GROUND WATER INFORMATION BOOKLET

# CHANDIGARH UT


**CENTRAL GROUND WATER BOARD**
**Ministry of Water Resources**
**Government of India**
**North Western Region**
**CHANDIGARH**
**2013**

# Contributor


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**PREPARED UNDER SUPERVISION OF**


**A. K. BHATIA**

**REGIONAL DIRECTOR**


**OUR VISION**

**"FRESH AND ADEQUATE WATER - FOR ALL"**

# GROUND WATER INFORMATION BOOKLET

# CHANDIGARH (U.T.)

## C O N T E N T S

# CHANDIGARH (UT) AT A GLANCE

| Sl.NO. | ITEMS | STATISTICS |
|---|---|---|
| 1. | GENERAL INFORMATION | |
| | i. Geographical Area (sq. km.) | 114 |
| | ii. Administrative Divisions | |
| | Number of Tehsil | One |
| | Number Of Sectors | 55 |
| | Number Of Villages | 13 |
| | iii. Population (As per 2001Census) | 1,054,686 |
| | a. Rural | 29,004 |
| | b. Urban | 1,025,682 |
| | c. Males | 580,282 |
| | d. Females | 474,404 |
| | e. Persons per sq. km | 9,252 |
| | f. % increase over 2001 - 2011 | 17.10 |
| | g. Literacy rate | 86.43% |
| | iv. Normal Annual Rainfall (mm) | 1061 |
| 2. | GEOMORPHOLOGY | |
| | Major physiographic Units | Siwalik Hills<br>Piedmont Zone (Kandi)<br>Sirowal Zone<br>Alluvial Plain |
| | Major Drainage | Sukhna Choe<br>Patiali ki Rao |
| 3. | LAND USE (Sq.km.) | |
| | a. Forest Area: | 2.12 |
| | b.Net area sown: | 11.12 |
| 4. | MAJOR SOIL TYPES | Sand to Sandy Loam ( Northern Part)loamy to silt loam (southern part) |
| 5. | AREA UNDER PRINCIPAL CROPS (Sq.km.) | 11.12 |
| 6. | IRRIGATION BY DIFFERENT SOURCES | |
| | Dugwells | - |
| | Tubewells/Borewells | 11.22 sq km. |
| | Tanks/ponds | - |

| | | |
|---|---|---|
| | Canals | - |
| | Other sources | - |
| | Net Irrigated area | 11.22 |
| 7. | NUMBER OF GROUND WATER MONITORING WELLS OF CGWB | |
| | No. of dug wells | 01 |
| | No of Piezometers | 28 |
| 8. | PREDOMINANT GEOLOGICAL FORMATIONS | Quaternary Alluvium |
| 9. | HYDROGEOLOGY | |
| | *Major Water bearing formation | Sand |
| 10. | GROUND WATER EXPLORATION BY CGWB | |
| | No. of wells drilled<br>EW<br>OW<br>PZ<br>SH | <br>06<br>05<br>18<br>00 |
| | Depth range(m) | 17- 465 |
| | Discharge(liters per minutes) | 83 -1880 |
| | Storativity (S) | $1.5x10^{-4}$ to $8.6x10^{-4}$ |
| | Transmissivity ($m^2$/day) | 74 - 590 $m^{2/}$day. |
| 11. | GROUND WATER QUALITY | |
| | Presence of Chemical constituents more than the permissible limit :<br>EC (micro mhos at $25^oC$)<br>F (mg/l)<br>As (mg/l)<br>Fe (mg/l) | <br>-<br>-<br>-<br>3.43 mg/l |
| | Type of water | Ca-$HCO_3$ |
| 12 | DYNAMIC GROUND WATER RESOURCES(2004) - Net annual ground water availability (shallow aquifer) ( MCM) | 19.40 |
| 13 | AWARENESS AND TRAINING ACTIVITY | |
| | Mass Awareness Programmes organized<br>Awareness programs<br>Training Programs | <br>5<br>12 |
| | Date | 2002-2012 |
| | Place | Chandigarh |
| | No of participants | 1600 (Approx.) |

| | | |
|---|---|---|
| 14. | EFFORTS OF ARTIFICIAL RECHARGE & RAIN WATER HARVESTING | |
| | Projects completed by CGWB (No.& Amount spent) | 10 nos.<br>Rs. 8,51,32,190/- |
| | Projects under technical guidance of CGWB (Numbers) | 21 |
| 15. | GROUND WATER CONTROL AND REGULATION | |
| | Number of OE Blocks. | - |
| | Number of Critical Blocks | - |
| | Number of blocks notified | - |
| 16 | MAJOR GROUND WATER PROBLEMS AND ISSUES. | Rising water table in shallow aquifer, declining piezometric head in deeper aquifer |

# GROUND WATER INFORMATION BOOKLET CHANDIGARH (U.T.)

## 1.0 INTRODUCTION

Chandigarh, the dream city of India's first Prime Minister, Shri Jawahar Lal Nehru, was planned by the famous French architect Le Corbusier. Picturesquely located at the foothills of Shivaliks, is also known, as the "CITY BEAUTIFUL". Chandigarh derives its name from the temple of "Chandi Mandir" located in the vicinity of the site selected for the City. It is located about 250 kms. north of New Delhi. At the time of reorganization of the state in 1966 into Punajb, Haryana and Himachal Pradesh, the city assumed the unique distinction of being the capital city of both, Punjab and Haryana States while it itself was declared as a Union Territory and under the direct control of Central Government and it does not form part of any of the two States. It lies between north latitudes $30^{o}$ 40' and $30^{o}$ 46' and east longitudes $76^{o}$ 42' and $76^{o}$ 51' and falls in Survey of India toposheets no. 53B/13 & 53B/14. Punjab state borders the UT in the south and southwestern sides and Haryana state on eastern side. UT of Chandigarh has an area of 114 sq.km., out of which 34 sq.km. is rural and remaining 80 Sq.km, is urban. The city is divided into 55 dwelling sectors. As per census 2011, total population of the city was 1,054,686 persons having a population density of 9252 persons/sq.km. The altitude of the city ranges from 304 to 365 meters above MSL.

Due to high urbanization, almost 77.94% of the total area is not available for cultivation. The net area sown is 11.12 sq.km. and the current fallow is 0.49 sq.km. Area under forest is 2.12 sq.km. Main crops grown during *Kharif* are rice, maize, potato and sugar cane while during *Rabi* season wheat, gram and oil seeds are grown.

The water requirement of the city for drinking, domestic and other purposes is 365 MLD (Million liters per day) water. A major part of water requirement of the city is met by canal water. Canal water supply to the city is approximately 305 MLD. There are 200 deep tubewells in the city, which contribute a total of 91 MLD of water from ground water reserves. Besides there are 39 tubewells, which provide drinking water to rural area also. The main source of irrigation is ground water through 30 deep tubewells installed for the purpose of irrigation by Chandigarh Administration. The projected water requirement at year 2021 would be 409.5 MLD whereas the total availability would be 310 MLD, so there would be a shortage of 99.5 MLD in future.

There are no large natural surface water bodies in Chandigarh though small ponds do exist in the rural areas. The Sukhna *Choe* has been dammed in northeast side of the city, which has given rise to an artificial lake covering

an area of about 1.62 sq.km. The lake, known as Sukhna has a water holding capacity of five million cubic meters (MCM).

UT of Chandigarh falls in the Ghaggar Basin. There are two major streams, Sukhna *Choe* and Patiali ki *Rao* that originate from Siwalik Hills ranges and forms the natural drainage of the city. The Sukhna *Choe* flows north to south drains the eastern part and joins the Ghaggar River. The other important stream is Patiala-ki Rao, which flows northeast to southwest and drains the northern parts of the city. Both these streams are ephemeral in nature and carry high flows during monsoon. The N-*Choe* flows through the leisure valley and drains major parts of the city. It flows from northeast to southwest direction and traverses north central part of the city. Another *Choe* Choi Nala originates from Sector-31 and drains southern most part of the city.
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Six exploratory wells and eighteen piezometers have been drilled by Central Ground Water Board in the UT Chandigarh for delineation aquifer geometry, quality of formation water and hydrogeological study of the area. The shallow and deep piezometers were constructed by the central Ground Water Board for the study of water level behavior in Chandigarh and changes in the quality of ground water in space and time.

## 2.0 RAINFALL AND CLIMATE

The climate of Chandigarh can be classified as subtropical with hot summer and cold winter except during monsoon season when moist air of oceanic origin reaches the area. There are four seasons in a year. The hot weather season starts from mid March to last week of the June followed by the southwest monsoon, which lasts up to September. The transition period from September to November forms the post monsoon season. The winter season starts late in November and remains up to first week of March.

The normal annual rainfall of the UT is 1061 mm, which is unevenly distributed over the area in 49 days. The southwest monsoon sets in from last week of June and withdraws in end of September, contributes about 80% of annual rainfall. July and August are the wettest months. Rest 20% rainfall is received during non-monsoon period in the wake of western disturbances and thunderstorms. The lowest rainfall, which was 49% less than normal, was recorded in 1987 and the highest rainfall, which was 69% more than normal, was recorded in 1971. Maximum amount of rain received by the city of Chandigarh during monsoon season is 195.5 mm in a single day.

The summers and winters exhibit extreme temperature interspersed by monsoon. The Mean Maximum temperature of the city is 39.1°C (May and June) and the mean Minimum is 6.1 °C (January). The highest recorded temperature in Chandigarh was 46.5$^{o}$ C on 20 June, 1964 and the minimum was (-)1.2$^{o}$ C on 26 January, 1964. The highest relative humidity touches

80% during July – August whereas the lowest relative humidity values of 26% are recorded during April-May. Wind velocity is maximum at 8.4 km/hr during May while it is minimum at 3.2 km/hour during September. The average annual evaporation for Chandigarh works is 2110 mm. The lowest monthly evaporation is 7.2 mm during January and highest of 36.3 mm takes place in May.

**Rainfall**

Normal Annual Rainfall : 1061 mm
Normal Monsoon Rainfall : 849 mm
Normal Rainy days : 49

**Temperature**

Mean Maximum : $39.1^0$C (May & June)
Mean Minimum : $6.1^0$C (January)

The rainfall data of the last 5 years of Chandigarh UT is given below:

| | 2008 | 2009 | 2010 | 2011 | 2013 |
|---|---|---|---|---|---|
| Rainfall in mm | 1224.5 | 873.9 | 1214 | 860.8 | 879 |
| | | | Source: IMD | | |

## 3.0 GEOMORPHOLOGY AND SOIL TYPES

Four physiographic units are encountered in Chandigarh; ***The Siwalik range*** trending NW-SE forms the northeastern boundary of Chandigarh and is exposed in a small patch on the northeastern side. Southwestern slopes of the foothills are covered with loose talus material deposited by hill torrents forming alluvial fans. These alluvial fans coalesce to form piedmont ***Kandi*** formation running parallel to the hill ranges. The piedmont deposits comprise of cobble, pebble and boulder, associated with sand, silt and clay. The Kandi formations merge into ***Sirowal*** formations in south and southwest. The Sirowal merges with the main ***Alluvial plain*** towards south and southwest. The alluvial deposits belong to Quaternary age and comprise layers of fine sand and clay. Coarser sediments occur along the Sukhna Choe and Patiali ki Rao whereas relatively finer sediments, thus restricting the aquifer disposition laterally, underlie the area between these two streams. The typical Kandi formations comprising boulders-gravel- coarse sand are not prevalent in the area since the source formations are fine grained.

The soils in UT Chandigarh are loamy sand at surface and calcareous sandy loam in subsurface layers. The hard clay forms pan at depths varying between 20 and 30 m. In northern parts the soil is sandy to sandy loam where as it is loamy to silt loam in southern parts. The soils in Chandigarh are light yellowish brown to pale brown in color. Soils are calcareous and normally having kankar. Almost all the soils are deficient in nitrogen, phosphorous and potash.

# 4.0 GROUND WATER SCENARIO

## 4.1 Hydrogeology

The Union Territory of Chandigarh is occupied by semi consolidated formations of upper Siwalik system of middle Miocene age that are exposed in north eastern fringe whereas the rest of the Territory is occupied by Indo-Gangetic plain comprising alluvium of Pleistocene age. The piedmont deposits at the foot of Siwalik Hills comprise cobble, pebble and boulder, associated with sand, silt and clay. The piedmont deposits are followed by alluvial plain comprised of clay, silt and sand.

The formations have been deposited by the drainage system originating in the Siwaliks. Coarser sediments occur along the Sukhna Choe and Patiali ki Rao whereas relatively finer sediments, thus restricting the aquifer disposition laterally, underlie the area between these two streams. The typical Kandi formations comprising boulders-gravel- coarse sand are not prevalent in the area since the source formations are fine grained. Based on the exploratory drilling carried out by Central Ground Water Board down to a depth of 450 mbgl, it can be concluded that fair to good aquifer horizons occur in most part of Chandigarh except in south-western parts near sectors 37,38,39,40 and 41. An aquifer, 20 meters thick, occurring at a depth of 160 mbgl, comprising medium to coarse sand, occurs in almost all of Chandigarh except around sector 38. It has also been inferred that the sediments are relatively coarse-grained up-to a depth of 180 mbgl below which they become finer. The yields of the deeper aquifers is also lesser as compared to the shallower ones.

The formations encountered in a borehole drilled down to 465 mbgl in sector 28, close to Sukhna Choe, are well-defined coarse sediments up to 240 mbgl. Below this depth the formations are finer grained. Whereas the shallow formations comprise coarse sand to gravel and pebbles intercalated with clays, the deeper ones are fine sands and silts. In sector 47, the aquifer material is coarse up to a depth of 174 mbgl below which it becomes finer. The aquifer material encountered at sector 33 is coarse up to 180 mbgl. This indicates that the thickness of coarser sediments is greater in northern parts of the city as compared to the southern parts.

Along Sukhna Choe, three prominent sand beds occur (inter-bedded with clay beds) within a depth of about 100 m. The upper sand beds are about 15 m thick and occur 8 m below land surface. Middle sand bed is about 18 m thick and occurs at depths varying from 21 to 38 mbgl. The deeper sand bed occurs at depth varying from 39 to 76 mbgl and is about 27 m thick. These beds are more persistent in the down stream direction of Sukhna Choe. The clay percentage vary from 30 to 62% while sand percentage vary from 38 to 70% in various well logs. In the area lying to the west of Industrial Area

around sector 27 to 31, thin sand beds, 3 – 6 m thick have been observed up to depth of 100 m. However, in this area thickness of clay beds is more than sand beds.

Along the Patiali-ki-Rao nala a single thick sand bed has been observed. This thick bed is inter-layered with clay lenses in northeast and southwest directions of the nala. The clay percentage varying from 31 to 88, and sand percentage varying from 12 to 69 have been encountered in various boreholes. This bed continues but thins towards southeast. Further this bed gets split up into two units separated by 20 – 25 m thick clay beds.

Lithological sequence encountered during drilling does not show any conformity in aquifer geometry in the area. The sub-surface formations are basically composed of pebbles, gravels and fine to coarse-grained sand with fair proportion of Kankar throughout. In the southern part of the area compact/cemented, poorly permeable silt beds exist below 250 mbgl. The litho logical logs of boreholes drilled indicate presence of saturated granular zones comprising of medium to coarse sand and gravel up to depth of 465 m. A distinct aquifer of around 10-20 m thickness at a depth of about 160 m exists persistently all over the UT area except southwestern parts.

Ground water in the area occurs under water table, confined as well as semi- confined conditions. The pumping test data of the aquifers tested in the city clearly indicates that good confined aquifers occur around sector 10,33, 38 and 47 while leaky are encountered around sector 28. One interesting feature is that the aquifers in the southern parts of the city are restricted in aerial extent due to lithological boundaries as deciphered from pumping test data. Ground water occurs under unconfined conditions down to about 80 m in Manimajra area. In other areas the semi-confined conditions prevail up to 20-30 m below land surface. Barring Manimajra area ground water below 20-30 m exist under confined conditions. The depth of the shallow aquifer system is less than 30m below ground level whereas the depth of the deeper aquifer system ranges from 40 to 450 mbgl of explored depth while in Manimajra area confined aquifers occur below 90 m.

During the exploratory drilling operations in the city in the year 1972-74 only deep (100-300 m) exploratory wells were constructed and aquifer performance tests were conducted. The transmissivity values for the deeper aquifer system ranged between 74 $m^2$/day at sector 10 to 590 $m^2$/day at sector 28. The storativity values ranged between $1.5x10^{-4}$ to $7.5x10^{-4}$ indicating confined nature of aquifer systems. A number of aquifer performance tests were also conducted on the existing shallow tubewells and only the recovery data was used to assess the aquifer parameters. The transmissivity values of shallow aquifers up to 100 m depth range obtained during these tests ranged between 70 and 466 $m^{2/}$day.

Water table elevation study reveals that the flow of ground water is from north to southwest and southern directions. Water table elevation difference between northern and southwestern parts is 20 m and lies between 330 m amsl and 310 m amsl. Due to this hydraulic difference the ground water moves from north to southwestern direction. In western area ground water flow is towards Patiala-ki- Rao and it flows parallel to Sukhna Choe. The ground water flow from extreme north to southwestern part suggests that ground water recharge takes place from recharge area running parallel to Siwaliks

During the pre-monsoon period depth to water level in the shallow aquifer system varies between 1.22 in the southern parts to 45 mbgl in the northern areas. In the western and south-western part of the city covering sectors 39 to 47 the water level is shallow – less than five meters. This is due to finer nature of sediments and lithological boundaries. In sectors falling along Madhya *Marg*, it is more than 15 m. It gradually deepens as we move from west to east and it is as deep as 30 m in the extreme eastern part covering part of Sector-26 and Manimajra. These are recharge areas with coarser sediments and steeper hydraulic gradients. In the deep aquifer system the water level lies between 15 and 80 m bgl. In the southwestern part of the city the water level of deep aquifer system is shallower as compared to northeastern part, where water level is more than 70 mbgl. In the area falling north of Madhya Marg, it varies from 16 m to 27 m below ground level. However in Manimajra area it is maximum in the range of 70 -80 mbgl.

The seasonal (Pre-post monsoon) water level fluctuation in the shallow aquifer is not significant. A greater part of the city has shown a rise in water levels, the maximum being 6.09 m meters in sector 12 and 0.14 meters at Maloya. The western side of the city has registered a decline, the maximum being 1.1 meters at Maloya.

The long term water level fluctuation data of the shallow aquifer system reveals that the northern and central parts of the city are showing a decline in water levels , rest of the area is showing a near static trend while the southern sectors are showing a rising trend. There is a general decline of water levels ranging between -0.43 m at sector 37 and -7.19 m at sector 12 while the rise of 0.04 m at Maloya and 2.92 m at sector 52 is observed.

### 4.2 Ground Water Resources

Ground Water Resources of Chandigarh have been estimated for the water table aquifer as on 31.03.2011 by taking into account the following data into consideration:

- The total geographical area of Chandigarh is 114 Sq.km. There is no area that is not suitable for ground water recharge.

- The depth to water level in shallow aquifers ranged from 4.48 m to 8.47 m during Pre-monsoon of 2006-2010 while it was 4.53 to 8.07 m during Post monsoon 2006-2010.
- Specific yield in the zone of water table fluctuation was taken as 12% and Rainfall infiltration factor as 20% (as per norms).
- As per information available, there was no pumpage/ground water draft from shallow aquifers.
- Irrigation was being done by deep Government tubewells only. There were 30 irrigation tubewells managed by Chandigarh Administration in the various villages of U.T., Chandigarh. The depth of these wells is in the range of 180 m – 250 m. These tubewells tap confined aquifers below 78 m from ground level.
- There were 239 tubewells for drinking water supply to the rural and urban population. These tubewells tap confined aquifers below 90 m from ground level. The depth of these wells ranges from 200-300 m.

The ground water resource of shallow aquifer in Chandigarh as on 31.03.2011 was as follows: -

- Recharge from rainfall during monsoon = 1545 ham
- Recharge from other source during monsoon = 62 ham
- Recharge from rainfall during non-monsoon = 488 ham
- Recharge from other sources during non-monsoon = 61 ham
- Total annual ground water recharge = 2156 ham
- Natural discharge during non-monsoon = 216 ham
- Ground Water Draft as on 31.03.2011 = nil
- Net annual ground water availability = 1940 ham

It has been estimated that the annual replenishable ground water resources (Net Ground Water Availability) of Chandigarh were 1940 hectare-meter (ham) as on 31$^{st}$ March 2011. This estimation is based on the recommendations of the Ground Water Estimation Committee (1997). These are the dynamic ground water resources that are likely to be replenished every year under normal rainfall. Since, there is no draft from shallow aquifers, the Chandigarh UT falls under **SAEF** category.

### 4.3 Ground Water Quality

Based on the data generated from the analysis of ground water samples drawn from hand pump and tube wells, it is found that the ground water is fresh and suitable for drinking as well as irrigation purposes. Normally, the ground water drawn from the deeper aquifers is less mineralized as compared to water drawn from shallow aquifers. The conductivity values are less than 1000 micro Siemens per cm except in shallow aquifer at Burail where conductivity is 1030 micro Siemens per cm. Geochemical facies evaluation of ground water indicates that most of the waters, both from shallow and deeper aquifer, are of Ca-$HCO_3$ type.

Concentration of some of the vital quality indicators such as F, $NO_3$, salinity, and hardness is within permissible limits of drinking water standards (BIS - 1991).

Among anions, bicarbonate is the dominant anion. Among cations, calcium is the dominant cation in most of the samples. In few wells either sodium or calcium + sodium character dominates.

Concentration of some of the vital quality indicators such as F, $NO_3$, salinity and hardness is within permissible limits of drinking water standards (BIS -1991) both at Shallow and deeper aquifers except at Dhanas where nitrate concentration is 58 mg/l which is more than the BIS limit of 45 mg/l. Nevertheless, in few well waters from very shallow zone, concentration of Fe more than 1.0 mg/l have been observed. Such waters are not suitable for domestic including drinking purposes. None of the ground water samples from deeper zone showed concentration of these constituents above maximum permissible level.

To evaluate irrigation suitability of ground waters, plot of SAR & EC on a widely used USSL diagram revealed that majority of the waters fall under $C_1S_1$, $C_2S_1$ and $C_3S_1$ classes of irrigation rating. Use of such waters for irrigation may cause medium salinity hazards to salt sensitive crops & low sodium hazard on soil with low permeability. However, these waters are suitable for customary irrigation to salt tolerant crops grown on soils of medium permeability.

### 4.4 Status of Ground Water Development

As Per the studies carried out by CGWB in Chandigarh, three aquifer groups have been identified. Aquifer Group –I occurs mainly in the northern parts of the city. It comprises of thin sand and gravel beds of varying thickness. This group occurs chiefly in the depth range of 325 to 315 m amsl (above mean sea level). Ground water occurs mainly in under confined conditions. The discharge of tubewells constructed in this group ranges between 450 and 900 lpm. for drawdowns ranging between 2.5 and 25 metres. Aquifer Group – II occurs in the depth range of 290 – 250 m amsl. This group occurs as middle level aquifer in the northern parts, while it becomes top aquifer in the central and southern parts of the city. This group chiefly comprises of thin sand beds inter-layered by thick clay beds. At present the main exploitation of ground water is from this group. The discharge of tubewells constructed in this group varies from 650 – 1000 lpm. Due to fine nature of sediments the drawdown is high. Aquifer Group – III is the last deepest aquifer group occurring in the area. The average thickness is around 30 m in the area. It occurs between 210 – 180 m amsl. The sediments of this group mainly comprises of sand, clay with occasional pebbles/gravel sequence. In the eastern part of the city covering Manimajra area, the aquifers comprise of boulder, cobble, pebble, gravel and sand. The thickness of individual confined aquifer is 10 to 30 m and sand is medium to

coarse grained. The water bearing zones are highly potential and yield about 2000 lpm. In other parts of the City, the shallow aquifer occurs under semi-confined conditions exist down to 20-30 m depth and its average thickness is about 15 m. The shallow aquifer is semi-confined and its thickness decreases towards north western and southwestern parts due to the intervening clay beds.

There are 200 deep tubewells in the city, which contribute a total of 91 MLD (20 MGD) of water from ground water reserves for drinking water supplies to the urban areas of the city. Besides there are 39 tubewells, which provide drinking water to rural area also apart 30 tubewells for irrigation.

## 5.0 GROUND WATER MANAGEMENT STRATEGY

### 5.1 Ground Water Development

As per the Water Supply Bye Laws of Chandigarh all the water supply is to be met from government tubewells and no private tubewells are allowed to be constructed. Also only the deeper aquifers, below 100 m, are to be exploited and thus at present there is none or negligible withdrawal of ground water from shallow aquifers in Chandigarh city. There are 200 deep tubewells in urban areas and 39 tubewells in rural areas for drinking purposes. For irrigation, there are 30 government tubewells in the rural areas. Almost all the areas of the UT of Chandigarh except the extreme northern part are suitable for ground water development through construction of tubewells. Due to occurrence of boulders at various depths in the northern and eastern parts, the drilling has to be undertaken by percussion or DTH-cum-Odex method. In other parts, rotary rigs are suitable. In the boreholes drilled in the boulder formations, tapping about 30 m of aquifer thickness through a slotted intake portion having a slot size in the range of 1.5-3.0 mm is most suitable and is likely to yield about 750 to 1000 lpm of good quality of ground water for moderate drawdowns. The length of housing shall depend on the water level in that area and in case of Mani Majra and similar areas in Chandigarh; it should be at least 75 meters. In the boreholes drilled with rotary rigs, an intake portion of 30 m through a slotted pipe of 1.0 to 1.5 mm slot size would yield about 400 to 800 lpm of ground water.

### 5.2 Water Conservation and Artificial Recharge

Chandigarh is a highly urbanized city and the rooftop of the buildings can be suitably used for artificial recharge of the rainfall falling in Chandigarh. There is lot of green area too and some water bodies that can also be effectively utilized for recharging the rainfall runoff. In Chandigarh, there are two distinct aquifer systems - shallow and deep. Shallow aquifer occurs under semi-confined conditions and exists down to 20 to 30 m below land surface. Deep aquifers below 40 m are under confined conditions. The piezometric head of the deep aquifers stands much below the water table of shallow

aquifers and thus it can receive water easily on being recharged artificially. The tubewells in Chandigarh are tapping only the deeper aquifer system which causes fall in piezometric head of deeper aquifer system; where as water level in the shallower aquifer system is rising. As per the prevailing hydrogeological conditions, the most suitable structure for artificial recharge to the ground water in the Union Territory of Chandigarh is trench cum recharge well. The dimensions of the trench would be site specific and will depend on the water availability. The depth of the recharge well is suggested to be around 40 m .The trench should be filled with the filter material The trench serves dual purpose of storing the excess water and filtering the suspended particles / silt. For construction of recharge well, a borehole of 450 mm (18") dia may be drilled with the Reverse Rotary rig and Recharge well assembly of 6" dia may be lowered into the borehole. In case sufficient space is not available in areas close to buildings, the drilling may be taken up with hand boring and dia of borehole should be 10". After construction of trench cum recharge well, the channelized water is to be connected with the recharge structures through R.C.C. or M.S. pipes.

Central Ground Water Board, North-Western Region has taken up the following artificial recharge projects in UT of Chandigarh under various centrally assisted schemes. These projects were executed by various agencies of Chandigarh Administration and Municipal Corporation.

1. Scheme of rooftop rainwater harvesting at CSIO Complex, Chandigarh (1998-99). Cost – Rs.2, 22,000/- (Injection wells and piezometers costing Rs.7,56,000/- constructed by the Central Ground Water Board.
2. Artificial recharge to ground water under central Sector scheme in Panjab University, Chandigarh (2000-2001). Cost – Rs.2, 78,900/-.
3. Artificial recharge to ground water in Leisure valley, Chandigarh (2000-2001). Cost – Rs.14, 38,000/-.
4. Scheme for roof top rainwater harvesting at Bhujal Bhawan Chandigarh (2001-2002). Cost – Rs.3, 74,000/-
5. Artificial recharge to ground water at office of Chandigarh Housing Board in sector 9, Chandigarh (2001-2002). Cost – Rs.11, 47,000/-. Amount released-Rs.8,00,000/-.
6. Scheme for rainwater harvesting at DAV School in Sector-8, Chandigarh (2001-2002). Cost – Rs.9, 41,000/-.
7. Artificial recharge to ground water at TTTI, Sector-26, Chandigarh (2001-2002). Cost – Rs.12, 13,000/-.
8. Scheme for utilizing surplus water monsoon runoff for sector 27,19,30,20, Chandigarh (2001-2002). Cost – Rs.10, 38,000/-.
9. Artificial recharge to ground water for Government College for Girls, Sector 11, Chandigarh (2003-2004) – Cost of the scheme – Rs.3, 75,000/-.
10. Detailed Project Report for Rain Water Harvesting and Artificial Recharge to Ground Water covering the entire campus of Panjab

University, sector-14, Chandigarh (2011-12). The scheme proposes to construct 54 recharge structures to recharge approx. 6538 cubic meters/hr of water at the cost of Rs. 776.03 lakhs. The work is under progress.

CGWB, NWR has also provided technical assistance to innumerable organizations and individuals regarding artificial recharge and rainwater harvesting in Chandigarh. Some of these are:

1. ISBT, Chandigarh, The Executive Engineer, Project PH Division No. 1, Chandigarh.
2. GPRA quarters, Sector 7, The Executive Engineer, CPWD Division-2,CPWD, Chandigarh.
3. Ryan International School, Sector 49-B, Chandigarh (U.T.)
4. Judicial Academy, Sector-43, Chandigarh. Executive engineer, PH Division 7, sector-11
5. Petrol Pump sector-41, Bharat Petroleum Corporation Ltd., Sector 19-B, Madhya Marg, Chandigarh
6. Indian Oil Petrol Pump, Sector 28-C, Chandigarh.
7. National Bank For Agriculture and Rural Development, Plot No. 3, Sector-34-A
8. A.G. Punjab Building, The Assistant Engineer, CPWD, Division VIII,
9. DLF Complex, IT Park, Kishangarh, Chandigarh.
10. BBMB complex, Sector 19, Chandigarh
11. Plot No. 4 and 5 for the existing building of A.G. Haryana, Sector 33-B, Chandigarh (U.T.). Chandigarh Central Sub Division No. 10, Central Public Works Department,
12. Geological survey of India, Sector 33-B Chandigarh Central Sub Division No. 10,Central Public Works Department,
13. Air force station, Sector 31 and Sector 47 for Married Accommodation Project (MAP).The Chief Engineer, HQ, CE Chandigarh Zone, 'N' Area, Airport Road, Chandigarh - 160 003.
14. G.G.D.S.D. College, Sector 32, Chandigarh.
15. Industrial Training Institute, Sector 28, Chandigarh.
16. Kendriya sadan, Sector 9, The Executive Engineer, CPWD Division, Chandigarh.
17. Government Central Grafts Institute for Women, Chandigarh.
18. PCDA Building complex at Sector 9, Chadigarh.
19. Various Building of Judicial complexes and Residence of Hon’ble Chief Justice and other Hon’ble Judges of Punjab and Haryana high court.
20. Family quarters at CRPF campus Hallomajra.
21. SBI Building at Sector 17, Chandigarh.

## 6.0 GROUND WATER RELATED ISSUES AND PROBLEMS

Fortunately there are no big issues related to ground water in the city except for a decline in the piezometric head of the deeper aquifers due to sustained pumping. As mentioned earlier too, the Water Supply Bye Laws of Chandigarh ensure all the water supply is to be met from government tubewells and no private tubewells are allowed to be constructed. Also only the deeper aquifers, below 100 m, are being exploited and thus at present there is none or negligible withdrawal of ground water from shallow aquifers in Chandigarh city. This is also evident from the fact that whereas there is a heavy decline in the water levels of the deeper aquifers due to sustained pumping, there is hardly any decline in water levels of the shallow aquifers (except in the central parts where the decline in the last five years can be attributed to leaky confined conditions). Another interesting observation is that while the water levels of the deeper aquifer are in the range of 20 to 80 mbgl, those in the shallow aquifer are in the range of 2 to 17 mbgl. The water levels are especially quite shallow in the southern sectors (and Mohali - where in certain areas water logged conditions exist and dewatering had to be resorted to while constructing multi-storeyed buildings). It is worth mentioning that the chemical quality of ground water of all the aquifer systems in Chandigarh is good and within the permissible limits prescribed by BIS (1991) for drinking water except at a couple of locations where water sample drawn from hand pumps that are about 15 m deep, the iron concentration was higher than the prescribed limits. This may also be due to corrosion in the delivery pipes.

## 7.0 AWARENESS AND TRAINING ACTIVITY

UT of Chandigarh is also the capital of the states of Haryana and Punjab. Thus there are a number of offices and organizations of these two states also in Chandigarh making it imperative to conduct quite a number of Water Management Training Programs in Chandigarh. Various programs conducted are as follows:

### 7.1 Training Programs

1. “Training Program of CGWB on Water Management and Rain Water Harvesting to Ground Water” from 2$^{nd}$ Sept. to 4$^{th}$ Sept. 2003. In this training Program 25 participants of different organization of Central and state Government of Punjab state were trained to adopt appropriate measure regarding water Management and Rain water Harvesting in their concerned organizations. Out of these 25 participants 4 were from MES, 11 from Public Health, 3 from CPWD, 3 from PSTC and one was from Railways.
2. “ Training Program of CGWB on Water Management and Rain Water Harvesting to Ground Water” from 28$^{th}$ October to 30$^{th}$ Oct., 2003. In this training Program 17 officers of different organization of Central

Government and State Government of Punjab state were trained to adopt appropriate measure regarding Water Management and Rain water Harvesting in their concerned organizations. Out of these 17 participants 2 were from Municipal Corporation Chandigarh, 1 from PWD (Public Health) Punjab, 4 from CPWD, 5 from BSNL, 1 from MES and 4 were architect of College of Architecture and Urban Development and Planning, Chandigarh.

3. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" from 1st December to 3rd December 2004. In this training Program, training was imparted to around 50 officers of different organizations of Central Government, U.T. Administration, Punjab Government and students from Geology department, Panjab University. Department of Forensic Science, Punjabi University, Patiala, Water Resources & Environment Dte, Punjab, Punjab Irrigation department, Punjab, Education department, Chandigarh Administration, P.H. Circle, Chandigarh, Punjab Urban Planning & Development Authority, Punjab, Air Force, Chandigarh, Department of Soil & Water Conservation, Punjab, National Institute of Teachers Training, College of Architecture, Punjab Police Housing Corporation, Department of Agriculture, Punjab, Department of Punjab Water Supply and Sanitation (Public Health Punjab), CPWD, Chandigarh and students from Geology department, Panjab University were adequately represented by their officers.
4. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" from 8th to 10th Feb., 2005. In this training Program, training was imparted to 33 officers of different organizations of State Government, Central Government and teachers from various schools of Chandigarh and Panchkula.
5. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" from 2nd to 4th March 2005. In this training Program, training was imparted to 45 officers of different organizations of State Government, Central Government and teachers from various schools of Chandigarh, Panchkula and Jalandhar.
6. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" on 13-14th of September 2005. In this training Program, training was imparted to around 50 officers of different organizations of Central Government, U.T. Administration, Punjab Government and students from Geology department, Panjab University. Department of Forensic Science, Punjabi University, Patiala, Water Resources & Environment Dte, Punjab, Punjab Irrigation department, Punjab, Education department, Chandigarh Administration, P.H. Circle, Chandigarh, Punjab Urban Planning & Development Authority, Punjab, Air Force, Chandigarh, Department of Soil & Water Conservation, Punjab, National Institute of Teachers Training, College of Architecture, Punjab Police Housing Corporation, Department of Agriculture, Punjab, Department of Punjab Water Supply and Sanitation (Public Health

Punjab), CPWD, Chandigarh and students from Geology department, Panjab University were adequately represented by their officers.

7. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" on 15-16th Dec., 2005. In this training Program, training was imparted to 50 officers of different organizations of State Government, Central Government and teachers from various schools of Haryana.
8. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" from 7nd to 8th March 2006 at Bhujal Bhawan, Chandigarh. In this training Program, training was imparted to approx. 50 officers of different organizations of State Government, Central Government and teachers from various schools of Chandigarh, Panchkula and Punjab state.
9. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" organised on 14-15 Sept., 2006. This training program was attended by nearly 40 persons from different organization.
10. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" organized on 12th March, 2007. Nearly 40 participants took active participation in understanding various methods being adopted for Artificial Recharge and Project Formulation.
11. "Rainwater Harvesting, Artificial Recharge to Ground Water and its Management" organized on 05th March, 2008. Nearly 50 participants took active participation in understanding various techniques of rainwater harvesting in Urban areas, Water quality for recharge, role of geophysics in artificial recharge site selection. Practical exercises were also given to trainees for project formulation. Various artificial recharge sites in Chandigarh were also shown to the trainees.
12. Two days Water Management Training Programme held at Bhujal Bhawan, NWR, Chandigarh on 3rd-4th March, 2011. A total of 23 trainees included officials of Indian Audit and Accounts Department, Principal Accountant General (Audit), Punjab, Chandigarh & Haryana; Research scholars of Department of Environment & Vocational Studies, Panjab University, Chandigarh and students of Government College for Commerce and Business. The programme was presided over by Shri A. K. Bhatia, Regional Director, NWR, Chandigarh.

### 7.2. Mass Awareness Programs

1. Mass Awareness Programme on Rainwater Harvesting for Ground Water recharge was organized at DAV Senior Secondary School, Sector 8, Chandigarh on 23rd February 2002.
2. As part of the celebration of International Fresh Water Year – 2003 a WATER MELA was organized on 20th and 21st October, 2003 at Govt. College for Girls, Sector 11, Chandigarh in which Prakriti, the environmental Society of the GCG-11 also collaborated in the function.

Students from as many as 12 different colleges of Chandigarh participated in seven events of competition.

3. Mass awareness program was organized at Panjab University, Chandigarh in association with Panjab University Environment Society on 26 and 27.10.2004 to create awareness amongst the students about water conservation, protection and management of ground Water.
4. Mass awareness Programme was organized at Sri Aurobindo School of Integral Education, Sector-27, Chandigarh .
5. Mass Awareness Programme & Jal Yatra activity was organised by NWR at village Dhanas, Chandigarh (UT) on 28.01.2011 at Government Senior Secondary School, Chandigarh presided over the function. During the Jal Yatra, a procession consisting of 300 students, teachers, parents, farmers and officers and officials of Central Ground Water Board was taken up through the entire village of Dhanas raising the stakeholder's awareness through various catching water conservations Banners and Slogans. In the activity, about 500 students of Govt. Sr. Sec. School Dhanas, teachers, Parent Teachers Association (PTA), Sarpanches, members of village panchayat, members of Sarv Shiksha Abhiyan, stake holders and officers and officials of CGWB were taken part actively. Cultural programme was also organised by the School children on the theme 'water'.

## 8.0 AREAS NOTIFIED BY CGW B/SGWA

No area has been notified in Union Territory of Chandigarh**.**

## 9.0 RECOMMENDATIONS

Chandigarh has a population of 10.54 lakhs as on 2011, however the project population in 2021 would be 12.40 Lakhs (approx.). Presently, a major part of water requirement of the city is met by canal water. Canal water supply to the city is approximately 305 MLD (67 MGD). There are 200 deep tubewells in the city, which contribute a total of 91 MLD (20 MGD) of water from ground water reserves. Besides there are 39 tubewells, that provide drinking to rural area also. Presently there is no gap between demand and supply and the average Domestic per capita per day supply to the residents of the Chandigarh is 252 litres against the National Norm of 135 lpcd. To cater to the water demand of the population in 2021, it would require 409.52 MLD (90 MGD) water, whereas available supply would be only 310 MLD (68 MGD). Thus there is a shortage of about 99.52 MLD (21.80 MGD). The above shortage would occur because of withdrawal of canal water by Panchkula (Haryana) and Chandimandir amounting to 9 MGD which is currently being utilized by Chandigarh and also reduction in the ground water availability in coming year.

As already mentioned, Chandigarh city has the twin problem of ground water decline as well as rise. Whereas the deeper aquifers are under great

stress and are depicting declining water levels, the shallow aquifers are not being put to any use and the water levels are rising and also causing near water logging conditions in the southern areas of the city. To balance this problem, it is essential that pumping from the deeper aquifers is reduced and that from the shallow aquifers be increased. There is also a shortage of about 0.241 (53 MGD) of drinking water in Chandigarh as on date. This can also be partially met through shallow dynamic ground water resources of the city. As mentioned above, annual replenishable ground water to the tune of 1940 ham are available in the city. Pumping out at least 70% of this resource i.e. 1358 ham annually is not likely to have any negative impact on the ground water regime. This can augment drinking water to the tune of 37 MLD (8.1 MGD). The exploitation from the shallow aquifer should be concentrated in the southern sectors, especially 39 to 55 because of shallow ground water levels.

Artificial recharge of the deeper aquifer should be taken up to arrest the decline in the piezometric head. It should be made compulsory for all the buildings having a roof area of more than 250 sq. meters. Artificial recharge can also be taken up in the Liesure Valley, along Sukhna Choe, Patiali Ki Rao and all the water bodies of Chandigarh.

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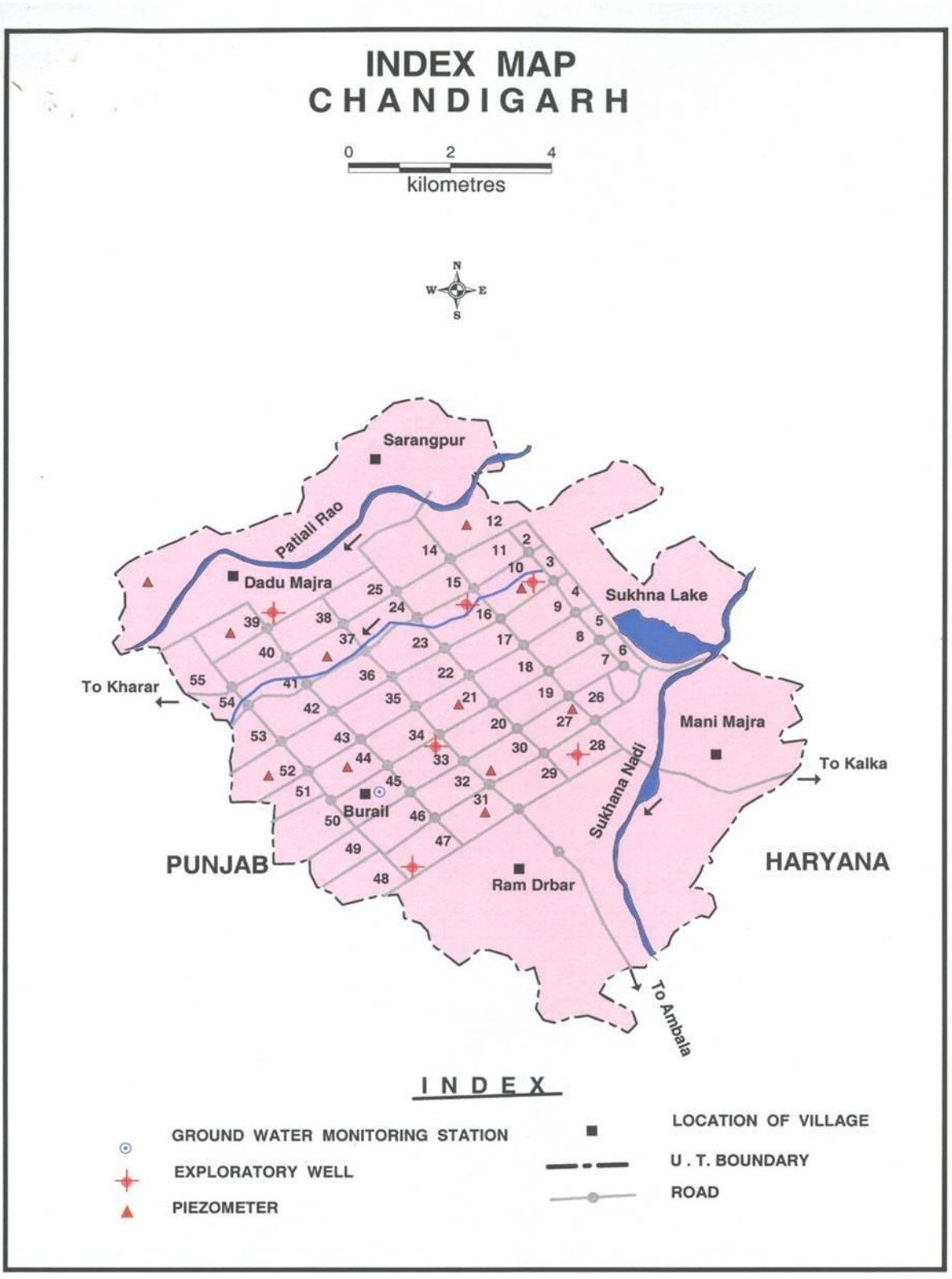
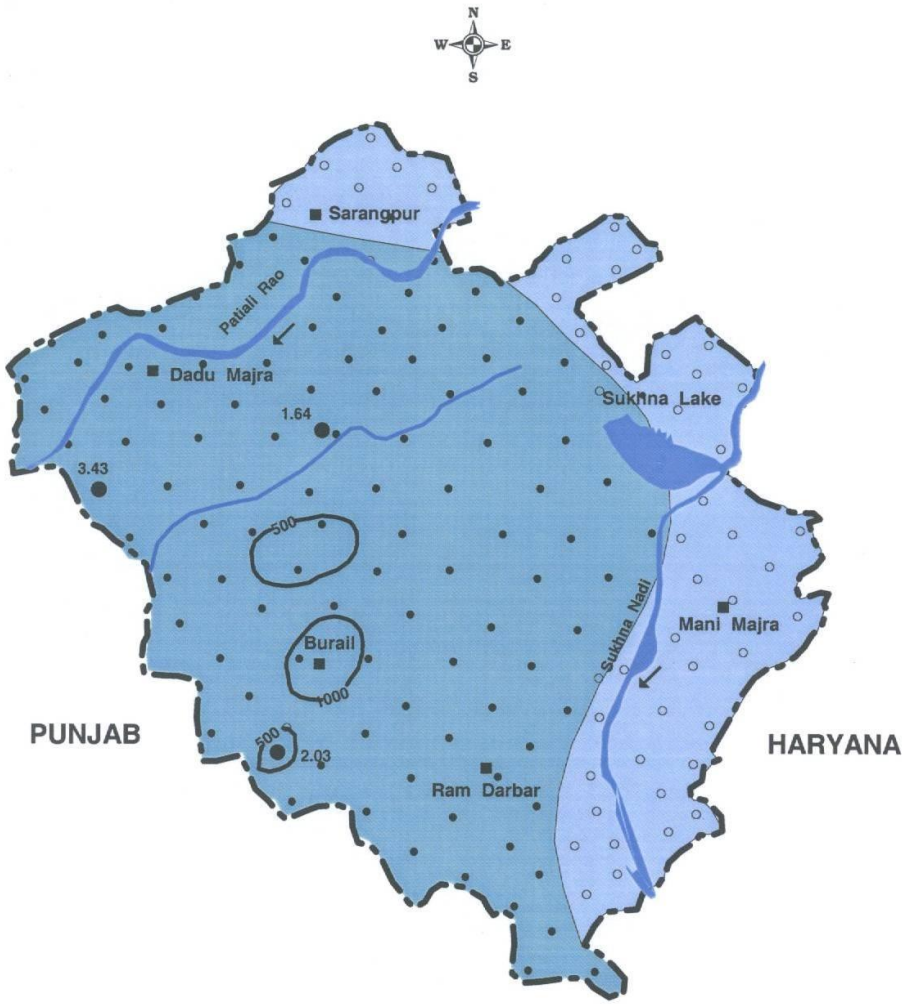

INDEX MAP
CHANDIGARH
0 2 4
kilometres
N
W E
S
Sarangpur
Patiali Rao
Dadu Majra
Sukhna Lake
To Kharar
Mani Majra
To Kalka
Sukhana Nadi
Burail
PUNJAB
HARYANA
Ram Drbar
To Ambala
INDEX
GROUND WATER MONITORING STATION
EXPLORATORY WELL
PIEZOMETER
LOCATION OF VILLAGE
U . T. BOUNDARY
ROAD

# HYDROGEOLOGY

## CHANDIGARH

0 2 4

kilometres



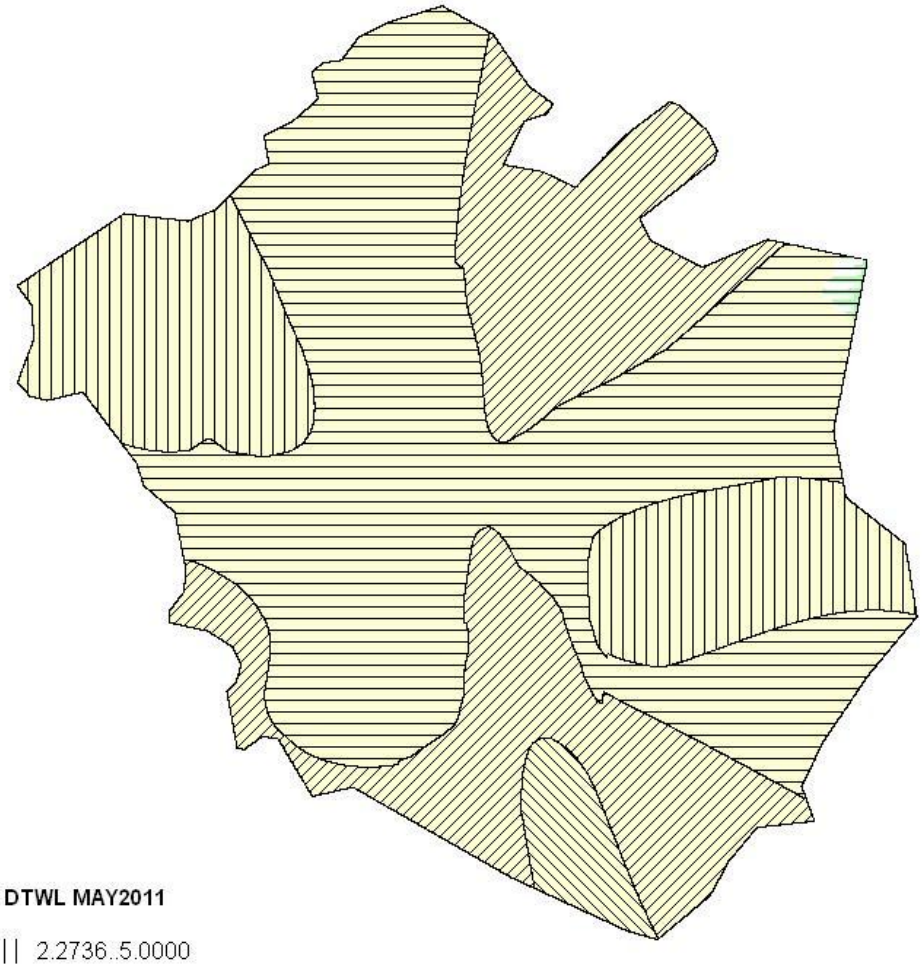

## INDEX

| | WELLS FEASIBLE | RIGS SUITABLE | DEPTH OF WELL ( m ) | DISCHARGE ( lpm ) | SUITABLE ARTIFICIAL RECHARGE STRUCTURES |
|---|---|---|---|---|---|
| Soft Rock Aquifer | Tube Wells | Reverse / Direct Rotary | 25 _ 400 | 300 - 1000 | Recharge Trench with Injection Well |
| Soft Rock Aquifer | Tube Wells | Percussion / Odex | 100 _ 300 | More than 500 | Recharge Trench with Injection Well |

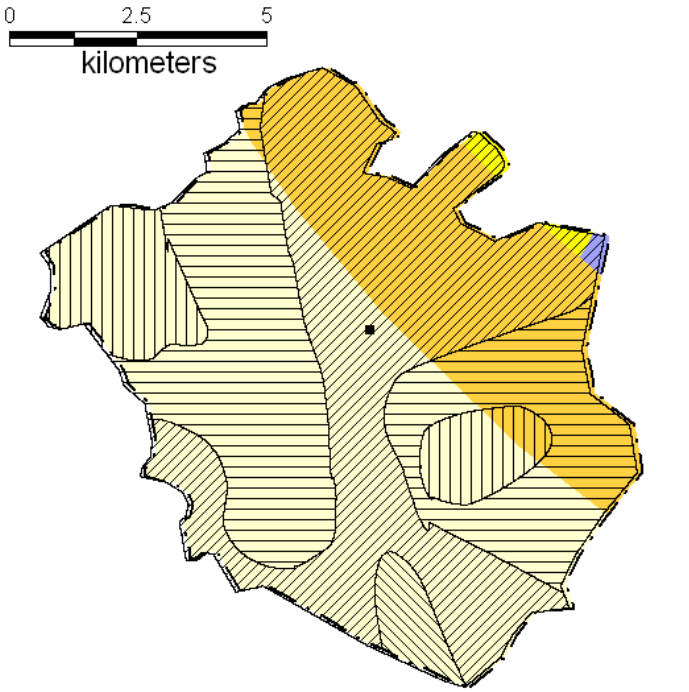
500 Electrical Conductivity ( Micromhos / Cm at 25 C )

3.43 Iron more than permissible limt ( 1.0 mg / l )

# DEPTH TO WATER LEVEL MAP
# CHANDIGARH
# MAY 2011



# DEPTH TO WATER LEVEL (POST MONSOON 2011)




**LEGEND**

DEPTH TO WATER LEVEL (M)

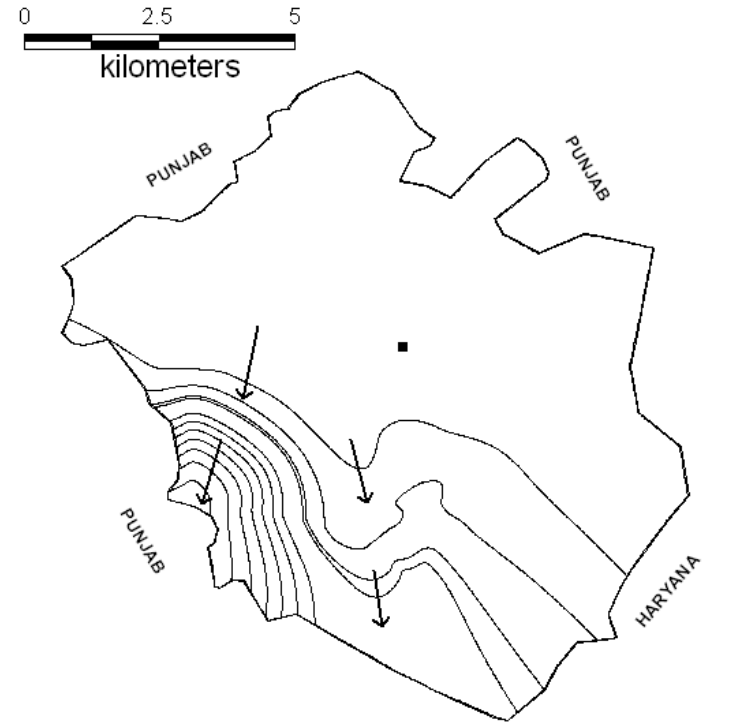
- 2.38 -- 5.00
- 5.00 -- 10.00
- 10.00 -- 20.00
- 20.00 -- 21.67

- AL02
- ALO3
- ALO4
- ST01

- CHANDIGARH HQ
- STATE BOUNDARY

CENTRAL GROUND WATER BOARD
NORTH WESTERN REGION
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

# WATER TABLE ELEVATION
# MAY 2011




## LEGEND

303 WATER TABLE ELEVATION CONTOUR (MAMSL)

GROUND WATER FLOW

CHANDIGARH HQ

STATE BOUNDARY

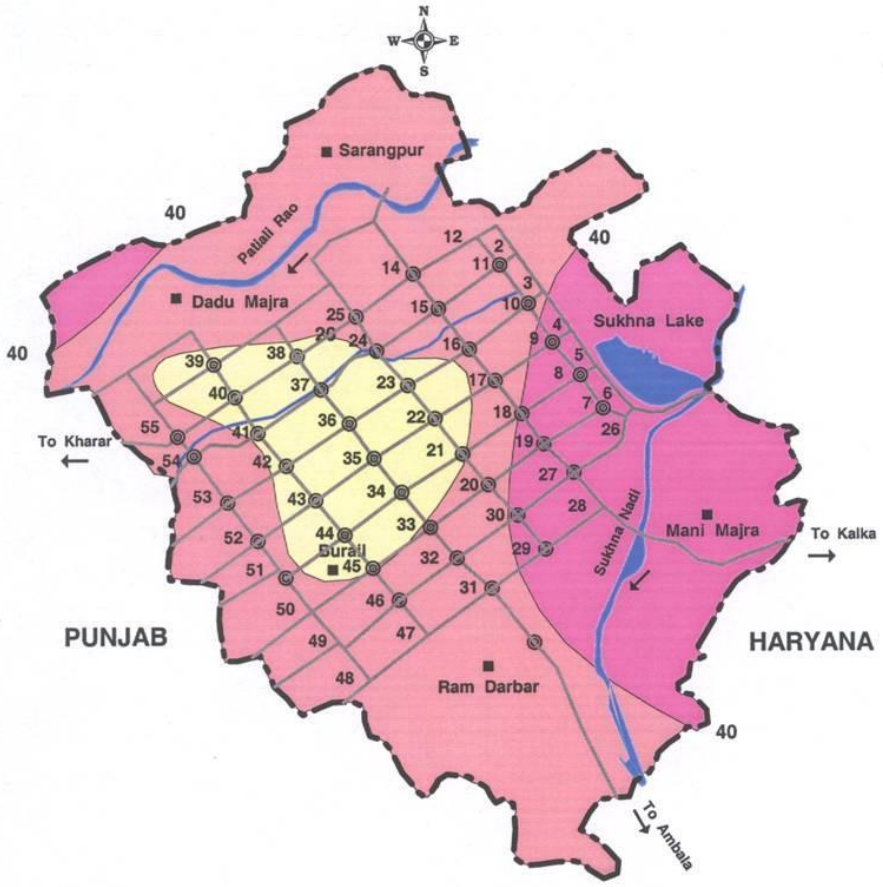
CENTRAL GROUND WATER BOARD
NORTH WESTERN REGION
MINISTRY OF WATER RESOURCES
GOVERNMENT OF INDIA

# DEPTH TO WATER LEVEL

## DEEP AQUIFER
## ( PRE MONSOON )

## CHANDIGARH

0 2 4
kilometres

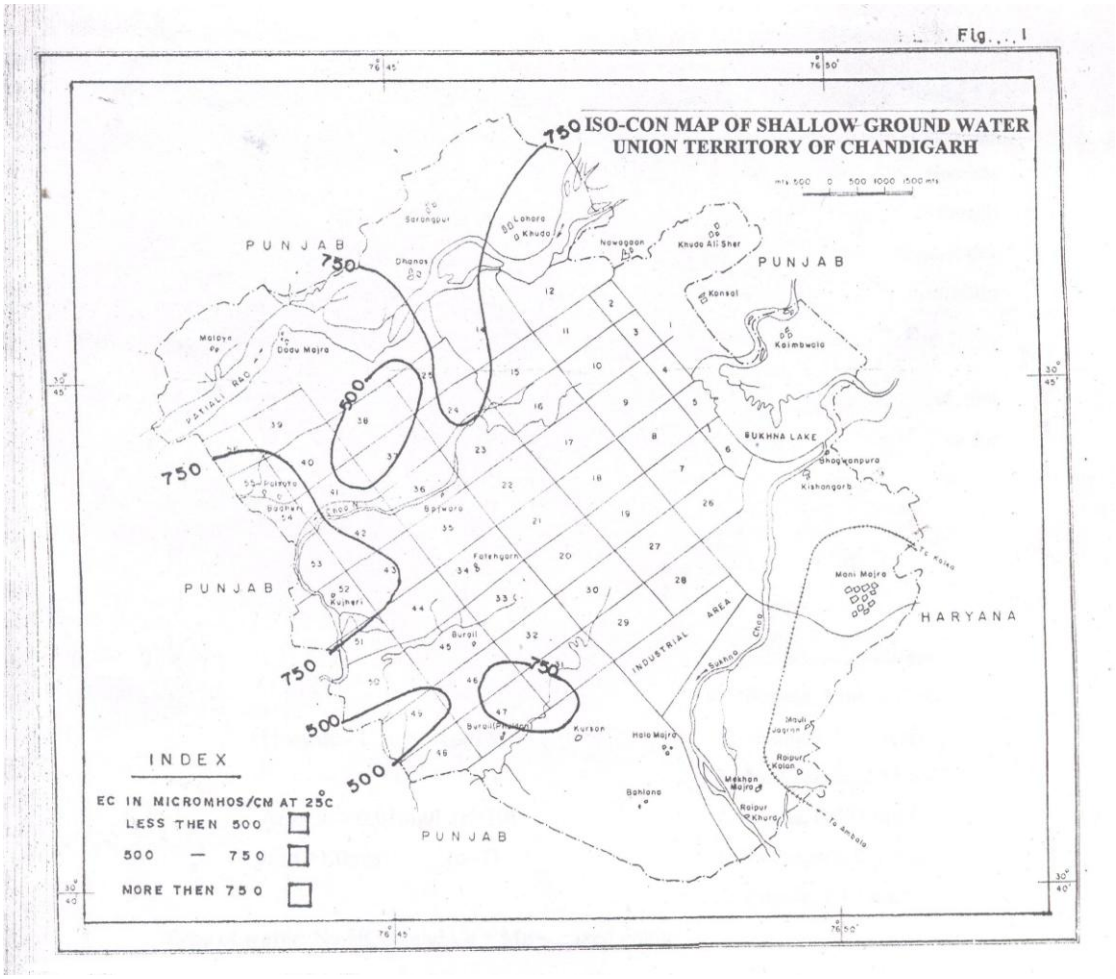



## INDEX

DEPTH TO WATER LEVEL IN m b g l.

| | | | | | |
|---|---|---|---|---|---|
| | 0 _ 20 | | | Above | 40 |
| | 20 _ 40 | | | | |

Fig. . . 1


ISO-CON MAP OF SHALLOW GROUND WATER
UNION TERRITORY OF CHANDIGARH
PUNJAB
HARYANA
BUKHNA LAKE
INDUSTRIAL AREA
Sarangpur
Lohara Khuda
Nawagaon
Khuda Ali Sher
Dhanas
Kansal
Kaimbwala
Malaya
Dadu Majra
Patiala Rao
Bhagwanpura
Kishangarh
Mani Majra
Sukhna Choe
Fatehgarh
Burail
Kurson
Hala Majra
Bahlana
Maul Jagran
Raipur Kalan
Raipur Khurd
Mekhan Majra
To Ambala
INDEX
EC IN MICROMHOS/CM AT 25°C
LESS THEN 500
500 — 750
MORE THEN 750
750
500

# GROUND WATER DEVELOPMENT POTENTIAL

## ( SHALLOW AQUIFER )

## CHANDIGARH

0 2 4

kilometres


INDEX

1940
NIL
–

NET ANNUAL GROUND WATER AVAILABILITY MCM

GROUND WATER DRAFT MCM

STAGE OF DEVELOPMENT %

SAFE