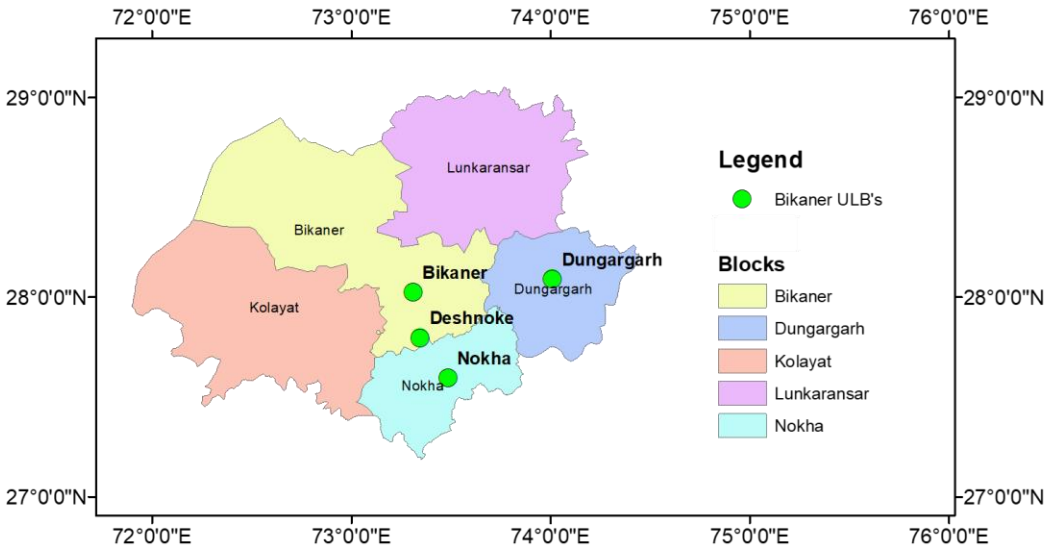
DISTRICT ENVIRONMENT PLAN

FOR

BIKANER DISTRICT



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Bikaner, Rajasthan, India

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PREFACE

We live in the 21st Century. Technology has boomed beyond belief within the past twenty years and has taken over various industries and workplaces. The population is expanding, the demand for resources is increasing, the climate is changing and the impact of humanity on the earth is increasing day by day. There would be daunting challenges for human society and the environment in coming times to facilitate safe, sufficient, and secured resources for all dimensions of life. We have to achieve a better quality of life for our growing population sustainably, without compromising the requirements of future generations to achieve the same.

The concept of sustainable development has challenged society to change from its destructive, exploitative philosophy to one that fosters long-term protection of the environment and its inhabitants. There is a shift from past practices when technological developments were guided by efficiency, productivity, profitability, and similar economic criteria. These remain valid, but added to them now are concerns about health and environmental impacts, resources and energy conservation, waste management and social impacts such as public inconvenience, unemployment and crime. Avoiding pollution controls, over-fertilizing the land, illegal mining, and similar harmful practices to meet the needs of a growing population, are short-term solutions that should not continue. Ultimately global sustainable development will require a stabilized world population living in a secure social and physical environment.

As directed by the Honorable National Green Tribunal (NGT), District Environment Plan has been prepared for the Bikaner district by taking into consideration of the current status of various environmental concerns and potential environmental issues required to be addressed keeping in view of desirable planned developmental activities in future. The District Environmental Plan for Bikaner District is in line with the model District Environment Plan of CPCB, New Delhi. This District Environment Management Plan would play an important role in implementing mitigation measures to minimize adverse environmental impacts associated with different activities.

The District Environment Plan is ambitious, though very necessary. The challenges ahead are considerable. We must achieve a permanently better standard of living for our growing population without compromising the needs of generations to come. I am sure the "District Environment Plan for Bikaner District" presented here will be useful in planning and executing various development schemes of the district without compromising environmental quality and will prove an invaluable asset for associated departments/agencies.

I am thankful to the entire team members who have actively participated for their invaluable contribution. I am happy to appreciate the co-operation of the entire District Administration and request that all concerned district officials must act to achieve the targets for maintaining a clean, safe, and secured environment in their respective domains to make this plan a success.

I wish to thank Sri Rangaswamy E, DCF, Bikaner and Nodal Officer& Member Secretary, District Environment Committee, Bikanerand his team for his active participation, necessary support and overall coordination during preparation of this district environment plan.

I wish to extend our special thanks to Prof. Ajit Pratap Singh, Professor and Dean, BITS Pilani, and his team for accepting the task of preparing the district environment plan for the Bikaner district. His consistent efforts, technical guidance and scientific view throughout for preparation of this report are highly appreciated. The plan shall surely prove most fruitful to the people of Bikaner district.

Bikaner
October 05, 2021

Sri Namit Mehta, IAS
District Collector and District Magistrate
Bikaner, Rajasthan, India

ABOUT THE REPORT

Since the beginning of civilization, human beings have been utilizing natural resources and the environment to fulfil their requirements. Progress towards different sectors, viz., agriculture, manufacturing, mining, infrastructure, transportation, industrialization, and energy production have extremely improved standards of living. However, this has been achieved at a cost to natural resources and environmental systems. Human impacts on the environment accelerated with the advent of the Industrial Age and the subsequent rapid growth of the human population, creating significant areas of resistance between humans and the environment. The quality of the environment has been degrading day by day, forests are replaced with sprawling development; water resources, viz., groundwater aquifers, rivers, lakes, and soil have been contaminating with harmful chemicals; endangered species are becoming extinct.

As the human population increases, so the demand for natural resources increases, and natural systems experience more pressure. These effects will appear in different areas in different ways. By 2050, at least two-thirds of the population will live in cities, putting pressure on urban systems that provide clean water, food, energy, and sanitation. As a result, rapid economic and population growth would threaten to dominate infrastructure and would lead to a sharp increase in pollution as was experienced by the developed world in the early 20th century. We will face new types of challenges - those driven by climate change - that are not equipped to handle existing policies, technologies, and infrastructure.

There is a need to support human and environmental needs while mitigating adverse impacts associated with human activities. Driven by public sentiment in support of protecting natural resources and human health and due to the execution of by-laws aimed at implementing some of the most powerful forms of environmental protection, we have achieved notable successes over the past few decades. However, solutions to the past will not be sufficient to overcome future problems. As humanity faces increasing and diverse challenges, a comprehensive plan needs to be developed at the district level to cover all issues related to the environment of the district.

Such an environment plan at the district level should deal with environmental conservation planning, pollution mitigation, management of wastes, conservation of natural resources including surface water and groundwater, and necessary measures for ecological balance in a sustainable manner. This plan is also required to restore the ecological balance of all the cities/ districts through smart planning for waste minimization, control of different types of

pollution, and intense drive for tree plantation so that we can build a better tomorrow with its unique strengths, inspire and implement visionary solutions, and continue to evolve in order to serve the best interests of people of the district of Bikaner and the planet.

As directed by the Hon'ble National Green Tribunal (NGT), District Environment Plan has been developed for the Bikaner district by taking into consideration of the current status of various environmental attributes and probable future environmental issues required to be addressed for future planned developmental activities.

The Environmental Management Plan plays an important role in implementing mitigation measures to minimize adverse environmental impacts on various developmental activities. We hope that the "District Environment Plan of Bikaner district" will be useful in planning and executing various development schemes by keeping in view of pressing challenges of different environmental problems of the 21st century and will prove an invaluable asset for different agencies working in this field for the betterment of the Bikaner district.

It is my heart's turn to express my deepest sense of gratitude to all of those who directly and indirectly helped me in this endeavour.

At the very outset, I express my deep sense of gratitude to District Environment Committee Chairman, Sh. Namit Mehta, IAS, District Collector, Bikaner, for his guidance, unceasing interest, constructive criticism and suggestions, and district-level support to develop a district environment plan for Bikaner District. Special thanks to the entire team of district administration, including Additional District Magistrates, CEO, ACEO, SDMs, Commissioner-Municipal Council, and all E.O.s, Tehsildars, and BDOs, for their continued excellent support and guidance.

Our most sincere gratitude to Sri Rangaswamy E. (IFS), DCF and Member Secretary, District Environment Committee (District Nodal Officer), and his entire team for their continued support and necessary help. We are also thankful to Sri Amit Soni, Regional Officer, RSPCB, Bikaner, for their continued support and necessary help.

I would like to extend my wholehearted thanks to the members of District Environment Committee viz., ADM, Bikaner, Regional Officer, RSPCB, Bikaner, Commissioner-Municipal Council, and all Executive Officers of all Nagarpalika/Municipal Board, secretary UIT, Bikaner, Chief Executive Officer, Zilla Parishad Bikaner, Regional Manager, RIICO, Bikaner, Executive and Assistant Engineers of Irrigation and Water Resource department, Executive Engineers, AENs & Chemist PHED, Deputy Director, Agriculture, Senior

Hydrogeologist Groundwater, Engineer in Charge, Mining Department, District Statistical Officer, Public Relation Officer, and several officials, agencies personnel who cooperated extremely well and all kind of support and data to me in completion of DEP. I feel no words to express my heartfelt gratitude and respect for all their kindness.

All of them have provided us their full support wholeheartedly with excellent cooperation.

We wish to extend our thanks to those who have helped to prepare this report directly or indirectly.

Last but not least, we are thankful to the entire team, especially Dr. Harish Pupalla, Assistant Professor, BML University, and my friend, who has continuously given his consistent efforts and support throughout for preparation of this report.

The report on ‘District Environment Plan of Bikaner district’ has been compiled in fourteen Chapters which are described as given below:

Chapter 1 on 'Introduction' addresses background information and aims & objectives of the study. This chapter covers the background of preparation of district environment plan along with the aim, objective & scope of the district environment plan. It also discusses the information on the constitution of the District Environment Committee / District Specific Task Forces for Environment management in context to the Bikaner district of Rajasthan.

Chapter 2 on 'Brief Profile of the District ' reveals the position of district towns/Nagarpalika along with population statistics.

Chapter 3 on ‘Solid Waste Management’ covers the present scenario of solid waste management of Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials as provided by CPCB for Model DEPs. Finally, it emphasizes the details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and proposed timeline for completion with the financial cost required. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks.

Chapter 4 on 'Plastic Waste Management' deals with the present scenario of plastic waste management of Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Finally, it emphasizes the details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and proposed timeline for completion with the financial cost required. The activities are suggested by

keeping in view of the future generation of wastes etc. with timelines for completing the tasks.

Chapter 5 on Construction and Demolition Waste Management' covers the present scenario of construction and demolition waste management of Bikaner district in general and its status in different urban local bodies (ULBs) particularly. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks.

Chapter 6 on 'Bio-Medical Waste Management' deals with the current status of bio-medical waste management in Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials has been presented as per the format prescribed by CPCB for Model DEPs. Finally, it emphasizes the details of action plans along with the actionable points, the present status of implementation, the gap to be addressed. The activities are suggested by keeping in view of the future generation of wastes etc.

Chapter 7 on ‘E-Waste Management' mainly deals with the current status of E-waste management in Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials has been presented as per the format prescribed by CPCB for Model DEPs. The details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and proposed timeline for completion with the financial cost required are also discussed.

Chapter 8 on ‘Hazardous Waste Management’ has dealt with the current status of the production of hazardous waste in the district. From the collated information, it is observed that no potential hazardous waste is noticed, essential resources might be required to assess its quantity in appropriate manner so that the mitigations activities can be performed.

Chapter 9 on ‘Water Quality Management Plan’ deals with the current status of water management in Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Finally, it emphasizes the details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and proposed timeline for completion. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks embodies, in short, the water policy matters and litigation factors.

Chapter 10 on ‘Domestic Sewage Management Plan’ & Industrial Waste Management Plan' is a comprehensive account of 'Domestic Sewage & Industrial Waste Management in Bikaner

district. It includes the details of ULB-wise sewage generation, treatment capacity available and treatment capacity utilization, sewerage connectivity, the gap of treatment. The details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and the proposed timeline for completion of the relevant tasks are also discussed.

Chapter 11 on ‘Air Quality Management Plan' deals with the Status and Inventory of Air Quality Management in the Bikaner District along with a brief insight on each of the air pollutants. From the collected information, it has been identified that Small Scale units especially stone crushers and mining activities along with Brick Kilns are the major sources of air pollution in the Bikaner district. However, emissions from the majority of the industries have been found within the permissible limits.

Chapter 12 discusses on ‘Mining Activity Management Plan’. Bikaner district is rich in mineral resources. Bikaner is fairly endowed with various minerals whose industrial use has immensely contributed to the economy of the district.

Chapter 13 on 'Noise Management Plan' deals with the Status and Inventory of noise pollution in Bikaner District. Though the study found that the noise level in all the measured locations is within the acceptable limits i.e., 85dBA, drawing conclusive remarks regarding the noise level in the Bikaner district may not be credible. Therefore, there is a need to conduct studies at multiple critical locations in the Bikaner district.

Chapter 14 on ‘Forest Conservation Practices’ covers the general information regarding types of forest found in Bikaner district, forest land, the current management practices being adopted. The threats to forest/forest land in context to this district have also been identified and discussed. Finally, different afforestation activities proposed in forest land, as well as city/town area, are listed along with brief action plans.

October 05, 2021

Pilani

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Chapter 1: Introduction

This chapter covers the background of preparation of district environment plan along with its aim, objective & scope of the district environment plan. It also discusses about the information on constitution of District Environment Committee / District Specific Task Forces for Environment management in context to Bikaner district of Rajasthan.

1.1 Background of Preparation of District Environment Plan:

Hon'ble National Green Tribunal, New Delhi has passed an order on 15-07-2019 in O.A. No. 710/2017 titled as Shailesh Singh Versus Sheela Hospital and Trauma Centre Shahjahanpur that it is necessary to have a District Environment Plan to be operated by the District Committee and further 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 CPCB shall facilitate the District Magistrates in preparation of District Environmental Plan by placing Model plan on its website. This model plan may be adopted as per local requirements by all District under supervision of District Magistrate.

In the above said order, it is stated that among others

"Chief Secretaries may personally monitor compliance of environmental norms (including BMW Rules) with the District Magistrate once every month. The District Magistrates may conduct such monitoring twice every month.

"We find it necessary to add that in view of Constitutional provisions under Articles 243 G, 243 W, 243 ZD read with Schedules 11 and 12 and Rule 15 of the Solid Waste Management Rules, 2016, it is necessary to have a District Environment Plan to be operated by a District Committee (as a part of District Planning Committee under Article 243 ZD) with representatives from Panchayats, Local Bodies, Regional Officers, State PCB and a suitable officer representing the administration, which may in turn be chaired and monitored by the District Magistrate. Such District Environment Plans and Constitution of District Committee may be placed on the website of Districts concerned. The monthly report of monitoring by the District Magistrate may be furnished to the Chief Secretary and may be placed on the website of the District and kept on such websites for a period of one year. This may be made operative from 1.08.2019. Compliance of this direction may also be seen by the Chief

Secretaries of the States/UTs. This may not only comply with mandate of law but provide an institutional mechanism for effective monitoring of environment norms."

Keeping in view of above facts, it has been planned to prepare the Environment Development Plan of **Bikaner District** in such a way so that District environment plan not only outline the present status and gaps in implementation but also identify agencies responsible, requirement of infrastructure facilities for sewage treatment, waste management, monitoring environmental quality etc. It should also provide timelines for implementation, identify local issues, constraints in implementation, priority action areas and issues requiring more attention.

Based on the District Environment Plans, State Environment Plans and National Environment Plan shall be prepared. It is required to ensure that information pertaining to all District Environment Plans is captured into State Environment Plans and National Environment Plan.

1.2 Aim, Objective & Scope of the District Environment Plan

The aims and objectives of this District Environment Plan (DEP) are set as given below:

- To ensure conservation of environment and natural resources at district level.
- Restore ecological balance.
- To achieve the Sustainable Development Goals (SDGs) and district level targets within the prescribed timeline.
- To ensure sustainability at district level following the principles of resource efficiency.
- To ensure decentralized micro level planning, execution and monitoring regarding environment conservation.
- To incorporate all facets of environmental conservation in micro level planning.
- To harness active participation of all stakeholders in planned environment conservation actions.
- Assess, mitigate and monitor adverse impacts of various pollution sources at district level.
- Capacity building of stakeholder, department, agencies, organizations and individuals at district level to understand and implement micro level environmental conservation actions.
- To harness inter-departmental coordination for implementation of action plans.

- To develop local knowledge centres and expertise for developing environmental conservation strategies at district level.
- To develop and implement micro monitoring system at district level.

1.3 Honourable N.G.T. Directions (Important NGT/Supreme Court/ High Court Cases on Environment Management (e.g., OA 673/2018; OA 681/2018/ OA 606/2018, etc.)

a. Hon'ble NGT in the last on eyear has issued several directions in various matters which have been based on status brought out by the CPCB on their website and status reports filed before the Tribunal.

b. As per honorable NGT order dated 15.07.2019 in O. A. No 710-713/2017, O.A. No.
606/2018, it is the duties and responsibilities of various stakeholders to make the solid waste management plan a successful and implementable action.

c. Thereafter, vide order dated 26.09.2019 in the present matter, it was observed: - (i) "This Tribunal in O.A. No. 606/2018, while dealing with the compliance of Municipal Solid Waste Management Rules, 2016 also flagged other issues and required monitoring at the level of the Chief Secretaries and the District Magistrates. The Chief Secretaries of all the States/UTs have appeared before this Tribunal, including the Chief Secretary of State of Rajasthan and directions have been issued for continuous monitoring and filing of further reports. (ii) Vide order dated 12.09.2019, while fixing a schedule for further appearance of the Chief Secretaries of all the States/UTs, direction has been issued to compile information with reference to the following specific thematic areas viz.:

    - Compliance to Solid Waste Rules including Legacy Waste.
    - Compliance to Bio-medical Waste Rules.
    - Compliance to Construction & Demolition Waste.
    - Compliance to Hazardous Waste Rules.
    - Compliance to E-waste Rules.
    - 351 Polluter Stretches in the country.
    - 122 Non-attainment cities.
    - 100 industrial clusters.
    - Status of STPs and re-use of treated water.
    - Status of CETPs/ETPs including performance.

- Ground water extraction/contamination and re- charge.
- Air pollution including noise pollution.
- Illegal sand mining.
- Rejuvenation of water bodies.

d. Hon'ble National Green Tribunal (NGT) has ordered Pan-India Directions on various issues relating to environment management and these are to be executed by the Central and State Governments and concerned institutions. Further, the Directions are required to be executed at District Level covering all cities, towns and villages.

e. The role and responsibilities of enforcement are with District Collectors/Magistrates, Pollution Control Boards, Municipal Bodies, Public Health Engineering Departments and others.

f. The present state level execution and monitoring mechanism on various State and Central Government's Schemes are monitored by Chief Ministers/ Chief Secretaries with DMs/DCs.

g. VariousDirectionsofNGTtobecoveredinDistrictEnvironmentManagement Plan(DEMP).

h. Information about any District Specific case (if any) and Committee/Task Force Constituted has also been discussed.

1.4 Information about Constitution of District Environment Committee / District Specific Task Forces for Environment management

In view of these directions, the District Collector of Bikaner (letter no.CB/General/Environment/2020/11889 dated 07.09.2020and Letter no. CB/General/Environment/2020/5935 dated 04.06.2020 constituted District Environment Committee with representatives from Village Panchayats, Municipal Councils, Regional Offices, Rajasthan State Pollution Control Board, Department of Environment and an officer representing the administration for preparing District Environment plan. Prof. Ajit Pratap Singh, BITS Pilani has been given the work of preparation of the District Environment Plan in association with Mr. Rangaswamy E, IFS, DCF, Bikanerand R.O., RSPCB, Bikaner, Commissioner Nagar Nigam, and Executive Officers of respective Nagar Palika, etc. (Letter no. NGT/PA/DCF-B/2020-21/2117 dated 10.03.2021 and F. No. 12(59)/Env/2018 dated 17.03.2021).

As per the OA no. 360/2018 titled as Shree Nath Sharma V/s Union of India, the Hon'ble NGT vide order dated 26.09.2019 has directed to constitute District Environment Committee for preparation and monitoring of District Environment Plan. Accordingly, District Environment Committee was constituted with representatives from Panchayats, Local Bodies, Regional Officer, Rajasthan State PCB and all concerned officials representing the district administration, in compliance to the said orders of the Hon'ble NGT.This District Committee has been chaired and monitored by the **Bikaner District Magistrate**. The District Environment Committee constituted by the District Collector, Bikaner, which is given in **Table 1.1**:

Table 1.1. District Environment Committee – Bikaner District

S. No.	Name	Designation
1.	District Collector and District Magistrate, Bikaner	Chairperson
2.	Superintendent of Police, Bikaner	Member
3.	Additional District Magistrate (City), Bikaner	Member
4.	Sri Om Prakash V, CEO ZilaParishad, Bikaner	Member
5.	Chief Medical and Health Officer, Bikaner	Member
6.	Commissioner, Nagar Nagam, Bikaner	Member
7.	Regional Officer, RSPCB, Bikaner	Member
8.	General Manager, District Industries Center, Bikaner	Member
9.	Regional Manager, RIICO, Bikaner	Member
10.	Deputy Director, Agriculture, Bikaner	Member
11.	Superintending Engineer, Water Resources Department, Bikaner	Member
12.	Assistant engineer Water resources Department	Member
13.	Superintending Engineer, Public Health Engineering Department, Bikaner	Member
14.	Scientist, Groundwater Department, Bikaner	Member
15.	District Transport Officer, Bikaner	Member
16.	District Education Officer, Primary and Secondary Education, Bikaner	Member
17.	Inspector, factory and boilers department, Bikaner	Member
17.	Mining Engineer, Bikaner	Member
18.	Deputy Conservator of Forest , Bikaner	Member Secretary and Nodal Officer

Different meetings of the District Environment Committee were held from time to time (e.g. 06/09/2021, etc.)to formulate the District Environment Plan for Bikaner District. The responsibility of all respective officials and every Municipal councils/Nagarpalika or Village panchayat were fixed. The details regarding various functions of the DEC, powers of the DEC and reports to be submitted by the DEC have also been notified. Subsequently,

questionnaire forms have been prepared to get authentic data in line with the model District Environment Plan (DEP) of CPCB and floated among all concerned representatives at various levels. They have been asked fill the questionnaire by providing their response for specific data covering following seven thematic areas.

- Waste Management Plan
    - Solid Waste Management Plan
    - Plastic Waste Management
    - C&D Waste Management
    - Biomedical Waste Management
    - Hazardous Waste Management
    - E-Waste Waste Management
- Water Quality Management Plan
- Domestic Sewage Management Plan
- Industrial Wastewater Management Plan
- Air Quality Management Plan
- Mining Activity Management plan
- Noise Pollution Management Plan
- Conservation of Water bodies
- Prevention of Illegal sand mining
- Environment Threats
- Soil and Agriculture Land

The awareness about preparation of District Environment Plans among the stakeholders of each department were created in a time bound manner and action plans formulated to implement it.

Chapter 2: Brief Profile of the District

2.1 Administrative Profile of District

Bikaner district is located in the north-western part of Rajasthan and encompassed between north latitudes 27°11’ to 29°03’ and east longitudes 71°52’ to 74°15’ covering a geographical area of 30247.90 Sq. kms. It is bounded on the north by Ganganagar District, on the east by Hanumangarh and Churu Districts, on the south by Nagaur and Jodhpur Districts, and on the west by Jaisalmer District and International border with Pakistan. The district is divided into eight sub-divisions for administration and development, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, Chhattargarh, Pugal and Dungargarh and eight tehsils, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, Chhattargarh, Poogal, and Dungargarh. The developmental activities of the district are being looked after by six Panchayat Samities, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, and Dungargarh. There are 874 villages and 219 Gram panchayats. There is one independent SubTehsil Bajju situated in Kolayat tehsil for better administration. The district has one Municipal Council, 219 Gram Panchayats, and 874 Villages. As per the 2011 Census, the district's total population is 2363937, out of which 1563553 are rural, and 800384 are urban. A map showing the blocks of the district is presented in **Figure-2.1**.

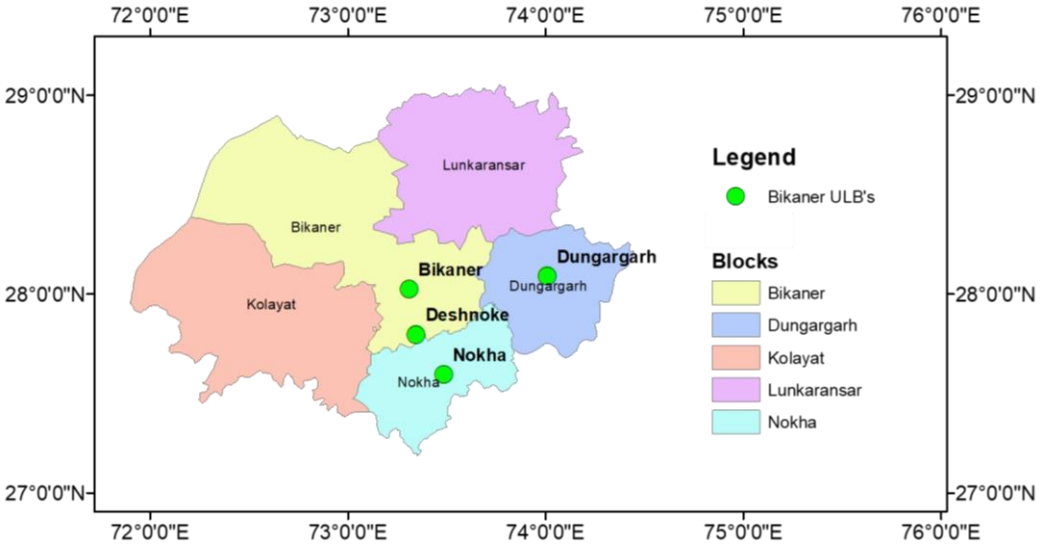


Figure 2.1. District map of Bikaner

2.2Rainfall & Climate

The district experiences an arid type of climate in the east to extremely arid in the west. The district's mean annual rainfall from 1991-2010 is 277.55 mm, whereas normal rainfall during

1901-1971 is lower than average and placed at 257.8 mm. Almost 90% of the total annual rainfall is received during the southwest monsoon, which enters the district in the first week of July and withdraws in the mid of September. As the district lies in the desert area, extremes of heat in summer and cold in winter are the characteristics of the desert. Both day and night temperatures increase gradually and reach their maximum values in April, May, and June. The temperature varies from 48 degrees in summer to 1 degree in winter. The atmosphere is generally dry except during the monsoon period. The humidity is the highest in August, with the mean daily relative humidity of 71% in the morning and 52% in the evening. The block-wise average rainfall is tabulated in **Table 2.1**.

Table 2.1. Block-wise rainfall statistics

Block name	Minimum rainfall (mm)	Maximum rainfall (mm)	Average rainfall (mm)
Bikaner	325.4	707.2	435.6
Kolayat	310.9	416.5	369.4
Lunkaransar	385.1	781.2	592.4
Nokha	400.0	538.9	440.9
Dungargarh	499.0	688.6	595.4
Khajuwala	288.0	345.3	315.7

2.3. Soil Types

The soils of the Bikaner district are predominantly light-textured, weak–structured, sand to sandy loam with the clay content. Arid climate with low rainfall, high temperature, and high evaporation losses has resulted in the parent material's physical and mechanical disintegration, giving rise to the predominance of coarse fractions in the soil. Minimal chemical weathering has taken place, and the development of soil is indistinct primarily. Soils are generally of desertic type with poor fertility status and very low water retention capacity. The soil profile studied during UNDP Project (1971-74) shows that the hydraulic conductivity in the soil profile reaches up to 10.9 cm/hr while the maximum available moisture in the soil profile remains to the extent of 1.13%. In general, the soils have good

porosity (40%) and good to very good permeability. Details of soil characteristics observed in the district are given in Table 2.2.

Table 2.2. Details of soil characteristics in Bikaner district

Major Soils	**Area (ha)**	**Percent (%) of total**
Deep Yellowish-brown sandy soils	3038	39.3
Deep Light yellowish brown loamy soils	2984	38.6
Medium Light yellowish brown loamy soils	1002	13.0
Others: Deep Pale brown loamy, medium yellowish brown sandy, shallow Pale brown gravelly sandy soils	686	8.92

2.4. Topography

Bikaner district is conspicuous of vast sandy areas and lack of hills. The topography is undulating interspersed with dunes of eolian origin. The table below reveals that the minimum elevation in the district is 103.7m above mean sea level (amsl) as found in Kolayat block, whereas the maximum elevation is 349.1m amsl in Nokha block where rocks of Tertiary sandstone are exposed. The general slope of the terrain is from southeast to northwest. The minimum and maximum elevation in each of the blocks is shown in Table 2.3.

Table 2.3. Block wise minimum and maximum elevation

S.No.	**Block name**	**Minimum Elevation**	**Maximum Elevation**
1.	Bikaner	123.2	298.6
2.	Kolayat	103.7	315.3
3.	Lunkaransar	149.5	246.8
4.	Nokha	261.6	349.1
5	Dungargarh	200.2	347.3
6	Khajuwala	107.9	163.0

2.5. Geology

The Bikaner district is predominantly covered (about 80%) by alluvial and eolian sand. Most of the eolian are seen as sand dunes of variable heights. Otherwise, the geologic succession of the area is represented by rocks of Palaeosoic to recent age. The next group of formations (after eolian and alluvial sand) is that of the Tertiary Group of rocks represented by Sandstones of variable grain size. These are also exposed in Bikaner- Kolayat region. Marwar Super Group, represented by Nagaur Sandstones and Bilara limestone, occupies the southeastern part of the district. A detailed insight into geologic succession is presented in Table 2.4.

Table 2.4. Geologic succession

Group	**Series/Super group**	**Geological unit**	**Formation**
Quaternary	Recent	Wind-blown sand	Very fine, buff to grey sand, well rounded to sorted by wind action
	Pleistocene	Alluvium	Unconsolidated to loosely consolidated sand, fine to medium, silty clays, and kankar with occasional horizons of gravel and coarse sand
Teritary	Eocene	Sandstone	Coarse and gritty sandstone usually consolidated, porous, within intercalated clays and gravel, fuller earth and lignite also occur in thin sequences.
Palaeozoic	Marwar Super Group	Nagaur Sandstone	Hard compactly consolidated, reddish sandstone interbedded with red shales
		Bilara Limestone	Limestone, hard, massive grey to blackish in colour with occasional cavities

2.6. Geomorphology

The description of the geomorphological units that are encountered in the district is given in **Table 2.5,** and the spatial distribution of these geomorphological units is presented in **Figure 2.2.**

Table 2.5. Description of geomorphological units of Bikaner district

Origin	Landform Unit	Description
Aeolian	Dune complex	An undulating plain composed of number of sand dunes of crescent shape
	Dune Valley Complex	The cluster of dunes and interdunal spaces with undulating topography formed due to wind-blown activity, comprising of unconsolidated sand and silt.
	Eolian Plain	Formed by aeolian activity, with sand dunes of varying height, size, and slope. Long stretches of the sand sheet. Gently sloping flat to undulating plain, comprised of fine to medium-grained sand and silt. Also scattered xerophytic vegetation.
	Eolian Plain (Reclaimed)	Gently sloping with a sheet of sand or sand dunes, scattered xerophytic vegetation.
	Interdunal Depression	Slightly depressed area in between the dunal complex showing moisture and fine sediments.
	Sandy Plain	Formed of aeolian activity, wind-blown sand with gentle sloping to undulating plain, comprising of coarse sand, fine sand, silt and clay.
Denudational	Buried Pediment	Pediment covers essentially with relatively thicker alluvial, colluvial or weathered materials.
	Pediment	Broad gently sloping rock flooring, erosional surface of low relief between hill and plain, comprised of coarse sand, fine sand, silt and clay.
	Pediplain	Coalescence and extensive occurrence of pediment.

Origin	Landform Unit	Description
Fluvial	Alluvial Plain (Sandy)	Flat to gentle undulating plain formed due to fluvial activity, mainly consists of gravels, sand, silt and clay with unconsolidated material of varying lithology, predominantly sand along the river.
Hills	Structural hills	Linear to arcuate hills showing definite trend-lines with varying lithology associated with folding, faulting etc.

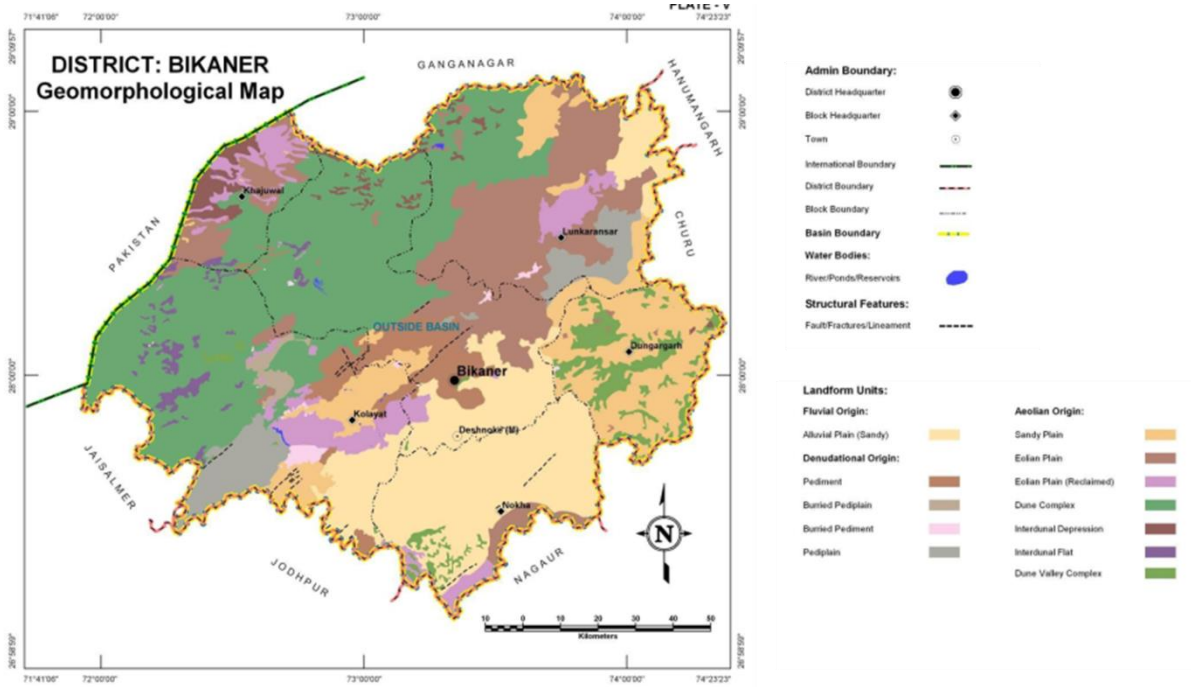


Figure 2.2. Spatial variation of Geomorphological units in the Bikaner district

2.7. Irrigation

The principal means of irrigation in the district are wells though the small area is irrigated by tanks also. Groundwater plays an important role in irrigation and is utilized through dug wells, dug cum bored wells, and tube wells.

2.8. Administrative setup

Administratively Bikaner district is part of Jodhpur division. This district is divided into 6 blocks namely Bikaner, Kolayat, Lunkaransar, Nokha, Dungargarh, and Khajuwala

2.10. Aquifers

A variety of rock types constitute aquifers in the Bikaner district. While older alluvium forms the most widespread aquifer material, most of it contains saline water, rendering it not very useful, and only about 8% of the district's aquifers contain fresh water in alluvial aquifers. Tertiary sandstones are also very good aquifers in spatial distribution and groundwater quality because they occupy about 31% of the district area, of which about 24% is a freshwater aquifer. Also important are Nagaur and Jodhpur sandstone and partly the Bilara limestone. Detailed insights on aquifer units of the Bikaner district are presented in Table 2.6.

Table 2.6. Description of aquifer units encountered in Bikaner district

Aquifer in Potential Zone	Area (sq km)	% age of district	Description of the unit/Occurrence
Older Alluvium Saline Areas	13067.8	43.2	Except for Nokha block, alluvium found in rest of the blocks is either partially or whol water categorized as non-potential area (Saline area).
Older Alluvium	2353.6	7.8	Older Alluvium mainly composed of unconsolidated to semi consolidated clay, sand gravel, pebble in varying proportions. Thickness of the litho unit varies considerably due to undulating bed rock topography. It occurs along the stream courses and flood plains of rivers. While older alluvium occupies large tracts in west, north and eastern parts, major part of it is saline and only narrow tracts in eastern fringe contains fresh water constituting potential zone.
Bilara Limestone	156.1	0.5	Bilara limestone is potential source of ground water. These are mostly dolomitic, grey or dark grey to black. The litho unit occupies small area in southern most part of Nokha block. Half of it contains freshwater and the rest is saline.
Bilara limestone saline areas	161.7	0.5	It is grey to buff coloured hard and compact in southern most part of Nokha block
Tertiary sandstone	7209.3	23.8	Medium to course grained, consolidated to semi consolidated sandstone occupy arear in Bikaner-kolayat region

Tertiary sandstone saline area	2132.4	7.0	Part of the tertiary sandstone contains saline ground water.
Nagaur& Jodhpur Sandstone	2,415.1	17.5	Buff to reddish-brown in colour, fine to medium grained hard and compact sandstone.
Nagaur & Jodhpur Sandstone saline areas	1409.6	4.7	The saline ground water containing parts of Nagaur and Jodhpur sandstones fall in this category

2.11. Stage of ground water development

Apart from the Kolayat and Lunkaransar, all other blocks in this district are overexploited, as shown in Table 2.7, warranting conservation measures.

Table 2.7. Categories of blocks based on the groundwater development in Bikaner

Categorization on the basis of stage of development of ground water	Block Name
Safe	Kolayat, Lunkaransar
Over Exploited	Nokha, Bikaner

More insight on the groundwater quantity and quality based on the water samples collected in the borewells of the district is expounded in Chapter 9. For better visualization of the variation, thematic maps have been developed and presented, further used in drawing the conclusion and the management plans.

2.12. Closure

As per Hon'ble NGT Order dated 26/09/2018 in O.A 360/2018, inventories have been generated for twelve ULB's of the Bikaner District, format developed by CPCB "O.A 360 NGT District information plan.xlsx. The data used for preparing District Environment Plan is based on the data provided by all representatives of ULB's in the format given by CPCB, as well as data accessed from relevant state web portals, i.e., Department of Mines and Geology, Central Ground Water Board, Ministry of micro small and medium enterprises, Environment Department of Rajasthan, Rajasthan State pollution control board (RSPCB), Rajasthan State Industrial Development & Investment Corporation, Bikaner District Collectorate, Ministry of Water Resources, River Development and Ganga Rejuvenation.

Documents referred for the preparation of DEP include state sewerage and wastewater policy, Reports of MSME-Development Institute, Hydrological atlas of Rajasthan, Reports of the potential industrial survey, reports of aquifer mapping and groundwater management by CGWB Rajasthan, Groundwater brochure of the Bikaner district.

The representatives of each urban local body (ULB) have been contacted for the information related to seven thematic areas such as Waste Management Plan, Water Quality Management Plan, Domestic Sewage Management Plan, Industrial Wastewater Management Plan, Air Quality Management Plan, Mining Activity Management plan, Noise Pollution Management Plan. Besides the attributes of each ULB, population details as per the 2011 census are also collected. Because of urbanization, the population of each ULB is projected and used in preparing the action plans.

The questionnaire floated, and the duly filled formats from all the twelve ULB's are appended, and the outcomes of the inventory are discussed in the subsequent Chapters.

Chapter 3: Solid Waste Management

This chapter covers the present scenario of solid waste management of Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials as provided by CPCB for Model DEPs. Finally, it emphasises the details of action plans along with the actionable points, the present status of implementation, gap to be addressed, and proposed timeline for completion.

3.1 Present status of solid waste management

Solid waste management is one of the most important services for maintaining the quality of life in urban as well as rural areas and for ensuring better standards of health and sanitation. Due to the rapid growth in the population of India, this service falls short of the desired level as the systems adopted are inefficient. Institutional weakness, shortage of human and financial resources, improper choice of technology, inadequate coverage, and lack of short- and long-term planning are responsible for the inadequacy of services.

Solid wastes, which include bio-medical, municipal and hazardous wastes is a major concern and an eyesore in urban areas. The unregulated disposal of wastes may affect the quality of groundwater in the area through the infiltration of water-soluble substances.

Rajasthan solid waste management policy has been notified by the Government of Rajasthan in the year 2019. The proposed policy on Solid Waste Management (SWM) in Rajasthan is in line with the SWM Rules, 2016 and provides a comprehensive vision for SWM, enabling frameworks and strategies to manage the challenges of SWM in Rajasthan. The policy provides a stimulus to the waste management economy, and promotes environmental up-gradation.

This Policy acts as a key instrument in highlighting the vision and strategic goals of the State Government for the development of solid waste management in a sustainable manner. It lays down a detailed roadmap of reduction, reuse, and recycling of waste through innovative technology, consumer service, and education for envisioning the environmental, social, cultural, economic, and technological, and public health concerns. Management of solid waste is a larger challenge not only because of its adverse health and environmental impacts but also due to huge quantities of waste generated. Most Urban Local Bodies (ULBs) lack the capability to handle such huge quantities of solid waste due to financial and institutional

frailty. Local authorities struggle from insufficient funds, resources, infrastructure, and appropriate strategies to improve solid waste management.

The Government of Rajasthan intends to adopt the 5R approach (Reduce, Reuse, Recycle, Recover and Remove) by imparting thrust on collection, segregation, improving data and analytics, minimizing environmental impacts, creating a market for recyclable products, and aiming towards sustainable development. The SWM plan should consider a long-term planning horizon of 20–25 years. Short-term implementation plans covering 5 years each should be slotted within the long- term plan for ease of implementation. The short-term plan should be reviewed and updated once every year for any midcourse correction as required. Local bodies should ensure that the short-term plan is aligned with long-term planning and implementation. The SWM plan should be according to the SWM Rules 2016.

As per the Solid Waste Management Rules, 2016, the urban local authorities themselves have responsibilities in managing solid waste in their jurisdictions. Bikaner comprises 4 urban local bodies (ULB's) where the generation of solid waste is predominant. These are Bikaner, Nokha, Dungergarth, and Deshnoke. Relevant data were collected from these ULBs in the model format in MS Excel. Data were authenticated and were analyzed. The data obtained from the local municipalities is shown in **Table 3.1** below:

Table 3.1: Quantity of solid waste generated by each ULB

ULB	**Name**	**Population as per 2021**	Quantity in MT/day	As per the standards
ULB1	Bikaner	765250	303	306.10
ULB2	Nokha	75606	25	26.46
ULB3	Dungergarth	61468	25	21.51
ULB4	Deshnoke	21046	7	7.36

Note: Population of 2021 is obtained by projecting the historic trends

3.1.1. Status of solid waste management in the Bikaner district

As per the data provided by the representatives of each ULB, it is observed that a total of 361.43 metric tons of solid waste is generated every day. On average, the typical composition of wet waste is around 50% and dry waste is 50%. Further, the average per capita waste generation is around 413 grams per day. This observation is in line with the conclusion i.e., it is estimated that solid waste generated in small, medium, and large cities/ towns are 0.1 Kg, 0.3-0.4 Kg, and 0.5 Kg per capita per day respectively as specified by the Central Pollution Control Board (CPCB) New Delhi. An interesting observation has been made from the data

interpretation. As evident from Table 3.1, the actual total solid waste that is being generated is close to the typical observation by CPCB. However, a relatively substantial deviation is observed in the case of Dungergarth. Besides solid waste generation, notable quantities of waste are being generated through street sweeping in ULB2- Nokha, ULB3- Dungergarth.

Authorities of Bikaner have strictly adhered to the guidelines of Rajasthan Solid Waste Management Policy and Strategy, 2019 and have been attempting to collect the waste. The door-to-door waste collection system is efficiently operational in Bikaner. From the data collected from Executive officers and Junior engineers, it is observed that in all the ULB's, the exercise of door-to-door waste collection is successfully implemented. In rural areas, the collection is expected to be achieved between 45 to 60%.

As per the guidelines of Rajasthan solid waste management policy and strategy, 2019 waste segregation is in practice. Attempts have been made to collect wastes by segregating wet and dry waste separately. The wastes have been collected twice a week. However, segregation at the source is quite challenging and it has to be practice in a much more effective and efficient way. The frequency of door-to-door collection among the ULB is strongly correlated with the density of population, collection system, and climatic conditions. The waste thus collected is finally transferred to the solid waste dumping sites. A geo tagged image of the solid waste dumping site of Bikaner is shown in **Figure 3.1**. For a better understanding of the correlation between the population and solid waste generated, transient images have been accessed from Google earth as shown in **Figure 3.1**. From **Figure 3.1**, it is evident that the dumping site is constructed recently, and it is anticipated that the generation of solid waste is increasing over the years which is obvious. However, the concern to be noted here is the need to identify the localities for dumping the waste strategically as the population of each ULB is expected to grow over the years.

Figure 3.1A. (a) Field view of solid waste dumping site of Bikaner on 25-08-2021, **(b)** Satellite view of landfill site in the year 2012, **(c)** Satellite view of landfill site in the year 2021.

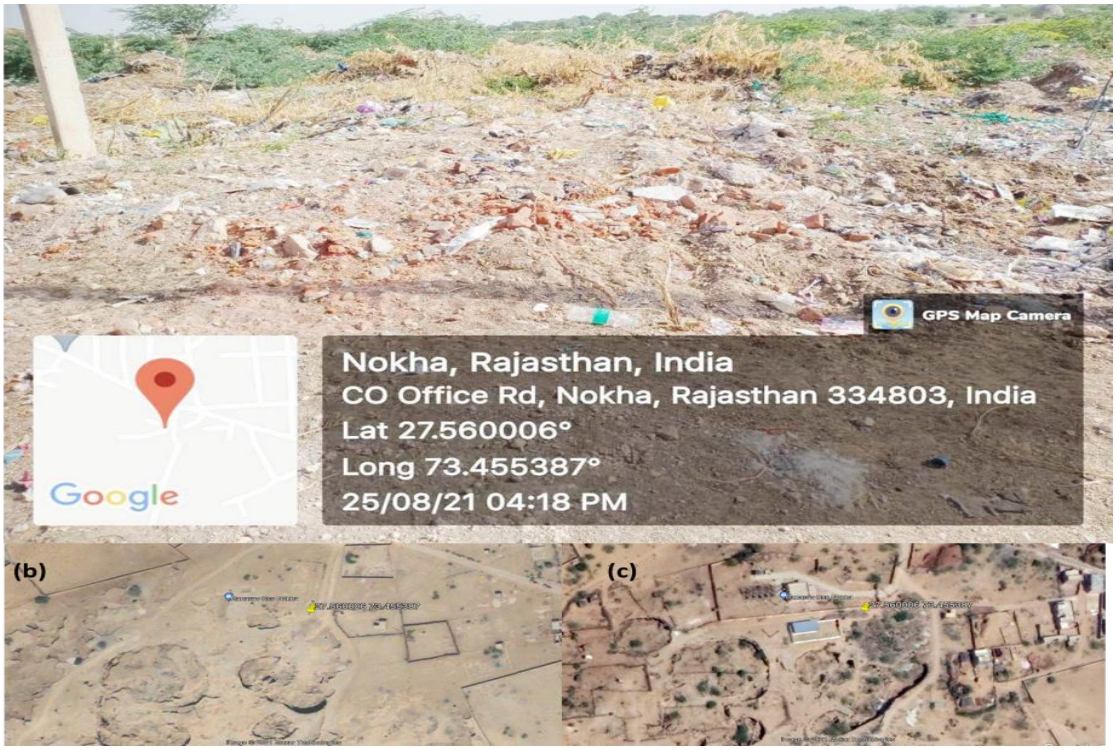


Figure 3.1B. (a) Field view of solid waste dumping site located in municipal board Nokha on 25-08-2021, **(b)** Satellite view of landfill site in the year 2012, **(c)** Satellite view of landfill site in the year 2021.

Figure 3.1C(i). (a) Field view of solid waste site located in Municipal Board Dungargarh on 25-08-2021, (b) Satellite view of landfill site in the year 2012, (c) Satellite view of landfill site in the year 2021.

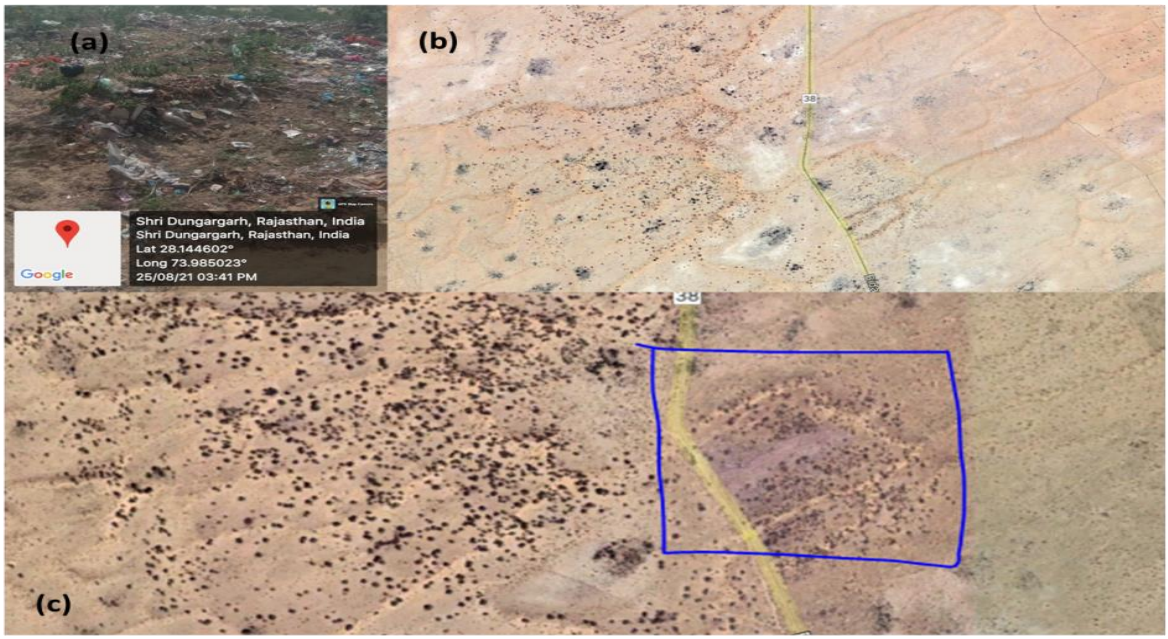


Figure 3.1C(ii). (a) Field view of solid waste site of Dungargarh on 25-08-2021, **(b)**Satellite view of landfill site in the year 2015. **(c)**Satellite view of landfill site in the year 2021.

Figure 3.1D: Solid waste dumping site located in Municipal Board Deshnoke on 25-08-2021
(b) Satellite view of landfill site in the year 2015, **(c)** Satellite view of landfill site in the year 2021.

Auto tippers, tractors, mini vehicles are the primary collection vehicles used for the collection ofhousehold wastes, which are loaded at a predesignated nodal point in the wards of MCs. TheCompactor/ mini trucks collect the waste from the hotels, restaurants, and marriage hallsdirectly. From the responses obtained from each ULB, it is noticed that there is no uniform system followed across all the ULB for the collection ofsolid waste. As per the guidelines of SWM, 2016, it is imperative to switch to electric vehicles for the collection of waste.

For the effective utilization of solid waste, material recycling facilities (MRF) are recommended in SWM 2016. The material recycling facilities in municipal boards Nokha (ULB2) and Deshkone (ULB4) are installed and are currently operational. The field images of MRF at Nokha and Deshnoke are shown in Figures 3.2A and 3.3B. The material recycling facilities under Municipal Corporation Bikaner are under construction, as shown in Figure 3.2C. The Municipal board Bikaner also has a well-equipped composting plant, as shown in Figure 3.2D.MRF facility is to be developed in municipal board Dungargarh. Its construction should be completed by December 2021, and all machinery shall be installed by March 2021 so that the facility be operational without any further delay.

Fig 3.2A.(a) MRF Site located in Municipal Board Nokha (b) Satellite view of MRF site in the year 2015, **(c)** Satellite view of MRF site in the year 2021.

Fig 3.2B. MRF Site located in Municipal Board Deshnoke(b) Satellite view of MRF site in the year 2013, **(c)** Satellite view of MRF site in the year 2021.

Figure 3.2C. (a) Field view of MRF site of Bikaner on 25-08-2021 (under construction), **(b)** Satellite view of landfill site in the year 2012, **(c)** Satellite view of landfill site in the year 2021.

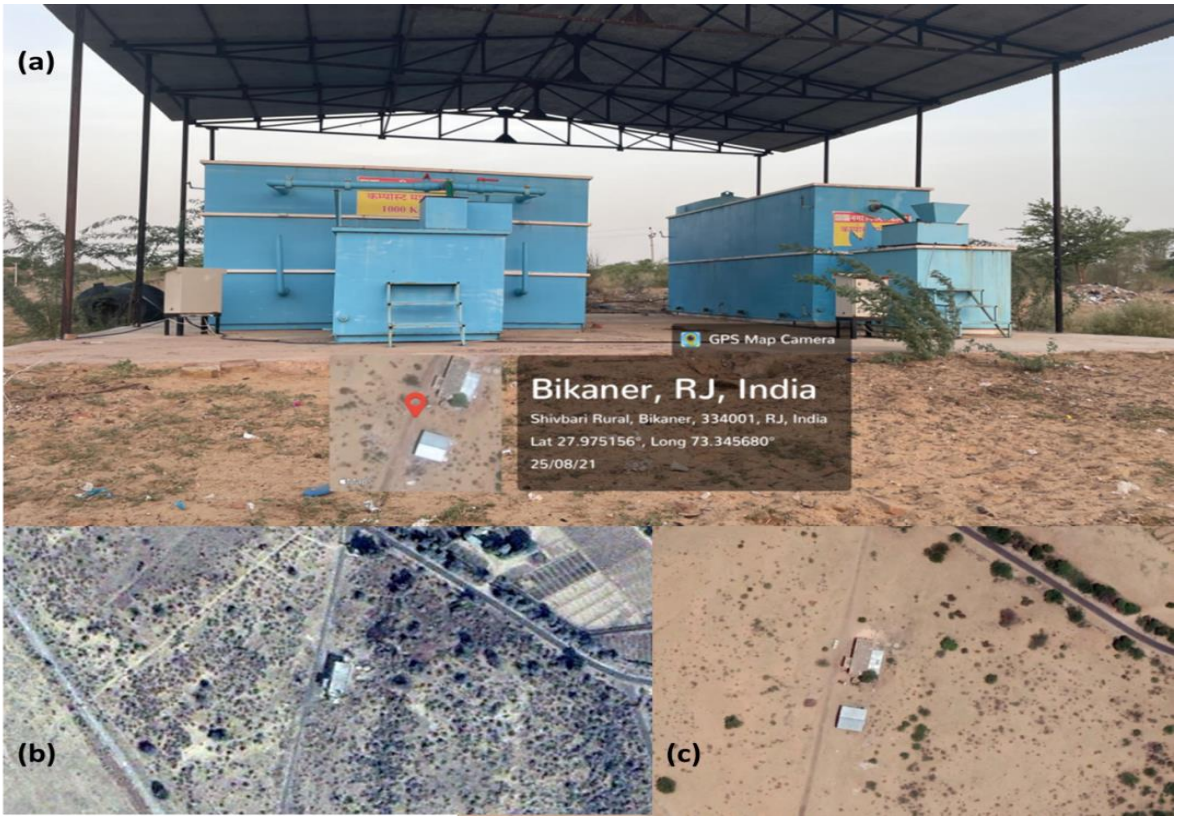


Figure 3.2D. (a) Field view of composting plant located in Municipal Corporation Bikaner on 25-08-2021, (b) Satellite view of landfill site in the year 2013, (c) Satellite view of landfill site in the year 2021.

As of the month of data collection (August 2021), the MRF center at ULB-1 Bikaner was under the construction stage. Though ULB-2 Nokha and ULB-4 Deshnoke have installed an MRF center, it is yet to be operational in an effective way through the active participation of ULB. The collected data shows that the MRF facility is not operational in the ULB, which contributes a large quantity of solid waste though it is now under construction with a designed capacity of 60 TPD and procurement of machinery is under process. The municipal board Dungargarh has also initiated a proposal to establish an MRF facility that may be operational from May 2022. The baseline data pertaining to different environmental attributes for a solid waste management plan under the present scenario are given in **Tables 3.2 to 3.5**.

3.1.2 Management Options for Solid waste

Legacy Waste

As can be seen from the photographs shown above, a large quantity of waste exists as the legacy waste in different dumpsites. The top states that dump waste unprocessed in dumpsites are Uttar Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Karnataka, and Delhi. Out of the total solid waste generated in India, 5% is recycled, 18% is composted and the rest 77% is in dumpsites. The number of dumpsites and quantity of waste dumped annually in tonnes in Rajasthan is 195 and 2,133,564 respectively which should be a concern for all of us including Bikaner.

The recent increase of the waste dumped can be owed to many factors like the growth of the e-commerce industry from shopping to ordering food. Many brand owners have shifted from larger stock-keeping unit size to smaller stock-keeping unit size due to changing market scenario. Shifting of public consumer preferences to daily use plastic products like bottles, and food containers. GST on recyclables makes it uneconomical for waste-pickers and to collect low-value waste. The main technologies for reclaiming land sites in India are bio capping and biomining. Biomining is the process of using microorganisms (microbes) to extract metals of economic interest from rock ores or mine waste. This biological decomposition of the waste decreases the volume of the waste by 40%. This is a low-cost solution compared to capping to remove the garbage hills and their lingering ill effects. The major issues of bio capping are subsidence, leachate and water contamination, soil waterlogging, and the release of toxic gases like methane. It achieves permanent near-zero emission of harmful gases (such as methane and ammonia) and leachate. Biomining also helps to recover soil from decomposed mixed waste.

Constraints and Motivating factors for at Source Segregation

Household attitude: The way households co-operate and respond to waste management issues is influenced by their education; therefore, the public's education is an essential element of the success of any waste management program.

- **Technical/Educational:** Knowledge is important to predict waste segregation behaviour. Basically, increasing knowledge will translate into a change in behaviour. Knowledge of household segregation is about where, what, when, and how to practice in a real life.

- **Environmental:** The surroundings in which people dwell play a major part in nurturing their mindset whether to practice source segregation or not. A locality near to landfill will never practice the same but instead, have an adverse impact altogether by dumping their waste untreated.
- **Financial:** Financial background plays an important factor in source segregation. It has been observed that people who are not practicing source segregation, face the difficulty of the lack of facility.
- **Institution:**Factors such as lack of implementation, weak enforcement, uncertainty over roles and responsibilities amongst governing authorities and limited stakeholder coordination have all contributed towards this disconnect between policy and practice.
- **Legal:** Enforcement of legal attributes in such sensitive issues tends to force the individual into waste segregation with the fear of penalties or legal actions to be taken upon him.

Duplication of effort: It has been noticed on numerous occasions we tend to deal more in terms of paperwork and less output on the field and this in return leads to duplication of effort where more than one project or intervention is needlessly implementing similar activities. This leads to the wastage of available resources as well as their underutilization.

The unsustainability of Municipal Solid Waste Management: The major sources of dumping of solid waste are landfills, and these often end as producing a legacy of wastes because the major part of this waste is unsegregated and untreated.

Lack of legislation: Poor implementation of laws often leads to inefficiencies in society. There is inadequate governance or the absence of clearly defined processes, roles, and decision-making responsibilities.

No pre-defined roles: Developed countries like Germany have pre-defined roles when dealing with waste management with testing of even leachate released, but this is absent in developing countries.

Motivating factors for source segregation:

- **Infrastructure:** Effective solid waste management is a major challenge in cities with high population density. Achieving sustainable development within a country experiencing rapid population growth and improvements in living standards is made

more difficult in many countries because it is a diverse country with many different religious groups, cultures, and traditions. All these problems can be efficiently dealt with by solid infrastructure.

- **Awareness:** Public awareness and attitudes to waste can affect the population's willingness to cooperate and participate in waste segregation practices. General awareness and information on the social, economic and environmental benefits of the successful practice are important factors that need to be continuously communicated to all sectors of the population.
- **Workshops:** Lack of knowledge is one of the main reasons why households did not separate their household waste and there should be an on going effort to educate those that are not separating at their residents and also reinforce the lessons to those separating at their house.
- **Regular collection:** Discipline creates an environment among people where people engage themselves on a regular basis and if policies are implemented on regular basis people tend to show active participation.
- **Incentives:** Incentive-driven drives gain huge attention among people even in a short period and thus create a sense of motivation for any work among the masses.
- **Enforced legislation:** Effective enforcement of environmental laws and regulations is crucial for proper environmental management; this drives fear of penalty or legal action and thus forces people to take the particular action as desired by policies.

3.1.3 Baseline Data for District Environment Plan

The baseline data has been collected from the district officials. The district's population for the years 2021, 2036, and 2051 has been predicted by considering the population growth from the last five decennial censuses from 1971 to 2011. Accordingly, the District Environment Management Plan (DEMP) has been prepared for 2036 & 2051, **as given in Table 3.2A**. As the developmental activities in any area depend upon the district's overall vision and mission, the proposed DEMP shall have to be updated after every five years depending on the overall growth and requirements of the district.

Table 3.2A: Population Information

S. No.	Year	District Population	Rural Population	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Urban Total
1	1971	594561	335998	208894	11222	21412	8231	258563
2	1981	877825	513664	287712	24119	29076	10995	364161
3	1991	1247603	729998	416289	35854	36463	13395	517605
4	2001	1902110	1262054	529690	49688	45020	15658	640056
5	2011	2363937	1563553	644406	62699	53294	18470	800384
6	2021	2865802	1911719	765250	75606	61468	21046	954083
7	2036	3522381	2367084	926970	94692	73315	24852	1155297
8	2051	4192834	2832386	1091884	114214	85379	28725	1360448

Table- 3.2B: Report on inventory of total solid waste generation

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Total solid waste Generation	MT/Day	303	25	25	7
Qty. of Dry Waste to be segregated	MT/Day	160.59	14	14	4
Qty. of Wet Waste to be segregated	MT/Day	142.41	11	11	2
Qty. of C&D Waste segregated	MT/Day	30	2	2	1
Qty. of Street Sweeping	MT/Day	Not estimated	2	2	Not estimated
Qty. of Drain Silt	MT/Day	Not estimated	4	4	Not estimated
Qty. of Domestic Hazardous Waste(DHW) collected	MT/Day	0.002	0	0	-
Qty. of Other Waste (Horticulture, sanitary waste, etc.)	MT/Day	Not estimated	0	0	Not estimated
No of Old dump sites	Nos or None	1	1	1	-
Qty stored in dumpsites	[MT] or [Not estimated]	781950	2	1	Not estimated
No of Sanitary landfills	Nos or None	None	0	0	None
No of wards	Nos	80	35	40	25

Table 3.2C: Compliance by Bulk Waste Generators

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
No of BW Generators	Nos.	190	0	0	0
No of on-site facilities for Wet Waste	Nos.	0	0	0	0

Table 3.2D: Compliance in segregated waste Collection of SW

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Total generation	MT/Day	303	25	25	7
Wet Waste	MT/Day	142.41*	11*	7	4
Dry Waste	MT/Day	160.59*	14*	7	2
C&D Waste	MT/Day	30	2	1	1

*Note: Though this quantity is the total quantity generated, which is being collected by the Nagar Nigam but only 10-15% this quantity is being segregated as of now.

Table 3.3: Status and Recommendations related to Waste Management Operations

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Door to Door Collection	percentage	100%	100%	100%	100
Mechanical Road Sweeping	percentage	10%	5%	Not initiated	Not initiated
Manual Sweeping	percentage	90%	95%	100%	100
Segregated Waste Transport	percentage	15%	50%	50%	20%
Digesters (Bio-methanation)	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Not initiated
Composting operation	percentage	0.50%	Not initiated	Not initiated	Not initiated
MRF Operation		MRF facility is under construction	MRF facility is installed	Proposal to install MRF facility imitated, construction will be completed by December 2021 and all machinery shall be installed by March 2022	MRF facility is installed
Use of Sanitary Landfill	percentage	no SLF	Not initiated	Not initiated	Not initiated
Reclamation of old dumpsites	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Initiated
Linkage with Waste to Energy Boilers / Cement Plants	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Not initiated
Linkage with Recyclers	Initiated /Not Initiated	Initiated	Not initiated	Not initiated	Not initiated
Authorization of waste pickers	Initiated /Not Initiated	Initiated	Not initiated	Not initiated	Not initiated
Linkage with TSDF / CBMWTF	Initiated /Not Initiated	Initiated	Not initiated	Not initiated	Not initiated
Involvement of NGOs	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Not initiated
Linkage with Producers / Brand Owners	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Not initiated
Authorisation of Waste Pickers	Yes/No	Not initiated	Not initiated	Not initiated	Not initiated
Issuance of ID Cards	Initiated /Not Initiated	Not initiated	Not initiated	Not initiated	Not initiated

Table 3.4: Status of Waste Management Operations

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Waste Collection Trolleys	Nos.	80	11	12	1
Mini Collection Trucks (Auto Tipper etc.)	Nos.	60	20	25	10
Segregated Transport	percentage	Yes, 15%	Yes, 70% covered	Yes, 70% covered	0
Bulk Waste Trucks	Nos.	16	0	0	Not available
Waste Transfer points	Nos.	10	0	0	Not available
Bio-methanation units	Nos. & Capacity	0	0	0	Not available
Composting units	Nos.& capacity	2 units, 1.5 TPD and pit composting planned at 30 places in Municipal Area, 10 TPD	0	0	Not available
Material Recovery Facilities	Nos. & capacity	1 No., under Construction, Procurement of Machinery is under process, 60 TPD	1 No, Installed, Capacity 2 TPD	1 No., Proposal to install MRF facility is under consideration, Capacity 2 TPD	1 No. Installed, Capacity 1.0 TPD
Waste to Energy (if applicable)	Nos.	Not Available	0	0	Not available
Waste to RDF	Nos.	Required	0	0	Not available
Sanitary Land fills	Nos.	Not Available	0	0	Not available
Capacity of sanitary landfills	MT/Day	Not Available	Not Available	Not Available	Not Available
Waste Deposit Centers (DHW)	Nos. & capacity	Not Available	1	0	Not available

Table 3.5A. Notification and Implementation of By-Laws

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
CAPEX Required	[INR] / [Not required]	436000000	11000000	15000000	10000000
OPEX Required	[INR per Year] / [% of requirement]	90000000	20000000	7500000	5000000
Adequacy of OPEX	[Yes] / [No]	No	Yes	Yes	No

3.1.4. Projected quantity of solid waste generation in Bikaner district

From the collected information, a positive correlation of 0.93 is observed between population and the quantity of solid waste generated. With urbanization, it is expected that the population of Bikaner district is likely to increase which will consequently increase the quantity of solid waste generation.

For a better understanding of the trend in increase, the population growth over the years is shown in **Figure 3.7** below. Considering the increase in population, the probable solid waste that may be generated is also estimated. A linear mathematical relation is proposed by considering the standards mentioned in CPCB to determine solid waste generation. The proposed equation is shown in Eq. (4.1).

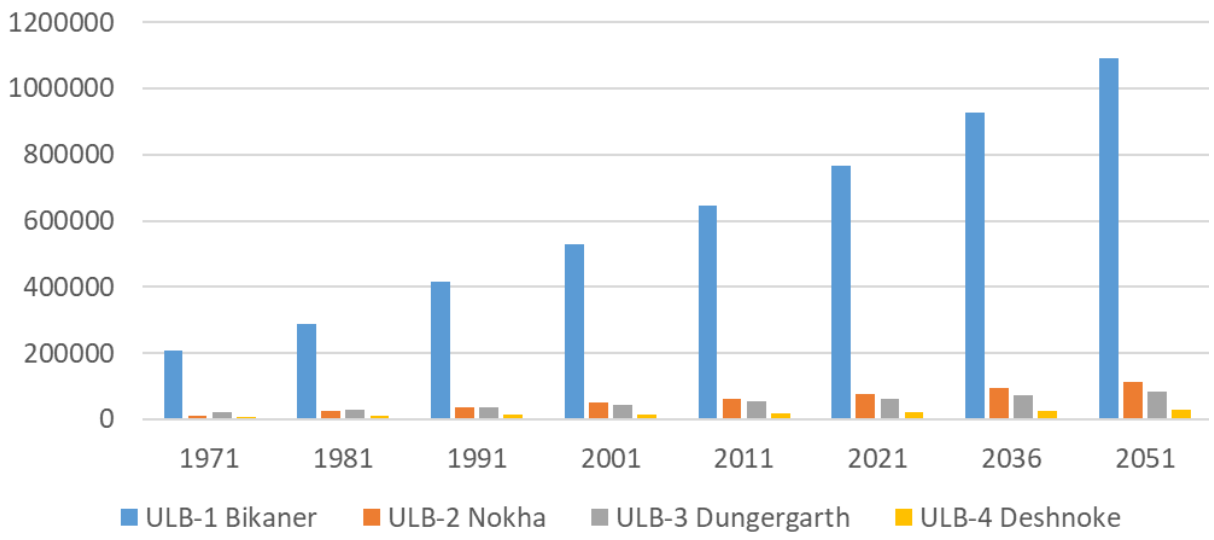


Figure 3.7: Projected population trends in each of the ULB's

$$W = 0.075\ RP + 0.35\ UP \qquad \text{Eq. (4.1)}$$

Where, W is the waste generated in kg per day; RP is the rural population; UP is the urban population. An inventory of probable solid waste that is going to be generated for the coming years is projected for the years 2036 and 2051 as shown in **Figure 3.8**. These estimates aid in procuring the essential infrastructure to meet the future demand.

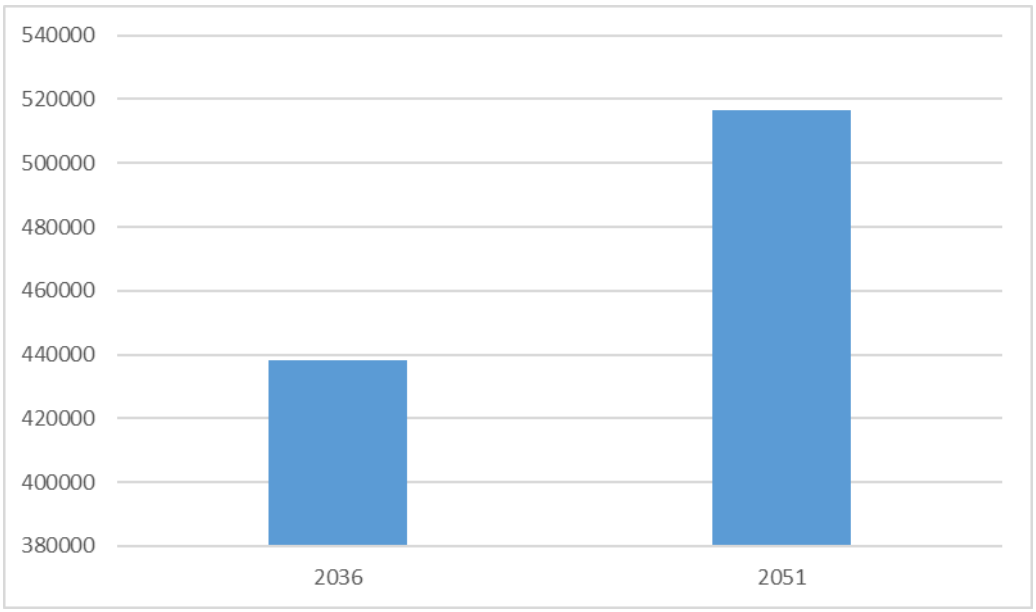


Figure 3.8: Estimated solid waste generation for the year 2036 and 2051

As per honorable NGT order dated 15.07.2019 in O. A. No 710-713/2017, O.A. No. 606/2018, it is the duties and responsibilities of various stakeholders to make the solid waste management plan a successful and implementable action. For the effective utilization of solid

waste management in theBikaner district, the following plan is proposed as shown in **Figure 3.9**.

Step-1: From the collected information, it is observed that the door-to-door collection is not in practice in all the rural areas. It is recommended that all the municipal councils, Nagar Palika, and village panchayats should enforce the implementation of door-to-door collection.

Step-2: The practice of waste segregation should be implemented at the household level. All the bulk generators should be identified and necessary infrastructure such as dustbins should be provided within the vicinity to ensure the proposed disposal of waste.

Step-3: Separate collection of Wet Waste (+ Sanitary Waste), Dry Waste (+ Domestic Hazardous waste) and Street Sweeping should be ensured in all parts of the district.

Step-4: Since it is a well-established fact that solid waste generation depends on the income levels, unlike following a fixed frequency throughout the district, deciding the frequency based on the quantum of waste generated should be considered to plan the activities. Wet waste should be collected on a daily basis.

Step-5: Adopting the cluster-based approach helps in the effective management of solid waste disposal. To optimize the resources and infrastructure, the transfer points and treatment facilities can be installed in each cluster. It is recommended to form clusters that will consequently help in the effective management of solid waste collection and disposal in rural areas of the Bikaner district.

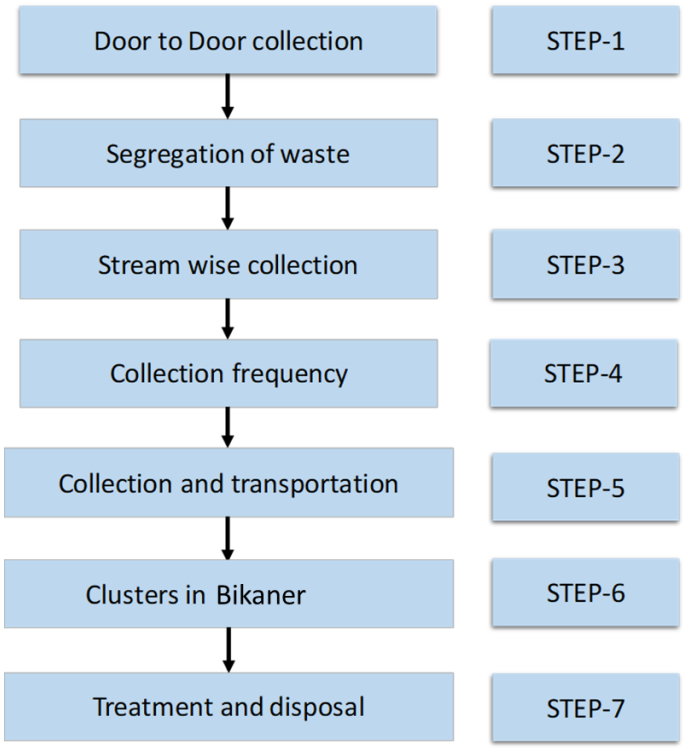


Figure 3.9: Framework for the effective solid waste management in Bikaner

A brief overview of the existing practices for solid waste management in all the ULB's of Bikaner are presented in **Table 3.2 to Table 3.5**.

The details of measurable and quantifiable targets, responsibilities of various departments with timelines for completing the tasks considering the next 10-year projections are made as presented in **Table 3.6**.

Table 3.6: Status and Recommendations on Adequacy of Financial Status of ULB for MSW Management

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
1.	Door to Door Collection of Solid Waste	It is implemented in all ULBs. All ULBs have achieved the target of 100% collection of solid waste	-	-	LSG Department (Municipal Bodies)
2.	Collection, Segregation, Transport, Disposal as per Rules	It not is achieved completely in any of the existing ULB's of Bikaner	100% should be achieved in all the ULB's. This includes additional efforts in all the ULB's and needs to kick start in a few ULB's.	The identified gap should be fulfilled in 9 months of duration Solid waste management to be done in accordance with the prevailing laws. The land is to be identified and acquired within 2 years to meet the 2036 requirement. Facilities are to be developed within the next two years to meet the present requirement.	LSG Department (Municipal Bodies)
3.	Segregation at Source	As per the data collected, it is apparent that all ULB's have created awareness to segregate dry and wet waste at the source.	Segregation of wastes should be done in a much more effective way. Also,only segregating the waste at source will not the serve the purpose if it is not transported, processed and disposed properly. There is a lot of scope to adopt integrated way of handling the waste by each ULB. It should be extended to all the rural parts of the districts.	It should be achieved to implement it in the next one year.	LSG Department (Municipal Bodies)
4.	Road Sweeping and Disposal of Waste Collected	Road sweeping is a common practice and is implemented in two different ways, i.e., mechanical sweeping and manual sweeping. The mechanical sweeping is initiated partially in two ULBs except in ULB-3	All the ULBs should procure infrastructure for mechanical sweeping. This will enhance the efficiency and frequency of waste collection. Also, each sweeping road person must be equipped with masks while sweeping the roads.	2 years	LSG Department (Municipal Bodies)

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
		Dungargarh and ULB-4 Deshnoke.			
5.	Material Recover Facility	This facility is available in ULB-2 and ULB-4. MRF facility yet to be functional in ULB-1 Bikaner and ULB-3 Dungargarh.	Though ULB-2 Nokha and ULB-4 Deshnoke have installed an MRF center, it is yet to be operational effectively through the active participation by the respective ULBs. The MRF facility is not operational in the ULB, which contributes a large quantity of solid waste though it is now under construction with a designed capacity of 60 TPD and procurement of machinery is under process. The municipal board Dungargarh should also execute a proposal to establish an MRF facility to be operational within the specified timelines by May 2022.	1.5 years	LSG Department (Municipal Bodies)
6.	Recycling of materials	Not effective. No linkage with the recycling units is established.	Recycling of wastes should be done through a systematic process that is currently missing in all the ULBs.	An implementation should achieve it in the next two years (i.e., by October 2023).	LSG Department (Municipal Bodies)
7.	Composting & Utilisation of Compost	As per the inventory collected, it is noticed that this technique is not well harnessed in any of the ULB's. It is partially implemented in ULB-1 Bikaner.	All ULB's has to plan for the installation of compost pits. They should also develop a business model of the utilization of compost to sustain themselves.	9 months	LSG Department (Municipal Bodies)
8.	Waste to Energy Plant or Linkage	It is not initiated by any of the ULBs.	All the ULBs have to take the necessary actions to promote the best practices of converting waste to energy or initiating to develop a linkage with an existing plant.	3 years	LSG Department (Municipal Bodies)
9.	Landfill	70% of the ULB has old	There are no proper plans available	Techniques like Biomining	LSG Department

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
	Availability	dumpsites.	currently with ULBs to handle the legacy waste.	and/or bio caping should be explored to reduce the volume of waste at landfill sites. It should be achieved to implement in the next five years (i.e., by June 2026). Also, the provision of sanitary landfills in each ULB has to be explored in the next five years.	(Municipal Bodies)
10.	Reclamation of old dumpsite (If available)	It is in practice in only ULB4	The rest of the ULB's should initiate the process of reclamation of old dumpsites.	The main technologies for reclaiming land sites such as bioremediation, bio capping and bio-mining are to be explored within the next two years.	LSG Department (Municipal Bodies)
11.	Strengthening of Manpower as required in ULBs	The number of manpower is not sufficient. They are also not aware of recent best practices applicable in the field.	The gap between the current and best practices should be identified, and actions should be taken immediately to adopt the best one.	All concerned staff members are to be trained to impart adequate knowledge for the proper implementation of sustainable SWM within the next two years. Also, logistic infrastructure is to be made available from the financial budget by the Government to conduct training programs/workshops starting from Financial Years 2021-22 onwards.	LSG Department (Municipal Bodies)/ Village Panchayat
12.	Authorisation of Waste Pickers (Issuance of ID cards)	It is not initiated in any of the ULBs.	All the ULBs has to initiate the process of authorization of waster picker immediately.	It is should be started within the next 6 months by involving NGOs and self-help groups by providing incentives to them.	LSG Department (Municipal Bodies)
13.	IEC Activity	Information Education Communication (IEC) has been practiced by all ULBs to generate	Awareness programmes should be organised at a given interval of time by each ULB.	It means the process of working with individuals, communities & societies to develop	LSG Department (Municipal Bodies), NGOs,

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
		awareness among the masses.		communication strategies to promote positive behaviour such IEC activity should be followed continuously through various means.	Educational Institutes, etc.
14.	Training of staff	Staff learnsthe process in a traditional way.	Programs are not being conducted currently in a methodical manner.	A systematic training program/workshop should be organised once in a two year to share the best practices to be adopted by ULBs in handling solid waste management.	LSG Department (Municipal Bodies)/ Village Panchayat, University
15.	Monitoring and Review	District Administration under the guidance of the District Collector has been monitoring the progress of solid waste management regularly on monthly basis.	Time-bound delivery of the outcomes	The district collector has been monitoring/reviewing the performance of their respective ULB/ Panchayats on solid waste management. However, He/she may constitute a district-level expert committee for suggestions and better implementation. People should also be made accountable if they do not perform.	District Collector or his/ her representative, District administration, RSPCB, LSG Department (Municipal Bodies)/ Village Panchayat

Chapter 4. Plastic Waste Management

This chapter covers the present scenario of plastic waste management of the Bikanerdistrict in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials has been analysed. Finally, it emphasises the details of action plans along with the actionable points, present status of implementation, gap to be addressed, and proposed time line for completion. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks.

4.1 Present scenario in the district

As per the report of Local Self Government Department, Rajasthan published in the year 2019, on an average, the total plastic waste being generated in Rajasthan is about 4% of the solid waste that is generated. It is becoming increasingly clear that plastics are posing significant environmental and health challenges in communities. Plastics are disturbing local ecological balances as they are easily admixed in water and land as micro-plastics. In their macro-form, they act as physical barriers that degrade soil quality and even ingested by livestock and other fauna to find its way in the human food chain. Plastics cause blockages in drains and streams resulting in severe floods and obstruction to runoffs.

According to the Rule 12 of Plastic Waste Management (Amendment) Rules, 2018 prescribed by Ministry of Environment, Forest and Climate Change (MoEF&CC), the enforcing authorities for plastic waste management shall be as given below:

1. The State Pollution Control Board in respect of a Union territory shall be the authority for enforcement of the provisions of these rules relating to registration, manufacture of plastic products and multi-layered packaging, processing and disposal of plastic wastes.

2. The concerned Secretary-in-charge of LSG shall be the authority for enforcement of the provisions of these rules relating to waste management by waste generator, use of plastic carry bags, plastic sheets or like, covers made of plastic sheets.

3. The concerned Gram Panchayat shall be the authority for enforcement of the provisions of these rules relating to waste management by the waste generator, use of plastic carry bags,

plastic sheets or like, covers made of plastic sheets in the rural area of the State or a Union Territory.

4. The authorities referred to in sub-rules (1) to (3) shall take the assistance of the District Magistrate or the Deputy Commissioner within the territorial limits of the jurisdiction of the concerned district in the enforcement of the provisions of these rules.

Plastic waste disposal methods are often basic and uninformed that further exacerbate the challenge. The open burning of plastics generates toxic emissions such as carbon monoxide, dioxins, and nitrides. Low-quality plastics that are common in rural areas also leach out toxic additives and substances. Policy measures are focused on segregation, collection, and in certain cases banning the use of certain categories of plastics altogether. However, most of this had traditionally been focused on urban India. In 2016, the plastic waste rules were extended for rural areas for the first time, with specific duties demarcated for Gram Panchayats. The lack of segregation of plastic waste, the absence of organized systems of collection and efficient aggregation, poor economic value in low-grade (thin) plastics and the livelihoods associated with plastic production have been the key categories of challenges.

Technically, plastics are divided into two categories as shown in **Figure 4.1**. Typically, plastic waste to be managed in accordance with the Plastic Waste Management (Amendment)Rules, 2018 with an emphasis on the 3R /4R principles of Reduce, Reuse, Recycle and Recovery.Segregated dry waste from all Municipal Councils should typically be dispatched to MRF centers that are installed in a few of the ULB's of the Bikaner district. Subsequently, the collected waste isfurther segregated manually into multiple categories such as plastic, paper, glass, coconut shell, clothes, and metal.Recyclables plastic waste are baled and sold to vendors through an auctioning process. The non-recyclable plastic waste is baled and transported to cement factories. Unfortunately, this is not in practice in majority of the ULB.

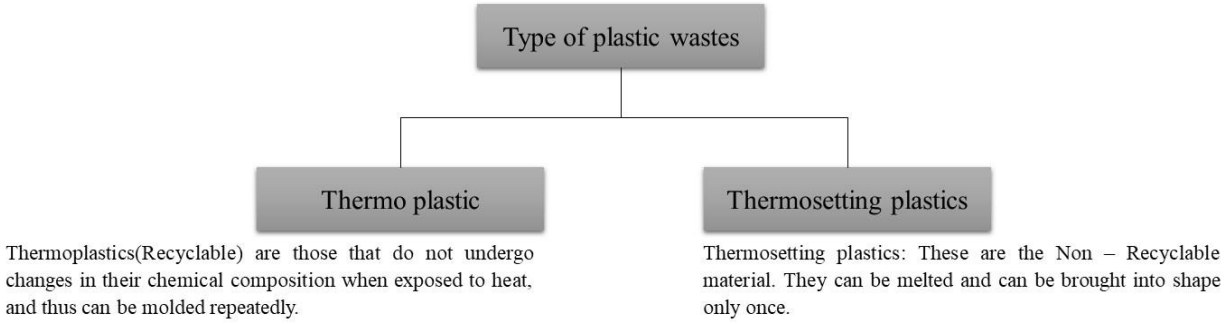


Figure 4.1. Types of plastic wastes

A study has been conducted in some selected parts of Rajasthan and it is noticed that the solid waste generation of all categories with different communities is 48179.1gm/month. Among this quantity of waste, the share of waste refuse and garbage category is 3112.2gm/months for papers and products, while for plastics it is 3832.8gm/month, glass content comprises waste is 1262.1gm/month and quantity of garbage category as kitchen waste is 39972gm/month (Anil, 2015). This observation in line with the conclusions drawn in the report of Local Self Government Department, Rajasthan report published in 2019. Owing to this, the percentage of plastic in the generated solid waste can be treated to be lying between 4% to 7%. To minimize the percent of plastic waste that is being generated in Bikaner, various actions have been enforced in all the ULB's. The list of actions taken in each of the ULB's is collated with the help of a survey and telephonic conversations with the representatives of each ULB as shown in **Tables 4.1 to 4.6**.

Table 4.1: Inventory of plastic waste generation

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Estimated Quantity of plastic waste generated	MT/day] / [Not Estimated]	12	1	1	Not Estimated

Table 4.2: Implementation of Collection

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Door to Door collection	[100%] / [partial %] / [not initiated]	100%	100%	100%	100%
Segregated Waste collection	[100%] / [partial %]	20%	70%	70%	20%
Plastic waste collection at Material Recovery Facility	[MRF used] / [not installed]	Not installed (MRF shall start working by December, 2021)	MRF used	Not installed (MRF shall start working by May, 2022)	MRF installed
Authorization of PW pickers	[Nos] / [not initiated]	Not initiated	0	0	Not initiated
PW collection Centers	[Nos] / [not established]	Not established	0	0	Not established

Table 4.3: Establishment of linkage with Stakeholders

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Established linkage with PROs of Producers	[Nos] / [not established]	Not established	0	0	Not established
Established linkage with NGOs	[Nos] / [not established]	Not established	0	0	Not established

Table 4.4: Availability of facilities for Recycling or utilization of PW

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
No. of PW recyclers	[Nos]	0	0	0	0
No Manufacturers	[Nos]	0	0	0	0
No of pyrolysis oil plants	[Nos]	0	0	0	0
Plastic pyrolysis	[Quantity in MT sent per Month]	0	0	0	0
Use in road making	[Quantity MT used per Month]	0	0	0	0
Co-processing in Cement Kiln	[Quantity in MT sent per Month]	28	0	0	0

Table 4.5: Implementation of PW Management Rules, 2016

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Sealing of units producing < 50-micron plastic	[All sealed] / [Partial] / [no action]	No action, there is no production units	No action, there is no production units	No action, there is no production units	No action, there is no production units
Prohibiting sale of carry bags < 50 micron	[Prohibited] / [Partial] / [no action]	Prohibited	0	0	-
Ban on Carry bags and other single use plastics as notified by State Government	[Implemented] / [Partial] / [no action] / [No Ban]	Partial	0	0	Implemented

Table 4.6: Implementation of Extended Producers Responsibility (EPR) through Producers/Brand-owners

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
No of Producers associated with ULBs	[Nos] / [None]	None	None	None	None
Financial support by Producers / Brand owners to ULBs	[Nos] / [None]	None	None	None	None
Amount of PRO Support	[Rs…]	0	0	0	0
Infrastructure support by Producers / Brand owners to ULBs	[Nos of Producers] / [None]	None	None	None	None
No of collection centers established by Producers / Brand owners to ULBs	[Nos] / [None]	None	None	None	None

From the attributes of Table 4.6, the following observations have been inferred:

- Authorization of plastic waste pickers should be given prime importance to ensure the effective collection of plastic waste. This exercise will also promote and create awareness that plastic waste is being collected individually. From the collected inventory data, it is noticed that notable quantity of plastic is being generated in majority of the ULB's. Unfortunately, the collected data infers to the fact that the plastic waste is not being recycled. no ULB are still to achieve the prohibition of plastic bags (<50 micron). ULBs should ensure corrective measures to ban carry bags and other single use plastics.
- In all the ULB's, implementation of the ban on plastics below <50 microns' thickness and single-use plastics has been done. Also, though the compliance of Plastic Waste as per Rule 05 and 06 of PWM Rules 2016 has been attempted, it is felt that it should be executed more systematically. Awareness programs to be conducted to inculcate best practices. All the rural areas should also be considered for the complete elimination of plastic usage. A detailed inspection by each ULB is also recommended to get an accurate inventory of plastic waste generation and its usage through different means.
- The segregated plastic to the cement plants is minimal from only ULB1. All ULBs must ensure segregation and collection of plastic waste through MRF centers. They should collaborate with appropriate NGOs and authorize well-equipped plastic waste pickers to improve the efficiency of the collection system.
- It is inferred that the concept of clusters would help in the effective management of plastic waste. The ULB which is not practicing the transfer of plastic waste can coordinate with the nearest ULB and transfer the quantity that is being generated by them to minimize the overall transportation cost. This activity may also help to generated revenue for the development of each ULB.
- Distance and the quantity of plastic waste generated in an ULB could be the vital factors that is impairing to transport the plastic waste to the cement factory. Under these prevailing conditions, the concept of clusters would help in the effective management of plastic waste. The ULB which is not practicing the transfer of plastic waste can coordinate with the nearest ULB and transfer the quantity that is being generated. This activity may also help to generate revenue for the development of each ULB.

4.2. Implementation of plastic waste management rule, 2016

A short survey is conducted to collect the status of implementation of plastic waste management rules, 2016 and the collated information is shown in **Table 4.5**.From the collected attributes, it is evident that all ULB's need to enforce the implementation of policies mentioned in PWM, 2016 in a much more aggressive way to prohibit sales of Carry bags < 50 microns and banning on Carry bags and other single-use plastics as notified by the State Government completely.

4.3 Recommendations for the effective management of plastic waste

Plastic waste after due recycling can be used in road construction, as RDF, in cement kilns, power plants, etc. A few of the areas in which plastic waste can be used are mentioned below:

1. Utilization of Plastic Waste in Road Construction:

As per circular from PWD letter No. SE/Road/2018- 19/D-707 dated 04/04/2019 for road construction, it has been suggested that plastic waste has great potential for bituminous construction. If added in small dosages (5-10%) by weight of bitumen, it helps in improving Marshall Stability, Strength, Fatigue Life and other desirable properties of bituminous mix and improves longevity and pavement performance, but uniform coating of plastic to be ensured. The generated plastic waste should also be used in the construction of PMGSY roads.

2. Co-processing of Plastic Waste as Refuse Derived Fuel (RDF):

Co-processing refers to the use of waste materials in industry process such as cement kilns or any other large combustion plants. Co-processing indicates substitution of primary fuel by waste as raw material, or materials recovered from waste. Waste materials such as plastic wastes, used for co-processing are referred as Refuse Derived Fuel. Co-processing of plastic waste offers advantages for cement industry or power plants in saving fossil fuels or raw material consumption and thus contributing in more eco-efficient ways of production.

3. Strengthening the governance by local governing bodies

Every local body shall be responsible for development and setting up of infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic waste either on its own or by engaging agencies or producers.

The local body shall be responsible for setting up, operationalization and co-ordination of the waste management system and for performing the associated functions, namely

a) ensuring segregation, collection, storage, transportation, processing and disposal of plastic waste
b) ensuring that no damage is caused to the environment during this process
c) ensuring channelization of recyclable plastic waste fraction to recyclers
d) ensuring processing and disposal on non-recyclable fraction of plastic waste in accordance with the guidelines issued by the Central Pollution Control Board
e) creating awareness among all stake holders about their responsibilities
f) engaging civil societies or groups working with waste pickers
g) ensuring that open burning of plastic waste does not take place.

The local body for setting up of system for plastic waste management shall seek assistance of producers and such system shall be set up within one year from the date of final publication of these rules in the Official Gazette of India. The local bodies are recommended to frame bye-laws incorporating the provisions of these rules.

The proposed action plan for management of plastic waste is presented in **Table 4.7**.

Table 4.7: Status and action plan for plastic waste management

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
1.	To develop and set up infrastructure for segregation, collection, storage, transportation, processing and disposal of the plastic.	As per the data collected, it is apparent that all ULBs have created awareness to segregate plastic at the source. However, collection, storage, transportation, processing and disposal of the plastic in an effective manner is not in practice currently.	Collection, storage, processing and disposal of the plastic needs attention to all ULBs.	The complete process should be placed within next one year to achieve the target of segregation, processing and disposal of plastic.	LSG Department (Municipal Bodies)
2.	Creating Material Recovery Facility (MRF)	It is operational only in ULB-2 and ULB-4.	Rest of the ULBs have to take necessary actions in installing an MRF centres in their respective ULBs.	All ULBs must install an MRF facility within next one year. They should also maintain record of amount of collection of plastic waste on daily basis.	LSG Department (Municipal Bodies)
3.	To frame bye laws incorporating the provision of Plastic Waste Management Rule	It is being implemented in all the ULBs.	There is a need to create awareness among the masses to inculcate best practices for not using plastic carry bags and other single-use plastics.	All ULBs must prohibit sales of Carry bags < 50 microns and ban on Carry bags and other single-use plastics completely within the next six months. They should create awareness programs monthly to inculcate best practices for not using single-use plastics till this objective is fulfilled.	State Level Monitoring Committee under the administrative control of DoE
4.	The ULBs shall seize banned plastic carry bags and impose fine on defaulters as per provision of the Rajasthan Municipalities Act, 2009 (Article 258)	It is partially implemented in ULB-1, and is being implemented in ULB-4.	ULB-2 and ULB-3 have to act seriously on seizing the plastic bags in case they find any violation of the Act.	Since it is a policy- related issue, it is recommended to implement it within 3 months.	Local self-government
5.	Organize IEC/ BCC activities and awareness programmes in various districts involving Municipalities & other stake-holders.	No notable activities are being conducted to bring awareness by any of the ULBs.	Local self-governments and NGO's need to actively participate. Self-helping groups can also be formed to conduct these activities.	At least 6 activities per year may be organized to bring awareness among the people.	Local self-government/ Non-government organizations, Self-helping groups

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
6.	To take steps for minimizing generation of plastic waste and segregate plastic waste at the source.	No specific measures are being taken.	Surprise inspection activities should be conducted in each of the ULB's and it should be extended to all the rural areas.	Activities performed to segregate plastic waste at the source should be recorded. Continuous monitoring and inspection is essential through competent authorities.	Local self-government/ Non-government organizations, Self-helping groups
7.	Recycling through Pyrolysis	It is not in practice in any of the ULB.	All the ULB's should initiate the process of thermal decomposition of plastic waste.		Local self-government
8.	Recycling through use in Roads	Plastic waste is not being used in the road construction in any of the ULBs.	Local self-government should promote the prospects of the using plastic waste in the road construction especially roads constructed under PMGSY.	This action can be taken in the next 2 years. If not a new road, plastic waste can also be used in the upgradation and maintenance activities of road network	Local self-government
9.	Co-processing in Kilns	One out of four ULB's, have only sent a minimal amount of plastic to cement kilns in the past.	ULB generating relatively less quantity of plastic waste and far away from cement factories should coordinate with the nearest ULB which has already planned to transport the plastic waste to cement factory.	It may be brought to practice on monthly basisonce a proper collection and segregation is developed.	Local self-government

Chapter 5: Construction & Demolition Waste Management

This Chapter covers the present scenario of construction and demolition waste management of the Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Finally, it emphasises the details of action plans along with the actionable points, present status of implementation, gap to be addressed, and proposed time line for completion with financial cost required. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks considering next 10-year projections.

5.1 Present scenario

The C&D wastes consist of unwanted material produced directly or incidentally by the construction. It may also contain hazardous substances. The Construction & Demolition (C&D) waste comprises of building materials, debrisand rubble resulting from construction, re-modeling, repair and demolition of any civil structureproduced in the district is presently being dumped on Road side and mostly filled in low lyingareas.

The Construction and Demolition (C&D) waste management and utilization strategy is intended to help facilitate the implementation of the C&D Waste Rules 2016 to ensure that ULBs across the country are able to adopt proper C&D waste management and recycled products find appropriate and adequate utilization. Although India produces enormous amounts of C&D waste and volumes are expected to grow further with time, there are no reliable estimates of generation volume, either at the local or national level. Management of the waste has historically been poor, with a very small fraction diverted for reuse and the rest dumped, often in an unauthorized manner, causing myriad environmental problems. The C&D Waste Rules 2016 laid out detailed duties and responsibilities of different stakeholders ranging from waste generators to ULBs to state and central government ministries and agencies. It also provided templates for documents needed for each management step to ease implementation. However, implementation of these Rules has not been to the full extent, despite guidelines and advisories in support of the Rules being issued by different agencies such as CPWD, BMTPC, MoHUA, etc. Delhi and Ahmedabad have pioneered C&D waste management in India with adoption of Public Private Partnership (PPP) which is regarded as sustainable. Best practice in India and abroad shows that 80-90% of C&D waste can be reused after processing in a variety of applications including landscaping, earth works and civil engineering applications. Processing technology is also not

complicated, comprising mainly of crushing, screening and washing to recover coarse and fine recycled aggregates, which can then be used directly or converted into pre-cast products. Independent testing has confirmed that the quality of products made from recycled aggregates can meet relevant standards and cost of such products can also be competitive with that of conventional products provided transportation distances are not prohibitive. BIS and the Indian Roads Congress have also come up with standards prescribing limits up to which recycled aggregates can be safely used in different applications.

Despite such prospects, C&D waste management and utilization has not progressed as envisaged under the 2016 Rules due to several factors. The biggest challenges are at the ULB level. In addition to land, financial resources and personnel constraints, ULB capacities to develop the management and business model are limited. In the absence of adequate state level facilitation, ULBs continue to dedicate their limited resources towards MSW, which is seen as a higher priority by the public. Additionally, the construction industry has its own set of challenges. Demolition has historically been dominated by small players with entrenched ways of working which often involve "getting rid" of the waste to cut costs. On the other hand, recycled products are perceived as inferior in quality and there are concerns about their economic viability. In these context, without a coordinated effort, implementation at the necessary scale will still remain a challenge for all its stakeholders. Ministry of Housing and Urban Affairs along with its specialized agencies and/or empaneled consultants shall handhold the ULBs for C&D waste management. An ad hoc expert task force needs to be created for developing a standard methodology for inventorisation and characterization of C&D waste. An online webportal, as part of the existing Swachh Bharat Mission portal, may be used for data agglomeration for proper inventorisation as well as for dissemination of best practices, toolkits on technology, management and business models, etc. In parallel, facilitation by state level agencies and departments (such as Urban Development) needs to be accelerated to ensure wide implementation throughout each state, and not just in a few pioneer cities. Special emphasis should be placed on the needs of smaller towns where the generation may not be enough to justify a large central processing facility.

Sustained engagement with the 4 construction industry will also be important, in collaboration with industry associations such as BAI, CREDAI, etc., addressing both their roles as responsible generators of waste and potential users of recycled products. Finally, there needs to be a push to

promote utilization of recycled products through a variety of channels including public procurement, development of standards and certification, green rating, quality assurance, GST rebates, and so on. This multi-faceted facilitation strategy, in collaboration with a wide range of stakeholders, needs to be sustained over the medium term, till the time a viable market for recycled products develops, allowing the private sector to profitably pursue recycling on its own.

As part of the on-going support to Resource Efficiency Strategy of NITI Aayog and European Delegation to India, the European Union Resource Efficiency Initiative for India (EU-REI),a consortium led by the Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ) GmbH with The Energy and Resources Institute (TERI), Confederation of the Indian Industry (CII) and adelphi proposed to develop a comprehensive Construction and Demolition (C&D) waste management strategy to promote circular economy in India. The goal of the strategy is to provide a framework of implementation of the C&D Waste Management Rules, 2016. Primary beneficiaries of the strategy will be the Urban Local Bodies (ULBs), Central and State Public Works Departments (CPWD & SPWD), Local Contractors. The strategy will strengthen the existing policy framework by Ministry of Environment, Forests and Climate Change (MoEFCC) as well as entrust Building Materials & Technology Promotion Council (BMTPC), Ministry of Housing and Urban Affairs (MoHUA) to further develop the implementation road map. Furthermore, the study will create additional value for relevant regulatory (e.g., Central Pollution Control Board) and implementing bodies, such as public enterprises involved in infrastructure development tasked with management of C&D waste. In addition, the paper will inform strategic decision making on resource efficiency at NITI Aayog.

5.2 Typical steps of processing C&D waste

Recycling of C&D waste starts with segregation of unwanted residual material such as plastic, wood, metal fragments, etc (constituting 10% of the total waste as per the TIFAC composition). The remaining bulky waste is fed into crushers and reduced to smaller and smaller sizes, with size fractions separated depending on end use. Fines are typically best recovered with a “wet process”. A simplified diagram depicting C&D waste processing is shown in **Figure 5.1.**

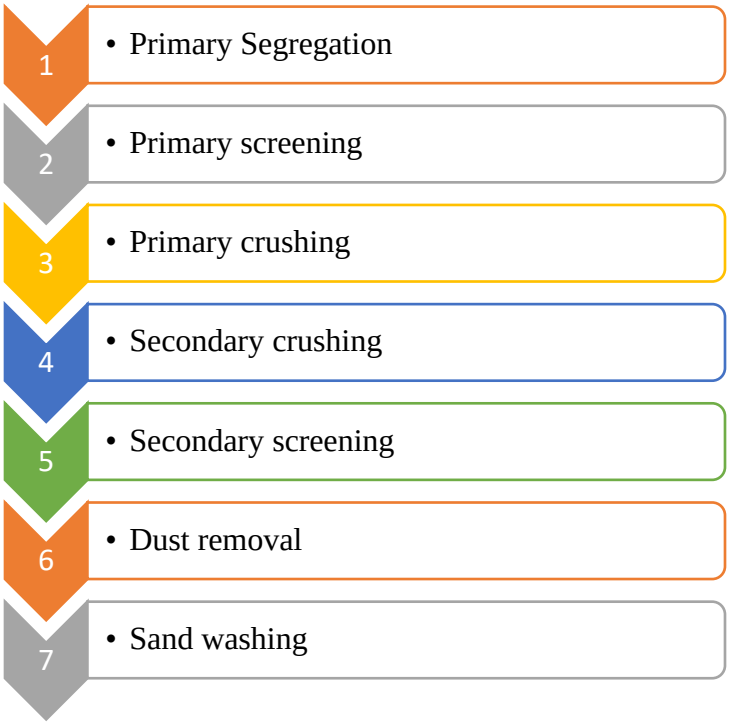


Figure 5.1: Typical steps involved in the recycling of C&D waste

These coarse and fine aggregates of various sizes can be used directly as recycled aggregates in construction or used to manufacture a range of pre-cast products. Products made from recycled aggregates typically tend to have a cost advantage over conventional products since natural aggregates are transported over long distances in most places. This holds true as long as the collection and transportation cost of C&D waste does not become exceedingly high due to long transportation distances.

5.3 Recommendations of National Building Code of India (2005)

As per National Building Code (NBC-CED 46) of India, 2005, part 11, the recycled aggregates can be used in the following areas.

1. Concrete for bulk fills
2. Bank protection
3. Base/fill of drainage structures
4. Pavements
5. Sidewalks
6. Kerbs and gutters

Up to 30% percent of natural crushed coarse aggregate can be replaced by the recycled concrete aggregate. This can be increased up to 50% percentage for pavements and other where under pure compression specific to the standards and practices pertaining to construction of roads.

The Indian Roads Congress (IRC) has issued 'IRC-121:2017 Guidelines for Use of C&D Waste in Road Sector' outlining what kind of materials from recycled C&D waste and in what proportion, may be safely used for specific road construction/repair application.

5.4 Status of C&D Waste Management in ULB's

A detailed survey has been conducted in all the ULB's to collect the details of quantity of C&D waste. The existing C&D sites are shown in **Figure 5.2**. The summary of the collected data is shown in **Tables 5.1 to 5.4**.

Designated covered vehicles are deployed for the collection of C&D waste in ULB-1 Bikaner and ULB-2 Nokha. The C&D wastes are transported from the waste collection center in the city to the deposition site as identified. ULB-3 Dungargarh and ULB-4 Deshnoke do not have any dedicated C&D dumping sites currently. They are disposing of C&D wastes in the low-lying areas depending on the available space as they do not have sufficient land to develop the site. The officials of these ULBs should identify the proper location for C& D deposition point. Municipalities also used to notify service helpline numbers to collect and transport C&D waste in the city. At present, all C&D waste is being dumped in the low-lying area.It is to be noted that there is no appropriate mechanism for collection and deposition of C&D waste in the rural areas of Bikaner district.

Fig. 5.2A: C&D Waste Dumping Site located in Bikaner Municipal Board (28.001359^0N, 73.305546^0E)

Fig. 5.2B: C&D Waste Site located in Nokha Municipal Board

5.5 Identified challenges and roadblocks for utilizing C&D waste in construction

There remains a host of challenges and roadblocks faced by both government agencies and the private sector that are hindering a wider and quicker adoption of C&D waste management initiatives. It is important to properly understand these challenges so that proposed actions can target them effectively.

5.5.1. Municipal bodies/local authorities

Local authorities/municipal bodies have the most important role in planning and implementing C&D waste management in their respective jurisdictions under the 2016 Rules. Even if the collection, transport and processing is actually contracted out to a private entity, the local authority is ultimately responsible for the overall performance of the management scheme. However, local authorities/municipal bodies appear to be the weakest link hindering rapid adoption of initiatives and face several challenges. Several factors are responsible for this, including:

a) Officials may understand the broader aspects of C&D waste management but require support to develop tailor-made solutions to their specific circumstances;

b) ULBs do not have adequate capacities and trained personnel to take up the initiatives;

c) ULBs do not have financial resources to hire a consultant for an initial feasibility study and/or a DPR;

e) C&D waste management is considered a low priority (the public is more concerned about MSW), especially in the absence of strong coordination/facilitation by state-level agencies.

Table 5.1:Inventory of C&D waste generation

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Estimated Quantity	[Kg/Day] / [Not estimated]	30000	2000	1000	200

Table 5.2:Establishment of C&D Waste Deposition centers

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Establishment of Deposition Points	[Yes] / [No]	Yes	Yes	Yes	No
C&D Deposition point identified	[Yes] / [No]	Yes	Yes	No	No

Table 5.3:Implementation of By-Laws for CD Waste Management

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Implementation of By-laws	[notified] / [not notified]	Notified	Notified	Notified	Not initiated
Collection of Deposition / disposal Charges	[Initiated] / [Not initiated]	Not initiated	Initiated	Initiated	Not initiated

Table- 5.4: Establishment of C&D Waste recycling plant or linkage with such facility

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Establishment CD Waste Recycling Plant	[Established] / [Sent to shared Facility] / [No facility exists]	No facility exists	0	0	Not initiated
Capacity of CD Waste Recycling Plant	[MT/Day] / [Not available]	Not available	0	0	Not available

b) Lack of monitoring capacity/resources

Local authorities/municipal bodies typically suffer from chronic shortages in personnel and resources. They are hard pressed to monitor, collect and dispose MSW adequately, a matter of greater concern to the public, and initiating a new C&D waste management system is an additional responsibility to them for which they feel unprepared. Most cities do not have demolition permits and therefore demolition sites and practices are poorly monitored, if at all. An ideal management plan would require the creation of a new C&D waste monitoring system, as envisioned by the 2016 Rules, for which effective coordination would be required between the ULB's Building Department and the Waste Management Department.

c) Lack of capacity and experience in C&D waste management

In addition to the overall capacity/resource issues, C&D waste management is a relatively new topic that many municipal officials have little awareness or experience of. Experience shows that even after capacity development workshops are held, local authorities/municipal bodies are unsure of how to proceed with waste estimation, feasibility planning, tendering and so on. In many cases, inexperience or prior negative experience with PPPs may be an additional cause of hesitation. The ability to hire a consultant for a feasibility study is limited by funding shortages; even when consultants are hired there is sometimes no guarantee that they will provide appropriate guidance.

d) Concern about finances and business case

Due to chronic financial pressures, local authorities/municipal bodies are instinctively wary of any new commitments that appear to them as a new source of expenditure. During capacity development workshops it is typically difficult to convince them about the successful business case employed in the Delhi and Ahmedabad models. The tipping fee paid to the contracted party by the ULB is seen as an unjustified burden when in reality it may not be a net expense given that: a) the ULB saves money by not having to haul bulky C&D waste, and b) the 2016 Rules allow the ULB to impose charges on waste generators; tipping fees can be paid from this revenue. In some cases, urban officials have even proposed that the contracted party actually pay the ULB rather than receiving a tipping fee for each tonne of C&D waste, and/or share profits from selling recycled products with the ULB. Not surprisingly, this deters potential investors since recycled C&D waste products are still a nascent market in India.

e) Lack of awareness and concern

The construction industry is entrenched in its waysand is historically used to turning a blind eye to howC&D waste is disposed; getting them to changetheir ways is likely to be a difficult and gradual task. At the same time, there is little awareness about **C**&D waste recycling and utilisation beyond usingrubble as a filling material

f) Dominance of the unorganized sector in demolition

The demolition sector is overwhelmingly dominated by small players in the unorganized sector, the only exception being a handful of specialized companies whose niche is high-tech demolition related to large infrastructure projects. This naturally makes it difficult for urban officials to monitor and regulate small demolition contractors who are typically not registered and are used to getting away with disposing of C&D waste in unauthorized locations.

g) Lack of confidence in recycled products

The experience in Delhi and Ahmedabad has shown that the market for recycled products made from C&D waste is still quite weak in India. Engagement with the construction industry repeatedly demonstrates that potential buyers are hesitant about such recycled products that they perceive to be inferior in quality. Even when informed about the updated BIS standard (383) that

allows recycled aggregates in many applications, potential buyers appear risk averse, pointing to their clients who seem to prefer “conventional” products.

h) Poor economic viability of recycled products

Currently aggregates are taxed at 5% and manufactured products are taxed at 18% making the use of recycled products economically unviable for customers. GST relaxation for C&D waste recycled products including manufactured products such as tiles, paver blocks, bricks, sand and aggregates may be considered.

i) Low engagement by public construction agencies

State government agencies such as PWD, Housing Development Board/Authority, City Development Authority, public sector utility companies, etc. are involved in significant construction/demolition work. As per the 2016 Rules, these entities are supposed to coordinate with local municipal bodies about proper disposal of their C&D waste, implement in-situ utilization of C&D waste in their own projects wherever feasible, and adopt policies to buy recycled products. However, engagement has remained weak, partly as a result of coordination challenges between state and local government level entities.

The proposed action plan for management of C&D waste is presented in **Table 5.5**.

Table 5.5: Action plan for C&D waste management

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
1.	Inventorisation of C&D waste	All ULB's of Bikaner district are currently maintaining the inventory of C&D waste being generated.	It is imperative to collect the statistics of C&D waste being generated.	8 months	Local self-government
2	Establishment of C&D waste deposition centers	All ULB's except ULB3, ULB4 have established the deposition centers as per the statistics collected.	Necessary actions are to be taken for the successful establishment of deposition centers.	2 years	Local self-government
3.	Identification of C&D waste deposition centers	ULB-1 Bikaner and ULB-2 Nokhahave identified the deposition centers.	Locations should be identified in ULB-3 Dungargarh and ULB-4Deshnoke for the establishment of C&D waste deposition centers.	9 months	Local self-governments
4	Implementation of bye laws	All ULB's except ULB-4have notified regarding the implementation of bye-laws	Necessary actions are to be taken by LSG's to notify the implementation of by-laws	9 months	Local self-governments
5	Collection of deposition and disposal charges	Its implementation is under practice in ULB-2 and ULB-3.	Remaining ULBsshould take necessary action to collect the deposition and disposal charges	9 months	Local self-governments
6	Establishment of C&D waste recycling center	Not existing in any of the ULB's	ULB's with no existing facilities should take appropriate actions to establish the recycling center as it is anticipated that the C&D waste is going to increase in the near future	2 years	Local self-governments

Chapter 6: Bio Medical Waste Management

This chapter mainly deals with the current status of bio-medical waste management in Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials has been presented as per the format prescribed by CPCB for Model DEPs. Finally, it emphasizes the details of action plans along with the actionable points, present status of implementation, gap to be addressed, and proposed time line for completion. The activities are suggested by keeping in view of the future generation of wastes etc. with timelines for completing the tasks considering next 15-year projections.

6.1 Present scenario disposal of hospitals biomedical waste: -

HCF's operating in District Bikaner have obtained connectivity with HCF's operating in District Bikaner have obtained connectivity with M/s E-Tech Project, Bikaner, operating its plant at Goga Gate, Bikaner, for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Nagar Nigam, Bikaner for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Municopal Council, Bikaner

All vehicles transporting biomedical wastes have installed GPS system for its proper monitoring and to ensure that the collection of biomedical waste has been done appropriately. The location of vehicles has also been tracked through GPS systems for their effective monitoring. It has been confirmed by the CMHO that the bio-medical waste disposal from all government hospitals has been done as per the prescribed rule. In case of non-compliance of disposal of bio-medical waste, instructions were issued to take strict actions against the respective Government/private hospitals and/or contractor as per rules. Presently the newly established Primary Health Centers do not have contract of disposal of bio-medical wastes with any company, which shall be completed very soon. The list of actions taken in each of the ULB's is collated with the help of a survey and telephonic conversations with the representatives of each ULB as shown in **Tables 6.1 to 6.7**. Also, data have been collected from Regional Officer, Rajasthan State Pollution Control Board, Bikaner.

Table 6.1: Inventory of Biomedical Waste Generation in Bikaner District

S.No	Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Census Town
1a	Population	[Nos as per 2011 census]	800384	644406	62699	53294	18470	Beriyawali 11831 And Kolayat 9684
2	Total no. of Bedded Hospitals	[Nos] / [No inventory]	152	84	21	17	1	
3	Total no. of non-bedded HCF	[Nos] / [No inventory]	25	20	1	0	0	
3a	Total no. Clinics	[Nos] / [No inventory]	14	10	4	0	0	
3b	No of Veterinary Hospitals	[Nos] / [No inventory]	30	15	2	3	1	
3c	Pathlabs	[Nos] / [No inventory]	60	55	3	0		
3d	Dental Clinics	[Nos] / [No inventory]	6	6	0	0	0	
3e	Blood Banks	[Nos] / [No inventory]	0	0	0	0	0	
3f	Animal Houses	[Nos] / [No inventory]	0	0	0	0	0	
3g	Bio-research Labs	[Nos] / [No inventory]	0	0	0	0	0	
3h	Others	[Nos] / [No inventory]	0	0	0	0	0	

Table 6.2: Inventory of Biomedical Waste Generation in Bikaner District

Attributes	Unit	Total in the District	ULB-1Bikaner	ULB-2Nokha	ULB-3Dungergarth	ULB- 4Deshnoke
Bedded HCFs	[Nos Authorized]	155	85	22	17	1
Non-bedded HCFs	[Nos Authorized]	132	105	9	3	1

Table 6.3: Biomedical Waste Treatment and Disposal Facilities (CBMWTFs)

Attributes	**Unit**	**Total in the District**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**Census town**	**Rural Area**
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470	**Beriyawali** 11831 And Kolayat 9684	1563553
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046		1911719
No of CBMWTFs	[Nos] / None	1	1	0	0	0		
Linkage with CBMWTFs	[Yes] / [no linkage]	HCF's operating in District Bikaner have obtained connectivity with M/s E-Tech Project, Bikaner, operating its plant at Goga Gate, Bikaner, for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Nagar Nigam, Bikaner.						
Capacity of CBMWTFs	[Adequate] / [Not adequate]	2000 kg/day	2000 kg/day	0	0	0	0	
Requirements of CBMWTFs	[Require] / [not required]	Not Required						
Captive Disposal Facilities of HCFs	[Nos] / [None]	Nil	Nil	Nil	Nil	Nil	Nil	

Note:ULB-3 Dungargarh was not situated in District Bikaner in 1991 Census.
Census Town Beriyawali and Kolayat's population is included with total urban population.

Table 6.4: Compliance by CBMWTFs

Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Compliance to standards	[Meeting] / [Not meeting] / [NA]	Nil	Nil	Nil	Nil	Nil
Barcode tracking by HCFs / CBMWTFs	[100%] / [Partly %] / [None]	Nil	Nil	Nil	Nil	Nil
Daily BMW lifting by CBMWTFs	[Kg / day]	*	*	*	*	*

*The details of Daily BMW lifting by CBMWTFs is given in Tables 6.6 and 6.7

Table 6.5: Status of Compliance by Healthcare Facilities

Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarh	ULB-4 Deshnoke
Pre-segregation	[100%] / [partly %] / [None]	100%	100%	100%	100%	100%
Linkage with CBMWTFs	[100%] / [partly %] / [None]	90%	90%	90%	90%	90%

Table 6.6: Quantity of Bio Medical Waste sent to TSDF site from Bikaner District in April 2021

Date	Red (kg/day)	Yellow (kg/day)	Blue (kg/day)	White (kg/day)	Total (kg/day)
01.04.21	47.15	448.52	94.85	1	591.52
02.04.21	46.5	458.8	69.6	3	577.9
03.04.21	50.7	493.9	88.08	4	636.68
04.04.21	2	245	3	3	253
05.04.21	26	426.74	85.7	2	540.44
06.04.21	38.55	456.3	86.6	5	586.45
07.04.21	21.8	440.2	60.05	1	523.05
08.04.21	36.85	466.58	82.97	3	589.4
09.04.21	29	455.85	53.65	3	541.5
10.04.21	37.55	508.13	68.31	4	617.99
11.04.21	2	254	5	3	264
12.04.21	52.75	554.97	82.38	2	692.1
13.04.21	48.5	455.64	107.43	3	614.57
14.04.21	27.8	429.3	61.7	3	521.8
15.04.21	29.45	432.7	79.15	2	543.3
16.04.21	28.3	433.35	42.85	3	507.5
17.04.21	33	535.56	75.3	2	645.86
18.04.21	2	259	1	1	263
19.04.21	45.95	591.9	59.35	2	699.2
20.04.21	36.5	616.87	93.28	2	748.65
21.04.21	30.5	554.75	61.85	1	648.1
22.04.21	4.7	693.14	94.61	3	795.45
23.04.21	34.7	651.9	53.6	2	742.2
24.04.21	29.59	574.57	70.07	3	677.23
25.04.21	4	359	1	2	366
26.04.21	34	603.4	82.6	3	723
27.04.21	47.9	623.65	61.62	2	735.17
28.04.21	31.1	562.6	64.95	4	662.65
29.04.21	52.19	668.92	110.85	2	833.96
30.04.21	30	551.55	42.5	4	628.05
TOTAL	**941.03**	**14806.79**	**1943.9**	**78**	**17769.72**
				Avg. BMW	573.216

Table 6.7: Quantity of Bio Medical Waste sent to TSDF site from Bikaner District in May 2021

Date	Red (kg/day)	Yellow (kg/day)	Blue (kg/day)	White (kg/day)	Total (kg/day)
01.05.21	34.4	640.25	89.05	1	764.7
02.05.21	2	417	2	2	423
03.04.21	34.9	535.06	52.1	2	624.06
04.05.21	34	540	71.45	3	648.45
05.05.21	30.7	605.8	43.35	2	681.85
06.05.21	41.19	547.2	50.14	2	640.53
07.05.21	32.9	494.18	43.45	1	571.53
08.05.21	44.05	750.03	74.95	2	871.03
09.05.21	4	339	2	2	347
10.05.21	35.45	625.15	75.2	4	739.8
11.05.21	57.57	660.68	103.75	1	823
12.05.21	47.85	659.05	82.05	3	791.95
13.05.21	32.85	579.45	52.88	2	667.18
14.05.21	33.15	542.1	50.65	1	626.9
15.05.21	56.19	517.58	89.39	2	665.16
16.05.21	3	374	0	2	379
17.05.21	50.3	660.45	79	1	790.75
18.05.21	33.88	597.48	82.62	2	715.98
19.05.21	28.1	729.1	51.25	2	810.45
20.05.21	34.02	469.13	56.1	2	561.25
21.05.21	33.3	554.7	44.95	1	633.95
22.05.21	49.82	584.92	104.21	2	740.95
23.05.21	3	379	4	3	389
24.05.21	35.2	552.1	58.8	3	649.1
25.05.21	37.01	665.14	71.81	2	775.96
26.05.21	28.3	603.25	69.75	2	703.3
27.05.21	38.19	595.58	81.65	3	718.42
28.05.21	41.1	566.7	60.25	1	669.05
29.05.21	51.89	700.57	91.58	3	847.04
30.05.21	2	339	2	2	345
31.05.21	39.75	528.05	91.7	2	661.5
Total	1030.06	17351.7	1832.08	63	20276.84
				Avg. BMW (kg/day)	**654.09**

6.2 Projection of future generation of Biomedical Wastes

Government of India has released "New Health Care Policy" in March 2017 to provide better health facilities and services to the entire population of India. According to WHO norms presently country is not meeting the availability of hospital beds for per 1000 population. As per the new health care policy total number of beds required in Bikaner district is given in **Table 6.8**. The total biomedical waste generation based on the total hospital bed requirement is given in **Table 6.9**.

Table 6.8: Requirement of hospital beds for Bikaner District

Items	Total requirement in Urban Area		Total requirement in Rural Area		Total requirement in Bikaner District	
Year	2036	2051	2036	2051	2036	2051
ICU Beds	635	748	1302	1558	1937	2306
Other Hospital Beds	1676	1973	3432	4107	5108	6080
Total	2311	2721	4734	5665	7045	8386
Remarks: Total requirements of hospital beds are on the basis New health care policy, 2017 and ICU beds requirements (0.55 beds/ 1000 population) is based on the findings of research papers.						

Table 6.9: Future Assessment of Biomedical waste generation for Bikaner District

Year	District Population	Total Beds	Total Biomedical waste generated (Ton/day) in Bikaner District
2036	3522381	7045	10.92
2051	4192834	8386	13.00
Remarks: Future assessment of biomedical waste generation is made on the basis of generation of biomedical waste per bed (as per published research data/ information)			

6.3. Implementation strategy of Bio-medical waste management

As in other solid waste management strategy, the first objective should be to achieve minimization and prevention of waste as much as possible. The next plan of action should be to ensure that biomedical wastes are not mixed with other waste and shall be collected and segregated at the site of generation itself. Segregation of waste into various categories has been given in Schedule-I of the Rules and Regulations. Biomedical waste can be collected in containers or bags of different colours for appropriate treatment. The colour coding, the type of container, and treatment options should be followed strictly as per the guidelines.

Some of the following essential points must be kept in mind while handling biomedical wastes:

1. Segregate waste at the point of generation.
2. Infectious wastes must not be mixed with safe general non-hazardous waste.
3. Loose garbage should not be thrown.
4. Colour-coded bins must be used all the times.
5. The garbage should not be thrown from the height.

The investment for an on-site waste management system in an individual health care setting is very high. In contrast, an integrated common treatment and disposal facility cost a maximum of IRS. 3—15/ kg/ day with an added benefit of no capital investment being required. The company/private entrepreneur setting up such a centralized facility will tend to make a profit of about 30 per cent, making it a sustainable venture. The advantages of a centralized facility are a reduction in pollution and energy consumption, streamlined collection, and treatment of waste.

The details of measurable and quantifiable targets, responsibilities of various departments with timelines for completing the tasks are presented in **Table 6.10**.

Table 6.10: Status and Recommendations on Adequacy of Status of ULB for Bio-medical Waste Management

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
1.	Inventorisation of Medical facilities producing Bio-Medical Waste	Inventorisation has been done in all ULBs	Not applicable	Once the facilities are established, they are recorded with due approval.	Medical & Health Department
2.	Preparation of Inventory of Biomedical Waste Generation	Under process	Proper quantification and record keeping is required	Data on bio-medical waste generation, treatment & disposal which are to be updated quarterly .	Medical & Health Department and RSPCB
3.	Capacity building/training of HCFs	For proper management of the waste in the healthcare facilities the technical requirements of waste handling are needed to be understood and practiced by each category of the staff in accordance with the BMWM Rules, 2016.	No systematic process	It should be completed within one year.	RSPCB & Medical & Health Department and RSPCB
4.	Authorisation of such facilities by SPCB/PCCs	HCF's operating in District Bikaner have obtained connectivity with M/s E-Tech Project, Bikaner, operating its plant at Goga Gate, Bikaner, for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Nagar Nigam, Bikaner.	Though process is placed, it is important to implement the same in an effective manner to authorize eligible HCFs and clinical as per the prescribed norms.	It should be completed within one year.	RSPCB

Sr. No.	Action Point	Present Status	Gap	Timeline	Department
5.	Availability of CBMWTFs or Linkage	All ULBs have linkage with with M/s E-Tech Project, Bikaner, operating its plant at Goga Gate, Bikaner, for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Nagar Nigam, Bikaner.	Not applicable	-	Medical & Health Department and RSPCB.
6.	Regular Inspection of CBMWTFs	Performed (when) Presently Bio-medical wastes has been sent to to M/s E-Tech Project, Bikaner, operating its plant at Goga Gate, Bikaner, for Collection, Transportation Treatment and Disposal of BMW, after due agreement with Nagar Nigam, Bikaner.	Not applicable	-	Team decided by District Collector
7.	Regular Inspection of HCFs	Performed by CMHO and team	Not applicable	More frequent visits are required.	Team decided by District Collector
8.	Bar Code System	Implementation Status	Should be given due priority	July 2022	Medical& Health Department

Chapter 7: E-Waste Management

This Chapter mainly deals with the current status of E-waste management in Bikaner district in general and its status in different urban local bodies (ULBs) particularly. Datasheet duly filled by concerned officials has been presented as per the format prescribed by CPCB for Model DEPs. Finally, it emphasizes the details of action plans along with the actionable points, present status of implementation, gap to be addressed, and proposed time line for completion.

7.1 Present scenario E-Waste management: -

The electronic goods contain hazardous materials like lead, mercury, cadmium and arsenic, which has been posing threats not only to the environment but also causing risks to the health of human beings. The risk factors of e-toxins related to our health and environment are harmful to lungs and kidneys, and peripheral nervous systems, increased risk of cancer, acute and chronic effects on plants, animals and micro-organisms.

E-waste or electronic waste can be defined as the electronic products nearing the end of their useful life such as discarded products like PCs, TV sets, cell phones, fax machines, microwave ovens, audio equipment, batteries, and the like. Most of the consumers are either unaware or ignore that computer and electronic equipment contain toxic materials and heavy metals. These materials, if thrown in the municipal solid waste stream, will end up in a landfill, or if incinerated, potentially create an unsafe environment by contaminating the land, water and air.

7.2. Implementation of E-Waste management

To reduce the environmental impact caused by improper disposal, and at the same time increase recycling, an efficient and effective computer and recycling depot should be facilitated for residents and business groups. These computer and other electronic equipment recycling depot should be able to collect all types of computer and electronic equipment such as monitors, central processing units (CPUs), laptop computers, printers, keyboards, fax machines, hard drives, modems, speakers, power sources, TV sets, VCRs, stereos, cellular phones, and wiring for recycling and reuse.

Also, proper awareness campaign on e-waste should be launched at frequent interval of time to keep e-waste out of landfills and incinerators. It is estimated that a major portion of electronic items is stored due to uncertainty of how to manage it. Due to this problem, later

on, they get easily mixed with municipal solid waste, which are finally disposed of to the landfills. Such terrible situations can be avoided appropriate attention are given on urgent basis by the consumers, manufacturers, local self-governments, and the public.

Some of the waste minimization techniques are as follows:

1. Inventory management, proper control over the materials used in manufacturing process is an important way to reduce waste generation.
2. All materials be approved prior to purchase, and evaluated.
3. Ensure that only the needed quantity is ordered.
4. Production process modification.
5. Volume reduction. This technique removes the hazardous portion of a waste from a non-hazardous portion and reduces the volume and thus cost of disposing of a waste material. It can be achieved by source segregation and waste concentration.
6. Recovery and reuse.
7. Extended producer responsibility (EPR). Government intervention is necessary to implement EPR on products such as electric bulbs, tube lights, batteries, computers, TV sets, which cannot be handled individually or locally and which need expertise in their disposal.
8. Separate days and facilities may be set apart for disposal of non-degradable but reusable and recyclable waste such as select e-waste items. These may be collected and stored in RRUs and may be made available for the users on charge.
9. It is important to adopt a 'permit — process approach' while handling modern hazardous waste operations. This requires complex engineering and scientific facility, adequacy of trained operators, safety systems and proper expertise to be secured for compliance, enforcement, issues connected with such management schemes. In the context of high technological revolution catching up in the Indian economy, the possibility of huge accumulation of e-waste, the problem of e-waste management aggravates the overall solid waste management. Effective 'permit— process approach' is critical to monitor the performance of operating e-waste disposal. It is worthwhile to consider separate enforcement agencies for this purpose.

10. Most important and critical point is the prevention of waste rather than managing it. It is possible if the electronic parts which are in working condition can be donated for reuse and for extending the lives of valuable products. Reuse also benefits society. It is therefore high time for the management to take measures for prevention of e-waste in a well-planned manner rather than having a 'wait and watch' policy. Not only will it save some anticipated disaster, but will also show the way to tackle this menace with proper E-waste management strategies.

The list of actions taken in each of the ULB's is collated with the help of a survey and telephonic conversations with the representatives of each ULB as shown in **Tables 7.1 to 7.4**. Also, data have been collected from Regional Officer, Rajasthan State Pollution Control Board.

Table 7.1: Status of facilitating authorized collection of E-Waste

Attributes	**Unit**	**Total in the District**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**CENSUS TOWN**
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470	**Beriyawali** 11831 And Kolayat 9684
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046	
Collection centers established by ULB in District	[Nos] / [None]	Nil	Nil	Nil	Nil	Nil	
Collection centers established by Producers or their PROs in the District	[Nos] / [None]	Nil	Nil	Nil	Nil	Nil	
Does the district has linkage with authorized E-Waste recyclers / Dismantler	[Yes] / [No]	Nil	Nil	Nil	Nil	Nil	
No authorized E-Waste recyclers / Dismantler	[Nos] / [None]	Nil	Nil	Nil	Nil	Nil	

Table 7.2: Status of Collection of E-Waste

Attributes	**Unit**	**Total in the District**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**
Authorizing E-Waste collectors	[Authorized] / [None]	Nil	Nil	Nil	Nil	Nil
Involvement of NGOs	[Yes] / [No] / [Nos]	Nil	Nil	Nil	Nil	Nil
Does Producers have approached NGOs/ Informal Sector for setting up Collection Centers.	[Yes] / [No] /[Nos]	Nil	Nil	Nil	Nil	Nil
Does ULBs have linkage with authorized Recyclers / Dismantlers	[Yes] / [No]	Nil	Nil	Nil	Nil	Nil

Table 7.3: Control E-Waste related pollution

Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046
Does informal trading, dismantling, and recycling of e-waste exists in District	[Yes] / [No]	Nil	Nil	Nil	Nil	Nil
Does the administration closed illegal E-Waste recycling in the District	[Yes] / [No] / [Nos]	Nil	Nil	Nil	Nil	Nil
No of actions taken to close illegal trading or processing of E-Waste	[Nos]	Nil	Nil	Nil	Nil	Nil

Table 7.4: Creation of Awareness on E-Waste handling and disposal

Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Census Town
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470	**Beriyawali** 11831 And Kolayat 9684
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046	
Does PROs / Producers conducted any District level Awareness Campaigns	[Yes] / [No] / [Nos]	Nil	Nil	Nil	Nil	Nil	
Does District Administration conducted any District level Awareness Campaigns	[Yes] / [No] / [Nos]	Nil	Nil	Nil	Nil	Nil	

7.3 Projection of future generation of E-Wastes

Currently, collection and disposal of E-Waste is not the focused area for all of us. In India only about 10% E-Waste was collected in year 2018-19 and it was about 3.5 % in year 2017-18. Use of electrical vehicles, installation of solar panels, Computers, laptops and mobile phones etc. will increase in future and that will lead to generate huge quantity of E-Waste that has to be handled properly. Presently no data is available on E-Waste with the district authority. On the basis of published data future plastic waste generation is given in **Table 7.5**.

Table: 7.5: Future Assessment of E-waste generation

Year	District Population	Total Projected E-waste (Ton/year) in the District
2036	3522381	3849
2051	4192834	6167
Remarks: Future assessment is based on the per capita present contribution (0.812 kg/ capita/ yr) with an increase of average 2% per year.		

There is total 22 authorized dismantler/ Recycler/ Refurbisher in Rajasthan currently according to RSPCB. But in Bikaner not a single authorized e-waste centre is working so informal activities have the interference with improper management of E-waste.

E-waste management, can be dealt by two ways:

*Case I:*Reuse, Refurbish, and Recycling

- A pick-up service for e-waste can be requested and desktops, laptops, LCD/LED monitors, printers, scanners, cell phones, fax machines, game consoles, CDs, DVDs, and computer accessories are tested for their reusability and hence, based on that it can be reused, recycled and refurbished. The waste received at this location is tested for its reusability.
- If the electronic product is still functional, it is sold at a lower cost for reuse. Also, the components of the electronics are tested separately and the working components are either sold individually or sometimes used to refurbish a new model and then sold as a unit.
- The electronics items that cannot be reused are sent for recycling. No machinery is used at this location. The electronics are manually dismantled and separated into

various streams and then individual streams are shipped to various locations for subsequent processing. The dismantling process is used to remove metals, plastics, circuit boards, and ink/toner before the e-waste is shipped to specific processers.

*Case II:*Manual Dismantling and Recycling

The waste from computers and televisions to small home appliances can be treated under this case. The main objective should be to remove hazardous materials from the waste stream and then ship the remaining material for subsequent processing. The processing centre should have four separate processing lines:

- Line 1 deals with computers and laptops. Workers remove components such as wire, circuit boards, and outer casings, and put them in separate containers for shipping.
- Line 2 works on removing hazardous materials from small home appliances. Major hazardous materials are batteries and mercury tubes.
- Line 3 is the accessories line dealing with the processing of computer accessories such as keyboards, printers, scanners, mouse, hard drives, etc. The major hazardous material to be removed from this line is the ink and toner from the printer.
- Line 4 is the display processing line dealing with dismantling of televisions and computer displays. The back panel of the CRT screen is leaded glass and is removed from the front panel, which is the high-quality glass. In the case of flat screens, the glycol assembly and mercury bulb are the major hazardous materials that are removed from the system.

After the dismantling and hazardous material removal, the remaining materials (mostly metal and plastic) are bailed and shipped for final processing.

The proposed action plan for management of E-waste management is presented in **Table 7.6**.**Table 7.6:** Action plans for E-waste management

S. No.	Action Point	Present Status	Gap	Timeline	Department
1.	Registration of E-Waste collectors	There are no ULBs at the moment authorizing E-Waste collectors.	First, we need to register E-Waste collectors with all ULBs. This will help to conduct the research activities and management.	12 months	LSG Department (Municipal Bodies)
2.	Partnering with NGOs	No ULBs have approached NGOs for setting up collection centres of E-waste.	NGOs pave a good way to raise awareness among the people.	2 months	LSG Department (Municipal Bodies) & NGOs
3.	Raising awareness about E-waste	There is very less awareness in society regarding E-waste.	More awareness will help create more action which will help to counter the rising E-waste problem.	3 months	LSG Department (Municipal Bodies), NGOs, Educational Institutes, etc.
4.	Establishment of E-Waste deposition and management centers	The number of management and deposition centres facilitating authorized collection of E-Waste are none currently.	The major aim is the collection of E-waste, which is posing a great threat, in a systematic manner.	12 months	LSG Department (Municipal Bodies)
5.	Implementation of bye laws	None of the ULBs have closed illegal E-Waste recycling or management in the district and there are no proper guidelines.	Necessary actions and guidelines should be provided.	6 months	LSG Department (Municipal Bodies)
6.	Collection of deposition and disposal charges	No implementation.	ULBs should take necessary action to collect the deposition and disposal charges after establishment of the system.	9 months	LSG Department (Municipal Bodies)
7.	Establishment of E-waste recycling center	There are no established recycling centers in any of the ULBs.	E-waste should be considered as an imminent threat and these should be established as soon as	1 year	LSG Department (Municipal Bodies)

S. No.	Action Point	Present Status	Gap	Timeline	Department
			possible.		
8.	Training of staff	There is no practice currently through which ULB staffs learns the process.	Programs are not being conducted currently in a methodical manner. A systematic training program/workshop should be organized once in a two year to share the best practices to be adopted by ULBs in handling E-waste management.	1 year	LSG Department (Municipal Bodies)/ Village Panchayat, University

Chapter 8: Hazardous Waste Management

Hazardous waste means any waste which by reason 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. Hazardous waste management is one of the most significant challenges our country faces today due to its prolonged health effects. Some attributes related to inventory management, site selection, hazardous waste-producing activities, disposal techniques, and types of hazardous waste have been discussed in this chapter.

Inventory management is one of the key components of management. Hazardous waste key components lie down in inventory management with proper characterization, waste generation amount estimation, and further which relates to collection and disposal. Inventory of hazardous waste in the district of Bikaner has been classified in **Table 8.1A**.

Hazardous waste is primarily generated from industrial activities and must be managed in an environmentally safe manner. The management of the hazardous waste is regulated as per the Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (HOWM Rules, 2016), notified by the Ministry of Environment, Forest and Climate Change, Govt. of India under the Environment (Protection) Act, 1986.

The HOWM Rules, 2016, lays down provisions with respect to generation, packaging, storage, transportation, recycling/reprocessing, utilization, treatment, disposal, etc. of hazardous waste and obtaining authorization from the concerned State Pollution Control Board (SPCB) / Pollution Control Committee (PCC) for the same. The HOWM Rules, 2016, also lays down the occupier's responsibility of hazardous waste for their safe and environmentally sound management following the waste management hierarchy viz. prevention, minimization, reuse, recycle, recovery, utilization, and lastly, safe disposal.

The recycling and utilization as resource or energy recovery of hazardous waste are a preferential option over hazardous waste disposal since it conserves resources and reduces carbon footprint. Utilization of hazardous waste by co-processing in cement Kiln has proven a sustainable option because there is a dual benefit in utilizing the waste as supplementary fuel and alternative raw material. The HOWM Rules, 2016, has stipulated provisions about such utilization of hazardous

waste as a resource or energy recovery. The HOWM Rules, 2016, stipulates provisions for maintaining records and filing annual returns pertaining to hazardous waste generation and their management. As per Rule 20(2) of the HOWM Rules, 2016, the occupier handling hazardous waste and operator of the disposal facility are required to submit the annual return (about hazardous wastes generation, storage, recycling, utilization, disposal, etc.) in the prescribed Form to SPCB/PCC by 30th June of every financial year. Based on this, SPCBs/PCCs are required to prepare an annual inventory of the waste generated, recycled, utilized, disposed of, etc. for the respective State/UT and submit the same to CPCB by 30th September of every financial year in accordance with the provisions stipulated under Rule 20(3) of the HOWM Rules, 2016. As per Rule 20(4) of the HOWM Rules, 2016, CPCB is required to prepare a consolidated report on the management of hazardous wastes and submit the same to the Ministry.

Under the provisions of the Hazardous Waste (Management & Handling) Rules, 1989, the State Board of Rajasthan had submitted the status of implementation of the rules in the State to the Hon'ble Supreme Court through its affidavit in July 1997. Hazardous Waste (Management & Handling) Rules, 1989 were subsequently superseded by Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008, vide notification dated 24/09/2008. The State Board of Rajasthan is regularly conducting a survey, inspections of hazardous waste generating units in light of the amended rules and presently identified 763 units up to 30/6/2009, which are covered under the Schedule "1" and "2" of the amended Hazardous Waste (Management, Handling & Transboundary Movement) Rules, 2008. The summary of district-wise hazardous waste generating units is presented in **Figure 8.1**. The type of industries, sector-wise in the districts include Cement, Ceramic, Chemical, Chlor alkali, Common Treatment Facility, Drugs & Pharmaceuticals, Dyes & Dye intermediate, Electronics, Engineering, fertilizers, Mining, Paints, Varnish & Ink, Pesticides, Petrochemical. Petroleum Drilling / Storage, Primary production of Zinc/Lead/ Copper, Secondary production of Metals Steel rolling mills, Tanneries, Textile, and Waste oil re-refiners.

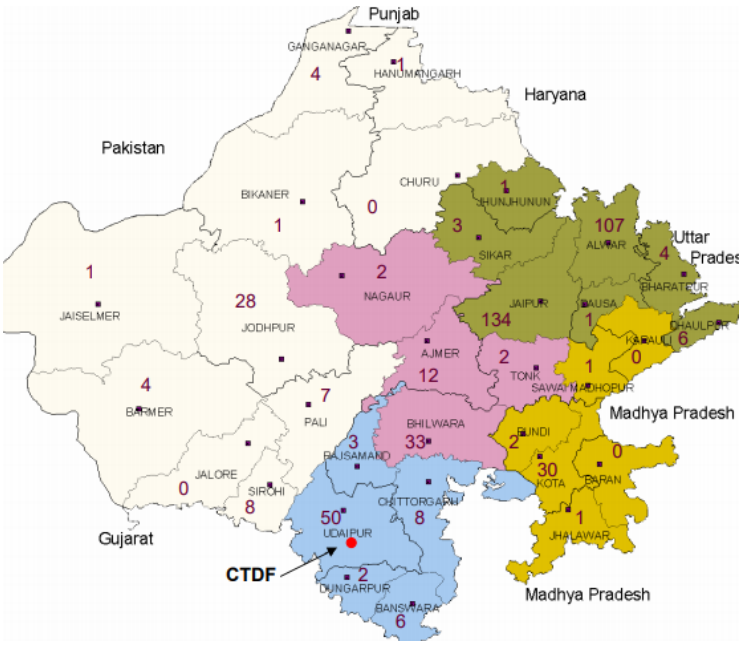


Figure 8.1: Total number of hazardous was generating units in each district

With special emphasis on the hazardous waste generation in Bikaner, a survey is conducted in each ULB, and the inventory of hazardous waste generation is collected, and the collated information is shown in **Table 8.1A to Table 8.1C**. In addition to the inventory of hazardous data, considering the inventory of solid waste generation, it is noticed that domestic hazardous waste is being collected at the household level without separating it at the source, and notable quantities have been found in ULB-1 (Bikaner). For effective management, it is recommended to separate it at the source. From the collated information, it is evident that no sources generating hazardous waste exist in the Bikaner district. Since no hazardous waste is being emitted from the existing industries, no essential resources are required for the mitigations activities.The TSDF refers to the treatment, storage, and disposal facility (TSDF) that follows the generator and transporter in the chain of waste management activities. These include general facility standards as well as unit-specific design and operating criteria. The general facility standards consist of good housekeeping provisions for any facility that handles hazardous waste. The unit-specific technical requirements are designed to prevent the release of hazardous waste into the environment. **Table 8.1C** shows the inventory of hazardous waste with respect to availability of common hazardous waste TSDF.

Table 8.1A. Inventory of Hazardous Waste

Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046
Quantity of HW	[MT/Annum]	84.243	84.243	0	0	0
Quantity of Incinierable HW	[MT/Annum]	0	0	0	0	0
Quantity of land-fillable HW	[MT/Annum]	0.392	0.392	0	0	0
Quantity of Recyclable / utilizable HW	[MT/Annum]	83.856	83.856	0	0	0
Contaminated Sites and illegal industrial hazardous waste dumpsites						
Attributes	**Unit**	**Total in the District**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**
Population	[Nos as per projected in 2021	2865802	765250	75606	61468	21046
No of HW dumpsites	[Nos] / [None]	None	None	None	None	None
Probable Contaminated Sites	[Nos] (provide list)	None	None	None	None	None

Table 8.1B. Inventory of Hazardous Waste

Authorization by SPCBs/PCCs						
Attributes	**Unit**	**Total in the District**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**
No of industries authorized	[Nos]	5	0	0	0	0
Display Board of HW Generation in front of Gate	[Nos]	5	0	0	0	0
Availability of Common Hazardous Waste TSDF						
Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Common TSDF	[Exists] / [No] / [Sent to Other District within State]	No	No	No	No	No
Industries linkage with TSDF	[Nos.]	Yes*	Yes*	Yes*	Yes*	Yes*

*Common TSDF is available at Udaipur and maintained by Udaipur Chamber of Commerce and Industries (UCCI), Udaipur. Hazardous waste from all industries situated in Bikaner is sent to UCCI for disposal.

Table-8.1C: Inventory of Hazardous Waste

Linkage of ULBs in District with Common TSDF						
Attributes	Unit	Total in the District	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
ULBs linked to Common TSDFs for Domestic Hazardous Waste	[Yes] / [No]	Common TSDF is available at Udaipur and maintained by Udaipur Chamber of Commerce and Industries (UCCI), Udaipur. Hazardous waste generate from aforesaid sources has been sent to UCCI for disposal .	No	No	No	No

Hazardous wastes in India and their sources

The hazardous wastes are being generated through different industrial products ranging from household's items to agricultural products, etc. A summary of some of the products along with their hazardous characteristics are given in **Table 8.2**.

Table-8.2: Industrial products and their hazardous characteristics

Industry	Potentially Hazardous Waste Generated
Plastic	Organic chlorine compounds
Pesticides	Organic chlorine compounds, Organic phosphate compounds
Medicine	Organic solvents and residue, heavy metals e.g., Hg and Zn
Paints	Heavy metals, pigments, solvents, organic residues oils and phenols
Metals	Heavy metals, fluorides, cyanides, acid and alkaline cleaners' solvents, pigments, abrasives plaiting salts, oils, phenols
Leather	Heavy metals, organic solvent
Textiles	Heavy metals, dyes, organic chlorine compounds, solvent

Hazardous Waste characterization

High Risk waste

They contain significant concentrations of constituents that are highly toxic, mobile, persistent, and/or bioaccumulative, e.g., chlorinated solvents, waste from metal degreasing (due to their toxicity, mobility, and to some extent persistence in the environment, etc.), cyanide waste (due to their high toxicity, etc.), dioxin-based waste (due to potential high toxicity and carcinogenicity effects, etc.), PCB (polychloro biphenyl) waste due to persistence and bioaccumulative properties, etc.

Intermediate Risk Waste

They contain metal hydroxide sludge (excluding Cr6+ which is under the high-risk waste due to its extreme toxicity). In this, the toxic metals of this category are relatively insoluble with low mobility.

Low Risk Waste

They include primarily high-volume low hazard wastes and some putrescible wastes.

Hazardous Waste Management Indian Context

Rules laid for India:

1. **Manufacture, storage and impact of hazardous chemicals rules, 1989** and amendments made there under
2. **Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996** and amendments made thereunder,
3. **Hazardous Waste (Management and Handling) Rules, 1989** and amendments made thereunder.
4. **Public Liability Insurance Act, 1991 and Rules,**
5. **National Environment Tribunal Act, 1995, and The Environment (Protection) Rules, 1986.**

Therefore, the following steps are being taken for effective management of hazardous waste:

1. To identify the main hazardous waste generators, and ascertain the quantity of various types of hazardous wastes**, an inventory of hazardous waste generating industries** has begun in India.
2. The nodal agency is the Ministry of Environment and Forests and the implementing agencies are the **Central/ State Pollution Control Board and State Department of Environment.** These agencies are actively working with industry to control the quality and quantity of wastes from different industrial units.
3. **The Water Act, 1974 and the Air Act, 1981** were for the prevention and control of pollution. These acts are oriented towards containments of pollutants from waste water discharges and air emissions, respectively without putting emphasis on the ultimate disposal of pollutants removed by the treatment systems adopted. If sludges are formed during waste water treatment, these two acts do not concern themselves with their disposal.
4. **The Hazardous waste (Management and Handling) Amendment, Rules, 2000, under the Environment (Protection) Act, 1986**, were introduced against this background.

They aim at providing control of the generation, collection, treatment, transport, import, storage and disposal of hazardous wastes. Their principal objective is to establish a control mechanism for the management of hazardous wastes. For this, a list of large/medium/small-scale industries are prepared.

The salient features of these rules are given below:

1. Eighteen categories of hazardous waste have been identified along with regulatory quantities. Apart from this, 44 processes generating hazardous wastes have been listed.
2. The generator must report the hazardous wastes being handled and apply to the State Pollution Control Board for handling authorization.
3. Wastes must be properly packed, labelled and transported in accordance with the Motor Vehicle Act 1988.
4. The generator must maintain records regarding safe handling, storage, transportation and disposal practices and file an annual return. The generator must also report accidents to State Pollution Control Board.
5. The transporter must have details for the requisite safety requirements applicable during transportation of hazardous wastes.
6. The operator of the treatment and disposal facility must maintain the norms of operation of such a facility and for identification and assessment of hazardous waste sites.
7. The State Pollution Control Board examines the applications for handling hazardous wastes and approves or denies authorization, as well as concluding periodic reviews of handling procedures.
8. The State Government maintains an inventory of hazardous wastes, makes environmental impact studies and identifies sites for disposal of hazardous wastes.

Hazardous waste treatment Techniques

The hazardous waste management techniques present around the globe are classified into 3 major categories namely the physical treatment processes, chemical treatment processes and the biological treatment processes depending upon the type of waste and its individual characteristics.

The codes further state the need and steps that we need to take in order to properly exercise these techniques. These techniques are solely dependent upon the characteristics of waste and the land and geographical conditions prevalent in the area. The hazardous waste management techniques and their subcategories have been mentioned in **Table 8.3**.

With the discussion on inventory management, code provisos, hazardous waste management techniques, the need for an action plan rises for proper implementation of the actions. Thus, the action plan for hazardous waste management that depicts the present status, gap, and timeline for the same has been stated in **Table 8.4**.

Table-8.3: Hazardous Waste Treatment Techniques

Physical Treatment Process									
(i) Gas Cleaning									
Mechanical Collection	Electrostatic Precipitation	Fabric filter	Wet scrubbing	Activated carbon adsorption	Adsorption				
(ii) Liquid Solid separation									
Centrifugation	Clarification	Coagulation	Filtration	Flocculation	Floating	Foaming	Sedimentation	Thickening	
(iii) Removal of Scientific components									
Adsorption	Crystallization	Dialysis	Distillation	Electrodialysis	Evaporation	Leaching	Reverse Osmosis	Solvent Extraction	Stripping
Chemical Treatment Process									
Adsorption	Chemical Oxidation	Chemical Precipitation	Chemical reduction	Combination and addition	Ion exchange	Neutralization	Pyrolysis		
Biological Treatment Process									
Activated sludge	Aerobic lagoons	Anaerobic Lagoons	Spray irrigations	Trickling filter	Waste Stabilization Pond				

Table 8.4: Action plan for hazardous waste management

S. No.	Action Point	Present Status	Gap and Action plan	Timeline	Department
1.	Inventory management of hazardous waste	All ULBs of Bikaner district are currently unable to maintain inventory of hazardous waste being generated.	Compiling a detailed list of all hazardous waste sources, the characteristics of the wastes and the amount generated of each category in the district is very essential. This will ensure that all wastes have been accounted for and documented. The inventory must be complete before the remaining components of the system to be implemented. The codes lay the foundation of 44 processes that generate the hazardous waste as well as categorize the same into 18 different categories.	1 year	RSPCB and ULBs
2.	Waste Minimization	There is no record/data available whether the best practices are currently being followed to reduce the quantity and/or toxicity of hazardous wastes of hazardous wastes produced, recover and reuse spent materials, and exchange wastes with other companies.	There is a need to put sincere efforts to reduce the quantity and/or toxicity of hazardous wastes of hazardous wastes produced, recover and reuse spent materials, and exchange wastes with other companies.	1 year	RSPCB and ULBs
3.	Collection of hazardous waste	The practice for the collection of hazardous wastes is in place.	Though the practice for the collection of hazardous wastes is in place, active participation from the public and respective industries is also required. Proper labelling, packing and transporting should take place according to Motor Vehicle Act 1988. Public should be made aware to help collection of hazardous waste. Also, the stored wastes must be collected at regular intervals by licensed haulers and transported by tanker truck or by flatbed truck (for drum-held wastes) to disposal.	2 years	Local self-government
4.	Establishment of hazardous waste hauling/deposition centers	Though the nearest waste disposal center is situated in Udaipur, no dedicated deposition centers are notified in nearby areas where the	Locations should be identified in the nearby area of the Bikaner district to establish a hauling/deposition center for collecting hazardous waste so that it becomes convenient and cost-effective. Wastes	1 year	Local self-governments

S. No.	Action Point	Present Status	Gap and Action plan	Timeline	Department
		public can dump hazardous wastes.	should be either hauled to a regional physical chemical treatment plant for processing and concentration, or taken directly to an approved hazardous waste treatment facility for final disposal.		
5.	Implementation of bye laws	Hazardous Waste (Management and Handling) Rules, 1989	Necessary actions are to be taken by LSG's to notify the implementation of by-laws. Public should be made aware to implement bye laws as per the Hazardous Waste (Management and Handling) Rules.	2 years	Local self-governments, SPCB
6.	Generator records	No current practice of this sort is being followed.	The generator must maintain records regarding safe handling, storage, transportation and disposal practices and file an annual return. The generator must also report accidents to Rajasthan State Pollution Control Board.	1 year	RSPCB and ULBs
7.	Establishment of hazardous waste recycling center	Not existing in any of the ULB's	ULB's with no existing facilities should take appropriate actions to establish the recycling center as it is anticipated that the hazardous waste is going to increase in the near future.	2 years	Local self-governments
8.	Spillage	There is no record/data available whether the best practices are currently being followed regarding spillage issues.	A well-publicized emergency plan should be in place for protection of human health and the prevention of environmental damage in the event of spills or the release of contaminants. The recovery and safe disposal of spilled waste, absorbents, and contaminated soil must also be considered.	2 years	RSPCB, ULBs and District Administration

Chapter 9: Water Quality Management Plan

Bikaner district is located in the north-western part of Rajasthan and encompassed between north latitudes 27°11’ to 29°03’ and east longitudes 71°52’ to 74°15’ covering a geographical area of 30247.90 Sq. kms. It is bounded on the north by Ganganagar District, on the east by Hanumangarh and Churu Districts, on the south by Nagaur and Jodhpur Districts, and on the west by Jaisalmer District and International border with Pakistan. The district is divided into eight sub-divisions for administration and development, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, Chhattargarh, Pugal and Dungargarh and eight tehsils, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, Chhattargarh, Poogal, and Dungargarh. The developmental activities of the district are being looked after by six Panchayat Samities, i.e., Bikaner, Kolayat, Nokha, Loonkaransar, Khajuwala, and Dungargarh. There are 874 villages and 219 Gram panchayats. There is one independent SubTehsil Bajju situated in Kolayat tehsil for better administration. The district has one Municipal Council, 219 Gram Panchayats, and 874 Villages. As per the 2011 Census, the district's total population is 2363937 out of which 1563553 is rural population, and 800384 is urban population.

9.1 Groundwater Quantity

The Palana sandstone member of the Palana series is the main aquifer in the district. Other aquifer formations are sandstone and limestone of the Nagaur group of rocks. Jodhpur sandstone and Quaternary alluvium also form aquifer whenever they extend in the zone of saturation.

The groundwater conditions in different formations in the district are described below. Quaternary Aquifer: The unconsolidated Quaternary sediments attain the status of the aquifer in the area north of latitude 28°03’ except around Dhirera and Dhulmera, Mechanical analysis of the aquifer material collected during direct rotary drilling reveals the presence of 20% clay content in the aquifer with sorting coefficient varying from 1.3 to 3.34, the average being in the range of 1.5 to 2.5. The groundwater occurs under water table conditions, and the yield varies from 75 lpm to less than 950 lpm. The thickness of alluvium in the exploratory well at Godwala-II is 187m, and the yield of the well is 947 lpm (Gadwala-II). The drilled depth of this borehole was 418.49 m, whereas constructed depth was 187 m. The slim hole at Karmisar has been drilled

to the depth of 510.27 m. The main potential area is the central part, where Quaternaries form potential aquifers to attain saturation.

9.2. Palana Sandstone Aquifer

Palana sandstone belonging to the lower Eocene to Palaeocene age forms the main and potential aquifer in the district. Palana Sandstone is overlain by Quaternary deposits and is underlain by rocks belonging to Nagaur Group of Marwar Supergroup. It mainly occupies the eastern part of the area and extends up to the south-western boundary of the district, i.e., south of Kalasar. The exploratory drilling indicates that Palana sandstone comprises mainly fine to coarse-grained sandstone, well-sorted white to grey with a sometimes pink tinge, poorly to moderately cemented, soft, and friable. Locally, it is more gravelly, poorly sorted, and intercalated with thin clay beds, especially in the lower part, close to its contact with the thick lower members of the Palana series. According to the regional structural pattern, the saturated thickness of Palana sandstone aquifer increases towards the north, except in the axial part of the Bikaner syncline around Sital, where it is reduced to 15 meters only. North of Bikaner, the saturated thickness of 5 Palana sandstone aquifer is about 80 meters. In Gajner, Akasar, and Soa, the saturated thickness is negligible, but it again attains a thickness of about 100 m at Kolayat and Baneri. The drilled depth in Palana sandstone varies from 105 mbgl to 505 mbgl.

Palana aquifer is found to be under phreatic conditions. The specific capacity of wells ranges from 3.6 to 28.1 m^3 /hr/m, transmissivity ranges up to 720 m^2 /day, and permeability from 1.65 to 13.5 m/day. The transmissivity values remain much below 100m^2 /day in the axial zone of the Bikaner syncline, and relatively high values are expected in the north-eastern part around Bikaner-Sujandesar and around Raneri in the west. The average specific yield of the aquifer is estimated at 7%.

9.2.1. Aquifers of Nagaur Group

Only the upper part of the Nagaur Group of rocks comprising mainly sandstones has been encountered just below the Palana series in most of the Kolayat-Bikaner-Sital-Surpura area. Groundwater in Nagaur Sandstone occurs under confined conditions mostly. In the explored part, its saturated thickness varies from 40 to 310 m. However, the Nagaur sandstone aquifer occurs under water table conditions in the Nokha area. In this area, its saturated thickness varies from a few m to a little over 50 m at Nokha. The yield of wells varies from 200 to 750 lpm.

Transmissivity is low and ranges from 2.5 to 50 m2 /day. Permeability is correspondingly low. The specific capacity of wells varies from 0.17 to 1.20 m2 / hr/ m. The specific yield of Nagaur Sandstone is estimated at 1% only. In the southernmost part of the district, the lower members of the Nagaur group comprising limestone - evaporite sequence also form an aquifer of insignificant potential in a localized patch.

9.2.2. Aquifers of Jodhpur Group

Jodhpur sandstone is compact, fine to coarse-grained, micaceous and purple to reddish-brown. In most of the Bikaner area, it lies below the evaporite sequence and contains saline groundwater. Groundwater occurs under phreatic conditions in Palana sandstone and Quaternary sediments, whereas it occurs mostly under confined conditions in Nagaur sandstone and Jodhpur sandstone in the district. In Tertiaries and Quaternaries, perched water bodies are formed by arresting downward movement of rainfall percolation by shales and clay lenses in the zone of aeration. Depth to the water level in such bodies varies from 5 to 30 mbgl; the shallower is in the Pipal area and deeper in the Lunkaransar Kutuwas area.

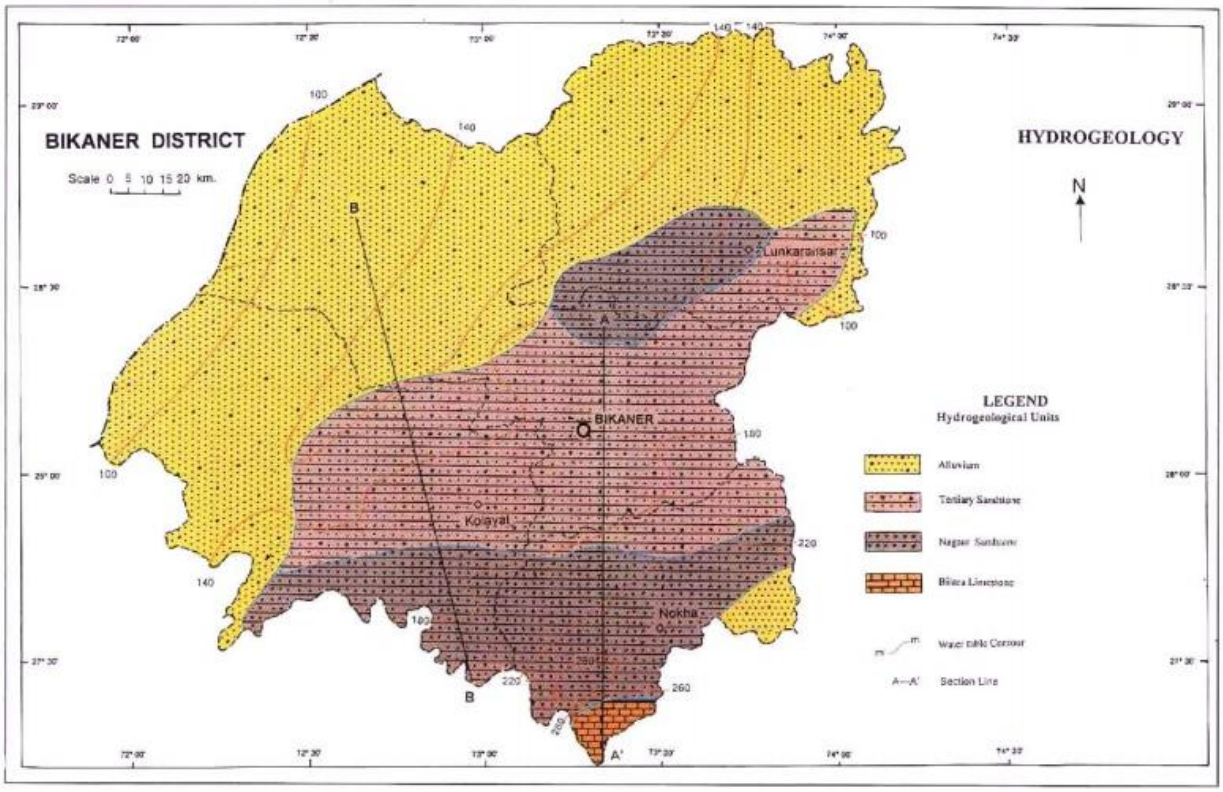


Figure 9.1. Hydrogeological map of Bikaner

Exploratory borehole data obtained by Central Ground Water Board has revealed that the Seasonal water level fluctuation of pre & post-monsoon, 2011 indicates a rise in all the blocks except central and western parts of Nokha, western and eastern parts of the Kolayat block, the southern part of the Bikaner block and northern part of Lunkaransar block only. The rising water level may be attributed to negligible exploitation of groundwater due to the salinity problem. As per the groundwater brochure of Bikaner district, Central Ground Water Board, and Ground Water Department, the Government of Rajasthan has jointly estimated Bikaner district's groundwater resources based on GEC-97 methodology it is noticed that the groundwater in Bikaner, Nokha, and Dungargarh is overexploited. It is also noticed that the groundwater in Khajuwala is saline because of which no water is being drawn for domestic use.

There is a need for scientific planning in the development of groundwater under different hydrogeological situations and to evolve effective management practices with community involvement for better groundwater governance. In view of emergent challenges in the groundwater sector in the state, there is an urgent need for comprehensive and realistic information pertaining to various aspects of groundwater resources available in different hydrogeological settings through systematic data collection, compilation, and data generation analysis and synthesis. The water quality and quantity of groundwater are monitored at few discrete wells in the district.

Therefore, mapping the groundwater level, quality of groundwater over the entire region of the Bikaner district is the need of the hour. Considering this in view, a detailed study is performed by collating the information available with CGWB and the Ministry of Jal Shakti. For a better understanding of the scenario, water level and water quality are discussed separately. Systematic and regular monitoring of groundwater levels brings out the changes taking place in the groundwater regime. The maps so generated are of immense help for regional groundwater flow modelling, which serves as a groundwater management tool to provide the necessary advance information to the user agencies to prepare contingency plans in case of unfavorable groundwater recharge situations. The data also has immense utility in deciding the legal issues arising out of the conflicting interests of groundwater users.

Water level data in Bikaner is monitored at 348 discrete locations, among with 134 are dug wells and 214 are piezometric wells. The spatial distribution of these monitoring wells is shown in **Figure 9.2**.

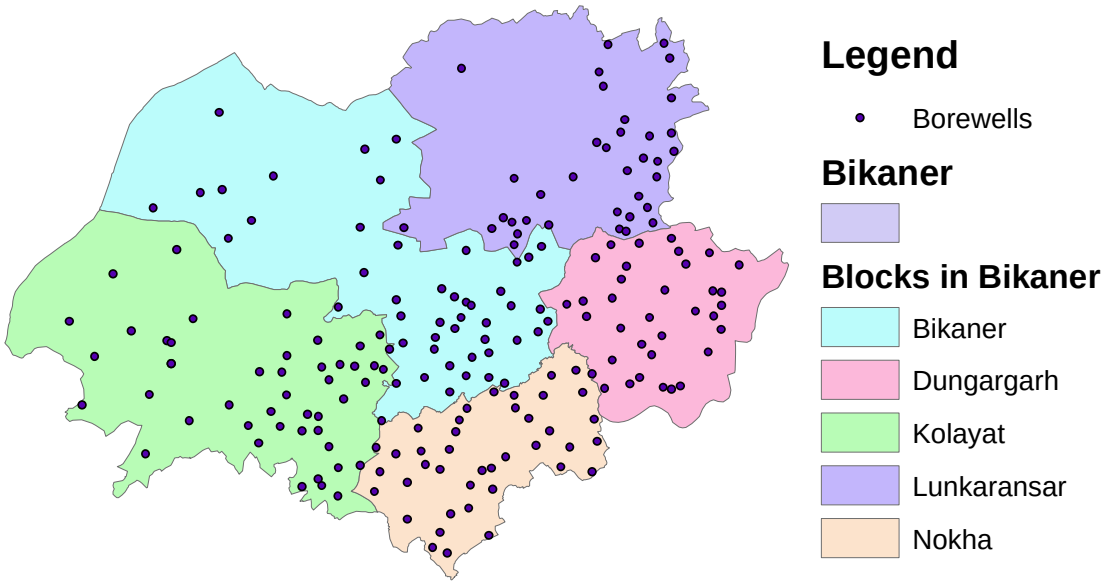


Figure 9.2: Spatial distribution of monitoring wells

The water level at these discrete locations during the pre-monsoon season and the post-monsoon season is reported by CGWB. The spatial variation of the water level during 2019 pre-monsoon and post monsoon is shown in **Figure 9.3 and Figure 9.4** respectively. It may be noted that the localities of damaged and dry wells are not shown in **Figure 9.3 and Figure 9.4.**

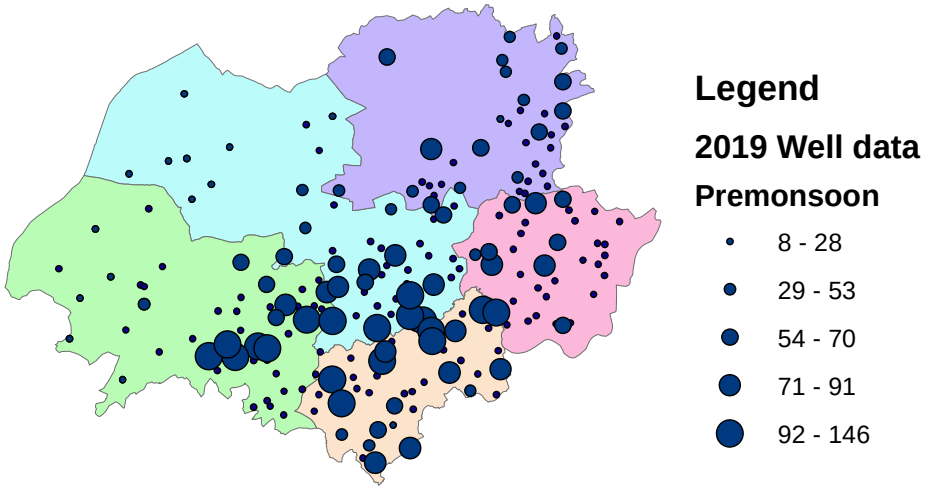


Figure 9.3. Water level data in the wells during pre-monsoon well in the year 2019

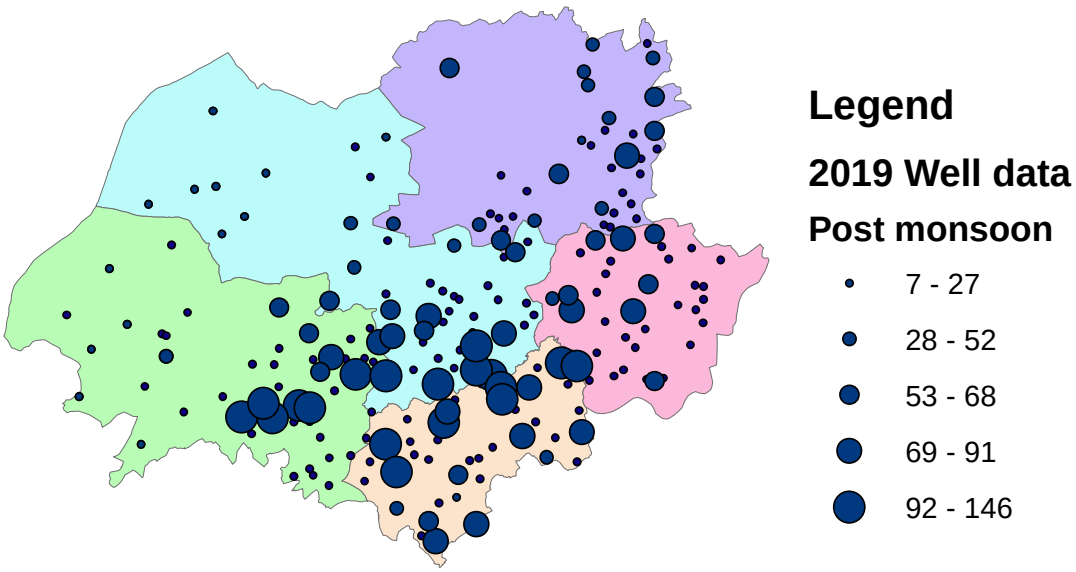


Figure 9.4. Water level data (m) in the wells during post-monsoon well in the year2019

Equivalent data for the pre-monsoon and post-monsoon season during 2020 is shown in **Figure 9.5 and Figure 9.6**.

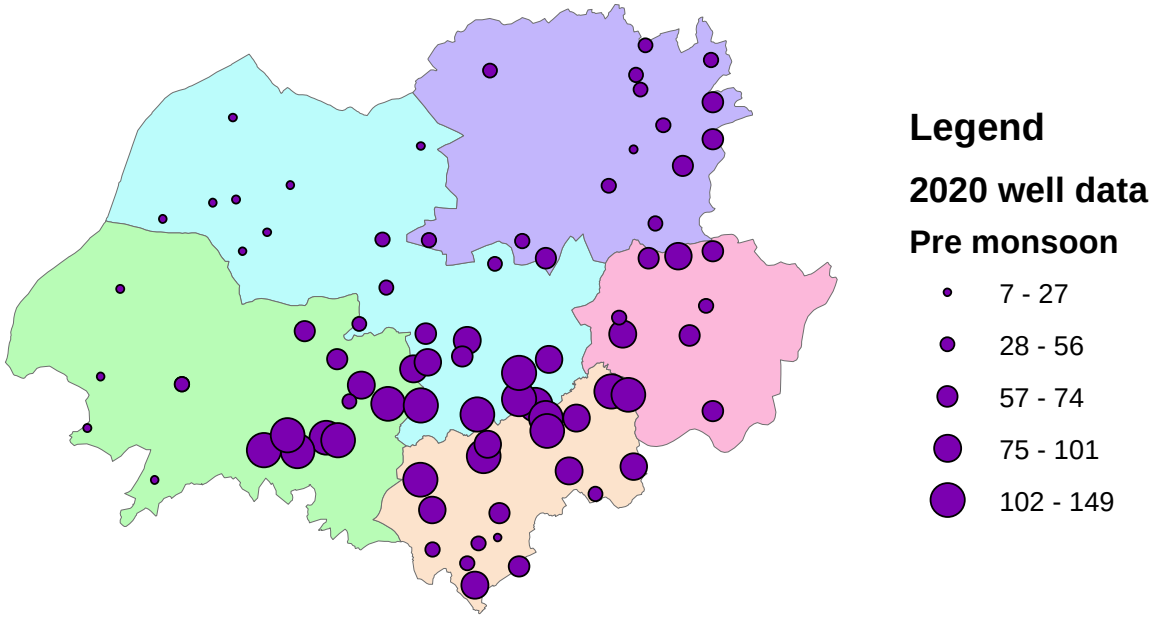


Figure 9.5. Water level data (m) in the wells during pre-monsoon well in the year 2020

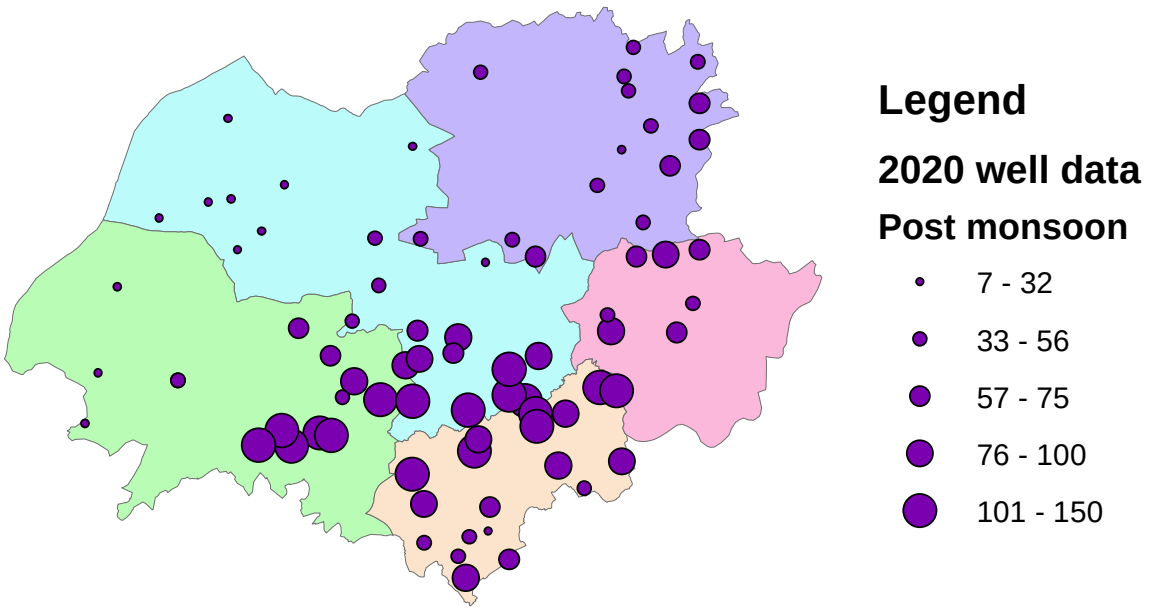


Figure 9.6. Water level data (m) in the wells during post-monsoon well in the year 2020

For a better understanding of the water level in the district, statistical analysis is performed, and the graphical summary of it is presented in **Figure 9.7**.

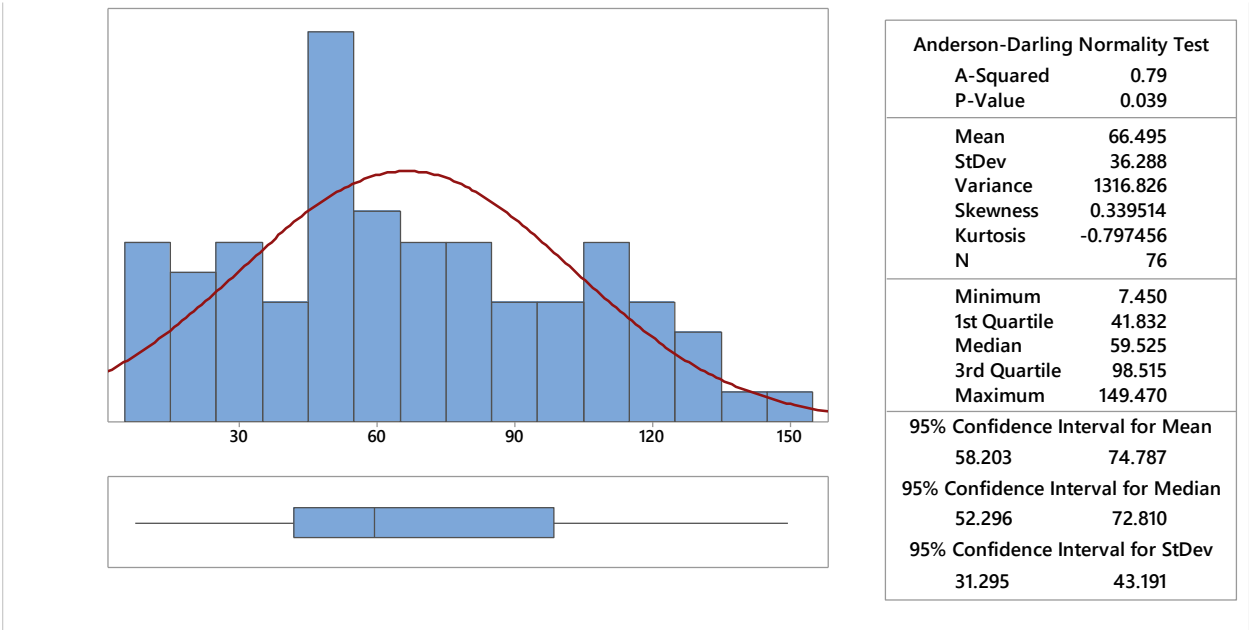


Figure 9.7. Graphical summary depicting the variation of water level in Bikaner district pre-monsoon season 2020

From Figure 9.7, it is evident that the variation of water level over the monitoring wells is notable. Nearly the water level at 19 borewells is below 41.83 meters, while the water level in

another 19 borewells is greater than 98.51 meters. The average water level of all the monitoring well is 66.49 meters. Though the graphical summary presents a brief overview of water level in all the borewells in Bikaner, the variation at the ungagged locations remains unmapped. Information on the water level over the entire Bikaner district helps in the management of existing water resources. Considering this, spatial interpolation techniques are used to map the water level variation over the entire district.

Kriging interpolation techniques are used to determine the spatial variation of the water level over the entire region, and the obtained variation for 2020 pre-monsoon period is presented in **Figure 9.8**. The equivalent analysis is made for the post-monsoon 2020 period, and the findings are presented in **Figure 9.9**.

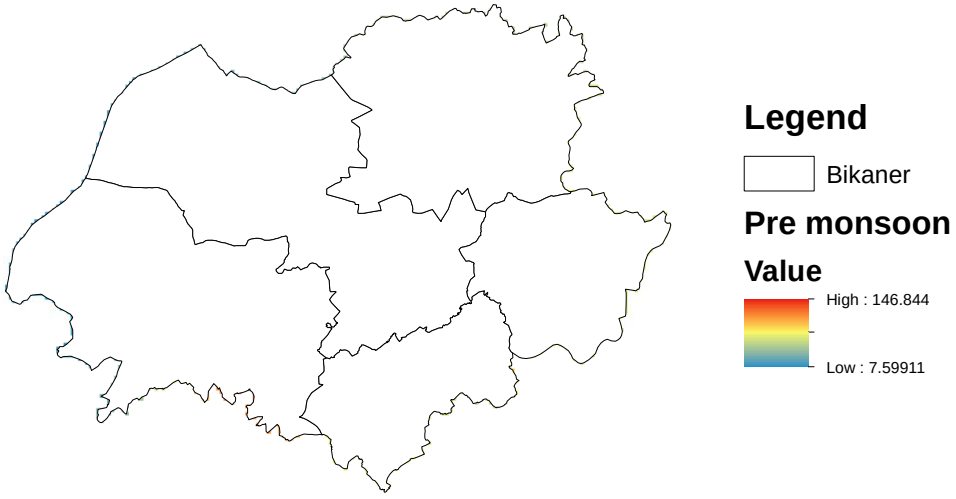


Figure 9.8. Variation of water level over Bikaner (Pre-monsoon, 2020)

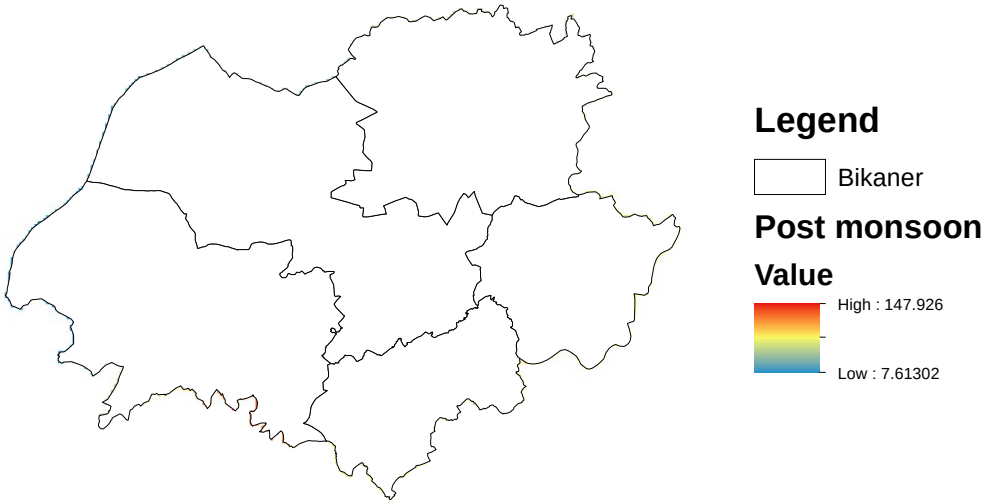


Figure 9.9. Variation of water level over Bikaner (Post-monsoon, 2020)

9.3Ground water quality

The chemical quality of groundwater in the district has been studied from the available chemical analysis data of water samples collected from the National hydrograph network stations located in various parts of the district. The analytical data of groundwater samples indicate that the groundwater is, in general, alkaline in nature. The groundwater of the Bikaner district possesses a relatively high mineral concentration, which varies considerably laterally and vertically.

The water quality data of exploratory bore holes reveal that the specific conductance varies from 650 to 80290 µS/cm at 25°C. The values more than 3000 µS/cm have been reported at Khujuwala (80290 µS/cm.) in the western part of the district; Motigarh (3485 µS/cm) in the central part of the district, Sajrasar (9515 µS/cm), Lunkaransar (11760 µS/cm), Badoniwali (12575 µS/cm), Malasar (35390 µS/cm), Sobhasar (5015 µS/cm), Banjarwali (19190 µS/cm), Goganpura (13800 µS/cm), Jesrasar (3100 µS/cm), Deshnok (5590 µS/cm), Palana (5270 µS/cm) andRaisar (4095 µS/cm) in the northern,central, eastern and south eastern parts of the district; and Govindsar (18980 µS/cm) andKolayat (7985 µS/cm) in south western part of the district. Chloride content also indicates a similar trend. Nitrate values vary from Traces at Govindsar to 480ppm at Jesrasar. The values of Nitrate more than 45 ppm have been found at Borabas (152 ppm), Raisar (384 ppm), Surpura (134 ppm), Hurlidhar Vyas colony, Bikaner (140 ppm), Civil lines Bikaner (210 ppm).

Detailed analysis of water samples collected from each block is available in the portal of Jal Jeevan Mission (https://ejalshakti.gov.in/). The details of quality parameters such as Turbidity (NTU) Arsenic (mg/l), Fluoride (mg/l), Iron (mg/l), Chloride(mg/l), Nitrate (mg/l), Sulphates (mg/l), Calcium(mg/l), Magnesium (mg/l), Manganese (mg/l), Copper (mg/l), E -Coli (MPN /100 ml), pH(pH), Salinity (mg/l), TDS (mg/l), Hardness (mg/l), Residual Chlorine (mg/l), Alkalinity (mg/l), Aluminum (mg/l), Coliform (MPN/100ml) are analyzed under the supervision of Department of Drinking water and sanitation. The block-wise statistics are analyzed, and the findings are presented in Table 9.1 below. The block-wise comparison of water quality parameters is analyzed, and the graphical summary of each variable is presented in **Figures 9.10-9.16.**

Table 9.1: Mean water quality of each block

ULB/Number of samples		Fluoride (mg/l)	Chloride (mg/l)	Nitrate (mg/l)	pH (pH)	TDS (mg/l)	Hardness (mg/l)
Bajju Khalsa (n=184)	Min	0.22	40	5	7.3	207	120
	Max	0.44	240	10	8.1	785	300
	Avg	0.24	42.44	6.82	7.63	249.08	137.77
Bikaner (n=466)	Min	0.18	30	0.31	7.2	220	60
	Max	2.63	1220	260	8.3	3570	1140
	Avg	0.51	219.06	22.60	7.76	809.36	253.78
Dungargarh (n=437)	Min	0.12	30	5	7.2	120	30
	Max	2.4	1570	250	8.51	3640	1260
	Avg	0.66	219.31	56.6	7.88	956.12	248.81
Khajuwala (n=153)	Min	0.22	4	4	7.34	218	120
	Max	0.26	50	8	7.8	260	150
	Avg	0.23	40.48	5.62	7.60	242.40	138.16

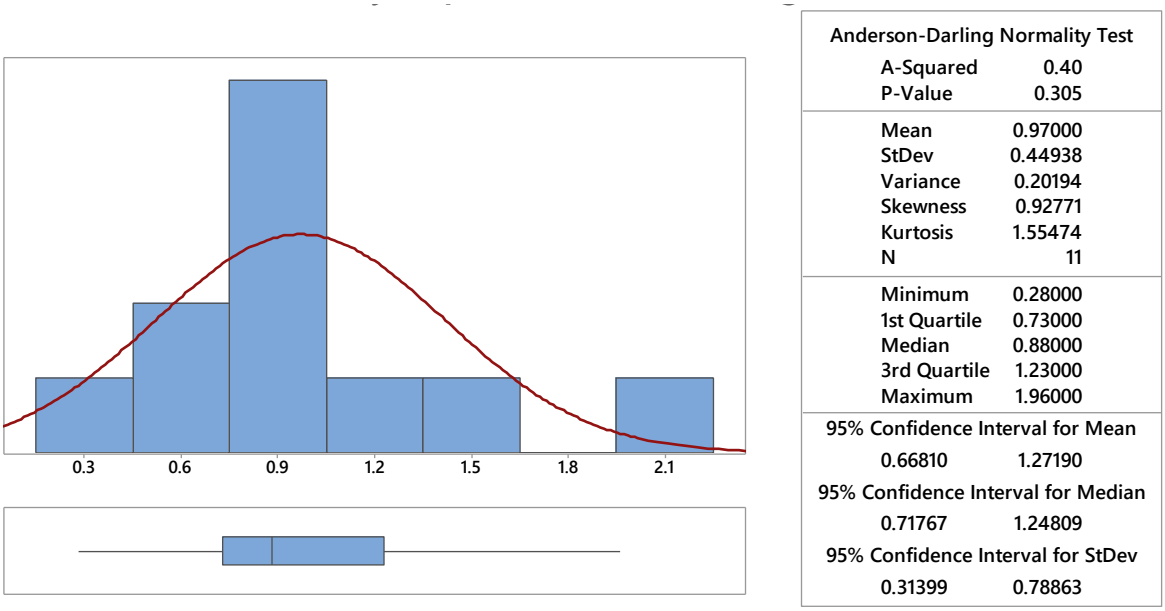
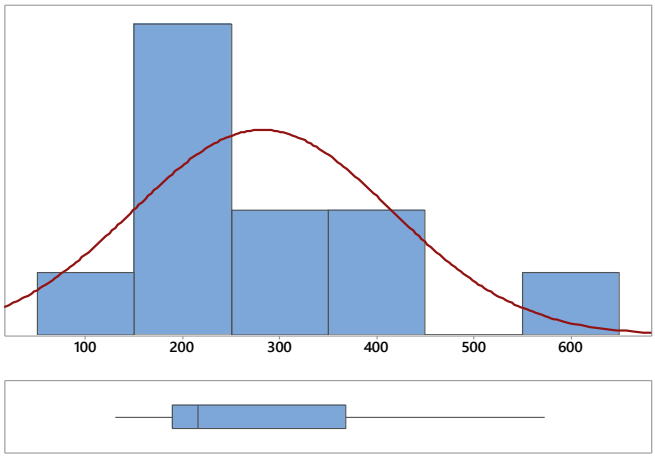
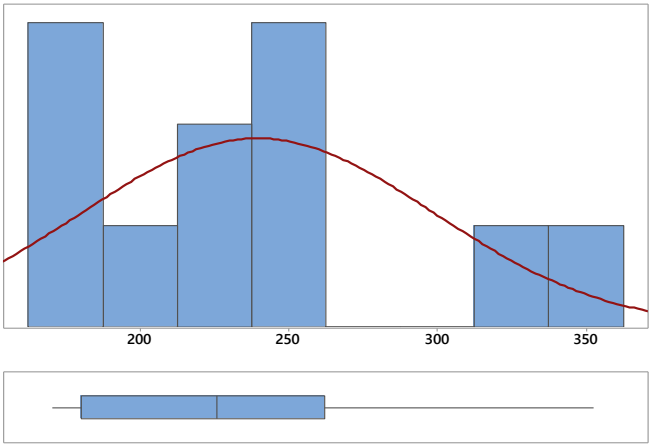


Figure 9.10. Statistical comparison of fluoride concentration in Bikaner



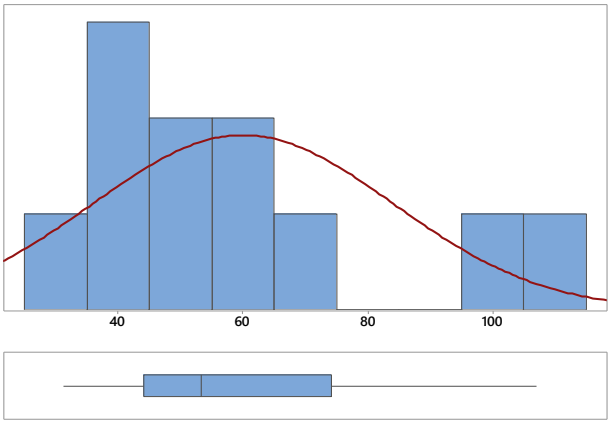
Anderson-Darling Normality Test	
A-Squared	0.58
P-Value	0.100
Mean	282.11
StDev	133.10
Variance	17716.64
Skewness	1.15581
Kurtosis	0.84684
N	11
Minimum	130.00
1st Quartile	189.75
Median	215.13
3rd Quartile	367.50
Maximum	573.55
95% Confidence Interval for Mean	
192.69	371.53
95% Confidence Interval for Median	
189.38	372.74
95% Confidence Interval for StDev	
93.00	233.59

Figure 9.11. Statistical comparison of chloride concentration in Bikaner



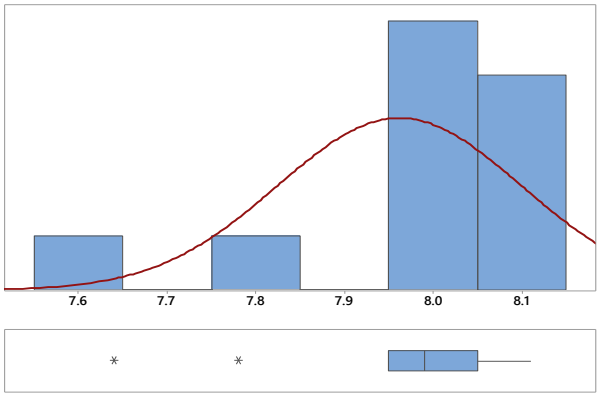
Anderson-Darling Normality Test	
A-Squared	0.35
P-Value	0.403
Mean	239.60
StDev	59.05
Variance	3487.46
Skewness	0.693763
Kurtosis	-0.144224
N	11
Minimum	170.49
1st Quartile	180.27
Median	225.96
3rd Quartile	262.04
Maximum	352.34
95% Confidence Interval for Mean	
199.93	279.27
95% Confidence Interval for Median	
179.66	267.07
95% Confidence Interval for StDev	
41.26	103.64

Figure 9.12. Statistical comparison of chloride concentration in Bikaner



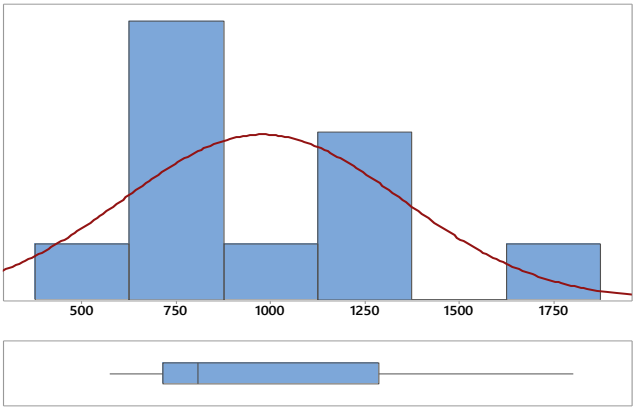
Anderson-Darling Normality Test	
A-Squared	0.46
P-Value	0.213
Mean	60.008
StDev	24.104
Variance	580.998
Skewness	0.956033
Kurtosis	0.171474
N	11
Minimum	31.150
1st Quartile	44.110
Median	53.360
3rd Quartile	74.250
Maximum	106.980
95% Confidence Interval for Mean	
43.815	76.201
95% Confidence Interval for Median	
43.367	76.122
95% Confidence Interval for StDev	
16.842	42.301

Figure 9.13: Statistical comparison of nitrate concentration in Bikaner



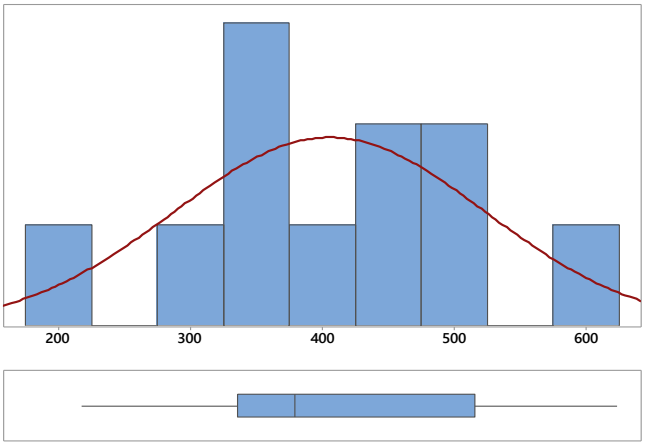
Anderson-Darling Normality Test	
A-Squared	0.87
P-Value	0.017
Mean	7.9618
StDev	0.1375
Variance	0.0189
Skewness	-1.57771
Kurtosis	2.26178
N	11
Minimum	7.6400
1st Quartile	7.9500
Median	7.9900
3rd Quartile	8.0500
Maximum	8.1100
95% Confidence Interval for Mean	
7.8695	8.0542
95% Confidence Interval for Median	
7.9360	8.0500
95% Confidence Interval for StDev	
0.0960	0.2412

Figure 9.14. Statistical comparison of pH concentration in Bikaner



Anderson-Darling Normality Test	
A-Squared	0.60
P-Value	0.087
Mean	978.47
StDev	370.12
Variance	136985.71
Skewness	1.16754
Kurtosis	0.96862
N	11
Minimum	574.64
1st Quartile	713.10
Median	808.32
3rd Quartile	1285.47
Maximum	1801.62
95% Confidence Interval for Mean	
729.82	1227.12
95% Confidence Interval for Median	
711.95	1286.61
95% Confidence Interval for StDev	
258.61	649.53

Figure 9.15. Statistical comparison of TDS concentration in Bikaner



Anderson-Darling Normality Test	
A-Squared	0.21
P-Value	0.805
Mean	405.54
StDev	117.64
Variance	13839.93
Skewness	0.301717
Kurtosis	-0.285973
N	11
Minimum	217.72
1st Quartile	335.42
Median	378.91
3rd Quartile	515.20
Maximum	623.19
95% Confidence Interval for Mean	
326.51	484.58
95% Confidence Interval for Median	
331.33	515.36
95% Confidence Interval for StDev	
82.20	206.46

Figure 9.16. Statistical comparison of Alkalinity concentration in Bikaner

9.3. GROUND WATER RELATED ISSUES AND PROBLEMS

9.3.1 Declining water level

Long-term water level data have indicated a declining water level trend. As a result, all the blocks except the Alsisar block have entered into the over-exploited category, which is needed to be controlled through notifying the blocks and a further imposing ban on construction of groundwater abstraction structures except under indispensable cases.

9.3.2. Fluoride hazards

Fluoride is an important constituent in determining the suitability of water for drinking purposes. A high fluoride concentration causes a mottling of teeth enamel, and regular intake of water with a high fluoride concentration may cause fluorosis. Fluoride concentration in the Bikaner district has been found to vary from traces to 1.45 ppm. For example, 4 out of 466 borewells in Bikaner and 10 out of 437 borewells in Dungargarh evidence that the fluoride concentration is beyond the permissible limits. Other than these borewells, the fluoride concentration is within permissible limits at the other borewells.

9.3.4. Nitrate hazards

The nitrate concentration in the groundwater varies widely. It ranges from Traces to as high as 420 ppm. In the northern and western parts of the district, nitrate concentration is under the permissible limit. 27 out of 467 borewells in Bikaner, 159 out of 437 borewells in Dungargarh evidence that the nitrate concentration is beyond the permissible limit, i.e., 45 mg/l while it is noticed that the concentration is within the permisisble limits in the remaining regions of Bikaner.

9.4. GROUND WATER DEVELOPMENT AND MANAGEMENT STRATEGY

9.4.1.Groundwater should be used judiciously, considering modern agriculture water management techniques by cultivating crops requiring less watering and use of sprinkler system and drip irrigation should be encouraged.

9.4.2.Modern agriculture management has to be taken into account for effective water management techniques involving the economic distribution of water, maintaining minimum pumping hours, and selecting the most suitable cost-effective crop pattern, i.e., for getting maximum agriculture production through minimum withdrawal. Adopting proper soil and

water management, even the groundwater with somewhat dissolved solids (TDS) may also be suitable for irrigation for salt-tolerant crops in the area having high salinity.

9.4.3. Desalination and defluorosis plants may be installed in the areas /villages facing groundwater salinity and fluoride hazards.

9.4.4The area is underlined by the moderate unsaturated thickness of alluvial, which provides sufficient scope of artificial augmentation of the groundwater body as alluvial formation has very good storage and transmission capacity in the district.

The surplus water during the rainfall can be used for artificial recharge through the various techniques feasible in alluvial and hard rock terrain. In the alluvial area, the following ways of recharge techniques may be adopted.

i) Rooftop/paved area rainwater harvesting for recharge to groundwater in the urban and industrial area.
ii) Village water runoff/rooftop water harvesting by dug wells/percolation tanks in the rural area.
iii) Construction of recharge shafts with gabion structures in nalas.
iv) Recharge by dug well/percolation pit in agriculture farm. In hard rock terrain, nala bunding, anicuts, dug wells, percolation tanks, etc. are feasible structures that may be used to recharge the groundwater body. Technical guidance is provided to various organizations as and when approached.

9.4.5.Mass awareness programmes should be arranged at the local level to make the common mass aware of the importance of groundwater resources, their better practices of use in domestic, irrigation, and industrial fronts, the present status of groundwater scenario, its conservation, etc.

9.4.6. Training programmes should be arranged at the local level to teach the common mass of various techniques of artificial augmentation to groundwater resources.

9.4.7.The water level fluctuations over the past reflect the excessive withdrawal of groundwater compared to recharge, resulting in depletion of groundwater levels and reduction in yields of wells.

9.5. Status and Inventory of water resources in Bikaner District

A short survey is conducted to collect the information of Water Resources Management Information and Inventory of water resources in Bikaner District and the collated information is shown in **Tables 9.1 to 9.9.**

Table 9.1. Inventory of water resources in Bikaner District

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**Overall in the district**
Population	[Nos as perprojectedin2011]	644406	62699	53294	18470	23,63,937
Population	[Nos as per projected in 2021]	765250	75606	61468	21046	
Rivers	Nos.	NA	NA	NA	NA	NA
Length of Coastline	meter	NA	NA	NA	NA	NA
Nalas/Drains meeting Rivers	Nos.	NA	NA	NA	NA	NA
Lakes / Ponds	Nos.	NA	NA	NA	NA	NA
Total Quantity of sewage and industrial discharge in District	MLD	NA	NA	NA	NA	NA

Table 9.2A: Details of Rivers in District

S. No.	**Name of River**	**Entry Point**	**Exit Point**	**Length**
1.	There is no river flowing through Bikaner district	NA	NA	NA

Note: If there is no river flowing through Bikaner district, please specify it.

Table 9.2B: List of Dam in District Bikaner under Water Resources Division, Bikaner

S. No.	**Name of Dams**	**Tehsil**	**FTL In Ft**	**GS in Mcft**	**LS (Mcft)**	**CCA in Ha**
1.	There is no dam in Bikaner district	NA	NA	NA	NA	NA

Table 9.2C: List of Dam in District Bikaner under Panchayat Raj Department

S. No.	Name of Dams	Gram Panchayat	Panchayat Samittee	Capacity In MCFT	CCA in Ha
1.	There is no dam in Bikaner district	NA	NA	NA	NA

Table 9.3: Control of Groundwater Water Quality

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**Overall in the district**
Population	[Nos as per projected in 2011]	644406	62699	53294	18470	23,63,937
Estimated number of bore-wells	[Nos]					20804(GW Assessment 2016-17)
No of permissions given for extraction of ground water	[Nos]					475
Number of ground water polluted areas	[Nos]	No	No	No	No	No
Ground water Availability	[adequate] /[not adequate]	1320.76 Hac.m(GW Assessment 2016-17)	00.00	0.0	00	3056.66 Hac.m

Table 9.4: Availability of Water Quality Data

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**
Population	[Nos as per projected in2011]	644406	62699	53294	18470
Creation of monitoring cell	[Yes] / [No]	No	No	No	No
Access to Surface water and ground water quality data at DM office	[Available] or[Not available]	No	No	No	No

Table 9.5: Control of River Side Activities

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per projected in2011]	644406	62699	53294	18470
River Side open defecation	[Fully Controlled] /[Partly controlled] /[no Measures taken]	Outside Basin	Outside Basin	Outside Basin	Outside Basin
Dumping of SW on river banks	[Fully Controlled] /[Partly controlled] /[no Measures taken]	Outside Basin	Outside Basin	Outside Basin	Outside Basin
Control measures for idol immersion	[Measures taken] /[Measures taken post immersion] / [No Measures taken]	Outside Basin	Outside Basin	Outside Basin	Outside Basin

Table 9.6: Control of Water Pollution in Rivers

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per projected in2011]	644406	62699	53294	18470
Percentage of untreated sewage	[%] (automatic SM1g/SM1a)	NA	NA	NA	NA
Monitoring of Action Plans for Rejuvenation of Rivers	[Monitored] /[Not monitored][not applicable]	NA	NA	NA	NA
No of directions given to industries for Discharge of Untreated industrial wastewater in last12 months	[Nos]	NA	NA	NA	NA

Table 9.7: Awareness Activities

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Overall in thedistrict
Population	[Nos as per projectedin 2011]	644406	62699	53294	18470	23,63,937
District level campaigns on protection of water quality	[Nos in previous year]	NA	NA	NA	NA	NA
Creation of District Oil Spill Crisis Management Group	[Created] / [Not Created]	NA	NA	NA	NA	NA
Preparation District Oil Spill Disaster Contingency Plan	[Prepared] / [Not Prepared]	NA	NA	NA	NA	NA

Table 9.8: Protection of Flood plains

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**Overall in thedistrict**
Population	[Nos as per projected in 2011]	644406	62699	53294	18470	23,63,937
Encroachment of flood plains is regulated.	[Yes] / [No]	No	No	No	No	No
Area affected	Hectare	No	No	No	No	No
Population affected	Nos	No	No	No	No	No

Table 9.9: Rainwater Harvesting

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**	**Overall in the district**
Population	[Nos as per projected in2011]	644406	62699	53294	18470	23,63,937
Action plan for Rain water harvesting	[Implemented] / [Not implemented]	NA	NA	NA	NA	NA

Table 9.6 Implementation strategy of Water Resources Management Plan

The details of measurable and quantifiable targets, responsibilities of various departments with timelines for completing the tasks are presented in **Table 9.10**

Table 9.10: Action plan for Water Resources Management Plan

S. No.	Action Points	Strategy and approach	Stake holders responsible
1.	Inventory of water resources in District	**Inventory of water resources in District covering Rivers, canals and other natural/ man made water bodies, Nalas/ Drains meeting Rivers Lakes / Ponds, etc. which is to be completed within June,2022**	CEO Zilla Parishad DFO ULBs
2.	Collection of Water Quality Data	**IoT enabled water quality sensors are to be installed in each of the monitoring wells to make the data collection centralized. This ensures the collection of water quality data without any errors.**	EE PHED
3.	Control of Groundwater Water Quality & Quantity	**Water quality of samples is analyzed, and the meticulous analysis of historic data revealed that the fluoride, chloride, nitrate, TDS, and hardness concertation in ground water is very high at various localities in Bikaner and Dungargarh**	EE PHED, ULBs, Ground Water Department
4.	Control of River side Activities	River side activities like Riverside open defecation, Dumping of solid waste on river banks, Idol immersion etc. to be controlled	District Administration EE PHED, BDOs EO of ULBs
5.	Awareness Activities	District level campaigns on protection of water quality and control of water pollution in rivers/canals and other water bodies.	EE PHE BDOs
6.	Protection of Flood plains	Encroachment of flood plains is to be regulated.	District Administration Circle Officers,
7.	Rainwater Harvesting	A separate action plan for rainwater harvesting in line with the Government policy would be prepared. From the collected data, it is observed that no notable actions are taken in any ULBs in this regard.	District Administration, EO of ULBs, BDOs
8.	Repair and treatment of water bodies/Talav	Water bodies have to be identified by the respective ULBs for restoration/ repair/and treatment work.	Dist. Admin BDOs Forest Department ULB officials CEO zila Parishad Land and water resource department
9.	Aqua life and ecological changes	Due to construction of Dams/Canals or other projects, study of any negative impact and their mitigation plans should be	Water Resource Department

S. No.	Action Points	Strategy and approach	Stake holders responsible
		assessed.	
10.	Awareness programs	Awareness programs on water quality, rain water harvesting should be conducted in each of the localities in Bikaner district. ULBs should collaborate with the local educational institutions to conduct the awareness programs.	All ULBs

Chapter 10: Domestic Sewage & Industrial Wastewater Management

This Chapter includes the details of ULB-wise sewage generation, treatment capacity available and treatment capacity utilization, sewerage connectivity, gap of treatment. The relevant information related to functioning status of treatment plant (if exists) and effluent discharge standards used and efficiency of plants are also included. Datasheet duly filled by concerned officials has been presented as per the format prescribed by CPCB for Model DEPs. Finally, it emphasizes the details of action plans along with the actionable points, present status of implementation, gap to be addressed, and proposed time line for completion of the relevant tasks. The activities are suggested by keeping in view of the future generation of wastes etc.

10.1 Present scenario of domestic sewage management

Safe potable water supply and hygienic sanitation facilities are basic essential requirements for healthy community and is to be given top priority. The safe water supply is essential throughout the year in all towns, urban centers and rural villages but it is quite challenging to maintain adequate quantity of supply of water in acute summer seasons. Similarly, hygienic sanitation facilities by means of appropriate treatment options are must to achieve proper living standards and quality of life of the people both in urban and rural areas. It also becomes important because about 80% of water used by the community comes out from houses and apartments, mostly coming from the kitchen, bathroom, and laundry sources. Things like dishwashing, the garbage disposal, and of course baths and showers are included in the mix in the form of waste water which unless properly collected, conveyed, treated and safely disposed off may eventually contaminate our valuable land and water resources, cause environmental degradation and cause of various health issues. The provision of safe drinking water alone cannot be sufficient to break the chain of water borne diseases. The safe disposal of wastewater is even much more important. Whenever, wastewater is disposed, it is essential to adopt appropriate treatment technologies to prevent any injury or health hazards. The projected total amount of sewage waste generated from each of the Urban Local Body (ULB) in 2021 is shown in **Figure 10.1**.

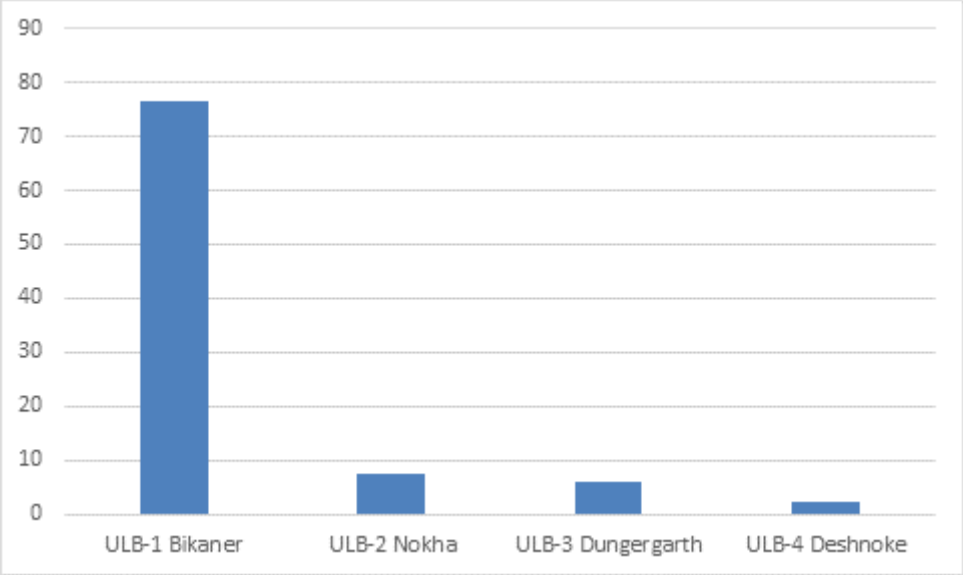


Figure 10.1: Amount of domestic sewage (in MT) generated in each ULB of Bikaner

For mapping the current scenario of the existing domestic sewage management practices, a survey with the representatives of each ULB has been conducted and the details of the inventory available is collated as summarized in **Tables 10.1 to 10.3**.

Currently all ULBs of Bikaner district either do not have appropriate domestic sewage treatment capacity facility or they do not have sufficient sewerage networks to transport it from its source (households) to the treatment plant. From the collected information, it is noticed that all the households in ULB's are not connected to sewage management infrastructure either at home or though proper drain across ULB to Sewage Treatment Plant. As a result, only some fraction of the sewage collected from these households is treated efficiently either at primary or secondary sewage treatment plants under current circumstances. Also, no systematic plan has been found to reuse this treated wastewater. The treated wastewater and sludge could be used effectively for crop irrigation or for public parks, sports fields, etc. provided certain quality constraints are met. Irrigational use of treated wastewater from STPs should not be regarded as just primitive and inferior method of getting rid of wastewater or sludge. Properly designed and operated, irrigation systems can be convenient and low cost methods, comparable with tertiary treatment and capable of satisfying environmental criteria. The reuse of treated effluents has definitely much wider application especially in arid or semi-arid regions.

The remaining domestic wastewater/ human excreta generated from urban population in different ULBs of Bikaner district is either being disposed in the form of on-site sanitation

like septic tank/soak pit or, bathroom and kitchen wastewater are being disposed into side road drains or directly on roads, thereby creating unhygienic conditions or, open defecation has been taking place due to non-availability of sanitation facilities. Though the septic tanks are an accepted onsite treatment, as the septic tanks are not designed and maintained properly, the effluent does not confirm to the standards. Due to poor maintenance, septic tanks do not function properly and often overflow into drains.

The untreated or partially treated sewage of about 60.15 MLD out of 92.3 MLD generated by them flows onto the land in low lying area, which mixes into the soil or water bodies directly or indirectly. It can also degrade quality of groundwater. Considering the increasing population, which consequently rises the amount of domestic sewage generation, there is a great need to speed up the process of connecting all households to the STP Plants.

Very few STP's are installed in the Bikaner district. Two out of four ULB's have STP with partial treatment capacity. The geotagged image of STPs in Bikaner and Nokha are shown in **Figures 10.2 and 10.3**, respectively.

ULB-1 Bikaner has one existing sewage treatment plant (STP) of 40 MLD capacity, which is located in Sardul Colony (Ballabh Garden), Bikaner, and it is based on SBR technology (**Figure 10.2A**). Another existing STP of 12 MLD capacity, located in Sarah Nathaniya (ULB-1 Bikaner), has been upgraded with SBR technology which was earlier working based on oxidation pond technology (**Figure 10.2B**). Sewer lines are very old which were installed in 1979-80 and are not sufficient to fulfill the present day requirement. These sewer lines can carry sewage flow of only 60% of the designed flow rate of existing plants of 52MLD. Hence, effective treatment of these plants is 0.60x52 = 31.2 MLD as all target population is not connected to the sewer lines against the required total sewage treatment capacity of 76.5 MLD. The remaining 45.3 MLD untreated or partially treated sewage has been discharged directly or indirectly into the environment.

Therefore, Nagar Nigam Bikaner is working on its up-gradation and new connectivity. DPR shall be prepared by the end of December, and funds shall be mobilized in due course of time so that tendering and work orders can be issued. The third STP of ULB-1 Bikaner of 20 MLD STP has also been constructed RUIDP in Ganga Shahar, near Kali Mata Mandir (**Figure 10.2C**). This is also based on SBR technology. The commissioning of this STP shall take place by the end of December.

ULB-2 Nokha has one existing sewage treatment plant of 1.0 MLD capacity, and it is based on SBR technology (Figure 10.3). About 95% target population is connected to the existing plants of 1.0 MLD as of September 2021. Hence effective treatment being done by the existing plant is 0.95x1.0 = 0.95 MLD. Two STPs with a treatment capacity of 4.0 MLD and 7.0 MLD have been proposed to install in Madia village and Roda village towards Charkada, respectively, under RUIDP Phase IV. These two STPs with a total treatment capacity of 11.0 MLD are under proposal development and may be commissioned by December 2024. Hence this ULB has an effective treatment capacity of STPs 0.95 MLD against the required toral sewage treatment capacity of 7.6 MLD. The remaining 6.65 MLD untreated or partially treated sewage has been discharged directly or indirectly into the environment.

Figure 10.2A: Existing STP located on Sardul Colony (Ballabh Garden), Bikaner, Bikaner (Capacity of plant is 40 MLD)

Figure 10.2B: Existing STP located in Sarah Nathaniya, Bikaner (28.047914^0 N, 73.266462^0 E) being upgraded to SBR Technology (Capacity of plant is 12.0 MLD)
(a) Field photograph (b) Satellite imagery in 2015 (c) Satellite imagery in 2021

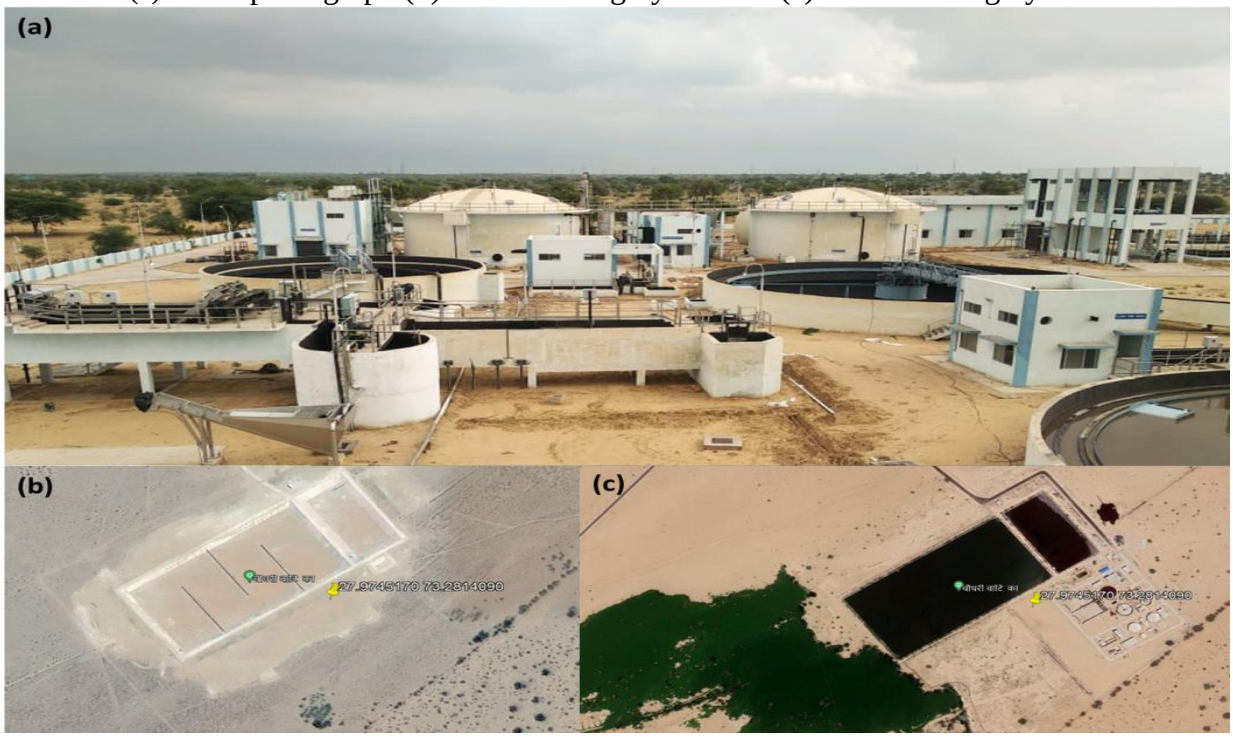


Figure 10.2C:STP located near Kali Mata Mandir, Gangashaha, Bikaner (27.9745170N, 73.2814090E) under construction (Capacity of plant is 20.0 MLD)
Field photograph (b) Satellite imagery in 2015 (c) Satellite imagery in 2021

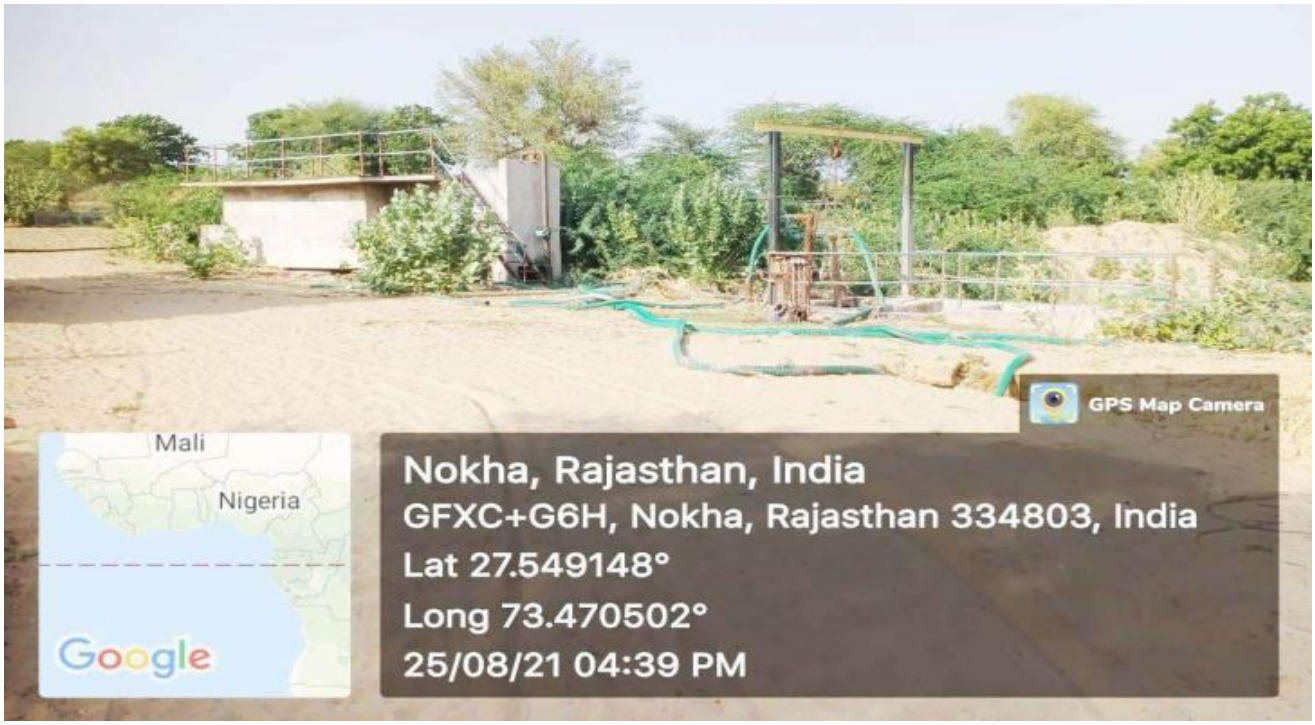


Figure 10.3: Existing STP located in Municipal Board Nokha, Bikaner (Capacity of plant is 1.0 MLD)

The status and the number of STPs required in each of the ULB is presented in **Table 10.1**. The details of adequacies of available infrastructure for sewage treatment and Sewerage Network are given in **Table 10.2 and Table 10.3 respectively**.

As STP's are located in a few of the ULB's, it is noticed that the quantity of untreated waste is relatively on a higher side. Lack of connectivity between household and the STP's is identified as the prime reason. Very few towns in the district has a sewerage network. Moreover, the percentage of population covered under the sewerage network is still on a lower side. Therefore, there is a great need to propel the connectivity between the household and the STP units.

It is therefore necessary to develop sewerage networks by connecting all households to installed Sewage Treatment Plants (STPs). Also those ULBs who do not have STP as on date should immediately plan to set up suitable STP of adequate capacity.

Table 10.1: Inventory of Sewage Management

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Total Quantity of Sewage generated in District from towns in 2021	[MLD]	76.5	7.6	6.1	2.1
Total Quantity of Sewage to be generated in District from towns in 2036	[MLD]	92.7	9.5	7.3	2.5
No of Class-II towns and above(having 0.5 to 1 lac population)	[Nos]	0	1	1	0
No of Class-I towns and above(having more than 1.0 lac population)	[Nos]	1	0	0	0
No of STPs installed	[Nos]	*2 STPs [40 MLD, 12 MLD]	1 STP [1.0 MLD]	0	0
No. of Towns needing STPs	[Nos]	01 STP [20 MLD in Ganga Sahar is under construction stage] + 01 additional [4.5 may be proposed should be installed by June 2024]*	02 [STP/FSTPs are required with their Capacity as 4 MLD & 7 MLD] which should be installed by June 2025]*	02 [FSTP is required which should be installed by June 2025]*. Proposal to install FSTP facility is under consideration. Survey and DPR is under preparation.	01 [STP/FSTP is required which should be installed by June 2025]*
Quantity of treated sewage flowing into Rivers (directly or indirectly)	[MLD]	0	0	0	0
Quantity of untreated or partially treated sewage (directly or indirectly)	[MLD]	45.3*	6.65*	6.1***	2.1****
Quantity of sewage flowing into lakes	[MLD]	0	0	0	0
Number of industrial townships	[Nos]	1	0	0	0

*Municipal Board Bikaner: The present available sewage treatment capacity is 52.00 MLD@1 STP with 40 MLD capacity and another STP of 12 MLD capacity. The existing sewer lines can carry sewage flow of only 60% of the designed flow rate of existing plants of 52MLD. Hence, effective treatment of these plants is 0.60x52 = 31.2 MLD as all target population is not connected to the sewer lines against the required total sewage treatment capacity of 76.5 MLD. RUIDP is constructing another STP of 20 MLD capacity near Kali Mata Mandir in Ganga Shahar that is based on SBR Technology. The commissioning of this STP shall take place by the end of December. Hence the quantity of untreated or partially treated sewage (discharged directly or indirectly into the environment) = total wastewater generated – effective quantity of treatment being done = 76.5-31.2 = 45.3 MLD.

**Municipal Board Nokha: There is one STP available with its sewage treatment capacity of 1.00 MLD. About 95% target population is connected to the existing plants of 1.0MLD as of September 2021. Hence effective treatment by these plants in ULB-2 is 0.95x1.0 = 0.95 MLD against the required toral sewage treatment capacity of 7.6 MLD. Two STPs with a treatment capacity of 4.0 MLD and 7.0 MLD have been proposed to install in Madia village and Roda village towards Charkada, respectively, under RUIDP Phase IV. These two STPs with a total treatment capacity of 11.0 MLD are under proposal development and may be commissioned by December 2025. About 6.65 MLD untreated or partially treated sewage has been discharged directly or indirectly into the environment.

***Municipal Board Dungargarh: There is no STP and sewerage network connectivity currently. ULB should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 6.1 MLD, and hence two STPs (or Faecal sludge Treatment Plant facility) with 6.1 MLD should be installed by June 2025.

****Municipal Board Deshnoke: There is no STP and sewerage network connectivity currently. ULB should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 2.1 MLD, and hence one STP (or Faecal sludge Treatment Plant facility) with 2.1 MLD should be installed by June 2025.

Table 10.2: Adequacy of Available Infrastructure for Sewage Treatment

Attributes	Unit	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Total Quantity of Sewage generated in District from towns in 2021	[MLD]	76.5	7.6	6.1	2.1
Total Quantity of Sewage to be generated in District from towns in 2036	[MLD]	92.7	9.5	7.3	2.5
% sewage treated in STPs	percentage	31.20 *	0.95**	0	0
Total available Treatment Capacity	[MLD]	52.0	1.0	0	0
Additional treatment capacity required	[MLD]	24.5*	6.65**	6.1#	2.1##

*Municipal Board Bikaner: The present available sewage treatment capacity is 52.00 MLD@1 STP with 40 MLD capacity and another STP of 12 MLD capacity. The existing sewer lines can carry sewage flow of only 60% of the designed flow rate of existing plants of 52MLD. Hence, effective treatment of these plants is 0.60x52 = 31.2 MLD as all target population is not connected to the sewer lines against the required total sewage treatment capacity of 76.5 MLD. RUIDP is constructing another STP of 20 MLD capacity near Kali Mata Mandir in Ganga Shahar that is based on SBR Technology. The commissioning of this STP shall take place by the end of December. Hence the quantity of untreated or partially treated sewage (discharged directly or indirectly into the environment) = total wastewater generated – effective quantity of treatment being done = 76.5-31.2 = 45.3 MLD.

**Municipal Board Nokha: There is one STP available with its sewage treatment capacity of 1.00 MLD. About 95% target population is connected to the existing plants of 1.0MLD as of September 2021. Hence effective treatment by these plants in ULB-2 is 0.95x1.0 = 0.95 MLD against the required toral sewage treatment capacity of 7.6 MLD. Two STPs with a treatment capacity of 4.0 MLD and 7.0 MLD have been proposed to install in Madia village and Roda village towards Charkada, respectively, under RUIDP Phase IV. These two STPs with a total treatment capacity of 11.0 MLD are under proposal development and may be commissioned by December 2025. About 6.65 MLD untreated or partially treated sewage has been discharged directly or indirectly into the environment.

#Municipal Board Dungargarh: There is no STP and sewerage network connectivity currently. ULB should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 6.1 MLD, and hence two STPs (or Faecal sludge Treatment Plant facility) with 6.1 MLD should be installed by June 2025.

##Municipal Board Deshnoke: There is no STP and sewerage network connectivity currently. ULB should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 2.1 MLD, and hence one STP (or Faecal sludge Treatment Plant facility) with 2.1 MLD should be installed by June 2025.

Table 10.3: Adequacy of Sewerage Network

Attributes	**Unit**	**ULB-1 Bikaner**	**ULB-2 Nokha**	**ULB-3 Dungergarth**	**ULB-4 Deshnoke**
Population	[Nos as per 2011 census]	644406	62699	53312	18470
Population	[Nos as per projected in 2021]	765250	75606	61468	21046
Total Quantity of Sewage generated in District from towns in 2021	[MLD]	76.5	7.6	6.1	2.1
No of ULBs having partial underground sewerage network	[Nos]	1	1	0	0
No of towns not having sewerage network	[Nos]	1	1	1	1
% population covered under sewerage network as on August 2021	[percentage]	31.20	95	0	0

10.2 Projection of future generation of domestic wastewater

Adequate quantity of generation of wastewater should be considered while designing collection, conveyance, treatment and safe disposal systems. The quantity of domestic waste water has been estimated for the year 2021, 2036 and 2036 as shown in **Table 10.4.**

Table 10.4: Future assessment of generation of domestic wastewater

Name of ULB	Year		
	2021	2036	2051
ULB-1 Bikaner	76.5	92.7	109.2
ULB-2 Nokha	7.6	9.5	11.4
ULB-3 Dungergarth	6.1	7.3	8.5
ULB-4 Deshnoke	2.1	2.5	2.9

The capacity requirement of STPs varies 15-25% for years 2021 and 2036 in different ULBs. As in SBR technology based STPs can handle flowrate quantity with a variation of 20-25% in an effective manner by changing the cycle duration and oxygen requirement, SBR technology may be used in these towns to meet not only the current requirement but also they can be used for future requirement of year 2036.

10.3 Industrial Wastewater Management Plan

Industrial wastewater is one of the significant pollution sources of water. A considerable amount of industrial wastewater has been discharged into different water bodies such as rivers, lakes, groundwater, etc. This results in severe pollution problems in the water environment and causes adverse effects on the ecosystem and human life. The characteristics of industrial wastewater depend on the type of industries as they produce types of contaminants.

The inventory of industrial wastewater generation in the Bikaner District is presented in Table 10.5.

Table 10.5: Inventory of industrial wastewater Generation in District

Attributes	Unit	Total Nos. in the district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
No of Industries discharging wastewater	[Nos]	63	56	4	0	0
Total Quantity of industrial wastewater generated	[KLD]	476.99 KLD/day	455.84 KLD/day	21.15 KLD/day	0	0
Quantity of treated IWW discharged into Nalas / Rivers	[MLD]	Nil	Nil	Nil	Nil	Nil
Quantity of un-treated or partially treated IWW discharged into lakes	[MLD]	Nil	Nil	Nil	Nil	Nil
Prominent Type of Industries	[Agro based] / [Chemical – Dye etc.] / [Metallurgical] / [Pharma] / [Pesticide] / [Power Plants] / [Mining] / [Automobile]	Wool Scouring Unit/ Food Processing Unit (63)	56	4	0	0
Common Effluent Treatment Facilities	[Nos] / [No CETPs]	No CETPs (Proposed No. 2)	Nil	Nil	Nil	Nil

Attributes	Unit	Total Nos. in the district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke
No of Industries meeting Discharge Standards	[Nos]	60	53	4	0	0
No of Industries not meeting discharge Standards	[Automatic]	3	3	0	0	0
No of complaints received or number of recurring complaints against industrial pollution in last 3 months	[Nos]	Nil	Nil	Nil	Nil	Nil
No industries closed for exceeding standards in last 3 months	[Nos]	Nil	Nil	Nil	Nil	Nil
No of industries where Environmental Compensation was imposed By SPCBs	[Nos]	Nil	Nil	Nil	Nil	Nil

The current status of indusial areas in Bikaner district along with their positive and negative outcomes are given in **Table 10.6**.

Table 10.6: Action Areas and their outcomes

S. No.	Action Areas	Outcome
1.	Inventorization of Water polluting industries	Done
2.	STPs in Water Polluting Industries	Provided and being monitored by RSPCB, Bikaner regularly.
3.	Direction and action to be taken against the industry for improving the conditions of existing water pollution control devices and increase in vigilance	Being done. Regular inspection and monitoring of all industries is being carried out by RSPCB. If any violation is observed. RSPCB is taking strictactionagainstthemunderWaterAct,1974.
4.	No Common Effluent Treatment Plant/STP in industrial Area	Not initiated
5.	Reusing of treated effluent by Industries	Not initiated
6.	Adoption of ZLD by industries	Not initiated

- The officials of RSPCB Bikaner used to submit monthly status reports of STP, CETP & ETP to Head office, RSPCB, Jaipur for further submission to CPCB.
- Besides this, review meetings used to be held under the chairmanship of Member Secretary, RSPCB, with stakeholder departments/ agencies responsible for operation & maintenance of the STPs. The responsible agencies/ authorities were directed to:
    - Improve operation and maintenance of the STPs.
    - Upgrade all the STP to achieve prescribed standards.
    - Explore the possibility of reuse of treated water of STP for gainful purposes and by nearby industrial units.
- There is no CETP in the Bikaner district. Installation of two CETPs have been proposed.

10.4 Role and Responsibilities of Authorities and actions require for Domestic Sewage Management and Industrial development scenario

In view of the existing inventory, sewage connections, population and industrial development, the following action plans (shown in **Table 10.7**) are proposed for the effective management of domestic sewage management.

Table 10.7: Action plan for domestic sewage and industrial wastewater/wastes management plan

S. N.	Action Points	Responsible Authorities	Strategy and approach & Time frame
1.	Inventory of Sewage Management	ULBs/ Village Panchayat	All ULBs/ Village Panchayat should complete the survey and identification all Households to ensure proper drainage and management of sewage. They should validate the projection of sewage generation rate and evaluate options for disposal system within one year.
2.	Adequacy of Available Infrastructure for Sewage Treatment	ULBs/ Village Panchayat	• All ULBs/ Village Panchayat must find out the treatment facility required and available within one year and make a plan for better wastes water management. • Some Household may have its own Sewage management infrastructure so as to pull down this water to maintain water level in earth and to reuse this water at various other domestic works after removing contaminants. i.e., Grey water after removing contaminants may be used in gardens, toilet flushing etc. • All households should be connected to sewage management

S. N.	Action Points	Responsible Authorities	Strategy and approach & Time frame
			infrastructure either at home or though proper drain across ULB to Sewage treatment Plant.
3.	Adequacy of Sewerage Network	ULBs/ Village Panchayat	• Proper sewerage systems to be constructed to connect all Households under each ULB to ensure total sewage management. • Bikaner Municipal Board: The present treatment capacity is 52.00 MLD, and 60% of the targeted population is connected with two plants as of September 2021. Hence, effective treatment of these plants is 0.60x52 = 31.2 MLD as all target population is not connected to the sewer lines against the required projected total sewage treatment capacity of 76.5 MLD. RUIDP is constructing another STP of 20 MLD capacity near Kali Mata Mandir in Ganga Shahar that is based on SBR Technology. The commissioning of this STP shall take place by the end of December. Hence the quantity of untreated or partially treated sewage (discharged directly or indirectly into the environment) = total wastewater generated – effective quantity of treatment being done = 76.5-31.2 = 45.3 MLD. Municipal board should work to commission 20 MLD plant located near Kali Mata Mandir in Gangashahar by December 2021. They should also expedite the expansion proposal of sewer lines up to the required capacity to cover all households to fulfill the requirement by June 2024. Also, an additional STP/FSTP of 4.5 MLD should be installed by June 2024. • Municipal Board Nokha: The present treatment capacity is 1.00 MLD, and 95% of the targeted population is connected with these plant as of September 2021. Hence effective treatment by these plants in ULB-2 is 0.95x1.0 = 0.95 MLD against the required toral sewage treatment capacity of 7.6 MLD. Two STPs with a treatment capacity of 4.0 MLD and 7.0 MLD have been proposed to install in Madia village and Roda village towards Charkada, respectively, under RUIDP Phase IV. These two STPs with a total treatment capacity of 11.0 MLD are under proposal development and should positively be commissioned by June 2025 with complete sewerage network connectivity for all households. About 6.65 MLD untreated or partially treated sewage has been discharged directly or indirectly into the environment. • Municipal Board Dungargarh: There is no STP and sewerage network connectivity currently. The municipal board should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 6.1 MLD, and hence two STPs (or Faecal sludge Treatment Plant facility) with 6.1 MLD should be installed by June 2025. • Municipal Board Deshnoke: There is no STP and sewerage network connectivity currently. The municipal board should work on a proposal with a detailed project report (DPR) to install faecal sludge treatment plant (FSTP) to cater to their needs. Currently, all quantity of untreated sewage (directly or indirectly) is being disposed to the environment = 2.1 MLD, and hence one STP (or Faecal sludge Treatment Plant facility)

S. N.	Action Points	Responsible Authorities	Strategy and approach & Time frame
			with 2.1 MLD should be installed by June 2025. • All these Municipal boards must ensure that the process of laying of sewerage network and households connections are made with newly installed STPs or conveyance system so that these plants should be operational with its full capacity. Implementation of faecal sludge management schemesshould also be done within the stipulated time.
4.	Creating a geospatial data	ULB and LSG	If a digital database of the existing inventory is made, it would be easy to classify the connected and unconnected households. This also helps to determine the optimal path for the connection between the household and the STP units.
5.	Creating a plan of reuse of treated effluents of STPs for irrigating public parks, agriculture, horticulture etc.	ULB and LSG	Rather than getting rid of the treated or partially treated effluents from STPs, municipal authorities should conserve the resources of treated effluents (both water + nutrients) by exploring their value addition in irrigation. As a case study, an attempt should be made to build farming into a waste disposal scheme by a value addition concept of using treated effluent according to its water + nutrient + soil conditioning value. Every Municipal board/Municipal Council must have a case study of this type in their locality by June 2025.
6.	Inventory of Industrial areas	RIICO/ District admin./RSPCB	Mapping types of industries and institutions and monitoring the level of pollution emissions (air, water, land, or noise pollution) along with disposal made by them should be completed. This task will be completed by June 2022. The responsible agency would ensure that pollution emissions by the industries do not exceed the prescribed limit.
7.	Provision of sanitation facilities for labourers/workers in industrial areas	RIICO	There must be sanitation facilities for labourers/workers in the industrial areas. RIICO should ensure that all workers have proper sanitation facilities. This task shall be completed by June 2022.
8.	Provision of storm-water drain in all industrial areas and drainage facilities	RIICO	There must be stormwater drain facilities in the industrial areas. However, it must be ensured that it should carry only stormwater. No industrial wastewater should flow in the stormwater drains. RIICO should ensure that stormwater drains are provided with flow measurement devices. This task shall be completed by June 2022.
9.	Monitoring and Review	District Collector	District collector will monitor/review the performance of their respective ULB/ Panchayats/ RSPCB/ RIICO / PHED/ WRD/ GWD on the respective issues related to the concerned department and may constitute district level expert committee for suggestions.

Chapter 11: Air Quality Management Plan

Under National Ambient Air Quality Standards, 2009; 12 pollutants are notified based on short term & long term monitoring for Industrial/residential and Sensitive/ecological areas, i.e., PM_{10}, $PM_{2.5}$, SO_2, NO_2, NH3, Pb, O_3, CO, Ni, As, benzo [a] pyrene (B[a]P) and Benzene. Under National Air Monitoring Program (NAMP), a huge quantity of data generates annually for prescribed parameters, i.e., PM_{10}, SO_2 and NO_2. CPCB evaluated the concept of Air Quality Index (AQI) utilizing the data of ambient air quality to ascertain the quality of air in terms of its probable impact on health and environment. A brief insight on each of the air pollutants is described below:

11.1. Major Air Pollutants

The most common outdoor air pollutants are discussed below (https://www.blf.org.uk/)

11.1.1. Particulate matter ($PM_{2.5}$ and PM_{10})

Particulate matter is a mix of solids and liquids, including carbon, complex organic chemicals, sulphates, nitrates, mineral dust, and water suspended in the air. PM varies in size. Some particles, such as dust, soot, dirt or smoke are large or dark enough to be seen with the naked eye. But the most damaging particles are the smaller particles, known as PM_{10} and $PM_{2.5}$.

11.1.2. Nitrogen Oxides (NO, NO_2, NO_x)

Nitrogen oxides are a group of seven gases and compounds composed of nitrogen and oxygen, sometimes collectively known as NO_x gases. The two most common and hazardous oxides of nitrogen are nitric oxide(NO) and nitrogen dioxide(NO_2).

11.1.3. Sulphur Dioxide(SO_2)

Sulfur dioxide, or SO_2 is a colorless gas with a strong odor, similar to a just-struck match. It is formed when fuel containing sulfur, such as coal and oil, is burned, creating air pollution.

11.1.4. Carbon Monoxide(CO)

Carbon monoxide is a colorless, highly poisonous gas. Under pressure, it becomes a liquid. It is produced by burning gasoline, natural gas, charcoal, wood, and other fuels.

11.1.5. Benzene, Toluene and Xylene (BTX)

Benzene, toluene, xylene, and formaldehyde are well-known indoor air pollutants, especially after house decoration. They are also common pollutants in the working places of the plastic industry, chemical industry, and leather industry

11.1.6. Ammonia (NH_3)

Ammonia pollution is pollution by the chemical ammonia (NH_3) – a compound of nitrogen and hydrogen which is a byproduct of agriculture and industry.

11.1.7. Ozone(O_3)

Ground-level ozone is a colorless and highly irritating gas that forms just above the earth's surface. It is called a "secondary" pollutant because it is produced when two primary pollutants react in sunlight and stagnant air. These two primary pollutants are nitrogen oxides (NO_x) and volatile organic compounds (VOCs).

11.2. Air Quality Index

Air quality index is calculated based on averages of all pollutant concentrations measured in a full hour, a full 8 hours, or a full day. The schematic illustration involved in the computation of AQI is shown in **Figure 11.1**. To calculate an hourly air quality index, we average at least 90 measured data points of pollution concentration from a full hour. The classification of regions based on AQI is shown in **Figure 11.2**.

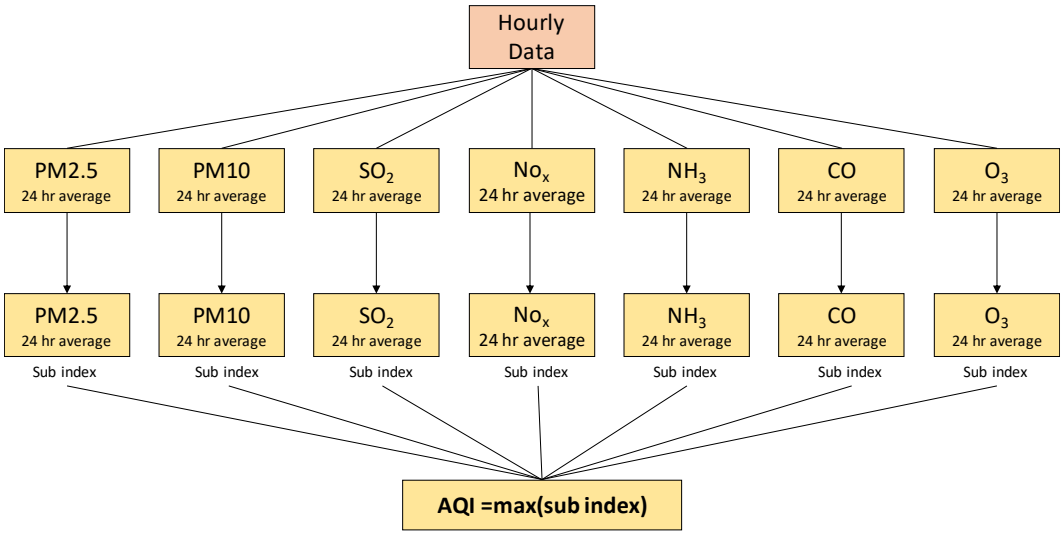


Figure 11.1. Computation of AQI

AQI	Remark	Color Code	Possible Health Impacts
0-50	Good		Minimal impact
51-100	Satisfactory		Minor breathing discomfort to sensitive people
101-200	Moderate		Breathing discomfort to the people with lungs, asthma and heart diseases
201-300	Poor		Breathing discomfort to most people on prolonged exposure
301-400	Very Poor		Respiratory illness on prolonged exposure
401-500	Severe		Affects healthy people and seriously impacts those with existing diseases

Figure 11.2. AQI ranges, Remarks, and possible health impacts

11.3. Status and Inventory of Air Quality Management in Bikaner District

A short survey is conducted to collect the information of Air Quality Management Information and Inventory of air quality management in Bikaner District and the collated information is shown in **Tables 11.1 and 11.2**.

Table 11.1: Inventory of Air Quality Management in Bikaner district

No.	Action Areas	Details of Data Requirement	Unit/ Status	Total Nos. in the district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Rural area
AQ1	**Availability of Air Quality Monitoring Network in District**								
AQ1a		Manual Air Quality monitoring stations of SPCBs /CPCB	[Nos] / [None]	Three Manual Air Quality Monitoring Stations are Proposed					
AQ1c		Automatic monitoring stations Operated by SPCBs / CPCB	[Nos] / [None]	One CAAQMA Station is Proposed					
AQ2	**Inventory of Air Pollution Sources**								
AQ2a		Identification of prominent air polluting sources	[Large Industry] / [Small Industry] / [Unpaved Roads] / [Burning of Waste Stubble] / [Brick Kiln] / [Industrial Estate] / [Others] (Multiple selection)	Large Scale Industries Situated in Bikaner District are:- 1. M/s Neyveli Lignite, Vill-Barsingsar, Dist-Bikaner 2. M/s V.S. Lignite, Vill-Gudha, Teh-Kolayat, Dist-Bikaner Beside this other prominent Units are Wool Scouring Unit, Plaster of Paris unit, Food Processing Unit, Ceramics and Brick Kiln Units					
AQ2b		No of Non-Attainment Cities	[Nos / [None]	Nil	Nil	Nil	Nil	Nil	Nil
AQ2c		Action Plans for non-attainment cities	[Prepared] / [Not yet prepared]	Nil	Nil	Nil	Nil	Nil	Nil
AQ3	**Availability of Air Quality Monitoring Data at DMs Office**								
AQ3a		Access to air quality data from SPCBs & CPCB through Dashboard	[Available] / [Not yet Available]	-	-	-	-	-	-
AQ4	**Control of Industrial Air Pollution**								

AQ4a		No of Industries meeting Standards		2908	843	125	38	5	
AQ4b		No of Industries not meeting discharge Standards		18*	0	0	**0**	0	**18**
* **Industries are situated out of ULB Area**									
AQ5	**Control of Non-industrial Air Pollution sources**								
AQ5a		Control open burning of Stubble – during winter	[Nos of fire incidents]	Nil	Nil	Nil	Nil	Nil	Nil
AQ5b		Control Open burning of Waste – Nos of actions Taken	[Nos]	Nil	Nil	Nil	Nil	Nil	Nil
AQ5c		Control of forest fires	[SOP available] / [No SoP]	Nil	Nil	Nil	Nil	Nil	Nil
AQ5d		Vehicle pollution check centers	[% ULBs covered]	Nil	Nil	Nil	Nil	Nil	Nil
AQ5e		Dust Suppression Vehicles	[% ULBs covered]						
AQ6	**Development of Air Pollution complaint redressal system**								
AQ6a		Mobile App / Online based air pollution complaint redressing system of SPCBs.	[Available] / [Not available]	Not available					

Table 11.2: Inventory of Air Polluting Industries in the District

Attributes	Unit	Total No. in district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnok	Rural Area
Type of Industries	[Nos]	2926	848	132	42	6	0
No of Crashers in the District	4	Nil	Nil	Nil	Nil	Nil	4

* Stone Crashers are situated outside ULB Area

11.4. Monitoring real-time air pollution

Large amount of granular data relating to the concentration of each air pollutants in India is available and it is made accessible to every citizen by Central Pollution Control Board (CPCB), India (https://app.cpcbccr.com/AQI_India/). Though there are numerous monitoring stations spread over the country, there exist no monitoring stations in Bikaner district. The locations of monitoring stations within the proximity of Bikaner are shown in **Figure 11.3**. For better understanding of the distribution of air pollution over the entire Bikaner the historic data of SO_2 emissions is accessed from TROPOMI Explorer (https://showcase.earthengine.app/) as shown in **Figure 11.4**. Though the imagery obtained from TROPOMI Explorer helps in the visualizing the variation of air quality over the years, due to the limited functionalities, it does not enable the user to study at a specific region of interest.

Figure 11.3: Locations of monitoring stations within the proximity of Bikaner district

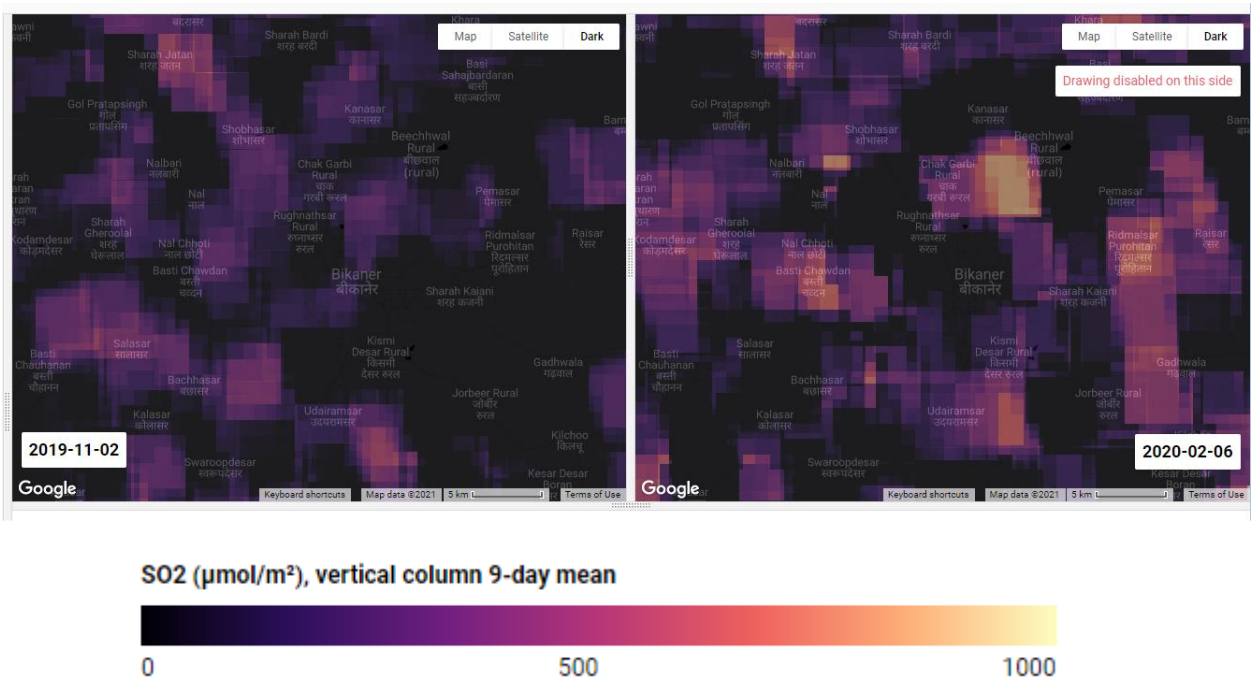


Figure 11.4: Variation of SO_2 over the Bikaner region

9.5. Inventory of Air Pollution Management Plan

A detailed survey is carried out in each ULB and the obtained information is collated as shown in **Tables 11.1 and 11.2**. From the collected information, it has been identified that 18 industries in Bikaner district are not meeting the standards. Considering the existing inventory, a detailed action plan is developed as shown in **Table 11.3**.

Table 11.3: Air Pollution Management Plan

Sr. No.	Action Point	Present Status	Gap	Strategy and approach &Timeline	Responsible Authorities/Department
1.	Availability of Air Quality Monitoring Network in District	There is no existing air quality monitoring network in the district. A location (district capital) is chosen for the installation of monitoring station.	There is a need of several monitoring stations in Bikaner	Online measuring system with public display board is to be installed within one year at least at one place in every ULB by December 2022.	Local self-government, RSPCB
2.	Inventory of air polluting industries in District	No systematic data is available.	Data need to be collected from polluting sources.	Inventory of all air polluting industries is to be mapped along with type of pollutant releasing, discharge, concentration and details of control device by December2021.	RSPCB/ RIICO
3.	Identification of hot spot	No such hot spot has be identified presently.	Details of critical location are not available.	Hot spot in relation to air pollution is to be identified within one year and plan is to be made to keep AQI as per norms.	RSPCB
4.	Monitoring the discharge of emissions from Industry	Real time monitoring of air pollution will help to control and keep track of the pollution levels from the industries.	Data need to be collected from any polluting sources.	December 2021	RSPCB

Sr. No.	Action Point	Present Status	Gap	Strategy and approach &Timeline	Responsible Authorities/Department
5.	Targeting 100% LPG access in households	A study published in Lancet has shown how premature deaths from household air pollution is responsible for health cost that is equivalent to close to 1 per cent of the state's GDP in Rajasthan	Maximizing clean energy access and enabling 100 per cent coverage of household with reliable LPG connection. At the same time eliminate use of solid fuels from open eateries and restaurants and link this with their commercial license.	By June 2022	Local self-government
6.	Improve walking and cycling	No programs that promote walking and cycling are in place in Bikaner	To Promote the use of cycles for the trips within 5km	Tracks should be constructed by each ULBs and Gram Panchayats.	ULBs/ Village Panchayats
7.	Electric vehicle programme:	No policies are in place	Promote the use of electric vehicles by proposing 100% exemption of taxes for electric vehicle.	By December 2024	State and Central Government
8.	Clean fuel initiative	No policies are in place	Discounts for the registration of LPG and CNG vehicles should be implemented.	By December 2022	State and Central Government
9.	Traffic Movement plan	City Traffic movement plan has been prepared time to time by local Police. Bye -pass is to be constructed for movement of heavy vehicles wherever feasible.		It should be ensured that air pollution be minimized at hot spots while educating public acceptability within one year. Bye -pass is to be constructed for movement of heavy vehicles wherever feasible within next 5 years.	Traffic Police, PWD

Sr. No.	Action Point	Present Status	Gap	Strategy and approach &Timeline	Responsible Authorities/Department
10.	Vehicle pollution check centers	Random checks are being done to ensure whether public follow best practices.	Proper record to be made available online with their names and vehicle numbers so that people avoid to break the rules.	Data availability should be made online by June 2022.	RTO, Local Police
11.	Dust Suppression Vehicles/Roads	Much of this dust is on the ground and when dry, it can be thrown up into the air by trucks and other vehicles.	If road conditions are poor bicyclists and two-wheeler motorcyclists face problems.	It should be ensured that dust from the road should not be thrown up into the air by vehicles, especially if road condition become poor. Proper speed limit must be specified with proper signage at critical locations whenever required.	RTO, Local Police, PWD
12.	Awareness Activities	The details of district level campaigns on effect of air pollution is not available.	Such information should be made available online at RSPCB website.	District level campaigns on effect of air pollution continuously.	RSPCB/ RIICO/ District Admin/ Educational Institutes
13.	Monitoring and Review	This is continuously being done by the District Administration		District collector or his representative should monitor/review the performance of their respective ULB/ Panchayats/ RSPCB/ RIICO / PHED/ WRD/ GWD on the respective issues related to concern department and may constitute district level expert committee for suggestions.	District Administration

Chapter 12. Mining Waste Management Plan

Bikaner district is well known for its lignite deposits. During the erstwhile Bikaner state, thermal power generation was based on the lignite resources of Palana. During the last two decades, the Department of Mines & Geology and other exploration agencies have carried out detailed exploration for lignite in different parts of the district. The investigation was guided by the stratigraphic control of the deposition of lignite, and all tertiary formations have been examined in ¬detail, and a number of lignite bearing areas were identified.

12.1 Present scenario in the district

In the Bikaner district, various types of minerals are available under a minor category such as Gypsum, Ball clay, Fuller's earth, Limestone, Bajri-Gravel, sandstone, etc. Bikaner district has some very important nonmetallic mineral deposits in the State. It has vast resources of lignite and gypsum, besides clay, fuller's earth, ochre, and grit. In the Bikaner district, no river is flowing. The sand is mainly found under the surface, so sand mining is done. In the Bikaner district, 82 mining leases are sanctioned by the department of mines & geology for sand/ bajari.

The list of various minerals that are found in Bikaner district are mentioned below:

Gypsum

(a) Tehsil Kolayat: Miranwala, Khayamwala, Kabrewala, Bhurasar, Maghnewala, Larewala, Karnisar, Jagasar, Tanwarwala, Deheriya, Jharkari, Akhusar, DhaniAbdullahwali andSanchu areas – Gypsum reserves – About 50 million tons. RSMML has applied most of the mining leases in these areas and also applied for reservation of gypsum blocks covering above villages. RSMML is operating Deheriya, DhanAbdullahwali, Bhurasar and Larewala in this area

(b) Tehsil Khajuwala: Ballar, Dantor, Makhani, Anandgarh, Siyasar, Nohsera, Nayagaon etc. Estimated gypsum reserves – 30 million tons. RSMML is operating their main mines i.e. Ballar Mines in this area. Nohsera and Nayagaon area is under the possession of Forest Department.

(c) Tehsil Pugal: Kundal, Kishanpura area. Estimated reserves – 2 million tons. RSMML is operating Kishanpura Gypsum Mines in this area. Gypsum reserves at Kundal gypsum

mines in Forest free/diversified land has been exhausted. Kishenpura gypsum Mines is also in exhausting stage. Balance reserves are mainly in Forest land.

(d) Tehsil Bikaner: Jamsar, Kaoni, Bharu, Randhisar, Dhirera, Jagatewala etc. The estimated reserves are of the order of 0.5 million tons. Most of the mines have exhausted or in exhausting stage. Bharu&Kaoni gypsum mines are operating by FAGMIL.

(e) Tehsil Lunkaransar: Lunkaransar Selenite (crystalline variety of gypsum). Estimated reserves 0.2 million tones. Mines is being operated by RSMML.

Clay

The main belt of Ball clay found in district occurs between villages Nal, Gajner, Deh, Mudh, Kotri, Chandi, Indo-Ka-Bala, Kolayat, Motawatan, gangapura, khari-Charnan, Gurha, Jegla-janglu, Hadlanetc in Kolayat tehsil. This belt extends over a strike length of 40 Km and width varying from 2-15 Km covering and area of about 400 SqKms. On the basis of available information of mining leases this area contains about 400 MT reserves of Ball clay.

Limestone

(a) Sarunda- Mendelia

The limestone occurs near Sarunda-Mandelia, tehsil Nokha in the form of isolated patches. Mandelia is about 55 km. S.W. of Nokha. Limestone is dirty, white-grey in colour. Grey colour limestone is cement grade in nature, and the dirty white pinkish colour is dolomitic and cherty. The department has carried out investigations, and a reserve of 5.2 million tonnes have been assessed containing CaO 17.36 to 52.36%, MgO 0.40 to 18.52%, and SiO_2.80 to 13.96%.

(b) Dawa, Selwa

It is located about 23 km south of Nokha. Limestone and dolomitic limestone occurs as five isolated mounds over a strike length of 3.2 km with width varying from 30 to 200 m. Limestone is fine-grained hard compact, light grey in colour with bangs of cherty and dolomitic limestone. About 5.50 million tonnes of geological reserves are inferred. The analytical result indicates 23.38% to 43.19% CaO, 12.7% to 18.70% MgO, and 6.84%.24.9% SiO_2. The sandstone of Dulmera has been an important source for Patti, Khanda, Katla, and dimensional stones. The sandstone is of red colour and can be easily given shapes by

chiselling. Sandstone is also found near Lalaji Ki Dhani in Nokha tel1sils. Ochres are mineral pigments in which iron acts as the colouring material either in the form of hematite (Red) or limonite (Yellow), or both. Bikaner district ochres have been known to occur in Mudh-Kolayat areas as pockets with clay deposits.

(c) Potash

The discovery of Halite at Lakhasar (28°06'-73°52 ') in a drilling hole put there as a part of the UNDP Project by GSI has led to the belief that potash minerals are occurring near Bikaner city. The potash mineralization is expected to extend further in the Bikaner district also, looking to the general geological setting of the area.

The Geological Survey of India (GSI) conducted exploration for Potash in the Nagaur-Ganganagar basin of North-west Rajasthan, covering parts of Churu, Bikaner, Hanumangarh, and Sri Ganganagar districts during 1974-1991. The area of the Nagaur-Ganganagar basin is 50,000 sq km, out of which 28500 sq km area has been explored by GSI. A total of 58733.95 m was drilled spread over 68 boreholes. In 47 boreholes, Potash mineralization with 1% K was reported. 2% K was identified in 8 sub-basins namely Lakhasar, Bikaner, Gharsisar, Hansera, Arjunsar, Jaitpura, Bharusari and Satipura. Potash with 3%K cut off with 1.5mtr minimum stopping width has been calculated for three sub-basins, i.e., Satipura, Bharusari, and Lakhasar. The total ore reserves (probable+possible) in the three sub-basins are of the order of 2476.58 million tonnes having 4.70% K and 23.54% Na.

(d) Bajri and Grit

These are clastic rocks consisting of medium size grains of silica and found south (and west) of Bikaner city where it is being mined for building purpose. The paleochannel of river Saraswati can be good source of Bajri. Department has identified some areas by remote sensing study of imageries.

(e) Glass Sand

Huge deposits of good quality glass sand are found near Mudh. The exposures are along the sides of the Nallah, presently being used by glass factory of Bikaner glass wares.

The geological reserve of lignite mineral in Bikaner district is shown in **Table 12.1**.

Table 12.1:Status of the explored lignite block

S. No.	Name of block	Area (in sqkms)	Geological reserves (in mt)	Name of allotte
1.	Palana, tehsil Bikaner	6.71	23.57	M/s. RSEB
2.	Barsinghsar tehsil Bikaner	16.00	77.83	M/s. N.L.C ltd
3.	Gurha-East, tehsil Kolayat	25.00	54.15	M/s. VS Lignite power ltd
4.	Gurha-West,tehsil Kolayat	10.27	41.65	M/s. RSMM ltd.
5.	Raneri, , tehsil Kolayat	28.00	33.92	M/s. N.L.C ltd
6.	Hadla, , tehsil Kolayat	16.00	59.63	M/s. N.L.C ltd
7.	Bithnok, , tehsil Kolayat	11.99	99.12	M/s. N.L.C ltd
8.	Riri, tehsil Dungargarh	40.00	182.43	M/s. N.L.C ltd
9.	Mandla-Charnan, , tehsil Kolayat	08.00	17.70	M/s. Indure Pvt. Ltd.
10.	Chak-Vijaysinghpura, tehsil Kolayat	04.50	02.30	Free

12.2Prevention of Illegal Sand Mining

In view of the order dated 03.05.2018 passed by SB Civil Writ Petition No. 9458/2018 filed in the Hon'ble High Court, in continuation Mines (Group-2) Department Rajasthan, Jaipur Order No. 20(8) Mines/Group-2/2013 dated 12.06.2019 for compliance in the Office of District Collector Bikaner Order No.:- F. 12-12 ( ) Revenue / Mineral / 2019 / 3552-3557 from date 22.07.2019 in Bikaner district against illegal gravel mining, issuance and gravel storage jointly till the advance order, order number 4041 of the office of even order number 4041 dated 17.07.2018. The following special inspection team (SIT) headed by the sub-divisional officer was constituted, the details of which are as under:

Table 12.2: Constitution of Special inspection team (SIT)

S. No.	Name of District	Inspection team
1	Bikaner	Concerned Tehsildar, District Bikaner
		Concerned SHO, District Bikaner
		Concerned Transportation Officer/ Representative, District Bikaner
		Mine Engineer/ Representative, District Bikaner

Action report are to be compiled by the Mining Engineer and sent to the District Collector, Office of Bikaner. In compliance of the said order, action has been taken against illegal mining/ issue of mineral gravel by SIT, the details of which are given in **Table 12.3**:

Table 12.3: Action taken against illegal mining/ issue of mineral gravel by SIT

S. No	Financial Year	Illegal Mining			Illegal Issuance		
		Number of cases	Amount Recovered (in Rs.)	FIR Recorded	Number of cases	Amount Recovered (in Rs.)	FIR Recorded
1.	2018-2019	04	5,75,700	0	252	2,27,39,738	41
2.	2019-2020	06	3,93,400	05	14	13,72,406	03
3.	2020-2021 (22-01-2021)	03	0	03	49	68,37,532	13
	Total	**13**	**9,69,100**	**08**	**315**	**3,09,49,676**	**57**

In this way, after taking action against illegal mining/issuance of mineral gravel by SIT, till now a total of 328 cases have been made and Rs.3,19,18,776/- (3.19 crore) has been recovered and FIR has been lodged of total 65 cases in the respective police stations.

Sand Sources in Bikaner District: -

No river flows in Bikaner district. Mineral gravel is mined in Bikaner district, which is found at a depth of about 1 meter to 3 meters from the surface. A total of 82 mining leases have been issued by the department for mining of mineral gravel in Bikaner district. Action is taken against illegal mining/issuance of mineral gravel by the SIT constituted by the District Collector.

A survey is conducted in the district including all the ULB's to collect the details of the inventory and the collated information is shown in **Table 12.4**. Details of compliance to

environmental conditions are presented in **Table 12.5** and the mining related environmental complaints are presented in **Table 12.6**.

Table 12.4: Inventory of mining in Bikaner district

Attributes	Unit	Total in the district
Population	[Nos as per 2011 census]	2363937
Population	[Nos as per projected in 2021]	2865802
Type of Mining Activity	[Sand Mining] / [Iron Ore] / [Bauxite] / [Coal] / Other [specify]Multiple selection in order of magnitude of operations	Sand Mining
No of Mining licenses given in the District	[Nos]	287
Area covered under mining	[Sq Km]	128.37 sq km
Area of District	[Sq Km]	30247.90 sq km
Sand Mining	[Yes] / [No]	(Non - river deposit) 2.62 sq km
Area of sand Mining	[River bed] / [Estuary] / [Non -river deposit]	Non - river deposit

Table-12.5: Compliance to Environmental Conditions

Attributes	Unit	Total in the district
Population	[Nos as per 2011 census]	2363937
Population	[Nos as per projected in 2021]	2865802
No of Mining areas meeting Environmental Clearance Conditions	[Nos]	275
No of Mining areas meeting Consent Conditions of SPCBs / PCCs	[Nos]	261

Table-12.6: Mining related environmental Complaints

Attributes	Unit	Total in the district
No of pollution related complaints against Mining Operations in last 1 year	[Nos]	Nil
No of Mining operations suspended for violations to environmental norms	[Nos]	Nil
No of directions issued by SPCBs	[Nos]	Nil

12.3 Measures to control pollution

From the data collected, it is noticed that no concerns related to Mining activities have been noticed in Bikaner. In general, the major concern of mining operations is open-cast mining, which severely affects the land use pattern. The major environmental impacts of mining operations are degradation of land, pollution of surface and groundwater resources, pollution of air, deforestation including loss of flora and fauna, rehabilitation of affected population including tribal and impact on historical monuments and religious places.

These mining activities will eventually contribute to the degradation of air quality, impart noise pollution, and may also cause water pollution in some instances. To minimize the impact of these activities, the following actions may be taken.

Measures to control air pollution

-Spraying of haulage/mine roads with water, use of dust extractors.

-Road carrying capacity studies shall be carried out in the mining belt area as well as the junctions wherein heavy movement of trucks carrying ores will be there.

-Trucks of larger carrying capacity shall be used for transport of ores to reduce air pollution and traffic congestion.

- Designated routes shall be provided or plan for transport of ores avoiding environmental sensitive areas.

- Monitoring shall be done that whether the trucks transporting ores are covered or not. Transport department in coordination with GSPCB shall monitor the activity.

- LSG, ULB in association with RSPCB should multiply the resources and increase the numbers of Ambient air monitoring locations. Since only one monitoring station is planned in Churu district, it should be imperative to plan for various others locations.

Measures to control noise pollution

Regular maintenance of machinery should be ensured.

Measures to control water pollution

The effluents from the mining plants should be treated before releasing from the plants.

The action points for the effective management of mining activities is presented in **Table 12.7**.

Table 12.7: Mining activity Management Plan

Action area	**Objective**	**Responsibility**	**Present status and action plans**	**Time schedule**
Inventory of mining in Bikaner district	To maintain the record and status of mines and mining lease area	Assistant Mining Engineer, Bikaner	Already maintained. However, all information should be accessible to the public through interactive website of mining department	June 2022
Monitoring	To restrict the illegal mining activities and to check if the emissions are within the permissible limits	Assistant Mining Engineer, Bikaner	Regular checking is done by the mining department to prevent the illegal mining and illegal transportation of minerals.	June 2022
Prevention of illegal River sand mining	To prevent illegal river sand mining	Special Investigation Team (SIT) i. Area Tahsildar, District Bikaner ii. Concerned SHO, District Bikaner iii. District Transport Officer/ Representative, District Bikaner iv. Mining Engineer / Representative, District Bikaner	1. Identification of river stretches, spots that may likely be used for illegal sand mining. 2. Frequent surprise checks in those illegal spots by the SIT and submit the investigation report to the District Collector on a monthly basis. 3. District Collector shall meet once in a month to discuss The illegal mining/ transporting/ damage caused to the environment and send a report to the State Level Task Force.	June 2022

Chapter 13: Noise Pollution Management Plan

Noise can be defined as unwanted or undesired sound and Noise pollution simply means when there is a lot of noise in the environment which is consequentially harms the environment and public wellbeing. Like smoking, noise pollution affects active and passive recipients when noise levels cross certain safe boundaries. Noise pollution affects both human health and behavior. Noise is among the most pervasive pollutants today. But it is an inescapable by-product of urbanization and industrialization. CPCB set standards for noise pollution in 1989 and the Ministry of Environment and Forests (MOEF) formulated Noise Pollution Rules only in 2000.

13.1 Status and Inventory of noise pollution in Bikaner district

A detailed information regarding inventory available for measuring the noise pollution is collected and the obtained information is shown in **Tables 13.1 and 13.2**.

Table 13.1: Inventory of Noise levels monitoring equipment

S.No	Attributes	No. of noise measuring devices with district administration	No. of noise measuring devices with SPCBs
1.	ULB-1 Bikaner	-	2
2.	ULB-2 Nokha		
3.	ULB-3 Dungergarth		
4.	ULB-4 Deshnoke		

Table 13.2. Inventory of capability to conduct noise level monitoring by State agency / District authorities

S. No.	Attributes	Capability to conduct noise level monitoring by State agency / District authorities	No of complaints received on noise pollution in last 1 year
1.	ULB-1Bikaner	0	0
2.	ULB-2Nokha	0	0
3.	ULB-3Dungergarth	0	0
4.	ULB-4Deshnoke	0	0

The monthly noise monitoring has been carried out by the State Board Laboratory for Residential, Commercial and Industrial Purpose in Bikaner. A sample of the same is given in **Table 13.3**. From the attributes of **Table 13.3**, it is evident that the noise level on all the measured locations is within the acceptable limits i.e., 85dBA. Drawing conclusive remarks regarding the noise level in Jhunjhunu district may not be credible. Therefore, there is a great need to conduct studies at multiple locations in Bikaner district. A short survey is conducted to collect the information of noise pollution management information and inventory in Bikaner district and the collated information is shown in **Tables 13.4 and 13.5**.

13.2. Implementation strategy for Noise Pollution Management Plan

The details of measurable and quantifiable targets, with timelines for completing the tasks are presented in **Table 13.6**.

Table 13.3: Details of monthly noise monitoring data carried out by the State Board Laboratory in Bikaner

Sr. No.	Location	September 2020		October 2020		November 2020		December 2020		January 2021		February 2021	
		Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time	Day Time	Night Time
		Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq	Leq
1	Regional Office, RSPCB, Plat No SP-33, Bichwal Industrial Area, Bikaner	66.5	74.6	58.3	63.6	59.9	66.3	62.6	63.9	59	57.8	59.3	60.7
2	P.B.M. Hospital, Bikaner	67.7	66.8	64.8	65.3	66.4	69.4	62.4	66.4	68.2	57.1	68.3	63.1
3	Junagarh Circle, Near Junagarh Fort, Bikaner	70	62.6	71.4	66.8	77	67.4	69.3	69.6	70.5	69.1	72.4	65.6
4	IGNP Colony, Ganganagar Road, Bikaner	60.1	65.5	62.5	66.3	56	56.8	59.6	55.9	56.8	57.6	63.6	60

*ND= Not Done. Acceptable noise limits = 85 dBA

Table 13.4: Capability to conduct noise level monitoring by State agency / District authorities: -

Attributes	Unit	Total Nos. in the district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarh	ULB-4 Deshnoke	Rural area
Capability to conduct noise level monitoring by State agency / District authorities	Yes	0	0	0	0	0	0
No of complaints received on noise pollution in last 1 year	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Table 13.5: Compliance to ambient noise standards

Attributes	Unit	Total Nos. in the district	ULB-1 Bikaner	ULB-2 Nokha	ULB-3 Dungergarth	ULB-4 Deshnoke	Rural area
Population	[Nos as per 2011 census]	2363937	644406	62699	53294	18470	1563553
Population	[Nos as per projected in 2021]	2865802	765250	75606	61468	21046	1911719
Implementation of ambient noise standards in residential and silent zones	[Regular Activity] / [Occasional] / [Never]	Occasional	-	-	-	-	-
Noise monitoring study in each ULB of the district	Carried out	4	Monthly Noise Monitoring is being carried out by State Board Laboratory at Residential, Commercial, Industrial, Silent Zones	0	0	0	0
Sign boards in towns and cities in silent zones	[Installed] / [Partial] / [Not Installed]	Not installed	-	-	-	-	-

Table 13.6: Action plan for Noise Pollution Management

Action area	Objective	Responsibility	Action to be taken	Timeline
Noise measuring devices	To measure the noise at the desired locations	ULB, RSPCB	Since only two noise measuring device in available in Bikaner city, conducting studies in all ULB's at regular intervals would be challenging. Therefore, noise measuring devices are to be procured.	By August, 2022
Noise level Monitoring	For establishing the ambient noise level	ULB, RSPCB	Noise levels should be monitored in each ULB on regular basis	By August, 2022
Compliances of standards	To maintain the noise levels below the standards set by CPCB	ULB, RSPCB	1. Proper Categorization of areas into industrial, commercial residential or silence areas/zones has to bed one. 2. Sign boards are to be installed in Silent zones even at panchayat levels. 3. Loudspeaker or a public address system should not be allowed to be used without obtaining written permission from the authority and not allowed to be used at night (between 10.00 p.m. to 6.00a.m.) 4. Special team for monitoring during festivals season has to be formed. 5. Transport department will have to take steps for monitoring/ checking of vehicles to ensure environmental norms are followed by the vehicles 6. Complaints record and redressal system should be made in place.	By August, 2022

Chapter 14: Forest Conservation Practices

This chapter covers the general information regarding types of forest found in Bikaner district, forest land and the current management practices being adopted. The threats to forest/ forest land in context to this district have also been identified and discussed. Finally, different afforestation activities proposed in forest land as well as city/town area are listed along with a brief action plans.

14.1 General Information Regarding Types of Forest in the District

The district comprises of **30247.90 sq. Kms** of geographical area, out of which **1250.67**sq. kms is covered with forest, which is around 4.13% of the entire district. This includes 266 forest blocks, 755.256sq. kms protected forest and at 836 block 489.414sq. kms under unclassified forest. The per capita forest is approximately 0.036 Ha (as per Census 2011), which is very low compared to the average per capita forest cover of 0.02 of Rajasthan and the country's average of 0.06 Ha per capita.

The terrain of the district is generally plain with sand dunes of the great Thar desert, etc. Apart from these, the rest of the area is covered with sand dunes, making it the eastern boundary of the Thar desert. Bikaner is the only district in the state with no perennial or seasonal rivers whatsoever.

The district has the very adverse climatic condition as the temperature varies from 0 degrees in winters to 50 degrees in summers. The average annual rainfall in this area is around 25mm. Primarily, this area has vegetation found in desert areas like trees of Acacia, Ber/ ziziphyus, tortalis, Khejri, Rohida, and Kumtha etc., and shrubs of thor, phog, Bui, Aak, Kheenp, etc.

Details of the local vegetation are given below:

1. Vegetation found on sand dunes
    - *Phog (Calligonumpolygonoides)*
    - *Bui (Aerva pseudotomento*sa½]
    - *Aak (Calotropis procer*a½]
    - *Kheenp (Leptadeniapyrotechnica)*

- *Saniya (Crotalaria burhia),*
- *Tumba (Citrulluscolocynthis),*
- *Thor (Euphorbia spp)*

2. Vegetation fund on loamy sand

- Khejri *(Prosopissineraria),*
- Rohida *(Tecomellaundulata),*
- Neem *(Azadiractaindica),*
- Ber *(Zizyphusspp),*
- Jaal *(Salvadoraspp),*
- Kankeda *(Maytenusemarginata),*
- Hingot *(Balanitesaegyptica),*
- Kair *(Capparis decidua),*
- Pharash *(Temarixarticulata),*

Forests are subjected to tremendous biotic pressure everywhere, and despite the advancement of science, the rural population still are dependent on these resources. Unscientific and often over exploitation has left these forests degraded along with all their components. These forests might be under degraded condition due to illegal cutting of trees and land encroachment. The income from forest produce is low. Thus, protecting and restoring such patches are essential to improving the environment, increasing biodiversity, and sustaining forest produce. In addition, plantations done on non-forest land, especially community lands, are being taken up to increase forest cover in the district.

The different ranges covered under Bikaner Forest Division are Bikaner North, Bikaner South, Nokha, Kolayat, Dungargarh, Loonkaransar, Chattargarh, Dantor, Bariyawali, 61 KYD, Sattasar, Khajuwala, the details of which are given in **Table 14.1**.

Table 14.1: Details of forest cover range-wise

Range	Panchayat Samiti Region	Forest Area (in hectares)
Bikaner North	Bikaner	24229.91
Bikaner South	Bikaner	5564.41
Shri Dungargarh	Shri Dungargarh	2100
Nokha	Nokha/ Panchoo	1234.011
Shri Kolayat	Shri Kolayat	1608.801
Loonkarnsar	Loonkarnsar	1770.125
Chattargarth	Pugal	11948.667
Sattasar	Pugal	9115.633
Dantor	Khajuwala	16373.699
Beriyanwali	Khajuwala	16831.613
61 KYD	Khajuwala	10229.193

The forestry development project taken up in this area mainly focus on Sand Dune Stabilisation under climate change scheme of state govt. In addition, in past, Canal Side development project was taken up in addition to Government of Japan aided project for the promotion of greenery.

As per statistics of 2020-21, there are 10 nurseries in Bikaner district, the details are given in **Table 14.2**.

Table 14.2: Number of Plants raised in Nurseries during 2020-21

Name of division	**Number of Plants (in Lakhs)**		
	For Distribution	**For Departmental Plantation**	**Total**
DCF Bikaner	1.65	0.80	2.45
DCF IGNP Stage-II Bikaner	2.40	0.81	3.21
DCF IGNP Stage-I Chhattargarh	1.20	1.56	2.76
Total	**5.25**	**3.17**	**8.42**

Wild life reserved area in Bikaner: Johar Beed

Wildlife was declared a 'Reserved Area' to protect wild animals and birds in 1962, vide notification No. P. 3 (22) Van dated 25.11.2008. This area was finally notified as reserved forest in 1966 under section 20 of Rajasthan forest Act 1953 and published in Rajasthan Gazette on Sep. 8, 1966, due to the importance of flora & fauna of wildlife reserved area Johar Beed. At the time of final notification total area of the block was (56.4662 Ha).

Johar beed, located about 12 km away from Bikaner in Rajasthan, is particularly famous as a destination to sight a variety of vultures in India as it is the dumping yard for the carcass. Johar beed is one of the few places in India where vultures, which have almost vanished from the cities, can be sighted. Apart from vultures, different varieties of eagles can also be seen in Johar beed amongst other birds.

The reserved wildlife area Johar Beed is mostly covered by grasses with very few and sparse trees of Prosopis cineraria, Salvadora Spp., Zizyphus S pp. (Ber), Capparis Spp. (Ker), Azadirachta Spp. etc. Grasses found in the area are Sewan, Doob, Moth, etc. The area becomes green during the rainy season but again dries up during the summer season. Some areas of wildlife reserved area Johar Beed having less vegetative cover & hence needs to be improved for the betterment of the fauna, existing therein.

Though Johar Beed is a small wildlife reserved area, it is unique in its biodiverse ecosystem. Presently, a very small number of tourists visit this area. Efforts are being made to increase sustainable eco-tourism so that surrounding villagers can realize employment benefits. For achieving this purpose, extension activities need to be taken up to popularize this reserve, and on the other hand, adequate facilities need to be developed in surrounding areas to provide suitable accommodation and food to Indian and foreign tourists.

Johar Beed conservation reserve area is rich in flora and wildlife animals, vulture and other resident and migratory birds, natural surroundings. A beautiful water body (pond) is situated, known as the feeding spot of wildlife animals and birds.

The existing status and best practices done in different ranges of the Bikaner district can be observed through some of the visuals, as shown in Figures 14.1 to 14.7.

Figure 14.1A: Nursery Shobhasar, Bikaner division, Bikaner

Figure 14.1B: Nursery Nokha, Bikaner

Figure 14.2A: Plantation Site at Bikaner north Dandusar Forest Area

Figure 14.2B: Plantation Site at Bikaner north Dandusar Forest Area

Figure 14.3A: Plantation site Mokhmpura Forest Area, Lookansar, Bikaner

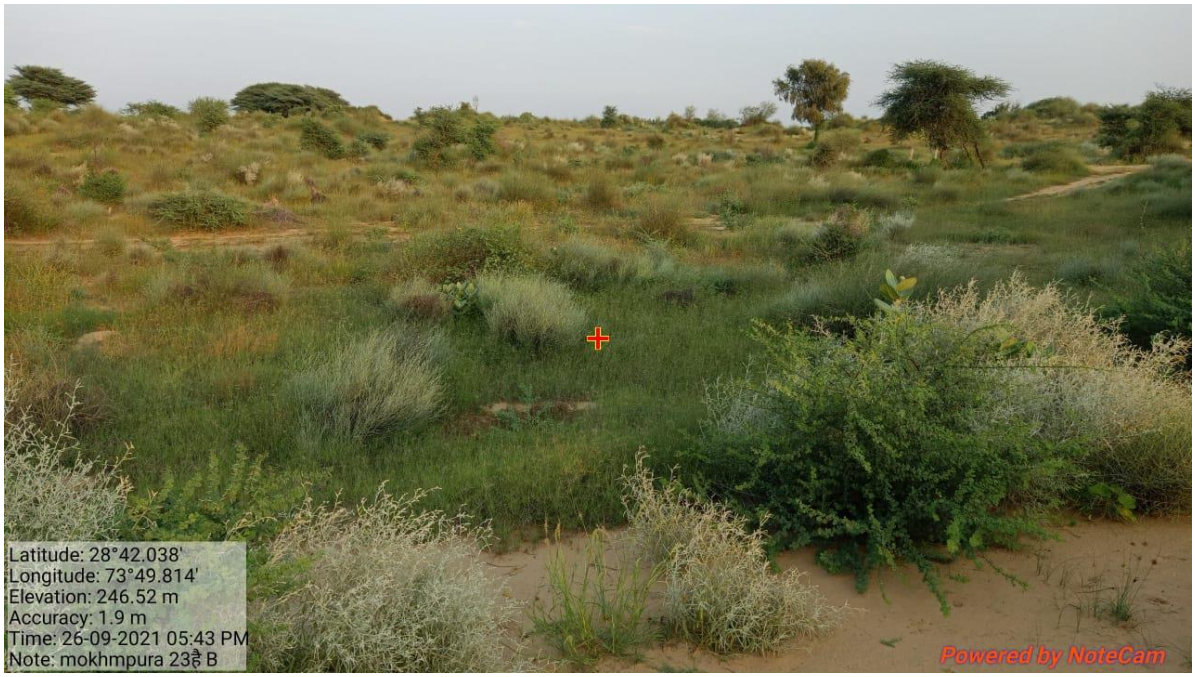


Figure 14.3B: Plantation site at Mokhmpura Forest Area, Lookansar, Bikaner

Figure 14.4A: Plantation site 7-10 MGD Range Lookansar, Forest Area, Bikaner

Figure 14.4B: 7-10 MGD Range Lukansar, Forest Area, Bikaner

Figure 14.5A: Canal side plantation in Chattargarha, Forest Area, Bikaner

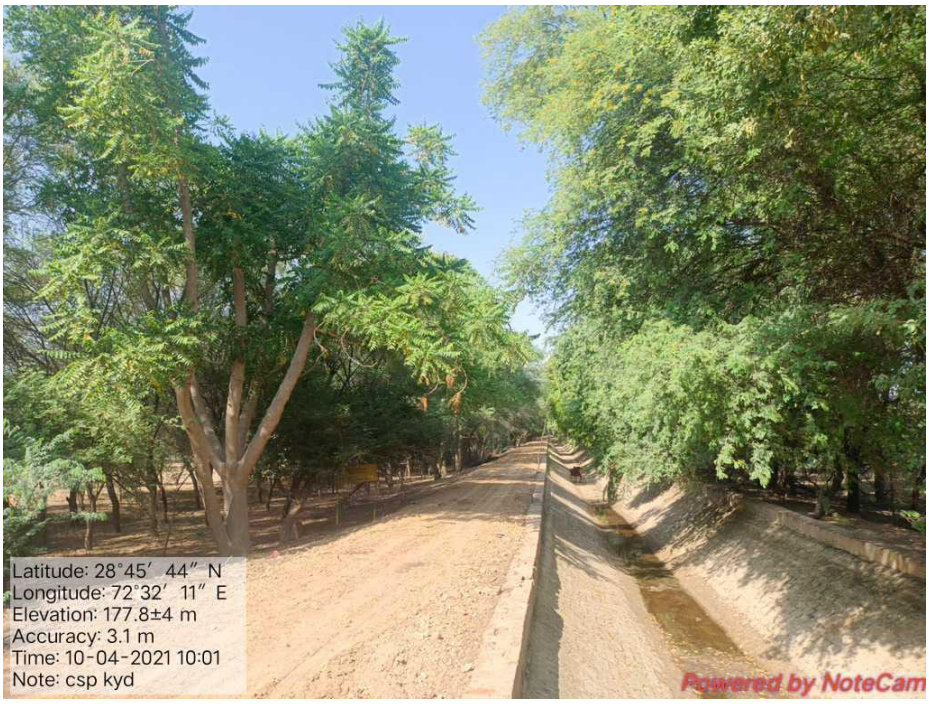


Figure 14.5B: Canal side plantation in Chattargarha, Forest Area, Bikaner

Figure 14.6A: Water body located in Johar beed, wildlife division, Bikaner

Figure 14.6B: Pond (TejaTalai) located in block no. 5, Bikaner

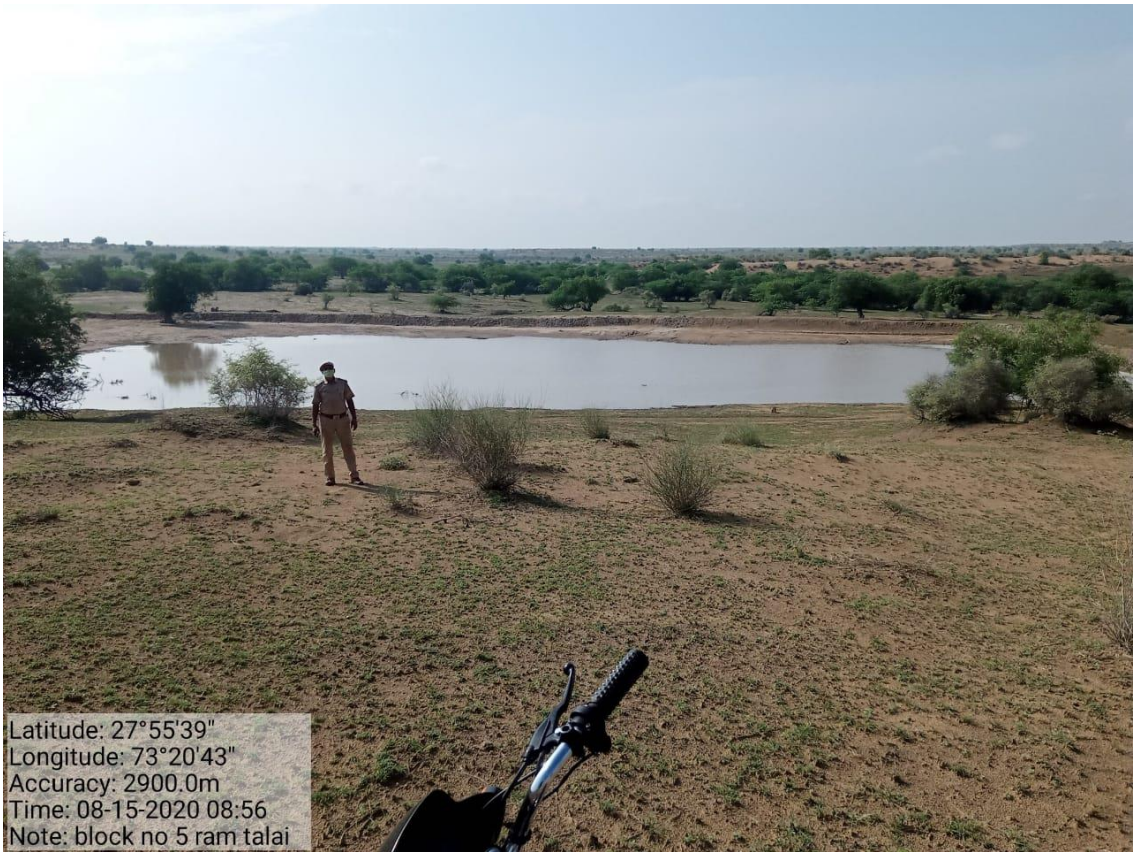


Figure 14.6C: Pond (Ram Talai) located in block no. 5, Bikaner

Figure 14.6D: Livelihood of birds near badaanicut, Bikaner

Figure 14.7A: Johar beed conservation reserve, Bikaner

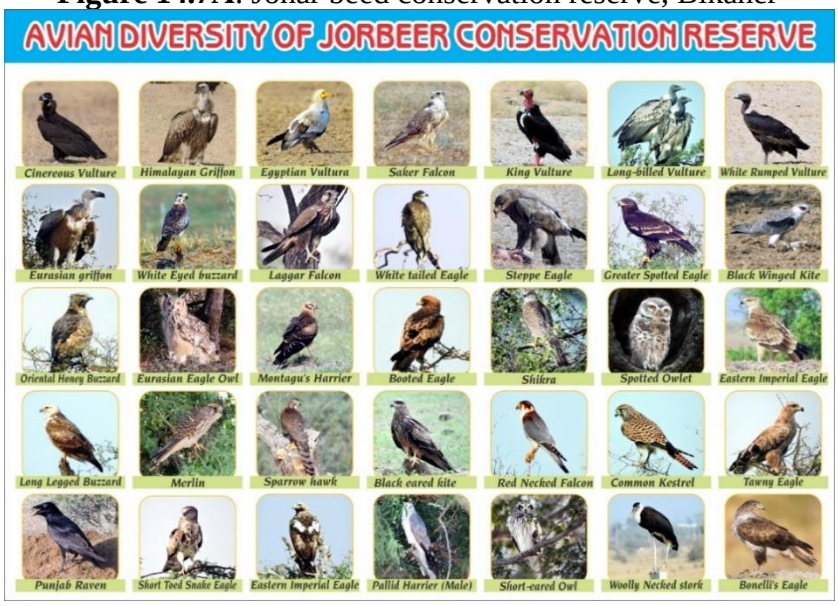


Figure 14.7B: Avian Diversity of Johar beed conservation reserve, Bikaner

Practices to Increase Green Cover in Bikaner District

The forest department has also initiated various forestry activities in recent times through mitigation efforts to reduce environmental pollution, which are given below:

The existing status and forest development practices done in different ranges of Bikaner district are given in Table 14.3.

Table 14.3: Actions taken/ planned for the development of forest cover range-wise during Year 2021-22

S. No.	Head	Name of Forest Division	Tree Planting (Except Road Side)			
			Forest Department			
			Target		Achievement	
			Ha	No. of Plants (In Lakhs)	Ha	No. of Plants (In Lakhs)
1	CAMPA	DCF, Bikaner	13.17	0.163	13.17	0.163
	Climate Change	-do-	80	0.48	80	0.48
2	Climate Change	DCF, Chhatargarh	150	0.90	150	0.90
	CAMPA	-do-	39.7	0.43	39.7	0.33
3	Climate Change	DCF, Stage II	100	0.60	100	0.60
	CAMPA	-do-	12.64	0.115	12.64	0.115
	Replantation	-do-	44	0.34	44	0.34
		Total	**439.51**	**3.028**	**439.51**	**2.928**

The range wise afforestation work planned under different schemes during 2020-21 has been summarized in **Tables 14.4, 14.5 and 14.6**:

Table 14.4: Range- wise planning of plantation under different schemes in the year 2021-22

District	Division	Scheme Name	Allotted	Number of plants to be planted
			Name of workplace Area (in Ha)	
Bikaner	DCF Bikaner	Climate Change	80	48000
		CAMPA	13.1695	11344
	DCF IGNP Stage-II Bikaner	Climate Change	100	60000
		CAMPA	12.64	11500
		Re Planting	44	34000
	DCF IGNP Stage-I Chhattargarh	Climate Change	150	90000
		CAMPA	39.7	43500
	Total		**439.5095**	**298344**

Table 14.5: Distribution of plants under different schemes for the year 2020-21
(Number of Plants in Lakhs)

District	Name of Forest Department	Scheme	Residue plants from distribution in the year 2019-20	Plants ready for distribution in the year 2020-21	Total (5+6)	With Charge Distribution	Free Distribution	Total (8+9)	Plants residues from distribution (7-10)
Bikaner	DCF Bikaner	Farm Forestry	0.328	0.70	1.028	0.866	0.0255	0.8915	0.136
		Toll Plant	0	0.15	0.15	0.0915	0	0.0915	0.0585
		MNAREGA	0	0	0	0	0	0	0
		Campa	0	0	0	0	0	0	0
		Total	**0.328**	**0.85**	**1.178**	**0.9575**	**0.0255**	**0.983**	**0.1945**
	DCF IGNP Stage –II Bikaner	Van Vidhya	0.095	0.70	0.795	0.795	0	0.795	0
		Toll Plant	0.06487	0.15	0.21487	0.19933	0	0.19933	0.01554
		Farm forestry	0	0.50	0.50	0.50	0	.50	0
		Total	**0.15987**	**1.35**	**1.50987**	**1.49433**	**0**	**1.49433**	**0.01554**
	DCF IGNP Stage –I Chhattargarh	Farm forestry	0	0.30	0.30	0.30	0	0.30	0

Table 14.6: Distribution of plants under Farm Forestry for the year 2020-21

District	District Target		Division	Division Target		Division-wise Achievement							
	Area Covered under Public & forest lands	No. of seedlings in lakhs planted on public and forest land		Area Covered under Public & forest lands	No. of seedlings in lakhs planted on public and forest land (Number)	Pt. No.51(a) Area Covered under Public & forest lands		Area Covered under Public & forest lands (8+9)	No. of seedlings in lakhs planted on public and forest land (Number)				
									by planting saplings		by seeds sowing/cutting		Total
						by Forest Dept.	by other Dept.		by Forest Dept.	by other Dept.	by Forest Dept.	by other Dept.	by planting sowing/ cutting
	Ha.	No. in Lakhs		Ha.	No. in Lakhs	Ha.		Ha.	No. in Lakhs		No. in Lakhs		No. in Lakhs
Bikaner	2625	17.06	DCF Bikaner	224.25	1.472	236.25	0	236.25	1.532	0	0	0	1.532
			Chattargarh Stage –I	570.36	2.855	570.36	0	570.36	2.855	0	0	0	2.855
			IGNP-II	290.75	1.877	290.75	0	290.75	1.877	0	0	0	1.877
			Total	**1085.36**	**6.204**	**1097.36**	**0**	**1097.36**	**6.264**	**0**	**0**	**0**	**6.264**

14.2 District Specific - Plantation through Ring-Pit method by NREGS funding

Having sandy soil and saline water, along with extreme temperatures in the district, it is not easy to grow vegetation in this region. The ring pit technique has been used in the district to grow trees with excellent results to combat adverse climatic conditions. This technique provides an avenue for regular watering and protection from grazing.

A network of nurseries has been established to support the plantation drive in the district with a major funding component from the NREGS scheme. During the year 2020-21, 171 work has been sectioned.

Overview of forest status in Bikaner District

Bikaner district is situated in the lap of the Thar desert and occupies an important place in the state of Rajasthan. In terms of area, Bikaner is spread over an area of 30247.90 sq km, which is 11.32 percent of the total area of Rajasthan. Due to low rainfall, extreme temperature, dry climate, and high evaporation, most of the district is treeless and dry except the Indira Gandhi

Canal Project area. There is a total forest area of 1250.67 sq km in the district, which is 4.13 percent of the total geographical area.

The entire forest region of the Bikaner district is divided into different forest divisions, classified into protected, classified forest, and unclassified forest areas. The present status of the availability of these areas under different forest divisions of the Bikaner district is summarised in Table 14.7.

Table 14.7: Status of forest areas under different forest divisions of Bikaner district

S. No.	Name of Forest Division	Protected Area (Ha)		Classified Forest Area (Ha)		Unclassified Forest Area (Ha)		Total Forest Area (Ha)		Status of amaldara head (Ha)	
		No. of Forest Blocks	Area	No. of Forest Blocks	Area	No. of Forest Blocks	Area	No. of Forest Blocks	Area	Amaldara Head	Balance in Amaldara Head
1.	Deputy Conservator of Forests, Bikaner	27	3512.696	-	-	34	10127.679	61	13640.375	10234.815	3405.560
2.	Deputy Conservator of Forests, EGNP, Stage I, Chhatargarh	214	59698.76	-	-	101	4805.432	315	64504.192	61885.093	2619.099
3.	Deputy Conservator of Forests, EGNP, Stage II, Bikaner	23	6222.417	-	-	701	34608.348	724	40830.765	38134.684	2696.081
4.	Deputy Conservator of Forests, Wildlife, Bikaner	2	6091.76	-	-	-	-	2	6091.76	5934.59	157.17
	Total	266	75525.63			836	49541.459	1102	125067.092	116189.182	8877.91

Naturally, trees of Khejdi, Rohida, Ber, Jal Peelu, Babool, Kikar, Kumtha, Kakeda, Hingota, France, Arni etc. are found here. Apart from these, shrubs like Ker, Aak, Fog, Bui, Sinia, Ghot, Khimp, Gundi, Naagfani, Arand, Baoli, Kaner, Boganbel etc. are found. Many types of useful grasses like Sevan, Dhaman, Bhurat, Lamp, Bharut, Gathil grass, Karad, Moonj etc. are found in abundance in the forest areas.

Bikaner district is very important from the point of view of desert wildlife. Among the mammalian wildlife, chinkara deer, black deer, nilgai, wild cat, fox, jackal, rabbit, sahli, mongoose, wild boar, langur, squirrel etc. are found here. Apart from these, Antkhor (Pangolin), Siyagosh (Caracal) wolf etc. have also been seen in the district.

At present, Bikaner district is divided into different forest divisions, whose work area is described in Table 14.8.

Table 14.8: Different forest divisions and their work area

S. No.	Name of Forest Division	Area of Operations
1.	Deputy Conservator of Forests, Bikaner	Tehsil Bikaner, Shridungargarh, Nokha, Uncommand Area of Kolayat, Lunkaransar
2.	Deputy Conservator of Forests, IGNP, Stage I, Chhatargarh	Tehsil Chhatargarh, Poogal, Khajuwala, E.G.N.P. 400 to 620 RD Main canal & its system
3.	Deputy Conservator of Forests, EGNP, Stage II, Bikaner	E.G.N.P. 620 to 1080 RD Main canal & its system
4.	Deputy Conservator of Forests, Wildlife, Bikaner	Jodbeed, Conservation Area, Beechwal Biological Park

1. Wildlife: Marudhara Biological Park Beechwal has been approved for 36.00 crores. Executive Agency DP RSRDC Ltd. Bikaner has completed the construction of 3500 meters wall against the boundary wall target of 3500 meters. Road construction in the campus, water reservoir for wildlife, and construction of chinkara cage have also been almost completed.
2. Twenty-point program: The target for the year 2021-22 is to plant 17.06 lakh saplings in an area of 2526 hectares. 2.59 lakh saplings are to be planted by the department in 395.51 hectares. The work has been started as soon as the rain starts.
3. MNREGA: 170 works were approved in 2019-20 under the MNREGA scheme. All the work is in progress.

14.3 Green Belt Development

There is great need to develop the forest which can improve the environment, increase biodiversity and sustained forest produce.Planting a suitable combination of trees that can grow fast and also have good leaf density shall be adopted to develop the green belt. It will act like a buffer to trap the airborne dust and also reduce the noise levels. From the aesthetic point of view also, this will have a positive impact. Keeping in view of these facts, forest department has been developing a green belt through plantation schemes in consultation with the local forest authorities for selection of site, specific species, seedling management, and plantation techniques and to up keep by deweeding, manuring and regular watering.

Criteria for selection of species: Species to be selected should fulfil the following specific requirements of the area. Availability of seed material

- Tolerance to specific conditions or alternatively wide adapts
- Ability to eco physiological conditions.
- Rapid growth capacity to endure water stress and climatic extremes after initial establishment
- Differences in height, growth habits
- Pleasing appearance
- Providing shade
- Ability of fixing atmospheric Nitrogen
- Improving waste lands

The greenbelt should be developed around the plant to act as a sink for pollutants, attenuation of noise levels and improvement in aesthetic quality of theplant. The following criteria should be adopted in the design of greenbelt: Generally, fast growing trees can be planted.

- Trees growing up to 10 m or more in height with thick perennial foliage can be planted around the plant.
- Trees can be planted in patches along the periphery to work as an indicator of pollution.
- Trees should be planted staggered in each row (minimum three rows encircling the perimeter of the plant).

The forest department has already developed a systematic plan for the management of forest conservation Practices by taking into consideration of various activities and mitigation efforts to

reduce environmental pollution such as afforestation, development of urban forest, reclaiming of degraded forest land, road side plantation, forestry activities to increase environmental awareness among people, etc.

References

1. Action Taken Report of the Rajasthan State Pollution Control Board, 2015.
2. Guidelines on Environmental management of Construction & demolition (C & D) Wastes, Central pollution control board, Ministry of Environment, Forest, and climate change, 2017
3. Rajasthan State Solid Waste Management Policy and Strategy, 2019.
4. Plastic waste management action plan forRajasthan, Local self-government department, 2019.
5. Strategy for Promoting Processing of Construction and Demolition (C&D) Waste and Utilisation of Recycled Products, Ministry of housing and urban affairs, 2018.
6. Inventory of Hazardous waste generating units in Rajasthan & Action taken report, Rajasthan State Pollution Control Board, 2009.
7. Ground Water InformationBikaner district, Rajasthan, Government of India Ministry of Water Resources Central Ground Water Board
8. Ground Water Yearbook Rajasthan, 2019-2020.
9. Ground water Level Scenario in Rajasthan – 2019, Ground Water Department, Government of Rajasthan.
10. Industrial potential survey, District industries centre, 2019-2020.
11. Hydrological Atlas of Rajasthan, Bikaner district, Ground Water Department, 2013.
12. Kumar, A. (2015), Urban Solid Waste: An Ecological Mess with Reference to Assessment and Management, IJRSI, Volume II, Issue-1.
13. Brief Industrial profile of Bikaner district, Ministry of MSME, Government of India
14. State sewerage and waste water policy, 2016, Government of India
15. Bhakar, P. and Singh, A.P. (2019). Groundwater quality assessment in a hyper-arid region of Rajasthan, India, Natural Resources Research, Volume 28(2), pp. 505-522. https://doi.org/10.1007/s11053-018-9405-4
16. Pandey, A., Singh, G., Palni, S., Chandra, N., Rawat, J.S., andSingh, A. P.(2021). Application of remote sensing in Alpine grasslands cover mapping of western Himalaya, Uttarakhand, India, Journal of Environmental Monitoring and Assessment.https://doi.org/10.1007/s10661-021-08956-9.

17. Singh, A.P., Chakrabarti S., and Kumar, S. and Singh, A. (2017). Assessment of air quality in Haora river basin using fuzzy multiple-attribute decision making techniques, Environmental Monitoring and Assessment, 189(8): 373. https://doi.org/10.1007/s10661-017-6075-3.
18. Singh, A.P., Khakolia, A., Tavanshetti, S., Yadav, J. (2019). Groundwater Quality Assessment Using GIS and Fuzzy Logic- A Case Study of Jhunjhunu District, Pollution Research, 38 (3), 655-662.
19. Singh, A.P. and Bhakar, P. (2020). Development of Groundwater Sustainability Index: A Case study of Western Arid Region of Rajasthan, India, Environment, Development and Sustainability, Springer. https://doi.org/10.1007/s10668-020-00654-9.
20. Srinivas, R., P. Bhakar, and A.P. Singh (2015). Groundwater Quality Assessment in some selected area of Rajasthan, India Using Fuzzy Multi-Criteria Decision Making Tool. ICWRCOE'15, Aquatic Procedia, Elsevier, Volume 4: pp 1023–1030. doi:10.1016/j.aqpro.2015.02.129.