National Institute of Urban Affairs

सत्यमेव जयते
Ministry of Housing and Urban Affairs
Government of India

स्वच्छ भारत
एक कदम स्वच्छता की ओर

How does urban India manage its waste?

AN ALMANAC OF WASTE MANAGEMENT PRACTICES

HOW DOES URBAN INDIA MANAGE ITS WASTE?

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2020

TITLE
HOW DOES URBAN INDIA MANAGE ITS WASTE?
AN ALMANAC OF WASTE MANAGEMENT PRACTICES

PUBLISHER
NATIONAL INSTITUTE OF URBAN AFFAIRS, DELHI

YEAR OF PUBLISHING
2020

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THE FULL REPORT SHOULD BE REFERENCED AS FOLLOWS
NIUA (2020) “How does urban India manage its waste?
An Almanac of Waste Management Practices” Delhi, India
Text from this almanac can be quoted provided the source is acknowledged.

FOREWORD

दुर्गा शंकर मिश्र
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Durga Shanker Mishra
Secretary

भारत सरकार
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Foreword

Swachh Bharat Mission launched in October 2014 is one of the most ambitious initiatives undertaken by the Government of India. The Mission had the twin objectives of making urban India open defecation free along with 100% scientific management of solid waste. To achieve this, it was important to build the capacity and knowledge of the municipal officials, who have the challenging task of implementing and ensuring the guidelines stated in the Solid Waste Management Rules, 2016.

On behalf of the Ministry of Housing and Urban Affairs (MoHUA), National Institute of Urban Affairs was entrusted with the task of organizing training and exposure workshops for the Urban Local Bodies from 2016 to 2020.

This document is the compilation of the various waste management practices being undertaken and initiated across the nation. It also provides information on cities that have shown commendable efforts in solid waste management practices.

I would like to take this opportunity to congratulate and appreciate the efforts made by NIUA successfully completing 154 workshops across India and documenting evidence based sustainable waste management models that have worked on the ground.

(Durga Shanker Mishra)

New Delhi
September 30, 2020

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PREFACE

कामरान रिज़वी
अपर सचिव
KAMRAN RIZVI
Additional Secretary

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PREFACE

With the increase in population of India, there is growing waste generation, whose proper management is an area of concern for the urban local bodies. To address and resolve these issues, Swachh Bharat Mission (SBM), which has been launched as India's biggest-ever cleanliness drive, aims to ensure door-to-door garbage collection and proper disposal of waste in all the 83,000 wards in urban areas.

In that regard, Ministry of Housing and Urban Affairs (MoHUA), Government of India, engaged National Institute of Urban Affairs for conducting Exposure Workshops on Waste Management for Urban Local bodies (ULBs). These workshops have been spread over four phases - 2016, 2017, 2018-19 and 2019-2020. In these five years, 154 workshops conducted across 58 locations in India, witnessed participation of 6160 officials representing 3221 Urban Local Bodies.

One of the pivotal features of the workshop has been the field visits that were organized for the participants providing on-ground exposure to various aspects of SWM. The visits benefited the ULBs in understanding and resolving various challenges they face regarding SWM and Faecal Sludge and Septage Management (FSSM). In addition, the ULBs were introduced to various innovative approaches for effective solid waste management.

This almanac is a compilation of these practices and innovative approaches, collated over the past five years, with an overall purpose to disseminate them across India for further adoption. The selected 27 locations are classified in four different categories: Tourist Cities, Capital and Administrative Cities, Industrial and Commercial Cities, and Trailblazers. The categorization of cities enhances the reading experience, so that cities with similar context can easily relate, compare and contrast between the shared examples. Each case discussed here contains essential project details such as the business model, the installed capacity of the facility, scale of the project, capital and operational expenditures and key highlights. In addition, some case studies, innovative and sustainable practices are discussed in detail. The compendium includes contact details of the concerned individuals and organizations of various projects to help the ULBs access any further information pertaining to the project.

I acknowledge the efforts of NIUA in bringing out this almanac, comprehensively covering all good and innovative approaches adopted across India, and hope this paves way towards a sustainable management of waste in India.

Kamran Rizvi

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ACKNOWLEDGMENT

The successful journey of Swachh Bharat Mission Exposure Workshop has been due to the relentless efforts and involvement of numerous organizations, individuals and the municipal bodies. These accomplishments were seen at the various waste management interventions that were implemented in each of these cities visited. "How Urban India manages its waste? An Almanac of Waste Management Practices" is the outcome of this journey. We extend our sincere gratitude to each and every one, who has contributed to this project.

Foremost, we are thankful to the Ministry of Housing and Urban Affairs (MoHUA), Government of India for being the source of inspiration and guiding force of this project. We would like to extend a heartfelt gratitude to Shri. Durga Shankar Mishra, Secretary, MoHUA, Government of India for providing National Institute of Urban Affairs (NIUA) the opportunity to extensively contribute and be a part of the Swachh Bharat Mission. We are greatly indebted to Shri. V. K. Jindal, former Joint Secretary and Mission Director, Swachh Bharat Mission (Urban) for his continuous guidance and engagement. This document would not have seen the light of the day without his immeasurable support. We would also like to thank the team members of the PMU at MoHUA for their constant support.

We wish to acknowledge the efforts of our partner training organizations in different cities for delivering the programme under tight timelines. The officials of the Urban Local Bodies where our workshops were held and the site in-charges deserve a special mention for providing necessary logistics during visits and providing technical information that have contributed in shaping up the synthesized document.

We are grateful to the officials of the State Governments and Union Territories, and State Urban Development Authorities who have greatly helped in formulating this document. We are also thankful to the resource persons and participants for sharing their on-ground experiences and valuable feedback.

We hope that the best practices documented in this almanac can help change the landscape of waste management in India.

Hitesh Vaidya
Director, NIUA

INTRODUCTION

Swachh Bharat Mission (Urban) 2014–20

Towards Achieving a Clean India

India's urban population has been increasing rapidly over the last few decades. As per Census of India, 1951, India had an urban population of 17.29%, which increased up to 31.16% in 2011. Due to urbanization and change in lifestyle, India had to deal with increased solid waste generation. Dealing with waste has now become a global issue, which poses a threat to public health, environment and economy.

SOLID WASTE SCENARIO IN URBAN INDIA

Solid Waste Management (SWM) is one of the 18 functions of the 12 Schedule of the 74th Constitutional Amendment Act (74th CAA) that comes under the purview of Urban Local Bodies (ULBs). To understand the importance of the linkages between MDGs, SDGs and Solid Waste Management in urban India, the approach and achievements of the Swachh Bharat Mission (Clean India Mission) becomes necessary. This note delineates major initiatives of solid waste management in India, particularly that of SWM Rules 2016 and Swachh Bharat Mission (Urban) (SBM-U) 2014-2020. Furthermore, one of the various components of SBM-U has been capacity building on SWM. In that context, National Institute of Urban Affairs (NIUA), a think tank under the Ministry of Housing and Urban Affairs (MoHUA) conducted several SBM exposure cum training workshops for ULB officials on behalf of MoHUA since 2016. This summary provides an overview of these workshops, the issues and challenges identified by the participants and the solutions to some of the problems faced by the community due to poor waste management.

SIGNIFICANCE OF SWM IN MDGS AND SDGS

It is significant that Solid Waste Management (SWM) is one of the important targets to be achieved under the Sustainable Development Goals (SDG, 2015 to 2030). Significance of proper treatment of solid waste is recognized in Sustainable Development Goals (SDGs-2015 to 2030) and it is embedded within the 17 goals of SDGs either explicitly or implicitly.

SDG 11, "Make cities and human settlements inclusive, safe, resilient and sustainable", explicitly discusses about SWM. Target no. 11.6 of SDG 11, says, member states decided to by 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management. Waste management has strong linkage to a range of global challenges, such as health (SDG 3), climate change (SDG 13), poverty reduction (SDG 1), clean water and sanitation (SDG 6), food and resources security (SDG 2) and sustainable production and consumption (SDG 12). It is also observed that, a significant proportion of the population of many large cities depends on solid waste management for their livelihood, whether employed by formal or informal organizations for street sweeping, waste collection, waste sorting, recycling and others. Also, a significant proportion population's livelihood is depended on the services that form the crucial part of waste management value chain.

SOLID WASTE MANAGEMENT INITIATIVES IN INDIA MSWM RULES 2000 AND SWM RULES 2016

The first comprehensive solid waste management rules were promulgated in 2000 by the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India (GOI). The rules provided detailed mandates on various aspects of Municipal Solid Waste Management (MSWM) and identified the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCBs) as nodal agencies to monitor its implementation directly in the union territories and the states respectively. Thereafter, due to its poor implementation and monitoring, in several states of India, the rules were revised in 2016 by the Ministry of Environment, thus releasing the latest Solid Waste Management (SWM) Rules in 2016. Under these rules, the responsibility of management of Solid Waste in cities has been entrusted with Urban Development Departments and Urban Local Bodies (ULBs) in the States. All Municipal Corporations and Municipalities have to prepare a Solid Waste Management Plan. Besides that, to operationalize the SWM Rules 2016, the Ministry of Housing and Urban Affairs (MoHUA) through Central Public Health Environment Engineering Organization (CPHEEO), has published manuals in October 2016 which has incorporated the necessary specifications and actions for ULBs to implement them in their cities.

KEY FEATURES OF THE SOLID WASTE MANAGEMENT RULES, 2016

- A mandate for all waste generators to segregate waste, but with specific penalty on non-compliers to be announced through bye-laws
- A mandate for bulk generators (any institution with an area greater than 5,000 square meters) to manage their own waste, but with penalty mentioned for non- compliance of the same to be announced through bye-laws
- An extended producer responsibility on brand owners to set up a collect-back scheme for managing waste produced during packaging
- Promotion of options like Biomethanation, waste to fuel oil or Refuse Derived Fuel (RDF), composting, WTE (waste-to-energy) plants are suggested for treating different streams of waste. The inclusion of Market Development Mechanisms (MDMS) in addition to the directive to the Department of Fertilizers to market city compost along with chemical fertilizers are also promoted.
- Provision for local bodies to levy waste collection fees on waste generators, with both fees and penalty for non-compliance to be announced through bye-laws.

SWACHH BHARAT MISSION (URBAN)

Swachh Bharat Mission (SBM) was launched on October 2, 2014. The initiative has two thrust areas - SBM (U) and SBM (R). SBM (U) operates under the Ministry of Housing and Urban Affairs and SBM (R) operates under the Ministry of Drinking Water and Sanitation, now integrated into Ministry of Jal Shakti (Water Resources). The key objectives of SBM are to address both elimination of open defecation and achieving solid waste management in all cities and villages in India. SBM (U) focuses specifically on all ULBs of India. The mission has various components

namely capacity building, construction of household toilets, community and public toilets, IEC & public awareness, solid waste management including faecal sludge management. To address primarily Solid Waste Management issues, SBM (U) launched a multipronged approach to counter the cyclical effects of de-motivation and poor performance of ULBs by infusing enthusiasm, financial support, a feeling of accountability among ULB staff towards cleanliness through organization of massive awareness campaigns among citizens who are the primary generators of solid waste in the cities.

ACHIEVEMENTS OF SBM[1]

Urban areas of 35 states / UTs have become ODF. In all, 4,324 cities have declared themselves ODF. This has been achieved by the construction of nearly 61.6 Lakh Individual Household Toilets and around 5.9 Lakh seats of Community / Public Toilets constructed under the Mission. MoHUA has launched the ODF+ and ODF++ protocols, with a focus on sustaining ODF outcomes and achieving holistic sanitation. While ODF+ protocol focuses on Operation & Maintenance of community toilet (CT) / public toilets (PT) by ensuring functionality and proper maintenance of CT/PTs for their continued usage, ODF++ focuses on addressing safe management of faecal sludge from toilets, and ensuring that no untreated sludge is discharged into open drains, water bodies or in the open. Till date, 1276 Cities have been certified ODF+ & 411 cities have been certified ODF++.[2]

ACHIEVEMENT OF SBM FOCUSSING ON SWM

At the time of launch of the Swachh Bharat Mission, approximately 86,18,255 MT per annum of waste was the treatment capacity across processes such as composting, bio-methanation, RDF and waste to energy plants (as per the erstwhile Planning Commission of India report). This has been enhanced substantially in the last 6 years, and presently, approximately 89,545 MT (65%) of waste is being treated and processed per day. Currently, the production capacity of waste to energy plants is 61 MW and that of waste to compost plants is 31.8 lakh MT. In addition, out of 84,475 wards, 96% of the wards are practicing 100% door to door collection and 75% of wards are practicing source segregation.[3]

The Protocol for Garbage Free Cities (GFC) was also launched during SBM 1. This protocol is based on 24 parameters and follows a SMART framework – Single metric, Measurable, Achievable, Rigorous verification mechanism and Targeted towards outcomes. It has been devised in a holistic manner including components such as cleanliness of drains and water bodies, plastic waste management, managing construction & demolition waste, etc. It is a single metric rating system, based on multiple parameters of SWM. It is envisioned that star rating initiative will also enable institutionalization of good practices such as source segregation, scientific processing of waste, dumpsite remediation, penalties and spot fines for littering, and compliance of bulk waste generators, amongst others. As on date, 6 Cities (Indore, Ambikapur, Navi Mumbai, Surat, Rajkot and Mysuru) are certified as 5-star cities, 65 cities are certified as 3-star cities & 70 cities are certified as 1-star cities.[4]

EXPOSURE CUM TRAINING PROGRAMME

As part of the capacity building programme under the SBM, NIUA has conducted Solid and Liquid Waste Management (SWM) workshops for the Urban Local bodies (ULBs). These have been spread over four phases - Phase I (2016), Phase II (2017), Phase III (2018-19) and Phase IV (2019-20). The purpose of the SWM Exposure Workshop was to get

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[1] *As of June, 2020, Source: http://swachhbharaturban.gov.in/*
[2] *Source: https://www.insightsonindia.com/2020/03/18/odf-and-odf-under-phase-2-of-the-swachh-bharat-mission-urban/*
[3] *Source: http://swachhbharaturban.gov.in/*
[4] *Source: https://gfcstarrating.org/User/GFCStarResult*

the participants recognize issues, challenges and constraints of SWM, understand the SWM Rules 2016, various approaches, technologies available to them and their financial implications while preparing an action plan to implement solutions in their cities.

In 2016, NIUA conducted twelve SBM-SWM workshops at United Service Institute of India, New Delhi. Each workshop had 40-45 senior officials from ULBs and covered 108 ULBs of 25 states and UTs and trained 224 municipal officials. A similar set of twelve workshops were conducted in 2017 at India Habitat Centre, New Delhi, covering 178 ULBs from 27 states and 5 UTs and trained 423 municipal officials. These workshops (Phase I – 2016 and Phase II - 2017) were conducted from May to October and duration of workshop were five days, wherein the first day was devoted to theoretical aspects while the next two days were site visit days. The ULB officials were taken to different locations in Delhi and other parts of NCR. They were explained the details of different plants for treatment of different components of solid waste generated in a city. The fourth and fifth days were devoted to explanation of technologies, exercises and competitions to assess the action plans of the groups. These workshops were called SWM Exposure Workshops because they provided the required exposure to the participants regarding the SWM Rules 2016 and the ways and means for achieving compliance with it. SBM SWM Exposure Workshop Phase III (2018-19), focused on capacity building of Class I (more than 1, 00,000 population), Class II (50,000 to 99,999 population) and Class III (20,000 to 49,999 population) cities, the major waste generators in India.

Project Sequence

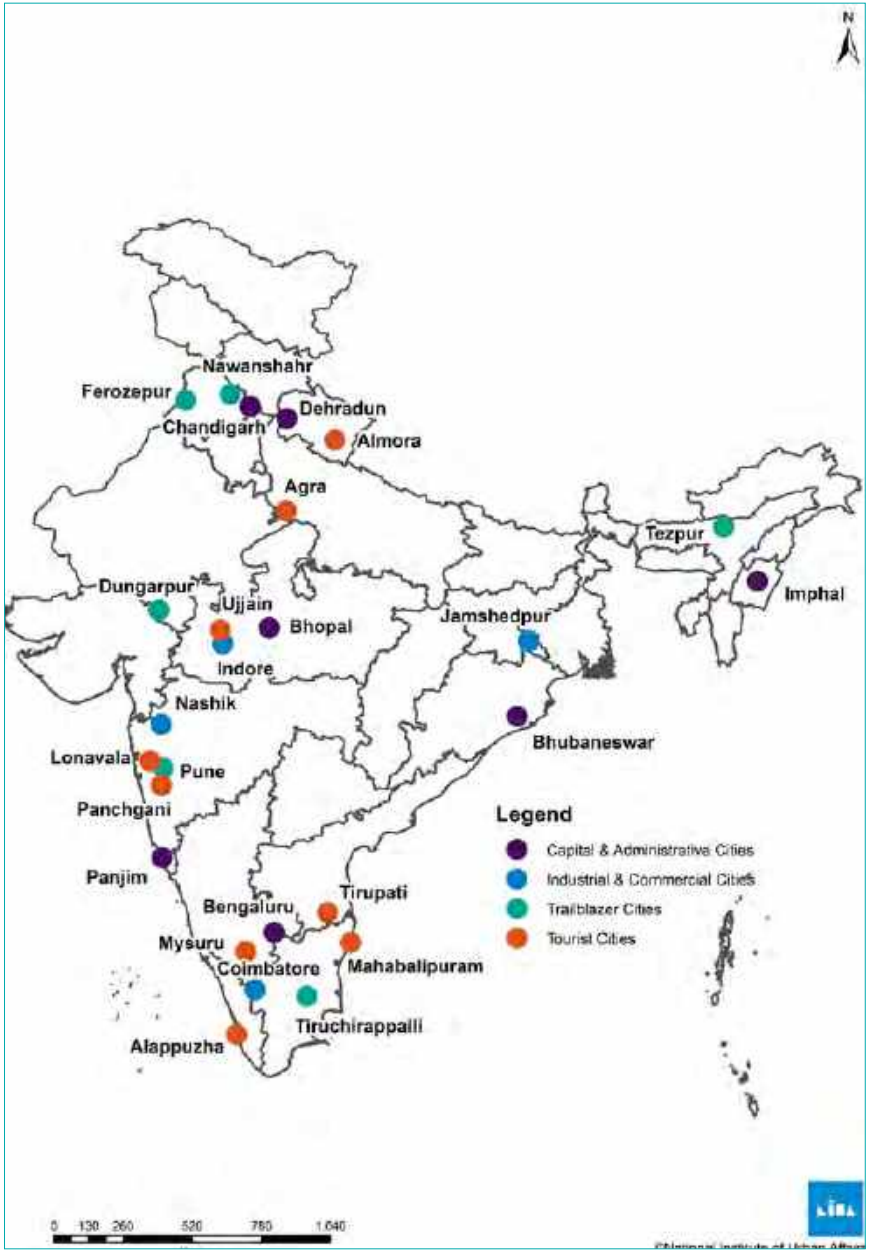
The third phase (2018-19) started with a five-day national master trainers' workshop in August, 2018 at the India Habitat Centre, New Delhi, wherein master trainers from thirteen Training Entities (TEs), selected through a competitive process, were trained. This was followed by the TEs conducting 80, three-day City Cluster Workshops, at 43 locations across India, from 17th September 2018 to 15th February, 2019. A total of 3439 officials from 1789 ULBs from 27 states and 4 UTs were trained.

During the 4th meeting of the NARC at the MoHUA regarding the Swachh Bharat Mission-Urban dated 22nd May, 2019, NIUA proposed an orientation programme for the elected representatives so that they could understand the issues and challenges involved and give their support, leadership and guidance to the efforts and initiatives being put-in by the bureaucrats and municipal workers. This proposal was accepted.

The fourth phase kick-started on 3rd October, 2019 with one day Training of Trainers (ToT meeting). From November 2019 to 30th June 2020 50 City Cluster Workshops were conducted - 40 for ULB Officials and 10 for Elected Representatives. 1869 participants representing 1010 ULBs, covering 26 states and 6 UTs participated in this phase. These workshops were held across 27 locations in India. In all, 5955 participants were trained in 154 SBM exposure workshops, covering 3085 ULBs from 2016 -2020.

In addition to this document, the knowledge gathered over the past five years of the project has been assimilated in the form of a Compendium titled; "Solid Waste Management Initiatives in Urban India: A Compendium". An interactive GIS portal has also been developed to get the bird's eye view of the project. Lastly, a video has also been produced, which talks about the journey of SBM Exposure Workshops since 2016 to 2020, and collates the waste management processes of India. These can be accessed at the NIUA website **www.niua.org.**

WORKSHOP LOCATIONS, 2019-20



ABOUT THIS ALMANAC

Under the SBM SWM Exposure Workshops, field visits formed an important element. These visits Under the SBM SWM Exposure Workshops, field visits formed an important element. These visits included on-ground exposure to various aspects of solid waste management such as source segregation, collection and transportation, processing and treatment and scientific disposal. The visits benefitted the ULBs in understanding as well as resolving the various issues and challenges related to SWM. Thus, a need was felt to consolidate and share the experiences with a wider audience keen on working towards a sustainable SWM.

WHAT IS THIS ALMANAC ABOUT?

This almanac comprises a compilation of innovative approaches adopted across India in the waste management sector in 26 locations. It highlights these initiatives along with their technical specifications and basic financial details. The locations have been categorized as Tourist Cities, Capital and Administrative Cities, Industrial and Commercial Cities and Trailblazers.

TOURIST

India with its rich history, culture and topography is a paradise for travelers. Tourism is a booming industry for the country, and is important for the country's economy. In 2018, this industry alone contributed to 9.2% of India's GDP. However, with the increase in the number of tourists in cities, there is an increase of free-floating garbage as well. To tackle the issue of waste generated by the floating population of India; various cities took up important measures to keep their city clean. SBM's SWM Workshops traced these best practices of waste management and also trained the ULBs on various methods of Solid Waste Management.

CAPITAL AND ADMINISTRATIVE

With the ever-growing population of Urban India; capital and administrative cities face the brunt of accommodating migrant workers due to the job opportunities available. But these cities, may not have the wherewithal to dispose of the waste generated by

its citizens. Effective leadership and administration of these cities are showing the way on how to manage solid waste efficiently, so that the same can be channelized in the surrounding cities as well. SBM's SWM Workshops took the opportunity to share these experiences, and further provided support by training the city officials.

INDUSTRIAL AND COMMERCIAL

Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. This is especially significant with regard to industrialised and commercial cities of India, wherein solid waste from industries, commercial areas and residential areas often get mixed and end up in dump yards The SWM Rules 2016 and SBM's new guidelines aimed at addressing this issue and promote prevention, minimisation, recycling and safe disposal of waste. SBM's SWM workshops took the opportunity to help ULBs of industrial and commercial cities to come up with practices to mitigate the waste menace and adopt environment-friendly practices through cross-learning.

TRAILBLAZERS

By definition; a trailblazer is a leader, who is the first to do something that other people do later. In order to improve the efficiency of waste management services, ULBs across India are seeking and even coming up with innovative methods. These innovations are cost-effective, environment-friendly, and definitely the need of the hour. SBM's SWM workshops scoped for these innovative methods so as to showcase these case studies to other ULBs, inspire them, and support these best practices.

WHO CAN BENEFIT FROM THIS ALMANAC?

This almanac is intended as a reference to ULB officials to understand and implement an appropriate SWM plan. The almanac is therefore structured based on the population, demography, administrative set-up and financial status. This in turn will assist in peer learning. The contact details included in the chapters' will be a ready reckoner in accessing further information regarding the facilities. Glossary has been included at the end of the document for better understanding of terminologies related to SWM.

FROM WHERE IS THE INFORMATION ADOPTED IN THE ALMANAC?

The information regarding the facilities have been obtained from the interaction with site personnel during the field visits. Other sources include data derived from websites of city corporations, NGOs, facility operators and other credible sources like research papers, news articles and reports.

LIST OF ABBREVIATIONS

ABR	Anaerobic Baffled Reactors
ACF	Activated Carbon Filter
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ANERT	Agency for Non-conventional Energy and Rural Technology
ANN	Agra Nagar Nigam
BARC	Bhabha Atomic Research Centre
BBMP	Bruhat Bengaluru Mahanagar Palike
BGD	Biogas Digester
BMC	Bhubaneswar Municipal Corporation
BMC	Bhopal Municipal Corporation
BMS	Building Management System
BMU	Bio-Methanation Unit
BOD	Biochemical Oxygen Demand
BOOT	Build, Own, Operate and Transfer
BOV	Battery Operated Vehicles
BWG	Bulk Waste Generator
C&D	Construction and Demolition Waste
CCMC	Coimbatore City Municipal Corporation
CCP	Corporation of the City of Panaji
CMC	City municipal council
COD	Chemical oxygen demand
CREST	Center For Renewable Energy & Sustainable Technologies
CSR	Corporate Social Responsibility
CV	Calorific Value
CWPU	Coconut Waste Processing Plant
DBOT	Develop, Build, Operate and Transfer
DEWATS	Decentralized Waste Water Management System
DFBOT	Design, Finance, Build, Operate and Transfer
DHW	Domestic Hazardous Waste
DTDC	Door to Door Collection
DWCC	Dry Waste Collection Centre
ETP	Effluent Treatment Plant
FSSM	Faecal Sludge and Septage Management
FSTP	Faecal Sludge and Treatment Plant
GDP	Gross Domestic Product
GHSD	Green House Solar Drier Roof (GHSD)
GI	Galvanized Iron
GoI	Government of India
GPRS/ GSM	General Packet Radio Service
GPS	Global Positioning System
GTS	Garbage Transfer Station
GVP	Garbage Vulnerable Point
HAG	Hot Air Generator
HDPE	High-density polyethylene
HFCW	Horizontal Flow Constructed wetland
HRT	Hydraulic retention time
IAF	Indian Air force
ICCC	Integrated Control and Command Centre
ICT	Information and communications technology
IEC	Information, Education and Communication
IMC	Indore Municipal Corporation
IMC	Imphal Municipal Corporation
IRTC	Integrated Rural Technology Centre
ISWM	Integrated Solid Waste Management
JUSCO	Jamshedpur Utility & Services Company
KCDC	Karnataka Compost Development Corporation
KIIT	Kalinga Institute of Industrial Technology
KILA	Kerala Institute of Local Administration
KLD	Kiloliters per day
KSPCB	Karnataka State Pollution Control Board
LDO	Light Diesel Oil
LCV	Light Commercial Vehicles
LDPE	Low-density polyethylene
LLPU	Leaf Litter Processing Unit
LMC	Lonavala Municipal Council
LSGD	Local Self Government Department
LTP	Leachate Treatment Plant
MBBR	Moving Bed Bio Film Reactor
MCC	Micro Composting Centre
MCC	Mysuru Municipal Corporation
MCC	Municipal Corporation of Chandigarh
MCF	Material Collection Facility
MLD	Million litres per day
MoHUA	Ministry of Housing and Urban Affairs
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MT	Metric tons
M-UASB	Modified Up flow Anaerobic Sludge Blanket
NEERI	National Environmental Engineering Research Institute

NGO	Non-Government Organization
NGT	National Green Tribunal
NMC	Nashik Municipal corporation
NPD	Nagar Parishad
O&M	Operation and Maintenance
ODF	Open Defecation Free
OREX	Organic Extrusion segregation technology
OSS	Onsite Sanitation System
OWC	Organic Waste Converter
PCC	Plain Concrete Cement
PCC	Plastic Collection Centre
PET	Polyethylene terephthalate
PGF	Planted Gravel Filter
PHSMC	Panchgani Hill Station Municipal Council
PMC	Pune Municipal Corporation
PP	Polypropylene
PPEs	Personal Protective Equipment's
PPP	Public Private Participation
PS	Polystyrene
PSF	Pressure Sand Filter
PSTR	Partially String Tank Reactor technology
PVC	Plasticized Polyvinyl chloride

R.C.C.	Reinforced Concrete Cement
RAAC	Residence Awareness Association of Coimbatore
RDF	Refuse derived fuel
RFID	Radio Frequency Identification
ROI	Return on Investment
RRP	Resource Recovery Park
RWAs	Resident Welfare Association
SBILD	State Bank Institute of Learning & Development
SBM	Swachh Bharat Mission
SCADA	Supervisory Control and Data Acquisition
SCF	Solid combined fuel
SCOPE	Society for Community Organization and Peoples Education
SDB	Stabilization Reactor
SDC	Swiss Agency for Development & Cooperation
SEP	Solar Evaporation Pond
SHGs	Self Help Groups
SLB	Service Level Benchmark
SLF	Sanitary Landfill Site
SPV	Special Purpose Vehicle
SRS	Septage Receiving Station
SRT	Solid retention time
SS	Stainless Steel
SSKs	Sehaj Safai Kendra's

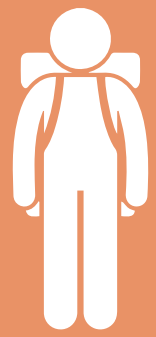
ST	Stabilization Tank
STP	Sewage Treatment Plant
SWM	Solid Waste Management
TCC	Tiruchirappalli City Municipal Corporation
TMC	Town municipal council
TMC	Tirupati Municipal Corporation
TP	Town Panchayats
TPD	Tons Per day
TTD	Tirumala Tirupati Devasthanam
TTS	Temporary Transfer Station
UASB	Up flow anaerobic sludge blanket
ULB	Urban Local Body
UMC	Ujjain Municipal Corporation
VFCW	Vertical-flow Constructed Wetland
VTS	Vehicle Tracking Solution
WATSAN	Water and Sanitation
WPP	Waste Processing Plant
WTC	Waste to Compost
ZWM	Zero Waste Management

Tourist Cities				
	2 UJJAIN	14 TIRUPATI	24 MYSURU	32 ALAPPUZHA
41 AGRA	50 PANCHGANI	60 LONAVALA	65 MAMALLAPURAM	77 BAGESHWAR
84 BENGALURU	102 BHOPAL	112 CHANDIGARH	119 Bhubaneswar	CAPITAL AND ADMINISTRATIVE CITIES
125 PANAJI	130 IMPHAL	135 DEHRADUN		

<table>
<tr><td></td><td></td><td>148
INDORE</td><td>159
COIMBATORE</td><td rowspan="2">INDUSTRIAL AND COMMERCIAL CITIES</td></tr>
<tr><td></td><td>174
NASHIK</td><td>182
JAMSHEDPUR</td><td>182
JAMSHEDPUR</td></tr>
<tr><td rowspan="2">TRAILBLAZER CITIES</td><td>191
PUNE</td><td>201
TIRUCHIRAPPALLI</td><td>212
NAWANSHAHR</td><td>219
DUNGARPUR</td></tr>
<tr><td>230
TEZPUR</td><td>234
FEROZEPUR</td><td>244
GLOSSARY</td><td></td></tr>
</table>

Location Map for Tourist Cities

India with its rich history, culture and topography is a paradise for travelers. Tourism is a booming industry for the country, and is important for the country's economy. In 2018, this industry alone contributed to 9.2% of India's GDP. However, with the increase in the number of tourists in cities, there is an increase of free-floating garbage as well. To tackle the issue of waste generated by the floating population of India; various cities took up important measures to keep their city clean. SBM's SWM Workshops traced these best practices of waste management and also trained the ULBs on various methods of Solid Waste Management.

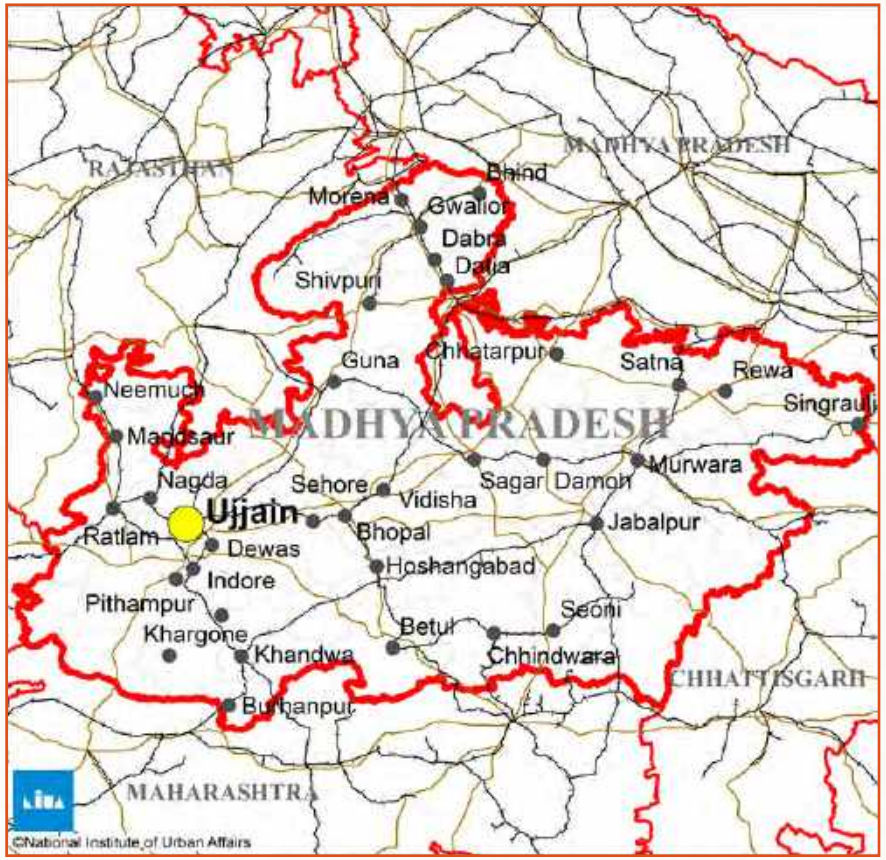


TOURIST CITIES

1

UJJAIN

Ujjain



Snapshot of Ujjain Municipal Corporation

State	Madhya Pradesh
Area	92.68 sq. km
No. of Wards	54
Population	5,15,215
Total Waste Generated	172 MT per day
Total wet waste generated	103 MT per day
Total dry waste generated	76 MT per day
Total domestic hazardous waste	0.050 MT per day

Ujjain is one of the holiest and ancient cities of India; located on the banks of river Kshipra in Madhya Pradesh. The Lord Mahakaleshwar temple in the city makes it a famous hindu pilgrimage centre. With numerous temples from different eras, Ujjain hosts the Kumbh Mela once every twelve years. These temples attract lots of tourists and worshippers to Ujjain. The city has a population of over 5.15 Lakh (Census 2011). However, it comprises a floating population that varies from 10,000 (Ten Thousand) to 10 Lakh (10,00,000) per day depending on the ongoing festivals.

Ujjain is a municipality with a mayor-council form of government. Ujjain Municipal Corporation (UMC) was established in 1956 under the Madhya Pradesh Nagar Palika Nigam Adhiniyam as Nagar Palika. In 1965, Ujjain Major Nagarpalika was given the status of municipal corporation and in 1971 the status of Ujjain municipal corporation was granted. The municipal area spans over 92.68 sq. km and is divided into 6 zones covering 54 wards.

Solid Waste Profile	
Door to door collection	100%
User charges	Rs. 50
Source Segregation	100%
Percentage of waste treated	100%
Percentage of waste sent to landfill	3-7%

The solid waste management in Ujjain has demonstrated an enormous growth by improving its ranking, which was 263 in 2014 and became 12 in 2017. In Swachh Survekshan 2018; Ujjain was also awarded the Cleanest City under 3-10 lakh population category. The city currently generates 190 tons of waste per day of which, 114 tons is wet waste and 76 tons amounts to dry waste. The city has achieved 100% door to door collection and source segregation. Door to door collection of segregated solid waste is done using 100 collection vehicles. The segregated waste collected is first brought to the transfer station-cum-MRF centre. The dry waste is further sorted and sent to the authorized recyclers, and the wet waste is transferred to the central processing facility.

With 100% treatment of the total waste collected; the city has taken a lot of noteworthy initiatives to manage its waste. Some of these good practices and innovative approaches are mentioned below:

Home composting by resident

IEC awareness on Plastic ban

Collection of platic waste

Pot (Matka) composting

Door to Door Collection

Door to door collection and transportation of waste for 54 wards is carried out by UMC on a daily basis. The collection vehicles have separate compartments for dry and wet waste. In addition, there are two separate bins for domestic hazardous waste; the yellow bin is used for collecting the sanitary waste and the red bin is used for any sharp items, razor blades, glass, etc. The waste collection vehicles are monitored and tracked from the command and control centre located at the Ujjain Smart City office, Kothi Road.

Segregated Door to Door Collection. Besides separate compartments for dry and wet waste, the garbage collection vehicle also has separate bins for Domestic hazardous waste. (Yellow bin - Sanitary waste and Red bin for sharp items, razer blades, glass,etc.)

Monitoring of waste collection and transportation vehicles at Integrated Command and Control Centre

Waste Transfer Station-cum-MRF Centres

Facility Highlights		
	Transfer Station 1	**Transfer Station 2**
Name of the Facility	Waste Transfer station, MR -5	Waste Transfer station, GauGhat
Location of the Facility	Ward No.4, Agar Road	Ward No.34
Area	400000 sq. feet	30000 sq. feet
Land Ownership	UMC	UMC
Owner of the facility	Global Waste Management	Global Waste Management
Year of Establishment	2016	2016
Type	Decentralized	Decentralized
Type of input	Wet, Dry, DH waste	Wet, Dry, DH waste
Input Capacity	136 MT	127 MT
Storage Capacity	72.5 MT	45.3 MT
Mechanism	Static Compactor Machine	Static Compactor Machine

The collected segregated waste from all the 54 wards are taken to the transfer stations. The city has two transfer station-cum-MRF centres. The capacity of transfer station is 136 and 127 MT respectively. While the capacity of each of MRF centre is 1.8 MT. Both the facilities have been established by UMC and are currently operated by a local NGO Partner; Basix India. The waste from the transfer stations are then transported to the centralized processing facility in vehicles, which have separate capsules for wet and dry waste. The segregated dry waste is further sorted into different categories in the MRFs and sent to the authorized recyclers. The facility involves ragpickers for sorting of waste, who are paid a monthly salary. The remaining collected dry waste that cannot be sorted due to the limited capacity of the MRFs is then sent to the centralized facility for further processing.

Waste Transfer station

Sorted Dry Waste at MRF centre

Centralized processing facility

Facility Highlights	
Name	Central Processing Plant
Location	Gondiya Facility
Area	36 Hectares
Land Ownership	UMC
Owner of the facility	UMC
Year of Establishment	2015
Type	Centralized
Type of input	Wet and Dry
Input Capacity	250 TPD
Processing Capacity	250 TPD

The centralized processing facility of 250 TPD capacity is situated at Gondiya, which is 15 kilometers (kms) far from the city. The total area of this facility is 36 hectares. The plant runs on PPP mode. The capital cost of 35 crore Rs was borne by UMC while the Operations and Maintenance (O & M) costs were borne by the contractor. The facility comprises two units:

- Wet Waste Processing Unit
- Dry Waste Processing Unit

Wet waste is processed into compost by Windrow Composting Method, while the dry waste is used for making RDF. On an average the facility produces 11-12 tons of compost per day. RDF produced in the plant is sent to the cement manufacturing industries.

Preparatory section unit of compost plant

Preparatory section unit of compost plant

Packaging of compost for sale

Biomethanation Plant

Facility Highlights	
Name	Biomethanation Plant
Location	Maksi road Sabzi mandi
Area	720 sq.m
Land Ownership	UMC
Owner	Ujjain Smart City Limited
Year of Establishment	2018
Type	Decentralized
Type of input	Wet
Input Capacity	5 TPD
Processing Capacity	5 TPD

Ujjain Smart City Limited with Aryan Associates (private contractor) has established a Biomethanation plant of capacity 5TPD at Maksi Road, Sabzi Mandi to manage the wet waste generated in the markets, which includes fruit and vegetable waste. This waste is treated in this facility to produce biogas, which is further converted into electricity. Approximately 600 kgs. of compost obtained per day as a by-product from the process is used in the city gardens. The plant also generates 225 units of electricity per day, which is used for street electrification. The capital cost of the plant, which is Rs 1.97 Crore has been borne by the Ujjain Smart City Limited, while the O&M cost for 5 years is being borne by the contractor.

Specifically marked bins are installed at daily vegetable markets for the collection of wet waste.

The project has received multiple awards: Skotch Award, ITPO Green Energy Award, Gurugram Smart Cities Award.

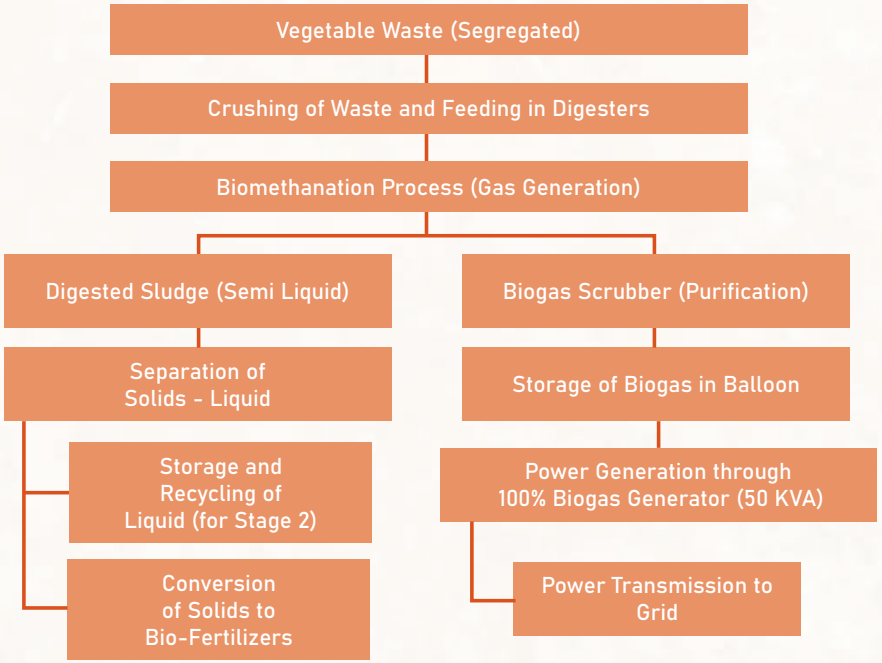
5 TPD Biomethanization plant

Slurry tank

Anaerobic digester

Gas balloon

Process flow diagram of Biomethanization plant



Faecal Sludge Treatment Plant

Facility Highlights	
Name	Faecal Sludge Treatment Plant
Location	Ward No.12 Gram Sadawal
Area	240 sq. m
Land Ownership	UMC
Owner of the facility	UMC
Year of Establishment	2018
Type	Decentralized
Type of input	Faecal
Input Capacity	100 KLD
Processing Capacity	100 KLD

The city has established a Faecal Sludge Treatment Plant (FSTP) with an input capacity of 100 KLD at Ward No.12 Gram Sadawal to manage the liquid waste. The plant is designed, installed and operated by a private contractor - DD Enviro. The capital cost of Rs 1.2 Crore has been borne by the Public Health Engineering Department of Ujjain.

Desludging requests are routed to the authorities through a dedicated helpline number available on the public domain. Desludging tankers are then sent to the reported locations for collection of faecal sludge. On a daily basis; UMC collects approximately 40,000 litres of faecal sludge with the help of 14 emptying/desludging tankers from the city. The collected faecal sludge is then transported to the plant for treatment. A patent indigenous technology named Hyper Core Technology is used for the treatment. The treated water is as per the standards of CPCB. This water is provided free of cost to the farmers for irrigation and to the ULB for gardening.

Faecal sludge collection vehicle


Faecal Sewage Treatment Plant based on Hyper Core Technlogy

Construction and Demolition Plant Facility

UMC has established a plant of capacity 100 TPD across 15000 sq. feet at Ward No.4, Agar Road for Construction and Demolition (C & D) waste processing. The plant runs on the PPP mode. The capital cost has been borne by the UMC, while the O&M costs have been borne by the contractor. The corporation has also provided the land for the facility. The waste is processed to obtain paver blocks, which are further used in other development projects by the UMC.

C&D waste recycling plant

Facility Highlights	
Name of the Facility	C&D Processing Plant
Location of the Facility	Ward No.4 MR 5 Agar Road
Area	15000 sq. feet
Land ownership	UMC
Owner of the facility	UMC
Year of Establishment	2019
Type	Decentralized
Type of input	Construction and Demolish waste
Input Capacity	100 TPD
Processing Capacity	100 TPD

Products obtained from C&D waste recycling plant

Zero Waste Ward No. 36

Some of the wards in the city, like ward No. 36 has got the award of Zero Waste Ward, which means that no waste goes out of this ward.

Home composting is religiously practiced by the residents. All the dry wastes are collected by the NGO (Basix India) on weekly basis and is sent for recycling. This ward is also practicing in-situ garden waste composting. The compost generated is then used in the gardens.

Zero wate ward

Snapshot of Ward no. 36	
Total Population of ward	9680
Total of households	1265
Name of Ward councilor	Durga Shakti Choudhary

Cloth to Paper Recycling Plant

Facility Highlights	
Name of the Facility	Cloth to Paper Recycle Plant
Area	60 sq. m
Land Ownership	Ujjain Municipal Corporation
Owner of the facility	Ujjain Municipal Corporation
Year of Establishment	2018
Type	Decentralized
Type of input	Wet
Input Capacity	0.035 TPD
Processing Capacity	0.035 TPD
Total Manpower	02

Process of making Cloth to Paper

This plant has been established with the aim to recycle the left over clothes by pilgrims at the banks of River Shipra. The capacity of the plants is 0.035 TPD. The cloths are recycled to obtain paper, which UMC is using currently for making office files.

Plant highlights

- ✓ *The project is phased on PPP mode where the contractor will setup the plant and generate revenue by selling the by-products.*
- ✓ *The capital expenditure of Rs 15 Lakh was borne by Ujjain Municipal Corporation.*
- ✓ *All operational and maintenance costs are being borne by the contractor.*
- ✓ *The plant is mostly operated by female workers.*
- ✓ *The project has received Swachh Survekshan 2019 Best innovation Award.*

Process flow diagram of Biomethanization plant

STAGE 1 : Collection of old and discarded cloth for preparing raw material

↓

STAGE 2 : Cutting of clothes into tiny pieces

↓

STAGE 3: Tiny pieces of clothes is then processed for 2-3 hours to convert it into Pulp form

↓

STAGE 4: Paper sheets are made up from Pulp

↓

STAGE 5: Paper sheet is then compressed

↓

STAGE 6: Finishing of the product made and then dries in open

Floral Waste Management Plant

Facility Highlights	
Name of the Facility	Floral Waste Management Plant
Location of the Facility	Mangalnath Road
Area	15000 sq.m
Land Ownership	UMC
Owner of the facility	UMC
Year of Establishment	2018
Type	Decentralized
Type of input	Wet
Input Capacity	5 TPD
Processing Capacity	5 TPD

A Floral Waste Management plant is situated at Mangalnath Road. The land has been provided by UMC to the Pushpanjali – a private enterprise. The plant has a decentralized unit with a capacity of 5 TPD. Flower waste generated in the Temples of Ujjain are collected by the company and

brought to this facility. 60% of those flowers (comparatively fresh ones) are used for making incense sticks, and the remaining 40% flower waste

Local women sorting different types of flowers

(slightly/and fully degraded) are used for making biofuel logs, which are used as an alternative fuel in cremation of dead bodies.

Plant highlights

- ✓ *The products obtained are Briquettes (Biofuel logs) and Incense sticks.*
- ✓ *The average quantity of briquettes produced is 2 TPD and the incense stick is 0.080 TPD.*
- ✓ *Specific bins marked for floral waste are placed at the temples and other holy places throughout the city so that citizens can easily identify the floral waste bins.*
- ✓ *Awards: Swachh Survekshan 2019 Best innovation Award and Skotch Award.*

Agarbatti and Incense sticks

Briquettes (Biofuel logs)

To Know More:

Name - Yogendra Singh Patel
Designation - Deputy Commissioner, Ujjain Municipal Corporation
Contact Number - 9406801278

2

TIRUPATI

Tirupati

Snapshot: Tirupati Municipal Corporation

State	Andhra Pradesh
Area	27.44 sq. km
No. of Wards	50
Population	2,87,482
Total Waste Generated	229 MT per day

Tirupati is a vibrant pilgrimage town located in the Chittoor district of Andhra Pradesh. The city is famous for the shrine of Tirumala Venkateswara Temple and other historic temples. Thus, it is often referred to as the 'Spiritual Capital of Andhra Pradesh'. In the year 2012-2013, India's Ministry of Tourism named Tirupati as the 'Best Heritage City. Tirupati has been selected as one of the hundred Indian cities to be developed as a smart city under Smart Cities Mission by the Government of India.

Tirupati Municipal Corporation (TMC) oversees the administration of the city. The Health Department of TMC is responsible for the management of solid waste in the city.

Collection and Transportation of Waste

The primary collection of waste in TMC is based on a three-pronged approach. In the crowded areas, mostly in the old city, waste is collected

through pushcarts, in other areas by tricycles and in the far-flung areas, where the houses are scattered, motor vehicles are operated for the service of waste collection from the houses. Door to door waste collection is carried out by the sanitary workers in all the 50 wards. All the staff involved in the handling of solid waste have been provided with Personal Protective Equipment (PPE) such as masks, shoes, florescent jackets etc., which are used on a daily basis.

Solid Waste Profile of the City	
Total Waste Generated	229 MT per day Wet Waste: 120 MT per day; Dry Waste : 53 MT per day, Inerts: 31 MT per day, C&D waste: 25 MT
Door to door collection	100%
Source Segregation	100%
Vehicles for collection and transportation	260 Push carts and 85 Tricycles

Sanitary workers collect segregated waste from the houses in separate bins. The collected segregated waste is then transported to the secondary collection points (SCPs). The rag-pickers collect the recyclable waste and sort them before selling them off to the kabadiwala. The wet waste is transferred to the compost yard situated at Thukivakam site. The remaining waste from the SCPs is then transferred to the transit station at Leela Mahal in Ward No. 44, spread across an area of 2 acres. Auto-tippers, dumper placer (DP) vehicles, tractors and tipper trucks are being used for the secondary collection and transportation of Municipal Solid Waste. From the transit station, the waste is finally transported to the existing dumpsite. Currently, there is only one existing dumpsite, which is located at Ramapuram village, which has been operational since the past 6 years. This site is approximately 25 kms away from the city centre and is spread across an area of 25 acres. A sanitary landfill facility is under construction at Ramapuram.

All the notified commercial areas are swept and cleaned twice a day as well as on all Sundays and festive holidays with mandatory night sweeping. Container bins have been placed at all the garbage vulnerable points. In addition to this, almost every commercial area has twin bins, for the convenience of the public. The city has taken a lot of initiatives to process 100% of the waste generated in the city. The major proportion of the bio-degradable (wet) waste collected in the city is processed through aerobic vermi-composting methods at the Thukivakam site.

Centralized Compost Plant at Thukivakam

Thukivakam village is located 10 kms away from the center of the Tirupur city. Wet waste is processed here by vermi-composting method within boxes. This plant is a centralized waste-to-compost facility that has been constructed and maintained by Tirupati Municipal Corporation (TMC). The facility converts wet waste into compost and provides farmers in rural areas with good quality manure. The facility was commissioned in the year 2010. It has an operating capacity of 55 MT. TMC feeds 50-55 MT of wet waste daily, which gets converted to around 15 MT of compost on an average. The cost of maintenance of the facility is Rs. 30 Lakhs per annum. This compost is given to the Horticulture Department of Tirupati Urban Development Authority (TUDA) and Tirupati Municipal Corporation (TMC) at no cost.

Composting Shed

Composting pit

Facility Highlight	
Area	40468 sq.m.
Processing Capacity	55 MT per day
Quantity of input	50-55 MT per day
Products obtained	Manure
Quantity of Manure obtained	15 MT per day
OPEX	Rs. 30 Lakh per annum
Manpower	15-20

The Box Composting Method

To start with the composting process, a base is prepared on the ground with gravel and wood-chips. Metal boxes of galvanised iron (GI) (Designed like baling boxes) are then placed on this base. A Bio-pulveriser machine is deployed to grind the fresh wet waste and convert it into smaller particles. Wet waste is then weighed and transferred to those vessels where it is crushed and compacted. Diluted cow dung slurry is sprinkled on the crushed waste in layers. The process is repeated till the boxes are filled completely. This wet waste pile is then watered for 2 days as the moisture helps in multiplying the bacteria, thereby decomposing the waste at a faster rate. Within a few days the pile begins to compact and the wet waste turns black in colour and emits an earth-like odour. The pile is spread and exposed to sunlight for 15 to 30 days in order to dry the moisture content.

Box composting

Manual sieving machine

Once the moisture evaporates, it is sent for screening. The mixture is screened in three stages. Screening machine separates the waste into specific sizes. Material screened in the first stage would be spread on the cement racks in monsoon sheds for 10 – 20 days. Material in the racks would be rotated once a week so that the waste on the lower side is also exposed to air for aerobic digestion. The process is repeated for the 2nd and 3rd stages as well. The final product obtained after the last screening process is the fine manure of good quality.

Biomethanization plant at Thukivakam

The Bio-CNG Plant at Thukivakam has been established by the Tirupati Municipal Corporation (TMC) in Public Private Partnership (PPP) mode with Mahindra Waste-to-Energy Solutions Ltd. for a concession period of 20 years. Here, wet waste is being converted to methane rich biogas and high-quality manure in a specially designed digester. This facility has been developed in technical collaboration with IIT-Delhi.

Facility highlights	
Quantity of input	50 MT per day
Products obtained	Bio gas
CAPEX	Rs 14.57 cr.
Manpower	10-12

At present, Mahindra has been supplying biogas to more than 10 hotels in Tirupati on a trial basis. TMC entered an MoU with Mahindra & Mahindra Ltd to generate gas from waste without financial burden over the civic body. The corporation is supplying 50 tonnes of wet waste the facility on a daily basis from Indira Priyadarshini Corporation vegetable market, Rythu Bazaar and other small vegetable markets apart from kitchen waste. Agricultural residues like straws and leaves would also be used as inputs for the facility. The TMC has provided land and water supply at Thukivakam for establishing and operating the facility. The facility has been spread over 6 acres of land and has a capital expenditure of 14.57 Crores.

Biomethanization plant at Thukivakam

Construction and Demolition (C&D) Plant at Thukivakam

The Construction and Demolition (C&D) waste management project will be set up in an area of 5 acres at Thukivakam at a cost of Rs 10 crore. The project has been established by TMC in partnership with Chennai-based Neeve Engineering. The plant will have an operating capacity of 80 TPD. The company will recycle the C & D waste for reuse in construction works.

Facility highlights	
Quantity of input	Approximately 50-60 MT per day
Products obtained	Aggregate and Sand
CAPEX	Rs 10 cr.
Manpower	5-6

Construction and Demolition Plant at Thukivakam

Resource Recovery Centre at Thukivakam

The resource recovery centre at Thukivakam was commissioned in March 2018 and is operated by Waste Management Solutions Pvt. Ltd (WMS). The waste is supplied to the MRF by the Tirupati Municipal Corporation (TMC) from the residential and commercial areas of Tirupati.

TMC has provided land and shed for the MRF and all operations of the MRF are carried out by WMS. The facility has an operating capacity of 50 TPD. The incoming waste is segregated at the facility and also crushed and shredded, if required. All sorts of waste that the facility is unable to recover is sent to the cement plants. The capital expenditure incurred in the process is Rs. 10 lakhs and operational expenses amount to Rs. 4 lakhs on a monthly basis.

Resource Recovery Centre at Thukivakam

Faecal Sludge Treatment Plant (FSTP) at Thukivakam

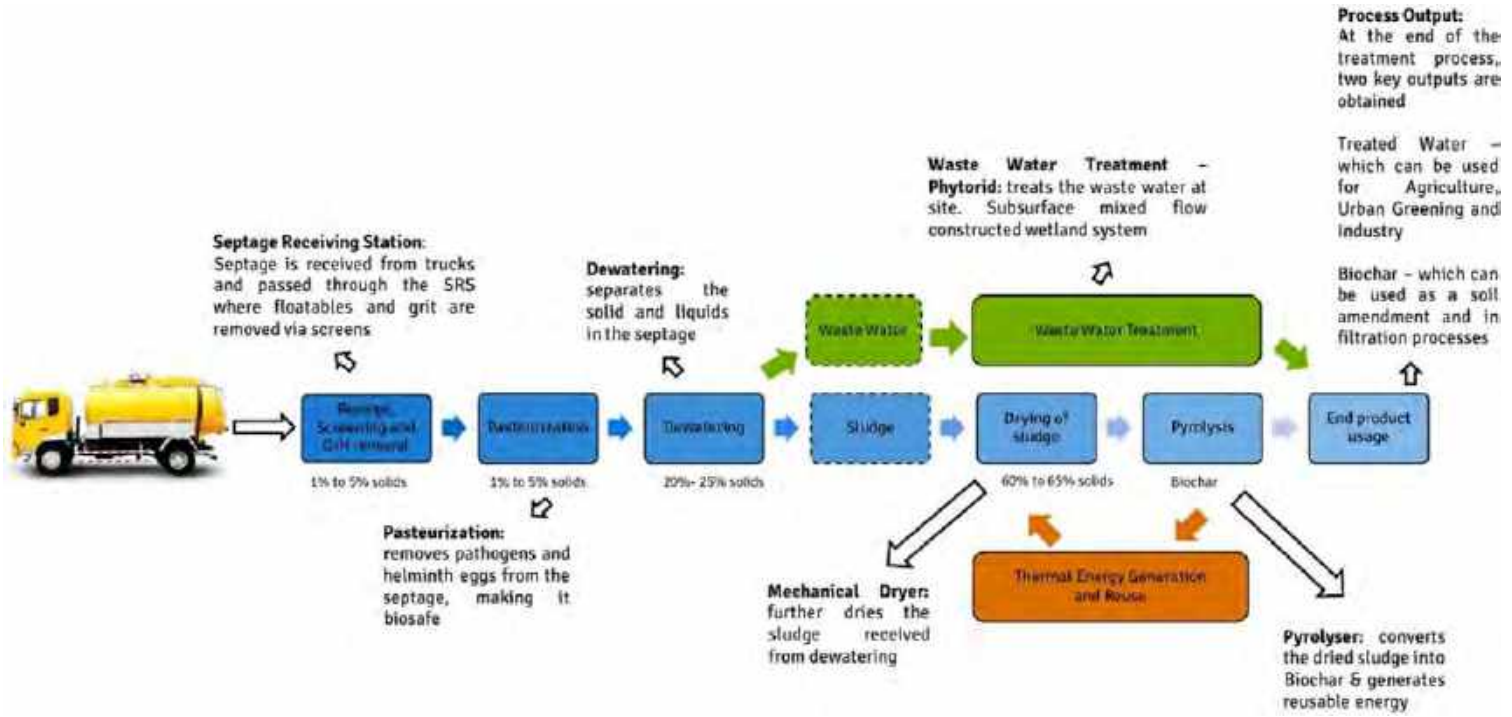
The Faecal Sludge Treatment Plant (FSTP) at Thukivakam with a capacity of 50 MLD was implemented in two phases; the first phase was commissioned in the year 1999 and second phase was commissioned in the year 2013. The FSTP plant is maintained and operated by the Tirupati Municipal Corporation (TMC). About 300 acres of land has been allotted to the facility in which the actual facility is spread over 130 acres.

The total sewerage network of Tirupati is of 260 kms and the sewage generated from the city is led via an under-drain system to the STP by gravity. The area covered by this system is 57% of Tirupati.

Faecal Sludge Treatment Plant (FSTP) at Thukivakam

Septage is received from the trucks and is passed through the Septage receiving station where floatables and grit are removed via screens. This is followed by pasteurization, which removes pathogens and helminth eggs from the septage, making it bio safe. Next, the septage undergoes dewatering that separates the wastewater (liquid component) and the sludge (solid component) present in it. The wastewater is treated in-situ by Phytorid Technology that involves subjecting the mixed flow of subsurface liquid through constructed wetland system. The treated water can be used for agriculture, urban greening and industries. The sludge, on the other hand, is dried by mechanical drier that removes moisture post-dewatering. It is then subjected to pyrolysis, which generates thermal energy that can be reused, as well as bio char which can be used for soil amendment and filtration purposes. The process has been depicted via a flowchart in Figure.

Co-treatment process followed at the FSTP at Tirupati



In Vessel Onsite Box Composting at Prakasam Park

In light of processing the bio-degradable waste generated at source, 100% of the Bulk Garbage Generators (BGGs) in the city have a facility for on-site composting of the wet waste generated by them.

Prakasam Park is one of the largest parks in the city of Tirupati, which is being maintained by the Corporation. It is located in Srinivasa Nagar, which is around 1.7 kms away from the center of the city. The park generates huge quantity of wet waste daily comprising dry leaves and other plant waste, making it one of the bulk generators in the city. An In-Vessel (Box) Composting unit was established by TMC in the year 2017 to process the biodegradable waste within the park itself.

Facility highlights	
Quantity of input (MT per day)	0.8-0.9
Products obtained	Manure
CAPEX	Rs 1,67,000
OPEX (per month)	Rs. 2.5 lakh (approx.)
Manpower	4

This composting unit is being maintained by the municipality staff. This unit contains 3 GI boxes of 1.8 MT capacity, 2 GI boxes of 2.7 MT capacity and 2 screening machines. The incoming waste comprises

around 250 to 300 kg of dry waste from the park and 600 to 750 kg of wet waste from the surrounding residential areas. The output is 30% of the feed, which amounts to around 300 kg on an average. This facility requires 4 dedicated workers for at least for 3 hours a day for operations and supervision. The waste takes around 30 days to get converted to compost. The process however gets delayed during monsoon season as the boxes are placed in the open. The rainfall also adversely affects the quality of the compost.

Onsite Box Composting at Prakasam Park

Manual sieving

Bio-Chest Machine at Indira Priyadarshini vegetable market

To process the organic waste produced from the vegetable markets, TMC installed two Bio-chest Machines at Rythu Bazaar and the Indira Priyadarshini Vegetable Market in 2017. Bio-chest OWC-A series is installed in both the locations having a per day processing capacity of 500 Kgs.

BioChest is an on-site In-Vessel organic waste composting unit. It is a combination of a device and process, targeting the quickest transformation of organic waste into consistent - quality compost at the lowest possible cost and management effort.

BioChest machine

Facility highlights	
Processing Capacity	0.45 MT per day
Quantity of input	0.45 MT per day
Products obtained	Manure
CAPEX	Rs 14.3 Lakh
Manpower	3-4

Key Highlights

- ✓ This initiative has helped in reducing the cost of transporting the organic waste to the processing facility.
- ✓ Composting via bio chest machine is less power intensive and requires less manpower since most of the operation is automatic.
- ✓ Due to its compact design, very limited space and infrastructure is needed for the reactor and the storage bins
- ✓ Bio-chest reactor has an inbuilt Biofilter, which helps remove the entire odour during composting or mixing process.

The unit for the Priyadarshini Vegetable market is located near the old TPPM School. The unit is being fed with the wet waste collected from

the Indira Priyadarshini vegetable market and surrounding restaurants. Everyday municipal workers feed the unit with the collected organic waste and microbial culture. For 500 kg of organic waste 250 ml of microbial culture is added. Bio-Chest uses forced aeration and mechanical agitation to control conditions and promote rapid composting.

The air blower in the system provides oxygen to the bacteria, which in turn helps in breaking the complex organic matter into simple molecules, resulting in release of energy, and increase in temperature. The inbuilt mixer and blower provide uniform aeration to all the waste materials present in the vessel. Through the aeration process the required temperature in the vessel is maintained. The unit has an inbuilt bio-filter, which scrubs all the obnoxious gases produced during the process and releases only the odour free gases out in the environment. The process of converting waste into compost takes a period of 21 days. Once the process is completed, the compost from the vessel can be emptied through the bottom door and can be used as a bio fertilizer after curing for 7 -9 days.

Aerobic Waste Composting at Tirumala Devasthanam Hill Temple Town

Tirupati is the 'Abode of Lord Venkateswara'. The temple town attracts devotees from all over the country. Shri Venkateshwara Temple receives around 65,000 pilgrims each day, and on special occasions this number even rises to about 5 lakhs. The Tirumala Tirupati Devasthanam (TTD) looks after the management of the temple.

TTD is making all efforts to keep the Tirumala hills clean and green, keeping in view of the serenity and sanctity of Tirumala. Dual dust bin system (Red and Green dust-bins) is maintained in all areas to collect the bio-degradable and non-biodegradable waste separately. About 36 MT per day of solid waste is generated on normal days and approximately 60 TPD during peak days. The general composition of garbage is 91.00% of organic waste and remaining in-organic waste such as plastics, glass, metals, paper cardboards, leather, cloth, coconut coir/shell etc.

Segregated waste collection

In order to process the biodegradable waste, a municipal solid waste management plant was set up at Kakulathippa in Tirumala hills by M/s Mahindra & Mahindra on behalf of TTD in the year 2004. From 2004 to 2011 the plant was maintained by M/s Mahindra & Mahindra. Currently, Bengaluru based firm M/s Bright Waste Technologies is looking after the operations and maintenance of the plant. The processing capacity of the plant is 50 TPD.

The segregated wet waste received in the facility is weighed and sent to the shredder machine for size reduction. The output from the shredder machine is then clustered into heaps and kept under a shed. Diluted culture is sprinkled on the heaps followed by thorough mixing. The bacteria in the culture facilitates decomposition of the waste. The heaps are then turned to ensure uniform aeration. The wet waste is exposed to air for around 30 days and in the meantime moisture content is evaporated due to the heat produced by the microbes.

Municipal Solid Waste Plant at TirumalaThe waste is then fed into the rotary where it is further processed into smaller particles and from there the product is sent to a trommel. The trommel segregates the waste in various sizes such as 6 mm, 14 mm and 40 mm. The 6 mm size waste particles are transferred to the de-stoner where the stones are removed. The 14 mm and 40 mm waste particles are further processed separately until 6 mm material is obtained. The 6 mm material thus

obtained is exposed to air for few days till the final manure is ready. The remaining rejects are sent to the landfill site. For every 100 kg of wet waste 20 kg to 30 kg of high-quality manure is produced, which is used for crops, gardens and nurseries. The final manure is then e-auctioned by TTD. Daily about 30-35 tons of wet waste is received at the plant for processing.

Key Highlights

- ✓ The MSW plant has proved immensely beneficial as it handles effectively more than 75 per cent of the daily waste generated in Tirumala helping the TTD administration to keep the hill town more clean winning many national awards.

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3

MYSURU

Mysuru

Snapshot: Mysuru Municipal Corporation

State	Karnataka
Area	128 sq. km
No. of Wards	65
Population	8,93,062
Total Waste Generated	402 MT per day

Mysuru (Previously known as Mysore) is the headquarters of Mysuru district which forms the southern-most district of Karnataka State. Mysuru is the name by which Karnataka State was known prior to 1973. Mysuru district is noted for it's rich history, monuments, forts, temples, art and culture. The region has been governed by many dynasties. It has been the capital of the Wodeyar Dynasty, which once ruled most of Karnataka. Mysore lost its status as the administrative centre of the kingdom, when the British moved the capital to Bangalore. It remained the capital of the Princely State of Mysore within the British Indian Empire until India became independent in 1947.

The municipal solid waste management in Mysuru Municipal Corporation (MCC) includes door to door collection, street sweeping activity and secondary collection and transportation. There is 100% door to door collection of waste in the city. Among the 65 wards; collection of waste

in 62 wards is handled by 620 outsourced labourers. The collection in the remaining 3 wards are managed by the Federation of Mysore City Wards Parliament (FMCWP) by engaging 30 workers. About 168 auto tippers and 396 pushcarts have been deployed by MCC for the door to door waste collection[1]. The daily movement of all the garbage collection vehicles is monitored by Global Positioning System (GPS) and Radio Frequency Identification (RFID)[2].

Waste collection vehicle

Solid waste profile of the city	
Total Quantity of Waste collected	420 MT
Waste sent to centralized compost plant	181 MT
Total Wastesent to the 5 ZWM Plants	23 MT
Waste sent for feeding cattle	4.5 MT
Rejects from compost Plant and ZWM Plant that is sent to the sanitary landfill	208.5 MT

[1] http://www.mysorecity.mrc.gov.in
[2] Swachh Survekshan Report, 2019

Street sweeping and drain cleaning activity in Mysuru takes place during the daytime from 6.30 A.M to 2.30 P.M. It is partly handled by the "Pourakarmikas" of MCC (17 wards), and partly by outsourced labourers (47 wards). Only in ward 28, it is managed by the FMCWP. Truck mounted street sweeping machinesare used for night sweeping of core area and main roads.Among the 420 MT per day of waste that is collected, about 181MT of waste per day is sent to centralized compost plant at Vidyaranyapuram.Around 23MT per day is sent to 5 Zero Waste Management (ZWM) plants located at 5 different zones of Mysuru city. These ZWM plants each have a capacity of 4.5 MT. About 4.5 MTof fresh market waste is sent to Pinjrapole Society where the waste is fed to the stray cattle. The remaining waste comprising of the rejects from the compost plant and zero waste management plants are sent to the sanitary landfill site at Vidyaranyapuram.

Zero Waste Management (ZWM) Plant at Kumbarakoppal

The "Zero Waste System" at Kumbarakoppalwas started in 2005 and covers 5 wards of MCC. It serves a population of20,000 and waste collected per day amounts to an average of 9 MT. The FMCWP operates the solid waste management system in this area. Itis entrusted with the workof collection, segregation and selling of waste. The systemoccupies an area of 0.6 ha of land and accommodates a segregation area, compost beds, shed for storage of segregated waste and vehicle parking area. Two people are assigned for door to door collection of waste from the wards from 7 AM to 10 AM. The residents have been provided with two plastic bins for separation of wet and dry waste. About 75% of the waste gets segregated at this stage[3]. Transportation of wet and dry waste is done in vehicles but with two different compartments. Each vehicle has an average capacity of 400 kg. Collected dry waste is transported to the

segregation plant. The wet waste is directly supplied to the composting beds.

Facility Highlights	
Area	0.6 ha
Processing Capacity	4.5 MT per day
Quantity of compost produced	2.5 – 3.5 MT per month
Manpower	30
OPEX	Rs 2,68,000 per month
Revenue Generated	Rs 11,000 per month

Segregation of dry waste at Kumbarakoppal, Mysuru

Segregation of dry waste is done in two stages. In the first stage, segregation of plastic, glass, and soft plastic is done. The second stage involves segregation of the sub parts of each material for marketing i.e. plastic with different colors and thickness. Segregation of dry waste is done in 17 categories, viz. (i) Milk covers (ii) Plastic bags (iii) Tablet (iv) Bulb (v) Oil packets(vi)Glass pieces (vii) Shoes (viii) Black Plastic (ix) White Plastic (x) Colored Plastic (xi)Tooth paste (xii) Cardboard (xiii)Waste Paper (xiv)Tins (xv)Road waste (xvi) Beer bottles (xvii) Plastic Bottles. Segregation of all material is done manually. Segregated bio degradable waste is directly dumped in composting beds. Each bed has a dimension of 3m x 3m x 1.8m. Usually two months are required to completely fill one composting bed. The compost is sold to local farmers.

Key Highlights

- ✓ A 'Stree Shakti' group is formed by local women which works for social awareness, daily report of waste collection and cooperation between workers and public at Kumbarakoppal.
- ✓ The net profit from the solid waste management system is utilized for providing medical and educational facilities to workers.

Vermicomposting and Kitchen Waste based Biogas plant at Mysore Zoo

Sri Chamarajendra Zoological Gardens, popularly known as the Mysore zoo, has a daily garbage generation of around 1000kg per day and comprises majorly of animal dung and some amount of food and horticulture waste. In Mysore zoo, bed vermicomposting method is adopted to process the organic waste. The dung from the enclosure is transported to the vermicomposting yard and heaped. Usually 8 to 10 days is sufficient to prepare one bed. The partially decomposed green material is placed over the heaped dung and mixed thoroughly and made into a bed. The zoo uses the Eudriluseugenae species of earthworm, as they are prolific breeders with high multiplication rate. The bed site should be free from all debris. In the case of hard ground, flooring is generally not required. Otherwise, flooring with locally available stones is prepared for the purpose of sieving and packing. Regular watering is carried out twice a day for about 10 days, then once a day for another 10 days and then on alternate days until vermicomposting is complete. This process helps to soften the raw material and maintain the required moisture in the bed.

[3] Zero Waste Management System: Case Study- Kumbarakoppal, Mysore, International Journal of Engineering Research & Technology (IJERT) Vol. 6 Issue 05, May - 2017

Facility Highlights	
Area	298 sq. m.
Quantity of input	0.9 MT per day
Quantity of compost produced	1 – 1.5 MT per day
Price of compost	Rs. 2800–5000 per ton
Manpower	5

Compost produced from animal dung at Mysore Zoo

After one month; black, granular, lightweight and humus-rich compost gets ready. To facilitate the separationof the worms from the compost, watering should be stopped 2 to 3 days before emptying of the beds. This forces about 80% of the worms to the bottom of the bed and the remaining worms can be removed by hand. The harvested vermicompost is then sieved to remove any debris and other waste before weighing and packing[4].

Key Highlights

- ✓ To boost the sales of vermicompost, the zoo authorities have started the process of registration of the brand with the Weights and Balance Department, Government of India. The compost is available for purchase at the zoo precincts for visitors, farmers and horticulture department.

Facility Highlights	
Quantity of input	1.3 MT per day
Quantity of biogas generated	120-130 cu. m. per day (Equivalent to 2-3 commercial LPG cylinders per day)
CAPEX	Rs 25,000,000
Manpower	3

Biogas plant at Mysore Zoo

In order to reduce the dependency on LPG cylinders, the Zoo Authorities have set up a biogas plant within the zoo premises adjoining the vermicomposting unit.The dung from the elephants forms 70%of the total waste produced in the zoo. It is rich in fibre content, which helps in the production of biogas. The byproduct, slurry, is then used to produce manure. The biogas plant works on the principle of biomethanation/ anaerobic digestion of waste to generate biogas. The anaerobic digestion occurs in three phases, hydrolysis of organic solids, acetic acid formation and biogas production. The biogas plant is of floating drum type having a capacity to process 1.3 MT of organic waste per day.

[4] B., D. P. (2019, January 28). Sustainable use of vermicomposting in Mysore zoo, India. Retrieved from www.academia.edu.

“Zero Waste Campus” of Infosys

The Infosys Mysore campus is a mini city spread over 350 acres that hosts more than 15,000 trainees residing on campus, more than 8,000 employees and several thousand contract workers. Segregation and composting hold an important position in the company's food waste management agenda. From 2012, Infosys adopted 100% segregation and on- site food waste treatment policy. Today, the campus has standardized the color, size and visual communication materials for food waste collection at food courts resulting in 100% segregation.Hazardous waste and e-waste are disposed to authorized recyclers, who possess the required clearances from the Pollution Control Boards.Paper waste is sent for recycling to authorized vendorswho in turn provide recycled paper products.

The biogas plant at the campususes segregated food waste from the food courts on a daily basis for gas generation. The food waste is anaerobically digested in the biogas digester from which it is directed to the storage unit. The plant provides gas on demand basis as per the needs of the food courts.

Facility Highlights	
Quantity of input	1.5 MT per day
Quantity of biogas generated	140 cu. m. per day (Equivalent to 3 commercial LPG cylinders per day)
Manpower	2-3

The plant is fully-automated and integrated with the building management system (BMS) to facilitate online monitoring on a continuous basis thereby minimizing manual intervention. The plant is estimated to generate about 140 cu.m. of gas per MT of food waste.

Scrapyard for segregation of waste into various categories

Biogas facility at Infosys Campus, Mysore

Bio-methanation at National Institute of Engineering (NIE) Campus

Facility Highlights	
Area	50 sq. m.
Quantity of input	60 kg per day
Capacity of plant	100 kg per day
Quantity of biogas generated	6 cu. m. per day
Quantity of manure generated	6 kg per day
CAPEX	Rs 5,50,000
Manpower	2
Savings	Rs. 182 per day through biogas and Rs. 21 per day through manure

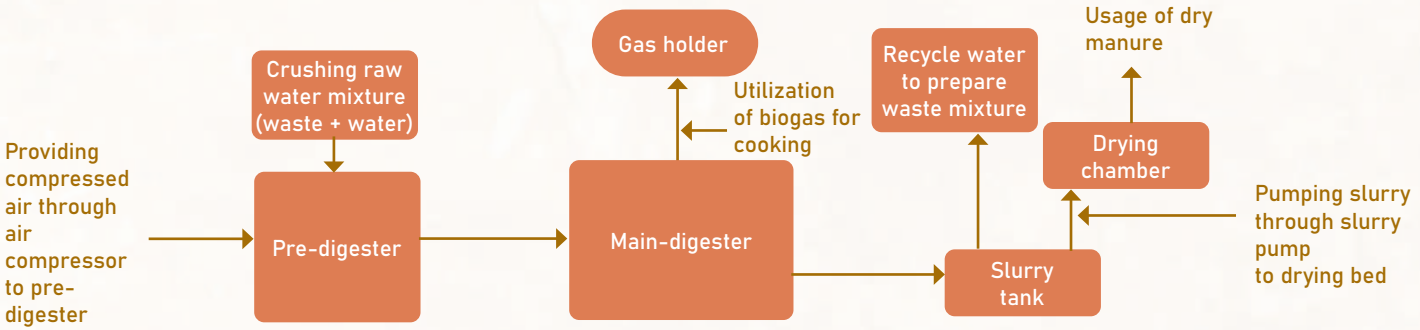
NIE-CREST (Center For Renewable Energy & Sustainable Technologies) has come up with kitchen waste-based biogas plants (KWBP) to manage wet waste generated from their canteen. This plant digests rice starch, used rice water, used tea and coffee powder, leftover rice and sambhar, waste flour, over-ripened fruits, used edible oil, vegetable waste and other cooked waste from the kitchen. The plant produces biogas that is used for cooking purposes in the canteen itself. The slurry is used as manure for the kitchen garden. The plant is designed, established and maintained by NIE-CREST[5].

Kitchen waste based biogas plant

Key Highlights

- ✓ The biogas plant at NIE-CREST has an annual savings of Rs. 66,576 due to the replacement of LPG and Rs. 10,950 from the manure production. Thus, the total returns from the facility amounts to around Rs. 77,525 per year.

Flowchart of the process involved in the Biomethanation plant



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4

ALAPPUZHA

Alappuzha

Snapshot: Alappuzha Municipality

State	Kerala
Area	46.71 sq. km
No. of Wards	52
Population	1,97,027
Total Waste Generated	53 MT per day

Alappuzha (formerly Alleppey) is known as the Venice of the East. The district's name is derived from its geographical position and physical features, which means "the land between the sea and the network of rivers flowing into it". Alappuzha district is divided into six municipalities; one of them being the Alapuzzha Municipality.

The municipality is one of the coastal municipalities of India. It is situated on the western coast of Kerala. It is the administrative headquarters of Alapuzha district and Ambalappuzha Taluk. Intertwined with canals network (9 main canals; 104 connecting canals) and backwaters, the town is a famous tourist destination famous for its boat races, backwater holidays, beaches, marine products and coir industry and houseboats.

Alappuzha municipality has 52 wards, of which, 23 wards are in the city and the remaining are rural wards. The municipality generates 58 tons of waste per day with 4-5% of plastic waste. As per the SLB report by Alappuzha Municipality for the year 2018-19; the city has achieved 100% household level coverage of solid waste management services, 100% efficiency in collection of municipal solid waste, 100% segregation of municipal solid waste and also 100% scientific disposal of municipal solid waste.

The decentralized waste management system executed in the city is very unique and has also bagged various awards. Besides, achieving first position in Kerala in the Swachh Survekshan 2019 Survey, conducted by the Ministry of Housing and Urban Affairs, Alappuzha was among the five cities of the world whose projects to end the problem of solid waste have been recognized as success stories by the **United Nations Environment Program** (UNEP) in 2017. The solid waste management system in Alappuzha municipality is described in detail as below:

SLB Report 2018-19				
S.No.	Indicators	MoHUA Benchmark	Service level Benchmarks	
			Status 2018-19	Target 2019-20
1	Household Level Coverage of SWM Services	100%	100	100
2	Efficiency of Collection of MSW	100%	100	100
3	Extent of Segregation of MSW	100%	100	100
4	Extent of MSW Recovered	80%	80	80
5	Extent of Scientific Disposal of MSW	100%	100	100
6	Efficiency of redressal of Customer Complaints	80%	80	80
7	Extent of Cost recovery in SWM Services	100%	80	85
8	Efficiency in collection of SWM charges	90%	80	83
9	Percentage of waste being processed scientifically	100%	85%	85%

Source: Alappuzha Municipality

Alappuzha Solid Waste Management Model

To handle the solid waste, the Alappuzha municipality has been implementing a project named "Nirmala Bhavanam Nirmala Nagaram" (Clean Home Clean City) since November 2012. The Clean Home Clean City programme was first started as a pilot in 12 of the most urbanized wards of the city. The main aim of this program was segregation and treatment of wet waste at source. Under this program; maximum number of households, depending on the availability of land, was instructed to set up either the portable or fixed biogas plants or go for pipe composting.

Awards bagged by the Alappuzha Municipality

- ✓ Centre for Science and Environment, Best Clean City Award 2017,18
- ✓ Kerala State Pollution Control Board Award 2015, 2016, 2017, 2018
- ✓ UNEP Award 2017- one among the best five cities in World for waste management
- ✓ Kerala State Government Award for Energy Management 2016,2017,2018

The fixed biogas plant has been designed by the Agency for Non-conventional Energy and Rural Technology (ANERT). It costs Rs. 17500 and can treat about 8-10 kgs of waste. The portable biogas plant has been designed by IRTC. The capacity of this plant is 1,000 litres, and it costs Rs. 13500. About 5-7.5 kgs waste can be converted into compost using this plant. Suchitwa Mission, the state's nodal agency in-charge of the total

Portable Biogas Plant

sanitation programme gave 75% subsidy to the portable biogas plants. Households, which could not install the plants due to financial or space constraints were urged to deposit their domestic waste in biogas plants of their neighbours as a part of a cluster programme.

The households with no other waste processing facilities could bring their waste to the waste collection centres set up by the municipality at public places and the old waste dumping spots. Each waste collection centre comprises of Thumburmuzhi bins and a resource recovery facility. The resource recovery facility further comprises of material collection centres or facilities (MCF) with shredding and bailing units. Segregated non-degradable waste brought by the public to the MCF units, other than the plastic waste, is handed over to scrap dealers or private agencies. Segregated plastic waste is then shredded and used for making roads. Good quality plastic waste is directly sold to the scrap merchants.

Thumburmuzhi bins are model aerobic composting units, developed in the Thumburmuzhi campus of Kerala Veterinary and Animal Science University to compost carcasses of animals (hence its name)

Waste Management Infrastructure in Alappuzha Municipality	
Number of Aerobic Units	30
Number of Aerobic Bins	265
Number of Biogas Plants	2850
Number of Pipe Compost Units	1800
Number of Material Collection Facility Centres	11

Source: Local Self Government Department, Government of Kerala

These waste collection centres are maintained by the 168 contingent workers of the municipality. The collection time of waste in the centres is fixed from 6 am to 12 noon during the day and 6 pm to 10 pm in the evening. About 10,000 households are connected to these collection centres. Apart from the households, 25 per cent of the bio-waste from small shops is also processed in these centres. The compost produced from the centres is given free of cost to farmers.

In addition, the municipality also conducts the plastic collection drives once in two-three months in all the wards. The plastic waste is collected by representatives of the Clean Kerala Company, formed under the Local Self Government Department (LSGD) of the Government of Kerala. The plastic is then sent to Erode in Tamil Nadu for further recycling.

Waste Collection Centre

Hotels, vegetable markets and wedding halls have been mandated to have their own plants or make arrangements to entrust their waste to recognized private service providers. The biomedical waste from the hospitals in the city is sent to a common biomedical waste treatment and disposal facility at Palakkad.

A squad comprising three municipality health workers also keeps guard at night to prevent dumping in dark corners and the canals. Heavy fines are imposed if caught.

Watsan Park

Under this program, Vazhicherry, the heart of the city, which was earlier a dumping spot has been converted into a WATSAN (water and Sanitation) park comprising Thumburmuzhi bins. The walls of the facility are decorated with attractive paintings and most of the meetings and conventions related to the waste management project are held here. WATSAN clubs have been formed in most of the schools. Regular programs are held in the schools for enhancing the awareness levels. Students are also involved in the campaign by encouraging them to collect plastic waste. They are given a coupon of Rs. 20 for a kilogram of plastic which can be then exchanged for a book from selected bookstalls in the city.

WAT-SAN Park

Source: Local Self Government Department, Government of Kerala

Some of the other solid waste management sites, are discussed in detail as below:

Alissery Waste Collection Centre

The facility is located near SDC and civil station within the Alappuzha municipality. The centre was established in the year 2012 under the 'Clean Home Clean City' program. The centre comprises of *Thumburmuzhi* aerobic composting bins for processing the wet waste and resource recovery facility for processing the dry waste.

	Facility Highlights
Land Ownership	Alappuzha Municipality
Year of Establishment	2012
Type	Decentralized
Type of input	Wet waste & dry waste
Input Capacity	63.5 MT per day
Processing Capacity	63.5 MT per day
Total Manpower	4
OPEX	Rs. 1-2 lakh per annum (Alappuzha Municipality)

Alissery Waste Collection Centre

The *Thumburmuzhi* aerobic composting bins consists of a tank of 4'x4'x4' size made up of ferro-cement or bricks. The tanks are designed such that air enters into the tank through the gaps on the sides. A layer of fresh cow dung or slurry from the biogas plant is put at the bottom of the tank to generate microbes for composting. Above this, a 6-inch layer of dry leaves or dry grass or small pieces of paper is placed. Over this, alternate layers of bio waste mixed with cow dung and dry leaves are placed till the top of the tank. The final layer should be of dry leaves. Dry leaves and dry grass absorb water oozing out from the garbage. Instead of cow dung, an inoculum developed from cow dung by Kerala Agriculture University is also used. The temperature inside the tank goes up to 75 degree Celsius. This prevents mosquitoes, flies and other small creatures.

The tanks are kept under a roof to avoid rain water falling into the tanks. About two ton of waste can be processed into compost in 90 days in the tank. The cost of one tank is Rs. 10000. The compost thus obtained from the tanks is sold free of cost to the farmers.

Thumburmuzhi aerobic composting bins

The resource recovery facility center in Alissery comprises one material collection facility, three shredding units and one bailing unit. Segregated non bio-degradable waste brought by the public to MCF units, other than plastic waste are handed over to scrap dealers or private agencies. Segregated plastic waste is then shredded and packed. A cement factory picks up the shredded plastic waste once a week. The plastic waste with good quality and bailed plastic bottles are directly sold to the scrap merchants.

Resource recovery facility

Shredding unit at the facility

Non-recyclable plastic shredded and packed

Key Highlights

- ✓ As door to door collection requires huge amount of cost in transportation as well as human resources for management, waste collection centres in Alappuzha municipality can be very evidently seen as the best model to exemplify efficient use of resources in solid waste management.
- ✓ One of the other highlights of this initiative is the active participation of residents with the authorities in managing waste.

Sustainable Office, Kerala State Pollution Control Board, Alappuzha

The office of the Kerala State Pollution Control Board follows a 'Zero Waste' model. The office has adopted various practices which ensure that, all the waste generated within the office premises is processed at source and only the waste which cannot be processed, reused or recycled is handed over to the authorities. The practices followed by the Kerala State Pollution Control Office to attain a 'Zero Waste' model comprise:

- **Organic Farming and Gardening:** The wet waste generated in the office premise is processed with the help of Bio-Composters. The compost thus obtained is used for organic farming and gardening.
- **Recycling:** All the dry waste generated in the office premise is being innovatively upcycled into useful products for reuse. For example, Paper waste is used to make decorative products, similarly, trash and used cans are recycled to be used as pots for gardening purposes. There is also a dedicated spot for collection of plastic bags within the office complex.
- Rain water harvesting system has been installed on the roof of the office building to save water, which is then further reused for gardening and cleaning purposes.
- Since the office complex had a well, a well recharge setup has been installed to recharge the ground water table and in turn revive the well.
- Smart fans and LED lights have been installed in the entire office complex for conserving energy.

Dedicated spot for plastic bag collection


Organic garden at the office complex


Bio composter used for processing wet waste


Recycled product from waste

Well recharging at the office complex

Canalapy Project: Canal Rejuvenation- Community Sanitation- Dewats

Alappuzha has an intricate network of canals originally constructed for inland water transportation. The canals over a period of time have turned into sewers owing to indiscriminate dumping of solid and liquid wastes from residential and commercial establishments.

To explore a practical and sustainable solution the Indian Institute of Technology,Bombay (IIT-B) and Kerala Institute of Local Administration (KILA) started working in Alappuzha from December, 2017. Under this programme, summer and winter schools were conducted to map the origin of waste at households, the household septic tank situation and people's willingness to participate in the rejuvenation process, etc.

Canalapy (Can Alappey) project is an initiative taken by the citizens of Alappuzha, to reclaim the canals of the town. With the tagline of 'Canals are not drains', it strives to clean, sustain and inspire the people to take care of their surroundings and make a difference to society.

Facility Highlights	
Location of the Facility	Chathanadu Municipal Colony, Alappuzha
Area	80 sq. m
Land Ownership	Alappuzha Municipality
Owner of the facility	Municipality
Year of Establishment	2017(project started)
Type	Decentralized
Type of input	Waste Water
Input Capacity	20 KLD
Processing Capacity	15 KLD
Total Manpower	1
CAPEX	22 lakhs for 20 KLD capacity plant
OPEX	Rs. 1-2 lakh

Funded by the Kerala Institute of Local Administration (KILA), the effort is supported by Cochin University College of Engineering, Kuttanad, IIT- Bombay, National Environmental Engineering Research Institute (NEERI), Consortium for DEWATS Dissemination Society, Bengaluru and Inspiration, Cochin.

The area chosen for the Canalapy DEWATS Project pilot phase is located in the Chathanadu ward of Alappuzha municipality. The area comprises of around 90 individual houses (predominantly middle-income group), the Municipal Colony with 48 houses, some small shops, commercial establishments and a Church.

Considering the availability of sanitation facilities in the area, as assessed through surveys; the project was executed in two stages. At first, individual toilets were constructed for every household where no sanitation facility was available.

Black and Grey water pipes from households connected to common underground pipe leading to settling tank

For the second stage, a decentralised waste water treatment system was designed to prevent the flow of discharge from these households directly into the canal. The black and grey water pipes from every household were connected to a common underground pipe, which lead to a common settling tank. The waste water thus accumulated is further treated by channeling the effluent through several stages before releasing it into the canal.

The treatment procedure is described below:

- Pre-Treatment: Settling Tanks are an integral part of every waste water treatment process. In the settling tank, the heavier settleable solids are removed from the effluent by sedimentation. The settling tank effluent is then conveyed from the top of the tank to the baffle tank. The sludge collected at the bottom of the settling tank is removed for further treatment.
- Primary Treatment: It takes place in a baffled tank. The baffled tank consists of a series of identical chambers through which the effluent moves from top to bottom. On the bottom of each chamber activated sludge is retained. During inflow into the chamber wastewater is intensively mixed up with the sludge whereby it is inoculated with wastewater organisms, which decompose the contained pollutants.
- Secondary treatment: It takes place in an anaerobic filter. Anaerobic filter is a device filled with a filter material through which the effluent moves from top to bottom.
- Tertiary treatment: The tertiary treatment is a root treatment zone called Planted Gravel Filter (PGF). PGF is a structure filled with gravel material and typically has plants of Canna Indica species. The species are known to have high tolerance to pollutants. The treated water is then finally released into the canal.

Planted gravel filter

Treated water released into the canal

Key Highlights

- ✓ Minimal external energy need for treatment
- ✓ Low Operational Costs
- ✓ Minimal maintenance
- ✓ Once the reed plants create an established stand, the plant foliage will soon blend naturally into the landscape. creating a pleasing sight as well!

To Know More:

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Kerala State Pollution Control Board Alappuzha
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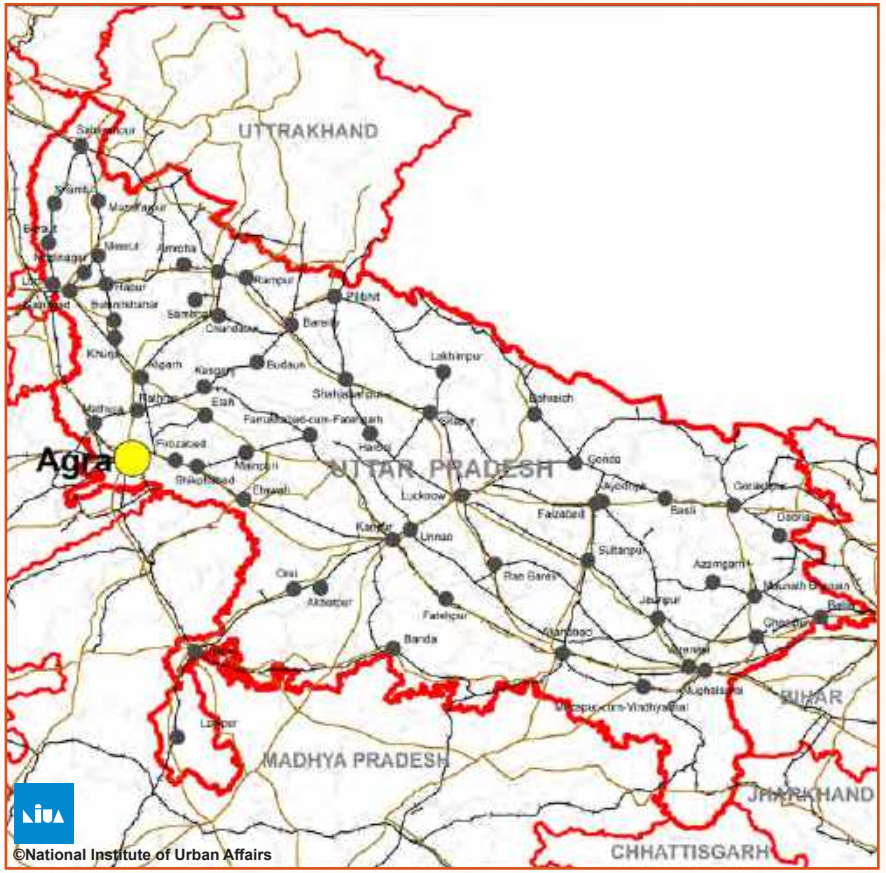
5

AGRA

Agra



Snapshot : Agra Municipal Corporation

State	Uttar Pradesh
Area	126.15 sq. km
No. of Wards	100
Population	15,87,006
Total Waste Generated	645 MT per day

The city of Agra is located on the banks of river Yamuna in the northern state of Uttar Pradesh in India. Being centrally located on the national map, Agra forms an important regional urban centre and a prominent tourist destination of India with numerous historical monuments in and around the city. Agra is known for the famous Mughal architecture - the Taj Mahal; one of the seven wonders of the world.

Agra was selected as a Smart City in September 2016 in the second round of the Smart Cities Challenge.

Agra Municipal Corporation or Agra Nagar Nigam (ANN) is responsible for the civic infrastructure and administration of the city of Agra. The Municipal Corporation area covers the entire city except for the area controlled by the Cantonment Board. The head of ANN is the Mayor. The city is divided into 5 zones and 100 wards for better administration.

The solid waste management system in the city has improved a lot over the past couple of years. In Swachh Survekshan 2019, ANN received 2 Star Rating in the Garbage Free City Rating Protocol, and for the first time it attained under 100 ranking by bagging the 85th rank all over India. Ward No. 44 of ANN; Katra Fulel also won the Swacch Ward Pratispardha in 2018.

Agra Solid Waste Management Model

Collection of Waste:

Door to door collection is already being practiced in Agra. The city has been divided into 5 zones for the ease in collection of waste. Each of these 5 zones is handled by one door to door collection (DTDC) agency. The city average of door to door collection coverage has reached 91.66%. The collection of municipal solid waste (MSW) is currently being done by 5 contractual agencies namely - OM Motors and Constructions, Arva Associates, S. R. Map Technology (SRMT), Society for Education and Welfare for All (SEWA), SPAAK Brason.

Primary Collection is done by DTDC agencies, whereas secondary collection is ANN's responsibility. Both of these collections are done by using handcarts and small motorized vehicles. A fleet of 203 small vehicles (consisting of Tata Ace, JSA, Auto Tippers) is being used for door to door collection. These vehicles have a trained team attached to each of them, with a specific area demarcated as their responsibility. Pamphlets are also distributed while collecting the waste and the vehicles have Swachh Bharat Mission related jingles (such as about source segregation) playing at all times. The private parties are monitored by an officer from ANN; usually a Supervisor, Sanitary Inspector and Zonal Sanitary Officer.

Segregation at source is around 40% in the municipal limits (partially in many wards). Collection happens in 3 streams. Green bins and containers receive organic and bio degradable waste, blue bins and containers receive dry and recyclable waste, and the Red bins receive the domestic hazardous waste (DHW).

Street sweeping staff of ANN is responsible for the collection of inert during the day, and in the night they sweep the commercial areas and all the streets of the city, which are collected in the 1.1 cubic meter bins strategically placed on roadside. BVG India Limited is responsible for the 2 kms perimeter around the Taj Mahal. BVG specializes in mechanized sweeping using electric equipments. These are then collected by ANN's waste collection vehicles. The waste is stored in secondary storages bins and dhalaoghars by the DTDC agencies, from where it becomes the responsibility of ANN to transport it further.

More than 400 rag pickers have been integrated in the waste management stream by the help of an NGO named Adarsh Sewa Samiti. This process shall be executed all year round unless each and every rag picker has been brought into the system. An extensive survey was performed by the NGO and ID cards were issued to these waste pickers. They have been given Personal Protection Equipment (PPE) for their safety. They have also been given basic training on waste management and segregation of waste. These waste pickers shall bring in all the Dry waste that is of monetary value. This step is intended to give them a better standard of living.

Transportation of Waste:

Transportation of waste done by ANN is divided into two categories:

- Primary Transportation- from unloading dhalaoghars/bins to secondary storage points
- Secondary Transportation- from secondary storage points to Kuberpur Landfill site

Segregated waste collection

Source: Agra Nagar Nigam

The door to door collection agencies collect waste from each establishment in their respective area limits as defined in their contracts and unload the waste in designated Transfer points/bins/dhalaoghars. Then the primary transportation vehicles (small vehicles of up to 2 m3 capacity) transfer the waste unloaded by the door to door collection agencies and road sweepers at the dhalaoghars/bins to secondary transfer stations. From the secondary transfer stations, larger vehicles of ANN take the wet and inert waste to the Kuberpur Scientific Landfill Site where they are processed accordingly. As of now, ANN has 93 such vehicles. The tractors available with the ANN are used only to transfer the inert waste such as Drain Silt and Street Sweeping.

Nationwide Waste Management Services Pvt. Ltd (NWMS) which is ANN's authorized dry waste collector and recycler agency is responsible for transportation of dry waste up to the Material Recovery Facility (MRF) at Rambagh-Tedhi Bagiya, after receiving the dry waste from door to door collection agencies in specially designed bags at designated spots. JRR Waste Management Services Pvt. Ltd. (JRR) collects the Domestic Hazardous Waste (DHW) from the door to door collection agencies in a similar manner. Construction and Demolition Waste (C&D Waste) is both collected and transported by Rise Eleven group through its SPV Friends Stone Crushing Company, Faridabad.

Processing of Waste

Wet Waste: Processing of wet waste is done by three decentralized Waste to Compost (WTC) Plants and one Flower to Compost Plant. There is also a centralized Waste to Compost facility operated by India Agro Organics at Kuberpur. On top of that, the residents of Agra practice home composting, which helps reduce the waste collection at source itself. Similar output is achieved with the help of composting pits in parks.

List of wet waste processing facilities in Agra Nagar Nigam

S. No	Name of the Plant	Address/ Location	Plant Owned by ULB or shared with other ULB	Capacity of the Facility (TPD)	Average amount of waste processed (TPD)
1	Rajnagar 2 MTD Flower to Compost Plant	Flower to Compost Plant, Rajnagar Shoe Exhibition	ULB Owned	2	2
2	Organic waste to compost unit WTC 1	Fatehpur Sikri Road	ULB Owned	2	2
3	Organic Waste to Compost Unit WTC 2	Near M&T Workshop, Transport Nagar	ULB Owned	1	1
4	Common Waste to Compost Plant WTC 3(specially for Bulk Waste Generators)	Near Dhandhupura STP	Private (NWMS)	4	4
5	Indian Agro Organics 20 MTD plant Kuberpur	Near Kuberpur Landfill	Private (Indian Agro Organics)	20	20

Source: http://www.nagarnigamagra.com/pdfs/ACTION%20PLAN%20200319%20FINAL_compressed.pdf

Flower Waste Composting Plant

Under central government's ambitious cleanness initiative 'Swachh Bharat Mission', Agra Municipal Corporation installed a 2 TPD flower

to composting plant in Rajnagar on March 2018. This facility utilizes the flower waste coming from different places like Temples, Mosques, Gurudwara's and wedding venues to produce compost. Till date around 28.80 MT compost has been prepared.

Collected flowers left for drying

Source:http://www.nagarnigamagra.com/AmrutReform2017-18/ANNEX-5.4.2-R50_Composting.pdf

Facility Highlights	
Processing Capacity of the facility	2 TPD
Input material	Cow dung and flower waste
Processing time	15-20 days
Number of pit	24
Capacity of each pit	1 TPD

Composting pits at the facility

Sieving of compost

Vegetable Waste to Compost Plant

Facility Highlights	
Processing Capacity of the facility	2 TPD
Input material	Vegetable waste and saw dust
Processing time	15-16 days
Technology	Mechanical composting using organic waste converter

Organic Waste Compost Plant

Sorting of organic waste

Processing of organic waste

Source:http://www.nagarnigamagra.com/AmrutReform2017-18/ANNEX-5.4.2-R50_Composting.pdf

Bulk Garbage Generators' Waste Processing Plant

Facility Highlights	
Capacity of the plant	4 TPD
Types of bulk generators	Hotels, Restaurants, Marriage hall etc
Type of waste	Cooked and un-cooked food waste
Principle of waste treatment	Pay and use basis
Charges of waste treatment	Rs. 13.5 per kg
Type of technology	Thermophillic composting
Processing time	One week
End product	Compost

Processing of food waste at the facility

Twenty ton per day Compost Plant at Kuberpur, Agra

ANN is operating a 20 ton per day (TPD) plant at Kuberpur, where decomposed organic waste collected from 70 city parks and wet waste collected from Basai vegetable market, Sikandra vegetable market and Awas Vikas vegetable market is processed into compost. A pit –based composting system has been implemented for the same. The compost thus obtained is sold in the open market by the partnering private company at a subsidized rate.

Facility Highlights	
Capacity of the plant	20 TPD
Type of waste	Cow dung and green waste
Processing	At 72 different parks of AMC
Processing@plant site	Maturing the semi matured compost, removal of inert materials and sieving through 4 mm pore size; Packing of compost
Ex-factory price of manure	Rs 3900/ton
Resources provided by AMC	Land and electricity

Dry Waste: The dry waste is processed in the centralized Material recovery facility managed by NWMS. Plastics of various types, glass, paper etc. are recovered in the facility.

List of Dry waste processing facilities in Agra Nagar Nigam

S.No	Name of the Plant	Address/ Location	Plant Owned by ULB or shared with other ULB	Capacity of the Facility (TPD)	Average amount of waste processed (TPD)
1	Nationwide Waste Management Service MRF	Rambagh NH 93 Opposite GAIL Office Tedhibagiya, Agra	Private (NWMS)	120	120

Source: http://www.nagarnigamagra.com/pdfs/ACTION%20PLAN%20200319%20FINAL_compressed.pdf

Material Recovery Facility at Tedhi Bagiya Agra

Agra municpal corporation has established a material recovery centre at Tedhi Bagiya, where dry waste such as paper, plastic, metel, glass, etc., are being segregrated from mixed dry waste. The segregated waste are then sold to respective material recyclers.

Material Recovery Facility at Tedhi Bagiya Agra

Facility Highlights	
Input capacity	40 TPD
Segregation of dry material	15-20 types of different waste
Type of dry waste	Paper, cardboard, plastic, glass, multilayer plastic etc
Processing	Compression, balling and selling to recycler. Obtaining recycling certificate for collector, recycler and AMC
Facility managed by	Nation Wide Waste Management services pvt.ltd
Revenue model	Expenses met by revenue generated from the sale of recyclable material

Sorting of dry waste at the facility

Processing of dry waste at the facility

Source: http://www.nagarnigamagra.com/AmrutReform2017-18/ANNEX-5.4.2-R50_Composting.pdf

Involvement of NGOs in Waste Management

Agra has various NGOs working in the field of Waste Management. Some of the noteworthy initiatives are discussed as below:

"We Self Depend Area Level Samiti" by Mrs. Neelam Sirsa Kushwaha is a dry waste recycling NGO in Agra. This group was formed to help local women become self-reliant while tackling the recyclable dry waste of the city. Dry waste such as paper, plastic bags, reels of threads, PET bottles etc. are used to make mats, home décor items, cloth bags, etc. There are now 20 groups of 10 women each. They are earning a monthly income of Rs. 2 lakhs. Mrs. Neelam Sirsa Kushwaha was also awarded the "Swacch Excellence Award" by the Government of India on 15th February, 2019 at New Delhi.

Dr. Anand Rai leads an NGO named "India Rising". This NGO has been in action for the last 5 years and has primarily functioned as an awareness spreading body. They have conducted awareness sessions, Nukkad Natak, distributed pamphlets, screened videos across the city. They are a group of diverse people with members as young as school students, and as old as retired officers. They usually gather at a place on each Sunday and perform the stipulated tasks. India Rising as an organization has also painted many walls in Agra; contributing to the city's beautification, and elimination of urination and spitting spots.

Innovative composting of dry leaves at PAC battalion by NGO Eco Friends-

Municipal Corporation of Agra has engaged an NGO named Eco friends for creating awareness and propagating home composting at individual house-hold level. Eco friends is involved in promoting plantation, creating awareness for garbage segregation and installations of leaf composters within the city. One of the innovative activities started by Eco friends is LEAF Composting. This group has started installing LEAF COMPOSTERS at parks and temples where huge numbers of leaf and flower waste is generated. The garden waste is converted into compost. Through this initiative, the group promotes alternate approaches to that of burning or open dumping of garden waste. Currently LEAF composting is practiced at many places in Agra.

Composting of dry leaves at PAC battalion by NGO Eco Friends

Smart City Initiatives

Under the Smart Cities Mission, various tasks have been taken up for improving the SWM of Agra city.

ICT based vehicle tracking system

- RFID/QR Based Tags have been installed on the bins as a new age solution to monitor the bins. Previously it was difficult to monitor all bins at once, but with the advent of IT and ICT enabled technology, it is easier for the supervising staff to monitor all of them at once. Similar tags have been assigned for all households, and vehicles that are involved in Solid Waste Management.
- A smart city control room is under construction, which shall facilitate all monitoring related tasks around the city.
- GPS and Biometric based handheld device with attendance management system application has helped in monitoring irregularities in duty hours performed by the workers.
- GPRS/GSM based device to send real time weigh bridge records help the authorities to track the movement of waste from one place to another and plug the losses incurred during their transport.

To Know More:

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6

PANCHGANI

Panchgani

Snapshot : Panchgani Municipal Council

State	Maharashtra
Area	6.12 sq. km
No. of Wards	17
Population	14,897
Total Waste Generated	7.2 MT per day

Panchgani is a famous hill station nestled amidst five hills in the Sahyadri mountain ranges in Maharashtra. The city is part of Mahabaleshwar Panchgani Eco-Sensitive Zone declared by the Ministry of Environment and Forests (MoEF), Government of India (GoI) in the year 2000. Besides other tourist attractions, it is famous for the table land; the second longest mountain plateau in Asia. Being a prominent tourist destination, the city has a high percentage of floating population at any given point in time.The city is divided into 17 wards and is governed by Panchgani Hill Station Municipal Council (PHSMC) led by a President and supported by 17councillors.

The solid waste management journey of the city is commendable and through dedicated efforts of the PHSMC; the city was adjudged the 'Cleanest city in the West Zone' (in the less than 1 lakh population category) by the Swachh Survekshan 2018 conducted by the Ministry of Housing and Urban Affairs.

Panchgani Solid Waste Management Model

Initially, the Municipal Council of Panchgani was faced with the twin challenge of tackling the new incoming waste of 5 -7 MT everyday as well as that of clearing the thousands of tons of old garbage dumped at the landfill site. Setting an example, Panchgani has remediated its previous garbage disposal site into a public park, which is now a major tourist attraction. The once known as the kachra (garbage) point is now rightly rechristened as the 'Swachh Bharat Point'. The Swachh Bharat Point comprises a composting unit, a dry waste segregation unit and an organic garden. The overall process for the waste collection and transportation in different areas of the city and processing has been outsourced by PHSMC to an external agency named Aaradhya Enterprises.

Every household segregates waste into two categories: wet and dry waste. Waste is then collected in segregated form and transported through GPS operated vehicles to the Swachha Bharat Point for processing. As on date, the city has achieved 100% door to door collection and 100% source segregation in all wards including commercial establishments and bulk generators. The bulk generators like parks are also composting in situ.

The wet waste is processed to obtain compost, while the dry waste is further segregated into different categories in the solid waste treatment facility at the Swachha Bharat Point. The compost produced further creates revenue for the council. Being an eco-sensitive zone, Panchgani channelizes its dry waste to Pune-based recycling centres. The saleable dry waste is sold to waste collectors, generating more revenue. To avoid Plastic Pollution, the non-recyclable plastic is shredded and used for construction of roads.

Since the city witnesses high footfall of tourists round the year, plastic waste generated from packaged food wrappers and plastic water bottles had become a menace. To deal with this issue, the council had put up signboards everywhere to inform tourists that throwing of garbage would be penalized. PHSMC also came up with an innovative

Segregated collection of waste in Panchgani
Source pic 2: https://pas.org.in/Portal/document/UrbanSanitation/uploads/Panchgani.pdf

way to manage the waste generated by tourists. Every tourist entering Panchgani was politely intercepted by a Swachh volunteer and handed over an eco-friendly bag wherein they could collect all their trash generated during the visit. A small deposit fee was charged which was refunded when the tourist handed over the trash bag during their return journey.

Eco friendly bags distributed to tourist to collect waste generated during their visit

Source: https://panchganihillstation.com/activity-detail/93/act

Panchgani is also completely binfree as alternative arrangements have been made for collecting fallen leaves by placing gunny bags at frequent intervals. Some of the other initiatives taken by the PHSMCtowards solid waste management are:

1. Ban on use of plastic

Plastic of less than 50 micron in thickness is banned since year 2005. If a commercial establishment is found to be using such banned plastic, a fine of Rs 500 is levied from first time offender and a repeat offender is fined Rs 5000. In FY 2015-16 PSHMC collected a total fine of Rs 4000.

2. Penalty for littering

PHSMC is the only council in the state to levy a penalty for any activity that creates dirt in the city. It has identified 22 such activities and fine for each act varies. Littering on street and public spaces,spitting, handing over unsegregated waste, etc. are some of the activities that attract penalty. The Safaikamgar report any such activity to Mukadams who are entrusted with the responsibility of collecting fine.

Instructional hoardings for public awareness

Source 1: https://cdn.cseindia.org/docs/photogallery/slideshows/10_20171212_Panchgini-presentation.pdf

Source 2: https://pas.org.in/Portal/document/UrbanSanitation/uploads/Panchgani.pdf

3. No Open defecation

Open defecation within the city has been recognized as a punishable offence and a fine of Rs 50 is collected from the defaulters. A monitoring squad consisting of 2 staff members has been constituted. This squad moves around the town in the morning between 6am to 8am to monitor ODF spots. In addition to collecting fines, the squad also makes the defaulters aware of the ill effects of open defecation.CCTVs have been put at these 'garbage vulnerable' points and through social media; pictures are circulated of all those found throwing garbage.

4. City Beautification

Garbage Vulnerable points are cleaned, painted and turned into selfie points.

Garbage vulnerable points painted with awareness messages

Source: https://panchganihillstation.com/

5. Cleanliness drives are organized to raise awareness amongst people towards cleanliness.

Cleanliness drives at schools and communities

Source: https://cdn.cseindia.org/docs/photogallery/slideshows/10_20171212_Panchgini-presentation.pdf

Various initiatives have been taken up by the schools in the town towards waste management. For instance, SanjeewanVidhyalaya, one of the pace setting learning institute of the town, through its project 'Connect the world child' - an experiential, doable, outreach programme is helping students in:

- Learning the science and technique of old and new world for saving water, energy and environment.
- Handling Waste
- Enriching the soil

Pit composting is being practiced in the organic garden of the school as a part of this project. The garden is maintained by the students. Around 100 kgs of wet waste is processed through the compost pits.

Composting pits at school complex

Sanjeewan Vidyalaya was founded in 1922. It is residential school spread over twenty-two acres of woodland and plateau. The school comprises a central school building, a large library, well-equipped laboratories, computer technology, learning cell, a multipurpose hall with 2 badminton courts, an open air theatre, a fine arts complex, facilities for physical activities including a swimming pool, a mini multipurpose Astroturf for basketball, tennis, football and hockey, a skating rink, and a spacious playground.


Organic Garden at Sanjeewan Vidyalaya

6. Model of 'Swachagrahis'

To generate employment for ladies, Panchgani model of Swachhagrahi was introduced by the council. In each ward, swachhagrahis are appointed on remuneration basis and their tasks comprise spreading awareness towards importance of source segregationand monitoring day to day collection and transportation activity.

All these efforts and commitment of the people have slowly and steadily turned Panchgani into a Zero Waste town.

Swachagrahis model of Panchgani

Source: https://cdn.cseindia.org/docs/photogallery/slideshows/10_20171212_Panchgini-presentation.pdf

Panchgani Swachh Bharat Point

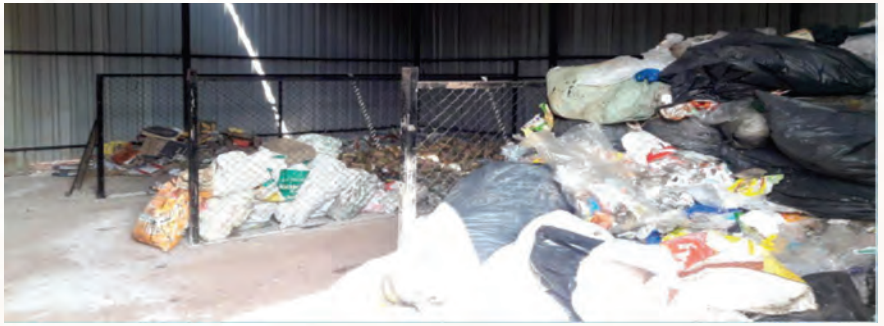
The waste collected from the city is brought to the Swachh bharat point where it processed in the solid waste treatment plant. The plant was commissioned on 2 December 2015 at cost of 1.15 Cr. The city received funds from the district Nagarothan for the project and contributed 20% of the project cost.

Facility Highlights	
Location	Swachh Bharat Point, Ward No 1
Land Ownership	Panchgani Municipal Council
Year of Establishment	2015
Area	1 acre
Type	Centralized
Type of input	Wet waste & dry waste
Input Capacity	7 MT per day
Processing Capacity	6 MT per day
Total Manpower	10
CAPEX	Rs. 1.15 cr

Swachh Bharat Point, Panchgani

The waste brought to the plant is first weighed. The dry waste is sent to the resource recovery centre where it is further segregated into seven different categories.The segregated dry waste is sold to the authorized scrap dealers.

The facility also comprises a shredding and bailing unit, where the non-recyclable plastic is shredded and packed and sent for making roads.



Waste Segregated into different categories in the Resource Recovery Centre

Source: https://cdn.cseindia.org/docs/photogallery/slideshows/10_20171212_Panchgini-presentation.pdf

Non-recyclable plastic shredded with the help of shredding machine

The wet waste is taken to the composting unit within the facility where it is processed into compost. About 3.5 tonnes of wet waste is treated daily in the composting unit. The waste is first passed into a shredding machine through a conveyer belt. The shredded waste is transferred to the composting unit through the conveyer belt where it is mixed with inoculum. Instead of using any other inoculum, the ash obtained from nearby sugar factories, which is also a cheaper and better option because of its carbon content, is used by the council. The mixture is then poured into the pits on a thin layer or either cow dung or matured compost. After 35-40 days, the matured manure is dried, sieved and packed for distribution. The compost is being sold at Rs.5/kg to the farmers. Roughly a ton of compost is being generated from the waste every day.

Wet waste processing at the facility

Process Flow Diagram

There is also an organic garden. In addition, there are three windmills and solar panels installed within the facility on pilot basis to reduce the energy consumption of the facility.

Organic garden at the facility

Solar panel installed at the facility

Windmills installed at the facility

Source: http://haritham.kerala.gov.in/wp-content/uploads/2020/01/punchgadi-muncipal.pdf

Key Highlights

- ✓ The importance of the Swachh Bharat Point goes beyond just beautification. The development of this spot today has resulted in cleaner air and a healthier environment for its citizens and has also helped in the conservation of this eco-

Sewage Treatment Plant

Facility Highlights	
Location	Hindu Smashan Bhumi (F.P. No. Q)
Area	1000 sq.m
Land Ownership	Panchgani hill Municipal Council
Owner of the facility	Panchgani hill Municipal Council
Year of Establishment	7th November, 2016
Input Capacity	1.5 MLD
Processing Capacity	1.5 MLD
Total Manpower	4
CAPEX	Rs 2, 37, 45, 480
OPEX	Rs 40,000-45,000 per month
Technology	MBBR technology

The drainage and sewerage system of Panchgani was established during the British times. The city has a mixed sanitation system (underground sewerage and onsite sanitation). PHSMC operates 1 vacuum emptier truck of capacity 3,000 litres for the emptying of septic tanks. For septic tanks outside the city limits, a private agency i.e. Chavhan Cleaning Services operates another vacuum emptier. There is also no monitoring of other private agencies involved in the septage management business. Thewastewater collected in the sewer system is conveyed to the treatment plant, while the emptied septage is discharged either at

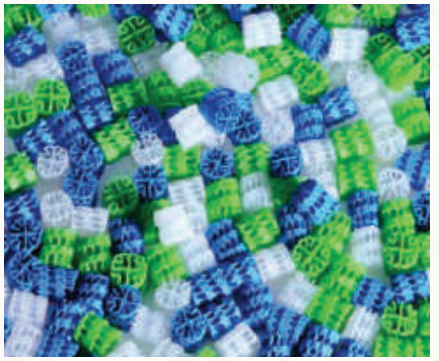
the sewage pumping station or to the nearest sewer manhole. There are three sewage treatment plants operational in the city at present. the treatment plant, while the emptied septage is discharged either at the sewage pumping station or to the nearest sewer manhole. There are three sewage treatment plants operational in the city at present.

The 1.5 MLD STP at Hindu Samshan Bhumi, usesMoving Bed Biofilm ReactorMBBR technology for treating the waste water. The project was executed in 2016 through a special grant under the VaishistyapurnaKaama Yojana of the Government of Maharashtra. The Panchgani HillStationMunicipal council contributed 10% of the project cost.

1.5 MLD STP at Hindu Samshan Bhumi,

The MBBR system consists of an aeration tank (similar to an activated sludge tank) with special plastic carriers. The bacteria/activated sludge grow on the internal surface of the carriers.These carriers have an internal large surface for optimal contact water, air and bacteria.The carriers are mixed in the tank by the aeration system and thus have good contact between the substrate in the influent wastewater and the biomass on the carriers.The bacteria break down the organic matter from the waste water. The aeration system keeps the carriers with activated sludge in motion. Only the extra amount of bacteria growth, the excess sludge will come separate from the carriers and will flow with the treated water towards the final separator. To prevent the plastic carriers from escaping the aeration, a sieve is placed on the outlet of the tank.

Septage treatment at the STP



The carrier material in MBBR system

Source: https://www.lenntech.com/processes/mbbr.htm#ixzz6KzQVwjPv

This method makes it possible to attain good efficiency resultingwith low energy consumption.The treated wastewater at present is provided to farmers on the downstream free of cost.

Besides this plant, there are two other treatment plants operational in the council. One with capacity 0.35 MLD situated at Shivaji Nagar and other with 0.65 MLD capacity located at Siddharth Nagar.Anoxic bio reactor technology is usedin both of these plants. The city availed special grants from the 12th Finance Commission for the project. The STP is operationalized and maintained by the private agency named Aquatech Pvt. Ltd.

To Know More

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Contact Number: 91 – 2168-244216/244206 /240287

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7

LONAVALA

Lonavala

Snapshot : Lonavala Municipal Council

State	Maharashtra
Area	3,884 sq. km
No. of Wards	12
Population	54119
Total Waste Generated	43 MT per day

Lonavala is a hill station situated on Sahyadri hills in Maval Taluka of Pune District in Maharashtra. It is about 64 kms far from the Pune city and 96 Kms from Mumbai; the Capital of Maharashtra. The name Lonavala is derived from the words 'leni' which means caves and 'avali' which means series. i.e. 'a series of Caves' which is a reference to the many caves like Karla Caves, Bhaja Caves and Bedsa that are close to Lonavala. Lonavala Municipal Council (LMC) is responsible for the hill station's development.

Lonavala generates 43 MTof waste per day out of which the total wet waste generation is 21.91 MT per day, dry waste generation is 20.73 MT per day and domestic hazardous waste is 0.01 MT. The total waste is collected and processed at integrated solid waste management facility.

Segregation, Collection and Transportation

Lonavala ensures 100% coverage of wards through its door to door collection system and 100 % segregation at source is practiced in the city. The Aadarsh Services is an external agency involved in the process of waste collection and transportation with around 25 collection vehicles. The solid waste from each collection point is brought by auto tipper (collection vehicle).

Dry Waste Segregation Centre

Dry Waste Segregation Centre is situated at Varsoli SWM Depot, a centralized system having a capacity of 25 MT and input capacity of 21 MT. Lonavala Municipal Council owns the facility centre. For operation of this centre LMC has an official agreement with a private agency named Babu Haider Shaikh & Services. The dry waste is further segregated and sent to the recyclers.

Facility Highlights	
Owner of the facility	Lonavala Municipal Council
Year of Establishment	September 2019
Type	Centralized
Input Capacity	21 MT per day
Processing Capacity	25 MT per day
Total Manpower	4

GPS route mapping

Collection vehicles

Bio Methanation Plant – with Co treatment of faecal sludge

The Bio Methanation Cum Electricity Generation Plant is located in Varsoli SWM Depot. The plant was established by Lonavala Municipal Council whereas designing and execution was done by Abhay Bio CNG Pvt Ltd. The total area of this facility is 150x150 feet and processing area is 450 sq.ft. The plant has a daily intake capacity of 5 MT per day of organic municipal garbage that comprises kitchen waste, paper, grass, gobar (cow dung), dry leaves etc. The gas is used to generate electricity with the help of a generator set. The electricity obtained is used for lighting the street in SWM Depot.

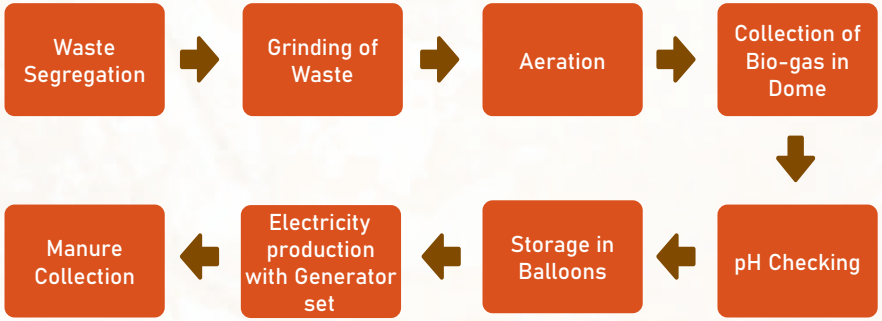
Facility Highlights	
Owner of the facility	Lonavala Municipal Council
Year of Establishment	2015
Type	Centralized
Type of input	Wet
Input Capacity	5 MT per day
Processing Capacity	5 MT per day
Total Manpower	15

BARC's NISARGRUNA technology based bio mechanisation plant

NISARGRUNA technology offers a "Zero garbage, Zero effluent" method for waste management. Unlike conventional bio-gas plants that can handle only cow dung and/or human waste, BARC's NISARGRUNA technology has the capability to process almost any biodegradable waste, such as kitchen waste, paper, grass, cow dung, dry leaves etc.

This makes, such bio-gas plants a good potential for energy generation in this biphasic-bio- methanation plant

The process followed at the Bio-Methanation-Cum Electricity Generation Plant is depicted in the diagram below:



Pit Composting

Pit Composting facility owned by LMC is situated at Varsoli SWM Depot. It is a centralized system having a capacity of 7 MT and input capacity of 5 MT. Lonavala administration setup 45 aerobic bed Composting pits of L 2.4m x B 1.2m x H 0.6, which is equal to quantity 1.73 Cu.m. From this composting facility, daily 50 kg of compost is produced, which is being used in parks and gardens of the Municipality.

Facility Highlights	
Area	Situated at Varsoli SWM depot
Land Ownership	Lonavala Municipal Council
Owner of the facility	Lonavala Municipal Council
Year of Establishment	September 2019
Type	Centralized
Input Capacity	2 MT per day
Processing Capacity	7 MT per day
Total Manpower	5

Aerobic bed Composting pits

Bulk Garbage Generators – Waste management in Housing Societies

1. Swapnalok Co-op Hsg Society is situated in Tungarli, Lonavala. It has 121 bungalows and total area is 16 acres. This society has a composting facility within their premises.
2. Lagoona Resort is also situated in Tungarli, Lonavala. It generates 60 kg of wet waste on a daily basis.. They have adopted mechanical on-site processing of Organic waste.

Drum Composting

OWC compost machine

Innovative Programme – School Passbook Scheme

Children play a crucial role in achieving the goals of Swachh Bharat Mission (SBM). Children's Role in SBM has been vital in making India cleaner and greener. Lonavala Municipal Council has initiated a Programme called 'School Passbook' with the school students in order to create awareness on SWM and Sanitation. It is a unique and innovative idea adopted by LMC. The students are required to bring waste in a segregated manner (Dry & Wet). According to different components of waste; students get points. Students bring their waste and submit it to the school and they are provided with passbooks, which consist of their names, the particulars, type of waste they have collected and the points they have earned out of it. These points are also included in their school curriculum, which is eventually counted and added to their individual grades. LMC's initiative to involve students has helped create awareness amongst themselves, their family and their surroundings.

School student recycle non degradable waste

To Know More:

Lonavala Municipal Council,
M G opposite bhaji market, taluka-, MG Rd,
Maval, Lonavla, Maharashtra 410401
Email – NA
Contact no. - 01800 233 5463

References:

www.lmc.or.in
https://twitter.com/swachh_lonavala?lang=en

8

MAMALLAPURAM

Mamallapuram

Snapshot: Mamallapuram Town Panchayat

State	Tamil Nadu
Area	12.568 sq. km
No. of Wards	15
Population	15,172
Total Waste Generation	8.250 MT per day

Mamallapuram, also known as Mahabalipuram, is a town in the state of Tamil Nadu, best known as the UNESCO World Heritage Site of 7th and 8th century Hindu group of monuments. Mahabalipuram town attracts roughly 3 million tourists every year. Once the abode of the famous demon King Mahabali, Mahabalipuram was later renamed Mamallapuram.

The Mamallapuram Town Panchayat is a Special Grade Town Panchayat, which comes under Kancheepuram District. Mamallapuram Town Panchayat comprises of 15 wards with a population of 15172 as per 2011 census. It consists of 5653 residential households with 744 commercial establishments. The town is spread over an area of 12.568 Sq. km. The town panchayat generates 8.250 MT of solid waste per day. Mamallapuram with its comprehensive waste segregation and management system has managed to go waste-free in a span of few years. The town has gained the label of 'Waste-Free' town of India.

With 'waste segregation at source' as their mantra, the town is managing waste effectively and has become completely litter-free. This commendable achievement is credited to an NGO; Hand in Hand India, a Tamil Nadu-based organization committed to the development of rural areas through a variety of projects along with local authorities and the people.

As per the SLB report by Mamallapuram Town Panchayat, for the year 2018-19, the town has achieved 100% household level coverage of solid waste management (SWM) services, 100% extent of town panchayat solid waste recovery and 95% extent of segregation of town panchayat solid waste.

SLB Benchmark Report 2018-19				
S.No.	Indicators	MoHUA Benchmark	Service level Benchmarks	
			Status 2018-19	Target 2019-20
1	Household Level Coverage of Solid waste management Services	100%	100	100
2	Efficiency of Collection of Town Panchayat solid waste	100%	95	100
3	Extent of Segregation of Town Panchayat solid waste	100%	95	100
4	Extent of town panchayat solid waste recovered	80%	100	100
5	Extent of Scientific Disposal of Town panchayat solid waste	100%	50	80
6	Efficiency of redressal of Customer Complaints	80%	100	100
7	Extent of Cost recovery in SWM Services	100%	10	50
8	Efficiency in collection of SWM charges	90%	50	90

Source: Mamallapuram Town Panchayat,Kancheepuram District

"2 Bins and One Bag Model": Each household has 2 bins and one bag – Green coloured bin for biodegradable waste, the black bin for non-bio-degradable waste like sanitary napkins, diapers, to name a few and a white bag for recyclable waste. Waste generators are expected to segregate their own waste and the collection of waste for both bins and white bag is done daily.

Keeping in view the population growth and expansion of the town, continuous IEC activities are planned to maintain efficiency. For source segregation, awareness is given by social animators or Self Help Groups (SHGs) to citizens/waste generators to insist on the need of continuous effort on segregation of waste as Wet (Bio-degradable) and Dry (Non Bio-degradable / Recyclable / Inert) Waste. Citizens are also motivated to practice home composting, which will considerably reduce the quantity of waste to be collected.

D2D Collection and Segregation of Domestic Solid Waste

At present, primary collection of waste is being effectively done utilizing 3 Battery Operated Vehicles (BOV) and 6 Light Commercial Vehicles (LCV). The entire collection is being carried out with the engagement of 71 sanitary workers including 55 outsourced contract workers. Route chart is prepared for each vehicle, each waste collector is designated streets, households and trips and there is a prescribed time for each trip. Wet waste from the commercial area is collected using tractor, while the market waste is collected using available tipper lorries. Domestic

hazardous waste such as diapers, napkins, blood stained cottons etc., are separately collected during the wet waste collection and sent for incineration on daily basis at the existing incinerators in the dump yard. To reduce the transportation cost; secondary transportation and secondary storage bins are avoided, and waste collected from the households is directly taken to the Resource recovery park.

Primary Collection of waste using light motor vehicles

Resourse Recovery Park (RRP) at Mamallapuram Town Panchayat

The resource recovery park at the Mamallapuram Town Panchayat has a waste handling capacity of up to 8.250 MT/day. The park comprises a windrow composting shed, vermi-composting shed, Bio gas plant, Storage room for recyclables, and Art from Waste Park. The RRP is spread across an area of 3 acres.

Resourse Recovery Park (Rrp) at Mamallapuram Town Panchayat

Windrow Composting shed at Resource Recovery Park

The organic waste brought to the RRP is processed into compost through aerobic decomposition at the windrow composting shed. At first, the obtained waste is passed through a shredder and mixed with necessary quantity of bioculture and sufficient moisture. The waste is then laid on the paved windrow platform into windrows. Each windrow is 3m long x 2m wide x 1.5m high, with a total volume not exceeding 9cu.m. The windrows are turned thoroughly on the 10th and 15th day from outside to the centre to provide aeration. On 20th to 30th day, the partially composted waste is passed through manually operated rotary screens of about 25mm square mesh to remove the inorganic and inert material. The screened bio-compost is kept for curing and then finally stored and sold to the farmers and local residents. The capacity of the windrow platform is 46 MT. Approximately 300 kg of bio compost is produced per day.

Windrow composting shed

Shredding and sieving units

Vermi-Composting in Resource Recovery Park

The vermi-composting shed has a capacity of 25 MT and comprises of a total of 16 bins. The organic waste is converted to compost using certain species of earthworms. 'Eisenia foetida' red earthworm is preferred because of its high multiplication rate, thereby converting the organic matter into vermi compost within 45-50 days.

Vermi composting pits

At first animal dung, mostly cow dung and dried chopped crop residues (Mixture of leguminous and non-leguminous crop residues enriches the quality of vermi compost) are collected and dumped into the pit. Water is sprinkled on the waste for a period of 15 days. Partially decomposed waste is then transferred to the pits and forms a 2-3 inch deep layer. A layer of cow dung is then spread over the mixture. The process is repeated until a desired height of accumulated waste is achieved. After this, earthworms are introduced into the waste pits to facilitate its further decomposition. Water should be sprinkled immediately after the release of worms and beds should be kept moist by sprinkling of water (daily) and by covering it with gunny bags. The beds should be turned once after 30 days for maintaining aeration and for proper decomposition. The waste takes about 40-45 days to fully decompose. When it is completely decomposed it appears black and granular. The compost should then be kept over a heap of partially decomposed cow dung so that earthworms could migrate to cow dung from compost. After two days compost can be separated and sieved for use. Approximately 80 kg of vermi- compost is produced daily.

Earthworms introduced to pits

Bio-methanation Plant, Resource Recovery Park

There are two bio gas plants operational in the RRP. Hand in Hand NGO in association with Mamallapuram Town Panchayat installed a 100 cu.m bio gas plant with a capacity to handle 500 kg of food waste generated daily by the hotels in Mamallapuram. Another 50 cu.m plant with a capacity to handle 250 kilograms was set up by the town panchayat at a cost of Rs. 13.5 Lakhs to handle the meat waste generated in the town.

The food waste is converted into methane, which is used for power generation through a 15 kVA/12 kW bio gas generator. The 100 cu.m plant produces 40 kg of gas per day generating approximately 12.5 kW electricity and the 50 cu.m produces 20 kg of gas per day generating 4kW of electricity. The electricity generated is used to electrify 30 street lights.

Feeding Platform

50 cubic meter Biomethanation Plant

100 cubic meter Biomethanation Plant

Process Description

At first the segregated food and meat waste brought into the plant site It is crushed using crusher/pulveriser along with suitable quantity of water to form slurry. The slurry is then collected into the inlet cum recycle chamber and then fed to the anaerobic digester. In the anaerobic digester, the food and meat waste is converted into biogas. Part of the treated overflow from the digester is recycled back for the slurry preparation and the remaining is discharged for suitable treatment. The bio-manure obtained through the process is periodically removed from the digester and is used as organic manure or soil conditioner. The biogas generated from the anaerobic digester is collected in the biogas holder, suitably pressurized, cleaned and used for power generation.

Biogas power generator

Power used for street lighting

This process leaves behind zero-waste as the gas generated is utilized for electricity and the leachate that is a by-product, is used as a natural fertilizer.

Benefits of Waste to Energy Project:

- ✓ *Neat and hygienic disposal of organic waste.*
- ✓ *No foul smell and flies / mosquito nuisance.*
- ✓ *Semi-automatic operation hence easy maintenance and less wear & tear of equipment.*
- ✓ *Only semi-skilled operators required.*
- ✓ *Utilization of energy generated for street lighting and manure for public gardens.*
- ✓ *Reduced burden on Landfills.*

Recyclable Storage Shed

At the recyclable storage shed, the recyclable wastes are further segregated into plastic bottles, aluminium foils, rubber products, plastic carry bags, and metal and glass products. This is then sold to the respective recyclers.

Dry waste segregated into various categories

Fecal Sludge Treatment Plant (FSTP), Karunguzhi Town Panchayat

Karunguzi Town Panchayat	
State	**Tamil Nadu**
Area	6 sq. km
No. of Wards	15
Population	9,964
Total Waste Generated	4 MT per day

Karunguzhi Town Panchayat is the neighboring town panchayat to Mamallapuram. One of the noteworthy initiatives of the Karunguzhi Town Panchayat is the Fecal Sludge Treatment Plant.

The Karunguzhi Town Panchayat is one of the first towns in India to move towards the 'full cycle of sanitation', i.e., access to toilets, safe containment, conveyance (through the sewer network or through trucks), and finally treatment and disposal of toilet waste. A pilot project (FSTP) based on cluster approach (serving Karunguzhi and Madurantakam) was built in Karunguzhi.

The septage collection process was virtually non-existent initially. The residents were charged high and inconsistent desludging charges by the service providers. With this pilot project, the desludging process was regulated and a seamless web based mechanism was developed to track and capture the desludging activity. With the help of this system, residents were charged affordable and standardized desludging fees and also unsafe discharge practices could be tracked.

Nearly half of the households in the Karunguzhi Town Panchayat are dependent on Onsite Sanitation System (OSS), predominantly septic tanks, as the underground sewage system is not affordable for small towns.

Details of septic tank and scale of septage management			
Town / Village	**Number of septic tanks**		**Average volume of septic tanks (Weighted)**
	Existing	**New**	
Karunguzhi - Standalone	1141	825	7.44
Maduranthakam	2310	5389	4.39
Total	3451	6214	
Average volume of septic tanks (m^3)			4.15

The septage collected from the septic tank is transported to the treatment site.

Layout of Karunguzi FSTP

Facility Highlights	
Name	Karunguzi FSTP
Location	Karunguzi Town Panchayath
Area	10.83 sq.m
Owner	Poonampatti Town Panchayath
Year of Establishment	2017
Type	Decentralized /Cluster
Type of input	Fecal Sludge and Septage
Input Capacity	6,000-8,000 litres
Processing Capacity	80%
Total Manpower	2

Sludge Drying Beds

The 23.40 cu.m volume of septage collected per day is fed into the sludge drying beds. The size of sludge drying beds is 8.20 m x 6.00 m and the depth of storage is 0.50 m. The facility comprises 20 sludge drying beds and the retention time for storage of sludge in the drying beds is 21 days.

The sludge drying beds are arranged in two rows with 10 beds in each row. Corrugated Galvalume MS sheet roof is used to cover the sludge drying beds to protect from the rain and to quicken the process of drying.

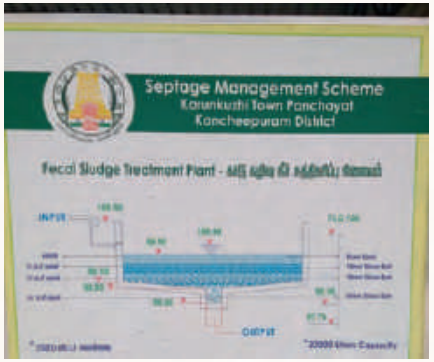
Sludge drying bed

The sludge drying beds are arranged such that the vacuum trucks can directly let the sludge into the inlet chamber. The size of the inlet chamber is 1.00 m x 1.00 m x 0.80 m. SS screens are used in the inlet chamber to remove the Grit and Coarse particles from entering into the drying bed.

Screened Inlet Chamber

Emptying of septage into drying bed

The sludge drying beds are filled with filter media to a depth of 0.40 m with bottom layer of 0.10 m filled with 40 mm HBG stone to cover the open jointed 200 mm stone ware pipe. The base slab is sloped towards centre at 1:15 slope to collect the filtered septage in 200 mm open jointed pipes. The sludge is retained to a depth of 0.50 m over the filter media. The collected filtrate through the stone ware pipes is let into the Planted Gravel Filter through 200 mm CI LA Class pipes. The retention of solids is estimated from 1.5% solid content to 20-30% solid content after the drying of septage in the sludge drying bed. The BOD reduction is 30%.



Filter media layer across sludge drying bed

Septage left for drying

Horizontal Planted Gravel Filter

The 22m^3 volume (reduction of 5% of volume) of effluent collected from the sludge drying bed is treated in the Horizontal Planted Gravel Filter. The retention time for the treatment of effluent in the horizontal planted gravel filter is 1.5 days and the volume of storage is 33m^3. The area required for the treatment is 4m^2/m^3 based on which 132m^2 is required for treatment. The size 1 unit is 17.00 m x 8.00 m (136m^2). The bottom portion is filled with graded gravel and pebbles to a depth of 0.60 m. Canna Indica plants are planted over the filtered media. The bottom of the slab is slopped towards the outlet for collection of treated effluent. The treated effluent collected from the outlet chamber is let into the maturation pond for tertiary treatment. The BOD reduction is 50%.

Septage passed from drying bed to Horizontal Gravel Filter

Cross section of the Horizontal Planted Gravel Filter

Canna Indica plants planted over filter media

Outlet chamber

Maturation Pond

The 22m^3 volume (reduction of 5% of volume) of effluent collected from the horizontal planted gravel filter is treated in the maturation pond. The retention time for the treatment of effluent in the maturation pond is 2 days. The volume for storage is 44m^3 and the depth of retention is 1.00 m. The area for the treatment is 44 m^2. The size of the unit is 7.00 m x 7.00 m (49 m^2). The treated effluent is collected in the Filtrate sump. The BOD reduction is 15%.

Maturation pond

Filtrate sump

The 22m^3 volume (reduction of 5% of volume) of treated effluent collected from the maturation pond is stored in the filtrate sump. The retention time for the treated effluent is 0.5 days. The volume for storage is 11m^3 and the depth of retention is 1.50 m. The size of the filtrate sump is 3.00 m dia to a depth of 5.00 m.

Filtrate sump

Effluent Disposal

The treated effluent is pumped to the nearby Killiyar River Odai through 200 mm HDPE pipes of length 300 m through 1 HP non clog submersible sewage pump sets with a 100% stand bye (1.50lpsx20m).

Treated effluent used for gardening

Pump room

The pump room of size 2 m x 3 m accommodates the panel board for the pump sets installed in the filtrate sump.

Sludge storage tank

About1.15 cu.m volume (5% of volume) of dried sludge, collected from the maturation pond is stored in the sludge storage tank. The retention time for the storage of dried sludge is 15 days. The volume of the storage tank is 17.25m3 and the depth is 0.50m. The size of the sludge storage tank is 7mx5m.

The final dried sludge is transferred to the RRP of the panchayat for the co-composting process.

Sludge storage yard

Dried sludge from the sludge drying beds is collected and transported to Resource Recovery Park for further treatment

To Know More:

Mamallapuram Town Panchayat
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Contact No.: 86109 50976
(Mr. Ragupathy, Sanitary Inspector)

Karunguzhi Town Panchayat
E mail ID: karunguzhi_tp@yahoo.co.in
Contact Number: 7824058572
(Mr. Thiru Kesavan, Executive officer)

Sources:

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8

BAGESHWAR

Bageshwar

* Workshop held at Almora

Snapshot: Municipal Council Bageshwar

State	Uttarakhand
Area	3.5 in sq. km
No. of Wards	11
Population	25000
Total Waste Generated	8 MT per day

Bageshwar is a town and administrative headquarter of Bageshwar district in the state of Uttarakhand, India. Located at a distance of 332 km from the state capital Dehradun, Bageshwar falls under the Kumaon Region.Bageshwar is known for its scenic beauty, glaciers, rivers and temples. It is also the administrative headquarters of Bageshwar district.It has a very rich and glorious history and held prominent importance as a major trade mart between Tibet and Kumaontill the Indo-China War of 1962.

Nagar Palika Parishad, Bageshwar or Bageshwar Municipal Council has received State and National Awards for its progress in managing their solid waste.In Swachh Survekshan 2019, Bageshwar, was ranked 389 at the national level.

Solid Waste generation profile	
Total waste generated	8 MT per day
Dry waste generated	2.4 MT per day
Wet waste generated	4.8 MT per day
Hazardous waste generated	0.4 MT per day
Domestic bio-medical waste generated	0.4 MT per day

The town generates approximately 8 MT of waste, whichis collected from the household or commercial establishment. The total wet waste generation is 4.8Tons per day and dry waste generation is 2.4 Tons per day. The municipality conducts door to door collection and transportation of municipal solid waste from all the 11 wards.Only 2 MT of the total waste generated is processed at the Material Recovery Facility (MRF). Most of the wet waste is composted in-situ at the household level and approximately 5 MT of waste is dumped at their trenching ground.

Segregated door-to-door waste collection by Paryaran MItras and Women SHG members

Collection and transportation

Bageshwar ensures 100% coverage of wards through its door to door collection system.The door-to-door collection of waste is done manually by the Paryavaran Mitras and women SHG members. For collection and transportation of waste, there are around 35 vehicles (including hand trolley, loader, auto tipper) are used. Collection of waste from residential and commercial areas by the sanitation staff is carried out from 6 AM to 10 AM

Facility details		
CAPEX		Approx. Rs 70 Lakh in machinery
OPEX		Approx. Rs 70 thousand per Month
Manpower		42 Paryavaran Mitra Self-Help Group (SHG) comprising of 34 women 22 Rag pickers are also involved.
Vehicles Employed	Hand trolley	22
	Collection Vehicles	7
	JCB	1
	TATA Ace	3
	TATA 407	1
	Mahindra DI	1

A pilot was done by the Council in ward no. 3, which generates an average of 750 kilograms of waste daily. They achieved 100% Door-to-door collection and segregation at source within 2 months. The Municipal Council has distributed waste bins to every household. The collection staff moves from door to door and collects only dry waste, hazardous and domestic bio-medical waste in plastic sacs from the households. The wet waste is composted in-situ home composting by the residents.

Profile of Ward no. 3	
No. of Slums	Nil
No. of Households	450
Door-to-door collection	100%
Segregation at source	100%
Total waste generated	Approx. 750 Kgs
User charge collected	NA
Manpower involved	6

In-situ composting at household level by the residents of Ward No. 3, Bageshwar

Facility Highlights	
Name of the facility	In-situ home composting
Location	Ward No. 3
Type	Decentralized
Type of input	Wet waste
Feeding capacity	Variable pit size, ranging from (1 x 1 x 1) metre to (3 x 1.5 x 1) metre

Due to a hilly terrain, the land availability for SWM is limited. Setting up of a large-scale processing unit for the management of wet and dry waste separately is always a challenge. Bageshwar Municipal Council has chalked out an innovative way to deal with it, especially the wet waste that is difficult to transport in such hilly areas. Almost all the households in Ward No. 3 of Bageshwar practise in-situ home composting in their premises. They have developed honey-combed pit structures of variable size, where they are managing the daily generation of the wet waste.

In-situ home composting at Ward No. 3, Bageshwar

Bageshwar Municipal Council has been keeping record of the residents practising in-situ home composting in the wards.

The process followed is aerobic composting, which converts the segregated wet organic matter into fine compost by means of bacterial decomposition. In this process, compost gets ready in 60-90 days, depending upon the climatic conditions.

Material Recovery Facility (MRF) at Garur-Bageshwar Road

Facility Highlights	
CAPEX	INR 5.5 Lakh
Opex	INR 0.35 Lakhs/Month (including agency fee of INR 5000)
Area	60 sq.m.
Land ownership	Bageshwar Municipal Council
Year of establishment	2016
Type	Centralized
Type of input	Segregated dry waste
Processing capacity	2 MT per day
Total manpower	2
Manpower structure	Skilled

Material Recovery Facility at Garur Road, Bageshwar

Bailing machine at MRF centre

Bailed dry waste

The MRF is managed by a private player- Watch King and Opticals. The Municipal Council pays Rs. 5000 per month for the management of the facility. The centre receives about 2 MT of segregated dry waste on a daily basis. However, no further sorting of this waste is done. All the material is put in the bailer machine and bailed material is sold off to the recycler.

To Know More:

Bageshwar Municipal Council
Website: http://www.nagarpalikabageshwar.in/
Email: nppbageshwar@gmail.com
Phone: 05963-220030

Reference:

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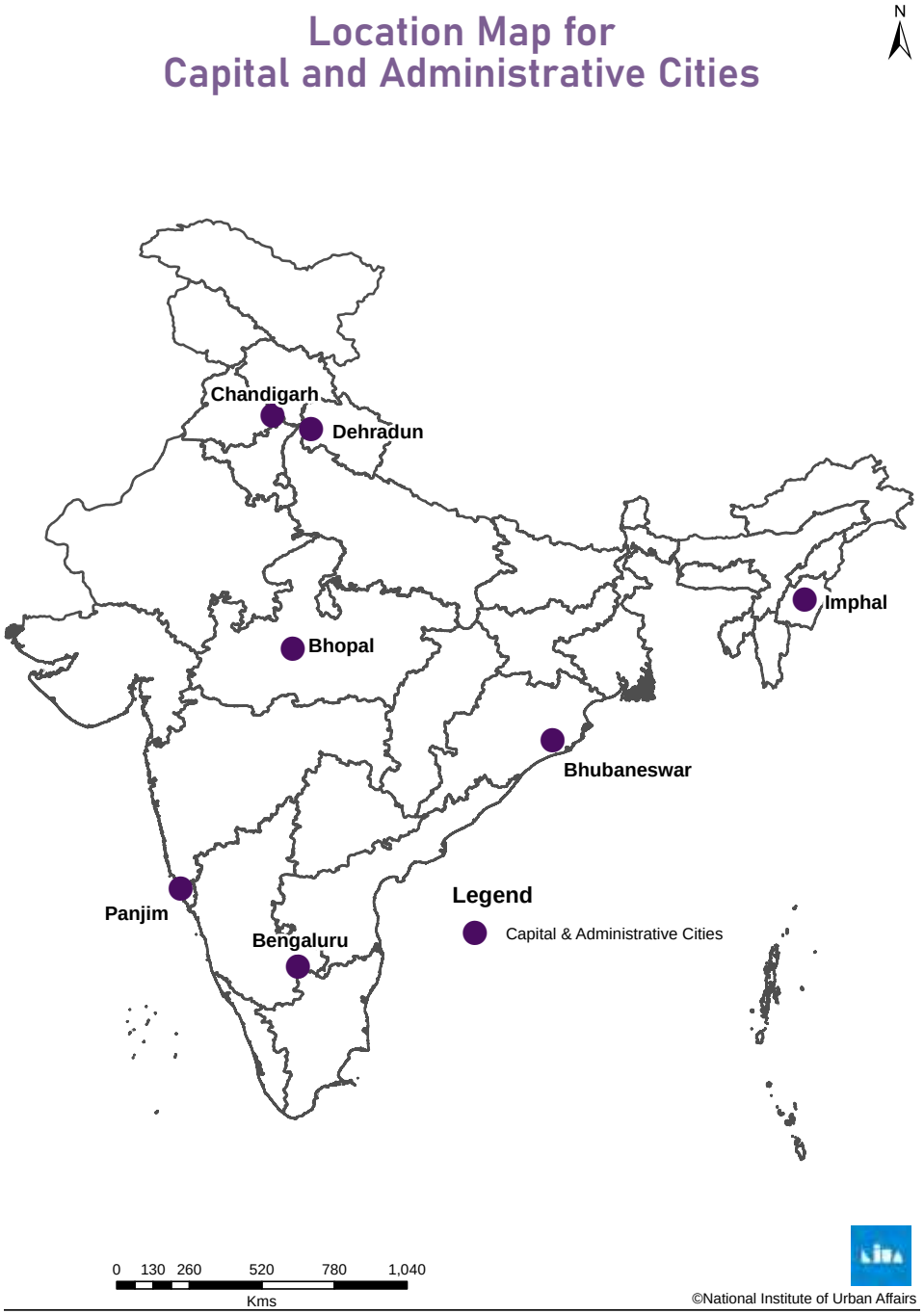
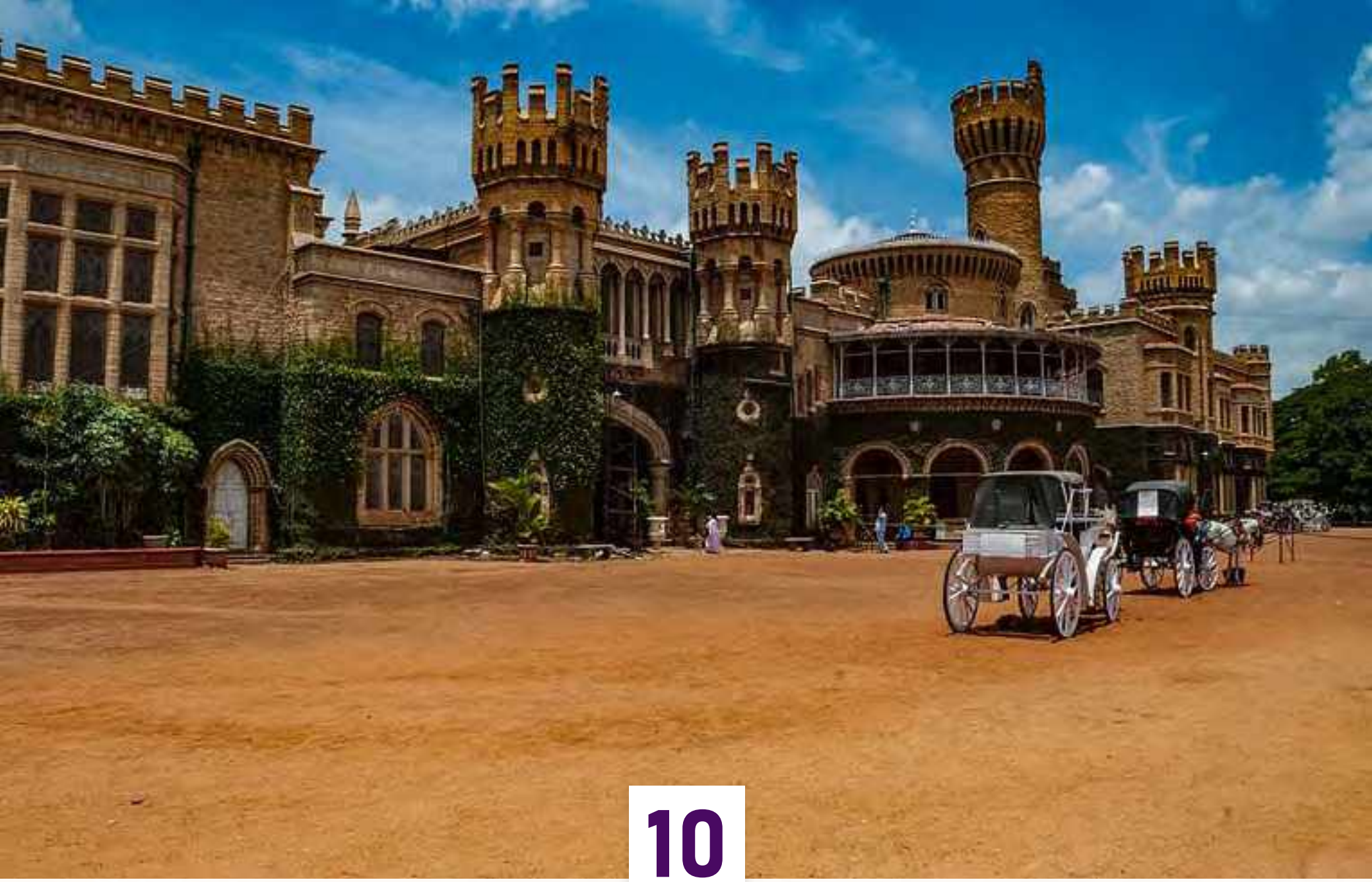
Location Map for Capital and Administrative Cities



With the ever-growing population of Urban India; capital and administrative cities face the brunt of accommodating migrant workers due to the job opportunities available. But these cities, may not have the wherewithal to dispose of the waste generated by its citizens. Effective leadership and administration of these cities are showing the way on how to manage solid waste efficiently, so that the same can be channelized in the surrounding cities as well. SBM's SWM Workshops took the opportunity to share these experiences, and further provided support by training the city officials.

CAPITAL AND ADMINISTRATIVE CITIES



10

BENGALURU

Bengaluru

Snapshot: Bruhat Bengaluru Mahanagar Palike

State	Karnataka
Area	713 sq. km
No. of Wards	198
Population	84,43,675
Total Waste Generated	5760 MT per day

Bengaluru, previously called Bangalore, is the capital of Karnataka state in India. It is the second fastest growing metropolis of India and also the fourth highest GDP contributor after cities like Mumbai, Delhi, and Chennai. Bengaluru is popularly known as the 'Silicon Valley' of India for being a major IT hub of the nation.

Bengaluru also holds the reputation of being called as the 'Garden City of India' due to the numerous parks, expansive public buildings and hospitals built to improve the city on the occasion of Silver Jubilee celebrations of the rule of Krishnaraja Wodeyar IV. On the cusp of achieving independence, Bangalore was still a part of the Princely State of Mysore in 1945-46.

After Indian independence, the two Municipal Boards were merged to form the Corporation of the City of Bangalore in 1949, under the

Bangalore City Corporation Act. The corporation then consisted of 70 elected representatives and 50 electoral divisions. The name of the council then changed — first to Bangalore City Corporation (BCC) and then to Bruhat Bengaluru Mahanagara Palike (BBMP).

Awareness at Compost Santhe

In January 2007, the Karnataka Government issued a notification to merge the areas under existing Bangalore MahanagaraPalike with seven City municipal council (CMC)'s, one Town municipal council (TMC) and 111 villages around the city to form a single administrative body, Bruhat Bangalore MahanagaraPalike. The process was completed by April 2007 and the body was renamed 'Bruhat Bengaluru Mahanagara Palike' (BBMP).

Bengaluru stands as the third most populous city in India. It has seen rapid urbanisation with its population doubling in a span of just twenty years. Though the city grew to embrace a successful and thriving IT economy; it led to an urban chaos, pushing the waste system close to its breaking point. The closure of the Mavallipura landfill by the Karnataka State Pollution Control Board (KSPCB) in 2012, following the protest by the villagers of Mandur, the directives issued by the Hon'ble High Court of Karnataka and on the recommendations and guidance of the Expert Committee i.e. a Sustainable Solid Waste Management Plan known as Kasa Muktha programmewas set up by the BBMP .The city's generationof approximately 5760 MT includes 64% wetwaste, 28% dry waste, 2% domestic hazardouswaste and 6% inert waste.

Processing Facilities in Bengaluru		
Processing Facilities	**Number of units**	**Percentage of Waste Processed**
Dry Waste Collection Centre (DWCC)	164	26%
Bio-Methanation Unit (BMU)	13	6%
Organic Waste Converter (OWC)	7	4%
Leaf Litter Processing Unit (LLPU)	4	2%
Coconut Waste Processing Plant (CWPU)	2	2%
Waste Processing Plant (WPP)	10	40%
Landfill	1	20%

The city has setup infrastructure facilities to process waste by stream at ward level. At the Zone level, Rs 440 crore have been invested to process over 80% of waste per day. The BBMP has adopted six strategies to manage the waste:

- **Investing in stream wise processing of waste:** Segregation at source, collection and transportation, infrastructure and technologies for processing.
- **Data Driven Approach for Estimation and Planning:** Ensuring stream wise collection and transportation
- **Enabling Market Dynamics:** Creating New Economic Opportunities: Polluter Pay Model for bulk generators, empanelment of authorized service providers
- **Awareness Creation and Enabling Behavioral Change:** Training programs, large events, cleanup drives

- Use of technology for data collection and monitoring: Creation of data repository, GIS mapping, control room and app usage
- Creating Institutional Capacities and Enabling Legislative Reforms: Reforms in legislation and new notifications, extended producer responsibility, SWM Cell, expert committee, intensive training programs.

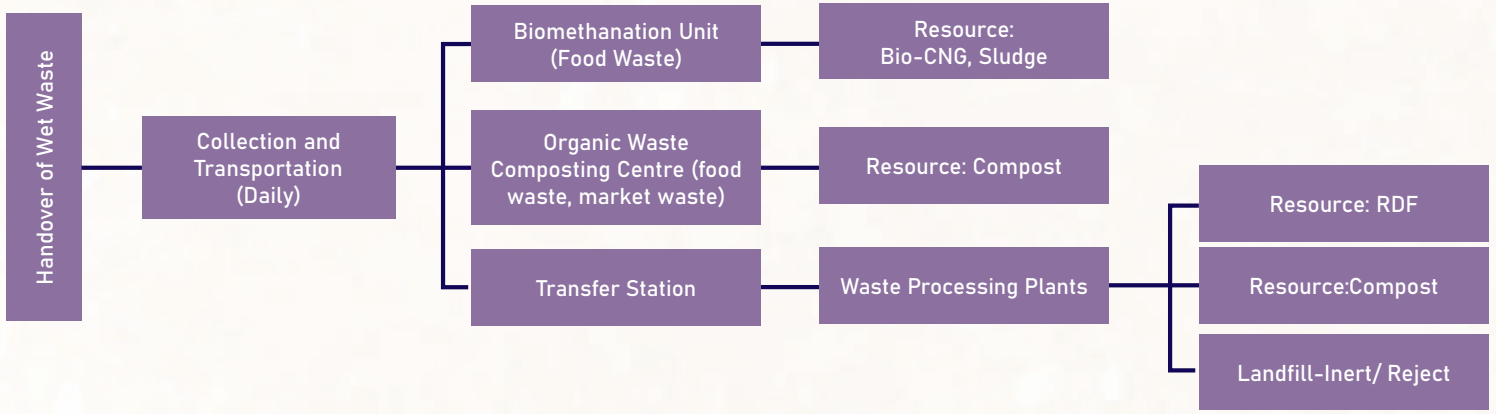
The city has 100% door to door collection. A three way source segregation (Two Bin and One Bag) is followed by domestic generators and two way source segregation is followed by commercial establishments around the city.

Bin requirement for non-bulk residential generators	
Generator	**Bin System Specification**
Independent Homes	2 BINS – 1 BAG Green Bin – Organic Waste Blue/White Bag – Dry Waste Red Bin – Domestic Hazardous Waste (Sanitary & Bio-medical Waste)
Multi Dwelling Units (< 50 flats)	3 BINS (for every 120 kgs generated) Green Bin – Organic Waste Blue Bin – Dry Waste Red Bin – (Sanitary & Bio-medical Waste)

Bin requirement for commercial establishments	
Generator	**Bin System Specification**
Commercial (>10 kgs/day) Shops, Supermarkets, commercial establishment, Campuses, Institutions, Clinics, Nursing Homes, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste
Eateries (>10 kgs/day) Food vending carts, food stalls, canteens, Bakeries, Darshinis, small hotels, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste
Street Vendors Vending stalls, counters, etc.	Green Bin – Organic Waste; Blue Bin – Dry Waste

Bulk Waste Generator (BWG) Management – According to the BBMP guidelines, the BWG have setup insitu management of organic waste and handing over of the garden-horticulture waste, sanitary waste, dry waste and e-waste to the empaneled vendors. BBMP has an online portal (BG Net) where all information of BWGs is recorded.

Wet Waste Flow Diagram of BBMP

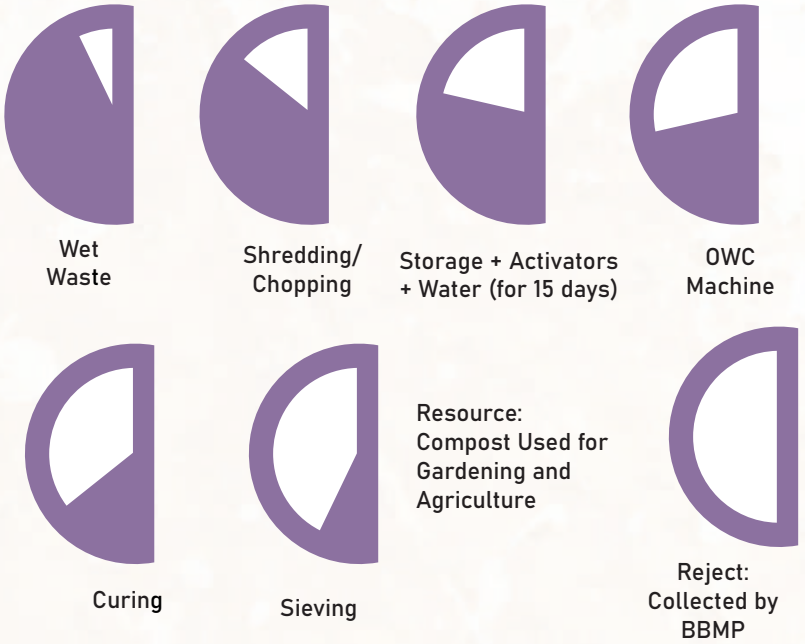


Organic Waste Converter Centre

Organic Waste Converter Centre

The Organic Waste Converter (OWC) plant works on the principle of Aerobic Microbial decomposition of solid waste into compost. This is a Bio Mechanical process which produces a homogeneous odour free output. The accountability for waste collection for the facility is on BBMP and the plants are operated and maintained by SHG or an agency. There are a total of seven such plants in Bengaluru with a capacity to manage 1 MT waste per day at the centre. The area ofthe plant is 220 sq. m.

Process Flow of Organic Waste Converter Centre



Bio Methanation Plant, Kuvempu Nagar

Bio Methanation Plant at Kuvempu Nagar

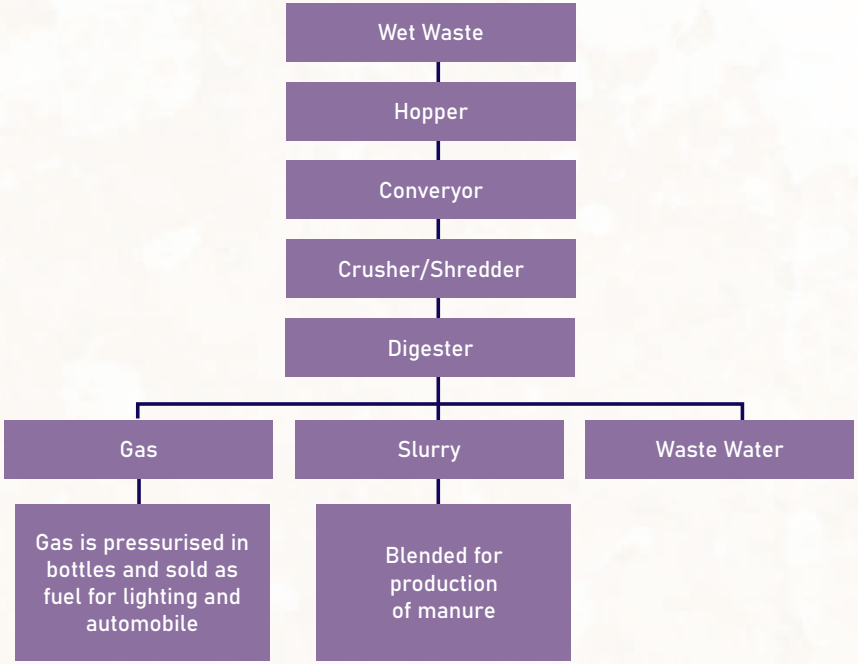
Facility Highlights	
Capacity of the facility	5 MT per day
Area of facility	600 sq. ft
CAPEX	Rs 70,00,000
OPEX	Rs 67,000 per month
Products obtained	Manure and Biogas
Quantity of Manure obtained	250 kg /day
Quantity of biogas generated	500 cu. m./day
Manpower	7

The BBMP has made it mandatory for citizens to segregate their waste. The agency involved in door to door collection aggregates the wet waste. The waste is taken to the plant to convert to energy (biogas powered engine). The plant was setup by Mailhem Engineers on Build, Own, Operate and Transfer (BOOT) basis in the year 2015. The plant processes 5 MT of waste per day. Biomethanation of organic wastes is accomplished by a series of biochemical transformations - hydrolysis, acidification and liquefaction followed by methane formation. The process generates biogas with high content of methane (55–70%) which after proper pre-treatment are directly used as fuel by employing gas engines to generate electricity. This technology has dual benefits. It gives biogas and manure a send product.

Key Highlights

- ✓ Decentralized Biomethanation Plants helps is reducing the cost of transportation of waste and managing the wet waste at the point of generation.

Process Flow Diagram of Biomethanation Plant



Leaf Litter Processing Unit (LLPU) Ward-151, Koramangala

Facility Highlights	
Capacity	1.5 MT per day
Area of unit	600 sq. ft including (storage area)
CAPEX	Rs 4,00,000
OPEX	Rs 45,000 per month

The Koramangala 3rd Block community (RWA) has set up a LLPU; a unique initiative that processes leaf and garden waste generated in the community/ ward, and converts it into usable compost. The unit is located at a public park in the area. The unit includes shredder and rotary sieves.

Collection Process

Step 1: Roads in the neighbourhood/ ward are swept by sweepers/ *Pourakarmikas* (PKs)

Step 2: Each sweeper transfers the litter into the Jumbo bag, which is then left alongside the road

Step 3: The Jumbo bags are then picked up by an Autotipper, to be taken to the LLPU

Processing at LLPU

Step 1: Segregation of input material – recyclables (paper/ plastic kept in separate bin)

Step 2: Sieving of segregated material to remove smaller size material, which need not be shredded

Step 3: Identified coarser size materials shredded and subjected to natural aerobic composting with the help of simple additives such as water and cow dung for about 15 days.

Step 4: After 15 days; the material which now has started to become a coarse compost, is turned again. The final compost is then sieved through the sieving machine to get coarse and fine compost.

The fine compost is used as manure for gardening and agriculture. This compost has been branded under the name of Kora3B Compost.

Key Highlights

- ✓ Since the alternative method in practice to leaf litter composting was the burning of leaves, leaf litter composting helps reduce the open burning of leaves. Leaf when composted can give high quality manure that can be used in agricultural practices. Coarser compost can be used for landscaping and horticultural practices.

Coconut Waste Processing Unit, Freedom Park

Facility Highlights	
Area of the facility	750 sq. m.
Processing Capacity of the facility	36 MT per day
Quantity of input	36 MT per day
Quantity of output	18 MT per day
Products obtained	Fibrous Material and Briquettes
CAPEX	Rs. 70,00,000
OPEX	Rs. 2,40,000 per month
Manpower	8

Coconut Waste Processing Unit

Tender coconut shell is the toughest and heaviest single item among the biodegradable waste the BBMP collects every day. It takes long to decompose and poses a challenge to vehicles as well as pedestrians, if not collected from the streets or the sidewalks. Coconut Waste Processing Unit (CWPU) receives coconut and sugarcane waste. The agency (CIPL Resurge Private Limited) has independently geo-tagged

coconut vendors and is currently collecting over 36 MT per day from major transportation hubs such as City Railway Station, Kempegowda Bus Station, and commercial areas such as City Market, Majestic, Chikpet, Binnypet, and Cottonpet. Under the arrangement, the BBMP has given on lease the land for three years behind Freedom Park, where huge mounds of discarded shells can be seen around the plant shed.

If stuff is fed into the compactor which turns them into cylindrical briquettes of 90-millimeter (mm) diameter each. Shredding yields both fibrous material and sawdust. The fibrous material can be separated and sent to coir industries. The residual sawdust is fed into the briquetting machines which produces solid, black coloured briquettes.

Shredding of Cocounut at Coconut Waste Processing Plant

Key Highlights

- ✓ Effective way of managing coconut waste and production of alternative fuel for energy generation at factories.

Dry Waste Collection Centre (DWCC) at Ward No 168, Pattabiraman Nagar

Dry Waste Collection Centre

The DWCC at Ward no 168, Pattabiraman Nagar is operated by Mansoor, a trained entrepreneur by Hasirudala for managing the dry waste in the ward. The built area of the DWCC is 320 sq. m and can manage waste upto 4 MT on a daily basis. The estimated dry waste generation and collection in the ward is 1.5 MT per day but the DWCC receives around 300 – 350 kg of dry waste from the BBMP waste collection vehicles every day. Apart from the households, additional 150-200 kg of dry waste is received from bulk generators. Dry waste received is mixed with around 60-70% plastics (high+low value), 10% metals and glass, 10% paper and 10% is reject material. The DWCC does not take thermocol and e-waste. Through established contacts, the accumulated dry waste (plastic, metal, glass and paper) is sold to large aggregators in Jolly Mohalla and the tetra packs are sold to Samarthanam Trust. The kurkure covers and laminates of packaged food is sold off to KK Plastics. The centre is managed by four people for sorting and segregating. The workers in the plant are paid Rs 350 on daily basis for managing the DWCC. On a similar model 164 DWCC are operational in the city to manage the dry waste in a decentralized manner.

Zero Waste Community, HSR Layout

Lane Composter at HSR Layout

The HSR Layout consists of 28,000 households and generates 65 MT of waste per day. The segregation level in the society is nearly 100% due to involvement of active members of the Resident Welfare Association who take firm steps for ensuring segregation in the neighborhood. The waste is segregated as wet (organic), dry (recyclables, low/no value inert waste), sanitary waste. E-waste is collected separately. The rental agreements with the tenants have a clause on waste segregation. If any new tenant is not segregating the waste, the landlord is immediately informed to persuade the tenant to do so.

The sanitation workers collect the wet and sanitary waste separately for 5 days a week, whereas dry waste is collected twice weekly. The wet waste is taken to transfer point, from there it is transferred to the compactor and sent to Karnataka Compost Development Corporation (KCDC). The dry waste is sent to the ward level Dry Waste Collection Centre (DWCC), where it is sorted, aggregated and sold off to the recycling industry.

The residents feel that their wet waste should not go out of the ward. Majority of the households in the neighbourhood practice home-composting or go for the lane composting. Each lane has 2 lane composters, which take around 500 kg of kitchen waste. The sanitation workers collect wet waste from the households. They fill the lane composter with the given wet waste and waste management committees supervise the composters.

The e-waste is collected separately by Saahas. The vehicle for e-waste collection comes once a month. The message of its arrival is sent to all residents via WhatsApp group. Whosoever has e-waste can give it at the e-waste collection vehicle.

Key Highlights

- ✓ Rental agreements with the tenants has a clause on waste segregation. If any new tenant is not segregating the waste, the landlord is immediately informed to act.

Festival Waste Management, Yelahanka Zone

Awareness Campaigns at School

A group of volunteers in Yelahanka go around schools, colleges and households to spread awareness during the series of festival throughout the year and call themselves as Yelahanka Eco Group. The initiative of Yelahanka Eco Group in managing festival waste started in 2015. They have been advising and promoting that for the household Ganesha idol immersion at the house is better so that lakes remain non-polluted. To ensure that lakes remain clean; they advise the removal of all the garlands and decorations like flowers and puja material, which could later on be sent for composting at the OWC Centre or for recycling through the DWCC. Kalayanis, which are non-movable tanks have been constructed at the corner of the lakes, at the edge of major lakes such as Ulsoor Lake, Sankey Tank, Hebbal Lake, etc. so that the main lake is not disturbed and idols are immersed separately. If the idols are large, they are immersed in water tanks which are portable. For Bakri-Eid too, extensive awareness campaigns are conducted. Volunteers go around and talk to the concerned people. A tractor is placed at one point in the area (especially near mosques), where all the collected animal waste is dumped. A pit is dug and after the festival the tractor with animal waste is brought to the pit/s where the animal waste is buried in the pit.

There is no capital expenditure involved in volunteer activities carried out are for limited days only. Operating and Management expenditure is borne by the BBMP directly or indirectly. For Ganesha Festival, Karnataka State Pollution Control Board (KSPCB) also contributes in terms of deploying vehicles at specific wards.

Decentralized Community Waste Management - Kasa-Rasa 2

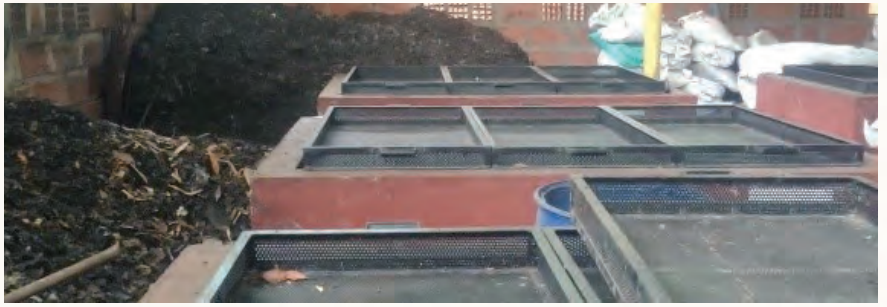
Segregating Waste

Facility Highlights	
Name of the Facility	Kasa Rasa
Location of the Facility	Koramangala
Area	228 sq. m.
Property type	Land is provided by BBMP
Owner of the facility	PPP model
Year of Establishment	2012
Type	Decentralised
Type of input	Dry and wet waste
Input Capacity	1-2.5 MT per day
Processing Capacity	0.5 MT biodegradable waste and 0.5 MT non-biodegradable waste
Total Manpower	4

Kasa Rasa is a community waste processing facility built under PPP model, where the land is provided by the Government (BBMP in this case), the capital cost of the infrastructure is supported by companies under corporate social responsibility, and the facility has been designed, setup and operated by Saahas NGO.

Upcycled Products

Collection Vehicle



Composting Pits

Awareness campaign to school children

Kasa Rasa showcases the decentralized waste management philosophy, where the community's waste is handled within the community and resources are recovered from the waste. This model also provides dignified livelihood opportunities for the waste workers. The capital cost of this facility (approximately Rs. 40, 00,000) was entirely funded by the corporate partners under CSR. The direct sources of revenue generation from the facility are sale of compost and recyclable dry waste. In addition, service fees from bulk waste generators located close to the facility for waste management services adds to the revenue of these units.

Biodegradable Waste

Biodegradable waste is processed either by aerobic tank composting with assistance of organic waste convertor for shredding/pulping the waste; or sent to the nearby biogas plant (owned and managed by Carbon Masters). The total time to generate compost is 25-30 days. The capacity of biogas plant is 4 TPD and is modular in structure (i.e. the capacity of the plant can be increased or decreased by adding or removing modules. The plant currently processes nearly 3 TPD of waste and generates biogas which is directly supplied to the nearby eatery. The dried slurry is co-composted and stabilized with dried organic waste to be further used as soil conditioner.

Non-biodegradable Waste

The non-biodegradable waste is manually sorted into different recycling categories and sent to the SZW's Material Recovery Facility located at Jigani on a weekly basis, from where the recyclable fraction is further sent to appropriate recycling destinations. The non-recyclable dry waste is sent to cement factories for co-processing.

Reject waste

Unusable inert waste is sent to MSGP Integrated Waste Management Facility where it is scientifically landfilled.

Products obtained

The bio-degradable waste is turned into compost and biogas. The biogas generated at Carbon Masters facility is directly supplied to the kitchen of a nearby restaurant.

Material Recovery Facility (Saahas Zero Waste)

Manual Soriting

Facility Highlights	
Area	1580 sq. m
Land Ownership	Leased land
Owner of the facility	Saahas Waste Management Private Limited
Year of Establishment	2017
Type	Decentralized
Total Manpower	60
Type of input	All types of non-biodegradable waste
Segregation levels	Segregation into more than 25 categories
Recovery rate	>90%
Input Capacity	250 MT per month
Processing Capacity	16 MT per day
Waste processing end destinations	Recycling facilities and cement plants

Bailed and stored paper waste

Bailed and stored multi-layered plastic

Load out

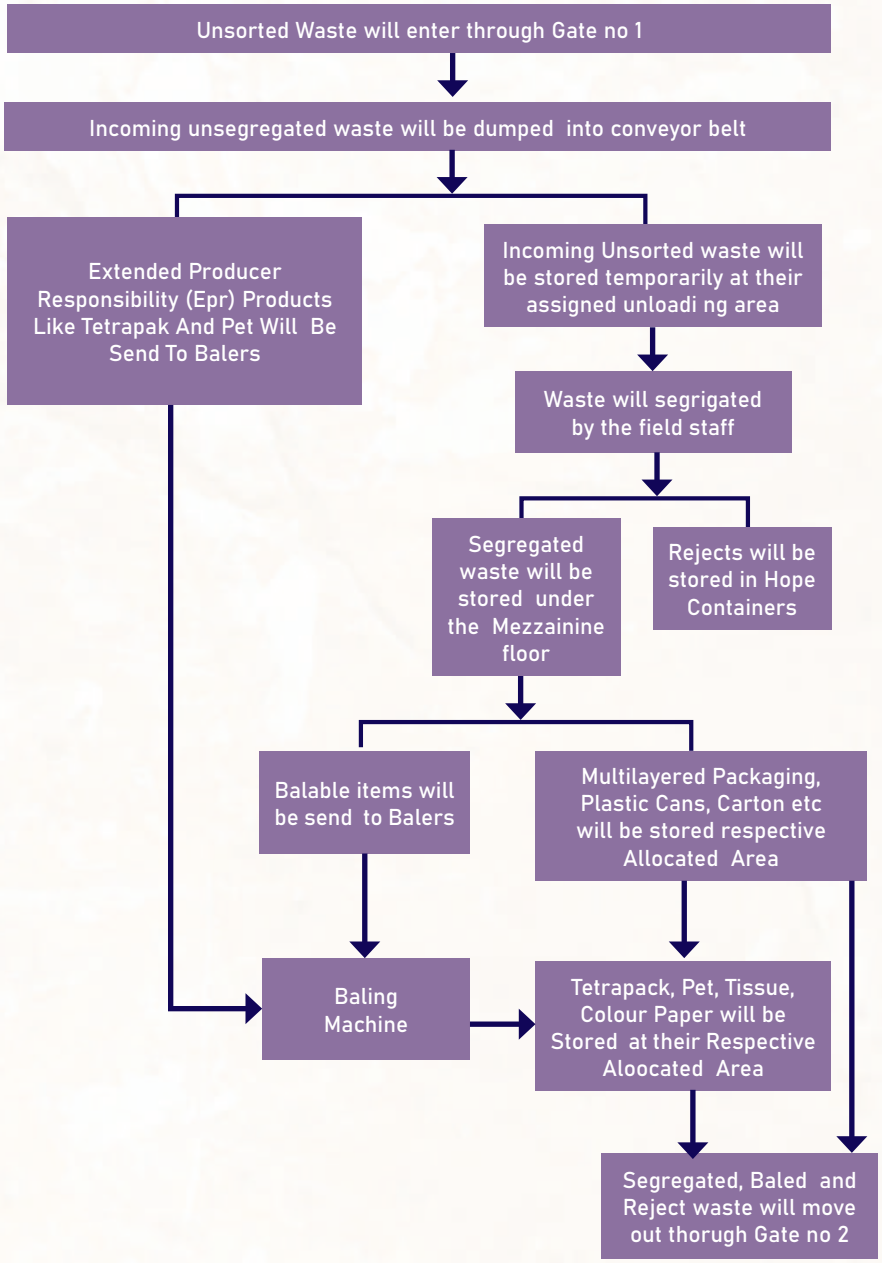
Saahas Zero Waste's Materials Recovery Facility (MRF) at Jigani, is one of its kind semi-mechanized materials recovery facilities available in Bengaluru. Established in 2017, the facility is designed, built, financed, owned and operated by Saahas Waste Management Private Limited. The unit spans over a leased land of 17,000 sq. ft. area and it has the capacity to manage 16 tonnes of waste per day. The recyclable and non-recyclable non-biodegradable waste is further sorted into more than 25 categories, baled and sent to appropriate recycling facilities and cement kilns for co-processing. Currently, the total manpower is 60 which includes segregation staff, baling personnel and loaders. At present, MRF receives waste mostly from the bulk waste generators where the waste is handled and managed by the Sahaas Zero Waste. In addition to this, waste also comes from smaller ULBs including Jigani and Bommasandra.

The capital cost of this facility is Rs. 60, 000,00 which was funded entirely by Saahas Waste Management Private Limited. The unit has been self-sustaining for last one year since its inception. The revenue generated from the sale of recyclables is sufficient to compensate for the expenses incurred in operating the unit.

SZW's Material Recovery Facility is receiving well segregated waste from bulk waste generators where waste is managed by SZW itself, which works on a semi-mechanized mode. The facility has a conveyor belt, which increases sorting efficiency (as compared to manual sorting) of material. In addition, there are balers to compress the sorted bio-degradable waste into bales for optimal transportation. The segregated recyclable categories of waste such as paper, carton, recyclable plastic etc. are sent to various recycling facilities while the non-recyclable waste such as multi-layered packaging are sent to cement plants for co-processing. Presently, the MRF is a zero waste to landfill facility.

The current flow of operations is depicted in the flowchart below:

MRG Process Flow Diagram



Swachhagraha Kalika Kendra

Swachhagraha Kalika Kendra at HSR layout

Swachhagraha Kalika Kendra is India's first solid waste management park and it is a unique initiative by HSR citizen's forum. The total area of the park is 1.5 acres and the main objective of this centre is to impart education on home and community composting and sensitizing the public towards waste management.

The centre houses more than 20 home and community composting models developed by different agencies, which can be implemented at various scales and diverse types of waste generators. Therefore, the centre has demonstrative models of various composting solutions to

meet the needs of individuals and bulk waste generators. In addition, regular training sessions on these models are regularly taken by various solid waste management experts. The centre also educates visitors on how the compost can be used to grow healthy chemical free vegetables.

Demonstration of potting mix composting

Demonstration of composting

Demonstration of BYA bin composting unit

The centre has also set up a biogas plant for demonstration purposes. The centre also houses interesting design elements that display the use of discarded waste items. Following items can be seen as examples of upcycling and utilization of waste for beautification of park:

- An arch made out of paint buckets,
- Some painted doors that were found in construction waste, bamboo railings with posters and messaging, wind-chimes made from bottle caps.
- The store-room wall is made from up-cycled construction and debris waste, the roofing from tetra-packs.

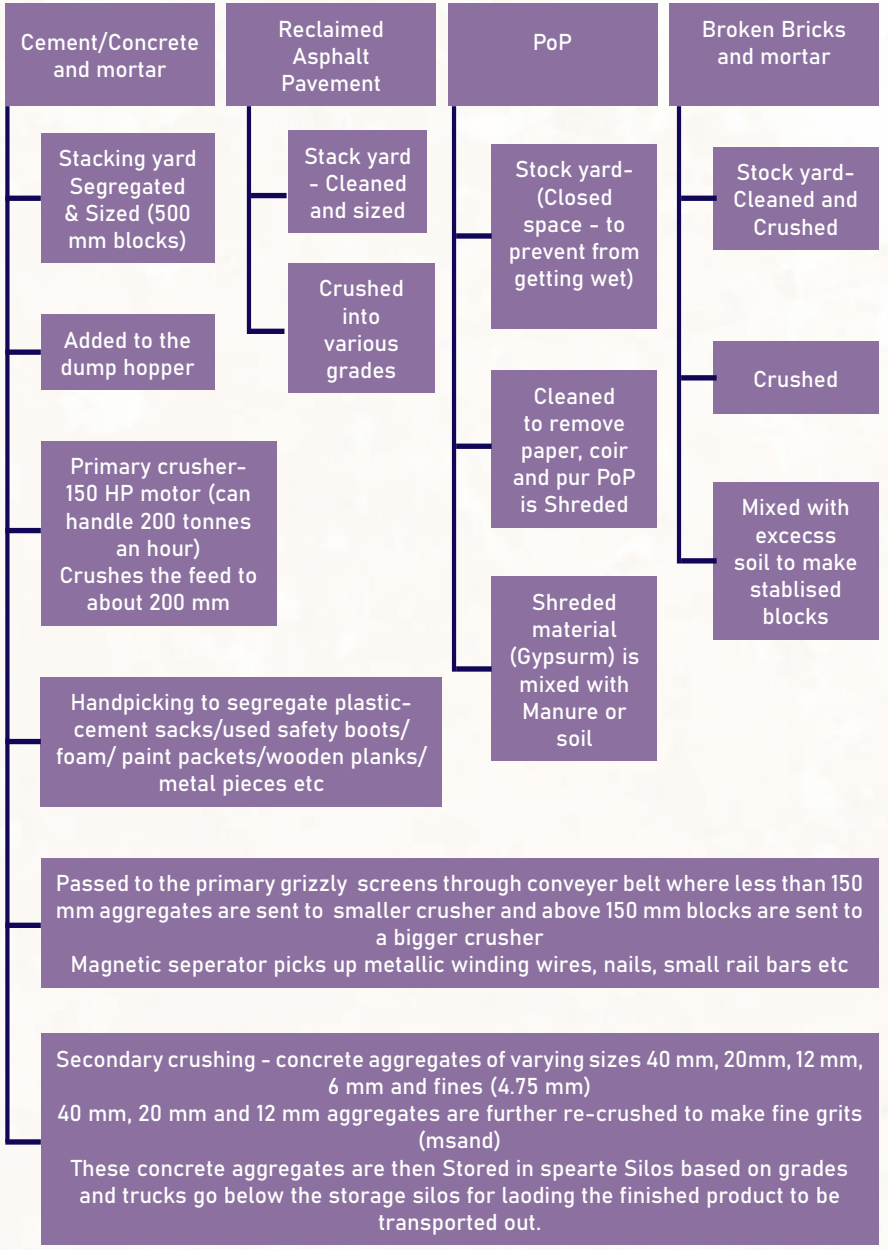
Construction and Demolition Waste Management plant

Facility Highlights	
Name of the Facility	Rock crystal (C & D Waste Management)
Location of the Facility	Chikkajala, Bengaluru
Area	3 acres
Year of Establishment	Est.2014
Type	Centralized
Type of input	Construction and Demolition Waste
Input Capacity	1000 MT per day
Processing Capacity	60 MT per day
Total Manpower	6 labour and one owner

Construction and Demolition Waste Management plant at Chikkajala

This C&D plant was setup by private agency Rock Crystal with processing capacity of 60 MT per day. The facility has been setup in 3 acres of land. However, the agency is currently in the process of further enhancing the plant and its processing capacity. The plant has a manufacturing unit of producing gravel, sand, cement aggregates of various grades. The products are then sold to construction firms. These are used for fixing tiles, concrete blocks and stabilized blocks. The annual revenue generated from this plant is Rs. 80, 00,000 approximately.

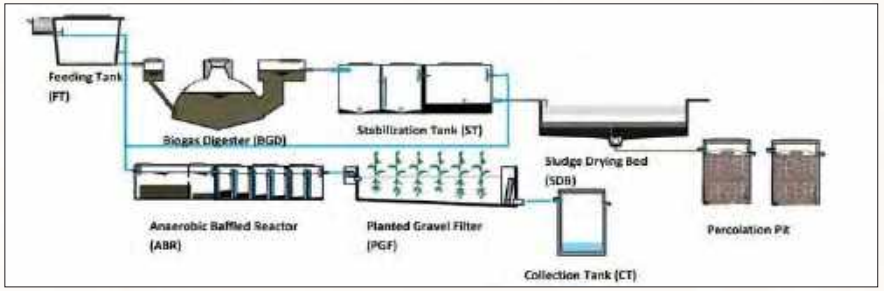
The process followed at the C &D facility is depicted in the diagram below:



Fecal sludge Treatment plant, Devanahalli

Facility Highlights	
Name of the Facility	Devanahalli FSTP
Location of the Facility	Devanahalli, Bangalore
Area	1425 sq.m (Build up area 625 sq.m)
Land Ownership	Town Municipal Council, Devanahalli
Owner of the facility	Town Municipal Council, Devanahalli and CDD Society, Bangalore
Year of Establishment	2015
Type	Centralized
Type of input	Faecal Sludge/Septage
Input Capacity	6000 litres/day
Processing Capacity	6000 litres/day
Total Manpower	1
Capex	65 lakh funded by BMGF
Opex	10 lakh per annum

Process Flow Diagram of Devanahalli FSTP:



Devanahalli town is situated around 39 kms away from Bengaluru and has population of around 28,309 (2011 census) . Most of the households depends on septic tanks and soak pits for sewage disposal. There are about 5110 septic tanks as per town municipal council. There is neither underground sewerage connection nor any organized septage treatment facility in the area which leads to washing of septage into existing open drains. This technology serves 100% treatment of fecal sludge obtained from Devanahalli town. This technology is developed by CDD Society.

The main treatment steps followed in this FSTP are solid-liquid separation, stabilization, dewatering of sludge and pathogen removal. The separated liquid component is also treated to meet discharge standards. The faecal sludge is conveyed to the FSTP through a desludging vehicle. The treatment modules for solid components are: Feeding Tank (FT) with screen chamber, Biogas Digester (BGD), Stabilization Reactor, Stabilization Tank (ST), Sludge Drying Bed (SDB) with Green House Solar Drier Roof (GHSD). Treatment modules for liquid components are: Integrated Settler, Anaerobic Baffled Reactor with filter chambers, Planted Gravel Filter (PGF) and Percolation pit. The treatment system also consists of a co-composting unit where the dried sludge from the SDB is composted with municipal solid waste

Technology demonstration

To Know More:

Bruhat Bengaluru Mahanagar Palike
Email: specialswmbbmp@gmail.com
Website: http://bbmp.gov.in
Contact Number: 080- 22975534

Leaf Litter Processing Unit (LLPU) Ward-151,Koramangala
Mr. Anil Chinnaiah, Secretary,
Koramangala 3rd block RWA, Koramangala, Bengaluru
Ph. No.: +91 9845210306

Dry Waste Collection Centre at Ward No 168, Pattabiramana Nagar
Email: nalini.hasirudala@gmail.com
Website: http://hasirudala.in
Contact Number: 080-22355553

HSR Citizen Forum
14th Cross Rd, Sector 4, HSR Layout, Bengaluru, Karnataka 560102
Website: www.hsrcitizenforum.in,
Email: hsrcitizenforum@gmail.com
Contact no: 080-41689889

Saahas Waste Management Private Limited (Saahas Zero Waste)
Website: www.saahaszerowaste.com
Email: info@saahaszerowaste.com
Contact no: 080-41689889

Rock Crystal Construction and Demolition Waste Management Plant
Email: managecnd@gmail.com
Contact no: Mr. Rajesh, Director,+91 9844033811

CDD Society, Bangalore
Website: https://www.cddindia.org
Email: roopa.b@cddindia.org
Contact no: 080 2848 6700

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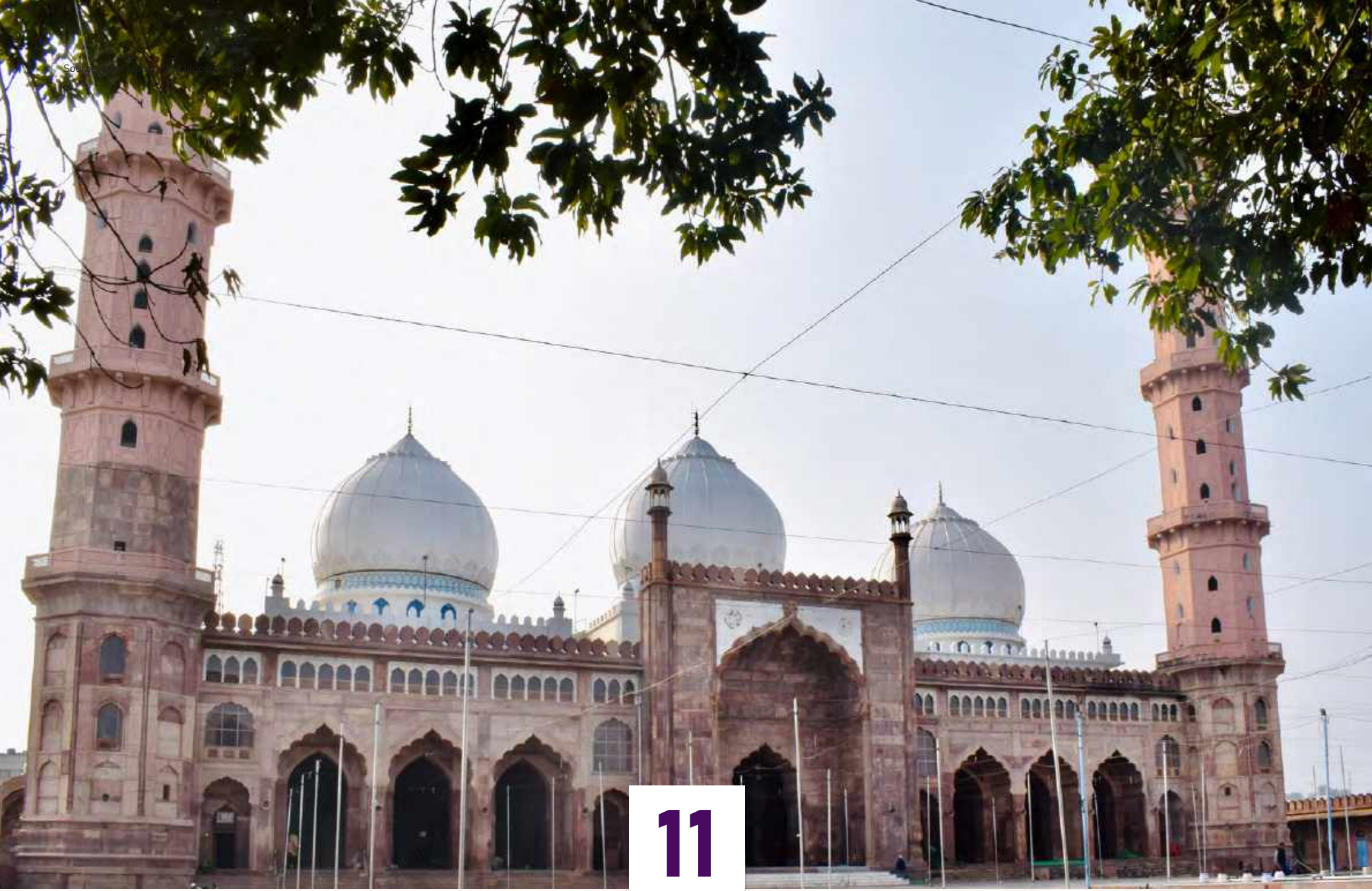
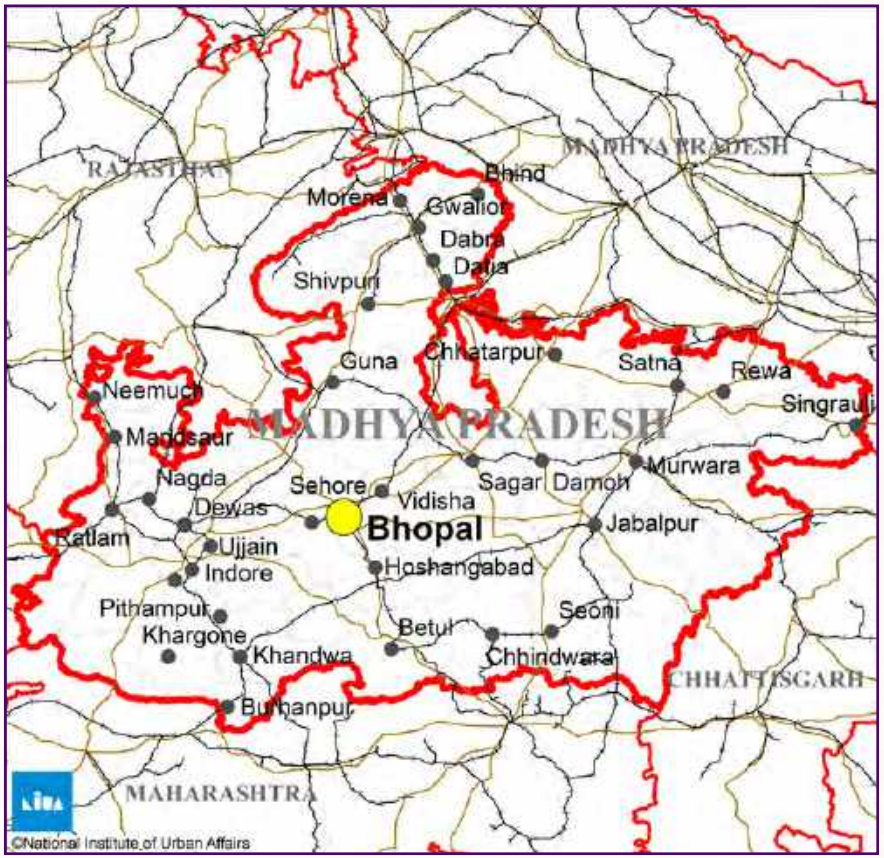
http://swachhbharaturban.gov.in/writereaddata/Day%201-Session%203-All%20PPTs.pdf



11

BHOPAL

Bhopal



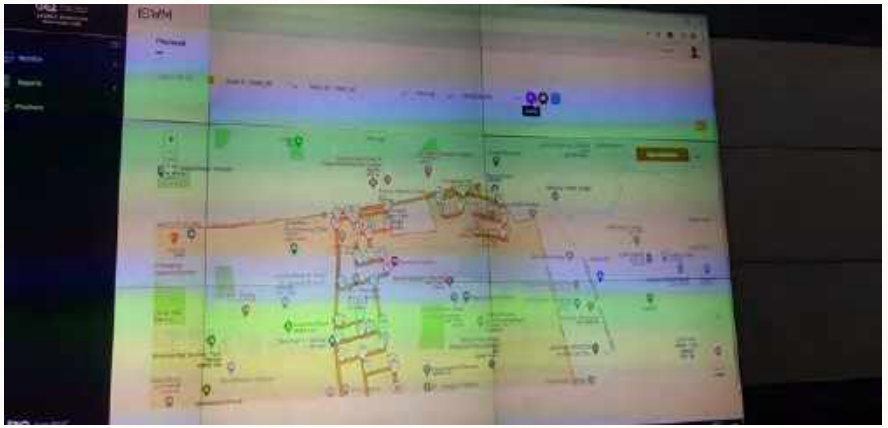
Snapshot: Bhopal Municipal Corporation

State	Madhya Pradesh
Area	413 sq. km
No. of Wards	85
Population	19,22,130
Total Waste Generated	800 - 900 MT per day
Total Wet Waste Generated	500 MT per day
Total Dry Waste Generated	400 MT per day

The Bhopal is the capital of Madhya Pradesh and the administrative headquarters of Bhopal district and Bhopal division. The city was the capital of the former Bhopal State (British India). Bhopal is known as the City of Lakes for its various natural as well as artificial lakes and is also one of the greenest cities in India. Bhopal has come a long way in the last three decades, and has witnessed a major transformation in its urban development. Bhopal Municipal Corporation (BMC) is responsible for ensuring delivery of basic services like drinking water, sanitation, etc. using Clean Technologies, Cost Efficient Methods and other Smart initiatives.

Administratively, the city is divided into 19 zones, which are further divided into 85 wards. The city generates approximately 800-900 MT waste, of which 500 MT is wet waste and 400 MT is dry waste comprising of recyclable and non-recyclable waste. Domestic hazardous waste is less than 1%. In the year 2017 and 2018, Bhopal city was ranked 2nd in the Swachh Survekshan. In the year 2019, the city received the title of "Cleanest Capital / UT City".

Integrated Control Command Centre



Real time tracking of SWM vehicles

Under Smart City Mission; an Integrated Control and Command Centre (ICCC) has been developed in Bhopal. Through the ICCC end to end monitoring is being done as follows:

- Real time tracking of SWM vehicles
- To assess the mileage as well as service of demarcated area of respective vehicle
- Monitoring of Smart bins
- Grievance redressal system
- Monitoring of Garbage vulnerable points (GVP)

Door To Door Collection

Collection Vehicle

BMC and private NGO (Basix Municipal Waste Ventures) has been handling 100 % door to door waste collection and transportation in all the wards. Around 200-250 rag pickers have also been hired by the BMC on contractual basis to segregate and collect waste. Approximately, 4 lakh households are covered in the Door to Door Collection.Segregated waste is collected by tricycles and auto-tippers from the households, markets and other generators. The waste is transferred to the transfer stations at 6 no's locations.

BMC has also installed bins with capacities of 1.1 and 4.5 cu m. all across the city. There are a total of 1153 bins in the entire city of Bhopal. From bins, waste is transferred to fully mechanized waste transfer stations

where segregated waste is transferred to the processing facility through capsules (20MT capacity) of 2 different colours (green for wet waste and blue for dry waste). From commercial and institutional areas; the waste is collected in refuse compactors and dumpers and is sent to the respective processing facilities based on the type of the waste. The frequency of waste collection is at least once from the entire city and twice from the commercial and institutional areas including street sweeping waste collection at night.

Separate dustbin for Wet and Dry waste

A user fee of Rs 1 per day i.e. Rs 360 per annum per household has been fixed by BMC, and Rs 500 per month applicable for commercial areas less than 5000 sq. ft and Rs 1000/month for areas more than 5000 sq. ft.

Transfer Stations

There are 6 operational decentralised modernized waste transfer stations in the city. Each transfer station has 2-4 capsules depending on the size of the transfer station. The waste from transfer stations is transferred to waste processing sites depending upon the type of waste. The wet waste goes to the Biomethanation plant and dry waste goes to recycling unit. The transfer station at Bhadbhada has an area of 1 acre (approximately) with a capacity of 100 MT per day. The site has two capsules each for dry and wet waste of 20 cum .Inbound commercial vehicles are first weighed at the weighbridge. Waste is weighed, and tipping fee is assessed as applicable.

Transfer Station and Capsule

Biomethanation Plant

Facility Highlights	
Land Ownership	Bhopal Municipal Corporation
Type	Decentralized
Type of input	Wet waste
Input Capacity	05 MT per day
Processing Capacity	05 MT per day
Total Manpower	5

Biomethanation plant at Bittan Market

There are 5 Biomethanation plants installed across the city for wet waste in a decentralised manner. Their capacity is in the range of 5 each.

One of the Biomethanation plant located in Bittan market, has a capacity of 5 TPD of wet waste. The waste is collected from the vegetable market and to produce biogas. From this biogas; BMC has generated electricity, which is being used in the vegetable market itself.

Centralized Composting Plant

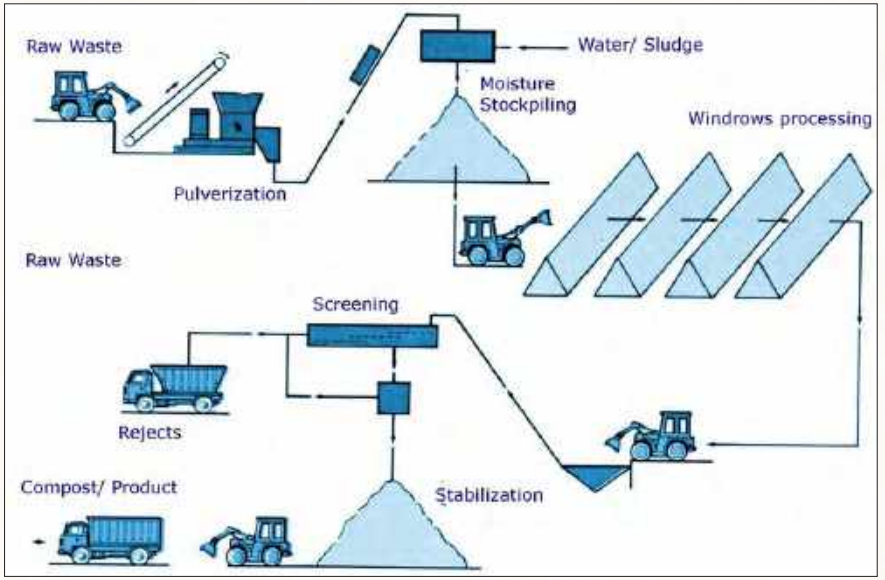
Facility Highlights	
Area	Approx. 10 Acres
Land Ownership,	Bhopal Municipal Corporation
Year of Establishment	2018
Type	Centralized
Type of input	Mixed waste
Input Capacity	300 MT per day
Total Manpower	100

A centralized compost plant is located at Adampur Chawani. The compost plant handles 300 MT of wet waste per day and has been operational since 2018.

The process of compost plant

Organic waste is formed into rows of long piles called "windrows" and aerated by turning the pile periodically by either manual or mechanical means. The height of pile is between 4 and 8 feet, it allows to generate sufficient heat and maintain temperatures, yet is small enough to allow oxygen to flow to the windrow's core.

Windrow Composting Process



Material Recovery Facility (MRF)

There are 3 MRFs in the city. Dry waste is segregated here manually into recyclables and non-recyclables. The decentralised material recovery facility is run by the NGO, Sarthak at Yaadgar-e-Shahjhani. The site is on an area of 300 sq.m with a capacity of 3 TPD of waste.

Facility Highlights	
Area	Approx. 300 Sqm
Land Ownership	Bhopal Municipal Corporation
Year of Establishment	2018
Type	Decentralized
Type of input	Dry
Input Capacity	3 MT per day
Processing Capacity	3 MT per day
Total Manpower	8

The main function of this MRF is to maximize the quantity of recyclables processed, while producing materials that will generate the highest possible revenues in the market. MRFs can also function to process wastes into feedstock for biological conversion or into a fuel source for the production of energy. They serve as an intermediate processing step between the collection of recyclable materials from waste generators and the sale of recyclable materials to markets for use in making new products. There are basically four components of an MRF facility: sorting, processing, storage, and load-out.

Fatka machine and Granular machine

Bailing unit, Fatka machine and granular machine

Plastic Waste Management Facility

Facility Highlights	
Area	Approx. 1.0 Acres
Land ownership	Bhopal Municipal Corporation
Owner of the facility	Sarthak
Year of establishment	2018
Type	Decentralized
Type of input	Dry waste
Input capacity	07 MT per day
Processing capacity	07 MT per day
Total manpower	10

The decentralised plastic waste facility, handled by NGO Sarthak, is located at Bhanpura. The plastic waste facility was initiated in the year 2018 and has a capacity of 15 TPD. It is on an area of 1 acre. This facility

recycles dry waste. Plastic recycling refers to the process of recovering waste or scrap plastic and reprocessing the materials into functional and useful products A bailing machine is used to compress and cut the waste. A fatka machine is used to remove any particle left in the plastic waste before processing in the granular machine. The granular machine makes granules of plastic waste for recycling purposes. The granules of plastic waste are then supplied to vendors who make plastic products.

Currently, only PET, HDPE, and PVC plastic products are recycled under curb side recycling programs. PS, PP, and LDPE typically are not recycled because these plastic materials get stuck in the sorting equipment in the recycling facilities causing it to break or stop. Lids and bottle tops cannot be recycled as well. Some plastic types are not recycled because they are not economically feasible to do so. The simplest of plastic recycling processes involves collecting, sorting, shredding, washing, melting, and pelletizing. The actual particular processes vary based on plastic resin or type of plastic product.

Type of Plastic	Examples
PS (Polystyrene)	Foam hot drink cups, plastic cutlery, containers, and yogurt.
PP (Polypropylene)	Lunch boxes, take-out food containers, ice cream containers.
LDPE (Low-density polyethylene)	Garbage bins and bags
PVC (Plasticised Polyvinyl chloride or polyvinyl chloride)	Cordial, juice or squeeze bottles
HDPE (High-density polyethylene)	Shampoo containers or milk bottles.
PET (Polyethylene terephthalate)	Fruit juice and soft drink bottles.

Most plastic recycling facilities use the following two-step process:

Step One: Sorting plastics automatically or with a manual sort to make sure all the contaminants are removed from the plastic waste stream.

Step Two: Melting down plastics directly into a new shape or shredding into flakes then melting down before being finally processed into granulate.

Bioremediations and Closure – Bhanpura

An old dumpsite at Bhanpura, Bhopal was an unscientific designated dumping ground. It was located near residential settlements and agricultural areas. The dump site had been a potential threat to the environment due to uncontrolled release of leachate, landfill gas and other environmental pollutants. It had been accumulating waste of the Bhopal city beyond its capacity since the last 35 years. Finally, it was abandoned in January 2018 due to orders from NGT.

Windrow formation

The objective of the bio-remediation and scientifically closure of the abandoned dump site at Bhanpura is to reclaim a parcel of the land from the existing foot print of the dump by shifting, compaction and profiling of MSW by scientific closure within a land of reduced foot print area with bio-remediation and processing of remaining waste to recover bio degradable waste and RDF material.

Separation of recyclables from dumpsite

Satellite image of Bioremediation site

Features of Bhanpura Landfill closure site:

- **Land Reclamation:** The ULB is using the reclaimed land from the dumpsite for setting up new facilities or any other suitable commercial activity within the purview of applicable rules and regulations of Government of India
- **Environmental benefits:** Control on further contamination of soil and ground water due to generation and percolation of leachate during rainy season & release of methane (landfill gas) into the atmosphere.
- **Odour & Health problems:** Controlling of odour and health problems by covering the accumulated waste with a liner.
- **Property value:** Once properly capped and covered with green top, the adverse impact on the property value around the existing dumpsite can be reversed.

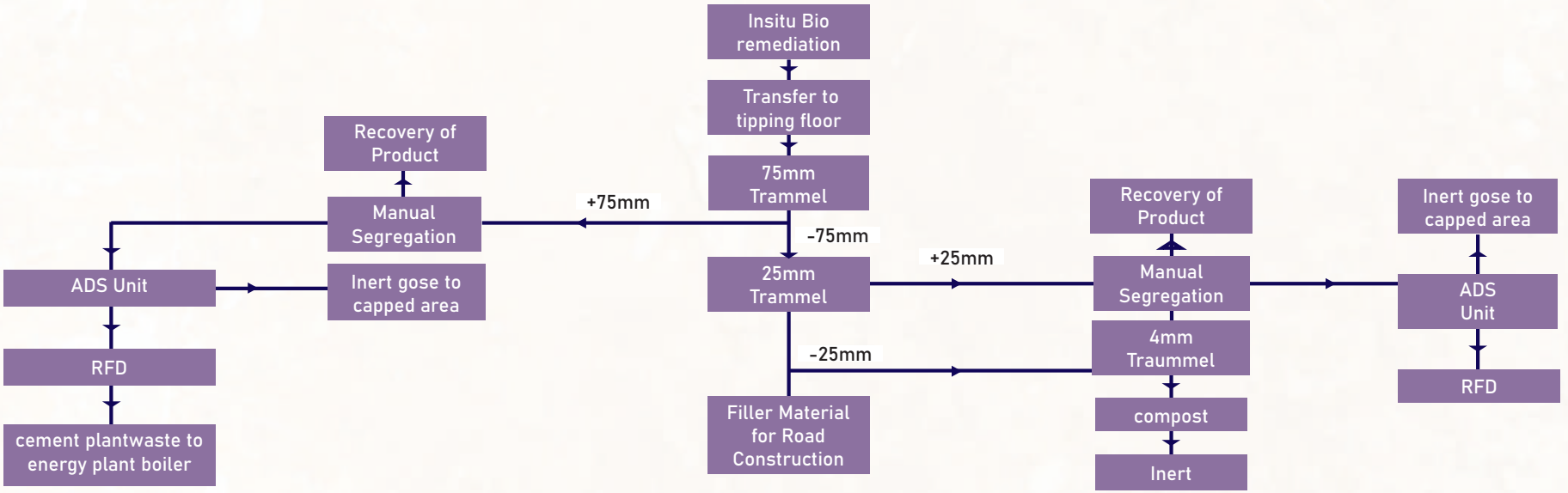
A concessionaire was appointed in January 2018 to reclaim 21acres of land out of the 36.9 acres through bioremediation activity scientific closure within 3 years. The bio remediation plant is of capacity 600 TPD.

Bhanpura Dumpsite is undergoing the following process:

- Bioremediation / Bio mining and reclamation of land
- Closure of Dumpsite
- Post Closure environment plan

The process of Bio remediation and Bio mining is shown in the chart below:

Process flow diagram of Bio remediation



Scientific Landfill – Adampur Chawani

The city of Bhopal disposes off its waste scientifically at the waste disposal facility located in Adampur Chawani. After processing of the waste, rejects are disposed in the landfill site. The site is of 45 acres approximately. The site has been operational for the last 2 years. Initially it was constructed for a period of 5 years. In the last 2 years; capacity cells were constructed that has been filled to its capacity.

To Know More:

Name of the Organization: Bhopal Municipal Corporation
Email: commoffice@bmconline.gov.in
Website: www.bhopalmunicipal.com
Contact Number: 91-755-2701222

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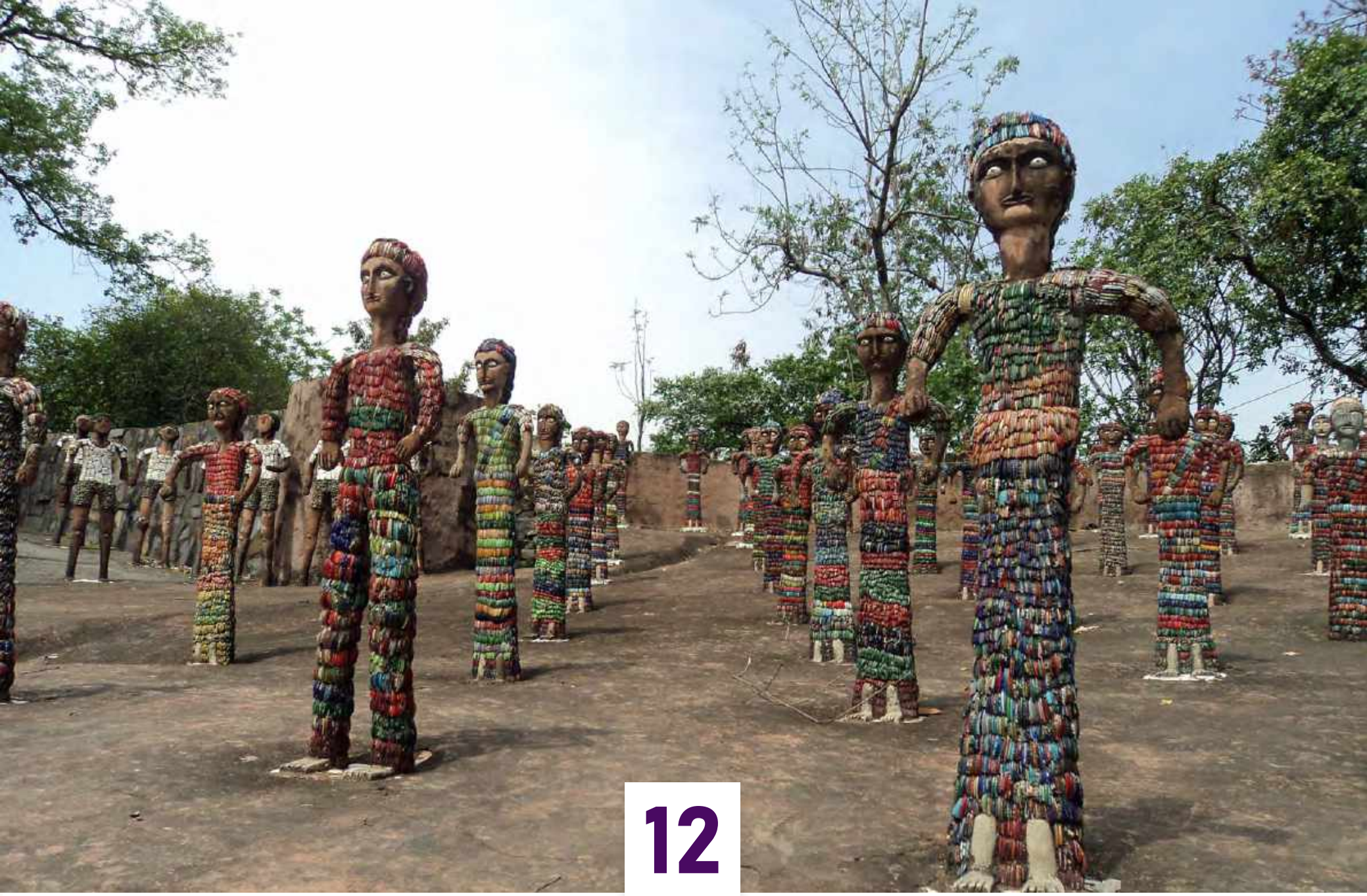


12

CHANDIGARH

Chandigarh

Snapshot: Chandigarh Municipal Corporation

State	Chandigarh
Area	114 sq. km
No. of Wards	26
Population	10,55,450
Total Waste Generated	425 MT per day

The Union Territory of Chandigarh is located in the foothills of the Shivalik hill ranges in the north, which form a part of the fragile Himalayan ecosystem.Chandigarh, the dream city of India's first Prime Minister, Sh. Jawahar Lal Nehru, was planned by the famous French architect Le Corbusier. Chandigarh is the one of the earliest planned cities in post-independence India and is one of the best-planned city in India. It is known for its architecture, urban design, and a quality of life, which is unparalleled. As the capital of the states of Punjab and Haryana, and the Union Territory of Chandigarh holds a prestigious place among the capital cities of India. Chandigarh derives its name from the temple of "Chandi Mandir" located in the vicinity of the city. The deity 'Chandi', the goddess of power and a fort of 'garh' laying beyond the temple gave the city its name "Chandigarh -The City Beautiful".

Chandigarh used to be the capital of Punjab till 1966. Once Haryana was carved out of Punjab as a new State; both Punjab and Haryana claimed the new city for its capital. Hence, it became a Union Territory as it is not a part of either of the states.

The Municipal Corporation of Chandigarh (MCC), India was formed within the Union Territory of Chandigarh under the Punjab Municipal Corporation Act in 1976. The corporation was later extended to the union territory, Chandigarh, by the Punjab Municipal Corporation Law (Extension to Chandigarh) Act, 1994.

Solid Waste Management in Chandigarh comes under the purview of the Municipal Corporation Chandigarh. Chandigarh today generates 425 MT per day of garbage a day and has an effective door to door waste collection system to address this waste. Out of the total waste generated 50%-55% comprises mainly compostable organics, 15%-20% inorganic waste and 25%-35% of the waste consists of inert waste.

Roads and community spaces of all the residential as well as commercial areas are clean as they are swept twice daily. The city has its own mechanism in place to manage Construction and Demolition(C&D) waste as per C&D Waste Management Rules, 2016. A cradle-to-grave approach has been adopted by the ULB for proper management of C&D waste.

Nearly 100% of the operational cost of sanitation and SWM is covered by property tax, user charges and advertisement rights on Community toilets/Public toilets and litter bins. The city has an integrated waste processing facility where the wet and dry waste are treated.

Segregation, Collection and Transportation

Chandigarh city ensures 100% door to door garbage collection from all the households. The city has achieved approximately 95% segregation of waste at source from both residential and commercial areas. Primary collection of the waste is done directly from households, institutions and other commercial establishments by tricycles and mechanized small vehicles. In Chandigarh, the Corporation has constructed buildings called Sehaj Safai Kendra's (SSKs) as primary collection centers.

Facility Highlights	
Wards covered	26
Total number of Sehaj Safai Kendra's	38
Waste received	1.8-2.7 MT per day per SSK
Manpower	114 for all 38 SSKs
CAPEX	1,90,00,000 for all 38 SSKs
OPEX	1,90,000-2,00,000 per month for all 38 SSKs

At present, there are 38 SSKs operational at various places in the city. Small, compact sized waste collection bins are placed inside the SSKs, where the Safai Karmis manually segregate the waste, which is not segregated at source or which is to be further segregated. The SSKs are basic, low cost units that do not require any heavy equipment or machinery for their functioning.

Sehaj Safai Kendra

The waste from various dustbins and SSKs is transported to either the waste processing plant or the landfill site by vehicles owned by the Municipal Corporation or hired from private bodies. A total of 133 conservancy vehicles are deployed for collecting and transporting the solid waste generated by the city.

Key Highlights

- ✓ The SSKs help in managing the waste within the community in a hygienic way.
- ✓ These also give the administration an opportunity to integrate the waste pickers into the system and make them part of the formal economy.

Processing and Disposal

Part of the solid waste in Chandigarh is processed at the Green Tech Fuel Processing Plant (A unit of Jaiprakash Associates Ltd.) located near the designated landfill site at Dadu Majra village. The organic, bio- degradable waste is processed to manufacture compost, while inorganic, combustible waste with high calorific value is segregated as Refused Derived Fuel (RDF). Part of the solid waste is treated in their Bio-methanation plant. However, the fraction of such waste being processed at the Bio-methanation plant is negligible compared to the total waste generated in the city.

Collection Vehicles

Dumping Ground at Dadu Majra

In Chandigarh, as processing is limited to the recorded amount of 250 MT per day, most of the MSW collected is directly dumped at the landfill site at Dadu Majra.

Integrated Solid Waste Management Facility

The Integrated SWM facility is located near the landfill site at Dadu Majra. The facility is spread over 11 acres out of which 5.5 acres is for the RDF plant and the other 5.5 acres for the composting facility. The facility was built on a PPP model between MCC and Green Tech Fuel Processing Plant. Green Tech is responsible for the complete processing of the waste sourced from the corporation, manufacturing compost and deriving the refuse derived fuel from it. The Total Capital expenditure of the facility is approximately 7.5 crore and the total operational expenditure is 3.5 lakh per month.

Trommel

Compost

Compost Packaging

Model of the plant

The Refuse-Derived Fuel (RDF) obtained from the plant has a calorific value of 3100 Kcal/Kg, while the moisture content is less than 15%.

The plant has installed state-of-the-art European technology, which is customized keeping in view the characteristics of Indian solid waste and its composition. The various processes involved at the RDF facility are depicted in the diagram below:

Apart from RDF, the facility also produces good quality compost through the process of aerobic composting. After maturation, waste is processed in 35 mm trommel followed by the 16 mm trommel. The rejected inorganic waste from both the trommels is transferred to the Secured Landfill (SLF), while organic waste is again transferred to windrows for further decomposition.

After the final quality testing, the produced compost is packaged into bags and sold at approximately Rs. 150 per ton.

Key Highlights

- ✓ The efficiency in collection and transportation of waste to the facility becomes a major challenge.

Process involved in the RDF facility

UNLOADING AND MANUAL SEPARATION → The tipper trucks are weighed at the weighbridge and then are loaded on the tipping floor.

HOMOGENIZATION → The particle size of waste varies widely and is difficult to process unless particle size is homogenized.

SIZE REDUCTION → A primary shredder is used to cut down the waste to less than 150 mm. After size reduction, the output proceeds towards further processing

DRYING → The waste is fed in to a Rotary Dryer by conveyer. The wet waste is dried by injecting hot air in to it. This reduces its moisture content to 15%.

SEGREGATION → The matter coming out of the Rotary Dryer is fed into the Rotary Trommel. Fine particles below 10 mm particle size are separated.

DENSIFICATION → RDF-pellets are produced by densifying the fluff in the "Special Purpose Densification Unit". The bulk density of RDF-Fluff is reduced by minimum of 5 times.

Construction & Demolition Waste Processing Facility

Chandigarh city is reusing the C&D waste, which is collected from 23 designated sites for disposal. A C&D waste processing facility has been set up over 2.5 acres of land. The site is located in the Industrial area phase-1, which was earlier used for waste disposal in the year 2016-17. Besides the processing unit, the plant also has a manufacturing unit producing Plain Concrete Cement (PCC) products to be used for pavements, road work, fencing work, etc.

Facility Highlights	
Capacity of the facility	45-55 MT per day
Area of the facility	2.5 Acres
CAPEX	Rs. 3 Cr
OPEX	Rs 200 TPD for processing the waste and Rs 200 TPD for collection of waste
Products obtained	Plain Concrete Cement (PCC) products
Manpower	25

Concrete mix is poured into the frames and left to set

The Concrete tiles are put in pond for curing

The plant has a processing capacity of 45-55 MT per day, however the corporation is currently in the process of further enhancing the plant and its processing capacity.

Key Highlights

- ✓ The corporation is currently in the process of further enhancing the plant and its processing capacity.
- ✓ Besides manufacturing many value added products like concrete blocks, such as kerb channels, PCC tiles etc., the project has also helped generate employment opportunities for many.

The process followed at the C &D facility is depicted in the diagram below

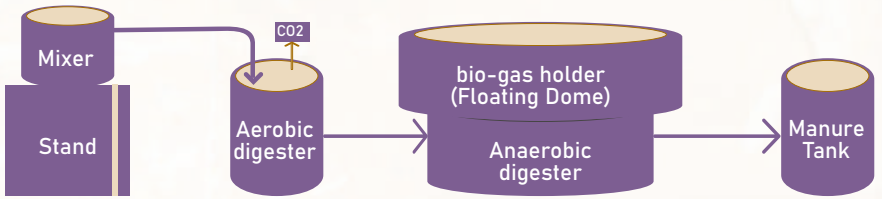
C&D waste Recycling Process

Collected waste is brought to the facility → Waste is segregated and crushed into smaller fractions → Dirt and other impurities are eliminated through washing → Waste is then mixed with sand, cement and water → Mixture is poured into frames and cured → Products manufactured: Concrete blocks, kerb channels, PCC tiles, etc.

Bio-Methanation-Cum-Electricity Generation Plant

Bio-Methanation-Cum Electricity Generation Plant

Schematic Bio-Methanation Plant Layout.



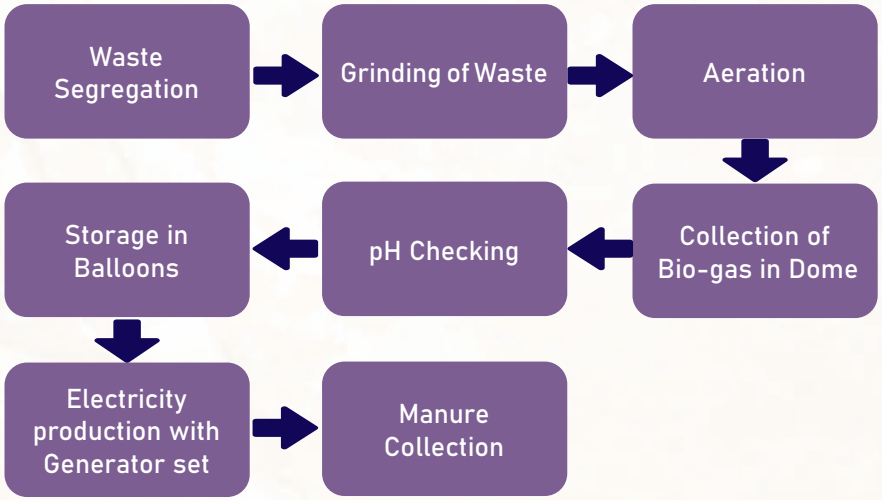
The Bio-Methanation-Cum-Electricity Generation Plant is located in the Industrial area, Phase-1 of Chandigarh. The plant was established by MCC, whereas the designing and execution was done by Avi Plast Garbage Treatment Projects, Mumbai. The project was commissioned in November, 2015 and inaugurated in November, 2016. The total area of this facility is 150x150 feet and processing area is 450 sq. ft. The plant has a daily intake capacity of 4.5MT per day of organic municipal garbage that comprises kitchen waste, paper, grass, gobar (cow dung), dry leaves etc.

Facility Highlights	
Total Capacity	4.5 MT per day
Processing Capacity	3.2 MT per day
Technology used	NISARGRUNA' Technology developed by Bhabha Atomic Research Centre (BARC)
CAPEX	Rs 96 Lakh (16 lakh Rs for 0.9 MT per day capacity)
OPEX	Approx. Rs. 1.6 Lakh per month
Products obtained	Biogas and weed free good quality manure
Manpower	5

NISARGRUNA technology offers a "Zero garbage, Zero effluent" method for waste management. Unlike conventional bio-gas plants that can handle only cow dung and/or human waste, BARC's NISARGRUNA technology has the capability to process almost any biodegradable waste, such as kitchen waste, paper, grass, cow dung, dry leaves etc. This makes, such bio-gas plants a good potential for energy generation in this biphasic-bio- methanation plant

The gas is used to generate electricity with the help of a generator set. The electricity so obtained is used to light the street lamps. Proper record of the materials taken in to the plant from all the sources is maintained through a register.

The process followed at the Bio-Methanation-Cum-Electricity Generation Plant is depicted in the diagram below:



Source: Chandigarh Municipal Corporation

Key Highlights

- ✓ Generation of good amount of high-calorie fuelgas
- ✓ Generation of high-quality, weed-less manure, which is an excellent soilconditioner.

Decentralised Onsite Composting

Onsite composting is an initiative taken by MCC to deal primarily with the large volumes of garden waste that is generated at various parks, residential colonies, schools, institutions and similar places. The idea is to minimize dumping of such waste to the landfill and utilizing the same for producing compost at the place of generation. For this, a standard structure is built as composting pit with a steel wire mesh surrounding it. All the garden waste is put inside the pit layer upon layer and some water is sprinkled to facilitate decomposition. Once the pit is filled, it is left for composting. It takes about 60 days for this system to prepare compost.

Composting at Shanti Kunj Sector 16

Composting at Green Belt Sector 21

To Know More:

Name of the Organization: Chandigarh Municipal Corporation
Email: cemcmcc-chd@nic.in
Website: http://mcchandigarh.gov.in
Contact Number: +91-172-2541002

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13

BHUBANESWAR

Bhubaneswar

Snapshot: Bhubaneswar Municipal Corporation

State	Odisha
Area	135 in sq. km
No. of Wards	67
Population	8,37,737
Total Waste Generated	520 MT per day

Bhubaneshwar is capital of Odisha (Orissa) state in the eastern part of India.Its mass of well-preserved sandstone temples, all oriented around the sacred lake Bindusarowar, makes it one of the most impressive ancient temple sites in the whole of India. This helped Bhubaneshwar earn its reputation as Ekamra Kshetra (Temple City).

Bhubaneswar replaced Cuttack as the capital on 19 August 1949, 2 years after India gained its independence from Britain. The modern city was designed by the German architect Otto Königsberger in 1946. Along with Jamshedpur and Chandigarh, it was one of modern India's first planned cities. Bhubaneswar is an emerging information technology (IT) and education hub, and is one of the country's fastest-developing cities.

The Bhubaneswar Municipal Corporation (BMC) is responsible for oversees and managing the city's 67 wards. Bhubaneshwar is also one of the 100 Smart Cities of India.

Solid Waste Management in Bhubaneswar comes under the purview of the Health and Sanitation department. There is 100% door to door collection in Bhubaneswar. Out of the 67 wards in Bhubaneswar Municipal Corporation (BMC), 57 wards are grouped into four packages for the purpose of the solid waste management activities. Three private agencies under Public Private Partnership (PPP) mode are carrying out the entire SWM (Solid Waste Management) activities in the privatized 57 wards on daily basis, which includes door-to- door garbage collection, street sweeping, MSW (Municipal Solid Waste) transportation, drain cleaning, drain de-silting, conservancy cleaning and bush cutting. In the remaining 10 wards, BMC is carrying out the SWM activities. Tricycles are used for door-to-door garbage collection. About 3290 staff members are involved in the door-to-door waste collection. Segregation of waste at source is absent in the city.

Tipper, trucks, dumper placers or compactors transport the MSW collected from various parts of the city to Temporary Transfer Station (TTS). An area of 10.45 ha. near Sainik School is being used as the TTS where the collected wastes are weighed and recorded. The payment to the private agencies is done on a monthly basis based on quantity of waste collected and transported. All MSW collected at the TTS is transported by the private agency through tippers and heavy vehicles to the dump site located at Bhuasuni. The waste collected at land fill site are dumped and levelled in layers by BMC on a daily basis. There are no operational solid waste treatment plants in Bhubaneswar.

Implementation of online monitoring and tracking of MSW Management activities in BMC area under a PPP mode was taken up under Bhubaneswar Smart City Plan. Currently the BMC is tracking 65 vehicles as part of the project[1]. In the following section, certain good approaches and case studies in Bhubaneswar related to SWM are discussed.

Biomethanation at Kalinga Institute of Social Sciences (KISS) Campus

Facility Highlights	
Area	140 sq. m.
Processing Capacity	1 MT per day
Quantity of input	700 – 750 kg per day
Products obtained	Manure and Biogas
Quantity of biogas generated	70 – 75 cu m. per day

Biogas plant at Kalinga Institute of Social Sciences (KISS) Campus

Kalinga Institute of Industrial Technology (KIIT) University constitutes 21 campuses with 23 canteens and 4 cafeterias. Kalinga Institute of Social Sciences (KISS), located at Chandaka Industrial Estate is a sister concern

[1] *City Sanitation Plan for Bhubaneswar, CDD Society*

of KIIT University. It has setup a biogas plant within its premises in order to sustainably manage the food waste from the canteen.

The canteen provides food to 25,000 students and the food waste generated in the canteen is approximately 4 MT per day. The plant uses segregated food waste that are sorted and fed to the crusher/shredder along with a suitable quantity of water to form a slurry. The homogenized slurry from the inlet chamber is then fed into the anaerobic digester. The anaerobic digester is designed with baffles, which trap the suspended

Facility Highlights	
CAPEX	Rs. 10,00,000
OPEX	Rs. 35,000
Savings	Rs. 78,000 per month
Manpower	5

Solids and allow degradation of the waste. The digester has slow revolving scum breaking mechanisms that breakdown the scum. The liquid overflowing from the digester collected in the recycling chamber is partly used for slurry preparation at the sorting table and the remaining is discharged to the drains after suitable dilution. The sludge is periodically removed from the bottom of the digester and can be used as manure for horticultural purposes. The biogas generated from the anaerobic digester is collected in the bio-gas holder, pressurized and is used as a cooking fuel for the canteen.

Key Highlights

- ✓ The Institute has a daily saving of Rs. 4000 after installation of the biogas plant.
- ✓ The institute won the Energy Globe World Award 2017 for its green initiatives.

Vermicomposting at Nandankanan Zoological Gardens

Vermicomposting at Nandankanan Zoological Gardens

Nandankanan Zoological Park is a 400 ha zoo at Bhubaneswar that has established a vermicompost facility in the Fodder Farm area, around 2 kms away from the park. The compost unit contains 6 pits of 10 tons capacity each. The dimension of each pit is 8ft x 3ft. The waste that is fed to these pits comprises 2-3 tons of dry leaves from park, straw and animal dung. At first animal dung, dry leaves and grass are collected and dumped into the pit. Water is sprinkled on the waste for a period of 15 days. Partially decomposed wet waste is then transferred to the pits and forms a 2-3 inch deep layer. A layer of cow dung is then spread over the mixture. This process is repeated until a desired height of accumulated waste is achieved. After this, earthworms are introduced into the waste

pits to facilitate its further decomposition. The compost takes about 2 months to fully decompose and be ready for use.

Facility Highlights	
CAPEX	Rs. 5,00,000
OPEX	Rs. 6500 per month
Manpower	30 -35 people
Compost produced	1 MT per batch

It is then screened and packed to be used in nurseries and botanical gardens. A total of 30 to 35 people are required for the 2-month duration for operation and supervision.

Faecal Sludge and Septage Management (FSSM) Plant at Basuaghai

Faecal Sludge and Septage Management (FSSM) Plant at Basuaghai

The state government has taken steps to implement FSSM at Basuaghai in the outskirts of Bhubaneswar in order to treat and thereafter safely dispose or reuse the faecal waste. This is being covered under the AMRUT scheme. The treatment plant has a current capacity of 75 KLD and is designed such that it has capacity to handle faecal waste generated for next 7 years. The plant involves a series of treatment steps to first separate the liquids from the solids, and then treat both the liquid and solid streams while recovering as much of the energy or nutritive value as possible.

Facility Highlights	
CAPEX	Rs. 35,400,000
OPEX	Rs. 19,30,000
Manpower	8-10

Lily plantation at Basuaghai premis

The plant has an elevated unloading platform for trucks and tankers. Faecal sludge is emptied into a sludge receiving box of 1.5 m x 1.5 m x 3m. It goes into an inlet channel of 3m length. Screen bar is placed in the channel at an angle of 45˚. From the screens, influent goes to Settling-

Thickening tanks of size 14.5 m x 2.5 m x 2.55 m. Thickened sludge is taken out of tanks after a period of 10 days and the supernatant goes into Anaerobic Baffled Reactors (ABR) chambers. The Thickened Sludge is taken to sludge drying beds where they are kept till they are fully dried under direct sunlight. The supernatant is then kept in ABR for 2-3 days for anaerobic treatment. Effluent from ABR is then sent to the horizontal planted or unplanted gravel filter. Water from gravel filters is then taken to polishing pond and finally the treated water is used within the plant premises for landscaping.

Key Highlights

- ✓ A population of 2,20,000 has been covered by the project.
- ✓ Effluent is used within the plant premises for landscaping and growing lilies.
- ✓ The present capacity of 75 KLD is proposed to be expandable upto 150 KLD.
- ✓ green initiatives.

To Know More:

Bhubaneswar Municipal Corporation (BMC)
Vivekananda Marg, Near Kalpana Square,
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14

PANAJI

Panaji

Snapshot: Corporation of the City of Panaji (CCP)

State	Goa
Area	8.12 sq. km
No. of Wards	31
Population	69,790
Total Waste Generated	47 MT per day

Panaji (also known as Panjim) is the capital of the State of Goa and district North Goa. It is situated on the banks of the river "Mandovi", and is connected to the mainland by bridges. It lies in the southwestern coast of India within the Konkan region. It is the first city in India to be built on a planned grid system. It is not only the state capital, but also an educational, commercial and cultural center of Goa.

The Corporation of the City of Panaji (CCP) is the oldest civic institution in Asia. It is also the world's smallest municipal corporation, catering to the civic needs of Panaji. This city is the largest city of Goa, and situated in the northern part of the state. The Government of Goa has designated Imagine Panaji Smart City Development Limited (IPSCDL), a wholly owned Government Company and Special Purpose Vehicle (SPV) of the Government of Goa as the State Mission Directorate for AMRUT and

State Level Nodal Agency and the State Mission Management Unit for Smart Cities Mission.

Aerial view of SWM plant

Currently, the city is generating 47 MT of waste per day from 31 wards out of which wet waste is 18.19 MT and dry waste is 22.54 MT. There is 100% door to door collection coverage in the city. SFC Environmental Technology Pvt Ltd is an external Agency carrying out the task of door to door collection in all the wards and transportation to the integrated solid waste management facility.

Integrated Waste Management Facility, Saligao

The total capacity of this treatment plant is 100 MT with an area of 82 acres. This plant is based on (Organic Extrusion segregation technology) OREX technology and is first of its kind in India. The plant has three section Biomethanization, Composting and RDF. OREX is the most advanced, fully automated, extrusion press based technology and the most suited for the Mixed Municipal Solid Waste as generated in the cities having very high organic and moisture content. The technology uses a unique extrusion press process to segregate mixed garbage into a Wet and Dry fractions automatically without any manual intervention. The full plant is controlled and monitored via a SCADA system and CCTV Cameras.

Process involved in the plant

The waste is brought to the plant by the panchayat in trucks and is weighed before being unloaded in the tipping floor. The front loader then takes this waste into a chain conveyer, which carries it into the bag opener, wherein, the bags are automatically opened and the contents are carried by the conveyor to the mechanical roller screens, where large size recyclables are screened and transferred on the sorted line. The waste is then taken into various recyclables fractions. These fractions are bailed and stored in proper containers before being taken to the recyclers.

The under fraction of the roller screen is taken to OREX, which is Organic Extrusion Segregation Technology. This unit automatically segregates the mixed waste into dry waste into inorganic fraction and wet into organic fraction. The organic is extruded out of the mixed waste under a very high pressure in a pulp form. The pulp is then pumped in the dry thermophilic fermenter from where methane is extracted. The H2S is removed from the biogas by the chemical scrubbing process and the pure biogas is send to two engines with the potential to generate 7 mw/ hour and the excess biogas is flared off.

The digested sludge from the digester is taken to a screw press where it is dewatered, and the fiber is fed in the in-vessel composter that converts it into compost. The dry remains from the OREX is further taken by a permanent magnet to remove ferrous metal followed by a flip flow screen and a wind sifter for separating the grit and the RDF. The RDF is used for crook processing by the cement factories and the grit is being used for filling up the low-lying areas or dispose into scientific

Manual Sorting

In vessel composting drums, compost screens

Weigh Bridge Station

Sorting Station with bunkers to sort 15 fractions

Baler Press Machine

Roller screen followed by a sorting station to recover recyclables

Biomethanization plant

Sanitary Landfill cells

using microbes. Once the organic has been removed; the effluents is pumped into a reverse osmosis unit for removal of dissolved solid. The clean and treated permeant is then used for gardening, floor cleaning, flushing, and non-portable functions. All that remains at the end is the grit which is less than 10 per of the waste received, this is put into the scientific landfill that is built and lined by bentonite HDPE and geotextiles covers.

Products generated at facility

Recycling materials: 5% to 8% comprises of paper, plastics, PET bottles, Glass, Metals, Wood, Coconut, AL cans, Tetra pack

- Compost: upto 20% used as fertilizer in agriculture
- Electricity: upto 1 MWH per 100 tons used in house
- RDF upto 15 % used as an alternative fuel
- Reduced inerts to landfill by (10 to 15%)

To Know More:

Name of the Organization: Corporation of the City of Panjim
Email: commissioner@ccpgoa.com
Website: http://ccpgoa.com/home
Contact Number: 18002333948

References:

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https://www.goa.gov.in
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15

IMPHAL

Imphal

Snapshot: Imphal Municipal Corporation

State	Manipur
Area	28 sq. km
No. of Wards	27
Population	2,68,483
Total Waste Generated	120 MT per day

Imphal is capital of Manipur known for its scenic landscapes and greenery. The city is sur rounded by a moat. Imphal used to be the royal seat of the former Kingdom of Manipur. It still contains the ruins of Kangla Palace (also known as Kangla Fort). Imphal Municipal Corporation (IMC) is responsible for the development of Imphal town which is the headquarter of Imphal District of the state. IMC consists of 27 wards.

The Imphal Municipality generates 120 MT of waste per day. IMC has collaborated with 6 NGOs namely, centre for Research on Environmental Development (CRED), Workers' Union Manipur (WUM), Seven Security Force (SSF), TACDEF Solid Waste Management, Khaba Waste Management System (KWAMS), and Social Upliftment & Welfare Organization (SUWO) to carry out the management of municipal solid waste. The collected waste is taken to Lamdeng.

Collection Vehicles

Separate dust bins (for wet and dry waste)

Solid Waste Treatment Plant, Lamdeng

The Solid Waste Treatment Plant at Lamdeng, constructed by the Manipur Government has been upgraded from its "Waste to Compost" policy to "Waste to Compost and Energy". The treatment plant operates on Public Private Partnership (PPP) model, without any further investment from the State Government. Imphal Municipal Corporation dumps 120 MT of solid waste daily. Separation of dry and wet, biodegradable and non-biodegradable waste isnot done at source.

Facility Highlights	
Area of Facility	12 acre
Plant Capacity	120 MT per day
CAPEX	Rs. 41,75,00,000
Output	Bio-Compost and Electricity
Manpower	19

The plant gives output of 14 percent high-grade bio-composes daily. It also generates 2MW power with the process of thermal gasifier. The responsibilities of the operation, upgradation, and maintenance of the plant on PPP mode has been given to Eco Care Pvt. Ltd, a private agency based in Ahmedabad. The end product of bio compost is being outsourced to one private firm, A1 Agro Company and has been marketed under the brand name of Nongin Bio-Compost.

Windrow formation

Conveyer belt

Final Compost

16 mm trommel

Bio fuel pellets

Small bio fuel pellets

Plastic waste Recycling, Imphal

S. J. Plastic Industries started by Mr. Itombi Singh and Sadokpam Gunakata has established a successful operation of Plastic waste recycling programme in Imphal in the year 2007. The plant collects 2 MT of plastic waste from the city with the help of small enterprises. The industry pays Rs. 8 per kg for collection and segregation of plastics into different categories. Out of the 120 categories of plastic waste, 30 categories are directly recycled across Manipur. The industry buys plastic waste at Rs. 8 per kg and sells the end product at Rs. 65 per kg to the wholesaler.

Waste plastics are segregated, cut in shredder, washed with water, dried and granulated for new product moulding to make end products such as flower pots, bins and pipes.

Manual segregated PET bottles

Segregated jar bottle cap

Segregated waste glass and electronic waste

Segregated LLDPE grade plastic

Segregated HDPE grade plastic

Shredder machine

Shredded plastic granuels

Plastic pellet making machine

Plastic pellets

Bailed plastic

Automatic Blow Moulding Machine

Finished product from recycled plastic

Innovative eco-friendly Pen, Chanu Associates

Chanu Associates is a Manipur-based start-up firm. A brainchild of a young and talented ecopreneur, Ngangom Monalisa Chanu; Chanu Associates, under the brand name 'Chanu' deals with a plethora of products that range from environment friendly pens with seeds, pencils, direct filling pens, paper bags, non-woven bags etc. Chanu Associates started its operation from 5th June, 2017.The venture started at a nominal investment of Rs. 20,000. Chanu envisions scaling new heights and avenues as an entrepreneur by production of environment friendly class 16 items.

The innovative eco-friendly pen, is a great alternative to plastic ballpoint pens, do not just address the plastic menace but also contain seeds that can grow into plant. Once the pen has been used up, it can be just planted into soil, the seed will sprout from the bottom of the Pen. These eco-friendly paper pens reduce plastic waste and also contribute in growing trees.

Once the ink of the pen gets over or the pencil is used up, it can be planted in 30 degree angle with sands. The capsule covered ultimately gets off and implanted seed get exposed to soil, moisture leading germination.

Demonstration of eco-friendly paper pencil

Pressing machine

Presently the startup produces 200-300 units and gets a profit of Rs. 50,000 per month. Recently, the firm was given loan by state government under Startup Conclave to upgrade machineries for a target of producing 3000-5000 units per day.

Production team of Chanu Associates

Ecofriendly Pens, Chanu Associates

Key Highlights

- ✓ Provide sustainable employment to at least a few unemployed job seekers from the region

To Know More:

Imphal Municipal Corporation
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Chanu Associates
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Call 087309 83897
Email: info@chanuenvi.com
Website: chanuenvi.com

16

DEHRADUN

Dehradun

Snapshot: Dehradun Nagar Nigam

State	Uttarakhand
Area	196 sq. km
No. of Wards	100
Population	5,69,578
Total Waste Generated	350 MT per day

Dehradun is the capital city of Uttarakhand as well as the District Headquarter and is the only corporation city in the state. The urbanization level in the state is highest in the vicinity, with 3 other major urban centres, Mussoorie, Hardwar and Rishikesh located within 30-50 Km range. Dehradun Nagar Nigam (DNN) along with other key agencies in the city and sub-region are responsible for the city's urban planning and urban management functions. Dehradun is also one of the cities enlisted under the Smart Cities Mission of India.

The city generates 350 MT of waste from its 100 wards. DNN carries out the Solid Waste Management activities in all the wards, which includes door to door collection, street sweeping, transportation of waste and drain cleaning. However, segregation of waste at source is lacking in the city. DNN has deployed vehicles; 75 tippers, 81 rickshaws and 4

compacters for door to door collection. Entire waste is processed in Integrated Solid Waste Management facility at Shishambara, which is 18 kms away from the city. For this entire process of SWM; 310 workers are involved and around Rs. 1 crore per month is spent on collection transportation.

Integrated Solid Waste Management Facility at Shishambara

The Integrated Solid Waste Management (ISWM) facility at Shishambara in Dehradun is currently operated by Ramky Enviro Engineers Ltd. DNN has developed a centralized processing plant and sanitary landfill for the entire city through an agreement with M/S Deshwal Waste Management Pvt. Ltd. (DWMPL) on 26th August, 2016. The total project cost is Rs 36 crore and the plant is spread over an area of 8.32 hectares including the composting plant RDF processing unit, leachate management system through Solar Evaporation Pond (SEP), Leachate Treatment Plant (LTP) and Sanitary Landfill Site (SLF). The capital grant from DNN is Rs. 21.97 crore. The plant has a capacity of 600 MT per day, and is operated in two shifts (8 hours each) with 55 manpower. At present, the plant is processing 350 MT of waste per day. This plant has been operational since December 2017. This facility is India's first fully covered mechanized aerobic windrow system technology based plant, covering an area of 1.40 hectares.

Facility highlights	
Total plant capacity	600 MT per day
CAPEX	Rs. 36 crore
OPEX	Rs 3500-4000 per MT
Current operational capacity	350 MT per day
Total area of ISWM facility	8.32 hectares
Total area of composting plant	3.40 hectares
Total area of sanitary landfill	1.40 hectares
Processing area	1.20 hectares
Manpower	50-55

1. Refuse Derived Fuel (RDF) Plant

The collected waste is passed through the pre-sorting section with 75 mm trommel. The 75 mm above recyclable material is segregated and stored.

2. Composting Plant

The compost plant comprises of waste receiving area and aeration bays chamber (windrows), where the sorted waste (less than 75mm) is dried through aeration system for preparation of compost.

In this plant almost 18 MT of compost is produced. The compost prepared in the plant is tested as per FCO 1985 Schedule IV specifications. Other than that, this plant has its own laboratory where testing is done on all the parameters such as NPK content, pH, moisture, all heavy metals etc.

3. Sanitary Landfill

The Sanitary Landfill (SLF) site covers an area of 1.4 hectares and has a capacity of 50 MT. It has been designed and constructed for the safe disposal of inert and final disposal of rejects from the treatment plant. The SLF comprises a geo-membrane (layer of Geo-Synthetic Clay Liner, HDPE Liner, Filter Media, and Geotextile) which prevents contamination of leachate in to the ground water.

Transferring waste in trommel

Presorting Unit

Compost yard

Solar Evaporation Pond

Leachate Treatment Plant

Sanitary Landfill

In-house laboratory

Laboratory testing equipment's

Process flowchart of ISWM

Stages followed in Integrated Solid Waste Management facility, Shishambara

Inward solid waste

↓

Unit I Weighting Bridge
Waste weighment and record for inventory

↓

Unit II Tipping floor
Unloading at tipping floor

↓

Unit III Presorting unit
Waste is presorted through 75mm trommel → **Storage unit**
Refuse derived fuel (RDF) and recyclables is stored in this unit

↓

Unit IV Windrow and Curing unit
Fermentation at mechanized aerobic windrow for 28 days

↓

Unit V Coarse segregation unit
Processing through 25mm trommel after 28 days → >25mm trommel screened RDF stored in storage unit

↓

Unit VI Refinement unit
< 25mm trommel screened material processing through 4mm trommel → < 25mm and >4mm trommel inserts and rejects dispose to sanitary landfill

↓

Unit VII Packaging unit
< 4mm fine screened compost

Solid Waste Management Facility, Nathuawala, Ward 100, (Sanitation Park)

Facility highlights	
Name of the facility	Sanitation Park
Location	Nathuawala, Ward 100, Dehradun
Area (in sq. m.)	2790
Land ownership	Dehradun Municipal Corporation (On Lease)
Owner of the facility	Dehradun Municipal Corporation
Implementing agency	Feedback Foundation Charitable Trust (FFCT)
Year of establishment	2019
Type	Decentralized
Type of input	Segregated waste (in 4-categories: Wet, Dry, Hazardous & Domestic Bio-medical)
Feeding capacity (per day in MT)	5
Processing capacity (per day in MT)	2.5
Total manpower	20
Capita investment	INR 30 Lakh
Opex	INR 5 Lakh/ Month (Including Manpower cost and Material)
Expected revenue generation (from sale of compost, recyclable dry waste)	INR 5.5 Lakh/ Month

Ward Profile	
Name of the Ward	Nathuawala, Ward 100, Nagar Nigam, Dehradun
State	Uttarakhand
Area (in)	30 sq. km.
No. of Slums	Nil
Population	13,000
Domestic waste generators	3029
Commercial waste generators	262
Institutional waste generators	11
Total Waste Generated	2.5 MT




Integrated Decentralized Solid Waste Management Facility, Nathuawala, Ward 100, Dehradun

This is a pilot project managed through PPP model by DNN and Feedback Foundation Charitable Trust (FFCT). The model is themed around the 'No Open Waste' [NOW] approach with the following objective.

- To create Nathuawala, Ward 100 as 'No Open Waste' through citizen's initiatives and technical support from Dehradun Municipal Corporation.
- To create a demonstrable and scalable integrated, decentralised SWM Model for wider replication across the state.

Collection of waste is carried out daily during 8.00 am to 12.00 noon from domestic households and from 12.00 noon – 1.00 pm from commercial & institutional establishments in the ward. During collection of waste, team

sensitize the households to avoid mixing of waste. The ward is divided into 6 clusters. Each cluster is having around 500 households. Daily customised 1 tri-cycles and 6 TATA Aces' are used for transportation of waste from various lanes to the sanitation park. 12 Swacchta Sainik and 4 cluster co-ordinators are deployed. Collection of waste is carried out in all days but dry recyclable is collected on Sunday.

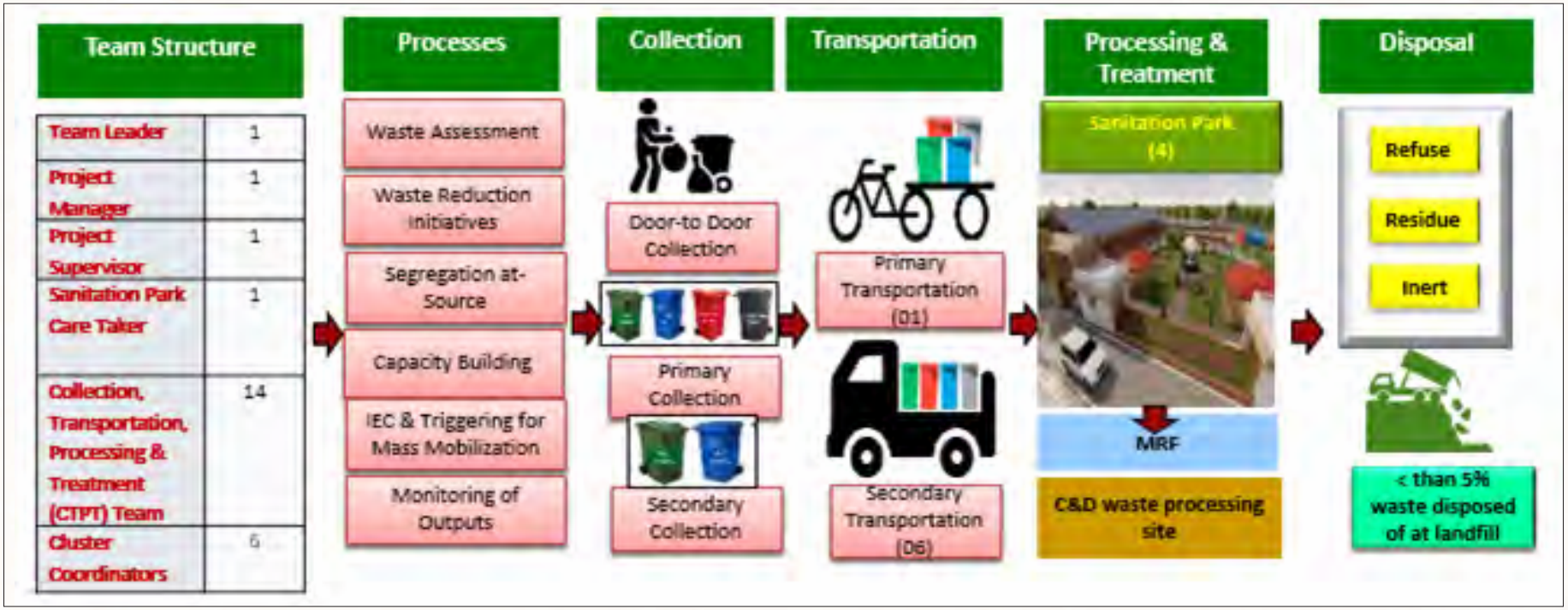
Almost 80 percent of waste generators in the ward practice segregation of waste in four categories- wet, dry, hazardous and domestic bio-medical waste. The team of motivators and cluster co-ordinators conduct regular triggering and sensitization sessions in the ward to motivate and encourage the citizens to segregate their waste.

Design of Solid Waste Management Facility, Nathuawala, Ward 100, Dehradun

A few salient features of Solid Waste Management model at Nathuawala

- Every day, before leaving for door to door collection, CTPT teams are briefed at the Sanitation Park.
- During briefing CTPT teams usually share their experiences, challenges (if any) of their allotted areas in the ward. Also strategy for households not segregating their waste is discussed.
- Churning of compost is carried out at regular interval at the Sanitation

Operating model of the Solid Waste Management Facility, Nathuawala, Ward 100, Dehradun



Park.

- For elevating compost quality, curing is carried out.
- Dry waste collected during door-to-door collections are further sorted into 28 different types.
- Weighing of dry waste after unloading at Sanitation park
- The sorted dry recyclables are kept in different chambers inside the Sanitation Park.
- Daily cleaning of vehicles used for collection of garbage by the team at the Sanitation Park.
- Daily cleaning in and around the Sanitation Park is carried out by all the CTPT team.
- Clean up drive carried out in the ward to sensitize the citizen about cleanliness.
- 50% of the space is green belt, where there is children playground and other recreational space available

Morning briefing at Sanitation Park

Processing of compost at Sanitation

Processing & Treatment Zones in Sanitation Park

The park will ensure third and fourth level segregation, sorting, resource recovery, storage, processing, treatment and safe disposal of more than 95% of waste collected from the focused decentralized level waste generators. A typical sanitation park has 8 processing & treatment zones.

- Composting zone (kitchen and garden waste)
- Recyclables zone
- Dry but non-recyclables zone
- E-waste zone
- Domestic hazardous waste zone
- Domestic Bio-medical waste zone
- Value-added products zone
- C&D waste zone

Composting zone (kitchen and garden waste)

Dry recyclable zone

Hazardous waste zone

Bio-medical waste zone

Information, Education and Communication (IEC) activities

Triggering and Swachhta rallies were carried out in the ward. Students were sensitized about the importance of segregation of waste at source and the benefits of it. Demonstration was made to show how to put four waste. During rally, various messaged related to Swachhta, segregation of waste at source, and environmental protection were cited by the students.

Triggering activities

Swachhta rallies

Clean-up drive

Clean up drive are carried out in the ward to sensitize the citizen about cleanliness.

Composting zone (kitchen and garden waste)

Visits for experiential learning

The Solid Waste Management model at Nathuawala is frequently visited by the ULB officials of Uttarakhand and other states of India, policy makers, Minsters, institutions, schools, colleges, local citizen groups, corporate, NGOs, media, NEWS agencies.

Cross-visits for experiential learning

Waste Management Facility at IAS Officers' Colony, Tehri House, Rajpur Road, Dehradun

Name of Gated Community	IAS Officers' Colony, Tehri House Rajpur Road, Dehradun
State	Uttarakhand
Area in (sq. km.)	
Total Waste Generators	200
Domestic waste generators	40
Total Waste Generated	200 Kg.
Wet waste	Approx. 60 Kilograms
Dry waste	Approx. 30 Kilograms
Hazardous waste	Approx. 2-3 Kilograms
Domestic bio-medical waste	Approx. 5-6 Kilograms
Inert	Approx. 1-2 Kilograms
Garden waste	Approx. 100 Kilograms

Following the success of the Nathuawala, Ward 100, Integrated Decentralised Solid Waste Management model, a small scale Sanitation Park has been developed. The IAS Officers' Colony, Tehri House, Rajpur Road, Dehradun is a gated community, where 40 families of IAS officers reside. It has a population of close to 200 and the daily generation of waste is approximately 100 kilograms. Of this, almost 50% is wet waste, 40% is dry waste and the hazardous and domestic bio-medical waste constitute 7% and 3% respectively.

Compost pits at IAS Officers' Colony, Tehri House

Sorted dry waste at IAS Officers' Colony, Tehri House

Facility Highlights	
Location	IAS Officers' Colony, Tehri House, Rajpur Road, Dehradun
Area (in sq. m.)	90
Land ownership	Dehradun Municipal Corporation
Owner of the facility	Dehradun Municipal Corporation
Implementing agency	Feedback Foundation Charitable Trust (FFCT)
Year of establishment	2019
Type	Decentralized
Type of input	Segregated waste
Feeding capacity (MT/day)	1
Processing capacity (MT/day)	0.10
Total manpower	2
Vehicles used	1 partitioned Tricycle
Capital investment	INR 3 Lakh
Opex	INR 15 Thousands/Month (Including Manpower and Material)
Expected revenue generation (from sale of compost, recyclable dry waste)	INR 20 Thousands/Month

The collection of waste from the residential quarters is done from 8:00-10:30. The waste generators practice segregation of waste in four categories; wet, dry, hazardous and domestic bio-medical waste. The wet waste is processed and put for composting in pits and the segregated dry waste is further sorted in to 7 categories.

Initiatives taken by Local NGO: Waste Warriors

Composting Enclosures

Mesh Pit

Composting Agent

Awareness through posters

Waste Warriors was founded by Jodie Underhill and Tashi Pareek in the year 2011. It is a non-profit organization and is registered under Societies Registration Act committed to tackling India's garbage problem. They started the campaign from their native place Dehradun through community clean-up drives, educational programs and creation of affordable and sustainable waste management system. Waste Warriors have prepared several composting enclosures across the city parks, where dry leaves are being used to make compost. Horticulture waste collected from all the parks of Dehradun is brought to Gandhi Park where 10 pits have been constructed to carry out composting. The total garden waste from all these parks (including Gandhi Park) amounts to 3200 kg per month. About 600 - 650 kg of compost is generated from these pits every month. One batch of compost takes around 45 days to get ready, which is then sieved and packed for sale. Once they are constructed; one supervisor personnel is required for monitoring and supervision of these pits . The capital expenditure includes cost of wooden poles, wire mesh, bamboo and paints for construction of the pits, which amounts to around Rs. 2200 per mesh pit. The operational expenditure is around Rs. 2000 per month that includes maintenance of the civil structures as well as payment of salaries to the supervisors. The compost thus produced is sold at Rs. 15 per kg to the residents, schools and other institutions. This compost is also available online.

Facility highlights	
CAPEX	Rs. 2200 per mesh pit
OPEX	Rs, 2000 per month
Manpower	2
Compost produced	600 – 650 kg

Key Highlights

- ✓ Economical model because the capital, operational and maintenance cost is too low.
- ✓ This organic compost is sold at Rs 15 per kg

Decentralized composting at Madhuban Hotel, Rajpur Road

Madhuban Hotel in Dehradun is one of the best luxury hotels in the city with an area of 4.4 hectares. This hotel has 107 guest rooms, four conference rooms and board rooms, amongst large stretches of lush green vegetation that includes gardens and lawn areas. The hotel has adopted decentralized composting from food waste within its premises. For this, they use the Quick Compost Machine from Alfa Therm Ltd. It is capable of converting food waste into compost in just 24 hours. The machine has a capacity to process 200 kg of wet waste per day and there is no necessity for a separate curing system in this composting method. The area occupied by the facility is around 24 sq. m.

The food waste is mixed with dry organic waste like garden waste in the ratio of 70:30 (70% food waste and 30% dry garden waste) and certain decomposing agents. Finally, the mix is put into the composter. The

composter converts the matter into compost in 24 hours. The most important aspect of this composter is that it is automatic and runs on 24x7 mode. The compost generated in this process is used in the hotel's gardens. This has helped the hotel authorities in completely cutting down the expenses that were earlier made on purchasing fertilizers.

Facility highlights	
CAPEX	Rs 9,75,000
OPEX	Operated by hotel
Revenue Generated	Manure used in horticulture
Manpower	1

The hotel generates 125 to 130 kg of food waste on a daily basis that amounts to 18 to 20 kg of compost, which is more than sufficient to meet the compost requirement of the gardens and lawns present in the hotel premises. The capital expenditure of the facility is Rs. 9, 75,000. Only one person has been employed from amongst the existing employees of the hotel for the supervision of the machine. The operational expenses include the electricity charges incurred for running the facility. Hence there are no operational expenditures incurred in this project.

Key Highlights

- ✓ As a token appreciation for their efforts in promoting eco-friendly tourism, Madhuban Hotel has been awarded the prestigious Green Hotelier Award from the International Hotel and Restaurant Association.
- ✓ This machine is one of the most advanced composting machines that converts food waste into compost in 24 hours.
- ✓ This machine is equipped with moisture reduction systems, odour control mechanisms and is fully automatic in operation.

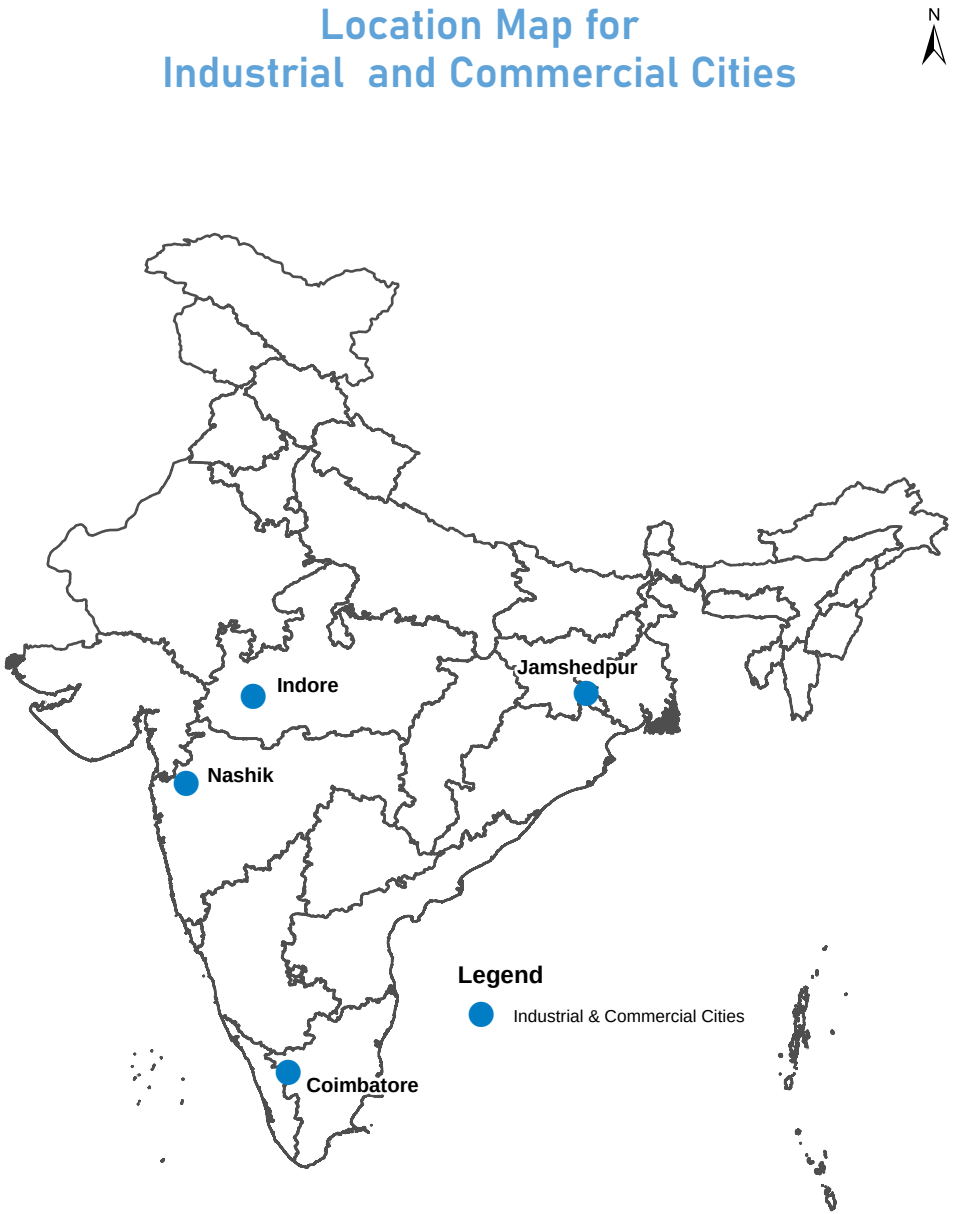
To know more:

Nagar Nigam Dehradun
Patel road near Doon hospital,
Dehradun, Uttarakhand, 248001
nagar_nigam2008@yahoo.com
0135-2714074, 2657884

References:

http://smartcitydehradun.uk.gov.in
https://nagarnigamdehradun.com
https://dehradun.nic.in

Location Map for Industrial and Commercial Cities



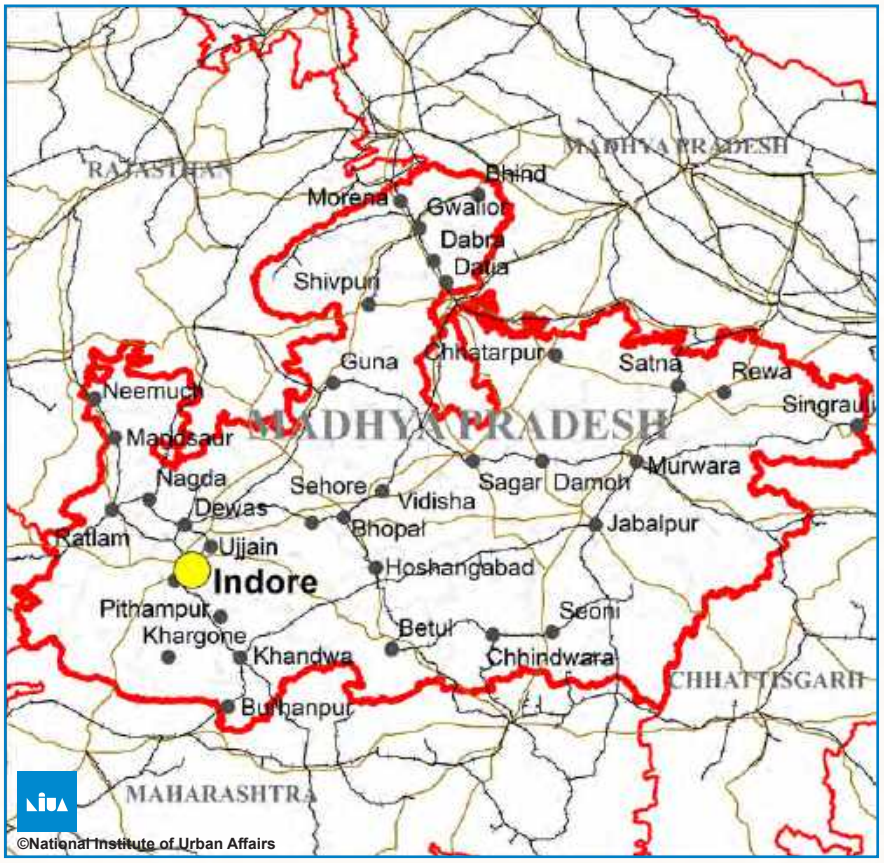
Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. This is especially significant with regard to industrialised and commercial cities of India, wherein solid waste from industries, commercial areas and residential areas often get mixed and end up in dump yards The SWM Rules 2016 and SBM's new guidelines aimed at addressing this issue and promote prevention, minimisation, recycling and safe disposal of waste. SBM's SWM workshops took the opportunity to help ULBs of industrial and commercial cities to come up with practices to mitigate the waste menace and adopt environment-friendly practices through cross-learning.

INDUSTRIAL AND COMMERCIAL CITIES

15

INDORE

Indore



Snapshot: Indore Municipal Corporation

State	Madhya Pradesh
Area	276 sq. km
No. of Wards	85
Population	27,50,000
Total Waste Generated	980 MT per day

Indore, located on the Western region of Madhya Pradesh is one of the most important commercial centres of the state. It is also the most populous and the largest city of Madhya Pradesh. Indore traces its roots to its 16th century founding as a trading hub between the Deccan and Delhi. t serves as the headquarters of both Indore District and Indore Division. It is also considered as an education hub of the state and has campuses of both the Indian Institute of Technology and the Indian Institute of Management. Indore's financial district, based in central Indore, functions as the financial capital of Madhya Pradesh and is home to the Madhya Pradesh Stock Exchange.

Indore has been selected as one of the 100 Indian cities to be developed as a smart city under the Smart Cities Mission. Indore has been part of Swachh Survekshan since its inception and had ranked 25th in 2016. It has been ranked as India's cleanest city four years in a row as per the Swachh Survekshan for the years 2017, 2018, 2019 and 2020.

Solid Waste Management in Indore comes under the purview of the Indore Municipal Corporation (IMC). Indore today generates over 980 MT of garbage per day, and all of it is collected from the source whether it is a household or a commercial establishment. The total wet waste generation is 510 MT per day and dry waste generation is 467 MT per day. The households are covered through the door to door collection system, while the semi-bulk and bulk generators are covered by the bulk collection system. IMC staff carries out sweeping twice a day in all the commercial areas of the city. Sanitary Inspectors track the activity log for sweeping. This is also additionally done through the Command and Control Centers established in the city for monitoring. The city has an Integrated Waste Processing Facility where the wet and dry waste is treated. The total manpower involved in the SWM of the city is 7000 persons.

Segregation, Collection and Transportation

Facility Highlights	
Area	250 sq. km.
Technology used	GPS, RFID
CAPEX	Rs 180 Cr
OPEX	Rs 155 Cr annually
Revenue Generated	Over Rs. 60 Cr (User fees collected -27 Cr)

Source: Indore municipal corporation

Indore ensures 100% coverage of wards through its door to door collection system. 100% segregation at source is being practiced in the city. The city's door to door collection and segregation is implemented and monitored with the help of six NGOs (four for source segregation and to create public awareness, and two for plastic waste management). All waste collecting vehicles have separate wet and dry waste collection partition in vehicles besides a separate container for domestic hazardous waste.

Vehicles having different compartments


Segregated waste being collected

A user charge of Rs 60 - Rs. 150 is collected from the residential units, and Rs. 100 - Rs. 180 is collected from the commercial units on a monthly basis. Aadhar linked biometric attendance for all waste cleaning workers is done in all the 85 wards.

Garbage Transfer Station (GTS)

The collected waste is taken to the GTS built in the city. Capacity of each GTS ranges between 150-200 MT of waste. The waste collecting vehicle which is brought to the garbage transfer station is weighed through the weigh bridges. The city has a total of 10 transfer stations, capital cost of each transfer station being Rs. 6 Crore. The garbage transfer stations are known as 'Green Transfer Stations' as each of the station saves approximately Rs. 20 Lakh per month on the fuel consumption and has its own Biomethanation plant. This plant uses 1.8 MT of waste to generate electricity, which is used in the transfer stations itself.

Garbage Transfer Station

Bin free city initiative

This initiative started in a phased manner from March 2016 to December 2016. Effective Door to Door (D2D) collection reduced the garbage on roads and open areas. On critical bin locations, the D2D garbage collecting vehicles were operated three times in a day

Flower composting

Food ATM

Bin free initiative in Indore

Pilot Project started in ward 71 and 42

January 2015

D2D Collection of waste in 10 wards

March 2016

Bin free initiative started

March 2016

D2D collection of waste in all wards

October 2016

Bin free city

December 2016

The waste is collected through partitioned vehicles known as 'Tippers' and is transported to one of the ten transfer stations. The wet waste from semi bulk generators generating 25 to 100 kg of waste is collected through the Bulk Collection System. All vehicles used in the collection and transportation system are monitored by a GPS enabled tracking system. The GPS system is constantly monitored by the monitoring cell.

The supply, installation, implementation and maintenance of GPS based Vehicle Tracking Solution (VTS) for MSW, CCTV cameras at community and public toilets, and integration of weighbridge at Devguradia landfill site, all together had a total cost of Rs. 1.29 crore. Along with the GPS and RFID trackers, the city also has a 'Push to Talk System.'

Key Highlights

- ✓ 2000 open dump spots in the city have been eliminated.
- ✓ Removal of garbage bins from all the 1170 locations in the city
- ✓ Increase in attendance of Safai Mitra due to Biometric attendance and monitoring

Integrated Solid Waste Processing Facility (Centralized)

Indore city has a Centralized Processing Unit situated at Devguradia, Nemawar Road. The total area of Devguradia processing and disposal site is around 146 acres. The waste collected at the garbage transfer stations in city is weighed, compressed and further moved to Devguradia processing site / Trenching Ground for final processing.

Facilities at Centralized waste processing plant

Facility 1 Centralized Organic Wet Waste Processing Unit
Facility 2 Automated Material Recovery Facility
Facility 3 Bioremediation of old dumpsite
Facility 4 Plastic waste collection and processing unit and Plastic waste fuel convertor unit
Facility 5 C&D Waste Plant
Facility 6 Scientific Landfill Site

1. Centralized Organic Wet Waste Processing Unit (Aerobic Composting Unit)

The wet waste is processed in two ways i.e. at the Central Processing Plant and at the Decentralized Waste Processing Units. All the wet waste of the bulk generators (30 kg and above) is processed within their premises, so this waste is not processed at the central processing plant. The wet waste from the Garbage Transfer Station (D2D Collection) and semi bulk collection (those generating 15 to 30 kg per day) is transported to the central wet waste processing plant, where it is processed into compost.

The wet waste after being bought to the processing unit, is kept in the open to decrease its moisture. Proper drainage lines are built near this area to discharge the fluid. This waste is treated properly from time to

time and the compost so produced is of good quality.

Composting Plant

2. Material Recovery Facility

The dry waste which is brought to the central processing and treatment facility at Devguradia is then sorted into different categories. The material was manually sorted by the waste pickers at the plant in two Material Recovery Facility (MRF) facilities where manual sorting of the dry waste into different categories was done. The MRF1 has been upgraded and converted to an automated plant, which has been installed by an Ahmedabad Based Company "Nepra Resource Management Private Ltd." under the PPP model. This helps in speedy segregation of waste. The plant has been installed with an investment of Rs. 20 Crore by Nepra for which, it received a financial assistance from Aavishkaar Venture Management Services. The company makes a payment of Rs. 1.50 Crore to the corporation every year.

This automated material recovery plant installation has a capacity of 300 TPD, which is equipped with an automated sorting system and conveyor belts that helps in sorting all kinds of dry waste more efficiently; making the process not only faster but also taking care of the health of the workers by minimizing their exposure to dust. At present 700 rag pickers are employed at the two MRF plants spread over an area of 10 acres. At these facilities, the dry waste is segregated into different components as metal, rubber, board, plastic, etc. The recyclable waste is sold to 14 Kabadiwalas, which are registered and authorized by IMC. In dry waste processing, inert is recovered at both the MRFs. The inert is then transferred to the sanitary landfill located near the premises. Before the transfer, the inert is weighed at the weighbridge and logged in the system. IMC is planning to install two more MRF facilities at Sirpur and Kabitkhedi with a capacity of 150 TPD each in order to meet the processing capacities of the city's waste, which is around 500-600 TPD.

Waste sorting

Automated MRF facilty

3. Plastic waste collection and processing unit

IMC has set up a Plastic Collection Centre (PCC) to reuse and recycle the city's plastic waste. Along with setting up a PCC, IMC has also installed a plastic cleansing machine known as a 'Phatka Machine.' Waste pickers segregate and sell the plastic waste that can be recycled. The remaining plastic waste is then taken to the PCC where it goes through the process of cleaning and shredding. Around 10 Tonnes of the shredded and purified plastic is sent to the plastic waste fuel converter unit while the rest of the plastic is sent to Madhya Pradesh Rural Road Development Authority for the construction of roads.

Plastic waste processing at the centre

Key Highlights

- ✓ From being one of the biggest plastic waste generators in MP in 2013, to putting 50% of city's plastic waste to reuse, Indore is a shining example for the other big cities in India facing with waste management problems.

4. Reverse Vending Machines

IMC adopted state-of-the-art technology; Reverse Vending Machines for in-situ conversion of plastic bottles to flakes. The machine can crush 90-120 bottles per hour. It can handle bottles up to the size of 2 liter. It can store flakes up to 10 or 500 bottles of different sizes. The machine has been installed at 10 different public places in the city. This innovative idea was adopted to reduce plastic bottle waste at public places and also reduce transportation cost of the bottles. To encourage disposal of plastic bottles through Reverse Vending Machines, a unique concept of incentivization was included under this intervention. The users can get an incentive of Rs 5/- per bottle as cash back through Paytm or Rs 5/- discount coupon, which can be used in public transport buses both within the city and for inter-city travel. To further promote usage of plastic vending machines, IMC has introduced SWACHH CARD, which is linked to 1500 shops of Indore, where the user can redeem the obtained points to get the benefit.

5. Plastic waste fuel convertor unit

IMC was facing difficulty in the disposal of scrap plastic such as chocolate wrappers, tobacco and pan-masala pouches. So, IMC came up with a plastic waste to fuel converter unit. This facility works on reverse polymerization process and is capable of producing at least 3000 litre of fuel per day with 10 tonnes of scrap plastic waste. The entire process takes at least 16 hours.

Plastic to fuel plant

Fuels produced by the plastic waste fuel converter unit

Presently, the unit is producing around 2400 litre fuel including diesel, petrol, as well as crude oil. The fuel produced is of good quality. This plastic waste fuel conversion unit has solved the problem of disposal of scrap plastic waste collected on a daily basis from the city. The capital cost of the plant is approximately Rs. 3 Crore.

Fuel generated is sold by the IMC at the rate of Rs. 35/ litre. It is fully utilized by the manufacturers of namkeen, chips and savories. The scrap plastic like wrappers, tobacco and pan masala pouches etc. were difficult to dispose and hence they are being converted to the biodiesel which is produced by reverse polymerization process. The other bye-product of this process is tar, which would be used in road construction work.

6. Bio Remediation of old dumpsite

During the previous year, by the process of Bio-mining; 200,000 MT old garbage was treated by Indore Municipal Corporation at Devguradia dump site. 5 Acre land has been reclaimed and a green belt has been developed. Recovered soil, compost and recyclables have been sold and rejects have been scientifically landfilled.

The capacity of the plant is 254 MT per day on 12 hour-basis, which is managed by E-Tech Projects. The mode of contract followed is annual and on per cu.m. term basis with extendable contract. Currently, they are charging Rs.500 per cu.m. The treatment involves separation of material with the help of trommel (25mm), followed by accumulating plastics through baling machines.

Indore has transformed its garbage landfill site into a beautiful garden in a short duration.

Before Bio Remediation

After Bio Remediation

Landfill turned into garden

7. Construction and Demolition (C & D) Waste Plant

Facility highlights	
Area of the facility	4 acres
Processing Capacity	100 MT per day
Products obtained	40 mm and 20mm maximum size aggregate, sand and sludge which are converted into useful end products.
CAPEX	2.5 Cr

Indore city generates 100 MT per day of C & D waste which is sent to four collection and segregation centers. For managing this amount of C & D waste, IMC has set up a construction and demolition debris waste processing facility, which has been constructed on a PPP model. Under the PPP model, IMC provided 4 acres of land for setting up the plant for 15 years. The period for the recovery of cost of construction is estimated to be 8 years.

C&D Facility

Products manufactured

The waste is subjected to a number of operations and processes through a number of units. The products obtained from the facility after treatment are paver blocks with finished surface, rough paver blocks, rectangular paver bricks and masonry bricks.

8. Scientific Landfill Site

Two engineered landfills of 6.25 acre each have been constructed and are used as and when required. Only the inert is being transferred to this site, which is approximately 5-6% of the total waste generated by the city.

Biomethanation Plant for Wholesale Vegetable and Fruit Market

Facility highlights	
Capacity of the facility	20 MT per day
Technology used	Bio-CNG
CAPEX	15 Cr
OPEX	NA
Products obtained	Bio-CNG and compost
Quantity of Bio-CNG generated	800kg on daily basis

Source: Indore municipal corporation

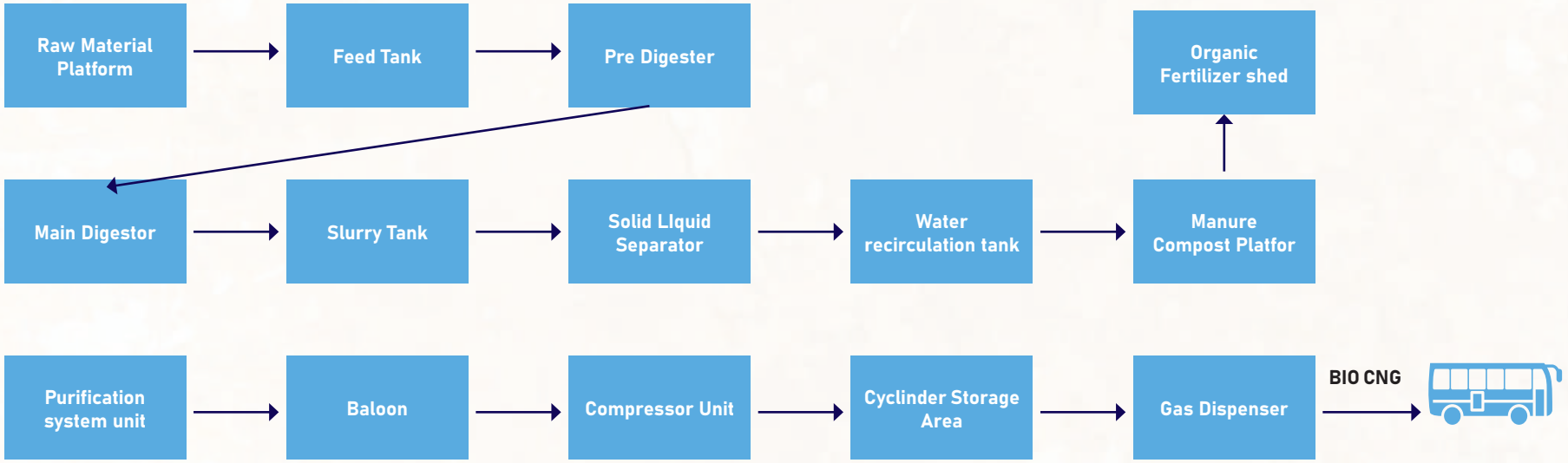
Approximately 20-25 MT per day of fruit and vegetable waste is generated in Choithram Mandi . Earlier, the waste was collected and transported to the centralized waste processing and disposal site of IMC. This incurred heavy transportation and manpower cost. Hence, IMC under its policy of promoting decentralized treatment of organic waste established a Bio-methanation plant (Bio-CNG Plant). Through tendering process; IMC appointed Mahindra & Mahindra Ltd., Mumbai to establish the plant, which was commissioned in December 2017. The concession period of the project is 15 years. Presently all the fruit and vegetable waste generated at Choithram Mandi is being collected and processed in the Bio-CNG plant.

Main Digester and Balloon

Approximately 800 kg of purified and compressed Bio-CNG, having 95% pure Methane gas is generated on a daily basis. The pressurized Bio-CNG gas is used as a fuel to operate approximately 15 city buses. Therefore, with the use of the Bio-CNG produced, there is a saving of Rs 4500 on the fuel expense of these buses, which would amount to a saving of about Rs. 1.35 lakh every month. The digested slurry is passed through solid liquid separation unit, filtered liquid is used in slurry making and the remaining solid are dried and converted into organic compost

Digester 1

Flowchart of the process involved in the Biomethanation plant



Faecal Sludge Management

In India, 7 Cities have gone beyond the ODF Status to adopt Faecal Sludge Management, one of them is Indore. The city received ODF++ certification under Open Defecation Free protocol, indicating that IMC has succeeded in achieving sanitation sustainability by addressing the complete sanitation value chain, including safe and complete faecal sludge management. Indore has achieved 100% treatment of the faecal matter generated in the city. Indore has three Sewage Treatment Plants (STPs) within the city for which proper log books are maintained. The three STPs are-

i. 245 MLD Sequencing Batch Reactors (SBR) based STP. This STP is the world's first largest 245 MLD STP with single stage SBR.
ii. 78 MLD and 12 MLD Up flow Anaerobic Sludge Blanket reactor (UASB) based STPs at Kabitkhedi. Along with the sewage treatment, electricity is also generated in these plants. The power generation capacity being around 18.5 KW to 22 KW.
iii. 122MLD STP

Sequencing Batch Reactors (SBR) based STP

Some good initiatives taken by IMC with the help of decentralized STPs are:

- Treatment and reuse of 50,000 litre per day sewage through decentralized STP at Zoo.
- Preservation of Khajarana lake water body by treating water through decentralized STP of capacity 2 lakhs litre per day

To know more

Indore Municipal Corporation
Website: http://www.imcindore.org/webindore/
Contact Number: 0731 253 5555

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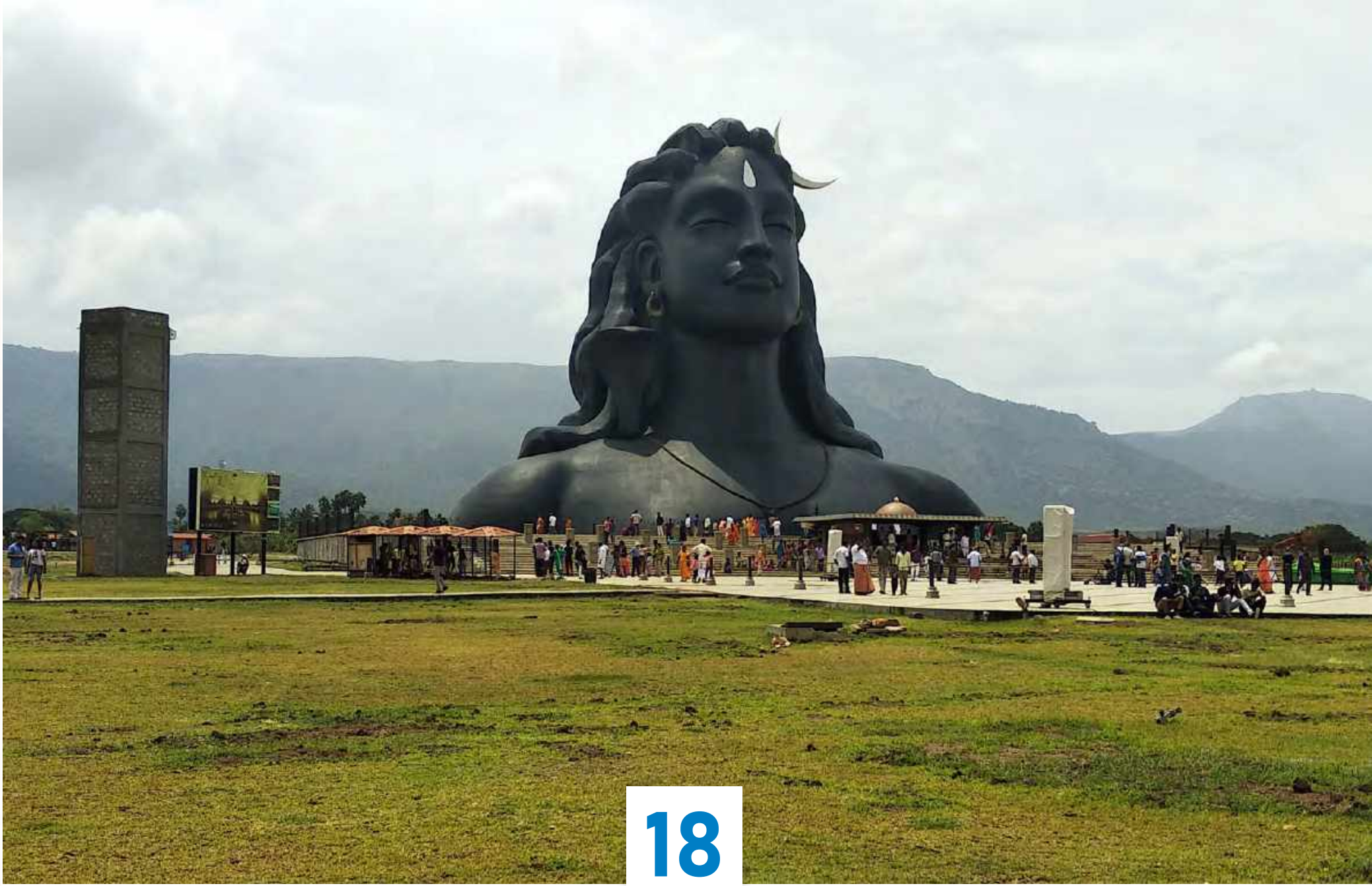


18

COIMBATORE

Coimbatore

Snapshot: Coimbatore City Municipal Corporation

State	Tamil Nadu
Area	257.04 sq.km
No. of Wards	100
Population	10,50,721
Total Waste Generated	1125 MT per day

Coimbatore is the second largest city of Tamil Nadu and one of the most industrialized cities of the state. Known as the textile capital of South India or the Manchester of the South India, Coimbatore is situated on the banks of the river Noyyal. There are more than 25,000 small, medium, large scale industries and textile mills in the city. It is also famous for foundry and automobile industries, manufacturing of textile industry equipment's, spares, motor pump sets, wet grinders and varied engineering goods and services. The development of Hydro electricity from the Pykara Falls in the 1930 led to a cotton boom in Coimbatore.

Coimbatore City Municipal Corporation (CCMC) is responsible for the city's overall development. Coimbatore is also one of the designated Smart Cities under Smart Cities Mission of Government of India.

Solid Waste Management in Coimbatore City is a function of the Health Department of Coimbatore City Municipal Corporation. The city is divided into five administrative zones – East, West, North, South and Central; each further subdivided into 20 wards. The total Municipal Solid Waste (MSW) generated in the city is 1125 MT per day. There is 100% source segregation of waste in the city.

Door to door collection of segregated solid waste is done by using both pushcarts and motorized vehicles depending on the locality and area covered. In localities with narrow lanes where movement of pushcart is not possible for waste collection, the city has come up with an innovative approach of installing waste collection stalls. The residents bring segregated waste at these stalls located, which are located at convenient distances. The corporation workers at these stalls further sort the waste brought by the residents and place them in respective bins.

Organic waste collection Stall at Kamaraj Nagar, Ward- 22, Coimbatore

Door to door collection at Sivasubramanium Road, Ward – 24, Coimbatore

Waste is also collected through motorized vehicles in many localities. Road sweeping and mopping is carried out with 12 road sweeping flipper machines. There are about 100 containers each of 2 MT capacity, which are placed at important locations in the town. 36 private tractors are being used for collection of waste from the bins. About 288 MT of waste is being collected and disposed off at the secondary collection points by these tractors. There are 4 Transfer Stations in the city at Peelaimedu, Ondipudur, Sathy Road and Ukkadam. Hook Loaders are used for secondary transportation of waste from transfer station to the centralized compost yard at Vellalore. The cost of transportation of waste borne by the corporation is huge.

Ward no. 23 in the Coimbatore corporation started with a pilot project called SUNYA project which aimed at a zero- waste approach, which included reduction, reuse, recycling solutions, information and educational campaigns, based on a strategic interaction of regional/ local government, and formal and informal stakeholders taking into account social, economic and environmental aspects, on a long-term sustainability. The details of the project are shared below:

Decentralized Waste Management Through Sunya Project In Ward Number 23

SUNYA was started as a pilot project in seven cities in Asia. Coimbatore in South India was one amongst them. Municipal Association of Nepal - MuAN and ICLEI - ARGE Müllvermeidung, based in Austria; and the Association of Flemish Cities and Municipalities (VVSG), based in Belgium were the partners for this project. The project aimed at:

- Building capacity and awareness of corporation health officials, regarding the concept of waste as a resource, ideas of waste to wealth and the importance of segregation.
- Institutionalizing informal sector in solid waste management as a means to provide productive employment and in turn improving their quality of life.

Ward no 23	
No. of Households	2199
No. of Commercial establishments	825
No. of Market:	1 Vegetable Market
No. of Sanitary Workers	92
No. of Streets Covered	32

The SUNYA project was launched on 2nd October, 2013 in Ward No. 23. The primary aim was to segregate the municipal waste at source and process it at household level or ward level to reduce the volume of waste reaching the compost yard and in turn also save the transportation cost.

The CCMC approach towards decentralizing waste management in Ward No. 23 included a strong IEC or soft component coupled with hard measures like procurement of vehicles for collect the segregated waste and setting up of composting and recycling facilities. The main activities included:

a. Stakeholder Group Formation

The CCMC set up a stakeholder group, which helped in guiding the process of implementation of the project. The group consisted of:

- Officials from Solid Waste Management Department, Coimbatore City Municipal Corporation (CCMC)
- Residence Awareness Association of Coimbatore, (RAAC)
- ITC, Coimbatore
- Hotels Association, Coimbatore
- Siruthuli (NGO), Coimbatore
- Shree Swastika Trust, Coimbatore

Since, the project required community support for successful implementation, communities were no longer seen only as beneficiaries but a rather critical stakeholder.

b. IEC Campaign

CCMC involved NGOs like RAAC, Siruthuli and Shree Swastika Trust for conducting the IEC campaign to generate awareness among citizens towards source segregation, reuse and recycling through handbills, pamphlets, etc. The campaign adopted a very unique and active model of starting activities early in the morning at 7.00 am. It was observed that when the waste was collected from households in the presence of ward councilor, zonal sanitary officer and other members, it created more positive impact in a considerable lesser time. CCMC also fined the households who failed to segregate waste, which served as a strong incentive for household segregation.

c. Collection and processing

- A 10 litre bin for biodegradable waste and a bag for recyclable waste were distributed to each household in the ward.
- Compost bins were distributed to households to promote household composting. Initially, 10 households were selected and training was given to them. The home compost manure thus produced was used for roof gardening.

Home composting was promoted to process wet waste at household level

- Red coloured community bins were placed for all the 21 streets of the ward for collection of hazardous waste. They were exclusively for collection of sanitary napkins and other hazardous waste.
- 15 new push carts were issued to sanitary workers with 4 bins for proper segregation.

Door to door waste collection at Kannusamy Road,Ward - 23.

- A decentralized compost plant was also set up in the ward office for composting the wet waste collected from the ward. In addition, about 70 to 80 kg of wet waste was processed for manure preparation at one of the dilapidated noon meal centers in Ward No. 23. The remaining 4 to 5 tons of wet waste was transported to Onampalayam for windrow composting. Shree Swastika Trust provided the technical support for the construction of the compost plant as well as trained the workers for the process of bio-composting.

Decentralized Composting of Waste

- Personal Protection Equipment (PPEs) was distributed to conservancy workers.
- ITC tied up with CCMC for collecting recyclables from Ward No. 23. The company provided separate bag to households for collection of recyclables. All the sanitary workers were actively involved in the collection of segregated waste. A separate register was issued to all the sanitary workers and the weight of the collected recyclable waste was measured in front of the respective workers and entered in their register and was acknowledged. The collected recyclables were stored at the ward office.

Recyclables collected and stored at Ward office

d. Felicitation

30 residents of Ward, who were actively involved in the source segregation, were appreciated for their contribution. Certificate of appreciation was given at their doorsteps by Mayor S.M. Velusamy and Commissioner Smt. G.Latha. The sanitary workers were also felicitated.

Residents receiving certificate of appreciation or their efforts towards waste management

Motivational hoardings hung across the city

In addition to this, banners were displayed in 10 places in the streets to motivate the other residents as well. Further, to encourage and motivate the workers,; 10 sanitary workers who were actively involved in the street maintenance were given 4 gm gold coin each. The others were also encouraged with gifts by the Corporation.

Outcomes of the Project

a. Infrastructural and Institutional

- Door-to-door collection of segregated waste from more than 2000 households and 750 commercial establishments was initiated.
- Binless ward: 89 bins of various capacities were removed from the streets of Ward No. 23 after the successful implementation of the source segregation at household and commercial establishment levels.
- Till now 4.36 tones of biodegradable waste has been converted into compost in the composting facility. The compost has been tested and found suitable for use in the gardens.

b. Economical

- ITC has collected more than 177 tons of recyclables till date since the project began
- More than Rs. 5.37 lakhs has been raised by selling the collected recyclables, which are further deposited in the workers' account.
- Decentralized waste treatment has reduced consumption of diesel for transportation of waste saving about 3150 litres of diesel and Rs. 1.55 lakhs per month.
- Rs. 60,000 has been collected as fines for littering.

c. Social

- The adoption of source segregation, reuse and recycling practices have been instilled in citizens who now take pride in living in a bin free ward
- Supplementary income is generated for waste pickers from sale of recyclables

Success factors:

Some of the key factors that ensured success of the project include:

- Extensive awareness generation and sensitization among citizens regarding source segregation and 3Rs concept helped to make them

more responsive.

- Stakeholder engagement was key to the success of the project.
- Commissioner and local ward councilor acted as "local champions" who launched the initiative and kept track of daily activities by visiting the pilot ward every day.
- Presence of local leaders encouraged local community and CCMC officials.
- Capacity building and training going hand in hand with building trust and ownership within the community helped in making the initiative a success.

Key Highlights

✓ *The successful implementation of decentralized municipal solid waste facility at the ward level has encouraged the CCMC to replicate the approach to all other wards in the West Zone. In fact, ITC has already started collecting recyclables from the entire West Zone. Much of the good impacts of the project were shared informally by waste workers and citizens who were impressed with the initiative, thereby generating public interest even without effort from CCMC. Resident associations from other wards are already approaching the CCMC to be part of this initiative and become zero waste wards. The project has shown that success of the decentralized waste management depends much more on community participation than on finances.*

Vermi-composting plant at Vellalore, Solid Waste Management Complex

The vermi-compost plant at Vellalore was established in 2016 by the CCMC at an estimated cost of Rs. 50 Lakhs. 100 MT of segregated waste is processed and converted into compost at this site.

Facility Highlights	
Name	Vermi Composting Plant
Location	Vellalore
Area	15 acres
Land Ownership	CCMC
Owner	The Commissioner CCMC
Year of Establishment	2015
Type	Centralized
Type of input	Wet Waste
Input Capacity	100 MT per day
Processing Capacity	100 MT per day
Total Manpower	25

The incoming waste is shredded and transferred to the windrows' platform. The temperature and moisture levels of the windrows are maintained at 50 – 55oC and 40 - 45% respectively. The mass is aerated at least twice in the two week duration of these windrows.

Incoming wet waste is sorted and shredded

Shredded waste is laid into windrows

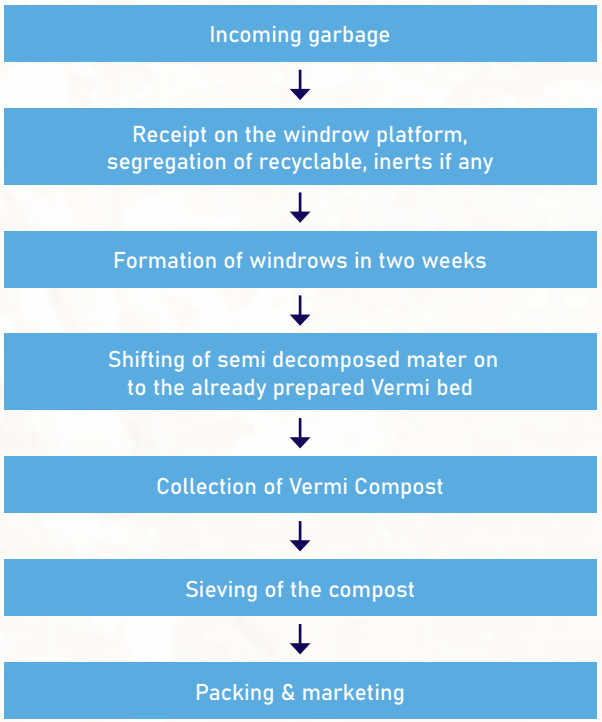
The partly digested mass gradually turns greenish in colour after which it is transferred to the pre-constructed vermi beds. These beds contain 4 - 5% by weight of worms and the temperature of the beds is maintained around 250C by sprinkling water regularly and using gunny bags for cooling. The completely digested compost reduces to 25% of its volume, which is dark brown in colour. It is then tested in the laboratory and sent for packaging.

Vermi-composting beds

Decomposition of waste in the vermi-composting beds

Sieving and Packing of Compost

Process flow Diagram



Biogas Plant at Amma Unavagam premises, North Zone

Facility Highlights	
Capacity	25 cu.m. per day
Quantity of Input	50 MT per day
CAPEX	Rs. 10,00,000
Product obtained	Biogas
Quantity of biogas generated	25 cu. m
Total Revenue Generated	Rs. 1500 per day in terms of savings
Manpower	2

Amma Unavagam is a food subsidization programme run by the Government of Tamil Nadu. Under the scheme, all Municipal Corporations of the state run canteens serving food at subsidized rates. CCMC generates 50 MT of waste from large community kitchens, hotels and markets. Instead of disposal at Vellalore dumpsite, CCMC generates biogas for cooking purpose, from this waste.

CCMC has installed a biogas plant at Amma Unavagam premises at Chitra Nagar, Saravanampatty of the North Zone. Vegetable waste, cooked and uncooked food waste from the hotels and restaurants in and around Saravanampatty including the Amma Unavagam are used to generate biogas through anaerobic digestion. Initially, 21 kgs of LPG gas was consumed per day, which amounted to a daily expenditure of Rs. 1500 resulting in a total expenditure of Rs.45,000 per month.

The bio-gas plant at Amma Unavagam

The gas produced being used in the Kitchen

About 27 LPG cylinders (each weighing 19 kgs) were utilized for cooking purpose in a month. After installation of this bio-gas plant, the utilization of LPG cylinders has been reduced to one per three months. Waste is collected by the waste collectors of CCMC which is then fed into the mixer for slurry preparation. Water is mixed in the ratio of 1:1 before putting it into the pre-digester tank. The slurry is stored in an elliptical digester tank. It takes about two to four weeks to digest the waste depending on the temperature. Thereafter, gas is produced and sent out through the gas outlet at the top of the plant. This gas burns with a blue flame and is being used for cooking. The gas is routed through the smaller pipes to 2 stoves and 2 idli cookers.

Key Highlights

- ✓ Amma Unavagams all over the city are currently estimated to feed about 20 % of the city's Below the Poverty (BPL) population on a daily basis.
- ✓ The outcome of the scheme is not only limited to mitigating food insecurity, but also to creating livelihood security for destitute women thus enabling inclusion of marginalized slum dwellers into formal employment.

Gasifier Crematorium at Najundapuram Area

Facility Highlights	
Capacity	5 MT per day
Quantity of Input	1.36 MT per day
CAPEX	Rs. 48,00,000
OPEX	Rs. 30,000 per month
Product obtained	Biogas
Quantity of biogas generated	100 cu. m. per day
Revenue Generated	Rs. 62,000 per month on an average in terms of savings

The Coimbatore City Municipal Corporation (CCMC) converted the then existing Biomass Gasifier Crematorium as LPG run gasifier crematorium in 2010 for cremation purposes. The Municipal Corporation Council evinced keen interest to Operate and Maintain (O&M) the above mentioned Gasifier Crematorium (Kayantha Sthanam Cremation Services) through PPP mode by entrusting the work to Isha Foundation, a Non-profit and spiritual organization located in Coimbatore.

Initially, the operator used to consume about 4 commercial LPG cylinders (19 kgs each) for cremation of an average of 5 dead bodies a day. This amounted to a daily expenditure of Rs. 4,180. Thus, on an average, about 120 LPG cylinders were consumed on a monthly basis. However, the operator collected only Rs. 1750 for a single cremation from the public. In order to bring down the cost, the CCMC initiated an innovative project in 2015 by installing a kitchen waste based biogas plant of 100 cu. m capacity in the crematorium premises. Kitchen waste amounting to 1.36 MT per day is collected daily from the households, hotels and restaurants in and around the Nanjundapuram area and processed in this plant. The food waste collected from the households and hotels are pulverized and transferred into the feeding tank. Adequate water is mixed with this material. The pulverized food wastes are then fed into the digester by means of a feed pump where digestion takes place.

Biogas Plant at Najundapuram crematorium

The gas produced is then passed through the scrubbers in which the hydrogen sulphide is removed. The biogas generated after purification is stored in a balloon made of polypropylene. The purified methane gas produced in the biogas plant is charged into the crematorium's burner as fuel along with the regular LPG cylinders and used for cremation.

Key Highlights

- ✓ *After installation of the Biogas plant, the usage of LPG cylinders has been reduced to 60 cylinders per month at the rate of 2 cylinders per day thereby reducing the cost to Rs.2,090/- per day.*
- ✓ *The plant does not release any foul odour and the water released from the plant is let out into the existing underground sewerage system.*

Biomethanation Plant at Bharathi Park, Ward - 22, Corporation Workshop

The Corporation has installed 1.5 MT Bio-Methanation Plant (PSTR-Partially String Tank Reactor technology) under CapaCITIES Sunya project in Ward No. 22 with the funding support of Swiss Agency for Development & Cooperation (SDC) and technical support of ICLEI South Asia. The residential and commercial segregated organic waste from the Ward is brought to this plant for processing and biogas thus obtained, is used to generate electricity. This biomethanation plant was inaugurated on 19th October, 2019 by Ms. Simonetta Sommaruga, Vice-President of the Federal Council and Minister for Environment, Transport, Energy and Communication, Switzerland.

Inauguration of Biomethanation Plant by Ms. Sommaruga, Minister for Environment, Switzerland

Facility Highlights	
Name	Biomethanation Plant
Location	Corporation's Workshop, Near Bharathi Park
Area	600 sq.m.
Land Ownership	Coimbatore Corporation
Owner of the facility	Coimbatore Corporation
Year of Establishment	2019
Type	Decentralized
Type of input	Wet Waste
Input Capacity	1.5 MT per day
Processing Capacity	1.5 MT per day
Total Manpower	03

The bio-methanation plant is now operational, and approximately 1500 kgs of segregated organic waste mixed with 1500 litres of water is being fed into this bio-methanation plant digester daily on an average basis. 60 to 80 cubic meter of gas is produced from which 100 units of electricity is generated daily.

Organic waste passed to the shredded through the conveyor belt

Organic waste shredded to form slurry to feed into the Digester

Digester

Balloon Room

At present, the generated electricity is being used for biogas plant's operations, and lightings of Corporation's workshop & Micro Composting Centre (MCC). The annual electricity cost offset to the Corporation is about Rs. 2.5 lakhs.

Faecal Sludge Treatment Plant (FSTP) at Periyanaicken Palayam Town Panchayat

Periyanaicken Palayam (PNP) and Narasimhanaicken Palayam (NNP) are two neighbouring Town Panchayats (TP) in the outskirts of the city of Coimbatore, with a collective population of 53,000 people and 14,366 households. Both the TPs are unsewered, with households having either septic tanks or soak pits. 7,752 HHs are identified to have septic tanks. An estimated 5 loads of septage is desludged everyday by private operators, amounting to 20,000 - 25,000 lts of septage. The proposed Faecal Sludge Treatment Plant (FSTP) is designed to handle a waste load of 25,000 lts of septage per day, with a peak capacity of 30,000 lts per day. The plant is spread across an area of 0.5 acres with an extended park area of 0.75 acres. The plant is built at a cost of Rs. 2.48 crore.

Operational components:

a. Septage Receiving Station (SRS)

The desludged faecal matter i.e. the septage from the onsite sanitation systems, either the septic tanks or the pits, is collected by vacuum

suction tankers and is directly fed into the Septage Receiving Station (SRS) via inlet pipe. The SRS unit consists of screens (mesh 3 no's) of dimension 0.6 m x 0.84 m, with a pore size of 12mm to separate the solid waste particles like cloths, paper, packets, etc. mixed with the septage. The mesh is placed at an angle of 45° in SRS. The screened septage flows into the grit chambers (2 no's) within the SRS for pre-settling the grit before entering the holding tanks. The SRS is designed with a hydraulic retention time of 1 day. The sand and silt present in the septage get settled in the SRS under the influence of gravity.

Septage Receiving Station

b. Storage Tank (Collection tank) –

The septage flows from the SRS to the storage tank by gravity. The storage tank has a capacity of 80 cu.m and equipped with 3 vertical baffles with vents. Thus, the storage tank consists of 4 chambers. Each chamber or tank has a dimension of 2.6m x 3.5m x 2.3m.

The storage tank provides a total of 3 days of retention time, and thus the following actions occur in the tank:

I. The septage gets homogenized in the Storage tank. Different quality septages from different sources is mixed in this unit.

II. Effective settlement of sludge occurs due to the 4-chambered tank as well as the retention time.

Submersible pumps are placed in the Storage tank (collection tank) to pump the settled sludge in the storage tank (collection tank) to the sludge holding tank. Two pumps are placed in the first 2 chambers of the storage tank (collection tank), and one pump is placed for the last two chambers of the storage tank. Around 60 -70% of the sludge is pumped to the sludge holding tank. The supernatant flows to the MBBR unit by gravity.

Storage Tank (Collection Tank)

c. Sludge Holding Tank

The sludge from the Storage tank is pumped to the Sludge holding tank of dimension 4.2m x 3m x 2.65m. The settled sludge is then pumped to the dewatering unit.

d. Dewatering Unit

The septage from the sludge holding tank is pumped to the dewatering unit. The dewatering unit consist of 2 parts:

- Polymer application system

- Volute Press

The polymer applicaion system includes Polymer mixing system, Polymer maturation tank and polymer dosing pump. The polymer solution is prepared in the polymer mixing system by mixing polymer and water at appropriate ratios and kept for maturation in the maturation tank. Post, maturation, the polymer is dosed to the septage at pre-determined dosing rate, for solid-liquid separation through flocculation.

The sludge is then passed through the dewatering unit. The dewatering unit consists of two phases:

- Phase 1: Thickening of the flocs formed occurs
- Phase 2: Squeezing of the sludge occurs

There are 2 screws in the dewatering unit - model 302, with DM handling capacity 60 Kg/hr/screw and handling a peak flow rate of 1500 lph/ screw. Hence, together 2 volute press can handle 25,000 lt of septage.

Dewatering unit

e. MBBR (Moving Bed Bio Film Reactor)

The supernatant from the Storage tank (Collection tank) and filtrate from the dewatering unit is fed to the MBBR for treatment. It consists of anoxic, aerobic tank, and sedimentation tank. The anoxic tank is the de-nitrification basin. The process involves the de-nitrification of waste streams using bacteria, which breaks down the nitrate in the waste to be used as an oxygen source. This breakdown of nitrate from the waste stream releases oxygen and nitrogen gas. The oxygen is consumed by the bacteria and the nitrogen gas is released into the atmosphere. The free-form nitrogen present in the wastewater is removed at this stage.

From anoxic tank water flows to the next tank i.e. aerobic tank. Aerobic tank is an aerated tank with moving biofilm. It is a super-activated biofilm aeration system. The moving bio films provide large surface for the optimal contact between the water, air and the bacteria. The bacteria or the activated sludge grows on the surface of the bio film. The bacteria breakdowns the organic matter in the wastewater. The tank is aerated to keep the bio films and the activated sludge in moving condition. The excess bacteria grown on the film i.e. the excess sludge gets detached from the bio films and flows, with the treated water to the sedimentation tank. The sludge gets deposited in the sedimentation tank. The COD and BOD reduction take place here.

Moving Bed Biofilm Reactor

f. Treated Water tank - 1

The treated water from the MBBR is stored in the pre-tertiary treated water tank. Further, its pumped to the Pressure Sand filter.

g. Pressure Sand Filter (PSF)

The treated water moves from the treated water tank to pressure sand filter. A Pressure Sand Filter is contained under pressure in a vertical FRP tank. The turbidity reduction takes place here. The Pressure Sand Filter consists of a multiple layer of sand with a variety in size and specific gravity. These filters are designed to remove turbidity and suspended particles present in the feed water with minimum pressure drop.

h. Activated Carbon Filter (ACF)

From the PSF; the water is pumped to the Activated Carbon Filter. ACF consist of a bed of activated carbon which adsorb the any contaminants, impurities etc., present in the water. It also removes smell in the water, and makes cloudy water clear by removing colour causing compounds in the water.

Pressure Sand Filter (PSF), Activated Carbon Filter (ACF) and UV Disinfection Unit

i. UV Disinfection

From ACF water is passed through the UV disinfection unit. The UV provides rapid, effective inactivation of microorganisms through a physical process. UV light has demonstrated efficacy against pathogenic organisms, including those responsible for cholera, polio, typhoid, hepatitis and other bacterial, viral and parasitic diseases.

After the tertiary treatment, the treated water is stored in the Treated water tank 2 and available for utilization. The treated water is currently used with the complex for gardening.

To Know More

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Coimbatore – 641035

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https://coimbatore.nic.in
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19

NASHIK

Nashik

Snapshot: Nashik Municipal Corporation

State	Maharashtra
Area	259 sq.km.
No. of Wards	108
Population	1,486,053
Waste Generated day	550 MT per day

Nashik or Nasik is a holy city situated in the northern parts of Maharashtra. The city has developed on both the banks of River Godavari, which divides the city into almost equal halves. Nashik is known for being one of the Hindu pilgrimage sites, that of Kumbh Mela which is held every 12 years

The city is called the "Wine Capital of India" as half of India's vineyards and wineries are located in Nashik. Over the years, this ancient city has developed into a metropolis with a flourishing Industrial Centre as well as an educational centre. Nashik Municipal corporation (NMC) has been responsible for the city's overall development.

Currently, the city generates 550 MT of waste per day from its 108 wards. Door to door waste collection system in Nashik is operational since 1996 through 'Ghanta Gadi' concept. Six private agencies under PPP mode are

carrying out collection and transportation of waste from all the wards. In this management system; approximately 206 Ghanta Gadi's, 50 other vehicles and 620 workers are deployed. All the vehicles are equipped with GPS for monitoring and tracking of routes. Also, separate vehicles for waste collection from hotels, gardens, and construction and demolition sites have been deployed. All the waste of the city is processed in the integrated solid management facility at Pathardi, Gaulane Road, which is 15 kms away from the city. Waste segregation is absent in the city. NMC has conducted extensive IEC campaigns to create awareness among citizens on waste segregation, and bulk generators have been informed to manage their wet waste within their premises.

Figure1: Ghanta Gadi doing MSW collection

Integrated Solid Waste Management Facility at Khat Prakalp

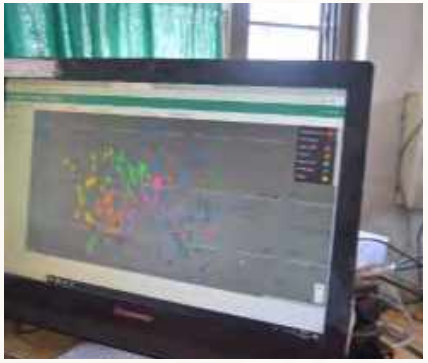
Facility highlights	
Total capacity	600 MT per day
CAPEX	Rs. 65,00,00,000
Manpower	110

The total capacity of ISWM is 600 MT with an area of 82 acres. In order to have smooth operations and efficient management of waste at the facility, NMC signed a contract with Pune based agency, Mailhem Ikos Environment Pvt. Ltd. on Design, Finance, Build, Operate and Transfer (DFBOT) basis for 30 years in 2017. The company is registered as Nashik Waste Management Pvt. Ltd. and has got the contract for operating the ISWM facility. As per the contract terms and conditions; the company is responsible for taking care of repair, upgradation and operation of compost and RDF plant, Leachate treatment plant, Plastic to fuel plant, Carcass incinerator, capping of dump site and setting up of new scientific landfill.

Online monitoring of vehicle and weighing systems

The RFID and GPS tracking system helps in recording the weight of the vehicle with and without waste, which is captured digitally through SCADA system. There are two weighing bridges, which are fully synchronized, and each has the capacity range of 25 MT. Every day the waste is collected from 7 am to 6.30 pm by 256 vehicles in 2 shifts. The total cost of equipment including 3 years of O&M for two weighing bridges was Rs. 25 lakhs. The annual maintenance cost is approximately Rs. 50,000.

Online data recording



Vehicle tracking

Compost plant

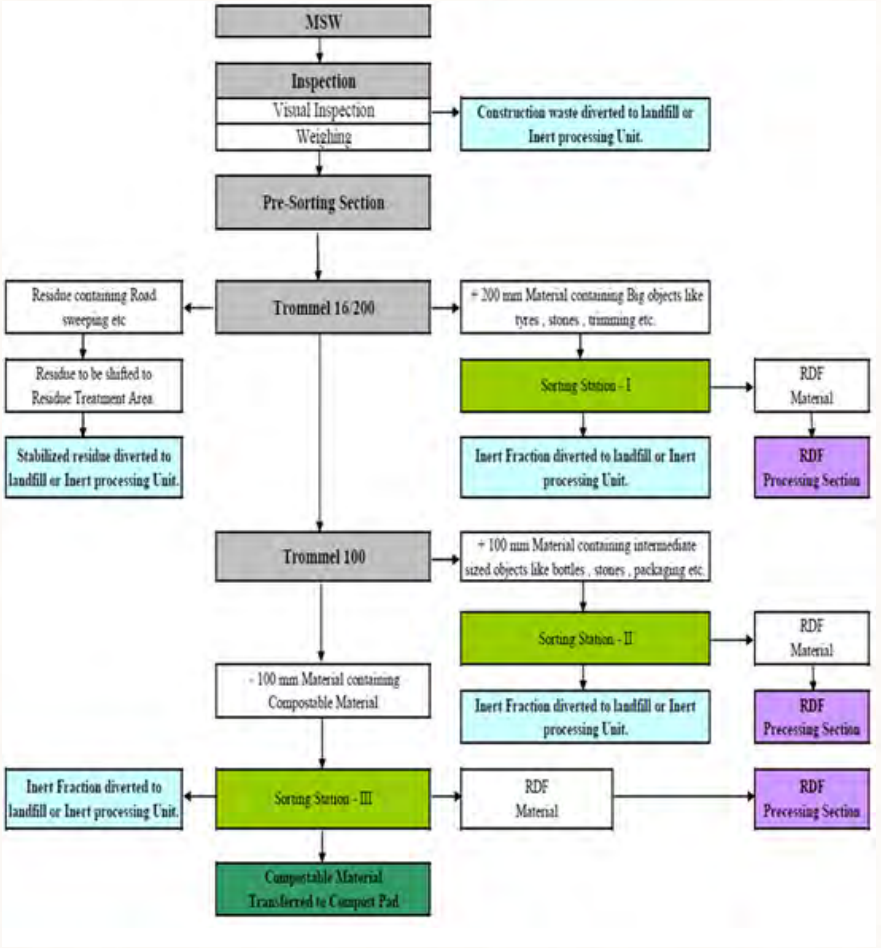
Windrow Composting at Compost Plant

The compost in this unit is prepared by Windrow method Aerobic composting. In this method there are three stages of treatment– Presorting, Composting and Mechanical composting. After applying the necessary quantity of microbial inoculant slurry preparation along with sufficient moisture, windrows are formed to facilitate composting. The width at the bottom of the windrow is 3-4 meter and height is up to 2 meter. The moisture content of the windrows is maintained at 45-55%. Once every week the windrows are turned and mixed thoroughly to homogenize the material using excavators.

After three turnings, during a period of three weeks, the partially composted garbage is then subjected to mechanical processing. The mechanical processing system consists of different types of automated trommel screens with sieve sizes of 35 mm and 16 mm. In this majority of the inorganic and inert materials get removed and the sieved organic materials below 16 mm size is kept for the process of curing. Later, the compost is refined through trommel screen followed by gravity separators. In these stages materials above 4 mm size, sand, silt etc. are removed. The remaining powdery compost is then stored in batches for quality check.

The plant prepares 50 MT of compost per day which is being sold in the market at Rs 3 per kg.

Flow Diagram of Compost Plant



RDF plant

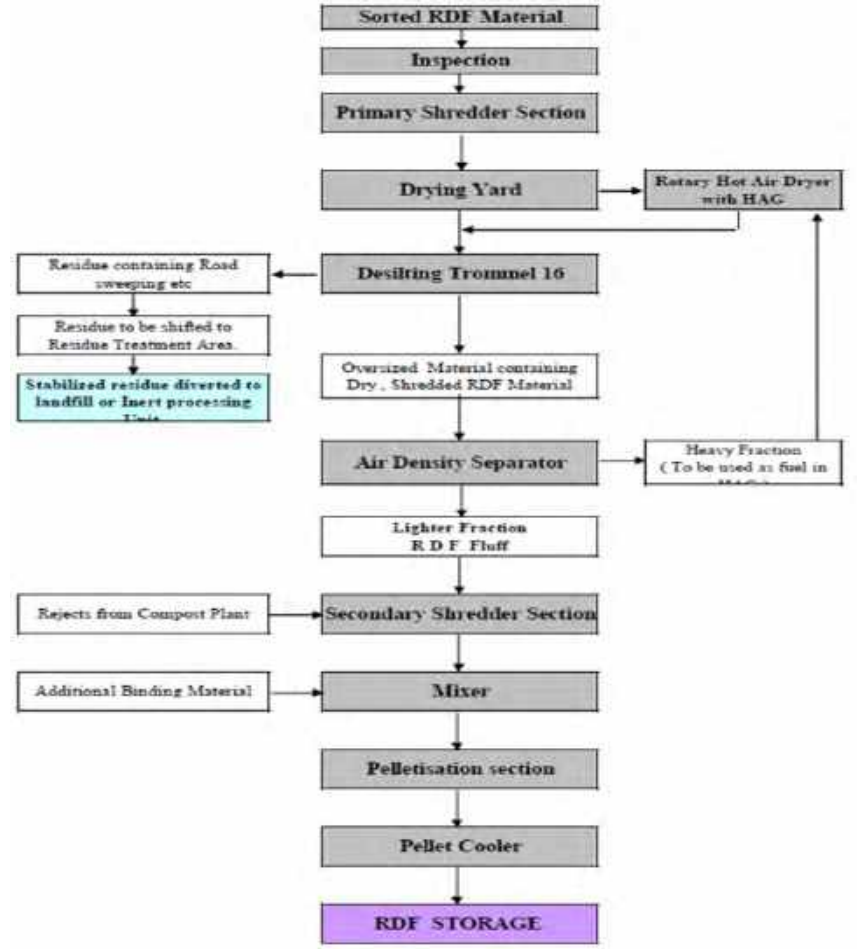
The incoming waste is put on a large primary crushing system to bring waste to a particle size (50-100 mm) in order to homogenize the mass for better handling as well for faster drying. Before putting the waste into the crushing system, manual sorting of large pieces of stones, tyres, etc. are done on a sorting belt conveyor. A magnetic separation unit is also attached to the sorting conveyor to remove ferrous particles. Waste coming out of the Primary Crushing System is spread over a paved yard. Then the waste is dried in a hot-air rotary drying system to reduce its moisture content to 15%. The hot air is generated in a fixed grate specially designed Hot Air Generator (HAG) where woody biomass extracted from waste is burnt. The heavy non-combustible fractions of waste like stones, glass etc. are separated by passing it through the specially developed air classifier in which the light combustibles and heavy combustibles materials are separated like wood, cloth, etc. for firing in the hot air generator. The dried and segregated waste is further grounded to produce Fuel Fluff.

The fuel fluff is sent to the densification unit to make fuel pellets. Then both fuel fluff and pellets are directly sold in the market. This fuel fluff is prepared into different categories based on its calorific value (CV).

The plant produces 10-20 MT G1 grade, 20-30 MT G2 grade and remaining 100 MT is of G3 or SCF grade.

- G1 grade has CV of 3500-4000 kcal and is sold at the rate of Rs. 1700 per MT
- G2 grade has CV of 2500-3500 kcal and is sold at the rate of Rs. 1000 per MT,
- G3 grade or the Solid combined fuel (SCF) has lower calorific value and is used in cement industries.

Flow Diagram of RDF Pla



The SCF fraction is sent to Chandrapur (Ambuja Cement Factory). The remaining RDF fluff is sold to the private agency at the rate of Rs. 800-1500 per MT. This plant produces 200 MT of RDF per day. The revenue generation is approximately between Rs. 4-5 lakh per month through sale of RDF.

Converyor Belt

Primary Crushing

Seperater

Densification Unit

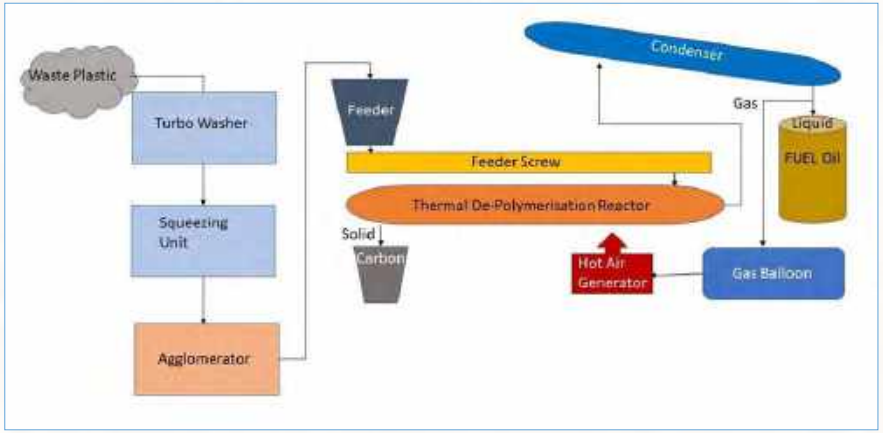
Leachate treatment plant

60% of the leachate, which comes to the treatment plant is from composting plant, while 40% is obtained through underground drains from the landfill site. The plant has a capacity of 0.6 MLD. The leachate quality and quantity vary seasonally. During monsoon; the quantity is 200 cu. m. while post monsoon, it is 100 cu. m. per day. After the treatment, leachate is used for production of biogas which is further used to generate electricity. The sludge is dried and used as a manure. The water coming out of the plant is used for maintaining the moisture in windrow composting (50%) and for irrigation after dilution (50%). The O&M cost of this plant is Rs. 2 Lakh annually, and the total requirement of electricity is 200kW to run the leachate treatment plant out of which 50 kW is self-generated.

Plastic to fuel plant

The plant has a capacity to process 4 MT of plastic with an efficiency of loading of 400 kg per hour. In this plant, only good quality of plastic is processed for fuel production while the remaining is used as RDF. The entire process finishes in 10 hours. The output is FO grade oil, which is used in small industrial furnaces. There is 40-45% oil recovery per day, which is equivalent to 1500-1800 litre per day. The generated gas is used in heating purpose, carbon black is sold as solid fuel, which is used in making briquettes. The plant has electricity consumption of 250 kW which is reduced by 110 kW due to use of gas in heating. The O&M cost of this plant is Rs. 90,000 monthly. The high CV of FO grade is almost equivalent to diesel and is sold at the rate of Rs. 35-40 per litre.

Process flow chart for plastic to fuel conversion



Plastic to Fuel Plant

Animal Carcass Incineration

The incinerator has burning capacity of around 300 kg. It takes around 4-5 hour to complete the process of incineration for 300 kg of animal carcass. The output of incineration is ashes and some parts of bones. These bones are disposed in the landfill and ash is used in compost. The O&M cost is Rs. 80,000 per month.

Animal Carcass Incineration Plant

Steps followed in Animal Carcass Incineration plant	
Step One:	Loading of the animal waste (weight more than 200 kg) at the furnace bed by overhead crane.
Step Two:	Then cover the dead animal waste by mixture of RDF and biomass.
Step Three:	Now after closing the bed, start primary burner and immediately turn on the I.D.
Step Four:	After few minutes turn on the secondary burner, the secondary burner must be heated for 15 minutes
Step Five:	Charging the incinerator with small waste (Hydraulic gate)
Step Six:	Maintain two-hour average temperature of 500°C-700°C during waste combustion cycle until all waste is incinerated to ashes/ bone-chips.
Step Seven:	All emissions must be vented through the single stack exhausting the incinerator.

Biomethanation Plant by Co-fermentation

Facility Highlights	
Area	6000 sq.m.
Processing Capacity	30 MT per day
CAPEX	Rs 8,02,00,000
OPEX	Rs 5,00,000 per year
Power Generation (in kWh/day)	3300

The concept of co-fermentation in this plant incorporates co-generation of heat and electricity. The heat generated is used for pasteurization and for increasing the temperature of the digester for an enhanced digestion process. The plant has capacity of 27 MT and processes daily 10 to 15 MT of organic waste from approximately 500 restaurants and 10 to 20 MT of septage from 400 community toilets, which is collected by trucks and delivered to the plant.

Approximately 2,500 cu. m. biogas and 3,300 kWh of electricity is produced per day. This electricity is fed to the MSEB grid, which is utilized by NMC to avail rebate on monthly electricity bills. The additional power generated by the company is the source of revenue. The nutrient-rich effluent from the treated septage can be used as moisturizing agent in the composting process. The sludge produced can be utilized in the composting plant. There are 18 workers deployed in this plant. The capital cost was around Rs.

8.02 crore (Rs. 6.8 crore from GIZ and 1.2 crore from VWMSPL). This project is implemented in DFBOOT (Design Finance Build Own Operate Transfer) mode of contract between VWMSPL and NMC is for 10 years. During this period NMC would pay Rs. 4.94 Lakh per year to the company for O&M cost.

Biomethanation Plant, Nashik

Sanitary landfill

The scientific capping of old dumpsite with an area of 4.8 hectares is under process and a new land area of 1.4 hectares has been selected for the development of sanitary landfill. Presently 30% closure has been done in Phase I covering the 20,000 cu. m. portion of the total 400000 cu. m. of area. The amount of garbage is estimated to be around 34,000 Tons. The total cost of closure of old dumpsite and the development of new Sanitary landfill is Rs 14 crore.

Converting Sanitary Landfill to Gardening

To know more

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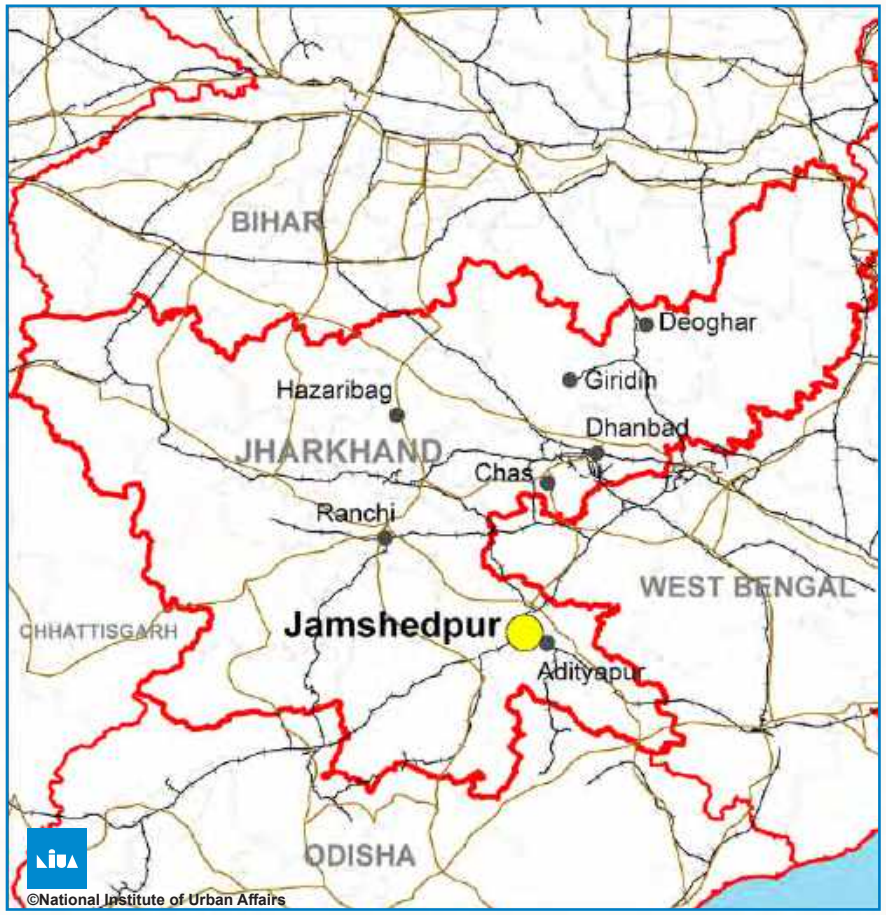
20

JAMSHEDPUR

Jamshedpur



Snapshot: Jamshedpur Notified Area Committee

State	Jharkhand
Area	99.75 sq. km
No. of Wards	240
Population	7,25,623
Total Waste Generated	349 MT per day

Jamshedpur is one of the oldest and is considered as the largest existing industrial town in India. It is also one of the first industrial planned cities of India and most populous urban agglomeration in the Indian state of Jharkhand. It was founded by Jamsetji Tata (Founder of Tata Groups) and was also named after him.

Jamshedpur ranked as 15th cleanest city in India in the Swachh Survekshan 2019 and was 7th cleanest city of India in 2010. The city also ranked as 2nd in India in terms of 'Quality of Life', and 84th fastest growing city of world according to City Mayors Foundation.

Tata Steel's town division, now under Jamshedpur Utility & Services Company (JUSCO), a subsidiary of the steel major, provides municipal and civic facilities to the city.

Jamshedpur has an organized 100% door to door waste collection and transportation controlled by JUSCO through its own team of conservancy workers. Currently, 86% of the households segregate waste into wet and dry. About 349 MT is generated every day and to manage the waste generation; JUSCO has roped in 257 waste pickers for door to door waste collection and segregation in the project named 2 Bin 1 Bag.

Sporting uniforms that come with safety masks and gloves, waste-pickers steer vans or carts to collect garbage at ECC Flats in Kadma, Jamshedpur.

In the early phase of the project, an enumeration drive was taken up by JUSCO to identify the number of waste pickers living in the city which gave an overview of the social and economic status of waste pickers. JUSCO then developed a system for issuance of occupational identity cards to waste pickers, which provided them access to all social security benefits granted by the Government of India (GOI).

Each waste-picker has a cart or a van with a green bin to collect kitchen and garden wastes; a red bin for collecting used sanitary napkins, bandages, rejected razors and blades, used syringes and injection vials; and a white bag for dry items such as plastic, paper, glass, rubber, cosmetics and e-waste.

Each team comprises of seven waste pickers. One represents as the team leader with whom work order is placed for rendering services of door to door collection. The remaining waste pickers are team members. A pilot study was done at ECC flat complex of 1500 households, Farm area colony - 500 household and Kadma Market consisting of 400 establishments to assess the facts for scaling up to entire Jamshedpur city. Based on the pilot study a total of 257 social entrepreneurs were engaged to cover 44,191 house holds for door to door collection of source segregated waste from this project.

The household waste contents of the green bin are taken to the JUSCO compost plant near Jubilee Park. The red bin trash goes to the Bara landfill. The white bag items go to the dry waste collection centre at Kadma, from where they reach the recycling units. The dry waste are further segregated at Dry Waste Collection Centre (DWCC), and the revenue which is generated through sale of recyclables is an incentive for the waste picker. This is for motivation and retention.

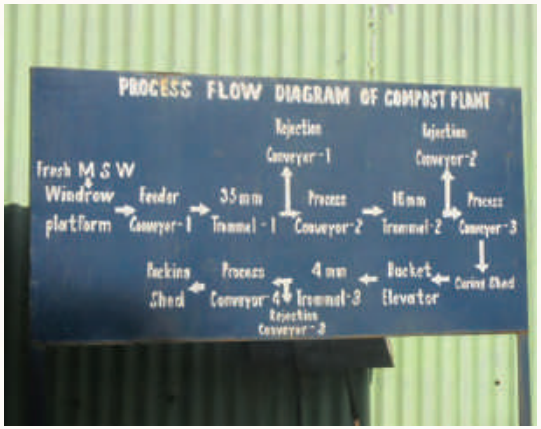
Composting Plant, Jubilee Park

Facility Highlights	
Area of facility	2 acres
CAPEX	Rs. 4,00,00,000
OPEX	Rs. 2,00,000 per month
Manpower	8

The composting plant near Jubilee Park handles this segregated wet waste and has a capacity of handling 50 MT of waste. Fresh garbage is stacked on the windrow platform. This is followed by mixing of inoculum and water with the garbage heap. This is done in order to fasten the

process of decomposition of organic matter. The moisture content of the waste is maintained at 40-45%, as less than this level would result in the killing of helpful microbes while more moisture would lead to anaerobic kind of decomposition. Water is sprinkled on the heap on a daily basis and it is turned at least once every week, so all the parts of wet waste get in contact with air. By the end of the fourth week the heap is decomposed completely, except items that take longer time to decompose (molasses, coconut fibre and shell etc.). These items are separated from the ready compost by a set of screening. First screening is of 35 mm, where larger objects are removed, and then the second screening is of 16 mm, where stones and other smaller undesirable particle are removed. After this, the product is again left for about 15 day for further decomposition, then again the same is passed through 8 mm screen , after which the compost gets ready.

Trommel



Process flow diagram

Dry Waste Collection Centre, Bistupur

The dry waste collected through door to door collection are brought to the DWCC centre. The DWCC has a storeroom and a change room. The entrance gate is wide enough to allow easy entry to the vehicles that bring in the collected waste. Once the waste is brought to the DWCC, the dry waste is divided into fifteen categories. Periodically when the resource grows into a substantial volume, it is sold off through a transparent process to the recyclers. The revenue which is generated through the sale of recyclables is completely an incentive for the waste pickers.

DWCC

Tricycle for Waste Collection at DWCC

Paper waste

Before the commencement of the project, the income of each waste picker was approximately Rs. 3000 per month. After the project; the income of each waste picker increased up to Rs. 14000, which includes a basic pay of Rs. 7202 per month and incentive up to 3000 per month, plus Provident Fund and Employee State Insurance benefits.

Key Highlights

- ✓ Increment in the income of waste picker and formalization of informal economy.

Biogas Plant at Xavier School of Management (XLRI), Sakchi

Facility Highlights	
Plant Capacity	1 MT per day
Area	45 sq.m
Bio Gas Generation	40 – 45 m^3 per day
CAPEX	Rs 3,00,000
OPEX	Rs 12,000 per month

Xavier's Labour Research Institute (XLRI) is the oldest management institute in the country. Under the campus sustainability initiative, XLRI converts about 400 kg of food waste to energy as part of its programme to reduce carbon emissions. The food waste from the college's five cafeterias goes into a giant biogas digester that generates gas equivalent to two LPG cylinders per day, or about a fifth of the kitchen fuel needed to feed 1,100 students on campus.

Biogas Plant

In similar manner, the biogas plants have been set up at - Chemmury Guesthouse in Northern Town, three graduate trainees' hostels in Kadma, residential flats near Kadma police station, Tata Football Academy in Bistupur and Tata Main Hospital. Three more are on the anvil at Tayo Rolls, JRD Tata Sports Complex and the centralised kitchen for midday meals at Ramdas Bhatta community centre.

Key Highlights

- ✓ The installation of biogas plant is helping in managing the food waste at source and saving the cost of LPG to cook food at canteens.

Recycling Plastic Waste to Construct Road

Road is made from waste plastic

The disposed plastic ranging from polybags to biscuit packets are used for constructing roads in the city using bitumen technology. JUSCO has constructed 12-15 km roads in the steel city, as well as widened 22 roads using the environmentally-friendly technology. Bitumen, also commonly known as Asphalt, is a sticky, black and highly viscous liquid or semi-solid form of petroleum. The primary use of bitumen is in road construction, where it is used as the glue or binder mixed with

aggregate particles to create asphalt concrete. The initiative is helping in reducing the use of bitumen by 7% in construction. For every stretch of such one km long and four metre wide road, one ton of bitumen costing Rs 50,000 is saved. The quality and longevity of roads made of waste plastic-aggregate-bitumen is two times better than bitumen road.

Key Highlights

- ✓ The installation of biogas plant is helping in managing the food waste at source and saving the cost of LPG to cook food at canteens.

Takeaways from the Project

- ✓ Gainful employment of waste pickers and appropriate solid waste management.
- ✓ JUSCO has helped waste pickers to become social entrepreneurs and led them towards better living conditions.
- ✓ City Reducing 90% of waste going to landfill site.

To Know More

JUSCO Chief Divisional Manager (Public Health Services)
Website: www.juscoltd.com
Email: corpcomm.jusco@tatasteel.com
Phone: 0657-6646000

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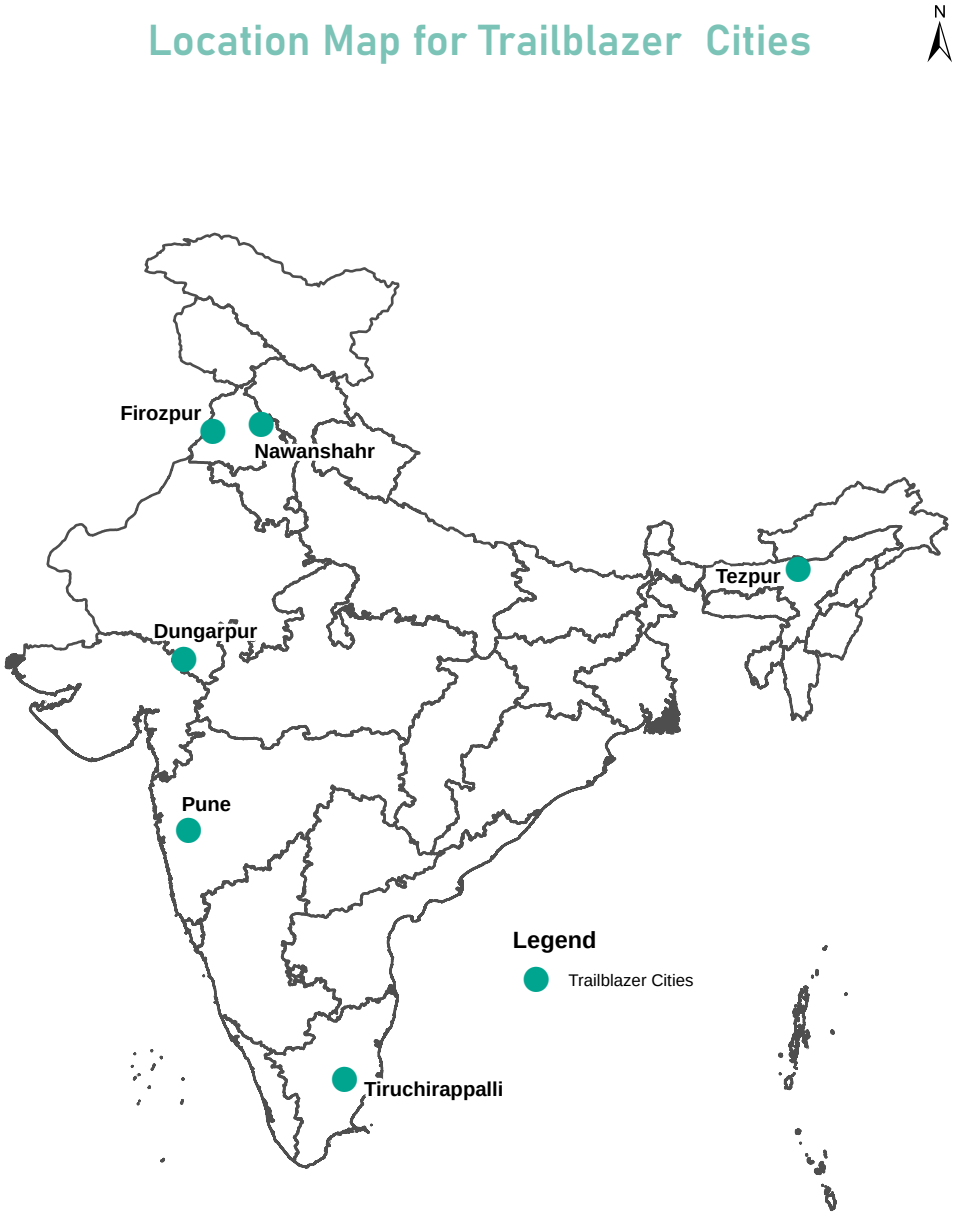
Location Map for Trailblazer Cities



By definition; a trailblazer is a leader, who is the first to do something that other people do later. In order to improve the efficiency of waste management services, ULBs across India are seeking and even coming up with innovative methods. These innovations are cost-effective, environment-friendly, and definitely the need of the hour. SBM's SWM workshops scoped for these innovative methods so as to showcase these case studies to other ULBs, inspire them, and support these best practices.

TRAILBLAZER CITIES

21

PUNE

Pune

Snapshot: Pune Municipal Corporation

State	Maharashtra
Area	331 sq. km
No. of Wards	15
Population	31,32,143
Total Waste Generated	1600-1700 MT Per day

Pune is the second largest metropolitan city in Maharashtra and is an important city in terms of its economical and industrial growth. Once the hometown of Marathas and a centre of power for the Maratha Empire, the presence of the numerous edifices in Pune links to its rich and glorious past.

The city is rapidly changing its character from a Pensioner's city to Educational –Administrative Center and now to an important Industrial hub with reference to the IT Center. The Pune Municipal Corporation (PMC) is the civic body that governs the city.

The solid waste management model of Pune has made big strides in recent years. The success of the 'Pune model' of Solid Waste Management (SWM) is often discussed as a model that should be replicated. The 'Pune Model' of SWM showcases 'stakeholder engagement' that extends from rag pickers' collectives, to citizen groups, NGOs, educational institutions and corporators.

Pune Solid Waste Management Model

In 2008, Pune Municipal Corporation (PMC) signed a five-year memorandum of understanding with SWaCH to decentralize the door to door collection services.

> In 2005, Kagad Kach Patra Kashtakari Panchayat in collaboration with SNDT's Department of Adult Education implemented a pilot program to upskill 1,500 waste-pickers as service-providers for door-to-door collection (DTDC) of household waste. This pilot not only improved livelihoods and work conditions, it also bridged the gap between households and the municipal waste-collection service. SWaCH Pune Seva Sahakari Sanstha was formed in 2007 from this very program.

As per the contract, SWaCH was responsible for collecting segregated waste from households, institutions and commercial establishments, depositing the waste at designated collection points, and charging a user fee. The agreement also authorized waste collectors to retain the right to the income earned from the recovery and sale of recyclables from the aggregated waste.

The door-to-door collection program was introduced first through a pilot in apartment complexes in wealthy areas, where citizens were highly aware, and had a willingness to pay, and were politically supportive of the initiative. The success of the pilot created demand in other areas of the city. Awareness initiatives, including rallies, one-on-one meetings, wand political endorsement by local councilors, further generated support for this initiative. In 2016, the agreement between PMC and SwaCH was renewed for another five years.

Through this arrangement, SWaCH cooperative members collect segregated (separated wet/organic waste and dry waste such as plastics, glass, paper, etc.) waste from households. The non-recyclable garbage is further segregated in sheds provided by PMC to retrieve recyclables such as paper, glass, and plastic for sale (Waste collectors retain all income from the sale of reclaimed materials). The wet/organic and non-recyclable waste is dropped off at PMC's 'feeder points,' from where it is collected by the municipal garbage trucks and sent to the processing sites.

Door to door segregated collection of waste by SWaCH member

Segregation of dry waste by SWaCH members

Source: https://swachcoop.com/

Dry waste shed at community level

Dry waste shed at ward level


Sorting of dry waste by SWaCH members at the dry waste shed

SWaCH members collect monthly user fees ranging from Rs. 10 to Rs. 40 per household and INR 100 per commercial entity for waste collection services. PMC partially subsidizes the collection costs in the slums so that households pay about Rs. 5 per month. The waste collection equipment and PPE are provided by PMC to the SWaCH cooperative members.

Since the SwaCH model is based on customer satisfaction; the service provider is directly accountable to the user and has incentives to provide quality services. The service provider is entitled to collect waste dumped outside homes, which encourages user compliance. PMC conducts individual consultations with households to gain user support and levies penalties on users who fail to provide payment for the services. In addition, to provide financial resilience to the public-private partnership, PMC provides an ongoing annual grant to SWaCH that covers management and training costs, awareness-generation programs, and welfare benefits for members of SWaCH. The grant does not cover the salaries of the collectors.

To encourage citizens to treat waste at the source and save logistical costs spent on handling and transportation of waste; PMC rebates 5 percent of property taxes to institutions. Many of these institutions hire SWaCH members to collectively compost about 10 tonnes of waste per day.

In 2016 SwaCH diverted 50,000 tonnes of waste to recycling. SWaCH also provides other allied waste management services such as composting of wet waste in spaces provided by the societies themselves. Members are trained to operate biogas plants and to compost waste. SWaCH members also operate biomethanation plants through build-operate-transfer contracts with the city.

This door-to-door collection partnership model with SWach has helped PMC save approximately Rs. 20 crore per annum in waste-handling costs alone. In addition, reduced vehicle usage for waste collection also significantly helped in reducing the carbon emissions. Through this partnership, Pune has achieved 100% door to door collection and 97% source segregation in its 15 wards besides offering sustainable and efficient daily waste collection services to residents and improving the livelihoods of waste collectors within the city.

For a city that generates 1600-1700 MT of waste per day, processing of waste is a crucial aspect for effective solid waste management. PMC has combined an integrated approach with a decentralised waste management strategy to process and handle the waste collected per day. The city has 25 decentralised Biomethanation plants, which process 120 TPD of waste producing 600kw of electricity and compost; Besides Ajinkya Biofert and Disha Waste Management Plant of capacity

300 TPD and Vermi– compost and compost plant at Hadapsar Ramp & Ram Tekdi Industrial Estate; the organic/wet waste is also processed at 13 decentralized composting and vermi-composting plants. Rochem Separation Systems; a dry waste processing plant at Ram Tekdi Hadapsar, processes about 300-350 TPD dry segregated waste to produce RDF (refuse derived fuel). Townships such as the unique Magarpatta City in Pune also take pride in being near-zero garbage.

PMC has also taken various other initiatives to further strengthen its drive towards effective solid waste management. For example, segregation of waste has been made mandatory for all residents with the levy of user charges. At the same time, there is a 5% tax rebate for those who have onsite waste disposal facilities. PMC makes it a point to highlight and celebrate those who adopt innovative solutions and practices SWM and sanitation, through awards and recognition. Pune's DBOT (Develop, Build, Operate and Transfer) project, NEX, started producing 45 tonnes of bio-CNG per day and 150 tonnes of organic manure at its Talegaon plant, based on anaerobic digestion system, which utilizes food waste from bulk producers such as hotels and markets. Pune's Municipal buses will soon use the fuel generated.

Key Highlights

- ✓ *SWaCH is India's first wholly-owned cooperative of self-employed waste collectors and other urban poor. It is an autonomous enterprise that provides front-end waste management services to the citizens of Pune.*

Waste To Energy Plant

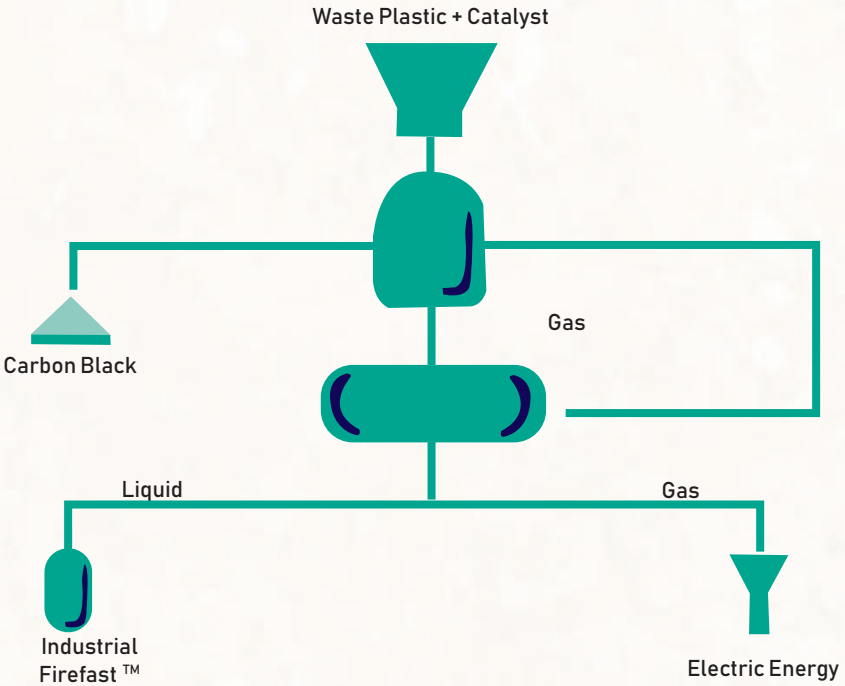
While plastic has been banned in the city, PMC still receives large quantities of plastic waste amounting to 200 TPD. In 2018, the PMC initiated the plastic to fuel plant under corporate social responsibility (CSR) with Pur O Fuel Pvt. Ltd. While the entire cost of operations of the project has been incurred by the company; PMC has provided space for the establishment of the plant, as well as water and electricity connections. The company invested Rs. 3.5 crore in the project.

Pur-O-Fuel Private Limited is a Private company incorporated on 05 October 2018. It is classified as Non-government company and is registered at Registrar of Companies, Pune.

Facility Highlights	
Name of the Facility	Plastic to Fuel Plant
Location of the Facility	Ghole Road Ramp, Opp Mayor Bunglow, Pune
Area	5000 sq. m.
Land Ownership	PMC
Year of Establishment	2019
CAPEX	Rs. 365 Lakh
Processing Capacity	4 TPD
Total Manpower	16

The plant currently processes 4 tonnes of plastic per day. Plastic is converted into fuel using an Indigenous process developed by Pur O Fuel Pvt. Ltd & Instroll Pvt. Ltd. The company has successfully registered for patents for the process, equipment's and catalyst.

Process Flow Diagram of Biomethanation Plant



The pre-processed raw material is introduced in reactor at elevated temperature in presence of a catalyst. The long chain hydrocarbon molecules in raw material are cracked into hydrocarbon vapors, hydrocarbon liquid and carbon black. The process parameters can be set to get desired quantity of liquid fuel or gaseous fuel as per requirement. Also, properties of fuels can be tweaked by setting appropriate process parameters. The resulting liquid fuel from the process is completely "Wax free". The products obtained from the process comprise L.D.O (Light Diesel Oil), dry carbon and combustible gas.

Key Highlights

- ✓ *The process is efficient, safe and simple. The flexibility of the process along with the efficiency and safety makes the process full proof and economically attractive.*

Mailhem Bio-Methanation Plant, Katraj

Facility Highlights	
Name	PMC Katraj K3,K4 Biogas Plant
Location	Katraj Kachara Ramp, Opp Katraj Dairy
Area	3375 sq. m.
Land Ownership	Pune Corporation
Owner of the facility	Mailhem IKOS Environment Pvt. Ltd ,Pune
Year of Establishment	June 2014
Type	Decentralized
Type of input	Segregated Wet Waste
Processing Capacity	10 MT per day
CAPEX	Rs. 1.8 cr
Total Manpower	10

The Bio-methanation plant at Katraj was established in 2014 to process the market and hotel waste of the Katraj area. Mailhem uses a proprietary Bio-methanation technology - Modified Up flow Anaerobic Sludge Blanket (M-UASB) for the effective treatment of organic waste. The technology has been proven successful in terms of Biomethanation for almost 25 years so far.

At first, the segregated wet waste collected from the sources is brought to the plant site. Then the market and food waste are crushed using a shredder and mixed with water to form slurry. The same is then collected in a mixing chamber. The slurry from the mixing chamber is then fed to the Mailhem® Anaerobic Digester.

Crushing of waste to form a slurry

In the Mailhem® Anaerobic Digester, the Organic Waste is converted to biogas and digestate. The biogas generated from the anaerobic digester is collected in the biogas holder. The same is further suitably scrubbed for H_2S removal and H_2S level in the gas is brought down to acceptable level for feeding to 100 % Biogas Genset for Power generation. Part of the digestate liquid overflow is recycled to feed slurry preparation and to save fresh water use. Balance liquid overflow can be utilized as liquid soil enricher after suitable dilution or connected to existing STP / ETP by client. The digestate slurry is removed periodically from the bottom of the digester and is used as a good soil enricher.

Biogas stored in the biogas holder

The operational cost is borne by the corporation and in addition, Rs. 800-1000 per ton tipping fee is provided.

Products Obtained	
Biogas	Approx. 600 to 630 cum/day
Equivalent Power	Approx. 625 to 650 Kwhr electrical units per day
Digestate Soil Enricher	Approx. 30 tons per month (in thickest slurry form)
Digestate Liquid Soil Enricher	Approx. 20 cu. m/day (part of it is recycled back into the system)

Key Highlights

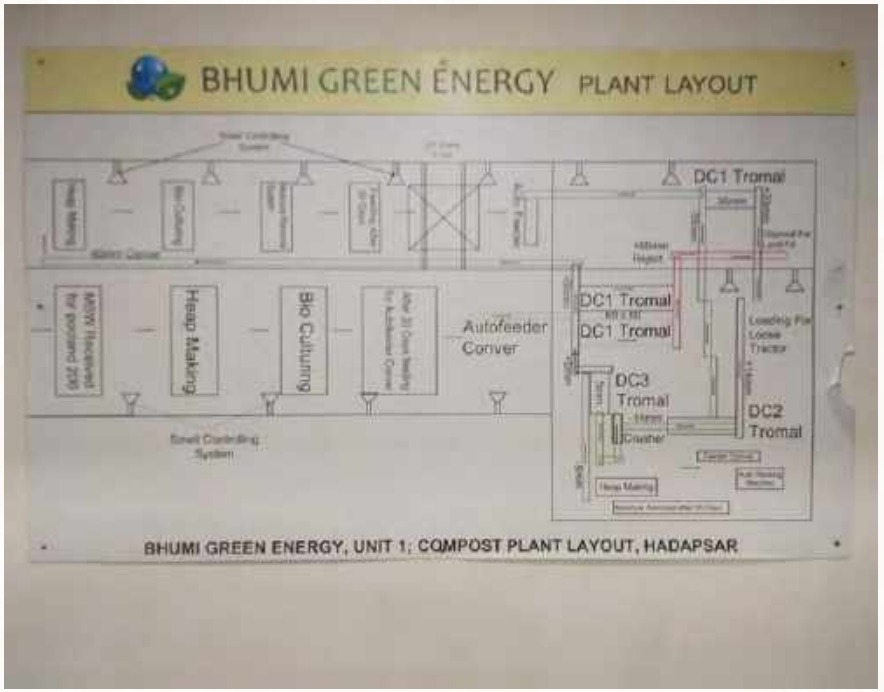
- ✓ *Mailhem Ikos has won the title of Garbage Guru in the India Today's 'Safaigiri' Summit & Awards, presented by our Honorable Prime Minister, Shri Narendra Modi on 2nd October 2015.*
- ✓ *This model can be an example to set decentralized unit across various cities. With this technology, even Bio-CNG plant can be set-up with dispensing units.*

M/S Bhumi Green Energy Composting Plant, Pune Maharashtra

Facility Highlights	
Name	M/s Bhumi Green Energy- Pune Maharashtra
Location	Hadpsar – Pune
Land ownership	Pune Municipal Corporation
Owner of the Facility	Partnership firm
Year of Establishment	15th December, 2015
Type	Centralized
Type of input	Wet waste
Input Capacity	200 MT per day
CAPEX	Rs 25 cr.

The Composting Plant at Hadpsar is a Turnkey project. The wet waste is processed through windrow method to obtain high quality compost, which is also certified by the guidelines of the Fertilizer Control Board.

Bhumi Green Energy, Unit I: Compost Plant Layout, Hadapsar



At first, the obtained waste is passed through a shredder. After adding the necessary quantity of bioculture and sufficient moisture, windrows are formed. The moisture content of the windrows is maintained as 45-55%. Once in every week, the windrows are turned and mixed thoroughly.

After a period of three weeks, the partially composted waste is then subjected to mechanical processing. The mechanical processing system comprises of different types of trommel screens with sieve sizes.

Sieving of compost

Compost packed and stored

Source: https://www.indiamart.com/bhumigreenenergy/compost-fertilizer.html#city-compost-fertilizer-powder

The majority of the inorganic and inert materials get removed and the sieved organic materials below 14 mm size is kept for curing process. Later the compost is refined through trommel screen followed by gravity separators to remove materials like sand, silt, etc. The final obtained compost is then packed and stored. The rejected waste is being used for scientific land filling.

The compost is directly sold to the farmers. Central funds assistance is received for the compost sold to the farmers.

Terrace Garden: Sahavardhan

Besides, the Pune Municipal Corporation, the residents of the Pune city have also come forward to contribute towards managing the solid waste innovatively.

A group of citizens called "Sahavardhan" took an initiative of converting Pune Municipal Corporation's office rooftop into a terrace garden. The group approached PMC which immediately agreed upon to lend the terrace of their Ghole Road Ward Office for the project. Pune Municipal Corporation sanctioned 1200 sq. ft. for the Terrace Garden Project and a Whatsapp Group was created asking interested, like minded citizens to join for the noble cause.

> Sahavardhan believes in the principle of "Alone, I cannot, together we can '.It's an opportunity to connect like-minded people with nature. Citizens like Retired Medical Scientist Shri Ram Datar and Shyamala Desai have been instrumental for this initiative.

Once the space was acquired, the group got engaged in collecting materials to develop a terrace garden. Instead of buying new pots, the group decided to recycle the available material. Pune Municipal Corporation provided raw materials, compost and coco-pits for the terrace garden project The Encroachment Department of Corporation also stepped in to help the group. Plastic crates procured from the encroachment department were used to plant samplings and seeds. Shredded coconut and wet waste obtained from Pune Municipal Corporation plants were converted into fertilizers to form the base and nestle the saplings. A variety of vegetables and herbs have been planted in over 100 crates.

Crates used for growing vegetables at the terrace

The project is not restricted to residents of Ghole Road and nearby areas; many citizens living in other parts of the city visit the terrace garden at least once a week to volunteer. Till date there have been total 21 volunteers. The volunteers are divided into 7 groups of three members each. Each group has been given the responsibility of volunteering for a day. The group creates a video blog and shares the list of tasks for the next group.

The committee members of the Sahvardhan Group do constant monitoring and follow-up, which is an integral element for the project to function smoothly. On an average, 2.5 kg wet waste gets processed in a day. The project was inaugurated on 2nd October 2019 and has proven to be a successful model. Sahavardhan and Pune Municipal Corporation have plans to extend the project to other locations.

Home Composting at Sathe Bunglow

Sathe Bunglow is an individual bunglow owned by Mr. Ashutosh Sathe & Madhumati Sathe. The residents practice home composting and have developed an organic garden, setting an example for other residents. Mrs. Sathe is a retired teacher and she started this initiative to recycle their wet waste at source. The wet waste is processed using various techniques in the backyard, for example, leaf and garden waste is processed through pile composting method, similarly, vermi-composting and pit composting are also practiced. The huge garden comprises of vivid vegetables, fruits, flowers, and unique species of trees. Mrs. Sathe has also won an award for her dedicated efforts.

Awarded with Swachh Nagrik award for dedicated efforts towards waste management

Mr. Sathe sharing his experiences with the participants

Garden waste turned into compost

To Know More:

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Pur O Fuel Pvt. Ltd
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M/s Bhumi Green Energy – Pune Maharashtra
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Sahavardhan
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22

TIRUCHIRAPPALLI

Tiruchirappalli

Snapshot: Tiruchirappalli City Corporation

State	Tamil Nadu
Area	176.23 sq. km
No. of Wards	65
Population	9,84,833
Total Waste Generated	450 MT per day

Tiruchirappalli, also known as Trichy, is the fourth largest city of Tamil Nadu and the transportation centre of the State. Located on the banks of river Cauvery, Trichy is famous for the 'Rock fort' located right in the middle of the city. Tiruchirappalli City Municipal Corporation (TCC) looks after the city administration of Tiruchirappalli. The city is subdivided into 4 administrative zones and 65 wards for effective administration. The corporation generates 450 MT of waste per day.

As per the SLB report by TCC for the year 2018-19, the city has achieved 100% household level coverage of solid waste management services, 100% efficiency in collection of municipal solid waste and 100% segregation of municipal solid waste.

SLB Benchmark Report for the year 2018-19				
S. No.	Indicators	MoHUA Benchmark	Service level Benchmarks	
			Status 2018-19	Target 2019-20
1	Household Level Coverage of SWM Services	100%	100	100
2	Efficiency of Collection of MSW	100%	100	100
3	Extent of Segregation of MSW	100%	100	100
4	Extent of MSW Recovered	80%	82	82
5	Extent of Scientific Disposal of MSW	100%	NA	NA
6	Efficiency of redressal of Customer Complaints	80%	80	80
7	Extent of Cost recovery in SWM Services	100%	100	100
8	Efficiency in collection of SWM charges	90%	90	90

Source: Tiruchirappalli City Corporation

Tiruchirappali City Municipal Corporation took great efforts to achieve 100% source segregation in all the wards. TVS Nagar located in the Ward No. 43 of TCC, comprising 141 houses generated about 253 kg of waste per day. No waste segregation practice was followed by the residents in this ward earlier. In order to achieve 100% source segregation in this ward, continuous awareness meetings with the residents, RWA's and SHG's for waste segregation were conducted by the corporation officials. An animation team was engaged to raise awareness towards waste segregation. The team organized community level programs twice a week. After months of efforts towards building awareness on waste segregation, residents started practicing source segregation. This initiative further helped the corporation achieve the target of 100% source segregation in the city.

Segregated door to door collection

After achieving 100% source segregation, the corporation then started building awareness towards home composting to reduce the quantum of waste going to the compost yard. The residents were explained the process of home composting by the animation team with the help of videos and pictures. In addition to this, the corporation also organized a "National level Expo" with an aim to help residents familiarize with the methods and devices available for practicing home composting. Moreover, various environment-friendly products and alternatives to banned plastic products were also displayed at the exhibition. After a month of efforts, many residents came forward voluntarily to practice home composting.

The non-biodegradable waste is collected by the corporation workers once a week, usually on Wednesdays. The collected non-biodegradable plastic waste is further segregated and handed over to the recyclers. The benefit of sale is handed over to the waste collectors.

Bulk Waste Generators contribute to nearly 30-40% of the daily waste. In order to reduce the quantum of waste at source, Tiruchirappalli City Corporation has identified 48 bulk waste generators, who are instructed to have onsite facility to process wet waste at source. At the same time, ULBs are required to identify the bulk waste generators, to organize meeting for all BWGs in the Corporation limit and explain the need of reducing waste and issued notices to make onsite facilities to handle waste in their own way.

Vermi-Composting at State Bank Institute of Learning & Development (SBILD)- Bulk Waste Generator (BWG)

The SBILD was established as a staff training centre in 1967, located inside the SBI, Trichy campus in Ward No. 44. It is one such example where the BWG is efficiently managing the waste at source. SBILD is built on a sprawling campus of about 2.25 acres, generating approximately 100 Kgs of garden and bio-degradable waste daily on an average. Earlier, the garden waste was aggregated at a place and was burned once in ten days. After the City Corporation's instructions to all Bulk Garbage Generators to effectively process the wet waste in their own premises, a solid waste management system at a cost of Rs. 3.60 Lakhs was established in the campus where the bio-degradable waste is processed through vermi-composting.

Facility Highlights	
Name	Bulk Waste Generator Responsibility
Location	Ward No.44, SBI bank Campus
Area	2.25 acres
Owner of the facility	SBI
Year of Establishment	2019
Type	Decentralized
Type of input	Wet
Input Capacity	0.10 MT per day
Processing Capacity	0.45 MT per day
Total Manpower	08

At first, the collected bio degradable garden waste and kitchen waste is put into the decomposition pits of size 30 ft X 5 ft X 3 ft (lxbxh) upto a height of 9 inches. Decomposing bacteria is sprayed on the waste to facilitate faster decomposition. Another layer of waste is then added to a height of 9 inches and again decomposing bacteria is sprayed. This process is repeated till the pit is completely filled. About 20 Litres of water is sprayed on the waste on alternate days so as to maintain humidity and conducive temperature to facilitate better decomposition. In about 30 to 40 days, the waste will be partially decomposed and is ready for being shifted to the Vermi-Composting Pits.

The partially decomposed waste is spread in the vermi-composting pit (20'X 5'X 3') upto a height of 9 inches. On top of the partially decomposed waste, fresh cow dung layer of about 6 inches is spread. About 11 liters

of decomposting bacterial preparation is further added. On the second day, earthworm (procured from Uppida Managalam Organic Farm, located near Trichy) is introduced into the pit. Water is sprayed every alternate day to keep the vermi bed moist. The vermi bed is covered with gunny bags to maintain the moisture level and to also get protection from the birds. By 23rd to 25th day, the earthworms start feeding on the partially decomposed waste and converts it to vermi-compost. In 20 to 30 days, about 30 to 40 Kgs of vermi-compost can be obtained. Till date, the facility has obtained 1347 Kgs of vermi-compost from this project, of which 685 Kgs has been sold at Rs. 20 per kg, aggregating to be Rs. 13700/- . The remaining vermi-compost is used within the campus.

Vermi composting pits at the facility

The campus is also producing its own Vermin Seed from the earthworm seed procured from the Agriculture University/ Producers approved by Directorate of Organic Certification, Government of TN. Through this project, a lot of waste is now handled at source and in turn rich manure is obtained which is again reused in the campus.

Biomethanation plant at Ambethkar Nagar Buriyal Ground

Facility Highlights	
Location	Ambethkar Nagar, Ward No.4, Srirangam Zone
Area	1400 sq.m.
Owner of the facility	Trichy Corporation
Year of Establishment	2015
Type	Decentralized
Type of input	Wet
Input Capacity	5.00 MT per day
Processing Capacity	4.50 MT per day
Total Manpower	07

The segregated organic municipal solid waste is brought into the plant site. It is further crushed using Crusher/pulverizer along with suitable quantity of water to form slurry. The slurry is then collected into an Inlet cum recycle chamber and then fed to the anaerobic digester. In the anaerobic digester, the organic waste is converted into Biogas, Bio-manure and Liquid overflow.

Part of the treated overflow from the digester is recycled back for the slurry preparation and the remaining is discharged for suitable treatment. The bio-manure is periodically removed from the digester and is used as a good organic manure or soil conditioner. The biogas generated from the anaerobic digester is collected in the biogas holder, suitably pressurized, cleaned and used for power generation. This process is based on a "zero garbage disposal" concept. Monitoring of the process is done daily to maintain a high-quality operation.

Making slurry to feed into digester

Digester

Details of the Digester	
Digester retention time: (Hydraulic retention time(HRT) / Solid retention time (SRT)	25 days
Type of high rate bio-methanation digester	Modified UASB
Digester Model (UASB, Modified UASB, Modified UASB, Completely mixed, Fixed bed, plug flow, CSTR,BARC-NISARGRUNA, any other.	Modified UASB

Balloon room

Bio Gas used for

Micro Composting Centre at Ambethkar Nagar

About 27.46 Tonnes of biodegradable waste is collected on daily basis from Ward 4, 5 and 6 of the Tiruchirappalli City Municipal Corporation. In order to minimize the expenditure on secondary transportation, and also to prevent open dumping, micro composting centres have been established to process the bio-degradable waste.

Facility Highlights	
Name	Micro Compost Centre (MCC)
Location	Ambethkar Nagar, Ward No.4, Srirangam Zone
Area	614 sq.m.
Owner of the facility	Trichy Corporation
Year of Establishment	2016
Type	Decentralized
Type of input	Wet
Input Capacity	5.00 MT per day
Processing Capacity	4.50 MT per day
Total Manpower	47

The micro composting centre comprises:

- Waste receiving platform
- Secondary segregation arrangement with organic shredder
- Pits in required capacity to convert shredded bio degradable waste into qualitative manure
- Shredding Machine
- Conveyor Belt
- Stabilization area

Micro Composting Centre is a decentralized waste processing facility where solid waste collected from a particular ward or housing colony through primary collection is scientifically processed in that particular locality.

At first, the collected bio-degradable waste is shredded into 20 mm to 40 mm size using a shredder. The shredded bio waste is then placed in the cubical pits over a thin layer of cow dung or matured compost. Effective microbial solution mixed with rice husk and rice bran is added with the shredded waste before placing it into the pits.

The shredded bio waste with accelerated microbial biomass reduces the volume of the bio waste to one third within seven days. The sequence of placing the waste in the cubical pits is: 1st day- 1st pit 2nd day- 2nd pit, 3rd day – 3rd pit and so on. The mixture in the pits is turned once in every 5 days to ensure sufficient aeration. On the 8th day, second filling of bio degradable waste is done in the same series of pits viz., 8th day- 1st pit, 9th day- 2nd pit, 10th day-3rd pit and so on. On the 15th day, third filling of bio degradable waste is done in the series of pits viz., 16th day- 1st pit, 17th day- 2nd pit, 18th day-3rd pit and so on. After 21 days, second stage of sequence by filling of bio degradable waste is done in the series of pits. After 42 days, the matured manure is dried, sieved and packed for distribution from each pit one by one. Leachate is collected and utilized for moisturizing the compost pit. The degraded matter is kept in a place for three days for stabilization/maturation before packing. Manure is distributed free of cost to the local farmers and public. Stock Register is maintained to keep a stock of organic manure. For daily operations of the micro composting centre, 47 NGO workers are involved.

Monitoring of the composting process is done daily to maintain a high-quality of operation. Compost quality is monitored based on per batch of compost being sold in the market.

Micro Composting Centre at Ambethkar Nagar

Sorting of waste

Shredding of waste

Composting pits at the facility

Key Highlights

- ✓ *The micro composting centres have not just reduced the quantum of waste transported to the dumpyard, but have also reduced the number of community bins used in the city. Earlier there were 7 community bins in the city and after the micro composting centre there are none. The usage of secondary collection vehicles has also reduced.*

Faecal Sludge Treatment Plant (FSTP) at Ponnampatty Town Panchayat

Facility Highlights	
Name	FSTP
Location	Poonampatti Town Panchayat
Area	10.83 sq.m.
Owner	Poonampatti Town Panchayath
Year of Establishment	2017
Type	Decentralized
Input Capacity	6,000-7,000 litres
Processing Capacity	80%
Total Manpower	2

This FSTP was commissioned on March 22, 2017 on World Water Day. FINISH (Financial Inclusion, improves in Sanitation and Health), Lucknow and Ponnampatty Town Panchayat came together to construct this Feacal Sludge Treatment Plant, costing around Rs 7.5 Lakhs (Finish – 6.0 lakhs & Ponnampatti Town Panchayats – 1.5 lakhs)

The septage from the black water feed tank is directed to the Vertical-flow Constructed Wetland (VFCW) (Reed Based Sludge Drying Bed). The three VFCW have a common drain underneath made of stainless steel. Provision is made to supply septage from feed tank separately to first, second and third chamber with appropriate pipe and valve system. The three chambers are filled and loaded sequentially. When the first chamber is filled and is getting dried (Minimum 20 tankers) the septage can be, if necessary be fed in to the second chamber or third chamber through the provisions made with valves.

Each of the three vertical chambers is having different filter materials (Layers of 40 mm, 20 mm, and 6 mm broken stone and a layer of coarse sand at the top). A common drain to collect the percolate is provided, which is covered with a stainless steel (SS) mesh to support the media.

Specific wetland plants are planted with the rhizomes located at the interface of the two layers of media at the top. The rhizomes create flow path facilitating easy movement of the sludge through the media. The media and the root zones also provides habitat for several kinds of bacteria to treat the leachate. The media acts as a filter to allow the partially treated liquid to the drain.

Unloading of septage into Feeding Tank

Septage from Feeding Tank is led into Vertical-flow Constructed Wetland

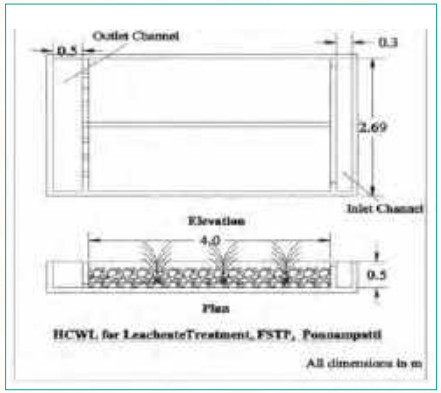
The leachate from the Vertical Wetland is treated in a Horizontal Flow Wetland, planted with standard wetland plants with high oxygen transfer

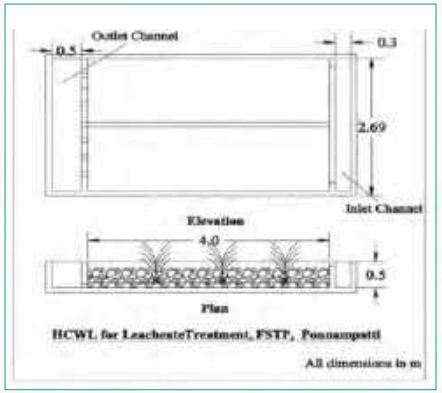
rates (eg Phagmites, Canna etc). The media along with the root zones of the vegetation provide habitat for various microorganisms. The wetland treats the water in various steps including sedimentation, adsorption, plant uptake, and reduction of organic load in the aerobic and anoxic zones within the wetland.

Horizontal-flow Constructed Wetland

Treated water from Horizontal-flow Constructed Wetland sent to collection tank

Layout of Horizontal-flow Constructed Wetland





The treatment here is to improve the quality of the leachate to meet the specifications for irrigation or for use in composting operations. The treated water from the Horizontal Flow Constructed wetland (HFCW) is then sent to the collection tank of the FSTP. The collection tank is provided for the intermediate storage of the treated leachate. The chemical quality of the treated water meets the irrigation standards. The colourless and odourless treated water is used for irrigating the plants and crops in the Resource Recovery Park.

Collection Tank

It is estimated that 75-80 percent of the volatile solids (VSS) in the sludge will be reduced during the long detention time on the bed. As a result of this reduction and the moisture loss, a 3-m-deep annual application will be reduced to 6-10 cm of residual sludge. The useful life of the bed is therefore 6-10 years between cleaning cycles.

The major advantage of the reed bed concept is the ease of operations and maintenance, and the very high final solids content (suitable for landfill disposal). This significantly reduces the cost for sludge removal and transport. A 6 to 7-year cleaning cycle for the beds seem to be a reasonable assumption. One disadvantage is the requirement for an

annual harvest of the vegetation and disposal of that material. However, over a 7-year cycle, the total mass of sludge residue and vegetation requiring disposal will be less than the sludge requiring disposal from sand drying beds or other forms of mechanical dewatering.

Ecosan Community Compost Toilet at Musiri Town Panchayat

The old abandoned toilet in the Musri town panchayat was in a dilapidated state; without proper water supply, roof, drainage or privacy, leading to open defecation. The site of the toilet is adjacent to an irrigation canal and is only 100 meters from the river Cauvery. Around 60 families are using this facility. Musiri town panchayat requested SCOPE to construct ECOSCAN toilet replacing the old toilet to completely stop the practice of open defecation.

The ECOSAN toilet is a closed system that does not need water, so it is an alternative to leach pit toilets in places where water is scarce or where the water table is high and there is an increased risk of groundwater contamination. The toilet is based on the principle of recovery and recycling of nutrients from excreta to create a valuable resource for agriculture.

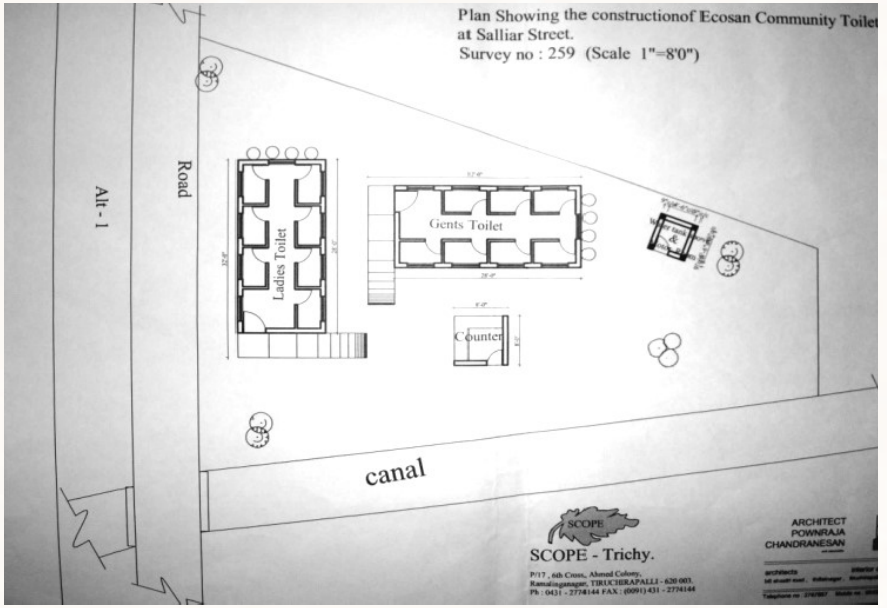
When the pit of an Ecosan toilet fills up, it is closed and sealed. After about eight to nine months, the faeces are completely composted to organic manure and can be used on farms. When the first pit is closed, users can switch to using the second pit.

The community ECOSAN was built with brick walls as super structure and the squatting base and roof with Reinforced Concrete Cement (R.C.C.) The squatting base was kept at a height of 5'6" from the base of the chamber. The height was kept more as the number of users is high.

Ceramic tiles are used for the walls and the floors for easy maintenance. Separate blocks have been kept for men, women, handicapped people and senior citizens.

Ecosan toilet have senior friendly design

Layout of Ecosan Toilet



Community members and SCOPE staff are responsible for the maintenance of the toilet. Town Panchayat is saving around Rs. 50,000 per annum on removal of black water every month. Now the area is healthy and hygienic. Waste water is being used in the neighbouring banana field. The project has been funded by WASTE, Netherlands and the total cost of the project is Rs. 8,50,000.

To Know More:

Tiruchirappalli City Municipal Corporation
E mail ID: commr.trichy@tn.gov.in
Contact No.: 0431-2415329

Society for Community Organisation and Peoples Education (SCOPE),
Ramalinga Nagar, Trichy
E mail ID: scopeagency1986@gmail.com
Contact Number: 9443167190 / 9965567190

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23

NAWANSHAHR

Nawanshahr

Snapshot: Nawanshahr Municipal Council

State	Punjab
Area	125 sq.km.
No. of Wards	17
Population	46,024
Total Waste Generated	12.6 MT per day

Nawanshahr is a town that became a district in 1995; now it is a municipal council in Shaheed Bhagat Singh Nagar district in Punjab. It is the headquarters of Shaheed Bhagat Singh Nagar District. It's homeland of India's famous freedom fighter Bhagat Singh. The town is said to have been built during the reign of Alaudin Khilji (1295-1316) by his Afghan Military Chief Nausher Khan. Previously it was called "Nausar" but with the passage of time, the town came to be known "The Nawanshahr". Nausher Khan had constructed five forts known as Havelis, whose remains still exist. Nawanshahr was founded by the migrants from Rahon near the Sutluj river as Rahon was in danger of being flooded. They named it Nawanshahar (New City).

Solid waste management in Nawanshahr comes under the purview of the Nawanshahr Municipal Council. Nawashahr today generates approximately 12.6 MT per day of garbage a day and all of it is

collected from the source, whether it is a household or a commercial establishment. The total biodegradable waste generation is 7.2 MT per day, non- biodegradable waste generation is 2.7 MT per day, combustible waste generation is 1.8 MT per day and inert waste is 0.9 MT per day. The households of all the 17 wards are covered by the door to door collection system. The city also ensures that the waste is treated efficiently in a decentralized or centralized waste processing plants. The city has integrated 100% of the informal waste pickers into the system. Furthermore, the city has initiated sweeping of the town twice or thrice daily to prevent littering. Various IEC activites were adopted for motivating the people to make their city clean.

Segregation, Collection and Transportation

Facility highlights	
Wards covered	17
Technology used	Specially designed waste collection vehicles
Manpower	55
CAPEX	Rs 55,00,000
OPEX	No cost- using their existing manpower
Revenue Generated	Approx. Rs. 3,221,700 (through user charges)

Nawanshahr ensures 100% coverage of wards through its door to door collection system. 100% segregation at source is being practiced in the city. In Nawashahr, door-to-door collection of waste is done with the help of 32 pheries (rerhi's) deployed for this purpose, each having a capacity of 400kg. The pheries are specially designed with separate compartments for wet and dry waste. In this way, waste is segregated efficiently at the source as per specification. The fleet of vehicles includes small carriers, rickshaws and motor bikes fitted with the collection system. The administration has taken an intelligent step by collecting the leftover fruit residue from the juice vendors in the evening. So that such waste is not disposed in waste bins and left untreated. A total of 55 workers are involved in this process.

Waste collection in tricycles with compartments for segregated waste

Segregated waste collected

A cost of Rs 15 Lakh (through donation made by residents) was used for designing the cycle rickshaws and motorcycle rickshaws for collecting the biodegradable and non-biodegradable waste in separate compartments. Total fund raised for starting the project is Rs 55 lakh, through public and people with local businesses.

Participation by various organizations

150 waste bins were provided by a local cooperative sugar mill. The rotary club in Nawashahr helped to purchase 150 pairs of PPE like gloves, masks, etc.

Key Highlights

- ✓ The Nawanshahr model is a community financing model: public donations and funds from civil society organizations.
- ✓ Specialized collection vehicles

Processing of the Waste Composting

Facility highlights of the pit composting facility	
Area of the facility (pits + premises)	865 sq.m.
Pit size	3 m x 1.5 m x 1 m (100 pits)
Processing Capacity of the facility	7.2-9 MT per day
Quantity of input	7.2 MT per day
Products obtained	Manure
Quantity of Manure obtained	1.8 MT per day

Composting

Nawanshahr administration took steps to undertake a complete makeover of the dumpsite, and constructed an aerobic honeycomb composting pit unit within the dumpsite to effectively treat the collected bio-degradable waste by converting it to a marketable compost. The pits are constructed with latticework walls to facilitate proper aeration and avoid foul odour. There are approximately 100 composting pits that are spread over an area of around 526 sq. m.

Composting pits

Composting shed

Fine compost prepared

The compost is prepared in 90 days. After 90 days, the compost formed is taken out and dried in the sun. Larger chunks are broken into smaller pieces and then sieved to collect the fine compost. A locally engineered legacy separator machine is additionally used in segregate legacy waste lying in the dumpsite.

The capital expenditure is based on donations by various organizations. For the operations and maintenance of the pits a total of 6 workers are directly involved along with the existing manpower from the Municipal Council.

De-centralised Composting Units in Schools, Colleges & Sabzi Mandi in Nawanshahr

Decentralised Composting Units at Schools in Nawanshahr

Nawanshahr has taken the concept of composting beyond a centralised set up to decentralised units. Various decentralised composting units have been built in schools, colleges and the vegetable market area, which are being managed by the respective authorities.

Material Recovery Facility centre: Dealing with Plastic Waste

Though the city performs 100% source segregation, for further segregation of the dry waste collected, it is done at the dumpsite both manually and mechanically. Identified waste pickers segregate the plastic wastes (polythene bags, plastic bags and other plastic waste) manually. The segregated waste is then sold to the recyclers (waste dealers).

Segregation of the dry waste by waste pickers

Segregation of the dry waste at the MRF

Bioremediation of Dump Site

The rejected material and segregated non-biodegradable waste is deposited at the dump site. The waste disposed of does not have any wet component in it; hence, the dumpsite remains odour free. Any bio-degradable component if present, gets automatically decomposed in the dumpsite, which is again sieved out with the use of locally engineered segregation machine. Remediation process of the dumpsite is ongoing.

Bio mining machines

Remediation of the existing dumpsite

IEC Activities for motivating the residents

Various activites were adopted for motivating the people and encouraging them to make their city clean. Some of the initiatives were Prabhat pheri for Swachhata, organizing meeting at the ward levels, meetings with senior citizens, meeting with the residents of the Model Town (RWA), spreading awareness at Gomti Nath Mandir, where people were gathered for religious functions, meeting with all Religious leaders and NGO's, sensitization of the waste collectors Other awareness rallies were organized by the students and other residents themselves.

Prabhat Pheris for Swachhta

Awareness rally by college students

Donated dustbins

The donated cloth bags facility

Along with this, for effective community engagement various safai abhiyans were organized, around 10,000 cloth bags were donated by an NGO to the residents so that the use of plastic bags can be reduced, 2000 HH waste bins (green and blue) were donated by the Municipal

CEO Mr. Ajoy Sharma monitoring the SWM

Poster making competition organized for school students

Commissioner, Dr. Kamaljit Lal to the residents; so that the residents are motivated to segregate the waste at source. Mr. Ajoy Sharma, CEO, reviewed the SWM Project undertaken by the city, through the various activities such as city level poster competitions between school students on the topic of Swachhata (Cleanliness), regional workshops and inviting various officials from Gujarat and Himachal Pradesh for a visit.

To Know More:

Name of the Organization: Municipal Council Nawashahr
Email: mcnawashahr@gmail.com
Website: http://lgpunjab.gov.in/eSewa/nawanshahr/
Contact Number: 9417479460

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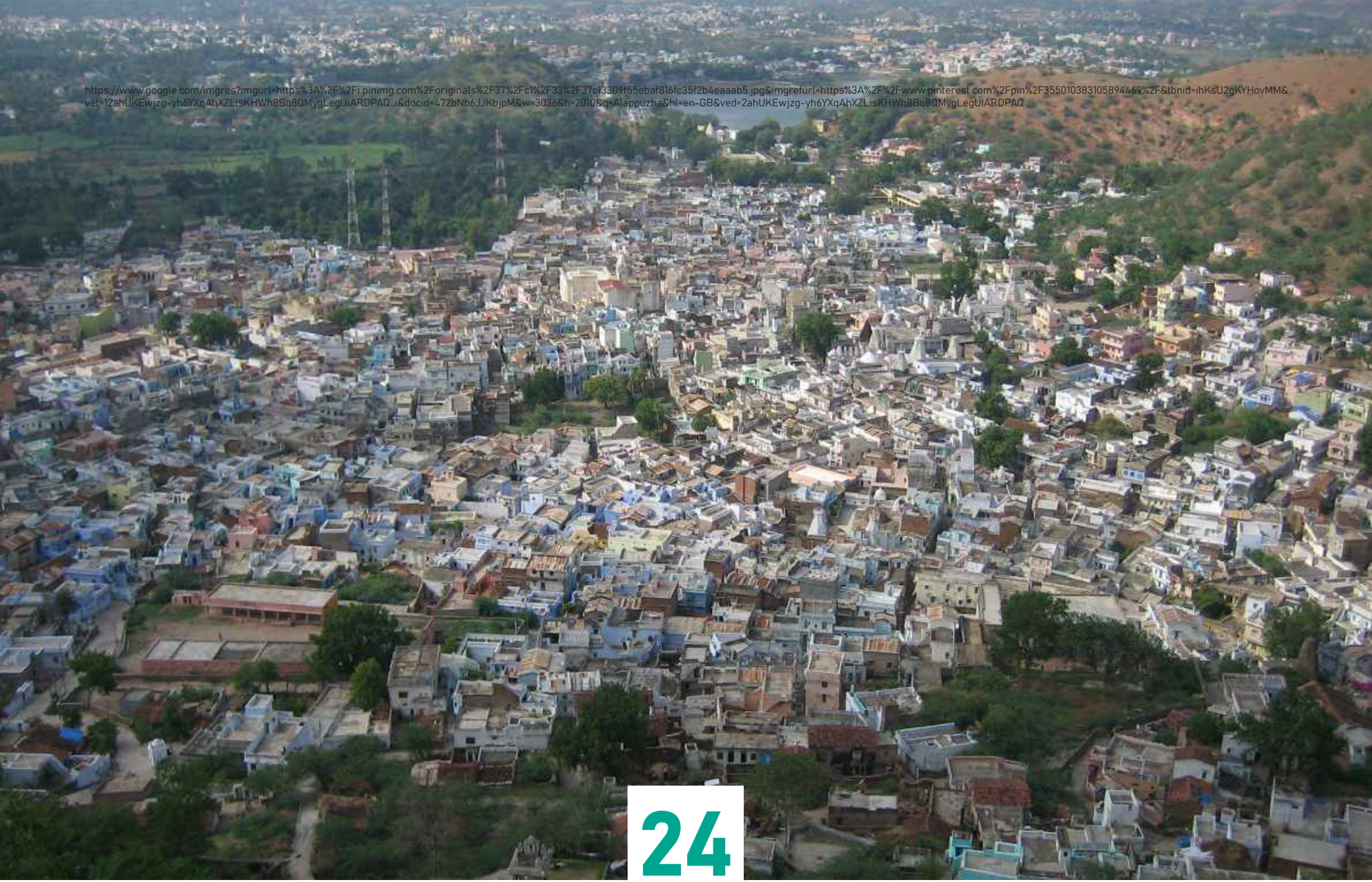


24

DUNGARPUR

Dungarpur

Snapshot: Municipal Council Dungarpur

State	Rajasthan
Area	14 sq.km.
No. of Wards	30
Population	47,706
Total Waste Generated	15.5 MT per day

Dungarpur is a city in the southernmost part of Rajasthan in India. It is the administrative headquarters of Dungarpur District. It is the fastest developing town in extreme South of Rajasthan with tehsil Aspur. Dungarpur literally means a town among the hills or Dungarpur a local name for a hill. The Dungarpur Municipal Council (Nagar Palika Dungarpur) is responsible for the development of the new planned city and takes care of its sanitation and solid waste management.

Dungarpur generates approximately 15.5 MT of garbage per day, and all of it is collected from the source; whether it is a household or commercial establishment. The total wet waste generation is 9.5 MT per day and dry waste generation is 6 MT per day. Nagar Palika Dungarpur (NPD) conducts door to door collection and transportation of municipal solid waste from all the 30 wards. The initiative started in 2015 and is managed by two NGOs, namely Urban Management Center and FINISH Society. The wet and dry waste are completely processed in the garbage

management center, which is situated 5 kms away from the city. The Dungarpur municipal council has also freed the city from plastics and has strictly enforced the ban on usage of plastic and polythene bags.

FINISH Society women helping in collecting waste

Segregation, Collection and Transportation

Dungarpur ensures 100% coverage of wards through its door to door collection system. 100% segregation of waste at source is being practiced in the city. Each household/commercial establishment is given separate dustbins for dry and wet waste at minimal cost so that dry and wet waste is collected separately.

Light motor vehicle used for waste collection

Low-cost dustbins distributed to citizens for segregation of waste at source

In Dungarpur, for the primary collection of waste, there are around twenty vehicles (Auto-tippers and cycle rickshaws) that are used, while for the secondary collection, five vehicles such as tractors, tractor loaders and refuse compactors are used. The waste is collected from the residential and commercial areas on a daily basis at a specified time. Everyday waste is collected twice; once in the morning in residential areas, and once in the evening in commercial areas. NPD has engaged three agencies for collection and transportation of waste in the city, namely: FINISH Society, Srijjan Seva Santhan and J. L. Company. Each of them is assigned 10 wards for the same.

Collection and Transportation		
Wards covered		30
Manpower		175
OPEX		Rs 9.00 lakh per month
Vehicles Employed	Collection Vehicles	14
	Tippers	2
	Tractor	1
	Lifter	1
	Total	18
User Charges	Domestic Users	Rs 50 per month
	Small Shops	Rs 100 per month
	Restaurants	Rs 200 per month
	Hotels	Rs 500 per month
	Institutes	Rs 500 per month
	Event Fees	Rs 2000 per event

Morning timing for collection is from 6.00 am till 11.00 am and evening shift is from 4.00 pm till 8.00 pm. There is a separate chamber for dry and wet waste, and two small chambers are fitted in vehicles for domestic bio-medical and hazardous waste. Each vehicle has a route map and Global Positioning System (GPS) by which common people and municipal officers can locate the vehicles. Swachhta song is played

in the vehicles so that people are made aware of waste collection time. Waste is transported daily to the Waste Management Centre at Bhandariya Ghata where this waste is processed.

Waste collection vehicles with separate compartments for segregated collection

Segregated collection of waste from waste generators

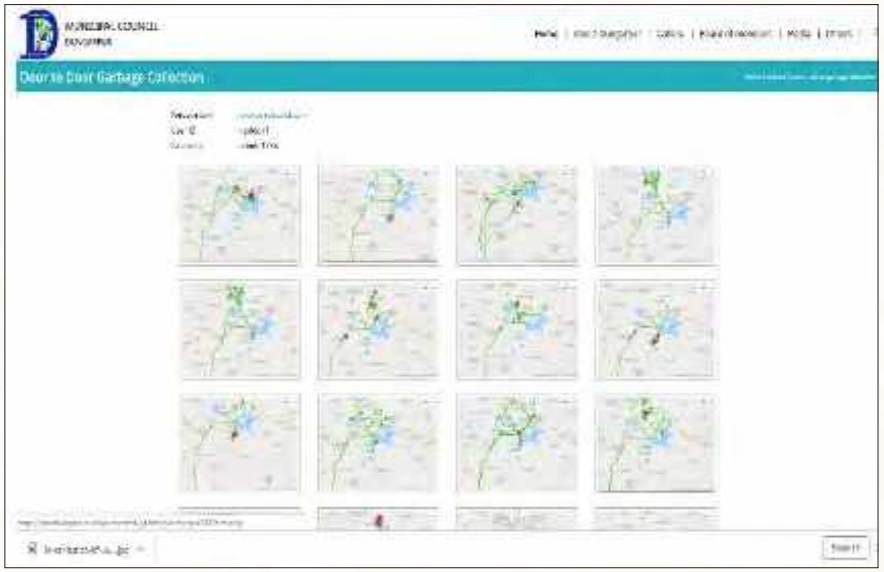
There are 5 commercial areas in Dungarpur. According to SWM Rules, 2016 Manual, there was requirement of 40 twin bins in commercial areas (1 twin bin in every 500 mtrs. of commercial area). 46 twin bins/litter bins are placed in commercial areas, which are emptied daily. These twin bins are cleaned on weekly basis via jetting machine.

Twin-bins installed at commercial places

GPS Vehicle Tracking System is in place in all 18 vehicles for tracking. Biometric attendance is also in place for sanitary staff, which is linked with their payroll.

Sensor-based smart bins are placed at various locations in the city (especially in the public areas), which are cleared on a daily basis. In addition to this, Dungarpur Nagar Parishad is using GPS to track movement of garbage trucks to ascertain whether they are rendering their duty regularly. Furthermore, Dungarpur has deployed Sensor-based smart bins in the city, which indicates the filling of containers on a real time basis and sends optimized routes directly to the drivers to reach the filled bins.

ICT based monitoring of garbage collection



Key Highlights

- ✓ Use of GPS tracking system for tracking the movement of garbage trucks.
- ✓ To check on the situation of waste, CCTV has been installed at the GVP points.

Integrated Solid Waste Management Facility

Dungarpur city has a centralized Integrated Solid Waste Management Center [ISWM] situated at Bhandariya Ghata. The land where the ISWM center is developed was a dump site earlier owned by Nagar Parishad, which was remediated to set up the facilities. The remediation process was carried out by NPD itself. Since the volume of the waste was less, it was capped with thick plastic sheet.

The site has a combination of technologies and facilities:

Facility 1: Material Recovery Facility	Facility 2: Biomethanation Plan	Facility 3: Vermi-composting Facility	Facility 4: Composting Unit	Facility 5: Sanitary Landfill Facility

Integrated Solid Waste Management facility

Segregated waste collected from the waste generators is received at the center, where it is weighed in computerized weighing scale to record the weight of wet and dry waste separately. The wet waste is then sent to the bio-methanation plant for further processing. The dry waste is sent to the Material Recovery Facility (MRF), where it is further sorted in to 10 broad categories. Each of the unit in the facility is discussed in detail below:

1. Material Recovery Facility

The Material Recovery Facility located in the ISWM processes the dry waste received from all the 30 wards of the city. This facility is used for secondary segregation of dry waste. The waste is further sorted into 10 different categories, such as plastics, paper, poly (aluminum coating and plain), metal, glass, wood, cloth, etc. Separate chambers have been built to store the sorted waste. PET bottles, polythene, paper and cardboards, etc. are compressed to make pellets to reduce the volume. The informal waste pickers have been integrated with this facility so that a permanent income is set up for these workers.

Facility Highlights	
Name	Material Recovery Facility
Location	Solid Waste Management Center, Bandariya Ghata, Dungarpur
Area	Approx. 1800 sq.m.
Land ownership	Nagar Parishad Dungarpur
Owner	Nagar Parishad Dungarpur
Year of establishment	2017
Type	Centralized
Type of input	Segregated dry waste
Feeding capacity	15 MT per day
Processing capacity	6 MT per day
Total manpower	10
Capita investment	Rs 50 lakh

Material Recovery Facility (MRF) Unit

Waste being further segregated at the MRF

Segregated waste store seperately at the MRF

Plastic waste bailed and stored at the MRF

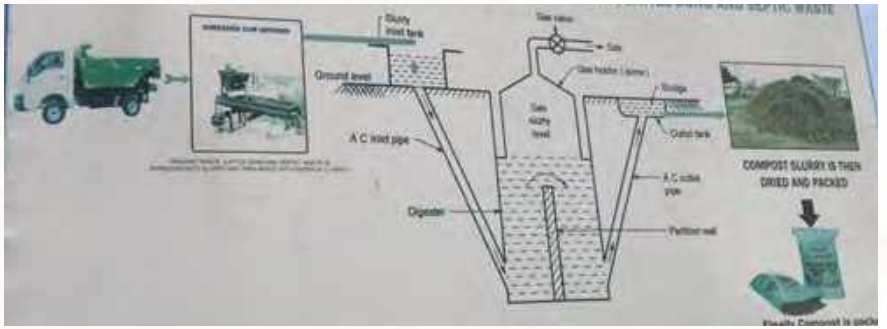
2. Biomethanation Plant

The bio-methanation plant at Dungarpur is the largest in the state and India's first of its kind co-processing plant, where city's organic waste, septage and cattle dung are processed together. In this regard, the plant represents an upgraded model in terms of the nature and composition of waste that is fed into it. Operation is running in full-fledged mode. CYRA Waste Pvt. Ltd. is the agency that operates and maintains the plant.

Facility Highlights	
Name	Bio-methanation Plant
Location	Solid Waste Management Center, Bandariya Ghata, Dungarpur
Area	Approx. 2250 sq. m.
Land ownership	Nagar Parishad
Owner	Nagar Parishad, operated by CYRA Engines
Year of establishment	2017
Type	Centralized
Type of input	Segregated waste (wet organic waste, cattle dung and septage)
Feeding capacity	6 MT per day
Gas capacity	350 cubic meters
Cycle time	90 days
Total manpower	4
CAPEX	Rs 90 lakh (@ Rs 20000 per cubic meter)
Expected revenue generation	Rs 10 lakh per month (From bio-gas and fertilizer)
Return on investment	5-10 Years

This plant generates methane gas for cooking and electricity. The residue of the process is the slurry, which is heated up to a critical temperature to make it pathogen free and then dried to obtain compost. The compost is sold at Rs. 4 per kilogram.

Process flow diagram of Bio methanition plant



Technical Specifications of Digester	
Diameter	41 feets
Weight	12 Tons
Type of digester	Floating dome digester

Organic waste crushed to form slurry

Slurry fed into digester

Floating dome Digester

Sludge in the outlet tank

In a study conducted by CYRA Waste Pvt. Ltd., for the feed data for 18 weeks of operation, it was observed that with 360,000 kg of organic waste, 51,000 kg of cow dung, 51,000 L of septage and 300 kg of water hyacinth as input feed, the plant generated 450 m3/day of biogas and the dome was lifted by 7 feet.

Key Highlights

- ✓ Replicability

  The Dungarpur model for managing both SWM and FSM has the potential to become a role model for cities of similar size in India. For small towns with population of around 2 to 3 lacs up and with wet waste generation up to 20 TPD, integrated biogas plant and co-composting are the ideal technology. With towns having wet waste generation of 15 TPD and less, the ideal proposition would be a Bio-CNG plant. This plant will also behave as FSSM plant.

- ✓ Sustainability

  In this plant, there is total biogas generation of 450 m3/day with the cost of Rs 20,000/m3. The revenue generated from sale of compost & liquid fertilizer till now is around Rs 10 lacs per annum. In around 10 years, the plant would become financially self-sustaining if the products of the plant are marketed and continued resource recovery is ensured. There is also a high scope of local employment generation with higher yield of organic compost. The biogas generated is not only used for plant's captive needs but also for other thermal and electrification purposes. The organic compost will also make district to move towards organic farming. This combination of solid waste management and faecal sludge and septage management can be a game changer for smaller towns.

3. Vermi-composting Facility

The Vermi-composting Facility at the ISWM Center, Bhandariya Ghata is established based on PPP mode with a private contractor in association with the Nagar Parishad. It has a processing capacity of 0.50 MT wet waste (mostly cow dung) per day.

Facility Highlights	
Location	Solid Waste Management Center, Bandariya Ghata, Dungarpur
Area	Approx. 150 sq.m.
Land ownership	Nagar Parishad
Year of establishment	2017
Type of input	Segregated waste (wet cattle dung)
Feeding capacity	0.50 MT per day
Cycle time	45 days
Total manpower	1-3
CAPEX	Rs 20 Lakh
OPEX	Rs 30, 000 per month

The inputs for the vermi-composting center come from the Gaushala located adjacent to the waste disposal center. More than 200 stray cattle of the city have taken shelter in the Gaushala. The process of vermi-composting takes 45 days to convert cow dung to compost. The compost obtained from the center is sold at Rs. 7 per kilogram. The center also prepares dry cow dung cakes, which sells at Rs. 30 per pack.

Vermi-composting center

Sieving and packing of compost

4. NADEP Pit Composting Facility

NADEP pits are constructed for composting of organic/wet waste. There are 15 such pits of the dimension 10 x 5 x 4 feet. The capacity of the composting pits is 1.5 MT/day. The NADEP composting pits come in use when the bio-methanation plant is not functional for any reason. The three agencies engaged by the NPD for the collection and transportation of waste are allotted five pits each to manage the wet waste as and when required. The compost produced in the process is sold at a rate of Rs 4 per kilogram.

NADEP Composting Pits

5. Sanitary Landfill Facility

The inert waste that remains after segregation is disposed at the Sanitary Landfill. This plant has a life period of 10 years. It also includes a leachate treatment plant. The capital cost for the construction of the sanitary landfill is Rs. 25 lakhs.

The landfill has been developed by an upper layer of thick polyethylene sheet followed by a 6-inch thick aggregate layer of 12/10 mm mix. PVC pipes run through the inner layers for circulation of gas and leachate. The leachate generated in the landfill is treated by the leachate treatment plant adjacent to the landfill.

Sanitary landfill site in the integrated unit

Drainage Treatment Plant

The drainage water treatment facility is located behind Patidar Hostel, Gapsagar Ring Road in Dungarpur. The plant is operated and maintained by Nagar Parishad Dungarpur that has the capacity to treat 10,000 liters of waste water per day coming from households, hotels and restaurants. The treated water is disposed off to the Gap Sagar Lake after balancing the Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) components, this helps in keeping the Gap Sagar lake clean. The capital cost of the plant is approximately Rs. 10 lakh and the operational cost of the plant is Rs. 10,000 per month.

Drain Water Treatment Plant

Drainage water collected at the treatment facility

Treatment of Drainage water at the facility

Construction & Demolition Waste Collection Center

NPD has set up a Construction & Demolition Waste Collection Center at the outskirts of the city on Sabela Bypass Road. The center serves as a disposal point of C&D waste generated in the city. The waste generator can dispose off the C&D waste with prior intimation to Nagar Parishad and anybody, who is in need, can take it away with an approval. The service is free of cost.

Construction & Demolition Waste Collection

Smart Public Toilet

NPD has constructed a number of smart public toilets, which are equipped with all modern amenities for the convenience of the users. The toilet is maintained by the caretaker of the facility, who is responsible for cleaning and for availability of amenities at the toilet.

Smart Public Toilet

Key Highlights

- ✓ Dungarpur was the first city of Rajasthan to be declared ODF. Now it has achieved the status of ODF+. It has been declared ODF four times.
- ✓ The city was selected among 16 cities of Asia and Africa by Bill and Melinda gates Foundation for research in SWM.
- ✓ It achieved 7th rank among smaller cities of population below 1 lac of India in Swachh Survekshan 2019 and was ranked the Best in Citizen Feedback in SS2019.
- ✓ Recently Dungarpur was awarded by Netherland Embassy for its work in Solid Waste Management
- ✓ Dungarpur was also awarded from His Excellency Marten van der Berg (Ducth Ambassador) and Mr. V.K. Jindal, Joint Secretary, MoHUA for its solid waste management initiatives

To Know More:

Name of the Organization: Municipal Council Dungarpur
Email: npd.dpr@gmail.com
Website: dmcdungarpur.in
Contact Number: 9782460637

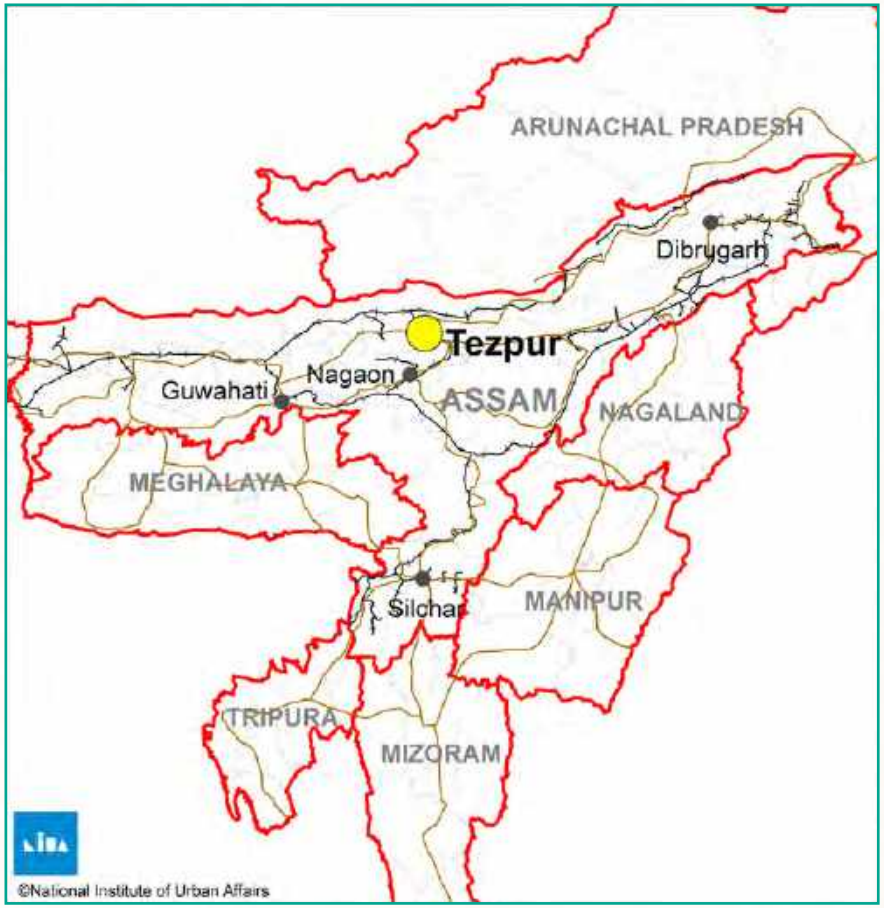
References:

Field visit and Personal discussion with Mr. Vikas Legha.
https://urban.rajasthan.gov.in/content/raj/udh/nagar-parishad-dungarpur/en/home.html#

25

TEZPUR

Tezpur



Snapshot: Municipal Council Tezpur

State	Assam
Area	14 sq.km.
No. of Wards	30
Population	80,575
Total Waste Generated	25 MT per day

Tezpur is an urban agglomeration and a small city on the banks of River Brahmaputra in Assam. It is the administrative headquarters of Sonitpur district and also an air force station of Indian Air force (IAF). Tezpur is considered as the 'Cultural Capital of Assam' and has also earned the status of a Clean City during the Swachh Survekshan. The district administration is responsible for the development of the district as a whole. The Deputy Commissioner is the head of the district administration. Tezpur Municipal Board was constituted in 1894 under the provisions of the municipal act. According to municipality act Tezpur municipality is a Grade II municipality.

In city, SWM comes under the purview of the Tezpur Municipal Board. To overcome bird menace, an inter-ministerial joint sub-committee was constituted by the Ministry of Defence. It provided recommendations for proper sanitation facilities, including solid waste management and drainage to overcome the bird menace in the 10 towns having airfields of Indian Air Force, which includes Tezpur. The scheme was approved by

Streets of Tezpur town

Plastic collection points

the Planning Commission on October 8, 2008 as a Central sector scheme. The Tezpur Municipal Board operates the facilities and oversees its day to day operations and maintenance (O&M). The O&M cost of the scheme is borne by the Tezpur Municipal board and Government of Assam. This project not only benefits the citizens of Tezpur, but also the IAF. Today, the city generates waste of approximately 25 MT per day, which is collected from the source; whether it is a household or a commercial establishment. Municipality Board conducts door to door collection and transportation of municipal solid waste from all its 19 wards. The door to door collection started in 2009 and is managed by one private agency namely,Radiant Skills and Environmental Solutions Private Limited. The total wet waste generation is 16.5 MT per day and dry waste generation is 10.5 MT per day. The wet and dry waste are completely processed in the centralized processing plant, which is situated 7 km away from the city. The municipality has also freed the city from plastics and has strictly enforced a ban on usage of plastic and polythene bags.

Segregation, Collection and Transportation

Twin dustbins

Waste collection vehicle

Tezpur ensures 80-90 % coverage of wards through its door to door collection system and 70-80% of waste segregation. In Tezpur, for the primary collection of waste, there are around 28 vehicles (including 14 Auto-tippers and 14 e-rickshaw) that are used, while for the secondary collection, 3 vehicles such as 2 tractors and 1 dumper placer are used. The waste is collected from the residential and commercials areas on a daily basis at a specific time. For processing, this waste is transported to integrated solid waste management facility.

Integrated Solid Waste Management Facility

Facility highlights	
CAPEX	Rs 3.5 cr.
OPEX (Rs.)	NA
Manpower	15
Compost produced	2-2.5 MT per day

Facilities in ISWM

- Facility 1: Material Recovery Facility (under construction)
- Facility 2: Composting Facility
- Facility 3: Sanitary Landfill Facility

The city has a Centralized Processing Unit situated at village Balichapori. Council has provided 15 acre of land area for this centralized facility. This centralized processing unit has the following facilities:

Integrated solid waste management facility

MRF (under Construction)

Composting plant

In this plant, 16.5MT per day of wasteis treated to produce 2-2.5 MT per day of compost by Windrow composting method. The watering is done manually. About 6 kg Inoculum is added in a windrow to accelerate microbial activities. Windrows are turned four times a week for aeration. After 30 days the waste is kept at maturation yard for a week. It is then segregated through 2.5 mm and 1.5 mm trommel. Finally, compost and inert material are separated.

The compost is collected and packaged in 25kg/5kg/1kg bags,which is sold to the local market directly. The dry waste is segregated and sent to the recyclers. In dry waste; 60-70 % of plastic are sent to the recyclers. The inert waste (6%-7%) that remains after segregation is disposed at the Sanitary Landfill.

To Know More:

Name of the Organization: Municipal council Tezpur
Email: chairmantmb@gmail.com
Website: http://sonitpur.nic.in/html/tmb.html
Contact Number: 03712-220008, 220119

Name of the Organization: Radiant Skills & Environmental Solutions Pvt. Ltd
Email: radiantmgmt@gmail.com
Website: NA
Contact Number: 7002053107

References:

Field visit and Personal discussion with Mr. Ashok Baruah (director, Radiant Skills and Environmental solutions pvt. Ltd., Tezpur)

http://sonitpur.nic.in/html/tmb.html
https://tezpur.assamonline.in/city-guide/administration-in-tezpur

26

FEROZEPUR

Ferozepur

Snapshot: Ferozepur Municipal Council

State	Punjab
Area	14 sq.m.
No. of Wards	31
Population	1,10,313
Total Waste Generated	42.63 MT per day

Ferozepur is an ancient city situated on the banks of the Sutlej river in Punjab. It is close to the present-day Indo-Pakistan border. The city has a rich and glorious historic importance. It was founded by Firoz Shah Tughluq of the Tughluq Dynasty; hence the city is named after him. Ferozepur is remarkably associated with the independence of India. Three heroic martyrs of India's freedom struggle; Shaheed Bhagat Singh and his associates Shaheed Rajguru and Shaheed Sukhdev have their final resting place on the banks of the river Sutlej in Ferozepur. The administration of the city is taken care by the Municipal Council, Ferozepur, which has a total of 31 wards.The Municipal Council has received State and National Awards for its progress in managing their solid waste and the district is currently enlisted under aspiration districts of India. During Swachh Survekshan 2019, Ferozepur was ranked 174 at national level and 8th in state level.

The city generates a total of 47 tons of solid waste on a daily basis. Out of which, 35 tons of waste is processed, while the remaining 12 tons is currently being sent to the dump yard. The city follows a decentralized model to manage its waste. Segregated waste is collected from door to door using collection vehicles, mainly tricycles, which are specially designed with segregated compartments. The waste is then brought to a collection point (Solid Waste Management Plant), wherein, the dry waste is further segregated into different categories and sold off to the recyclers or authorized scrap dealers. The wet waste is processed into compost and is distributed free of cost to the farmers.

Waste Generation Profile	
Total waste generated	42.63 MT per day
Amount of waste processed	31.75 MT per day
Amount of waste sent to the dump yard	10.88 MT per day
Waste generation per capita	426 grams
Amount of dry waste generated	17.23 MT per day
Amount of wet waste generated	25.4 MT per day
Amount of hazardous waste generated	0.09 MT per day

Collection and Transportation		
Total no of wards	31	
Wards covered	27	
Manpower	300	
CAPEX	INR 36 Lakh	
Vehicles Employed	Collection Vehicles	138 Tricycles
	Tippers	13 Tipper, 1 Dumper
	Tractor	5
	Lifter	3 JCB, 1 Tractor Loader
	Total	161
User Charges	Domestic Users	INR 50/Household

Separate compartments in waste collection vehicles for segregated collection

Source segregation and door-to-door collection at Ward No. 20, Ferozepur

Waste Generation Profile	
No. of Households	172
Households covered for door-door collection	100%
No. of households practicing segregation at source	100%
Total Waste Generated	387 Kgs
User charges collected	Rs 50-70/household

Municipal Council, Ferozepur is responsible for the daily collection and transportation of waste in Ward No. 20. The ward generates an average of 387 kilograms of waste daily. The residents of the ward practice 100% source segregation. Waste is segregated into four categories - wet, dry, hazardous and domestic bio-medical waste. A total of three sanitation workers collect the waste form the households in specially designed vehicles with separate compartments.

Once the waste is collected from all the households in the ward, it is then brought to the solid waste management plant set up at ward no. 19.

Solid Waste Management Plant, Ward No. 19, Mall Chowk, Ferozepur

The solid waste management plant set up at Ward No. 19 is an initiative by the Municipal Council to process and treat the waste generated on a daily basis. The plant caters to the waste collected in the six surrounding wards. It is an integrated facility comprising a composting section and a Micro Segregation Unit, which is a Material Recovery Facility (MRF). The plant manages a total of 5 MT of wet waste and 1 MT of dry waste on a daily basis. Daily intake of the waste is registered.

Facility Highlights	
Area	446 sq.m.
No. of wards covered	6
Land ownership	Municipal Council, Ferozepur
Owner	
Year of establishment	2019
Type	Integrated decentralized Facility with composting and Material Recovery Facility (MRF)
Type of input	Segregated waste in 4 categories- Wet, Dry, Hazardous, Domestic Bio-medical waste
Processing capacity	Composting section – 137.7 Tons (5.5 T x 25) per day MRF section – 20 Tons per day
Total manpower	4-5
Capital investment	Rs 7.5 Lakh
OPEX	Rs 30,000 per month

Solid Waste Management Plant, Ward 19

Waste in-take record

The wet waste received at the SWM plant is treated in upper-ground *NADEP pits. There are a total of 25 pits of 3 x 1.5 x 1.5 meter dimension each. The segregated wet waste is processed in the pits.

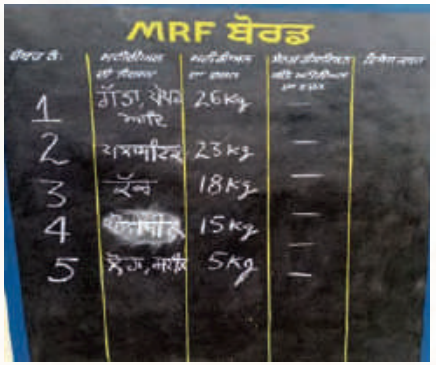
Regular turning of the matter is done to allow aeration and better decomposition. *This method is named after Narayan DeotaoPandharipande (NADEP) who developed it.The wet waste converts into compost in 45-60 days. It is then sieved and packed and sold at INR 30 per kg.

NADEP Composting pits at SWM Plant

Sieving and packing of compost

The segregated dry waste received at the micro segregation section is further sorted into 30 categories. Upon achieving a critical mass, the sorted dry waste is sold off at prevailing market rates.

Dry Waste Segregation categories



Rate list of segregated dry waste

Micro Segregation section at SWM Plant

Sorting section

Key Highlights

- ✓ The micro-segregation unit is a unique project in north India, which has been developed based on the learnings from Ambikapur model. Municipal Council, Ferozepur has received state and national level awards for remarkable progress done in SWM.
- ✓ The decentralized model has helped in saving cost of transportation of waste.

Waste Management at Dev Samaj Women's College

Dev SamajWomen'sCollage, near Bansi Gate, Circular Road, is an excellent example of how waste can be creatively reused and utilized. The campus has successfully demonstrated the recycling and reuse of Construction and Demolition (C&D) waste. This change was brought about by Mrs. Madhu Prasher, the Principalof the College.

Dev Samaj College for Women

TheC & D waste generated after the renovation of the college campus has been innovatively used inside the campus. Various furniture and decoration pieces likedining tables, double beds, chairs and tables, flower pots, photo frames, decoration for lighting, jewelry and makeup accessories, etc. have been made out ofwaste.The types of waste materials used are primarily C & D Waste, old iron and wooden material, old cardboard,glasses etc.

Use of C & D waste at Dev Samaj School for Women

Besides recycling and reusing waste, the college campus has adopted practices like composting to manage the wet waste generated at source. All the bio-degradable wet waste and garden waste generated in the school is processed to obtain compost, which is further used in the organic garden. Upper-ground NADEP pits are developed for this purpose. In addition, there are few underground compost pits also.

Facility Highlights	
Total waste generated	Approx. 140 Kg/Day
Total wet waste generated	Approx. 72 Kg/Day
Total wet waste processed	Approx. 72 Kg/Day
Total dry waste generated	Approx. 48 Kg/Day
Total dry waste processed	Approx. 30 Kg/Day
Composting technology practiced	Vermi composting, and Honeycomb aerobic (pit) composting
Type of input	Bio-degradable wet waste and garden waste
CAPEX	Rs 70,000-80,000

The college students conduct street plays, awareness drives and campaigns to raise awareness towards importance and need of waste management and protecting the environment.

Composting at Dev Samaj College for Women

Sohangarh Natural Farms

The Sohangarh Natural farms is located in the village of SohangarhRattewala) near Guru HarSahai town in Ferozepur district. The farm is owned and managed by Punjab-based attorney, Mr. Kamaljeet Singh Hayer. Following the concept of 'You are what you eat', Mr. Kamaljeet Singh Hayer has converted his 20 acres of family land into an organic farm with no use of any pesticides or chemicals.

The farm boasts of 1,500 trees of 120 different species. These are a mix of fruits, medicinal, forest and nitrogen-fixing trees, with shade area of three acres of land. The rest of the farmland is used to grow and harvest more than 50 seasonal crops each year.It also has a small pasture with herbs for cattle to graze on and produce nutritious milk.The farm has more than 50 types of herbs like lemongrass, stevia, and basil, as well as 25 native livestock, including cows, buffaloes, goats, poultry and birds.

Facility Highlights	
Name	Sohangarh Natural Farms
Location	Village Sohangarh, Rattewala
Area	20 acres
Land ownership	Mr. Kamaljeet Singh Hayer
Owner of the facility	Mr. Kamaljeet Singh Hayer
Implementing agency	Self-initiative
Year of establishment	2012
Type	Decentralized
Significance	Pesticide-ridden dead soil converted into fertile farm, rainwater harvesting pond

Mr. Kamaljeet Singh Hayer sharing his experiences with participants

The farm also comprises a rainwater harvesting pond that harvests rainwater and canal water to meet farm needs.

Rain Water Harvesting Tank	
Size of the Tank	33 Lakh Litres
CAPEX (rain water harvesting pond and pipeline)	Rs 7 lakh
Cost of Pump	Rs 50,000

Advocate Kamaljeet Singh Hayer besides the rainwater harvesting pond

Irrigation canal connecting with the rainwater harvesting tank and the NADEP Composting Pit

A lot of practices have been adopted in the farm to avoid the use of chemical fertilizers and pesticides. For example, Jeevamrutham (an indigenous fertilizer) is prepared on farm to nourish the soil as per the following specifications.

- Cow dung: 10 Kgs
- Cow urine: 5 Litres
- Jaggery: 1 Kg
- Gram floor: 1Kg
- Pure soil: 50 Grams

The crop residue is also mulched back into the soil. Compost is also prepared in the farm using NADEP method. Some of his important nitrogen-fixing trees grown on the farm include Moringa Oleifera and Khejri. The dry leaves, stems and roots of these trees, convert atmospheric gas into nitrogen, when in contact with the soil. They improve the yield too when grown next to fruit trees.Some of the medicinal trees grown include neem, calotropis, and chaste tree. The leaves of these trees are soaked in cow urine or boiled in water and sprayed on the leaves of plants to protect them from pests and diseases.

"Jeevamrutham" (an indigenous fertilizer) prepared in the tank

Mr. Singh vouches for inter-cropping and multi-cropping and insists on growing native varieties of the crops. Apart from preserving these seeds, he also sells most of his farm produce locally. He has laid the foundation stone for a training centre, and aims to conduct training sessions for farmers every quarter, once the construction is complete.Currently, his farm has a daily footfall of 20-50 visitors, most of whom are farmers. He has been conducting free training sessions for them every month.

Garbage Vulnerable Point (GVP) converted into Park at Mall Road

The Municipal Council,Ferozepur has successfully converted one of its historic garbage vulnerable point into a beautiful park under public private participation (PPP) model. The council took the possession of the land in 2014-15 and engaged Baghi Hospital owned by Dr. Kamal Baghi to develop and maintain the park. There is an open gym developed, which is used by about 300 citizens daily. One large LED screen is also installed in the park that telecasts live Gurubani, Kirtan from Shri Harmandir Sahib, Amritsar. The park is open for fixed hours every morning and evening for public. People can access the park and use its facilities free of cost. The park is currently being managed under the supervision of Dr. Kamal Baghi.

Municipal Council Park

The Municipal Council Park developed and maintained by the Municipal Council, Ferozepur is an example of a site where most of the waste materials have been reused to create things with aesthetic value and for beautification. The key elements of the park include:

- Selfie point
- Birds food house
- Wall paintings inside park
- Water bottling plants
- Green waste compost yard
- Open gymnasium
- Children swings

Beautification of Municipal Council park by recycling waste

To Know More:

Municipal Council, Ferozepur
Website: https://mcferozepur.punjab.gov.in/
Email: eomcfzr1632@gmail.com
Contact no: 9915187543, 9876610707

References:

https://mcferozepur.punjab.gov.in/about.html
https://ferozepur.nic.in
http://championsofchange.gov.in/dashboard

GLOSSARY

Aerobic composting - A controlled process involving microbial decomposition of organic matter in the presence of oxygen.

Anaerobic digestion - A controlled process involving microbial decomposition of organic matter in absence of oxygen.

Bailing - A machine used to compress recyclables into bundles to reduce volume. Balers are often used for newspaper, plastics, and corrugated cardboard.

Biodegradable waste - Any organic material that can be degraded by micro- organisms into simpler stable compounds.

Bio-methanation - A process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas.

Bulk waste generator - Includes buildings occupied by the Central government departments or undertakings, State government departments or undertakings, local bodies, public sector undertakings or private companies, hospitals, nursing homes, schools, colleges, universities, other educational institutions, hostels, hotels, commercial establishments, markets, places of worship, stadia and sports complexes having an average waste generation rate exceeding 100kg per day.

Bye-laws - A regulatory framework notified by local body, census town and notified area townships for facilitating the implementation of these rules effectively in their jurisdiction.

Capacity building - Enabling people, organizations, and societies to develop, strengthen, and expand their abilities to meet their goals or fulfill their mandates is referred to capacity building. . It is a long-term and continuous process that focuses on developing human resources, organizational strength, technology know-how etc involving all

stakeholders and is strengthened through the transfer of knowledge and skills that enhance individual and collective abilities to deliver services and carry out programs that address challenges in a sustainable way.

Composting - A controlled process involving microbial decomposition of organic matter.

Compactor vehicle - A collection vehicle using high-power mechanical or hydraulic equipment to reduce the volume of solid waste.

Construction and demolition waste – The waste comprising of building materials debris and rubble resulting from construction, re-modelling, repair and demolition of any civil structure.

Conveyor belt-A wide belt made of rubber, textile, nylon or more commonly composite material, which moves on wide rollers. In compost industry chain drive is popular as the belt moves in a guided manner, directed by the chain sprockets. Conveyor belts are used for material movement in different stages.

Curing - Allowing partially composted materials to reside in a pile for a specified period of time as part of the maturing process in composting.

Decentralized processing - Establishment of dispersed facilities for maximizing the processing of biodegradable waste and recovery of recyclables closest to the source of generation so as to minimize transportation of waste for processing or disposal.

Disposal- The final and safe disposal of post processed residual solid waste and inert street sweepings and silt from surface drains on land as specified in Schedule I to prevent contamination of ground water, surface water, ambient air and attraction of animals or birds.

Domestic hazardous waste- Domestic hazardous wastes means waste contaminated with hazardous chemicals or infectious waste such as discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles, gauge and syringes, etc. generated at the household level.

Door to door collection - Collection of solid waste from the door step of households, shops, commercial establishments , offices , institutional or any other non-residential premises and includes collection of such waste from entry gate or a designated location on the ground floor in a housing society , multi storied building or apartments , large residential, commercial or institutional complex or premises.

Dry waste - Waste other than bio-degradable waste and inert street sweepings and includes recyclable and non-recyclable waste, combustible waste and sanitary napkin and diapers, etc.

Dump sites - A land utilised by local body for disposal of solid waste without following the principles of sanitary land filling.

E-waste - Means electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded as waste.

Extended Producer Responsibility (EPR) - Responsibility of any producer of packaging products such as plastic, tin, glass and corrugated boxes, etc., for environmentally sound management, till end-of-life of the packaging products.

Facility - Any establishment wherein the solid waste management processes namely segregation, recovery, storage, collection, recycling, processing, treatment or safe disposal are carried out.

Fine - Penalty imposed on waste generators or operators of waste processing and disposal facilities under the bye-laws for non-compliance of the directions contained in these rules and/or bye- laws.

Handling - Includes all activities relating to sorting, segregation, material recovery, collection, secondary storage, shredding, baling, crushing, loading, unloading, transportation, processing and disposal of solid wastes.

Inert - Wastes which are not bio-degradable, recyclable or combustible street sweeping or dust and silt removed from the surface drains.

Incineration- An engineered process involving burning or combustion of solid waste to thermally degrade waste materials at high temperatures.

Informal sector-The part of an economy that is characterized by private, usually small-scale, labour-intensive, largely unregulated, and unregistered manufacturing or provision of services.

Informal waste collector - includes individuals, associations or waste traders who are involved in sorting, sale and purchase of recyclable materials.

Integrated Solid Waste Management (ISWM) - ISWM refers to a strategic initiative for the sustained management of solid waste through the use of a comprehensive integrated format generated through sustained preventive and consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.

Leachate - The liquid that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it.

Materials Recovery Facility (MRF) - A facility where non-compostable solid waste can be temporarily stored by the local body or any other entity mentioned in rule 2 or any person or agency authorized by any of them to facilitate segregation, sorting and recovery of recyclables from various components of waste by authorized informal sector of waste pickers, informal recyclers or any other work force engaged by the local body or entity mentioned in rule 2for the purpose before the waste is delivered or taken up for its processing or disposal.

Municipal Solid Waste (MSW) - Includes the domestic waste, commercial waste, institutional waste, market waste and other non-residential wastes, street sweepings, silt removed/collected from the surface drains, horticulture waste, construction and demolition (C&D) waste and treated bio-medical waste excluding industrial hazardous waste, and e-waste generated in any municipal authority area in either solid or semi-solid form.

Non-biodegradable waste - Any waste that cannot be degraded by microorganisms into simpler stable compounds.

Operator of a facility - A person or entity, who owns or operates a facility for handling solid waste which includes the local body and any other entity or agency appointed by the local body.

Primary collection - Collecting, lifting and removal of segregated solid waste from source of its generation including households, shops, offices and any other non- residential premises or from any collection points or any other location specified by the local body.

Processing - Any scientific process by which segregated solid waste is handled for the purpose of reuse, recycling or transformation into new products.

Recycling - the process of transforming segregated non-biodegradable solid waste into new material or product or as raw material for producing new products which may or may not be similar to the original products.

Refuse Derived Fuel (RDF) - Segregated combustible fraction of solid waste other than chlorinated plastics in the form of pellets or fluff produced by drying, shredding, dehydrating and compacting combustible components of solid waste that can be used as fuel. Residual solid waste - And includes the waste and rejects from the solid waste processing facilities which are not suitable for recycling or further processing.

Sanitary land filling - The final and safe disposal of residual solid waste and inert wastes on land in a facility designed with protective measures against pollution of ground water, surface water and fugitive air dust, wind-blown litter, bad odour, fire hazard, animal menace, bird menace, pests or rodents, greenhouse gas emissions, persistent organic pollutants slope instability and erosion.

Sanitary waste - Wastes comprising of used diapers, sanitary towels or napkins, tampons, condoms, incontinence sheets and any other similar waste.

Secondary storage - The temporary containment of solid waste after collection at secondary waste storage depots or MRFs or bins for onward transportation of the waste to the processing or disposal facility.

Segregation - Sorting and separate storage of various components of solid waste namely biodegradable wastes including agriculture and dairy waste, non- biodegradable wastes including recyclable waste, non-recyclable combustible waste, sanitary waste and non-recyclable inert waste, domestic hazardous wastes, and construction and demolition wastes.

Sludge - A semi-liquid residue remaining from the treatment of municipal and industrial water and wastewater.

Sorting - Separating various components and categories of recyclables such as paper, plastic, cardboards, metal, glass, etc., from mixed waste as may be appropriate to facilitate recycling.

Stabilising- the biological decomposition of biodegradable wastes to a stable state where it generates no leachate or offensive odours and is fit for application to farm land ,soil erosion control and soil remediation.

Street vendor - Any person engaged in vending of articles, goods, wares, food items or merchandise of everyday use or offering services to the general public, in a street, lane, side walk, footpath, pavement, public park or any other public place or private area, from a temporary built up structure or by moving from place to place and includes hawker, peddler, squatter and all other synonymous terms which may be local or region specific. and the words "street vending" with their grammatical variations and cognate expressions, shall be construed accordingly.

Tipping fee - A fee or support price determined by the local authorities or any state agency authorised by the State government to be paid to the concessionaire or operator of waste processing facility or for disposal of residual solid waste at the landfill.

Transfer station - A facility created to receive solid waste from collection areas and transport in bulk in covered vehicles or containers to waste processing and, or, disposal facilities.

Transportation - Conveyance of solid waste, either treated, partly treated or untreated from a location to another location in an environmentally soundmanner through specially designed and covered transport system so as to prevent the foul odour, littering and unsightly conditions.

Treatment - The method, technique or process designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its volume and potential to cause harm.

Trommel - An improved version of rotary screen, which is driven from outside, preferably using hydraulic power packs to keep the movement smooth, especially while starting after a power cut. The screen is covered from outside to control dust.

Urban Local body - Includes the municipal corporation, nagar nigam, municipal council, nagar palika, nagar palika parishad, municipal board, nagar panchyat, town panchayat, notified area committee or any other local body constituted under the relevant statutes where management of solid waste is entrusted to such agency including the body in notified industrial township, notified area, villages declared outgrowth in urban agglomeration by the Registrar General and Census Commissioner of India from time to time.

User fee - a fee imposed by the local body and any entity mentioned in rule 2 on the waste generator to cover full or part cost of providing solid waste collection, transportation, processing and disposal services.

Vermi-composting - The process of conversion of bio-degradable waste into compost using earth worms.

Waste generator - And includes every person or group of persons, every residential premises and non-residential establishments including Indian Railways, defense establishments, which generate solid waste.

Waste hierarchy - The priority order in which the solid waste is to should be managed by giving emphasis to prevention, reduction, reuse, recycling, recovery and disposal, with prevention being the most preferred option and the disposal at the landfill being the least.

Waste picker – A person or groups of persons informally engaged in collection and recovery of reusable and recyclable solid waste from the source of waste generation the streets, bins, material recovery facilities, processing and waste disposal facilities for sale to recyclers directly or through intermediaries to earn their livelihood.

Waste-to-Energy system (WTE) - A method of converting MSW into a usable form of energy, usually though combustion.

Windrow - Long trapezoidal heaps or piles. Long composting heaps are referred to as 'windrow'. The base is wider and the top is narrower.

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