केंद्रीय भूमि जल बोर्ड

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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

PALI BLOCK, KORBA DISTRICT, CHHATTISGARH

उत्तर मध्य छत्तीसगढ़ क्षेत्र, रायपुर

North Central Chhattisgarh Region, Raipur

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AQUIFER MAPPING AND MANAGEMENT PLAN FOR PALI BLOCK (KORBA DISTRICT), CHHATTISGARH

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ABBREVIATIONS

DW	Dugwell	**m bgl**	meter below ground level
EC	Electrical Conductivity	**m2/day**	Square meter/ day
GS	Gabion structures	**m3/day**	cubic meter/day
GW/ gw	Ground Water	**MCM/mcm**	Million Cubic Meter
ha	Hectare	**mm**	Milimeter
Ham	Hectare meter	**OE**	Overexploited
HP	Handpump (Shallow)	**Sq Km**	Square Kilometer
lpm	litres per minute	**STP**	Sewage Treatment Plant
lps	liters per second	**T**	Transmissivity
m	meter	**TW**	Tubewell

BLOCK-WISE AQUIFER MAPS AND MANAGEMENT PLANS

1. Salient Information:

About the area: Pali Block is situated on the south western part of Korba district of Chhattisgarh and is bounded on the north by Podi Uprora block, west and south by Bilaspur district, in the east by Katghora and Podi Uprora block. The block area lies between 22.20 and 22.71 N latitudes and 82.60 and 83.14 E longitudes. The geographical extension of the study area is 1504.82 sq.km representing around 21 % of the district's geographical area. Administrative map of the block is shown in Fig. 1. Geomorphology mainly comprises of structural plains and denudational hills on Gondwana rocks and structural plains on Proterozoic rocks and pediplain. Geomorphology map is shown in Figure 2. The major drainage of the block includes Tan Nala, Jatashankari Nala, Ganjar Nala, Lilagar Nala all of which are parts of Mahanadi Basin and tributary of Hasdeo River. Drainage map shown in Fig.3.

Population: The total population of Pali block as per 2011 Census is 198746 out of which rural population is 193232 while the urban population is 5514.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
Pali	198746	100092	98654	193232	5514

Source: CG Census, 2011

Growth rate: The decadal growth rate of the block is 25 % 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. 2012 to 2017) 1155.4 mm with 50 to 60 rainy days.

Table-2: Rainfall data in Pali block in mm

Year	2012-13	2013-14	2014-15	2015-16	2016-17
Annual rainfall	1239.0	1282.00	1017.40	1063.80	1175.0

Source: IMD

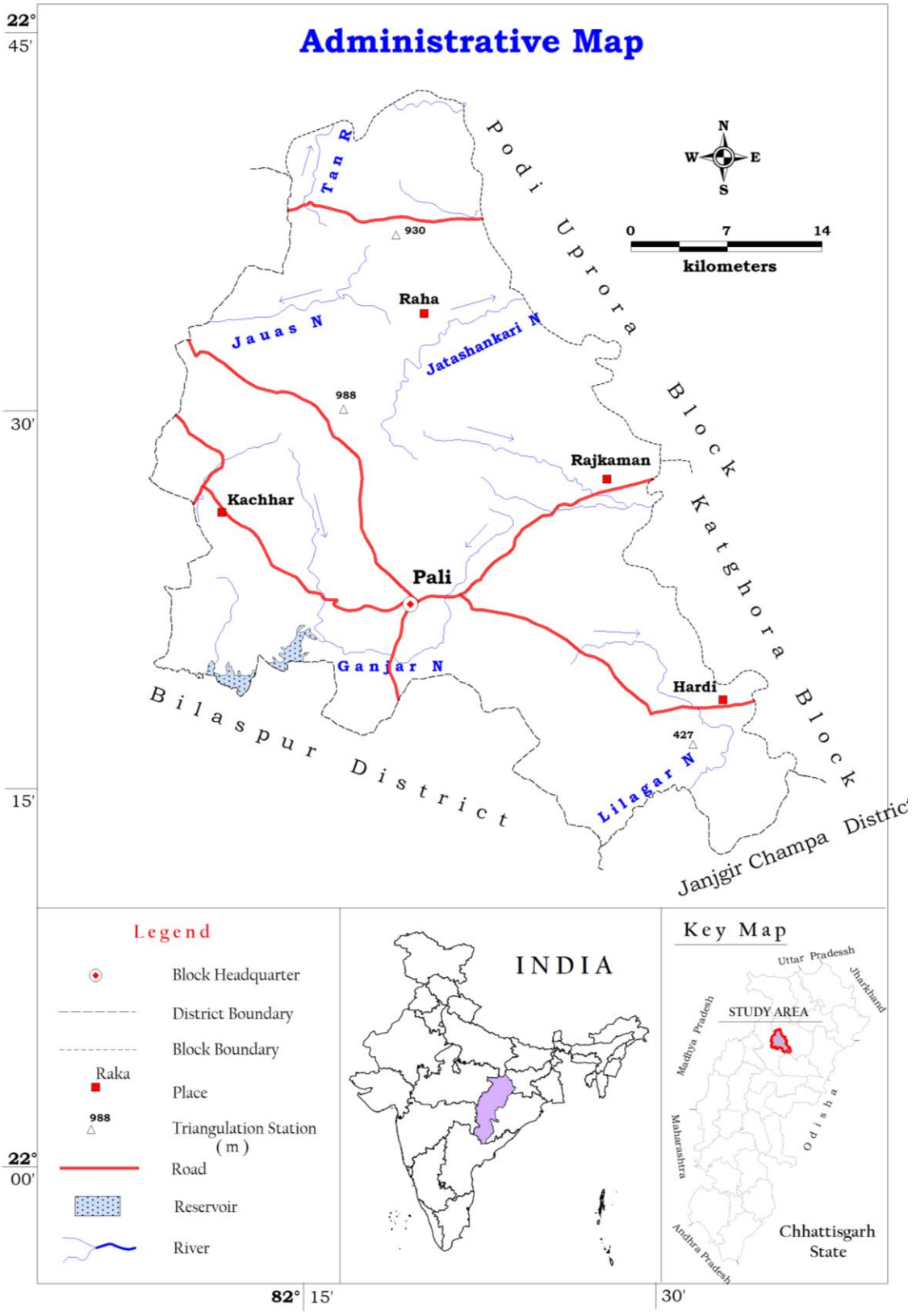

Figure 1 Administrative Map of Pali Block

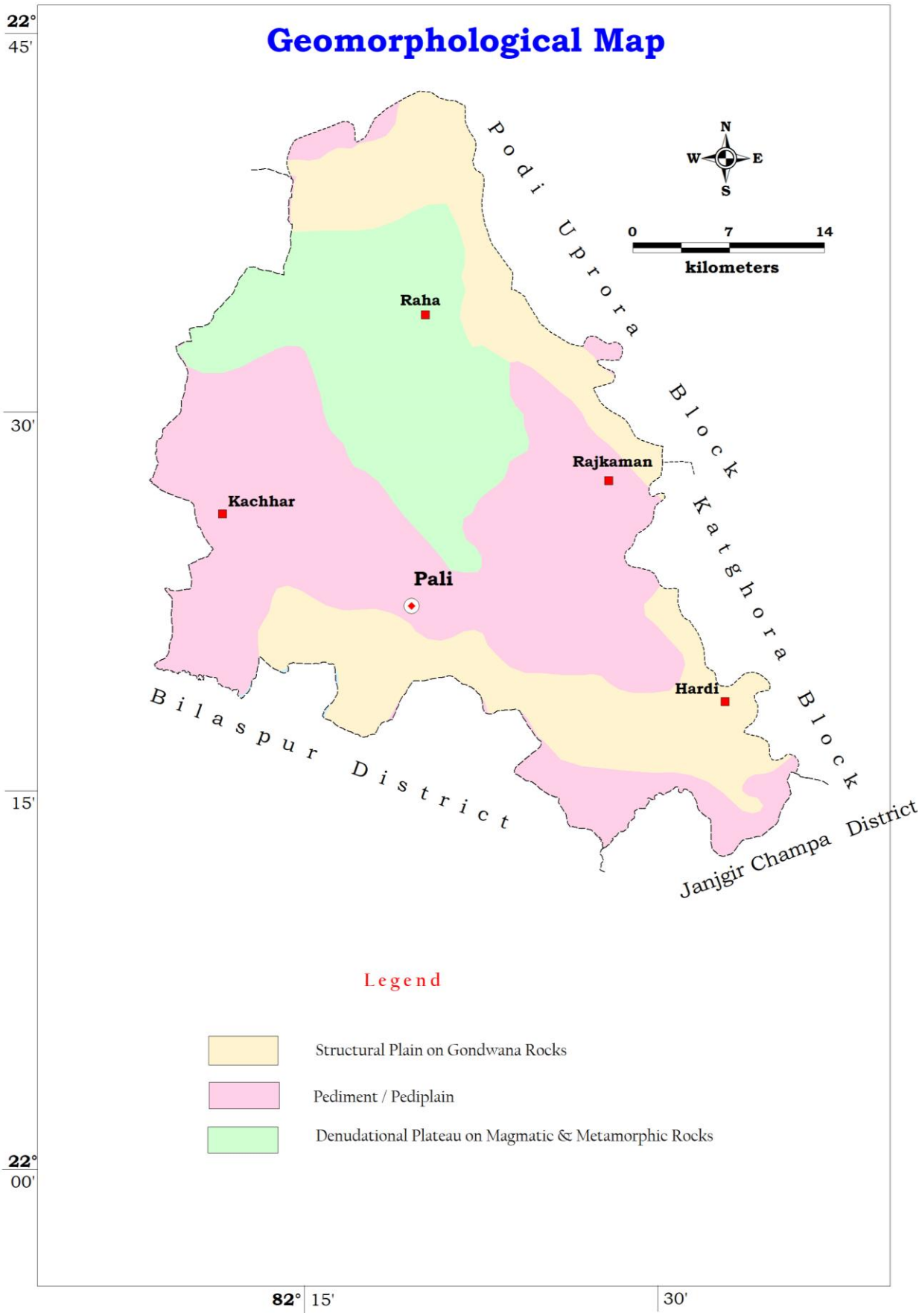

Figure 2 Geomorphology Map of Pali Block

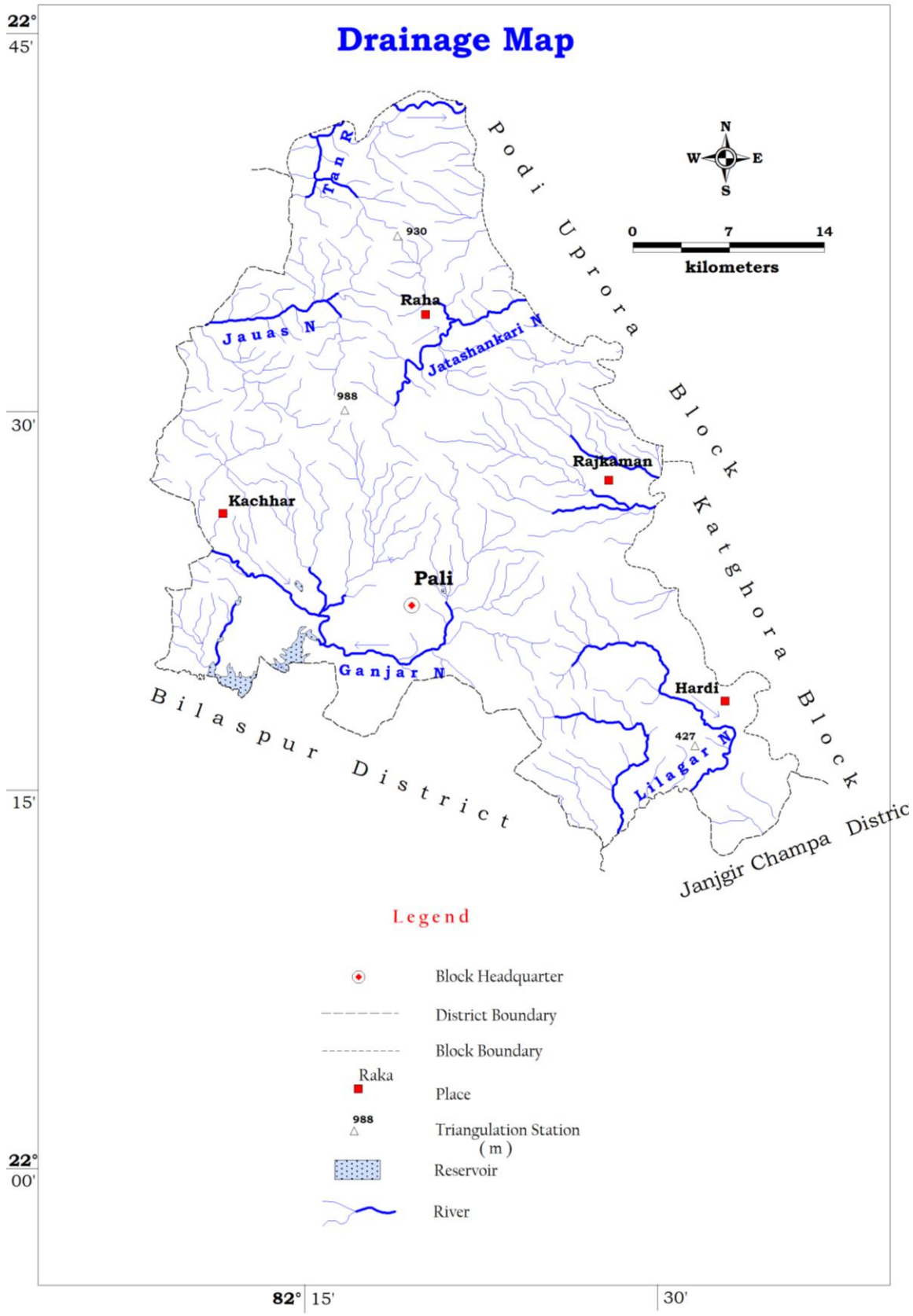

Figure 3 Drainage Map of Pali Block

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 Pali block is given in Table 3 (A, B, C, D, E).

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

Block	Total geographical area (village record)	Revenue forest area	Area not available for cultivation	Net sown area	Double cropped area	Gross cropped area
Pali	99201	43327	15832	30743	2356	33099

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
Pali	99201	43327	15832	6093	3206	30743	2356	33099

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

Block	Kharif	Rabi	Cereal				Pulses	Tilhan	Fruits Vegetables	Reshe	Mirch Masala
			Wheat	Rice	Jowar & Maize	Others					
Pali	30741	2358	206	27578	767	218	3234	618	468	52	50

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

No. of canal s (private and Govt.)	Irrigated area	No.of bore wells/ Tube wells	Irrigated area	No. Of dug wells	Irrigated area	No. of Talabs	Irrigate d area	Irrigated area by other sources	Net Irri-gated area	Gross irrigat ed area	% of irrigated area wrt. Net sown area
-	691	-	59	-	197	-	168	195	1310	1310	4.26 %

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
Pali	1310	256	19.54

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

Table – 4 (A): Ground Water Budget of Pali block in Ham

Assessment Unit Name	Assessment Unit code	Ground Water Recharge(Ham)				Total Annual Ground Water (Ham) Recharge	Total Natural Discharges (Ham)
		Monsoon Season		Non-monsoon season			
		Recharge from Rainfall	Recharge from Other Sources	Recharge from Rainfall	Recharge from Other Sources		
Pali	CGKO0004	6066.29	191.82	940.43	373.31	7571.85	388.07

Table – 4 (B): Ground Water Dynamic Resource of Pali block in Ham

Annual Extractable Ground Water Recharge (Ham)	Current Annual Ground Water Extraction(Ham)				Annual GW Allocation for for Domestic Use as on 2025	Net Ground Water Availability for future use	Stage of Ground Water Extraction (%)	Categorization (OE/Critical/Semicritical/Safe)
	Irrigation Use	Industrial Use	Domestic Use	Total Extraction				
7183.78	1456	0.00	502.85	1958.85	590.32	5137.46	27.27	Safe

Table – 4 (C): Ground Water Static Resource of Pali block in Ham

Static Resources Area	**Pre-monsoon water level**	**Bottom of unconfined aquifer**	**Difference**	**Specific Yield**	**Total Static Resources**
150482	8.22	100	91.78	0.002	27622.48

Existing and Future Water Demand (2020)*:* The existing draft for irrigation in the area is 1456 Ham while the total extraction for all uses is 1958.85 Ham. At present scenario to meet the future demand for water, a total quantity of 5137.46 ham of ground water is available for future use.

Water Level Behavior: (i) Pre- monsoon water level: In the pre-monsoon period, it has been observed that in Pali block, water level in dugwells (phreatic aquifer) vary between 1.9 to 12.9 mbgl with average water level of 6.57 mbgl. In semiconfined aquifer, the maximum water level is 21.79 mbgl, the average water level is 11.90 mbgl.

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

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Pali	1.9	12.9	6.57

Water Level (in mbgl)

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

Block Name	Semiconfined Aquifer		
	Min	Max	Avg
Pali	2.5	21.79	11.90

(ii) Post- monsoon water level**:** In the post-monsoon period, it has been observed that the water level varies from 1.7 to 11.2 mbgl with an average of 4.62 mbgl in phreatic aquifer. In semiconfined/ formation, the post monsoon water level variation range is 1.80 to 20.50 mbgl with average of 9.09 mbgl.

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

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Pali	1.7	11.2	4.62

Water Level (in mbgl)

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

Block Name	Semiconfined Aquifer		
	Min	Max	Avg
Pali	1.8	20.5	9.09

(iii) Seasonal water level fluctuation: The water level fluctuation data indicates that in Pali block, water level fluctuation in phreatic aquifer varies from 0.67 to 4.45 m with an average fluctuation of 1.94 m. Water level fluctuation in semiconfined Aquifer varies from 0.15 to 7.04 m with an average fluctuation of 2.81 m.

Table 5E: Aquifer wise Depth to Water Level Fluctuation

Block Name	Phreatic Aquifer		
	Min	Max	Avg
Pali	0.67	4.45	1.94

Table 5F: Aquifer wise Depth to Water Level Fluctuation

Block Name	Semiconfined Aquifer		
	Min	Max	Avg
Pali	0.15	7.04	2.81

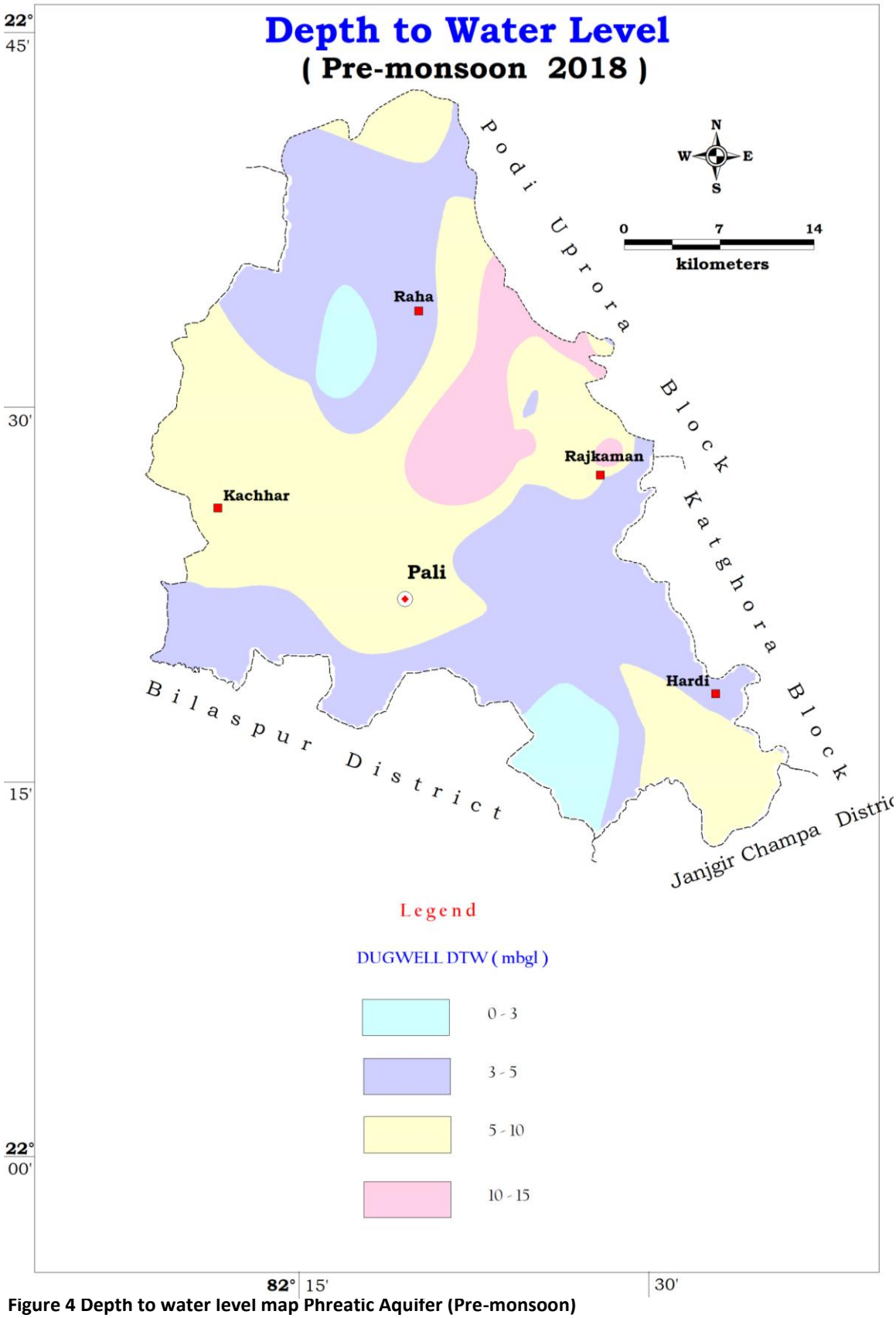

Figure 4 Depth to water level map Phreatic Aquifer (Pre-monsoon)

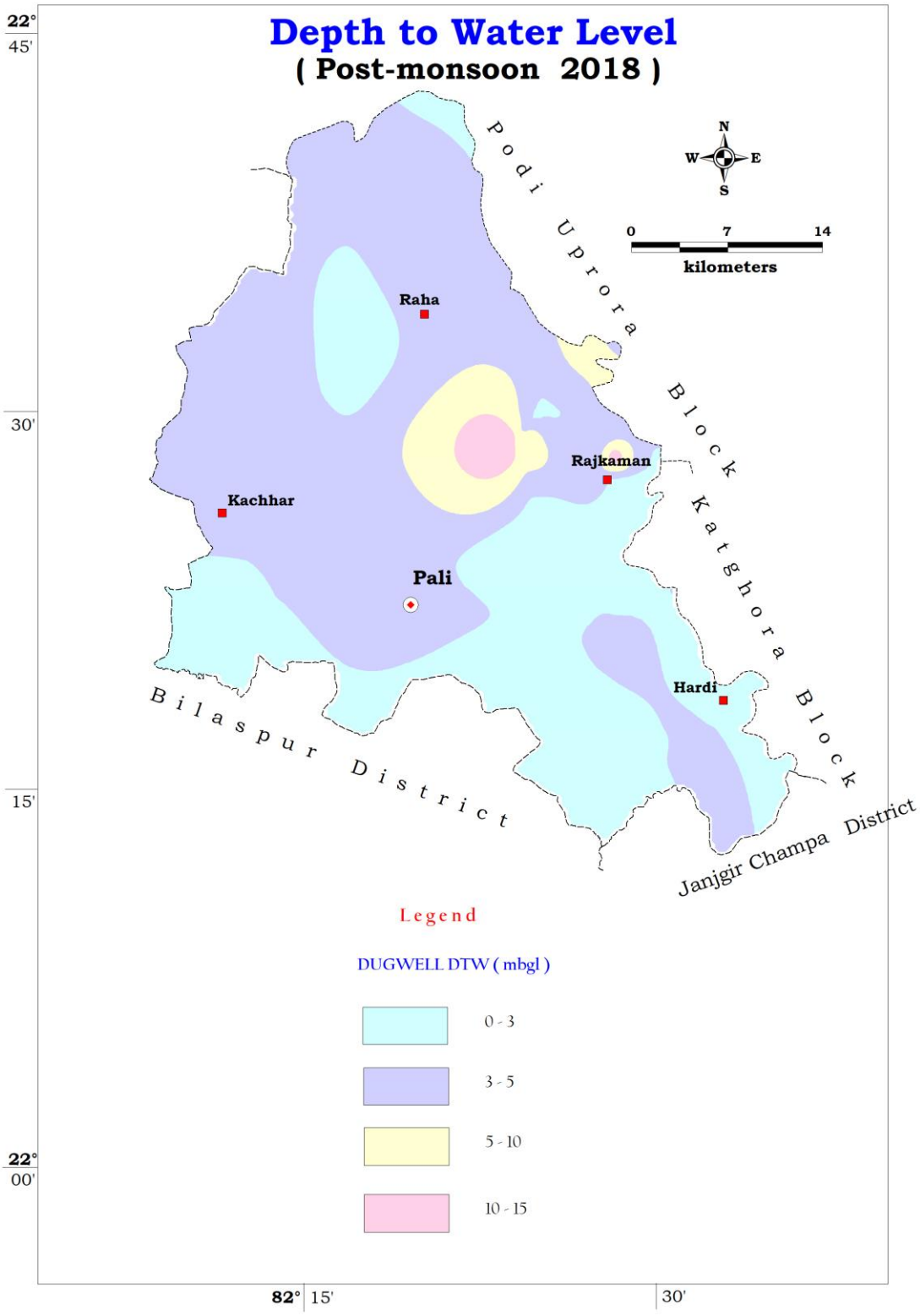

Figure 5 Depth to water level map Phreatic Aquifer (Post-monsoon)

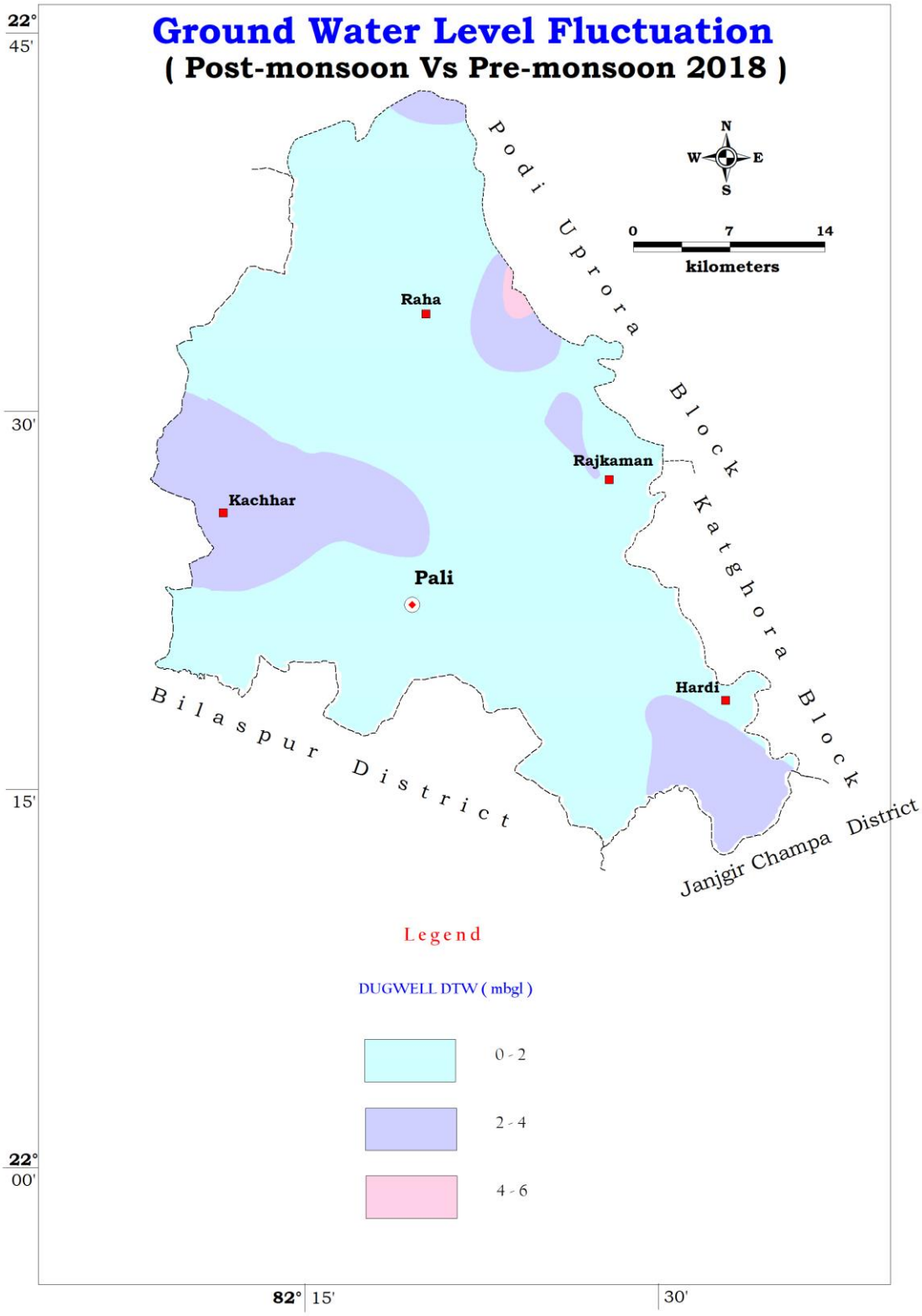

Figure 6 Depth to water level fluctuation map of Phreatic Aquifer

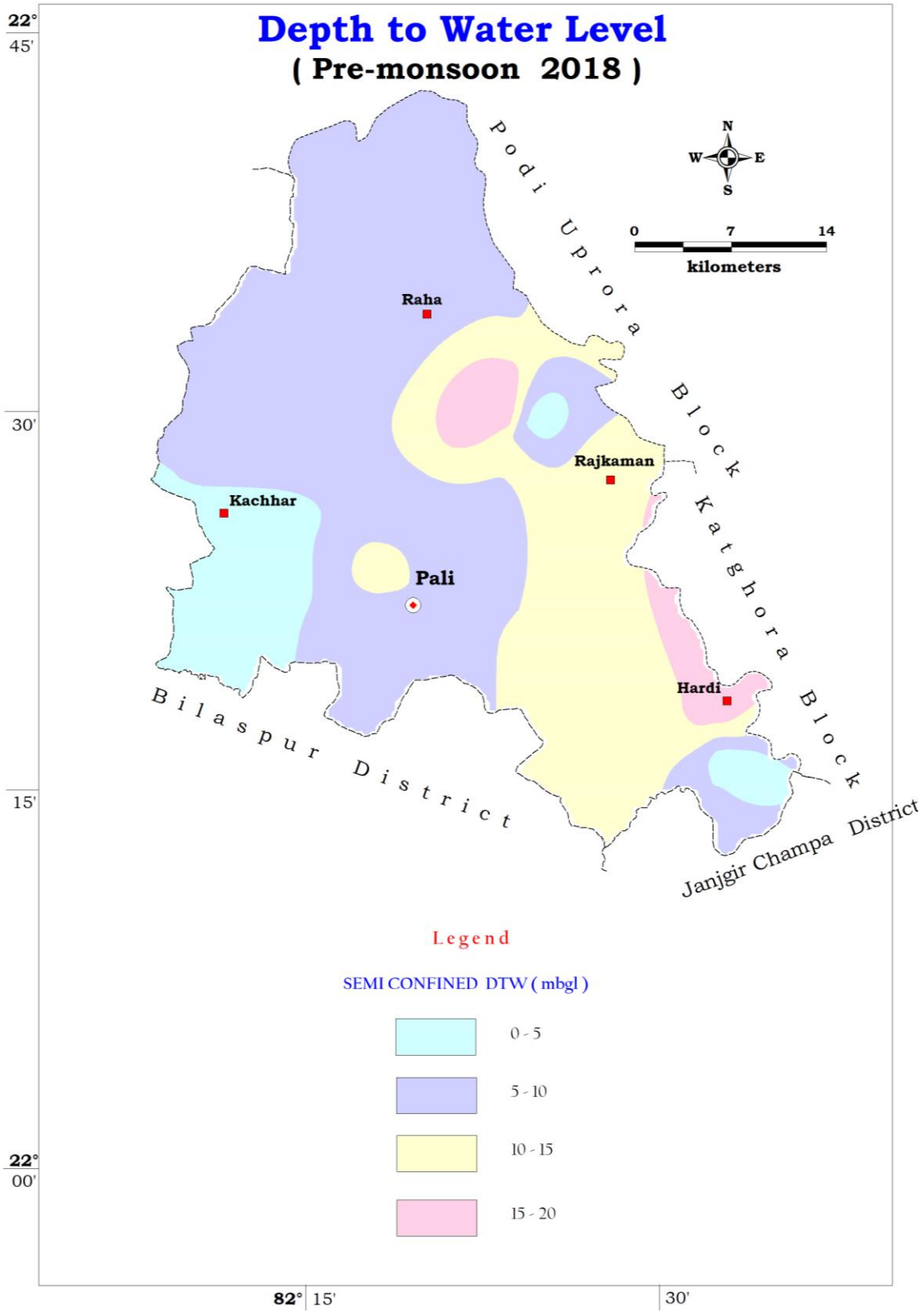

Figure 7 Depth to water level map Semiconfined Aquifer (Pre-monsoon)

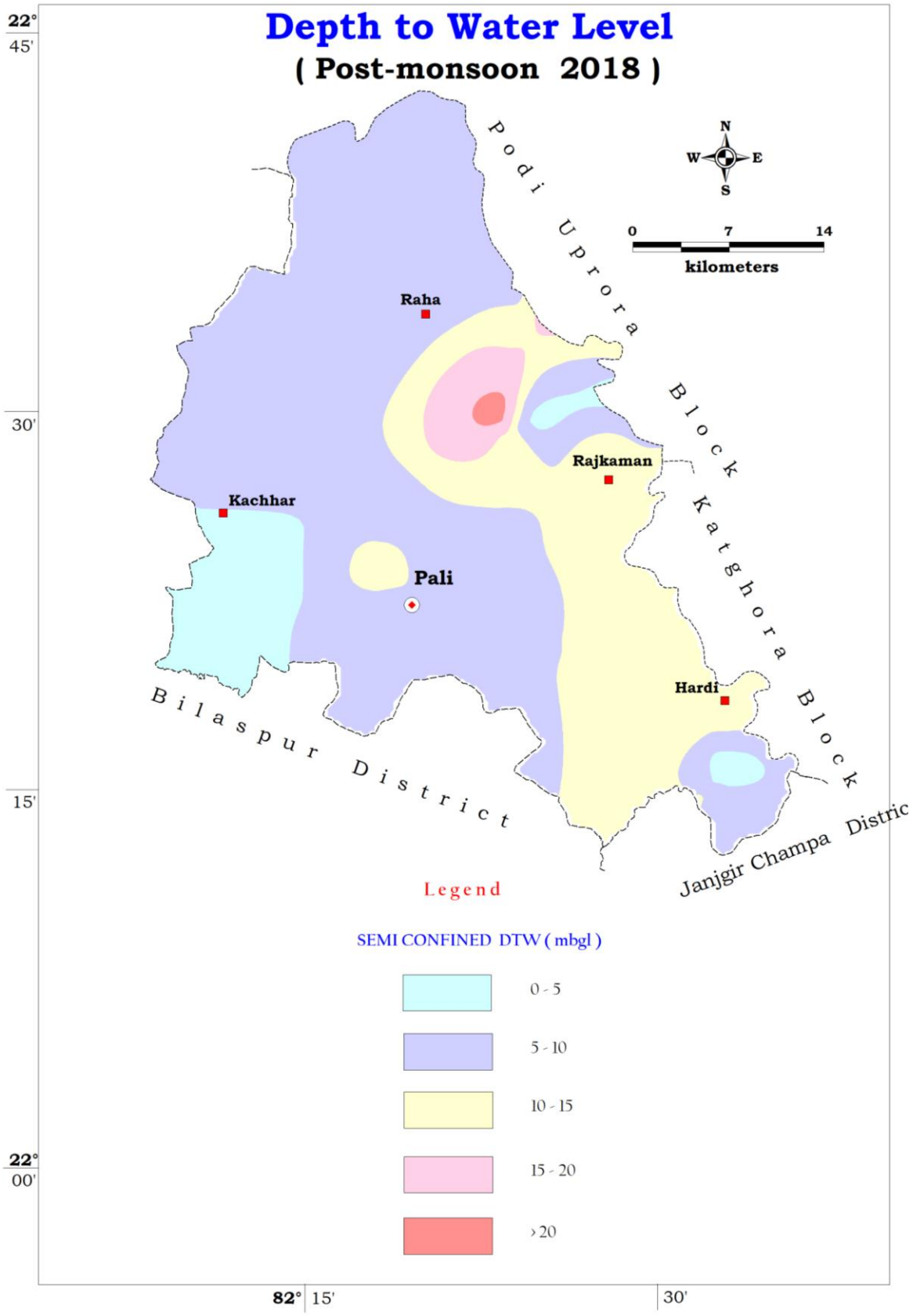

Figure 8 Depth to water level map Semiconfined Aquifer (Post-monsoon)

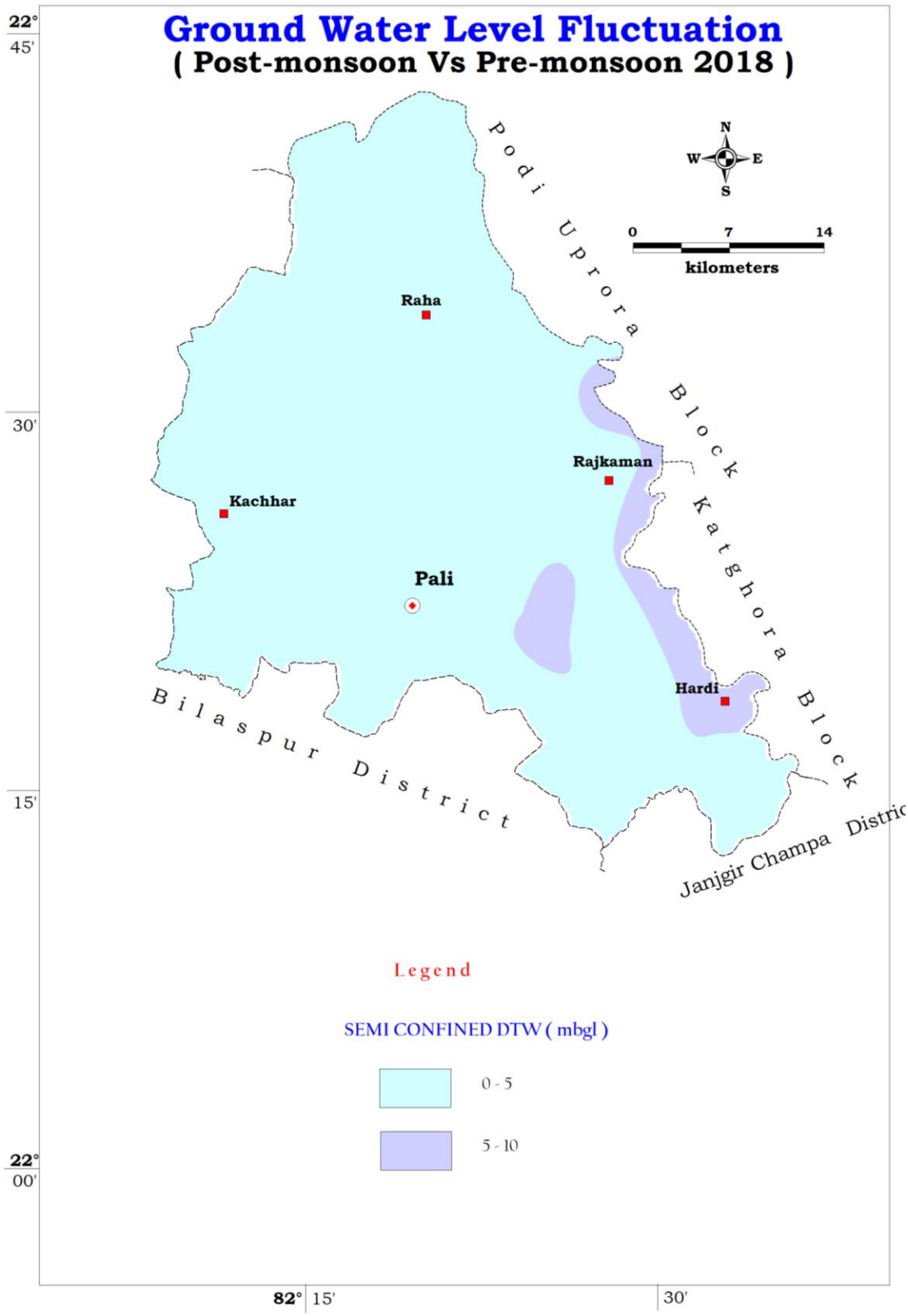

Figure 9 Depth to water level fluctuation map of Semiconfined Aquifer

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

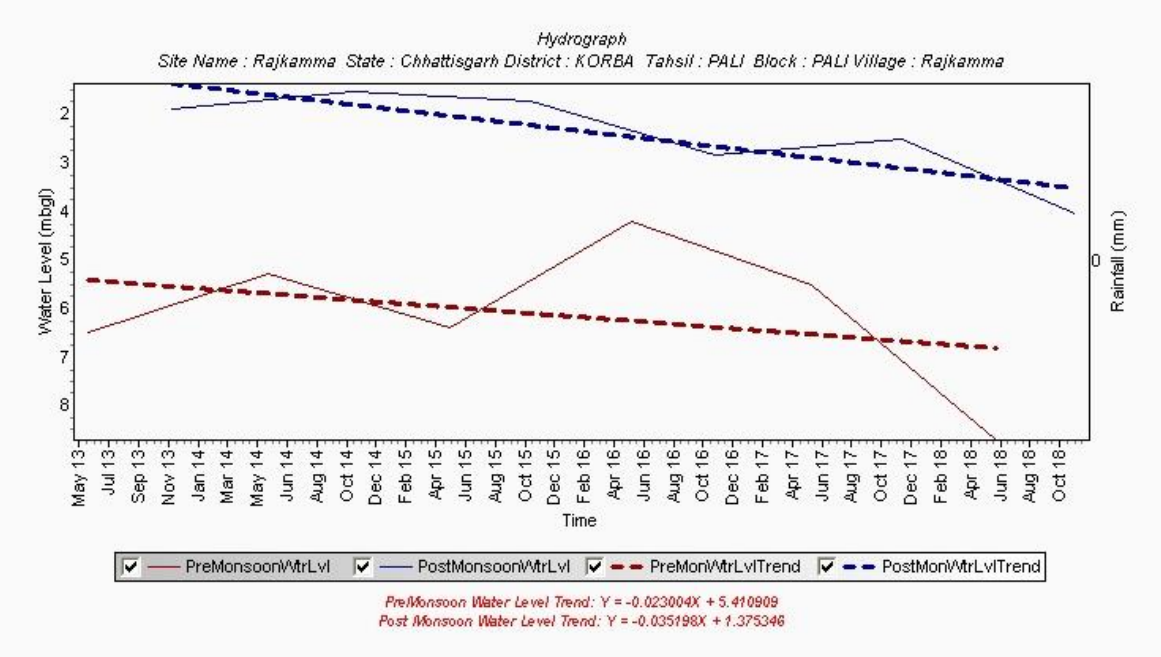

Figure 10 a: Hydrograph of Rajkamma village, Pali block

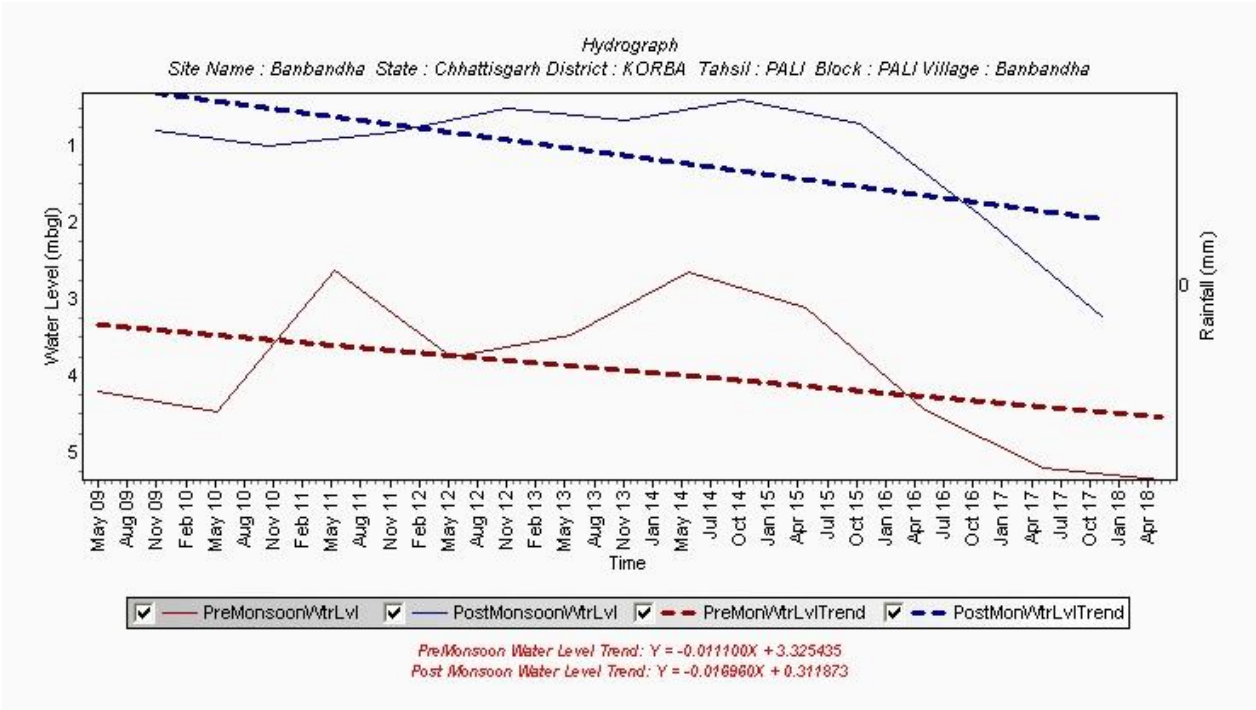

Figure 10 b: Hydrograph of Banbandha, Pali block

2. Aquifer Disposition:

Number of Aquifers: There are two major aquifer system viz. Granite Aquifer system and Sandstone Aquifer system. Both the aquifer system have the shallow aquifer and deeper aquifer which occurs in phreatic and Semiconfined condition respectively. Although there are few patches of Laterite, Deccan basalt, unclassified metamorphic, biotite schist and other rocks.

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

Sandstone Aquifer System: The average thickness of the weathered portion in the area is around 21 m. In general, the discharge varies from 0.1 lps to 5.49 lps with an average yield of 1.86 lps. The average drawdown of the formation is around 28 m. rotary drilling technique is preferred in sandstone aquifer where well construction is required depending upon the water zone and formation encountered. Water zone has been encountered up to 200 meter. Transmissivity range observed is 3.74 to 115.28 sq meter/day with average of 21.86 sqm /day.

Granite Aquifer System: The average thickness of the weathered portion in the area is around 12.83 m. In general, the discharge varies from negligible to 3 lps. The average drawdown of the formation is around 28 m. DTH drilling technique is preferred in Granite aquifer where well construction is required depending upon the thickness of weathered zone. Water zone has been encountered up to 167 meter in the block. Transmissivity range observed is upto 7.38 sq meter/day.

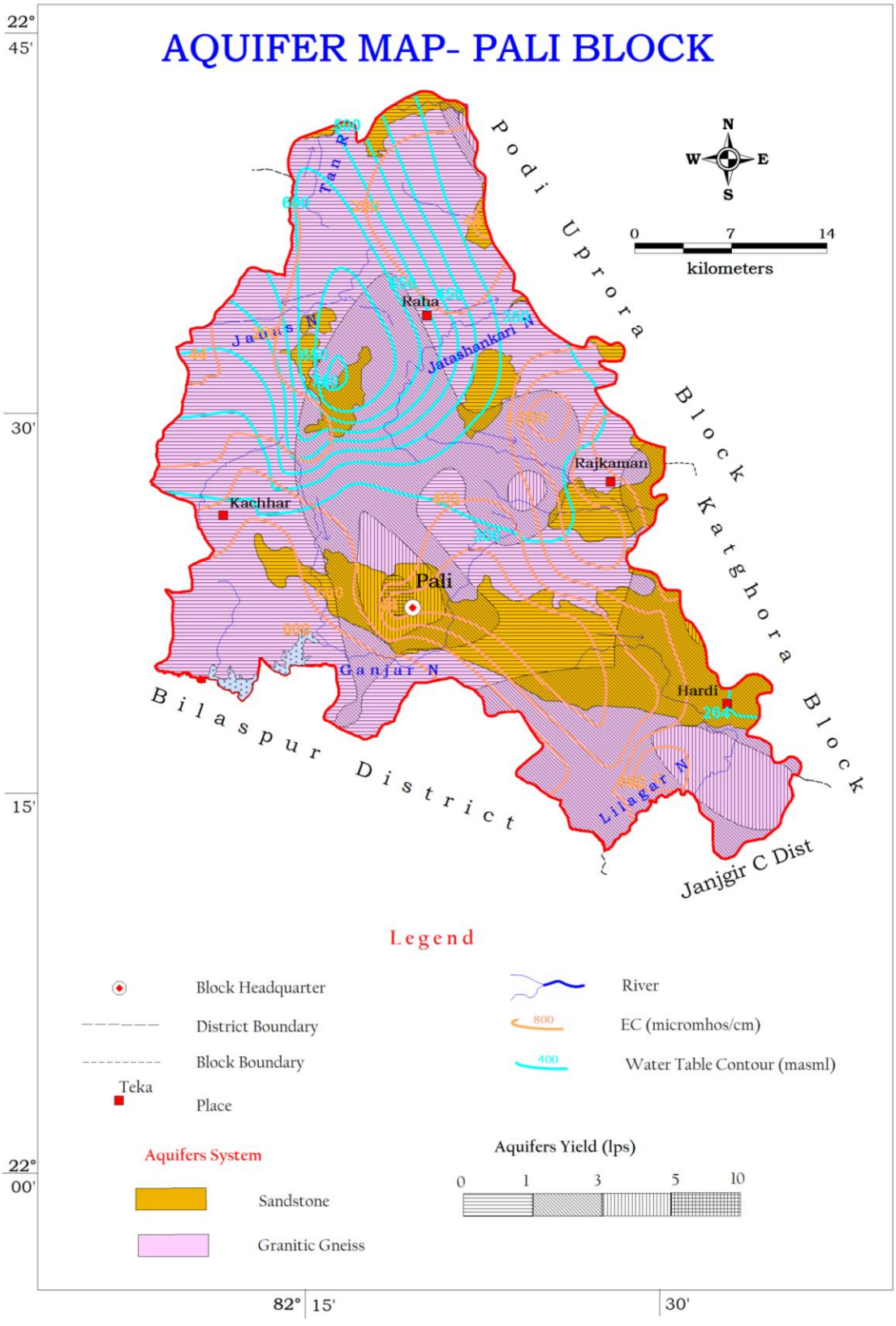

Figure 11: Aquifer map of Pali block

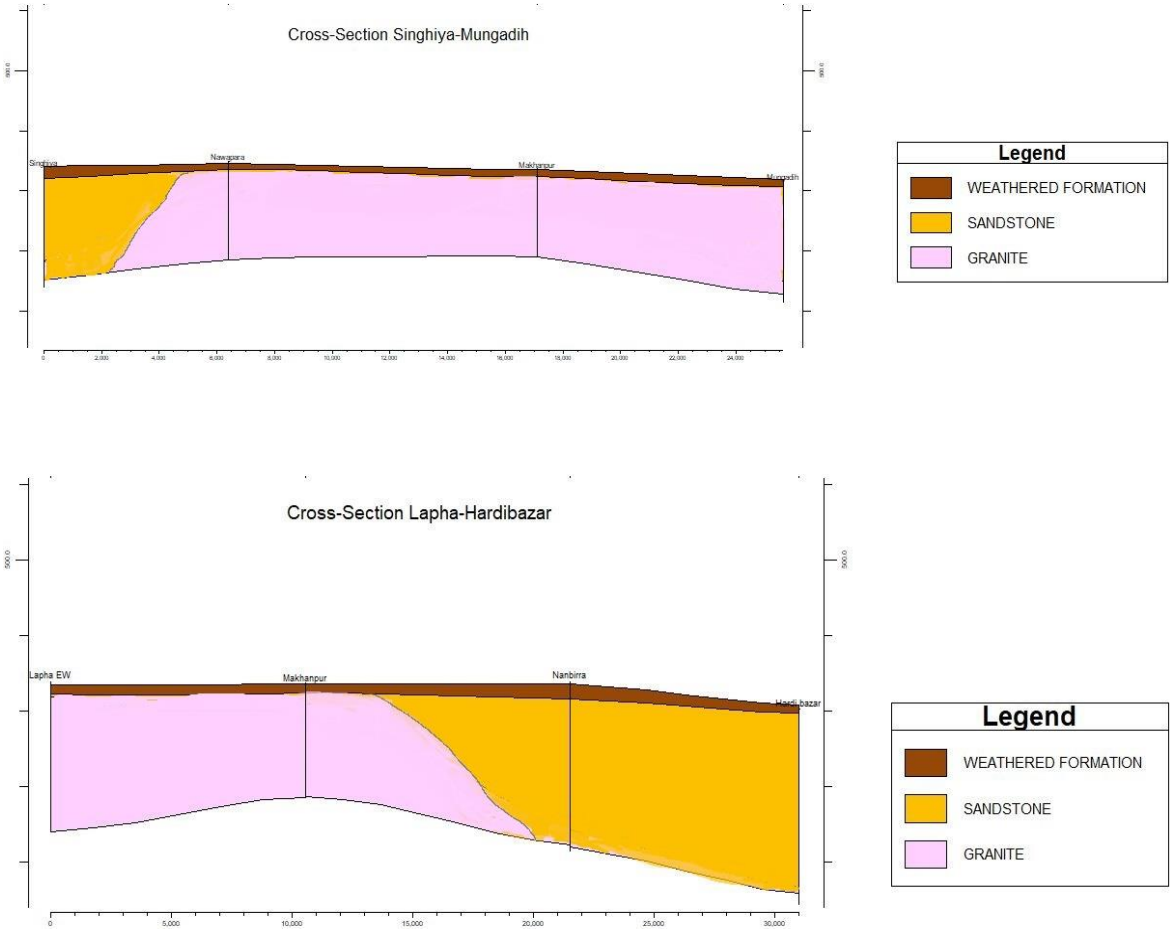

Figure-12, Disposition of Aquifer, Pali Block

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

Resource availability of Pali block is given in the table -4 where net ground water availability for future use is 5137.46 ham. The extraction details and the future scenario (2025) along with the categorisation is also depicted in the table-4.

Table 7 Categorization of Assessment Unit

District	Block	Stage of Ground water development (%)	Categorisation
Korba	Pali	27.27	Safe

Categorisation: Pali block falls in safe category. The stage of Ground water development is 27.27 %. The Net Ground water availability is 5137.46 ham. The Ground water draft for all uses is 1958.85 Ham. The Ground water resources for future uses for Korba Block is 5137.46 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). Floride value is above permissible limit in Chuhradand village.
Overall ground water of the study area is suitable for the drinking, agriculture and industrial purpose.

4. 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)

Aquifer	Area Identified for Artificial Recharge (Sq Km)	Sp. Yield for the formation	Volume of unsaturated space available for recharge (MCM)
Granite	689	0.002	1.378

5. 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 and Iron has been reported from several locations (annexure I).

6. Management Plan:

6.1 Supply side interventions

(i) 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 dug borewells/ existing handpump 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.

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

(iii) 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 for Artificial recharge (MCM)	Types of Structures Feasible and their Numbers			
			Percolation tank	Check dam	RS	G
Pali	689	1.378	4	16	28	40
	Recharge Capacity (MCM)		0.8	0.16	0.28	0.2

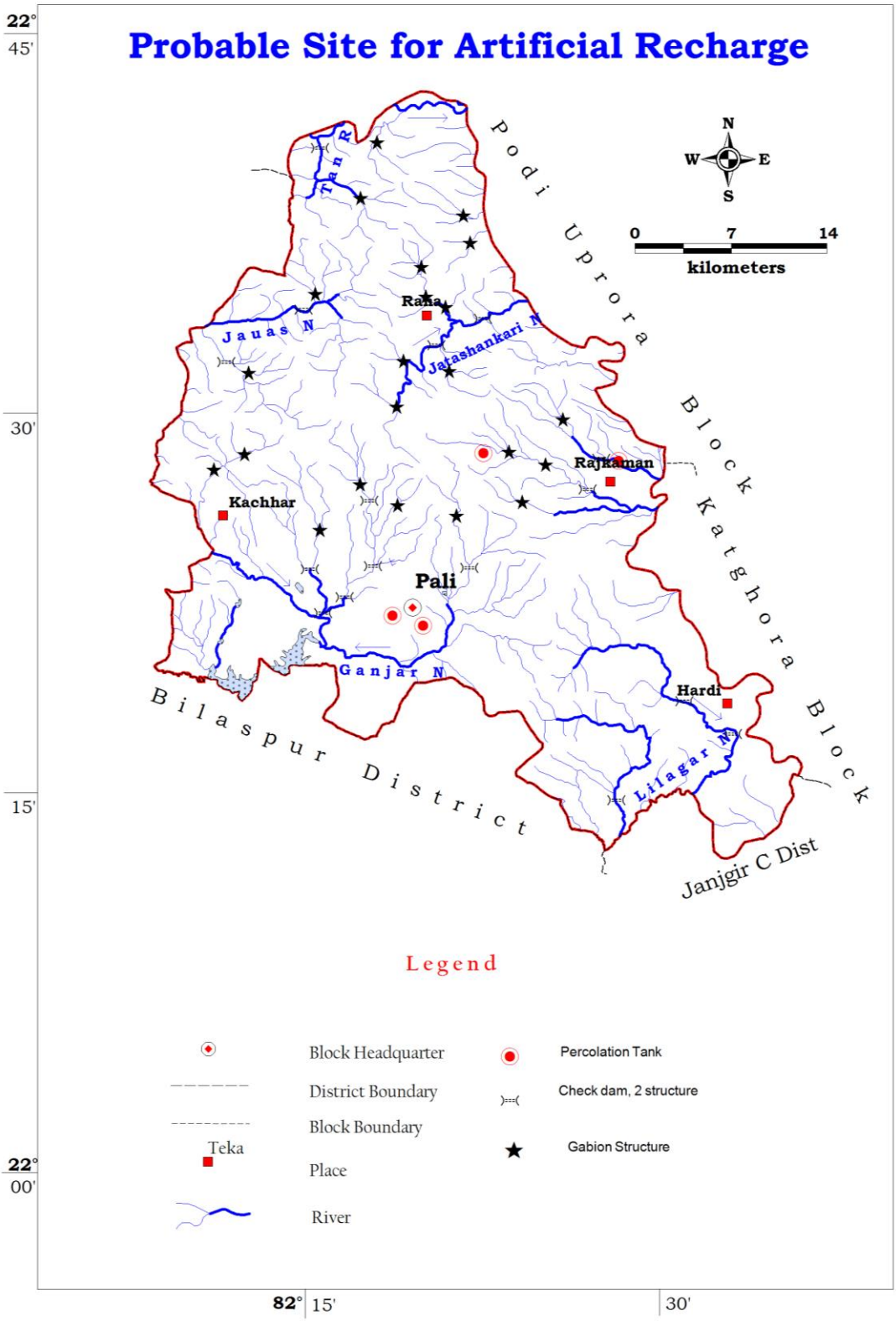

Figure 13 Map of proposed sites for artificial recharge of groundwater in Pali block

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

6.2 Demand Side Interventions

Since the stage of development in the block is 27.27 %. There is scope of utilizing more ground water for future irrigation purpose. Additional number of Ground water abstraction structure may be developed for the effective utilization of ground water resources in the block

Table 10: Potential of Additional GW abstraction structure creation

Net Groundwater availability (ham)	Stage of ground water Development (%)	Present ground water draft (HaM)	Ground water draft at 70% stage of development (ham)	Surplus ground water at present Stage of Development (ham)	Number of TW Recommended in each block (Assuming unit draft as 1.6 ham/structure/year)	Number of DW Recommended in each block (Assuming unit draft as 0.72 ham/structure/year)
5137.46	27.27	1958.85	3596.222	1637.372	614	910

7. Conclusion:

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: 11).

Table 11: Detail of groundwater saved through change in cropping pattern and other interventions

Block	Existing Gross Ground Water Draft for Irrigation in Ham	Additional Saving of GW after using Micro Irrigation methods in Ham	GW Potential created after Artificial recharge structure in Ham	Development by new GW abstraction structure	Additional GW irrigation 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
Pali	1456	436.8	137.8	1637.37	2211.97	4424	13.36%

Annexure I Chemical Analysis of Ground water during NAQUIM study in Pali block

Sl No	Location	Source of Sample	pH	EC at 25°C (µS/cm)	CO3	HCO3	Cl	F	SO4	TH	Ca	Mg	Na	K	Si	PO4
					Concentration in mg/l											
1	Chuhra dand	hp	7.44	625	Nil	207	53.3	1.52	33.898	200	36	26.4	43.4	1	33.52	0.005
2	Patpara	hp	7.15	1099	Nil	305	74.6	1.08	86.441	450	100	48	29.4	5.8	34.23	0.007
3	Pipardih	hp	7.48	517	Nil	307	10.7	0.71	11.492	230	72	12	19.3	0.9	27.09	0.007
4	Badebanka	hp	7.58	406	Nil	165	32	1.47	12.288	130	42	7.2	31.3	1.1	28.27	0.0023
5	Rajkamma	dw	7.61	742	Nil	159	103	1.08	42.034	250	64	21.6	38.2	2.9	20.46	0.03
6	Mangamar	hp	7.31	891	Nil	287	88.8	1.18	3.3898	330	84	28.8	37.3	1.3	28.78	0.027
7	Tiwarta	hp	7.62	594	Nil	304	35.5	0.62	3.1356	255	78	14.4	14.8	3.2	8.827	0.006
8	Andikachar	hp	7.79	337	Nil	207	10.7	0.64	0.1695	150	30	18	10.2	9.5	7.602	0.04
9	Hardibazar	hp	7.48	718	Nil	366	60.4	0.68	0.0847	275	46	38.4	27.2	58.7	6.071	0.014
10	Jorhadabri	hp	7.43	620	Nil	323	35.5	0.58	21.271	260	84	12	32.1	3.6	15.71	0.008
11	Nawadih	hp	7.49	1008	Nil	287	107	0.42	57.373	345	68	42	44.5	6.7	16.12	0.038
12	Sirli	hp	7.42	594	Nil	269	35.5	0.57	27.627	250	40	36	18.1	0.7	14.8	0.009
13	Chodha	hp	7.33	211	Nil	107	10.7	0.5	0.8475	90	14	13.2	11.2	1.3	10.51	0.006
14	Nunnera	hp	7.1	104	Nil	24.4	14.2	0.25	0.4237	40	6	2	4.4	7.6	14.64	0.044
15	Bhanwar	hp	7.56	699	Nil	298	14.2	1.37	28.814	105	24	10.8	142	1.2	10.87	0.032
16	saila	hp	7.56	562	Nil	244	42.6	0.82	23.898	185	38	21.6	34.6	9.9	7.551	0.003
17	Jemra	hp	7.55	314	Nil	149	14.2	0.7	22.746	135	38	9.6	11.6	1.7	20.36	0.005
18	Bagdara	hp	7.32	536	Nil	220	28.4	1.27	1.6949	140	16	24	53	1.9	13.93	0.04
19	Pahadjamni	hp	7.38	186	Nil	90.5	7	0.9	1.6102	70	8	12	20.3	0.9	26.53	0.009
20	Pali	hp	6.97	81	Nil	34	7	0.33	0.4237	30	8	2.4	2.7	5	8.776	0.006
21	Nawapara Kanaihapara	hp	7.72	820	Nil	293	10.7	0.99	45	330	100	19.2	26.2	2.8	31.99	0.007
22	Silli	hp	7.11	901	Nil	244	110	0.38	56.864	375	60	54	32.7	5.4	10.71	0.006
23	Mungadih	hp	7.28	849	Nil	400	49.7	0.5	3.8983	360	10	80.4	34.1	1.7	9.847	0.042
24	Dumarkachhar	hp	6.98	98.6	Nil	36.6	14	0.95	0.7627	40	10	3.6	4.9	6.4	9.745	0.009