DISTRICT AT A GLANCE

SHAHDOL DISTRICT
MADHYA PRADESH

Ministry of Water Resources

Central Ground Water Board

North Central Region
BHOPAL

2013

SHAHDOL DISTRICT PROFILE

S. N.	ITEMS	STATISTICS
1.	**GENERAL INFORMATION**	
	i) Geogeaphical area	5841Sq. Km
	ii) Administrative Divisions (As on 2013) Number of Tehsils	4 (Beohari, Jaisinghnagar, Sohagpur, Jaitpur)
	Number of Blocks	5 (Beohari, Jaisinghnagar, Sohagpur,Gohparu, Burhar)
	Number of Panchayats	4 Nagar Panchayats (Beohari,Jaisinghnagar, Khand and Burhar) 391 Village Panchayats.
	Number of Villages	852
	iii) Population (As per 2011 census)	10,64,989 persons
	iv) Normal Rainfall (mm)	11.31.4 mm
2.	**GEOMORPHOLOGY**	
	i) Major Physiographic Units ii) Major Drainage	1. High Lands of Maikal mountain range 2. The Hills of Eastern Plateau, 3. Low Lands of Rivers/ Upper Son Valley Ganga Basin (Son River and its tributaries Tipan, Chandas, Bakan and Banas)
3.	**LAND USE (sq km)**	
	i) Forest area:	2278.85
	ii) Net area sown:	1728.00
	iii) Cultivable area:	2313.00
4.	**MAJOR SOIL TYPES**	
		Clayey loam and sandy loam soil. (Ustocherpts/ Ustorthents/ Rhodustalfs/ Haplustalfs/ Haplusterts as per pedological taxonomy)
5.	**AREA UNDER PRINCIPAL CROPS (Sq.Km.)**	
		Paddy (1087), Jowar (22.8), Maize (116.8), Tuar (77.3), Urad (60.33), Soyabeen (16.7), Other Pulses (15.9), Til (54.2), Alsi (33), Wheat (241), Gram (42.5), Mustard (44.34) and Vegetables (17.84)
6.	**IRRIGATION BY DIFFERENT SOURCES**	

		Number of Structures	Area (sq km)
	Dugwells	2470	37.98
	Tube wells/Bore wells	513	13
	Tanks/Ponds	457	24
	Canals	76	44
	Other Sources		89.0
	Gross Irrigated Area		208
7.	**NUMBER OF GROUND WATER MONITORING WELLS OF CGWB (As on 31.3.2013)**		
	No. of Dug Wells No. of Piezometers	19 4	
8.	PREDOMINANT GEOLOGICAL FORMATIONS		
		Archaean granite gneisses/ quartzite/ schist, Vindhyan Sandstone/Shale, Gondwana Sandstone/Shale, Lameta Sandstone/Limestone, Deccan Trap basaltic lava flows and older dolerite dykes/ sills and Recent laterite and alluvium	
9.	HYDROGEOLOGY		
	Major Water Bearing Formations	Gondwana Sandstone , Lametas underlying Deccan Trap	
	Pre-monsoon depth to water level (2012) Post-monsoon depth to water level (2012)	3.03 to 13.57 m.bgl 1.66 to 17.86 m.bgl	
	Long Term water level trend in 10 years (2003-2012) in m/yr	Rise 0.08 to 0.19 Fall 0.56-0.88 m.bgl	
10.	GROUND WATER EXPLORATION BY CGWB (As on 31.3.2013)		
	No of wells drilled (EW,OW,PZ,SH, Total)	16EW,07 OW and 4 Pz Total -27	
	Depth Range (m)	88.85 to 303 m.bgl	
	Discharge (litres per second)	meagre to 10 lps.	
11.	GROUND WATER QUALITY		
	Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)	EC-175-1440, Nitrate-.1-34, Fluoride – 0.05-0.69 in phreatic aquifer	
	Type of Water	Calcium Bicarbonate type	
12.	DYNAMIC GROUND WATER RESOURCES (2009) in MCM		
	Net Ground Water Availability	639.09 MCM	
	Gross Annual Ground Water Draft	40.83 MCM	
	Projected Demand for Domestic and	20.1 MCM	

	Industrial uses upto 2033	
	Stage of Ground Water Development	6 %
13.	AWARENESS AND TRAINING ACTIVITY	
	Mass Awareness Programmes Organised Date Place No. of Participants	Nil
	Water Management Training Programmes Organised Date Place No. of Participants	Nil
14.	EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING	
	Projects completed by CGWB (No. & Amount Spent)	Nil
	Projects under technical guidance of CGWB (Numbers)	Nil
15.	GROUND WATER CONTROL AND REGULATION	
	Number of OE Blocks	All blocks are under Safe category
	Number of Critical Blocks	
	Number of Blocks notified	
16.	MAJOR GROUND WATER PROBLEMS AND ISSUES	
		i. Dewatering of Coal Mines leading to decline in groundwater level ii. Under-utilisation of groundwater resources for irrigation

1.0 INTRODUCTION

Shahdol district is predominantly a tribal district, situated in the eastern part of Madhya Pradesh. Prior to 1998-99, district Umaria and district Anuppur were parts of Shahdol district. A new district Umaria was formed out of district Shahdol, in the year 1998-99 and a new district Anuppur was formed out of district Shahdol in the year 2003. Because of the division of the district on 15-8-2003, the area of the district at present remains 5841Sq. Kms. It is surrounded by Koriya district (Chhatisgarh State) and Sidhi district in the East, Bilaspur district (Chhatisgarh State), Anuppur and Mandla districts in the South, Satna and Sidhi districts in the North and Umaria district in the West. This district is situated between 23°00' N and 24°18'N latitude and 81°00' E to 82°00' E longitude, extending 100 Kms. from East to West and 141 Kms. from North to South. It is covered in Survey of India Degree sheet Nos. 63H and 64E. Shahdol is the district headquarter and Sohagpur, Beohari, and Jaisinghnagar are some of the major towns. Shahdol is located on the Bilaspur-Katni Section of the South-Eastern Railways.The district is divided into four Tehsils and five development Blocks (Plate-I).

Table - 1 : Administrative Divisions, District Shahdol, M.P.

Tehsils	**Block**	**Area Sq.Km.**	**Municipalities**	**Nagar Panchayats**
Beohari	Beohari	1110	-	Beohari
Jaisinghnagar	Jaisinghnagar	1639	-	Jaisinghnagar
				Khand
Sohagpur	Sohagpur	810	Shahdol	-
	Gohparu	935		
Jaitpur	Burhar	1347	Dhanpuri	Burhar
	District Total	**5841**		

DRAINAGE

The entire district is drained by Son River and its tributaries. Thus the area falls in the Ganga Basin. The river Son flows due north till the northern extent of the district, marking the western boundary of the district Shahdol with Umaria District. Thereafter, the river Son flows due east and marks the northern boundary of Shahdol district with Satna district.The important tributaries of the Son river are the Kunak nadi and the Chuwadi nadi. The river son draining the south eastern parts of the district through its important tributaries like Tipan, Chandas and Bakan flow in the north-west direction with a dendritic pattern, draining the central plains of the district.

Another important tributary of the Son River is the Banas river, flowing along the eastern boundary of the district, marking the boundary of the district Shahdol with Sidhi District. The north-western part of the district is drained by the Banas river and its tributaries namely the Jhanapar river, Kormar nadi, the Rampa nadi, and the Odari Nadi. Banas River confluences with the Son River at the northernmost tip of Shahdol District.

IRRIGATION

Bansagar is a multipurpose river valley project on Son River situated in Ganga Basin in Madhya Pradesh, envisaging both irrigation and hydroelectric power generation. The Bansagar Dam across Son River is constructed at village Deolond in Shahdol district on

Rewa – Shahdol road. However, irrigation through this Project will benefit only a small area in the north of the District. Shahdol district still has poor irrigation facility. Only 9% of the total crop gets irrigation facility. Tribals of the district prefer the cultivation in the old traditional method and depend mainly on rain. The area irrigated by canals, tubewells, dugwells and tanks are tabulated below in Table 2.

	IRRIGATION BY DIFFERENT SOURCES		
		Number of Structures	**Area (sq km)**
	Dugwells	2470	37.98
	Tube wells/Bore wells	513	13
	Tanks/Ponds	457	24
	Canals	76	44
	Other Sources		89.0
	Gross Irrigated Area		208

CROPPING PATTERN

District is very backward in the field of agriculture. The size of the fields is very small and the tribals are mainly marginal farmers. The yearly yield of the products from the fields is not enough for their home use. Paddy, Kodo, Kutko and Maize are the crops of the district. Til, Mustard and Groundnut are the main oilseeds produced here. The farmers have started the production of Sunflowers and Soyabean. In the central and southern part of the district, paddy is the main crop grown during Kharif season and in the north-west, wheat is the main crop grown during Rabi season.

CGWB ACTIVITES

Central Ground Water Board has carried out extensive field work in the district of Shahdol to provide scientific base to understand the dynamic system of ground water in the region. Systematic hydrogeological surveys were carried out in the district during the year 1987-88 by Sh. R.N. Sharma and Sh.A.K.Budhauliya, then Junior Hydrogeologists and Sh. A.K.Jain, Sh. M.L.Parmar, Sh. M.V.Gopal and Sh. I.Javid Ali, then Assistant Hydrogeologists.

Detailed hydrogeological work was carried out in the District under Technology Mission Programme for drinking water during the period 1988 to 1991 by Sh. R.N. Sharma, then Junior Hydrogeologist and Sh. I.Javid Ali, Sh. A.Srinivas and Sh. R.M.Verma, then Assistant Hydrogeologists.

Re-appraisal Hydrogeological Surveys of the area was carried out by Shri A.K.Jain, Junior Hydrogeologist during year 1998-99. CGWB had carried out regular Groundwater Exploration in the district during the period 1988-93 and a total of 16exploratory wells were drilled at various places in different geological formations of the district.

2.0 RAINFALL & CLIMATE

Shahdol district experiences a temperate climate characterized by a hot summer, well-distributed rainfall during the south-west monsoon season and mild winter. The winter season commences from December and lasts till the end of February followed by the summer from March to middle of June. The south-west monsoon or rainy season continues from middle of June to September when south west monsoon is active while October and November months constitute post- monsoon or retreating monsoon season. The climate of Shahdol District, as calculated by Thornthwaite Precipitation Effectiveness Method, is humid climate with forest type vegetation.

The month of May is the hottest month with mean daily maximum temperature at 41.4^0C and mean daily minimum temperature at 26.5^0C. With the onset of south-west monsoon during June, there is an appreciable drop in day temperature, while at the end of the September or in early October, there is slight increase in day temperature but nights become progressively cooler. January is generally the coolest month with the mean daily maximum temperature at 25.6^0C and the mean daily minimum temperature at 8.4^0C. The average daily maximum temperature is about 41.4^0C and minimum temperature is about 26.5^0C. During the southwest monsoon season the relative humidity generally exceeds 88% (August month). In rest of the year is drier. The driest part of the year is the summer season, when relative humidity is less than 38%. April is the driest month of the year. The wind velocity is higher during the pre-monsoon period as compared to post monsoon period. The maximum wind velocity of 6.8 km/hr is observed during the month of June and minimum 2.3 km/hr during the month of December. The average normal annual wind velocity of Shahdol district is 4.3 km/hr.

The normal rainfall of Shahdol district is 1131.4 mm .

As per rainfall statistics, frequency of occurrence of Normal drought in the area is 25 % and that of Mild drought is also 25 % while occurence of severe droughts in the area is only 5 % i.e. on an average there is a possibility of occurrence of a normal or mild drought once in every seven years, while that of severe draughts is once in every 20 years. The area does not experience any most severe drought.

3.0 GENERAL GEOLOGICAL FEATURES

3.1 General Geological Succession

The stratigraphic sequence of various geological units with their respective rock types are described below.

AGE	LITHOSTRATIGRAPHIC UNIT	LITHOLOGY
Recent to sub recent	Alluvium, Laterite	Sandy loam, silty sand, coarse medium laterite
Cretaceous to Eocene	Deccan Trap	Basaltic lava flows and older dolerite dykes and sills.
Upper Cretaceous	Lameta	Sandstone, siliceous limestone, marl and Shales.
Lower Cretaceous	Chandia (Gondwana Supergroup)	White clays and medium grained sandstone
Late Norian to Rhaetic	Parsora (Gondwana Supergroup)	Coarse-grained sandstone variegated shale and lilac coloured clays.
Upper Permain to Larnic	Tihki Pali (Gondwana Supergroup)	Coarse grained sandstone grey shale, red shale, red green and mottled clay with thin coal bands
Late Permain	Barakar	Sand stone, Shales and Coal seams
Upper Carboniferous to Lower Permain	Talchir	Tillite, sandstone and green shale
Pre - Cambrian	Lower Vindhyan (Semri series)	Porcellanite shales sandstone basal conglomerates
	Bijawar	Quartzes, Gneisses
Algonkian	Archaean	Granite, Gneisses, Schists etc.

3.2 Geomorphology And Soil Types

The District is located in the north-eastern part of the Deccan Plateau. It lies at the trijunction of Maikal Ranges of the Satpura Mountain, the foot of the Kaimur Range of the Vindhyan Mountain. In between these hill ranges lies the narrow valley of the Son and its tributaries.

Physiographically, structural landforms, represented by plateau and low lying plains with average altitude of 450m to 500m above MSL, are developed in northern, northeastern and northwestern and central parts of the district. In the southern part of the District, hills and highlands of Maikal Range and high to medium level (500m to 990m) plateau and flat topped, step like terraces are developed. Fluvial Land Forms represented by flood plains are present along the western boundary of the district. The maximum elevation of the area is 1123m above mean sea level at Singingarh Hill (23°03’40” : 81°27’37”) in Satpura hills, in southern part of the district.

Soil

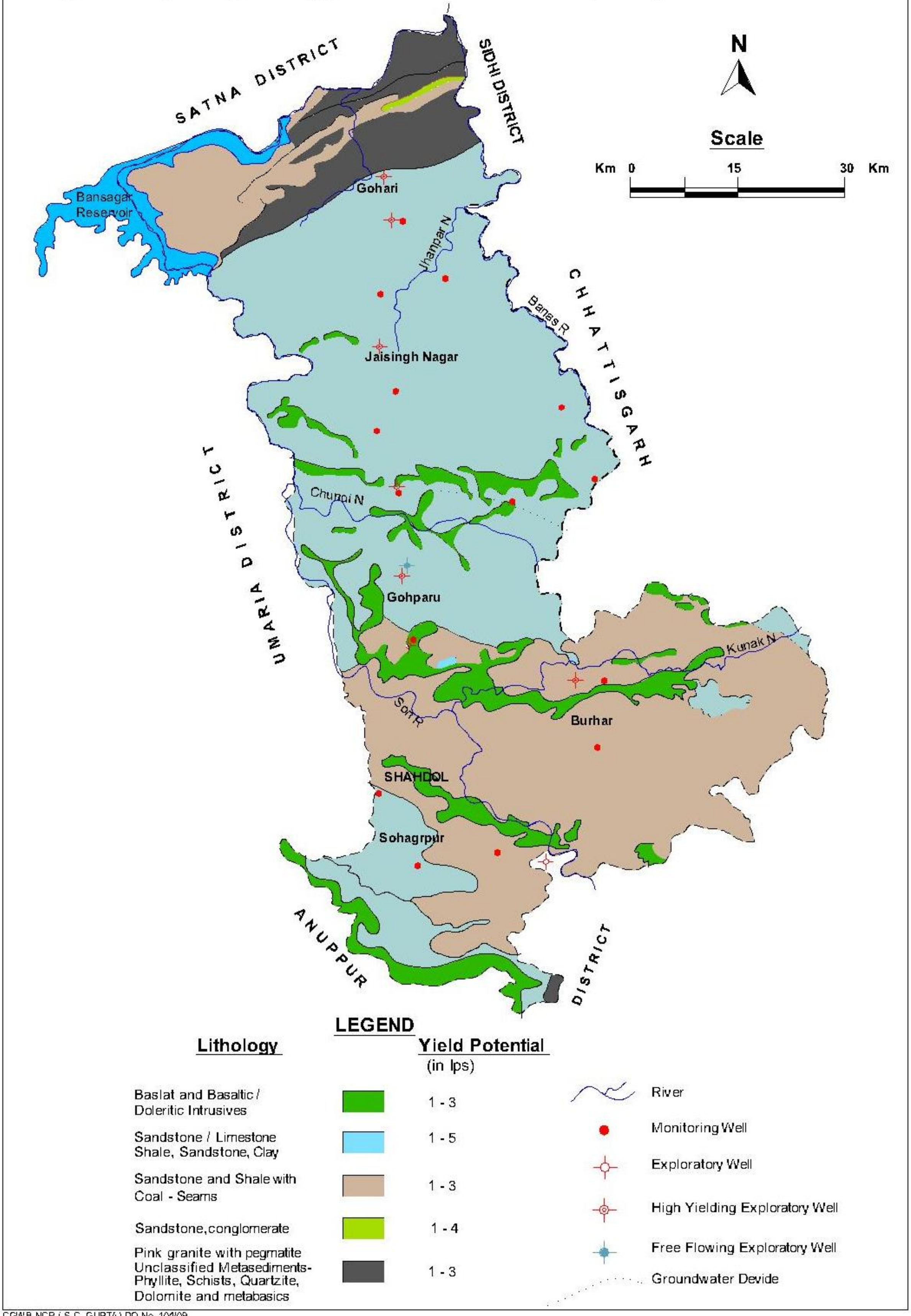
The soils in the area are generally of clayey loam types with sandy loam soil in some areas. In the northern and central parts of the District, the undulating plateau with mounds are covered with slightly deep soil, well drained, fine to fine loamy soils on gentle slopes marked by moderate erosion. The southern hilly region is covered by very shallow loamy soils, some what excessively drained. The soils developed on moderately steep slopes are marked by severe erosion. The soils have been classified as Ustocherpts/ Ustorthents/ Rhodustalfs/ Haplustalfs/ Haplusterts, as per pedological taxonomy.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology, Aquifer System And Aquifer Parameters

The water bearing properties of different hydrogeological units occurring in Shahdol District are described below. Hydrogeology of the district is shown in Fig-2.

Fig. 2 : Hydrogeology, Shahdol District (M.P.)



4.1.1 Bijawar Series

This consists of Quartzites, Gneisses and Schists, which are moderately weathered and jointed. Weathering in quatrizites has gone as high as 10 m. These rocks out crop in the area of Beohari block. Groundwater occurs in the secondary porosity, developed in the weathered, sheared, fractured portion of these rocks. The dug wells yield as high as 40,000 litres per day to as low as 400 litres per day. The wells dry up in summer. The premonsoon water level in wells go as deep as 12m and rise up during post monsoon to as high as 1.60m bgl.

4.1.2 Lower Vindhyan

Semri series of rocks represent Lower Vindhyans in the district. They also support development of ground water through open wells. Porcellanite shales layer and its stratification allow some percentage of water to percolate downward and move along the planes of bedding and water gets pooled up in weathered zones/disintegrated crushed zones, along the contact planes. Semi weathered yellowish shale from undulating topography. The Vindhyans have also developed aquifer with the groundwater flow gradient of 1 in 200 in the NE direction, almost in the dip direction of the shales (600N).

The dugwells in Vindhyans aquifer vary in depth range from 16.6-20mbgl. The depth to water level in the wells during pre monsoon ranges between 4.80 to 15m bgl.

4.1.3 Gondwanas

The Gondwana group of rocks, that bears the coal deposit, is also a fine groundwater repository in this district. The felspathic medium to coarse grained sandstone, bears groundwater in the interconnected primary pores is the formation as well as the contact planes between shales and sandstone. Groundwater is also mined out along with the coal in almost all the coal fields of the district. Groundwater occurs in both unconfined conditions in the Gondwana formations of the district.

Due to excessive pumpage of groundwater from the underneath coal mines, there has been excessive lowering of water levels in the phreatic groundwater regime overlying the coal field areas. Gondwana formation particularly the upper part of the Barakar sandstone supports development of phreatic aquifers which extends from few meters below ground level to 25 m below land surface.

The fluctuation of groundwater level is between 3-5m.

4.1.4 Lametas

These are sedimentary deposits resting over Gondwana formations (some times resting over the Granites directly). Generally, these are compact and impervious rocks (siliceous limestone). However, at places the nodular limestone and poorly consolidated sandstone have allowed the development of ground water in confined and unconfined system.

Since the Lametas are generally thickly forested, population and habitation is been rather sparse. However, there are quite a few number of dug wells that are used for drinking purpose by the tribal population. It is found that about 80% of the dug wells are within the depth range of 8 m to 16 m bgl. with a diameter of 3-4 m. The pre -monsoon depth of water level goes as deep as 17m to 20 m and rise up to as high as 12-16 m . The yield of the well is between 50,000 litres per day to 75,000 litrer per day.

4.1.5 Deccan Traps

Many basaltic / doleritic dykes and sills (equivalent to Deccan Traps) cut across Gondwana and Lameta formations. These dykes and sills are spread near the surface or spread over the paleo-topography surface in limited area as basaltic flows and form hills wherever exposed. These are weathered, vesicular, jointed and fractured similar to Deccan Trap basalts without the layering feature of basaltic flows. These exhibit scope of groundwater development because of the development of secondary porosity. The yield is limited and vary according to the degree of weathering, weathered mantle, presence of fractures and joints etc. However, on drilling a borehole piercing the thin dolerite/ basalt near the base of these hills (dyke/ sills), where the dolerite/ basalt flow pinches, good yields are obtained from the underlying Gondwana and Lameta formations.

The wells in the basaltic flows of Deccan Traps vary in depth between the range of 6-9 m bgl. With a diameter of 2m to 3m . The wells go dry during summer. The yield varies between post monsoon and premonsoon from 1,30.000 litres per day to 70,000 litres per day.

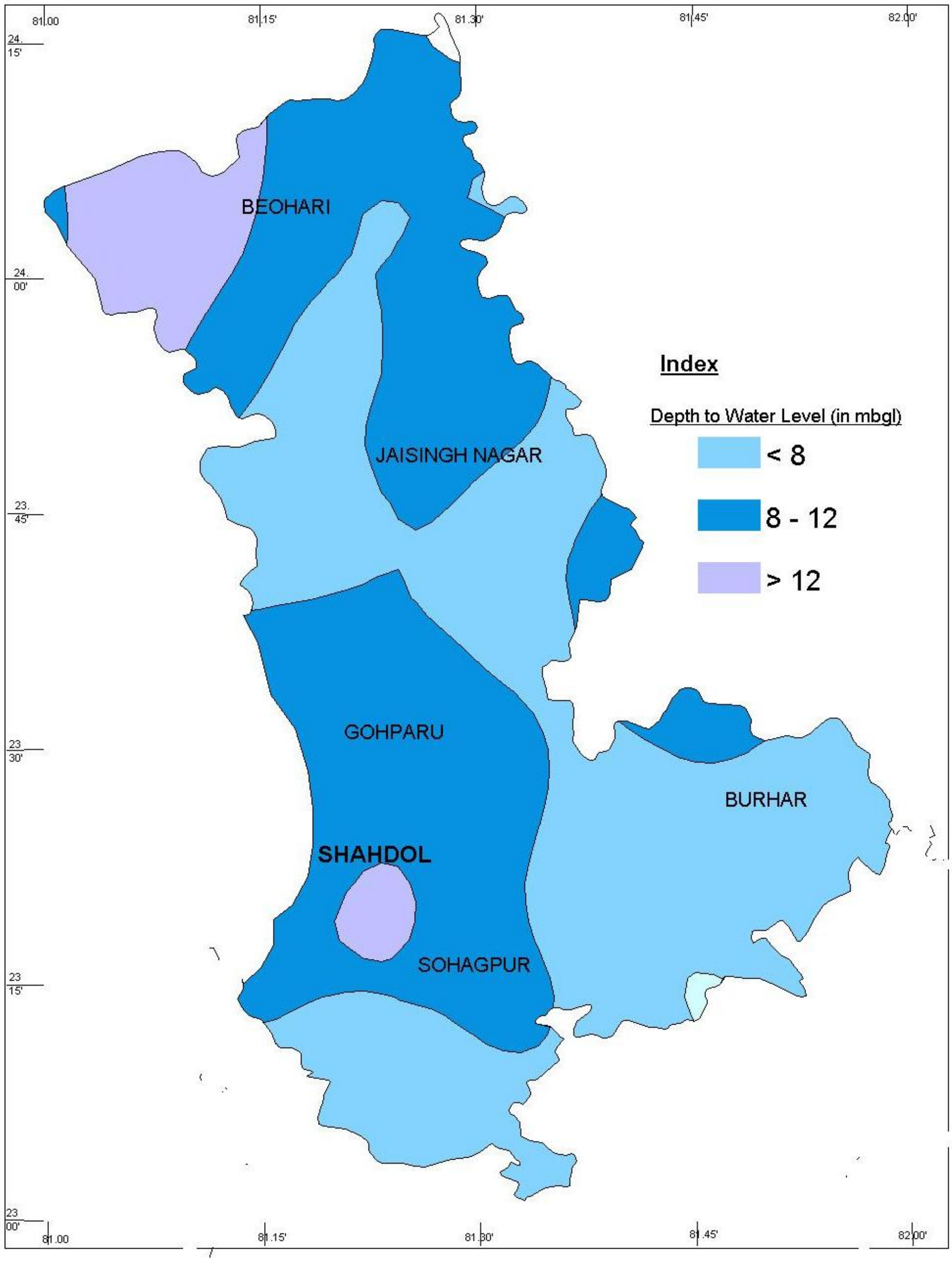
4.2 Water Levels

Ground water levels form a very important parameter of the ground water system. The groundwater balance expresses itself in the change in water levels; hence a continuous record is important and useful. CGWB has 19 National Hydrograph Monitoring wells and 4 Peizometers in Shahdol district.

Pre Monsoon Depth to Water Level (May-2012)

In general depth to water level in the area ranges from 3.03 to 13.75 m below ground level. Shallow water level of less than 8 m has been recorded in the north-central& south-eastern part of the district. Depth to water level between 8to 12 m bgl. is occurring in northern &western part of the district. Depth to water level >12 m. bgl. is recorded in isolated patches in north-western part of the district.

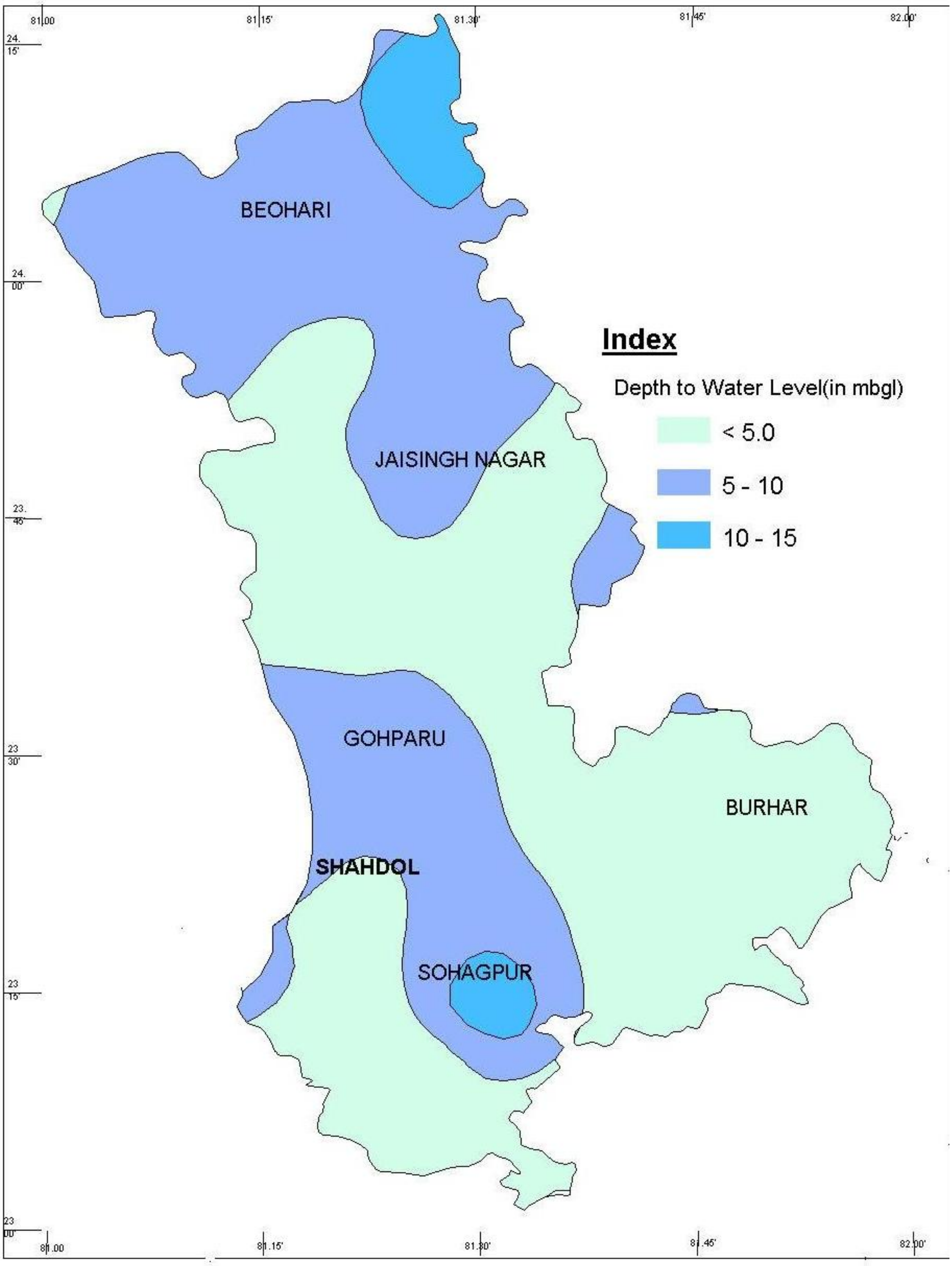
Depth to Water Level- Pre-Monsoon(May'2012) District Shahdol, M.P.



Post Monsoon Depth to water level (November-2012)

In general, during post-monsoon period, depth of water levels in the district ranges between 1.66 and 17.86 m below ground level. Shallow water level of less than 5 m is occurring in major part of the district. Depth to water level between 5 to 10m bgl. is observed in northern & south- westrern part of the district. Depth to water level between 10-15 m. bgl. is recorded in isolated patches in north-eastern& southern part of the district.

Depth to Water Level Post - Monsoon(Nov' 2012) District Shahdol, M.P.



4.3 Change in Ground Water Levels

Long Term Trend Analysis

To study change in ground water regime of the area during pre and post monsoon periods over 10 years (2003 to 2012), water level data of 18 Hydrograph Monitoring Wells, have been used which indicate rising trend with an average rise of water level from 0.08 m/year to 0.19m/year& the rate of decline ranges from 0.56 m/year to 0.88m/year.

Long term decline in water levels is perhaps due to increased dependency on ground water resources for various uses and continuous withdrawal of it at various places.

4.4 Ground Water Exploration

Groundwater Exploration through deep drilling was carried out by deploying four direct rotary rigs to drill through semi consolidated Gondwana sediments. Central Ground Water Board carried out exploratory drilling programme in the area between 1990 and 1994 and during this period 16 exploratory wells and 7 observation wells were constructed. 4 number of piezometers were drilled in Shahdol district under Hydrology Project for water level monitoring purpose. The details of piezometers are given in table 4.

Exploration revealed occurrence of potential aquifer within Lameta formation.The Gondwana formations – the clay and mudstone facies of Tihiki stage overlying the arenaceous facies of Pali beds have an aquifer system of moderate to high yield potential in Beohari Block. The yields range from 6 to 10 lps with average drowdown of 12 to 15 m over static water level (which vary from 6 to 7.5 m.bgl). However exploratory well at Bhejari site was abandoned due to insignificant yield. The Upper Barakar Sandstone of Gondwana Super Group has a positive piezometric head and at many places, auto-flowing condition occur, e.g. in Churmura (Shallow), Churmura (Deep) and Gohparu exploratory tubewells.

The Upper Barakar Sandstone are devoid of coal seams while Middle and Lower Barakars have a number of coal seams occuring at different depths, from surface exposures to 150 m.bgl. The well at Gohparu was auto flowing, but its yield was meagre. Well at Churmura confirmed a three aquifer system, out of the middle aquifer (80 – 160 m.bgl) and third aquifer (deeper 210 – 240 mbgl) showed auto-flowing condition with piezometric head of 3.3 m agl and 5 m agl respectively with free flow discharge of 3 lps. At Bijha site, very shallow water level of 0.19 m bgl was recorded with a discharge of 3.4 lps.

Table 5. : Hydrogeological Details of Piezometers drilled in Shahdol district.

S.N	Name of site	Depth (m)	Aquifer zones	SWL mbmp	Yield (lpm)	E.C. (µS/cm)	Aquifer
1	Burhar-D 23°13'30" 81°31'28"	58.15	12.6-17.8 50.0-52.0	22.0	4.2	365	Barakar Sandstone
2	Burhar-S 23°13'30" 81°31'28	30.69	12.6-17.8	9.8	4.2	570	Barakar Sandstone
3	Jaisinghnagar-D 23°40'42" 81°23'48"	46.48	32.0-35.0	1.58	1.25	166	Upper Gondwana Sandstone
4	Shahdol-D 23°17'55" 81°21'35"	61.77	37.5-38.5 46.0-50.1	9.75	0.5	466	Gondwana Sandstone

4.5 Ground Water Resources

The groundwater resources of the District are under-developed and under-utilised. 513 tubewells and 2470dugwells facilitate to irrigate an area of 50.98 sq.km. of agricultural land as against 2714.12 sq.km cultivable area and 2313 sq.km of net sown area in the district. The net groundwater availability of the district is 639.09 MCM while gross annual groundwater draft in the district is only 43.43 MCM. The stage of ground water development of the district is only 6%. Shahdol comes under safe category from ground water development point of view.

Net Groundwater Availability for future irrigation development is 590.97 MCM. There is ample scope for development of groundwater for irrigation, industrial and domestic purposes.

Block wise ground water resources are given in Table-5

District/ Assessment Unit	Sub-unit Command/ Non-Command/	Net Annual Ground water Availability (ham)	Existing Gross Ground water Draft for Irrigation (ham)	Existing Gross Ground water Draft for Domestic & Industrial water Supply (ham)	Existing Gross Ground water Draft for All uses (ham)	Provision for domestic, and industrial requirement supply to next 25 year (2033) (ham)	Net Ground water Availability for future irrigation d development (ham)	Stage of Ground water Development (%)
Shahdol								
Beohari	Command							
	Non-Command	8154	786	385	1172	407	6960	14
	Block Total	**8154**	**786**	**385**	**1172**	**407**	**6960**	**14**
Burhar	Command							
	Non-Command	16944	118	309	427	371	16455	3
	Block Total	**16944**	**118**	**309**	**427**	**371**	**16455**	**3**
Goparu	Command							
	Non-Command	11982	108	233	340	359	11516	3
	Block Total	**11982**	**108**	**233**	**340**	**359**	**11516**	**3**
Jaisinghnagar	Command							
	Non-Command	18791	844	394	1238	577	17370	7
	Block Total	**18791**	**844**	**394**	**1238**	**577**	**17370**	**7**
Sohagpur	Command							
	Non-Command	8038	377	529	906	895	6766	11
	Block Total	**8038**	**377**	**529**	**906**	**895**	**6766**	**11**
	District Total	**63909**	**2233**	**1850**	**4083**	**2610**	**59067**	**6**

Table 5: Ground Water Resources of Shahdol district, M.P as on march- 2011.

Assessment Unit/ District	Command/ non-Command/ Block Total	Net Annual Ground water Availability (%)	Existing Gross Ground water Draft for Irrigation	Existing Gross Ground water Draft for Domestic & Industrial water Supply	Existing Gross Ground water Draft for All uses	Allocation for domestic & industrial requirement supply upto next 25 years (2035)	Net Ground water Availability for future irrigation	Stage of Ground water Development
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Sohagpur	Command	0	0	0	0	0	0	0
	Non-Command	80.17	4.32	5.74	10.06	15.03	60.81	13
	Total	**80.17**	**4.32**	**5.74**	**10.06**	**15.03**	**60.81**	**13**
Jaisingh nagar	Command	0	0	0	0	0	0	0
	Non-Command	191.53	8.46	4.12	12.58	12.28	170.79	7
	Total	**191.53**	**8.46**	**4.12**	**12.58**	**12.28**	**170.79**	**7**
Beohari	Command	0	0	0	0	0	0	0
	Non-Command	85.90	7.94	3.90	11.85	10.44	67.52	14
	Total	**85.90**	**7.94**	**3.90**	**11.85**	**10.44**	**67.52**	**14**
Burhar	Command	0	0	0	0	0	0	0
	Non-Command	165.76	1.18	3.10	4.28	7.88	156.70	3
	Total	**165.76**	**1.18**	**3.10**	**4.28**	**7.88**	**156.70**	**3**
Gohparu	Command	0	0	0	0	0	0	0
	Non-Command	121.34	1.14	2.41	3.55	7.20	113.00	3
	Total	**121.34**	**1.14**	**2.41**	**3.55**	**7.20**	**113.00**	**3**
	District Total	**644.69**	**23.05**	**19.28**	**42.33**	**52.82**	**568.82**	**7**

4.6 Ground Water Quality

In order of determine the Chemical Quality of ground water to assess the suitability for agriculture and drinking purposes, a total number of 19 water samples from phreatic aquifer were collected .

Quality of Ground Water for Drinking Purpose

The quality of ground water in district is being assessed by the analysis of groundwater samples from 19 number of hydrograph stations collected during May,2011 .The analysis of water samples for year 2011 indicate that The electrical conductivity (EC) values indicative of total dissolved solids in groundwater were found to be in the range of 175and 1440 µs/cm at 25^0C.

Temporary Hardness of water can be removed by boiling. However, shallow ground water is vulnerable to contamination from different sources. Nitrate concentration ranges between to 34ppm.The study of analyzed data shows that Shahdol district does not have any problem of fluoride since all the wells have fluoride less than 1.5 ppm of BIS (1990) permissible limit and ranges between 0.05-0.69ppm. In general, groundwater in phreatic aquifer is fresh and fall in classification of good category for drinking purpose.

Quality of Ground Water for Irrigation Purposes

The chemical quality of groundwater is an important factor to be considered in evaluating its suitability for irrigation purpose. The parameters such as EC, Sodium Absorption Ratio (SAR), percent sodium (% Na) and Residual Sodium Carbonate (RSC) are used to classify the water quality for irrigation purpose. US Salinity Laboratory suggested a diagram of classifying waters for irrigation purposes in 1954. It is clear that more than 82% groundwater samples from the district fall under C_2-S_1 class (medium salinity and low sodium) which means that these waters can be used for all type of crops on soils of low to high permeability, without causing problem of salinity. The groundwaters representing the wells of Singhpur, Gohparu and Beohari are grouped under C_3-S_1 (high salinity and low sodium) class, indicating that groundwater from these areas can be used for irrigation purposes on well drained soils or used for salt tolerant crops like groundnut, safflower etc.

5.0 GROUND WATER MANAGEMENT STRATEGY

Shahdol district has been identified as drought prone area. Drought has been recognised as a hydrological phenomena which occurs in certain frequency of incidence and cause misery and economic crises practically every alternate third year. Therefore, a scientific study of its cause and effects and pooling these experiences for the most optimum utilisation of the limited water resources should be the first task of the district’s development authorities. Groundwater development and management is an important measure for drought mitigation.

5.1 Ground Water Development for Rural Water Supply

Practically, the entire district of Shahdol has been suffering from the problem of drinking water. The problems get more pronounced during the year of deficient rainfall. Though the State Public Heath Engineering Department with its division at Shahdol, which is entrusted the task of providing drinking water supply to urban and rural population, has made considerable progress in providing drinking water facilities in problem villages under accelerated Rural water supply Scheme, much work is to be done through concrete and concerned plan of action to tackle the problem on short term and long term. Water is being supplied through dugwells, tubewells, hand pumps. At places mine discharge water and water from surface water sources is also being supplied. Detailed hydrogeoligical surveys for proper source of drinking water supply is to be investigated in villages which have no source of drinking water, in villages where tube wells failed and villages where yield dwindle in the summer affected due to coal mining activities and villages where piped water supply schemes are to be strengthened and in villages which are partially covered.

5.2 Problem related with Deforestation and Soil Erosion

Due to improper and unscientific management as well as exploitation of forest to yield high revenue, there has been a regular degradation in forest quality and its coverage during the pre independence period. Deforestation has been also caused by large scale mining of coal through open cast system and rehabilitation and construction of residential colony surrounding mine area.

In Shahdol district there has been tremendous depletion of the forest cover in the recent past due to heavy human interference. After Independence, survey and demarcation was carried out but the ecological degradation could not be controlled due to natural influence of unfavorable geological formation and human interference. Poverty and ignorance of local Adivasis, regular fire incidence and periodical droughts have also contributed to devastation of vegetation resulting in retrogression of forest. Regression in ecology and degradation in vegetation cover has done a great damage to soil and moisture conservation in the district, there is an urgent need to reverse this process by a proper a forestation program with latest management technique and innovations.

Soil erosion in general occurs when rains are heavy and flow of water through the field occurs with high velocity . This erosion by water is accelerated due to defective method of cultivation, burning or destruction of forest for shift cultivation, excessive grazing by animals, inadequate precipitation etc. As a result. Vegetation cover is reduced and soils are exposed to erosion. Thereby fissures and gullies are formed within cultivated areas through which rain water flows and carries away the fertile soil. There is thus a need for a scientific approach for implementing soil conservation measures. To begin with the task of reviving unproductive land into productive land, proper and improved technology of plantation vis-a-vis protection of land against varieties of erosion can lead to a successful programme of afforestation in this district. Vast tract of waste land needs reclamation. The moisture retention capacity of the degraded land has to be restored by suitable engineering skill and schemes. Groundwater development plays an important role in forest development

5.2.1 Problems related with the Dewatering of Phreatic Aquifer Due to Mining of Coal

Sohagpur coal field is the main coal mining area of the district. There are 71 village which fall in the various coal fields of the district. These are identified for the problem of depletion in the general water table and decline in the tube well discharge. Gondwana formation particularly the upper part of Barakar Sandstone support development of phreatic aquifers which extends from few metres below ground level to 25 m below land surface. Underground and opencast excavations behave as large sinks and create hydraulic gradient towards the mine. Mine water is pumped out for trouble free mining operations. Continuous withdrawal of water from Coal mines for their mining activities is causing adverse impact on ground water regime of the area which ultimately results in declining water levels, drying up of wells, dwindling of their discharge and some times land subsidence. As per Central Mine and Design Institute, Bilaspur, in Sohagpur Coalfield area daily 29,890 cubic metre water is being pumped for trouble free mining operations. Out of 29,890 cubic metre water per day, 9,869 cubic metre is used for domestic water supply, 2,667 cubic metre is used for mine industry and balance 21,223 cubic metre water per day goes as discharge runoff. These figures indicate that such a huge quantity of important ground water resource go as waste.

Strict water management practices should be adopted for the coal-mining belt. Abandoned mines can be treated as a big rainwater harvesting and artificial recharge structure. Hence, priority needs to be given for mine water harvesting and sustainable development. In post-mining, the abandoned mine voids should be backfilled to serve as huge groundwater reservoirs and recharge structures. In open cast mines, the permeability of the reclaimed area is usually higher than the in-situ and allows to infiltrate up to 40% of rainfall. These areas can be the major water pockets for future development. Thus, with proper water management, by mining out one resource ‘Coal’, another valuable resource ‘Water’ may be generated. Coal mining can an eco-friendly engineering activity by adopting groundwater resource management.

6.0 RECOMMENDATIONS

Based on the hydrogeological studies the following recommendations are made for proper development and utilization of the available groundwater resources and management of ground water resources.

Shahdol comes under safe category from ground water development point of view. Net Groundwater Availability for future irrigation development is 64469 ham. There is ample scope for development of groundwater for irrigation, industrial and domestic purposes.

Groundwater development should be carried out in the district in a planned manner for agricultural development, industries and afforestation. Groundwater development and management is also an important measure for drought mitigation.

Detailed hydrogeoligical surveys for proper source of drinking water supply is to be investigated in villages which have no source of drinking water, in villages where tube wells failed and villages where yield dwindles in the summer as also in villages affected due to coal mining activities and villages where piped water supply schemes are to be strengthened and in villages which are partially covered.

The areas, where tubewells are to be constructed, should be geophysically surveyed since there recommendations are based on the hydrogeological surveys on regional scale and furnished a broader picture of hydrogeological conditions in the district.

These areas are recommended for dugwells having depth of 12-15 mbgl and 8-10 m diameter. Horizontal boring is recommended in the dugwells constructed in valley portions to enhance the yields of the wells.

In some watershed areas, where deforestation has occurred and soils are exposed to erosion, watershed management may be adopted by constructing gully plugs, contour bunding and artificial recharge structures after detailed micro level surveys, to increase retention of soil moisture, stop soil erosion and increase the ground water potential. Stop dams are recommended across the streams sections near villages, so that the stored water can be used for domestic purposes in the tribal pockets.

Strict water management practices should be adopted for the coal-mining belt. Mines can be treated as a big rainwater harvesting and artificial recharge structure. Hence, priority needs to be given for mine water harvesting and sustainable development.

In post-mining, the abandoned mine voids should be backfilled to serve as huge groundwater reservoirs and recharge structures.

In open cast mines, the permeability of the reclaimed area is usually higher than the in-situ formations and allows infiltration up to 40% of rainfall. These areas can be the major water pockets for future development. Thus, with proper water management, by mining out one resource ‘Coal’, another valuable resource ‘Water’ may be generated.

Coal mining can an eco-friendly engineering activity by adopting groundwater resource management.