

DEHRADUN CITY AIR ACTION PLAN (Second Revision)



PREPARED BY:
**UTTARAKHAND POLLUTION CONTROL
BOARD, DEHRADUN**



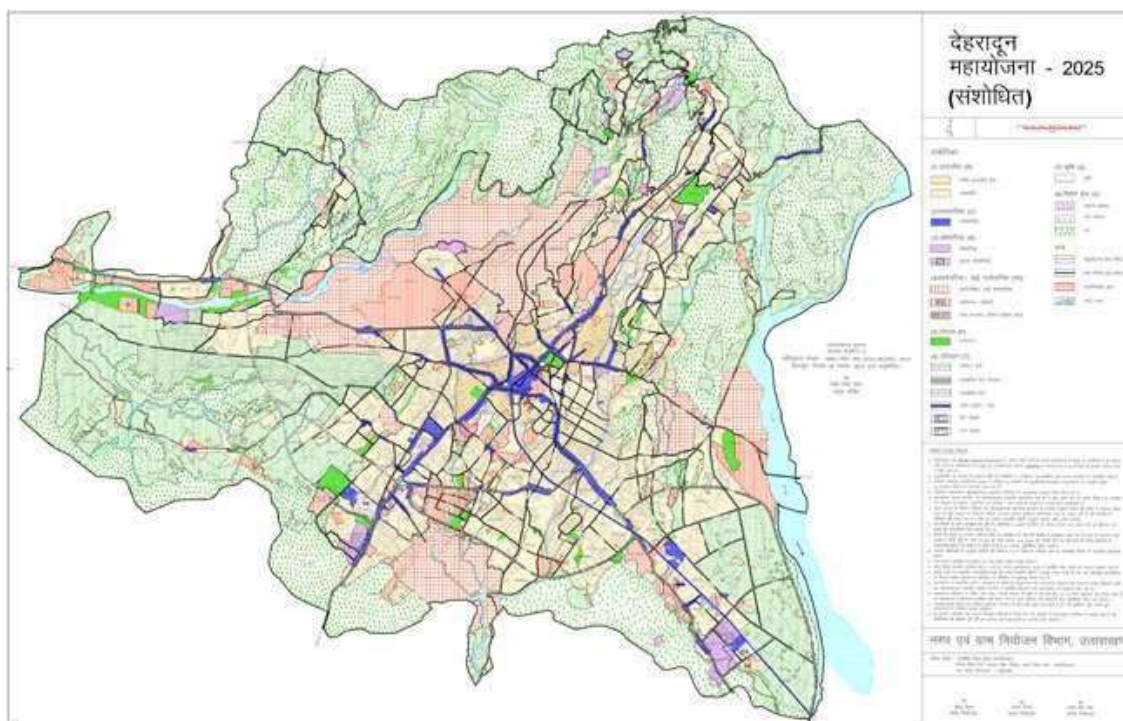
उत्तराखण्ड शासन

APPROVED BY:-
**AMBIENT AIR QUALITY MONITORING
COMMITTEE**
GOVERNMENT OF UTTARAKHAND
CONSTITUTED IN COMPLIANCE OF HON'BLE NGT ORDER
IN OA NO 681/2018

Contents

Background.....	3
Why Clean Air Action Plan?	5
Dehradun City Clean Air Action Plan-Need Assessment.....	6
Emissions Inventory for DehradunIn2016-2017	8
Clean Air Action Plan for Dehradun City	9
Financial Layout	20
Annexures	21
Disclaimer	32

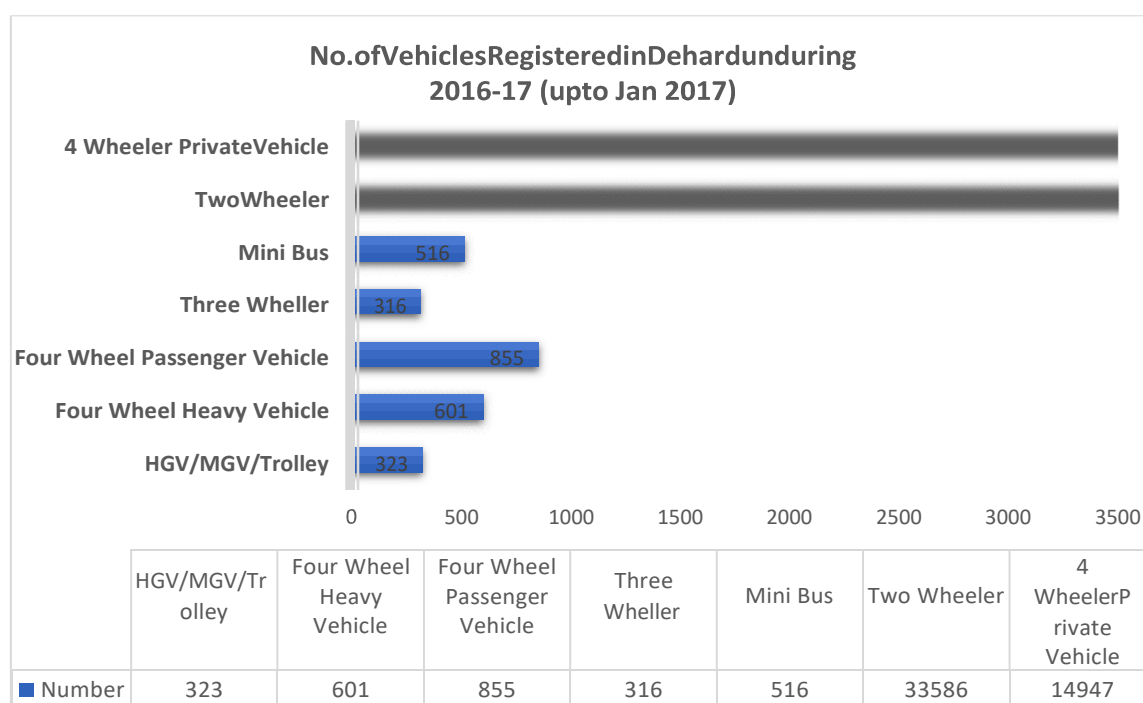
I. Background



Dehradun, the capital of Uttarakhand is positioned in the fertile region of the Doon Valley between the rivers Yamuna and Ganga. The city is spread over an area of 64.4 Sq. Km with a population of 569,578 as per the census of 2011. The city's population density is 8633/km² with a decadal population growth rate of 37.4%. With a steady rate of population growth and urbanization there is increasing pressure on resources in the city and the air quality of the city has been steadily deteriorating. More than three decade ago, air pollution was discussed in the context of limestone mining, but this was banned in 1986 by the Hon'ble Supreme Court, and Government of India restricted developmental activities by enacting Doon Valley Notification, 1989.

There are reports including the Greenpeace report, Apocalypse 2017 that states that city's annual average PM₁₀ levels was more than thrice the permissible limit making Dehradun city in Uttarakhand an entrant in the list of 10 worst cities with an annual average of 238 µg/m³. The report also suggests that these top most polluted cities need to improve monitoring and management of air quality and a stricter time bound air action plan is the need of the hour. At present Dehradun city has three stations to measure PM₁₀ levels. However, PM_{2.5} level is being measured since January 2019 only. According to the Central

Pollution Control Board (CPCB)’s report on air quality index of 273 cities, released in January 2018, Dehradun stood at 241 (Times of India; 12th April 2018). Further, another study conducted by Pollution Control Research Institute (PCRI), Bharat Heavy Electronics Limited (BHEL) Haridwar during 2016-17 on behalf of Uttarakhand Pollution Control Board, it was found that the level of PM₁₀ and PM_{2.5} was much higher than standard values. Today, vehicular emissions are being discussed as the main source of air pollution. According to the road transport authority, only 10,000 vehicles were registered in Dehradun between 1937 and 1967. At present, there are more than 126,452 vehicles plying on the roads with more than 100,000 of these are two-wheelers. However, the length and width of roads have increased only marginally.



A study by the Dehradun-based People's Science Institute (PSI), a non- governmental organization, says that the high levels of pollution in Dehradun are mainly due to natural dust and particulate-laden smoke from diesel-fuelled vehicles, especially vikrams, trucks, buses and three-wheelers. Another cause for concern mentioned in the same report are two-wheelers.

II. Why Clean Air Action Plan?

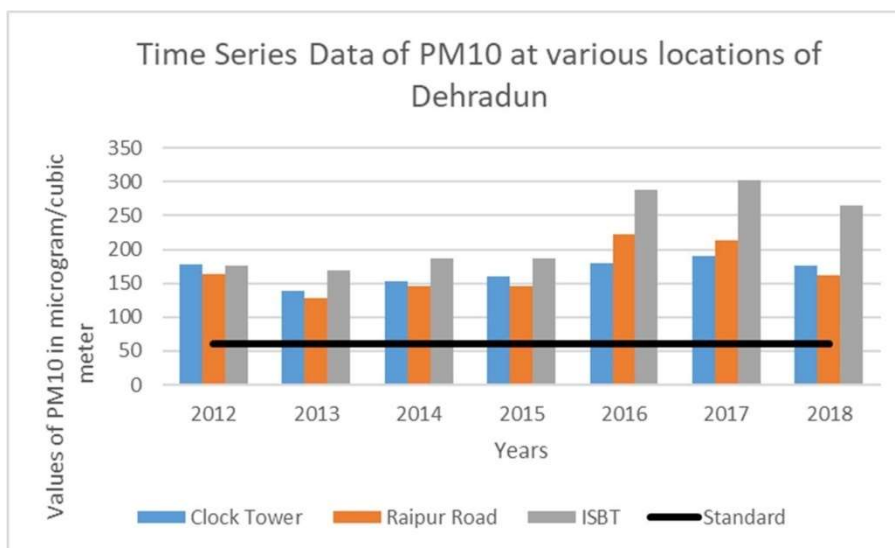
India with an emerging economic development faces enormous challenges when it comes to maintaining pace with the burgeoning population and parallel increase in urban development. This has been the scenario not only in mega cities but also in medium and small sized urban areas for the past many years now. Studies indicate that multiple factors are responsible for air pollution that emerges from sectors like power, transport, industry, residential, construction and waste. Despite having national standards and checks for various sources of emissions, many Indian cities are suffering from alarmingly high rates of air pollution emissions. While India has specified national ambient air quality standards, many cities have not been able to meet these standards. It is in view of this and the growing demand for clean air, the central government under the National Clean Air Programme (NCAP) announced a comprehensive plan to overcome the challenges in over a hundred non-attainment cities. The objective of the proposed clean air action plan is to meet the prescribed annual average ambient air quality standards at Dehradun City in a stipulated timeframe. Within the Clean Air Action Plan the NCAP suggests the following actions:

- To augment and evolve effective and proficient ambient air quality monitoring network across the country for ensuring comprehensive and reliable database
- To have efficient data dissemination and public outreach mechanism for timely measures for prevention and mitigation of air pollution and for inclusive public participation in both planning and implementation of the programmes and policies of government on air pollution
- To have a feasible management plan for prevention, control and abatement of air pollution. It has been proposed under the NCAP that the city action plans need to be guided by a comprehensive science-based approach involving
 - (i) Identification of emission sources;
 - (ii) Assessment of extent of contribution of these sources;
 - (iii) Prioritizing the sources that need to be tackled;
 - (iv) Evaluation of various options for controlling the sources with regard to feasibility and economic viability; and
 - (v) Formulation of action plans.

III. Dehradun City Clean Air Action Plan- Need Assessment

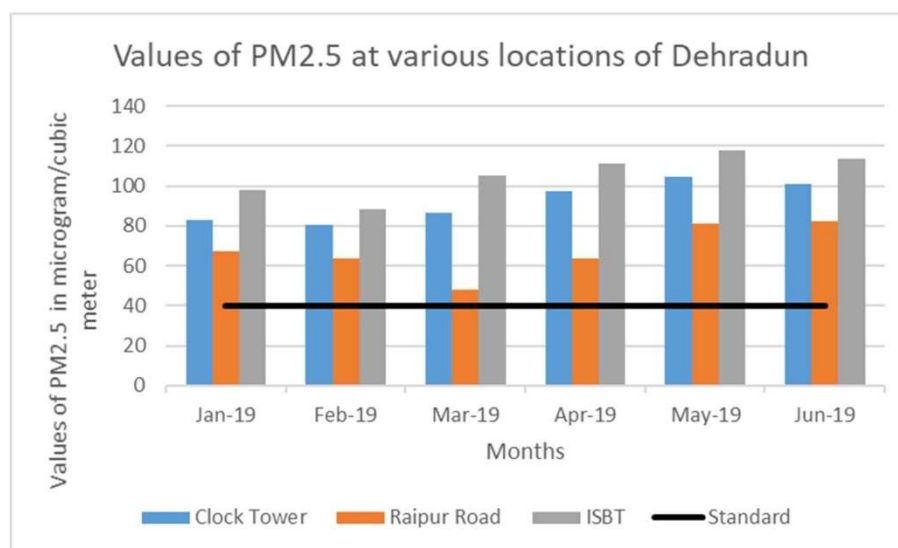
Air pollution is an intrinsically complicated issue that varies from city to city. In other words, air pollution is not just about the level of pollutants in a city or the number of monitoring stations, or city level policies, or health impact studies or rigorous scientific assessments to determine the sources of air pollution such as emission inventories or source apportionment studies, but a composite of all these features. Moreover, it is a well thought out combination of all these factors that can together systematically and sustainably address the issues of air pollution, or what can be called air quality management (AQM). AQM refers to the entire process of protecting the air quality of a city, region or nation. The process involves determining emission sources, assessing air quality status and its impacts and formulating and implementing solutions that are effective and target main pollution sources. While various tools exist to measure environmental performance, there is no generally accepted methodology for an objective, comprehensive assessment of a city's management of air pollutants and greenhouse gas emissions that also identifies areas in which it has improved.

There are 03 manual ambient air quality monitoring stations at Dehradun being operated by Uttarakhand Pollution Control Board (UKPCB). The monitoring stations calculate the ambient air quality of three pollutants – PM₁₀, NO_x and SO_x. PM_{2.5} is being monitored since January 2019. Based on ambient air quality levels the pollutant of concern is PM₁₀ & PM_{2.5}.



As the monitoring stations are manual, real time air quality data for the city is not available, so calculation of air quality index (AQI) is difficult. An AQI is defined as an overall scheme that transforms weighted values of individual air pollution related parameters (PM_{10} , $PM_{2.5}$, SO_2 , CO , visibility, etc.) into a single number or set of numbers. Specifically, it establishes the relationship between human exposure, health effects and air quality. This is aggravated by the fact that there is a dearth of city specific air quality health effect studies and assessments for Dehradun.

Such assessments are important when it comes to framing policy and taking city specific decisions. The Clean Air Management Capacity Index brought out that there is a lack of city specific source apportionment and emissions inventories. Source apportionments and emissions inventories are the technical assessments that allow for an identification of sources that are affecting the air quality in varying degrees in a specific region. A source apportionment study is an important tool in framing policy as every city has different sources of air pollution depending of city specifics such as levels of urbanization, land use patterns and topology. For instance, Dehradun is prone to the temperature inversions which affect air pollution because they change the dynamics of air movement. Further, industry is not a major cause of air pollution in the city as red category industries are not allowed to operate in Dehradun. This is an important factor when framing policy and determining air actions. Thus, there is a need to increase and invest in source apportionment studies, emission inventories and increasing the monitoring framework in the city to include real time monitoring stations.



The Clean Air Policies and Actions Index brought out that though there are policies in place there is a need to facilitate collaborations across departments at the city level so that air quality actions can be mainstreamed in all urban development related decisions. A clean air action plan is one of the main means to achieve this co-ordination and systematic action.

IV. Emissions Inventory for Dehradun in 2016-2017

Uttarakhand Pollution Control Board engaged PCRI in 2016 PCRI to undertake an intensive study to measure baseline pollutants and air toxic levels at different locations of Dehradun city which includes residential, industrial, background (reference), commercial and sensitive areas. The study included monitoring ambient air quality for 30 days continuously in three seasons (summer, post-monsoon and winter) at seven identified locations in the city where air monitoring stations were installed. The summer season study was carried out from 15-06-2016 to 14-07-2016. The post monsoon season study was carried out from 1-11-16 to 30-11-16 and winter season was carried out from 9-12-16 to 28-01-17. The seven sites were selected to cover ambient air quality near roadsides, residential, commercial, industrial, outskirts, commercial and sensitive areas. The seven sites are

- i.) Ghanta Ghar – Center of the city.
- ii.) ISBT – Main bus terminal of the city.
- iii.) ONGC/FRI – Research institutes with expanse of green area.
- iv.) Survey Area – Busy area with high vehicular population.
- v.) Rajpur Road – Commercial Area.
- vi.) Raipur – Residential area.
- vii.) Wild Life Institute of India.

The pollutants monitored at all seven sites were - SO₂, NO_x, CO, PM₁₀ and PM_{2.5}. Additionally, in order to get a wider cross-section of vehicles in-use/on-road, a systematic survey of vehicle population in the city was undertaken at the following sites: i. Ghanta Ghar – Center of the city. ii. ISBT – Main bus terminal of the city. iii. ONGC/FRI – Research institutes with expanse of green area. iv. Survey Area – Busy area with high

Vehicular population. All emission factors used for assessment were those approved by the CPCB or the Automotive Research Institute of India. Results of the Emission Inventory are presented in detail in **Annexure-1**.

V. Clean Air Action Plan for Dehradun City:

City: Dehradun

Pollutant of Concern: PM 10, PM 2.5

Main Sources: Vehicular emissions, re-suspended dust, construction and demolition activities and municipal solid waste burning.

Air Pollution Levels: Details of air pollution as carried out by PCRI on behalf of UEPPCB during 2016-17 in given at Annexure 2

Type of Action: The recommended action has been designated as either policy, regulatory or implementation. Their explanation is given below.

- a. Policy Action: This refers to an action that requires the framing of a new policy at the city or state level.
- b. Regulatory Action: This refers to an action that requires better/different implementation of an existing policy or rule.
- c. Implementation Action: This refers to an action that requires local execution of an activity.

Time Period of Implementation: Depending on estimated time for implementation of the action the time periods were divided into Immediate (Within in 06 months) short Term (by 2022), medium term (by 2025) and long term (by 2030). The time period for the Clean Air Action Plan is envisaged as 2020-2030- (10 year period).

Detailed Action plan for improvement of Air Quality of Dehradun
Executing Agencies and implementation time frame

<u>Action</u>	<u>Agency Responsible</u>	<u>Type of Implemen tation</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Data Research and Management of Air Quality				
Air Quality Monitoring to be strengthened by installation of real time sensors and monitors <u>Implementation</u>	Uttarakhand Pollution Control Board (UKPCB)	Short	Within 06 months from approval of Plan	Besides the 3 manual monitoring stations, 03 CAAQMS to be installed (as per guidelines of CPCB on networking of air quality monitoring stations). 2 CAAQMS to be provided by CPCB.
Capacity building on how to strengthen air quality management for the city to be carried out for all departments that are involved in city administration. <u>Implementation</u>	UKPCB	Short	Within 06 months from approval of Plan	Capacity building needs to be identified by UKPCB and training organized.
Centre of Excellence on air quality to be set up by pooling in all technical organization in the city. The technical organization will promote and aid the city administration and UKPCB in undertaking air quality research <u>Policy</u>	UKPCB and designated institutions	Mid	March 2023	This will require a coordinating agency to facilitate the process
Emission Inventory and Source Apportionment Study <u>Implementation</u>	UKPCB	Mid	March 2023	This study will help to find the exact source of pollution at designated places.

<u>Type of Action</u>	<u>Agency Responsible</u>	<u>Type of Implemen- tation</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Vehicular Emission				
A city-wide drive will be launched to check and curtail polluting vehicles <u>Implementation</u>	Transport Department Traffic Police Municipal Corporation	Immediate	Within 3months from date of approval	Checking underway by transport department. Traffic police and MC need to be empowered and capacity built for the same. Sensors can be acquired under smart city programme to track polluting vehicles and penalize owners of polluting vehicles.
A public awareness campaign will be launched to inform the public about anti-idling measures, vehicle maintenance, eco-driving, use of public transport etc. <u>Implementation</u>	District Administration Municipal Corporation Transport Department UKPCB	Short	Within 06 months from approval of Plan	Civil society and citizen groups, educational institutes will be involved.
Prevent parking of vehicles in non-designated areas. - Determination of hotspots to launches action in phased manner. - Determine best strategy for positive outcome. - Branch out to other parts of the city <u>Regulatory</u>	Transport Department Traffic Police Municipal Corporation	Short	Within 06 months from approval of Plan	8.5 lakhs vehicles in the city (floating population is added to this is tourist population), roads are narrower, thus roadside parking is leading to congestion. Designated areas for parking are inadequate.
Checking for fuel adulteration periodically and random checking of fuel to be initiated. <u>Implementation</u>	Transport Department District Administration Civil Supply Department Oil Companies	Short	Within 06 months from approval of Plan	
Plan to be prepared for widening of busy roads and de-congestion of traffic. <u>Policy</u>	Municipal Corporation Public Works Department (PWD) Mussoorie Dehradun Development Authority (MDDA) Smart City	Mid	March 2023	Can be taken under Smart City Mission.

Expressway/bypass and flyovers to be built to decrease vehicular congestion. <u>Policy</u>	PWD Smart City	Long	March 2026	
Battery operated vehicles and e-rickshaws to be introduced. - Determination of areas that most need last mile connectivity to initiate launch. - Determine need and capacity for city. - Launch more e-rickshaws accordingly. <u>Implementation</u>	Transport Department	Short	Within 06 months from approval of Plan	Underway
Public Transport to move to cleaner fuels such as CNG in a phased manner. <u>Policy</u>	Transport Department	Mid	March 2023	
Better traffic management/ intelligent traffic system to be launched for monitoring and de-congestion (Smart Traffic) <u>Regulatory</u>	Transport Department Urban Development Department District Administration Smart City	Mid	March 2023	Can be integrated within the Smart City Mission
Restriction on plying and phasing out of 15 years old commercial diesel driven vehicles. <u>Policy</u>	Transport Department	--	--	Presently 3098 commercially driven Diesel Vehicles and this number will increase upto 3197 in next 05 year. However, Ban on diesel driven vehicles is under the preview of the Central Government.
Use of cleaner fuels (CNG/LPG) for commercial passenger vehicles <u>Implementation</u>	Transport Department Civil Supply Department Oil companies	Mid	March 2023	After introduction of CNG/LPG driven vehicles, old diesel driven vehicles will be replaced in phased manner.

Regular checking of vehicles and Establishment of adequate number of Pollution Checking Centers to issue PUC (Pollution Under Control Certificate) <u>Regulatory</u>	Transport Department Traffic Police	Short	Within 06 months from approval of Plan	It is policy of Transport Department to allow to run PUC centers at no cost if the person willing to do it with its own resources. Transport Department will make it mandatory that the all Government Departments must have to have their vehicles checked and get PUC in time. Also, surveillance will be increase. After increase in demands, the number of PUC centers will automatically be increased. Transport Department will also do the vehicle checking by Mobile Laboratories. Which are to be procured. Total no. of PUC centers established in last six months in dehradun: 113 Total PUC certificates to vehicles in last six months: 134729
Integration of all Pollution Checking Centers with Single web based software for ensuring control & monitoring of polluting vehicles. Strengthening facility for enforcement regarding the vehicles involved in pollution emission. <u>Implementation</u>	Transport Department	Short	Within 06 months from approval of Plan	Software for this action is ready. Testing and Customization will be done in the given timeframe.
Monitoring on vehicle fitness of Commercial Vehicles <u>Regulatory</u>	Transport Department Traffic Police	Immediate	Within 3months from date of approval	
Periodic calibration test of vehicular emission monitoring instrument <u>Regulatory</u>	Transport Department	Short	Within 06 months from approval of Plan	
IR Cameras/on road remote sensing of vehicular emissions to detect polluting vehicles much like how the traffic police's camera detects vehicle number plate. <u>Implementation</u>	Transport Department Police	Mid	March 2023	This action point will help to catch the polluting vehicles and therefore, regulation on polluting vehicles can be made effectively.
<u>Action</u>	<u>Agency Responsible</u>	<u>Type of Implemen tation</u>	<u>Time Target</u>	<u>Remarks</u>

Source Group				
Re-suspension of road dust and other Fugitive Emissions				
Roads to be regularly monitored to ensure maintenance <u>Policy</u>	Municipal Corporation	Short	Within 06 months from approval of Plan	Digging of roads for multiple purposes by multiple agencies to be monitored/ approved at a single point/agency.
Green buffers to be introduced on either sides of traffic corridors <u>Implementation</u>	Municipal Corporation MDDA District Administration	Mid	March 2023	Grasses, shrubs and small flowering trees should be given prominence. Forest department can be engaged.
Greening of open areas, schools, gardens, community places and housing societies. <u>Implementation</u>	Municipal Corporation MDDA Forest Department Smart City	Mid	March 2023	Can be done under Smart City Mission
Ensure sidewalks are present in major parts of the city for pedestrians <u>Policy</u>	Urban Development Department Smart City, PWD	Long	March 2026	Can be done under Smart City Mission
Daily Cleaning of roads by Vacuum cleaning machines <u>Implementation</u>	Municipal Corporation	Short	Within 06 months from approval of Plan	Can be done under Smart City Mission
Creation of green lungs in the city through city forestation. <u>Implementation</u>	Municipal Corporation PWD MDDA Smart City	Mid	March 2023	Can be done under Smart City Mission

<u>Action</u>	<u>Agency Responsible</u>	<u>Type of Implemen tation</u>	<u>Time Target</u>	<u>Remarks</u>
<p style="text-align: center;">Source Group</p> <p style="text-align: center;">Open Burning of Municipal Solid Waste</p>				
Restriction on open burning of municipal solid waste, Biomass, plastic, horticulture waste etc <u>Implementation</u>	Municipal Corporation	Immediate	Within 3months from date of approval	Govt. of India with G.O. dated 29.12.2016
Immediate lifting of solid wastes generated from de-silting and cleaning of municipal drains for its disposal <u>Implementation</u>	Municipal Corporation	Short	Within 06 months from approval of Plan	To be lifted within 48 hrs
Transportation of municipal solid wastes, construction materials and debris in covered system <u>Implementation</u>	Municipal Corporation	Immediate	Within 3months from date of approval	

<u>Action</u>	<u>Agency Responsible</u>	<u>Type of Implemen tation</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Control of Construction and Demolition Activities				
Enforcement of construction and demolition rules 2016. <u>Implementation</u>	MDDA District Administration Municipal Corporation	Immediate	Within 3months from date of approval	
Water sprinkling, curtains, barriers and dust suppression unit to be used during all construction and demolition activities including covering the construction sites <u>Implementation</u>	MDDA District Administration Municipal Corporation	Short	Within 06 months from approval of Plan	Firstly, Will be implemented at sites having more than 10,000 sq. Mt. Covered area
Ensure construction material is transported and carried in close containers. <u>Implementation</u>	Municipal Corporation Transport Department Traffic Police	Immediate	Within 3months from date of approval	
Identification of designated place/ areas for disposal of demolition waste <u>Regulatory</u>	District Administration Municipal Corporation	Short	Within 06 months from approval of Plan	
Restriction on storage of construction materials along the road <u>Policy</u>	Municipal Corporation MDDA	Immediate	Within 3months from date of approval	

<u>Action</u>	<u>Agency Responsible</u>	<u>Type of</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Industrial emission				

Industrial emission control <u>Regulatory</u>	UKPCB Industrial Department	Continuous Activity		<ul style="list-style-type: none"> Dehradun is protected & Restricted Area is due to Doon Valley notification. Since 1989 Red category industries are prohibited in Doon valley. Mainly small / green category industry and service sector industry are established in Dehradun. Source Apportionment and Emission Inventory study for Dehradun is already produced in Action Plan, which will cover the industrial contribution towards Action Plan. There is not any red Category of the Unit in Dehradun. However, there are 26 Orange categories of units established within the Dehradun and adjacent to Municipal Boundaries. Out of these 26 units: <ul style="list-style-type: none"> 07 Brick Kilns and only 04 are operational. 06 Pharma formulation/cosmetic units which are using LPG/Briquets as a fuel in their Boilers. 13 Units are such which do not have any furnace/ Boilers. State Board has notified Approved Fuel and accordingly, UKPCB will not issue any fresh permission for use of Furnace oil and Pet coke. All Industries in Dehradun will be directed to ensure, good housekeeping for reduction of re-suspension of dust and fugitive emission. Green Belt, wherever required and feasible, to be increase.
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<u>Action</u>	<u>Agency Responsible</u>	<u>Type of</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Domestic				
Ensure 100% spread of LPG connection for cooking purposes in the city. <u>Regulatory</u>	District Administration. Civil Supply Department	Short	Within 06 months from approval of Plan	
Replacement of Wood which is used as Domestic Fuel <u>Implementation</u>	District Administration Municipal Corporation Forest Department	Mid	March 2023	To be implemented in the geographical area of Nagar Nigam.
Ensuring promotion & use of cleaner fuel for commercial purposes like local Dhaba/ eateries <u>Implementation</u>	District Administration Municipal Corporation Forest Department Civil Supply Department	Mid	March 2023	To be implemented in the geographical area of Nagar Nigam.
Removal of Open DG sets <u>Regulatory</u>	UKPCB Industry Department Municipal Corporation District Administration	Mid	March 2023	

<u>Action</u>	<u>Agency Responsible</u>	<u>Type of</u>	<u>Time Target</u>	<u>Remarks</u>
Source Group				
Others				
Compliance of guidelines on D.G. sets regarding use of retrofitted emission control system (PM captured efficiency 70%) capacity equal to or above 800KW <u>Regulatory</u>	UKPCB Industry Department District Administration	Short	Within 06 months from approval of Plan	
Public Grievance Redressal Portal <u>Implementation</u>	UKPCB	Immediate	Within 3months from date of approval	Portal will be created on the web site of Board for Redressal of public complaints on air pollution along with a supervisory control for the disposal of complaints All such complaint will be addressed and disposed in a month time.
Issue of advisory to public for prevention and control of air pollution, Vehicle fitness, maintenance and minimize use of personal vehicles etc <u>Regulatory</u>	UKPCB Municipal Corporation Transport Department	Immediate	Within 3months from date of approval	

Financial Lay Out

Following Financial Lay out is being given for execution of Air Action Plan for Dehradun:-

S. No.	Name of Action Point	Financial Layout in Rs
1	Paving of shoulders along the urban roads.	15.00 crore
2	Tanker and tractor required for water spray on road (10 nos)	0.45 crore
3	Vacuum road sweeping machines (04 N0s)	3.0 crore
4	Small vacuum cleaning machines for smaller roads (10 Nos)	1.2 crore
5	Mobile vehicular checking labs/ PUC centers (04 nos)	0.6 crore
6	Emission inventory and source apportionment study	1.0 crore
7	Installation and AMC for 05 years for CAAQMS (03 umbers)	7.5 crore
8	Installation Infra Red Cameras at major Traffic junctions to detect polluting vehicles (20 Numbers)	0.5 crore
9	I & E activities	1.0 crore
	Total	30.25 Crore

Annexure-1 Survey of Vehicular Pollution and Emission Inventory: Dehradun

Summer Season

Vehicle Count and Emission Rate for vehicle during Summer Season (2016-17)

Location	Time	Type	Number	CO Kg/h	HC Kg/h	NOx Kg/h	SO2 Kg/h	Particulate Kg/h
Ghanta Ghar	9:00 AM	2 Wheeler	4519	104.2	97.5	19.7	0.4	0.1
		3 Wheeler	3254	75.0	70.2	14.2	0.3	0.1
		Car	5132	118.3	110.8	22.4	0.4	0.1
	To	Truck	3940	90.8	85.0	17.2	0.3	0.1
		Bus	3522	81.2	76.0	15.4	0.3	0.1
		LCV	3135	72.3	67.7	13.7	0.3	0.1
	6:00 PM	Total	23502	541.8	507.2	102.5	1.9	0.6
ISBT	9:00 AM	2 Wheeler	1267	29.2	27.3	49.7	918.6	0.3
		3 Wheeler	173	4.0	33.7	6.8	125.9	0.0
		Car	231	5.3	44.9	9.1	167.5	0.1
	To	Truck	500	11.5	97.1	19.6	362.4	0.1
		Bus	297	6.8	57.7	11.6	215.2	0.1
		LCV	162	3.7	31.5	6.4	117.7	0.0
	6:00 PM	Total	2631	60649.9	292.2	103.3	1907.2	0.6
ONGC/ FRI	9:00 AM	2 Wheeler	1788	41.12	7.8	0.1	0.0	41.2
		3 Wheeler	1250	28.75	5.5	0.1	0.0	28.8
		Car	1876	43.15	8.2	0.2	0.0	43.3
	To	Truck	1390	31.97	6.1	0.1	0.0	32.1
		Bus	878	120.19	3.8	0.1	0.0	20.2
		LCV	581	13.36	2.5	0.0	0.0	13.4
	6:00 PM	Total	7763	178.55	33.9	0.6	0.2	179.0
Survey Area	9:00 AM	2 Wheeler	2577	59.4	55.6	11.2	0.2	0.1
		3 Wheeler	1341	30.9	28.9	5.8	0.1	0.0
		Car	3277	75.6	70.7	14.3	0.3	0.1
	To	Truck	2064	47.6	44.5	9.0	0.2	0.1
		Bus	1148	26.5	24.8	5.0	0.1	0.0
		LCV	1078	24.9	23.3	4.7	0.1	0.0
	6:00 PM	Total	11486	264.8	247.9	50.1	0.9	0.3

Post-Monsoon Season

Vehicle Count and Emission Rate for vehicle during Post-Monsoon Season (2016-17)

Location	Time	Type	Number	CO Kg/h	HC Kg/h	NOx Kg/h	SO2 Kg/h	Particulate Kg/h
Ghanta Ghar	9:00 AM	2 Wheeler	3874	89.31	83.61	16.89	0.31	0.10
		3 Wheeler	2789	64.30	60.19	12.16	0.22	0.07
		Car	4399	101.43	94.95	19.19	0.35	0.11
	To	Truck	3377	77.85	72.88	14.73	0.27	0.08
		Bus	3019	69.61	65.16	13.17	0.24	0.08
		LCV	2687	61.95	57.99	11.72	0.22	0.07
	6:00 PM	Total	20144	464.44	434.78	87.85	1.62	0.50
ISBT	9:00 AM	2 Wheeler	1086	25.04	25.04	23.44	4.74	0.09
		3 Wheeler	149	3.43	3.43	3.21	0.65	0.01
		Car	19	4.57	4.57	4.27	0.86	0.02
	To	Truck	428	9.88	9.88	9.25	1.87	0.03
		Bus	254	5.87	5.87	5.49	1.11	0.02
		LCV	139	3.21	3.21	3.00	0.61	0.01
	6:00 PM	Total	2255	51.99	51.99	48.67	9.83	0.18
ONGC/ FRI	9:00 AM	2 Wheeler	1532	35.33	33.07	6.68	0.12	0.04
		3 Wheeler	1072	24.71	23.13	4.67	0.09	0.03
		Car	1608	37.07	34.71	7.01	0.13	0.04
	To	Truck	1192	27.47	25.72	5.20	0.10	0.03
		Bus	752	17.35	16.24	3.28	0.06	0.02
		LCV	498	11.48	10.75	2.17	0.04	0.01
	6:00 PM	Total	6654	153.41	143.62	29.02	0.54	0.17
Survey Area	9:00 AM	2 Wheeler	2209	50.93	47.68	9.63	0.18	0.06
		3 Wheeler	1150	26.50	24.81	5.01	0.09	0.03
		Car	2809	64.77	60.63	12.25	0.23	0.07
	To	Truck	1769	40.78	38.18	7.71	0.14	0.04
		Bus	984	22.69	21.24	4.29	0.08	0.02
		LCV	92	21.30	19.94	4.03	0.07	0.02
	6:00 PM	Total	9845	226.98	212.48	42.93	0.79	0.25

Winter Season

Vehicle Count and Emission Rate for vehicle during Winter Season(2016-17)

Location	Time	Type	Number	CO Kg/h	HC Kg/h	NOx Kg/h	SO2 Kg/h	Particulate Kg/h
Ghanta Ghar	9:00 AM To 6:00 PM	2 Wheeler	3228	74.4	69.7	14.1	0.3	0.1
		3 Wheeler	2324	53.6	50.2	10.1	0.2	0.1
		Car	3666	84.5	79.1	16.0	0.3	0.1
		Truck	2814	64.9	60.7	12.3	0.2	0.1
		Bus	2516	58.0	54.3	11.0	0.2	0.1
		LCV	2239	51.6	48.3	9.8	0.2	0.1
		Total	16787	387.0	362.3	73.2	1.4	0.4
ISBT	9:00 AM To 6:00 PM	2 Wheeler	905	20.9	19.5	3.9	0.1	0.0
		3 Wheeler	124	2.9	2.7	0.5	0.0	0.0
		Car	165	3.8	3.6	0.7	0.0	0.0
		Truck	357	8.2	7.7	1.6	0.0	0.0
		Bus	212	4.9	4.6	0.9	0.0	0.0
		LCV	116	2.7	2.5	0.5	0.0	0.0
		Total	1879	43.3	40.6	8.2	0.2	0.0
ONGC/ FRI	9:00 AM To 6:00 PM	2 Wheeler	1277	29.4	27.6	5.6	0.1	0.0
		3 Wheeler	893	20.6	19.3	3.9	0.1	0.0
		Car	1340	30.9	28.9	5.8	0.1	0.0
		Truck	993	22.9	21.4	4.3	0.1	0.0
		Bus	627	14.5	13.5	2.7	0.1	0.0
		LCV	415	9.6	9.0	1.8	0.0	0.0
		Total	5545	127.8	119.7	24.2	0.4	0.1
Survey Area	9:00 AM To 6:00 PM	2 Wheeler	1841	0.0	0.0	0.0	0.0	0.0
		3 Wheeler	958	0.0	0.2	0.0	0.0	0.0
		Car	2341	0.1	0.5	0.0	0.0	0.0
		Truck	1474	0.0	0.3	0.0	0.0	0.0
		Bus	820	0.0	0.2	0.0	0.0	0.0
		LCV	770	0.0	0.1	0.0	0.0	0.0
		Total	8204	189.1	1275.7	35.8	0.7	0.2

Annexure 2: Results of ambient air quality and vehicular emissions

Summer Season

Ambient Air Monitoring at Dehradun for Summer Season (2016-17)

Average, Cumulative Percentile, Maxima & Minima Respirable Suspended Particulate Matter (RSPM) PM₁₀

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	205	26	155	250	172	186	205	228	248
A2	Survey Area	302	30	256	363	269	277	299	323	358
A3	ONGC/FRI	206	16.4	187	241	198	203	215	221	239
A4	ISBT	191	15	171	241	182	189	193	204	240
A5	Rajpur Road	191	19.9	159	230	166	178	187	212	227
A6	Raipur	353	38	292	413	302	315	358	389	409
A7	Wildlife Institute of India	168	17.7	144	209	148	155	165	183	206

Average, Cumulative Percentile, Maxima & Minima Particulate Matter PM_{2.5} (P.M. 2.5)

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	123	16	93	150	103	112	123	137	149
A2	ISBT	196	20	164	229	169	175	188	204	228
A3	ONGC/FRI	106	9	107	137	115	118	125	118	139
A4	Survey Area	119	9	107	143	109	113	116	122	141
A5	Rajpur Road	115	12	95	138	100	107	112	127	136
A6	Raipur	209	23	172	249	181	189	215	212	247
A7	Wildlife Institute of India	96	11	76	121	90	93	99	110	119

**Average, Cumulative Percentile, Maxima & Minima
Sulphur-Dioxide (SO₂)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	5	1	3	6	4	4	5	5	6
A2	ISBT	4	1	4	6	3	3	4	5	6
A3	ONGC/FRI	4	1	3	6	3	4	4	4	5
A4	Survey Area	4	1	3	6	4	4	4	5	6
A5	Rajpur Road	4	1	3	6	4	4	4	5	6
A6	Raipur	4	1	3	5	4	4	4	5	6
A7	Wildlife Institute of India	4	1	BDL	5	3	3	4	4	5

**Average, Cumulative Percentile, Maxima & Minima
Oxide of Nitrogen (NO_x)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	15	1	14	14	14	15	15	17	20
A2	ISBT	15	1	14	14	14	15	17	19	23
A3	ONGC/FRI	15	1	14	14	14	14	15	16	18
A4	Survey Area	15	1	14	14	14	14	15	16	18
A5	Rajpur Road	20	1	17	22	18	19	20	16	22
A6	Raipur	20	1	17	22	18	19	20	20	22
A7	Wildlife Institute of India	15	1	14	14	14	14	15	15	16

**Average, Cumulative Percentile, Maxima & Minima
Ozone (O₃)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	36	3	30	41	33	35	37	38	41
A2	ISBT	35	2	30	39	32	32	35	36	39
A3	ONGC/FRI	34	2	29	38	30	32	34	35	38
A4	Survey Area	32	2	29	38	30	30	34	34	39
A5	Rajpur Road	32	2	31	39	30	31	34	35	36
A6	Raipur	32	2	28	37	30	31	34	35	36
A7	Wildlife Institute of India	33	2	30	30	30	32	34	35	36

**Average, Cumulative Percentile, Maxima & Minima
Carbon Monoxide (CO)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	0.84	0.07	0.70	1.40	0.98	0.77	0.84	0.91	0.97
A2	ISBT	0.63	0.07	0.49	1.20	0.84	0.55	0.63	0.70	0.85
A3	ONGC/FRI	0.56	0.14	0.42	1.20	0.84	0.53	0.56	0.70	0.84
A4	Survey Area	0.91	0.21	0.70	1.60	1.12	0.84	0.91	1.00	1.11
A5	Rajpur Road	0.42	0.07	0.35	0.80	0.56	0.39	0.42	0.50	0.55
A6	Raipur	0.63	0.04	0.49	1.10	0.77	0.55	0.63	0.71	0.77
A7	Wildlife Institute of India	0.14	0.01	0.06	0.30	0.21	0.10	0.14	0.18	0.21

Post-Monsoon Season

Ambient Air Monitoring at Dehradun for Post Monsoon Season (2016-17)

Average, Cumulative Percentile, Maxima & Minima Respirable Suspended Particulate Matter (RSPM) PM₁₀

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	180	23	136	220	151	164	180	201	218
A2	Survey Area	272	27	230	327	242	249	269	291	322
A3	ONGC/FRI	177	14	161	207	170	175	185	190	206
A4	ISBT	160	13	144	202	153	158	162	171	202
A5	Rajpur Road	174	18	148	209	151	162	170	193	207
A6	Raipur	176	19	145	205	150	157	178	194	204
A7	Wildlife Institute of India	143	15	122	178	126	132	140	156	175

Average, Cumulative Percentile, Maxima & Minima Particulate Matter PM_{2.5} (P.M. 2.5)

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	126	16	95	154	106	115	126	140	153
A2	Survey Area	185	18	157	222	165	170	183	198	219
A3	ONGC/FRI	115	9	105	135	111	113	120	124	134
A4	ISBT	114	9	102	144	108	112	115	121	143
A5	Rajpur Road	110	11	93	132	95	102	107	122	130
A6	Raipur	121	13	100	142	104	108	123	134	141
A7	Wildlife Institute of India	91	10	78	114	81	84	90	101	112

**Average, Cumulative Percentile, Maxima & Minima
Sulphur-Dioxide (SO₂)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	BDL	0	BDL	BDL	1	1	1	3	4
A2	Survey Area	BDL	0	BDL	BDL	1	1	1	1	BDL
A3	ONGC/FRI	BDL	0	BDL	BDL	1	1	1	1	BDL
A4	ISBT	3	0	BDL	6	1	1	3	3	6
A5	Rajpur Road	BDL	0	BDL	BDL	1	1	1	1	BDL
A6	Raipur	BDL	0	BDL	BDL	1	1	1	1	BDL
A7	Wildlife Institute of India	BDL	0	BDL	BDL	1	1	1	1	BDL

**Average, Cumulative Percentile, Maxima & Minima
Oxide of Nitrogen (NO_x)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	6	0	5	6	5	5	6	6	6
A2	Survey Area	4	0	4	5	4	4	4	5	5
A3	ONGC/FRI	4	0	4	5	4	4	4	5	5
A4	ISBT	6	0	5	6	5	5	6	6	6
A5	Rajpur Road	4	0	4	5	4	4	4	5	5
A6	Raipur	4	0	4	5	4	4	4	5	5
A7	Wildlife Institute of India	4	0	4	5	4	4	4	4	5

**Average, Cumulative Percentile, Maxima & Minima
Ozone (O₃)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	19	1	16	22	18	18	20	20	22
A2	Survey Area	18	1	16	21	17	17	18	19	21
A3	ONGC/FRI	18	1	16	20	16	17	18	19	20
A4	ISBT	7	1	16	20	16	16	17	18	20
A5	Rajpur Road	18	1	16	21	17	18	18	19	21
A6	Raipur	17	1	15	20	16	16	17	18	19
A7	Wildlife Institute of India	18	1	16	20	16	17	18	19	20

**Average, Cumulative Percentile, Maxima & Minima
Carbon Monoxide (CO)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	0.2	0.0	0.0	0.3	0.2	0.2	0.2	0.3	0.3
A2	Survey Area	0.2	0.0	0.0	0.2	0.1	0.2	0.2	0.2	0.2
A3	ONGC/FRI	0.2	0.0	0.0	0.2	0.1	0.2	0.2	0.2	0.2
A4	ISBT	0.3	0.1	0.0	0.3	0.2	0.2	0.3	0.3	0.3
A5	Rajpur Road	0.1	0.0	0.0	0.2	0.1	0.1	0.1	0.1	0.2
A6	Raipur	0.2	0.0	0.0	0.2	0.1	0.2	0.2	0.2	0.2
A7	Wildlife Institute of India	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1

Winter Season

Ambient Air Monitoring at Dehradun for Winter Season (2016-17)

Average, Cumulative Percentile, Maxima & Minima Respirable Suspended Particulate Matter (RSPM) PM₁₀

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	198	25	150	242	166	180	198	221	240
A2	Survey Area	285	29	242	343	254	262	282	306	338
A3	ONGC/FRI	197	16	179	230	189	194	205	211	228
A4	ISBT	173	14	155	219	165	171	175	185	218
A5	Rajpur Road	189	20	161	228	165	177	185	210	225
A6	Raipur	186	20	154	218	159	166	189	206	216
A7	Wildlife Institute of India	156	16	133	194	137	144	153	170	191

Average, Cumulative Percentile, Maxima & Minima Particulate Matter PM_{2.5} (P.M. 2.5)

All values in $\mu\text{g}/\text{m}^3$

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	135	17	102	165	113	122	135	150	163
A2	Survey Area	188	19	160	226	168	173	186	202	223
A3	ONGC/FRI	126	10	114	147	121	124	131	135	146
A4	ISBT	120	9	107	151	114	118	121	127	150
A5	Rajpur Road	133	14	113	160	115	124	130	147	158
A6	Raipur	126	14	104	147	108	112	128	139	146
A7	Wildlife Institute of India	95	10	81	118	84	88	93	103	116

**Average, Cumulative Percentile, Maxima & Minima
Sulphur-Dioxide (SO₂)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	2	0	1	3	2	2	2	2	3
A2	Survey Area	BDL	0	1	BDL	1	1	2	2	2
A3	ONGC/FRI	2	0	1	BDL	1	2	2	2	2
A4	ISBT	BDL	0	1	3	2	2	2	2	3
A5	Rajpur Road	BDL	0	1	BDL	2	2	2	2	2
A6	Raipur	BDL	0	1	BDL	2	2	2	2	2
A7	Wildlife Institute of India	BDL	0	1	BDL	1	1	2	2	2

**Average, Cumulative Percentile, Maxima & Minima
Oxide of Nitrogen (NO_x)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	8	1	7	10	8	8	8	9	9
A2	Survey Area	6	0	6	7	6	6	6	7	7
A3	ONGC/FRI	7	0	6	8	6	6	6	7	8
A4	ISBT	8	1	7	10	8	8	8	9	10
A5	Rajpur Road	7	0	6	8	6	6	7	7	8
A6	Raipur	7	0	6	8	6	6	7	7	8
A7	Wildlife Institute of India	6	0	6	8	6	6	6	7	8

**Average, Cumulative Percentile, Maxima & Minima
Ozone (O₃)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	15	1	12	16	13	14	15	15	16
A2	Survey Area	14	1	12	16	13	13	14	15	16
A3	ONGC/FRI	14	1	12	15	12	13	14	14	15
A4	ISBT	13	1	12	15	12	12	13	14	15
A5	Rajpur Road	14	1	12	16	13	14	14	15	16
A6	Raipur	13	1	11	15	12	12	12	14	15
A7	Wildlife Institute of India	13	1	12	15	12	13	13	14	15

**Average, Cumulative Percentile, Maxima & Minima
Carbon Monoxide (CO)**

All values in µg/m³

Site Code	Location	Mean	S.D	Min	Max	Percentile				
						10 th	25 th	50 th	80 th	98 th
A1	Ghanta Ghar	0.4	0.0	0.3	0.4	0.3	0.3	0.4	0.4	0.4
A2	Survey Area	0.3	0.0	0.2	0.4	0.2	0.2	0.3	0.3	0.4
A3	ONGC/FRI	0.2	0.1	0.2	0.4	0.2	0.2	0.2	0.3	0.4
A4	ISBT	0.4	0.1	0.3	0.5	0.3	0.4	0.4	0.4	0.5
A5	Rajpur Road	0.2	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2
A6	Raipur	0.3	0.0	0.2	0.3	0.2	0.2	0.3	0.3	0.3
A7	Wildlife Institute of India	0.1	0.0	0.0	0.1	0.0	0.0	0.1	0.1	0.1

Disclaimer

This plan is prepared by Uttarakhand Environment Protection and Pollution Control Board in alliance with Pollution Control Research Institute, Haridwar and Clean AirAsia.