DISTRICT ENVIRONMENTAL PLAN

(As per the Hon'ble National Green Tribunal (NGT) vide order O.A. no. 360/2018 dated 26.09.2019)

HARIDWAR

G.B. Pant National Institute of Himalayan Environment (NIHE), HQ, Kosi-Katarmal Almora-263643, Uttarakhand, India

CONTRIBUTORS

Director, GBP-NIHE	Project Coordinator
Dr. J.C. Kuniyal, Scientist 'G' & Head CEA&CC, GBP-NIHE	Principal Project Investigator
Dr. G.C.S Negi, Scientist 'G' & Head CSED, GBP-NIHE	Co-Project Investigator
Dr. I.D. Bhatt, Scientist 'F' & Head CBCM, GBP-NIHE	Co-Project Investigator
Dr. Sumit Rai, Scientist 'C', GBP-NIHE	Co-Project Investigator
Dr. Kapil Kesarwani, Scientist 'C', GBP-NIHE	Co-Project Investigator
Dr. Dalbeer Singh Pharswan, Project Scientist, GBP-NIHE	Team Member
Mr. Manav Sharma, Researcher, GBP-NIHE	Team Member
Mr. Tapan Ghosh, Researcher, GBP-NIHE	Team Member
Mr. Dheeraj Tewari, Field Surveyor, GBP-NIHE	Team Member
Mr. Pramod Joshi, Field Surveyor, GBP-NIHE	Team Member
Administration	
District Magistrate Haridwar	Chairperson
Divisional Forest Officer, Haridwar	Member Secretary

PREFACE

Hon'ble National Green Tribunal (NGT) vide order, dated 26/09/2019 in O.A. No. 360 of 2018 filed by Shree Nath Sharma Vs. Union of India and Others directed that Central Pollution Control Board (CPCB) shall facilitate the District Magistrates in preparation of the District Environmental Plan (DEP) by placing a model plan on its website. This model plan may be adopted as per local requirements by all districts under the supervision of the District Magistrate. The said order also directs that the Department of Environment in respective states should collect district plans to prepare State Environment Plan (SEP), which shall be monitored by respective Chief Secretaries of the State by 15/12/2019. Based on State Environmental Plans, CPCB and Ministry of Environment, Forest & Climate Change (MoEFCC) shall prepare a National Environmental Plan (NEP), under the supervision of Secretary, MoEFCC and Chairman, CPCB.

There are diverse environmental issues that address our key responsibilities to the community and its surrounding environment. As a set of target, fourteen areas by Hon'ble NGT and one more - plastic waste by Government of Uttarakhand were included under the district plan. These 14 areas were regarding compliance to rules for solid waste including legacy waste, bio-medical waste, Construction & Demolition waste (C&D), hazardous waste, Electronic waste (E-waste), polluter stretches, non-attainment cities, Industrial clusters, the status of Sewage Treatment Plants (STPs) and re-use of treated water, the status of Common Effluent Treatment Plants (CETPs)/ Effluent Treatment Plants (ETPs), ground water extraction/ contamination and re-charge, air pollution including noise pollution, illegal sand mining, and rejuvenation of water bodies. In addition, plastic waste was also assessed based on consultative workshops with the state government including State Pollution Control Board (SPCB).

The present environmental plan describes the status quo of 15 thematic areas and sets out strategies to mitigate their impact on different environmental parameters and human health. It briefly touches upon the basic need for bringing in mountain perspective in developmental planning. Implementation of this plan based on selected indicators will resolve different environmental issues. Also, it will meet compliance of different departments within a district. It will also allow a variety of environmental opportunities associated with different activities to be further undertaken from a view point of sustainable development. We hope this document will act as a noble reference for various stakeholders interested in sustainable development planning for the Haridwar district. Moreover, it will help to develop comprehensive understanding of the environmental planning process in view of socio-economic and financial situation of the district.

Date:

Principal Investigator, Co-Project Investigators & Project staff

ACKNOWLEDGEMENT

The present 'District Environment Plan' has been an outcome of coordinated efforts put together by different stakeholders from top to bottom in the state as well as in the district. At the outset, we thank the Chief Secretary, Uttarakhand Government; Shri Aanand Bardhan, and Shri S.P. Subudhi, Member Secretary, UKPCB. We thank the Director, G.B. Pant National Institute of Himalayan Environment (GBPNIHE), Kosi-Katarmal, Almora for providing necessary facilities, instrumental support and encouragement. We are also thankful to Chairman & District Magistrate (DM), Divisional Forest Officer (DFO), Member Secretary, for their time to time valuable inputs in the formulation of the DEP. We acknowledge all the support received from different departments including the DM office, UKPCB, Nagar Palika Parishad (NPP), Forest department, Health department, Jal Sansthan, Irrigation department, Mining Department, Regional Transport Officer (RTO), etc. for providing the information in a very satisfactory manner. The guidance and support from MoEFCC and the Government of Uttarakhand remained a constant source of inspiration at stages of this work. We thank and acknowledge all officers/ staff who could directly or indirectly contribute their valuable inputs in completing the work. We also extend our thanks to all the colleagues who made this work a memorable and worthwhile experience.

In the last but not least, our especial thanks go to Uttarakhand Pollution Control Board (UKPCB), Government of Uttarakhand, for financial support (Letter No. UKPCB/HO/Gen.183-431/2020/2156-415, dated 05/08/2020) to conduct the study in the 13 districts as well as the state of Uttarakhand.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

AMRUT	- Atal Mission for Rejuvenation and Urban Transformation
APL	- Above Poverty Line
AR6	- Sixth Assessment Report
As	- Arsenic
ASSOCHAM	- Associated Chambers of Commerce and Industry of India
BaP	- Benzo(a) Pyrene
BHEL	- Bharat Heavy Electricals Limited
BMWMIS	- Biomedical Waste Management Information System
BPL	- Below Poverty Line
C	- Carbon
C_6H_6	- Benzene
C&D waste	- Construction and Demolition waste
CACMP	- Catchment Area Conservation and Management Plan
CAMPA	- Compensatory Afforestation Fund Management and Planning Authority
CBMWTF	- Common Bio-Medical Waste Treatment Facility
Cd	- Cadmium
CD	- Check Dam
CETP	- Common Effluent Treatment Plant
CFL	- Compact Fluorescent Lamp
CGWB	- Central Ground Water Board
CH_4	- Methane
CHC	- Community Healthcare Centre
CK	- Chal Khal
CO	- Carbon monoxide
CO_2	- Carbon dioxide
CPCB	- Central Pollution Control Board
CPHEEO	- Central Public Health and Environmental Engineering Organisation
Cr	- Chromium
CSC	- Community Sanitary Complex
CT	- Contour Trench
Cu	- Copper
DDT	- Dichloro Diphenyl Trichloroethane
DPR	- Detailed Project Report

DPRO	- District Panchayati Raj officer
EEE	- Electronics and Electrical Equipment
EEMI	- Electricals & Electronics Manufacturing in India
ENVIS	- Environmental Information System
ETP	- Effluent Treatment Plant
E-waste	- Electronic waste
F	- Fluoride
FPZ	- Flood Plain Zones
FSI	- Forest Survey of India
FSSM	- Faecal Sludge and Septage Management
GBPNIHE	- Govind Ballabh Pant National Institute of Himalayan Environment
GIS	- Geographical Information System
GPIs	- Grossly Polluting Industries
GPS	- Global Positioning System
HCF	- Health Care Facility
HFL	- Highest Flood Level
ICIMOD	- International Centre for Integrated Mountain Development
ICT	- Information and Communication Technology
IEC	- Information, Education and Communication
IHHL	- Individual House Hold Latrine
IPC	- Inter-Personal Communication
IPCC	- Intergovernmental Panel on Climate Change
IRAP	- Integrated Rural Accessibility Planning
ISO	- International Organization for Standardization
ISWM	- Integrated Solid Waste Management
IWRM	- Integrated Water Resources Management
LPV	- Low Value Plastic
MBBR	- Moving Bed Biofilm Reactor
MDWS	- Ministry of Drinking Water and Sanitation
MLP	- Multi Layered Plastic
MMT	- Million Metric Tons
MoEFCC	- Ministry of Environment, Forest and Climate Change
MoF	- Ministry of Finance
MoUHA	- Ministry of Urban and Housing Affairs

MPCC	- Medical Pollution Control Committee
MRF	- Material Recovery Facility
MSME	- Micro, Small and Medium Enterprises
MSW	- Municipal Solid Waste
MTPD	- Metric Ton per Day
NA	- Data Not Available/ Not Applicable
NATCOM	- National Communication
NAAQS	- National Ambient Air Quality Standards
NCAP	- National Clean Air Programme
NASA	- National Aeronautics and Space Administration
NCEPC	- National Committee on Environment Planning and Coordination
NGO	- Non-Governmental Organization
NGT	- National Green Tribunal
NH	- National Highway
NH_3	- Ammonia
Ni	- Nickel
NITI	- National Institution for Transforming India
NO_2	- Nitrogen Dioxide
NP	- Nagar Panchayat
NPP	- Nagar Palika Parishad
NTFP	- Non-Timber Forest Product
NUSP	- National Urban Sanitation Policy
NWMP	- National Water Resources Monitoring Programme
OCEMS	- Online Continuous Effluent Monitoring System
ODF	- Open Defecation Free
OSS	- On-Site Sanitation
O_3	- Ozone
PAT	- Perform, Achieve and Trade
Pb	- Lead
PCC	- Pollution Control Committee
PHC	- Primary Healthcare Centre
PIBO	- Producer, Importer and Brand Owner
PM	- Particulate Matter
PT	- Percolation Tank

PUC	- Pollution under Control
PWD	- Public Works Department
QPD	- Quintal per Day
RBM	- River Bed Mineral
RoHS	- Restriction of Hazardous Substances
RSM	- Rural Sanitary Mart
RTRWH	- Rooftop Rain Water Harvesting
RWD	- Rural Works Department
SAAS	- Software as a Service
SBM-G	- Swachh Bharat Mission-Gramin
SDG	- Sustainable Developmental Goals
SIDCUL	- State Industrial Development Corporation of Uttarakhand Limited
SLWM	- Solid and Liquid Waste Management
SO_2	- Sulphur Dioxide
SPCB	- State Pollution Control Board
SSMG	- Sustainable Sand Management Guidelines
STP	- Sewage Treatment Plant
TPD	- Tons per Day
TSDF	- Treatment Storage and Disposal Facilities
UKPCB	- Uttarakhand Pollution Control Board
ULB	- Urban Local Body
UNDP	- United Nations Development Programme
UREDA	- Uttarakhand Renewable Energy Development Agency
WHO	- World Health Organization
ZED	- Zero Defect Zero Effect
ZLD	- Zero Liquid Discharge
µg	- Microgram

EXECUTIVE SUMMARY

Haridwar district is witnessing an unprecedented rise in levels of urbanization, rising quantity of waste and lack of sustainable public transport. Moreover, increased tourism has brought with it several environmental and urban planning related challenged for the district. While the causal mechanisms of environmental and climate change are numerous and complex, economic growth and population growth are the factors that can be highlighted to explain the increasing stress imposed by human interference on the natural environment.

To analyse the current environmental status and to furnish a comprehensive plan to mitigate the environmental deterioration, GBPNIHE was assigned with the task to prepare district Environment plan. Detailed deliberations were carried out to devise the action plan focusing on explicit thematic areas, which includes:

- ***Waste Management Operations:*** Only few of the ULBs of the district have proper mechanism for waste management. Waste management in other ULBs such as Piran Kaliyar, Jhabrera and Bhagwanpur needs revamp as they are lacking in the basic infrastructure. However, there is no established mechanism for waste collection in the rural areas.
- Waste segregation at source is a major issue in all the urban local bodies of the district. This has proliferated the issue of unscientific plastic waste management in the district Moreover, the waste recovery and disposal facilities are not robust. Due to improper segregation of municipal solid waste, the domestic hazardous and E-waste are also dumped in the landfill sites causing environmental hazards.
- ***Biomedical Waste Management:*** As the district is having the facility for the treatment of biomedical waste, hence its management is quite satisfactory as of now. Private agency has been working in biomedical waste management in Haridwar district, especially in operation and maintenance of CBMWTF.Pre-segregation of biomedical waste in practised in every healthcare facility. This helps in sooth disposal and transportation of waste to treatment facility. The only thing that needs to be addressed is the tracking of waste generated to comply with the latest biomedical waste management rules.
- ***Construction and demolition waste management:*** Rapid urbanisation and infrastructure development in the district has led to the generation of C&D waste by manifolds. Still the district lacks mechanism for proper handling of this waste. By laws must be framed to have a common set of guidelines for management of C&D waste. Simultaneous establishment of dumping zones and C&D waste processing plant will help channelize the idle waste towards new construction activities.

- ***Hazardous Waste Management:*** Uttarakhand Pollution Control Board maintains the inventory of hazardous waste generated in the district. Information related to the amount of hazardous waste processed is also available. More than half of the hazardous waste generated is recyclable and reusable. Availability of TSDF ensures effective processing of the toxic waste generated in the district. UKPCB is currently working on streamlining the hazardous waste generated in service sector (especially automobile sector) in its current hazardous waste management operations.
- ***E-Waste Managemen****t*: E-waste generation is on rise not only in urban areas but also in the rural areas of the district. Currently, E-waste is quantified in the district based on the waste received at authorised E-waste recyclers/dismantlers in the district. Bulk consumers including government departments are the major contributors of e-waste. The district administration and Uttarakhand pollution control board are working on establishment of toll free number and collection centre for effective e-waste management.
- ***River Polluter Stretch in Haridwar:*** Ganga river stretch from Haridwar to Sultanpur has been identified as a polluter stretch of Priority IV in the district. Industrial pollution is one of the major reasons for the deteriorating water quality in the polluter stretch. Surface water quality and groundwater quality is regularly monitored according to the norms set by Central Pollution control Board. Currently the water quality standards are within the prescribed limits which has led to improvement in water quality standards from Class-C to Class-B.
- ***Industrial Clusters in Haridwar:*** Industrial clusters have been a driving force of development in the district. IIE SIDCUL promotes industrial development in the district. Environment standard related to air and water quality are regularlty monitored in the industrial estates It is important to ensure that development model must not harm the environment assets in the district.
- ***Wastewater Management***: Currently, 7 STPs are operational in Haridwar district primarily serving the households of Nagar Nigam Haridwar and Nagar Nigam Roorkee. One of STPs in Jagjeetpur is generating CNG from the sludge accumulated after the treatment of wastewater. The project is one of its kind in northern India.

  At present, 85% and 20% population in Haridwar and Roorkee are connected through sewerage network respectively. To connect rest of the population, the urban local bodies have sent the proposals to the government. Other urban local bodies are also needs suitable treatment facilities *(off-site or on-site)* based on their financial conditions
- A common effluent treatment plant is operational in SIDCUL, Hardiwar which is connected to more than 500 industrial units. Several other industrial estates are operational in the district

which needs to be connected with the current facility or if possible a separate facility. These small industrial estates have their separate Effluent treatment plant operational within the boundary limits. The effluent from the CETP is regularly monitored and the quality is within the prescribed limits as per the data available.

- ***Air and Noise Pollution:*** Considerable portion of Haridwar district lies in indo-Gangetic plains, thus it is susceptible to air pollution, especially during winter season. Industrial air pollution, stubble burning, vehicular pollution are the major causes of deteriorating air quality in the district. Particulate matter, specifically PM10 values have exceeded the prescribed values for the past five years. More air quality monitoring stations are desired to ascertain the degree of air pollution in different regions of the district.

  Noise level standards have more or less remained within the standards even during festive seasons. State transport department has banned multi-toned horn for vehicles except ambulance, fire brigade vehicles etc. in the district.
- ***Surface and Groundwater Management:*** Several perennial and seasonal rivers traverses through the Hardiwar district that predominantly lies on the flood plains of Ganga River. Nalas and drains are discharged onto rivers, which may deteriorate the water quality. Ground water monitoring at probable contaminated location and polluter stretch is done of half-yearly basis. Several policies including installation of water meters, Rainwater harvesting in households are promulgated in the district for management of water resources.

  Several works have been undertaken by forest department for rejuvenation activities in Jhilmil Lake conservation area including construction of check dams, cleaning of drains etc. Action plan for Rejuvenation of polluter stretch of Ganga River has been prepared by Uttarakhand Pollution control board under the guidelines of Hon'ble National Green Tribunal for restoring water quality**.**
- ***Mining activity:*** Mining department and forest department issues permissions for mining under their jurisdiction areas. Sand mining is prevalent in the district. Some cases of illegal mining have been registered and penalties were charged subsequently.

The execution of this management plan will require the integration and co-operation of the people, private and public stakeholders of Haridwar. This plan aims at reducing the risk on the human health and environment with a target of sustainable development.

INTRODUCTION

Establishing a link between environmental degradation, poverty and economic sustainability has always been a challenging task before the planners. The world's poor are significantly prone to natural disasters pertaining to the fact that in many cases their livelihoods are directly dependent on the natural resources. Human welfare is closely associated with the health of the environment. Around the world, 24 percent of deaths can be traced back to avoidable environmental factors (WHO, 2018). People are in direct need of clean air to breathe, freshwater to drink and suitable places to live in that are free from pollutions including toxic substances and hazards. The 2030 agenda for Sustainable Development Goals (SDGs) and its 17 Goals adopted by world leaders define a blueprint for future development trajectory to all the nations with a focus on poverty eradication, environmental sustainability, peace and harmony (Anonymous, 2018; WHO, 2018; Azash and Thirupalu, 2017). Recently, Intergovernmental Panel on Climate Change (IPCC) released a Report on "Climate Change 2021- The Physical Science Basis" as a part of IPCC's Sixth Assessment report *(AR6)*. The facts presented in this report raised a crucial red flag regarding global temperatures that have already risen by about 1.1 ºC from pre-industrial times and has warned that 1.5 ºC threshold is likely to be breached before 2040 *(the stated objective of 2015 Paris Agreement, the international architecture to fight climate change, is to limit temperature increase to within 2 ºC from pre-industrial times)* (IPCC, 2021). For the Indian perspective, the report says that waves and humid heat stress will be more intense and frequent in 21st century (IPCC, 2021). Changes in monsoon precipitation are also expected as both annual and summer monsoon precipitation are projected to increase (Krishnan et al, 2020). In regard to the Himalayan context, the area is one of the most fragile mountainous regions of the world. Hence, it is susceptible to changes in Environmental conditions and ecology (Krishnan et al, 2020). These mountains are considered to be the Water tower of South Asia, as major rivers of the Indian sub-continent originate from the Himalayan Mountains. However, the area has become a global hotspot since the past two decades in view of environmental degradation. The indirect impact is also seen in the glaciological aspect of these mountains (Eriksson et al, 2019). Almost, 500 million people of South Asia are dependent upon the health aspect of the Himalayan ecosystem. In India, the Himalayan Mountain Chain directly serves a national interest because of working as a guard in view of defense purpose, unique ecosystem in view of permanent snow cover and incessant sources of water and biodiversity hotspots. The people in downhill slopes and in the Indo–Gangetic plains realize its significance in many more aspects in view of sustainable development. A prerequisite for such sustainability is

ecological audit in areas, which at once would apprise about the present environmental issues and a strategy to meet the targets for the future (Sandhu and Sandhu, 2015).

Uttarakhand being a crucial chunk of the Himalayan regime is utmost vulnerable to environmental degradations and risks. About three fourth of the state's population is rural, therefore their livelihoods are almost dependent on natural resources (Raj, 2015). The traditional customs and traditional knowledge of the local people of Uttarakhand tend to be sustainable and are in harmony with the natural ecosystem. However, these traditional customs and traditional knowledge are often overlooked as sometimes reckless development of roads, infrastructure, and environmental degradation takes precedence over the traditional ecological knowledge. The recent data on SDGs indices released by NITI Aayog shows that the state is one of the top gainers with increase in overall index by 8 points. However, a lot is needed to be done in terms of the indicators related to Climate Action *(SDG, 13)* (Chopra, 2014). The tragedy of ecological governance in most parts is that it remains trapped in Environment-Development Binary. In contrast, the people of Uttarakhand had in past shown with movements such as the Chipko Andolan (1953), which gave an idea of human well-being sensitive to forests, mountains, and water bodies (Sarkar, 2018).

The art of establishing balance between economic development and sustainable development is known to many, but how it is implemented in the ground is known to few. We need to devise a strategy to break this trade off so that a mutually beneficial situation is achieved for the environment and society (Messerli et al, 2019). Environment plan is a prerequisite to understand how the social, political and economic factors are affecting the environment considering development. Environmental planning begins in India in early 1970s after Human Environment Conference at Stockholm held by United Nations, which led to the formation of National Committee on Environment Planning and Co-ordination (NCEPC*)* (NATCOM, 2012). Subsequently, then the Ministry of Environment and Forest (MoEF) was formed in mid 1980s by Government of India., realizing that the conservation of nature and its sustainability is a basic requirement for sustaining healthy life on globe. The key purpose of this plan is therefore to implement and devise programs intended to reduce pollution loads in different natural components, suggest mitigating or minimizing impacts, conserving and protecting the environment which could be considered together as a base for sustainable development (UNDP, 2015; Gaur, 2008).

FUNDAMENTAL PRINCIPLES OF ENVIRONMENT PROTECTION

(Judgments of the Hon'ble Supreme Court of India)

Sustainable Development

Hon'ble Supreme Court has recognized the principle of sustainable development as a basis for balancing ecological imperatives with development goals. In rural litigation and entitlement Kendra, *Dehradun Vs. State of U.P.*, the Supreme Court 1985 was apprised with the problem of the mining activities in the limestone quarries in Dehradun-Mussoorie area (Azash and Thirupalu, 2017; Anonymous, 2014). This was the first case of its kind in the country involving issues relating to environment and ecological balance and brought into sharp focus the conflict between development and conservation. In this case, the Supreme Court emphasized the need for reconciling development and conservation in the larger interest of the country (Anonymous, 2014; Sahu, 2014). Furthermore, it was realized that the necessary condition for achieving sustainable development is ecological security, economic efficiency and social equity (Rajaram, 2005).

Precautionary Principle

The emergence of precautionary principle marked a shift in the international environmental jurisprudence– a shift from assimilative capacity principle to precautionary principle. Basically, it is a principle which ensures that a substance or activity posing threat to the environment is prevented due to adversely affecting it, even if there is no conclusive scientific proof lining that particular substance or activity to the environment damage (Kriebel et al, 2001). In *Vellore Citizens Welfare Forum Vs. Union of India*, it was alleged that the untreated effluent being discharged by tanneries in Tamil Nadu was entering into the river, agricultural fields and was significantly polluting the water. Justice Kuldip Singh *(Known to be Green Judge)* observed that "even otherwise once these principles are accepted as a part of the Customary International Law, there would not be difficulty in accepting them as a part of domestic law (Venkat, 2012). It is almost accepted proposition of municipal law, that the rule of customary international law, which are not contrary to the municipal law shall be deemed to be incorporated in the domestic law and shall also be followed by the courts of laws of the country. According to this special principle, the burden is on the person wanting to change the status quo to show that the actions proposed will not have any adverse effect, the presumption operating in favor of environmental protection (Singh, 2000).

Polluter Pays Principle

Polluter Pays Principle (PPP) has become a popular slogan in recent times. *"If you make a mess, it's your duty to clean it up".* It should be mentioned that in environmental law, this principle doesn't refer to Fault". Instead, it favours a curative approach which is concerned with repairing ecological

damage (Kriebel et al, 2001). The Hon'ble Supreme Court held that as per the Polluter Pays Principle, "once the activity carried on is hazardous or inherently dangerous, the person carrying out such activity is liable to make good the loss caused to any other person by this activity irrespective of the fact whether he took reasonable care while carrying on his activity. While applying the principle of polluter pays, the Supreme Court later expressed the view that compensation to be awarded must have some correlation not only with the magnitude and capacity of the enterprise but also with the harms caused by it (Kriebel et al, 2001).

Public Trust Doctrine

The public trust doctrine primarily rests on the principle that certain resources like air, sea water and forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The said resources being a gift of nature, they should be made freely available to everyone irrespective of the status in life. This doctrine came up 2014 for consideration in the *M.C. Mehta vs. Kamal Nath* (Anonymous, 2014). Though the Supreme Court did not specifically refer to the Doctrine of Public Trust directly, in many cases they have given impact on this doctrine implicitly (Azash and Thirupalu, 2017). Traditionally, the doctrine of public trust was applied only for protection of access to the common for public benefit, now the doctrine is being applied even to prevent over-exploitation of the environmental components (Azash and Thirupalu, 2017).

Public Liability Insurance

The Public Liability Insurance Act 1991 has been enacted with the objective of providing immediate relief to the victims of accidents that might occur while handling hazardous substances. The owner who has control over handling of hazardous substances is required under the act to pay specified amounts to the victims as interim relief based on "No-Fault" liability. The expression 'Handling' is defined widely to include manufacture, trade and transport of hazardous substances. *Accidents by reason of war or radioactivity are excluded from the scope of the Act (*Azash and Thirupalu, 2017). The principle of absolute liability was propounded in case of *MC Mehta vs. Union of India* with the primary question regarding 0the extent to which industries engaged in hazardous and inherently dangerous industries can be held liable. This principle was further reaffirmed in the Indian Council for *Enviro Legal Action vs. Union of India* in which it was held that industries will be absolutely liable to the harm caused to villages due to pollution caused due to soil and underground water. Hence, these are bound to take remedial measure to improve the situation *(*Azash and Thirupalu, 2017).

ENVIRONMENT MANAGEMENT SYSTEM (ISO 14001:2015)

An environmental management system helps organizations identify, manage, monitor, and control their environmental issues in a holistic manner. ISO 14001 is an internationally agreed standard that sets out the requirements for an environmental management system (Da, 2015). It helps organizations to improve their environmental performance through more efficient ways of resource use and reduction of waste. Other ISO standards that look at different types of management systems such as ISO 9001 for quality management and ISO 45001 for occupational health and safety, all use a high-level of structure. This means that ISO 14001 can be integrated easily into existing ISO management systems. ISO 14001 includes the need for continual improvement of an organization system and approach to environmental concern (Da, 2015). It is suitable for organizations of all types and sizes, let they be private, or not-profit organisation or governmental. It is desirable that an organisation should consider all environmental issues relevant to its operations such as air pollution, water and sewage issues, waste management, soil contamination, climate change mitigation and adaptation, and resource use efficiency (Ferronato and Torretta, 2019).

DISTRICT PROFILE

Haridwar district lies on the western part of Uttarakhand state (Fig. 1). Prior to its inclusion in the newly created state of Uttarakhand, the district was part of Saharanpur Divisional Commissionaire. The district is ringed by Saharanpur in west, Dehradun in the north and east, Pauri Garhwal in the east, Muzzaffar Nagar and Bijnor in the south. The district headquarters is situated in Roshnabad, near Haridwar Railway station. Haridwar is one of the first towns where Ganga emerges from the mountains to touch the planes (District Survey Report, 2018). It is also a point of entry to Dev Bhoomi and Char Dham *(Four main centres of pilgrimage in Uttarakhand).* The district is well connected with all major destinations across Uttarakhand and Northern India with series of national highways (NH 34, NH 309, NH 7).

Entitled as *"Gateway to Gods"*, the legend says that Haridwar has been sanctified by the presence of three Gods; Brahma, Vishnu and Mahesh. Devout believers feel that they can approach heaven by getting their salvation after a dip in the sacred Ganga. Haridwar is also one of the four places where Kumbh Mela is celebrated after every twelve years and Ardh Kumbh after every six years. Being one of the oldest cities, Haridwar finds its mention in the ancient Hindu scriptures as it waves through the life and time, stretching from the period of Buddha to the more recent British advent. Haridwar has not only remained the abode of sound body, mind and spirit but also served as centre of attraction for arts, science and culture, Haridwar's long standing position as a great source for

Ayurvedic medicines and herbal remedies as well as its unique Guru Kul School of traditional education gives unique flavour and charm (DIPSR, 2021).

The district not only has religious importance but is also home to another temple of modern civilization i.e. *Bharat Heavy Electricals Limited* (BHEL), a Navratna PSU to its credit apart from Integrated Industrial Estate (IIE) established at Haridwar under SIDCUL *State Industrial Development Corporation of Uttarakhand Limited* (SIDCUL). Moreover, the district abodes IIT Roorkee, the epitome institute of Engineering and Science which is also one of the oldest and prestigious technical institution of Asia. Another university of the district i.e. Gurukul having vast campus provides traditional education of its own kind (DIPSR, 2021).

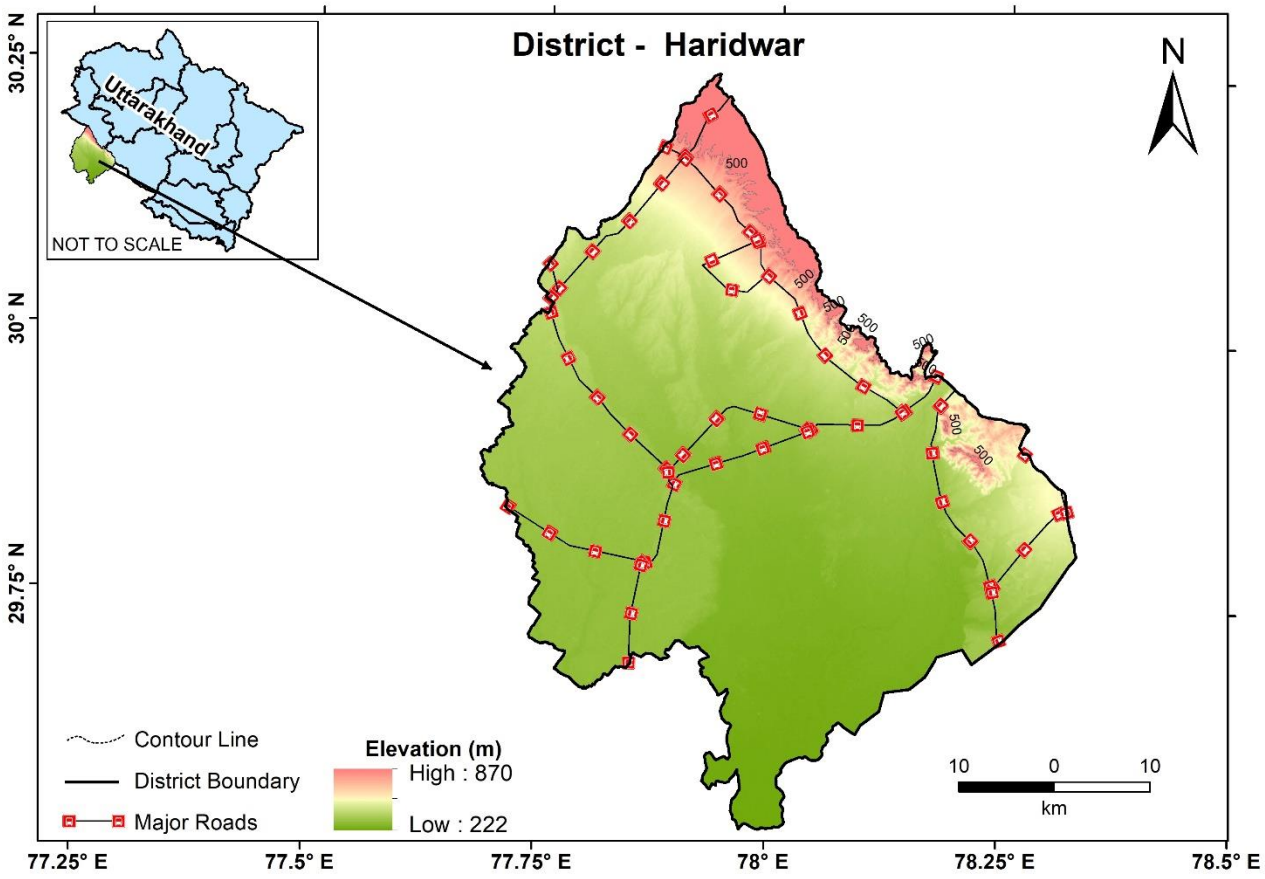


Fig. 1. Location and salient features of Haridwar district

District at a glance

Table 1. Represents the geographical aspect, population data and administrative setup of Haridwar district.

Geographical Location	
Latitude	22 0 30' 'N
Longitude	78 0 10' E
Geographical Area (km^2)	2360
Average elevation (metre) of district headquarter	314
Distance from State capital (Dehradun)	63 km
Population Data (2011 Census)	
Total Population (Number)	1,890,422
Male Population (Number)	1,005,295
Female Population (Number)	88,5,127
Population density/km^2	801
Population growth rate (%)	30.63%
Overall Literacy rate (%)	73.43%
Male literacy (%)	81.04%
Female literacy (%)	64.79%
Sex Ratio	880
Urbanised area (%)	36.66%
Rural area (%)	63.66%
Administrative Divisions	
Tehsils	03
Blocks	06
Nyay Panchayats	46
Village Panchayats	316
Total Revenue villages	510
Municipal councils	03
Nagar panchayats	04
Cantonment boards	01

(*Source*: District Census Handbook 2011; District statistical report 2018)

Topography

Topographically, the district has distinctive features compared to any other region of Gangetic plains of India. Northern part of the district are steep hills of the Shivalik chain and below the hills is the sub montane and the Tarai tract (Gantait and Agarwala, 2021) (Table 2). The total altitude ranges from 233 to 868 meters above sea level. The flood plain area is flattish and low lying while being adjacent to the river Saloni (District Survey Report, Haridwar, 2018).

Table 2. Physiographic divisions

Physiographic Feature	Predominant Area	Soil Type
Structural Hills	Middle and Upper Shivaliks	Composed of sand stones, sands, clay, silt etc.
Bhabar	Bhagwanpur block and part of Bahadrabad block	Composed of heterogeneous materials ranging from boulders, gravels, sand and silt.
Tarai or the Plains	Just below the Bhabar zone	Composed of fine grained sand, gravels, clays etc.

Drainage System

River Ganga forms the major drainage system of the area. It enters at the boundary of Haridwar town and flows southwardly draining the eastern part of the district (Table 3). Apart from this, the other prominent river in the area is Saloni, which drains the central part of the district (Gantait and Agarwala, 2021; District Survey Report, Haridwar, 2018).

Table 3. Major river systems in Haridwar District

River System	Origin	Drainage area	Local tributaries
Ganga River system	Gomukh (Terminus of Gangotri Glacier)	Eastern part of the district	Kotwali Rao
			Rasawan Nadi
			Pili Nadi
			Ban ganga
Saloni River System	Saharanpur	Central part of the district	Mohand Rao
			Chillawal Rao
			Ratmau Rao
			Gholna Rao

(*Source*: District Survey Report, Haridwar, 2018)

Climate

District Haridwar has very moderate subtropical climate which can be high on humidity. The region experiences moderate subtropical to humid climate throughout the year. There are three distinctive seasons in Haridwar i.e. winter, monsoon and summer. District comes under hot sub-humid (dry) eco-region with alluvium-derived soils. The eco-region has hot, sub humid (dry) climate and it covers northern Indo-Gangetic Plain, including piedmont plain of the Western Himalayas. The temperature begins to rise from March and reaches to its maximum during May. Monsoon commences by the mid-June and begins to lower by the end of September. The temperature remains low during the winter season in the month of December to February.

Rainfall

The average normal annual rainfall in Haridwar district is 1174.3 mm, out of which 84% is received during monsoon season and only 16% occurs during non-monsoon period. The monthly distribution of rainfall during the monsoon season over the district exhibits that June, July and August are the wettest month in the district having a rainfall 387.8 mm, 304.7mm and 412.8 mm respectively (Gantait and Agarwala, 2021). The highest rainfall is recorded generally during the month of August. The monsoons retreat in the first fortnight of October giving a meagre rainfall of 24.6 mm. Maximum rainfall occurs in the foothills of Himalayas and gradually decreases towards south. (District Survey Report, Haridwar, 2018).

Groundwater

As far as ground water exploration is concerned Central Ground Water Board has constructed 33 tube wells in the district. The common generic water sources used for water supply schemes over the district are Deep tube-well, Shallow Tube-well and treated surface water. Deep tube well is noted to be highly tapped for water schemes in Haridwar district (Gantait and Agarwala, 2021). The Ganga Alluvium comparatively covers a large area in Hardwar district, where maximum agricultural activities are going on, hence there has been a stress on the unconfined aquifer in some parts of the district. The dynamic groundwater resources are becoming scarce due to accelerated water demand and limited surface water availability in the unconfined aquifer. Moreover, Environment risk assessment shows that Groundwater is contaminated with metals in varying degrees due to anthropogenic activities (Gantait and Agarwala, 2021).

Land use Pattern

The greater portion of the district is open and highly cultivated. There are many uses of the land within physical, social and economic framework which often operate together. The major land use in Haridwar area comprises of agriculture, forest area and fallow area (Table 4).

Table 4. Land use pattern

Land use	Area (km^2)	Percent of Total Area (%)
Net Sown area	1160.82	49.86
Forest area	724.31	31.11
Cultivable waste land	17.38	0.74
Present Fallow land	46.75	2.00
Other Fallow land	33.47	1.43
Non-cultivable land	33.91	1.45
Other land Excluding Agriculture *(roads, settlements, canals, ponds, dams etc.)*	295.25	12.68
Pasture land	0.66	0.02

Groves and Gardens	15.43	0.66
Total	**2327.98**	

Forest Area

Broad leaved deciduous forests, riverine vegetation, scrubland, grasslands and pine forest form the range of flora in the region. Moreover, the Gangetic eco-system forms an important environment for aquatic, semi-aquatic and hydrophilic floral associations (FSI 2019). Combined area of the forest under different sub-type was highest in the Moderate Forest Cover (MDF) and lowest in Very Dense Forest (VDF) (Table 5) (FSI 2019). The vegetation patterns along Ganga varies according to seasonal changes and flood level Species composition differs by the function of water supply and different soil type which has a sharp influence on plant species distribution. The vegetation formations in the riverine area of the district changes wherever a road embankment or any anthropogenic activities are raised. (Gantait and Agarwala, 2021).

Table 5. Forest cover of Haridwar District

Particular	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	Change as of 2017-2019 assessment
Forest Area of Haridwar (Km^2)	2360	74.74	276.42	234.09	585.25	-2.75

Sources: FSI Report 2019

Fauna and Flora

Flora

Owing to vast area under forests (quarter of the area), Ayurvedic herbs and other forest products are abundant in the district. They also provide productive livelihood resources. The trees mainly found are Sal (*Shorea robusta),* Chir (*Pinus roxburghii*), Khair (*Senegalia catechu*), Shishum (*Dalbergia sissoo*), Bamboo (*Bambusa vulgaris*), Sahtoot (*Morus Alba*), Tun (*Toona ciliata*), and Papri (*Holoptelea integrifolia*). Some of the trees are utilized in manufacturing of paper and match sticks.

Fauna

The fauna of the district is varies considerably due to the presence of hills and forest. Some part of Rajaji National Park, situated in Haridwar district and in the Gangetic Plains biogeographic zone, has a diverse and biogeographically important mammalian assemblage. More than 50 species of mammals including the highly endangered Asian Elephant are found in the park. Over 300 species of birds, of which about 90 species are migrants including Pochards, Gulls, Mallards, Teals, Shell

ducks visit the water bodies of Bhimgoda and Virbhadra Barrage and wetlands of river Ganga. The species mainly found in the forests are Indian deer (*Axis axis*), Nilgai (*Boselaphus tragocamelus*), wolf (*Canis lupus*), Rabbit (*Oryctolagus cuniculus*), Fox (*Vulpes vulpes*) and Languor (*Semnopithecus schistaceus*). Elephant (*Elephas maximus*) also occasionally descend into the sub-montane area across the Ganga. Game- birds like Peafowl (*Pavo cristatus*), Black partridge (*Melanoperdix niger*), Grey partridge (*Perdix perdix*), Sand goose (*Pteroclididae*), Jungle fowl (*Galloanserae*) and migrant birds like Snipe (*Gallinago gallinago*), Quail (*Coturnix coturnix*) and waterfowls (*Anseriformes*) are also found in these forests. Tigers and leopards have practically seemed to be disappeared in the region.

Industrial Scenario of Haridwar

Haridwar is rapidly developing as an important industrial hub of Uttarakhand since the establishment of State Government Agency, *State industrial development corporation of Uttarakhand Limited* (SIDCUL) and setting up of an integrated Industrial Estate (IIE). Some of the reputed Industries like Indo-Asian Switchgear Limited, Hindustan Unilever Limited, TATA Motors, Reliance, Lotus, Avon, Vijay Electrical, SBL, Hero Honda, Control & Switchgear Limited, ITC, Mahindra & Mahindra etc. have already set up their manufacturing units in the district. Apart from this, the district also comprises of many Industrial and Agricultural sector likes Stone Rolling Mills, Textile Mills, Paper Mills, Sugar Mills, Mentha Oil, Paint Industry Units and Flour and Rice Mills. On the other side, floriculture, rice and wheat production, fish farming sectors etc. have augmented industrial landscape of the region (DIPSR, 2021). Bharat heavy Electrical Limited (BHEL), a Public sector undertaking (PSU) is also located in Haridwar district and is spread across an area of 12 $km^{2.}$

Culture and Tradition

A paradise for nature-lovers, Haridwar presents kaleidoscope of Indian culture and civilization. Considered as one of the seven holy cities of Hinduism, the region has a captivating blend of tradition, history and religion. As per religious beliefs, god has left his footprints in this holy land and the folk songs still chant the incident. Festivals and fairs are integrally associated with the culture of Haridwar. Apart from the usual Hindu festivals, Kavad Mela, Somvati Amavasya Mela and Kumbh mela are celebrated with great enthusiasm and respect.

An inherent part of culture is its Yoga Ashrams. Located amidst the beautiful natural landscapes beside the holy river Ganga, these ashrams are the learning centers of the age old Indian spiritual and physical practice.

ENVIRONMENTAL CONCERNS IN THE DISTRICT

The Haridwar city has a religious significance as the holy Ganga River enters the Indo-Gangetic plains in Haridwar for the first time. Having such a large settlement on its banks in Haridwar, the river is also exposed to contamination. A recent study conducted by the researchers from the Doon University has indicated a very high presence of pollutants in the urban stretches of river Ganga at Haridwar and Rishikesh. The study indicates that millions of pilgrims visiting the two cities, especially Haridwar for the Kumbh Mela are exposed to the high concentrations of pollutants. These pollutants include anti-inflammatory and common antibiotics caffeine and antibacterial medicines. Amongst others, the overall concentration of polypropylene copolymer (PPCP) in the stretch was found to be up to 1104.84 nanograms per litre (District Survey Report, 2018). According to the researchers, mass bathing, urban waste, effluent from domestic sewage treatment plants and effluent treatment plants of the nearby industrial area could be a potential source of PPCPs.

The depletion and contamination of groundwater due to rapid urbanization and industrialization has led to reduction in the flow of the river. Moreover, the water retaining structures such as the Dams and Barrages in the upstream hilly areas of the state are obstructing the natural flow of the river and damaging the riverine ecology. Another major concern is the illegal mining practices in the river despite a ban on mining activities in and around many stretches of the river and the district. *Maitri Sadan,* an ashram in the district has at the forefront in fighting for the restoration of the holy river in the district and elsewhere. Three monks from the ashram even sacrificed their lives for this.

Being a pilgrimage site and one of the holiest places in India, Tourist and pilgrimage influx is experienced throughout the year in Haridwar town. However, infrastructure development has not paced up with such large tourist influx, especially during festive seasons. Furthermore, natural resources have been suffering their worst depletion due to substantial industrialization and commercialization. Air pollution has emerged as a serious concern in Haridwar from the past decades. The situation of air pollution is going from bad to worse in Haridwar city as per the residents and medical experts. Especially in past one decade the holy city has registered escalated respiratory patients. According to a recent report, summers in the town has posed respiratory hazards as the concentration level of PM_{10} and $PM_{2.5}$, the two deadliest components of air pollution increases during that time (CPCB 2020). Heavy tourist influx which accounts for excessive movement of vehicles during that time has been one of the major reason for this problem. If the trend continues, it will lead to disastrous situation choking respiratory tract and causing asthma, warns the experts.

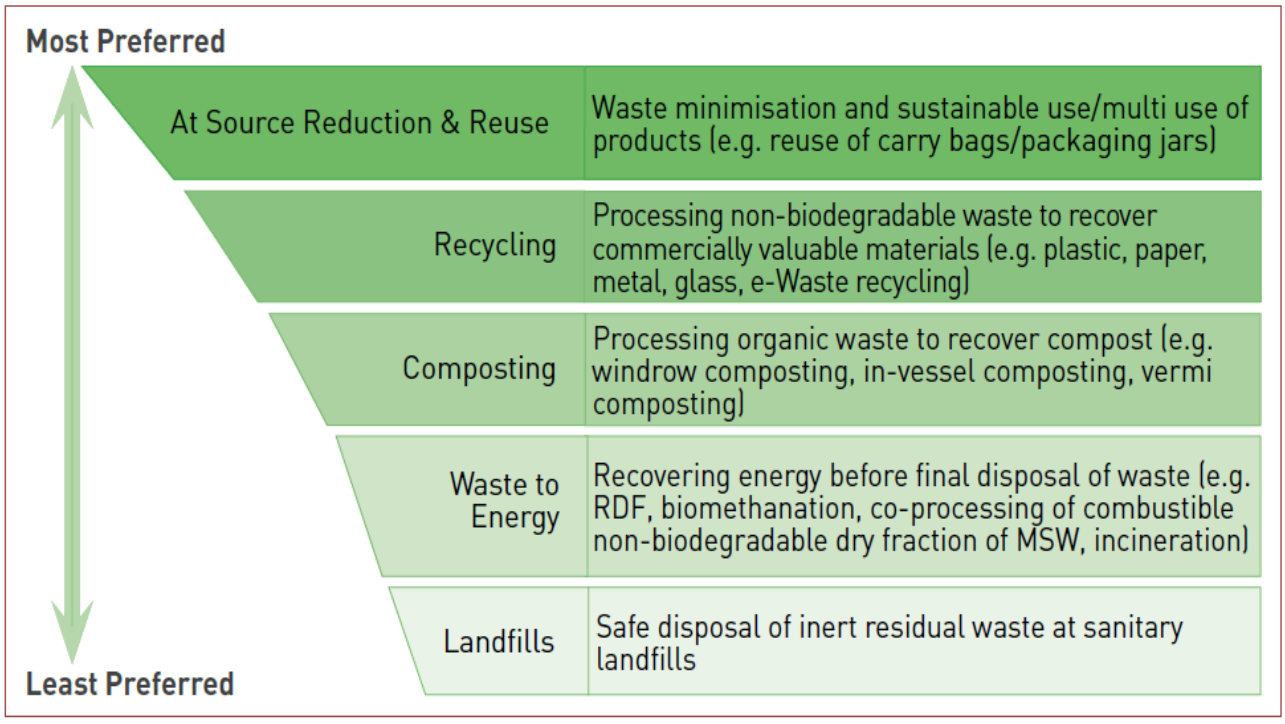
DATA AND IMPACT ANALYSIS

SOLID WASTE MANAGEMENT

Ministry of Environment, Forest and Climate Change (MoEF&CC) defines Municipal Solid Waste (MSW) as commercial and residential waste generated from a municipal area either solid or semi-solid form excluding hazardous waste (Industrial), but including treated bio-medical waste. Predominantly, about 0.17 kg of MSW is generated per capita per day in small towns compared to about 0.67 kg per capita per day in cities. More than 70% of waste in India is considered to be dumped in an unsatisfactory manner (Sharma and Jain, 2019).

Integrated Solid Waste Management (ISWM)

It is based on the waste management hierarchy, with an aim to reduce the amount of waste being disposed while maximizing resource recovery and efficiency (Fig. 2). Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of process and technologies.



(Source: MoHUA, 2016)

Fig. 2. New Waste Management Paradigm

Waste Management in Haridwar district

Large divergence in waste generation is noticeable in Haridwar district pertaining to the fact that some of the areas are developed and rest are in developing stage. Some ULBs have not estimated their dry and wet waste (Table 6). Waste management operations such as door to door collection, sweeping etc., are performed in the district with one of the ULB accomplishing 100% source

segregation (Table 7). Wide anomalies have been observed in disposal of waste as some of the ULBs have established sanitary landfill while few of them are openly dumping their waste which is an area of concern. Some of them have established wet waste composting pits and material recovery facility. (Table 8, and 9)

Table 6. Inventory of total solid waste generation

Name of Urban Local Body	**Population *(2011 census)***	**Number of Wards**	**Solid waste generation *(MTPD)***			
			Dry	**Wet**	***Other waste**	**Total**
Nagar Nigam Haridwar	251197	60	Not estimated	Not estimated	Not estimated	200
Nagar Nigam Roorkee	118188	40	31.95	72	1.05	105
Nagar Palika Parishad Manglaur	52971	20	4	16	NA	20
Nagar Palika Parishad Shivalik Nagar	31600	13	6.5	5	NA	11.5
Nagar Panchayat Laksar	25754	11	1.5	5.625	0.4	7.525
Nagar Panchayat Piran Kaliyar	19201	9	Not estimated	Not estimated	Not estimated	11
Nagar Panchayat Landhora	18370	9	2	5	NA	7
Nagar Panchayat Bhagwanpur	17179	9	4	5	2	11
Nagar Panchayat Jhabrera	11186	9	6	4	Not estimated	10
Cantonment Board Roorkee	14689	7	0.5	3.5	Not estimated	4
BHEL Industrial township Ranipur	46948	13	1.2	6.8	Not estimated	8

(Source: District Administration Haridwar, 2021)

**Other waste may include sanitary waste, domestic hazardous waste, horticulture waste etc.*

Table 7. Waste management operations

Waste Management Operations	**Outcome**			
Segregation at source	No source segregation	Partial segregation *(≤ 50%)*	Partial Segregation *(> 50%)*	Complete source segregation

<table>
<tr><td></td><td>Piran Kaliyar
BHEL Industrial township Ranipur</td><td>Haridwar
Jhabrera
Landhora
Cantonment Board Roorkee</td><td>Roorkee
Manglaur
Laksar
Bhagwanpur</td><td>Shivalik Nagar</td></tr>
<tr><td>Door to Door Collection</td><td colspan="4">All the ULBs except Cantt. Board Roorkee and BHEL industrial township Ranipur have 100 percent coverage for door-to-door collection.
Secondary bins are used to collect the municipal solid waste in BHEL Industrial Township Ranipur.</td></tr>
<tr><td>Sweeping</td><td colspan="4">Sweeping is done manually in all the ULBs except Roorkee where both mechanical and manual sweeping is carried out.</td></tr>
<tr><td rowspan="2">Segregated waste Transport</td><td>Completely Segregated Transport</td><td colspan="2">Partial segregated Transport</td><td>Combined Transport</td></tr>
<tr><td>Shivalik Nagar</td><td colspan="2">Haridwar
Roorkee
Manglaur
Laksar
Bhagwanpur
Jhabrera
Landhora
Cantonment Board Roorkee</td><td>Piran Kaliyar
BHEL Industrial township Ranipur</td></tr>
<tr><td rowspan="2">MRF (Material Recovery Facility) operation</td><td colspan="2">ULBs with installed Material Recovery facility</td><td colspan="2">ULBs without Material Recovery facility</td></tr>
<tr><td colspan="2">Haridwar
Roorkee
Laksar
Cantonment Board Roorkee</td><td colspan="2">Manglaur
Laksar
Bhagwanpur
Jhabrera
Landhora
Piran Kaliyar
BHEL Industrial township Ranipur
Shivalik Nagar</td></tr>
<tr><td rowspan="11">Authorization and issuance of Identity cards to waste pickers/Sanitation workers</td><td colspan="2">ULB</td><td colspan="2">Sanitary workers</td></tr>
<tr><td colspan="2">Nagar Nigam Haridwar</td><td colspan="2">498</td></tr>
<tr><td colspan="2">Nagar Nigam Roorkee</td><td colspan="2">593</td></tr>
<tr><td colspan="2">Nagar Palika Parishad Manglaur</td><td colspan="2">151</td></tr>
<tr><td colspan="2">Nagar Palika Parishad Shivalik Nagar</td><td colspan="2">65</td></tr>
<tr><td colspan="2">Nagar Panchayat Laksar</td><td colspan="2">75</td></tr>
<tr><td colspan="2">Nagar Panchayat Piran Kaliyar</td><td colspan="2">36</td></tr>
<tr><td colspan="2">Nagar Panchayat Landhora</td><td colspan="2">45</td></tr>
<tr><td colspan="2">Nagar Panchayat Bhagwanpur</td><td colspan="2">50</td></tr>
<tr><td colspan="2">Nagar Panchayat Jhabrera</td><td colspan="2">44</td></tr>
<tr><td colspan="2">Cantonment Board Roorkee</td><td colspan="2">50</td></tr>
</table>

	BHEL Industrial township Ranipur	-
Involvement Of NGOs *(Non-Governmental Organizations*) / private agencies	Few ULBs are assisted by private agencies to handle their waste management operations.	
Linkage With Treatment Storage and Disposal Facilities (TSDF) / Bio-Medical Waste Treatment Facility (CBMWTF)	Currently, no ULB has established linkage with Treatment Storage and Disposal Facilities (TSDF) / Bio-Medical Waste Treatment Facility (CBMWTF).	

Table 8. Present infrastructure for waste management

Name of ULB	**Waste collection trolleys**	**Mini collection trucks/ tractors/ others**	**Composting units/ On-site composting facilities**	**Material Recovery Facility (Available/Not Available)**	**Landfills (open dumping/ Trenching Ground/sanitary landfills)**
Nagar Nigam Haridwar	120	106	07	Available	Both Sanitary landfill and Trenching ground
Nagar Nigam Roorkee	90	160	29	Available	Trenching Ground
Nagar Palika Parishad Manglaur	15	10	00	Not Available	Open dumping
Nagar Palika Parishad Shivalik Nagar	12	13	12	Not Available	Open dumping
Nagar Panchayat Laksar	50	15	01	Available	Trenching Ground
Nagar Panchayat Piran Kaliyar	00	14	00	Not Available	Open dumping
Nagar Panchayat Landhora	45	9	35	Not Available	Open dumping
Nagar Panchayat Bhagwanpur	14	04	00	Not Available	Trenching Ground
Nagar Panchayat Jhabrera	00	06	00	Not Available	Open dumping
Cantonment Board Roorkee	10	04	01	Available	Sanitary landfill
BHEL Industrial township Ranipur	00	09	02	Not Available	Open dumping

(Source: District Administration Haridwar, 2021)

Table 9. Methods of treatment, disposal, and recovery

Name of ULB	Wet waste management	Dry Waste Management (waste to Energy/Recycling/incineration/ open Dumping in Trenching ground/ sanitary landfill)	Remediation of the old dump site
Nagar Nigam Haridwar	Windrow composting method is used for wet waste management.	• ULB is working with German firm GIZ for the recovery of recyclable waste. • A sanitary landfill of 10000 MT capacity is used for disposal of inert waste.	Approximately 5 Lakh MT legacy waste is accumulated in the old dump sites at Sarai near Chandighat. A proposal has been sent for remediation of these dumpsites.
Nagar Nigam Roorkee	Composting of wet waste is done by the Nagar Nigam in 39 dedicated composting pits.	• Dry waste after collection is segregated into different categories at a material recovery facility. • Recyclable waste is sold to the two authorized recyclers (Space Society & Midass Greentech). • Residual (Inert waste) is dumped in the trenching ground.	Remediation of old dumpsite spread across 0.16km^2 is under process in the ULB.
Nagar Palika Parishad Manglaur	No dedicated facility is available for the treatment of wet waste.	All the waste generated (both dry and wet) is disposed at an open dumping site.	Around 12285 MT legacy waste is present in the old dumpsite of the ULB which would be sent for the treatment to the proposed waste to energy plant under the Roorkee Cluster.
Nagar Palika Parishad Shivalik Nagar	Composting of wet waste is done in 12 dedicated composting pits.	• Recyclable waste is sent to some recycling facility at Delhi NCR. • Residual/Inert waste is deposited in an open dumpsite.	There is no old dump site within the ULB.
Nagar Panchayat Laksar	• Composting of wet waste is done with the help of a composting machine. • Manure thus produced is either sold or utilized by Nagar panchayat itself.	• Dry waste is segregated into different categories at material recovery facility. • Recyclable waste is sold to local scrap pickers authorized by Nagar Panchayat. • Around 1 MT/Month of plastic waste is sent to the cement plant to be used as fuel.	Remediation of legacy waste was completed two years ago.

Nagar Panchayat Piran Kaliyar	No dedicated facility is available for the treatment of wet waste.	All the waste generated (both dry and wet) is disposed at an open dumping site.	There is no old dump site within the ULB.
Nagar Panchayat Landhora	Decentralized composting is used for the management of wet waste and overall 35 such facilities are present in the Nagar Panchayat.	Dry waste is disposed in open dumpsite.	The remediation of legacy waste is recently started in the ULB.
Nagar Panchayat Bhagwanpur	No dedicated facility is available for the treatment of wet waste in the Nagar Panchayat.	All the waste generated is dumped in the trenching ground.	There is no old dump site within the ULB.
Nagar Panchayat Jhabrera	No dedicated facility is available or the treatment of wet waste in the Nagar Panchayat	All the waste generated (both dry and wet) is disposed in dumping site	There is no old dump site within the ULB.
Cantonment Board Roorkee	Composting facility is available for the management of wet waste.	A Sanitary landfill is available for the disposal of dry waste.	There is no old dump site within the ULB.
BHEL Industrial township Ranipur	A part of wet waste is processed in decentralized composting pits.	All the waste (both dry and wet) is collected from the 300 secondary bins and then disposed in the landfill.	The legacy waste deposited will undergo treatment in the proposed BHEL-Shivalik Nagar cluster-based treatment facility.

Gap identification and proposed policies for effective waste management in Haridwar district

Improper segregation of waste is a common gap identified in almost all ULBs of the district. Most of the ULBs have no material recovery facility, which has become one of the reason for open dumping of waste (Table 10). However; all the ULBs have their DPRs approved to overhaul their waste management operations (Table 11). Some of them have adopted cluster-based approach to revamp and modernize their solid waste management.

Table 10. Gap identification

Name of ULB	Observed Shortcomings	Remarks
Nagar Nigam Haridwar	No estimated quantity of segregated dry and wet waste	Nagar Nigam has not provided the rough estimate of quantity of dry and wet waste generated.
	Partial source segregation of waste	Source segregation is performed in few wards of the ULB. In the rest of the wards, combined waste is collected.

	Partially segregated waste transport	Segregated waste transport corresponds to source segregation. Hence, its viability depends on primary segregation.
	Remediation of legacy waste is not initiated	A proposal is sent for remediation of the legacy waste.
Nagar Nigam Roorkee	Partial source segregation of waste	ULB is expecting to achieve the target of complete source segregation in near time.
	Partially segregated waste transport	Segregated waste transport is carried out in the majority of the regions, only a few areas are left to cover.
Nagar Palika Parishad Manglaur	Partial source segregation of waste	Source segregation is not performed in a few wards. However, ULB is aiming for complete source segregation.
	Partially segregated waste transport	Segregated waste transport corresponds to source segregation. Hence, its viability depends on primary segregation.
	Non-availability of any waste recovery facility	The waste processing facility is proposed under the Roorkee cluster.
	No facility for the treatment of wet waste	Both dry and wet waste is dumped in the open landfill site.
	No involvement of NGO/Private agencies	The assistance of expert private agencies is desired to improve waste management operations.
	No linkage established with authorized waste recyclers	Some of the waste is collected by local rag pickers which are not authorized so far.
	Open dumping of municipal solid waste	Lack of scientific disposal facilities is exaggerating the situation.
	Remediation of legacy waste is not initiated	Remediation will begin once the waste processing plant under the proposed Roorkee cluster will be started.
Nagar Palika Parishad Shivalik Nagar	Non-availability of any waste recovery facility	Waste recovery and processing facilities are proposed under BHEL & Shivalik Nagar cluster.
	Open dumping of municipal solid waste	Lack of scientific disposal facility is the main reason behind it.
Nagar Panchayat Laksar	Partial source segregation of waste	ULB is trying hard to achieve the target of complete source segregation.
	Partially segregated waste transport	Segregated waste transport corresponds to source segregation. Hence, its viability depends on primary segregation.
	No linkage established with authorized waste recyclers	Recyclable waste is sold to local rag pickers, which are not authorized so far.
Nagar Panchayat Piran Kaliyar	No estimated quantity of segregated dry and wet waste	Nagar Panchayat has not provided the rough estimate of quantity of dry and wet waste generated.
	No source segregation of waste	Lack of awareness could be the reason behind it.
	No segregated waste transport	Combined waste is transported to the dump site.

	Non-availability of any waste recovery facility	ULB will be clubbed under the Roorkee cluster for waste processing.
	No facility for the treatment of wet waste	All the waste (both dry and wet) is dumped in the open dumpsite.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No linkage established with authorized waste recyclers	Local Scrap pickers collect the recyclable materials from the dumpsite.
	Open dumping of municipal solid waste	Lack of scientific disposal facility could be the reason.
Nagar Panchayat Landhora	Partial source segregation of waste	Lack of awareness among the community could be the reason.
	Partially segregated waste transport	Due to partial source segregation, it is difficult to achieve complete segregated waste transport.
	Non-availability of any waste recovery facility	ULB will be clubbed under the Roorkee cluster for waste processing.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No Linkage established with authorized waste recyclers	Unauthorized rag pickers collect the recyclable materials from the dumpsite.
	Open dumping of municipal solid waste	Lack of scientific disposal facility is the main reason behind it.
Nagar Panchayat Bhagwanpur	Partial source segregation of waste	Most households practise source segregation.
	Partially segregated waste transport	Some part of the waste is transported in the combined form.
	Non-availability of any waste recovery facility	ULB will be clubbed under the Roorkee cluster for waste processing.
	No facility for the treatment of wet waste	All the waste (both dry and wet) is dumped in the trenching ground.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No linkage established with authorized waste recyclers	Unauthorized rag pickers collect the recyclable materials from the dumpsite.
Nagar Panchayat Jhabrera	Partial source segregation of waste	Lack of awareness among the community could be the reason behind it.
	Partially segregated waste transport	Due to partial source segregation, it is difficult to achieve complete segregated waste transport.
	Non-availability of any waste recovery facility	ULB will be clubbed under the Roorkee cluster for waste processing.
	No facility for the treatment of wet waste	Both dry and wet waste is dumped in the open landfill site.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No linkage established with authorized waste recyclers	Unauthorized rag pickers collect the recyclable materials from the dumpsite.

	Open dumping of municipal solid waste	Lack of scientific disposal facility could be the reason.
Cantonment Board Roorkee	Partial source segregation of waste	Waste is completely segregated in the final segregation site.
	Partial coverage for door to door collection	Secondary bins are also there in the Cantonment area to collect the waste.
	Partially segregated waste transport	Due to partial source segregation, it is not possible to implement completely segregated waste transport.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No linkage established with authorized waste recyclers	All the waste is dumped in the sanitary landfill site.
BHEL Industrial township, Ranipur	No source segregation of waste	As door to door collection of waste is not functional in the ULB, hence source segregation cannot be ascertained. It is totally on the discretion of the household.
	No door to door collection	300 secondary bins are there in the township to collect the waste.
	No segregated waste transport	Waste is collected in combined form from the bins installed within the township.
	Non-availability of any waste recovery facility	The waste processing facility is proposed in a cluster with Shivalik Nagar.
	No involvement of NGO/Private agencies	ULB is performing all the waste management operations by itself.
	No linkage established with authorized waste recyclers	All the waste is deposited in the landfill site and will be processed once the waste processing facility will start.
	Open dumping of municipal solid waste	Lack of scientific disposal facility could be the reason.

Table 11. Proposed policies and budget requirements put forward by different stakeholders in the district

Proposed Policy	Stakeholders Responsible	Proposed Activities
Revamping Solid waste management in Nagar Nigam Haridwar	Nagar Nigam Haridwar	• ULB is planning to achieve 80% source segregation within one year. • At least 80% waste processing and user charge collection is targeted for the year 2022. • Sanitary Landfill site phase-2 is expected to be complete soon. • DPR for ramping up waste management operations is approved.

Revamping solid waste management in ULBs grouped under the Roorkee cluster (Roorkee, Manglaur, Piran Kaliyar, Landhora, Bhagwanpur, Jhabrera)	State Government	• Waste to energy plant is proposed for the Roorkee cluster, for which many ULBs are clubbed. • Remediation of the legacy waste is also proposed to be done in this plant.
Revamping solid waste management in Shivalik Nagar and BHEL Industrial Township	State Government	A common solid waste processing facility is proposed for Shivalik Nagar and BHEL Township. Land will be provided by BHEL and the required funds will be provided by the state government. Nagar Palika Parishad Shivalik Nagar will run this facility.
Ramping up solid waste management in Nagar Panchayat Laksar.	Nagar Panchayat Laksar	• Renovation and complete modernization of integrated solid waste management (ISWM) facility is proposed. It is expected to be achieved by 2023. • Establishment of a solid waste management-training centre. • Complete Mechanisation of street sweeping up to 2023.
Ramping up solid waste management in Cantonment Board Roorkee.	Cantonment Board Roorkee	• ULB is targeting to achieve the status of ODF+ in the next year. • ULB is also aiming to achieve the target of the seven-star garbage rating up to 2025.

SUCCESS STORY – Swachh Laksar Pariyojna (Nagar palika parishad Laksar)

Nagar Palika Parishad Laksar in collaboration with EnviGrow Sustainable Solutions LLP has initiated Swachh Laksar Pariyojna to transform existing landfill into zero waste system. They are managing the waste through their innovative "S2CE" zero waste model.

Glimpses of the project

- Waste audit is conducted for scientific analysis of waste. This helps to understand nature of the waste, composition, recycling potential and selection of treatment technology.
- Single compartment vehicle is modified into two-component vehicle for segregated waste collection. Moreover, these vehicles are monitored through GPS and android based mobile application.
- Nagar Palika Parishad Laksar has been successful in diverting almost 10 tons of dry waste from the landfill.
- SWM workers, which are also recognized as "Swachhata Sathi" have been issued apron, safety kits and ID cards. Regular campaigns are organized regularly to create awareness among citizens and a level of responsibility in sanitation workers (Fig. 3).

Fig. 3. Solid Waste Management in Nagar Palika Parishad Laksar

Rural Solid Waste Management

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As per reported by *Ministry of Drinking Water and Sanitation* (MDWS) about 0.3 to 0.4 million metric tonnes of solid waste is generated in rural India every day. With the objective of achieving ODF plus status and to improve cleanliness, hygiene and the general quality of life in rural areas, the aspect of Solid and Liquid Waste Management (SLWM) assumes greater significance. Most of the solid waste generated in rural areas can be reused after generation, because of that generation rate of rural areas is much less as compared to urban areas.

Current standpoint about Rural Waste Management in India

Rural waste has distinct characteristics as compared to urban waste in terms of composition and its types. Here, majority of the waste belongs to biodegradable category. In view of management, the rural areas are yet to formalise their solid waste management operations, hence it cannot be easily quantified.

- According to 2011 census, 68.84% of total population in India lives in rural areas, which generate almost 0.3-0.4 million metric tonnes of waste per day.
- Due to lack of commercial development, rural solid waste only contains Domestic waste (92.4%) as a major contributor to the total waste generated.
- Rural community produces comparatively more biodegradable waste (63.5%) compared to non-bio-degradable waste (36%).
- About 78% of the rural population use open dumping for storage and collection of solid waste.

Vegetation suitable for rehabilitation of dumping sites

Phytoremediation, collectively referring to all plant based technologies, uses green plants to remediate contaminated sites (Sadowsky, 1999). Natural or planted vegetation on landfill sites has a key role in soil erosion control and removal of contaminants, besides imparting aesthetic value (Table 12). Moreover, it may be used in leachate treatment. Landfill vegetation often shows signs of damage commonly caused by the presence of landfill gas in the root protection zone. The aim for the reconstruction of a suitable medium for landfill re-vegetation is to provide a cover that is deep and as favourable to root growth as is necessary to achieve desired plant performance (Nagendran et al, 2006). In this context, locally available species could be hardened and resistant in reclaiming the waste dump problem.

Table 12. Vegetation suitable for rehabilitation of dump sites

Botanical Name	Local and English Name	Assimilating capacity	Altitude (m)	Site/ Location
Populus nigra L.	Popular	Accumulation of Cd, Pb, As, and Ni	100-1800	Houda et al, 2016
Populus alba L.	Black popular	Accumulation of Cd and Pb	100-1400	Houda et al, 2016
Mangifera indica	Mango	Absorb dust particles	100-1200	Shukla, et al, 2019
Delonix regia (Bojer ex Hook.) Raf.	Gulmohar	Accumulation of (Cd, Pb, Zn and Cu)	250-1250	Ukpebor et al, 2010
Cynodon dactylon (L.) Persoon	Dubla, Doob	Absorbs Arsenic and Fluoride from wastewater	400-2500	Chaphekar, et al., 1980
Cassia fistula L.	Amaltas	Absorbs Arsenic and Fluoride from wastewater	100-1500	Houda et al, 2016

Projected Population and Solid Waste Generation in Haridwar District

Projecting waste quantities in a near future is as difficult as predicting changes in waste composition for a locality or town. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste bulk density. Generally, lower is the level of economic development, greater will be the change between waste generation and disposal.

In the present context, population Census data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste generation projection is done based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant
- In view of changing waste paradigm and floating population, 1.5% yearly growth in per capita waste generation is assumed.
- Analysis includes population and waste generation estimations for only urban local bodies and does not include peri-urban and rural areas. (Table 13 and 14).

Table 13. Projected population and waste generation

ULB	**Projected Population**			**Existing/Projected Waste Generation (MTPD)**		
	2021	**2031**	**2041**	**2021**	**2031**	**2041**
Nagar Nigam Haridwar	324885	398573	472261	200.00	282.17	377.94
Nagar Nigam Roorkee	138860	159532	180204	105.00	138.73	177.14
Nagar Palika Parishad Manglaur	63358	73745	84132	20.00	26.77	34.52
Nagar Palika Parishad Shivalik Nagar	46338	60176	74014	11.50	17.17	23.88
Nagar Panchayat Laksar	33266	40778	48290	7.53	10.61	14.20
Nagar Panchayat Piran Kaliyar	25797	32393	38989	11.00	15.88	21.61
Nagar Panchayat Landhora	20704	23038	25372	7.00	8.96	11.15
Nagar Panchayat Bhagwanpur	22499	27819	33139	11.00	15.64	21.06
Nagar Panchayat Jhabrera	12988	14790	16592	10.00	13.10	16.61
Total				**365.03**	**529.03**	**698.11**

Table 14. Projected decadal change in solid waste generation

Name of ULB	%age Rate of Growth (2021-2031)	%age Rate of Growth (2031-2041)
Nagar Nigam Haridwar	4.10	3.39
Nagar Nigam Roorkee	3.21	2.76
Nagar Palika Parishad Manglaur	3.38	2.89
Nagar Palika Parishad Shivalik Nagar	4.93	3.90
Nagar Panchayat Laksar	4.09	3.38
Nagar Panchayat Piran Kaliyar	4.44	3.60
Nagar Panchayat Landhora	2.79	2.44
Nagar Panchayat Bhagwanpur	4.21	3.46
Nagar Panchayat Jhabrera	3.09	2.68

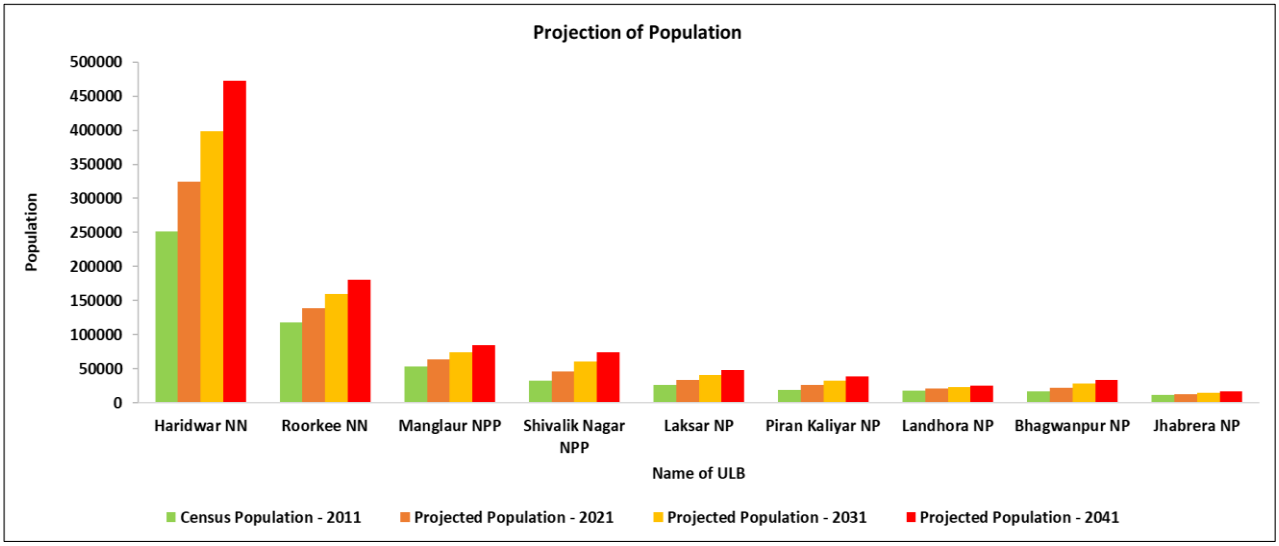


Fig. 4. Geographical representation of projected population

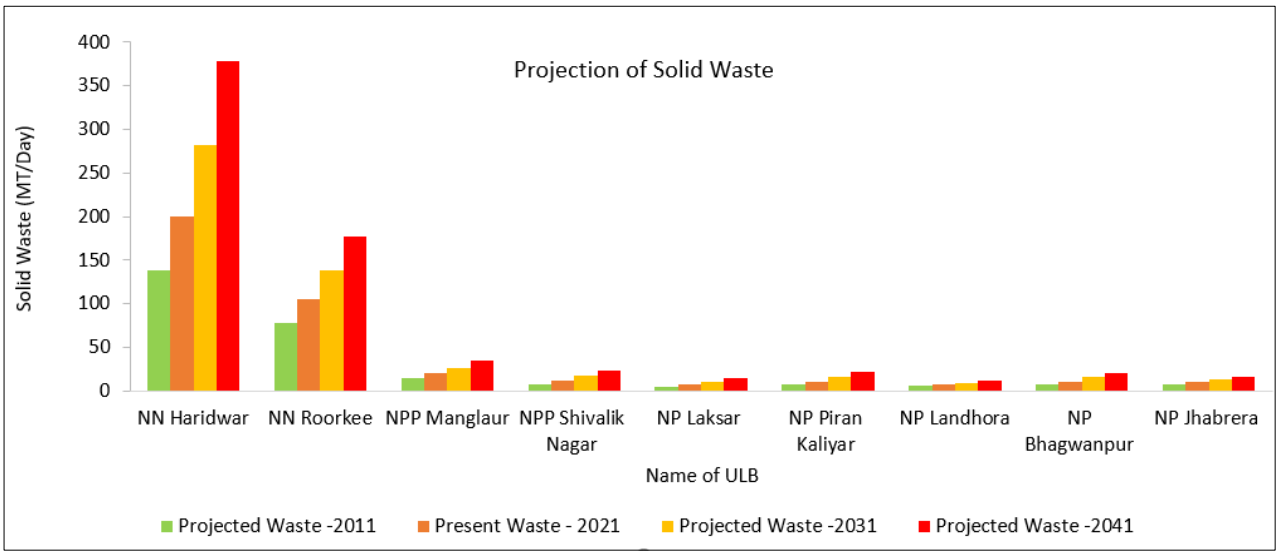


Fig. 5. Projected solid waste generation

Inferences drawn from the projection of waste

- Solid waste generation in the district is expected to rise in coming decades and would cross 500 MTPD by 2031.
- Nagar Nigam Haridwar and Nagar Nigam Roorkee contributes for more than half of the solid waste generated in the district.
- 3 to 4 % growth rate in solid waste generation is expected in coming decades.
- Increased urbanization will change the waste composition in the district. The quantity of wet waste may decrease; however, there would be increase in e-waste, hazardous waste generation, plastic waste etc.

.

BIO MEDICAL WASTE MANAGEMENT

According to latest biomedical waste management rules (published in 2016 and amended in 2019), biomedical waste is defined as such waste that is generated during diagnosis, treatment or immunization of human beings or animals, or in research activities pertaining thereto or in the production or testing of biological experiments. The fact sheet of WHO states that 20% of the total waste generated by health care activities is hazardous. All the biomedical waste generated is essential to be properly collected, segregated, stored, transported, treated and disposed of in a safe manner to prevent spreading infectious diseases. The health system of Uttarakhand constitutes a large network of health care facilities based on three-tier system that comprises of district level health care facilities (District hospitals, base hospitals, etc.), community health care centres (CHCs), and primary health care centres (PHCs). Biomedical waste generation has shown a wide variation in Uttarkhand due to its typical physiographical conditions and changing density of population. Handling and disposal of biomedical waste is done as per BMW rules, 2016 (Fig. 6).

(*Source: CPCB, 2019*)

Fig. 6. Segregation of biomedical waste as per BMW rules, 2016

Importance of Biomedical Waste Management in the Wake of Pandemic

Due to the onset of covid pandemic, biomedical waste generation increased worldwide. Similar trend was also observed in our country from 2019 to 2021. The daily biomedical waste generation increased from 619 MTPD to 800 MTPD in India (CPCB, 2021) and from 3.8 MTPD to 6.26 MTPD in Uttarakhand state (ENVIS, 2020). In Almora district, the daily biomedical waste generation increased by four times during the peak of the pandemic situation. At present, the biomedical waste is being generated not only from the health care facilities but also from the quarantine centres, and

residential areas where patients were in a home isolation. Bio-medical waste ought to be segregated in the households as well as from the municipal solid waste. Thus, it has to be properly disposed of to get rid of the risks of infection among the workers handling the municipal solid waste in urban local bodies.

Biomedical waste management in Haridwar district

Quite a few government and private healthcare facilities are available in Haridwar district and almost 80% of them are authorised by Uttarakhand pollution control board (UKPCB). (Table 15). Maximum healthcare facilities have established linkage with CBMWTF, which is subjected to routine inspection.

Table 15. Inventory of current healthcare infrastructure for Bio-medical waste Management

S. No.	Parameter	Outcome	
1.		**Facility**	**Numbers**
	Health-care facilities in the district	Govt. Bedded HCFs	48
		Private bedded HCFs	153
		Govt. Non-bedded HCFs	12
		Private Non-bedded HCFs	113
		Veterinary Hospitals	17 (16+ 01 Mobile veterinary hospital)
		Pathology Labs	67
		Dental Clinics	32
		Blood Banks	01
		Bio-research labs	01
		Others	Govt. Ayurvedic HCFs- 28 Other HCFs not applied- 51
		Total	***523***
2.	Number of health care facility authorised by SPCB/PCC	***Facility***	***Numbers***
		Govt. Bedded HCFs	38
		Private bedded HCFs	138
		Govt. Non-bedded HCFs	12
		Private Non-bedded HCFs	110
		Private Ayurvedic Bedded HCFs	05
		Private Ayurvedic Non- Bedded HCFs	01
		Govt. Veterinary HCFs	09
		Blood Bank	01
		Private pathology labs	64
		Private dental clinics	32
		Bio Research Labs	01
		Total	***411***

3.	Linkage with Common Bio-medical Waste Treatment Facility (CBMWTF)	472 Health care facilities are linked to Medical Pollution Control Committee (MPCC), Mandawar, Bhagwanpur, District. Haridwar. However, no ULB has established linkage with CBWTF for biomedical waste management.
4.	Capacity of Common Bio-medical Waste Treatment Facility (CBMWTF)	MPCC receives Bio medical waste of entire Garhwal Region, therefore capacity is assessed with respect to total waste received from other districts also.
5.	Captive disposal facilities	NIL

(*Sources: Health Department of Haridwar 2021*)

Prevailing Bio-Medical Waste Management in the District

- Presently, 523 HCFs have been inventorized by the State Pollution control board, out of which 411 HCFs have valid authorization /consent to operate. Notice has been issued to rest of HCFs. Before issuing, it is mandatory to get membership of CBWTF in order to ensure proper collection of bio-medical waste generated by HCFs
- GPS system enabled vehicles are used in order to ensure proper tracking of waste.
- Routine inspection of CBMWTF is being done by the head office and regional office.

Current Status and proposed policies for Biomedical waste management in Haridwar District

Unlike in other districts, the biomedical waste is segregated in healthcare facilities according to latest Bio-medical waste management rules, 2016. Waste is segregated into different categories according to composition and then lifted to CBMWTF at Bhagwanapur (Table 16).Some policy interventions are proposed for enhancing biomedical waste management operations (Table 17).

Table 16. Current status of biomedical waste management

S. No.	Action areas	Outcomes	
1.	Composition of Bio-medical waste	Bio-medical waste generally comprises of Discarded blood, used bandages, Used dressings, discarded Gloves and other medical supplies.	
		Category	**Percentage (%)**
		Yellow Category	22.90
		Red Category	19.15
		White category	0.0624
		Blue category	57.88
2.	Daily Bio-medical waste lifting by Common Bio-medical waste treatment facility (CBMWTF)	**Category**	**Kg/day**
		Yellow Category	550
		Red Category	460
		White category	1.5
		Blue category	1390

3.	Adequacy of facilities to treat biomedical waste	In case of Haridwar district, the capacity seems to be adequate.
4.	Pre segregation of waste by Health care facilities.	100%
5.	Segregation of BMW as per guidelines of BMW rules, 2016	In Practice
6.	Tracking of biomedical waste (Implementation of bar code system for tracking)	Partially (Almost 50%)
7.	Expenditure regarding handling and treatment of Bio-medical waste	Common bio-medical waste treatment and disposal facility is being operated by the private entrepreneur. Private party collects, transports, treats and dispose bio-medical waste from health care facilities and charge some fees as per their mutual consent. (Generally private party and Indian Medical Association decide charges of Bio-medical waste on mutually agreed basis. However, in case of any dispute, UKPCB may intervene foe smooth functioning).

Table 17. Proposed Policies and Budget Requirement from Health Department for Bio-medical waste management

Proposed Policy	Stakeholder
Third party verification of Common Bio-medical Treatment and disposal facilities.	Health Department and UKPCB
Bar-code tracking with 100% coverage	Health Department and UKPCB

CONSTRUCTION & DEMOLITION WASTE MANAGEMENT

Construction and Demolition (C&D) waste is produced in the construction, remodelling, repair and demolition of residential / commercial buildings and other structures and pavements. C&D waste mainly consists of concrete, bricks, sanitary ware, glass, steel, plastic, etc. (Table 18). According to a general estimate, 40% of the total C&D waste originates from renovation work, while 50% from the demolition work and remaining 10% from new construction work (CPCB, 2020) (Table 19).

Implementation of 3R Principle in C&D Waste Management

Construction and demolition waste is inert in nature. It does not create chemical or biochemical pollution .Hence in view of its management, maximum emphasis should be given on 3R Principle. The concept of 3R, which refers to reduce, reuse and recycle particularly in the context of production and consumption is well known today. Waste reduction is presumed to be optimal measure for C&D waste management due to its minimal adverse impact on environment. Applicable building materials can be reused for original activity or to fulfil any other purpose. Steel, doors and windows, wood, bricks and other construction items can be easily taken out and again put to reuse without much processing. The last but not least step is to recycle the C&D waste considered fit for recycling. This is usually done by converting the waste into recycled sand and aggregates that have various construction applications. This principle can be applied to the entire life cycle of products and services – starting from design and extraction of raw materials from collection to transport, and then manufacturing, practicing scientific disposal. Hence, it is evident that application of 3R principle would help reduce the C&D waste in the construction industry.

Present State of Affairs

- According to a report by Transparency Market Research (2016), the volume of construction waste generated worldwide every year will nearly double to 2.2 billion tonnes by 2025 (CWM, 2020).
- Our country generates 150 million tonne/year C&D waste but the official recycling capacity is a meagre 6500 tonnes/day or just about 1% (as per building material promotion council (CWM, 2020).

Table 18. Characteristics of C&D Waste in India

Debris type	Percentage (%)
Wood	42.4
Drywall	27.3
Concrete	12.0
Brick and Other Mixed Debris	7.3
Cardboard	5.4

Metals	1.8
Asphalt	1.4
Plastic & Foam	1.4
Other packaging	0.6
Textiles	0.4

Table 19. Thumb rule for estimation of C&D waste generation for India

Range	Type of construction
40-60 kg/m^2	New construction
40-50 kg/m^2	Building repair
300-500 kg/m^2	Demolition of building

Present Infrastructure within the State

- Currently, no treatment facility is available in the state for processing the C&D waste.
- In hilly districts, ample dumping zones are not established due to which waste is dumped at
- As C&D waste management is not initiated in the state, hence it is not possible to assess the total amount of waste generated.

C&D Waste Management in Haridwar district

Construction and demolition waste is not yet quantified in the district despite rapid infrastructure development in the district. Only one dumping zone is established until date (Table 20). This has led to rampant C&D waste disposal in riverbanks and other non-designated places (Table 21).

Table 20. Current status related to C&D waste generation

S. No.	Action Areas	Outcomes/Remarks
1.	Quantity of C&D waste generated *(KGPD)*	Not estimated as no collection initiated. However, the quantity is assumed minimal.
2.	Collection of C&D waste	None of the ULBs have initiated the collection of C&D waste in the district.
3.	Establishment of Deposition points/Dumping Zones	One deposition point is established in Sherpur Roorkee.
4.	Establishment of Linkage with any C&D waste recycling facility	There is no C&D waste treatment facility in the district. Moreover, none of the ULBs have linkage with any common C&D waste treatment facility.

Table 21. Gap Identification

S. No.	Observed shortcoming	Outcome/Remarks
1.	Quantification of C&D waste.	As the collection of C&D waste is not initiated hence quantification of C&D waste generated in the district is not possible.
2.	Establishment of collection centre /Deposition points/Dumping Zones.	Lack of dumping zones leads to accumulation of C&D waste in public places and non-designated places.
3.	Implementation of by-laws for C&D waste management.	Due to lack of awareness regarding C&D waste management, it is not properly segregated, and as of now the process of implementing by-laws for the C&D waste management is not initiated by any of the ULBs within the district.
4.	Lack of strategies for C&D waste management.	Due to a lack of strategies for C&D waste management, dumping of C&D waste is done along the banks of rivers which distorts the river profile.

C&D Waste Management in Rural Areas

In the rural areas of Haridwar district, construction work is observed to be limited. Therefore, minimal amount of C&D waste is generated which mainly consists of the soil excavated from the foundation trenches and stones from the hill slopes. This excavated soil is reused in filling the plinth and trenches or many times used in filling the low-lying area. Stones obtained from the hill slopes are used in masonry work. There is an issue of improper dumping of muck dumping along the river banks or seasonal streams (khads) or construction of roads. These issues need to be addressed within a strategy for managing construction and demolition waste.

HAZARDOUS WASTE MANAGEMENT

Hazardous Waste is any waste which because of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment (whether alone or in contact with other wastes or substances). State Pollution control board (SPCB) is responsible for tabulation of hazardous waste generating units and quantification of waste generated in respective state. Hazardous industrial wastes in India can be categorized broadly into two categories as under:

- Hazardous wastes generated from various industries in India.
- Hazardous industrial wastes transported to India from the western countries for re-processing and recycling.

Present state of affairs

- Almost 9 MMT of hazardous waste was generated in India in the year 2020. Half of the hazardous waste generated was utilizable (Table 22).
- Hazardous and Other wastes (Management and Transboundary Movement) rules, 2016 govern the collection, transfer, Processing, treatment and disposal of hazardous waste.
- The rules were amended on March 2019 keeping in consideration the ease of doing business, boosting make in India initiative by simplifying the procedures, while at the same time upholding the principles of sustainable development.
- According to CPCB Report 2019-20, there are 69,308 hazardous waste generating units in India having authorized annual capacity to generate about 39.46 million MT of hazardous waste. However, about 8.78 million MT hazardous waste was generated during 2019-20, based on the annual returns submitted by such units (CPCB, 2020).

Table 22. Hazardous waste generation in India

Type of hazardous waste	Quantity/Year (MMT)	Total waste (%)
Land-fillable	2.13	24.29
Incinerable	0.40	4.52
Recyclable	2.07	23.59
Utilizable	4.18	47.60

Source: (CPCB, 2020)

Hazardous waste management in Haridwar district

Industrial processes are the main source of hazardous waste in the district. Much of the hazardous waste generated is quantifiable and is managed according to Hazardous and Other wastes (Management and Transboundary Movement) rules, 2016 (Table 23). TSDF is also available in the

district, which facilitates scientific management of hazardous waste in Haridwar district (Table 24). However, verification of records and inclusion of hazardous waste generated in automobile industries needs consideration (Table 25).

Table 23. Inventory of Hazardous waste in the district

S. No.	Parameter	Present status			
1.	Quantity of Hazardous waste generated in the district. (MT/Year)	Incinerable	Landfillable	Recyclable/ Reusable	**Total**
		3875.2	11490.9	15084.83	**30450.93**
	Quantity of Waste Processed (MT/Year) (Listed under Schedule - IV Hazardous waste)	Recycled		162.2	
		Utilized (Co-processed in Cement Klin)		814	
		Disposed is secured landfill		1471.9	
		Disposed through incinerator		2369.2	
2.	Total number of units authorised under Hazardous Waste Management Rules, 2016	2146 (Each industry has display board of Hazardous Waste generation in front of gate)			
3.	Number of Hazardous waste Dumpsite	01			

Table 24. Current status related to Hazardous waste management

S. No.	Action Areas	Outcome And Remarks
1.	Method of Disposal	Incinerable and land fillable waste is disposed through Common Treatment, Storage and Disposal Facility (TSDF) and recyclable hazardous waste is being recycled through registered recyclers located within the state and outside the state.
1.	No. of captive / common TSDF (Treatment storage and disposal facilities) in the district.	One (M/s Bharat Oil & Waste Management Ltd. Mauza Mukimpur, Roorkee-Laksar Road, Roorkee, Haridwar)
2.	Industries Linkage with common TSDF	519 Units (Almost 1627 units generate recyclable/co-process/ own utilization waste, hence they do not require linkage with Common TSDF. They can dispose their waste through registered/authorized recycler/co-processor).
3.	Number of ULBs linked with common TSDFs	No ULB in the district is linked with common TSDFs.
4.	Contaminated sites/probable contaminated sites within the district	A premise of M/s Rishabh Velveleen Limited, Village Ibrahimpur, Roorkee, Haridwar has been identified as Contaminated site.

		Details of site:	
		Latitude	29º55’28’N
		Longitude	78º04’41’E
5.	Regulation of industries & facilities generating Hazardous waste	Industries generating hazardous waste are regularly monitored by state pollution control board.	
6.	Compliance with Hazardous Waste and Management Rules,2016	All the industries adhere to the Hazardous waste management rules, 2016. Following are some notable areas where compliance is done: • Annual inventory submitted by the units with respect to quantity of hazardous waste generated, daily records etc. • Directory of Hazardous waste generating units in service sector and domestic hazardous waste. • Hazardous waste disposed/stored by generator and received by common Treatment, storage and disposal facility (TSDF). • Display board, adequate collection and storage facility within generator premises.	

Table 25. Gap Identification

Observed Shortcomings	Remarks
Verification of record with respect to generation/storage and disposal by the generator.	Random verification of industries generating hazardous waste with respect to the manufacturing process is required.
Record of Hazardous waste generated in service sector especially in the Automobile sector.	Identification of hazardous waste generating units in the service sector, physical verification of quantity and type of waste is required.
Estimation of quantity of hazardous waste within waste generator premises.	Special/technical support in the field of hazardous waste management is required.
Lack of Instrumentation and additional infrastructure.	Technical support in terms of following points is required. • Identification of Probable contaminated site due to improper handling of hazardous waste. • Reclamation of contaminated sites.

ELECTRONIC WASTE MANAGEMENT

The Discarded and end-of-life electronics products ranging from computers, equipment used in Information and Communication technology (ICT), home appliances, audio and video products and all of their peripherals are known as Electronic waste (E-waste). Computer devices contributes to almost two third of electronic waste in India (Table 26). It is categorised into 21 types under two broad categories:

- Information technology and communication equipment.
- Consumer electrical and electronics.

The ill effects of e-waste could be on soil through leaching of hazardous contents from landfills; in water due to recycling process *(if not carried our properly),* through inhalation of gases during recycling, contact of the skin of the workers with hazardous substances and contact during acid treatment used in recovery process (EEMI, 2018).

Government of India has notified E-Waste Management Rules 2016, which are expanded to manufacturer, dealer, re-furbisher and Producer Responsibility Organization (PRO) of components, consumables, spares and parts of Electronics and Electrical Equipment (EEE) in addition to equipment as listed in Schedule I appended with the rules. Moreover, Compact Fluorescent Lamps (CFL) and other mercury containing lamps are also brought under the provisions of these Rules**.** Amendments were further made on March 2019 with the objective of channelizing the E-waste generated in the country towards dismantlers and recyclers in order to formalise the e-waste recycling sector.

Table 26. Bifurcation of E-waste based on electronic appliances

Types of Waste	Contribution (%)
Computer devices	70
Telecom sector	12
Medical equipment	7
Electric equipment	8
Others	3

(Garg, 2019)

Worldwide Scenario

- Electronics and Electrical Equipment (EEE) are manufactured and disposed worldwide. In 2016, 44.7 Million Metric Tons (MMT) of e-waste was generated worldwide *(equivalent to 6.1kg/inhabitant)*. Following the current growth rate of rising e-waste, it is estimated that by 2021, quantity has already risen to 52.2 Million Metric Tons or 6.8 kg/inhabitant.

- Out of the total e-waste produced in 2016, only 20% (8.9 MT) is documented to be collected properly and recycled, while there is no record of the remaining e-waste. The quantity of e-waste generated worldwide is expected to grow at a rate of 3.15% (CAGR).

Indian Scenario

- According to Central Pollution Control Board (CPCB), India generated more than 10 Lakh tonnes of e-waste in 2019-20. Against this, the e-waste dismantling capacity has not been increase from 7.82 lakh tonnes since 2017-18
- In 2018, the Ministry of Environment had told the tribunal that 95% of e-waste in India is recycled by the informal sector and scrap dealers unscientifically dispose of it by burning or dissolving it in acids.
- India has emerged as fifth largest Electronic waste producer in world. City-wise, Mumbai tops the list in producing electronic waste, followed by New Delhi, Bangalore and Chennai.
- The government offices, public and private sector companies generate nearly 75% of e-waste; with the contribution of individual household only being 16%.
- India's first e-waste clinic for segregating, processing and disposal of waste from household and commercial units has been set-up in Bhopal, Madhya Pradesh.

E-waste Management in Haridwar district

E-waste management is still in its early phase in the district. It comes under the mandate of UKPCB which measures its quantity on monthly basis (Table 27). However, due to expected increment in e-waste generation in near future, certain activities such as primary segregation, establishment of collection centres, etc. needs deliberation by the respective authority (Table 28).

Table 27. Current standpoints regarding E-waste generation and collection

S. No.	Parameter	Outcome & Remarks	
1.	Quantity of E-waste generated per month.(MT/Month)	1354.93	
2.	Toll-free number in the district for the citizens to deposit E-waste.	Not initiated	
3.	Collection centre established by ULBs in the district.	At present there are no collection centre established by any of the ULBs or the district administration.	
		Name of the recycler and dismantler	**Quantity of waste collected on average basis (MT/Month)**

4.	Authorized E-waste Recyclers/dismantlers in the district	Attero Recycling Pvt. Ltd. 173, Raipur industrial area, Bhagwanpur, Roorkee, Haridwar.	1182.46
		Bharat Oil and waste management Ltd. Mauza Makhimpur, Roorkee, Laksar road, Haridwar	4.04
		Resource E-waste Solutions Pvt. Ltd., F-97, Industrial area, Bahadrabad, Haridwar	120
		Scarto Metal Recycle Plant,Kh no. 314, Kh.Village Mehwar Khurd, Mangalore, Haridwar	47.94
		Anmol Paryavaran Sanrakshan Samiti, Kh No. 85/2, 87/1, Daulatpur, Bhagwanpur	0.56
		Total = 5 Authorised Recyclers and Dismantlers	
5.	Linkage with any E-waste recycling facility	District has linkage with all the 5 Authorised Recyclers and Dismantlers	
6.	Control over illegal trading or processing of E-waste in the district.	Controlled	
7.	Total number of Bulk Consumers / Producers/ Manufacturer who submitted annual returns	15 Units including Central government or State Government departments, public sector undertakings, banks ,educational institutions, multinational companies etc.	
8.	Level of Compliance in terms of Electronic Waste Rules, 2016	• Compliance in terms of Extended Producer Responsibility Authorisation(EPRA) for producers under Rule 13 (1) • Compliance in terms of authorisation for manufacturer under Rule 13 (2) • Compliance in terms of Annual return in Form (2) and Form (3) for bulk consumers under Rule (9)	

Source: Uttarakhand State Pollution Control Board (2021)

Table 28. Gap identification

S. No.	Observed Shortcomings	Remarks
1.	Establishment of collection centres & Toll free number	• As there is no facility of Toll free number to deposit E-waste in the district so all the E-waste generated from the residential areas is mixed with municipal solid waste and thus not treated properly. • Collection centre need to be established within Districts for collecting and e-waste from household and Bulk consumers.
2.	Segregation of E-waste by ULBs	Lack of awareness and weak departmental enforcement has hindered the segregation of e-waste from each household.
3.	Identification of Bulk Consumers/producer/manufacturer within district	It should be mandated to get the actual quantity of e-waste generated in the district.

IDENTIFICATION OF POLLUTER STRETCHES

The polluted locations in a continuous sequence are defined as polluted river stretches and are categorized in five priority classes based on BOD concentration (Table 29). The Central Pollution Control Board (CPCB) in 2018 identified 351 Polluted river stretches in India. The national-level assessment of water quality for identification of Polluted river stretches has found that there are 31 states and Union territories having rivers and streams not meeting water quality criteria. Currently, 9 rivers are monitored in Uttarkhand at 28 different locations.

Table 29. Criteria for prioritization

Priority area	BOD Level (mg/l)
Priority I	> 30
Priority II	20-30
Priority III	10-20
Priority IV	6-10
Priority V	3-6

(Source: CPCB, 2018)

Polluter Stretches in Haridwar District

River Ganga traversing from Haridwar to Sultanpur has been identified as a polluter stretch of priority IV in Haridwar district. Maintaining water quality of river Ganga is a matter of paramount importance at least for bathing purpose i.e. Class B, throughout the state. Municipal drains are main cause of concern and as such, industrial wastewater doesn't flow directly into river Ganga. 22 Drains have been identified in order to check pollution level in river Ganga and diverted to STPs.

Name of River	Stretch Identified	Towns Identified	Approx. length of Stretch (in km)
Ganga	Haridwar to Sultanpur	• Haridwar • Rishikesh	10

Identification of sources of pollution in the polluter stretch

There are certain factors that can deteriorate riverine ecology. Industrial pollution, domestic sewage etc. are such potential sources of pollution (Table30). This in turns leads to health concerns, environmental degradation etc. It is prerequisite to maintain water quality in accordance to the criteria set out as per designated best use (Table 31).

Table 30. Identification of sources of pollution in the polluter stretch

Potential Source of Pollution	Remarks
Industrial Pollution	• There are 07 Grossly Polluting Industries (GPIs) operating in Hardiwar.

	• Individual effluent treatment plant and Common Effluent Treatment Plant (CETP) are monitored by Uttarakhand Pollution Control Board (UKPCB) • Industrial hazardous waste mainly used oil/Contaminated barrels are being recycled through registered recyclers. Rest is either disposed through Treatment, Storage and Disposal Facility (TSDF) or incinerated.
Domestic Sewage	As per Report of the Uttarakhand Payjal Nigam, from Haridwar town upto Sultanpur, no liquid domestic drain is flowing into river ganga. However all 22 drains located in Haridwar area has been tapped.
Solid Waste	There has been restriction on illegal disposal of solid waste along the river bank and flood plain zone

Table 31. Water quality standards for different purposes

Designated Best Use	**Class**	**Criteria**	
		Parameter	**Prescribed value**
Drinking water source without Conventional treatment but after disinfection	A	pH	6.5- 8.5
		DO	6 mg/l or more
		BOD	2 mg/l or less
		Total Coliforms (MPN/100ml)	50 or less
Outdoor Bathing (Organized)	B	pH	6.5-8.5
		DO	5mg/l or more
		BOD	3 mg/l or less
		Total Coliforms	500 or less
		(MPN/100ml)	
Drinking water source after conventional treatment and disinfection	C	pH	6-9
		DO	4 mg/l or more
		BOD	3mg/l or less
		Total Coliforms (MPN/100ml)	5000 or less
Propagation of Wild life and Fisheries	D	pH	6.5-8.5
		DO	4gm/l or more
		BOD	2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste Disposal.	E	pH	6.0-8.5
		Electrical Conductivity	2250
		Sodium Absorption ratio	Max.26
		Boron Max.	2mg/l
	Below -E	Not meeting any of the above standards	

Surface Water Quality of River Ganga in Different Locations

Water quality characteristics are regularly monitored at stipulated locations of Ganga river in Haridwar district. These include monitoring at Har-ki-Pauri, Bindughat, Upper Ganga canal etc. It takes into consideration the values of parameters such as pH, BOD, DO etc. to ascertain the water quality in a specific location (Table 32).

Table 32. Surface water quality characteristics of river Ganga at different monitoring stations in Haridwar district

Year	Name of monitoring station	pH	BOD (mg/l)	COD (mg/l)	DO (mg/L)	Faecal Coliform (MPN/100 ml)	Total Coliform (MPN/100 ml)
2021	Harki Pauri Haridwar at Rishikul Bridge	7.8	1.3	5.6	8.9	44.4	85.2
	Upper Ganga Canal D/S Roorkee, Haridwar,	7.6	1.3	6.0	9.4	65.6	110.8
	River Ganga at Harki Pauri Haridwar	7.8	1.2	5.2	9.4	42.8	67.2
	Ganga Canal at Dam Koti, Haridwar (Harki Pauri)	7.8	1.0	4.4	9.4	40.2	73.2
	Bindhughat, Dudhiyavan, Haridwar	7.8	1.2	4.8	9.4	61.4	95.6
	Balakumari Mandir, Ajeetpur, Haridwar	7.8	1.4	6.4	9.1	79.4	134.0
	Lal Ta Rao Bridge, Haridwar	7.8	1.2	4.4	9.3	46.4	79.4
	River Song near Satyanarayan Temple D/S Raiwala	7.9	1.5	6.4	9.4	69.0	105.6
	Lakshmanjhula, Swargashram U/S of Rishikesh	7.5	1.0	4.0	10.2	15.0	34.2
	Rishikesh, Near Pashulok, Uttarakhand	7.6	1.1	4.0	10.0	19.2	39.4
	Lakkarghat O P, Haridwar	7.5	1.3	5.2	9.4	22.2	41.6
	Swargaashram-1, Rishikesh	7.6	1.1	4.4	9.6	19.6	40.8
2020	Harki Pauri Haridwar at Rishikul Bridge	7.1	0.9	4.2	8.7	36.3	66.1
	Upper Ganga Canal D/S Roorkee, Haridwar,	7.6	1.2	5.5	9.4	51.2	107.8
	River Ganga at Harki Pouri Haridwar	7.8	0.9	4.3	9.7	35.5	67.8
	Ganga Canal at Dam Koti, Haridwar (Harki Pauri)	7.8	0.9	4.2	9.9	32.5	60.0
	Bindhughat, Dudhiyavan, Haridwar	7.8	1.0	5.1	9.6	42.0	85.8
	Balakumari Mandir, Ajeetpur, Haridwar	7.7	1.2	6.2	9.3	61.3	108.3
	Lal Ta Rao Bridge, Haridwar	7.8	1.0	4.4	9.5	40.8	77.3
	River Song near Satyanarayan Temple D/S Raiwala	7.9	1.2	5.6	9.4	51.4	95.8
	Lakshmanjhula, Swargashram U/S of Rishikesh	7.6	0.8	4.1	10.7	14.1	35.3

	Rishikesh, Near Pashulok, Uttarakhand	7.7	0.9	4.1	9.8	22.8	42.5
	Lakkarghat O P, Haridwar	7.6	1.2	5.8	9.1	26.3	47.7
	Swargaashram-1, Rishikesh	7.7	1.0	4.8	9.4	26.7	47.7
2019	Harki Pauri Haridwar at Rishikul Bridge	7.9	1.0	4.0	9.8	40.9	90.0
	Upper Ganga Canal D/S Roorkee, Haridwar,	7.9	1.0	4.7	9.4	66.4	137.5
	River Ganga at Harki Pouri Haridwar	7.9	1.0	4.0	9.7	33.3	78.3
	Ganga Canal at Dam Koti, Haridwar (Harki Pauri)	7.9	1.0	4.0	9.9	36.7	80.0
	Bindhughat, Dudhiyavan, Haridwar	8.0	1.0	5.2	9.5	65.5	137.5
	Balakumari Mandir, Ajeetpur, Haridwar	7.6	1.2	6.3	9.0	146.4	269.2
	Lal Ta Rao Bridge, Haridwar	8.0	1.0	4.0	9.5	40.3	88.3
	River Song near Satyanarayan Temple D/S Raiwala	7.9	1.0	5.7	9.2	98.2	201.7
	Lakshmanjhula, Swargashram U/S of Rishikesh	7.8	1.0	4.0	10.2	20.1	45.8
	Rishikesh, Near Pashulok, Uttarakhand	7.8	1.0	4.0	9.8	33.1	71.7
	Lakkarghat O P, Haridwar	8.1	1.0	6.0	9.2	55.0	135.0
	Swargaashram-1, Rishikesh	8.0	1.0	4.0	9.7	50.0	137.5
2018	Harki Pauri Haridwar at Rishikul Bridge	7.9	1.0	4.0	9.2	0.0	106.7
	Upper Ganga Canal D/S Roorkee, Haridwar,	7.3	0.9	4.7	8.3	0.0	134.2
	River Ganga at Harki Pouri Haridwar	8.0	1.0	4.2	9.3	0.0	98.3
	Ganga Canal at Dam Koti, Haridwar (Harki Pauri)	8.0	1.0	4.0	9.5	0.0	85.0
	Bindhughat, Dudhiyavan, Haridwar	8.0	1.0	5.0	9.4	0.0	139.2
	Balakumari Mandir, Ajeetpur, Haridwar	7.9	1.1	5.7	9.2	0.0	260.8
	Lal Ta Rao Bridge, Haridwar	7.9	0.0	4.2	9.4	0.0	100.0
	River Song near Satyanarayan Temple D/S Raiwala	7.7	1.1	5.7	8.9	0.0	211.7
	Lakshmanjhula, Swargashram U/S of Rishikesh	7.6	1.0	4.0	9.9	0.0	43.0
	Rishikesh, Near Pashulok, Uttarakhand	7.6	1.0	4.0	9.6	0.0	66.4
	Lakkarghat O P, Haridwar	-	-	-	-	-	-
	Swargaashram-1, Rishikesh	-	-	-	-	-	-

(Source: UKPCB, 2021).

Ground water quality in stations under polluted river stretches in Haridwar district

Half-yearly monitoring of ground water quality is done in stations under polluted rivers stretches of Ganga. The quality parameters were compared with standard permissible limits for drinking water and the values are within the acceptable limit (Table 33 and 34).

Table 33. Ground water quality in stations under polluted river stretches of Ganga (half early monitoring) (June 2020)

Parameters	Ground Water Stations under Polluted River Stretches		Acceptable Limits (as per IS:10500-2012	Permissible Limits (As per IS:10500-2012
	U/S of River Ganga, B/W Missarpur and 27 MLD STP at Jagjeetpur	D/S of River Ganga, Ajeetpur (Near Shiv Mandir, Laksar Road) Balakumari Mandir		
Turbidity (NTU)	<0.1	<0.1	1	5
pH	7.86	7.34	6.5-8.5	No Relaxation
Total dissolved Solids (mg/l)	225	326	500	2000
Chloride (mg/l)	15	27	250	1000
Nitrate (mg/l)	BDL	BDL	45	No Relaxation
Fluoride (mg/l)	BDL	BDL	1	1.5
Conductivity (uS/cm)	371	531	NA	NA
Total Iron (mg/l)	BDL	BDL	0.3	1
Total Hardness (mg/l)	211	266	200	600
Nitrite (mg/l)	BDL	BDL	NA	NA

(Source: UKPCB, 2021).

BDL= Below detection level
NA= Not applicable

Table 34. Ground water quality in stations under polluted river stretches of Ganga (half early monitoring) (December 2020)

Parameters	Ground Water Stations under Polluted River Stretches		Acceptable Limits (as per IS:10500- 2012	Permissible Limits (As per IS:10500-2012
	U/S of River Ganga, B/W Missarpur and 27 MLD STP at Jagjeetpur	D/S of River Ganga, Ajeetpur (Near Shiv Mandir, Laksar Road) Balakumari Mandir		
Turbidity (NTU)	<0.1	<0.1	1	5
pH	7.29	7.28	6.5-8.5	No Relaxation
Total dissolved Solids (mg/l)	238	345	500	2000
Chloride (mg/l)	10	20	250	1000
Nitrate (mg/l)	BDL	BDL	45	No Relaxation
Fluoride (mg/l)	BDL	BDL	1	1.5
Conductivity (uS/cm)	389	556	NA	NA
Total Iron (mg/l)	BDL	BDL	0.3	1
Total Hardness (mg/l)	255	310	200	600
Nitrite (mg/l)	BDL	BDL	NA	NA

(Source: UKPCB, 2021).

BDL= Below detection level
NA= Not applicable

Current status regarding river water quality in the polluter stretch

- UKPCB *(Uttarkhand State pollution control board)* and Uttarkhand Jal Nigam are working in collaboration for determining water quality of aquatic resources and interception and diversion of drains to Sewage Treatment Plants.
- Water quality of river Ganga is being monitored regularly at several locations. Water quality standards are meeting prescribed standards for outdoor bathing (Class-B).
- Apart from regular water quality parameter, pesticide residues and heavy metal concentration were also done through third party approved laboratory. Pesticides residue were not detected while heavy metal concentration was within prescribed limits.
- As much as 6 directions under relevant sections of Water act,1972 were given to Industries for discharge of industrial wastewater in past one year.
- There has been improvement in water quality standards as the river water quality has been elevated from Class-C *(Water fit for drinking only after conventional treatment)* to Class –B *(Water fit for outdoor bathing)*.
- Flood plain zoning is enacted on both side of the river to restrict activities under FPZ act.

WASTE WATER MANAGEMENT AND SEWAGE TREATMENT PLANT

Domestic sewage is a type of wastewater that is produced by a community of people in any area. It is characterized by a certain volume of flow and physical condition, along with chemical and toxic constituents and its bacteriologic properties. Around 80% of water supply flows back into the ecosystem as wastewater, which can cause major health hazard and environmental degradation, (Denchak, 2018).

According to a report of the Central Pollution Control Board (2015), India has the capacity to treat approximately 37% of its wastewater. In other words, this comes about 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD. Moreover, most of the sewage treatment plants do not function at their optimum capacity and do not conform to the standards as prescribed (Table 35).

Sewerage system with individual household latrines connected with pipelines comes only 31.7 per cent of the total urban households. More than half of the urban population in the State relies on on-site sanitation (OSS) systems like septic tanks. Septic tanks and other On-site Sanitation system covers 53.1 per cent of the total wastewater generated in the state. Further, some individual households in the state discharge the waste from their toilets directly into open drains

Table 35. Current scenario related to STPs (MLD) in Uttarakhand

Number of STPs Installed in Uttarakhand	71
Total Sewage Generation	627
Installed Capacity	448.18
Operational Treatment Capacity	345
Actual Utilization	187 *(42% of installed capacity, 54% of Operational capacity)*
80 % of the state's total sewage treatment plant capacity caters to Dehradun, Rishikesh and Haridwar (Plain areas).	

(Source: ENVIS Centre on Hygiene, sanitation, sewage treatment systems and technology)

Sewage treatment in Haridwar district

At present, major areas of Haridwar and Roorkee nagar nigam are connected through sewerage network. Most of the Sewage treatment plants are working on full capacity. Moreover, all the nalas are tapped and connected to STPs (Table 36 and 37).

Table 36. Current scenario related to STPs in Haridwar district

Number of towns with Sewage treatment plant in the district	02 (Haridwar and Roorkee)
Total number of STPs in the district	07
Total Sewage Generation (MLD)	122
Total Installed Capacity (MLD)	145 *(Except BHEL Ranipur , Saliyar STP, as they are operated by different agencies)*
Operation Treatment Capacity (MLD)	120
Total Quantity of Sewage flowing into Rivers Directly or indirectly	All the nalas are tapped and are connected to sewage pumping stations and sewage treatment plant.

Table 37. Inventory of sewage Treatment plants

Name of ULB	Location	Number of STPs	Installed Capacity (MLD)	Current Operational capacity (MLD)
Haridwar	Jagjeetpur	3	18	Running on Full Capacity
			27	Running on Full capacity
			68	45
	Sarai village	2	14	Running on Full Capacity
			18	Running on Full Capacity
	BHEL Ranipur	1	07	Running on Full Capacity
Roorkee	Saliyar	1	33	Running on Full Capacity

Sewerage network in Haridwar district

Maximum population of Haridwar nagar nigam is covered under existing sewerage network. However, more than half population of Roorkee nagar nigam lacks piped sewerage network system (Table 38). Treated wastewater released from the treatment plants are reused for irrigation purpose and dried manure from the sludge is being sold to local farmers (Table 39).

Table 38. Adequacy of sewerage network in Haridwar District

Name of ULB	Action areas	Outcomes
Haridwar	Coverage area of Sewerage Network	Currently 85% of population in the ULB is connected with the sewerage network.
	Additional Treatment Capacity Required	10 MLD as per Jal Sansthan.
Roorkee	Coverage area of Sewerage Network.	Currently 40% of the population *(almost 5600 households)* is connected with the sewerage network.

Table 39. Current standpoint regarding sewage management in the district

Name of ULB	Present state of affairs
Haridwar	• Approximately 9 % of treated waste released from Jagjeetpur STPs (27 MLD and 18 MLD) is being used for irrigation of roughly 593 Bigha land available near these treatment plants. • Almost 12 sludge drying beds are being used by Jal Sansthan (in 18 MLD STP) Jagjeetpur followed by sludge digester. Dried sludge(manure) is being used in Department Gardening purposes and distributed to Local Farmers. • SBC *(Soil Bowl Centrifuge)* is being used by Jal Sansthan in 27 MLD STP Jagjeetpur. Dried Manure is being distributed to local farmers. • Manuel scavenging is totally controlled and banned as per the central government guidelines. Moreover, a mechanical super sucker machine is in operation for cleaning sewer. This technology is very effective and is currently propagated in limited cities (In Uttar Pradesh, only Ghaziabad is using this technology)
Roorkee	• The Sarai Sewage treatment plant is developed under HAM (hybrid Annuity) based Public Private Partnership Model at a cost of 41.40 crore rupees under Namami Gange Programme. • For reuse of treated water released from Sarai STP, an irrigation canal is being proposed by Uttarakhand Irrigation Department. • Jal Sansthan is using SBC (Soil Bowl Centrifuge) in Sarai Sewage treatment plant. Dried Manure is being distributed to local farmers.
Other ULBs	Rest of the district uses the conventional treatment method of Septic Tank + Soak Pit for sewage disposal.

Gap Identification and proposed policies in Haridwar district

Lack of sustainability, weak operation and maintenance policy etc. are some of the gaps identified in the management of sewage treatment plants in the district (Table 40). Much of the policies are currently focusing on infrastructure development to cover maximum population under sewerage network (Table 41).

Table 40. Identification of gap

Name of ULB	Gap identified	Remarks
Haridwar and Roorkee	Less sustainability in existing sewer system	Use of ASP (activated sludge process) is recommended.
	Lack of Operation and Maintenance (O&M) policy	Policies are framed and funded by central government but there is lack of adherence to Operation and Maintenance (O&M) standards in ground.
	Breakdown maintenance rather than Preventive maintenance	Preventive maintenance is preferred to lessen the likelihood of equipment breakdown.
	Lack of manpower	It is leading to reduced productivity and extended workhours.

Table 41. Proposed policies and budget requirement put forward by different stakeholders in the district

Name of ULB	Stakeholders Responsible	Proposed policy	Instruments and Budget Requirement
Hardiwar	• Uttarakhand Jal Sansthan • Uttarakhand Jal Nigam	Connecting rest of households *(almost 15 %)* with the piped sewerage network..	DPR of this proposal is sent for approval. Project cost is estimated to be around 800 crores.
Roorkee	• Uttarakhand Jal Sansthan • Uttarakhand Jal Nigam	• Connecting almost 80% of population (Almost 14000 households) with the sewer network. • Additional Sewerage treatment capacity requirement.	DPR is sent to the funding agency (KFW Development bank).

Details of expenditure for waste water management

Nagar Nigam Haridwar has provided information regarding their expenditure in managing the Sewage treatment plant and the sewer lines. Capital expenditure amounts to around 250 crores and operating expenses are around 6.5 crores per annum.

SUCCESS STORIES

CNG generation project - Jagjeetpur Haridwar

Biogas, a renewable energy can be produced from a variety of organic raw materials and utilized for various energy services such as heat, combined heat and power, or as a vehicle fuel. Emphasis is laid on sludge from municipal wastewater treatment plants which if handled properly can be a valuable resource for renewable energy production.

In 18 MLD sewage treatment plant *(Based on Activated sludge process technology)* in Jagjeetpur Haridwar, there was an issue of disposal of sludge that is accumulated after treating the water. Subsequently with the guidance of senior official of Utttarakhand Jal Sansthan, the division prepared a proposal for generation of CNG along with running and maintenance on PPP (Public Private Partnership) model (Table 42).

Table 42. Details of the project

Project Name	**Development and Commercialization of bio CNG from Sewage sludge, at sewage treatment plant, Jagjeetpur, Haridwar.**	
Cost Incurred	The project is funded by technology Development Board (under Department of science and technology).	
	Cost incurred by company (Rupees in Lakhs).	431.00
	Amount spent till date (Rupees in Lakhs)	330.85

Implementing agency	Anaerobic Energy Private limited.		
Uniqueness of the project	• Company has entered into technology tie up with three leading research institutes namely: 1. Indian Oil Research and Development, Faridabad 2. Shriram Institute of Industrial research, Delhi 3. IIT Guwahati • The project supports multiple initiatives of Government of India (Namami gange, Swachhata etc.)		
Benefits accrued	**Benefits to the department**	**Benefits to the Government of Uttarakhand**	**Other Collateral Benefits**
	• Estimated Revenue earnings of about 1.51 crore rupees over a period of five years. • Saving roughly 3.50 crore rupees in O&M expenditure of these facilities including salaries.	Estimated GST earnings of about 1.0 crore rupees over a period of seven years	Cow dung from a number of Gaushalas flow into sewer. Since the company has agreed to collect this cow dung, the problem of choking of sewer lines is likely to be reduced to a great extent

Liquid waste management in rural areas

Since the water supply for domestic purpose in rural areas has improved considerably over the years, the quantity of wastewater disposed of has also increased. Hence, effective wastewater management system needs to be introduced to mitigate the problem of contamination in larger areas of rural environment. Untreated wastewater is discharged directly into the nearby areas and water bodies. This leads to contamination of surface as well as sub-surface water, having negative effects on human health and surrounding environmental components.

Current standpoint about Rural Waste Water Management in India

- United Nations Sustainable Development Goal 6 focuses on access to clean water and sanitation to all. The initiative in achieving this goal is to sensitize communities regarding hygiene and sanitation.
- With ever increasing population and sprawling urban environment, wastewater management has become a serious issue. Rural India with old or without any infrastructure has reached to a tipping point.
- India has highest number of people with no access to clean drinking water. Even with abundance of water availability in certain places, there could not be access to safe, constant supply of drinking water.

Policies for Rural Waste management in India

Various interventions are made under Swachh Bharat Mission (SBM-G) to mitigate the ecological and health related impacts of liquid waste in rural areas. These include infrastructure development financial compensation, awareness programs etc. targeting remotest of the villages (Table 43)

Table 43. Policies Undertaken for Waste Water Management in Rural India

Current Policy	Sponsoring agency	Remarks
Construction and Usage of Individual Household Latrines (IHHLs)	Under Swachh Bharat Mission- Gramin (SBM-G)	There are various models of toilets available based on safe sanitation technologies like Twin pit, Septic tank, Bio toilets etc.
Availability of Sanitation Material through Rural Sanitary marts (RSM), Self-help groups (SHGs)	Under Swachh Bharat Mission- Gramin (SBM-G)	To provide material, services and guidance needed for constructing different types of latrines and other sanitary facilities for clean environment,
Community Sanitary Complex (CSCs)	Under Swachh Bharat Mission- Gramin (SBM-G)	Such complexes comprise of appropriated number of toilet seats ,bathing cubicles etc.(Only where there is lack of space in the village for construction of household toilets.)
Financial Assistance	Under Swachh Bharat Mission- Gramin (SBM-G)	Up to Rs.12000 is provided to BPL (below poverty line) households and identified APL (Above poverty line) households for construction of one unit of IHHL. It is not the cost of the toilet but an incentive amount.
Mensural Health Management	Under Swachh Bharat Mission- Gramin (SBM-G))	It is aimed at making behavioural change in woman and adolescence girls using a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of the menstruation period, and having access to facilities to dispose of used menstrual management materials.

INDUSTRIAL WASTE WATER MANAGEMENT (ETP/CETP)

Effluent Treatment Plant (ETP) is a process design for treating the industrial wastewater for its reuse or safe disposal into the land. The effluent treatment plants are used for the removal of high amount of organic compounds, debris, dirt, grit, pollution, toxic, non-toxic materials and polymers, etc. from industrial effluent. The ETP plants use evaporation and drying methods, and other auxiliary techniques such as centrifuging, filtration, incineration for chemical processing and effluent treatment.

Effluent is generated in many manufacturing industries like textile, pharmaceuticals and chemicals, tanneries, etc. Contaminated water cannot be released without treatment as it contains toxic and non-toxic chemicals. Releasing it may cause contamination of the existing pure water and will affect adversely the environment. As a result, ETP's are installed in manufacturing industries.

So far, industrial policy is focused mainly on sustained growth in productivity, optimal utilisation of human capital and flexibility in adjusting to markets.

Common Effluent Treatment Plant

The concept of common effluent treatment plant has been accepted as a solution for collecting, conveying, treating and disposing of the effluents from the industrial states. The CETP concept helps small and medium scale industries to dispose of their effluents which otherwise may not be so economic to them in disposing of as a single unit. Therefore, CETP is an option, which not only protects environment but also divides the investment and operational cost.

CETP can be changed to combined effluent treatment plant when it collects sewage from surrounding localities and treat it with industrial wastewaters. The advantages of such systems are:

- Dilution of toxic constituents and dissolved inorganic solids from the industrial wastewaters.
- Better control over the process due to continuous seeding of microorganisms from sewage.
- Sewage provides sufficient nutrients (N, P).
- Reduced operating cost in the form of adding chemicals.

CETPs in Uttarakhand

Currently, 3 CETPs are operational in the state, primarily in SIDUCUL which connects more than 900 different industrial units (Table 44).

Table 44. State Scenario of CETPs

Total CETPs in Uttarakhand	At present, there are three CETPs operational in the state in following industrial areas: • *IIE SIDCUL, Pantnagar* • *CETP Sitarganj* • *SIDCUL Haridwar*
Total Design Capacity (MLD)	13
Members Units (Industrial Units)	920

(Source: ENVIS Centre on Hygiene, sanitation, sewage treatment systems and technology)

Industrial waste Management in Haridwar District

Major industries of the district comes under State Infrastructure and Industrial Development Corporation Uttarakhand Ltd. (SIDCUL), which is established with an objective of providing industrial development of the region. A CETP is also operational (in SIDCUL) which is connected to more than 500 industries (Table 45). Almost all industries are meeting environmental Industry standards as per UKPCB (Table 46).

Table 45. Inventory of Industries and waste water generation in Haridwar district

S. No.	Parameter	Present Status	
1.	Prominent Industries in Haridwar District	• Pharmaceutical Formulation • Automobile parts manufacturing/assembling • Food processing • Paper Mills • Sugar Mills • Distillery	
2.	Number of industries discharging waste water	450	
3.	Total quantity of industrial wastewater generated (MLD)	10.6	
4.	Quantity of treated waste water discharged into water bodies (MLD)	5.2	
5.	Quantity of un-treated or partially treated Industrial waste water discharge into lakes	NIL (Many industries operate on zero liquid discharge)	
6.	Common Effluent Treatment Plant facilities	**(01)**	
		Name of CETP	CETP SIDCUL, Haridwar Uttarakhand
		Member units connected (members)	520

		Type of Industries	Mixed type
		Designed capacity (MLD)	5.2

(Source: ENVIS Centre on Hygiene, sanitation, sewage treatment systems and technology)

Table 46. Status of compliance by Industries

S. No.	Action Areas	Outcomes
1.	Number of industries meeting standards	450
2.	Number of industries not meeting standards	NIL
3.	Number of complaints received against industrial pollution in last 3 months	No complaints received in last three months regarding breeching of industrial norms.
4.	Number of Industries where Environmental Compensation was imposed by State Pollution Control Board (SPCB)	03

CETP Outlet Information

Monthly sampling of the treated effluent quality is done based on Standards laid by MoEFCC for Common Effluent Treatment Plants as per, (Environment Protection Rules, 1986) (Table 47).

Table 47. Monthly report of CETP outlet at SIDCUL, Haridwar-2020

Sampling location	Month	Colour	Odour	pH	BOD (mg/l)	COD (mg/l	TS (mg/l)	TDS (mg/l	TSS (mg/l
Common Effluent Treatment (CETP) outlet, SIDCUL, Haridwar	Jan, 2020	Colourless	Not specific	7.79	28	236	1051	959	92
	Feb, 2020	Colourless	Not specific	7.8	26	208	952	878	74
	Mar, 2020	Colourless	Not specific	7.49	29	224	989	907	82
	April, 2020	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
	May, 2020	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
	Jun, 2020	Colourless	Odourless	7.65	28	236	897	817	80
	July, 2020	Colourless	Odourless	7.83	29	214	810	728	82
	Aug, 2020	Turbid	Not specific	7.46	29	218	1053	965	88
	Sept, 2020	Colourless	Not specific	8.04	28	196	1657	1570	87
	Oct, 2020	Colourless	Not specific	7.88	27	194	1654	1572	82
	Nov, 2020	Colourless	Odourless	7.37	22	132	1883	1815	68
	Dec, 2020	Colourless	Not specific	7.2	27	182	1639	1551	88
Prescribed standards		-	-	**6.5-8.5**	**30**	**250**	-	-	**100**

Current Status Regarding Effluent Treatment Plant in Haridwar District

- Major Industrial cluster is integrated industrial Estate (IEE) SIDCUL *(State Industrial Development Corporation of Uttarakhand limited),* Haridwar which is well connected with Common Effluent Treatment System (CETP) and equipped with online continuous effluent monitoring system (OCEMS).
- Uttarakhand State Pollution Control Board is doing regular Monitoring /Sampling.
- Pollution load in surface water streams/rivers/drains especially in Laksar Drain, Sheela nala has been a matter of concern.
- Grossly Polluting Units (GPI's) have their own treatment facility *(In-house effluent treatment)plant)* and are also connected with OCEMS *(online continuous effluent monitoring system)*
- Industries established in industrial cluster other than IEE SIDCUL Haridwar, Raipur Industrial area, Lakeshwari industrial area, Devbhoomi industrial area, IP2 Salempur, IP-4 Begampur and Salempur rajputana have their own treatment facility and are operating on zero liquid discharge.

Policy interventions and desired level of compliance

Most of the industrial units coming under SIDCUL are connected to CETP and rest of the industries operate on zero liquid discharge However to cater the anticipated industrial waste, a CETP is proposed in one of the industrial areas (Table 48).

Table 48. Proposed policies and desired level of compliance as per different stakeholders

Strategy/Policy	Purpose
Proposed CETP for Bhagwanpur Industrial area	To cater the growing need of safe effluent disposal from the industrial estate.
Implementation of maximisation water recycling extent in the grossly effluent generating units such as paper mills, sugar mills and distillery.	To achieve Zero liquid discharge and minimization of pollution load into surface water streams / rivers / drains.
Enforcement in major polluting units to upgrade augmentation/modification in manufacturing process and effluent treatment plants.	• To minimize the water consumption extent • To improve the quality of treated water for maximum recycling in the process.

INDUSTRIAL CLUSTERS

A cluster is a geographically proximate group of interconnected companies and associated institutions in a particular field, that share common markets, technologies, worker's skill needs and which are often linked by buyer-seller relationships. Industries are growing at common centres/estates/parks as the resources, man power, transportation, marketing are feasible. Generally, medium and small-scale industries are developed at such areas and form Industrial clusters. Industrial clusters are increasingly recognized as an effective means of industrial development and promotion of small and medium-sized enterprises. Due to lack of awareness and ignorance of waste management technologies, environmental pollution has been proliferated to surrounding environment. Therefore, such industrial areas have to be assessed for improving the quality of the environment.

The Ministry of Environment, Forest and Climate Change (MoEFCC) has developed the criteria for categorization of industrial sectors based on the Pollution Index, which is a function of the emissions (air pollutants), effluents (water pollutants), hazardous wastes generated and consumption of resources (Table 49).

Moreover, Central pollution control board (CPCB) developed Comprehensive Environment Pollution index (CEPI) to find out the index value to characterise quality of the environment. Monitoring is carried out by CPCB through recognized environmental laboratory periodically and CEPI is assessed based on the recorded monitoring data (Table 50). The evaluated CEPI reflected the environmental quality of the industrial areas and serve as a standard to assess the progress achieved in the implementation of action plans (Table 51) describes number of industries in Haridwar district based on pollution index.

Table 49. Based on pollution Index (Categorization of Industries Based on Range Indices)

Pollution Index of industrial Sectors	Category
60 and above	Red
Between 41 and 59	Orange
Between 21 and 40	Green
Up to 20	*White

**A new category of white industries, which is practically non-polluting, does not require Environmental Clearance (EC) and Consent and will help in getting finance from lending institutions*.

Table 50. Based on CEPI Score

CEPI Score	Category
Exceeding 70	Industrial cluster is treated as critically polluted
Between 60-70	Industrial cluster is treated as severally polluted

Table 51. Inventory of industries in Haridwar District

Category	Number of Industries
Red	346
Orange	1513
Green	1407
White	172
Total	***3438***

** The number of industries keeps changing monthly, quarterly or yearly based on the authorisation received by UKPCB.*

IIE SIDCUL, Haridwar

State Infrastructure and Industrial Development Corporation Uttarakhand Ltd. (SIDCUL) is a government of Uttarakhand enterprise established primarily with an objective of providing overall industrial development through special purpose vehicles, investments etc. SIDCUL in Hardiwar district are allocated in two regions that area:

- IP-2 IIE, SIDCUL, Haridwar, District Haridwar
- IP-4, Industrial area, Bahadrabad, District Haridwar

Integrated industrial estate Haridwar comes under SIDCUL, which promotes industrial development and consequently develop industrial infrastructure. IIE, Haridwar has presence of major companies including Mahindra, Hero Moto Corp. etc. It has good connectivity with other regions of the state and the country with ample amount of infrastructure (Table 52).

Table 52. Integrated Industrial Estate, Haridwar

IIE, SIDCUL *(State Infrastructure and Industrial development Corporation of Uttarakhand), Haridwar*	
Total Area (Acres)	2038
Total Allottable Area (Acres)	1695
Total number of Industries	714
Infrastructure availability	• High Class Road • Electricity and LED Street Lights • Data Com Services • Fire and Police Stations • Common effluent treatment Plant *(CETP)*

Air and Water Quality Monitoring in Industrial Areas of Hardiwar district

Air and Water quality parameters are monitored to check the pollution levels in the Industrial areas of the district. Yearly data for air pollution is recorded for the past 5 years (Table 53) and half-yearly data of ground water quality is recorded for the year 2020. PM_{10} value depicts air quality as

satisfactory to moderately poor. Ground water parameters are within permissible limits (Table 54 and 55).

Table 53. Air quality monitoring

Year	SIDCUL, II, Ranipur		
	PM_{10} ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
2021	114.83	10.8	18.60
2020	94.87	8.98	14.46
2019	131.15	19.70	23.78
2018	22.99	17.98	21.98
2017	100.5	22.2	25.4
Standards (Annual)	60	50	40

Table 54. Ground water quality half yearly monitoring is performed at selected areas of Haridwar district (Data June 2020)

Parameter	Bhagwanpur Industrial Area-1	Bhagwanpur Industrial Area-2	Roorkee Industrial Area-1	Roorkee Industrial Area-2	SIDCUL Industrial Area-1	SIDCUL Industrial Area-1	Permissible Limits (As per IS:10500-2012
Turbidity (NTU)	<0.1	<0.1	<0.1	Sampling not done due to Covid 19 Containment Zone	<0.1	<0.1	5
pH	7.35	7.8	7.31		7.31	7.24	No Relaxation
Total dissolved Solids (mg/l)	371	288	342		430	394	2000
Chloride (mg/l)	95	40	52		99	40	1000
Nitrate (mg/l)	BDL	BDL	BDL		BDL	BDL	No Relaxation
Fluoride (mg/l)	BDL	BDL	BDL		BDL	BDL	1.5
Conductivity (uS/cm)	604	356	552		682	693	NA
Total Iron (mg/l)	BDL	BDL	BDL		BDL	BDL	1
Total Hardness (mg/l)	306	166	231		301	200	600
Nitrite (mg/l)	BDL	BDL	BDL		BDL	BDL	NA

BDL= below detection level
NA = Not applicable

Table 55. Ground water quality half yearly monitoring is performed at selected areas of haridwar district (Data December 2020)

Parameter	Bhagwanpur Industrial Area-1	Bhagwanpur Industrial Area-2	Roorkee Industrial Area-1	Roorkee Industrial Area-2	SIDCUL Industrial Area-1	SIDCUL Industrial Area-1	Permissible Limits (As per IS:10500-2012
Turbidity (NTU)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5
pH	7.3	7.29	7.24	7.72	7.26	7.3	No Relaxation
Total dissolved Solids (mg/l)	382	360	356	293	338	402	2000
Chloride (mg/l)	89	25	25	20	23	24	1000
Nitrate (mg/l)	BDL	BDL	BDL		BDL	BDL	No Relaxation
Fluoride (mg/l)	BDL	BDL	BDL		BDL	BDL	1.5
Conductivity (uS/cm)	618	582	576	474	551	651	NA
Total Iron (mg/l)	BDL	BDL	BDL		BDL	BDL	1
Total Hardness (mg/l)	290	320	245	160	220	295	600
Nitrite (mg/l)	BDL	BDL	BDL		BDL	BDL	NA

BDL= Below detection level
NA = Not applicable

Current status regarding industrial clusters in Haridwar

Regarding Air quality
Permanent Ambient Air Quality Monitoring station are located in following locations: • Industrial Area at IIE SIDCUL, Haridwar • Rishikul Ayurvedic Medical College, Haridwar
Regarding ground water monitoring
Ground water monitoring *(At selected locations in Half-yearly basis)* is being done by the UKPCB and so far, no ground water contamination has been reported.
Regarding Industrial Waste water
Industrial clusters like IIE Ranipur, Haridwar are having adequate drainage and conveyor system for Common Effluent Treatment Plant. However other Industrial Clusters like: • Raipur Industrial area, Bhagwanpur • Shiv Ganga Industrial Estate, Lakeswari • Lakeshwari Industrial Estate, Lakeswari • Salempur Rajputana Industrial area Requires establishment of Common Effluent Treatment Plant and adequate Drainage System.*(Currently they are having their own treatment facility and some of them are working on Zero Liquid Discharge).*

GROUND WATER EXTRACTION/CONTAMINATION AND RE-CHARGE

Groundwater is found underground in the cracks and spaces in soil, sand and rock. Over 70% of the earth's surface is covered in water but of that water, just 1% is readily available for human use, out of which, 99% is stored beneath our feet as groundwater *(The Groundwater Foundation, 2021).*

Ground water extraction

Over 80-85% of our country's population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Due to overuse of groundwater, the water table is decreasing with rapid rate and it will be precarious for mankind.

Ground water contamination

Groundwater contamination occurs when man-made products (such as, gasoline, oil, road salts and chemicals) get into the groundwater and makes it unsafe and unfit for any kind of use for humans and as well as other animals *(The Groundwater Foundation, 2021*). Unfortunately, groundwater is susceptible to pollutants. Hazardous materials from the land surface can move through the soil and end up in the groundwater. For example, pesticides and fertilizers can find their way into groundwater supplies over time. Also, groundwater is contaminated by the untreated waste from septic tanks and toxic chemicals from underground storage tanks and leaky landfills.

Groundwater Recharge

Groundwater recharge is a hydrological process, when water (rain, snowmelt etc.) moves downward from surface to groundwater. Mostly groundwater recharge happens naturally but due to high amount of groundwater extraction, water table is falling down day by day. Saving groundwater is very important for mankind as it is the major source of drinking water and agricultural irrigation water (The Groundwater Foundation, 2021). A comparison of depth to water level of August 2019 with decadal mean of August (2009-2018) indicates that there is decline of more than 4m in the groundwater level in state of Uttarakhand (CGWB,2019-20). Therefore, some artificial methods (Rainwater harvesting, Injection wells, etc.,) are encouraged nowadays to save groundwater.

Water Resources in Haridwar District

Several perennial and seasonal rivers traverses through the Hardiwar district that predominantly lies on the flood plains of Ganga River. Natural and artificial water bodies are also prevalent in the district (Table 56). Pollution control measures like open defecation, dumping of solid waste etc. are supervised in the flood plains of the rivers (Table 57)

Table 56. Water Resources in the District

S. No.	Water Resource	Number			Name and Length/Area in the District	
1.	Rivers	Perennial	Non-perennial	Total	**Name**	**Length (km) (Approx.)**
					Perennial	
					Ganga	60
					Solani	50
					Banganga	55
					Non-Perennial	
		03	07	10	Kotwali Rao	16
					Rasawan Rao	16
					Pili Nadi	12
					Sipla Nadi	20
					Mohand Rao	19
					Ratmau Rao	35
					Gholna Rao	12
2.	Lakes/ pond	03			**Name**	**Area (ha)**
					Jhilmil	148
					Bhimgoda Barrage	106
					Banganga Wetland	90

Table 57. Pollution control in water resources

S. No.	**Parameter**	**Current Status**
1.	Open Defecation in River/Nala/Khad	Fully Controlled *(District is declared Open defecation free)*
2.	Dumping of Solid waste on River Banks	Partially Controlled
3.	Control Measures for idol immersion	No measures taken
	Number of Nalas/Drains meeting Rivers	22 Drains
4.	Number of directions given to Industries for discharge of untreated industrial wastewater in past on year	06 *(Directions issued under relevant section of the Water act,1974*)
5.	Monitoring of Action Plans for rejuvenation of rivers	Monitored
6.	Encroachment of Flood Plains	13 encroachments have been identified. Government enacts flood plain zoning act for restricting activities in flood plains of Ganga river.

Groundwater management in Haridwar district

Treated surface water and tube wells are the common water source for water supply in the district. Permissions are provided for extraction of groundwater (Table 58). Adequate ground water is available in the district pertaining to the fact that most of the blocks in the district are categorized as safe (Table 59).

Table 58. Information of Groundwater in District

S. No.	Parameter	Current Status	
1.	Number of permissions given for extraction of groundwater	ULB	Permissions given
		Haridwar	211
		Laksar	4
		Roorkee	21
		Bahadrabad	141
		Bhagwanpur	35
		Khanpur	0
		Total	***412***
2.	Estimated number of bore-wells/hand pumps	694 government tube wells *(557 are operational)*	
3.	Groundwater polluted areas in the district	None	
4.	Adequacy of Groundwater Availability	Adequate	

Table 59. Groundwater availability in the district

Assessment unit name	Total Annual groundwater Recharge (ham)	Stage of Groundwater Extraction (%age)	Categorization
Bahadrabad	11351.54	70.76	Semi critical
Bhagwanpur	8044.93	70.28	Semi critical
Gurkul Narsen	9245.96	37.77	Safe
Khanpur	4444.51	57.9	Safe
Laksar	6957.96	64.25	Safe
Roorkee	5955.82	67.35	Safe

Ground water quality in Haridwar district

Ground water quality is monitored on half-yearly basis at 10 monitoring stations located in different regions of the district. Parameters such as pH, turbidity, TDS etc. are measured which were found to be within permissible limits for the year 2020 (Table 60 and 61)

Table 60. Half yearly ground water monitoring (at 10 monitoring stations) (June 2020)

Parameter	Bhagwanpur Industrial Area-1	Bhagwanpur Industrial Area-2	Roorkee Industrial Area-1	Roorkee Industrial Area-2	SIDCUL Industrial Area-1	SIDCUL Industrial Area-1	RBNS Sugar Mill Campus, Laksar	Padartha (Near Primary School) Padartha	Municipal Solid waste Land field site, Sarai, Jwalapur (Near M. Primary School	Municipal Solid waste Land field site, Sarai, Jwalapur (Janta Chowk)	Acceptable Limits (As per IS:10500-2012	Permissible Limits (As per IS:10500-2012
Turbidity (NTU)	<0.1	<0.1	<0.1	Covid 19 Containment Zone	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	5
pH	7.35	7.8	7.31		7.31	7.24	7.7	7.38	7.28	7.34	6.5-8.5	No Relaxation
Total dissolved Solids (mg/l)	371	288	342		430	394	470	353	401	581	500	2000
Chloride (mg/l)	71	17	22		15	22	42	22	39	44	250	1000
Nitrate (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	45	No Relaxation
Fluoride (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	1	1.5
Conductivity (uS/cm)	604	356	552		682	693	763	576	651	942	NA	NA
Total Iron (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	0.3	1
Total Hardness (mg/l)	306	166	231		301	200	402	336	346	457	200	600
Nitrite (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	NA	NA

BDL= Below detection level
NA = Not applicable

Table 61. Half yearly ground water monitoring (*at 10 monitoring stations) (*December 2020)

Parameter	Bhagwanpur Industrial Area-1	Bhagwanpur Industrial Area-2	Roorkee Industrial Area-1	Roorkee Industrial Area-2	SIDCUL Industrial Area-1	SIDCUL Industrial Area-1	RBNS Sugar Mill Campus, Laksar	Padartha (Near Primary School) Padartha	Municipal Solid waste Land field site, Sarai, Jwalapur (Near M. Primary School	Municipal Solid waste Land field site, Sarai, Jwalapur (Janta Chowk)	Acceptable Limits (As per IS:10500-2012	Permissible Limits (As per IS:10500-2012
Turbidity (NTU)	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	5
pH	7.3	7.29	7.24	7.72	7.26	7.3	7.41	7.19	7.19	7.19	6/5-8.5	No Relaxation
Total dissolved Solids (mg/l)	382	360	356	293	338	402	515	388	418	458	500	2000
Chloride (mg/l)	89	25	25	20	23	24	30	20	15	35	250	1000
Nitrate (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	45	No Relaxation
Fluoride (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	1	1.5
Conductivity (uS/cm)	618	582	576	474	551	651	837	631	681	742	NA	NA
Total Iron (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	0.3	1
Total Hardness (mg/l)	290	320	245	160	220	295	450	375	400	480	200	600
Nitrite (mg/l)	BDL	BDL	BDL		BDL	BDL	BDL	BDL	BDL	BDL	NA	NA

BDL= below detection level
NA = Not applicable

Current standpoint regarding Water Resources Management and Groundwater Quality in Haridwar district

Present state of affairs

- Ground water quality monitoring under National Water Resources Monitoring Programme (NWMP) is being carried by Uttarkhand pollution control board (UKPCB) at 10 locations.
- Random Checking of groundwater quality at probable contaminated locations is also done by UKPCB. Moreover, monitoring at two new locations at upstream and downstream of Polluted River Stretch (viz. Haridwar to Sultanpur) is also carried out at half yearly basis.
- Central groundwater Water Board (CGWB) exercises assessment and computation of groundwater resources once in every three years in consultation with State government departments. Beside this, CGWB conducts awareness programs in several areas to solve local groundwater problems and discuss methods of groundwater conservation through participatory approach.
- Rain water harvesting techniques are encouraged in various industries of the district.

Proposed policies for effective water resource management in Haridwar district

Various departments are working in consonance to achieve sustainability in ground water and surface water consumption in the district. Proposed policies includes implementing rainwater harvesting, encouraging modern irrigation techniques etc (Table 62).

Table 62. Policies proposed by stakeholders for water resource management

Policy Proposed	Department Responsible
Installation of Water Meters in all houses and water charges to be collected as per the actual consumption to curtail the misuse of ground water.	Jal Sansthan Jal Nigam Irrigation department
Implementing rainwater harvesting in all the houses, government buildings educational institutes etc. with roof top area greater than 200 $m^{2.}$	Jal Sansthan Jal Nigam Irrigation department
Encouraging modern irrigational techniques such as drip irrigation ,sprinklers instead of continuing flood irrigation practices	Jal Sansthan Jal Nigam Irrigation department
To conduct groundwater profile of the district through third party institutions	*Uttarakhand Pollution Control Board* (UKPCB)

Artificial Recharge Potential of Haridwar District

Uttarakhand state has a very prominent drainage system varying from first to fifth order with main drainage patterns being dendritic, trellis and rectangular. Major part of the hilly areas has a slope of more than 20% *(A slope of the magnitude of this order makes the area unsuitable for groundwater development due to low groundwater potential)*. Ground water mainly occurs under unconfined conditions and the water table follows the topography.

The entire area falling in the foot hills of the Himalayas i.e. Bhabar areas and the intermountain Doon gravel areas have been considered as areas suitable for ground water augmentation through artificial recharge. Haridwar district possess deeper water levels in Bahadarabad, Roshanabad and Lal Dhang areas giving thereby the scope of artificial recharge through construction of appropriate interventions like gabions, recharge shafts, injection wells, check dams, sand gully plugs etc. whereas in southern part, the rooftop harvesting may be practised (Table 63 and 64).

Table 63. Artificial recharge structures constructed in Haridwar District under Catchment area conservation programme (CACMP)

District	**Number of Structures**					**Total Cost (in lakhs)**					**Total Cost (In lakhs)**
	CD	CK	RTRWH	PT	CT	CD	CK	RTRWH	PT	CT	
Haridwar	0	0	3	0	0	0	0	1	0	0	1

CT-Contour Trench, CK –Chal Khal, RTRWH -Rooftop Rain Water Harvesting, CD- Check Dam, PT-Percolation Tank, NA-Not Available

Table 64. Proposed artificial recharge structures with cost estimate

District	**Number of Structures**					**Total Cost (in lakhs)**					**Total Cost (In lakhs)**
	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	
Haridwar	400	100	10	0	225	200	30	0.7	0	3.375	234.075

CT-Contour Trench, CK –Chal Khal, RTRWH -Rooftop Rain Water Harvesting, CD- Check Dam, PT-Percolation Tank, NA-Not Available

AIR AND NOISE POLLUTION MANAGEMENT

Air Pollution Management

The ambient air that is the atmospheric air in its natural form consists of nearly 99.9% of Nitrogen, Oxygen, Water vapors, Carbon dioxide, and some other gases like helium, argon, methane etc. surrounds the earth and forms its atmosphere. Any undesirable change in the composition of ambient air is called air pollution. The undesirable substances can be in solid, liquid, and gaseous forms and when present in sufficient concentration for a sufficient time under certain conditions can endanger human health and welfare of plants and animals. According to Global Air report 2020, Air pollution has now become the biggest health risk in India. Most of the cities in our country (majority of them are from the region of Indo-Gangetic plains) are facing the problem of air pollution which has led to increase in cases of breathing discomfort and other related diseases. To tackle the problem of air pollution in our cities, Government of India has taken many steps, one of them being National Clean Air Program (NCAP) 2019. Under this programme, 122 cities in the country are identified as non-attainment cities, which include three cities from the Uttarakhand *(Dehradun, Rishikesh and Kashipur)*. These cities have fallen short of the National Ambient Air Quality Standards (NAAQS) for over five years. Goal ofNational Clean Air Program (NCAP) is to meet the prescribed annual average ambient air quality standards at all locations in the country in a stipulated timeframe. The tentative national level target of 20% to 30% reduction of $PM_{2.5}$ and PM_{10} concentration by 2024 is proposed under the NCAP taking 2017 as the base year for the comparison of concentration. The ambient air quality standards as set by Central Pollution Control board are mentioned (Table 65).

Table 65. National ambient air quality standards in India

Pollutant	**Time weighted average**	**Concentration in Ambient Air**	
		Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Area (notified by Central (Government)
Sulphur Dioxide (SO_2), µg/m3	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO_2), µg/m^3	Annual* 24 hours**	40 80	30 80
Particulate Matter (size less than 10 µm) or PM_{10} µg/m^3	Annual* 24 hours**	60 100	60 100
Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ µg/m^3	Annual* 24 hours**	40 60	40 60

Ozone (O_3) µg/m^3	8 hours* 1 hour**	100 180	100 180
Lead (Pb) µg/m	Annual* 24 hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 hours* 1 hour**	02 04	02 04
Ammonia (NH3) µg/m^3	Annual* 24 hours**	100 400	100 400
Benzene (C6H6) µg/m^3	Annual*	5	5
Benzo (a) Pyrene (BaP)-particulate phase only, ng/m^3	Annual*	1	1
Arsenic(As), ng/m^3	Annual*	6	6
Nickel (Ni), ng/m^3	Annual*	20	20

Source: National Ambient Air Quality Standards, Central Pollution Control Board Notification in the Gazette of India, Extraordinary, New Delhi, 18th November, 2009.

** Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.*

*** 24 hourly or 8 hourly or 1 hourly monitored values, as applicable, shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring.*

Current scenario of air pollution in Haridwar district

Two permanent air quality stations are operational in the district, precisely in Haridwar Nagar nigam. However, the district is still devoid of automatic air quality monitoring station. Ambient air quality index indicates the air quality to be moderate to poor (Table 66). Leading cause for this declining air quality can be industries, vehicular pollution etc (Table 67). Some initiatives have been taken but still the district administration and the concerned authorities are yet to come up with a strategy to mitigate air pollution (Table 68).

Table 66. Air quality monitoring and data accessibility

Action Area	Outcomes
Number of automatic air quality monitoring stations in the district	Yet to be installed
Number of manual air quality monitoring stations in the district	**Two** Permanent air quality monitoring stations are located at following locations: • Industrial area at IIE SIDCUL, Haridwar • Rishikul Ayurvedic Medical College , Rishikul, Haridwar
Ambient Air Quality Index	Moderate to Poor
Availability of air quality monitoring data	Air quality data is regularly updated in the website of Uttarakhand state pollution control board (UKPCB)

Table 67. Identification of sources of air pollution

Action Areas	Outcomes
Number of non-attainment cities in the district	No city in the district is classified as non-attainment city according to national clean air program (NCAP).
Prominent sources of air pollution in the district	• Industries • Vehicular Pollution Burning of Municipal Waste
Industrial pollution	Large Industries namely • Sugar Industries • Distillery Industries • Pulp & Paper Units • Bricks Kilns • Induction Furnace are majorly responsible for air pollution in the district.
Control of industrial air pollution	As much as 503 Industrial units are meeting the prescribed air quality standards.
Non-industrial air pollution	
Open burning of waste	Although open burning of waste is not allowed, even then practices of open burning of waste is common in the district. Inefficient waste collection system could be one of the reasons.
Control of open burning of stubble-during winter	Not inventorized
Vehicular pollution	Following areas have been identified as hotspots for Vehicular pollution: Bahadrabad Shantikunj Chandipul Circle BHEL Barrier No. 2
Other sources of Air pollution	Dhabas/local restaurants in Haridwar uses wood and coal for the preparation of food on Bhattis/Tandoors.This give rise to the fugitive uncontrolled emissions and effects the nearby areas.

Table 68. Control measures for Air pollution in the District

Action Area	Outcomes
District level action plan for air pollution	At present, no such action plan has been prepared.
Awareness on air Quality	People are not yet apprised of the health risks associated with the air pollution when levels are high.
Development of Air pollution complaint redressed system	Available online at the official website of Uttarakhand Pollution Control Board (UKPCB)

Air Quality monitoring and proposed policies in Haridwar District

Yearly air quality data for past five years is available for one of the monitoring stations in Haridwar district (SIDCUL, Ranipur). PM_{10} values have exceeded every year except for 2018. Other parameters are within the limits (Table 69). Policies for future are currently focussed on setting up a network of air quality monitoring stations in the district (Table 70).

Table 69. Air quality monitoring in Haridwar district

Year	SIDCUL, II, Ranipur		
	PM_{10} (µg/ m^3)	SO_2 (µg/ m^3)	NO_2 (µg/ m^3)
2021	114.83	10.8	18.60
2020	94.87	8.98	14.46
2019	131.15	19.70	23.78
2018	22.99	17.98	21.98
2017	100.5	22.2	25.4
Standards (Annual)	**60**	**50**	**40**

Table 70. Policies proposed by stakeholders for air quality management

Policy Proposed	Department Responsible
Strengthening Ambient air quality network by establishing Ambient air quality stations in major towns within the district.	UKPCB
Ambient air quality station is proposed to be established latest by 2022	UKPCB

Noise Pollution Management

Noise pollution may be defined as regular exposure to elevated sound levels that may lead to adverse effects in humans or other living organisms. According to WHO sound levels less than 70 dB are not damaging to living organisms and exposure of noise level beyond 85 dB constantly for more than 8 hrs. may be hazardous and leads to loss of hearing. Although noise pollution is not a big issue in the district but proper monitoring is required to maintain noise level within the desirable limits (Table 71).

Table 71. Permissible noise level standards

Area code	Category of area/zone	Limits in dB(A) L_{eq}	
		Day Time	Night Time
A	Industrial Zones	75	70
B	Commercial Zones	65	55
C	Residential Zones	55	45
D	Silence Zones	50	40

Source- Noise Pollution (Regulation and Control) Rules, 2000

- Day time shall mean from 6.00 a.m. to 10.00 p.m.
- Night time shall mean from 10.00 p.m. to 6.00 a.m.
- Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
- Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.
- dB(A) L_{eq} denotes the time weighted average of the level of sound in decibels on scale 'A' which is relatable to human hearing.
- "Decibel" is a unit in which noise is measured.
- "A", in dB(A) L_{eq}, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.
- L_{eq}: It is an energy mean of the noise level over a specified period.

Noise Pollution in Haridwar District

The district authorities have measuring devices to monitor the noise levels but routine monitoring is absent in major hotspots of the district (Table 72). Noise level monitoring is generally carried out occasionally during festivals and public events (Table 73). Thus far, it is not a big issue in the district, However, policies related to maintaining noise level standards, ban on multi-toned horn etc. are floated to mitigate the prevalent noise pollution (Table 74).

Table 72. Current status related to noise pollution management

S. No.	Parameter	Current Status
1.	Number of noise level measuring devices available with various agencies in the district.	03
2.	Number of complaints received by State pollution control board related to noise pollution in past 1 year.	04 Complaints were registered. All of them were redressed.
3.	Implementation of ambient noise standards in residential and silent zones.	Occasionally done
4.	Capability to conduct noise level monitoring by State agency/District Authorities	Available with the competent authority
5.	Noise monitoring study in district	Noise level monitoring is carried out during Deepawali festival.
6.	Setting up of Sign Boards	Not installed
7.	Routine monitoring of Ambient Noise level at various locations	Ye to be initiated

8.	Responsibility of departments regarding vehicular noise pollution	• To adhere with noise levels guidelines coming under Motor Vehicles Act,1998 • State Transport department is responsible for execution of noise standards and implementation of Noise control measures.

Table 73. Noise level monitoring carried out during Deepawali Festival (2019 and 2020)

Monitoring locations	**Average $L_{equivalent}$ dB(A)**			
	09 Nov to 10 Nov 2020	**14 Nov to 15 Nov 2020**	**21 Oct to 22 Oct 2019**	**27 Oct to 28 Oct 2019**
Vivek Vihar, Ranipur	44.2	58.4	-	-
BHEL Hospital, Haridwar	43.4	50.0	41.4	49.2
Prachin Adbhut Ashram	48.0	66.2	-	-
Rajlok Vihar, Ranipur	-	-	46.7	57.7
Le Grand Hotel, Haridwar	-	-	60.6	69.8

Table 74. Responsibility of various departments to mitigate noise pollution

Responsibility	**Department Responsible**
Ban on use of Multi-toned horn or any other device giving an unduly harsh, shrill, loud, or alarming noise, (Nothing contained in this policy shall prevent the use on vehicles used as an ambulance, vehicles used by police officers, Fire fighters, Operators of construction equipment vehicles or the officers of motor vehicle departments).	State Transport Department
Execution of noise standards and implementation of Noise control measures.	State Transport Department

ILLEGAL SAND MINING

The Mines and Minerals (Development and Regulation) Act, 1957 has empowered state governments to make rules to prevent illegal mining, transportation and storage of minerals. However, still large numbers of illegal mining cases are registered in the country and in some cases, many of the officers even lost their lives while executing their duties to curb illegal mining. Ministry of Environment, Forest & Climate Change (MoEF&CC) put forward the sustainable sand management guidelines (SSMG) 2016, which focus on the management of sand mining in India, but there is a need to revamp the existing system for effective enforcement of regulatory provisions and their monitoring. Recently, in 2020, new set of guidelines have been put forward by (MoEF&CC) in 2020, which focuses on the effective monitoring of sand mining *(from the identification of sand mineral sources to its dispatch and end-use by consumers and general public)* and uniform protocol for the whole country. Also, states are advised to conduct river audits and monitoring of mining activities with night vision drones and other modern surveillance equipment.

Sand being an important economic resource and the second most used mineral after water is one of the main ingredients of concrete and mortar. Besides its economic importance, it also constitutes an important abiotic component in the aquatic ecosystem like rivers. As our country has seen robust growth in the infrastructure sector in the recent decade the demand for sand increased by manifolds. Further, with the announcement of the national infrastructure pipeline project, the demand for sand is going to increase exponentially in the near future. In recent years, Uttarakhand has also seen an increase in riverbed quarrying operations. With the establishment of the stone crusher industry especially in the southern Terai and Bhabar region of the state, the scale and intensity of RBM (Riverbed Minerals) excavation has further increased in the past few decades. Uncontrolled and illegal mining of river bed minerals like sand has led to the loss of revenue to the state, degradation of aquatic and riparian habitat *(through large changes in the channel morphology)* and geology of adjoining groundwater systems.

Mining activities in Haridwar District

Sand mining in prevalent in Haridwar district owing to its large flood plains. Mining department is the district Nodal Authority that issues mining permissions of mining in the district. Forest department issues permission only in Forestland. Consent from UKPCB is requisite irrespective of land type (Table 75).

Table 75. Inventory of mining activities in the district

Concerning Department	Total number of mining sites	Operational mining sites	Number of mining sites meeting consents of State Pollution Control Board
Mining Department	52	15	15
Forest Department	07	07	07

Current scenario regarding mining activities in Haridwar district

Legal mining activities are carried out in Haridwar district under mining and forest department. Ample revenue is generated from these activities (Table 76). Cases against illegal mining are registered and penalties are charged subsequently under Uttarkhand Illegal mining, storage and transportation protection manual, 2005 (Amendment 2020) (Table 77)

Table 76. Current status of mining activities in Haridwar district

Concerning Department	Type of mining activity (Legal/ Illegal)	Area under mining activities (km^2)	Revenue generated (financial year (2020-2021)
Mining Department	Legal	3.25	7,78,48,866
Forest Department	Legal	12.48	3,94,13,229

Table 77. Action against Illegal Mining Activities

Concerning Department	Cases registered of illegal mining activities	Penalties charged for illegal mining activities
Mining Department	46	7,76,00,000
Forest Department	92	9,57,000

Additional capacity required by the concerning departments to curb the illegal mining activities

- Advance surveillance equipment's.
- Technical expertise
- Training of workforce

REJUVENATION OF WATER BODIES

Most of India's major water resources *(underground waterways, lakes, rivers and reservoirs)* depends on monsoon rains to replenish/recover them. Nearly 600 million Indians faced high to extreme water stress and about 2 lakh people dies every year due to inadequate access to safe water. The NITI Aayog in 2018 released the results of a study warning that India is facing its "worst water crisis" in history and that demand for potable water will outstrip supply by 2030, if concrete steps are not taken. If matters are to continue, there will be a 6% loss in the country's GDP by 2050.High amount of water extraction and mismanagement of water resources are causing drought and sudden flood in several part of our country. Rejuvenation of waterbodies also play a vital role to improve the water quality and storage of surface run off water. For these reasons, we need to store, manage and rejuvenate the existing waterbodies. We can use several government policies/Schemes like Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Atal Bhujal Mission etc. to restore and rejuvenate the water bodies. The Water Stress Index 2019 by London-based Verisk Maplecroft ranks India as the 46th highest risk country *(Verisk Maplecroft 2019)*. India is also 13th on the Aqueduct's Water Risk atlas and listed as one of the world's ***"extremely water-stressed countries"*** *(World Resources Institute 2019).*

Rejuvenation of water bodies in Haridwar district

Rejuvenation works are carried out by irrigation (> 1.5 Ha) and forest department (<1.5 Ha) in Haridwar district. Total 10 projects are listed under MNREGA and CAMPA by forest department, out of which 06 are taken up for restoration and plantation works. One major rejuvenation work undertaken is of Jhilmil Lake, which is a marshy wetland and is a part of Jhilmil Lake Conservation area. The rejuvenation works are carried out in consonance with biodiversity conservation, promotion of ecotourism etc.

Jhilmil Lake Conservation area

Jhilmil lake conservation area is the first conservation reserve in the state of Uttarkhand. This region adorns Uttarakhand as a wetland and is famous for its unique biodiversity. This conservation area with an area of 3783.50 hectare is corridor for most of animals relocating from Rajaji National park. The area is the only and last natural habitat of the very rare reindeer species in northern Himalayan foothills. This conservation reserve is rich in fauna and flora diversity including species of deer, Elephant, Common leopard etc. Uttarakhand only surviving herd of Swamp deer are prevalent in this conservation area.

Inside this conservation area lies Jhilmil Lake, which is a natural saucer-shaped landform and is marshy in nature. The area of the structure is around 148.60ha, which is predominantly marshy in

nature. For proper scientific management and conservation of this specific area, a special management unit named Rasiyabad unit was formed. Jhilmil Jheel wetland is literally the last piece of primordial Terai marshland to survive untouched in Uttarakhand. The wetland is a source of water for wildlife, helps in nutrient retention and ground water recharge, serves as flood control mechanism and helps stabilise the microclimate of the area.

Works Undertaken in Jhilmil lake Conservation area

Several works have been undertaken in the conservation area for maintaining the ecological balance, natural environment, zoology etc. in the region (Fig. 7). These includes:

- Cleaning of drains
- Construction of check dams
- Spur construction works to stop land erosion
- Construction of watch tower to monitor safety of forest and wildlife
- Construction of drinking ponds for wild animals.

Fig. 7. Restoration works in Jhilmil Lake Conservation area




PLASTIC WASTE MANAGEMENT

Plastic waste is defined as the accumulation of plastic objects (e.g. Plastic bottles, bags etc.) in the environment that adversely affects the Wildlife and Humans. Its broad range of application is in packaging films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, building materials, etc. The ongoing pandemic has caused a rapid growth in the generation of plastic waste for the medical, packaging and other services *(like PPE kit, gloves, face shield, packaged food, etc.).*

Plastic products have become an integral part in our daily life pertaining to the fact that its production has crossed 150 million tonnes per year globally *(CPCB, 2013).* India generates 15 million tonnes of plastic waste every year but only one fourth is recycled due to lack of a functioning solid waste management system. This leads to burden on the landfills and poor socio-economic conditions of the waste pickers, mostly women *(UNDP, 2018-2024).*

India is committed to take action for mitigation of pollution caused by littered Single Use Plastics. In the 4th United Nations Environment Assembly held in 2019, India has piloted a resolution on addressing single–use plastic products pollution, recognizing the urgent need for global community to focus on this very important issue. The adoption of this resolution at UNEP was a significant step.

Plastic Waste Management Amendment Rules, 2021

Keeping in view the adverse impacts of littered plastic on both terrestrial and aquatic ecosystems, the MOEF&CC has notified the Plastic Waste Management Amendment Rules,2021, which prohibits identified single use plastic items which have low utility and high littering potential by 2022.Salient features of this amendment are as follows:

- The manufacture, import, stocking, distribution, sale and use of single-use plastic, including polystyrene and expanded polystyrene, commodities shall be prohibited with effect from the 1st July, 2022.
- In order to stop littering due to light weight plastic carry bags, with effect from 30th September, 2021, the thickness of plastic carry bags has been increase from 50 microns to 75 microns and to 125 microns with effect from 31st December,2022. This will allow reuse of plastic carry due to increase in thickness.
- The plastic packaging waste, which is not covered under the phase out of identified single use plastic items, shall be collected and managed in an environmentally sustainable way through extended producers' responsibility of the Producer, Importer and Brand Owner (PIBO). For

effective implementation of Extended Producer Responsibility, the guidelines for extended producer responsibility being brought out have been given legal force through Plastic Waste Management Amendment Rules, 2021.

- The State government and concerned Central Ministries and associated departments have also been requested to develop a comprehensive Action plan for elimination of single use plastics and effective implementation of Plastic Waste ManagementRules,2016 and its execution in a time bound manner.
- Directions under Section 5 of Environment (Protection) Act, 1986, have been issued to all state for setting up for institutional mechanism for strengthening enforcement of Plastic Waste Management rules, 2016.

Status of plastic waste in ULBs of Haridwar district

With increasing urbanization, Plastic waste generation has also increased in Haridwar district.Its generation ranges from 0.05 MT/day in cantonment board Roorkee to 8 MT/day in Nagar nigam Roorkee (Table 78). Some of the ULBs are still not estimating their plastic waste in the district. The major compositions of plastic waste are polythene bags including ruptured ones, wrappers of milk products, mineral water bottles, toffee wrappers, etc.

Table 78. Plastic waste generation from Urban Local Bodies

Name of Urban Local Body	Population (2011 census)	Number of Wards	Estimated Quantity of Plastic Waste Generated (MT/Day)
Nagar Nigam Haridwar	251197	60	6
Nagar Nigam Roorkee	118188	40	8
Nagar Palika Parishad Manglaur	52971	20	2
Nagar Palika Parishad Shivalik Nagar	31600	13	0.25
Nagar Panchayat Laksar	25754	11	0.4
Nagar Panchayat Piran Kaliyar	19201	9	Not Estimated
Nagar Panchayat Landhora	18370	9	0.5
Nagar Panchayat Bhagwanpur	17179	9	1
Nagar Panchayat Jhabrera	11186	9	1
Cantonment Board Roorkee	14689	7	0.05
BHEL Industrial township Ranipur	46948	13	Not Estimated

Plastic waste management in Haridwar district

Waste management operations are carried out in each district which includes segregation at source, door to door collection, sweeping, waste transport, waste disposal etc., (Table 79). Infrastructure

has been developed for plastic waste management pertaining to financial conditions (Table 80). Some ULBs have established linkage with vendors for recycling of plastic waste.

Table 79. Plastic waste management operations

Waste Management Operations	Outcome	
Door to Door Collection	• All the ULBs except Cantt. Board Roorkee and BHEL industrial township Ranipur have 100 percent coverage for door-to-door collection. • Secondary bins are used to collect the waste in BHEL Industrial township ,Ranipur.	
Segregated Waste Collection	• Shivalik Nagar is implementing completely segregated waste collection. • Piran Kaliyar and BHEL Industrial Township are collecting combined waste. • In the rest of ULBs, waste from limited wards is obtained in segregated form.	
Material Recovery Facility (MRF) operation	• Only four ULBs (*i.e. NN Haridwar, NN Roorkee, Nagar Panchayat Lakshar, and Cantonment Board Roorkee*) have established Material Recovery Facility.	
Linkage with Public Relation Officers (PROs) of producers	Nagar Panchayat Lakshar hasestablished linkage with Public Relation Officer of the producers.	
Involvement of Non-Governmental Organizations (NGOs)/ private agencies	• NN Haridwar, NN Roorkee, NPP Shivalik Nagar, and NP Lakshar have hired private agencies to assist them in their waste management operations. • Many NGOs in these municipal bodies are involved in making people aware of cleanliness.	
Authorization and issuance of Identity cards to waste pickers	***ULB***	***Numbers***
	Nagar Nigam Haridwar	498
	Nagar Nigam Roorkee	593
	Nagar Palika Parishad Manglaur	151
	Nagar Palika Parishad Shivalik Nagar	65
	Nagar Panchayat Laksar	75
	Nagar Panchayat Piran Kaliyar	36
	Nagar Panchayat Landhora	45
	Nagar Panchayat Bhagwanpur	50
	Nagar Panchayat Jhabrera	44
	Cantonment Board Roorkee	50
	BHEL Industrial township Ranipur	10

Table 80. Present infrastructure for plastic waste management

Name of ULB	Inventory of infrastructure available for Plastic Waste Management Operation				
	Plastic Waste collection centres	**Plastic Compactor**	**Linkage with Plastic waste Recyclers**	**Material Recovery Facility (Available/Not Available)**	**Remarks**
Nagar Nigam Haridwar	2000[a]	01	Established	Available	-
Nagar Nigam Roorkee	183[a]	01	Established	Available	Four wards of the ULB are declared bin free.
Nagar Palika Parishad Manglaur	00	00	Not Established	Not Available	Plastic waste is collected through door-to-door collection and no secondary bins are installed currently as the ULB is eying to achieve the status of bin free.
Nagar Palika Parishad Shivalik Nagar	110[b]	Ko	Established	Not Available	• Plastic waste is collected through door to door collection. • ULB is declared as bin free in 2018 so all the secondary bins are of capacity lesser than 50 kg.
Nagar Panchayat Laksar	00	01	Established	Available	• Plastic waste is collected through door to door collection • ULB is declared bin free in 2020.
Nagar Panchayat Piran Kaliyar	100[a]	00	Not Established	Not Available	-
Nagar Panchayat Landhora	20[a]	00	Not Established	Not Available	-
Nagar Panchayat Bhagwanpur	35[a]	00	Not Established	Not Available	-
Nagar Panchayat Jhabrera	00	00	Not Established	Not Available	Plastic waste is collected through door to door collection and no secondary bins are installed currently as the ULB is eying to achieve the status of bin free.
Cantonment Board Roorkee	15	01	Not Established	Available	
BHEL Industrial township Ranipur	300[a]	00	Not Established	Not Available	

[a] *Secondary bins used for plastic waste collection*;
[b] *Secondary bins of capacity less than 50 kg.*

Identification of Gap

As Plastic waste is a part of Municipal Solid waste, hence the impediments are more or less same as mentioned in Table 81, which includes source segregation of waste, segregated waste transport etc. Apart from this, characterisation of waste, linkage with recyclers, strict vigilance, establishment of green protocol etc. are necessary to minimize the impact of plastic waste on environment and human health.

Plastic Waste generation from Industrial sector

Plastic waste is generated from industries involved in processing, packaging etc. They are liable to get registered by respective State pollution control boards under plastic waste Management rules, 2016. In Haridwar district, the inventory of plastic waste generated from industries, specifically manufacturing sector is maintained by Uttarakhand Pollution Control Board (Table 81).

Table 81. Plastic Waste management in Industrial sectors

Action Areas	Outcome And Remarks
Estimated quantity of plastic waste generated by industries (MT/Day)	40.4 (Primarily from manufacturing sector)
Number of industries registered by UKPCB under Plastic Waste Management rules, 2016	121
Number of industrial units recycling plastic waste with authorized recyclers	86
Number of recyclers registered by UKPCB under Plastic Waste Management rules,2016	35 (having recycling capacity of 6889 MT/Month)
Number of producers registered by UKPCB under Plastic Waste Management rules, 2016	68 (Having waste generation quantity of 815 MT/Month)
Established linkage with NGOs	M/s ITC limited (Packaging and printing Unit) is engaged with Saahas Waste Management Pvt. Ltd and Recycle Waste Management Ltd. for channelizing the Multi-layered plastic (MLP) /Low-value plastic (LPV)

Current Status of plastic waste management in Industrial sector

- M/s Gangotri paper mills have used almost 23.5 MT/Month plastic waste for co-processing in Cement kiln.
- UKPCB has started the service of registration/renewal of industries through Online Consent Management System (OCMMS) integrated with Single Window Clearance system.
- 286 industries (Plastic packaging, processing, pharmaceuticals etc.) were sent notice for enforcement of Plastic waste management rule, 2016 during financial year 2020-21.

Projected Population and Plastic Waste Generation in Haridwar District

Plastic waste in India has increased steadily over the past 50 years. It is expected to double over the next 20 years. Its growth rate in India is considered to be the highest in the world.

Projecting waste quantities in coming future is a difficult task. It is because of its changing composition over the seasons and periods due to ever changing dietary habits, economic conditions of the people and pandemic situation like COVID-19 in the concerned region. Crop harvesting season with adequate availability of a variety of food also affect the plastic generation. Lower is the level of economic development, greater will be the change between plastic waste generation and disposal. Moreover, COVID-19 like pandemic situation also caused remarkably plastic waste generation for creating medical tools and devices. These could be syringes, insulin pens, intravenous line (IV), surgical gloves, catheters, inflatable splits, etc.

Census population data for the year 2001 and 2011 is taken for population forecast. Decadal population and subsequent waste forecasts done is based on following presumptions:

- Arithmetic increase method is used for the decadal population forecast, hence the rate of change of population with time is assumed constant.
- The per capita generation of plastic waste was estimated to be 11 kg/annum (Centre for Science and Environment, 2019).
- It is assumed that 70% of the total plastic waste consumed is discarded as waste (CPCB, 2013).
- 16 % yearly growth in per capita plastic waste consumption has been taken keeping in mind the changing waste paradigm and floating population. *(Centre for Science and Environment,2019)*
- This analysis included population and waste generation estimations for only urban local bodies and did not include peri-urban and rural areas (Table 82 and 83)

Table 82. Projected population and estimated plastic waste generation in Haridwar district

Name of ULBs	Projected Population			Projected Waste Generation (MTPD)		
	2021	**2031**	**2041**	**2021**	**2031**	**2041**
Nagar Nigam Haridwar	324885	398573	472261	06	19.13	36.63
Nagar Nigam Roorkee	138860	159532	180204	08	23.89	43.60
Nagar Palika Parishad Manglaur	63358	73745	84132	02	6.05	11.15
Nagar Palika Parishad Shivalik Nagar	46338	60176	74014	0.25	0.84	1.67
Nagar Panchayat Laksar	33266	40778	48290	0.4	1.27	2.43
Nagar Panchayat Landhora	20704	23038	25372	0.5	1.44	2.57
Nagar Panchayat Bhagwanpur	22499	27819	33139	01	3.21	6.18
Nagar Panchayat Jhabrera	12988	14790	16592	01	2.96	5.36
Total				**19.15**	**58.79**	**109.59**

Table 83. Decadal increase in waste generation

Name of ULB	Rate of Growth (%) (2021-2031)	Rate of Growth (%) (2031-2041)
Nagar Nigam Haridwar	21.89	9.14
Nagar Nigam Roorkee	19.87	8.24
Nagar Palika Parishad Manglaur	20.26	8.42
Nagar Palika Parishad Shivalik Nagar	23.76	9.86
Nagar Panchayat Laksar	21.87	9.12
Nagar Panchayat Landhora	18.93	7.79
Nagar Panchayat Bhagwanpur	22.14	9.24
Nagar Panchayat Jhabrera	19.60	8.12

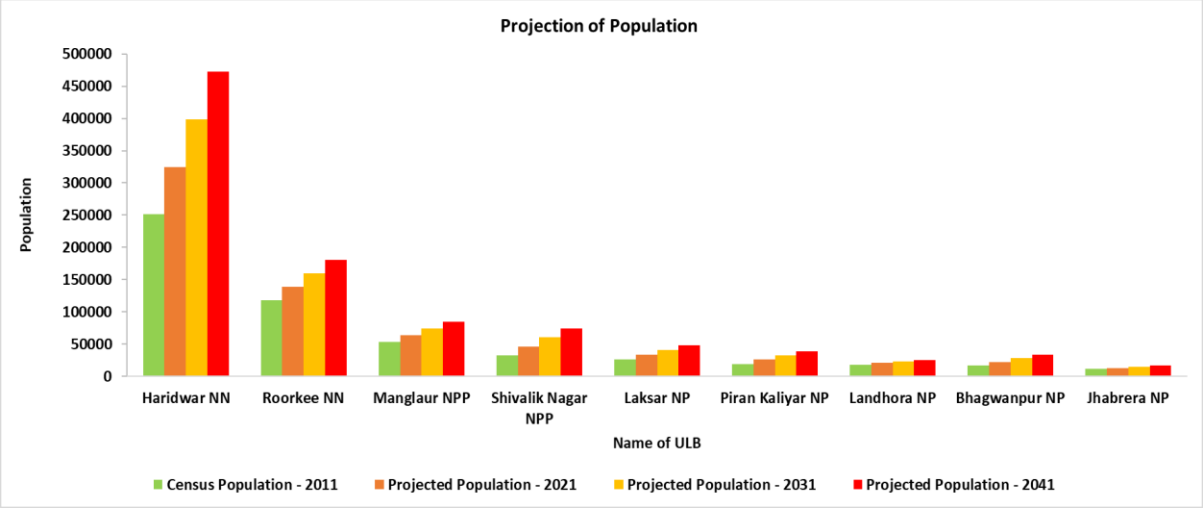


Fig. 8. Geographical representation of projected population

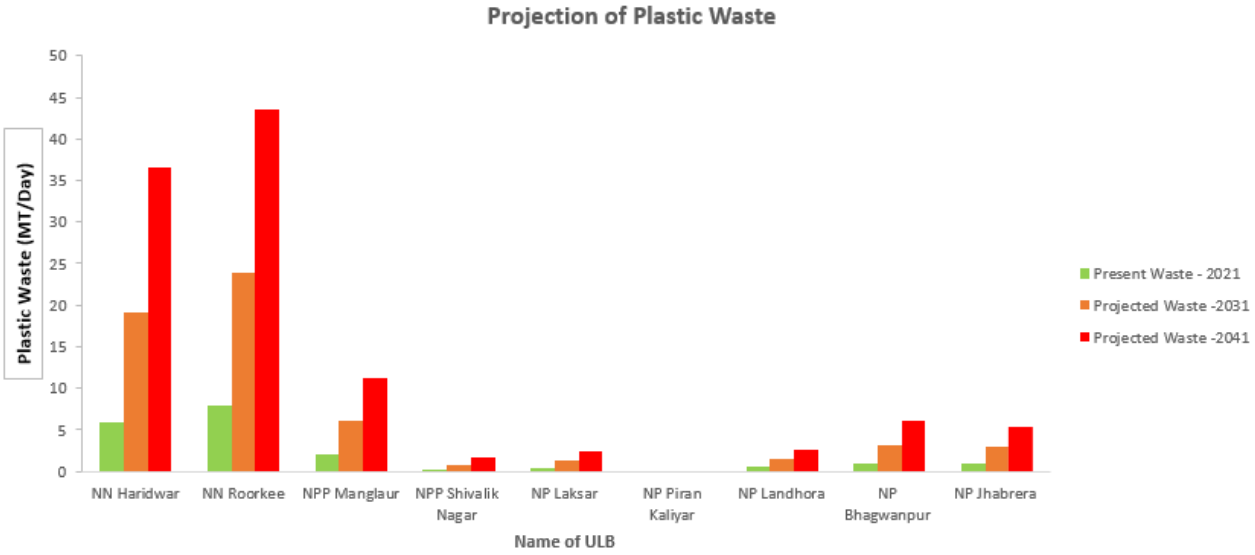


Fig. 9. Projected plastic waste generation

Inferences drawn from plastic waste projection

- Plastic generation in the district is expected to rise in coming decades and would cross 100 MTPD by 2041.
- Rapid Urbanization would lead to increase in plastic waste consumption and it will change the waste composition in the district. The percentage of plastic waste will increase in per capita waste generation.
- 10 to 20 % growth rate in plastic waste generation is expected in the decades to come.

ASSESSMENT OF URBAN LOCAL BODIES IN HARIDWAR DISTRICT

In order to push the Urban Local bodies to adopt effective waste management, an assessment of their waste management operations has been carried out (Table 84, Table 85). The main objective of this assessment is to let ULBs know their present status regarding various waste management operations in Solid waste management, bio-medical waste management, C&D waste management etc. Based on the adopted methodology, few inferences have been drawn to let administration know about their performance in various indicators.

Table 84. Assessment of Urban Local Bodies in Haridwar District

Indicators	**Maximum Points**	**Urban Local Body**									
		NN Haridwar	NN Roorkee	NPP Manglaur	NPP Shivalik Nagar	NP Laksar	NP Piran Kaliyar	NP Landhora	NP Bhawanpur	NP Jhabrera	Cantt Roorkee
Solid Waste Management											
Segregation	**4**	2	3	3	4	3	0	3	3	3	3
Collection	**4**	4	4	4	4	4	4	4	4	4	4
Segregated Waste Transport	**4**	3	3	3	4	3	3	3	3	3	3
Wet Waste Processing	**2**	2	2	0	2	2	0	2	0	0	2
Dry Waste Processing	**4**	4	4	0	0	4	0	0	0	0	2
Disposal	**2**	2	1	0	0	1	0	0	1	0	2
Inclusion of Informal Sector	**1**	1	1	0	1	1	0	0	0	0	0
Bio-medical waste Management											
Linkage with Common Bio-medical Waste Treatment and Disposal Facility (CBWTF)	**1**	0	0	0	0	0	0	0	0	0	0
Hazardous Waste Management											
Linkage with Treatment, Storage and Disposal Facilities (TSDF)	**1**	0	0	0	0	0	0	0	0	0	0
C&D Waste management											
C&D Waste Processing	**1**	0	0	0	0	0	0	0	0	0	0
E-Waste Management											

E-waste Collection and Linkage with Recyclers	**2**	0	0	0	0	0	0	0	0	0	0
General Information											
Innovation and use of indigenous Techniques	**2**	2	2	0	1	2	0	0	0	0	1
Enforcement of Bye-laws and Waste Management Rules, 2016	**2**	2	2	1	2	2	1	1	1	2	1
Total	**30**	**22**	**22**	**11**	**18**	**22**	**08**	**13**	**12**	**12**	**18**

Table 85. Final assessment of Urban Local Bodies of Haridwar District

Name of ULBs	Score (out of 30)	Score Percentage (%)	Ranking
NN Haridwar,	22	73.33	**I**
NN Roorkee,	22	73.33	**I**
NP Laksar	22	73.33	**I**
Cantonment Board Roorkee,	18	60	**II**
NPP Shivalik Nagar	18	60	**II**
NP Landhora	13	43.33	**III**
NP Bhagwanpur	12	40	**IV**
NP Jhabrera	12	40	**IV**
NPP Manglaur	11	36.67	**V**
NP Piran Kaliyar	08	26.67	**VI**

Observations from data assessment

- Overall, Nagar Nigam Haridwar, Roorkee and Nagar Palika Laksar are performing well among all the urban local bodies of the district.
- NPP Manglaur, NP Piran Kaliyar, NP Bhagwanpur and NP Jhabrera are lacking wet waste management facility. They need to reconsider their wet waste management strategies.
- Nagar Palika Laksar are successfully using the LLP model to achieve effective solid waste management. They are currently focussing on integrated solid waste management to accomplish zero waste management.
- NN Haridwar is doing waste recovery and disposal efficiently but segregation of waste at source needs attention.
- NP Piran Kaliyar is lacking even basic waste management facilities. Hence, a complete overhaul is need of the hour for effective waste management.
- All ULBs needs to establish linkage with CBWTF and TSDF for scientific management of Bio-medical waste, sanitary waste, domestic hazardous waste, e-waste etc.

ACTION PLAN

- Based on the data analysis and gap identification, an action plan is devised to minimize adverse impact on the environment considering development.
- A holistic action plan is provided keeping in mind the present state of affairs and environmental changes that may occur in years to come.
- Qualitative and quantitative approach is pursued to formulate a long term and short term action plan for different thematic.
- Action plan is provided keeping in mind the financial constraints of urban local bodies and various other departments.
- Departments responsible for ensuring compliance have been mentioned with reference to each action point to integrate the efforts and activities of each department in pursuit of common purpose.

Action Plan for Solid Waste Management

Haridwar district is one of the largest generators of solid waste in the state. Moreover, wide variations in the quantity of waste generation and waste management practices have been observed. Some of the methods adopted by ULBs for managing of solid waste have turned obsolete and require complete overhaul. ULBs need to design a pathway comprising of private agencies, NGOs and residents in scientific management of waste in the district.

Focus Areas

- *Accurate Quantification and Characterization of waste*
- *Remediation of historical landfills.*
- *Cluster based management of Solid waste.*

Based on analysis of data, this action plan defines the areas where each ULB needs to work based on their current waste management operations (Table 86). This is a holistic plan which defines action areas based on gap assessment of each ULB. Each action point is in compliance with the guidelines of Solid Waste Management rules, 2016

Table 86. Action plan for solid waste management

Action Point	Concerning ULB	Purpose	Strategy/Approach	Stakeholder Responsible
Estimating quantity of dry and wet waste from total waste	• Nagar Nigam Haridwar • Nagar Panchayat Piran Kaliyar	• Determining waste composition in the region. • Ascertaining the need of equipment's and machinery for waste management operations accordingly.	• Appropriate Sampling mechanism as per Municipal solid waste management manual, Swachh Bharat Mission. This will help in getting informal estimate of waste composition in the region. • Single compartment vehicle should be modified into double component vehicle. This has been done by Nagar Panchayat Laksar. • Establishment of transfer station/Secondary segregation points.	Nagar Nigam/Nagar Panchayat
Primary Segregation (Segregation at Source)	All ULBs except Nagar Palika Shivalik nagar	• Higher Recovery of Recyclables. • Hygienic environment for handling of waste.	• Separate Storage Bins. • Regular awareness campaigns • Man power Management. • Behavioural change Communication techniques.	• Nagar Palika/Nagar Palika parishad/ Nagar Panchayat • Residents and NGOs

Door to Door Collection	• BHEL Industrial township • Cantonment Board Roorkee	• Effective Waste segregation. • Efficient Energy recovery. • To limit the landfill disposal. • To formulate Sustainable waste management model	• Promoting decentralized waste management. • Training waste pickers. • Providing equipment, infrastructure and management support.	• Nagar Nigam • Township administrator
Segregated Waste Transport	All ULBs	• To reduce open dumping of waste. • Reduction of Historical waste. • To reduce contamination of ground water. • Reduction of transportation charges.	• Optimizing Waste Management Infrastructure (Collection trucks, trolleys). • Man power optimization at Recovery facility.	Nagar Palika/Nagar Palika parishad/ Nagar Panchayat
Wet Waste Management	• Nagar Palika Parishad Manglaur • Nagar Panchayat Piran Kaliyar • Nagar Panchayat Bhagwanpur • Nagar Panchayat Jhabrera	• Initiating scientific solid waste management. • Eliminating the expense of fertilizer • Promoting eco-friendly organic fertilizers	• Home compositing • Constructing decentralized composting pits	Nagar Panchayat Residents/NGOs
Dry waste Management in Secondary facility/Trenching ground/Transfer Station	• Nagar Palika Parishad Manglaur • Nagar Panchayat Piran Kaliyar • Nagar Panchayat Bhagwanpur • Nagar Panchayat Jhabera • Nagar Panchayat Landhora • BHEL Industrial township Ranipur	Scientific management of dry waste	• Establishing Material Recovery facility • Linkage with recyclers	Nagar Palika/Nagar panchayat/Township administrator

Regular waste audit	• Nagar Nigam Haridwar • Nagar Nigam Roorkee • Nagar Parishad Manglaur • Nagar Palika Parishad Shivalik nagar • Cantonment board Roorkee	• To determine changes in waste composition • Ensuring that the ULBs are adhering to MSW rules, 2016.	• A team of expert must be devised to monitor changing waste paradigm in the district.	Nagar Nigam/Nagar Panchayat/Sanitary inspectors
Landfill mining	All ULBs	• To mitigate environmental impact of waste. (Methane emission) • Resource Recovery of excavated waste.	Phytoremediation must be practised	Nagar Palika/Nagar Palika parishad/ Nagar Panchayat
Cluster based approach to Solid waste management	All ULBs	• To club the villages in peri-urban areas of the town with the nearby solid waste management facility for effective waste management in rural areas. • To execute Rurban mission of Government of India.	• By merging schemes from Central and state government department with Rurban Mission of Ministry of Rural development • Roorkee cluster is one such cluster for revamping solid waste management practices. It includes Roorkee, Manglaur, Piran Kaliyar ,Landhora,Bhagwanpur and Jhabera	District Administration District Panchayati Raj Officer (DPRO)
Community participation for waste management	All ULBs	• Social and Behavioural Change Communication • Cleanliness drive campaigns throughout the district	• IEC (Information, Education and Communication) activities in Educational institutions. • IPC (Inter-personal communication): School children and Sanitation workers to spread awareness amongst people regarding waste management.	District Administration
Establishment of Green Protocol	All ULBs	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.	• By encouraging Green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration

Phytoremediation as a Mitigation Measure (for treatment of solid waste)

Natural or planted vegetation on a landfill has an important role in erosion control and removal of contaminants, besides imparting aesthetic value. Moreover, it may also be used in leachate treatment. Phytoremediation is a promising, plant-based technology in which the plants and their associated microbes are utilized to absorb and clean up environmental contamination through engineered constructed systems. The ultimate aim is to either remove the pollutant from the contaminated media or to alter the chemical and physical nature of the contaminant so that it eliminates the risk to human health and the environment. Several plants are being identified to be used in phytoremediation task (Table 87).

Table 87. Phytoremediation as a mitigation measures (for landfill)

Botanical name	**Local Name**	**Altitude (m)**	**Assimilating capacity**	**References**
Cassia fistula L.	Golden Rain Tree	100-1400	Absorbs Arsenic and Fluoride from Industrial Water	Chaudhary & Rathore, 2019
Morus alba L.	Mulberry	300-2200	Absorbs Zn, Hg, As, Pb, Cu and Cd from Industrial Water	Janta *et* al., 2016
Dalbergia sissoo Roxb. ex DC.	Sheesham	Upto 1500	Absorbs nutrients from sludge	Kapoor *et* al., 2013
Calotropis gigantea (L.) Dryand.	Crown Flower	up to 1000	Helpful in absorption of Radioactive elements from soil	Kumar *et* al., 2013
Lemna minor L.	Duckweed	Upto 1200	Absorbs Cr and Pb from water	Kaur *et* al., 2021

Action Plan for Bio-medical Waste Management

Authorised health-care facilities in Hardiwar district are managing the waste in a scientific way. Though, they lack captive disposal facilities but most of them have linkage with CBWTF in Bhagwanpur. Biomedical waste generated from households needs effective segregation and management. This action plan provides holistic approach, which includes governance, infrastructure, training and immunization, services etc. to tackle the unprecedented growth in biomedical waste. Some technological interventions like Plasma waste treatment technology is desired in near future (Table 88).

Focus Areas

- *Linkage of ULBs with CBWTF*
- *Waste Inventorization*
- *Ensure scientific distribution of waste*

Table 88. Action plan for Bio-medical waste management

Action Areas	Purpose	Stakeholders
Governance		
Authorisation of all HCFs (Allopathic, AYUSH etc.) by Uttarakhand state Pollution control board (UKPCB).	To ensure compliance with the Biomedical waste management rules 2016.	Uttarakhand state Pollution control board (UKPCB)
Linkage of District level hospitals and Community Health Centres (CHCs) with Common Biomedical waste treatment facility (CBWTF).	To ensure proper disposal of Biomedical waste as specified under Biomedical waste management rules, 2016.	Health Department
Linkage of ULBs with Common Biomedical waste treatment facility (CBWTF).	To ensure segregation of Biomedical waste from Municipal solid waste and thus its proper disposal as per Biomedical waste management rules, 2016.	All ULBs
Implementation of Kayakalp initiative	To promote cleanliness, hygiene and infection control practices in public healthcare facilities.	Health Department
Infrastructure		
Construction and maintenance of Biomedical waste collection shed at district level HCFs and CHCs.	To ensure proper segregation of Biomedical waste into different categories as specified under Biomedical waste management rules, 2016.	Health Department
Training and Immunisation		
State level and District level orientation programs for healthcare workers to sensitize them about effective Biomedical waste management.	To ensure proper handling and segregation of biomedical waste in HCFs	Health department
• Setting up of Biomedical Waste Database at State level (specifically for primary health-care facilities) • Training on Biomedical Waste Management Information System (BMWMIS) to all data entry operators and pharmacists.	To keep records of biomedical waste generated in every HCF of the district (especially in PHCs at rural areas).	Health department

Immunisation (Tetanus and complete doses of Hepatitis-B) of all hospital staff involved in Biomedical waste management.	To avoid any kind of infection while handling Biomedical waste.	Health department
Services		
Establishing bins and bags at each generation points in HCFs with IEC posters displayed.	• To ensure segregation at each generation point and avoid mixing with MSW. • To spread awareness amongst the people related to biomedical waste management.	Health department
Timely replacement of bags, BMW transfer to collection shed and then prompt lifting to biomedical waste treatment facility from the shed.	To ensure timely disposal of biomedical waste.	Health Department and UKPCB.
Information		
Development of an IT-enabled data management system to keep inventory of waste collection, consumables supply, training programs etc. in HCFs (including PHCs in the district)	To ensure transparency in the biomedical waste management system up to primary level.	Health Department
Display details regarding authorisation, treatment and annual report of all Health-care facilities on website.	To make the information open source and ensure transparency.	Health Department and UKPCB.

Action Plan for C&D Waste Management

All municipalities and town panchayats in the district are advised to ensure that the Construction and Demolition wastes is disposed without affecting the environment. The detailed guidelines to be followed in respect of C&D waste management Rules, 2016 for the District administration (Table 89).

Focus Areas

- *Identification of dumping zones*
- *Quantification of C&D waste*
- *Setting up of C&D waste processing plant*
- *Framing of bye-laws*

Table 89. Action plan for C&D waste management

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Setting up of C&D Waste Dumping Site for local construction activities and road construction debris.	To ensure compliance with C&D Waste Management Rules 2016.	• Establishment of dumping zone such that it also caters for C&D waste of peri-urban areas and nearby villages. • Proper collection and transportation systems should be set up to aid processing. Illegal dumping practices should be discouraged by imposing penalties on open dumping.	• All ULBs • Public Works Department (PWD)
Setting up of Construction and demolition waste processing plant	For stacking, crushing, processing and manufacturing of various C&D products	C&D waste processing plant should be setup in proximity with all the Urban areas of the district.	• Nagar Nigam/Nagar Palika • District administration
Arrangement of Size grading	To facilitate reuse of C&D Waste.	This can be done by erecting sturdy metallic screens of different sizes at an angle and putting the waste over them with the help of front-end loader.	• All ULBs • PWD (Public Works Department)
Coordination and Collaboration amongst different departments.	To take care of C&D waste in addition to other municipal garbage, if there is no consolidated Solid Waste management department.	Close coordination between Sanitary department, Municipal Engineering Department and Town planning department is required for efficient management of C&D Waste management.	• All ULBs • Public Works Department (PWD)

Framing by-laws for C&D waste management.	To ensure compliance with C&D Waste Management Rules 2016.	• By-laws must be framed by each ULBs as per C&D waste management rule for proper disposal of C&D waste in the district. • Provision of heavy fines should be done under these by-laws for illegal dumping of demolition waste such as excavated earth material on the banks of river or on the hill slopes.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)
Plantation in old dumpsites.	Established the slope at old dumping zones.	Plantation at old dumping zone should be done with the help of community participation to stabilize the slope over there.	• All ULBs and District Panchayati Raj officer (DPRO) • Public Works Department (PWD)

Action Plan for Hazardous Waste Management

Hazardous waste generation in Hardiwar district mostly accounts for the waste generated from the industrial processes. Basic hazardous waste management facilities are available in the district. However, inventorization of hazardous waste generated from domestic households is still an issue. This action plan (Table 90) provides some key areas in which the district needs to work to achieve effective hazardous waste management complying with latest hazardous waste management rules, 2016

Focus Areas

- *Separate coloured bins for hazardous waste/e-waste*
- *Linkage of ULBs with TSDF*
- *Streamlining of hazardous waste in current waste management operations*

Table 90. Action plan for Hazardous waste

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Linkage of ULBs with common Treatment, Storage and Disposal Facilities (TSDF) or disposal facility	To ensure segregation of domestic hazardous waste from municipal solid waste and its proper disposal.	• All the ULBs of the district should establish linkage with nearby common TSDF or disposal facility to ensure proper disposal of hazardous waste to avoid its dumping in the landfill site. • One Collection facility should be setup in the district to collect domestic hazardous waste from the rural areas of the district.	• All ULBs • State pollution control board
Training of sanitation workers regarding segregation of domestic hazardous waste.	To ensure proper handling of waste and avoid any kind of infection.	Training programme should be organised at state/district level for handling and segregation of domestic hazardous waste which will also ensure proper segregation of waste.	State government and District Administration
IT enabled systems for inventorization of the hazardous waste.	To ensure compliance to Hazardous waste management rule 2016.	State pollution control board should inventories the generation, collection, and disposal of both domestic and industrial hazardous waste in its website so that complete transparency is maintained in the management of hazardous waste.	State pollution control board

Action Plan for E-Waste

E-waste management in the district involves due interventions from Uttarkhand pollution control board. This is done to avoid the harmful effects of hazardous waste in environment and human health. Bulk consumers, which adds to more than half of the e-waste generated in the district, have been identified. Still some basic management facilities are hard to find in the district. This action plan discusses key areas where due intervention is needed to achieve effective waste management in compliance with E-waste management rules, 2016 (Table 91). Some of the action needs to be addressed immediately such as establishment of collection centre etc. while others can be initiated with the due course of time.

Focus Areas

- *Doorstep collection of E-waste through toll free numbers or IT enabled interventions.*
- *To stop unregulated backyard operations of e-waste.*

Table 91. Action plan for E-waste

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Establishing E-waste Collection Centres	• Collection centre should be established for all ULBs in such a way that they could also cater the collection from nearby rural areas. • A Toll Free Number must be issued for the collection of E-waste	• All ULBs • UKPCB	• To ensure proper segregation of E-waste from municipal solid waste • Capacity building of stakeholders to promote effective E-waste management.
Authorization of E-Waste Pickers	Identity cards should be issued to all the waste pickers.	District administration and ULBs	To avoid illegal trading and processing of E-waste.
Linkage of ULBs with authorized recyclers/ Dismantlers	All the ULBs in the district should establish linkage with any of the five authorized E-waste recyclers.	All ULBs	To ensure proper recycling if possible and if not then proper disposal as per E-waste management rule 2016.
Market survey for identification of brand/producers /bulk consumers. Physical Verification of a Manufacturer.	Regular Auditing of an area by a survey team.	• District administration • UKPCB	To ensure compliance with E-waste management rules, 2016
District level Awareness campaign	• Promoting *Information, Education & Communication* (IEC) activities in educational institutions (Schools, Colleges etc.) • Promoting Awareness programmes under Digital India Initiative *(Initiated by Ministry*	District administration	Promoting behavioural change in public.

	of Electronics and Information Technology) about alternate methods of disposing E-waste.		
Extended Producer Responsibility	• Random sampling of electrical and electronic equipment's placed on market to monitor and verify the compliance of *Restriction of Hazardous Substances* (RoHS) provisions as per the guidelines of *Central Pollution Control Board* (CPCB) • "E-waste Return" Programme should be initiated to incentivize people and bring about behaviour change.	State Government and UKPCB	• Proper Collection and Disposal of E-waste • Channelization of e-waste generated from *the "end-of-life"* products to ensure environmental sound management.

Action Plan for River Polluter Stretch in Haridwar

Water quality in polluter stretch (Surface water and ground water) is regularly monitored by Uttarakhand Pollution Control board. The values of the water quality parameters are well within the standards. Tapping of nalas might have played a role in enhancing the water quality in the district. The action plan below envisages on the areas including technological interventions, administrative regulations, and preventive measure to improve the water quality and riverine ecology (Table 92).

Table 92. . Action plan for polluter stretch in Haridwar

Action Point	Stakeholders Responsible
Industrial Effluent Management	
Routine/surprise Inspection of GPIs (Gross polluting industries) and Red category industries for ensuring Compliance of effluent discharge standards as prescribed under Environment (Protection) rules, 1986, as amended	• Special Environmental Surveillance Task Force • Uttarakhand pollution control board (UKPCB)
Strengthening of Environment Surveillance squad (ESS)	UKPCB
Monitoring of Drains carrying industrial wastewater and CETP (Common Effluent Treatment Plant) outlet	UKPCB
Sewage Management	
Interception and diversion of all 22-drains	Uttarakhand Payjal Nigam
Installation of 2 STPs (68 MLD at Jagjeetpur and 14 MLD at Sarai)	
Solid Waste Management	
Door to Door Collection of Waste in all 40 wards	Nagar Nigam,Haridwar
Source segregation of wastes in all 40 wards	
Efficient Operation of waste processing facilities	
Groundwater Quality	
Groundwater quality monitoring at during summer (May–June) and winter(December-January)	Uttarakhand pollution control board (UKPCB)
Flood Plain zone	
Flood Plain zoning	Irrigation department
Regulation restricted activities in flood plain zones	• Irrigation department • District Administration
Environmental Flow	
Maintaining environment flow(a minimum of 15% discharge in lean period) in river Ganga and its major tributaries	Uttarakhand Jal Vidyut Nigam Ltd.

**Action Plan as per UKPCB report titled "Revised action plan for Rejuvenation of Ganga River Stretches"*

Phytoremediation as a Mitigation Measure (for rejuvenation of polluter stretches)

Aquatic plants, demonstrate a high potential to purify river water, Industrial waste water effluents and contaminated water (Samal et al., 2019). The tolerant plants, planted in the riverbank, can purify the river water by absorption, adsorption, accumulation and degradation of contaminants. These plants exhibited significant capacity to remove nutrients such as total Nitrogen and Phosphorus from

water bodies (Tong, et al 2003). The plant roots provide strong and extensive rhizosphere systems, which facilitate the growth of bacteria and other microorganisms (Steenhoudt, et al., 2000; Zimmels, et al, 2008). These microorganisms play a significant role in the removal of organic and inorganic contaminants from wastewater and contaminated water by degradation of organic chemicals and accumulation of nutrients and other metal contaminants. This phytoremediation process can be applied along either the riverbank or wastewater/storm water discharge point. The technique has low cost and wider community acceptance, irrespective of geographical locations (Table 93).

Table 93. Phytoremediation as a mitigation measures (for polluter stretches)

Botanical name	Local name	Assimilating capacity	Altitude (m)	Remarks
Pontederia cordata		Removal of nutrients and organic matter by aquatic plants and aeration. *P. cordata* has a strong impact on water purification even without concurrent aeration.	< 1000	Anawar et al, 2020
Ipomoea aquatic Forssk.	Water spinach	Removal of TN and TP, *Ipomoea aquatica* (water spinach) has thriving roots and high growth rates and has high capacities to absorb nitrogen, phosphorus, and other nutrients or pollutants		Tang et al, 2020
Persicaria lapathifolia (L.) Delarbre		Removal of BOD, COD, nutrient, metal		Rudin et al, 2016
Canna indica L.		Ecological floating bed for removal of nutrients		Barya, 2020
Iris pseudacorus L.		Ecological floating bed for removal of nutrients		
Accords calamus L		Ecological floating bed for removal of nutrients		
Typha domingensis Pers.		Decrease in BOD, COD and total organic carbon (TOC) was observed.		Gomber et al, 2013
Leptochloa fusca (Lam.) N.Snow		Decrease in BOD, COD.		
Brassica juncea (L.) Czern.	Sarso	Used to remove As, Pb, and Cd concentration in contaminated soil		Yasin et al, 2021

Fig. 10. Plant species for polluter stretches

Action Plan for Industrial Clusters in Haridwar District

Industrialization of Haridwar district has been a driving force for the development of the district in the past decade. However, maintenance of pollution levels be it water or air has been a task. This acion plan marks some areas, which would be helpful in near future to ensure smooth working of industrial clusters (Table 94).

Table 94. Action plan for industrial clusters

Action Point	Purpose	Stakeholders
Formation of Central Cluster Cell	For maintaining Cluster Information, performance evaluation, identification and facilitation of sharing of best practices among the cluster participants.	IIE, SIDCUL
Encouraging Cluster Association	To represent the interest of cluster units and interface with various government departments and other agencies to promote state of productivity.	IIE,SIDCUL
Upgrading clusters through infrastructure investment	To bring suppliers ,producers, sellers and buyers together and help build the forward and backward linkages, thus facilitation the scaling up of the clusters	IIE, SIDCUL
Knowledge sharing and collaboration	To encourage association between clusters enterprises, universities, research institutes to spur innovation and growth	IIE,SIDCUL

Action Plan for Waste Water Management (STPs)

Central Pollution Control Board (CPCB) and Uttarakhand Pollution Control Board (UKPCB) have periodically issued directions to the urban local bodies to set up Sewage Treatment Plants (STPs) of adequate capacity including provision for sewerage system to cover the entire local/urban areas and the treated effluent to comply with the standards in order to prevent deterioration of surface, sub-surface and coastal waters. The treated sewage, after ensuring that the prescribed standards for core parameters are met are either used for irrigation or let into water bodies. The detailed utilization of treatment sewage by the district is given in (Table 95).

Table 95. Action plan for waste water management (STPs)

Action Point	Concerning ULB	Strategy/Approach	Stakeholder Responsible	Purpose
Continuous Effluent Monitoring station	All ULBs	• Self-monitoring mechanism in the form of Online Continuous effluent monitoring system.	• Jal Sansthan/Jal Nigam • State Pollution control board	• To ensure that the STP meet out the prescribed standards as per Environment Protection Act, 1986.
Decentralized waste water management under Atal mission for Rejuvenation and Urban transformation (AMRUT) by Faecal Sludge and Septage Management system (FSSM)		• In line with National FSSM policy, each state is expected to develop and issue an FSSM implementation strategy and plan guideline. This may be integrated with overall city land use planning. • Capacity building and training on FSSM (at City level) to build their personnel capacities and organizational systems for delivery of sanitation services.	Ministry of Housing and Urban development, Government of India	• Promoting community-planned and managed faecal sludge and septage management for group of households. • Rehabilitation of old sewerage system. • To augment limited treatment capacity. • Recycling and reuse of waste water for beneficial purposes.
City Sanitation Plan under National Urban Sanitation policy	All ULBs	• Enhance synergy among municipal government agencies, the private sector, NGOs and others. • Increase funding from sources other than municipal government (such as from the national and provincial governments, donor	Ministry of Housing and Urban Development, Government of India	• Citywide Sanitation Sector development. • Awareness generation and behaviour change in field of Sanitation. • Sanitation and safe disposal of waste.

		agencies, the private sector)		
Use and Pay model	All ULBs	By Software as a service (SaaS) integrated platforms.	Jal Sansthan /Jal Nigam	City would pay for per litres of water treated
Automation of all water infrastructures including valves and pipelines	All ULBs	Integration of new age technologies with real time data tracking.	Jal Sansthan /Jal Nigam	To check any malfunction such as leakage, unauthorised connection etc
Integrated Urban Water management	All ULBs	Promoting simultaneous planning of urban infrastructures with decentralised approach for new interventions in parallel to the existing centralised systems.	Jal Sansthan /Jal Nigam	This approach encourages not to look water supply in isolation but in coordination with related sectors such as sanitation ,storm water and rain water conservation and waste water reuse,

Phytoremediation as a mitigation Measure (for domestic waste water)

With removal of some biotic and abiotic pollutants (by absorbing these pollutants), certain plants, can help in the natural treatment of domestic waste water (Table 96).

Table 96. Phytoremediation as a mitigation measures (for STPs)

Botanical name	**Local name**	**Altitude (m)**	**Assimilating capacity**
Jacaranda mimosifolia D. Don	Jacarnda	500-2400	Antimicrobial action against E.coli and Staph bacteria
Salix babylonica L.	Willow	1400-2000	Improve the quality of ground water by absorbing ammonical nitrogen and heavy metals
Canna indica L.	Canna	1800-2000	Used for removal of ammonical nitrogen from sewage
Azolla pinnata R.Br.	Azolla	Upto 1000	Used for cleaning of sewage and degrades diesel fuel and absorbs mercury and cadmium
Typha domingensis Pers.	Southern Cattail	upto 1500	Reduces bacteria from water and absorbs Al, Fe and Zn from Sewage.

Action plan for industrial waste water management

One Common effluent treatment plant is currently operational in Haridwar. Other; industrial estates have their effluent treatment plant of industrial wastewater management. Some industries are working on Zero liquid discharge in the district.

The action plan below focuses on policy level interventions to ensure effective wastewater management in the district. (Table 97 and 98)

Table 97. Action plan for industrial waste water management

Action Point	Stakeholders Responsible	Purpose
Guidelines for Conducting Safety Audit as per NGT	• Central Pollution Control Board (CPCB) • (Uttarakhand State Pollution Control Board (UKPCB) Ministry of Environment, Forest and Climate Change (MoEF&CC)	• To mitigate industrial accidents.
Capital subsidies and other forms of Financial support to install ETPs	• Directorate of Industries, Government of Uttarakhand	• Ensuring sustainability of Industrial units. • To encourage a calibrated green focus.
Energy Efficiency in Industrial Sector through Perform, Achieve and Trade (PAT) Scheme.	• Directorate of Industries, Government of Uttarakhand • Uttarakhand State Pollution Control Board (UKPCB)	• To reduce Specific energy consumption in energy intensive structure. • To enhance cost effectiveness of energy saving through certifications of excess savings.
Zero Effect Zero Defect (ZED) Certification.	• Directorate of Industries, Government of Uttarakhand • Uttarakhand State Pollution Control Board (UKPCB)	• To achieve high quality manufacturing that is also green. • To Rate Micro, Small and Medium Enterprises (MSMEs) on quality control and certification for energy efficiency.
• Enforcing over ground and pressurized effluent carrying network • To ban the carrying of effluent up to common collection point through underground and gravity network**.**	Uttarakhand State Pollution Control Board (UKPCB)	To control unauthorised discharge and subsequently excessive pollutant load at CETP inlet.

Table 98. Common effluent treatment plant management

Action Point	Stakeholders Responsible	Purpose
Dedicated Agency for Effluent Management	Uttarakhand State Pollution Control Board) (UKPCB)	By State pollution control board.
Solid and Salt waste management in ZLD CETPs	Uttarakhand State Pollution Control Board) (UKPCB)	Promote ZLD Technologies that does not result in waste salt and sludge which may cause serious disposal issues

Action Plan for Water Resources Management and Ground Water Extraction/Contamination

Surface water and ground water quality is a highlighted issue in Haridwar distict. Continues monitoring is done to ensure that the values are within prescribed limits. Moreover, rainwater harvesting techniques are also encouraged for effective water resource management in the district. This action plan focuses on the areas, which form the prerequisite for effective water resource management. Each action point complies with the guidelines under Water (prevention and control of pollution act, 1974), (Amendment) Rules 2021 of water resource management act, 1986. The current action points must be addressed in a timeframe of 5-10 year considering the financial constraints. (Table 99 and 100).

Focus Areas

- *Mapping of water scarce areas*
- *Assessment of Groundwater availability in area*

Table 99. Water Resources Management

Action Point	Purpose	Strategy/Approach
Integrated water resources management (IWRM) at River basin level	To achieve water security for all purposes, managing risks and to mitigate disasters	By considering basin/sub basin as a basic unit for planning and management.
River Basin Master Plan	Periodic review of hydrological conditions prevailing over a basin Identification of protected areas	By analysing River Basin Characteristics
Mapping of water scarce areas in a district	To get estimate of vulnerable areas in the district.	• By using modern mapping tools such as Geographical Information System (GIS) and Remote sensing • By setting up an interdisciplinary framework consisting of Local institution and empowered government agency
Assessment of water Resources in various river basin	To collect reliable data To assess water resources potential and analysing water requirements for various uses,	Using Modern technology and Hydrological modelling
Public Awareness and use of Low Cost technologies	For better water application efficiency	Using field application methods such as Drip irrigation/micro sprinkler irrigation systems in water scarce areas. This can be achieved by bringing government subsidies in this area as the local people needs incentives to up bring this modern technology.

Integrated Rural area Programme (IRAP)	• For constant interactive relationships between different departments • Location specific programmes can be drawn up locally under this overall programme.	By bringing together all the programmes of different ministries as well as rural employment and development programme into one for effective collaboration and planning.

Table 100. Ground water management

Action Point	**Strategy/Approach**	**Purpose**
Multidisciplinary Approach (Nexus between groundwater, agricultural policy, urban infrastructure and energy consumption)	By integrated vision and coordination amongst different departments.	For groundwater sustainability
Mapping of aquifer at micro level	By Maintaining an Aquifer information and Management system	• To quantify the available ground water resources • To formulate plan appropriate to the scale of demands and aquifer characteristics.
Designated Idol Immersion Sites within municipal area or bank of river	• By constructing temporary confined ponds with removable synthetic liners at the bottom. • Discouraging use if synthetic material, Plaster of Paris, Baked clay, resin fibres and thermocol for making of idols. • Following CPCB evolved guidelines for immersion of idols and other puja materials in different water bodies.	To prevent any stray immersion of idols in the river or its banks.
Identification of Non-point sources of Pollution (Pollution resulting from land runoff, precipitation, drainage, seepage etc.)	• Controlling soil erosion by planting more trees and covering bare soil with vegetation. • Constructing wetlands.	Non-point source pollution is a leading cause of deteriorating water quality as when the runoff moves ,it picks up and carries away natural and human-made pollutants finally depositing them in lakes, rivers and groundwater.
Mitigating Groundwater Contamination	• Reducing the use of pesticides and fertilizers. • Encouraging Organic farming in the area by organising various Information, Education and Communication (IEC) campaigns.	• To ensure the ground water quality of an area. • To reduce health hazards caused due to contaminated water.

Action Plan for Air and Noise Pollution

Air pollution in Haridwar district has been a common affair for past decade. Yet the local people are still not aware about the deteriorating air quality in the district. Apart from setting up reasonable air quality monitoring station, this action plan focusses on areas, which requires collaborative efforts from different departments to mitigate air pollution in the district. (Table 101).

Focus Areas

- *Control on Stubble burning*
- *Vehicular traffic management*
- *Stack Emission Monitoring*
- *Regular Awareness campaigns*

Presently, Noise pollution is not a major issue in the district. However, some administrative level intervention will help to clamp down the nuisance caused due to honking in the district (Table 102). "Operation Decibel" formulate by Kerala could be a better follow up for the same.

Table 101. Action plan for air quality management

Action Areas	Strategies/Approach	Stakeholders	Purpose
Solid waste collection system	• Door-to-Door collection of waste in the urban areas and provision of dry waste collection from rural areas within the district. • After implementing proper collection mechanism, hefty fines must be charged on open burning of waste.	All ULBs and District Panchayati Raj Office (DPRO).	To reduce emission of harmful gases by open burning of waste especially in urban areas.
Vehicular Traffic management	• Checking adulteration of fuel. • Promoting intercity and intra-city public transportation with green fuel alternatives such e-buses etc. • Paving of road shoulders especially in urban areas.	• Department of Police • Transport Department • Public works department	• To reduce emissions caused by vehicles. • To identify area specific vehicular pollution
District level action plan for air pollution	A district level task force with some experts can be formed for air quality management in the district.	District Administration	To improve existing air quality.
Awareness on air quality	Mass awareness can be promoted with Information, education and communication (IEC) activities by involving institutions such as schools and colleges for this purpose.	District Administration	To promote awareness among the masses regarding the issue.
Encouraging CNG and battery operated public transport vehicles	Supporting the applicability of Electric and hybrid buses in following areas: • School Buses, • City Buses, • Tourism, • Company vehicles	District Administration	• To reduce local air pollution • Higher efficiency of electric propulsion system.

Dust control measures	Following Dust abatement measures need to be taken for mitigating its impact on health of an individual and environment: • Sprinkling of water/fine spray to suppress dust re-suspension • Management of Transport vehicles by Pollution under Control (PUC) compliance. • Dry sweeping of work areas to be discouraged. • Development of green buffer for construction activities site (Preferably shrubs and trees that have low uptake of water.	District Administration	To control dust at source and prevent it from becoming airborne, since suppression is virtually impossible once it has become airborne.
Restriction of heavy driven vehicle in Haridwar during day time	The entry points should be decided for non-entry of the heavy-duty diesel vehicles.	District Administration	• For traffic regulation and mitigating road congestion. • To improve daytime air quality
Social Forestry plantation	• Prioritizing native trees/shrubs and grasses of particular agro climatic zone (as plantation of exotic tree/shrub species often results in low survival rate inferior productivity and higher cost of maintenance). • Integrating green corridor development and management for upcoming highway projects.	District Administration	For environment protection and beautification in urban areas.
Mainstreaming and integrating existing policies and programmes of the National Action Plan on Climate Change (NAPCC) and other initiatives of government of India in reference to climate change	By mainstreaming the initiatives under eight national missions of NAPCC namely: • National Solar Mission • National Mission for Enhanced Energy Efficiency • National Mission on Sustainable Habitat • National Water Mission • National mission for sustaining Himalayan ecosystem • National mission for a Green India. • National mission for sustainable agriculture. • National Mission on Strategic Knowledge for Climate Change	District Administration	For an accelerated implementation of time-bond plans through collaborations.

**Key points for the action areas in this thematic are influenced by NCAP (National Clean Air Programme) report by MoEFCC and Action plan for Air quality improvement of Haridwar city by UKPCB*

Table 102. Action plan for mitigating noise pollution

Action Areas	Strategies/Approach	Stakeholders	Purpose
Traffic management	• Signboards should be placed at sensitive locations in the towns within the districts and if required, silent zones should be established. • Green belts can be formed along the roads in the urban areas to reduce noise levels.	• District Administration • Public Works department and ULBs	To ensure noise level within permissible limits.
Complaint redressing system	Online complaint registration and redressal system for noise pollution.	District Administration	To sort out grievances registered by citizens
Mass Awareness	Mass awareness campaigns must be organized with the help of Information, Education and Communication (IEC) activities by taking the help of institutions such as schools and colleges for this purpose.	District Administration	To promote awareness among the masses regarding the health impacts such a Noise induced Hearing Loss (NIHL), high blood pressure, sleep disturbances, heart disease due to noise pollution.

Action Plan for Mining activities

Sand mining is widespread in the flood plains of Ganga river and its tributaries. Different departments are working to ensure that no illegal mining happens in the district. The action plan provided below mainly emphasize on areas, which includes monitoring of the mining operation by using the latest technologies as per the sustainable sand mining guidelines 2016 (Table103).

Focus Areas

- *Identification of hotspots of illegal mining*
- *Digitization of trading process*

Table 103. Mining activity management plan

Action Areas	Strategies/Approach	Stakeholders	Purpose
Monitoring of mining activity	• A district-level task force should be formed to monitor mining activities and to conduct river audits and surveillance. • For the rivers marking the boundaries with other districts, a combined task force should be formed to monitor mining activity in the river.	District Administration	To ensure sustainable mining activity within the district.
System for online purchase and sale of sand and other RBMs	An online system should be made at the state or district level for e-auctioning the mines to ensure transparency in the system.	State Government and District Administration	To ensure compliance to Enforcement and Monitoring guidelines for Sand mining, 2020.
Identification of hotspots for illegal mining	The district task force should identify the possible hotspots for illegal mining through surveillance and patrolling.	District Administration	To have check on the mining activities in the district.
Community participation	A toll-free number must be issued for citizens in the district to register any complaint against any illegal mining practices as identified by them in their vicinity	District Administration	• To understand local faction's willingness in curbing illegal mining from the area. • To have local check on the illegal mining activities in the district.

Action Plan for Rejuvenation of Waterbodies

Rejuvenation works are in progress in Jhilmil Jheel Conservation are and Polluter stretch of River Ganga in Haridwar district. Different department including forest department and Uttarakhand Pollution control board are working for restoration of water bodies and their water quality in the district. The ongoing project to rejuvenated Indrawati River exhibits a lot of potential. This action plan discusses some modalities, which includes scientific interventions as well as convergence activities to revive the flow of any water body and its sustainable management (Table 104)

Table 104. Action plan for Rejuvenation of Water bodies

Action Point	Strategy/Approach	Purpose
River Catchment / Basin Management	Participatory and self-management institutional framework for administering the catchment with a combination of engineering, social and scientific management.	Reducing levels of potential contaminants in raw water.
Plantation in Flood plain zones (FPZ)	Vegetation that acts as natural resistant to soil disturbances and standing water must be encouraged.	• To reduce shoreline erosion • Particular type of plants act as natural barriers to dissipate waves and back-lying areas from flooding.
Prohibition of disposal of Municipal Plastic waste and Biomedical waste (specially in flood plain zones)	• Awareness and behavioural change activities. • Provisions of heavy fine for those found throwing garbage in rivers.	• To maintain ecological balance of the water body • To prevent pollution activities nearby river basin.
Spring-shed and stream shed management	• By Constructing loose boulder check dams. • Encouraging Information, Education and Communication (IEC) activities in local institutions (schools, colleges etc.)	To improve water resource sustainability To enhance water discharge from springs and rivers
Convergence Activities	By making use of Social media platforms	Ensuring Community participation

**Key points for the action areas in this thematic are influenced by rejuvenation activities carries out for Kosi river(Almora), Bhela river(Kashipur) and Heval River (Tehri Garhwal)*

Action Plan for Plastic Waste Management

Plastic waste causes a plethora of problems when it leaks into the environment. Stranded single use plastics create visual pollution. There is evidence that the toxic chemicals added during the manufacture of plastic, transfers to animal tissue, eventually entering the human food chain. Moreover, by clogging sewers and providing breeding grounds for mosquitoes and pests, plastic bags can increase the transmission of vector-borne diseases like malaria, cholera.

Focus Areas

- *Streamlining of plastic waste in current waste management operations.*
- *Emphasis on Extended Producer Responsibily*
- *Formalization of waste pickers*

Plastic waste management is still not robust in the district. Plastic waste generation is likely to escalate with rapid urbanization in the district. Almost one third of plastic waste generated ends up in river bodies, which has damaged riverine ecology.

Amalgamation of scientific and convergence activities are required for effective plastic waste management in the district. This action plan focusses on key areas which needs to be addressed for plastic waste management in the district (Table 105).

Table 105. Action plan for plastic waste management

Action Point	Strategy/Approach	Stakeholder Responsible	Purpose
Source segregation	• ULBs should distribute separate bins to households, street vendors and other shopkeepers as done by NP Dwarahat. • Distribution of separate bins to every households and shopkeepers in rural areas under Swachh Bharat Mission Gramin should be ensured. • Mass awareness programmes regarding source segregation with the inclusion of institutions such as schools and colleges.	All ULBs, District Panchayati raj Officer (DPRO), Village Panchayats	• To ensure better efficiency in waste processing • Higher recovery of resources.

Effective Collection and segregated waste transport	• Training waste pickers and providing them proper equipment suitable as per the topography of the area for door to door collection in urban areas. • Establishing plastic waste collection centres in rural areas where door to door collection is not possible. • Provision of separate vehicles is done for dry and wet waste to ensure utilisation of manpower. • ULBs can establish linkage with the NGOs working in this field for effective waste collection in the urban areas.	All ULBs, District Panchayati Raj Officer (DPRO), Village Panchayats	• To reduce open dumping of waste • To reduce monkey menace (which is a huge issue in the urban areas of the district) • To ensure optimum utilisation of manpower • To ensure compliance with plastic waste management rules 2016
Linkage of ULBs & other collection centres with recyclers/ cement plants / Public Works Department	• NP Dwarahat, NP Chaukhutiya should establish linkage with any recyclers as other ULBs of the district already have linkage with some of the recyclers. Plastic waste collection centre to be started in rural areas should also be linked with recyclers. • Plastic waste can be used in road construction for this ULBs should coordinate with the construction agencies such as Public Works Department.	All ULBs, District Panchayati Raj Officer (DPRO),,	• To avoid open dumping of plastic waste. • To ensure reuse and recycle of plastic waste.
Implementation of extended producer responsibility (EPR) through producer/Brand owner	• ULBs can ask the manufacturers collectively or individually in line with the principle of extended producer responsibility (EPR) to provide the required finance to establish plastic waste collection centres.	All ULBs	To reduce the workload of ULBs
Community participation for waste management	• Information, Education and Communication (IEC) activities in Educational institutions. • Inter-personal communication (IPC): School children and Sanitation workers to spread awareness amongst people regarding waste management	District Administration	• Social and Behavioural Change Communication • Cleanliness drive campaigns throughout the district
Establishment of Green Protocol	• By encouraging Green protocol in local schools, public functions, IEC campaigns, sports events, annual temple festivals and other gatherings.	District Administration	• To prevent use of disposables and using alternatives like glass/Stainless steel etc. • To bring generation of non-biodegradable waste close to zero.

CONCLUSION

Over the past few decades, ever growing environmental problems have invited lots of attention of the stakeholders like academicians, local government, environmental planners, social activists and judiciaries. The environmental issue has therefore raised a large scale public concern. Many actions have been taken by the Government of India and concerned Environmental Protection Agencies to protect different environmental components, ecosystem services and human health from a particular pollution and degradation threat. Despite, some of the successes achieved on the grounds, many more problems continue to remain unresolved with the new ones emerging continuously day by day. With the ever increasing native and floating population and resultant anthropogenic pressures, sometimes addressing a strategy becomes a bit difficult. However, combined and interdependence might reduce complexity of environmental systems. The present new challenges before planners and policymakers might be resolved if a scientific spirit could be maintained in management actions on a ground. Scientific research could play an important role in managing and minimising pollution loads. The scientific studies and their implementation on ground will continue to play its vital role in resolving environmental problems. The environmental problems may lead to a sectoral view of problems like pollution, health, basic sanitation, land management, and conservation and sustainable use of natural resources. Decisions based on incorrect or incomplete understanding of environmental components would not allow to achieve the targeted goals of environmental management with lower risks and cost. This report as an environment plan of the district describes a framework for acquiring an idea to manage current problems of environmental aspects such as solid waste, biomedical waste, C&D waste, e-waste, industrial waste water, plastic waste, etc. These problems need to be considered as a tool to prepare for a variety of problems in view of emerging in near future. Though there is no any optimal institutional framework for environmental and natural resource management at the district level, yet some general features of an ideal institutional system could be many. These could be as follows: (i) flexibility of a plan or a model, (ii) capacity to generate information and create awareness of the importance of environmental problems among the decision-makers at all levels, (iii) decentralized decision-making and enforcement, (iv) involvement of individuals for a clear-cut role, and consensus of stakeholders (governmental agencies, non-governmental organizations, community groups and other associations) in environmental management; and (v) a high-level political will and support . There is a need to apply from the sectoral approach to collaborate approach. This is a need of the hour to mitigate and minimise the environmental impacts in our surroundings.

Environmental planning for different environmental components need to be adhered to the principle of sustainability where science serves as a quantifiable tool. The environmental management approach needs to be holistic in nature. Decision making is an integration of science and management to get people involved and managers to act and to plan.

Haridwar district generates ample amount of solid waste per day owing to its ever growing population. Waste management practices are different in each ULB of the district. Historical waste in the streets, river side areas create nuisances and tarnished the aesthetic beauty of the place. Waste management operations are essential for ganga rejuvenation.

Fig. 11. Different activities in Haridwar District for preparation of District Environment Plan

(A & B) A consultative workshop/Seminar in the district on preparation for District Environment Plan

REFERENCES

Aayog, NITI. (2018). Composite Water Management Index: a tool for water management.

Anonymous, (2018). "Uttarakhand Vision 2030" Planning Commission, Government of Uttarakhand,

Attri, S.D., & Tyagi, A. (2010). Climate profile of India. Environment Monitoring and Research Center, India Meteorology Department: New Delhi, India.

Azash, S.M.D. & Thirupalu, N. (2017). Fundamental Principles of Environmental Protection and Sustainable Development, National Conference on Marketing and Sustainable Development, Vol. 13, pp 14, ISBN 978-1-943295-10-4

Chaphekar, S.B., Boralkar, D.B., Shetye, R.P. (1980). Effects of industrial pollutants on plants, Final Report of UGC sponsored project.

Chopra, R. (2014). Uttarakhand: Development and ecological sustainability. Oxfam India

CPCB, (Central Pollution Control Board) (2013). Overview of Plastic Waste Management by Central Pollution Control Board New Delhi

CPCB, (Central Pollution Control Board) (2019). Biomedical waste management as per biomedical waste management rules 2016 for the year 2019.

CPCB, (Central Pollution Control Board) (2020). Annual Report 2019-20 by Central Pollution Control Board New Delhi

CWM, (2020) Construction Waste Market, Global Industry Analysis, Size, Share, Growth, Trends, and Forecast 2017-2025 by Energy & Natural Resources

Da, Fonseca, L.M.C.M. (2015). ISO 14001: 2015: An improved tool for sustainability." Journal of Industrial Engineering and Management 8.1 (2015): 37-50.

Das T.M (1981) Plants and Pollution Presidential address in Section of Agricultural Sciences. Indian Science Cong. Assessment Meeting, B.H.U. Varanasi.

Dash, P., & Punia, M. (2019). Governance and disaster: Analysis of land use policy with reference to Uttarakhand flood 2013, India. International Journal of Disaster Risk Reduction, 36, 101090.

District Census Handbook (2011), District Census Handbook Haridwar, Census 2011, http://www.censusindia.gov.in/2011census/dchb/0507_PART_A_DCHB_ Haridwar.pdf

District Statistical Report (2018). District statistical Handbook 2018, Haridwar, https:// Haridwar.nic.in/document-category/statistical-report.

District Survey Report (2018). District Survey Report: District Haridwar 2019-20. District Survey Report of River Bed Mining of Haridwar, Uttarakhand. In Compliance of Ministry of Environment, Forest and Climate Change Notification No. 2827 dated: 25th July 2018

District Survey Report (2020). District Survey Report of Silica Sand, Haridwar, Uttarakhand Geology and Mining Unit, Uttarakhand Government, District Office, Haridwar, Uttarakhand

EEMI, (2018). Electricals and Electronics Manufacturing in India. NEC Technologies India Private Limited https://in.nec.com/en_IN/pdf/

Eriksson, M., Xu, J., Shrestha, A.B., Vaidya, R.A., Santosh, N., Sandström, K. (2009). The changing Himalayas: impact of climate change on water resources and livelihoods in the greater Himalayas. International centre for integrated mountain Development (ICIMOD).

Ferronato, N., & Torretta, V. (2019). "Waste mismanagement in developing countries: A review of global issues." International journal of environmental research and public health 16,6: 1060.

Forbes, K., Broadhead, J., Brardinoni, A. D., Gray, D., & Stokes, B. V. (2013). Forests and landslides: The role of trees and forests in the prevention of landslides and rehabilitation of landslide-affected areas in Asia Second edition. Rap Publication, 02.

FSI, (2019). Forest Survey of India: An Assessment Report on Forest Cover Status of India. Government of India: Ministry of Environment and Forest (MoEF); Forest Survey of India Dehradun. https://fsi.nic.in/forest-report-2019.

Gaur, A.C. (2008). Basic environmental engineering. New Age International.

Groundwater Brochure of District Dehradun, Uttarakhand, (2011). Central Groundwater Board, Ministry of Water Resources, Govt. of India.

Groundwater Year Book India 2019-20, (2020) Central Ground Water Board (CGWB), Ministry of Jal Shakti, Department of Water resources, River Development and Ganga Rejuvenation, Government of India.

Gupta, S. (2014). Ground Water Scenario of Himalayan Region, India. Central Ground Water Board.

Handl, G. (2012). Declaration of the United Nations conference on the human environment (Stockholm Declaration), 1972 and the Rio Declaration on Environment and Development, 1992, United Nations Audiovisual Library of International Law, 11

IPCC, (2021). "AR6 Climate Change 2021: The Physical Science Basis." Working Group I contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Cambridge, UK: *Cambridge University Press*

Kala, C.P., Dhyani, P.P., & Sajwan, B.S. (2006). Developing the medicinal plants sector in northern India: challenges and opportunities. Journal of Ethnobiology and Ethnomedicine, 2(1), 1-15.

Khanduri, S. (2018). Landslide distribution and damages during 2013 Deluge: a case study of Chamoli district, Uttarakhand. Journal of Geography and Natural Disasters, 8(2), 1-10.

Kriebel, D., et. al., (2001). "The Precautionary Principle in Environmental Science." Environmental health perspectives 109, no. 9: 871-876.

Krishnan, R., Sanjay, J., Gnanaseelan, C., Mujumdar, M., Kulkarni, A., Chakraborty, S. (2020). Assessment of climate change over the Indian region: a report of the ministry of earth sciences (MOES), government of India. Springer Nature

Kroll, C., Warchold, A., Pradhan, P. (2019). Sustainable Development Goals (SDGs): Are we successful in turning trade-offs into synergies. Palgrave Communications, 5(1), 1-11.

Meenakshy, V., Mahadevan, T.N., Misra, U.C. (1981). Nature and extent of biomagnification of fluoride in forage around a phosphate fertilizer plant, Proceeding, Biological, Indian Environment Pollution pp 9

Messerli, P, et al. (2019). Global sustainable development report 2019: the future is now–science for achieving sustainable development.

Misra, A. (1978). Chipko movement: Uttarakhand women's bid to save forest wealth (No. 1). People's Action

MoEF&CC, (2018). Ministry of Environment, Forest and Climate Change, 2018. Beat Plastic Pollution: Good News from India. MoEFCC, New Delhi.

MoEF&CC, (2021). Annual Report Ministry of Environment, Forest and Climate Change, Government of India, New Delhi

MoUHA, (2016). Ministry of Urban Development, Municipal Solid Waste Management Manual-Part II, Central Public Health and Environment Engineering Organization, p. 6.

Nagendran R., Selvam A., Joseph K., Chiemchaisri, C. (2006). Phytoremediation and rehabilitation of municipal solid waste landfills and dumpsites: a brief review. Waste Manage; 26:1357–69.

Nagendran, R., Selvam, A., Joseph, K., Chiemchaisri, C. (2006). Phytoremediation and rehabilitation of municipal solid waste landfills and dumpsites: A brief review. Waste Management, 26(12), 1357-1369.

NATCOM, (2012). India: Second National Communication to the United Nations Framework Convention on Climate Change. *Ministry of Environment and Forests, Government of India, available at http://envfor. nic. in/, viewed on December, 10*, 2013.

Negi, G.C.S., Rawal, R.S., Dhyani, P.P., Palni, L.M.S. (2012). Twenty Priority Issues for Forestry Research with Particular Reference to Indian Himalayan Region in the RIO+20 Era. Glimpses of Forestry Research In The Indian Himalayan Region, 1.

Anonymous, (2014). Before The National Green Tribunal, Principal Bench, New Delhi.

Pal, S.S., Kansal, A., Rawat, T. (2018). Bio-Medical Waste in Pandemic COVID 19 Uttarakhand UKPCB Envis Newsletter 16(2): pp 1-6.

Parkash, S. (2015). A study on flash floods and landslides disaster on 3rd August 2012 along Bhagirathi Valley in Uttarkashi District, Uttarakhand. World Centre of Excellence on Landslide Disaster Reduction, National Institute of Disaster Management, Ministry of Home Affairs, Government of India.

Paul, P.P. (2014). Doctrine of Public Trust and Its Application by the Judiciary in Environmental Governance of India: A Critique. Indian JL & Just., 5, 82.

Prajapati, S.K. (2012). "Biomonitoring and speciation of road dust for heavy metals using Calotropis procera and Delbergia sissoo."Environmental Skeptics and Critics 1(4): 61-64.

Raj, J. (2014). Uttarakhand action plan on climate change, transforming crisis into opportunity. Government of Uttarakhand, Dehradun.

Rajaram, V., Dutta, S., Parameswaran, K. (Eds.). (2005). Sustainable mining practices: A global perspective. CRC Press, 2005.

Sadowsky, M.J. (1999). Phytoremediation: past promises and future practices. In: Bell, C.R., Brylinsky, M., Johnson-Green, P. (Eds.), Proc. 8th Int. Symp. on Microbial Ecology. Atlantic Canada Society for Microbial Ecology, Halifax, Canada.

Sahu, M. (2014). Sustainable Development: Judicial Trends in Mining Cases. Available at SSRN 2854092.

Samant, S.S., Dhar, U., Rawal, R.S. (1998). Diversity and distribution of wild edible plants of Indian Himalaya, In: Plant diversity of the Himalaya, edited by PC Pandey & SS Samant, (Gyanodaya Prakashan, Nainital), 2001a, 421-482.

Sandhu, H., Sandhu, S. (2015). Poverty, development, and Himalayan ecosystems. Ambio, 44(4), 297-307.

Sarkar, A. (2018) Environmental conservation in terms of contribution from women, International Conference on Literature, Society & the Global Media, International Journal of Research Culture Society, pp 29-30 ISSN: 2456-6683.

SBM, (2016). Swachh Bharat Mission, Municipal Solid Waste Management Manual Part II: The manual, Central Public Health and Environmental Engineering Organisation (CPHEEO), Ministry of Urban Development.

Sharma, K.D., Jain, S. (2019). Overview of municipal solid waste generation, composition and management in India. Journal of Environmental Engineering 145(3), 04018143.

Singh, N.K. (2000). The Indian Constitution and Customary International Law: Problems and Perspectives. Student Advoc, 12, 81.

The Groundwater Foundation (2020). National Groundwater Association, https://www.groundwater.org/get-informed/groundwater/contamination.html, Accessed (17 May 2020).

The sub-national Water Stress Index (2019), formulated by London-based risk analytics firm Verisk Maplecroft, https://www.maplecroft.com/

UNDP. (2015). Resolution adopted by the General Assembly on 11 September 2015. A/RES/69/315 15 September 2015. New York: United Nations (UNDP).

UNDP. (2020). Report, Plastic Waste Management Programme. (2018-2024), United Nations Development Programme (UNDP).

Varghese, B., Jose Paul, N.I. (2013). Disaster management: a case study of Uttarakhand. Water, climate and tourism—is it a boon or bane to mankind and economic environment.

Venkat, A. (2012). 'Polluter Pays' Principle: A Policy Principle. Available at SSRN 2458284.

Vinuesa, R., et al., (2020). The role of artificial intelligence in achieving the Sustainable Development Goals. Nature communications, 11(1), 1-10

WHO, (2018) Delivering Quality Health Services: A Global Imperative. OECD Publishing.

World Resources Institute (2019), https://www.wri.org/insights/17-countries-home-one-quarter-worlds-population-face-extremely-high-water-stress.

DIPSR, (2021). Brief Industrial Profile of Haridwar District, Micro, Small & Medium Enterprises Development Institute Kham Bangla, Kaladungi Road Haldwani, Nainital, Uttarakhand, India pp.1-42

Gantait, S., Agarwala, DK. (2021). Bibliography and Abstracts of papers on flora of Uttar Pradesh and Uttarakhand, under ENVIS partner on biodiversity botanical survey of India Ministry of Environment, Forest and Climate Change

NATCOM, 2004. India's Initial National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Forests, Government of India, New Delhi

Houda, Z., Bejaoui, Z., Albouchi, A., Gupta, D. K., & Corpas, F. J. (2016). Comparative study of plant growth of two poplar tree species irrigated with treated wastewater, with particular reference to accumulation of heavy metals (Cd, Pb, As, and Ni). Environmental monitoring and assessment, 188(2), 1-10.

Ukpebor, E.E., Ukpebor, J.E., Aigbokhan, E., Goji, I., Onojeghuo, A.O., and Okonkwo, A.C. (2010). *Delonix regia* and *Casuarina equisetifolia* as passive biomonitors and as bioaccumulators of atmospheric trace metals. Journal of Environmental sciences, 22(7), 1073-1079.

Shukla, S., Sharma, R. B., and Sahu, M. (2019). Dust Pollution Affect Morphophysiological traits of Plant *Mangifera indica* Linn. Int. J. Bot, 15, 1-4.

Samal, K., Kar, S., Trivedi, S. (2019). Ecological floating bed (EFB) for decontamination of polluted water bodies: Design, mechanism and performance. Journal of environmental management, 251, 109550.

Tong, C.H., Yang, X.E., Pu, P.M. (2003) Eects and Mechanism of Hydrophytes on Control of Release of Nutrient Salts in Lake Sediment. J. Agro Environ. Sci. 2003, 22, 673–676.

Steenhoudt, O.; Vanderleyden, J. Azospirillum, a free-living nitrogen-fixing bacterium closely associated with grasses: Genetic, biochemical and ecological aspects. FEMS Microbiol. Rev 2000, 24, 487–506.

Zimmels, Y.; Kirzhner, F.; Malkovskaja, A. Application and features of cascade aquatic plants system for sewage treatment. Ecol. Eng. 2008, 34, 147–161.