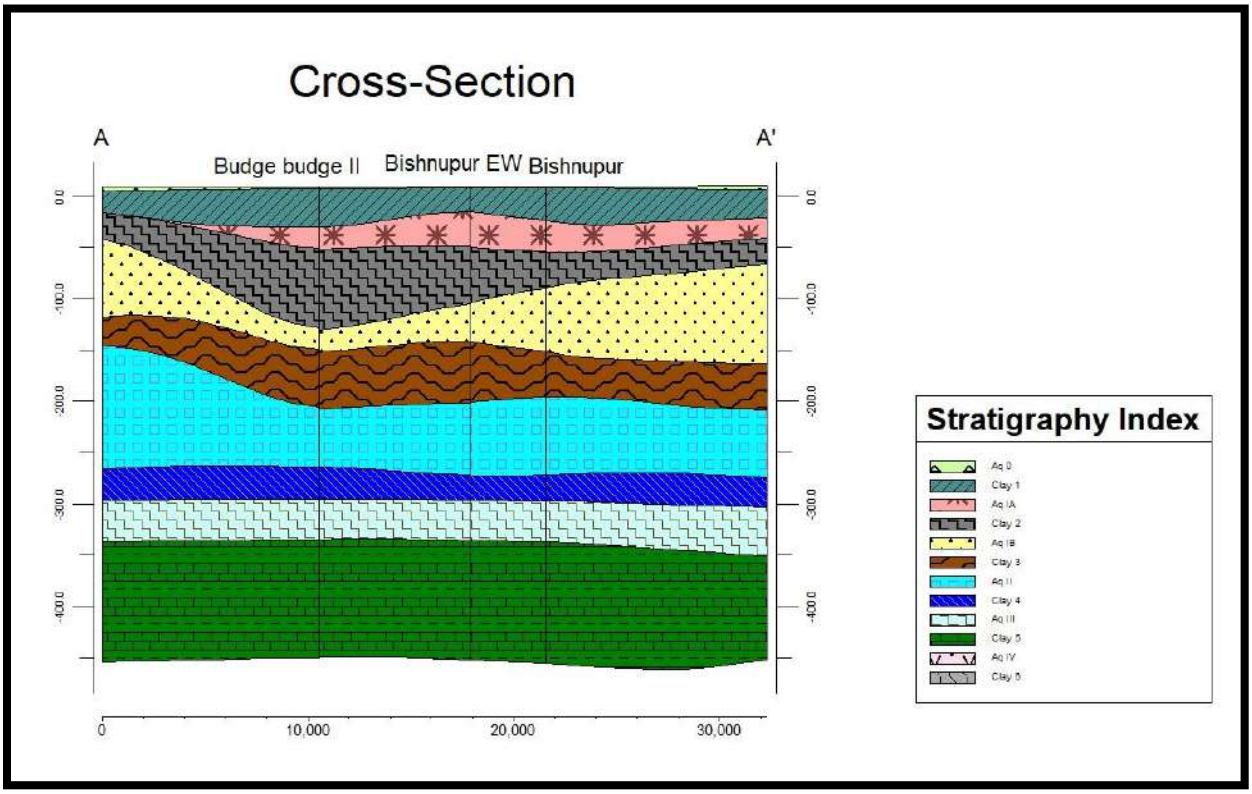


Fig 8.18.6: W-E section in blocks of Bishnupur I & Bishnupur II, South 24 Parganas district

8.19 Jaynagar I

8.19.1 Salient Information

Block Name: Jaynagar I

Area (in Km^2): 111.10

District: South 24 Parganas

State: West Bengal

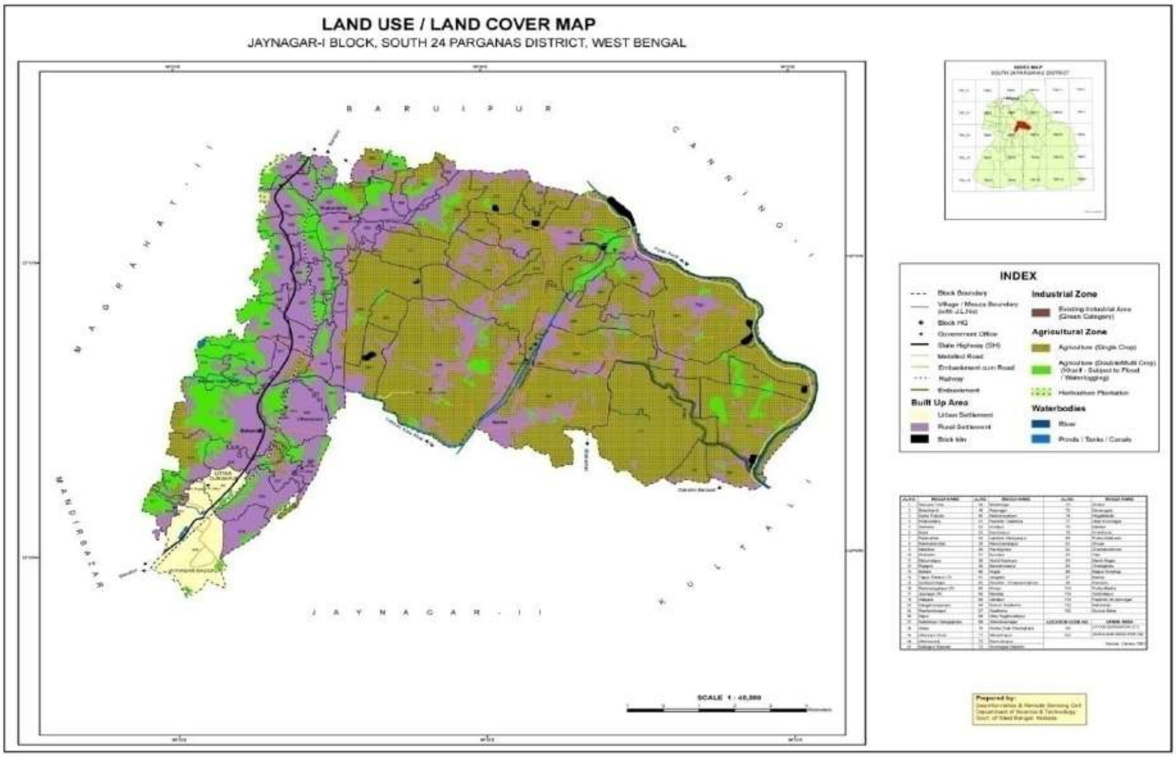
Population (as on 2011):

Total	263151
Rural	216829
Urban	46322

Approximate Decadal Growth Rate from 2001-2011: 20.3%

Rainfall: Average annual rainfall (district) for the period 2012 -16 (in mm): 1756.1

Land use:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.19.1: Land use & Land cover map of Jaynagar I block

Table 8.19.1 – Salient Land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard (ha)	River (ha)	Ponds / Tanks / Canal (ha)
Jaynagar I	11110	9380	26.69	45.13	85.42

8.19.2 Aquifer disposition & Characteristic

Table 8.19.2 – Aquifer wise depth ranges

Name of Block	Aquifer IA	Aquifer IB	Aquifer II
	Depth Range (m bgl)	Depth Range (m bgl)	Depth Range (m bgl)
Jaynagar I	10 - 30, 45-55	70 - 85, 95 - 145, 155-200	210 - 300

8.19.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer presents in this block so resource has not been calculated as per GEC-97. Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.19.3 – Ground water resources

Resource Availability	Aquifer II(ham)
Dynamic Resource	21.51

8.19.4: Seasonal long term water level trends(2008 to 2017):

Table 8.19.4- Aquifer wise water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Jaynagar I	I	-	50.3	-	108.3
Jaynagar I	II	-	34.65	-	13.5

8.19.4 Chemical quality of ground water & contamination

Table 8.19.5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)

Jaynagar I	Nil to 0.001(Aq IA)	345(AqIA) 200-340(Aq II)	1572(Aq IA) 4523-8467 (Aq IB) 1048-2058(Aq II)	0.34(Aq IA) 0.00-0.03(Aq II)	1.17(AqIA) 2.94-3.93(AqII)

Table 8.19.6 – Percentage of tube wells showing As-contamination in ground water

Blocks	Arsenic (<0.01 ing/1) in percentage	Arsenic (>0.01-<0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max ppm
Jaynagar I	94.53	1.86	3.60	805	0.61

(Source – PHED, Govt. of West Bengal)

In Jaynagar I block, two prominent aquifers have been identified from the exploration data of CGWB and other state govt.organizations: Aquifer I & Aquifer II. Aquifer I is divided into two parts (Aquifer IA & IB) by a thick clay layer of 15-20m. Aquifer IA is occurring at a depth 10 m bgl to 55 m bgl and Aquifer IB is occurring at a depth of 97mbgl to 200mbgl. Aquifer IA contains fresh water where as Aquifer IB is brackish /saline, EC is as high as 7000 µs/cm (Sarberia). The deeper Aquifer II is occurring at a depth range of 210mbgl to 300mbgl. This aquifer is fresh water bearing and generally tapped for drinking water purpose.

As per PHED chemical analysis data, in only 15 out of 805 tube wells, ground water is arsenic bearing within the range of 0.01 mg/l to 0.05mg/l and in 29 tube wells As concentration is more than 0.05mg/l. The maximum concentration of arsenic found in Jaynagar I block is 0.61mg/l.

8.19.5 Present water supply scenario

A population of 18006(Nov,2017) is still not covered by any water supply scheme in this block by PHED. Hence the tube wells, tapping the fresh deeper aquifers with proper cement sealing against thick clay bed will produce arsenic free fresh ground water to villages which are yet to be covered by water supply scheme of PHED.

8.19.6 Management plan for domestic usage

a. Construction of wells

As evidenced from the exploration, arsenic free deeper aquifer ranging from 210 to 300 mbgl (clay intercalations present in between)is potential to yield to the tune of 26 lps and can cater to the need of rural water supply. The demand for potable water vis-à-vis availability of arsenic free ground water from the deeper aquifers has been calculated for Jaynagar I block of South 24 Parganas district for drinking and domestic purpose & is given in the table below. Considering human drinking and domestic demand of water @70 lpcd & projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number of tube wells having size 10 inch X 6 inch with depth 300(max. depth considered) mbgl has been calculated and shown in Table 8.19.7. It has been found that water from **2 number of tube wells tapping Aquifer II can cater the need of water for drinking and domestic purpose for 23864 people living in risk zone (by 2027).The tube wells should be constructed by tapping the aquifers which is separated from top arseniferous and saline aquifers by a persistent clay blanket with proper cement sealing against the clay layer**. This cement sealing should be kept in order to prevent the vertical percolation of water from the top contaminated aquifers.

Table 8.19.7 – Estimation of nos. of tube wells & construction cost

Block	**Population in risk zone where no water supply scheme exists till now(As per census 2011)**	**Growth rate(%) per year as per Census 2011**	Projected population in risk zone projected up to 2027	**Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027**	**Discharge of tube wells tapping suitable aquifer(lps)**	**Total discharge per day assuming 8 hours run(lpd)**	**Number of tube wells needed to cater the requirement**	Construction Cost of tube wells of 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakhs as per latest approved bid
Jaynagar I	18006	2.03	23864	1670502.776	26	748800	2	50

Roof top rain water harvesting is another way which can be implemented to fulfil the demand of fresh water for drinking and domestic purpose.

8.19.7 Management Plan for irrigation

Drilling data available from CGWB and other state govt. departments indicates occurrence of fresh ground water bearing aquifer below 210m. There is only one prominent river i.e. Piyali, in the eastern zone, which is almost in dying condition due to several interruptions for agrarian purpose. Now, out of 11110 ha geographical area of Jaynagar I block, 9380 ha area is cultivable.

The 4th MI census data of different irrigation schemes in this block is given below:

Table 8.19.8 – Nos. of irrigation sources & respective CCAs

Block	**Total CCA (Ha)**	**No of STW**	**CCA (Ha)**	**No of DTW**	**CCA (Ha)**	**Surface Flow**	**CCA (Ha)**	**Surface lift**	**CCA (Ha)**
Jaynagar I	6212.98	4	34	4	34	109	5844.98	27	224

Problems:

1.Though use of shallow groundwater is very less in irrigation still the water level trend is declining below -0.40 m/yr

2. Arsenic contamination found in Jaynagar I block from shallow tubewells,maximum being 0.61mg/l

3. 3167.02 ha land is still not covered by any irrigation schemes.

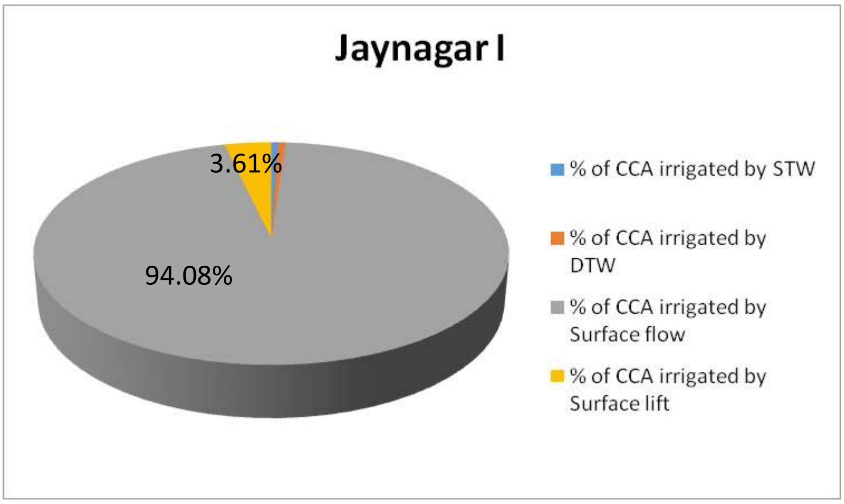


Fig.8.19.2 – Percentage of CCAs of different sources of irrigation

Solutions:

1. Fig 8.19.3 represents combined map of 10 years (2007-2016) post monsoon water level trend of Aquifer IA and postmonsoon depth to water level of November,2016. It shows that in the whole block, the water level of shallow aquifer is having declining trend below -0.40m/yr and the northern part of the block (bordered by red line)is having water level below 3m from the ground surface. As the shallow ground water is used in very low quantity for irrigation, this may not be the reason for declining ground water level. However,**in surrounding areas including adjoining Baruipur block situated just to the north of Jaynagar I block, shallow ground water is extensively used. Artificial recharge must be considered mainly in area marked by red line to increase the ground water level**.

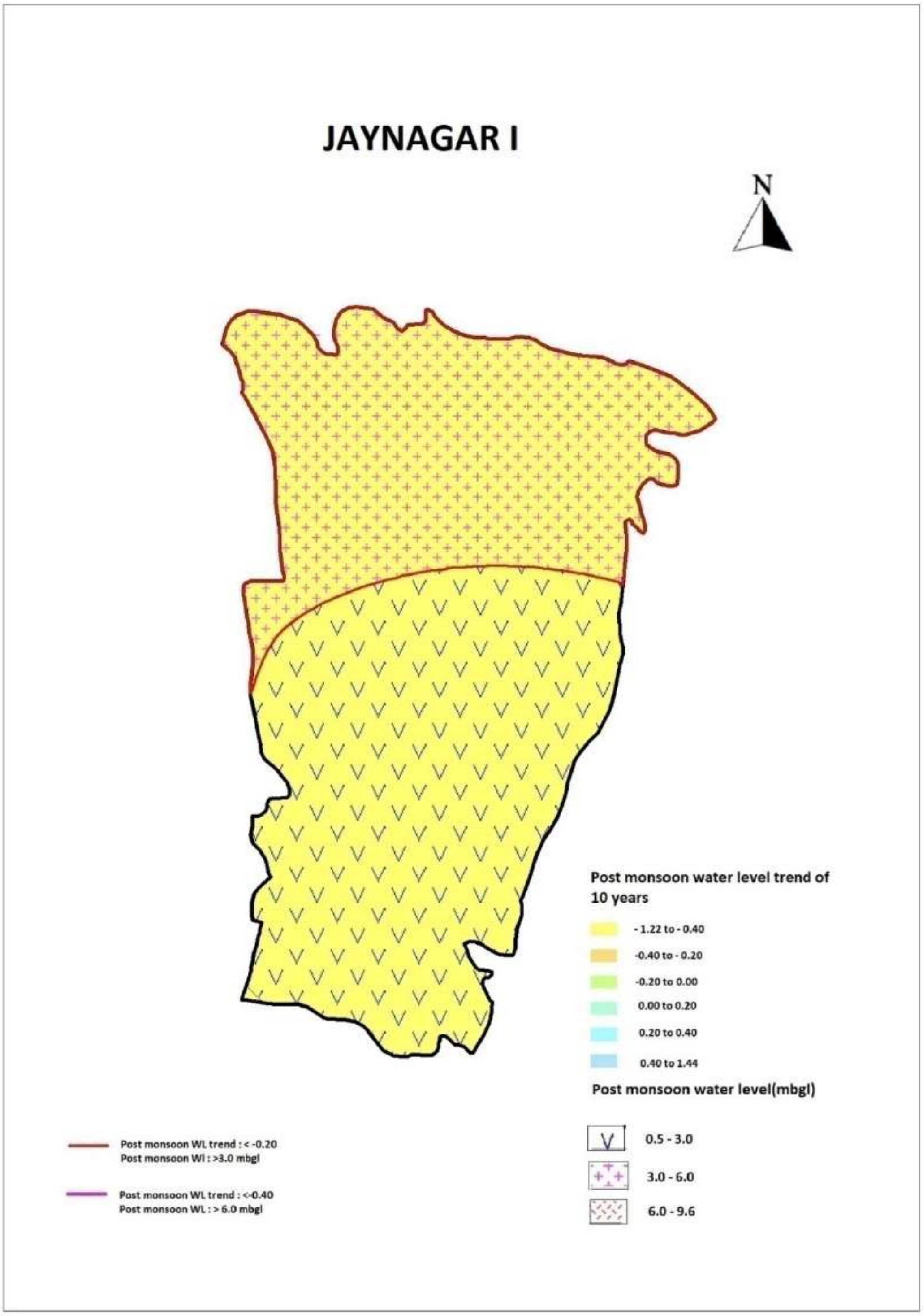


Fig 8.19.3:Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Jaynagar I

2. The shallow aquifer is arsenic contaminated in this block(>.01mg/l). So **to prevent the consumption of arsenic contaminated water the following things can be done**:

- **Artificial recharge may be considered which will eliminate the problem of both declining water level and arsenic contamination**

- **Cultivation of arsenic resistant crops in areas where shallow tube wells are used for irrigation water**
- **Flower cultivation may be considered in arsenic affected areas**
- **Water from shallow tube wells should be avoided strictly for drinking or cooking purpose**

3 **3167.02 ha of cultivable land is not covered by any irrigations schemes in Jaynagar I block. So, To maximize the usage of available water the following methods can be used for irrigation :**

- **Implementation of modern irrigation practices like irrigation with subsurface porous pipes, drip irrigation, sprinklers to avoid excess water loss.**
- **Cultivation of low water requiring and arsenic resistant crops**
- **Direct sowing of seeds through drum seeders can save 50% of the water required otherwise**
- **Rainwater harvesting can be considered for solving this problem**. The approximate **surface runoff** has been calculated taking into consideration all the factors as described in the management plan described under Baruipur block. After calculation, it has been found that **annually 1762.69 ham (Table 8.19.9 below) will be available as surface run off approximately which can be used for farming** throughout the year by storing it in conservation structures like farm pond, irrigation tank etc.

The details of calculation is given below:

Table -8.19.9 – Estimation of rainfall run off component in block

Block	Normal annual rainfall in m(50 yrs data from IMDB) 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient after Dhruvana rayana,1993 'C'	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Jaynagar I	2.088	9380	0.4	Alluvial soil	7834.176	5875.632	2937.816	1762.69

The major crops, vegetables, fruits, flowers, spices irrigated in Jaynagar I block are:

Crops	Aman, Boro, Aus paddy, mustard, musur, jute , mustard ,sesame, potato, khesari and a small quantity of sugarcane
Vegetables	Cabbage, Cauliflower, Lady's Finger, Cucurbits, Radish, Beans
Fruits	Guava, Banana, Mango, Litchi
Spices	Chilli, Turmeric, Ginger

The water requirement for kharif crops (aman, jute, sugarcane) is fulfilled by monsoon rain fall mainly but if irregularities in rainfall occur then irrigation is needed. For fruits and vegetables, 0.65 m and 0.45 m are average water requirements respectively. For irrigation of Rabi crops like wheat, mustard, sesame, potato, khesari etc. an average of 0.35 m water column is required.

The possible coverage of the remaining cultivable land(3167.02ha) with the harvested surface runoff has been calculated considering different types of agricultural pattern and given in table 19.10.

Table - 8. 19.10 – Allocation of water & possible coverage of crops

Block	Harvested surface Runoff 'vf' (ham)	Fruits Water depth = 0.65 m		Boro Waterdepth= 1.2m		Vegetables Water depth= 0.45m		Rabi crops(mustard, khesari etc) Water depth= 0.35m		Total area covered 'A'(ha)	Land Required to store harvested Runoff(vf)*	Remaining cultivable land (ha)
		%	Area covered (ha)	%	Area covered(ha)	%	Area covered (ha)	%	Area covered (ha)		Area (ha)	
Jaynagar I	1762.69	30	813.55	40	587.56	20	783.42	10	503.63	2688.16	646.32	-

*considering 10% more volume to avoid spill over

The above distribution of available harvested surface runoff has been done based on the crop pattern, benefit to cost ratio of crops,land availability and maximum land coverage possible. Any other distribution pattern can be followed as per requirement. The storage of runoff can be done in the remaining cultivable land in the form of conservation structures and calculated in the above table considering 3m depth. As the requirement of land for storage of 1762.63 ham is more than the available land, the excess water can be used for domestic purpose, artificial recharge etc

8.20 Magrahat II

8.20.1: Salient Information

Block Name: Magrahat II

Area(in km^2): 127.14

District: South 24 Pargana

State: West Bengal

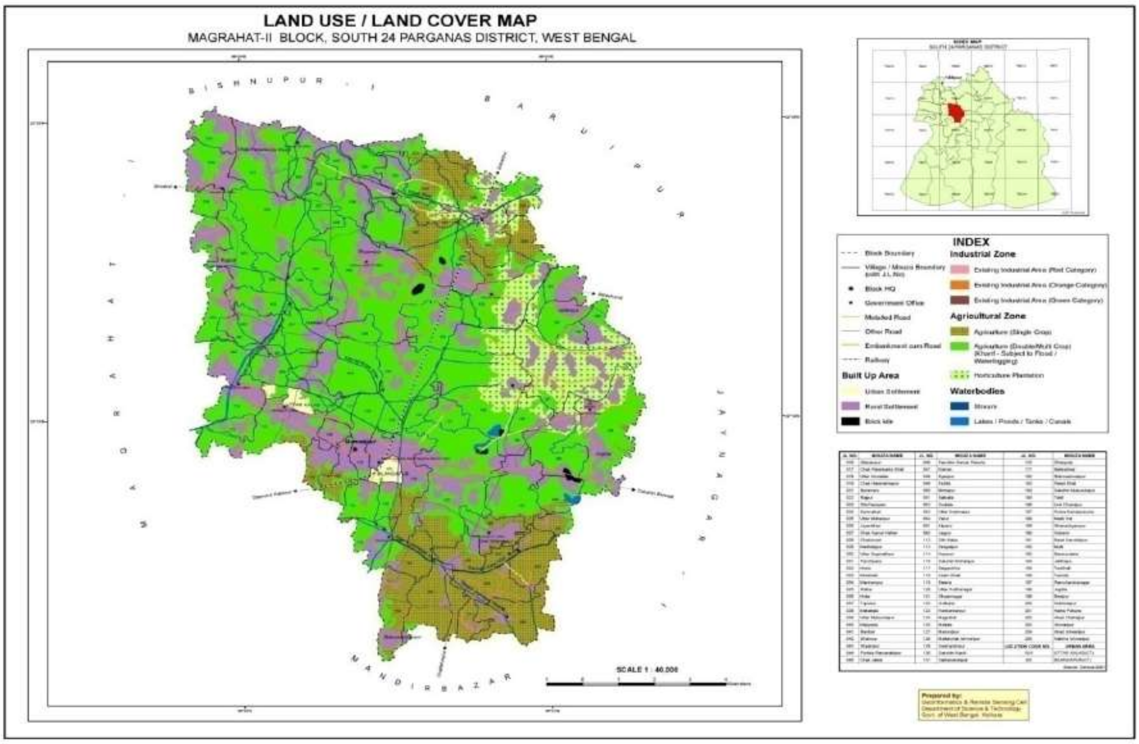
Population(as on 2011):

Total	304744
Rural	218504
Urban	86240

Approximate Decadal Growth Rate from 2001-2011: 17.1%

Rainfall: Average annual rainfall (district)for the period from 2012 -16 (in mm):1756.1

Landuse:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.20.1: Landuse & Land cover map of Magrahat II block

Table -8.20.1 – Salient land use features in Magrahat block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard(ha)	Brick kiln (ha)	Lakes/Ponds/Tanks/Canals (ha)
Maghrahat II	12714	11591	1129.337	30.63	70.965

8.20.1 Aquifer disposition & Characteristic

Table- 8.20.2 – Aquifer wise depth ranges

Name of Block	Aquifer IA	Aquifer IB	Aquifer II
	Depth Range (m bgl)	Depth Range (m bgl)	Depth Range (m bgl)
Magrahat II	6-45	95-140, 150-165	211 - 295

8.20.2 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer presents in this block so resource has not been calculated as per GEC-97 .Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table -8.20.3 – Aquifer wise ground water resources

Resource Availability	Aquifer II (ham)
Dynamic Resource	8.49

8.20.3 Seasonal long term water level trends (2008 to 2017)

Table – 8.20.4 – Seasonal water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Magrahat II	II	8.7	-	39.5	-

8.20.4 Chemical Quality of Ground Water & Contamination

Table 8.20.5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Magrahat II	Nil to 0.004 (Aq IA)	425 (Aq IB) 240-285 (Aq II)	2326 (Aq IB) 778-1953 (Aq II)	0.00 (Aq IB) 0.05-0.07 (Aq II)	1.2(Aq IB) 1.01-4.71(Aq II)

Table 8.20.6 – Percentage of tube wells showing As-contamination in ground water

Blocks	Arsenic (<0.01 mg/l) in percentage	Arsenic (>0.01-<0.05 mg/l) in percentage	Arsenic (> 0.05 mg/l) in percentage	Total Tube well	Max concentration (mg/l)
Magrahat II	97.90	1.61	0.48	620	0.22

Till now no exploration has been done in Magrahat II block by CGWB and not much data is available from other departments. So, aquifer delineation has been done in this block based on explorations in surrounding blocks, geophysical surveys available and in field hydrogeological studies. From these data, it has been interpreted that the upper shallow Aquifer IA exists in this block at a depth of 6 – 45mbgl and the brackish/saline Aquifer IB is occurring at a depth from 95 – 165mbgl approximately(vide Fig. 20.3 & Fig. 20.4). Geophysical & field surveys have confirmed the brackish nature of this aquifer. Aquifer II is fresh in this block also and is occurring approximately at a depth range of 211-295mbgl.

As per PHED, Govt. of West Bengal chemical analysis data out of 620tube wells surveyed, only 1.61% tube wells are found to have As contamination within the range of 0.01mg/l – 0.05mg/l and only 0.48% tube wells have shown arsenic contamination more than 0.05mg/lt(Table 20.6).

8.20.5 Present water supply scenario

PHED, Govt. of West Bengal has covered the whole Magrahat II block by water supply schemes. So, no management plan has been suggested for drinking and domestic use. Besides, many tanks, ponds shallow & deep tube wells also exist in this block.

8.20.6 Management Plan for irrigation

The shallow aquifer in Magrahat II block is arsenic infested as per PHED report.Now out of 12714 ha geographical area of Magrahat II block, 11591 ha area is cultivable. Of this 1722.50ha area is irrigated by surface water and only 40 ha area is irrigated by ground water. The details of irrigation schemes present in this block is given below(4th MI census):

Table 8.20.7 – Nos. of irrigation sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA (Ha)	No of DTW	CCA (Ha)	Surface Flow	CCA (Ha)	Surface lift	CCA (Ha)
Magrahat II	1762.5	0	0	2	40	0	0	288	1722.5

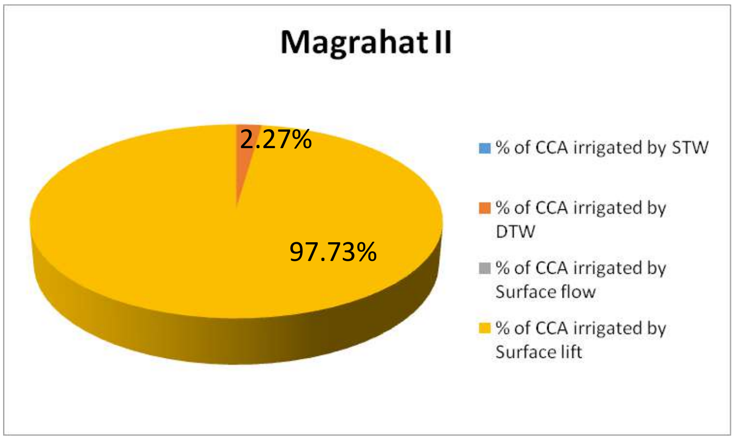


Fig. 8.20.2 – Percentage of CCAs of different sources of irrigation

Problems and Solutions:

1. As per 4th MI census, 97.73% of the total CCAsis irrigated by surface lift schemes and no shallow tube well irrigation scheme is present in Magrahat II block. Still Fig 8.20.3 shows that the whole block is having declining post monsoon trend of Aquifer IA below -0.20m/year and in more than 90% of the block the water level is below 3m from ground surface. The reason behind this is not clear. May be the huge population is using high amount of shallow ground water for domestic purpose except drinking. To increase the water level artificial recharge must be implemented for shallow Aquifer IA in this block.

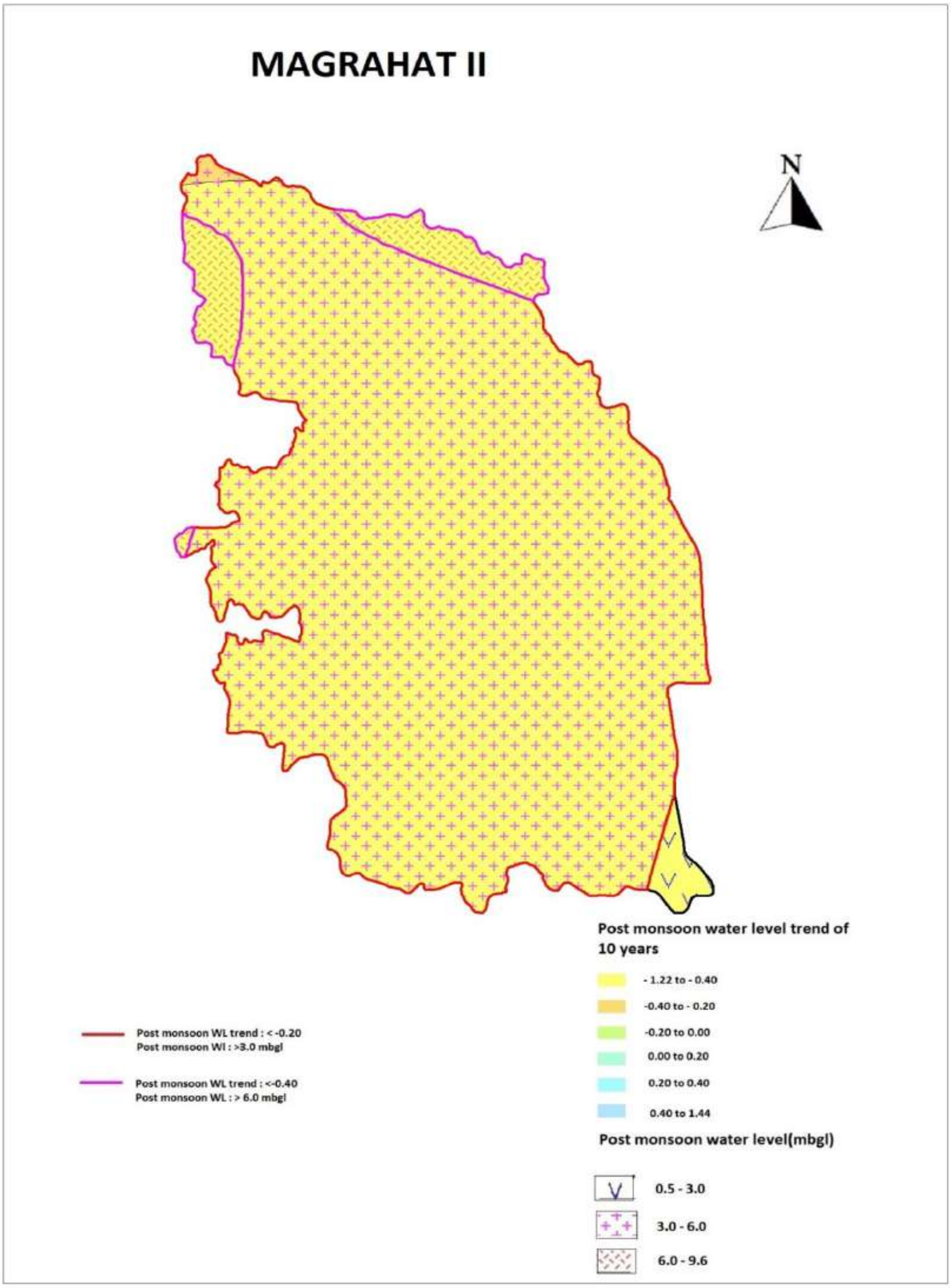


Fig 8.20.3:Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Magrahat II

2. Very less number of samples from tube wells tapping Aquifer IA has arsenic concentration above permissible limit. As water from this aquifer is not used for irrigation, chance of arsenic in food chain through crops is less. However, **people from villages are having shallow tube wells tapping Aquifer IA at their homes. So, awareness must be created in them regarding the use of this ground water so that no one gets affected by arsenic contamination**.

3. As per 4th MI census data 9828.5ha cultivable area is not covered by any irrigation scheme in Magrahat II block. So, **to maximize the usage of available water and irrigate this remaining land the following methods can be used for irrigation**:

- **Implementing modern irrigation practices like drip water irrigation, sub-surface irrigation, sprinklers to avoid excess water loss.**
- **Cultivation of low water requiring crops**
- **Direct sowing of seeds using drum seeders to reduce water usage almost by 30%**
- Rainwater harvesting must be considered for catering to the need of water for irrigation in the remaining cultivable area. The approximate **surface runoff** has been calculated taking into consideration all the factors as described in management plan under Baruipur block. After calculation it has been found that **annually 2722.726 ham (Table 8.20.8) will be available approximately from surface run off** by which can be used for farming throughout the year by storing it in conservation structures.

Table-8. 20.9 – Estimation of surface run off component in block

Block	**Normal annual rainfall in m(50 yrs data from IMD B) 'Rn'**	**Total cultivable area(ha) 'A'**	**Run off co efficient from Dhruvanarayana ,1993 'C'**	**Major type of soil available in that block**	**Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham**	**75% (deducting runoff to existing drainage)of 'Vt' = V (ham)**	**50% of V (Non committed) = Vnc (ham)**	**60% of Vnc (deducting e-flow) = Vf (ham)**
Magrahat II	2.088	11591	0.5	Clay loam	12101.004	9075.753	4537.877	2722.726

Now the major crops, vegetables in Magrahat II block are:

Crops	Boro, Aman, Maskalai, Musur, Jute, Khesari, Sugarcane, Mustard
Vegetables	Potato, Cabbage, Cauliflower, Lady's Finger, Cucurbits, Radish, Beans

Boro cultivation is done mostly in Magrahat II block which requires 1.2 m water depth. Beside this other kharif and rabi crops are also grown here. Kharif crops generally do not need any irrigation but on an average 0.35 m water depth is required for cultivation of rabi crops. Lots of vegetables are also grown in this block which requires an average of 0.45 m of water column. So, **a number of distribution patterns of harvested surface runoff is given below considering the type of crops grown here, benefit to cost ratio, availability of land and water, and land for storage of this harvested water**:

Table 8.20.10 – Irrigation water allocation & possible cropping patterns

Block	**Harvested surface Runoff 'vf' (ham)**	**Boro Waterdepth = 1.2m**		**Vegetables Water depth= 0.45m**		**Rabi crops(mustard, khesari etc) Water depth= 0.35m**		**Total area covered 'A'(ha)**	**Land Required to store harvested Runoff(vf)***	**Remaining cultivable land (ha)**
		%	**Area covered (ha)**	**%**	**Area covered (ha)**	**%**	**Area covered (ha)**		**Area (ha)**	
Magrahat II	2722.726	40	907.57	30	1815.15	30	2333.76	5056.48	998.33	3773.68
Magrahat II	2722.726	30	680.68	30	1815.15	40	3111.68	5607.52	998.33	3222.65
Magrahat II	2722.726	10	226.89	20	1210.1	70	5445.45	6882.44	998.33	1947.72

*considering 10% more volume to avoid spill over

So, from the above table it is clear that more area can be irrigated as we increase the percentage of cultivation of rabi crop. In this way, **a optimum distribution of the harvested run off can be achieved which will ultimately give maximum profit to the farmers considering all the associated factors like transportation, labour charge, time etc**.

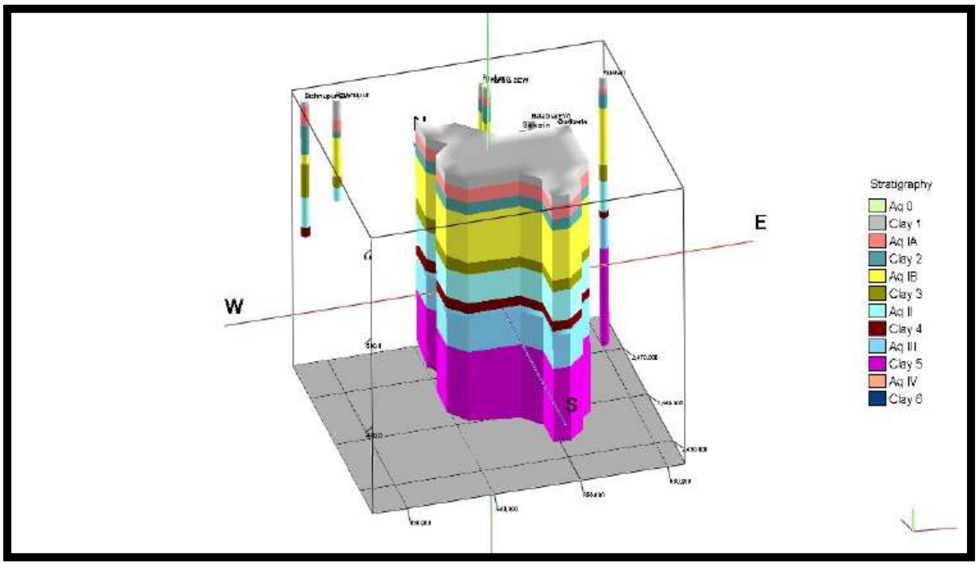


Fig 8.20.3: 3Ddisposition of aquifers in Magrahat II & Jaynagar I blocks

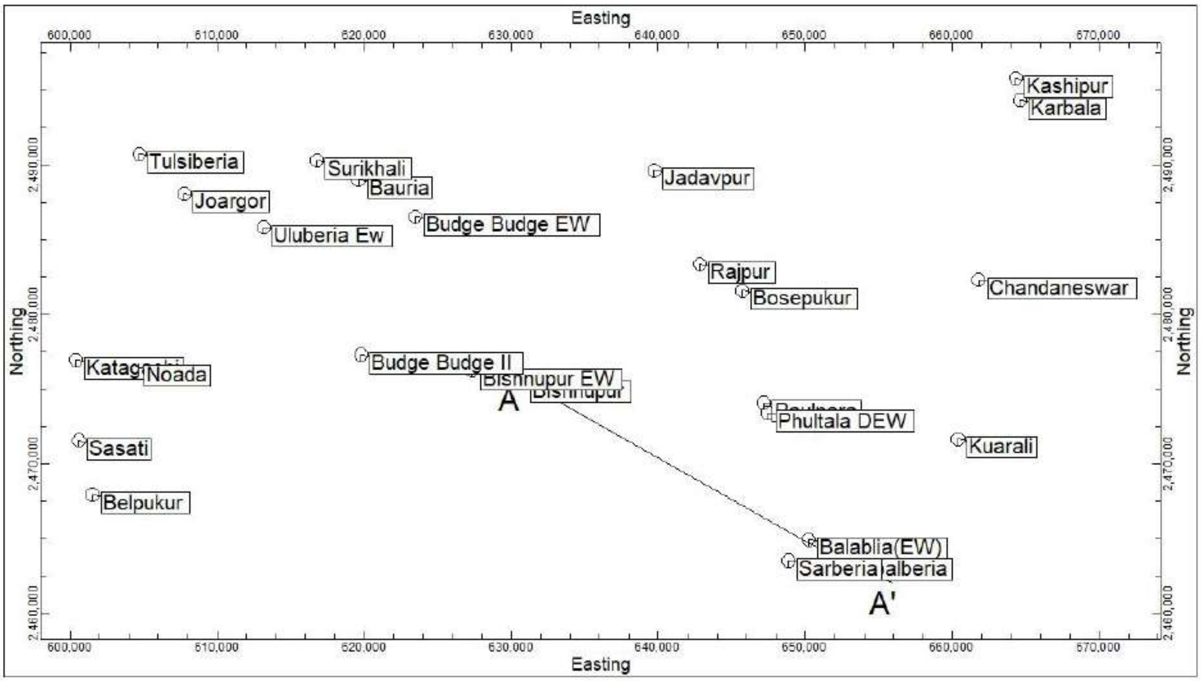


Fig 8.20.4: NW-SE section index line in Jaynagar I & Magrahat II blocks, South 24 Parganas district

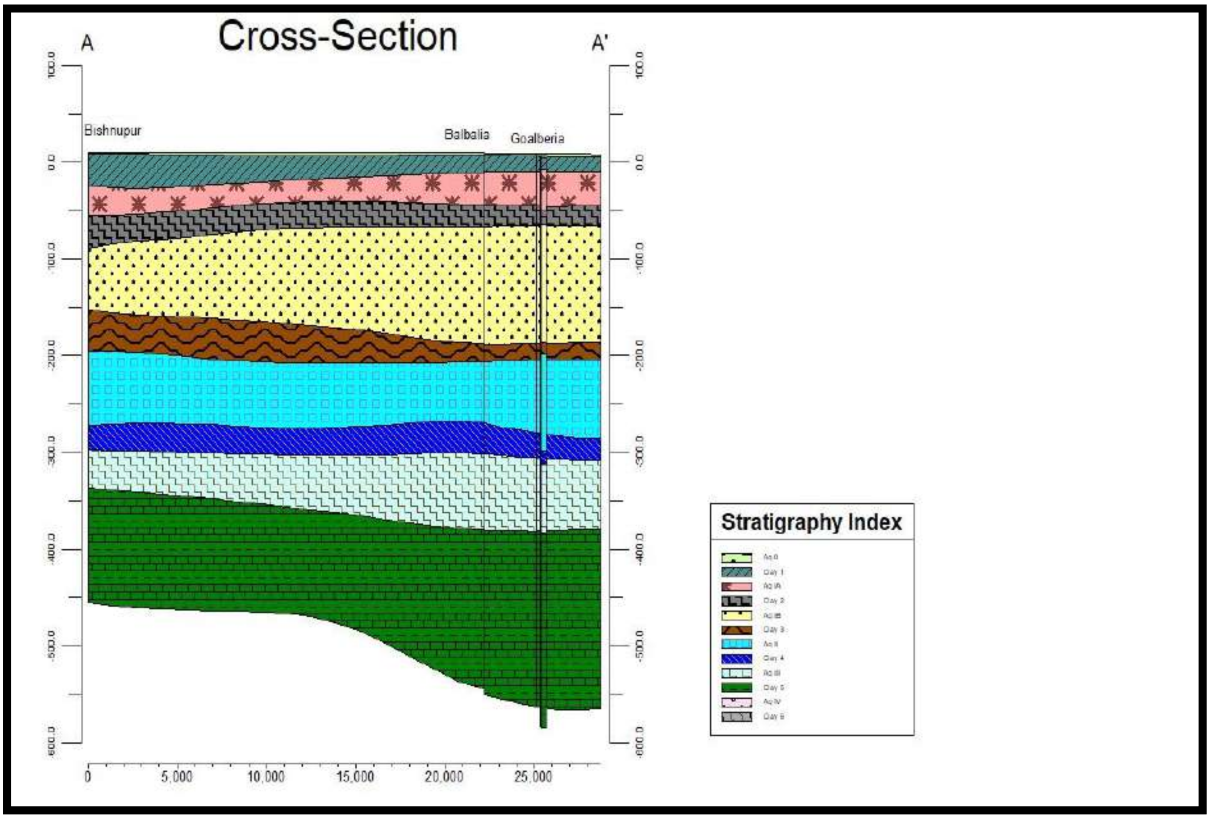


Fig 8.20.5: NW-SE section in Jaynagar I & Magrahat II blocks, South 24 Parganas district

8.21 Budge Budge II

8.21.1 Salient Information

Block Name: Budge Budge II

Area (in km^2):108.19

District: South 24 Parganas

State: West Bengal

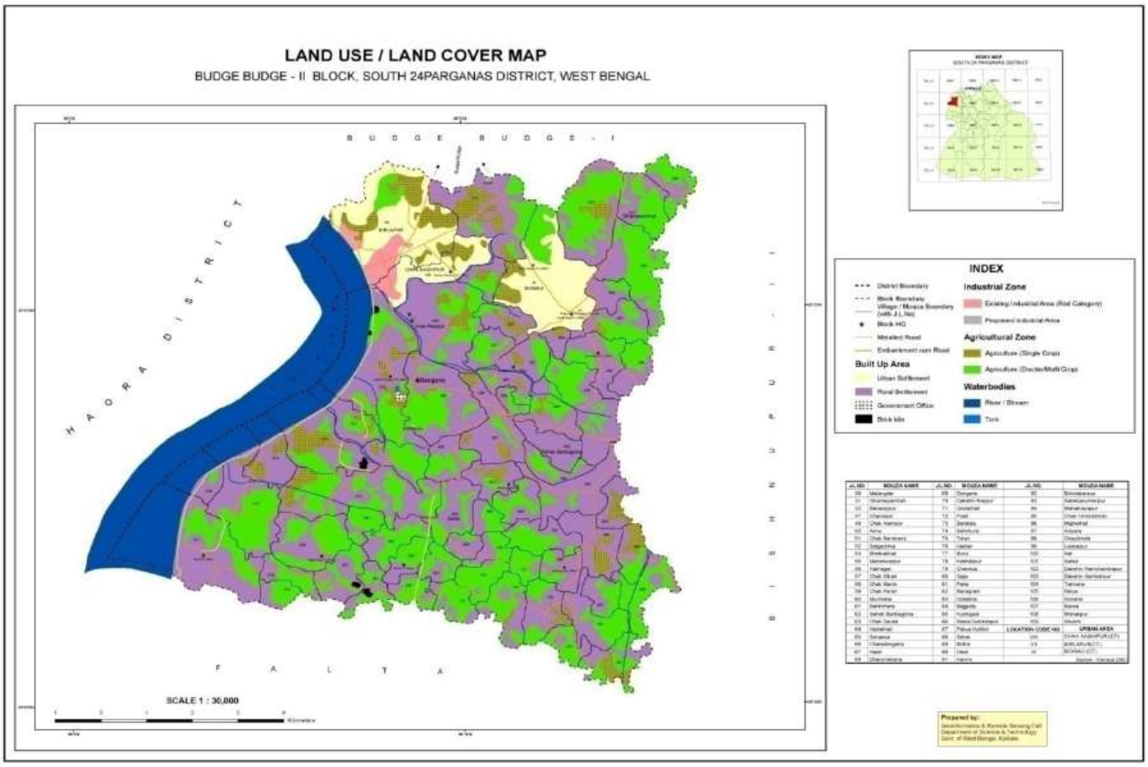
Population(2011):

Total	192134
Rural	135254
Urban	56880

Approximate Decadal Growth Rate from 2001-2011: 11.6%

Rainfall: Average annual rainfall (district)for the period2012 -16 (in mm):1756.1

Land use



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig.8.21.1: Landuse& Land cover map of Budge Budge II block

Table8.21.1 – Salient land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Industry (ha)	Tanks (ha)	River (ha)
Budge budge II	10819	2025	100.32	1.56	599.9

8.21.2 Aquifer disposition & Characteristic:

Table 8.21.2 – Aquifer wise depth ranges & parameters

Name of Block	Aquifer IA		Aquifer IB	Aquifer II	
	Depth Range (m bgl)	Discharge (m^3/hr)	Depth Range (m bgl)	Depth Range (m bgl)	Discharge (m^3/hr)
Budge Budge II	35-65	18	150- 175	215 - 275	90

8.21.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97. Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.21.3 – Ground water resources

Resource Availability	Aquifer II(ham)
Dynamic Resource	7.53

8.21.4 Seasonal long term water level trends (2008 to 2017):

Table 8.21.4 – Water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Budge Budge II	I	-	0.4	12	-
Budge Budge II	II	-	68.6	-	196.95

8.21.5 Chemical quality of ground water & contamination

Table - 8.21.5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Budge Budge II	Nil to 0.002 (Aq IA)	65 (Aq IA) 160 (Aq II)	1438 (Aq IA) 989 (Aq II)	1.2 (Aq IA) 0.07 (Aq II)	3.66 (Aq IA) 1.06 (Aq II)

Table 8.21.6 – Percentage of tube wells showing As-contamination in ground water

Blocks	Arsenic (<0.01 mg/l) in percentage	Arsenic (>0.01- <0.05 mg/1) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max concentration (mg/l)
Budge Budge II	98.13	1.87	0.00	375	0.03

(Source- PHED, Govt. of West Bengal)

In Budge Budge II block, two prominent aquifers have been identified from the exploration data of CGWB and other state govt, organisations. Aquifer IA is ranging from 35- 65 mbgl, and Aquifer IB is ranging from a depth of 150 – 175mbgl and brackish to saline in nature. Aquifer II is occurring at a depth of 215 – 275mbgl in this block and it bears fresh ground water(vide Fig. 8.21.2 & Fig. 8.21.3).
As per PHED chemical analysis data out of 375 tube wells, arsenic within the range of 0.01 mg/l to 0.05mg/l in shallow ground water has been observed in 7 tube wells only(vide Table - 8. 21.6).

8.21.6 Present water supply scenario

A population of 12035(Nov,2017) is still not covered by any water supply scheme in this block. Hence, tube wells, tapping the fresh deeper aquifers with proper cement sealing against thick clay bed may produce arsenic free fresh ground water to villages, yet to be covered by water supply scheme of PHED.

8.21.7 Management plan for domestic usage

a. Construction of tube wells

As evidenced from the exploration, arsenic free deeper aquifers ranging from 215 to 275 mbgl is potential to yield to the tune of 25 lps and can cater to the need for rural water supply. The demand for potable water vis-à-vis availability of arsenic free ground water from the deeper aquifers has been calculated for Budge Budge II block of South 24 Parganas district for drinking and domestic purpose & is given in Table 8.21.7. Considering human drinking and domestic demand of water @70 lpcd & projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.
The number of tube wells having size 10 inch X 6 inch with depth 300(max. depth considered) mbgl has been calculated and shown in Table 8.21.7.It has been found that water from **1 tube well tapping Aquifer II can cater the need of water for drinking and domestic purpose for 14264 people living in risk zone by 2027**.The tube well should be constructed by tapping aquifer II which is separated from top saline & arseniferous aquifers by a persistent clay blanket. Proper cement sealing against clay layer should be kept in order to prevent the vertical percolation of arseniferous and saline water from the top contaminated aquifers.

Table 8.21.6 – Estimation of Nos. of tube wells for water supply & cost estimate

Block	**Population in risk zone where no water supply scheme exists till now(As per census 2011)**	**Growth rate(%) per year as per Census 2011**	Projected population in risk zone projected up to 2027	**Requirement of water for drinking and household purposes per day @ 70 litre per day per capita for projected population in 2027**	**Discharge per tube well tapping suitable aquifer(lps)**	**Total discharge per day assuming 8 hours run(lpd)**	**Number of tubewells needed to cater the requirement**	**Cost of tube well (300 m depth)& 10"x6" dia.@ Rs. 18 lakh as per latest approved Bid**
Budge Budge II	12035	1.16	14264	998501.2816	25	720000	1	18

8.21.8 Management Plan for irrigation

A very few numbers of drilling have been conducted in this block by CGWB. These data and and hydrogeological survey in Budge Budge II block indicate availability of fresh ground water below 215mbg.The shallow aquifer is arsenic affected (as per PHED report).Now out of 10819 ha geographical area of Budge Budge II block, only 2025ha area is cultivable. The data of 4th MI Census is given below:

Table 8.21.8 – Nos. of irrigation sources & corresponding CCAs

Block	**Total CCA (Ha)**	**No of STW**	**CCA (Ha)**	**No of DTW**	**CCA (Ha)**	**Surface Flow**	**CCA (Ha)**	**Surface lift**	**CCA (Ha)**
Budge Budge II	1591.29	1	2	5	100	370	1474.47	5	14.82

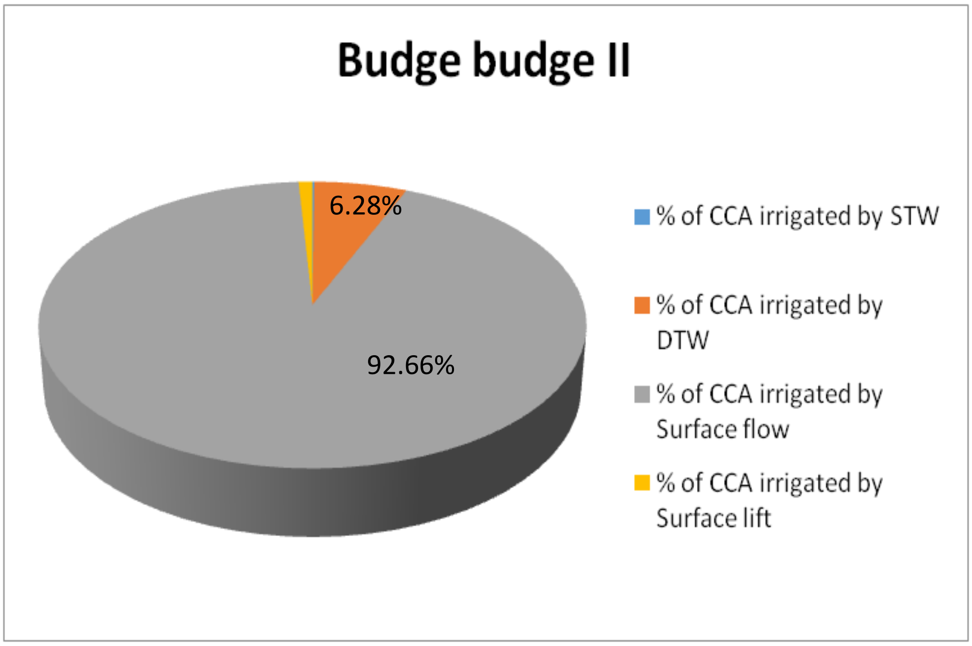


Fig. 8.21.2 – Percentage of CCAs of different sources of irrigation

Problems & Solutions:

1. In Fig. 8.21.3, a combined map of both post monsoon water level trend for 10 years and post monsoon depth to water level for Aquifer IA has been shown and the area bounded by red border is having water level trend below -0.20m/yr and depth to water level is below 3m from ground surface. **In majority of the area, post monsoon water level of shallow aquifer ranges within 0 to 3 m bgl and water level trend varies from 0 to -0.40 m/yr. The best possible solution is to implement artificial recharge structures to increase the water level of shallow aquifer**.
2. Arsenic concentration above permissible limit has been encountered in sporadic locations and irrigation water drawn from shallow aquifer is very less,**so the probability of arsenic infestation in crops grown in Budge Budge II block is very less. Water consumption from tube wells tapping shallow aquifer in affected places should be avoided completely for drinking and cooking purpose**.
3. **433.71 ha cultivable land is not covered by any irrigation schemes. To utilize the available resource to irrigate this remaining land, the following steps can be taken**:

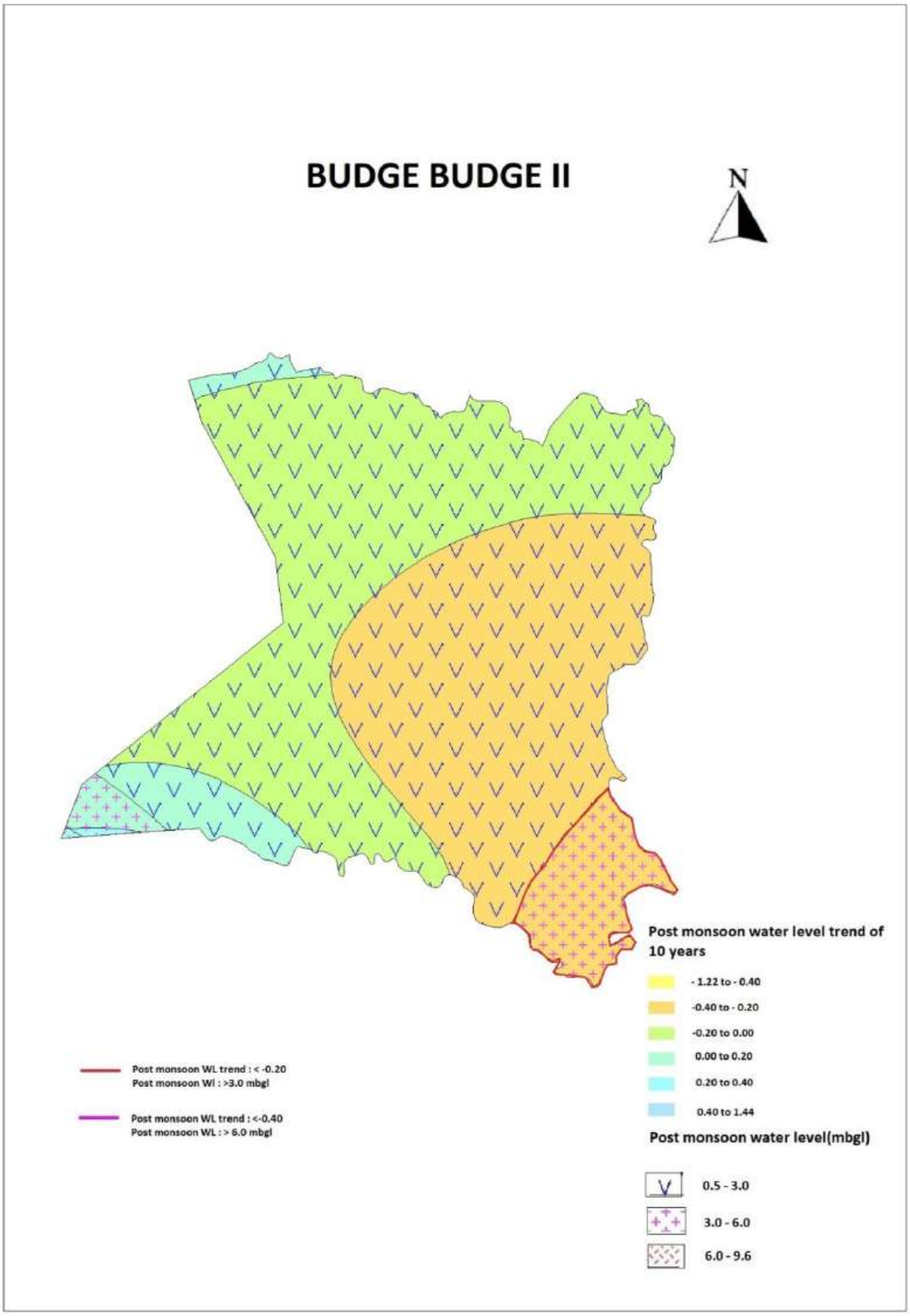


Fig 8.21.3: Combined map of Post monsoon depth to water level and 10 years water level trend of Aquifer IA in Budge Budge II

- **Implementing modern irrigation practices like drip water irrigation system, sprinklers, poly house system to avoid excess water loss**
- **Cultivation of low water requiring crops.**
- **Using drum seeders for direct sowing of paddy seeds.**

- Rainwater harvesting may be considered for catering the need of water for irrigation in the remaining cultivable area. The approximate **surface runoff** has been calculated taking into consideration all the factors as described in management plan under Baruipur block. After calculation it has been found **that annually 285.4 ham (**Table-8.21.9**)**will be available approximately which can be used for farming throughout the year by storing it in conservation structures.

Table- 8. 21.9 – Estimation of surface run offin block

Block	**Normal annual rainfall in m (50 yrs data from IMDB) 'Rn'**	**Total cultivable area (ha) 'A'**	**Run off co efficient from Dhruvanarayana, 1993 'C'**	**Major type of soil available in that block**	**Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham**	**75% (deducting runoff to existing drainage) of 'Vt' = V (ham)**	**50% of V (Non committed) = Vnc (ham)**	**60% of Vnc (deducting e-flow) = Vf (ham)**
Budge Budge II	2.088	2025	0.3	Sandy loam	1268.46	951.345	475.6725	285.4

The major crops, vegetables, fruits, flowers, spices irrigated in Budge Budge II block are :

Crops	Mainly Aman & Boro
Flower	Marigold, Tuberose, Ornamental Plants

Aman cultivation is suggested in the remaining land as the water requirement is catered by monsoon rainfall. But boro cultivation needs 1.2 m depth of water for irrigation. So,**a combination of boro,flower or vegetable cultivation may be done in this 433.71 ha** and given in Table - 8.21.10:

Table -8.21.10 – Possible water allocation & possible cropping pattern

Block	Harvested surface Runoff 'vf' (ham)	Boro Waterdepth= 1.2m		Flowers /Vegetbles Water depth= 0.45m		Total area covered 'A'(ha)	Land Required to store harvested Runoff(vf)*	Remaining cultivable land (ha)
		%	Area covered (ha)	%	Area covered (ha)		Area (ha)	
Budge Budge II	285.4	50	118.92	50	317.11	436.03	104.5	-
Budge Budge II	285.4	75	214.05	25	158.55	372.61	104.5	-

*considering 10% more volume to avoid spill over

If the harvested water is distributed in equal amount for both boro and flower or vegetable cultivation, the total remaining area can be irrigated but the storage of harvested water has to be done in the existing water storage structures. Whereas, if 75% of the water is used for boro cultivation then majority of the harvested water can be stored within the remaining cultivable area only (considering 3 m depth at least). And the remaining water can be stored in existing tanks, ponds etc.

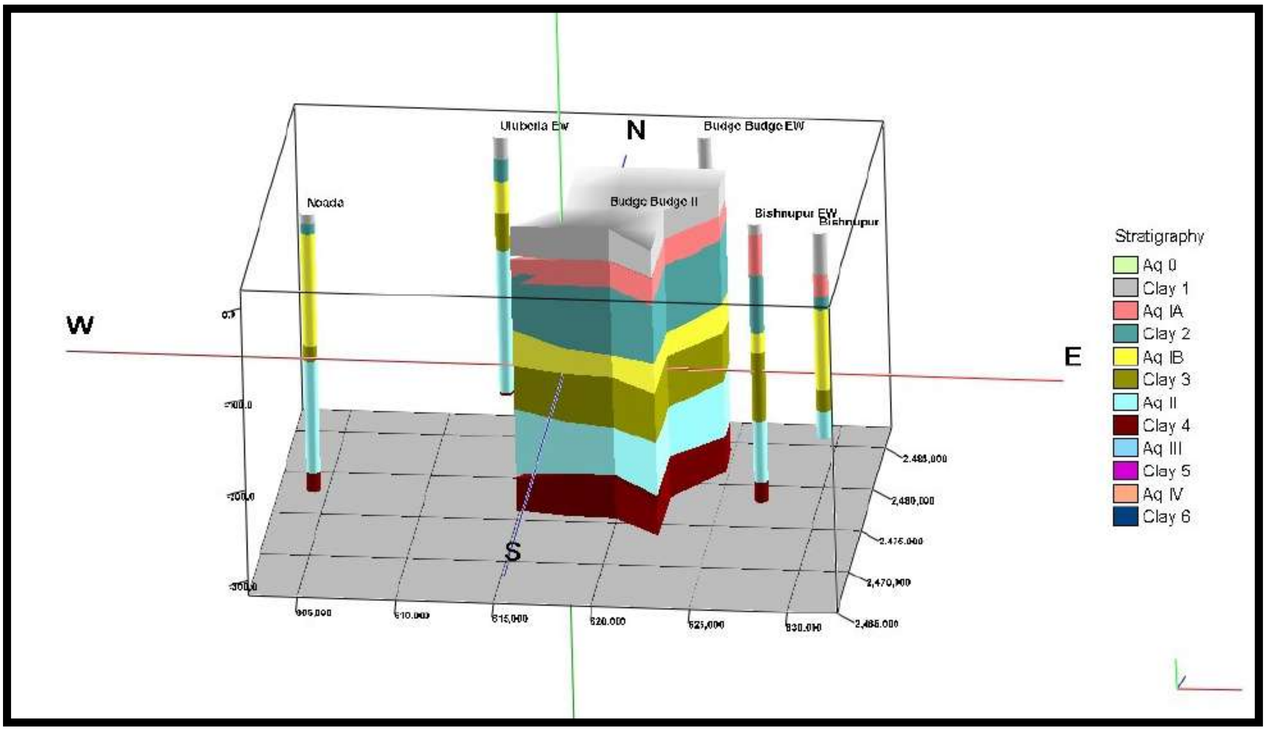


Fig 8.21.3: 3D disposition of aquifers in Budge Budge II block

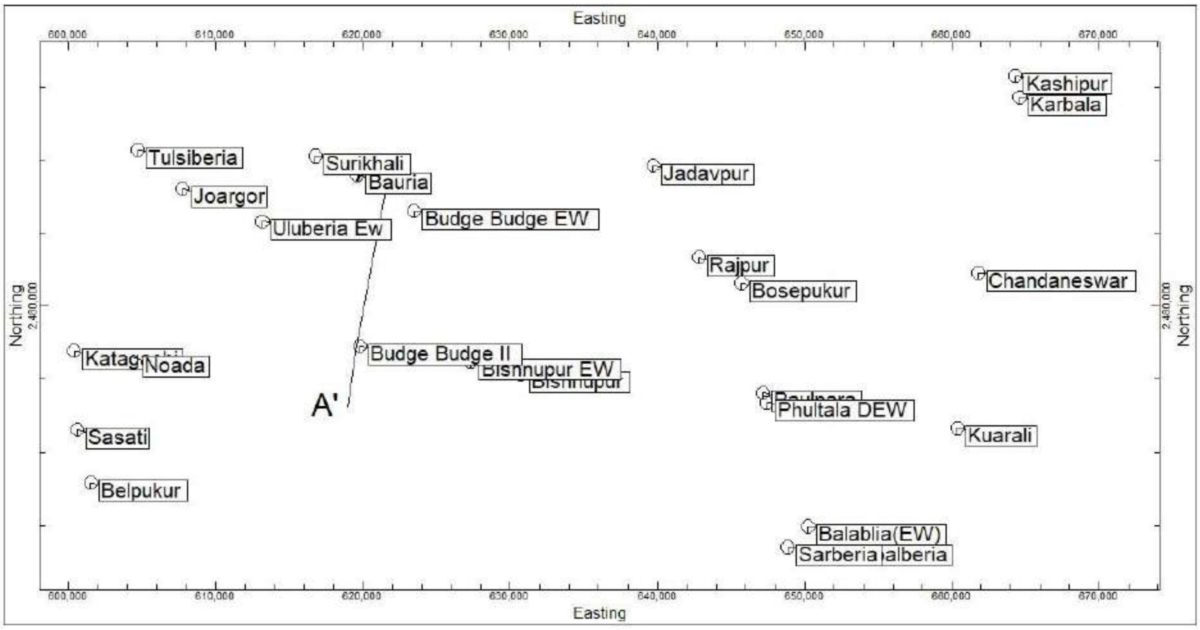


Fig. 8.21.4: N-S section index line in Budge BudgeII block, South 24 Parganas

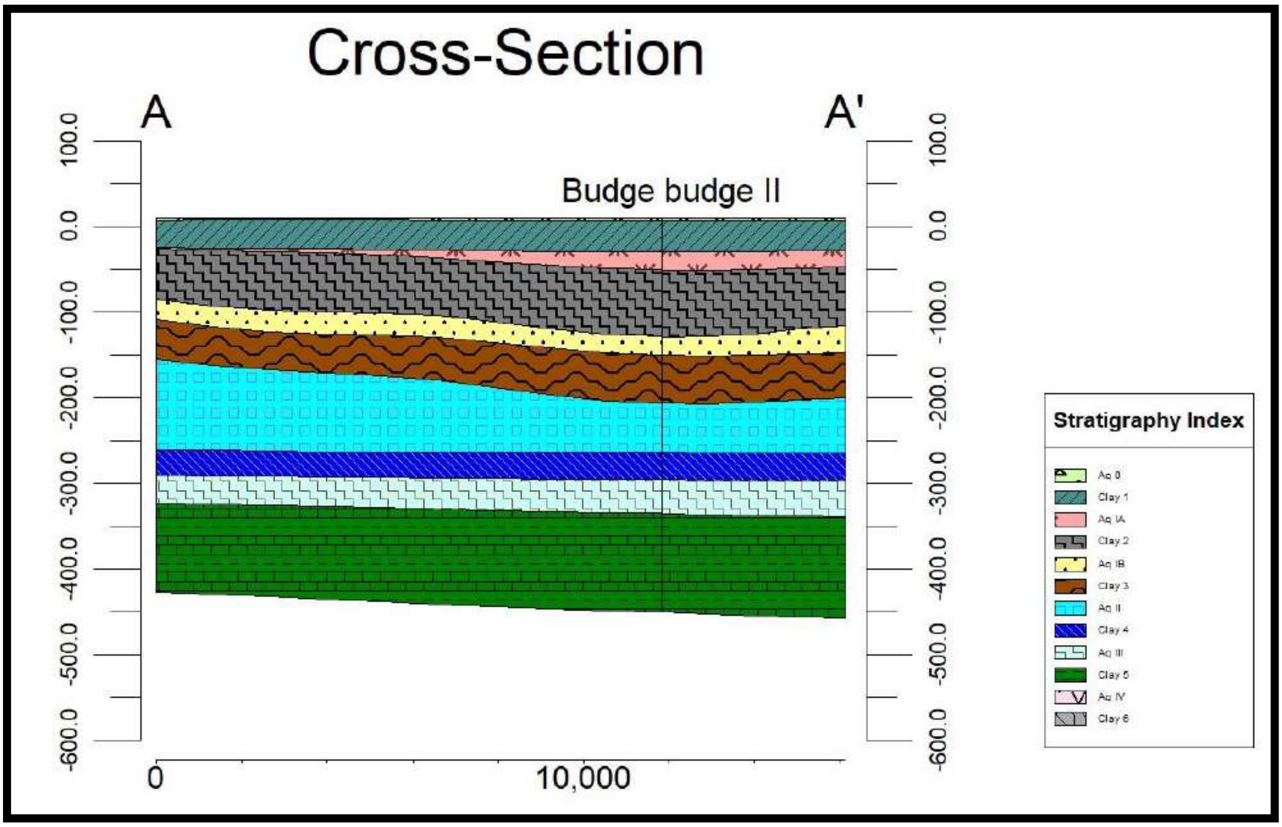


Fig 8.21.5: N-S cross section in Budge BudgeII block, South 24 Parganas

Block wise Management Plan in parts of Howrah District

Block wise Management Plan in parts of North 24 Parganas District

8.22 Uluberia I

8.22.1 Salient Information

Block Name: Uluberia I

Area(in km^2):102.35

District: South 24 Parganas

State: West Bengal

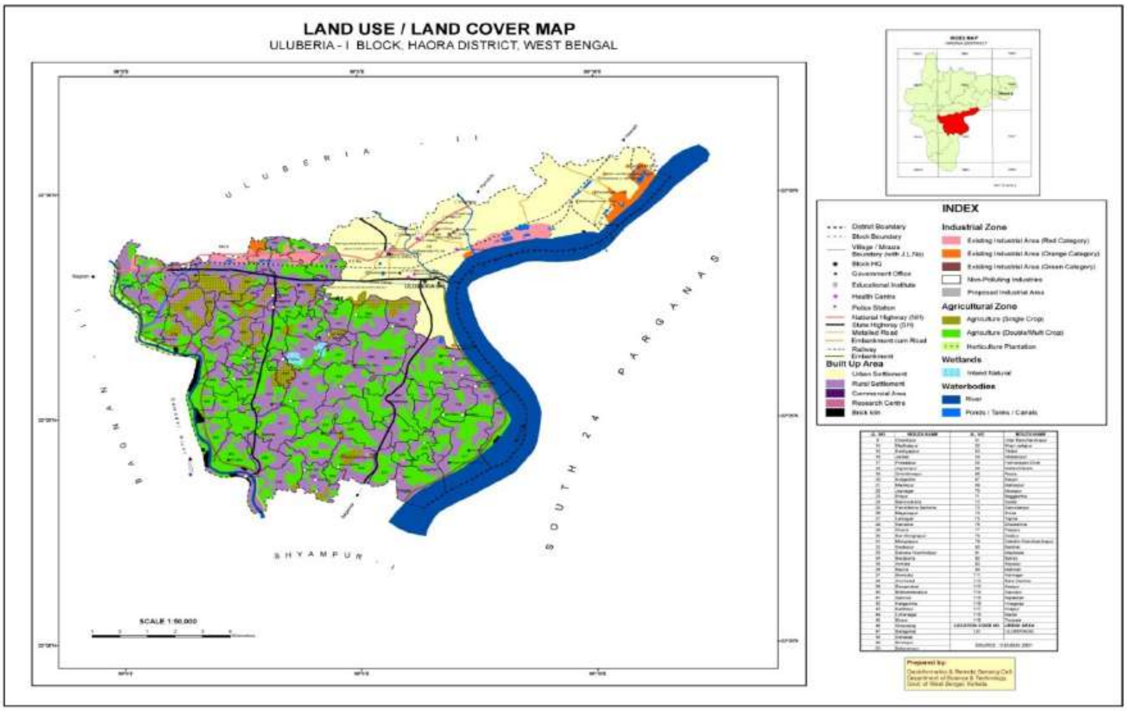
Population(2011):

Total	215392
Rural	184781
Urban	30611

Approximate Decadal Growth Rate from 2001-2011: 18.3%

Rainfall: Average annual rainfall (district) for the period 2012-16 (in mm): 1451.88

Land use:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.22.1: Land use & Land cover map in Uluberia I block

Table 8.22.1 – Salient Land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Area under pasture & orchard (ha)	Industry (ha)	River (ha)	Lakes / Ponds / Tanks/ Canals (ha)
Uluberia I	10235	6000	73.97	459.50	1088.41	112.16

8.22.2 Aquifer disposition & Characteristic:

Table-8. 22.2– Aquifer wise depth ranges

Name of Block	Aquifer IB	Aquifer II
	Depth Range (m bgl)	Depth Range (m bgl)
Uluberia I	20 - 80, 95 - 135	145 - 190, 195 - 280

8.22.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97 .Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.22.3 – Ground water resources

Resource Availability	Aquifer II(ham)
Dynamic Resource	23.09

8.22.4 Seasonal long term water level trends (2008 to 2017)

Table 8.22.4 – Water level trends

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Uluberia I	II		139.65		9.15

As the shallow aquifer is brackish /saline in Uluberia I block, it is hard to find any tube well tapping this aquifer

8.22.5 Chemical quality of ground water & contamination

Table - 8.22.5 - Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Uluberia I	Nil to 0.0001 (Aq IA)	175-375 (Aq II)	1043-2470 (Aq II)	0.00 (Aq II)	0.00-3.4 (Aq II)

The exploration data of CGWB and other state govt. organisations indicates existence of two prominent aquifers in Uluberia I block. The shallow aquifer is occurring at a depth from 20 mbgl to

135mbgl and the deeper aquifer is ranging from 145 mbgl to 280 mbgl(vide fig 8.22.2 &fig 8.22.3).The shallow aquifer is brackish/saline in nature but the deeper aquifer is fresh water bearing. No arsenic contamination has been found in this block.

8.22.6 Present water supply scenario

Total population of Uluberia I block is **215392** of which till now (Nov,2017) a population of 103396 people has not been covered by any water supply schemes of PHED.

8.22.7 Management plan for domestic usage

a. Construction of wells

During pumping test at the time of exploration, it has been observed that the fresh deeper aquifer is having a

yield rate to the tune of 12.5 litres per second and can cater to the need of population under risk zone. The

demand for potable water from the deeper aquifer has been calculated for Uluberia I block of Haora district for

drinking and domestic purpose & is given in Table 8.22.6. Considering human drinking and domestic demand of

water @70 lpcd & projected population upto 2027 (Calculating Population growth per year as per Census 2011),

the demand of water for human population as on 2027 has been calculated.

Number of tube wells having size 10 inch X 6 inch with depth 300 m bgl (maximum depth considered) has

been calculated and shown in the table below. It has been found that **ground water from 26 tube wells can**

cater the need for drinking and domestic purpose of 133608 people living in risk zone by 2027. The tube wells

should be constructed by tapping the aquifers which is separated from top saline aquifers by a persistent clay

blanket. Provision for sealing the top brackish/saline aquifers with proper cement sealing against clay layer

should be kept in order to prevent the vertical percolation of saline water from the top.

Table 8.22.6 – Estimation of nos. of required tube wells & cost estimate

Block	**Population in risk zone where no**	**Growth rate(%) per**	Population in risk zone projected	**Requirement of water for drinking and**	**Discharge per tube well**	**Total discharge per day**	**Number of tubewells needed to cater the**	**Cost of the tube well of 300 m depth &**

	water supply exists till now(Census 2011)	**year as per Census 2011**	up to 2027	**household purposes per day (@ 70 litre per day per capita) in litres for projected population in 2027**	**tapping suitable aquifer (lps)**	**assuming 8 hours run(lpd)**	**requirement**	**10"x6" dia @ Rs. 18 lakh) as per latest approved Bid**
Uluberia I	103396	1.83	133608	9352560	12.5	360000	26	468

b. **Rooftop rainwater harvesting** is strongly recommended in this block as the drinking and domestic water requirement is too high. An example is given below:If the roof area/catchment area is minimally 500 sqm, for annual rainfall of 1.75 m in Bhangar II block, the harvested water will be- 500 X 1.45 X 0.8 (runoff coefficient for metal sheets being 0.7-0.9)= 580 cu.m i.e. 580000 litres, which can cater drinking and domestic needs of almost 22 persons for whole year considering proper conservation of the water.

Combined installation of both deep tube wells and roof top rainwater harvesting system is recommended in this block. Govt. schools, panchayat office, police stations, clubs - all these can be selected for roof top rainwater harvesting so that all the villagers can use the water and it will also spread awareness among school children and commoners.

8.22.8 Management Plan for irrigation

Drilling data available from CGWB and other state govt. departments indicates occurrence of fresh ground water bearing aquifer below 145m in Uluberia I block. Now out of 10235 ha geographical area of Uluberia I block,6000 ha area is cultivable, of which 4156.93ha area is irrigated by surface water and only 2.3 ha area is irrigated by ground water . The details of irrigation schemes from 4th MI Census is given in Table 8.22.7:

Table 8.22.7 – Nos. of irrigation sources & corresponding CCAs

Block	**Total CCA (Ha)**	**No of STW**	**CCA (Ha)**	**No of DTW**	**CCA (Ha)**	**Surface Flow**	**CCA (Ha)**	**Surface lift**	**CCA (Ha)**
Uluberia I	4159.23	1	2.3	0	0	55	2190.54	178	1966.39

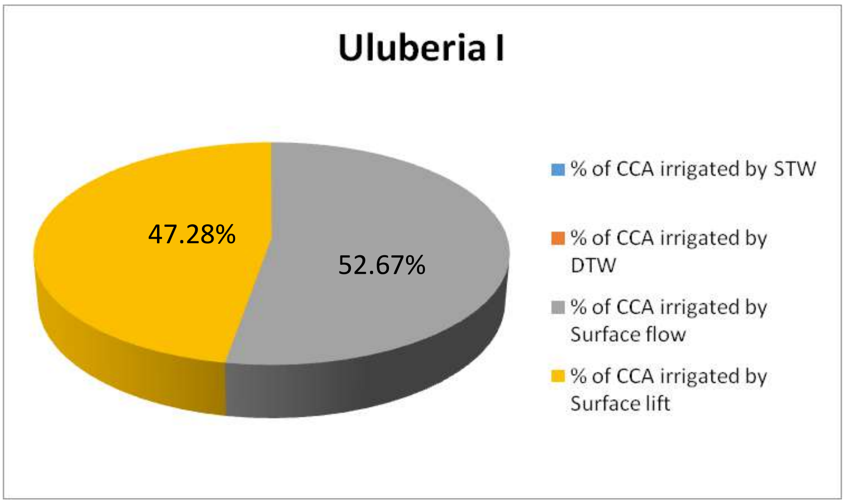


Fig. 8.22.2 – Percentage of CCAs of different sources of irrigation

Problems & Solutions:

1. As per 4th MI census data water from shallow aquifer is withdrawn from one tube well only for irrigation purpose mainly because of the salinity of Aquifer IB in this block (Aquifer IA has not been encountered in this block). So, **to irrigate 1840.77 ha of remaining cultivable area the following methods may be useful**:

- **Implementation of modern irrigation practices like drip water irrigation system, sprinklers, sub surface irrigation to avoid excess water loss**
- **Cultivation of low water requiring crops, e.g. sesame, millets, sorghum etc.**
- **Cultivation of Kharif crops like paddy and sugarcane which are the major crops in this block and the water requirement for these crops can be catered by monsoon rainfall.**
- **Salt tolerant crops may be cultivated. eg. barley, wheat, sunflower, yellow mustard, sugar beets, spinach etc. where EC value is within the crop's tolerable limit**
- **Rainwater Harvesting must be given priority for irrigation of 1840.77ha cultivable land which is not covered by any irrigation scheme**. The approximate surface runoff has been calculated taking into consideration all the factors like e-flow, water required for natural flow to drainage, committed purposes (already existing water bodies in that area). The 'total cultivable area' and 'Normal annual rainfall' have taken into account for the calculation. The runoff co-efficient for annual normal rainfall is taken from a table after Dhruvanarayana,1993 which considers the soil type, land use and slope of the area. After calculation, it has been found that **annually 1344.6ham may be harvested approximately**. The detail of the calculation for Uluberia I block is given below:

Table 8.22.8 – Estimation of rainfall surface run off component in block

Block	Normal annual rainfall in m'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana,1993 'C'	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (Rn X A X C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Uluberia I	1.66	6000	0.6	Silty clay	5976	4482	2241	1344.6

The major crops irrigated in Uluberia I block are: wheat, gram, mustard, rapeseed, rice and sugarcane. Beside this, jute, khesari, sesame and some vegetables like chillies, brinjal are also grown in this block. The water requirement for kharif crops (aman rice, sugarcane,jute) is fulfilled mainly by monsoon rain fall, and these crops are also preferable in the remaining land. So, **1344.6ham of water could be conserved in the existing ponds / tanks in this block and for this, 493 ha of the remaining cultivable area considering 3 m depth and 10% excess storage could be utilized.** So the **water required for irrigation of vegetables and rabi crops in the remaining 1347.77 ha cultivable land is = 0.45 X 1347.77 ham = 606.49 ham which can be obtained entirely from rainwater harvesting. The excess water i.e. 798 ham (approximately) can be used for multiple cropping.** As the **shallow aquifer is saline, artificial recharge to shallow aquifer is of no use, but mixing of saline water and the fresh rain water can be done after proper experimentation, to decrease the salinity for utilization in irrigation. This water can be purified properly to use for drinking purpose as the drinking water crisis is huge in Uluberia I block. Fish farming can also be done which will further strengthen the economic condition of the farmers**.

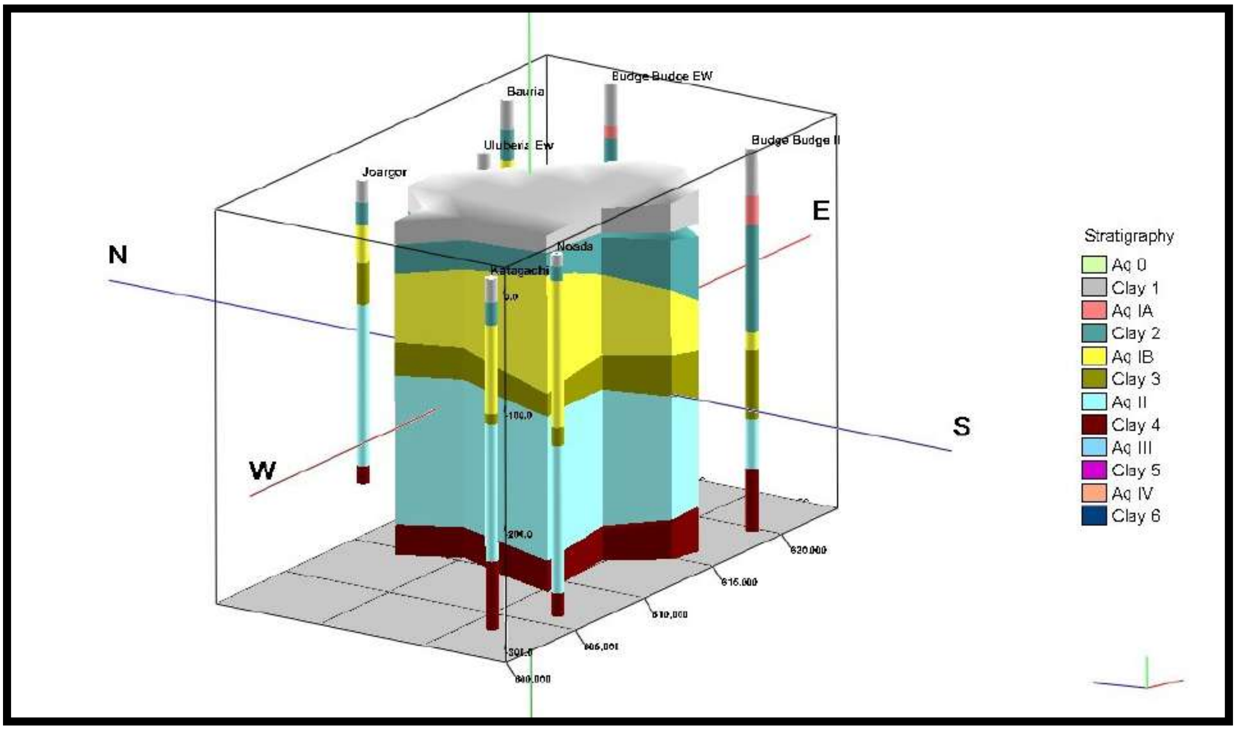


Fig 8.22.3: 3D disposition of aquifers in Uluberia I block, Howrah district

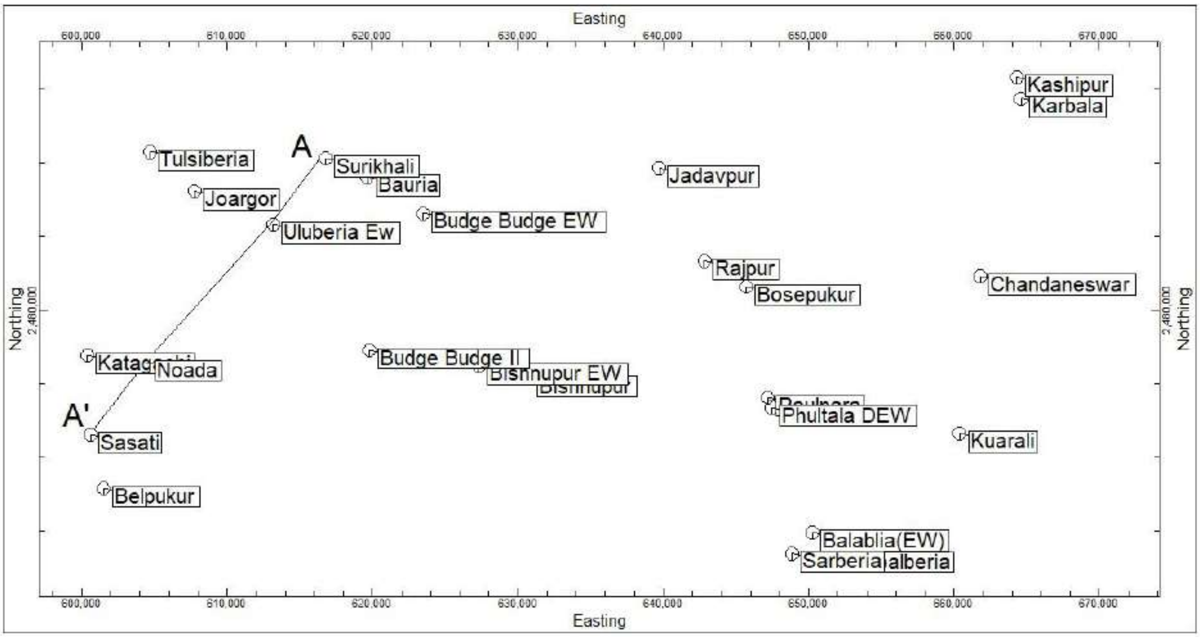


Fig 8.22.4: NE-SW cross section index line in Uluberia I block, Howrah district

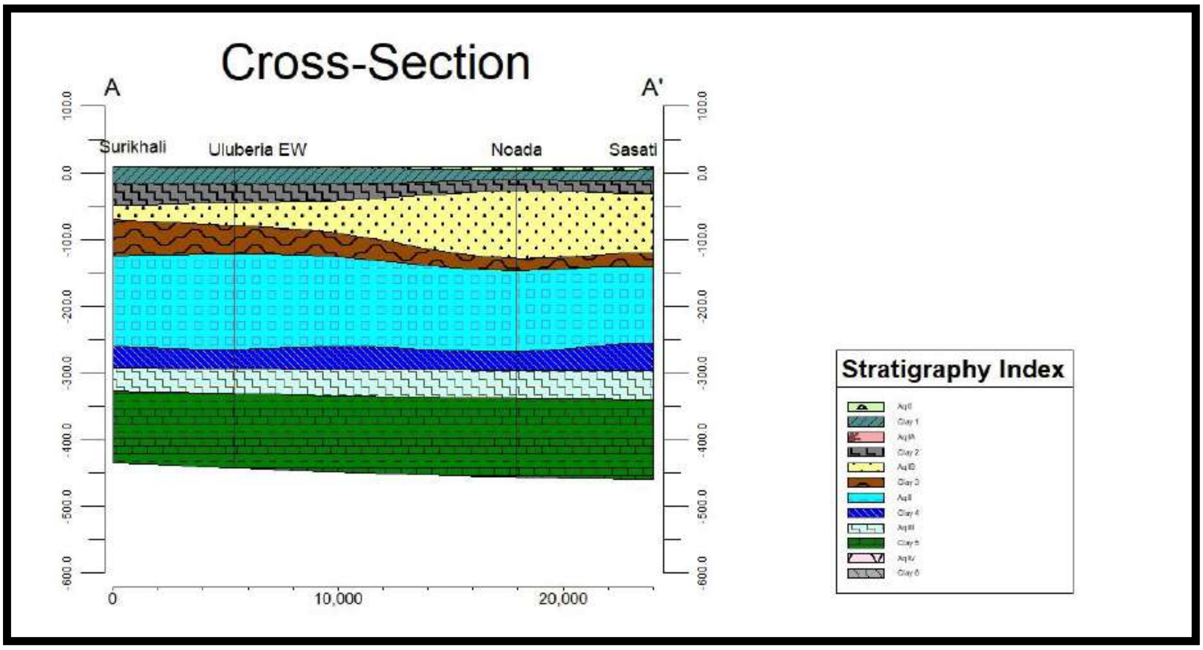


Fig 8.22.5: NE-SW cross section in Uluberia I block, Howrah district

8.23 ULUBERIA II

8.23.1 Salient Information

Block Name: Uluberia II

Area(in km^2):80.98

District: South 24 Parganas

State: West Bengal

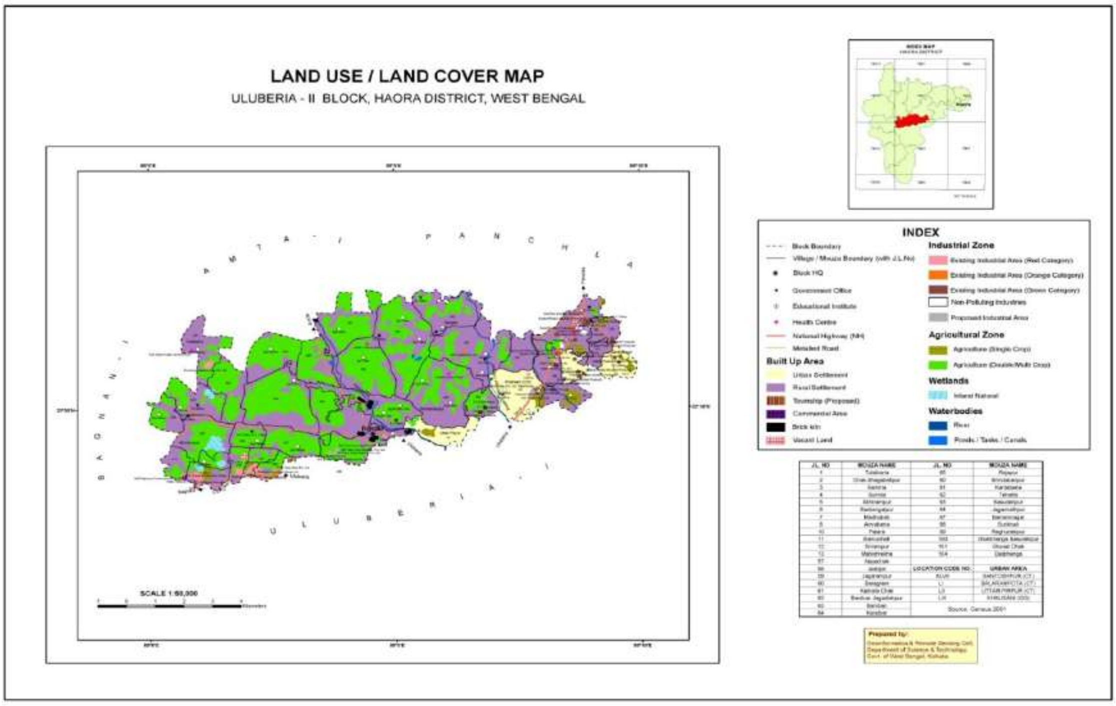
Population (2011):

Total	191599
Rural	80793
Urban	110806

Approximate Decadal Growth Rate from 2001-2011: 18.4%

Rainfall: Average annual rainfall (district) for the period 2012 -16 (in mm): 1451.88

Land use:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig 8.23.1: Land use map of Uluberia II block

Table 8.23.1 – Salient land use features in block

Name of the block	Geographic Area (ha)	Cultivable Area (ha)	Industry(ha)	Ponds / Tanks/ Canal (ha)	River (ha)
Uluberia II	8098	5000	64.05	20.34	17.52

8.23.2 Aquifer disposition & Characteristic

Table 8.23.2 – aquifer wise depth ranges

Name of Block	Aquifer IB	Aquifer II
	Depth Range (m bgl)	Depth Range (m bgl)
Uluberia II	20 - 80, 95 - 135	150- 195, 205-275

8.23.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97.Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.23.3 – Ground water resources

Resource Availability	Aquifer II (ham)
Dynamic Resource	12.44

8.23.4 Chemical quality of ground water & contamination

Table - 8.23.4 -Range of chemical parameters

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Uluberia II	Nil to 0.0001	650 (Aq IB) 195 - 205 (Aq II)	1956 - 2852 (Aq IB) 918-940 (Aq II)	0.24 (Aq IB) 0.00 (Aq II)	7.66 (Aq IB) 0.37-0.39 (Aq II)

Table - 8. 23.5 – Percentage of tube wells showing As-contamination in ground water

Blocks	Arsenic (<0.01 mg/l) in percentage	Arsenic (>0.01-<0.05 mg/l) in percentage	Arsenic (> 0.05 mg/1) in percentage	Total Tube well	Max As concentration (mg/l)
Uluberia II	98.67	0.66	0.66	452	0.16

(Source- PHED, Govt. of west Bengal)

In Uluberia II block, fresh deeper aquifer occurs in the depth span of 150-275mbgl, separated from the upper aquifer by a 10-15 m thick clay bed(vide fig 8.23.2 &8.23.3). Hence the tube wells, tapping the fresh deeper aquifer with proper cement sealing against thick clay bed will produce arsenic free fresh ground water to villages, yet to be covered by water supply scheme of PHED.

Sporadic occurrence of arsenic in shallow ground water is encountered in Uluberia II block. As per PHED chemical analysis data of 452 tube wells, arsenic above 0.01 mg/l in shallow ground water has been observed in 6 tube wells of which arsenic concentration found to be more than 0.05 mg/l in 3 of the tube wells(Table 8.23.6).

8.23.5 Present water supply scenario

A population of 67651(Nov. 2017) is still not covered by any water supply scheme in this block by PHED.

8.23.6 Management plan for domestic usage

a. Construction of wells

As evidenced from the exploration, arsenic free deeper aquifers ranging from 150 to 275mbgl are potential to yield to the tune of 12.5 litres per second with a drawdown of 6 m (approx) and can cater to the need of rural water supply. The demand for potable water and availability of arsenic free ground water from the deeper aquifers has been calculated for Uluberia II block of Haora district for drinking and domestic purpose & given in table below. Considering human drinking and domestic demand of water @70 lpcd& projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

The number and cost of tube wells having size 10-inch X 6 inch with depth 300(max. depth considered)mbgl has been calculated and shown in Table 8.23.7. It has been found that **ground water from total of 17 tube wells can cater the need of water for drinking and domestic purpose for 87542 people living in risk zone.** The tube wells should be constructed by tapping the aquifers which is separated from top arseniferous aquifers by a persistent clay blanket. Provision for sealing the top arseniferous aquifers with proper cement sealing against clay layer should be kept in order to prevent the vertical percolation of contaminated water.

Table 8.23.6 – Estimation of Nos. of required tube wells & cost estimate

Block	**Population in risk zone where no water supply scheme exists till now(Census 2011)**	**Growth rate(%) per year as per Census 2011**	Projected population in risk zone projected up to 2027	**Requirement of water for drinking and household purposes per day (@ 70 litre per day per capita) for projected population in 2027**	**Discharge per tube well tapping suitable aquifer(lps)**	**Total discharge per day assuming 8 hours run(lpd)**	**Number of tubewells needed to cater the requirement**	Cost of the tube well of 300 m depth (approx) & 10"x6" dia @ Rs. 18 lakhs as per latest approved Bid
Uluberia II	67651	1.84	87542	6127940	12.5	360000	17	425

c. **Rooftop rainwater harvestingis recommended in this block along with installation of tube wells** as the drinking and domestic water requirement is too high. The govt. schools, hostels, panchayat office, clubs or some village houses can be chosen for this purpose. An example is given below:If the roof area/catchment area is 500 sqm, for annual rainfall of 1.75 m in Bhangar II block, the harvested water will be- 500 X 1.45 X 0.8 (runoff coefficient for metal sheets being 0.7-0.9)= 580 cu.m i.e. 580000 litres, which can cater drinking and domestic needs of almost 22 persons for whole year considering proper conservation of the water. Proper storage, purification and expert advice is recommended before usage of harvested rain water.

8.23.7 Management Plan for irrigation

The main problems in Uluberia II block is the salinity and arsenic contamination in the shallow aquifers of Uluberia II block. Out of 5000 ha cultivable land, 1401.69 ha area is irrigated by surface water and only 54.89ha area is irrigated by ground water and there is no irrigation scheme to cover the remaining 3543.42 ha of cultivable land. So, the **following steps can be taken to solve the problem**:

- **Implementing modern irrigation practices like drip water irrigation system, sprinklers, poly house farming to avoid excess water loss**
- **Cultivation of low water requiring crops (Sorghum, millets) and salinity (barley, wheat, sunflower, yellow mustard, sugar beets, spinach water melon) & arsenic resistant crops(though shallow ground water usage is only 1.02% for irrigation)**
- **Cultivation of Kharif crops like paddy, sugarcane, Jute etc. so that the water requirement can be catered by monsoon rainfall(depending on the soil pattern of that area)**
- **Usage of drum seeders for direct sowing in case of paddy seeds will reduce 30% of water requirement during transplantation.**

- **Rainwater harvesting must be considered for irrigation of the remaining cultivable land. The harvested surface run off is calculated in the same way as described in 'Uluberia I'. After calculation it has been found that annually 1120.5 ham is available approximately which can be used for farming throughout the year by storing it to conservation structures like farm pond, irrigation tank or 410 ha unused cultivable land with 3 m depth . The detail of the calculation is given below:**

Table 8.23.7 – Estimation of Rainfall surface run off component in block

Block	Normal annual rainfall in m 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana,1993 'C'	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (RnXAXC) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non committed)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Uluberia II	1.66	5000	0.6	Silty clay	4980	3735	1867.5	1120.5

The major crops irrigated in Uluberia II block are: aman, sugarcane, wheat, gram, rapeseed, khesari and some amount of mustard, jute and sesame. Of these, the water requirement for kharif crops(aman, sugarcane, jute) is fulfilled mainly by monsoon rainfall, that's why kharif cultivation is preferable in the remaining land too. Now for irrigation of Rabi crops like wheat, gram, mustard, sesame etc. average 0.35m depth of water is required. So, **for irrigation of Rabi crops in the remaining 3133.42 (keeping 410 ha for water storage) ha cultivable land, total water requirement is = 0.35 X 3133.42ham =1096.7 ham of which can be fulfilled totally from the harvested rainwater**.

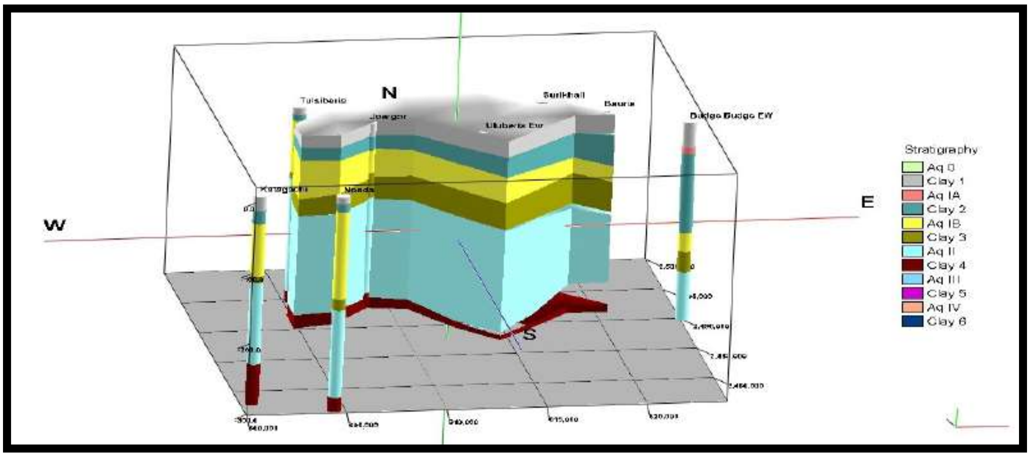


Fig 8.23.2: 3D aquifer dispositions in Uluberia II block, Howrah district

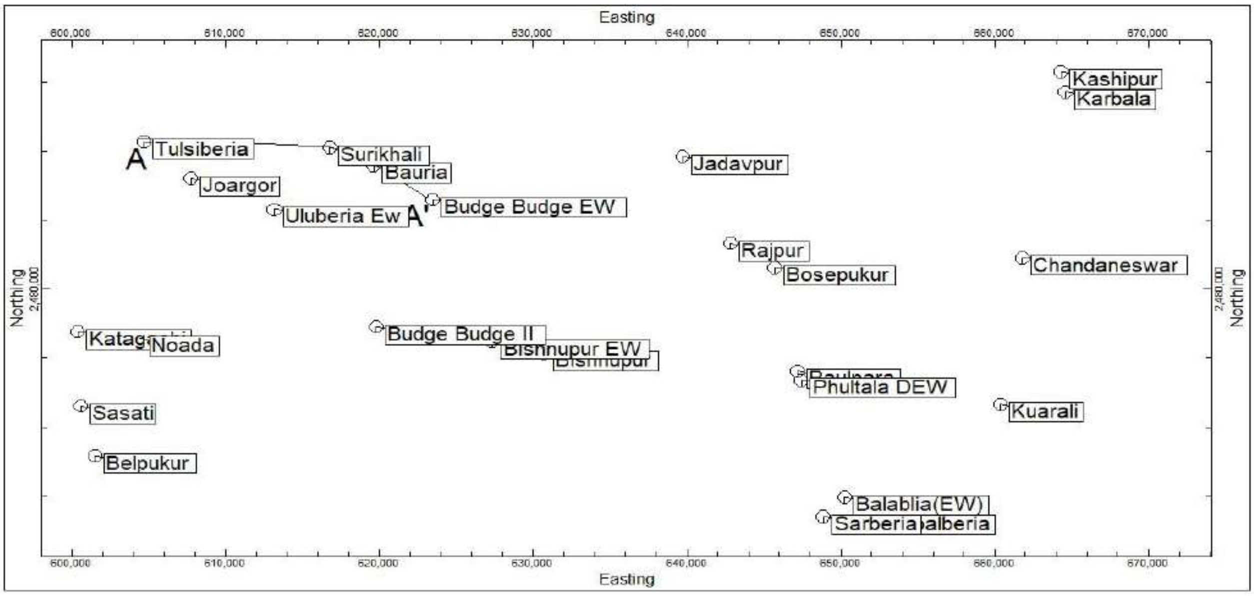


Fig 8.23.3: W-E cross section index line in Uluberia II block, Howrah district

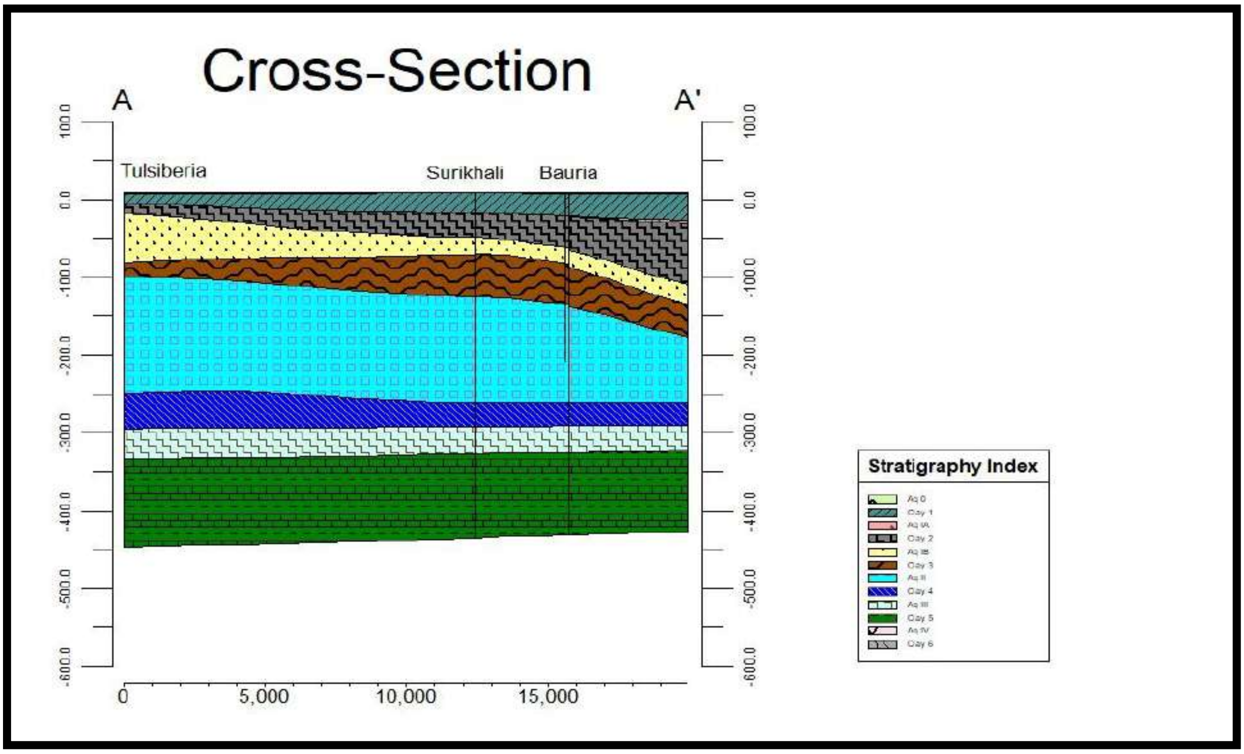


Fig 8.23.4: W-E cross section in Uluberia II block, Howrah district

8.24 hyampur II

8.24.1 Salient Information

Block Name: Shyampur II

Area (in km^2): 117

District: South 24 Pargana

State: West Bengal

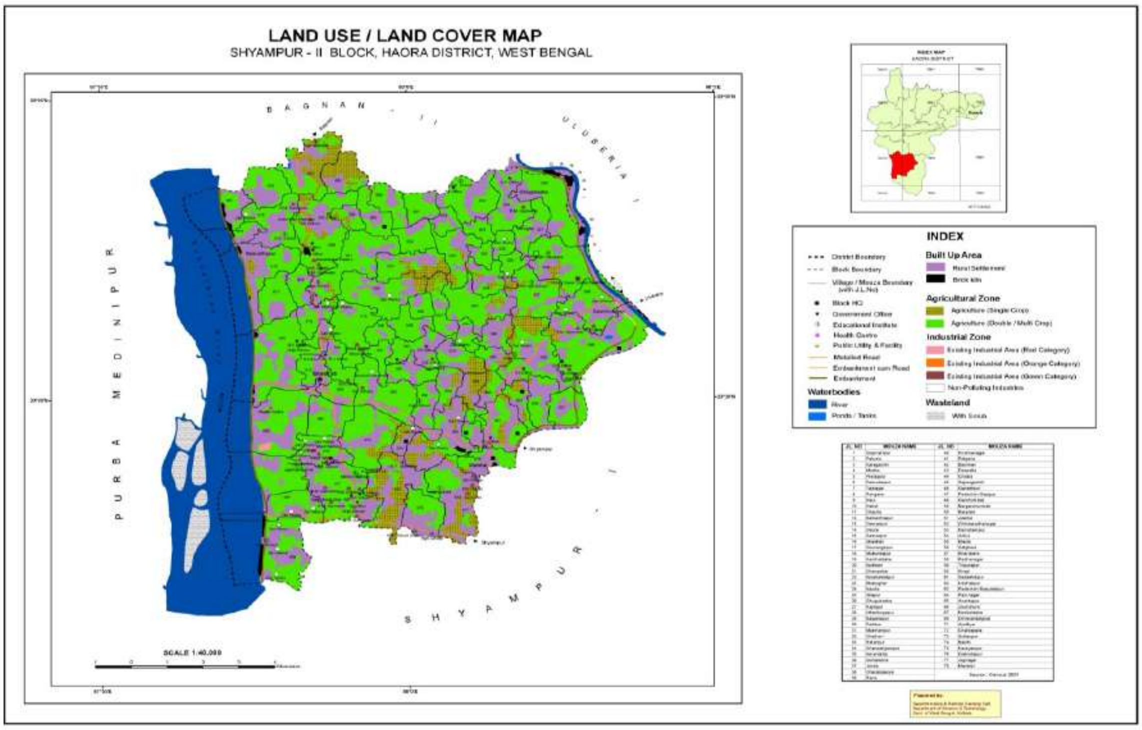
Population (2011):

Total	196164
Rural	175475
Urban	20689

Approximate Decadal Growth Rate from 2001-2011: 14.7%

Rainfall: Average annual rainfall (district) for the period 2012 -16 (in mm): 1451.88

Land use:



(Source- Land & Land Reforms Dept., Govt. of West Bengal)

Fig. 8.24.1: Land use map of Shyampur II block

Table 8.24.1- Salient land use features in block

Name of the Block	Geographic Area (ha)	Cultivable Area (ha)	Brick kiln (ha)	Ponds / Tanks (ha)	River (ha)
Shyampur II	11700	8700	61.84	3.88	829.49

8.24.2 Aquifer disposition & Characteristic:

Name of Block	Aquifer IB		Aquifer II	
	Depth Range (mbgl)	Discharge(m^3/hr)	Depth Range (mbgl)	Discharge (m^3/hr)
Shyampur II	30 - 80, 90 - 130	39.71	145 - 175, 190 - 255	39.96

8.24.3 Aquifer Wise Ground Water Resource Availability & Extraction

No unconfined aquifer present in this block so resource has not been calculated as per GEC-97.Dynamic resource of Aquifer II has been calculated from the pre and post monsoon fluctuation in water level.

Table 8.24.3: Ground water resource

Resource Availability	Aquifer II(ham)
Dynamic Resource	17.784

8.24.4 Seasonal long term water level trends of Aquifer II (2008 to 2017):

Block	Aquifer	Pre-monsoon Trend		Post- monsoon Trend	
		Rise (cm/year)	Fall (cm/year)	Rise (cm/year)	Fall (cm/year)
Shyampur II	II		43		57.1

8.24.5 Chemical Quality of Ground Water & Contamination:

Table 8.24.5: Range of Chemical Pollutants:

Block	As (mg/l)	TH (mg/l)	EC (µS/cm)	F (mg/l)	NO_3 (mg/l)
Shyampur II	Nil to 0.006	155-220(Aq II)	1027-1144(Aq II)	0.00-0.25(Aq II)	0.64-1.68(Aq II)

Two prominent aquifers have been encountered till now up to a drilling depth of 300 m (from CGWB and other state govt. data) in Shyampur II block. The first aquifer is brackish/saline in nature and ranges from 30-130 mbgl with intercalated clay layers. The second aquifer ranging from 145-255mbgl is fresh water bearing (vide Fig 24.2 &Fig. 24.3). Till now no serious arsenic contamination has been found in this block(Table 8.24.5).

Total population of Shyampur II block is 196164 of which till now (Nov.,2017) a population of 161320 people has not been covered by any water supply schemes of PHED.

8.24.6 Management plan for domestic usage:

a. Construction of wells

The exploration activities in Shyampur II block revealed that the fresh deeper aquifer is having a yield rate to the tune of 11.1 litres per second with drawdown of 5.6 m (approx) and can cater the need of population under risk zone. The demand for potable water from the deeper aquifer has been calculated for Shyampur II block of Haora district for drinking and domestic purpose & is given in the table below. Considering human drinking and domestic demand of water @70 lpcd & projected population upto 2027(Calculating Population growth per year as per Census 2011), the demand of water for human population as on 2027 has been calculated.

Number of tube wells having size 10 inch X 6 inch with depth 260(maximum depth considered) mbgl has been calculated and shown in Table 8.24.6. It has been found that water from **44 tube wells can cater the need for drinking and domestic purpose of 199168 people living in risk zone up to 2027**. The tube wells should be constructed by tapping the aquifers which is separated from top saline aquifer by a persistent clay blanket. Provision for sealing the top brackish/saline aquifer with proper cement sealing against clay layer should be kept in order to prevent the vertical percolation of saline water from the top.

Table 8.24.6– Estimation of nos. of required tube wells & cost estimate

Block	Population in risk zone where no water supply scheme exists till now(As per census 2011)	Growth rate(%) per year as per Census 2011	Projected population in risk zone projected up to 2027	Requirement of water for drinking and household purposes per day (assuming 70 litre per day per capita) in litres projected till 2027	Discharge per Tw tapping suitable aquifer(lps)	Total discharge per day assuming 8 hours run(lpd)	Number of Tubewells needed to cater the requirement	Cost of the tube well of 260 m depth (approx) & 10"x6" dia @ Rs. 22 lakhs (In lakh) as per CGWB, EFC
Shyampur II	161320	1.47	199168	13941760	11.1	319680	44	968

b. Rooftop rainwater harvesting is strongly recommended in this block as the drinking and domestic water requirement is too high. The govt. schools, hostels, clubs or some village houses can be chosen for this purpose . an example is given below: If the roof area/catchment area is 500 sqm, for annual rainfall of 1.75 m in Bhangar II block, the harvested water will be- 500 X 1.45 X 0.8 (runoff coefficient for metal sheets being 0.7-0.9)= 580 cu.m i.e. 580000 litres, which can cater drinking and domestic needs of almost 22 persons for whole year considering proper conservation of the water.So, if rooftop rainwater harvesting can be implemented in Shyampur II blockwith proper purification and storage of water together with tube wells, it will solve the problem of continuously increasing fresh water demand.

8.24.7 Management Plan for irrigation:

Out of 11700 ha geographical area of Shyampur II block, 8700 ha area is cultivable. The detail of irrigation schemes in this block as per 4th MI census is given below:

Table 8.24.7– Nos. of irrigation sources & corresponding CCAs

Block	Total CCA (Ha)	No of STW	CCA (Ha)	No of DTW	CCA (Ha)	Surface Flow	CCA (Ha)	Surface lift	CCA (Ha)
Shyampur II	5185.22	0	0	1	40	13	593.87	426	4551.35

Because of the brackish/saline nature of shallow aquifer no water from this aquifer is used for irrigation. 87.78% of the irrigation water demand is fulfilled by lifting from surface water bodies. **Still 3514.78ha of cultivable land is not covered by any irrigation schemes**. The **following steps can be taken to solve this issue**:

- **Cultivation of low water requiring crops, e.g. sesame, millets, sorghum etc. so that more land can be irrigated with available water**
- **Cultivation of Kharif crops like paddy, sugarcane, Jute etc. so that the water requirement can be catered by monsoon rainfall (depending on the soil pattern of that area).**
- **Use of drip irrigation, sprinklers instead of flood irrigation to reduce excess water loss due to evaporation and runoff.**
- **Rainwater harvesting should be given priority to resolve water shortage issues. The surface runoff can be harvested and stored to use further for irrigation of the remaining cultivable area. The calculation is given in the table below and it has been found that annually 1949.67 ham is available approximately which can be used for farming throughout the year by storing it to conservation structures or 715ha of remaining land with 3 m depth. The detail of the calculation is given below:**

Table - 8. 24.8– Estimation of Rainfall surface run off component in block

Block	Normal annual rainfall in m 'Rn'	Total cultivable area(ha) 'A'	Run off co efficient from Dhruvanarayana,1993 'C'	Major type of soil available in that block	Total volume of surface runoff available Annually 'Vt' (Rn x A x C) ham	75% (deducting runoff to existing drainage)of 'Vt' = V (ham)	50% of V (Non commited)= Vnc (ham)	60% of Vnc(deducting e-flow)= Vf (ham)
Shyampur II	1.66	8700	0.6	Silty clay	8665.2	6498.9	3249.45	1949.67

The major crops irrigated in Shyampur II block are: aman, jute, sugarcane and little amount of wheat, black gram,sesame, mustard and some vegetables like chillies, brinjal. Out of these,the kharif cropsaman,sugarcane,jute) are irrigated mainly by monsoon rain fall. Beside this, for irrigation of Rabi crops like wheat, black gram, chillies, mustard, sesame etc. and different vegetables average 0.35 and 0.45m depth of water is required respectively.

So, for irrigation in **the remaining 2799.78ha of cultivable land, approximate water requirement will be = 0.45 X 2799.78 ham =1259.9 ham which can be obtained entirely from rainwater harvesting. The excess water i.e. 690 ham (approximately) can be used for drinking purpose(after proper purification) as the demand of fresh drinking water is high in Shyampur II, multiple cropping or fish farming**.

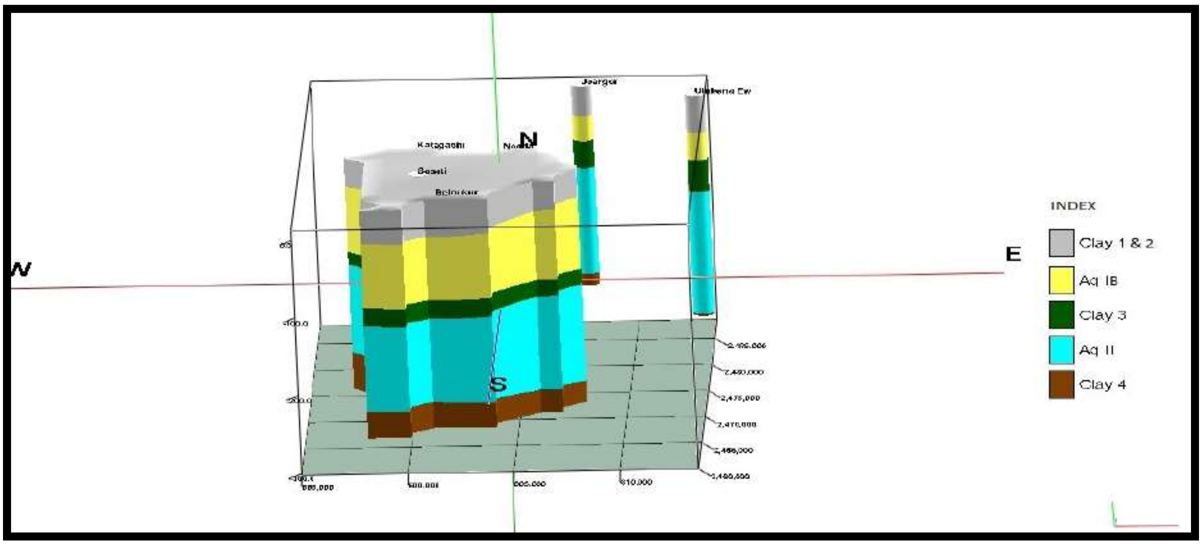


Fig8.24.2: Disposition of aquifers in Shyampur II block, Howrah district

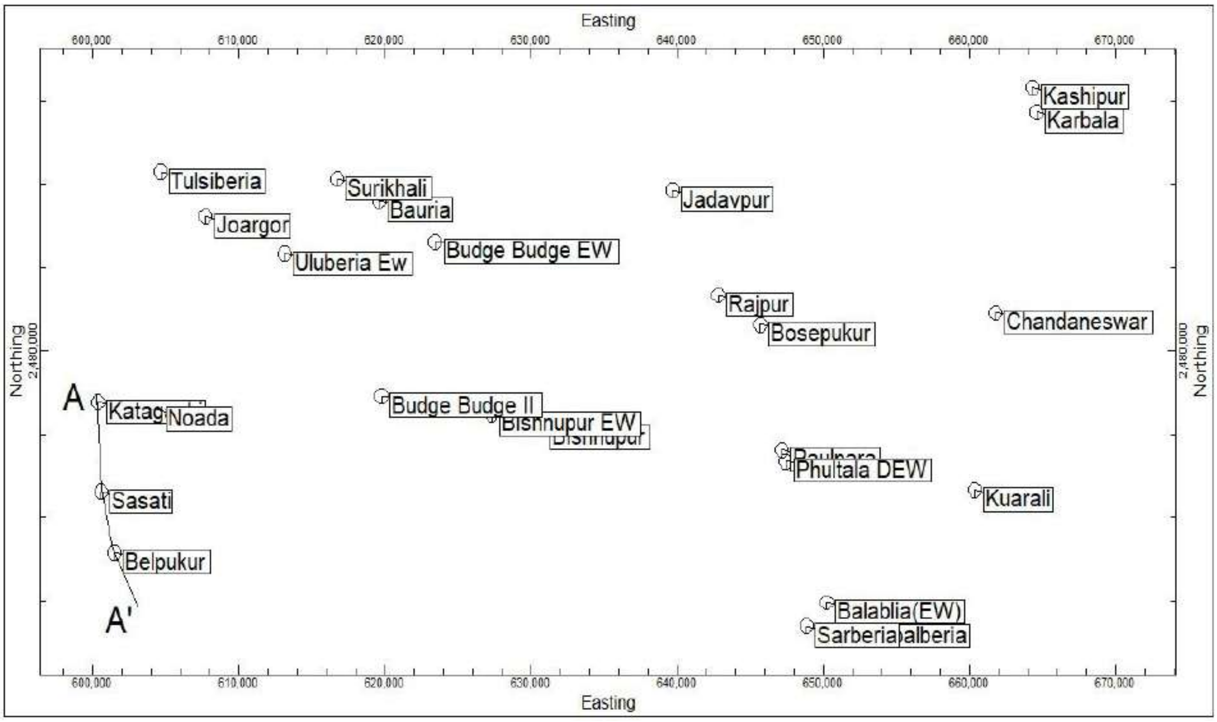


Fig 8.24.3:N-S section index line in Shyampur II block, Howrah district

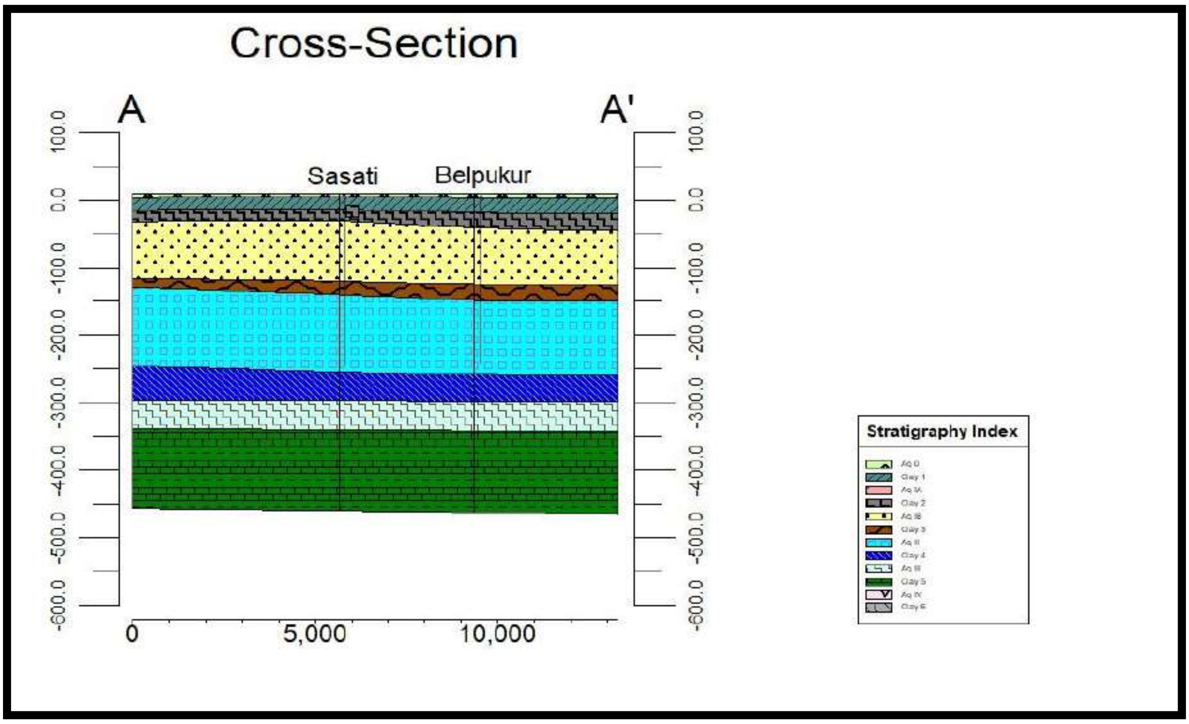


Fig 8.24.4:N-S section index line in Shyampur II block, Howrah district

DATA GAP ANALYSIS IN PARTS OF DISTRICTS OF N. 24 PARGANAS, S. 24 PARGANAS & HOWRAH, WEST BENGAL

9.0 DATA GAP ANALYSIS FOR AQUIFER MAPPING PROGRAMME IN PARTS OF DISTRICTS OF N. 24 PARGANAS, S. 24 PARGANAS & HOWRAH WEST BENGAL STATE

(AAP 2016-17)

The study area comprisees 25 blocks in 3 districts namely South 24 Parganas, Howrah and North 24 Parganas districts in West Bengal. The present area covers a total area of 3834.59 sq km and it eextends between North latitudes 23°07'48.1" and 22°54'33.6" and East longitudes 87°56'30.5" and 89°04'07.7". The study area falls in the Survey of India Toposheet Nos.79B/2, 3, 6, 7, 8, 10, 11, 12 13, 14, 15 & 73 N/15. Data gap in terms of requirement of exploratory tube well (EW), water level monitoring station (key wells), geophysical studies, viz. Vertical Electrical Sounding (VES), Transient Electromagnetic Method (TEM), additional water quality monitoring stations, etc. to study different aquifers (Aq) in the area and the same have been tabulated quadrant wise in different Toposheets in following 11 Tables.

From data gap analysis, it has been found that for aquifer mapping study, additional 25 EW are required: 6 EW each for Aquifer I, Aq I (Depth 100 m) and Aquifer II, Aq II (Depth 200 m) and, remaining 13 EW for Aquifer III, Aq III (Depth 300 m). Besides, 17 OW are required; out of which 15 OW, 5 each for Aq I, Aq II and Aq III are required for monitoring of ground water regime in 2B Quadrant of 5 Toposheets, and 2 OW, 1 each for Aq I and Aq II, have been suggested in 3A Quadrant of Toposheet No. 79 B/11. Additional VES/TEM hase been suggested at 120, 150 and 65 nos. for Aq I, Aq II and Aq III respectively. Similarly, additional key wells recommended for water level monitoring are 32, 39 and 36 for Aq I, Aq II and Aq III respectively. Again, additional water quality monitoring stations have been suggested for 21, 39 and 36 nos. for Aq I, Aq II and Aq III respectively.

Tentative locations of tube wells earmarked for outsourcing have been given in Table 13.

Table. 1 – Data gap in Toposheet No. 79 B/2

Quadrant No.	No. of additional EW required			No. of additional VES/TEM required			No. of additional water level monitoring stations required			No. of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
3A	0	0	0	1	1	1	0	1	1	0	1	1	
3B	0	0	1	2	2	1	0	1	1	0	1	1	
3C	0	0	0	1	2	1	0	0	0	0	0	0	
Total	**0**	**0**	**1**	**4**	**5**	**3**	**0**	**2**	**2**	**0**	**2**	**2**	

Note:

No. of additional EW required- 1(Aq-III:1)

No. of additional VES/TEM required- 12 (Aq-I:4, Aq-II:5, Aq-III:3)

No. of additional water level monitoring stations required -4 (Aq-I:0, Aq-II: 2, Aq-III:2)

No. of additional water quality stations required-4 (Aq-I:0, Aq-II: 2, Aq-III:2)

Table.2 – Data gap in Toposheet No. 79 B/3

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1A	0	0	0	1	1	1	0	0	0	0	0	0	
1B	0	0	0	1	2	1	1	1	0	1	1	0	
1C	0	0	0	1	2	1	1	1	0	1	1	0	
2A	0	0	0	1	2	1	1	1	0	1	1	0	
2B	1	1	1	2	2	1	1	1	1	1	1	1	
2C	0	0	0	3	3	1	1	0	0	1	0	0	
3A	0	0	0	1	1	1	0	0	0	0	0	0	
Total	**1**	**1**	**1**	**10**	**13**	**7**	**5**	**4**	**1**	**5**	**4**	**1**	

Note:

No. of additional EW required- 3(Aq-I:1, Aq-II:1, Aq-III:1)

3 OW in 2B

No. of additional VES/TEM required- 30 (Aq-I:10, Aq-II:13, Aq-III:7)

No. of additional water level monitoring stations required -10 (Aq-I:5, Aq-II: 4, Aq-III:1)

No. of additional water quality stations required-10 (Aq-I:5, Aq-II: 4, Aq-III:1)

Table. 3 – Data gap in Toposheet No. 79 B/6

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1C	0	0	0	0	2	1	0	0	1	0	0	1	
2B	0	0	0	0	2	1	0	0	0	0	0	0	
2C	0	0	0	0	3	1	0	1	1	0	1	1	
3B	0	0	0	1	2	1	0	1	1	0	1	1	
3C	0	0	1	3	3	1	0	0	1	0	0	1	
Total	0	0	**1**	**4**	**12**	**5**	**0**	**2**	**4**	**0**	**2**	**4**	

Note:

No. of additional EW required- 1(Aq-III:1)

No. of additional VES/TEM required- 21 (Aq-I:4, Aq-II:12, Aq-III:5)

No. of additional water level monitoring stations required -6 (Aq-I:0, Aq-II: 2, Aq-III:4)

No. of additional water quality stations required-6 (Aq-I:0, Aq-II: 2, Aq-III:4)

Table. 4 – Data gap in Toposheet No. 79 B/7

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1A	0	0	0	1	2	1	1	1	1	1	1	1	
1B	0	0	0	3	3	1	0	1	1	0	1	1	
1C	0	0	0	3	3	1	0	1	1	0	1	1	
2A	0	0	0	3	3	1	0	1	0	0	1	0	
2B	1	1	1	3	3	1	0	1	0	0	1	0	
2C	0	0	0	3	3	1	0	0	0	0	0	0	
3A	0	0	0	1	1	1	0	0	0	0	0	0	
3B	0	0	0	3	3	1	0	0	0	0	0	0	
3C	0	0	0	3	3	1	0	1	0	0	1	0	
Total	1	1	**1**	**23**	**24**	**9**	**1**	**6**	**3**	**1**	**6**	**3**	

Note:

No. of additional EW required- 3 (Aq-I:1, Aq-II:1, Aq-III:1)

3 OW in 2B

No. of additional VES/TEM required- 56 (Aq-I:23, Aq-II:24, Aq-III:9)

No. of additional water level monitoring stations required -10 (Aq-I:1, Aq-II: 6, Aq-III:3)

No. of additional water quality stations required-10 (Aq-I:1, Aq-II: 6, Aq-III:3)

Table. 5 – Data gap in Toposheet No. 79 B/8

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1B	0	0	1	2	2	1	1	1	1	1	1	1	
1C	0	0	0	2	2	1	1	1	1	1	1	1	
Total	0	0	**1**	**4**	**4**	**2**	2	2	**2**	2	2	**2**	

ote:

No. of additional EW required- 1 (Aq-III:1)

No. of additional VES/TEM required- 10 (Aq-I:4, Aq-II:4, Aq-III:2)

No. of additional water level monitoring stations required -6 (Aq-I:2, Aq-II: 2, Aq-III:2)

No. of additional water quality stations required-6 (Aq-I:2, Aq-II: 2, Aq-III:2)

able. 6 – Data gap in Toposheet No. 79 B/10

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1A	0	0	0	0	2	1	0	1	1	0	1	1	
1B	0	0	0	0	2	1	0	1	1	0	1	1	
1C	0	0	0	1	2	1	0	1	1	0	1	1	
2A	0	0	0	0	3	1	0	1	1	0	1	1	
2B	0	0	0	3	3	1	1	0	1	1	0	1	
2C	0	0	0	2	3	1	1	0	1	1	0	1	
3A	0	0	0	3	3	1	1	1	0	1	1	0	
3B	0	0	0	3	3	1	0	0	1	0	0	1	
3C	0	0	0	1	2	1	1	1	1	1	1	1	
Total	0	0	**0**	**13**	**23**	**9**	4	6	**8**	4	6	**8**	

Note:

No. of additional EW required- 0

No. of additional VES/TEM required-45 (Aq-I:13, Aq-II:23, Aq-III:9)

No. of additional water level monitoring stations required -18 (Aq-I:4, Aq-II: 6, Aq-III:8)

No. of additional water quality stations required-18 (Aq-I:4, Aq-II: 6, Aq-III:8)

Table. 7 – Data gap in Toposheet No. 79 B/11

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
1A	0	0	0	3	3	1	0	1	1	0	1	1	
1B	0	0	1	3	3	1	0	1	1	0	1	1	
2A	0	0	0	2	2	1	0	1	0	0	1	0	
2B	0	0	0	1	1	1							
3A	1	1	0	2	2	1	1	1	0	1	1	0	
3B	0	0	0	1	1	1							
Total	1	1	**1**	**12**	**12**	**6**	1	4	**2**	1	4	**2**	

Note:

No. of additional EW required- 3 (Aq-I:1, Aq-II:1, Aq-III:1)

2 OW in 3A

No. of additional VES/TEM required- 30 (Aq-I:12, Aq-II:12, Aq-III:6)

No. of additional water level monitoring stations required -7 (Aq-I:1, Aq-II: 4, Aq-III:2)

No. of additional water quality stations required-7 (Aq-I:1, Aq-II: 4, Aq-III:2)

Table. 8 – Data gap in Toposheet No. 79 B/13

Quadrant No.	No. Of additional EW required			No. Of additional VES/TEM required			No. Of additional water level monitoring stations required			No. Of additional water quality stations required			Remarks
	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	Aq-I	Aq-II	Aq-III	
2A	0	0	0	3	3	1	0	1	1	0	1	1	
2B	1	1	1	3	3	1	0	1	1	0	1	1	
2C	0	0	0	2	2	1	0	0	0	0	0	0	
3A	0	0	1	3	3	1	0	0	1	0	0	1	
3B	0	0	0	3	3	1	0	1	1	0	1	1	
3C	0	0	0	1	2	1	0	0	0	0	0	0	
Total	1	1	**2**	**15**	**16**	**6**	0	3	**4**	0	3	**4**	

Note:

No. of additional EW required- 4 (Aq-I:1, Aq-II:1, Aq-III:2)

3 OW in 2B

No. of additional VES/TEM required- 37 (Aq-I:15, Aq-II:16, Aq-III:6)

No. of additional water level monitoring stations required -7 (Aq-I:0, Aq-II: 3, Aq-III:4)

No. of additional water level monitoring stations required -7 (Aq-I:0, Aq-II: 3, Aq-III:4)

Table. 9 – Data gap in Toposheet No. 79 B/14

Quadrant No.	**No. Of additional EW required**			**No. Of additional VES/TEM required**			**No. Of additional water level monitoring stations required**			**No. Of additional water quality stations required**			**Remarks**
	Aq-I	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	
1A	0	0	0	3	3	1	0	0	1	0	0	1	
1B	0	0	0	3	3	1	1	1	1	1	1	1	
1C	0	0	0	1	2	1	1	1	1	1	1	1	
2A	0	0	0	3	3	1	1	1	1	1	1	1	
2B	1	1	1	3	3	1	0	1	1	0	1	1	
2C	0	0	0	1	2	1	0	1	1	0	1	1	
3A	0	0	0	1	1	1	1	1	0	1	1	0	
3B	0	0	0	3	3	1	0	0	0	0	0	0	
3C	0	0	1	2	2	1	1	1	1	1	1	1	
Total	1	1	**2**	**20**	**22**	**9**	5	7	**7**	5	7	**7**	

No. of additional EW required- 4 (Aq-I:1, Aq-II:1, Aq-III:2)

3 OW in 2B

No. of additional VES/TEM required- 51 (Aq-I:20, Aq-II:22, Aq-III:9)

No. of additional water level monitoring stations required -19 (Aq-I:5, Aq-II: 7, Aq-III:7)

No. of additional water level monitoring stations required -19 (Aq-I:5, Aq-II: 7, Aq-III:7)

Table. 10 – Data gap in Toposheet No. 79 B/15

Quadrant No.	**No. Of additional EW required**			**No. Of additional VES/TEM required**			**No. Of additional water level monitoring stations required**			**No. Of additional water quality stations required**			**Remarks**
	Aq-I	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	
1B	0	0	0	1	2	1	0	0	0	0	0	0	
2A	0	0	0	1	2	1	0	0	0	0	0	0	
2B	1	1	1	3	3	1	0	0	1	0	0	1	
2C	0	0	0	1	2	1	0	0	0	0	0	0	

3A	0	0	0	2	2	1	0	0	0	0	0	0	
3B	0	0	0	3	3	1	1	1	1	1	1	1	
3C	0	0	0	2	2	1	0	0	0	0	0	0	
Total	**1**	**1**	**1**	**13**	**16**	**7**	**1**	**1**	**2**	**1**	**1**	**2**	

Note:

No. of additional EW required- 3 (Aq-I:1, Aq-II:1, Aq-III:1)

3 OW in 2B

No. of additional VES/TEM required- 36 (Aq-I:13, Aq-II:16, Aq-III:7)

No. of additional water level monitoring stations required -4 (Aq-I:1, Aq-II:1, Aq-III:2)

No. of additional water level monitoring stations required -4 (Aq-I:1, Aq-II:1, Aq-III:2)

Table. 11 – Data gap in Toposheet No. 73 N/15

Quadrant No.	**No. Of additional EW required**			**No. Of additional VES/TEM required**			**No. Of additional water level monitoring stations required**			**No. Of additional water quality stations required**			**Remarks**
	Aq-I	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	**Aq-I**	**Aq-II**	**Aq-III**	
2C	0	0	1	1	2	1	1	1	0	1	1	0	
3C	0	0	0	1	1	1	1	1	1	1	1	1	
Total	**0**	**0**	**1**	**2**	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**1**	

Note:

No. of additional EW required- 1 (Aq-I:0, Aq-II:0, Aq-III:1)

No. of additional VES/TEM required- 7 (Aq-I:2, Aq-II:3, Aq-III:2)

No. of additional water level monitoring stations required -5 (Aq-I:2, Aq-II:2, Aq-III:1)

No. of additional water level monitoring stations required -5 (Aq-I:2, Aq-II:2, Aq-III:1)

Table 12: Available salient data of exploratory tube wells & quality data of ground water

District	Block	Location	Well Type	AAP	Lat	Long	Drill Depth (mbgl)	Well Depth (mbgl)	Zone tapped/ Fractures encountered (mbgl)	Geology	SWL (mbgl)	Discharge (lps)	Drawdown (m)	T (m2/day)	S	EC	Cl (mg/l)	Fe (mg/l)	As (mg/l)	F (mg/l)
Howrah	Uluberia II	Fort Gloster / Bauria(EW)	EW	1962-63	22.47	88.13	310.9	192	30.00-72.0,93.00-107.00,148.00-189.00	Alluvium	5.59	58.27	3.98				840			
Howrah	Shyampur - II	Belpukur (EW)	EW	2006-07	22.36	88.00	245.5	244.5	224.50 – 242.50	Alluvium										
Howrah	Shyampur -II	Sasati	DEW	2007-08	22.35	87.98	250.3	241	204-222,229-238	Alluvium	8.55	11.1	5.61							
Howrah	Shyampur -II	Sasati	SEW	2007-08	22.35	87.98	130	75	37-42, 66-72	Alluvium	4.15	11.03	9.79	260.8						
Howrah	Shyampur -II	Belpukur	EW-III	2007-08	22.32	87.98	348.7	223	196-220	Alluvium	8.2	2.33								
North 24 Parganas	Barasat-II	Choumaha	DEW	2006-07	22.65	88.55	265.4	250	205-221,242-246	Alluvium	3.15	46.8	12.51	1256						
North 24 Parganas	Barasat-II	Choumaha	IEW	2006-07	22.65	88.55	316.4	165	143-161	Alluvium	3.27	68.4	2.781	3867						
North 24 Parganas	Barasat-II	Choumaha	SEW	2006-07	22.65	88.55	50	44	30-42	Alluvium	4.02	3.33	11.43	175.7						
North 24 Parganas	Barasat-II	Pakdah	DEW	2006-07	22.68	88.57	324.4	185	158-182	Alluvium	1.7	21.83	3.49	6526	3.8×10^{-1}					
North 24 Parganas	Barasat-II	Pakdah	DOW	2006-07	22.68	88.57	188.9	185	164-182	Alluvium		12								
North 24 Parganas	Barasat-II	Pakdah	SEW	2006-07	22.68	88.57	56.31	52	40-50	Alluvium	4.28	14								
North 24 Parganas	Barasat-II	Pakdah	SOW	2006-07	22.68	88.57	52	50	40-50	Alluvium	4.38	12								
North 24 Parganas	Basirhat-II	Jafarpur	DEW	2009-10	22.67	88.79	325.5	162	135-159	Alluvium	7.1	1.14								
North 24 Parganas	Basirhat-II	Jafarpur	IEW	2009-10	22.67	88.79	121.6	110	90-108	Alluvium	7.86	13.83								
North 24 Parganas	Basirhat-II	Jafarpur	OW	2010-11	22.67	88.79	40.9	28.5	22.50-26.50	Alluvium	6.5	6.5								
North 24 Parganas	Haroa	Khasbalanda	DEW	2009-10	22.59	88.69	325	208	175-205	Alluvium	4.33	11.48	1.41	2269.62 (Jacob's)/ 2420.93 (Theis)						
North 24 Parganas	Haroa	Khasbalanda	DOW	2009-10	22.59	88.69	204	203	180-186,194-200	Alluvium	4.29	11.7	0.3	2593.85 (j)/ 2269.62 (T)	8.438×10^{-4}					
North 24 Parganas	Haroa	Khasbalanda	SEW	2009-10	22.59	88.69	56.12	38	20-26,30-36	Alluvium	0.89	12.48	2.12	789.52 (J)/122.42 (T)						
South 24 Parganas	Baruipur	Phultala	DEW	2007-08	22.34	88.46	317.2	253	238-250	Alluvium	5.18	26								
South 24 Parganas	Baruipur	Phultala	IEW	2007-08	22.34	88.46	160	153	132-150	Alluvium	7.1	4.25								

South 24 Parganas	Baruipur	Phultala	SEW	2007-08	22.34	88.46	99.80	98	86-95	Alluvium		9.8								
South 24 Parganas	Baruipur	Kurali	EW	1974-75	22.41	88.42	601.7	299	153.00-159.85,175.42-179.44,191.62-197.62,240.44-246.56,280.76-295.97	Alluvium		35.98	4.57	3019	0.0003		752			
South 24 Parganas	Baruipur	Balbalia	EW	1975-76	22.40	88.40	553.7	No assembly	20.00-34.80,54.90-72.00,102.60-108.00,129.00-132.00,150.00-156.00,174.00-178.00,189.00-201.00,216.00-222.00,228.00-243.00,300.00-312.00,318.00-330.00,360.00-384.00	Alluvium										
South 24 Parganas	Baruipur	Jalerhat	EW	1988-89	22.36	88.32	411.9	280.3	236.00-242.00,248.00-260.00,270.00-276.00	Alluvium		21.99	12.43	1725	0.0015	4267	1028			
South 24 Parganas	Baruipur	Jalerhat (OW-I)	OW-I	1988-89	22.36	88.32	419.5	405	390.00-402.00	Alluvium										
South 24 Parganas	Baruipur	Jalerhat (OW-II)	OW-II	1988-89	22.36	88.32	411.9	253	238.00-250.00	Alluvium										
South 24 Parganas	Baruipur	Jalerhat (OW-III)	OW-III	1988-89	22.36	88.32	60	39	24.00-36.00	Alluvium		3.32				16340	5461			
South 24 Parganas	Baruipur	Baruipur (EW)	EW	1990-91	22.41	88.36	400.1	283	210.00-222.00,226.00-229.00,235.00-247.00,265.00-280.00	Alluvium		24.1	9.36	1727	0.00009	916	28			
South 24 Parganas	Baruipur	Baruipur (OW-I)	OW-I	1990-91	22.41	88.36	400.1	232	210.00-222.00,226.00-229.00	Alluvium										
South 24 Parganas	Baruipur	Baruipur (OW-II)	OW-II	1990-91	22.41	88.36	287.3	245	235.00-242.00	Alluvium										
South 24 Parganas	Bhangar-I	Kashipur (EW)	EW	1977-78	22.52	88.45	607.5	278	150.00-163.00,172.00-192.00,202.00-206.00,225.00-	Alluvium	3.05	61.58 (500 minutes of pumping)	5.1	6514		1200	134			

									231.00,245.00-249.00,270.0-275.00											
South 24 Parganas	Bhangar-II	Karbala	DEW	2007-08	22.55	88.60	247.3	239	224-236	Alluvium	3.55	35	1.22	695.7	8.13×10^{-3}					
South 24 Parganas	Bhangar-II	Karbala	DOW	2007-08	22.55	88.60	241.3	239	224-236	Alluvium	3.51	16.4								
South 24 Parganas	Bhangar-II	Karbala	IEW	2007-08	22.55	88.60	185.6	179	158-176	Alluvium	2.85	24	0.76	2670						
South 24 Parganas	Bishnupur –II	Bishnupur (EW)	EW		22.48	88.14	304.8			Alluvium										
South 24 Parganas	Budge Budge II	Dongaria/ Nodakhali	DEW	2008-09	22.44	88.20	323	267	240-264	Alluvium	7.28	25								
South 24 Parganas	Budge Budge II	Dongaria/ Nodakhali	OW	2008-09	22.44	88.20	272	265	244-262	Alluvium	7.26	4								
South 24 Parganas	Budge Budge II	Dongaria/ Nodakhali	SEW	2008-09	22.44	88.20	91.35	68	53-65	Alluvium	13.09	5								
South 24 Parganas	Joynagar-I	Goalberia (EW)	EW	1976-77	22.31	88.40	589.5	345	257.0-261.00,263.00-268.00,272.00-278.00,282.00-289.00,295.00-302.00,317.00-327.00,330.00-335.00,337.00-342.00	Alluvium	0.95	57.80 (500 minutes of pumping)	15.25	1309		1800 - 5790	400-1978			
South 24 Parganas	Sonarpur	Bosepukur (Rajpur) (EW)	EW	1992-93	22.54	88.34	402.8	337	168.00-180.00,186.00-198.00,316.00-334.00	Alluvium		6.28				7000	1917			
South 24 Parganas	Sonarpur	Bosepukur (Rajpur) (OW)	OW	1992-93	22.54	88.34	402.8	342	232.00-238.00,328.00-339.00	Alluvium		2.5	10			1068	99			
South 24 Parganas	Sonarpur	Rajpur (EW)	EW		22.52	88.34	612.6			Alluvium										

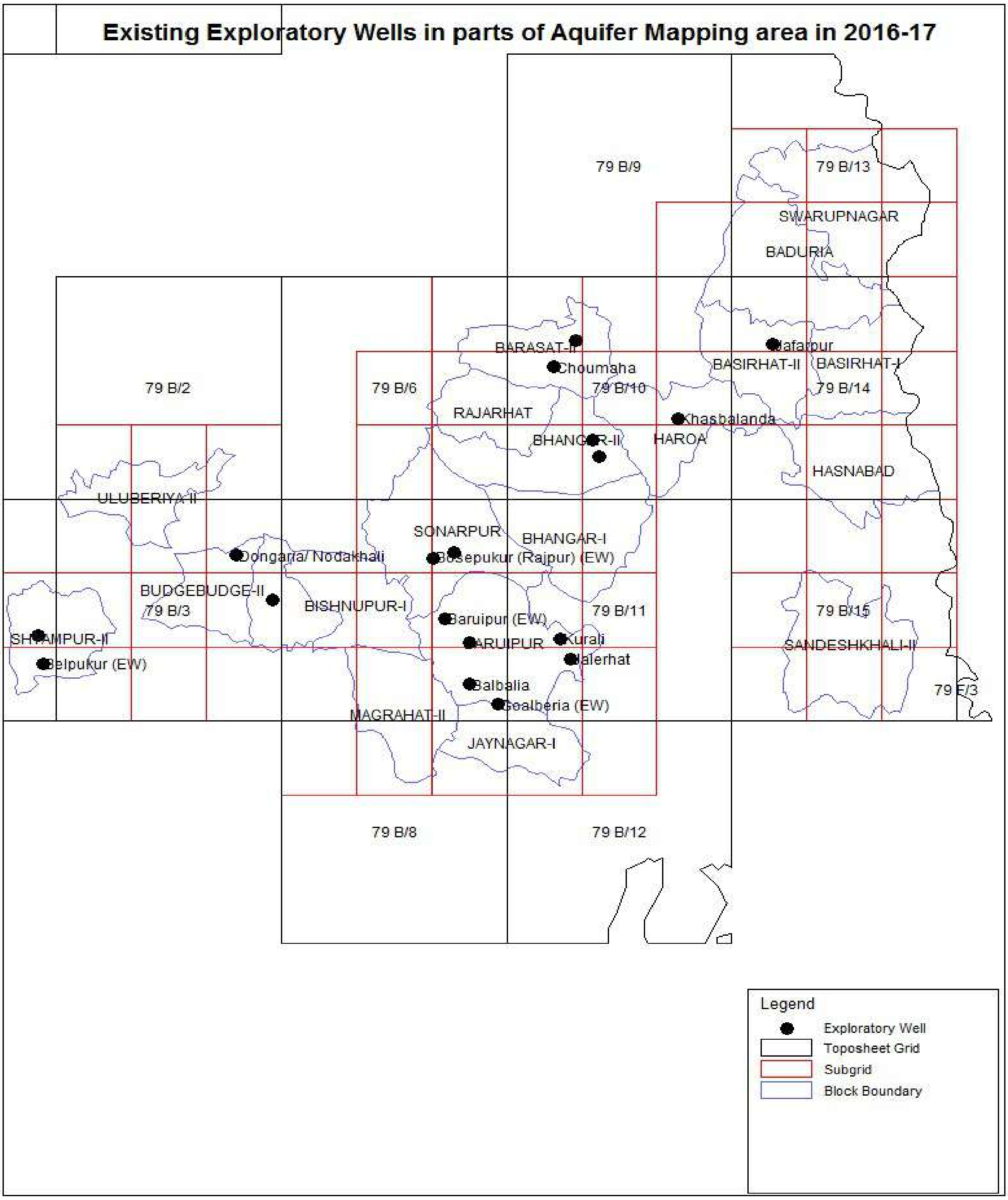


Fig. 1: Location of toposheet wise existing exploratory tube wells in different blocks in study area

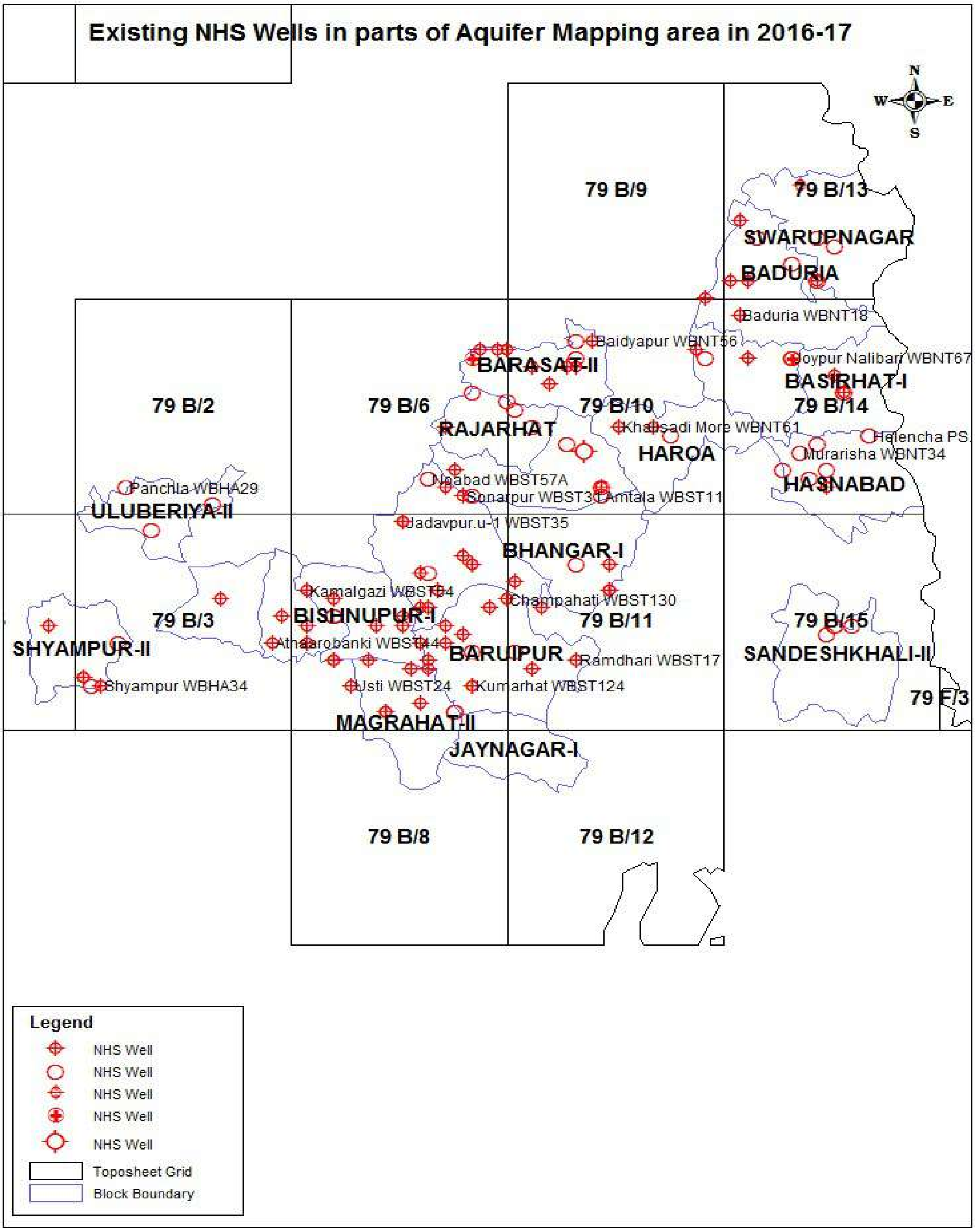


Fig. 2: Location of toposheet wise existing Hydrograph Stations in different blocks in study area

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 73 N/15

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Fig. 3: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/2

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Fig. 4: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/3

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 02

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Fig. 5: Availability of geophysical data in Toposheet

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Toposheet No. 79 B/6</td></tr>
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Fig. 6: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/7

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Fig. 7: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/8

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No. of Elec. Logging: Nil</td>
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Fig. 8: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/10

Aq. Gp.	VES/ TEM
Ist	Yes
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Yes
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Yes
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Fig. 9: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/11

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Fig. 10: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/12

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No. of Elec. Logging: Nil</td>
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Fig. 11: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise) Toposheet No. 79 B/13		
Not included in the AAP 2016-17 **No. of Elec. Logging: Nil**	**Not included in the AAP 2016-17** **No. of Elec. Logging: Nil**	**Not included in the AAP 2016-17** **No. of Elec. Logging: Nil**
Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**	Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**	Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**
Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**	Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**	Aq. Gp. / VES/ TEM Ist / Nil IInd / Nil **No. of Elec. Logging: Nil**

Fig. 12: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/14

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: 01

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Fig. 13: Availability of geophysical data in Toposheet

Data adequacy of Geophysical data for Two Aquifer group system in Alluvial areas (quadrant wise)

Toposheet No. 79 B/15

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Not included in the AAP 2016-17

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Aq. Gp.	VES/ TEM
Ist	Nil
IInd	Nil

No. of Elec. Logging: Nil

Fig. 14: Availability of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 73 N/15

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<table>
<tr><td>Aq. Gp.</td><td colspan="3">VES/TEM</td></tr>
<tr><td></td><td>Req</td><td>Exist</td><td>Gap</td></tr>
<tr><td>Ist</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>IInd</td><td>1</td><td>0</td><td>1</td></tr>
</table>
</td>
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Fig. 15: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/2

Not included in the AAP 2016-17	Not included in the AAP 2016-17	Not included in the AAP 2016-17
Not included in the AAP 2016-17	Not included in the AAP 2016-17	Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	1	0	1

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Fig. 16: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	1	0	1

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	2	0	2
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	1	0	1

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Fig. 17: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/6

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	3	0
IInd	2	0	2

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	2	0
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	5	0
IInd	3	0	3

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Fig. 18: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/7

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	1	0	1

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Fig. 19: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/8

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Fig. 20: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/10

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	8	0
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	5	0
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	0	8	0
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Fig. 21: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/11

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	1	0	1

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	1	0	1

Not included in the AAP 2016-17

Fig. 22:Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)
TOPOSHEET No. 79 B/12

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Fig. 23: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/13

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Fig. 24: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/14

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	1	0	1
II^{nd}	1	0	1

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	3	0	3
II^{nd}	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
I^{st}	2	0	2
II^{nd}	2	0	2

Fig. 25: Data gap analysis/ requirement of geophysical data in Toposheet

Data gap analysis for geophysical data of Two Aquifer group system in Alluvial areas (quadrant wise)

TOPOSHEET No. 79 B/15

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Not included in the AAP 2016-17

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	1	0	1
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	3	0	3
IInd	3	0	3

Aq. Gp.	VES/TEM		
	Req	Exist	Gap
Ist	2	0	2
IInd	2	0	2

Fig. 26:Data gap analysis/ requirement of geophysical data in Toposheet

Table 13 - Tentative locations / sites of Exploration in parts of Howrah, S 24 Parganas and N 24 Parganas districts in West Bengal to be outsourced during AAP 2016-17										
Well No.	**Toposheet No.**	**Quadrant No.**	**Block / District**	**Tentative Location**	**No. of exploratory wells**			**Design of wells**		
					Aquifer I (up to 100 m)	**Aquifer II (up to 200 m)**	**Aquifer III (up to 300 m)**	**Aquifer I (up to 100 m/ as per actual depth of aquifer)**	**Aquifer II (up to 200 m/ as per actual depth of aquifer)**	**Aquifer III (up to 300 m/ as per actual depth of aquifer)**
1	79B/2	3B	Uluberia II (Howrah)	Balarampota			1 (SPEW)	-	-	152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
2	79 B/3	2B	Budge Budge (S 24 PGS)	Gadakhali	1EW +1OW	1EW +1OW	1EW +1OW	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia
3	73 N/15	2C	Shyampur II (Howrah)	Jagadishpur			1 (SPEW)	-	-	152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
4	79 B/7	2B	Bishnupur I (S 24 PGS)	Andharmanik	1EW +1OW	1EW +1OW	1EW +1OW	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia

5	79 B/11	1B	Bhangar I (S 24 PGS)	Badura			1 (SPEW)	-	-	152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
6	79B/11	3A	Baruipur (S 24 PGS)	Mallikpur Narayangarh	--	1EW +1OW	1EW +1OW		**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia
7	79 B/8	1B	Mograhat-II (S 24 PGS)	Mograhat			1 (SPEW)	-	-	152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
8	79B/12	1A	Jaynagar I (S 24 PGS)	Sasthitala			1 (SPEW)			152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
9	79 B/15	2B	Sandeshkhali – II (N 24 PGS)	Yet to be finalise	1EW +1OW	1EW 1OW	1EW +1OW	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia
10	79 B/6	3C	Bhangar II (S 24 PGS)	Mahisbathan			1 (SPEW)			152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.

11	79B/14	2B	Bashirhat – I(N 24 PGS)	Yet to be finalise.	1EW +1OW	1EW +1OW	1EW +1OW	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia
12	79 B/14	3C	Hasnabad (N 24 PGS)	Yet to be finalish.			1 (SPEW)			152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
13	79 B/13	3A	Baduria (N 24 PGS)	Yet to be finalish.			1 (SPEW)			152 mm dia with 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot.
14	79 B/13	2B	Swarupnagar (N 24 PGS)	Yet to be finalish.	1EW +1OW	1EW +1OW	1EW +1OW	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia	**EW**: 254x152 mm with 40 m Housing & 24-30 m strainer as per availability of aquifer & with 0.5 to 1 mm slot. . **OW**: 152 mm dia
TOTAL (17 EW+ 17 OW+ 8 SPEW = 42)					**5 EW+ 5 OW**	**6 EW+ 6 OW**	**6 EW + 6 OW+8 SPEW**			
SPEW: Special purpose Exploratory wells, to be converted to Piezometer										