DISTRICT ENVIRONMENTAL PLAN

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

NAINITAL

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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 District Environmental Plan by placing a model plan on its website. This model plan may be adopted as per local requirement by all Districts under the supervision of District Magistrate (DM). The said order also directs that Department of Environment in respective states should collect district plans to prepare State Environment Plan, 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 (MoEF&CC) shall prepare a National Environmental Plan, under the supervision of Chairman, CPCB and Secretary, MoEF&CC.

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 Govt of Uttarakhand were included under district plan. These 14 areas were regarding compliance to rules for: solid waste including legacy waste, bio-medical waste, construction & demolition waste, hazardous waste, e-waste, polluter stretches, non-attainment cities, industrial clusters, status of Sewage Treatment Plants (STPs) and re-use of treated water, 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 SPCB.

Implementation of the environment plan based on certain indicators will do noticeably more to ensure that these objectives are achieved and our compliance obligations could be met. It will also allow environmental opportunities associated with our activities to be further explored and undertaken. Environmental plan describes how action might impact the natural environment in which it occurs and set out clear commitments how those impacts will be avoided, minimized, and managed so that they are environmentally acceptable. We hope this document will act as an easy reference for various stakeholders interested in progression of sustainable development planning for the Nainital district. Moreover, it will help develop a comprehensive understanding of environmental planning process, which has gone into development of the area over the period. Finally, it briefly touches upon the prime need for developing a vision of mountain perspective in view of sustainable developmental planning of the district.

Date: July, 4, 2022

Principal Investigator,
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In the last but not least, our special 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.

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ABBREVIATIONS

AMRUT	-Atal mission for Rejuvenation and Urban Transformation
APL	-Above Poverty Line
AR	-Assessment Report
As	-Arsenic
BMWMIS	-Biomedical Waste Management Information System
BPL	-Below Poverty Line
C	-Carbon
C&D waste	-Construction and Demolition waste
CACMP	-Catchment Area Conservation Programme
CAGR	-Compound Annual Growth Rate
CANTT	-Cantonment Board
CBMWTF	-Common Bio-Medical Waste Treatment Facility
Cd	-Cadmium
CD	-Check Dam
CEMS	-Continuous Emission Monitoring System
CETP	-Common Effluent Treatment Plant
CFL	-Compact Fluorescent Lamps
CGWB	-Central Ground Water Board
CH_4	-Methane
CO	-Carbon monoxide
CO_2	-Carbon dioxide
CPCB	-Central Pollution Control Board
CPHEEO	-Central Public Health and Environmental Engineering Organisation
Cr	-Chromium
CSCs	-Community Sanitary Complex
CT	-Contour Trench
Cu	-Copper
DDT	-Di-chloro Diphenyltrichloroethane
DPR	-District Project Report
DPRO	-District Panchayati Raj Officer
E-Waste	-Electronic Waste

EEE	-Electronics and Electrical Equipment
ENVIS	-Environmental Information System
ETPs	-Effluent Treatment Plants
F	-Fluoride
FPZ	-Flood Plain Zones
FSI	-Forest Survey of India
FSSM	-Faecal Sludge and Septage Management system
GBPNIHE	-G.B. Pant National Institute of Himalayan Environment
GIS	-Geographical Information System
GPS	-Global Positioning System
HCFs	-Health Care Facilities
ICT	-Information and Communication Technology
IEC	-Information, Education and Communication
IHHLs	-Individual Household Latrines
IPC	-Inter-Personal Communication
IPCC	-Intergovernmental Panel on Climate Change
IRAP	-Integrated Rural Area Programme
ISO	-International Organization for Standardization
ISWM	-Integrated Solid Waste Management
IWRM	-Integrated Water Resources Management
MBBR	-Moving Bed Biofilm Reactor
MDWS	-Ministry of Drinking Water and Sanitation
MMT	-Million Metric Tons
MoEF&CC	-Ministry of Environment, Forest &Climate Change
MoF	-Ministry of Finance
MoUHA	-Ministry of Urban & Housing Development
MPCC	-Medical Pollution Control Committee
MRF	-Material Recovery Facility
MSMEs	-Micro, Small &Medium Enterprises
MSW	-Municipal Solid Waste
MTPD	-Metric Tonne per Day
NA	-Not Applicable

NAAQS	-National Ambient Air Quality Standards
NACP	-National Clean Air Program
NASA	-National Aeronautics &Space Administration
NCEPC	-National Committee on Environment Planning &Co-ordination
NGOs	-Non-Governmental Organizations
NGT	-National Green Tribunal
NH	-National Highway
NITI	-National Institution for Transforming India
NMHS	-National Mission of Himalayan Studies
NP	-Nagar Panchayat
NPP	-Nagar Palika Parishad
NTFPs	-Non-Timber Forest Products
ODF	-Open Defecation Free
OSHA	-Occupational Safety and Health Administrations
PAT	-Perform, Achieve &Trade
PCC	-Pollution Control Committee
PHCs	-Primary Health Centre
PIBO	-Producer, Importer and Brand Owner
PM	-Particulate Matter
PPP	-Polluter Pays Principle
PWD	-Public Works Department
QPD	-Quintal Per Day
RBMs	-Riverbed Minerals
ROHS	-Restriction of Hazardous Substances
RSM	-Rural Sanitary Marts
SBM-G	-Swachh Bharat Mission Gramin
SDGs	-Sustainable Developmental Goals
SIDCUL	-State Industrial Development Corporation of Uttarakhand Limited
SLWM	-Solid and Liquid Waste Management
SPCB	-State Pollution Control Board
STP	-Sewage Treatment Plant
TPD	-Tonne Per Day

TSDF	-Treatment Storage and Disposal Facilities
UKPCB	-Uttarakhand Pollution Control Board
ULBs	-Urban Local Bodies
UNDP	-United Nations Development Programme
UREDA	-Uttarakhand Renewable Energy Development Agency
WHO	-World Health Organization
ZED	-Zero Effect Zero Defect
ZLD	-Zero Liquid Discharge
RTO	-Regional Transport Officer
µg	-Microgram

EXECUTIVE SUMMARY

Increasing population in the plain areas of Tarai and Bhabar and simultaneous expansion of tourist hubs in the hilly region have adverse effects on the environment and ecology of the district of Nainital. Major issues related to waste management, air and water pollution, mining operations remain relevant in the district and stipulates prompt action to stop further deterioration. Environmental and climate change issues are numerous and complex in 8 ULBs of Nainital district. Economic and population growth have been the factors that need to be highlighted to explain the increasing biotic and abiotic stress imposed by human interferences on the natural environment.

In view of analysing the current status and furnishing a comprehensive plan to mitigate the environmental deterioration, GBPNIHE was assigned with the task to prepare an Environment Plan for the District of Nainital. Detailed deliberations were carried out to devise the action plan focusing on explicit thematic areas which are as under:

- ***Waste Management Operations:*** Waste management practices (including source segregation, door to door collection, road sweeping, etc.) followed in the hilly regions of the district are quite similar. ULBs of Plain region have robust waste management system with mechanized waste processing technique and designated dumping sites.
- In the hilly regions, lack of waste disposal system is hampering solid waste management. Moreover, there is no robust system or policy framework to manage sudden rise in waste during tourist seasons.
- While waste generation in plain regions (Tarai and Bhabar) is quite high compared to that of the hilly areas. Still, there is no mechanism to manage and quantify other wastes such as sanitary waste, horticultural waste (dry leaves and twigs from horticultural plants), etc.
- Based on our estimation, as the population rise, both solid waste and plastic waste generation are projected to cross 300 MT and 100 MT per day respectively by 2040. Rapid urbanization, high tourist influx, change in habits and attitude of stakeholders would be the major factors for the expected rise.
- Topography based waste management and lean waste management strategies (elimination of non-value added activities) need to be applied for effective solid waste management operations.
- Management of domestic hazardous waste and e-waste has been initiated in two ULBs of the district. Toll free number for e-waste collection, separate black box for hazardous

waste/e-waste, etc. are some of the major steps taken to streamline them under current waste management operations.

- More than 150 industries are generating hazardous waste in the district. These have linkage with a Treatment, Storage and Disposal Facility (TSDF) at Rudrapur, and Udham Singh (U.S.) Nagar. These industries are strictly regulated by State Pollution Control Board.
- Plastic waste generation is the maximum at Nagar Nigam Haldwani. This waste is a part of segregated dry waste. It is either sold to local rag pickers after segregation or channelized to authorised recyclers in Haldwani.
- Based on our assessment, NPP Ramnagar is performing exceptionally well in view of every aspect of waste management. Other ULBs need to ramp up the works proposed by them in their Detailed Project Reports for effective solid waste management.
- ***Biomedical Waste Management:*** HCFs in the district have established linkage with CBMWTF at Rudrapur, U.S. Nagar and a mini CBMWTF at Susheela Tiwari Govt. Hospital, Haldwani. Small quantity of biomedical waste generated is disposed of by deep burial method. These are those HCFs which don't fall under the ambit of coverage by CBWTF.
- ***Construction and Demolition Waste Management:*** Many ULBs of the district have established collection centres, specifically for C&D waste. NPP Bhowali has started imposing fines on illicit dumping of C&D waste. However, local residents still prefer to use this C&D waste for local reparation works and filling of low lying area.
- ***Waste water Management***: At present, 4 STPs (2 in NPP Nainital,1 each in Bhimtal and Ramnagar) are operational in the district. Some STPs are under construction in NN Haldwani and NPP Ramnagar.
- Other ULBs use septic tank for the disposal of waste water.
- ***Air and Noise Pollution:*** It is difficult to ascertain the prevailing air quality in the hilly areas due to lack of ambient air quality monitoring stations. Rampant forest fires, increased vehicular influx during tourist season may have already deteriorated the air quality in the region. Air quality is being monitored at Nagar Nigam Haldwani which is one of the most urbanized and populous regions of the district.
- A Forest Fire Protection Management Scheme has been framed by the forest division of Nainital district. This provides outlay of fire sensitive areas, causes and effects of forest fires, objectives and strategies to mitigate forest fires and details of work performed for the year 2020-21.

- Noise levels are measured in four different locations of Nagar Nigam Haldwani and Nagar Palika Nainital.
- A special noise monitoring drive is carried out to study the impact of fire crackers during Deepawali festival in different locations of Nagar Nigam Haldwani.
- ***Surface and Groundwater Management:*** The district is gifted by nature with several water bodies, especially lakes which are the major sources of fresh water. Open defecation, dumping of solid waste near river catchment and other forms of human activities have been causing pollution in the district.
- Steps have been taken for rejuvenation of Sukhatal lake which usually turns dry during winter and pre-monsoon months. Restoration works include converting some parts of the catchment into perennial lake, provision of boundary walls, construction of gravity drain, etc.
- ***Mining Activity:*** The district of Nainital has high potential for sand mining which makes it a profitable business activity. License for the same is provided by the district authority after due diligence. Penalties are charged as per Mines and Minerals (Development and Regulation) Act,1957 for the illegal mining activities registered in the district.

The execution of this management plan in the district of Nainital will require the integration and co-operation of the stakeholders at all levels, viz., public including natives, private organizations, local government, etc. This plan aims at reducing the ever increasing risks on the human health and environmental components with a target of sustainable development in the district.

INTRODUCTION

Establishing a link between environmental degradation, poverty and economic sustainability have been always 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 state of health condition 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 & 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 regarding raising a crucial red flag that global temperatures have already risen by about 1.1ºC from pre-industrial times and has warned that 1.5ºC threshold is likely to be breached before 2040 *(the stated objectives of 2015 Paris Agreement, the international architecture to fight climate change, is to limit temperature increase to within 2ºC 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 pattern are also expected, 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 originates from the Himalayan Mountains. However, the area has become a global hotspot since the past two decades in view of ever increasing environmental degradation. The indirect impact has 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 as a national interest because it is working as a guard in view of defense purpose, unique ecosystem in view of permanent snow cover, 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 & 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 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 of the 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 by 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 began 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. 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 the 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

The district of Nainital known as the lake district of India was constituted as a separate district in 1891. It is also the divisional headquarter of the Kumaon division. In the east it shares its boundary with district of Champawat, in the north with district Haridwar, in the south with district of Udham Singh Nagar, in the west with district of Pauri Garhwal and in its south western portion it shares a small boundary with Uttar Pradesh (Fig. 1). Serving as the summer capital of the United provinces during the British era, the district has strong colonial heritage with vibrant clusters of villas and bungalows. The district is well connected with the other districts of Uttarakhand by a network of all-weather metalled roads. The major national highways passing through the district are NH 309 and NH 109.

Nainital district hosts some of the major tourist destinations of the country. The majestic mountains and the sparkling waters of the lakes add an immense lot to the beauty of the district. Whether it is the group of lakes present in the district, *(in which Nainital, Bhimtal, Naukuchiatal, Sattal, Khurpatal and Harishtal etc are prominent)* or the oldest Tiger Reserve in the country *(the Corbett National Park),* which is famous worldwide for adventure tourism, the district does not fall short from attracting visitors from far-away places. Nainital town itself is a picture-postcard perfect hill station which is surrounded by seven hills, popularly known as “Sapta Shring”, and is

centred around the emerald mountain lake Naini, which on most days is dotted with colourful sailboats. Apart from this, places such as Mukteshwar, Ramgarh etc. adds to the picturesque beauty of the district.

Nainital is also famous for its eminent educational institutions and research facilities which have stood since British era. The observatory of Aryabhata research institute of observational sciences (ARIES) located in Nainital is the centre for astronomical studies and optical tracking of the artificial satellites. Some of the important schools in district includes the Sherwood College, St. Joseph College, Sainik School, etc.

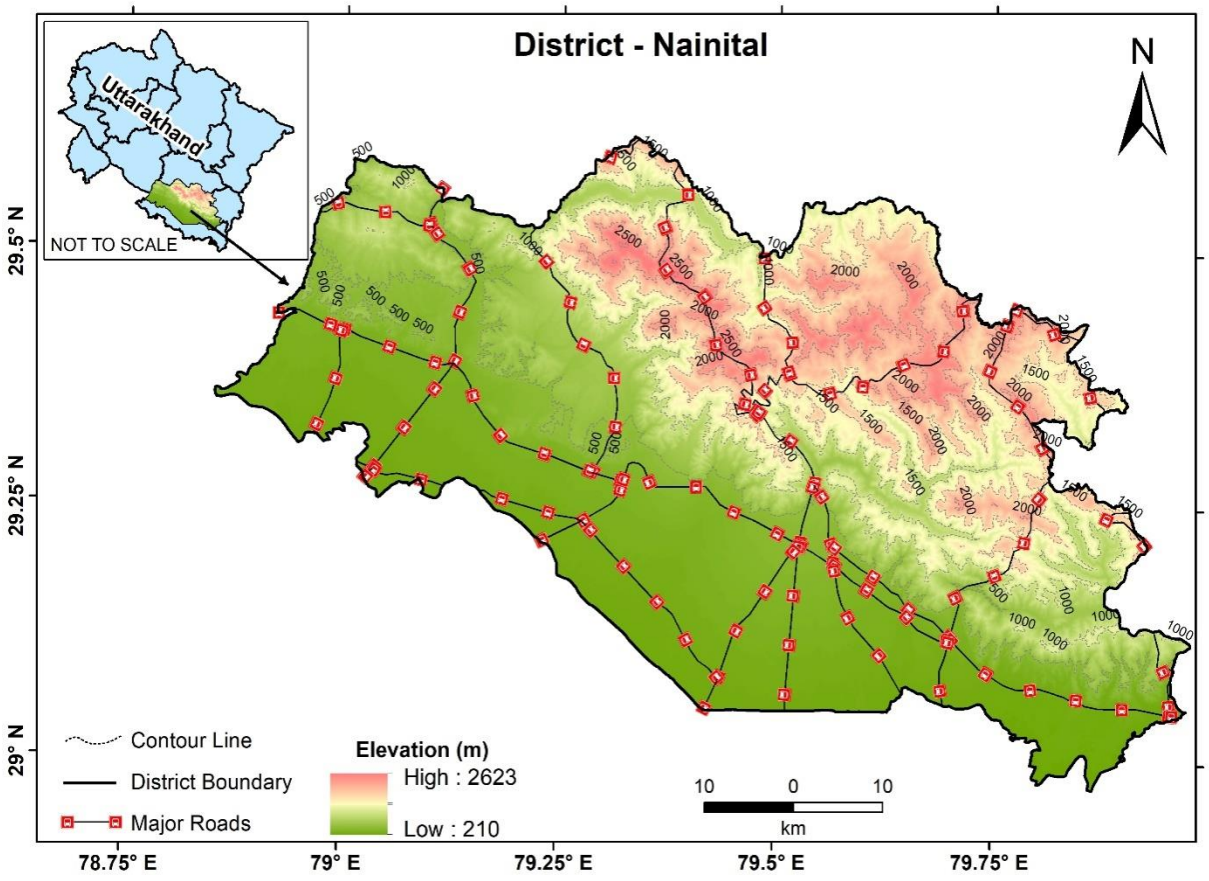


Fig. 1. Location map of Nainital District

District at a glance

Table 1 below represent the geographical aspect, population data and administrative setup of Nainital district.

Table 1. District at a Glance

Geographical Location	
Latitude	$29^{o}00'N$ -$29^{0}05'N$
Longitude	$78^{0}80'E$ -$80^{0}14'E$
Geographical Area	4251 km^2

Average elevation of district headquarter	1938 m
Population Data (2011 census)	
Overall Population	954605
Male Population	493666
Female Population	460939
Population density	225
Population growth rate	25.13%
Literacy rate	83.88%
Male literacy	90.07%
Female literacy	77.29%
Sex Ratio	934
Administrative Divisions	
Tehsils	09
Blocks	08
Nyay Panchayats	44
Village Panchayats	511
Total census villages	1050
Municipal corporation	01
Municipal councils	03
Cantonment boards	01
Nagar panchayats	03

Source: District census handbook 2011 and District statistical report 2018-19

Topography

Nainital district has a varied topography. Geographically, the district is divided into 2 major zones viz. Mountainous region in the north and the plain area in the southern part (Table 2). The district consists of many other geographical features such as lakes, springs, rivers and rivulets etc.

Table 2. Topographical features of Nainital District

Geographical Region		**Location**	**Geographical Features**
Mountain region	Lesser Himalayan region	Northernmost part of the district	Elevation ranges from 1200m to 2700m and many lakes are present in this region.
	Shivalik region	Between lesser Himalayan region and plain areas of the district	Average elevation varies from 700 to 1200m. Heavy rainfall is the main feature of this region.
Plain Region	Bhabar zone	South to the Shivalik zone (Areas around Haldwani)	Undulated landform.
	Terai Zone	Southern part of the district	High groundwater level. Soil is best suited for agriculture.
	Doon valley	Kota Doon Area around Kotabagh, Patli Doon valley near Ramnagar	Heavy rainfall is the main feature of this region. Soil is suitable for agriculture.

Source: Socio economic report 2018-19

Climate

Due to the variation in topography, there is also a lot of disparity in the climate of Nainital district. The climate varies from sub- tropical to cold temperate in the district. Due to the presence of the lake, the weather of the city of Nainital remains on a bit colder side than that of the nearby areas. In the region of Bhabar, the maximum temperature reaches 40^0 C in summer, whereas in the northern hilly areas it varies between 30^0 C to 32^0 C. In winter, the temperature in the high altitude regions dips to sub-zero levels.

Rainfall

Nainital district receives an average of 1700 mm of rainfall throughout the year. Areas around foothills receives more precipitation as compared to the other parts of the district. The maximum part (about 70 to 80 %) of the total rainfall is received from the southwest monsoon. The rainy season starts from the end of June and lasts till September. Due to western disturbances, the district receives rain in the lower areas and snowfall in the higher areas in winter.

Surface water Resources

Sources of surface water are available in abundance in Nainital district. Fresh water lakes, ponds and rivers are prevalent on hilly areas of the district (Table 3). These are used for drinking and irrigation purpose. Due to the abundance of lakes, Nainital is often called the City of Lakes.

Table 3. Major Freshwater Sources in the District

Major lakes in the District	Nainital, Bhimtal, Naukuchiyatal, Saattal, Khurpatal, Sukhatal, Malwatal, Sadiyatal and Harishtal
Major Rivers in the district	Kosi, Dabka, Bakra, Gaula, Deoha, Nandhaur, Shipra

Ground Water Resources

The availability of ground water in the district varies with the topography. In the northern lesser Himalayan region, groundwater fed lakes are found near Nainital and Bhimtal town and in other hilly areas of the district, groundwater is often found in aquifers. There is usually a shortage of ground water in the Bhabar region due to the gentle longitudinal ground slope of this area which seeps the underground water from this area to the Terai region. Ground water is often found in abundance in the Terai region, due to which this area is rich in agriculture.

Fauna and Flora

Flora

Nainital district has highest forest cover among all the districts of Uttarakhand. Areas around Kathgodam and Haldwani are famous for their timber industry since the British era. Although

there has been a fall in the forest cover compared to 2017 assessment, Forest cover is still in abundance covering around 71.55% of total geographical area of the district (Table 4).

Table 4. Forest cover in Nainital district

District	**Geographical area**	**2019 Assessment**			**Total**	**Change with respect to 2017 assessment**
		Very dense Forest	Moderately Dense Forest	Open Forest		
Nainital (km^2)	4251	773.06	1,728.93	539.57	3,041.56	-6.44

Source: Forest Survey of India report 2019 (vol. 2), pp-284-294

There is great variation in the vegetation with respect to elevation and thus it makes the district very rich in terms of biodiversity. Table 5 represents various species of plants that are found in the district.

Table 5. Altitudinal variations of floral species

Zone	**Major Species**	**Locations**
Sub-Tropical	Sal, Haldu, Teak, Semal, Bamboo, etc.	Places with elevation up to 1200m (Terai, Bhabar, and lower Shivalik Hills)
Temperate	Pine, Oak, Rhododendron, etc.	Places with elevation up to 1800m (Upper Shivalik Hills and above)
Sub alpine	Poplar, spruce, silver fir, blue pine, Deodar, Oak, Rhododendron, etc.	Places with elevation up to 2700m (Higher reaches of the district)

Source: Forest Survey of India report 2019 (vol. 2), pp-284-294

Fauna

The dense forests in the district is a habitat for a great range of animal and bird species (Table 6). Special efforts have been made for the conservation of wildlife in the district.

Table 6. Protected areas in the district

National Park/ Wildlife sanctuary/ Reserve	**Major Species**
Corbett National Park	Royal Bengal Tiger, Asiatic elephant, varieties of deer, Golden Jackal, and many other species of mammals, reptiles, birds and fishes.
Nandhaur Wildlife sanctuary	Asian elephant, leopard, tiger and sloth bear, etc.
Sitabani Wildlife Reserve	Tiger, Leopard, Asiatic Elephant, and around 600 bird species etc.
Pangot and Kilbury bird sanctuary	Around 600 species of birds are found out of total 1200 birds species of India.

Culture and Tradition

Nainital is well known for the lively celebration of fairs and festivals that showcase the culture and traditions enveloping the rich Kumauni culture. Nanda Devi Mahotsav and Nainital Sardosav (Winter fair) are some of the festivities of the district. Northern Hilly regions of the district is

home to Kumauni community whereas Terai and Bhabar region inhabits people of different factions living in harmony. Hindi and Kumauni are major spoken languages in the district.

MAJOR ENVIRONMENTAL CONCERNS IN NAINITAL DISTRICT

Nainital is one of the major tourist attractions in the country. The Naini Lake in the Nainital town provides water (for drinking, recreational activities) to nearly 40000 local inhabitants and thousands of tourists. Increase in the local population, logarithmic increase in the tourist efflux and the concurrent mushrooming of a large number of hotels in the catchment area have severely affected the resources and biodiversity of this watershed. The same is the case with the other lakes of the district especially the Bhimtal lake.

The other factors that threaten the survival of this Himalayan lake include the drying up of its sources like Sukhatal due to increasing siltation, Construction and encroachments on the slopes around the lake, eutrophication of the lake water due to the entry of solid waste, construction debris, and other pollutants into the lake water. Despite of installing sewer lines to prevent sewage discharge, some effluents from drains and leakage still make their way into the lake. Climate change and comparative warming of the Himalayas are also affecting these lesser Himalayan lakes.

Moreover, in the Bhabar and Terai region, the population is increasing exponentially as the people of the state have the mindset of migrating from the hills to the plain areas for better educational, healthcare facilities and livelihood opportunities. This region saw a rapid growth in Urbanization in the recent decade. Especially the cities like Haldwani and Ramnagar saw enormous population growth due to which the resources in this region are overstressed. The Air Quality has depleted, groundwater level has gone down, Surface water quality has declined and many other problems related to waste management and urban infrastructure are arising mainly due to unplanned development in the region.

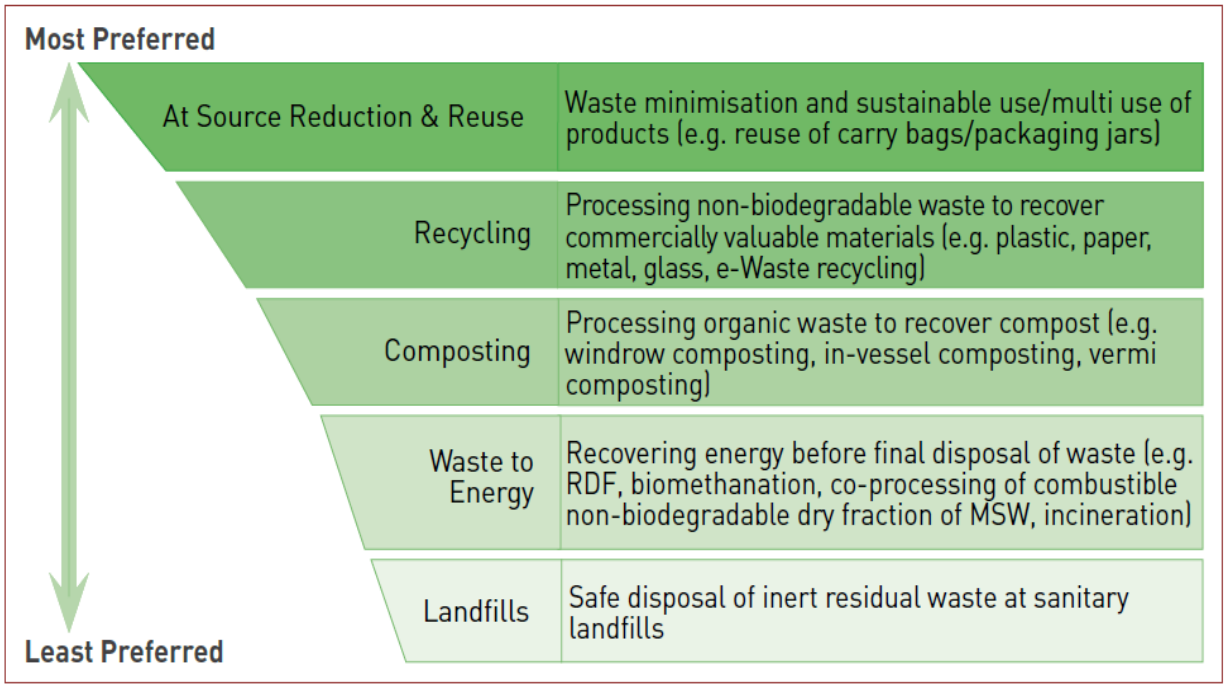
DATA AND IMPACT ANALYSIS

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 in 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 of 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. Waste management paradigm

Solid waste management in Nainital district

Nagar Nigam Haldwani contributes for more than two third of the total waste generated in the district of Nainital with significant amount being dry waste. ULBs, precisely from hilly areas have large fraction of wet waste in their total waste (Table 7). Primary waste management operations are robust in many ULBs but some of them are lacking even basic operations such as source

segregation. Municipalities have established linkages with different private firms/NGOs to improve and optimize their current solid waste management system (Table 8).

Table 7. Inventory of Total Solid Waste generated

Name of Urban Local Body (ULB)	Population (2011 census)	Number of wards	Solid Waste Generation (MTPD)			
			Dry	Wet	*Other Waste	Total
Nagar Nigam (NN) Haldwani	280604	60	66	54	Nil	120
Nagar Palika Parisad (NPP) Ramnagar	54787	20	3.84	8.88	0.88	13.6
Nagar Palika Parisad (NPP) Nainital	41377	15	07	08	Nil	15
Nagar Palika Parisad (NPP) Bhowali	8483	07	0.5	0.2	1.3	2
Nagar Panchayat (NP) Bhimtal	14882	09	1.35	0.9	Not Estimated	2.25
Nagar Panchayat (NP) Kaladungi	7706	07	0.014	3.47	Nil	3.48
Nagar Panchayat (NP) Lalkuan	7644	07	02	1.2	Nil	3.2
Cantonment Board (CB) Nainital	1398	02	0.065	0.065	Nil	0.13

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

Table 8. Waste management operations

Waste Management Operations	Outcome	
Segregation at source	ULB	Source Segregation (%)
	NN Haldwani	70
	NPP Ramnagar	100
	NPP Nainital	00
	NPP Bhowali	60
	NP Bhimtal	90
	NP Kaladungi	75
	NP Lalkuan	100
	CB Nainital	100
Door to door collection	All the ULBs have 100% coverage for Door to Door collection.	
Sweeping	Except NPP Ramnagar (Mechanical - 25%), all ULBs in the district are accomplishing 100% sweeping manually.	
Segregated transport of waste (received	ULB	Transportation of waste in segregated manner (%)
	NN Haldwani	70
	NPP Ramnagar	100
	NPP Nainital	00

from door to door collection)	NPP Bhowali	60
	NP Bhimtal	90
	NP Kaladungi	75
	NP Lalkuan	100
	CB Nainital	100
	Collected segregated waste is transported by twin compartment vehicles and rest (i.e. unsegregated waste) is transported in combined manner.	
Material Recovery Facility (MRF) operation	ULBs having Material Recovery facility (Automated/Semi Automated)	ULBs with no Material Recovery facility
	• NN Haldwani • NPP Ramnagar • NP Kaladungi • NP Bhimtal • NP Lalkuan • CB Nainital	• NPP Nainital • NPP Bhowali
Involvement of Non-Governmental Organizations(NGOs)/ private agencies	**NGOs/ Private agencies**	**ULB**
	Magic Genie Smartech Solutions Limited	NPP Haldwani
	Nivaran Seva Samiti	• NPP Ramnagar • NPP Nainital • NPP Bhowali • NP Bhimtal
	Maa Ganga Seva Samiti	NP Kaladungi
	KPS Enviro Tech Private Limited	NP Lalkuan
	Hilldaari (an initiative by Nestle India)	CB Nainital
Authorization and issuance of Identity cards to waste pickers/sanitation workers	ULB	Number
	NN Haldwani	1000
	NPP Ramnagar	109
	NPP Nainital	60
	NPP Bhowali	28
	NP Bhimtal	23
	NP Kaladungi	18
	NP Lalkuan	23
	CB Nainital	32
Direct linkage with Treatment Storage and Disposal Facilities (TSDF)/ Bio-Medical Waste Treatment Facility (CBMWTF)	Not initiated	

Availability of infrastructure for waste management

Trolleys, Mini trucks with twin compartment are available for waste collection and transportation in the district. Wet waste is processed in both centralized and decentralized manner. Barring some, most of the ULBs are using material recovery facility to process their dry waste (Table9). After segregation, reusable dry is either picked up by local rag pickers or is channelized through private agencies which are handling waste management operations of ULBs. Almost all the ULBs direct their leftover waste to trenching ground at Haldwani (Table10).

Table 9. Existing infrastructure for waste management operations

Name of ULB	Inventory of infrastructure involved in waste management operation					
	Waste collection trolleys	**Mini collection trucks/ tractors/ others**	**Composting units/ on-site composting facilities**	**MRF/ (available/ not available)**	**Landfills (dumping ground/ trenching ground/ sanitary landfills)**	**Remarks**
NN Haldwani	360	128	05	Available	Trenching ground	• Separate compartment vehicles are being used for transportation of source segregated waste. • Trenching ground (04 ha) is available for waste disposal.
NPP Ramnagar	100	16	25	*Available	Trenching ground	• E-rickshaws have been deployed for waste collection from congested areas. • Trenching ground (01 ha)is available for waste disposal.
NPP Nainital	--	15	40	Not Available	Not available	• Collected waste is partially segregated in a temporary location and sold/sent to the local rag pickers/recyclers. • Waste from roadside dustbins is hydraulically lifted and compressed in a

						refuse compactor vehicle. • The waste is then transferred to Haldwani for recycling/disposal.
NPP Bhowali	08	10	02	Not Available	Not available	• NPP Bhowaliis using a Hydraulic compactor vehicle for compaction and transportation of dry waste (Particularly from roadside dustbins).
NP Bhimtal	09	12	04	*Available	Not available	Composting pits have been constructed in Vikas Bhawan and Industrial area.
NP Kaladungi	10	04	07	*Available	Temporary dumping site in forest land	• The ULB doesn't have a designated place for waste disposal. They are dumping their waste in forest land under mutual consent agreement. • Waste is being disposed by filling small pits holes that have been dug on the forest land.
NP Lalkuan	10	06	12	*Available	Not available	Woman self-help group are active for awareness regarding dry waste management.
CB Nainital	06	02	08	*Available	Not available	• Generated waste is partially segregated in a temporary place and sold/sent to the local rag pickers/ recyclers. • Left over waste is transferred to trenching ground at Haldwani.

** Semi Automated Recovery Facility*

Table 10. Methods of treatment, disposal and recovery

Name of ULB	Wet waste management (centralised/ decentralized or home composting)	Dry waste management (waste to energy/ recycling/ incineration/ dumping in trenching ground/ sanitary landfill)	Remediation of the old dump site
NN Haldwani	Total 5 composting pits are constructed in trenching ground for wet waste processing.	• After secondary segregation, the reusable and recyclable waste is channelized throughMagic Genie Smartech Solutions Limited. • Leftover waste is dumped at trenching ground.	No old dumpsites are available within the ULB.
NPP Ramnagar	• 25 composting pits are available in the ULB. • 13 are constructed near municipality office and 12 of them in different wards of the ULB.	• Triple compartment (Dry, Wet and Domestic Hazardous Waste) vehicles are being used for segregated waste collection. Hence, toxic waste doesn't form much part of dry waste. • After secondary segregation, the reusable and recyclable waste is channelized through Nivaran Seva Samiti. • Leftover waste is dumped at trenching ground.	• There is an old dumpsite with 22000 MT legacy waste. • A DPR has been prepared to undertake its remediation works.
NPP Nainital	• 40 composting pits are available in the ULB. • 36 pits are constructed at Narayan Nagar ward and 04 of them in several parks of the town.	• After secondary segregation, the reusable and recyclable waste is channelized through Nivaran Seva Samiti. • This waste is then either sold to local rag pickers or sent to authorised recycler for further processing. • Leftover waste is transported and disposed at trenching ground in Haldwani. • These ULBs are part of *Haldwani-Rudrapur Cluster which promotes Integrated Solid Waste Management (ISWM)	No old dumpsites are available within the administrative areas of these ULBs.
NPP Bhowali	2 composting pits are available for wet waste processing (Near Air force station and Ramgarh road)		
NP Bhimtal	4 composting pits are available for wet waste processing.		
NP Kaladungi	7 composting pits are available for wet waste processing.	• Maa Ganga Seva Samiti is assisting the ULB in waste management operations. • Segregated dry waste is	

		either sold to rag pickers or is channelized to the recycling facility. • Leftover waste is dumped at forest land using small pit holes.	
NP Lalkuan	Total of 12 centralized composting pits are available near municipality office.	• KPS Enviro Tech Private Ltd. manages its waste collection, segregation etc. • Waste is manually segregated and fraction of this waste is sold to local rag pickers. • Left over waste is transferred to Haldwani, either for recycling or dumping in trenching ground. • Lalkuan is also a part of Haldwani-Rudrapur Cluster.	
CB Nainital	8 composting pits are available for wet waste processing.	• Dry waste is managed by Cantt. Board itself. After secondary segregation, the waste is sold to local rag pickers. • Leftover waste is disposed in trenching ground at Haldwani.	

**Haldwani-Rudrapur Cluster also comprises of Nagar Nigam Rudrapurand Nagar Palika Kichha from U.S. Nagar District.*

Gap Identification and Proposed Policies

Unavailability of fully automated waste recovery facility and waste disposal sites are some of the major gaps in solid waste management operations of Nainital district. Some of the ULBs are even lacking source segregation which is a huge concern (Table 11). However, each ULB has approved DPR to revamp their waste management operations. This generally includes civil works, procurement of transportation vehicles etc. Some ULBs are even working in cluster based approach for effective waste management (Table 12).

Table 11. Gap identification

Name of ULB	Observed shortcomings	Remarks
NN Haldwani	No estimated quantity of other waste such as sanitary waste, domestic hazardous waste, horticulture waste etc.	Other waste quantification is important for better characterization of waste.

	Lack of Mechanical sweeping.	This could be one of the reasons of air pollution due to road dust.
	Non-availability of decentralized composting pits.	Composting pits are not constructed in major locations across the city. This may hamper wet waste processing.
NPP Nainital	No source segregation.	Waste segregation at source is not practiced in Nagar Palika Nainital. The waste exists in mixed form.
	No estimated quantity of other waste such as sanitary waste, domestic hazardous waste, horticulture waste etc.	Other waste quantification is important for better characterization of waste.
	Absence of waste recovery facility.	Waste is segregate manually by waste pickers which may cause health hazard.
	Non-availability of designated dumping/trenching ground for waste disposal.	There is no designated waste dumping site in the town despite of the fact that about 15MT waste is generated daily
	No estimation of quantity of floating waste generated during tourist season.	Waste quantity increases manifold due to huge tourist influx in the town, still Nagar Palika is devoid of any data of excess waste generated during that particular time.
	Lack of By-laws implementation.	Lackadaisical approach is being followed for enactment of bye-laws.
NPP Bhowali	Partial source segregation of waste.	Although the ULB has achieved 60% source segregation, it needs to achieve complete source segregation for effective waste classification and processing.
	Absence of waste recovery facility.	Waste is segregated manually by waste pickers which may cause health hazard.
	Non-availability of designated dumping/trenching ground for waste disposal.	Although the waste generated per day is less, still it is recommended to have one disposal site with segregation shed.
NP Bhimtal	No estimation of segregated waste.	Segregated waste quantity is not available despite of the fact that the Nagar Palika is practising nearly 90% source segregation.
	Absence of fully automated recovery facility.	Only compacting operations are performed by Nagar Palika in a temporary segregation site/transfer station.
	Non-availability of designated. dumping/trenching ground for waste disposal.	Waste disposal site is required as Bhimtal is also one of the major tourist destination of Kumaon region.
NP Kaladungi	No estimated quantity of other waste such as sanitary waste, domestic hazardous waste, horticulture waste etc.	Other waste quantification is important for better characterization of waste.
	Absence of fully automated recovery facility.	Manual segregation is prevalent in the town

	Lack of scientific disposal of waste.	Forest land is used for waste disposal, it may harm the forest ecology in future.
NP Lalkuan	No estimated quantity of other waste such as sanitary waste, domestic hazardous waste, horticulture waste etc.	Other waste quantification is important for better characterization of waste.
	Absence of fully automated recovery facility.	Only compacting operations are performed by Nagar Palika in their office premises
	Non-availability of designated dumping/trenching ground for waste disposal.	An authorised dumping site/Trenching ground may help channelize the waste from unspecified disposal/collection site.
CB Nainital	No linkage with authorized recyclers.	Dry waste after segregation is sold to local rag pickers.
	Lack of waste disposal site.	Although Cantt. Board Nainital is not much populated, it may require a small dumping site for waste disposal.
** A common gap that has been identified in the waste management operations of the district is the lack of linkage with Treatment Storage and Disposal Facility (TSDF) and Common Biomedical Waste Treatment Facility (CBMWTF) for the disposal of domestic hazardous waste ,sanitary waste and biomedical waste.		

Table 12. Proposed policies and budget requirements put forward by different stakeholders in the district

ULB	Proposed Policy	Current status and Budget requirement
NN Haldwani	Revamping Solid Waste Management	• DPR of 33.952 Cr. has been approved by the department for civil works-compost plant and site work, buying vehicles, SLF and further improvement in solid waste management operations in the ULB.
NPP Ramnagar		• DPR of 5.83 Cr. has been approved by the department for purchasing waste transportation vehicles, instrumentation, equipment's, sanitation materials (Helmet, gloves etc.) and civil works for effective solid waste management in the ULB. • NPP Ramnagar has applied for Bin free city status
NPP Nainital		• DPR of 3.5 Cr. has been approved by the department for purchasing composting machine, machinery for material recovery facility and various civil works. • NPP Nainital has applied for Bin free city status.
NPP Bhowali		• A tender is approved for setting up the Material recovery facility in the ULB. • NPPBhowali has applied for Bin free city status
NP Bhimtal		• NP Bhimtalis working with 'Haldwani-Rudrapur Cluster' for effective solid waste management in the ULB. • NPP Bhimtal is declared as bin free city.
NP Kaladungi		• The DPR of 97 lakhs has been approved for establishment of Material recovery facility and effective solid waste management in the ULB.

NP Lalkuan		• ULB has envisaged a need to expand its waste recovery operations and developing micro composting centres. • NP Lalkuan is also working with 'Haldwani-Rudrapur Cluster' for effective solid waste management in the ULB.

Vegetation suitable for reclamation of dumping sites

Besides having aesthetic value, vegetation (natural or planted) on a landfill site has an important role to play in soil formation, removal of contaminants and erosion control (Sadowsky, 1999). Moreover, vegetation may also be used in leachate treatment. Sometimes, vegetation over landfill sites may show signs of damage due to presence of landfill gas (LFG) in the root zone. In view of reconstruction of a suitable medium for landfill, afforestation, plantation, or re-vegetation might provide a capping that is deep and as favourable as to root growth to achieve desired plants performance in getting over these degradations. In this context, locally available species could be hardened and resistant in reclaiming the waste dump problem (Table 13).

Table 13. Suggested vegetation for reclaiming landfill sites in Nainital district

Botanical Name	Local and English Name	Life form	Assimilating capacity	Altitude (m)	References
Quercus leucotrichophora A. Camus	Banj oak	Tree	Microbial biodegradation, binding, holding soils, and/or decreased leaching	1200-2400	Kumar et al. 2021
Bauhinia variegata L.	Kachnar	Tree	Absorbs Zn, Hg, As, Pb, Cu and Cd from wastewater	1250-1800	Agarwal et al. 2011
Populus nigra L.	Popular	Tree	Accumulation of Cd, Pb, As, and Ni	100-1800	Houda et al., 2016
Populus alba L.	Black popular	Tree	Accumulation of Cd and Pb	100-1400	Houda et al., 2016
Mangifera indica	Mango	Tree	Absorb dust particles	100-1200	Shukla et al., 2019
Adina cordifolia (Roxb.) Hook. f. ex Brandis	Haldu	Tree	conversion of Se and Hg to volatile chemical from groundwater	Upto-1500	Prajapati 2012
Berberis aristata DC.	Kingore	Shrub	Metals, radionuclides, hydrophobic organics	1350-2000	Khan et al., 2019
Berberis asiatica Roxb. ex DC.	Kilmora	Shrub	Adsorb all the dissolved gases	1650-2400	Khan et al., 2019
Cynodon dactylon (L.) Persoon	Dubla, Doob	Herb	Absorbs Arsenic and Fluoride from wastewater	700-2500	Sekabira et al. 2011
Azolla pinnata R. Br.	Azolla	Herb	Control the Hg, and Cd from wastewater also known as bio-fertilizer	400-2200	Kumar et al. 2020

Estimated Future population and Solid Waste Generation in Nainital District

Forecasting waste quantities in the future is as difficult as it is in predicting changes in waste composition. Storage methods, salvaging activities, exposure to the weather, handling methods and decomposition, all have their effects on changes in waste density. As a general rule, the lower the level of economic development, the greater the change between generation and disposal.

Census population data for the years 2001 and 2011 has been taken for population forecast. Decadal population and subsequent waste forecast has been done based on the following presumptions:

- The arithmetic increase method has been used for the decadal population forecast, hence the rate of change of population with time is assumed to be constant.
- 1.5% yearly growth in per capita waste generation has been taken keeping in mind the changing waste paradigm and floating population *(MOF, 2009).*
- The analysis includes population and waste generation estimations only for Urban Local Bodies (ULBs) and does not include peri-urban and rural areas (Table 14 and 15; Fig. 3 and 4).

Table 14. Projected Population and Waste Generation

Name of ULB	Projected Population			Existing/Projected Waste Generation(MTPD)		
	2021	2031	2041	2021	2031	2041
Nagar Nigam Haldwani	432193	583782	735371	120.00	186.40	270.03
Nagar Palika Parisad Ramnagar	63369	71951	80533	13.60	17.76	22.86
Nagar Palika Parisad Nainital	44124	46871	49618	15.00	18.32	22.31
Nagar Palika Parisad Bhowali	11940	15397	18854	2.00	2.97	4.18
Nagar Panchayat Bhimtal	23890	32898	41906	2.25	3.56	5.22
Nagar Panchayat Kaladungi	9284	10862	12440	3.20	4.15	5.31
Nagar Panchayat Lalkuan	8764	9884	11004	3.48	4.68	6.17
Total				159.53	237.85	336.07

Table 15. Decadal Change in Waste Generation

Name of ULB	Growth rate (%) (2021-2031)	Growth rate (%) (2031-2041)
Nagar Nigam Haldwani	5.53	4.49
Nagar Palika Parisad Ramnagar	3.06	2.87
Nagar Palika Parisad Nainital	2.22	2.17
Nagar Palika Parisad Bhowali	4.83	4.08
Nagar Panchayat Bhimtal	5.84	4.65

Nagar Panchayat Kaladungi	3.45	3.17
Nagar Panchayat Lalkuan	2.97	2.80

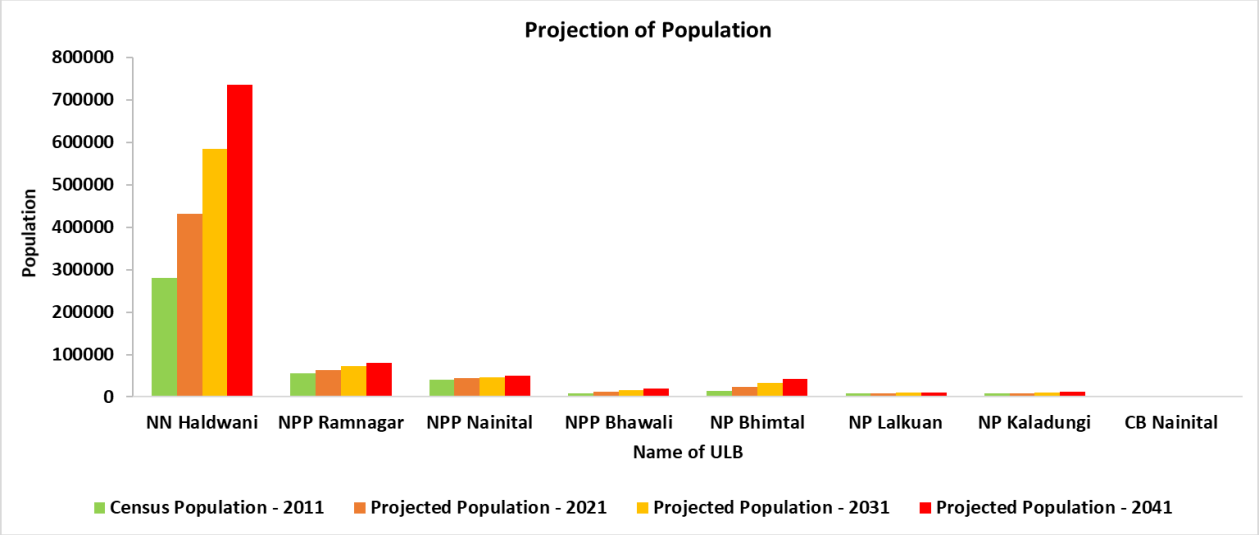


Fig. 3. Graphical representation of projected population

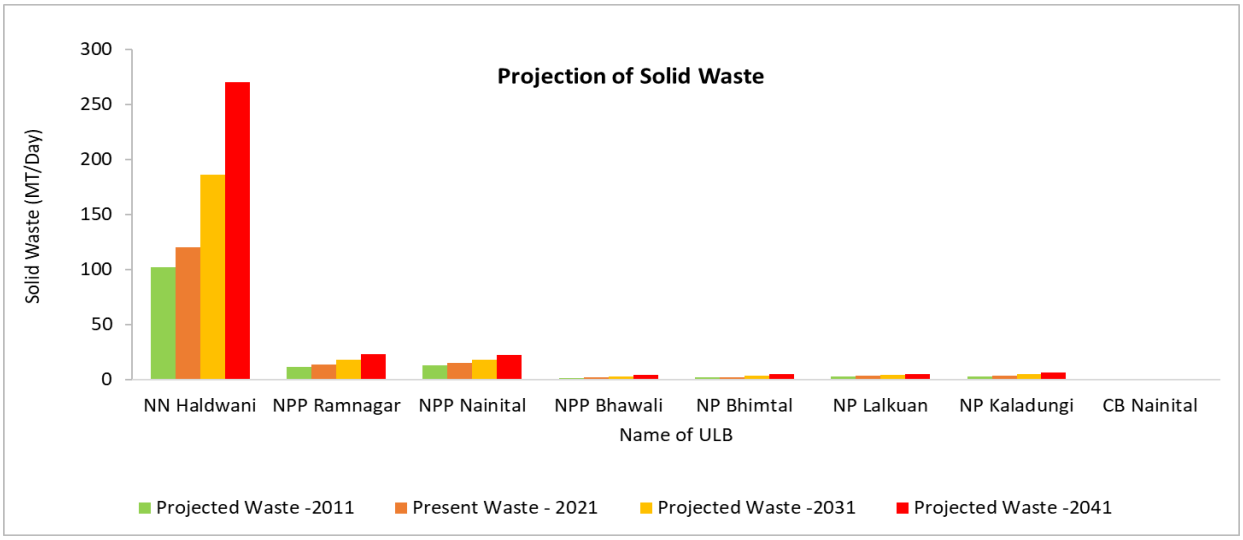


Fig. 4. Projection of Solid waste generated

Inferences drawn from the projection of waste

- Solid waste generation in the district is expected to rise in coming decades and would cross 300 MTPD by 2041.
- With its waste generation expected to cross 270MTPD by 2041, Nagar Nigam Haldwani would be the largest contributor of solid waste in the district.

- Quantity of waste will also rise in hilly regions which may increase land issues pertaining to waste disposal.
- Increased urbanization will alter 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.

Rural Solid Waste Management

The domestic waste generated in rural households of India is increasingly becoming an issue of serious concern. As reported by the 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 improving 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 the generation rate of rural areas is much less as compared to urban areas.

Current standpoint about rural waste management in India

- According to 2011 census, 68.84% of total population in India live 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 contains only domestic waste (92.4%) as a major contributor to the total waste generation.
- Rural community produces comparatively more biodegradable waste (63.5%) compared to non-biodegradable waste (36%).
- About 78% of the rural population use open dumping as storage and collection of solid waste.

BIOMEDICAL 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 Healthcare Centres (CHCs), and Primary Healthcare Centres (PHCs). Biomedical waste generation has shown a wide variation in Uttarakhand 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. 5).

(Source: CPCB 2019)

Fig. 5. 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). 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 are 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 Nainital District

More than 400 Healthcare facilities (including both government and private) are available in the district of Nainital. Many of them have been authorised by UKPCB and few hundreds have linkage with CBMWTF. Maximum quantity of biomedical waste generated from these HCFs is lifted to CMBWTF at Rudrapur or Mini CBMWTF at Susheela Tiwari Govt. Hospital, Haldwani (Table 16). Major steps such as pre-segregation of biomedical waste, formation of district level monitoring committee etc. have been taken for effective biomedical waste management in the district (Table 17).

Table 16. Inventory of current healthcare infrastructure

S. No.	Parameter		Outcome	
1.	Health care facilities in the district		***Facility***	***Numbers***
			Bedded HCFs	141
			Non-bedded HCFs	278
			Total	**419**
2.	Miscellaneous health care facilities in the district		***Facility***	***Numbers***
			Clinics	204
			Veterinary Hospitals	30
			Pathology Labs	22
			Dental Clinics	21
			Blood Banks	01
			Animal Houses	Data not Available
			Bio-Research labs	
			Others	
			Total	**278**
3.	Number of health care facilities authorised by SPCB/PCC		374	
	Linkage with Common Bio-medical Waste Treatment Facility (CBMWTF)		163	
4.	Total Biomedical Waste (BMW) generated in the district (kg/day)		627.12	
5.	Daily Bio-Medical Waste (BMW) lifting by Common Bio-Medical Waste Treatment Facility (CBMWTF) (kg/day)		328.7[a]	
6.	Other disposal method (kg/day)	Deep Burial Method	57.12	
		Transferred to Mini CBMWTF at Susheela Tiwari Govt. Hospital, Haldwani	241.3	
7.	Capacity of the Common Bio-Medical Waste Treatment Facility (CBMWTF)		Not available	

[a] *This quantity of waste is lifted to Global Environmental Solutions, a CBMWTF at Rudrapur, U.S. Nagar*

Table 17. Current status of biomedical waste management

S. No.	Action areas	Outcomes
1.	Adequacy of facilities to treat biomedical waste	Currently, the facilities available for Biomedical waste management seems adequate.
2.	Segregation of BMW as per guidelines of BMW Rules, 2016	All the healthcare facilities of the district properly segregate their biomedical waste into separate colour-coded bins as per BMW Rules, 2016.
3.	Tracking of biomedical waste (Implementation of bar code system for tracking).	Total 16 HCFs in the district has Bar code tracking facility to track and well manage the BMW.
4.	District level monitoring committee	Already established under the chairmanship of the District Magistrate.

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 (Table 19), (CPCB, 2020).

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

(SWM Report, 2017, Uttarakhand)

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

(Sekhar, 2015)

C&D waste management in Nainital District

Collection centres have been established by some ULBs for C&D waste management. However, in many areas, local people use this waste for reparation works (Table 20). C&D waste is not yet quantified in the district but due to rising construction activities, it may become necessary for the administration to get some relevant data regarding the C&D waste generated (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 (kg/day)	• Not estimated, however the quantity is assumed to be minimal. • C&D waste generated from the respective areas are either used for filling the low lying areas or reparation of road patches.	
2.	Collection and Deposition of C&D waste	**Name of ULB**	**Current Status**
		NN Haldwani	Collection centre is established but generators try to use the waste locally.
		NPP Ramnagar	Collection centre is built near solid waste dumping ground. People from Rural area often take the C&D waste from the centre for their local construction/repairing purpose.
		NPP Nainital	Construction is banned in Nagar Palika Nainital.However , Nagar Palika is searching for land

			to deposit waste from demolition.
		NPP Bhowali	Collection centre is established ,however local residents prefer to use the waste for their own purpose.
		NP Bhimtal	Not initiated
		NP Kaladungi	Land for C&D collection has been finalized.
		NP Lalkuan	Not initiated
		CB Nainital	Not initiated
3.	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 has direct linkage with any common C&D waste treatment facility.	
4.	To stop illicit dumping of C&D waste, NPP Bhowali has started imposing fines on the violators.		

Table 21. Gap identification

S. No.	Observed shortcoming	Outcome/Remarks
1.	Quantification of C&D waste.	This might be helpful for the departments to undertake waste minimization plan.
2.	Establishment of collection centre/deposition points/ dumping zones.	• ULBs with no deposition/dumping points are using dumping zones authorised under NH & PMGSY. • In some cases , C&D waste is left in the backyard.
3.	Implementation of by-laws for C&D waste management.	• Initiated by NN Haldwani and NPP Bhowali • In other ULBs, formulation of byelaws is in progress.

C&D waste management in rural areas

In the rural areas of the district, construction work is very limited therefore minimal amount of C&D waste is generated. This 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 on the river banks during the construction of roads which needs to be addressed.

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:

- 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)	% age of Total waste
Land-fillable	2.13	24.29%
Incinerable	0.40	04.52%
Recyclable	2.07	23.59%
Utilizable	4.18	47.60%

Hazardous waste management in Nainital district

Hazardous waste generated from the industries is quantified by UKPCB in the district. Recyclable/reusable type has maximum share among different categories of hazardous waste (Table 23). Quantification, Collection and treatment of domestic hazardous waste remains in dismal state in the district. Industries generating hazardous waste are linked with TSDF at Khanpur, U.S. Nagar (Table 24).

Table 23. Inventory of hazardous waste in the district

S. No.	Parameter	Present status			
1.	Quantity of Hazardous waste generated in the district (in MT/annum)	Incinerable	Landfillable	Recyclable/Reusable	Total
		5.5	2.21	22.05	29.76
2.	Number of hazardous wastes generating industries in the district	171			
3.	Industries authorized by UPCB/ PCC	171			

Table 24. Current status related to hazardous waste management

S. No.	Action Areas	Outcome and Remarks
	Inventorization/ collection of domestic hazardous waste	Domestic hazardous waste is not quantifiable in the district. However separate collection of domestic hazardous waste has been initiated by Nagar Palika Ramnagar by deploying triple compartment vehicle.
1.	No. of captive/ common Treatment Storage and Disposal Facilities (TSDF) in the district.	No such facility exists in the district.
2.	Linkage with common TSDF	Industries of the district are linked with Environmental Solutions (GES), a TSDF at Khanpur, Uttarakhand.
	Number of ULBs directly linked with common TSDFs	No ULB in the district is directly linked with common TSDFs.
3.	Display board of hazardous waste generation in front of gates of respective industries	As per state pollution control board only05 hazardous waste generating industries in the district have installed display board in front of their gates.
	Regulation of industries & facilities generating hazardous waste	Industries generating hazardous waste are strictly regulated by SPCB.
5.	Contaminated sites/ probable contaminated sites within the district	Not found in the district

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 25). 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 out 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 (ASSOCHAM, 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 25. 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

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

- In 2016, India generated 2 Million Metric Tons(MMT) of E-waste. The transported e-waste in India from developed countries has further complicated the management of e-waste.
- India discarded approximately 1.85 million tonnes(MT) of e-waste in 2016 which is about 12% of the global e-waste production.
- 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%.

E-waste Management in Nainital District

Some ULBs of the plain region have taken steps regarding e-waste management such as establishment of collection centres, setting up toll free number etc. One of the ULB has established linkage with authorised e-waste recyclers/dismantler for e-waste processing (Table 26). In hilly areas of the district, no such steps have been taken as the quantity is assumed to be very less. Basic requirements for effective e-waste management such as segregation, identification of bulk consumers are not fulfilled in the district (Table 27).

Table 26. Current standpoints regarding e-waste generation and collection

S. No.	Parameter	Outcome & Remarks	
1.	Quantity of E-waste generated per annum (As per SPCB)	Uttarakhand (MT)	16260
		Nainital	Not Estimated
2.	Number of authorized E-waste recyclers/ dismantlers in the state.	**(05)** • Attero Recycling Pvt. Ltd. Raipur, Bhagwanpur • Bharat Oil & Waste Management, Mukhimpur, Laksar • Resource E-Waste Solution Pvt. Ltd. Bahadrabad • Scarto Metal Recycle Plant, Mewar Khurd, Roorkee • Anmol Paryavaran Sarakshan Samiti, Daulatpur Budhwa Shahid, Banjarewala	
3.	Toll-free number in the district for the citizens to deposit E-waste.	Except Nagar Nigam Haldwani, no other ULB has setup toll free number to deposit e-waste.	
4.	Collection centre established by ULBs in the district.	Collection initiated by Nagar Nigam Haldwani and Nagar Palika Ramnagar	

5.	Linkage with any E-waste recycling facility	Nagar Palika Ramnagar has established linkage with Bharat Oil and Waste Management Ltd.(BOWML) to channelize e-waste.
6.	Control over illegal trading or processing of E-waste in the district.	Partially Controlled
7.	Other relevant information	• Nagar Nigam Haldwani has established collection centres and toll free number, still local residents prefer to sell their e-waste to kabadis. • Nagar Palika Ramnagar uses separate black box in its collection vehicles for e-waste. On an average it is collecting 1kg e-waste per day. Nagar Palika has collected almost 586 kg of e-waste which will be channelized to authorised recycler once the quantity reaches 01 MT.

Table 27. Gap identification

S. No.	Observed Shortcomings	Remarks
1.	Establishment of collection centres	Only two ULBs have established collection centres for e-waste.
2.	Segregation of E-waste	Except Nagar Palika Ramnagar , no other ULB has initiated segregation of e-waste as most of them assume its quantity to be minimal.
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.
4.	Linkage of ULBs with authorised recyclers/ dismantlers	Inventorization of e-waste is prerequisite for establishing linkage.

WASTE WATER MANAGEMENT AND SEWAGE TREATMENT PLANT

Domestic sewage is the type of waste water that is produced by a community of people and is characterized by volume of flow, physical condition, chemical and toxic constitute and its bacteriologic status. Around 80% of water supply flows back into the ecosystem as wastewater, this can be a critical environmental and health hazard if not treated properly.

Currently, India has the capacity to treat approximately 37% of its wastewater, or 22,963 million litres per day (MLD), against a daily sewage generation of approximately 61,754 MLD according to the 2015 report of the Central Pollution Control Board. Moreover, most sewage treatment plants do not function at maximum capacity and do not conform to the standards prescribed (Table 28).

Piped sewerage system connects only 31.7 per cent of the total urban households with individual household latrines. More than half of the urban population in the State relies on On-Site Sanitation (OSS) systems such as septic tanks *(53.1 percent)* for the collection of faecal sludge and wastewater. Further, some individual households in the state discharge the waste from their toilets directly into open drains (Table 28).

Table 28. Current Scenario related to STPs (MLD) in Uttarakhand

Number of STPs Installed in Uttarakhand	**71**
Total Sewage Generation (MLD)	627
Installed Capacity (MLD)	448.18
Operational Treatment Capacity (MLD)	345
Actual Utilization (MLD)	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 Management in Nainital district

Total four STPs are currently operational in the district with overall capacity of 9.5 MLD. Some STPs are under construction while some of them have been proposed to be developed in near future (Table 29).

Table 29. Inventory of sewage treatment facilities in district

S. No	ULBs	Location	Installed STP capacity (MLD)	Operational capacity (MLD)	Status of nalas meeting in the waterbodies		
					Total no. of nalas	No. of tapped nalas	No. of un-tapped nalas
1.	Nainital	Hari Nagar	0.45	0.25	--	--	--
		Krishna Nagar	0.80	0.45	--	--	--
2.	Bhimtal	Bhimtal	1.25	0.81	--	--	--
3.	Ramnagar	Ramnagar	7.00	Under trial	--	--	--
STPs under construction in the district							
	ULBs	Location	Installed Capacity (MLD)		Remarks		
4	Ramnagar	Ramnagar	1.50		Jal Sansthan is working to set up the STP in this ULB. Approx. 45% of has been done till April, 2021.		
5	Haldwani	Indira Nagar	28.00		Sewer line has been laid through AMRUT programme. Approx. 15% of the work has been done till Jan, 2022.		
6	Nainital	Narayan Nagar	0.45		STP is setting up through AMRUT programme. Approx. 15% of the work has been done till April, 2021.		
STP Proposed in the district							
7	Nainital	Rusipond	18	DPR is approved for setting up the STP for better management of sewage treatment in the district.			

Liquid Waste Management in Rural Areas

Since the water supply for domestic purposed in rural areas has improved considerably over the years, the quantity of wastewater that is disposed as also increases. Hence effective wastewater management systems need to be introduced in the rural areas to mitigate the problem of contamination in the majority of rural areas, untreated wastewater is discharged directly into the local surroundings and water bodies. This leads to contamination of surface as well as sub-surface water, having negative effects on the environment and human health.

Current standpoint about Rural Waste Water Management in India

- With Population growth and rapid industrialization, wastewater management has become a serious issue. Rural India with old or no infrastructure has reached a tipping point.
- India has the highest number of people who don't have access to clean drinking water. Even abundance of water in certain places do not guarantee access to safe, reliable, drinking water.
- United Nations Sustainable Development goal 6 focuses on access to clean water and sanitation for all. The goal of the initiative is to sensitize communities to the advantages of hygiene and sanitation.

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 village (Table 30).

Table 30. 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.

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 population depends on groundwater for drinking water. Groundwater is also one of our most important sources of water for irrigation. Due to overuse and leverage of high amount of groundwater water table decreasing with rapid rate and it will very harmful 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 hydrologic process, when water (rain, snow-melt etc.) moves downward from surface to groundwater. Mostly groundwater recharged by 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 sources 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) are applied nowadays to save groundwater.

Groundwater management in the district

The district of Nainital is naturally gifted with numerous water bodies which are major source of drinking water and irrigation. River Kosi, originating from Kausani hills is the only perennial river traversing the district apart from other seasonal streams. Often called as "The Lake District of India", the district has several lakes surrounded by hills covered with coniferous forest (Table 31).

Table 31. Water Resources in Nainital District

S. No.	Water Resources	Remarks				
1.	Rivers	Name	Block	Place of Origin		Total length within the district (km)
		Kalsa	Bhimtal Dhari	Dharo hills		32
		Suyal	Ramgarh	--		30
		Kosi	Betalghat	Kausani		68
		Shipra		Bhowali		18
		Dabaka	Ramnagar	Nainital hills		21
		Khichdi	Kotabagh	Ramnagar hills		3.39
		Nihal		Nainital hills		13
		Baur				28
		Karari				23
2.	Lakes and Ponds	Name	Location	Surface area (ha)	Max. depth (m)	Gross Capacity(MCM)
		Naini Tal	29°38' 79°46'	46.70	27.15	8.11
		Naukuchiya Tal	29°32' 79°58'	25.80	40.30	5.371
		Bhim Tal	29°21' 79°33'	45.30	23.38	4.598
		Sat Tal	29°32' 79°21'	14.80	10	0.89
		Sarita Tal	29°22' 79°22'	0.64	3	0.19
		Nal Damyanti Tal	29°21' 79°32'	0.17	1.80	0.032

Table 32. Pollution control in water resources

S. No	Parameter	Current Status
1.	Open defecation in River/ Nala/ Khad	Partially controlled
2.	Dumping of solid waste on river banks	Partially controlled
3.	Control measures for idol immersion	Measure taken
4.	Nalas/Drains meeting rivers	N/A
5.	Disposal of untreated sewage in rivers	Sewage is not directly discharged into water bodies.
7.	Encroachments near flood plains	Not monitored yet.
8.	Protection of flood plains	No work has been started yet but the district administration is planning to demarcate FPZ.

Table 33. Information of groundwater in the district

S. No	Parameter	Current Status
1.	Estimated numbers of bore-wells/ hand pumps	--
2.	Groundwater polluted area in the district	None
3.	Adequacy of groundwater availability	Adequate
4.	Access to surface water and groundwater quality data at DM office	N/A
5.	Is there any action plan available for this district	N/A

Current standpoint regarding water resources management in Nainital district

Present state of affairs

- Common water sources used for water supply schemes over the district are:
  1. *Deep Tubewells*
  2. *Rivulets/Naulas/Gadheras*
  3. *Springs*
  4. *Rivers*
  5. *Khadins / Nadins/ Tankas/ Ponds / Wells/ Ooranis*
  6. *Treated Surface water*
  7. *Streams*
  8. *Others sources (Infiltration well, Shallow tube-well and Open-well)*
- Rivulets/ Naulas/ Gadheras (45.5%)followed by Deep tube-well (24.4%) and Springs (16.6%) are tapped for water schemes in Nainital district.
- The Ramgarh block has the highest water dependency on Springs, approx.27% of total water supply schemes.

Artificial Recharge of Groundwater

The groundwater development in the Nainital district is not much despite shortage of water in many regions. The valley fills along the major rivers are potential zones which can be explored for groundwater development and study. Artificial recharge potential for the region has been investigated to cater the growing domestic and irrigation water demand (Table 34). This could be further developed scientifically in a phased manner for future needs.

Table 34. Scope of Artificial recharge in Nainital district

District	Area (km^2)	Area identified for Artificial recharge (AR) (km^2)	Volume of unsaturated zone (MCM)	Available sub-surface space for AR (MCM)	Water required for artificial recharge (MCM)	Surplus available for recharge (MCM)
Nainital	3422	856	1711	257	341	2140

The conservation structures need to be constructed at different topographical levels so as to utilize the water thus stored throughout the year, especially during lean period. Summer. Keeping in mind

the future scenario the state government has undertaken development of artificial recharge structures under different programs The state government has constructed and proposed various artificial recharge structures (Table 35 &36).

Table 35. Artificial Recharge and RTRWH Structure constructed in Nainital district under catchment area conservation Program (CACMP)

District	Number of structures					Total cost (in lakhs)					Total cost (in lakhs)
	CD	CK	RTRWH	PT	CT	CD	CK	RTRWH	PT	CT	
Nainital	91	0	270	5	100	9.1	0	94.5	0.1	0.53	104.23

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

Table 36. Artificial recharge and cost estimate in Nainital district

District	**Structures proposed**					**Unit cost estimate (in lakhs)**					**Total cost (in lakhs)**					**Total cost (in lakhs)**
	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	RTRWH	CD	PT	CK	CT	
Nainital	250	125	80	200	400	0.5	0.3	0.7	0.15	0.015	125	37.5	5.6	30	6	204.1

CT-Contour Trench, CK- Chal Khal, RTRWH- Rooftop rainwater harvesting, CD- Check Dam, PT- Percolation Tank, NA- Data 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, argon, 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 state of 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 includes three cities from the Uttarakhand *(Dehradun, Rishikesh and Kashipur)*. These are the cities that 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 (Table 37).

Table 37. 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 CentralGovernment)
Sulphur Dioxide (SO2), (µg/m^3)	Annual* 24 hours**	50 80	20 80
Nitrogen Dioxide (NO2), (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 (O3) 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 (NH_3) µg/m^3	Annual* 24 hours**	100 400	100 400
Benzene (C_6H_6) 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: NAAQS, 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 Nainital district

One manual air quality monitoring station is available in Nagar Nigam Haldwani at a commercial zone. Air quality data for this monitoring station is regularly updated online by the state pollution control board (Table 38). This is important to understand the impact of vehicular pollution, industrial pollution, increase in construction activities etc. on air quality. Other regions of the district are devoid of any permanent monitoring station. Increase in forest fires, mining activities etc. may have already deteriorated the air quality (Table 39).

Several departments have been playing the part under their jurisdiction to control air pollution; be it UKPCB, transport or forest department. Regular check on industrial activities, Challan imposed for violating vehicular pollution norms etc. are some measures taken to improve air quality (Table 40).

Table 38. 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	01 at Govt. Hospital, Haldwani
Availability of air quality monitoring data	Monthly air quality data is uploaded in the website of UKPCB.

Table 39. Identification of sources of air pollution

Action area	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).
Identification prominent sources of air pollution in the district	Unprecedented forest fires, vehicular pollution ,industrial pollution, riverbed mining etc. are major reasons for air pollution in the district.

Table 40. Control measures for industrial/ non industrial air pollution

Action Areas	Outcomes	
Control of industrial air pollution	As many as 229 industries are meeting air quality standards in the district.	
Control of non-industrial air pollution		
(a) Control open burning of waste	Open burning of waste is strictly prohibited in the urban areas of the district. However due to lack of waste management system in the rural areas waste burning is still prevalent.	
(b) Control of forest fires	The forest department is trying its best to control forest fires but the result is yet to be seen on the ground. Every year hectares of forests are damaged due to forest fires.	
(c) Control of vehicular pollution	**Name of the ULBs**	**No. of PUC centres**
	Haldwani	62
	Ramnagar	08
	Bhowali	01
	Bhimtal	01
	Total	**72**
Challan imposed for violating the polluting control norms	**473**	
District level action plan for air pollution	At present, no such action plan has been prepared.	
Awareness on air quality	• Road safety programs are organized by transport department to spread awareness regarding vehicular air pollution • Pollution certificate is made compulsory for vehicle registration, transfer and other such certifications • Forest Fire protection management plan is prepared for the district to ascertain prevailing conditions and define objectives to mitigate forest fires.	
Development of air pollution complaint redressal system	Not Initiated	

Air Quality Monitoring in Nainital district

Air quality data for the monitoring station at Nagar Nigam Haldwani depicts exceeding values of PM_{10} for the past five years. Other parameters are within the prescribed limit (Table 41).

Table 41. Air Quality monitoring in Nagar Nigam Haldwani

Year	Ambient Air Quality Monitoring Location Haldwani, Naintal			
	Govt. Hospital Haldwani			
	PM_{10} (µg/ m^3)	$P.M_{2.5}$ (µg/ m^3)	SO_2 (µg/ m^3)	NO_2 (µg/ m^3)
2022	111.82	32.41	7.23	24.68
2021	117.05	38.05	8.15	27.16
2020	107.52	-	7.26	25.50
2019	110.91	-	7.57	28.10
2018	125.92	-	11.38	22.94
Standards (Annual)	*60*	*60*	*50*	*40*
24 Hours	*100*	*100*	*80*	*80*

Forest Fire Protection Management Scheme in Nainital District

Every year, forest fire causes rampant destruction in the district of Nainital. This pertains to the fact that more than 70% of total geographical area of the district is under forest cover. There are around 700 highly forest fire sensitive zone in 08 forest divisions of the district (This number excludes Tarai east and Tarai west division as entire forest area of these divisions are under highly sensitive zone). Major causes of forest fire include that due to natural and anthropogenic activities or it may be considered as negligence of local public (Table 42). The highest risk of forest fire occurs between March 15 and June 15.

Table 42. Details of forest fire sensitive areas under Nainital district

Sr. No.	Range name	Highly sensitive area (Nos.)
1.	Nainital Forest Division, Nainital	293
2.	Haldwani Forest Division, Haldwani	86
3.	Tarai East Forest Division, Haldwani	Whole area of this division is under highly forest fire sensitive zone
4.	Tarai Central Forest Division, Haldwani	79
5.	Tarai West Forest Division, Ramnagar	Whole area of this division is under highly forest fire sensitive zone
6.	Ramnagar Forest Division, Ramnagar	118
7.	Land Conservation Forest Division, Nainital	80
8.	Corbett Tiger Reserve, Ramnagar	22

Table 43. Causes and Effects of forest fire in the district

Causes of forest fire		Effects of forest fire
Due to nature	This is due to high temperature, low humidity, wind speed and constant dryness.	➢ Many important plant species are destroyed. ➢ Leads to waterlogging which reduces water seepage. ➢ Loss of wildlife and many micro-
Anthropogenic activities/ Negligence of	➢ From the spark emanating from the smoke of motor vehicles. ➢ Unintended smouldering of cigarettes, bidis, and	

the general public	matchsticks thrown by passers-by and shepherds. ➢ Unorganized campfires at campsite and fairs. ➢ Unintended forest fire because of burning of dry grass in the fields after crop harvesting.	organisms. It may lead to destruction of natural habitat and extinction of many species. ➢ The fulfilment of the various needs of the daily use of the common man gets hampered. ➢ Reduces subsistence agriculture which has severe consequences on the livelihood of forest communities.
Intentionally	➢ By residents to obtain new grass and clear paths. ➢ Due to personal rivalries. ➢ To block the natural regeneration of forests/vegetation near dwellings. ➢ For the purpose of hunting wild animals.	

Glimpses of Forest fire Management Plan of Nainital District

Based on certain objectives, different strategies have been devised to mitigate forest fires. These includes preventive as well as fighting measures (Table 44). Work is in progress to establish crew station, fire line, controlled fire measures etc., (Table 45).

Table 44. Objectives and Strategies of forest fire management plan in the district

Objectives of forest fire management plan		➢ Reducing fire incidents level at minimal point. ➢ Saving biodiversity and conservation of natural water sources & soil. ➢ To aware the people about the loss and bad effect of forest fire. ➢ To maintain environmental balance by protecting forest and wild animals.
Strategies for mitigating forest fire	Fire prevention measures	➢ Marking sensitive areas and announcement of most sensitive/ crucial time of forest fire. ➢ Organized public awareness program (seminars, training, fire safety week etc.). ➢ Formation of fire safety committees. ➢ Cleaning forest areas and creating fire lines in both side of motorways/walkways/ horse roads.
	Fire Fighting measures	➢ Establishment of fire watch tower and appointments of fire watcher's/ village guards.
		➢ . Establishment of crew stations and control room. ➢ Arrangement of firefighting equipment's (fire suppression system).

Table 45. Division wise details of work done in pre fire season, 2022 in the district

S. No	Division Name	No. of crew station	Fire line in both sides of motor road and walkways/ surrounding areas of plantation (km)	Controlled fire (h)
1	Nainital Forest Division, Naimital.	70	2823.76	21484.30
2	Haldwani Forest Division, Haldwani.	24	990.32	8173.70
3	Tarai East Forest Division, Haldwani.	21	600.00	5465.53
4	Tarai Central Forest Division, Haldwani.	22	1191.73	8162.28
5	Tarai West Forest Division, Ramnagar.	15	391.00	12187.26
6	Ramnagar Forest Division, Ramnagar.	34	902.30	11061.30
7	Land Conservation Forest Division, Nainital.	38	6799.30	0.00
8	Corbett Tiger Reserve, Ramnagar.	25	622.53	1400.00
Total		**249**	**14320.94**	**67934.36**

Gap Identification

Air pollution is not paid much heed in Hilly areas of the district, neither by the administration nor general public. Thousands of tourists visit Nainital every year which increases vehicular influx and subsequently deteriorates air quality. No district level committee has been formed to discuss the status quo regarding air pollution. Several steps have been taken by forest department to mitigate air pollution and forest fires but pristine air looks like a distant dream.

Noise pollution management

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 a big issue in the district but proper monitoring is required maintain noise level within the desirable limits. Following table represents the permissible noise level standards in India (Table 46).

Table 46. 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

Note: - 1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. 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
4. 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.
A "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 Nainital district

Noise level monitoring is carried out in two ULBs of the district; Nagar Nigam Haldwani and Nagar Palika Nainital. Challans have been imposed by transport department for violation of noise pollution norms (continuous honking, pressure horns etc.) (Table 47).

Table 47. 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.	01 with Regional Office UKPCB, Haldwani.
2.	Number of complaints received by State pollution control board related to noise pollution in past 1 year.	No complaint were registered.
3.	Implementation of ambient noise standards in residential and silent zones.	Local police is responsible for the implementation of the ambient noise level standards.
4.	Challans imposed for violating the noise pollution norms	83 (Related to vehicular noise pollution) by RTO
5.	Noise monitoring study in district	Monitoring is carried out in Nagar Nigam Haldwani and Nagar Palika Nainital.
6.	Setting up of Sign Boards	Sign boards are installed around hospital, schools and along the highways.
7.	Routine monitoring of Ambient Noise level at various locations	Initiated

Monitoring of Noise levels in Nainital district

Four locations at different areas of NN Haldwani and NPP Nainital are monitored to get some information about prevailing noise levels (Table 48). Generally, the noise levels are within the permissible limit in all the monitoring stations. A special noise level monitoring drive is carried out at different locations in NN Haldwani during Deepawali festival (Pre-Deepawali and Deepawali day) to determine the impact of fire crackers on noise pollution (Table 49).

Table 48. Prevailing Noise levels in Nainital district

Monitoring locations	Zone	Noise Level dB (A)					
		2022	2021	2020	2019	2018	2017
Mallital Near N.P.P. Office, Nainital	Commercial	56.7	53.18	56.18	52.51	52.54	54.50
Awas-Vikas Chowk, Nainital Road,Haldwani	Commercial	47.8	49.55	49.52	52.88	53.86	53.29
Beershiva School, Nainital Road, Haldwani	Commercial	56.4	53.03	53.41	55.50	54.23	54.78
Tikonia Chowk, Haldwani	Commercial	62.3	56.87	56.18	62.82	61.85	62.95

Table 49. Noise level monitoring carried out during Deepawali festival (2021)

Monitoring locations	Pre-Deepawali Day (29.10.2021)	Deepawali Day (04.11.2021)
Sheeshmahal Colony, Haldwani	64.5	73.8
St. Paul's School, Haldwani	48.6	65.5
Mangal Parao, Haldwani	70.7	78.8

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 Riverbed Mining (RBM) 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 the district

Sand mining is very common on the river flood plains. Mining license is given by the district authority after scrutinizing the consent conditions of particular site. Penalties have been levied on illegal mining activities in the district (Table 50 and 51).

Table 50. Prevalent Mining Activities

Total area of district(km^2)	4251
Type of Mining Activity	River Bed Mining (mainly sand) is prevalent in the district.
Total no of sand mining sites in the district	61
Total mining area	22.95 km^2
Number of mining licenses given by the district authority	61
Action against illegal mining activities in the district (in the financial year 2020-21)	57
Penalties charged for the illegal mining activities/ Earnings from mining royalty	During the financial year 2021-22, INR 38.8922Cr. has been imposed against 57 cases of illegal mining activities in the district. Out of which INR 1.2278 Cr. has been deposited.

Source: Geology and Mining Unit, Nainital

Table 51. Compliance with environmental standards

Mining areas meeting environmental clearance conditions	06
Mining areas meeting consent conditions of UKPCB	06
Mining operations were suspended for violations of environmental norms	Nil
Pollutions related complaints against mining operations in past one year	Nil

REJUVENATION OF WATER BODIES

Most of India's major water resources *(underground waterways, lakes, rivers and reservoirs)* have to depend on monsoon rains to replenish/recover them. Nearly 600 million Indians faced high to extreme water stress and about 2 lakh people died 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. Due the high amount of water extraction and mismanagement of water resources are causing drought and sudden flood in several part of our country. Rejuvenation of water bodies also play a vital role to improve the water quality and storage of surface runoff water. For these reasons we must need to store, manage and rejuvenate the existing water bodies. We can use several government policies/Schemes like Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS), 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 works in Nainital district

Various water retention works are undertaken by Nainital forest division under different schemes. These includes construction of ponds, Chal-Khal, Contour trenches etc. This will serve twin purpose of fulfilling water needs and mitigating forest fires (in pine dominated forests) in the district (Table 52).

Table 52. Present scenario in the district (Nainital Forest Division)

Name of Department	Work Undertaken	Work Performed	
Nainital Forest Division	Construction Activities	State-Sponsored	Under CAMPA
	Number of Ponds	59	121
	Chal-Khal	--	140
	Check Dam	--	1112
	Contour Trenches	58	44525
	Dry Water Source	--	38
	Water-Holes	12	--
	Perculation Tank	--	326
	Water Harvesting Tank	--	24
Total		**129**	**46286**

Rejuvenation and redevelopment of Sukhatal

Sukhatal is a natural depression which probably was a lake in distant past. It gets filled up during the monsoon season when inundation occurs and excess water has to be pumped out. However, it turns dry within next 3-4 months of dry spell.

Importance of Rejuvenating Sukhatal Lake

A very important aspect of this work is to assess the impact of the creation of water body at Sukhatal on the Nainital lake. This pertains to the fact that Sukhatal catchment contributes significantly to the subsurface inflow in Naintal lake (Almost 30-40% of the subsurface flow into Nainital lake).

Initiation of the Work

In February 2016, Department of Hydro and Renewable Energy(HRED), IIT Roorkee studied and prepared a report for the Irrigation department for rejuvenation of Sukhatal Lake. HRED presented three options for the revival of lake out of which second option was finalized which included works such as provision of boundary walls, spillage arrangement, conveyance arrangement and shoreline development works.

It was in July 2020, when the Commissioner, Kumaon Mandal directed the District Level Development authority, Nainital(DLDAN) to develop Sukhatal as a recharge zone and tourist destination. DLDAN further assigned the task of preparing the scheme to M/s Accurate and Associates Infra Pvt. Ltd., Haridwar (AAIPL). Upon vetting by HRED IIT, Roorkee, the proposal was submitted to DLDAN with following scope of works:

- Converting part- 9145 m^2 of the Sukhatal depression area into perennial lake with a storage capacity of 18,290 m^2 by making boundary walls and rigid impervious bed.
- Allowing 1400 m^2 of the depression to remain as natural with capacity of 2800 m^2.
- Providing 10 infiltration wells for recharge in the proposed perennial lake
- Providing a children's park in the raised area which has become a safe haven for dumping of solid and construction waste.
- Providing a walkway around the whole area.

Recommendation based on the proposal

Based on hydrological study and opinion from concerned departments, following recommendations were made:

- There is sufficient runoff from the catchment of Sukhatal to fill up the lake even in the years of below average rainfall
- Use of Geosynthetic Clay liner was recommended to make impermeable bed of perennial lake.
- Construction of infiltration well was not recommended as it may disturb the surface lithology of the area.
- The proposal to establish a children's park was also not recommended as it would mean encroaching upon the lake area.

Current Status

Taking due consideration of the recommendations by expert committee, the work was assigned with a financial outlay of around 29.16 crores. Almost one-third of the work is complete and the department is optimistic about completing the project before Dec'22. Moreover, construction of gravity drain has been envisaged recently to avoid flood like situation and inundation of the surrounding area.

Fig. 6. Proposed Destination point and Bird's eye view of Sukhatal Catchment Area

Fig. 7. Undergoing Works for Development of Sukhatal as recharge zone

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 tons per year globally *(CPCB, 2013).* India generates 15 million tons 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 producer's 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 Management Rules,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.

Current scenario of Plastic waste in Nainital District

Nagar Nigam Haldwani accounts for more than 90% of the Plastic waste generated in Nainital district. This may be attributed to the fact it is highly populous and urbanized (Table 53). Other ULBs generates little quantity of measurable plastic waste which is further sent to authorized recycler at Haldwani for further processing (Table 54).

Table 53. Inventory of Plastic Waste Generation

Name of Urban Local Body	Population (2011 census)	Number of Wards	Estimated Quantity of Plastic Waste Generated (MT/Day)
NN Haldwani	280604	60	9.9
NPP Ramnagar	54787	20	0.21
NPP Nainital	41377	15	0.15
NPP Bhowali	8483	07	0.06
NP Bhimtal	14882	09	0.02
NP Kaladungi	7706	07	0.012
NP Lalkuan	7644	07	0.30
CB Nainital	1398	02	--

(Source: District administration, Nainital 2022)

Table 54. Present Infrastructure for Plastic Waste Management Operations

Name of ULB	Inventory of infrastructure available for plastic waste management operation		
	Availability of plastic compactor	**Linkage with Plastic waste recyclers**	**Remarks**
NN Haldwani	Available	Except Cantonment Board Nainital, all other ULBs have linkage with recyclers to channelize their plastic waste	Plastic waste after compaction and bailing operation is sent to authorised recycler at Haldwani for further process.
NPP Ramnagar	Available		
NPP Nainital	Not Available		
NPP Bhowali	Not Available		
NP Bhimtal	Available		

NP Kaladungi	Available		
NP Lalkuan	Available		
CB Nainital	Available		

Gaps identified in the management of plastic waste in the district

Plastic waste management is a part of solid waste management operations and include all its aspects. Many ULBs have basic infrastructure for dealing with plastic waste but somehow it continues to clog the drains and pollute water bodies. Plastic waste forms a larger chunk of waste littered in roads especially in tourist places. Moreover, there is no separate policy framework to deal with the floating waste of which plastic waste forms a huge part.

Estimated Future Population and Plastic Waste Generation in Nainital District

Plastic waste in India has surged over the past 50 years and is expected to double again over the next 20 years. The growth rate of the Indian plastic industry is one of the highest in the world.

Forecasting waste quantities in the future is as difficult as it is in predicting changes in waste composition. As a general rule, the lower level of economic development, the greater the change between generation and disposal.

Census population data for the years 2001 and 2011 has been taken for population forecast (Table 55). Decadal population and subsequent waste forecast has been done based on the following presumptions:

- The arithmetic increase method has been used for the decadal population forecast, hence the rate of change of population with time is assumed to be constant.
- The per capita consumption of plastic waste has been taken as 11kg/annum. *(Centre for Science and Environment, 2019).*
- It is considered that 70% of total plastic waste consumption 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)*
- The analysis includes population and waste generation estimations only for urban local bodies and does not include peri-urban and rural areas. (Table 55 and 56; Fig.6)

Table 55. Projected Population and Waste Generation

ULB	Projected Population			Present/ Projected Plastic Waste Generation (MTPD)		
	2021	2031	2041	2021	2031	2041
Nagar Nigam Haldwani	432193	583782	735371	9.90	34.77	113.87
Nagar Palika Parisad Ramnagar	63369	71951	80533	0.21	0.62	1.80
Nagar Palika Parisad Nainital	44124	46871	49618	0.15	0.41	1.14
Nagar Palika Parisad Bhowali	11940	15397	18854	0.06	0.20	0.64
Nagar Panchayat Bhimtal	23890	32898	41906	0.02	0.07	0.24
Nagar Panchayat Kaladungi	9284	10862	12440	0.30	0.88	2.55
Nagar Panchayat Lalkuan	8764	9884	11004	0.01	0.04	0.11
Total				**10.65**	**36.99**	**120.35**

Table 56. Decadal Change in plastic waste Generation

Name of ULB	Rate of Growth % (2021-2031)	Rate of Growth % (2031-2041)
NN Haldwani	25.12	22.75
NPP Ramnagar	19.52	19.10
NPP Nainital	17.62	17.52
NPP Bhowali	23.53	21.84
NP Bhimtal	25.80	23.12
NP Kaladungi	20.42	19.78
NP Lalkuan	19.32	18.95

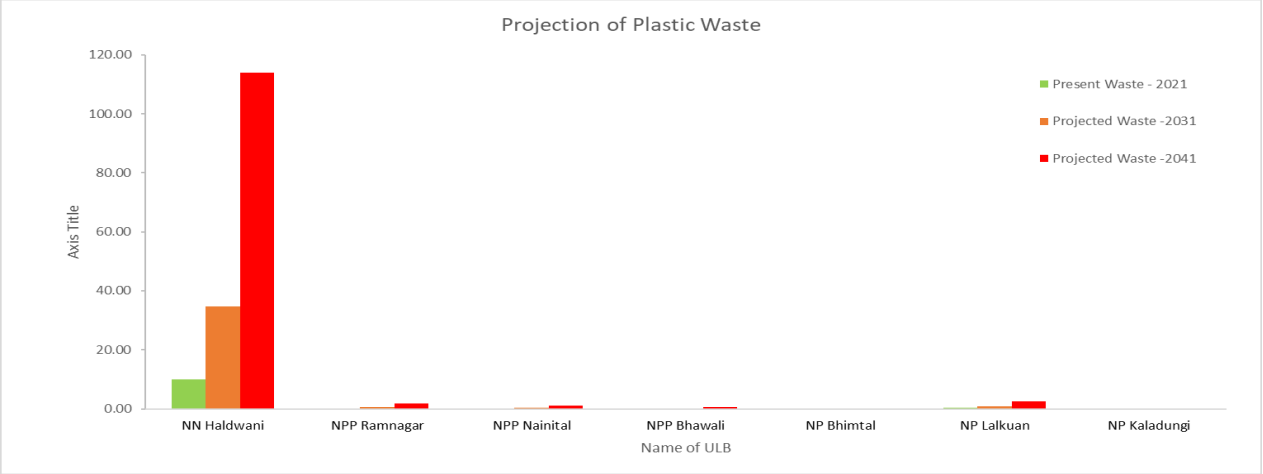


Fig. 8. Projected plastic waste generation

Inferences drawn from plastic waste projection

- Plastic waste generation is expected to rise at a substantial rate and would cross 100 MTPD by 2041. As expected, Nagar Nigam Haldwani would be the largest contributor.
- With increasing urbanization, the proportion of plastic waste in dry waste will also rise. This means that it will become necessary for ULBs to transform waste processing techniques and machinery accordingly.

ASSESSMENT OF URBAN LOCAL BODIES IN NAINITAL 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 57, Table 58). 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 57. Assessment of urban local bodies in Nainital district

Indicators	Maximum Points	Urban Local Body							
		NN Haldwani	NPP Ramnagar	NPP Nainital	NPP Bhowali	NP Bhimtal	NP Kaladungi	NP Lalkuan	CB Nainital
Solid Waste Management									
Segregation	**4**	2	4	0	2	4	3	4	4
Collection	**4**	4	4	4	4	4	4	4	4
Segregated Waste Transport	**4**	1	2	0	1	1	1	2	2
Wet Waste Processing	**2**	2	2	2	2	2	2	2	2
Dry Waste Processing	**4**	4	4	2	2	4	4	4	2
Disposal	**2**	1	1	0	0	0	0	0	0
Inclusion of Informal Sector	**1**	1	1	1	1	1	1	1	1
Bio-medical waste Management									
Linkage with CBWTF(Common Bio-medical Waste Treatment and Disposal Facility)	**1**	0	0	0	0	0	0	0	0
Hazardous Waste Management									
Linkage with TSDF (Treatment, Storage and Disposal Facilities)	**1**	1	1	1	1	1	1	1	1
C&D Waste management									
C&D Waste Processing	**1**	0	0	0	0	0	0	0	0
E-Waste Management	**2**	1	2	0	0	0	0	0	0
General Information									

Innovation and use of indigenous techniques	**2**	0	0	0	0	0	0	0	0
Enforcement of Bye-laws and Waste Management Rules, 2016	**2**	2	2	1	1	2	2	2	2
Total	**30**	**19**	**23**	**10**	**14**	**19**	**18**	**20**	**18**

Table 58. Final Assessment of Urban Local bodies of Naintal

Name of ULB	Score (out of 30)	Score Percentage (%)
NPP Haldwani	19	63.33
NPP Ramnagar	23	76.66
NPP Nainital	10	33.33
NPP Bhowali	14	46.66
NP Bhimtal	19	63.33
NP Kaladungi	18	60
NP Lalkuan	20	66.66
CB Nainital	18	60

Observations from data assessment

- Except NPP Nainital all other ULBs are doing well source segregation and door to door collection of segregated waste.
- Except NPP Nainital and NPP Bhowali, all others ULBs has their own MRF facilities to manage the dry waste.
- In NN Haldwani and NPP Ramnagar have their trenching ground but for the other ULBs trenching ground is not available for the disposal of inert waste.
- None of the Urban Local Bodies has linkage with CBWTF (Common Biomedical Waste Treatment Facility).
- Only NPP Ramnagar is performing decently in management the waste, all other ULBs are performing near to equal as compared to each other but the overall performance in waste management is not satisfactory.

ACTION PLAN

Action Plan for Solid Waste Management

All ULBs are performing fairly in waste management operations. Dry waste management is almost similar in the district but hilly regions rely on trenching ground at Haldwani to dispose their leftover waste.

Focus areas

- *Waste management practices in consonance with growing tourism activities.*
- *Framing Anti-littering regulations.*
- *Topography based solid waste management*

Nainital district has distinctive topography which makes it challenging to manage the solid waste. This action plan below focuses on the basic point, which forms the prerequisite for effective solid waste management. Each action point is in compliance with the guidelines of Solid Waste Management Rules, 2016.The current action points must be addressed in a timeframe of 5-10 years considering the financial constraints (Table 59).

Table 59. Action plan for solid waste management

Action Point	Concerning ULB	Purpose	Strategy/Approach	Stakeholder Responsible
Primary Segregation (Segregation at Source)	Nagar Palika Nainital	• Higher Recovery of Recyclables. • Hygienic environment for handling of waste. • Efficient Energy Recovery	• Separate Storage Bins. • Regular awareness campaigns • Man power Management. • Behavioural change Communication techniques. • Home composting	• Nagar Palika • Residents and NGOs
Segregated Waste Transport	• Nagar Palika Nainital • Nagar Palika Bhowali	• Reducing open dumping of waste. • Reduction of Historical waste. • Minimizing ground water contamination • Reduction of transportation charges.	• Optimizing Waste Management Infrastructure (Collection trucks, trolleys). • Man power optimization at Recovery facility.	Nagar Palika
Dry waste Management in Secondary facility/Trenching ground/Transfer Station	• Nagar Palika Nainital • Nagar Palika Bhowali	Scientific management of dry waste	• Establishing Material Recovery facility • Linkage with recyclers	Nagar Palika

Designated waste disposal site as per SWM rules ,2016	• Nagar Palika Nainital • Nagar Palika Bhowali • Nagar Panchayat Bhimtal • Nagar Panchayat Lalkuan	• Reducing local dump sites and heaps of historical waste. • A section of dumping site can also be used for waste segregation and processing	• Site selection criteria based on factors such as groundwater depth, land slope, soil properties etc. • Fast tracking transfer of land and other legal formalities.	Nagar Palika
Regular waste audit	• Nagar Nigam Haldwani • Nagar Palika Ramnagar • Nagar Palika Nainital	• 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 Palika
Landfill mining/remediation of dump site	Nagar Palika Ramnagar	• To mitigate environmental impact of waste. (Methane emission) • Resource Recovery of excavated waste.	• Nagar Palika Ramnagar can go through the technique used by Nagar Nigam Kashipur and Nagar Nigam Rudrapur of U.S. Nagar district to remediate or clear the dump site. • Phytoremediation must be practised	Nagar Palika
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.	• 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	District Administration

			waste management.	
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

Action Plan for rural waste management in India

The Government of India as well as state government is looking up at every Gram Panchayats (GPs) to come up with a working system to manage solid waste. At the moment there are Gram Panchayats in Tamil Nadu, Andhra Pradesh, West Bengal, Gujarat and Chhattisgarh which have created a robust and sustainable system to manage solid waste.

Owing to increase in tourist activities, numerous resorts and homestays have come up in the outskirts of the cities which generally comes under the village administration. Traditional waste management techniques are used in these areas which could be catastrophic to the environment. However, based on practical models, some policies have been propagated by both Central and State government for solid waste management in rural areas (Table 60).

Table 60. Policies undertaken for rural waste management in India

Current Policy	**Sponsoring agency**	**Remarks**
Decentralized Waste Management	Under Swachh Bharat Mission-Gramin (SBM-G)	Decentralized systems such as household compost and biogas plants shall be encouraged.
Community Sanitary Complex(CSCs)	Under Swachh Bharat Mission-Gramin (SBM-G)	Such complexes comprise an appropriate number of toilet seats, bathing cubicles etc.(Only where there is a lack of space in the village for the construction of household toilets).
Cluster Approach to Solid Waste Management	Rurban Mission of Ministry of Rural Development	It aims at developing infrastructure and livelihood opportunities in a cluster of Gram panchayats that demonstrate economic growth potentials.
Community Participation through IEC(Information, Education and Communication) Activities	National Institute of Rural Development and Panchayati Raj	All the stakeholders need to plan for a series of IEC campaigns to educate the residents on how proper segregation at the household levels eases the entire process of managing waste at subsequent stages.

Action Plan for Bio-Medical Waste

Biomedical waste of authorized health-care facilities is lifted to CBMWTF at Rudrapur or to Mini CBMWTF in Haldwani. Still there remains a huge gap in the number of authorized HCFs and those having linkage with CBMWTF.

With the onset of the pandemic, it has become clear that a proper healthcare system is need of the hour. It also provides the opportunity to improve biomedical waste management in the district. Moreover, during outbreaks such as covid-19, materials or substances which carry infection (fomites) acts as key vehicle for the transmission of the disease. Streamlining the bio-medical waste may help in reducing the infection and its transmission. This action plan provides holistic approach, which includes governance, infrastructure, training and immunization, services etc. to tackle the unprecedented growth in biomedical waste. Immediate action is required in some of the areas such as segregation and tracking of the waste generated etc. while other action points must be executed in due course of time (Table 61).

Focus Areas

- *Quantification/scientific management of biomedical waste generated from domestic households, nursing homes etc.*
- *Cluster based approach for biomedical waste management in hilly regions.*

Table 61. 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,	Health Department

	2016.	
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

Some ULBs in the district have initiated collection and disposal of C&D waste but it still needs a strong framework to deal with the ever-growing C&D waste. As the district is a major tourist hub, construction activities are expected to increase exponentially which will demand sound management techniques. Hence, some basic facilities need to be developed to manage its growth. The action plan provides below provide a sustainable approach for the management of the C&D waste in compliance with the latest C&D waste management rules 2016 (Table 62).

Focus Areas

- *C&D waste processing plant at a common place.*
- *Implementation of bye-laws.*

Table 62. 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.	• Transition points must be defined to deposit C&D waste. • 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)
Quantification of C&D waste generated	To keep account of C&D waste generated or dumped based on area and type of buildings demolished.	Giving demolition permits to waste generators rather than reconstruction permits.	• 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 to the urban areas of the district.	• Nagar Nigam/Nagar Palika • District administration
Arrangement of Size	To facilitate reuse	This can be done by erecting sturdy metallic screens of	• All ULBs • PWD (Public

grading	of C&D Waste.	different sizes at an angle and putting the waste over them with the help of front-end loader.	Works Department)
Involvement of Private enterprise	Assortment and transportation of C&D waste	Public private partnership schemes must be encouraged	ULBs
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

Hazardous waste can be a potential threat to human health and environment. This makes it necessary to manage hazardous waste to minimize its harmful impact.

Hazardous waste generated from industries is quantifiable in the district. Except few ULBs, none has mechanism for dealing with either separate collection of hazardous waste or its management. This action plan 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 (Table 63).

Focus Areas

- *Streamlining hazardous waste in current waste management operations.*
- *Linkage of ULBs with TSDF.*
- *Centralized collection centre for nearby ULBs.*

Table 63. 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 &(District Panchayati Raj officer (DPRO)
Training of sanitation workers regarding segregation of domestic hazardous waste	To ensure segregation of domestic hazardous waste from municipal solid waste	Training programme should be organised at state/district level for handling and segregation of domestic hazardous waste so that sanitation workers should not catch any kind of infection during its handing and its proper segregation could be possible.	State government and District Administration
IT enabled systems for inventorization of the hazardous waste m	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 on its website so that complete transparency is maintained in the management of hazardous waste in the district.	State pollution control board

Action Plan for E-Waste Management

Few ULBs have taken some crucial steps such as establishment of collection centers and setting up of toll free number for e-waste management in the district. However, many ULBs are still devoid of management services related to e-waste. This may be due to lack of awareness amongst local residents as well as district administration.

Focus Areas

- *To stop unregulated backyard operations of e-waste.*
- *Cluster based management of e-waste.*
- *Regular awareness programs and IEC activities.*

E-waste needs to be streamlined in the current waste management operation, moreover a detailed framework must be developed for its management. This action plan discusses key areas where intervention is needed to achieve effective waste management in compliance with E-waste management rules, 2016 (Table 64).

Table 64. 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.)	District administration	Promoting behavioural change in public.

	• Promoting Awareness programmes under Digital India Initiative (Initiated by Ministry 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 Waste Water Management (STPs)

Except Haldwani, Sewage treatment plants are operational in major cities of the district. Actual utilization capacity has been low for these STPs but this usually follows seasonal changes. Some STPs have been proposed for other ULBs which also includes developing sewer networks to connect domestic households.

Focus Areas

- *Decentralized waste water management.*
- *Consideration of tourist influx while planning/developing waste water management infrastructure.*
- *Site specific wastewater management.*

This action plan focusses on addressing concerns of each ULB pertaining to the policies and design sanctioned by the respective administration (Table 65).

Table 65. Action plan for waste water management

Action areas	Concerning ULB	Strategy/Approach	Stakeholder Responsible
Decentralized waste water management under Atal mission for Rejuvenation and Urban transformation(AMRUT) by Faecal Sludge and Septage Management system (FSSM)	As per feasibility analysis	• 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
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 agencies, the private sector)	Ministry of Housing and Urban Development, Government of India
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
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

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

Water Resources and Groundwater management requires an integrated approach from different departments such as the District administration, Panchayati Raj, Jal Sansthan, Jal Nigam, Payjal Nigam, Forest Department etc. Each department is expected to work in tandem with each other to achieve effective management of resources, be it land or water. The action plan focuses on the areas, which form the prerequisite for effective water resource management. Each action point is in compliance 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 66 & 67).

Focus Areas

- *Mapping of water scarce areas*
- *Encouraging the use of organic fertilizers*
- *Crop diversification*

Table 66. 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 67. Ground water management

Action Point	Purpose	Strategy/Approach
Multidisciplinary Approach(Nexus between groundwater, agricultural policy, urban infrastructure and energy consumption)	For groundwater sustainability	By integrated vision and coordination amongst different departments.
Mapping of aquifer at micro level	• To quantify the available ground water resources • To formulate plan appropriate to the scale of demands and aquifer characteristics.	By Maintaining an Aquifer information and Management system
Artificial recharge of Ground water	• To ensure sustainability of ground water resources • To ensure the quality of recharge to prevent possible contamination	• By demarcating groundwater recharge zones by identifying critical natural recharge areas of an aquifer and those areas that require special attention with regard to recharge of groundwater. • By using broad leaf plants to improve the moisture content in the soil and thereby increasing the groundwater level and water holding capacity of soil. • Improving the scale of work done through various schemes such as MNREGA which will help develop indigenous recharge methods (such as Chal-khal).
Identification of Non-point sources of Pollution (Pollution resulting from land runoff, precipitation, drainage, seepage etc.)	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.	• Controlling soil erosion by planting more trees and covering bare soil with vegetation. • Constructing wetlands.
Mitigating Groundwater Contamination	• To ensure the ground water quality of an area. • To reduce health hazards caused due to contaminated water.	• Reducing the use of pesticides and fertilizers. • Encouraging Organic farming in the area by organising various Information, Education and Communication (IEC) campaigns.

Action Plan for Air and Noise Pollution

Increased vehicular pollution, especially during the tourist season, forest fires and other anthropogenic activities may result in deteriorating air quality in the district. As of now, air quality in plain region is monitored from past five years. District administration might require a holistic policy to deal with increased air pollution in tourist places, which are specifically located in the hilly regions of the district (Table 68).

Focus Areas

- *Air quality monitoring in hill regions.*
- *Implementation of forest fire management plan*

Table 68. Action plan for air quality management

Action Areas	Purpose	Strategies/Approach	Stakeholders
Air quality monitoring	To identify the hotspots within the district and further development of mitigation measures for those areas.	Ambient air quality monitoring stations can be installed in all the urban centres and other identified areas such as construction sites after manual air quality monitoring.	Uttarakhand state pollution control board (UKPCB)
Solid waste collection system	To reduce emission of harmful gases by open burning of waste especially in urban areas.	• Door to Door collection of waste in the peri-urban areas and provision of dry waste collection from rural areas within the district. • After implementing proper collection mechanism, provision of heavy fines should be made on open burning of waste.	All ULBs and District Panchayati Raj Office (DPRO)
Control over forest fires	To reduce harmful emissions due to massive forest fires in the district.	• Providing the forest department adequate manpower and machinery to control forest fires. • Proper coordination between various departments involved in this operation. • Proper inspection of civil forests and forests under van panchayats by training the personnel engaged in the maintenance of these forests. • Development of mixed forests by planting indigenous broadleaf plants which maintains moisture in the soil and	Government of Uttarakhand and District Forest Department

		reduce the chances of fire.	
Vehicular Traffic management	To reduce emissions caused by vehicles.	• Checking adulteration of fuel • Promoting intercity and intra-city public transportation with green fuel alternatives such e-buses & rickshaws etc. • Paving of road shoulders especially in urban areas.	• Department of Police • Transport Department • Public works department
District level action plan for air pollution	To improve existing air quality.	A district level task force with some experts can be formed for air quality management in the district.	District Administration
Awareness on air quality	To promote awareness among the masses regarding the issue.	Mass awareness can be promoted with IEC activities by involving institutions such as schools and colleges for this purpose.	District Administration
Complaint redressal system	To sort out grievances registered by citizens	Online complaint registration and redressal system should be formed at the district level to register complaints regarding air pollution issues.	• Uttarakhand state pollution control board (UKPCB) • District administration

Action Plan for Noise pollution management

As of now, Noise levels are monitored enlarge cities and major tourist hubs. The district administration has the capacity to deal with noise pollution collaborative efforts by different department would be beneficial in near future (Table 69).

Table 69. Action Plan for Noise pollution management

Action Areas	Purpose	Strategies/Approach	Stakeholders
Noise level monitoring	To recognize the current situation of noise levels in the district and identify the hotspots	Noise monitoring studies need to be done in the district especially within the urban centres within the district by manual monitoring. In the areas identified as hotspots, continuous monitoring stations should be set up.	Uttarakhand state pollution control board (UKPCB)
Traffic management	To ensure noise level within permissible limits	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
Complaint redressing system	To sort out grievances registered by citizens	Online complaint registration and redressal system for noise pollution should be made which can be used by citizens, Traffic police, ULBs, and state pollution control board.	District Administration
Mass Awareness	To promote awareness among the masses regarding the issue	Mass awareness campaigns must be organized with the help of IEC activities by taking the help of institutions such as schools and colleges for this purpose	District Administration

Action Plan Mining Activity management

Sand mining is prevalent in the district and forms a major part of the revenue for state government. However, cases of illegal mining activities have come into notice which may hamper the river profile and exaggerated environmental concerns.

Focus Areas

- *Stringent Environmental clearance conditions.*
- *Identification of hotspots*
- *Digitization of trading process*

The action plan provided below mainly emphasize on areas, which includes monitoring of the mining operation by using the latest technologies, regular audit of the mining sites and other guidelines as per the Sustainable Sand Mining Guidelines 2016 (Table 70).

Table 70. Mining activity management plan

Action Areas	Purpose	Strategies/Approach	Stakeholders
Monitoring of mining activity	To ensure sustainable mining activity within the district.	• 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
System for online purchase and sale of Sand and other RBMs	To ensure compliance to Enforcement and Monitoring guidelines for Sand mining, 2020.	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
Identification of hotspots for illegal mining	To have check on the mining activities in the district.	The district task force should identify the possible hotspots for illegal mining through surveillance and patrolling.	District Administration
Community participation	• To understand local community's willingness in curbing illegal mining from the area. • To have local check on the illegal mining activities in the district.	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

Action Plan for Rejuvenation of Waterbodies

Development of Sukhatal is a major restoration project in the district. Apart from this, other rejuvenation works by forest department are also underway in the district. This action plan will further help the organizations/departments blend their indigenous techniques with scientific rationale to achieve the desired results (Table 71)

Table 71. 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. • Distribution of water and prioritization of water uses under stressed conditions.
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 acts 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 (Pauri 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

- *Separate framework for plastic waste management in tourist hubs.*
- *Prioritizing plastic waste management in Plain regions, where its quantity is substantial.*
- *Emphasis on Extended Producers Responsibility.*

Plastic waste forms a major chunk of dry waste in the district and its processing is part of solid waste management practices. There is no separate policy framework of plastic waste management in the district. Different strategies need to be devised for dealing with plastic waste, especially in tourist hubs of hilly region. Action plan below addresses some key points which are prerequisite for sound plastic waste management (Table 72). These must be acted upon in a timeframe of 5-10 years considering the financial constraints.

Table 72. Action Plan for Plastic waste management

Action Point	Purpose	Strategy/Approach	Stakeholder Responsible
Source segregation	• To ensure better efficiency in waste processing • Higher recovery of resources.	• ULBs should distribute separate bins to households, street vendors and other shopkeepers. • 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
Effective Collection and segregated waste transport	• To reduce open dumping of waste • To reduce monkey menace (which is a huge issue in the urban areas of the state) • To ensure optimum utilisation of manpower • To ensure compliance with plastic waste management rules	• 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

	2016		
Linkage of ULBs & other collection centres with recyclers/ cement plants / Public Works Department	• To avoid open dumping of plastic waste. • To ensure reuse and recycle of plastic waste.	• 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, DPRO (District Panchayati raj Officer),
Implementation of extended producer responsibility (EPR) through producer/Brand owner	To reduce the workload of ULBs	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
Community participation for waste management	Social and Behavioural Change Communication Cleanliness drive campaigns throughout the district	• 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
Establishment of Green Protocol	• 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

CONCLUSION

Distinct topography from plain to hills and varying population density within different topographic regions make it challenging to find one stop solution for the environment related issues in the district. More than half of the population is concentrated in Haldwani and it also accounts for about 75% (120 out of 159.6 MT) of the total waste generated per day in the district. The hilly region together accounts for meagre 26 MT of waste generated per day. Primary waste management operations such as source segregation, door to door collection, transportation, etc. are optimum in the district except Nainital town which is yet to begin source segregation of waste. Hilly regions have adopted common methodology for waste management which includes secondary segregation at some temporary locations, waste compacting, selling waste to local rag pickers and then channelizing the leftover waste to trenching ground at Haldwani. The ULBs of plain regions of the district have robust waste management facilities. Nagar Palika Ramnagar has started mechanical sweeping of roads (25% coverage) in some locations and even uses triple compartment vehicles for waste collection, which effectively segregates the toxic hazardous waste. Waste disposal has been an issue in the district, especially in the hilly regions where there was not even a single disposal ground available. There is no provision to manage the sudden increase in solid waste generation in Nagar Palika Nainital which witnesses high tourist influx in summer season every year. Plastic waste forms a fraction of dry waste (10.65 out 80.7 MT/D) in the district. Usually, it is compacted and then is sent to authorised recyclers for further processing at Haldwani. In the hilly regions, ULBs usually prefer to sell the reusable plastic waste to the local rag pickers. Cluster based approach may help the ULBs in achieving effective solid waste management. This will also address the land related issues for setting up a dumping ground. The distinct topography of the district also demands a need of topography based waste management plan. More than 29.76 MT per annum of industrial hazardous waste is generated in the district from 171 industrial units. More than 70% (22.05 out of 29.76 MT) is reusable and recyclable. As far as domestic hazardous waste is concerned, Nagar Palika Ramnagar has streamlined its waste management operations by initiating separate transportation in triple compartment vehicle. Other ULBs are yet to take any pragmatic action to manage hazardous waste. This may become a major health hazard in the district. ULBs must establish collection centres, linkage with TSDF for effective hazardous waste management. E-waste management is still in its early stage in the district of Nainital. Some steps have been taken for its management such as separate collection (in Black Box by NPP Ramnagar), setting up of toll free number for its collection (NN Haldwani), establishment of collection centres (NN Haldwani and NPP Ramnagar), and linkage with e-waste

recycler (NP Ramnagar). E-waste needs to be inventoried, especially from the bulk consumers (Govt. departments, Educational institution, etc.) where it is lying idle for decades. Rapid development has prompted extensive construction activities in the district which in turn has led to increase in C&D waste. Many ULBs of the district have established collection centres but local people prefer to use it either for reparation works or filling of low lying areas. C&D waste from collection centre in Nagar Palika Ramnagar is taken by people from rural areas for their local construction works. C&D waste needs to be given due consideration in near future for its proper utilization and to mitigate backyard dumping. The district of Nainital has ample facilities to treat and manage the biomedical waste generated in its HCFs. Out of 419 HCFs (bedded and non-bedded) in the district, 374 are authorised by UKPCB and 163 have established linkage with CBMWTFs (one at Rudrapur and a mini CBWMTF at Shusheela Tiwari Govt. Hospital Haldwani) to manage its biomedical waste. HCFs which do not fall under the ambit of CMBWTF, deep burial method is practiced there for waste disposal. Pandemic outbreaks such as Covid-19 led to sudden increase in biomedical waste generation. This needs to be considered for biomedical waste management in the district. One small step would be to link ULBs with CBMWTF or with major HCFs so that biomedical waste generated in domestic households, nursing homes, etc. could be handled scientifically. In view of waste water treatment, total 04 STPs of 9.5 MLD installed capacity (i.e. 7 MLD in NPP Ramnagar, 1.25 MLD in Bhimtal and 02 STPs with combined capacity of 1.25 MLD in NPP Nainital) are available in the Nainital district. Sewage Treatment Plant is under construction in NN Haldwani. Moreover, 1 STP with expected installed capacity of 18 MLD is proposed in NPP Ramnagar. Decentralized waste management and co-treatment need to be propagated for effective waste water management in the district. This also adheres to the AMRUT mission of the government of India. At present, air quality levels are monitored only in Nagar Nigam Haldwani (Govt. Hospital) for the past five years. PM_{10} value (avg.114.64) has exceeded the permissible limit during every single year. Other regions are still devoid of any facility to ascertain air quality levels despite of the fact that air pollution has changed climate patterns and has brought about many other environmental changes in a recent past. Forest fires have been a persistent problem in the dry season. About 678 high sensitive zones (related to fire zones) have been demarcated by forest department. Whole of the area of Tarai East and Tarai West forest division comes under high sensitive zone. Other sensitive issues such as increased vehicular pollution especially in tourist season goes unnoticed. Awareness campaigns regarding air pollution, road safety program, compulsion of pollution certificate to obtain various certifications from RTO, etc. are some of the steps that have been taken to mitigate air pollution especially in the plain regions. A forest fire management plan has been prepared for the district of

Nainital whose key objectives include reducing forest fires, biodiversity conservation, etc. Numerous fire prevention and firefighting measures have been taken for the same. Noise pollution is not a major issue in the district. However, noise levels are measured in four different stations in NN Haldwani and NPP Nainital. To determine the impact of fire crackers on noise levels, a special noise level monitoring drive is performed (3 different locations of N.N. Haldwani) on Pre-Deepawali and Deepawali day. The district of Nainital has abundant water resource including lakes and rivers (9 rivers and 6 major lakes). These water bodies are major sources of drinking water and irrigation purpose. Major pollution causing activities such as dumping of waste in river side, open defecation, disposal of untreated sewage, etc. are partially controlled. Recognizing the need for water conservation, Nainital forest division has undertaken various water restoration works including construction of Chal-Khal, contour trenches, percolation tanks, etc. One major restoration work includes rejuvenation and redevelopment of Sukhatal lake, whose depleting water level and seasonal nature have been a cause of concern for the district authorities. Works undertaken for Sukhatal rejuvenation are as follows: converting 9145 m^2 of the Sukhatal depression into perennial lake with storage capacity of 18.290 m^3 construction of gravity drain, use of geo-synthetic clay liners to make impermeable bed of lake and other beautification works. Almost 22.95 km^2 of the area is used for mining activities in the district, of which sand mining is the most important. Actions have been taken against illegal sand mining activities in the district (penalties amounting to almost INR 38.89 Cr. have been imposed). Stringent environmental clearance conditions, surveillance through modern technologies, system for online commerce, etc. may be required in near future to stop illegal mining activities.

The district of Nainital is one of the most visited tourist places in India. Thus, this town remains in the limelight of tourists, media and environmental activists. It needs to give due consideration to environmental planning to conserve the natural aesthetics and ecosystem based services. Eco-tourism and Environmental tourism need to be propagated in the district through robust policy framework.

Fig. 9. Consultative workshops with district officers and local administration at Nainital for the preparation of District Environment Plan (November 06, 2020)

REFERENCES

Anonymous, (2016). Solid Waste Management in Rural Areas a Step-by-Step Guide for Gram Panchayats, A Companion to The Facilitators of Swachh Bharat Mission (Gramin), Centre for Rural Infrastructure National Institute of Rural Development & Panchayati Raj Rajendranagar, Hyderabad,

Anonymous, (2018). "Uttarakhand Vision 2030" Department of Planning Commission, Government of Uttarakhand, Institute for Human Development Plot No. 84, Functional Industrial Estate (FIE), Patparganj, Delhi- 110092.

ASSOCHAM (2018). Electricals & Electronics Manufacturing in India (2018) NEC Technologies India Private Limited, Advant Navis Business Park, Plot No.-7, Noida, New Delhi.

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,

CPCB, (2013). Overview of Plastic Waste Management, Central Pollution Control Board, Parivesh Bhawan, East Arjun Nagar, Delhi-110032.

CPCB, (2019). Biomedical waste management as per biomedical waste management rules 2016, Central Pollution Control Board, Parivesh Bhawan, East Arjun Nagar, Delhi-110032.

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

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

Forest Survey of India (FSI, 2019). An Assessment Report on Forest Cover Status of India. Government of India: Ministry of Environment and Forest (MoEF); Forest Survey of India Dehradun, Vol-II, pp, 284-294, https://fsi.nic.in/forest-report-2019.

Gantait, S., Agarwala, D.K. (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

Gaur, A.C. (2008). Basic environmental engineering. New Age International. Publishing for one World new age International (P) Limited, Publishers 4835/24, Ansari Road, Daryaganj, New Delhi – 110002

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, pp, 1-203.

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), pp 1-10.

Khan, S.M., Page, S., Ahmad, H., Shaheen, H., Harper, D. (2012). Vegetation dynamics in the Western Himalayas, diversity indices and climate change. Sci. Technological Development. 31 (3), pp, 232-243.

Malik, A., Kumar, A., Guhathakurta, P., & Kisi, O. (2019). "Spatial-temporal trend analysisof seasonal and annual rainfall (1966–2015) using innovative trend analysis methodwith significance test", Arabian Journal of Geosciences 12 (328), pp, 1-23,

Messerli, P., Murniningtyas, E., Eloundou, P., Foli, E.G., Furman, E., Glassman, A, & Ypersele, J. P. (2019). Global sustainable development report 2019: the future is now–science for achieving sustainable development (2019)..

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

Sekabira, K., Oryem, H., Mutumba, G.B., & Basamba, T.A. (2011). Heavy metal phytoremediation by *Commelina benghalensis* (L) and *Cynodon dactylon* (L) growing in urban stream sediments. International Journal of Plant Physiology and Biochemistry, Vol. 3(8), pp. 133-142.

Shukla, S., Sharma, R.B., & Sahu, M. (2019). Dust Pollution Affect Morpho-physiological traits of Plant *Mangifera indica* Linn. International Journal of Botany,15, 1-4.

The Groundwater Foundation (2020). National Groundwater Association, Accessed website (17 May 2020).

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

UNDP Report, (2018-2024). Handbook on Sustainable Urban Plastic Waste Management, United Nations Development Programme (UNDP) and NITI Aayog New Delhi, pp.1-142.

Wetlands of Uttarakhand (2012). Report jointly published by the Uttarakhand Forest Department and WWF India, pp 1-194,DOI:10.13140/RG.2.2.14255.02728.

WHO, (2018). Delivering Quality Health Services: a global imperative for universal health coverage. World Health Organization, OECD & International Bank for Reconstruction and Development. Pp 93, ISBN 978-92-64-30030-9

Websites Used

http://www.uttarainformation.gov.in/
http://www.nird.org.in
https://in.nec.com/en_IN/pdf/
https://ueppcb.uk.gov.in/
https://fsi.nic.in/forest-report
https://www.maplecroft.com/
https://www.wri.org
www.newagepublishers.com