केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण

विभाग, जल शक्ति मंत्रालय

भारत सरकार

Central Ground Water Board

Department of Water Resources, River Development and Ganga Rejuvenation,

Ministry of Jal Shakti

Government of India

AQUIFER MAPPING AND MANAGEMENT OF GROUND WATER RESOURCES

KHADGAWAN BLOCK, KOREA DISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

REPORT ON
AQUIFER MAPPING AND MANAGEMENT PLAN
OF KHADGAWAN BLOCK, KOREA DISTRICT, CHHATTISGARH

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Government of India

RAIPUR
2017-18

Acknowledgement

I wish to express my sincere gratitude and indebtedness to Shri C. Paul Prabhakar, Regional Director, CGWB, NCCR, Raipur for giving the opportunity to prepare and write this block report.

I am extremely grateful to Sh. A.K. Biswal, Scientist-D, for his continuous guidance and technical support during preparation of this report.

I would like to acknowledge the help rendered by Shri A.K. Patre, Scientist-D, for their constant support and improvement during compilation of the report.

The efforts made by Sh. T.S. Chouhan, Draftsman, for digitization of maps are thankfully acknowledged.

The author is thankful to Technical Section, Data Centre, Chemical Section, Report Processing Section and Library of CGWB, NCCR, Raipur for providing the various needful data without which the report could not have been completed.

The author is also thankful to the state agencies for providing the various needful data without which the report could not have been completed.

Lastly, I offer my thanks to all the individuals who helped at various stages in this endeavour.

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Scientist-'B'

AQUIFER MAPPING AND MANAGEMENT PLAN FOR KHADGAWAN BLOCK (KOREA DISTRICT), CHHATTISGARH

CONTENTS

BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information:

About the area: Khadgawan Block is situated on the southern part of Korea district of Chhattisgarh and is bounded on the north by Baikunthpur block, in the north west by Manendragarh Block, in the south east by Bilaspur district and in the east by Surajpur district. The block area lies between 22.935 and 23.256 N latitudes and 82.14 and 82.613 E longitudes. The geographical extension of the study area is 811.92 sq.km representing around 15.27 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology mainly comprises of structural plains of Gondwana rocks. Geomorphology map is shown in Figure 2. The major drainage of the block includes Kudra Nala, Budhri Nala, Gorghela Nala and Hasdo river. All the drainage are part of Mahanadi basin and tributaries of Mahanadi river. Drainage map shown in Fig.3.

Population: The total population of Khadgawan block as per 2011 Census is 173747 out of which rural population is 104440 while the urban population is 6930772507.The population break up i.e. male- female, rural & urban is given below -

Table- 1: Population Break Up

Block	Total population	Male	Female	Rural population	Urban population
Khadgawan	173747	88363	85384	104440	69307

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 6.75 as per 2011 census.

Rainfall: The study area receives rainfall mainly from south-west monsoon. The months of July and August are the heaviest rainfall months and nearly 95% of the annual rainfall is received during June to September months. Average annual rainfall in the study area is (Average of the last five years i.e. 2010 to 2015) 1590.34 mm with 50 to 60 rainy days. The average annual rainfall for the district is around 1208.20 mm (1975-2011).

Table-2: Rainfall data in Khadgawan block in mm

Year	2010-11	2011-12	2012-13	2013-14	2014-15
Annual rainfall	541.50	1109.30	1301.80	934.10	914.80

Source: IMD

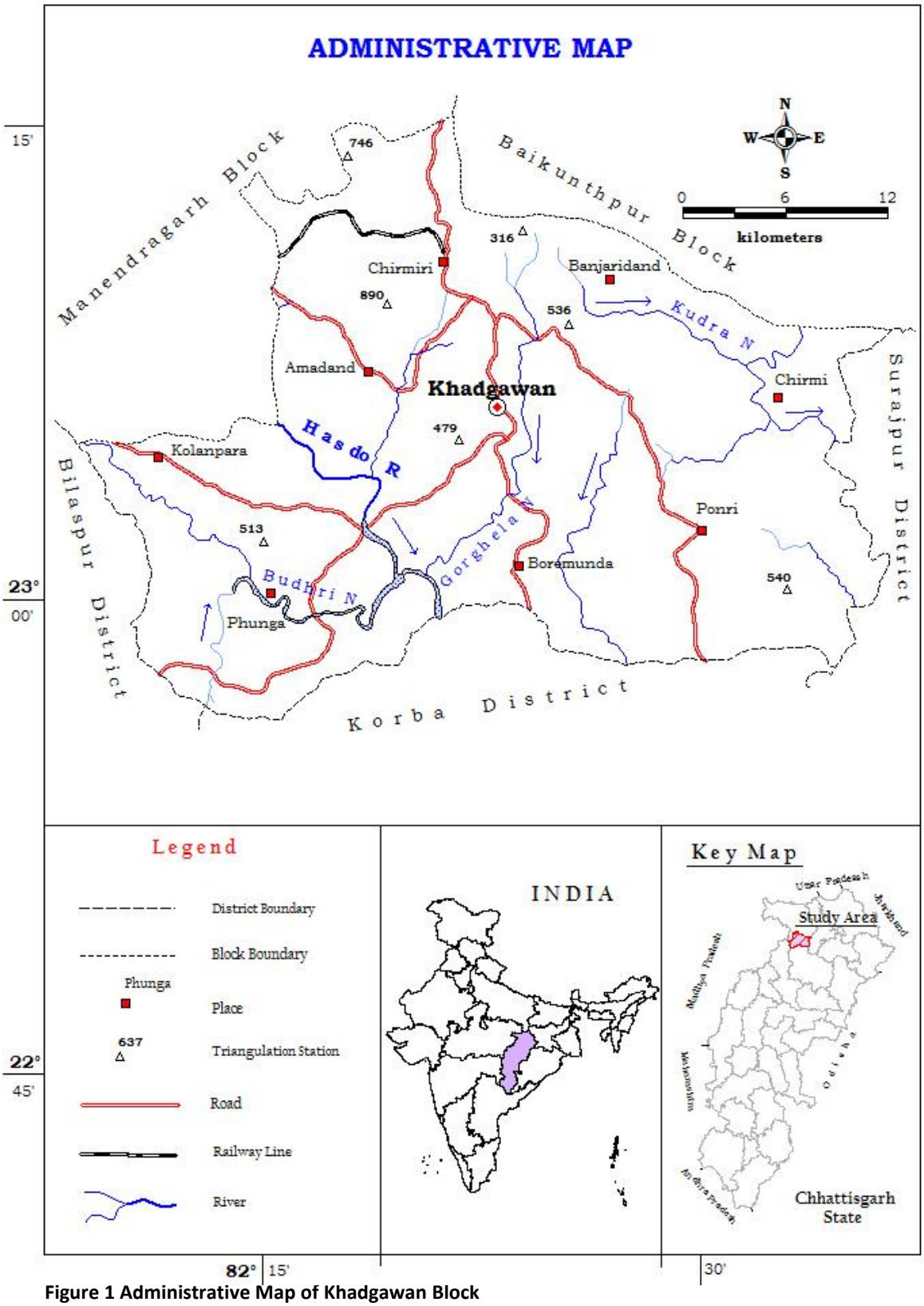

Figure 1 Administrative Map of Khadgawan Block

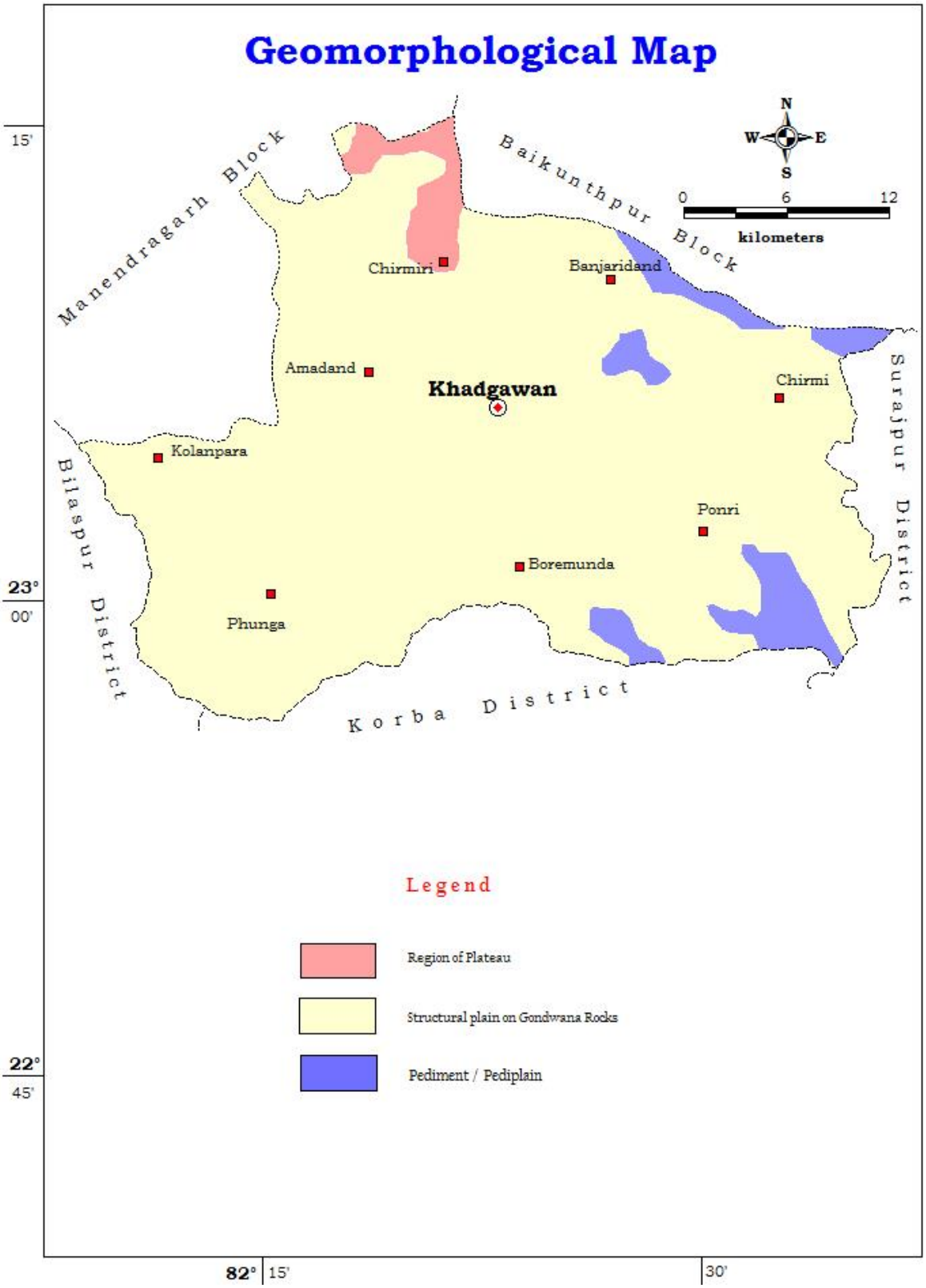

Figure 2 Geomorphology Map of Khadgawan Block

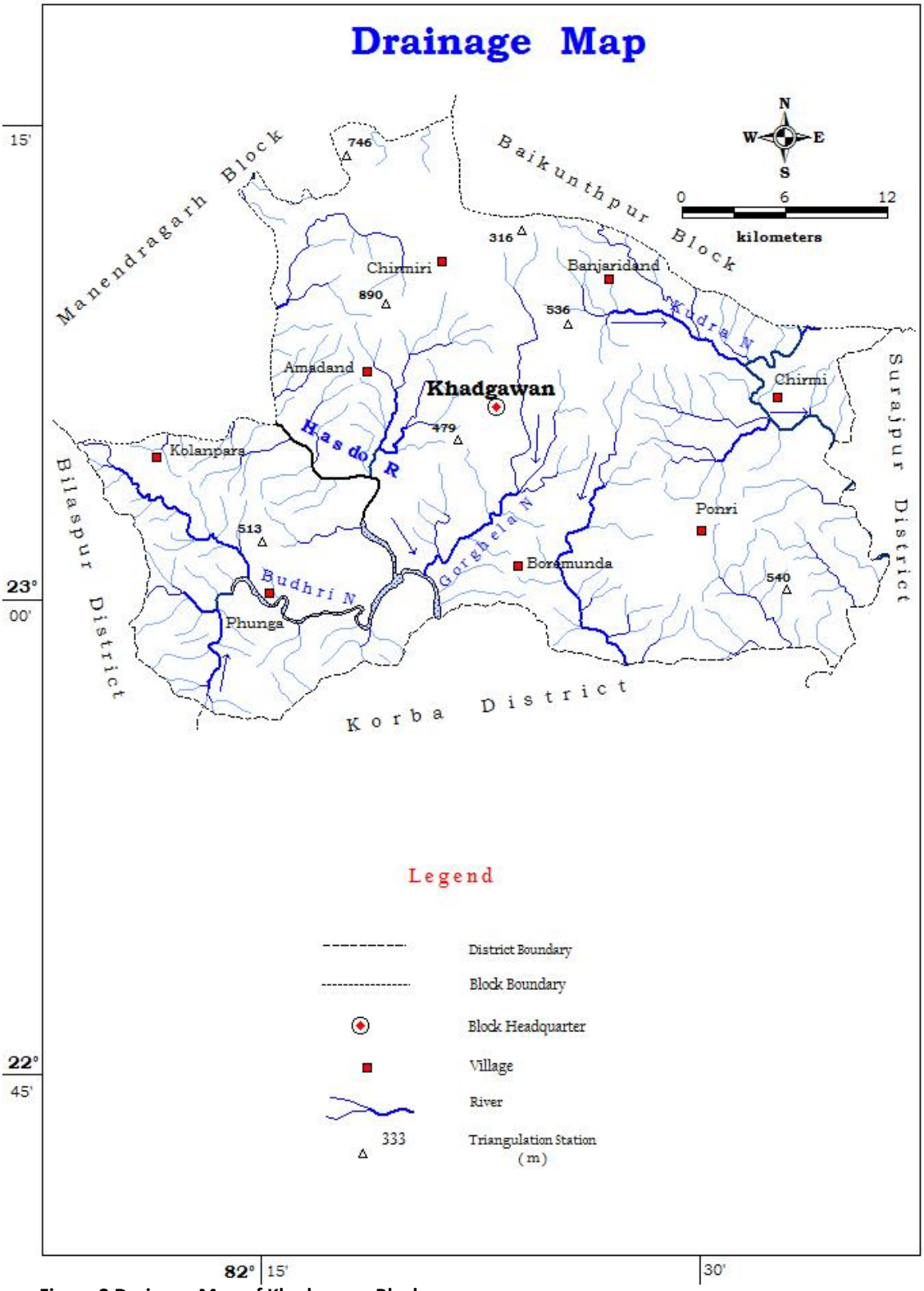

Figure 3 Drainage Map of Khadgawan Block

Agriculture and Irrigation**:** Agriculture is practiced in the area during Kharif and Rabi season every year. During the Kharif, cultivation is done through rainfall while during the Rabi season, it is done through ground water as well as partly through surface water like canals and other sources. The groundwater abstraction structures are generally Dugwells, Borewells /tubewells. The principal crops in the block are Paddy, Wheat, Vegetables and pulses.

In some areas, double cropping is also practiced. The agricultural pattern,cropping pattern and area irrigated data of Khadgawan block is given in Table 3 (A, B, C, D, E).

Table 3 (A): Agricultural pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Khadgawan	78090	6256	4181	29163	2080	31243

Table 3 (B): Land use pattern (in ha)

Block	Total geographical area	Revenue forest area	Area not available for cultivation	Non agricultural & Fallow land	Agricultural Fallow land	Net sown area	Double cropped area	Gross cropped area
Khadgawan	78090	6256	4181	14124	4255	2080	2080	31243

Table 3 (C): Cropping pattern (in ha)

Block	Kharif	Rabi		Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala
			Wheat	Rice	Jowar& Maize	Millets	Others					
Khadgawan	29102	2141	342	19867	2286	1022	1005	3525	2289	802	105	106

Table 3 (D): Area irrigated by various sources (in ha)

No. of canal s (privat e and Govt.)	Irrigate d area	No.of bore wells / Tube wells	Irrigate d area	No. Of dug wells	Irrigate d area	No. of Talabs	Irrigated area	Irrigate d area by other sources	Net Irri-gated area	Gross irrigat ed area	% of irrigate d area wrt. Net sown area
12	589	196	163	861	239	262	35	193	1131	1219	4 %

Table 3 (E): Statistics showing Agricultural land Irrigated

Block	Net Irrigated Area	Net Irrigated Area by ground water	Percentage of Area Irrigated by ground water
Khadgawan	1131	402	35.54

Groundwater Resource Availability and Extraction: Based on the resource assessment made, the resource availability in aquifer wise in Khadgawan block is given in the table-4.

Table – 4: Ground Water Resources of Khadgawan block in Ham

Assessment Unit / Block	**Command / Non Command**	**Recharge From Rain Fall During Monsoon Season in Ham**	**Recharge From Other Sources During Monsoon Season in Ham**	**Recharge From Rain Fall During Non Monsoon Season in Ham**	**Recharge From Other Sources During Non Monsoon Season in Ham**	**Total Annual Recharge in Ham (4+5+6+7)**	**Natural Discharge During Non Monsoon Period in Ham**	**Net Ground Water Availability in Ham (8-9)**
Khadgawan	Command	51.12	56.85	4.49	33.58	146.04	14.6	131.44
	Non Command	8800.38	64.51	589.51	499.12	9953.52	497.68	9455.84
	Block Total	8851.5	121.36	594	532.7	10099.56	512.28	9587.28

Existing and Future Water Demand (2025)*:* The existing Gross Ground Water Draft for Irrigation in the area is 2704 Ham while Gross Ground Water Draft for All Uses is 3117.09 Ham. At present scenario to meet the future demand for water, a total quantity of 6312.6 Ham of ground water is available for future irrigation development and 570.68 Ham of ground water is available for domestic and industrial uses.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Khadgawan block, water level in dugwells (phreatic aquifer) vary between 3.7 to 11.5 mbgl with average water level of 6.37 mbgl. In deeper fractured aquifer, the maximum water level is 19.3 mbgl, the average water level is 12.36 mbgl.

Table 5A: Aquifer wise Depth to Water Level (Pre-monsoon)

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Khadgawan	3.7	11.5	6.37

Water Level (in mbgl)

Table 5B: Aquifer wise Depth to Water Level (Pre-monsoon)

Block Name	Fractured Aquifer		
	Min	Max	Avg
Khadgawan	4.52	19.3	12.36

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 0.25 10.28 mbgl with an average of 2.58 mbgl in phreatic aquifer. In fractured formation, the post monsoon water level variation range is 3.4 to 13.65 mbgl with average of 9.3 mbgl.

Table 5C: Aquifer wise Depth to Water Level (Post-monsoon)

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Khadgawan	0.25	10.28	2.57

Water Level (in mbgl)

Table 5D: Aquifer wise Depth to Water Level (Post-monsoon)

Block Name	Fractured Aquifer		
	Min	Max	Avg
Khadgawan	3.4	13.65	9.3

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Khadgawan block, water level fluctuation in phreatic aquifer varies from 1.22 to 6.27 m with an average fluctuation of 3.79 m. Water level fluctuation in fractured aquifer varies from 0.65 to 7.8 m with an average fluctuation of 3.06 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Khadgawan	1.22	6.27	3.79

Water Level (in m)

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Fractured Aquifer		
	Min	Max	Avg
Khadgawan	0.65	7.8	3.06

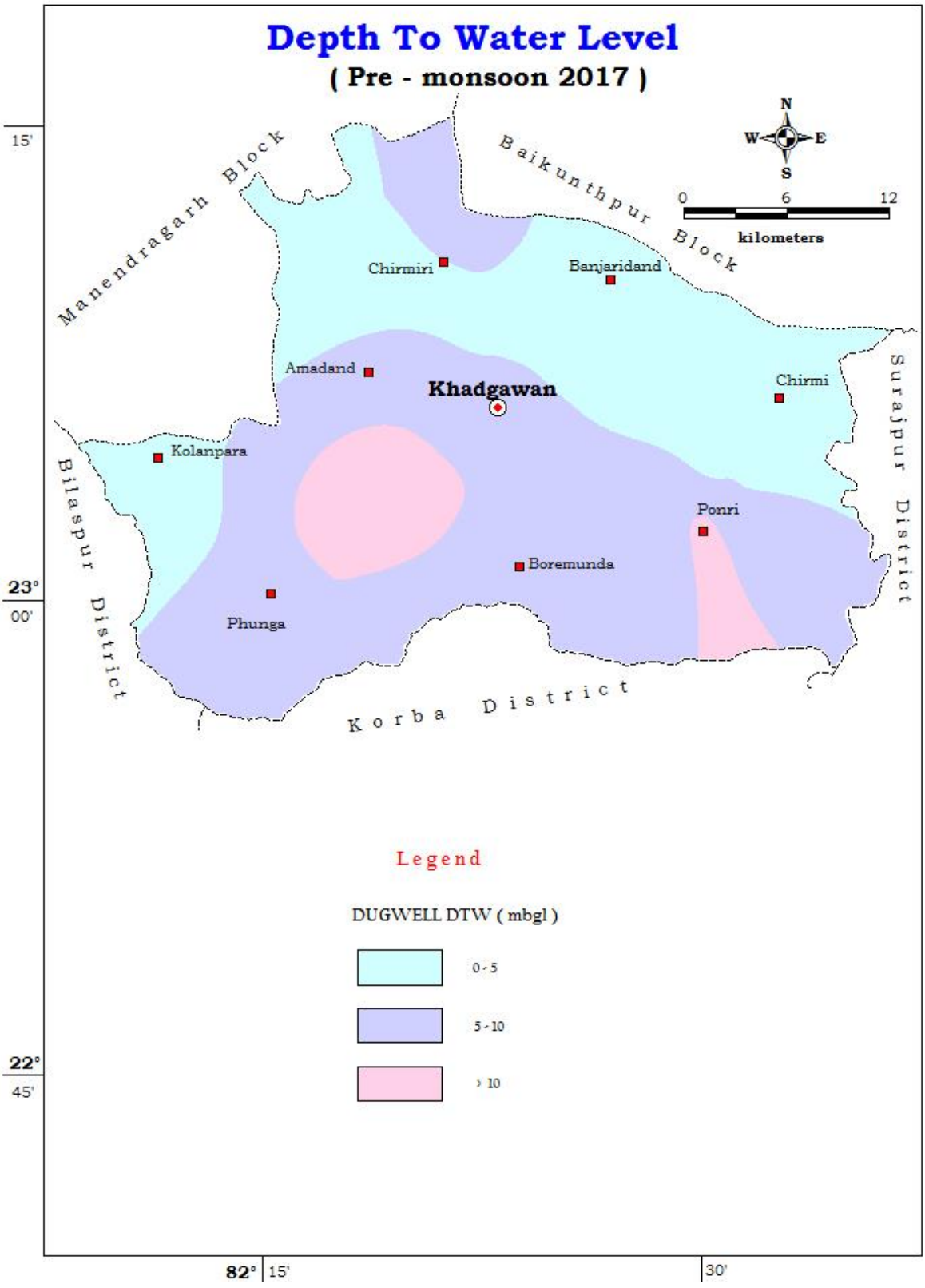

Figure-4: Depth to water level map Phreatic Aquifer (Pre-monsoon)

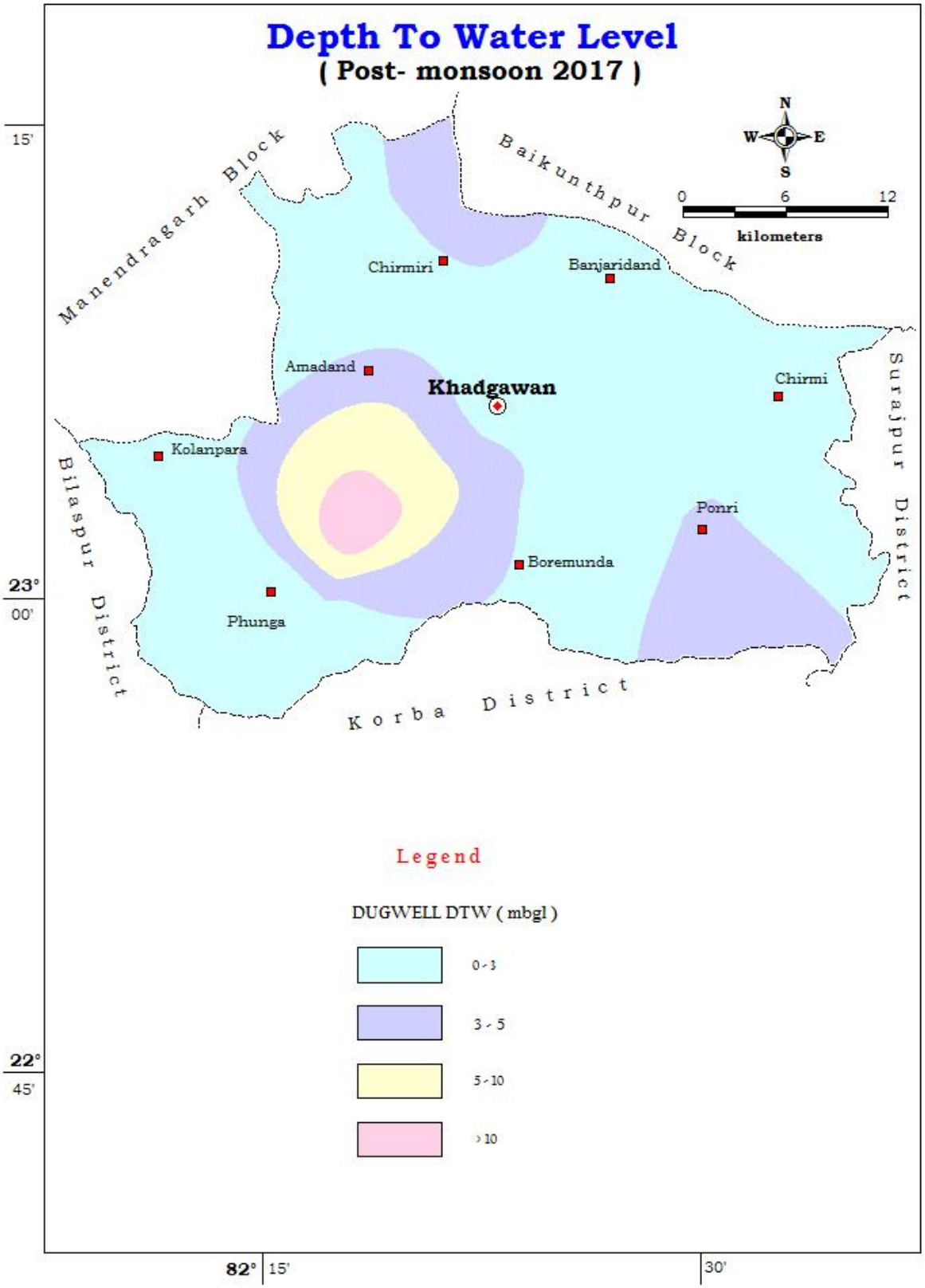

Figure 5: Depth to water level map Phreatic Aquifer (Post-monsoon)

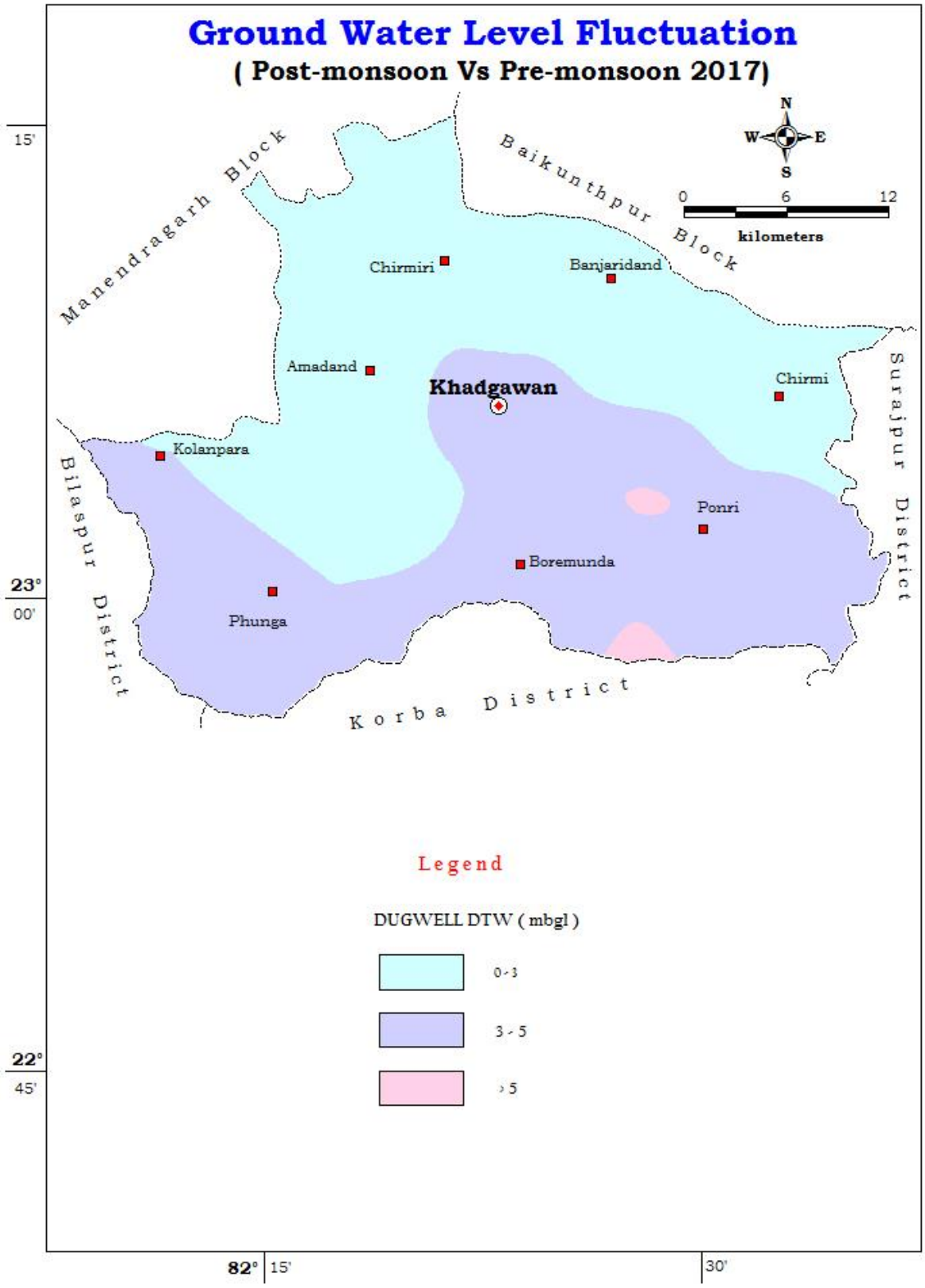

Figure 6: Depth to water level fluctuation map of Phreatic Aquifer

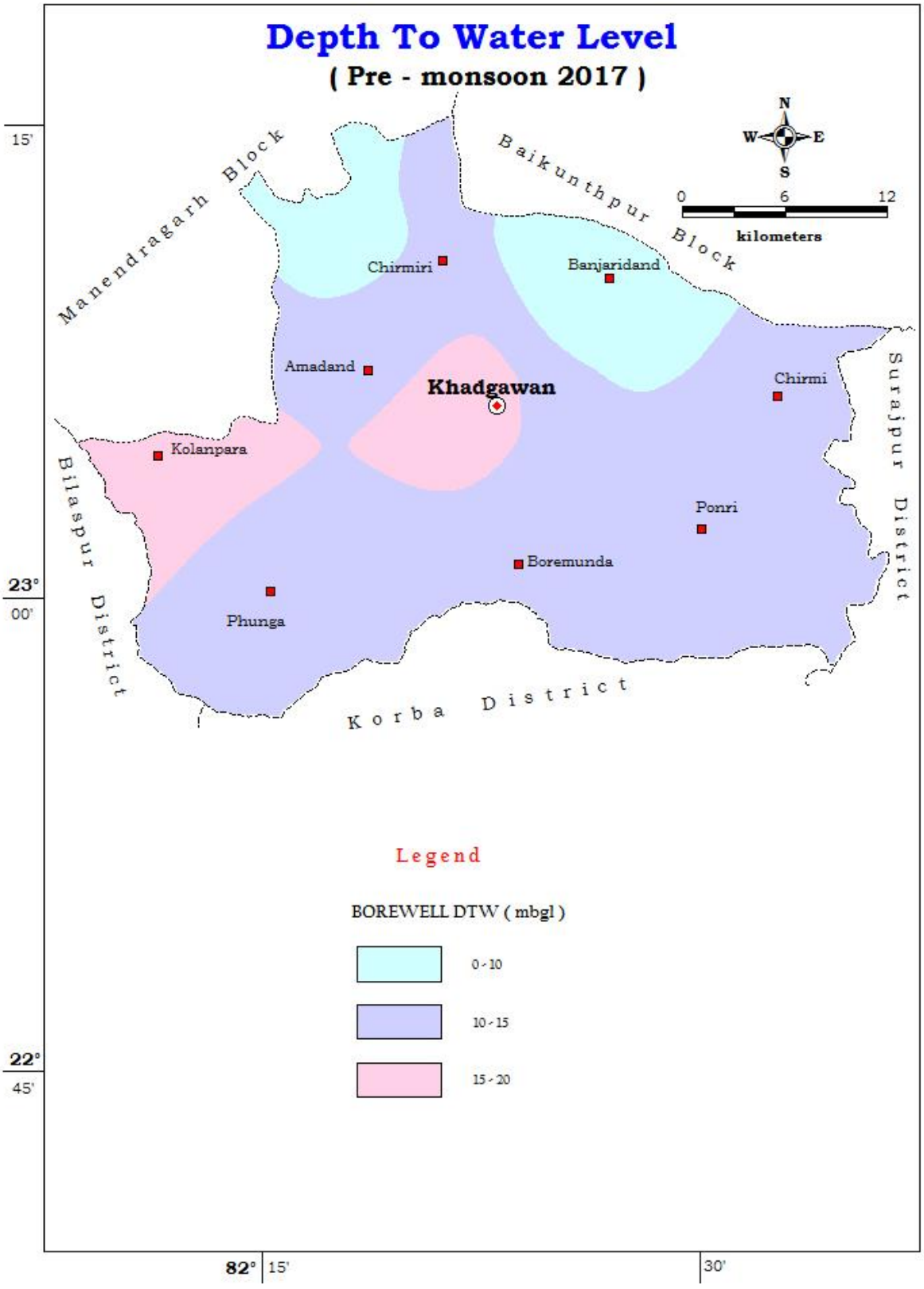

Figure-7: Depth to water level map Fractured Aquifer (Pre-monsoon)

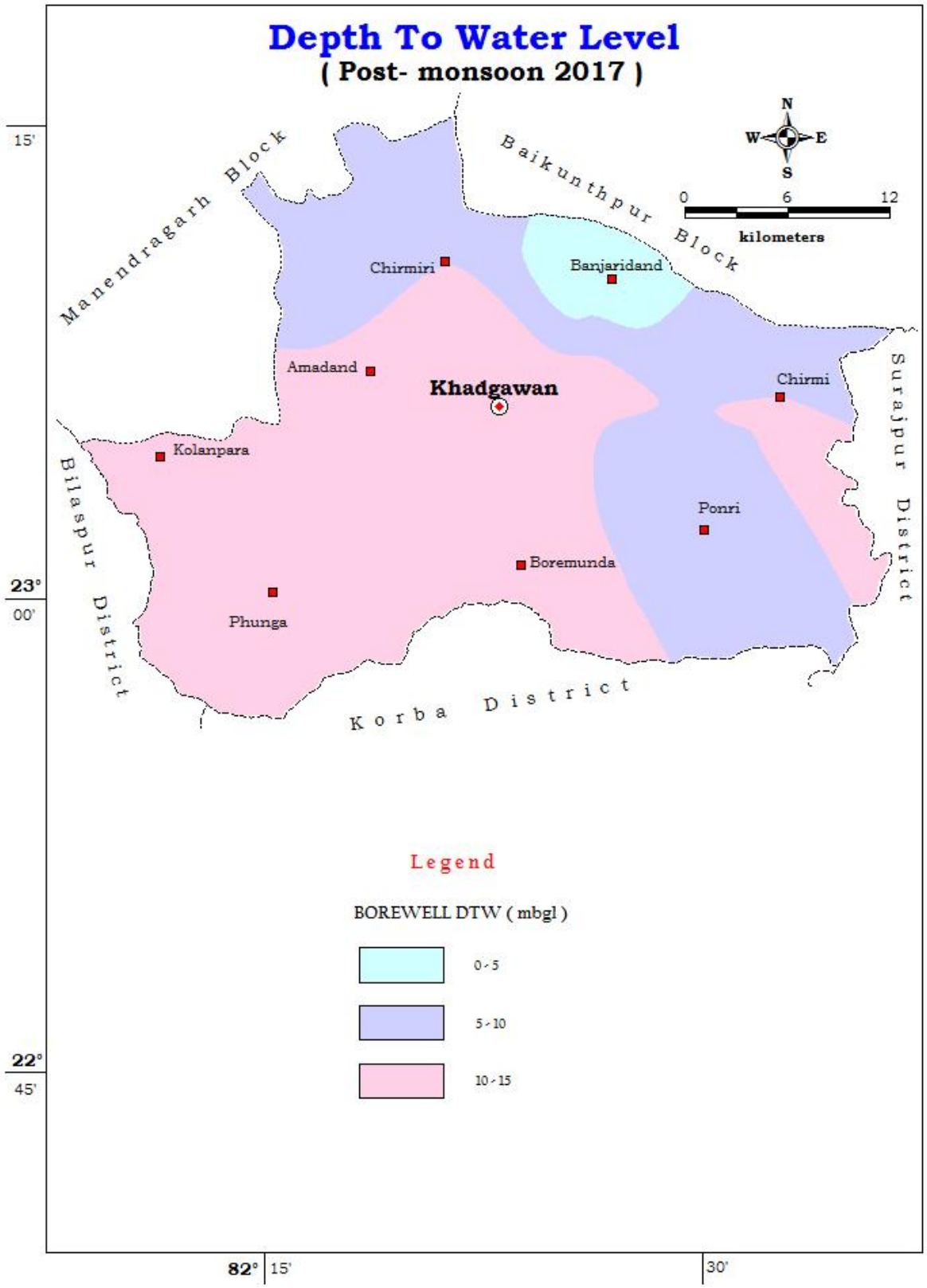

Figure-8: Depth to water level map Fractured Aquifer (Post-monsoon)

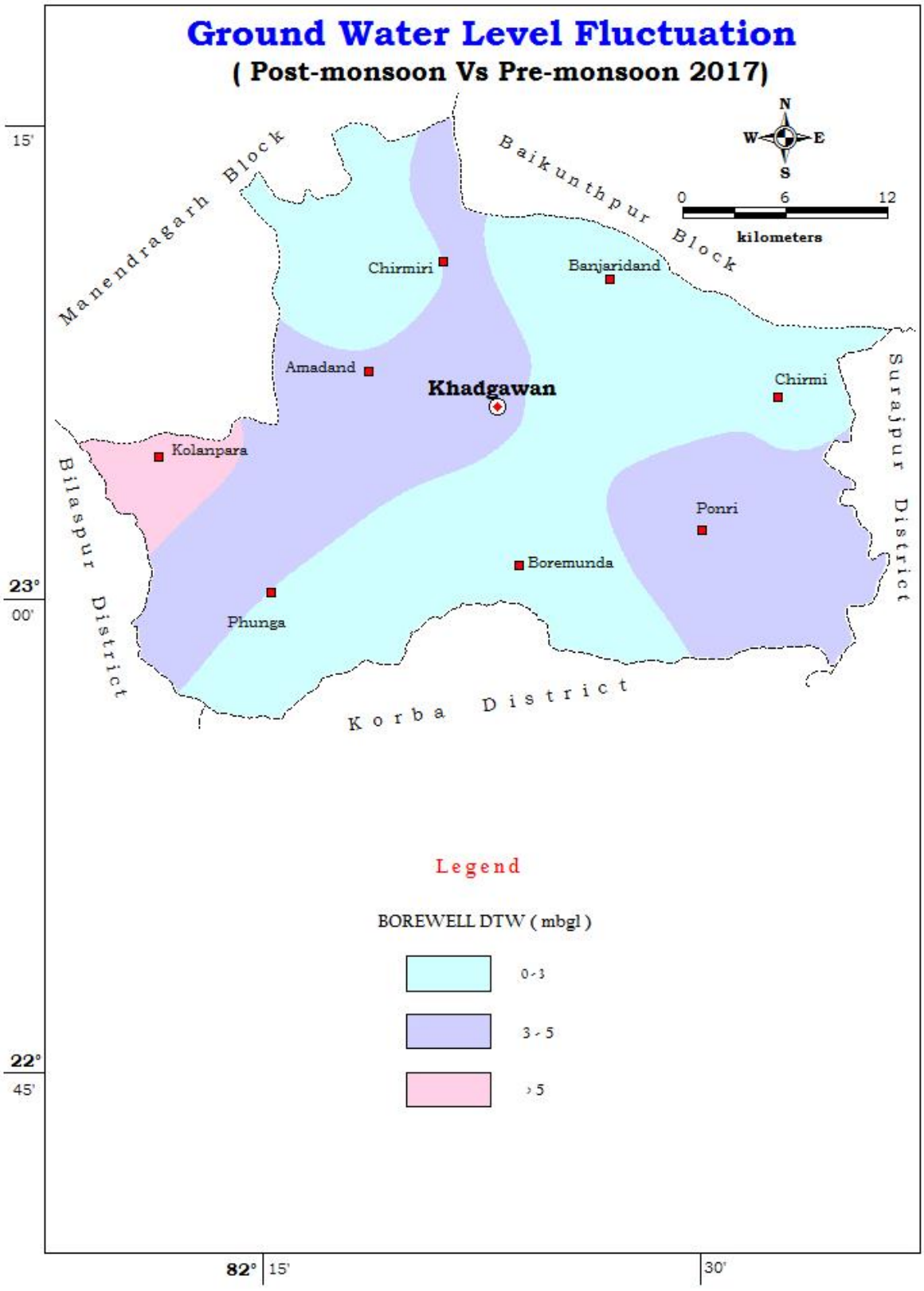

Figure 9: Depth to water level fluctuation map of Fractured Aquifer

(iv) <u>The long term water level trend</u>: There is no significant decline in water level in pre and post monsoon period in all observed NHS networks.

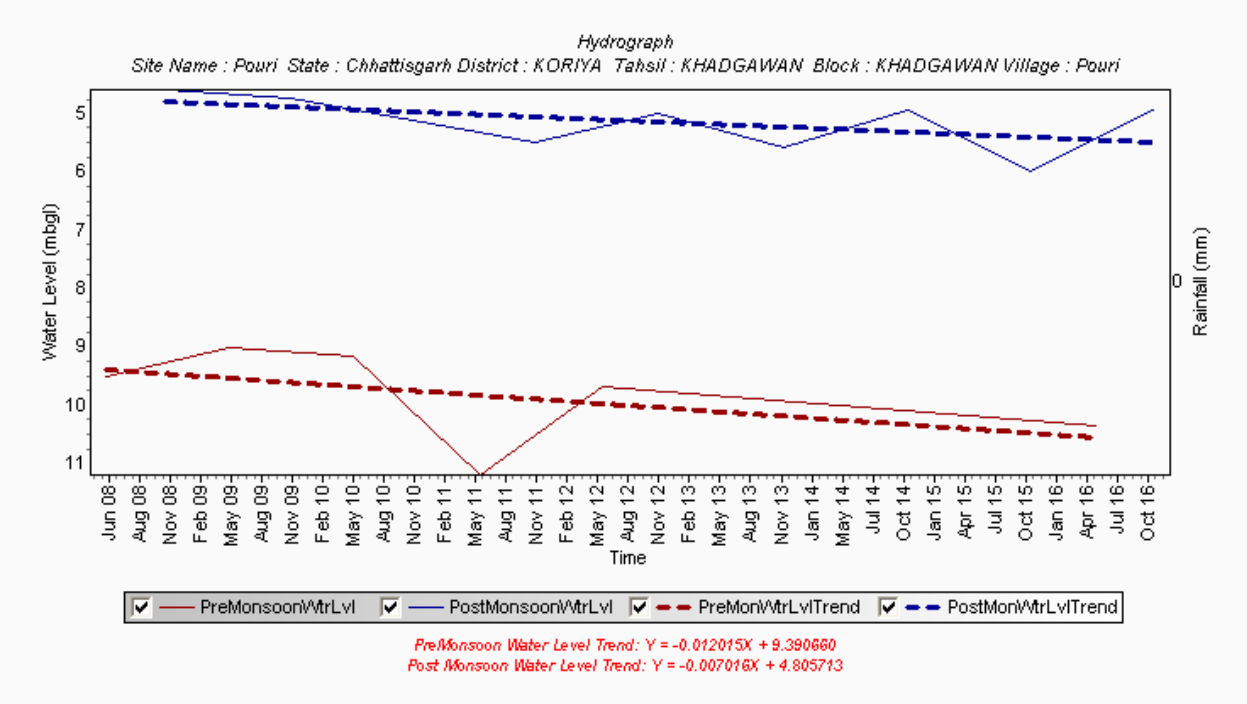

Figure 10: Hydrograph of Pouri village, Khadgawan block

2. Aquifer Disposition:

Number of Aquifers: There are only one major aquifers viz. Gondwana Sandstone which in phreatic and fractured condition serve as major aquifer system in the block. Although there are few patches of Deccan basalt, unclassified metamorphic and granite.

3-d aquifer disposition and basic characteristics of each aquifer:

Geologically the block exhibits lithology of Archean to Cretaceous. More than 80 % of the Block area are covered by Gondwana Sandstone of Permian age. At few places Deccan trap of Cretaceous age has been exposed. Apart from these rocks at some place Unclassified metamorphic and Granite of Archean to Proterozoic age also occurs.

The Gondwana Super Group of formations can be divided into two groups. The first one consists of Barakar and Talchir sand stone, shales, siltstone with coal seams. The Barakar sand stone are of felspathic in composition and medium to coarse grained. When the sand stone is enriched with siliceous material it acts like a hard rock, becomes impervious and hence is not a good aquifer. The shales are fine grained and at times are carbonaceous in nature. They are not good aquifers. The ground water movement is controlled by the intergranular pore spaces, joints and fractures. The ground water occurs under water table, semi -confined to confined conditions. The shale beds act as confining layer thereby differentiating various aquifer systems existing this part of the area. The Talchir sand stones are mostly fine grained, compact and yield low discharges. Four exploratory bore wells were drilled by the department in this part of the area covering Barakar formations.

The average thickness of the weathered portion in the area is around 21 m. The occurrences of fractures at depth in the area are not common and whenever occur are less potential in ground water point of view. Fractures are mostly confined to 100m depth. In general, the discharge varies from negligible to 4.21 lps with an average yield of 1.5 lps. The development in these formations is mostly by way of dug wells. The average drawdown of the formation is around 21.7 m.

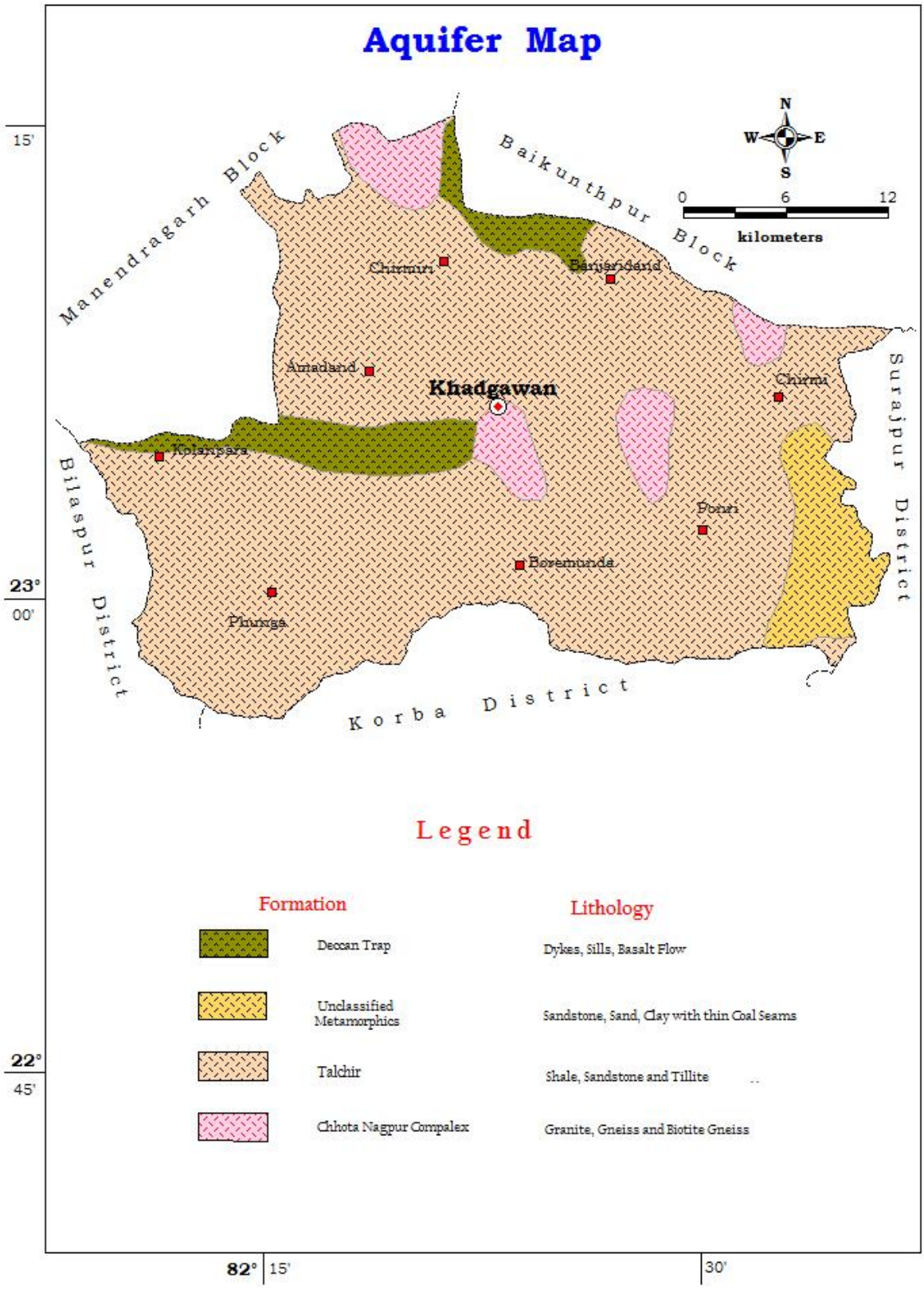

Figure 11: Aquifer map of Khadgawan block

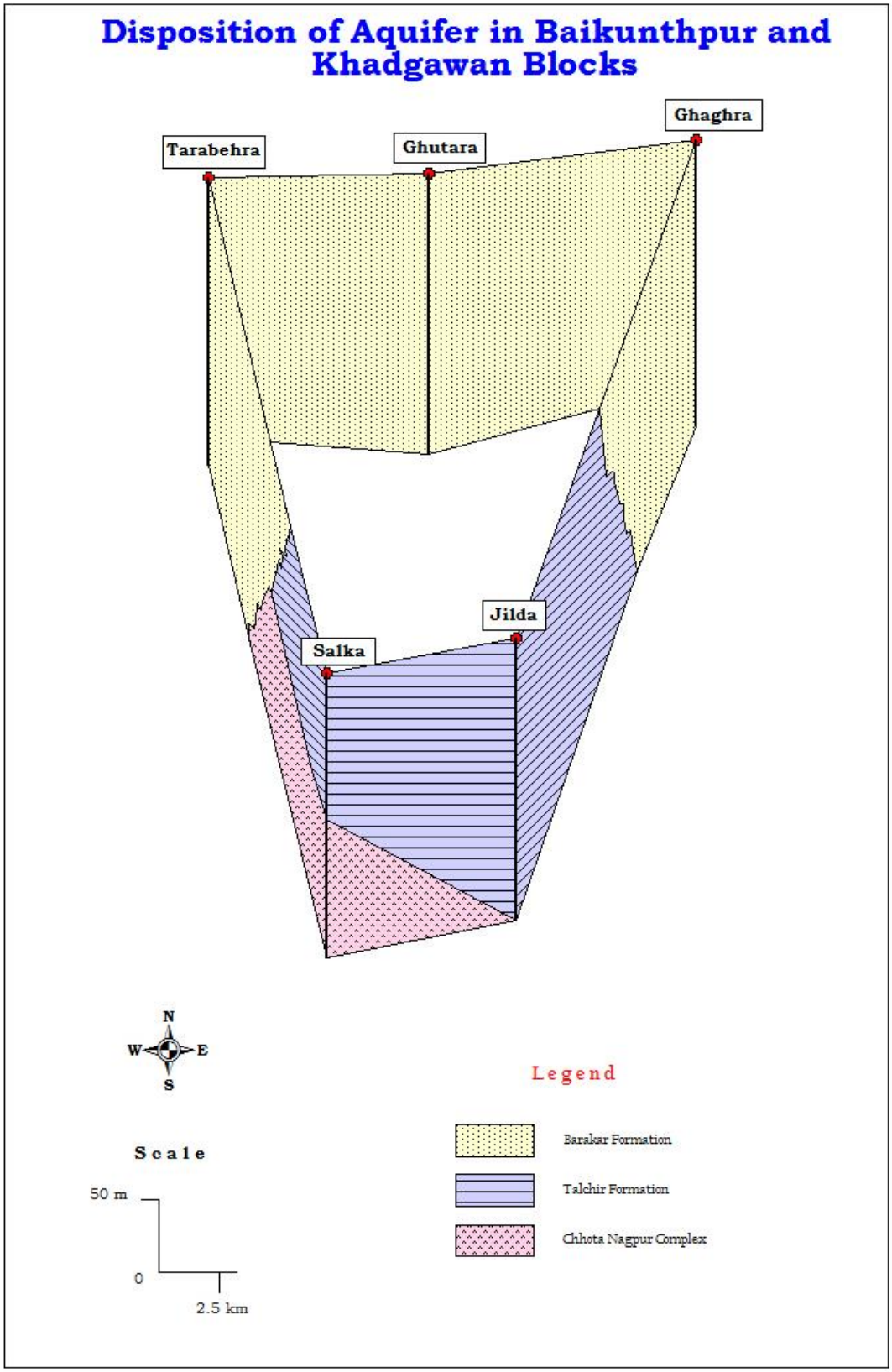

Figure-12, Disposition of Aquifer, Khadgawan Block

3. Ground water Resource, extraction, contamination and other issues:

Aquifer wise resource availability is given in the table -4 where the total resource available in Khadgawan block is 6405.2 ham.The extraction details and the future scenario (2025) along with the categorisation is depicted in the table-6 & 7.

Table-6: Ground water Resources of Khadgawan block

District	Assessment Unit / Block	Net Ground Water Availability in Ham	Existing Gross Ground Water Draft for Irrigation in Ham	Existing Gross Ground Water Draft for Domestic & Industrial Water Supply in Ham	Existing Gross Ground Water Draft for All Uses in Ham	Allocation For Domestic & Industrial Water Supply in Ham (2025)	Net Ground Water Availability for Future Irrigation Development in Ham (2025)
Khadgawan	Khadgawan	9587.28	2704	413.09	3117.09	570.68	6312.6

Table 7 Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorisation
Khadgawan	Khadgawan	32.51	Safe

Categorisation: Khadgawan block falls in safe category. The stage of Ground water development is 32.51 %. The Net Ground water availability is 9587.28 ham. The Ground water draft for all uses is 3117.09 Ham. The Ground water resources for future uses for Khadgawan Block is 6883.28 Ham.

Chemical Quality of Ground water and Contamination**:** Throughout the study area, the water samples from both dugwell and handpumps were collected and chemical analysis has been completed (Annexure I). In most of the locations especially wherever the sample source is shallow tube well there is higher concentration of Fe content. At few locations such as Khandora, Katkona and Bhauta village, there is higher concentration of Fluoride. Apart from these two elements other parameters are within permissible limit.

Ground Water Resource enhancement:

Aquifer wise space available for recharge and proposed interventions:

Table -8: Summarised detail of Volume of porous space available for recharge (Aquifer wise)

Formation	Area Identified for Artificial Recharge (Sq Km)	Available thickness of unsaturated zone (m)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (MCM)
Gondwana sandstone	260	1.5, 4.5	0.015	7.65

4. Issues and Management plan

Issues:

(i) During summer, dugwells in villages are dry except a few locations. Several handpumps also stop yielding water. The aquifer itself is a low yielding one.

(ii) High value of Fluoride has been reported from Khandora, Katkona and Bhauta village.

Management Plan

Supply side interventions:

(i) Khadgawan block experienced drought situation because of poor monsoon. Sanctuary wells may be constructed for drinking needs as a step towards crisis management.

(ii) It has been observed during fieldwork in pre-monsoon period, there is colossal wastage of groundwater through public water supply system. In this state, the Government has undertaken “Nal Jal Yojana” to provide water to villages. Under this scheme, the government has dug borewells of about 150-200feet depth, lowered a pump in the well to draw out water and constructed a small tank to hold water. Unfortunately, people do not switch off the pump once the tank is full. Also the pipes are not fitted with taps to control the flow of water. So Information, education and Communication (IEC) activities to be organized to sensitize people on the issues of depleting groundwater resource. Massive awareness campaigns are essential to aware people about the importance community participation in saving water.

(iii) Desiltation of existing Tanks and Talabs to be carried out for efficient storage of rainwater. Also Rain water harvesting structures (Figure 13, Annexure I) may be constructed in villages to reduce stress on groundwater.

(iv) It has been observed that the demand of ground water is increasing for irrigation, industrial and domestic uses. At location near urban areas water level is declining, so we have to go for artificial recharge on a long term sustainability basis. Artificial

Recharge structures may be constructed at suitable locations especially in the areas where the water level remains more than 3m in the post-monsoon period in this block to arrest the huge non-committed run-off and augment the ground water storage in the area. The different types of artificial structures feasible in the block are described in table-9.

Table-9: Types of Artificial Recharge structures feasible

Name of Block	**Area Feasible for recharge (sq.km)**	**Volume of Sub Surface Potential to be recharged through other methods (MCM)**	**Types of Structures Feasible and their Numbers**			
			P	**NB & CD**	**RS**	**G**
Khadgawan	260	7.65	26	255	102	306
	Recharge Capacity (MCM)		**5.2**	**2.55**	**1.02**	**1.53**
	Estimated cost (Appx.)		**Rs. 10.7 crore**			

(v) Govt. may set up network of grids to purchase electricity generated from solar panels. This will encourage the farmers not to waste electricity by extracting groundwater unnecessarily and also provide alternative income.

(vi) Fluoride and Iron filter plant may be installed in the villages having higher value of contaminants.

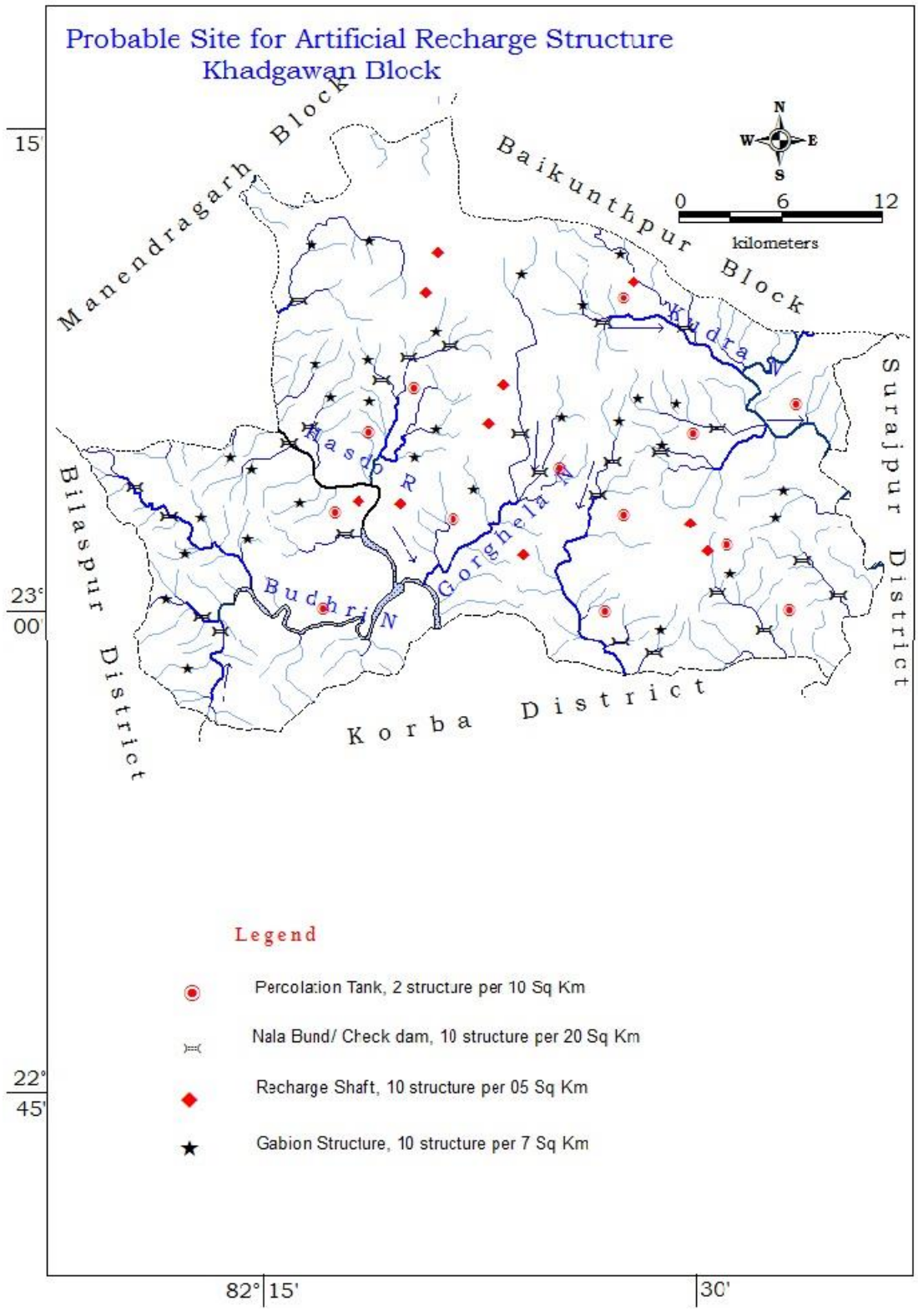

Figure 13: Map of proposed sites for artificial recharge of groundwater in Khadgawan block

Demand Side Interventions

Since the stage of development in the block is 32.51 %. There is scope of utilizing more ground water for future irrigation purpose. For effective utilization of Ground water existing draft for irrigation may be coupled with micro irrigation system. Change in irrigation pattern, optimum use of available resource, use of ground water potential created after artificial recharge can lead to groundwater savings and increase in gross cropped area of the block (Table: 10).

Table 10: Detail of groundwater saved through change in cropping pattern

Block	Existing Gross Ground Water Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham	Net Ground Water Availability for Future Irrigation Development in Ham	GW Potential created after Artificial recharge structure in Ham	Total GW Potential created in Ham	Additional Irrigation potential creation for Maize/ wheat in winter season in Ha (Assuming 500 mm water requirement)	Percent increase in Crop area compare to Gross cropped area
Khadgawan	2704	811.2	6312.6	765	7888.8	15777.6	50.48

Annexure I Proposed sites for artificial recharge of groundwater in Khadgawan block

Sl No	Village_name	Longitude	Latitude	Feasible structure
1	Kadambahara	82.4438	23.0596	Check Dam/ Nala Bund
2	Tedama	82.5612	23.0253	Check Dam/ Nala Bund
3	Gengi	82.5821	23.0074	Check Dam/ Nala Bund
4	Tolanga	82.5129	23.009	Check Dam/ Nala Bund
5	Sagarpur	82.5471	22.9893	Check Dam/ Nala Bund
6	Patma	82.5192	23.1011	Check Dam/ Nala Bund
7	Padita	82.4841	23.0877	Check Dam/ Nala Bund
8	Jilibandh	82.4516	23.075	Check Dam/ Nala Bund
9	Karwa	82.41	23.0715	Check Dam/ Nala Bund
10	Khadgawan	82.3988	23.0916	Check Dam/ Nala Bund
11	Bari	82.4566	22.9829	Check Dam/ Nala Bund
12	Mugum	82.4759	22.977	Check Dam/ Nala Bund
13	Banjaridand	82.445	23.1649	Check Dam/ Nala Bund
14	Govindpur	82.4937	23.1459	Check Dam/ Nala Bund
15	Barampur	82.3586	23.137	Check Dam/ Nala Bund
16	Barampur	82.3344	23.1303	Check Dam/ Nala Bund
17	Makundpur	82.3191	23.1191	Check Dam/ Nala Bund
18	Balsota	82.2714	23.1644	Check Dam/ Nala Bund
19	Udhanapur	82.2781	23.0946	Check Dam/ Nala Bund
20	Koda	82.1837	23.0713	Check Dam/ Nala Bund
21	Neori	82.1998	23.0508	Check Dam/ Nala Bund
22	Lalpur	82.2259	22.9889	Check Dam/ Nala Bund
23	Belbehara	82.2199	23.0055	Check Dam/ Nala Bund
24	Kochaka	82.2983	23.0388	Check Dam/ Nala Bund
25	Udhanapur	82.2661	23.0864	Check Dam/ Nala Bund
26	Bari	82.4799	22.9894	Gully Plug/ Gabion Structure
27	CHIRMIRI	82.3807	23.177	Gully Plug/ Gabion Structure
28	Gadhtar	82.4567	23.1768	Gully Plug/ Gabion Structure
29	Singhat	82.4229	23.0996	Gully Plug/ Gabion Structure
30	Ganeshpur	82.4672	23.1093	Gully Plug/ Gabion Structure
31	Ganeshpur	82.4889	23.1063	Gully Plug/ Gabion Structure
32	Badesalhi	82.5508	23.0616	Gully Plug/ Gabion Structure
33	Badesalhi	82.5459	23.0482	Gully Plug/ Gabion Structure
34	Tolanga	82.5202	23.0184	Gully Plug/ Gabion Structure
35	Duggi	82.442	23.0887	Gully Plug/ Gabion Structure
36	Padita	82.4852	23.0886	Gully Plug/ Gabion Structure
37	Banjaridand	82.4353	23.1663	Gully Plug/ Gabion Structure
38	Sajapahad F7	82.3295	23.2028	Gully Plug/ Gabion Structure
39	Balsota	82.2659	23.1802	Gully Plug/ Gabion Structure

Sl No	Village_name	Longitude	Latitude	Feasible structure
40	Barampur	82.3505	23.1435	Gully Plug/ Gabion Structure
41	Kadrewa	82.3111	23.1294	Gully Plug/ Gabion Structure
42	Phunga	82.242	23.0363	Gully Plug/ Gabion Structure
43	Dhoulpur	82.2444	23.0728	Gully Plug/ Gabion Structure
44	Sainda	82.3505	23.0937	Gully Plug/ Gabion Structure
45	Piparbahara	82.3385	23.0788	Gully Plug/ Gabion Structure
46	Jadhari	82.2894	23.11	Gully Plug/ Gabion Structure
47	Amadand	82.3119	23.1078	Gully Plug/ Gabion Structure
48	Bardar	82.3722	23.0624	Gully Plug/ Gabion Structure
49	Painari	82.2717	23.0557	Gully Plug/ Gabion Structure
50	Belbehara	82.2194	23.019	Gully Plug/ Gabion Structure
51	Jadhari	82.2805	23.1271	Gully Plug/ Gabion Structure
52	Lalpur	82.2236	22.9913	Gully Plug/ Gabion Structure
53	Sakada	82.2076	22.9705	Gully Plug/ Gabion Structure
54	Mendra	82.2146	23.0482	Gully Plug/ Gabion Structure
55	Dhoulpur	82.2323	23.0787	Gully Plug/ Gabion Structure
56	Gadhtar	82.4583	23.1617	Percolation Tank
57	Chirmi	82.5573	23.1066	Percolation Tank
58	Bachara	82.5178	23.0337	Percolation Tank
59	Sagarpur	82.5542	22.9965	Percolation Tank
60	Chhuri	82.4478	22.9988	Percolation Tank
61	Kadambahara	82.4583	23.0494	Percolation Tank
62	Karwa	82.4213	23.0732	Percolation Tank
63	Sainda	82.3376	23.1149	Percolation Tank
64	Chhote Kaluwa	82.3111	23.0918	Percolation Tank
65	Kochaka	82.2918	23.0508	Percolation Tank
66	Katkona	82.2854	23.0002	Percolation Tank
67	Bardar	82.3602	23.0471	Percolation Tank
68	Padita	82.4985	23.091	Percolation Tank
69	Khadgawan	82.3803	23.0959	Recharge Shaft
70	Thangaon	82.3891	23.116	Recharge Shaft
71	Pondi	82.4969	23.0445	Recharge Shaft
72	Bachara	82.5065	23.0304	Recharge Shaft
73	Kochaka	82.3055	23.0564	Recharge Shaft
74	Shivpur	82.3331	23.0579	Recharge Shaft
75	CHIRMIRI	82.3513	23.1852	Recharge Shaft
76	Bhukbhuki	82.3462	23.1658	Recharge Shaft
77	Gadhtar	82.464	23.1695	Recharge Shaft
78	Ratanpur	82.4039	23.0282	Recharge Shaft

Annexure II Chemical analysis Khadgawan Block

Location	Source	pH	TDS	EC	CO3	HCO3	Cl	F	SO4	Ca	Mg	Na	K	TH	PO4	Sio2	Fe
Khandora	HP	7.5		445	0	207	21	**1.67**	12	16	7.2	73	0.4	70	0	38	0.347
Chirmiri	HP	7.59		435	0	159	14	0.52	5	44	9.6	23	0.4	150	0	14	0.034
Chote Salhe	DW	7.48		224	0	122	7	0.33	5.5	20	9.6	14	0.7	90	0	11	0.128
Jilda	HP	7.13		393	0	232	7	0.24	2	36	17	24	2.2	160	0	14	0.159
Singhat	HP	7.52		546	0	183	42	0.17	24	56	17	34	0.6	210	0	17	2.069
Bodemuda	HP	7.11		478	0	244	14	0.26	4	16	4.8	87	0.5	60	0	14	0.503
Katkona	HP	7.8		487	0	268	21	**1.55**	8	20	24	54	0.4	150	0	12	0.034
Chirmiri	HP	7.7		302	0	134	28	0.36	5	40	12	4.7	1.8	150	0	15	1.943
Barbaspur	HP	7.42		411	0	134	35	0.16	21	48	14	16.5	0.5	180	0	14	3.728
Sajapahar	HP	7.2		536	0	293	21	0.14	14	48	26	29	1.7	230	0	20	0.065
Mero	HP	7.3		432	0	183	21	0.21	12	24	12	45	0.4	110	0	21	1.036
Bhauta	HP	7.2		502	0	244	21	**1.83**	12	28	9.6	71	1.9	110	0	14	0.159