Draft Report

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

Report

on

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLAN

Chopda, Raver & Yaval Talukas

Jalgaon District, Maharashtra

(Part-I)

मध्य क्षेत्र, नागपुर

Central Region, Nagpur

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PART -I

भारत सरकार

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जल संसाधन, नदी विकास एवं गंगा संरक्षण मंत्रालय

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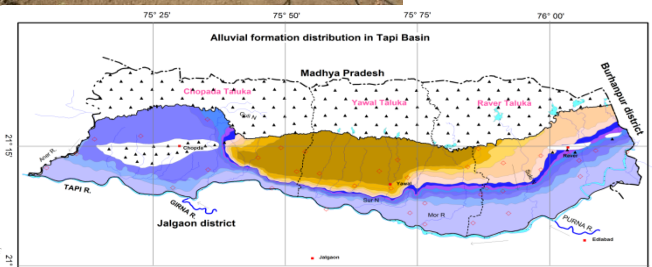
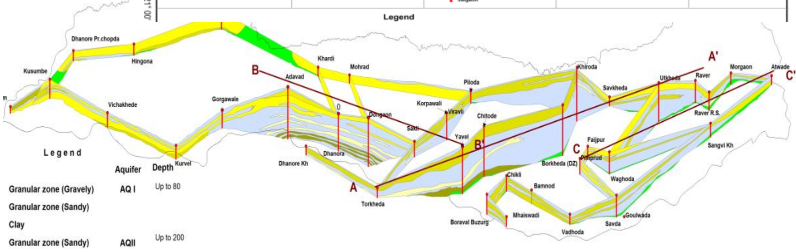
CENTRAL GROUND WATER BOARD

जल बचत जल संचय

Aquifer Maps and Ground Water Management Plan





CHOPDA, RAVER & YAVAL Talukas, **JALGAON** District, Maharashtra

चोपड़ा, रावेर तथा यावल तालुका, जिला जलगांव, महाराष्ट्र

मध्य क्षेत्र, नागपुर/ Central Region, Nagpur

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PART-I

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, CHOPDA, RAVER AND YAVAL TALUKAS, JALGAON DISTRICT MAHARASHTRA STATE

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PART-I

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, CHOPDA, RAVER AND YAVAL TALUKAS, JALGAON DISTRICT MAHARASHTRA STATE

CONTENTS

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, **CHOPDA, RAVER AND YAVAL TALUKAS, JALGAON DISTRICT** MAHARASHTRA STATE

1 INTRODUCTION

In XII five year plan, National Aquifer Mapping (NAQUIM) had been taken up by CGWB to carry out detailed hydrogeological investigation on toposheet scale of 1:50,000. The NAQUIM has been prioritised to study Over-exploited, Critical and Semi-Critical talukas as well as the other stress areas recommended by the State Govt. Aquifer mapping is a process wherein a combination of geologic, geophysical, hydrologic and chemical analyses is applied to characterize the quantity, quality and sustainability of ground water in aquifers.

The vagaries of rainfall, inherent heterogeneity & unsustainable nature of hard rock aquifers, over exploitation of once copious alluvial aquifers, lack of regulation mechanism has a detrimental effect on ground water scenario of the Country in last decade or so. Thus, prompting the paradigm shift from "**traditional groundwater development concept**" to "**modern groundwater management concept**".

Varied and diverse hydrogeological settings demand precise and comprehensive mapping of aquifers down to the optimum possible depth at appropriate scale to arrive at the robust and implementable ground water management plans. The proposed management plans will provide the **"Road Map"** for ensuring sustainable management and equitable distribution of ground water resources, thereby primarily improving drinking water security and irrigation coverage. Thus the crux of NAQUIM is not merely mapping, but reaching the goal-that of ground water management through community participation. The aquifer maps and management plans will be shared with the State Govt. for its effective implementation.

1.1 Objective and Scope

Aquifer mapping itself is an improved form of groundwater management – recharge, conservation, harvesting and protocols of managing groundwater. These protocols will be the real derivatives of the aquifer mapping exercise and will find a place in the output i.e, the aquifer map and management plan. The activities under NAQUIM are aimed at:

- identifying the aquifer geometry,
- aquifer characteristics and their yield potential
- quality of water occurring at various depths,
- aquifer wise assessment of ground water resources
- preparation of aquifer maps and
- Formulate ground water management plan.

This clear demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a **"Road Map"** to systematically manage the ground water resources for equitable distribution across the spectrum.

An area of 43,058 sq.km. was initially envisaged to be covered during the XII plan, which has been increased to 49,000 sq.km. to cover the gap areas as well as recent drought affected areas of Latur district.

1.2 Approach and Methodology

The ongoing activities of NAQUIM include toposheet wise micro-level hydrogeological data acquisition supported by geophysical and hydro-chemical investigations supplemented with ground water exploration down to the depths of 200 / 300 meters.

Considering the objectives of the NAQUIM, the data on various components was segregated, collected and brought on GIS platform by geo-referencing the available information for its utilisation for preparation of various thematic maps. The approach and methodology followed for Aquifer mapping is as given below:

Compilation of existing data (Central & State Govt.)

↓

Generation of different thematic layers

↓

Identification of Primary Aquifer

↓

Identification of data gaps

↓

Data generation (water level, exploration,
geophysical, hydrochemical, hydrogeological etc.)

↓

Robust Aquifer Maps with 3D disposition

↓

Preparation of Aquifer Management Plan

1.3 Study area

Keeping in view the current demand vis-à-vis supply and futuristic requirement of water, NAQUIM was taken up in prioritised areas covering Over-exploited, Critical and Semi-Critical talukas. Hence, Over-Exploited and Semi-Critical talukas of Jalgaon district has been taken up for aquifer mapping in Raver (OE), Yaval (OE) and Chopda (SC) taluka, by covering an area of 3038 sq.km. in the year 2015-16. The area forms part of the Tapi basin and encapsulates 14 watersheds fully or partially. Out of the total area of 3038 sq.km., the hilly area is 1081 sq.km., command area is 539.63

sq.km. and non command area is 1417 sq.km. The index map of the study area is presented **in Fig.1.1.**

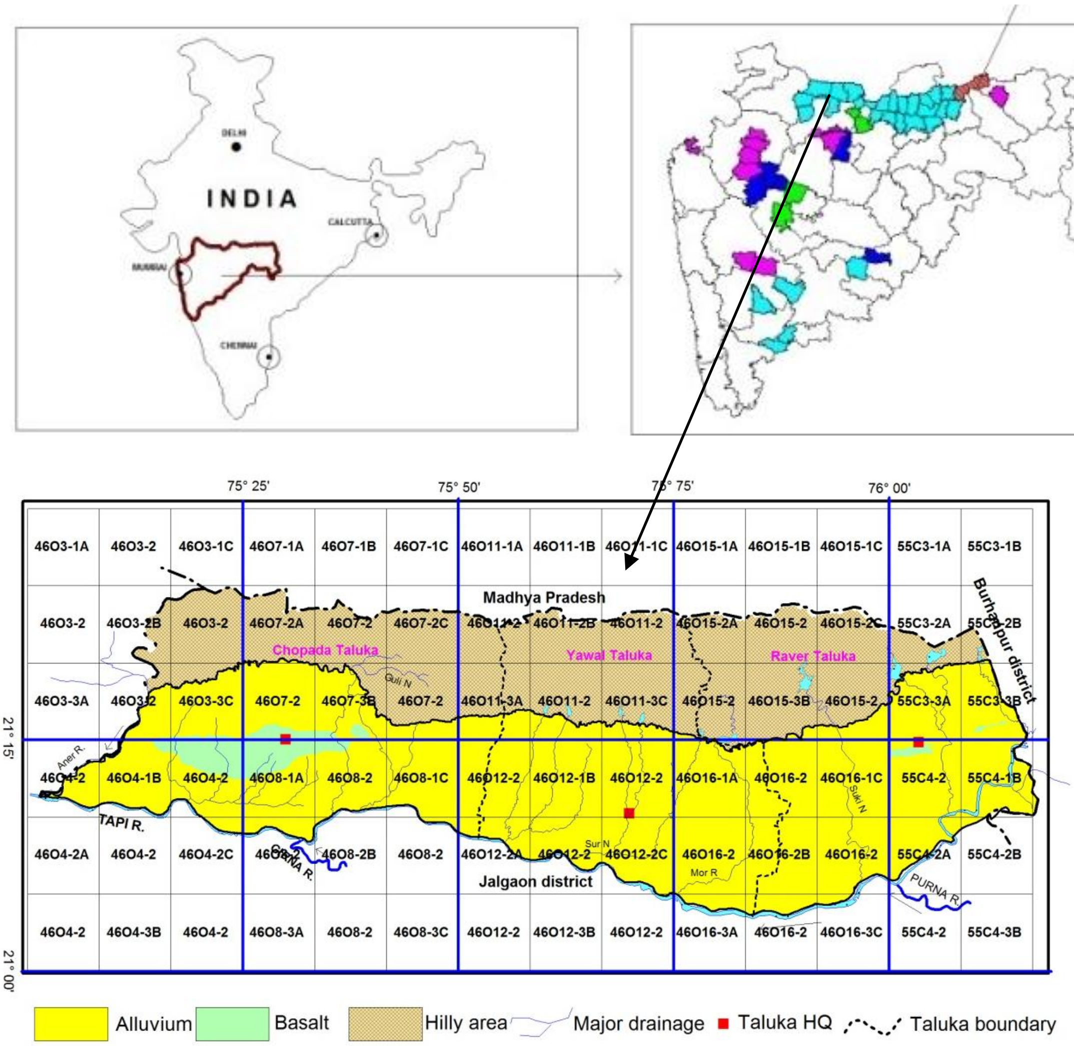

Fig.1.1: Location Map of the area

1.4 Data Adequacy and Data Gap Analysis:

The available data of the Exploratory wells drilled by Central Ground Water Board, Central Region, Nagpur, Geophysical Survey carried out in the area, Ground water monitoring stations and ground water quality stations monitored by Central Ground Water Board were compiled and analysed for adequacy of the same for the aquifer mapping studies. In addition to these the data on ground water monitoring stations and ground water quality stations of the State Govt. (GSDA) was also utilised for data adequacy and data gap analysis. The data adequacy and data gap analysis was carried out for each of the quadrant of falling in the study area mainly in respect of following primary and essential data requirements:

- Exploratory Wells
- Geophysical Surveys
- Ground Water Monitoring and
- Ground Water Quality

After taking into consideration, the available data of Ground Water Exploration, Geophysical survey, Ground Water Monitoring and Ground Water Quality, the data adequacy is compiled and the summarised details of required, existing and data gap of Exploratory wells, Ground Water monitoring and Ground water quality stations is given below.

Table – 1.1: Data Adequacy and Data Gap Analysis

TALUKA	**EXPLORATORY DATA**			**GEOPHYSICAL DATA**			**GW MONITORING DATA**			**GW QUALITY DATA**		
	Req.	Exist.	Gap	Req	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap
Chopda	14	14	0	14	4	10	13	13	0			
Raver	16	16	0	11	11	0	14	14	0			
Yaval	21	21	0	14	14	0	16	16	0			
Total	**51**	**51**	**0**	**29**	**29**	**10**	**43**	**43**	**0**			

1.5 Rainfall and Climate

Agriculture in the area depends mainly on the rainfall from south-west monsoon. The area experiences the sub-tropical to tropical temperate monsoon climate. The long term rainfall data (1901-2015) of the rain gauge stations located at taluka headquarters of Chopda, Raver and Yaval had been collected from available sources and was subjected to various types of statistical analysis to understand the characteristic of the rainfall. It was observed that the distribution of rainfall is more or less uniform over the area. The rains usually start in the second week of June and last till the end of September. The intensity of rainfall is the highest in July. On the basis of rain fall analysis it is observed that:

- The normal annual rainfall in the area is 731.60 mm in Chopda, 734.20 mm in Raver and 739.60 mm in Yaval taluka.
- However, during the year 2015, deficient rainfall was recorded @ 34% deficient in Chopda, 38% deficient in Raver and 39% deficient in Yaval taluka.
- The coefficient of variation in rainfall has been observed between 29 and 30.
- Normal rainfall has been received for 57 % of years at Raver and Yaval, whereas for Chopda it was 62% of the years, whereas excess rainfall has been received for 19% of years at Chopda and Raver, whereas for Yaval it is 21 % of the years
- The talukas have suffered moderate drought conditions in 19 to 22 % of years.
- The long term trend of rainfall was also calculated and rising trend was observed at Chopda @ 0.39 mm/year, 0.22 mm/yr at Raver and falling trend was observed at Yaval @ 0.08 mm/yr.

There is one meteorological observatory in the district located at Jalgaon. The temperature rises rapidly after February till May, which is the hottest month of the year. In May, the average maximum temperature is 42.15°C with the minimum being 26.62°C. With the arrival of southwest monsoon in the area by around mid June there is an appreciable drop in the day temperature and the weather becomes pleasant. With the withdrawal of the monsoon by the end of September day temperatures rise a little in October. Both day and night temperatures begin to drop rapidly by November. December is the coldest month with the mean daily minimum and maximum temperatures at 11.18°C and 30.02°C respectively.

1.6 Physiography

The area forms part of the Tapi Alluvial Basin and the Physiography of the area is depicted in **Fig. 1.2**. The northern part of Tapi valley forms parts of the Satpuda Hill Ranges with a maximum elevation of about 785 m above mean sea level (amsl). Physiographically, this hill ranges are mainly made up of denudational slope region (728 sq.km), low level plateau (about 442 sq.km), middle level plateau (about 320 sq.km.) and high level plateau (10 sq.km). South of these hilly tracts, the alluvial older flood plains (about 1028 sq.km) of the Tapi River Basin with characteristic alluvial fan type deposits (144 sq.km) in the foothill zones are occurring. Further south, immediately adjoining the Tapi River, the area is characterised by badland topography occupied by recent flood plains is observed.

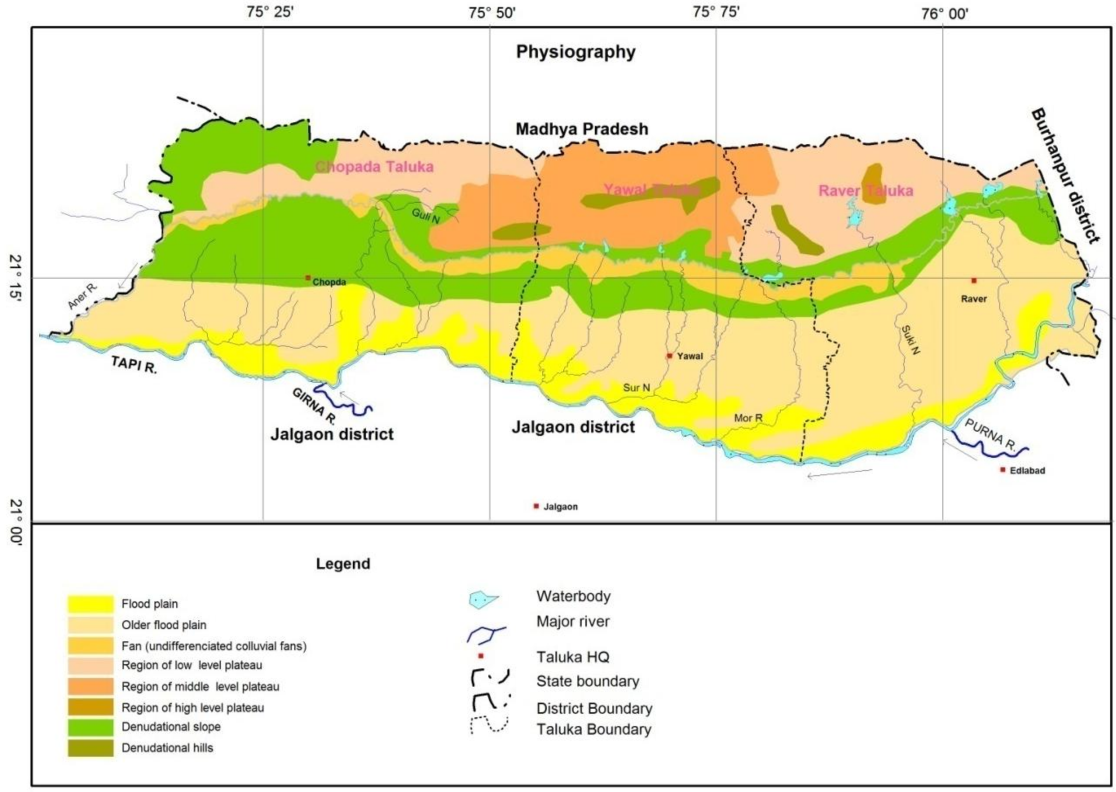

Fig.1.2: Physiography

1.7 Geomorphology

Geomorphologically the area comprises mainly of the hilly area of Satpudas in the north, followed by Piedmont zone and alluvial plains in the central and southern parts which cover the major part of the area (**Fig.1.3**). The alluvial plains are further subdivided into deep and moderate alluvial plains. The plateau region is observed in western part around Chopda and in small eastern part near Raver, which are primarily Deccan Trap Basalt. The recent alluvial plains are observed in small parts along the minor drainages/tributaries of Tapi river.

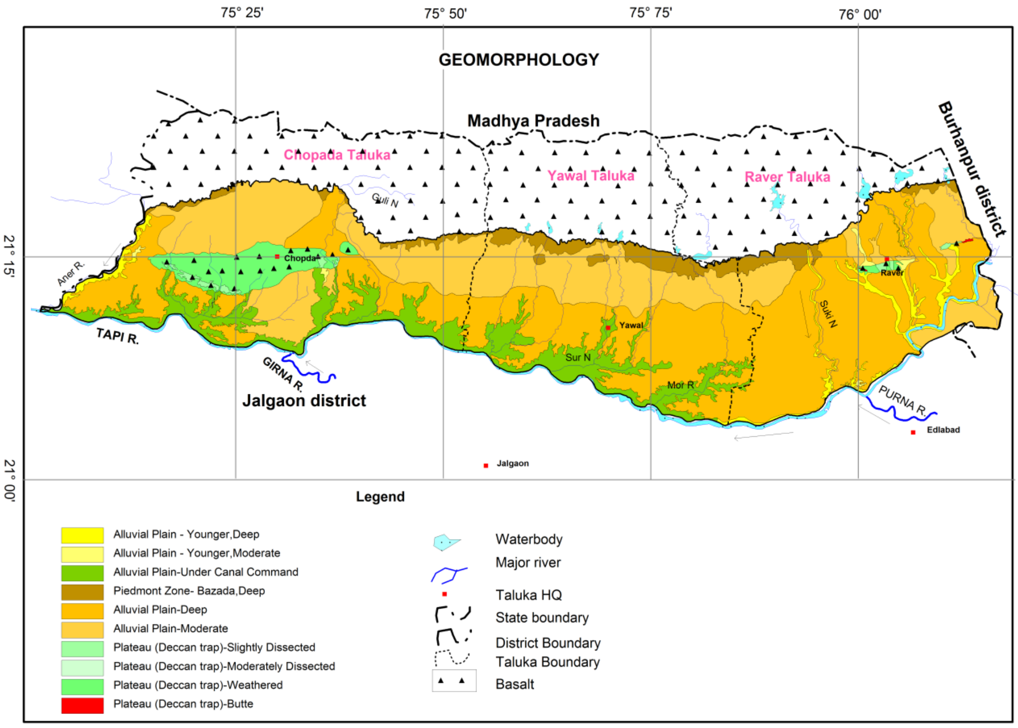

Fig.1.3: Geomorphology

1.8 Land Use, Agriculture, Irrigation and Cropping Pattern

In accordance with the prevailing land use scenario all across the State, the major part of the area is covered by agricultural land (1766.50 sq.km.), followed by settlement/habitations (34.04 sq.km.) and forest (5.11 sq.km.). The area under Kharif crops is the most dominant occupying 781.87 sq.km, followed by 2-crops area occupying 540.73 sq.km and horticulture plant Banana is the cash crop occupying 422.31 sq.km. The spatial distribution of land use is presented in **Fig. 1.4**. The cultivation of water intensive cash crop Banana is totally dependent on ground water and almost entire banana crop is under drip irrigation. The ground water based irrigation caters to the major area i.e., 707.52 sq.km. (36% of cultivable area), whereas surface water irrigated area is about 273 sq.km (14% of cultivable area). The irrigation map of the area is presented in **Fig. 1.5**. The ground water based drip irrigation is also prevailing in most of the irrigated area i.e., 517.34 sq.km, thus water use efficiency measures have already been in place.

Table- 1.2: Taluka wise Land Use, Agriculture and Irrigation (fig. in sq.km)

Taluka	Agriculture	Forest	Settlement / Built up	Agricultural Land Break up				GW irrigated	SW irrigated	GW based Drip irrigation
				Kharif	Rabi	2-crop	Banana			
Chopda	620.64	1.32	10.82	432.51	16.27	142.78	134.30	292.44	133.11	205.46
Raver	610.62	0.83	11.62	149.75	0.64	261.84	148.72	259.48	29.20	207.58
Yaval	535.24	2.96	11.60	199.61	0.73	136.11	139.29	155.60	110.60	104.30
Total	**1766.5**	**5.11**	**34.04**	**781.87**	**17.64**	**540.73**	**422.31**	**707.52**	**272.91**	**517.34**

The agricultural distribution of crops does not follow traditional pattern as cash crop banana is the major crop being harvested in 422.31 sq.km. area followed by cereals like jowar, bajra, wheat etc being grown in 339.39 sq.km, pulses like tur, gram etc., covering 260.76 sq.km. whereas cotton being grown in 310 sq.km. area of Chopda taluka.

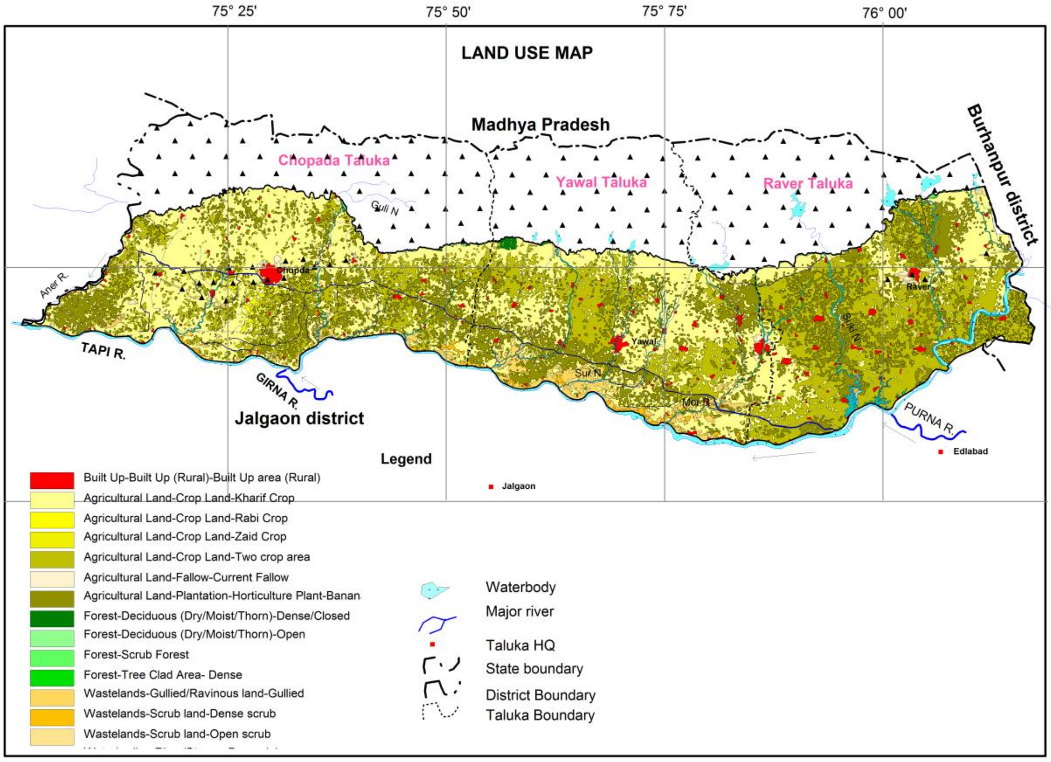

Fig.1.4: Land Use

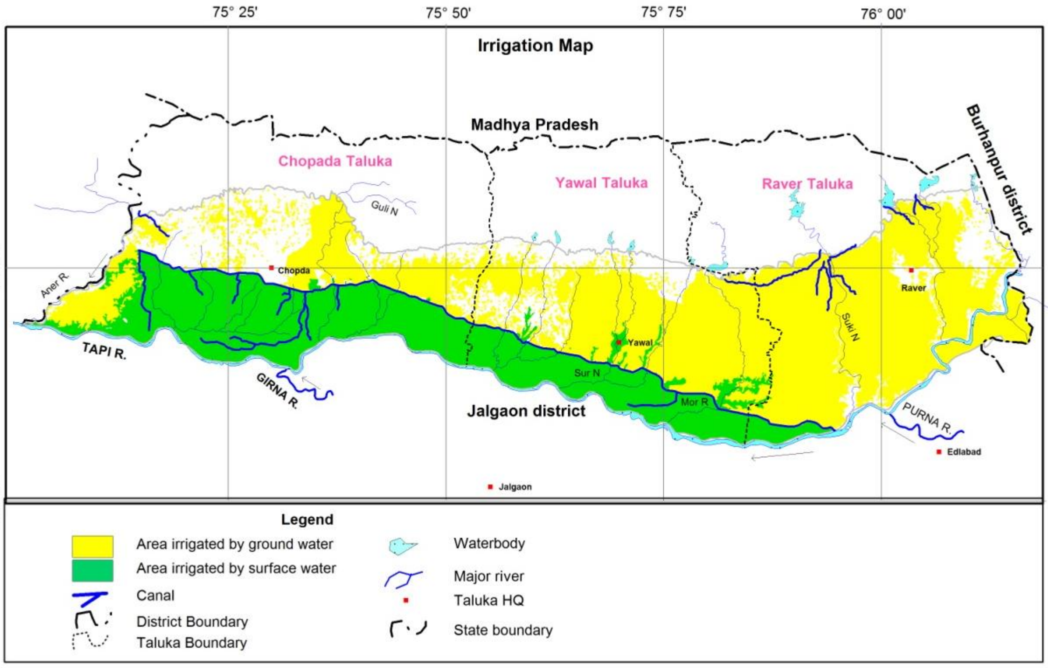

Fig.1.5: Irrigation

1.9 Hydrology and Drainage

Tapi River has its origin in the Multai hills of the Satpuda Ranges, 3 km north-west of Multai (21°47':78°19'; 55-K/5) in Betul district of Madhya Pradesh. The River in its initial stage flows almost in a westerly direction followed by a south-westerly course of about 240 km through steep rocky gorge until it reaches Burhanpur, where the valley opens out as a flat-bottomed and steep-sided elongated Basin, the long axis of which runs almost east-west specially in Jalgaon district of Maharashtra. The principal tributaries on the left bank from the south, beginning from the east, are the Purna, the Bhogavati, the Vaghur, the Girna, the Bori, the Panjhra, the Buray, the Amaravati and the Shivnad. Except for the Purna, the Bhogavati and the Vaghur, all the left bank streams have their sources in the Sahyadri hills.

About 11 irrigation projects are existing in the area, which have been taken up on different tributaries of Tapi river. The projected live storage and current utilisation status of these projects is presented in Table- 1.3. The drainage, watersheds and irrigation projects of the area are presented in **Fig. 1.6**.

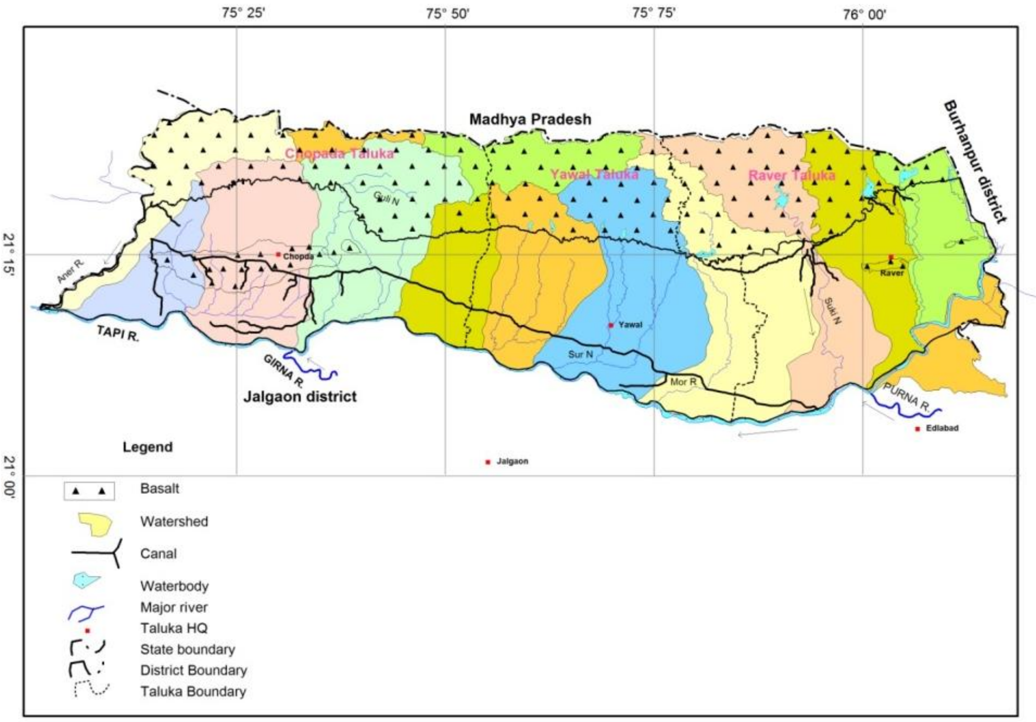

Fig.1.6: Drainage and Hydrology

Table – 1.3: Details of existing irrigation projects.

Sr. No.	Name of Project	Projected Live Storage (MCM)	2014-15		
			Live Storage (MCM)	Utilization for Irrigation (MCM)	Area Irrigated (Ha)
1.	Mor Medium Project	7.960	7.960	1.18	100
2.	Mangrul Medium Project	6.407	6.407	0.00	0
3.	Gul Medium Project	22.760	19.520	1.00	76
4.	Suki Medium Project	39.850	39.850	13.29	15970
5.	Aabhora Medium Project	6.020	6.020	1.43	2916
6.	Matran Nalla M. I.	3.108	3.108	0.36	60
7.	Gangapuri M. I.	2.299	2.299	0.00	0
8.	Waghzira M. I.	1.855	1.155	0.00	0
9.	Borkheda Sangvi M. I.	1.401	1.402	0.00	0
10.	Nimbadevi M. I.	2.139	2.139	0.00	0
11.	Vadri M. I.	2.266	0.262	0.00	0
12.	**Total**	**96.065**	**90.12**	**17.26**	**19122**

A perusal of above table indicates that 11 irrigation projects are existing in the area with projected live storage of 96.05 MCM. In 2014-15, the live storage was 90.12 MCM and the irrigated area is 19122 ha. It is also observed that in most of the projects the utilisation of the surface water for irrigation is almost negligible. This figures corroborates the fact observed during the field visit, that the preference of the people/stake holders has shifted from the surface water irrigation to ground water irrigation because almost 100% of the farmers have shifted from flood irrigation to modern irrigation practices. It was also observed from the views of the stake holders that instead of using the canal irrigation, they insist to release water into the rivers as it benefits their wells by means of artificial recharge.

1.10 Prevailing Water Conservation and Recharge Practices

Central Ground Water Board (CGWB), Central Region, Nagpur has carried out pioneering pilot project studies on Artificial Recharge to Ground Water in mountain front consisting of Bazada and Alluvial areas of TE-17 and TE-11 Watersheds, Jalgaon district, Maharashtra under Central Sector Scheme (CSS) during VIII and IX Plans respectively. In TE-17 watershed, a total of 10 structures were completed i.e., 3 Percolation Tanks, 1 Injection Well, 2 Recharge Shafts, 1 DW recharge, 3 Others (Conversion of 2 VT into 2 PT and 1 Nallah diversion to utilise existing capacity of PT) at the cost of Rs. 29.79 lakhs. In TE-11 watershed, 5 Percolation Tanks and 5 Recharge Shafts were completed at the cost of Rs. 74.33 lakh. These studies have revealed the following:

a) The Percolation Tanks and Recharge Shafts are the feasible recharge structures in the Mountain Front area consisting of talus and scree deposits (Bazada). The Bazada forms principal recharge zone for the alluvial aquifers, which have subsurface linkage with other granular zones of alluvial area.

b) In the flat alluvial terrain beyond talus and scree deposits, it is found that due to absence of foundation rock, the artificial recharge structures like Percolation Tanks and Cement Plugs are not feasible options. Therefore, it was suggested that ground water augmentation in this area should be undertaken by constructing recharge shafts and utilising existing dugwells.

c) CGWB recommended that “feasibility study of mega artificial recharge scheme along the mountain front needs to be carried out by the State Government for bulk augmentation by harnessing the surplus runoff of the Tapi River during monsoon period”.

The State Govt. has also constructed number of water conservation structures such as cement bund (495), nala bund (120), percolation tank (25), storage tanks etc., in the area and the details are presented in Table 1.4.

Table – 1.4: Details of Water Conservation Structures constructed by State Govt.

S. No.	Taluka	Cement Bund		Nala Bund		Percolation Tank		Other Structures	
		No.’s	Capacity (ham)	No.’s	Capacity (ham)	No.’s	Capacity (ham)	No.’s	Capacity (ham)
1.	Chopda	326	363.00	32	24.88	1	41.00	-	-
2.	Raver	135	224.34	0	0	18	287.50	11	71.00
3.	Yaval	34	113.60	88	288.18	6	174.00	-	-
4.	**Total**	**495**	**700.94**	**120**	**313.06**	**25**	**502.5**	**11**	**71.00**

2 DATA COLLECTION AND GENERATION

The data collection from various agencies such as GSDA, Irrigation, Agriculture, Revenue, etc., was carried out. The data was collected and then compiled and validated so as to remove the discrepancies and make it utilisable on GIS platform.

2.1 Data Collection and Compilation

The data collection and compilation for various components was carried out as given below.

- Hydrogeological Data – Current and historical water levels along with water level trend data of 43 monitoring wells representing shallow aquifer of CGWB and GSDA.
- Hydrochemical Data - Ground water quality data of 23 monitoring wells of CGWB and GSDA representing shallow aquifer and data of 34 exploratory wells and 60 tubewells / borewells of Irrigation Dept. representing deeper aquifer.
- Exploratory Drilling – Ground water exploration data of 51 exploratory wells of CGWB down to the depth of 323 m bgl.
- Geophysical Data - VES data of 29 locations of CGWB.
- Hydrology Data – Data on various irrigation projects, their utilisation status from Irrigation Dept.
- Hydrometeorological Data - Long term rainfall data for each of the taluka from Revenue Dept.
- Irrigation Data – Data on land under surface and ground water irrigation, drip irrigation from Irrigation Dept. and Agriculture Dept.
- Water Conservation Structures – Numbers, type and storage potential of water conservation structures prevailing in the area.
- Cropping Pattern Data – Data on prevailing cropping pattern from Agriculture Dept.

2.2 Data Generation

Based on the data collected and existing data available with CGWB, data adequacy was worked out to decide the scope and extent of further data generation. The data requirement was optimised and considering the predominance of alluvial aquifers in the area, it was decided that the existing hydrogeological data is sufficient to generate the desired outputs of aquifer maps and management plan. Hence additional data generation activities for hydrogeological inputs were not carried out.

However, the thematic layers for various themes needed to be procured and the following layers were procured from MRSAC. These thematic layers supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

- Drainage
- Physiography
- Geomorphology
- Soil
- Land Use – Land Cover
- Geology and Structure

Similarly, the hydrogeological data on Bazada aquifer was sparse, hence micro level hydrogeological survey was carried out at 19 locations and the ground water quality of this formation was also analysed.

3 Data Interpretation, Integration and Aquifer Mapping

The data collected and generated on various parameters viz., water levels, water quality, exploration, aquifer parameters, geophysical, hydrology, hydrometeorology, irrigation, thematic layers was interpreted and integrated. Based on this the various maps on hydrogeology, aquifer wise water level scenario both current and long term scenarios, aquifer wise ground water quality, 2-D and 3-D sub surface disposition of aquifers by drawing fence and lithological sections, aquifer wise yield potential, aquifer wise resources, aquifer maps were generated and as discussed in details.

3.1 Hydrogeology

Hydrogeology is concerned primarily with mode of occurrence, distribution, movement and chemistry of water occurring in the subsurface in relation to the geological environment. The occurrence and movement of water in the subsurface is broadly governed by geological frameworks i.e., nature of rock formations including their porosity (primary and secondary) and permeability. The principal aquifers in the area is Bazada, Alluvium and Basalt and the occurrence and movement of ground water in these rocks is controlled by various factors such as grain size and clay content in Bazada, ground water accumulation in Alluvial aquifer is directly proportional to the granular zones i.e., the ground water accumulation will be higher in coarser formation and the formation clear of clayey admixture or intercalation. Whereas in Basalt, the occurrence and movement of ground water primarily depends on the degree of interconnection of secondary pores/voids developed by fracturing and weathering. The hydrogeological map of area is prepared and presented in Fig.3.1.

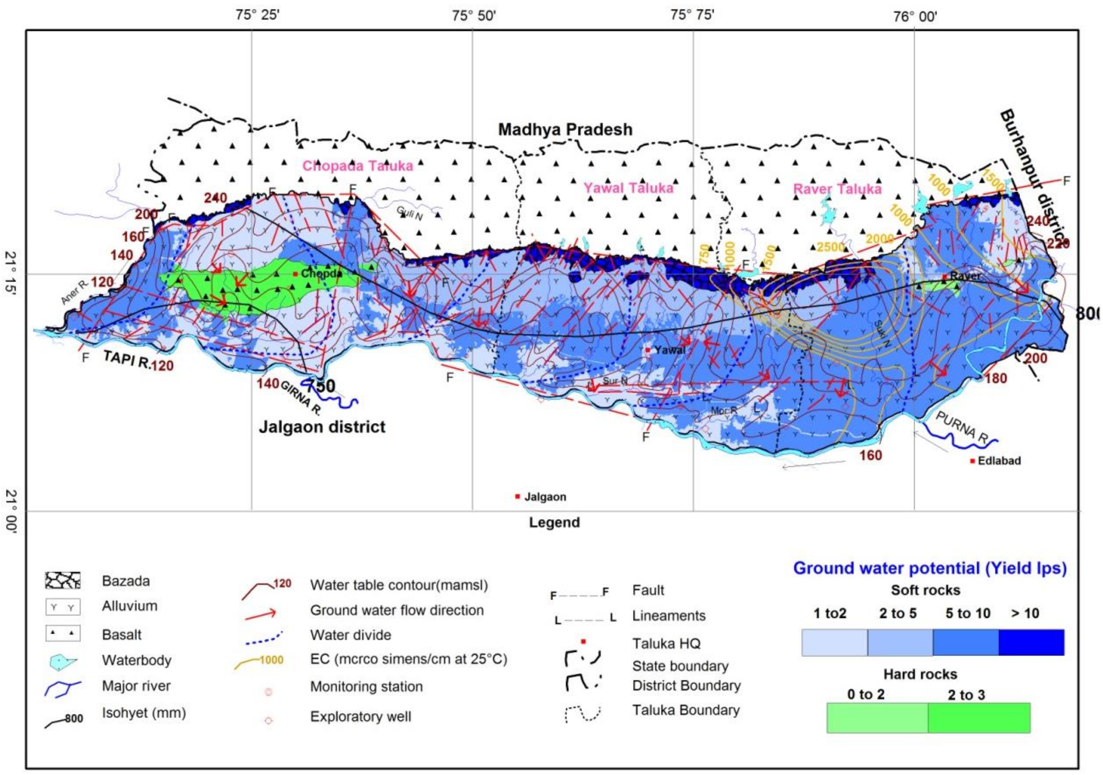

Fig. 3.1: Hydrogeology

3.2 Occurrence of Ground Water in Bazada

The boulder formation (Bazada Zone) occurs between 230 and 340 m.amsl in the foot hill zone of Satpuda and covers about 97 sq.km area in northern part. The Bazada acts as a recharge zone to the alluvium occurring southwards and at the same time forms a potential aquifer for ground water development due to its highly porous and permeable nature. These are formed due to the deposition of rock fragments in the valley, transported mechanically by gravity or from the streams descending from the Satpuda Hill Range. The transported materials are known as 'Talus and Scree desposits' together popularly known as 'Bazada'. The north-south extension of Bazada zone at the surface varies from 1.5 to 6.5 km. The Bazada formation is poorly sorted and generally devoid of any layered sequence. The maximum thickness of these deposits is not known. However, around Naygaon, it is more than 100 m bgl thick.

The depth of the dugwells in Bazada range from 16.20 to 70.60 m bgl which are the preferred ground water abstraction structures, ground water occurs in unconfined conditions and the depth to water level varies from 5.10 to 52.10 m bgl, however in majority of the wells it is between 20 and 40 m bgl. Bazada is one of the high yielding aquifer of the area and yields are mainly observed in the range of 5 to more than 15 lps with continues pumping.

3.3 Occurrence of Ground Water in Alluvium

The principal water bearing formations in the Alluvium are granular zones consisting mainly of sand, gravel and pebble which are encountered at various depths. The clay horizons occurring at various depths as alternate layers form aquiclude when these layers are significantly thick. The ground water in alluvial parts of the Basin is generally developed by dug wells. The dugwells depth in the alluvium range between 13 and 70 m bgl and the diameter of these dug wells range between 1.85 and 12.30 m. In recent years, tubewells of about 80-200 m depth are preferred groundwater structures because of their easiness in construction.

Ground water in alluvial formation occurs under water table conditions at shallow depth upto 60 mbgl, but at deeper levels it occurs under semi-confined to confined conditions. Multi-aquifer system exists in alluvium where each aquifer is separated by confining clayey formations which act as aquiclude. In exploratory tube wells drilled by CGWB down to 300 m bgl at Dongaon, 9 water bearing zones were encountered in the depth range between 91 and 296 m bgl. The thickness of individual water bearing granular zone varies from 4-14 m. In the tubewells drilled by GSDA for water supply, 2 to 4 water bearing granular zones have been encountered. The thickness of individual zone varies from 3 to 20 m.

3.4 Occurrence of Ground Water in Basalt

The basaltic lava flows of Upper Cretaceous to Lower Eocene age occur in the northern part forming the Satpuda hill ranges and consists of two units namely lower massive unit and upper vesicular unit occurring in layered sequence. The various flows are generally separated by bole/inter-trappean beds normally consists of clay. The Deccan Trap Basalt is observed as inliers in 2 small patches in and around Chopda in western part and Raver in eastern part covering an area of about 83 sq.km.

Ground water occurs in unconfined state in shallow aquifer tapped by dugwells of 10 to 25 m depth, water levels are ranging from 7.50 to 18.50 m bgl and yield varies from 1 to 3 lps. The deeper aquifer is also present which is being tapped by borewells and it ranges from 18-153 m bgl, whereas the water level ranges from 5.40 to 19.75 m bgl.

3.5 Water Level Scenario

3.5.1 Water Level Scenario – Shallow Aquifer

The depth to water level scenario for present scenario and historical period was generated by utilizing 47 monitoring wells representing shallow aquifer of CGWB and GSDA (**Annexure-I**).

The water level data monitored during May 2014 indicated that the pre-monsoon depth to Water Level ranges from 1.30 (Lalmati) to 53.07 (Faizpur) m bgl. The pre-monsoon DTW map as shown in Fig 3.2 shows that groundwater levels are moderately deep (<20 mbgl) around Chopda, east and south east of Raver. The deeper water levels of more than 20 m bgl are observed in central and eastern parts mainly in Yaval and Raver talukas.

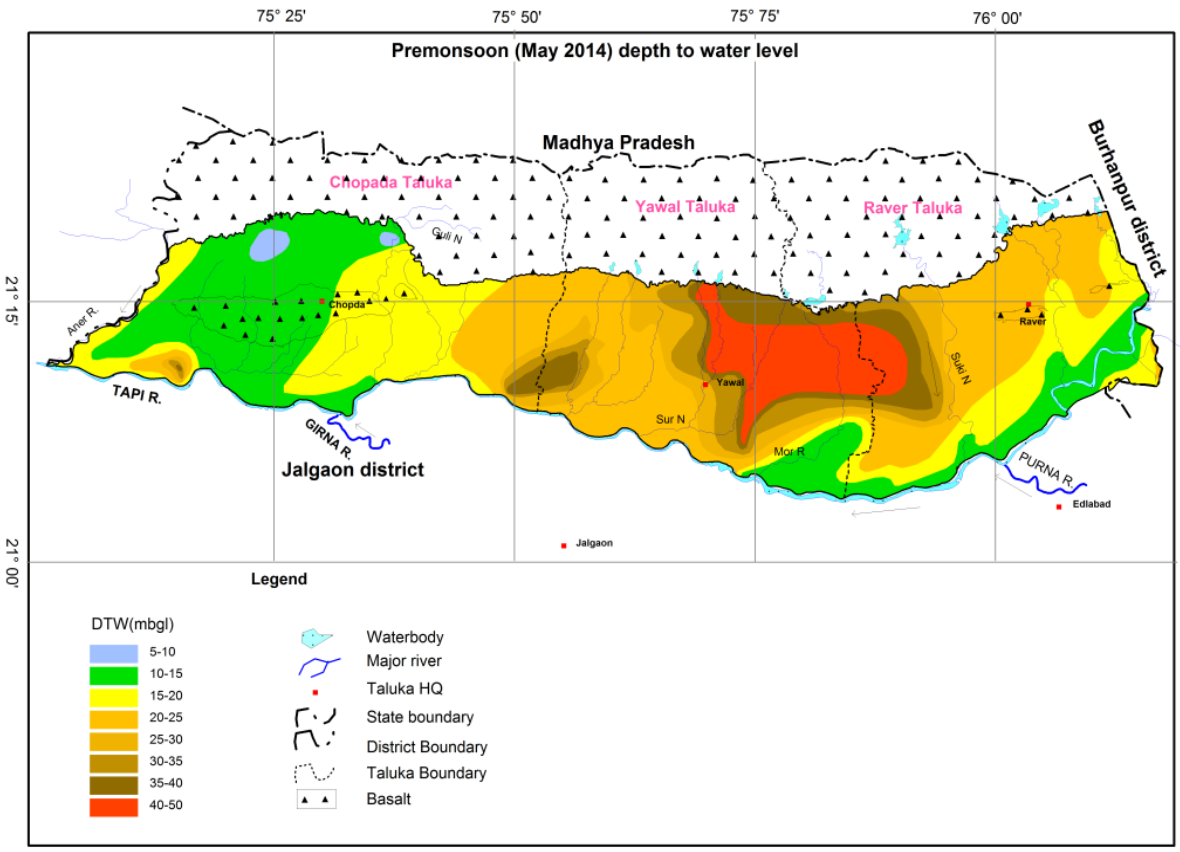

Fig. 3.2: Premonsoon Depth to Water Level (May 2014)

The post-monsoon water levels (2014) range between 0.10 (Lalmati) and 56.00 m bgl (Sangvi Bk). The post-monsoon water level map (**Fig.3.3**) of the area shows that shallower water levels upto 10 mbgl are seen west of Chopda. In major part of the area the water levels lies between 10 and 20 m bgl. Around Yaval deeper water levels of 25-45 m bgl are observed.

The water table elevation map for premonsoon period (2014) was also prepared (**Fig.3.4**) to understand the ground water flow directions. The water table elevation ranges from 240 m amsl to 120 m amsl and the flow is mainly in North to South direction towards Tapi River.

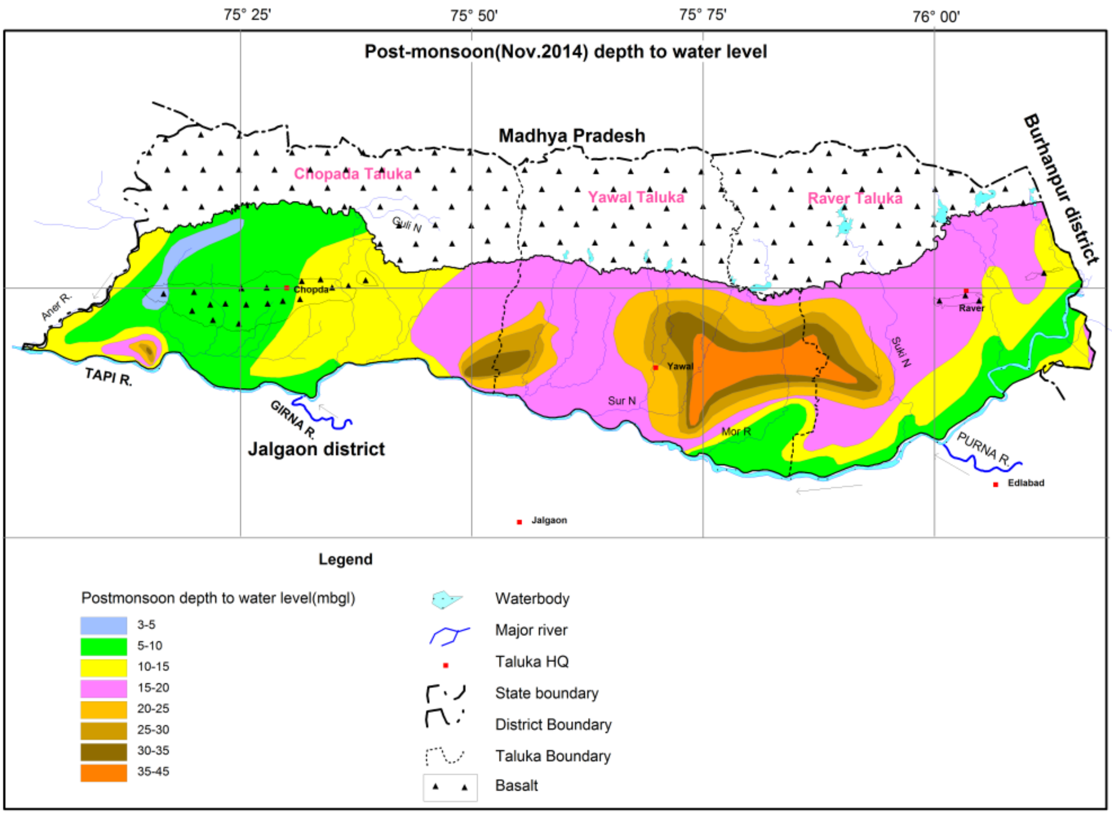

Fig. 3.3: Postmonsoon Depth to Water Level (Nov. 2014)

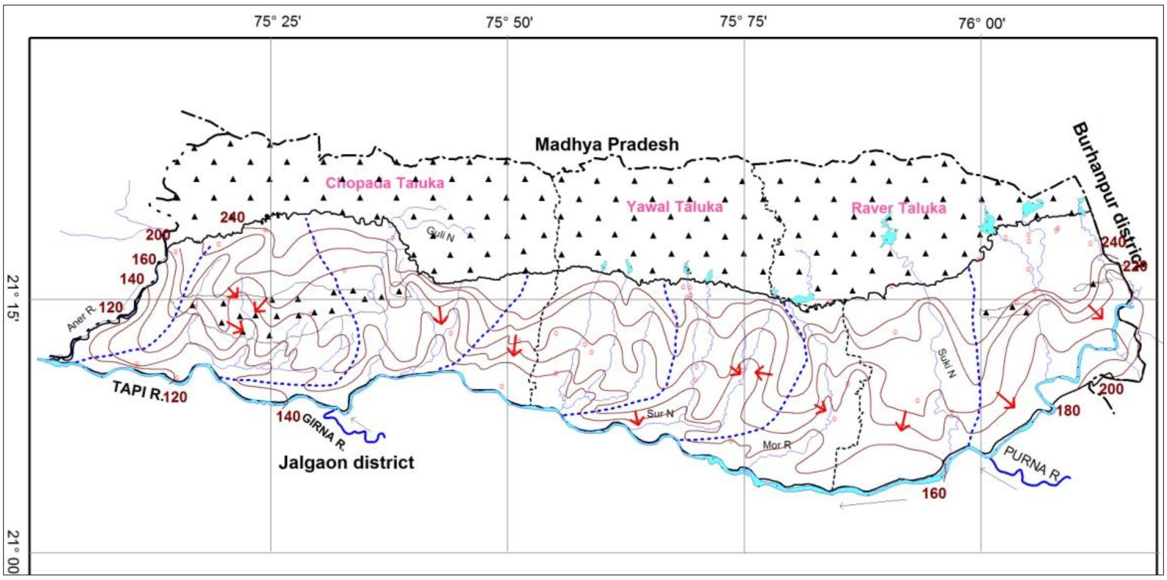

Fig. 3.4: Premonsoon Water Table Elevation (May 2014)

The water level fluctuations for pre and postmonsoon seasons vary from 0.20 (Moharle) to 24.28 (Yaval) m (**Fig.3.5**). However in 68% of wells it is upto 10 m and average fluctuation is 5.57 m. The major part of the area is showing water level fluctuation upto 6m, whereas higher water level fluctuations have been observed in Yaval taluka.

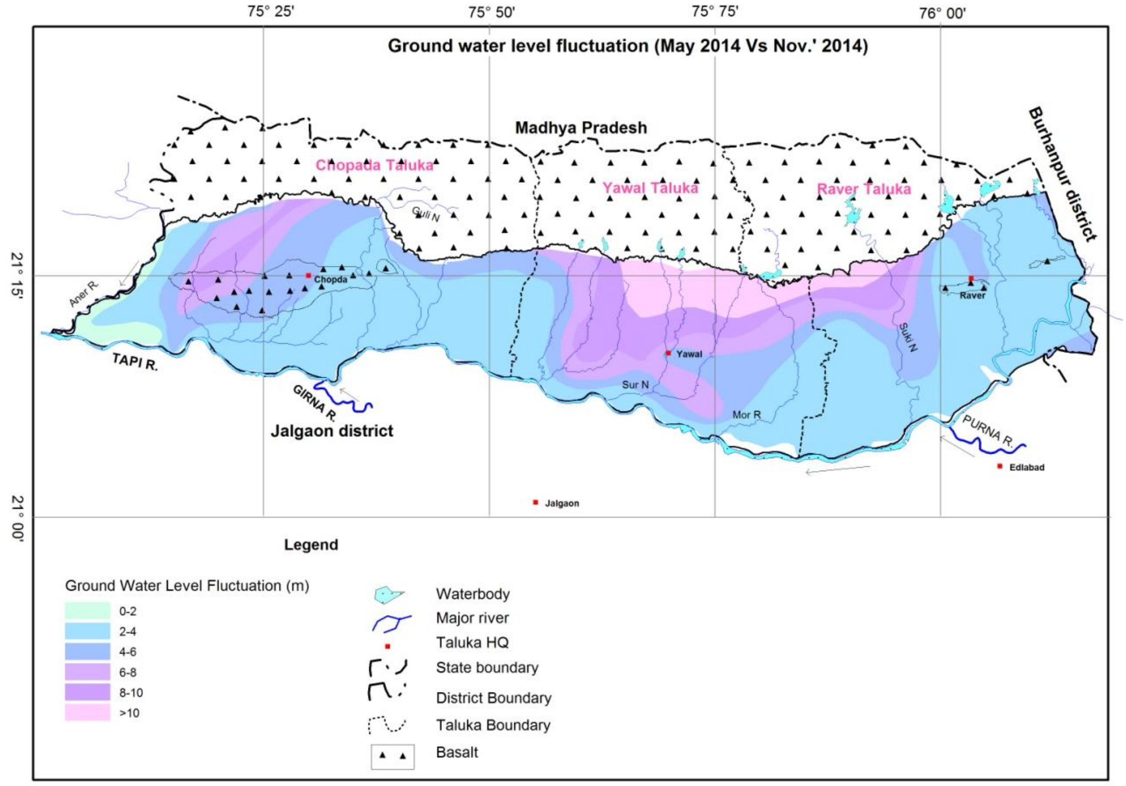

Fig. 3.5: Water Level Fluctuation (May to Nov. 2014)

3.5.2 Long Water Level Trend

In order to study long term behavior of the water levels and also the effect of various developmental activities with time, the data between the periods from 1985 to 2014 were taken for analysis and also to study the decadal changes. The trend of water levels for both pre and post monsoon periods for three decades i.e. from 1985-94, 1995-2004 and from 2005-14 (**Annexure-II**) have been computed and discussed below.

3.5.2.1 Decadal Water Level Trend (1985-94)

Decadal premonsoon water level trend analysis for the period of 1985-94 indicates that during pre-monsoon period (**Fig 3.6**) the marginal rise upto 0.2 m is observed in western parts of Chopda and south eastern parts of Raver talukas. The decline in water level from 0.2 to 0.4 m is observed south of Yaval and Raver talukas, while decline in water levels of more than 0.6 m/year is observed in the central part of the area covering major part of Yaval and Raver talukas.

3.5.2.2 Decadal Water Level Trend (1995-2004)

Decadal premonsoon water level trend analysis for the period of 1995-2004 indicates that during pre-monsoon period (**Fig 3.7**) decline in water level is observed in major part of the area ranging from 0.2 to 0.4 m in southern parts of Chopda, Yaval and Raver talukas, while the central part of area covering major parts of Yaval and Raver talukas shows falling trend @ 0.4 to 0.6 and even more than 0.6 m/year.

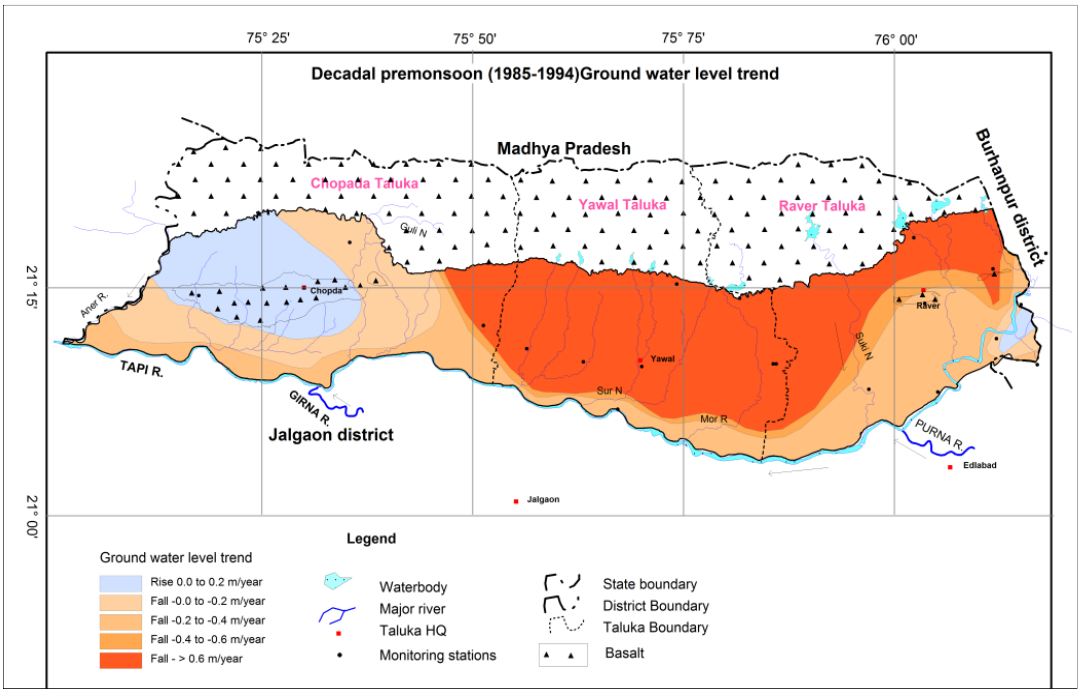

Fig. 3.6: Decadal Premonsoon Water Level Trend (1985-1994)

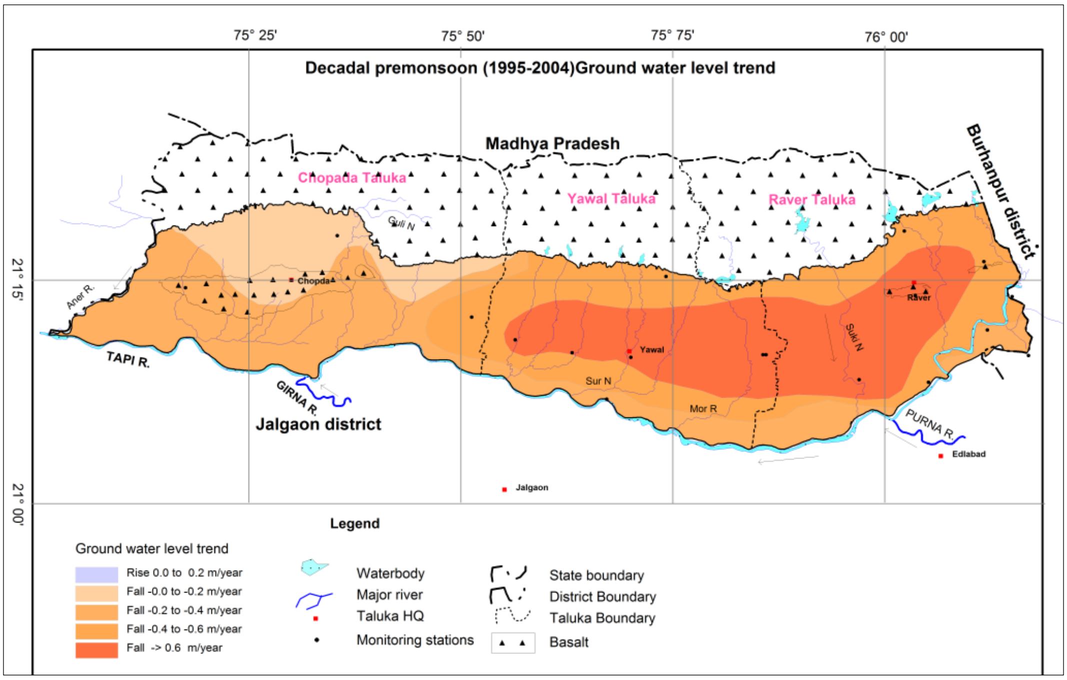

Fig. 3.7: Decadal Premonsoon Water Level Trend (1995-2004)

3.5.2.3 Decadal Water Level Trend (2005-2014)

Decadal premonsoon water level trend analysis for the period of 2005-2014 indicates that during pre-monsoon period (**Fig 3.8**) there is rise in water level upto 0.2 m/year in west of Chopda taluka. Decline in water levels from 0.2 to 0.4 m/year is seen south of Chopda, Yaval and Raver talukas, while the central part of the area covering major part of Yaval and Ravel talukas shows fall in water level of 0.4 to 0.60 m/year.

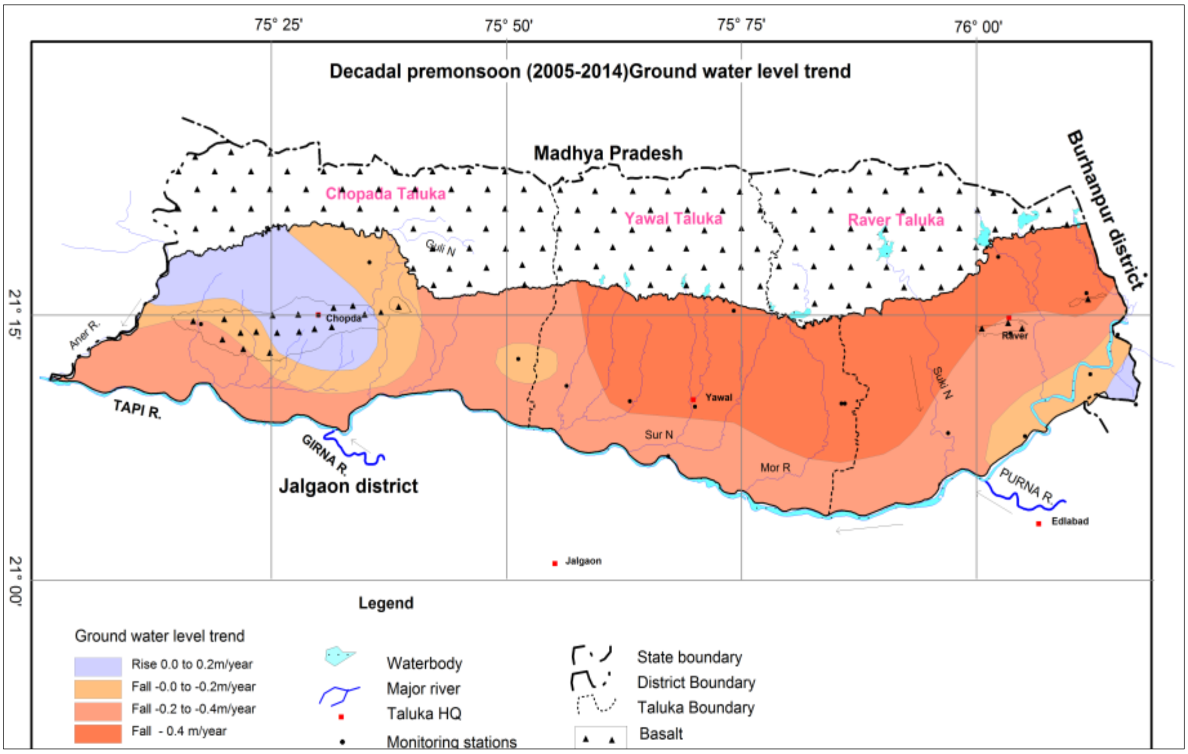

Fig. 3.8: Decadal Premonsoon Water Level Trend (2005-2014)

3.5.2.4 Decadal Water Level Trend Comparison

The comparison of decadal water level trend is given in Table 3.1. It has been observed from the table that initially in the decadal period of 1985-1994 an area of around 1800 sq. km was showing the declining trend in water levels and 271 sq.km area was showing rising trend, however during the decadal period of 1995-2004 entire area is showing declining trend. This increase may be due to over exploitation of ground water resources to meet the irrigation demand of proliferate banana cropped area. This has been resulted in drying up of many dug wells in the area and farmers have to opt for construction of deeper tube wells to meet the irrigation demand of their cash crop. However, the introduction and adoption of advance irrigation practices like drip and sprinkler in recent years have changed the irrigation draft in the area. This has been clearly observed from the decadal trend analysis of the period 2005-2014 where the area under declining trend of more than 0.60 m/year has been completely wiped off and the water level decline rates have been reduced as compared to last decade.

Table- 3.1: Analysis of Long Term Premonsoon Water Level Trends.

Premonsoon Water level trend in m/year		Area under category (Sq.Km) during year 1985-94	Area under category (Sq.Km) during year 1995-2004	Area under category (Sq.Km) during year 2005-2014
Rise	0-0.2	271.05	Nil	208.65
Fall	Upto 0.2	279.00	227.90	265.18
	0.2 to 0.4	571.37	603.16	806.57
	0.4 to 0.6	113.07	550.97	685.50
	> 0.6	836.44	575.80	Nil

3.5.3 Water Level Scenario – Deeper Aquifer

The present water levels of 60 tubewells/borewells representing deeper aquifers was also obtained from Irrigation Dept. (**Annexure-III**) and utilized to prepare the water level scenario of deeper aquifers.

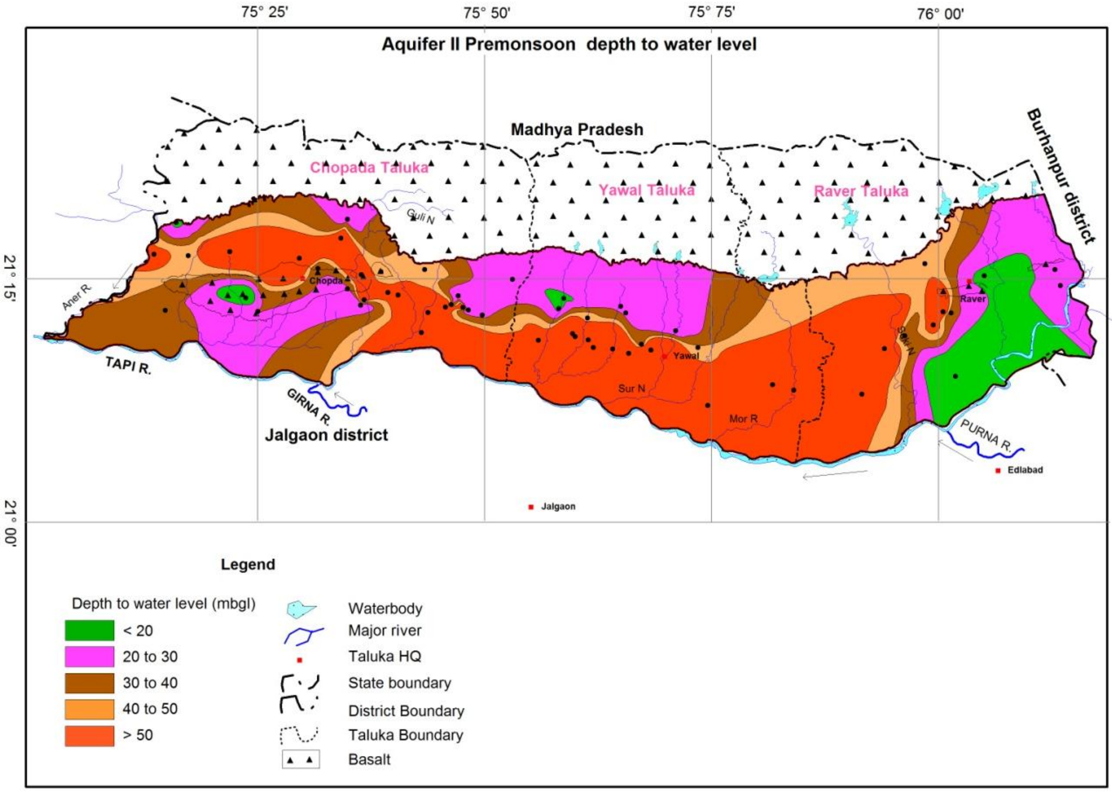

Fig. 3.9: Premonsoon Depth to Water Level (2015) – Deeper Aquifer

The **premonsoon** water level data monitored during May 2015 indicated that the depth to water level ranges from 11.00 (Chahardi) to 130 (Sakli) m bgl. The pre-monsoon DTW map as shown in Fig 3.9 shows that groundwater levels are within 20 mbgl in southern part of Raver taluka. The deeper water levels of 20 to 50 m bgl are observed in northern part of the area, whereas very deep water levels of more than 50 m bgl are mainly observed in southern parts.

The **postmonsoon** water level data monitored during Nov. 2015 indicated that the pre-monsoon depth to water level ranges from 6.60 (Chahardi) to 121.92 (Sakli) m bgl. The post-monsoon DTW map as shown in Fig 3.10 indicates that groundwater levels of 10 to 20 m bgl are mainly observed in southern part of Raver taluka. The deeper water levels of 20 to 50 m bgl are observed in northern part of the area, whereas very deep water levels of more than 50 m bgl are mainly observed in southern parts.

The comparison of pre and post monsoon water level maps indicates that the area under 20 to 30 m bgl has increased slightly, which is probably due to the monsoon recharge. However, areas of deeper water levels of more than 50 m are almost same indicating that the natural recharge due to monsoon is unable to replenish this aquifer. Thus concerted efforts for large scale artificial recharge needs to be adopted for these areas.

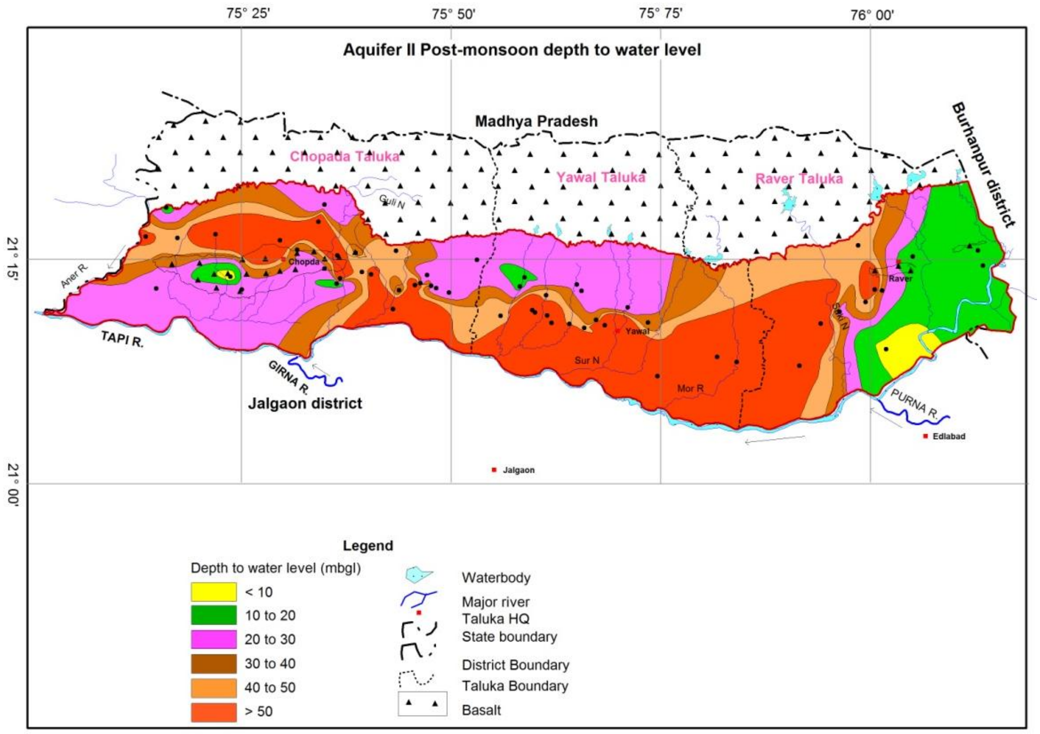

Fig. 3.10: Postmonsoon Depth to Water Level (2015) – Deeper Aquifer

3.6 Ground Water Quality

The ground water quality of both the shallow and deeper aquifers has been assessed. Ground water quality data of 23 monitoring wells of CGWB and GSDA representing shallow aquifer and data of 34 exploratory wells and 60 tubewells / borewells of Irrigation Dept. representing deeper aquifer have been utilised to decipher the quality scenario.

3.6.1 Ground Water Quality – Shallow Aquifer

The overall ground water quality (2014) of shallow aquifer in the area is good and suitable for drinking and irrigation purposes (**Annexure-IV**). The electrical conductivity (EC) ranges from 386 (Deozhari) to 5040 (Sadavan) microsiemens/cm**;** Total Hardness (TH) ranges from 35 to 1600 mg/l and Fluoride concentration ranges from BDL to 1.10 mg/l. The EC map is given in **Fig. 3.9** which shows that in major parts, the EC is ranging from 750 to 2250 microsiemens/cm. In northern parts, the EC is less than 750 microsiemens/cm. A small patch west of Raver shows higher EC of more than 2250 microsiemens/cm. Similarly nitrate contamination is also observed at 7 places ranging from 59 to 287 mg/L.

3.6.2 Ground Water Quality – Deeper Aquifer

The overall ground water quality (2015) of deeper aquifer in the area is good and suitable for drinking and irrigation purposes (**Annexure-V**). The electrical conductivity (EC) ranges from 371 (Kusumba) to 1800 (Waghode) microsiemens/cm**;** Total Hardness (TH) ranges from 202 to 1050 mg/l. The EC map is given in **Fig. 3.10** which shows that in major parts the EC values are low and are ranging from 250 to 750 microsiemens/cm. The small patches of the EC ranging from 750-2250 microsiemens/cm are observed south and west of Raver.

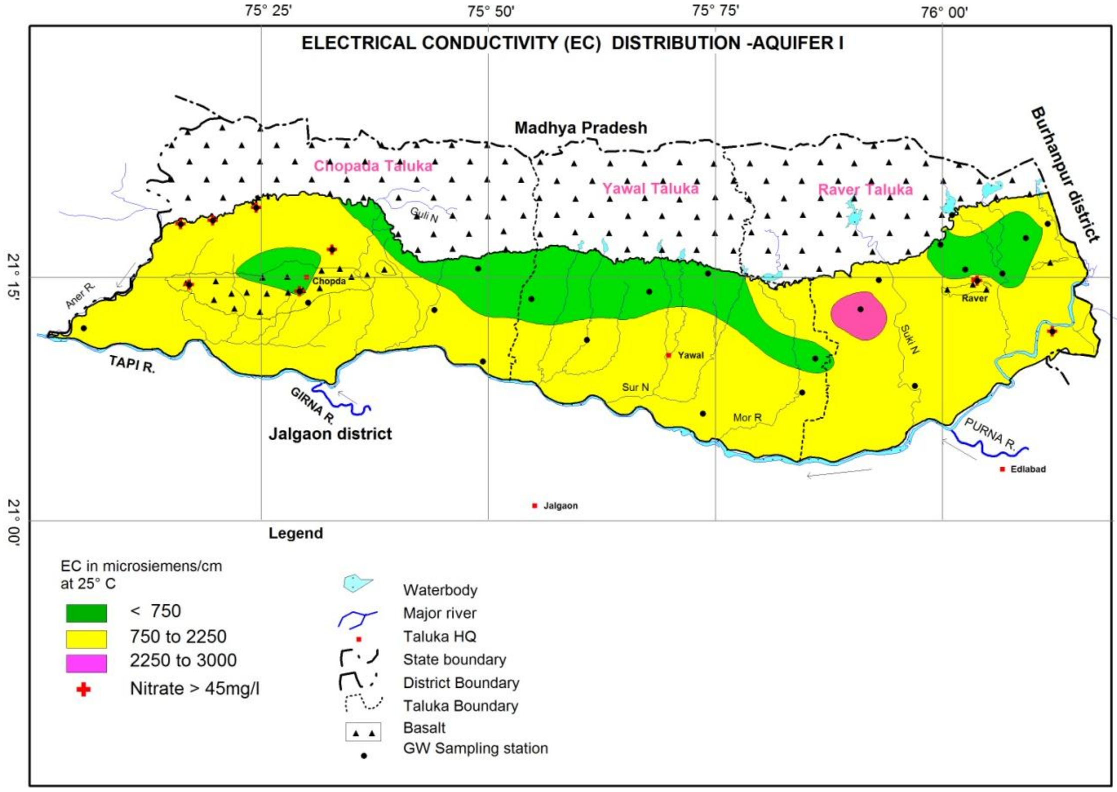

Fig. 3.9: Distribution of EC in Shallow Aquifer.

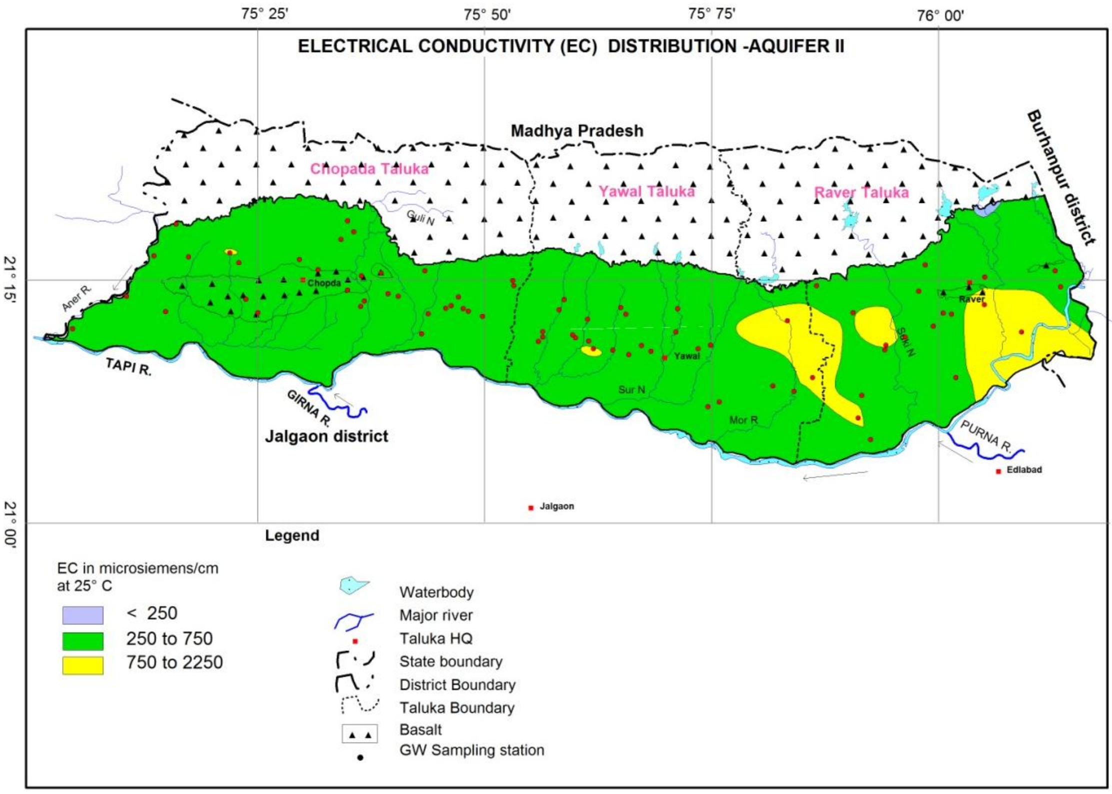

Fig. 3.10: Distribution of EC in Deeper Aquifer.

3.7 3-D and 2-D Aquifer Disposition

The data generated from ground water monitoring wells, micro level hydrogeological inventories, exploratory and observation wells (**Annexure-VI**), various thematic layers was utilized to decipher the aquifer disposition of the area. This particularly includes the information on geometry of aquifers and hydrogeological information of these aquifers. Three main types of formations are observed in the area i.e., Bazada, Alluvium and Basalt. The aquifer units in each of the formation are listed below:

- **Bazada** – Single unit (upto 100 m)
- **Alluvium** –
  - Aquifer – I : upto 80 m,
  - Aquifer – II : 80 to 200 m and
  - Aquifer – III : > 200 m
- **Basalt** –
  - Aquifer - I upto 30m
  - Aquifer - II 30 to 150 m

The fence diagram indicating the disposition of various aquifers is presented in **Fig.3.10**. In central part of the area the thickness of alluvium is more i.e., around 323 m bgl and all the 3 types of Alluvial aquifers are encountered. As we move away from central part the thickness of alluvium goes on decreasing and basalt aquifer is exposed at surface northwestern part as inlier.

The Alluvial aquifer-I is observed in the entire area, except where basalt is exposed at the surface. The Alluvial aquifer-II is observed in central and north-eastern parts. The Bazada aquifer occurs along the northern boundary as it is deposited along the foothills of Satpuda hills.

The aquifer disposition / geometry of Basalt which occurs as inlier in north-western part is not clear in the Fence diagram, however a separate 3-D disposition of the basalt is presented and discussed in chapter 3.8.2

3.7.1 Hydrogeological Cross Sections

To study the aquifer disposition in detail, various hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' representing southwest – north east direction, B-B' representing northwest – southeast direction and C-C' representing east- west direction (in eastern part) as marked in **Fig.3.10.**

3.7.1.1 Hydrogeological Cross Section A-A'

Hydrogeological cross section A-A' represents southwest – north east direction and data of 6 exploratory wells i.e., Turkheda, Yaval, Chitode, Borkheda, Utkheda and Raver has been utilised. It can be clearly seen from the section that the sand and clay layers are intercalated and the thickness of granular zones in 2nd and 3rd aquifer is less as compared to 1st aquifer. In the central part the alluvium thickness is maximum upto 323 m at Chitode and it decreases in both the directions and it is minimum in southwest (74 m) and north east part (125 m). The basement rock i.e., Basalt has been encountered in all the wells except Turkheda indicating that the maximum depth of alluvium will not be more that 323 m in the area. The water levels has also been depicted in the section and a close observation of water level indicates that the water levels are residing below the start of Aquifer-I and thus sufficient part of Aquifer-I has been dewatered due to over-exploitation.

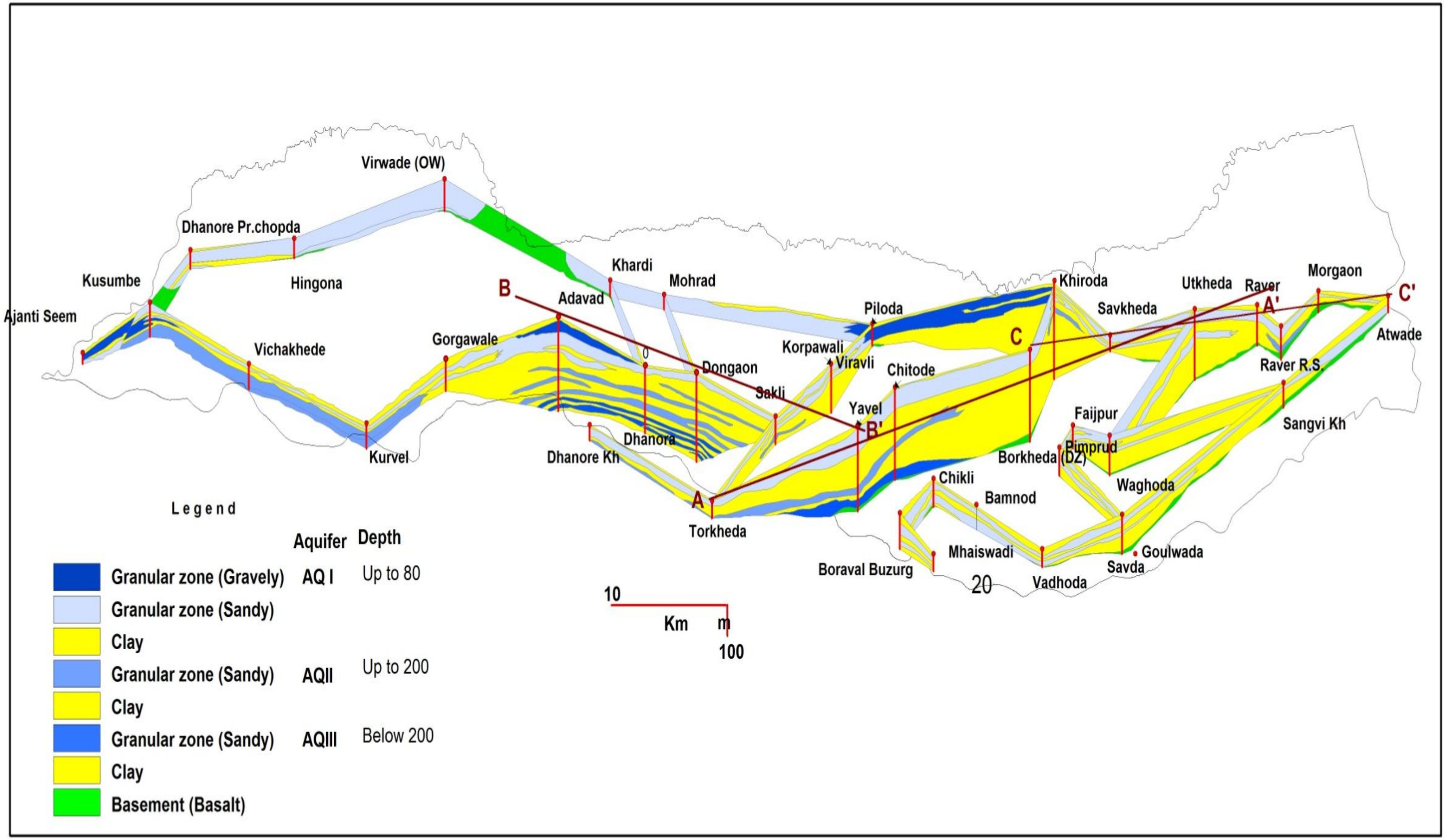

Fig. 3.10: 3-D Fence Diagram showing aquifer disposition.

3.7.1.2 Hydrogeological Cross Section B-B'

Hydrogeological cross section B-B' represents northwest – southeast direction and data of 5 exploratory wells i.e., Mangrule, Adwal, Dhanora, Dhangaon and Yaval has been utilised. In this section the disposition of Bazada aquifer (Gravely Granular Zone) is observed between Mangrule and Dhanora. The basement rock i.e., Basalt has been encountered in only two wells in north western part at Mangrule and at Yaval in south eastern part. The water levels has also been depicted in the section and a close observation of water level indicates that the water levels are residing below the start of Aquifer-I and thus sufficient part of Aquifer-I has been dewatered due to over-exploitation.

3.7.1.3 Hydrogeological Cross Section C-C'

Hydrogeological cross section C-C' represents east – west direction and data of 4 exploratory wells i.e., Borbheda, Utkheda, Raver and Adwad has been utilised. This section represents eastern part of the area and it is observed that Aquifer-II and III are not present in this area. In this section the alluvium thickness is maximum in western parts at Borbheda and gradually goes on decreasing towards east and at Adwad it is only 58 m. The basement rock i.e., Basalt has been encountered in all the wells.

3.8 Aquifer Characteristics

Three types of aquifers are observed in the area i.e., Bazada, Alluvium and Basalt, but the Alluvium aquifer is the main aquifer occurring in major part of the area. The aquifer characteristics of each of the aquifer as deciphered from the study are detailed below.

3.8.1 Bazada Aquifer

The Bazada aquifer is poorly sorted admixture of sand, pebbles, cobbles, boulders and sometimes clay and generally devoid of any layered sequence. The maximum thickness of these deposits is not known. However, around Naygaon, it is more than 100 m bgl thick.

The ground water in Bazada (Talus and Scree) formation occurs under unconfined and semi-confined conditions and form highly productive zone in the area. The formations are highly porous and permeable in nature, which facilitate ground water movement with much ease than in the Alluvial and Basaltic aquifers. The yield of dugwells occurring in this formation is generally higher than those tapping Basaltic and Alluvial aquifer. It generally ranges from 5 to more than 10 lps.

The depth of the dugwells in Bazada range from 16.20 to 70.60 m bgl which are the preferred ground water abstraction structures, ground water occurs in unconfined conditions and the depth to water level varies from 5.10 to 52.10 m bgl, however in majority of the wells it is between 20 and 40 m bgl.

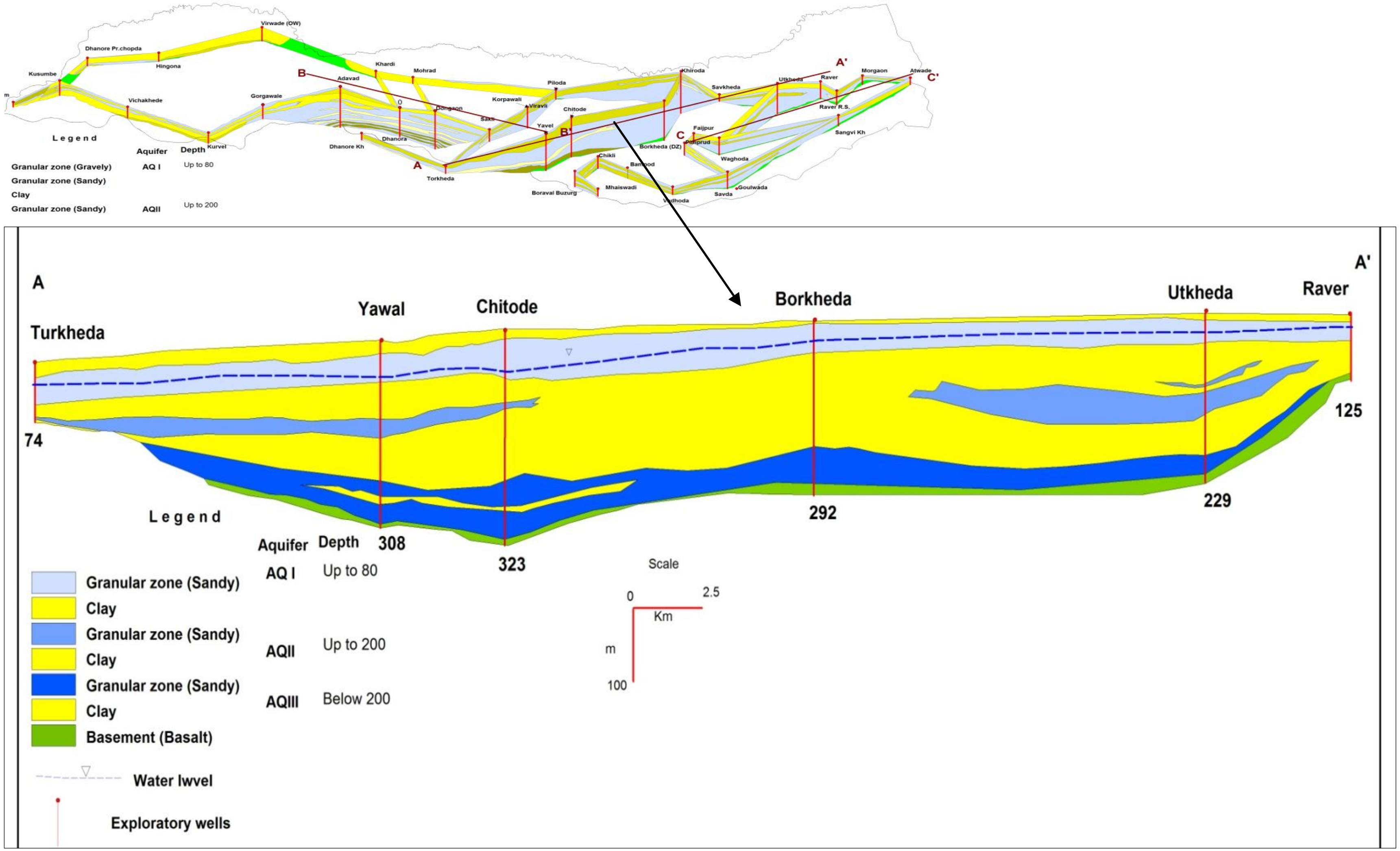

Fig. 3.11: Hydrogeological Section A-A'

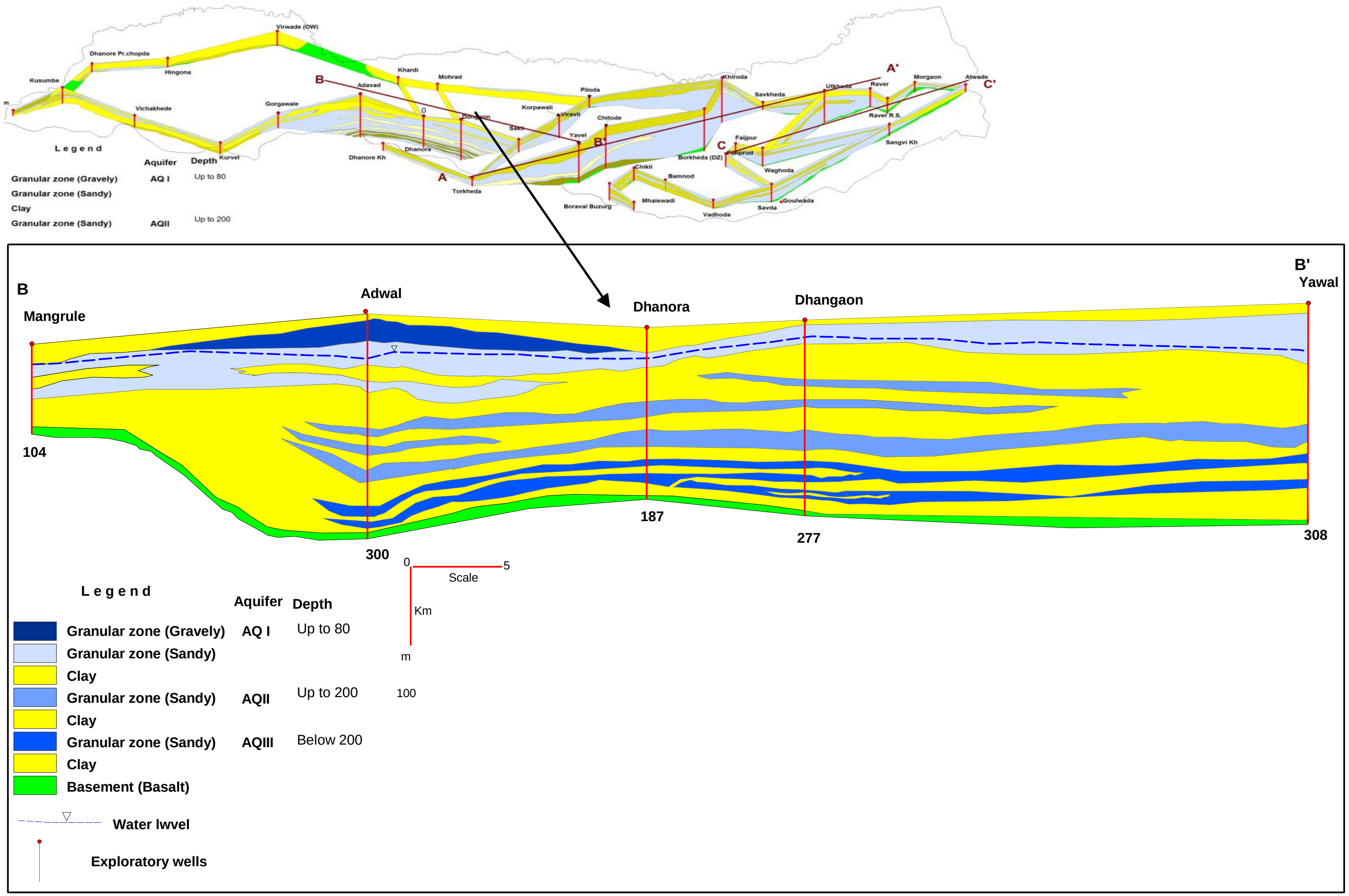

Fig. 3.12: Hydrogeological Section B-B'

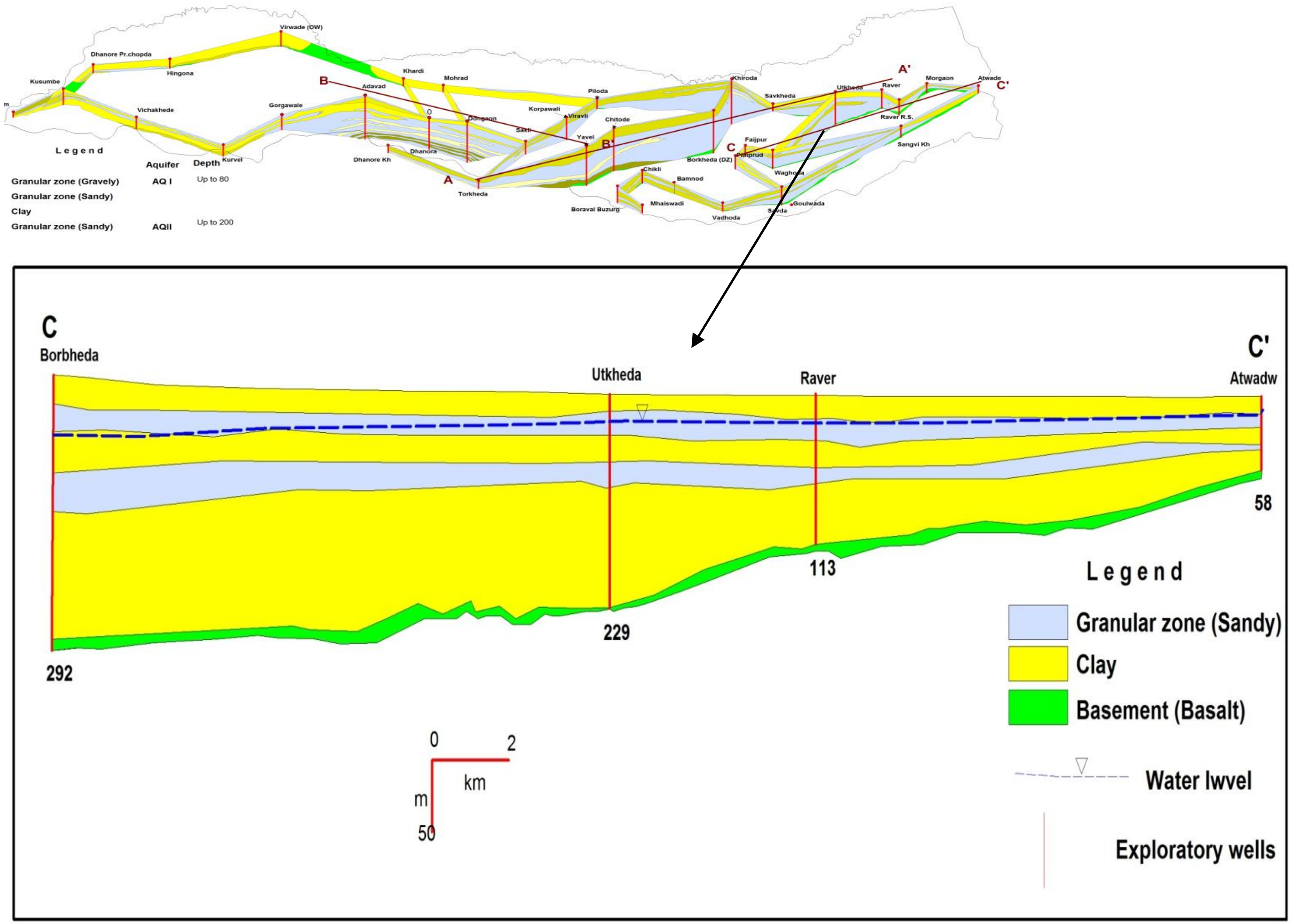

Fig. 3.13: Hydrogeological Section C-C’

3.8.2 Alluvium Aquifer

The alluvium aquifer is broadly divided in to three aquifers as narrated below and depicted in Fig 6.4.

Aquifer – I: Younger alluvium in upper zone occurring upto 80 mbgl;

Aquifer – II: Older alluvium in middle zone occurring from 80 to 200 mbgl and

Aquifer – III: Older alluvium in lower zone occurring beyond 200 m

The total thickness of alluvium is estimated to be more than 300 m along the foot hills of Satpuras. The southern part of the alluvium along the present Tapi River is only 30 to 50 m thick. In western part, the thickness ranges from 50 to 100 m, maximum thickness of more than 323 m in the central part, while in eastern part it ranges from 40 to 225 m.

3.8.2.1 Alluvium Aquifer –I

The spatial distribution of alluvial aquifer - I down to 80 m depth is depicted in **Fig. 3.15**. The perusal of figure reveals that the thickness of aquifer - I ranges from 30 to 80 m and comprises of 3 to 4 granular zones consisting mainly of sand, gravel and pebble beds entrapped in thick clay layers.

Table-3.2: Alluvial Aquifer – I Characteristics.

Depth Range	Upto 80 m
Granular thickness	2 to 67 m
Yield range	50 to 400 m3/day
Water level	15 to 50 m
Quality	Mainly Potable. High EC & Nitrate in eastern parts of Raver
GW Resource	324.33 MCM Dynamic + Instorage 2.84 = Total - 327.17 MCM

Thickness of granular thickness ranges from 2 to 67 m, however in major part of the area, the thickness of granular zones is within 40 m. The cumulative thickness, of granular zones in Aquifer-I, is higher in central part of the basin. The yield range of the aquifer varies from 50 to 400 m3/day, whereas water level ranges from 15 to 50 m. The ground water quality is potable in major part except high EC and nitrate in eastern parts of Raver taluka.

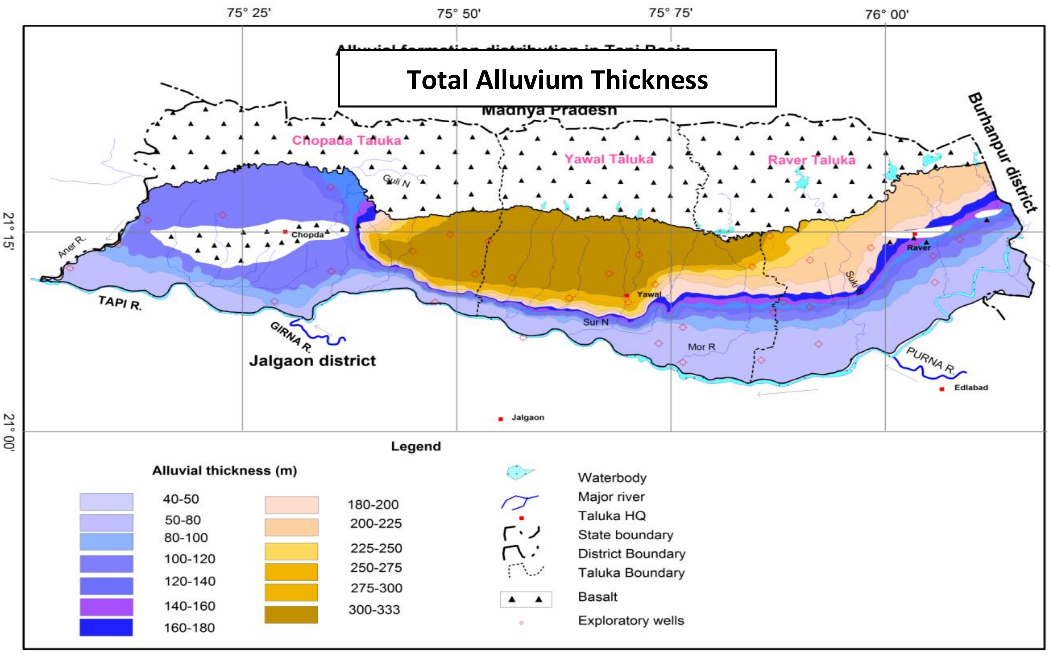

Fig.3.14: Total Alluvium Thickness.

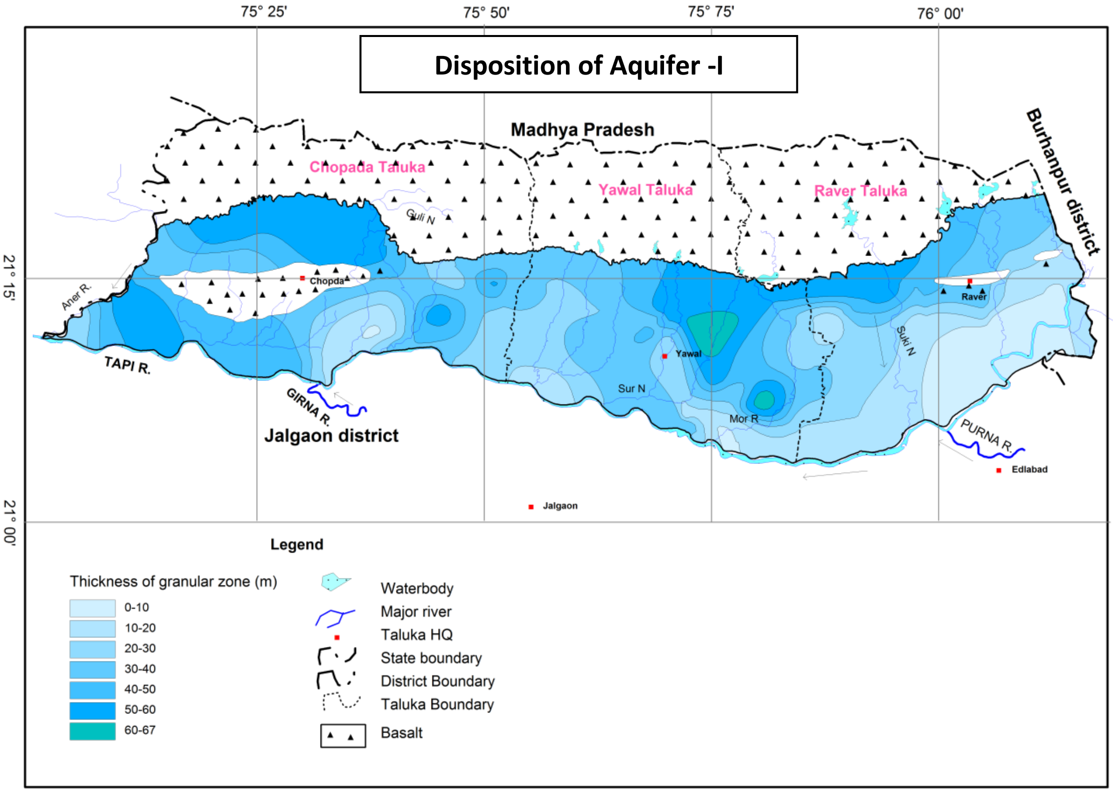

Fig.3.15: Disposition of Aquifer -I.

3.8.2.2 Alluvium Aquifer –II

The alluvial aquifer - II ranges in depth from 80 to 200 m and its spatial distribution is depicted in **Fig. 3.16**. The thickness of aquifer - II ranges from 10 to 120 m and comprising of only 2 to 3 granular beds consisting mainly of sand, gravel and pebbles. Thickness of these granular beds is observed to be between 2 and 30 m, however in major part of the area, the thickness of granular zones is within 5 m, which indicates that in Aquifer – II, the granular zones are thinner as compared to Aquifer-I. The cumulative thickness of granular zones occurring in Aquifer - II, is observed to be more in west-central part, the thickness is negligible in eastern part. The yield range of the aquifer varies from 200 to 400 m3/day, whereas water level ranges from 10 to 45 m. The ground water quality is potable in the entire area.

Table-3.3: Alluvial Aquifer – II Characteristics.

Depth Range	80 – 200 m
Granular thickness	2 to 30 m
Yield range	200 to 400 m3/day
Water level	10 to 45 m
Quality	Potable
GW Resource	34.53 MCM

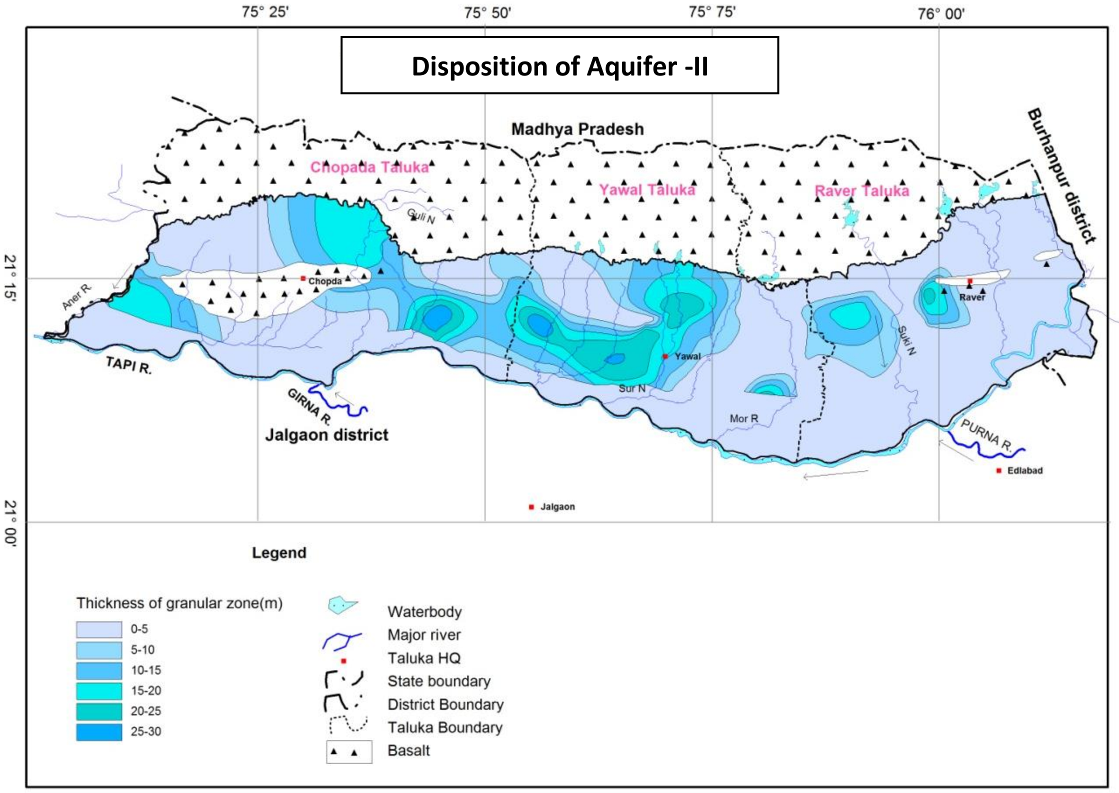

Fig.3.15: Disposition of Aquifer -II.

3.8.2.3 Alluvium Aquifer –III

The alluvial aquifer - III ranges in depth from 200 to 333 m and its spatial distribution is depicted in **Fig. 3.16**. The thickness of aquifer - III ranges from 5 to 135 m bgl and comprising of 2 to 3 granular beds consisting mainly of fine sand and gravel with thick interclaltions of clay. The Aquifer – III occurs in restricted area in centralpart. The thickness of granular zones is observed between 4 and 40 m. The cumulative thickness of granular zones in Aquifer - III is higher around Yaval town. The yield range of the aquifer varies from 200 to 400 m3/day, whereas water level ranges from 10 to 35 m. The ground water quality is potable in the entire area.

Table-3.4: Alluvial Aquifer – III Characteristics.

Depth Range	> 200 m (explored down to 330 m)
Granular thickness	4 to 40 m
Yield range	200 to 400 m3/day
Water level	10 to 35 m
Quality	Potable
GW Resource	8.61 MCM

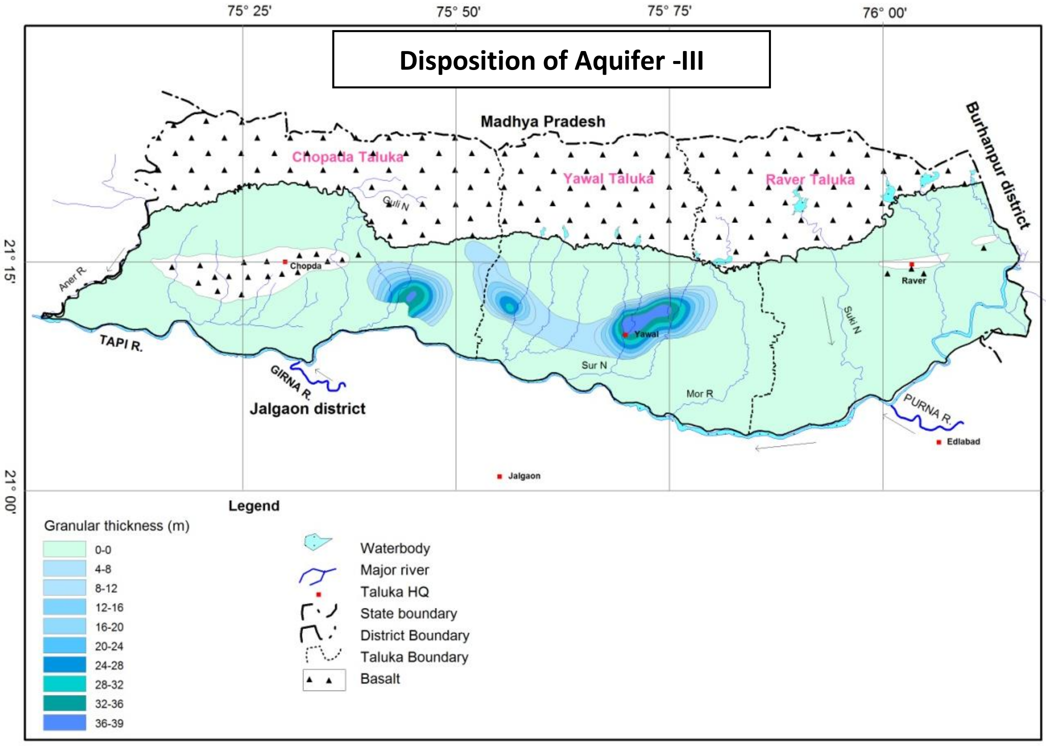

Fig.3.16: Disposition of Aquifer -III.

3.8.3 Deccan Trap Basalt Aquifer

Basalt occurs as inlier at two places in the area around Chopda and small part around Raver. It comprises two distinct units viz, upper vesicular unit and lower massive unit. The massive basalt is hard, compact and does not have primary porosity and hence impermeable. Weathering, jointing and fracturing induces secondary porosity in massive unit of basalt. In vesicular basalt, when vesicles are interconnected constitutes good primary porosity and when the vesicles are filled/ partly filled the porosity is limited. Ground water occurs under phreatic/ unconfined to semi-confined conditions in basalts.

The 3-D disposition of Basalt aquifer is shown in **Fig. 3.17** and the aquifer characteristics are presented in Table- 3.5.

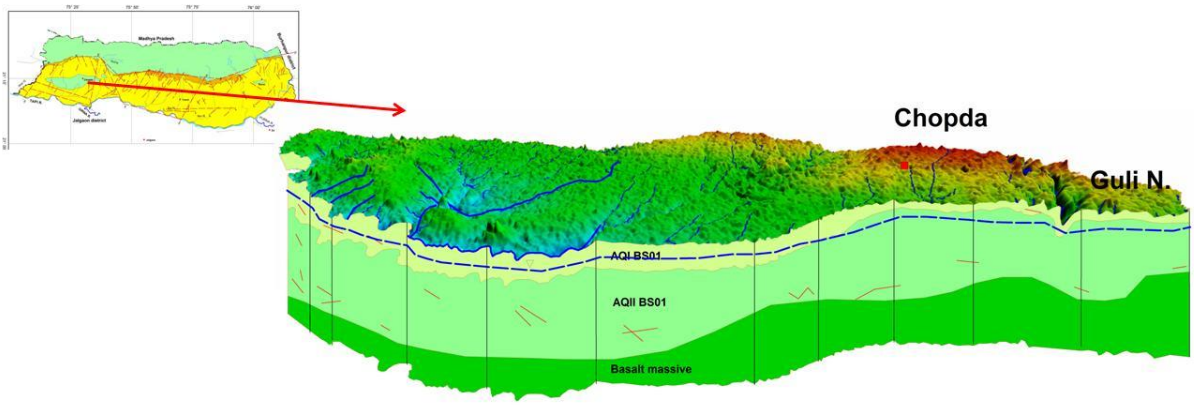

Fig. 3.17: 3-D Aquifer Disposition of Basalt Aquifer

The Aquifer-I is observed in the depth range of 10 to 25 m bgl with water levels of 7.50 to 18.50 m bgl and thickness of 0.50 to 4.00 m. The yield of the dugwells tapping this aquifer generally ranges from 1 to 20 m^3/day. The Aquifer –II is observed in the depth range of 18 to 153 m bgl with water levels of 5.40 to 19.75 m bgl and thickness of 0.50 to 3.00 m. The yield of the borewells tapping this aquifer generally ranges from 22 to 356 lpm.

Table- 3.5: Basalt Aquifer Characteristics.

Type of Aquifer	Formation	Depth range (mbgl)	SWL (mbgl)	Thickness (m)	Fracture Depth Range (m bgl)	Yield	Sustaina-bility	Transmissivity (m^2/day)	Sy/S	Suitability for drinking/ irrigation
Aquifer-I	Weathered/ Fractured Basalt	10-25	7.50 to 18.50	0.5 to 4.00	8 to 25	1-20 m^3/ day	1 to 2 Hours – recurring	-	0.02	Yes for both
Aquifer-II	Jointed/ Fractured Basalt	18-153	5.40 to 19.75	0.5 to 3	18 to 153	22 – 356 lpm	0.5 to 4 hours	360.05 to 562.81	3.47 x 10^{-3} to 3.96 x 10^{-4}	Yes for both

4 Ground Water Resources

The ground water resources have been assessed for three types of aquifer existing in the area i.e., Aquifer-I, Aquifer-II and Aquifer-III. The details of the assessment are discussed below.

4.1 Ground Water Resources – Aquifer-I

The ground water resource assessment as on March 2013 has been carried out and the salient features of the resources are given in Table 4.1, 4.2 and 4.3 and the map depicting the taluka wise distribution of ground water resources and categorisation of the talukas is presented in **Fig 4.1**.

As per Table-4.1, out of the total 303681 ha area, recharge worthy areas are 53963 ha in command areas and 233893 ha in non-command areas.

Table-4.1: Ground Water Recharge Worthy Areas for Resource Estimation

Taluka	Predominant Formation	Total Geographical Area (ha)	Hilly Area (ha)	Ground Water Recharge Worthy Area	
				Command area (ha)	Non-command area (ha)
Chopda	Alluvium	114265.00	4085.00	40448.00	69732.00
Raver	Alluvium	98066.00	4159.00	5989.00	87918.00
Yawal	Alluvium	91350.00	7581.00	7526.00	76243.00
Total		**303681**	**15825**	**53963**	**233893**

4.1.1 Recharge Component

During the monsoon season, the rainfall recharge is the main recharge parameter, which is estimated as the sum total of the change in storage and gross draft. The change in storage is computed by multiplying groundwater level fluctuation between pre and post monsoon periods with the area of assessment and specific yield. Monsoon recharge can be expressed as:-

$R = h \times Sy \times A + DG$

where,

h = rise in water level in the monsoon season, Sy = specific yield

A = area for computation of recharge, DG = gross ground water draft

The monsoon ground water recharge has two components- rainfall recharge and recharge from other sources. The other sources of groundwater recharge during monsoon season include seepage from canals, surface water irrigation, tanks and ponds, ground water irrigation, and water conservation structures.

During the non-monsoon season, rainfall recharge is computed by using Rainfall Infiltration Factor (RIF) method. Recharge from other sources is then added to get total non-monsoonrecharge.

The season wise and taluka wise assessment of recharge from various components such as rainfall and other sources for various units was done and presented in Table-4.2 and **Fig.4.1**. The recharge from rainfall contributes maximum component (25037.78 ham) during monsoon season and recharge from other sources (7202.13 ham). The total annual ground water recharge is 34238.90 ham and net ground water availability after natural discharge is 32434.41 ham.

Table-4.2: Recharge Components evaluated for Resource Estimation

Administrative Unit	Command / Non-Command / Total	Recharge from rainfall during monsoon season (ham)	Recharge from other sources during monsoon season (ham)	Recharge from rainfall during non-monsoon season (ham)	Recharge from other sources during non-monsoon season (ham)	Total Annual Ground Water Recharge (ham)	Provision for Natural Discharges (ham)	Net Annual Ground Water Availability (ham)
Chopda	Command	3256.32	18.36	35.32	2778.15	6088.15	396.96	5691.19
Chopda	Non Command	5844.80	151.43	69.53	872.36	6938.13	346.91	6591.22
Chopda	**Total**	**9101.12**	**169.80**	**104.85**	**3650.51**	**13026.27**	**743.86**	**12282.41**
Raver	Command	522.24	91.69	65.59	875.18	1554.70	77.74	1476.97
Raver	Non Command	7680.34	176.74	956.56	1503.62	10317.26	515.86	9801.39
Raver	**Total**	**8202.58**	**268.42**	**1022.15**	**2378.81**	**11871.96**	**593.60**	**11278.36**
Yawal	Command	699.65	98.35	12.87	581.22	1392.09	69.60	1322.48
Yawal	Non Command	7034.43	152.97	169.60	591.59	7948.59	397.43	7551.16
Yawal	**Total**	**7734.08**	**251.31**	**182.48**	**1172.81**	**9340.67**	**467.03**	**8873.64**
Area Total		**25037.78**	**689.53**	**1309.48**	**7202.13**	**34238.9**	**1804.49**	**32434.41**

As per Table 4.2, the net annual ground water availability comes to be 32434.41 ham. The annual gross draft for all uses is estimated at 30949.63 ham with irrigation sector being the major consumer having a draft of 30111.24 ham. The annual draft for domestic and industrial uses was 838.38 ham. The allocation for domestic & industrial requirement supply up to next 25 years is about 1263.07 ham.

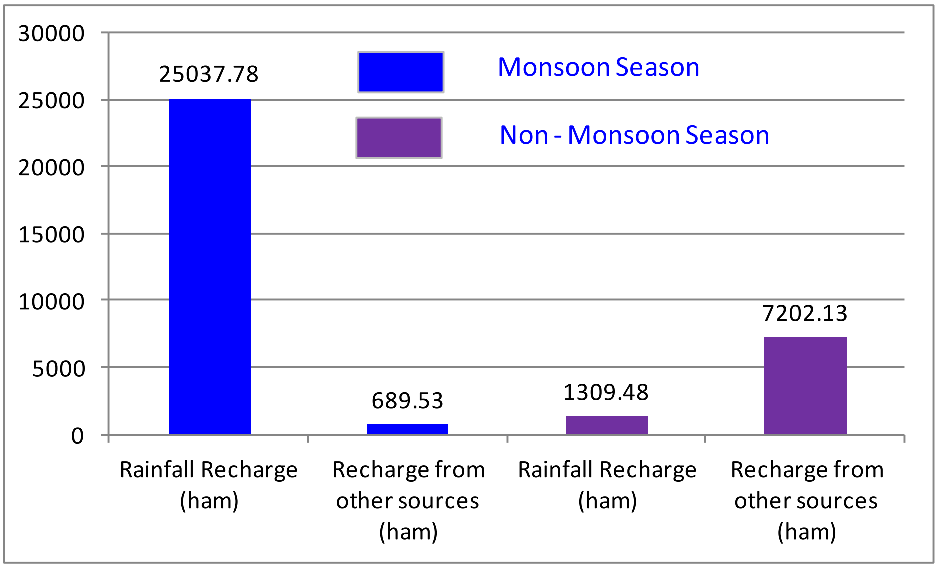

Fig.4.1: Season wise recharge from various sources

The perusal of table indicates that the demand of water for is much higher than its natural recharge, as out of 3 administrative units (Talukas) in Tapi Basin, two talukas namely Yaval and Raver are categorised as "Over-Exploited" and Chopda taluka is categorised as "Safe". However its stage of development is also more than 70% i.e., 75% but due to insignificant falling trend in premonsoon and rising trend in postmonsoon season it is categorised as Safe. Thus there is not much scope for future ground water development unless the aquifers is augmented.

Table- 4.3: Ground Water Resources Availability, Draft and Stage of GW Development

Taluka	Command / Non-Command / Total	Net Annual Ground Water Availability (ham)	Existing Gross Ground Water Draft for irrigation (ham)	Existing Gross Ground Water Draft for domestic and industrial water supply (ham)	Existing Gross Ground Water Draft for All uses (ham)	Provision for domestic and industrial requirement supply to 2025 (ham)	Net Ground Water Availability for future irrigation development (ham)	Stage of Ground Water Development (%)	Category
Chopda	Command	5691.19	4485.04	147.44	4632.48				
Chopda	Non Command	6591.22	4457.04	198.32	4655.35				
Chopda	**Total**	**12282.41**	**8942.08**	**345.75**	**9287.84**	**628.64**	**3168.06**	**75.62**	**Safe**
Raver	Command	1476.97	3793.57	55.88	3849.44				
Raver	Non Command	9801.39	8312.52	218.95	8531.47				
Raver	**Total**	**11278.36**	**12106.09**	**274.82**	**12380.91**	**335.20**	**0**	**109.78**	**Over Exploited**
Yawal	Command	1322.48	2745.25	52.64	2797.89				
Yawal	Non Command	7551.16	6317.82	165.17	6482.99				
Yawal	**Total**	**8873.64**	**9063.07**	**217.81**	**9280.88**	**299.23**	**0**	**104.59**	**Over Exploited**
Area Total		**32434.41**	**30111.24**	**838.38**	**30949.63**	**1263.07**	**3168.06**		

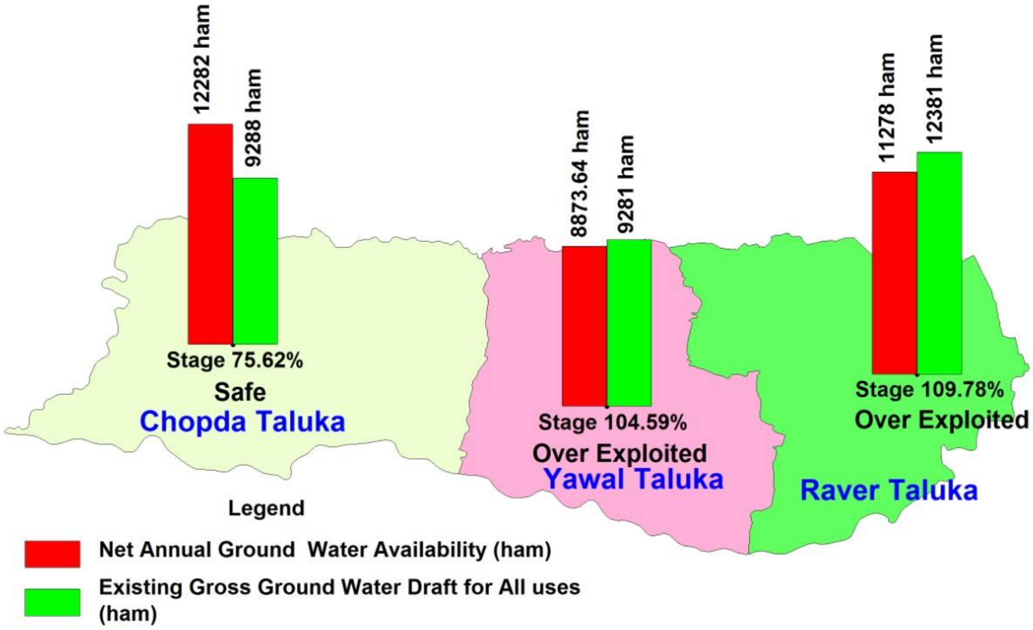

Fig.4.2: Ground Water Resources

4.2 Ground Water Resources – Aquifer-II and Aquifer-III

The ground water resource of the aquifer –II and III were also estimated to have the corret quantification of resources so that proper management strategy can be framed. To assess these resources, the area was divided into 4816 polygons based on the granular zones occurring below water level and the thickness of aquifer –II and III in that particular polygon (if present), then the storativity value for the nearest exploratory well was taken into consideration. By applying the formula of deeper ground water resource estimation as given by CHQ during the static ground water resources was utilised i.e.,

GWR = Area x Thickness of aquifer x Storativity

By applying above formula, the ground water resources of aquifer-II and III were estimated and are presented below in Table- 4.4. Thus the total resources of aquifer-II and III have been estimated as 34.53 and 8.61 MCM respectively. Due to absence of aquifer-III in Raver taluka, the resources for that aquifer in Raver taluka are Nil.

Table- 4.4: Ground Water Resources of Aquifer-II and III.

S. No.	Taluka	GWR – Aquifer-II	GWR – Aquifer-III
1.	Chopda	6.38	2.59
2.	Raver	15.25	0
3.	Yaval	12.90	6.02
4.	**Total**	**34.53**	**8.61**

5 GROUND WATER RELATED ISSUES

The study area forms part of Tapi Alluvial Basin and is famous for banana cultivation. It has witnessed large scale ground water development to suffice the water needs of cash crops particularly banana crop resulting in over-exploitation of ground water resources. This has cascading effects on ground water regime of the area as large scale water level decline has been observed. Though the farmers of the area have adapted large scale micro irrigation techniques, however limited ground water availability has stunted the increase in irrigation potential. The major issues afflicting the areas are discussed below

5.1 Cash Crop Cultivation

The cultivation of cash crop banana is wide spread and covers an area of about 400 sq.km.'s (**Fig. 5.1**) and entire cultivation is supported by ground water based irrigation. Banana is a water intensive crop with crop period of 12-15 months and annual crop water requirement is to the tune of 1.70 m. Thus huge quantum of ground water is required to sustain the crop for such a long duration of 12 to 15 months.

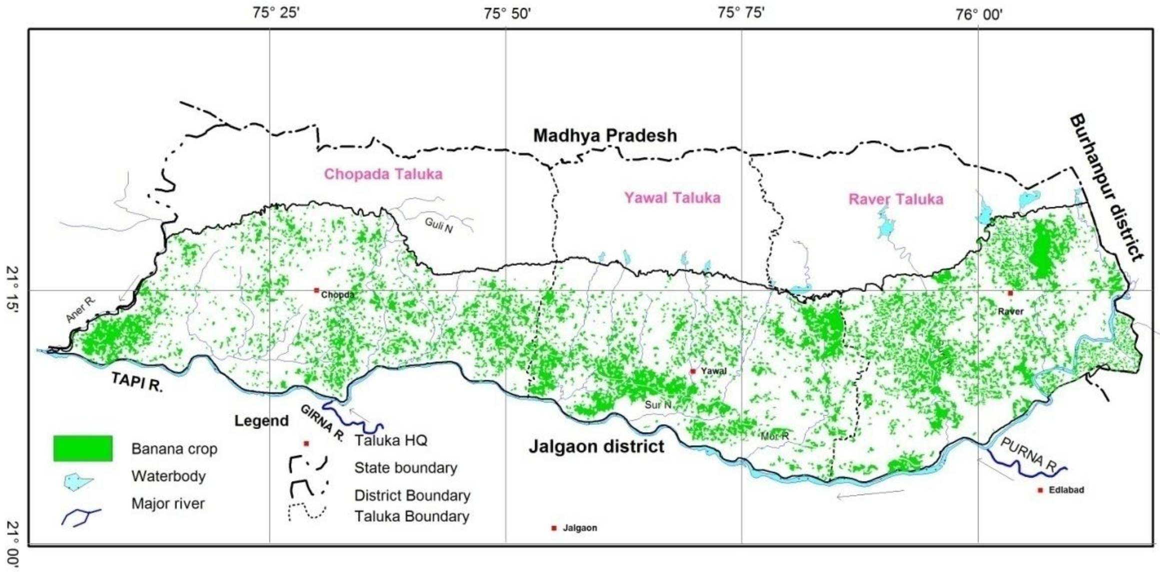

Fig.5.1: Area occupied by Banana Cultivation.

5.2 Over Exploitation

The stage of ground water development has increased over the period of time from 2004 to 2011 in 2 talukas from 80.23% to 85.54% in Chopda taluka; from109.92% to 133.80% in Yaval taluka, whereas in Raver taluka it has decreased from 133.37% to 123.39%. In 2013, the stage of ground water development has decreased in all the 3 talukas (**Fig. 5.2**). However, still the Yaval and Raver talukas have been categorised as Over-Exploited and Chopda taluka even though being categorised as Safe, it can again migrate towards semi-critical if necessary precautions are not put in place.

The main reason for ground water overdraft is for irrigation purpose (**Fig.5.3**). The draft for these 3 talukas has increased from 291.96 MCM in 2004 to 301.11 MCM in 2013.

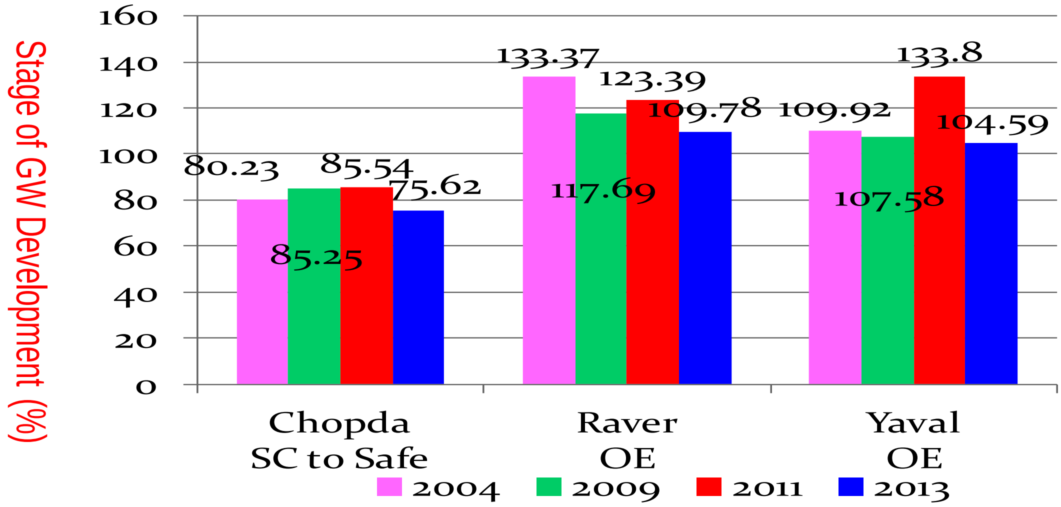

Fig.5.2: Increase in Stage of GW Development

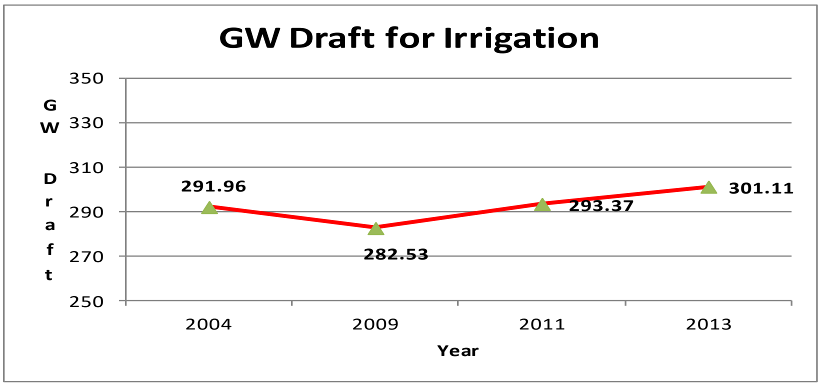

Fig.5.3: Increase in GW Draft for Irrigation

5.3 Deeper Water Levels

The ground water exploitation has resulted in lowering of water levels and over a period of time, the ground water levels have gone down considerably. At present, the deeper water level areas of more than 20 m bgl are observed in 1051 sq.km. area i.e., 55% of the area. (**see Fig.3.2**).

5.4 Declining Water Levels

The ground water exploitation has resulted also resulted in declining of water levels over the period of time. At present, the declining water level trend of more than 0.20 m/year has been observed in about 1492 sq.km area during 2005-14 i.e., 76% of the area (**see Fig.3.8**).

5.5 De-saturated Granular Zones

The ground water exploitation has resulted also resulted in de-saturation of granular zones. The granular zones consisting of sand, gravel and pebbles form the potential ground water aquifer in alluvium. These granular zones in different proportions occur at various depths overlained and underlained by the thick and thin clay beds. The data and lithological logs generated during ground water exploration programme of CGWB and data obtained from State ground water department was utilized for identifying the disposition of granular zones and spatial distribution of water levels was also prepared. Based on the overlay analysis of these two GIS layers, the spatial distribution of de-saturated aquifers was obtained (**Fig.5.3**). The total area which has been identified as occupied by de-saturated granular zones is 1039 sq.km.

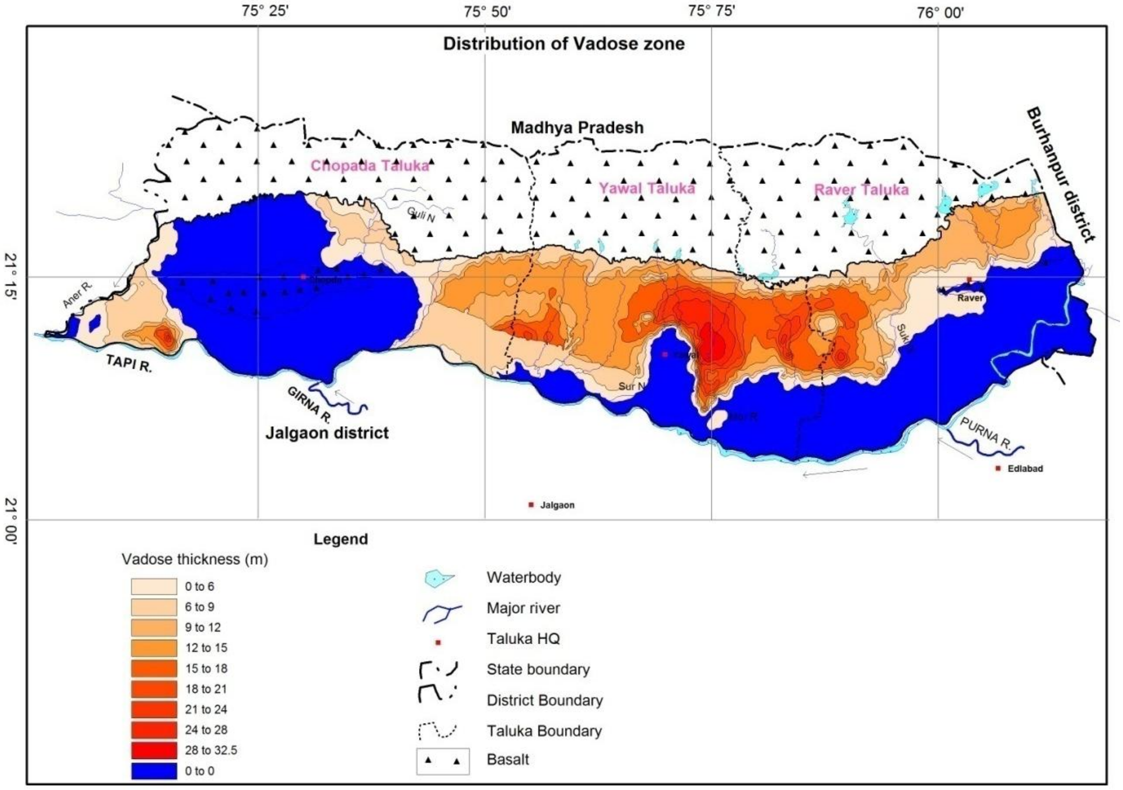

Fig.5.3: De-saturated Granular Zones.

5.6 Micro Irrigation Techniques

Micro Irrigation practices are being practiced in the area since last decade or so. The preference of the people/stake holders has also shifted from the surface water irrigation to ground water irrigation because almost 100% of the farmers have shifted from flood irrigation to modern irrigation practices particularly for banana crop. The ground water based drip irrigation system is preferred in the area to obtain maximum yield of the cash crop like banana as canal / surface water is less suitable for banana cultivation. The ground water is also the most dependable source of water supply at the time of crop requirement. Total area irrigated by ground water based drip irrigation is 517.34 sq.km as per the data provided by Agriculture Dept. out of the total irrigated area of out of the total ground water irrigated area of 707.52 sq.km.

Thus further scope of implementing the water use efficiency measures by drip/sprinkler to save or manage the ground water resources are almost negligible in the area.

6 Proposed Management Strategy

The present stage of development in these 3 talukas is 75.62% in Chopda taluka, 109.78% in Raver taluka and 104.59% in Yaval taluka. The ground water over development is taking place in these areas on account of irrigation requirement of cash crops like banana and sugarcane. Due to dwindling ground water resources, the farmers have shifted to drip irrigation in 517.34 sq.km out of the total ground water irrigated area of 707.52 sq.km., thus further scope for savings of water by means of the drip irrigation in ground water irrigated area is minimal.

Ground water management strategy has been prepared with the objective of bringing the current stage of ground water development down to 70% so that the taluka/block comes under Safe category by adopting both supply side and demand side interventions. The taluka/block wise sustainable management plan have been suggested for these 3 talukas based on data gap analysis, data generated in-house, data acquired from State Govt. departments and GIS maps prepared for various themes. All the available data was brought on GIS platform and an integrated approach was adopted for preparation of aquifer maps and aquifer management plans of Chopda (OE), Raver (OE) and Yaval (OE) taluka of Jalgaon district which are presented in Table 6.1 and discussed below.

6.1 Aquifer Management plan for Chopda Taluka

The geographical area of Chopda Taluka is 1142.65 sq. km. and the stage of ground water development is **75.62%** and categorised as Safe. Three aquifer systems have been identified in Chopda taluka in Alluvial formation with 1st aquifer upto 80 m depth, 2nd aquifer upto 200 m depth with granular thickness of upto 25 m and 3rd aquifer below 200 m depth occurring in eastern part of the taluka with granular thickness of upto 28 m. Whereas in Deccan Trap Basalt areas, two aquifer system has been identified, with 1st aquifer observed in the depth range of 10 to 25 m bgl and 2nd aquifer in the depth range of 18-153 m bgl. The annual replenishable ground water resource available in Aquifer I is 122.82 MCM and the gross ground water draft for all uses is 92.87 MCM. Whereas the ground water resource available in Aquifer II and III are 6.38 MCM and 2.59 MCM respectively.

Supply side interventions are proposed to tackle the over-exploitation through Rainwater harvesting and artificial recharge. The volume of unsaturated granular zone available in Chopda taluka is worked out as 3016.80 MCM. The recharge potential of the aquifer has been estimated as 283.65 MCM. To meet this recharge potential, the surface water requirement will be 377.25 MCM, however the surplus surface runoff availability is limited to the tune of 9.15 MCM, which has been considered for planning of artificial recharge measures to tackle the over-exploitation condition. To utilise this quantum of 9.15 MCM of surface water in the taluka, a total of 21 percolation tanks, 30 check dams and 68 recharge shafts are recommended to be constructed in the taluka. The volume of water expected to be conserved/recharged @75% efficiency will be 3.15 MCM through percolation tank, 0.68 MCM through check dams and 3.06 MCM by means of recharge shaft. The cost estimates for 21 percolation tank, 30 check dams and 180 recharge shafts are Rs. 31.50 crores, Rs. 9.00 crores and Rs. 1.70 crores respectively. The proposed locations of artificial recharge structures are given in **Annexure VII** and are shown in **Fig 6.1.**

The rainwater harvesting in urban areas can be adopted in 25% of the household (12987) with 50 Sq. m roof area. A total of 0.38 MCM potential can be harvested by considering 80% runoff coefficient. The estimated cost for rainwater harvesting through roof top is calculated as Rs. 19.48 crores. Hence this technique is not economically viable and therefore it is not recommended.

Overall total volume of water expected to be recharged or conserved by artificial recharge is 6.89 MCM with a cost estimate of Rs. 42.20 crores, excluding Roof top rain water harvesting which is not economically viable.

Demand side interventions such as change in cropping pattern has not been proposed in the area as banana crop which is the principal crop of the area drives the economy of the region. As discussed earlier, the scope for increasing areas under micro-irrigation techniques like drip irrigation are also minimal in the area as out of 292.44 sq.km area covered by ground water irrigation, about 205.46 sq.km area has already been covered by drip irrigation.

Alternative surface water sources to the tune of 101.74 MCM will be available in the area in the form of Tapi Mega Recharge Scheme being proposed by MoWR, RD & GR. The implementation of the scheme will augment the ground water recharge to the tune of 76.31 MCM and the aquifers of the area will be able to accept this much quantum of water as the total recharge potential of the aquifer in this taluka is about 283.65 MCM.

The additional ground water resources augmented in Chopda taluka by regular artificial recharge structures will be 6.89 MCM, whereas by Tapi Mega Recharge Scheme it will be 76.31 MCM and the total resources available will be 83.20 MCM, whereas resources required for bringing stage of ground water development from existing 75.62% to 70% are 6.90 MCM. Thus an additional quantum of ground water to the tune of 76.30 MCM will be available in the taluka after bringing the stage of ground water development to 70%. This 76.30 MCM of ground water resource can bring an additional area of 117.38 sq.km., under assured ground water based irrigation considering the crop water requirement of 0.65 m.

6.2 Aquifer Management plan for Raver Taluka

The geographical area of Raver Taluka is 980.66 sq. km. and the stage of ground water development is **109.78%** and categorised as Over-Exploited. Two aquifer systems have been identified in Raver taluka in Alluvial formation with 1st aquifer upto 80 m depth with maximum thickness of granular zone being 60 m, 2nd aquifer upto 200 m depth with granular thickness of upto 20 m, whereas the 3rd aquifer below 200 m depth present in other two talukas is absent in Raver taluka. The annual replenishable ground water resource available in Aquifer I is 112.78 MCM and the gross ground water draft for all uses is 123.80 MCM. Whereas the ground water resource available in Aquifer II are 15.25 MCM.

Supply side interventions are proposed to tackle the over-exploitation through Rainwater harvesting and artificial recharge. The volume of unsaturated granular zone available in Raver taluka is worked out as 3027.57 MCM. The recharge potential of the aquifer has been estimated as 294.22 MCM. To meet this recharge potential, the surface water requirement will be 391.31 MCM, however the surplus surface runoff availability is limited to the tune of 12.20 MCM, which has been considered for planning of artificial recharge measures to tackle the over-exploitation condition. To utilise this quantum of 14.42 MCM of surface water in the taluka, a total of 31 percolation tanks, 12 check dams and 95 recharge shafts are recommended to be constructed in the taluka. The volume of water expected to be conserved/recharged @75% efficiency will be 4.65 MCM through percolation tank, 0.27 MCM through check dams and 4.28 MCM by means of recharge shaft. The cost estimates for 31 percolation tank, 12 check dams and 95 recharge shafts are Rs. 46.50 crores, Rs. 3.60 crores and Rs. 2.38 crores respectively. The proposed locations of artificial recharge structures are given in **Annexure VIII** and are shown in **Fig 6.1.**

Table 6.1- Proposed Ground Water Management Plans for Chopda, Raver and Yaval Talukas, Jalgaon District

Block	Chopda	Raver	Yawal	Total
District	Jalgaon	Jalgaon	Jalgaon	
State	Maharashtra	Maharashtra	Maharashtra	
Area	1142.65	980.66	913.51	
Major Issues Identified	Over - Exploitation Declining & Deepening WL De-saturation of Aquifer-I	Over - Exploitation Declining & Deepening WL De-saturation of Aquifer-I	Over - Exploitation Declining & Deepening WL De-saturation of Aquifer-I	
Stage of GW Development	75.62%	109.78%	104.59%	
Annual Available Resource (MCM)	122.82	112.78	88.73	324.33
Gross Annual Draft (MCM)	92.87	123.80	92.80	309.47
DEMAND (MCM)				
Agricultural demand -Rainfed	212.41	151.37	138.37	502.15
Agricultural demand -GW	160.52	323.22	169.38	653.12
Agricultural demand -SW	133.11	29.20	110.20	272.51
Domestic demand - GW	4.71	1.14	13.60	19.45
Domestic demand - SW	1.57	0.38	4.53	6.48
Total Demand(MCM)	**512.32**	**505.31**	**436.08**	**1453.71**
SUPPLY (MCM)				
Agricultural Supply -Rainfed	212.41	151.37	138.37	502.15
Agricultural Supply -GW	92.93	177.27	102.33	372.53
Agricultural Supply -SW	133.11	29.20	110.60	272.91
Domestic Supply - GW	4.71	1.14	13.60	19.45
Domestic Supply - SW	1.57	0.38	4.53	6.48
Total supply (MCM)	**444.73**	**359.36**	**369.43**	**1173.52**
DEMAND - SUPPLY GAP (MCM)	67.59	145.95	66.65	280.19
Gap met from Existing Micro Irrigation Techniques	67.59	145.95	66.65	280.19
PRESENT DEMAND - SUPPLY GAP (MCM)	0.00	0.00	0.00	0.00
GAP TO BRING STAGE OF GWD UPTO 70%	6.90	44.85	30.69	82.44
TOTAL GAP TO BRING STAGE OF GWD UPTO 70%	6.90	44.85	30.69	82.44
Interventions proposed to deal with overexploitation				
SUPPLY SIDE INTERVENTIONS				

Block	Chopda	Raver	Yawal	Total
Rainwater Harvesting and Artificial Recharge				
Volume of unsaturated granular zone(MCM)	3016.80	3027.57	6072.59	12116.96
Recharge Potential (MCM)	283.65	294.22	583.02	1160.89
Surface water requirement @ 75% efficiency (MCM)	377.25	391.31	775.39	1543.95
Availability of Surplus surface runoff (MCM)	9.15	12.20	12.80	34.15
Proposed Structures				
Percolation Tank (@ Rs.150 lakh, Av. Gross Capacity-100 TCM*2 fillings = 200 TCM) **Volume** of Water expected to be conserved / **recharged** @ 75% efficiency (MCM) Estimated Expenditure (Rs. in Cr.)	21 no.'s 3.15 MCM Rs. 31.50 crore	31 no.'s 4.65 MCM Rs. 46.50 crore	30 no.'s 4.50 MCM Rs. 45.00 crore	82 12.30 MCM Rs. 123 crore
Check Dam (@ Rs.30 lakh, Av. Gross Capacity-10 TCM * 3 fillings = 30 TCM) **Volume** of Water expected to be conserved / **recharged** @ 75% efficiency (MCM) Estimated Expenditure (Rs. in Cr.)	30 no.'s 0.68 MCM Rs. 9.00 crore	12 no.'s 0.27 MCM Rs. 3.60 crore	0 0 0	42 0.95 MCM Rs. 12.60 crore
Recharge Shaft (@ Rs.2.5 lakh, Av. Gross Capacity-60 TCM) **Volume of Water** expected to be conserved / **recharged** @ 75% efficiency (MCM) **Estimated Expenditure** (Rs. in Cr.)	68 no.'s 3.06 MCM Rs. 1.70 crore	95 no.'s 4.28 MCM Rs. 2.38 crore	114 no.'s 5.13 MCM Rs. 2.85 crore	277 12.47 MCM Rs. 6.93 crore
RTRWH - Urban Areas				
Households to be covered	12987	13725	12156	38868
Total RWH potential	0.47	0.51	0.45	1.43
Rainwater harvested / recharged @ 80% runoff co-efficient	0.38	0.41	0.36	1.15
Estimated Expenditure (Rs. in Cr.)	19.48	20.59	18.23	58.3
Total volume of water expected to be recharged/conserved by AR	6.89	9.20	9.63	25.71
Total Estimated Expn. for AR (Rs. In Crore)	45.00	48.25	44.05	137.3

DEMAND SIDE INTERVENTIONS	Chopda	Raver	Yawal	Total
Proposed Cropping Pattern change	None			
Micro irrigation techniques	Already existing in major areas	Already existing in major areas	Already existing in major areas	Already existing in major areas
Alternate Sources				
Alternative ground water sources	Nil	Nil	Nil	Nil
Alternative surface water sources - Tapi Mega Recharge Scheme	101.74	87.18	89.21	278.13
Quantum of water recharged- Tapi MRS	76.31	65.39	66.91	208.61
Probable Benefits				
Additional GW resources available after implementing above measures	83.19	74.58	76.54	234.31
Resources required to bring stage upto 70% (MCM)	6.90	44.85	30.69	82.44
Reduction in stage of GW Development	From 75.62% to 70%	From 109.78% to 70%	From 104.59% to 70%	
Additional GW resources available after bringing down stage of GWD to 70% (MCM)	76.30	29.73	45.85	151.87
Additional Area proposed to be brought under assured GW irrigation (sq.km.)	117.38	45.74	70.54	233.65
Regulation				
Regulatory Measures	Regulation of wells below 80 m	Regulation of wells below 80 m	Regulation of wells below 80 m	

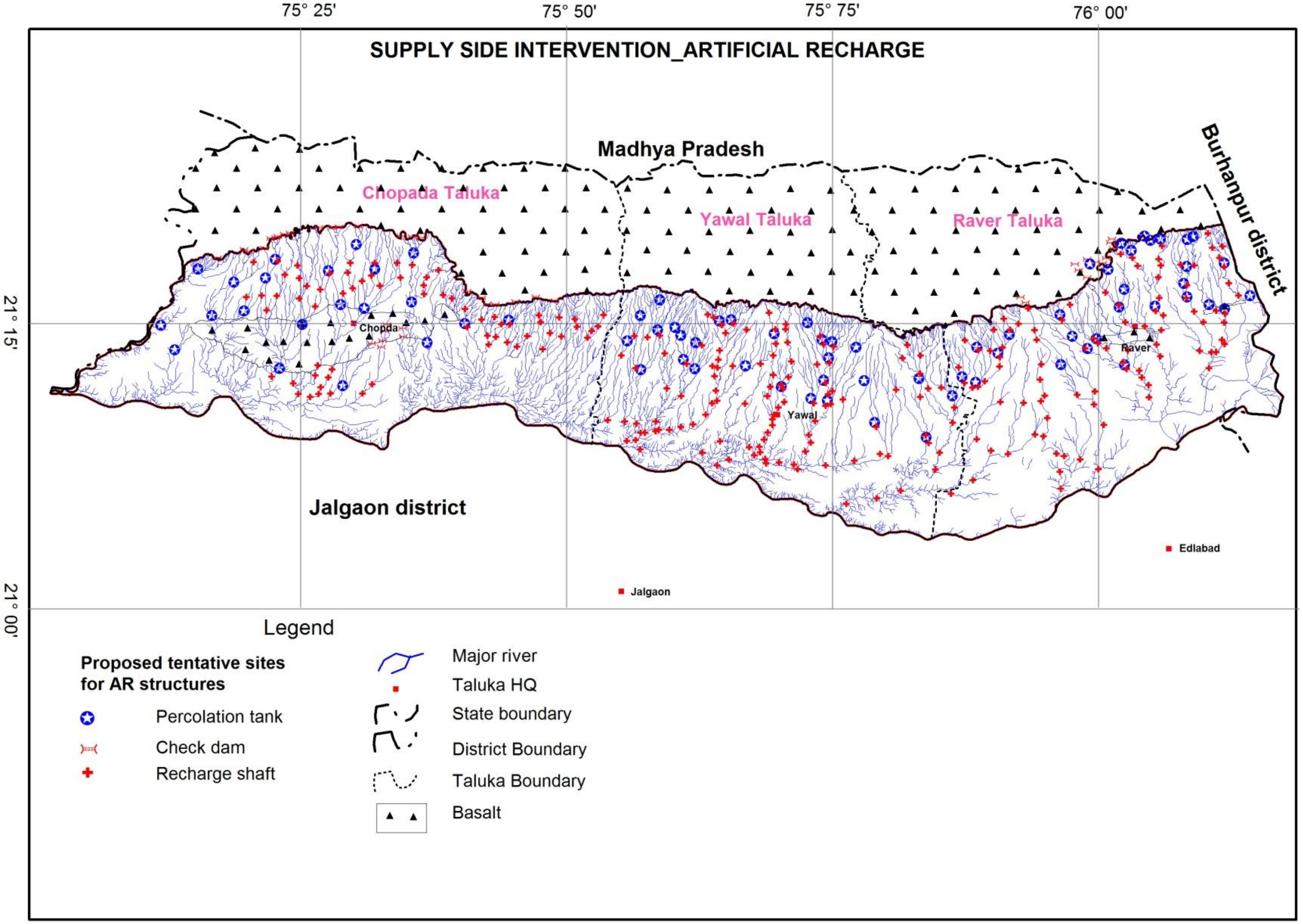

Fig. 6.1- Locations of proposed Artificial Recharge Structures.

The rainwater harvesting in urban areas can be adopted in 25% of the household (13725) with 50 Sq. m roof area. A total of 0.41 MCM potential can be harvested by considering 80% runoff coefficient. The estimated cost for rainwater harvesting through roof top is calculated as Rs. 20.59 crores. Hence this technique is not economically viable and therefore it is not recommended.

Overall total volume of water expected to be recharged or conserved by artificial recharge is 9.20 MCM with a cost estimate of Rs. 52.48 crores, excluding Roof top rain water harvesting which is not economically viable.

Demand side interventions such as change in cropping pattern has not been proposed in the area as banana crop which is the principal crop of the area drives the economy of the region. As discussed earlier, the scope for increasing areas under micro-irrigation techniques like drip irrigation are also minimal in the area as out of 292.44 sq.km area covered by ground water irrigation, about 205.46 sq.km area has already been covered by drip irrigation.

Alternative surface water sources to the tune of 87.18 MCM will be available in the area in the form of Tapi Mega Recharge Scheme being proposed by MoWR, RD & GR. The implementation of the scheme will augment the ground water recharge to the tune of 65.39 MCM and the aquifers of the area will be able to accept this much quantum of water as the total recharge potential of the aquifer in this taluka is about 294.22 MCM.

The additional ground water resources augmented in Raver taluka by regular artificial recharge structures will be 9.20 MCM, whereas by Tapi Mega Recharge Scheme it will be 65.39 MCM and the total resources available will be 74.58 MCM, whereas resources required for bringing stage of ground water development from existing 109.78% to 70% are 44.85 MCM. Thus an additional quantum of ground water to the tune of 29.73 MCM will be available in the in the taluka after bringing the stage of ground water development to 70%. This 29.73 MCM of ground water resource can bring an additional area of 45.74 sq.km., under assured ground water based irrigation considering the crop water requirement of 0.65 m.

6.3 Aquifer Management plan for Yaval Taluka

The geographical area of Yaval Taluka is 913.51 sq. km. and the stage of ground water development is **104.59%** and categorised as Over-Exploited. Three aquifer systems have been identified in Yaval taluka in Alluvial formation with 1st aquifer upto 80 m depth with maximum thickness of granular zones encountered being 67 m, 2nd aquifer upto 200 m depth with granular thickness of upto 30 m and 3rd aquifer below 200 m depth occurring in eastern part of the taluka with granular thickness of upto 39 m. The annual replenishable ground water resource available in Aquifer I is 88.73 MCM and the gross ground water draft for all uses is 92.80 MCM. Whereas the ground water resource available in Aquifer II and III are 12.90 MCM and 6.02 MCM respectively.

Supply side interventions are proposed to tackle the over-exploitation through Rainwater harvesting and artificial recharge. The volume of unsaturated granular zone available in Yaval taluka is worked out as 6072.59 MCM. The recharge potential of the aquifer has been estimated as 583.02 MCM. To meet this recharge potential, the surface water requirement will be 775.39 MCM, however the surplus surface runoff availability is limited to the tune of 12.80 MCM, which has been considered for planning of artificial recharge measures to tackle the over-exploitation condition. To utilise this quantum of 12.80 MCM of surface water available in the taluka, a total of 30 percolation tanks and 114 recharge shafts are recommended to be constructed. The volume of water expected to be conserved/recharged @75% efficiency will be 4.50 MCM through percolation tank and 5.13 MCM by means of recharge shafts. The cost estimates for 30 percolation tanks and 114 recharge shafts are Rs. 45 crores and Rs. 2.85 crores respectively. The proposed locations of artificial recharge structures are given in **Annexure IX** and are shown in **Fig 6.1.**

The rainwater harvesting in urban areas can be adopted in 25% of the household (12156) with 50 Sq. m roof area. A total of 0.36 MCM potential can be harvested by considering 80% runoff coefficient. The estimated cost for rainwater harvesting through roof top is calculated as Rs. 18.23 crores. Hence this technique is not economically viable and therefore it is not recommended.

Overall total volume of water expected to be recharged or conserved by artificial recharge is 9.63 MCM with a cost estimate of Rs. 47.85 crores, excluding Roof top rain water harvesting which is not economically viable.

Demand side interventions such as change in cropping pattern has not been proposed in the area as banana crop which is the principal crop of the area drives the economy of the region. As discussed earlier, the scope for increasing areas under micro-irrigation techniques like drip irrigation are also minimal in the area as out of 155.60 sq.km area covered by ground water irrigation, about 104.30 sq.km area has already been covered by drip irrigation.

Alternative surface water sources to the tune of 89.21 MCM will be available in the area in the form of Tapi Mega Recharge Scheme being proposed by MoWR, RD & GR. The implementation of the scheme will augment the ground water recharge to the tune of 66.91 MCM and the aquifers of the area will be able to accept this much quantum of water as the total recharge potential of the aquifer in this taluka is about 583.02 MCM.

The additional ground water resources augmented in Yaval taluka by regular artificial recharge structures will be 9.63 MCM, whereas by Tapi Mega Recharge Scheme it will be 66.91 MCM and the total resources available will be 76.54 MCM, whereas resources required for bringing stage of ground water development from existing 104.59% to 70% are 30.69 MCM. Thus an additional quantum of ground water to the tune of 45.85 MCM will be available in the taluka after bringing the stage of ground water development to 70%. This 45.85 MCM of ground water resource can bring an additional area of 70.54 sq.km., under assured ground water based irrigation considering the crop water requirement of 0.65 m.

7 Sum-Up

A thorough study was carried out based on data gap analysis, data generated in-house, data acquired from State Govt. departments and GIS maps prepared for various themes. All the available data was brought on GIS platform and an integrated approach was adopted for preparation of aquifer maps and aquifer management plans of Chopda (OE), Raver (OE) and Yaval (OE) taluka of Jalgaon district.

The study area is spanning over 3038 sq.km, out of which 1081 sq.km is hilly area. Geologically the area is occupied by Bazada (97 sq.km.), Alluvium (1777 sq.km.) and Basalt (83 sq.km.). The stage of ground water development is 75.62% in Chopda, 109.78% in Raver and 104.59% in Yaval taluka. The area has witnessed ground water depletion and over exploitation over a period of time. The deeper water levels of more than 20 m bgl has been observed in about 1051 sq.km areas and declining water level trend of more than 0.20 m/yr. has been observed in 1492 sq.km. This has been due to cultivation of water intensive cash crop like banana (422 sq.km), sugarcane (76 sq.km) and are completely dependent on ground water irrigation. The increasing allurement towards cash crops and decreasing availability of water have compelled the farmers to shift from traditional irrigation methods to micro irrigation techniques like drip irrigation. At present the area under drip irrigation is 517.34 sq.km. (73%) out of the total ground water irrigated area of 707.52 sq.km., thus further scope for introducing the drip irrigation in ground water irrigated area is minimal.

Ground water management plan has been prepared with the objective of bringing the current stage of ground water development down to 70% so that the taluka/block comes under Safe category by adopting both supply side and demand side interventions. The typical / in vogue supply side interventions like artificial recharge / water conservation structures have limitations, as the increase in recharge vis-à-vis the total annual replenishable recharge will be only 5.61% in Chopda taluka, 8.15% in Raver taluka and 10.85% in Yaval taluka. In Chopda taluka, these supply side interventions will contribute entire quantum of water required to bring the stage of ground water development down to 70%. However, in Raver and Yaval talukas only 20% and 31% of the total requirement of ground water resources required to bring the stage of ground water development down to 70% will be met. Thus the objective of the management plan, to bring down the stage of development towards Safe category will not be achieved by regular/in-vogue intervention measures.

In these areas, the Task Force constituted by Govt. of India, MoWR, RD & GR has recommended the Tapi Mega Recharge Scheme and major part of the area falls in these 3 talukas of Jalgaon district. The alternate surface water source is available by proposing the diversion wier on Tapi River at Khariya Guti Ghat (MP). The quantum of ground water recharged from Tapi Mega Recharge Scheme in Chopda taluka will be 76.31 MCM, 65.39MCM in Raver taluka and 66.91 MCM in Yaval taluka.

The probable benefits of the proposed management plan after implementing above measures will help in bringing the stage of ground water development down to 70% in all the 3 talukas. Further ground water resources of 76.30 MCM in Chopda taluka; 29.73 MCM in Raver taluka and 45.85 MCM in Yaval taluka will be available for utilisation. This will be able to bring about 117.38 sq.km area under assured irrigation in Chopda taluka; 45.74 sq.km. in Raver taluka and 70.54 sq.km. in Yaval taluka.

These interventions also need to be supported by regulation of deeper aquifer and hence it is recommended to regulate/ban deeper tubewells/borewells of more than 80 m depth in these 3 talukas, so that the deeper ground water resources are protected for future generation and also serve as ground water sanctuary in times of distress/drought. IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory groundwater management.

Annexure-I

Depth to Water Level Data of Shallow Aquifer

S. No.	Village	Lat	Long	RL	May_14	Nov_14	Flu
1.	Abhoda kh	21.3107	76.0264	300.7	6.5	1.7	4.8
2.	Adavad	21.2167	75.4403	190.7	23.1	19.1	4
3.	Adgaon	21.2786	75.3278	213.9	17	13	4
4.	Balvadi	21.1389	75.9694	223	6.52	4	2.52
5.	Bhokari	21.2583	76.0569	256.7	10.3	9.6	0.7
6.	Budhgaon	21.1722	75.1508	164	40	35.6	4.4
7.	Chinchati	21.2631	75.9056	327.1	23.1	4.3	18.8
8.	Chincholi	21.2167	75.5514	221.7	25	21.1	3.9
9.	Chopda	21.2356	75.2922	190.1	10.7	3.7	7
10.	Dambhurni	21.1769	75.5511	194.4	33.1	32.5	0.6
11.	Dhanora2	21.2089	75.5125	207.7	20	17.35	2.65
12.	Faizpur	21.1667	75.8597	225.3	53.07	51.8	1.27
13.	Galangi	21.1861	75.1089	158.8	17.8	16.2	1.6
14.	Giradgaon	21.1978	75.5889	212.4	25.2	16.3	8.9
15.	Hated bk	21.2425	75.1706	185.3	12.9	3.1	9.8
16.	Karjane	21.3184	75.2444	256.8	7.45	1.6	5.85
17.	Kingaon	21.2058	75.5819	217.3	17.92	11.95	5.97
18.	Lalmati	21.2893	75.9977	306.8	1.3	0.1	1.2
19.	Lasur	21.3043	75.1953	259	12	4.9	7.1
20.	Lohara	21.2474	75.8408	450	30.8	15.6	15.2
21.	Maratha	21.2966	75.1494	218	15.3	12.4	2.9
22.	Mitavali	21.1639	75.4939	168.4	36	32.6	3.4
23.	Mohrale	21.2353	75.6769	274	24	23.8	0.2
24.	Nagalwadi	21.3067	75.2961	240.7	11.2	6.5	4.7
25.	Nimgaon	21.1103	75.7361	203.2	50.55	42.7	7.85
26.	Padale bk	21.305	76.1158	277	6.9	3	3.9
27.	Raver	21.2467	76.0381	260	26.8	19.5	7.3
28.	Sangvi bk	21.18	75.7481	226.7	0	56	0
29.	Savkheda bk	21.2175	75.9097	249.3	43.6	22.5	21.1
30.	Viroda	21.1319	75.8453	214.3	12.6	9.7	2.9
31.	Vishnapur	21.311	75.3793	280.3	8.7	6	2.7
32.	Waghoda bk	21.15	75.9333	228	35.5	32.4	3.1
33.	Yawal	21.17	75.6986	218.3	10.2	6.2	4
34.	Yawal-1	21.1833	75.7	228	51.18	26.9	24.28
35.	Mohrale	21.2519	75.6894	306.8	46.5	0	0
36.	Mohrale Shivar	21.2623	75.6859	327	40.7	0	0
37.	Haripura	21.2614	75.6931	318.6	52.1	0	0
38.	Haripura	21.2539	75.6936	307.9	41.2	0	0
39.	Mohgaon	21.3202	76.0818	302.8	24.1	0	0
40.	Mohgaon	21.3181	76.08	296.2	22.4	0	0
41.	Kerhala	21.2794	76.0507	294	22.1	0	0
42.	Pimpri	21.3136	76.0506	291.8	18	0	0
43.	Pimpri	21.3072	76.0508	285.3	16.25	0	0

Annexure-II

Long Term Water Level Trend (m/year)

Location	Lat	Long	Pre Trend (1986-1995)	Post Trend (1986 to 1995)	Pre Trend (1996-2004)	Post Trend (1996-2004)	Pre Trend (2005-2014)	Post Trend (2005-2014)
Bahadurpur1	21.29	76.18			-0.124	-0.2312	0.0734	-0.5741
Balvadi	21.14	75.97		3.4047	-0.9825	-0.1181	0.5015	-0.1557
Chopda	21.25	75.30	0.0709	0.0378	-0.2259	-0.1555	0.3955	0.3075
Damburni-Pz 2	21.18	75.56			-2.5981	-0.5425		
Damburni-Pz1	21.18	75.56			-2.6353	-0.6994		
Dangarda	21.25	75.74	0	-0.2332	-0.1388	0.2184	-0.0585	-0.0811
Dhanora	21.21	75.51	-0.678	-0.8782			1.2861	2.583
Faizpur	21.17	75.86			-0.4736	-0.0384	0.5059	-0.1992
Faizpur2	21.17	75.86					-1.64	
Hated Budruk	21.24	75.18	0.0914	-0.0016	-0.3974	0.006	-0.2564	-0.253
Ichchapur	21.15	76.16	-0.0222		-0.1563	-0.0681	0.2492	0.3242
Mendhoda	21.11	76.03	0.258		0.002	-0.0397	-0.0316	-0.1391
Nachankheda	21.23	76.15			-0.7529	-0.5997	0.1535	-0.5758
Narvel	21.19	76.12	0.0484		-0.5344	-1.0597	-0.0671	0.3398
Raver	21.10	75.72	-0.4358	0.1387	-0.8097	-1.6207	1.6812	1.7645
Sakli	21.17	75.63			0.1282	-0.0948	-5.4961	0.7448
Yawal	21.08	75.79	1.0057	-0.0041				
Abhora Bk	21.31	76.01			-0.0361	-0.8621		
Khanapur	21.27	76.12	1.1279	0.458				
Shelgaon	21.09	75.68	0.7124	2.2179				
Virwade	21.30	75.35	-0.4713	-0.5203	-0.306			

Annexure-III

Depth to Water Level Data – Deeper Aquifer

SN	Village	Taluka	Latitude	Longitude	Eleva-tion (amsl)	Geology	Aquifer	Depth (m bgl)	Premonsoon WL (m bgl)	Post-monsoon WL (m bgl)
1	ADAVAD 2	Chopda	21.22	75.44	204	Alluvium	AL01	79.25	61.00	33.53
2	ADAVAD SIWAR	Chopda	21.22	75.46	200	Alluvium	AL01	91.44	65.00	60.96
3	ADAVAD1	Chopda	21.26	75.43	239	Alluvium	AL01	73.11	45.00	42.67
4	BHAWALE	Chopda	21.28	75.14	221	Bazada	AL02	67.06	54.00	51.82
5	CHAHARDI	Chopda	21.23	75.24	185	Basalt	BS01	47.24	11.00	6.60
6	CHAHARDI	Chopda	21.22	75.25	188	Basalt	BS01	121.92	30.00	27.43
7	CHOPDA	Chopda	21.27	75.30	214	Bazada	AL02	304.80	96.00	91.44
8	CHOPDA SIWAR	Chopda	21.26	75.32	202	Basalt	BS01	124.97	32.00	30.48
9	GHUMAVAL	Chopda	21.23	75.37	195	Alluvium	AL01	91.44	67.00	60.96
10	GHUMAVL	Chopda	21.22	75.36	194	Alluvium	AL01	91.44	25.00	18.29
11	HINGONE	Chopda	21.28	75.22	229	Bazada	AL02	131.00	73.00	70.10
12	LASUR	Chopda	21.27	75.17	203	Basalt	BS01	152.40	47.00	45.72
13	LONI 1	Chopda	21.22	75.48	211	Alluvium	AL01	91.44	65.00	42.67
14	LONI 2	Chopda	21.22	75.46	210	Alluvium	AL01	91.44	30.00	24.38
15	LONI 3	Chopda	21.23	75.47	219	Alluvium	AL01	76.20	25.00	21.34
16	MAGRUL	Chopda	21.24	75.39	204	Alluvium	AL01	76.20	57.00	45.72
17	MARATHA	Chopda	21.31	75.16	221	Basalt	BS01	76.20	19.00	18.29
18	MOHRAD	Chopda	21.25	75.53	246	Bazada	AL02	42.67	22.00	21.33
19	PANCHAK	Chopda	21.22	75.48	206	Alluvium	AL01	76.20	23.00	21.34
20	PANCHAK	Chopda	21.21	75.50	209	Alluvium	AL01	91.44	29.00	24.38
21	RUKHAN KHEDA	Chopda	21.24	75.35	200	Alluvium	AL01	121.92	29.00	27.43
22	VARDI SIWAR	Chopda	21.23	75.40	198	Alluvium	AL01	91.44	41.00	36.57
23	VARDI SIWAR	Chopda	21.23	75.40	195	Alluvium	AL01	121.92	70.00	67.05
24	VARDRI	Chopda	21.26	75.39	209	Alluvium	AL01	121.92	42.00	39.62
25	VATAR	Chopda	21.19	75.43	178	Alluvium	AL01	85.34	75.00	70.10
26	VATAR/VADGAON SIWAR	Chopda	21.19	75.43	178	Alluvium	AL01	85.34	73.00	70.10
27	VIRVADE	Chopda	21.31	75.35	245	Bazada	AL02	106.68	28.00	24.38
28	VIRVADE	Chopda	21.29	75.34	224	Bazada	AL02	91.44	75.00	73.15
29	ATWADE	Raver	21.24	76.13	237	Alluvium	AL01	33.50	21.00	12.00
30	BHOKRI	Raver	21.25	76.05	257	Alluvium	AL01	27.43	18.00	15.24
31	KHANAPUR	Raver	21.26	76.13	243	Basalt	BS01	182.88	21.00	11.00
32	KUSUMBA	Raver	21.27	75.99	275	Bazada	AL02	152.40	47.00	45.70
33	NIMBOLE	Raver	21.15	76.02	236	Alluvium	AL01	57.91	11.00	9.00
34	PARSA SIWAR	Raver	21.22	76.00	243	Alluvium	AL01	121.92	80.00	76.20
35	RAVER SIWAR	Raver	21.22	75.15	238	Alluvium	AL01	85.34	31.00	23.00
36	SAO KHEDA	Raver	21.13	75.92	253	Alluvium	AL01	91.44	60.00	57.91
37	VIVRE BUDRUKH	Raver	21.22	76.01	248	Bazada	AL02	103.63	33.00	30.48
38	VIVRE SIWAR	Raver	21.20	75.99	257	Alluvium	AL01	76.20	55.00	48.76
39	WADGAON	Raver	21.19	75.96	249	Alluvium	AL01	91.44	32.00	27.43
40	WAGHODS	Raver	21.18	75.94	252	Alluvium	AL01	106.68	70.00	66.05

SN	Village	Taluka	Latitude	Longitude	Eleva-tion (amsl)	Geology	Aquifer	Depth (m bgl)	Premonsoon WL (m bgl)	Post-monsoon WL (m bgl)
41	BAMNOD	Yaval	21.14	75.82	215	Basalt	BS01	106.68	95.00	91.44
42	BHALOD	Yaval	21.25	75.36	219	Alluvium	AL01	82.29	70.00	64.00
43	CHITODA	Yaval	21.18	75.73	219	Basalt	BS01	60.96	41.00	36.57
44	CHUNCHALE	Yaval	21.21	75.61	228	Bazada	AL02	152.40	46.00	45.72
45	DAHIGAON	Yaval	21.22	75.66	258	Alluvium	AL01	106.68	29.00	27.43
46	DAHIGAON 1	Yaval	21.22	75.65	256	Alluvium	AL01	91.44	29.00	27.43
47	GIRIDGAON	Yaval	21.19	75.60	215	Alluvium	AL01	161.54	82.00	79.25
48	GIRIDGAON	Yaval	21.19	75.60	216	Alluvium	AL01	161.54	110.00	106.68
49	MALOD	Yaval	21.22	75.58	235	Alluvium	AL01	121.92	19.00	18.29
50	NAYAGAON	Yaval	21.23	75.59	245	Bazada	AL02	91.44	19.00	18.29
51	RAJORA	Yaval	21.12	75.75	204	Alluvium	AL01	121.93	105.00	99.06
52	SAKLI	Yaval	21.18	75.64	217	Alluvium	AL01	182.88	106.00	45.00
53	SAKLI	Yaval	21.18	75.62	212	Alluvium	AL01	182.88	130.00	121.92
54	VARODA	Yaval	21.17	75.66	221	Alluvium	AL01	106.68	91.00	42.00
55	VIRAWALI SIWAR	Yaval	21.18	75.67	220	Alluvium	AL01	91.44	35.00	33.28
56	WAGHODA	Yaval	21.19	75.61	217	Alluvium	AL01	152.40	108.00	106.68
57	YAVAL	Yaval	21.20	75.71	243	Alluvium	AL01	106.68	25.00	22.86
58	YAVAL	Yaval	21.18	75.68	223	Alluvium	AL01	137.16	120.00	118.87
59	DAMBURNI	Yawal	21.19	75.56	207	Bazada	AL02	121.92	55.00	45.72
60	VIRODA	Yawal	21.14	75.84	207	Basalt	BS01	106.66	67.00	65.53

Annexure-IV

Ground Water Quality – Shallow Aquifer

SN	District	Taluka	Village	Source	Lati-tude	Longi-tude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Fe	Cl	SO4	F	NO3
									mg/L												
1	Jalgaon	Chopda	Ghosdogaon	DW	21.20	75.05	7.69	1195	781	288	50	39.61	76.1	3.1	0	237	0.02	140	53.9	0	0
2	Jalgaon	Raver	Ahirwadi	DW	21.29	76.09	7.94	546	355	237	32.8	37.67	8.4	0.5	1.94	238	0.03	14	7	0.16	31
3	Jalgaon	Chopda	Maratha	DW	21.30	75.16	7.93	776	504	298	40.8	47.63	37.1	0.1	0	232	1.71	70	38	0.35	59
4	Jalgaon	Chopda	Hated .bk.	DW	21.24	75.17	8.1	815	530	314	78.4	28.67	74.8	0.7	0	256	0.63	132	18	0.43	72
5	Jalgaon	Chopda	Lahasur	DW	21.31	75.20	8.02	1277	830	457	63.6	72.41	79.3	0.3	0	344	0.4	120	87	0.3	103
6	Jalgaon	Chopda	Karjane	DW	21.32	75.24	8.59	990	744	347	50.4	53.70	81.1	0.7	9.6	187	0.52	120	85	0.35	103
7	Jalgaon	Chopda	Chopda	DW	21.22	75.30	7.91	1403	912	204	33.6	29.16	148	5.9	0	277	0	228	0	0	0
8	Jalgaon	Chopda	Adgaon	DW	21.28	75.33	8.19	782	508	249	52.4	28.67	29.3	2.8	0	195	0.19	56	11	0.5	70
9	Jalgaon	Chopda	Adawad	DW	21.22	75.44	7.49	1084	705	304	40	49.57	73.6	1.4	0	268	0	140	0	0	0
10	Jalgaon	Chopda	Mitawali	DW	21.16	75.49	7.63	942	612	224	43.2	28.19	29.5	0.7	0	295	0	48	0	0	0
11	Jalgaon	Chopda	Deoziri	DW	21.26	75.49	8.07	386	251	131	40.8	7.05	21.2	4.8	1.53	138	0.3	34	11	0.18	4
12	Jalgaon	Yawal	Chincholi	DW	21.23	75.55	7.73	676	439	265	62	26.73	32.2	0.2	1.27	251	0.19	48	25	0.52	38
13	Jalgaon	Yawal	Waghoda	DW	21.19	75.61	8	790	514	244	60.8	22.36	68.5	2.6	0	204	0.09	130	26	0.44	23
14	Jalgaon	Yawal	Mohrale	DW	21.24	75.68	7.97	719	467	265	57.2	29.65	32.1	1.4	1.74	198	0.23	60	44	0.16	39
15	Jalgaon	Yawal	Nimgaon	DW	21.11	75.74	8.03	1218	792	352	46.4	57.35	109	1.3	0	337	0.18	196	19	0.4	18
16	Jalgaon	Yawal	Viroda	DW	21.13	75.85	7.75	1240	806	490	65.2	79.46	80.9	0.4	0	400	0.2	120	90	0.11	28
17	Jalgaon	Raver	Savkheda kh.	DW	21.22	75.91	7.67	1340	871	364	78.4	40.82	102	2.2	0	366	0.1	166	30	0.22	21
18	Jalgaon	Raver	Lohara	DW	21.25	75.93	8.41	1653	1074	408	49.6	69.01	135	0.2	4.8	399	0.14	202	28	0.5	24
19	Jalgaon	Raver	Lalmati	DW	21.28	76.00	8.39	535	348	249	40.8	35.72	10.4	0.5	5.68	246	0.09	14	7	0.11	31
20	Jalgaon	Raver	Rasalpur	DW	21.26	76.03	8.29	477	310	257	36	40.58	10.9	0.7	4.75	259	0.13	20	5	0.35	16
21	Jalgaon	Raver	Bhokri	DW	21.25	76.07	8.51	451	293	220	22.8	39.61	9.6	0.5	5.66	186	0.11	18	8	0.05	29
22	Jalgaon	Raver	Padle bk.	DW	21.31	76.12	7.81	789	513	310	62	37.67	35.4	0.4	0	268	0.18	68	20	0.37	23
23	Jalgaon		Abhora Bk	DW	21.31	76.01	8	915	0	420	0	0.00	0	0	0	494	0	0	0	0.32	29
24	Jalgaon		Balvadi	DW	21.14	75.97	8.32	874	416	420	26.0	86.28	6.79	0.12	0	195	0	120.53	45.0		0
25	Jalgaon		Chopda	DW	21.24	75.29	8.2	500	0	35	0	0.00	0	0	0	67	0	0	0	0.67	5
26	Jalgaon		Dangarda	DW	21.25	75.74	7.98	668	318	325	24.0	64.41	4.16	0.19	0	342	0	17.7	4	0.41	18

SN	District	Taluka	Village	Source	Lati-tude	Longi-tude	pH	EC (µS/cm)	TDS	TH	Ca	Mg	Na	K	CO3	HCO3	Fe	Cl	SO4	F	NO3
									mg/L												
27	Jalgaon		Faizpur	DW	21.17	75.86	7.9	480	0	140	0	0.00	0	0	0	232	0	0	0	0.2	22
28	Jalgaon		Narvel	DW	21.19	76.12	7.5	1556	0	535	0	0.00	0	0	0	403	0	0	0	0.01	287
29	Jalgaon		Raver	DW	21.25	76.04	8.06	1108	524	540	20.0	119.0	9.74	0.03	0	214	0	99.2	34.1	BDL	219
30	Jalgaon		Sadavan Bk	DW	21.22	75.91	7.45	5040	0	1600	0	0.00	0	0	0	531	0	0	0	0.94	118

Annexure-V

Ground Water Quality – Deeper Aquifer

S. No.	Village	Taluka	Latitude (Dd)	Longitude (Dd)	EC µmho /cm at 25°C	pH	TDS mg/l
1	Loni 1	Chopda	21.2207	75.4760	520	7.6	360
2	Adavad 2	Chopda	21.2156	75.4377	540	7.8	360
3	Mangrul	Chopda	21.2360	75.3933	525	7.8	375
4	Vardri	Chopda	21.2574	75.3857	524	7.8	375
5	Ghumavl	Chopda	21.2230	75.3632	455	7.8	325
6	ghumaval	Chopda	21.2288	75.3672	455	7.8	325
7	vardi siwar	Chopda	21.2335	75.4045	520	7.6	365
8	panchak	Chopda	21.2180	75.4819	530	7.8	365
9	Rukhan Kheda	Chopda	21.2397	75.3487	525	7.8	365
10	vardi siwar	Chopda	21.2335	75.4045	530	8.8	365
11	varoda	Yaval	21.1737	75.6586	530	7.8	365
12	sakli	Yaval	21.1783	75.6408	530	7.8	365
13	giridgaon	Yaval	21.1910	75.5997	530	7.8	365
14	giridgaon	Yaval	21.1938	75.5967	530	7.8	365
15	yaval	Yaval	21.1967	75.7103	655	7.3	475
16	dahigaon 1	Yaval	21.2219	75.6496	460	7.9	315
17	dahigaon	Yaval	21.2150	75.6552	470	7.5	315
18	virawali siwar	Yaval	21.1828	75.6725	458	8.1	328
19	Waghoda	Yaval	21.1875	75.6142	455	7.8	325
20	sakli	Yaval	21.1795	75.6196	790	7.8	562
21	raver siwar	Raver	21.2177	75.1482	455	7.8	325
22	parsa siwar	Raver	21.2164	76.0048	455	7.8	325
23	wadgaon	Raver	21.1916	75.9630	455	7.8	325
24	waghods	Raver	21.1785	75.9405	455	7.8	325
25	Sao Kheda	Raver	21.1316	75.9154	455	7.8	N/A
26	Vivre Siwar	Raver	21.2028	75.9940	455	7.8	325
27	Atwade	Raver	21.2432	76.1340	455	7.8	325
28	Loni 2	Chopda	21.2237	75.4630	538	7.6	375
29	vatar/Vadgaon Siwar	Chopda	21.1948	75.4303	525	7.8	375
30	adavad1	Chopda	21.2596	75.4339	525	7.8	365
31	Adavad siwar	Chopda	21.2213	75.4568	545	7.8	345
32	loni 3	Chopda	21.2328	75.4709	558	7.8	355
33	panchak	Chopda	21.2130	75.4973	525	7.8	365
34	vatar	Chopda	21.1948	75.4303	525	7.8	375
35	Rajora	Yaval	21.1201	75.7458	685	7.8	485
36	Bhalod	Yaval	21.2544	75.3641	640	8	438
37	yaval	Yaval	21.1768	75.6829	668	7.3	465
38	malod	Yaval	21.2198	75.5817	412	7.5	285

39	Bhokri	Raver	21.2533	76.0505	455	7.8	325
40	nimbole	Raver	21.15.943	76.0187	670	7	485
41	Chahardi	Chopda	21.2307	75.2367	611	8.62	533
42	Chahardi	Chopda	21.2165	75.2501	620	8.6	375
43	Chitoda	Yaval	21.1797	75.7347	455	8.4	320
44	Bamnod	Yaval	21.1413	75.8171	410	7.5	320
45	Khanapur	Raver	21.2599	76.1281	455	7.8	325
46	Chopda siwar	Chopda	21.2610	75.3162	455	7.8	325
47	Maratha	Chopda	21.3130	75.1580	525	7.8	365
48	Viroda	Yawal	21.1357	75.8403	650	N/A	N/A
49	Hingone	Chopda	21.2780	75.2190	755	7.7	533
50	Lasur	Chopda	21.2738	75.1735	525	7.8	365
51	Bhawale	Chopda	21.2753	75.1355	525	7.8	365
52	virvade	Chopda	21.3112	75.3487	525	7.8	375
53	virvade	Chopda	21.2918	75.3416	525	7.8	375
54	Mohrad	Chopda	21.2495	75.5307	600	N/A	N/A
55	chunchale	Yaval	21.2100	75.6133	450	8	320
56	nayagaon	Yaval	21.2302	75.5873	410	7.5	287
57	Vivre Budrukh	Raver	21.2153	76.0139	455	7.8	325
58	kusumba	Raver	21.2657	75.9850	371	8	438
59	Chopda	Chopda	21.2712	75.2958	552	9	371
60	Damburni	Yawal	21.1872	75.5589	470	7.6	353
61	Gaulwada	Raver	21.0861	75.9250	420	8.02	202
62	Atwade		20.1833	76.1375	430	7.7	240
63	Virwade (OW)	Chopda	21.3000	75.3556	440	8.34	240
64	Dongaon	Yawal	21.1972	75.5639	460	8.3	240
65	Mohrad (DZOW)	Raver	21.2444	75.8653	470	8.63	225
66	Kusumbe	Chopda	21.2333	75.1056	480	7.91	240
67	Virwade	Chopda	21.3000	75.3556	500	8.43	270
68	Mohrad	Chopda	21.2444	75.5319	500	8	250
69	Palsoda	Yawal	21.2208	75.7125	520	7.71	277
70	Palsoda (DZOW)	Yawal	21.2208	75.7125	520	8.29	300
71	Kusumbe	Chopda	21.2333	75.1056	530	8.09	290
72	Mohrad (OW)	Raver	21.2444	75.8653	550	8	310
73	Borkheda	Yawal	21.2083	75.8333	550	8.57	282
74	Chitode	Yawal	21.1833	75.7486	590	7.91	290
75	Dongaon (OW)	Yawal	21.1917	75.5639	600	8.5	335
76	Dongaon	Yawal	21.1972	75.5639	610	8.3	335
77	Chikli O.W.	Yawal	21.1250	75.7583	630	8.7	300
78	Ajantisim	Chopda	21.2000	75.0458	660	7.97	395
79	Utkheda	Raver	21.2389	75.9778	690	8	360
80	Hingona	Chopda	21.2681	75.2292	700	7.5	390
81	Hingona	Chopda	21.2681	75.2292	710	7.67	375

82	Ajantisim	Chopda	21.2000	75.0458	720	8.02	390
83	Chikli Bk	Yawal	21.1250	75.7583	720	8.3	360
84	Savkheda	Raver	21.2167	75.9056	740	8.03	352
85	Savkheda	Raver	21.2167	75.9056	750	8.5	415
86	Utkheda	Raver	21.2389	75.9778	750	8.5	415
87	Pimprud	Yawal	21.1500	75.8611	840	8.3	468
88	Pimprud	Yawal	21.1500	75.8611	870	8	480
89	Savda R.S.	Raver	21.1083	75.9111	1050	8	370
90	Raver R.S.	Raver	21.2250	76.0500	1250	8.35	644
91	Borkheda (DZ)	Yawal	21.2083	75.8333	1430	7.75	824
92	Raver R.S. (OW)	Raver	21.2250	76.0500	1450	8.3	960
93	Waghode Bk	Edlabad	21.1833	76.9417	1700	7.9	1015
94	Waghode	Raver	21.1833	75.9417	1800	7.8	1050

Annexure – VI

Details of Ground Water Exploration

S. No.	Village	Long	Lat	Type	Geology	Aquifer	Drilling depth (mbgl)	Construction depth (mbgl)	Casing (mbgl)	AQ_Zones (mbgl)	SWL (mbgl)	Discharge (lps)	DD (m)	T (m2/day)	S
1	Adavad	75.45	21.22	EW	Alluvium	Gravel	300	299	-	84 -89 ,165 -169 ,180 -184 ,240 -243,259 -267, 275 -284, 286 -296	30	7.76	-	82.5	-
2	Bamnod	75.80	21.11	PZ	Alluvium	Alluvium	70.25	67	67	60 -70	-	1.37	-	-	-
3	Bhatkhed	75.98	21.25	PZ	Alluvium		74	47.5	47.5	41 -47	31.88	-	-	-	-
4	Borkheda (DZ)	75.83	21.21	OW	Alluvium	Gravel	292	277	48	40 -41, 43 -45, 260 -271, 46 -54	-	3	-	-	-
5	Dhanora	75.51	21.21	Pz	Alluvium		68	64	64	-		30.13		-	-
6	Dongaon	75.56	21.20	EW	Alluvium	Basaltic Gravel	300	299	43	91 -99 ,121 -126 ,165 -169 ,187 -192 ,197 -205 ,208 -219 ,228 -233 ,267 -277 ,282 -296	30.5	12	-	178	-
7	Faijpur	75.86	21.17	PZ	Alluvium		98	76	76	43 -46 ,72 -75	46	0.78		0	-
8	Gorgawale	75.34	21.17	EW	Alluvium	Sand	90	75	53.5	64 -73	30.2	4	2.18	575.3	-
9	Goulwada	75.93	21.09	EW	Alluvium	Sand	54.5	53	5	16 -17.5 ,23 -28 ,35 -36 ,29.5 -30.5 ,38 -39 ,48 -49.5 ,50.5 -52.5	-	1	-	-	-
10	Hingona	75.23	21.27	EW	Alluvium	Basaltic Gravel	75	73	48	35 -40 ,53 -56 ,65 -71	9	7.77	-	54	-
11	Kusumbe	75.11	21.23	OW	Alluvium	Gravel	111.75	109.5	46	42 -49 ,51.5 -54 ,60 -61.5 ,79 -85 ,86 -89 ,90.5 -95 ,97 -100	12.9	4.5		-	-
12	Mangrule	75.33	21.17	EW	Alluvium	Sand	104.8	71.5	37.5	29.5 -33.5, 64 -72 ,72 -74	13.9	4.5	9.64	122	-
13	Mhaiswadi	75.76	21.09	EW	Alluvium	Sand	60	53.5	53	10.36 -11.55, 12.8 -15.24, 24.38 -25.64, 17.6 -19.2 ,34.75 -35.97,37.1 45.11, 50.6 -51.82, 54.26 -56.06, 59.79 -60.96	35	-	-	-	-
14	Mohrad	75.53	21.24	EW	Alluvium	Gravel	300.19	120	44	48 -51, 54 -56, 79 -84, 87 -	20.3	8	-	-	-

S. No.	Village	Long	Lat	Type	Geology	Aquifer	Drilling depth (mbgl)	Construction depth (mbgl)	Casing (mbgl)	AQ_Zones (mbgl)	SWL (mbgl)	Discharge (lps)	DD (m)	T (m2/day)	S
										94, 96 -98, 107 -117					
15	Palsada	75.71	21.22	EW	Alluvium	Gravel	300.17	160	43	48 -50, 53 -62, 70 -76, 149 - 155	29	6	-	-	-
16	Pimprud	75.86	21.15	EW	Alluvium	Gravel	123.5	67	-	47 -53 ,48 -51 ,53.5 -65.5	39.67	15	0.87	2525	-
17	Raver R.S.	76.05	21.23	EW	Alluvium	Gravel	113	53	40.5	15 -16 ,18.5 -20 ,28 -30 ,23 - 25 ,36 -50	28.3	21.52	3.03	-	-
18	Sakli	75.63	21.17		Alluvium		76.21	-	75		-	-	-	-	-
19	Savda R.S.	75.91	21.11	EW	Alluvium	Gravel	52	51	-	46.5 -50.5	36	10.16	8.26	-	-
20	Savkheda	75.91	21.22	OW	Alluvium	Gravel	73.66	72	35	46 -48 ,52 -54 ,61 -64 ,66 - 70	31.2	3.17	3.68	-	-
21	Utkheda	75.98	21.24	OW	Alluvium	Gravel	64	63	-	39.5 -42 ,49 -50.5 ,51.5 - 52.5 ,58 -61.5	31.55	1.37	3.51	-	-
22	Vadhoda	75.85	21.09	EW	Alluvium	Sand	45.5	44.5	75	20.72 -23.77 ,25.6 -29.26 ,42 -43.9 ,35.35 -40.84	28	1	-	-	-
23	Vargawhan	75.49	21.17	EW	Alluvium	Sand	56	53	44.5	7 -11 ,15 -19 ,33 -39 ,19 -31 ,42 -45 ,46 -49 ,50 -52	12	2.5	-	-	-
24	Virwade (OW)	75.36	21.30	OW	Alluvium	Basaltic Gravel	103.6	96	46	50 -70 ,84 -86 ,89 -93	11.7	3.77	4.4	-	-
25	Waghoda	75.94	21.18	OW	Alluvium	Basaltic Gravel	154.52	93	91	73 -80 ,86 -90	45	1	-	-	-
26	Ajanti Seem	75.05	21.20				44.25	-	-	-	-	-	-	-	-
27	Atwade	76.13	21.23				53.3	-	-	-	-	-	-	-	-
28	Boraval Buzurg	75.72	21.11				56.39	-	-	-	-	-	-	-	-
29	Chikli	75.75	21.15				87	-	-	-	-	-	-	-	-
30	Chitode	75.74	21.20				333	-	-	-	-	-	-	-	-
31	Dambhurni	75.56	21.18				51.1	-	-	-	-	-	-	-	-
32	Dhanore Kh	75.47	21.16				68	-	-	-	-	-	-	-	-
33	Dhanore Pr.chopda	75.14	21.26				63	-	-	-	-	-	-	-	-
34	Kherale Bk	75.99	21.20	PZ	Alluvium	Sand&	100	31	24.5	24-30	13.4	3.17	0.1	-	-

S. No.	Village	Long	Lat	Type	Geology	Aquifer	Drilling depth (mbgl)	Construction depth (mbgl)	Casing (mbgl)	AQ_Zones (mbgl)	SWL (mbgl)	Discharge (lps)	DD (m)	T (m2/day)	S
						Gravel									
35	Khiroda	75.88	21.21	PZ	Alluvium	Sand& Gravel	100	54	40	40-52	16.93	2.64	4.4	-	-
36	Korpawali	75.68	21.21				152.4	-	-	-	-	-	-	-	-
37	Kurvel	75.29	21.16	EW			50	-	-	-	-	-	-	-	-
38	Morgaon	76.09	21.24				22.86	-	-	-	-	-	-	-	-
39	Nimgaon	75.73	21.13				53.34	-	-	-	-	-	-	-	-
40	Piloda	75.71	21.22				58.22	-	-	-	-	-	-	-	-
41	Rajora	75.72	21.10				71.93	-	-	-	-	-	-	-	-
42	Raver	76.03	21.25				125.88	-	-	-	-	-	-	-	-
43	Sangvi Kh	76.05	21.19				62.79	-	-	-	-	-	-	-	-
44	Sangvre	76.06	21.20				50.9	-	-	-	-	-	-	-	-
45	Satod	75.71	21.22				57.91	-	-	-	-	-	-	-	-
46	Savda	75.91	21.11				125.27	-	-	-	-	-	-	-	-
47	Torkheda	75.56	21.13				36.88	-	-	-	-	-	-	-	-
48	Viravli	75.68	21.19				55.78	-	-	-	-	-	-	-	-
49	Vivra	75.98	21.20				117.04	-	-	-	-	-	-	-	-
50	Yavel	75.70	21.18				308.45	-	-	-	-	-	-	-	-
51	Adavad	75.43	21.17				245.06	-	-	-	-	-	-	-	-

Annexure-VII

Proposed Artificial Recharge Structures in Chopda Taluka

SN	Village	Taluka	Longitude	Latitude	Type of Recharge structure
1.	CHOPDA	Chopda	75.3168	21.2327	Check dam
2.	Garatad (n.v.)	Chopda	75.3257	21.2293	Check dam
3.	CHOPDA	Chopda	75.3271	21.2347	Check dam
4.	CHOPDA	Chopda	75.3295	21.2428	Check dam
5.	CHOPDA	Chopda	75.3309	21.2487	Check dam
6.	Rukhankhede Pr.chopda	Chopda	75.3464	21.2386	Check dam
7.	Rukhankhede Pr.chopda	Chopda	75.3459	21.2456	Check dam
8.	Lasur	Chopda	75.2157	21.3157	Check dam
9.	Forest	Chopda	75.2219	21.3241	Check dam
10.	Chaugaon	Chopda	75.2264	21.3251	Check dam
11.	Chaugaon	Chopda	75.2284	21.3261	Check dam
12.	Chaugaon	Chopda	75.2344	21.3282	Check dam
13.	Chaugaon	Chopda	75.2399	21.329	Check dam
14.	Angurne	Chopda	75.267	21.3339	Check dam
15.	Varad	Chopda	75.2797	21.334	Check dam
16.	Varad	Chopda	75.2859	21.3344	Check dam
17.	Nagalwadi	Chopda	75.304	21.3351	Check dam
18.	Lasur	Chopda	75.2017	21.3125	Check dam
19.	Shikawal	Chopda	75.1718	21.3074	Check dam
20.	Lasur	Chopda	75.1968	21.3147	Check dam
21.	Virwade	Chopda	75.3445	21.326	Check dam
22.	Virwade	Chopda	75.3547	21.3257	Check dam
23.	Virwade	Chopda	75.3631	21.3249	Check dam
24.	Vardi	Chopda	75.4063	21.2782	Check dam
25.	Vardi	Chopda	75.4252	21.2671	Check dam
26.	Adwad	Chopda	75.4519	21.2692	Check dam
27.	Vardi	Chopda	75.433	21.2666	Check dam
28.	Vardi	Chopda	75.4201	21.2724	Check dam
29.	Forest	Chopda	75.4712	21.2734	Check dam
30.	Khardi	Chopda	75.4893	21.27	Check dam
31.	Lasur	CHOPDA	75.1873	21.2863	Percolation tank
32.	Chaugaon	CHOPDA	75.217	21.2899	Percolation tank
33.	Mamlade	CHOPDA	75.2761	21.2963	Percolation tank
34.	CHOPDA	CHOPDA	75.2876	21.2665	Percolation tank
35.	Adgaon	CHOPDA	75.3199	21.2975	Percolation tank
36.	Galangi	CHOPDA	75.1188	21.2485	Percolation tank
37.	Ghodgaon	CHOPDA	75.1315	21.2269	Percolation tank
38.	Shikawal	CHOPDA	75.1534	21.2975	Percolation tank
39.	Chaugaon	CHOPDA	75.2262	21.3063	Percolation tank
40.	Nagalwadi	CHOPDA	75.3023	21.3191	Percolation tank
41.	Ambade	CHOPDA	75.3545	21.2686	Percolation tank
42.	Vardi	CHOPDA	75.4045	21.25	Percolation tank
43.	Virwade	CHOPDA	75.3561	21.3118	Percolation tank
44.	Adwad	CHOPDA	75.4456	21.2528	Percolation tank
45.	Machale	CHOPDA	75.3692	21.2333	Percolation tank
46.	CHOPDA	CHOPDA	75.3098	21.2632	Percolation tank
47.	Galwade	CHOPDA	75.1668	21.2571	Percolation tank
48.	Chahardi	Chopda	75.2301	21.2106	Percolation tank
49.	Chahardi	Chopda	75.2517	21.2491	Percolation tank
50.	Hatede Bk.	Chopda	75.1968	21.2612	Percolation tank

SN	Village	Taluka	Longitude	Latitude	Type of Recharge structure
51.	Tawase Bk.	Chopda	75.2896	21.1956	Percolation tank
52.	Kazipura	Chopda	75.2184	21.2614	Recharge shaft
53.	Majare Hingone	Chopda	75.2278	21.2738	Recharge shaft
54.	Chunchade	Chopda	75.2486	21.2717	Recharge shaft
55.	Akulkhede	Chopda	75.2639	21.2647	Recharge shaft
56.	Chahardi	Chopda	75.2481	21.1882	Recharge shaft
57.	Chahardi	Chopda	75.2431	21.1973	Recharge shaft
58.	Chahardi	Chopda	75.2639	21.2045	Recharge shaft
59.	Chahardi	Chopda	75.2664	21.2133	Recharge shaft
60.	Lasur	Chopda	75.199	21.273	Recharge shaft
61.	Majare Hingone	Chopda	75.2134	21.2743	Recharge shaft
62.	Chunchade	Chopda	75.2561	21.2823	Recharge shaft
63.	Mamlade	Chopda	75.2686	21.2794	Recharge shaft
64.	Akhatwade	Chopda	75.2797	21.2097	Recharge shaft
65.	Chahardi	Chopda	75.2763	21.2027	Recharge shaft
66.	Chahardi	Chopda	75.2691	21.1939	Recharge shaft
67.	Chahardi	Chopda	75.2672	21.188	Recharge shaft
68.	Chahardi	Chopda	75.2589	21.1857	Recharge shaft
69.	Tawase Bk.	Chopda	75.278	21.1885	Recharge shaft
70.	Kurvel	Chopda	75.3082	21.1885	Recharge shaft
71.	Dhanwadi (n.v.)	Chopda	75.3174	21.1968	Recharge shaft
72.	Chaugaon	Chopda	75.2351	21.2924	Recharge shaft
73.	Chaugaon	Chopda	75.2287	21.3042	Recharge shaft
74.	Lasur	Chopda	75.206	21.3037	Recharge shaft
75.	Chaugaon	Chopda	75.247	21.3006	Recharge shaft
76.	Chunchade	Chopda	75.2489	21.2895	Recharge shaft
77.	Mamlade	Chopda	75.2775	21.2936	Recharge shaft
78.	Varad	Chopda	75.2966	21.3029	Recharge shaft
79.	Varad	Chopda	75.2946	21.2944	Recharge shaft
80.	CHOPDA	Chopda	75.2993	21.2807	Recharge shaft
81.	CHOPDA	Chopda	75.2899	21.2761	Recharge shaft
82.	Adgaon	Chopda	75.3198	21.3027	Recharge shaft
83.	Adgaon	Chopda	75.3409	21.3027	Recharge shaft
84.	Adgaon	Chopda	75.3246	21.2828	Recharge shaft
85.	Vardi	Chopda	75.4069	21.2465	Recharge shaft
86.	Vardi	Chopda	75.4202	21.2532	Recharge shaft
87.	Mangrul	Chopda	75.4257	21.239	Recharge shaft
88.	Mangrul	Chopda	75.4268	21.2315	Recharge shaft
89.	Adwad	Chopda	75.4443	21.2333	Recharge shaft
90.	Adwad	Chopda	75.4534	21.2295	Recharge shaft
91.	Adwad	Chopda	75.4631	21.2388	Recharge shaft
92.	Adwad	Chopda	75.4756	21.2509	Recharge shaft
93.	Khardi	Chopda	75.4844	21.2413	Recharge shaft
94.	Khardi	Chopda	75.4933	21.255	Recharge shaft
95.	Khardi	Chopda	75.4953	21.2385	Recharge shaft
96.	Loni	Chopda	75.4778	21.2274	Recharge shaft
97.	Vargavhan	Chopda	75.5097	21.247	Recharge shaft
98.	Bidgaon	Chopda	75.5199	21.2372	Recharge shaft
99.	Bidgaon	Chopda	75.5349	21.2574	Recharge shaft
100.	Adwad	Chopda	75.4468	21.2488	Recharge shaft
101.	Adwad	Chopda	75.4387	21.2491	Recharge shaft
102.	Vardi	Chopda	75.4049	21.2625	Recharge shaft
103.	Vadati	Chopda	75.3924	21.2718	Recharge shaft

SN	Village	Taluka	Longitude	Latitude	Type of Recharge structure
104.	Vadati	Chopda	75.3841	21.2747	Recharge shaft
105.	Virwade	Chopda	75.3797	21.2964	Recharge shaft
106.	Adwad	Chopda	75.4324	21.2553	Recharge shaft
107.	Adwad	Chopda	75.4742	21.2571	Recharge shaft
108.	Ichhapur	Chopda	75.508	21.2537	Recharge shaft
109.	Bidgaon	Chopda	75.5238	21.2434	Recharge shaft
110.	Bidgaon	Chopda	75.5296	21.2473	Recharge shaft
111.	Adwad	Chopda	75.4337	21.238	Recharge shaft
112.	Narwade	Chopda	75.3661	21.2754	Recharge shaft
113.	Narwade	Chopda	75.3658	21.2832	Recharge shaft
114.	Virwade	Chopda	75.3686	21.2904	Recharge shaft
115.	Adgaon	Chopda	75.3442	21.2899	Recharge shaft
116.	Nagalwadi	Chopda	75.3165	21.2917	Recharge shaft
117.	Nagalwadi	Chopda	75.3079	21.2868	Recharge shaft
118.	Chahardi	Chopda	75.2231	21.2031	Recharge shaft
119.	Virwade	Chopda	75.3553	21.301	Recharge shaft

Annexure-VIII

Proposed Artificial Recharge Structures in Raver Taluka

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
1.	Lalmati	Raver	75.9894	21.3063	Check dam
2.	Jinsi	Raver	76.0111	21.3207	Check dam
3.	Jinsi	Raver	76.0128	21.3239	Check dam
4.	Ambhode Bk.	Raver	76.014	21.3155	Check dam
5.	Ambhode Bk.	Raver	76.007	21.3068	Check dam
6.	Lalmati	Raver	76.0041	21.3024	Check dam
7.	Lalmati	Raver	75.9974	21.3035	Check dam
8.	Forest	Raver	75.9777	21.3019	Check dam
9.	Forest	Raver	75.9814	21.2967	Check dam
10.	Forest	Raver	75.9893	21.2901	Check dam
11.	Lohare	Raver	75.9312	21.2682	Check dam
12.	Forest	Raver	75.9266	21.273	Check dam
13.	Savkhede Kh.	RAVER	75.9056	21.224	Percolation tank
14.	Rozode	RAVER	75.8844	21.1985	Percolation tank
15.	Raver (rural)	RAVER	76.0245	21.2137	Percolation tank
16.	Raver (rural)	RAVER	75.998	21.2365	Percolation tank
17.	Bhatkhede	RAVER	75.9895	21.228	Percolation tank
18.	Khirode Pr.raver	RAVER	76.0196	21.2645	Percolation tank
19.	Rasalpur	RAVER	76.0532	21.2651	Percolation tank
20.	Karjod	RAVER	76.0833	21.2734	Percolation tank
21.	Khanapur	RAVER	76.1185	21.263	Percolation tank
22.	Chorwad	RAVER	76.1423	21.2743	Percolation tank
23.	Khirode Pr.raver	RAVER	76.0242	21.2798	Percolation tank
24.	Utkhede	RAVER	75.9755	21.239	Percolation tank
25.	Kusumbe Bk.	RAVER	75.9641	21.2575	Percolation tank
26.	Lohare	RAVER	75.9161	21.2402	Percolation tank
27.	Khirode Pr. Yawal	RAVER	75.8857	21.2292	Percolation tank
28.	Khirode Pr. Yawal	RAVER	75.8717	21.2033	Percolation tank
29.	Karjod	RAVER	76.1041	21.2667	Percolation tank
30.	Ahirwadi	RAVER	76.0829	21.2998	Percolation tank
31.	Padale Bk.	RAVER	76.1182	21.3029	Percolation tank
32.	Karjod	RAVER	76.0803	21.2852	Percolation tank
33.	Vivare Kh	RAVER	75.9647	21.214	Percolation tank
34.	Raver (Rural)	Raver	76.0182	21.2407	Percolation tank
35.	Pimpri	Raver	76.0432	21.3264	Percolation tank
36.	Pimpri	Raver	76.0584	21.3241	Percolation tank
37.	Mohagan Bk.	Raver	76.0834	21.3237	Percolation tank
38.	Mohagan Bk.	Raver	76.0888	21.3262	Percolation tank
39.	Pimpri	Raver	76.049	21.3228	Percolation tank
40.	Ambhode Kh.	Raver	76.0309	21.314	Percolation tank
41.	Lalmati	Raver	75.9922	21.302	Percolation tank

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
42.	Ambhode Kh.	Raver	76.0213	21.3201	Percolation tank
43.	Khirode Pr.raver	Raver	76.0091	21.2973	Percolation tank
44.	Vivare Bk.	Raver	75.9968	21.1903	Recharge shaft
45.	Thorgavhan	Raver	75.882	21.1126	Recharge shaft
46.	Maskawad Bk.	Raver	75.915	21.1355	Recharge shaft
47.	Dasanoor	Raver	75.9403	21.1526	Recharge shaft
48.	Singat	Raver	75.968	21.1336	Recharge shaft
49.	Puri	Raver	75.964	21.12	Recharge shaft
50.	Chinchol	Raver	75.9647	21.1052	Recharge shaft
51.	Kandwel	Raver	76.0001	21.1221	Recharge shaft
52.	SAVDA	Raver	75.8858	21.1484	Recharge shaft
53.	Rozode	Raver	75.8869	21.1944	Recharge shaft
54.	Rozode	Raver	75.8742	21.1976	Recharge shaft
55.	Savkhede Bk.	Raver	75.8986	21.2258	Recharge shaft
56.	Khirode Pr. Yawal	Raver	75.8874	21.2266	Recharge shaft
57.	Khirode Pr. Yawal	Raver	75.8748	21.2352	Recharge shaft
58.	Kalmode	Raver	75.8685	21.2116	Recharge shaft
59.	Savkhede Kh.	Raver	75.9077	21.2204	Recharge shaft
60.	Wadgaon	Raver	75.9497	21.1865	Recharge shaft
61.	Vivare Bk.	Raver	75.9801	21.1873	Recharge shaft
62.	Waghode Bk.	Raver	75.9297	21.1803	Recharge shaft
63.	Kochoor Bk.	Raver	75.908	21.1811	Recharge shaft
64.	Ajande	Raver	76.041	21.2024	Recharge shaft
65.	Punkhede	Raver	76.0583	21.221	Recharge shaft
66.	Khirwad	Raver	76.1039	21.2108	Recharge shaft
67.	Morgaon Kh.	Raver	76.1109	21.2249	Recharge shaft
68.	Khirwad	Raver	76.0952	21.2257	Recharge shaft
69.	Morgaon Bk.	Raver	76.1187	21.2319	Recharge shaft
70.	Khanapur	Raver	76.1106	21.2612	Recharge shaft
71.	Khanapur	Raver	76.1189	21.2583	Recharge shaft
72.	Khanapur	Raver	76.1319	21.2744	Recharge shaft
73.	RAVER	Raver	76.0436	21.2473	Recharge shaft
74.	Rasalpur	Raver	76.0541	21.2605	Recharge shaft
75.	Raver (rural)	Raver	76.0277	21.2264	Recharge shaft
76.	Bhatkhede	Raver	75.9997	21.2324	Recharge shaft
77.	Vivare Bk.	Raver	75.9876	21.2279	Recharge shaft
78.	Raver (rural)	Raver	76.0255	21.2512	Recharge shaft
79.	Raver (rural)	Raver	76.0069	21.2769	Recharge shaft
80.	Karjod	Raver	76.0835	21.2832	Recharge shaft
81.	Ahirwadi	Raver	76.0776	21.3013	Recharge shaft
82.	Ahirwadi	Raver	76.0902	21.3005	Recharge shaft
83.	Padale Bk.	Raver	76.1138	21.3074	Recharge shaft
84.	Khirode Pr.raver	Raver	76.0371	21.3004	Recharge shaft

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
85.	Pimpri	Raver	76.0569	21.3063	Recharge shaft
86.	Utkhede	Raver	75.966	21.253	Recharge shaft
87.	Kusumbe Kh.	Raver	75.9735	21.2662	Recharge shaft
88.	Lohare	Raver	75.9252	21.2497	Recharge shaft
89.	Lohare	Raver	75.911	21.2539	Recharge shaft
90.	Savkhede Bk.	Raver	75.9019	21.2442	Recharge shaft
91.	Lohare	Raver	75.94	21.2441	Recharge shaft
92.	Padale Kh	Raver	76.1167	21.3172	Recharge shaft
93.	Ajande	Raver	76.0268	21.2098	Recharge shaft
94.	Golwadi	Raver	75.9831	21.1309	Recharge shaft
95.	Waghadi	Raver	76.0052	21.161	Recharge shaft
96.	Singat	RAVER	75.9606	21.136	Recharge shaft
97.	Dasanoor	RAVER	75.9483	21.1512	Recharge shaft
98.	Singanoor	RAVER	75.9519	21.1671	Recharge shaft
99.	Waghode Bk.	RAVER	75.9461	21.182	Recharge shaft
100.	Chinawal	RAVER	75.9451	21.2005	Recharge shaft
101.	Kumbharkhade	RAVER	75.9465	21.2141	Recharge shaft
102.	Gaulkhede	RAVER	75.9422	21.2353	Recharge shaft
103.	Lohare	RAVER	75.9342	21.2627	Recharge shaft
104.	Punkhede	RAVER	76.0549	21.2313	Recharge shaft
105.	Bhokari	RAVER	76.0592	21.2441	Recharge shaft
106.	Bhokari	RAVER	76.061	21.257	Recharge shaft
107.	Kerhale Kh.	RAVER	76.057	21.2722	Recharge shaft
108.	Kerhale Kh.	RAVER	76.0563	21.2904	Recharge shaft
109.	Pimpri	RAVER	76.0588	21.3005	Recharge shaft
110.	Pimpri	RAVER	76.0599	21.3178	Recharge shaft
111.	Ambhode Kh.	RAVER	76.0212	21.3107	Recharge shaft
112.	Ambhode Kh.	RAVER	76.032	21.3073	Recharge shaft
113.	Khanapur	RAVER	76.1226	21.285	Recharge shaft
114.	Padale Bk.	RAVER	76.1183	21.2995	Recharge shaft
115.	Padale Kh	RAVER	76.107	21.3161	Recharge shaft
116.	Padale Kh	RAVER	76.1031	21.3286	Recharge shaft
117.	Rozode	RAVER	75.8816	21.1936	Recharge shaft
118.	Rozode	RAVER	75.8932	21.1994	Recharge shaft
119.	Chinawal	RAVER	75.907	21.2122	Recharge shaft
120.	Savkhede Kh.	RAVER	75.9099	21.2288	Recharge shaft
121.	Lohare	RAVER	75.9172	21.2443	Recharge shaft
122.	Raver (rural)	RAVER	76.0385	21.2083	Recharge shaft
123.	Raver (rural)	RAVER	76.0233	21.2154	Recharge shaft
124.	Bhatkhede	RAVER	76.0074	21.2283	Recharge shaft
125.	Bhatkhede	RAVER	75.9958	21.2367	Recharge shaft
126.	Khirode Pr.raver	RAVER	76.0193	21.2657	Recharge shaft
127.	Karjod	RAVER	76.0828	21.2722	Recharge shaft

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
128.	Karjod	RAVER	76.09	21.2603	Recharge shaft
129.	Waghod	RAVER	76.0987	21.2509	Recharge shaft
130.	Waghod	RAVER	76.1183	21.2505	Recharge shaft
131.	Morgaon Bk.	RAVER	76.1161	21.2353	Recharge shaft
132.	Morgaon Kh.	RAVER	76.1063	21.2249	Recharge shaft
133.	Nimbol	RAVER	76.0476	21.185	Recharge shaft
134.	Ajande	RAVER	76.0472	21.1958	Recharge shaft
135.	Vivare Bk.	RAVER	75.9962	21.1789	Recharge shaft
136.	Waghode Kh	RAVER	75.899	21.1384	Recharge shaft
137.	FAIZPUR	RAVER	75.8646	21.1761	Recharge shaft

Annexure-IX

Proposed Artificial Recharge Structures in Yaval Taluka

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
1.	Chincholi	YAWAL	75.5573	21.2348	Percolation tank
2.	Khalkot	YAWAL	75.5693	21.2571	Percolation tank
3.	Ichkheda	YAWAL	75.5857	21.2443	Percolation tank
4.	Ichkheda	YAWAL	75.5876	21.2705	Percolation tank
5.	Kingaon Bk	YAWAL	75.6098	21.2184	Percolation tank
6.	Naigaon	YAWAL	75.6075	21.2397	Percolation tank
7.	Naigaon	YAWAL	75.602	21.2464	Percolation tank
8.	Chunchale	YAWAL	75.6206	21.2102	Percolation tank
9.	Chunchale	YAWAL	75.6216	21.2333	Percolation tank
10.	Savkhedesim	YAWAL	75.6549	21.2531	Percolation tank
11.	Chunchale	YAWAL	75.6438	21.2522	Percolation tank
12.	Dahigaon	YAWAL	75.6683	21.2129	Percolation tank
13.	Korpawli	YAWAL	75.695	21.2409	Percolation tank
14.	Dangarkuthora	YAWAL	75.7267	21.2507	Percolation tank
15.	Dangarkuthora	YAWAL	75.7496	21.2339	Percolation tank
16.	Bhorkhede Kh	YAWAL	75.7721	21.2294	Percolation tank
17.	Hingone	YAWAL	75.7799	21.1998	Percolation tank
18.	Nhavi P Yaval	YAWAL	75.8315	21.2017	Percolation tank
19.	FAIZPUR	YAWAL	75.8629	21.1865	Percolation tank
20.	Virode	YAWAL	75.838	21.1502	Percolation tank
21.	Bhalod	YAWAL	75.7897	21.1633	Percolation tank
22.	Atrawal	YAWAL	75.7453	21.1825	Percolation tank
23.	YAWAL	YAWAL	75.7019	21.1947	Percolation tank
24.	YAWAL	YAWAL	75.7296	21.1843	Percolation tank
25.	Chitode	YAWAL	75.7417	21.2001	Percolation tank
26.	Dangarkuthora	YAWAL	75.7463	21.2199	Percolation tank
27.	Dangarkuthora	YAWAL	75.7401	21.2358	Percolation tank
28.	Dongaon	YAWAL	75.5697	21.2096	Percolation tank
29.	Chunchale	Yawal	75.6439	21.2281	Percolation tank
30.	Borale	Yawal	75.6487	21.218	Percolation tank
31.	Padalse	Yawal	75.8025	21.1337	Recharge shaft
32.	Kosgaon	Yawal	75.8141	21.1034	Recharge shaft
33.	Bhortek	Yawal	75.7915	21.0967	Recharge shaft
34.	Anjale	Yawal	75.7631	21.0918	Recharge shaft
35.	Karanji	Yawal	75.847	21.1218	Recharge shaft
36.	Virode	Yawal	75.8405	21.1452	Recharge shaft
37.	Pimprud	Yawal	75.8632	21.1629	Recharge shaft
38.	Nhavi P Yaval	Yawal	75.8327	21.2058	Recharge shaft
39.	Nhavi P Yaval	Yawal	75.8399	21.1928	Recharge shaft
40.	FAIZPUR	Yawal	75.8525	21.1937	Recharge shaft
41.	Hambardi	Yawal	75.8099	21.1917	Recharge shaft

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
42.	Bhalod	Yawal	75.7914	21.1593	Recharge shaft
43.	Sangvi Bk	Yawal	75.7599	21.1834	Recharge shaft
44.	Atrawal	Yawal	75.7484	21.1791	Recharge shaft
45.	YAWAL	Yawal	75.7324	21.1801	Recharge shaft
46.	YAWAL	Yawal	75.7034	21.193	Recharge shaft
47.	Sakali	Yawal	75.6416	21.1823	Recharge shaft
48.	Sakali	Yawal	75.6081	21.1861	Recharge shaft
49.	Dambhurni	Yawal	75.5548	21.1642	Recharge shaft
50.	Dagadi	Yawal	75.5838	21.1556	Recharge shaft
51.	Dagadi	Yawal	75.5843	21.1642	Recharge shaft
52.	Shiragad	Yawal	75.5736	21.154	Recharge shaft
53.	Dambhurni	Yawal	75.5659	21.1622	Recharge shaft
54.	Nhavi P Adawad	Yawal	75.539	21.1652	Recharge shaft
55.	Pathrale	Yawal	75.5695	21.1396	Recharge shaft
56.	Pilode Kh	Yawal	75.6278	21.1365	Recharge shaft
57.	Shirsad	Yawal	75.6677	21.1796	Recharge shaft
58.	Shirsad	Yawal	75.6446	21.1466	Recharge shaft
59.	Pimpri	Yawal	75.6528	21.1308	Recharge shaft
60.	Shirsad	Yawal	75.672	21.1414	Recharge shaft
61.	YAWAL	Yawal	75.6936	21.166	Recharge shaft
62.	Bhalshiv	Yawal	75.682	21.1369	Recharge shaft
63.	Bhalshiv	Yawal	75.6877	21.1274	Recharge shaft
64.	Pimpri	Yawal	75.6416	21.1255	Recharge shaft
65.	Tembhi Kh	Yawal	75.7299	21.1457	Recharge shaft
66.	Rojore	Yawal	75.7436	21.1254	Recharge shaft
67.	Borawal Bk	Yawal	75.7173	21.1223	Recharge shaft
68.	Borkhede Bk	Yawal	75.8328	21.2219	Recharge shaft
69.	Borkhede Bk	Yawal	75.8205	21.2311	Recharge shaft
70.	Dangarkuthora	Yawal	75.7512	21.2294	Recharge shaft
71.	Dangarkuthora	Yawal	75.7416	21.2314	Recharge shaft
72.	Mohrale	Yawal	75.7064	21.249	Recharge shaft
73.	Savkhedesim	Yawal	75.657	21.2496	Recharge shaft
74.	Chunchale	Yawal	75.646	21.2484	Recharge shaft
75.	Mohrale	Yawal	75.6693	21.2445	Recharge shaft
76.	Kingaon Bk	Yawal	75.6129	21.2142	Recharge shaft
77.	Chunchale	Yawal	75.6275	21.2308	Recharge shaft
78.	Kingaon Bk	Yawal	75.5923	21.2238	Recharge shaft
79.	Ichkheda	Yawal	75.5877	21.239	Recharge shaft
80.	Kasarkhede	Yawal	75.5761	21.2377	Recharge shaft
81.	Adgaon	Yawal	75.5638	21.2387	Recharge shaft
82.	Chunchale	Yawal	75.6331	21.2577	Recharge shaft
83.	Dahigaon	Yawal	75.6565	21.2124	Recharge shaft
84.	Borale	Yawal	75.6419	21.2111	Recharge shaft

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
85.	Mahelkhedi	Yawal	75.6825	21.2142	Recharge shaft
86.	Dangarkuthora	Yawal	75.7359	21.214	Recharge shaft
87.	Sakali	Yawal	75.5943	21.1928	Recharge shaft
88.	Chincholi	Yawal	75.5517	21.2219	Recharge shaft
89.	Dongaon	Yawal	75.5651	21.2106	Recharge shaft
90.	Ridhori	Yawal	75.837	21.1056	Recharge shaft
91.	Awar	Yawal	75.5568	21.1469	Recharge shaft
92.	Shiragad	YAWAL	75.5651	21.1476	Recharge shaft
93.	Shiragad	YAWAL	75.57	21.154	Recharge shaft
94.	Dagadi	YAWAL	75.587	21.1567	Recharge shaft
95.	Thorgavhan	YAWAL	75.5966	21.1567	Recharge shaft
96.	Manwel	YAWAL	75.6077	21.1594	Recharge shaft
97.	Manwel	YAWAL	75.6189	21.1614	Recharge shaft
98.	Shirsad	YAWAL	75.6309	21.1699	Recharge shaft
99.	Sakali	YAWAL	75.6369	21.18	Recharge shaft
100.	Sakali	YAWAL	75.6405	21.191	Recharge shaft
101.	Sakali	YAWAL	75.6392	21.2037	Recharge shaft
102.	Borale	YAWAL	75.6374	21.2126	Recharge shaft
103.	Chunchale	YAWAL	75.6383	21.255	Recharge shaft
104.	Savkhedesim	YAWAL	75.6495	21.2414	Recharge shaft
105.	Chunchale	YAWAL	75.6441	21.2263	Recharge shaft
106.	Borale	YAWAL	75.6427	21.2182	Recharge shaft
107.	Mohrale	YAWAL	75.6905	21.2593	Recharge shaft
108.	Mohrale	YAWAL	75.6965	21.2449	Recharge shaft
109.	Korpawli	YAWAL	75.697	21.2321	Recharge shaft
110.	Korpawli	YAWAL	75.6943	21.2219	Recharge shaft
111.	YAWAL	YAWAL	75.6943	21.2047	Recharge shaft
112.	YAWAL	YAWAL	75.6916	21.1942	Recharge shaft
113.	YAWAL	YAWAL	75.689	21.1861	Recharge shaft
114.	YAWAL	YAWAL	75.7017	21.1957	Recharge shaft
115.	YAWAL	YAWAL	75.7088	21.203	Recharge shaft
116.	Satod Pr Yawal	YAWAL	75.7113	21.2167	Recharge shaft
117.	Vadri Kh	YAWAL	75.7079	21.2331	Recharge shaft
118.	Korpawli	YAWAL	75.7061	21.2447	Recharge shaft
119.	Dangarkuthora	YAWAL	75.7383	21.2388	Recharge shaft
120.	Dangarkuthora	YAWAL	75.7474	21.2152	Recharge shaft
121.	Chitode	YAWAL	75.7438	21.1978	Recharge shaft
122.	Sangvi Bk	YAWAL	75.7461	21.1876	Recharge shaft
123.	YAWAL	YAWAL	75.7048	21.1812	Recharge shaft
124.	YAWAL	YAWAL	75.6994	21.1761	Recharge shaft
125.	YAWAL	YAWAL	75.6954	21.1699	Recharge shaft
126.	YAWAL	YAWAL	75.6938	21.1608	Recharge shaft
127.	YAWAL	YAWAL	75.6892	21.1544	Recharge shaft

S. No.	Village	Taluka	Longitude	Latitude	Proposed Recharge structure
128.	YAWAL	YAWAL	75.6856	21.1483	Recharge shaft
129.	Bhalshiv	YAWAL	75.6813	21.142	Recharge shaft
130.	Bhalshiv	YAWAL	75.6767	21.1346	Recharge shaft
131.	Bhalshiv	YAWAL	75.687	21.131	Recharge shaft
132.	Takarkhede	YAWAL	75.6999	21.1282	Recharge shaft
133.	Borawal Kh	YAWAL	75.714	21.1261	Recharge shaft
134.	Tembhi Kh	YAWAL	75.7246	21.1378	Recharge shaft
135.	YAWAL	YAWAL	75.7278	21.1523	Recharge shaft
136.	YAWAL	YAWAL	75.7336	21.1645	Recharge shaft
137.	Atrawal	YAWAL	75.7436	21.1777	Recharge shaft
138.	Sangvi Bk	YAWAL	75.7499	21.1907	Recharge shaft
139.	Virode	YAWAL	75.8378	21.1518	Recharge shaft
140.	Nhavi P Yaval	YAWAL	75.8324	21.1856	Recharge shaft
141.	Marul	YAWAL	75.8161	21.2197	Recharge shaft
142.	Pilode Bk	YAWAL	75.7708	21.1295	Recharge shaft
143.	Padalse	YAWAL	75.795	21.1356	Recharge shaft
144.	Vadhode P Sawada	YAWAL	75.8508	21.1366	Recharge shaft