केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

AQUIFER MAPPING REPORT

Warud and Morshi Talukas, Amravati District, Maharashtra (Part-I)

मध्य क्षेत्र, नागपुर

Central Region, Nagpur

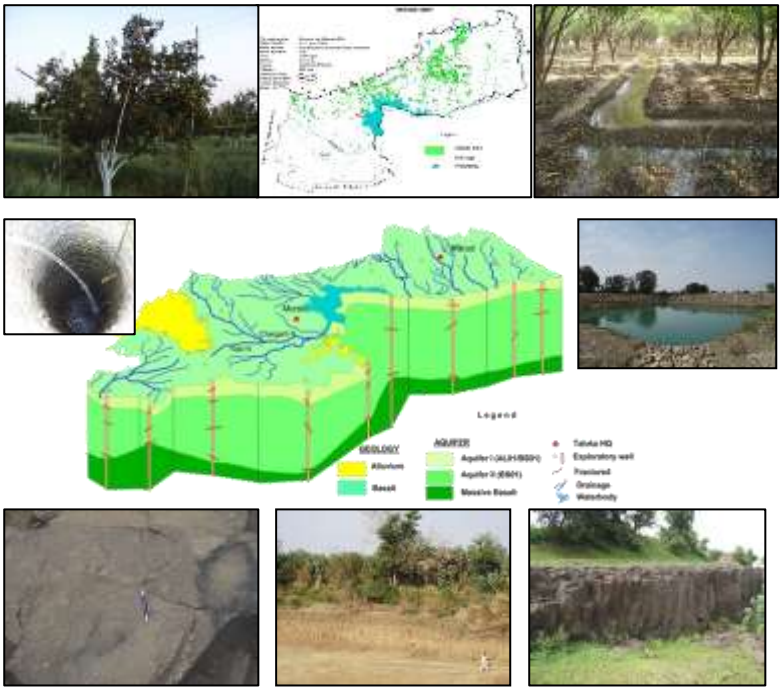
भारत सरकार
Government of India
जल संसाधन, नदी विकास एवं गंगा संरक्षण मंत्रालय
Ministry of Water Resources, River Development & Ganga Rejuvenation
केन्द्रीय भूमि जल बोर्ड
CENTRAL GROUND WATER BOARD

PART-I

जल बचत जल संचय

जलभृत नक्शे तथा भूजल प्रबंधन योजना पर संक्षिप्त रिपोर्ट

Report on Aquifer Maps and Ground Water Management Plans



वरुड तथा मोर्शी तालुका, जिला अमरावती, महाराष्ट्र

WARUD AND MORSHI Talukas, AMRAVATI District, Maharashtra

मध्य क्षेत्र, नागपुर / Central Region, Nagpur

जून 2017 /June 2017

PART-I

AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, WARUD AND MORSHI TALUKA, AMRAVATI DISTRICT, MAHARASHTRA

CONTRIBUTORS'

Principal Authors

Dr. Bhushan R. Lamsoge	:	Senior Hydrogeologist/ Scientist-D
J. R. Verma	:	Scientist-D
Kartik P. Dongre	:	Scientist -C

Supervision & Guidance

D. Subba Rao	:	Regional Director
Dr. P .K. Jain	:	Supdtg. Hydrogeologist

Hydrogeology, GIS maps and Management Plan

J. R. Verma	:	Scientist-D
Dr. Bhushan R. Lamsoge	:	Senior Hydrogeologist/ Scientist-D
Rahul R. Shende	:	Assistant Hydrogeologist
Kartik P. Dongre	:	Scientist -C

Groundwater Exploration

Kartik P. Dongre	:	Scientist -C
Vijesh V. K.	:	Junior Hydrogeologist/ Scientist-B
M. R. K. Reddy	:	Junior Hydrogeologist /Scientist-B
Abhay Nivasarkar		Junior Hydrogeologist /Scientist-D

Chemical Analysis

Dr. Devsharan Verma	:	Scientist B (Chemist)
Dr. Rajni Kant Sharma	:	Scientist B (Chemist)
T. Dinesh Kumar	:	Assistant Chemist

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AQUIFER MAPS AND GROUND WATER MANAGEMENT PLANS, WARUD AND MORSHI TALUKA, AMRAVATI DISTRICT, MAHARASHTRA

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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 Administration of Warud and Morshi taluka, Amravati district, Maharashtra 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.

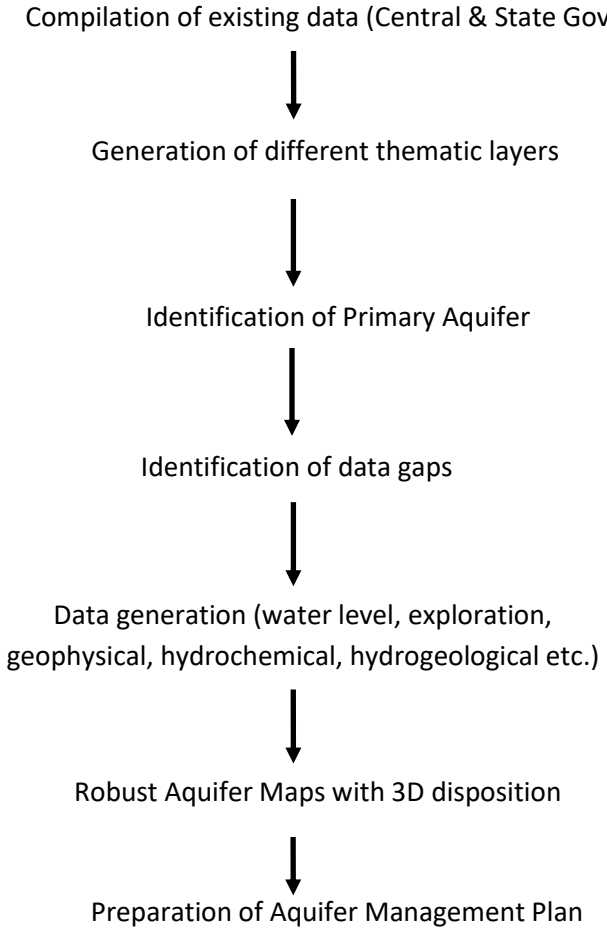
This clear demarcation of aquifers and their potential will help the agencies involved in water supply in ascertaining, how much volume of water is under their control. The robust and implementable ground water management plan will provide a **"Road Map"** to systematically manage the ground water resources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

Thus, Warud and Morshi taluka, Amravati district, Maharashtra covering an area of 1554 sq.km. including 745 sq.km. in Warud and 809 sq.km. in Morshi, have been entirely covered during the Annual Action Plan of 2012-13.

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:



1.3 Study area

Keeping in view the current demand and supply and futuristic requirement of water, Central Ground Water Board has initiated the National Aquifer Mapping Programme (NAQUIM) in India during XII five year plan, with a priority to study Over-exploited, Critical and Semi-Critical talukas. Thus, Warud and Morshi talukas have been taken up to carry out detailed hydrogeological investigation covering an area of 1554 sq.km. including 745 sq.km. in Warud and 809 sq.km. in Morshi in the year 2012-13. The index map of the study area is presented in **Fig. 1.1a** while an administrative map is presented as **Fig. 1.1b**. These talukas are categorized as Over Exploited, as per Ground Water Resources Estimation carried out by CGWB and GSDA as on March 2013.

1.4 Data Adequacy and Data Gap Analysis:

The available data of the Exploratory wells drilled by Central Ground Water Board, Central Region, Amravati, 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

The locations of existing exploratory wells and ground water monitoring wells which were also used as ground water quality sampling locations are shown in **Fig. 1.2.**

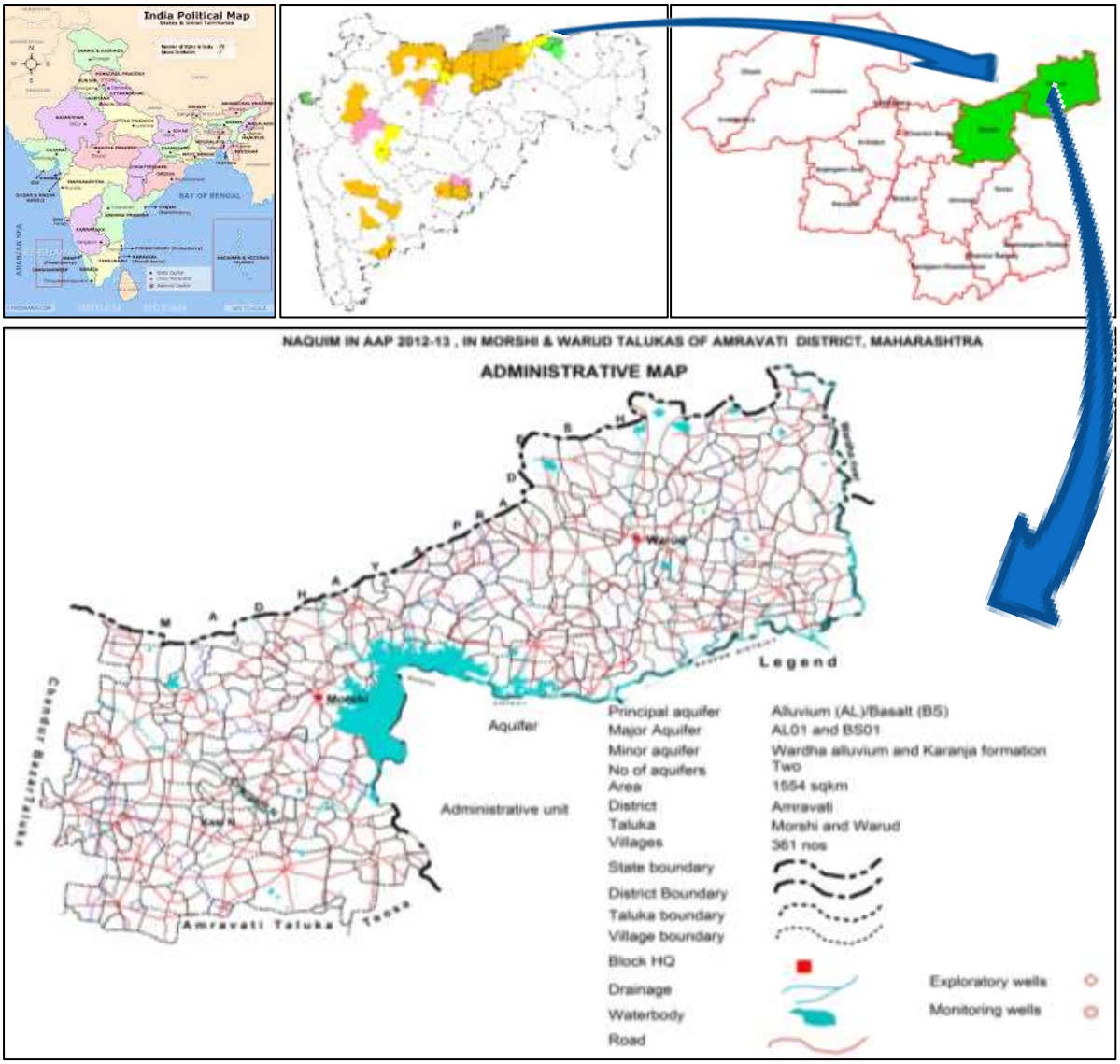


Fig. 1.1a & b: Index & Administrative map, Warud and Morshi Taluka, Amravati District

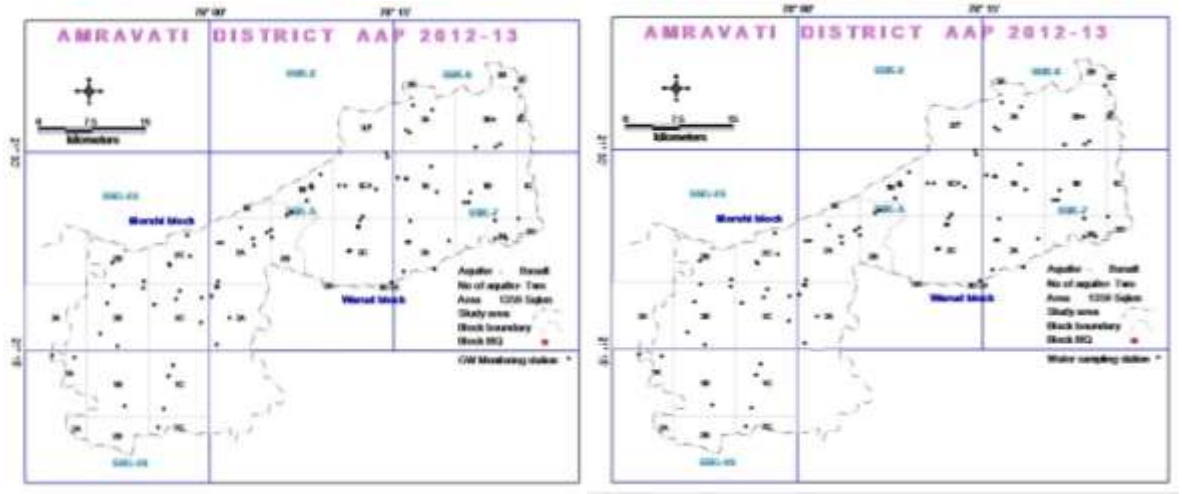


Fig 1.2: Locations of Existing Exploratory Wells and Ground Water Monitoring Wells.

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 and discussed in detail.

Table 1.1: Data Adequacy and Data Gap Analysis

EXPLORATORY DATA			GEOPHYSICAL DATA			GW MONITORING DATA (AQI)			GW MONITORING DATA (AQII)			GW QUALITY DATA (AQI)			GW QUALITY DATA (AQII)		
Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap	Req.	Exist.	Gap
10	34	0	66	41	48	22	103	0	10	14	0	22	103	0	10	14	0

1.5 Data Gap Identification

The data adequacy as discussed above indicates that the existing data is not sufficient for preparation of aquifer maps; hence data gap has been identified for Exploratory Wells, Geophysical Survey (VES), Ground Water Monitoring Wells and Ground Water Quality. Based on the data gap identification, the data generation activity was planned and completed in 2012-13.

1.6 Rainfall And Climate

The area experiences the sub-tropical to tropical temperate monsoon climate and characterised by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. In Winter average minimum temperature is about 9-15 °C. In summer average maximum temperature is about 38-42.2 °C. The mean minimum and maximum temperature is 15.1°C and is 42.2°C respectively. As per Agro-climatic Zones of the Agriculture Department, both the talukas are categorised under 'Moderate Rainfall Climatic Zone-08'.

Rainfall data of rain gauge stations located at taluka headquarters of Warud and Morshi have been collected from available sources and are subjected to various types of statistical analysis to understand the characteristic of the rainfall.

The long term rainfall analysis (**Table 1.2**) for the period 1901 to 2015 for Warud taluka and Morshi taluka indicates that there is insignificant fall (-1.89 mm/year) in the rainfall at Warud while significant rise (+0.92 mm/year) in rainfall at Morshi taluka. The probability of normal rainfall is

about 69 % in Warud and 63 % in Morshi taluka while the chances of droughts is about 17 % in Warud and 18 % in Morshi taluka.

Table 1.2: Long term rainfall analysis, Warud and Morshi taluka, Amravati district.

CATEGORY	WARUD TALUKA		MORSHI TALUKA	
PERIOD	1901 to 2015		1901 to 2015	
NO OF YEARS	114		114	
NORMAL RAINFALL	932.7 mm		838.2 mm	
STANDARD DEVIATION	243 mm		274 mm	
COEFF OF VARIATION	26 %		33 %	
RAINFALL TREND / SLOPE	-1.89 mm/year		0.92 mm/year	
	Number of years	**% of total years**	**Number of years**	**% of total years**
DEPARTURES				
POSITIVE	60	52	46	40
NEGATIVE	55	48	68	60
DROUGHTS				
MODERATE	17	15	21	18
SEVERE	1	1	1	1
ACUTE	0	0	0	0
NORMAL & EXCESS R/F				
NORMAL	80	69	71	63
EXCESS	17	15	21	18

NOTE: Rainfall departure: EXCESS: > +25; NORMAL: +25 TO -25; MODERATE: -25 TO -50; SEVERE: -50 TO -75; ACUTE: < -74

The average rainfall for the last ten years ranges from 550 mm to 1135.5 mm in Warud taluka while 593.4 mm to 1185.8 mm in Morshi taluka. Thus, it has been observed that there is about 50 % variation in the minimum to maximum rainfall in both the talukas. The average annual rainfall is 872.07 mm & 819.41 mm in Warud and Morshi talukas respectively for the decade 2006 to 15. The annual rainfall data of last ten years is given in **Table 1.2 and 1.3.**

Table 1.3: Annual Rainfall Data of 10 years, Taluka Warud and Morshi (in mm)

Year	Warud Taluka			Morshi Taluka		
	Annual Rainfall	**Dep%**	**Category**	**Annual Rainfall**	**Dep%**	**Category**
2006	845.1	-9	NORMAL	736.7	-12	NORMAL
2007	998.4	+ 7	NORMAL	1071	+ 28	EXCESS
2008	550	-41	MODERATE	619.8	-26	MODERATE
2009	837.5	-10	NORMAL	593.4	-29	MODERATE
2010	923.2	-1	NORMAL	1185.8	+ 41	EXCESS
2011	761.1	-18	NORMAL	609.2	-27	MODERATE
2012	960.7	+ 3	NORMAL	852.8	+ 2	NORMAL
2013	1135.5	+ 22	NORMAL	967.5	+ 15	NORMAL
2014	775.4	-17	NORMAL	694.8	-17	NORMAL
2015	933.8	+ 0	NORMAL	863.1	+ 3	NORMAL
	872.07			819.41		

1.7 Physiography

The area can be broadly divided into three physiographic units i.e., the Melghat Hill range, the plain area of the Paynghat and flood plain. The Melghat hills are made up of Gawilgarh hills, which are a part of the Satpura hill ranges and occupied northern part of Morshi and Warud talukas. The elevation in the area range between 340-540 mamsl. The physiography of the area is shown in **Fig. 1.3.**

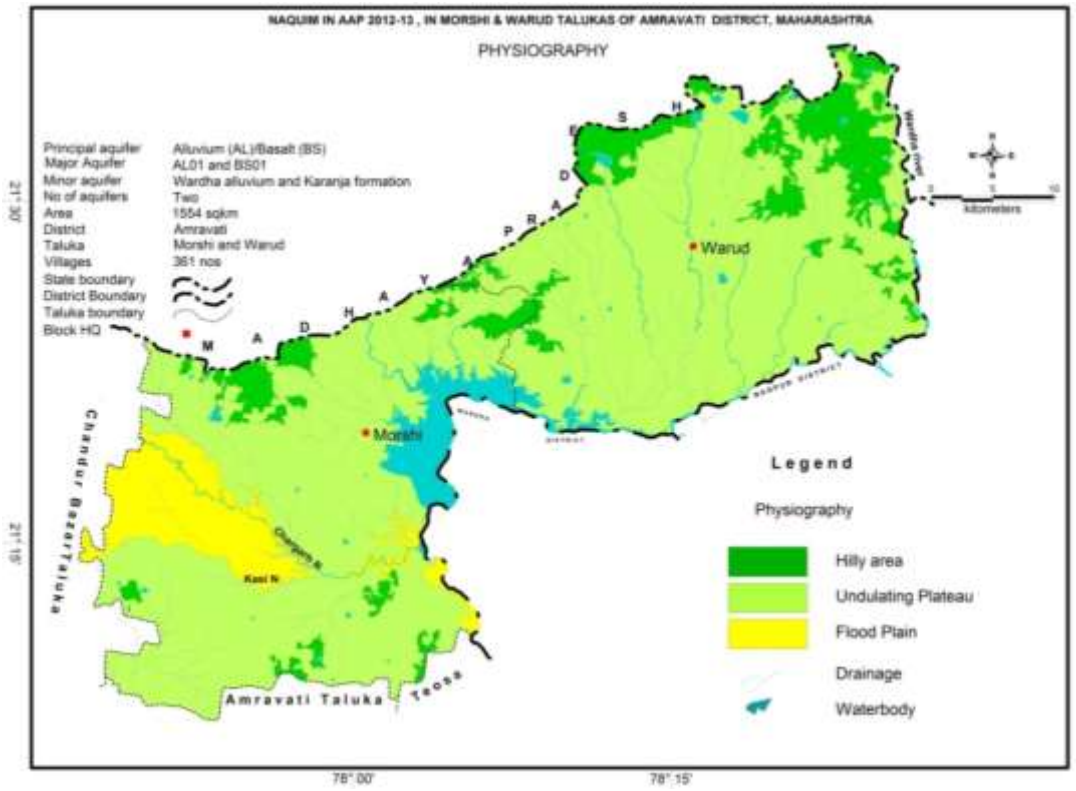


Fig. 1.3: Physiography, Warud and Morshi taluka, Amravati district

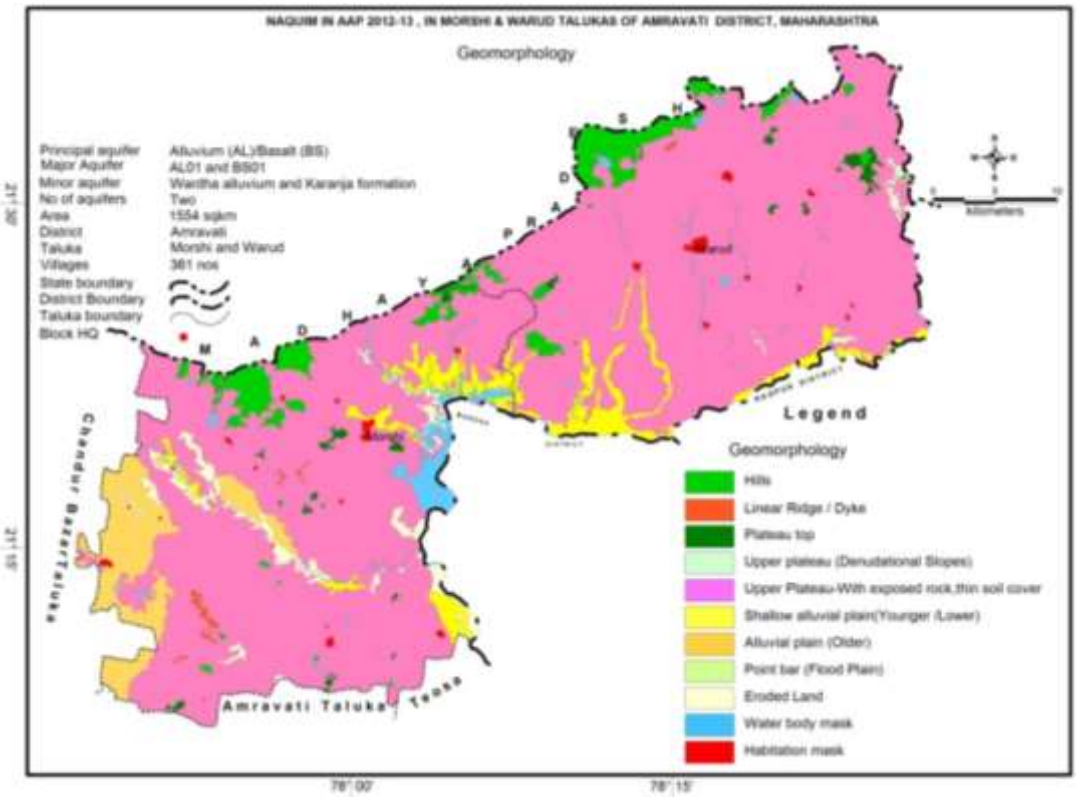


Fig. 1.4: Geomorphology, Warud and Morshi taluka, Amravati district

1.8 Geomorphology

The analysis of geomorphological data and thematic map collected from MRSAC, Nagpur reveals that almost entire area forms the Upper Plateau-Highly Dissected (HDP), which can be broadly divided in to three units depending on extent of weathering and thickness of soil cover viz. 1) MDP-a, in eastern, northern and western part and mostly Morshi taluka having negligible soil cover. 2) MDP-b, occupying western, eastern and central parts mostly Morshi taluka with thin soil cover and 3) MDP-c, mostly occurs in eastern and central part covering almost warud taluka with very thin soli cover and exposure of rocks. The geomorphology of the area is shown in **Fig. 1.4.**

1.9 Land Use, Soil, Land Use, Agriculture, Irrigation and Cropping Pattern

The landuse details and the thematic map available with the MRSAC, Nagpur has been collected and analysed with reference to the present agricultural practices, various land use etc. It has been observed that the major parts of the area are covered by agricultural land. Forest covers very little area in the northern and northwestern part. The built up area is reflected wherever settlements have come up. The overall land use, agriculture and irrigation are presented in Table **1.4a and b**. The thematic map on land use is shown in **Fig. 1.5**

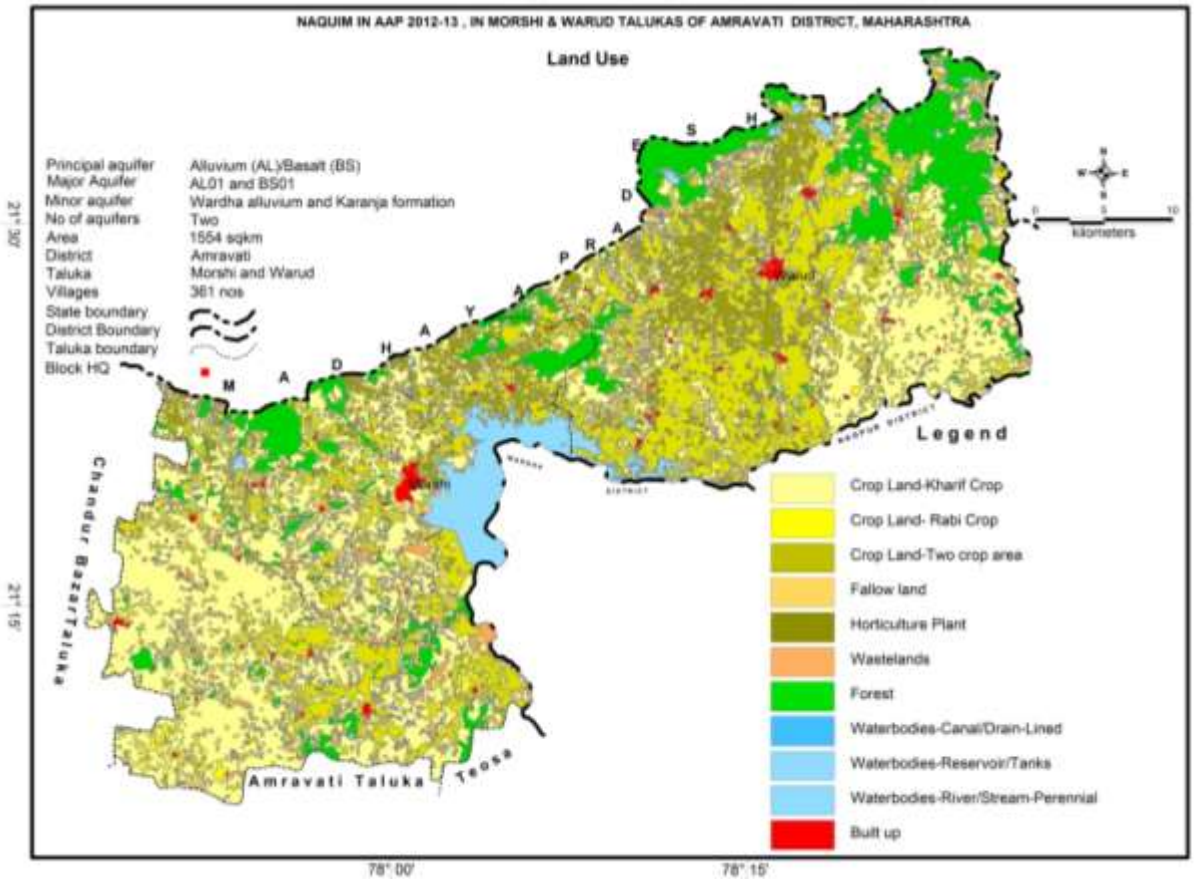


Fig. 1.5: Landuse, Warud and Morshi taluka, Amravati district

The agricultural distribution of crops does follows traditional pattern as oil seeds is the most dominant single crop in the Warud and Morshi taluka followed by Cereals, cotton, oranges and pulses. The ground water based irrigation caters to the major area i.e., 206.13 sq.km. (17.80 % of net sown area), while surface water irrigated areas is only about 17.53 sq.km (1.13 % of net sown area).

Table 1.4a: Land Use, Agriculture and Irrigation (fig. in sq.km)

Geographical Area	Cultivable/ Agricultural	Forest	Agricultural Land Break up area			Area under irrigation		Total irrigation	Area under Drip & Sprinkler
			Cultivable	Net Sown	Double cropped	GW	SW		
Warud	597.30	99.55	597.30	547.77	17.53	119.37	13.08	132.45	47.80
Morshi	658.55	79.07	658.55	609.74	10.20	86.76	0	86.76	39.43
Total	1255.85	178.62	1255.85	1157.51	27.73	206.13	13.08	219.21	87.27

Table 1.4b: Taluk wise area under different crops (fig. in sq.km)

Taluka	Oil seeds	Pulses	Oranges	Cereals	Cotton
Warud	33.91	38.22	98.57	194.30	68.59
Morshi	268.32	90.16	43.00	52.35	172.70
Total	302.23	128.38	141.57	246.65	241.29

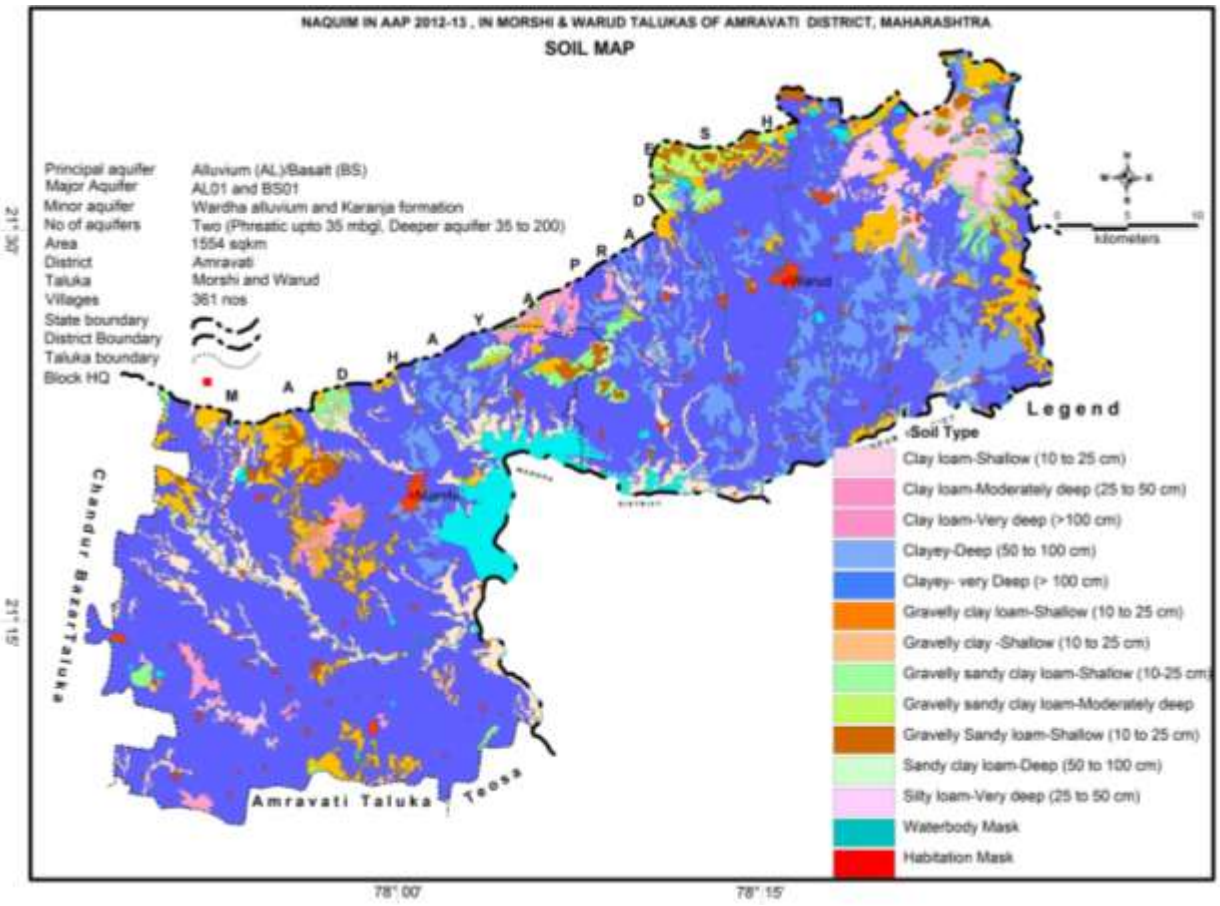


Fig. 1.6: Soil, Warud and Morshi taluka, Amravati district

The soil data and the thematic map of the area available with the MRSAC, Nagpur has been collected and analysed. It has been observed that the major part of the area is occupied by clayey soil followed by clayey loam observed along the northern fringe of the area. The small portion of the area in eastern and southern part is occupied by sandy loam to sandy clay type of soil whereas sandy loam also occurs in very small patch in western boundary of the area. The thematic map on the soil distribution in the study area is shown in **Fig. 1.6.**

1.10 Hydrology and Drainage:

1.10.1 Hydrology

There are no major and medium irrigation projects in the study. However, the State Govt. constructed a number of minor irrigation structures. As per the Irrigation Department, Govt. of Maharashtra, 6375 ha and 2272 ha land was irrigated in Warud and Morshi talukas due to these minor irrigation structures respectively. The Abstract of irrigation projects are presented as **Table 1.5** while details of area presented as **Annexure-I.**

Table 1.5: Abstract irrigation projects, Warud and Morshi taluka, Amravati district

Taluka	MI Tank	KTW	PT	Diversion Dam	LIS	Total	Total irrigation capacity Area under crop (Ha)	Gross storage (MCM)
Warud	20	34	14	10	1	79	6375	27.5
Morshi	12	17	4	2	--	35	2272	12.028
						114	8647	39.528

(Source: Irrigation Department, Govt. of Maharashtra, June 2005)

1.10.2 Drainage

The northern and southern part of the area is occupied by hillocks. The central part is occupied by valleys of Wardha River. The hills consist of E-W to NW-SE ridges with steep slopes and spurs with step like terraces. The height of the hillocks varies between 100 to 150 m above the ground level. The minimum elevation in the area is 340 m above m.s.l. and the maximum being 540 m above m.s.l. The remaining part of the area is nearly plain terrain with few isolated mounds.

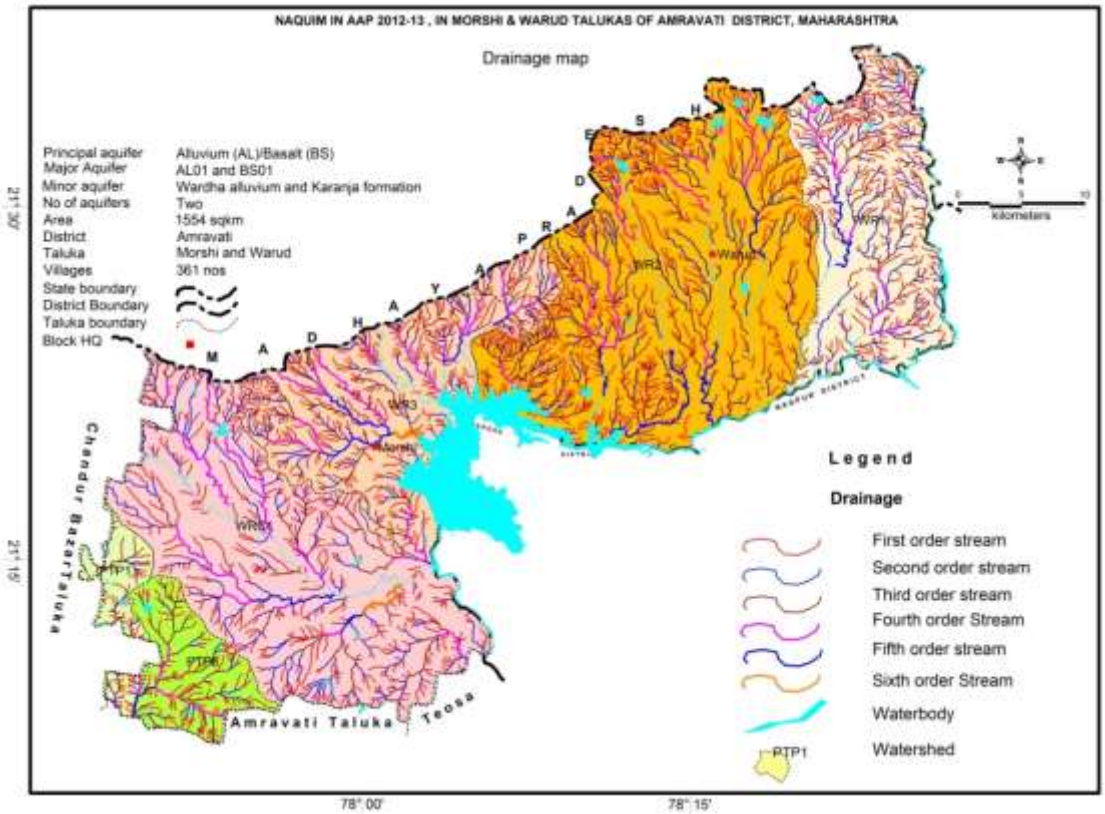


Fig. 1.7: Drainage, Warud and Morshi taluka, Amravati district

Wardha river and its tributaries Chargarh and Maru Nadi and other main nalas viz., Madar, Zari, Chudamai, Deonad, Dhodana, Kasi, Kadak, Pak, Dhawagiri and Chandrabhaga and their tributaries constitute the principal drainage system in the area. The other nalas are seasonal emanating from the hilly terrain and form the main nalas and rivers. The drainage pattern is mainly sub dendritic to sub parallel. The meandering of Wardha river indicates their mature stage of development. Initially, Wardha river flows from southward, when Jam Nadi meets near Jalalkheda, Wardha river flows south westerly and then southerly. This is due to presence of structural discontinuity and shows its structural control. The drainage map of study area is shown in **Fig. 3.5.**

1.11 Prevailing Water Conservation and Recharge Practices

The State water conservation department, Agricultural department, Social forestry along with Zilla parishad has constructed various water conservation structures, like percolation tanks, check dams, KT weirs, mati nala bandh, nala bunding, gully plugs, gabion structures, farm ponds, vanrai bandhara etc. The various Govt and NGO at suitable sites construct these structures. However, as per the data available, check dams are the most preferred water conservation structures in study area. At present, under *Jal yukt shivar* scheme of Agriculture Department, which is a flagship programme of Chief Minister, check dams and farm ponds are being constructed in the Warud and Morshi taluka.

2 DATA COLLECTION AND GENERATION

The primary data such as water levels, quality, and lithological inputs were available with CGWB as well as GSDA, Govt. of Maharashtra has been collected and utilised as baseline data. However, the ancillary data such as numbers of ground water abstraction structures, irrigation facilities, rainfall etc., have been collected from the various State govt. departments and compiled.

2.1 Data Collection and Compilation

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

i. Hydrogeological Data – Current and historical water levels along with water level trend data from 103 monitoring wells in Warud & Morshi taluka representing Aquifer-I. The water levels of 34 exploratory wells in Warud & Morshi taluka representing Aquifer-II were also collected and compiled.
ii. Hydrochemical Data - Ground water quality data from 34 monitoring wells in Warud & Morshi taluka representing Aquifer-I and data of 14 exploratory wells in Warud & Morshi taluka representing Aquifer-II were also collected and compiled.
iii. Exploratory Drilling – Ground water exploration data of 13 existing exploratory wells in Warud and Morshi talukas were complied.
iv. Geophysical Data – The weathered zone resistivity and weathered zone thickness data from CGWB were complied. In all 175 (71 and 104 VES during 2006-07 and 2012-13 respectively) Vertical Electrical Soundings (VES) were conducted.
v. Hydrology Data – Data on various irrigation projects, their utilisation status, number of ground water abstraction structures and area irrigated from Irrigation department were compiled.
vi. Hydrometeorological Data - Long term rainfall data for each of the taluka from IMD and Dept. of Agriculture were complied.
vii. Water Conservation Structures – Numbers, type and storage potential of water conservation structures prevailing in the area from Dept. of Agriculture, ZP, Social forestry etc. were complied.
viii. Cropping Pattern Data – Data on prevailing cropping pattern from Agriculture Dept. were complied.

2.2 Data Generation

After taking into consideration, the data available with CGWB on Ground Water Exploration, Geophysical survey, Ground Water Monitoring Wells (GWMW) and Ground Water Quality, the data adequacy were compiled. The requirement, availability and gap of major data inputs i.e., exploratory wells, geophysical data, GWMW and ground water quality data are detailed in the **Table 1.1**. Based on Data Gap Analysis, all the necessary data was generated as discussed below.

2.2.1 Ground Water Exploration

As seen from **Table-1.1**, exploratory drilling was required at 10 locations. The drilling at these sites was done down to targeted depth by deploying three rigs i.e., DTH-REL-06/119, DTH/LMP-87/77 and, DTH-LMP-87/74 to assess the lithological disposition of shallow aquifer (Aquifer-I) and deeper aquifer (Aquifer-II). Ground water exploration down to the depth of 200 m bgl in Warud and Morshi has been taken up where the data gap exists and accordingly total 21 wells were constructed including 11 EW + 2 OB in Morshi & 5 EW + 3 OW in Warud have been constructed. The details of aquifers encountered are discussed in successive chapter. The locations of exploratory wells are shown in **Fig. 2.1**. The details of existing and newly constructed exploratory and observation wells is given in **Annexure-II**.

2.2.2 Ground Water Monitoring Wells

As observed from **Table-1.1**, GWMW's were required at 22 locations for Aquifer-I and Aquifer-II correspondingly 103 key observation wells (KOW) were established and 34 EW were monitored in addition to the existing GWMW to assess the ground water scenario of shallow & deeper aquifer (Aquifer-I & II) of the area. Alos, 104 VES were also conducted in the area. The locations of KOW's, EW's and VES are shown in **Fig. 2.1**. The details of existing and newly established GWMW/KOW's are given in **Annexure-III**.

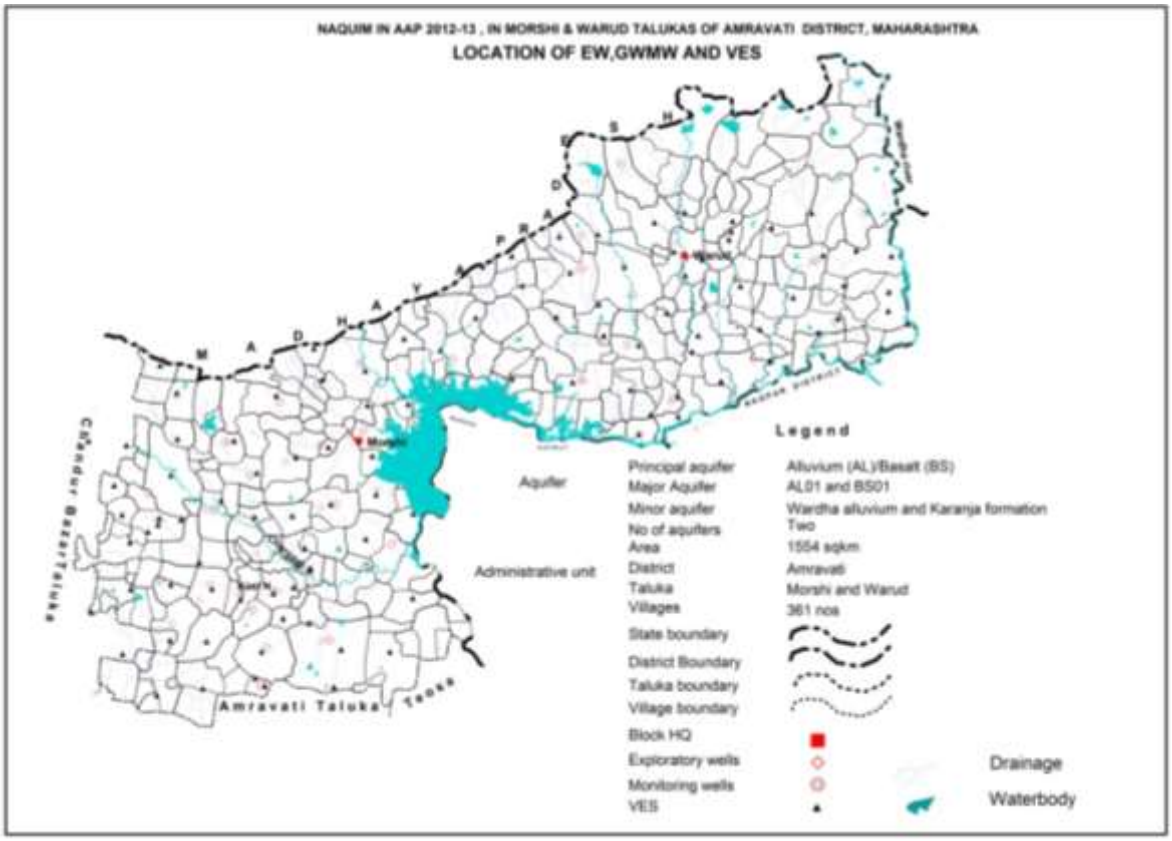


Fig.2.1: Locations of Exploratory Wells Ground Water Monitoring Wells & VES

2.2.3 Ground Water Quality

As observed from **Table-1.1**, GWMW's were required at 22 locations for Aquifer-I and Aquifer-II correspondingly 103 key observation wells (KOW) were established and 34 EW were monitored in addition to the existing GWMW to assess the ground water quality of shallow & deeper aquifer (Aquifer-I, & II) of the area. The details of chemical analysis of existing and newly established GWMW/KOW's are given in **Annexure-IVA and B.**

2.2.4 Micro Level Hydrogeological Data Acquisition

In addition to the KOW's, micro level hydrogeological data was also required as per data gap analysis for deciphering the sub-surface lithological disposition, water level scenario and other hydrogeological inputs such as weathered thickness etc., of shallow aquifer (Aquifer-I). Thus 278 well, 125 in Warud and 143 in Morshi talukas respectively, were inventoried for micro level data acquisition. The details of dugwells inventoried for micro-level data acquisition are given in **Annexure-V**. The locations of micro level hydrogeological data acquisition wells are shown in **Fig. 2.2**.

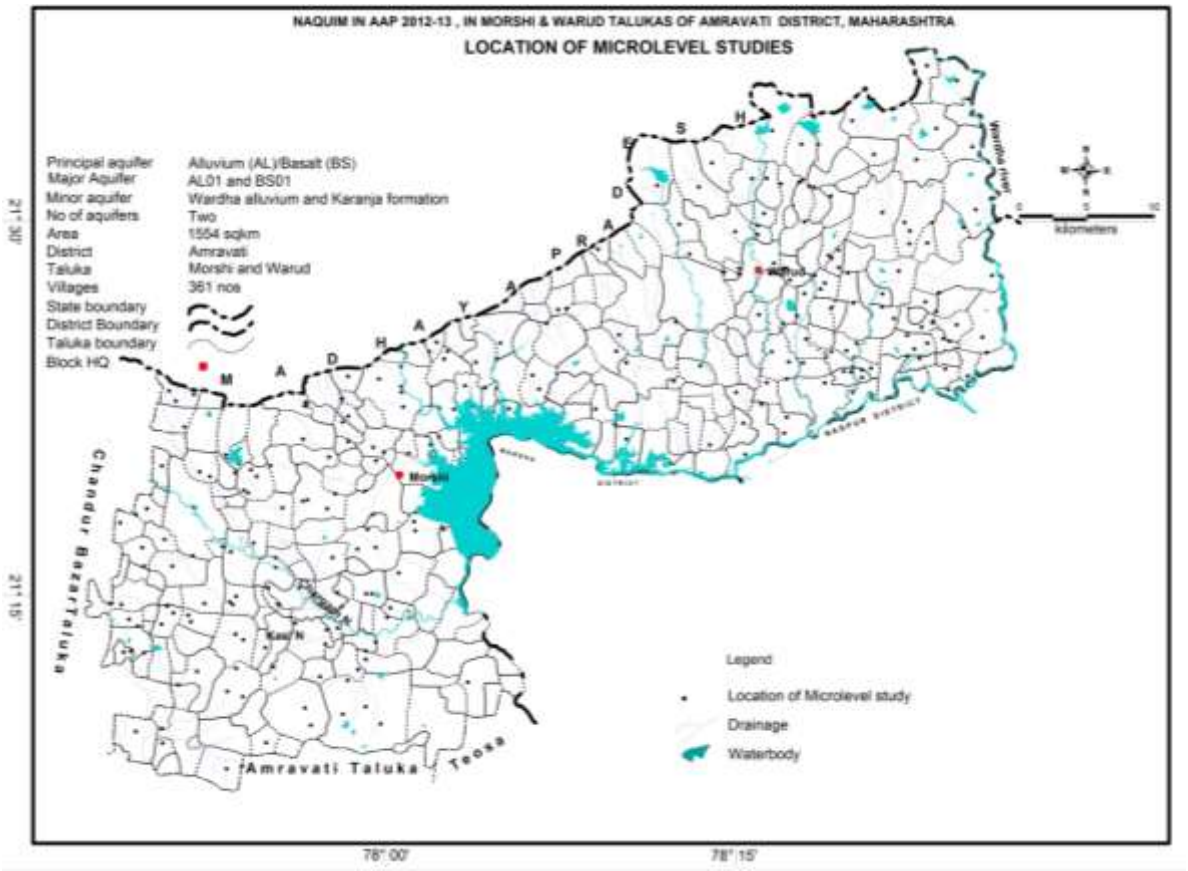


Fig.2.2: Locations of Micro Level Hydrogeological Data Acquisition Wells

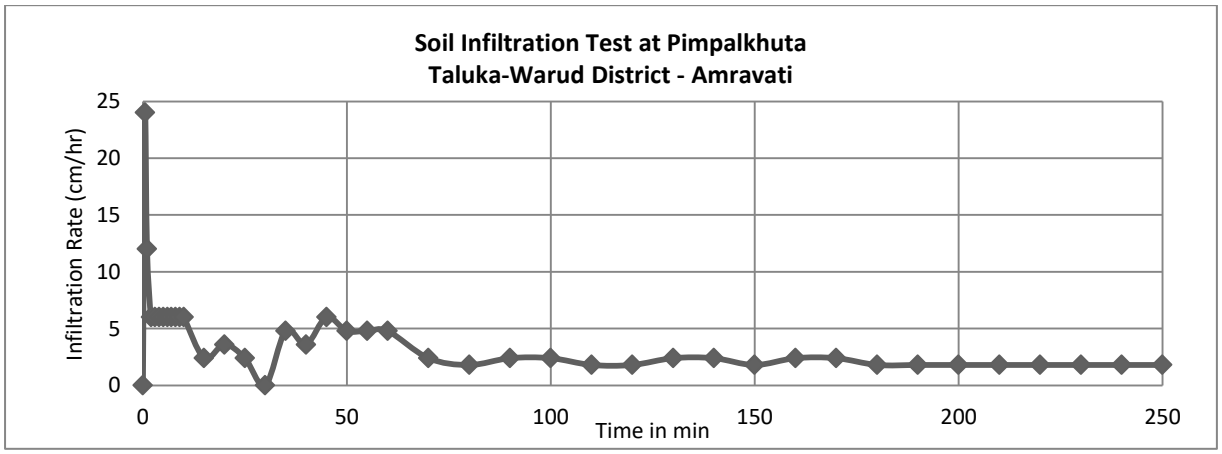
2.2.5 Soil Infiltration test

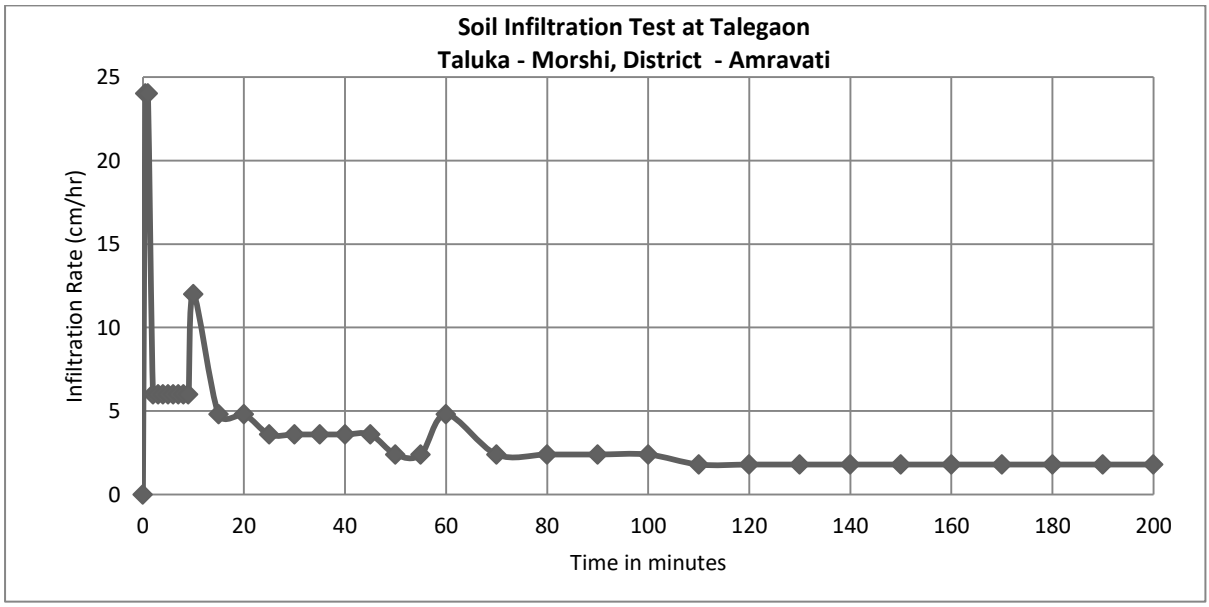
To estimate the actual rate of infiltration of various soil cover and their impact on recharge to ground water, 9 infiltration tests, 5 in Warud and 4 in Morshi talukas have been conducted on various soil types (**Fig. 2.3**). The data has been analyzed and the salient features of the infiltration tests are presented in **Table 2.1**, whereas the data is presented in **Annexure-VI** and the plots of soil infiltration tests are presented in **Fig. 2.3**. The duration of the test ranged from 100 to 300 minutes, the depth of water infiltrated varied from 10 cm to >100 cm and the final infiltration rate in the area ranged from 1.20 cm/hr (Karanjgon, Warud; Sadatpur & Udkhed, Morshi) for the very deep clayey soil type to 14.4 cm/hr at Januna for gravelly clay loam soil type.

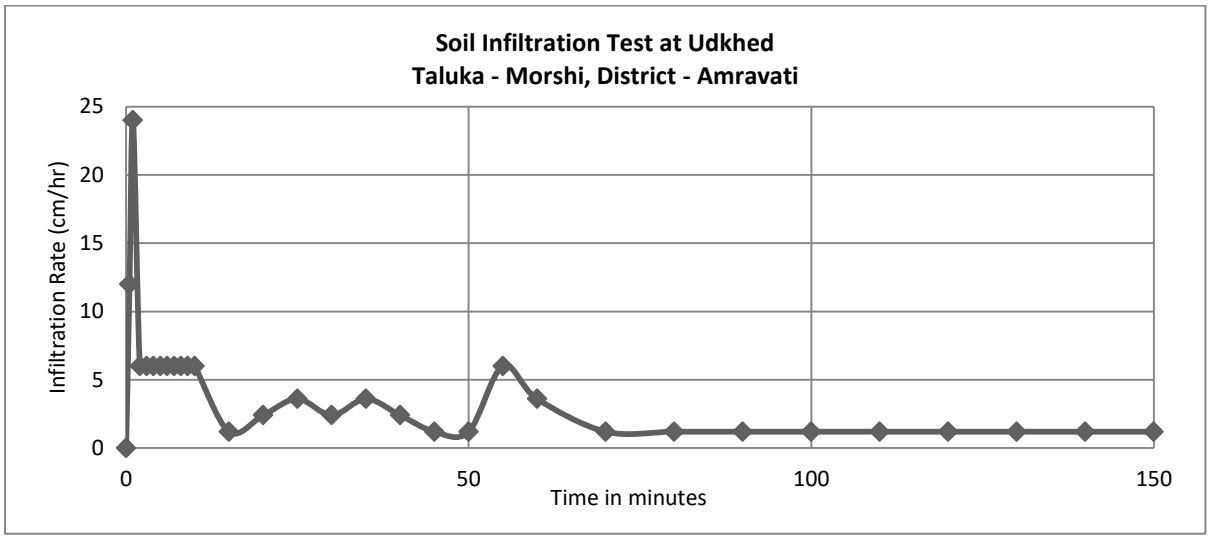
Table 2.1: Salient Features of Infiltration Tests

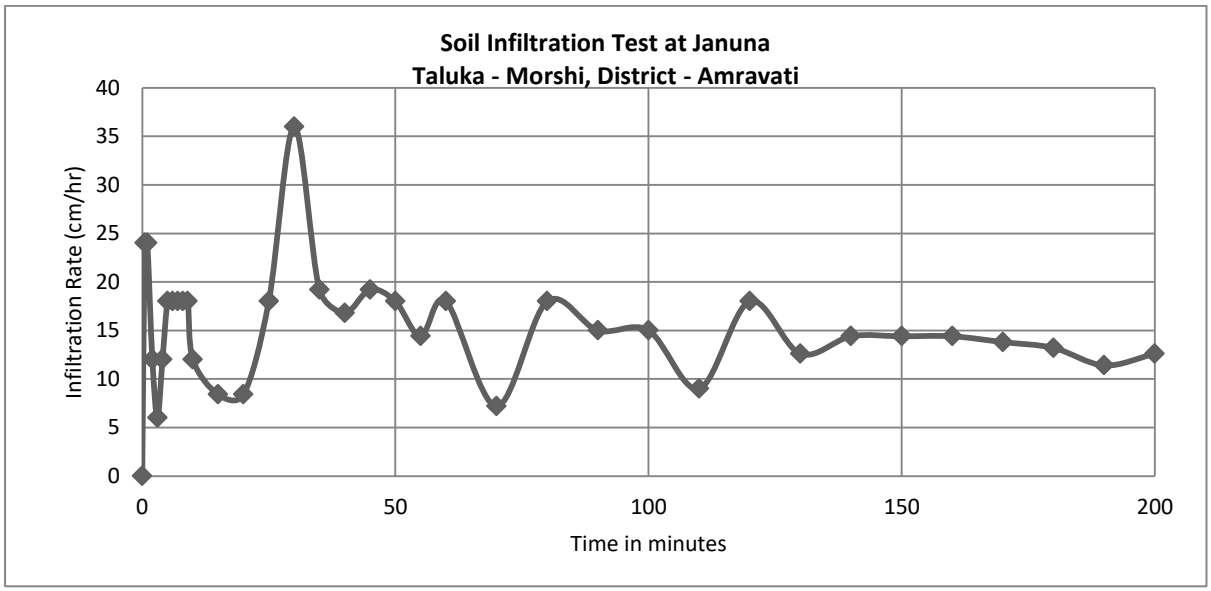
Sl. No	Village / Location	Taluka	Latitude (Deg Dec)	Longitude (Deg Dec)	Test Duration (min)	Soil Type	Infiltration Rate (cm/yr)
1	**Pimpalkotha (Ujad)** : in the Agriculture land of Sh. Liladhar Khasba opposite to Ganesh wadi	Warud	21.437	78.267	250	Clayey-Very Deep (> 100m)	1.8
2	**Karanjgaon :** in the agriculture land of Sh. Mohan M. Chimote in the outskrit of village on road to Loni	Warud	21.4045	78.2002	150	Clayey- Very Deep (>100 cm)	1.2
3	**Kharad Pusla :** Back side of Railway Station	Warud	21.4941	78.3551	300	Gravelly Clay Loam-Shallow	3.6

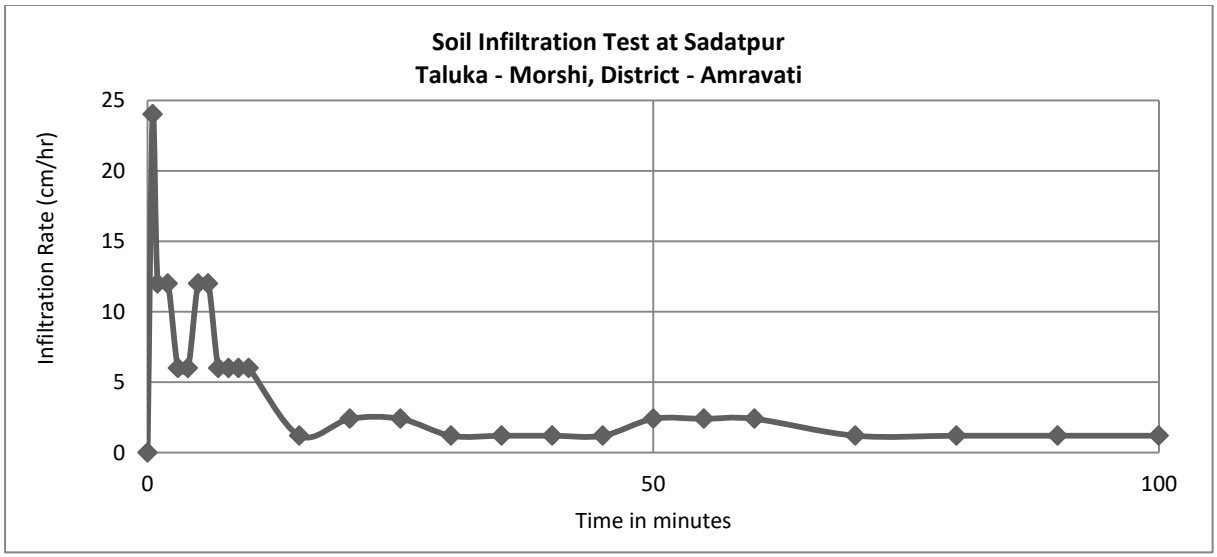
						(10-25 cm)	
4	**Bhadnoli (Ujad)** :Near Railway Bridge in the orange orchid of Sh. Damodar M. Darodkar	Warud	21.4671	78.3037	200	Clay-Very Deep (50 To 100 cm)	7.2
5	**Talegaon** : Near Over Head Tank in the village	Morshi	21..227	77.855	200	Clay Loam - Moderately Deep (25 to 50 cm)	1.8
6	**Udkhed :** In the premises o Muldle High School in the village	Morshi	21.2789	77.8886	150	Clayey- Very Deep (>100 cm)	1.2
7	**Januna :** In the agriculture land of Sh. Kisan M. Nipane	Morshi	21.387	77.9406	200	Gravelly Clay Loam-Shallow (10-25 cm)	12.6 To 14.4
8	**Sadatpur (Mouza) :** In the agriculture land of Sh. Radheshyam Biyani	Morshi	21.3439	77.9964	100	Clay-Very Deep (>100 cm)	1.2
9	**Dapori** : in the agriculture land of Smt. Archana Vijay Vighe near Govt. Primary School	Morshi	21.3885	77.057	180	Silty Loam-Very Deep (>100 cm)	1.8

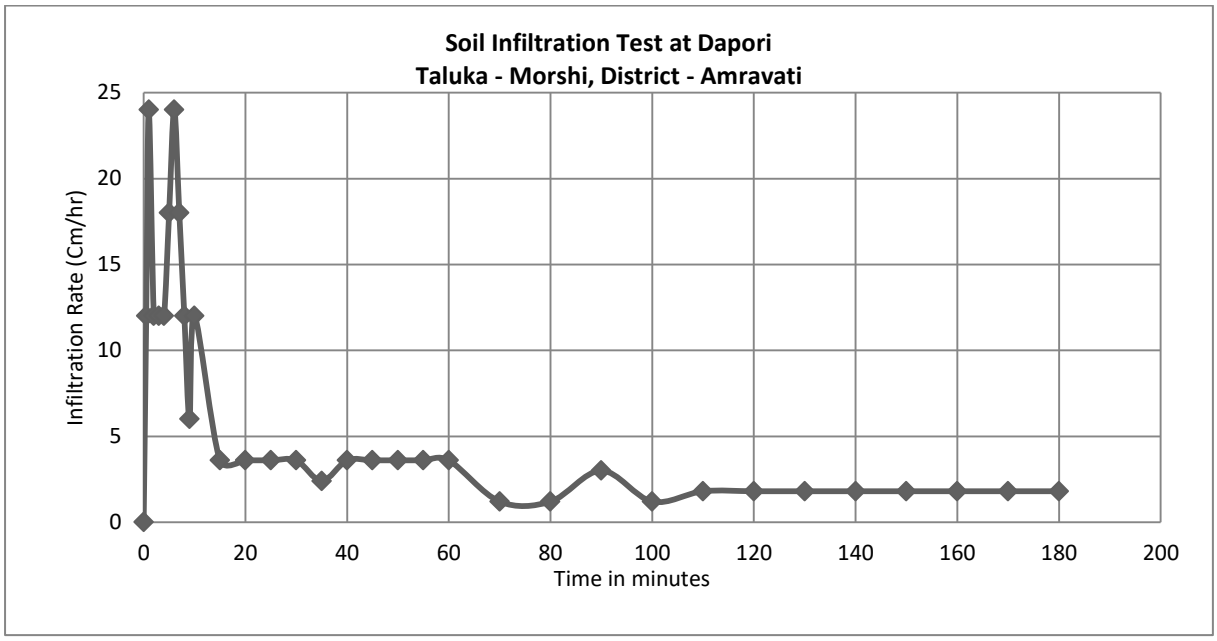


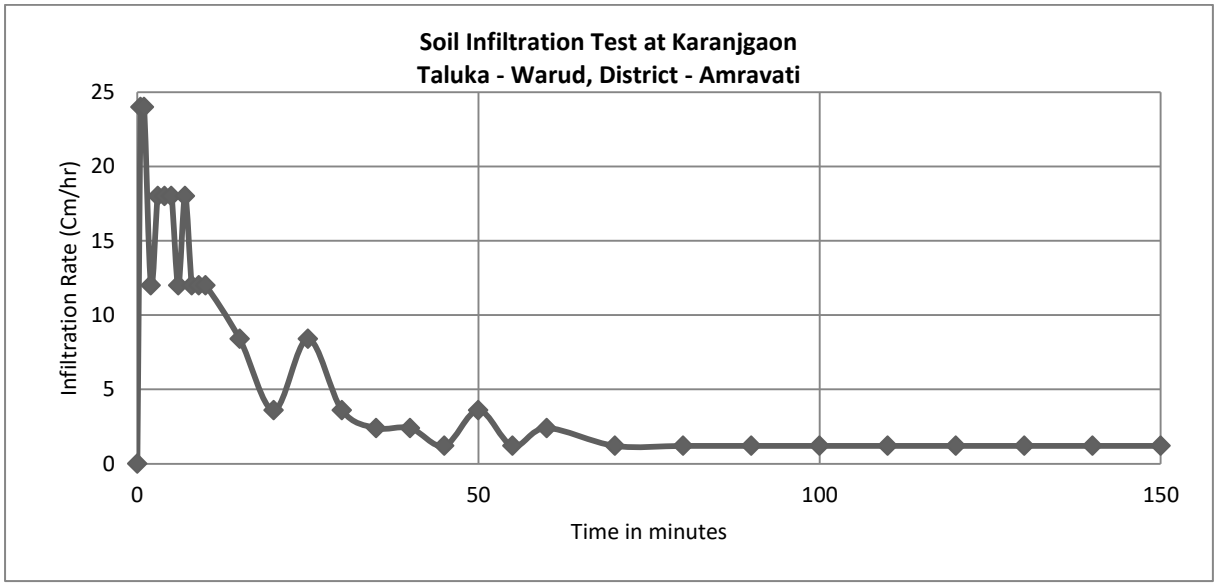


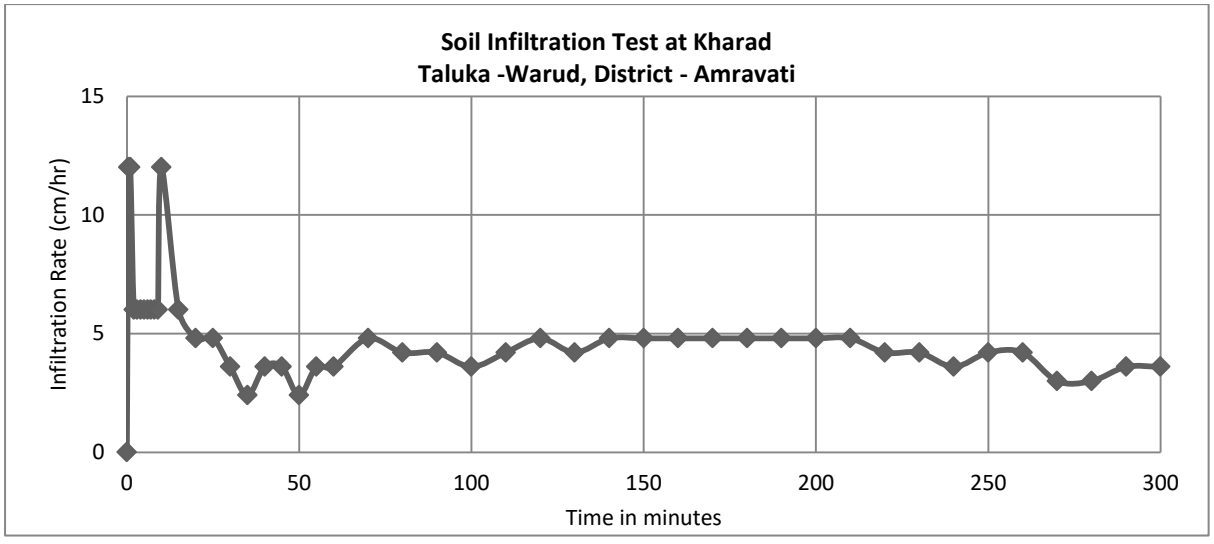

Soil Infiltration Test at Udkhed
Taluka - Morshi, District - Amravati
Infiltration Rate (cm/hr)
25
20
15
10
5
0
0
50
100
150
Time in minutes


Soil Infiltration Test at Januna
Taluka - Morshi, District - Amravati
Infiltration Rate (cm/hr)
40
35
30
25
20
15
10
5
0
0
50
100
150
200
Time in minutes


Soil Infiltration Test at Sadatpur
Taluka - Morshi, District - Amravati
Infiltration Rate (cm/hr)
25
20
15
10
5
0
0
50
100
Time in minutes


Soil Infiltration Test at Dapori
Taluka - Morshi, District - Amravati
Infiltration Rate (Cm/hr)
0
5
10
15
20
25
0
20
40
60
80
100
120
140
160
180
200
Time in minutes


Soil Infiltration Test at Karanjgaon
Taluka - Warud, District - Amravati
Infiltration Rate (Cm/hr)
0
5
10
15
20
25
0
50
100
150
Time in minutes


Soil Infiltration Test at Kharad
Taluka -Warud, District - Amravati
Infiltration Rate (cm/hr)
0
5
10
15
0
50
100
150
200
250
300
Time in minutes

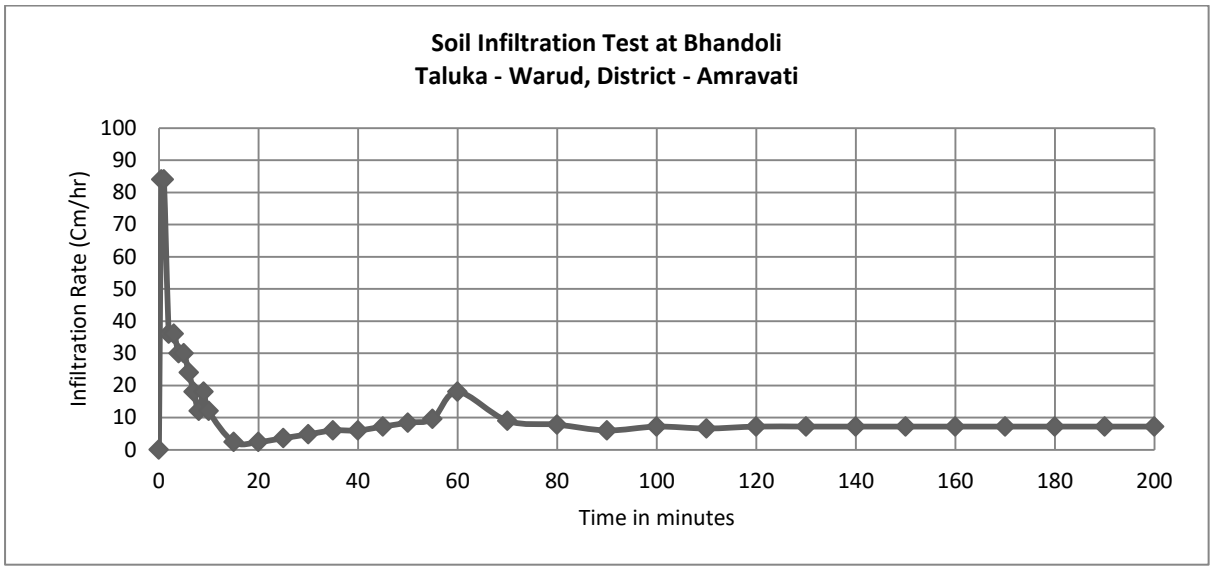


Fig.2.3: Soil Infiltration tests Plots, Warud and Morshi taluka, Amravati district.

2.2.6 Thematic Layers

The following five thematic layers were also generated on GIS platform, which supported the primary database and provided precise information to assess the present ground water scenario and also to propose the future management plan.

I. Drainage
II. physiography
III. Geomorphology
IV. Soil
V. Land Use – Land Cover
VI. Geology and Structure

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 aquifer characteristic 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 Geology

Geologically, the area is divided into following two parts i.e., Deccan Trap Basalt, and Alluvium formation. The generalized geological sequence occurring in the area is given in **Table 3.1** and the geological map with basaltic flows is shown in **Fig. 3.1.**

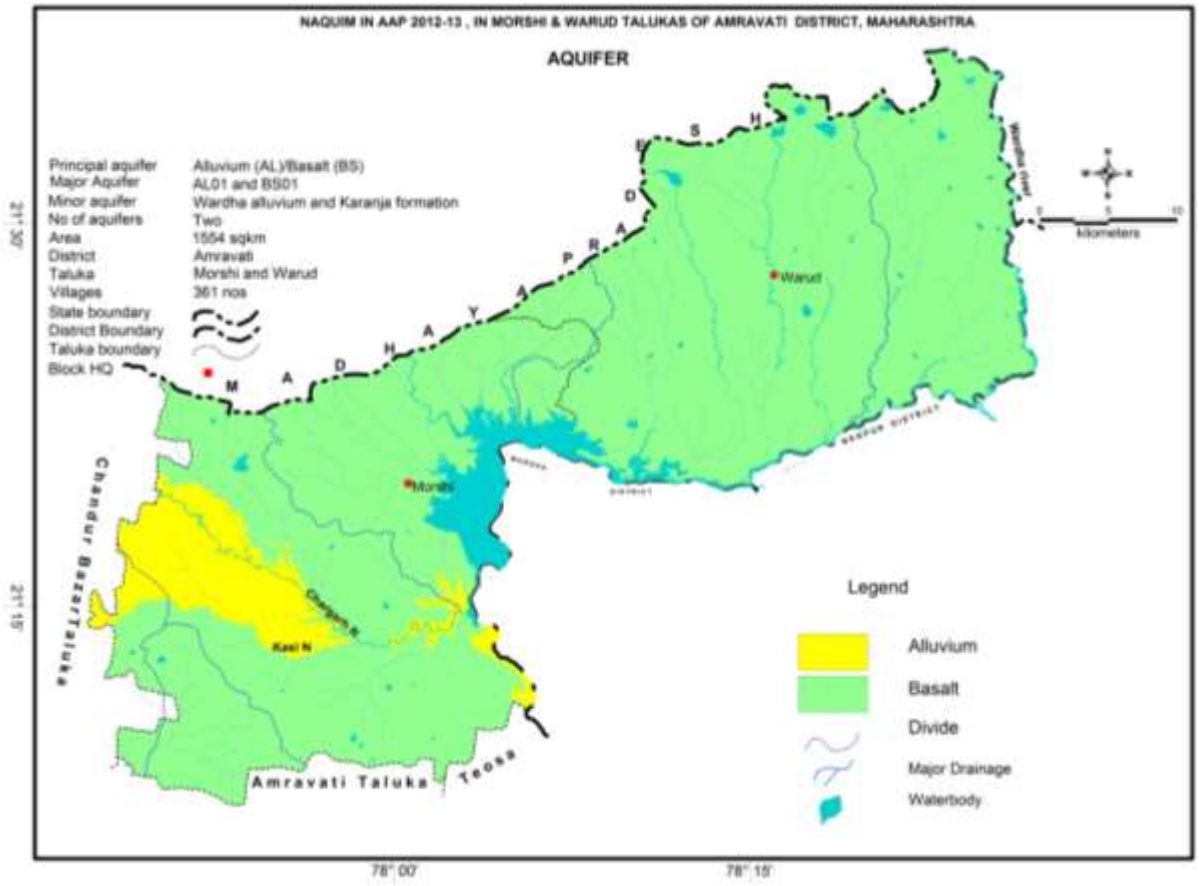


Fig. 3.1: Geology with basaltic flows, Warud and Morshi taluka, Amravati district

Table 3.1: Generalized Geological sequence, Warud and Morshi taluka, Amravati district

Geologic Period	Age in million years	Stratigraphic unit	Lithology
Recent to Sub-Recent	-	Alluvium (Purna River & Wardha river)	Sand, silt and clay. (Purna River Alluvium and Wardha river Alluvium)
Lower Eocene to upper Cretaceous	30-60	Deccan traps	Basalt hard, massive, vesicular, amygdaloidal varieties with inter- trappean.

3.2 Hydrogeology

Hydrogeologically, the area occupied is mainly comprised of Deccan traps with inter-trappean beds of Upper Cretaceous- Lower Eocene age. The geology and hydrogeology of the area are depicted in **Fig. 3.1 and 3.2** respectively.

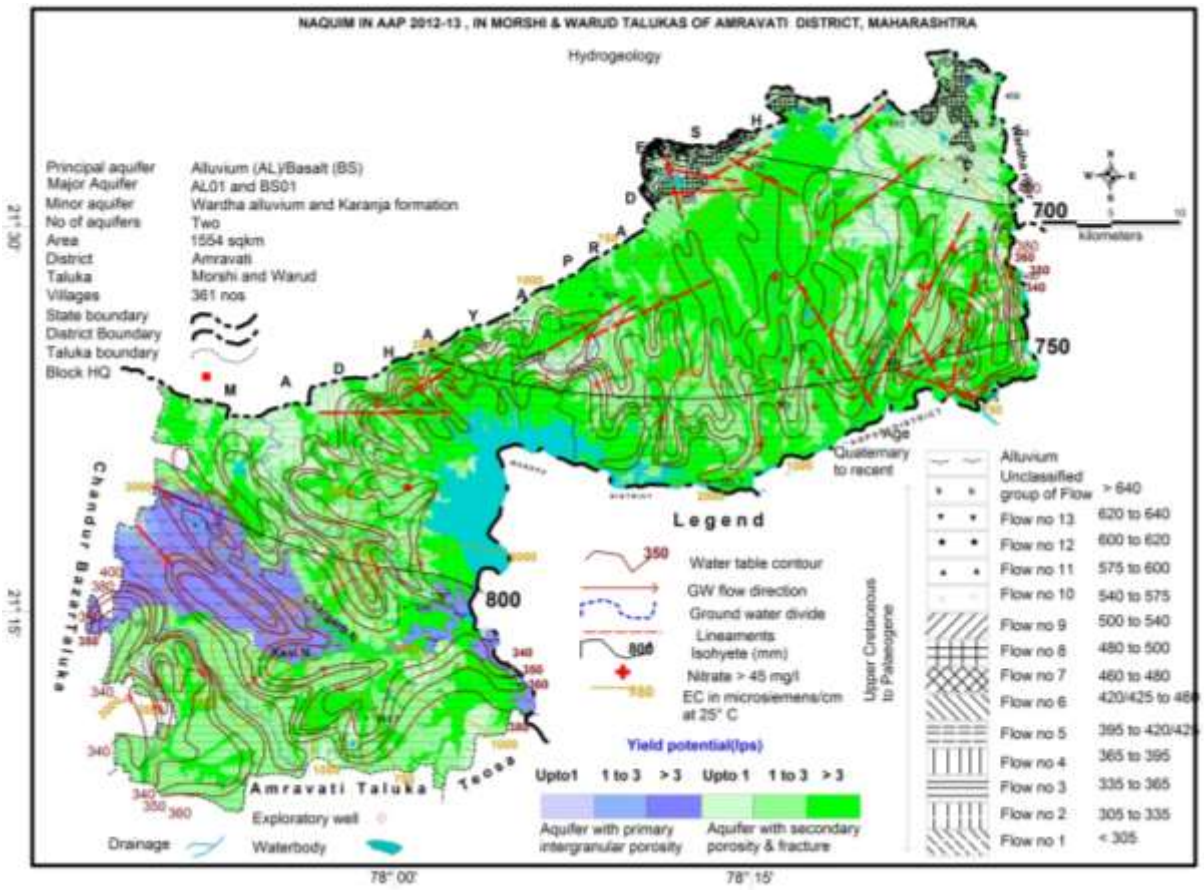


Fig. 3.2: Hydrogeology, Warud and Morshi taluka, Amravati district

The lava pile exposed within the altitude of 340 to 540 mamsl, consists of 15 basalt flows of 'aa' type occupying major part of the area. Each flow comprise of three units namely top vesicular basalt followed by fractured/massive basalt followed by massive basalt. Recent Alluvium is occupied along the Wardha River and its major tributaries. Also, a major part of the Central and Western Morshi taluka is occupied by the Purna river alluvium.

The yields of wells are functions of the permeability and transmissivity of aquifer encountered and vary with location, diameter, and depth etc. There are three types of ground water structures in the area i.e. dugwells, borewells and dug cum borewells (DCB). Dugwells are generally used for both domestic water supply and irrigation purposes in this area. It is observed that the dugwells varying from 5.60 m to around 30 m in depth in basaltic lava flows can sustain assured water supply for domestic needs of about 500 people throughout the year. The yield of dugwells in basalt for irrigation purposes varies from 20 to 90 m^3/day. However, dugwells in alluvium and wells located in favourable area in basalt can yield 100 to 250 m^3/day. Ground water is predominantly used for irrigation, as it is the major ground water utilising sector in these intense orange growing talukas. State government has drilled large number of borewells fitted with hand pumps and electric motors for rural drinking water purposes in the area. Yields of borewells range from 500 to 3000 lph. The ground water development in these talukas is mostly through dugwells.

3.2.1 Occurrence of Ground Water in Basalt and Alluvium (Shallow Aquifer-I)

Ground water occurs under phreatic/ unconfined to semi-confined conditions in basalts. Ground water occurs in unconfined state in shallow Aquifer-I tapped by dugwells of 5 to 30 m depth, water levels are ranging from 0.8 to 26.00 m bgl and yield varies from 1 to 3 lps. In alluvium aquifer,

ground water occurs in unconfined condition, observed in southwestern part of Morshi taluka. The aquifer generally occurs in the depth of 25 to 35 mbgl.

3.2.2 Occurrence of Ground Water in Basalt (Deeper Aquifer-II)

The deeper aquifer-II is also present and only observed in Basaltic terrain which is being tapped by borewells and it occurs to the depth <160 m bgl i.e., 30 to 200 mbgl, whereas the water level ranges from 6 to 30 m bgl with yield of 50 to 150 lpm.

3.3 Geophysical Survey (VES)

Electrical resistivity surveys were carried out in these areas, to identify the ground water potential zones, for better ground water management planning. In all 175 (71 and 104 VES during 2006-07 and 2012-13 respectively) Vertical Electrical Soundings (VES) were conducted in a nearly grid pattern, by deploying the ABEM SAS 300C Terrameter and using the Schlumberger electrode configuration. The VES location map is shown in **Fig 3.3** and the details of VES results is presented in **Annexure VII**.

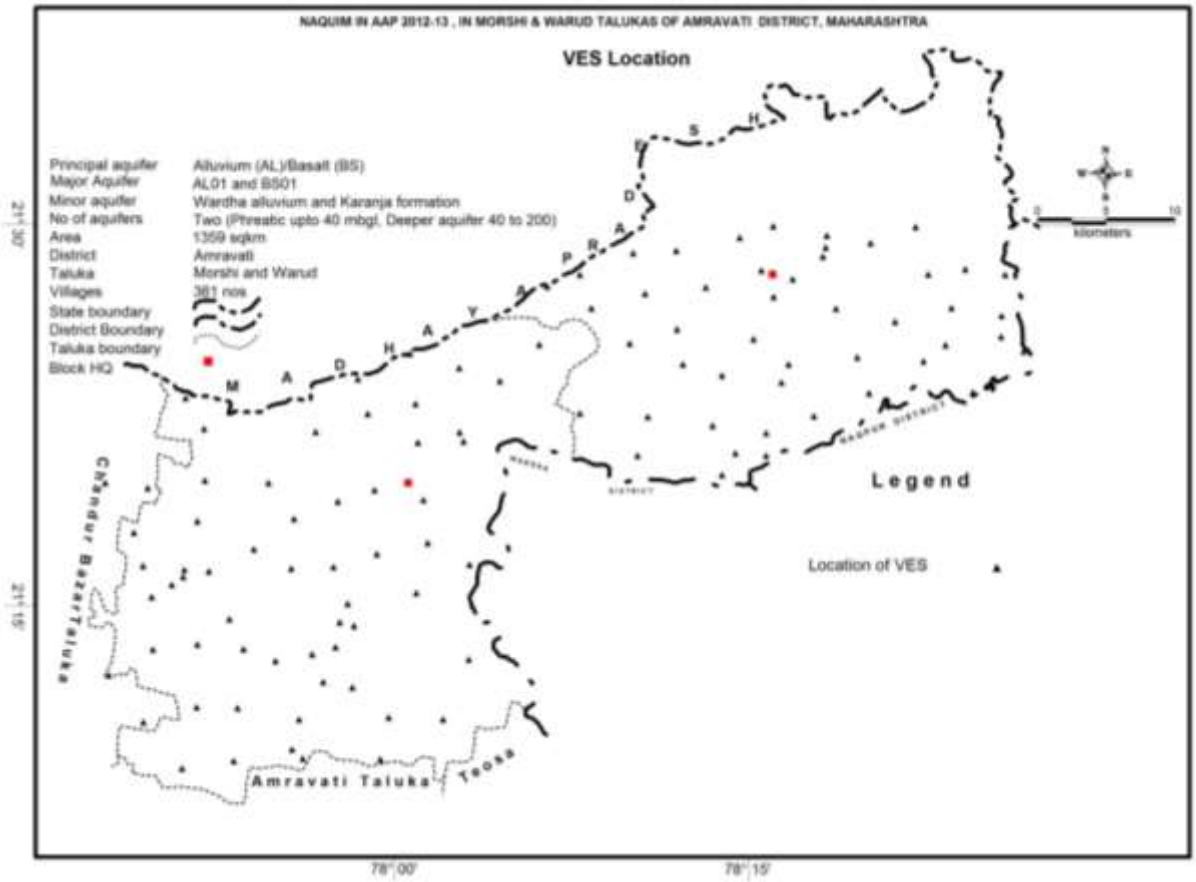


Fig. 3.3: Locations of geophysical surveys (VES), Warud and Morshi taluka, Amravati district

The data was processed and interpreted by using appropriate software after marginally modifying the manually interpreted results keeping in view the local geology and hydrogeology. Contour maps for different geo-electric layer parameters were generated to infer the nature of the topsoil and to demarcate the ground water potential zones in order to achieve the objectives. From the Longitudinal Conductance (S) and Transverse Resistance (T) values ground water potential zones are demarcated. Different resistivity ranges were assigned to have associated with different geological formations/litho units.

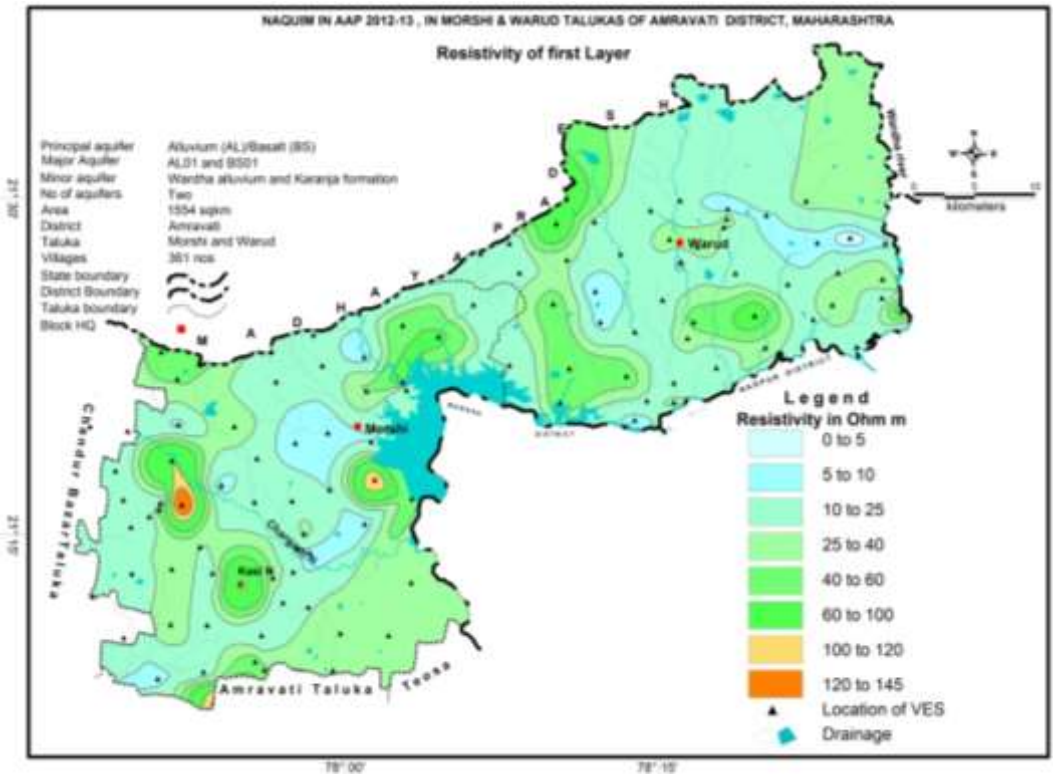


Fig. 3.4: Distribution of Resistivity for First Layer

Distribution of 1st layer resistivity:

The first layer generally represents the topsoil or the weathered part of the uppermost basaltic flow. The resistivity of this layer is varying from 3 to 286 Ohm m (Fig II). Its thickness is varying from 0.19 to 14.90 m. The low resistivities less than 10 Ohm m and occasionally raising to 30 Ohm m are caused by the Black Cotton Soil or highly weathered basaltic formations; by clays (less than 10 Ohm m) and by sands (between 10 Ohm m and 30 Ohm m) in alluvial formations. The low resistivities between 3 and 20 Ohm m of the top layer infer that the top soil is a part of alluvium along the drainage flowing through that area. This may be the reason why the first layer thickness is quite large, reaching up to 14.9 (**Fig. 3.4).**

Distribution of 2nd layer resistivity:

The resistivity of the 2nd layer is varying between 2 and 14000 Ohm m with thickness ranging from 0.6 to 99.3 m (Fig III). The resistivities less than 5 Ohm m in the western part of the study area represent alluvium with 2 to 5 Ohm m as clay, 5 -10 Ohm m as silty sand or sandy clay and 10 to 15 Ohm m as sand and / or clayey sand and weathered basalt in the eastern part of the area. Resistivity more than 40 Ohm m represents hard and compact basaltic formations in the eastern, central and southeastern part of the study area where as the other places, the resistivities from 15 to 40 Ohm m represent jointed / fractured basaltic formations (**Fig. 3.5).**

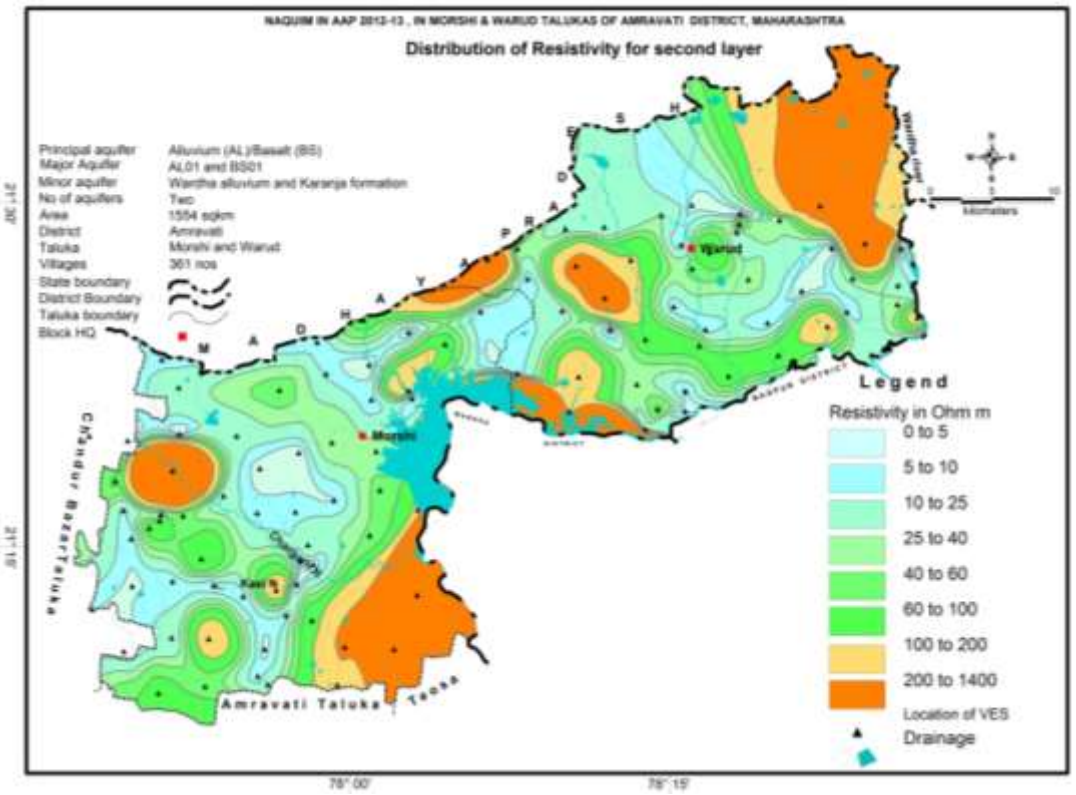


Fig. 3.5: Distribution of Resistivity for Second Layer

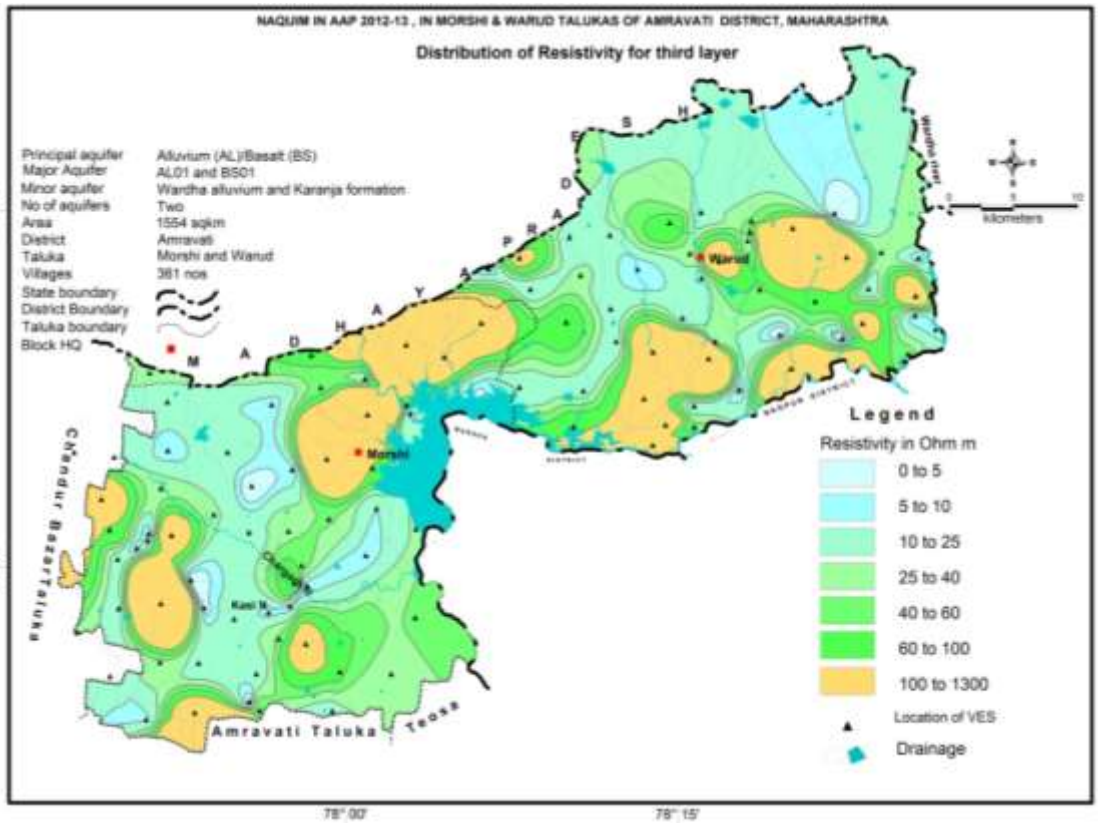


Fig. 3.6: Distribution of Resistivity for third Layer

Distribution of 3rd layer resistivity:

The resistivity of the 3rd layer is varying between 1 and 1420 Ohm m with thickness ranging from 1.20 to 186.10 m (Fig IV). The resistivities less than 5 Ohm m in the western part of the study

area represents alluvium with 2 to 5 Ohm m as clay, 5 -10 Ohm m as silty sand or sandy clay and 10 to 15 Ohm m as sand and / or clayey sand and weathered basalt. The resistivity contours less than 40 Ohm m elongating in NE-SW and NW-SE directions infer jointed/fractured basaltic formations and these may be due to a group of lineaments. The high resistivities more than 40 Ohm m represent massive basaltic formations in the central, northern and southern part (**Fig. 3.6).**

Distribution of 4th layer resistivity:

The resistivities of 4th layer are varying from 2 to 4881 Ohm m (Fig V) with thickness ranging from 3.12 to 201 m. In the western and SE parts of the toposheet no. G/16 & 15 and central, north and eastern parts of toposheet no. 55 K/3 & 7, the resistivities are varying from 5 to 40 Ohm m elongating in N-S, EW and NW-SE directions indicating the presence of a set of lineaments / fractured system. The high resistivities in the rest of the area infer hard and massive basaltic formations (**Fig. 3.7).**

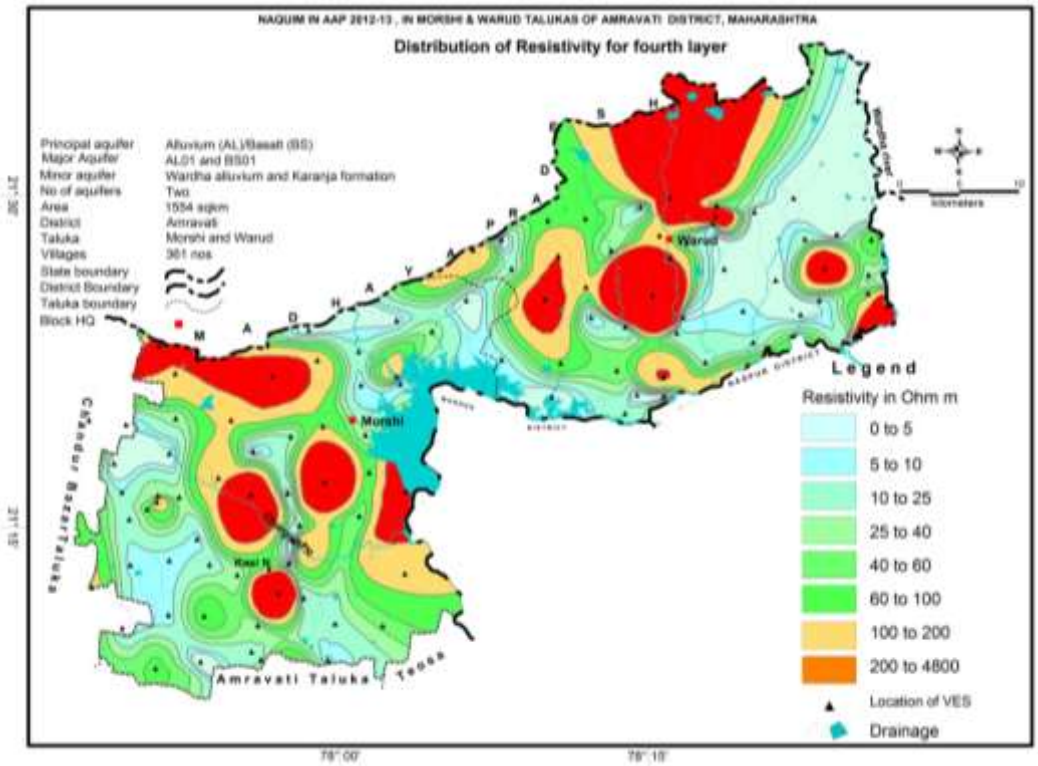


Fig. 3.7: Distribution of Resistivity for forth Layer

Distribution of 5th layer resistivity:

The resistivities of 5th layer are varying from 2 to 2784 Ohm m (Fig VI) with thickness ranging from 5.70 to 123.8 m. However its value is less than 40 Ohm m, at few places, in the western and SE parts of the toposheet no. G/16 and central, north and eastern parts of topo sheet no. 55 K/3 & 7, the resistivities are varying from 5 to 40 Ohm m elongating in N-S and NE-SW directions indicating the presence of a set of lineaments / fractured system. The high resistivities in the rest of the area infer hard and massive basaltic formations (**Fig. 3.8).**

Transverse Resistance and Longitudinal Conductance:

Based on the VES results, Transverse Resistance (T) and Longitudinal Conductance (S) were estimated and contour maps for T and S were generated (**Fig. 3.9 and 3.10**). In general, the T values are ranging from 6.4 to 41609 Ohm m^2, whereas the S values are ranging from 0.026 to 60.8 mhos. The average value of T is 3991 Ohm m^2 and that of S is 3.66 mhos.

More than average Transverse Resistance (T) values of 3991 Ohm m^2 in the southeastern part topo sheet 55 G/16 northern part of toposheet 55 G/15 and maximum part of 55 K/3 and South

western and some patches in northern part 55 K/7 whereas remaining area occur less than average values.

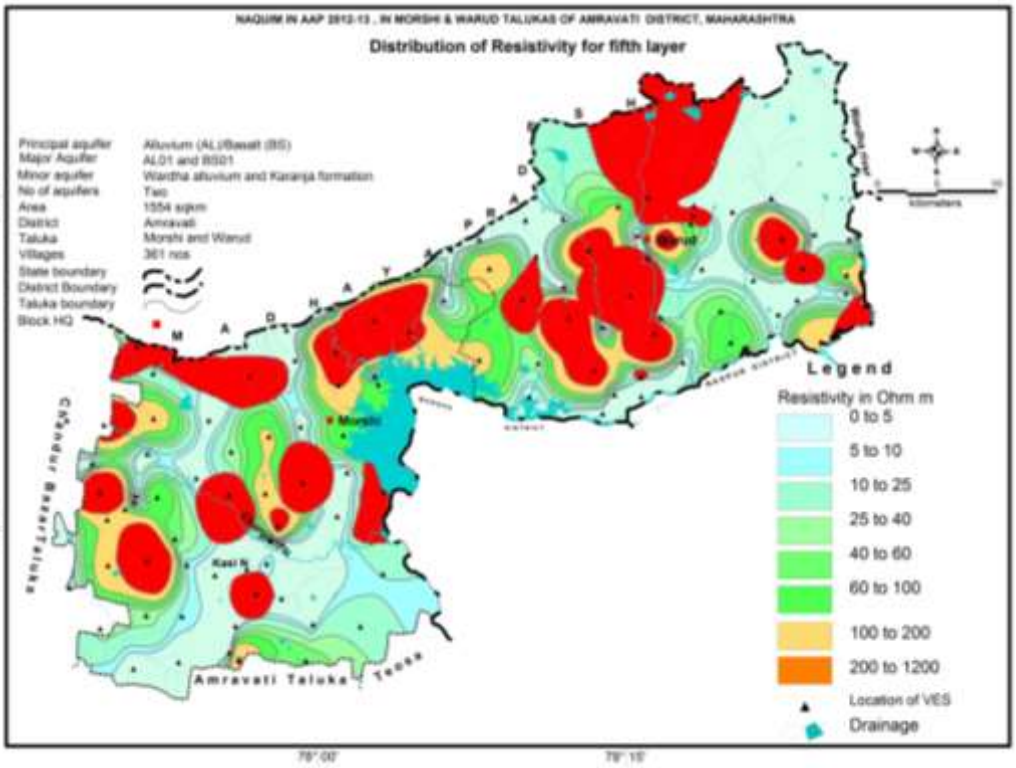


Fig. 3.8: Distribution of Resistivity for fifth Layer

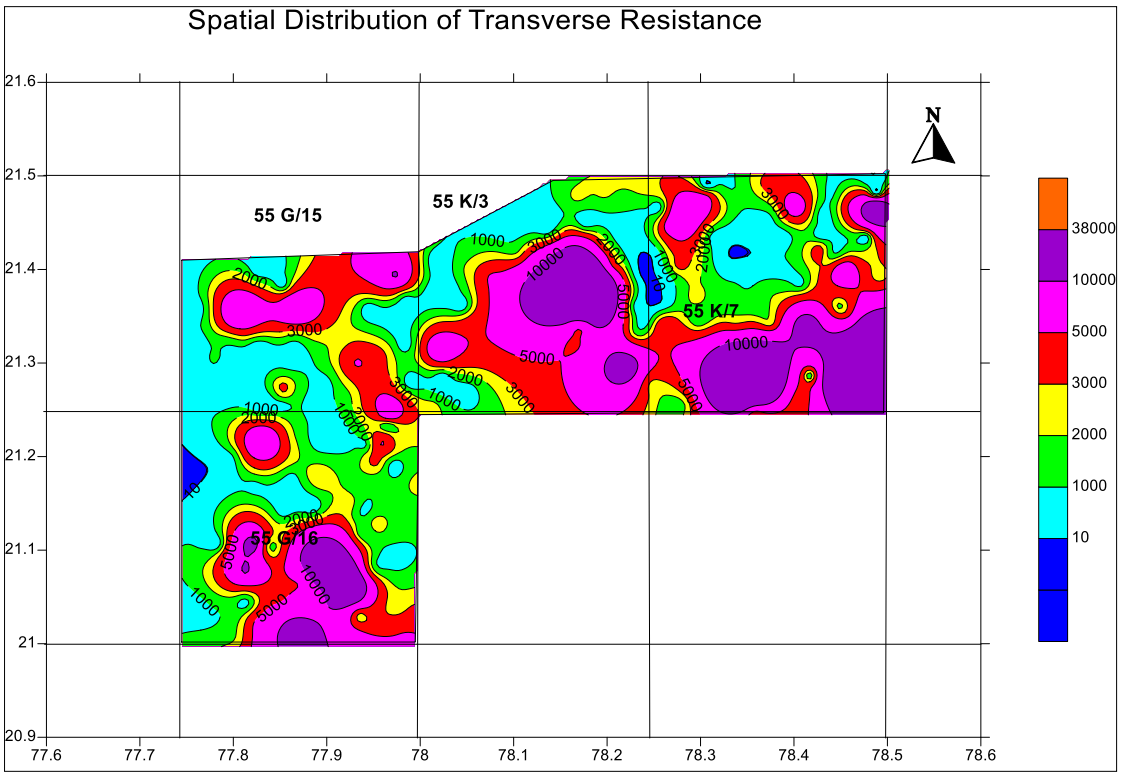


Fig. 3.9: Distribution of Transverse Resistance

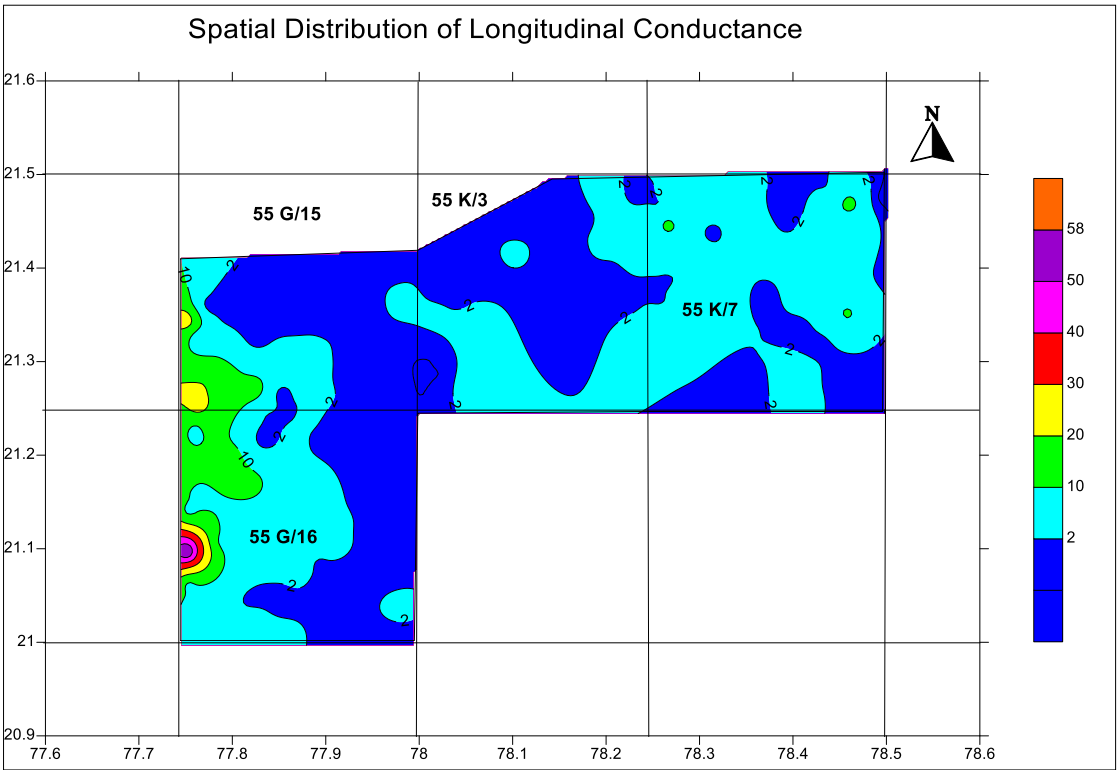


Fig. 3.10: Distribution of Longitudinal Conductance

More than average Longitudinal Conductance (S) values of 3.66 mhos in the western and and eastern part of the area southeastern part topo sheet 55 G/16 northern part of topo sheet 55 G/15 and maximum part of 55 K/3 and South western and some patches in northern part 55 K/7 whereas remaining area occur less than average values.

Based on the Transverse Resistance (T) and Longitudinal Conductance (S), the areas where Transverse Resistance is below average and Longitudinal Conductance is above average were considered as ground water potential zones. Whereas, Transverse Resistance is above average and Longitudinal Conductance is below average were considered as shallow basement.

The general resistivity and thickness ranges of topsoil are 3 to 30 Ohm m and 0.2 to 1.5m respectively. The high resistivities in the western parts of the area are due to the exposures of the massive basaltic rocks or the topsoil is transported from the nearby hills or derived after the weathering of the basaltic formations. The low resistivities of the top layer infer that the topsoil is a part of alluvium along the drainage flowing through the area. The resistivity contours less than 40 Ohm m of the 3rd layer elongating in NE-SW and NW-SE directions infer jointed/fractured basaltic formations and these may be due to a group of lineaments.

Based on the Transverse Resistance (T) and Longitudinal Conductance (S), the areas where Transverse Resistance is below average and Longitudinal Conductance is above average were considered as ground water potential zones and demarcated. An inferred fence diagram has been prepared using interpreted VES data supported by drill log data. The diagram gives a three dimensional view of the nature and disposition of the subsurface formations.

3.4 Ground Water Dynamics

To decipher the ground water dynamics of shallow Aquifer-I, 34 KoW and 278 micro-water level wells were established. For deeper Aquifer-II, 34 exploratory wells have been drilled and studied. The water level data from Jun. 2012 to Jan 2015 were collected and analysed. The ground water level scenarios for Shallow Aquifer-I and Deeper Aquifer-II are analysed as follows.

3.4.1 Depth to water level (Shallow Aquifer-I)

To understand the depth to water level scenario in Warud and Morshi Talukas, water level measurement from all the key observation wells (KOW) were carried out in the month of May and November. The pre and post monsoon data collected from these KOWs along with data collected by CGWB and GSDA, GoM from there network monitoring stations have been used to ascertain the water level scenario and preparation of depth to water level maps of the area.

3.4.1.1 Pre-monsoon Depth to Water Level (2012, 2013 and 2014)

The depth to water levels in Warud-Morshi Talukas during May 2012 ranges between 4.30 (Dhamangaon) and 22.25 (Surli) m bgl. Depth to water levels during premonsoon shows water levels within 10 m bgl are observed south western part, whereas, water levels between 10-20 mbgl is observed in 60% area in these talukas.

The depth to water levels in Warud-Morshi Talukas during May 2013 ranges between 4.60 (Nimbhi) and 16.95 (Katpur) m bgl. Depth to water levels during premonsoon shows water levels within 10 m bgl are observed south western part and along major drainages. Whereas, water levels between 10-20 mbgl is observed in 60% area in these talukas.

The depth to water levels in Warud-Morshi Talukas during May 2014 ranges between 4.60 (Nimbhi) and 23.40 (Surli) m bgl. Depth to water levels during premonsoon shows water levels within 10 m bgl are observed south western part and along major drainages. Whereas, water levels between 10-20 mbgl is observed in 60% area in these talukas.

The premonsoon depth to water level map is given in **Fig. 3.11 a, b & C** and the water level data is presented as **Annexure-VIII.**

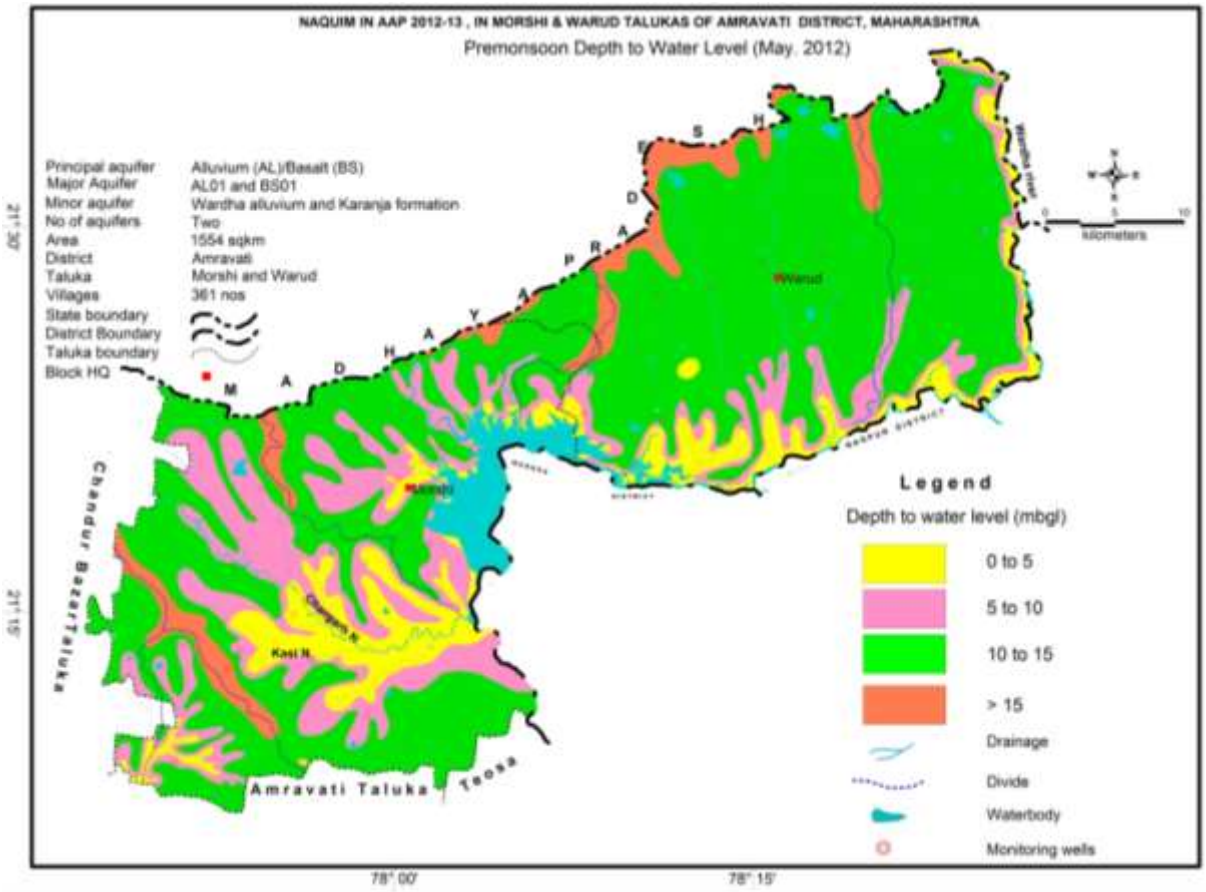


Fig. 3.11a: Shallow Aquifer-I, Depth to Water Level (pre-monsoon May-2012)

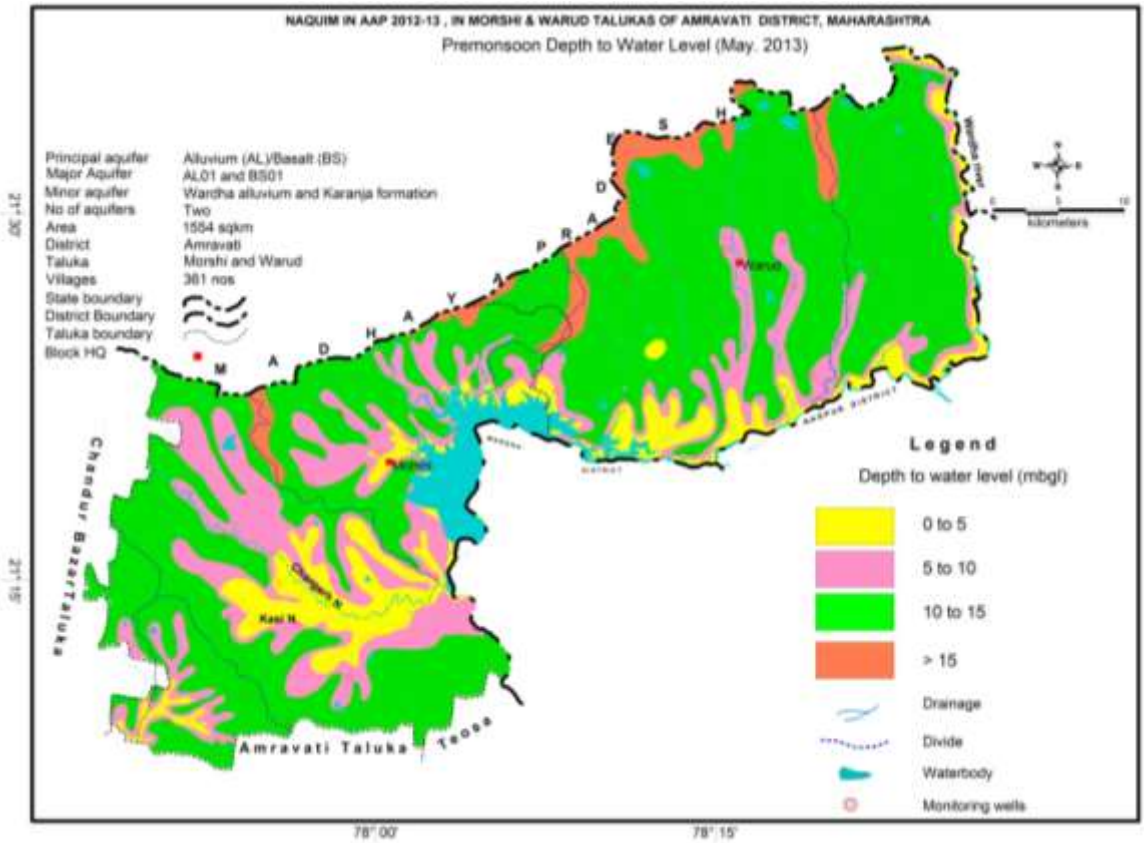


Fig. 3.11b: Shallow Aquifer-I, Depth to Water Level (pre-monsoon May-2013)

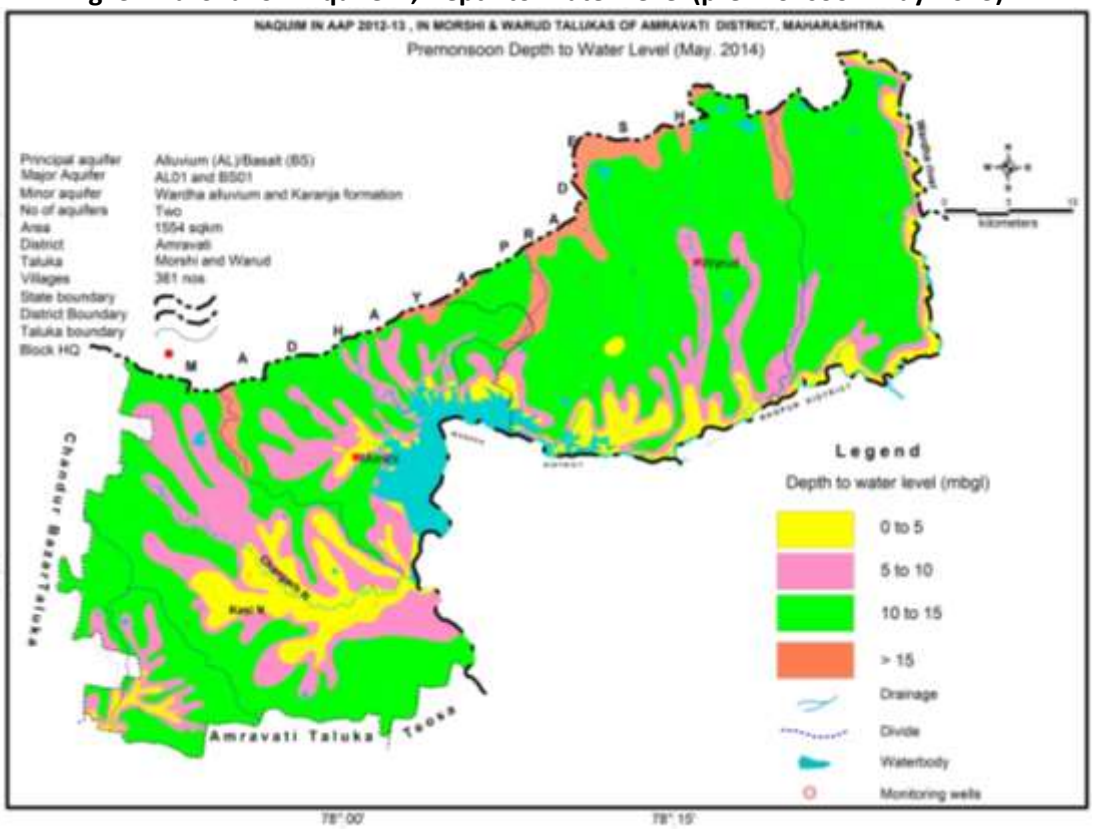


Fig. 3.11c: Shallow Aquifer-I, Depth to Water Level (pre-monsoon May-2014)

3.4.1.2 Post-monsoon Depth to Water Level (2012, 2013 and 2014)

The depth to water levels in Warud-Morshi Talukas during Nov 2012 ranges between 0.70 (Taroda) and 16.60 (Loni) m bgl. Except small isolated patch in western part, where water level is more than 10 mbgl, rest of the area shows Depth to water levels during postmonsoon within 10 m bgl.

The depth to water levels in Warud-Morshi Talukas during Nov 2013 ranges between 1.30 (Pardi) and 13.80 (Jarud) m bgl. Except small isolated patch in western part, where water level is more than 10 mbgl, rest of the area shows Depth to water levels during postmonsoon within 10 m bgl.

The depth to water levels in Warud-Morshi Talukas during Nov 2014 ranges between 1.85 (Nimbhi) and 14.30 (Jarud, Uthkhed) m bgl. Except small isolated patch in western part, where water level is more than 10 mbgl, rest of the area shows Depth to water levels during postmonsoon within 10 m bgl.

The post monsoon depth to water level map is given in **Fig. 3.12 a, b & C** and the water level data is presented as **Annexure-VIII.**

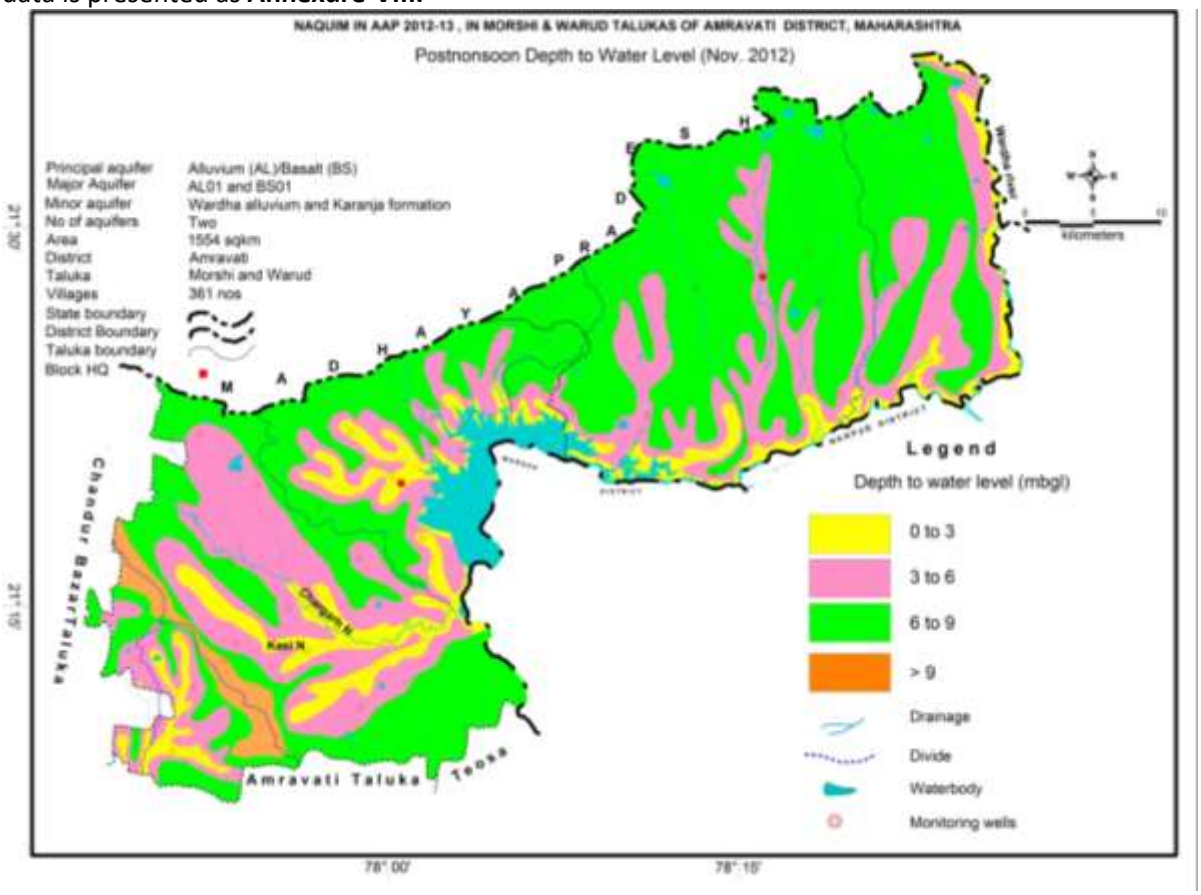


Fig. 3.12a: Shallow Aquifer-I, Depth to Water Level (post-monsoon Nov.-2012)

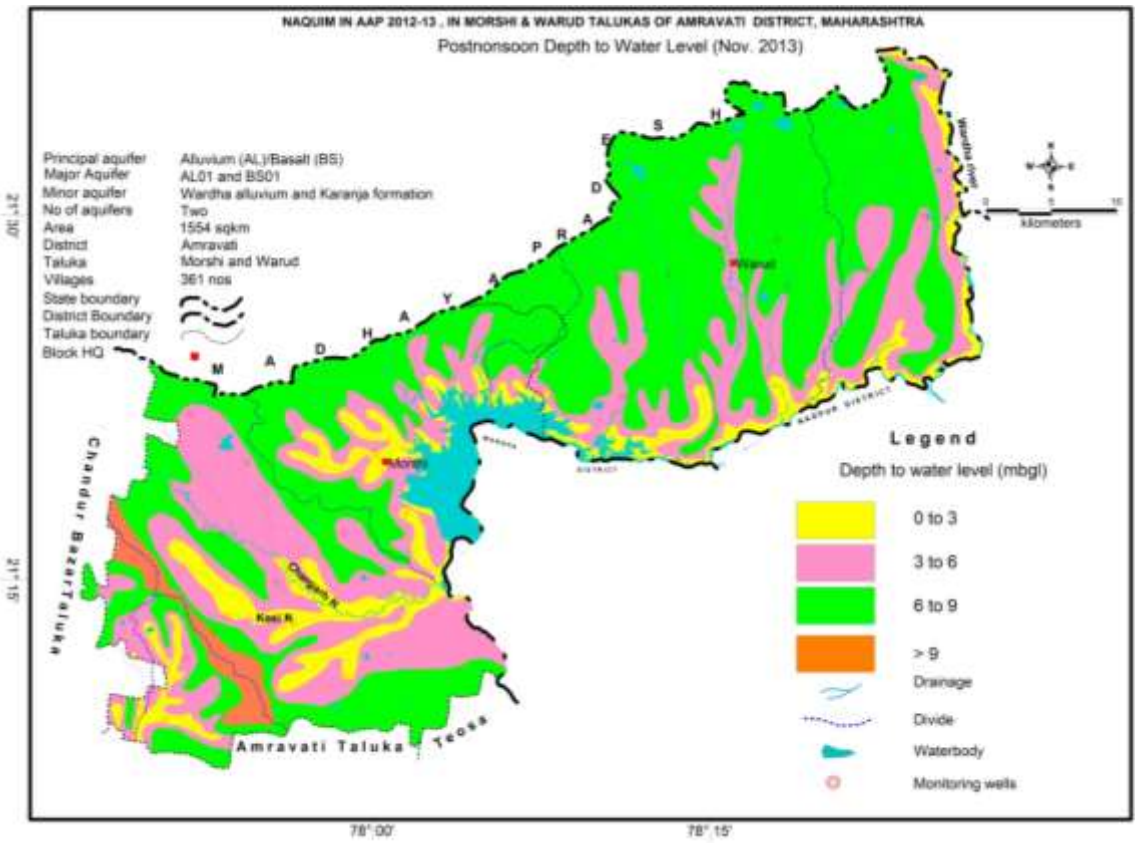


Fig. 3.12b: Shallow Aquifer-I, Depth to Water Level (post-monsoon Nov-2013)

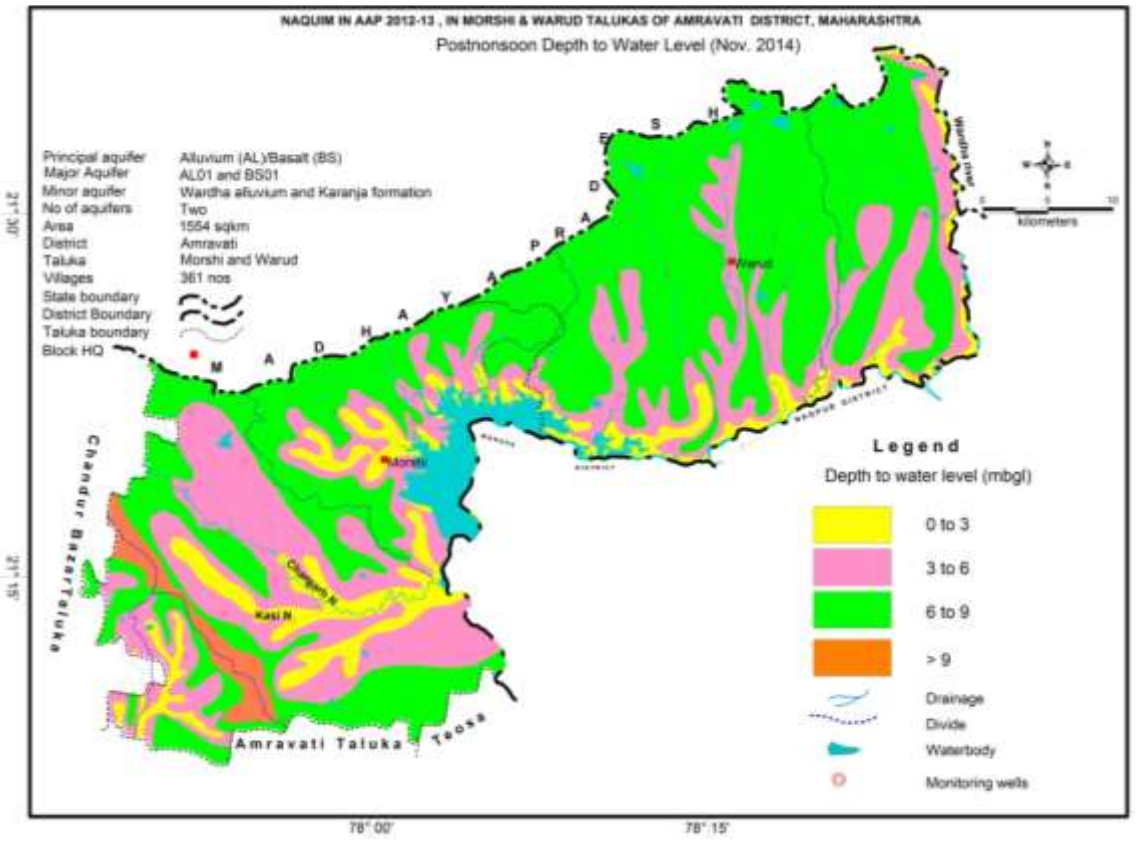


Fig. 3.12c: Shallow Aquifer-I, Depth to Water Level (post-monsoon Nov-2014)

3.4.2 Depth to water level (Deeper Aquifer-II)

In Aquifer-II, the depth to water levels in Warud-Morshi Talukas during May 2014 ranges between 3.80 m bgl (Talegaon) and >100 m bgl (Sawangi). The deeper DTWL (>50 m bgl) has been observed in northern and central part of the Warud taluka and NW part of the Morshi taluka. The Shallow DTWL (upto 10 m bgl) has been observed in central part of the area, particularly in the vicinity of the Upper Wardha dam. The water levels between 10-20 mbgl has been observed in SW and eastern part followed by the water level 20-50 mbgl. The premonsoon depth to water level for Aquifer –II is given in **Fig.3.13a** and the details are presented in **Annexure IX**.

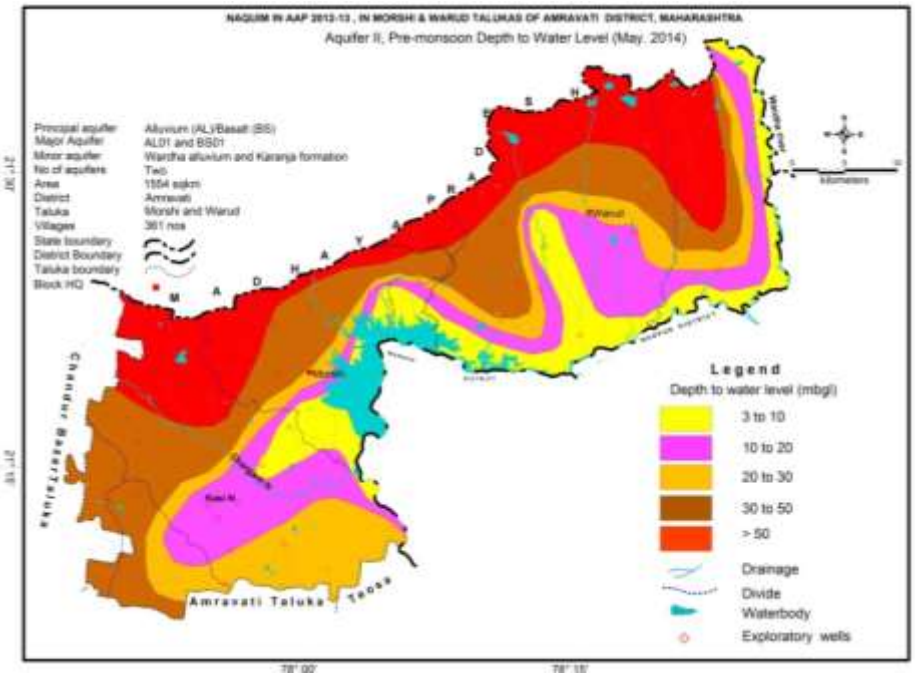


Fig. 3.13a: Deeper Aquifer-II, Depth to Water Level (pre-monsoon May-2014)

The post-monsoon DTWL ranges from 3.20 m bgl (Talegaon) and >100 m bgl (Sawangi) in Aquifer-II and presented in **Fig. 3.13b**. The area representing post monsoon DTWL in Aquifer is more or less same except small variation in the areas.

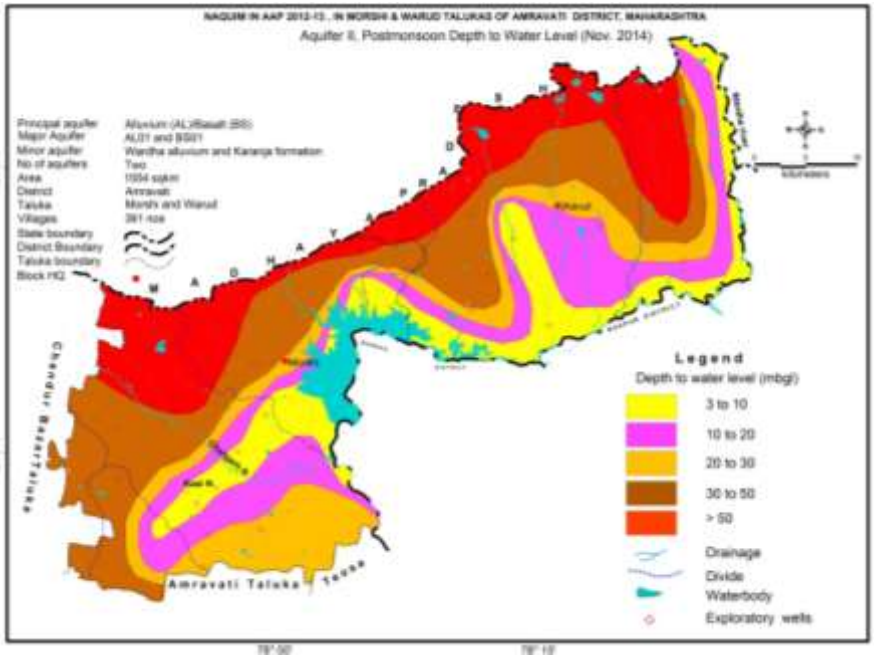


Fig. 3.13b: Deeper Aquifer-II, Depth to Water Level (post-monsoon May-2014)

3.4.3 Water Level Fluctuation, Shallow Aquifer-I

The water level measured during pre and post monsoon period was used to calculate the fluctuation. The pre and post monsoon change in DTWL (mean May / Nov. 2012-13 wrt May / Nov. 2014) was obtained from difference in water level during pre and post monsoon water level. In the area, number of wells and their percentage falling in each fluctuation range is presented in **Fig. 3.14a and b**.

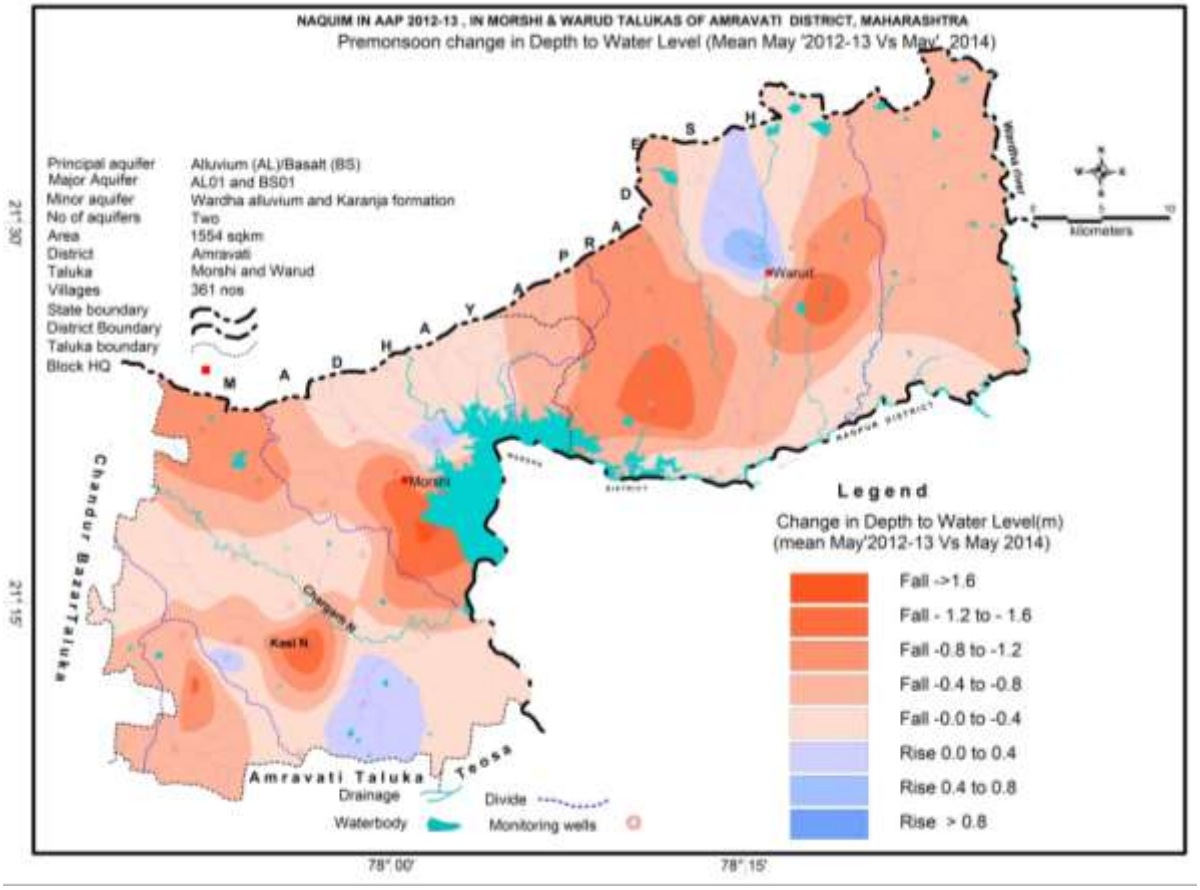


Fig. 3.14a: Shallow Aquifer-I, Premonsoon change in DTWL (Mean May 2012-13 wrt May 2014)

The water level fluctuations are grouped under three categories and are discussed under.

0-2 m and 2-4 m	-	Less water level fluctuation
4-6 m and	-	Moderate water level fluctuation
6-8 m	-	High water level fluctuation

During pre and post monsoon period it has been observed that, most of the area is showing fall in ground water level when compared with Mean May/Nov 2012-13 wrt May/Nov. 2014. The fall ranges from negligible to -1.6 m. However, at some places rise in ground water level has been observed in isolated patches ranging from negligible to 0.8 m.

3.4.4 Depth to Water Level Trend (2005-14)

Based on the CGWB's GWMW and Observation wells of GSDA, Amravati, the long-term trend of water levels for pre-monsoon and post-monsoon periods for the last ten years (2005-14) have

been computed. The long term water level datat of 18 GWMW of CGWB and 36 OB Wells of GSDA has been utilised. The maps depicting the special variation in long-term water level trend in pre and post monsoon is presented as **Fig 3.15 and 3.16** respectively. The data is presented in **Annexure X**.

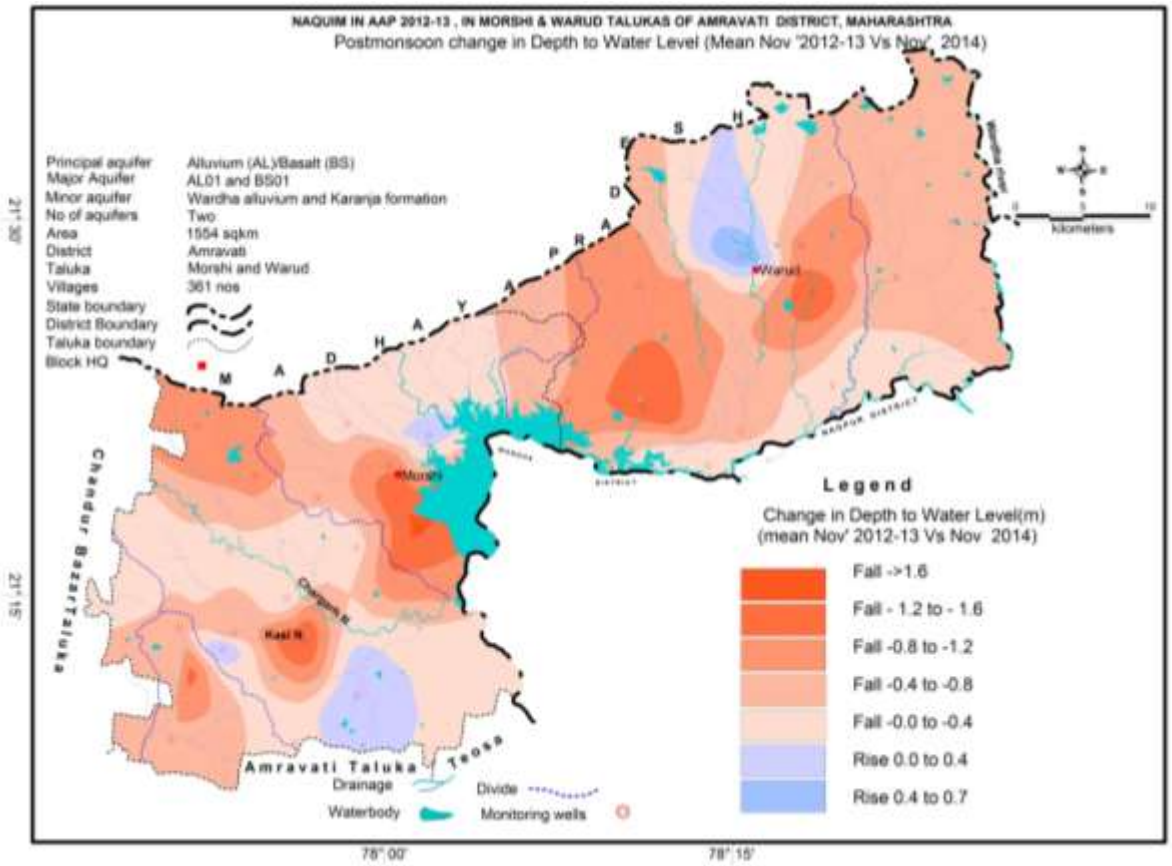


Fig. 3.14 a: Shallow Aquifer-I, Postmonsoon change in DTWL (Mean Nov 2012-13 wrt Nov 2014)

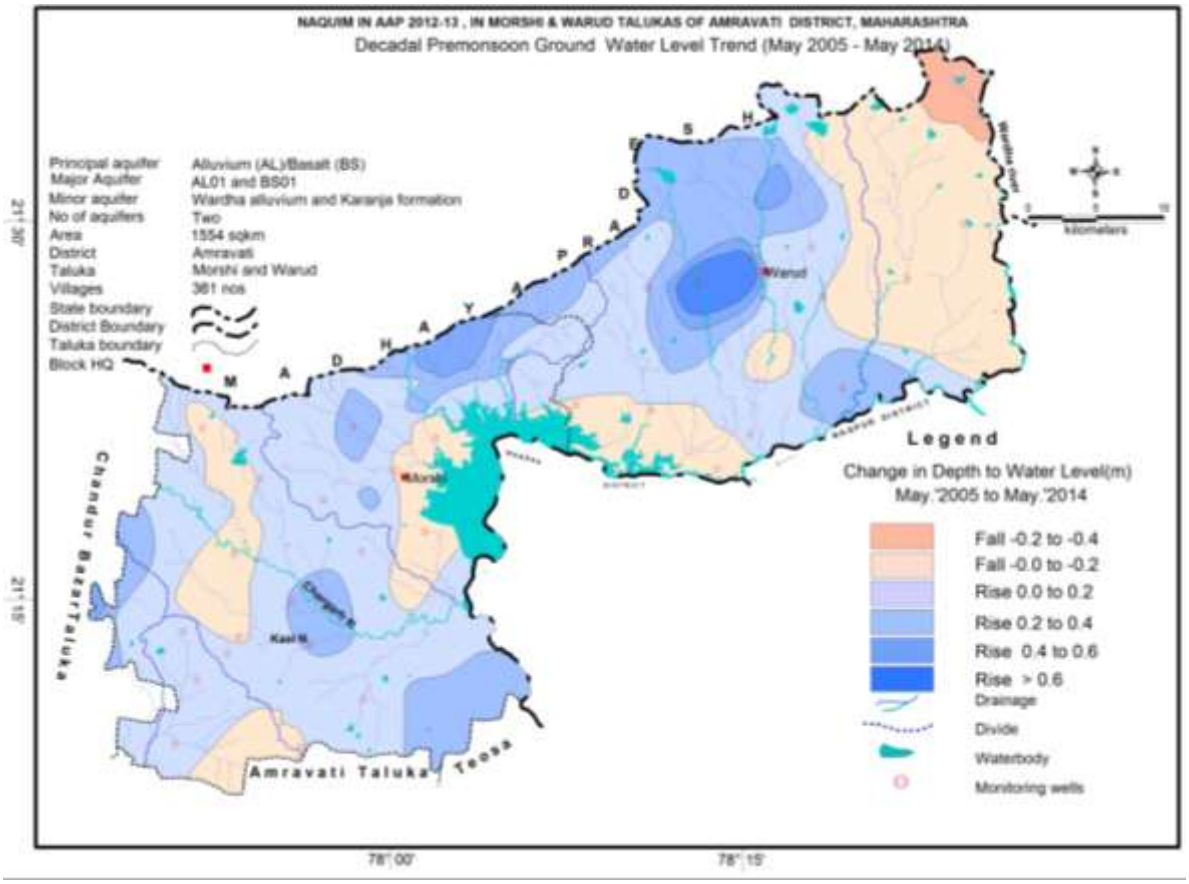


Fig 3.15: Decadal Pre -monsoon decadal ground water level trend (May 2005- May 14)

In the study area, pre monsoon rise in water levels trend has been recorded at 49 stations and it ranges between 0.8439 m/year (Jarud) to 0.560 m/year (Musalkhed) while falling trend was observed in five (05) stations varing from 0.0029 m/year (Pimpri) to 0.2545 (pimplagad).

In pre monsoon the falling water level trend has been observed eastern part of the Warud taluka while small patches of falling trend has been observed in NW and S of Morshi taluka. The rest of the area is showing rise in water level trend.

In the study area, post monsoon rise in water levels trend has been recorded at 49 stations and it ranges between 1.7818 m/year (Rawala) to 0.0381 m/year (Morshi) while falling trend was observed in five (05) stations varing from 0.00105 m/year (Morshi) to 1.0642 (Amdapur).

In post monsoon the falling water level trend has been observed only in southern part of Warud town while small patches of falling trend has been observed in and around Morshi town and western part of Morshi town of Morshi taluka. The rest of the area is showing rise in water level trend.

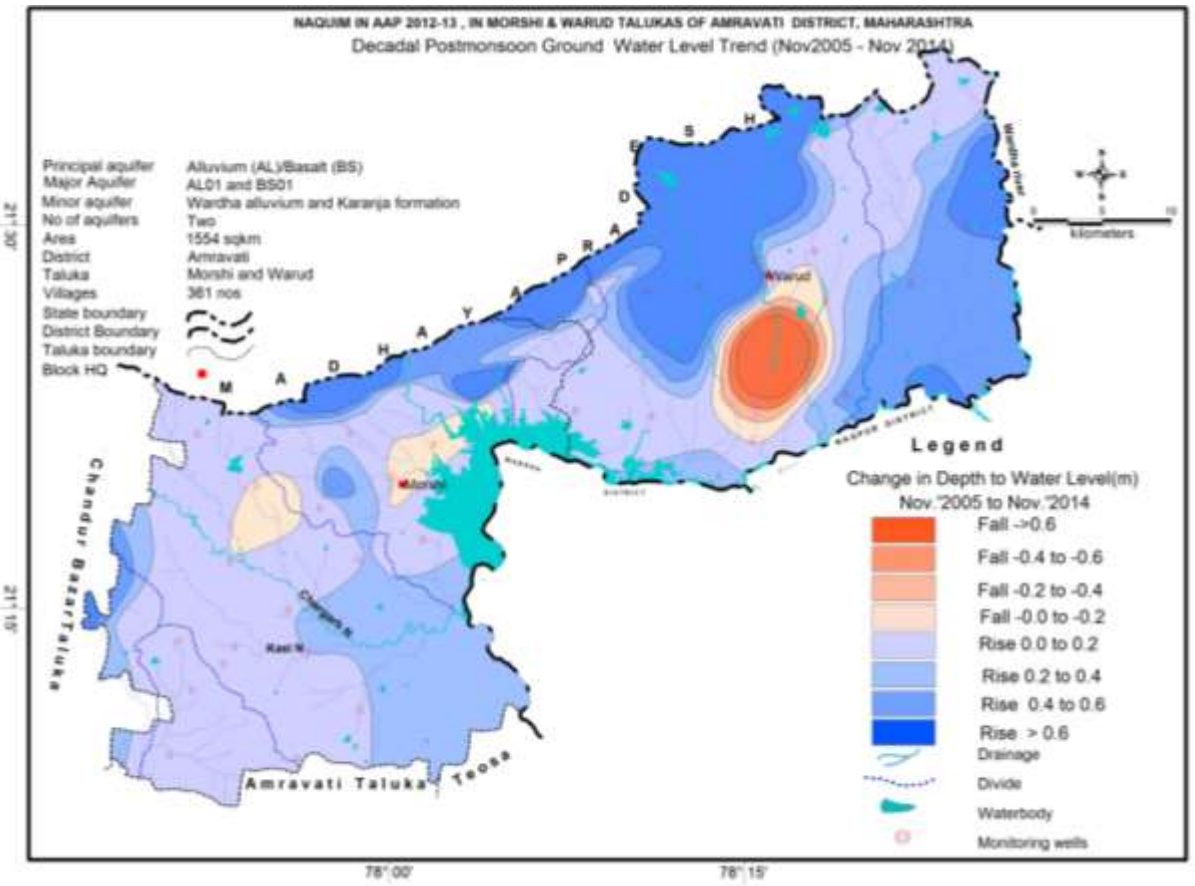


Fig 3.15: Decadal Post -monsoon decadal ground water level trend (Nov 2005 - Nov 14)

3.4.5 Hydrograph Analysis

The hydrographs of fourteen (14) GWMW, 5 in Warud taluka and 9 in Morshi taluka, were analysed for the period from 2005 to 2014. It is observed that the long-term water level trends during pre and post-monsoon seasons are rising. The variation in short term and long-term water level trends may be due to variation in natural recharge due to rainfall and withdrawal of groundwater for various agricultural activity, domestic requirement and industrial needs. The analysis of hydrographs show that the annual rising limbs in hydrographs indicate the natural recharge of groundwater regime due to monsoon rainfall, as the monsoon rainfall is the only source of water (**Fig. 3.16 a to 3.16 n**). However, the groundwater draft continuously increases as indicated by the recessionary limb. The groundwater resources are not replenished / recharged fully and the groundwater levels are under continuous stress and depleting. It has also been observed that there were few years when the recharge exceeded draft for a particular period or year but in the next successive year, the draft again exceeded recharge.

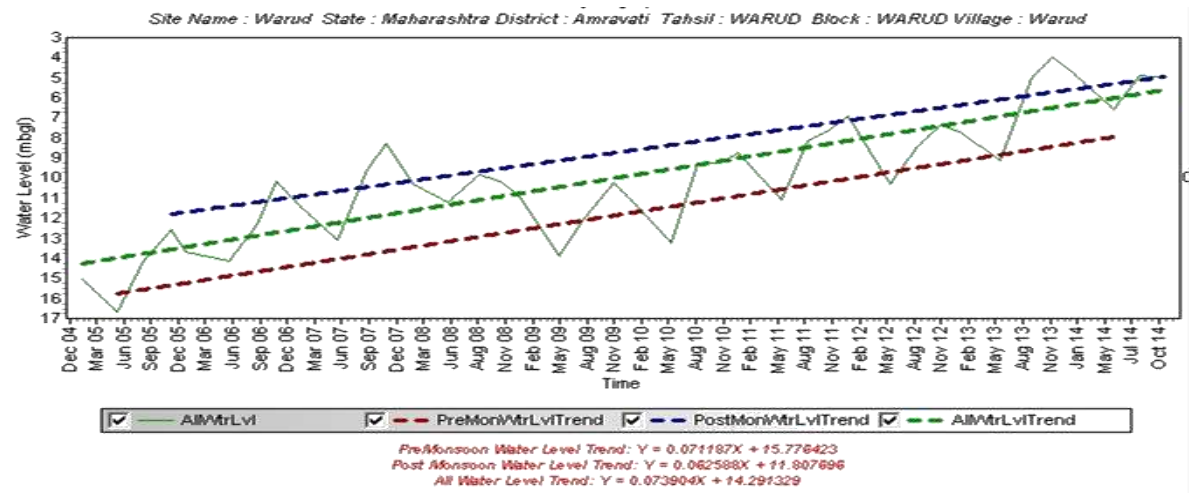


Fig 3.16 a: Hydrograph (2005-14), Warud, Warud taluka, Amravati district

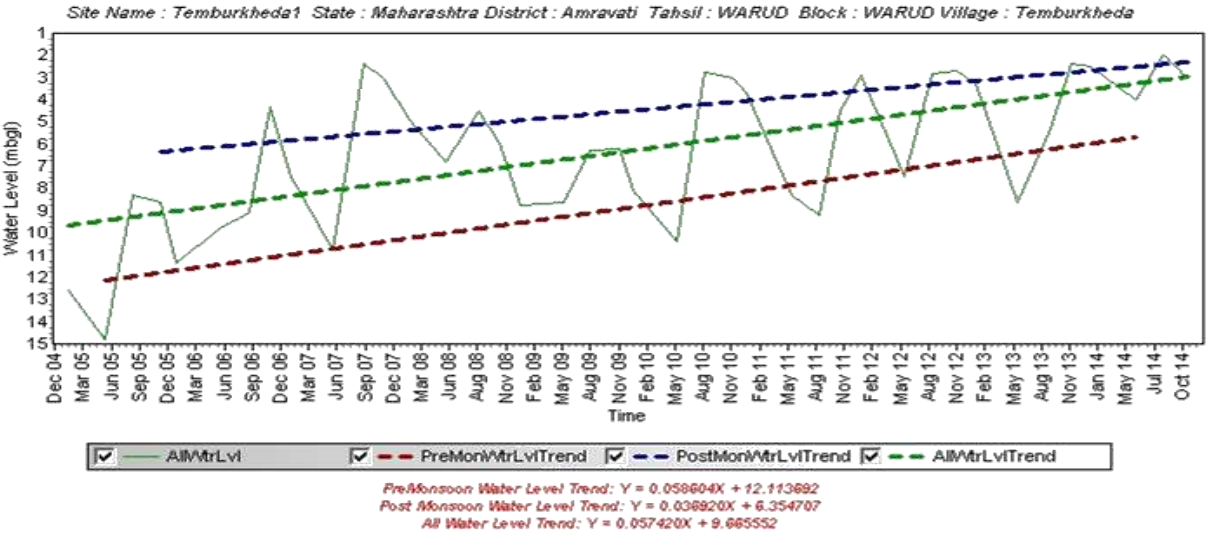


Fig 3.16 b: Hydrograph (2005-14), Tembhurkheda, Warud taluka, Amravati district

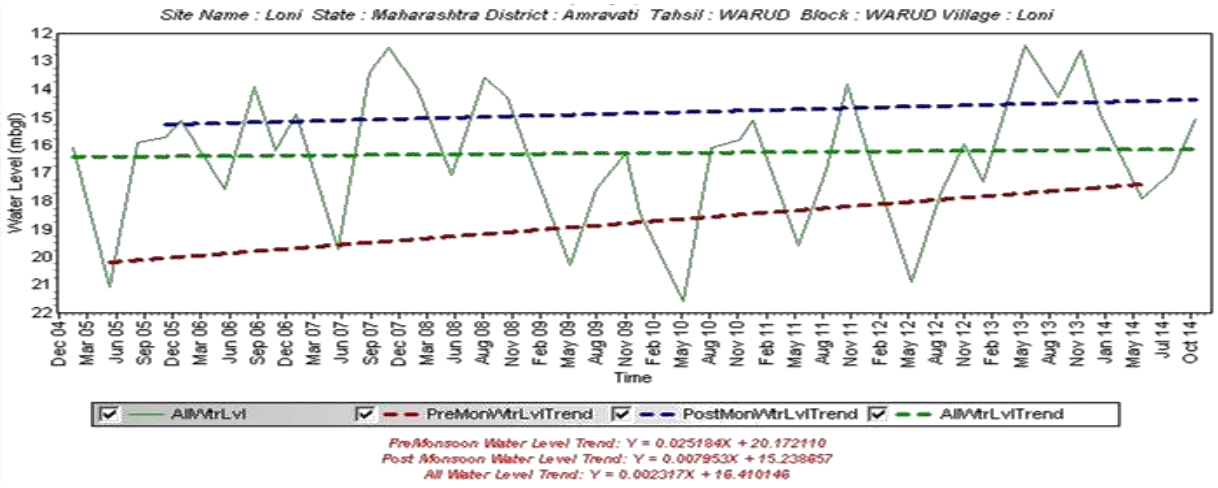


Fig 3.16 c: Hydrograph (2005-14), Loni, Warud taluka, Amravati district

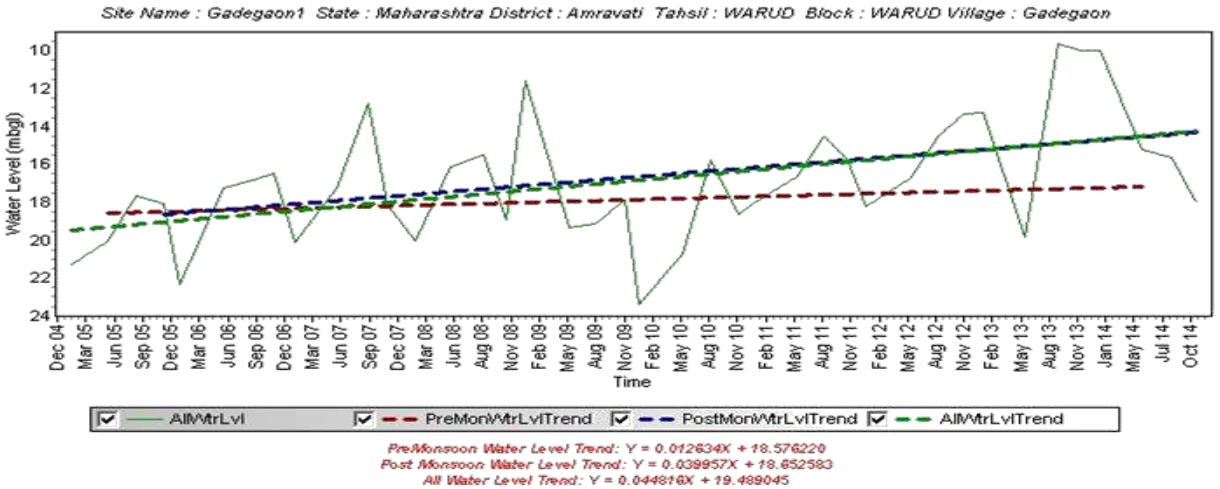


Fig 3.16 d: Hydrograph (2005-14), Gadegaon, Warud taluka, Amravati district

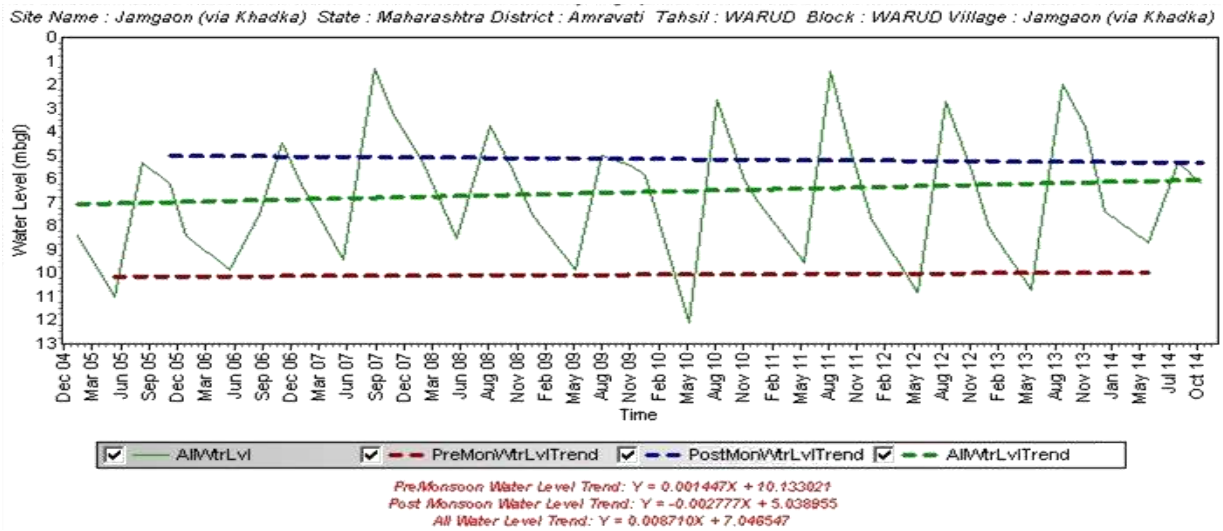


Fig 3.16 e: Hydrograph (2005-14), Jamgaon, Warud taluka, Amravati district

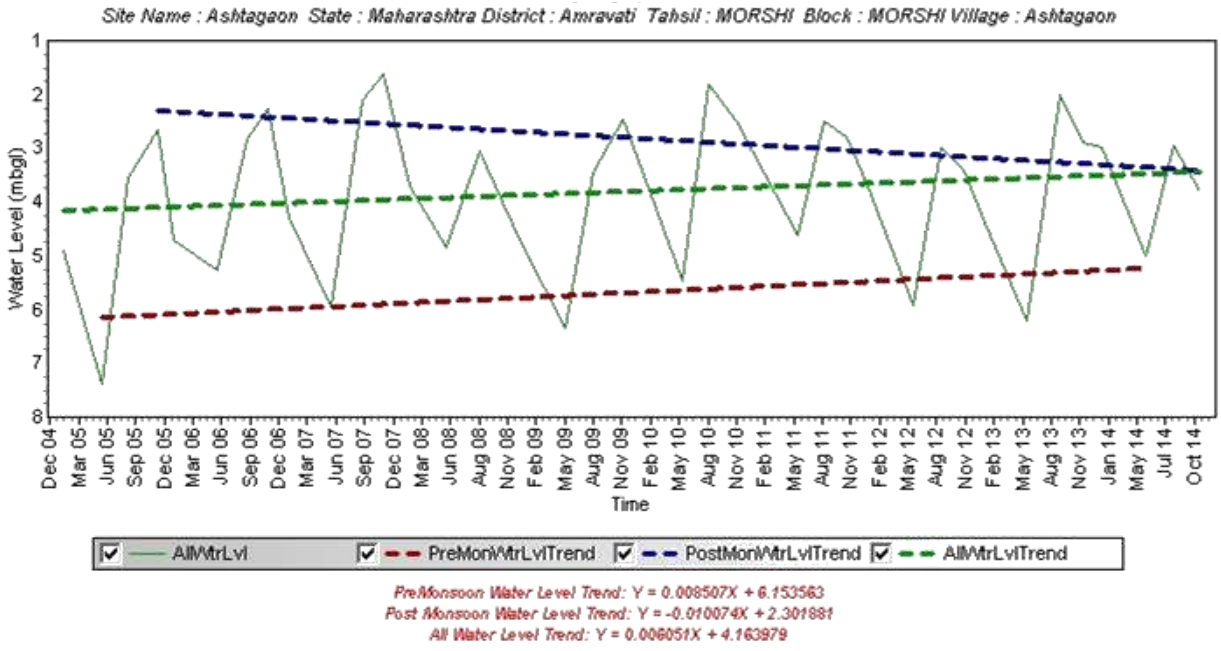


Fig 3.16 f: Hydrograph (2005-14), Ashtgaon, Morshi taluka, Amravati district

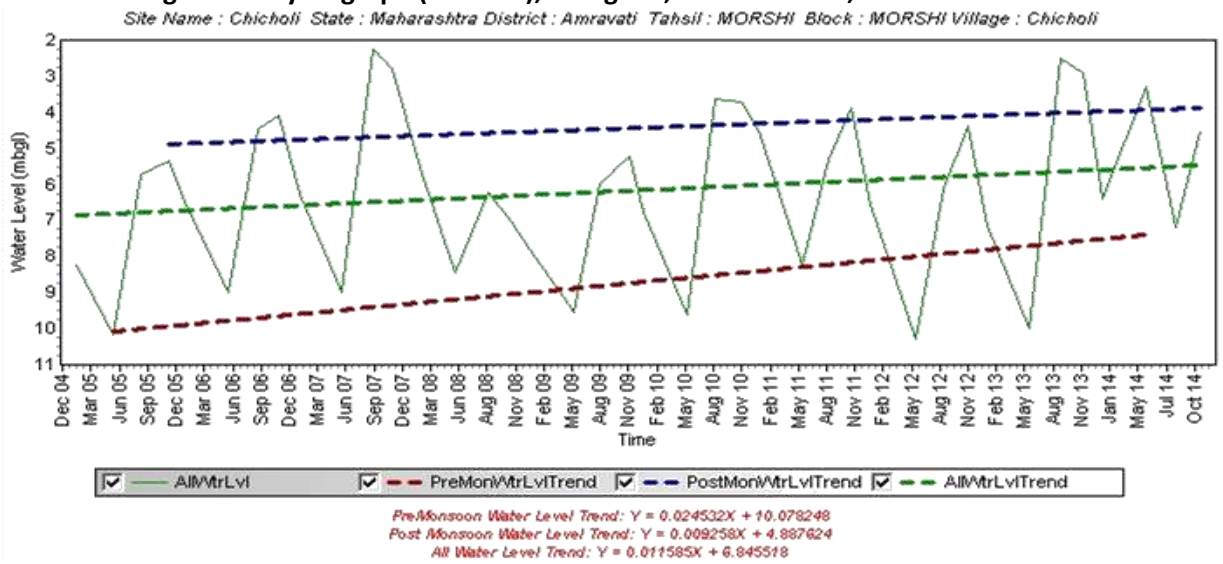


Fig 3.16 g: Hydrograph (2005-14), Chicholi, Morshi taluka, Amravati district

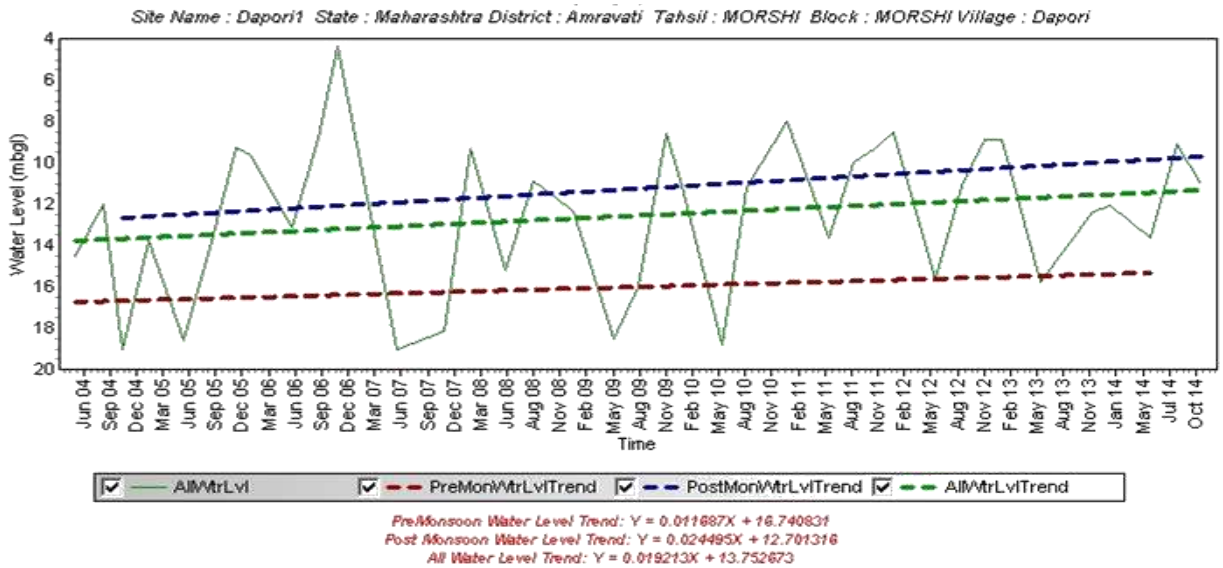


Fig 3.16 h: Hydrograph (2005-14), Dapori, Morshi taluka, Amravati district

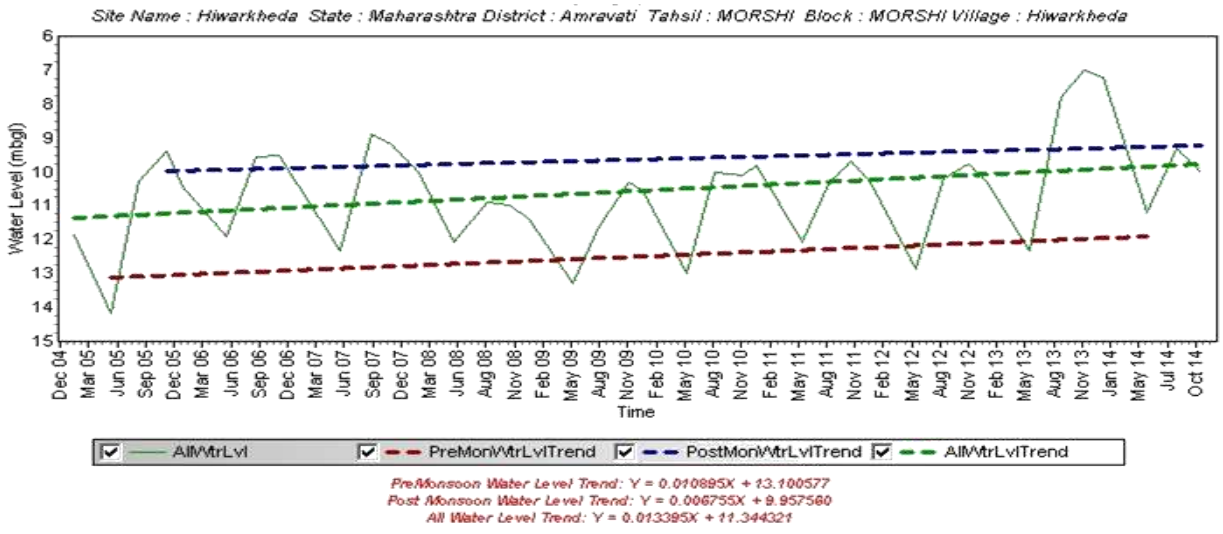


Fig 3.16 i: Hydrograph (2005-14), Hiwarkhed, Morshi taluka, Amravati district

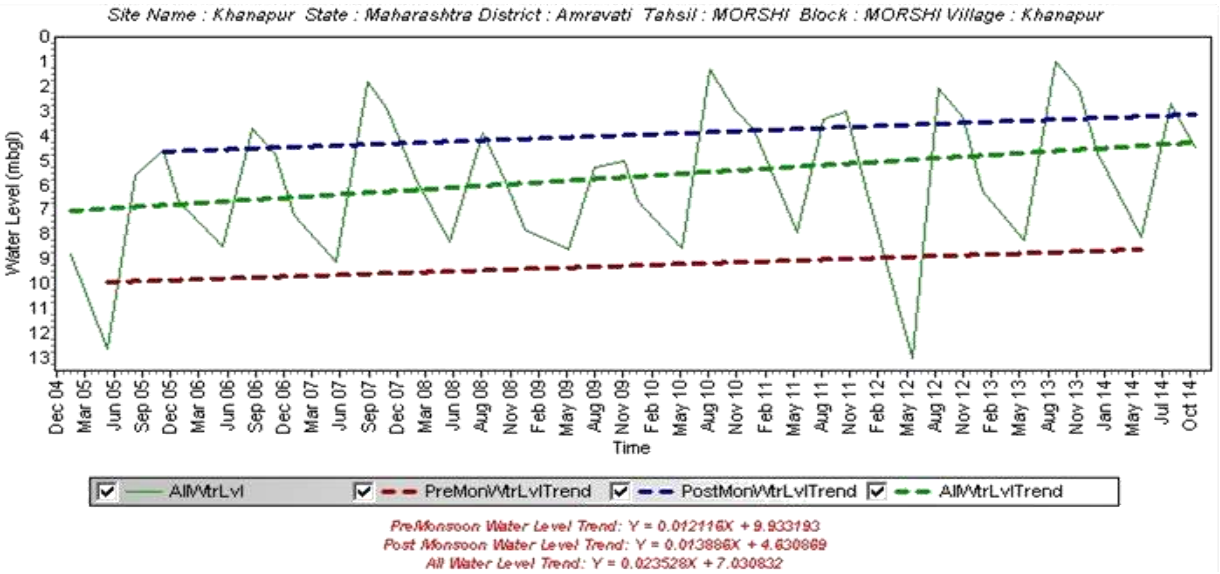


Fig 3.16 j: Hydrograph (2005-14), Khanapur, Morshi taluka, Amravati district

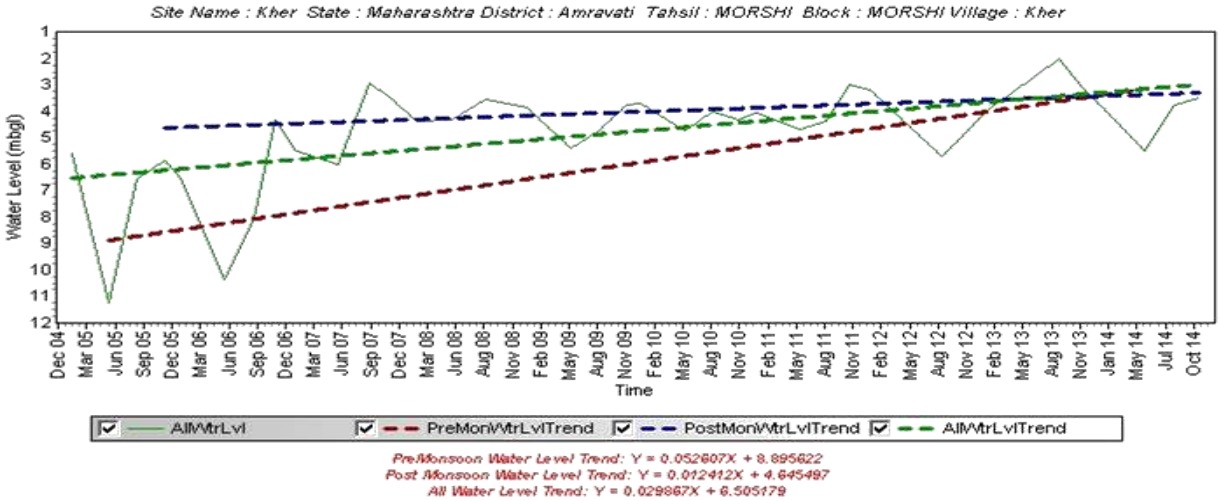


Fig 3.16 k: Hydrograph (2005-14), Kher, Morshi taluka, Amravati district

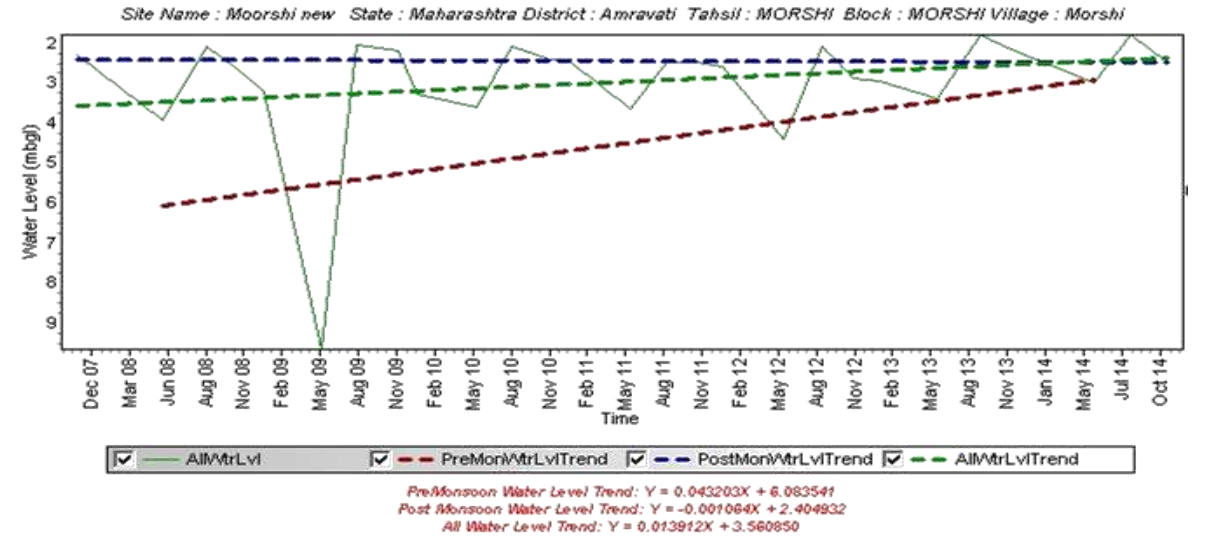


Fig 3.16 l: Hydrograph (2005-14), Morshi, Morshi taluka, Amravati district

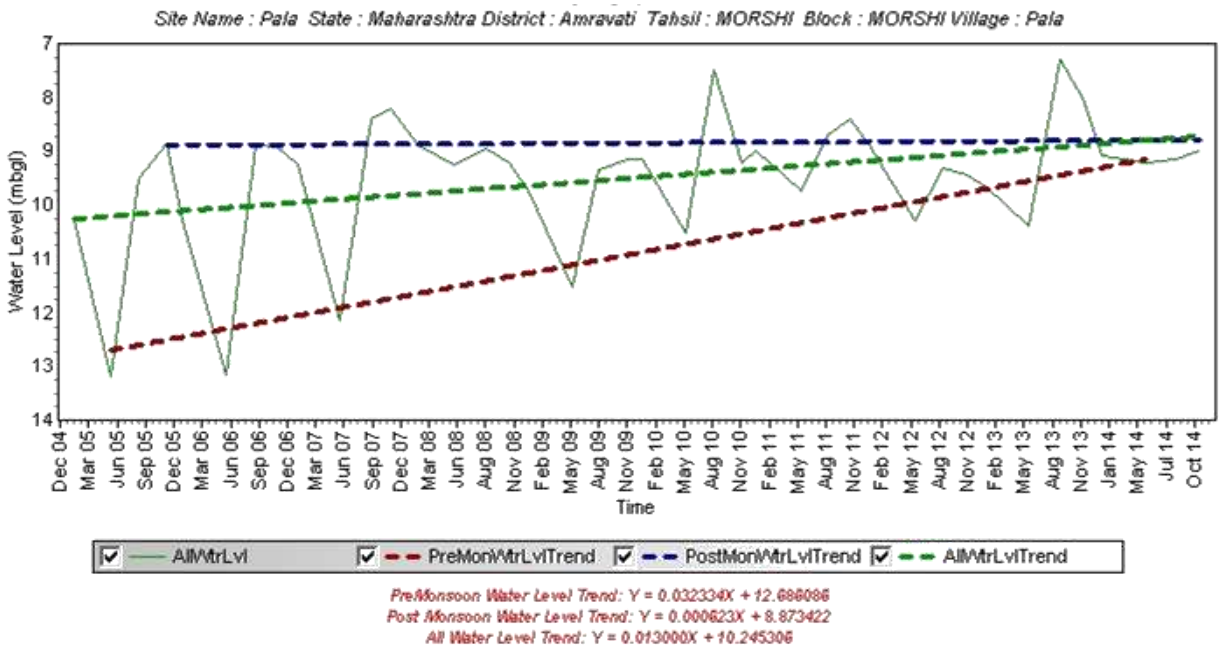


Fig 3.16 m: Hydrograph (2005-14), Pala, Morshi taluka, Amravati district

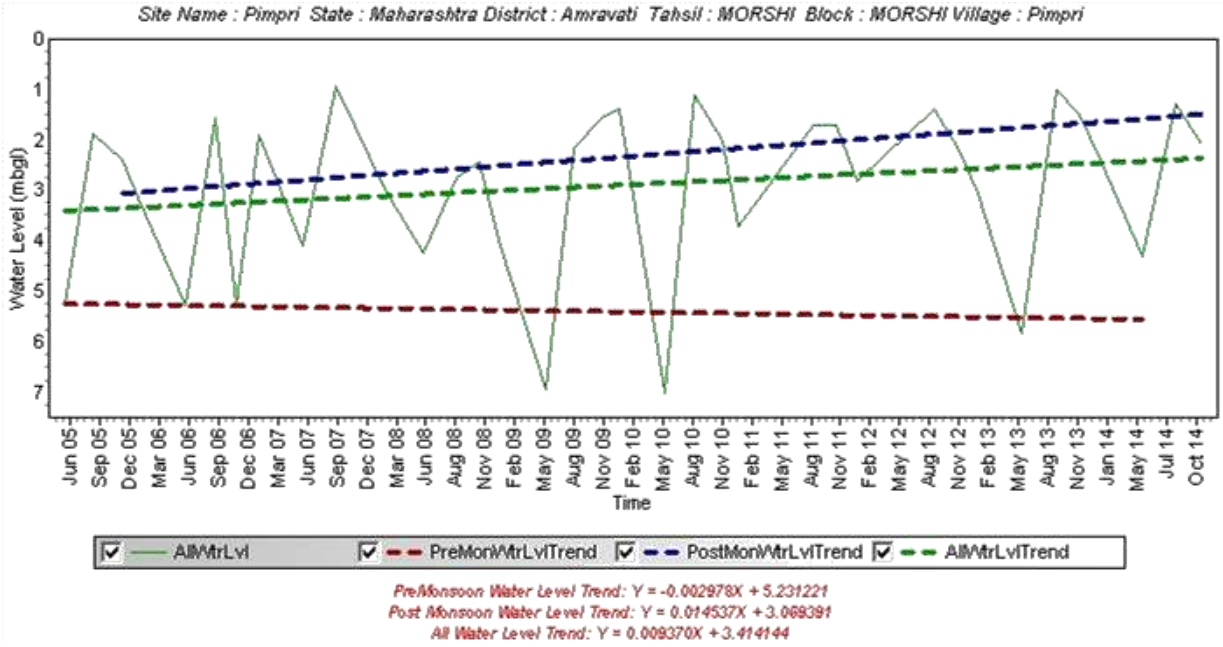


Fig 3.16 n: Hydrograph (2005-14), Pimpri, Morshi taluka, Amravati district

3.4.6 Ground Water Flow

In a groundwater regime, equipotential lines, the line joining points of equal head on the potentiometric surface, were drawn based on the area of variation of the head of an aquifer. Based on the Water table elevation, ground water flow directions are demarcated (**Fig. 3.17**). It has been observed that

1) The area under study Wardha river and its tributaries Chargarh and Maru Nadi and other main nalas viz., Madar, Zari, Chudamai, Deonad, Dhodana, Kasi, Kadak, Pak, Dhawagiri and

Chandrabhaga and their tributaries constitute the principal drainage system in the area. The other nalas are seasonal emanating from the hilly terrain and form the main nalas and rivers. The drainage pattern is mainly sub dendritic to sub parallel. The meandering of Wardha river indicates their mature stage of development. Initially, Wardha river flows from southward, when Jam Nadi meets near Jalalkheda, Wardha river flows south westerly and then southerly. This is due to presence of structural discontinuity and shows its structural control.

2) The water table varies from 330 m amsl near Wardha river in southeastern part of Morshi taluka to about 497 m amsl near Shekdari in Northern part of Warud taluka.
3) The overall ground water movement in Warud taluka is from North to south and then from NNE to SSW because of the structural control due to Salbardi fault.
4) The overall ground water movement in Morshi taluka is from northwest to Southeast i.e. towards Wardha river.

It has been observed that the ground water flow directions follow the major drainage of Wardha river and topography of the area. This indicates the topographic control for the ground water movement. However, in northern part of the study area, the ground water movement is control by structural discontinuity and also acts as a water divide.

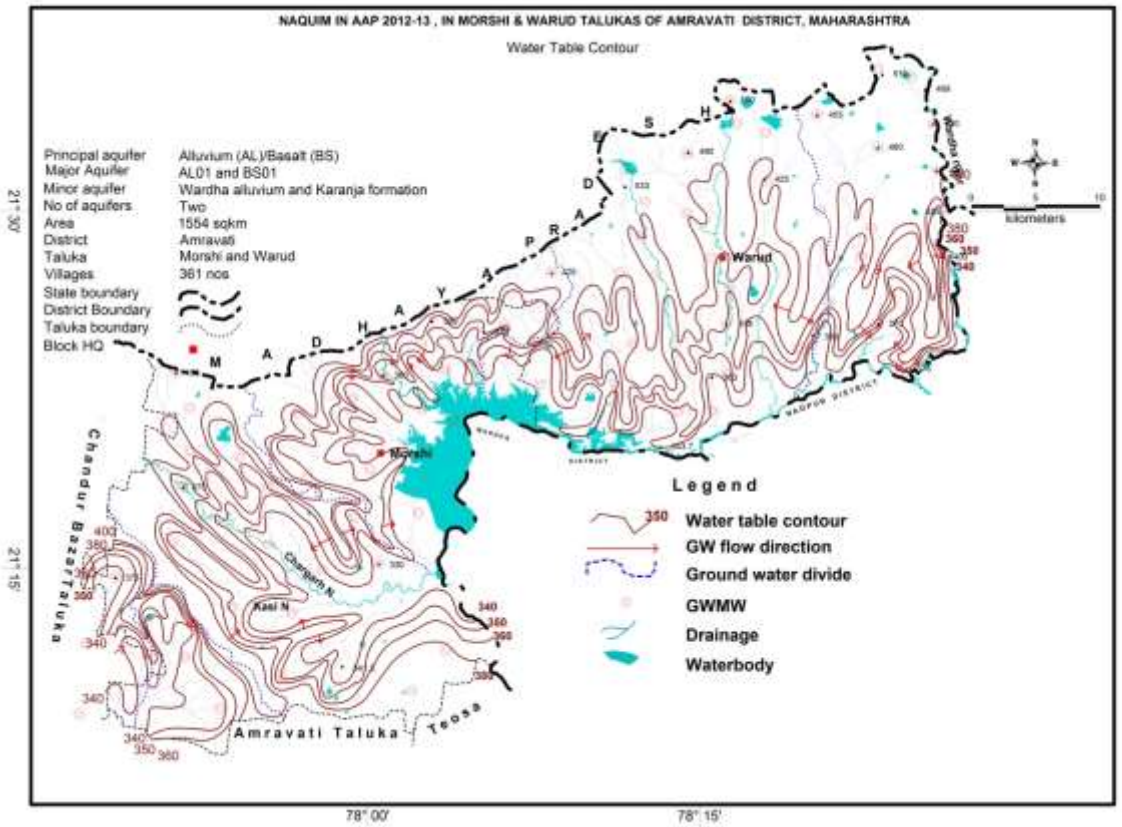


Fig. 3.17: Ground water flow, Warud and Morshi taluka, Amravati district

3.5 Ground Water Quality

The suitability of ground water for drinking/irrigation/industrial purposes is determined keeping in view the effects of various chemical constituents present in water on the growth of human being, animals, various plants and also on industrial requirement. Though many ions are very essential for the growth of plants and human body but when present in excess, have an adverse effect on health and growth. For estimation of the quality of ground water, ground water samples from 32 KOW's (shallow dug wells representing phreatic aquifer) have been collected during pre-monsoon. Similarly for Aquifer – II, the ground water samples were collected during the drilling and

pumping test activities of 20 exploratory constructed in Warud and Morshi. The ground water samples were analysed for major chemical constituents. The aquifer wise ranges of different chemical constituents present in ground water are given in **Table 3.2.** The details of water quality analysis of Aquifer I and II is given in **Annexure IV A and B**.

Table 3.2: Aquifer wise ranges of chemical constituents in Warud and Morshi

Constituents	Shallow aquifer		Deeper aquifer	
	Min	Max	Min	Max
pH	7	8.4	7	9.4
EC	300	3900	470	1610
TDS	429	2223	188	1060
TH	165	1050	9	685
Calcium	10	126	4	166
Magnesium	26	244	2	84
Potassium	-	-	15	161
Sodium	-	-	0.9	4
Carbonate	0	75	0	18
Bi-carbonate	116	476	12	427
Chloride	39	429	11	269
Sulphate	-	-	7	670
Nitrate	8	59	2	90
Fluoride	0	0.34	0	1.74

According to above table, out of 71 total samples of shallow aquifer, 42.25 % (30 samples) falls in excellent category while 47.89% (34 samples) falls under Good and permissible limit while only 7 samples (9.86 %) are falling in doubtful category. Out of 21 exploratory wells drilled, a total of 14 samples of deeper aquifer were analysed, out of 14 samples 64.28 % (9 samples) falls in excellent category while 35.72 % (5 samples) falls under good and permissible category. The iso-conductivity map of Aquifer I and II has been prepared and presented as **Fig 3.18** and **Fig 3.19** respectively.

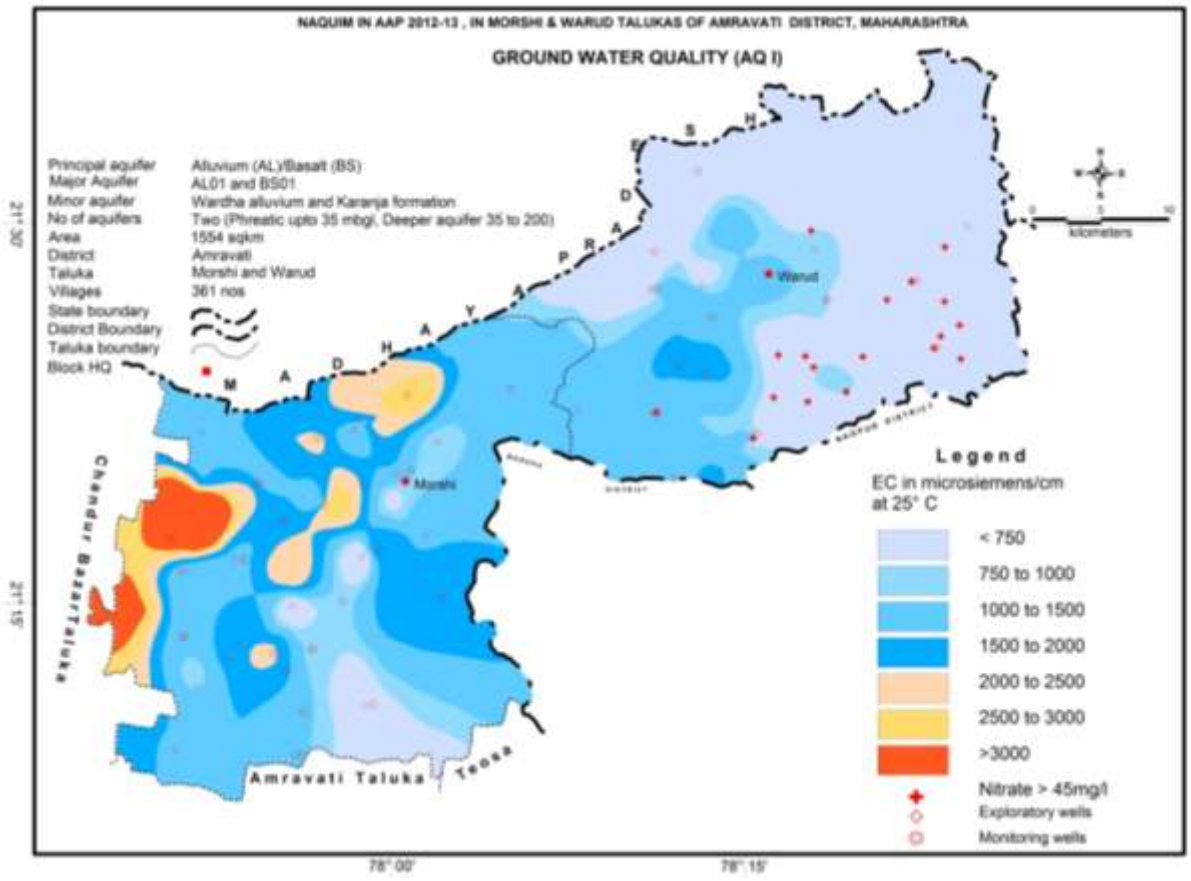


Fig. 3.18: Ground water quality, Aquifer-I, Warud and Morshi taluka, Amravati district

On perusal of the **Fig 3.18** it is observed that the electrical conductivity for shallow aquifer in Warud taluka is within Permissible Limit (750-2250 µMhos/cm @ 25°C). Nitrate concentration of >45 mg/l is observed in southern part of Warud taluka, where intense agricultutal activity is predominant. In Morshi taluka, it is observed that electrical conductivity of ground water observed Doubtful (>2250 µMhos/cm @ 25°C) in north-central and central-western part of the taluka. It is covering Pala-Chikal Sawangi, Khed, Rithpur area. Whereas, perusal of **Fig 3.19** for Aquifer-II shows that, the quality of water is good for both Drinking and agricultural activity. Except nitrate concentration >45 mg/l is reported at Katpur in morshi taluka. It is due to the interaction of aquifer-I as the first zone was encountered above 30 mbgl.

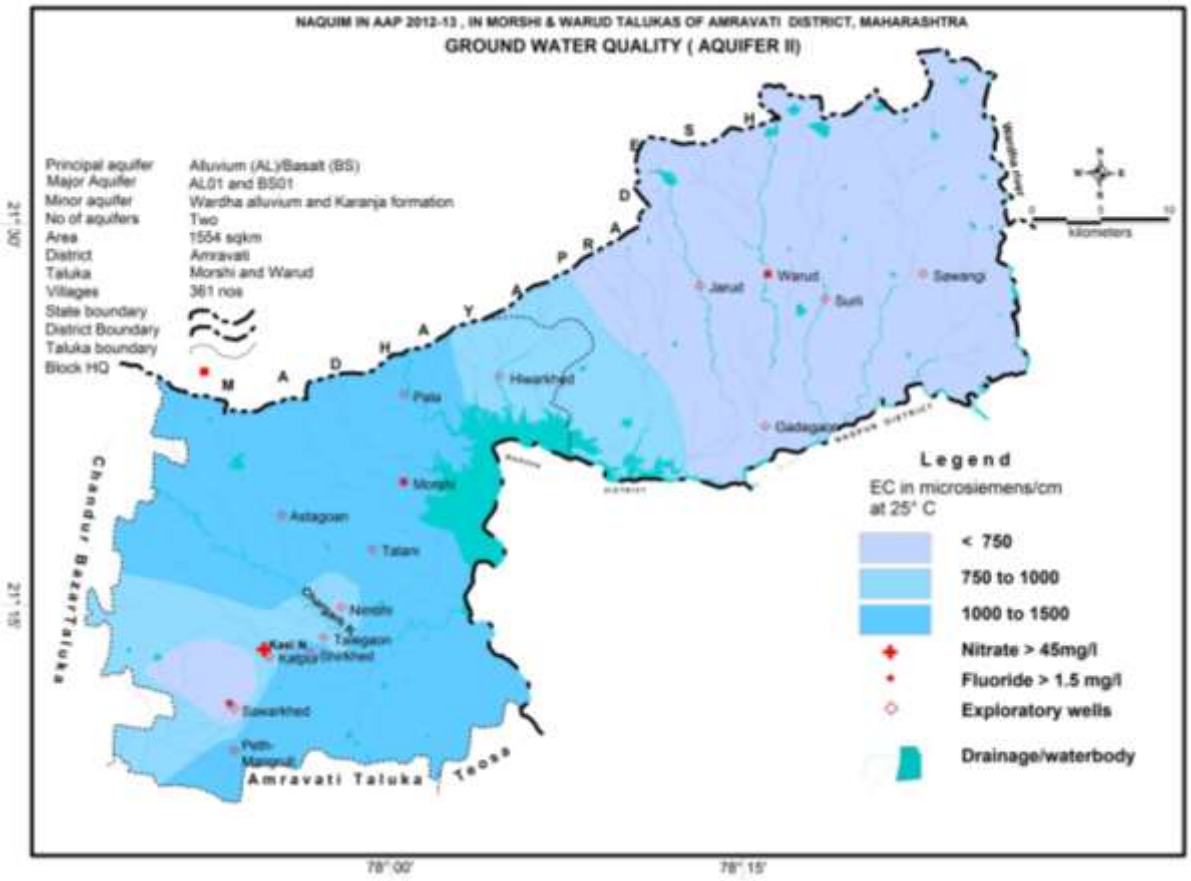


Fig. 3.19: Aquifer-II, Iso conductivity, Warud and Morshi taluka, Amravati district

3.6 3-D and 2-D Aquifer Disposition

Based on extensive analysis of historical data, micro level hydrogeological survey data generated and ground water exploration carried out Morshi and Warud, the following two types of aquifers has been demarcated and the details of ground water exploration is given in **Annexure-II**. The ground water exploration data has been used to generate the 3D disposition of deeper basaltic aquifers. It comprises of all existing litho-units and the zones tapped during the ground water exploration, forming an aquifer. Based on the ground water exploration and micro-level hydrogeological survey, lithological Fence diagram has been generated and shown in **Fig. 3.20**. The aquifer units in each of the formation are listed below:

- **Alluvium –** occurs in south-western part of Morshi taluka
  Aquifer –I (Shallow Aquifer): 12 to 35 m (Alluvium – Sand)
- **Basalt –** occurs in Deccan trap basalt which is exposed in major parts of the area
  Aquifer –I (Shallow Aquifer)**: 10 to 35 m** (weathered / fractured Basalt)
  Aquifer –II (Deeper Aquifer): **35 to 135 m** (Jointed / fractured Basalt)

To visualize the Aquifer-I and Aquifer-II, a schematic 3-D aquifer disposition has been prepared and shown in **Fig. 3.15.**

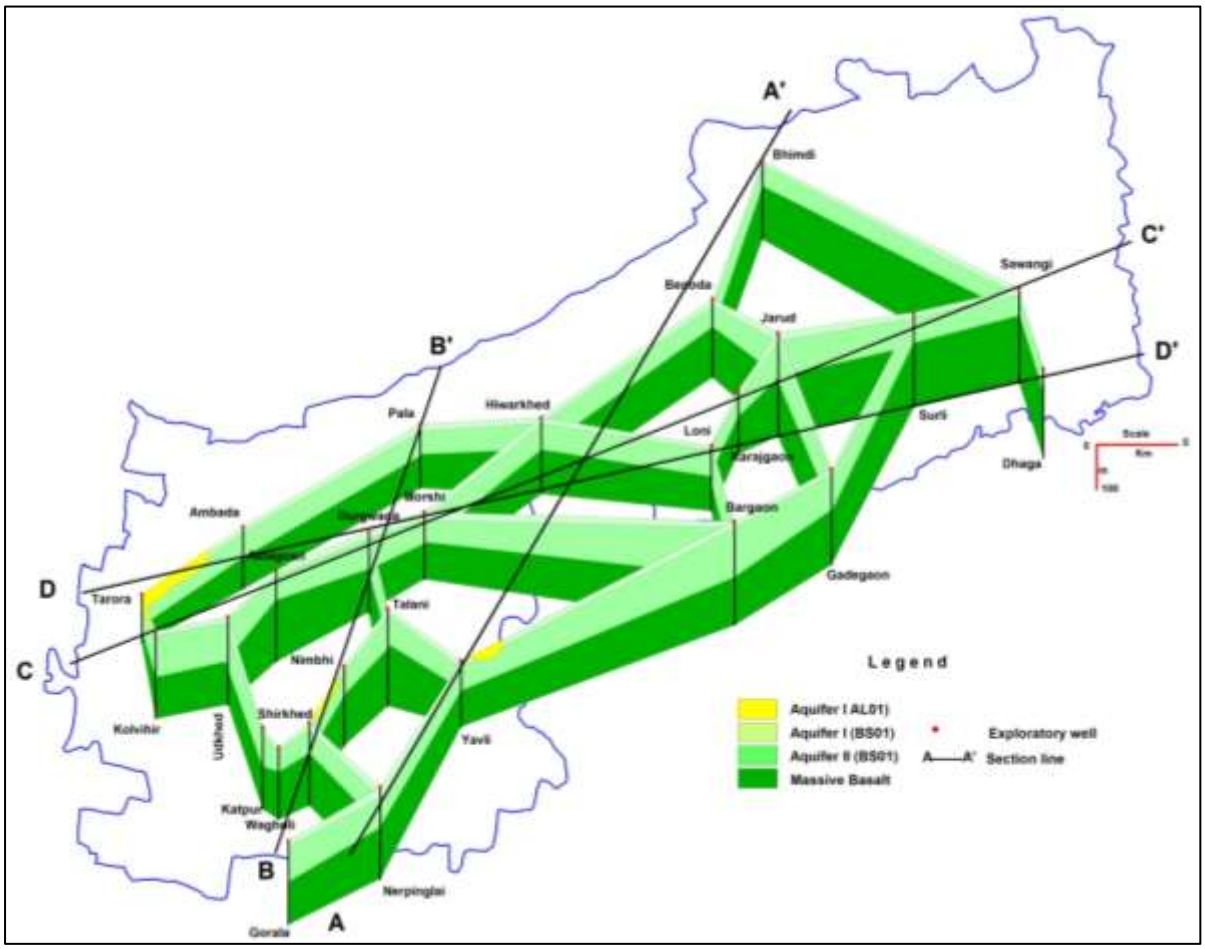


Fig. 3.20: 3-D Fence diagram, Warud and Morshi taluka, Amravati district

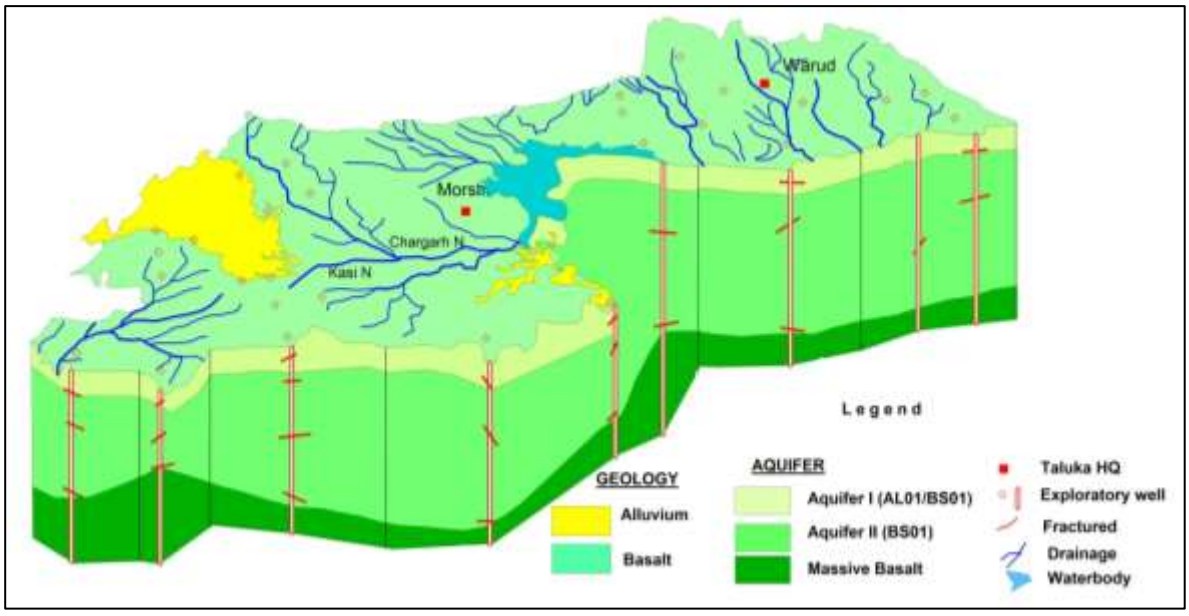


Fig. 3.21: Schematic 3-D Aquifer Disposition, Warud and Morshi taluka, Amravati district

3.6.1 Hydrogeological Cross Sections

Based on ground water exploration a sub-surface lithological section has been prepared to know the lithological continuity and its extent. The aquifer disposition in detail, various

hydrogeological cross section indicating aquifer geometry has been prepared viz. A-A' representing southwest-west to north-northeast direction, B-B' representing southwest–northeast direction covering alluvium areas, C-C' representing northwest-southeast direction excluding alluvium area, and D-D' representing north-south direction as marked in **Fig. 3.20.** The sections are shown in **Fig 3.22 a** to **3.22 d.**

3.6.1.1 Hydrogeological Cross Section A-A'

Section A-A' represents the basaltic terrain sub-surface hydrogeology & aquifer disposition along Nerpinglai, Morshi taluka to Bhimdi, Warud taluka, down to explored depth from 98 to 171.95 m bgl. The data of four exploratory wells i.e., Nerpinglai, Yavali, Benida and Bhimdi has been utilised. The Basalt has been encountered down to depth of 171.95 m bgl. The thickness of massive basalt/basement is observed more at Nerpinglai & Bhimdi. The water levels have also been depicted in the section and a close observation of water level indicates the water levels of both shallow and deeper aquifer-I and II are entirely distinct. Also, the water levels in aquifer –I is shallow while it is relatively deeper in Benoda area in Aquifer-II. The Nerpinglai area has excellent ground water potential as it was high yielded exploratory well.

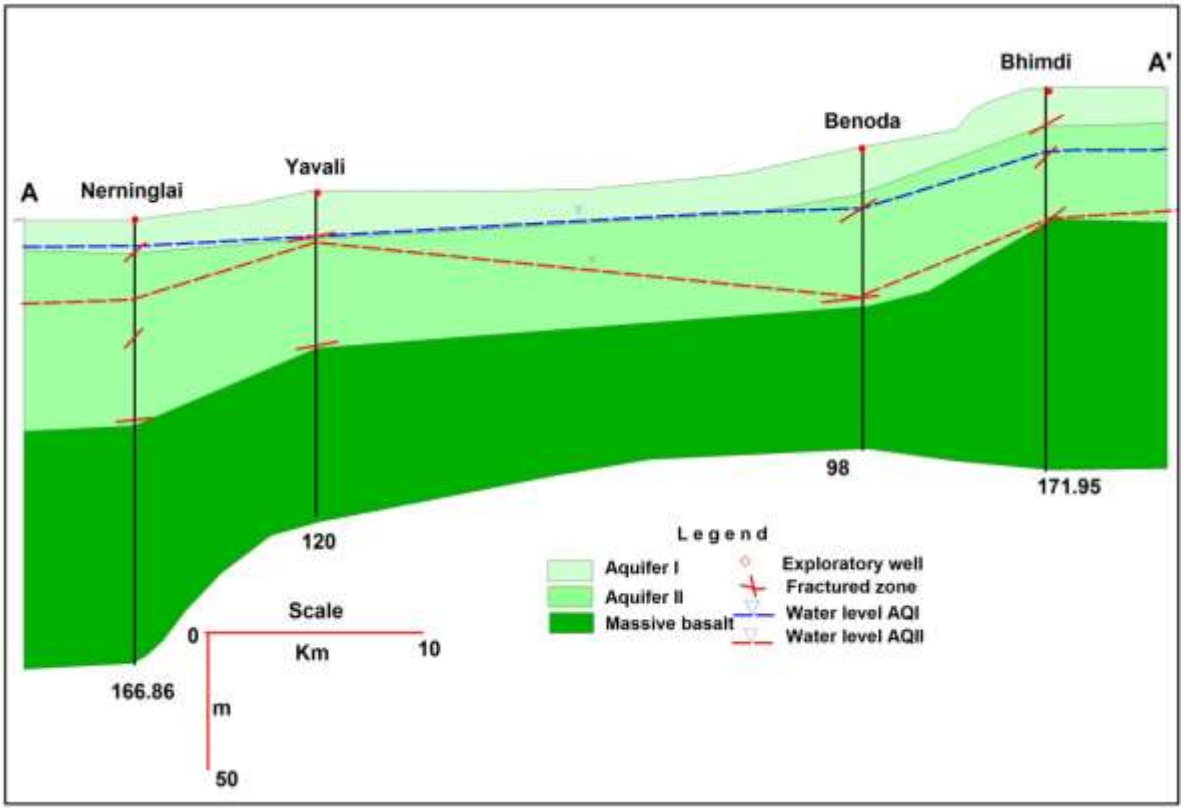


Fig. 3.22 (a): Lithological section A-A', Warud and Morshi taluka, Amravati district

3.6.1.2 Hydrogeological Cross Section B-B'

Section B-B' represents the basaltic terrain sub-surface hydrogeology & aquifer disposition along Gorala to Pala, with explored depth from 89 to 202.45 m bgl. The data of 6 exploratory wells i.e., Gorala, Shirkhed, Nimbhi, Talni, Durgwada and Pala has been utilised. The Basalt has been encountered down to depth of 200 m bgl. The thickness of massive basalt/basement is observed more uniformly distributed. The water levels have also been depicted in the section and it indicates

that the water levels of both shallow and deeper aquifer-I and II are almost coincide, except from Talni to Pala, where the deeper water levels has been observed in Aquifer-II. The Aquifer-I (Shallow) has water levels residing within the aquifer zone.

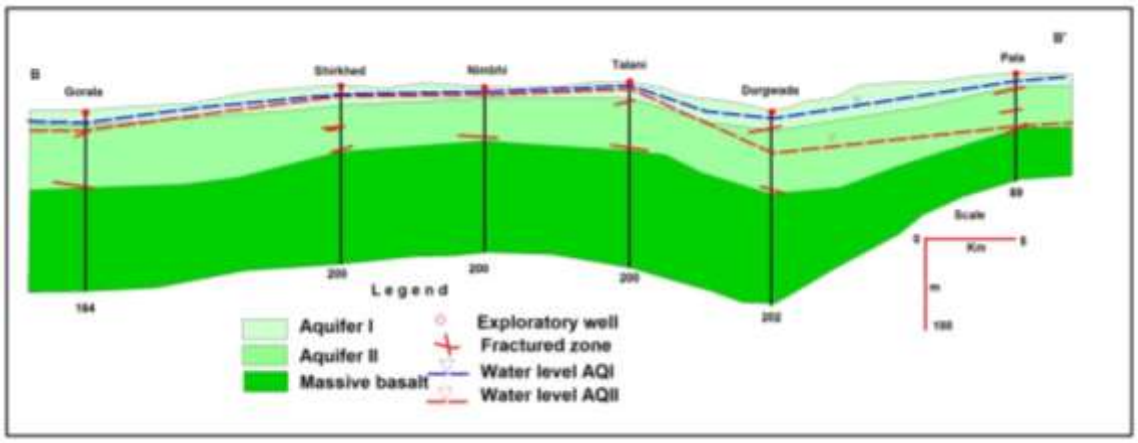


Fig. 3.22 (b): Lithological section B-B', Warud and Morshi taluka, Amravati district

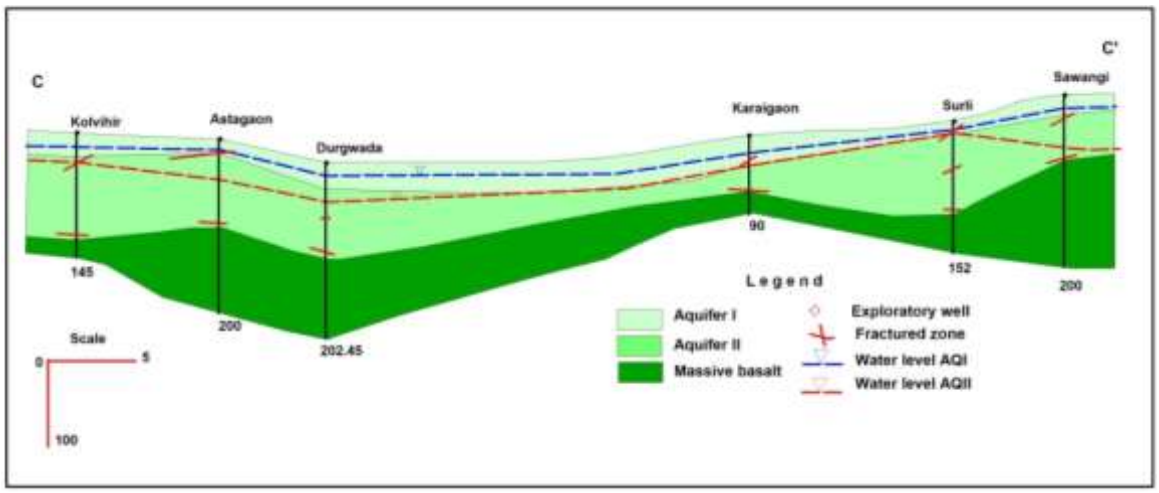


Fig. 3.22 (c): Lithological section C-C', Warud and Morshi taluka, Amravati district

3.6.1.3 Hydrogeological Cross Section C-C'

Section C-C' represents the major part consisting of basaltic terrain sub-surface hydrogeology & aquifer disposition with explored depth ranging from 90m to 202.45m bgl. The data of six exploratory wells i.e., Kolvihir, Ashtagaon, Durgwada, Karajgaon, Surli and Sawangi has been utilised. The Basalt has been encountered down to depth of 202.45 m bgl. The thickness of massive basalt/basement is unevenly distributed and encountered maximum at Sawangi. The water levels have also been depicted in the section and it indicates that the water levels of both shallow and deeper aquifer-I and II are almost coincide. The Aquifer-I (Shallow) has water levels residing within the aquifer zone. In Aquifer-II (deeper) it is observed that water level is shallow in entire basaltic terrain while it is deeper in Sawangi area.

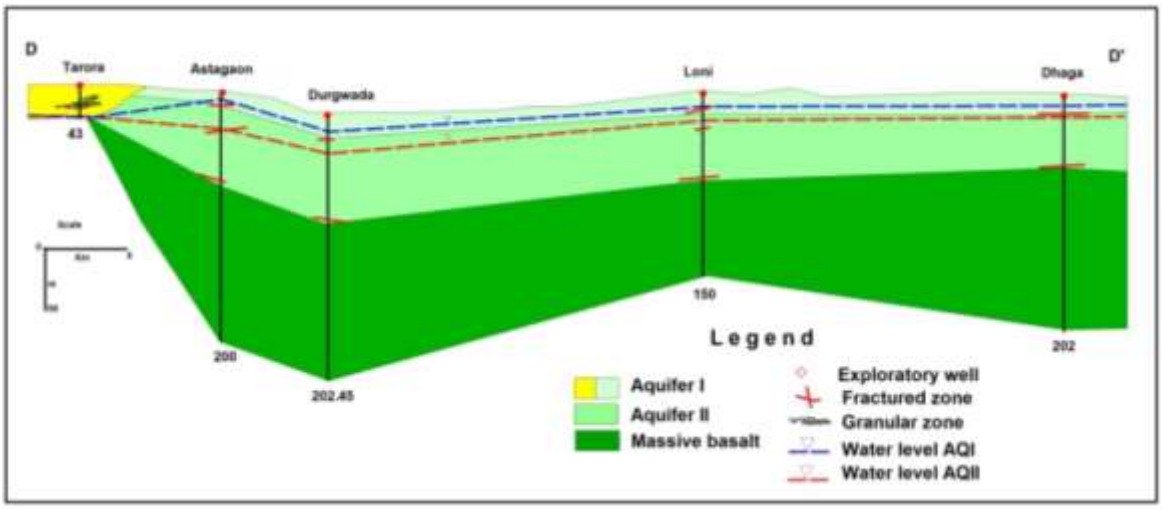


Fig. 3.22 (d): Lithological section D-D', Warud and Morshi taluka, Amravati district

3.6.1.4 Hydrogeological Cross Section D-D'

Section D-D' represents the major part consisting of basaltic terrain sub-surface hydrogeology & aquifer disposition except at western part where Purna Alluvium encountered, near Tarora, with explored depth ranging from 43m to 202.45m bgl. The data of five exploratory wells i.e., Tarora, Ahtagaon, Durgwada, Loni and Dhaga has been utilised. The granular zone in Purna Alluvium (Deeper Aquifer-I) has been encountered at shallow depth only in Tarora. The thickness of Aquifer-II (Deeper aquifer) is uniformly distributed. The water levels have also been depicted in the section and it indicates that the water levels of both shallow and deeper aquifer-I and II are almost coincide.

3.7 Aquifer Characteristics

Although, basalt is the only formation exposed in the area and forms the major aquifer but Alluvium (Purna river alluvium) is also plays a vital role in aquifer-I. At some places, alluvium occurs in along the Wardha, and its tributaries in Morshi taluka, however, it does not form as potential aquifer. The summarised aquifer characteristics are presented in **Table 3.3**.

Table 3.3 Aquifer Characteristic of Warud and Morshi Taluka, Amravati district

Type of Aquifer	Formation	Depth range (m bgl)	SWL (m bgl)	Thickness (m)	Fractures / Granular Zones encountered (m bgl)	Yield	Sustainability	Aquifer parameter (Transmissivity – m^2 /day)	Sy/S	Suitability for drinking/ irrigation
Aquifer-I	Deccan Trap-Weathered / Fractured Basalt	10-35	4.60 to 23.15	0.5 to 4.00	5 to 35	10 to 100 m^3 /day	1 to 4 Hours – recurring	-	0.02	Yes for both (except Nitrate affected villages for drinking)
Aquifer-I	Alluvium - Sand	12-35		3 to 6	8 to 35	50 to 100 m^3 /day	2 to 4 hours		0.04 to 0.06	Yes for both
Aquifer-II	Jointed /Fractured Basalt	35-135	6 to > 50	0.5 to 7.0	35 to 135	25 - 200 LPM	2 to 4 hours	10-300	6 x 10^{-3} to 1.25 x10^{-4}	Yes for both

Basalt is the main rock type of the area and 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 lava pile exposed within the altitude of 340 to 540 mamsl, consists of 15 basalt flows of 'aa' type, demarcated based on GSI maps and ground water exploration, occupying major part of the area. Each flow comprise of three units namely top vesicular basalt followed by fractured/massive basalt followed by massive basalt. The hydrogeological map is shown in **Fig 3.2.** The 3-D disposition of Basalt aquifer is shown in **Fig. 3.20 & 3.21** and the aquifer characteristics are presented in **Table- 3.3**.

Aquifer-I (shallow) in the area predominantly consists of weathered fractured and jointed basalt and exposed almost covering entire area. It is 'Unconfined Shallow Aquifer', occurs in Deccan trap basalt. Ground water is present in pore spaces in the vesicular unit of each flow and in the weathered fractured and jointed portions of massive unit. However, secondary porosity and permeability that has been developed due to weathering and fracturing play a very important role in the storage and movement of ground water. Weathering not only produces granular materials but also widens the fractures, joint and shear zones and constitute ground water potential aquifers in the area. In alluvium terrain, southwest part of Morshi taluka, Aquifer-I is consists of sand and thin patches of clay lenticulars. Although it is not forming a good potential aquifer, but plays vital role in hydrogeology of the area.

The **Shallow Basaltic Aquifer-I** is observed in the depth range of 10 to 35 m bgl with water levels of 4.60 to 23.15 m bgl and thickness of 0.5 to 4.00 m. The fractures are encountered from 5 m bgl to 35 m bgl. The yield of the dugwells tapping this aquifer generally ranges from 10 to 100 m^3/day, which sustains from 1 to 5 hs. The overall groundwater quality is suitable for both drinking/domestic and irrigation purposes except at few villages where nitrate contamination is observed.

The **Shallow Alluvium Aquifer-I** is observed in the depth range of 12 to 35 m bgl and thickness of 3 to 6m. The granular zones are encountered from 8 m bgl to 35 m bgl. The yield of the dugwells tapping this aquifer generally ranges from 50 to 100 m^3/day, which sustains from 2 to 4 hrs. The overall groundwater quality is suitable for both drinking/domestic and irrigation purposes. Based on Ground Water Exploration, map of Aquifer –I depicting depth of occurrence and fractured rock thickness is generated and shown in **Fig 3.23.**

Dugwells tapping Alluvium in western part and along Wardha river of Morshi Taluka is high and ranges between 50 to 100 m^3/day. Around 20% area of Morshi taluka covering basaltic formation is having high yield in the range of 50 to 100 m^3/day. Rest of the taluka is having moderate yield in the range of 25 to 50 m^3/day. Whereas, In Warud taluka, around 70% area covering basaltic formation is having high yield of dugwells in the range of 50 to 100 m^3/day. About 15% areas is having moderate yield in the range of 25 to 50 m^3/day. Rest of the area excluding hilly part if having low yield upto <25 m^3/day. The yield potential map of Aquifer-I for Warud and Morshi taluka is shown in **Fig. 3.24**.

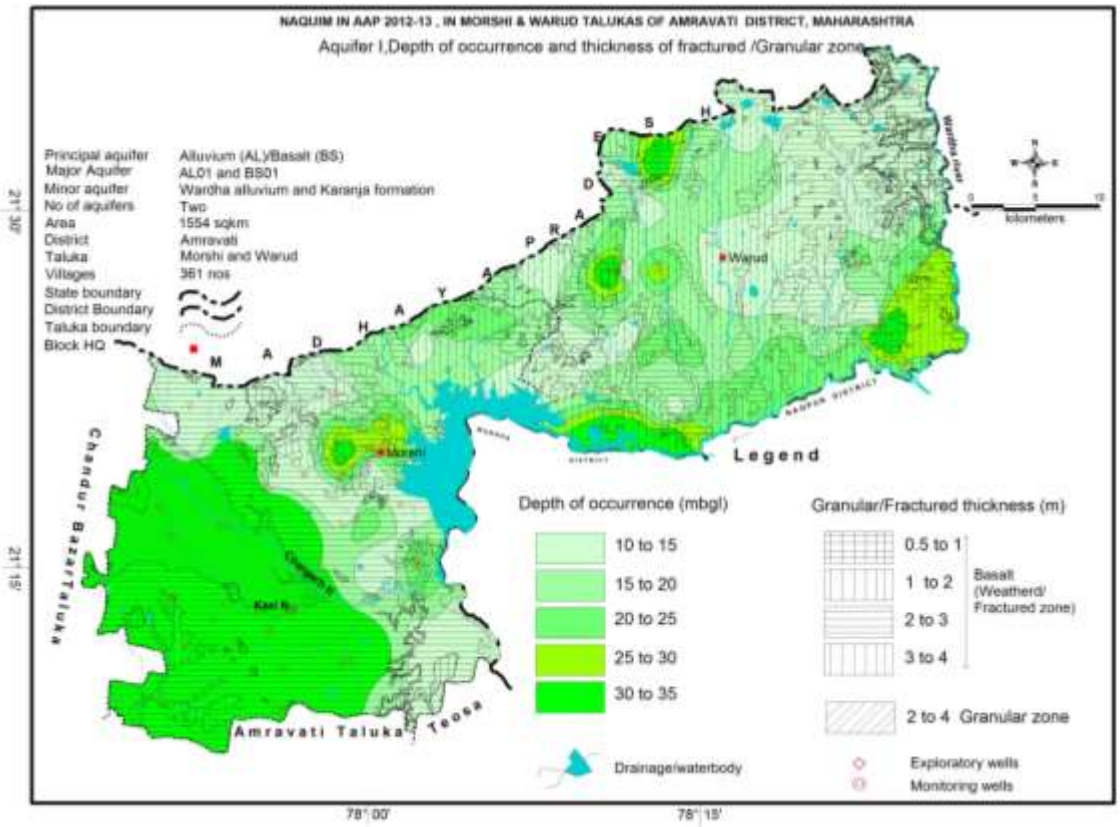


Fig. 3.23: Depth of occurrence & fractured rock thickness of Aquifer-I (shallow), Warud and Morshi taluka, Amravati district

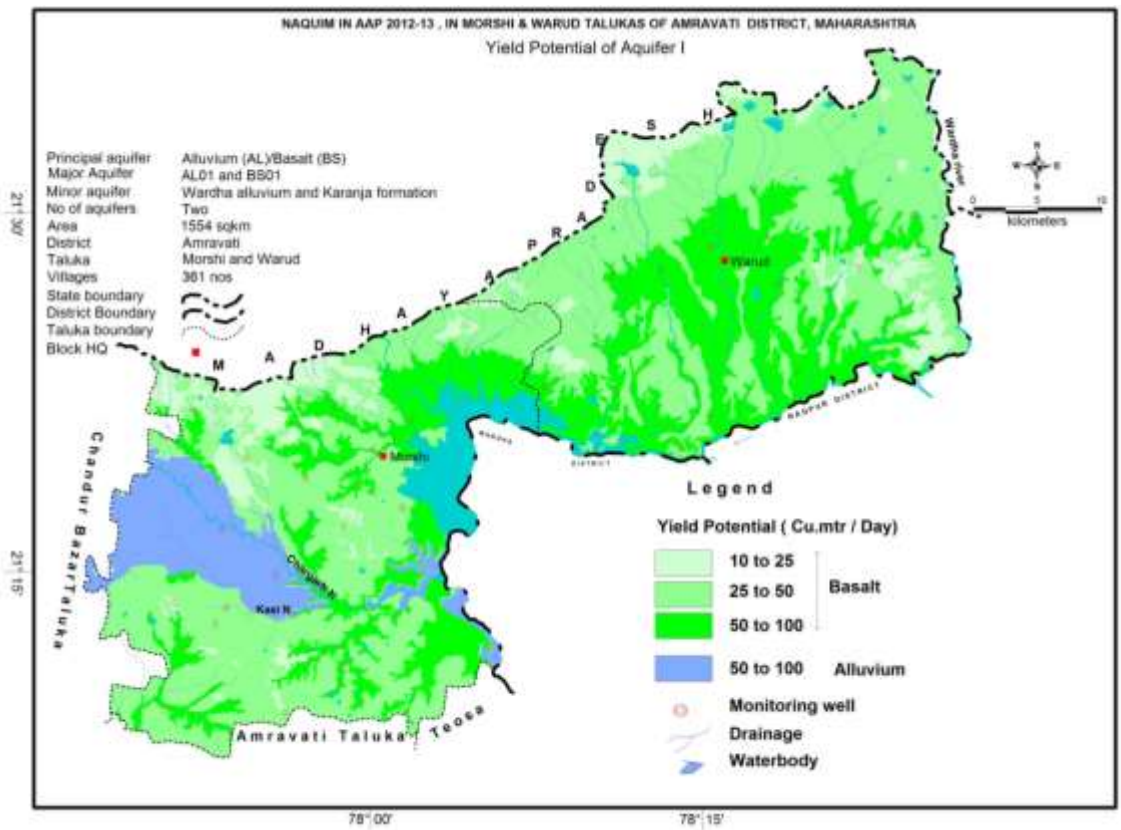


Fig. 3.24: Aquifer-I (shallow), Yield potential, Warud and Morshi taluka, Amravati district

Aquifer II – Semi-confined to Confined Deeper Aquifer. Generally occurs in Deccan trap basalt, which is expose in major parts. The Aquifer-II is observed in the depth range of 35 to 135 m bgl with water levels of 6.00 to > 50.00 m bgl and thickness of 0.50 to 7.00 m. The fractures are encountered from 35 to 135 m bgl. The yield of the borewells tapping this aquifer generally ranges from 25 to 200 lpm which sustains from 2 to 4 hs. The transmissivity ranges from 10 to 300 m^2/day. The overall groundwater quality is suitable for both drinking/domestic and irrigation purposes. Based on Ground Water Exploration, map of Aquifer –II depicting depth of occurrence and fractured rock thickness is generated and shown in **Fig 3.25**.

The data of exploratory wells reveals that, in Morshi Taluka high yielding area is restrict to southern part of the Morshi taluka and ranges between and ranges between 1 to >2 lps in terms of yield potential. Rest of the area is having moderate to low yield upto 1 lps. Whereas, In Warud taluka, around 80% area covering basaltic formation of is having low yield of bore wells upto 1 lps. Only 20% areas is having moderate to high yield in the range of 1 to 2 lps. The yield potential map of Aquifer-II for Warud and Morshi taluka is shown in **Fig. 3.26.**

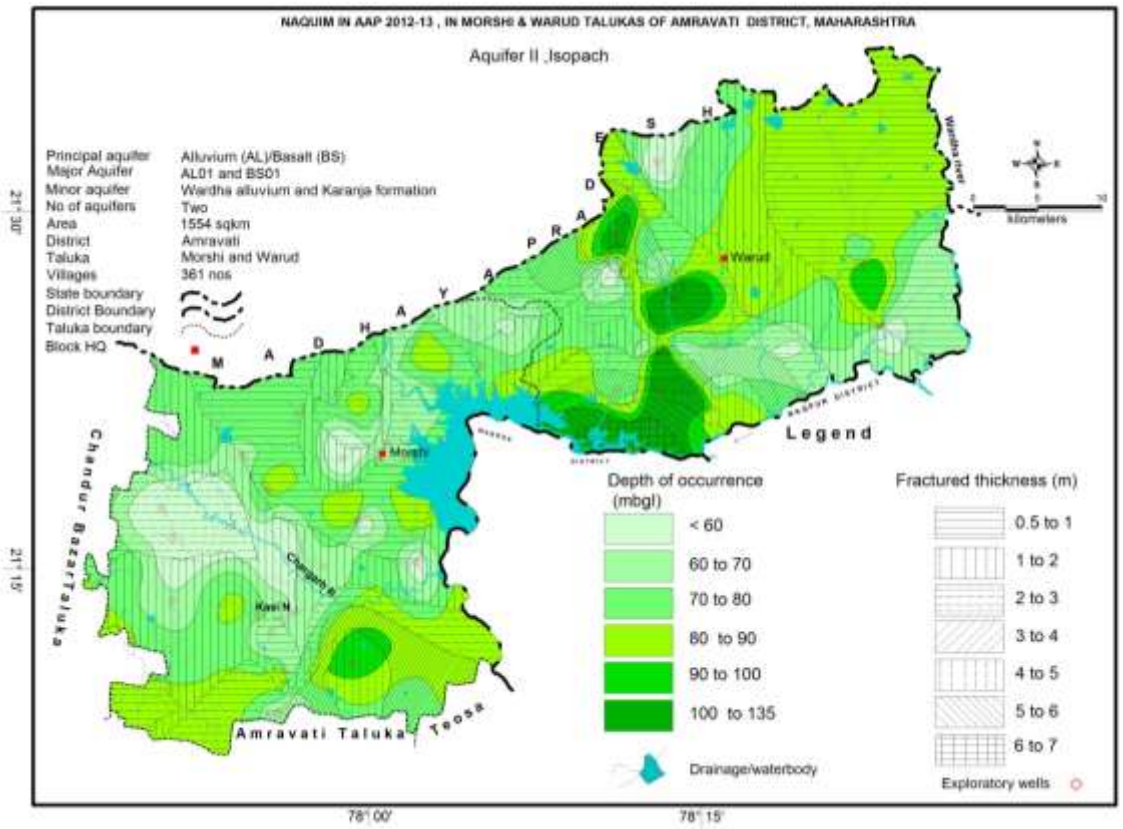


Fig. 3.25: Aquifer-II (deeper), Isopach depicting Depth of occurrence & fractured rock thickness, Warud and Morshi taluka, Amravati district

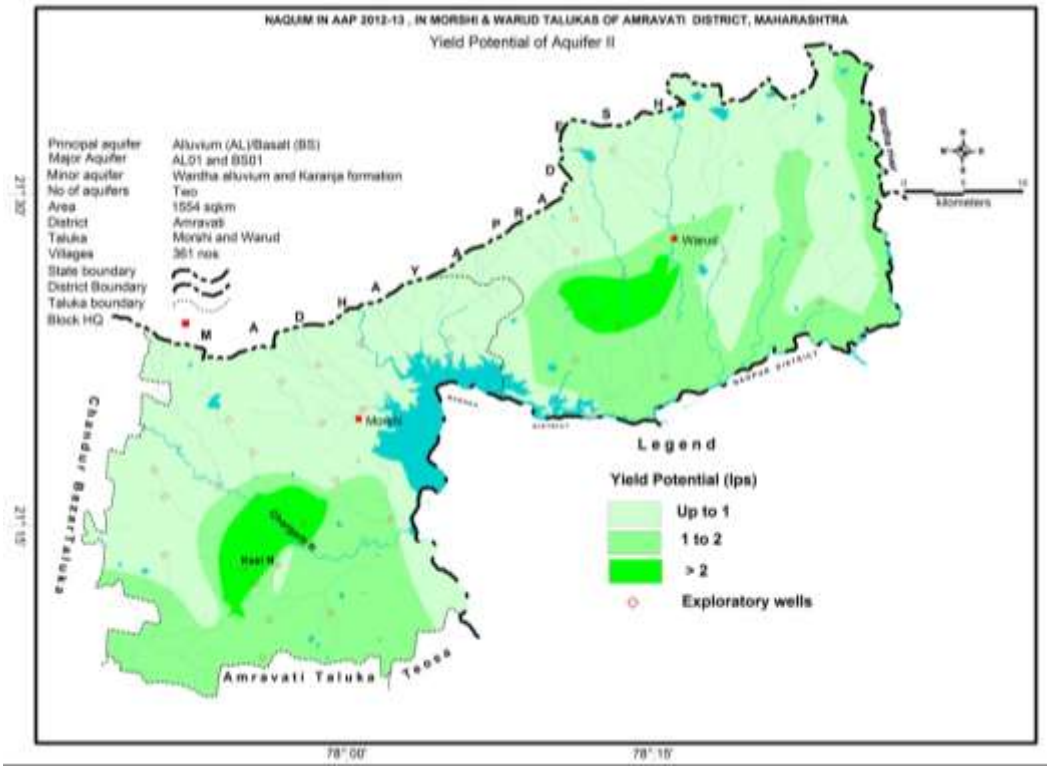


Fig. 3.26: Aquifer-II (deeper), Yield potential, Warud and Morshi taluka, Amravati district

The cumulative aquifer group thickness map consisting of Aquifer-I and II has been prepared and presented as **Fig. 3.27**.

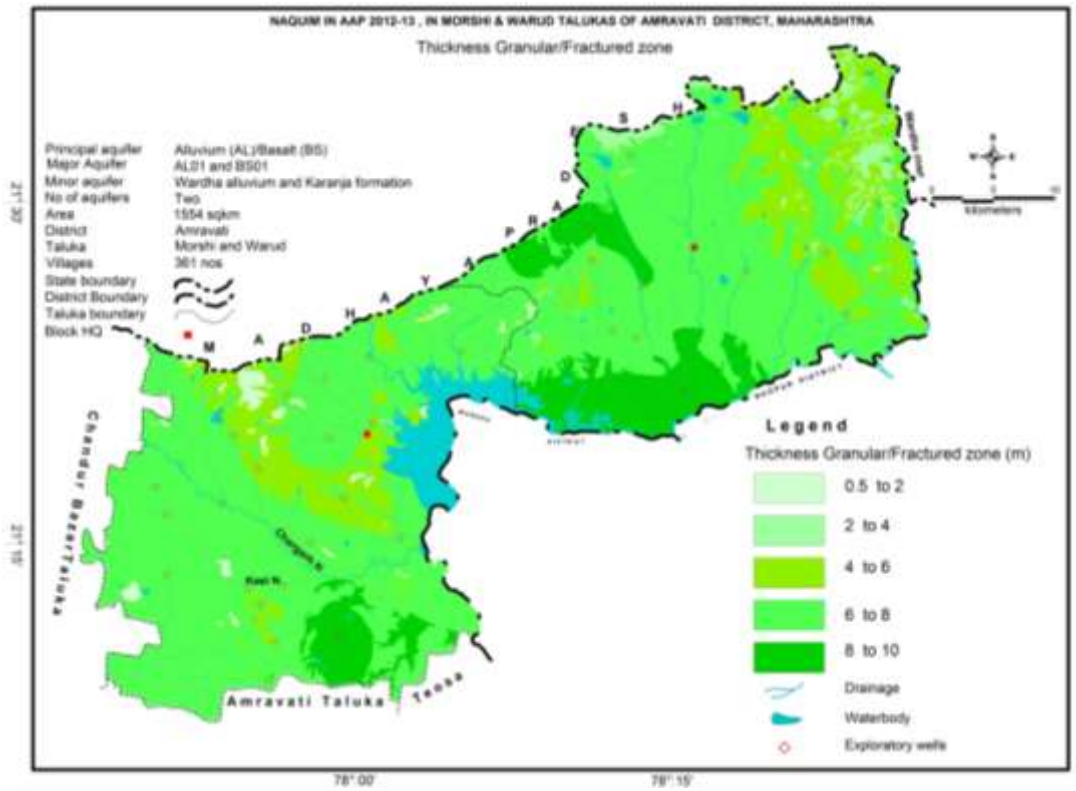


Fig. 3.27: Aquifer group thickness of I and II (fractured rock thickness), Warud and Morshi taluka, Amravati district

4 Ground Water Resources

The ground water resources have been assessed for three types of aquifer existing in the area i.e., Aquifer-I and Aquifer-II. 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** and **4.2** 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 1,55,449 ha area, total recharge worthy areas is 1,38,638 ha including 6689 ha command areas and 1,31,949 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)
Warud	Basalt	74544.00	6012.00	3219.00	65313.00
Morshi	Basalt	80905.00	10799.00	3470.00	66636.00
Total		155449	16811	6689	131949

4.1.1 Recharge Parameters

During 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, S_y = specific yield

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

The specific yield value as estimated from dry season balance method or field studies was taken, wherever available. In absence of field values of specific yield values through above methods recommended values as per GEC-1997 norms has been taken. The specific yield value for Deccan Traps - 0.002 to 0.03. Here, the value for Specific yield is taken as 0.02.

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 recharge from rainfall, 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-monsoon recharge. As the area is occupied by Deccan traps, the factor is taken as 0.07 to 0.14 depending on the formation, which is weathered basalt and vesicular jointed basalt. The details of Recharge parameters are given in **Table 4.2.** It is estimated that the *recharge from rainfall during monsoon season* is 12890.74 ham while it is 1099.40 during non-monsoon. Considering the *natural discharges* of 1182.25 ham, net *ground water availability* estimated as 22462.72 ham.

Table 4.2: Recharge components evaluated Ground Water Resources Estimation

Taluka	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)
Warud	Command	403.24	151.26	41.85	1020.99	1617.33	80.87	1536.46
	Non Command	6689.40	978.20	828.83	2978.84	11475.27	573.76	10901.51
	Total	7092.64	1129.46	870.68	3999.83	13092.60	654.63	12437.97
Morshi	Command	286.83	36.06	17.22	1395.99	1736.09	86.80	1649.29
	Non Command	5511.27	926.11	211.50	2167.39	8816.28	440.81	8375.46
	Total	5798.10	962.17	228.72	3563.38	10552.37	527.62	10024.75
Area Total		12890.74	2091.63	1099.4	7563.21	23644.97	1182.25	22462.72

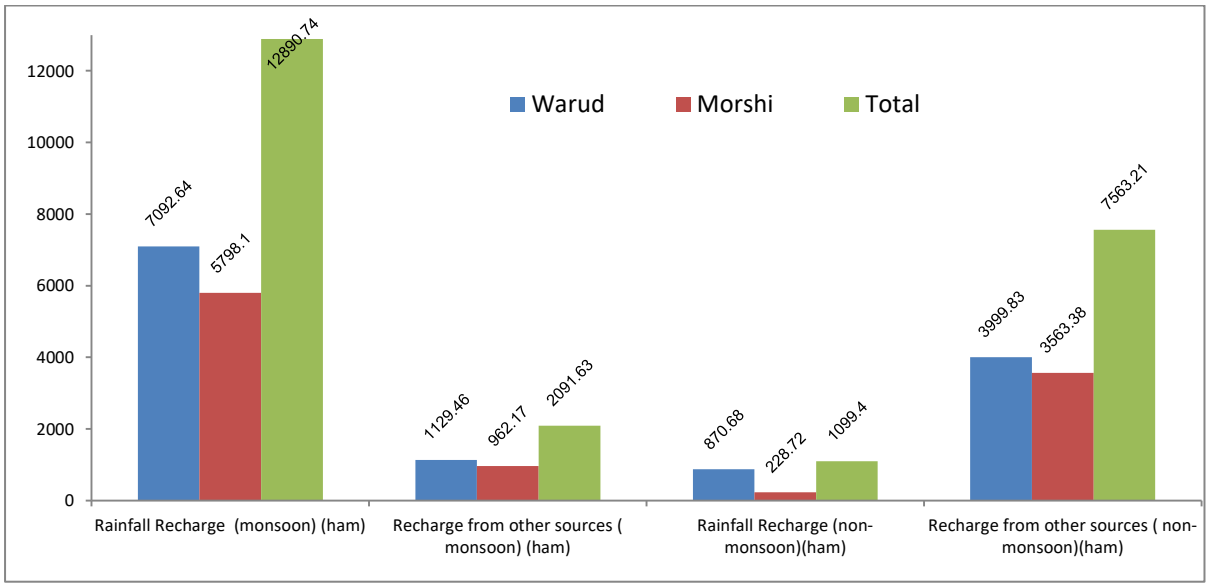


Fig.4.1: Season wise recharge from various sources, Warud and Morshi taluka, Amravati district

4.1.2 Other Parameters

The discharge parameters include natural discharge in the form of springs and base flow and discharge for ground water irrigation, domestic and industrial draft. The net annual ground water availability comes to be 22,462.71 ham. The annual gross draft for all uses is estimated at 24,452.09 ham with irrigation sector being the major consumer having a draft of 23,869.15 ham. The annual draft for domestic and industrial uses was 582.94 ham. The allocation for domestic & industrial requirement supply up to 2025 years is about 740.47 ham (Table 4.3). The stage of ground water development of Warud and Morshi taluka is 122.79 % and 91.57 % respectively (Fig.4.2). As the stage of ground water development is 122.79 % and there is significant decline in ground water level trend noticed and hence, Warud taluka is categorised as 'Over exploited' while the Morshi taluka is categorised as 'Semi-critical' where only pre-monsoon ground water level trend is showing significant decline. The details of ground water resources are given in **Table 4.3.**

Table 4.3 Ground water resources, Aquifer-I (Shallow, weathered/jointed Basalt), Warud and Morshi taluka (2013)

Taluka	Command/Non-command	Net Annual Ground Water Availability	Existing Gross Ground Water Draft for irrigation	Existing Gross Ground Water Draft for domestic and industrial water supply	Existing Gross Ground Water Draft for All uses	Provision for domestic and industrial requirement supply to 2025	Net Ground Water Availability for future irrigation development	Stage of Ground Water Development (%)/Category
Warud	Command	1536.46	2374.71	83.48	2458.19	269.27	0.00	122.79/Over exploited
	Non Command	10901.51	12629.74	184.57	12814.31			
	Total	12437.97	15004.45	268.05	15272.50			
Morshi	Command	1649.29	552.39	43.69	596.08	471.20	1556.33	91.57/semi-critical
	Non Command	8375.46	8312.30	271.21	8583.51			
	Total	10024.75	8864.70	314.89	9179.59			
Area total		22462.72	23869.15	582.94	24452.09	740.47	1556.33	

4.2 Ground Water Resources – Aquifer-II

The ground water resource of the Aquifer – II (Basalt) was also estimated to have the corret quantification of resources so that proper management strategy can be framed.

To assess these resources of Aquifer-II (Basalt), the area was divided into 11 polygons (5 in Morshi & 6 in Warud) based on fractured rock thickness occurring below water level and the thickness of Aquifer –II 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 CGWB, 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 was estimated and presented below in **Table- 4.4**. In Warud and Morshi taluka, Aquifer-II has 20.56 MCM & 13.02 MCM of ground water resources are available. Thus, the total resources of Aquifer-II has been estimated as 33.58 MCM.

Table 4.4: Ground Water Resources of Aquifer-II (Deep, fractured basalt)

SN	Mean thickness of fractured rocks	Taluka	Area(Sqkm)	Storativity	GW resource of AQII (MCM)
1	1.25	Morshi	189.279	0.006	1.419593
2	2.5	Morshi	345.282	0.006	5.17923
3	3.5	Morshi	188.443	0.006	3.957303
4	4.5	Morshi	57.8945	0.006	1.563152
5	5.5	Morshi	27.3387	0.006	0.902177
	Taluka Total				13.02145
6	1.25	Warud	251.691	0.0097	3.051753
7	2.5	Warud	205.09	0.0097	4.973433
8	3.5	Warud	130.07	0.0097	4.415877
9	4.5	Warud	76.6903	0.0097	3.347532
10	5.5	Warud	36.9286	0.0097	1.970141
11	6.5	Warud	44.5256	0.0097	2.807339
	Taluka Total				20.56607
	Grand total				33.58753

5 GROUND WATER RELATED ISSUES

The Warud and Morshi talukas are the part of famous 'Orange belt' of Vidarbha region of Maharashtra. It is famous for orange/sweet lime cultivation. Over the period of years the ground water is being exploited for cultivation of oranges/sweet lime. Due to which, the ground water development has been drastically raised. On the contrary, the area shows rise in water levels due to many reasons like assured rainfall region, construction of water conservation structures by various government agencies & NGOs, micro irrigation practices adopted by the farmers etc. The stage of ground water development is 122.79 % and there is significant decline in ground water level trend is noticed and hence, Warud taluka is categorised as 'Over exploited'. While in the Morshi taluka, stage of ground water development is 91.57 % and categorised as 'Semi-critical' where only pre-monsoon ground water level trend is showing significant decline. 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 identified in Warud and Morshi Talukas are over-exploitation, declining water levels, limited aquifer potential and water scarcity during lean period. The major issues afflicting the areas are discussed below

5.1 Orange/Sweet lime Cultivation as a Cash Crop

The cultivation of cash crop orange/sweet lime is wide spread and covers an area of about 114 sq.km.'s and entire cultivation is ground water based drip irrigation (**Fig. 5.1**). Depending upon the water availability, farmers used to change the crops from orange to sweet lime and visa-vies. Further scope for WUE is minimal in Orange, but scope exists for other crops.

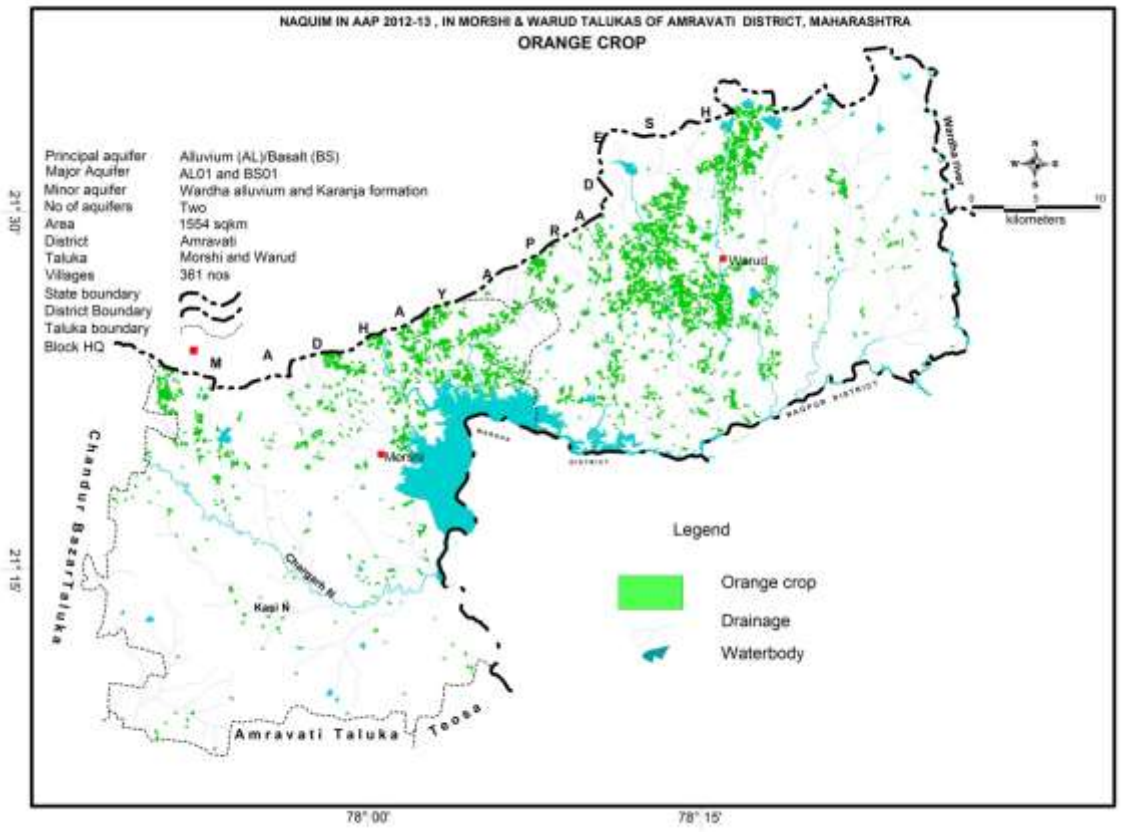


Fig. 5.1: Orange/Sweet lime cultivation, Warud and Morshi taluka, Amravati district

An orange orchard is irrigated at an interval of 10-15 days during winter months whereas during summer months it is irrigated at an interval of 5-7 days. Water requirement of citrus trees are generally higher than most of the other sub-tropical fruits due to recurrent growth and development. The water requirement varies from 900 to 1100 mm per year depending upon the location. Water requirement of young (1-4 years old), middle (5-8 years old) and mature (9 and more) Nagpur orange/sweet lime trees varies from 5 to 15 litres/day, 35 to 105 litres/day and 60 to 170 litres/day respectively. *Mrig* crop (monsoon blossom) which matures in February-March has great potential for export since arrivals of orange/sweet lime fruit in international market are very less during this period. It is observed that, to meet the demand of ground water of orange/sweet lime cultivation, farmers were stared drilling more and more irrigation wells over the period.

5.2 Over Exploitation of Ground Water

The stage of ground water development has changed over the period of time from 2008 to 2013 from 140.21 % to 122.79 % in Warud taluka and from 112.73 % to 91.57 % in Morshi taluka (**Fig. 5.2**). The stage of ground water development in Warud taluka is fluctuating and show rise from 2011 to 2013 indicating that alarming situation will be arise if necessary precautions will not be taken at this time. The decline in stage of development in 2011 as compare to 2004 is may be due to significant number of water conservation structures constructed by various Central/State/NGO agencies in both Warud and Morshi talukas. One of the main reasons for ground water excessive draft is for irrigation purpose (**Fig. 5.3**). The draft has increased in 2013 as compare to 2011. Also, the gap between the availability of ground water and draft is increasing over the period from 2011 to 2013. In both the talukas, it is to notice that ground water draft is more than availability of ground water (**Fig. 5.4**).

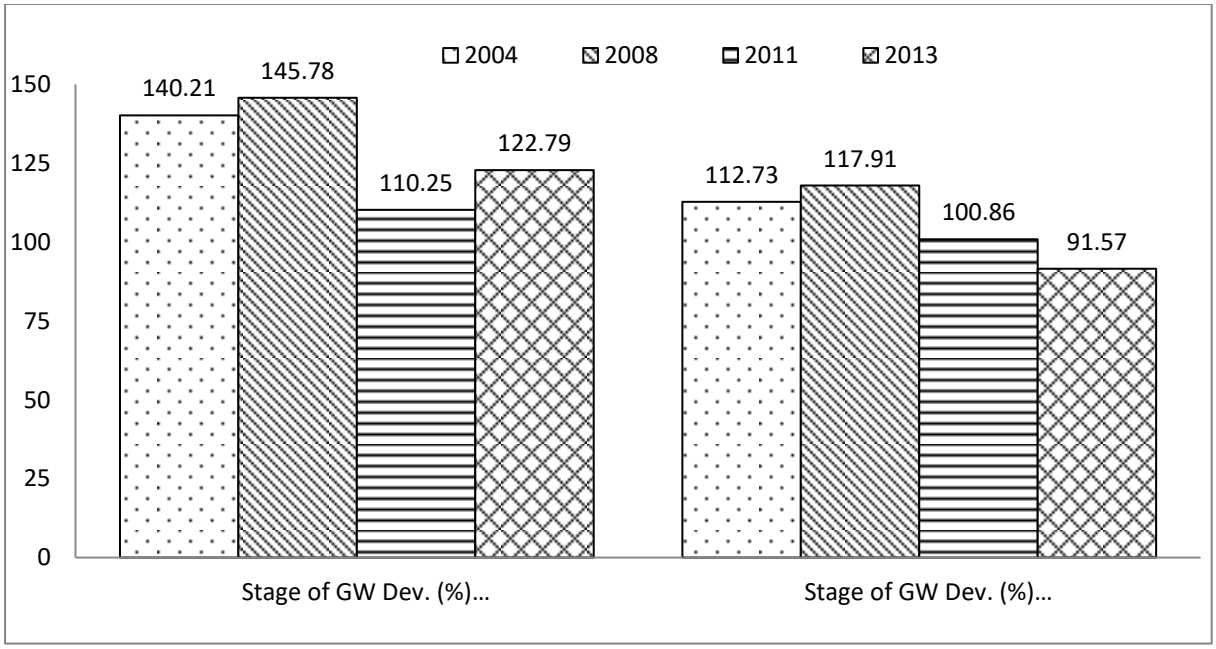


Fig. 5.2: Change in stage of ground water development, Warud and Morshi taluka, Amravati district

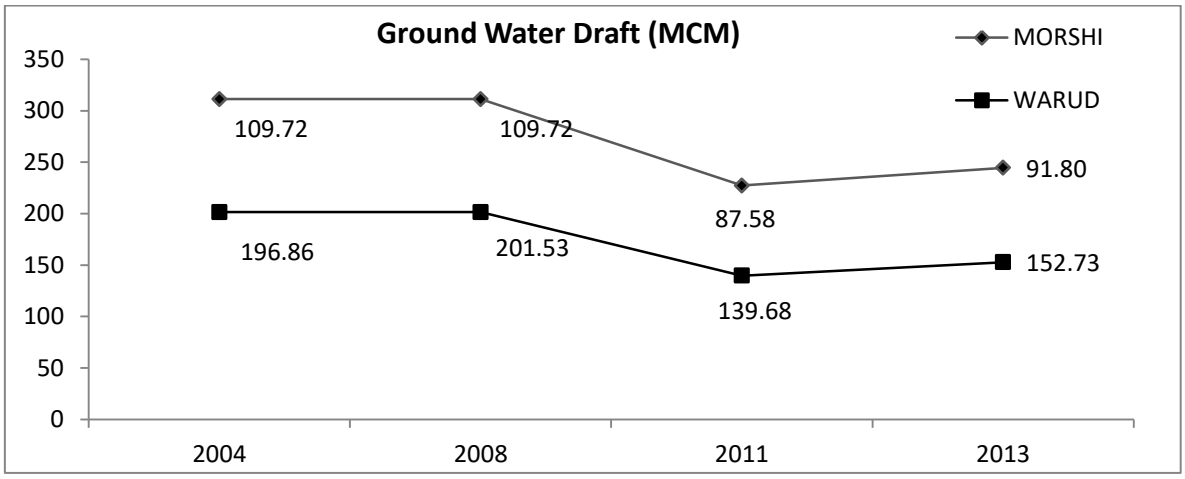


Fig. 5.3: Change in ground water draft, Warud and Morshi taluka, Amravati district

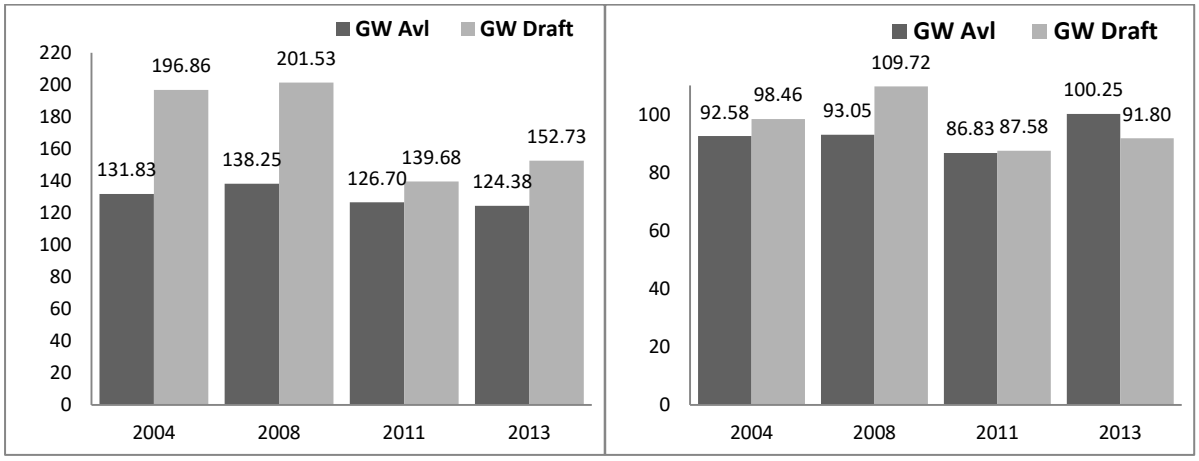


Fig. 5.4: Ground water availability and draft, Warud and Morshi taluka, Amravati district

5.3 Limited Aquifer thickness and Water scarcity

During the extensive fieldwork, micro-level hydrogeological surveys have been carried out covering entire area. It is observed that the thickness of aquifer both Aquifer-I and II has limited aquifer thickness i.e., and upto 4 m in Aquifer-I, upto 7 m in Aquifer-II (**Fig. 3.23 and 3.25**). Due to which aquifer get saturated for very less period. Hence, entire area is facing drinking and domestic water scarcity during the lean period from March to June.

5.4 Traditional and Micro Irrigation Techniques

Micro Irrigation practices, like drip and sprinkler irrigation, are being practiced in the area since last decade or so. The ground water based drip irrigation system is preferred in the area to obtain maximum yield of the cash crop like orange/sweet lime.



The ground water is the most dependable source of water supply at the time of crop requirement. Although, the facilities for drip irrigation are exists but the farmers are still prefer to irrigate the orange orchards by traditional flood irrigation method, which causes undue feeding of ground water. This is because of irregular electricity supply, high maintenance cost of drip/sprinkler system, etc.

The year wise daily water requirement for an orange tree (in lit per day per tree) upto 10 years by applying drip technology is presented in the **Table 5.1, Fig. 5.5** and **5.6**. It has been observed that using drip irrigation, the average rate of water utilization for irrigation is about 87 litre/day/tree showing progressive rise with maximum utilization during the months of March, April, May and June (PKV, 2009).

Table 5.1: Daily month wise water requirement (lit per day per tree) for an orange tree upto 10 years by drip irrigation (after PKV, 2009)

Year	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec	Total
1	--	--	--	--	--	37	19	14	17	18	19	17	141
2	22	31	41	57	71	50	26	20	24	25	25	22	414
3	27	37	50	69	85	59	30	24	28	32	29	26	496
4	38	51	71	98	120	72	37	29	34	39	35	32	656
5	40	54	75	103	127	76	39	30	36	41	37	33	691
6	43	59	82	113	139	83	42	33	39	45	41	37	756
7	46	62	86	118	145	86	44	35	41	47	42	38	790
8	49	67	93	128	157	94	48	37	44	50	46	41	854
9	55	77	103	142	175	105	53	42	49	56	51	46	954
10	61	84	116	159	196	117	60	47	55	63	57	52	1067

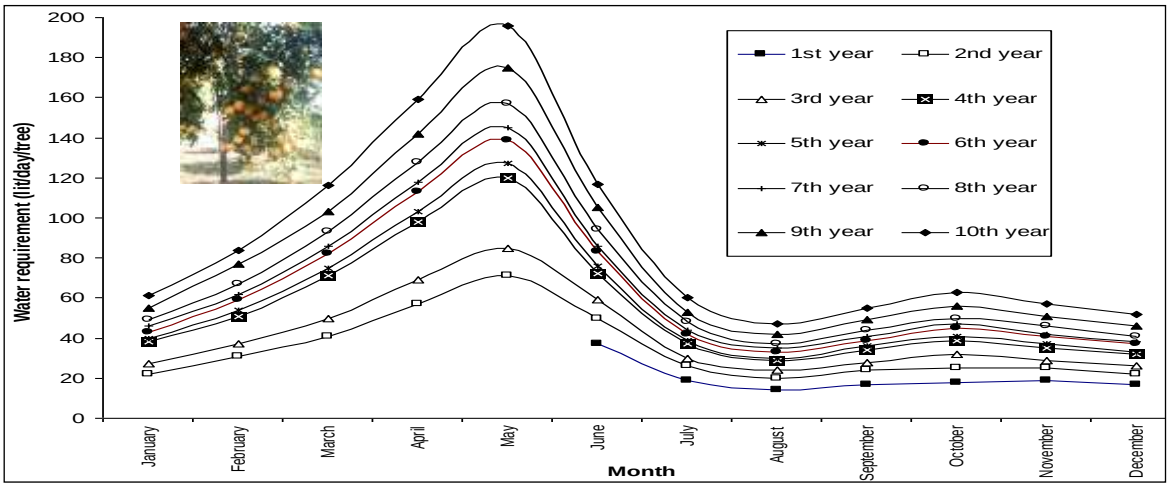


Fig. 5.5: Daily month wise water requirement for an orange tree (after PKV, 2009)

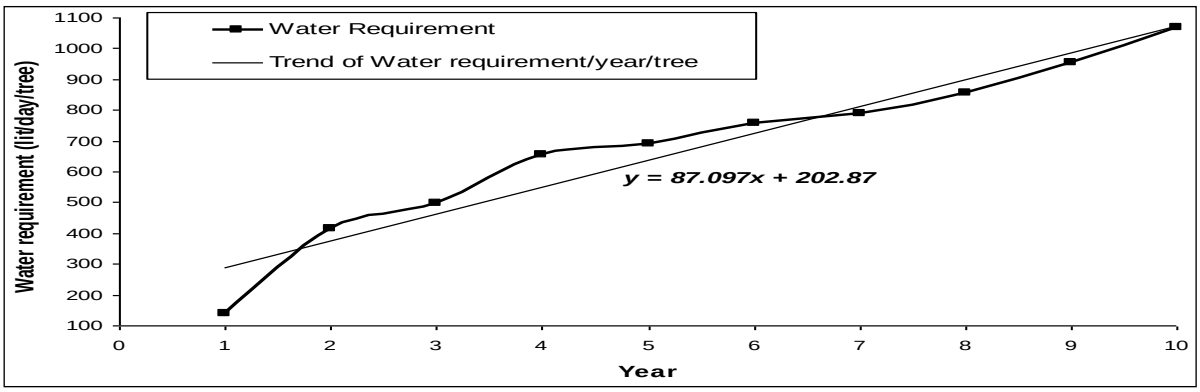


Fig. 5.6: Year wise water requirement for an orange tree (after PKV, 2009)

As per the data provided by Agriculture Dept. Govt. of Maharashtra, total irrigated area is 219.21 sq. km (132.45 sq km in Warud and 86.76 sq km in Morshi taluka). While total area irrigated by ground water based drip irrigation is 87.27 sq km (47.80 in Warud and 39.47 sq km in Morshi taluka). Thus, there is further scope of implementing the water use efficiency measures by drip/sprinkler to save or manage the ground water resources in the area.

6 MANAGEMENT STRATEGIES

Warud and Morshi taluka has ample of ground water potential apart from the small surface water resources for irrigation. It is observed that the farmers are facing problem due to non-availability of required quantum of ground water during the lean/scarcity period. To tackle these issues, a management plan has been formulated considering the availability of non-committed surface runoff, scope for artificial recharge to ground water, desilting of water bodies etc. Thus, 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. For this exercise ground water resources estimated during the study period was considered. The taluka/block wise sustainable management plan have been suggested for these 2 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 Warud and Morshi talukas of Amravati district and is presented in **Table 8.1**.

6.1 Aquifer Management Plan for Warud Taluka

The geographical area of Warud Taluka is 745 sq. km., as per ground water resources estimation 2011, the stage of ground water development is **110.32 %** and categorised as over-exploited. The annual ground water resource available is 126.69 MCM and the gross ground water draft for all uses is 139.76 MCM including 137.07 MCM for irrigation and 2.69 MCM for domestic sector. The major issues identified in Warud Taluka are over exploitation of ground water, high stage of ground water development, limited aquifer potential, and water scarcity during lean period.

The Agricultural **demand** in rainfed area is worked out as 190.38 MCM. The agricultural demand from ground water is 169.5 MCM and while no demand for surface water. Whereas, the domestic demand for ground water and surface water is 2.02 and 0.67 MCM. The Agricultural **supply** in rainfed area is 190.38 MCM due to monsoon. The agricultural supply from ground water is 139.76 MCM, while its nil from surface water. Whereas, the domestic supply for ground water and surface water is 2.02 and 0.67 MCM. Hence, there is a gap of 29.74 MCM in Demand-Supply side. To bring the stage of ground water development upto 70 % it is estimated that about 56.66 MCM of water is required to recharge.

Supply side interventions proposed to tackle above said major issues through rainwater harvesting and artificial recharge. The volume of unsaturated granular zone available in Warud taluka is worked out as 1386.23 MCM. The volume of water required for recharge the area is 27.72 MCM. The surface surplus non-committed runoff availability is 16.45 MCM, which is considering for planning. For this, a total of 65 percolation tank and 115 Check dams are required as recharge measures. The volume of water expected to be conserved/recharged @75% efficiency is 9.75 MCM through Percolation tank and 2.59 MCM through Check dams. The cost estimate for 60 percolation tank and 148 check dams are Rs. 97.50 crore and Rs. 34.50 crore respectively. The location of artificial recharge structures proposed are given in **Annexure XI, XII and XIII** and shown in **Fig 6.1.**

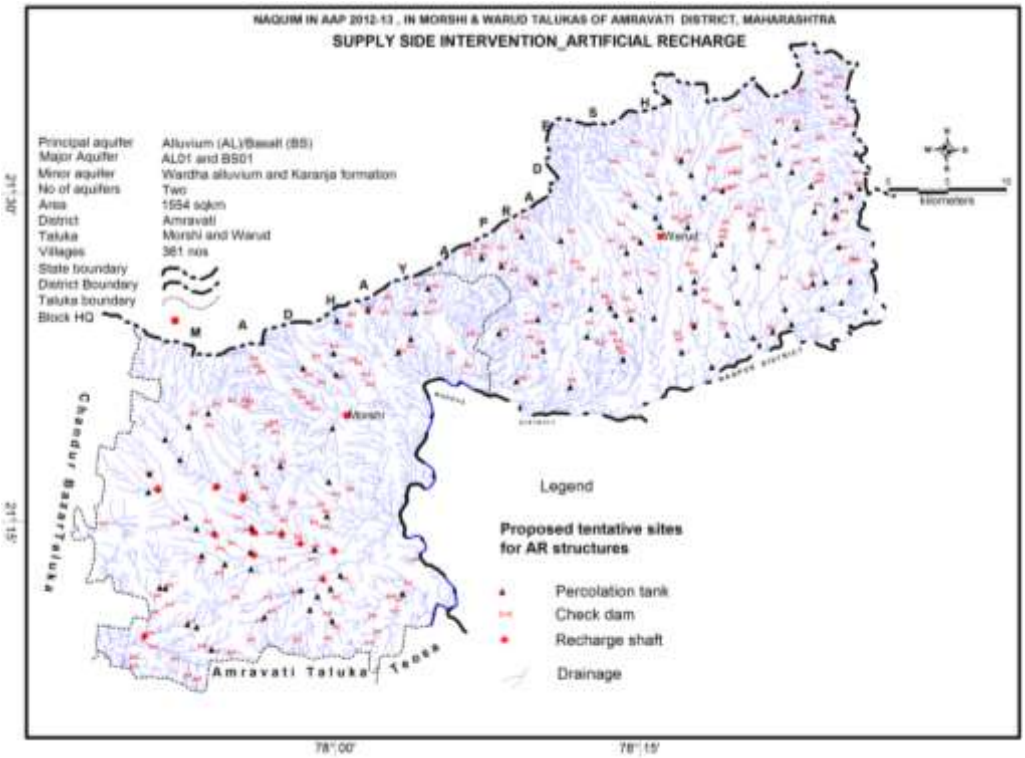


Fig. 6.1- Supply side intervention -proposed Artificial Recharge Structures, Warud and Morshi taluka, Amravati district

The rainwater harvesting in urban areas can be adopted in 25% of the household with 50 Sq. m roof area. A total of 0.37 MCM potential can be generated by taking 80% runoff coefficient. The estimated cost for rainwater harvesting through rooftop is calculated as Rs. 19.47 crore. Hence, this technique is not economically viable and therefore it is not recommended.

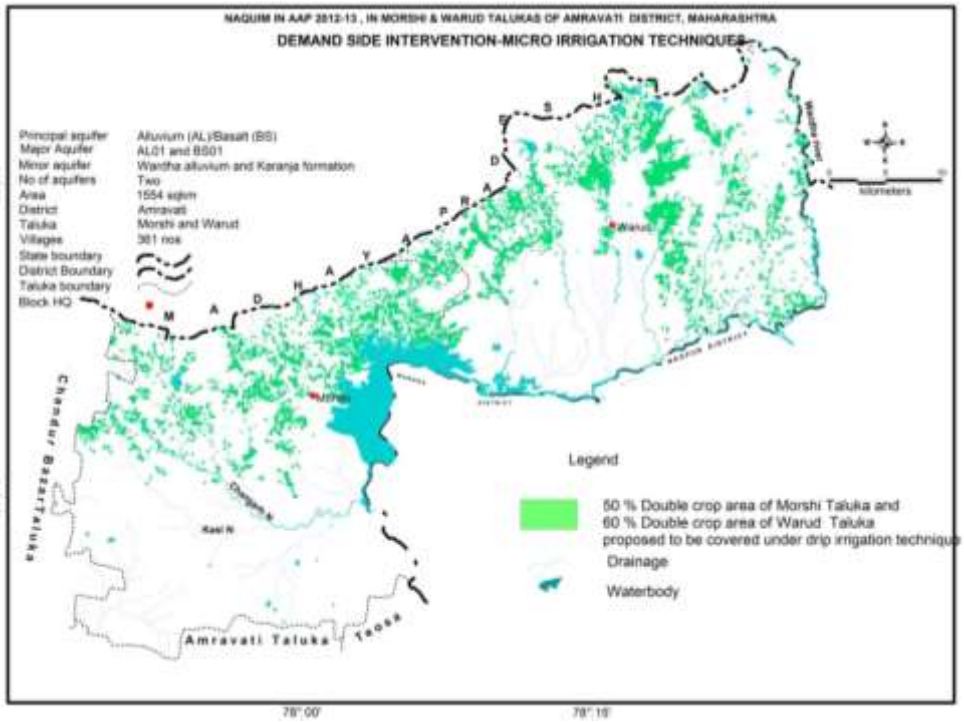


Fig. 6.2a- Demand side intervention- area proposed to be covered under drip irrigation, Warud and Morshi taluka, Amravati district

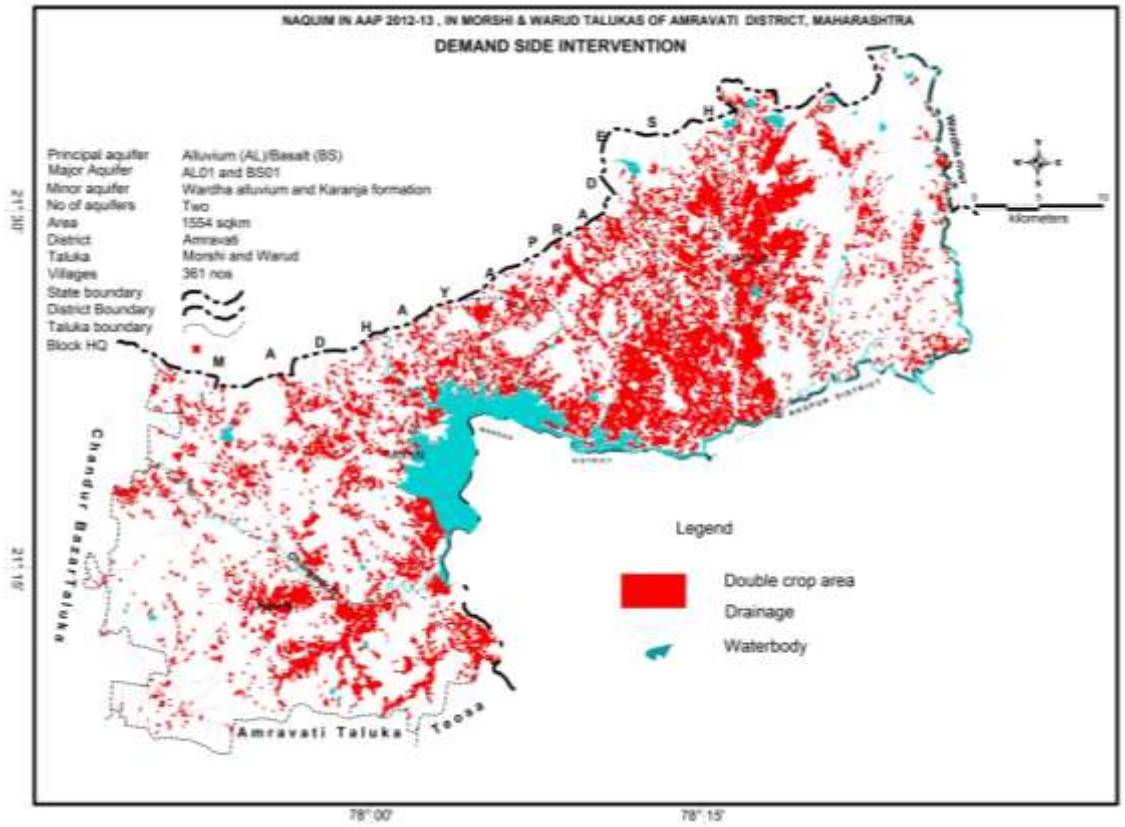


Fig. 6.2b- Demand side intervention- double cropped area, Warud and Morshi taluka, Amravati district

Overall total volume of water expected to be recharged or conserved by artificial recharge is 12.34 MCM with a cost estimate of Rs. 132 crore, 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 orange/sweet lime cultivation drives the economy of the region. However, as discussed earlier, there is a scope for increasing areas under micro-irrigation techniques like drip irrigation. About 60% of double crop area (i.e. 204.56 sq km) is proposed to be covered under drip irrigation i.e., about 122.74 sq km (**Fig. 6.2 a and b**). Due to which about 49.09 MCM water is expected to be saved (water req for Surface Flooding 0.90 m., Drip 0.50 = saving 0.4 m). The expenditure of Rs. 75.82 Crore is expected considering Rs. 25,000/- per acre, towards the implementation of micro-irrigation in Warud Taluka.

Thus, following benefits are expected, after implementation of above said Aquifer Management Plan in Warud taluka.

1. Additional ground water resources available after implementing above measures is 4.77 MCM and mitigating the gap to bring stage of ground water development upto 70% or about 61.42 MCM of additional ground water resources available after implementing above measures with current stage of ground water development.
2. About 7.34 sq km additional area will be covered under assured irrigation after implementation of artificial recharge to ground water with estimated expenditure of Rs. 132 crore.
3. About 122.74 sq km additional area will be covered under assured irrigation after implementation of micro irrigational techniques.
4. There will be rise in water level at a rate of about 4.12 m/year in the area.
5. About 13.07 MCM of water expected to be saved as ground water draft above 100% is taking place from deeper aquifer.

Apart from this, it is propose to impose ground water regulatory measures like banning the bore well drilling down to 60 m bgl for irrigation purpose.

Table 8.1: Aquifer Management Plan of Warud and Morshi Taluka, Amravati district

Items	Taluka / Block Warud			Taluka / Block Morshi			Total
District	Amravati		District	Amravati			
State	Maharashtra		State	Maharashtra			
Area	745		Area	809			1554
Major Issues Identified	Over - Exploitation Declining WL Limited Aquifer Potential Water Scarcity - lean period		Major Issues Identified	Over - Exploitation Declining WL Limited Aquifer Potential Water Scarcity - lean period			
Stage of GW Development	110.32%		Stage of GW Development	101.26%			
Annual Available Resource (MCM)	126.69	183.35	Annual Available Resource (MCM)	86.83			213.52
Gross Annual Draft (MCM)	139.76	0.76	Gross Annual Draft (MCM)	87.92			227.68
Domestic Requirements (MCM)	2.69	72.96714286	Domestic Requirements (MCM)	4.71			7.40
DEMAND (MCM)		0.7	**DEMAND (MCM)**				
Agricultural demand - Rainfed	190.38		Agricultural demand - Rainfed	210.02			400.40
Agricultural demand -GW	169.5		Agricultural demand -GW	103.63			273.13
Agricultural demand -SW	0.00		Agricultural demand -SW	63.03			63.03
Domestic demand - GW	2.02		Domestic demand - GW	3.53			5.55
Domestic demand - SW	0.67		Domestic demand - SW	1.18			1.85
Total Demand(mcm)	**362.57**		**Total Demand(mcm)**	**381.39**			743.96
SUPPLY (MCM)			**SUPPLY (MCM)**				
Agricultural Supply -Rainfed	190.38		Agricultural Supply -Rainfed	210.02			400.40
Agricultural Supply -GW	139.76		Agricultural Supply -GW	87.92			227.68
Agricultural Supply -SW	0.00		Agricultural Supply -SW	63.03			63.03
Domestic Supply - GW	2.02		Domestic Supply - GW	3.53			5.55
Domestic Supply - SW	0.67		Domestic Supply - SW	1.18			1.85
Total supply(mcm)	**332.83**		**Total supply(mcm)**	**365.68**			698.51
DEMAND - SUPPLY GAP (MCM)	**29.74**		**DEMAND - SUPPLY GAP (MCM)**	**15.71**			45.45
Gap met from Existing Micro Irrigation Techniques in entire orange cropped area of 73.57 sq.km. @ WUE 0.4 m	29.43		Gap met from Existing Micro Irrigation Techniques in entire orange cropped area of 38.75 sq.km. @ WUE 0.4 m	**15.50**			44.93
PRESENT DEMAND - SUPPLY GAP	**0.31**		**PRESENT DEMAND - SUPPLY GAP**	**0.21**			0.52

Items	Taluka / Block Warud			Taluka / Block Morshi			Total
(MCM)			**(MCM)**				
GAP TO BRING STAGE OF GWD UPTO 70%	**56.35**		**GAP TO BRING STAGE OF GWD UPTO 70%**	**27.73**			84.08
TOTAL GAP TO BRING STAGE OF GWD UPTO 70%	**56.66**		**TOTAL GAP TO BRING STAGE OF GWD UPTO 70%**	**27.94**			84.60
Interventions proposed to deal with overexploitation			**Interventions proposed to deal with overexploitation**				
SUPPLY SIDE INTERVENTIONS			**SUPPLY SIDE INTERVENTIONS**				
Rainwater Harvesting and Artificial Recharge			**Rainwater Harvesting and Artificial Recharge**				
Volume of unsaturated granular zone (MCM)	1386.23		Volume of unsaturated granular zone (MCM)	1178.52			2564.75
Recharge Potential (MCM)	27.72		Recharge Potential (MCM)	82.50			110.22
Surface water requirement @ 75% efficiency (MCM)	36.97		Surface water requirement @ 75% efficiency (MCM)	110.00			146.97
Availability of Surplus surface runoff (MCM)	16.45		Availability of Surplus surface runoff (MCM)	13.80			30.25
Surplus runoff considered for planning (MCM) @ 100%	16.45	12.34	Surplus runoff considered for planning (MCM) @ 100%	13.80	10.35		30.25
Proposed Structures	Percolation Tank (@ Rs.150 lakh, Av. Gross Capacity-100 TCM*2 fillings = 200 TCM)	Check Dam (@ Rs.30 lakh, Av. Gross Capacity-10 TCM * 3 fillings = 30 TCM)	Proposed Structures	Percolation Tank (@ Rs.150 lakh, Av. Gross Capacity-100 TCM*2 fillings = 200 TCM)	Check Dam (@ Rs.30 lakh, Av. Gross Capacity-10 TCM * 3 fillings = 30 TCM)	Recharge Shaft (@ Rs.2.5 lakh, Av. Gross Capacity-60 TCM)	
Number of Structures	65	115	Number of Structures	50	105	11	**346.00**
Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	9.75	2.59	Volume of Water expected to be conserved / recharged @ 75% efficiency (MCM)	7.50	2.36	0.50	**22.70**
Estimated Expenditure (Rs. in Cr.)	97.50	34.50	Estimated Expenditure (Rs. in Cr.)	75.00	31.50	0.28	**238.78**
RTRWH - Urban Areas			**RTRWH - Urban Areas**				
Households to be covered (25% with 50 m2 area)	12982		Households to be covered (25% with 50 m2 considering	10614			23595.25

Items	Taluka / Block Warud			Taluka / Block Morshi			Total
			roof top area)				
Total RWH potential (MCM)	0.37		Total RWH potential (MCM)	0.27			0.64
Rainwater harvested / recharged @ 80% runoff co-efficient	0.29		Rainwater harvested / recharged @ 80% runoff co-efficient	0.22			0.51
Estimated Expenditure (Rs. in Cr.) @ Rs. 15000/- per HH	19.47	**Economically not viable & Not Recommended**	Estimated Expenditure (Rs. in Cr.) @ Rs. 15000/- per HH	15.92	**Economically not viable & Not Recommended**		35.39
Total volume of water expected to be recharged/conserved by AR	12.34		**Total volume of water expected to be recharged/conserved by AR**	10.36			22.70
Total Estimated Expn. For AR	132.00		**Total Estimated Expn. For AR**	106.78			238.78
DEMAND SIDE INTERVENTIONS			**DEMAND SIDE INTERVENTIONS**				
Proposed Cropping Pattern change	None		Proposed Cropping Pattern change	None			
Area proposed to be covered (sq.km.)	-		Area proposed to be covered (sq.km.) 40% of sugarcane area	-			
Volume of Water expected to be conserved (MCM)	-		Volume of Water expected to be conserved (MCM). Sugarcane requirement - 2.45 m, Pomegranate with Drip - 0.7 m, WUE - 1.75 m	-			
Estimated Expenditure	-		Estimated Expenditure	-			
Micro irrigation techniques			**Micro irrigation techniques**				
60% of Double crop area (204.56) proposed to be covered under Drip (sq.km.)	122.736		50% of Double crop area (124.22) proposed to be covered under Drip (sq.km.)	62.11			184.85
Volume of Water expected to be saved (MCM). Surface Flooding req- 0.90 m. Drip Req. - 0.50, WUE- 0.4 m	49.09		Volume of Water expected to be saved (MCM). Surface Flooding req- 0.90 m. Drip Req. - 0.50, WUE- 0.4 m	24.84			73.94
Estimated Expenditure (Rs. in Cr.) @ Rs. 25,000/- per acre	75.82		Estimated Expenditure (Rs. in Cr.) @ Rs. 25,000/- per acre	38.37			114.19

Items	Taluka / Block Warud			Taluka / Block Morshi			Total
Alternate Sources			**Alternate Sources**				
Alternative ground water sources	Nil		Alternative ground water sources	Nil	Nil		
Location and other details of the sources	Nil		Location and other details of the sources	Nil	Nil		
Volume of Water expected to be served from these sources	Nil		Volume of Water expected to be served from these sources	Nil	Nil		
Alternative surface water sources	Nil		Alternative surface water sources				
Additional GW resources available after implementing above measures (MCM) and mitigating the GAP TO BRING STAGE OF GWD UPTO 70% OR	4.77		**Additional GW resources available after implementing above measures (MCM) and mitigating the GAP TO BRING STAGE OF GWD UPTO 70% OR**	7.26			12.03
Additional GW resources available after implementing above measures WITH CURRENT STAGE OF GW DEVELOPMENT AND	61.43		**Additional GW resources available after implementing above measures WITH CURRENT STAGE OF GW DEVELOPMENT AND**	35.20			96.63
Additional Area (sq.km.) proposed to be brought under assured GW irrigation with av. CWR of 0.65 m OR	7.34		**Additional Area (sq.km.) proposed to be brought under assured GW irrigation with av. CWR of 0.65 m OR**	11.17			18.51
Rise in WL (m/yr)	**4.12**		**Rise in WL (m/yr)**	**2.36**			
Regulatory Measures	**Regulation of wells below 60 m**		**Regulatory Measures**	**Regulation of wells below 60 m**			
Volume of Water expected to be saved (MCM) since GW draft above 100% is taking place from deeper aquifer	13.07		Volume of Water expected to be saved (MCM) since GW draft above 100% is taking place from deeper aquifer	1.09			14.16

6.2 Aquifer Management Plan for Morshi Taluka

The geographical area of Morshi Taluka is 809 sq. km., as per ground water resources estimation 2011, the stage of ground water development is **101.26 %** and categorised as over-exploited. The annual ground water resource available is 86.93 MCM and the gross ground water draft for all uses is 87.92 MCM including 83.21 MCM for irrigation and 4.71 MCM for domestic

sector. The major issues identified in Morshi Taluka are over exploitation of ground water, high stage of ground water development, limited aquifer potential, and water scarcity during lean period.

The Agricultural **demand** in rainfed area is worked out as 210.02 MCM. The agricultural demand from ground water is 103.63 MCM and while demand from surface water is 63.03 MCM. Whereas, the domestic demand for ground water and surface water is 3.03 and 1.18 MCM. The Agricultural **supply** in rainfed area is 210.02 MCM due to monsoon. The agricultural supply from ground water is 139.76 MCM, and while demand from surface water is 63.03 MCM. Whereas, the domestic supply for ground water and surface water is 3.53 and 1.18 MCM. Hence, there is a gap of 15.71 MCM in Demand-Supply side. To bring the stage of ground water development upto 70 % it is estimated that about 27.94 MCM of water is required to recharge.

Supply side interventions proposed to tackle above said major issues through rainwater harvesting and artificial recharge. The volume of unsaturated granular zone available in Morshi taluka is worked out as 1178.52 MCM. The volume of water required for recharge the area is 82.50 MCM. The surface surplus non-committed runoff availability is 13.80 MCM, which is considering for planning. For this, a total of 50 percolation tank, 105 Check dams and 11 recharge shafts are required as recharge measures. The volume of water expected to be conserved/recharged @75% efficiency is 7.5 MCM through Percolation tank, 2.36 MCM through Check dams and 0.50 MCM through recharge shaft. The cost estimate for 50 percolation tank, 112 check dams and 7 recharge shafts are Rs. 75 crore, Rs. 31.50 crore and 0.28 crore respectively. The location of artificial recharge structures proposed are given in **Annexure XI, XII and XIII** and shown in **Fig 6.1.**

The rainwater harvesting in urban areas can be adopted in 25% of the household with 50 Sq. m roof area. A total of 0.27 MCM potential can be generated by taking 80% runoff coefficient. The estimated cost for rainwater harvesting through rooftop is calculated as Rs. 15.92 crore. 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 10.35 MCM with a cost estimate of Rs. 106.78 crore, 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 orange/sweet lime cultivation drives the economy of the region. However, as discussed earlier, there is a scope for increasing areas under micro-irrigation techniques like drip irrigation. About 50% of double crop area (i.e. 124.22 sq km) is proposed to be covered under drip irrigation i.e., about 62.11 sq km (**Fig. 6.2 a and b**). Due to which about 38.37 MCM water is expected to be saved (water req for Surface Flooding 0.90 m., Drip 0.50 = saving 0.4 m). The expenditure of Rs. 38.37 Crore is expected considering Rs. 25,000/- per acre, towards the implementation of micro-irrigation in Morshi Taluka.

Thus, following benefits are expected, after implementation of above said Aquifer Management Plan in Morshi taluka.

1. Additional ground water resources available after implementing above measures is 7.26 MCM and mitigating the gap to bring stage of ground water development upto 70% or about 35.20 MCM of additional ground water resources available after implementing above measures with current stage of ground water development.
2. About 11.17 sq km additional area will be covered under assured irrigation after implementation of artificial recharge to ground water with estimated expenditure of Rs. 106.78 crore.
3. About 62.11 sq km additional area will be covered under assured irrigation after implementation of micro irrigational techniques.
4. There will be rise in water level at a rate of about 2.36 m/year in the area.
5. About 1.09 MCM of water expected to be saved as ground water draft above 100% is taking place from deeper aquifer.

Apart from this, it is propose to impose ground water regulatory measures like banning the bore well drilling down to 60 m bgl for irrigation purpose.

6.3 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 Warud and Morshi taluka of Amravati district.

The study area is spanning over 1554 sq.km., out of which 745 sq.km. falling in Warud and 809 sq. km. in Morshi taluka. Geologically, the area is occupied entirely by Basalt, however, Purna Alluvium is observed in western part of the Morshi taluka. Over exploitation of ground water, declining of ground water levels, limited aquifer thickness and, water scarcity during lean period are the major issues in the area. The stage of ground water development is 110.32 % in Warud and 101.26 % in Morshi taluka. The farmers are using traditional farming & irrigation methods (rainfed & flood irrigation) for oil seed, pulses, cereals, cotton etc. However, for orange/sweet lime orchards they have adopted micro irrigation techniques like drip irrigation. At present, there is scope for introducing the drip irrigation in double crop irrigated area.

The overall quality of ground water is found suitable for drinking, domestic, and irrigation purposes, except at few places, except in Aquifer-II nitrate concentration >45 mg/l is reported at Katpur in morshi taluka. It is may be due to the interaction of aquifer-I as the first zone was encountered above 30 mbgl. Nitrate concentration of >45 mg/l is observed in southern part of Warud taluka, where intense agricultural activity is predominant. Rest of the parameters is within permissible limit.

It is recommended that the occurrence of red bole beds in local hydrogeological conditions should be consider as the red boles in basaltic terrain plays major role.

Ground water management plan has been prepared for Aquifer I (Weathered and jointed fracture Basalt and granular zones of Purna alluvium), Aquifer II (Jointed and Fractured Basalt) with the objective of bringing the current stage of ground water development down to 70% by adopting supply side and demand interventions. There is gap of 29.74 MCM and 15.71 MCM between demand and supply in Warud and Morshi taluka respectively. As a part of supply side interventions, feasible artificial recharge, water conservation measures like, percolation tank, check dam, recharge shaft, depending on the source water availability in the taluka, are recommended. Also, as demand side interventions, 184.85 sq km double crop area(122.74 & 62.11 sq km in Warud and Morshi taluka) has been identified for micro irrigation techniques like drip irrigation.

1. Additional ground water resources available after implementing above measures is 12.03 MCM (4.77 MCM in Warud taluka and 7.26 MCM in Morshi taluka) mitigating the gap to bring stage of gwd upto 70%. In other terms, about 96.63 MCM (61.43 MCM in Warud taluka and 35.20 MCM in Morshi taluka) of additional ground water resources available after implementing recommended measures with current stage of ground water development.
2. About 18.51 sq km (7.34 sq km in Warud taluka and 11.17 MCM in Morshi taluka) additional area will be covered under assured irrigation after implementation of artificial recharge to ground water with estimated expenditure of 238.78 crore (Rs. 132 crore in Warud taluka and 106.78 crore in Morshi taluka).
3. About 184.85 sq km area (122.74 sq km in Warud and 62.11 sq km in Morshi taluka) additional area will be covered under assured irrigation after implementation of micro irrigational techniques with estimated expenditure of 114.19 crore (Rs. 75.82 crore in Warud taluka and 38.37 crore in Morshi taluka)..
4. There will be rise in water level in both the talukas at a rate of about 4.12 m/year in Warud taluka and 2.36 m in Morshi taluka.

5. About 14.16 MCM (13.07 MCM in Warud taluka and 1.09 MCM in Morshi taluka) water expected to be saved as ground water draft above 100% is taking place from deeper aquifer.

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 60 m depth in these 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 and shall be used as sanctuary for drinking water supply. IEC activities and capacity building activities needs to be aggressively propagated to establish the institutional framework for participatory groundwater management.

Annexure-I Details of Medium, Bigger Minor and Minor irrigation projects (>100 ha), Warud and Morshi taluka, Amravati district

Sl No	Name of project	Scheme	Taluka	Total irrigation capacity Area under crop (Ha)	Gross storage (MCM)	Live Storage (MCM)	Total useable water (in MCM)		Irrigation capacity
							For irrigation	For drinking	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
(A) Completed Projects									
1	Triveni	MI tank	Morshi	522	3.29	3.01	3.01	--	> 250 ha
1	Pak	MI tank	Morshi	190	1.17	1.17	1.17	--	101 to 250 ha
2	Pat	MI tank	Morshi	150	0.91	0.91	0.91	--	
3	Khed	MI tank	Morshi	120	0.68	0.68	0.68	--	
4	Dabheri	MI tank	Morshi	106	0.6	0.6	0.6	--	
				566	**3.36**	**3.36**	**3.36**	**0**	
1	Shahadpur	MI tank	Morshi	90	0.365	0.365	0.365	0.365	0 to 100 ha
2	Wagholi	MI tank	Morshi	79	0.442	0.442	0.442	--	
3	Pimpri	MI tank	Morshi	68	0.37	0.37	0.37	0.25	
4	Asona	MI tank	Morshi	88	0.482	0.482	0.482	--	
				325	**1.659**	**1.659**	**1.659**	**0.615**	
1	Ridhpur	K T Weir	Morshi	47	0.18	--	--	--	0 to 100 ha
2	Kolvihir	K T Weir	Morshi	44	0.16	--	0.16	--	
3	Umarkhed	K T Weir	Morshi	62	0.27	--	0.27	--	
4	Dapori	K T Weir	Morshi	52	0.09	--	0.09	--	
5	Khopda	K T Weir	Morshi	47	0.25	--	0.13	--	
6	Udkhed	K T Weir	Morshi	43	0.2	--	0.19	--	
7	Naya wadhoda	K T Weir	Morshi	43	0.23	--	--	--	
8	Porgahvan	K T Weir	Morshi	43	0.04	--	0.04	--	
9	Lihida	K T Weir	Morshi	45	0.13	--	0.23	--	
10	Ladki	K T Weir	Morshi	14	0.12	--	0.12	--	
11	Ladki-1	K T Weir	Morshi	22	0.08	--		--	
12	Nimbhi	K T Weir	Morshi	20	0.19	--	0.56	--	
13	Nerpinglai	K T Weir	Morshi	9	0.04	--	0.06	--	
14	Khed	K T Weir	Morshi	16	0.29	--	0.015	--	
15	Inapur	K T Weir	Morshi	24	0.11	--	--	--	
16	Inapur-3	K T Weir	Morshi	16	0.71	--	--	--	
17	Pala	K T Weir	Morshi	75	--	--	--	--	
				622	**3.09**	**0**	**1.865**	**0**	
1	Damyanti	Diversion dam	Morshi	48	--	--	--	--	0 to 100 ha
2	Kamlapur	Diversion dam	Morshi	40	--	--	--	--	
				88	**--**	--	--	--	
1	Sawarkheda	PT	Morshi	27	0.127	--	--	--	0 to 100 ha
2	Nerpinglai	PT	Morshi	82	0.327	--	--	--	
3	Sawarkheda-1	PT	Morshi	10	0.053	--	--	--	
4	Aakhatwada	PT	Morshi	30	0.122	--	--	--	
				149	**0.629**	**--**	**--**	**--**	
		Sub-total		**2272**	**12.028**	**8.029**	**9.894**	**0.615**	
1	Shekdari	MI tank	Warud	1340	5.22	4.56	4.88	--	> 250 ha
2	Wai	MI tank	Warud	536	2.78	2.59	2.42	0.17	
3	Satnur	MI tank	Warud	299	1.54	1.46	1.46	--	
4	Waghad zunj	K T Weir	Warud	496	1.75	1.75	1.75	--	
				2671	**11.29**	**10.36**	**10.51**	**0.17**	
1	Jamgaon	MI tank	Warud	121	0.67	0.56	0.56	--	101 to 250 ha

Sl No	Name of project	Scheme	Taluka	Total irrigation capacity Area under crop (Ha)	Gross storage (MCM)	Live Storage (MCM)	Total useable water (in MCM)		Irrigation capacity
							For irrigation	For drinking	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	Padhri	MI tank	Warud	153	0.94	0.86	0.86	--	
3	Chinch gavhan	MI tank	Warud	200	0.67	0.64	0.64	--	
4	Belsavangi	MI tank	Warud	160	0.48	0.48	0.48	--	
5	Belsavangi	MI tank	Warud	119	0.784	0.77	0.77	--	
6	Nagthana	MI tank	Warud	212	2.55	1.67	1.67	--	
7	Jamalpu	MI tank	Warud	122	1.012	0.94	0.94	--	
				1087	**7.106**	**5.92**	**5.92**	**0**	
1	Savgi	MI tank	Warud	89	0.521	0.521	0.521	--	
2	Waghoda	MI tank	Warud	42	0.1	--	0.21	--	
3	Lakhra	MI tank	Warud	21	0.13	--	0.1	--	
4	Wai-2	MI tank	Warud	81	0.43	--	0.4	--	0 to 100 ha
5	Linga	MI tank	Warud	94	0.47	--	0.47	--	
6	Shendurjanaghat	MI tank	Warud	50	0.25	--	0.25	--	
				377	**1.901**	**0.521**	**1.951**	**0**	
1	Morchud	K T Weir	Warud	70	0.3	--	0.3	--	
2	Wav ruli	K T Weir	Warud	39	0.18	--	0.18	--	
3	Loni-1	K T Weir	Warud	30	0.14	--	0.14	--	
4	Surali	K T Weir	Warud	65	0.29	--	0.29	--	
5	Jarud	K T Weir	Warud	80	0.41	--	0.41	--	
6	Pusla	K T Weir	Warud	50	0.2	--	0.22	--	
7	Chandas Wathoda-1	K T Weir	Warud	57	0.25	--	0.21	--	
8	Loni-2	K T Weir	Warud	58	0.24	--	0.24	--	
9	Ismailpur	K T Weir	Warud	34	0.13	--	0.13	--	
10	Malkhed	K T Weir	Warud	25	0.09	--	0.09	--	
11	Dhanodi	K T Weir	Warud	61	0.27	--	0.27	--	
12	Pusla-1	K T Weir	Warud	28	0.12	--	0.12	--	
13	Kurali	K T Weir	Warud	30	0.13	--	0.13	--	
14	Beskheda	K T Weir	Warud	17	0.08	--	0.08	--	
15	Benoda	K T Weir	Warud	16	0.06	--	0.06	--	0 to 100 ha
16	Ittamgaon	K T Weir	Warud	43	0.17	--	0.17	--	
17	Bahada	K T Weir	Warud	16	0.06	--	0.06	--	
18	Belora	K T Weir	Warud	42	0.16	--	0.16	--	
19	Jarud	K T Weir	Warud	87	0.4	--	0.16	--	
20	Savanga	K T Weir	Warud	17	0.08	--	0.08	--	
21	Shendurjanaghat	K T Weir	Warud	32	0.08	--	0.1	--	
22	Dhaga	K T Weir	Warud	10	0.05	--	0.05	--	
23	Pusla-4	K T Weir	Warud	24	0.06	--	0.06	--	
24	Musalgaon	K T Weir	Warud	37	0.16	--	0.16	--	
25	Loni	K T Weir	Warud	21	--	--	--	--	
26	Benoda	K T Weir	Warud	14	0.05	--	0.05	--	
27	Amdapur	K T Weir	Warud	14	0.04	--	0.04	--	
28	Pusla	K T Weir	Warud	11	0.09	--	--	--	
29	Chandas p -2	K T Weir	Warud	40	0.09	--	--	--	
30	Belsavangi	K T Weir	Warud	16	--	--	--	--	
				1084	**4.38**	**0**	**3.96**	0	
1	Sinbhora	LIS	Warud	38	--	--	0.17		
1	Satnut-1	Diversion dam	Warud	84	--	--	--	--	0 to 100 ha

Sl No	Name of project	Scheme	Taluka	Total irrigation capacity Area under crop (Ha)	Gross storage (MCM)	Live Storage (MCM)	Total useable water (in MCM)		Irrigation capacity
							For irrigation	For drinking	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2	Satnur-2	Diversion dam	Warud	64	--	--	--	--	
3	Lendinala	Diversion dam	Warud	50	--	--	--	--	
4	Benoda	Diversion dam	Warud	50	--	--	--	--	
5	Pandharighat	Diversion dam	Warud	60	--	--	--	--	
6	Bhimdi-1	Diversion dam	Warud	36	--	--	--	--	
7	Zatamziri	Diversion dam	Warud	40	--	--	--	--	
8	Karjgaon	Diversion dam	Warud	40	--	--	--	--	
9	Khadla	Diversion dam	Warud	40	--	--	--	--	
10	Satnur-3	Diversion dam	Warud	36	--	--	--	--	
				500	**--**	**--**	**--**	--	
1	Lodhan	PT	Warud	55	0.328	--	--	--	
2	Dhanodi	PT	Warud	50	0.334	--	--	--	
3	Rawala	PT	Warud	60	0.283	--	--	--	
4	Bhugona	PT	Warud	41	0.215	--	--	--	
5	Pimpalkhuta	PT	Warud	36	0.191	--	--	--	
6	Karanjgaon	PT	Warud	82	0.272	--	--	--	
7	Chinchargavhan	PT	Warud	51	0.262	--	--	--	0 to 100 ha
8	Zolamba-2	PT	Warud	55	0.281	--	--	--	
9	Shahpur	PT	Warud	54	0.277	--	--	--	
10	Benoda	PT	Warud	43	0.198	--	--	--	
11	Aasona	PT	Warud	17	0.124	--	--	--	
12	Bhimdi	PT	Warud	15	0.071	--	--	--	
13	Ekal vihir	PT	Warud	47		--	--	--	
14	Ghorad	PT	Warud	50		--	--	--	
				656	**2.836**	--	--	--	
		Sub-total		**6375**	**27.513**	**16.801**	**22.341**	**0.17**	
		Total		**8647**	**39.541**	**24.83**	**32.235**	**0.785**	

(B) Ongoing projects

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Pusli	MI tank	Warud	309	6.62	6.21	1.594	1.45	
2	Loni dhavalgiri	MI tank	Warud	636	11.37	7.93	7.93		>250
				945	**17.99**	**14.14**	**9.524**	**1.45**	
1	Palsona	MI tank	Warud	118	0.809	0.795	0.795	--	101 to 250 ha
2	Loni	MI tank	Warud	147	1.26	1.14	1.14	--	
				265	**2.069**	**1.935**	**1.935**	**0**	
1	Porgavhan	K T Weir	Warud	84	0.3	0.3	--	--	
2	Kati	K T Weir	Warud	11	0.036	0.036	--	--	0 to 100 ha
3	Gadegaon	K T Weir	Warud	42	0.126	0.126	--	--	
				137	**0.462**	**0.462**	**0**	**0**	
		Sub-total		**1347**	**20.521**	**16.537**	**11.459**	**1.45**	

Sl No	Name of project	Scheme	Taluka	Total irrigation capacity Area under crop (Ha)	Gross storage (MCM)	Live Storage (MCM)	Total useable water (in MCM)		Irrigation capacity
							For irrigation	For drinking	
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	Ghoddev	MI tank	Morshi	207	2.027	1.74	1.74	--	101 to 250 ha
1	Udkhed	MI tank	Morshi	17	0.051	0.051	0.05	--	0 to 100 ha
2	Khed-2	MI tank	Morshi	27	0.114	0.114	0.114	--	
		Sub-total		**44**	**0.165**	**0.165**	**0.164**	**0**	
		Total		**1391**	**20.686**	**16.702**	**11.623**	**1.45**	

(Source: Irrigation Department, Govt. of Maharashtra, June 2005)

Annexure-II Salient Features of Ground water exploration in Morshi and Warud taluka, Amravati district.

Sl no	Village	Type of well	Taluka	Latitude	Longitude	Depth (mbgl)	Casing depth (mbgl)	Zones encountered /tapped (mbgl)	Aquifer	SWL (mbgl)	Q (lps)	DD (m)	Trans-missivity (m^2/day)	Stora-tivity	EC (µ mhos/cm at 25° C)	F (mg/l)	NO_3 (mg/l)
1	Katpur	EW	Morshi	21°12'55"	77°54'55'	194.00	12.00	15-18, 50-53	FB	69.4	7.76	11.20	551.27	1.28×10^{-4}	710	0.4	51
2	Katpur	OW	Morshi	21°12'55"	77°54'55'	185.00	12.00	16-19, 50-53	FB	68.80	5.94	9.20			980	0.42	37
3	Ner Pinglai	EW	Morshi	21°10'22"	77°59'00'	166.85	9.00	163-164	FB	27.15	5.37	16.16	490.03	3.71×10^{-1}			
4	Ner Pinglai	OW	Morshi	21°10'22"	77°59'00'	97.50	9.00	113-116	Fb	27.13		0.17					
5	Nimbhi	OW	Morshi	21°14'52"	77°57'56"	200.00	7.50	8, 46-48, 59-61, 140-142 (VB)	FB	4.28	5.00	12.50			690	0.48	1.02
6	Nimbhi	EW	Morshi	21°14'52"	77°57'56"	200.00	6.00	71-74	FB	3.40	4.00	29.60			770	0.51	0.6
7	Sawarkhed	EW	Morshi	21°10'53"	77°53'26'	200.00	6.10	59-62	FB	9.40	0.38	NA			600	1.74	21.3
8	Shirkhed	EW	Morshi	21°13'05"	77°56'39"	200.00	11.50	32-35(VB)	VB	10.83	1.00	28.69	1.83		1370	0.48	24.84
9	Talegaon	EW	Morshi	21°13'41"	77°57'13"	203.00	8.30	25-28	FB	2.30	0.49	32.10	1.98		900	0.26	10
10	Astagoan	EW	Morshi	21°18'30"	77°55'28"	200.00	5.60	98.5	JMB	>50	0.03						
11	Pala	EW	Morshi	21°23'15"	78°00'37"	31.80	5.60										
12	Talani	EW	Morshi	21°17'09"	77°59'17"	200.00	5.70	32	FB	7.90	0.40						
13	Hiwarkhed	EW	Morshi	21°23'58"	78°04'39"	172.10	9.20		JMB	5.62	0.38		15.84		930		
14	Jarud	EW	Warud	21°27'32"	78°13'08"	200.00	8.20	18.50,102.50,134,147	FB	7.70	3.14	29.11	95.82	3.57×10^{-3}	670		
15	Jarud	OW	Warud	21°27'32"	78°13'08"	150.70	16.50	18.50,48.50	FB	6.40		1.50					
16	Peth-Mangruli	EW	Warud	21°09'14"	77°53'26"	200.00	11.50	19.60,117, 126	FB	14.55	3.00	1.35	84.32		1140		
17	Peth-Mangruli	OW	Warud	21°09'14"	77°53'26"	172.10	11.50	18	FB	14.69		1.11	91.55	6.15×10^{-3}			
18	Gadegaon	EW	Warud	21°22'00"	78°15'55"	178.20	11.50	19-22, 34-37, 41-44 & 126-129	FB	5.78	0.14		25.41	$1.25\ 10^{-4}$	550	0.35	2
19	Gadegaon	OW	Warud	21°22'00"	78°15'55"	73.50	11.50	11-13, 37-40 &71-74	FB	7.00	1.37	41.00	0.73	-	860	0.48	23
20	Sawangi	EW	Warud	21°28' 02"	78°22'35"	200.00	5.60	-	-	-	-	-	-	-	-	-	-
21	Surli	EW	Warud	21°27'01"	78°18'26"	152.00	15.50	24-27 & 105-108	FB	14.54	0.78	39.64	0.40	-	710	0.32	29

Annexure-III Details of GW monitoring wells and KOWs in Morshi and Warud taluka, Amravati district.

S.No	KOW. No.	Village	Latitude(N)	Longitude (E)	Y	X	Depth (m bgl)	RL	Premonsoon WL (May 12)	Postmonsoon WL (Nov. 12)
1	AN-17	Adgaon	21°10'58.5'	77°58'52.8"	21.1828	77.9811	11.00	348.3	8.00	5.40
2	AN-30	Dhamangaon	21°13'41.5"	77°51'11.1"	21.2281	77.8531	8.35	373.8	4.30	1.70
3	AN-32	Gorala	21°11'45.3"	77°51'45.9'	21.1958	77.8625	17.10	357.9	12.50	5.23
4	AN-34	Katpur	21°09'12.9"	77°50'50'	21.1533	77.8472	17.00	348.4	7.50	2.25
5	AN-62	Ner Pingli	21°09'05.5''	77°56'10.6''	21.1514	77.9361	8.95	381.3	4.75	1.45
6	AN-0	Nimbhi	21°12'48.2"	77°53'3.04"	21.2133	77.8842	21.00	363.2	20,4	10.10
7	AN-25	Shirkhed PZ	21°14'53.9"	77°55'47.6"	21.2481	77.9297	8.20	349	6.25	3.85
8	AN-46	Talegaon	21°13'28.1"	77°53'33.0"	21.2244	77.8925	17.60	359.2	12.02	6.30
9	AN-0	Vichori	21°13'09.2"	77°56'34.7"	21.2192	77.9428	200.00	346.8	--	--
10	KPD-5K7	Ekalvihir	21°29'54"	78°24'27"	21.49833	78.4075	15.00	420	12.35	5.15
11	KPD-15K7	Dhanodi	21°28'57"	78°17'59"	21.4825	78.29972	15.00	404.7	7.70	6.50
12	KPD-18K7	Sawangi	21°27'42"	78°22'04"	21.46167	78.36778	20.00	392	15.65	12.75
13	KPD-26K7	Surli	21°27'01"	78°18'26"	21.45028	78.30722	30.00	388.6	22.25	7.65
14	KPD-30K7	Pavni	21°23'21"	78°19'18"	21.38917	78.32167	18.00	361	8.27	4.40
15	KPD-33K7	Gadegaon	21°21'31"	78°15'21"	21.35861	78.25583	20.00	358.7	17.10	15.90
16	KPD-92K7	Warud	21°28'35"	78°15'24"	21.47639	78.25667	15.00	407	9.50	6.60
17	VJ-1	Benoda	21°27'21''	78°10'56''	21.45583	78.18222	15.90	414.3	10.35	5.20
18	VJ-2	Jarud	21°27'34''	78°13'09''	21.45944	78.21917	16.21	412	14.05	13.20
19	VJ-3	Loni	21°22'29''	78°11'08''	21.37472	78.18556	14.15	363.1	12.00	16.60
20	VJ-4	Hathorna	21°20'09''	78°13'56''	21.33583	78.23222	19.45	353.7	13.30	10.95
21	VJ-5	Mamdapur	21°22'41"	78°07'55"	21.37806	78.13194	7.90	348.4	6.60	3.65
22	VJ-6	Morshi	21°20'08''	78°00'11''	21.33556	78.00306	16.10	349.1	8.50	--
23	VJ-7	Bhaipur-1	21°21'22.20"	78°01'56.46"	21.35611	78.03222	14.65	343.4	10.25	6.80
24	VJ-8	Pardi	21°17'39"	78°01'28.8"	21.29417	78.02444	11.40	331	5.30	2.85
25	VJ-9	Nagarwadi	21°21'39.4"	77°47'8.8"	21.36083	77.78556	14.25	429.7	9.00	5.80
26	VJ-10	Wani	21°19'47"	77°46'58"	21.32972	77.78278	14.00	412.7	11.10	10.50
27	VJ-11	Pimpri	21°21'47.6"	77°51'59.1"	21.36306	77.86639	7.60	426.4	6.00	3.30
28	VJ-12	Uthkhed	21°16'45.5	77°53'21"	21.27917	77.88917	22.35	373	16.80	15.40
29	VJ-13	Ambara	21°19'46"	77°54'27"	21.32944	77.9075	13.60	386.3	11.50	2.70
30	VJ-14	Taroda	21°21'50"	77°58'24.3"	21.36389	77.97333	11.00	376.7	10.35	0.70
31	VJ-15	Khanapur	21°18'53"	77°57'9.2"	21.31472	77.9525	14.10	376.3	9.30	4.45
32	VJ-16	Talni-2	21°16'52.3"	77°58'47.5"	21.28111	77.97972	7.25	361.7	4.70	5.80

Annexure-IV A Aquifer-I, Ground water quality of Morshi and Warud taluka, Amravati district

Village/ Location	Depth (mbgl)	Aquifer	pH	EC (µS/cm)	TDS (mg/L)	TH (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	CO3 (mg/L)	HCO3 (mg/L)	Cl (mg/L)	SO4 (mg/L)	NO3 (mg/L)	F (mg/L)
Roshankheda	18.00	Aquifer-I	8	950	618	390	60	58	nd	nd	0	323	64	nd	8	0.11
Chandas	20.00	Aquifer-I	8.1	830	540	405	52	67	nd	nd	0	250	82	nd	15	0.17
Mendhi	20.00	Aquifer-I	8	3420	2223	600	126	69	nd	nd	0	134	429	nd	17	0.17
Haturna Road	25.00	Aquifer-I	8.4	1320	858	380	24	78	nd	nd	30	171	121	nd	18	0.25
Pandhurna Road	15.00	Aquifer-I	8.3	1110	722	260	26	47	nd	nd	51	360	53	nd	19	0.23
Warud	15.00	Aquifer-I	8.3	1030	670	380	30	74	nd	nd	21	177	78	nd	21	0.27
Surli	30.00	Aquifer-I	8.1	820	533	315	12	69	nd	nd	0	195	60	nd	26	0.12
Dewatwada	18.00	Aquifer-I	8.1	1290	839	475	34	95	nd	nd	0	146	177	nd	27	0.17
Ghorad	24.00	Aquifer-I	8.4	660	429	225	16	45	nd	nd	30	207	35	nd	29	0.16
Katol Road	25.00	Aquifer-I	8.1	1280	832	440	36	85	nd	nd	0	134	149	nd	31	0.27
Multai Road	15.00	Aquifer-I	8	800	520	325	46	51	nd	nd	0	165	50	nd	32	0.27
Dhanodi	15.00	Aquifer-I	7.7	990	644	415	52	69	nd	nd	0	146	82	nd	33	0.10
Amner	30.00	Aquifer-I	8.3	990	644	310	26	60	nd	nd	51	323	53	nd	36	0.13
Ismailpur	12.00	Aquifer-I	8.3	2120	1378	0	42	-26	nd	nd	27	159	248	nd	37	0.16
Ekalvihir	15.00	Aquifer-I	8	580	377	305	40	50	nd	nd	0	122	46	nd	38	0.10
Tembhurkheda Road	12.00	Aquifer-I	8.1	1090	709	350	28	68	nd	nd	0	207	85	nd	41	0.34
Wandii	20.00	Aquifer-I	8.3	1250	813	165	10	34	nd	nd	75	128	39	nd	44	0.18
Jamthi	15.00	Aquifer-I	8	700	455	320	36	56	nd	nd	0	201	46	nd	45	0.19
Malkhed	20.00	Aquifer-I	7.8	1130	735	555	88	81	nd	nd	0	134	121	nd	45	0.10
Udapur	22.00	Aquifer-I	7.9	860	559	370	12	83	nd	nd	0	183	64	nd	48	0.10
Wadala	30.00	Aquifer-I	8.1	1220	793	295	14	63	nd	nd	0	372	71	nd	48	0.10
Gadegaon	20.00	Aquifer-I	8.1	1120	728	410	14	91	nd	nd	0	311	82	nd	49	0.09
Sawangi	20.00	Aquifer-I	8	920	598	400	10	91	nd	nd	0	153	74	nd	49	BDL
Pavni	18.00	Aquifer-I	7.8	980	637	375	12	84	nd	nd	0	201	67	nd	51	0.10
Wadegaon	15.00	Aquifer-I	7.9	1440	936	650	22	145	nd	nd	0	122	266	nd	51	0.11
Musalkheda	15.00	Aquifer-I	8.1	970	631	410	16	90	nd	nd	0	214	60	nd	53	BDL
Beshkheda	12.00	Aquifer-I	7.8	1420	923	450	12	102	nd	nd	0	220	135	nd	53	0.22
Dhaga	12.00	Aquifer-I	8.1	970	631	280	16	58	nd	nd	0	195	74	nd	53	0.09
Ekdara	10.00	Aquifer-I	8	2190	1424	455	14	102	nd	nd	0	476	138	nd	55	0.10
Ampend	12.00	Aquifer-I	7.8	1360	884	345	10	78	nd	nd	0	226	124	nd	55	0.10
Babulkheda	20.00	Aquifer-I	7.9	1400	910	610	12	141	nd	nd	0	244	128	nd	55	0.11
Chinchargavan	15.00	Aquifer-I	7.9	1560	1014	550	12	126	nd	nd	0	165	152	nd	55	0.14
Morchund	30.00	Aquifer-I	7	5620	3653	450	12	102	nd	nd	0	360	71	nd	55	0.10
Rajurabazar	15.00	Aquifer-I	7.7	2680	1742	1050	18	244	nd	nd	0	116	305	nd	59	0.14

Annexure-IV B Aquifer-II, Ground water quality of Morshi and Warud taluka, Amravati district

Village/ Location	Depth (mbgl)	Aquifer Type	pH	EC (µS/cm)	TDS (mg/L)	TH (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	CO_3 (mg/L)	HCO_3 (mg/L)	Cl (mg/L)	SO_4 (mg/L)	NO_3 (mg/L)	F (mg/L)
Ner Pinglai EW	166.85	Aquifer-II	8	1220	725	275	72	23	152	4	0	159	234	100	60	-
Ner Pinglai OW	97.50	Aquifer-II	8	640	355	180	24	29	63	4	0	177	78	50	18	-
Durgwada EW	200	Aquifer-II	8.2	470	235	200	38	26	16	0.5	0	207	32	10	9	-
Bargaon EW	262.90	Aquifer-II	9.4	520	340	65	22	2	95	0.9	18	12	92	96	13	-
Ambada EW	202.45	Aquifer-II	8.3	600	300	235	38	34	31	2	0	336	18	-	5	-
Dhanora EW	200	Aquifer-II	8.2	470	188	180	14	30	-	-	0	201	11	-	22.9	0.53
Jarud EW	200	Aquifer-II	7.9	560	224	305	66	34	-	-	0	183	53	-	25	0.17
Sawarkheda EW	200	Aquifer-II	8.5	600	240	9	4	19	-	-	18	183	43	-	21.3	1.74
Gadegaon EW	178.2	Aquifer-II	7.1	550	310	260	26	41	15	5	0	305	32	7	2	0.35
Gadegaon OW	73.5	Aquifer-II	7.35	860	510	320	54	45	50	8	0	427	50	8	23	0.48
Loni EW	150.55	Aquifer-II	8.3	1610	924	685	136	84	55	2	0	177	269	200	90	0
Surli EW	152	Aquifer-II	7	710	430	240	34	38	46	6	nil	232	74	37	29	0.32
Bhimdi EW	171.95	Aquifer-II	8	1600	1060	510	166	23	133	2	0	73	28	670	4	0
Dhaga EW	202.45	Aquifer-II	8.3	1120	665	210	50	21	161	2	0	183	177	150	9	0

Annexure-V Details of micro-level wells in Morshi and Warud taluka, Amravati district.

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
1	HASHAMPUR	MORSHI	21.2421	78.0034	348	BS01	8.7		2.2	340	1.5	1.75	2	5	6	3.00
2	NAYA WATHODA	MORSHI	21.2357	78.0011	349	BS01	9.9		5.55	630	3.5	4.1	3	4	5	3.00
3	SAMBHAPUR/NIMBHI	MORSHI	21.2521	77.9656	359	BS01	8.6	3.2	7	1398	3.2	3.2	3	3	2	3.00
4	DARYAPUR/SHIRKHED	MORSHI	21.2274	77.9578	352	BS01	15.8	12	12.4	853	12	12	2	2	1	5.00
5	SHAHNAWAJPUR	MORSHI	21.2178	77.9567	355	BS01	5.75	3.17	5.42	455	3.17	3.17	2	2	DRY	3.00
6	NERPINGLAI	MORSHI	21.1937	77.9728	351	BS01	13.35	5.15	10.51	1136	5,15	5,15	6	10	7	5.00
7	BARHANPUR	MORSHI	21.2010	77.9801	346	BS01	10.8	6.1	7.8	866	6.1	6.1	3	6	DRY	5.00
8	MAMDAPUR	MORSHI	21.2156	77.9139	360	BS01	20.1	10	15,6	1060	10	10	4	5	DRY	3.00
9	LASKHARPUR/ DHAMANGAON	MORSHI	21.2244	77.8926	365	BS01	17.6	6.55	11.4	1130	6.55	6.55	3	3	DRY	3.00
10	PORGAVHAN	MORSHI	21.2461	77.8883	371	BS01	11.85	3.8	DRY				2		DRY	3.00
11	VISHNORA	MORSHI	21.2449	77.8703	368	BS01	18,20	14.2	16.2	822	14.2	14.2	3	3	DRY	3.00
12	SULTANPUR	MORSHI	21.2371	77.8586	372	BS01	13	4.42	7.6	735	4.42	4.42	2	2	DRY	5.00
13	BRAHMANWADA	MORSHI	21.2311	77.8396	377	BS01	6	3.48	4.85	536	3.48		4	4	DRY	3.00
14	TRIMALPUR RITHPUR	MORSHI	21.2442	77.8108	378	BS01	11		4.45	1975	3.05					
15	YASHWANTPUR	MORSHI	21.2344	77.8162	387	BS01	15.6		9	956	4.7		5	5	DRY	3.00
16	SAHADPUR	MORSHI	21.2298	77.8226	390	BS01	14.72	1.2	9.3	982	1.2		4	4	DRY	3.00
17	ISMAILPUR	MORSHI	21.2122	77.8270	384	BS01	12,47	4	5.7	935	4					
18	AJAMPUR VICHORI	MORSHI	21.1997	77.8651	370	BS01	11.67	4.8	9.63	1212	4.8		5	4	DRY	3.00
19	PATUR	MORSHI	21.1617	77.8400	359	BS01	6		5	2382			4	4	DRY	3.00
20	KHOPDA	MORSHI	21.2689	77.9212	363	BS01	19.1	7.6	15.1	841	7.6		5	5	5	1.50
21	JAYMALPUR KHOPDA	MORSHI	21.2556	77.9161	365	BS01	26		17.75	1177	3.3		2	2	DRY	3.00
22	SONGAON PORGAVHAN	MORSHI	21.2497	77.8930	371	BS01	25.4	12.25	19.68	1258	12,25		7	5	3	5.00
23	BAHIRAMPUR BRAHMANWADA	MORSHI	21.2431	77.8438	389	BS01	23	3	11.3	764	3		3	3	DRY	3.00
24	WARHA	MORSHI	21.2852	77.9051	382	BS01	11.2		8,85	1278	2.75					
25	NAGARWADI UDKHED	MORSHI	21.2793	77.8892	389	BS01	24.8	2.1	15	1535	2.1					
26	KHED	MORSHI	21.3091	77.8622	396	BS01	8	2	6.25	--	2					
27	KOLVIHIR	MORSHI	21.2698	77.8472	395	BS01	16.15	3.85	7.6	944	3.85		4	3	DRY	3.00
28	DASHNUR	MORSHI	21.3865	77.8449	461	BS01	9.4	3.18	8.52	628	3.18		4	3	DRY	3.00
29	MANIARDHI	MORSHI	21.3708	77.8737	449	BS01	11.73	3.84	6	464	3.84		4	3	4	3.00
30	SAIWADA	MORSHI	21.3326	77.8668	402	BS01	13	5	10.8	1057	5					
31	HIRAPUR AMBADA	MORSHI	21.3320	77.8922	398	BS01	22.75	4	9.33	696	4		4	4	4	5.00
32	AMBADA	MORSHI	21.3295	77.9076	393	BS01	9	4	7.5	--	4					
33	Belkhed	MORSHI	21.3424	77.9593	383	BS01	29.63	5	17.7	1000	5		4	4	dry	3.00

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
34	TARODA	MORSHI	21.3657	77.9693	396	BS01	21.4	8.45	7.92	690	8.45		8	6	4	5.00
35	KHOPARA	MORSHI	21.3489	77.9909	375	BS01	14.76	6.2	8.27	841	6.2		3	3	DRY	3.00
36	MANIMPUR	MORSHI	21.3454	77.9986	369	BS01	18.2	10.25	17.45	788	10.25		3	3	DRY	3.00
37	DHANORI	MORSHI	21.3695	77.9732	387	BS01	15.1	4.35	12.1	1011	4.35					
38	JANUNA	MORSHI	21.3764	77.9426	408	BS01	14	7.16	7.16	704	7.16		5	5	3	3.00
39	CHINCHPUR	MORSHI	21.3769	77.9434	406	BS01	12.3	2.3	6.85	585	2.3		3	3	3	3.00
40	AMBORI	MORSHI	21.3790	77.9428	404	BS01	9.53	3.88	3.88	482	3.88		3	3	3	3.00
41	IRUR	MORSHI	21.3368	77.9177	400	BS01	30.88	3.8	18.7	787	3.8		4	4	DRY	3.00
42	AMBADA	MORSHI	21.3339	77.9035	397	BS01	18.75	5.9	10,71	669	5.9		3	3	DRY	3.00
43	CHARUD	MORSHI	21.3381	77.8948	404	BS01	8.72		2.58	480	2.58					
44	BHANGARA	MORSHI	21.3440	77.8855	413	BS01	7.3		6	694	4		3	4	DRY	3.00
45	MAMADAPUR	MORSHI	21.3366	77.8399	433	BS01	25	6	18	731	6		3	2	2	3.00
46	DOMAK	MORSHI	21.2987	77.8099	413	BS01	14.84	6.2	8.7	817	6.2		6	6	2	3.00
47	KHANAPUR-1	MORSHI	21.3140	77.9439	380	BS01	13.07		9.63	784	4		3	3	3	3.00
48	KHANAPUR-2	MORSHI	21.3131	77.9406	390	BS01	13.6	3.1	8.4	762	3.1		3	3	3	3.00
49	GUJARMALI	MORSHI	21.3202	77.8985	391	BS01	20.65	4.2	10.15	806	4.2		3	3	3	3.00
50	TARODA	MORSHI	21.2877	77.8417	399	BS01	13.1	8	11.3	2112	8		2	2	2	5.00
51	RAIPUR	MORSHI	21.3082	77.8290	401	BS01	18.2		15.3	1454	5.5		3	4	2	3.00
52	ASTOLI	MORSHI	21.2822	77.8258	393	BS01	15.9		4.8	1760	4		2	3	2	3.00
53	YERLA	MORSHI	21.3198	77.9851	390	BS01	10.7	4.1	8.05	1705	4.1		3	2	2	3.00
54	AHMADABAD	MORSHI	21.3042	77.9908	367	BS01	15.2	4	13.2	790	4		4	4	4	5.00
55	TALNI	MORSHI	21.2823	77.9929	353	BS01	8	3	5	950	3		3	3	2	3.00
56	PARDI	MORSHI	21.2934	78.0211	342	BS01	8		3.5	--	2					
57	SIRUR	MORSHI	21.1925	78.0587	337	BS01	10.67		3.5	512	2.5		3	3	2	5.00
58	PALA-1	MORSHI	21.3759	78.0124	373	BS01	21.2		10.7	1055	5		4	4	4	5.00
59	PALA-2	MORSHI	21.3857	78.0112	368	BS01	12	1.45	8.2	1351	1.45		1	1	1	1.00
60	BHIWKUNDI	MORSHI	21.3961	77.9729	412	BS01	18.53	2.15	14.5	725	2.15		4	4	5	5.00
61	PALA-3	MORSHI	21.3944	77.9952	387	BS01	15.22	5.8	8.48	1079	5.8		3	3	4	5.00
62	DEOTHAN	MORSHI	21.4175	78.0062	381	BS01	20.12	4.38	14.87	513	4.38		3	3	3	5.00
63	JAMATHI DONGARYAWALI	MORSHI	21.4126	78.0311	378	BS01	21.4	6.85	9	1159	6.85		5	5	5	3.00
64	DONGARYAWALI	MORSHI	21.4077	78.0418	383	BS01	16.25	4.87	6.6	1089	4.87		14	14	14	10.00
65	BOPALAWADI	MORSHI	21.4054	78.0644	374	BS01	18	4.2	10.1	861	4.2		3	3	3	3.00
66	ISMAILPUR	MORSHI	21.3884	78.0794	359	BS01	11.8	2.16	7.15	1129	2.16					
67	DORALI	MORSHI	21.3746	78.0883	355	BS01	15	3.45	8.63	781	3.45		4	4	5	3.00
68	LAKHARA	MORSHI	21.4313	78.1151	406	BS01	26	10.26	21.25	1078	10.26		5	5	4	5.00
69	MOLVAN	MORSHI	21.4183	78.0819	376	BS01	14.3	2.13	7.3	1073	2.13		6	6	4	3.00

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
70	Sirajgaon	MORSHI	21.1347	77.8861	404	BS01	18.2	7.25	15.6	1170	7.25					
71	Gorala	MORSHI	21.1639	77.9464	423	BS01	8.95	4.1	5.1	450	4.1					
72	Ghorgohan	MORSHI	21.1828	77.8978	429	BS01	12.3	1.75	7.1	570	1.75					
73	Ner Pingli	MORSHI	21.1711	77.9692	370	BS01	11	3	9.4	1450	3					
74	Rohankhed	MORSHI	21.1864	77.8867	396	BS01	10.9	3.8	8.9	850	3.8					
75	Akhatwara	MORSHI	21.2078	77.9856	361	BS01	15.4	6.7	13.95	1050	6.7					
76	Lihidha	MORSHI	21.2192	77.9928	336	BS01	11.2	8	9.05	1360	8					
77	Shirkhed	MORSHI	21.2319	77.9353	356	BS01	6.7	5	5.1	1780	5					
78	Lehegaon	MORSHI	21.1961	77.9531	365	BS01	9	8	7.7	1960	8					
79	Saverkhed	MORSHI	21.1753	77.9422	374	BS01	12	3	9.65	970	3					
80	Bilapur	MORSHI	21.1522	77.9144	389	BS01	9.55	5.35	Dry	1160	5.35					
81	NanduraPinglai	MORSHI	21.1762	77.9854	379	BS01	7.5	2.3	Dry	590	2.3					
82	Kekatpur	MORSHI	21.2133	77.9854	374	BS01	12	4.5	9.65	700	4.5					
83	Nerpiglai	MORSHI	21.1647	77.9964	383	BS01	11	2.35	9.75	570	2.35					
84	Nimbhi	MORSHI	21.2444	77.9228	365	BS01	8.2	4.1	6.65	630	4.1					
85	Wagoli	MORSHI	21.2028	77.9197	381	BS01	19.15	4.2	16.85	1150	4.2					
86	Inapur	MORSHI	21.2428	77.9683	350	BS01	8.2	5.6	5.6	2050	5.6					
87	Porgohan	MORSHI	21.2442	77.8906	383	BS01	8	5.5	Dry	1280	5.5					
88	Khopri (Shirkhed)	MORSHI	21.2286	77.9656	354	BS01	19.2	11.2	13.9	930	11.2					
89	Dabheri	MORSHI	21.2133	77.8175	403	BS01	11.95	3.9	6.75	NA	3.9					
90	Katpur	MORSHI	21.2017	77.8931		BS01	21	7	20.4	1120	7					
91	BrahmanwadaDeve	MORSHI	21.2386	77.8481	416	BS01	14.25	1.55	4.5	1680	1.55					
92	Dmamangaon	MORSHI	21.2208	77.8981	371	BS01	21	8		1280	8					
93	Rithpur	MORSHI	21.2447	77.8031	411	BS01	14.7	9.4	10.15	1350	9.4					
94	Talegaon	MORSHI	21.2328	77.8606	387	BS01	9.35	3	4.7	1200	3					
95	Barhanpur	MORSHI	21.2125	77.8125	388	BS01	13.1	5.95	10.6	1640	5.95					
96	Vichori	MORSHI	21.1908	77.8514	387	BS01	17.1	3.1	13.1	840	3.1					
97	Sirasgaon-II	MORSHI	21.1367	77.8972	381	BS01	15.2	9.1	11.49	1600	9.1					
98	Adgaon	MORSHI	21.1519	77.8403	361	BS01	17	7	7.95	2100	7					
99	Katsur	MORSHI	21.1597	77.8211	354	BS01	9.8	3.8	4	4200	3.8					
100	HIWARKHED	MORSHI	21.3886	78.0711	359	BS01	16	5.65	15.75	1110	5.65					
101	BELONA	MORSHI	21.3969	78.1050	350	BS01	16	5.8	13.7	1440	5.8					
102	DAPORI-2	MORSHI	21.3764	78.0622	350	BS01	14	6.5	11.15	1100	6.5					
103	DONGAR YAVLI-2	MORSHI	21.4075	78.0794	364	BS01	13	5.25	9.25	790	5.25					
104	GODDEV	MORSHI	21.4189	78.0364	396	BS01	12	4.3	10.5	1110	4.3					
105	MORSHI	MORSHI	21.3450	78.0164	360	BS01	16	8.5	8.5	1420	8.5					

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
106	MANIPUR	MORSHI	21.3400	77.9931	360	BS01	18	12.6	14.2	850	12.6					
107	DAPORI-1	MORSHI	21.3900	78.0567	350	BS01	13	10.7	10.7	1030	10.7					
108	DONGAR YAVLI-1	MORSHI	21.4131	78.0442	375	BS01	13	4.5	7.85	1060	4.5					
109	SALBARDI	MORSHI	21.4028	78.0108	374	BS01	27	7.8	17.2	760	7.8					
110	PALA	MORSHI	21.3894	78.0111	359.18	BS01	12	7.7	9.95	1650	7.7					
111	BHAIPUR-1	MORSHI	21.3506	78.0319	346	BS01	15	12.35	10.25	790	12.35					
112	MENGANWADI	MORSHI	21.3750	78.0383	346	BS01	13	4.8	11.15	640	4.8					
113	MAIWARI	MORSHI	21.3742	78.0489	364	BS01	16	10.7	12.1	560	10.7					
114	BHAIPUR-2	MORSHI	21.3558	78.0381	354	BS01	20	7.7	10.3	810	7.7					
115	NASIRPUR	MORSHI	21.2942	78.0411	329	BS01	12	6.95	6.95	1360	6.95					
116	PARDI	MORSHI	21.2994	78.0203	346	BS01	11	2.9	5.3	1400	2.9					
117	DURGWADA	MORSHI	21.3056	78.0219	368	BS01	8	1.85	4.45	680	1.85					
118	SIMBHORA	MORSHI	21.2783	78.0581	327	BS01	20	17.05	12.35	520	17.05					
119	PIMPALKHOTA (MOTA)	MORSHI	21.2653	78.0092	333	BS01	17	2.55	8.15	890	2.55					
120	ASHTOLI	MORSHI	21.2697	77.8269	395	BS01	5	2.5	2.85	2600	2.5					
121	DOMAK	MORSHI	21.3081	77.8292	397	BS01	29	>13.5	13.5	1100	>13.5					
122	RAIPUR	MORSHI	21.3042	77.8214	406	BS01	15	1.35	12.85	1000	1.35					
123	GANESHPUR	MORSHI	21.3842	77.8628	454	BS01	8	4.7	7.1	890	4.7					
124	DASHSUR	MORSHI	21.3797	77.8497	433	BS01	12	4.75	10.75	780	4.75					
125	PIMPRI	MORSHI	21.3625	77.8558	434	BS01	8	2.2	6	1290	2.2					
126	UTHKHED	MORSHI	21.2828	77.8833	373	BS01	22	8.65	16.8	1350	8.65					
127	SAIWARA	MORSHI	21.3294	77.8742	401	BS01	11	4.45	9.4	900	4.45					
128	AMBARA	MORSHI	21.3186	77.9014	386	BS01	14	3.55	11.5	1370	3.55					
129	KOLVIHIR	MORSHI	21.2767	77.8619	370	BS01	7	4.05	3.25	1050	4.05					
130	CHINCHOLI GAVLI	MORSHI	21.3544	77.9408	391	BS01	18	0.15	10.15	470	0.15					
131	DHANORA-1	MORSHI	21.3972	77.9400	423	BS01	11	4.5	10	650	4.5					
132	TARODA	MORSHI	21.3528	77.9731	394	BS01	11	1.95	10.35	1000	1.95					
133	DHANORA-2	MORSHI	21.3814	77.9692	386	BS01	15	4.15	13.25	1300	4.15					
134	KHANAPUR	MORSHI	21.3081	77.9581	387	BS01	14	7.35	9.3	1020	7.35					
135	ASHTAGAON	MORSHI	21.3086	77.9261	378	BS01	9	3.1	5.3	850	3.1					
136	CHIKHAL SAVANGI	MORSHI	21.3181	77.9636	377	BS01	8	4.6	7.15	470	4.6					
137	YERLA	MORSHI	21.2514	77.9900	364	BS01	10	3.9	6.5	1910	3.9					
138	TALNI-1	MORSHI	21.2942	77.9869	361	BS01	7	3.35	3.35	560	3.35					
139	ASONA	MORSHI	21.2514	77.9861	342	BS01	9	3.9	7.2	920	3.9					
140	PIMPALKHUTA	MORSHI	21.2756	77.9619	363	BS01	8	2.6	6.55	1300	2.6					
141	BORNA	MORSHI	21.2756	77.9211	362	BS01	12	4.35	10.55	680	4.35					

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
142	LARKI	MORSHI	21.2553	77.9378	357	BS01	6	2.9	3.5	1160	2.9					
143	TALNI-2	MORSHI	21.2811	77.9797	374	BS01	8	2.3	4.7	300	2.3					
144	SHAHPUR	WARUD	21.4654	78.2421	415	BS01	20.83	11.5	14.37	782	11.5	11.5	4	5		5
145	ISAMBRI	WARUD	21.4776	78.2173	430	BS01	17.6	2	8.5	995	2	2		6	3.00	3
146	GAVANKHUND	WARUD	21.4973	78.2101	452	BS01	14	1.6	9.5	786	1.5	1.5	12	4	12.00	3
147	SHEKDARI	WARUD	21.5232	78.1942	503	BS01	9.7	5.9	7.3	518	5.9	5.9	1	1	1.00	3
148	BHEMDI	WARUD	21.5223	78.2239	466	BS01	13.45	2.3	6.21	507	2.3	2.3		4	6.00	5
149	ZATAMZARI	WARUD	21.5382	78.2333	493	BS01	7.3	2.7	5.23	515	2.7	2.7		4		3
150	PIMPALSHENDA	WARUD	21.5278	78.2620	451	BS01	12	1.8	3.4	948	1.8	1.8	3	3	3.00	3
151	TIWSAGHAT	WARUD	21.5281	78.2726	451	BS01	14.65	1.9	7.75	1166	1.9	1.9	3	4	4.00	3
152	WAI BK	WARUD	21.5046	78.2708	418	BS01	14.3	10	10	1335	10	10	5	5	5.00	5
153	SHENDURJANAGHAT	WARUD	21.5244	78.2827	433	BS01	19.15	4.7	5.45	1078	4,7	4.7	3	3	3.00	3
154	MALKAPUR	WARUD	21.5254	78.2960	435	BS01	9	3.62	7.17	742	3,62	3.62	3	3	4.00	3
155	JAMTAL	WARUD	21.5271	78.2982	441	BS01	11.8	2.17	8	1060	2.17	2.17	3	4	6.00	3
156	PUSLI	WARUD	21.5505	78.3095	460	BS01	15.61		2.76	640	1.5	2.2	5	5	5.00	3
157	MALKAPUR KHEDI	WARUD	21.5228	78.3031	437	BS01	11.05	2.4	7.6	543	2.4	2.4	5	4	6.00	3
158	WAI KHURD	WARUD	21.5664	78.3337	467	BS01	9,6	3.1	3.1	600	3.1	3.1	4	4	4.00	3.5
159	KHEDI MAUJE	WARUD	21.5221	78.3062	435	BS01	16.87	1	8.53	660	1	1	2	3	4.00	3
160	MALVIHIR	WARUD	21.5163	78.3186	431	BS01	11.39	4.12	6.5	727	4.12	4.12	2	4	5.00	3
161	PUSLA	WARUD	21.5053	78.3552	422	BS01	14.6	2.5	5.2	1066	2.5	2.5				
162	PANDHARI	WARUD	21.5406	78.3795	451	BS01	12.7	2.57	11.9	484	2.57	2.57	4	4		3
163	MAHENDRI	WARUD	21.5612	78.3938	485	BS01	17.7	1.75	8	704	1.75	1.75	3	3	2.00	3
164	PIMPLAGAD	WARUD	21.5810	78.4166	466	BS01	7.53	4.8	4.8	746	4.8	4.8	3	3	4.00	3
165	JAMGAON	WARUD	21.5932	78.4087	488	BS01	11.2	3.5	7.3	646	3.5	3.5	5	4	5.00	3
166	KARLI	WARUD	21.6030	78.3872	492	BS01	13.2	4.4	8.2	694	4.4		5	5	2.00	3
167	ZOLAMBA	WARUD	21.3877	78.1096	364	BS01	10.92	3	6.45	1541	3		3	3	3.00	3
168	ISAPUR	WARUD	21.3745	78.1501	364	BS01	8.2	2.5	6	549	2.5		4	4	4.00	5
169	JAMALPUR	WARUD	21.3642	78.1639	362	BS01	12		5.5	908	3		3	3	3.00	3
170	ITTAMGAON	WARUD	21.3543	78.1722	357	BS01	13.8	7.15	11.5	1298	7.15		5	5	5.00	3
171	AJITPUR BAPKI	WARUD	21.3383	78.2033	352	BS01	15		4	655	2					
172	NANDGAON	WARUD	21.3506	78.2318	361	BS01	16.3	4.43	14	1243	4.43		3	3	DRY	3
173	PARDI	WARUD	21.4715	78.2776	402	BS01	10	6	8	--	6					
174	BHANDOLI	WARUD	21.4543	78.3112	398	BS01	13	7	DRY		7		3		DRY	3
175	DHAMANDAS	WARUD	21.4808	78.1518	474	BS01	19	6	14.4	614	6		4	4	4.00	3
176	BARGAON	WARUD	21.4413	78.1291	426	BS01	30.57	5.93	23.6	959	5.93		5	5	4.00	5
177	KHADKA	WARUD	21.4406	78.1232	419	BS01	17	2.3	14.73	804	2.3		3	3	3.00	3

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
178	GOREGAON	WARUD	21.4238	78.1669	400	BS01	7.25	4.6	4.6	844	4.6		8	8	6.00	3
179	WADHONA	WARUD	21.4128	78.1650	403	BS01	14.3	6.53	8.87	743	6.53		8	8	7.00	2
180	ASONA	WARUD	21.4053	78.1720	393	BS01	13.37	5.43	8.15	422	5.43		6	6	4.00	3
181	RAVALA	WARUD	21.5597	78.2763	485	BS01	15.63	2.8	8.36	896	2.8		5	4	3.00	3
182	SATNOOR	WARUD	21.5507	78.2976	463	BS01	11.4	1.5	7.83	1048	1.5		3	3	1.00	3
183	KHAPERKHEDA	WARUD	21.5439	78.3492	440	BS01	13.83	1.8	9.32	880	1.8		3	3	3.00	3
184	TARODI	WARUD	21.4849	78.3876	423	BS01	19.47	2.6	15.9	784	2.6		3	3	2.00	3
185	LINGA	WARUD	21.5071	78.4221	434	BS01	9.5	4.4	8.27	611	4.4		3	4	2.00	3
186	KARWAR	WARUD	21.5490	78.4197	457	BS01	8.9	2	8.78	544	2		2	2	1.00	3
187	MORSHI KHURD	WARUD	21.4122	78.4298	399	BS01	21.4	5	15	928	5		2	2	3.00	3
188	GAULKHED AMNER	WARUD	21.3903	78.4162	385	BS01	13.5	6	10.48	923	6		2	2	2.00	3
189	BELKHEDA	WARUD	21.4197	78.4033	390	BS01	11.27	5.32	10.05	542	5.32		3	3	3.00	3
190	ISMAILPUR	WARUD	21.4083	78.3818	378	BS01	11.82	7.9	10.1	2063	7.9		3	3	3.00	3
191	PIMPALKHUTA	WARUD	21.4324	78.2074	420	BS01	12	3.65	10.5	932	3.65		2	2	2.00	3
192	PETHMANGRULI	WARUD	21.4032	78.2249	407	BS01	29.05		19.2	1070	5		3	3	1.00	3
193	NAMAPUR	WARUD	21.3931	78.2060	386	BS01	13.72	6.88	9.8	752	6.88		2	2	1.00	3
194	SHIRPUR	WARUD	21.4313	78.2844	422	BS01	22.95	9.3	14	809	9.3					
195	ISAPUR	WARUD	21.4087	78.3349	378	BS01	20.75		7.56	741	7.56					
196	KHANAPUR	WARUD	21.3991	78.3328	383	BS01	13		12.3	1695	6		5	6	DRY	3
197	CHAINPUR	WARUD	21.3955	78.3405	377	BS01	13	11.63	11.63	1119	11.63		12	12	6.00	3
198	KURALI	WARUD	21.4512	78.2995	393	BS01	19.9	9.43	17	1040	9.43		4	4	3.00	5
199	SURYAKHEDA	WARUD	21.4767	78.3169	410	BS01	13.67	3.05	12.3	477	3.05		1	2	2.00	3
200	KUBHAKHEDA	WARUD	21.4752	78.3189	414	BS01	14.7	4.8	12.7	782	4.8		4	4	3.00	3
201	DABHI	WARUD	21.4649	78.3305	414	BS01	13	3.88	10.4	636	3.88		2	2	4.00	3
202	WARUD	WARUD	21.4644	78.2525	415	BS01	21.2		12.9	1378	5.2		4	4	4.00	3
203	Urad	WARUD	21.4844	78.3747	411	BS01	8		6.8	1980	0					
204	Jamthi	WARUD	21.4983	78.3908	414	BS01	15		11.72	650	0					
205	Ekalvihir	WARUD	21.4953	78.4133	421	BS01	15		12.35	740	0					
206	Malkhed	WARUD	21.4992	78.2997	407	BS01	20		16	1020	0					
207	Dhanodi	WARUD	21.4681	78.2869	415	BS01	15		7.7	840	0					
208	Roshankheda	WARUD	21.4364	78.2944	389	BS01	18		14.9	800	0					
209	Chandas	WARUD	21.4450	78.3344	398	BS01	20		11.7	680	0					
210	Sawangi	WARUD	21.4664	78.3669	358	BS01	20		15.65	730	0					
211	Musalkheda	WARUD	21.4425	78.3550	395	BS01	15		7.45	840	0					
212	Ekdara	WARUD	21.4319	78.3911	389	BS01	10		4.9	1920	0					
213	Ampend	WARUD	21.4458	78.3861	394	BS01	12		6.6	1250	0					

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
214	Beskheda	WARUD	21.4305	78.4085	388	BS01	12		6.1	1190	0					
215	Babulkheda	WARUD	21.4014	78.4003	390	BS01	20		14.6	1270	0					
216	Dhaga	WARUD	21.4289	78.3833	394	BS01	12		7.6	940	0					
217	Udapur	WARUD	21.4003	78.3406	381	BS01	22		16.85	800	0					
218	Surli	WARUD	21.4633	78.3069	392	BS01	30		22.25	700	0					
219	Rajura Bazar	WARUD	21.4125	78.2761	391	BS01	15		10.5	2450	0					
220	Chinchargavan	WARUD	21.4053	78.2986	384	BS01	15		11.9	1460	0					
221	Morchund	WARUD	21.4058	78.2883	388	BS01	30		26	1040	0					
222	Pavni	WARUD	21.3994	78.3278	364	BS01	18		8.27	870	0					
223	Wadala	WARUD	21.3689	78.2869	376	BS01	30		25	1270	0					
224	Wadegaon	WARUD	21.3919	78.2725	380	BS01	15		11.3	1170	0					
225	Gadegaon	WARUD	21.3650	78.2558	373	BS01	20		17.1	1110	0					
226	Wandli	WARUD	21.3583	78.2850	370	BS01	20		17.9	1060	0					
227	Amner	WARUD	21.3872	78.4025	385	BS01	30		20.5	870	0					
228	Ghorad	WARUD	21.4081	78.3819	375	BS01	24		11.7	710	0					
229	Ismailpur	WARUD	21.4097	78.3733	384	BS01	12		11.6	1750	0					
230	Warud	WARUD	21.4681	78.2528	400	BS01	15		9.5	980	0					
231	Tembhurkheda Road	WARUD	21.4967	78.2664	426	BS01	12		8.5	1040	0					
232	Multai Road	WARUD	21.4925	78.2500	423	BS01	15		10.7	780	0					
233	Pandhurna Road	WARUD	21.4683	78.2844	412	BS01	15		12.1	1110	0					
234	Haturna Road	WARUD	21.4650	78.2783	395	BS01	25		14.5	1150	0					
235	Katol Road	WARUD	21.4647	78.2747	401	BS01	25		11	1250	0					
236	Dewatwada	WARUD	21.3856	78.3342	381	BS01	18		14.5	1160	0					
237	Mendhi	WARUD	21.4022	78.3342	379	BS01	20		9.2	2900	0					
238	Multai Road	WARUD	21.4906	78.2661	419	BS01	15	7	8.8	1100	7					
239	Pandhurna Road	WARUD	21.4803	78.3239	416	BS01	15	3	0.8	720	3					
240	URAD	WARUD	21.4986	78.3711	414	BS01	15	6	9.3	980	6					
241	JAMTHAL	WARUD	21.4183	78.3875	412	BS01	24	10	17.9	780	10					
242	EKALVIHIR	WARUD	21.4214	78.3989	418	BS01	10	3	5.6	760	3					
243	GANESHPUR	WARUD	21.4633	78.4336	410	BS01	24	3	18.7	760	3					
244	URAD	WARUD	21.4930	78.3751	424	BS01	24	7	17.4	760	7					
245	MUGHALKHEDA	WARUD	21.4511	78.3553	403	BS01	17	5	10.6	740	5					
246	SURLI	WARUD	21.4418	78.3186	390	BS01	15	5.3	12.6	860	5.3					
247	SURLI	WARUD	21.4686	78.3241	408	BS01	20	5.2	16	610	5.2					
248	SURLI	WARUD	21.4583	78.3142	403	BS01	18	3.6	13.1	900	3.6					
249	FATEHPUR	WARUD	21.4211	78.3008	390	BS01	15	8.5	9.4	810	8.5					

SN	Village	Tehsil	Lat_deci	Long_deci	Elevation	Geology	Well Depth (mbgl)	Lining (mbgl)	DTW (Mbgl)	EC	Total Thickness weathered portion (m)	Depth to Fractures (mbgl)	No. of hours pump runs in Kharif	No. of hours pump runs in Rabi	No. of hours pump runs in Summer	Rate of discharge (lps)
250	ROSHANKHEDA	WARUD	21.4603	78.2892	405	BS01	12	5	8.7	840	5					
251	AHMEDPUR	WARUD	21.4373	78.2670	392	BS01	18	4.6	12.1	1160	4.6					
252	Pavni	WARUD	21.3918	78.3142	379	BS01	25	9.6	18.2	700	9.6					
253	UDAPUR	WARUD	21.4183	78.3369	379	BS01	20	14	16.8	330	14					
254	MANDHI	WARUD	214016	78.3472	378	BS01	15	11	12.4	1050	11					
255	UDAPUR	WARUD	21.4133	78.3294	376	BS01	14	5	9.4	760	5					
256	UDAPUR	WARUD	21.4125	78.3189	383	BS01	15	8.5	8.9	870	8.5					
257	R BAZAR	WARUD	21.3944	78.2867	385	BS01	30	22	25	1000	22					
258	KATI	WARUD	21.3856	78.2506	381	BS01	20	12	15.5	1000	12					
259	WAGHAL	WARUD	21.3775	78.2689	370	BS01	12	4	9.6	1050	4					
260	GADGAON	WARUD	21.3442	78.2572	365	BS01	15	8	11.1	950	8					
261	WATHODA	WARUD	21.4347	78.3636	391	BS01	15	5	11	800	5					
262	EKDARA	WARUD	21.4235	78.3731	388	BS01	22	17	18.1	850	17					
263	DHAGA	WARUD	21.4144	78.3781	380	BS01	24	14	19	1050	14					
264	AMPEND	WARUD	21.4519	78.3958	391	BS01	16	4.8	12.6	650	4.8					
265	AMPEND	WARUD	21.4394	78.3939	389	BS01	20	6.4	14.4	800	6.4					
266	EKDARA	WARUD	21.4325	78.3914	382	BS01	25	10	19.7	1150	10					
267	PORGAVHAN	WARUD	21.4222	78.4269	390	BS01	8	2	6.7	630	2					
268	WEDHAPUR	WARUD	21.3964	78.4164	388	BS01	15	7	11.5	600	7					

Annexure-VI: Detailed Data of Soil Infiltration Tests, Warud and Morshi taluka, Amravati district

1. SOIL INFILTRATION TEST DATA- Pimpalkotha (Ujad)

1.	Date	03-01-2016
2.	Village	Pimpalkotha (Ujad)
3.	Location	In the Agriculture land of Sh. Liladhar Khasba opposite to Ganesh Wadi
4.	Taluka	Warud
5.	District	Amravati
6.	Co-ordinate	21^0 26' 15.5" & 78^0 16' 2.0"
7.	Elevation (a msl)	387
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clayey-Very Deep (> 100m)
11.	Final Infiltration Rate	1.8 cm/hr
12.	Total Precipitation	10.7 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	0	0		6	0	o
2	0.5	0.5	0.5	6.2	0.2	24
3	1	0.5	1	6.1	0.1	12
4	2	1	2	6.1	0.1	6
5	3	1	3	6.1	0.1	6
6	4	1	4	6.1	0.1	6
7	5	1	5	6.1	0.1	6
8	6	1	6	6.1	0.1	6
9	7	1	7	6.1	0.1	6
10	8	1	8	6.1	0.1	6
11	9	1	9	6.1	0.1	6
12	10	1	10	6.1	0.1	6
13	15	5	15	6.2	0.2	2.4
14	20	5	20	6.3	0.3	3.6
15	25	5	25	6.2	0.2	2.4
16	30	5	30	6	0	0
17	35	5	35	6.4	0.4	4.8
18	40	5	40	6.3	0.3	3.6
19	45	5	45	6.5	0.5	6
20	50	5	50	6.4	0.4	4.8
21	55	5	55	6.4	0.4	4.8
22	60	5	60	6.4	0.4	4.8
23	70	10	70	6.4	0.4	2.4
24	80	10	80	6.3	0.3	1.8
25	90	10	90	6.4	0.4	2.4
26	100	10	100	6.4	0.4	2.4
27	110	10	110	6.3	0.3	1.8
28	120	10	120	6.3	0.3	1.8
29	130	10	130	6.4	0.4	2.4
30	140	10	140	6.4	0.4	2.4
31	150	10	150	6.3	0.3	1.8
32	160	10	160	6.4	0.4	2.4
33	170	10	170	6.4	0.4	2.4
34	180	10	180	6.3	0.3	1.8
35	190	10	190	6.3	0.3	1.8
36	200	10	200	6.3	0.3	1.8
37	210	10	210	6.3	0.3	1.8
38	220	10	220	6.3	0.3	1.8
39	230	10	230	6.3	0.3	1.8
40	240	10	240	6.3	0.3	1.8
41	250	10	250	6.3	0.3	1.8
	TOTAL				10.7	

2. SOIL INFILTRATION TEST DATA- Talegaon

1.	Date	03-02-2016
2.	Village	Talegaon
3.	Location	Near Over Head Tank in the Village
4.	Taluka	Morshi
5.	District	Amravati
6.	Co-ordinate	21^0 13' 37.8" & 77^0 51' 18.7"
7.	Elevation (a msl)	380
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clay Loam - Moderately Deep (25 to 50 cm)
11.	Final Infiltration Rate	1.8 cm/hr
12.	Total Precipitation	9.1 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.2	0.2	24
3	1	0.5	1	6.2	0.2	24
4	2	1	2	6.1	0.1	6
5	3	1	3	6.1	0.1	6
6	4	1	4	6.1	0.1	6
7	5	1	5	6.1	0.1	6
8	6	1	6	6.1	0.1	6
9	7	1	7	6.1	0.1	6
10	8	1	8	6.1	0.1	6
11	9	1	9	6.1	0.1	6
12	10	1	10	6.2	0.2	12
13	15	5	15	6.4	0.4	4.8
14	20	5	20	6.4	0.4	4.8
15	25	5	25	6.3	0.3	3.6
16	30	5	30	6.3	0.3	3.6
17	35	5	35	6.3	0.3	3.6
18	40	5	40	6.3	0.3	3.6
19	45	5	45	6.3	0.3	3.6
20	50	5	50	6.2	0.2	2.4
21	55	5	55	6.2	0.2	2.4
22	60	5	60	6.4	0.4	4.8
23	70	10	70	6.4	0.4	2.4
24	80	10	80	6.4	0.4	2.4
25	90	10	90	6.4	0.4	2.4
26	100	10	100	6.4	0.4	2.4
27	110	10	110	6.3	0.3	1.8
28	120	10	120	6.3	0.3	1.8
29	130	10	130	6.3	0.3	1.8
30	140	10	140	6.3	0.3	1.8
31	150	10	150	6.3	0.3	1.8
32	160	10	160	6.3	0.3	1.8
33	170	10	170	6.3	0.3	1.8
34	180	10	180	6.3	0.3	1.8
35	190	10	190	6.3	0.3	1.8
36	200	10	200	6.3	0.3	1.8
	TOTAL				**9.1**	

3. SOIL INFILTRATION TEST DATA Udkhed

1.	Date	03-02-2016
2.	Village	Udkhed
3.	Location	In the premises of Mundle Highschool in the village
4.	Taluka	Morshi
5.	District	Amravati

6.	Co-ordinate	21^0 16' 44.2" & 77^0 53' 19.2"
7.	Elevation (a msl)	379
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clayey- Very Deep (>100 cm)
11.	Final Infiltration Rate	1.2 cm/hr
12.	Total Precipitation	5.3 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Iinfiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.1	0.1	12
3	1	0.5	1	6.2	0.2	24
4	2	1	2	6.1	0.1	6
5	3	1	3	6.1	0.1	6
6	4	1	4	6.1	0.1	6
7	5	1	5	6.1	0.1	6
8	6	1	6	6.1	0.1	6
9	7	1	7	6.1	0.1	6
10	8	1	8	6.1	0.1	6
11	9	1	9	6.1	0.1	6
12	10	1	10	6.1	0.1	6
13	15	5	15	6.1	0.1	1.2
14	20	5	20	6.2	0.2	2.4
15	25	5	25	6.3	0.3	3.6
16	30	5	30	6.2	0.2	2.4
17	35	5	35	6.3	0.3	3.6
18	40	5	40	6.2	0.2	2.4
19	45	5	45	6.1	0.1	1.2
20	50	5	50	6.1	0.1	1.2
21	55	5	55	6.5	0.5	6
22	60	5	60	6.3	0.3	3.6
23	70	10	70	6.2	0.2	1.2
24	80	10	80	6.2	0.2	1.2
25	90	10	90	6.2	0.2	1.2
26	100	10	100	6.2	0.2	1.2
27	110	10	110	6.2	0.2	1.2
28	120	10	120	6.2	0.2	1.2
29	130	10	130	6.2	0.2	1.2
30	140	10	140	6.2	0.2	1.2
31	150	10	150	6.2	0.2	1.2
	TOTAL				**5.3**	

4. SOIL INFILTRATION TEST DATA Januna

1.	Date	03-02-2016
2.	Village	Januna
3.	Location	In the Agriculture land of Sh. Kisan M. Nipane
4.	Taluka	Morshi
5.	District	Amravati
6.	Co-ordinate	21^0 23' 13.3" & 77^0 56' 26.5"
7.	Elevation (a msl)	420
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Gravelly Clay Loam-Shallow (10-25 cm)
11.	Final Infiltration Rate	12.6 To 14.4 cm/hr (Highly variable)
12.	Total Precipitation	48.8 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
2	0.5	0.5	0.5	6.2	0.2	24
3	1	0.5	1	6.2	0.2	24
4	2	1	2	6.2	0.2	12
5	3	1	3	6.1	0.1	6
6	4	1	4	6.2	0.2	12
7	5	1	5	6.3	0.3	18
8	6	1	6	6.3	0.3	18
9	7	1	7	6.3	0.3	18
10	8	1	8	6.3	0.3	18
11	9	1	9	6.3	0.3	18
12	10	1	10	6.2	0.2	12
13	15	5	15	6.7	0.7	8.4
14	20	5	20	6.7	0.7	8.4
15	25	5	25	7.5	1.5	18
16	30	5	30	9	3	36
17	35	5	35	7.6	1.6	19.2
18	40	5	40	7.4	1.4	16.8
19	45	5	45	7.6	1.6	19.2
20	50	5	50	7.5	1.5	18
21	55	5	55	7.2	1.2	14.4
22	60	5	60	7.5	1.5	18
23	70	10	70	7.2	1.2	7.2
24	80	10	80	9	3	18
25	90	10	90	8.5	2.5	15
26	100	10	100	8.5	2.5	15
27	110	10	110	7.5	1.5	9
28	120	10	120	9	3	18
29	130	10	130	8.1	2.1	12.6
30	140	10	140	8.4	2.4	14.4
31	150	10	150	8.4	2.4	14.4
32	160	10	160	8.4	2.4	14.4
33	170	10	170	8.3	2.3	13.8
34	180	10	180	8.2	2.2	13.2
35	190	10	190	7.9	1.9	11.4
36	200	10	200	8.1	2.1	12.6
	TOTAL				**48.8**	

5. SOIL INFILTRATION TEST DATA Sadatpur

1.	Date	03-02-2016
2.	Village	Sadatpur
3.	Location	In the Agriculture land of Sh. Radheshyam Biyani
4.	Taluka	Morshi
5.	District	Amravati
6.	Co-ordinate	21^0 20’ 38.1” & 77^0 59’ 47.3”
7.	Elevation (a msl)	362
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clay-Very Deep (>100 cm)
11.	Final Infiltration Rate	1.2 cm/hr
12.	Total Precipitation	3.8 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.2	0.2	24
3	1	0.5	1	6.1	0.1	12
4	2	1	2	6.2	0.2	12
5	3	1	3	6.1	0.1	6

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
6	4	1	4	6.1	0.1	6
7	5	1	5	6.2	0.2	12
8	6	1	6	6.2	0.2	12
9	7	1	7	6.1	0.1	6
10	8	1	8	6.1	0.1	6
11	9	1	9	6.1	0.1	6
12	10	1	10	6.1	0.1	6
13	15	5	15	6.1	0.1	1.2
14	20	5	20	6.2	0.2	2.4
15	25	5	25	6.2	0.2	2.4
16	30	5	30	6.1	0.1	1.2
17	35	5	35	6.1	0.1	1.2
18	40	5	40	6.1	0.1	1.2
19	45	5	45	6.1	0.1	1.2
20	50	5	50	6.2	0.2	2.4
21	55	5	55	6.2	0.2	2.4
22	60	5	60	6.2	0.2	2.4
23	70	10	70	6.2	0.2	1.2
24	80	10	80	6.2	0.2	1.2
25	90	10	90	6.2	0.2	1.2
26	100	10	100	6.2	0.2	1.2
	TOTAL				**3.8**	

6. SOIL INFILTRATION TEST DATA Dapori

1.	Date	03-02-2016
2.	Village	Dapori
3.	Location	In the Agriculture land of Smt Archana Vijay Vighe near primary school
4.	Taluka	Morshi
5.	District	Amravati
6.	Co-ordinate	21^0 23’ 18.8” & 77^0 03’ 25.6”
7.	Elevation (a msl)	347
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Silty Loam-Very Deep (>100 cm)
11.	Final Infiltration Rate	1.8 cm/yr
12.	Total Precipitation	8.8 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.1	0.1	12
3	1	0.5	1	6.2	0.2	24
4	2	1	2	6.2	0.2	12
5	3	1	3	6.2	0.2	12
6	4	1	4	6.2	0.2	12
7	5	1	5	6.3	0.3	18
8	6	1	6	6.4	0.4	24
9	7	1	7	6.3	0.3	18
10	8	1	8	6.2	0.2	12
11	9	1	9	6.1	0.1	6
12	10	1	10	6.2	0.2	12
13	15	5	15	6.3	0.3	3.6
14	20	5	20	6.3	0.3	3.6
15	25	5	25	6.3	0.3	3.6
16	30	5	30	6.3	0.3	3.6
17	35	5	35	6.2	0.2	2.4
18	40	5	40	6.3	0.3	3.6

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
19	45	5	45	6.3	0.3	3.6
20	50	5	50	6.3	0.3	3.6
21	55	5	55	6.3	0.3	3.6
22	60	5	60	6.3	0.3	3.6
23	70	10	70	6.2	0.2	1.2
24	80	10	80	6.2	0.2	1.2
25	90	10	90	6.5	0.5	3
26	100	10	100	6.2	0.2	1.2
27	110	10	110	6.3	0.3	1.8
28	120	10	120	6.3	0.3	1.8
29	130	10	130	6.3	0.3	1.8
30	140	10	140	6.3	0.3	1.8
31	150	10	150	6.3	0.3	1.8
32	160	10	160	6.3	0.3	1.8
33	170	10	170	6.3	0.3	1.8
34	180	10	180	6.3	0.3	1.8
	TOTAL				**8.8**	

7. SOIL INFILTRATION TEST DATA Karanjgaon

1.	Date	03-02-2016
2.	Village	Karanjgaon
3.	Location	In the Agriculture land of Sh. Mohan Mahadevrao Chimote in the outskirt of village on road to Loni.
4.	Taluka	Warud
5.	District	Amravati
6.	Co-ordinate	21^0 24’ 16.5” & 78^0 12’ 0.8”
7.	Elevation (a msl)	392
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clayey- Very Deep (>100 cm)
11.	Final Infiltration Rate	1.2 cm/hr
12.	Total Precipitation	7.5 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.2	0.2	24
3	1	0.5	1	6.2	0.2	24
4	2	1	2	6.2	0.2	12
5	3	1	3	6.3	0.3	18
6	4	1	4	6.3	0.3	18
7	5	1	5	6.3	0.3	18
8	6	1	6	6.2	0.2	12
9	7	1	7	6.3	0.3	18
10	8	1	8	6.2	0.2	12
11	9	1	9	6.2	0.2	12
12	10	1	10	6.2	0.2	12
13	15	5	15	6.7	0.7	8.4
14	20	5	20	6.3	0.3	3.6
15	25	5	25	6.7	0.7	8.4
16	30	5	30	6.3	0.3	3.6
17	35	5	35	6.2	0.2	2.4
18	40	5	40	6.2	0.2	2.4
19	45	5	45	6.1	0.1	1.2
20	50	5	50	6.3	0.3	3.6
21	55	5	55	6.1	0.1	1.2

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
22	60	5	60	6.2	0.2	2.4
23	70	10	70	6.2	0.2	1.2
24	80	10	80	6.2	0.2	1.2
25	90	10	90	6.2	0.2	1.2
26	100	10	100	6.2	0.2	1.2
27	110	10	110	6.2	0.2	1.2
28	120	10	120	6.2	0.2	1.2
29	130	10	130	6.2	0.2	1.2
30	140	10	140	6.2	0.2	1.2
31	150	10	150	6.2	0.2	1.2
	TOTAL				**7.5**	

8. SOIL INFILTRATION TEST DATA Kharad Pusla

1.	Date	03-02-2016
2.	Village	Kharad Pusla
3.	Location	Near (back side of) Railway Station
4.	Taluka	Warud
5.	District	Amravati
6.	Co-ordinate	21^0 29’ 39.1” & 78^0 21’ 18.7”
7.	Elevation (a msl)	427
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Gravelly Clay Loam-Shallow (10-25 cm)
11.	Final Infiltration Rate	3.6 cm/hr
12.	Total Precipitation	21.4 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.1	0.1	12
3	1	0.5	1	6.1	0.1	12
4	2	1	2	6.1	0.1	6
5	3	1	3	6.1	0.1	6
6	4	1	4	6.1	0.1	6
7	5	1	5	6.1	0.1	6
8	6	1	6	6.1	0.1	6
9	7	1	7	6.1	0.1	6
10	8	1	8	6.1	0.1	6
11	9	1	9	6.1	0.1	6
12	10	1	10	6.2	0.2	12
13	15	5	15	6.5	0.5	6
14	20	5	20	6.4	0.4	4.8
15	25	5	25	6.4	0.4	4.8
16	30	5	30	6.3	0.3	3.6
17	35	5	35	6.2	0.2	2.4
18	40	5	40	6.3	0.3	3.6
19	45	5	45	6.3	0.3	3.6
20	50	5	50	6.2	0.2	2.4
21	55	5	55	6.3	0.3	3.6
22	60	5	60	6.3	0.3	3.6
23	70	10	70	6.8	0.8	4.8
24	80	10	80	6.7	0.7	4.2
25	90	10	90	6.7	0.7	4.2
26	100	10	100	6.6	0.6	3.6
27	110	10	110	6.7	0.7	4.2
28	120	10	120	6.8	0.8	4.8
29	130	10	130	6.7	0.7	4.2

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
30	140	10	140	6.8	0.8	4.8
31	150	10	150	6.8	0.8	4.8
32	160	10	160	6.8	0.8	4.8
33	170	10	170	6.8	0.8	4.8
34	180	10	180	6.8	0.8	4.8
35	190	10	190	6.8	0.8	4.8
36	200	10	200	6.8	0.8	4.8
37	210	10	210	6.8	0.8	4.8
38	220	10	220	6.7	0.7	4.2
39	230	10	230	6.7	0.7	4.2
40	240	10	240	6.6	0.6	3.6
41	250	10	250	6.7	0.7	4.2
42	260	10	260	6.7	0.7	4.2
43	270	10	270	6.5	0.5	3
44	280	10	280	6.5	0.5	3
45	290	10	290	6.6	0.6	3.6
	300	10	300	6.6	0.6	3.6
	TOTAL				**21.4**	

9. **SOIL INFILTRATION TEST DATA**

1.	Date	03-04-2016
2.	Village	Bhadnoli (Ujad)
3.	Location	Near Railway Bridge in the orange orchid of Sh. Damodar M. Darodkar
4.	Taluka	Warud
5.	District	Amravati
6.	Co-ordinate	21^0 28’ 1.7” & 78^0 18’ 13.4”
7.	Elevation (a msl)	406
8.	Initial Water Level	6
9.	Geology	Deccan Trap Basalt
10.	Soil Type	Clay-Very Deep (50 To 100 cm)
11.	Final Infiltration Rate	7.2 cm/hr
12.	Total Precipitation	27.6 cm

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
1	**0**	0		**6**	**0**	**o**
2	0.5	0.5	0.5	6.7	0.7	84
3	1	0.5	1	6.7	0.7	84
4	2	1	2	6.6	0.6	36
5	3	1	3	6.6	0.6	36
6	4	1	4	6.5	0.5	30
7	5	1	5	6.5	0.5	30
8	6	1	6	6.4	0.4	24
9	7	1	7	6.3	0.3	18
10	8	1	8	6.2	0.2	12
11	9	1	9	6.3	0.3	18
12	10	1	10	6.2	0.2	12
13	15	5	15	6.2	0.2	2.4
14	20	5	20	6.2	0.2	2.4
15	25	5	25	6.3	0.3	3.6
16	30	5	30	6.4	0.4	4.8
17	35	5	35	6.5	0.5	6
18	40	5	40	6.5	0.5	6
19	45	5	45	6.6	0.6	7.2
20	50	5	50	6.7	0.7	8.4
21	55	5	55	6.8	0.8	9.6
22	60	5	60	7.5	1.5	18
23	70	10	70	7.5	1.5	9

S. No	Clock Time	Duration (min)	Cumulative Time (min)	Water Level Depth (cm)	Infiltrated Water Depth (cm)	Infiltration Rate (cm/hr)
24	80	10	80	7.3	1.3	7.8
25	90	10	90	7	1	6
26	100	10	100	7.2	1.2	7.2
27	110	10	110	7.1	1.1	6.6
28	120	10	120	7.2	1.2	7.2
29	130	10	130	7.2	1.2	7.2
30	140	10	140	7.2	1.2	7.2
31	150	10	150	7.2	1.2	7.2
32	160	10	160	7.2	1.2	7.2
33	170	10	170	7.2	1.2	7.2
34	180	10	180	7.2	1.2	7.2
35	190	10	190	7.2	1.2	7.2
36	200	10	200	7.2	1.2	7.2
	TOTAL				**27.6**	

Annexure-VII VES Results, Morshi and Warud taluka, Amravati District

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
1	Warud	4 Km North of Warud	21°29'54.5"	78°16'01.7"	11	I	10	2.3	2.3	Top Soil
						II	14	10.3	12.6	Weathered Basalt
						III	104	30.1	42.7	Massive Basalt
						IV	8	36	78.7	Fractured Basalt
						V	752			Massive Basalt
2	Dhanodi	At 4 km Stone to Warud on Dhanodi Road	21°28'43.0"	78°18'07.5"	12	I	10	2.6	2.6	Top Soil
						II	5	2.1	4.7	Weathered Basalt
						III	41	186.1	190.8	
						IV	601			Massive Basalt
3	Malkhed	North of the village	21°29'32.3"	78°18'17.3"	13	I	12	1.2	1.2	Top Soil
						II	5	7.4	8.6	Weathered Basalt
						III	13	20.5	29.1	
						IV	35			Fractured Basalt
4	Dhanodi	At 8 km Stone to Warud	21°29'15.0"	78°20'08.5"	14	I	14	0.9	0.9	Top Soil
						II	25	4.5	5.4	Weathered Basalt
						III	89	6.5	11.9	Massive Basalt
						IV	8	26.4	26.4	Fractured Basalt
						V	109			Massive Basalt
5	Urad	1 km from Pusla on Mowad Road	21°29'53.0"	78°22'02.4"	15	I	13	0.9	0.9	Top Soil
						II	9	5.6	6.5	Weathered Basalt
						III	46	72	78.5	Vesicular Basalt
						IV	152			Massive Basalt
6	Ganeshpur	4.5 km from Ganeshpur on Urad Road	21°28'13.8"	78°24'08.4"	16	I	9	0.6	0.6	Top Soil
						II	20	6.5	7.1	Weathered Basalt
						III	130	60.9	68	Massive Basalt
						IV	14			Fractured Basalt
7	Sawangi	Near GP School	21°28'01.6"	78°22'34.6"	17	I	36	9.3	9.3	Top Soil
						II	20	32.7	42	Weathered Basalt
						III	52			Vesicular Basalt
8	Godhni	4 Km from Mowad on Borgaon Road	21°29'15.0"	78°26'30.0"	18	I	21	0.4	0.4	Top Soil
						II	10	5.7	6.1	Weathered Basalt
						III	15	27.1	33.2	
						IV	82			Massive Basalt
9	Belona	1 Km E of Belona on Norkhed Road	21°28'15.0"	78°29'15.0"	19	I	23	3.2	3.2	Top Soil
						II	81	13.8	17	Massive Basalt
						III	149	133	150	

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						IV	11			Fractured Basalt
10	Khargaon	3 km from khairgaon on Yerla Road	21°26'30.0"	78°28'40.0"	20	I	12	0.9	0.9	Top Soil
						II	8	3.4	4.3	Weathered Basalt
						III	15	16.6	20.9	
						IV	8.5	24.8	24.8	
						V	111			Masive Basalt
11	Narsingi	Near Dug Well	21°21'46.2"	78°27'00.0"	21	I	21	0.8	0.8	Top Soil
						II	5.4	9.1	9.9	Weathered Basalt
						III	25	25	34.9	Fractured Basalt
						IV	7.4	44.9	44.9	
						V	271			Masive Basalt
12	Rohna	1 km SE of the Village on Katol Road	21°20'29.4"	78°28'51.0"	22	I	26	0.7	0.7	Top Soil
						II	4.8	3	3.7	Weathered Basalt
						III	6.3	18.4	22.1	
						IV	315	55.1	55.1	Masive Basalt
						V	6.5			Fractured Basalt
13	Jamgaonkalan	At 2 km to Kapa, 500m W of Jamgaonkalan Village	21°19'27.2"	78°25'50.8"	23	I	10	1.97	1.97	Top Soil
						II	25	2.4	4.37	Weathered Basalt
						III	455	24	28.37	Masive Basalt
						IV	100			
14	Ghogra	At 1 km Stone to Ghogra Village	21°17'35.1"	78°25'09.2"	24	I	14	1.7	1.7	Top Soil
						II	416	2.4	4.1	Masive Basalt
						III	4.4	18.2	22.3	Fractured Basalt
						IV	181			Masive Basalt
15	Lohara	500m from Lohara on Lohara-Sawangi Road	21°16'01.0"	78°24'16.0"	25	I	6.4	1.98	1.98	Top Soil
						II	20	2.35	4.33	Weathered Basalt
						III	175	17.8	22.13	Masive Basalt
						IV	6	24.8	46.93	Fractured Basalt
						V	2455			Masive Basalt
16	Datewadi	1 km East of the Village	21°20'54.2"	78°24'47.5"	26	I	41	1.4	1.4	Top Soil
						II	21	2.5	3.9	Weathered Basalt
						III	16	15	18.9	
						IV	185	73.9	92.8	Masive Basalt
						V	11			Fractured Basalt
17	Wadhona	1 km S of the Village on Ramthi Road	21°18'42.6"	78°21'57.3"	27	I	70	0.6	0.6	Top Soil
						II	175	7.4	8	Masive Basalt
						III	421	4.5	12.5	

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						IV	90	180.6	193.1	
						V	8.2			Fractured Basalt
18	Ramthi	1 km S of the Village on Arambhi Road	21°16'46.5"	78°21'07.2"	28	I	156	1.25	1.25	Top Soil
						II	83	11.9	13.15	Masive Basalt
						III	1347	28.3	41.45	
						IV	5.5			Fractured Basalt
19	Kharala	1 km W of the Village on Arambhi Road	21°15'17.8"	78°21'28.4"	29	I	68	1.1	1.1	Top Soil
						II	192	5.3	6.4	Masive Basalt
						III	65	39.9	46.3	
						IV	145			
20	Pandhardhakni	1 km N of the Village	21°17'13.5"	78°26'33.6"	30	I	23	0.6	0.6	Top Soil
						II	14000	1.3	1.9	Masive Basalt
						III	117			
21	Sinjar	Near Bus Stop	21°20'48.5"	78°22'29.7"	31	I	17	0.9	0.9	Top Soil
						II	7.4	3.5	4.4	Weathered Basalt
						III	20	5.2	9.6	
						IV	102	11.3	11.3	Masive Basalt
						V	24	24.8	36.1	Fractured Basalt
						VI	65			Masive Basalt
22	Dawsa	500m E of the village	21°20'33.4"	78°20'26.2"	32	I	12	0.9	0.9	Top Soil
						II	6.5	3	3.9	Weathered Basalt
						III	45	4.3	8.2	Vesicular Basalt
						IV	10	9	9	Fractured Basalt
						V	61	58.2	67.2	Masive Basalt
						VI	1.7			Fractured Basalt
23	Thadipavni	Near 1 km stone at Thadipavni on Ambada Road	21°21'03.0"	78°17'57.6"	33	I	15	0.9	0.9	Top Soil
						II	6.7	13.5	14.4	Weathered Basalt
						III	14	33.2	47.6	
						IV	4881			Masive Basalt
24	Waghal	500m W of the village	21°20'54.3"	78°15'43.1"	34	I	9	3.4	3.4	Top Soil
						II	17	3.5	6.9	Weathered Basalt
						III	7.5	10.4	17.3	
						IV	37	139.5	139.5	Fractured Basalt
						V	755			Masive Basalt
25	Wadegaon	At 10 Km stone to Warud on Gadegaon Road	21°23'46.2"	78°16'22.1"	35	I	14	1.1	1.1	Top Soil
						II	6.4	8.8	9.9	Weathered Basalt
						III	76	13.7	23.6	Masive Basalt

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						IV	19			Fractured Basalt
26	Dhanodi	North of the village	21°29'04.6"	78°18'14.2"	36	I	15	2	2	Top Soil
						II	103	2.9	4.9	Masive Basalt
						III	5.6	5.8	10.7	Fractured Basalt
						IV	29	201	211.7	
						V	322			Masive Basalt
27	Mowad	8 km to Narkhed on Mowad-Narkhed road, at 8 km atone	21°28'34.1"	78°27'43.7"	37	I	23	0.75	0.75	Top Soil
						II	4	6.9	7.65	Weathered Basalt
						III	24	26.1	33.75	
						IV	184	23.5	57.25	Masive Basalt
						V	5.7	44.5	44.5	Fractured Basalt
						VI	17	40	84.5	Fractured Basalt
						VII	178			Masive Basalt
28	Belona	300m N of School, behind School	21°29'05.8"	78°29'19.9"	38	I	34	1	1	Top Soil
						II	146	2.1	3.1	Masive Basalt
						III	8	2.9	6	Fractured Basalt
						IV	107			Masive Basalt
29	Tinkheda	4.5 km to Bhishur on Bhishur-Tinkheda Road	21°23'44.8"	78°29'37.9"	39	I	5.4	2.1	2.1	Top Soil
						II	323	5.9	8	Masive Basalt
						III	17	3.6	11.6	Fractured Basalt
						IV	106			Masive Basalt
30	Inderwada	0.5 km W of the Village	21°21'16.1"	78°27'37.5"	40	I	52	0.7	0.7	Top Soil
						II	2.8	0.9	1.6	Weathered Basalt
						III	1420	3.6	5.2	Masive Basalt
						IV	3.6	38.4	43.6	Fractured Basalt
						V	1206			Masive Basalt
31	Udapur	0.5 km W of the Village	21°24'46.1"	78°19'34.9"	41	I	11	0.9	0.9	Top Soil
						II	5.9	15.7	16.6	Weathered Basalt
						III	72			Masive Basalt
32	Khargaon	0.5 km S of the Village	21°25'59.6"	78°26'56.1"	42	I	12	0.7	0.7	Top Soil
						II	3.8	4.6	5.3	Weathered Basalt
						III	14	35.6	40.9	
						IV	445			Masive Basalt
33	Thugaondev	SW of the village laong the Road n Jallkheda-Mowad	21°24'16.7"	78°27'11.8"	43	I	13	0.9	0.9	Top Soil
						II	6.7	3	3.9	Weathered Basalt
						III	9.5	4.2	8.1	
						IV	6.9	26.9	35	Fractured Basalt

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						V	72	123.8	123.8	Masive Basalt
						VI	4380			
34	Porgavhan	S of the Village	21°25'34.1"	78°25'39.7"	44	I	15	2	2	Top Soil
						II	42	7.4	9.4	Vesicular Basalt
						III	3	7	16.4	Fractured Basalt
						IV	42	97.8	114.2	Vesicular Basalt
						V	2784			Masive Basalt
35	Warud	1 km from Warud on Nagpur Road	21°27'50.6"	78°16'50.7"	45	I	10	1.1	1.1	Top Soil
						II	6.3	7.1	8.2	Weathered Basalt
						III	61	25.6	33.8	Masive Basalt
						IV	12	31.4	65.2	Fractured Basalt
						V	236	37	102.3	Masive Basalt
						VI	2488			
36	Sahur	1 km S of the vllage on Dhadi Road	21°18'04.0"	78°13'16.6"	46	I	286	0.8	0.8	Top Soil
						II	8.7	8.2	9	Weathered Basalt
						III	29	63.3	72.3	Fractured Basalt
						IV	177	28.6	100.9	Masive Basalt
						V	151	56.6	157.5	
						VI	33			Fractured Basalt
37	Manikwada	1 km E of the vllage on Susundra Road	21°15'52.2"	78°17'02.1"	47	I	9.5	1.8	1.8	Top Soil
						II	4.8	1.9	3.7	Weathered Basalt
						III	98	14	17.7	Masive Basalt
						IV	23	15.4	33.1	Fractured Basalt
						V	83			Masive Basalt
38	Jamgaon	W of the Village on Mnaikwada Road	21°17'09.6"	78°14'39.2"	48	I	33	0.7	0.7	Top Soil
						II	5.9	0.6	1.3	Weathered Basalt
						III	32	86.2	87.5	Fractured Basalt
						IV	154			Masive Basalt
39	Wadala	W of the Village	21°19'39.5"	78°09'48.3"	49	I	60	2.6	2.6	Top Soil
						II	1308	3.3	5.9	Masive Basalt
						III	68			
40	Nandgaon	SE of the village	21°20'59.1"	78°14'25.6"	50	I	27	0.5	0.5	Top Soil
						II	4.4	16.8	17.3	Weathered Basalt
						III	44			Vesicular Basalt
41	Nimbi	Backside of the School	21°15'04.8"	77°58'02.4"	51	I	10	0.9	0.9	Top Soil
						II	30	1.2	2.1	Weathered Basalt
						III	7	2.7	4.8	Weathered Basalt

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						IV	453	21.1	25.9	Masive Basalt
						V	3.6			Fractured Basalt
42	Nimbi	7m S of AMT NAMP 2012051	21°15'04.8"	77°58'02.4"	52	I	13	3.7	0.9	Top Soil
						II	57	9.2	1.2	Vesicular Basalt
						III	305	15.6	2.7	Masive Basalt
						IV	13			Fractured Basalt
43	Nandurapinlai	Infront of Mandir	21°07'56.6"	77°57'13.8"	53	I	17	0.9	0.9	Top Soil
						II	162	3.1	4	Masive Basalt
						III	107	13.3	17.3	Masive Basalt
						IV	43	18.7	36	Vesicular Basalt
						V	162			Masive Basalt
44	Nandurapinlai	10m N of AMT NAMP 2012053	21°07'56.6"	77°57'13.8"	54	I	17	0.9	0.9	Top Soil
						II	274	3	3.9	Masive Basalt
						III	61	72	75.9	
						IV	211			
45	Wardhi	In front of the School	21°07'19.0"	77°56'15.5"	55	I	26	2.6	2.6	Top Soil
						II	213	3.7	6.3	Masive Basalt
						III	125			
46	Gadegaon	On Warud road	21°21'47.0"	77°15'43.0"	WB-73	I	20	0.5	0.4547	Top Soil
						II	7	2.3	2.7297	Weathered Basalt
						III	10	4.2	6.9377	
						IV	20	24.7	24.65	Fractured Basalt
						V	175			Masive Basalt
47	Rajura	South of Rajura	21°24'29.0"	78°16'40.0"	WB-74	I	49	0.4	0.3975	Top Soil
						II	5	5.2	5.6395	Weathered Basalt
						III	3	3.9	9.4915	
						IV	42	82.3	82.28	Vesicular Basalt
						V	236			Masive Basalt
48	Warud	Adrsh Nagar on Warud Murshi road (by the side of cottan mill)	21°28'11.0"	78°15'31.0"	WB-77	I	12	0.9	0.9	Top Soil
						II	5	1.1	2.01	Weathered Basalt
						III	19	8.2	10.201	
						IV	8	12.4	12.36	
						V	142			Masive Basalt
49	Sawangi		21°28'0.0"	78°22'18.0"	WB-84	I	86	1.6	1.56	Top Soil
						II	52	1.5	3.09	Masive Basalt
						III	318	4.7	7.83	
						IV	26	5.6	5.57	Fractured Basalt

Sr. No.	Village	Location	Lat	Long	Geo-electrical parameters					Anticipated Lithology
					VES	Layer	Resistivity in Ohm m	Thickness in m	Depth to the bottom of the layer in m	
1	2	3	4	5	6	7	8	9	10	11
						V	115			Masive Basalt
50	Jamthi Ganeshpur		21°28'0.0"	78°25'49.0"	WB-85	I	9	0.9	0.9	Top Soil
						II	3	1.5	2.4	Weathered Basalt
						III	6	24.6	27	
						IV	77			Masive Basalt
51	Amner		21°23'23.0"	78°24'27.0"	WB-86	I	7	0.9	0.9	Top Soil
						II	5	9.2	10.061	Weathered Basalt
						III	10	40.0	50.041	
						IV	72			Masive Basalt
52	Amner	4 km from Amner on Amner Wedapur Khairgaon road	21°25'0.0"	78°26'36.0"	WB-87	I	10	0.6	0.6	Top Soil
						II	4	5.6	6.2	Weathered Basalt
						III	25	21.2	27.4	Fractured Basalt
						IV	6	23.5	23.5	
						V	314			Masive Basalt
53	Dhaga	Between Dhaga and Ekdara	21°23'18.0"	78°23'18.0"	WB-88	I	18	2.0	2.01	Top Soil
						II	6	2.5	4.489	Weathered Basalt
						III	37	18.4	22.889	Fractured Basalt
						IV	8	27.6	27.61	
						V	125			Masive Basalt
54	Wathoda		21°26'10.0"	78°21'10.0"	WB-89	I	13	1.9	1.902	Top Soil
						II	4	2.3	4.167	Weathered Basalt
						III	11	5.5	9.705	
						IV	4	12.2	12.23	
						V	30			Vesicular Basalt
55	Surli		21°26'40.0"	78°18'40.0"	WB-90	I	9	0.9	0.9	Top Soil
						II	44	9.1	10.037	Vesicular Basalt
						III	17	12.4	22.397	Fractured Basalt
						IV	209			Masive Basalt

Annexure-VIII Aquifer-I, Depth to water level data Warud and Morshi taluka, Amravati district

S.No	KOW. No.	Village	Latitude(N)	Longitude (E)	Depth (m bgl)	RL	JUNE-12	AUG-12	Nov-12	JAN-13	May-13	AUG-13	NOV-13	JAN-14	MAY-14	AUG-14	NOV-14	JAN-15
24	VJ-8	Pardi	21°17'39"	78°01'28.8"	11.40	331	5.30	0.75	2.85	2.50	5.60	1.50	1.30	5.10	5.90	2.30	3.70	3.10
19	VJ-3	Loni	21°22'29''	78°11'08''	14.15	363.1	12.00	15.00	12.00	12.60	12.60	12.30	12.30	11.00	14.00	13.50	13.70	13.00
9	AN-0	Vichori	21°13'09.2"	77°56'34.7"	200.00	346.8	12.50	4.80	5.83	10.90	9.30	5.00	8.10	8.90	10.40	6.26	8.40	9.80
13	KPD-26K7	Surli	21°27'01"	78°18'26"	30.00	388.6	22.25	6.35	9.65			10.00	12.50	10.50	23.40	8.60	12.50	22.50
3	AN-32	Gorala	21°11'45.3"	77°51'45.9'	17.10	357.9	4.75	0.40	3.80	7.70	6.50	0.10	3.50	9.85	6.50	5.50	4.90	6.60
27	VJ-11	Pimpri	21°21'47.6"	77°51'59.1"	7.60	426.4	6.00	1.50	3.30	4.50	7.00	2.15	3.70	4.70	6.30	2.80	4.70	6.35
22	VJ-6	Morshi	21°20'08''	78°00'11''	16.10	349.1	8.50	5.35	5.35	7.30	9.30	6.00	5.40	6.95	8.40	6.00	6.50	6.95
29	VJ-13	Ambara	21°19'46"	77°54'27"	13.60	386.3	11.50	1.80	2.70	4.97	12.00	2.00	3.80	5.05	12.10	2.20	4.20	4.95
17	VJ-1	Benoda	21°27'21''	78°10'56''	15.90	414.3	10.35	5.40	5.20	7.30	10.20	6.00	8.60	8.25	11.00	5.00	7.80	9.00
11	KPD-15K7	Dhanodi	21°28'57"	78°17'59"	15.00	404.7	7.70	4.85	6.50		8.80	5.23	5.30	5.80	8.10	6.25	6.80	7.83
21	VJ-5	Mamdapur	21°22'41"	78°07'55"	7.90	348.4	6.60	2.25	3.65	3.80	7.00	2.15	2.50	5.30	6.70	2.60	3.90	4.10
18	VJ-2	Jarud	21°27'34''	78°13'09''	16.21	412	14.05	13.80	13.20	12.00	14.56	11.05	13.80	12.36	15.00	12.90	14.30	9.80
4	AN-34	Katpur	21°09'12.9"	77°50'50'	17.00	348.4	20.40	5.05	10.10	19.40	18.95	6.20			18.95	4.00	10.80	18.50
8	AN-46	Talegaon	21°13'28.1"	77°53'33.0"	17.60	359.2	4.30	1.25	2.10	3.70	5.55	1.60	2.70	3.50	5.55	1.55	3.10	4.10
15	KPD-33K7	Gadegaon	21°21'31"	78°15'21"	20.00	358.7	17.10	13.80	13.30	13.23	17.80	9.60	10.00	10.90	18.20	15.60	12.20	15.88
12	KPD-18K7	Sawangi	21°27'42"	78°22'04"	20.00	392	15.65	10.20	12.75			8.30	9.20	10.70	15.00	6.80	11.50	14.40
10	KPD-5K7	Ekalvihir	21°29'54"	78°24'27"	15.00	420	12.35	1.80	5.15			1.90	5.40	6.80	11.40	2.20	5.80	10.50
2	AN-30	Dhamangaon	21°13'41.5"	77°51'11.1"	8.35	373.8	12.02	7.00	6.80	7.00	10.55	7.15	7.15	8.80	10.55	6.40	7.40	10.35
31	VJ-15	Khanapur	21°18'53"	77°57'9.2"	14.10	376.3	9.30	1.95	4.45	6.50	9.80	2.13	6.90	7.20	9.60	3.40	6.10	7.60
25	VJ-9	Nagarwadi	21°21'39.4"	77°47'8.8"	14.25	429.7	9.00	8.10	5.80	7.60	9.10	8.30	6.75	8.60	10.00	7.10	6.60	8.75
28	VJ-12	Uthkhed	21°16'45.5	77°53'21"	22.35	373	16.80	13.30	15.40	14.56	17.00	13.90	12.60	14.35	17.00	12.10	14.30	
30	VJ-14	Taroda	21°21'50"	77°58'24.3"	11.00	376.7	10.35	7.50	6.70	7.50	11.20	7.70	7.30	9.40	11.30	9.75	7.30	9.55
32	VJ-16	Talni-2	21°16'52.3"	77°58'47.5"	7.25	361.7	4.70	1.35	3.80	4.20	4.80	2.30	3.31	3.50	4.80	1.75	3.85	3.75
14	KPD-30K7	Pavni	21°23'21"	78°19'18"	18.00	361	8.27	6.45	4.40			3.00	2.00	5.60	8.80	3.20	3.40	3.50
5	AN-62	Ner Pingli	21°09'05.5''	77°56'10.6''	8.95	381.3	8.80	4.95	6.00	8.00	7.90	4.45	5.90	4.00	7.90	1.45	6.10	7.30
7	AN-25	Shirkhed PZ	21°14'53.9"	77°55'47.6"	8.20	349	4.75	1.60	0.00	4.40	4.80	-0.65	-0.32	0.78	4.90	-0.65	-0.30	1.15
26	VJ-10	Wani	21°19'47"	77°46'58"	14.00	412.7	11.10	5.70	10.50	9.20	12.60	10.80	9.70	9.65	12.07	10.00	10.20	9.80
20	VJ-4	Hathorna	21°20'09"	78°13'56''	19.45	353.7	13.30	12.00	10.95	10.20	13.90	10.30	9.10	9.85	14.00	8.50	10.10	9.00
23	VJ-7	Bhaipur-1	21°21'22.20"	78°01'56.46"	14.65	343.4	10.25	11.60	6.80	9.30	11.00	12.30	6.20	7.05	10.10	6.30	6.40	7.40
1	AN-17	Adgaon	21°10'58.5'	77°58'52.8"	11.00	348.3	7.50	2.30	2.70	5.25	7.45	2.45	2.40	3.90	7.60	1.95	2.30	4.80
6	AN-0	Nimbhi	21°12'48.2"	77°53'3.04"	21.00	363.2	6.25	1.05	4.25	6.40	4.60	2.50	6.40	4.30	4.60	1.85	5.00	4.90
16	KPD-92K7	Warud	21°28'35"	78°15'24"	15.00	407	9.50	7.40	7.35	7.72	9.10	5.00	4.00	4.70	6.60	4.90	5.00	5.83

Annexure-IX Aquifer-II, Depth to water level Morshi and Warud taluka, Amravati district

Village	Type of well	Taluka	Latitude	Longitude	Y	X	Depth (mbgl)	SWL Pre 2014 (mbgl)	SWL Post 2014 (mbgl)
Astagoan	EW	Morshi	21°18'30"	77°55'28"	21.30833	77.92444	200.00	55.00	55
Gadegaon	OW	Warud	21°22′00″	78°15′55″	21.36667	78.26528	73.50	8.12	6.25
Hiwarkhed	EW	Morshi	21°23'58"	78°04'39"	21.39944	78.0775	172.10	6.9	5.62
Jarud	EW	Warud	21°27'32"	78°13'08"	21.45889	78.21889	200.00	9.2	7.70
Katpur	EW	Morshi	21°12'55"	77°54'55'	21.21528	77.91528	194.00	7.2	5.9
Nimbhi	OW	Morshi	21°14'52"	77°57'56"	21.24778	77.96556	200.00	5.4	4.28
Peth Mangruli	EW	Warud	21°09'14"	77°53'26"	21.15389	77.89056	200.00	17.75	14.55
Sawangi	EW	Warud	21°28′ 02″	78°22′35″	21.46667	78.37639	200.00	100.00	100
Sawarkhed	EW	Morshi	21°10'53"	77°53'26'	21.18139	77.89056	200.00	9.40	8.7
Shirkhed	EW	Morshi	21°13'05"	77°56'39"	21.21806	77.94417	200.00	14.25	10.83
Surli	EW	Warud	21°27′01″	78°18′26″	21.45028	78.30722	152.00	15.65	13
Talani	EW	Morshi	21°17'09"	77°59'17"	21.28583	77.98806	200.00	8.10	6.4
Talegaon	EW	Morshi	21°13'41"	77°57'13"	21.22806	77.95361	203.00	3.80	3.2
Ner Pinglai	EW	Morshi	21°10'22"	77°59'00'	21.17278	77.98333	166.85	27.15	24.3

Annexure-X Aquifer-I, Pre and Post Monsoon water level trend (2006-15), Morshi and Warud taluka, Amravati district.

Village	Taluka	Y	X	TREND Pre-monsoon (cm/yr)	TREND Pre-monsoon (m/yr)	TR_ Pre-monsoon	TREND Post-monsoon (cm/yr)	TREND Post-monsoon (m/yr)	TR_ Post-monsoon
Bhivkundi	MORSHI	21.39583	77.96972	-18.93	-0.19	RISING	-108.57	-1.09	RISING
Chikhalsawangi	MORSHI	21.32556	77.95917	-12.06	-0.12	RISING	-54.15	-0.54	RISING
Dapori	MORSHI	21.39167	78.05833	-17.62	-0.18	RISING	-123.78	-1.24	RISING
Dhanora	MORSHI	21.36944	77.97306	-29.27	-0.29	RISING	-15.00	-0.15	RISING
Donger Yawali New	MORSHI	21.40556	78.04167	-45.97	-0.46	RISING	-41.27	-0.41	RISING
Hiwarkhed	MORSHI	21.40278	78.08333	-25.21	-0.25	RISING	-75.87	-0.76	RISING
Kamlapur	MORSHI	21.17083	78.05	-26.64	-0.27	RISING	-39.55	-0.40	RISING
Khanapur	MORSHI	21.23194	77.95	-29.70	-0.30	RISING	-22.55	-0.23	RISING
Morshi	MORSHI	21.3375	78.01111	4.76	0.05	RISING	3.82	0.04	RISING
Pala	MORSHI	21.38639	78.01667	-26.42	-0.26	RISING	-7.76	-0.08	RISING
Pimpalkhuta	MORSHI	21.25806	78.00944	2.36	0.02	RISING	-20.70	-0.21	RISING
Riddhapur	MORSHI	21.24444	77.78611	-47.79	-0.48	RISING	-73.52	-0.74	RISING
Umarkhed	MORSHI	21.42444	78.11083	-1.35	-0.01	RISING	-15.67	-0.16	RISING
Vishnora	MORSHI	21.25611	77.87472	5.46	0.05	RISING	-0.19	0.00	RISING
Yerla	MORSHI	21.31667	77.98889	-22.12	-0.22	RISING	-26.15	-0.26	RISING
Amdapur	WARUD	21.41389	78.27139	0.00	0.00	RISING	106.42	1.06	FALLING
Amner	WARUD	21.39167	78.38611	-18.82	-0.19	RISING	-65.09	-0.65	RISING
Benoda	WARUD	21.45833	78.18333	-20.06	-0.20	RISING	-88.24	-0.88	RISING
Dhaga	WARUD	21.41667	78.41806	-0.30	0.00	RISING	-42.73	-0.43	RISING
Haturna New	WARUD	21.33056	78.23333	12.48	0.12	FALLING	-33.27	-0.33	RISING
Jamgaon	WARUD	21.45972	78.1375	-39.69	-0.40	RISING	-112.64	-1.13	RISING
Jarud	WARUD	21.45833	78.21667	-84.94	-0.85	RISING	-87.64	-0.88	RISING
Karajgaon-1	WARUD	21.40611	78.20056	-22.79	-0.23	RISING	-51.91	-0.52	RISING
Karwar	WARUD	21.54722	78.42222	19.35	0.19	FALLING	-73.80	-0.74	RISING
Mahendri	WARUD	21.51111	78.39306	-13.73	-0.14	RISING	-60.06	-0.60	RISING
Musalkhed New	WARUD	21.45	78.35278	5.61	0.06	RISING	-43.18	-0.43	RISING
Pandhari	WARUD	21.54167	78.38472	5.27	0.05	RISING	-24.67	-0.25	RISING
Pawani New	WARUD	21.38889	78.32361	-37.39	-0.37	RISING	-44.36	-0.44	RISING
Pimpalgad	WARUD	21.58056	78.41389	25.45	0.25	FALLING	-14.24	-0.14	RISING
Pusala	WARUD	21.50694	78.35972	-18.12	-0.18	RISING	-6.79	-0.07	RISING
Rawala	WARUD	21.55972	78.275	-19.35	-0.19	RISING	-178.19	-1.78	RISING
Satnur New	WARUD	21.55417	78.30139	4.12	0.04	RISING	-10.48	-0.10	RISING
Surali	WARUD	21.41944	78.20694	-27.76	-0.28	RISING	-79.30	-0.79	RISING
Tembhurkheda	WARUD	21.5	78.23889	-50.96	-0.51	RISING	-147.43	-1.47	RISING
Teosaghat	WARUD	21.525	78.27083	-48.33	-0.48	RISING	-107.18	-1.07	RISING
Warud	WARUD	21.46861	78.25444	-83.64	-0.84	RISING	-108.73	-1.09	RISING

-ve value indicates rising while +ve value indicates falling trend.

Annexure XI Location of proposed Percolation tanks in Morshi and Warud taluka, Amravati district

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
1	Ajampur	Morshi	77.8568	21.1988	Percolation tank
2	Akhatwada	Morshi	78.0047	21.2082	Percolation tank
3	Ambada	Morshi	77.8965	21.3316	Percolation tank
4	Asona	Morshi	77.9937	21.2533	Percolation tank
5	Bopalawadi	Morshi	78.0658	21.4083	Percolation tank
6	Dapori	Morshi	78.0623	21.3882	Percolation tank
7	Dapori	Morshi	78.052	21.3781	Percolation tank
8	Dhamangaon	Morshi	77.8913	21.2232	Percolation tank
9	Dhanora	Morshi	77.9741	21.3659	Percolation tank
10	Indur	Morshi	77.8805	21.3216	Percolation tank
11	Jamathi	Morshi	78.0275	21.4103	Percolation tank
12	Katpur	Morshi	77.9103	21.2164	Percolation tank
13	Khanpur	Morshi	77.9346	21.2415	Percolation tank
14	Khanpur	Morshi	77.9565	21.239	Percolation tank
15	Khanpur	Morshi	77.9337	21.2415	Percolation tank
16	Khed	Morshi	77.8735	21.2962	Percolation tank
17	Khed	Morshi	77.8614	21.3117	Percolation tank
18	Khopada	Morshi	77.9258	21.2676	Percolation tank
19	Khopada	Morshi	77.925	21.2669	Percolation tank
20	Kolvihir	Morshi	77.8477	21.2715	Percolation tank
21	Kolvihir	Morshi	77.8553	21.275	Percolation tank
22	Kolvihir	Morshi	77.8553	21.274	Percolation tank
23	Kopara	Morshi	78.0011	21.361	Percolation tank
24	Ladki	Morshi	77.9322	21.2447	Percolation tank
25	Lashkarpur	Morshi	77.9011	21.2406	Percolation tank
26	Lihida	Morshi	77.9839	21.2278	Percolation tank
27	Mamdapur	Morshi	77.9311	21.2256	Percolation tank
28	Mangrul	Morshi	77.8795	21.1707	Percolation tank
29	Mangrul	Morshi	77.8871	21.1685	Percolation tank
30	Molvan	Morshi	78.0766	21.4267	Percolation tank
31	Nerpingalai	Morshi	77.9979	21.1733	Percolation tank
32	Nerpingalai	Morshi	77.9968	21.1979	Percolation tank
33	Nerpingalai	Morshi	77.9859	21.192	Percolation tank
34	Nerpingalai	Morshi	77.9724	21.1968	Percolation tank
35	Nerpingalai	Morshi	77.9797	21.1821	Percolation tank
36	Pala	Morshi	77.9994	21.3771	Percolation tank
37	Pala	Morshi	78.002	21.402	Percolation tank
38	Pimpalkhuta	Morshi	77.9363	21.2862	Percolation tank
39	Porgavhan	Morshi	77.8871	21.2436	Percolation tank
40	Rajurwadi	Morshi	78.0554	21.1943	Percolation tank
41	Rohnal	Morshi	77.9555	21.2914	Percolation tank
42	Sawarkhed	Morshi	77.9424	21.1763	Percolation tank
43	Shirajgaon	Morshi	77.8991	21.1516	Percolation tank
44	Shirkhed	Morshi	77.9315	21.213	Percolation tank
45	Talni	Morshi	77.9951	21.2794	Percolation tank
46	Taroda	Morshi	77.8485	21.2853	Percolation tank
47	Udkhed	Morshi	77.9027	21.2757	Percolation tank
48	Vichori	Morshi	77.8616	21.1982	Percolation tank
49	Vishnora	Morshi	77.8784	21.2524	Percolation tank
50	Yerla	Morshi	77.9982	21.3203	Percolation tank
51	Ajitpur-bhapki	Warud	78.1928	21.3515	Percolation tank
52	Antarkhop	Warud	78.2661	21.4961	Percolation tank
53	Asona.	Warud	78.1709	21.3795	Percolation tank
54	Asona.	Warud	78.1661	21.403	Percolation tank
55	Babhulkheda	Warud	78.3991	21.4114	Percolation tank
56	Bargaon.	Warud	78.1366	21.4436	Percolation tank
57	Benoda.	Warud	78.1853	21.4632	Percolation tank
58	Beskheda	Warud	78.4017	21.4315	Percolation tank
59	Beskheda.	Warud	78.4219	21.4321	Percolation tank
60	Bhalapur.	Warud	78.4127	21.4584	Percolation tank
61	Bhandoli	Warud	78.3108	21.4527	Percolation tank

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
62	Bhandoli.	Warud	78.3166	21.4607	Percolation tank
63	Chichargawan	Warud	78.2952	21.4241	Percolation tank
64	Chinchargavhan.	Warud	78.2945	21.4323	Percolation tank
65	Davargaon	Warud	78.2498	21.4252	Percolation tank
66	Deutwada	Warud	78.3426	21.3892	Percolation tank
67	Ekalvihir	Warud	78.4097	21.4823	Percolation tank
68	Ekalvihir	Warud	78.4104	21.4947	Percolation tank
69	Ekdara	Warud	78.3916	21.4304	Percolation tank
70	Gaulkheda	Warud	78.2361	21.3728	Percolation tank
71	Ghorad	Warud	78.3586	21.3938	Percolation tank
72	Ghorad	Warud	78.3685	21.411	Percolation tank
73	Goregaon	Warud	78.1644	21.4316	Percolation tank
74	Jamthi Ganeshpur.	Warud	78.4013	21.4695	Percolation tank
75	Jarud.	Warud	78.239	21.4539	Percolation tank
76	Kekatwada.	Warud	78.3422	21.4761	Percolation tank
77	Khadka.	Warud	78.1204	21.4501	Percolation tank
78	Linga	Warud	78.4297	21.5031	Percolation tank
79	Linga	Warud	78.4271	21.5296	Percolation tank
80	Linga.	Warud	78.4227	21.4968	Percolation tank
81	Malkapur	Warud	78.2918	21.513	Percolation tank
82	Malkhed	Warud	78.3173	21.5012	Percolation tank
83	Malkhed	Warud	78.3021	21.4964	Percolation tank
84	Mangruli	Warud	78.2423	21.4036	Percolation tank
85	Mangruli	Warud	78.2301	21.4065	Percolation tank
86	Mankapur	Warud	78.153	21.4665	Percolation tank
87	Morangana	Warud	78.2615	21.4043	Percolation tank
88	Morshi Kh	Warud	78.4345	21.4092	Percolation tank
89	Namapur	Warud	78.2066	21.39	Percolation tank
90	Pandhari	Warud	78.3784	21.5494	Percolation tank
91	Pardi	Warud	78.2891	21.4736	Percolation tank
92	Pawani	Warud	78.3214	21.3916	Percolation tank
93	Pawani	Warud	78.3089	21.3669	Percolation tank
94	Porgavhan	Warud	78.4146	21.416	Percolation tank
95	Pusla	Warud	78.3743	21.5156	Percolation tank
96	Pusla	Warud	78.3638	21.5218	Percolation tank
97	Rajura Bajar	Warud	78.2942	21.3981	Percolation tank
98	Ramapur	Warud	78.3603	21.5388	Percolation tank
99	Rasulpur	Warud	78.374	21.3994	Percolation tank
100	Roshankhed	Warud	78.2827	21.4269	Percolation tank
101	Shahapur	Warud	78.2503	21.4619	Percolation tank
102	Shekapur	Warud	78.3269	21.4424	Percolation tank
103	Shingori	Warud	78.1486	21.3558	Percolation tank
104	Tarodi	Warud	78.3927	21.4856	Percolation tank
105	Tembhurkheda	Warud	78.2456	21.4901	Percolation tank
106	Tiwsa	Warud	78.2835	21.5238	Percolation tank
107	Udapur	Warud	78.3297	21.4163	Percolation tank
108	Urad	Warud	78.3899	21.5046	Percolation tank
109	Wadegaon	Warud	78.2842	21.3781	Percolation tank
110	Warud	Warud	78.2664	21.4738	Percolation tank
111	Warud	Warud	78.2626	21.4809	Percolation tank
112	Wathoda	Warud	78.3464	21.4439	Percolation tank
113	Wawruli	Warud	78.2256	21.4121	Percolation tank
114	Wawruli	Warud	78.2094	21.4113	Percolation tank
115	Zolamba	Warud	78.1345	21.3924	Percolation tank

Annexure XII Location of proposed check dam in Morshi and Warud taluka, Amravati district

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
1	Adgaon	Morshi	77.8689	21.145	Check Dam
2	Adgaon	Morshi	77.8486	21.1646	Check Dam
3	Adgaon	Morshi	77.8527	21.1805	Check Dam
4	Ahmadpur	Morshi	78.0055	21.3596	Check Dam
5	Ajampur	Morshi	77.8652	21.1863	Check Dam
6	Ajampur	Morshi	77.8645	21.2008	Check Dam
7	Ajampur	Morshi	77.8546	21.193	Check dam
8	Akhatwada	Morshi	78.008	21.2059	Check Dam
9	Ambada	Morshi	77.9035	21.3389	Check Dam
10	Ambada	Morshi	77.8977	21.3228	Check Dam
11	Asona	Morshi	77.9925	21.2572	Check Dam
12	Asona	Morshi	77.9887	21.2628	Check dam
13	Aurangpur	Morshi	77.8792	21.1324	Check Dam
14	Bahadurnagar	Morshi	77.8103	21.2481	Check dam
15	Belona	Morshi	78.1113	21.3925	Check Dam
16	Bodna	Morshi	77.9207	21.2864	Check Dam
17	Bopalawadi	Morshi	78.0758	21.4086	Check Dam
18	Bopalawadi	Morshi	78.0599	21.4076	Check Dam
19	Chincholi	Morshi	77.94	21.364	Check dam
20	Chincholi	Morshi	77.9368	21.3681	Check dam
21	Dapori	Morshi	78.0553	21.3793	Check Dam
22	Dapori	Morshi	78.0624	21.3831	Check Dam
23	Daryapur	Morshi	77.9477	21.2408	Check Dam
24	Dhamangaon	Morshi	77.8905	21.2192	Check Dam
25	Ghoddeo Kh.	Morshi	78.0437	21.4206	Check Dam
26	Gorala	Morshi	77.9319	21.1598	Check Dam
27	Hashampur	Morshi	77.9918	21.2454	Check Dam
28	Hirapur	Morshi	77.8843	21.3317	Check Dam
29	Hiwarkhed	Morshi	78.0954	21.3779	Check Dam
30	Inapur	Morshi	77.9701	21.2377	Check Dam
31	Irur	Morshi	77.9157	21.3417	Check Dam
32	Irur	Morshi	77.9279	21.3372	Check dam
33	Irur	Morshi	77.9272	21.3421	Check dam
34	Irur	Morshi	77.9306	21.3405	Check dam
35	Jamathi	Morshi	78.0286	21.4126	Check Dam
36	Januna	Morshi	77.9345	21.3739	Check dam
37	Jayatapur	Morshi	78.0463	21.1928	Check dam
38	Kamalapur	Morshi	78.0493	21.1815	Check dam
39	Kamalapur	Morshi	78.0529	21.1898	Check dam
40	Katpur	Morshi	77.9057	21.2105	Check Dam
41	Katpur	Morshi	77.9062	21.2289	Check Dam
42	Khanapur	Morshi	77.9459	21.3226	Check dam
43	Khanapur	Morshi	77.9499	21.3255	Check dam
44	Khanapur	Morshi	77.9518	21.318	Check dam
45	Khanpur	Morshi	77.9294	21.2431	Check Dam
46	Khopada	Morshi	77.9256	21.2707	Check dam
47	Kopara	Morshi	77.9893	21.3558	Check Dam
48	Kopara	Morshi	77.9788	21.3612	Check Dam
49	Ladki	Morshi	77.9215	21.2524	Check Dam
50	Lihida	Morshi	77.9813	21.2205	Check Dam
51	Mamdapur	Morshi	77.916	21.2331	Check Dam
52	Mangrul	Morshi	77.8826	21.173	Check Dam
53	Mangrul	Morshi	77.8916	21.155	Check dam
54	Molvan	Morshi	78.0676	21.4298	Check Dam
55	Molvan	Morshi	78.0825	21.4287	Check Dam
56	Molvan	Morshi	78.0802	21.4174	Check Dam
57	MORSHI	Morshi	78.0294	21.3541	Check dam
58	Munaimpur	Morshi	77.9848	21.2306	Check Dam
59	Munaimpur	Morshi	77.9828	21.2488	Check Dam
60	Nerpingalai	Morshi	77.994	21.1793	Check Dam
61	Nerpingalai	Morshi	78.0009	21.1692	Check Dam

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
62	Nerpingalai	Morshi	77.9944	21.1607	Check Dam
63	Nerpingalai	Morshi	77.9695	21.159	Check Dam
64	Nerpingalai	Morshi	78.0012	21.1916	Check dam
65	Nerpingalai	Morshi	77.9684	21.196	Check dam
66	Nimbhi	Morshi	77.9512	21.2604	Check Dam
67	Nimbhi	Morshi	77.9583	21.2503	Check Dam
68	Nimbhi	Morshi	77.9652	21.2638	Check dam
69	Pala	Morshi	78.0117	21.3988	Check Dam
70	Pala	Morshi	77.9992	21.383	Check Dam
71	Pala	Morshi	78.0194	21.3703	Check dam
72	Pala	Morshi	78.0158	21.3733	Check dam
73	Pimpalkhuta	Morshi	77.9426	21.2749	Check Dam
74	Pimpalkhuta	Morshi	78.0131	21.2744	Check dam
75	Porgavhan	Morshi	77.8961	21.2497	Check Dam
76	Rajurwadi	Morshi	78.0599	21.2029	Check dam
77	Rasulpur	Morshi	77.9156	21.1495	Check Dam
78	Rasulpur	Morshi	77.9798	21.3398	Check dam
79	Rasulpur	Morshi	77.973	21.3442	Check dam
80	Rasulpur Belkhed	Morshi	77.9694	21.3488	Check dam
81	Rohnal	Morshi	77.9569	21.2951	Check Dam
82	Rohnal	Morshi	77.9349	21.2912	Check Dam
83	Sadanpur	Morshi	77.984	21.3356	Check dam
84	Salbardi	Morshi	78.0141	21.4074	Check Dam
85	Salepur	Morshi	78.0284	21.1571	Check Dam
86	Savanga	Morshi	77.836	21.1459	Check Dam
87	Sawarkhed	Morshi	77.985	21.3758	Check Dam
88	Sawarkhed	Morshi	77.9489	21.1812	Check Dam
89	Sawarkhed	Morshi	77.9387	21.1741	Check Dam
90	Sawarkhed	Morshi	77.9456	21.1918	Check Dam
91	Shahanawajpur	Morshi	77.9571	21.2205	Check Dam
92	Sherlas	Morshi	78.0349	21.1654	Check dam
93	Shirajgaon	Morshi	77.9023	21.1508	Check Dam
94	Shiralas	Morshi	78.0313	21.1776	Check Dam
95	Supala	Morshi	78.0256	21.3615	Check dam
96	Surwadi Bk.	Morshi	78.1096	21.3682	Check Dam
97	Talni	Morshi	78.0012	21.2703	Check dam
98	Taroda	Morshi	77.8488	21.2867	Check dam
99	Tuljapur	Morshi	78.0675	21.2209	Check dam
100	Vishnora	Morshi	77.8698	21.2485	Check dam
101	Vithalpur	Morshi	77.8351	21.1397	Check dam
102	Vitthalpur	Morshi	77.8511	21.1539	Check Dam
103	Wagholi	Morshi	77.919	21.1921	Check Dam
104	Yawali	Morshi	78.0409	21.4088	Check Dam
105	Yawali	Morshi	77.8875	21.1298	Check Dam
106	Ajitpur-bhapki	Warud	78.194	21.3573	Check dam
107	Asona.	Warud	78.16	21.3902	Check dam
108	Asona.	Warud	78.1686	21.3859	Check dam
109	Bargaon.	Warud	78.1466	21.4408	Check dam
110	Benoda	Warud	78.1961	21.4475	Check dam
111	Benoda.	Warud	78.16	21.4356	Check dam
112	Benoda.	Warud	78.1785	21.4394	Check dam
113	Bhalapur.	Warud	78.4159	21.4584	Check dam
114	Bhandoli	Warud	78.3142	21.4595	Check dam
115	Bhandoli.	Warud	78.3177	21.4665	Check dam
116	Bhemdi	Warud	78.2286	21.5236	Check dam
117	Chinchargavhan.	Warud	78.3038	21.4173	Check dam
118	Chinchargavhan.	Warud	78.303	21.4262	Check dam
119	Chinchargavhan.	Warud	78.315	21.4122	Check dam
120	Dhaga	Warud	78.3861	21.4272	Check dam
121	Dhamandhas	Warud	78.1562	21.4809	Check dam
122	Ekalvihir	Warud	78.4099	21.4792	Check dam
123	Ekdara	Warud	78.392	21.4376	Check dam
124	Gaulkheda	Warud	78.233	21.3821	Check dam

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
125	Ghorad	Warud	78.3571	21.397	Check dam
126	Goregaon	Warud	78.1621	21.4327	Check dam
127	Jamalpur	Warud	78.1539	21.359	Check dam
128	Jamgaon.	Warud	78.3965	21.5919	Check dam
129	Jamgaon.	Warud	78.1378	21.4463	Check dam
130	Jamgaon.	Warud	78.1366	21.4582	Check dam
131	Jamtal.	Warud	78.3375	21.5473	Check dam
132	Jamtal.	Warud	78.3298	21.5343	Check dam
133	Jamtal.	Warud	78.3231	21.5328	Check dam
134	Jamthal	Warud	78.3163	21.5315	Check dam
135	Jamthi Ganeshpur	Warud	78.4063	21.469	Check dam
136	Jamthi Ganeshpur.	Warud	78.4168	21.4856	Check dam
137	Jarud	Warud	78.2017	21.4422	Check dam
138	Jarud.	Warud	78.2363	21.4588	Check dam
139	Jarud.	Warud	78.2127	21.4338	Check dam
140	Jarud.	Warud	78.2258	21.4634	Check dam
141	Jarud.	Warud	78.239	21.4384	Check dam
142	Kachurna.	Warud	78.2174	21.3851	Check dam
143	Kachurna.	Warud	78.2354	21.3784	Check dam
144	Kachurna.	Warud	78.231	21.3872	Check dam
145	Karajgaon.	Warud	78.1813	21.4142	Check dam
146	Karwar	Warud	78.421	21.5514	Check dam
147	Karwar.	Warud	78.4154	21.5568	Check dam
148	Karwar.	Warud	78.4094	21.553	Check dam
149	Kekatwada	Warud	78.3415	21.472	Check dam
150	Kekatwada.	Warud	78.3412	21.483	Check dam
151	Khadka.	Warud	78.1211	21.453	Check dam
152	Khaperkheda.	Warud	78.3643	21.5547	Check dam
153	Kharad.	Warud	78.3469	21.4875	Check dam
154	Khedi	Warud	78.3118	21.5023	Check dam
155	Kumbikhed	Warud	78.318	21.4714	Check dam
156	Kumdara.	Warud	78.1238	21.4587	Check dam
157	Linga	Warud	78.4286	21.5072	Check dam
158	Linga	Warud	78.4263	21.5155	Check dam
159	Linga.	Warud	78.4191	21.4992	Check dam
160	Loni.	Warud	78.1643	21.375	Check dam
161	Mahendri.	Warud	78.3822	21.5776	Check dam
162	Mahendri.	Warud	78.4004	21.5731	Check dam
163	Mahendri.	Warud	78.4048	21.5657	Check dam
164	Malkapur	Warud	78.3081	21.519	Check dam
165	Malkhed	Warud	78.2895	21.4817	Check dam
166	Malvihir	Warud	78.3303	21.5156	Check dam
167	Malvihir	Warud	78.3253	21.5152	Check dam
168	Malvihir	Warud	78.3212	21.5031	Check dam
169	Malvihir	Warud	78.3252	21.5046	Check dam
170	Mangona	Warud	78.1938	21.4707	Check dam
171	Mangruli	Warud	78.2424	21.4098	Check dam
172	Mangruli	Warud	78.2386	21.4194	Check dam
173	Mankapur	Warud	78.1499	21.471	Check dam
174	Milanpur	Warud	78.2602	21.4384	Check dam
175	Morchund	Warud	78.3184	21.4005	Check dam
176	Pandharghati	Warud	78.1125	21.4579	Check dam
177	Pandharghati	Warud	78.1092	21.4534	Check dam
178	Pandhari	Warud	78.3781	21.5539	Check dam
179	Pandhari	Warud	78.3979	21.5419	Check dam
180	Pandhari	Warud	78.3771	21.5357	Check dam
181	Pethmangruli	Warud	78.2281	21.3929	Check dam
182	Pimpalshende	Warud	78.262	21.5296	Check dam
183	Pimpalshende	Warud	78.2578	21.513	Check dam
184	Pimplagad	Warud	78.413	21.5881	Check dam
185	Pimplagad	Warud	78.4047	21.5824	Check dam
186	Porgavhan	Warud	78.4242	21.4497	Check dam
187	Porgavhan	Warud	78.4271	21.4491	Check dam

SN	Village	Taluka	Longitude	Latitude	Artificial recharge structure
188	Pusla	Warud	78.3501	21.527	Check dam
189	Pusla	Warud	78.3514	21.513	Check dam
190	Pusli	Warud	78.329	21.5626	Check dam
191	Rajura Bajar	Warud	78.2933	21.4	Check dam
192	Roshankhed	Warud	78.2948	21.4564	Check dam
193	Roshankhed	Warud	78.2938	21.4397	Check dam
194	Roshankhed	Warud	78.29	21.4455	Check dam
195	Sawanga	Warud	78.2089	21.4008	Check dam
196	Sawangi	Warud	78.3529	21.4721	Check dam
197	Sawangi	Warud	78.3572	21.4624	Check dam
198	Shahapur	Warud	78.2459	21.4653	Check dam
199	SHENDURJANA	Warud	78.2895	21.5316	Check dam
200	Suryakhed	Warud	78.3301	21.4887	Check dam
201	Suryakhed	Warud	78.3203	21.4773	Check dam
202	Tarodi	Warud	78.3934	21.5248	Check dam
203	Tarodi	Warud	78.3979	21.5139	Check dam
204	Tarodi	Warud	78.3967	21.5089	Check dam
205	Tarodi	Warud	78.3958	21.4911	Check dam
206	Tembhurkheda	Warud	78.2345	21.4759	Check dam
207	Tembhurkheda	Warud	78.24	21.4986	Check dam
208	Tiwsa	Warud	78.2823	21.5259	Check dam
209	Urad	Warud	78.3783	21.5229	Check dam
210	Wadegaon	Warud	78.2818	21.3881	Check dam
211	Wadegaon	Warud	78.2809	21.3927	Check dam
212	Wadhona	Warud	78.1587	21.4015	Check dam
213	Wai Bk.	Warud	78.2774	21.4991	Check dam
214	WARUD	Warud	78.279	21.481	Check dam
215	WARUD	Warud	78.2853	21.4785	Check dam
216	Wathoda	Warud	78.3679	21.4352	Check dam
217	Wawruli	Warud	78.2215	21.4208	Check dam
218	Wawruli	Warud	78.2253	21.4164	Check dam
219	Zatamziri	Warud	78.2449	21.5387	Check dam
220	Zolamba	Warud	78.1396	21.3957	Check dam

Annexure XIII Location of Recharge Shaft, Morshi and Warud taluka, Amravati district

SN	Village	Taluka	X	Y	Structure
1	Vitthalpur	Morshi	77.9997	21.2271	Recharge shaft
2	Khopada	Morshi	77.9035	21.2762	Recharge shaft
3	Adgaon	Morshi	77.8442	21.1619	Recharge shaft
4	Vitthalpur	Morshi	77.9902	21.2055	Recharge shaft
5	Vitthalpur	Morshi	77.972	21.2326	Recharge shaft
6	Khopada	Morshi	77.9568	21.2403	Recharge shaft
7	Ladki	Morshi	77.9337	21.2238	Recharge shaft
8	Porgavhan	Morshi	77.9019	21.2394	Recharge shaft
9	Khanpur	Morshi	77.9337	21.2415	Recharge shaft
10	Khopada	Morshi	77.925	21.2669	Recharge shaft
11	Kolvihir	Morshi	77.8553	21.274	Recharge shaft