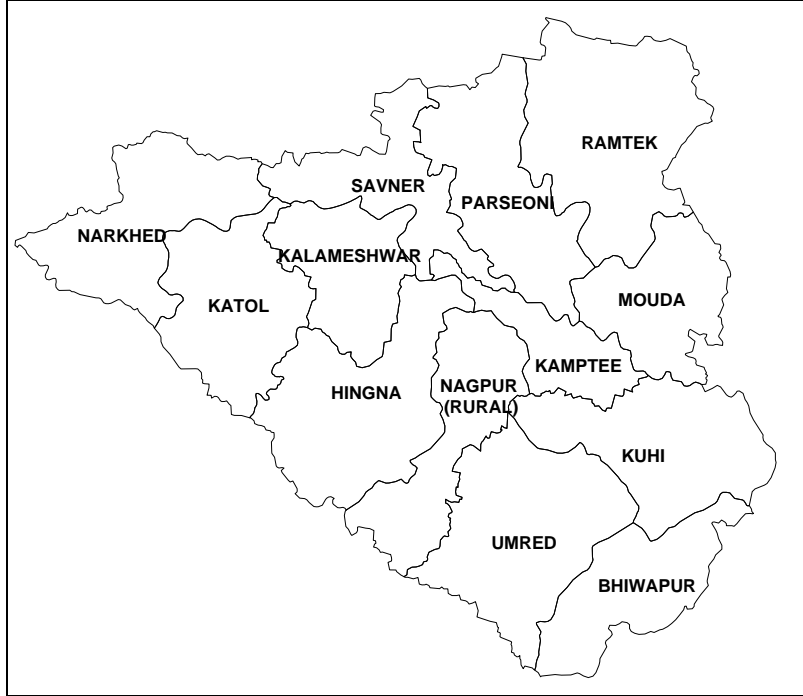


भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूमिजल बोर्ड
GOVERNMENT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत नागपुर जिले की
भूजल विज्ञान जानकारी
GROUND WATER INFORMATION
NAGPUR DISTRICT
MAHARASHTRA



By
Afaque Manzar
Scientist-B

द्वारा
आफ़ाक़ मंजर
वैज्ञानिक- ख

मध्य क्षेत्र
नागपुर
CENTRAL REGION
NAGPUR
2013

NAGPUR DISTRICT AT A GLANCE

- 1. GENERAL INFORMATION**
 - Geographical Area : 9892 sq. km.
 - Administrative Divisions : Taluka-14; Nagpur(Urban), Kamptee, Mouda, Ramtek, Parseoni, Saoner, Kalmeshwar, Narkhed, Katol, Hingna, Nagpur(Rural), Umred, Kuhi, Bhiwapur.
 - Villages : 1562
 - Population (2001 Census) : 40.51 Lakh
 - Normal Annual Rainfall : 1000 mm to 1200 mm
- 2. GEOMORPHOLOGY**
 - Major Physiographic unit : Three; Northern hilly area, Western hilly area and Kanhan & Wena river valley area
 - Major Drainage : Two; Wardha and Wainganga
- 3. LAND USE (2000-01)**
 - Forest Area : 1350 sq. km.
 - Net Area Sown : 5074 sq. km.
 - Cultivable Area : 5759 sq. km.
- 4. SOIL TYPE**

Medium to deep clayey, black cotton soils; medium, loamy alluvial soils; shallow sandy, clayey red soils.
- 5. PRINCIPAL CROPS (2010-11)**
 - Jowar : 525 sq. km.
 - Cotton : 374 sq. km.
 - Wheat : 310 sq. km.
 - Rice : 434 Sq km
 - Total Pulses : 936 sq. km.
 - Soyabean : 2069 sq km
 - Fruits : 343 sq km
- 6. IRRIGATION BY DIFFERENT SOURCES (2006-7)**

Nos./Potential Created (ha)

 - Dugwells : 69695 / 140154
 - Borewells and Tubewells : 127 / 246
 - Surface Flow Schemes : 732/1278
 - Surface Kift Schemes : 14589 / 41576
 - Net Irrigated Area : 183254 ha
- 7. GROUND WATER MONITORING WELLS (As on 31/03/2012)**
 - Dugwells : 43
 - Piezometers : 18
- 8. GEOLOGY**
 - Recent : Alluvium
 - Upper Cretaceous-Lower Eocene : Deccan Trap Basalt
 - Cretaceous : Lameta
 - Permian to Carboniferous : Gondwana
 - Archean : Crystalline rocks
- 9. HYDROGEOLOGY**
 - Water Bearing Formation : Archean- Weathered and fractured Granite Gneiss, Gondwana- Kamptee and Barakar Sandstone, Trap-covered Gondwana; Deccan Trap-Weathered/Fractured /Jointed Massive or Vesicular Basalt; Alluvium- Sand and Gravel

- Premonsoon Depth to Water Level : 0.08 to 15.59 m bgl
(May-2011)
- Postmonsoon Depth to Water Level : 0.60 to 10.60 m bgl
(Nov.-2011)
- Premonsoon Water Level Trend : Rise: 0.02 to 0.54 m/year
(2001-2010) Fall: 0.006 to 0.86 m/year
- Postmonsoon Water Level Trend : Rise: Negligible to 0.63 m/year
(1998-2007) Fall: 0.001 to 0.24 m/year
- 10. GROUND WATER EXPLORATION (As on 31/03/07)**
- Wells Drilled : EW-69, OW-43, PZ-22
- Depth Range : 6.5 to 307.0 m bgl
- Discharge : 0.01 – 38.05 lps
- Storativity : 5.5×10^{-5} to 2.95×10^{-3}
- Transmissivity : 7.11 to 279.13 m²/day (Basalt)
- 11. GROUND WATER QUALITY**
- Good and suitable for drinking and irrigation purpose, however localized magnesium, nitrate and fluoride contamination and high salinity hazard is observed.
- Type of Water : Ca/ -HCO₃
- 12. DYNAMIC GROUND WATER RESOURCES- (As on 31/03/2004)**
- Net Annual Ground Water : 1058.12 MCM
- Availability
- Annual Ground Water Draft : 407.80 MCM
(Irrigation+Domestic)
- Allocation for Domestic and : 126.80 MCM
Industrial requirement up to next 25
years
- Stage of Ground Water : 38.54%
Development
- 13. AWARENESS AND TRAINING ACTIVITY**
- Mass Awareness Programme : Two
- a. Date : 22/01/03, 01 & 02/02/05
- b. Place : Akoli and Nagpur
- Water Management Training : Five
Programme
- a. Date : 12/02/02; 25 to 27/08/03; 01 to
05/02/05 (RWH Week); 05/03/02; 22
& 23/09/05
- b. Place : Nagpur, Ramtek, Kamptee
- 14. ARTIFICIAL RECHARGE & RAINWATER HARVESTING**
- Projects Completed : Two; RWH at KITS, Ramtek &
Rajbhawan, Nagpur
- Projects under Technical Guidance : Nil, however technical guidance for
AR/RWH provided to about 20
organizations
- 15. GROUND WATER CONTROL & REGULATION**
- Over-Exploited Taluka : None
- Critical Taluka : None
- Semi-Critical Taluka : None
- Notified Taluka : None
- 16. MAJOR GROUND WATER PROBLEMS AND ISSUES**
- Ground water quality in parts of Nagpur city is adversely affected by nitrate contamination, whereas in Kalmeshwar and Hngna MIDC areas the contamination of ground water of phreatic zone has taken place due to discharge of industrial effluents.

Ground Water Information Nagpur District

Contents

1.0	Introduction	1
2.0	Climate and Rainfall	3
3.0	Geomorphology and Soil Types	4
4.0	Ground Water Scenario	5
4.1	Hydrogeology.....	5
4.2	Ground Water Resources.....	10
4.3	Ground Water Quality	14
4.4	Status of Ground Water Development.....	16
5.0	Ground Water Management Strategy	16
5.1	Ground Water Development.....	17
5.2	Water Conservation and Artificial Recharge.....	19
6.0	Ground Water Related Issues and Problems.....	19
7.0	Mass Awareness and Training Activities.....	20
7.1	M.A.P. and W.M.T.P.	20
7.2	Participation in Exhibition, Mela, Fair etc.	20
8.0	Areas Notified by CGWA/SGWA	20
9.0	Recommendations	20

List of Figures

1. Location
2. Hydrogeology
3. Depth to Water Level (Premonsoon- May 2007)
4. Depth to Water Level (Postmonsoon- Nov. 2007)
5. Water Level Trend (Premonsoon- 1998-2007)
6. Ground Water Resources (March-2004)

List of Tables

1. Studies undertaken by CGWB
2. Salient Features of Ground Water Exploration
3. Salient Features of Rainfall Analysis of Nagpur District (1901-1999)
4. Taluka wise Ground Water Resources (March 2004)
5. Geochemical Classification of Ground Water Samples
6. Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003)
7. Classification of Ground Water for Irrigation based on SAR and RSC.
8. Formation-wise yield of Dug Wells.
9. Formation-wise yield of Bore Wells.
10. Nature and Yield Potential of Aquifers.
11. Status of MAP and WMTP.

Ground Water Information Nagpur District

1.0 Introduction

Nagpur district is one of the nine districts of Vidarbha Region of Maharashtra State. It is situated on the eastern part of the State abutting Chindwada district of Madhya Pradesh in north. It is bounded by Wardha and Amravati districts in the west, Bhandara district in the east and Chandrapur district in the south. It lies between north latitudes 20°35' and 21°44' and east longitudes 78°15' and 79°40' and falls in Survey of India topo-sheets 55 K, O and P. The district has a geographical area of 9892 sq. km.

The district headquarters is located at Nagpur Town. For Administrative convenience, the district is divided in 14 talukas viz, Nagpur (Urban), Saoner, Parseoni, Ramtek, Mouda, Kamthi, Kuhi, Bhiwapur, Umrer, Nagpur (Rural), Hingna, Katol, Narkhed and Kalmeshwar. It has a total population of 40.51 lakh as per 2001 census. The district has 29 towns, 1562 inhabited villages and 312 uninhabited villages. The district forms part of Godavari basin. Wainganga River is the main river flowing through the district.

Central Ground Water Board has taken up several studies in the district. A list of studies conducted in the district is presented in Table-1.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	Shri Atram, N. S.	(1970-71, 1971-72, 1976-77, and 1981-82)	Systematic Hydrogeological Surveys
2.	Shri Gajbhiye N. G.	1975-76	Systematic Hydrogeological Surveys
3.	Shri Motghare	1976-77 and 1977-78	Systematic Hydrogeological Surveys
4.	S/Shri Sudarshan G, Jain, S.K. and Binoy Ranjan and by Talukdar, T.	1990-91	Systematic Hydrogeological Surveys
5.	S/Shri Bhattacharya, S. Joshi. D. and Binoy Ranjan	1991-92	Reappraisal Hydrogeological Studies
6.	Shri Deshmukh, A. B.	1995-95	Pollution Studies
7.	S/Shri Bansal S.K., and P.K. Jain.	1997-98	Urban Hydrogeological Studies
8.	Shri Subbarao D.	1997-98	Pollution Studies
9.	S/Shri Bansal S.K. and Tiwari A.N.	1999-2000	Pollution Studies

Shri K. N. Murthy (SHG) and K. B. Sahoo (JHG) in 1999-2000 compiled the report entitled "Ground Water Resources and Development Potential of Nagpur District, M.S."

Ground water exploration in the district was undertaken in the trap covered Gondwana (1989-90, 1992-93,); Gondwana formation (1979-80, 1994-95, 2003-

04 and 2004-05); Deccan trap (1989-92) and in Archeans (1989-95), (2005). A total number of 72 Exploratory Wells (EW) and 44 Observation Wells (OW) and 9 Piezometers (PZ) were drilled at 78 sites. Further during 2011-12, 13 PZ were drilled in the district by out sourcing (WAPCOS). Pumping tests to determine aquifer parameters were also conducted at 9 sites. The taluka wise salient features of ground water exploration are given in **Table-2**.

Table 2: Salient Features of Ground Water Exploration.

S. No.	Taluka	Wells			Depth (mbgl)	SWL (mbgl)	Dis-charge (lps)	Draw-Down (m)	Zones (mbgl)
		EW	OW	PZ					
1.	Bhiwapur	3	1	2	36.5-202.55	4.92-5.3	0.38-1.37		22.0-140
2.	Hingna	2	3	2	40.0-234.8	14.68-27.65	0.5-21.33		
3.	Kalmeshwar	9	4		79.3-278	4.55-28.5	0.38-17.92	5.6-11.95	28.0-107
4.	Kamthi	6	3		29.93-202.45	4.53-16.45	1.37-8.85		11-140.4
5.	Katol	6	3	3	6.5-254	6.00-28.3	Traces-38.5	9.76-20.57	12.19-219.5
6.	Kuhi	4	3		36.5-200				5.0-99.75
7.	Mouda	2	1		174.5-187.25	1.0	1.37-4.43	25.06-42.58	34.75-147.65
8.	Nagpur (R)	2		3	76.59-159.45	24.15	1.37-2.64		7.0-75.0
9.	Nagpur (U)	1	1	1	143.56-300	10.05	0.03-3.17		21.5-32.0
10.	Narkhed	3	1	4	40.0-207.4	1.19-11.85	6.81	1.29-2.82	
11.	Parseoni	17	4	2	27.5-199.64	4.05-19.6	0.08-7.76		6-163.05
12.	Ramtek	4	2		68.75-214.75	4.69-5.05	0.14-4.43	3.42-18.44	
13.	Saoner	8	17	1	43.0-307	2.30-29.05	0.38-14.40	8.05-31.06	5.25-140.2
14.	Umred	2		4	20.0-200	3.64-5.07	0.01-2.16		24.0-122
	TOTAL	69	43	22	6.5-307	1.0-29.05	0.01-38.5	1.29-42.58	5-219.5

The depth of the wells varies from 6.5 to 307 metres below ground level (m bgl), while discharge varies between 0.01 and 38.5 litres per second (lps). Out of 69 exploratory wells drilled in the district, 27 exploratory wells have shown discharges more than 3 lps. The deepest water level being recorded at K. Pipala village in Saoner taluka i.e., 29.05 m bgl. Deeper aquifer zones have been encountered in many wells beyond 50 m depth, the deepest being at 287.73-296.57 m at Silewara (BHE II) exploratory well in Saoner taluka.

A map of the district showing the taluka boundaries, taluka headquarters,

physical features and location of exploratory and monitoring wells is presented as Figure-1.

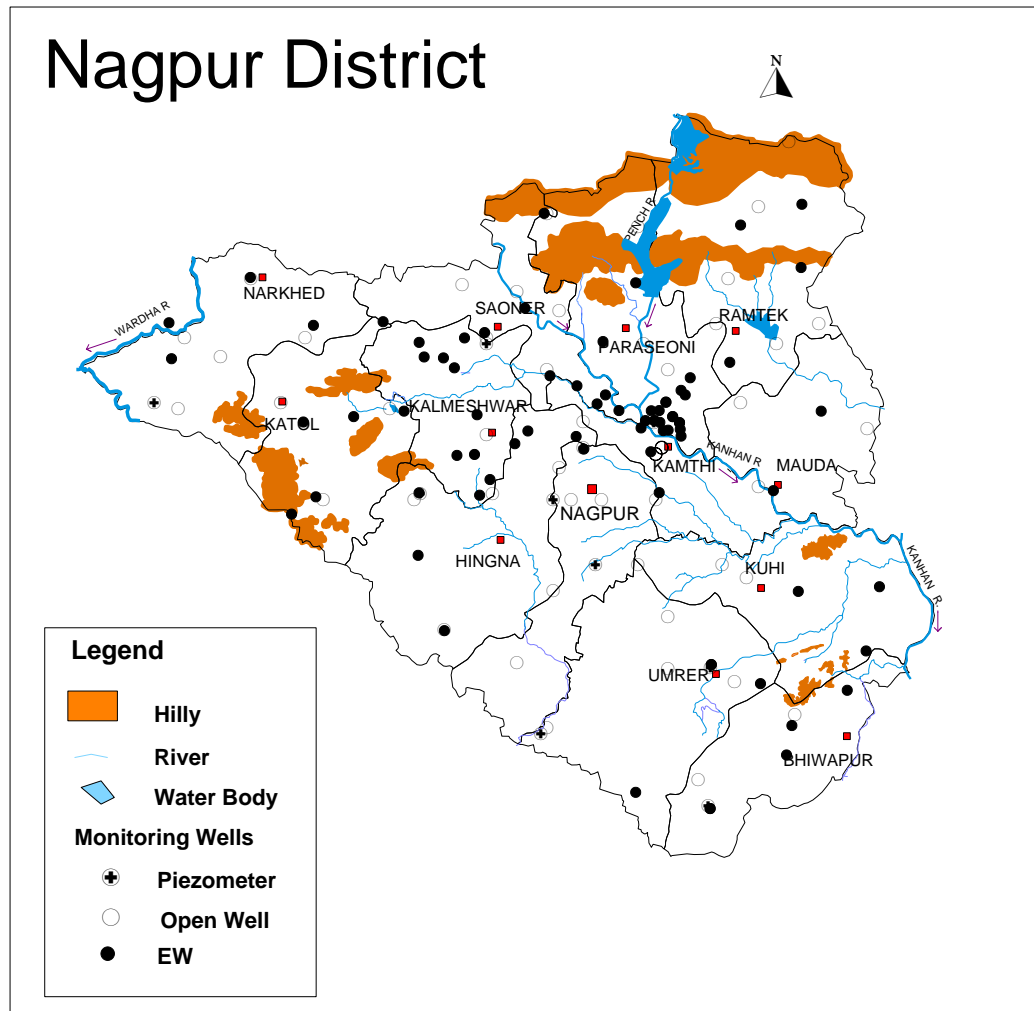


Figure-1: Location

2.0 Climate and Rainfall

The climate of the district is characterized by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. The mean minimum temperature is 12°C and mean maximum temperature is more than 45°C.

. The normal annual rainfall (1901-1992) over the district ranges from about 1000 mm to 1200 mm. It is the minimum in the western parts around Katol (985.4mm) and increases in the eastern direction and reaches a maximum around Umrer (1213.6 mm).

Rainfall data from 14 rain gauge stations for the periods 2002-2011 are given in table 3. The average annual rainfall for the last 10 years ranges from 753.9 in Hingni to 1164.9 in Umrer. It is also observed that all stations have recorded average annual rainfall within the range of district normal annual rainfall except at Hingni, Katol, Narkhed and Kamleshwar where it is less than .

Table 3: Rainfall data of Nagpur District (2002-2011)

Taluka	In mm										
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Average
Nagpur city	1176.1	1431.5	702.3	973.4	975.7	741	952.9	954.4	1395.3	879.4	1018.2
Nagpur gramin	966.7	1229	689	1274.7	1205.5	966.3	953.2	947.4	1494.7	913.8	1064.0
Kamthi	1035.8	1208.7	707.1	1475.8	1178.2	1205	791.6	1032.6	1098.6	861.3	1059.5
Hingni	479.2	770	583.3	920.4	814.9	806	683.1	724.7	942.2	814.8	753.9
Ramtek	1101.3	822.5	733.9	1435.5	1133	1370.8	865.3	905.2	1184	885.1	1043.7
Parshiwani	850.1	1056.9	858.4	1239.5	1106.2	878.8	1068.6	983.6	1086.6	1043.8	1017.3
Maudha	904	1171.6	631.3	1679.1	1114.3	1030.9	814.1	1280.4	1520.5	1366.2	1151.2
Katol	649.6	920.1	555.1	1092.3	937.4	1271.8	773.2	888.4	1027.9	801.8	891.8
Narkhed	822.8	778	606.7	914.9	768.6	1281.3	671	954.1	1136.9	764.9	869.9
Savner	823.6	1063.6	812.6	1497.2	974.1	1209	873.6	941.6	1078.4	945.8	1022.0
Kalmeshwar	740	1092.9	808.6	1320.9	916.4	1203.4	675.9	780.5	1180.5	855.2	957.4
Umrer	846.2	1296.8	747.1	1856.3	1014.2	1464	1060.36	926.2	1551.2	887.1	1164.9
Bhiwapur	923.3	1146.3	740.4	1431.2	1045.6	1341.8	853.2	993.7	1690.1	1088.4	1125.4
Kuhi	859.2	1057.2	596.4	1543.8	828.6	1286	817.9	950.3	1291.5	1024.7	1025.6
Average	869.9	1074.7	698.0	1332.5	1000.9	1146.9	846.7	947.4	1262.7	938.0	1011.8

(Source: www.agri.mah.nic.in)

3.0 Geomorphology and Soil Types

The district forms part of Deccan Plateau having flat topped and terraced features. Eastward and northeastwards the landscape changes due to the change in the underlying rocks. The rocks of Gondwana series present a low rolling topography with a poor soil cover and vegetation. On the north the upland ranges are the extension of Satpuras which gradually narrows down towards west. South of these upland range stretches the Ambegad hills, the western extremity of which is the Nagpur district. The Ramtek temple is on the spur of this range. The Girad hill range extends along the southeast and separates the valley of the Kar from that of Jamb upto Kondhali. Another main hill range runs northwards through Katol taluka from Kondhali to Kelod separating the Wardha and Wainganga valleys. The northeastern and east central parts of the district is drained by the Wainganga and its tributaries. The central and western portion is drained by the Wena which is a tributary of Wardha river.

There are six types of soils found in Nagpur district. The details are as follows:

- 1) **Kali soils:** These are black cotton soils which are fine grained clayey in texture and varies in depth from 1 m to 6 m or more and retain moisture. They are found around Kalmeshwar, Saoner and Nagpur.
- 2) **Morand soils:** These are predominant in the district. They are black cotton soils with higher percentage of lime than the Kali soils. They are black, grey or light to dark brown in colour, clayey in texture and have a depth of about 1 to 3 m.
- 3) **Khardi soils:** They are shallow soils mixed with sand and found mainly in hills. These are grey in colour, clay loam in texture.

- 4) **Bardi soils:** They are red gravel covered with boulders found on summits and slopes of trap hills and are less fertile in nature.
- 5) **Kachchar soils:** They are mainly found in the banks of Kanhan river and are alluvial soils, loamy in nature and vary in depth from 1 to 3 m.
- 6) **Wardi soils:** They are red soils with a large amount of sand. They are shallower and clayey loam in nature. They are mainly found in the paddy tracts in the eastern part of the district. Ground Water Scenario

4.0 Ground Water Scenario

4.1 Hydrogeology

The important water bearing formations of Nagpur district are discussed below. A map depicting the hydrogeological features is shown in Figure-2.

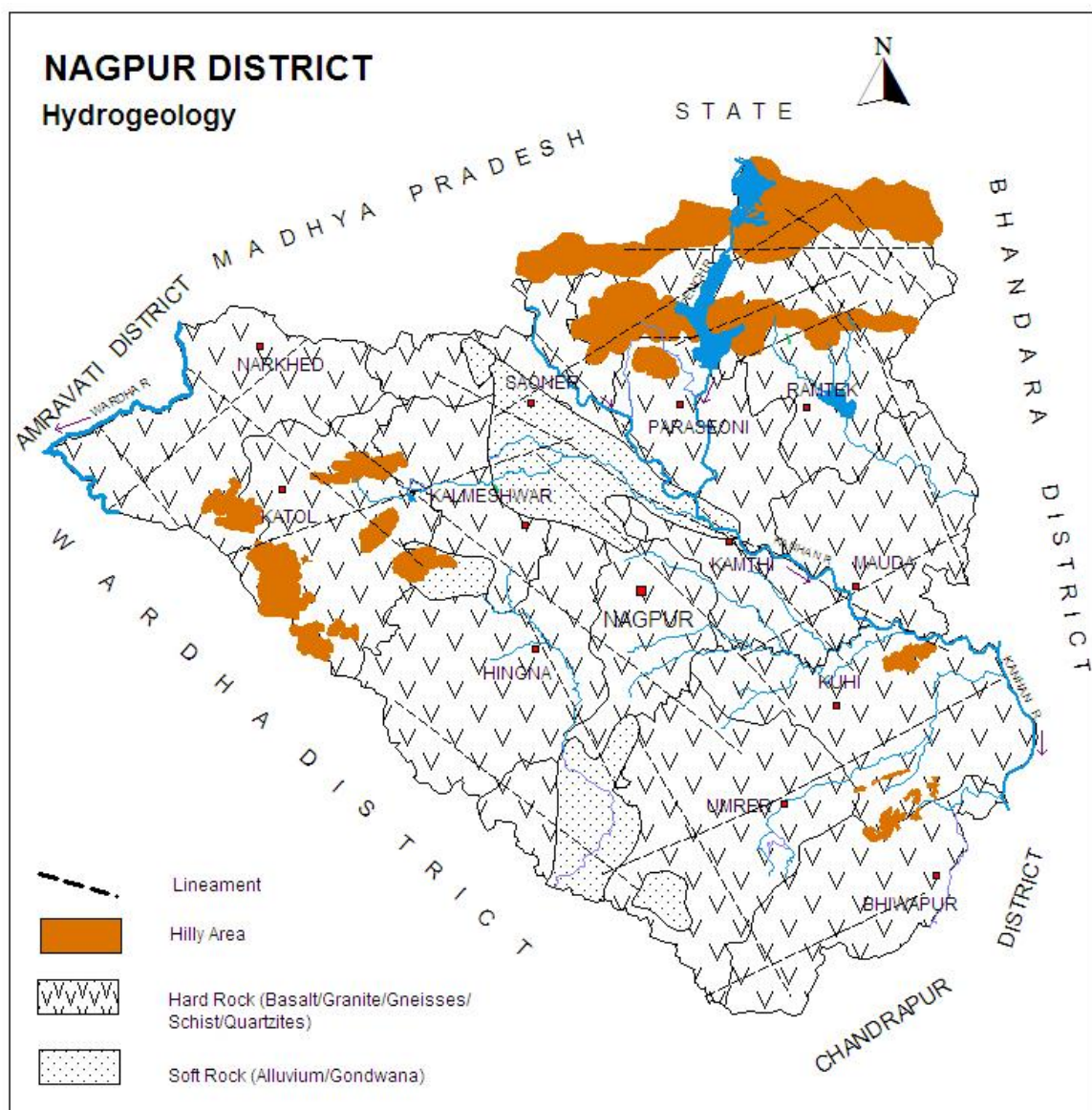


Figure-2: Hydrogeology

4.1.1 Consolidated Formations

Archeans and the Deccan trap basalts are the two consolidated formations,

which form the Hard rock aquifers occurring in the district.

a) Archaean- The crystalline rocks comprising of gneiss, schist, pegmatite and quartzite are the main formations occurring in north-eastern and south eastern parts of the district. In these rocks, weathered zone which is down to a depth of 25 m.bgl, forms the important shallow aquifer for dugwells. In unweathered crystalline rocks, the occurrence of ground water is mainly controlled by joints and fractures. Higher yields are generally associated with lineaments. Ground water at places occurs in fractured zones at depth in semi-confined to confined conditions.

b) Deccan Traps- Basalt is the main formation of the district and occupies an area of about 4300 sq. km. Ground water occurs under phreatic conditions in the exposed lava flows and in semi-confined to confined state in the subsurface flows. Ground water is present in pore spaces in the vesicular unit of each flow and in the jointed and fractured portions of massive unit. However, secondary porosity and permeability developed on account of weathering, fracturing and joints play a very important role in the storage and movement of ground water. This has given rise to good aquifers. Weathering not only produces granular materials but also widens the fractures, joint and shear zones.

4.1.2 Semi-Consolidated Formations

Two type of semi consolidated formations i.e. Lameta and Gondwanas occur in the district. They along with the unconsolidated Alluvial formation form the soft rock aquifers occurring in the district.

a) Lameta beds- Lameta beds, found to the north of the district in a small patch are compact, clayey and poor in permeability. Hence it is not a good water bearing formation

b) Gondwana Sediments- Gondwana formation, occupying a total area of about 470 sq.km, occurs in the northern part of the Nagpur city extending from Kamptee to Saoner, and an isolated patch also occurs near north of Sathnaori. Among the Gondwanas, the Barakars and Kamthis generally consist of medium to coarse-grained friable sandstone. These constitute the important water bearing formations in the district. Barakars are usually associated with coal seams of economic importance.

4.1.3 Unconsolidated Alluvial Formations

Alluvium consisting of sand, silt, clay and kankar forms the potential water bearing formations and occurs in southern part of the district from Butibori to Bela. The alluvium of recent to sub-recent age and are found to have been deposited along the Kanhan and Pench Rivers and their tributaries. They overlie the older formations such as Archeans, Gondwana and Basalt and have thickness more than 25 m. These formations are highly productive aquifers and sustain long duration pumping with very less drawdown and fast recuperation. Ground water occurs in water table and semi-confined conditions in the alluvial formation.

4.1.4 Water Level Scenario

Central Ground Water Board periodically monitors the National Hydrograph Network Stations (NHNS) stations in Nagpur district, four times a year i.e., in January, May (Premonsoon), August and November (Postmonsoon). The data on pre and post monsoon water level along with fluctuation during 2011 and long

term trend are given in table 4.

Table 4: Water Level Data with Long-term Trend (2001-2010)

Station	Water Level 2011 (mbgl)		Fluctuation (m)	Water Level Trend 2001-2010 (m/Year)			
	Premonsoon	Post Monsoon		Premonsoon		Postmonsoon	
				Rise	Fall	Rise	Fall
Amgaon	4.9	3.2	1.7				
Bela2	4.05	3.9	0.15				
Besur	0		0		0.8687	0.0560	
Borkhedi	6.75	3.7	3.05		0.1456	0.0186	
Chacher	7.34	2.5	4.84	0.0671			0.0019
Chargaon (Punarwasi)	7.35	2.5	4.85	0.0983		0.1460	
Chorbaoli	5.45	3.9	1.55	0.0934		0.0510	
Deolapar	5.85	2.7	3.15		0.0610		0.0387
Dhapewada	11.9	10.2	1.7				
Gondegaon	0		0	0.4257			
Gumgaon	6.65	2.9	3.75	0.1327			0.0030
Kalmeshwar	3.1	1.9	1.2	0.1124		0.0000	
Kamptee	6.4	4.8	1.6	0.3785			0.0537
Kanholi bara	8.46	4.5	3.96	0.1469		0.0122	
Katol	0			0.2449		0.3250	
Kelod	6.95	6.6	0.35	0.1866		0.2146	
Khat	4.08	1	3.08		0.3533		0.0124
Khubala	3.1	2.5	0.6	0.0842		0.0263	
Koradi	4.1	2.9	1.2		0.0060	0.0037	
Kothulna	4.9	1.6	3.3	0.3039		0.1762	
Kondhali	0	6.1	-6.1	0.0213		0.1602	
Kuhi	5.85	3	2.85		0.0304	0.1457	
Lohara	4.05	1.6	2.45	0.1156		0.0577	
Makardhokda	4.54	3.4	1.14	0.5037		0.6385	
Manegaon Tek	7.25	10.6	-3.35		0.1998		0.0937
Mangli1	9.1	5.9	3.2			0.5499	0.1449
Mohpa	7.8	5.5	2.3				
Muda2	0	5					
Nagalwadi	9.5	8	1.5	0.1695			0.0929
Nagpur (VRCE)	2.1	1.3	0.8				
Nagpur City	6.05	3.9	2.15		0.2392		0.0212
Narkhed	9.7	6.6	3.1	0.2751		0.3350	
Nawegaon (Deshmukh)	7.9	3.4	4.5		0.2741		0.1448
Nayakund	15.55	6.6	8.95	0.1963		0.4753	
Ngpur City	6.05	5.2	0.85	0.2532			0.2486
Panchgaon	5.15	3.5	1.65	0.1193			0.1248
Parseoni	7.8	5.3	2.5		0.4431		0.1348
Ramtek	6.59	4.6	1.99	0.0553		0.0507	

Rohna	5.1	4.6	0.5	0.5448		0.5871	
Sathnaori	15.9	9.2	6.7	0.1786		0.1848	
Satnaori (Tola)	9.1	7	2.1				
Saoner	0		0	0.0975		0.4904	
Sawargaon	9.4	9	0.4				
Sirpur Toli	4.25	3.9	0.35	0.0758			0.0028
Sivani	5.25	2.2	3.05		0.0579		0.0081
Umrer	0.8	0.6	0.2	0.3281		0.4193	
Umrer (P1)	4.5	3.7	0.8				
Uti	4.85	1.6	3.25	0.0459		0.0155	
Wagholi	7.2	1.7	5.5	0.1441		0.1135	
Wardhamna	4.25	0.6	3.65		0.1232	0.0314	

4.1.4.1 Depth to Water Level – Premonsoon (May-2011)

The depth to water levels in the district during May 2011 ranges between 0.08 (Umrer) and 15.59 (Sathnaovi) m bgl. Depth to water levels during premonsoon (May 2011) has been depicted in **Figure-3**. Shallow water levels within 10 m bgl are seen in almost entire district. Water levels in the range of 10-20 m bgl are observed parts of Kamleshwar, Hingna, Narkhed, Paraseoni talukas as isolated patches.

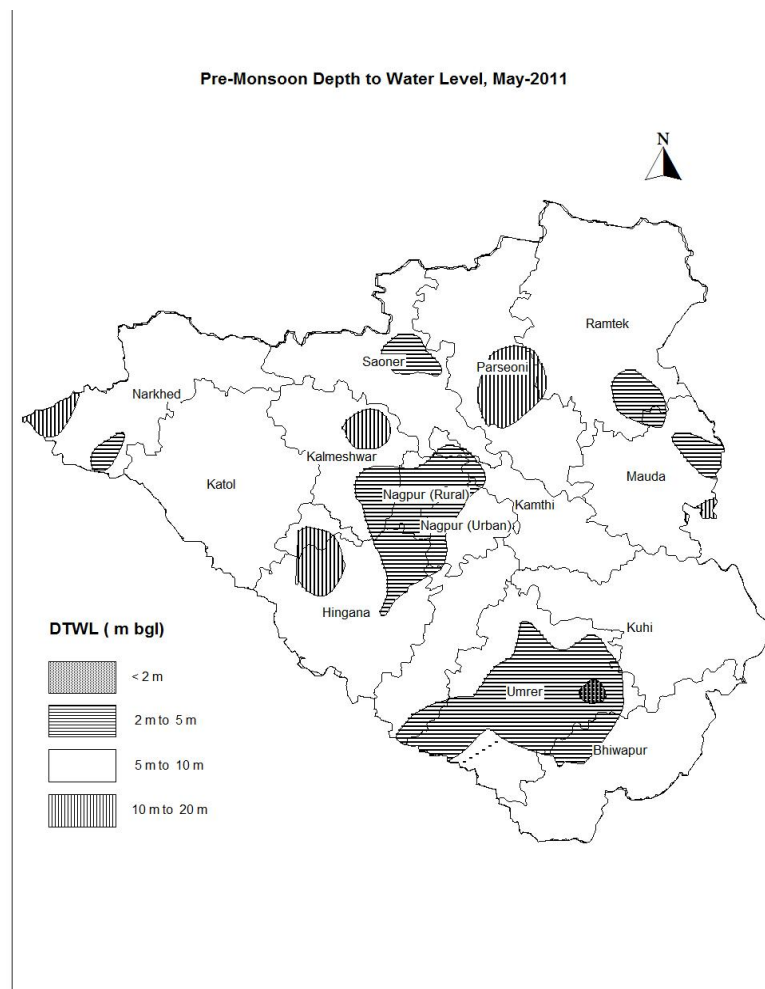


Figure-3: Depth to Water Level (Premonsoon- May 2011)

4.1.4.2 Depth to Water Level – Postmonsoon (Nov.-2011)

The depth to water levels during Nov. 2011 ranges between 0.60 m bgl (Umrer) and 10.60 m bgl (Manegaon Tek). Spatial variation in postmonsoon depth to water levels is shown in **Figure-4**. In the entire district the water levels are shallow within 10 m bgl. Water levels of 2-5 m bgl is the most dominant range occupying major parts of Ramtek, Mouda, Kuhi and Bhiwapur talukas. Water levels of less than 2 m bgl are observed in isolated patches i.e., parts of Narkhed, Nagpur, Umrer and Mouda Talukas.

4.1.4.3 Seasonal Water Level Fluctuation– (May-Nov. 2011)

In major part of the district rise in water levels in the range of 0.15 (Bela 2) to 8.95 m (Nayakund) is observed. Major Parts of the district has recorded rise of water level in the range of 2-4m. Fluctuation of less than 2 is observed in NW, Central parts of the district and in parts of Umrer and Ramtek Talukas. Fluctuation of mothan 4m are observed in patches in parts of Paresoni. Mouda, Kamleshwar, Hingna and Bhiwapur Talukas.

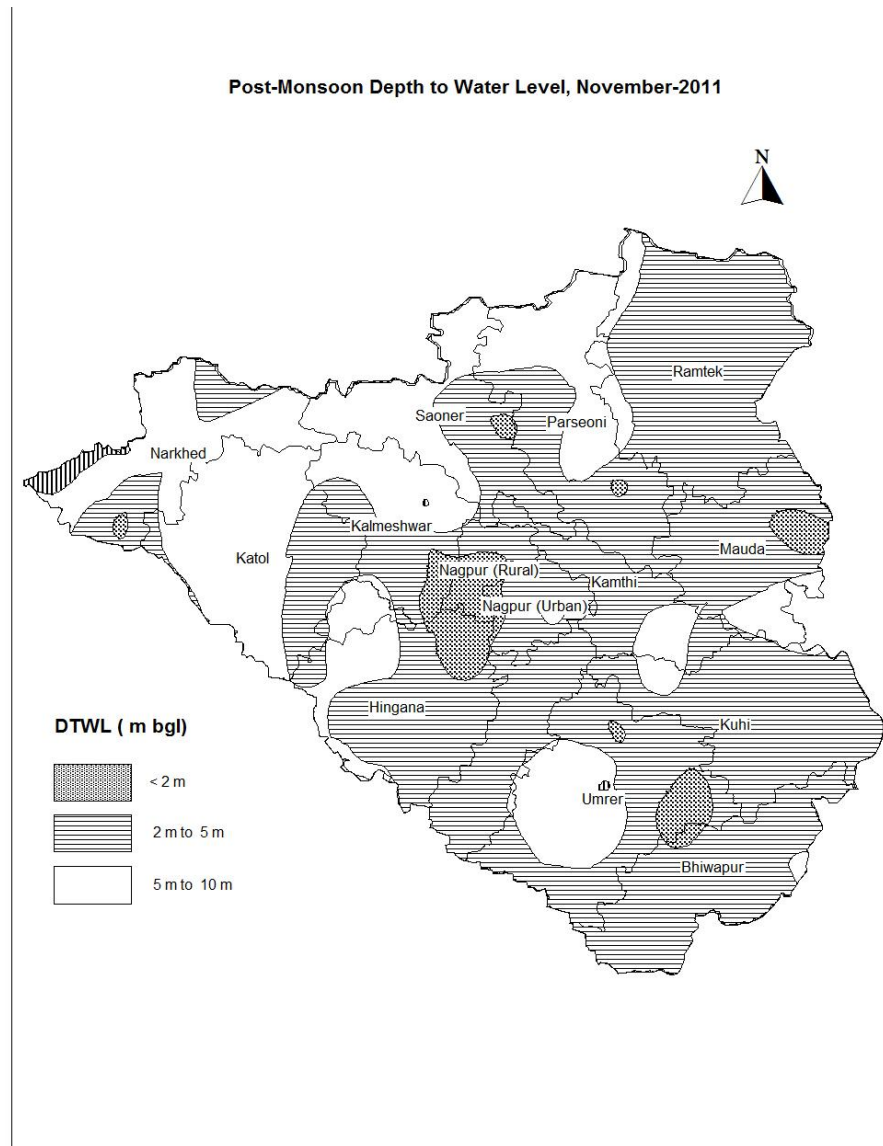


Figure-4: Depth to Water Level (Postmonsoon- Nov.2007)

4.1.4.4 Water Level Trend (2001-2010)

Analysis of water level trend indicates that during premonsoon period, rise in water levels has been recorded at 28 stations and it ranges between 0.02 (Kondhli) and 0.54 m/year (Rohana). Fall in water levels has been observed in 12 stations in the range of 0.006 m/year (Koradi) to 0.86 m/year (Besur). During postmonsoon period, rise in water levels has been recorded at 26 stations and it ranges from negligible to 0.63 m/year (Makardhokda), whereas at 15 stations, fall in water levels ranging between 0.001 m/year (Cacher) and 0.24 m/year (Nagpur City) is observed. Thus in major part of the district, both during pre and postmonsoon periods declining as well as rising trend of water levels have been observed.

4.1.5 Aquifer Parameters

The aquifer parameters are available from pumping tests conducted at 9 exploration sites. The transmissivity of Deccan Traps varies between 0.67 (Kanyadoh) and 248 m²/day (Narkhed) while the storage coefficient varies from 5.51×10^{-5} to 2.95×10^{-3} . In Archean gneisses transmissivity varies from 49.18 (Ramzanghoti) to 279.13 m²/day (Bothia Palora) and storage coefficient varies from 4.12×10^{-4} to 8.9×10^{-4} . In Gondwana transmissivity varies from 9.32 (Pipla Dakbangla) to 250 m²/day (Silewara) and storage coefficient varies from 5.8×10^{-4} to 9.8×10^{-3} .

4.2 Ground Water Resources

Central Ground Water Board and Groundwater Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Nagpur district based on GEC-97 methodology. The same is presented in **Table-5**. Taluka wise ground water resources are shown in **Figure-4**.

As per the estimation the net annual ground water availability comes to be 1058.12 MCM. The total gross draft for all uses is estimated at 407.80 MCM with irrigation sector being the major consumer having a draft of 343.59 MCM. The allocation for domestic and industrial water requirements are worked at 126.80 MCM. The net ground water availability for future irrigation is estimated at 588.05 MCM. Stage of ground water development varies from 12.0% (Mouda) to 75% (Narkhed). The overall stage of ground water development for the district is 38.54%. All the talukas have been categorised as "Safe" .

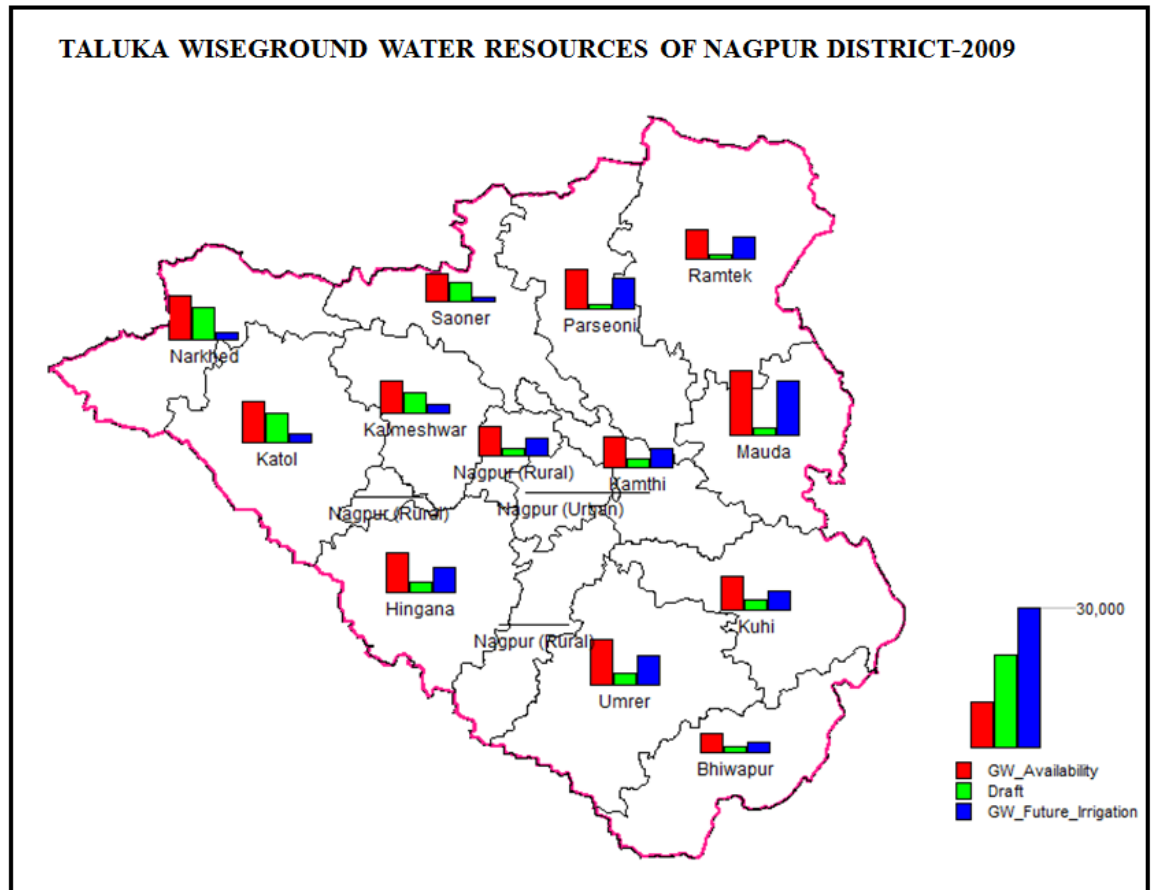


Figure-5: Ground Water Resources (March 2004)

Table-4: Taluka wise Ground Water Resources (March 2009).

Taluka	Area type	Net annual ground water availability (ham/yr.)	Annual ground water draft (ham/yr.)			Allocation for domestic & industrial requirement supply up to next 25 years (ham/yr.)	Groundwater availability for future irrigation (ham/yr.)	Stage of groundwater development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
NAGPUR	COMMAND	246.37	32.29	10.25	42.54				Safe
	NON	6252.49	1587.56	396.58	1984.14				
	TOTAL	6498.86	1619.85	406.83	2026.67	878.77	3928.23	31.19	
KAMTEE	COMMAND	6390.43	1438.97	357.34	1796.31				Safe
	NON	616.51	190.09	64.46	254.55				
	TOTAL	7006.93	1629.06	421.80	2050.86	849.50	4438.58	29.27	
HINGANA	COMMAND	722.47	342.56	34.14	376.70				Safe
	NON	7926.43	1759.09	404.21	2163.30				
	TOTAL	8648.90	2101.65	438.35	2540.00	961.18	5530.46	29.37	
KATOL	COMMAND	1314.62	1171.71	50.99	1222.69				Safe
	NON	7824.23	4933.80	463.68	5397.49				
	TOTAL	9138.85	6105.51	514.67	6620.18	1004.01	2190.20	72.44	
NARKHED	COMMAND	1742.28	1045.85	33.48	1079.32				Safe
	NON	7861.53	5251.33	874.99	6126.32				
	TOTAL	9603.81	6297.18	908.46	7205.64	1612.43	1844.15	75.03	
SAONER	COMMAND	2969.64	2044.25	66.16	2110.41				Safe
	NON	3175.07	2099.94	275.47	2375.42				
	TOTAL	6144.71	4144.20	341.63	4485.83	762.47	1254.41	73.00	
KALMESHWAR	COMMAND	448.59	652.15	18.44	670.59				Safe
	NON	6798.63	3628.95	306.06	3935.01				
	TOTAL	7247.22	4281.11	324.50	4605.60	685.23	2130.10	63.55	

Taluka	Area type	Net annual ground water availability (ham/yr.)	Annual ground water draft (ham/yr.)			Allocation for domestic & industrial requirement supply up to next 25 years (ham/yr.)	Groundwater availability for future irrigation (ham/yr.)	Stage of groundwater development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
RAMTEK	COMMAND	2635.83	219.13	136.17	355.30				Safe
	NON	4067.80	428.44	453.01	881.46				
	TOTAL	6703.63	647.57	589.18	1236.76	1180.66	4929.37	18.47	
PARSHIONI	COMMAND	7185.61	590.31	220.99	811.30				Safe
	NON	1435.09	433.70	75.81	509.53				
	TOTAL	8620.70	1024.00	296.80	1320.80	591.52	6947.73	15.32	
MOUDA	COMMAND	13740.20	1180.47	372.88	1553.35				Safe
	NON	389.57	155.06	44.86	199.92				
	TOTAL	14129.77	1335.53	417.74	1753.27	835.49	11958.73	12.41	
UMRED	COMMAND	1434.75	639.17	263.02	902.20				Safe
	NON	8633.20	1424.83	575.67	2000.50				
	TOTAL	10067.95	2064.01	838.69	2902.70	1464.65	6594.31	28.83	
BHIWAPUR	COMMAND	470.77	361.63	62.51	424.13				Safe
	NON	4020.20	780.09	336.10	1116.19				
	TOTAL	4490.97	1141.72	398.61	1540.32	779.27	2618.50	34.30	
KUHI	COMMAND	447.51	127.38	29.53	156.91				Safe
	NON	7062.79	1840.83	494.09	2334.92				
	TOTAL	7510.30	1968.21	523.62	2491.83	1075.00	4444.01	33.18	
DISTRICT TOTAL	COMMAND	39749.07	9845.87	1655.90	11501.75				Safe
	NON	66063.54	24513.71	4764.99	29278.75				
	TOTAL	105812.60	34359.60	6420.88	40780.46	12680.18	58808.78	38.54	

4.3 Ground Water Quality

CGWB is monitoring the ground water quality of the Nagpur district since the last four decades through its established monitoring wells. The objectives behind the monitoring are to develop an overall picture of the ground water quality of the district. During the year 2011, the Board has carried out the ground water quality monitoring

of 36 monitoring wells. These wells mainly consist of the dug wells representing the shallow aquifer. The sampling of ground water from these wells was carried out in the month of May 2011 (pre-monsoon period). The water samples after collection were immediately subjected to the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analyzed, include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO₃) and Fluoride (F). The sample collection, preservation, storage, transportation and analysis were carried out as per the standard methods given in the manual of American Public Health Association for the Examination of Water and Wastewater (APHA, 1998). The ground water quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of ground water quality in the district in the year 2011.

4.3.1 Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TA, TH, NO₃ and F prescribed in the standards and is given in **Table-5**.

Table-5: Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003)

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TA (mg/L)	200	600	22	14	-
TH (mg/L)	300	600	24	9	3
NO ₃ (mg/L)	45	No relaxation	22	-	14
F (mg/L)	1.0	1.5	35	-	-

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit)

The perusal of **Table-5** shows that the concentrations of all the parameters except nitrate in most of the samples are the maximum permissible limit of the within BIS standards. It is also seen from the **Table-5** that the potability of

ground water in the wells is mainly affected due to the Nitrate (NO₃) as its concentration exceeds more than MPL in 39% of samples. Overall, it can be concluded that the ground water quality in the wells monitored in the district is affected because of high NO₃ concentrations.

4.3.2 Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

Electrical Conductivity (EC)

The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows.

Low Salinity Water (EC: 100-250 µS/cm): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop.

Medium Salinity Water (EC: 250 – 750 µS/cm): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High Salinity Water (EC: 750 – 2250 µS/cm): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very High Salinity Water (EC: >2250 µS/cm): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected.

The classification of ground water samples collected from monitoring wells for was carried out irrigation purpose and given below in **Table-6**.

It is clear from the **Table-6** that maximum number of samples (67%) falls under the category of medium salinity water while nearly 5% of samples fall in very high salinity water category. This shows that the ground water in the pre-monsoon season from shallow aquifer in the district should be used for irrigation with proper soil and crop management practices..

Table-6: Classification of Ground Water for Irrigation based on EC.

Type	EC (µS/cm)	No. of Samples	% of Samples
Low Salinity Water	<250	Nil	Nil
Medium Salinity Water	250-750	24	67
High Salinity Water	750-2250	10	28
Very High Salinity Water	>2250	2	5
Total		36	100.0

4.3.3 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is considered to be superior to EC as a measure of sodicity particularly at low salinity levels. The classification of ground water samples based on RSC values for its suitability for irrigation purpose is shown below in **Table-7**.

Table-7: Classification of Ground Water for Irrigation based on RSC.

Type	RSC	No. of Samples	% of Samples
Good	<1.25	33	92
Doubtful	1.25-2.50	3	8
Unsuitable	>2.50	-	-
Total		36	100

The perusal of **Table-7** shows that the RSC values of ground water samples collected from the wells is less than 1.25 in about 92% of wells, which reflects that the overall quality of ground water in the monitoring wells is good for irrigation

4.3 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area. The yields of wells are functions of the permeability and transmissivity of aquifer encountered and varies with location, diameter and depth etc. Ground water in the area is being developed by two type of abstraction structures i.e., borewells and dugwells. However dugwells are the main ground water abstraction structures in the district. The yield of such structures varies from 20 to 380 m³/day. High yielding dugwells are generally located in weathered and fractured Basalts, fractured granites and Gondwana formations occurring in physiographic depressions.

The minor irrigation census data (2000-01) indicates that area irrigated by ground water is 914.68 sq.km., whereas surface water accounts for 341.74 sq.km., of area and net irrigated area stands at 1256.42 sq.km., Thus it is clear that ground water is the major source of irrigation as it accounts for about 73% of net irrigated area. The district had 59407 irrigation dugwells, which create an irrigation potential of 1413.71 sq.km., out of which 1236.25 sq.km., of irrigation potential is utilised. In addition to this 12.00 sq.km., of irrigation potential is utilised through 533 borewells/tubewells.

State government has drilled large number of borewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. The GSDA, Government of Maharashtra till 2006-07 has constructed about 9953 borewells for rural water supply, out of which 9483 are fitted with hand pumps whereas 470 are fitted with electric pumps. The borewells have depth range of 40 to 70 m with the yield range from poor to more than 10000 lph.

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the State of Maharashtra. The ground water development in some parts of the State has reached a critical stage resulting in decline of ground water levels. There is thus a need to adopt an integrated approach of development of ground water

resources dovetailed with ground water augmentation to provide sustainability to ground water development.

5.1 Ground Water Development

The basalt is the main formation of the district and occupies an area of about 4300 sq. km. It is observed that the vesicular and weathered basalts are more productive than the massive and jointed basalts. Though the Archaeans are highly weathered, they form moderate potential aquifers. Alluvium is the most potential aquifer occurring in the district. In general, the Gondwana formation gives moderate to high yield while the Lameta is poor yielding aquifer in the district. Dugwells are most common ground water extraction structure in the district and are used for both domestic and irrigation purposes. The formation wise yield of dugwells is given in **Table-8**.

Table-8: Formation-wise yield of Dugwells.

S. No.	Rock Formation	Depth range (m bgl)	Yield range (m ³ /day)		Remarks
			Winter	Summer	
1.	Archaen	4.97-26.00	20-300	5-120	Weathered and fractured formation form good aquifers.
2.	Gondwana	8.00-19.65	40-200	20-80	Kamthi is best aquifer.
3	Lameta	5.85-17.15	-	-	Poor aquifer and cannot sustain pumping.
4	Deccan Trap				
a)	Massive Basalt	5.1-13.00	20-90	10-20	Poor aquifer, sustain limited pumping.
b)	Vesicular Basalt	5.7-13-55	20-288	20-240	During summer yield is mostly between 20-60 m ³ /day
c)	Weathered Basalt	4.00-17.25	30-384	10-128	Summer yield is between 20 to 80 m ³ /day
d)	Jointed Basalt	5.20-11.75	35-240	6-190	Summer yield is around 40 m ³ /day
5	Alluvium	8.10-16.30	110-300	40-300	Restricted along the rivers and their tributaries

The yields of borewells vary widely in the district depending on the type of formations, depth of water bearing zones, types and extent of lineaments. Based on the exploration carried out by C.G.W.B. the yield range of borewells occurring in different formations of the district is tabulated in **Table-9**.

Table-9: Formation-wise yield of Borewells.

S. No.	Rock Formation	Depth range (m bgl)	Yield range (m ³ /day)
1	Archeans	42.00 to 216.57	5 to 1040
2	Gondwana	60.00 to 300.00	90 to 780
3	Trap covered Gondwana	79.00 to 300.76	15 to 690
4	Deccan Trap	103.00 to 254.0	10 to 1650

The nature and yield potential of the aquifers occurring in different areas is given in **Table-10**. A perusal of **Table-10** shows that the 8 talukas i.e., Katol, Umred, Kalmeshwar, Narkhed, Hingna, Kuhi, Mouda, Kamptee talukas have medium to high yield potential and the suitable abstraction structures are dugwell and DCB. However Katol and Narkhed talukas, which have been categorised as Semi-Critical needs careful planning for both ground water abstraction as well as augmentation, so that the sustainable development is achieved.

Table-10: Nature and Yield Potential of Aquifers.

Sr. No.	Taluka	Main Aquifer	Yield Potential	Type of Wells Suitable
1.	Nagpur	Basalt	Medium	Dugwell DCB
2.	Katol	Basalt	Medium to High	Dugwell DCB
3.	Ramtek	Basalt Gondwana	Low to High	Dugwell DCB
4.	Parseoni	Basalt Gondwana	Low to High	Dugwell DCB
5.	Umred	Basalt Gondwana	Medium to High	Dugwell DCB
6.	Saoner	Basalt Gondwana	Low to High	Dugwell DCB
7.	Bhiwapur	Basalt	Medium	Dugwell DCB
8.	Kalmeshwar	Basalt Gondwana	Medium to High	Dugwell DCB
9.	Narkhed	Basalt	Medium to High	Dugwell DCB
10.	Hingna	Basalt Gondwana	Medium to High	Dugwell DCB
11.	Kuhi	Basalt	Medium to High	Dugwell DCB
12.	Mouda	Basalt	Medium to High	Dugwell DCB
13.	Kamptee	Basalt Gondwana	Medium to High	Dugwell DCB

5.2 Water Conservation and Artificial Recharge

Ground water plays vital role for irrigation in Nagpur district, as a result the ground water levels are depleting at faster rate. To avoid over-exploitation of ground water resources, there is a need to increase irrigation facilities from surface water sources and to conserve water flowing out from area through rivers and nalas at various places by constructing different types of water conservation structures. These structures will not only prevent outgoing surface run-off from the small watersheds, but also will act as artificial recharge structures and arrest soil erosion.

One Rooftop Rainwater Harvesting Scheme was taken up and completed successfully by CGWB during 2001-02 at KITS, Ramtek under Central Sector Scheme for Artificial Recharge. Buildings of IT Department and Boys Hostel were identified for harvesting rainwater from roof tops. Total 196 cubic meter of rain water was harvested and recharged in a year in IT block and around 200 cubic meter in Triveni Hostel building in the year 2002-03. The water level rose in the wells/borewells of the campus within 3-4 years. The pumping hours of water supply borewells located up to 200 metres distance increased by around 1 hour and yield of the bore wells increased by 500 to 1000 litres/hours.

Demonstrative Project of artificial recharge was taken in Rajbhawan, Nagpur under Central Sector Scheme. Under this scheme 49 water conservation structures were constructed for rainwater harvesting and artificial recharge of ground water. It is aimed to use the structures as demonstrative model for State Govt, NGOs and public.

6.0 Ground Water Related Issues and Problems

The long term rainfall data analyses of Nagpur, Ramtek, Katol, Parseoni, Umred, Saoner indicates that these talukas had faced medium drought conditions in 13 to 20 % of the years. A hydrogeology study was carried out for Nagpur Metropolitan Region which includes Nagpur Municipal Corporation Area, Cantonment Board of Kamthi, two Municipal towns of Kamthi and Kalmeshwar and 262 surrounding villages. It was observed that ground water quality is adversely affected by nitrate contamination in various localities in eastern and southern part of Nagpur City. This zone is the end point for the entire municipal and domestic waste of the City discharged through Nag Nadi. This indiscriminate discharge of liquid waste in drain and on land, disposal of solid waste in land fill sites without hydrogeological consideration and microbial reaction in soil are contribution to high level Nitrate at these places. Such indiscriminate discharge of liquid and solid waste to Nag Nadi should be immediately stopped.

In rural areas also the ground water quality is mainly affected by nitrate as 46% of samples are having high nitrate concentration. Continuous intake of high nitrate concentration water causes infant methaemoglobinemia, popularly known as Blue Babies disease. Thus all the wells used for water supply should be first analysed for nitrate contents and if the nitrate content is found beyond permissible limit the ground water may be used for other purposes than drinking. Adequate sanitary protection to the wells may be provided to control the nitrate contamination.

Study of ground water quality around Hingna and Kalmeshwar MIDC area has revealed that contamination of ground water of phreatic zone has taken place due to discharge of industrial effluents.

7.0 Mass Awareness and Training Activities

7.1 M.A.P. and W.M.T.P.

Till March 2007, 2 MAP and 5 WMTP had been organised in the district of Nagpur. The details are given in **Table-11**.

Table-11: Status of MAP and WMTP.

S. No.	Item	AAP	Venue	Date
1	MAP	2002-03	Akoli	22/01/03
2		2004-05	Nagpur	01 & 02/02/05
3	WMTP	2001-02	Nagpur	12/02/02
4		2001-02	Ramtek	05/03/02
5		2003-04	Nagpur	25 to 27/08/03
6		2004-05	Nagpur (RWH Week)	01 to 05/02/05
7		2005-06	Kamptee	22 & 23/09/05

7.2 Participation in Exhibition, Mela, Fair etc.

During the MAP and WMTP at various places, exhibitions depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps. The models, maps, posters were explained to the visitors in details.

8.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas fall under "Safe" category and no taka been notified either by CGWA or SGWA.

9.0 Recommendations

1. Shallow aquifer of hard rock formations such as Archeans and Deccan traps can be tapped by large-diameter open wells, and should be pierced to a total thickness of weathered and jointed and vesicular units in favourable hydrogeological and topographical areas.
2. The dug-cum-borewells (DCB) may also be constructed in favourable hydrogeological settings to tap the upper weathered zones and lower fractured and jointed formations.
3. Gondwana, which forms the best aquifer in the district, can be tapped through tubewells. Trap-covered-Gondwana is also to be developed through borewells. The shallow Alluvium can be developed through shallow tubewells down to the depth of 25 to 30 mbgl.
4. Artificial recharge methods like construction of percolation tanks, contour bunding and nala bunding may be constructed in large scale in non-command areas so as to augment the groundwater recharge. Such structures are must in Narkhed and Katol Saoner talukas, where ground water development is 72% , 75% and and 73% respectively.
5. Percolation tanks utilizing surplus rainwater in hilly areas may be constructed to increase the seepage to ground water especially in Narkhed, Kalmeshwar and Katol talukas.
6. In the Kalmeshwar and Hingna MIDC areas, the nalas carrying the industrial effluents must be lined horizontally and vertically on both sides, so as to avoid contamination of ground water. A final sewage treatment plant must

take care of all the sewage's coming through the lined nalas before being disposed off in the nearby rivers with proper check.

7. A huge quantity of wastewater from the Nagpur urban area and different industries surrounding the cities are being discharged to the rivers, such as Nag Nadi, and its tributaries resulting in the pollution of ground water as well as surface water. Hence, it is recommended that along with lateral lining, bottom lining may also be provided to the channels to stop the vertical seepages.
8. To prevent the Nitrate pollution in the Nagpur city and rural areas, sanitary protection around the borewells and dugwells may be done for larger diameter, than being done at present. The Nitrate content of the ground water may be determined before commissioning of the borewell/dugwell for public use. The land fill sites must be selected carefully at places away from the habitation and after giving due considerations to the hydrogeological settings.
9. Due to construction of cement road and various infrastructures the area available for ground water recharge has been reduced drastically in urban areas. In view of this rooftop rain water harvesting practices are to be adopted in urban area, like Nagpur City, to augment the recharge of ground water as the recharge is becoming lesser and lesser day by day.