



**भारत सरकार  
जल संसाधन मंत्रालय  
केंद्रीय भूजल बोर्ड**

**GOVERNMENT OF INDIA  
MINISTRY OF WATER RESOURCES  
CENTRAL GROUND WATER BOARD**

**महाराष्ट्र राज्य के अंतर्गत नाशिक जिले की  
भूजल विज्ञान जानकारी  
GROUND WATER INFORMATION  
NASHIK DISTRICT  
MAHARASHTRA**



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**मध्यवर्ती क्षेत्र  
नागपुर  
CENTRAL REGION  
NAGPUR  
2009**

## **NASHIK DISTRICT AT A GLANCE**

### **1. GENERAL INFORMATION**

Geographical Area	:	15530 sq. km
Administrative Divisions (As on 31/03/2007)	:	Taluka – 15; Nashik, Igatpuri, Dindori, Peint, Surgana, Deola, Satana, Kalwan, Chandwad, Niphad, Sinnar, Yeola, Malegaon, Nandgaon, Trimbakeshwar.
Villages	:	1931
Population	:	49,94,000
Normal Annual Rainfall	:	500 mm to 3400 mm

### **2. GEOMORPHOLOGY**

Major Physiographic unit	:	3; Satmala, Selbari and Dolbari, hill ranges, eastern and southern plains and Godavari valley.
Major Drainage	:	2 ; Godavari and Girna

### **3. LAND USE (2000-01)**

Forest Area	:	321 sq. km.
Net Area Sown	:	6385 sq. km.
Cultivable Area	:	8261 sq. km.

### **4. SOIL TYPE**

:	:	4; Lateritic black soil (Kali), Reddish brown soil (Mal), Coarse shallow reddish black soil (Koral) and Medium light brownish black soil (Barad).
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### **5. PRINCIPAL CROPS (2000-01)**

Bajra	:	3366 sq. km.
Rice	:	553 sq. km.
Pulses	:	648 sq. km.
Oil Seeds	:	515 sq. km.
Sugar Cane	:	312 sq. km.

### **6. IRRIGATION BY DIFFERENT SOURCES (2000-01) – Nos./Potential Created (ha)**

Dugwells	:	154261 / 278911
Tubewells/Borewells	:	6232 / 12870
Tanks	:	3338 / 5716
Other Minor Surface Sources	:	3038 / 4699
Net Irrigated Area	:	207614

### **7. GROUND WATER MONITORING WELLS (As on 30/11/2007)**

Dugwells	:	42
Piezometers	:	14

### **8. GEOLOGY**

Recent	:	Alluvium
Upper Cretaceous-Lower Eocene	:	Deccan Trap Basalt

### **9. HYDROGEOLOGY**

Water Bearing Formation	:	Basalt – Weathered / fractured / jointed vesicular / massive, under phreatic and semi-confine to confined conditions.
Premonsoon Depth to Water Level (May-2007)	:	0.50 to 12.80 m bgl

Postmonsoon Depth to Water : 0.80 to 18.70 m bgl  
 Level (Nov.-2007)  
 Premonsoon Water Level Trend : Rise : Negligible to 0.52 m/year  
 (1998-2007) Fall : Negligible to 1.06 m/year  
 Postmonsoon Water Level Trend : Rise : 0.03 to 0.75 m/year  
 (1998-2007) Fall: Negligible to 0.61 m/year

**10. GROUND WATER EXPLORATION (As on 31/03/07)**

Wells Drilled : Peizometers- 14  
 Depth Range : 30.60 to 70.00 m bgl  
 Discharge : 0.14 to 1.73 lps

**11. GROUND WATER QUALITY**

Good and suitable for drinking and irrigation purpose, however localized nitrate contamination is observed.

**12. DYNAMIC GROUND WATER RESOURCES (As on 31/03/2004)**

Net Annual Ground Water : 1820.82 MCM  
 Availability  
 Annual Ground Water Draft : 909.72 MCM  
 (Irrigation + Domestic)  
 Allocation for Domestic and : 48.50 MCM  
 Industrial requirement up to next  
 25 years  
 Stage of Ground Water : 49.96 %  
 Development

**13. AWARENESS AND TRAINING ACTIVITY**

Mass Awareness Programme : Nil  
 Water Management Training : 1  
 Programme  
 a. Date : 09/03/2003  
 b. Place : Nashik

**14. GROUND WATER CONTROL AND REGULATION**

Over-Exploited Taluka : None  
 Critical Taluka : None  
 Semi – Critical Taluka : 3; Niphad, Sinnar and Chandwad.  
 Notified Taluka : None

**15. MAJOR GROUND WATER PROBLEMS AND ISSUES**

Major part of the district (about 75%) falling east of Western Ghats comprising almost entire Sinnar, Niphad, Surgana, Kalvan, Satana, Chandwad, Yeola talukas and parts of Dindori, Peint and Malegaon talukas is classified as drought areas. The premonsoon water level trend shows fall in water level up to 20 cm/year in major parts of the district, occupying central, northwestern, western, eastern and southern parts of the district in entire Kalvan, Surgana, Dindori, Chandvad, Nandgaon, Yeola, Niphad, Igatpuri talukas and parts of Baglan (Satana), Malegaon, Sinnar, Nashik and Peint talukas. Similarly as per current assessment of ground water resources it is also seen that the ground water development in Chandwad, Niphad and Sinnar talukas have already reached up to 90% and these talukas fall under “Semi-Critical” category. At some places like Satana, Sinnar, Jalgaon and Rasalapur the EC of ground water is about 3000  $\mu$  mhos/cm at 25°C. The ground water quality is mainly affected by nitrate as 27% of samples are having high nitrate concentration.

# Ground Water Information Nashik District

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# Ground Water Information

## Nashik District

### 1.0 Introduction

Nasik District is situated in north western part of Maharashtra. It lies between 19°35' and 20°50' north latitude and between 73°16' and 74°56' east longitude and falls in parts of Survey of India degree sheets 46-H, 46-L and 47-E and 47-I. The district has a geographical area of 15530 sq. km. It is surrounded by Dhule district in the north, Dangs and Surat district of Gujarat State in the northwest, Jalgaon in the east and northeast, Ahmednagar in the south, Aurangabad in the southeast and Thane in the west and southwest.

The district headquarters is located at Nasik Town. For administrative purpose four divisions have been formed namely Nasik, Niphad, Malegaon and Peth. The district is further subdivided in to 15 talukas viz., Nashik, Igatpuri, Dindori, Peint, Sargana, Deola, Satana, Kalwan, Chandwad, Niphad, Sinnar, Yeola, Malegaon, Nandgaon and Trimbakeshwar.

As per 2001 census, the population of the district is 49.94 lakh. The district has 18 towns and 1931 villages. Nashik is one of the largest district in Maharashtra in terms of area and population. The district forms part of Godavari basin (southern part) and Tapi basin (northern part). Godavari and Girna are the main rivers 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 N.G. Gajbhiye	1971 – 72	Systematic Hydrogeological Surveys in parts of Nashik district.
2.	Dr. S.S. Rao	1977-78	Systematic Hydrogeological Surveys in parts of Nashik district.
3.	Shri V.V. Rane	1978-79	Systematic Hydrogeological Surveys in parts of Nashik district.
4.	S/Shri S. Das and D.B. Shetye	1980-81	Systematic Hydrogeological Surveys in parts of Nashik district.
5.	S.S. Sudarshana	1982-83	Systematic Hydrogeological Surveys in parts of Nashik district.
6.	S/Shri Binoy Ranjan and S.K. Bhatnagar	1989-90	Systematic Hydrogeological Surveys in parts of Nashik district.
9.	S/Shri B.K. Kallapur and S. Kudesia	1991-92	Reappraisal Hydrogeological Studies in parts of Nashik district.
11.	Shri D. Saha	1995-96	Reappraisal Hydrogeological Studies in parts of Nashik district.
12.	S/Shri A.B. Kawade, S.C. Paranjape and Sunil Toppo	2004-05	Reappraisal Hydrogeological Studies in parts of Nashik district.

In addition to the above a report on “Ground Water Resources and Development Potential of Nashik District, Maharashtra” was issued during year 1991 by Shri P.K. Agrawal, Scientist- C. Ground water exploration is yet to be

taken up in the district, however during 1995, 14 Piezometers (Pz) have been drilled in the district to monitor the water levels. The salient features of Piezometers are given in **Table-2**.

**Table-2: Salient Features of Piezometers.**

S. No.	Location	Depth (m bgl)	SWL (m bgl)	Discharge (lps)	Zones (m bgl)
1	Sinner	50.00	3.90	0.14	15.00
2	Pimpalnara	50.00	12.80	1.05	24.00
3	Pimplus	30.60	7.85	1.05	11.00
4	Vavi	30.60	9.78	1.73	18.00
5	Palkhed	50.00	-	1.16	4.20
6	Vinchur	50.00	34.60	1.16	38.00
7	Pandurli	30.60	7.00	0.56	22.50
8	Jakhori	50.00	20.90	0.14	40.80
9	Adgaon	42.80	5.32	0.14	7.50
10	Pachorewani	50.00	30.10	0.14	15.80 43.50
11	Umbrane	50.00	13.80	1.73	18.40
12	Gilane	50.00	6.65	1.16	7.00
13	Khamkheda	30.60	12.60	1.05	15.40
14	Shirpuruwadi	70.00	-	-	-

It is observed from Table-2 that the depth of the 14 Piezometers drilled ranged from 30.60 to 70.00 meters below ground level (m bgl). The discharge from these wells varied from 0.14 to 1.73 litres per second (lps), for a high drawdown of >100 m. Static water levels ranged from 3.90 to 34.60 m bgl. The potential aquifer zones have been encountered in the depth range of 4.20-40.80 mbgl.

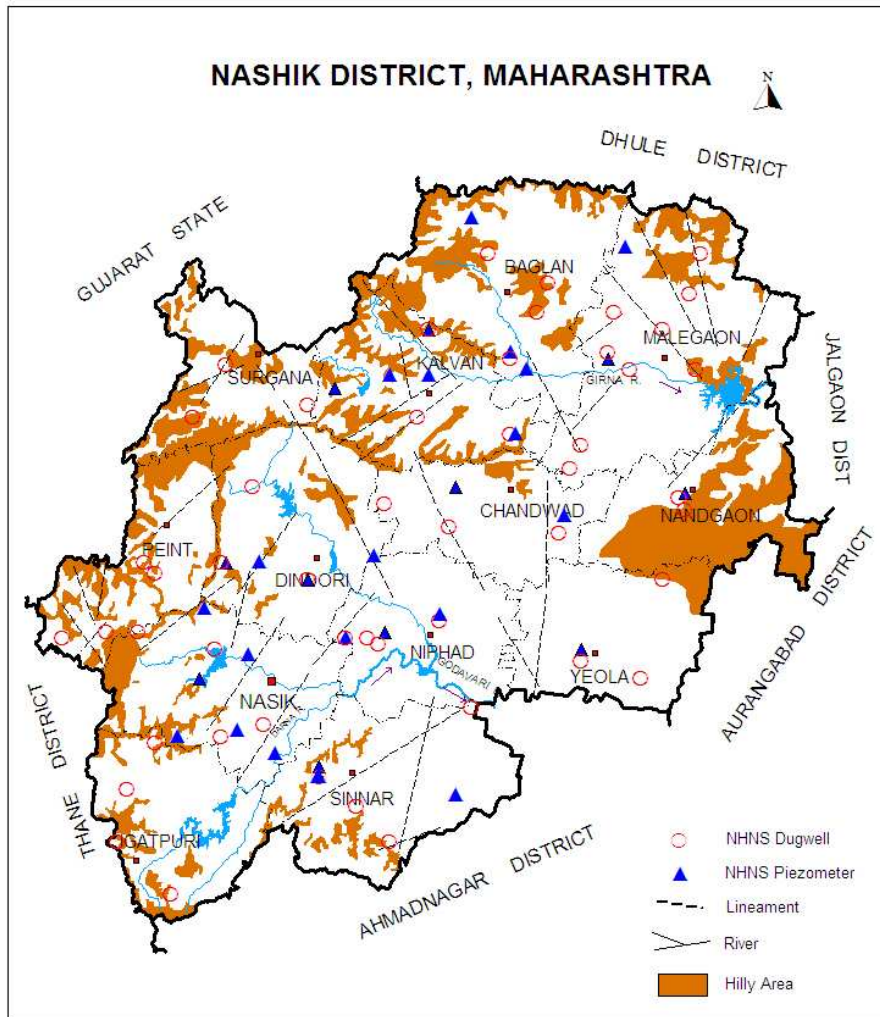
A map of the district showing the taluka boundaries, taluka headquarters, physical features and location of exploratory and monitoring wells is presented as **Figure-1**.

## 2.0 Climate and Rainfall

The climate of the district is on the whole is agreeable. The climate of Nashik district is characterized, by general dryness throughout the year except during the south-west monsoon season. The winter season is from December to about the middle of February followed by summer season which last up to May. June to September is the south-west monsoon season, whereas October and November constitute the post-monsoon season. The maximum temperature in summer is 42.5°C and minimum temperature in winter is less than 5.0°C. Relative humidity ranges from 43% to 62%.

The normal annual rainfall in the district varies from about 500 mm to 3400 mm. It is minimum in the north eastern part of the district and increases towards west and reaches a maximum around Igatpuri in the western ghat. The chances of receiving normal rainfall are maximum (50 to 55%) in the north eastern part around Malegaon and Nandgaon and minimum in the central part of the district. The study of negative departures of the annual rainfall over normal reveals that major part of the district (about 75%) falling east of Western Ghats comprising almost entire Sinnar, Niphad, Surgana, Kalvan, Satana, Chandwad, Yeola

talukas and parts of Dindori, Peint and Malegaon talukas can be categorized as drought area. The average annual rainfall for the period 1998 to 2007 ranges from about 541 mm (Devali) to 3486 mm (Igatpuri) and same is presented in Table-3.



**Figure-1: Location**

**Table-3: Annual Rainfall Data (1998 – 2007) (mm)**

S. No.	Taluka	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	Avg.
1	Baglan	53	636	327	382	583	577	745	603	960	810	625
2	Chandwad	658	690	463	559	716	438	828	640	1161	791	694
3	Devali	751	541	409	448	377	391	465	491	864	675	541
4	Dindori	744	693	536	487	867	860	1093	799	1082	772	793
5	Igatpuri	3826	2733	2084	2993	2847	3569	3902	4463	4778	3664	3486
6	Kalwan	748	653	318	490	868	772	1031	874	1414	826	799
7	Malegaon	648	798	409	383	553	395	672	422	851	739	587
8	Nandgaon	882	736	696	382	584	400	517	413	878	629	612
9	Nasik	941	803	773	646	813	912	1058	1202	1323	833	930

10	Niphad	799	790	540	500	694	619	1044	885	879	781	753
11	Peth	2140	1898	1233	1684	1772	2160	2603	2847	3345	1957	2164
12	Sinnar	854	740	555	421	465	811	702	676	951	689	687
13	Surgana	1734	2144	1111	1527	2048	1927	2474	3067	2992	1947	2097
14	Trimba- keshwar	935	1879	1477	1799	2120	2312	2459	3749	3794	2515	2304
15	Yevla	722	691	498	484	444	392	863	507	932	679	621

### 3.0 Geomorphology and Soil Types

The district forms part of Western Ghat and Deccan Plateau. Physiographically Nasik district comprises varied topography. The main system of hills is Sahayadri and its offshoots viz., Satmala, Selbari and Dolbari hill ranges. These hill ranges along with eastern and southern plains and Godavari valley are the distinct physiographic units. The northern part of the district falls under Tapi basin and is drained by easterly flowing Girna River along with its tributaries, whereas the southern part of the district falls under Godavari basin and is drained by Godavari River and its tributaries. Other important rivers in the district are Damanganga, Vaitarna, Darna, Kadva, Aram, Mosam, Panjan and Manegad.

The soils of the district are the weathering products of Basalt and have various shades from gray to black, red and pink color. The soils occurring in the district are classified in the four categories namely lateritic black soil (Kali), reddish brown soil (Mal), coarse shallow reddish black soil (Koral), medium light brownish black soil (Barad). In general the soils are very fertile and suitable for growing cereal and pulses. The black soil contains high alumina and carbonates of calcium and magnesium with variable amounts of potash, low nitrogen and phosphorus. The red soil is less common and is suitable for cultivation under a heavy and consistent rainfall.

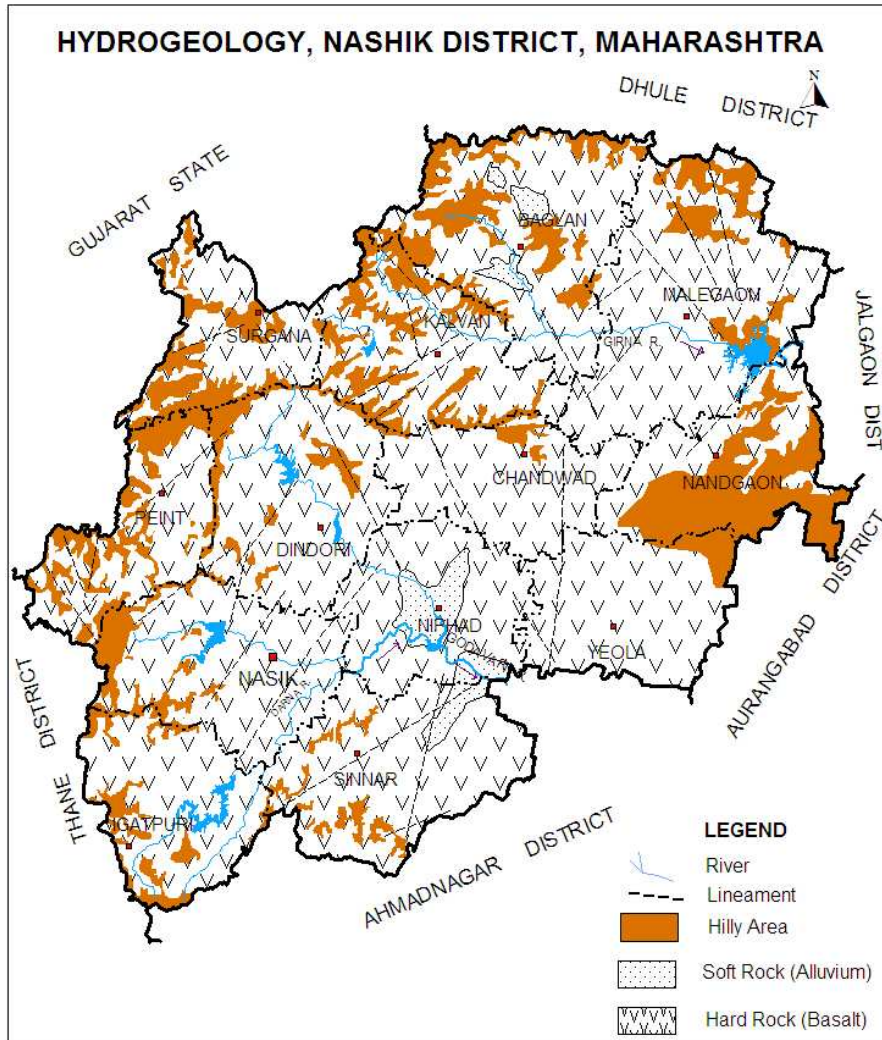
### 4.0 Ground Water Scenario

#### 4.1 Hydrogeology

The entire area of the district is underlain by the basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow alluvial formation of Recent age also occurs as narrow stretch along the banks of Godavari and Girna Rivers flowing in the area. A map depicting the hydrogeological features is shown as **Figure-2**.

##### 4.1.1 Hard Rock (Deccan Trap Basalt)

Basaltic lava flows occupies about 90% of the area of the district. These flows are normally horizontally disposed over a wide stretch and give rise to table land type of topography also known as plateau. These flows occur in layered sequences and represented by massive unit at the bottom and vesicular unit at the top of the flow. These flows are separated from each other by marker bed known as 'bole bed'.



**Figure-2: Hydrogeology**

The ground water in Deccan Trap Basalt occurs mostly in the upper weathered and fractured parts down to 20-25 m depth. At places potential zones are encountered at deeper levels in the form of fractures and inter-flow zones. The upper weathered and fractured parts form phreatic aquifer and ground water occurs under water table (unconfined) conditions. At deeper levels, the ground water occurs under semi-confined to confined conditions. The yield of dugwells tapping upper phreatic aquifer down to the depth of 12 to 15 m bgl ranges between 45 to 90 m<sup>3</sup>/day depending upon the local hydrogeological conditions. Borewells drilled down to 70 m depth, tapping weathered and vesicular basalt are found to yield 18 to 68 m<sup>3</sup>/day. The discharge of Peizometers ranges from 0.14 to 1.73 as seen from CGWB data.

**4.1.2 Soft Rock (Alluvium)**

Alluvium occurs in small areas in the form of discontinuous patches along the banks and flood plains of major rivers like Godavari, Girna and their tributaries. In alluvium the granular detrital material like sand and gravel usually occurring as thin layer in the district yields water. In the district Alluvium occupies

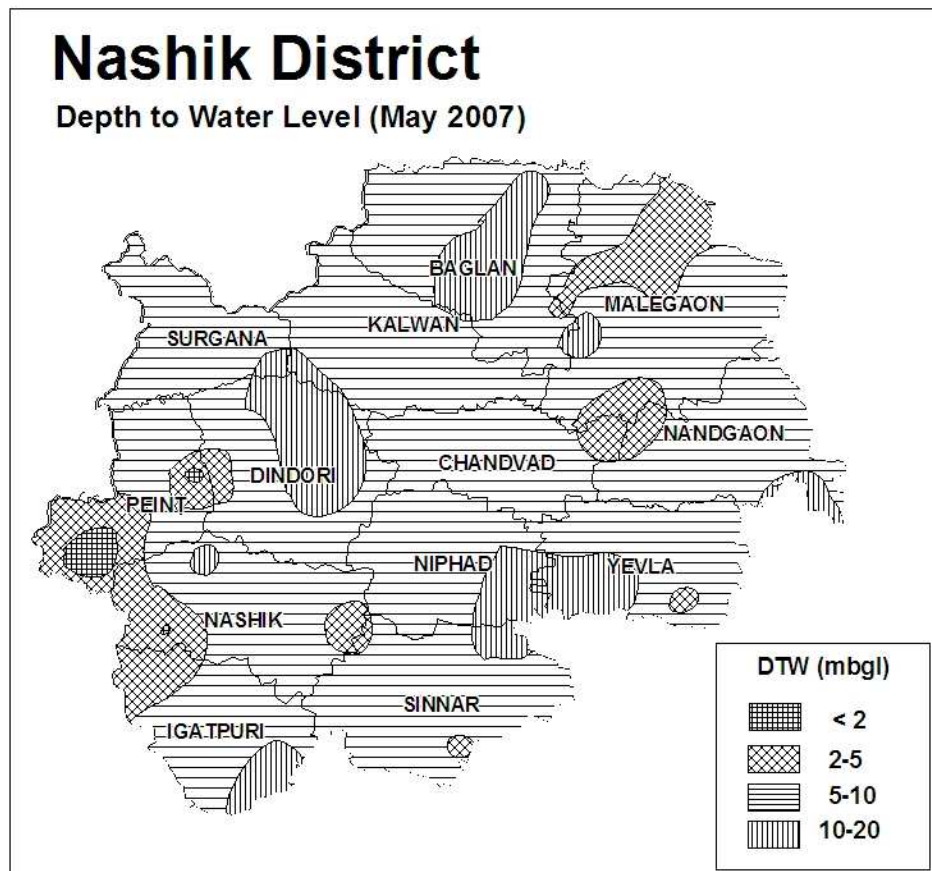
an area of 1500 sq.km and it ranges in thickness from 7- 21 meters. It consists of reddish and brownish clays with intercalations of sand, gravel and kanker. The loosely cemented coarse sands and gravels form 3-4 meters thick lower most horizons at the bottom of these alluvial pockets. Ground water in Alluvium occurs both under semi confined and confined conditions. The dugwells constructed in Alluvium has been ranging in depth from 8-12 m, whereas the borewells range in depth form 15 to 20 m and the yield of both the dugwells and borewells ranges from 13 to 22 m<sup>3</sup>/day.

#### 4.2 Water Level Scenario

Central Ground Water Board monitors water levels in 56 National Hydrograph Network Stations (NHNS) stations in the district. These NHNS are measured four time in a year viz., January, May (Premonsoon), August and November (Postmonsoon).

##### 4.2.1 Depth to Water Level – Premonsoon (May 2007)

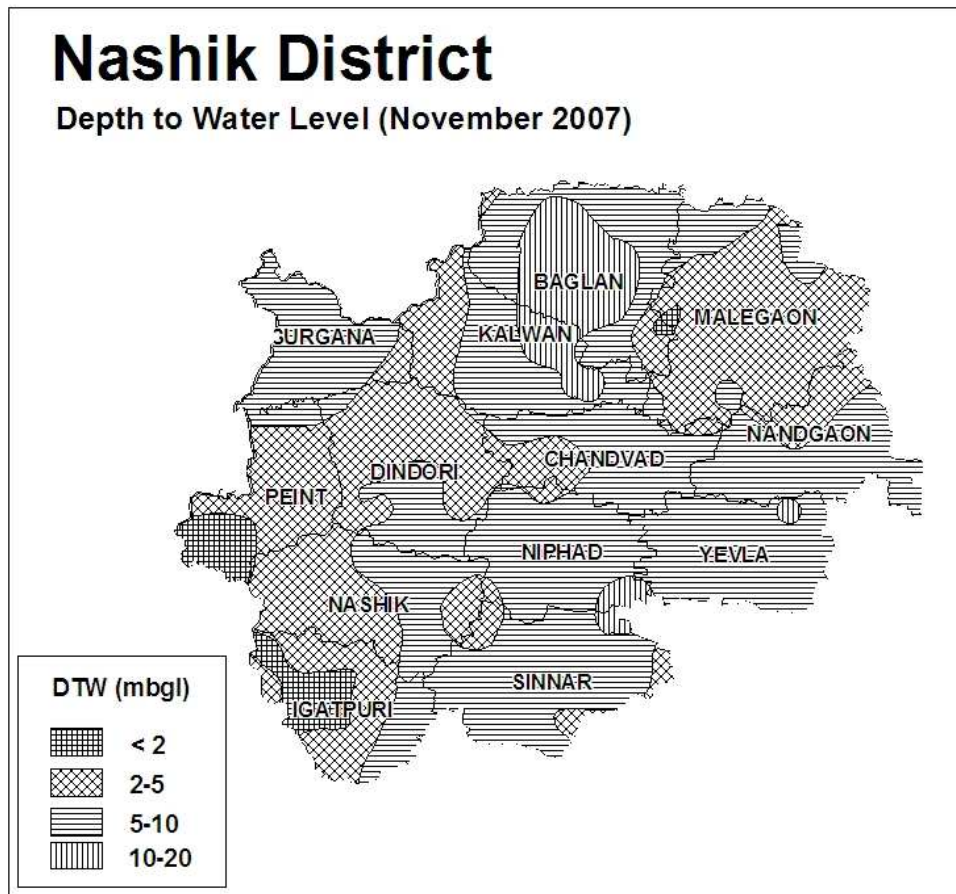
The premonsoon depth to water levels monitored during May 2007 ranges between 0.50 m bgl (Harsul) and 12.80 m bgl (Ravalgaon). The depth to water levels during premonsoon has been depicted in **Figure-3**. The water levels in major part of the district covering entire western, central, north eastern and eastern parts are between 5 and 10 m bgl. Shallow water levels within 5 m bgl occur in southwestern parts of the district in parts of Peint, Nashik and Igatpuri talukas. Deeper water levels of 10 to 20 m bgl are observed in 2-3 isolated patches covering small parts of Yeola, Niphad, Dindori and Baglan (Satana) talukas.



**Figure-3: Depth to Water Level (Premonsoon- May 2007).**

**4.2.2 Depth to Water Level – Postmonsoon (Nov. 2007)**

The depth to water level during postmonsoon (Nov. 2007) ranges between 0.80 m bgl (Lakhmapur) and 18.70 m bgl (Satana). Spatial variation in postmonsoon depth to water level is shown in **Figure-4**. The water levels between 5 and 10 m bgl have been observed in major parts of the district in the south eastern, eastern and north western parts of the district. The shallow water levels within 5 m bgl are observed in southwestern and western parts of the district covering western parts of Nashik and Igatpuri talukas almost entire Peint, and northern parts of Dindori taluka and also in northeastern parts covering almost entire Malegaon taluka. Deeper water levels of 10 to 20 m bgl are observed in northern parts of the district in Baglan (Satana) taluka.



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

**4.2.3 Seasonal Water Level Fluctuation (May to Nov. 2007)**

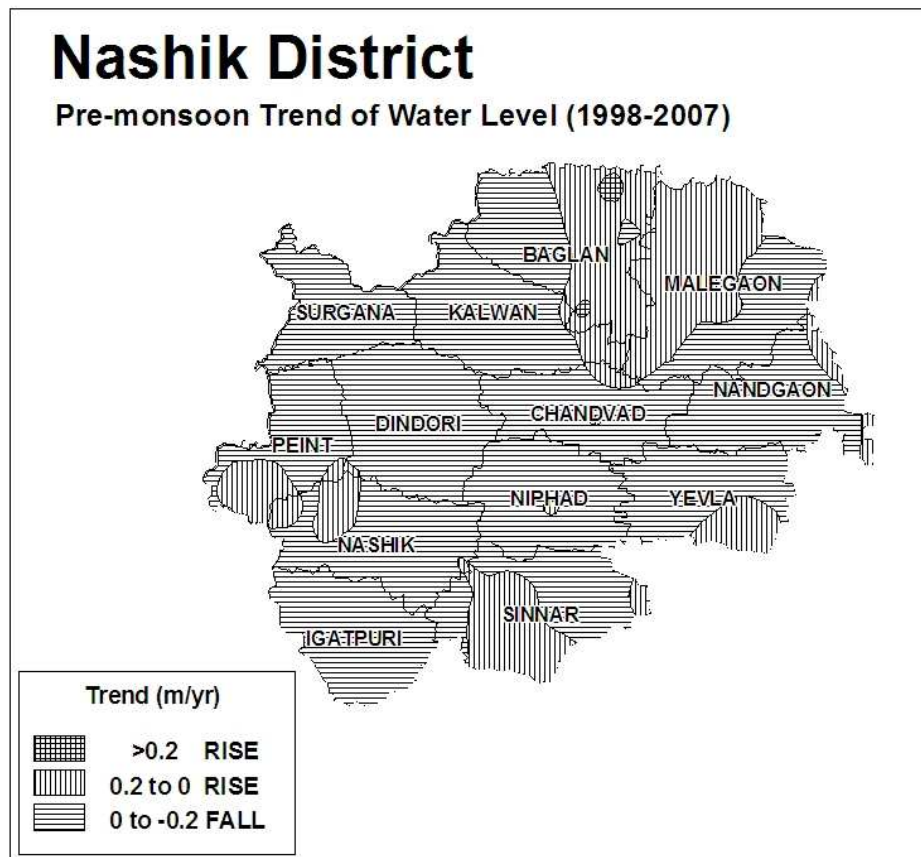
Seasonal water level fluctuation between premonsoon and postmonsoon of 2007 have been computed. Rise in water level in range of 0.15 (Raslapur) to 10.45 m (Ravalgaon) is observed in the district. However, fall in water level was also observed at 10 locations ranging between 0.05 (Deolali) to 6.30 m (Satana) in a 3-4 small isolated patches in parts of Baglan (Saytana), Malegaon and Nashik talukas. Rise in the water levels up to 4 m have been observed in major part of the district in southern, southwestern and easter parts of the district covering almost entire Sinnar, Igatpuri, Nashik, Peint, Niphad and Nandgaon

talukas and parts of Dindori, Chandvad, Yeola, Malegaon, Kalvan and Baglan (Satana) talukas. While rise in water levels of more than 4 m is seen in central and north western parts of the district in parts of Chandwad, Kalwan, Dindori and almost entire Surgana taluka.

#### 4.2.4 Water Level Trend (1998-2007)

Trend of water levels for premonsoon and postmonsoon periods for last ten years (1998-2007) have been computed for 54 NHNS. Analysis of long term water level trend data indicates that rise in water levels in premonsoon period has been recorded at 15 NHNS and its ranges from negligible at few NHNS to 0.52 m/year (Andarsul) and fall in water levels has been observed in 39 NHNS and it ranges between negligible at few NHNS to 1.06 m/year (Gangbari). During postmonsoon period rise in water levels has been recorded at 25 NHNS ranging from 0.03 to 0.75 m/year (Tinghri) while at 29 NHNS fall in water level have been recorded and it ranges between negligible at few NHNS and 0.61 m/year (Surgana). Thus in major parts of the district, both during premonsoon and postmonsoon seasons declining water level trends have been recorded.

The premonsoon trend map was also prepared and the same is presented in **Figure-5**. It shows that the fall in water level trend of up to 20 cm/year is observed in major parts of the district, occupying central, northwestern, western, eastern and southern parts of the district in entire Kalvan, Surgana, Dindori, Chandvad, Nandgaon, Yeola, Niphad, Igatpuri and parts of Baglan (Satana), Malegaon, Sinnar, Nashik and Peint talukas. Thus the situation is quite critical in almost entire district and the future ground water conservation and recharge structures needs to be prioritized in these areas.



### Figure-5: Water Level Trend (Premonsoon- 1998-2007)

The rise of up to 20 cm/year has been observed in 3-4 isolated patches with major patch being observed in northern part of the district occupying parts of Baglan (Satana), Malegaon talukas, in southern part of the district in parts of Sinnar taluka and in western part of the district occupying parts of Nashik and Peint talukas.

### 4.3 Yields of Dugwells and Borewells

The yields of the wells are the functions of the permeability and transmissivity of aquifer encountered. This varies with location, diameter and depth of wells. There are mainly three types of ground water structures i.e. dugwells, borewells and tubewells in the area. Their yield characteristics are presented in Table-4. Dugwells are generally used for both domestic water requirements and for minor irrigation purposes in the district. The depth of dugwells in Basaltic area of the district ranges from 12 to 15 m and the yield varies from 45 to 90 m<sup>3</sup>/day depending upon the local hydrogeological conditions. Borewells drilled down to 70 m depth, tapping weathered and vesicular basalt are found to yield 18 to 68 m<sup>3</sup>/day. The discharge of Piezometers ranges from 0.14 to 1.73 as seen from CGWB data. This variation of yields in the single type of aquifer is due to lateral/spatial variation in permeability of the formation/aquifer material. The dugwells constructed in Alluvium has been ranging in depth from 8-12 m with diameters of 2-3 m, whereas the borewells range in depth from 15 to 20 m and the yield of both the dugwells and borewells ranges from 13 to 22 m<sup>3</sup>/day.

Table-4: Yields of Wells.

S. No.	Formation	GW Abstraction Structure	Depth Range (m bgl)	Yield Range (m <sup>3</sup> /day)
1	Alluvium	Dugwell	8 to 12	13 to 22
		Shallow Tubewell	15 to 20	
2	Basalt	Dugwell	12 to 15	45 to 90
		Borewell	50 to 70	18 to 68

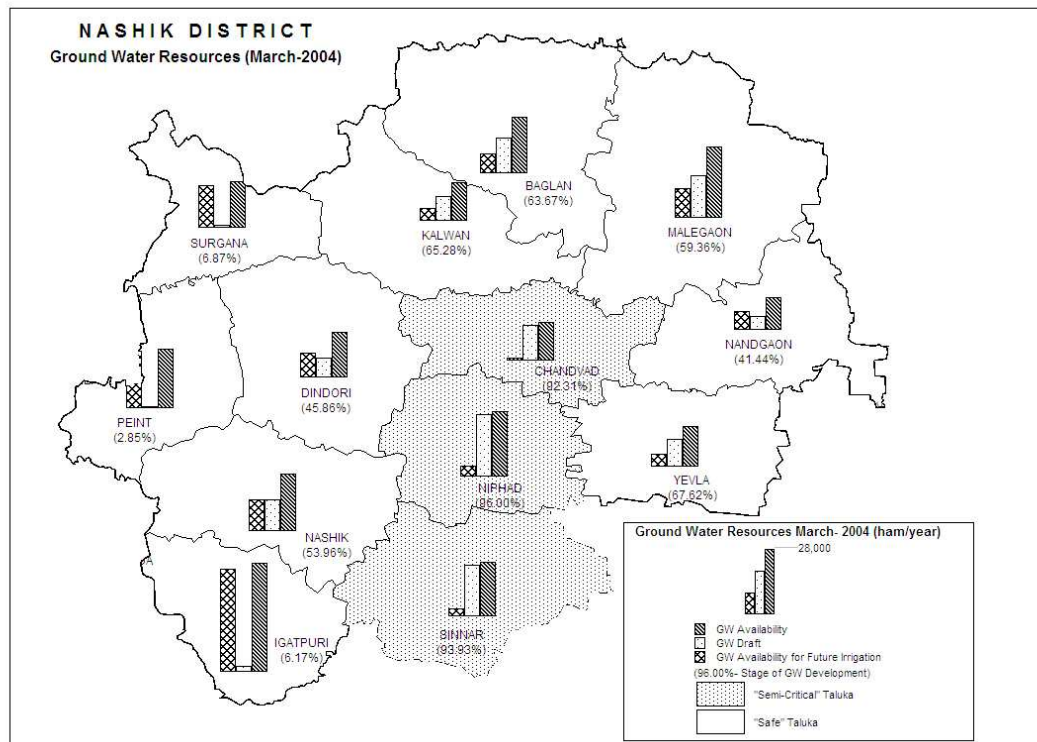
### 4.4 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of Satara district based on GEC-97 methodology and the same are presented in Table-5. Taluka wise ground water resources are shown in **Figure-6**.

Ground water resources estimation was carried out for 13488.56 sq. km. area out of which 1631.35 sq. km. is under command and 11857.21 sq. km. is non-command. As per the estimation the total annual ground water recharge is 1925.18 MCM with the natural discharge of 104.35 MCM, thus the net annual ground water availability comes to be 1820.82 MCM. The gross draft for all uses is estimated at 909.72 MCM with irrigation sector being the major consumer having a draft of 880.12 MCM. The net annual ground water availability for future irrigation is 943.62 MCM, whereas the allocation for domestic and industrial requirements is 48.50 MCM. Stage of ground water development varies from 2.85% (Peint) to 96.00 % (Niphad), whereas the overall stage of ground water development for the district is about 50%. Taluka wise assessments indicate that most of the talukas in the district fall under "Safe" category except Niphad, Sinnar and Chandwad talukas which fall under "Semi-Critical" category.

Similarly the watershed wise assessment has also been done for the district and out of 80 watersheds assessed, 53 watersheds fall under “Safe” category, 18 fall in “Semi-Critical” category (TE-68B, TE-81, TE- 91, TE-92, TE-93, TE-96, TE-128, TE-130, GV-14, GV-15, GV-15, GV-16, GV-17, GV-23, GV-26A, GV-26A’, GV-28A, GV-31A, GV-34A); 2 in “Critical” category (TE-109 and GV-24); 7 in “Over-Exploited” category (TE-80, GV-07, GV-09, GV-20, GV-21, GV-27, GV-29A).

In all these “Semi-Critical”, “Critical”, “Over-Exploited” watersheds and 3 “Semi-Critical” talukas viz., Niphad, Sinnar and Chandwad talukas future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices.



**Figure-6: Ground Water Resources (March 2004).**

#### 4.5 Ground Water Quality

Central Ground Water Board monitors the ground water quality of the district through analysis of water samples collected from its National Hydrograph Network Stations (NHNS) which represent the shallow aquifer of the district only. The objective behind quality monitoring is to understand an overall picture of ground water quality of the district. During year 2007, CGWB has carried out the ground water quality monitoring at 26 NHNS.

The results of chemical analysis shows that the ground water in the district is alkaline in nature, while EC and TDS values shows that the ground water in the district is mineralized to medium extent. At some places like Satana, Sinnar, Jalgaon and Rasalapur the EC of ground water is about 3000  $\mu$  mhos/cm at 25°C. In all these places except Jalgaon the high EC is accompanied by high chloride and nitrate ion concentration indicating contamination due to anthropogenic sources.

**Table-5: Ground Water Resources (March 2004).**

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.)	Ground water availability for future irrigation (ham/yr.)	Stage of ground water development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Nasik	Command	7825.33	2561.78	96.45	2658.23	172.75	5118.26	33.97	
	Non command	6768.01	5085.17	131.00	5216.16	197.20	2849.46	77.07	
	Total	14593.34	7646.95	227.45	7874.40	369.95	7967.72	53.96	Safe
Peth	Command	854.75	5.82	4.54	10.36	9.08	839.85	1.21	
	Non command	14230.86	182.40	237.28	419.68	474.57	13573.90	2.95	
	Total	15085.62	188.21	241.82	430.04	483.65	14413.75	2.85	Safe
Dindori	Command	3574.45	1166.10	46.52	1212.62	84.73	2398.33	33.92	
	Non command	7948.78	3894.37	177.36	4071.73	347.92	3730.32	51.22	
	Total	11523.23	5060.47	223.88	5284.35	432.65	6128.65	45.86	Safe
Surgana	Command	133.97	4.24	2.50	6.74	5.01	124.72	5.03	
	Non command	11554.82	625.82	170.78	796.60	341.55	10587.44	6.89	
	Total	11688.79	630.06	173.28	803.34	346.56	10712.16	6.87	Safe
Kalwan	Command	589.16	203.97	25.76	229.73	26.61	358.57	38.99	
	Non command	9359.50	6091.21	173.20	6264.41	346.39	2921.90	66.93	
	Total	9948.66	6295.19	198.95	6494.14	373.00	3280.47	65.28	Safe
Igatpuri	Command	4830.51	11.05	5.40	16.45	10.80	4808.66	0.34	
	Non command	22912.83	1568.81	125.33	1694.14	250.66	21093.35	7.39	
	Total	27743.34	1579.87	130.73	1710.60	261.46	25902.01	6.17	Safe
Niphad	Command	7862.28	6747.62	147.05	6894.66	166.73	1840.23	87.69	
	Non command	8670.13	8786.79	190.11	8976.89	145.55	987.58	103.54	
	Total	16532.40	15534.40	337.15	15871.56	312.28	2827.81	96.00	Semi-Critical
Sinnar	Command	1812.17	394.62	33.13	427.75	61.00	1356.55	23.60	
	Non command	12122.27	12433.93	227.18	12661.11	67.39	768.48	104.45	
	Total	13934.43	12828.55	260.31	13088.86	128.39	2125.03	93.93	Semi-Critical

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.)	Ground water availability for future irrigation (ham/yr.)	Stage of ground water development (%)	Category
			Irrigation	Domestic & industrial uses	Total				
Yeola	Command	2736.94	1670.13	84.91	1755.04	151.91	914.90	64.12	
	Non command	7671.26	5117.53	165.41	5282.94	329.60	2224.76	68.87	
	<b>Total</b>	<b>10408.20</b>	<b>6787.66</b>	<b>250.32</b>	<b>7037.98</b>	<b>481.51</b>	<b>3139.66</b>	<b>67.62</b>	Safe
Chandwad	Command	1724.38	1433.55	33.09	1466.64	66.18	224.65	85.05	
	Non command	7991.02	7388.68	113.35	7502.04	166.63	463.96	93.88	
	<b>Total</b>	<b>9715.40</b>	<b>8822.23</b>	<b>146.45</b>	<b>8968.67</b>	<b>232.81</b>	<b>688.61</b>	<b>92.31</b>	Semi-Critical
Malegaon	Command	5530.87	2001.73	96.34	2098.07	192.68	3336.47	37.93	
	Non command	12734.41	8501.89	242.14	8744.03	418.97	4029.48	68.66	
	<b>Total</b>	<b>18265.28</b>	<b>10503.62</b>	<b>338.48</b>	<b>10842.09</b>	<b>611.65</b>	<b>7365.95</b>	<b>59.36</b>	Safe
Baglan Satana	Command	4378.54	1324.21	69.64	1393.85	139.27	2915.06	31.83	
	Non command	9939.62	7538.34	184.06	7722.40	333.11	2186.29	77.69	
	<b>Total</b>	<b>14318.16</b>	<b>8862.55</b>	<b>253.69</b>	<b>9116.24</b>	<b>472.38</b>	<b>5101.35</b>	<b>63.67</b>	Safe
Nandgaon	Command	297.92	65.09	9.24	74.33	6.96	225.86	24.95	
	Non command	8028.19	3207.25	168.71	3375.96	337.42	4483.53	42.05	
	<b>Total</b>	<b>8326.11</b>	<b>3272.34</b>	<b>177.95</b>	<b>3450.29</b>	<b>344.38</b>	<b>4709.39</b>	<b>41.44</b>	Safe
<b>District Total</b>	<b>Command</b>	<b>42151.27</b>	<b>17589.91</b>	<b>654.57</b>	<b>18244.48</b>	<b>1093.71</b>	<b>24462.11</b>	<b>43.28</b>	
	<b>Non command</b>	<b>139931.70</b>	<b>70422.19</b>	<b>2305.90</b>	<b>72728.09</b>	<b>3756.96</b>	<b>69900.45</b>	<b>51.97</b>	
	<b>Total</b>	<b>182082.97</b>	<b>88012.10</b>	<b>2960.47</b>	<b>90972.56</b>	<b>4850.67</b>	<b>94362.56</b>	<b>49.96</b>	

The concentration of major ions indicates that among the cations, the concentration of magnesium ion is highest followed by sodium and calcium, while among the anions the concentration of chloride ion is highest, followed by bicarbonate, sulphate and nitrate ions.

#### 4.5.1 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., TDS, TH, Ca, Mg, Cl, SO<sub>4</sub>, NO<sub>3</sub> and F prescribed in the standards and is given in Table-6.

**Table-6: 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
TDS (mg/L)	500	2000	15	11	Nil
TH (mg/L)	300	600	13	9	4
Ca (mg/L)	75	200	25	1	Nil
Mg (mg/L)	30	100	7	15	4
Cl (mg/L)	250	1000	21	5	Nil
SO <sub>4</sub> (mg/L)	200	400	21	5	Nil
NO <sub>3</sub> (mg/L)	45	No relaxation	19	-	7
F (mg/L)	1.0	1.5	26	Nil	Nil

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

The Table-6 shows that out of the 26 ground water samples, 7 samples (27%) have Nitrate (NO<sub>3</sub>) concentration more than MPL (>45 mg/L). The concentrations of most of the other parameters are less than MPL except Total Hardness (TH) and Magnesium (Mg) at 4 NHNS (Satana, Sinnar, Raslapur and Nandgaon). It is also seen that the concentration of parameters such as Cl and F in all the samples are within the MPL. Therefore, it can be concluded that the ground water quality in majority of the area is good for drinking purpose except localized nitrate contamination.

#### 4.5.2 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. Sodium Absorption Ratio (SAR) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

##### 4.5.2.1 Sodium Absorption Ratio (SAR)

Sodium Absorption Ratio (SAR) is an expression pertaining to cation make up of water and soil solution and is used for characterizing the sodium hazard of irrigation water.

SAR value is used to calculate the degree to which irrigation water tends to enter into cation exchange section in the soil. The main problem with high sodium concentration is its effect on soil permeability. Sodium also contributes directly to the total salinity of the water and may be toxic to sensitive crops such as fruit trees. The higher value of SAR indicates soil structure damage.

#### 4.5.2.2 Residual Sodium Carbonate (RSC)

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

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

<b>SAR</b>	<b>&lt;10</b>		<b>10-18</b>		<b>18-26</b>		<b>&gt;26</b>	
<b>Category</b>	<b>Good</b>		<b>Good to Permissible</b>		<b>Doubtful</b>		<b>Unsuitable</b>	
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%	No. of Samples	%
26	25	96	1	4	Nil	-	Nil	-
<b>RSC</b>	<b>&lt;1.25</b>		<b>1.25-2.50</b>		<b>&gt;2.50</b>			
<b>Category</b>	<b>Good</b>		<b>Doubtful</b>		<b>Unsuitable</b>			
Total Samples	No. of Samples	%	No. of Samples	%	No. of Samples	%		
26	25	96	Nil	-	1	4		

The Table-7 shows that SAR and RSC values of majority of ground water samples are less than 10 and 1.25 respectively indicating ground water is good for irrigation purposes. However, the SAR and RSC values of ground water sample collected from the well located at Jalgaon is above 10 and 2.50 respectively suggesting that the ground water from this well is unsuitable for irrigation purposes. Overall, the ground water quality in the wells monitored is good for irrigation purpose and there is a less possibility of developing sodium hazard.

#### 4.6 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. Ground water in the district is predominantly used for irrigation as it is the major ground water utilizing sector. The ground water development in the district is mostly through dugwells. The minor irrigation census data of 2000-01 indicates that the area irrigated by ground water is 691 sq.km., whereas surface water accounts for 1386 sq. km. of the area and the net irrigated area stand at 2077 sq. km. Thus it is clear that surface water is the major source of irrigation as it accounts for 67% of the net irrigated area.. There are about 1,54,261 dugwells in use in the district which create an irrigation potential of 2789 sq. km. out of which 2763 sq. km. of irrigation potential is utilized, whereas 6232 borewells create an irrigation potential of 129 sq. km. out of which 127 sq. km. of irrigation potential is utilized.

In addition to this, till March 2006, State government agencies has drilled 6140 successful borewells/tubewells under various schemes for rural water supply out of which 5618 are fitted with hand pumps and 522 are fitted with

electric motors. The reported yields of borewells/tubewells range from 500 to 3000 lph and the success rate of borewells/tubewells is about 62%.

## **5.0 Ground Water Management Strategy**

Ground water has special significance for agricultural development in the district. Ground water development in some part of the district has reached to a critical stage resulting in decline of ground water levels. Thus, there is 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**

Major part of the district is underlain by Deccan Trap Basalt, hence the most feasible abstraction structure for ground water development are dugwells followed by borewells. However, the borewells generally tap deeper fractures thus sites for borewell need to be selected only after proper scientific investigation so as to minimize the failure rate. The yield of dugwells in Basalt may be expected from 20 to 100 m<sup>3</sup>/day depending on the local hydrogeological conditions. In Alluvium, the shallow tubewells tapping the granular zones till the basement is encountered are the most feasible ground water abstraction structure, that are expected to yield up to 25 m<sup>3</sup>/day followed by dugwells, where the thickness and areal extent of Alluvium is less.

The hilly areas of the district where rocks are hard and compact, resistant to weathering with steep gradient causing rapid runoff and low infiltration are not feasible for ground water development. Such areas occur in southern part of the district covering almost entire Sinnar taluka and southern part of Igatpuri taluka; western part of the district covering almost entire Peint taluka and eastern part of district covering southern part of Nandgaon taluka. Similarly, in central-southern part of the district covering Chandwad, Niphad and Sinnar talukas, which have been categorised as "Semi-Critical", future ground water development is not recommended without adhering to the precautionary measures, i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices, so that the sustainable development is achieved.

### **5.2 Water Conservation and Artificial Recharge**

In Basaltic area, the artificial recharge structures feasible are check dams, gully plugs, percolation tanks, nalla bunds, etc. The structures like gully plugs, contour bunds are most favorable in hilly areas, particularly in almost entire Sinnar and Peint talukas and parts of Igatpuri and Nandgaon talukas. Existing dugwells can also be used for artificial recharge, however, the source water should be properly filtered before being put in the wells. The most feasible artificial recharge structure suitable for Alluvial areas restricted along the banks of major rivers and their tributaries, are shallow recharge wells on the river bed of the tributaries. Percolation tanks are also suitable, wherever source water availability is there.

The sites for artificial recharge structures need to be located where the hydrogeological conditions are favorable, i.e., where sufficient thickness of de-saturated/unsaturated aquifer exists and water levels are more than 5 m deep.

## 6.0 Ground Water Related Problems

It is seen from long term rainfall data that major part of the district (about 75%) falling east of Western Ghats comprising almost entire Sinnar, Niphad, Surgana, Kalvan, Satana, Chandwad, Yeola talukas and parts of Dindori, Peint and Malegaon talukas experiences drought conditions for more than 20% of the years. Therefore, these areas are classified as drought areas. The premonsoon water level trend shows fall in water level up to 20 cm/year in major parts of the district, occupying central, northwestern, western, eastern and southern parts of the district in entire Kalvan, Surgana, Dindori, Chandwad, Nandgaon, Yeola, Niphad, Igatpuri talukas and parts of Baglan (Satana), Malegaon, Sinnar, Nashik and Peint talukas. Similarly as per current assessment of ground water resources it is also seen that the ground water development in Chandwad, Niphad and Sinnar talukas have already reached up to 90% and these talukas fall under "Semi-Critical" category. Thus the situation is quite critical in almost entire district and the future ground water conservation and recharge structures needs to be prioritized in these areas.

At some places like Satana, Sinnar, Jalgaon and Rasalapur the EC of ground water is about 3000  $\mu$  mhos/cm at 25°C. In all these places except Jalgaon the high EC is accompanied by high chloride and nitrate ion concentration indicating contamination due to anthropogenic sources. At such places ground water at deeper levels may be explored. The ground water quality is mainly affected by nitrate as 27% 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.

## 7.0 Mass Awareness and Training Activities

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

Till March 2007, 1 Water Management Training Programme (WMTP) had been organised in the district. The details are given in Table-8.

**Table-8: Status of WMTP.**

S. No.	Item	AAP	Venue	Date	Participants
1.	WMTP	2003-04	Rotary Hall, Ganjmal, Nashik.	09/03/03	125

### 7.2 Participation in Exhibition, Mela, Fair etc.

During the Indian Agricultural Trade Fair (IATF), held at Nashik during 30/11/05 to 05/12/05, an exhibition stall depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps of Nashik district. The models, maps, posters were explained to the visitors in details and leaflets on water conservation in day-to-day life and artificial recharge were provided to the visitors.

## 8.0 Areas Notified by CGWA / SGWA

As per ground water resources estimation, three talukas viz., Chandwad, Niphad and Sinnar talukas fall under "Semi-Critical" category. However, so far

none of the talukas have been notified either by CGWA or SGWA for ground water regulation in the district.

## **9.0 Recommendations**

1. The major part of the district is underlain by Deccan Trap Basalt, where only dugwells are most feasible ground water abstraction structures for development. However the borewells are another alternative but sites for borewell need to be selected only after proper scientific investigation.
2. Borewells generally tap deeper fracture which may not be sustainable throughout the year. Hence the borewell should only be used for drinking purpose and not for irrigation purposes.
3. Alluvium occurs in small areas alongside the river courses which is about 20 m thick. The ground water in the Alluvium can be developed through dugwells and shallow tubewells expected to yield upto 25 m<sup>3</sup>/day.
4. The overall stage of ground water development for the district is about 50%. Therefore, there is scope for future development of ground water resources.
5. In the "Semi-Critical", "Critical", "Over-Exploited" watersheds and 3 "Semi-Critical" talukas viz., Chandwad, Niphad and Sinnar the stage of ground water development indicates a very limited scope for further ground water development unless ground water recharge exceeds the ground water draft by artificial means. Therefore future ground water development is not recommended without adhering to the precautionary measures i.e., artificial recharge to augment the ground water resources and adoption of ground water management practices in these areas.
6. The hilly areas of the district are not feasible for ground water development. Such areas occur in southern part of the district covering almost entire Sinnar taluka and southern part of Igatpuri taluka; western part of the district covering almost entire Peint taluka and eastern part of district covering southern part of Nandgaon taluka.
7. The ground water quality is mainly affected by nitrate as 27% of samples are having high nitrate concentration. 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 purposes other than drinking. Adequate sanitary protection to the wells may be provided to control the nitrate contamination. At some places like Satana, Sinnar, Jalgaon and Rasalapur, the EC of ground water is about 3000  $\mu$  mhos/cm at 25°C. At such places ground water at deeper levels may be explored.
8. The scope exists for construction of suitable artificial recharge structure in the district. The structure recommended particularly for the hilly area occupying almost entire Sinnar and Peint talukas and parts of Igatpuri and Nandgaon talukas are contour bunds, gully plugs, nala bunds and check dams etc. For other hard rock areas of the district, nala bunds, check dam, KT weirs and percolation tanks at suitable sites are suggested. The existing dugwells may also be used for artificial recharge of ground water by insuring that the water used for recharge should be free from silt and other impurities.
9. The existing percolation tanks and village ponds need to be rejuvenated to act both as water conservation and artificial recharge structure.

10. To enhance the ground water resources and for sustainable development, mass awareness programmes should be organized in large scale by district administration. Such programmes are necessary so as to educate the user regarding yielding capacity of aquifer and declining trend of water levels in the district. Similarly farmer should also be encouraged to adopt appropriate crop planning and irrigation practices.