केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

AQUIFER MAPPING REPORT

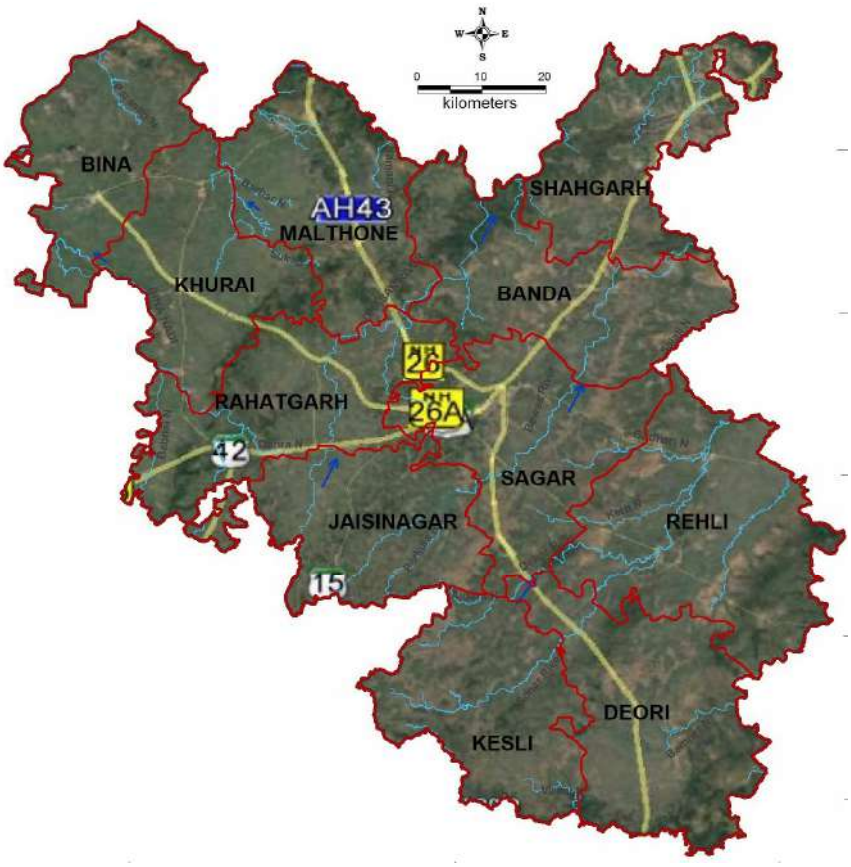
Sagar District, Madhya Pradesh

उत्तरी मध्य क्षेत्र, भोपाल

North Central Region, Bhopal

CENTRAL GROUND WATER BOARD

MINISTRY OF WATER RESOURCES, RIVER DEVELOPMENT & GANGA REJUVANATION



AQUIFER MAPPING AND MANAGEMENT PLAN OF SAGAR DISTRICT, MADHYA PRADESH

BY

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STA (HG)

CENTRAL GROUND WATER BOARD

NORTH CENTRAL REGION, BHOPAL

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PREFACE

Aquifer mapping is as a multi-disciplinary scientific process, wherein a combination of geological, geophysical, hydrological and geochemical studies are applied to characterize the quantity, quality and sustainability of ground water. Systematic aquifer mapping is a procedure to improve our understanding of the hydrogeological framework of aquifer system.

Under the project on National Aquifer Mapping (NAQUIM) in XII & XIII Plan to formulate sustainable aquifer management plan, Central Ground Water Board (CGWB), North Central Region, Bhopal has taken up Sagar disrtict to prepare the 3-Dimensional Model and 2-Dimensional Aquifer Maps for the entire district and formulate Block-wise Aquifer Management Plan.

Sagar district occupies an area of 10252 sq km out of which the ground water recharge worthy area is 9254 sq. km. and the rest is covered by hilly and forest area. The major rivers flowing through the area includes the river Bina, Dhasan, Bewas, Sonar and Bamner. The major part of the district is covered by the Deccan trap lava flows and in eastern part by Vindhayan sandstones. On the basis of the 70 Exploratory borewells drilled by CGWB, NCR under its Exploratory/NAQUIM program, it has been observed that the yield varies from meagre to 5lps in basalt and meagre to 4 lps in Vindhyans. As per the Dynamic Ground Water Resource Assessment Report (2013), the net ground water availability in the district is 1212.88 MCM and ground water draft for all uses is 736.11 MCM, resulting the stage of ground water development to be 60.69 % as a whole for district.

The Sagar district falls under safe category. After the implemented of project interventions in the report, the stage of development is expected to improve by 7% i.e. from 60.69% to 53.44% for the Sagar district and additional area for the irrigation will be 26256Ha.

Sagar district comprises of eleven blocks, namely Banda, Bina, Deori, Jaisinagar, Kesli, Khurai, Malthone, Rahatgarh, Rehli, Sagar and Shahgarh. As per the Management plan prepared under NAQUIM of all the Block of Sagar District , a total number of 233 Percolation Tanks, 466 Recharge Shafts/Tube wells and 1901 Nala Bunds/Check Dams/Cement Plugs have been proposed and financial expenditure is expected to be Rs 270.78 Crores in Sagar District for sustainable development and management of ground water resources.

Before finalization of this report a three tier evaluation mechanism is adopted ,presentations were made at Regional level & State level Coordination Committee ,then the revised presentation were made before the Member and finally it was presented to National Level Expert Committee , after all corrections this report is prepared.

Results of these comprehensive studies will contribute significantly to ground water sustainable management tools. It will not only enhance the long-term aquifer monitoring networks and but would also help in building the conceptual and quantitative regional ground-water-flow models for planners, policy makers and other stakeholders.

I would like to place on record my appreciation for ***Dr. L.K. Mathur, Scientist 'D'*** who had supervised and guided ***Dr.K.Paramasivam ,STA Hg*** to compile this report . I fondly hope that this report will serve as a valuable guide for sustainable development of ground water in the Sagar District, Madhya Pradesh.

Parvinder Singh
(Regional Director)

1. INTRODUCTION

Aquifer mapping can be defined as a scientific process, wherein a combination of geologic, geophysical, hydrologic and chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. Systematic aquifer mapping is expected to improve our understanding of the geologic framework of aquifers, their hydrologic characteristics, water levels in the aquifers and how they change over time, and the occurrence of natural and anthropogenic contaminants that affect the portability of ground water. Results of these studies will contribute significantly to resource management tools such as long-term aquifer monitoring networks and conceptual and quantitative regional ground-water-flow models used planners, policy makers and other stakeholders. Aquifer mapping at the appropriate scale can help prepare, implement and monitor the efficacy of various management interventions aimed at long-term sustainability of our precious ground water resources, which, in turn, will help achieve drinking water security, improved irrigation facilities and sustainability in water resources development in the country as a whole. Various on-going activities of Central Ground Water Board, such as ground water monitoring, ground water resource assessment, artificial recharge and ground water exploration in drought, water scarcity and vulnerable areas can also be integrated in the aquifer mapping project.

1.1. Objectives:

Aquifer Mapping is an attempt to combine a combination of geologic, geophysical, hydrologic, chemical field and laboratory analyses are applied to characterize the quantity, quality and sustainability of ground water in aquifers. The major objectives of aquifer mapping are

- Delineation of lateral and vertical disposition of aquifers and their characterization on 1: 50,000
- Quantification of ground water availability and assessment of its quality to formulate aquifer

- Management plans to facilitate sustainable management of ground water resources at appropriate scales through participatory management approach with active involvement of stakeholders.

1.2. Scope of the Study:

The Social Outputs and benefits are less tangible but their significance in the contest of sustainable management of ground water resources cannot be underestimated

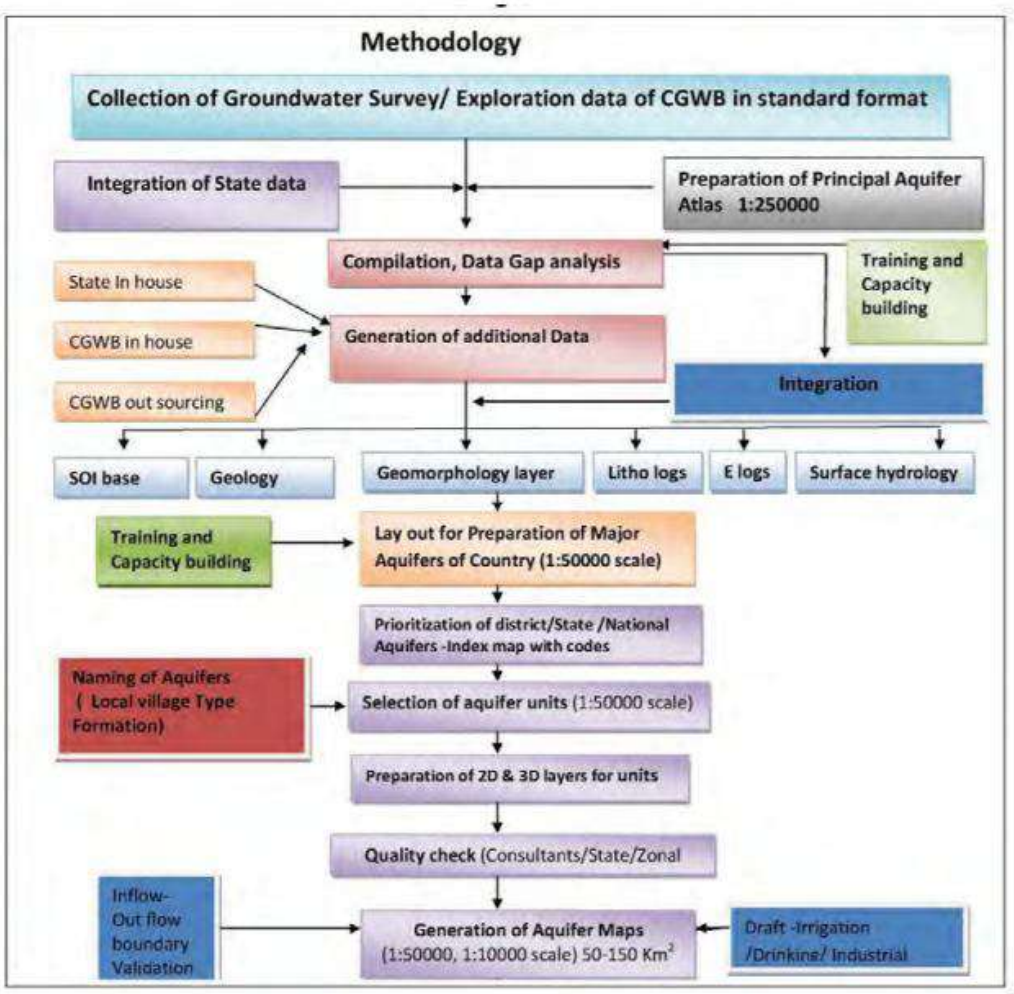
• Involvement of community and stakeholders would enable the State Governments to manage their resources in an efficient and equitable manner, thereby contributing to improved overall development.

• Demystification of science will result in better understanding of aquifers at community level. The amalgamation of scientific inputs and traditional wisdom would ensure sustainable ground water resource management.

• Community participation and management would ensure sustainable cropping pattern, thereby contributing towards food security.

1.3. Approach and Methodology:

National Aquifer Mapping Programme basically aims at characterizing the geometry, parameters, behavior of ground water levels and status of ground water development in various aquifer systems to facilitate Major Aquifers planning of their sustainable management. The major activities involved in this process include compilation of existing data, identification of data gaps and generation of data for filling data gaps and preparation of aquifer maps. The overall methodology of aquifer mapping is presented once the maps are prepared, plans for sustainable management of ground water resources in the aquifers mapped shall be formulated and implemented through participatory approach involving all stakeholders.



1.4. Study Area:

Sagar district is located in the north central part of the state of Madhya Pradesh and occupies area of 10252 sq km. and recharge worthy area is 9254 sq km. The district extends between the latitude of $23^0$10' and 24^0 27' north, longitude of 78^0 04' and 79^0 21'east. The district is bound in the north by state of Uttar Pradesh, in the north east by Chhatarpur district in south and west by Raisen, in the south east by Narsinghpur district, in the northwest by Guna district and in the east by Damoh district (fig 1). The National highway No. 26 passes through Sagar town. The district falls in survey of India toposheet No. 55M, 54L and 54P. A detail of Blocks in the study area is given in Table No. 1.

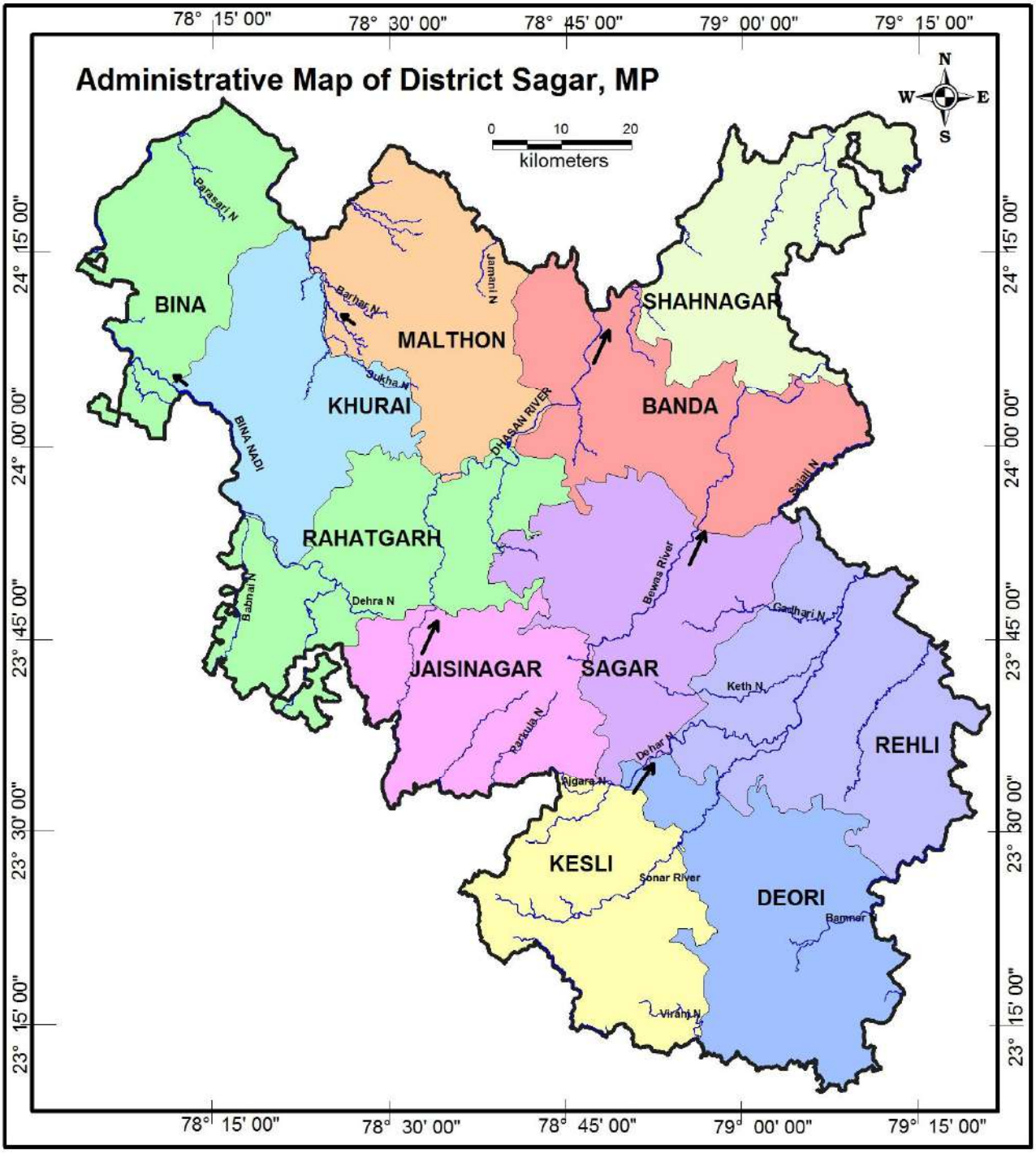


Fig. 1: Administrative Map, Sagar District

Block	Geographical Area (sq km)	Recharge worthy area (sq km)
Banda	953	831.30
Bina	826	821.00
Deori	1014	867.50
Jaisinagar	913	764.90
Kesli	791	658.60
Khurai	937	907.40
Malthone	838	778.80
Rahatgarh	985	890.68
Rehli	1125	1019.80
Sagar	1173	1075.70
Shahgarh	697	638.50
Total	10252	9254

Table 1: Detail of Blocks in the study area

1.5. Rainfall & Climate

The climate of the Sagar district can be classified mainly into three seasons. Winter season starts from middle of November to end of February. March to May constitutes summer season and the monsoon season starts from second week of June to end of September.

There are six rain gauge stations in Sagar district. Maximum rainfall occurs along the south western boundary of the district and decreases towards the north and slightly towards the east. In the southwestern parts of the district, Rehli gets a marked amount of low rainfall mainly due to its location in the valley on the leeward side of the hill range.

The normal annual rainfall of the district is 1118.2 mm. About 90% of the annual rainfall takes place during the southwest monsoon period i.e. June to September only 5.5% of annual rainfall takes place during winter and about 4.5% of rainfall occurs during the summer months.

During winter season, January is the coldest month with the temperature falling as low as 11.6^0 C and max up to 24.5^0 C. During the month of May, temperature goes up to 40.7^0 C (max.).

Block	2009&10 Rainfall (mm)	2010&11 Rainfall (mm)	2011&12 Rainfall (mm)	2012&13 Rainfall (mm)	2013&14 Rainfall (mm)	Average Rainfall (mm)
Banda	1617.2	586.6	484	586.6	1471	949.08
Bina	1129.6	932.8	734.4	932.8	1450	1035.92
Deori	2011.5	1499	986	1499	1095	1418.1
Jaisinagar	1446.4	883	583.8	883	1523	1063.84
Kesli	2159.5	1065.2	820	1065.2	1566	1335.18
Khurai	1185.2	1024	905	1024	1655	1158.64
Malthone	1340.2	921.4	703.7	921.4	1132	1003.74
Rahatgarh	1415.4	1180.4	658	1180.4	1559	1198.64
Rehli	1509	781	736.6	781	1170	995.52
Sagar	1555.4	987.3	594.9	987.3	1474	1119.78
Shahgarh	1218.2	923	571	923	1474	1021.84
District	1507.96	980.33	707.03	980.33	1415.36	1118.20

Table: 2 Rainfall Data of Sagar District

1.6. Physiography/DEM:

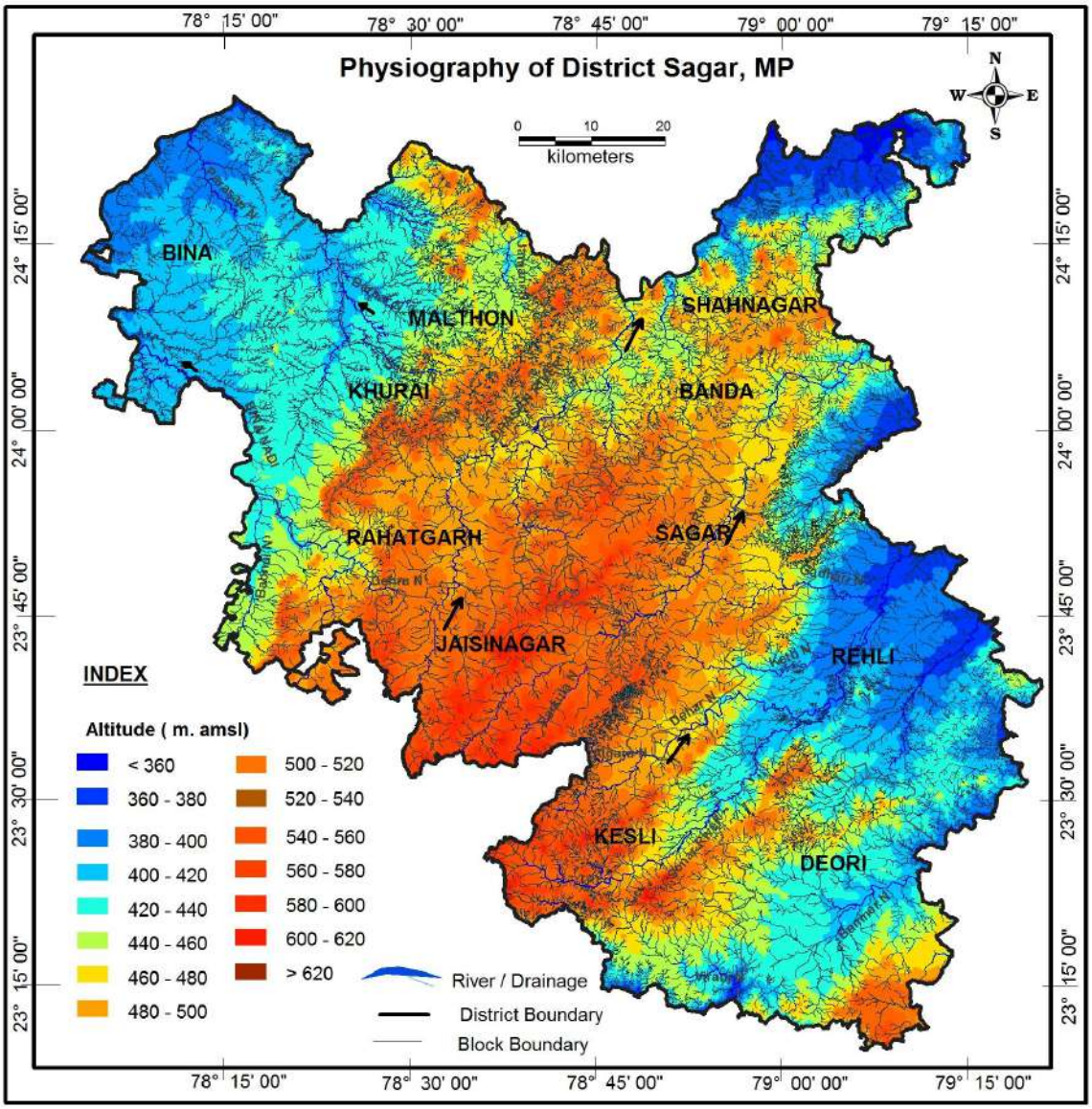
Sagar district lies at the South part of the Bundelkhand region, which widens in the south and south west. It lies northern boundary of the Narmada River and is separated from tis valley by a steep escarpment towards the south. The area is large and covered by the Deccan trap lava flows whereas at places like vindhayan sandstone also shown. The average elevation of the district is about 452 to 533 mamsl. It ranges from 353 mamsl in the Dhasan river bed in the north to 683 mamsl at Naharmau peak in the southwest.

The physical divisions of the district are represented by the basins of several rivers. The area in the north west falling under Khurai tehsil is almost a level tract with an elevation of about 411 to 427 mamsl and is drained towards north-west by Thimpa, Parasasi and Bina rivers. These rivers are tributaries of the Betwa river. The Khurai plain is separated from the rest of the district

by a series of steeply rising hills. These hills attain an elevation of upto 533 mamsl and also act as a water divide.

To the east and south-east of the above discussed hills are the five parallel valley of Dhasan, Bewas, Sonar, Kopra and Bamner rivers. These basins are separated by hills rising 91 to 153 meters above the general ground surface. The highest hill range of Tendu Dabar attains a height of 665 mamsl.

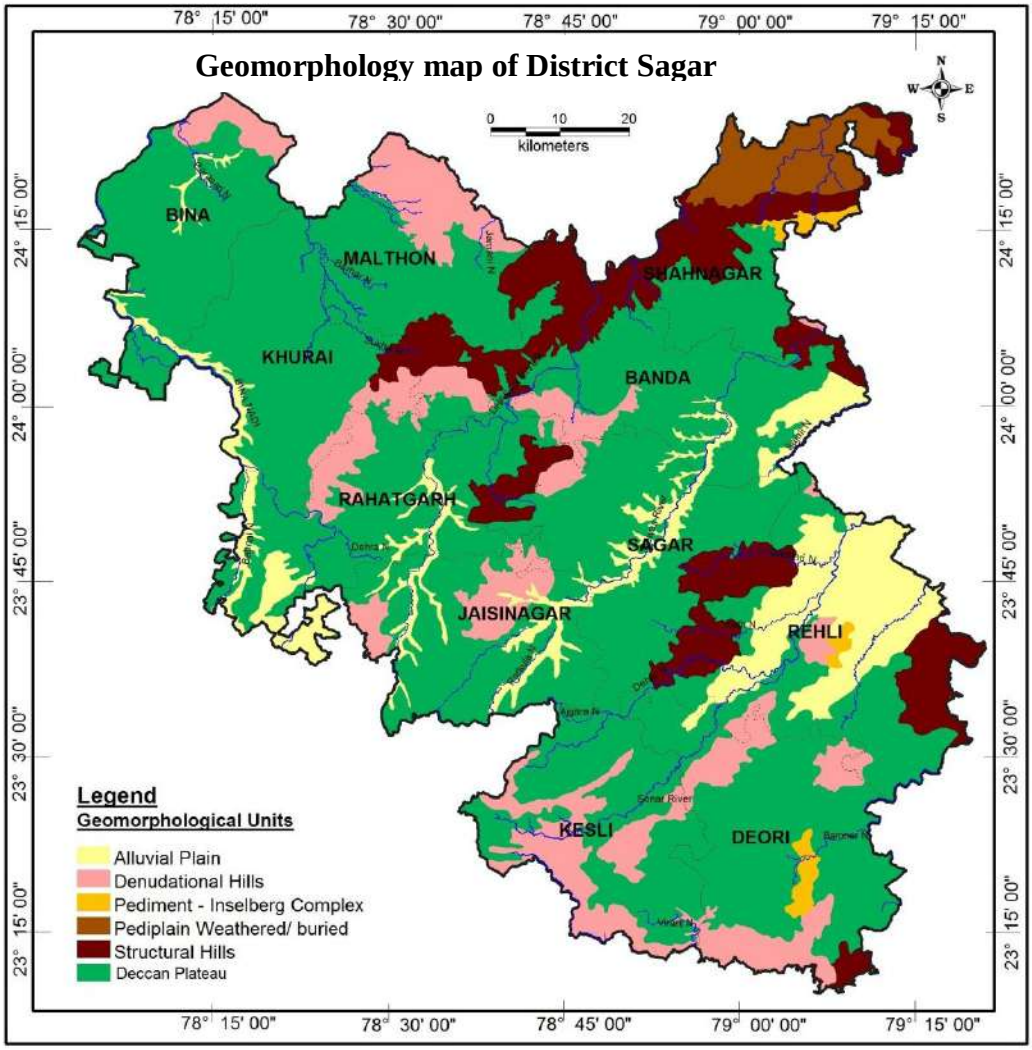
Fig.2 Physiography map of Sagar District



1.7. Geomorphology:

Generally Sagar district, landforms have been classified on the basis of genetic factor and the geomorphic processes involved. Further, the geomorphic units have been classified on the basis of differential erosion of rock material, process and relief amplitude. The classification system adopted is as per ITC scheme of classification of landforms Fig. no. 3.

Fig. 3: Geomorphological Map, Sagar District



Three groups of landforms have been identified in the area:

1. Denudational Landforms
2. Depositional Landforms
3. Structural Landforms

1.7.1. Denudational Landforms

a) Denudational Hills, Metamorphic, DNH (M) and Volcanic DNH (V) These are remnants of natural dynamic process of denudation, weathering and fluvial action. The geomorphic forms occur as residual hills, denudational hills with scree or debris. These have high relief and steep sided slopes and are generally highly jointed and fractured. These have poor ground water potential. DNH (M) occupy the central parts of the area covering Sagar town and the area west of it. DNH (V) occur in a very small area along the southeastern boundary of the district.

b) Pediplain Metasedimentary, PP (MS), Pediplain over Gondwana sediments, PP (GW), and Pediplain Volcanic, P (V) Pediplain refers to the flat or gently sloping surface, which is the end product of erosion. In Sagar, pedeplains have developed over schists and metabasics in a small patch north of Sihora in the northernmost extremity of the district. The PP (GW) occupy a small area in the eastern parts of Sagar city. Volcanic pediments, in which the underlying rock is basalt, occupy a small patch in the southwestern extremity of the area. This is characterized by a broad landscape of low relief broken by isolated residual uplands with thick overburden of weathered material. It is developed over schists and meta-basics in the district and has thick soil cover. It occurs north of Sihora and has good ground water potential.

c) Deccan Plateau, OPT, this is the largest landform in the district covering large tracts in southern and eastern parts. It is formed due to volcanic eruption of basaltic lava having very low dip slopes. The upper-most part of the plateau comprises of soil whereas the lower part is hard. Low relief and undulating topography characterize the plateau. This unit has moderate ground water potential, especially along lineaments and in the weathered zones.

d) Structural Hills, Vindhyan Sediments, SH (VC)

These are mostly composed of sandstones of Vindhyan supergroup and are associated with folds and are criss-crossed by joints and fractures etc. These occur in the form of linear to arcuate hills depicting definite trend lines. These have poor ground water potential.

e) Linear Ridge, LR

These are also composed of Vindhyan sandstone and occur as long and narrow ridges and represent areas of high run-off. The ground water potential of this landform is almost negligible.

1.7.2. Depositional Landforms

(a) Alluvial Plain, AP

This unit occupying a large tract in the western parts between the Narmada and Hiran rivers is composed of gravel, sand, silt and clay. This area has a flat to gently undulating topography of low relief and has good to excellent ground water potential.

1.7.3. Structural Landforms

The lineaments and the ridges formed due to folding and faulting form these landforms.

1.8. Soil cover :

The major part of Sagar district is covered by black cotton soil. However, clay loam soils occurs in the northern parts of Banda block, north of Malthone, west of Sagar town, Kesli and Deori blocks. Sands clay loam covers the areas falling in the southern parts Deori and Kesli blocks, east of Rehli and northern parts of Shahgarh block. Rehli block is by and large, covered by sandy loam soils.

1.9. Hydrology and Drainage:

Sagar district lies mainly in Ganga basin and partly in Narmada basin. Almost 97% of the district falls in the Ganga basin out of which 44% falls in the Ken sub-basin and 56% in the Betwa sub-basin. The surface water divide between the Ganga and the Narmada basin running almost in a east- west direction in the southern parts of the district also acts as a ground water divide in the area. The main rivers in the district are Upper Sonar, Bewas, Kopra, Bearma in the Ken sub-basin and Bina, Jamni, Naren and Dhasan in the Betwa sub-basin. Sindhor is the only river in the Narmada basin Fig.No.4.

The Dhasan emerges from just south of the district and flows initially in the south and then to the north. It also forms the boundary with Jhansi district of Uttar Pradesh. The Kopra and Bewas are tributaries of the Sonar. The Sonar joins Bamber and then both river joins Ken river. The Ken is a tributary of the Yamuna river. The drainage pattern is dendritic type. At a few place especially around Sagar town and near Khimlasa and Jaisinagar radial drainage pattern is also formed.

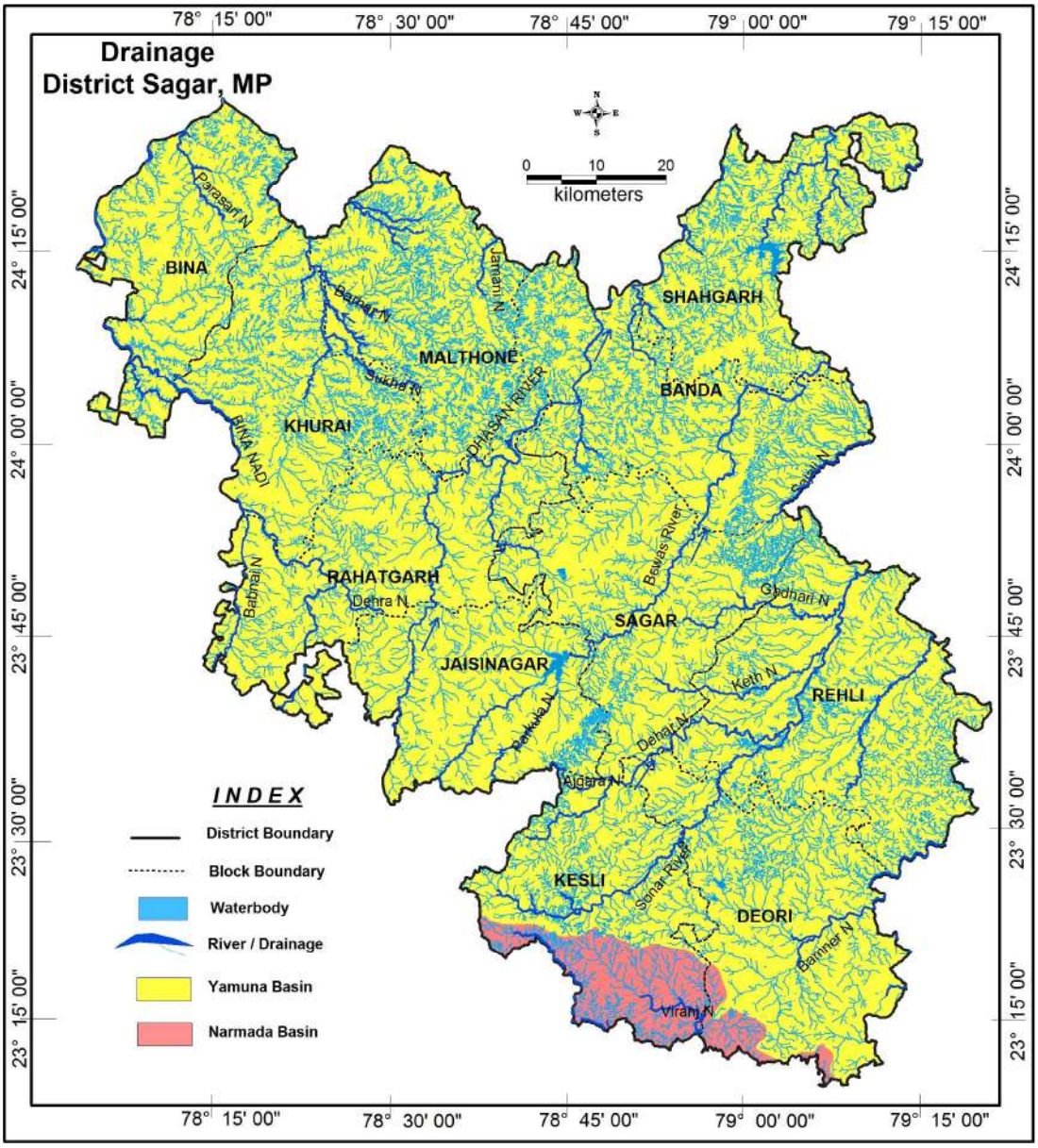


Fig. 4: Drainage Map, Sagar District

1.10. Land Use, Irrigation, and Cropping Pattern

As per the district statistical handbook 2013, the total area of Sagar district was 1020523 hectares (ha) Out of which, agricultural area is 454361 ha (44%) , 363407ha (35 %) is under forests. other non-cultivable land excluding barren land is 1981856 ha (19%).water Body area shows 5269 ha. (0.6%) Urban area is 4830ha (0.46%) The other area shown was 2013 ha90.1%). Which are shows in .Fig.**No**:5.

The area irrigated by tubewells was 85328 ha (33.66% of the total irrigated area), by open-wells -152360ha (59.76%), irrigated by canals was 11375 ha (4.46 % of the total irrigated area)and by ponds 5382 ha (2.11%) . The total area under assured irrigation from various sources was only 254940 ha. This was only 24.86% of the net sown area and 22.7% of the total sown area. Thus almost 75.14% of the sown area in the district is dependent on rain-fed irrigation

The principal crop grown during Rabi season is Wheat . It is sown in an area of 220810 ha. The other major Rabi crop is gram under which an area of 112926 ha is sown. Paddy is sown in an area of 8967 ha. The total area under Cereal crops is 243806 ha, under pulses it is 192355 ha, and under Oilseeds it is 173472 ha.

Table.3 Irrigation Details

Block	Tube Well Irrigated Area (Ha)	Dug Well Irrigated Area (Ha)	Ground Water Irrigated Area (Ha)	Canal Irrigated Area (Ha)	Pond Irrigated Area (Ha)	Surface Water Irrigated Area (Ha)
Banda	13016	13862	26878	258	510	768
Bina	19790	10010	29800	-	-	0
Deori	13343	9983	23326	2046	196	2242
Jaisinagar	4655	14783	19438	443	-	443
Kesli	2313	13215	15528	1586	32	1618
Khurai	8874	15362	24236	976	649	1625
Malthone	1880	9440	11320	290	593	883
Rahatgarh	3037	20455	23492	36	-	36
Rehli	12467	20170	32637	226	2389	2615
Sagar	5381	19420	24801	427	210	637
Shahgarh	1067	5660	6727	5087	803	5890
Total	85823	152360	238183	11375	5382	16757

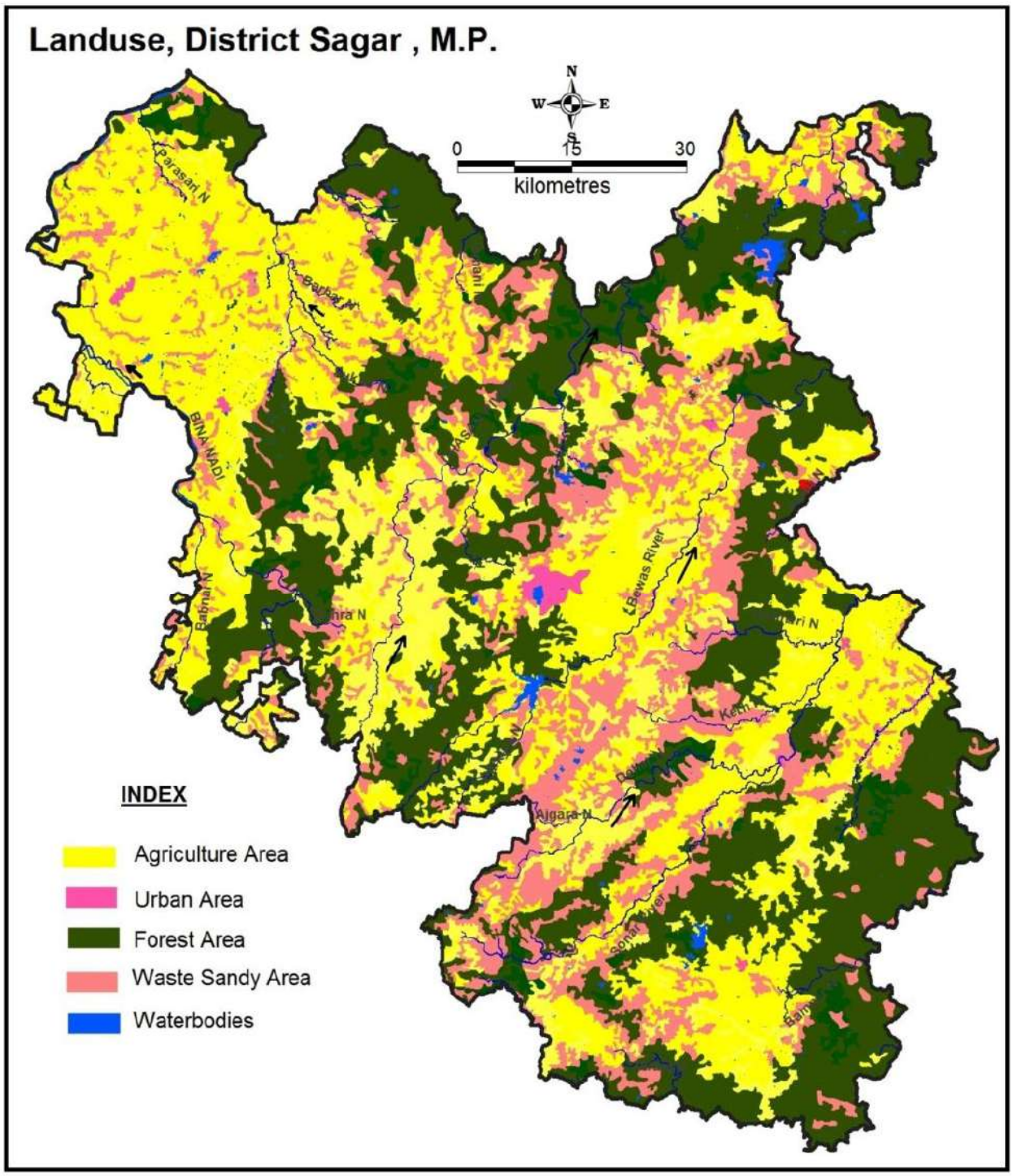


Fig. 5: Land Use Map, Sagar District

2. DATA COLLECTION AND GENERATION

2.1. Hydrogeology:

Sagar District forms the central part of the Vindhyan basin. The northern part of the district is occupied by the Bundelkhand massif. The Southwestern parts of the Area are covered by the Deccan traps . This district also limits the Northeasterly extension of the Deccan trap flows.

Granites

The granites and granitic gneisses in the area are quite hard and generally devoid of any primary porosity. However, due to weathering of the top mantle, jointing and fracturing secondary porosity has developed at a few places. The thickness of the weathered mantle varies from negligible near the outcrops to as much as 15 meter in the valleys and topograhpics lows. The joints and fractures close down after 35 to 30 meter. Ground water in thus formation occurs under water table condition. Tube wells in the granites are and the ground water is withdrawn. Mostly through dug wells. The tube wells sustain a maximum discharge of about two litres per second (lps) for appreciable drawdowns. The yield of open wells ranges between 20 to 100 m^3/day.

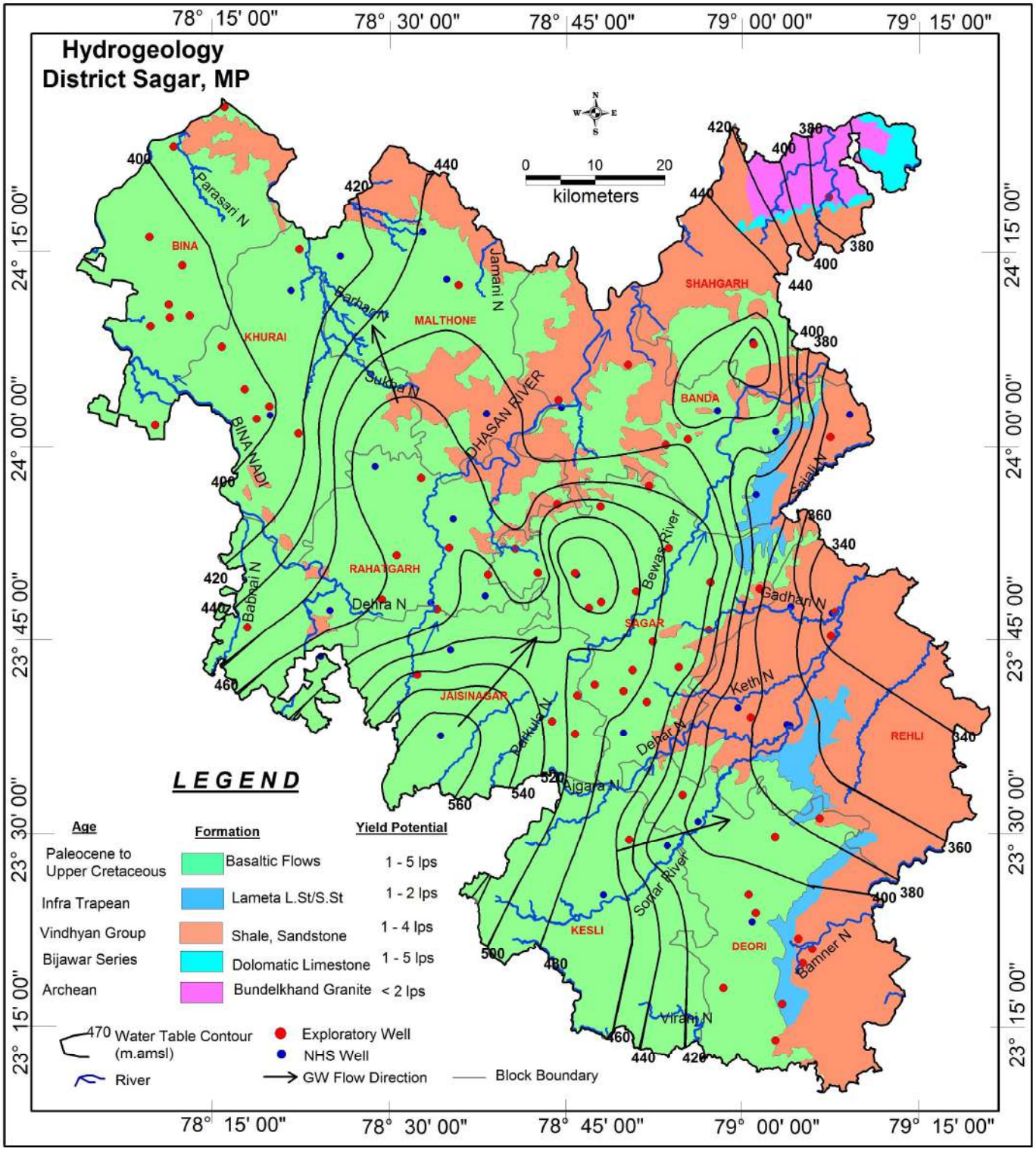
Bijawar

The Bijawars are exposed in a tiny patch in the north eastern extremity of the district. These are composed of siliceous lime stones, breacia and shales. These formations have any significant ground water occurrence.

Vindhyans

In the vindhyan sandstones, primary porosity varies from negligible to as high as 30% depending on the degree of compaction. The storage and movement of ground water in these formation is controlled mainly by the secondary porosity and permeability created due to weathering jointing and fractured. Ground water occurrence is good along the liveaments and their in trisections and occurs under water table condition. The tube wells an these formation yield up to two lps and the dug wells have yields to 100 m^3/day.

Fig. 6: Hydrogeological Map, Sagar District



Lametas

These are intertrappean formations comprising siliceous limestone and sandstone. The lametas are fairly thick at places and attain up to 45 meter thickness east of Sagar and near Deori. The limestones of the lametas are poor quality aquifer in the district. However, sandstones are semi consolidated and have primary porosity also. These formations support dug wells having moderate to good yield in the range of 50 to 200 m^3/day.

Deccan Traps

Deccan traps are the most important formations in the district due to their large aerial extent. The weathered jointed, fractured and vesicular units of basalts form moderately potential aquifers. The zeolitic basalt in weathered form also makes good aquifer. The red bole bed, which is predominantly clay, is non productive and acts as a confining layer also. A common weathering product of the trap is a friable light greenish or yellowish green mantenlin locally called as “Murram” however.

Murram does not occurs everywhere the trap zones bearing “Murram” forms potential aquifers. Basalt vindhyan contact is not a promising zone. However wherever thick vesicular and fractured/jointed zone is encountered in the basalts. It can sustain tube wells of moderate to good discharges. The discharge in the depth range of 38 to 40 and 47 m at Mirkheri was about 16 lps. The dug wells in these formations can sustain yield of up to 750 m^3/day. During the Betwa Project at the time of drilling Methane Gas was Encountered at Mirkheri site.

Laterites

Laterite, a by product of weathering of basalt (at some places). In found only to the west of Sagar town. This formation has not attained significant thickness in the area.

Alluvium

The alluvial deposits are confined mostly to the area along the river courses and in the eastern parts of the district. It is composed of five to medium sand, silt, clay and kankar. The alluvium

supports tube wells and dug wells wherever thick and can sustain tube wells with discharge up to 10 lps.

2.2. Ground water scenario:

The monitoring of ground water levels of the area give a picture of the behavior of ground water regime over space and time. It is a very important parameter that is used in assessing the ground water resourses and clearing area for future development. In sagar distict, CGWB is monitoring ground water levels four times a year. There are 38 national hydrograph stations (NHS) and 9 piezometers. The behavior of ground water regime for the pre-monsoon and post-monsoon period of 2016 is discussed hereunder.

Pre-monsoon (May 2016)

The Pre-monsoon depth to water level (DTWL) ranged between 1.92 mbgl in to 36.52 mbgl. However, in major part the DTW ranged between 5 to 10 mbgl. Deeper water levels of more than 20 mbgl are observed in isolated patches in western part and are presented in fig. 7a.

Post-Monsoon (Nov 2016)

The Post-monsoon depth to water level (DTW) map is presented in fig. 6. It varies from 1.09-22.00 mbgl. In major part the DTWL was less than 10 mbgl. Deeper water levels of more than 10 mbgl are observed in isolated patches in north western, south eastern and in few pockets central part and are presented in fig. 7a.

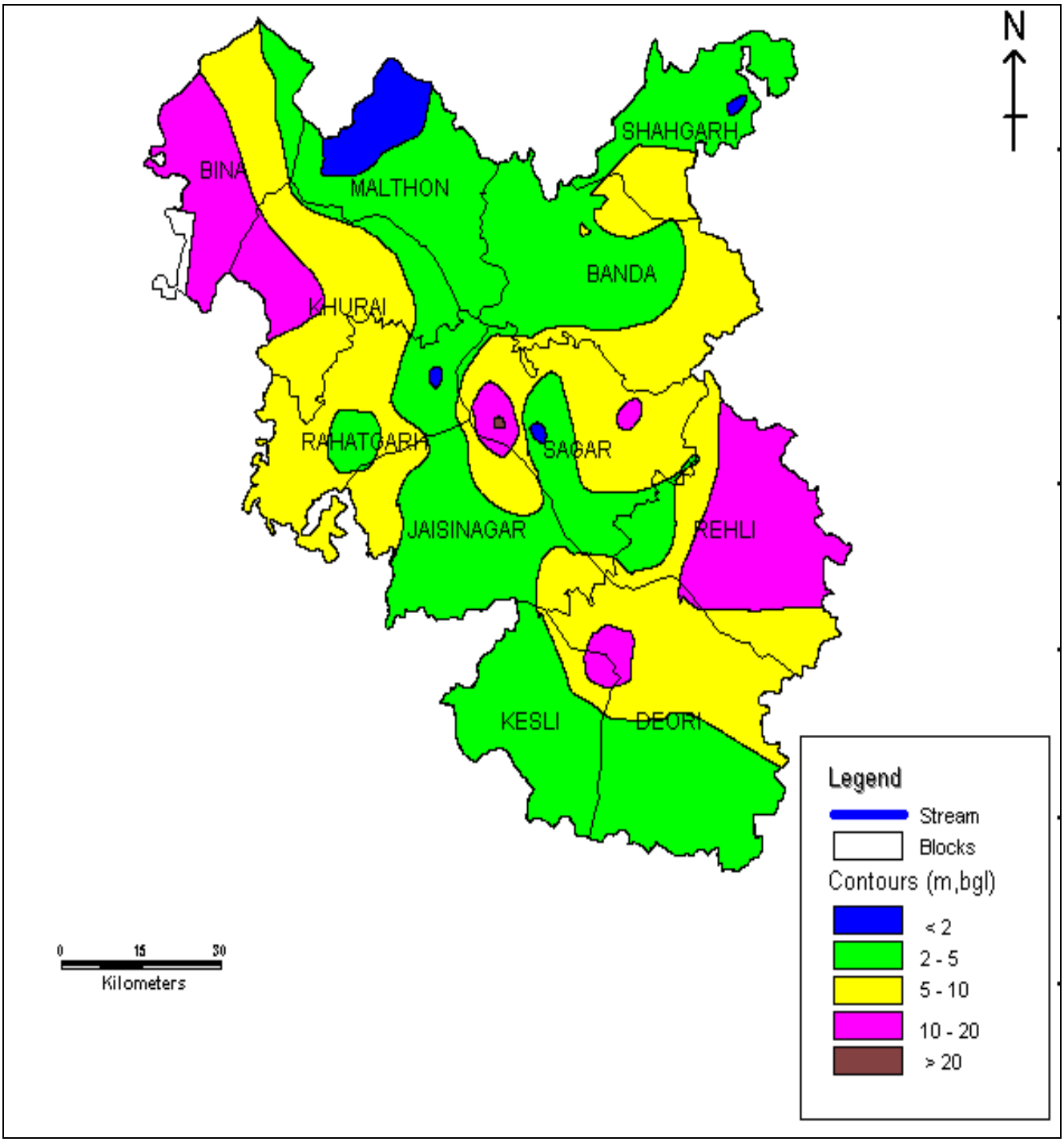


Fig. 7a: Pre-monsoon (May 2016) DTWL Maps, Sagar district

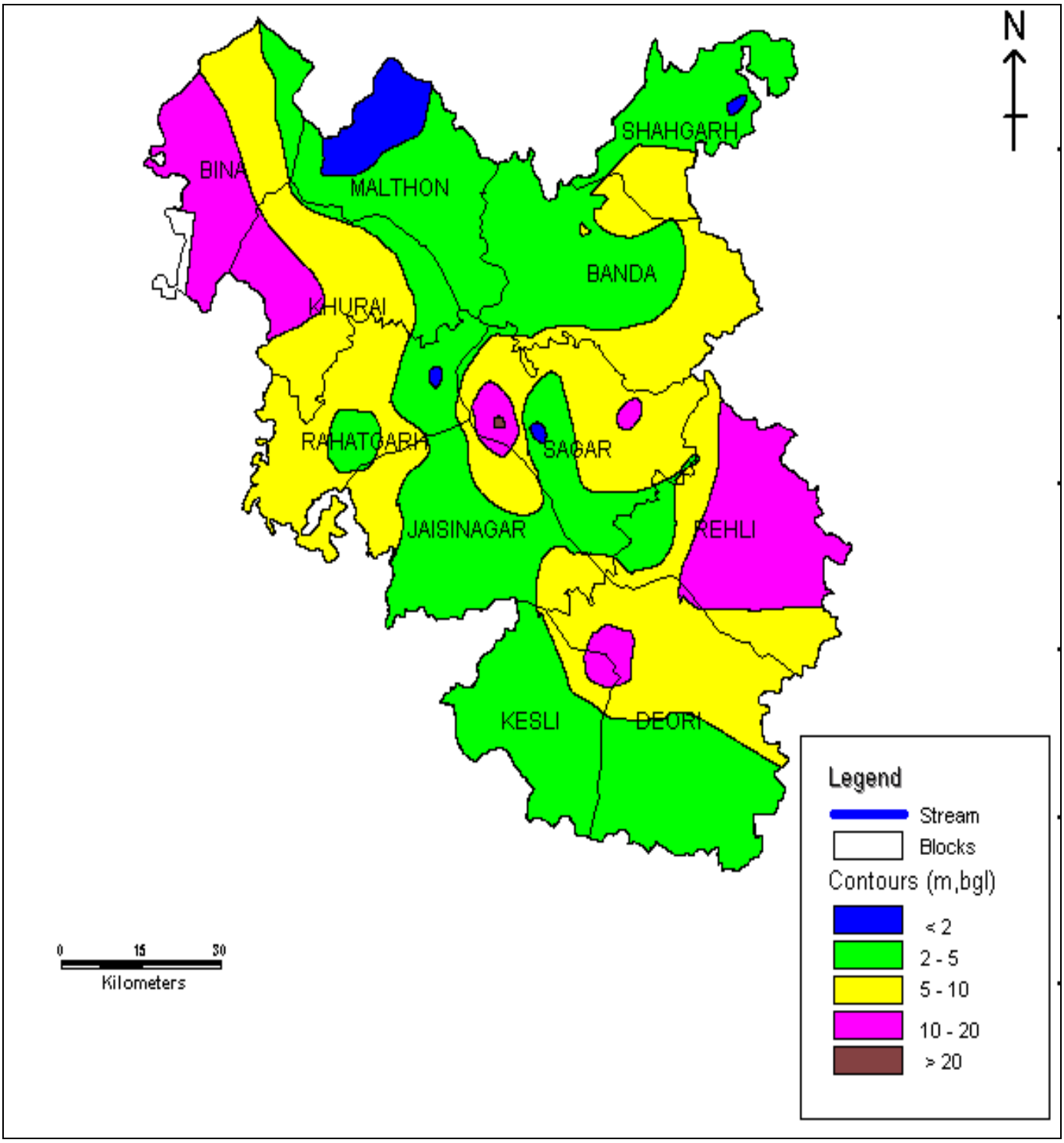
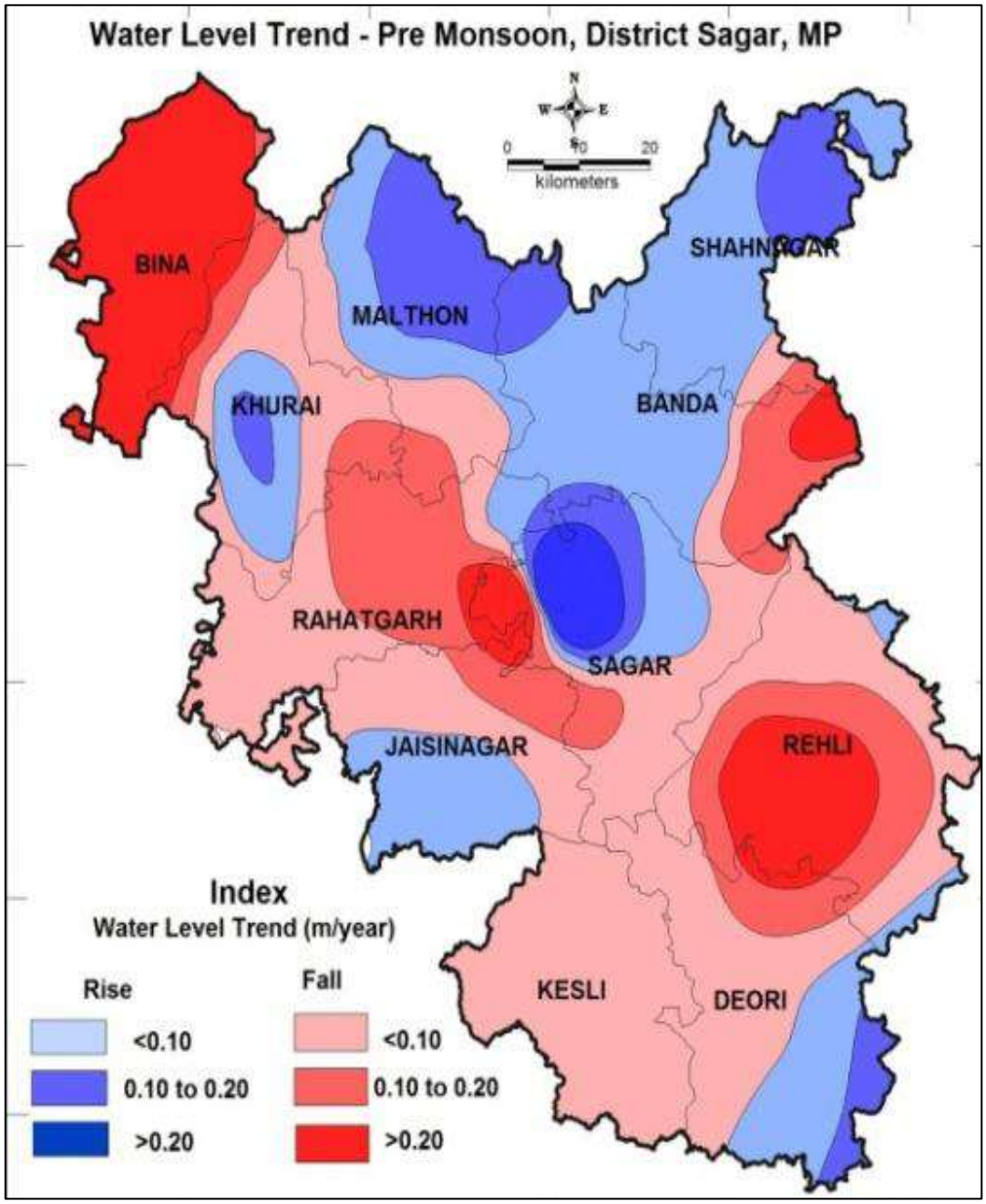


Fig. 7b: Post-Monsoon (Nov 2016) DTWL Maps, Sagar district

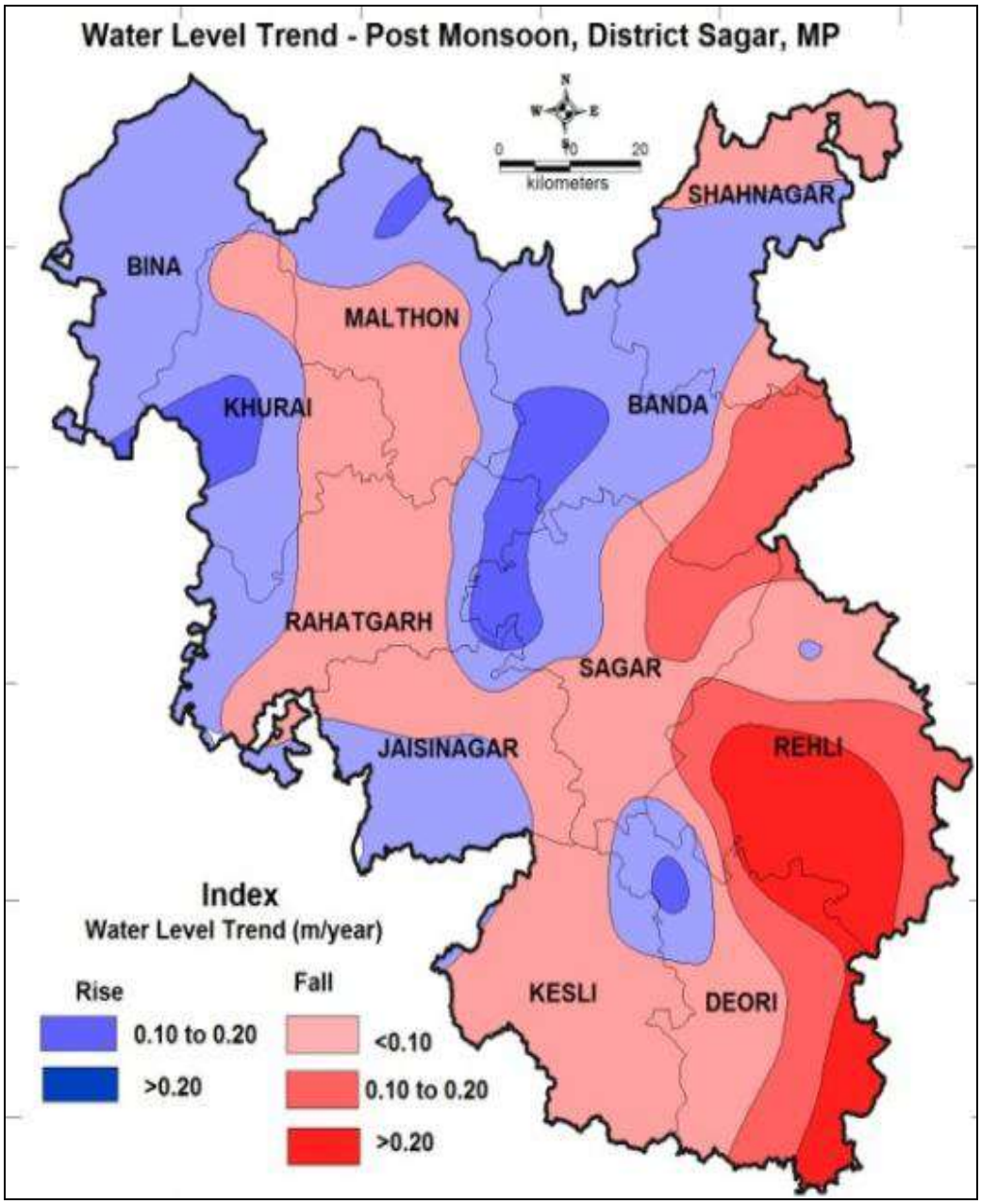
Water Level Trend (1995-2016)

The Water level trend for the 22 years (1995-2016) presented in the fig. 7 shows that both rise and fall is observed. The rise is observed in about 30% of the area in the range of 0.01 to 0.17 m/ year. The decline is observed in about 70% of the area in the range of 0.09 to 0.1 m/year.

Fig. 8: DTWL Rising/Declining



Trend Maps, Sagar district



2.3. Ground water Exploration:

CGWB has drilled 60 exploration borewells and 9 Piezometers (Fig. 9).On the basis of samples collected during drilling, lithologs have been prepared. The aquifer parameters are calculated on the basis of pumping tests. The salient details of thesome of the drilled bore wells and piezometers is given in Table No 4 & 4a

Fig. 9:Exploratory wells location Map, Sagar District

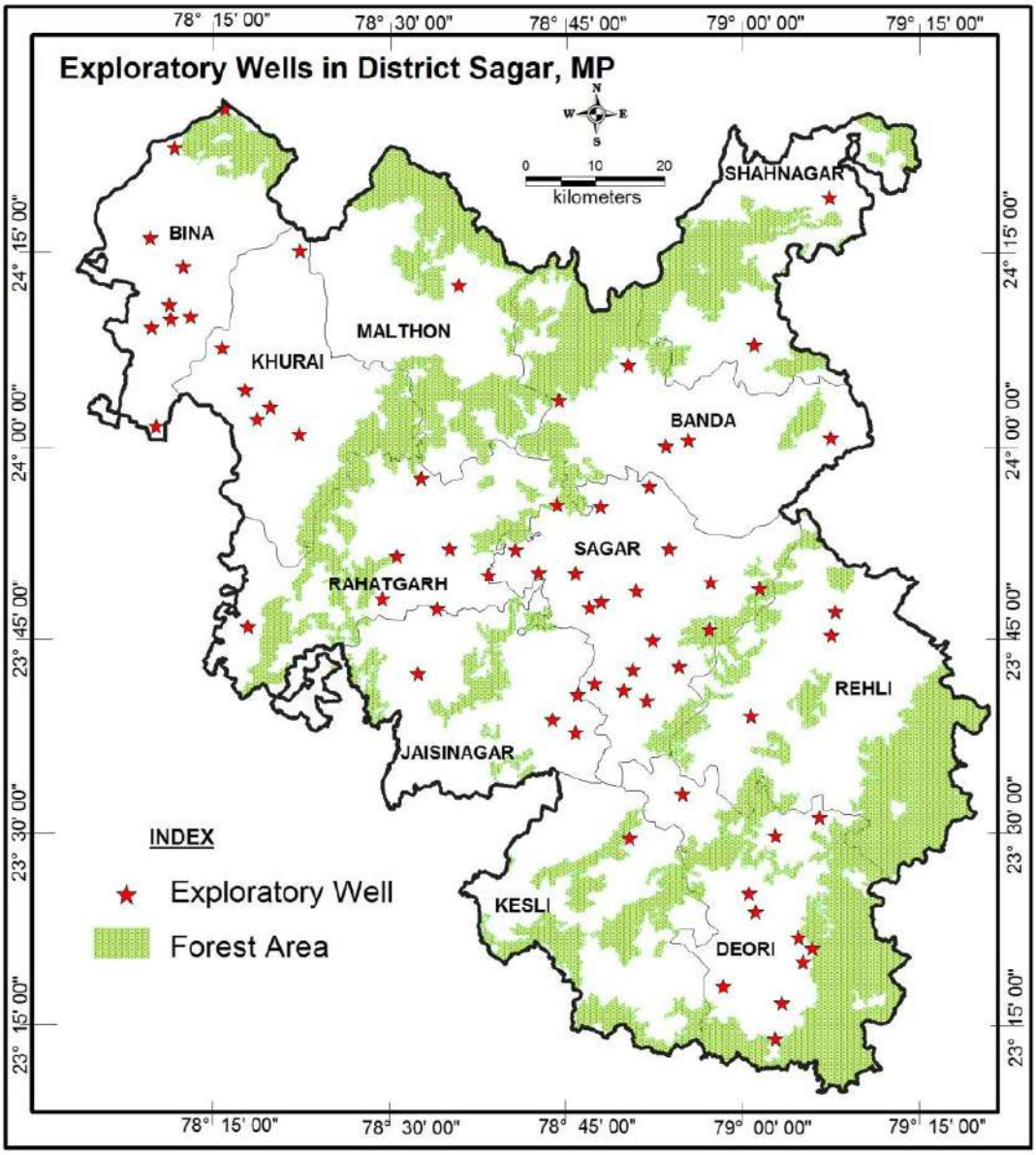


Table No :4 Salient Features of the Exploratory Wells Constructed Sagar District during NAQUIM, CGWB, NCR, Bhopal

S.No	Location	Lattitude	Longtude	Block	District	Depth Drilled (M)	Depth of the Well (m)	Thickness of weathering (m)	Length of Cassing lowered with dia	Fractured Encountered (m)	Aquifer	SWL(m)	Discharge (lps)	DD(m)
1.	Belai	24.2336111	78.20889	Bina	Sagar	203.4	203..1	12.3	72	53-6-56-6	Basalt/Shale		Meagar	
2.	Kanjiya EW	24.3869444	78.19667	Bina	Sagar	102.4	102.4	17	18	14-17,,99.40-102.4	Laterite /Sandstone	30.5	12	5.95
3.	Agasod	24.2697222	78.1625	Bina	Sagar	200	200	18	12	12-15	Basalt/Shale	8.3	0.1	
4.	Gaudana EW	24.1544444	78.16417	Bina	Sagar	65.8	65.8	8	8	53.6-56.7	Basalt/Sandstone	7.3	3.5	
5.	Hiranchipa	24.16807	78.21928	Bina	Sagar	34					Basalt/Shale		Abantant	
6.	Hiranchipa	24.16807	78.21928	Bina	Sagar	200	200	14	18	14-17	Basalt/Shale	10.2	0.2	
7.	Sandi	24.02638	78.17081	Bina	Sagar	80.3	80.3	12.1	12.3	32-35	Basalt/Shale	18.2	0.2	
8.	Siloda EW	24.01574	78.37356	Khurai	Sagar	123.5	123.5	17		13.7-16.7,62.5-65.5	Basalt/Sandstone	14.2	1.3	
9.	Ghatiyari EW	24.128	78.26476	Khurai	Sagar	105.5	105.5	12	8	7.9-10.9	Basalt/Sandstone	4.9	2.3	

10.	Khurai	24.0348	78.3142	Khurai	Sagar	200	200			26.2-29.2	Sandstone		Meager	
11.	Girwar	23.8236	78.9569	Sagar	Sagar	200.2	200.2	5.5	6	119.9-123,126-129.1	Basalt	55.4	3.2	
12.	Barouda	23.7144	78.912	Sagar	Sagar	199.2	199.2	5.5	6	21.1-25.1	Basalt	33.1	0.2	
13.	Basiya Bhansa	23.8677	78.5869	Rathgarh	Sagar	74.2	74.2	23.9	24.4	5.50-7.1	Basalt/Sandstone	31.2	0.2	
14.	Gidwani	23.9219	78.80117	Sagar	Sagar	200	200	5.5	6	83.4-86.50	Baslat	14.2	1.8	
15.	Sironja	23.7984	78.8021	Sagar	Sagar	200	200	5.5	6		Basalt/Shale		Meager	
16.	Dungasara	23.8676	78.89788	Sagar	Sagar	202.3	202.3	5.5	6	147.3-150.2	Sandstone	22.4	Meager	
17.	Dudhoniya	23.7621	78.9548	Sagar	Sagar	200.3	200.3	5.5	6	135.2-138.2		20.1	0.3	
18.	Kishanpura	23.7101	78.8464	sagar	Sagar	200.3	200.3	17.17	18		Basalt		Meagar	
19.	Karrapur	23.9487	78.8697	Sagar	Sagar	200.3	200.3	5.5	6		Basalt		Meagar	
20.	Barpani	23.81528	79.02633	Sagar	Sagar	200.2	200.2	5.5	6		Basalt		0.2	
21.	PamakheriEW	23.8117	78.85159	Sagar	Sagar	200.2	200.2	5.5	6	165-168,187-190	Basalt	30.4	3.2	

22.	Patha	23.62842	78.76541	Sagar	Sagar	200.2	200.2	5.5	6	62-65	Basalt	21.3	0.2	
23.	Sagar civillineEW	23.8356	78.76541	Sagar	Sagar	92.5	92.5	18	12	18-21,37.6-40.6,	Basalt	4.8	3.2	
24.	Dalpathpur	24.13113	79.01838	Banda	Sagar	203.1	203.1	9.3	10.81	7-10.9,	Basalt	6.4	0.2	
25.	Binaka	24.105	78.8404	Banda	sagar	200	200	7.5	7.9		Basalt		Meager	
26.	Behrol EW	24.0593	78.7419	Banda	sagar	200.3	200.3	9.3	8	62.8-65.8,71.9-75,142-145	basalt/Shale		5.5	
27.	Kanadari	24.001	78.8937	Banda	Sagar	202.6	202.6	7	6	38.4-41.4,136.-139,193.4-196.5	Basalt/Shale		0.2	
28.	Kandwa	24.0109	79.1268	Banda	Sagar	203.1	203.1	7	6	26.2-29.3	sanastone/ Shale		0.2	
29.	Ishwarpur EW	23.35032	79.10097	Deori	Sagar	200	200				Lamita/Sandtone			
30.	Jaithpur	23.4955	79.0483	Deori	Sagar	200	200				Lamita/Sandtone			
31.	Anathpura	23.51916	79.11135	Deori	Sagar	200	200				Lamita/Sandtone			
32.	Khamkera	23.5496	78.9172	Deori	Sagar	157	157	15	6	30.2-33.2	Lamita/Sandtone		0.3	

Table :4a Salient Features of the Observation Wells Constructed Sagar District during NAQUIM, CGWB, NCR, Bhopal

1	Kanjiya OW	24.3869444	78.19667	Bina	Sagar	111.6	111.6	15	30	41.40-44.50,75-78,105.5-108.5	Laterite /Sandstone		14	
2	Gaudana OW	24.1544444	78.16417	Bina	Sagar	60.8	60.8	3	57	26.2-29.2	Basalt/Sandstone	6.6	1.2	
3	Siloda OW	24.01574	78.37356	Khurai	Sagar	140.3	140.3	14		7.1-10.1,53.8-56.9	Basalt/Sandstone	39	3.1	
4	Ghatiyari OW	24.128	78.26476	Khurai	Sagar	76.1	76.1	11		9.1-112.2	Basalt/Sandstone	5.2	2.1	
7	Girwar OW	23.8236	78.9569	Sagar	Sagar	129.1	129.1	5.5	6	119.9-123,	Basalt	55.3	1.8	
8	Pamakheri OW	23.8117	78.85159	Sagar	Sagar	184.1	184	5.5	6		Basalt	32.4	2.2	
9	Sagar civillineOW	23.8356	78.76541	Sagar	Sagar	201.3	201.3	18	18	16.20-19.30,62-65,147.5-148.6	Basalt	6.8	1.8	
10	Behrol OW	24.0593	78.7419	Banda	sagar	111.7	111.7	9.3	8	62.8-65.8,71.9-75,	basalt/Shale		3.2	
11	Ishwarpur OW	23.35032	79.10097	Deori	Sagar	100	100				Lamita/Sandtone			

2.4. Hydrochemical :

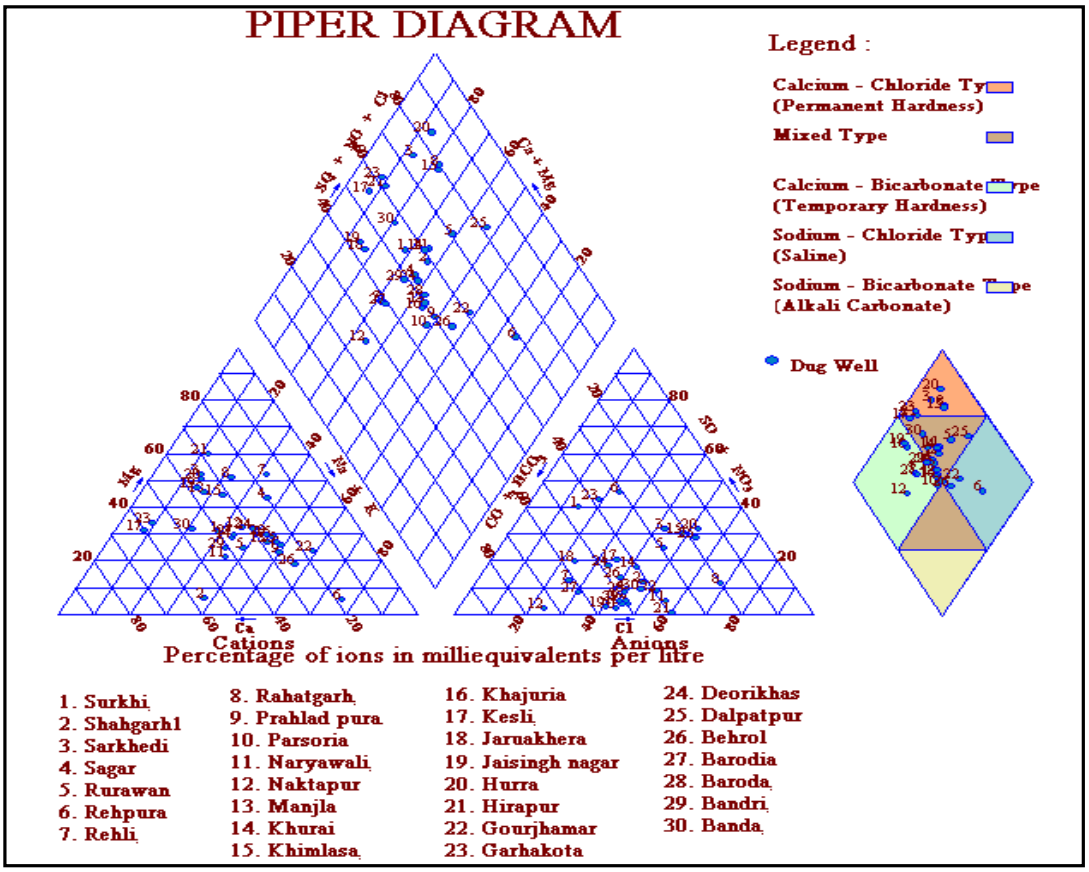
Ground Water Quality of Sagar District

The water samples were collected from National Hydrograph Stations in clean double stoppered poly ethylene bottles from 30 different locations of Sagar district during May 2014.

Quality of Ground Water for Drinking Purpose:

The ground water samples from Sagar district have varied range of pH from 7.38 to 9.05. As per BIS(IS 10500 : 2012) recommendation, most of the water samples have pH recorded within the permissible limits of 6.5 to 8.5, except samples from Dalpatpur (8.76) and Parsoria (9.05) village. The ground water of the study area can be assessed as slightly alkaline to strong alkaline. The electrical conductivity of ground water samples in Sagar district varies from 168 to 2620 µS/cm at 25°C. The electrical conductivity from Sagar district shows variability, One sample from Khimlasa village shows highest EC i.e. 2620 µS/cm, while five samples shows EC

Fig 10: Hill Piper Diagram representing classification of water samples collected from National Hydrograph Stations, Sagar District, Madhya Pradesh



in between 1000-2000 µS/cm and the EC of remaining 24 samples is below 1000 µS/cm. So overall ground water quality in Sagar district is good.

The fluoride concentration in Sagar district lies in between 0.15 to 0.92 mg/l, which represent that all the samples are within the permissible limit i.e. 1.5mg/l as per BIS(IS 10500 : 2012). Nitrate in ground water samples of Sagar district fall within limits of 1 to 93 mg/l. It is observed that 20% samples have Nitrate concentration more than the acceptable limit i.e. 45mg/l, while rest 80% samples have concentration less than acceptable limit. There is no permissible limit for Nitrate as per BIS (IS 10500: 2012). Highest nitrate is reported in the water sample collected from Sagar (93mg/l). High nitrate in ground water samples may be due to anthropogenic activities or excessive use of fertilizers. The range of Total Hardness (as $CaCO_3$) in ground water samples of study area is 20 to 1005 mg/l. Except the water sample from one location i.e. Khimlasa (1005 mg/l), the remaining samples from29 locations reported Total Hardness within the permissible limits i.e. 200-600mg/l.

Piper diagram has three parts: a Cation triangle, an Anion triangle, and a Central diamond-shaped field. In Cation triangle, the relative percentages of the major cations (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}) are plotted. In Anion triangle the major anions ($HCO_3^{-}+CO_3^{2-}$, SO_4^{2-}, Cl^{-}) are plotted. These points are then projected to the central diamond shaped field.

Out of the total ground water samples analyzed from Sagar district, 56.66 % of samples are Mixed type, 20% samples shows nature of water as Calcium-Bicarbonate type, hence show temporary hardness while 13.33% samples fall in the region of Calcium-Chloride type, so have permanent hardness features and the rest 10% samples have saline water (Sodium-Chloride type).

Quality of Ground Water for Irrigation Purpose:

In classification of water for irrigation purpose, it is assumed that the water will be used for irrigation purpose based upon its soil texture, infiltration rate, drainage and climate. The chemical data of all the water samples from Sagar district is plotted on U.S. Salinity Laboratory diagram. It is clear that approx. 26.66% wells of study area are observed under C_2-S_1 Class

(Medium Salinity & Low Sodium) which means that these waters can be used for irrigation purpose for most of the crops, 66.66% of total ground water samples fall under C_3-S_1 class (High Salinity & Low Sodium). One sample from Rehpura Village is observed under C_1S_1 (Low Salinity & Low Sodium), and the remaining one from Khimlasa village is observed in C_4S_1 Class (Very High Salinity & Low Sodium). Water from these areas can be used for irrigation, considering the salinity content of the ground water.

Fig 11: US Salinity Diagram for water samples collected from National Hydrograph Stations of Sagar District, Madhya Pradesh

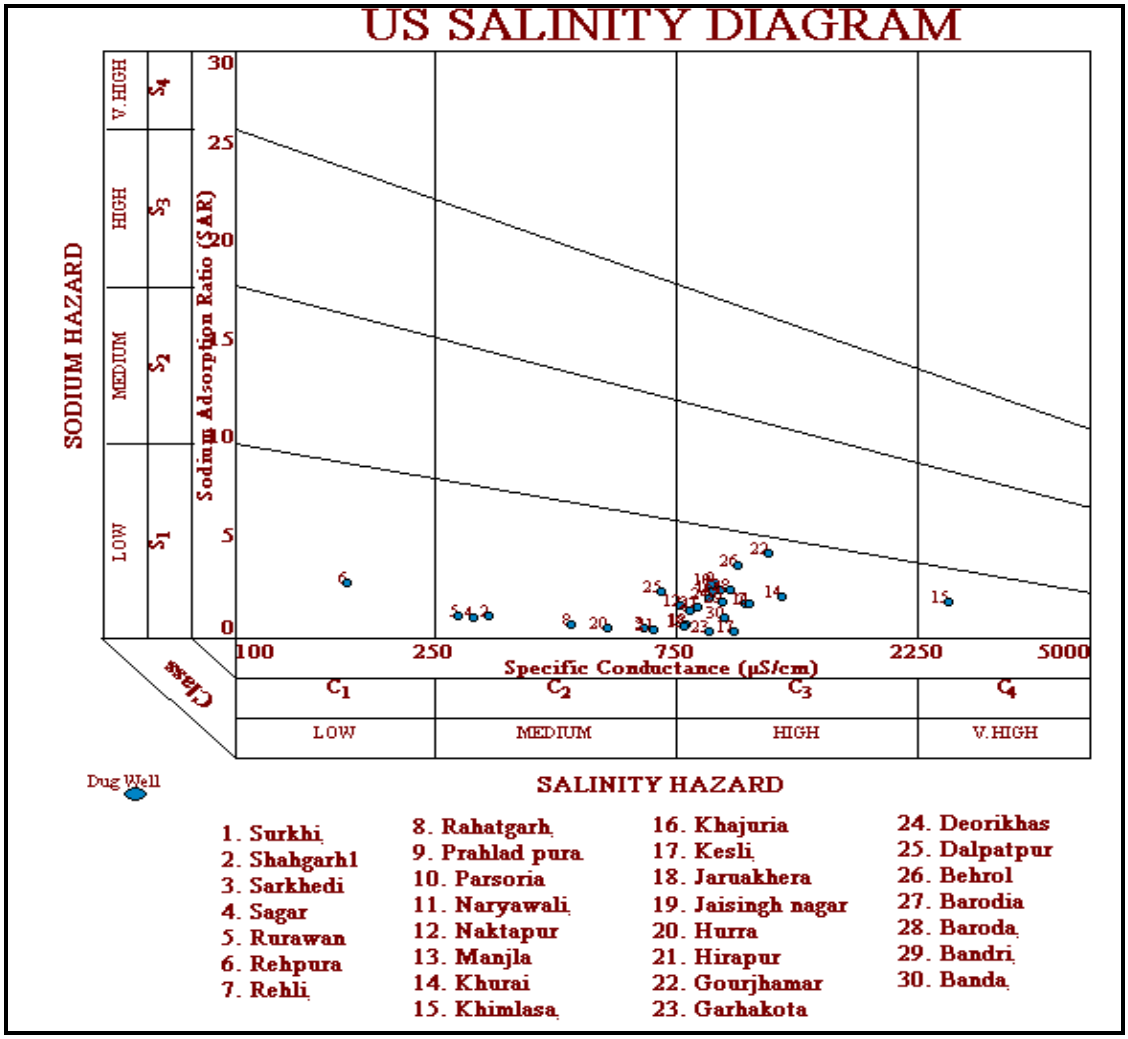


Table 5: Analysis Results Ground water Quality of National Hydrograph Monitoring Station of Sagar District (May-2014)

Sl. No.	Locations	LAT	LONG	pH	EC	CO_3	HCO_3	Cl	SO_4	NO_3	F	PO_4	TH	Ca	Mg	Na	K	SiO_2
1	Banda	24.0456	78.9672	7.51	940	0	244	160	23	25	0.29	0.014	370	88	36	45	1.3	37
2	Bandri	24.0417	78.6397	7.75	930	0	287	145	6	23	0.47	0.009	305	76	28	73	1.0	42
3	Baroda	23.7158	78.9097	7.85	960	0	281	149	31	12	0.40	0.003	275	52	35	95	0.4	36
4	Barodia	24.2158	78.5833	7.90	830	0	305	92	32	2	0.76	0.003	275	60	30	60	8.0	38
5	Behrol	24.0497	78.7458	7.93	1000	0	281	142	66	1	0.38	0.002	220	50	23	125	10.0	39
6	Dalpatpur	24.1342	79.0167	8.76	705	24	31	138	62	51	0.39	0.015	185	36	23	75	3.0	45
7	Deorikhas	23.3856	79.0156	7.95	875	0	250	106	72	7	0.91	0.018	270	52	34	76	2.0	52
8	Garhakota	23.7839	79.1289	7.61	875	0	201	60	158	29	0.58	0.000	400	100	36	18	0.5	47
9	Gourjhamar	23.5156	78.9394	7.95	1145	0	268	213	42	9	0.92	0.009	235	40	33	153	3.0	51
10	Hirapur	24.3656	79.2106	7.92	677	0	159	145	2	2	0.55	0.014	300	38	50	17	2.0	39
11	Hurra	23.7278	78.4053	7.77	550	18	49	96	25	72	0.37	0.010	235	38	34	18	0.4	62
12	Jaisingh nagar	23.6261	78.5750	7.98	780	0	262	113	9	3	0.33	0.009	330	58	45	27	0.2	46
13	Jaruakhera	23.9733	78.4819	8.00	790	0	268	67	45	40	0.30	0.008	325	58	44	31	2.0	52
14	Kesli	23.4206	78.8056	7.43	980	0	262	124	45	66	0.72	0.001	450	118	38	18	0.8	55
15	Khajuria	23.9397	78.6864	7.78	890	0	275	142	15	2	0.39	0.015	245	46	32	87	8.0	47
16	Khimlasa	24.2011	78.3631	7.45	2620	0	329	454	350	43	0.35	0.012	1005	168	142	135	9.0	42
17	Khurai	24.0394	78.3333	7.62	1220	0	293	184	65	52	0.20	0.005	400	90	43	96	1.0	57
18	Manjla	23.9372	79.0214	7.86	920	0	275	149	20	3	0.40	0.017	255	52	30	92	4.0	49
19	Naktapur	24.2764	78.5494	7.58	770	0	342	67	8	2	0.43	0.020	250	50	30	60	4.0	51
20	Naryawali	23.9061	78.5925	7.75	1055	0	244	213	12	18	0.15	0.015	340	90	28	75	19.0	59
21	Parsoria	23.8539	78.9356	9.05	885	0	268	149	9	3	0.48	0.014	225	44	28	96	7.0	48
22	Prahlad pura	24.0183	79.0494	7.87	900	0	268	149	15	4	0.34	0.017	225	48	26	97	11.0	62
23	Rahatgarh	23.7875	78.4181	8.20	467	0	55	113	24	3	0.50	0.009	180	24	29	23	2.0	48
24	Rehli	23.6406	79.0653	7.96	1032	0	384	96	3	77	0.54	0.014	350	32	66	75	1.8	54
25	Rehpura	23.7158	78.8136	8.14	168	0	31	14	30	9	0.24	0.023	20	6	1	29	0.5	59
26	Rurawan	24.1817	79.0250	8.11	280	0	49	46	25	11	0.44	0.018	85	20	9	25	0.5	50
27	Sagar	23.8333	78.7675	8.20	300	0	85	46	10	5	0.26	0.002	95	12	16	24	1.9	48
28	Sarkhedi	23.7361	78.5886	8.16	650	0	98	99	27	93	0.32	0.027	280	44	41	20	0.4	52
29	Shahgarh1	24.3197	79.1194	8.00	320	0	79	53	17	2	0.91	0.019	100	36	2	27	1.0	49
30	Surkhi	23.6297	78.8333	7.38	805	0	220	43	135	27	0.29	0.012	285	64	30	53	1.7	47

2.5. Geophysical :

CGWB has also carried out Geophysical resistivity surveys in 30 locations of Sagar District, Madhya Pradesh (Fig. 13). A detailed observation of the results for the VES conducted has been presented in the Table 7.

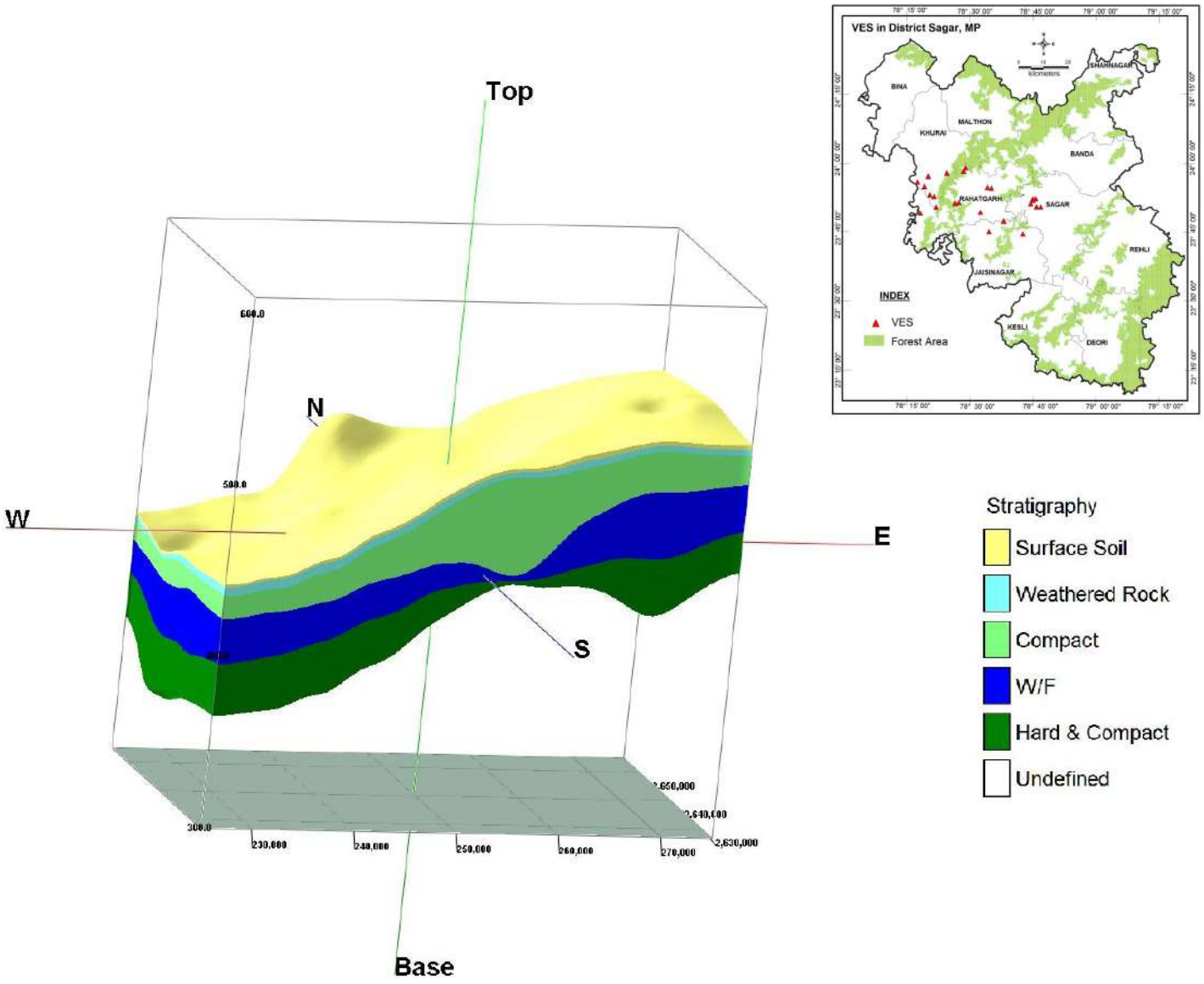


Fig 12: Map showing locations of VES, and interpretation model Sagar District Madhya Pradesh

Table 6: Geophysical Analysis of VES conducted in Sagar District, Madhya Pradesh																	
Sr.No.	Location	District	Co-ordinates		Elevation	Geoelectrical layers Resistivity and thickness											
			N	E		ρ_1	ρ_2	ρ_3	ρ_4	ρ_5	ρ_6	h_1	h_2	h_3	h_4	h_5	Total H
						(in Ohm-m)						in m.					
1	Norja	Sagar	23.82056	78.54361	493.3	2	2000	30	4000	10000		1	3.5	12	33		50
2	Norja	Sagar	23.82056	78.54361	493.3	3	5000	2000	70	550	15500	2.5	2.5	14.5	34	44	98
3	Badua	Sagar	23.7878	78.6355	524.6	30	500	90	10000	45000		5.5	7	27	46		85
4	Badua	Sagar	23.78778	78.63528	524.1	45	250	550	70	50000		5	6.5	31	38.5		81
5	Sarkhedi	Sagar	23.7504	78.5776	513.8	11	3	240	16000			1.2	1.5	32			34.5
6	Sarkhedi	Sagar	23.75028	78.5775	514.3	8	60	960	15000			2.5	3.5	93			98
7	Sotiya	Sagar	23.7415	78.7122	530.8	20	210	450	550	85	400	2.5	3	21	31	67	125
8	Sotiya	Sagar	23.74139	78.71194	530.7	25	220	500	400	210		2.2	3.7	26.5	50		82.5
9	Gawri	Sagar	23.9158	78.3209	442.9	10	30	75	2500	20000	70000	0.5	0.2	11	15	40	67
10	Gawri	Sagar	23.913	78.3205	411.5	45	180	75	2500	24500	65500	2.6	2	7.8	40	46	98.5
11	Rajoli	Sagar	23.8182	78.3046	436.7	10	5	9	3500	15000	60	1	3	9	7.5	2	22
12	Rajoli	Sagar	23.81806	78.30444	437.6	8	6	36	2000	5000	220	1.3	5	10	65	51	132
13	Kundru	Sagar	23.8859	78.3433	440	9	270	20	5000	10000		1.3	0.2	47	74		122
14	Kundru	Sagar	23.88583	78.34306	439.7	12	32	20	30	70	5500	1.3	4	8	22	32	67
15	Chakarpur	Sagar	23.841	78.3676	441.3	12	7000	30000	15000			1	29	45			75
16	Chakarpur	Sagar	23.84083	78.3675	440	5	15	2500	5000	1250	5500	1.3	2	2	5.5	14	25
17	Kakalwara	Sagar	23.9639	78.41096	448.3	275	15	2.5	1250	2500		1	2	8	17		27.5
18	Kakalwara	Sagar	23.9658	78.41036	446.9	45	5	10	2500	250	5500	2.5	5.5	5	30	36	78
19	Sabdha	Sagar	23.95256	78.33626	437.6	5	15	2500	25000			1	6.5	11.5			19
20	Sabdha	Sagar	23.953	78.3364	437.9	10	25	75	25500	3500	25555	2.5	2.7	7.5	12.5	38	63.5
21	Nagna	Sagar	23.9125	78.57133	497.4	5.5	30	38000	85000			3.5	20	34			58
22	Nagna	Sagar	23.9134	78.5718	492.6	5	10	40	110	50	5500	1.3	2.5	6	16	47	63
23	Mudra	Sagar	23.9713	78.4772	499.1	10	5	25	5	32		1	8.5	23	32		54.5

24	Mudra	Sagar	23.9847	78.4845	499.3	5	7.5	20	15	190	5500	3.3	6.3	26	62	32.5	130
25	Masenia	Sagar	23.85458	78.4439	463.7	80	500	5	25	200	10	1.2	1.3	3	32.5	50.5	88
26	Masenia	Sagar	23.8548	78.4427	471.9	130	50	10	20	90	40	4	3.3	10	10	75	100
27	Military School	Sagar	23.8419	78.7658	536.8	9	3	1200	250	150	5500	1	3	8	15	29	55
28	MilitarySchool	Sagar	23.84194	78.78278	609.4	6	30	1500	100	2000	150	4	4	12	11	23	54
29	CI Gate	Sagar	23.8707	78.7512	530.3	6.5	74	6	2550	5500		3	2	5	22		32
30	CI Gate	Sagar	23.87083	78.75111	529.3	10	20	10	45	200	5500	3	8	10	11	22	54
31	Jhansi Gate	Sagar	23.8538	78.7432	520.6	36	2500	10	60	50000	1250	3.5	1.75	2.5	3	22	33
32	Jhansi Gate	Sagar	23.85361	78.74306	520.4	40	2000	150	240	1500	4500	2.5	8.3	15	15	66	107
33	OfficerMess	Sagar	23.866	78.7535	543.2	17	8	75	15000	45000		2	0.5	0.2	42		44.7
34	Officer Mess	Sagar	23.86583	78.75333	545	20	50	1500	5500	30000		2	5	10	23		40

3. DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

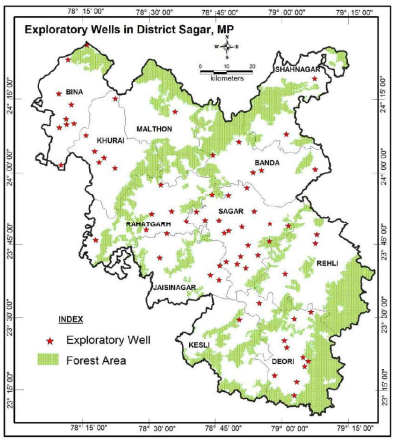
The lithological data collected from 70 CGWB Exploratory Borewells were studied, compiled and integrated as per Rockworks software format to prepare the 3-Dimensional Stratigraphic model and 2-Dimensional Cross section. From the 3-D Model and 2-D Section is presented in the fig 4 & 5 it has been interpreted that the major water bearing zones has been encountered in weathered/fractured basalts and fractured sandstone/shale formations.

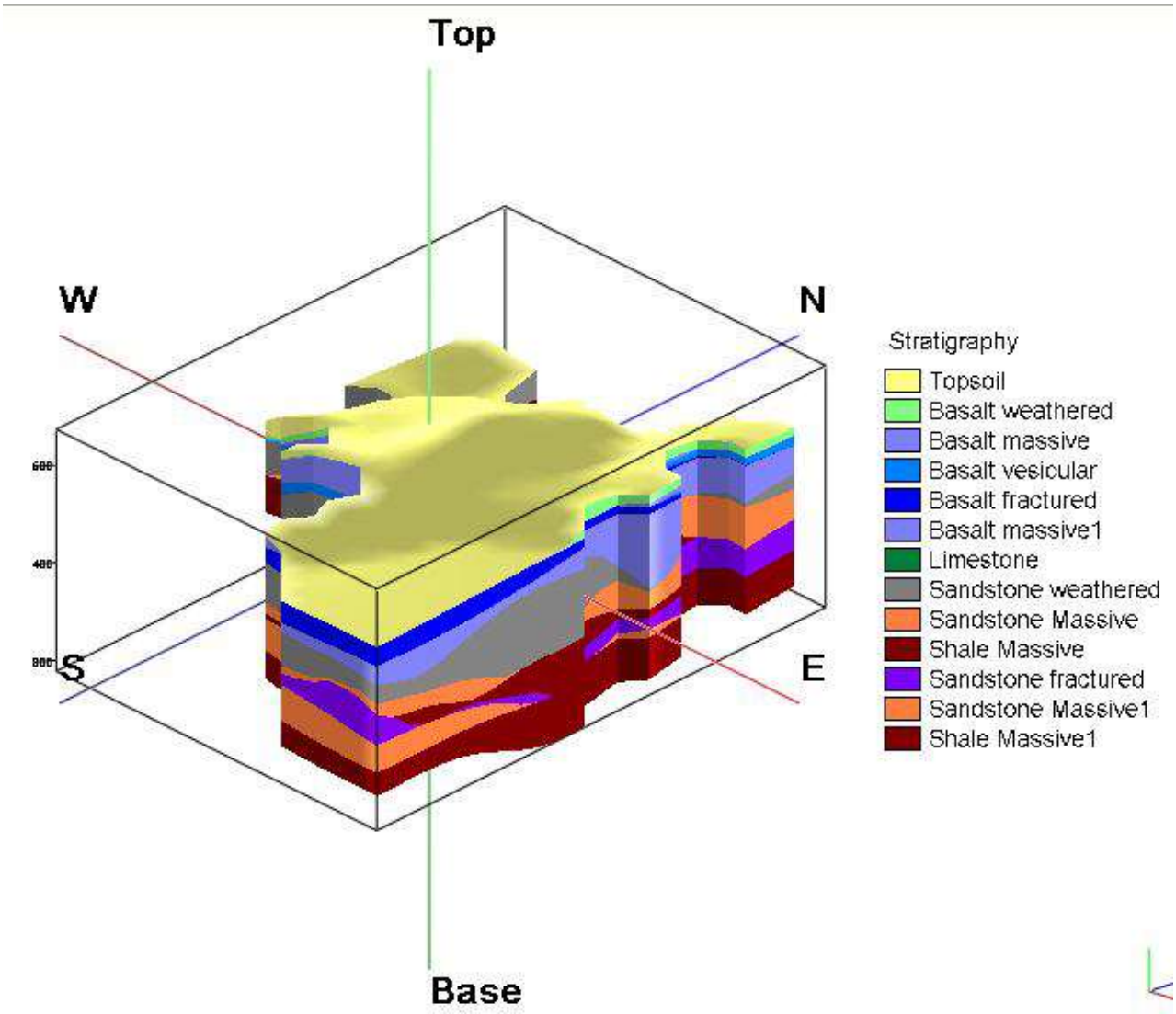
3.1 3-D Lithological & 3-D Stratigraphic model

A 3-Dimensional Lithological & Stratigraphic model was prepared for the Sagar district, Madhya Pradesh after detailed analysis of the pre-existing and available bore-log data collected from the Basic Data Reports of CGWB. A comprehensive analysis was made as per lithology and stratigraphy of the area. The location details with RL values and their corresponding stratigraphic details as per the Rockworks format is provided in the Annexures- I and II.

The 3-D Model results showed that the region is dominantly occupied by Basalt and sandstone/Shale, Limestone respectively. The sub-surface lithology has been broadly classified into Top soil/Unsaturated zone, underlain by Weathered Basalt and Sanadstone/Shale which has been considered as shallow aquifer (upto a depth of 30 mts).

Fig 13: 3-D Lithological Model of Sagar District, Madhya Pradesh

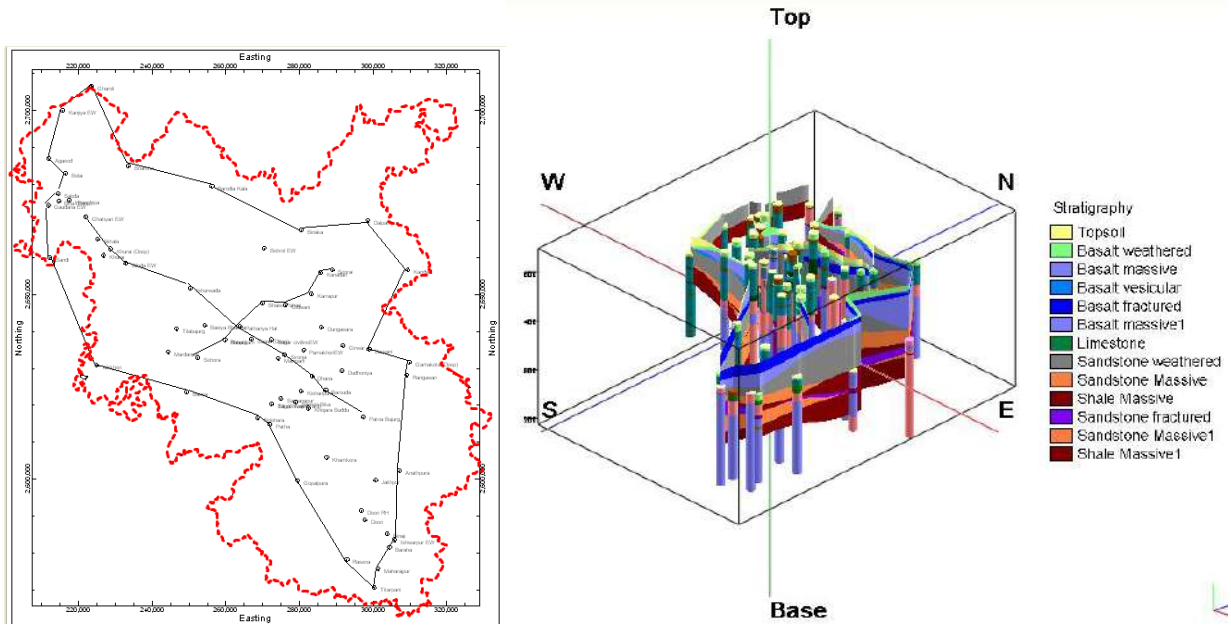




3.2 Fence Diagram

The Fence diagram was also prepared using the Rockworks software. The pattern for the Fence was chosen as such to cover the maximum portion of the region to represent the enhanced picture of the sub-surface as deciphered from the 3-D stratigraphic model. It has also been interpreted from the diagram that the shallow and deeper aquifers are not in connection to each other

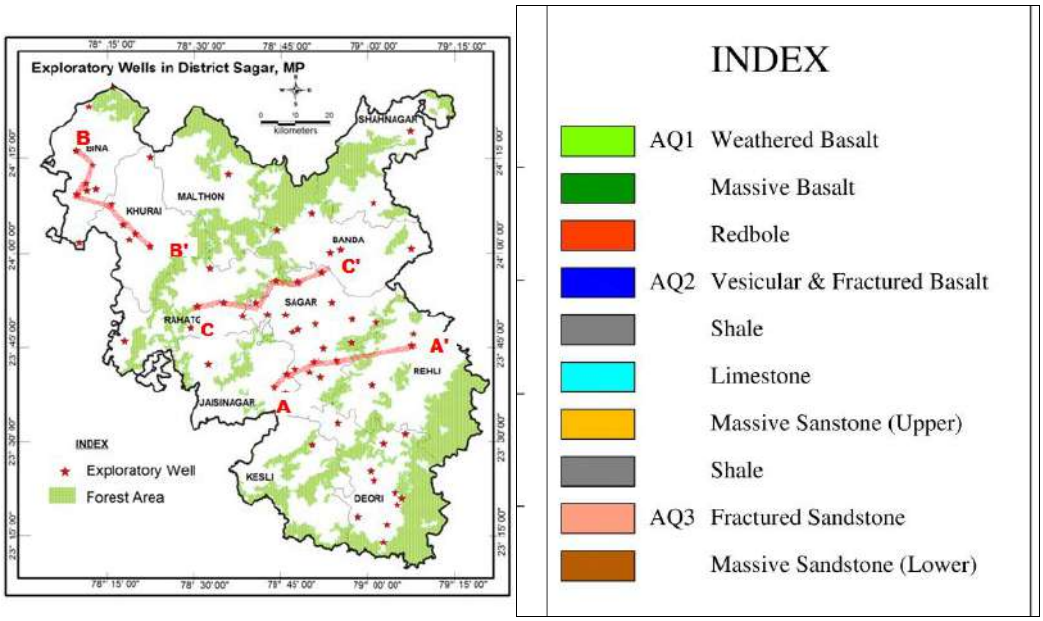
Fig 15: Fence Diagram, Sagar District, Madhya Pradesh

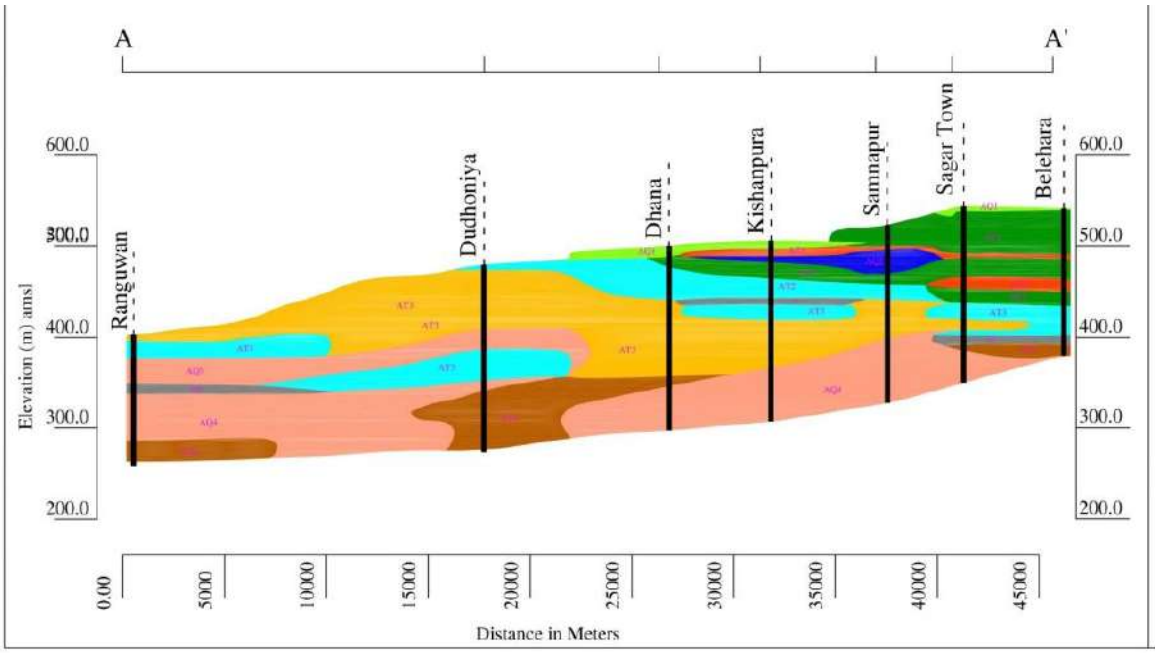


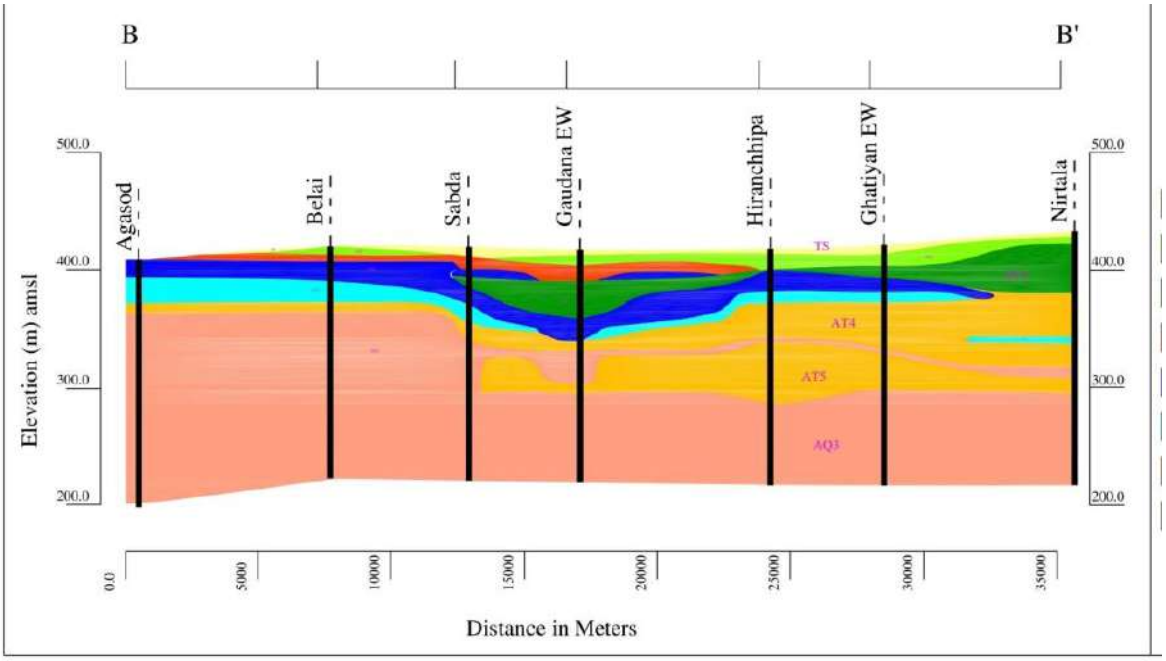
3.3. 2-D Cross Section section of Sagar District

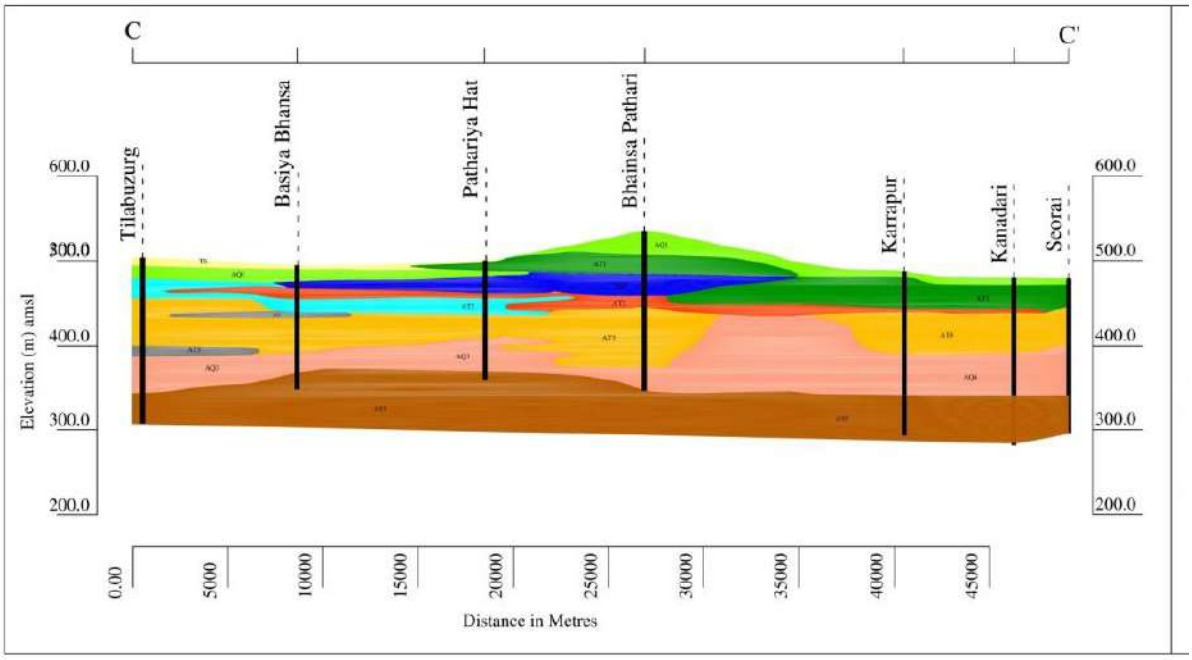
2-Dimensional cross-section along the section line A-A'(Ranguwan–Belehara) ,B-B'(Agasod-Nirtala) and C-C'(Tilabujurg-Seorai) (W-E),NW-SE,W-E direction respectively covering the wells has been prepared using Rockworks. The cross-section shows that the shallow aquifer is not continuing for the whole region and occurs as narrow pinches in the northern portion of Sagar. The deeper aquifers whereas, occurs throughout the section line and can be encountered at depth where fractures are present.

Fig. 16: 2-D Cross sections along A-A' (Ranguwan–Belehara), B-B' (Agasod-Nirtala) & C-C' (Tilabujurg-Seorai), Sagar District)






B
B'
Agasod
Belai
Sabda
Gaudana EW
Hiranchhipa
Ghatiyan EW
Nirtala
TS
AT4
AT5
AQ3
500.0
400.0
300.0
200.0
Elevation (m) amsl
0.0
5000
10000
15000
20000
25000
30000
35000
Distance in Meters


C
C'
Tilabuzurg
Basiya Bhansa
Pathariya Hat
Bhainsa Pathari
Karrapur
Kanadari
Scorai
600.0
500.0
400.0
300.0
200.0
Elevation (m) amsl
0.00
5000
10000
15000
20000
25000
30000
35000
40000
45000
Distance in Metres

4. GROUND WATER RESOURCES

Sagar district is underlain by Basaltic lava flows of Deccan trap, Vindhyan Sandstone and Alluvium. Dynamic ground water resources of the district have been estimated on block-wise basis. Out of 10,252 sq. km of geographical area, 9,254 sq. km (90%) is ground water recharge worthy area and 998 sq. km is forest and hilly area (10%). There are eleven assessment units (block) in the district out of which 10 blocks fall under safe category. Only Banda block comes under semi-critical category with stage of ground water development being 78.25%. The net ground water availability in the district is 1212.88 MCM and ground water draft for all uses is 736.11 MCM, making stage of ground water development to 60.69% as a whole for the district. Table 7 shows the Dynamic Ground Water Resource Assessment estimated by CGWB for the year 2013.

The Ground Water Resource of Sagar district has also been calculated block-wise as an outcome of NAQUIM. The In-storage resource for the shallow aquifer below zone of fluctuation (upto 30 mbgl) is computed to be around 430.09 MCM. The static resource for the deeper aquifer (30-200 mbgl) is computed as 247.59 MCM. The draft of dug well and tube well has been calculated separately to assess the ground water draft for irrigation from shallow and deeper aquifers that accounts to 705.98 MCM and 159.74 MCM respectively. The block-wise ground water resources and draft as an outcome of NAQUIM is presented in the Table no 8.

Table 7: Dynamic Ground Water Resources (as on March 2013)

Assessment Unit / District	Command / Non Command	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	Net Ground Water Availability for Future Irrigation Development in Ham	Stage of Ground Water Development in %	Category
Banda	Non Command	9654.52	7166.07	388.77	7554.84	589	1899.45	78.25	Semi Critical
	Block Total	9654.52	7166.07	388.77	7554.84	589	1899.45	78.25	Semi Critical
Bina	Non Command	11705.14	7016.22	307.04	7323.26	882	3806.92	62.56	Safe
	Block Total	11705.14	7016.22	307.04	7323.26	882	3806.92	62.56	Safe
Deori	Command	1836.23	164.43	8.61	173.04	41	1630.8	9.42	Safe
	Non Command	11858.58	5676.59	309.88	5986.47	778	5403.99	50.48	Safe
	Block Total	13694.81	5841.02	318.49	6159.51	819	7034.79	44.98	Safe
Jaisinagar	Non Command	12253.27	7446.99	198.56	7645.55	898	3908.28	62.4	Safe
	Block Total	12253.27	7446.99	198.56	7645.55	898	3908.28	62.4	Safe
Kesli	Non Command	10009.11	5450.62	260.24	5710.86	680	3878.49	57.06	Safe
	Block Total	10009.11	5450.62	260.24	5710.86	680	3878.49	57.06	Safe
Khurai	Non Command	14220.98	8934.62	241.63	9176.25	523	4763.36	64.53	Safe
	Block Total	14220.98	8934.62	241.63	9176.25	523	4763.36	64.53	Safe
Malthone	Non Command	9239.99	4689.27	341.28	5030.55	871	3679.72	54.44	Safe
	Block Total	9239.99	4689.27	341.28	5030.55	871	3679.72	54.44	Safe
Rahatgarh	Non Command	10614.45	6491.34	218.07	6709.41	578	3545.11	63.21	Safe
	Block Total	10614.45	6491.34	218.07	6709.41	578	3545.11	63.21	Safe
Rehli	Non Command	9669.1	6487.13	249.83	6736.96	1052	2129.97	69.68	Safe
	Block Total	9669.1	6487.13	249.83	6736.96	1052	2129.97	69.68	Safe
Sagar	Non Command	11470.72	7779.56	304.52	8084.08	568	3123.16	70.48	Safe
	Block Total	11470.72	7779.56	304.52	8084.08	568	3123.16	70.48	Safe
Shahgarh	Command	2843.18	91.96	27.13	119.09	72	2679.22	4.19	Safe
	Non Command	5912.89	3202.74	158.09	3360.83	723	1987.15	56.84	Safe
	Block Total	8756.07	3294.7	185.22	3479.92	795	4666.37	39.74	Safe
DISTRICT TOTAL		**121288.16**	**70597.54**	**3013.65**	**73611.19**	**8255**	**42435.62**	**60.69**	**Safe**

Table 8: Ground Water Resources (outcome of NAQUIM)

	Shallow Aquifer						Deeper Aquifer		Total GW Resources (MCM)	Gross Ground Water Draft (MCM)
BLOCKS	**Dynamic Resources (MCM)**	**In Storage Resources (MCM)**	**Total Resources (MCM)**	**Irrigation Draft (MCM)**	**Domestic+ Industrial Draft (MCM)**	**GW Draft (MCM)**	**Static Resources (MCM)**	**GW Draft (MCM**		
Banda	96.55	57.27	153.81	65.13	3.89	71.66	15.09	6.53	168.9	75.55
Bina	117.05	24.59	141.65	34.75	3.07	70.16	43.1	35.41	184.75	73.23
Deori	136.95	19.26	156.21	43.45	3.18	58.41	23.42	14.96	179.63	61.6
Jaisinagar	122.53	35.45	157.99	70.58	1.99	74.47	14.92	3.89	172.9	76.46
Kesli	100.09	39.52	139.61	49.6	2.6	54.51	11.85	4.91	151.46	57.11
Khurai	142.21	73.77	215.98	40.55	2.42	89.35	53.08	48.8	269.06	91.76
Malthone	92.4	66	158.4	42.94	3.41	46.89	9.7	3.95	168.1	50.31
Rahatgarh	106.14	19.91	126.05	50.45	2.18	64.91	17.37	14.47	143.42	67.09
Rehli	96.69	37.48	134.17	48.75	2.5	64.87	24.48	16.12	158.64	67.37
Sagar	114.71	11.78	126.49	70.21	3.05	77.8	24.2	7.58	150.69	80.84
Shahgarh	87.56	30.46	118.02	29.83	1.85	32.95	14.17	3.12	132.19	34.8
Total	**1212.88**	**430.07**	**1628.37**	**546.23**	**30.14**	**705.98**	**247.59**	**159.74**	**1875.96**	**736.11**

5. GROUND WATER RELATED ISSUES

5.1. Declining of water level

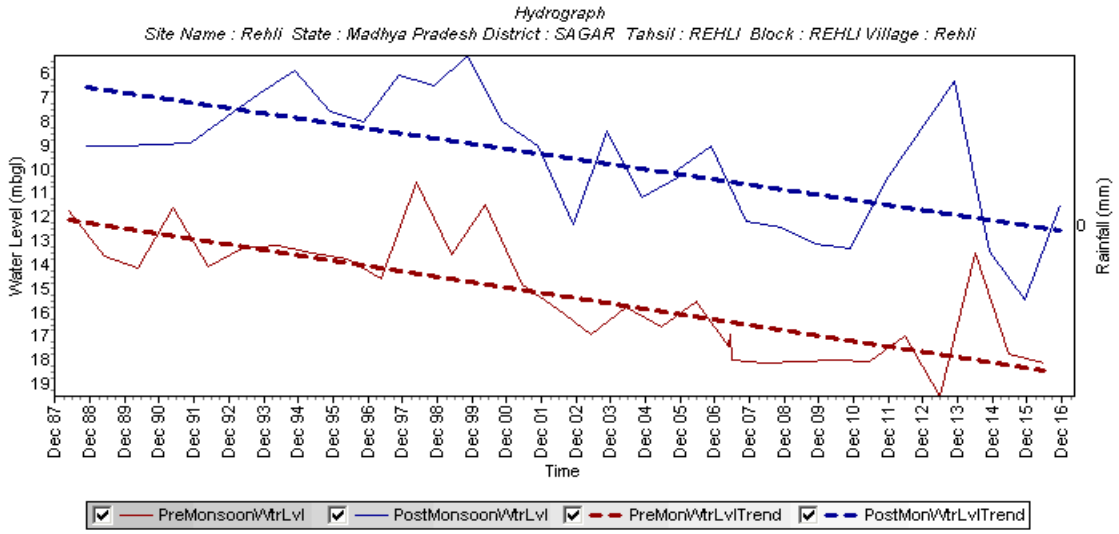
The long-term water level trend analysis indicates mixed results. During pre-monsoon season, out of 39 Hydrograph Stations, more than 60 percent of the areas are showing declining trend (Fig. 17). Similarly, during post-monsoon season, out of 39 stations stations more than 70 percent of the areas are showing falling trend in the district and all stations of Rehli, Bina, Sagar and Banda blocks are showing depletion of water levels in the area. Ground Water Resource Estimation also reveals that out of 11 Blocks of the district 1 Blocks have crossed 70% stage of ground water development. Non-command area of Banda falls in the semi-critical category and Sagar blocks are Safe. Over all stage of ground water development of the district is computed as 60.59%, which cautions for further uncontrolled withdrawal of ground water.

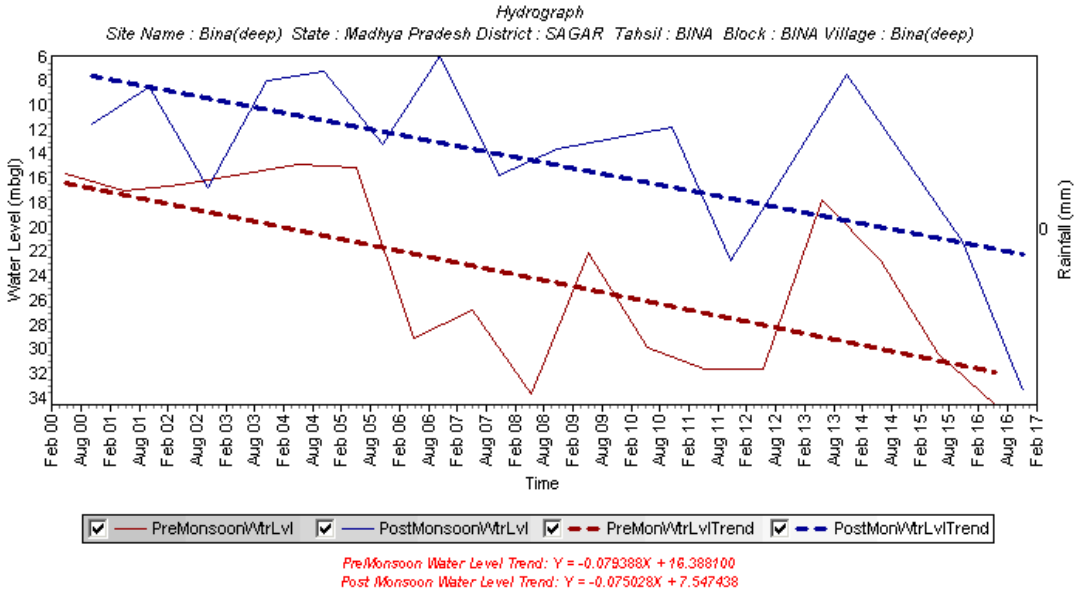
5.2. Ground water quality

Excessive nitrate content is reported in the district at Maximum concentration at Satkhedi, Shagarh, Sagar Dalpathpur,Hurra, Kesli, Khurai, Rehli. High nitrate content in ground water of these areas is perhaps from seepage of seweage into ground water system of the area, causing local pollution and contamination of ground water.

The EC values higher than 1000 µS/cm has also been found at places in Sagar district. Although the district does not faces salinity problems but the higher value of more than 2620 µS/chas been found at Khimlasa.

Fig 17: Hydrographs showing declining water level trend during Pre-monsoon and Post-Monsoon at sites Rehili and Bina, Sagar District, Madhya Prades





6. GROUND WATER MANAGEMENT STRATEGIES

Groundwater has been contributing more to agricultural wealth than surface irrigation since ages. Tube wells are now the largest source of irrigation in the country. Since this sector has almost no dependence on the government, it is growing at a rapid rate and it is estimated that one million wells are added every year (Shah and Deb, 2004). Being an individually managed source, ground water irrigation is also a more efficient form of irrigation, with crop yields per cubic meter of water being 1.2 to 3 times higher than surface irrigation. However, since this sector has grown through investment by individual farmers, with little state involvement compared to canal irrigation, government support for understanding this sector and improving its performance is negligible. The major issues for the future growth of groundwater irrigation are declining resource base, demand driven growth, and a lack of policy and regulatory framework. Since groundwater extraction is primarily driven by the needs of the population and the density of farmer population and not the quality of resource, groundwater irrigation is scaling up even in such hard rock areas causing irreversible depletion of the resource base (Shah and Deb, 2004). To warrant the current situation effective groundwater management strategies needs to be evolved.

6.1. District Ground Water Management Plan (Outcome of NAQUIM)

Sagar district has been facing problems of ground water exploitation which in turn are depleting the ground water resources in the area. This has led to evolve sustainable water conservation and management practices through an integrated approach. The ground water management plan for Sagar district has been made keeping in view the area specific details and includes the strategies like enhancing the ground water resources through construction of artificial recharge structures such as percolation tanks, check dams/nala bunds, recharge shafts, etc. and ensuring water use efficiency through maintenance/ renovation of existing water bodies/water conservation structures. Also, adoption of micro-irrigation techniques such as sprinkler irrigation has been proposed, that would not only conserve ground water resources by reducing the draft, but would also increase the net cropping area thereby augmenting the agricultural economy of the district.

6.1.1. Supply Side Management

Artificial recharge to ground water is one of the most efficient, scientifically proven and cost effective technology to mitigate the problems of over exploitation of ground water resources. The artificial recharge techniques simultaneously rejuvenates the depleted ground water storage, reduces the ground water quality problems and also improves the sustainability of wells in the affected areas.

The supply side management plan for Sagar district has been formulated using the basic concepts of hydrogeology. Sub-surface storage is calculated by multiplying the total area with the respective specific yield (considering the variable lithology) and the unsaturated zone thickness obtained by subtracting 3 mts from the post-monsoon water level. The volume of ground water recharge generated through pre-existing rain water harvesting/water conservation structures is subtracted from the sub-surface storage to assess the available storage potential. Thus, the surface water requirement to completely saturate the sub-surface storage is obtained by multiplying a factor of 1.33 to available storage potential. A runoff coefficient factor of 0.23 has been considered for Sagar district to calculate the total surface water runoff, 30% of which accounts to the non-committed runoff which is available to sustain the proposed artificial recharge structures. Further, the number of structures has been calculated by allotting 35%, 20% and 35% of non-committed runoff to Percolation tanks, Recharge shafts/Tube wells and Nala bunds/Check dams/Cement Plugs respectively. The remaining runoff is considered to restore the pre-existing village tanks, ponds and water conservation structures. A detailed calculation of the proposed artificial recharge structures is presented in the Table no. 12.

A financial outlay plan has also been chalked out, assuming the cost for the artificial recharge structures to be Rs. 20 lakhs each for percolation tanks, Rs. 10 lakhs each for Nala bunds/Check Dams/Cement Plugs, Rs. 5 lakhs each for Recharge shafts/Tube wells and Rs. 2 lakhs each for renovation of Village tanks/ponds/WCS. This accounts to a total of Rs. 270.78 Crores to successfully implement the supply side management strategy. Table no. 13 represents the complete financial outlay plan for the district.

6.1.2. Demand Side Management

Micro irrigation technologies such as drip and sprinkler systems are being increasingly promoted as technological solutions for achieving water conservation. micro-irrigation comprises two technologies—drip and sprinkler irrigation. Both saves conveyance losses and improve water application efficiency by applying water near the root-zone of the plant Some benefits of the micro-irrigation have been listed below:

1. The increase in yield for different crops ranges from 27 per cent to 88 per cent and water saving ranges from 36 per cent to 68 per cent vis-à-vis conventional flow irrigation systems (Phansalker and Verma, 2005).
2. It enables farmers to grow crops which would not be possible under conventional systems since it can irrigate adequately with lower water quantities.
3. It saves costs of hired labour and other inputs like fertilizer.
4. It reduces the energy needs for pumping, thus reducing energy per ha of irrigation because of its reduced water needs. However, overall energy needs of the agriculture sector may not get reduced because most farmers use the increased water efficiency to bring more area under irrigation.

Adoption of Sprinkler irrigation techniques would save 20% of gross ground water draft for irrigation. Also, the 60% of additional recharge created by construction of artificial recharge structures can be utilized to increase the total cropping area, thereby enhancing the productivity and economy of the district. A summarized table for the demand side management is given in the Table no. 14.

Table 9: Ground Water Management– Supply Side, Sagar District, Madhya Pradesh

Station	Rainfall (m)	Area (Sq Km)	Area suitable for recharge (Sq Km)	Average post-monsoon water level (m)	Unsaturated zone (m)	Average SP Yield (%)	Sub-surface storage (mcm)	Surface water required (mcm)	Surface water (Run-off) available (mcm)	Non-committed Run-off (mcm)	Percolation tank	Recharge shaft/ Tube well	NB/ CD/ CP	No of Villages
Banda	0.95	953	831.30	3.9	0.90	0.015	11.22	14.93	238.25	71.48	15	30	104	164
Bina	1.04	826	821.00	4.51	1.51	0.015	18.60	24.73	433.19	129.96	25	49	173	155
Deori	1.42	1014	867.50	4.23	1.23	0.015	16.01	21.29	253.50	76.05	21	43	149	244
Jaisinagar	1.06	913	764.90	6.55	3.55	0.015	40.73	54.17	228.25	68.48	54	108	379	145
Kesli	1.34	791	658.60	3.3	0.30	0.015	2.96	3.94	252.71	75.81	4	8	28	177
Khurai	1.16	937	907.40	4.22	1.22	0.015	16.61	22.09	234.25	70.28	22	44	155	170
Malthone	1.00	838	778.80	3.37	0.37	0.015	4.32	5.75	209.50	62.85	6	11	40	174
Rahatgarh	1.20	985	890.68	3.96	0.96	0.015	12.83	17.06	246.25	73.88	17	34	119	198
Rehli	1.00	1125	1019.80	3.49	0.49	0.015	7.50	9.97	281.25	84.38	10	20	70	215
Sagar	1.12	1173	1075.70	5.34	2.34	0.015	37.76	50.22	293.25	87.98	50	100	352	152
Shahgarh	1.02	697	638.50	3.68	0.68	0.015	6.51	8.66	174.25	52.28	9	17	61	107
Total	**1.12**	**10252**	**9254**	**4.23**	**1.69**	**0.021**	**175**	**233**	**2563**	**853**	233	466	1630	**1901**

Table 10: Financial Outlay Plan- Supply Side Management, Sagar District, Madhya Pradesh

District	Area Suitable for AR	Volume of Surface Water available for AR (MCM)	Volume of Water required for recharge (MCM)	Proportionate Surface water for planning AR (MCM)	Percolation Tanks structure Nos	cost (crores)	NB/ CD/ CP structure Nos	cost (crores)	Recharge shaft/ Tube well structure Nos	cost RS in (crores)	Renovation of Village Ponds Nos	cost (crores)	Total Cost of RS in crores
Banda	831.30	238.25	14.93	11.22	15	2.99	104	10.40	30	1.50	164	3.28	18.17
Bina	821.00	433.19	24.73	18.60	25	4.95	173	17.30	49	2.45	155	3.10	27.80
Deori	867.50	253.50	21.29	16.01	21	4.26	149	14.90	43	2.15	244	4.88	26.19
Jaisinagar	764.90	228.25	54.17	40.73	54	10.83	379	37.90	108	5.40	145	2.90	57.03
Kesli	658.60	252.71	3.94	2.96	4	0.79	28	2.80	8	0.40	177	3.54	7.53
Khurai	907.40	234.25	22.09	16.61	22	4.42	155	15.50	44	2.20	170	3.40	25.52
Malthone	778.80	209.50	5.75	4.32	6	1.15	40	4.00	11	0.55	174	3.48	9.18
Rahatgarh	890.68	246.25	17.06	12.83	17	3.41	119	11.90	34	1.70	198	3.96	20.97
Rehli	1019.80	281.25	9.97	7.50	10	1.99	70	7.00	20	1.00	215	4.30	14.29
Sagar	1075.70	293.25	50.22	37.76	50	10.04	352	35.20	100	5.00	152	3.04	53.28
Shahgarh	638.50	174.25	8.66	6.51	9	1.73	61	6.10	17	0.85	107	2.14	10.82
TOTAL	**9254**	2563.00	232.80	175.04	233	46.56	1630	163.00	466	23.20	1901	38.02	270.78

6.2. Post-Intervention Impact

The expected outcome of the proposed interventions from both supply side and demand side has been described in Table no 15. It can be envisaged that the Stage of ground water development for the entire Sagar district, would reduce to 53.74% as compared to the present stage of ground water development of 60.69% after implying and successful implementation of proposed interventions.

6.3. Block-wise Ground Water Management Plan (Outcome of NAQUIM)

As per directions of Ministry of Water Resources, River Development and Ganga Rejuvenation, Government of India, Aquifer Management Plan for Sagar district has been prepared block-wise. The plan for each block discusses the broad framework of ground water situation in the block, status of water availability (both surface and ground water), feasibility of artificial recharge and other water conservation structures and their numbers and cost estimates.

Table 11: Groundwater Management- Demand Side Management, Sagar District, Madhya Pradesh

Block	Ground Water Irrigated Area (Ha)	50% of GW Irrigated Area (Sq.Km)	Saving by Sprinkler in MCM
Banda	26878	134.39	10.7512
Bina	29800	149	11.92
Deori	23326	116.63	9.3304
Jaisinagar	19438	97.19	7.7752
Kesli	15528	77.64	6.2112
Khurai	24236	121.18	9.6944
Malthone	11320	56.6	4.528
Rahatgarh	23492	117.46	9.3968
Rehli	32637	163.185	13.0548
Sagar	24801	124.005	9.9204
Shahgarh	6727	33.635	2.6908
TOTAL	238183	1190.915	95.2732

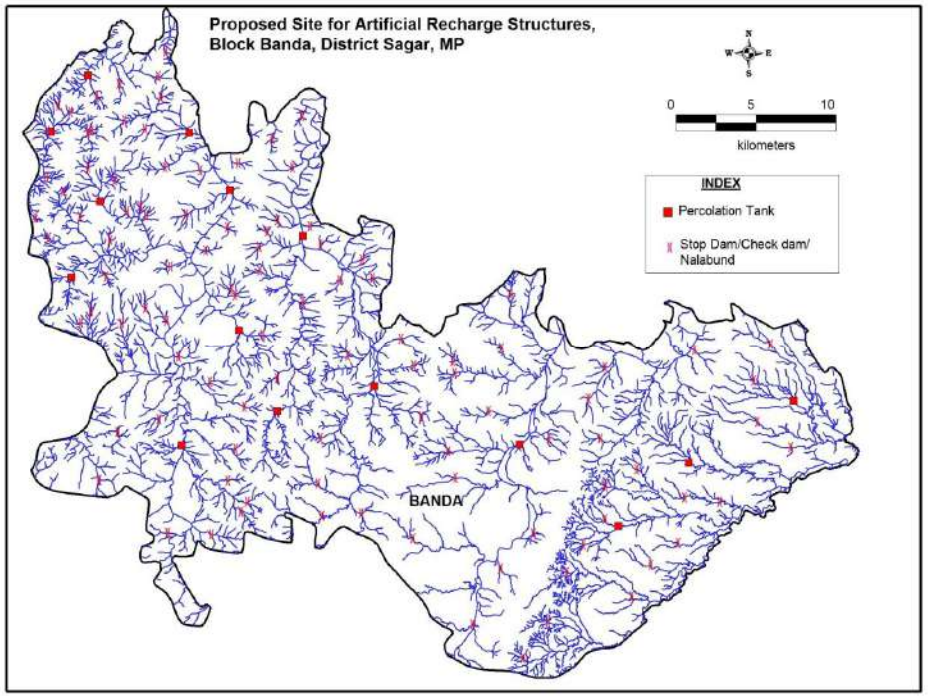
Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Banda	96.54	71.66	3.88	75.54	**78.25**	10.75	11.22	107.76	6.73	96.54	**66.37**	1683
Bina	117.05	70.16	3.07	73.23	**62.56**	11.92	18.60	135.64	11.15	117.05	**53.43**	2789
Deori	136.94	58.41	3.18	61.59	**44.98**	9.33	16.01	152.95	9.60	136.94	**40.45**	2401
Jaisinagar	122.53	74.47	1.98	76.45	**62.40**	7.78	40.73	163.26	24.43	122.53	**57.04**	6110
Kesli	100.09	54.50	2.60	57.10	**57.06**	6.21	2.96	103.05	1.77	100.09	**51.11**	445
Khurai	142.21	89.34	2.41	91.76	**64.53**	9.69	16.61	158.81	9.96	142.21	**57.95**	2491
Malthone	92.40	46.89	3.41	50.30	**54.44**	4.53	4.32	96.72	2.59	92.40	**50.01**	648
Rahatgarh	106.14	64.91	2.18	67.09	**63.21**	9.40	12.83	118.97	7.69	106.14	**54.97**	1924
Rehli	96.69	64.87	2.49	67.37	**69.68**	13.05	7.50	104.18	4.49	96.69	**56.45**	1124
Sagar	114.70	77.79	3.04	80.84	**70.48**	9.92	37.75	152.46	22.65	114.70	**61.37**	5664
Shahgarh	87.56	32.94	1.85	34.79	**39.74**	2.69	6.513	94.07	3.90	87.56	**38.29**	977
TOTAL	1212.88	705.97	30.14	736.11	**60.69**	95.27	175.03	1387.91	105.02	1212.88	**53.74**	26256

Table 12: Post-Intervention Impact, Sagar District, Madhya Pradesh

1.Block Banda District Sagar

Blocks	**Banda**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	96.55
In Storage Resources (MCM)	57.27
Total Resources (MCM)	**153.81**
Irrigation	65.13
Domestic+Industries	3.89
GW Draft (MCM)	71.66
Deeper Aquifer (30-200m)	
Static Resources (MCM)	15.09
GW Draft (MCM	6.53
Total GW Resources (MCM)	168.90
Gross Ground Water Draft (MCM)	75.55

Area in Sq Km	953	
Rainfall in m	0.95	
Area Suitable for Recharge in Sq Km	831.3	
Average Post Monsoon DTW in mbgl	3.9	
Unsaturated Zone in m	0.9	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	11.22	
Surface Water Required (MCM)	14.93	
Runoff Available (MCM)	238.25	
Non committed Runoff available (MCM)	71.48	
Percolation Tanks	15	**2.99 (Rs 20 Lakh Per Structure)**
Recharge Shaft/ Tube Wells	30	1.50 (Rs Five Lakh Per Structure)
NB/CD/CP	104	10.40(Rs 10 Lakh Per Structure)
Renovation of Village Ponds	164	3.28(Rs two Lakh Per Structure)
Total Cost INR in Crores		**18.17**

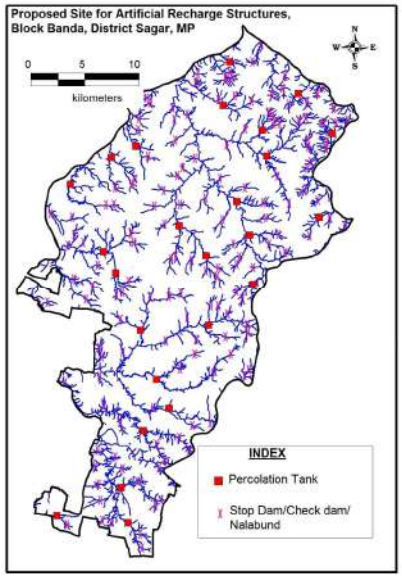


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Banda	96.54	71.66	3.88	75.54	**78.25**	10.75	11.22	107.76	6.73	96.54	**66.37**	1683

2.Block Bina, District Sagar

Blocks	**Bina**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	117.05
In Storage Resources (MCM)	24.59
Total Resources (MCM)	**141.65**
Irrigation	34.75
Domestic+Industries	3.07
GW Draft (MCM)	70.16
Deeper Aquifer (30-200m)	
Static Resources (MCM)	43.10
GW Draft (MCM	35.41
Total GW Resources (MCM)	184.75
Gross Ground Water Draft (MCM)	73.23

Area in Sq Km	826	
Rainfall in m	1.04	
Area Suitable for Recharge in Sq Km	821.00	
Average Post Monsoon DTW in mbgl	4.51	
Unsaturated Zone in m	1.51	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	18.60	
Surface Water Required (MCM)	24.73	
Runoff Available (MCM)	433.19	
Non committed Runoff available (MCM)	129.96	
Percolation Tanks	**25**	**2.99 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	49	2.45(Rs Five Lakh Per Stucture)
NB/CD/CP	173	17.30(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	155	3.10(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**27.80**

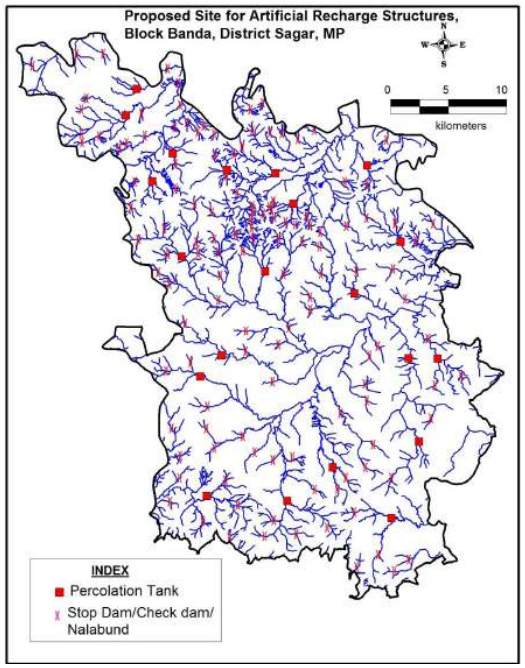


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Bina	117.05	70.16	3.07	73.23	**62.56**	11.92	18.60	135.64	11.15	117.05	**53.43**	2789

3.Block Deori District Sagar

Blocks	**Deori**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	136.95
In Storage Resources (MCM)	19.26
Total Resources (MCM)	**156.21**
Irrigation	43.45
Domestic+Industries	3.18
GW Draft (MCM)	58.41
Deeper Aquifer (30-200m)	
Static Resources (MCM)	23.42
GW Draft (MCM	14.96
Total GW Resources (MCM)	179.63
Gross Ground Water Draft (MCM)	61.60

Area in Sq Km	1014	
Rainfall in m	1.42	
Area Suitable for Recharge in Sq Km	867.50	
Average Post Monsoon DTW in mbgl	4.23	
Unsaturated Zone in m	1.23	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	16.01	
Surface Water Required (MCM)	21.29	
Runoff Available (MCM)	253.50	
Non committed Runoff available (MCM)	76.05	
Percolation Tanks	**21**	**4.26 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	43	2.15(Rs Five Lakh Per Stucture)
NB/CD/CP	149	14.90(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	244	4.88(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**26.19**

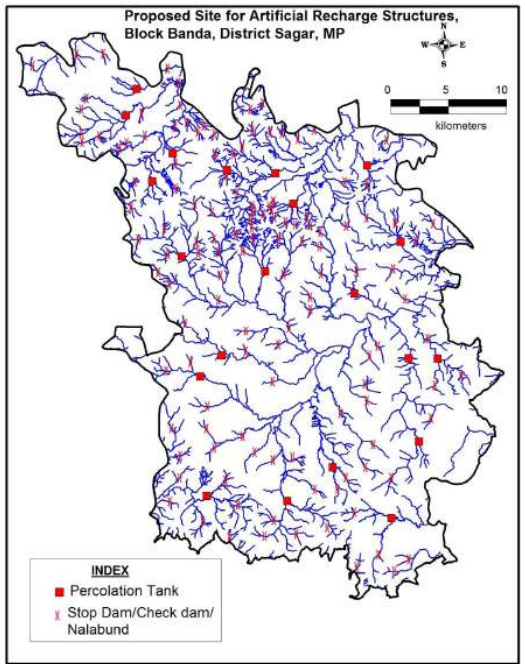


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Deori	136.94	58.41	3.18	61.59	**44.98**	9.33	16.01	152.95	9.60	136.94	**40.45**	2401

4.Block **Jaisinagar,** District Sagar

Blocks	**Jaisinagar**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	122.53
In Storage Resources (MCM)	35.45
Total Resources (MCM)	**157.99**
Irrigation	70.58
Domestic+Industries	1.99
GW Draft (MCM)	74.47
Deeper Aquifer (30-200m)	
Static Resources (MCM)	14.92
GW Draft (MCM	3.89
Total GW Resources (MCM)	172.90
Gross Ground Water Draft (MCM)	76.46

Area in Sq Km	913	
Rainfall in m	1.06	
Area Suitable for Recharge in Sq Km	764.90	
Average Post Monsoon DTW in mbgl	6.55	
Unsaturated Zone in m	3.55	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	40.73	
Surface Water Required (MCM)	54.17	
Runoff Available (MCM)	228.25	
Non committed Runoff available (MCM)	68.48	
Percolation Tanks	**54**	**10.83 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	108	5.40(Rs Five Lakh Per Stucture)
NB/CD/CP	379	37.90(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	145	2.6(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**26.19**

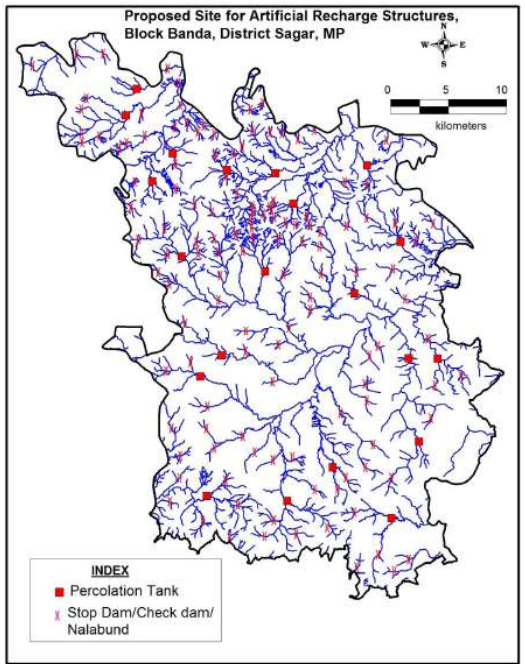


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Jaisinagar	122.53	74.47	1.98	76.45	**62.40**	7.78	40.73	163.26	24.43	122.53	**57.04**	6110

5.Block **Kesli,** District Sagar

Blocks	**Kesli**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	100.09
In Storage Resources (MCM)	39.52
Total Resources (MCM)	**139.61**
Irrigation	49.60
Domestic+Industries	2.60
GW Draft (MCM)	54.51
Deeper Aquifer (30-200m)	
Static Resources (MCM)	11.85
GW Draft (MCM	4.91
Total GW Resources (MCM)	151.46
Gross Ground Water Draft (MCM)	57.11

Area in Sq Km	791	
Rainfall in m	1.34	
Area Suitable for Recharge in Sq Km	658.60	
Average Post Monsoon DTW in mbgl	3.3	
Unsaturated Zone in m	0.30	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	2.96	
Surface Water Required (MCM)	3.94	
Runoff Available (MCM)	252.71	
Non committed Runoff available (MCM)	75.81	
Percolation Tanks	4	**0.79 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	8	0.40(Rs Five Lakh Per Stucture)
NB/CD/CP	28	2.80 (Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	177	3.54(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**7.53**

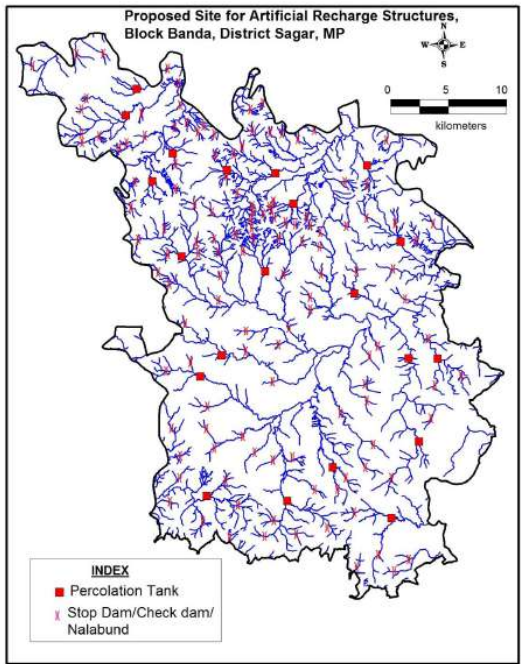


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Kesli	100.09	54.50	2.60	57.10	**57.06**	6.21	2.96	103.05	1.77	100.09	**51.11**	445

6.Block **Khurai,** District Sagar

Blocks	**Khurai**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	142.21
In Storage Resources (MCM)	73.77
Total Resources (MCM)	**215.98**
Irrigation	40.55
Domestic+Industries	2.42
GW Draft (MCM)	89.35
Deeper Aquifer (30-200m)	
Static Resources (MCM)	53.08
GW Draft (MCM	48.80
Total GW Resources (MCM)	269.06
Gross Ground Water Draft (MCM)	91.76

Area in Sq Km	937	
Rainfall in m	1.16	
Area Suitable for Recharge in Sq Km	907.40	
Average Post Monsoon DTW in mbgl	4.22	
Unsaturated Zone in m	1.22	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	16.61	
Surface Water Required (MCM)	22.09	
Runoff Available (MCM)	234.25	
Non committed Runoff available (MCM)	70.28	
Percolation Tanks	**22**	**4.42 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	44	2.20 (Rs Five Lakh Per Stucture)
NB/CD/CP	155	15.50(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	170	3.40 (Rs two Lakh Per Stucture)
Total Cost INR in Crores		**25.52**

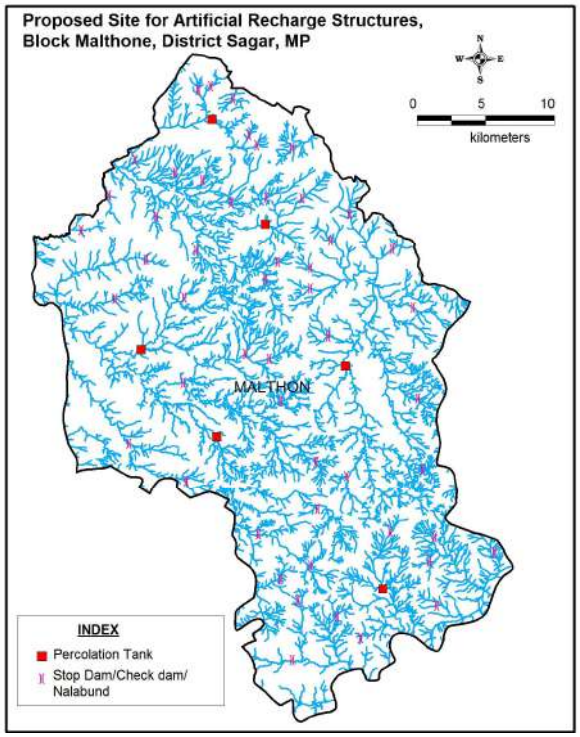


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Khurai	142.21	89.34	2.41	91.76	**64.53**	9.69	16.61	158.81	9.96	142.21	**57.95**	2491

7.Block **Malthone,** District Sagar

Blocks	**Malthone**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	92.40
In Storage Resources (MCM)	66.00
Total Resources (MCM)	**158.40**
Irrigation	42.94
Domestic+Industries	3.41
GW Draft (MCM)	46.89
Deeper Aquifer (30-200m)	
Static Resources (MCM)	9.70
GW Draft (MCM	3.95
Total GW Resources (MCM)	168.10
Gross Ground Water Draft (MCM)	50.31

Area in Sq Km	838	
Rainfall in m	1.00	
Area Suitable for Recharge in Sq Km	778.80	
Average Post Monsoon DTW in mbgl	3.37	
Unsaturated Zone in m	0.37	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	4.32	
Surface Water Required (MCM)	5.75	
Runoff Available (MCM)	209.50	
Non committed Runoff available (MCM)	62.85	
Percolation Tanks	11	**1.15 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	6	0.55 (Rs Five Lakh Per Stucture)
NB/CD/CP	40	4.00(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	174	3.48(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**9.18**

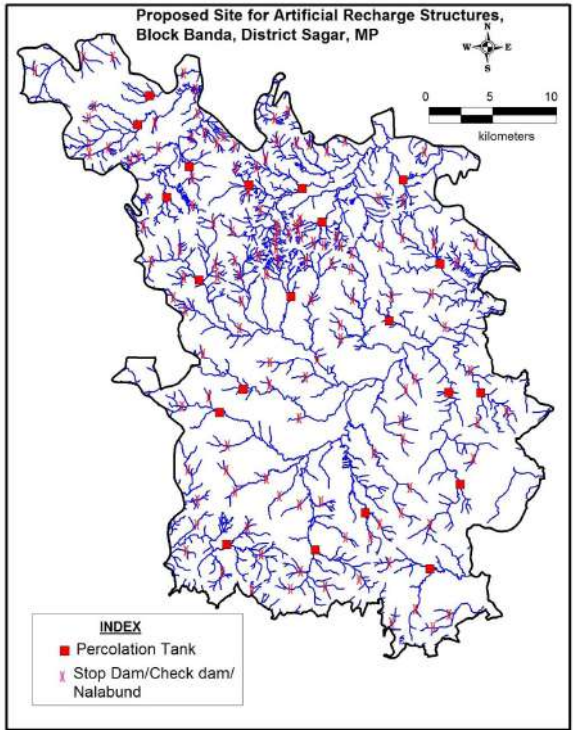


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Malthone	92.40	46.89	3.41	50.30	**54.44**	4.53	4.32	96.72	2.59	92.40	**50.01**	648

8.Block **Rahatgarh,** District Sagar

Blocks	**Rahatgarh**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	106.14
In Storage Resources (MCM)	19.91
Total Resources (MCM)	**126.05**
Irrigation	50.45
Domestic+Industries	2.18
GW Draft (MCM)	64.91
Deeper Aquifer (30-200m)	
Static Resources (MCM)	17.37
GW Draft (MCM	14.47
Total GW Resources (MCM)	143.42
Gross Ground Water Draft (MCM)	67.09

Area in Sq Km	985	
Rainfall in m	1.20	
Area Suitable for Recharge in Sq Km	890.68	
Average Post Monsoon DTW in mbgl	3.96	
Unsaturated Zone in m	0.96	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	12.83	
Surface Water Required (MCM)	17.06	
Runoff Available (MCM)	246.25	
Non committed Runoff available (MCM)	73.88	
Percolation Tanks	17	**3.41 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	34	1.70(Rs Five Lakh Per Stucture)
NB/CD/CP	119	11.90(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	198	3.96(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**20.97**

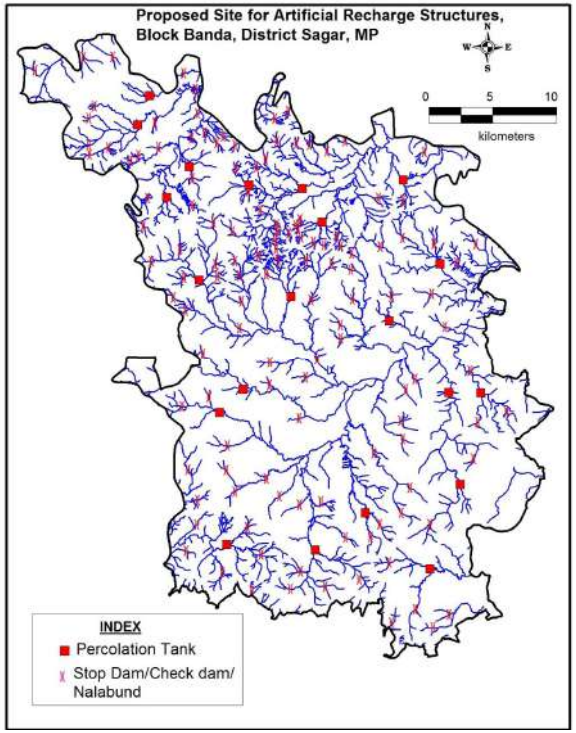


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Rahatgarh	106.14	64.91	2.18	67.09	**63.21**	9.40	12.83	118.97	7.69	106.14	**54.97**	1924

9.Block **Rehli,** District Sagar

Blocks	**Rehli**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	96.69
In Storage Resources (MCM)	37.48
Total Resources (MCM)	**134.17**
Irrigation	48.75
Domestic+Industries	2.50
GW Draft (MCM)	64.87
Deeper Aquifer (30-200m)	
Static Resources (MCM)	24.48
GW Draft (MCM	16.12
Total GW Resources (MCM)	158.64
Gross Ground Water Draft (MCM)	67.37

Area in Sq Km	1125	
Rainfall in m	1.00	
Area Suitable for Recharge in Sq Km	1019.80	
Average Post Monsoon DTW in mbgl	3.49	
Unsaturated Zone in m	0.49	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	7.50	
Surface Water Required (MCM)	9.97	
Runoff Available (MCM)	281.25	
Non committed Runoff available (MCM)	84.38	
Percolation Tanks	10	**1.99 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	20	1.00 (Rs Five Lakh Per Stucture)
NB/CD/CP	70	7.00(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	215	4.30(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**14.29**

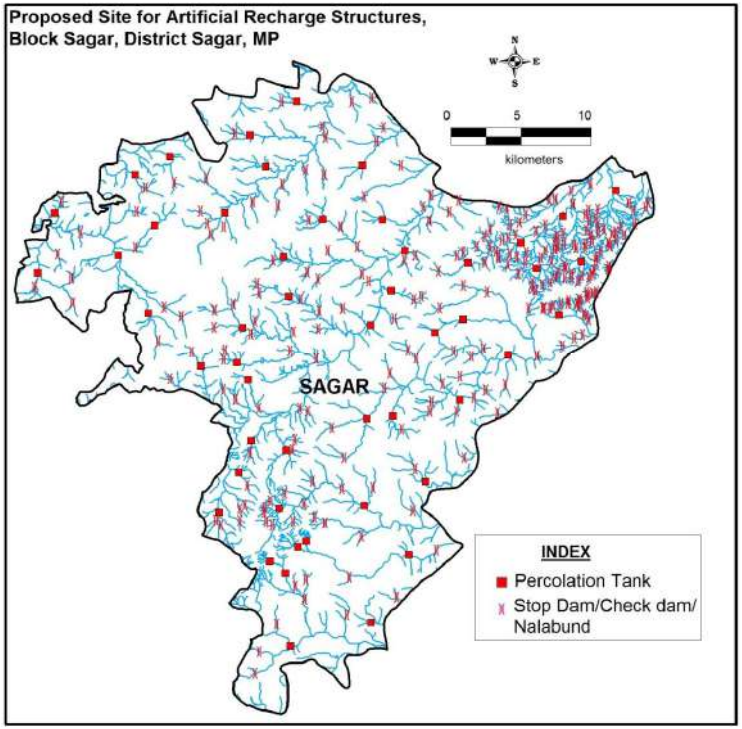


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Rehli	96.69	64.87	2.49	67.37	**69.68**	13.05	7.50	104.18	4.49	96.69	**56.45**	1124

10.Block **Sagar,** District Sagar

Blocks	**Sagar**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	114.71
In Storage Resources (MCM)	11.78
Total Resources (MCM)	**126.49**
Irrigation	70.21
Domestic+Industries	3.05
GW Draft (MCM)	77.80
Deeper Aquifer (30-200m)	
Static Resources (MCM)	24.20
GW Draft (MCM	7.58
Total GW Resources (MCM)	150.69
Gross Ground Water Draft (MCM)	80.84

Area in Sq Km	1173	
Rainfall in m	1.12	
Area Suitable for Recharge in Sq Km	1075.70	
Average Post Monsoon DTW in mbgl	5.34	
Unsaturated Zone in m	2.34	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	37.76	
Surface Water Required (MCM)	50.22	
Runoff Available (MCM)	293.25	
Non committed Runoff available (MCM)	87.98	
Percolation Tanks	50	**10.04 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	100	5.00(Rs Five Lakh Per Stucture)
NB/CD/CP	352	35.20(Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	152	3.03(Rs two Lakh Per Stucture)
Total Cost INR in Crores		53.28

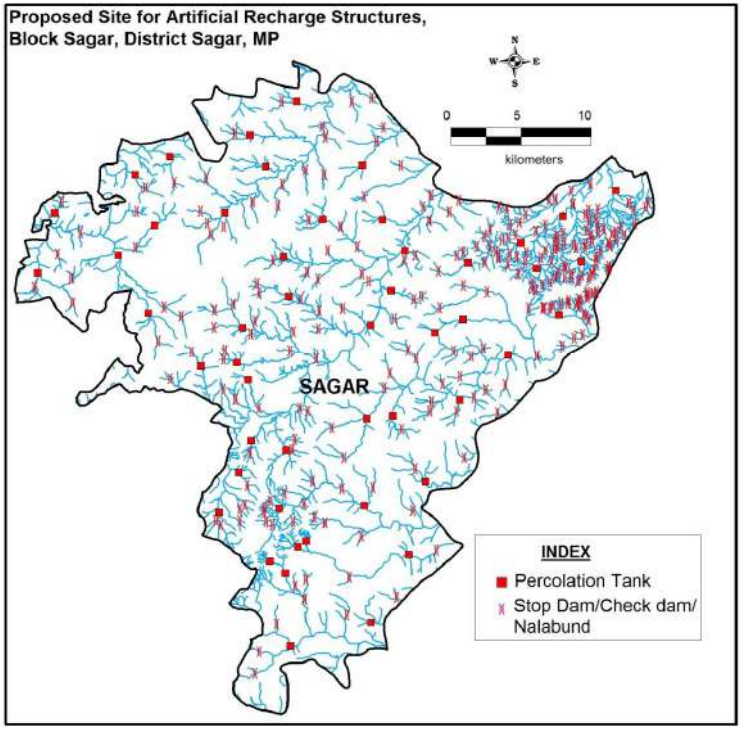


Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Sagar	114.70	77.79	3.04	80.84	**70.48**	9.92	37.75	152.46	22.65	114.70	**61.37**	5664

11.Block **Shahgarh,** District Sagar

Blocks	**Shahgarh**
Shallow Aquifer (0-30m)	
Dynamic Resources (MCM)	87.56
In Storage Resources (MCM)	30.46
Total Resources (MCM)	**118.02**
Irrigation	29.83
Domestic+Industries	1.85
GW Draft (MCM)	32.95
Deeper Aquifer (30-200m)	
Static Resources (MCM)	14.17
GW Draft (MCM	3.12
Total GW Resources (MCM)	132.19
Gross Ground Water Draft (MCM)	34.80

Area in Sq Km	697	
Rainfall in m	1.02	
Area Suitable for Recharge in Sq Km	638.50	
Average Post Monsoon DTW in mbgl	3.68	
Unsaturated Zone in m	0.68	
Average Specific Yield in %	0.015	
Sub Surface Storage Available (MCM)	6.51	
Surface Water Required (MCM)	8.66	
Runoff Available (MCM)	174.25	
Non committed Runoff available (MCM)	52.28	
Percolation Tanks	9	**1.73 (Rs 20 Lakh Per Stucture)**
Recharge Shaft/ Tube Wells	17	0.85 (Rs Five Lakh Per Stucture)
NB/CD/CP	61	6.10 (Rs 10 Lakh Per Stucture)
Renovation of Village Ponds	107	2.14(Rs two Lakh Per Stucture)
Total Cost INR in Crores		**10.82**



Block	Net GW Availability in MCM	GW Draft for Irrigation in MCM	GW Draft for Domestic & Industrial in MCM	Gross Draft in MCM	Stage of Development %	Saving by Sprinkler in MCM	Additional recharge created by AR in MCM	After intervention of AR Structure Net GW AvL. in MCM	After intervention of AR Structure & utilisation of 60% of additional GW created. in MCM	Draft after sprinkler & additional area created for agriculture in MCM	Stage of Development after intervention %	additional area irrigated by GW after intervention (Ha)
Shahgarh	87.56	32.94	1.85	34.79	**39.74**	2.69	6.513	94.07	3.90	87.56	**38.29**	977

7. CONCLUSIONS AND RECOMMENDATIONS

- Sagar District occupies an area of 10252 Sq.Km and it is second largest geographical area in District of Madhya Pradesh. water recharge worthy area is 9254 sq. km. and the rest is covered by hilly and forest area.
- The major rivers flowing through the area includes the river Bina, Dhasan, Bewas, Sonar and Bamner.
- The major part of the district is covered by the Deccan trap lava flows and in eastern part by Vindhayan sandstones.
- Sagr district comprises eleven blocks, namely Banda, Bina, Deori, Jaisinagar, Kesli, Khurai, Malthone, Rahatgarh, Rehli, Sagar and Shahgarh.
- The phreatic aquifer is recharged during monsoon and sustains for 3 to 4 months.
- More stress on Groundwater, 93 % of irrigation carried out by Ground water and 7% of irrigation by surface water.
- Groundwater decline range is 0.10 to 0.20 m/year. More decline in Banda, Rehli ,Bina and Sagar Blocks Pre-Monsoon: 0. 13-0.17 m/yr, Post-Monsoon: 0. 09-0.20 m/yr
- Isolated pockets TDS- ranges from >500 to 3516 mg/l. Isolated pockets Nitrate ranges from >45 to 380 mg/l
- On the basis of the 70 Exploratory borewells drilled by CGWB, NCR under its Exploratory/NAQUIM program, it has been observed that the yield varies from meager to 5lps in basalt and meager to 4 lps in Vindhyans.
- As per the Dynamic Ground Water Resource Assessment Report (2013), the net ground water availability in the district is 1212.88 MCM and ground water draft for all uses is 736.11 MCM, resulting the stage of ground water development to be 60.69 % as a whole for district. The Sagar district falls under safe category.
- 1 (semi critical) out of 11Blocks 78.28 % Stage of Development in Banda Block

- After the interventions suggested in the report, the stage of development is expected to improve by 7% i.e. from 60.69% to 53.44% for the Sagar district.
- As per the Management plan prepared under NAQUIM of all the Block of Sagar District, a total number of 233 Percolation Tanks, 466 Recharge Shafts/Tube wells and 1901 Nala Bunds/Check Dams/Cement Plugs have been proposed.
- Financial expenditure is expected to be Rs 270.78 Cores in Sagar District for sustainable development and management of ground water resources.
- The number of artificial recharge structure and financial estimation has been proposed based on the CGWB Master plan 2013. It may be differ from the field condition as well as changes in dynamic Ground water resources.
- It is also recommended implementation intervention would be three face fist face should be in above 70 % stage of Development of the Blocks.

Annexure I

Rock work software format exploratory wells

Bore	File	Easting	Northing	Elevation	CollarElevation	TotalDepth
Agasod	Agasod	78.1625	24.2697	399	399	200.00
Anathpura	Anathpura	79.1114	23.5192	418	418	200.00
Bamori Bika	Bamori Bika	78.8333	23.6833	526	526	200.00
Bansa	Bansa	78.5419	23.7045	513	513	200.00
Baraha	Baraha	79.0875	23.3319	421	421	201.10
Barodia Kala	Barodia Kala	78.6000	24.2083	453	453	126.00
Barouda	Barouda	78.9120	23.7144	496	496	199.20
Barpani	Barpani	79.0263	23.8153	446	446	200.20
Basiya Bhansa	Basiya Bhansa	78.5869	23.8677	492	492	74.20
Behrol EW	Behrol EW	78.7419	24.0593	454	454	200.30
Belai	Belai	78.2089	24.2336	424	424	200.00
Belehara	Belehara	78.7326	23.6446	543	543	163.00
Bhaisa Pahari	Bhaisa Pahari	78.7397	23.9250	544	544	165.00
Bhapel	Bhapel	78.6417	23.8333	511	511	200.00
Bharcha	Bharcha	78.3750	24.2542	412	412	103.00
Bina (Deep)	Bina (Deep)	78.1911	24.1653	410	410	76.70
Binaji	Binaji	79.0811	23.3639	417	417	92.00
Binaka	Binaka	78.8404	24.1050	449	449	200.00
Dalpathpur	Dalpathpur	79.0184	24.1311	500	500	203.10
Deori	Deori	79.0208	23.3972	431	431	135.00
Deori RH	Deori RH	79.0109	23.4208	448	448	200.00
Dhana	Dhana	78.8750	23.7472	500	500	203.00
Dudhoniya	Dudhoniya	78.9548	23.7621	473	473	200.30
Dungasara	Dungasara	78.8979	23.8676	494	494	202.30
Garhakota (Deep)	Garhakota (Deep)	79.1333	23.7853	377	377	120.00
Gaudana EW	Gaudana EW	78.1642	24.1544	404	404	65.80
Gharoli	Gharoli	78.2732	24.4475	377	377	122.49
Ghatiyari EW	Ghatiyari EW	78.2648	24.1280	413	413	105.50
Gidwani	Gidwani	78.8012	23.9219	520	520	200.00
Girwar	Girwar	78.9569	23.8236	480	480	200.20
Gopalpura	Gopalpura	78.8417	23.4917	476	476	102.60
Hiranchipa	Hiranchipa	78.2193	24.1681	418	418	200.00
Ishurwada	Ishurwada	78.5470	23.9585	497	497	200.00
Ishwarpur EW	Ishwarpur EW	79.1010	23.3503	417	417	200.00
Jaithpur	Jaithpur	79.0483	23.4955	433	433	200.00
Kanadari	Kanadari	78.8937	24.0010	484	484	202.60
Kandwa	Kandwa	79.1268	24.0109	387	387	203.10
Kanjiya EW	Kanjiya EW	78.1967	24.3869	387	387	111.60
Karrapur	Karrapur	78.8697	23.9487	494	494	200.30
Khamkera	Khamkera	78.9172	23.5496	431	431	157.00
Khejara Buddu	Khejara Buddu	78.8667	23.6694	499	499	203.00

Khurai	**Khurai**	**78.3142**	**24.0348**	**432**	**432**	**200.00**
Khurai (Deep)	**Khurai (Deep)**	**78.3322**	**24.0508**	**441**	**441**	**75.00**
Kishanpura	**Kishanpura**	**78.8464**	**23.7101**	**507**	**507**	**200.30**
Maharajpur	**Maharajpur**	**79.0583**	**23.2792**	**431**	**431**	**180.70**
Mainpani	**Mainpani**	**78.7847**	**23.7903**	**541**	**541**	**200.00**
Mardanpur	**Mardanpur**	**78.4917**	**23.8014**	**503**	**503**	**200.00**
Mirkheri	**Mirkheri**	**78.3011**	**23.7653**	**445**	**445**	**171.33**
Nirtala	**Nirtala**	**78.2972**	**24.0732**	**431**	**431**	**88.88**
PamakheriEW	**PamakheriEW**	**78.8516**	**23.8117**	**502**	**502**	**200.20**
Patha	**Patha**	**78.7654**	**23.6284**	**549**	**549**	**200.20**
Pathariya Hat	**Pathariya Hat**	**78.6806**	**23.8667**	**493**	**493**	**120.00**
Patna Bujurg	**Patna Bujurg**	**79.0139**	**23.6500**	**408**	**408**	**105.00**
Rahatgarh	**Rahatgarh**	**78.6417**	**23.8333**	**511**	**511**	**200.00**
Ranguwan	**Ranguwan**	**79.1278**	**23.7542**	**381**	**381**	**123.40**
Rasena	**Rasena**	**78.9750**	**23.3000**	**444**	**444**	**136.00**
Sabda	**Sabda**	**78.1900**	**24.1833**	**409**	**409**	**85.94**
Sagar civillineEW	**Sagar civillineEW**	**78.7654**	**23.8356**	**548**	**548**	**92.50**
Sagar Town	**Sagar Town**	**78.7681**	**23.6778**	**545**	**545**	**111.80**
Sagar (Deep)	**Sagar (Deep)**	**78.7128**	**23.8361**	**509**	**509**	**98.00**
Samanapur	**Samanapur**	**78.7929**	**23.6917**	**527**	**527**	**200.00**
Sandi	**Sandi**	**78.1708**	**24.0264**	**416**	**416**	**80.30**
Sehora	**Sehora**	**78.5694**	**23.7889**	**494**	**494**	**103.00**
Seorai	**Seorai**	**78.9250**	**24.0083**	**480**	**480**	**160.00**
Siloda EW	**Siloda EW**	**78.3736**	**24.0157**	**438**	**438**	**123.50**
Sironja	**Sironja**	**78.8021**	**23.7984**	**519**	**519**	**200.00**
Tilabujurg	**Tilabujurg**	**78.5125**	**23.8583**	**510**	**510**	**200.00**
Tilli (Shivajii Ward)	**Tilli (Shivajii Ward)**	**78.7681**	**23.6778**	**545**	**545**	**200.00**
Titarpani	**Titarpani**	**79.0489**	**23.2325**	**446**	**446**	**200.00**

Bore	Depth1	Depth2	Stratigraphy
Agasod	0	6.5	Basalt weathered
Agasod	6.5	28	Basalt massive
Agasod	28	32	Limestone
Agasod	32	42	Sandstone Massive
Agasod	42	200	Shale Massive
Anathpura	0	6	Basalt weathered
Anathpura	6	17	Basalt massive
Anathpura	17	32	Limestone
Anathpura	32	50.6	Sandstone Massive
Anathpura	50.6	200	Shale Massive
Bamori Bika	0.00	13.00	Topsoil
Bamori Bika	13.00	15.75	Basalt weathered
Bamori Bika	15.75	89.25	Basalt massive
Bamori Bika	89.25	99.75	Sandstone fractured
Bamori Bika	99.75	110.25	Shale Massive

Bamori Bika	110.25	200.00	Sandstone Massive
Bansa	0	8.47	Basalt weathered
Bansa	8.47	39.5	Basalt massive
Bansa	39.5	73.46	Basalt vesicular
Bansa	73.46	98.87	Basalt massive1
Bansa	98.87	118.65	Sandstone Massive
Bansa	118.65	200	Shale Massive
Baraha	0	2.8	Sandstone weathered
Baraha	2.8	21.1	Sandstone Massive
Baraha	21.1	201.1	Shale Massive
Barodia Kala	0.00	9.5	Basalt weathered
Barodia Kala	9.50	31.50	Basalt massive
Barodia Kala	31.50	54.00	Sandstone Massive
Barodia Kala	54.00	67.00	Sandstone fractured
Barodia Kala	67.00	112.75	Shale Massive
Barodia Kala	112.75	126.00	Sandstone Massive1
Barouda	0	10.5	Basalt weathered
Barouda	10.5	25	Basalt massive
Barouda	25	73	Sandstone Massive
Barouda	73	130.5	Shale Massive
Barouda	130.5	200	Sandstone Massive1
Barpani	0	8.4	Sandstone weathered
Barpani	8.4	64	Sandstone Massive
Barpani	64	66	Sandstone fractured
Barpani	66	200	Shale Massive
Basiya Bhansa	0	11	Basalt weathered
Basiya Bhansa	11	72	Basalt massive
Behrol EW	0	8	Sandstone weathered
Behrol EW	8	62.8	Sandstone Massive
Behrol EW	62.8	73	Sandstone fractured
Behrol EW	73	138	Sandstone Massive1
Behrol EW	138	200	Shale Massive
Belai	0	18.3	Topsoil
Belai	18.3	50	Basalt massive
Belai	50	56.4	Basalt fractured
Belai	56.4	200	Shale Massive
Belehara	0	56.51	Basalt massive
Belehara	56.51	90.4	Basalt vesicular
Belehara	90.4	108	Basalt fractured
Belehara	108	152.55	Basalt massive1
Belehara	152.55	163	Sandstone Massive
Bhaisa Pahari	0.00	13.00	Basalt weathered
Bhaisa Pahari	13.00	47.25	Basalt massive
Bhaisa Pahari	47.25	84.00	Basalt fractured
Bhaisa Pahari	84.00	157.00	Basalt massive1
Bhaisa Pahari	157.00	165.00	Sandstone Massive
Bhapel	0	11	Sandstone weathered

Bhapel	11	136	Sandstone Massive
Bhapel	136	200	Shale Massive
Bharcha	0.00	10.50	Topsoil
Bharcha	10.50	18.25	Sandstone weathered
Bharcha	18.25	65.50	Sandstone Massive
Bharcha	65.50	103.00	Shale Massive
Bina (Deep)	0.00	10.10	Topsoil
Bina (Deep)	10.10	18.75	Basalt weathered
Bina (Deep)	18.75	46.20	Basalt massive
Bina (Deep)	46.20	58.40	Basalt vesicular
Bina (Deep)	58.40	76.70	Sandstone Massive
Binaji	0	65.5	Shale Massive
Binaji	65.5	70	Sandstone fractured
Binaji	70	92	Shale Massive1
Binaka	0	6	Basalt weathered
Binaka	6	35	Basalt massive
Binaka	35	174	Sandstone Massive
Binaka	174	200	Shale Massive
Dalpathpur	0	9	Basalt weathered
Dalpathpur	9	15	Basalt massive
Dalpathpur	15	24	Basalt vesicular
Dalpathpur	24	48	Basalt massive1
Dalpathpur	48	72	Sandstone Massive
Dalpathpur	72	200	Shale Massive
Deori	0	4.9	Topsoil
Deori	4.9	11	Basalt weathered
Deori	11	26.2	Basalt massive
Deori	26.2	68.9	Sandstone Massive
Deori	68.9	135	Shale Massive
Dhana	0	14	Basalt weathered
Dhana	14	53	Basalt massive
Dhana	53	60	Basalt vesicular
Dhana	60	169	Sandstone Massive
Dhana	169	203	Shale Massive
Dungasara	0	6	Sandstone weathered
Dungasara	6	137	Sandstone Massive
Dungasara	137	145	Sandstone fractured
Dungasara	145	200	Shale Massive
Garhakota (Deep)	0.00	6.60	Topsoil
Garhakota (Deep)	6.60	54.60	Limestone
Garhakota (Deep)	54.60	80.60	Sandstone Massive
Garhakota (Deep)	80.60	90.60	Sandstone fractured
Garhakota (Deep)	90.60	120.00	Sandstone Massive1
Gaudana EW	0	15.3	Topsoil
Gaudana EW	15.3	59	Basalt massive
Gaudana EW	59	62	Sandstone fractured
Gharoli	0	3.28	Topsoil

Gharoli	3.28	7.5	Basalt weathered
Gharoli	7.5	16.82	Basalt massive
Gharoli	16.82	115.34	Shale Massive
Gharoli	115.34	122.49	Sandstone Massive
Ghatiyari EW	0	9	Basalt weathered
Ghatiyari EW	9	24	Basalt massive
Ghatiyari EW	24	42	Basalt vesicular
Ghatiyari EW	42	105	Sandstone Massive
Gidwani	0	8.5	Basalt weathered
Gidwani	8.5	69	Basalt massive
Gidwani	69	75	Sandstone fractured
Gidwani	75	173	Shale Massive
Gidwani	173	200	Sandstone Massive
Girwar	0	15	Sandstone weathered
Girwar	15	63	Sandstone Massive
Girwar	63	119	Shale Massive
Girwar	119	127	Sandstone Fractured
Girwar	127	200	Sandstone Massive1
Gopalpura	0	15	Basalt weathered
Gopalpura	15	32.3	Basalt massive
Gopalpura	32.3	47.6	Basalt vesicular
Gopalpura	47.6	87.2	Basalt massive1
Gopalpura	87.2	102	Sandstone Massive
Hiranchipa	0	3	Topsoil
Hiranchipa	3	17	Basalt weathered
Hiranchipa	17	28	Basalt vesicular
Hiranchipa	28	55	Basalt massive
Hiranchipa	55	136	Sandstone Massive
Hiranchipa	136	200	Shale Massive
Ishurwada	0	3	Topsoil
Ishurwada	3	5.65	Basalt weathered
Ishurwada	5.65	25.43	Basalt massive
Ishurwada	25.43	67.81	Basalt vesicular
Ishurwada	67.81	101	Sandstone Massive
Ishurwada	101	113	Shale Massive
Ishurwada	113	200	Sandstone Massive1
Ishwarpur EW	0	11	Basalt weathered
Ishwarpur EW	11	20.1	Limestone
Ishwarpur EW	20.1	42.92	Sandstone Massive
Ishwarpur EW	42.92	48.86	Sandstone fractured
Ishwarpur EW	48.86	180.7	Shale Massive
Jaithpur	0	11	Basalt weathered
Jaithpur	10	19	Limestone
Jaithpur	19	59	Sandstone Massive
Jaithpur	59	200	Shale Massive
Kanadari	0	8.9	Basalt weathered
Kanadari	8.9	38.4	Basalt massive

Kanadari	38.4	41	Sandstone fractured
Kanadari	41	150	Sandstone Massive
Kanadari	150	200	Shale Massive
Kandwa	0	6	Sandstone weathered
Kandwa	6	12	Sandstone Massive
Kandwa	12	20	Shale Massive
Kandwa	20	29	Sandstone fractured
Kandwa	29	200	Sandstone Massive1
Kanjiya EW	0	9	Topsoil
Kanjiya EW	9	44	Sandstone Massive
Kanjiya EW	44	63	Shale Massive
Kanjiya EW	63	78	Sandstone fractured
Kanjiya EW	78	111.6	Sandstone Massive1
Karrapur	0	6	Basalt weathered
Karrapur	6	21	Basalt massive
Karrapur	21	142	Sandstone Massive
Karrapur	142	150	Shale Massive
Karrapur	150	200	Sandstone Massive1
Khamkera	0	8	Basalt weathered
Khamkera	6	30	Basalt massive
Khamkera	30	36	Sandstone fractured
Khamkera	36	157	Sandstone Massive
Khejara Buddu	0	24	Basalt massive
Khejara Buddu	24	40	Basalt vesicular
Khejara Buddu	40	105	Sandstone Massive
Khejara Buddu	105	203	Shale Massive
Khurai	0	6	Sandstone weathered
Khurai	6	26	Sandstone Massive
Khurai	26	35	Sandstone fractured
Khurai	35	200	Sandstone Massive1
Khurai (Deep)	0.00	11.00	Topsoil
Khurai (Deep)	11.00	24.00	Sandstone weathered
Khurai (Deep)	24.00	55.00	Sandstone fractured
Khurai (Deep)	55.00	75.00	Sandstone Massive
Kishanpura	0	18	Basalt weathered
Kishanpura	18	27	Basalt massive
Kishanpura	27	39	Basalt vesicular
Kishanpura	39	90	Basalt massive
Kishanpura	90	147	Sandstone Massive
Kishanpura	147	200	Shale Massive
Maharajpur	0	11	Topsoil
Maharajpur	11	19	Limestone
Maharajpur	19	21	Sandstone fractured
Maharajpur	20.1	50.6	Sandstone Massive
Maharajpur	50.6	180.7	Shale Massive
Mainpani	0.00	15.25	Topsoil
Mainpani	15.25	21.75	Basalt massive

Mainpani	21.75	36.75	Basalt vesicular
Mainpani	36.75	75.25	Basalt massive1
Mainpani	75.25	141.75	Sandstone Massive
Mainpani	141.75	200.00	Shale Massive
Mardanpur	0	11	Basalt weathered
Mardanpur	11	45.21	Basalt massive
Mardanpur	45.21	48.03	Basalt fractured
Mardanpur	48.03	62.16	Shale Massive
Mardanpur	62.16	84.75	Sandstone Massive
Mardanpur	84.75	113	Shale Massive1
Mardanpur	113	200	Sandstone Massive1
Mirkheri	0	7.4	Basalt weathered
Mirkheri	7.4	38	Basalt massive
Mirkheri	38	59	Basalt fractured
Mirkheri	59	165	Basalt massive1
Mirkheri	165	171.33	Sandstone fractured
Nirtala	0	8.3	Basalt weathered
Nirtala	8.3	32	Basalt massive
Nirtala	32	53	Basalt fractured
Nirtala	53	88.88	Sandstone Massive
PamakheriEW	0	8	Basalt weathered
PamakheriEW	8	21	Basalt massive
PamakheriEW	21	33	Basalt vesicular
PamakheriEW	33	87	Basalt massive1
PamakheriEW	87	180	Shale Massive
PamakheriEW	180	190	Sandstone fractured
PamakheriEW	190	200	Sandstone Massive
Patha	0	6	Basalt weathered
Patha	6	60.5	Basalt massive
Patha	60.5	72	Basalt fractured
Patha	72	97	Sandstone Massive
Patha	97	120	Shale Massive
Patha	120	200	Sandstone Massive1
Pathariya Hat	0	5.1	Basalt weathered
Pathariya Hat	5.1	30	Basalt massive
Pathariya Hat	30	72	Basalt vesicular
Pathariya Hat	72	78	Sandstone Massive
Pathariya Hat	78	120	Shale Massive
Patna Bujurg	0	3	Topsoil
Patna Bujurg	3	53	Basalt massive
Patna Bujurg	53	62	Sandstone fractured
Patna Bujurg	62	105	Sandstone Massive
Rahatgarh	0	18	Basalt massive
Rahatgarh	18	23	Basalt vesicular
Rahatgarh	23	200	Shale Massive
Ranguwan	0	3	Topsoil
Ranguwan	3	35	Shale Massive

Ranguwan	35	45	Sandstone fractured
Ranguwan	45	93.5	Shale Massive1
Ranguwan	93.5	123.4	Sandstone Massive
Rasena	0	5	Basalt weathered
Rasena	5	29.3	Basalt massive
Rasena	29.3	44.5	Basalt vesicular
Rasena	44.5	65.9	Sandstone Massive
Rasena	65.9	136	Shale Massive
Sabda	0	11.04	Topsoil
Sabda	11.04	13.83	Basalt weathered
Sabda	13.83	23.75	Basalt massive
Sabda	23.75	43.33	Basalt vesicular
Sabda	43.33	54.2	Basalt massive1
Sabda	54.2	85.94	Sandstone Massive
Sagar civillineEW	0	4	Topsoil
Sagar civillineEW	4	19.3	Basalt weathered
Sagar civillineEW	19.3	37.6	Basalt massive
Sagar civillineEW	37.6	43.7	Basalt fractured
Sagar civillineEW	43.7	140.5	Basalt massive1
Sagar civillineEW	140.5	148.2	Sandstone fractured
Sagar civillineEW	148.2	202.3	Sandstone Massive
Sagar Town	0	6	Basalt weathered
Sagar Town	6	99	Sandstone Massive
Sagar Town	99	102	Shale Massive
Sagar Town	102	111.8	Sandstone Massive1
Sagar (Deep)	0.00	6.00	Basalt weathered
Sagar (Deep)	6.00	37.00	Basalt massive
Sagar (Deep)	37.00	49.00	Basalt vesicular
Sagar (Deep)	85.00	98.00	Basalt massive1
Samanapur	0	56.51	Basalt massive
Samanapur	56.51	70.63	Basalt vesicular
Samanapur	70.63	81.93	Basalt massive1
Samanapur	81.93	115.82	Sandstone Massive
Samanapur	115.82	200	Shale Massive
Sandi	0	7.5	Basalt weathered
Sandi	7.5	27	Basalt massive
Sandi	27	32	Basalt vesicular
Sandi	32	78	Basalt massive1
Sandi	78	82	Sandstone Massive
Sehora	0	8.5	Basalt weathered
Sehora	8.50	26.25	Basalt massive
Sehora	26.25	43.00	Basalt fractured
Sehora	43.00	103.00	Sandstone Massive
Sehora	0.00	3.50	Topsoil
Sehora	3.50	10.50	Basalt weathered
Sehora	10.50	15.75	Basalt massive
Sehora	15.75	55.00	Sandstone Massive

Sehora	55.00	78.75	Shale Massive
Sehora	78.75	160.00	Sandstone Massive1
Siloda EW	0	9	Topsoil
Siloda EW	9	21	Basalt massive
Siloda EW	21	30	Basalt vesicular
Siloda EW	30	56	Basalt massive1
Siloda EW	56	65	Basalt fractured
Siloda EW	65	147	Sandstone Massive
Sironja	0	9	Basalt weathered
Sironja	9	106	Basalt massive
Sironja	106	115	Sandstone fractured
Sironja	115	200	Shale Massive
Tilabujurg	0	3.82	Topsoil
Tilabujurg	3.82	11.3	Basalt weathered
Tilabujurg	11.3	28.26	Basalt massive
Tilabujurg	28.26	45.21	Basalt vesicular
Tilabujurg	45.21	93.22	Basalt massive1
Tilabujurg	93.22	96.05	Shale Massive
Tilabujurg	96.05	107.35	Sandstone Massive
Tilabujurg	107.35	163	Shale Massive
Tilabujurg	163	200	Sandstone Massive1
Tilli (Shivajii Ward)	0.00	5.25	Topsoil
Tilli (Shivajii Ward)	5.25	10.50	Basalt weathered
Tilli (Shivajii Ward)	10.50	29.25	Basalt vesicular
Tilli (Shivajii Ward)	29.25	52.00	Basalt massive
Tilli (Shivajii Ward)	52.00	55.00	Basalt fractured
Tilli (Shivajii Ward)	55.00	100.00	Basalt massive1
Tilli (Shivajii Ward)	100.00	147.00	Sandstone Massive
Tilli (Shivajii Ward)	147.00	200.00	Shale Massive
Titarpani	0	3	Sandstone weathered
Titarpani	3	10	Sandstone Massive
Titarpani	10	11	Sandstone fractured
Titarpani	11	200	Shale Massive

Bore	Depth1	Depth2	Lithology
Agasod	0	1.5	Topsoil
Agasod	1.5	6.5	Basalt weathered
Agasod	6.5	12	Basalt massive
Agasod	12	15	Basalt fractured
Agasod	15	28	Basalt massive
Agasod	28	32	Limestone
Agasod	32	34	Sandstone Massive
Agasod	34	200	Shale Massive
Anathpura	0	0.5	Topsoil
Anathpura	0.5	6	Basalt weathered
Anathpura	6	17	Basalt massive

Anathpura	17	32	Limestone
Anathpura	32	50.6	Sandstone Massive
Anathpura	50.6	200	Shale Massive
Bamori Bika	0.00	0.8	Topsoil
Bamori Bika	0.80	13.00	Clay
Bamori Bika	13.00	15.75	Basalt weathered
Bamori Bika	15.75	89.25	Basalt massive
Bamori Bika	89.25	99.75	Sandstone fractured
Bamori Bika	99.75	110.25	Shale Massive
Bamori Bika	110.25	200.00	Sandstone fractured
Bansa	0	2.82	Topsoil
Bansa	2.82	8.47	Basalt weathered
Bansa	8.47	33.91	Basalt massive
Bansa	33.91	39.5	Clay
Bansa	39.5	50.86	Basalt vesicular
Bansa	50.86	62.16	Basalt massive
Bansa	62.16	73.46	Basalt vesicular
Bansa	73.46	98.87	Basalt massive
Bansa	98.87	107.35	Sandstone Massive
Bansa	107.35	112.1	Shale Massive
Bansa	112.1	118.65	Sandstone Massive
Bansa	118.65	135	Shale Massive
Bansa	135	137	Shale Fractured
Bansa	137	189	Shale Massive
Bansa	189	192	Shale Fractured
Bansa	192	200	Shale Massive
Baraha	0	0.5	Topsoil
Baraha	0.5	2.8	Sandstone weathered
Baraha	2.8	21.1	Sandstone Massive
Baraha	21.1	201.1	Shale Massive
Barodia Kala	0.00	1.2	Topsoil
Barodia Kala	1.20	9.5	Basalt weathered
Barodia Kala	9.50	31.50	Basalt massive
Barodia Kala	31.50	54.00	Sandstone Massive
Barodia Kala	54.00	57.75	Sandstone fractured
Barodia Kala	57.75	91.75	Sandstone Massive
Barodia Kala	91.75	112.75	Shale Massive
Barodia Kala	112.75	126.00	Sandstone fractured
Barouda	0	1	Topsoil
Barouda	1	10.5	Basalt weathered
Barouda	10.5	21	Basalt massive
Barouda	21	25	Basalt weathered
Barouda	43.2	73	Sandstone Massive
Barouda	73	130.5	Shale Massive
Barouda	130.5	200	Sandstone Massive
Barpani	0	1.5	Topsoil
Barpani	1.5	8.4	Sandstone weathered

Barpani	8.4	64	Sandstone Massive
Barpani	64	66	Sandstone fractured
Barpani	66	200	Shale Massive
Basiya Bhansa	0	1	Topsoil
Basiya Bhansa	1	11	Basalt weathered
Basiya Bhansa	11	18	Basalt massive
Basiya Bhansa	18	27	Clay
Basiya Bhansa	72	57	Basalt massive
Basiya Bhansa	57	61	Clay
Basiya Bhansa	61	68	Basalt massive
Basiya Bhansa	68	72	Clay
Behrol EW	0	0.7	Sandstone weathered
Behrol EW	0.7	8	Sandstone weathered
Behrol EW	8	62.8	Sandstone Massive
Behrol EW	62.8	73	Sandstone fractured
Behrol EW	73	138	Sandstone Massive
Behrol EW	138	142	Shale Massive
Behrol EW	142	145	Shale Fractured
Behrol EW	145	200	Shale Massive
Belai	0	3	Topsoil
Belai	3	18.3	Clay
Belai	18.3	53.4	Basalt massive
Belai	53.4	56.4	Basalt fractured
Belai	56.4	84	Shale Massive
Belai	84	136	Shale Massive
Belai	136	200	Shale Massive
Belehara	0	2.82	Topsoil
Belehara	2.82	50.86	Basalt massive
Belehara	50.86	56.51	Clay
Belehara	56.51	67.81	Basalt vesicular
Belehara	67.81	79.11	Basalt massive
Belehara	79.11	90.4	Clay
Belehara	90.4	92.8	Basalt fractured
Belehara	92.8	108	Basalt vesicular
Belehara	108	141.25	Basalt massive
Belehara	141.25	152.55	Clay
Belehara	152.55	163	Sandstone Massive
Bhaisa Pahari	0.00	1.5	Topsoil
Bhaisa Pahari	1.50	13.00	Basalt weathered
Bhaisa Pahari	13.00	18.25	Clay
Bhaisa Pahari	18.25	47.25	Basalt massive
Bhaisa Pahari	47.25	52.50	Basalt vesicular
Bhaisa Pahari	52.50	84.00	Basalt fractured
Bhaisa Pahari	84.00	94.50	Clay
Bhaisa Pahari	94.50	152.50	Basalt massive
Bhaisa Pahari	152.50	157.00	Clay
Bhaisa Pahari	157.00	165.00	Sandstone Massive

Bhapel	0.00	1.20	Topsoil
Bhapel	1.2	11	Sandstone weathered
Bhapel	11	17	Sandstone Massive
Bhapel	17	20	Sandstone fractured
Bhapel	20	68	Shale Massive
Bhapel	68	136	Sandstone Massive
Bhapel	136	160	Shale Massive
Bhapel	160	200	Sandstone Massive
Bharcha	0.00	5.25	Topsoil
Bharcha	5.25	10.50	Clay
Bharcha	10.50	18.25	Sandstone weathered
Bharcha	18.25	65.50	Sandstone Massive
Bharcha	65.50	103.00	Shale Massive
Bina (Deep)	0.00	1.95	Topsoil
Bina (Deep)	1.95	10.10	Clay
Bina (Deep)	10.10	18.75	Basalt weathered
Bina (Deep)	18.75	27.90	Basalt massive
Bina (Deep)	27.90	30.95	Basalt massive
Bina (Deep)	30.95	37.05	Basalt vesicular
Bina (Deep)	37.05	46.20	Basalt massive
Bina (Deep)	46.20	58.40	Basalt vesicular
Bina (Deep)	58.40	64.50	Sandstone Massive
Bina (Deep)	64.50	70.60	Sandstone Massive
Bina (Deep)	70.60	76.70	Sandstone Massive
Binaji	0	1	Topsoil
Binaji	1	65.5	Shale Massive
Binaji	65.5	70	Sandstone fractured
Binaji	70	92	Shale Massive
Binaka	0	6	Basalt weathered
Binaka	6	35	Basalt massive
Binaka	35	174	Sandstone Massive
Binaka	174	200	Shale Massive
Dalpathpur	0	1.2	Topsoil
Dalpathpur	1.2	9	Basalt weathered
Dalpathpur	9	12	Basalt massive
Dalpathpur	12	15	Clay
Dalpathpur	15	24	Basalt vesicular
Dalpathpur	24	48	Basalt massive
Dalpathpur	48	72	Sandstone Massive
Dalpathpur	72	200	Shale Massive
Deori	0	4.9	Clay
Deori	4.9	11	Basalt weathered
Deori	11	26.2	Basalt massive
Deori	26.2	47.6	Sandstone Massive
Deori	47.6	56.7	Shale Massive
Deori	56.7	68.9	Sandstone Massive
Deori	68.9	135	Shale Massive

Dhana	0	1.9	Topsoil
Dhana	1.9	11	Basalt weathered
Dhana	11	14	Clay
Dhana	14	53	Basalt massive
Dhana	53	60	Basalt vesicular
Dhana	60	169	Sandstone Massive
Dhana	169	203	Shale Massive
Dungasara	0	0.5	Topsoil
Dungasara	0.5	6	Sandstone weathered
Dungasara	6	147	Sandstone Massive
Dungasara	147	145	Sandstone fractured
Dungasara	117	200	Shale Massive
Garhakota (Deep)	0.00	2.60	Topsoil
Garhakota (Deep)	2.60	6.60	Clay
Garhakota (Deep)	6.60	42.60	Limestone
Garhakota (Deep)	42.60	54.60	Sandstone fractured
Garhakota (Deep)	54.60	75.60	Limestone
Garhakota (Deep)	75.60	87.60	Sandstone Massive
Garhakota (Deep)	87.60	90.60	Sandstone fractured
Garhakota (Deep)	90.60	120.00	Sandstone Massive
Gaudana EW	0	3	Topsoil
Gaudana EW	3	15.3	Clay
Gaudana EW	15.3	59	Basalt massive
Gaudana EW	59	62	Sandstone fractured
Gharoli	0	3.28	Topsoil
Gharoli	3.28	7.5	Basalt weathered
Gharoli	7.5	12	Basalt massive
Gharoli	12	16.82	clay
Gharoli	16.82	19.87	Sandstone Massive
Gharoli	19.87	90.94	Shale Massive
Gharoli	90.94	101.14	Sandstone Massive
Gharoli	101.14	115.34	Shale Massive
Gharoli	11.34	122.49	Sandstone Massive
Ghatiyari EW	0	9	Basalt weathered
Ghatiyari EW	9	24	Basalt massive
Ghatiyari EW	24	30	Basalt vesicular
Ghatiyari EW	30	42	Basalt massive
Ghatiyari EW	42	105	Sandstone Massive
Gidwani	0	8.5	Basalt weathered
Gidwani	8.5	30.5	Basalt massive
Gidwani	30.5	36.4	Clay
Gidwani	36.4	69	Basalt massive
Gidwani	69	75	Sandstone fractured
Gidwani	75	173	Shale Massive
Gidwani	173	200	Sandstone Massive
Girwar	0	2	Topsoil
Girwar	2	63	Sandstone Massive

Girwar	63	119	Shale Massive
Girwar	119	127	Shale Fractured
Girwar	127	200	Sandstone Massive
Gopalpura	0	1	Topsoil
Gopalpura	1	15	Basalt weathered
Gopalpura	15	32.3	Basalt massive
Gopalpura	32.3	47.6	Basalt vesicular
Gopalpura	47.6	87.2	Basalt massive
Gopalpura	87.2	100	Sandstone Massive
Gopalpura	100	102	Sandstone fractured
Hiranchipa	0	3	Topsoil
Hiranchipa	3	17	Basalt weathered
Hiranchipa	17	28	Basalt vesicular
Hiranchipa	28	55	Basalt massive
Hiranchipa	55	111	Sandstone Massive
Hiranchipa	111	136	Sandstone Massive
Hiranchipa	136	200	Shale Massive
Ishurwada	0	2.82	Topsoil
Ishurwada	2.82	5.65	Basalt weathered
Ishurwada	5.65	25.43	Basalt massive
Ishurwada	25.43	59.33	Basalt vesicular
Ishurwada	59.33	64.98	Basalt massive
Ishurwada	64.98	67.81	Clay
Ishurwada	67.81	101	Sandstone Massive
Ishurwada	101	113	Shale Massive
Ishurwada	113	158.2	Sandstone Massive
Ishurwada	158.2	166.64	Shale Massive
Ishurwada	166.64	200	Sandstone Massive
Ishwarpur EW	0	11	Basalt weathered
Ishwarpur EW	11	20.1	Limestone
Ishwarpur EW	20.1	42.92	Sandstone Massive
Ishwarpur EW	42.92	48.86	Sandstone fractured
Ishwarpur EW	48.86	64.82	Shale Massive
Ishwarpur EW	64.82	70.36	Shale Fractured
Ishwarpur EW	70.36	180.7	Shale Massive
Jaithpur	0	11	Basalt weathered
Jaithpur	10	19	Limestone
Jaithpur	19	53	Sandstone Massive
Jaithpur	53	57	Shale Massive
Jaithpur	57	59	Shale Fractured
Jaithpur	59	200	Shale Massive
Kanadari	0	8.9	Basalt weathered
Kanadari	8.9	38.4	Basalt massive
Kanadari	38.4	41	Sandstone fractured
Kanadari	41	85	Sandstone Massive
Kanadari	85	136	Shale Massive
Kanadari	136	139	Shale Fractured

Kanadari	139	193	Shale Massive
Kanadari	193	196	Shale Fractured
Kanadari	196	200	Shale Massive
Kandwa	0	6	Sandstone weathered
Kandwa	6	12	Sandstone Massive
Kandwa	12	18	Shale Massive
Kandwa	18	26	Sandstone Massive
Kandwa	26	29	Sandstone fractured
Kandwa	29	200	Sandstone Massive
Kanjiya EW	0	6.1	Topsoil
Kanjiya EW	6.1	9	Clay
Kanjiya EW	9	41	Sandstone Massive
Kanjiya EW	41	44	Sandstone fractured
Kanjiya EW	44	63	Shale Massive
Kanjiya EW	63	75	Sandstone Massive
Kanjiya EW	75	78	Sandstone fractured
Kanjiya EW	78	63	Shale Massive
Kanjiya EW	63	105	Sandstone Massive
Kanjiya EW	105	111.6	Sandstone fractured
Karrapur	0	1.0	Topsoil
Karrapur	1	6	Basalt weathered
Karrapur	6	21	Basalt massive
Karrapur	21	142	Sandstone Massive
Karrapur	142	150	Shale Massive
Karrapur	150	200	Sandstone Massive
Khamkera	0	1	Topsoil
Khamkera	1	8	Basalt weathered
Khamkera	6	30	Basalt massive
Khamkera	30	33	Sandstone fractured
Khamkera	33	52	Sandstone Massive
Khamkera	33	157	Sandstone Massive
Khejara Buddu	0	2	Topsoil
Khejara Buddu	2	20	Basalt massive
Khejara Buddu	20	24	Clay
Khejara Buddu	24	40	Basalt vesicular
Khejara Buddu	40	105	Sandstone Massive
Khejara Buddu	105	203	Shale Massive
Khurai	0	6	Sandstone weathered
Khurai	6	26	Sandstone Massive
Khurai	26	29	Sandstone fractured
Khurai	29	57	Sandstone Massive
Khurai	57	200	Sandstone Massive
Khurai (Deep)	0.00	1.50	Topsoil
Khurai (Deep)	1.50	11.00	Clay
Khurai (Deep)	11.00	24.00	Basalt weathered
Khurai (Deep)	24.00	30.00	Sandstone fractured
Khurai (Deep)	30.00	40.00	Sandstone Massive

Khurai (Deep)	40.00	55.00	Sandstone fractured
Khurai (Deep)	55.00	75.00	Sandstone Massive
Kishanpura	0.00	1.00	Topsoil
Kishanpura	1	9	Basalt weathered
Kishanpura	9	18	Clay
Kishanpura	18	24	Basalt massive
Kishanpura	24	27	Clay
Kishanpura	27	39	Basalt vesicular
Kishanpura	39	42	Clay
Kishanpura	42	66	Basalt massive
Kishanpura	66	72	Clay
Kishanpura	72	90	Basalt massive
Kishanpura	90	147	Sandstone Massive
Kishanpura	147	200	Shale Massive
Maharajpur	0	11	Clay
Maharajpur	11	19	Limestone
Maharajpur	19	21	Sandstone fractured
Maharajpur	20.1	50.6	Sandstone Massive
Maharajpur	50.6	180.7	Shale Massive
Mainpani	0.00	15.25	Clay
Mainpani	15.25	21.00	Basalt massive
Mainpani	21.00	21.75	Clay
Mainpani	21.75	36.75	Basalt vesicular
Mainpani	36.75	44.50	Basalt fractured
Mainpani	44.50	47.25	Basalt weathered
Mainpani	47.25	55.00	Basalt vesicular
Mainpani	55.00	68.25	Basalt fractured
Mainpani	68.25	75.25	Basalt massive
Mainpani	75.25	77.25	Basalt weathered
Mainpani	77.25	81.25	Basalt vesicular
Mainpani	81.25	141.75	Sandstone Massive
Mainpani	141.75	200.00	Shale Massive
Mardanpur	0	1	Topsoil
Mardanpur	1	11	Basalt weathered
Mardanpur	11	39.56	Basalt massive
Mardanpur	39.56	45.21	Clay
Mardanpur	45.21	48.03	Basalt fractured
Mardanpur	48.03	62.16	Shale Massive
Mardanpur	62.16	84.75	Sandstone Massive
Mardanpur	84.75	113	Shale Massive
Mardanpur	113	200	Sandstone Massive
Mirkheri	0	1	Topsoil
Mirkheri	1	5	Basalt weathered
Mirkheri	5	7.4	clay
Mirkheri	7.4	18	Basalt massive
Mirkheri	18	20.65	Basalt vesicular
Mirkheri	20.65	28	Basalt massive

Mirkheri	28	31	Basalt fractured
Mirkheri	31	36.37	Basalt vesicular
Mirkheri	36.37	58	Basalt massive
Mirkheri	58	59	Basalt fractured
Mirkheri	59	81	Basalt massive
Mirkheri	81.83	84.88	clay
Mirkheri	84.88	122	Basalt massive
Mirkheri	122	124.53	clay
Mirkheri	124.53	158.58	Basalt massive
Mirkheri	158.58	161.23	clay
Mirkheri	161.23	170	Basalt massive
Mirkheri	170	171.33	Sandstone fractured
Nirtala	0	2	Topsoil
Nirtala	2	8.3	Basalt weathered
Nirtala	8.3	18.92	Basalt massive
Nirtala	18.92	19.92	clay
Nirtala	19.92	42	Basalt massive
Nirtala	42	42.5	Basalt fractured
Nirtala	42	52	Basalt massive
Nirtala	52	53	Sandstone fractured
Nirtala	53	88.88	Sandstone Massive
PamakheriEW	0	2	Topsoil
PamakheriEW	3	8	Basalt weathered
PamakheriEW	8	18	Basalt massive
PamakheriEW	18	21	Clay
PamakheriEW	21	30	Basalt vesicular
PamakheriEW	30	33	Clay
PamakheriEW	33	78	Basalt massive
PamakheriEW	78	87	Sandstone Massive
PamakheriEW	87	163	Shale Massive
PamakheriEW	163	165	Sandstone fractured
PamakheriEW	165	187	Sandstone Massive
PamakheriEW	187	190	Sandstone fractured
PamakheriEW	190	200	Sandstone Massive
Patha	0	1	Topsoil
Patha	1	6	Basalt weathered
Patha	6	60.5	Basalt massive
Patha	60.5	72	Basalt fractured
Patha	72	97	Sandstone Massive
Patha	97	120	Shale Massive
Patha	120	200	Sandstone Massive
Pathariya Hat	0	5.1	Basalt weathered
Pathariya Hat	5.1	27	Basalt massive
Pathariya Hat	27	30	Clay
Pathariya Hat	30	48	Basalt vesicular
Pathariya Hat	48	63	Basalt massive
Pathariya Hat	63	72	Basalt vesicular

Pathariya Hat	72	78	Sandstone Massive
Pathariya Hat	78	120	Shale Massive
Patna Bujurg	0	3	Topsoil
Patna Bujurg	3	25	Basalt massive
Patna Bujurg	25	30	Clay
Patna Bujurg	30	53	Basalt massive
Patna Bujurg	53	62	Sandstone fractured
Patna Bujurg	62	99	Sandstone Massive
Patna Bujurg	99	105	Sandstone fractured
Rahatgarh	0	1	Topsoil
Rahatgarh	0	14	Basalt massive
Rahatgarh	14	18	Clay
Rahatgarh	18	23	Basalt vesicular
Rahatgarh	23	200	Shale Massive
Ranguwan	0	3	Topsoil
Ranguwan	3	32.5	Shale Massive
Ranguwan	32.5	35	Sandstone Massive
Ranguwan	35	45	Sandstone fractured
Ranguwan	45	93.5	Shale Massive
Ranguwan	93.5	123.4	Sandstone Massive
Rasena	0	5	Basalt weathered
Rasena	5	29.3	Basalt massive
Rasena	29.3	44.5	Basalt vesicular
Rasena	44.5	65.9	Sandstone Massive
Rasena	65.9	136	Shale Massive
Sabda	0	3.6	Topsoil
Sabda	3.6	11.04	clay
Sabda	11.04	13.83	Basalt weathered
Sabda	13.83	20.98	Basalt massive
Sabda	20.98	23.75	Clay
Sabda	23.75	40.28	Basalt vesicular
Sabda	40.28	43.33	clay
Sabda	43.33	54.2	Basalt massive
Sabda	54.2	85.94	Sandstone Massive
Sagar civillineEW	0	4	Topsoil
Sagar civillineEW	4	10.1	Basalt weathered
Sagar civillineEW	10.1	19.3	Clay
Sagar civillineEW	19.3	37.6	Basalt massive
Sagar civillineEW	37.6	43.7	Basalt fractured
Sagar civillineEW	43.7	62	Basalt massive
Sagar civillineEW	62	65	Clay
Sagar civillineEW	65	92.5	Basalt massive
Sagar civillineEW	92.5	95.6	Clay
Sagar civillineEW	95.6	147.5	Basalt massive
Sagar civillineEW	147.2	148.2	Sandstone fractured
Sagar civillineEW	148.2	202.3	Sandstone Massive
Sagar Town	0	0.3	Topsoil

Sagar Town	0.3	6	Basalt weathered
Sagar Town	6	99	Sandstone Massive
Sagar Town	99	102	Shale Massive
Sagar Town	102	111.8	Sandstone Massive
Sagar (Deep)	0.00	1.50	Topsoil
Sagar (Deep)	1.50	6.00	Basalt weathered
Sagar (Deep)	6.00	34.00	Basalt massive
Sagar (Deep)	34.00	37.00	Clay
Sagar (Deep)	37.00	49.00	Basalt vesicular
Sagar (Deep)	49.00	85.00	Basalt vesicular
Sagar (Deep)	85.00	98.00	Basalt massive
Samanapur	0	1	Topsoil
Samanapur	1	25	Basalt massive
Samanapur	25	28.26	Clay
Samanapur	28.26	56.51	Basalt massive
Samanapur	56.51	70.63	Basalt vesicular
Samanapur	70.63	81.93	Basalt massive
Samanapur	81.93	115.82	Sandstone Massive
Samanapur	115.82	200	Shale Massive
Sandi	0	1	Topsoil
Sandi	1	7.5	Basalt weathered
Sandi	7.5	27	Basalt massive
Sandi	27	32	Basalt vesicular
Sandi	32	78	Basalt massive
Sandi	78	82	Sandstone Massive
Sehora	0	1	Topsoil
Sehora	1	8.5	Basalt weathered
Sehora	8.50	21.00	Basalt massive
Sehora	21.00	26.25	Clay
Sehora	26.25	42.00	Basalt fractured
Sehora	42.00	43.00	Clay
Sehora	43.00	68.25	Sandstone Massive
Sehora	68.25	103.00	Sandstone Massive
Sehora	0.00	2.50	Topsoil
Sehora	2.50	10.50	Basalt weathered
Sehora	10.50	15.75	Basalt massive
Sehora	15.75	40.75	Sandstone Massive
Sehora	40.75	55.00	Sandstone Massive
Sehora	55.00	78.75	Shale Massive
Sehora	78.75	130.00	Sandstone Massive
Sehora	130.00	160.00	Sandstone Massive
Siloda EW	0	9	Clay
Siloda EW	9	18	Basalt massive
Siloda EW	18	21	Clay
Siloda EW	21	30	Basalt vesicular
Siloda EW	30	53	Basalt massive
Siloda EW	53	56	Basalt fractured

Siloda EW	56	102	Basalt massive
Siloda EW	102	119	Basalt vesicular
Siloda EW	119	147	Sandstone Massive
Sironja	0	0.4	Topsoil
Sironja	0.4	6	Basalt weathered
Sironja	6	9	Clay
Sironja	9	106	Basalt massive
Sironja	106	115	Sandstone fractured
Sironja	115	200	Shale Massive
Tilabujurg	0	2.82	Topsoil
Tilabujurg	2.82	8.47	Basalt weathered
Tilabujurg	8.47	11.3	Clay
Tilabujurg	11.3	28.26	Basalt massive
Tilabujurg	28.26	45.21	Basalt vesicular
Tilabujurg	45.21	90.4	Basalt massive
Tilabujurg	90.4	93.22	Basalt vesicular
Tilabujurg	93.22	96.05	Shale Massive
Tilabujurg	96.05	107.35	Sandstone Massive
Tilabujurg	107.35	119	Shale Fractured
Tilabujurg	107.35	163	Shale Massive
Tilabujurg	163	164	Sandstone fractured
Tilabujurg	164	200	Sandstone Massive
Tilli (Shivajii Ward)	0	1	Topsoil
Tilli (Shivajii Ward)	0.00	5.25	Clay
Tilli (Shivajii Ward)	5.25	10.50	Basalt weathered
Tilli (Shivajii Ward)	10.50	29.25	Basalt vesicular
Tilli (Shivajii Ward)	29.25	49.00	Basalt massive
Tilli (Shivajii Ward)	49.00	52.00	Clay
Tilli (Shivajii Ward)	52.00	55.00	Basalt fractured
Tilli (Shivajii Ward)	55.00	91.75	Basalt massive
Tilli (Shivajii Ward)	91.75	100.00	Clay
Tilli (Shivajii Ward)	100.00	147.00	Sandstone Massive
Tilli (Shivajii Ward)	147.00	200.00	Shale Massive
Titarpani	0.00	0.30	Topsoil
Titarpani	0.3	3	Sandstone weathered
Titarpani	3	10	Sandstone Massive
Titarpani	10	11	Sandstone fractured
Titarpani	11	200	Shale Massive

Bore	Date	Depth1	Depth2	Aquifer
Agasod		0	8.3	UnSaturated Zone
Agasod		8.3	12	Basalt massive
Agasod		12	15	Aquifer I
Agasod		15	28	Basalt massive
Agasod		28	32	Limestone

Agasod		32	34	Sandstone Massive
Agasod		34	200	Shale Massive
Anathpura		0	14.5	UnSaturated Zone
Anathpura		14.5	17	Basalt massive
Anathpura		17	32	Limestone
Anathpura		32	50.6	Sandstone Massive
Anathpura		50.6	200	Shale Massive
Bamori Bika		0.00	13.00	UnSaturated Zone
Bamori Bika		13.00	15.75	Aquifer I
Bamori Bika		15.75	89.25	Basalt massive
Bamori Bika		89.25	99.75	Aquifer II
Bamori Bika		99.75	110.25	Shale Massive
Bamori Bika		110.25	200.00	Sandstone Massive
Bansa		0	12.3	UnSaturated Zone
Bansa		12.3	33.91	Basalt massive
Bansa		33.91	39.5	Clay
Bansa		39.5	50.86	Basalt vesicular
Bansa		50.86	62.16	Basalt massive
Bansa		62.16	73.46	Aquifer II
Bansa		73.46	98.87	Basalt massive
Bansa		98.87	107.35	Sandstone Massive
Bansa		107.35	112.1	Shale Massive
Bansa		112.1	118.65	Sandstone Massive
Bansa		118.65	135	Shale Massive
Bansa		135	137	Aquifer II
Bansa		137	189	Shale Massive
Bansa		189	192	Aquifer II
Bansa		192	200	Shale Massive
Baraha		0	21.1	UnSaturated Zone
Baraha		21.1	201.1	Shale Massive
Barodia Kala		0.00	9.5	UnSaturated Zone
Barodia Kala		9.50	31.50	Basalt massive
Barodia Kala		31.50	54.00	Sandstone Massive
Barodia Kala		54.00	57.75	Aquifer II
Barodia Kala		57.75	91.75	Sandstone Massive
Barodia Kala		91.75	112.75	Shale Massive
Barodia Kala		112.75	126.00	Aquifer II
Barouda		0	21	UnSaturated Zone
Barouda		21	25	Aquifer I
Barouda		43.2	73	Sandstone Massive

Barouda		73	130.5	Shale Massive
Barouda		130.5	200	Sandstone Massive
Barpani		0	15.4	UnSaturated Zone
Barpani		15.4	64	Sandstone Massive
Barpani		64	66	Aquifer II
Barpani		66	200	Shale Massive
Basiya Bhansa		0	31.2	UnSaturated Zone
Basiya Bhansa		31.2	57	Basalt massive
Basiya Bhansa		57	61	Clay
Basiya Bhansa		61	68	Basalt massive
Basiya Bhansa		68	72	Clay
Behrol EW		0	15.4	UnSaturated Zone
Behrol EW		15.4	62.8	Sandstone Massive
Behrol EW		62.8	73	Aquifer II
Behrol EW		73	138	Sandstone Massive
Behrol EW		138	142	Shale Massive
Behrol EW		142	145	Aquifer II
Behrol EW		145	200	Shale Massive
Belai		0	7.2	UnSaturated Zone
Belai		7.2	53.4	Basalt massive
Belai		53.4	56.4	Aquifer II
Belai		56.4	84	Shale Massive
Belai		84	136	Shale Massive
Belai		136	200	Shale Massive
Belehara		0	23.1	UnSaturated Zone
Belehara		23.1	56.51	Clay
Belehara		56.51	67.81	Aquifer II
Belehara		67.81	79.11	Basalt massive
Belehara		79.11	90.4	Clay
Belehara		90.4	92.8	Aquifer II
Belehara		92.8	108	Basalt vesicular
Belehara		108	141.25	Basalt massive
Belehara		141.25	152.55	Clay
Belehara		152.55	163	Sandstone Massive
Bhaisa Pahari		0.00	18.25	UnSaturated Zone
Bhaisa Pahari		18.25	47.25	Basalt massive
Bhaisa Pahari		47.25	52.50	Aquifer II
Bhaisa Pahari		52.50	84.00	Basalt vesicular
Bhaisa Pahari		84.00	94.50	Clay
Bhaisa Pahari		94.50	152.50	Basalt massive

Bhaisa Pahari		152.50	157.00	Clay
Bhaisa Pahari		157.00	165.00	Sandstone Massive
Bhapel		0	13.64	UnSaturated Zone
Bhapel		11	17	Sandstone Massive
Bhapel		17	20	Aquifer I
Bhapel		20	68	Shale Massive
Bhapel		68	136	Sandstone Massive
Bhapel		136	160	Shale Massive
Bhapel		160	200	Sandstone Massive
Bharcha		0.00	10.50	UnSaturated Zone
Bharcha		10.50	18.25	Aquifer I
Bharcha		18.25	65.50	Sandstone Massive
Bharcha		65.50	103.00	Shale Massive
Bina (Deep)		0.00	10.10	UnSaturated Zone
Bina (Deep)		10.10	18.75	Aquifer I
Bina (Deep)		18.75	27.90	Basalt massive
Bina (Deep)		27.90	30.95	Basalt massive
Bina (Deep)		30.95	37.05	Aquifer II
Bina (Deep)		37.05	46.20	Basalt massive
Bina (Deep)		46.20	58.40	Aquifer II
Bina (Deep)		58.40	64.50	Sandstone Massive
Bina (Deep)		64.50	70.60	Sandstone Massive
Bina (Deep)		70.60	76.70	Sandstone Massive
Binaji		0	21	UnSaturated Zone
Binaji		21	65.5	Shale Massive
Binaji		65.5	70	Aquifer II
Binaji		70	92	Shale Massive
Binaka		0	15.8	UnSaturated Zone
Binaka		15.8	35	Basalt massive
Binaka		35	174	Sandstone Massive
Binaka		174	200	Shale Massive
Dalpathpur		0	6.3	UnSaturated Zone
Dalpathpur		6.3	15	Clay
Dalpathpur		15	24	Aquifer I
Dalpathpur		24	48	Basalt massive
Dalpathpur		48	72	Sandstone Massive
Dalpathpur		72	200	Shale Massive
Deori		0	6	UnSaturated Zone
Deori		6	11	Aquifer I
Deori		11	26.2	Basalt massive

Deori		26.2	47.6	Sandstone Massive
Deori		47.6	56.7	Shale Massive
Deori		56.7	68.9	Sandstone Massive
Deori		68.9	135	Shale Massive
Dhana		0	14	UnSaturated Zone
Dhana		14	53	Basalt massive
Dhana		53	60	Aquifer II
Dhana		60	169	Sandstone Massive
Dhana		169	203	Shale Massive
Dungasara		0	22.4	UnSaturated Zone
Dungasara		22.4	147	Sandstone Massive
Dungasara		147	145	Aquifer II
Dungasara		117	200	Shale Massive
Garhakota (Deep)		0.00	11.60	UnSaturated Zone
Garhakota (Deep)		11.60	42.60	Limestone
Garhakota (Deep)		42.60	54.60	Aquifer II
Garhakota (Deep)		54.60	75.60	Limestone
Garhakota (Deep)		75.60	87.60	Sandstone Massive
Garhakota (Deep)		87.60	90.60	Aquifer II
Garhakota (Deep)		90.60	120.00	Sandstone Massive
Gaudana EW		0	7.3	UnSaturated Zone
Gaudana EW		7.3	15.3	Clay
Gaudana EW		15.3	59	Basalt massive
Gaudana EW		59	62	Aquifer II
Gharoli		0	7.5	UnSaturated Zone
Gharoli		7.5	12	Basalt massive
Gharoli		12	16.82	clay
Gharoli		16.82	19.87	Sandstone Massive
Gharoli		19.87	90.94	Shale Massive
Gharoli		90.94	101.14	Sandstone Massive
Gharoli		101.14	115.34	Shale Massive
Gharoli		11.34	122.49	Sandstone Massive
Ghatiyari EW		0	5	UnSaturated Zone
Ghatiyari EW		5	24	Basalt massive
Ghatiyari EW		24	30	Aquifer I
Ghatiyari EW		30	42	Basalt massive

Ghatiyari EW		42	105	Sandstone Massive
Gidwani		0	14.5	UnSaturated Zone
Gidwani		14.5	30.5	Basalt massive
Gidwani		30.5	36.4	Clay
Gidwani		36.4	69	Basalt massive
Gidwani		69	75	AquiferII
Gidwani		75	173	Shale Massive
Gidwani		173	200	Sandstone Massive
Girwar		0	36	UnSaturated Zone
Girwar		36	63	Sandstone Massive
Girwar		63	119	Shale Massive
Girwar		119	127	Aquifer II
Girwar		127	200	Sandstone Massive
Gopalpura		0	15	UnSaturated Zone
Gopalpura		15	32.3	Basalt massive
Gopalpura		32.3	47.6	Basalt vesicular
Gopalpura		47.6	87.2	Basalt massive
Gopalpura		87.2	100	Sandstone Massive
Gopalpura		100	102	Aquifer II
Hiranchipa		0	10.2	UnSaturated Zone
Hiranchipa		10.2	28	Aquifer II
Hiranchipa		28	55	Basalt massive
Hiranchipa		55	111	Sandstone Massive
Hiranchipa		111	136	Sandstone Massive
Hiranchipa		136	200	Shale Massive
Ishurwada		0	13.5	UnSaturated Zone
Ishurwada		5.65	25.43	Basalt massive
Ishurwada		25.43	59.33	Basalt vesicular
Ishurwada		59.33	64.98	Basalt massive
Ishurwada		64.98	67.81	Clay
Ishurwada		67.81	101	Sandstone Massive
Ishurwada		101	113	Shale Massive
Ishurwada		113	158.2	Sandstone Massive
Ishurwada		158.2	166.64	Shale Massive
Ishurwada		166.64	200	Sandstone Massive
Ishwarpur EW		0	11	UnSaturated Zone
Ishwarpur EW		11	20.1	Limestone
Ishwarpur EW		20.1	42.92	Sandstone Massive
Ishwarpur EW		42.92	48.86	Aquifer II
Ishwarpur EW		48.86	64.82	Shale Massive

Ishwarpur EW		64.82	70.36	Aquifer II
Ishwarpur EW		70.36	180.7	Shale Massive
Jaithpur		0	12.6	UnSaturated Zone
Jaithpur		12.6	19	Limestone
Jaithpur		19	53	Sandstone Massive
Jaithpur		53	57	Shale Massive
Jaithpur		57	59	Aquifer II
Jaithpur		59	200	Shale Massive
Kanadari		0	24	UnSaturated Zone
Kanadari		24	38.4	Basalt massive
Kanadari		38.4	41	Aquifer II
Kanadari		41	85	Sandstone Massive
Kanadari		85	136	Shale Massive
Kanadari		136	139	Aquifer II
Kanadari		139	193	Shale Massive
Kanadari		193	196	Aquifer II
Kanadari		196	200	Shale Massive
Kandwa		0	13.6	UnSaturated Zone
Kandwa		13.6	18	Shale Massive
Kandwa		18	26	Sandstone Massive
Kandwa		26	29	Aquifer II
Kandwa		29	200	Sandstone Massive
Kanjiya EW		0	15.6	UnSaturated Zone
Kanjiya EW		15.6	41	Sandstone Massive
Kanjiya EW		41	44	Aquifer II
Kanjiya EW		44	63	Shale Massive
Kanjiya EW		63	75	Sandstone Massive
Kanjiya EW		75	78	Aquifer II
Kanjiya EW		78	63	Shale Massive
Kanjiya EW		63	105	Sandstone Massive
Kanjiya EW		105	111.6	Aquifer II
Karrapur		0	1.0	Topsoil
Karrapur		1	6	UnSaturated Zone
Karrapur		6	21	Basalt massive
Karrapur		21	142	Sandstone Massive
Karrapur		142	150	Shale Massive
Karrapur		150	200	Sandstone Massive
Khamkera		0	6	UnSaturated Zone
Khamkera		6	30	Basalt massive
Khamkera		30	33	Aquifer II

Khamkera		33	52	Sandstone Massive
Khamkera		33	157	Sandstone Massive
Khejara Buddu		0	19	UnSaturated Zone
Khejara Buddu		19	20	Basalt massive
Khejara Buddu		20	24	Clay
Khejara Buddu		24	40	Basalt vesicular
Khejara Buddu		40	105	Sandstone Massive
Khejara Buddu		105	203	Shale Massive
Khurai		0	16.8	UnSaturated Zone
Khurai		16.8	26	Sandstone Massive
Khurai		26	29	AQUIFER I
Khurai		29	57	Sandstone Massive
Khurai		57	200	Sandstone Massive
Khurai (Deep)		0.00	13.50	UnSaturated Zone
Khurai (Deep)		13.50	30.00	AQUIFER I
Khurai (Deep)		30.00	40.00	Sandstone Massive
Khurai (Deep)		40.00	55.00	Aquifer II
Khurai (Deep)		55.00	75.00	Sandstone Massive
Kishanpura		0.00	18.00	UnSaturated Zone
Kishanpura		18	24	Basalt massive
Kishanpura		24	27	Clay
Kishanpura		27	39	Basalt vesicular
Kishanpura		39	42	Clay
Kishanpura		42	66	Basalt massive
Kishanpura		66	72	Clay
Kishanpura		72	90	Basalt massive
Kishanpura		90	147	Sandstone Massive
Kishanpura		147	200	Shale Massive
Maharajpur		0	6.1	UnSaturated Zone
Maharajpur		6.1	19	Limestone
Maharajpur		19	21	AQUIFER I
Maharajpur		20.1	50.6	Sandstone Massive
Maharajpur		50.6	180.7	Shale Massive
Mainpani		0.00	15.25	UnSaturated Zone
Mainpani		15.25	21.00	Basalt massive
Mainpani		21.00	21.75	Clay
Mainpani		21.75	36.75	Basalt vesicular
Mainpani		36.75	44.50	Aquifer II
Mainpani		44.50	47.25	Basalt massive
Mainpani		47.25	55.00	Basalt vesicular

Mainpani		55.00	68.25	Aquifer II
Mainpani		68.25	75.25	Basalt massive
Mainpani		75.25	77.25	Aquifer II
Mainpani		77.25	81.25	Basalt vesicular
Mainpani		81.25	141.75	Sandstone Massive
Mainpani		141.75	200.00	Shale Massive
Mardanpur		0	21.35	UnSaturated Zone
Mardanpur		21.35	39.56	Basalt massive
Mardanpur		39.56	45.21	Clay
Mardanpur		45.21	48.03	Basalt massive
Mardanpur		48.03	62.16	Shale Massive
Mardanpur		62.16	84.75	Sandstone Massive
Mardanpur		84.75	113	Shale Massive
Mardanpur		113	200	Sandstone Massive
Mirkheri		0	5	UnSaturated Zone
Mirkheri		5	7.4	clay
Mirkheri		7.4	18	Basalt massive
Mirkheri		18	20.65	AQUIFER I
Mirkheri		20.65	28	Basalt massive
Mirkheri		28	31	Aquifer II
Mirkheri		31	36.37	Basalt vesicular
Mirkheri		36.37	58	Basalt massive
Mirkheri		58	59	Aquifer II
Mirkheri		59	81	Basalt massive
Mirkheri		81.83	84.88	clay
Mirkheri		84.88	122	Basalt massive
Mirkheri		122	124.53	clay
Mirkheri		124.53	158.58	Basalt massive
Mirkheri		158.58	161.23	clay
Mirkheri		161.23	170	Basalt massive
Mirkheri		170	171.33	Aquifer II
Nirtala		0	4.6	UnSaturated Zone
Nirtala		4.6	8.3	AQUIFER I
Nirtala		8.3	18.92	Basalt massive
Nirtala		18.92	19.92	clay
Nirtala		19.92	42	Basalt massive
Nirtala		42	42.5	Aquifer II
Nirtala		42	52	Basalt massive
Nirtala		52	53	Aquifer II
Nirtala		53	88.88	Sandstone Massive

PamakheriEW		0	18	UnSaturated Zone
PamakheriEW		18	21	Clay
PamakheriEW		21	30	Basalt vesicular
PamakheriEW		30	33	Clay
PamakheriEW		33	78	Basalt massive
PamakheriEW		78	87	Sandstone Massive
PamakheriEW		87	163	Shale Massive
PamakheriEW		163	165	Aquifer II
PamakheriEW		165	187	Sandstone Massive
PamakheriEW		187	190	Aquifer II
PamakheriEW		190	200	Sandstone Massive
Patha		0	21.3	UnSaturated Zone
Patha		21.3	60.5	Basalt massive
Patha		60.5	72	Aquifer II
Patha		72	97	Sandstone Massive
Patha		97	120	Shale Massive
Patha		120	200	Sandstone Massive
Pathariya Hat		0	15.8	UnSaturated Zone
Pathariya Hat		15.8	27	Basalt massive
Pathariya Hat		27	30	Clay
Pathariya Hat		30	48	Basalt vesicular
Pathariya Hat		48	63	Basalt massive
Pathariya Hat		63	72	Basalt vesicular
Pathariya Hat		72	78	Aquifer II
Pathariya Hat		78	120	Shale Massive
Patna Bujurg		0	15	UnSaturated Zone
Patna Bujurg		15	25	Basalt massive
Patna Bujurg		25	30	Clay
Patna Bujurg		30	53	Basalt massive
Patna Bujurg		53	62	Aquifer II
Patna Bujurg		62	99	Sandstone Massive
Patna Bujurg		99	105	Aquifer II
Rahatgarh		0	12.65	UnSaturated Zone
Rahatgarh		0	14	Basalt massive
Rahatgarh		14	18	Clay
Rahatgarh		18	23	AQUIFER I
Rahatgarh		23	200	Shale Massive
Ranguwan		0	3	UnSaturated Zone
Ranguwan		3	32.5	Shale Massive
Ranguwan		32.5	35	Sandstone Massive

Ranguwan		35	45	Aquifer II
Ranguwan		45	93.5	Shale Massive
Ranguwan		93.5	123.4	Sandstone Massive
Rasena		0	5	UnSaturated Zone
Rasena		5	29.3	Basalt massive
Rasena		29.3	44.5	Aquifer II
Rasena		44.5	65.9	Sandstone Massive
Rasena		65.9	136	Shale Massive
Sabda		0	8.1	UnSaturated Zone
Sabda		8.1	11.04	clay
Sabda		11.04	13.83	Aquifer I
Sabda		13.83	20.98	Basalt massive
Sabda		20.98	23.75	Clay
Sabda		23.75	40.28	Basalt vesicular
Sabda		40.28	43.33	clay
Sabda		43.33	54.2	Basalt massive
Sabda		54.2	85.94	Sandstone Massive
Sagar civillineEW		0	4	UnSaturated Zone
Sagar civillineEW		4	10.1	Basalt weathered
Sagar civillineEW		10.1	19.3	Clay
Sagar civillineEW		19.3	37.6	Basalt massive
Sagar civillineEW		37.6	43.7	Aquifer II
Sagar civillineEW		43.7	62	Basalt massive
Sagar civillineEW		62	65	Clay
Sagar civillineEW		65	92.5	Basalt massive
Sagar civillineEW		92.5	95.6	Clay
Sagar civillineEW		95.6	147.5	Basalt massive
Sagar civillineEW		147.2	148.2	Aquifer II
Sagar civillineEW		148.2	202.3	Sandstone Massive
Sagar Town		0	6	UnSaturated Zone
Sagar Town		6	99	Sandstone Massive
Sagar Town		99	102	Shale Massive

Sagar Town		102	111.8	Sandstone Massive
Sagar (Deep)		0.00	21.00	UnSaturated Zone
Sagar (Deep)		21.00	34.00	Basalt massive
Sagar (Deep)		34.00	37.00	Clay
Sagar (Deep)		37.00	49.00	Basalt vesicular
Sagar (Deep)		49.00	85.00	Basalt massive
Sagar (Deep)		85.00	98.00	Basalt massive
Samanapur		0	17.62	UnSaturated Zone
Samanapur		1	25	Basalt massive
Samanapur		25	28.26	Clay
Samanapur		28.26	56.51	Basalt massive
Samanapur		56.51	70.63	Basalt vesicular
Samanapur		70.63	81.93	Basalt massive
Samanapur		81.93	115.82	Sandstone Massive
Samanapur		115.82	200	Shale Massive
Sandi		0	18.2	UnSaturated Zone
Sandi		18.2	27	Basalt massive
Sandi		27	32	Aquifer II
Sandi		32	78	Basalt massive
Sandi		78	82	Sandstone Massive
Sehora		0	1	UnSaturated Zone
Sehora		1	26.25	Basalt weathered
Sehora		26.25	42.00	Aquifer II
Sehora		42.00	43.00	Clay
Sehora		43.00	68.25	Sandstone Massive
Sehora		68.25	103.00	Sandstone Massive
Sehora		0.00	4.48	UnSaturated Zone
Sehora		4.48	10.50	Basalt weathered
Sehora		10.50	15.75	Basalt massive
Sehora		15.75	40.75	Sandstone Massive
Sehora		40.75	55.00	Sandstone Massive
Sehora		55.00	78.75	Shale Massive
Sehora		78.75	130.00	Sandstone Massive
Sehora		130.00	160.00	Sandstone Massive
Siloda EW		0	14.5	UnSaturated Zone
Siloda EW		14.5	18	Basalt massive
Siloda EW		18	21	Clay
Siloda EW		21	30	AQUIFER I
Siloda EW		30	53	Basalt massive
Siloda EW		53	56	Aquifer II

Siloda EW		56	102	Basalt massive
Siloda EW		102	119	Basalt vesicular
Siloda EW		119	147	Sandstone Massive
Sironja		0	9	UnSaturated Zone
Sironja		9	106	Basalt massive
Sironja		106	115	Aquifer II
Sironja		115	200	Shale Massive
Tilabujurg		0	111.3	UnSaturated Zone
Tilabujurg		11.3	28.26	Basalt massive
Tilabujurg		28.26	45.21	Basalt vesicular
Tilabujurg		45.21	90.4	Basalt massive
Tilabujurg		90.4	93.22	Aquifer II
Tilabujurg		93.22	96.05	Shale Massive
Tilabujurg		96.05	107.35	Sandstone Massive
Tilabujurg		107.35	119	Aquifer II
Tilabujurg		107.35	163	Shale Massive
Tilabujurg		163	164	Aquifer II
Tilabujurg		164	200	Sandstone Massive
Tilli (Shivajii Ward)		0	10.5	UnSaturated Zone
Tilli (Shivajii Ward)		10.50	29.25	AQUIFER I
Tilli (Shivajii Ward)		29.25	49.00	Basalt massive
Tilli (Shivajii Ward)		49.00	52.00	Clay
Tilli (Shivajii Ward)		52.00	55.00	Aquifer II
Tilli (Shivajii Ward)		55.00	91.75	Basalt massive
Tilli (Shivajii Ward)		91.75	100.00	Clay
Tilli (Shivajii Ward)		100.00	147.00	Sandstone Massive
Tilli (Shivajii Ward)		147.00	200.00	Shale Massive
Titarpani		0.00	10.00	UnSaturated Zone
Titarpani		10	11	AQUIFER I
Titarpani		11	200	Shale Massive