

DISTRICT AT A GLANCE

S.No.	ITEMS	Statistics	
1.	GENERAL INFORMATION		
	i) Geographical area (sq. km)	3898	
	ii) Administrative Divisions (As on) Number of Tehsil/Blocks Number of Panchayats/Villages	4/4 324/632	
	iii) Population	24,65,827	
	iv) Average Annual Rainfall (mm)	939.1	
2.	GEOMORPHOLOGY		
	i) Major Physiographic Units	Plateaus, plains of extrusive origin, colluvial fans.	
	ii) Major Drainage	Chambal, Gambhir, Kshipra, Khan (Ganga basin) & Choral, Kanar (Narmada basin)	
3.	LAND USE (sq km)		
	i) Forest area:	292.16	
	ii) Net area sown:	1508.87	
	iii) Cultivable area:	1508.87	
4.	MAJOR SOIL TYPES	Medium Black Soil	
5.	AREA UNDER PRINCIPAL CROPS	4322.53	
6.	IRRIGATION BY DIFFERENT SOURCES (Area and Number of Structures)	Area (sq km)	Number
	Dugwells	106.98	12767
	Tube wells/Bore wells	1257.04	37852
	Tanks/Ponds	13.50	275
	Canals	18.43	11
	Other Sources	112.92	
	Net Irrigated Area	1508.87	
	Gross Irrigated Area	1508.87	
7.	NUMBER OF GROUND WATER MONITORING WELLS OF CGWB(As on 31.3.2007) No. of Dug Wells No. of Piezometers	11 18	
8	PREDOMINANT GEOLOGICAL FORMATIONS	Basalt (Deccan Traps)	
9	HYDROGEOLOGY Major Water Bearing Formation Pre-monsoon depth to water level during	Basalt (fractured/weathered)	

	2006 Post-monsoon depth to water level during 2006 Long Term water level trend in 10 years (1997-2006) in m/yr a) Pre monsoon b) Post monsoon	6.3 – 15.7 mbgl 1.40 – 10.08 mbgl Rise – 0.003-0.158 m/yr. Fall - 0.04- 0.19 m/yr Rise – 0.02-0.04 m/yr Fall - 0.08-0.38 m/yr
10.	GROUND WATER EXPLORATION BY CGWB (As on 31.3.2007)	
	No of wells drilled (EW,OW,PZ,SH, Total)	9 EW, 18 Pz,
	Depth Range (m)	33-238.00 mbgl
	Discharge (litres per second)	0.5-6.33
	Storativity (S)	-
	Transmissivity (m ² /day)	31.8-149.6
11.	GROUND WATER QUALITY	
	Presence of Chemical constituents more than permissible limit (eg EC, F, As,Fe)	EC (3174 µS/cm)
12	DYNAMIC GROUND WATER RESOURCES (2004) in MCM	
	Annual Replenishable Ground Water Resources	569.02
	Net Annual Ground Water Draft	594.26
	Projected Demand for Domestic and Industrial Uses upto 2025	59.65
	Stage of Ground Water Development	104%
13.	AWARENESS AND TRAINING ACTIVITY	
	Mass Awareness Programmes Organised Date Place No. of Participants	1 22.9.2000 Indore 225
	Water Management Training Programmes Organised Date Place No. of Participants	Nil
14	EFFORTS OF ARTIFICIAL RECHARGE & RAINWATER HARVESTING	
	Projects completed by CGWB (No. & Amount Spent)	1 Rs. 6.92 lakhs
	Projects under technical guidance of CGWB (Numbers)	Nil

15.	GROUND WATER CONTROL AND REGULATION	
	Number of OE Blocks	2 (Indore & Sanwer)
	Number of Critical Blocks	1 (Depalpur)
	Number of Blocks notified	Sanwer & Indore Municipal Corporation.
16	MAJOR GROUND WATER PROBLEMS AND ISSUES	Over - exploitation

1.0 INTRODUCTION

Indore district lies in the heart of Malwa plateau and covers an area of 3831 sq km. It is bounded by N latitudes 22° 31' and 23° 05' and E longitudes 75° 25' and 76° 15' in the survey of India toposheet nos. 46M, 46N and 55B. Indore district is bounded in the north by Ujjain district, in the south by Khandwa district, in the east by Dewas district and in the west by Dhar district. Indore district is divided into four tehsils and four development blocks. It has 632 villages. The total population of the district is 24,65,827 (2001 Census) of which 7,35,464 is rural and 17,30,363 is urban.

The district lies partly in the Chambal sub basin of the Ganga basin (75%) and partly in the Narmada basin (25%)(Fig. III). The main rivers draining the district in the north are Chambal, Gambhir, Khan and Shipra. The southern fringe of the district, south of the hills is drained by the river Narmada, flowing from east to west. Its main tributaries are Choral and Kanar.

Since the rivers flowing in the district originate in the district itself and the plateau is plain, there is not much scope for construction of major irrigation projects. Availability of surface water at 75% dependability is 871 MCM. There are 78 completed surface water minor irrigation schemes and four completed lift irrigation schemes with an irrigation potential of 74.47 sq km in the district. The main source of irrigation in the district is ground water, which irrigates 1364.02 sq km i.e 90.4% of the total irrigated land.

2.0 RAINFALL & CLIMATE

The climate of Indore district is characterized by hot summer and well-distributed rainfall during the southwest monsoon season. Monsoon arrives generally in the middle of June and the weather becomes pleasant. January is generally the coolest month. Sometimes in December, the minimum temperature drops down to even as low as about 2 to 3°C. There are seven rain gauge stations in Indore district, namely Indore, Mhow, Manpur, Depalpur, Sanwer, Hatod and Gautampura. The district receives maximum rainfall during the south west monsoon period. Thus about 91.2 % of the total annual rainfall takes place during the south west monsoon period (June to September) alone. The maximum monthly rainfall takes place during the month of July. Season wise, the distribution of rainfall during the remaining period of the year is somewhat as follows:

- i) about 7.2% of the annual rainfall in winter.
- ii) About 1.75 of the annual rainfall in summer and
- iii) About 8.9% of the annual rainfall from October to about the first week of June.

This meager rainfall between November to the first week of June is hardly sufficient to build up the Soil-moisture and thus it does not contribute to the ground water potential of the area. It is only during the monsoon period that surplus water for deep percolation can be available.

3.0 GEOMORPHOLOGY & SOIL TYPE

Geomorphologically, the district can be divided into three units; Units of extrusive origin, units of denudational origin and units of fluvial origin (Plate II). The units of extrusive origin comprise of Region of middle level plateaus (550-900m amsl), Region of low level plateaus (350-550m amsl) and Plain. The Region of middle level plateaus are scattered, while the Regions of low-level plateaus form the main unit in the district. The Plain occupies a very small area around the border of Khandwa district. Of the units of denudational origin, denudational slope on Deccan Trap occupy a large area in Mhow block and is mostly covered with forests. The undifferentiated colluvial fans occupy a very small area in Mhow block. The Unit of fluvial origin viz; floodplain is confined to the drainage of the main rivers in the district.

The district is covered by medium black soils. These soils are 0.46 to 0.9 meters thick and are rich in lime and lime nodules. The sub-soil and the partially disintegrated rock below allows easy drainage and hence these medium black soils can be freely irrigated.

4.0 GROUND WATER SCENARIO

4.1 Hydrogeology

The Deccan Traps, which are the predominant rocks in the district, have wide variation in the water bearing properties of the different units constituting them. The massive basalts their weathered zones and secondary porosities and the vesicular basalts with their minutely connected and partially filled vesicles play an important role in determining the occurrence, movement and storage of ground water. These invariably form potential aquifers. The red-bole is non productive. In the alluvial areas, the occurrence of ground water is governed by sand/clay ratio. The sand beds generally form good aquifers, but due to the limited thickness and erratic occurrence in the form of lenses, the ground water structures in them are poor to moderately productive.

The main source of recharge to the basaltic aquifer in the district is rainfall. To some extent, recharge also takes place by influent seepage from the streams and their tributaries. Due to low permeabilities of basalts and undulating topography, the run off is very high. This restricts the recharge to ground water body. This is reason for large scale seasonal fluctuation in the water level of the wells tapping trappean formation. Ground Water in the Deccan Traps in Indore district occurs mostly under water table conditions. The nature of topography, extent and depth of weathering, distribution of secondary porosity in the form of fractures and joints and the occurrence and disposition of vesicular units govern the movement of ground water.

At some places, confined conditions area also observed due to the alternating nature of the impermeable massive and productive vesicular basalts. At places, like Khajarana, Betma and Gautampura, semi-artesian conditions are also observed.

The Central Ground Water Board has carried out exploratory drilling at 9 locations in Gambhir basin and has constructed 18 piezometers in the entire district under Hydrology Project. Apart from this, the State Govt. in the Khan sub-basin has drilled boreholes. These boreholes drilled in the northern and north western part of the district down to a depth of 100 mbgl through older Trap units have recorded larger yields – 375 to 825 lpm than the boreholes piercing younger trappean units in the southern part of the district where the yields vary between 75 to 225 lpm. It has also been observed that the yields of dug-cum-bore wells tapping confined aquifers are two to three times higher than the yields of wells tapping the water table aquifer.

A study of the lithologs of exploratory wells and piezometers indicates that almost ten vesicular layers have been encountered within a thickness of 218 m. The individual layers vary in thickness from 3 to 20 meters. Pumping tests were carried out at Rojri, Harsola and Sonway. The discharge during the tests ranged between 160 and 260 lpm. The transmissivity values ranged between 127.7 m²/day to 149.6 m²/day. It was observed that the vesicular zones occurring below a depth of 30 m have poor water yielding capacity. The thickness of the weathered formation encountered ranges between 6 and 30 m. The thickness of the water bearing zones is generally between 1 and 3 meters. However, a 14 m thick water bearing zone was struck at Gautampura.

4.2 Water Levels

4.2.1 Depth to Water Level – Premonsoon (2006)

The depth to water level map (premonsoon 2006) reveals that the water levels in the range of 10-20 mbgl occupy almost the entire Depalpur Block and a maximum part of Indore Block. Some parts of Mhow and Sanwer Blocks have water levels in the range of 10-20 mbgl. Shallower water levels of 5-10 mbgl cover the remaining parts of the district.

4.2.2 Depth to Water Level – Postmonsoon (2006)

Observation of the depth to water level map (postmonsoon 2006) reveals that a major part of the district has water levels in the range of 2-5 mbgl. Some parts of Sanwer and Depalpur Blocks have water levels in the range of 5-10 m bgl as also do isolated patches in Indore Block and some part in Mhow Block. Deeper water levels of 10-20 m bgl are found in north western part of Depalpur Block.

Ground Water Resources

The ground water resources of Indore district were computed using GEC (1997) using 2004 as base year. Out of a total area of 3898 sq.km., 53 sq km falls in the Canal Command Area and rest in Non-Command Area. There is no poor ground water quality area in the district. The total annual ground water recharge in the district is 598.97 MCM out of which 29.95 MCM is treated as natural discharge during non-monsoon season, leaving a net annual ground water availability of 569.02 MCM. The existing ground water draft for irrigation is 569.43 MCM and the existing ground water draft for domestic and industrial requirement is 24.84 MCM making a total of 594.26 MCM for existing gross ground water draft for all

uses. The stage of ground water development comes out to be 104%. Considering a quantity of 59.65 MCM as allocation for domestic and industrial requirement supply upto next 25 years, the net ground water availability for future irrigation development comes out to be **-60.05 MCM**.

Out of 4 Blocks in the district, 2 (Indore & Sanwer) are falling in the category of Over-exploited Blocks, 1 (Depalpur) in Critical category and 1 (Mhow) in Safe category. The Block wise ground water resources are given in table 2.

4.3 Ground Water Quality

Quality of Ground Water for drinking

Ground water quality in Indore district is assessed annually by CGWB on the basis of water samples collected from hydrograph stations in the district. Ground water in the district is generally medium to high saline as electric conductivity values varies between 534 to 3170 $\mu\text{s}/\text{cm}$. High EC of more than 1500 $\mu\text{s}/\text{cm}$ at 25°C were found in dug wells of Dharampuri, Sanwer (2850 $\mu\text{s}/\text{cm}$ at 25°C) and Ushapura (3170 $\mu\text{s}/\text{cm}$ at 25°C) villages. Constituents like fluoride, sulphate, calcium and magnesium were within the safe limits for drinking waater as per BIS standards in all villages except Sanwer and Ushapura villages where chloride concentration were found to be 752 mg/l and 887 mg/l respectively. Nitrate in the ground water of Indore district is varying between 2 to 177 mg/l. Nitrate more than 45 mg/l was found in four villages namely Sanwer (52 mg/l), Hatod (79 mg/l), Machal (139 mg/l) and Ushapura (177 mg/l). High nitrate in the village area is apparently due to excessive use of fertilizers and agricultural waste. The total hardness of ground water in the district is generally under safe limit as per BIS standards. Ground water of Machal, Sanwer and Ushapura village is not safe for drinking.

Quality of water for irrigation

High SAR is not good for irrigation as it leads to sodium hazard. Water samples in the district generally fall in $C_2 S_1$, $C_3 S_1$ and $C_4 S_1$ classes of US salinity diagram. However, ground water in the district is generally safe for irrigation but proper drainage system is required where EC is more than 1500 $\mu\text{s}/\text{cm}$.

Geogenic problems

Fluoride in the district is generally below 1.5 mg/l. The groundwater in the district is generally safe for drinking. More than 1.5 mg/l is responsible for bone deformation. No arsenic has been detected in the district.

4.4 Status of ground water development

Ground water is the main source of water both for drinking and irrigation in the district. 95% of irrigation in the district is from ground water though the level of irrigation in the district is only about 52%. The total number of dug wells and tube wells in the district during 2004 were 16474 & 23117. On the drinking water front, almost all the urban centers have supplies from ground water ranging from 50% to 100%. There has been a steady rise in ground water development in the district. As per the ground water resource estimates worked out, the block wise draft for drinking and industry and the allocation for the next 25 years has been worked out and given in table below-

Assessment Unit	Command/ Non-command/ Total	Existing gross ground water draft for industrial and domestic water supply (Ham)	Allocation for domestic and industrial requirement for next 25 years (Ham)
Indore	Command	0	0
	Non-command	1211	3949
	Total	1211	3949
Sanwer	Command	0	0
	Non-command	372	606
	Total	372	606
Depalpur	Command	24	39
	Non-command	386	629
	Total	410	668
Mhow	Command	25	26
	Non-command	466	715
	Total	491	741
	District Total	2484	5965

Thus it can be seen that in future 5965 Ham is required for drinking. But in Indore & Sanwer blocks this quantity will be available only if irrigation is reduced as already the irrigation draft is exceeding the net ground water availability.

Ground water development in the district is high as evident from the stage of development, with 2 overexploited, 1 critical block & 1 safe block. At present, 7265 Ham of ground water is available for irrigation in 2 blocks. The withdrawal of ground water has exceeded the natural recharge in 2 blocks in a normal monsoon year. In the blocks falling under safe or critical category also, the number of ground water abstraction structures, the cropping pattern and the cropping intensity will increase with the passage of time commensurate with the progress of the district. This would be further aggravated with the increase in drinking and industrial water requirement due to bursting population and rapid industrialisation. This situation is alarming leading to a stress on the resources, and in turn, resulting in mining of ground water. Hence the need of the day is to use the resource judiciously and conserve it to the maximum.

5.0 GROUND WATER MANAGEMENT STRATEGY

5.1 Ground Water Development

Based on the ground water availability for future irrigation the feasible ground water structures have been worked out. The district being underlain by hard rocks, tube wells are not feasible everywhere. Hence, 50 % of the resources have been assigned to dug wells and tube wells respectively. The unit draft of a dug well is 0.175 & 0.7 Ham for Command and Non- command area respectively; and that of a tube well is 0.5 & 2 Ham. The average depth of irrigation being 0.6 m, the command area of a dug well works out to be 0.29 Ha and that of a tube well is 0.83 Ha in command area and 0.16 Ha & 3.3 Ha in non-command area. 5871 additional dug wells and 2055 shallow tube wells can be constructed in Command area and 9593 dugwells and 3358 tube wells can be constructed in non-command areas of the district to fully utilize the balance available. This would create an additional irrigation potential of 12054.75 ha. For ground water development through these structures suitable sites would have to be scientifically selected on the basis of intensive hydrogeological surveys, supported by remote sensing and geophysical surveys.

Block	GW Resources Available for Future Irrigation Use at 100% Development	Dug Wells			Tube Wells			Balance irrigation Potential
		Unit Draft	Command Area	Dug well feasible	Unit Draft	Command Area	Tubewell feasible	
	Ham	Ham	Ha	No	Ham	Ha	No	Ha
Command Area								
Depalpur	303	0.175	0.29	866	0.5	0.83	303	502.63
Mhow	1752	0.175	0.29	5005	0.5	0.83	1752	2905.61
Total	2055			5871			2055	3408.24
Non-Command area								
Depalpur	200	0.7	1.16	143	2	3.33	50	322.38
Mhow	5011	0.7	1.16	3579	2	3.33	1253	8324.13
Total	5211			3722			1303	8646.51
Grand Total	7266			9593			3358	12054.75

The normal pumping hours for a dugwell are about 300 and for a tube well about 550 per annum. The pumps installed are mostly of 3 HP. Thus the power requirement works out to be

Dug well : $3 \times 746 \times 300 = 671.4 \text{ KW/Yr}$ or 0.67 MW/Yr.
Tube well: $3 \times 746 \times 550 = 1230.9 \text{ KW/Yr}$ or 1.23 MW/Yr

The total power requirement to energize additional ground water structures would be 10557.65 MW/Yr.

The optimum utilization of ground water in the district can be achieved through 9593 additional dug wells and 3358 tube wells. This would require about 10557.65 MW/Yr of power. These structures need to be restricted to two blocks viz. Depalpur & Mhow. The development should be taken up in a phased manner spread over a period of 10 years. This would also not put undue pressure on the power sector. In Indore, and Sanwer blocks further development should be stopped and conservation and recharge measures should be taken up in earnest to combat the situation.

Areas recommended for Ground Water Development

In Indore district, based on the prevailing hydrogeological conditions, some areas are feasible for construction of only dug wells and some for shallow tube wells. Shallow tube wells can be constructed mostly in the Gambhir river Basin. Areas suitable for construction of dug wells are shown in Fig.

Water Conservation And Artificial Recharge

Artificial Recharge & Water Conservation

Projects Completed by CGWB

Roof top Rain Water Harvesting in PHED Colony, Musakhedi, Indore

Location: PHED Colony, Musakhedi, Indore city

Structures: Roof top Rain Water Harvesting

Expenditure: Rs. 6.94 lakhs (Rupees Six lakhs ninety four thousand only)

Implementing Agency: Public Health Engineering Department, Govt. of M.P.

Geology: Basalt

Indore city is highly urbanized and developed with high percentage of paved area resulting in reduction of natural ground water recharge, increase in runoff, decline in water level and decrease in yield of ground water abstraction structures. In PHED colony, Musakhedi, a total roof area of 2710 sq. m was utilized for roof top rain water harvesting. The roof top rain water was diverted to a recharging well through troughs into collection chambers and then through a filter chamber. A piezometer of 60 m depth was drilled and equipped through DWLR to assess the impact of roof top rain water harvesting. Studies conducted have shown that there is a rise in water level of almost 4 – 5 meters after the monsoon. Dry hand pumps in the Colony have started to yield water and electric consumption has reduced due to lower head.

Areas Notified by CGWA/SGWA

Sanwer Block and Indore Municipal Corporation have been notified by CGWA for Registration and Regulation. Indore Block has been notified for Registration.

Recommendations

- i) Micro-level hydrogeological surveys should be taken up in Sanwer and Indore Blocks to assess the ground water resources and also to locate suitable areas for conservation and artificial recharge of ground water.
- ii) No further ground water development should take place in Sanwer and Indore Blocks which are coming under the category of Over-exploited Blocks.
- iii) In Indore district, the topography towards the southern side is quite irregular. In such areas, shallow, flat bottomed and closely spaced ditches or furrows which provide maximum water contact area can be highly successful for conservation and recharge.