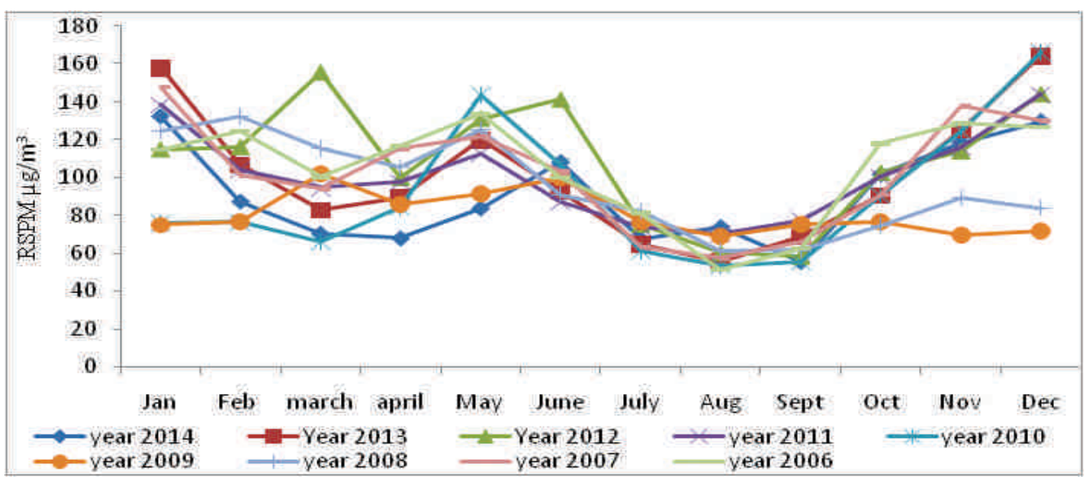
of NO_2 in the city is recorded to be 17.38 µg/m^3; however, due to increasing vehicular density in the city the levels of NO_2 are increasing year by year, mainly since 2010. Comparatively higher concentrations were observed at Industrial area and the monitoring point located at Sec 17, due to frequent movement of heavy vehicles.

Trends of RSPM in Chandigarh:



Source: Member secretary CPCC, Chandigarh

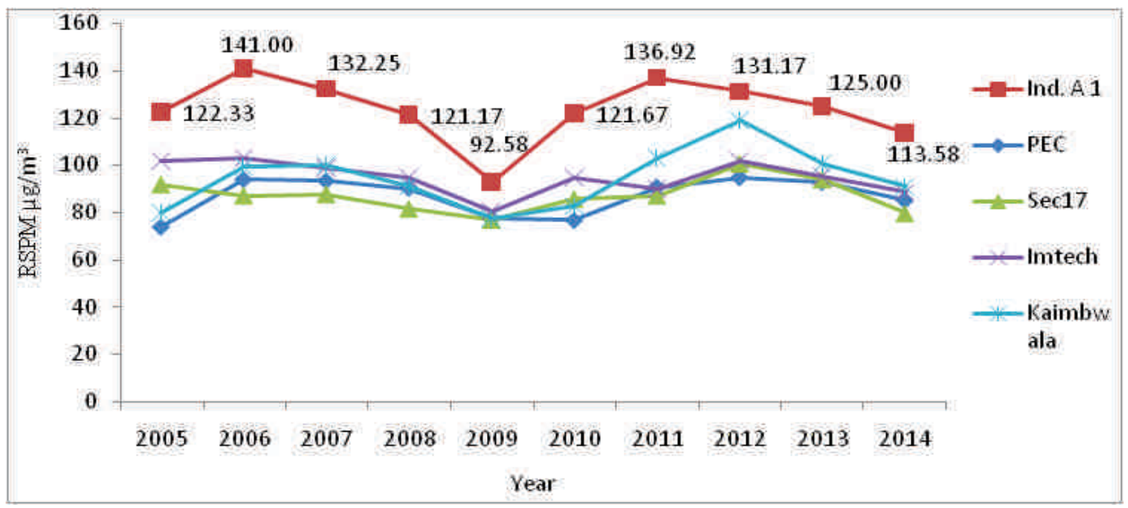
The above graphs clearly show the variations in the trend of RSPM levels in the city, changing with the seasons throughout a year. The level of RSPM was observed to follow the same trend every year, in last decade.

- The levels of **RSPM** in the air of Chandigarh were observed to **increase** with the decrease in temperature, from **October to January (winter season)**.
- Further the **RSPM** count start **decreasing** with the temperature rise from **February to April.**
- Again the **high RSPM** count was observed in the months of **May June** (crop harvesting season)
- During the Monsoonal months, **July September,** the **RSPM level** remains to the **lower limits** due to the rainfall activities.

RSPM monitoring in Chandigarh has been performed at five different locations i.e. Industrial area Phase 1, Punjab Engineering College (University of Technology) Sec 11, Commercial complex Sec 17, IMTECH Sec 39 and a village named Kaimbwala.

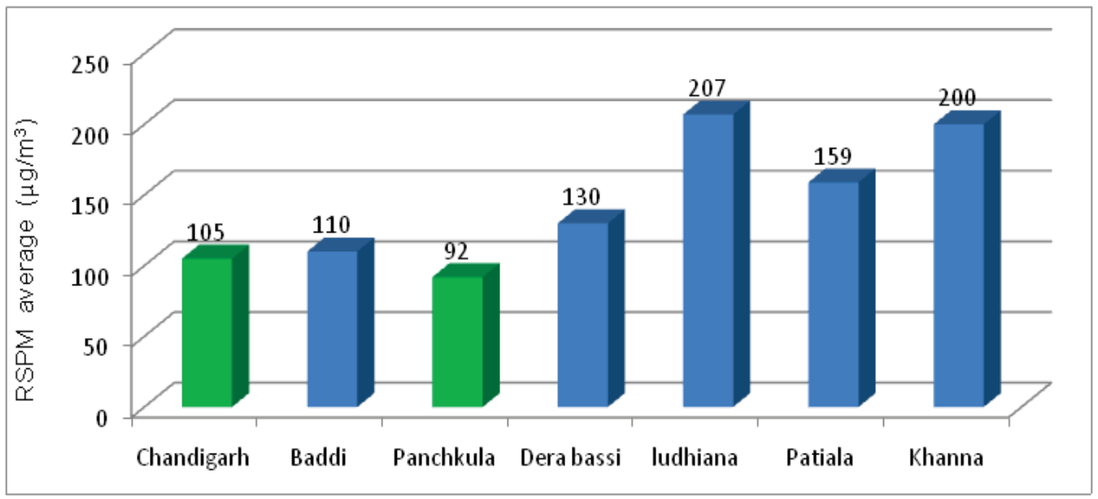
- Due to high industrial and heavy vehicular activities, **highest RSPM levels** were observed at the monitoring point located at **Industrial Area Phase 1 (123.76 avg. / 10 yr) followed by IMTECH Sec 39 (94.89 avg. /10 yr)**, Chandigarh.
- The lowest RSPM level in the city was observed for the Punjab Engineering College (University of Technology) Sec 11 **(86.8 avg. /10 yr).**

➢ Yearly average of RSPM at Chandigarh (Monitoring point wise)



Source: Member secretary CPCC, Chandigarh

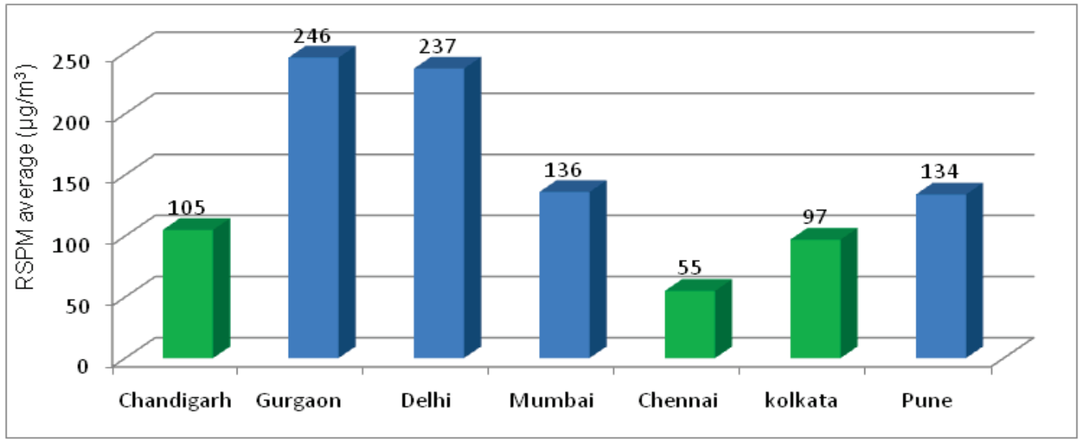
➢ Comparison with the neighbouring cities of Chandigarh: (average



Source: Member secretary CPCC, Chandigarh; HPCB (Haryana); CPCB

Though the average RSPM level of Chandigarh is quite higher (**105 µg/m^3**) than the permissible limits (**Annual Avg. 60 µg/m^3**) given by ***National Ambient Air Quality Standards of India. But the air of Chandigarh is still in much better conditions as compared to its neighbouring cities. Highly polluted neighbourhood always contributes a lot towards the pollutant levels of city.***

➢Comparison with the major cities of India: (average 2014)



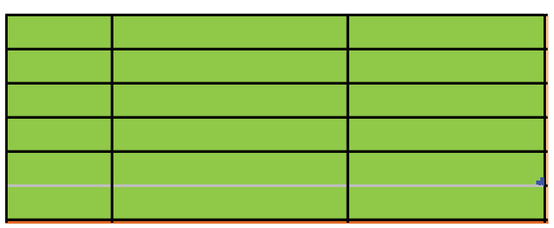
The comparison of the RSPM level of Chandigarh with the major cities of India shows that only the coastal cities such as **Chennai & Kolkata** has the Annual RSPM level **lower** than that of Chandigarh, whereas the remaining shows very high inclination.

Air quality during Diwali

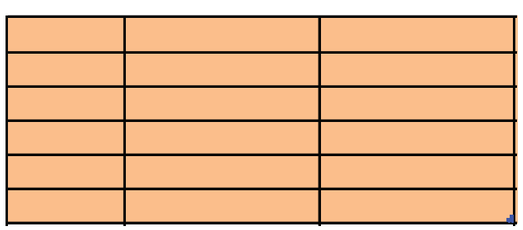
Trends of So_x During Diwali

The So_x level of Chandigarh is under control. As it observed from previews four year's data sulfur dioxide level of Chandigarh before and during Diwali is lie below the detectable limits (BDL) therefore assigned a constant value "2" for the ease of data management.

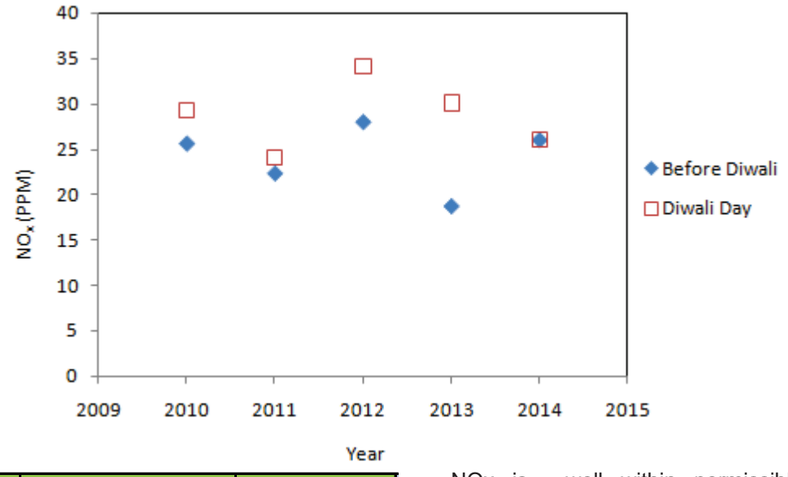
Trends of No_x During Diwali

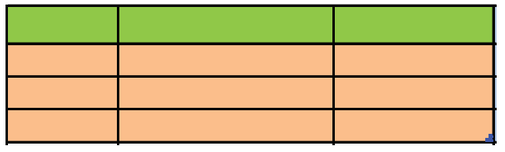


No_x Level of Sec 29 (Values in PPM)



No_x Level of Sec 22 (Values in PPM)

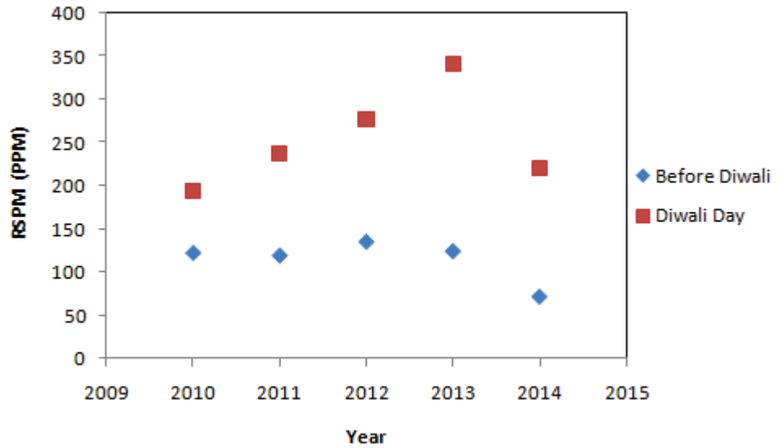




No_x Level of Sec 17 (Values in PPM)

NOx is well within permissible limits in Chandigarh. Though the level of pollutants rises during Diwali festival but still it is well below permissible limits. The applicable permissible limit, for 24 hours' average, is 80 µg/ m^3 for Nox.

Trends of RSPM During Diwali



The above graph shows the notable increase in the RSPM levels of the city before Diwali day and on Diwali. Due to the excessive use of fire crackers by the city residents and the adjoining states of Haryana, Punjab and Himachal Pradesh, the RSPM level of the city reaches to the dangerous level every year. The maximum increase in RSPM till date was observed for the year of 2013, however due to increasing awareness among the people through FM radio, newspaper advertisements, newsletters, campaigns by eco clubs and schools oragnized by Environment Department, Chandigarh, the difference has been notably decreased in the year 2014.

Year	Before Diwali	Diwali Day
2010	29	31
2011	25	25
2012	28	36
2013	19	33
2014	30	27

RSPM Level Sec 29 (Values in PPM)

Year	Before Diwali	Diwali Day
2010	153	251
2011	143	301
2012	145	280
2013	109	450
2014	68	218

RSPM Level Sec 22 (Values in PPM)

Year	Before Diwali	Diwali Day
2012	111	207
2013	135	165
2014	75	185

RSPM Level Sec 17 (Values in PPM)

The Average RSPM Level of Chandigarh is 105 ppm on normal days that is above permissible limit as per the ambient air quality standards of India. The RSPM level rises during diwali period because of smoke and other pollutants by released from burning crackers .

Factors Effecting Air Quality

Possible Reasons behind the high RSPM levels:

- ***Crop Harvesting Seasons:***
  Located nearby the agricultural hubs (Punjab/Haryana), city received a lot RSPM from the wheat harvesting, stubble burning and field ploughing/preparation for the next crop during summers (**April - June**); whereas the repetition same activities for rice cultivation takes place during winters (**Oct-Nov**).
- ***Effect of Pollens:***
  Plants and Trees used to propagate their seeds through air by the process of Pollination. Almost all the flowering plants distribute their seeds through air to the nearby area. In the process, as the size of these pollens lie within the limits of RSPM (less than 10 µm) therefore pollens counts for the major part in the RSPM level of any city. Chandigarh, a green city, also has very high density planted series of different trees, which consists of a major fraction of flowering trees. List of flowering (pollinating) trees in Chandigarh is given below:

Sr. No	Name of the Plant	Number of plants
1	EUCALYPTUS HYBRID	14912
2	ALSTONIA SCHOLARIS	13639
3	MANGIFERA INDICA	9924
4	MORUS	8402
5	TERMINALIA ARJUNA	8170
6	TOONA CILIATA	7198
7	SWIETENIA MAHAGONI	6012
8	FICUS INFECTORIA	5653
9	SCHLEICHERA OLEOSA	5164
10	CALLISTEMON VIMINALIS	3537
11	CASSIA FISTULA	3495
12	ALBIZZIA PROCERA	3479
13	ACACIA	3478
14	LAGERSTROEMIA THROELLI	3075
15	BAUHINA VARIEGATA	2989
16	KIKAR	2688
17	JACARANDA MIMOSIFOLIA	1891
18	MELALEUCA ALTERNIFOLIA	1585
19	BARRINGTONIA ACUTANGULA	1371
20	DELONIX REGIA	1279
21	PTEROSPERMUM ACERIFOLIUM	1198
22	ZIZYPHUS	1151
23	HETEROPHRAGMA ROXBURGHI	1113
24	ACACIA AURICULIFORMIS	917
25	BOMBAX CEIBA	894
26	CASSIA SIAMEA	780

Source: An Inventory of Multipurpose Avenue Trees of Urban Chandigarh, India

- ***Temperature Effect:***

- Diagrams shows the rising RSPM levels during the low temperature seasons because when temperature declines, the air masses gets denser and settle down causing the phenomenon of "**Inversions**".
- The cold and humid **air traps** the pollutants to the lower heights and prevent their dilution in environment thus one of the main reason behind the high RSPM.
- In hot days the vehicular emission also increases due to the **air conditioner load**.

During the winter season, average mixing height is lower as compared to other seasons and atmospheric dispersion is typically at a minimum and therefore the pollutants will not be as widely dispersed. Lower

average mixing height in winter season results in less volume of troposphere available for mixing and hence higher concentrations. Calm conditions in winter season result in less dispersion of pollutants resulting in building up their levels. The monsoons results in large amount of precipitation, high wind velocities and changes in general wind direction. The large amounts of precipitation reduce atmospheric pollution via associated wet deposition processes. Further wind velocities will allow for pollutant transport away from sources and increase mixing processes, thereby resulting in lower levels.

However in the rest of the period the low RSPM is controlled by the rainfall (**monsoon/western disturbances**) and spreading due to heated air masses & wind speed.

- ***Location of the city & Industrial surroundings:***

  - Chandigarh is surrounded by the **Industrial hubs** such as Baddi, Mohali, Zirakpur, Derabassi and Panchkula. Chandigarh too has a vast number of Industrial setups. As observed, the RSPM level of these cities is usually remains higher than that of the Chandigarh; therefore it can contribute to the RSPM of the city.

  - RSPM levels in air also increases due to the **operation season of brick kilns** (Oct May) and **sugar mills** (Oct - March) located at the surroundings of Chandigarh. Their continuous exhaust releases enormous amounts of SPM/RSPM, which can travel tens of kilometers to the nearby areas.

- ***Human Activities:***

  - High RSPM levels in the months of winter may also be attributed to the **shooting of fire crackers** due to number of festivals like Diwali (**Nearly Rs. 10 Crores**), Guruparav and New Year eves; moreover it's the season when most of the marriages happen in the north region.

  - **Falling of leaves and their illegal burning** in autumn season i.e November to January (winters) is also one of the main reason behind high RSPM in winters as green leaves exhibits a ultimate property of adsorbing the suspended particulates and purifying air.

- ***Population & Vehicle density:***

  As per the census 2011, the population of city has crossed the mark of 10 Lakh. The population density during the last 5 decades (1961-2011) has increased 9 fold, from 1051 to **9252 persons per sq. Km**. Due to the high economic status; the city has the largest density of vehicles (**878 vehicles/1000 people**) also, which is one of the main contributors to the RSPM level. Frequent braking and idling at light points; resulting in higher emission of pollutants. Moreover unmanaged diesel auto rickshaw and buses also adding up to the problem.

- ***Transportation Load in the city:***

  With the increase in population the need of travel facilities has also been increasing. People used to travel daily to the city from adjoining Haryana, Himachal and Punjab and enter Chandigarh from Zirakpur, Panchkula, Mullanpur, and Mohali. It was estimated that Chandigarh has nearly 5471 registered and about 3000 unregistered auto-rickshaws (including LPG/CNG) running daily throughout the city. It was estimated that nearly 5000 diesel auto-rickshaws join the city traffic daily including the auto from the neighbouring Haryana and Punjab.

  As per the information obtained from the RLA department, Chandigarh; more than 3,18,000 four wheelers, 4494 buses, 8243 goods vehicle and more than 6,05,800 two wheelers were registered with the city till year 2013.
  The Govt. Road transport is also packed with a huge vehicular load, as the CTU only has around 417 buses (209 on local route) running around 16 hrs/day throughout the city. Whereas the total bus movement in the city (including other sate transport) is about 1900 per day. The distribution of buses coming from the other states is as below:

State of ENVIRONMENT Chandigarh - 2014

Transport All State Buses

Depot	ISBT Sector 17	ISBT Sector 43	Total No of Buses
AC Private Integral Buses	-	77	77
Haryana	472	146	618
HRTC	83	166	249
J & K	-	5	5
PRTC	29	278	307
Punjab	79	481	560
Rajasthan	14	2	16
U.P	3	3	6
Uttrakhand	23	9	32
Total	703	1167	1908

As per the national summary report 2010 (CPCB) the total contribution of vehicular exhaust of any city adds up 15 70% of the total PM_{10} level, depending upon the density of vehicles and weather conditions, out of which the main contributors (56%) are diesel vehicles including buses, trucks and auto-rickshaws. (*Bangalore is the only city with highest PM contribution coming from vehicular sector with 41%. Pune with 61 % and Chennai with 72 % show the highest percent contribution from road dust. Pune has the lowest industrial contribution (1-3%) as it has mainly engineering industries and also most of them are outside the city boundary*).

The proposed action plan to control particulate pollution (high $RSPM_{10}$):

1. Control over Diesel locomotives:

- Transportation is one of the main causes of RSPM at any place. Chandigarh has very high density of diesel based auto (including from the nearby states) and public transport buses. There should be a strict regulation over the diesel auto in Chandigarh and their replacement should be done from CNG/electricity based auto-rickshaws.
- Moreover, suitable action should also be taken against the highly polluting/unmaintained vehicles.
- Overloading of the public transport mainly auto rickshaw, should also be checked strictly.
- New projects (under/over pass bridge) for the traffic bypass should be initiated for the hustle free and smooth travel in the city and to avoid excessive fuel burning by the traffic jams occurred due to traffic lights and roundabouts.

2. Control over Pollinating Vegetation:

- A thorough study is required for the quantitative and qualitative analysis of the pollinating trees available in the city and their capacity of pollination.
- Quantification of the extent of RSPM addition by the pollinating trees should also be done.
- Further, the plantation of identified species of plants should be avoided and suitable measures should be taken for their possible replacement.

3. Control over highly Polluting Industries:

- Quantification of the emissions of each industry can help to locate the highly polluting units and control the pollution caused by them.
- Industries should also submit data on the source of emission (whether boiler or furnace or cupola etc) boiler capacity, type of fuel used, fuel consumed per day, number of working hours per day, and quantity of emissions of all pollutants (SOx, NOx, RSPM).

4. Sensitisation of the nearby Industrial States:

- Chandigarh, being a small city surrounded by the big industrial hubs, is very much affected by the high RSPM levels of the nearby cities. Therefore, they should be sensitized against the issue and coordinated to initiate necessary steps to control the situation.
- Uncontrolled stubble burning in the nearby agriculture area should also be checked properly.
- Brick kilns are among the main pollutant emitting production units and are present in a high number across the city in the territory of Haryana, Punjab and Himachal. Particularly in winters, the coal consumption in these units increases gradually to maintain the temperature of boiler in cold climate; thus releasing excessive emissions of particulates in winters. Therefore, required steps should be taken to control such activities.

5. Awareness:

Time to time initiation of effective awareness programmes for the city residents, school children, colleges/university students, industrialists, and farmers should be done, to aware them against the detrimental consequences of burning fire crackers, waste leaves, waste paper & plastics, and stubble burning etc. by using different means such as:

- Printed materials such as newsletters, magazines, pamphlets etc
- Organising Mob shows, theatre plays
- Seminars and workshops
- Industrialists should also make aware about the health implications and environmental losses caused by the polluted emissions of their units.

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Administrative Initiatives

Chandigarh Administration has taken requisite steps to control the air pollution generation and to enhance the air quality of Chandigarh. As an initiative to clean air, Chandigarh is declared as smoke free zone. Nobody is allowed to smoke in public areas. Chandigarh is all set to become a solar city with installation of solar lights and state level energy park. Electricity generation from renewable sources is under research and proposal. Subsidies to battery operated vehicles and alternate sources of energy are granted.

City has strict regulation over the vehicular movement and the traffic rules. All routes throughout the city are occupied with the active & attentive traffic police officers who keeps a sharp eye on the traffic violators. Due to strict norms, the commuters used to follow all rules and keeps their vehicles up to date. In year 2014, only 16 challans has been issued for the vehicles violating pollution norms.

People in city beautiful are very sensitive about their health concerns and much aware of the ill effects of smoking. In year 2014 from Jan 1 to Dec 31, total 870 challans were fined for smoking at public places and total Rs. 1,74,000 were collected.

RESPONSES

A. Legislative & Policy Responses:

1. The entire Union Territory has been declared as 'air pollution control area' vide notification no. G.S.R. 71(E) [NO.Q-14012/87-CPA] dated 1st February, 1988 with the aim of exercising the powers conferred by sub-section(1) of section 19 of the Air (Prevention and Control of Pollution) Act, 1981, to reduce air pollution.

2. The Central Pollution Control Board was monitoring the Air Quality in Chandigarh from 1989 to 1992 and Chandigarh Pollution Control Committee was set up thereafter. The ambient air quality is currently being monitored by CPCC at five points.

3. The Environment (Protection) Act, 1986 & The Motor Vehicles Act, 1988 and rules notified there under and all other legislations of the central government are being implemented in the UT.

4. Directions have been issued u/s 5 of The Environment (Protection) Act, 1986 to the Municipal Corporation, as well as, other concerned institutions for doing organic composting to prevent burning of leaves and to prevent air pollution.

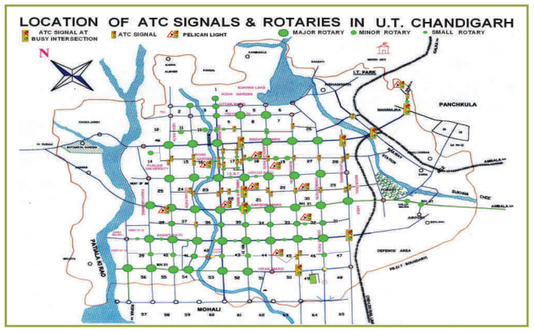
B Infrastructural Responses

a. Industrial Pollution Control:

1. The industrial zone is situated towards Southeast of the city in the leeward direction. Green rows and columns of mango trees separate it from the rest of the city. It is located ideally near the railway station for easy transportation of raw materials and goods. The IT Park of the city is located in a pollution free environment near the foothills of the mountains. Recently the Administration has acquired another 152 acres of land in revenue estate of Village Mauli Jagran for developing Phase-III of the Industrial area.
2. All the air polluting industries under Red Category in the Union Territory have installed air pollution control equipments.
3. No air polluting industry is allowed to operate in non confirming areas (outside Industrial area).

B. Vehicular Pollution Control:

1. Compulsory 'Pollution Under Control' (PUC) certificates for vehicles has been introduced by Chandigarh Traffic Police. Pollution monitoring facilities are available at most of the Petrol Pumps & Vehicle Repair Maintenance units in the city. As per data provided by the State Transport Authority, Chandigarh, 30 authorized stations are operative for issuing 'Pollution Under Control' certificates (PUC). Regular monitoring by the Traffic Police ensures reduced pollution of air from vehicles. 1142 challans were issued in year 2011. This ensures compliance.
2. Lead free petrol was introduced in Chandigarh in early 2000. This is expected to reduce lead pollution in air. Other clean fuels like LPG are also introduced in city. Chandigarh Administration has taken steps to promote battery operated vehicles which do not pollute while running on roads.
3. Many roundabouts which were facing traffic congestion problems especially during peak hours have been converted into traffic light points with timers and slip roads to ensure easy flow of vehicles. Moving one step further to grid based movements of traffic, Administration has closed rotaries connecting sector in the middle. 4. Cycle tracks have been developed along all major Margs and important Paths in Chandigarh. The Chandigarh Traffic Police has also started compulsory segregation of slow moving vehicles in separate lanes especially during peak hours.
5. Routes of HTV and interstate buses in the city are specified.
6. Chandigarh Traffic Police has also taken measures to ensure smooth moving of the traffic, reducing jams, and hence, minimizing wastage of fuel. Chandigarh wins the first place in India when it comes to roads' width. It is estimated that



RESPONSES

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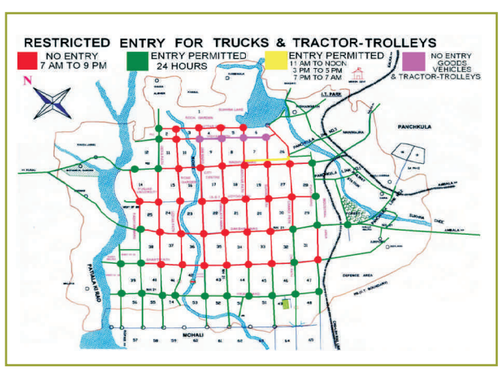
Chandigarh wins the first place in India when it comes to roads' width. It is estimated that Chandigarh has zero congestion level.



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5. Mass emission standards for new vehicles were notified in the country in 1991. In Chandigarh Bharat Stage II norms are applicable.

B. Infrastructural Responses

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7. To reduce incoming inter state buses within the city center, a new ISBT was set up in Sector 43 in 2002 which has started functioning to its capacity in year 2008. Thus, buses coming from other states do not interfere the local traffic.
8. The scooter repair market was shifted from sector 21 in the city center to sector 43 & 48 at the outskirts.
9. Metro DPR is approved and project is moving on.

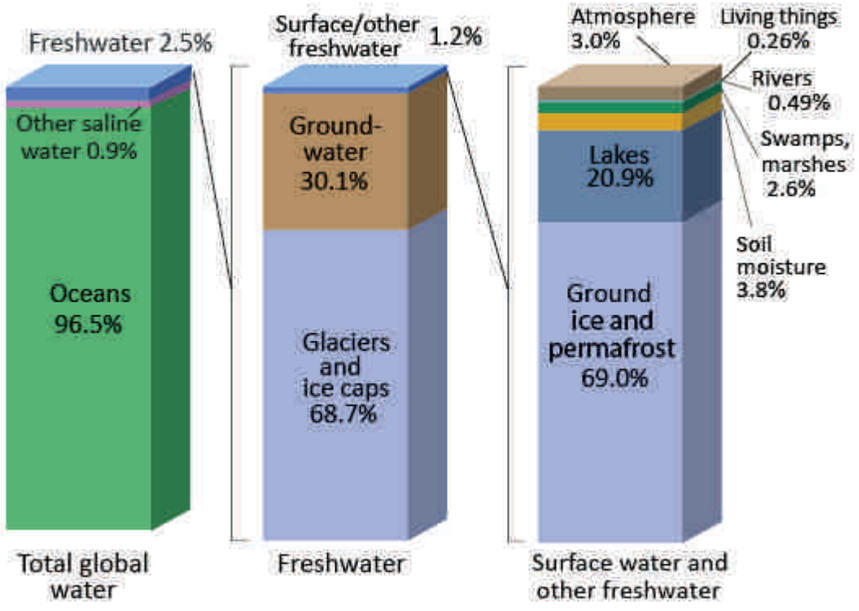
c) Air Pollution control from Municipal & Commercial Sources:

1. To assess the pollution caused by gensets in Chandigarh, a survey was conducted by CPCC. Notices were issued and remedial actions taken.
2. Burning of leaves has been banned by the Municipal Corporation. Composting is being promoted instead.
3. Burning has also been banned at the Chandigarh land fill site and regular compaction is carried out.
4. CPCC has closed down small kilns being operated at 8 Dhobhi Ghats and at Kumhar Colony (for baking clay pottery) and initiated disciplinary action against Junk Dealers burning plastic wastes. The Administration has modernized the Dhobi Ghats to control pollution.
5. Smoking has also been banned in Chandigarh.

WATER

Water, the essence of life, is essential for the survival of all forms of life on the earth. More than two-third part i.e. 70% of earth's surface is covered by water. Among this, 96.5% of water is found in the form of oceans which is salty and not fit for drinking. The remaining 2.5% is fresh water, out of which majority of water i.e. more than 68.7% is frozen in the form of glaciers or ice caps, 30.1% is ground water and nearly 1.2% is available as drinking water in the form of ground ice (permafrost), lakes, rivers, swamps, and soil moisture etc . Figure below shows the detailed distribution of total global water available into different forms and sectors. Its was studied that the major portion of the available water on the earth hardly participates in global water cycle, thus, remains preserved at their original place of existence. The only part of water used by the living beings is the cyclic water that undergoes different processes such as evaporation/transpiration, cloud formation, precipitation (snow/rain/drizzles/hails/dew/fog), soil infiltrations and ground water formation etc. Therefore, in conclusion, merely negligible portion of the total water on earth is accessible to the mankind and require very intelligent usage & least wastage.

Water Budget of Earth



Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, Water in Crisis: A Guide to the World's Fresh Water Resources.
NOTE: Numbers are rounded, so percent summations may not add to 100.

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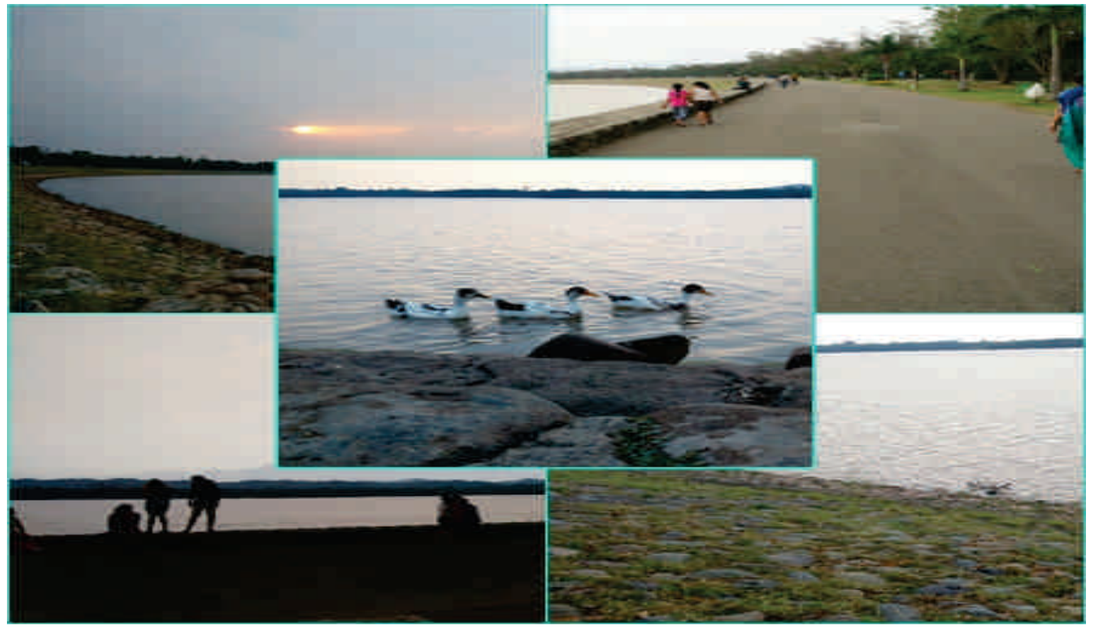


The present water supply service area of Municipal Corporations Chandigarh (MCC) is 114 km^2, which includes MCC area 79.34 km^2 and rural area of 34.69 km^2. The urban area falls in jurisdiction of Municipal Corporation and the water supply system is entrusted to Public Health wing of MCC. The rural area comprises of 13 villages overseen by the Engineering Department. The water supply to the villages is provided with tube wells in and around the villages. Other urban/rural areas have water source of 67 MGD from Bhakra Main Canal which is 27 km away from Chandigarh and 20 MGD from 239 tube wells located in the city. The transmission mains carry raw water from Kajuali to the water treatment plants located at Sector 39. At sector 39, the water is treated, disinfected and transmitted to 7 No. subsidiary water works located in Sectors 12, 26, 32, 37, 52 and Manimajra.

The average availability of water in Chandigarh is reasonably high at 332 Liters per Capita per Day (LPCD), stands second in the country after Goa (343 LPCD). Chandigarh gets 14.5 million gallons per day (MGD) water as its share from each phase of Kajauli water supply scheme. Chandimandir cantonment and Haryana is in process of installing its infrastructure for treatment and transmission of water. The net available water will be only 78.0 MGD if Haryana and Chandimandir Cantonment starts drawing it share of raw water from Chandigarh

STATUS OF GROUND WATER, Chandigarh

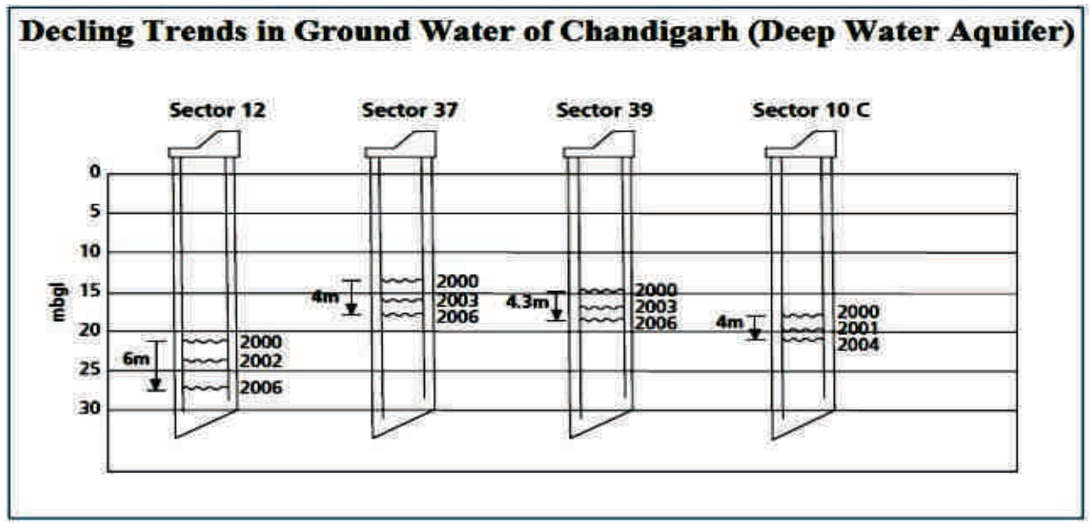
Status of Ground Water Level in Chandigarh Ground water level of Chandigarh has declined at a fast speed in the last decade. The data collected by the CGW, Chandigarh shows a gradual decrease in the total replanishable Ground Water Resources (3.636%)and the available ground water resources (3.645%).

Status of Ground Water	2004	2009	2013
Annual Replenishable Ground Water Resources (MCM)	2255 ham	2173 ham	2173 ham
Available Ground Water Resource	2030 ham	1956 ham	1956 ham
Balance Ground Water	2030 ham	1956 ham	1956 ham
Level of Ground Water Development	N.A.	N.A.	N.A.
Net Draft	N.A.	N.A.	N.A.
Provision for Industrial/Domestic and other uses & Natural Discharge etc	225 ham	217 ham	217 ham

Source: Scientist'D' & TS for Regional Director, Chandigarh

Ground Water in Deep Aquifers

Chandigarh is a rapidly growing city and in the last decade (2001-2011), its population growth rate was observed to be about 28%. Being one of the densely populated city (9252/sq km), its demand for water is estimated to grow steeply. It is estimated that by 2026, the water demand will be 523.41 MLD that is about 22.72% higher over the 2011 demand of 426.50 MLD. Due to excessive withdrawing and comparatively lesser annual replenishment, the ground water level of deep aquifers in Chandigarh has been suppressed on an average of 4m in 6 years at different locations throughout the city.



Source: National data centre, Central Ground Water Board, Faridabad (Haryana)

Chandigarh, experiences heavy rainfall during monsoonal season i.e. July to late September receiving average rainfall of 1059.3 mm, which is calculated to be 60380.1million litres or 13241gallons or 36.28 MGD per annum. As per the study conducted by Ground Water Board, Chandigarh this heavy amount of water seeps down to the aquifers and helps to recharge them remarkably.

Year	Pre-Monsoon Water Level Range	Post Monsoon Water Level Range	Units
2009	2.84-18.60	2.30-19.96	m bgl
2010	0.58-22.12	1.89-21.97	m bgl
2011	2.27-21.67	2.38-21.68	m bgl
2012	3.12-23.67	2.03-24.15	m bgl
2013	4.62-22.49	2.98-20.50	m bgl

Source: Scientist' D' & TS For Regional Director, Suprintending Hydrogeologist For Reg. Dir.GroundWaterB.Chandigarh

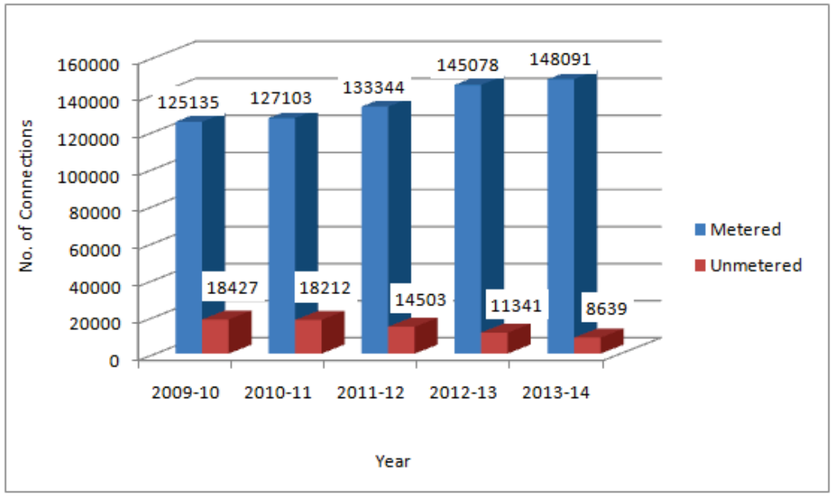
Status of Drinking Water in Chandigarh

The City has been divided into 7 zones for the purpose of distribution of drinking water, including town of Manimajra. The total installed capacity of drinking water from the four phases of surface source is about 67 MGD. Apart from the piped supply, about 20 MGD is also abstracted through deep bore wells with power pumps. Out of the total 156730 water connections,more than 94% connections are metered and flat rate connections are given to rehabilitated colonies. Besides there are 800 stand posts in the city 332 LPCD water is 10-12 hours.

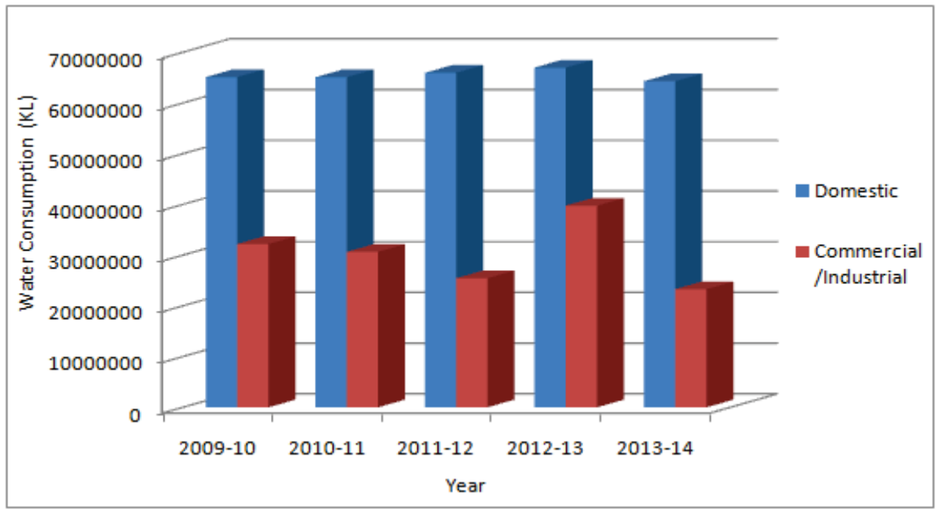
Source: Executive Engg., MCPH, Div 2, Chandigarh.
Superintending Engineer, MCPH Circle, Chandigarh. (M.C-17)

Water connections

The steep growth in the population had also increase the demand of water for the daily purposes. Water supply in Chandigarh is regulated by the municipal corporation of the city and it was calculated that the total water connections have been increased from 1,43,562 in 2009-10 to 1,56,730 in the year 2013-14. Regularization of the unmetered connections is also moving at a faster rate in the city.



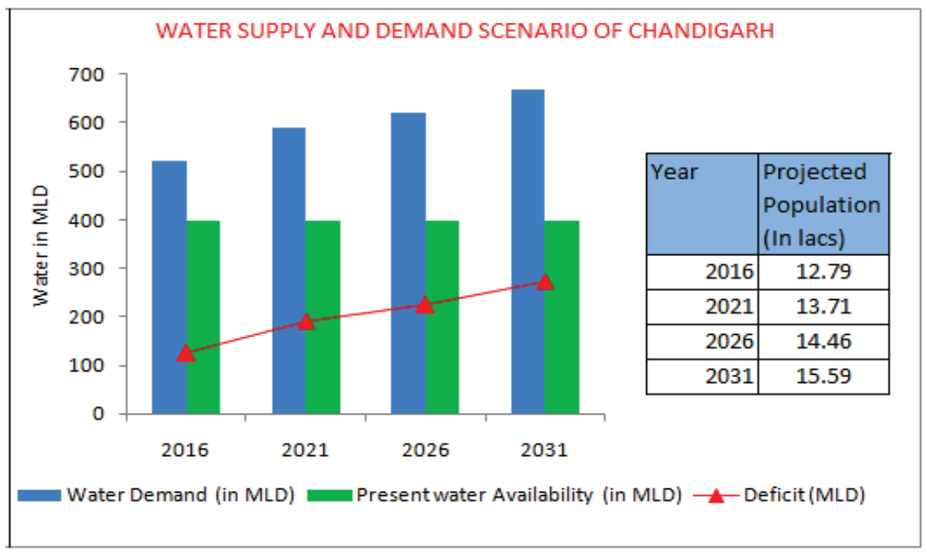
Water Consumption



Water Supply and demand Scenario

Year	Population in Lacs	Domestic Requirement @150 LPCD In MLD	Industrial Commercial @ 4000 gallon/ Acres/Day Area in Acres	Industrial Commercial Requirement in MLD	Community Institutional @ 4000 gallon/Acres/ Day Area in Acres	Community Institutional Requirement in MLD	Water Requirement: Requirement For Stand Post Lav Blocks MLD	Wastage Water Leakage %	Total Leakage MLD	Total Requirement	Horticulture Requirement @ 5400 Gallon /Acres /Day Area in Acres	Horticulture Requirement in MLD	Gross Requirement MLD
2011	10.55	158.25	1921.63	29.09	3048.5	46.15	20.07	15	38.04	291.60	6600	134.90	426.50
2016	12.79	191.85	1998.50	30.26	3170.44	48.00	24.43	8	44.18	338.72	6600	134.90	473.62
2021	13.71	205.65	2078.44	31.47	3297.25	49.92	29.77	8	47.52	364.33	6600	134.90	499.23
2026	14.46	216.90	2161.60	32.73	3429.15	51.92	36.29	8	50.68	388.51	6600	134.90	523.41
2031	15.59	233.85	2248	34.03	3566.32	53.99	44.19	8	54.91	420.98	6600	134.90	555.88
2036	16.95	254.25	2338	35.40	3709	56.15	53.86	8	59.95	459.61	6600	134.90	594.51

Table of the total water availability of Chandigarh and the possible projection of its demand in near future :



Year	Projected Population (In lacs)
2016	12.79
2021	13.71
2026	14.46
2031	15.59

According to Bureau of Indian Standards (BIS) code 1172-1993 the per capita water requirement for the cities with habitations more than 100,000 with full flushing systems require 150-200 Liters per day. This may come down to 135 Liters per capita for Economically Weaker section of the society. In this context, Chandigarh is providing more water per capita than required.

Water demand based on the current population (census 2011, 10.55 Lakh) is around 426.50 MLD. This includes 158.25 MLD for domestic consumption, 29.09 MLD for commercial or industrial demand, 46.15 MLD for community institutional demand, 20.07 MLD for standpost lavatory blocks and a wastage of water, nearly 15%, stands at 38.04 MLD. In addition horticultural water demand is 134.90 MLD.

GROUND WATER

Water is used for various domestic and commercial purposes that includes drinking water and for washing of cars also. It may be used for irrigation or processing of ore. Quality of water is the reflection of wide variety of chemical and biological constituents present in it. The quality is beneficial when these constituents are present within desirable levels. Bureau of Indian Standards (BIS) and US Federal Water Pollution Control Administration, 1968 have specified concentration limits of various constituents for waters for different uses, such as domestic, agriculture and Industrial.

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Just like a processed poison is a medicine and unprocessed medicine is a poison; medical researchers have established that presence of some constituents in drinking water, in small amount, are essential for living beings, whereas in large concentrations, those are injurious to human health. Based on these considerations, Bureau of Indian Standards (BIS) has prescribed limits for various physical, chemical, biological, and radio nuclides for waters used for drinking purposes. Limits for some constituents have been extended to maximum permissible levels; uses of these waters are permitted only in the absence of an alternative source with desirable concentrations.

CPCB has described the water quality in following table (DBU Classsification):

Drinking Water Source without conventional treatment but after disinfection	A	• Total Coliforms, Organisms, and MPN/100ml shall be 50 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 6mg/l or more
Outdoor bathing (Organised)	B	• Total Coliforms, Organisms, and MPN/100ml shall be 500 or less • pH between 6.5 and 8.5 • Dissolved Oxygen 5mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Drinking water source after conventional treatment and disinfection	C	• Total Coliforms, Organism, and MPN/100ml shall be 5000 or less • pH between 6 to 9 • Dissolved Oxygen 4mg/l or more • Biochemical Oxygen Demand 5 days 20°C 3mg/l or less
Propagation of Wild life and Fisheries	D	• pH between 6.5 to 8.5, Dissolved Oxygen 4mg/l or more • Free Ammonia (as N) 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste Disposal	E	• pH betwwn 6.0 to 8.5 • Electrical Conductivity at 25°C • micro mhos/cm Max.2250 • Sodium Absorption Ratio Max. 26 • Boron Max. 2mg/l

GROUND WATER QUALITY TESTING

CPCC takes samples of ground water from various locations of Chandigarh to test and report. Following is the test report for recent years of ground water in Chandigarh:

Ground water Sample Collection by CPCC

Water Quality

Every house of the city has access to the clean drinking water supplied by the municipal corporation during the regular periods of time everyday. Due to small agricultural fields, the use of harmful chemicals such as pesticides is also very controlled in the city. Thus the water quality of the Chandigarh lies with in the limits as prescribed by the BIS standards of drinking water. Water analysis conducted by the Central Ground Board of the shallow and deep aquifers of the city shows the absence of any impurity including heavy metals.

Year	Field	Pb	Cd	Mn	Fe	Cr	As	Units
2013	Water Samples of Tubewell	0.000-0.022	0.004-0.007	0.003-0.360	0.000-2.89	-	<0.01	mg/l
2013	Water Samples of Hand Pump	0.000-0.110	0.004-0.006	0.001-0.800	0.100-3.430	-	-	mg/l
2013	Water Samples of Tap Water	0.009-0.015	0.006-0.007	0.000-0.030	0.130-1.390			mg/l

Source-: Central Ground Water Board, North Western Region, Chandigarh.

Data of Drains/ STP for the month of February 2013

Source: CPCC, Chandigarh

No ground water from shallow tubewells in Chandigarh is prescribed as drinkable. MC discourages use of handpumps for drinking water. Hand pumps in markets serve other purposes of the use of water. These Handpumps are painted red to indicate the same. MC has given potable water supply to various sections of market/commercial places which is for hours in a day.

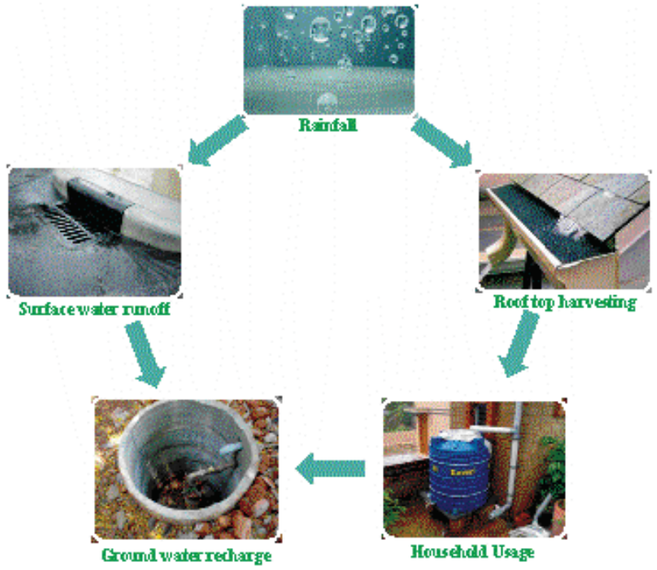
CPCC, Chandigarh taking water samples for testing

Conservation of Water:

Water conservation means protecting our water resources from pollution and being wasted. It is important because plants, humans and animals all need water to survive. Without water, the earth would have no life. Due to consistent water resources, but increasing population and demand of water; the city beautiful has also been practicing water conservation by following different conservation strategist.

Rain Water Harvesting

Rain water harvesting (RWH) for recharge augmentation is among the major activities being taken by the Central Ground Water Board for the effective implementation of demonstrative schemes. With the exponentially increasing demand of water resources due to escalating population, the city beautiful“Chandigarh”, has also implicated the scheme at the remarkable speed in a very short span of time. The rainwater harvesting potential of Chandigarh, with an area of 114 sq km and the average annual rainfall of 1059.3, is calculated to be 60380.1million litres or 13241gallons or 36.28 MGD. Thus, the potential is more than the water pumped out of aquifers and therefore, efficient harvesting of rain water and proper recharging of ground water will go a long way in contributing towards sustainability of water supply.



LIST OF ARTIFICIAL RECHARGE SCHEMES IMPLEMENTED IN CHANDIGARH

1. Scheme of rooftop rainwater harvesting at CSIO Complex, Chandigarh (1998-99).
2. Artificial recharge to ground water under central Sector scheme in Panjab University, Chandigarh (2000-2001).
3. Artificial recharge to ground water in Leisure valley, Chandigarh (2000-2001).
4. Scheme for roof top rainwater harvesting at Bhu-Jal Bhawan Chandigarh (2001-2002).
5. Artificial recharge to ground water at office of Chandigarh Housing Board in sector 9, Chandigarh (2001-2002).
6. Scheme for rain water harvesting at DAV School in Sector-8, Chandigarh (2001-2002).
7. Artificial recharge to ground water at TTTI, Sector-26, Chandigarh (2001-2002)
8. Scheme for utilising surplus water monsoon runoff for sector 27,19,30,20, Chandigarh (2001-2002).

Details about the installed capacity of the schemes:

No. Of Units	Type of scheme	Total annual Capacity (Lakh Cubic meter)
6	Roof Top Rain Water Harvesting	0.144-0.13
1	Roof Top & Pavement catchments Rain Water Harvesting	34.50
1	Recharge Trenches	9.50

Area wise Rain Water

Chandigarh has a total rain water harvesting capacity of more than 70% of the total land area.
The total capacity of water that would be available for recharge annually is:
58 sq km (area) x 1059.3 (rainfall) x 0.5 (rainfall coefficient) = 30,720 million lt

From Roads	15.89 sq. km
From the Rooftop of Residential area	30.19 sq. km
From Public and Institutional Buildings	7.94 sq. km
From Shopping area	3.97 sq. km

To reduce dependence on ground water a short term legal frame work has been laid by the Administration to make provisions for rain water harvesting mandatory while granting the additional covered area to all plots above 500 m^2 area.

Recycle and Reuse of Water:

Under the JNNURM, the MCC has already set in motion a process to treat and reuse sewage water for horticultural purposes. Chandigarh is unique because it has huge demand for water for horticulture purposes. The total water demand for horticulture purposes is 20 MGD. To reduce its pressure for fresh water, a tertiary treatment (TT) plant was set up in Diggian in 1991. Distribution system has been laid to distribute this treated water for the green areas in Sectors 1-12 and Sector 26. At present 7 MGD of TT water is being distributed through pipe lines to green areas in Sectors 1-12 and Sector 26.

Chandigarh administration aims to achieve reduced dependence of ground water by 50

Tertiary treated water supply for irrigation of gardens, green belts and houses up to 1 kanal -

In order to conserve the fresh water, tertiary treated water could be used for irrigation purposes for gardens, green belts etc. A project Tertiary Water Supply for irrigation of green belts in Chandigarh City was conceived in the late 80's & the first 10 MGD Tertiary Treatment Plant for treating sewage already treated up to secondary level to Tertiary level was commissioned in year 1991. Under this project, Pre-stressed Pipes (PSC) was laid from STP at Diggian (Phase XI, Mohali) to Rajindra Park, Sector -1 Chandigarh for carrying Tertiary Treated water to City for irrigation of gardens, green belts & lawns. Along with this skeleton distribution network for supplying Tertiary treated water to multi kanal houses in about 10 Sectors was laid. Initially, the requirement of the water in these Sectors was limited to 3 to 5 MGD as limited pipe network was laid. In order to utilize 10 MGD capacity of Tertiary treated water, a 2nd Project for Tertiary Treated Water Supply line was aged and executed in the year 2005 and the same was completed in the year 2007.

Sewerage System and Sewage Treatment in Chandigarh -

Chandigarh city is fully covered with sewerage facility. Out of 87 MGD water being supplied to the residents of the city, 67 MGD sewage effluent is being generated. It is on the way of becoming the only city in India with 100% sewage treatment in the near future. Presently, the capacity of Sewage Treatment Plants (STP) in the city is 56.25 MGD and another 10 MGD STP is under construction which is likely to be commissioned by this year ending 2012.

Municipal Population	10.54 Lacs
Volume of Domestic & Industrial Waste Water Generated	57 MGD (Approx.)
Treated waste water	53.85 MGD
No. of STPs	5
Capacity of Each STP	16 MGD – 3 BRD 5 MGD – Raipur Kalan 30 MGD – Diggian 1.25 MGD – Raipur Khurd 1.6 MGD – Dhanas **Total : 53.85 MGD**
Proposed STPs	1.7 MGD at Khuda-ali-sher. 15 MGD is under renovation at Diggian, Mohali. **Total: 16.7 MGD**
Mode of Disposal	Natural Choe for all except Diggian. Diggian STP effluent goes to Irrigation Channel