DRAFT

सत्यमेव जयते

GOVERNMENT OF INDIA

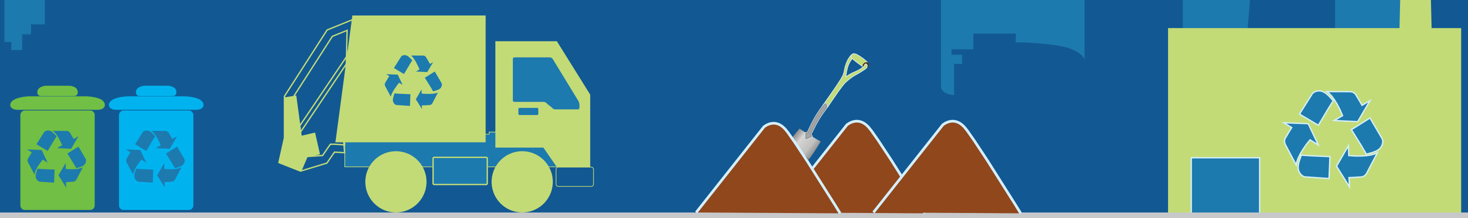
MINISTRY OF URBAN DEVELOPMENT

http://moud.gov.in

MUNICIPAL SOLID WASTE MANAGEMENT MANUAL

Central Public Health and Environmental Engineering Organisation (CPHEEO)

May, 2014



सत्यमेव जयते

Government of India

Ministry of Urban Development

http://moud.gov.in

MUNICIPAL SOLID WASTE MANAGEMENT MANUAL

Central Public Health & Environmental Engineering Organisation (CPHEEO)

IN COLLABORATION WITH

german cooperation
DEUTSCHE ZUSAMMENARBEIT

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

GERMAN INTERNATIONAL COOPERATION

May 2014

MESSAGE

FOREWORD

PREFACE

Acknowledgement

Vision Statement

The Ministry of Urban Development's vision of the National Urban Sanitation Policy states that

'All Indian cities and towns become totally sanitized, healthy and liveable and ensure and sustain good public health and environmental outcomes for all citizens with a special focus on hygienic and affordable sanitation facilities for the urban poor and women.'

With the support of the Municipal Solid Waste (Management & Handling) Rules, 2000 of the Ministry of Environment & Forest, the Ministry of Urban Development aims to guide all urban areas in the country towards Sustainable Municipal Solid Waste Management, adopting the aspects of waste minimization at source with an emphasis on the 3R principles of reduce, reuse and recycle; with proper systems of segregation, collection, transportation, processing, treatment and disposal in complete harmony with the environment, thereby leading to the achievement of the aim of NUSP.

Table of Contents

LIST OF TABLES

PART I: SALIENT FEATURES OF THE MSWM MANUAL: AN OVERVIEW

PART II: MANUAL ON MUNICIPAL SOLID WASTE MANAGEMENT ------------------------------------1

LIST OF FIGURES

PART I: SALIENT FEATURES OF THE MSWM MANUAL: AN OVERVIEW

PART II: MANUAL ON MUNICIPAL SOLID WASTE MANAGEMENT

Part I: Salient Features of the MSWM Manual: An Overview

Chapter 1:

Management Aspects: Planning, Institutional And Financial Aspects

1. Introduction: How To Use This Manual

Urban India is facing an ever increasing challenge of providing for the incremental infrastructural needs of a growing urban population. According to the 2011 census, the population of India was 1.21 billion; of this 31% live in cities. It is further projected that by 2050 half of India's population will live in cities.

With this increasing population, management of Municipal Solid Waste (MSW) in the country has emerged as a severe problem not only because of the environmental and aesthetic concerns but also because of the sheer quantities generated every day. According to Central Pollution Control Board 1, 27,486 TPD (Tons per day) of Municipal Solid Waste was generated in India during 2011-12, with an average waste generation of 0.11 kg/ capita/day. Of the total waste generated, approximately 89,334 TPD (70%) of MSW was collected and only 15,881 TPD (12.45%) was processed or treated. Segregation at source, collection, transportation, treatment and scientific disposal of waste was largely insufficient leading to degradation of the environment and poor quality of life.

The fact that management of MSW was getting critical, first became evident in the 1990s when large scale concerns regarding unsuitable municipal waste management practices resulted in numerous Public Interest Litigations (PILs), prompting the Supreme Court of India, in 1996, to order the Ministry of Environment and Forests (MoEF), Government of India, to release the Municipal Solid Waste (Management & Handling) Rules. The Rules , released in 2000, contained directives for all ULBs to establish a proper system of waste management, including a timeline for installation of waste processing and disposal facilities by end of 2003, not only for metros and Class I cities but for all ULBs in the country. The Ministry of Urban (MoUD), Government of India developed a Guidance Manual for SWM for all Urban Local Bodies (ULBs) and published it simultaneously with the Rules in 2000. However, till 2003, all ULBs were to establish a sustainable MSW system including treatment and sanitary landfill.

In order to give a push to MSW Management in cities, Government of India has sanctioned the 12th and 13th Finance Commission Grants and funds were also allocated for improvement of MSWM under flagship projects like JnNURM, UIDSSMT from 2005 onwards. Funds for MSWM projects are also available from State Government funds. Many Urban Local Bodies (ULBs) have put in place systems of door to door collection, transportation, treatment and a safe disposal of waste. However, despite encouraging pilots and achievements, most ULBs continue to face challenges not only in the areas of appropriate and/ advanced collection & transportation systems, technology selection and disposal methods but also in sustainable financial management of MSWM. The non-compliance issue is still true after 14 years of the notification of the MSW Rules, 2000.

The Government of India continues to address these challenges and to support the States and ULBs in developing modern and appropriate MSWM systems, through the draft revised MSW (M&H) Rules 2013 by the Ministry of Environment and Forest (MoEF) and the parallel revision of MSWM Manual 2000 by the Ministry of Urban Development (MoUD). The manual is based on learnings from 14 years' experience gained post the notification of the Rules in 2000.

The revised Manual includes:

- a wealth of practical experiences gained from many ULBs on what works and what may not work under specific conditions;
- the reflection of new technologies and approaches available in the MSWM sector in India;
- improved institutional approaches and planning tools such as a combined planning for MSWM and Urban Sanitation;
- a fresh understanding of "Integrated Solid Waste Management", as an approach that not only focuses on technical aspects of solid waste management but also addresses issues of waste minimization, reuse, recycling, and socio-cultural (inclusivity), institutional, financial, and legal aspects;
- newly emerging issues/themes such as climate change, relevance of informal sector to MSWM as well as its links to gender equity and gender related issues;
- the need for state and regional strategies and handholding support for MSWM.

The Revised Manual addresses all relevant aspects of MSWM namely planning, technical, institutional, financial and legal dimensions.

The Manual has the following structure and addresses different target groups in its different sections:

The layout of the Manual will help the target groups to navigate within its different parts and contents. Key elements of this 'navigation system' are:

Key messages as 'take away notes'	Segregation is the key to an effective waste management
Additional information	
Ideas	
Practical case examples	
References to connected information in other chapters:	Chapter x
Citation on texts in rules (coloured)	Rules
Calculations	

2. Management Aspects: Planning, Institutional And Financial Aspects

Chapter 1

2.1 The Regulatory Framework: Key Requirements By The MSW Rules, 2000 And Draft Revised MSW Rules 2013 And Other Directives

A number of rules and guidelines regulate the management of MSW (including this Manual as given below):

MSW Management and Handling Rules 2000 and revised draft 2013	• Municipal Solid Waste (Management & Handling) Rules, 2000 by MoEF • ***Revised draft of Rules*** circulated in the year 2013 by MoEF • Designates Urban Local Bodies responsible for MSWM and lays down the mandatory functions to be performed by various stakeholders • weblink : http://www.moef.nic.in/legis/hsm/mswmhr.html
Manual on Municipal Solid Waste Management and Handling 2014	• ***Guidelines*** published by Ministry of Urban Development through CPHEEO in the year 2014 • Provide implementation guidelines for all aspects of MSWM, including segregation, collection, transportation, treatment and disposal • weblink : http://urbanindia.nic.in/publicinfo/swm/swm_manual.htm
National Urban Sanitation Policy (NUSP)	• ***Policy*** prepared by the Ministry of Urban Development in **2008** • Broadly covers aspects of urban sanitation, with a specific focus to eliminate open defecation in cities • Focus on re-orienting institutions for developing city-wide approach to sanitation, covering all its aspects including Solid Waste Management • weblink: www.urbanindia.nic.in/programme/uwss/NUSP.pdf
Rules for Special Wastes	• Plastic Waste (Management and Handling) Rules, 2011 • Bio-medical Waste (Management and Handling) Rules, 2009 and draft 2011 • E-Waste (Management and Handling Rules), 2011 • Battery (Management and Handling Rules), 2001 • Construction & Demolition (C&D) Waste Rules, under consideration
Other Relevant Rules & Task Force Reports	• Inter-ministerial Task Force on Integrated Plant and Nutrient Management using City Compost, 2005 • Fertilizer (Control) Order (FCO), 2009; PROM, 2013 by Ministry of Agriculture • Report of the Task Force on Waste to Energy, Planning Commission, 2014

Management of industrial hazardous wastes

Industrial hazardous waste is managed through the **Hazardous Waste (Management and Handling) Fourth Amendment Rules 2010** and follows a regime different from the MSWM. Hazardous waste is typically identified with properties of ignitability, corrosivity, reactivity and toxicity. Urban Local Bodies need to ensure that industrial hazardous wastes do not get mixed with the municipal solid waste stream. Wastes containing toxic components which are usually included in MSW, such as batteries, CFLs, tube lights, household cleaning agents, etc., are referred to in this Manual as **Special Wastes.**

Municipal Solid Waste (Management & Handling) Rules 2000 and draft revised MSW Rules 2013

The MSW Management and Handling Rules 2000 are under revision by MoEF and the draft revised Rules in 2013will reflect new systems, technology developments and concepts for an integrated MSWM. In particular the Rules cover the following aspects:

- list of authorities involved in MSWM and their corresponding duties;
- mandatory MSWM Policy/Strategy to be prepared by the State or the Union Territory;
- mandatory MSWM Plans to be prepared by the municipal authority;
- specific requirements for the management of MSW including segregation into wet and dry waste, as well as restriction on material to be disposed in landfills; only non-reactive inert and pre-treated waste may be disposed;
- levy of service fees by the municipal authority to make this service sustainable;
- requirements for landfill sites including site selection and mandatory lining system;
- requirement of environmental clearances for setting up MSW processing and disposal facilities including landfills;
- standards for composting;
- standards of treated leachate;
- emission standards for incineration facilities;
- mandatory annual reporting by the municipal authority on MSW operations;

Municipal authorities and all stakeholders must carefully go through the above provisions of MSW Rules 2000 and the draft revised MSW Rules 2013 and make concerted efforts to improve SWM systems and services accordingly.

Chapter 2

2.2 Modern Integrated Municipal Solid Waste Management: Concepts & Benefits

The Integrated Solid Waste Management (ISWM) system is based on the 'waste management hierarchy', (see figure 1.1) with an aim to reduce the amount of waste being disposed, while maximizing resource recovery and efficiency. Based on this waste management hierarchy, an assessment of local needs and conditions should lead to the selection of an appropriate mix of processes and technologies. The preferred waste management strategies within the hierarchy include:

- **At source reduction and reuse at source:** The most preferred option for waste management is to prevent the generation of waste at various stages including at product design stage, production, packaging, use and reuse stages of a product. Waste prevention helps reduce handling, treatment, and disposal costs and reduces various environmental impacts such as leachate, air emissions and generation of greenhouse gases.
- **Waste recycling:** Recovery of recyclable material resources through a process of segregation, collection and re-processing to create new products is the next preferred alternative.
- **Waste to composting:** The organic fraction of waste can be composted to improve soil health and agricultural production adhering to FCO norms.
- **Waste-to-Energy:** Where material recovery from waste is not possible, energy recovery from waste through production of heat, electricity, or fuel is preferred. Bio-methanation, waste incineration, production of Refuse Derived Fuel (RDF) and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted "Waste to Energy" technologies.
- **Waste Disposal:** Remaining residual wastes at the end of the hierarchy, which are ideally comprised of inerts, are to be disposed in sanitary, lined landfills, which are constructed in accordance with stipulations of the MSW Management and Handling Rules, 2014.

The hierarchy implies that all options of waste minimization should be exercised before treatment and disposal technologies are selected and implemented.

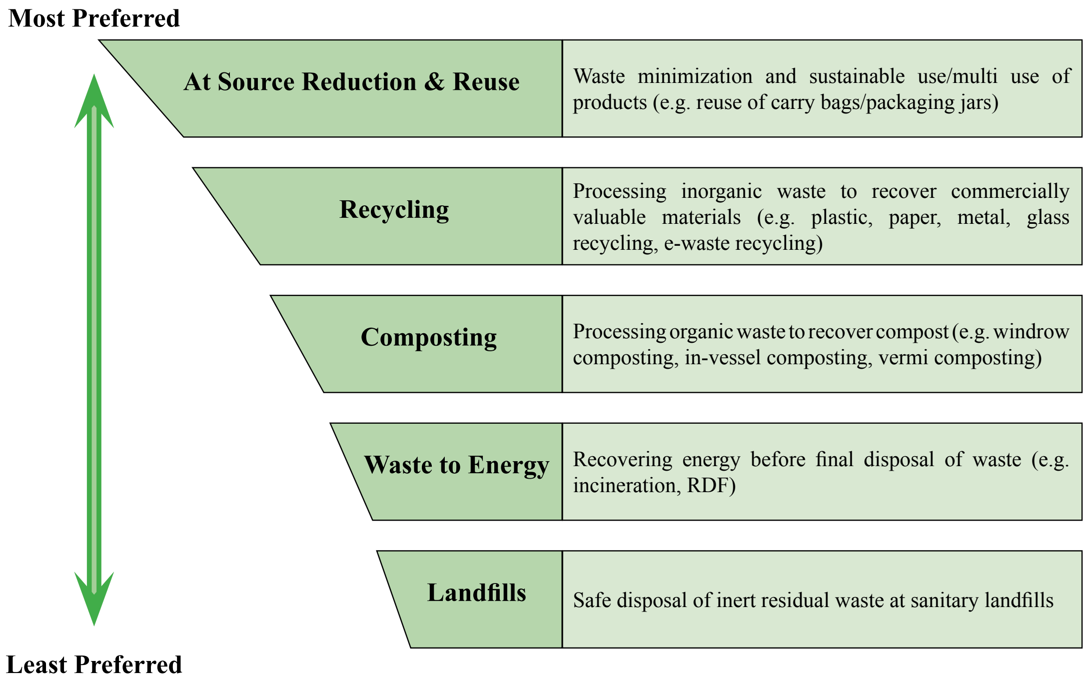


Figure 1.1: Integrated Solid Waste Management Hierarchy

The ISWM concept, as described is closely linked to the **3R approach** (**R**educe, **R**euse, and **R**ecycle), which is also aimed at optimizing the management of municipal solid waste from all the waste-generators (households, commercial and institutional establishments, parks and gardens , construction and demolition activities, urban agriculture, safety and healthcare facilities) and involving all the stakeholders (waste generators, service providers, informal sector, regulators, government, and community/neighbourhoods). The adoption of the 3R concept helps to minimize the amount of waste to be handled by the municipal authority minimizing the public health and environmental risks associated with it.

Integrated solid waste management has also to reflect the following aspects:

- **MSW and climate change:** MSW is related to climate change in several ways: (i) Integrated solid waste management reduces the emissions of greenhouse gases (mainly carbon dioxide and methane) resulting from waste management and, thereby, the contribution of MSWM to climate change. Waste minimization, waste recycling, waste-to-energy strategies and landfill gas capture and use are reduction strategies for greenhouse gases, either directly (landfill gas capture) or by better using the energy and resources inherent in products and materials ('climate footprint') (ii) MSWM should also reflect needs for adaptation to future impacts of climate change. An example is site selection and design of landfills, which might have to reflect changing ground water tables or patterns of rainfall.

- **Gender equity aspects:** Women are involved in and affected by MSWM in multiple ways. They work in ULBs (e.g. many street sweepers and door step collectors are also women) and also in the informal sector. They are disproportionally affected by inadequate and unhygienic practices in MSWM. This requires interventions which would protect women from the harmful effects of unhygienic practices which also affect their social functions in child care and family food supply. Moreover they are often the first customers of any MSW collection service and engage in segregation of waste at source at the household level. The SWM system design should therefore consider the health and safety concerns of women. The SWM system should also engage in a social impact assessment which allows for gender gaps to be brought to the forefront for systematic analysis and corrective/ appropriate responses.

- **Informal sector integration in MSWM:** An implication of the comprehensive understanding of ISWM is that it will involve various stakeholders – going far beyond a merely public task for the ULB. Important groups include the **private** sector (see Chapter 1: Municipal Solid Waste Management Plan: Step- Wise Guidance of Part II of the manual) and the **informal** sector. The informal sector plays an important role in the SWM value chain by recovering valuable materials from waste. It includes both, "kabadi system / scrap dealers" and rag pickers. They help reducing environmental impacts by improving resource recovery and reducing waste quantities for disposal. The integration of the informal sector into the formal solid waste management system through RWAs, CBOs, NGOs, SHGs and private sector will contribute to the reduction of the overall SWM costs, provide support to the local recycling industry and create new job opportunities.

Chapter 1
Section 1.4.4.8

Options for enabling conditions and supportive actions for informal sector involvement:

- Organization of informal sector workers into legally recognized, membership-based associations and their reflection in relevant policy decisions.
- Official recognition of these informal associations as viable partner organizations for SWM service delivery.
- Motivating private sector / NGOs/ SHGs to involve these informal associations in SWM service delivery by upgrading them from being waste / rag pickers on streets to waste collectors from source.
- Promotion of schemes to provide social security and health benefits to members of these associations.
- Providing low-interest loans to organizations of waste pickers seeking to bid for tenders and contracts.

- Providing incentives to encourage participation of informal sector associations through excise and tax exemptions and other fiscal concessions.
- Giving priority to these associations in taking up small contracts of waste collection and small-scale processing as informal sector enterprises.
- Reserving land in development plans for decentralized processing of bio-degradable wastes, and for setting up material recovery facilities.
- Supporting capacity development programmes for informal sector associations catering to the special needs of women.

Key messages for decision-makers

The MSWM system is dependent, inter alia, on a well-planned implementation of the concept of 3Rs, and involvement of the informal sector.ULBs may chart out well-defined strategies for waste minimization, recovery and segregation involving the informal sector directly or through RWAs/ CBOs /NGOs or the private sector.

2.3 Preparation Of A Municipal Solid Waste Management Plan - A Seven Step Approach

Chapter 1
Section 1.4

Solid Waste Management is essentially a municipal function and it is mandatory for all municipal authorities to provide this service efficiently to keep the cities and towns clean, process the waste and dispose off the residual municipal solid waste in an environmentally acceptable manner. In line with that, Urban Local Bodies (ULBs) should systematically develop their MSWM systems including carefully accessing their requirements of tools, equipment, vehicles, processing and disposal facilities in a way and at a pace which is locally doable, meets the long term needs of the ULB and is also financially sustainable. It is imperative to take stock of the situation and develop a Municipal Solid Waste Management Plan which addresses all aspects of solid waste management in terms of the draft MSW Rules 2013, and which is in line with the State Sanitation Strategy under the National Urban Sanitation Policy and the State Policy / Strategy on Municipal Solid Waste Management.

The development of a Municipal Solid Waste Management Plan follows a **7-step process**, which is illustrated below in figure 1.2.

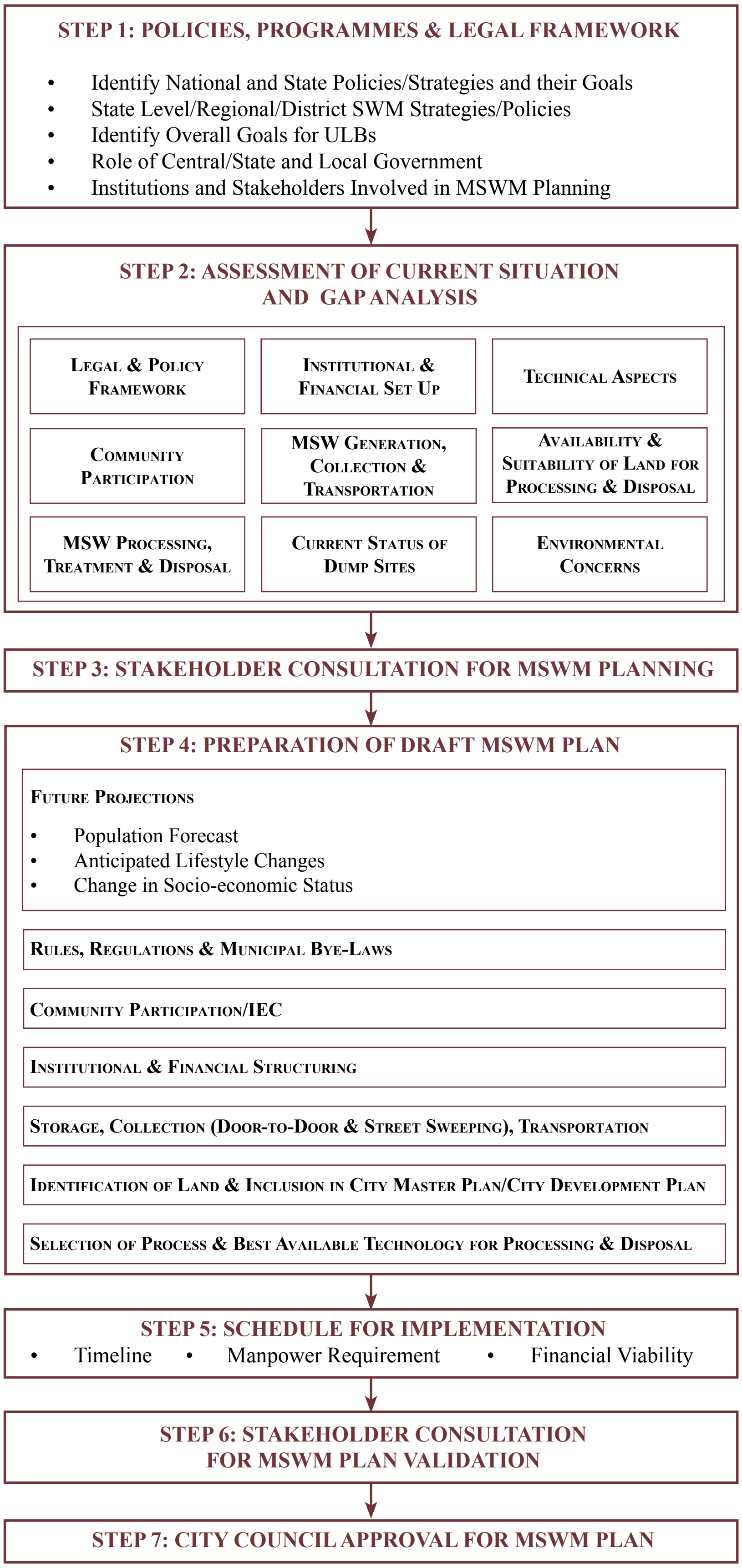


Figure 1.2: 7-Step Approach for Developing a MSWM Plan

2.3.1 Step 1: Policies, Programmes & Legal Framework

Chapter 1
Section 1.4.1

Step 1 entails a detailed review and analysis of National, State and municipal level Laws, Rules, Policies, programmes and guidance that are related to solid waste management. The ULB shall prepare a list of all mandatory and recommendatory actions required as per the MSW (M&H) Rules, 2000; draft revised MSW (M&H) Rules, 2013, the National Urban Sanitation Policy, the Service Level Benchmarks for MSWM service provision, the Fertilizer Control Order (FCO) 2009, 2013 and other relevant policy guidance and ensure that the MSWM action plan is developed within these framework conditions.

2.3.2 Step 2: Assessment Of Current Situation & Gap Analysis

Chapter 1
Section 1.4.2

The municipal authority should then carry out a critical assessment of the current status of solid waste management in the city as per the relevant National, State and Local level rules, policies and strategies for Municipal Solid Waste Management governing the ULBs. The assessment should clearly bring out the deficiencies / gaps that need to be bridged to meet the obligations. A further part of the assessment focuses on the waste quantification and characterization. This is essential as quantities and composition of waste differs widely.

2.3.3 Step 3: Stakeholder Consultation For MSWM Planning

Chapter 1
Section 1.4.3

Due to the number of institutions and stakeholders involved in MSWM, it is important that the MSWM plan which aims to bridge the gaps or improve the level of service, is developed through a consultative process. Stakeholders' views, their willingness to participate and pay for the service is also to be considered.

2.3.4 Step 4: Preparation Of Draft MSWM Plan

Chapter 1
Section1.4.4

Considering the identified gaps, future population projections & waste generation rates, current and future quality and quantity of waste (based on changing lifestyles and economic status), inputs from stake holders, financial situation and technical capabilities of the local body, the municipal authority should prepare its draft short term and long term MSWM plan.

Chapter 1
Section1.4.5

2.3.5 Step 5: Schedule For Implementation

The municipal authority should specify needs for institutional strengthening and financing. Subsequently, an operational plan should be prepared as an integral part of the MSWM plan. PPP for infrastructure development and service delivery may be fully explored during this exercise.

Chapter 1
Section1.4.6

2.3.6 Step 6: Stakeholder Consultation For MSWM Plan Validation

Provision of effective solid waste management services is substantially dependent on community behaviour and practices. Therefore, citizens and stakeholders should be consulted before finalization of the MSWM Plan.

Chapter 1
Section1.4.7

2.3.7 Step 7: Council Approval For MSWM Plan

The final MSWM plan is to be presented to the elected body of the local authority to seek approval and to officially formalize the plan. Council should be made aware of the short term and long term actions to be taken and should also approve the financial plan and necessary institutional strengthening for implementation of these actions.

2.4 Role Of State And Regional Level Authorities

Chapter 1
Section1.4.1.5

Besides the ULBs, **States** have specific responsibilities in MSWM. These can be summarized as follows:

- The Secretary-in-charge of the Urban Development Department (UDD) of the concerned State or Union Territory has the overall responsibility for the implementation of MSWM Systems in cities/ towns in line with MSW Rules.
- UDD is required to prepare a State Policy / Strategy for Municipal Solid Waste Management in the State.
- UDD has to report on Service Level Benchmarks for solid waste management service provision in ULBs to the Ministry of Urban Development (MoUD).
- UDD is also responsible for approval of land transfer from State to ULBs (for all projects).
- States have the power to regulate the creation of staff positions (technical and non-technical) in the ULBs.

- The State Pollution Control Board (SPCB) is responsible for monitoring the compliance with the MSWM plan and the MSW Rules. And it is authorized to give environmental clearance to facilities as listed in the Environmental Impact Assessment (EIA) Notification 2006.
- The power to authorize municipal authorities or operators to set up treatment and disposal facilities also lies with the SPCB.

The MSW Strategy of the State should be part of the State Sanitation Strategy (SSS) under the National Urban Sanitation Policy (NUSP). As per NUSP (2008) all States have to set up their SSS within 2 years. The SSS may create enabling framework conditions with respect to urban sanitation including MSWM.

2.4.1 Creation Of Regional Facilities

Finding suitable land in each city / town for setting up a sanitary landfill for safe disposal of waste is a matter of great concern in the country and it is technically and financially unviable to operate small SLFs. Both arguments favour that state authorities may bring cities together to set up shared common landfill facilities, which might be organized at district or even regional level through inter-municipal agreements. The cooperation among ULBs might also include common treatment facilities for MSW besides common landfill, if financially viable.

Key messages for decision-makers

The municipal authority should carefully look at the State policy, its directives and regulatory framework and explore options for setting up regional or district level common processing / disposal facilities for groups of towns /cities in consultation with all stakeholders including political leadership of all participating towns. Stakeholders need to be convinced of the economic and environmental benefits of a common facility and the win-win situation arising out of such a decision. The top management should launch negotiations with potential cooperation partners in general and with the host city in particular, where the facility is proposed to be created.

2.5 Understand Local SWM Needs

Chapter 1
Section1.4.1.5

In order to develop a MSWM plan, the ULB should accurately assess the baseline of SWM service and analyze system deficiencies in the context of MSW Rules and utilize that information for further planning, implementation and monitoring processes. Local conditions shall be considered while assessing the inadequacy of existing service and planning for the future with due consideration of local demography, physical location, growth objectives of the ULB as well as social and environmental conditions.

The assessment of the baseline vis- a- vis requirements of existing regulation, policies and guidelines and identified SLBs will result in an identification of key shortfalls in achieving the desired level of services and shall form the basis for preparing a plan to improve the MSWM system. Figure 1.3 is a schematic diagram depicting the issues to be considered while assessing gaps in MSW service provision.

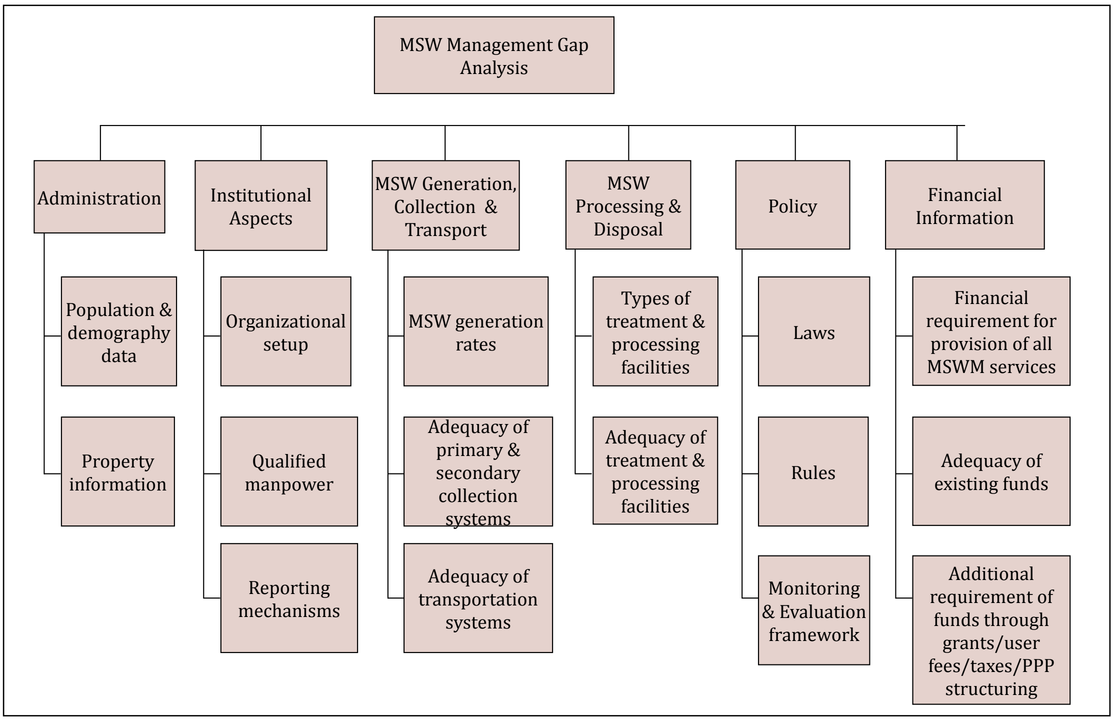


Figure 1.3: MSWM Management Gap Analysis

Chapter 1
Section 1.4.3

2.6 Role Of Stakeholders In MSWM Planning

The main responsibility for preparing a MSWM Plan lies with the ULB, specifically the solid waste management division. A core team/advisory team, also called the internal stakeholders, may be constituted for developing the MSWM Plan. This team should be a multi-departmental team, involving all the departments concerned with, influenced by and/or influencing solid waste management services within a city. This core team/internal stakeholder team should be led by the Commissioner/Chief Executive of the ULB.

Municipal officials may also seek advisory support from experts in the field, academicians and environmental planners/engineers, if sufficient capacity is not available within the ULB.

Informing and involving the community (external stakeholders), as well as creating channels for all stakeholders to participate in decision making are all very important steps for successful implementation of SWM strategies.

Typical stakeholders for a MSW management system include households, businesses, industries, informal sector, the local government, NGOs, community-based organizations (CBOs), Self- help groups (SHG), women's groups, secondary school and college students, or members of other institutions who may have a role to play in ensuring the involvement of the community.

Stakeholders are to be consulted atleast twice during the process of MSWM Plan preparation, initially in defining the objectives and goals of the plan and later (Step 6) to discuss the proposed plan and seek their inputs and approval. The ULB may constitute a stakeholder committee for the purpose, with members representing all concerned groups. These groups would need to represent the interest of men, women, youth, marginalized/ vulnerable groups of people who are all part of the MSWM process. Specifically, the involvement of women's groups during the planning phase is essential.

2.7 Establish Appropriate Institutional Mechanisms

Chapter 1
Section 1.4.4.4

Planning for an efficient and advanced MSWM system is not restricted to the procurement of vehicles, equipment or adequate infrastructure. Equally important is an effective institutional structure capable to steer and implement the MSWM system. By and large, solid waste management services are currently looked after by the Health Department of the local authority, usually headed by a medical doctor, who is generally not well versed with emerging technologies and technological aspects of processing and disposal of waste. It is strongly recommended that large urban local bodies have a SWM Department headed by an environmental / civil / public health engineer while small ULBs have a specific solid waste management cell with technical and managerial personnel as recommended in this manual.

There is also an urgent need to train and update the capacities of staff involved in solid waste management activities. Professionalizing the solid waste sector will not only build the capacities of workers to perform more effectively and efficiently but will also inculcate a sense of responsibility and pride towards their profession. This will lead to an improvement in service delivery and better management of activities.

Professionalizing solid waste management services also demands that workers should perform their duties in a healthy environment under safe conditions; adequate and appropriate Personal Protective Equipment (PPE) should be provided, adequate to the task of the employee.

Chapter 1
Section 1.4.4.5

2.8 Ensure Sustainable Financing For MSWM

The planning for an advanced MSWM system should be based on accurate financial calculations, taking into consideration all relevant costs and most likely revenues to be realized. This important task within the planning process (reflected in the steps 2, 4 and 5 of the 7-step approach) is to ensure financial viability of the MSWM system and its sustainability in the long run. Full Cost Accounting (FCA) provides a framework for evaluating all costs associated with the integrated waste management operations as mentioned above. FCA for MSWM can be defined as a systematic approach for determining the full costs of a solid waste management system at local level over a period of time. It tends to uncover hidden and overlooked costs and allocates costs to all the specific activities and operations. This helps the decision-makers to compare present and proposed services accurately, predict future costs reliably and evaluate privatization/ PPP options thoroughly.

The major types of costs that are considered for full cost accounting of solid waste management typically include: (see figure 1.4):

- **Up-front costs** such as pre-operative investments and expenses necessary to implement MSW services.
- **Operating costs** which include capital costs and daily expenses of managing MSW.
- **Back-end costs** comprise of the expenditure required to wrap up operations and maintenance of MSW facilities at the end of their life-time.
- **Contingent costs** include cost that might or might not be incurred at some point in future. Examples are remediating costs for disasters (fire etc.).
- **Environmental costs** result from environment protection or mitigation during MSW transportation, treatment and disposal activities.
- Social costs are costs incurred to mitigate adverse impacts on health & well-being of local community on account of improper MSWM. An assessment & consideration of these costs is required before selecting the waste management options

These categories together cover the “life cycle” of MSW activities from the “cradle (up-front costs)” to “grave (back-end costs)”.

Up-Front Costs
- Land acquisition
- Permits
- Building construction
- IEC* Activities

Operating Costs
- Capital cost
- Debt service cost
- Operation and maintenance costs involved in daily activities
- IEC* Activities

Contingent Costs
- Remediation costs
- Liability costs (e.g property damage, personal injury)

Back –End Costs
- Site closure
- Building/ equipment decommissioning
- Retirement/health benefits for current employees

Environmental Costs
- Costs involved in mitigating adverse effect on environment (costs for implementing EMP*)
- Downstream impacts

Social Costs
- Quality of life
- Aesthetic impacts
- Community image
- Effects on property values

** EMP: Environment Management Plan; IEC: Information & Education Campaign*

Figure 1.4: Types of costs to be reflected in the Full Cost Accounting (FCA)

Sources of financing

While deciding to introduce a new MSW system or to construct and operate processing or disposal facilities, proper care should be taken to assess the capital sources and revenue implications. ULBs have to ensure that the needed resources for O&M of the MSWM system will be continuously available and reserve funds will be kept aside to meet replacement costs of vehicles, equipment, plants and machinery at the end of their life time. The following sources of financing should be considered:

- **JnNURM Grants:** The Jawaharlal Nehru National Urban Renewal Mission (JnNURM) was launched by the Government of India in 2005, envisaging an investment of more than Rs.1,00,000 Crore during a period of 7 years from 2005/06 to 2011/12 (scheme extended as transit for 2 years till 2013-14) with a committed Central Government share of Rs. 66,000 Crore. JnNURM is a reform driven, fast track programme to ensure planned development of identified cities with a focus on efficiency in urban infrastructure/service delivery, and through community participation and enhanced accountability of ULBs/para states towards citizens. Further information on JnNURM is available at: http://jnnurm.nic.in/wp-content/uploads/2011/01/English1_Toolkit1.pdf
- 12th& 13th Finance Commission Grants
- UIDSSMT Grants

- **PPP as a source of funding (see in-depth section below):** Public Private Partnerships (PPP) are innovative approaches used by the public sector to attract private sector to make investments and take up certain responsibilities of service delivery, while the public sector retains the principal responsibility for these services. PPP mechanisms aim – as the case may be - at financing, designing, implementing and operating public sector facilities and services through service provisions (short and long term, in some cases up to 30 years). A pre-defined contract agreement regulates how rewards and risks will be shared with the private contractor.
- **Loans from Bilateral and Multilateral Agencies:** Bi-lateral and Multi-lateral bodies also known as Development Agencies like World Bank, Asian Development Bank (ADB) and KfW-Development Bank, provide soft loans on long term and grants for infrastructure projects. Usually, these funds are given in the form of soft loans with a grant component for project preparation or capacity building. In certain cases, retroactive financing arrangements can also be agreed to; wherein funds spent in project preparation are financed after the loan agreements are finalized. For accessing funds from Bi-lateral and Multi-lateral agencies it is a prerequisitive that there should be long term planning as well as State support.
- **National/ State level Infrastructure Funds:** Infrastructure funds both at the National and State level play an important role for financing infrastructure projects. Funds at the National level set-up by Financial Institutions and Banks have started. They are supplemented by State level Infrastructure Funds (from supply side) and Pooled Finance Funds (from demand side) at the State level (e.g. Tamil Nadu has provided funds for infrastructure projects). There is a dearth of these types of funds; however the Ministry of Urban Development has recently issued guidelines for the formation of State Pooled Finance Entities (SPFEs). The Finance Budget 2007 has also allowed SPFEs to issue tax-free municipal bonds (see below). Union Budget 2013-14 had proposed funding for Waste to Energy projects in Municipal Solid Waste.
- **Municipal Bonds and Debentures:** are issued by the ULBs. The bonds/ debentures are issued to the general public or to specific institutional investors. In case of municipal bonds, they can either be taxable or tax-free. In India, the Municipal Bond market is still in its nascent stages. Only ULBs which are large and have a buoyant revenue base have been successful in the past in raising funds through Municipal Bonds (example: Ahmedabad).
- **Loans from Financial Institutions:** Specialized Financial Institutions e.g. IDFC and IL&FS are agencies which provide loans and a variety of instruments for infrastructure financing. Other Financial Institutions e.g. ICICI, IDBI, LIC of India, etc. also provide funds for infrastructure projects. These institutions have access to funds with long

repayment periods e.g. loans from development agencies, bonds from the open market, foreign institutional investors, etc. and are thus able to lend for relatively longer durations than banks. The credit rating of the ULB plays an important role here. The better the credit rating with respect to repayment of principal and interest, the lower is the rate of interest, since risk is lower and vice-versa. Certain Financial Institutions provide credit enhancement mechanisms, which are essential to enhance the inherent credit quality and credit rating, thereby resulting in lower interest rates. This facility is now also being extended by the Ministry of Urban Development (MoUD) through its Pooled Finance Development Fund (PFDF) scheme. Institutions may also provide guarantees for funds accessed from other sources.

- **Bank Loans:** Banks have prescribed norms and well laid down procedures for grant of loans. Since the deposit base of Banks is for short duration (generally 1-3 years), loans are provided also for a short to medium term. Banks generally do not cater to the long-term needs of infrastructure projects. Bank loans are especially relevant to finance the short term needs of institutions e.g. as working capital loan, bridge loans, loans against property, etc.
- **Enhancing continuous revenues in SWM Projects:** It is of paramount importance for sustainable financing to strengthen project revenues. It is imperative that the projects are planned in such a way that they are self-sustainable and can deliver desired outcomes for a longer period. MSWM operations usually depend on SWM taxes or fees/charges. Other sources of revenues might be relevant as illustrated in figure 1.5.

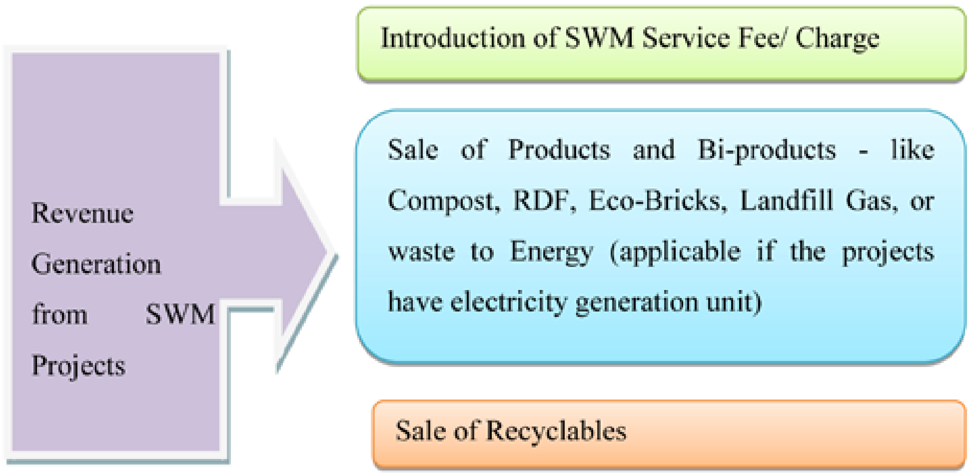


Figure 1.5: Illustration of SWM Revenue Streams

Introduction of SWM Service Charge / User Charges: According to the 74th amendment to the Constitution ULBs can impose taxes and raise funds for public health, sanitation, conservancy and solid waste management. It is desirable to levy a dedicated tariff for solid waste services. Following basic principles may be considered by Local Bodies while prescribing norms for levying user charge/service fee for Solid Waste Management services.

- Polluter Pays Principle: Those responsible for waste generation should pay for its collection and safe disposal.
- Proportionality: The user fees should be in proportion to the quantity of waste generated and level of service provided to waste generators. Variable rates may be prescribed for different categories of waste generators keeping in view their waste generation pattern. A fair user fee will facilitate better compliance.
- Capacity to pay: Affordability of Tax Payers may be kept in view.

Key tasks for decision-makers

Sustainable financing of MSWM systems is crucial for effective service delivery. Make sure that ULB finds a sustainable solution to financing investments and operation & maintenance. Levy of user fees are needed to sustain the service in an efficient manner.

Chapter 1
Section 1.4.4.6

2.9 Make-Or-Buy Decisions / Public Private Partnership (PPP)

ULBs may contract private service providers for provision of specified solid waste collection, transportation, treatment, processing and disposal services.

In principle, the following options exist for contracting services out:

Table 1.1 Options for contracting services

MSW Management & Operation	Characteristics	Relevant Contract Models	Examples of implementing ULBs
Collection and Transportation	• Large number of work force, vehicles & equipment • Logistics intensive • Citizen interface • Investment ranges widely depending on scope of work	Service contracts; Management contracts; concession for a term of 7 years +	Bangalore, Surat, Ahmedabad, Jodhpur
Street sweeping*	• Labour intensive • Minimal investment in tool and equipment • Limited /technical skills • Logistics intensive	Service contracts subject to Contract Labour (Regulation & Abolition) Act 1970.	Hyderabad, Chennai, Rajkot
Transport	• Capital intensive • Fleet management skills	Concession contracts	Bangalore, Delhi, Chennai Ahmedabad, Surat
Processing and Disposal	• Capital intensive • Technically skilled manpower required • Experience of technology deployed	Concession contracts (DBO, BOO, DBOOT) for 20 years +	Surat, Ahmedabad, Navi, Mumbai, Pune, Jodhpur

Note: * Street Sweeping usually stays with the ULB to ensure employability of current workforce

Sourcing out MSWM services should be carefully considered taking into account all relevant aspects such as:

- Technology assessment & specification of the technology selected and services to be outsourced; potentially including a technology assessment.
- Justification of the need for contracting and identification of appropriate contract models and their pros and cons.
- Commercial feasibility of services to be outsourced.
- Duration of the contracted service: All PPP contracts shall be for a duration that may enable the concessionaire to recover the capital investments made by them in easy instalments, while also financing O & M cost of service.

- Specific outputs and performance standards for the contracted service.
- Adequate social and environmental safeguards for service provision.
- Possible risks: technical, operational and financial. Is it realistic that liability for key risks can be transferred to the operator?
- Where acquisition of land/rehabilitation of the community is involved, the ULB should ensure that the private agency meets with all applicable norms for compensation, relocation and rehabilitation. The risks have to be assigned to the Public entity, in such cases.

Contracting models should preferably be performance based and the payment made to private partner be measured on outputs reflecting the service quality levels as defined in the contract. Private Service Providers have to be held accountable for the required standards of services, as well as its effectiveness and efficiency. Certain precautions must be taken while selecting a specific contractor for MSW service provision, to ensure an efficient solid waste management system:

- Clearly address the specific requirements in the tender specifications. Prefer performance based terms of reference.
- Select the bidder based on both technical and financial bids and not solely on the criteria of selecting the lowest bidder.
- In ULBs with a population over 1 lakh, at least 2 contractors may be considered for collection and transportation service if out-sourced.
- Ensure timely payments for contracted services, thereby also insuring the provision of the stipulated standard of service provision.
- Where contract labour is hired, the ULB shall ensure compliance with the provisions of the "Contract Labour Abolition & Regulation Act 1970"
- Contract management and supervision: Monitoring mechanism and penal provisions shall be clearly spelt out in the contract document and strictly adhered to. Record shall be maintained of observations made by the supervisory officers and corrective measures taken. Penal provisions may be invoked if the concessionaire fails to perform after due notice.

The procurement process for a PPP should follow a systematic process of several steps beginning with the preparation of Expression of Interest (EoI), Request for Proposal (RFP) document and Concession Agreement (CA) and ending with an award of work to the selected firm. In single step process the EoI is not sought separately.

Key messages for decision-makers

Outsourcing MSWM services should be carefully considered taking into account all relevant aspects. There is no 'one-size-fits-all solution' for ULBs. Each PPP option should be assessed considering pros and cons of the respective community. Contracting models should be performance based and the payment made to private partner should be based on measured outputs reflecting the service quality levels as defined in the contract.

2.10 Centralized Vs. Decentralized MSW Management Systems

Decentralized waste management systems/community level waste management systems reduce the burden of handling large volumes of MSW at a centralized location, with a corresponding reduction in costs of transportation and intermediate storage. Some of the advantages of decentralized waste management include:

Chapter 1
Section 1.4.4

- Decentralized options have a lower level of mechanization than the centralized solutions and generate local employment. They provide income and job opportunity for informal workers and small entrepreneurs.
- Decentralized options can be tailor made for the local waste stream, climate, social and economic conditions.
- Decentralized systems reduce the cost incurred for the collection, transportation and disposal of waste by the urban local bodies.

Decentralized Solid Waste Management solutions are suitable when:

- Suitable land for waste management facilities (composting organic waste, recyclable sorting facilities) is available in neighbourhoods
- There is no local resistance against siting the plant
- Availability of local expertise/NGOs to handhold the process in an environmentally acceptable manner
- Municipality has in- house capacity of effectively monitoring decentralized systems
- Markets for compost/recyclables are accessible

However, for MSW processing /treatment facilities like material recycling facilities, Material recovery facilities, RDF plants and municipal sanitary landfills, centralized systems which can benefit from economies of scale should be preferred.

Key messages for decision-makers

Decentralized solid waste management systems are preferred to reduce the environmental and monetary costs of transporting waste over large distances. Collection of recyclables, composting of organics are some of the activities which can be taken up at the local level, either at a colony level or ward level. Processing/treatment and disposal facilities, which are viable only at a certain scale, like recycling facilities, RDF plants and municipal sanitary landfills, should be planned for at the centralized/regional level, depending on the size of the ULB. Decentralized MSW management facilities may be funded through community based co-operatives, local NGOs, PPP mode or through municipal funds. Community ownership of decentralized systems is critical for their success and continued operation.

2.11 Role Of The Informal Sector

The informal sector, constituting kabadi system and waste pickers/rag pickers, plays an important role in the SWM value chain by recovering valuable material from waste. They help reduce environmental impacts by improving resource recovery and reducing disposal requirements. The integration of the informal sector into the formal solid waste management system will contribute to the reduction of the overall system costs, provide support to the local recycling industry and create new job opportunities.

The "integration" of the informal waste sector refers to several ways in which the waste pickers/ rag pickers could be involved in formal waste management systems. This is made possible through a set of formal or informal arrangements between waste pickers themselves or organizations of waste pickers or organizations working with waste pickers with local authorities in their operational area. The integration process would typically result in the accrual of social benefits to waste pickers.

Key messages for decision-makers

Developing formalized material recovery systems are capital intensive. Therefore, the informal sectors if existing, should be encouraged to work in MRF Units, while ensuring environmental, health & safety safeguards. Through the process of formalizing the informal sector, social identity, social security, health care benefits and a stable livelihood should be given to informal sector workers. Waste pickers/ rag pickers could be employed in door-to-door collection activities, sorting recyclable waste, collection and segregation of recyclable material, set-up and management of recyclable/reusable waste take-back/buy-back facilities, waste sorters in processing facilities (e.g. at the sorting conveyor). Mechanisms to identify and recognize the informal waste workers should be constituted.

3. Technical Aspects: Collection, Segregation & Transportation

Chapter 2
Section 2.1

3.1 At-Source Minimization: Options To Reduce The Amount Of Waste

The ISWM (Integrated Solid Waste Management) hierarchy of waste management as explained above prioritizes waste minimization (reduction at source and reuse) as the preferred waste management strategy because it is the most effective way to reduce the quantity of waste, the cost associated with its handling, and its environmental impacts.

Waste minimization strategies require policy interventions at the National, State and/or Local level, depending on the type of the intervention (e.g. minimizing use of packaging material, promoting use of refill containers, buy back of reusable or recyclable packing material, introducing a national deposit system on beverage packages) and the scale at which the intervention needs to be initiated for effective implementation. Initiatives which require a behaviour change in the community need to be supported by consistent awareness programmes.

Waste Minimization Strategies requiring National or State level interventions or support

- **Extended Producer Responsibility (EPR):** EPR can be established for wastes like electronics, batteries, packaging and consumer durables by State and National governments. States can take initiatives in this matter; regulations are usually legislated at State and National levels.
- **Promotion of voluntary action:** Encouraging business groups to reduce volumes of packaging, while maintaining the requisite strength. Example: Godrej has a 'No Packaging Policy' for refrigerators. The company ensures that the packaging, in which the appliance is delivered, is taken back by the supplier and reused.
- **Frame rules and bye laws** banning use and/or sale of certain types of products and packaging that cannot be reused, repaired, recycled, or composted. With State support, local authorities are enabled to issue and enforce such ordinances

- Developing **eco-labelling standards** for certain products based on their potential for waste reduction and recycling in respect to the product or connected packaging.

Waste Minimization Initiatives usually requiring ULB Support/Action

- Promoting and implementing **awareness and education programs** that address different stakeholders: residential, commercial and industrial educational programs, school programs that increase public awareness and participation in at-source waste reduction programs. Campaigns might include promotion of material substitution where possible (e.g. promoting the use of rechargeable batteries instead of single use batteries, buying refills etc.).
- **Developing and promoting at-source reduction programs** in the community, e.g. domestic composting programs can reduce the volume of food waste, leaves and garden trimmings entering the city level collection system.
- **Bans within local authorities' jurisdiction** (usually National / State Level authorization required; see above): Replacing non-recyclable / disposable materials and products with recyclables and reusable materials and products (e.g. banning the use of plastic bags).
- **Product stewardship and Green Procurement implementing programs** whereby the suppliers of a product are responsible for providing a take-back program to promote recycling. Take- back examples are computer monitors, auto oil, batteries, paper, milk pouches, etc. Procurement programs in local governments and businesses should be designed to give preference to recyclable products.
- **Local businesses should be encouraged** to reward consumers for returning recyclable products/ products which are toxic (e.g. batteries). These initiatives require existing manufacturers' EPR programs (see above).
- **Business assistance programs** advise businesses how to use materials more efficiently and reduce waste generation.
- **Supermarkets & retail stores** are often some of the most effective partners for a municipal waste minimization program. These provide a central and consistent point for consumer education, packaging reduction projects and collection of recyclable wastes.
- **Promoting materials exchange and reuse programs** that divert materials from the waste stream going to landfill (e.g. programs which link sellers of used furniture with potential second hand furniture buyers).

- Establishing incentives for at-source reduction through the principle of **"pay as you throw",** supported by bye-laws. ULBs can stipulate variable solid waste management charges, based on the quantities being disposed per household/establishment. Variable rates can be fixed for pre-defined ranges of waste quantities, progressively increasing with waste generation rates. This would also imply that the ULB has the resources to record waste generation quantities. This system will function successfully only if the progressively increasing tariff is restrictive enough to prevent waste generation.

Key messages for decision-makers

Waste minimization strategies at ULB level are quite new. ULBs can play a pioneering role by reducing the amount of waste to be handled by propagating and promoting the 3R concept.

3.2 Waste Segregation, Collection And Transportation

MSW should be stored at the source of waste generation till it is collected for disposal by ULB staff or appointed contractors. It is essential to segregate wastes into different fractions, commonly referred to as primary segregation. Segregation of municipal solid waste needs to be linked to primary collection of waste from the door step and given high priority by the ULBs. Unless primary collection of segregated waste is not planned by the ULBs the source segregation by waste generators will be meaningless.

The fractions into which the waste has to be segregated should be decided upon by the respective ULB based on the waste characterization, the ULB's capacities and facilities, and other framework conditions (existing kabadi systems, traditions in the community, available space in residential areas and in streets etc.). At a minimum level, indicated as the **basic segregation**, waste should be segregated by waste generators into two fractions: wet (green container) and dry (bluecontainer) (see figure 1.6). This system is referred to as the 2-bin system. The wet fraction should preferably be used for composting and as many fractions as possible from the dry waste should be sent for recycling.

Figure 1.6: 2-bin system for dry and wet waste

3.2.1 Segregated Collection

Collectionof segregated municipal waste from the source of its generation is an essential step in solid waste management. Inefficient waste collection service has an impact on public health and aesthetics of towns and cities. Collection of wet and dry waste separately enhances the potential of cost effective treatment of such wastes and of deriving optimum advantage from the recyclable material fed into the system.

Waste collection service is divided into **primary and secondary collection**. The different collection systems are illustrated in figure 1.7.

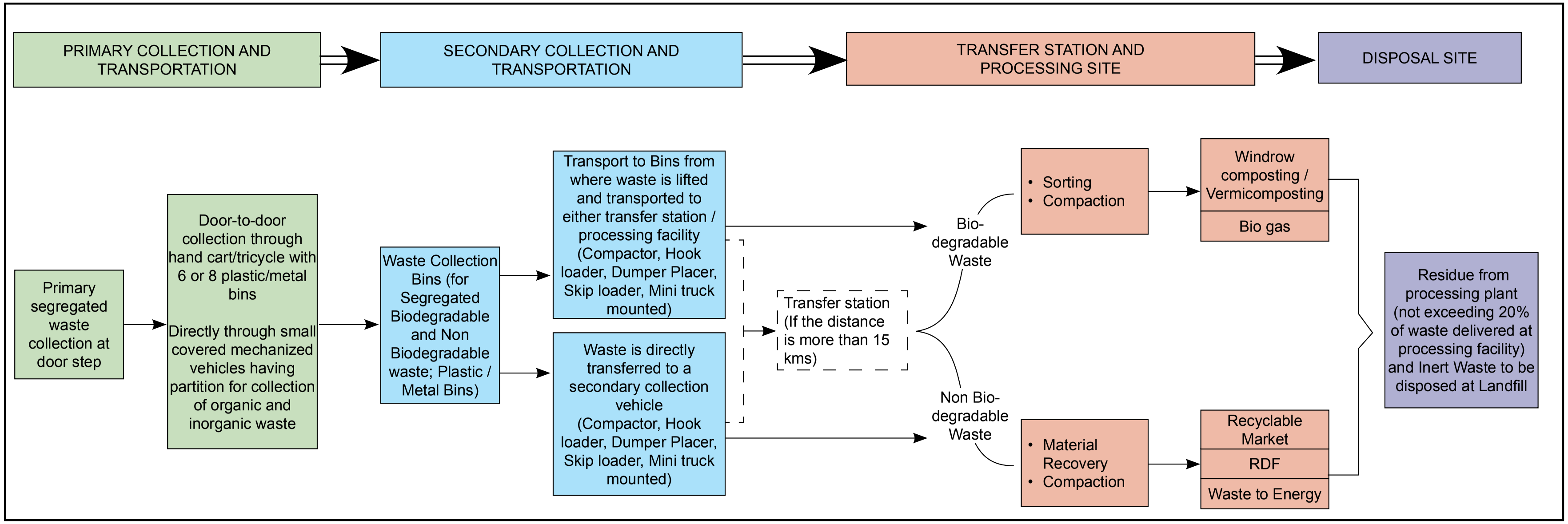
Primary collection refers to the process of collecting waste from households, markets, institutions and other commercial establishments and taking the waste to a storage depot/ transfer station or directly to the disposal site, depending on the size of the city and the prevalent waste management system.

Secondary collection includes picking up waste from community bins, waste storage depots or transfer stations and transporting it to waste processing sites or to the final disposal site. Primary collection must be introduced both in small and large towns/cities. Secondary collection systems are necessary in all cities and towns for collection of waste deposited by the waste generators in the community bins or by sanitation workers at the secondary waste storage depots or for onward transportation of waste to processing / disposal facilities.

A well synchronised primary and secondary collection and transportation system is essential to avoid containers' overflow and waste littering on streets. Further, the transport vehicles should be compatible with the equipment design at the waste storage depot in order to avoid multiple handling of wastes and should be able to transport segregated waste. They should also be easy to maintain.

Key messages for decision-makers

Develop an appropriate system to ensure segregation, collection and transportation of waste from source by deploying tools, equipment and vehicles suitable under local conditions. A too complex system might not be manageable; a too simple system without any segregation might miss existing opportunities for recycling and composting.



- *The compactor is an appropriate vehicle for collecting biodegradable and recyclable component of MSW*
- *Skip loaders/ Hook loaders are preferred for collecting inert waste or Construction and Demolition waste*
- *Waste may be transferred to the transfer station if the processing site is located at least 15 kms away from the city*

Figure 1.7: Flow chart of household waste collection, transportation and disposal

3.2.2 Street Cleaning And Drain Cleaning Material

Street cleaning is an age old fundamental service rendered by municipal authorities in India to ensure clean and hygienic urban conditions. Until recently all domestic and trade waste was being discharged on the streets or street bins and street sweeping was the principal method of waste collection. With the introduction of door to door collection systems in many urban areas, there is a sizeable reduction in the quantity of waste and change in its composition. The street waste should ideally comprise of dust and tree leaves and some litter disposed by citizens on the streets but till such time door to door collection becomes effective, the street sweeping will also include sizeable portions of food waste as well as recyclable waste. Manual sweeping is commonly practiced in India as many streets are congested and narrow road conditions are not conducive for mechanical sweeping. Inefficient waste collection systems coupled with public littering significantly contribute to waste piles in streets.

A wide variety of tools and equipment are available for manual and mechanical sweeping. Municipal authorities must avoid multiple handling of waste by converting traditional handcarts into containerised handcarts to facilitate direct transfer of waste from handcart to a container of collection vehicle. Through the introduction of efficient methods, municipal authorities can achieve significant improvement in quality of service and financial savings. ULBs should determine the frequency of street cleaning based on local conditions for efficiency of staff. Also, the time of street cleaning should be carefully defined to avoid conflicts with traffic, parked vehicles and pedestrians.

In many cities there are open **surface drains** along the road side, which need to be cleaned on a regular basis to permit free flow of storm/grey water. Solid waste management authorities should ensure that citizens and sweepers do not dispose waste into drains, through training, campaigning, statutory regulations and monetary fines. A further approach to prevent this is to make the same staff responsible for cleaning streets as well as adjacent surface drains up to a depth of 90 cm.

It is very important to ensure that street sweepings and drain cleaning material are not allowed to be mixed with the waste collected from households and commercial establishments as it can seriously hamper treatment and recycling options for the household and commercial wastes and add to the cost of processing of waste.

Key messages for decision-makers

Ensure that street sweeping, drain cleaning and waste collection form a consistent system. Prevent street sweeping and drain cleaning material from being mixed with waste collected from households. Also street sweepings should not be discharged into surface drains.

Chapter 1: Section 1.4.4.11 & Chapter 3

4. Technical Aspects: Processing & Treatment Of MSW

4.1 Waste Treatment: How To Select Appropriate Technologies

The selection and adoption of MSW processing technologies should be based on defined selection criteria and be subject to a detailed due diligence study, which ascertains the appropriateness of the technology to the prevailing conditions of the respective ULB. ULBs might even acquire external expertise, to find the most viable solution among complex technologies. Relevant selection criteria are listed in table 2 and applied to a number of common strategies and technology options.

Key messages for decision-makers

Ensure that selected MSWM technologies fit to the local conditions. There is no 'one-size-fits-all' solution. Be careful with facilities which are not proven. Technology offers by companies are often biased by their economic interests. Therefore check for successful and proven project references and experiences in other ULBs. Seek opinions of independent experts and consult the State Pollution Control Board for validation of the proposed technology.

Table 1.2 Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies[33]

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
TECHNICAL CRITERIA							
Facility Location[34, 35]	Plant should be located at least one km away from habitation, if it is open windrow composting. The distance could be 500 m in case of covered plants.	Within the residential area (with appropriate environmental safe guards)	Plant should be located at least 500 m away from residential areas, for plant sizes upto 500 TPD.	Plant should be located at least 500 m away from residential areas.	Plant should be located at least 1km away from residential areas.	Plant should be located at least 500 m away from residential areas.	Landfill sites must be located at least 1 km away from residential areas and should abide by the criteria mentioned in MSW Rules and state level guidelines
Buffer Zone (No Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 mfor facilities for dealing with more than 75 or less than 100 TPD; 300 m forfacilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.						

33 Adopted from various sources (JnNURM, World Bank)

34 Site selection criteria specified by the EIA Notification 2006 and its amendments shall be considered.

35 CPCB Guidance on Criteria for Site Selection for Landfills shall also be considered

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Natural environment	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation					Should be avoided in marshy land and in conditions where the ground water table is l 2 mtr. from the base of the liner. In marshy land apart from ground and surface water contamination potential, there could be huge risks due to structural safety of the landfill (slippage and complete breakdown)
Land Requirement	High (For 300TPD of MSW: six ha of land is required)	High (Suitable for quantities less than 20 TPD)	Low to Moderate (For 300 TPD of MSW: 2 ha of land is required)	Low to Moderate (For 300 TPD of MSW: 2 ha of land is required)	Low To be assessed	Low (For 300 TPD of MSW: 6 ha of land is required)	Very High (For 300 TPD of MSW: 30 ha of land is required for 20 years)

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Waste Quantity which can be managed by a single facility	20 TPD and above	1 TPD to 20 TPD	1 TPD at small scale to 500 TPD at larger scale	100 TPD and above	500 TPD and above (smaller plants are not techno-economically viable, given the cost of required environmental control equipment & boiler technology	500 TPD and above (economically sustainable at 500 TPD plant size)	100 TPD inert and above. Smaller landfills are not techno-economically viable
Requirement for Segregation prior to technology	High	Very high	Very high	High	High – Feed stock should be free from inerts and low on moisture content	low	Only inert waste may be placed in landfills as per MSW (M&H) Rules, 2000
Rejects	About 30% including inerts if only composting is done[36] 15% rejects with RDF, if located in the same plant	About 30% including inerts	About 30% from mixed waste	Around 30% from mixed waste	Around 15%		No rejects
Potential for Direct Energy Recovery	No	No	Yes	No (feed stock for energy recovery)	Yes	Yes	Not as per MSW (M&H) Rules, 2000

36 In cases of an integrated facility of composting and RDF, 15% rejects from mixed waste stream is expected

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Technology Maturity	Windrow composting technique is well established	Community scale projects are successful	Feasibility for biodegradable waste is proven. Not suitable for mixed waste	Quality of RDF should be based on end use, no clear consensus on quality requirements. Burning of RDF below 850°C for less than 2 seconds residence time can pose serious problems of health and environment. Rules regulating characteristics of RDF and guidelines for appropriate use not prescribed by concerned authority.	Technology is available. However constraints of low calorific value, high moisture content and high proportion of inert waste should be considered while undertaking the project commercially.	Technology is proven and widely used world over but not suitable under Indian conditions where waste has very low calorific value. Can be used selectively after raising calorific value of segregated waste.	Sanitary landfill is a proven method for safe disposal of waste, practiced world over. However it has environmental implications and efforts have to be made to minimize waste going to landfills. MSW Rules only permit inert wastes to be landfilled.

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
FINANCIAL CRITERIA							
Indicative Capital Investment[37]	(Typically 15-20 Cr for 500 TPD plant)	1 Cr. per 20 TPD	(Typically 75-80 Cr for 500 TPD plant)	(Typically 17-20 Cr for 500 TPD plant)	Very High capital, operating and maintenance costs. 15 Cr. per MW power production	(Typically 80-90 Cr for 500 TPD plant)	High
Market for By-product/ End Product	Quality compost compliant with FCO 2009 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has recommended co-marketing of 2-3 bags of compost with 7-8 bags of inorganic fertilizer.	Good market potential in Urban and Rural areas. However it is not adequately explored.	The technology is not fully explored, though it has a potential to generate energy as well as digested sludge manure.	Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	Good potential of energy generation if power purchase agreements are made reflecting true cost of production including O&M costs	Quality compost compliant with FCO 2009 has a good market. Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	No potential, since it is stipulated by the MSW (M&H) Rules 2000, that only inert wastes are to be disposed in landfills

[37] Source: JnNURM Toolkit , November 2012

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
MANAGERIAL CRITERIA							
Labour Requirement	Labour intensive	Labour intensive	less Labour intensive	Labour intensive (based on current practice)	not labour intensive but Requires considerable technical capacity,	Not labour intensive but requires considerable technical capacity,	Only inert wastes are to be interred in sanitary landfills. Labour intensive but requires considerable technical expertise as well.
Predominant skills for Operation and Management	Skilled & Semi-skilled[38] labour	Skilled & Semi-skilled labour	Skilled labour	Skilled & Semi-skilled labour	Highly skilled required	Highly skilled labour	Skilled and semi-skilled labour.
ENVIRONMENTAL CRITERIA							
Concerns for toxicity of product	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms.	The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with.		-	-		- -

[38] On-site training is required for unskilled labour, as a minimum requirement for efficient operation

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Leachate Pollution	High if not treated appropriately	Insignificant quantities at low waste volumes per vermi-pit.	High if not treated appropriately	Low	Low (provided fly-ash is managed appropriately and disposed in a hazardous waste landfill.	Low	Moderate to high depending upon the leachate recycling and control systems. Leachate management during monsoons requires special attention
Atmospheric pollution	Low (Dust, aerosol etc.). Odour issues.	Low. Odour issues.	Low Leakage of biogas. Odour issues	Low to Moderate (Dust, aerosols). Very high if RDF is not burnt at required temperature. Odour issues.	Very high if not managed properly. (Emissions due to incomplete combustion of municipal refuse contain a number of toxic compounds, requiring appropriate emissions control systems)	Moderate, require appropriate emission control systems (Air emission include acid gases, dioxins and furans)	Air pollution and problems of odour and methane emissions if not managed properly.

Criteria	Windrow Composition	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Other	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Presence of inappropriate material in the RDF (chlorinated plastics). Fire and safety issues to be taken care of.	Disposal of bottom ash and slag. Fire and safety issues to be taken care of.	Presence of inappropriate material in the RDF (chlorinated plastics). Fire and safety issues to be taken care of.	Polluted surface runoff during wet weather, groundwater contamination due to leachate infiltration, spontaneous ignition due to possible methane concentration.

*Actual planning and implementation will also depend on engineering and installation of plants
Further detailed information on the different technologies and their implementation requirements are to be found in sections 3.2 to 3.5 of chapter 3 of Part II of this manual.

4.2 Recycling and Recovery

Chapter 3
Section 3.1

Recycling is a process by which materials that are otherwise destined for disposal are collected, processed and re-manufactured. Recycling diverts a significant fraction of municipal, institutional and business waste from disposal and, thereby, saves scarce natural resources as well as reduces environmental impacts and the burden on public authorities to manage waste. Recycling can generate revenues, which result in reducing can reduce the overall costs for MSWM. Benefits of recycling include:

For the ULB:

- Reduces the volume of waste to be managed
- Cost Savings, if noticeable revenues can be generated. Revenues can be generated from sale of recyclables
- Longer life span of landfills, since recyclables are diverted away from landfills
- Reduced needs for environmental management efforts by the ULB

For the economy:

- Reduction of use of raw materials, fertilizers etc.
- Cheap products made from recycled materials
- For the poor: livelihood opportunities for recyclers and recycling industry.

For the environment:

- Sustainable use of resources: less energy consumption and less pollution.
- Reduced land use for disposal sites.
- Reduced environmental impacts including climate change impacts.

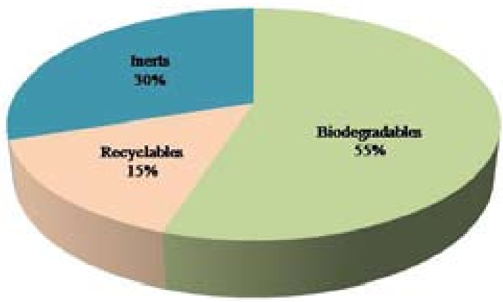


Figure 1.8: Typical fractions of municipal solid waste generated in India

The India wide characterization of wastes in figure 1.8 underlines that there is additional potential for recycling solid waste discarded by the citizens; it has to be noted that considerable amounts of recyclables are already taken up-front by the kabadi system/ scrap dealers prior to waste disposal by the citizens. Efforts should be made to further segregate the recyclables currently being disposed by households, shops and establishments and to pass them on to the recycling industry. Every strategy for recycling (as also for other steps of MSWM) should be based on a thorough waste analysis / characterization in the respective city. Based on such studies, a detailed estimation of the recycling potentials of each material needs to be done and strategies and technologies for recycling need to be identified. Successful case studies in India are given in various sections in Parts II and III.

The analysis should include identification of potential buyers for recyclables and affordable market prices

Chapter 3

4.3 Processing Technologies

The ISWM framework should be used as a guide for selecting most appropriate technologies for managing MSW. Integrated Solid Waste Management plants typically have pre-processing facilities to separate organics from recyclables and other high calorific waste. The organic waste is usually composted or processed anaerobically for production of energy. Recyclables are separated and sent to wholesalers for further supply to recycling facilities. High calorific wastes are then baled and can be used as fuel or co-processed in cement plants.

Chapter 3
Section 3.2

4.3.1 Composting

After waste minimisation and recycling systems, the ISWM hierarchy indicates adoption of resource recovery strategies and composting as the third preferred waste management practice, ensuring that waste is processed appropriately to facilitate further use of the material.

Composting is a controlled aerobic process of biologically “digesting” the municipal solid waste, so it may be recycled for other purposes – plant nutrient, stabilization of soil in remediation process or soil amendment for recovery of poor soils.

Compost production can be carried out at the decentralized level (home composting/bin composting/box composting/vermicomposting/in-vessel composting) or at a centralized level (windrow composting/in-vessel composting/aerated static pile), depending upon the feasibility of implementation. Both processes required significant pre-processing and only organic matter is to be composted.

Compost produced should meet with quality criteria specified by the MSW Rules and the Fertilizer Control Order 2009 and 2013. A market for the compost should be ascertained before sizing the compost plants.

4.3.2 Waste To Energy

Chapter 3
Section 3.3

Where material recovery and composting from municipal solid waste is not possible or desirable due to local conditions or because of the nature of waste, recovery of energy from municipal solid waste is suggested as a feasible alternative. When high calorific value fraction of the MSW is either incinerated or processed anaerobically (biomethanation), the resultant energy, either as heat (incineration) or biogas (methane) can be reused either directly or converted to electricity using appropriate generators. Sale of this energy should result in the financial viability of waste to energy systems. Where the tariff of power is not high enough to ensure financial sustainability of the plant, a tipping fee may be considered by the ULB.

Care should be taken that the requisite mass of waste is available for achieving requisite economies of scale; environmental controls should be in place to meet with stringent norms for incineration. Typically, only cities which are able to supply atleast 500 TPD of waste should venture to install waste to energy plants. Where national legislation does not prescribe norms for emissions from incinerators, the CPCB/SPCB may consider accepted international emission control norms.

4.3.3 Refuse Derived Fuel

Chapter 3
Section 3.4

Refuse Derived Fuel (RDF) refers to the high calorific non-recyclable fraction of processed municipal solid waste which is used as a fuel for either steam/ electricity generation or as alternate fuel in industrial furnaces/boilers. The composition of RDF is a mixture that has higher concentrations of combustible materials than those present in the parent mixed MSW.

RDF should preferably be co-processed in cement plants. Co-processing of RDF in steel industry and for power generation is also indicated, but not proven in India.

Chapter 3
Section 3.5

4.3.4 Technologies Under Development

Prevalent municipal solid waste treatment and processing technologies are based on long-lasting experiences in many countries. With respect to the applicability of upcoming technologies in India, some of these technologies are being tested with support from the Government of India. The results of these tests should be awaited.

Till these technologies are well established commercially, these should be regarded as experimental technologies and should be handled either as an R&D project or through specially designed concession agreements. Five years' successful commercial operation of new technologies may be regarded as a safe bet. Pyrolysis, gasification and bio-reactor landfills are a few technologies which are being tried on an experimental basis in India; however, none of these technologies have a proven track record for commercial application.

Chapter 3
Section 3.6

4.3.5 C&D WASTE PROCESSING

Construction and Demolition waste means any waste generated during construction, demolition or re-modelling of any civil structure. MSW Rules indicate that C&D waste should also be managed by the ULB. Draft C&D Waste Management Rules are also being proposed by the Ministry of Environment & Forests.

Construction and demolition waste includes, but is not limited to concrete, bricks, tiles, stone, soil, rubble, plaster, drywall/gypsum board, wood, plumbing fixtures, non-hazardous insulating material, plastics, wall paper, glass, metals (such as steel, aluminium), asphalt etc.

ULBs should make arrangements for placement of appropriate containers (skips or other containers) and their removal at regular intervals or when they are filled either through own resources or by appointing private operators. The collected waste should be transported to appropriate site(s) for further processing and disposal either through own resources or by appointing private operators. ULBs should monitor and record generation of construction and demolition waste within its jurisdiction.

In consultation with expert institutions, the urban local bodies (ULBs) shall plan for appropriate management of C&D waste generated including processing facility and further plan to use the recycled products in the best possible manner. These institutions can also suggest ways to introduce 'de-construction' activity from the construction planning stage and provide assistance in this matter.

Municipal authorities should make bye-laws as well as special arrangements for storage, transportation, processing and disposal of C& D waste.

Key messages for decision-makers

The choice of technologies for processing, treatment and disposal of solid waste management in a ULB should be guided by the ISWM hierarchy. Collection of segregated waste improves the performance of processing and treatment facilities. The first preference should always be given to segregating recyclables for further reuse/ recycling. Organic waste may be composted aerobically to produce compost or used for generating energy through anaerobic decomposition processes. High calorific value material should be further segregated and may be used for co-processing in cement plants or as fuel in appropriately designed and environmentally controlled industrial boilers. Incinerator plants should be planned for only in those ULBs where a minimum of 500 TPD of segregated waste can be supplied on a daily basis to the plant, after ensuring implementation of higher order technologies in the ISWM hierarchy. Process and environmental controls and monitoring of the entire system are critical for the environmentally sustainable functioning of these plants. Technologies which are still under development, like pyrolysis, gasification and bioreactor landfills should not be attempted, unless their commercial application is proven in India.

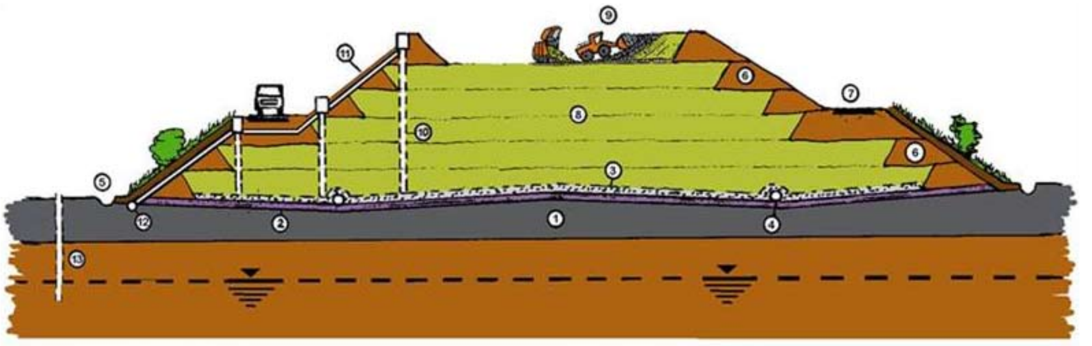
5. Technical Aspects: Solid Waste Disposal In Municipal Sanitary Landfills

Chapter 4

5.1 Where It All Ends: Ensure Planning And Operation Of State-Of-The-Art Landfills

Sanitary landfills are facilities for final disposal of Municipal Solid Waste on land, designed and constructed with the objective of minimizing impacts to the environment. The Municipal-Solid Waste (Management and Handling) Rules 2000 and draft revised Rules 2013 provide comprehensive regulations on the siting, design and operation of sanitary landfills.

A modern landfill complying with these requirements is a complex facility with various equipments to minimize environmental impacts. Figure 1.9 provides an overview on its basic components.



1. Geological barrier
2. Impermeable base liner
3. Drainage layer
4. Leachate collection system
5. Storm-water drain ditch
6. Bordering dams
7. Circulation roads
8. Landfill body
9. Filling and compacting in layers
10. Gas venting system
11. Protective cover system
12. Gas collectors
13. Groundwater control
14. Re-planting

Figure 1.9: Components of a Sanitary Landfill

Wastes suitable for landfilling

Condition and composition of wastes suitable for disposal in a municipal sanitary landfill are regulated by the MSW Rules 2000 and draft 2013. Sanitary landfilling is necessary for the following types of waste:

i. Waste that is by its nature or through pre-treatment non-biodegradable and inert;

ii. comingled waste (mixed waste) not found suitable for waste processing;

iii. pre-processing and post-processing rejects from waste processing plants;

iv. non-hazardous waste not being processed or recycled.

Sanitary Landfilling is not allowed for the following waste streams in the municipal solid waste:

i. Bio-degradable waste/garden waste (it should preferably be composted);

ii. dry recyclables (it should preferably be recycled);

iii. hazardous wastes (needs hazardous waste sites with special equipment).

Site selection for a landfill

A landfill operation with minimized environmental impacts starts with the selection of an appropriate site. The MSWM Rules 2000 and draft revised Rules 2013 stipulate that the minimum distance that needs to be maintained from the landfill shall be determined by the State Environmental Impact Assessment Authority. The municipal authority should therefore approach the State Environmental Impact Assessment Authority through the State Pollution Control Board to determine the distances to be maintained from habitation clusters, forest areas, water bodies, monuments, national parks, wetlands and places of cultural, historical and religious importance and accordingly select an appropriate site. Indicative figures based on past experiences are given in the manual.

Key messages for decision-makers

A well-equipped and operated landfill site is indispensable for any MSWM system for safe disposal of residual waste. Construction of common /regional landfill facilities should be considered keeping in view professional management, economies of scale and environmental benefits

6. MSWM Plan Implementation

6.1 MSWM Plan Implementation & Requisite Clearances

The chief executive of the local body i.e. Municipal Commissioner / Secretary / Executive officer, is responsible for implementing the MSWM Plan, which is to be developed in line with guidance given in Chapter 1 of Part II of this manual. The chief executive should operationalize the plan through the Solid Waste Management Department or Cell of the ULB.

Key activities to be undertaken while implementing the short term MSWM Plan are shown in figure 1.10.

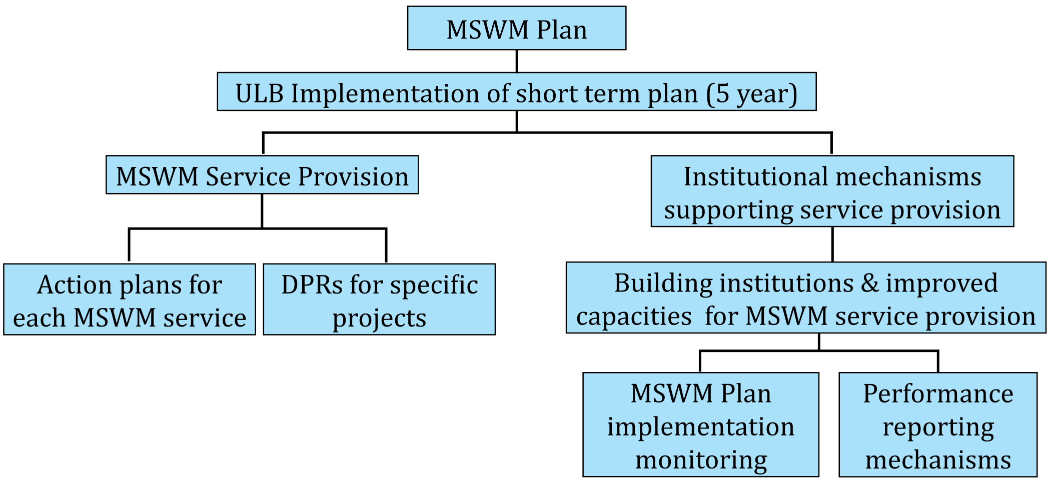


Figure 1.10: Components of MSWM Plan Implementation

Municipal solid waste management processing/treatment and disposal facilities require legal/statutory clearances and approvals for their establishment, depending on the type of facility to be created. Municipal Solid Waste (M&H) Rules 2000/2013and the Environmental Impact Assessment (EIA) Notification, 2006 (MoEF) provide guidance on the statutory requirements for establishing storage/processing/treatment/disposal facilities. An indicative list of clearances and applicable Acts that govern the establishment of Municipal Solid Waste disposal facilities is given below.

An Indicative list of statutory clearances/applicable Acts and non-statutory approvals required by all MSWM Processing/Treatment/ Disposal Facilities

Statutory Clearances

- Environmental Clearances [The Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Cess Act,1977; The Air (Prevention and Control of Pollution) Act, 1981; The Environmental (Protection) Act, 1986, and Rules; The EIA Rules, 2006]
- Clearance from the State Pollution Control Board
- Clearance from Airport Authority
- FCO Clearance for compost based plants
- Land use from Revenue Authority
- State Electricity Authority Clearance for Providing Grid Connectivity

Non-statutory Approvals

- Proof of Possession of Site
- Bank Loan Sanction Letter and Agreement
- Bank Appraisal Note
- Water Supply Agreement
- Power Purchase Agreement
- MSW Supply Agreement with Municipal Authority

Other acts that may govern the establishment of these facilities are (depending on the specific condition of implementation):

- The Public Liability Insurance Act, 1991 and Rules 1991
- The Industries (Development and Regulation) Act, 1951
- The Factories Act, 1948
- The Motor Vehicles Act, 1938, amended in 1988 and Rules, 1989
- The Petroleum Act, 1934
- The Indian Explosives Act, 1908
- The Energy Conservation Act, 2001

6.2 Contracting Arrangements For MSWM Service Provision

Chapter 5
Section 5.3

Following essential aspects should be considered by the ULB while deciding to contract out municipal solid waste management services:

- The ULB should identify services that can be effectively provided by the existing staff and available financial resources.
- Subsequently, services which would need to be outsourced due to limited in-house technical know-how, capability and/financial resources should be identified.
- Benefits and potential issues with outsourcing services which the ULB cannot provide (as identified above) should be fully evaluated and understood. Justification for the need to contract out identified services should be prepared.
- Commercial/economic feasibility of the services to be contracted out should be ascertained and appropriate contract models and their benefits are to be assessed for each of the services to be contracted out.
- Where contract labour is hired, the ULB should ensure compliance with the provisions of the "Contract Labour Abolition & Regulation Act 1970"
- Sharing of all possible risks: technical, operational and financial between ULB and the operator should be detailed
- Where acquisition of land/ rehabilitation of the community are involved, the ULB should stand-in for the contractor in addressing such aspects.
- Contracts should specify the range of technology/technologies that can be adopted after the ULB undertakes a thorough assessment of available technologies for specific services.

- On ascertaining the benefit of outsourcing services, the ULB shall prepare a Terms of Reference for the contracted service

Not all contracting models are suitable for each of the solid waste management operations. Municipal Authorities may adopt one or more of the following contracting models:

- Service Contract (door to door collection and transportation of waste)
- Management Contract (door to door collection, C&D waste collection, secondary storage and transportation of waste)
- Build and Transfer (Transfer station, Sanitary Landfill (SLF))
- Build, Operate and Transfer (Biomethanation, Composting, SLF)
- Build, Own, Operate (Composting, Refuse Derived Fuel (RDF), incineration)
- Design, Build, Own, Operate and Transfer (DBOOT) Contract (large compost plants, RDF plants, incineration and SLF)
- Design, Build, Finance, Operate and Transfer (DBFOT) Contract (large compost plants, RDF plants, incineration and SLF)

ULBs may decide to bundle certain services while contracting out solid waste management operations, in order to build accountability and efficiency in the system.

A transparent procurement process should be adopted for the selection of PPP partner preferably through a Transaction Advisor after preparing a detailed project report. The Municipal Authority has an option of adopting a single stage selection process or a two stage selection process for awarding contracts to the private sector.

6.2.1 Enabling Conditions For Successful PSP/PPP Contracts

- A transparent bidding process
- Timely handover of facilities free from encumbrances (physical and legal)
- Clearances /approvals/ decision making process need to be expeditious – delays in approval/ clearances have serious consequences
- A sustainable project structure and revenue model with appropriate risk allocation
- Price sensitivity of the financial proposal shall be established, specifically with respect to capital/ subsidies/ sale of products - this is a robust indicator of the financial viability of proposed projects, even when there is a change in the assumed circumstances. .

- Political and stakeholder involvement and acceptance; these are crucial pre-requisites for successful PSPs/PPPs
- Cost recovery/revenue mechanisms shall be based on a real-world assessment
- Transparent subsidies & credit enhancement help expedite financial closure
- Clear performance based indicators
- Appropriate incentives

Key messages for decision-makers

The Chief Executive of the ULB is responsible for the implementation of the short term MSWM Plan. Plan implementation includes planning for services which the ULB may undertake with its own staff and identifying activities which would require private sector participation. Institutional capacities and financial resources should be secured while beginning plan implementation. Outsourced activities will need to be tendered out as per specific provisions with adequate safe guards built into the bid documents. Depending on the nature of activities to be tendered out, one of several models of contracting may be adopted, as is relevant to the project on hand. A transparent bidding process and performance benchmarks combined with stringent monitoring ensures the success of PPP projects.

7. Management Aspects: Monitoring MSW Service Provision

Chapter 6

7.1 Monitoring MSWM Plan Implementation

Chapter 6
Section 6.1

A comprehensive monitoring and evaluation system should be adopted for assessing progress towards meeting the targets in the MSWM Plan and for monitoring successful implementation of the plan. The monitoring system adopted should:

- collect data regularly and
- analyze collected information, take/propose corrective measures, and support the planning & implementation process.

Institutionalizing appropriate quality assurance systems is essential to ensure a continuous and efficient municipal solid waste management system. The performance of all components of solid waste management systems, from collection to processing and disposal, should be maintained on a daily basis. Monitoring and evaluation of MSWM within a Management Information System shall follow a prescribed schedule, with regular reporting to show progress or gaps in provision of services. Urban local bodies might appoint an independent body to evaluate service provision.

Provision of citizen centric services shall also be monitored through a feed-back mechanism which should primarily focus on concerns of the community regarding door step collection, primary storage and transportation of waste.

Collection and analysis of data related to solid waste management is required to assess the existing situation and propose adequate measures to improve service delivery. A Management Information System (MIS) system can store and retrieve relevant information for analysis, which can then be used by decision makers.

The head of the solid waste management department should be responsible for monitoring and evaluation. A dedicated Monitoring &Evaluation team should be constituted with distinct roles and responsibilities. Field level staff shouldbe inducted and reporting schedules should be fixed.

Reports generated should capture critical information about SWM of planning area. Reports should be effectively used for decision making, identifying gaps and corrective measures beneficial for decision makers. Standard formats should be developed for producing reports on daily, monthly, quarterly or annual basis, as per requirement. Where possible, an MIS system should be developed to facilitate the collection and reporting of this information. This information should also be used for mid-term review of the MSWM Plan and for defining goals of future planning periods.

This information can also be used for the assessment of Service Level Benchmarks (SLBs). State Governments use SLBs to monitor long term progress of SWM service provision in ULBs. Release of funds from the State Finance Commission is partially contingent on achievement of pre-defined goals of SLBs.

The relevant indicators have been stipulated by the Ministry of Urban Development (MoUD):

1) Household level coverage of SWM services
2) Efficiency of collection of municipal solid waste
3) Extent of segregation of municipal solid waste
4) Extent of municipal solid waste recovered

5) Extent of scientific disposal of municipal solid waste

6) Efficiency in redressal of customer complaints

7) Extent of cost recovery in SWM services

8) Efficiency in collection of SWM charges

7.2 Importance Of O&M For Ensured Service Delivery

Chapter 6
Section 6.2

- Irrespective of whether the provision of services is by private contractor or ULB, operation & maintenance plan has to be adhered to. The Operation & Maintenance (O& M) plan should be drafted by the authority responsible for procurement and management of equipment/facilities: either the ULB or the private operator. O&M plans developed by private operators should be ratified by the solid waste management department.

- The O&M Plan should include preventive maintenance schedules and responsibilities and also guidance for break-down maintenance. It should be the responsibility of the supervisor and operator to regularly maintain and update the O&M Plan. It should also indicate procedures for recording, reporting, analysis and further action.

- Preventive Operation & Maintenance (O&M) of equipment, vehicles and facilities ensures the long term sustainability of solid waste management service provision. All contracts to private sector players, irrespective of the mode of contracting, should include a provision for operation & maintenance of all vehicles, equipment and installations during the period of contract. The term of the contract should be co-terminus with the expected life of the vehicles and equipment particularly where the contractor is expected to invest in the procurement of vehicle and equipment.

- Citizens should be provided an opportunity to report issues related to MSWM service provision. A citizen charter should be developed to inform citizens of the type of services provided and the complaint redressal process implemented in the ULB.

Key messages for decision-makers

MSW service provision should be monitored on a continual basis to ensure designed service levels on a continuous basis. Management Information Systems (MIS) should be used to record periodic data, retrieve such information and analyse it for the purpose of decision making. Operation & Maintenance plans should be prepared by each of the operators/in-charges of SWM services or projects. The ULB should scrutinise and validate the O&M plans of private service providers. Preventive maintenance is very essential for ensuring road worthy vehicles and well-functioning equipment. Budgeting for preventive maintenance and recording failures should be insisted upon by the ULB. Citizens should be given an avenue to report on and seek redressal for service issues through an appropriate complaint redressal system.

Chapter 7

8. What To Do With 'Special Wastes'?

Special Waste includes any solid waste or combination of solid wastes that, because of its quantity, concentration and physical / chemical characteristics or biological properties, require special handling and disposal to protect human health, as well as the environment and / or to exploit special potentials for recycling. In line with this definition, the following wastes are defined as Special Wastes:

1. Plastics waste
2. Biomedical waste
3. Slaughterhouse waste
4. Electric and electronic waste (e-waste)
5. Waste Tyres
6. Battery Waste

Ideally, special wastes should not enter the municipal solid waste streams, but as many of the above wastes are also generated at household level, quite frequently they end up in the mixed MSW stream due to lack of segregation at source or imperfect collection systems. A number of special rules beside the MSW (Management and Handling) Rules 2000 and draft 2013 are applicable to these special wastes. In general, special wastes need separate collection and treatment systems in order to

- avoid contamination of other waste streams (relevant for biomedical waste, slaughterhouse waste, e-waste and battery waste);

- apply specified recycling technologies (relevant for plastic waste, e-waste, and waste tyres); and/or
- manage large quantities of waste

Accordingly, the different types of special waste require specific collection and treatment systems which are specified in chapter 5.

How far are ULBs responsible?

By far not all special wastes require operational involvement of the ULB. The following options are relevant:

- **Systems of Extended Producer Responsibility (EPR):** Batteries and certain types of e-waste can be collected and treated through return systems operated by producers or retailers of these products.
- **Full responsibility of the private sector:** Some special wastes such as End-of-Life Vehicles are usually operated in full responsibility of the private sector. The role of public agencies is restricted to control functions, e.g. in respect to the compliance with environmental requirements.
- **PPP:** Certain waste types can be handled within PPP schemes. This might be especially relevant for biomedical and slaughterhouse wastes.
- **Integrated ULB operation:** Plastic waste is also a non-hazardous component of municipal solid waste. The ULB should establish special collection systems within their general MSWM operations.

Key messages for decision-makers

Take a critical look at which special wastes your ULB can and should reliably handle and how this should be done. If necessary establish sustainable and well-controlled solutions with/ without third parties, as mentioned above.

The full test of the Manual on MSW Management is to be found in Part II of this manual.

Part II: Manual on Municipal Solid Waste Management

Part II: MANUAL ON MUNICIPAL SOLID WASTE MANAGEMENT

Background: Urbanization And Municipal Solid Waste

Urban India is facing an increasing challenge to provide for the incremental infrastructural needs of the growing urban population. According to the 2011 census, the population of India was 1.21 billion, of this 31% lives in cities. It is further projected that by 2050 half of India's population will live in cities.

With this increasing population, the management of Municipal Solid Waste (MSW) in the country has emerged as a severe problem not only because of the environmental and aesthetic concerns but also because of the sheer quantities generated every day. According to the Central Pollution Control Board 1, 27,486 TPD (Tons per day) of Municipal Solid Waste was generated in India during 2011-12, with an average waste generation of 0.11 kg/capita/day. Of the total waste generated, approximately 89,334 TPD (70%) of MSW was collected and only 15,881 TPD (12.45%) was processed or treated. Segregation at source, collection, transportation, treatment and scientific disposal of waste was largely insufficient leading to degradation of environment and poor quality of life.

The fact that management of MSW was increasingly becoming a critical issue, first became evident in the 1990s, when large scale concerns regarding unsuitable municipal solid waste management resulted in numerous Public Interest Litigations (PILs) prompting the Supreme Court of India, in 1996, to order the Ministry of Environment and Forests (MoEF), Government of India, to release Municipal Solid Waste (Management & Handling) Rules in 2000. The Rules contained directives for all ULBs to establish a proper system of waste management including a timeline for installation of waste processing and disposal facilities by end of 2003, not only for metros and Class I cities but for all ULBs. The Ministry of Urban (MoUD), Government of India developed a Guidance Manual for SWM for all Urban Local Bodies (ULBs) and published it simultaneously with the Rules in 2000. However, until 2003, all ULBs were not able to establish a sustainable MSW system including treatment and disposal systems.

In order to give an impetus to MSW Management in cities, Government of India has sanctioned the 12th and 13th Finance Commission Grants and funds were allocated for improvement of MSWM under flagship projects like JnNURM and UIDSSMT from 2005 onwards. Funds for implementation of SWM projects are also available from State funds. Many ULBs have put in place systems of door to door collection, transportation, treatment and safe disposal of waste. However, despite encouraging pilots and achievements, most

ULBs continue to face challenges not only in the selection of appropriate or advanced collection & transportation systems, treatment & processing technology and disposal methods, but also in the sustainable financial management of MSWM. Non-compliance with MSWM Rules is still a relevant cause for concern even after 14 years of notification of the MSW Rules, 2000.

The Government of India continues to address these challenges and to support the States and ULBs in developing modern and appropriate MSWM systems, through the draft revised MSW (M&H) Rules 2013 by the Ministry of Environment and Forest (MoEF) and the parallel revision of MSWM Manual 2000 by the Ministry of Urban Development (MoUD). The manual is based on learnings from 14 years' experience gained post the notification of the Rules in 2000.

Chapter 1:

Municipal Solid Waste Management Plan: Step-Wise Guidance

1. Municipal Solid Waste Management Plan: Step-Wise Guidance

As many of the municipal authorities have not yet developed in-house capabilities to independently govern, the Central and State Governments continue to play a crucial role by formulating policies, programmes, regulations and by providing technical and financial assistance for infrastructure development including management of municipal solid wastes in urban areas. Though Municipal Solid Waste Management is an essential service and a mandatory function of municipal authorities across the country, it is still being managed in an unplanned manner giving rise to serious problems of health especially for women and children and environmental degradation. This clearly underscores the need for preparing a strategic and detailed solid waste management plan by the ULBs. Every ULB should undertake the preparation of a Municipal Solid Waste Management Plan (MSWM Plan), addressing short term and long term actions.

MSWM is an integral component of municipal services, responsible for a safe and healthy environment. Therefore, preparation and implementation of a strategic and detailed municipal solid waste management plan is essential

1.1 Requirements And Stipulations By The Rules

Draft Rules The Municipal Solid Waste (Management & Handling) Rules 2013 stipulate in Clause 5 (8) that each municipal authority "shall prepare a Municipal Solid Waste Management Plan as per policy or strategy of the State Government or Union Territory" administration concerned Cause 4(1) and Clause 8 further stipulate that "the State Governments shall prepare a State Policy or Strategy on Solid Waste Management consistent with the State Sanitation Strategy under the National Urban Sanitation Policy (NUSP)". The Rules do not provide further guidance on the contents and development of the MSWM Plan.

MSW (M&H) Rules, 2013 stipulate that every ULB shall prepare a MSWM Plan and every State a Solid Waste Management strategy

This chapter therefore provides step- wise guidance to local authorities in the preparation of Municipal Solid Waste Management Plans. Municipal Solid Waste Management is essentially a municipal function and it is mandatory for all municipal authorities to provide this service efficiently to keep the cities / towns clean and dispose of the municipal solid waste in an environmentally acceptable manner complying with the Municipal Solid Waste (Management & Handling) Rules 2000/2013. However, it is also pertinent that Solid Waste Management systems adopt measures (as per the Supreme Court Directives- 1998) which not only improve the environmental degradation but also look at how high levels of toxins are affecting the health of men, women and children. The State level Municipal Acts clearly mention the mandatory functions that the ULBs must perform and also the additional discretionary functions that ULBs should perform. ULBs therefore have to prioritize their mandatory functions by duly considering their current status & deficiencies and bridging existing gaps. It becomes imperative to take stock of the existing situation and develop a Municipal Solid Waste Management Plan addressing all aspects of solid waste management in compliance with the MSW Rules 2000/ 2013, and in alignment with the respective State Sanitation Strategy under the National Urban Sanitation Policy and also following the principles of the Integrated Solid Waste Management (ISWM) hierarchy.

> A long term MSWM Plan: once every 20-25 years
> A short term MSWM Plan – once every 5 years
> Review of short term plan: once every 2-3 years

The MSW Management Plan encompasses institutional strengthening, human resources development, technical capacity building, financial capacity and arrangements (PPP framework), community participation, legal framework and mechanism for enforcement and public grievance/complaint redressal. The MSWM Plan should consider short term (5 years) and long term planning periods (20-25 years). The Plan should be reviewed and updated once every 2-3 years. Local authorities should ensure that the short term plan is aligned with long term planning and implementation.

1.2 GUIDING PRINCIPLES FOR MUNICIPAL SOLID WASTE MANAGEMENT

1.2.1 THE INTEGRATED SOLID WASTE MANAGEMENT SYSTEM

> ISWM is a strategic approach to manage MSW in a sustainable manner by considering all aspects of MSWM viz. generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency.

Management of municipal solid waste and adoption of processing technologies are dependent on the quantity and characteristics of the total waste generated in a local authority, the financial resources available and in-house capability of local authorities to oversee project implementation.

The Integrated Solid Waste Management (ISWM) proposes a waste management hierarchy with the aim to reduce the amount of waste being disposed, while maximizing resource conservation and resource efficiency. The ISWM hierarchy ranks waste management operations according to their environmental, economic and energy impacts. Source reduction or waste prevention, which includes reuse, is considered the best approach (tier 1) followed by recycling (tier 2) and composting of organic matter of waste, resulting in recovery of material (tier 3). The components of waste that cannot be prevented or recycled can be processed for energy recovery (tier 4). Tier 5 is disposal of waste in sanitary landfill, which is the least preferred option. Based on this waste management hierarchy (see figure 1.1) and local conditions, an appropriate system and technology should be selected as the MSW Management Plan.

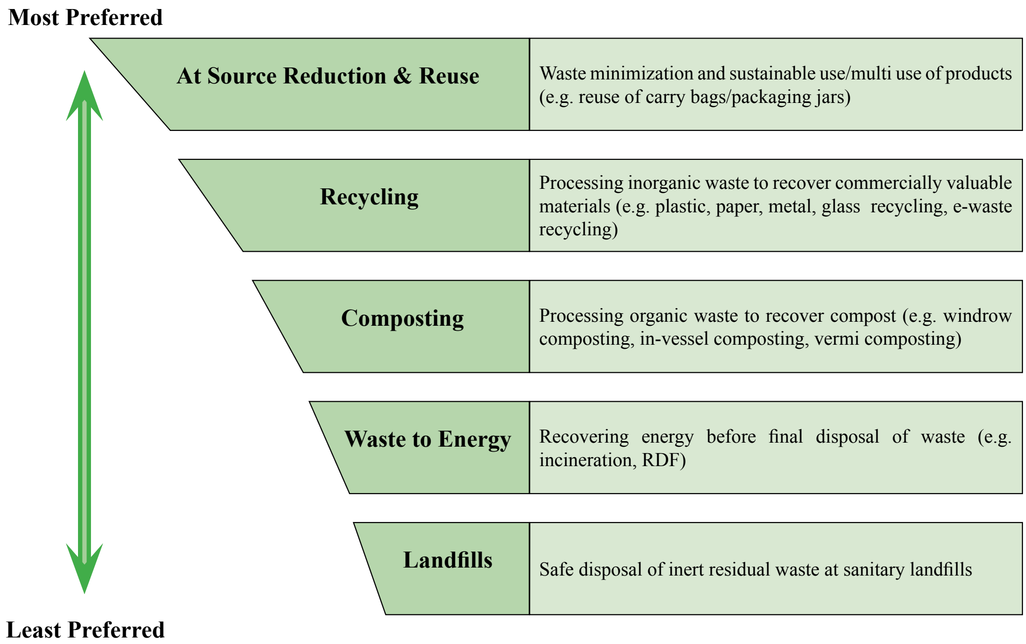


Figure 1.1: ISWM Hierarchy

- At Source Reduction and Reuse: The most preferred option for waste management in the ISWM hierarchy is to prevent the generation of waste at various stages including the design of products, production, packaging, use and reuse of a product. Waste prevention helps to reduce handling, treatment, and disposal costs and reduces various environmental impacts such as leachate, air emissions and generation of greenhouse gases. Minimization of waste generation at source and reuse of products are the most preferred waste prevention strategies.

The ISWM hierarchy ranks waste management strategies according to their environmental benefits

- Waste Recycling: Environmentally suitable recycling of waste to recover material resources through a process of segregation, collection and re-processing to create new products is the next preferred alternative. In the waste management hierarchy composting is considered as an organic material recovery process and is often considered at the same hierarchical level as inorganic waste recycling.
- Waste to Energy: Where material recovery from waste is not possible, energy recovery from waste through production of heat, electricity, or fuel is preferred. Bio-methanation, waste incineration, production of refuse derived fuel (RDF) and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted "Waste to Energy" technologies.
- Waste Disposal: Residual inert wastes at the end of the hierarchy are to be disposed in sanitary, lined landfills, which are constructed in accordance with stipulations prescribed in MSW Management and Handling Rules. All over the world, landfills which integrate the capture and use of methane are preferred over landfills which

Preferential order of waste management options as per the ISWM hierarchy:
- At Source Reduction and Reuse
- Waste Recycling
- Composting
- Waste to Energy
- Waste Disposal

flare landfill gas. The least preferred option is to dispose waste in landfills, where no landfill gas capture is planned for. However, Indian laws and rules do not permit disposal of organic matter into sanitary landfills and mandate that only inert rejects (residual waste) from the processing facilities and inert street sweepings etc. can be landfilled. In cases where old dumps are to be closed, there is a possibility of capturing methane gas for further use, which may be explored. However, repeated burning of the waste significantly decreases the potential of capturing methane.

The hierarchy indicates that all options of at source waste minimization should be utilized before appropriate treatment technologies are selected and implemented. The ISWM hierarchy in figure 1.1 is based on the above discussion and analysis.

The concept of integrated solid waste management (ISWM), as described, is closely linked to the 3R approach (Reduce, Reuse, and Recycle), which also preliminarily emphasizes the importance of waste reduction, reuse and recycling over other forms of waste processing/ management. The adoption of these principles helps in minimizing the amount of waste to be disposed, thus also minimizing the public health and environmental risks associated with it. Maximization of resource recovery at all stages of solid waste management is advocated by both approaches.

1.2.2 Extended Producer Responsibility

Extended Producer Responsibility (EPR) is a policy approach, wherein, a producer is held responsible for the post-consumer stage of a product, typically for defined tasks of separate collection (e.g. for hazardous waste components), reuse (e.g. disposal-refund systems for bottles), recycling (e.g. for used cars) and / or storage and treatment (e.g. for batteries). EPR programs are commonly made mandatory through legislation, but can also be adopted voluntarily (i.e. retail take- back programs). National and State level involvement is necessary to ensure that EPR initiatives are successfully implemented. However, ULBs should also encourage local level initiatives based on the principles of EPR. Refer to section 2.1.3.1 of Part II of this manual for further guidance.

1.2.3 Decentralized Waste Management Systems

Decentralized community level solid waste management systems are preferred to centralized waste management solutions. Decentralized waste management systems/ community level waste management systems reduce the burden of handling large volumes of MSW at a centralized location, with a corresponding reduction in costs of transportation and intermediate storage.

Some of the advantages of decentralized waste management include:

- Decentralized options have a lower level of mechanization than the centralized solutions and generate local employment. They provide income and job opportunity for informal workers and small entrepreneurs.
- Decentralized options can be tailor made for the local waste stream, climate, social and economic conditions.
- Decentralized systems reduce the cost incurred for the collection, transportation and disposal of waste by the urban local bodies.

Collection of recyclables and management of organic waste through home composting systems and community level composting systems are preferred. Refer to Section 1.4.4.7 of Part II of the manual for further details.

1.2.4 Integration Of The Informal Sector

In India the informal sector, comprising of kabadi system and rag pickers, play a significant role in collection and processing of recyclable material. There is a significant thrust in various national and state level policies, to recognize, identify and integrate informal sector workers into formal waste management processes and initiatives. Creation of livelihoods, social acceptance and security for informal sector workers and regularizing the recycling sector are all benefits of integrating the informal sector. Section 1.4.4.8 of Part II of the manul further elaborates on these aspects.

1.3 Overview Of Developing A MSWM Plan In An Urban Local Body

The preparation of a MSWM Plan follows a 7 step process, complying with MSW (M&H) Rules and other relevant guidelines provided by the GoI

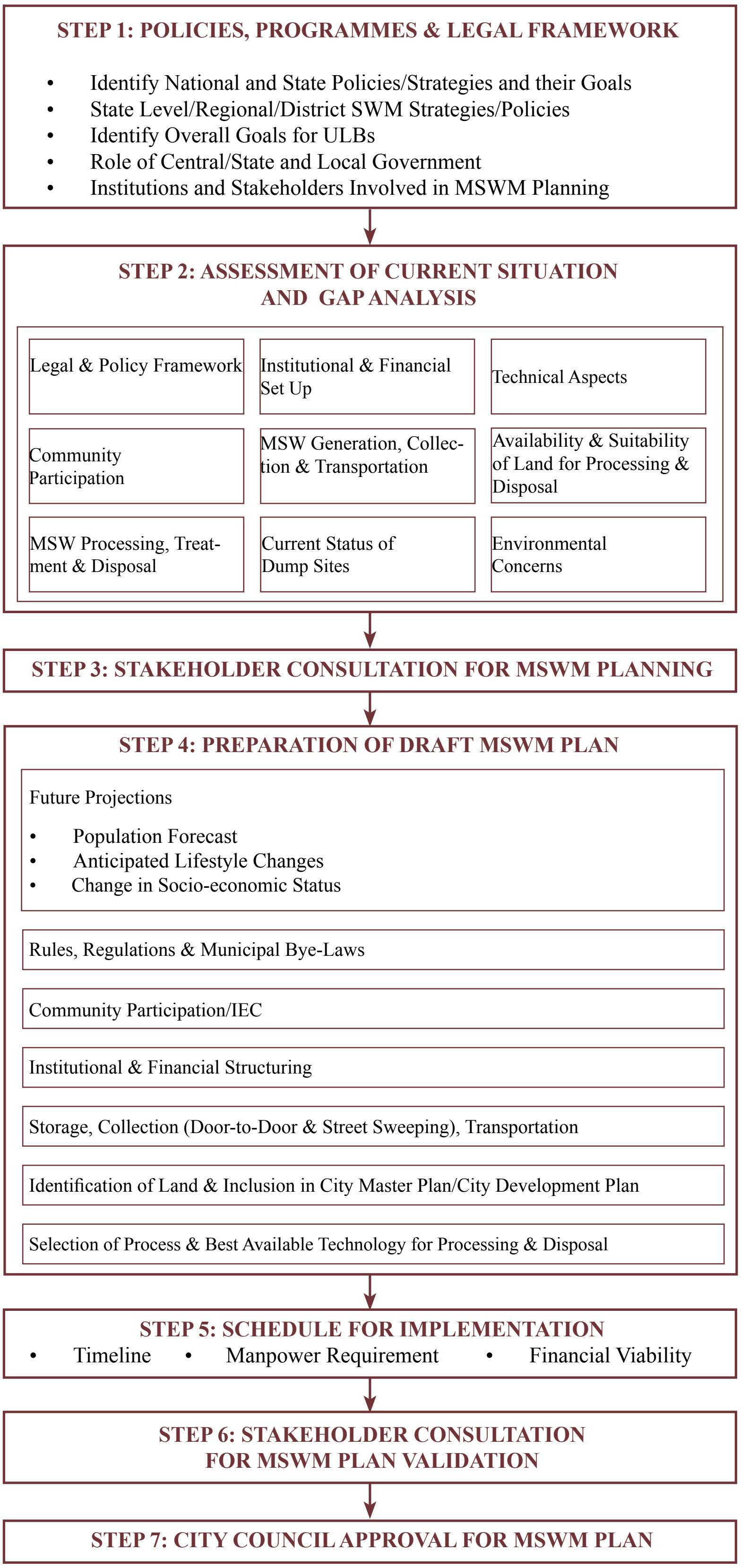


Figure 1.2: Steps for Preparing a MSW Plan

Planning for the MSW management services follows a 7-step process, as illustrated in figure 1.2, which should be undertaken by all Urban Local Bodies to ensure compliance with MSW Management & Handling Rules and other relevant guidelines provided by the Government of India and the respective State Governments. It is envisaged that the five year short term plan shall be reviewed once every two – three years. The following steps provide a general overview of the planning process. Each step of the planning process is further elaborated in Section 1.4.

Step 1: Policies, Programmes & Legal Framework

Step 1: Review & Analysis of policies, programmes and legal framework

Step 1 entails a detailed review and analysis of national, state and municipal level laws, rules, policies, programmes and guidance related to solid waste management. The ULB shall prepare a list of all mandatory and recommended actions required as per the MSW (M&H) Rules, 2000 and other relevant policy guidance and ensure that the MSWM Plan is developed within these framework conditions.

Step 2: Assessment of Current Situation& Gap Analysis

The municipal authority should then carry out a critical assessment of the current status of solid waste management in the city as per the Municipal Solid Waste (Management & Handling) Rules, the National Urban Sanitation Policy, the Service Level Benchmarks (SLBs) for solid waste management service delivery (prescribed by the Ministry of Urban Development, GoI), the directives of the State Government and the local Municipal Acts governing the ULBs. The assessment should clearly identify the deficiencies / gaps that need to be bridged to meet legal obligations. Gaps with respect to human resources, institutional capacity, infrastructure, financial resources, inclusiveness in service provision, conducive regulatory framework, availability of essential data, land availability, stakeholder willingness, awareness levels and IEC needs of the community should also be identified.

All aspects of the existing MSW management system need to be considered in detail before an MSWM Plan can be prepared

Assessment of Current Solid Waste Management Situation in the City – What to do?

Ward-wise and consolidated details

- Demographic data of population (which includes sex disaggregated data), number of households, shops and establishments, population growth pattern,waste generation data
- Physical and chemical composition of waste

- Inventory of human resources at various levels
- Inventory of equipment, bins, vehicles and available land for solid waste management facilities.
- PPP status in providing services; extent of private sector participation in delivery of service and cost benefits / quality of service derived.
- Extent and involvement of community participation in solid waste management with an overview of the kind of community engagement, the outreach services, the number of men and women and also activities documented on engaging communities.
- Make a note of the kind of IEC materials developed whether they target a particular aspect of SWM, if the message is gender sensitive and not merely reinforcing stereotype roles of men and women

Storage at source & source segregation

- Details of waste storage at source & source segregation, number of fractions in which waste is segregated.

Primary collection system in practice

- Door to door collection, collection from community bins or any other method, requirements of collectors, frequency of collection, percentage of coverage under each collection method including a proper gap analysis

Street sweeping

- frequency of street sweeping, coverage, inclusiveness of slums and informal settlements, safety provisions should also be looked into

Secondary storage

- Secondary storage in covered street bins/containers, masonry/ concrete bins / enclosures, dhalaos, open waste storage sites or any other method,bin-population ratio, or no secondary storage - direct transportation of waste

Transportation

- Type and number of vehicles used, quantity & percentage of waste transported each day in covered vehicles and open vehicles, frequency of transportation from secondary storage sites, percentage of manual loading vis-a vis mechanical loading.

Processing of waste

- Quantity & percentage of waste processed, technology adopted, percentage of residual waste sent to disposal site, realization of revenues from the processing facility, beneficiaries of the revenues

Disposal of waste

- Whether the city has a sanitary landfill? If yes, area & capacity of the landfill, volume of the current cell and expected life, quantity of waste deposited annually at the landfill over the life of the landfill
- Identify location of existing dump sites, and issues identified with these sites.
- Land availability for MSWM as per City Development Plan/City Master Plan

Financial Assessment

- The budgetary allocations and actual annual expenditure on SWM services vis-a-vis total revenue budget of the municipal authority
- Cost per tonne of various components of SWM service
- Assessment of tax or user fees levied for providing SWM service and extent of cost recovery

Assessment of Social Impacts

- Estimate the impacts of the existing waste management system on the informal sector of kabadi system and rag pickers, either negatively (hygienic impacts), or positively (revenues for the informal sector).

Assessment of environmental and health impacts

- The impacts on the environment and public health due to existing waste management practices; impact on ground water, soil, etc.
- Assess existing SWM facilities and related land use issues. Old dump sites closure issues.
- Analyse gaps (including socio-economic and gender related disparities that may exist) focussing on deficiencies of the existing system by reflecting all issues mentioned above.
- Compare the current situation with service level benchmarks prescribed by the Government of India.

Table 1.4 indicates specific details to be considered at different scales (city level, ward level) for assessing the baseline of MSW service provision in a ULB. An indication of stakeholders who may be involved in SWM services is also provided in the table, these stakeholders will need to be involved in the planning process.

Step 3: Stakeholder Consultation for Planning

Municipal solid waste management has a direct relation with the community and other waste generators. Due to the number of institutions and stakeholders involved in MSWM it is important that the MSWM Plan, which aims to bridge the gaps or improve the level of service, is developed through a consultative process. Stakeholders' views, their willingness to participate and pay for the service is to be considered. ULBs shall ensure that women, as important providers of solid waste management services as well as beneficiaries of these services, shall be adequately involved in the stakeholder consultations and decision making processes.

Step 4: Preparation of Draft MSWM Plan

Identified gaps, future population projections & waste generation rates, current and future quality and quantity of waste (based on changing lifestyles and economic status), inputs from stake holders, financial situation and technical capabilities of the local body should be analyzed and assessed. The municipal authority should prepare its draft short term and long term MSWM Plan, considering the provisions of local municipal Act, MSW (M&H) Rules, NUSP and the SLBs. Requirements for equipment, vehicles, manpower, land revenues etc., for providing door to door collection, street sweeping, secondary storage, transportation, processing and final disposal of waste should be considered.

Waste minimization/reduction, waste reuse and waste recycling practices (3Rs: Reduce, Reuse and Recycle) have a significant impact on the waste composition and quantities of waste to be handled and disposed. ULBs should therefore plan for an effective IEC campaign to promote the concept of 3Rs to minimize waste generation. Decentralized approaches for treatment and disposal of waste will also reduce waste quantities to be transported and handled compared to centralized plants, and should therefore be included in the MSWM Plan, where ever appropriate.

The size of the city, projected waste generation rate, waste characterization, geographical location, climatic conditions and environmental, social and economic considerations impact the selection of appropriate processes and technologies for processing and disposal of waste.

The choice of technologies should be guided by proven performance track records within or outside India, technical feasibility under local conditions, financial viability/potential for cost recovery and environmental regulations.

> Adoption of novel technologies, whose performance has not been proven in the Indian context and whose performance is dependent on very specific input waste characteristics should be avoided.

The institutional framework for providing solid waste management services, its monitoring and supervision through municipal departments or Public Private Partnership (PPP) needs to be planned. Depending on the size of the city, a dedicated solid waste management department, or a MSWM Cell or responsible staff should be made accountable for solid waste management and implementation of the MSWM Plan. Duties of the responsible staff should be detailed out and disclosed to public. Capacity building needs of staff should also be addressed.

Identifying appropriate benchmarks for performance and delivery of solid waste management services is an integral part of the planning process. As a minimum, the Service Level Benchmark indicators need to be regularly monitored. Performance of all contracted services shall also be appropriately monitored, reported and analysed. A Management Information System (MIS) should be set up to record and monitor all information/data on MSWM.

Step 5: Schedule for Implementation

An implementation plan, indicating allocation of resources and specifying timelines should be prepared. The implementation plan should address institutional strengthening, raising financial resources through levy of taxes and user fees, accessing loans from financial institutions and obtaining government grants, specific project development and roll-out. The institutional and financial operating plan should be an integral part of the MSWM Plan. PPP for infrastructure development and service delivery may be fully explored during this exercise. A macro level time plan for implementation of key activities proposed under the short and long term plans should be included in the MSWM Plan.

Step 6: Stakeholder Consultation for MSWM Plan Validation

Provision of effective solid waste management services is substantially dependent on community behaviour and practices. Segregation of waste at source, delivering waste to door-step collectors, participating in waste recycling, buy-back programmes and most importantly, exploring options for waste minimization are all dependent on active and appropriate public involvement and support. Citizens should be made aware of the full scale of solid waste management services provided by the Urban Local Bodies and their potential involvement in implementing the plan. Including women in the plan validation and decision making process is critical for ensuring successful plan implementation. The financial health and environmental benefits accruing under the MSWM Plan should be determined and highlighted.

Step 7: Council Approval for MSWM Plan

The final MSWM Plan is to be presented to the elected body of the local authority to seek approval and to officially formalize the plan. Council should be made aware of the short term and long term actions to be taken and should also approve the financial plan for implementation of these actions.

1.4 Seven Step Approach For Municipal Solid Waste Management Planning

1.4.1 Step 1: Policies, Programmes & Legal Framework

Step 1: Identify relevant policies, programmes & applicable legal framework

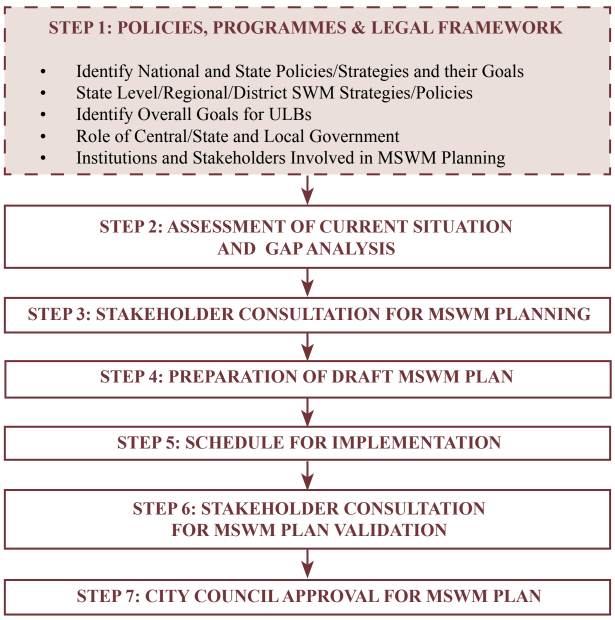


Figure 1.3: Step 1 in MSWM Plan

1.4.1.1 Identify National And State Policies/ Strategies And Their Goals [1]

The Government of India has undertaken a number of initiatives to address SWM issues in recent years. The policy interventions by the Government of India in managing municipal solid waste can be traced back to 1960s when the Ministry of Food and Agriculture (MoA) announced loans for composting of solid waste. But focused policy approach towards managing solid waste gained momentum only after the plague outbreak in Surat in 1994. The J.L Bajaj Committee constituted in 1995, by the Planning Commission immediately after the plague outbreak, made wide ranging recommendations including waste segregation at source, primary collection, levy of user charges, use of appropriate equipment and vehicles, focus on landfilling and composting. Parallel to this, the Ministry of Health and Family Welfare initiated a National Mission on Environmental Health and Sanitation while the Central Public Health and Environmental Engineering Organization (CPHEEO) under the Ministry of Urban Development (MoUD) prepared a draft policy paper that detailed funding issues and requirements for MSWM.

The Ministry of Environment and Forests (MoEF) notified the Municipal Waste (Management and Handling) Rules in September 2000. The Rules provide detailed guidelines on various aspects of Solid Waste Management and identify the Central Pollution Control Board (CPCB) and the State Pollution Control Boards (SPCB) as nodal agencies to monitor its implementation directly in the Union Territories and the States respectively. The MSW (M&H) Rules are currently being revised by the MoEF.

> In order to better manage MSW within their jurisdiction, ULBs should be aware of the other different categories of waste, which should not be allowed to mix with MSW.

Other policy initiatives which inform and guide provision of MSWM services include the recommendations of the Technical Advisory Group on MSWM (2005) and the Inter-Ministerial Task Force on Integrated Plant Nutrient Management (2005), the Hazardous Waste (Management & Handling) Rules (1989), Bio-Medical Waste (Management & Handling) Rules (1998), the Plastic Waste (Management & Handling) Rules, 2011, the Draft Bio-Medical Waste (Management & Handling) Rules, 2011 and the E-waste (Management & Handling Rules), 2011, all of which cover specific types of waste generated in Urban Local Bodies, but which are not regulated by the Municipal Solid Waste (M&H) Rules, 2000. However, they provide guidance to the management of certain streams of waste which may otherwise inadvertently find their way into the municipal waste streams.

The National Urban Sanitation Policy (NUSP) introduced in 2008 broadly covers aspects of urban sanitation. Municipal solid waste management is an important focus area in the NUSP. The NUSP stipulates that MSWM should also be covered in the State Sanitation

---

[1] JnNURM (2007),"Toolkit for Solid Waste Management"; available at: http://jnnurm.nic.in/toolkits-report-primers.html

Strategy (SSS) and the City Sanitation Plan (CSP). This requires close linkages between the waste management and the sanitation planning in a particular ULB. The National Mission on Sustainable Habitat (NMSH) approved in 2010 under the National Action Plan on Climate Change (NAPCC) highlights the importance of adopting recycling strategies in order to avoid greenhouse gas emissions.

There are the Rules/Regulations/Policies reforms which guide the municipal solid waste management service delivery. Provisions for floating tax free bonds by ULBs, income tax relief to waste management agencies, introduction of double accounting system in ULBs, development of Model Municipal Bye-Laws are other major policy/regulatory directives which guide ULBs in certain aspects of planning for and operationalizing MSW services. Overarching guidelines for private sector participation and Public Private Partnership (PPP) arrangements have also been drawn by the Department of Economic Affairs, GoI. A "Toolkit for Public Private Partnership Frameworks in Municipal Solid Waste Management" was developed by the Ministry of Urban Development, GoI.

Table 1.1: Important Policy Landmarks and Initiatives by Government of India[2] on Solid Waste Management

<table>
<tr><th>Year</th><th colspan="6">Rules/Policies/Schemes/Financial Plans</th></tr>
<tr><td>1989</td><td colspan="2">The Hazardous Waste (Management & Handling) Rules</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1994-95</td><td colspan="2">MSW Management - Strategy Paper by NEERI</td><td>J.L Bajaj Committee</td><td></td><td></td><td></td></tr>
<tr><td>1998</td><td colspan="2">Bio-medical Waste Handling Rules, 1998</td><td>Hon. Supreme court appointed Barman Committee</td><td></td><td></td><td></td></tr>
<tr><td>2000</td><td colspan="2">MSW (Management & Handling) Rules, 2000</td><td>CPHEEO Manual on MSW 2000</td><td></td><td></td><td></td></tr>
<tr><td>2005</td><td colspan="2">Report of The Technology Advisory Group on Solid Waste Management, 2005</td><td rowspan="8">JNNURM (2005-12)- 40 MSW Projects of Rs 2186 Cr sanctioned so far- 65 cities covered</td><td rowspan="8">UIDSSMT (2005-12)- 51 MSW Projects of Rs 327 Cr sanctioned so far- 632 cities covered</td><td rowspan="6">12th Finance Commission (2005-10)- Rs 2500 Cr for 423 Class I cities</td><td></td></tr>
<tr><td>2006</td><td colspan="2">Strategy & Action Plan-Use of compost in cities</td><td></td></tr>
<tr><td>2007</td><td></td><td></td><td></td></tr>
<tr><td>2008</td><td>National Urban Sanitation Policy</td><td>Service Level Benchmarking in MSWM</td><td></td></tr>
<tr><td>2009</td><td colspan="2">Draft document on E Waste handling Rules</td><td></td></tr>
<tr><td>2010</td><td colspan="2">National Mission on Sustainable Habitat</td><td rowspan="4">13th Finance Commission (2010 - 15) - Establishing standards for delivery of essential services</td></tr>
<tr><td>2011</td><td>Plastic Waste (Management & Handling) Rules, 2011</td><td>The E-waste (Management & Handling Rules), 2011</td><td></td></tr>
<tr><td>2012</td><td></td><td></td><td></td></tr>
<tr><td>2013</td><td colspan="2">Draft Municipal Solid Waste (M&H)Rules (2013)</td><td></td><td></td><td></td></tr>
</table>

2 Adapted from: JnNURM, "Toolkit for Solid Waste Management"; available at:http://jnnurm.nic.in/toolkits-report-primers.html

1.4.1.2 MSWM Plan - Link To SLBS

As a part of the on-going endeavour to introduce greater accountability among urban local bodies to improve urban services, the MoUD has prepared Service Level benchmarks (SLB) at the national level for service provision in 4 key sectors- water supply, sewerage, solid waste management and storm water management. Devolution of the 13th Finance Commission Grants to ULBs has been lined to their assessment and achievement of SLBs.

Current SLBs and future targets for improved service levels are to be furnished annually by ULBs to the concerned departments in respective States and notified in the Gazette. Release of performance related grants is contingent on the assessment of SLBs by the concerned state level department and the MoUD. Service Level Benchmarking for all 4 core sectors is one of the nine reform conditions (condition no.8) stipulated by 13th Finance Commission, to be fulfilled by the States and Urban Local Bodies every year, starting from F.Y.2010-11 to 2014-15.

ULBs should assess their current compliance with prescribed SLBs and should determine milestones for achieving identified targets within a specified timeline

Monitoring performance and improvements is envisaged as the goal of the Service Level Benchmarking programme. Benchmarking should be used as a tool for undertaking objective performance analysis by ULBs to improve their activities. The benchmarking of services enables state level agencies and local level service providers to initiate a process of performance monitoring and evaluation against agreed targets.

The following SLBs have been developed by the MoUD for measuring and monitoring provision of solid waste management services by ULBs.

Table 1.2: Service Level Benchmarks for Solid Waste Management[3]

S.No.	Indicator	Unit	Value
1.	Household level coverage of SWM services	As % of households and establishments that are covered by daily door-step collection system	100%
2.	Efficiency of Collection of municipal solid waste	As % of total waste collected by ULB and authorized service providers against waste generated within the project area (excluding the waste recycled through rag pickers)	100%
3.	Extent of Segregation of municipal solid waste	As % of households and establishments that segregate their waste	100%

[3] Adapted from: JnNURM, (2012), "Toolkit for Solid Waste Management"; available at:http://jnnurm.nic.in/toolkits-report-primers.html

S.No.	Indicator	Unit	Value
4.	Extent of municipal solid waste recovered	Quantum of waste collected, which is either recycled or processed, expressed as %	80%
5.	Extent of scientific disposal of solid waste	As % of waste disposed in a sanitary landfill site against total quantum of waste disposed in landfills and dump sites	100%
6.	Cost recovery in SWM services	Expressed as % recovery of all operating expenses related to SWM services that the ULB is able to meet from the operating revenues of sources related exclusively to SWM	100%
7.	Efficiency in redressal of customer complaints	As a % of total number of SWM related complaints resolved against total number of SWM complaints received within 24 hour time period	80%
8.	Efficiency in collection of charges	Efficiency in collection is defined as- current year revenues collected, expressed as a % of the total operating revenues, for the corresponding time period	90%

Detailed guidance on the measurement and evaluation of the Service Level Benchmarks for SWM service provision are given in the SLB Handbook of the MoUD[4].

1.4.1.3 State Level Solid Waste Management Strategies/Policies

Municipal Solid Waste Management Plans should take cognizance of State level Solid Waste Management strategies/policies. These policies provide further guidance to ULBs to implement the MSW (M&H) Rules.

While various states are in the process of defining the state level MSW Management strategy, some states like Karnataka[5] and most recently, Andhra Pradesh[6] has notified State level ISWM strategies. The strategy for Andhra Pradesh is given in Annexure 1.

4 http://www.urbanindia.nic.in/programme/uwss/slb/handbook.pdf

5 Karnataka State Policy on Integrated Solid Waste Management, Available: http://www.uddkar.gov.in/SolidWasteManagement

6 Available: (http://www.cdma.gov.in/cdma/Downloads/ISWM%20Strategy%202014.pdf)

Karnataka State Policy on Integrated Waste Management

The state of Karnataka adopted a policy on Integrated Solid Waste Management in the year 2004 with the objective of developing and implementing scientific & sustainable methods for municipal waste management. The policy follows MSW (M&H) Rules 2000 and maintains that all Class I cities in the state shall have both compost plants and landfill sites while other cities/towns less than 1 lakh shall have only suitable engineered landfill sites.

Funds were made available under 11^{th} Finance and 12^{th} Finance Commissions for purchase of land, development of landfill sites, procurement of tools, equipment & vehicles and IEC activities.

The primary objectives of the Karnataka State Policy on Integrated Waste Management are:

- To provide directions for managing solid waste management activities in an environmentally, socially and financially sustainable manner.
- To establish an integrated and self-contained operating framework for MSWM.
- To enhance the ability of ULBs to provide effective waste management services to their citizens.

Some of the principles of the State Policy on Integrated Waste Management include:

- Public awareness regarding minimizing and avoiding multiple handling of waste
- Defining the roles and responsibilities of various stakeholders in an operating framework
- Developing systems for effective resources utilization and deployment
- Promoting recovery of value from MSW; developing treatment and final disposal facilities as per the statutory requirements

In order to enhance the stakeholders' involvement in MSWM, the State Policy also proposes the following innovations:

- Entrusting the responsibility of source segregation and primary collection to the waste generator level i.e. relevant community based organizations
- Developing and maintaining Information, Education and Communication (IEC) activities and awareness programs

- Defining and utilizing the role of NGOs as a communication bridge between the ULB, community and Self Help Groups (SHG)/ Resident's Welfare Association (RWA) to help in promoting awareness program and to engage with communities in understanding their difficulties, gaps and challenges in implementation. Recommendations and consultations with NGOs/RWAs on how to ensure an effective SWM system.
- ULBs shall allow RWA/SHG to contract with private operators for various waste management activities, under specified guidelines and structures.

The State Policy on various activities of MSW management includes:

- Primary Collection: The ULBs shall charge a user fee for door to door collection. The MSW from bulk generators shall be collected and transferred directly to the secondary transport system
- Street Sweeping and Drain Cleaning: ULBs shall enter into appropriate contractual agreement with private operators for street sweeping should ensure fair wages and practices
- Secondary Collection and Transportation: The ULBs shall abide by the statutory guidelines of MSW (M& H) Rules 2000 and adopt the thumb rules of usage of metal containers and reduced multiple handling by using dumper placers or tractors with tipping trailer mechanism
- Treatment and Disposal: The ULBs shall make a well-informed decision while selecting treatment technologies and shall contract private partners on a tipping fee basis. The policy follows the MSW (M&H) Rules 2000 and maintains that all Class I cities in the state shall have both compost plants and landfill sites while other cities/towns less than 1 lakh shall have only suitable engineered landfill sites.

1.4.1.4 Identify/Analyse Regional/District Solid Waste Management Plan[7]

Technical, financial and managerial challenges of solid waste management in cities can be addressed by considering regional arrangements for municipal solid waste management.

Facilitating establishment of regional facilities and promoting decentralized waste management facilities, as appropriate, should be included in the key provisions of the state level strategy

Regional SWM facilities:

- enable authorities to take advantage of economies of scale by aggregating inert waste generated across their jurisdictions. These facilities have to be professionally

[7] MoUD,(nd)"Municipal Solid Waste Management on a Regional Basis"; available at: http://www.urbanindia.nic.in/programme/uwss/mswm/msw_guide_note.pdf

managed, given the scale of operations reduce the financial and technical burden on each individual authority and help authorities address MSW management in a cost-effective manner, with access to technologies requiring a higher order of resources than available with a single ULB.

- result in more efficient use of land and other scarce natural resources within the region.

> Guidance for establishing regional facilities shall be provided by the State Governments. A solid waste management cell may be constituted within the Urban Development Department at State level or within the Directorate/ Commissionerate of Municipal Administration or its equivalent department. Policy decisions regarding criteria for clustering of ULBs, structure of partnerships and guidance on cost and revenue sharing, ensuring protection of human rights of all workers/labourers shall be taken by this state level nodal agency.

1.4.1.4.1 Objectives of Regional Solid Waste Management Plans

Regional approach facilitates establishment of MSW processing and disposal facilities for ULB clusters. It benefits both large as well as small ULBs.

A 'Regional MSW Management Facility' serves multiple ULBs and facilitates regional level disposal of MSW. In cases where land is not available for processing and disposal, regional processing & disposal facilities may be proposed. To the extent possible efforts should be made to treat waste locally. Only in cases where there is scarcity of land or expertise, regional processing facilities shall be proposed.

With a view to reduce expenditure of hauling small quantities of waste to regional facilities, transfer stations may be established. Regional systems benefit both large municipal bodies, which experience scarcity of land resources, as well as smaller municipalities, which are challenged by limited technical and financial resources for establishing own facilities.

> Land is scarce in urban areas; rapid urbanization results in land being subsumed in the growth zone. The buffer area required for waste processing facilities restricts development on prime lands which may fall within the buffer zone. Small ULBs are restricted by their technical and financial resources to develop waste management facilities within their jurisdictions.
>
> ULBs are encouraged to develop organic waste processing facilities locally; inerts and process rejects may be hauled from a transfer facility to a centralized/regional processing facility. In cities with over 1 lakh population, where the dry and inert waste

is being transferred to a regional facility, a transfer station should be constructed for the storage of wastes upto 20 tonnes. Long haul container systems should be used to transport this waste to the regional waste processing/landfill facility. Street sweepings are also to be collected at the transfer stations and are to be put directly into the long hauling container system in a segregated manner.

The Suchitwa Mission of the Kerala State Government[8] initiated a study to compare the costs of providing sanitary landfills in all of its 5 city corporations and 49 municipalities. The State of Kerala is constrained by the lack of suitable land for landfill construction. Therefore, Regional Sanitary Landfill Facilities (SLFs) are suggested. A comparative study on the land and cost requirement for a SLF for a single ULB, in comparison to requirements for a Regional SLF are given below.

No	Item	Individual SLF for each ULB	Regional SLF
1	Land requirement (Ha)	2316	957
2	Cost of land (Rs. per Ha)	40 Crores	0.18 Crores
3	Savings on land cost (Rs)	754 Crores	
4	O&M cost per MT (Rs)		555
5	Savings per annum on O&M (Rs)	13 Crores	

1.4.1.4.2 Institutional Aspects of Regional Approaches[9]

A regional facility entails an institutional arrangement that enables the association of partnering municipalities to provide specific solid waste management services. Some of the attributes of a regional approach are:

- It is constituted specifically to provide a particular service (solid waste processing or disposal).
- It is governed by a board of directors, a council or an executive body which is unique to the organization.

[8] Information from Suchitwa Mission; available at: http://www.sanitation.kerala.gov.in/

[9] Water and Sanitation Program, 2007. "Moving Towards the Regional Approach, Water and Sanitation Program"; available at http://www.wsp.org/sites/wsp.org/files/ publications/519200880608_SWM_dec_07.pdf

- It is usually not dependent on taxes for funding, but raises fund through service tipping fees paid by partnering local bodies.
- It may or may not involve the participation of a private sector service provider.
- It often requires special legislation and ordinances for its establishment.

Various implementation arrangements can be applied to establish a Regional SWM project

1.4.1.4.3 Implementation of Regional Solid Waste Management Plans

Regional projects can be implemented either through[10]:

- Inter Municipal Agreements
- Authorities, Trusts and Special Districts
- Non-profit Public Corporation
- Regional Council
- Private Sector Participation

Inter Municipal Agreements are contracts between two or more municipalities who combine their resources to perform a specific task together. The primary advantages of inter municipal agreements are flexibility and customization. Inter municipal agreements are often better suited for limited regional projects. One of the challenges to these agreements is the difficulty in obtaining capital financing because each participating municipality might have to raise money for the project individually.

Authorities, Trusts and Special Districts can be created by some governments dedicated to organize their regional programs. These entities have the power to impose regulations, to contract with private companies, to issue bonds, to levy taxes or assessments, or to use other means to raise funds for specific projects.

Non Profit Public Corporations are owned and managed by participating municipalities and are run as independent businesses while member municipalities pay dues. Non-profit public corporations raise additional funds through fund raising. However, establishing these organizations can be time consuming.

Regional Councils are another approach used for inter municipal cooperation to organize and manage all types of cooperative projects. The council provides flexibility and helps in bringing public and private partners together to take decisions.

[10] Zhu, D. et. al. (2008) "Improving Municipal Solid Waste Management in India"; available at http://cma.tn.gov.in//swm_in_india.pdfdec_07.pdf

Private Sector Participation can be used for different services like transporting MSW to the regional landfill system, financing, construction and operation. Regional organizations can enter into binding agreements with businesses to provide specified services for less cost and improved services. Contracts between local governments and businesses generally are governed by the public contracting laws of the State.

Some of the guiding principles that should be taken into consideration while planning, developing, implementing and managing Regional MSW Projects are discussed briefly below:

1.4.1.4.4 Land Allocation for Regional MSW Projects

Land identified for a regional facility cannot be assigned to other uses to ensure and protect the viability of proposed MSWM facilities

Land for a Regional MSW management project can be provided through any of the following mechanisms:

- Provided and owned by the State Government or by one of the authorities participating in the Regional MSW Project
- Acquired by one of the participating authorities and allocated by passing appropriate resolutions, without any State Government assistance
- Acquired by the State Government and vested with a particular municipality or a group of municipalities; and
- Provided by the private sector participant

Before the selection of any site for the development of a Regional SWM Facility, it should be ensured that the land use cannot be changed by the competent authority for the duration of the project. This ensures bankability and viability of the project.

- The area of land being provided should be sufficient to enable the type of Regional MSW Facility intended to be developed on the land using specified technology.
- The location should enable optimum number of authorities to have viable access to the facility developed thereon.
- Land that is already within the possession of either the State Government or any Authority may be preferred over lands that require acquisition of private land or from any other entity
- Acquisition of privately owned land may be undertaken in cases where no government land is available
- Land that has been identified for development/implementation of Regional MSW

Projects shall be notified as having been allocated for the purposes of a Regional MSW Projects only.

- The State Government should undertake to control land use in and around the Regional MSW Facility in accordance with development controls to prevent encroachment or development of habitations, structures etc.

Appropriate arrangements for collection of user charges and tipping fees will ensure financial viability of MSWM projects.

1.4.1.4.5 Solid Waste Quantity and Tipping Fee

- Depending on the type of waste processing facility intended to be established, each authority shall have to assure a certain quality and quantity of MSW it supplies to the project
- The tipping fee should be structured so as to enable viable implementation of the project depending on the circumstances and the location of the project.
- In order to guarantee their ability to pay the tipping fee, each participating Authority shall make appropriate arrangements such as imposing and collecting a fee from within its jurisdiction for the provision of MSW services. An escrow and charge structure with respect to the identified revenue streams may be created to provide for security of payment of the tipping fee.
- State Governments may also resort to an intercept mechanism whereby, the State Government may provide the required payments directly, for and on behalf of the Authority. Under the proposed structure, the participating authorities will contractually agree to the State intercept mechanism.

1.4.1.4.6 Collection and Transportation of MSW

- The authorities participating in a Regional MSW Project would undertake to improve the efficiency of their MSW collection and transportation systems in a phased and time-bound manner to ensure that the minimum quantity assured to be delivered at the processing facility and / or disposal site reaches the site regularly.

Examples of Regional or Inter-Municipal Arrangements under Development [11]

Gujarat: Regional landfill sites have been identified: 45 sites have been proposed for 161 municipalities; such that the maximum transport distance is 25 km. Proposals envisage private sector involvement and the Gujarat State Waste Management Company will be the sole contracting agent. Memorandum of Understanding will be signed between the cooperating Municipalities and the state nodal agency. 9 sites are at an advanced stage of construction of sanitary landfill facilities.

Kerala: A recent study recommended that the 14 districts in the state be divided into 6 zones, each with its own landfill site for receiving waste from all towns in that particular zone. The feasibility study for construction of one regional landfill has commenced[12].

West Bengal: In the Kolkata Metropolitan Development Authority area, municipalities propose to use one common landfill site. Regional landfills are also being planned in other parts of the state; the Asansol urban area, consisting of the Asansol Municipal Corporation (AMC), Durgapur Municipal Corporation (DMC), and the municipalities of Ranigunj, Jamuria and Kulti, under the nodal Asansol Durgapur Development Authority (ADDA), have developed a regional engineered landfill facility. A Public Private Partnership was formed for implementation of the project.

Maharashtra: The Maharashtra Metropolitan Regional Development Authority (MMRDA) has decided to develop a regional landfill facility to cater to 2500 metric tonnes of incoming waste with a design period of 25 years. Urban Local Bodies in the Metropolitan Region from 6 Municipal Corporations / Councils are envisaged to use this facility. Thane-Kalyan-Dombivali, Bhiwandi-Nizampur, Ullhasnagar, Ambarnath and Kulgaon-Badlapur are the ULBs that will be catered to under this project.

Orissa: The cities of Bhubaneswar and Cuttack have associated to commission a common solid waste management facility for treating approximately 600 tonnes of waste from both ULBs. The Orissa Industrial Infrastructure Development Corporation is acting as transaction advisory to facilitate this project. The selected concessionaire will be responsible for designing and constructing the requisite transfer station, transporting waste from the transfer station to the waste management facility and identify, design, construct and operate waste management facilities based on appropriate technologies selected by the concessionaire.

Andhra Pradesh: The State Government has developed a strategy and issued comprehensive guidelines for setting up regional facilities. 124 urban local bodies have been clubbed into 19 clusters. 5 facilities were established and operated through private sector concession agreements.

11 Water and Sanitation Program, 2007. "Moving Towards the Regional Approach, Water and Sanitation Program"; available at http://www.wsp.org/sites/wsp.org/files/ publications/519200880608_SWM_dec_07.pdf

12 Information from Suchitwa Mission; available at: http://www.sanitation.kerala.gov.in/

For further details please refer to the MoUD Guidance 'Municipal Solid Waste Management on a Regional Basis' (footnote 16).

1.4.1.5 Role Of Central, State And Local Governments

While the onus of providing solid waste management services in urban areas lies with the ULBs, as specified in Municipal Solid Waste (M&H) Rules 2000, Central and State Governments have a significant role to play in defining the frameworks within which service provision can be planned and executed by ULBs.

Key roles of the Central and State Governments are listed below:

Table 1.3: Roles of Central, State and Local Governments in MSWM

Level of Government	Role
Central Government	**Legal & Policy Framework** The MSW (M&H) Rules by the MoEF mandate provision of SWM services by municipal authorities in urban areas in the country. The Model Municipal Law, circulated to all states by the MoUD, specifies guidelines for the drafting municipal laws covering all aspects relating to managing the civic affairs, good governance, provision of essential infrastructure & services, raising financial resources for providing the services. The National Municipal Accounting Manual gives guidance for municipal accounting purposes. Sanitation and solid waste are categorized as a separate function, with a specific function code for solid waste management. **Financial Support** The MoUD, through various schemes and missions, like the JnNURM, provides financial support to MSWM projects. It has also facilitated allocations of 12thFinance Commission grants to the extent of Rs 25 billion to ULBs for improving SWM. The Centre has also been supporting training and capacity-building programs for municipal authorities. Rs 87,519 Crores are allocated to the Urban Local Bodies under the 13th Finance Commission Grants (FY 2009-10 to FY 2014-15). The Ministry of Agriculture (MoA) and the MNRE are also playing an active role in promoting and providing financial support for composting of municipal solid waste and waste-to-energy projects, respectively

State Government	The draft MSW (M&H) Rules, 2013 indicate: The Secretary-in charge of the Department of Urban Development of the concerned State or the Union territory, as the case may be, shall have the overall responsibility for the enforcement of the provisions of these rules in the metropolitan cities. States shall prepare State level Municipal Solid Waste Management policy or strategy, which shall provide policy guidance to all ULBs within the state. This strategy shall be in consonance with the State Sanitation Strategy prepared under the National Urban Sanitation Policy (NUSP), if available. States have the responsibility of reporting on Service Level Benchmarks for solid waste management service provision in ULBs to the MoUD on an annual basis. State Pollution Control Boards (SPCB) are responsible for monitoring the implementation of the Municipal Solid Waste (M &H) Rules. The power to grant consent to municipal authorities or operators to set up treatment and disposal activities lies with the SPCB. Where the land is owned/acquired by the Government, States are also responsible for approving/facilitating the allocation of land to private players for constructing SWM facilities, especially in the case of regional facilities States have the power to regulate/sanction creation of staff positions (technical and non-technical) in the ULBs. Provide guidance to cities to manage finances provided by the Finance Commission grants for SWM activities.
District/ Region	As per the MSW (M&H) Rules, 2013, the District Magistrate or the Deputy Commissioner of the concerned district has the overall responsibility for the implementation of the provisions of these rules within the territorial limits of their jurisdiction.
Urban Local Bodies	As per the 74th CAA, the MSW (M&H) Rules and the State municipal laws, ULBs are primarily responsible for the provision of municipal solid waste management services. Monitoring and reporting of SLBs for SWM services annually to the State

1.4.1.5.1 Guidance on State &ULB Institutional Linkages

The State or Union Territory Government shall constitute a specific Solid Waste Management cell (SWM cell) within the Department of Urban Development at the State level. This cell shall be responsible for developing the State level Solid Waste Management Strategy, in discussion with relevant stakeholders. This cell may be constituted in the Directorate/Commissionerate of Municipal Administration (DMA/CMA) or in the nodal department at the State level, for monitoring SWM service provision in the State.

Creation of a State Level Solid Waste Management Cell is central to the implementation, facilitation and monitoring of MSWM facilities in the State

Meaningful Reporting

All ULBs shall report directly to the State level SWM cell on annual reporting requirements on municipal solid waste management

Policies on regional planning for municipal solid waste management in the State shall be prepared by the State level Solid Waste Management Cell in consultation with district/ regional Commissioners and ULB authorities.

In addition to the annual reporting to state pollution control boards on provision of SWM services, all local authorities shall also bi-annually report to the solid waste management cell. District level authorities (District Collector or equivalent authority) are responsible for implementing regional waste management strategies (where in force) and shall send district level annual reports on implementation of regional strategies to the MSW management cells

The state level SWM cell shall submit an annual report to the SPCB, to be forwarded to the CPCB. The report shall be analyzed by the CPCB and feedback sent to the SPCB and the State Urban Development Department. The report shall compile data on the SWM strategy for the State and level of service provision, while identifying significant gaps in service. The gap analysis would also look into prevailing socio-economic factors, health related issues, working conditions for wage earners/contractual labourers etc.

1.4.2 Step 2: Assessment of Current Situation/ Status and Gap Analysis

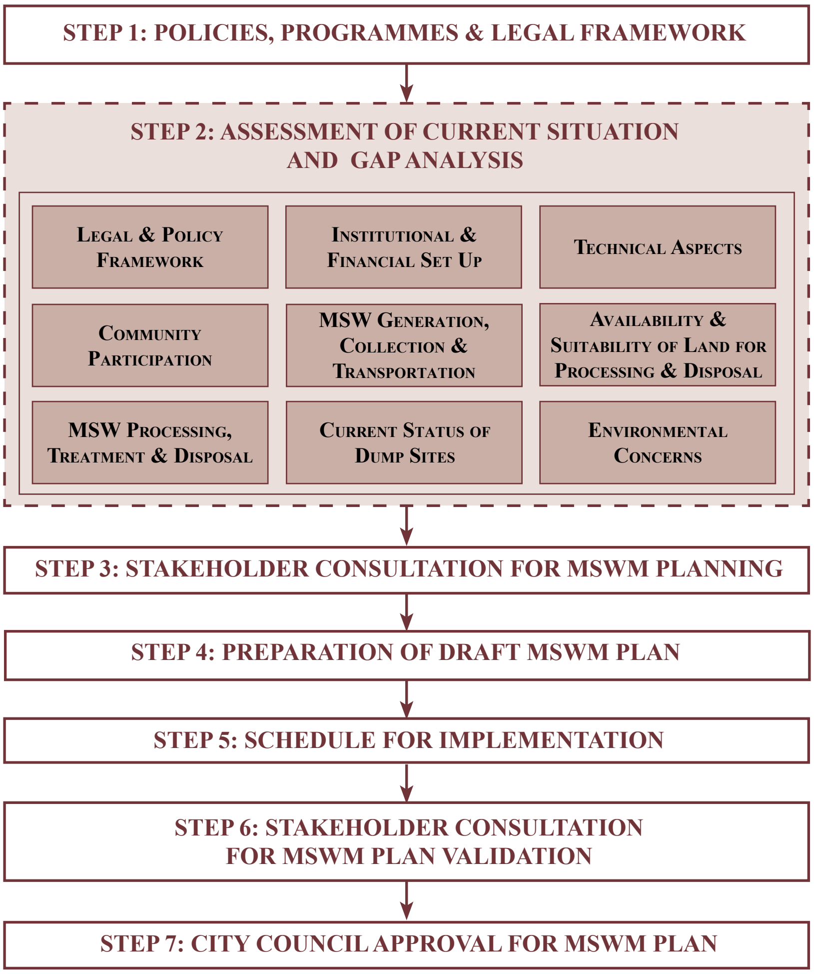


Figure 1.4: Step 2 in MSWM Plan

The solid waste management department in the ULB should collect baseline information that needs to be assessed as indicated in table 1.4. Baseline information shall be gathered from ward level records, city wide MSW management records and field investigations as required, as depicted in figure 1.5.

The main objective of the baseline study is to understand the existing solid waste system as accurately as possible, analyze system deficiencies in the context of MSW Rules, 2000 and utilize that information for further planning, implementation and monitoring processes. Local conditions shall be considered while assessing the inadequacy of existing service and planning for the future with due consideration of local demography, physical location, growth objectives of the ULB as well as social and environmental conditions.

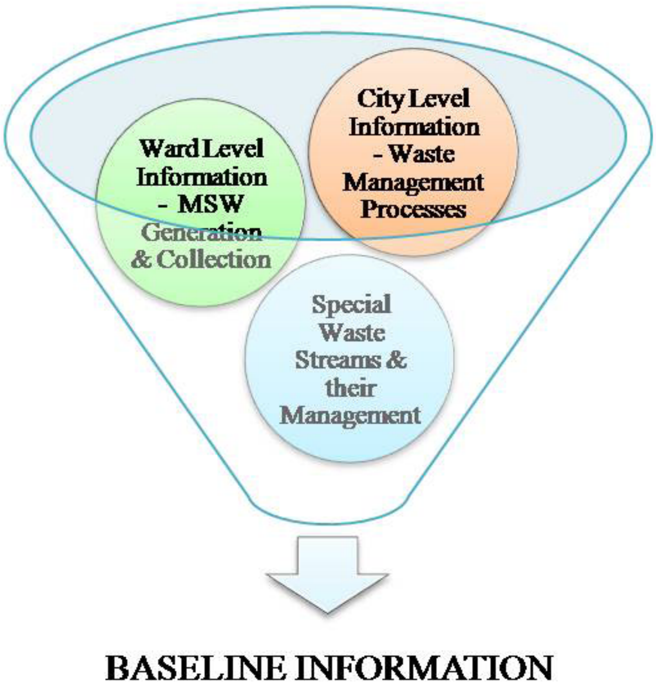


Figure 1.5: An Overview of Baseline Information Required for Strategic Planning

The main objective of the baseline study is to understand the existing solid waste system as accurately as possible, analyze system deficiencies in the context of MSW Rules, 2000 and utilize that information for further planning, implementation and monitoring processes. Local conditions shall be considered while assessing the inadequacy of existing service and planning for the future with due consideration of local demography, physical location, growth objectives of the ULB as well as social and environmental conditions.

1.4.2.1 Gap Analysis

The assessment of the information on the current status of waste management in the ULB vis- a- vis the requirements of existing regulation, policies and guidelines and identified SLBs will result in an identification of key shortfalls in achieving the desired level of services and shall form the basis for preparing a plan to improve the MSWM system. Figure 1.6 illustrates a schematic depicting the issues to be considered while assessing gaps in MSW service provision.

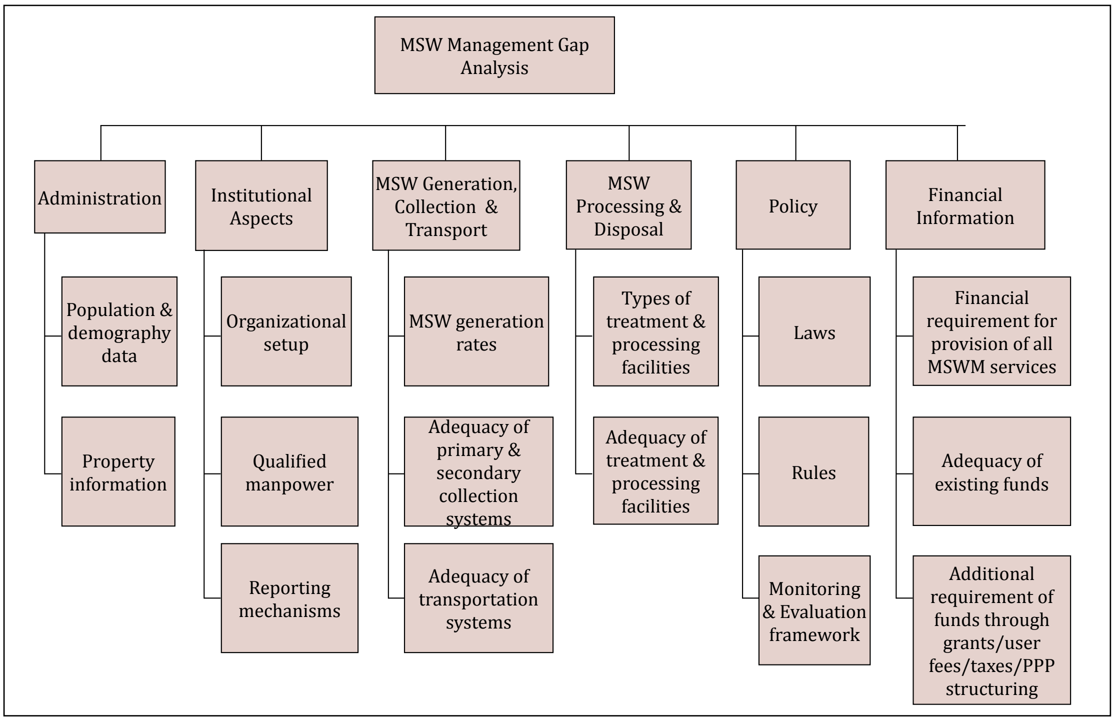


Figure 1.6: Considerations for Gap Analysis

An indicative list of specific information to be collected and analyzed for establishing the baseline of SWM service provision is given in Table 1.4.

Table 1.4: Matrix for Collection of Baseline Information

Data / Information at City level	Information at Ward level	Identification of Stakeholders
Administration		
• Identify political and administrative boundaries within the ULB • Prepare a city map showing total area in Sq. km., ward boundaries and city level demographic details • Depict on map, areas served by door to door collection, community bin collection system and areas not served • Details of jurisdiction area & decadal growth of the city in last three decades • Details of existing monitoring and reporting system	• Ward level population and demography details • Number and location of slums (notified & non-notified) and their population • Identify number of MSW generators in each ward (households, commercial establishments, institutional/bulk generators, industries and markets)	

This information is important for regular monitoring of SWM service provision. Please refer to table 6.1 in chapter 6 for details of the MIS system used for monitoring MSW service provision

Data / Information at City level	Information at Ward level	Identification of Stakeholders
Institutional Aspects		
• Organization structure of the ULB • Organizational structure of SWM department in the city with full details of incumbents, their numbers, roles and responsibility • Number and level of engineers with the municipal authority vis-a-vis with the SWM department • Number and level of sanitary workers employed by the ULB for street cleaning, drain cleaning, transportation, processing and disposal of waste (regular and contractual) • Provisions for workers (access to toilets, storage facility, linkages with community level crèches/ aanganwadis) • Sweeper /road length ratio, sweeper/ supervisor ratio, sweeper/population ratio, sweeper /bin ratio • Details of MSWM tasks outsourced to external entities through various contracting procedures	• Ward level human resources details • Number of Junior Engineers at ward level • Number of chief sanitary inspectors/officers • Number of sanitary inspectors • Number of sanitary supervisors • No of sanitary workers	• Identification of operators in the city, extent of their coverage, the user fees levied by them and level of their performance • List of known recyclers in the ULB • Approximate number of informal rag pickers and kabari walas in the ULB • Identification of NGOs/ Voluntary groups/ Self-help groups involved in SWM
Natural Environment		
• Climate, rain fall, temperature, wind speed/direction, dispersion conditions • Topography and drainage conditions • Land use and Land cover • Soil type • Groundwater table • Surface water sources • Sensitive natural areas (mangroves, eco-sensitive zones)		-

Data / Information at City level	**Information at Ward level**	**Identification of Stakeholders**
MSW Generation, Collection & Transportation		
• Waste generation rates, seasonal fluctuations • Extent of population practicing waste storage at source & waste segregation • Extent of waste recycling/ recovery • Details of primary waste storage facilities • Number of community bins, their location and type of waste collected • Coverage of population in day to day street sweeping • Extent of coverage of slums and informal settlements, • Waste transportation :Number of Vehicles and types of Vehicles for primary, secondary and tertiary transportation (differentiated for main waste types) • Number of trips made by vehicles in each shift • Quantity of solid waste transported by each vehicle • Percentage of waste collected each day • Frequency of collection from street bins	• Quantity and characteristics of waste generated and collected per ward • Waste quantities from different generators (Residential, Commercial, Institutional, Markets, bulk generators, MSW from Businesses) • Quantity of Construction & Demolition waste • Quantity of E-Waste • Quantity of Plastic waste • Quantity of Bio-medical waste • Status of at source waste collection • Waste collection frequency • Details of available community bins and waste storage depots • Details of number and type of vehicles used and transportation • No. of nuisance spots in the ward where waste is indiscriminately disposed of	• Role and extent of informal sector (rag pickers/kabadi system) • Involvement of Resident Welfare Associations (RWAs)/ Self Help Groups (SHG) in collection of recyclables • Role of market associations • Role of institutions like universities, cantonments, Government offices etc. • Role of commercial enterprises, hotel associations etc.

Data / Information at City level	Information at Ward level	Identification of Stakeholders
MSW Processing, Treatment & Disposal		
• Presence/Absence of waste treatment/processing/disposal facilities in the ULB • Technology adopted in each of the facilities • Percentage of MSW treated each day through any of the following technologies :Compost plants (decentralized and centralized) both windrow and vermi-composting • RDF plants • Waste to Energy plants • Special waste treatment facilities if any • Quantity and characterization of waste treated/processed in each facility • Quantity and characteristics of rejects from each facility and their disposal • Capacity, design life, technology, environmental management systems in each of the processing/ treatment • Waste disposal methods adopted/whether sanitary landfill facilities exist • If yes, current capacity, waste disposed each day, expected life of landfill, facilities provided at the landfill	• Existing decentralized waste processing and / or disposal systems, size, and technology adopted • Reject management systems from decentralized facilities • Material recycling facilities	• Private sector,NGOs or RWAs/SHGs civil bodies, individuals involved in MSW processing at decentralized and centralized levels and extent of their coverage

Data / Information at City level	Information at Ward level	Identification of Stakeholders
Policy		
• List out mandates/ provisions of national/state/regional laws/ rules, regulations and policies related to MSW management and status of their implementation • Existing Monitoring & Evaluation (M&E) mechanism for assessing MSW management		
• Financial Information		
• Annual revenue and Capital costs incurred by ULB for MSW management – direct expenditure & contracting costs • costs per tonne of waste collected/treated/processed/ disposed • User charge prescribed for door to door collection service revenues therefrom and expected • Revenue generation from user charges / percent recovery • Revenue generation from resource recovery • O&M costs for MSW management • Cost recovery for MSW management services	• User charge prescribed for door to door collection service revenues there from and expected • Revenue generation from user charges / percent recovery	•

1.4.2.2 Data Collection Methodology

Detailed information for assessing the adequacy of municipal solid waste management services may not be readily available with the ULB. Collection of data mentioned in table 1.4 could overburden smaller ULBs. Therefore, efforts may be made to collect secondary data from previous surveys/ studies undertaken for other purposes, where available with the local body. Some data may also be available with service providers, City Planning Departments; etc. Essential information may also be collected from field level supervisors, after imparting requisite training on the type and manner of data to be collected from their respective wards.

Primary data shall be collected only when authentic secondary data is unavailable. Primary data may be collected through conducting surveys and measurements at the point of generation, using data collection formats.

1.4.2.2.1 Representative data

Where the collection of primary data from the entire planning area is not possible, representative samples may be collected. The size of the representative sample shall be guided by consideration of the variations in demography and income levels in constituent areas and seasonal variations.

1.4.2.3 Quantification And Composition Of Waste

The quantity and composition of MSW generated in the ULB is essential for determining collection, processing and disposal options that could be adopted. They are dependent on the population, demographic details, principal activities in the city/ town, income levels and lifestyle of the community.

Waste generation is strongly dependent on the local economy, lifestyle and infrastructure. It has been well established that waste generation of an area is proportional to average income of the people of that area. It is also observed that generation of organic, plastic and paper waste is high in high income areas.

An assessment[13] states that the per capita waste generation is increasing by about 1.3% per year. With an urban growth rate of 3-3.5% per annum, the annual increase in waste quantities may be considered at 5 % per annum. Impacts of increasing ULB jurisdiction should also be considered while assessing future waste generation rates.

Several studies were conducted by the CPCB over the last two decades to arrive at waste generation details and solid waste composition of waste generated in the country. Summaries of the several findings are listed below:

- **1996:** The Characterization studies carried out by NEERI in the year 1996 indicate that MSW contains large organic fraction (30-40%), ash and fine earth (30-40%), paper (3-6%) along with plastic glass and metal (each less than 1%), calorific value of refuse ranges between 800-1000 kcal/kg and C/N ratio ranges between 20 and 30.

13 Zhu, D. et. al. (2008) "Improving Municipal Solid Waste Management in India"; available at http://cma.tn.gov.in//swm_in_india.pdf

Study revealed that quantum of waste generation varies between 0.2-0.4 kg/capita/day in the urban centers and it goes up to 0.5 kg/capita/day in metropolitan cities. The study was carried out in a total of 43 cities of varying sizes, as detailed out in the table 1.5 below. The results were presented in a report published by NEERI "Strategy Paper on Solid Waste Management in India" (1996).

Table 1.5: Per-capita waste generation rates from NEERI Study in 1996

Population Range (in million)	No. of Cities Surveyed	Average per capita value (kg/capita/day)
0.1 to 0.5	12	0.21
0.5 to 1.0	15	0.25
1.0 to 2.0	9	0.27
2.0-5.0	3	0.35
>5.0	4	0.50

- **1999-2000:** The Municipal Solid Waste Study conducted by CPCB through EPTRI in 1999-2000 in 210 Class I Cities and 113 towns of Class II Towns indicated that Class I Cities generated 48,134 MT of municipal solid waste per day while Class II towns generated 3401 MT/ day of municipal solid waste. The study revealed that waste generation rate in Class I cities was approximately 0.34 kg/capita/day while the waste generation rate in Class II towns was found to be 0.14 kg/capita/day.
- **2004-2005:** NEERI's study on "Assessment of Status of Municipal Solid Wastes Management in Metro Cities and State Capitals" in 2004-2005, assessed 35 metro cities and 24 State capitals. Studies have revealed that waste generation rate varies from 0.12 to 0.60 kg per capita per day. Analysis of physical composition indicates total compostable matter in the waste is in the range of 40-60 percent while recyclable fraction was observed between 10 and 25 percent. The moisture content in the MSW was observed to vary from 30 to 60 per cent while the C: N ratio was observed to be in the range of 20-40.
- **2010-2011:** The survey conducted by the Central Institute of Plastics Engineering and technology (CIPET) at the instance of CPCB has reported generation of 50,592 tonnes of MSW per day in the year 2010-11 in the same 59 cities.
- **2011-2012:** As per information received from State Pollution Control Boards/ Pollution Control Committees (in between the year 2009-12) for 34 states and Union Territories, 1, 27,486 TPD (tons per day) municipal solid waste was generated in the country during 2011-12. The average rate of waste generation in the entire country, based on this data, was calculated to be 0.11 kg/capita/day. Out of 1,27,486 MT of waste generated approximately 89,334 TPD (70%) of MSW is collected and 15,881

TPD (12.45%) is processed or treated.

Other studies and observations indicate that waste generation rate is found to be between 200 and 300 gm/ capita /day in small towns / cities with population below 2, 00,000. It is usually 300 to 350 grams /capita/day in cities with population between 2,00,000 and 5,00,000, 350 to 400 gm/capita/day in cities with population between 5,00,000 to 10,00,000 and 400 to 600 gm/capita/day in cities with population above 1 million.

However, these are only indicative figures, which need to be verified while planning city specific MSWM systems.

1.4.2.3.1 Waste Quantification

Current Practice: Waste generation rates are quantified by measuring the load of waste in collection vehicles either at a municipal or private weigh bridge in the city. Alternately, the volumes of different vehicle used for transportation of waste are considered and a thumb rule of 400 to 500 kg per cubic meter is applied for determining the quantity of waste transported per trip per type of vehicle. A summation of the quantities of waste transported by each vehicle type multiplied by the total number of trips to the landfill by similar vehicles determines the total quantity of waste transported in the ULB. The practice of an eye estimate of waste quantity transported is not reliable as many times trucks carrying waste are half full or carry light material.

Current Practice for Estimation of Quantity of Transported Waste

Total Waste Collected = Quantity of Waste Transported by Each Vehicle X No. of Trips

The quantity of waste measured at transfer stations or processing/disposal sites also does not accurately reflect waste generation rates, since these measurements do not include:

- Waste disposed of at un-authorized places, vacant lots, alleys, ditches etc.
- Waste recovered by the kabadi system
- Waste recovered by informal waste collectors/rag pickers from the streets, bins, and intermediate transfer points etc.

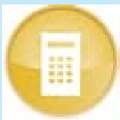
Sampling for Waste Quantification

Solid waste is very heterogeneous in nature and its composition varies with place and time. Even samples obtained from the same place (sampling point) on the same day, but at different times may show totally different characteristics.

Long Term Planning: For the purpose of long term planning, the average amount of waste disposed by a specific class of generators can be estimated only by averaging data from several samples collected continuously for a period of 7 days at multiple representative locations within the ULB jurisdiction, in each of the 3 main seasons viz. summer, winter and rainy seasons. Waste quantities should be aggregated over the 7 day period, weighed and averaged. These quantities can then be extrapolated to the entire ULB and per capita generation assessed.

This should be repeated once every 5 years at the time of the review of the MSW management plan

Short Term Planning: Select at least 100 representative sampling locations per 1,00,000 population including households of low, mid and higher income, commercial establishments, institutional generators, hospitals and health care establishments, small and medium enterprises, hotels, function halls, vegetable markets, sports complexes/facilities, places of worship (temples/ mosques) and other significant representative groups. Storage bags sufficient for 3 to 7 days can be distributed to each waste generator who may be advised to deposit all waste generated daily in the given bag which is to be handed over to the specified waste collector on the subsequent day in the morning; the bags so distributed may be collected daily for a minimum of 3 to 7 days continuously and weighed immediately after collection using a sensitive weighing machine and record may be kept of the waste generated by different categories of waste generators. The waste collected from each category may thereafter be mixed category wise and segregated component wise and each component may be weighed separately to arrive at the waste composition in different categories of waste generators. This representative waste quantity and quality when extrapolated to the entire ULB and divided by the population will give the per capita waste generation rates.



Quantifying Total Waste for Processing/Disposal

Municipal Solid Waste in the Indian context does not include waste material such as newspapers, tins, bottles etc., that are sold for a price directly by waste generators to the informal sector, hence this waste does not enter the municipal solid waste stream.

Quantities of waste generated in the city need to be assessed to establish adequacy of existing systems and to plan for augmentation of treatment and disposal facilities. Waste moving through the system should be quantified at multiple locations to assess the actual quantities of waste available for processing and direct disposal.

Figure 1.7 below, gives an indication of sampling points along the waste management chain.

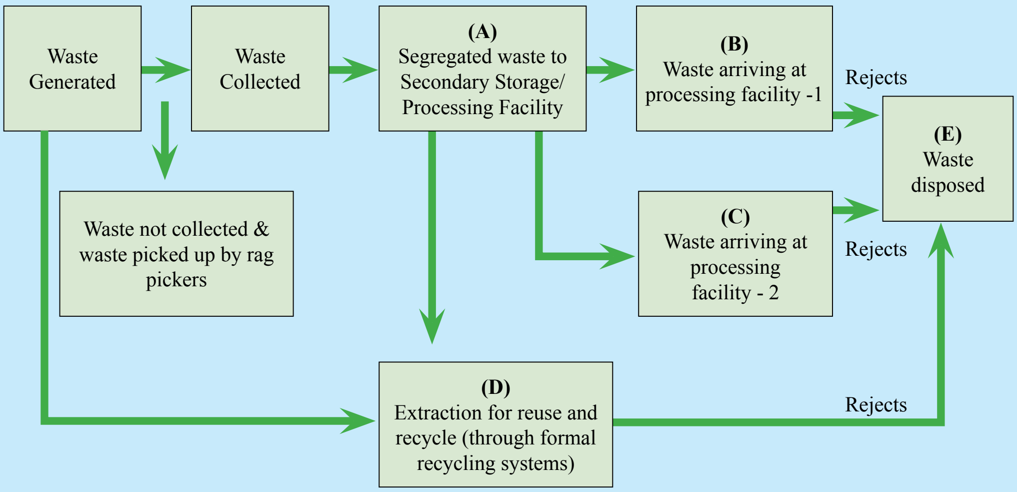


Figure 1.7: Waste Flow Diagram Depicting Points of Quantification[14]

Entire waste collected from the city shall be weighed at a suitable weigh bridge/ weigh bridges set up at transfer stations or enroute processing and disposal facilities. Larger cities may have more than one transfer station. In smaller cities where there may not be any transfer station, the processing and/or disposal facility may be the first point where waste from the entire city is deposited. The sum of the waste quantities recorded at transfer points or the quantity of waste deposited directly at the processing facility and landfill site shall indicate the quantum of MSW that is to be handled by the ULB (Sampling point A) on a daily basis. This figure cannot be taken as waste quantity generated in the city, since certain quantity of waste is picked up from the system by the informal sector/rag pickers to earn their living, or by the agency entrusted with

[14] Environmental Resources Management (2000). Strategic Planning Guide for Municipal Solid Waste Management. The World Bank, SCD and DFID, Waste-Aware, London. Available at: http://www.worldbank.org/urban/solid_wm/erm/start_up.pdf.

waste collection before the waste reaches the processing or disposal site. Besides, some percentage of waste is not collected at all due to system deficiencies. The total waste generated in the city is a sum of waste deposited at the processing facility, directly at the landfill site, waste segregated enroute processing / disposal site and the waste not collected at all. It is therefore difficult to arrive at an exact figure of waste generation in the city.

- Based on the processing/treatment scheme selected, segregated waste streams may be sent to a single integrated waste management facility or more than one facility, each handling a specific waste stream. Waste quantities that are processed by each of such facilities shall be measured (e.g. Sampling points B,C,D,E in waste flow diagram shown in figure 1.7).
- A weigh bridge should be placed at a suitable location to weigh waste before being transferred to different treatment/processing/disposal facilities.
- Quantities of rejects that are being sent to the landfill facility from each of the processing facilities shall also be measured. For e.g. In the waste flow diagram above, a weigh bridge at an appropriate location may be used to quantify waste going to points A, B, C and E. Waste collected by decentralized collection centers has to be weighed by weighing scales at the decentralized facility (point D).
- Cities with population less than 2,00,000 should tie up with private weigh bridges for daily weighment of waste being managed by the ULB.

1.4.2.3.2 Determining Waste Composition

Municipal solid waste composition and characteristics vary considerably, not only between cities but also within a ULB – daily, seasonal and temporal fluctuations are usually observed. MSW is heterogeneous in nature and consists of varied waste fractions (for a list of MSW constituents please refer to section 2.1.1, table 2.1 of chapter 2 in Part II of this manual), requiring multiple samples at multiple locations.

Quartering & coning method is a well-established technique for waste characterization.

The quartering and coining method (as shown in figure 1.8) is one of the best techniques for determining the composition and characteristic of municipal waste. The sample is reduced to a more manageable size as the actual classification is carried out by hand.

Selection of sampling sites is a critical first step in this process. The following aspects shall be considered:

- Waste sampling sites and frequency of sampling shall be in accordance with guidance given in section 1.4.2.3.1
- The sample collection sites should be representative and include all major sources of waste generation including, but not restricted to residential (including slums), commercial, business and market (vegetable market, meat market, slaughter house, grain market etc.,) areas.
- Sample sites should also be representative of all income groups within the ULB.

Quartering & Coining Sampling Procedure

- Take 10 kg of municipal waste mixed from outside and inside of the waste pile, sourced from random entities in an identified sampling location.
- Samples from all heterogeneous sampling points shall be mixed thoroughly.
- The sample is placed as a uniform heap.
- The heap is divided into four portions using straight lines perpendicular to each other.
- Waste from opposing corners of the divided heap is removed to leave half of the original sample. The remaining portions are again thoroughly mixed and the quartering process is repeated until a desired size is obtained (10 kg of waste can be handled/ segregated efficiently).
- The last remaining opposing fractions of waste shall be mixed and analyzed for identifying physical and chemical properties of the waste.
- Chemical analysis of the waste sample follows the physical constituent analysis. Chemical analysis of the sample shall be performed in a laboratory accredited by the Ministry of Environment & Forests (MoEF)[15].

[15] Ministry of Environment and Forests (MoEF)(2013); available at http://www.envfor.nic.in/legis/env_lab.htm

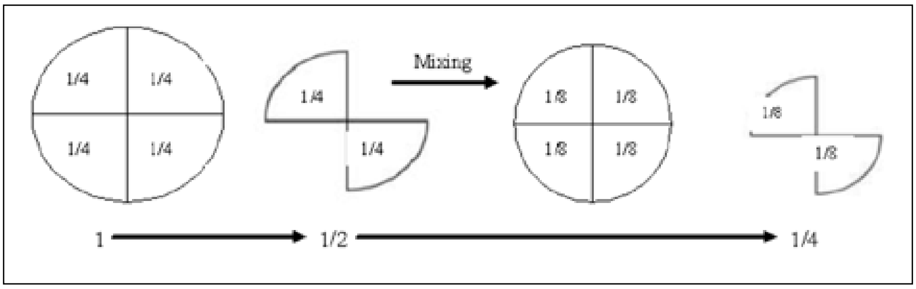


Figure 1.8: Characterization of MSW through Quartering Method[16]

Proportion of Waste Constituents: The size distribution of waste constituents in the waste stream is important because of its significance on the selection of appropriate collection/transportation/processing/treatment and disposal practices. The waste characterization method mentioned above shall be followed to assess proportions of waste constituents.

Critical parameters for selecting the appropriate processing technology are: waste quantity and characteristics, such as density, moisture, calorific value, toxicity etc.

1.4.2.3.3 Physical Characteristics of Municipal Waste

1. Density of Waste

The density of waste (mass per unit volume, kg/m^3) determines the storage and transportation volume requirements. MSW density in India is typically around 450-500 kg/m^3.

Impact of Density on Waste Transportation Choices

The efficacy of using compactor bins and refuse compactors is dependent on the initial density of waste. Low density wastes (e.g. packaging wastes, plastic waste) may be hauled most efficiently through the use of compactors, where a compaction ratio as high as 2.5:1 is achievable. Compactors offer little or no advantage and are not cost-effective for transportation of wastes with high densities (e.g. street sweeping waste). In general, compactors may be used for all municipal wastes, except inert wastes.

Method for Bulk Density Measurement

Materials and Apparatus:

- Wooden box of l m^3 capacity
- Wooden box of 1 ft^3 capacity

[16] MoUD (2000). Solid Waste Management Manual & Adapted from: JnNURM, (2012), "Toolkit for Solid Waste Management"; available at: http://jnnurm.nic.in/ toolkits-report-primers.html

- Spring balance weighing upto 50 kg

> Solid waste with high moisture content results in increasing collection and transportation costs.

Procedure: A composite sample of solid waste collected from different parts of the heap should be taken in the smaller 1 ft^3 box and weighed with the help of a spring balance. After weighing, contents of this smaller box (1 ft^3) are emptied into the bigger l m^3 box. This is repeated till the larger box is filled to the top. Once the larger box is filled, the weight of the waste is noted. The waste should not be compacted by pressure. Repeat the entire procedure thrice and take the average weight to arrive at the weight per cubic meter.

2. Moisture Content

Moisture content of solid wastes is usually expressed as the weight of moisture per unit weight of wet material.

> Determining calorific value of waste is important to determine the potential for recovering Refuse Derived Fuel (RDF) and its utilization in cement/ power/ waste to energy plants.

$$\text{Moisture Content (\%)} = \frac{\text{Wet weight} - \text{dry weight}}{\text{Wet weight}} \times 100$$

A typical range of moisture content is 20 – 45% representing the extremes of wastes in an arid climate and in the wet season of a region having large precipitation. Values greater than 45% are however not uncommon. Moisture increases the weight of solid waste and therefore the cost of collection and transport. Consequently, waste should be insulated from rainfall or other extraneous water.

Moisture content is a critical determinant in the economic feasibility of incineration processes since energy (i.e. heat) must be supplied for evaporation of water and in raising the temperature of the water vapour. Moisture content is generally found to be high in wastes containing a higher proportion of food wastes.

3. Calorific Value

Calorific value of waste is defined as the amount of heat generated from combustion of a unit weight of the waste, expressed as kJ/kg. The calorific value is determined experimentally using a Bomb Calorimeter, in which the heat generated from the combustion of a dry sample is measured, at a constant temperature of 25°C. Since the test temperature is below the boiling point of water, the combustion water remains in the liquid state. However, during combustion the temperature of the combustion gases remains above 100°C so that the water resulting from combustion is in the vapour state.

4. Bio-Chemical Characteristics

Chemical characteristics of waste are essential in determining the efficacy of any treatment process.

- **Chemical characteristics:** pH, Nitrogen, Phosphorus and Potassium (N-P-K), total Carbon, C/N ratio, calorific value.
- **Bio-Chemical characteristics:** carbohydrates, proteins, natural fiber, and biodegradable factor.
- **Toxicity:** Toxicity profile of MSW includes heavy metals, Persistent Organic Pollutants (POPs), pesticides and insecticides. The Toxicity Characteristic Leaching Procedure (TCLP) is used for ascertaining the toxicity profile of MSW.

Bio-chemical characteristics of waste determine the suitability of specific treatment processes. ULBs should use this information to select the most appropriate treatment process

1.4.3 Step 3: Stakeholder Consultation For Planning

Figure 1.9: Step 3 in the MSWM Plan

1.4.3.1 Departments Involved In MSWM Planning (Internal Stakeholders)

The main responsibility for preparing a MSWM Plan lies with the ULB, specifically the solid waste management division. A core team/advisory team, also called the internal stakeholders, may be constituted for developing the MSWM Plan.

1.4.3.1.1 Plan Preparation – Core Team

Proactive involvement of internal and external stakeholders helps in developing an inclusive and strategic MSWM framework

The core team/internal stakeholder group consists of:

1. The Commissioner/Chief Executive of the ULB
2. Head of the SWM department
3. Environmental Engineer in the SWM department
4. Head of the Town Planning Department
5. Heads of the water supply, public health/sanitation and sewerage departments
6. Head of the accounts department
7. Ward level officials in the SWM department, including sanitary inspectors, technical officers and engineers

Specific responsibilities of each of these officials are given below:

- Commissioner/Chief Executive of ULB
  - Responsible and accountable for MSWM Plan preparation and implementation
- Head of the MSW management department in the ULB
  - Responsible for establishing the baseline and analyzing gaps in MSW management service provision.
  - Responsible for coordinating various departments and stakeholders to be involved in development of MSW management plan in the ULB.
  - Responsible for assessing options and suggesting viable alternatives to be ratified by the stakeholders
- Environmental engineer (if appointed by the ULB) and ward level officials of the solid waste management department:
  - Inform the planning process with field level consultations and information
- Head of Town Planning department
  - Responsible for identifying viable locations for establishing solid waste management facilities and ensuring appropriate land use controls
- Heads of water supply, public health/sanitation and sewerage departments
  - Explore potential cross-linkages and advise the MSW plan process

- Head of Accounts department
  - Advice on potential revenues, costs and implementing practices for appropriately recording SWM revenue and expenditure

Key persons to be consulted by core team before finalization of the draft plan

- Political head/Mayor/ chairman of ULB: Advising on the MSWM Plan process with local level concerns and ensuring that the plan equitably addresses local MSWM management issues
- Representatives of the solid waste management cell at the state level and CMA/DMA level to ensure that the planning process is in line with policies and strategies at the state. Their inclusion ensures the potential of exploring opportunities for regional level planning for MSW management service provision.
- District Magistrate/ Collector of the district in which the ULB is located: Responsible for allocation of land, ensuring implementation of regional level strategies and identifying synergies with other ULBs in the region
- Representative from State Pollution Control Board/Authority: Responsible for ensuring compliance with MSW (M&H) Rules and compliance with other related statutory provisions for establishing and operating MSW management facilities.
- Heads of concerned parastatal agencies related to urban service provision/city planning and land-use issues

1.4.3.1.2 Advisory Role

The municipal authority may also take advice from:

- Academicians and practicing professionals with solid waste management related expertise shall be involved.
- Where an environmental engineer is not hired by the ULB, an environmental engineer/ planner may be co-opted in an advisory role.

Stakeholder Consultations to be held at least twice while preparing the MWSM Plan

1.4.3.2 External Stakeholders

The first step for the local body is to define a methodology for reaching out to all stakeholders in an equitable manner, at various stages of the MSWM Planning process and implementation. Informing and involving the community, as well as creating channels for all stakeholders to participate in decision making are all very important steps for successful implementation of SWM strategies.

Typical stakeholders for a MSW management system include households, businesses, industries, informal sector, the local government, NGOs, community-based organizations (CBOs), Self- help groups (SHGS), women's groups, secondary school and college students or members of other institutions who may have a role to play in ensuring the involvement of the community.

Stakeholders are to be consulted at least twice during the process of MSWM Plan preparation, initially in defining the objectives and goals of the plan and later (Step 6) to discuss the proposed plan and seek their inputs and approval. The ULB may constitute a stakeholder committee for the purpose, with members representing all concerned groups. These groups would need to represent the interest of men, women, youth, marginalized/ vulnerable groups of people who are all part of the MSWM process. Specifically, the involvement of women's groups during the planning phase is essential.

The initial consultation process (Step 3) should identify the following:

- The ability and willingness of stakeholders to cooperate in the operation and management of the service
- The demand they have for the type and requirement of service and frequency
- Their attitude towards participating in experiments or pilot projects, particularly projects relating to source segregation, reuse, recycling of waste and final treatment & disposal
- Their willingness to work with different sections of society, such as rag pickers, municipal workers, and entrepreneurs
- Their willingness to pay for the services, the mode of payment, and the frequency of payment

1.4.3.3 Defining The Goals And Objectives Of The MSWM Plan

Once the framework at National, State and ULB level is defined and the stakeholders mapped, the next step will be for the ULB and the stakeholder group to define the goals and objectives of the MSW Plan.

A Municipal Solid Waste Management Plan (also known as Integrated Municipal Solid Waste Management Plan) is a ratified document that defines the goals and objectives of solid waste management, to be achieved over specific planning horizons and which gives details of specific actions that need to be implemented to meet these objectives.

1.4.4 Step 4: Preparation Of Draft MSWM Plan

STEP 1: POLICIES, PROGRAMMES & LEGAL FRAMEWORK

↓

STEP 2: ASSESSMENT OF CURRENT SITUATION AND GAP ANALYSIS

↓

STEP 3: STAKEHOLDER CONSULTATION FOR MSWM PLANNING

↓

STEP 4: PREPARATION OF DRAFT MSWM PLAN

- Future Projections
  - Population Forecast
  - Anticipated Lifestyle Changes
  - Change in Socio-economic Status
- Rules, Regulations & Municipal Bye-Laws
- Community Participation/IEC
- Institutional & Financial Structuring
- Storage, Collection (Door-to-Door & Street Sweeping), Transportation
- Identification of Land & Inclusion in City Master Plan/City Development Plan
- Selection of Process & Best Available Technology for Processing & Disposal

↓

STEP 5: SCHEDULE FOR IMPLEMENTATION

↓

STEP 6: STAKEHOLDER CONSULTATION FOR MSWM PLAN VALIDATION

↓

STEP 7: CITY COUNCIL APPROVAL FOR MSWM PLAN

Figure 1.10: Step 4: Preparation of Draft MSWM Plan

MSWM Plan should be integrated with local development plans, National policies and strategies. It is desirable to review the plan once every 2-3 years.

The MSWM Plan cannot be developed in isolation. It has to consider objectives of other planning processes in-force in the ULB. Objectives of the Master plan and the City Development Plan shall be considered. Linkages with City Sanitation Plans (where relevant) and NUSP shall also be ensured.

Depending on the existing relevant plans for the urban area and the size of the area that the SWM plan is prepared for, it is desirable to review the plan once every 2-3years, with the objective of continuous improvement towards meeting service delivery standards.

The plan may be developed by considering several factors such as future population and waste generation projections, applicable laws and policies, institutional & financial structuring, inclusive and equitable community involvement, technical considerations in collection &transportation, availability of land and best suited technologies for handling waste generated in the ULB, based on the ISWM hierarchy.

1.4.4.1 FUTURE PROJECTIONS

Estimating future waste generation quantities and composition is critical for developing a Municipal Solid Waste Management Plan. Planning horizons for solid waste processing/ treatment/disposal projects typically extend to 20-30 years, depending on the nature of the facility. Forecasting future solid waste generation is dependent on various factors. These include:

1) Future population forecasts
2) Anticipated lifestyle changes
3) Change in socio – economic profile of the ULB

Short-term plan: 5 years
Long-term plan: 20-25 years
Mid-term review: between 2nd and 3rd year

While preparing a municipal solid waste management plan, the following design periods (time-frame) have to be decided depending upon the necessity of the solid waste management plan:

(i) Short-term plan: 5 years

(ii) Long-term plan: 20-25 years

(iii) Mid-term review between 2nd and 3rd year

1.4.4.1.1 Forecasting Waste Generation

Future Waste Generation = Per capita waste generation * Projected population

1.4.4.1.2 Population Projection

Population projection is dependent on factors governing future growth and development in the considered jurisdiction. Growth in all development sectors should be considered. Special factors causing sudden immigration or influx of population should also be foreseen to the extent possible. Population growth can be estimated using multiple methods which are suited for cities of different sizes and stages of growth:

Arithmetic Increase Method: If there has been a constant increase in population (in absolute numbers) over the past few decades, then for the purpose of future projection, Arithmetic Increase Method could be used.

Population projection using the arithmetic increase method is calculated using the equation:

Pb = Pa+ (average decadal increase *t)

t = no. of years between year a (base year) and year b (projected year)

For example, following is the population of 1971 and 2011 in a city:

P 1971 = 5000

P 2011 = 7050

Arithmetic rate of growth:

$$P = P_1 + K_a (t - t_1)$$

$$Ka = \frac{P_2 - P_1}{t_2 - t_1}$$

P = population

t = time

K_a = arithmetic growth constant

Ka = (7050-5000) / (2011-1971) = 51.25

P = 5000 + (51.25) * (2021-1971) = 5000 + 2562.5 = 7562.5

P = 7050 + (51.25) * (2021-2011) = 7050 + 512.5 = 7562.5

In this method the increase of population per year/decade is calculated from past records and the average increase is added to the present population to find out population in next years/decade. This computation is suitable for historical, well settled and established cities.

Geometrical Increase Method: In this method the geometric mean of decadal averages considered to be the rate of growth. This method is used for new and growing cities; which may have irregular growth patterns.

Population projection using the geometrical increase method is calculated using the equation:

Population projection is calculated using the equation:

$P_b = P_a\ (1+r)t$;

P_b	is population of the year for which projection is to be made
P_a	is population of the base year
r	is the rate of growth divided by 100
t	is the number of years between 'a' and 'b'

Example: If present population (2011) of a city is 1000 with a growth rate of 1.8 percent, then project the population for the year 2021.

$P_{2021} = P_{2011} * (1 + 1.8/100)^{10}$

$= 1000 * 1.195$

$P_{2021} = 1195$

Determination of Decadal Population Growth Rate (Geometric): If the population growth rate is not available for a city, population growth trend has to be determined first. This could be done by comparing the population growth for last five decades. If the decadal increase in population (in absolute numbers) is not constant, then the growth rate has to be determined at first.

Determination of Decadal Population Growth Rate (Geometric): Example

For example, following is the population of five decades of a city

Year	Census Population	Growth rate
1971	5000	
1981	6095	2%
1991	7430	2%
2001	9146	2.1%
2011	11250	2%
2021	13590	

The growth rate has to be determined first by using the following formula:

r $= \{(P_{1981}/P_{1971})^{1/t} – 1\} * 100$

(here t = 10)

After finding out the average growth rate (in percent), future projection could be done using the growth rate in the geometric increase method, as described above.

1.4.4.2 Per-Capita Waste Generation

Per-capita waste generation rates are to be established for each city based on the procedure specified in section 1.4.2.3.

1.4.4.3 Rules, Regulations & Municipal Bye-Laws

The ULB shall consider all existing national & state rules and policies, identified in Step 1 and 2 of the planning process. Local bye-laws governing waste management, if any, shall also be considered. The framework for the plan shall be defined by these existing directives. The plan shall at a minimum seek to meet the objectives of all such policies and guidance. If applicable, due consideration shall be given to any legal directives on specific service provision, which may be time bound.

1.4.4.4 Planning For An Institutional Structure (To Bridge The Gaps)

For planning an efficient and advanced MSWM system, it is essential to have an efficient institutional structure besides having adequate infrastructure and equipment. MSW management is both a managerial problem and a technical issue.An effective institutional

It is of crucial importance to institutionalize a dedicated MSWM Department/ Cell/Staff within the ULB, having desired technical and managerial expertise

set-up capable of designing, implementing and monitoring the MSWM system needs to be established within the local authority. Currently, in many small and medium towns, sanitary inspectors look after SWM. Whereas in many of the cities, the health officer, usually a medical doctor by profession, heads the solid waste management department, who very often do not have adequate exposure to technical and logistic practices in solid waste management. It is therefore strongly recommended that the urban local bodies should have a SWM cell or SWM department having staff with technical and managerial skills.

The Supreme Court's Expert Committee on SWM has recommended hiring the following professionals in municipal services to scientifically manage municipal solid waste (Supreme Court appointed expert committee report 1999):

1.4.4.4.1 Towns below 1 Lakh Population

- One qualified sanitation diploma holder Chief Sanitary Inspector or as Sanitary Officer (S.O.) if the population is more than 50000.
- One qualified Sanitary Inspector (S.I.) @ 50000 population
- One qualified Sanitary Sub-Inspector (S.S.I) @ 25000 population
- One Sanitary Supervisor (S.S.) @ 12,500 population

1.4.4.4.2 Cities between 1 and 2.5 lakh population

- Qualified Sanitation Diploma holder/Chief Sanitary Inspector or Sanitation Officer @ one S.O. per l lakh population or part thereof to look-after the collection, transportation, processing and disposal of waste or @ 1 per 2 sanitary inspectors, whichever is less.
- Qualified Sanitation Diploma holder Sanitary Inspector (S.I.) @ one S.I. per 50,000 population or part thereof or @ 1 per 80 sweepers, whichever is less.
- Qualified sanitation diploma holder Sanitary Sub-inspector (S.S.I.) @ one S.S.I. per 25,000 population or part thereof or @ l per 40 sweepers, whichever is less.
- Sanitary Supervisors (a person who can read, write and report) @ one S. S. per 12,500 population or part thereof, or 1 per 20 sweepers, whichever is less.

1.4.4.4.3 Cities having population between 2.5 and 5 lakhs

- Public Health/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering in the Grade of Assistant Executive Engineer to be in charge of SWM department.
- Public Health/Environmental Engineer in the grade of Assistant Engineer to look after the transportation, processing and disposal of waste.
- CSI or Sanitary Officers @ one S.O. per l lakh population for supervising the storage, street sweeping and primary collection of waste.
- Sanitary Inspectors, Sanitary Sub-inspectors, Sanitary Supervisors should be as per the yardstick indicated in 1.4.4.4.2 above.

1.4.4.4.4 Cities having population between 5 and 20 lakhs

- Public Health/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering of the level of Executive Engineer to be in-charge of the SWM department.
- Public Health/Environmental Engineers/or Civil Engineer having training in environmental or public health engineering of the level of Assistant Executive Engineer per 5 lakhs population.
- Public Health/Environmental Engineers/or Civil Engineer having training in environmental or public health engineering of the level of Assistant Engineer per 2.5 lakhs population.
- CSI/Sanitary Officers, Sanitary Inspectors, Sanitary Sub-inspectors and Sanitary Supervisors as per yardstick indicated in 1.4.4.4.2 above.

1.4.4.4.5 Cities having population between 20 and 50 lakhs

- Public Health Engineer/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering of the level of Superintending Engineer to be the Head of SWM Department.
- Public Health/Environmental Engineers/or Civil Engineer having training in environmental or public health engineering of the level of Executive Engineer @ one Ex. Eng. per 20 lakhs population or part thereof.
- Rest of the supervisors and staff as per the yardstick already indicated in 1.4.4.4.2 to 1.4.4.4.4 above.

1.4.4.4.6 Cities above 50 lakhs population

- Public Health Engineer/Environmental Engineer/or Civil Engineer having training in environmental or public health engineering of the level of Chief Engineer to be in charge of the SWM department.
- Superintending Engineer per 40 lakh population or part thereof.
- Rest of the officers, supervisor's etc. as per yardsticks already indicated in 1.4.4.4.2 to 1.4.4.4.5 above.

Note: In cities where health officers are looking after SWM or part thereof, in addition to their principal function of taking preventive health measures, they may be gradually made free from this responsibility and replaced by environmental or public health engineers.

Health & SWM Wings Differentiated in Andhra Pradesh

The Government of Andhra Pradesh, in order to focus on achieving the objectives of the MSW (M&H) Rules, 2000, has initiated several programmes and initiatives. Strengthening capacity within ULBs to plan for and execute all actions along the SWM chain has been given priority. The Commissioner & Director of Municipal Administration has issued orders in June, 2013 to all District Collectors and Municipal Commissioners to create two separate wings in the ULBs and clearly demarcate the roles of health and SWM functionaries. Further, ULBs have been asked to stop outsourcing activities of the SWM and Health departments, as these departments are now differentiated and are being staffed appropriately. Over 150 environmental engineer posts in various cadres have been sanctioned till 2013, to manage the SWM wing.

The list of different roles allocated to each of these wings may be found in Annexure 2.

Capacity building of staff is essential for enhancing their skills to provide and monitor SWM service provision.

There is an urgent need to train and enhance the capacities of staff involved in solid waste management activities. Professionalizing the solid waste sector will not only build the capacities of workers to perform more effectively and efficiently in the existing conditions, but will also inculcate a sense of responsibility and pride towards their profession. Provision of hygienic and safe working conditions for workers and encouraging the use of Personal Protective Equipment (PPE) should also be a part of this effort. The positive impact of such actions on the well-being of all workers and specifically women involved in solid waste management services is undeniable. These efforts will also lead to an improvement in service delivery and hence better management of activities.

Training and capacity building activities that could be organized for solid waste staff include:

- Special training for unqualified staff and sanitation workers.
- Training for supervisors and senior officers: All officers and supervisors must be trained in skills required for an effective and efficient SWM sector including for instructing the sanitation workers. Best practices adopted by different cities within the state, the country and internationally should be made known to senior staff.
- Refresher courses for supervisory staff: Refresher courses should be conducted for officers and supervisors at least once in every five years.
- Professional growth opportunities: Adequate professional growth opportunities should be built into the SWM hierarchy to encourage supervisory staff members to remain in the department to avoid attrition.

1.4.4.5 FINANCIAL IMPLEMENTATION STRUCTURE

1.4.4.5.1 Assessment of overall costs (full cost assessment)[17,18]

The planning for an advanced MSWM system should be based on accurate financial calculations taking into consideration all relevant costs (see below) including hidden costs and most likely revenues to be realized. This important task within the planning process is to ensure financial viability of the MSWM system and its sustainability in a long run.

Municipal authorities need to be aware of the full costs and returns of the proposed MSWM system

ULBs generally fund their solid waste management activities through a combination of government grants and internal revenues from property tax and non-tax revenues; some ULBs finance projects through PPP arrangements. Very few ULBs resort to taking loans for SWM services. Revenues from SWM service provision and expenditure on various components of MSW management are usually not properly accounted for. Segregated financial information pertaining to MSW management service is required to assess the financial viability of service provision.

Full Cost Accounting (FCA) (as shown in figure 1.11) provides a framework for identifying and evaluating all costs associated with the integrated waste management options

16 EPA, (1997), "Full Cost Accounting for Municipal Solid Waste Management: A Handbook"; available at http://www.epa.gov/waste/conserve/tools/fca/docs/fca-hanb.pdf

17 DEHNR, (1997), "Analysis of the Full Costs of Solid Waste Management for North Carolina Local Governments"; available at http://infohouse.p2ric.org/ref/ 01/00369.pdf

MSWM services are traditionally financed through a combination of government grants and revenues

as required above. FCA can be defined as a systematic approach for identifying and determining the full cost of solid waste management system at local level over a period of time.

The major types of costs that are considered for full cost accounting of solid waste management typically imply:

- **Up-front costs** that include the pre-operative investments and expenses necessary to implement MSW services
- **Capital Costs** include one-time fixed cost for setting a typical MSW facility
- **Operating costs** which include daily expenses of managing MSW
- **Back-end costs** comprise of the expenditure required to wrap up operations and maintenance of MSW facilities at the end of their useful lives
- **Contingent costs** which include costs that might or might not be incurred at some point in future. Examples include remediating future releases of pollutants
- **Environmental costs** are the implications on the environment that might occur due to MSW transportation, treatment and disposal activities

Full Cost Accounting reflects the real costs of the MSWM system:

- Up-front costs
- Operating Costs
- Contingent Costs
- Back-end costs
- Environmental Costs &
- Social Costs

Up-Front Costs • Land acquisition • Permits • Building construction • IEC* Activities	**Operating Costs** • Capital cost • Debt service cost • Operation and maintenance costs involved in daily activities • IEC* Activities	**Contingent Costs** • Remediation costs • Liability costs (e.g property damage, personal injury)
Back –End Costs • Site closure • Building/ equipment decommissioning • Retirement/health benefits for current employees	**Environmental Costs** • Costs involved in mitigating adverse effect on environment (costs for implementing EMP*) • Downstream impacts	**Social Costs** • Quality of life • Aesthetic impacts • Community image • Effects on property values

** EMP: Environment Management Plan; IEC: Information & Education Campaign*

Figure 1.11: Elements of Full Cost Accounting

These categories together cover the "life cycle" of MSW activities from the "cradle (up-front costs)" to "grave (back-end costs)". Full cost accounting provides accurate and complete information on the real costs of managing solid waste. It tends to uncover hidden and overlooked costs and allocates all costs to the specific activity. This helps decision-makers to compare present and proposed services accurately, predict future costs reliably and evaluate privatization options thoroughly.

Social costs are costs incurred to mitigate adverse impacts on health and well-being of local community, on account of improper Solid Waste Management. In India, such impacts are generally not compensated. Impacts of MSW storage depots, as well as MSW treatment and disposal facilities on the health, quality of life and value of property in the neighbourhood are considered. An assessment and consideration of these impacts is required before selecting waste management options, even though they are not easily quantifiable.

Other advantages of full cost accounting include:

- Urban local bodies can use FCA as a planning tool for preparing budgets and determining future direction
- FCA helps the ULBs to examine various financial scenarios and their resulting impacts in the future
- FCA could also be used while analyzing costs over a long term horizon
- Full cost results can also be used for maintaining transparency between the ULBs and the general public. Full cost results can be presented to the public through the newspaper and other methods of communication. However, FCA does not address non-monetary costs and benefits like social costs and public expectations. Results from FCA should be considered in conjunction with non-monetary costs to help ULBs to make better informed solid waste management decisions.

The following section provides schemes on how to calculate and document the total costs of a standalone fully compliant Municipal Solid Waste Management System.

Up-Front Costs: Front end costs include pre-operative activities that are required before implementing any MSWM system. This could include costs towards investigation e.g., topographical surveys, geotechnical, geological, hydro geological, Environment Impact Assessment etc., table 1.6 gives an overview of front end costs involved in a typical MSWMS.

Table 1.6: Indicative Front End Costs in a Typical MSWMS

Sl. No	Description	Nos.	Unit Rate	Amount
1	Obtaining permit for land			
2	Topographical Survey			
3	Geotechnical investigation			
4	Geological investigations			
5	Hydrogeological investigations			
6	Waste Characterization			
7	Waste Quantification			
8	Detailed designs			
9	Environmental impact assessment			
10.	Others			

Capital Costs

Capital costs are one-time fixed costs associated with a project which may include the price of purchased assets such as land, vehicles, equipment, or other supplies. The capital costs involved in MSW Management system can be further divided based on activities and will include:

- **Collection and Transportation:** Purchase of collection tools, storage bins, transportation vehicles, construction of transfer stations. An indicative format for assessing capital costs for collection and transportation is given in table 1.7.
- **Processing and Disposal:** Cost of land, buildings, plant machinery, process equipment, material handling equipment, pollution control equipment like electrostatic precipitators, bag filters and other dust control equipment, transport vehicles, material recovery facilities, construction of sanitary landfill, laboratory facilities, rain water drainage management, electrical equipment, backup of power, green belt etc. An indicative format for assessing capital costs for processing and disposal is given in table 1.8.

Table 1.7: Indicative Format for Assessing Capital Costs for Collection and Transportation System

S. No	Description	DTD	SS & DC	SC & T	CM	Total (A)	15% contingency (B)	Unit Rate (INR) (A+B)	Amount
1	Pushcart Bins (6 per pushcart)								
2	Push carts								
3	Tri Cycle								
4	Tricycle Bins (8 per Tricycle)								
5	Auto Tipper (1cu.m)								
6	Metal Tray, metal plate								
7	Tipper Trucks								
8	1.0 Cum container with strips strips(Dumper bins)								
9	3.0 Cum Skips (Dumper bins)								
10	4.5 Cum Skips (Dumper bins)								
11	Dumper Placers								
12	Refuse Compactors 16								
13	Drain Cleaning / Jetting machine								
14	Mechanized Sweeper Trucks large /small								
15	Others								

(DTD: Door to Door, SS&DC: Street Sweeping & Drain Cleaning, SC&T: Street Collection & Transportation, CM: Cleaning of Markets)

Table 1.8: Indicative Format for Assessing Capital Costs for Establishing Processing and Disposal Systems for MSW

S. No.	Description	Nos.	Unit Rate	Amount
1	Land			
2	Buildings			
3	Process equipment (trommel, sieves, separators)			

S. No.	Description	Nos.	Unit Rate	Amount
4	Material Handling- conveyors, loaders, elevators			
5	Pollution control equipment			
6	Transport – Tippers, tractors			
7	Material recovery facility			
8	Sanitary landfill			
9	Rain water management – drains, ponds			
10	DG set, Transformer yard, cables			
11	Weigh bridge			
12	Security			
13	Office/MIS/Lab			
14	Others			

Operation & Maintenance Cost: Operations and Maintenance cost is an ongoing cost and shall include all costs incurred in the course of operation of the facility on a daily basis. It shall include labour& salaries, administrative and management cost, maintenance of vehicles and equipment, fuel/tires etc. Table 1.9 gives an overview of estimated cost and maintenance cost incurred in managing MSWM.

Table 1.9: Indicative Format for Assessing Operation and Maintenance Cost of MSWM System

S. No	Description	Quantity	Unit Rate (Rs)	Total Amount (Rs)
I	Collection and Transportation Vehicles& Equipment			
	All equipment (metal tray, brooms, Personal protective equipment etc.)			
	Fuel			
	Vehicle Maintenance Cost @ (%) of Vehicle Cost			
	Cost of spares, tyres etc.			
	Others			
II	Salaries of Municipal Workers for Collection and Transportation			
	Supervisor			
	Sweepers/Loaders/Sanitary Workers			
	Driver			
	Others			

S. No	Description	Quantity	Unit Rate (Rs)	Total Amount (Rs)
III	Salaries for Workers for Processing and Disposal Facility			
	Plant in Charge			
	Plant Supervisors			
	Fitters			
	Electrician			
	Vehicle Maintenance-in- Charge			
	Stores-in-Charge			
	Landfill-in-Charge			
	Weighbridge Operator			
	Office-in-Charge			
	Yard Operation-in-Charge			
	Others			
IV	Salaries for Laboratory Staff			
	Quality and Assurance Chemist			
	Other lab staff			
	Others			
V	Personal Protection Equipment			
	Face Mask			
	Gum Boot			
	Hand Gloves			
	Uniform			
	Others			

Some of the other costs that need to be considered are:

- **Working capital costs:** Comprising interest on at least two months receivables. This would include revenue from tipping fee, electricity sale, compost sale and any other product sold. In addition at least two months operation and maintenance costs have to be built in.
- **Finance costs:** Comprising depreciation, interest on debt, income taxes, sinking fund for refurbishment, insurances, bank guarantees, and post closure monitoring etc.

Financial viability of the MSWM Plan can be ensured through consideration of several cost recovery mechanisms: user fees, sale of end products, municipal funds and grants from state and Central Governments, loans and funding from private sector through PPPs

1.4.4.5.2 Financial Viability of MSWM System

Municipal Solid Waste Management being an essential mandatory service should be planned in a manner that meets all statutory requirements. The level of sophistication could vary depending on the financial capability of the municipal authority. Sustainable design and implementation of systems should be ensured. MSWM projects should be made viable by ensuring cost recovery through levy of user fees from the beneficiaries, prescribing appropriate fees / tipping fees for the services rendered, sale of end products from the processing of waste, allocation of funds from municipal internal resources and government grants, viability gap funding from the government, if any and introducing public private partnerships for efficiency and attracting private sector investments.

It is to be clearly understood that MSW management services are sustainable only if they are financially viable on a stand-alone basis. Therefore, the assessment of the financial viability is an important step in planning a MSWM system. The deficit in funding planned services, if any, should be estimated. Table 1.10 gives you a format for assessing deficits over a time period.

Variable User charges may be charged based on the quantity of waste generated and the level of service provision

Table 1.10: Format for Assessing Financial Deficits for Provision of MSW Management Services

S. No	Description	Year 01 (Rs)	Year 02 (Rs)	Year 03	Year....	Year 20 (Rs)
1	Cost					
2	Revenue					
	Deficits (Total Cost) 1-2					

1.4.4.5.3 Identification of Sources for Finance[19,20]

To enhance the tax base cross subsidization and higher charges for commercial, bulk generators etc., should be considered. Moderate rate, least exemptions and wider coverage of all classes of tax payers will fetch higher revenues.

The extent of service provision by the ULBs is determined largely by the availability and allocation of finances to different services and functions. ULBs are empowered to derive their income from several sources such as taxes, fines, penalties and remunerative enterprises. Apart from the above mentioned sources, local bodies also depend upon grants and loans to meet their financial needs.

The traditional sources of financing solid waste management activities include:

- Local taxes such as the property tax, water tax, conservancy tax, development fee
- User charges
- Rents from properties, license fees , and other non-tax revenues
- Grants from State and Central Government (JnNURM grants, UIDSSMT grants, State Finance Commission Grants)
- Loans from Capital Market, Government/ Financial Institutions (HUDCO/NABARD)

[18] GIZ and TERI, 2011 “Environmental Fiscal Reforms in India: Where and How?”

[19] GIZ “Economic Instruments in the Waste Management Sector”. Available at:http://www.giz.de/de/downloads/gtz2010-en-foes-economic-instruments-waste-management.pdf

- Loans from International agencies like the World Bank, ADB , JBIC, KfW
- Public Private Partnerships
- Municipal Bonds/Debentures
- Revenue from sale of products from waste processing plants (if owned by the ULB)
- Tipping fees from the private operator

(a) Local Tax- Property Taxes

Property tax is the single largest internal source of revenue to the ULBs, contributing as much as 25 to 30% to the total revenue of the local bodies. Government grants are another major source of revenue, mainly utilized for paying wages to employees and for undertaking specific projects. Most of the ULBs use a sizable part of the property tax to support SWM activities. However, since the assessment and collection of property tax is poor, ULBs are unable to allocate adequate funds for SWM services. Further, the lump-sum approach of the property tax does not impose any incentive for at-source waste minimization as discussed in section 2.1 of Part II of the manual.

(b) User Charges

Following basic principles may be considered by local bodies for levying user/service fee for Solid Waste Management services.

- Polluter Pays Principle: Those responsible for waste generation should pay for its collection and safe disposal.
- Proportionality: The user fees should be in proportion to the quantity of waste generated and level of service provided to waste generators. Households generate much less waste compared to commercial, institutional and industrial establishments and among the households; the poor generate less waste as compared to rich. Therefore variable rates may be prescribed for different categories of waste generators keeping in view their waste generation potential. At least 3 categories of service charge may be prescribed for:

i. Households

ii. Commercial/ Institutional/Industrial waste generators

iii. Bulk waste generator such as Hotels/Function Halls/Restaurants, Large Commercial/ Institutional / Industrial establishment etc.

- Capacity to pay: Affordability of the tax payer may be kept in view while fixing user charges. A fair service charge tariff will facilitate better compliance. Moderate rate, least exemptions and wider coverage of all classes of tax payers will fetch higher

Efficient administration of service fee depends on 3A's:
- Accountability
- Acceptability
- Affordability

revenues.

Following criteria may be considered for enhancing the tax base in an ULB:

i. Subsidy for the poor: The element of cross subsidization may be introduced to give relief to the poor and disadvantaged, to ensure that they are not deprived of basic services.

ii. Higher rates from non-residential establishments: Higher rates may be prescribed for commercial, institutional and industrial establishments & bulk waste generators as they produce substantially more wastes than households and usually have a better capacity to pay.

iii. Willingness to Pay: People are usually willing to pay for a good service. However it is desirable to ascertain their willingness to pay for different levels of services. Citizens may prefer a higher level of service and be willing to pay more for the same. This consultation will promote better compliance.

iv. From an assessment of the current scenario of SWM service fees levied in the local bodies, it does not seem practical to immediately introduce higher rates of service fees that may be required to make SWM services self-sustaining. User fees may be increased gradually, synchronous with the provision of MSW management services. Efforts should be made to reach the level of full sustainability over a period of 5 years. The service fee structure may be so devised that in commensurate with the level of service provided and may be increased gradually with improved level of services; increasing the level of acceptability among citizens and ensuring their compliance. As an immediate action, SWM service fees may be increased by the local bodies to cover the O&M cost over a period of 3 years. Within the same ULB, where the level of service differs in different wards/areas, differential rates may be charged in different areas in accordance with the level of service. Uniform rates may be applied when under-served areas are also provided full and adequate services. However, services to the poor may continue to be subsidized, even when full service levels are achieved in such areas.

Measures to Minimize the Burden of Service Charges Making Solid Waste Management Effective and Affordable

i. Street sweeping and its disposal to be charged to general taxes: Costs for provision of basic solid waste management services, viz. general street cleaning, drainage cleaning and cleaning of public spaces etc., can be met through general taxes which are typically used to finance public services.

ii. Municipal Authority should introduce 100% door-to-door collection. Door-to-door collection, transportation, processing and disposal of waste may be completely entrusted to the private sector to ensure efficiency and economize expenditure of the ULB. User fees may be levied to cover full O&M cost of collection and transportation and part of the cost of treatment & disposal of waste. Processing facilities may be created on a PPP basis to keep costs under control. Smaller municipalities should go in for simple contracts which can be financed and managed by the ULB.

Steps for determining SWM service fee

While determining SWM service fee, the capital, O&M, institutional, political and social arrangements should be considered

Determining SWM fee involves several considerations such as (1) Capital and O&M cost of services, (2) Number and type of waste generators, (3) Level of service to be provided, (4) Willingness and ability to pay for the service, (5) Levels of targeted subsidy, (6) Required establishment cost of the institutional arrangement for service delivery and cost recovery etc. Evidence of the rationale used for defining SWM fees could be a key factor in securing political commitment to regulate and enforce user fee collection.

Following steps may be taken by local bodies to determine service fee structure.

1. Understand tariff/fee base
2. Set norms of tariff fixation
3. Communication with consumers
4. Set method of collection of SWM service fees

Step 1: Understand Tariff/Fee Base: First step of tariff setting is to understand the target for base of SWM tariffs. Local bodies need to understand the number and type of waste generators to estimate volumes and types of waste generated, SWM expenditure and identify service options; these considerations will form the basis for determining the tariff rate.

Following analysis is required to estimate service levels and costs of service provision which are required for determining tariffs for different levels of customers.

a) Classify waste generators into different categories and determine their numbers:

Classify waste generators into different categories such as households, commercial &

institutional establishments and determine their numbers. This will help the ULBs in understanding the number and type of waste generators to be served and the frequency of service required. Following information may therefore be gathered from each of the waste generator groups:

- Household Consumers
  - Current number of households in each settlement area such as ward
  - Status of collection service in different types of settlements such as door to door collection or community bin collection or none
  - Frequency of collection
  - Level of service desired by the households, willingness of the households to practise the 3R principle, and segregate the waste at source, do home composting etc.
  - Willingness to pay and ability to pay
- Commercial and Institutional Establishments
  - Number of shops/establishments
  - Number of institutions (offices, schools/colleges, temples)
  - Hospitals, hotels, restaurants & guesthouses, etc.
  - Number of industries (manufacturing industries)
  - Status of collection service such as door to door collection or community bin collection or none
  - Frequency of collection
  - Level of service desired
  - Willingness to practise 3Rs and segregate the waste at source
  - Willingness to pay and ability to pay

This data may be analyzed and classified into different groups such as:

(1) Poor and non-poor households,

(2) Small & medium shops and establishments (less than 200/500/1000 sq.ft. in area)

(3) Large commercial establishments above 1000 sq.ft.

(4) Bulk waste generators

(b) Estimates of waste generation:

It is essential to have a fair estimate of the amount of waste generated in the city / town that will help in estimating the manpower, vehicles and equipment required for primary collection, transportation, treatment and disposal of waste. Following information should be collected to estimate waste generation:

- **Households:** domestic waste generated per capita per day by different households in the city and its composition (organic and inorganic waste); generally higher income HHs generate more non-biodegradable and recyclable waste, such as packaging materials, glass, metal etc.
- **Non-residential premises:** waste generated by shops, offices, workshops, hotels, and restaurants etc.; non-hazardous health care and industrial waste generated in the city on a day to day basis; waste generated by vegetable, fruit, meat and fish markets physical composition of waste generated.
- **Bulk waste generators:** estimated waste generation from public places; waste collected from street cleaning and drainage cleaning activities each day; refuse collected from parks, gardens and other public place; waste collected from unauthorized disposal sites in the city

This data will give an indication of waste generated by different categories of waste generators which will eventually help in scientifically determining the variable rates for different categories as mentioned above. It will also give an indication of the actual cost incurred by the local body in providing services. The scientific method for estimating waste generation rates in a city is given in section 1.4.2.3 of this chapter.

(c) Estimates of the cost

An analysis of costs for provision of various levels of service is necessary to determine the fee structure. Cost components for SWM services need to be categorized as below:

- Collection
  - Types of collection vehicles & technology used
  - Manpower required for providing collection service
  - Capital cost of storage bins, collection vehicles
  - Cost calculation - fuel, labour, materials, safety measures, maintenance, PPE, depreciation cost

  - Cost per Metric Ton of waste collected/day
  - Overhead
- Transportation
  - Transportation cost from door-to-door collection site to the treatment / disposal site or transportation from community bins / transfer stations to treatment/ disposal site.
  - Cost of transportation vehicles and equipment required
  - Cost of transfer station
  - Cost of fuel, labour, maintenance, safety measures, PPE, depreciation cost
  - Cost per MT of waste transported
  - Overhead
- Processing
  - Type of processing technology adopted
  - Cost of construction of processing facility
  - Cost of Operation & maintenance of the processing facility
  - If PPP mode is adopted, residual financial burden on the ULBs, including tipping fee
  - Cost per MT of waste treated
  - Overhead
- Disposal
  - Land cost/ lease cost
  - Sanitary landfill construction cost
  - Vehicles and equipment cost
  - Environmental protection costs in affected areas.
  - SLF operation & maintenance cost
  - Labour, fuel, amenities cost
  - Closure, monitoring & rehabilitation costs, capital and recurring cost of per MT waste disposal
  - Overheads
- Administrative overheads

- Day to day office/staff expenditure
- Billing and revenue collection charges
- Public awareness
- Information system and data collection (MIS)
- Overheads

(d) Determine service options

The service levels selected to cater to user's requirements e.g. types of tools, equipment, vehicles to be used, and frequency of service to be provided etc. will determine the cost of service. ULBs need to decide on the level of service it desires to provide by keeping in mind the cost of services and its capability to recover the cost. Service levels need to be determined prior to fixing service fee. Followings are the options for the ULB:-

- Consumers
  - Residential consumers in Urban Areas: Door to door primary collection of MSW from households on a daily basis may be considered necessary.
  - Non-residential consumers:
    a. Door-to door collection from commercial establishments and offices or kerbside collection on a daily basis may be considered as an adequate service level.
    b. For bulk waste generators such as hotels, restaurant and large complexes, waste collection service can be given on a demand basis. The service levels may be determined contractually keeping in view the amount and type of waste generated.
    c. For vegetable & fruit market waste and construction waste generating site, the ULB should provide waste storage containers and transport them on a regular basis as per contractual terms.
- Public Places
  - The ULB is required to clean all public places, roads, in residential and commercial areas, which includes street sweeping, cleaning of public spaces and surface drains.

- Special services of cleaning could be provided on chargeable basis during or after special events in public places.

Step: 2 Norms of fee fixation

Key considerations for prescribing a fee structure for provision of SWM services:

- Surveys have indicated that urban poor generate about 100 gm/capita, whereas the rest generate above 200 gm /capita/day. This justifies the variable charges for the different strata of society. Urban poor maybe charged 50% lower fees than other income groups on the basis of equity i.e. less quantity of waste generated and their lower capacity to pay.

Criteria for Giving Subsidy to Urban Poor

Identification of urban poor is essential to enable access to urban services at a subsidized rate. The followings process may be followed by the ULBs for identifying poor and vulnerable sections of the community in order to administer lower SWM charges.

The economic status of families may be determined based on the type and size of dwelling units/localities and level of basic service provided to them. As a thumb rule, people living in slums and informal settlements, devoid of basic services may be considered to be eligible to pay lower rates of service fee. Besides slum dwellers, residents in dwelling units smaller than 25 m^2 could also be given the benefit.

The commercial, institutional and industrial establishments generate larger quantities of waste. The rate could be kept higher for large commercial establishments and bulk waste generators, keeping in view the large quantity and volume of waste generated by them.

A minimum of 50% of door-to-door collection costs (including O&M costs) should be recovered from households initially and 100% in case of non-residential premises.

ULBs may charge higher rates in areas with higher levels of service and should aim at achieving 100% cost recovery within 3 years. In-case of institutional, commercial and industrial buildings, 100% O&M cost recovery may be made from the very beginning.

Rationale for Determining Tariff for Door to Door Collection Service

- 100% O&M cost recovery - institutional, commercial and industrial waste
- 50% O&M cost in beginning and 100% in 3 years – general households
- 25% O&M cost in beginning and 50% in 3 years – poor households

Norms for Tariff Determination for Door to Door Collection

- Tariff for non-residential premises based on the size of the premises. e.g.:
  - Upto 1000 ft^2 (small tenements): Rs. A
  - 1000 – 2000 ft^2 : Rs. A x 2
  - 2000 – 4000 ft^2: Rs. A x 3
  - More than 4000 ft^2 : Rs. A x 4
- Bulk waste generators/vegetable, fruit & meat/fish markets: Fees fixed on the basis of volume and quantity of waste generated per day; fees should recover 100% of the O&M cost and should consider number of units served (in case of markets)
- No fee may be collected for cleaning and collecting waste from public places. Revenue from the general tax may be used to cover these costs.

Step: 3 Communication with Consumers

To gain popular acceptance of solid waste management service fee by the users, it is important that the process of determining the fee is transparent and communicated to all stakeholders. The local body may organize public consultation to have citizen's views on the proposed service fee structure and levy of lower rates from the poor. This will facilitate better acceptance and payment of user fees.

Step 4: Mechanisms for Recovery of Solid Waste Management User Charges

Use of Fiscal Instruments: Presently, the use of economic instruments for recovery of solid waste management costs in India is not well established, although some instruments are used to a limited extent. However, the use of environmental fiscal reforms through appropriate economic instruments for financing MSWM can fill some of the gaps that have been identified by the ULBs. Some of the possible methods for recovering MSWM charges are tabulated below in Table 1.11.

Table 1.11: Mechanisms for recovery of MSWM user charges[21]

Mechanism	Administrative Costs: Tax and data collection, monitoring, identification of user charges	Social Effects: Vertical and Horizontal equity; linkages with ability to pay	Environmental Effects: linkages to waste generation and incentive to reduce waste	Revenue Generation and Potential Cost Recovery	Political and Public Acceptance
• Levy of SWM tax along with property taxes, determined on the basis of the unit Area Based System (ABS) (household or commercial establishments)	• Shift to area based system will result in simple and transparent tax administration system, making monitoring easier and will result in clear identification of small and large waste generators and their categories. • It will facilitate collection of SWM charges along with annual property tax, thereby minimizing cost of tax recovery.	• Provides for vertical equity as poorer households and small establishments will tend to pay less for waste services. Very poor households can be further subsidized to enable them to pay. • Can be horizontally equitable if amount paid is linked to the service levels and the quantity of waste generated.	• Can provide incentives to reduce waste if solid waste tax is differentially fixed for varying waste generation rates; bulk waste generators paying higher charges than smaller generators.	• It may be difficult to revise the solid waste tax annually to cover increasing costs, as the revision of property tax is carried out only once in 5 years or infrequently • Will depend on the existing collection efficiency of property tax which is very low, but is expected to increase with the shift to unit area based system of property taxation	• Unit area based system is already accepted and currently in place in many states • Any increase in SWM tax rates will need to be justified and will require political support for implementation

21 GIZ & T E R I, (2011), "Environmental Fiscal Reforms in India: Where and How?" New Delhi: The Energy and Resources Institute. pp 43-64.

Mechanism	Administrative Costs: Tax and data collection, monitoring, identification of user charges	Social Effects: Vertical and Horizontal equity; linkages with ability to pay	Environmental Effects: linkages to waste generation and incentive to reduce waste	Revenue Generation and Potential Cost Recovery	Political and Public Acceptance
Levy of separate solid waste user charges and using direct collection or "pay as you throw systems"	This will add to the cost of tax administration as a separate arrangement will have to be made for collection of user fee. If the responsibility of collection of user fees is passed on to the PPP partner, the municipal administration cost may reduce but actual cost may not reduce as collection cost may be added by the contractors in their tipping fees. Besides, the concessionaires, not having legal powers may not be in a position to collect from defaulters and this will necessitate enforcement measures by the local authorities to recover dues from defaulters "Pay-per-bag" systems may provide incentives to minimize waste generation or littering. This system can be implemented with adequate checks and balances. Measuring waste may be a problem.	Can be vertically and horizontally equitable if amount paid is linked to the unit areas based service levels and the quantity of waste generated Can be vertically equitable if charges levied vary with socio-economic status: reduced rates for poor households and higher rates for rest	Provides incentives for waste reduction and supports the proportionality principle (the more you generate, the more you pay).	Collection efficiency will be important in determining the cost recovery Administrative costs for direct collection need to be determined Flat-rate charges and variable-rate charges generate less variability in revenue If based on service level or on quantity of waste delivered , it may encourage illegal dumping, since people may not want to pay higher charges	Need political support in introducing user fees in addition to property tax. The user fee structure needs to be designed scientifically and increasing the charges from year to year could be difficult

Mechanism	Administrative Costs: Tax and data collection, monitoring, identification of user charges	Social Effects: Vertical and Horizontal equity; linkages with ability to pay	Environmental Effects: linkages to waste generation and incentive to reduce waste	Revenue Generation and Potential Cost Recovery	Political and Public Acceptance
Levy of user charge linked to utility (water/electricity) bill	This can be an efficient and cost effective system in recovery of user charges as defaulters will have a fear of disconnection of utility service in case of failure to pay. Administration cost will also go down substantially as user fees will get collected monthly or bi- monthly along with utility charges. This will also result in maintaining a cash flow to ensure timely payment to the service provider. Willingness of concessionaire is necessary to undertake this responsibility on payment of a small fee, administration cost of ULB will thus be very low Some cost may be incurred in the transfer of funds from the ULB to the concessionaire	Will be horizontally and vertically equitable	Provides no incentives for waste reduction but does have inbuilt equity	Collection efficiency of user fees will increase substantially and help ULBs in paying the concessionaire on time and make PPP service sustainable	Linking of the MSWM charge to the already existing utility billing system will require negotiations with utility company Political and public acceptance may be a problem

(c) Grants from Central or State government

It has been widely recognized that the urban local bodies are unable to meet the expenditure for their activities solely by internal resources. Hence, ULBs require substantial financial support from the Central and State Government in the form of grants and funds. Some of the grants and funds available to ULBs presently are:

- The 13th Finance Commission Grant
- JnNURM-UIG grants
- JnNURM-UIDSSMT grants
- State Finance Commission Grants

(d) Subsidies

The Ministry of New and Renewable Energy (MNRE) has been promoting waste to energy projects – refuse derived fuel, biomethanation, biogas, and gasification by providing financial incentives to proponents. The incentives are given to both private as well as public sector entrepreneurs and investors. The subsidy has been in the range of Rs.15 million to Rs.30 million per MW. For commercial projects, financial assistance is provided by way of interest subsidy in order to reduce the rate of interest to 7.5% capitalized with an annual discount rate of 12%. The assistance/subsidy is routed through financial institutions.

- Financial assistance up to 50% of capital cost of the project limited to Rs. 3.00 crore per MW is provided to the project proponent for demonstration projects
- In addition to the above, financial incentive at the rate of Rs. 15.00 lakh per MW is given to Municipal Corporations/ Urban Local Bodies, for supplying the garbage free of cost at the project site and providing land on a long-term lease, viz. 30 years and above, at a nominal rent.
- State Nodal Agencies are given an incentive @ Rs.5.00 lakh per MW of power for promotion, co-ordination and monitoring of projects.
- There is also a provision for financing 50% of the cost of preparation of Detailed Project Reports (DPR) or Techno-economic Feasibility Reports, subject to a maximum of Rs.2.00 lakh per report to the project proponent.

The Ministry of Environment and Forests and the Ministry of Agriculture have subsidized compost plants upto 50% of the capital cost. The purpose of the subsidies has been to promote technologies which might otherwise not be taken up on purely financial grounds.

(e) Loans from Capital Market or from Government/ Financial Institutions

ULBs can also approach capital markets either directly or through an intermediary. The ULBs can also take advantage of funding from financial institutions for SWM which charge relatively lower rates of interest. Some of the financial institutions include:

Private-sector participation is a beneficial option for financing municipal services while ensuring improved service delivery.

- Housing and Urban Development Corporation (HUDCO)
- Infrastructure Development Finance Company (IDFC)
- Infrastructure Leasing and Financial Services (IL & FS)
- National Bank for Agriculture and Rural Development (NABARD)
- Indian Renewable Energy Development Agency (IREDA)
- Industrial Development Bank of India (IDBI)
- Industrial Finance Corporation of India (IFCI)
- Commercial banks, suppliers, creditors and private venture capital funds

(f) Loans and grants from Bilateral and Multilateral Donors

ULBs could also consider the opportunity of funds from bi-lateral and multi-lateral donors like World Bank, Asian Development Bank, KfW (German Development Bank) etc. for soft loans and grants for infrastructure projects, after due approval from the State. States could also access these funds and provide them to the ULBs.

(g) Public Private Partnerships (PPPs)

The success of PPPs depends on the three necessary conditions of competition, transparency and accountability

Need for Public Private Partnerships in Solid Waste Management: Private sector joining hands with the public sector has become essential for providing SWM services and creating essential infrastructure for collection, transportation, treatment and disposal of waste, resulting in efficient maintenance and cost effective provision of services.

Advantages of Public Private Partnerships: Private sector participation brings in efficient technology, financial resources, trained manpower, managerial autonomy and efficiency in operation at a relatively low cost along with accountability and flexibility in bringing about a change as and when required.

PPP has distinct advantages and challenges which must be taken into consideration while embarking upon PPP mode of service delivery. The advantages include flexibility, increased efficiency and contestability:

Flexibility:

- The private sector can easily hire qualified staff members and pay the salaries as per expertise.
- Salaries and bonuses can be linked to staff performance, thereby providing incentives for efficiency and good work.
- Employee can be easily terminated when performance is unsatisfactory.
- More effective administration due to fewer bureaucratic responsibilities
- Less political interference with private sector involvement.
- A faster and simpler decision-making process
- Increased efficiency:
- New equipment or spare parts for equipment maintenance can be easily acquired.
- The private sector is more open to technology and expertise.
- The private sector has easy access to financial resources for new investments.
- Full cost accounting
- Incentives for good performance and efficiency are offered.

Contestability: competition between the private and public sectors - is effective in improving cost-effectiveness

Regular monitoring and reviewing of performance of the private entity against predefined performance criteria by the ULBs is important for the success of PPP projects.

Some of the challenges for effective PPP implementation include:

- Performance monitoring
- Customer satisfaction
- Accountability to the beneficiaries for services rendered.

The ULB should ensure that the private sector player is selected through a transparent selection process after carefully prescribing minimum qualification and experience needed to perform the function effectively and the contract documents are prepared professionally. The ULB also has an obligation to ensure that the private sector partner adheres to the local, regional and national legal requirements which entails workers' rights, workers' equitable remuneration and other legal requirements/ factors such as bonuses, maternal/ paternal leave, annual leaves, clauses for termination with proper notice periods, setting up of staff committees, sexual harassment committees (now mandated by law) and other relevant labour rights based units.

Management of PPPs is another critical issue, which will ultimately determine the success of the project. A well-defined action plan, including a plan to monitor specific indicators is essential to evaluate the performance of any project. The ULB should have appropriate in-house capacity to regularly review the performance of all PSP/PPP projects. Further details on contract monitoring are included in section 5.4.7 of Part II of this manual.

(h) Municipal bonds and debentures

Ahmedabad Municipal Corporation is one of the pioneering cities to issue Municipal Bonds and Debentures

This is a good source of raising finance from the market and very popular in several developed countries. Tax free municipal bonds can be issued for raising finances from the market for infrastructure development. Such bonds can be issued by ULBs having good financial health and good credit rating to attract investors to invest in municipal bonds. The amount invested is redeemable after a specific period with a definite rate of interest. Presently, the concept of Municipal bonds is at a nascent stage in India and only a few ULBs with a large and buoyant revenue base (credit rating) have been successful in raising funds through them (e.g. Ahmedabad has raised finance several times through tax free bonds and have been able to raise money for infrastructure development very swiftly).

(i) Revenue from sale of products derived from waste processing:

ULBs can minimize expenditure by seeking private sector participation. For a waste processing, private sector entities can be entrusted with the responsibility of processing the municipal waste at their own cost by allowing them to set up the waste processing facilities on municipal land and giving them the agreed quantity of waste (preferably at no charge) at a designated site for a fixed contract period. ULBs may set up such facilities at their own cost and carry out its operation and maintenance through expert agencies and earn revenues from the sale of end products like compost, RDF or electricity.

(j) Tipping fee, solid waste tax/cess:

This could be another source of revenue. The fee may be prescribed for large waste generators for processing /and / or disposal of their waste at the landfill. This could be in the form of fixed monthly fee for providing access to the processing / disposal facility.

1.4.4.5.4 Deficit Management

The ULB should endeavour to recover 100% of the total costs of services as estimated above through levy of user charges on "Polluter Pays"principle. This should include costs of door to door collection, transportation, processing and final disposal of waste at the landfill. The cost of street sweeping, its transportation and disposal should be met from the municipal general budget. Since it may not be immediately achievable to recover the costs of service indicated above through user fees, a beginning should be made to recover at least 100% of the cost of collection and transportation (Operation & Maintenance costs only) through levy of user fees within the period of 3 years; subsequently the user fees may be gradually raised to cover the gap in recovery of processing cost and O&M of landfill costs. Table 1.12 indicates a format for recording the revenue required to bridge the financial viability of providing MSW management services.

Table 1.12: Format for assessing the gap and bridging the financial deficit for MSW management services

S. No	Description	Year 01	Year 02	Year 03	Year	Year 20
1	Deficit					
2	Target % to be met by user fee					
3	Municipal fund					
4	State Subsidy/ other sources					

Mechanisms for collecting user fees need to be put in place and the user fee collection system should be institutionalized. If necessary the Municipal Act needs to be suitably amended to enable these actions. A detailed cost recovery report should be prepared covering the whole gamut of MSW management. The ULB should allocate only the required resources as planned and attempt to work within the earmarked and identified resources. Any excess manpower or vehicles available or deployed should be phased out resulting in a reduction of actual costs.

1.4.4.6 Analysis Of Appropriate PPP Contract Models

A contract between a public and private entity is an arrangement between two parties where the private party is paid a fee for investing in necessary infrastructure , vehicles and equipment or for managing an existing asset or business as well as providing the desired services. Management contracts transfer limited responsibilities and risk to the private party, whereas contracts like Design, Build, Own, Operate and Transfer (DBOOT) put significant responsibility on the contractor. The contracts have to be structured in a way that they bridge the financial and institutional gap which local bodies cannot fill easily from internal resources and capabilities.

Contracting models should be performance based and the payments made to private partners should be linked to outputs reflecting the service quality levels which are pre-defined in the contract[22].

Table 1.13: Key Characteristics of Contracts in MSW Sector

MSW Management &Operation	Characteristics	Relevant Contract Models	Implementing ULB
Collection and Transportation	• Large and diverse work force , vehicles &equipment • Intensive logistics • Citizen interface • Investment ranges widely depending on scope of work	Service contracts; Management contracts; Concession contracts	Bangalore, Surat, Jodhpur, Ahmedabad, etc.
Street sweeping[23]	• Labour intensive • Minimal investment in tool and equipment • Limited technical skills • Logistics intensive	Service contracts	Hyderabad, Chennai, Rajkot etc.
Transport	• Capital intensive • Fleet management skills	Concession contracts	Bangalore, Delhi, Chennai, Surat, Ahmedabad, etc.
Processing / Disposal	• Capital intensive • Technically skilled manpower required • Experience of technology deployed	Concession contracts (DBO, BOO), DBOOT	Surat, Ahmedabad, Navi Mumbai, Pune etc.

ULBs should play a critical role in monitoring various contractual arrangements in order to avoid risks associated with contracts

Table 1.14 summarizes relevant contracts for specific MSWM activities. While each of the operations have a distinct scope and can be handled under separate contracts, various models exist for efficient MSW management, which revolve around a combination of these operations. Some of the possible combinations of contracts include:

1. Separate contracts for collection, transportation, processing and disposal activity- A total of four contracts.

22 Draft National PPP Policy, GOI, 2011
23 Subject to compliance with Contract Labour Regulation Act (CLRA) 1996

2. Collection and transportation contract, processing contract and disposal contract (e.g. total of three contracts, as in Shimla).
3. Collection and transportation contracts in one package and processing and disposal contracts in another package (e.g. total of two contracts, as in Bangalore).
4. One integrated contract for all four activities – as in Raipur, Guwahati, Jodhpur, Lucknow, Kanpur, Allahabad etc.

Each of the above options has certain advantages and disadvantages and may be adopted with checks and balances in the contracts to minimize the risk. In each successive model, the level of responsibility on the private player is relatively higher, with the fourth model allocating the highest responsibility to the private entity. The ULB plays the role of a client and a monitoring agency. Through this model, a high degree of accountability and better compliance is achieved, as the private agency is a professional player liable to the ULB.

The Government of India in cooperation with the Asian Development Bank (ADB) elaborated a "Toolkit for Public Private Partnership frameworks in Municipal Solid Waste Management"[24] which supports ULBs within a 4-step approach to establish a PPP system adequate to the conditions in the respective city. It is strongly recommended to apply this Toolkit for establishing a 'hand-tailored' PPP system.

[24] http://www.urbanindia.nic.in/programme/uwss/SWM_PPP_Tookit-Volume-I.pdf
http://www.urbanindia.nic.in/programme/uwss/SWM_PPP_Tookit-Volume-II.pdf

Table 1.14: : Contracting Models & Private Sector Responsibilities[25]

Option	General Characteristics	Aim of having private sector participation	Operations and Maintenance	Capital Investment and asset ownership	Responsibility	Contract Duration
Service Contract	The private sector provides a clearly defined service to the public partner	To increase efficiency of particular public services	Public and private	Public	Public	1-2 years or 5-8 years
Management Contract	The private partner is responsible for operating and maintaining system	To increase efficiency of service with improved management structures	Private	Public	Public	3-5 years
Design-Built-Operate (DBO)	The private contractor is responsible for designing, constructing and infrastructure	Enhance commitment level because of full responsibility	Private	Public	Shared	5-8 years
Lease	The private partner is fully responsible for operation and maintenance;	Increased responsibility	Shared	Public	Public	8-15 years
Build-Own-Operate (BOO)	The private partner builds a facility that is based on a defined design and owns and operates it. The private partner charges a tipping fee to recover its cost	To transfer the responsibility of investment and management in a cost-effective manner with all risks on the private partner	Private	Private	Private	15-30 years

25 Adapted from Cointreau-Levine (1994); International Consortium, GTZ-ERM-GKW (2004); World Bank (2004)

Option	General Characteristics	Aim of having private sector participation	Operations and Maintenance	Capital Investment and asset ownership	Responsibility	Contract Duration
Build-Own-Operate and Transfer (BOOT)	The private partner builds a facility that is based on a defined design and owns and operates it. The private partner charges a tipping fee to recover its cost. The private company then later transfer asset to the public partner.	To obtain private sector investment with operating and management risks on the private partner and eventual asset transfer to the public.	Private	Private	Private	15-30 years
Build-Operate-Transfer (BOT)	The private partner is responsible for constructing, financing and operating the facility during the contract period. After the contract period, the facility is transferred to the public.	To transfer all risks to the private partner	Private	Private	Private	20-30 years
Concession (including fee collection)	The private partner is fully responsible for operation, maintenance and investment	To create competition in the market	Private	Private	Private	25-30 years

1.4.4.7 Role Of Decentralized MSW Management Systems

Decentralized systems require a higher degree of commitment from the community as their participation is crucial in ensuring the sustained performance of these systems.

Decentralized waste management systems/community level waste management systems reduce the burden of handling large volumes of MSW at a centralized location, with a corresponding reduction in costs of transportation and intermediate storage. Some of the advantages of decentralized waste management include:

- Decentralized options have a lower level of mechanization than the centralized solutions and generate local employment. They provide income and job opportunity for informal workers and small entrepreneurs.
- Decentralized options can be tailor made for the local waste stream, climate, social and economic conditions.
- Decentralized systems reduces cost incurred for the collection, transportation and disposal of waste by the urban local bodies.

While planning for decentralized systems, adequate care should be taken to ensure that these systems are an integral part of the larger solid waste management strategy of the city. Other centralized waste processing/treatment systems should not consider waste volumes which are already being processed/treated in decentralized facilities.

1.4.4.7.1 Favourable conditions for implementation of decentralized systems

Decentralized Solid Waste Management solutions are suitable when:

- Suitable and sufficient land for waste management facilities (composting organic waste, recyclable sorting facilities) is available in neighbourhoods
- There is no local resistance against siting the plant
- Availability of local expertise/NGOs to handhold the process in an environmentally acceptable manner
- Municipality has in- house capacity of effectively monitoring decentralized systems
- Markets for compost/recyclables are accessible

In addition to local material recovery/recyclable sorting facilities, decentralized compost plants, biomethanation (Biogas) plants, vermi-composting, windrow composting and bin-composting, are all easy to establish at the community/ institutional level. Sizes can vary from small backyard composting to plants processing 3 to 20 tons of organic waste/ day. Material take-back and recycling facilities can also be established at the local community level, to increase efficiency of collection.

Dry Waste Collection Centers (DWCCs) run by various agencies in Bangalore in co-ordination with the BBMP are decentralized bulk sorting and processing facilities. Waste managers perform secondary and tertiary sorting of the waste here before finally selling it to recycling centers. Bulk collection through informal sector results in larger returns and more jobs opportunities.

Bhabha Atomic Research Centre (BARC) has developed Nisarguna technology[26] for generating bio- gas from organic waste. Small plants ranging from 0.5 tonne to 5.0 tonnes can be set up at an affordable cost at decentralized locations / large institutions / markets etc. More than 150 plants are operational in the state of Maharashtra and few other states.

Decentralized Waste Management System for Apartment Complexes- A Public Private initiative in Kochi

Year of start: 2007

Main players: Cochin Municipal Corporation (CoC), Kerala Builders Forum now called Confederation of Real Estate Developers' Associations of India (CREDAI)

Approach: Kochi witnessed rapid urbanization in last few years with various developmental and infrastructural projects. As an outcome of this rapid urbanization, the city witnessed the problems of waste management and its disposal. The garbage crisis of 2007, deteriorated the condition of Kochi as the city had no dedicated place for waste disposal and waste was seen everywhere. In order to address the problem of garbage disposal in residential colonies with focus on health, hygiene and safety, a joint initiative was carried out by Corporation of Kochi and Kerala Builders Forum later called CREDAI. To manage the solid waste the following approach was adopted in high rise apartments to implement an eco-friendly solid waste management system:

- A suitable technology was identified and approved by Clean Kerala Mission, Government of Kerala and the implementation of this decentralized system of waste management in few apartment complexes on a trial basis was started in 2007.
- Planning and formulation of strategy and a dedicated team for implementation of the decentralized system for the high rise apartments.

[26] Gokaldas,V.,(2012)."Waste Picker-Run Biogas Plants as a Decentralized Solution", In: On the Road to Zero Waste: Success and Lessons From Around The World, GAIA

- Setting up of source segregated door to door collection system of waste in each of the apartment complexes.
- Establishment of the Bio-Bin system to process the bio-degradable waste to produce and utilize the compost on site within the apartment complex.
- Establishment of a recycling and plastic shredding unit by Corporation of Cochin and managed by CREDAI
- Collection of dry/ recyclable material is sold to generate revenue for the CREDAI workers
- Regular skill development and awareness programs through the print and mass media for the workers and citizens

Outcome:

- Currently 350 apartment complexes in Kochi are covered under this initiative
- Decentralized system in apartment complexes led to employment opportunities for economically weaker section especially women for operationalizing and monitoring of the unit
- Effective monitoring and timely complaint redressal at the time of any failure of the unit

Success factors:

- Legal framework making the system mandatory for all apartment complexes
- Proactive role of CoC to decentralize waste management within all apartment complexes and regular monitoring by the officials
- Capacity building of the workers
- Regular monitoring by CREDAI at the premises

Overall Sustainability:

The initiative of CREDAI in the apartment complexes is a self-sustainable working model showcasing the viability of decentralized waste management system. Onsite operation and maintenance of the composting system as well as other expenditures are being met by the collection of user charges at the rate of Rs. 100-150/- as well as sale from the recyclables. In order to further strengthen and ensure sustainability of the system, Local Self Government Department (Govt. of Kerala) issued an order in 2012 for making it mandatory for the apartments through the building associations/ firms to manage the waste within the apartment complexes through different technologies for composting and sale of recyclable material.

1.4.4.7.2 Management & Monitoring of Decentralized MSWM Facilities

A decentralized facility at the household level need not be registered; however, all other decentralized facilities above 1 TPD should be registered with the local authority and monitored by the local authority as well as the pollution control board. Appropriate norms for operation and maintenance should be prescribed & monitored by both the local authority and the pollution control board.

Decentralized MSW management facilities may be funded through community based co-operatives, local NGOs, PPP mode or through municipal funds. Community ownership of decentralized systems is critical for their success and continued operation. The four management models for decentralized waste management systems are tabulated below (Table 1.15). The relevance of different models is dependent on local conditions and cultural backgrounds. All the decentralized models are equally beneficial to the urban local body by reducing overall waste management costs.

Table 1.15: Management Models for Decentralized Waste Management[28]

Options	Purpose	Main Actors	Role of City Government or Municipality	Advantages	Constraints
• Model 1: Municipality owned-Municipality operated	• Focused on reducing cost of transportation of waste, centralized treatment and disposal in landfills • Local employment opportunity	• Municipality	• Investment provider, Implementing and monitoring agency	• Cost saving in transportation, centralized processing and disposal • Profitable use of waste • Job opportunities for the unemployed youth • Entrepreneurship development	• Availability of suitable land • Objection from the neighbour hood • Occasional problems of odour • Operating efficiency and marketing potential • Lack of coordination between departments regarding the use of the compost products within the ULB.

28 Adapted from: Waste Concern, (2006), "Decentralized Composting for Cities of Low and Middle Income Countries", Dhaka, Bangladesh, pp 33

Options	Purpose	Main Actors	Role of City Government or Municipality	Advantages	Constraints
• Model 2: Municipality owned-community operated	• Community is involved in the management of primary waste collection and treatment. • Capital cost is borne by local body • Local employment opportunity • Enterpreneurship development • Non-profit seeking model	• Municipality, Local community, NGOs/ RWAs	• Make capital investments • Supports communities in finding/ allotting land. • Collection and disposal of residual waste. • Monitoring agency	• Cost saving in transportation and centralized processing and disposal • Profitable use of waste • Job opportunities for the unemployed youth • Enterpreneurship development • Reduction in municipal burden due to community participation. • Improvement of solid waste management through voluntary participation	• Lack of community awareness and interest in decentralized project • Lack of informal leader among the community to lead the cause of the project • Availability of skilled labour and entrepreneurs
Model 3: Municipality owned-privately operated	Profit seeking model Requires full cost recovery (from collection fees and compost sales) Cost reduction through lower transport and disposal costs.	Municipality, Private sector or NGO	Funding capital expenditure. Identify and allot land for composting, Contracts out the operation and maintenance Monitors performance of contractors.	Reduce municipal burden of SWM through private sector participation. Know- how and efficient management through private sector Partnership with private entrepreneurs.	Lack of community awareness and interest Need for a reliable and skilled partner with sense of entrepreneurship. Inefficient contract management

Options	Purpose	Main Actors	Role of City Government or Municipality	Advantages	Constraints
Model 4: Privately owned-privately operated	Profit seeking enterprise based on compost market conditions. Income is generated through sale of products like compost and collection charges	Private sector	Select a private operator through a transparent process Formulation of transparent regulations for public-private partnerships. Cooperates in supplying raw waste and disposal of residues Synchronize centralized and decentralized systems	Reduce the municipal burden of SWM through private sector participation. Investment of funds and know-how through private investors Partnerships with private entrepreneurs. Creates employment and business opportunities	Lack of private land Lack of vital compost markets

1.4.4.8 Arrangements for Informal Sector Integration

The informal sector, constituting waste pickers/rag pickers, plays an important role in the SWM value chain by recovering valuable material from waste. They help reduce environmental impacts by improving resource recovery and reducing disposal requirements. The integration of the informal sector into the formal solid waste management system will contribute to the reduction of the overall system costs, provide support to the local recycling industry and create new job opportunities. They have significant expertise in sorting municipal waste and are an asset for processing and material recovery facilities.

The informal sector is the backbone of the SWM value chain, recovering nearly 50% of recyclables generated by households

Integrating the Informal Waste Sector – Policy Directives

The "integration" of the informal waste sector refers to several ways in which the informal waste sector could be involved in formal waste management systems. This is made possible through a set of formal or informal arrangements between waste pickers themselves or organizations of waste pickers or organizations working with waste pickers with local authorities in their operational area. The integration process would typically result in the accrual of social benefits to waste pickers."[29]

Some of the salient features of the policies/ regulations pertaining to Municipal Solid Waste Management as they relate to the informal waste management sector are:

- National Environment Policy, 2006: Acknowledges the informal waste sector and states "Give legal recognition to, and strengthen the informal sector systems of collection and recycling of various materials. In particular enhance their access to institutional finance and relevant technologies"
- National Action Plan for Climate Change, 2009[30] (NAPCC) stresses the need for giving legal recognition to the informal sector, which it recognizes as the "backbone of India's highly effective recycling system".
- National Labour Commission, 2002[31] also "recognizes the useful role played by the

[29] Chikarmane, P.; Narayan, L.; Chaturvedi, B (2008), Recycling livelihoods – Integration of the Informal Recycling Sector in Solid Waste Management in India. May, 2008. Study prepared for GTZ´s sector project "Promotion of concepts for pro-poor and environmentally friendly closed-loop approaches in solid waste management" (unpublished). Available at: http://www2.gtz.de/dokumente/bib-2010/gtz2010-0485en-informal-recycling-india.pdf

[30] NAPCC, 2009, Available at http://pmindia.nic.in/climate_change_english.pdf

[31] Second National Labour Commission, Ministry of Labour, Government of India.2002. Available at: http://www.labour.nic.in/lcomm2/nlc_report.html

> scrap collectors both in helping recycling activities as well as in maintaining civic hygiene. It is, therefore, essential that they should be protected from insecurity of various forms. The measures that could be thought of in this regard are providing identity cards, receipts for transactions, minimum wages when they are employed by contractors or other employers, health facilities, creation of welfare funds, prohibition of child labour from the activity and the likes. The commission fully endorses the suggestions made by the United Nations Development Programme (UNDP) and the International Labour organization (ILO)".
>
> Progressive regional legislation has been made in some of the states in India e.g. Maharashtra, which facilitates inclusion of the informal waste sector into formal systems.

Developing formalized material recovery systems is capital intensive. Therefore, informal sectors, if existing, should be encouraged, while ensuring environmental, health & safety safeguards.

There are various political, legal, cultural and social conditions that determine the best possible approach to informal sector integration. Local, regional and national legislative frameworks for informal workers should be considered.

Certain enabling conditions and supportive actions for promoting the integration of the informal sector:

- Organization of informal sector into recognized, membership-based associations or cooperatives. These associations would have to have true representation of women as part of their leaders/ members
- Recognition of these associations for SWM service delivery.
- Creation of a policy framework for informal waste sector recognition and an inclusive framework to facilitate their participation in the delivery of service.
- Promotion of social security and health benefits to members of these associations.
- Encourage informal sector/ NGO/ CBO through linkage to National Urban Livelihood Mission.
- Providing low-interest loans to organizations of waste pickers seeking to bid for tenders and contracts.
- Providing exemptions on fees and deposits for participation of informal sector associations in bidding for solid waste management contracts
- Provisions of basic amenities and facilities for the informal workers to work effectively (PPE, timely wages, bonuses etc., proper facilities for women to be able to leave their children in the hours that they work, linkages with community centres/ aanganwadis may be established, safety and security provided to all workers, proper redressal

mechanisms for formal complaints, sexual harassment policy/ committees etc.

- Encourage informal sector involvement in provision of waste collection and sorting services.
- Reserving land in development plans for decentralized processing of bio-degradable wastes and collection of recyclables.
- Supporting capacity development programmes for informal sector associations (see Box below).

Scope for Informal Sector Integration in SWM Activities

- Door-to-door collection
- Sorting recyclable waste
- Collection and segregation of recyclable material
- Manual sorting at the manual sorting conveyor belt in a Material Recovery Facility
- Set-up and management of recyclable/reusable waste take-back/buy-back facilities
- Waste sorters in processing facilities (e.g. at the sorting conveyor)

Capacity Building and Training of Informal Sector for Providing MSW Management Services

- Improvement of managerial skills (business management, accounting, marketing, negotiation skills);
- Maintenance of work ethics and organization/team work;
- Training in sorting, processing, recycling techniques and value added services;
- Formalization requirements for waste worker organizations;
- Environmental and health aspects of waste management activities;
- Occupational hygiene and safety;
- Business support services linked to large scale formal recycling industries;

1.4.4.9 Segregated Collection (Door To Door Collection, Street Sweeping& Drain Cleaning), Storage & Transportation

Door to door collection of segregated waste is mandatory as per MSW (M&H) Rules, 2000. Collection of segregated waste from residential areas, commercial and institutional areas is to be planned by ULBs. Frequency of waste collection is dependent on the quantum of waste generated by each of these groups and the level of segregation. While residential waste is to be collected daily, waste from market areas, commercial establishments and institutions may be collected twice a day. The quantum of waste generated and collected also determines the mode of transportation used to collect waste at the door step. Segregated/separate containers are required for collection of different fractions; ata minimum, ULBs shall collect wet and dry waste separately.

Waste collected from the door step may either be stored in a secondary collection point or transferred directly to secondary collection vehicles (bin-less cities). The feasibility of choosing between secondary storage or direct transfer to secondary collection vehicles is to be ascertained based on the availability of secondary collection vehicles, extent of collection area, timings of collection. Where waste from all residential areas is collected during morning hours, the requirement for secondary collection vehicles will be much higher in case of direct transfer from primary collection vehicles to secondary collection vehicles. Wet and dry waste is to be transported in separate vehicles.

The establishment of intermediate transfer stations is determined by the distance between secondary waste collection points and the final treatment/disposal point. If the distance from the city jurisdiction to the final treatment/disposal points exceeds 15 km., transfer stations may be established.

The choice of secondary collection vehicles is to be synchronized with the design of secondary collection bins and storage containers in the transfer station. Compactors may be used to haul wastes from transfer stations to the waste disposal site.

Details on the segregated collection and transportation and choice of containers and transportation systems are given in chapter 2 of Part II of this manual.

1.4.4.10 Identification of Land & Inclusion in City Master Plan/City Development Plan

Availability of suitable, encumbrance free land within the ULB's jurisdiction for locating waste processing and treatment facilities is the biggest challenge faced by the ULBs.

Planning for solid waste treatment and processing facilities should begin with the identification of suitable land duly allowing adequate buffer areas, as indicated in table 1.16. The City Master Plan and Town Planning/Spatial Planning maps should identify and reserve such land for SWM facilities. The requirement of land is to be calculated based on a tentative assessment of possible disposal options available to the ULB. Land clearance from concerned authorities for establishment of MSWM facilities is to be obtained by the ULB at the earliest possible instance, thereby avoiding inadvertent delays during the implementation process. Care should be taken that MSW processing and disposal facilities should consider environmental considerations; an indicative list is provided below:

Table 1.16: Criteria for Identifying Suitable Land for Sanitary Landfill Sites

S. No	Place	Minimum Siting Distance
1	Habitation	500 m for facilities dealing with 100 TPD or more of MSW; 400 m for facilities for dealing with more than 75 or less than 100 TPD; 300 m for facilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.
2	Rivers, lakes, water bodies	200 m
3	Non meandering water (canal, drainage etc.)	30 m
4	Highway or railway line	300 m from center line
5	Coastal regulation zoning	Sanitary Landfill site not permitted
6	Earthquake Zone	500 m from fault line fracture
7	Flood prone area	Sanitary Landfill site not permitted
8	Water table	2 m for landfills or as appropriate for considered facilities
9	Airport	20 km

1.4.4.11 SELECTION OF PROCESS & BEST AVAILABLE TECHNOLOGY FOR PROCESSING & DISPOSAL

ULBs should carefully assess unproven technologies and consult the SPCBs in order to avoid becoming testing grounds for yet to be commercially established technologies

Designing and implementing new waste management systems and optimizing existing ones should consider aspects of resource recovery, environmental soundness, financial sustainability, stakeholder involvement and institutional capabilities, in addition to focusing on the technical and technological appropriateness of systems for handling and disposing waste. This implies that the selection of best MSWM options for a particular ULB goes far beyond a technology selection.

The selection of waste management processes and technology shall be based on the 5 tier ISWM waste management hierarchy, which is explained in section 1.2 of this chapter. The corresponding illustration of the ISWM hierarchy is reiterated in figure 1.1 for easy reference.

The selection of technology should be based on defined selection criteria, local conditions and subject to a detailed due diligence study. The relevant criteria are listed in table 1.17 and applied to a number of common strategy and technology options.

In cases where Municipal authorities feel challenged to ensure appropriate selection processes, they may seek external expertise to ascertain the most viable solutions.

Table 1.17: Indicative Criteria for Selection of Appropriate Technology or Combination of Technologies[33]

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
TECHNICAL CRITERIA							
Facility Location[34, 35]	Plant should be located at least one km away from habitation, if it is open windrow composting. The distance could be 500 m in case of covered plants.	Within the residential area (with appropriate environmental safe guards)	Plant should be located at least 500 m away from residential areas, for plant sizes upto 500 TPD.	Plant should be located at least 500 m away from residential areas.	Plant should be located at least 1km away from residential areas.	Plant should be located at least 500 m away from residential areas.	Landfill sites should be located at least 1 km away from residential areas and should abide by the criteria mentioned in MSW Rules and state level guidelines
Buffer Zone (No Development Zone)	500 m for facilities dealing with 100 TPD or more of MSW; 400 mfor facilities for dealing with more than 75 or less than 100 TPD; 300 m forfacilities dealing with 50-75 TPD of MSW; 200 m for facilities dealing with less than 50 TPD MSW. For Decentralized plants handling less than 1 TPD MSW no buffer zone is required; however adequate environmental controls are required.						

33 Adopted from various sources (JnNURM, World Bank)
34 Site selection criteria specified by the EIA Notification 2006 and its amendments shall be considered.
35 CPCB Guidance on Criteria for Site Selection for Landfills shall also be considered

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Natural environment	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation	Composting in coastal/high rainfall areas should have a shed to prevent waste from becoming excessively wet and thereby to control leachate generation					Should be avoided in marshy land and in conditions where the ground water table is l 2 m from the base of the liner. In marshy land apart from ground and surface water contamination potential, there could be huge risks due to structural safety of the landfill (slippage and complete breakdown)
Land Requirement	High (For 300TPD of MSW: six ha of land is required)	High (Suitable for quantities less than 20 TPD)	Low to Moderate (For 300 TPD of MSW: 2 ha of land is required)	Low to Moderate (For 300 TPD of MSW: 2 ha of land is required)	Low To be assessed	Low (For 300 TPD of MSW: 6 ha of land is required)	Very High (For 300 TPD of MSW: 30 ha of land is required for 20 years)

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Waste Quantity which can be managed by a single facility	20 TPD and above	1 TPD to 20 TPD	1 TPD at small scale to 500 TPD at larger scale	100 TPD and above	500 TPD and above (smaller plants are not techno-economically viable, given the cost of required environmental control equipment & boiler technology	500 TPD and above (economically sustainable at 500 TPD plant size)	100 TPD inert and above. Smaller landfills are not techno-economically viable
Requirement for Segregation prior to technology	High	Very high	Very high	High	High – Feed stock should be free from inerts and low on moisture content	low	Only inert waste may be placed in landfills as per MSW (M&H) Rules, 2000
Rejects	About 30% including inerts if only composting is done[36] 15% rejects with RDF, if located in the same plant	About 30% including inerts	About 30% from mixed waste	Around 30% from mixed waste	Around 15%		No rejects
Potential for Direct Energy Recovery	No	No	Yes	No (feed stock for energy recovery)	Yes	Yes	Not as per MSW (M&H) Rules, 2000

36 In cases of an integrated facility of composting and RDF, 15% rejects from mixed waste stream is expected

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Technology Maturity	Windrow composting technique is well established	Community scale projects are successful	Feasibility for biodegradable waste is proven. Not suitable for mixed waste	Quality of RDF should be based on end use, no clear consensus on quality requirements. Burning of RDF below 850°C for less than 2 seconds residence time can pose serious problems of health and environment. Rules regulating characteristics of RDF and guidelines for appropriate use not prescribed by concerned authority.	Technology is available. However constraints of low calorific value, high moisture content and high proportion of inert waste should be considered while undertaking the project commercially.	Technology is proven and widely used world over but not suitable under Indian conditions where waste has very low calorific value. Can be used selectively after raising calorific value of segregated waste.	Sanitary landfill is a proven method for safe disposal of waste, practiced world over. However it has environmental implications and efforts have to be made to minimize waste going to landfills. MSW Rules only permit inert wastes to be landfilled.

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
FINANCIAL CRITERIA							
Indicative Capital Investment[37]	(Typically 15-20 Cr for 500 TPD plant)	1 Cr. per 20 TPD	(Typically 75-80 Cr for 500 TPD plant)	(Typically 17-20 Cr for 500 TPD plant)	Very High capital, operating and maintenance costs. 15 Cr. per MW power production	(Typically 80-90 Cr for 500 TPD plant)	High
Market for By-product/ End Product	Quality compost compliant with FCO 2009 has a good market. IPNM Task Force (vetted by Supreme Court, 1 Sep 2006) has recommended co-marketing of 2-3 bags of compost with 7-8 bags of inorganic fertilizer.	Good market potential in Urban and Rural areas. However it is not adequately explored.	The technology is not fully explored, though it has a potential to generate energy as well as digested sludge manure.	Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	Good potential of energy generation if power purchase agreements are made reflecting true cost of production including O&M costs	Quality compost compliant with FCO 2009 has a good market. Good market potential for RDF. In small cities, RDF plants only become feeders of RDF to large RDF based power plants and cement plants.	No potential, since it is stipulated by the MSW (M&H) Rules 2000, that only inert wastes are to be disposed in landfills

[37] Source: JnNURM Toolkit , November 2012

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
MANAGERIAL CRITERIA							
Labour Requirement	Labour intensive	Labour intensive	less Labour intensive	Labour intensive (based on current practice)	not labour intensive but Requires considerable technical capacity,	Not labour intensive but requires considerable technical capacity,	Only inert wastes are to be interred in sanitary landfills. Labour intensive but requires considerable technical expertise as well.
Predominant skills for Operation and Management	Skilled & Semi-skilled[38] labour	Skilled & Semi-skilled labour	Skilled labour	Skilled & Semi-skilled labour	Highly skilled required	Highly skilled labour	Skilled and semi-skilled labour.
ENVIRONMENTAL CRITERIA							
Concerns for toxicity of product	The final product is generally applied to soil and used as manure. Can contaminate the food chain if compost is not meeting FCO norms.	The product is generally safe as worms cannot endure significant contamination of raw materials. FCO Standards are to be met with.		-	-		- -

38 On-site training is required for unskilled labour, as a minimum requirement for efficient operation

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Leachate Pollution	High if not treated appropriately	Insignificant quantities at low waste volumes per vermi-pit.	High if not treated appropriately	Low	Low (provided fly-ash is managed appropriately and disposed in a hazardous waste landfill.	Low	Moderate to high depending upon the leachate recycling and control systems. Leachate management during monsoons requires special attention
Atmospheric pollution	Low (Dust, aerosol etc.). Odour issues.	Low. Odour issues.	Low Leakage of biogas. Odour issues	Low to Moderate (Dust, aerosols). Very high if RDF is not burnt at required temperature. Odour issues.	Very high if not managed properly. (Emissions due to incomplete combustion of municipal refuse contain a number of toxic compounds, requiring appropriate emissions control systems)	Moderate, require appropriate emission control systems (Air emission include acid gases, dioxins and furans)	Air pollution and problems of odour and methane emissions if not managed properly.

Criteria	Windrow Composting	Vermiculture	Biomethanation	RDF	Incineration	Integrated System (Composting + RDF)	Sanitary Landfill
Other	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Fire and safety issues to be taken care of	Presence of inappropriate material in the RDF (chlorinated plastics). Fire and safety issues to be taken care of.	Disposal of bottom ash and slag. Fire and safety issues to be taken care of.	Presence of inappropriate material in the RDF (chlorinated plastics). Fire and safety issues to be taken care of.	Polluted surface runoff during wet weather, groundwater contamination due to leachate infiltration, spontaneous ignition due to possible methane concentration.

*Actual planning and implementation will also depend on engineering and installation of plants
Further detailed information on the different technologies and their implementation requirements are to be found in sections 3.2 to 3.5 of chapter 3 of Part II of this manual.

1.4.4.12 Planning For Effective Community Participation Through IEC

An efficient waste management program, regardless of the strategy, requires significant cooperation from waste generators and active community participation.

Along with strategic planning, significant cooperation and support from the community is essential for successful implementation of the MSWM Plan.

IEC is a multi-level tool for promoting and sustaining risk-reducing behaviour change in individuals and communities. The decision to adopt new ideas or behaviour is the result of a complex process and takes place only over a period of time. Development and implementation of an IEC campaign involves planning and implementing a comprehensive, strategic set of interventions and activities to change behaviour at many levels to achieve the objectives of the MSWM Plan.

Awareness and education campaigns are essential to bring about a behavioural change among the citizens in managing their waste. The Information, Education and Communication (IEC) campaign should not only target households, shops, commercial and institutional premises, but also all other stake holders such as municipal officials, elected representatives, schools, non-governmental organizations (NGOs), the informal sector, media, etc. to ensure their participation in managing city waste by discharging their role effectively.

An IEC campaign is not a single time activity; on the contrary, depending on the stage of planning or implementation, constant communication with the community and all relevant stakeholders is a necessity.

Community Participation as an accelerator for efficient SWM

Communities should:

- Actively participate in waste reduction, reuse and recycling
- Stop littering the streets, drains, open spaces and water bodies
- Practice segregation of waste at source into biodegradable (wet) and non-biodegradable (dry) waste, ensuring that other wastes belonging to the 'special' category are handed over separately[39].
- Participate in primary collection of waste through RWAs, self-help groups, NGOs, or individual waste collectors by paying for the services provided.
- Encourage and assist in local composting and recycling initiatives.
- Promote effective provision of SWM services for low-income populations.

[39] More details in Chapter 3 of Part III of this manual

A sustained campaign of targetted messages, relevant to the ongoing planning/ implementation phase, specific to each considered social group, will result in bringing about a significant change in behaviour patterns.

1.4.4.12.1 Communicating the MSWM Plan

Successful implementation of the MSWM Plan is dependent on its ownership by multiple actors. Periodic and timely dissemination of various facets of the MSWM Plan would bring a significant change in human behaviour. This in turn will improve the standard of cleanliness in the city and give a better quality of life to the citizens. Figure 1.12 below describes the planning process for an effective IEC/awareness generation campaign:

PHASE I: ASSESSMENT

↓

Step 1: Rapid Assessment of Existing Situation

↓

PHASE II: PLANNING

↓

Step 2: Defining the Target Audience and Segmentation

Step 3: Defining the Communication Objective for the Target Audience

Step 4: Development of Communications Channels

Step 5: Selection of Appropriate Communications Channels

Step 6: Formulation of Detailed Action Plan

↓

PHASE III: IMPLEMENTATION

↓

Step 7: Implementation of Awareness Raising Campaign which are gender sensitive

↓

PHASE IV: MONITORING

↓

Step 8: Monitoring and Evaluation of Campaign

Figure 1.12: Planning Process for an IEC Campaign

Step 1: Rapid Assessment of the Existing Situation

Rapid assessment of the existing solid waste management situation in city's ward/ community enables ULBs to identify key community behaviour patterns that could aid or impede the implementation of the plan. The communication campaign should seek to change undesirable practices and strengthen complimentary habits.

Strengthening and clarifying the roles of key actors within and outside the ULB, should be a key outcome of a communication plan.

Step 2: Defining the Target Audience and Segmentation

The target audience is the waste generator who needs to be educated and motivated to effectively participate in managing waste. All households, commercial establishments and other institutional premises have to be reached through IEC campaign to cooperate in the municipal authority in managing their waste. This can be achieved through intermediaries such as RWAs, CBOs, NGOs, SHGs and social organizations along with the elected representatives and municipal officials.

Table 1.18: Target groups for IEC

Primary Target Group	Secondary Target Group
Women	Associations and Organizations, SHGs groups etc.
HIG /MIG Households	RWAs, NGOsand CBOs
LIG Households	Corporators
Owners and workers of commercial and Institutional establishments	Local leaders
Slum Dwellers	Service providers
School children	Teachers

Impacts of gender vulnerability and poverty are essential dimensions that must be considered in all communications.

Information, Education and Communication
- Inform the public of waste management methods and requirements
- Gain public support for MSWM initiatives

Step 3: Defining the Objectives of Communication

Communication shall not be an add-on but an integral part of awareness raising campaign. A communication programme objective will reflect the anticipated impact on the stakeholders. It will identify how participants' and partners' behaviour will improve; to what extent and over what period of time.

Step 4: Developing Communication Channels

A well-conceived communication objective shall be **SMART:**

Simple and clear,

Measurable,

Attainable,

Reasonable,

Timely and location specific

Step 5: Selection of Appropriate Strategic Communication Channels

Low-, medium- and high-cost IEC tools should be combined to achieve the maximum possible impact.

The communication channels chosen in the IEC campaign should be accessible by the target audience, should be replicable and cost effective.

Channels of communication should be selected based on important considerations:

- The channels selected must be those that reach their group with the greatest degree of frequency, effectiveness and credibility.
- Recognize that the different channels play different roles.
- Recognize that the different channels of communication are utilized differently by both sexes (male/ female)
- Use **several channels simultaneously**. The integrated use of multiple channels increases the coverage, frequency and impact of communication messages.
- The **programmer's human and financial resources** should be capable of managing the chosen media
- Select channels that are **accessible and appropriate** to programme participants; for example:
  - Radio messages should be scheduled for those radio stations that programme participants actually listen to and at broadcast times when they actually listen.
  - Print materials, should be used only for literate or semiliterate participants who are accustomed to learning through written and visual materials.
  - Community/Interpersonal communication should be provided reliably by credible sources.

Newspaper, Magazines, Posters, Billboards, Stickers, Flip Charts, Advertisements, Pamphlets & Handbills

- Results of channel analysis will help the team/working group to know which channels are best suited to the messages and participants and whether local capacity needs to be strengthened in order to carry out the communication programme.

Print Medium:

While the print medium is more appropriate for the literate class, however it is also a good medium for all sections of the society, given the importance of visual communication. For the illiterate, messages can be conveyed pictographically in print. The messages to be conveyed should be clear and easily comprehensible.

Messages on product reuse, recycling and disposal can be printed on all products used by the community.

Audio- Visual Medium:

This is a very effective medium and can convey messages which can make large and long lasting impacts. Mass media channels have the proven capability to reach and inform large audiences and are successful in influencing attitudes and motivating behavior change. Advances in technology have brought electronic media to the forefront as one of the most effective tools for social development. Media partnerships with local radios and TV stations can help to continuously keep the awareness level on sanitation and hygiene related issues high. Moreover, electronic media tends to overcome all barriers of illiteracy. Catchy jingles on specific issues tend to grab the attention of the audience and have a higher recall compared to conventional advertisements.

Radio, Television, Cinema, Music

Internet:

Interactive websites can prove to be an effective mode of communication especially to reach the children, college going students and also the working class in the society. Interactive websites shall include the following features:

- Be visually appealing and effective in conveying the targeted message
- Frequently Asked Questions (FAQ) in question and answer format.
- Accept queries or comments
- Provide Information about various workshops happening in the city on waste management
- A feature stating the existing waste regulations in a form easily understood by common people
- Facility for lodging complaints

School children should be primary targets of IEC campaigns as they are major agents of change in the society.

- A corner/feature to highlight the innovative waste management or waste to resource - a way to appreciate as well as provide encouragement to other citizens
- Links to research for gathering more information on certain topics related to waste. These topics can keep on changing according to the theme
- Guidance documents; case studies of best practices
- Inventory of waste management solution providers

Interpersonal:

Interpersonal communication is the most effective communication tool amongst all: Individual Counselling, Community-level interaction, Motivation Sessions, Small Group Discussions, Peer Education, and Door-to-door Visits.

Interpersonal communication involving persuasive dialogues and discussions with individual members of the household especially during door to door visits has been the most effective communication tool within the IEC framework. Mass media channels are appropriate for creating awareness, but interpersonal interactions are essential for persuading individuals to adopt health or sanitation promoting behaviour. It tends to build the confidence of people who feel that the local government is actually trying to reach them personally and also mitigate any false information. The use of existing SHGs, community groups available in the area may also be utilized as vehicles for communication.

Others:

Traditional tools of communication like Kalajathas (musical/dance dramas), puppet shows, street plays etc. are developed from the beliefs, customs, and rituals practiced by the people. These are very old and deeply-rooted in Indian culture. It thus represents a form of communication employing vocal, verbal, musical and visual folk art forms, transmitted to a society or group of societies from one generation to another. This need to be specific in addressing the needs of the community and care should be taken for it to be both culturally and gender sensitive.

Organizing rallies, walkathon or any contest in a public setting can raise high media interest and carries sanitation messages into communities. Possible formats like SwachtaSaptah (cleanliness pledge), Cleaning Drive and official events are also supportive occasions to address sanitation and hygiene matters. Special annual events can be created to refresh awareness or to award communities/households for their performance.

Awareness activities for school children bring about the longest impact and result in quickly visible and sustained changes in the society. Children are active communicators and carry a lot of convincing powers. It is also easier to modify behaviour of the children through information sharing, increasing knowledge base and motivation. Regular meetings should be held with the school authorities for organizing school activities on the hygiene and sanitation issues. Appropriate activities as per the age and class of the children may be taken up in schools. Activities which engage both young boys and girls should be encouraged, as this contributes significantly to healthy socialization. Reinforcement of negative gender roles, stereotypical behaviours must be discouraged.

Step 6: Formulation of a detailed Action Plan for Awareness Generation

Once the target group and mode of communication is selected, a detailed action plan, including an exact timeframe, has to be developed. The detailed work plan will serve as a comprehensive blueprint to carry out the entire awareness raising campaign. The activities in the action plan may be categorized according to short, medium and long-term programming. The local Government can use the work plan to keep track of and monitor the activities and the progress of its awareness raising campaign. Resources both – institutional and financial should also be identified to support the implementation of the plan.

Step 7: Implementation an Awareness Raising Campaign

All the efforts of the previous steps that led to a detailed plan have to be put into practice. All identified awareness raising measures will be implemented, according to the detailed list of activities, the resources and approved budget after having done a pre-testing of the key materials. The whole implementation should be overlooked and coordinated by a team/committee of the local Government.

Implementation of Awareness Raising Campaign

- Indicate the issues to be covered as per social and cultural needs/ requirements
- Draft relevant messages for selected media
- Field test draft material and finalize material with selective target groups (include women, youth and children as target groups)
- Train the field workers/Municipal Corporations/NGOs/SHGs
- Monitor progress in the field

Step 8: Monitoring and Evaluation of Campaign

As per the parameters outlined in the awareness generation plan, the designated monitoring and evaluation team/committee should conduct regular monitoring and evaluation so that the local Government can measure the success of the campaign and its key messages as well as learn from mistakes. The programme should be monitored through an assessment of indicators for behavioural change and other targeted impacts.

Package of IEC Material[40]

Suggested communication tools for use in Solid Waste Management[41]

- Dance, drama, puppetry and street plays can be used as a part of long term strategy. These can also be used for making necessary information dissemination in residential colonies.
- Short films can be prepared for the benefit of citizens as well as the staff of SWM Department clearly indicating Do's and Don'ts.
- A wall magazine/poster can be prepared for information and dissemination in schools as well as in offices
- Drawing and essay competitions on SWM for school students should be arranged with prize incentives
- Campaigns and programmes should be arranged by involving celebrities. The role of female celebrities could be utilized to bring about specific awareness on women related issues, sanitary issues etc.
- Cooperation of spiritual leaders should be sought for propagation of the messages for proper solid waste management
- Municipal agencies, while licensing the fairs and festivals etc. should insists on the organizers to provide the banners with SWM messages
- All hoardings should carry a prominent line seeking cooperation of the citizens in maintaining the city clean
- A logo/mascot/slogan regarding importance of keeping cities should be coined/ framed with the help of expert agencies which should be widely adopted

40 Report of the Technology Advisory Group on Solid Waste Management, 2005
41 Used by Ahmedabad Municipal Corporation for preparing their IEC campaign

- The literature on best practices should be prepared and distributed to the citizens
- Note books for school children printed through Government agencies should carry the message on cleanliness campaigns
- Small booklets to serve as a ready reckoner on SWM should be prepared
- Magic shows/ simple magic program should be popularized which will propagate the ideas.
- Messages can be widely distributed by printing them on milk pouches, T shirts etc.

1.4.5 STEP 5: SCHEDULE FOR IMPLEMENTATION

Figure 1.13: Step 5: Schedule for Implementation

The MSWM Plan should address short term (5 years) and long term planning periods (20-25 years). The short term plan should lead to the achievement of the long term plan. Each short term plan should be reviewed every 2-3 years, to ensure higher success of implementing all plan activities. Based on the identification of service levels to be achieved during the short term, a detailed time plan should be prepared for actions to be undertaken in each year. The implementation plan should also include a detailed estimate of required human resources and investments.

- The long term plan should be further drilled down to identify short term action plans, associated with time lines for implementation. Each long term plan will typically consist of 4-5 short term planning cycles. Actions to be undertaken in each of these planning cycles should be clearly identified.
- The five year short term plan (as shown in figure 1.15) may be broken up into specific action plans covering various aspects such as institutional strengthening, community mobilization, waste minimization initiatives, waste collection and transportation, treatment and disposal and other policy changes as may be deemed necessary.

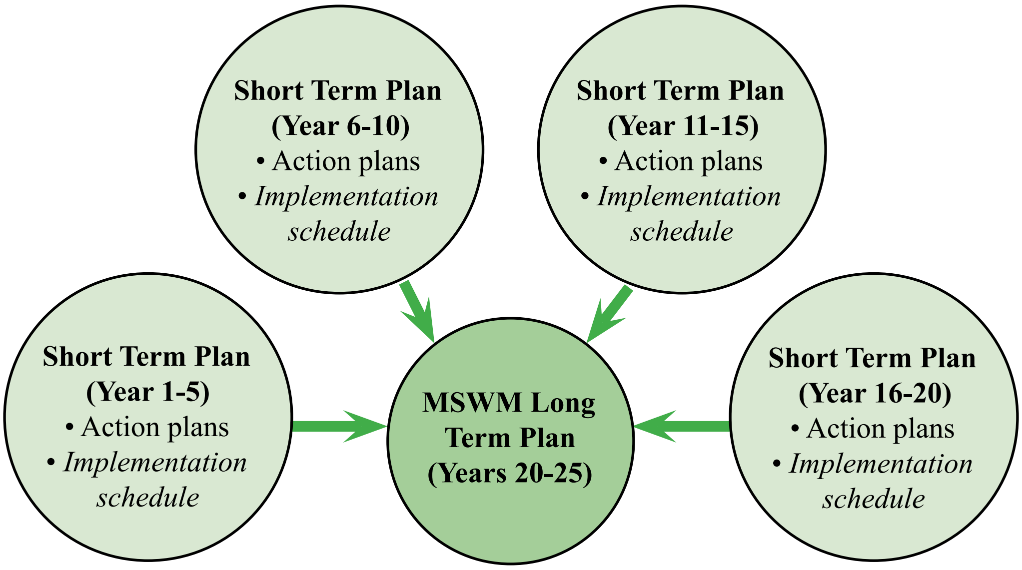


Figure 1.14: Components of the MSWM Plan

- The financial outlay required for each action plan is to be elaborated and sources of finance need to be ascertained in the planning phase. Financial planning also has a direct impact on the contracting mechanisms to be adopted.
- Multi-year actions are to be further elaborated on a yearly basis, with a cost attached to each year's implementation. Clear definition of the roles of various stakeholders of the action is to be elaborated, and adequacy of requisite manpower is to be ascertained.
- ULBs may need to enhance the technical capacity of MSWM staff, in order to plan and execute the MSWM Plan in a financially viable and sustainable manner. A detailed yearly and equitable staffing capacity & training requirement is to be prepared and any identified gaps are to be filled before implementation of the action plan.

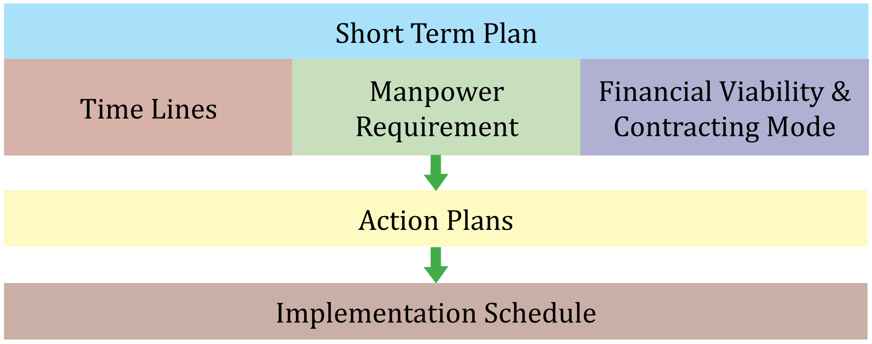


Figure 1.15: Components of a Short Term Plan

1.4.6 Step 6: Stakeholder Consultation For MSWM Plan Validation

Figure 1.16: Step 6: Stakeholder Consultation for MSWM Plan Validation

The draft MSWM Plan, complete with action plans and an implementation schedule is to be presented to and accepted by the stakeholder committee which provided inputs to the draft plan. (Step 3 of the planning process).

Based on the feedback of the stakeholder team, further revisions to the plan may be required.

1.4.7 Step 7: City Council Approval For MSWM Plan

City Council ratification of the Draft MSWM Plan along with an agreed implementation schedule is vital for future implementation

After due consideration of the recommendations of the stakeholder committee, the revised plan is to be submitted to the City Council of the ULB or equivalent body for validation and adoption as an official plan.

The City Council should concur with the provisions of the plan including proposed tariff and revenue collection mechanisms, modes of engagement of private sector, implications on existing and proposed municipal staff and proposed locations of waste management facilities.

Changes to any of these elements of the plan would have larger implications on the viability of the plan and should be duly noted and addressed before finalization of the plan. The final plan, after any such changes is to be clearly communicated and presented to the Council for final ratification.

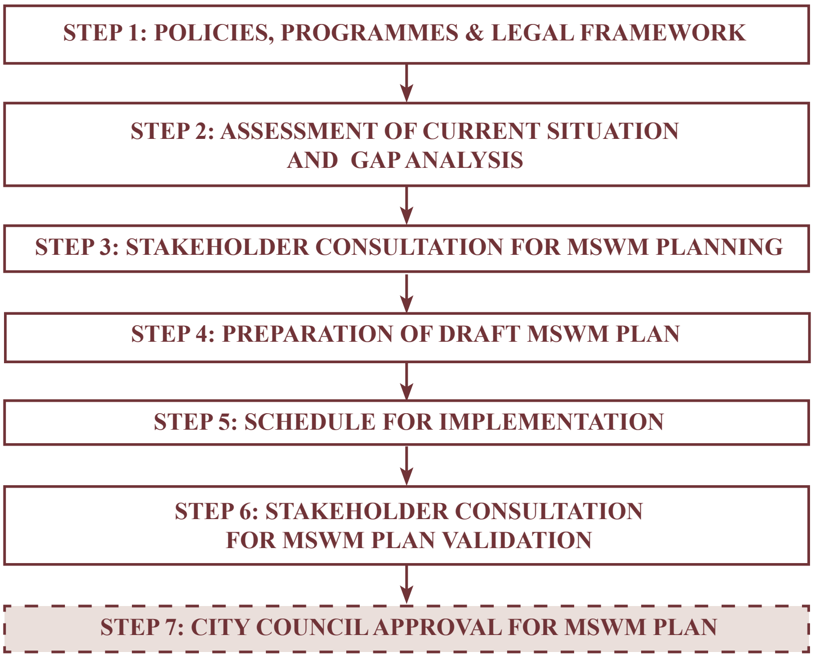


Figure 1.17: Step 7 in MSWM Plan

Subsequent chapters give details of technical aspects required for developing nad implementing a MSWM plan. Further details of plan implementation and monitoring of service provision are detailed in chapters 5 and 6.

Chapter 2:

Technical Aspects: Collection, Segregation and Transportation

2. Technical Aspects: Collection, Segregation and Transportation

2.1 Waste Minimization (At Source Reduction And Reuse)

2.1.1 Waste Minimization In ISWM Hierarchy

The ISWM (Integrated Solid Waste Management) hierarchy of waste management prioritizes waste minimization (reduction at source and reuse) as the most preferred waste management strategy. (figure 2.1)

At Source reduction is the most preferred tier in the ISWM hierarchy because of its potential to directly reduce the quantity of waste generated and hence reduce associated financial and environmental costs

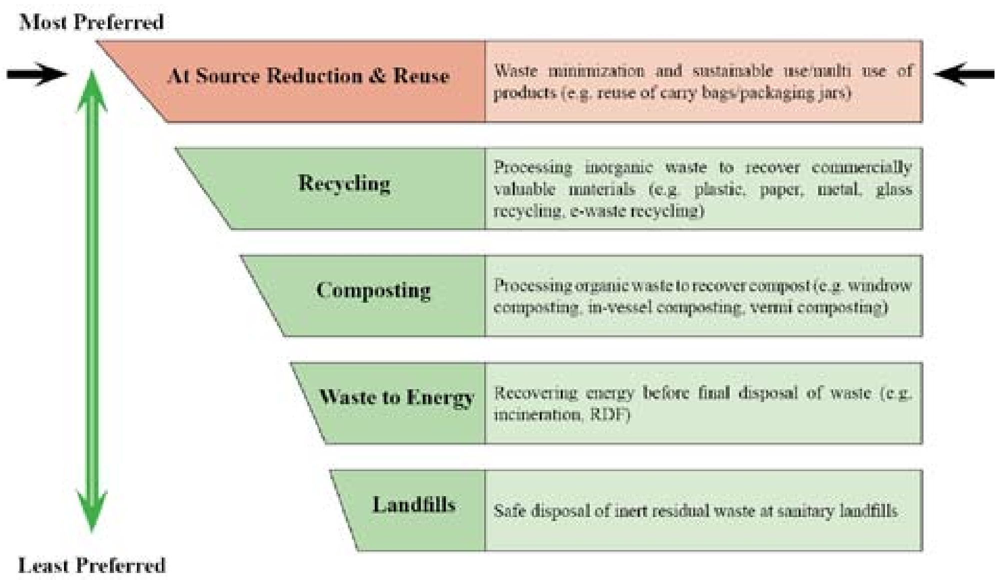


Figure 2.1: Waste Minimization in the ISWM Waste Hierarchy

Waste minimization results in reducing the amount and/or toxicity of the wastes produced. Minimization is the most preferred waste management strategy in the hierarchy as it reduces the quantity of waste to be handled, the cost associated with its handling, and its environmental impacts.

2.1.2 Need & Benefits Of Waste Minimization

It is estimated by State and regional offices of the CPCB that urban India generated 1,27,486 Metric Tonnes[1] of municipal solid waste per day in 2011-12. Of this waste 40-60% is organic and 10-20% are recyclables. The associated cost for processing and disposing

[1] Status Report on Municipal Solid Waste (2011-2012), CPCB

80%[2] of this waste, at an average cost of 1,000 INR per MT is approximately 10 Crores INR per day. Waste minimization results in savings, which accrue through avoided collection, treatment and disposal costs.

Waste minimization includes activities that reduce waste generated as a result of product creation and use. It also encompasses those activities that increase product durability, reusability and reparability.

Reduction in the use of environmental and material resources accrues as a result of waste minimization programmes. In addition, the rapidly decreasing land bank in urban areas, rising costs of procuring land for processing and disposal and associated environmental impacts are all critical and significant reasons to promote waste minimization. Disposal of waste results in large scale emissions of greenhouse gases (GHG) methane (CH4) and Carbon dioxide (CO_2), waste minimization would lead to a reduction in GHG emissions and associated climate change impacts.

2.1.3 Strategies For Waste Minimization

Waste minimization strategies require policy interventions at the National, State and/or local level, depending on the type of the intervention (e.g., minimizing use of packaging material, promoting use of refill containers, buy back reusable or recyclable packing material introducing national deposit system on beverage packages) and the scale at which the intervention needs to be initiated for effective implementation. Initiatives which require a behaviour change in the community need to be supported by consistent awareness programmes.

Source reduction could include various strategies such as EPR, tax incentives and eco-labelling standards. Establishment of eco industrial parks supports source reduction.

2.1.3.1 Waste Minimization Strategies Requiring A National Or State Level Directive

Extended Producer Responsibility (EPR) is a policy approach, wherein, a producer is held responsible for the post-consumer stage of a product, typically for defined tasks of separate collection (e.g. for hazardous waste components), reuse (e.g. disposal-refund systems for bottles), recycling (e.g. for used cars) and / or storage and treatment (e.g. for batteries). EPR programs are commonly made mandatory through legislation, but can also be adopted voluntarily (i.e. retail take- back programs).

The advantages of EPR systems include:

- Reduction in natural resource demands of packaging and product containers
- Create incentives for environmentally friendly product designs
- Reduce waste disposal costs for ULBs

2 Assuming that 20% is recycled and does not enter the municipal solid waste stream to be processed

- Provide a monetary incentive to the consumer to return the product or package
- Create infrastructure for collection and recycling of material

Extended Producer Responsibility (EPR) around key problem wastes like electronics, batteries, packaging and consumer durables (e.g. home appliances, electronics, home and office furniture) is essential for their appropriate disposal. Extended Producer Responsibility (EPR) policies are usually legislated at State and National levels.

EPR tools are documented in the box below:

Typical EPR Tools include:
- Deposit Refund Systems
- Quotas
- Product Bans
- Product Charges
- Collection systems

Typical EPR Tools[3]

- **Deposit-Refund Systems** (also known as beverage container deposit legislation and bottle bills): Producers charge the consumers an additional disposal fee, which is refunded upon receiving the used container. In the beverage industry, used glass bottles and aluminium cans are collected by the seller from the user and the deposit is refunded, for e.g. reusable soft drink glass bottles and large sized mineral water containers. Lead acid batteries are also taken back through the deposit-refund system, by manufacturers. **Example:** In 2003, Germany introduced a mandatory Deposit-Refund System for certain one-way beverage packaging, which is defined as ecologically disadvantageous. The main goal is to discourage this packing in the market.
- **Quotas:** Government authorities stipulate that a certain percentage of product content/ products/packaging material should be from recycled material. **Example:** Germany has set a requirement in its previous packaging ordinance that 72% of beer and soft drink containers be refillable. If the quota is not achieved, a mandatory deposit system will enter into force. Through an amendment of the ordinance, most beverage one-way containers are subject to the mandatory deposit system.
- **Product Bans:** The threat of product bans motivates producers to phase out undesirable materials, to design for recyclability and ensure high rates of reuse or recycling. **Example:** In Sweden, the voluntary deposit system for aluminium cans results in achieving the government mandated recycling rate. The driver behind the deposit system is the potential for a 'can ban' if the rates fall below the recycling rate set by government.

"Godrej" has a 'No Packaging Policy' for refrigerators'. The company ensures that the packaging, in which the appliance is delivered, is taken back by the supplier and reused

3 Extended Producer Responsibility: Container Deposit Legislation Report. Available at: http://www.zerowaste.co.nz/assets/Reports/Beveragecontainers.pdf

- **Product Charges:** Product charges influence the choice of materials used. An eco-tax levied on PVC in Belgium increased the cost of the product and reduced consumption of this polymer.
- **Collection Systems:** Producer and/ or the retail trade can be made responsible for taking back packages and used products such as batteries and CFL. **Example:** Germany adopted in 1991 the first Packaging Ordinance, which makes industry responsible for collecting packages.

In India, the informal sector (kabadi system) is largely involved in collection of recyclables and material recovery. EPR initiatives which integrate and encourage informal sector participation in collection of recyclables from consumers benefit from the increased collection efficiency that this sector is able to achieve, which may then result in lower supply chain costs (collection costs).

Additionally, the National or State Government can promote initiatives which would encourage adoption of waste minimization oriented practices:

- Promotion of voluntary action: Encouraging business groups to reduce volumes of packaging, while maintaining the requisite strength.
- Authorizing local authorities to frame rules and local bye laws and enact local ordinances banning use and/or sale of certain types of products and packaging that cannot be reused, repaired, recycled, or composted. National/State level legal frame work and policy should also mirror such ordinances, to better enable local authorities to enforce such ordinances, laws and rules.
- Develop eco-labeling standards based on potential for waste reduction due to product packaging and potential for recycling/ reuse
- Promote development of eco-industrial parks, which are industrial areas where in material and resource exchange synergies, are established between businesses and industries. Such parks might operate facilities for recycling and product reuse processes.

Shimla city was able to effectively enforce a full ban on plastic carry bags in the city, only when the Himachal Pradesh State government passed legislation on banning their use.

A ban on non-biodegradable packaging for 25 kinds of edible food stuffs has also been enforced by the Himachal Pradesh State government, forcing perishable food manufacturers to adopt biodegradable packaging.

2.1.3.2 Waste Minimization Initiatives Requiring ULB Support/Action

- Promoting and implementing awareness and education programs that address different stakeholders: Residential, commercial and industrial educational programs that increase public awareness and participation in at source reduction programs.
- Developing and promoting at source reduction programs in the community, e.g., domestic composting programs that reduce the volume of food waste, leaves and garden trimmings entering the collection system.
- Campaigns for reducing the use of specific non-recyclable, non-reusable or toxic material. Practicing and promoting material substitution where possible. (Promoting the use of rechargeable batteries instead of single use batteries)
- Bans within local authorities' jurisdiction (see also National / State level initiatives above): Replacing disposable materials and products with recyclables and reusable materials and products (e.g., banning the use of plastic bags).
- Green Procurement & Take Back programmes: Whereby the suppliers of a product to the municipality are responsible for providing a take back program and to promote the recycling of e.g., computer monitors, auto oil, batteries, paper etc. Procurement programmes in the government and businesses should be designed to give preference to recyclable products.
- Local businesses should be encouraged to reward consumers for returning recyclable products/ products which are toxic (e.g., batteries). EPR programmes by manufacturers are a pre-requisite to these initiatives (see section 2.1.3.1 above).
- Educational and on-site business & industry assistance programs should be promoted that advise businesses how to use materials more efficiently and reduce waste generation.

International case studies on waste minimization are given in Annexure 3.

Examples of Onsite Business Assistance Programmes

- Reducing office paper waste by implementing a formal policy to duplex print all draft reports, and by making training manuals and personnel information available electronically.
- Improving product design to use less material.
- Redesigning packaging to eliminate excess material while maintaining strength.
- Working with customers to design and implement a packaging return program.
- Switching to reusable transport containers.
- Purchasing products in bulk.

In many international communities, household waste disposal fee is directly proportional to the quantity of waste disposed and segregation achieved.

- Supermarkets & retail stores are often some of the most effective partners for a municipal waste minimization programme. These provide a central & consistent point for consumer education, packaging reduction projects and collection centers for recyclable waste.
- Promoting materials exchange and reuse programs that divert materials from the waste stream which will eventually go to the landfill, e.g.: Programs which link sellers of used furniture with potential second hand furniture buyers.
- Establishing incentives for at- source reduction through the principle of "pay as you throw", supported by bye-laws. Urban local bodies can collect variable solid waste management charges, based on the quantities being disposed per household/ establishments. Variable rates can be fixed for pre-defined ranges of waste quantities, progressively increasing with waste generation rates. This would also imply that the ULB has the resources to record waste generation quantities. This system will function successfully only if the progressively increasing tariff is restrictive enough to prevent waste generation.

2.1.4 Developing A Waste Minimization Programme In Local Authorities

- Waste minimization programmes should be spearheaded by local authorities, not only to ascertain a cohesive and coordinated approach, but also to ensure that the requisite backward linkages (e.g. segregated collection of recyclables) and forward linkages (e.g. market linkages for recycling and reuse) are developed along the material supply chain, to support re-processing of material, which would otherwise enter the municipal waste stream. EPR initiatives and initiatives including local businesses and recycling industries are critical for the success of these programmes. Planning for waste minimization programmes would be a part of the overall MSWM planning process as described in detail in chapter 1 of Part II this manual. The typical process for developing a minimization programme includes several steps which are laid out in figure 2.2.

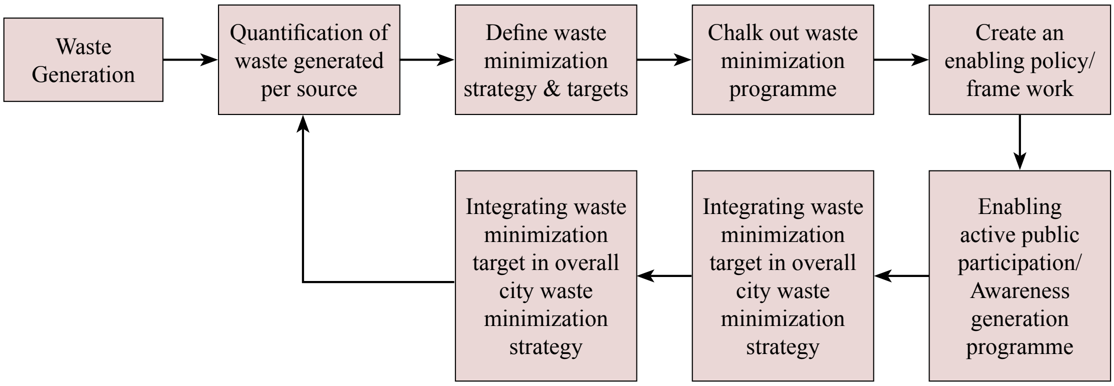


Figure 2.2: Developing a Waste Minimization Program

- Identification and quantification of main contributors to the waste problem (local Waste Information Data System is required).
- Definition of sectoral waste minimization potentials and targets (residential, organic market waste, institutional waste, MSW from business& hospitals).
- Identification/Adoption of appropriate programmes for waste minimization, targeted at producers and generators. Programmes should be well defined, considering viable and efficient collection and recycling systems. Supporting proposed programmes with required municipal bye-laws to ensure implementation.
- Developing an institutional mechanism with all relevant stakeholders to facilitate implementation of the programme.
- Assess the capacity of the ULB to implement the programme and seek external expertise if required.
- Active awareness raising campaigns advertising the targets, programmes and modes of involvement of stakeholders. Targeting school children, women groups and actively engaging with the business community is a must.
- Integrating waste minimization targets in the overall waste management strategy of the city.

- Periodic monitoring of mid-term targets and strengthening institutional arrangements and reviewing stakeholder responsibilities. Ensure an annual review of targets and achievements.

2.1.5 Ensuring Feasibility Of Waste Minimization Programmes

For a successful waste minimization programme, technical expertise, institutional mechanisms, market linkages and regulatory and penal provisions are a pre requisite.

Waste minimization programmes should always be supported by requisite expertise (either in-house or contractual), institutional mechanisms, market linkages, access to robust recycling technologies, as well as regulatory and penal provisions, if needed. Actively involving all stakeholders right from the target setting and planning process is a pre-requisite for implementing waste minimization initiatives. Involvement of the state government to pass certain ordinances may also be required, depending on the nature of the programme. A strong local leadership, like the Ward Councilor and/ or a local champion is usually the driving force behind the success of such initiatives.

2.2 Source Segregation

Source segregation is the setting aside of inorganic and organic waste at their point of generation by the generator. Separating waste at source ensures that organic and inorganic waste is less contaminated and can be collected and transported for further processing. Segregation of waste also optimizes waste processing and treatment technologies. It results in high proportion of recyclables that could be recycled and reused leading to less consumption of virgin material. Indirectly, source segregation also impacts climate change and has many other advantages which are discussed below in this section.

2.2.1 MSW Rules' Requirements On Source Segregation

Rules: Schedule –II, Clause 2: Segregation of Municipal Solid Waste

"In order to encourage the citizens, municipal authority shall organise awareness programmes for segregation of wastes and shall promote recycling or reuse of segregated materials. The municipal authority shall undertake phased programmes to ensure community participation in waste segregation. For this purpose, regular meetings at quarterly intervals shall be arranged by the municipal authorities with representatives of local resident welfare associations and non-governmental organizations."

2.2.1.1 Segregation Of Municipal Solid Waste At Source

Waste should be stored at the source of waste generation till it is collected for disposal by ULB staff or appointed contractors. It is essential to segregate wastes into wet waste (kitchen waste) and dry waste (recyclable waste and others), commonly referred to as primary segregation. Segregation of municipal solid waste needs to be linked to primary collection of waste from the door step and given high priority by the ULBs; unless door to door collection of segregated waste is practiced by the ULBs, source segregation by waste generators will remain a meaningless exercise.

The local community should be educated and enthused to perform the following actions to ensure collection of segregated waste:

- At the household level MSW should be segregated into wet and dry fractions, at a minimum, and stored in separate containers.
- Waste should be placed at the door step before the appointed time, in segregated containers.
- Ensure domestic bio-medical waste and other special wastes (e.g. batteries, used CFLs, tube lights, chemical/paint/insecticide containers etc.,) are handed over separately at the door step or at special pick-up points specified by the municipal authority or through the relevant retail trade (e.g. for batteries). As long as there are no specific pick-up points/services for collecting such waste, these wastes may be handed over along with the dry waste fraction as an interim solution.
- Diapers and sanitary napkins should be wrapped securely before being put in the bin meant for dry waste, for the protection of the waste handlers and should be marked with a “Red Cross” to enable further segregation and disposal in municipal sanitary landfills or incinerators, as applicable to the local context. The Bruhat Bangalore Mahanagara Palike (BBMP) has set up domestic sanitary waste collection centres in 22 wards, where citizens may also drop-off such wastes, in addition to other dry recyclable waste.

MSW (M&H) Rules, 2000 mandate segregation of waste into two categories:

- Wet waste (kitchen waste)
- Dry Waste (Recyclables and others)

After achieving basic segregation of wet and dry fractions, ULBs should aim to move towards BASIC+ segregation, segregation of the dry stream into four different fractions

Segregation of Municipal Solid Waste – Basic Principles

At the very minimum, waste should be segregated by waste generators into two fractions – wet fraction (green container) and dry fraction (blue container), indicated as BASIC segregation. Based on further processing of waste, local authorities may direct waste generators to further segregate the dry fractions of waste into four fractions (BASIC+ segregation) – 1. Paper and cardboard 2. Container and packaging of all kinds including plastic (excluding containers of hazardous waste) 3. Rags, rubber, wood, discarded clothing, furniture 4. Metal, glass and inerts.

Municipal Authorities should:

1. Ensure primary and secondary collection & transportation of segregated waste streams consisting of at least two fractions, wet and dry. These wastes should not be mixed during collection and transportation.

2. Further segregation of waste (as indicated in Table 2.1) should be attempted once two-bin segregation is achieved.

3. Establish collection systems (e.g. community pick-up points or delivery systems through the retail trade) for special waste generated in the households. Waste may be collected from these facilities once in 15 days or as found appropriate by the ULB.

4. Till such time dedicated collection systems are not established for special waste, special waste should be collected as part of the "dry waste"

Table 2.1: Indicative List for Segregation of Household Wastes[4]

BASIC SEGREGATION					
Wet Waste (Green bin)	**Dry Waste (Blue bin)**				**Special Waste[5]**
	WITH FURTHER SUB-SEGREGATION BASIC+				
Food wastes of all kinds, Cooked and uncooked, including eggshells and bones, flower and fruit wastes including juice peels and house-plant wastes Soiled tissues, Food wrappers Paper towels	Paper Cardboard and cartons	Containers & packaging of all kinds excluding those containing hazardous materials Compound packaging (tetrapak, blisters etc.) and plastics Packaging of all kind	Rags Rubber Wood Discarded clothing Furniture	Metals Glass (all kinds) Inerts House sweepings and inerts (not garden, yard or street sweepings)	Printer & printer cartridges Electronic parts and equipment Batteries from flashlights and buttons cells. Lights bulbs, tube lights and Compact Fluorescent Lamps (CFL) Chemicals and solvents and their empty containers Paints, oil, lubricants, glues, thinners and their empty containers Insecticides, pesticides and herbicides and their empty containers Photographic chemicals Bleaches and household kitchen & drain cleaning agents Car batteries, oil filters and car care products and consumables Thermometers and other mercury containing products Discarded medicines Injection needles and syringes after destroying them.

4 Adapted from the Manual on Municipal Solid Waste Management, CPHEEEO, MoUD, GOI, 2000

5 To be stored and disposed separately

"A Journey towards a successful waste management system leading to a landfill-less city"

Location: Panaji

Year of start: 2003

Main Players: Corporation of Panaji (CoP), Schools and College Staff & Students, RWAs, local leaders/celebrities

Approach: Panaji, the capital of Goa, is a city with a strong cultural heritage. Apart from being a popular tourist destination, it is also an administrative center and commercial hub for the State, under the strong political will and administrative leadership of the Municipal Commissioner, a comprehensive city revitalization campaign was launched with an intention to improve sanitary conditions and solid waste management in the city. The 'Bin Free in 2003' campaign was part of an initiative called "Together for Panjim" which was launched to improve sanitary conditions in the city. Under this initiative the following strategies were adopted for bringing about significant improvements in the solid waste management system.

Technical Strategy:

- Community bins were substituted by trolley bins as an intermediate stage of transfer.
- Modifications were made in the hydraulic arm of the garbage trucks to enable transfer of waste from the trolley bin into the truck without manual intervention.
- Segregation at source was initially introduced as wet and dry segregation, into in 2 bins.
- Household bins with screw on lids were designed in order to prevent spillage of garbage by stray animals when households kept waste outside for collection.

Segregation of dry waste into 8 streams

Currently, segregation at source is undertaken in 8 clear streams of waste (wet, paper, plastic bags, metals/ glass, non- recyclable, tetra-packs, cardboard, plastic bottles) with designated colour coding for all the mentioned waste fractions.

- Material Recycling Stations were established within colonies for further segregation of dry waste.
- Decentralized Composting units were constructed for converting wet waste into manure for the community usage. Hotels were also asked to install decentralized composting units in their premises.


Composting units in housing societies

- Tie-ups with various recycling units for selling bulk segregated waste.
- Extended Producer Responsibility(EPR) initiatives through innovative measures like:
  - tie-ups with local dairies for paying residents a specified amount for returning washed empty plastic milk bags at the local dairy booths.
  - tie-up with Tetrapak Company, for buy back of empty tetrapak containers.
- Co-processing plastics and other dry fraction rejects in the cement industry:
  - Two baling machines of the sizes 1ft x1ft and 1m x1m for bailing dry fractions/ plastic waste for different cement plants, were designed and bailed waste was sent to 4 different cement plants, located at distances varying from 250 to 600 km from CoP, for co-processingof plastic and other dry waste.
- Hazardous waste like batteries and tube lights were segregated and once sufficient quantities obtained, are transported to the Hazardous waste - Treatment Storage and Disposal Facility (TSDF) site in Karnataka.
- E-waste and thermocol are collected separately, but currently no tie-ups exist for them.


Segregated transport

Institutional Strategy:

- A Solid Waste Management Cell was formed in the CoP, headed by a Waste Management Officer.
- The field services are headed by a Sanitary Inspector who is in-charge of 15 supervisors to oversee the collection and transportation of each zone.
- Intensive monitoring by the Corporation staff.

- Centralized complaint redressal system established with a 24 hour helpline number to clear any uncollected/ unattended garbage. Quick response vehicle designated for the purpose.
- Adequate health and safety measures provided to the sanitary workers.

Public Communication Strategy:

- To initiate the segregation process at the household level, green and black bins were initially provided to the residents at subsidized rates.
- For increasing community participation in this drive, the Municipal Commissioner and the Waste Management Officer organized community meetings to disseminate the details of the management system, it's functioning and the segregation of waste at household level.
- As part of the campaign, cultural programs like music festivals, fairs, carnivals were held with a theme and message of civic hygiene and responsibilities of citizens towards maintaining cleanliness in the city.
- Involvement of schools and colleges in the campaigns.
- Waste management was introduced to children from primary school onwards and children learn the different colour codes for the segregation in school.

Financial Strategy:

- User charges have been introduced by CoP and are collected by the supervisors. The supervisors maintain the ward wise accounts, are responsible for payment of cash incentives to the collection and transportation workers and deposit the surplus amount with the CoP.
- Other revenue sources include:
  - Sale of compost
  - Sale of segregated waste for recycling like plastic bottles, cardboard boxes, etc.
  - EPR initiatives – like Tetrapak
- Costs are incurred by CoP for bailing and transporting waste for co-processing to cement plants. This acted as an incentive for increasing recycling tie-ups with other players in the market.

Outcome:

- 100% collection of segregated waste from the households as well as further sorting at the recycling stations in 8 streams of waste.
- Active involvement of ragpickers, women volunteers/ SHGs in streamlining the waste management system.
- Segregated waste transported to the recycling units and compost units for further processing.
- Improved recycling efficiency through market creation and tie-ups for PET bottles, plastic bags, etc.
- Minimized waste to landfill through effective management by co-processing waste fractions and sending hazardous waste to Treatment Storage & Disposal Facility (TSDF).

Success factors:

- Clarity of vision for the city coupled with a strong and stable leadership
- Institutional and managerial model within CoP established.
- Technical innovations for segregation, minimal manual handling of waste, co-processing, EPR, tie-ups.
- Intensive campaigning, meetings with RWAs on the overall concept of segregation at source. Active involvement of youth, local celebrities, corporation staff, community for awareness generation activities. Including the waste segregation system in the school curricula from primary level onwards.

Overall Sustainability:

The expenditure on the solid waste program has been managed entirely from the corporations own sources. Collection of user charges and the various recycling initiatives have resulted in the financial sustainability of the project. The cash incentive scheme for the workers has ensured the program is running on the ground. Surplus fund is deposited with the Corporation for later utilization/ innovation.

Location & Intervention: Source Segregation of Municipal Solid Waste and its Institutionalization at Kochi

Year of Start: 2007

Main Players: Corporation of Cochin, RWAs, Ward Committees, Kudumbashree, CREDAI (The Confederation of Real Estate Developers Association of India), Rotary Club and Other CBOs/NGOs

Approach: In 2002, the Corporation of Cochin (CoC), based on an earlier pilot initiative, decided to scale-up waste segregation at source and door to door collection initiatives as part of an integral solid waste management strategy. The poor situation of solid waste management in the city triggered acceptance of these systems by various stakeholders. The CoC initiated a city wide process of segregation at source at the ground level as a joint initiative with, community representatives, Kudumbashree, RWAs/ NGO and CREDAI. The following integrated approach was adopted covering institutional, managerial, legal, financial and IEC initiatives/improvements to achieve source segregation.

Institutional:

- Ward level Sanitation Committees were formed with the respective ward Councilor as chairman and Junior Health Inspector, representatives of RWAs, Kudumbashree, CREDAI, NGOs etc. as members for each ward.
- Health and safety measures were provided to the sanitation workers partially.
- CoC has provided two different color bins free to households -green (wet waste) bin of 15l capacity and white (dry waste) bin of 10l/capacity to all households.
- CoC provided three wheeler cycles/pushcarts and auto rickshaws to the wards for door to door collection.
- CoC provided trucks and regular workers for onward transporting of MSW at the ward level collection.

Managerial:

- Out of 74 wards, 15 wards are being served by Kudumbashree (self -help groups of women) and the remaining 59 wards are served by contracted workers of the RWAs/ NGOs and CREDAI (serving in high rise apartments registered under CREDAI).
- In addition to this, CoC's regular sanitary workers were also involved.

Legal:

- CoC passed bye-laws in 2008 in order to make segregation mandatory and stringent penal provision have been provided in case households do not provide segregated waste to the waste collectors.
- Initially a patrolling system was designed to monitor illegal dumping, collection and transportation of waste. The monitoring is done in shifts and a spot fine ranging from Rs.250 to 10,000 is charged, depending on the quantity & quality of waste during illegal dumping.
- CoC also levied fines on transportation contractors for not transporting segregated waste from HHs.

Financial:

- User charges were introduced by the CoC which are collected @Rs. 30 - 80/ household and @Rs.100-200/commercial establishment.

IEC:

- Members of the ward level sanitation committees organized the meetings with residents, interacted with communities regarding the concept and importance of segregation.
- Simultaneously under IEC and awareness generation activities among citizens, CoChas published various brochures, pamphlets and involved print and electronic media for disseminating necessary information on segregation at household level.

Outcome:

- Collection of 80% segregated waste from households in form of wet and dry fractions.
- The collection system as developed by RWAs, Ward level committees, Kudumbashree, CREDAI integrated rag-pickers on contractual basis as waste collectors.
- Door to door collection and segregation at source ultimately led to a bin free city as well as reducing the amount of waste to the landfill.
- Segregated waste was transported to the processing plant.

2 differently coloured bins, 12-15 litres each per household are recommended to promote and ensure segregation:

- Covered Green Bin: Wet waste
- Covered Blue Bin: Dry Waste

Success Factors:

- Institutional and managerial models were established.
- Intensive interactive meetings on the overall concept of segregation with residents and citizens of wards held by the Ward Council, Corporation officials, Councilors as well as representatives of NGOs & Sanitation committees.
- Ensuring effective community participation to adapt to the new system.
- Development and dissemination of the communication tools on a regular basis to the communities.
- Active involvement of educational institutions, NGOs, local celebrities for awareness generation activities.

Overall Sustainability:

It is a self-sustainable working model with no direct financial involvement from the municipal budget except for provision of physical infrastructure like hand- carts and O&M of transportation system. The collection system is completely managed by the RWAs, CREDAI and Kudumbashree. User charges are collected directly by the door-to-door waste collectors and are used for funding the salary of the workers. The collection and segregation system in Kochi is sustaining on its own since 4 years from its inception.

2.2.1.2 Storage Of Municipal Solid Waste At Source

2.2.1.2.1 Household Level Storage

Number and capacity of bins required depends on quantity of waste to be stored before collection plus an additional 100% storage to avoid spillage.

At the household level dry waste and wet waste should be stored in separate garbage bins, of appropriate capacity and colour (as indicated in Figure 2.3). Wet waste is to be placed in a covered green bin and dry waste in a covered blue bin. Capacity of bins depends on frequency of collection (daily, alternate day or on demand) and quantity of waste generated.

A container of 12 to 15 liter (0.015 m^3) capacity for a family of 5 members should be adequate for dry and wet waste each, if collection takes place daily. However, a household may keep larger containers or more than one container to store the waste produced in 24 hours having a spare capacity of 100% to meet unforeseen delays in clearance or unforeseen extra loads. If dry waste is not collected daily, container capacity has to be enlarged accordingly. Wet waste collection bins should be washed by the household each time they are emptied. It is not desirable to use plastic bags in waste bins[6].

In large apartment complexes and multistoried buildings large sized waste collection bins, for both wet waste and dry waste, should be placed at a convenient location. Residents in such buildings/complexes should deposit segregated waste in the respective bins either themselves or through the Resident Welfare Association (RWA)/ Community Based Organization (CBO) organized door-to-door collection system. Specification of bins and containers shall be compatible with primary collection vehicles.

Typical specifications for bins used in apartment complexes and large buildings:

60 liters (25 kg) garbage bins suitable for 12 households, 120 liters (24 kg) garbage bins suitable for 24 households or 240 liters (96 kg) garbage bins suitable for 48 households, etc. of standard quality, HDPE, injection molded, UV tested, durable and withstand rough handling, ,and compatible with lifting mechanism on primary collection vehicle, if applicable. The specific size of the containers depends on the number of connected households and the frequency of collection.

Figure 2.3: Bins for collection of dry waste and wet waste[7]

2.2.1.2.2 On-site storage of bulk wastes

Shops, commercial establishments and businesses should store segregated waste on-site. Whereas vegetable and flower market waste generators should deposit their waste in conveniently located large green bins. Number and capacity of bins required may

[6] As per Plastic Waste Management Rules, 2011

[7] Source: Rodrigues, S., 2013,"Panjim's Initiatives in Solid Waste Management", Available at:http://iipnetwork.org/Rodriguez_Towards-Green-Trash)

be computed by considering quantity of waste to be stored before collection plus an additional 100% storage. Storage bins should be compatible with the primary collection system, avoiding multiple handling of waste.

Typically four wheeled, HDPE, injection molded, international standard, UV tested bins or metal bins of different capacities, for instance for 240 litres (96 kg), 600 liters (270-280 kg), 770 liters (315-350 kg), 1100 liters (449 – 495 kg), may be used for bulk waste. These bins should be compatible with auto lifting by standard universal bin lifting device on mobile compactors and other vehicles.

2.2.1.2.3 Storage of municipal solid waste in public places/parks

Figure 2.4: Typical waste collection bins in parks& along walk-ways

Adequate number of bins at optimum distance (between 25-250 meters) should be placed at public places to avoid littering

With a view to ensure that streets and public places are not littered with waste, litter bins (as shown in Figure 2.4) may be provided on important streets, markets, public places, tourist spots, bus and railway stations, large commercial complexes, etc. at a distance ranging from 25 m to 250 m depending on the local condition. The waste collected should be segregated into wet and dry waste.

2.2.1.3 Storage Of Yard Waste/Garden Waste

On site composting of yard waste/ green waste should be promoted

Bulk generators of garden waste/yard waste should store green waste on site. In large cities, the municipal authority may provide large containers or facilitate provision of large containers/bins through private sector participation for storage of such waste.In small cities such waste may be stored at site and the municipal authority may facilitate its periodic collection, either through the SWMdepartment orby involving the private sector. The skip bins/containers shall be of a standard design, amenable to automatic hydraulic lifting and unloading by a transport vehicle. This waste should not be mixed with domestic waste. The local authority should however promote on site composting of such waste by the waste generators.

2.2.1.4 STORAGE AND PROCESSING OF SPECIAL WASTES

Special wastes are a category of wastes generated by residential/commercial/institutional facilities which are regulated by Rules other than the MSW (M&H) Rules, 2000 and consist of the fractions mentioned in the box below.

Special Waste Categories from households

- Printer cartridges, electronic parts and equipment
- Batteries from flashlights and button cells
- Bleaches and household kitchen & drain cleaning agents
- Car batteries, oil filters and car care products, consumables
- Chemicals and solvents and their empty containers
- Insecticides, pesticides and herbicides and their empty containers
- Light bulbs, tube-lights and compact fluorescent lamps (CFL)
- Paints, oils, lubricants, glues, thinners, and their empty containers
- Photographic chemicals
- Thermometers and other mercury containing products
- Discarded medicines, injection needles and syringes, after destroying them
- Fish/meat waste
- C&D waste

Special wastes can pose a substantial or potential threat to health and environment, because of their constituents which may be hazardous in nature.

A municipal waste component is said to be of hazardous nature if it contains one of the following characteristics.

1) Ignitability
2) Corrosivity
3) Reactivity
4) Toxicity

All waste generators should be directed by the municipal authority not to mix domestic special waste with either the wet waste or dry waste, but to store such wastes separately and hand over to the special waste collection centers, which should be established by the urban local bodies, and/or to collection schemes through retail trade.

Manufacturers and suppliers of products resulting in special wastes, should be encouraged to develop such "take back" systems, and treat and/or recycle such wastes, as appropriate.

MSW waste having hazardous components have to be distinguished from hazardous wastes, as defined by the Hazardous Waste (Management & Handling) Rules, 2000 generated by commercial and industrial units. Hazardous wastes should be disposed by the generating unit at the nearest Treatment, Storage and Disposal Facility as per prescribed procedures. Local authorities can also hold other hazardous waste manufacturers accountable, under aforesaid rules. E-waste shall be segregated at source and shall not be mixed with municipal solid waste. Special wastes are covered in detail in chapter 7 of Part II.

2.2.2 Public Participation & Awareness

Building community awareness and consensus is essential for ensuring community participation in storage of segregated waste

Municipal authorities should organize awareness generation programmes promoting segregation of waste and recycling or reuse of segregated waste. The community should be educated, informed and trained on waste segregation. ULBs should sensitize citizens to possible environment and health hazards of improper waste management.

This process is most effective when lead is taken by the Mayor/Chairperson and Chief Executive of the ULB and prominent people are involved in the campaign to motivate the society at large. Sustained efforts to motivate the citizens over a period of 15 days to one month, backed by efficient door to door collection and transportation systems will ensure good results in household level waste segregation. (For e.g. case study on Warangal).

Involvement of RWAs, CBOs, NGOs/SHGs and Market Associations is imperative to ensure the success of segregation at source. Regular meetings between the ULB staff and representatives of RWAs, Market associations, NGOs/ SHGs and other stakeholders should be held till the community fully adopts this practice.

The ULB through NGOs, Rotary Clubs, CBOs, and other such organizations should conduct school level awareness and education programmes focusing on source segregation, waste minimization through reduce, reuse and recycle and the importance of proper management of waste. Students (both girls and boys) should be made aware of the menace posed by increasing waste quantities and environmental impacts of unscientific disposal. School authorities should educate and encourage students to practice segregation of waste generated in schools as per specifications (Please refer to table 2.1 of this chapter).

The Clean City Championship – A Participatory Approach for Improved Solid Waste Management in Warangal

Location: Warangal

Population: 3,512,576, (Census, 2011)[8]

Year of start: 2012

Main Players: Directorate of Municipal Administration, Govt. of A.P., Warangal Municipal Corporation (WMC), Clean City Foundation (CCF), APITC (Andhra Pradesh Industrial & Technical Consultancy Organization), APPCB (Andhra Pradesh Pollution Control Board), communities and school students.

Approach: In order to make waste management a competitive sport and for introducing source segregation and door to door collection service amongst the citizens, The Clean Cities Foundation in partnership with the Directorate of Municipal Administration (DMA) started the initiative in collaboration with APPCB and APITC. This was a low cost participatory approach for integrated solid waste management for a city. The process included a hands-on approach to planning a sound waste management system and then implementing cost effective solutions on the ground. Strong leadership from the administrators and politicians ensured participation and revenue generation for sustaining the process.

The following approach was adopted:

- Financial grants for the championship were first secured from different departments at State level.
- Intensive pre-championship activities were carried out, namely:
  - Planning Inputs: Resource and capacity enhancement needs for WMC were assessed

8 http://www.census2011.co.in/census/district/126-warangal.html

- Administrative Planning: Creation of Solid Waste Management and Resource Management wing within WMC with clear roles and responsibility focused on MSW Management.
- Technical Planning: Micro Route Maping and Collection and Transportation Efficiency Route Synchronization
- Procurement of necessary infrastructure like
  - ✓ Push carts with tools for segregation, bins, weighing scales, dry resource bags, Personal Protective Equipment (PPE).
  - ✓ Modifications in height of tractors, fitting of sirens and audio systems
  - ✓ Constructing vermi-compost sheds. Improvement of windrow compost pads and dumpsite
  - ✓ Installation of dry – resource centers with bailing units
  - ✓ Fund for installing bio-gas plant procured.
- Transportation plan and rationalization of vehicles, including servicing and deployment of compacters for secondary transportation.
- Route and loading plans (373 push-cart wise maps for 53 wards) were prepared by field level functionaries for entire city on GIS maps provided by WMC, thus ensuring ownership of WMC.
- Tie-ups with:
  - ✓ Private weigh bridge close to dumpsite for continuous measurement of waste quantities
  - ✓ Recycling units for recyclable waste with an aim to sustain the activity through revenue generation and creation of market for the material
  - ✓ With cement plants for dry combustibles that could not be recycled
- Stakeholder involvement:
  - ✓ Women SHGs involved in door to door collection of waste in 60,000 households, already served by them and then to demonstrate to other households in area.
  - ✓ Mass awareness campaigns regarding segregation of waste were organized for citizens through different means like media, cycle rallies, etc. Focus group discussions using religious groups, RWAs, Schools, Colleges, SHGs, etc., also conducted.

  - ✓ The WMC staff and municipal staff from other cities were divided into teams and receivedhands on trainingon all concepts during the championship. There were 240 teams from WMC and 130 teams from other cities.
- – Training and Capacity Building:
  - ✓ Teams for carrying out the collection and segregation of waste were organized.
  - ✓ Training provided to the municipal staff and workers on the collection and segregation process.

- The Championship :
  - – Championship spread over 7 days
  - – Different colored contest cards were introduced for Municipal Staff, SHGs, and households during the championship. Signatures on the cards by the route monitors (NCC cadets) on all days earned eligibility to be part of the target group draw for prizes at the end of the championship.
  - – Intensive micro and macro level management and continuous dynamic SMS Updates were made on the official website of WMC for verification.
  - – Each participating team (WMC and other cities) assessed for performance and winning team rewarded.

Outcome:

- Solid waste management wing was established to oversee the task carried out on a timely basis and to address the problems as and when generated.
- Segregated waste was collected and weighed on daily basis, per route and the data bank was updated on real-time basis through internet. Accurate measurements of the total waste generated in Warangal city and of the waste that was recycled into paper, plastic, combustible and compostable was documented.
- Segregated waste was further transported to sorting centres, recycling units and cement plants.
- WMC was able to reduce 30 to 40% of waste going to the dumpsite.
- Improved collection efficiency through constant training, monitoring and efforts from the team to build the capacities of the workers.

Success Factors:

- A strong political and administrative will was required and the Commissioner led the championship.
- Strategic planning and correct pre-assessment of the existing situation.
- Minimal financial inputs were needed to improve/ adapt the locally appropriate technologies for the required capacity of MSW in city.
- Training of municipal staff and SHGs on the ground and ownership of the ground level workers in the system.
- Training and capacity building of the ULB staffs as well as awareness and involvement of the citizen to ensure the continued practice of the system.
- Intensive campaigning and interaction of officials with citizens regarding the proposed system - door to door collection and segregation of waste.
- Intensive monitoring of the activities by ULB with support of different group like citizen groups, National Cadet Corps (NCC), online systems, etc.

Sustainability:

The championship has resulted in the reduction of 30 – 40%of waste being sent to dump site by WMC. There has been a reduction in O&M costs by 30%. It was showcased that such an initiative can be sustained through regular municipal budget of the ULB as well as from the revenue generated from the sale of recyclables and compost. However for centralized infrastructure and rehabilitation of dumpsite, financial aid will be required. This model of championship has been replicated in Guntur and Visakhapatnam in Andhra Pradesh and many more Municipalities have showed interest in replicating this methodology to set up an efficient system of awareness raising, segregation, recycling and transportation of waste.

2.3 COLLECTION AND TRANSPORTATION

2.3.1 MSW Rules' Requirements On Collection & Transportation

Rules: Schedule –II, Clause1: Collection of Municipal Solid Waste

"Littering of municipal solid waste shall be prohibited in cities, towns and in urban areas notified by the State Governments. To prohibit littering and facilitate compliance, the following steps shall be taken by the municipal authority namely:

i. Organizing house-to-house collection of municipal solid waste through any of the methods, like community bin collection (central bin), house-to-house collection, collection on regular pre-informed timings and scheduling by using bell ringing of musical vehicle (without exceeding permissible noise level);

ii. Devising collection of waste from slums and squatter areas or localities including hotels, restaurants, office complexes and commercial areas;

iii. Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes;

iv. Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose;

v. Collected waste from residential and other areas shall be transferred to community bin by hand-driven containerized carts or other small vehicles;

vi. Horticultural and construction or demolition wastes or debris shall be separately collected and disposed off following proper norms. Similarly, wastes generated at dairies shall be regulated in accordance with the State laws.

vii. Waste (garbage, dry leaves) shall not be burnt;

viii. Stray animals shall not be allowed to move around waste storage facilities or at any other place in the city or town and shall be managed in accordance with the State laws.

2. The municipal authority shall notify waste collection schedule and the likely method to be adopted for public benefit in a city or town.

3. It shall be the responsibility of generator of wastes to avoid littering and ensure delivery of wastes in accordance with the collection and segregation system to be notified by the municipal authority as per para 1(2) of this schedule”

Schedule –II, Clause 4: Transportation of Municipal Solid Waste

“Vehicles used for transportation of wastes shall be covered. Wastes should not be visible to public, nor exposed to open environment preventing their scattering. The following criteria shall be met, namely:

i. The storage facilities set up by municipal authorities shall be daily attended for clearing

Primary Collection: Collection of waste from source of generation

of wastes. The bins or containers wherever placed shall be cleared before they start overflowing.

ii. Transportation vehicles shall be so designed that multiple handling of wastes, prior to final disposal, is avoided."

2.3.2 General Principles

Secondary Collection: Collection of waste from community bins/ storage depots/ transfer stations for transportation to processing/ disposal site

Collection of segregated municipal waste is an essential step in solid waste management. Inefficient waste collection service has an impact on public health and aesthetics of towns and cities. Collection of wet and dry waste separately enhances the potential of cost effective treatment of such wastes cost effectively and ensure optimum advantage from the recyclable material fed into the system. Waste collection services are divided into primary and secondary collection. Primary collection refers to the process of collecting waste from households, markets, institutions and other commercial establishments and taking the waste to a storage depot/ transfer station or directly to the disposal site, depending on the size of the city and the waste management system prevalent in the city.

Synchronization between primary and secondary collection is very essential in order to avoid spillage of containers/ littering/ manual handling.

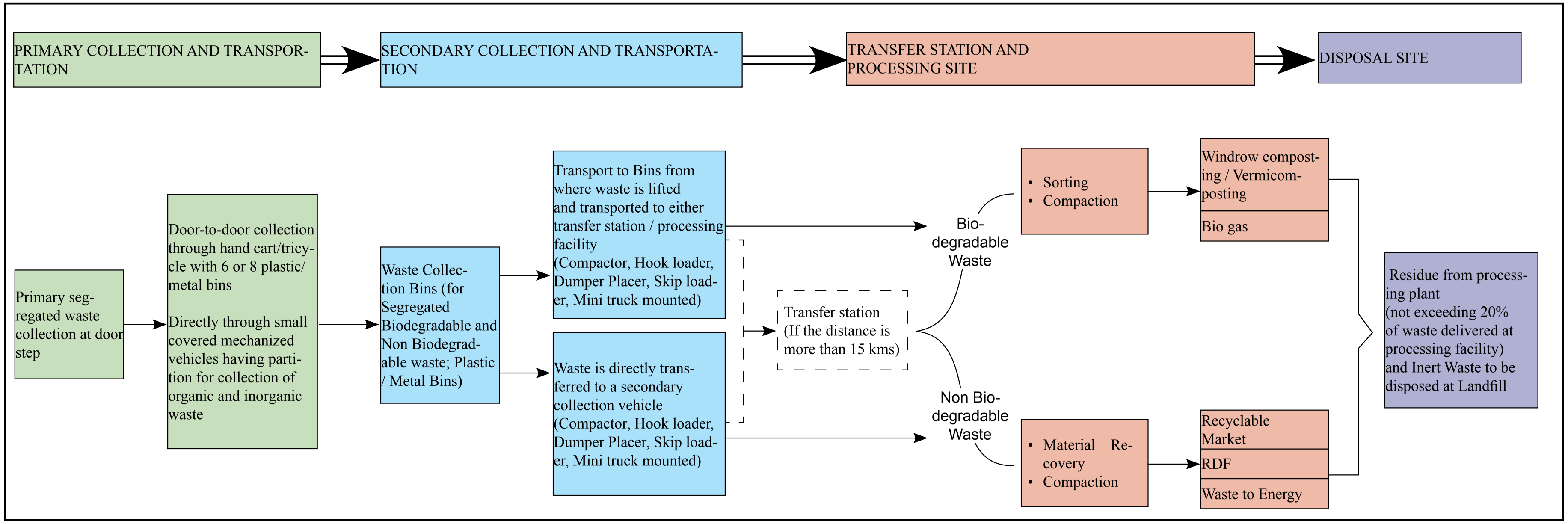
Secondary collection includes picking up waste from community bins, waste storage depots or transfer stations and transporting it to waste processing sites or to the final disposal site. Primary collection must ensure separate collection of certain waste streams / fractions depending on the separation and reuse system applied by the respective town/ city (see section 2.2). Segregated waste must be stored on-site in separate containers for further collection and should be kept separate during all steps of waste collection, transportation and processing.

A well synchronised primary and secondary transportation system, with regular and (with respect to primary collection) well communicated intervals of operation is essential to avoid containers' overflow and waste littering on streets. Further, the transport vehicles should be compatible with the equipment design at the waste storage depot and should be able to transport segregated waste. They should also be easy to maintain.

Street sweeping and drain cleaning waste is to be collected in separate bins and transported directly to the sanitary landfill facility

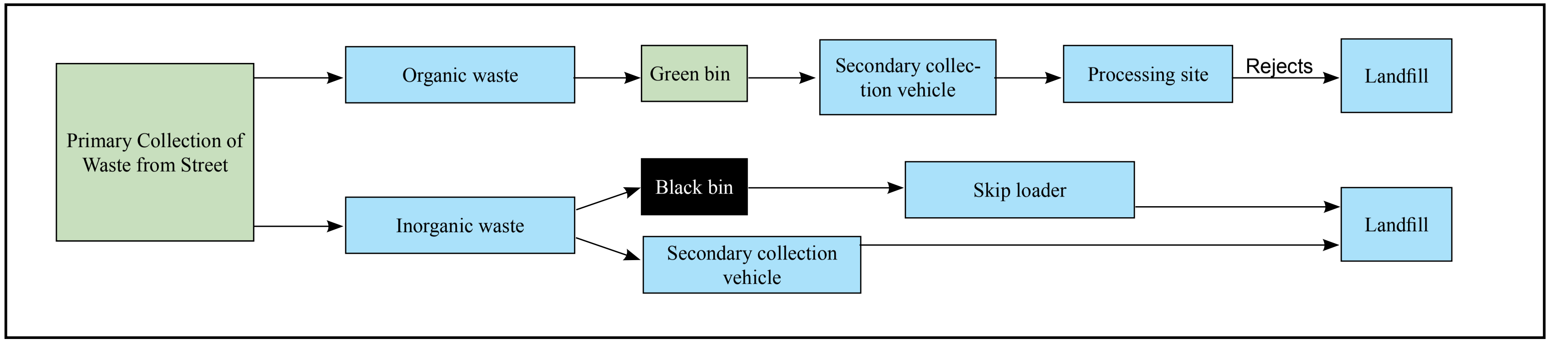
Figures 2.5 to 2.7, given below, indicate suggested movement of household waste, market waste, street sweeping and drain silt through the municipal solid waste management system.

It is essential to separate street sweeping and drainage waste completely from household waste streams through all stages of collection, transport and treatment since street sweeping and drainage infiltrates significant amounts of toxic substances (e.g. heavy metals) and is often responsible for contamination of waste streams envisaged for composting and recycling. Accordingly, street sweeping and drainage silt are covered in separate flow charts. For household waste, a tertiary collection is only necessary in large cities where the transfer stations are located at great distance from disposal and treatment facilities. This is indicated in the chart through dotted arrows.



- *The compactor is an appropriate vehicle for collecting biodegradable and recyclable component of MSW*
- *Skip loaders/ Hook loaders are preferred for collecting inert waste or Construction and Demolition waste*
- *Waste may be transferred to the transfer station if the processing site is located at least 15 kms away from the city*

Figure 2.5: Flow chart for household waste collection, transportation & disposal



Street sweepings are predominantly inert wastes. A skip loader/ hook loader is preferred for transportation of street sweepings.

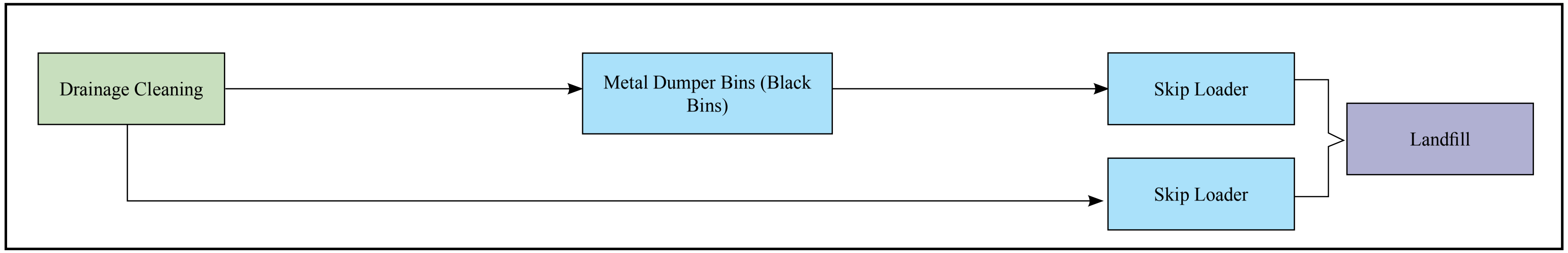


Figure 2.6: Flow charts for collection, transportation & disposal of street sweeping & drain silt

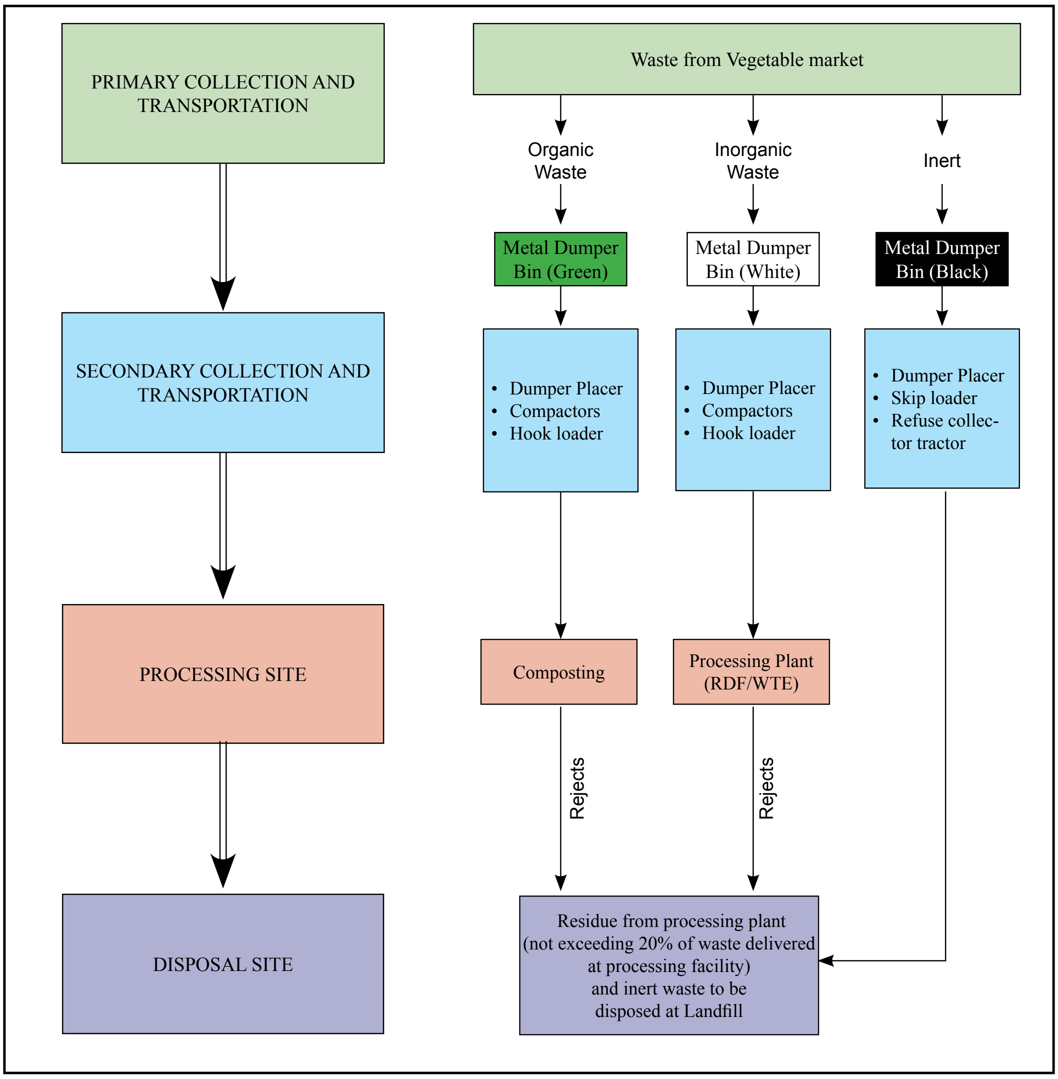


Figure 2.7: Flow chart for collection, transportation & disposal of vegetable market waste

Informal recycling activities reduce environmental costs and also provide employment opportunities. However, ensuring hygienic conditions and environmentally sound recycling practices is a challenge.

Role of the Informal Sector in Primary Waste Collection

The involvement of the informal sector is also to be examined and integrated into the waste management system of the city. The informal sector in any city comprises of two systems i.e. the kabadi system or the rag pickers.

The informal "kabadi system" network forms an important link in the overall waste recycling system prevalent in the country. They can be compared to micro-entrepreneurs who buy reusable and recyclable material like newspapers, metal, glass, cardboards, plastics, etc. from households or commercial areas. Citizens should be encouraged to continue the practice of selling recyclable wastes to the "kabadi system", as they constitute the first link in the waste recycling system.

Rag pickers are also an important part of the informal recycling system and are instrumental in recovering discarded recyclables in disposed municipal waste that have not been bought by the kabadi system. In an ideal system, rag pickers should be integrated into the system by training and employing them for door-to-door collection of waste by the RWA's, NGOs, CBOs and the like. The ragpickers who work as waste collectors should be allowed to collect recyclables separately alongside wet and dry fractions.

Rag pickers may also be encouraged to form cooperatives, through the involvement of local NGOs/Self-Help Groups (SHGs) and may be allowed to collect recyclables from households. Such initiatives will not only ensure a higher level of income to rag pickers, but will also ensure hygienic conditions for rag pickers and environmentally safe waste recycling practices. Also, a lot of ragpickers are usually harassed by the police, property owners, shop keepers in the vicinity. Many of them have to justify their work to various people and are condemned by society. Many of them are in fact women, who have to live with the insecurity of harassment and threat to their livelihood. Organizing them into cooperatives tend to protect their rights thereby retaining their dignity of labour, work, their right to livelihood and right to access recyclables.

Rag pickers are instrumental in recovering recyclables that have not been bought by the kabadi system

2.3.3 Location And Organization Of Primary Collection

Primary collection of segregated municipal solid waste from individual households and establishments (door to door collection) is accomplished through the use of containerized push carts/tri-cycles, small mechanized vehicles, compactors and/or tipping vehicles depending on the terrain of the locality, width of streets and building density.

In order to improve/ optimize collection efficiency, collection vehicles should be adapted to the street width, accessibility and localized conditions

Spacious and well- lit safe neighborhoods allow collection systems with compactor vehicles and tipping equipment which are more efficient. Narrow streets do not allow for the use of conventional primary collection vehicles. In cramped neighborhoods, hand carts/push carts, tri-cycles and/or small mechanized vehicles may be used for door to door collection of waste, which may then be transferred to a larger vehicle in the vicinity. Where access to individual houses/establishments is difficult, hand carts/ rickshaws could be made to stand at designated spots.

In hilly areas many of the houses are accessible only by means of footpaths or through steps, thus restricting the use of hand carts and/or tri-cycles. In such instances, waste collectors should ideally carry a waste bag/basket on their back for wet waste and through another bag collect segregated dry waste from each household.

Frequency of collection is determined by the density of area, collection system and climatic conditions. E.g. wet waste should be collected daily in hot and humid areas

Waste collection route planning is critical to ensure an efficient door to door collection and transportation system. In hilly areas, waste collection should ideally start at the highest point and proceed to lower levels. This would ensure that waste collectors/waste collection vehicles need not carry increasing amounts of waste up steep slopes.

The frequency of door to door collection should be determined by the density of population, the collection system and climatic conditions. In hot and humid regions, at least wet waste is to be collected on a daily basis. Isolated houses, shops and establishments may be served on a less than daily basis, depending on quantities of waste generated. Motorized collection vehicles are able to handle relatively larger quantities of waste and are preferred for periodic waste collection.

Domestic waste could be collected in the morning hours before 12 noon. Waste from the commercial areas could be collected between 10.00 am and 2 pm. Vegetable market waste should be collected in non-peak hours either early morning or late in the afternoon or at night. The collection of market waste might also need to be done more than once a day.

The municipal authority may promote/engage RWAs, CBOs, NGOs/SHGs or the private sector to provide door to door collection services. Penal provisions may be introduced after assessment/review of overall management system, for failure of service where contracts are awarded.

CASE STUDY

Door to Door Garbage Collection- An initiative of Shimla Municipal Corporation and SEHB Society

Location: Shimla

Main Players: Shimla Municipal Corporation, Shimla Environment Heritage Conservation and Beautification (SEHB) Society

Year of Start: 2010

Approach: Shimla, the capital city of Himachal Pradesh with a strong cultural heritage and panoramic scenic beauty is amongst the famous tourist destinations in India. Due to rapidly growing population and poor infrastructure towards the end of 19th century, the hygiene, sanitation and public health became a cause of concern for the city. The initiatives taken by Municipal Corporation to deal with the solid waste menace and overall situation remained largely unsatisfactory wherein SMC undertook three door to door collection initiatives involving various NGOs, voluntary organizations to collect waste from the households from 1999-2008. However, the concerns raised by local people that was followed by a writ petition, resulted in the High Court of HP issuing directions to improve the MSW system. Subsequent to the directions of the High Court, the State Urban Development Department notified door-to-door collection initiative for Shimla in 2006. This led to the establishment of SEHB society registered under the Himachal Pradesh Societies Registration Act in 2009.

Under this initiative the following approach was adopted for bringing about significant improvements in solid waste management system:

Institutional & Managerial:

- The SEHB Society's waste collection initiative is headed by the Municipal Commissioner with responsibility of overall supervision by the Corporation Health Officer as member secretary of the society. Collection and transportation services are looked after by the SEHB staff which is supervised by the Chief Sanitary Inspector.
- A dedicated team has been allocated for smooth functioning of the system. Every ward has a dedicated Supervisor and assistant supervisor with 2 coordinators looking after all 25 wards and reporting to the Sanitary Inspectors.
- A mechanism for collection was defined through a methodology of physical verification for households and communities.
- Optimization of routing of each vehicle and provision of substitution plan for any breakdown in vehicles was established
- Centralized complaint redressal system within MCS and dedicated telephone lines at SEHB office were established to resolve the complaints of users. Feedback registers are updated on daily basis.
- Regular monitoring by the Health Officer and Sanitary Inspectors as well as pre-arrangement/ substitution of the workers to maintain the efficiency and absence from work
- Effective and timely remittance of salaries of the field staff
- Shimla Municipal Corporation provided Identity cards to SEHB Society's workers and also provided EPF and ESI benefits to all registered SEHB workers.
- Regular health checkups of garbage collectors

- Woman participation was encouraged through different modalities-providing easy terrain to work; work close to their homes; husband and wife working in same wards
- To maintain the collection efficiency, the day offs with adequate substitutes are ensured

Legal:

- Introduction of door to door collection bye laws with special mandate for citizens to handover the municipal solid waste to SEHB society, the agency authorized by SMC
- Introduction of user charges by SMC and its provision within the bye laws for compliance.
- Introduction of penal provisions for non- compliance by citizens like littering and non-participation in the door to door collection system.

IEC:

- For increasing community participation in this initiative, SMC organized community meetings to disseminate the details of the collection system and its functioning.
- Mass (jingles for radio channels, local advertisements)and print media was used to further promote the initiative and sensitize people.
- Ward level lucky draw for registered users
- Distributing society's annual calendar to the households with all necessary information and messages
- Documenting and dissemination SEHB's case study and brochure for further outreach and sensitizing people for the initiatives taken

Outcome:

- More than 90% of coverage in 25 wards and collection of waste from the households
- Effective and timely redressal of complaints by the ward supervisors for non -delivery of service
- Compliance with laws pertaining to the MSW Management
- Overall environmental improvement and aesthetic value of the city

- Less incident of monkey nuisance and conflict

Success Factor:

- A strong political and administrative will to improve the MSW system in the city
- Strategic planning and revisiting/ assessing the existing situation
- Intensive campaigning and interaction of officials with citizens regarding the proposed door to door collection system
- Effective monitoring and follow up by officials
- Penalty provisions for littering and non-compliance in the door to door collection system through Bye laws

Overall Sustainability:

Collection of user charges has resulted in the financial sustainability of the project. There has been a steady rise in the user charges collection during the last financial year. A dedicated team has been appointed for maintaining the regular cash flow essential to meet the salaries and operational liabilities of the self- financing scheme. Strict monitoring is carried out to ensure the collection and also the planning of surplus for overhead expenditures.

2.3.4 VEHICLES AND EQUIPMENT FOR PRIMARY COLLECTION

Primary collection vehicles should meet local requirements. Before selecting a vehicle for primary collection, it is advisable to assess the amount of waste generated, local climatic conditions, topography of the area and available facilities for repair and maintenance of vehicles.

Vehicles Typically Used for Primary Collection

- Hand carts/tricycles with containers or bins
- Tri-cycle with hydraulic tipping containers
- Mini-truck with hydraulic tipping container
- Four Wheeled mini-trucks with garbage collection bins

Details of typically used primary vehicles are given below.

2.3.4.1 Hand Carts/Tricycle With Containers or Bins

As mentioned before, street sweeping should not be mixed with household waste

Hand carts should have a capacity to carry 4 to 6 containers of 25 to 40 liter capacity. The containers should be of two colours, green (wet waste) and blue (dry waste), for collection of wet and dry waste separately(refer to figure 2.8). Bins should be made of HDPE, injection molded, UV tested, universally used as standard garbage handling bins.

Containerized hand carts are suitable for door to door collection of municipal solid waste from households, shops and establishments from narrow lanes and hilly areas and also for collection of street sweepings where women sanitation worker are involved in street sweeping. Bins/ containers can be easily unloaded into secondary collection bins or secondary transport vehicles, based on the prevalent collection and transportation system in the ULB without depositing the waste on the ground necessitating multiple handling of waste.

Tricycles with 6 to 8 containers from 40 liters to 60 liters capacity can also be used for door to door collection of waste from narrow lanes where male work force is engaged to facilitate picking up larger quantity of waste in one trip and taking the waste to a secondary waste storage depots placed at longer distance.

Figure 2.8: Hand carts with bins

Please refer to sub section 2.3.3.2(type of equipment for street sweeping) for further details.

2.3.4.2 Tricycle With Hydraulic Tipping Containers

MSW tricycles should have mild steel epoxy painted, tipping containers of 350 liters (140 Kilograms/ trip), mounted on a standard tricycle (please refer to figure 2.9). This is suitable for door to door collection from small lanes and small generators.

Figure 2.9: Tricycle with hydraulic tipping container

2.3.4.3 Light Commercial Vehicles (Mini Trucks) With Hydraulic Tipping Containers

This vehicle is suitable for door to door collection of segregated waste from lanes of width less than 5 meters with a total pay load capacity of nearly 600 – 900 kilograms per trip. The load height is approximately 1500 mm from the ground level. It should have a leak proof MS load body with drainage tube and plug. The small tipper should be built on a suitable chassis. These vehicles should have four openings, 2 on each side to facilitate direct transfer of waste from a domestic bin to the vehicle. It can also have a central removable partition to facilitate storage of segregated components of waste. It is desirable to use upto 3 m^3 capacity vehicle for door to door collection to cater to a large number of houses in a single trip (please refer to figure 2.10).

Figure 2.10: Mini Truck with hydraulic container

2.3.4.4 Four Wheeled Mini Truck With International Standard Garbage Collection Bins

Adequate repair and maintenance system should be established to service mechanical and manual vehicles and other heavy equipment, thereby lowering potential down-time of vehicles and equipment.

The main advantage of using bins instead of a hydraulic container is that the load height can be brought down from 1500 mm in case of the previous design to 1200 mm from ground or less, if the bins are brought down for collection.

Avoidance of hydraulic tipping will make it suitable for use in remote places also, where suitable provisions for maintenance of hydraulic component of large number of vehicles may not be available and is also costly and time consuming.

A typical set up: The vehicle can carry 8 bins of minimum 240 liters. Bins should be made of injection molded HDPE. Each mini truck should carry 4 green containers for wet waste and 4 blue containers for dry waste.

Apart from vehicles, urban local bodies should have adequate workshop facilities for the maintenance of their fleet of vehicles, containers, handcarts etc. The workshop, public or private or PPP, should have adequate technical staff (both trained men and women), spares and preventive maintenance schedules to ensure that at least 80% of the vehicles runon the road each day and the down time of repair/maintenance is minimised to the extent possible. For more information on preventive maintenance, please refer to Section 6.1.4 of Part II of the manual.

2.3.5 Manpower And Vehicle Requirements For Primary Collection

Efficient primary collection requires adequate equipment, facilities and trained man power. Table 2.2 below gives specifications of the requisite primary waste collection service systems to be deployed in different types of localities. Table 2.3 gives service norms for deployment of vehicles and manpower for primary collection. The specific requirement for equipment/vehicles should be calculated based on future waste generation projections of the city (at least for coming 5 years).

Table 2.2: Elements of Primary Waste Collection System

Source	Primary Collection services	Transportation	PPE for waste handler
Societies/ Apartment Complexes	Door to Door collection services Minimum of Two bins for collection of wet waste and dry waste (10-15L) A pair of community bins of 60 litres(20 to 30 kg) or 120 litre capacity (40 to 60 kg) or 240 lit capacity (80 to 120 kg) or 1.1 cu. m capacity (300 to 450kg) depending on no of houses to be served (i.e. 12, 24, 48, 200 units). The specifications should be as per Central Institute of Plastics Engineering and Technology (CIPET) advise Contract for door to door collection should be given to Private sector/ RWAs/ CBOs/ NGOs/SHGs	Containerized light weight handcarts Tricycles for both men/ women Pick up Vans Motorized waste collection vehicle Any suitable combination of the above	Gloves Shoes Clothes that cover whole body
Inaccessible Residential Areas	Two separate community bins/ containerof 60 to 120 litre capacity for 20 to 40 dwelling units Two domestic bins for storage of waste at source 5, 10, 15, 20 litres (for 2 to 8 Kg waste) capacity, as per CIPET specification	Containerized light wieght hand carts Tricycle for both men/ women Waste collected from the area should be transferred to a LCV outside the slum area	Gloves Shoes Clothes that cover whole body

Source	Primary Collection services	Transportation	PPE for waste handler
Residential areas	Door to door collection services for segregated waste 12 to 15 litres capacity domestic bins, one of them with lid, made as per CIPET specification Contract for door to door collection should be given to Private firm/NGOs/ RWA/ SHGs	Containerized Handcarts Tricycles for both men and women Pick up Vans Motorized waste collection vehicle	Gloves Shoes Clothes that cover whole body
Markets/ Bulk Waste Generators	Door step collection services for recyclable material/ dedicated waste streams on full cost recovery basis Markets: Number of 1.1 to 4.00 cu. mt. covered bins for storage of waste as per the quantity of waste generated in the market. Large commercial complexes could use 3.0 cu.m.to 7.0 cu.m. container	Motorized waste collection vehicle with container lifting devise Compactors compatible with containers Non compactor trucks	Heavy duty,gloves Shoes Clothes that cover whole body Face mask
Hilly areas	Door to door collection service for segregated waste Manual collection or small motorized vehicles work well Door to door collection service for segregated waste 5, 10, 15, 20 litres (for 2 to 8 Kg waste) capacity, HDPE, injection moulded, tested bins Two domestic bins of 12 to 15 litres or a pair of community bins of 60, 120, 240 litre depending on the number of houses to be served (20, 40, 80 houses)	Lightweight containerized handcarts Tricycles for both men and women Pick up Vans Motorized waste collection vehicle Combination of vehicles specified above	Heavy duty gloves Shoes Clothes that cover whole body Face mask

Table 2.3 indicates 'thumb rules' for the deployment of vehicles and human resources for primary waste collection.

Table 2.3: Estimates for Deployment of Vehicles and Manpower for Primary Collection[9]

Vehicle for primary collection	Number of Households to be covered in different areas	Population Served	Staff Required
Push Carts	Congested area: 300 Households Medium Density area: 200 Household Scattered Area: 125 House holds Hill area : 85-90 Households	1500 1000 625 400 to 450	1 person per push cart
Tricycle	Congested area: 300 households Medium Density area: 250 households Scattered Area: 200 House holds Hill area : 125Households	2000 1500 1000 Hilly areas are difficult to serve and population/ households served should be decided based on operational conditions	1 person per tri-cycle
Light Commercial Vehicles (LCV) having 500 to 700 kg capacity	1000 households	5000	1 driver & two labour per LCV
LCV with more than 700 kg capacity	1500 to 2000 households	7500 to 10,000	1 driver & two labour per LCV

(Note: Compactor may not be used for primary collection purposes)

2.3.6 Involvement Of The Community In Primary Collection

Community participation in waste management activity is critical for ensuring a well-functioning collection system. Involvement of the community in the primary collection system, specifically in determining waste collection system and timings, is important for the effective planning and implementation of the primary waste collection system.

9 Reference Material on Municipal Waste Management for Urban Local bodies, **All India Institute of Local Self Government,2012**

Recycling carried out by informal sector (individual or group of waste pickers) plays a critical role in reducing waste quantities and depletion of raw materials as well as minimizing the financial and environmental burden of cities.

Community initiatives need to be inclusive. Engagement of men, women, youth, and children should be given the due importance. Separate group discussions, involvement of community leaders, community associations, SHGs, local members who represent the interest of the community at large (especially with a focus on bringing in the voices of women) must be adapted. For this innovative means of gathering people, interested community members, engaging with the women, youth and school children must be thought of and planned for.

2.3.7 Informal Collection Of Recyclables

The informal sector popularly known as "kabadi system"is involved in purchase of about 70 to 75% of recyclables in the country from households and commercial establishments. In this informal sector, there are individuals, families, groups and small enterprises that carry out unregistered and unregulated activities. There is another set of informal sector known as "rag pickers" who pick up discarded recyclable waste from the streets, bins, dump sites etc. They pick up 5 to 10 % of the municipal waste which is of value to them to earn their living (please refer to figure 2.11). This informal sector helps to reduce the depletion of raw materials, natural resources and energy that otherwise would be used in the production of new products. For more information on role of informal waste sector, please refer to box on 'Role of Informal Sector in Primary Waste Collection'.

ULBs should make concerted efforts to integrate the informal sector of rag pickers into regular waste collection operations through the private sector, NGOs, RWAs etc.

Local "kabadi system" purchase recyclable waste from households, shops and establishments, segregate this waste in plastic, paper, metal, cardboard, e-waste, glass and then sell the segregated waste to the large wholesalers. The larger wholesaler is the final link between the recycling factory and the "kabadi" and can extend credit, bargain for better pricing etc.

Sorting of discarded waste by the informal sector or 'rag pickers' also occurs on the street corners, municipal bin level and at the dump sites where the rag pickers sort the recyclable material from the mixed waste discarded by the waste generators. This form is fraught with danger and makes the rag pickers susceptible to injuries and infections.

With an aim to avoid child labour, unhealthy practice of segregation of recyclable material from soiled and infected waste without any use of PPE (Personal Protective Equipment) to reduce exploitation and discrimination of this low income group and also to arrive at efficient and consistent segregated collection systems, municipal authorities should make concerted efforts to integrate the informal sector of rag pickers into regular waste collection operations through private sector, NGOs, CBOs, SHGs and RWAs and aim should be to raise the status from rag pickers to waste collectors and provide them with tools for their work and PPE like gloves, shoes, full sleeves coat through their employers. Assessing the size of the existing informal system and the quantity of material handled by them in a town/city; identifying the number of rag pickers and kabadi system and their linkages to the wholesale market, are all important pre-requisites to defining any initiative to integrate them into the formal system. Organizing the informal sector to form viable business groups and societies, with the help of local NGOs is an ideal approach for achieving this integration. Such initiatives should be supported by appropriate local policy and bye-laws, where required; this would result in institutionalizing and ensuring rights of workers (both men and women) for the entire process. Once organized, provision of social security and welfare benefits to waste pickers should be also considered. As a general rule, any form of health problems related to occupational health hazards should be addressed appropriately. Social benefits of workers should include health check ups, medical health care and treatment facilities. Care must be taken to ensure that workers (be it contractual or otherwise) have access to proper facilities such as separate toilets for men and women, storage space for leaving behind their belongings etc. For further information, please refer to Section 1.4.4.8 of Part II of this manual.

Figure 2.11: Waste Picker with recyclable material

Organizing the Unorganized - Towards formalization and social inclusion of informal waste pickers and recyclers

Location: Pune, Pimpri Chinchwad, Maharashtra

Main Players: Kagad Kach Patra Kashtakari Panchayat (waste pickers trade union), SWACH (co-operative), Pune and Pimpri Chinchwad Municipal Corporations

Starting year: KKPKP- 1993, SWACH-2007

Approach: The Kagad Kach Patra Kashtakari Panchayat (KKPKP) is a registered trade union of waste pickers, scrap collectors and itinerant buyers working in the cities of Pune and Pimpri Chinchiwad (Maharashtra). The first and founding convention of KKPKP was organized in 1993 at which 800 scrap collectors, waste pickers and itinerant buyers resolved to register a trade union. KKPKP has the objective of securing the livelihood of scrap collectors, restoring their dignity and rights as workers and as citizens. The union was formed on the basic premise that scrap collection is 'work' and scrap collectors are 'workers'. In 2013 KKPKP has a membership of around 9,000 persons most of whom are Dalit women. In 1998 KKPKP promoted Kagad Kach Patra Nagari Sahakari Pat Sanstha (KKPNSPS), a savings linked credit cooperative of waste pickers.

In 2007 KKPKP promoted a waste picker workers cooperative called SWaCH (Solid Waste Collection Handling). SWaCH is the institutionalized outcome of a pilot project jointly undertaken by KKPKP, SNDT Women's University and the Pune Municipal Corporation.. The autonomous social enterprise provides front end waste management services that include door to door waste collection; composting; biogas plant operation and maintenance through an agreement with the Pune Municipal Corporation. 350 members of KKPKP also work as contract workers in door to door collection for the Pimpri Chinchwad Municipal Corporation.

2300 SWaCH members service 4 lakh households, offices, shops and small commercial enterprises in Pune Municipal Corporation. The workers of SWaCHare not municipal employees but have been authorised to recover user fees for the services that they provide. Each worker provides door to door waste collection services to about 100-150 households and is paid Rs.20-30 per household per month by the service user and also has rights over the recyclable materials. Together the workers earn minimum or higher than minimum wages with flexible hours of work. Collection is carried out using push carts and motorized waste collection vehicles. Collection and safety equipment and space for material recovery is provided by the Pune Municipal Corporation. Between 2012 and 2013 SWaCH has cost the Pune Municipal Corporation a total of Rs.3.63 crores which amounts to Rs.2 per household per month which is the lowest spent by any municipality in the country. A proposal for provision of social security and welfare benefits to waste pickers is under consideration of the Pune Municipal Corporation.

Institutional Structure:

KKPKP is a democratic membership organization. Its office bearers include the President, General Secretary, Joint Secretary and a Treasurer. The main decision making body is the Representatives Council of 80 members, largely women. The Council meets once a month for deliberations and resolving issues. The education level of the members varies from illiterate to class 12 who take care of the functions of the union. The union also has a few hired staff, quite a few of whom are members' children. All members pay an annual membership fee.

Approaches for Economic, Social and Political Inclusion:

Waste pickers are an economically marginalized, socially excluded and politically disempowered occupational community. The KKPKP therefore relies on the twin strategies of struggle and agitation for rights and social justice as well as reconstruction through institutional alternatives. Institutionally, SWaCH and the credit cooperative (KKPNSPS) deal more with economic and financial inclusion while the KKPKP focuses more on social and political inclusion and addressing injustice and inequality.

- Seeking State recognition of scrap collectors as „workers" and scrap collection as 'work'
- Organizing and mobilizing scrap collectors into a trade union so that they are recognized as workers
- Visibility and voice for waste pickers as workers, Dalits, women and citizens
- Seeking municipal recognition and legitimacy through issue of photo-identity cards for contribution to waste management and recycling
- Rights to access recyclables
- Claims on government resources such as space for material recovery centres; collection and safety equipment; children's education scholarships; medical and life insurance and welfare benefits
- Market interventions for fair trade and labour practices in the scrap trade
- Revision and restructuring of solid waste management to include labour, governance and environmental concerns
- Engagement in citizenship rights and governance

Outcome

- Recognition as workers and scrap collection as work in Maharashtra and some other states through provision of identity cards. Waste pickers have been recognized as workers in various government documents such as the Bajaj Commission Report, Second National Labour Commission Report, Plastic Waste Management and Handling Rules
- Entitlements to collection equipment, medical and life insurance, educational benefits for children
- Inclusion as an occupational category under the Socio-economic Caste Census and Antyodaya beneficiaries under the Food Security Act
- Pune Municipal Corporation provided identity cards to KKPKP workers in 1995-96 and later provided medical insurance and educational scheme benefits to all registered waste pickers.
- Pimpri Chinchwad provided dedicated space for sorting and segregation of waste in 1998.
- Organized door-to-door collection and transportation services for the citizens through SWaCH and KKPKP since 2006.
- SWaCH and KKPKP have organized drop-off points for waste collection, collection of e-waste and old clothes, environmental awareness campaigns and other outreach programs for the citizens.

Contribution to Outcomes

- Strong political influence through intensive mass campaigning and rallies
- Participatory institutional structures and processes in the union and cooperatives
- Use of research to inform advocacy
- Participatory and inclusive approaches
- Support of academic and other institutions

Overall Sustainability

KKPKP is supported through membership fees and its member based economic activities. KKPNSPS is a financial institution that sustains through savings and lending operations. SWaCH sustains through member contributions from the services that they provide through the cooperative. SWaCH also receives some infrastructure and equipment assistance from the Pune Municipal Corporation.

2.3.8 SECONDARY COLLECTION AND TRANSPORTATION

As specified under General Principles (Section 2.3.2 above) secondary storage/collection and transportation is necessary for waste collected from households by smaller vehicles such as carts, tricycles, rickshaw etc.

Secondary waste storage containers should be covered and designed to facilitate mechanical lifting to avoid multiple handling.

2.3.8.1 CONCEPT OF BIN LESS AREA/ CITY

Wherever possible, it is advisable to synchronise primary collection and secondary collection, thereby avoiding the need for secondary storage bins/depots.

Segregated waste at the household level is collected by primary collection vehicles, which directly transport this waste to secondary collection vehicles. Secondary collection vehicles are parked at specific locations for the entire duration of time taken for primary collection daily. Separate vehicles/chambers within a vehicle should be provided, to ensure segregated transportation of waste.

Direct transfer of waste from the primary collection point to secondary collection vehicles promotes a bin-less arrangement for waste collection and transportation. Issues related to placement of bins, littering around bins, non-lifting of bins as per schedule and continuous movement of fleet to lift bins and replace them is avoided. However, such systems are successful only when there is sufficient fleet of secondary collection vehicles to synchronise with primary collection and where good coordination systems exist. Without adequate management controls, such systems may fail resulting in street corner littering. It is also advisable to place back- up collection bins in commercial/high foot-fall areas to cater to unexpected waste generation.

The Kochi Municipal Corporation has successfully implemented a bin-less system in a few wards of the city.

2.3.8.2 SECONDARY STORAGE

Storage depots are required for secondary collection of waste, in cities where the bin-less system is not adopted. In most cities following types of waste storage depots exist:

1. Cement-concrete bins
2. Masonry bins

3. Dhalaos

4. Metal bins/containers

Being unhygienic, cement-concrete bins, masonry bins and dhalaos are being replaced by metal containers. In general, waste storage containers should be covered, and should be designed to facilitate mechanical lifting in order to avoid multiple handling and environmental harm.It is necessary to wash community bins at regular intervals to ensure a healthy and hygienic environment for users and workers.The design of waste storage containers/depots (secondary collection points) should be synchronous with the design of vehicles deployed for both primary and secondary waste collection. (refer to figure 2.12)

Dhalaos or masonry storage depots or area level waste collection centres, which are commonly used in cities like Delhi and others, are found to be unhygienic, environmentally unsafe and unsuitable for secondary waste collection. Where such systems exist, they are to be phased out as soon as possible.

Figure 2.12: Synchronized Primary Collection & Secondary Storage[10]

[10] JnNURM Toolkit on Solid Waste Management, MoUD, GoI

2.3.8.3 Design Specifications Of Secondary Storage Systems

Indicative Secondary Storage Systems

- Bins for community places, on public roads and for bulk generators
- 1100 litre capacity four wheeled bins/containers, designed for lifting by compactor
- 3000 to 7000 liter capacity metal containers, designed for lifting by dumper placer system
- Hook lift Containers 8 cu.m. or larger (Multi-Purpose bulk waste containers)

2.3.8.4 Bins For Community Places, On Public Roads And For Bulk Generators

- Galvanized iron mobile garbage bins ranging from 0.5 cu.m.to 7 cu.m. capacity are available. The bins are designed to be liftedor emptied by mechanized container lifting devices such as compactors, dumper placers etc. They canbe used for storage and handling of biodegradable and recyclable waste. They can also be used for secondary storage of street sweeping and silt collected from drains.
- The bins are suitable for bulk waste generators and for placement as community bins at waste storage depots.

2.3.8.5 Four Wheeled Compactor Container

- The mobile compactors are designed for transfer points on public roads and places and especially suitable for biodegradable and recyclable waste.
- The containers are available at 8 cu.m. to 10 cu.m. or larger. They are designed for lifting by universal hook lift system mounted on heavy duty trucks and madefor the following purposes:
  - Suitable for carrying all types of waste in bulk
  - The top loading containers are suitable for depositing debris and biodegradable waste components of MSW.

Use of Stationary Compactors for Improved Secondary Collection and Transportation in Kolkata

Location: Kolkata

Year of start: 2012

Main Players: Kolkata Municipal Corporation (KMC) and Kolkata Environment Improvement Project of Asian Development Bank (ADB).

Approach: To improve the collection efficiency and transportation system in Kolkata city, KMC has piloted the use of stationary compactors for secondary waste collection, given the high volumes of waste generated in densely populated areas under the Kolkata Environment Improvement Project of Asian Development Bank (ADB). The stationary compactors, when coupled with hook loaders, provide high transport efficiency for waste. The approach that was adopted for installation and operationalization of stationary compactor is detailed below:

- Identification of 78 sites for installation of stationary compactors by KMC.
- Procurement of portable compactors and prime movers (hook loaders) by KMC with financial assistance from JnNURM.
- The waste compactors were specifically designed for each site based on the space availability and volume of waste generated in the service area.

Stationary Compactor

- In order to synchronize the system with the existing primary collection system, the portable compactors were installed with a tip cart mechanism. The tip cart mechanism proved to be flexible for manual feeding, wheel barrow feeding and feeding by small 1-2 m^3 auto tippers.
- Training and capacity building of the municipal workers for the operation and maintenance of the compactor. Orientation for the primary collection workers.

Outcomes:

Mechanised transfer from bin to compactor

- Collection and transportation efficiency of the MSW system has been improved after the introduction of the stationary compactors
- Municipal waste is now transported in closed containers that minimize odor and spilling of garbage.
- Open dumping and burning of waste at the secondary collection points has been stopped
- Portable compactors and prime movers facilitate night transportation of municipal waste.

Success Factors:

- Strong political will to eradicate open dumping sites from the city.
- Minimal disturbance to the established primary collection system in the areas.
- Use of static compactors led to increase collection and transportation efficiency for the entire city
- Small space available was optimally utilized for installation of the compactors with minimal construction at the sites.
- Provision of adequate training and capacity building for the municipal and primary collection staff.

Overall Sustainability:

Currently only 5 stationary compactors have been installed. However, funding is required for establishing the entire system. With only one year of operations, the overall sustainability of the system is still to be assessed.

2.3.9 Criteria For Sizing Waste Storage Capacities

Secondary waste storage capacities should be designed to accommodateat least double the expected daily in-flow of waste. The storage capacity should be 20% more the expected daily in flow of waste.

2.3.10 Maintenance Of Waste Storage Depots/Containers

Periodic inspection of waste storage depots/ containers to be carried out once in three months

Periodic inspection should be carried out once in three months of the waste storage depots and any damage caused to the flooring, screen walls, etc. should be repaired.

The metal sheet of the containers might corrode if not well maintained. At a minimum, annual painting of the container from inside and outside must be carried out for increasing the life of containers. Potentially necessary replacements should be provided from stand-by equipment.

2.3.10.1 Secondary Segregation And Segregation At Transfer Stations

Unsegregated waste which has not been sorted at primary level should be segregated either at an intermediate stage (e.g. transfer station) or at the processing plant, prior to treatment, in cases where waste is brought directly to the plant from the waste collection areas. Segregation may be accomplished through manual and/or mechanized segregation. Multiple handling of waste should be avoided.

2.3.11 TYPES OF VEHICLES AND EQUIPMENT FOR TRANSPORTATION

Larger capacity vehicles should transport waste from the secondary or tertiary collection point (depot / transfer station) to the processing and treatment facility or landfill. The types of vehicles should synchronize well with containers placed at depots / transfer stations to prevent multiple handling of waste. The selection of the type of vehicles should reflect the quantity of waste to be transported, the distance to be travelled, the road widths, road conditions, work shop facilities, etc.

Vehicles typically used for secondary transportation of wastes

- Dumper placers/skip loaders,
- Refuse collector without compactor,
- Refuse collection mobile compactors
- Mini truck with tipping floor
- Hook loader/hook lifter

2.3.11.1 Skip Truck (Dumper Placer)

Skip trucks are used for transportation of skips (dumper bins) of different sizes to treatment or disposal sites (please refer to figure 2.13). The usual skip sizes are 2.5, 3, 4.5 and 7 cu.m. When a full skip (container) is lifted, an empty skip should be replaced to prevent littering. These are also appropriate vehicles for transportation of inert or Construction & Demolition waste.

Skip Trucks are recommended for transportation of large quantities of C&D and inert waste

- The system should be used to lift waste containers with wastes having densities upto 1000kg per cubic meter
- The skip loader should be able to make at least 5-6 trips in an 8 hour shift within a radius of 15 kilometers. Twin dumper placers can also be used to lift twice the number of containers in the given time.

Figure 2.13: Skip Truck (Dumper Placer)[11]

[11] Ready Reckoner on Municipal Solid waste Management for urban local body, Commissionerate of Municipal Administration, Chennai, 2008

2.3.11.2 Refuse Collector Without Compactor

At places where small size containers of 0.5 to 1.1cu.m. are placed, the refuse collector machine, without compaction, of 6 to l5 cu.m. capacity, having top or back loading facility may be used. This vehicle lifts and unloads the contents of the small container into the body of the vehicle through a hydraulic system and puts the empty container back in place.

2.3.11.3 Rear Loading Compactor Trucks Used For Transportation

Compactor trucks are used for transportation from smaller transfer points either to larger transfer stations or directly to treatment or disposal sites. Compactors can be of different sizes(refer to figure 2.14 and figure 2.15), some features of the compactor trucks are:

- The loading hopper should be suitable for unloading tipper vehicles and hand held bins, as appropriate for the primary collection
- Compaction capability to compress garbage/ solid waste between 800 and 900 kilograms per cubic meter.

The three sizes used in India at present are:

- Small size compactor of 5-6 cubic meters for 4.5 to 5.5 tonnes waste/ trip.
- Medium size compactors of 8 – 10 cubic meters with a payload capacity of 7 to 7.5 tonnes/ trip.
- Large size compactors of 12 – 14 cubic meters with a payload capacity of 10 to 12 tonnes/ trip

Figure 2.14: Medium size compactor truck[12]

[12] Image sourced from TPS Infrastructure Pvt. Ltd

Figure 2.15: Transfer of waste from secondary collection bins to Refuse Compactor[13]

Routing of secondary collection vehicles should be planned to ensure synchronization of primary collection, maximize operational efficiency and minimize environmental impacts of transportation. Transportation through environmentally sensitive areas should be avoided.

2.3.11.4 Light Commercial Vehicle With Tipping Floor

Wherever possible, municipal authorities should plan for direct transfer of wastes collected from households into secondary collection vehicles. In such instances, mini trucks with a tipping floor are appropriate for secondary waste transportation. Door to door collectors and sweepers may be directed to transfer the waste from primary collection vehicles/ hand carts directly into these vehicles. Specifications of mini trucks with a tipping floor are given in section 2.3.4.3 of Part II.

In small cities with poor repair and maintenance facility, where hi-tech vehicles may not work efficiently, tractor-trolley combination for lifting of containers or towing of containers by tractors may be used. Simple hydraulic tipping-trailers are recommended to avoid manual unloading at processing plants or disposal sites.

2.3.12 Waste Transportation Planning And Deployment Of Equipment And Vehicles

Secondary collection and transportation contributes significantly to the cost of solid waste management services. Vehicle productivity is the primary indicator of the efficiency of secondary waste collection/transport system. Efficiency may be improved by optimizing the collection and transfer operations. Collection routes should be effectively planned to minimise transport distances and ensure an equitable distribution of workload amongst staff. All the vehicles may be utilized in atleast two shifts, depending on waste generation, to lift all containers, to ensure full utilization of the fleet of vehicles and to limit the size of the fleet in total. Transportation of waste during night time may be done in areas prone to traffic congestion.

[13] JnNURM Toolkit on Solid Waste Management

To facilitate efficient and cost effective collection and transportation, ULBs should develop a proper strategy for deployments of collection and transportation vehicles. The following tables (Table 2.4 and 2.5) show some indicative models of deployment for collection and transportation vehicles for various quantities of generation of MSW. However, during MSWM Plan preparation and consequent DPR preparation most suitable solutions need to be tailor made according to the local condition. As already mentioned in section 1.4.4.9 of Part II, it is important to design the system only on the basis of real data on waste quantities and waste composition.

The waste generation quantity should be assessed locally, these are only indicative figures.

Table 2.4: MSW Management Plan for Municipal Councils and A, B, C class cities[14]

Approximate Population	ULB Generating Tonnes/day	Primary doorstep segregated collection equipment And vehicles	Secondary collection of street waste equipment and vehicles	Decentralized or centralized processing, recovering and recycling	Waste disposal at common/regional landfill
Up to 50000	2.0 to 2.5 TPD per 10000 population	Door to door collection services through containerzied handcarts or tri-cycles Two bins for storage of wet waste and dry waste 10 to 15 litres capacity domestic bins one of them with lid (as per CIPAT specifications) A pair of community bins of 60 litres (20 to 30 kg) or 120 litre capacity (40 to 60 kg) or 240 lit capacity (80 to 120 kg) or 1.1 cu.m. capacity (300 to 450 kg) Bulk generators at source requires 120 liters (49 kg waste), 240 litres (96 kg waste) bins Contract for door to door collection should be given to private firm/ RWA, if possible	3 to 4 cu.m containers to be placed at the rate 4 per sq.km area or 1 per 5000 population. Transportation of containers by tractor by having container lifting device	Decentralized processing through composting or bio gas technology for both biodegradable and recyclable waste collected from households/ shops etc. If no land is available for decentralized processing, town level processing must be done and direct transfer of waste collected from streets and drains to disposal site through tractors at the rate of 1 tractor per 10,000 population	Inert only to be transported to common/regional landfill facility

14 Reference Material on Municipal Waste Management for Urban Local bodies, All India Institute of Local Self Government,2012 &Manual on Municipal Solid Waste Management, CPHEEEO, MoUD, GOI, 2000

Approximate Population	ULB Generating Tonnes/day	Primary doorstep segregated collection equipment And vehicles	Secondary collection of street waste equipment and vehicles	Decentralized or centralized processing, recovering and recycling	Waste disposal at common/regional landfill
50,000 to 100, 000	10-30 TPD @ 250 gm/capita/ day	80% households to be served by covered tractor or covered LCV for door to door collection @ 1 vehicle / 1500 households/shops etc. 20% households to be served by tricycles with container for door to door collection or handcarts for narrow lanes @ 1 tricycle / 200 units Direct transfer of waste from tricycle to tractor or LCV to processing facility	100% Street sweeping waste to be collected in containerized handcarts and deposited in 3-4 cu.m. containers. Containers to be placed @ 4 per sq.km area or 1 per 5000 population. Containers to be lifted by tractors or twin bin dumper placers.	50% decentralized processing of waste if suitable space is available If no space, domestic and trade waste to be processed at centralized facility with resource recovery	Inert only from the processing facility Street sweepings and silt from the drains may be landfilled.

Table 2.5: MSW Management Plan for Municipal Corporations[15]

Approximate Population	ULB Generating Tonnes/day	Primary doorsteps segregated collection equipment and vehicles	Secondary collection place, equipment and vehicles	Decentralized/ Centralized processing, recovery & recycling	Bulk transportation, landfill disposal
1,00,000 to 5,00,000	25-150 TPD	75% (approx.) through covered LCV vehicle for door to door collection 25% door to door collection through containerized tricycles or handcarts from narrow lanes Direct transportation of waste to processing facility if distance is under 5 km or through use of compactors, if distance of processing facility is longer. Compactors to be deployed based on capacity of vehicle and volume/ weight of waste	Street sweeping and silt from the drains may be collected in containerized hand carts and taken to secondary storage depot having 1.1 m^3 to 4 m^3 metal containers Containers to be placed @ 4 per sq.km area or 1 per 5000 population. Containers to be lifted by twin bin dumper placers or refuge collector/ compactor machines. Dumper placers&compactors based on capacity of vehicle and volume/weight of waste	100 % door to door collected waste to be processed at decentralized sites , if available or processed at one single facility. Composting and/or bio gas/ RDF facility may be created.	Inert street sweeping Silt from the drains and residual waste from processing plants to be landfilled.

15 Reference Material on Municipal Waste Management for Urban Local bodies, **All India Institute of Local Self Government,2012**

Approximate Population	**ULB Generating Tonnes/day**	**Primary doorsteps segregated collection equipment and vehicles**	**Secondary collection place, equipment and vehicles**	**Decentralized/ Centralized processing, recovery & recycling**	**Bulk transportation, landfill disposal**
Population between 5- 10 lakhs	150-400 TPD	75% (approximately) using covered LCV for door to door collection 25% door to door collection through containerized tricycles or handcarts from narrow lanes Direct transportation of waste to processing facility if distance is under 5 km. or through use of compactors, if distance of processing facility is longer. Compactors to be deployed based on capacity of vehicle and volume/ weight of waste	Street sweeping and silt from the drains may be collected in containerized hand carts and taken to secondary storage depot having 1.1 m^3 to 4 m^3 metal containers Containers to be placed @ 4 per sq.km area or 1 per 5000 population. Containers to be lifted by twin bin dumper placers or refuse collector/ compactor machines. Dumper placers and compactors to be deployed based on capacity of vehicle and volume/weight of waste	100 % door to door collected waste to be processed at decentralized sites , if available or processed at one single facility. Composting and/or biogas/ RDF facility may be created.	Inert street sweepings, Silt from the drains and residual waste from processing plants to be landfilled.

Approximate Population	ULB Generating Tonnes/day	Primary doorsteps segregated collection equipment and vehicles	Secondary collection place, equipment and vehicles	Decentralized/ Centralized processing, recovery & recycling	Bulk transportation, landfill disposal
Above 10 lakhs	400 TPD & above	75% (approximately) covered LCV for door to door collection 25% door to door collection through containerized tricycles or handcarts from narrow lanes Direct transportation of waste to processing facility if distance is under 5 km or through compactors or transfer stations, if distance of processing facility is longer. Compactors to be deployed based on capacity of vehicle and volume/ weight of waste. Large containers of 10 tons(+) capacity with hook loaders may be deployed at transfer stations for bulk transfer of waste through procesing / disposal facility	Street sweeping and silt from the drains may be collected in containerized hand carts and taken to secondary storage depot having 1.1. m^3 to 4 m^3 metal containers Containers to be placed @ 4 per sq.km area or 1 per 5000 population. Containers to be lifted by twin bin dumper placers or refuge collector/ compactor machines. Dumper placers and compactors to be deployed based on capacity of vehicle and volume/weight of waste	100 % door to door collected waste to be processed at decentralized sites, if available or processed at one single facility. Composting and/ or biogas/ RDF or waste to energy power plants may be installed as power plants will not be viable if the waste is less than 500 tpd.	Inert street sweepings, Silt from the drains and residual waste from processing plants to be landfilled.

2.3.12.1 Management Information System For Waste Transportation

Advanced information management, mapping and communication technologies may be used for efficient MSW management:
- Management Information System (MIS)
- Radio Frequency Identification (RFID)
- Global Position System (GPS)
- General Packet Radio System (GPRS)
- Geographic Information System (GIS)

Geographic Information System (GIS) and other Management Information Systems (MIS) are important tools for ULBs to manage solid waste in large and mega cities. (Refer to section 6.1.1 of Part II for further information)

It is essential for the head of the SWM department as well as the head of the ULB tobe informed of the day to day performance of the solid waste management service, the service being very vital for maintaining the health and well-being of the people.

As part of the larger MIS systems[16], daily reports on a number of aspects of the solid waste transportation system need to be complied in order to take stock of existing performance and take corrective measures as and when required:

- The number of sanitary workers (sex disaggregated data) with their proper roles and responsibilities laid out, supervisors and drivers on rolls and reporting to duty, details of absenteeism, authorised leaves/public holidays and substitute arrangements
- Vehicles and equipment reporting on duty and performing the expected function, number of vehicles off the road on account of breakdown.
- Quantity of waste transported, treated and disposed of at the treatment/processing facilities and at the landfill.
- Arrangements made or proposed for clearing breakdowns

In addition to information on waste generation and composition, staff position, staff requirements, specific engagement of NGOs/SHGs, community authorities/organizations, recovery of user fees, location of waste storage depots, number of vehicles, their capacities and types, number of bins, as well as location and capacity of waste processing and disposal sites is required.

This data coupled with spatial data may be used in GIS software to maintain and manage the waste transportation and processing system. A Global Positioning System (GPS) can be synchronized with the GIS system to monitor and track waste transportation vehicles and identify any irregularities in waste movement. More information regarding advanced communication technologies like GPS, GIS and GPRS can be found in Section 6.1.1 of Part II.

Details of information to be collected and maintained in a MIS system for monitoring provision of SWM services are given in Section 6.1.2 of Part II of this manual.

16 Refer chapter 2 of Part II of this manual

2.3.12.2 Management Of Contracts For Waste Collection And Transportation

Municipal authorities might involve the private sector to ensure efficient service delivery and bring in expertise and finances that may not be available with the ULB. Collection and transportation of waste can be entrusted to a private contractor in parts or in full. It is essential to determine the exact services to be rendered through private sector participation such as number of households, shops and establishments to be served, frequency of service, time of service delivery, type and level of service to be provided, types and capacity of vehicles to be used, distance from service area to transfer station/ processing and disposal site. It is also essential to set up a mechanism for measuring the performance of the contractors and decide the manner in which payment should be released.

The contractor should keep all vehicles and equipment deployed for performing the services in good working condition. The contractor must also ensure efficient, inclusive and fair treatment of its workers. Specific requirements for women workers such as provision of crèches, linkages to aangawadis in the nearby community should be encouraged.

It is necessary to develop a proper contract management and monitoring system before contracting private firms.

For details please refer to Section 5.3 of Part II of this Manual.

2.4 Street Cleaning

Street cleaning is a fundamental service ensuring clean and hygienic urban conditions. Generally households, commercial entities and transport operators should be made responsible for garbage minimization on the streets. Street wastes include paper, plastics, dirt, leaves and other vegetative matters. Manual sweeping is commonly practiced in India as many streets are congested and narrow. Inefficient waste collection systems coupled with public littering significantly contribute to waste piles in streets.

A wide variety of tools, equipment and methods, both manual and mechanical, are available for street sweeping. Through the introduction of efficient methods, municipal authorities can achieve significant financial savings.

2.4.1 MSW Rules Requirements On Street Cleaning

Both manual and mechanical street cleaning are possible. However, manual street cleaning is preferred in narrow, congested streets and in streets where the road carpeting is damaged.

Rules: As per MSW Rules 2000/2014, littering of municipal solid waste is prohibited in cities, towns and in urban areas notified by the state government.

Manual handling of wastes is prohibited. However, if unavoidable due to constraints, manual handling should be carried out under proper precautions with due care for safety of workers. Workers should be provided with uniforms, shoes, gloves and other implements etc., for their safe and easy working. They should be subjected to periodic health checks and should be provided with social security benefits including health insurance.

2.4.2 Planning For Street Cleaning

It is necessary to have a well-planned system for street sweeping including adequate staffing and equipment. Street sweepers should be instructed to report daily for duty at a designated location, which could be the nearest municipal ward office or could be an office space identified by the commissioned contractor. However, it should be ensured that such location will have a provision for storing street sweeping equipment. The location may also serve as an office for supervisor. The following table 2.6 comprises some important aspects for planning of street cleaning.

Table 2.6: Street Sweeping Norms for Small towns /Small Cities/ Mega Cities

Planning for street sweeping			
	Small town	**Small City**	**Mega city**
Equipment	Long handle broom Metal tray-metal plate Containerized hand cart or tricycle Tractor with covered trolly. Or container wth container lifting devise	Long handle broom Metal tray-metal plate Containerized hand cart or tricycle Secondary storage bin Dumper placer/Compactor Mechanical sweeper Container lifting devises	Long handle broom Metal tray-metal plate Containerized hand cart or tricycle , secondary storage bins, Dumper placers/compactors Container lifting devises Mechanical road sweepers
Staff requirement based on road density	High density roads: 1 person per 300-350 running meter road length Medium density roads: 1 person per 500 running meter of road length Low density roads: 1 person per 750 to 1000 meter of road length	High density roads: 1 person per 300-350 running meter road length Medium density roads: 1 person per 500 running meter of road length Low density roads: 1 person per 750 to 1000 meter of road length	High density roads: 1 person per 300-350 running meter road length Medium density roads: 1 person per 500 running meter of road length Low density roads: 1 person per 750 to 1000 meter of road length
Scheduling	Please refer to table 2.7		

2.4.2.1 Street Classification and Street Cleaning Requirement

Planning an effective street sweeping system requires classification of streets, according to the required frequency of sweeping. The classification may be based on location, traffic intensity, type of surface, character of area (e.g. commercial, residential) and others.

Streets are classified based on their location, traffic intensity, type of street surface, land use of adjacent area (e.g., commercial, residential), and others. Based on the street classification, the level of service for street sweeping may be determined. Table 2.7 relates the classification of streets to the suggested sweeping frequency.

Table 2.7: Typical Classification of Streets and Frequency of Sweeping

Class	Character of Street	Frequency of Sweeping
A	City centre – shopping areas	Daily/Twice, depending on need
B	Market areas	Daily
C	Minor streets	Daily
D	Sub-urban shopping streets	Daily
E	Residential streets	Daily
F	Roads and streets having no households/establishments on either sides	Once a week
G	Highways	Rarely necessary to sweep highways due to turbulence through motor traffic
H	Sub-urban main streets	Twice a week
I	Open spaces	Occasionally, when required. (minimum once in a fortnight)

In cities/towns where door step collection of waste is ensured, the frequency of road sweeping can be reduced; especially in low-density and low traffic areas.

ULBs should adjust the frequency of street cleaning based on local conditions. Also, the time of street cleaning should be carefully defined to avoid conflicts with traffic, parked vehicles and pedestrians. The service should be carried out preferably during hours of less activities in the streets, e.g., early in the morning and at night. Night-time service is only advisable on main roads which are well- lit, mainly because street cleaning activities can disturb residents and could be potentially dangerous; especially for women workers. ULBs should ensure the safety of all workers who are sweeping roads at night by providing them with appropriate Personal Protection Equipment (PPE). Should women be engaged, sufficient protection to be provided to ensure that they are not harassed by strangers, police/law enforcers or other members of the community. Proper uniforms which have reflectors (for the night work) be provided with ID cards, would ensure they are recognized as workers with proper access to protection officers/ police head quarters if required. Constant check-ins and regulatory mechanisms should be put in place to ensure that all workers are safe from all forms of harassments, dangers and accidents. Adequate protection should be afforded to women working at night through deployment of constables/patrol teams who should be informed of how many women at any given point of time would be engaged in work on particular streets.

[17] Manual on Municipal Solid Waste Management, CPHEEO, MoUD, GOI, 2000

Street sweeping in residential areas may be carried out in two spells, 5 hours in the morning and 3 to 4 hours in the afternoon. Staff involved in street sweeping should also be responsible for cleaning drains (upto 18" in depth), along the same "beat". Multiple handling of wastes should be avoided. The local sanitary inspector should be responsible for inspecting and maintaining records on the extent of service provision.

ULBs can adopt different strategies for tourist places, where large number of people are present almost at all hours. In such places regular cleaning throughout the day (2 to 3 times) and during weekends and national holidays may be necessary.

2.4.3 Manual Street Cleaning

2.4.3.1 Description

Manual cleaning involves sweeping and collection of waste by sanitation workers from streets, roads, lanes and by lanes and public places. Street sweeping normally comprises of cleaning the road surface and footpaths on both sides of the road. All waste from street sweeping should be transported separately without mixing with domestic or any other commercial establishment wastes, to ensure efficient waste processing and to avoid mixing of inerts with other waste, there by minimizing the burden of segregation of such inert waste from the mixed waste, facilitating efficient waste processing.

Ideally, street sweepings and silt collected from drains should be transferred from the wheel barrows to a designated black storage bin/container placed at waste storage depot. Depending on the type of road and activity on the road, the size of the bins may be decided. These bins should be regularly lifted by municipal authorities before bins start over flowing and taken to waste processing facility for further processing (sand recovery facility, if available) or for disposal at the landfill.

2.4.3.2 Types of Street Cleaning Equipment

Use of appropriate tools plays an important role in improving work efficiency. Equipment for manual sweeping should be easy to handle for both men and women and relatively light in weight, to ensure that workers do not expend disproportionate energy in wielding such equipment. Local authorities should apply modern technology where appropriate and should also organise training and capacity building programmes for their staff.

Commonly used equipment for street cleaning:

Brooms with sufficiently long handles allow for easy removal of street sweepings and dust

Brooms with sufficiently long handle: Long handled brooms cause less strain and supports a correct body posture while working. An adequate type uses bunches of filaments inserted into a wooden stick. The length of the broom should be such that the male and female work force can use it comfortably, without bending. Care to be taken to ensure that the handles for the broom are not heavy, light- weight material to be given preference. The filaments of the broom should be tightly spaced to facilitate easy collection of fine silt and dust, leading to efficient cleaning of streets. There are two types of long handled filamentous broom used by municipal staff in India as depicted in figure 2.16.

- Fan shaped Filament broom: The filaments of the broom fan out facilitating removal of litter from the streets but leave behind sand and silt.
- Bunched Filament broom: The filaments are bunched together to facilitate removal of both litter and sand/silt from roads or streets.

Figure 2.16: Fan shaped &bunched (Delhi model) filament brooms

A typical long handled filament broom may consists following specification (As per Delhi Model)

- Length of the broom:80-85 cm
- Weight of the broom: 1 kg

- Binding material: 20 gauge MS sheet ring having width of 1.5-2 cm
- Handle of the broom: Bamboo of 135 cm length, 3-4 cm diameter
- Weight of the bamboo handle: 900 gm. (approximately)

Shovels: Heaps of street wastes gathered by brooms have to be picked up and placed in a container. The conventional tool for this purpose is a large straight-blade shovel or metal plate and metal tray. However, when the wastes comprise large quantities of light materials such as leaves, a shovel is ineffective because dried leaves fall of or are blown away during transfer. A solution is a pair of flat boards, usually plywood, between which the wastes are retained by hand-pressure.

Handcarts: Handcarts facilitate transportation of street waste. Hand carts should have four to six detachable polyethylene containers with a capacity of 25 – 40 litres each to allow easy transferring of waste into community waste storage bins. It must have sealed ball bearings and handles having a cross bar upto navel height, its wheels should have rubber strips or tyres for ease of handling and minimising fatigue.

2.4.4 Mechanized Street Cleaning

Generally, mechanized street cleaning equipment have a driving unit attached with brushes for dislodging sticking material. They may also be equipped with a water tank and sprayers to loosen particles and reduce dust. A vacuum system or conveyor system transfer wastes from the street to the storage receptacle. There is a wide range of mechanized street cleaners available in the market. Equipment should be chosen carefully, taking into account street conditions and needs of the city, reliability, ease of procurement of spare parts, investment, operation and maintenance costs.

ULBs should make well informed decisions while choosing mechanical sweepers and should consider local conditions, investment &operation and maintenance costs.

2.4.4.1 Mechanical Broom Sweeper

A mechanical broom (refer to figure 2.17) is designed to remove standard road waste, using various kinds of circulating brushes that sweep material onto a conveyer belt and then into bins. Mechanical street sweepers use a gutter broom which displaces debris from the kerb into the path of the main broom, which is attached to a conveyer belt. Mechanical brooms have an ability to pick up large debris such plastic bottles, canes, wet vegetation, gravel and coarse sand. They are also effective in removing packed dirt from roadways. However, they are ineffective in picking up fine material.

A mechanical broom has lower energy demand than regenerative sweepers and vacuum sweepers (see following sub-sections). Gender stereotyping of the role of the 'driver' should be avoided. Women should also be encouraged to take to driving the mechanical broom and should be provided with the necessary training.

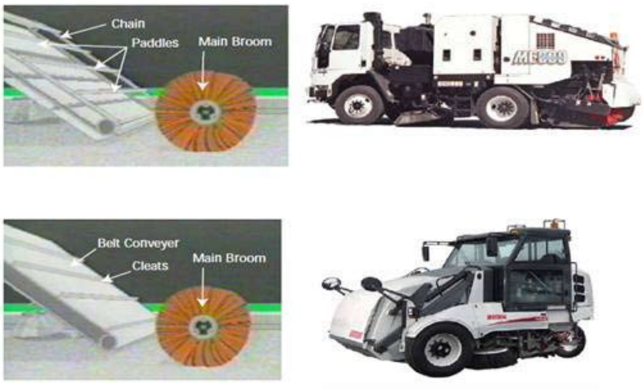


Figure 2.17: Mechanical Broom Sweeper[18]

2.4.4.2 Regenerative Air Sweeper

The regenerative air sweeper (refer to figure 2.18) uses a broom to collect large debris/ wastes; it also uses forced air and high power vacuum for the collection of fine material. The sweeper blows high pressure air onto the road to loosen very fine sediment. A vacuum suction lifts all particles and captures them in a hopper. Regenerative air sweeper can remove fine sand and dust, provided the surface is dry. Regenerative air sweepers contribute to preventing air pollution by capturing fine sand particles. They have relatively higher energy consumption compared to the mechanical broom sweeper and are quite expensive. They however can clean a wider path, and limit the amount of dust-laden air that is exhausted back into the atmosphere. They are also able to pick up large sized debris, since the blast of air is able to dislodge material and get them into the airflow stream that is created by the suction.

[18] Resource for implementing a street sweeping best practices, Local road research board, Department of transportation, Minnesota, 2008

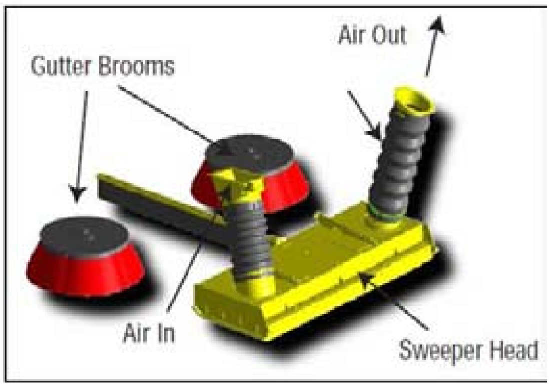


Figure 2.18: Regenerative Air Sweeper

2.4.4.3 Vacuum Sweeper

A vacuum sweeper uses a broom to move debris towards the vacuum nozzle. Typically, there is a suction inlet on one side of the sweeping head, and the “used” air is constantly exhausted during the sweeping process (please refer to figure 2.19). There are various types of vacuum sweepers based on the location of the vacuum nozzle. Vacuum sweepers utilize a fan that exhausts its air directly to the atmosphere and uses water for dust suppression. They can vacuum material from channels and gutters and collect fine particles from within cracks also, but cannot pick up large debris like tree trimmings and disposed packaging. However, since there is no vacuum suction beneath the broom, the area of the road under the broom may still retain fine material. Even though vacuum sweepers use water-based dust suppression systems, they exhaust a high level of particulates into the atmosphere on a continual basis.

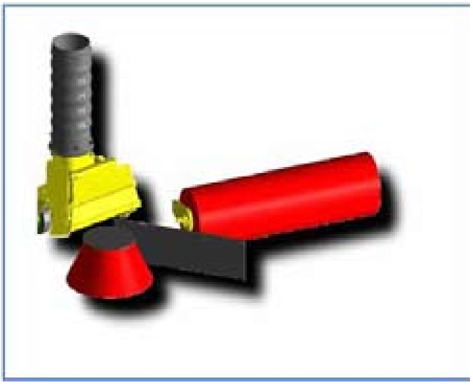


Figure 2.19: Vacuum Sweeper and Vacuum Nozzle[19]

[19] Resource for implementing a street sweeping best practices, Local road research board, Department of transportation, Minnesota, 2008

There are two types of power sweeper machines (vacuum sweepers) available in the Indian market

- **Chassis mounted:** The power sweeping unit with container is mounted on a vehicular chassis with hydraulic motors and power controls for driving brushes, suction unit and jet washing with auxiliary engine carrying out these functions, whereas the automobile chassis engine drives the vehicle. The payload capacity of power sweeping machines is approximately 4000-5000 kg. with a 4 to 6 cubic meter stainless steel or higher grade container for storage of sweeping wastes.
- **Self-Propelled Power Sweeping Machines:** The self-driven power sweeping machine (refer to figure 2.20) is a composite vehicle with a container, hydraulic motor and power controls for driving brushes, suction unit and jet washing. The payload capacity ranges from 2000 to 3000 kg in a container of 1. 75 – 2.5 cubic meters. These are comparably small machines which can be deployed on both narrow and wide roads. Two side brushes throw dust towards a main or inner broom which finally transports dust into a central hopper.

Mechanised sweepers with a capacity of 1.85 cubic meters with three front brushes are capable of working at two levels and can be used to clean foot paths as well. An attached vacuum wander hose can collect heavy material. An attached sprinkling bar can be used for washing streets.

Using one self-propelled and one chassis mounted power sweeper in conjunction will yield the best results and can cover a total of 50 km in two 8 hour stretches.

Figure 2.20: Self-propelled road sweeping machine[20]

The following operational conditions should be considered for mechanized street sweeping:

- It is essential to work mechanized sweepers in minimum 2 shifts to ensure economic viability.

[20] TPS Infrastructure Pvt. Ltd.

- One skilled operator and one semi-skilled co-operator are required to operate a mechanized sweeper.
- Given that the machine will not be able to clean odd and uneven places, an additional group of 4 manual sweepers may also need to be deployed with every power sweeper.
- Typical fuel efficiency of a mechanized sweeper is 1.5-2 kilometres per litre and lower, if road conditions are not conducive or in places of heavy littering.
- All brushes are to be replaced/refurbished after nearly every 1000 kilometres of sweeping operations (7-10 days actual operations in two shifts).

Collected sweeping to be unloaded into containers and transported to the disposal place in a separate vehicle other than the mechanical sweeper.

2.4.4.4 Financial Implications Of Mechanized Street Sweeping

The cost of mechanized sweeping includes cost of purchasing the machine, annual cost of operation and maintenance, cost of disposing of the debris and wages of the driver and helper. It is also necessary to consider efficiency, average life, and availability of spare parts and the presence of authorised garages for maintenance of the machine before buying the product, so that improvement in street cleaning services would not result in unexpected costs.

Selection of an appropriate Power Sweeper

The selection of the type of sweeper will depend on specific conditions of roads targeted for sweeping. In general, mechanical sweepers are more effective at picking up large debris and cleaning wet streets and have lower capital and operating costs. However, mechanical sweepers can create large amounts of airborne dust. Vacuum-assisted and regenerative air sweepers are more effective at removing fine particles and associated heavy metals but tend to be ineffective at cleaning wet streets; they are effective in areas where Respirable Particulate Matter (RPM) is a cause of concern. They may also be noisier than mechanical sweepers.

Compared to mechanical broom sweepers and air regenerative sweepers, vacuum sweepers are more effective but also more expensive. However, given their high performance rate in comparison to the other two options, vacuum sweepers yield substantially better cost efficiency in most cases.

2.4.5 Cleaning Of Surface Drains

In order to ensure that sweepers do not dispose waste into drains, same staff that is responsible for cleaning street should be made responsible for cleaning adjacent drains as well

In many cities there are open surface drains along the road side, which needs to be cleaned on a regular basis to permit free flow of storm/grey water. Solid waste management authorities should ensure that citizens and sweepers do not dispose waste into drains, through campaigning, statutory regulations and monetary fines. A further approach to prevent this is to make the same staff responsible for cleaning streets as well as adjacent drains up to a depth of 45-60 cm.

Staff required for drain cleaning is dependent on the length of drain. As a general principle, one person can clean upto 500 m of a shallow surface drain (not more than 45-60 cm) per day. This thumb rule could be adjusted based on local conditions. Necessary tools which meet proper standards of safety, safety equipment and vehicles for waste transfer should be given to the drain cleaners. Generally light-weighted shovels and handcarts are required as tools for drain cleaning. The equipment does not differ much from the one for street cleaning.

Silt removed from surface drains and stored on the shore of the drain should be collected as soon as possible and transported directly to the landfill

The removal of silt from surface drains or storm water drains deeper than 60 cm and manholes should be done by the engineering division of the local authority using special equipment. It is advisable to explore new technologies like suction pumps loaded onto trucks (refer to figure 2.21), for removal of silt from manholes to avoid manual scavenging.

Figure 2.21: Truck mounted with pressure water jetting and suction machine[21]

[21] Bhopal Municipal Corporation

2.4.5.1 Silt Management

The silt collected from surface drains should not be allowed to stay on open roads or foot paths beyond 4 hours. Wet silt should be removed from the main roads in less than 4 hours and in other areas within 24 hours and should be directly transported to the landfill or be disposed of at the waste storage depots in the black-container, in order to prevent nuisance and health hazards. . This waste is not amenable for composting given the possibility of high contaminants and inert content in the silt.

2.4.6 Transfer Stations

In large cities where disposal sites are more than 15 km away from the collection area, it is economical to set up transfer stations as a tertiary collection system (see figure 2.5) to save transportation time, equipment and fuel. The transfer station can also be equipped with a material recovery facility, where recyclables are sorted and sent for further processing or to recyclable markets. Transfer stations usually consist of large size containers of about 15 to 25 cu. m. A ramp facility can be provided to facilitate unloading of vehicles or dumper placer containers, directly into large vehicles or containers kept at a lower level just below the ramp. The transfer station can also have the facility of a hopper, into which waste can be transferred, and then with the help of a static compactor, waste can be pushed into the large hauling vehicle/container.

Transfer stations should be set up in large cities where disposal sites are more than 15 km to save on transportation time, equipment, fuel and costs

Transfer stations are usually part of the waste management system in large cities like Delhi, Mumbai, Bengaluru, Calcutta, Ahmedabad, Coimbatore, Chennai etc. The smaller municipal authorities should consider setting up simple transfer stations having a ramp facility to facilitate transfer of waste from a small vehicle/container to a large hauling vehicle. Only large cities should consider setting up large transfer station to handle over 300 tonnes of waste per day using static compactor facilities.

Smaller municipalities should consider setting up simple transfer stations having a ramp facility

As a general rule of thumb

- If the one-way travel distance to disposal is over 15 km or the one-way travel time is over 30 minutes, the need for transfer stations should be assessed.
- Transfer stations should be made only when the cost of direct haul in collection vehicles would outweigh the cost of supplemental haul in large bulk-haul transfer vehicles plus the cost of the supporting transfer system infrastructure at the transfer station and disposal site.

Large ULBs should consider setting up transfer stations to handle at least 300 TPD using static compacter facilities

2.4.6.1 Types Of Transfer Stations[22]

In case of large- scale transfer station, discharge hoppers and transfer vehicles should be provided to make sure that collection trucks are never kept waiting

Waste is unloaded at a transfer station either directly into tertiary transport vehicles (direct unloading) or into a storage area.

Direct Unloading: A direct unloading system involves a two-level arrangement, wherein the collection vehicles drive up a ramp to the upper level in order to discharge the waste into a transfer vehicle parked onsite or loading system as depicted in figure 2.22.

Direct unloading systems require limited civil works and stationary equipment facilities, and are thus low cost solutions for implementing and operating. However, the direct unloading system requires that the availability of transfer vehicles at the transfer station keep pace with the arrival of collection vehicles, so that no delays are caused in the collection operations. The direct unloading system is usually implemented only as a small-scale system, i.e., typically where the quantity of waste handled is less than 300 tonnes/ day. In most cities, collection vehicles arrive at the transfer station within one or two peak hours per shift. The size of the transfer fleet, in a direct unloading system, would have to meet these peak hour demands.

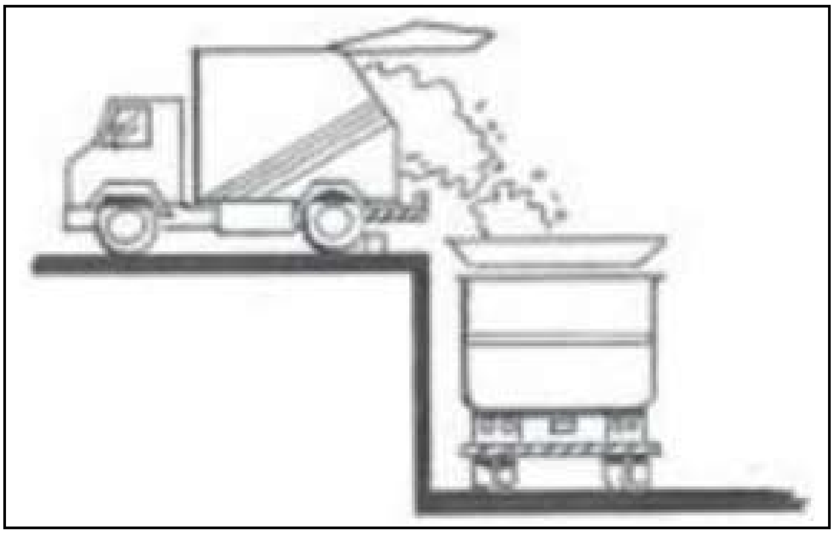


Figure 2.22: Direct Transfer Station[23]

Unloading-to-Storage: An unloading-to-storage system involves collection vehicles discharging into a storage area. From the storage area, wastes are subsequently loaded into transfer vehicles. The storage area may be a platform on the same level as the unloading level, in which case only a two-level arrangement is required. The storage area may be

22 Cointreau, S., (n.d), Transfer Station Design Concepts for Developing Countries. [online], Available at: http://siteresources.worldbank.org/INTUSWM/Resources/463617- 1202332338898 /transferdesignoptions.pdf [Accessed on: 17.09.2013]

23 JnNURM Toolkit on Solid Waste Management, MoUD, GoI

a pit, below the level of the unloading level, and above the level on which the transfer vehicle is parked, in which case a three-level arrangement is required. The storage area is commonly designed to hold the peak quantity of waste generated in one day.

In the unloading-to-storage system, waste unloaded to a storage platform is pushed by a bulldozer (or wheeled loader) into a hopper or onto a conveyor. Waste unloaded to a storage pit is picked up by an overhead crane or pushed by a bulldozer to the receiving hopper. The crane or bulldozer operator visually inspects the waste during operation to set aside any wastes which are potentially hazardous or could damage the transfer vehicle during loading as depicted in figure 2.23.

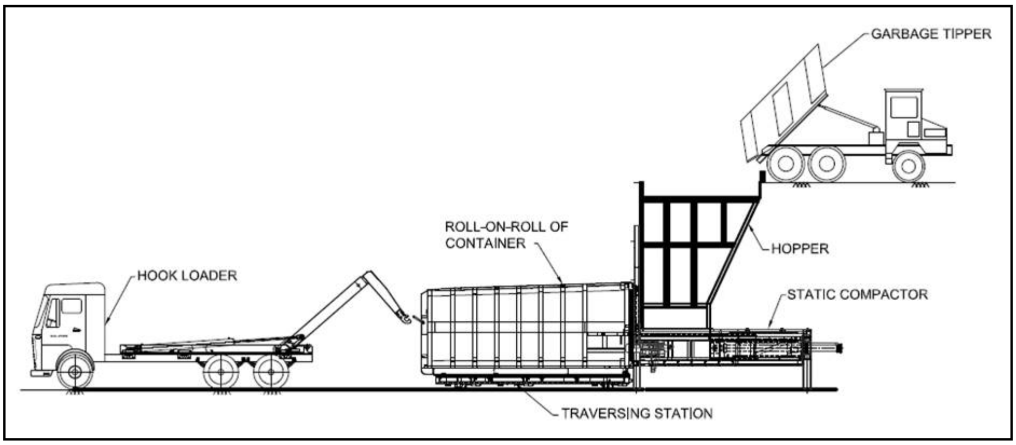


Figure 2.23: Stationary Compactor Transfer station design[24]

Figure 2.24 shows the typical activities at the Transfer Station.

Figure 2.24: Transfer Station Operations[24]

[24] Sourced from Municipal Corporation of Faridabad

Modern Waste Transfer Stations in Coimbatore

Modern MSW transfer stations are located in cities like Coimbatore and Surat. Coimbatore city has three modern transfer stations at Peelamedu, Sathy Road and at Ukkadam. All transfer stations have facilities to quickly unload the waste, compact it and transfer to the waste processing facilities. The transfer station has a specially designed industrial type building suitable for monsoon operations. Waste is brought to the transfer station for loading into larger containers. These transfer stations are designed keeping in mind local conditions, and with an aim to achieve maximum utilization of space and most importantly, to ensure a quick turn over of unloading and loading of waste

The transfer station comprises of several equipment such as heavy duty high compaction compactor, hopper, charge box, load on loaders, and/or a trailer type hook loader with a container of 20 cubic meters. The system is designed to process 200 tons of compacted waste per day.

Transfer station capacity and waste loading bay arrangement

These transfer stations are initially designed for 200 TPD waste handling capacity; For 200 TPD capacity transfer stations, one stationary compactor with 35 ton per hour throughput is provided, initially. An additional bay to house a similar compactor for future augmentation will be provided. In addition, an additional bay without stationary compactor for loading the waste into open-at-top containers by direct deposition of waste into the container is provided. Each transfer station is able to handle more than 200 TPD of waste. The working shift coincides with the arrival of waste from 7.00 a.m. to 3.00 p.m. (varies as per the required condition).

As the waste quantity increases in peak hours, waste is directly loaded into open containers to match the increased waste quantity. The transfer station is at all times able to load the open containers without compaction; the advantage of this arrangement is that during downtime of the stationary compactor, the transfer station operations are able to continue without any disruption.

To facilitate unloading operations on the floor, a separate area with enough space for1 hour storage, with a waste height of 0. 5 m for peak hour waste arrivals (30 tons per hour) is provided on the upper deck portion of the transfer station. This facility is however used only under exceptional conditions.

The figures 2.25 and 2.26 depicts the condition of the site before and after the construction of transfer station.

Following are the Salient Features of a transfer station located at Sathy Road in Coimbatore

Area of the site	:	1.55 Acres
Designed capacity	:	200 TPD
Total No. of Stationery Compactor	:	1
Capacity of Charge Box or Hopper	:	3.34 m3
Round distance from transfer station to disposal site	:	34 km.
Waste handled during Peak Hour (6.30 to9.30 A.M)	:	70 Tons
System capacity	:	35 TPH
Capacity of Computerized weigh Bridge	:	40 Tons

Figure 2.25: Site before commencement of work

Figure 2.26: Site after commencement of work

Chapter 3:

Technical Aspects of Processing and Treatment of MSW

3. Technical Aspects Of Processing And Treatment Of MSW

Management of municipal solid waste and adoption of processing technologies are dependent on the quantity and characteristics of the total waste generated in a local authority, the financial resources available and in-house capability of local authorities to oversee project implementation.

ISWM is a strategic approach to manage MSW in a sustainable manner by considering all aspects of MSWM viz. generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency

The Integrated Solid Waste Management (ISWM) system proposes a waste management hierarchy with an aim to reduce the amount of waste being disposed, while maximizing resource conservation and resource efficiency. Based on the suggested waste management hierarchy (see figure 1) and an assessment of local needs and conditions, an appropriate selection of processes and technologies should be done. The preferred waste management strategies are:

- **At Source Reduction and Reuse:** Revention of waste generation is the most preferred option for waste management, as given by the ISWM hierarchy. Waste generation could be prevented at the design, production, packaging, use and reuse stages of a product. At source waste reduction/waste prevention helps in reducing handling, treatment, and disposal costs and also reduces various environmental impacts such as leachate, air emissions and generation of greenhouse gases. Minimization of waste generation at source and reuse of products are the most preferred waste prevention strategies.
- **Waste Recycling & Composting :** Environmentally suitable recycling of waste and subsequent recovery of material resources through a process of segregation, collection and re-processing to create new products is the next preferred alternative. In the waste management hierarchy, composting is considered as an organic material recovery process and is often considered at the same hierarchical level as inorganic waste recycling.

The ISWM hierarchy ranks waste management strategies according to their environmental benefits.

- **Waste to Energy:** Where material recovery from waste is not possible, energy recovery from waste by production of heat, electricity, or fuel is preferred. Bio-methanation, waste incineration, production of refuse derived fuel (RDF) and co-processing of the sorted dry rejects from MSW in cement kilns are commonly adopted "Waste to Energy" technologies.
- **Waste Disposal:** Residual inert wastes at the end of the hierarchy are to be disposed in sanitary, lined landfills, which are constructed in accordance with stipulations prescribed in MSW Management and Handling Rules, 2000.

  All over the world, landfills which integrate the capture and use of methane are preferred over landfills which flare landfill gas. The least preferred option is to dispose waste in landfills, where no landfill gas capture is planned for.

However, Indian laws and Rules do not permit disposal of organic matter into sanitary landfills and mandate that only inert rejects (residual waste) from processing facilities and inert street sweepings etc. can only be landfilled.I n cases where old dumps are to be closed, there is a possibility of capturing methane gas for further use, which may be explored. However, repeated burning of the waste significantly decreases the potential of capturing methane.

- The hierarchy indicates that all options of at source waste minimization should be utilized before appropriate treatment technologies are selected and implemented. The ISWM hierarchy in figure 3.1 is based on the above discussion and analysis.

Preferential order of waste management options as per the ISWM hierarchy:
- At Source Reduction and Reuse
- Waste Recycling
- Composting
- Waste to Energy
- Waste Disposal

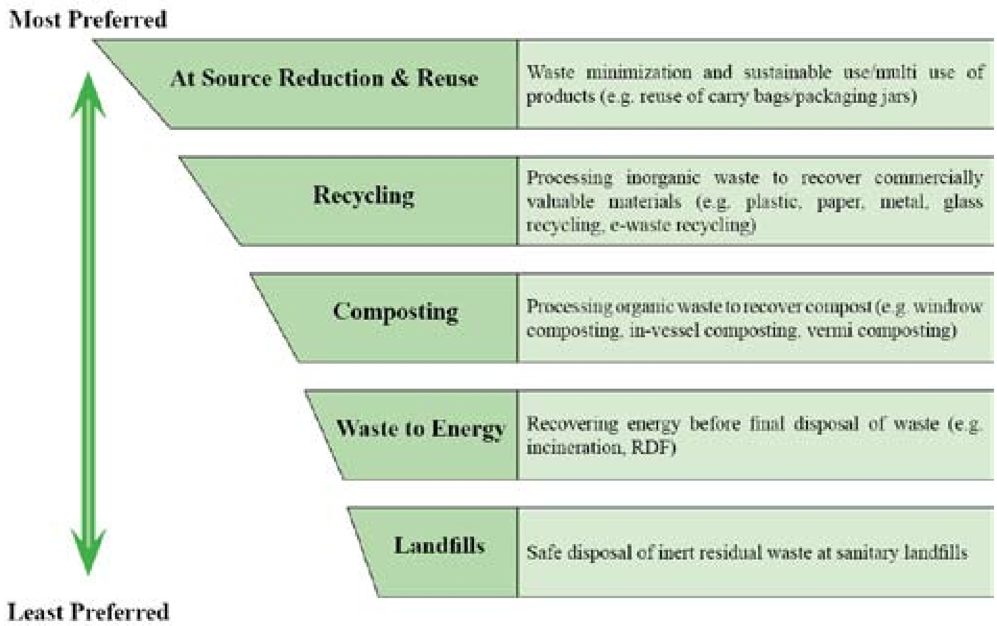


Figure 3.1: Integrated Solid Waste Management Hierarchy

The sections below elaborate on MSWM processing technologies and disposal options in the order as specified by the ISWM hierarchy.

At source reduction of waste or waste minimization is addressed in section 2.1 of Part II. **Waste minimization should be the prime objective of any waste management system in ULBs.**

3.1 Recycling & Recovery

Recycling is the process by which materials that are otherwise destined for disposal are collected, processed and remanufactured or reused. Recycling diverts a significant fraction of municipal, institutional and business waste away from disposal and, thereby, saves scarce resources as well as reduces environmental impacts and the burden of waste management on public authorities. If appropriate market mechanisms are established, recycling can generate revenues, contributing to the overall cost recovery for municipal solid waste service provision.

According to the ISWM hierarchy, recycling is a preferred waste management strategy and recycling systems should be adopted before planning for any waste processing/treatment facilities. Figure 3.2 indicates the importance of recycling in the ISWM hierarchy.

3.1.1 Advantages Of Recycling

Recycling plays a vital role in reducing waste amount, returning resources back to use and minimizing the financial and environmental burden of MSWM

- For the ULB
  - Reduces waste volume
  - Cost savings in collection, transport and disposal
  - Longer life span for landfills
  - Reduced environmental management efforts
- For the economy:
  - Reduction of imports of raw materials, fertilizers etc. and hence foreign currency required.
  - Livelihood opportunities for recyclers in the recycling industry
- For the environment
  - Sustainable use of resources: less material and energy consumption and consequently lower pollution.
  - Reduced amount of waste going to storage sites / reduced requirement of land.
  - Reduced environmental impacts including impacts of climate change.

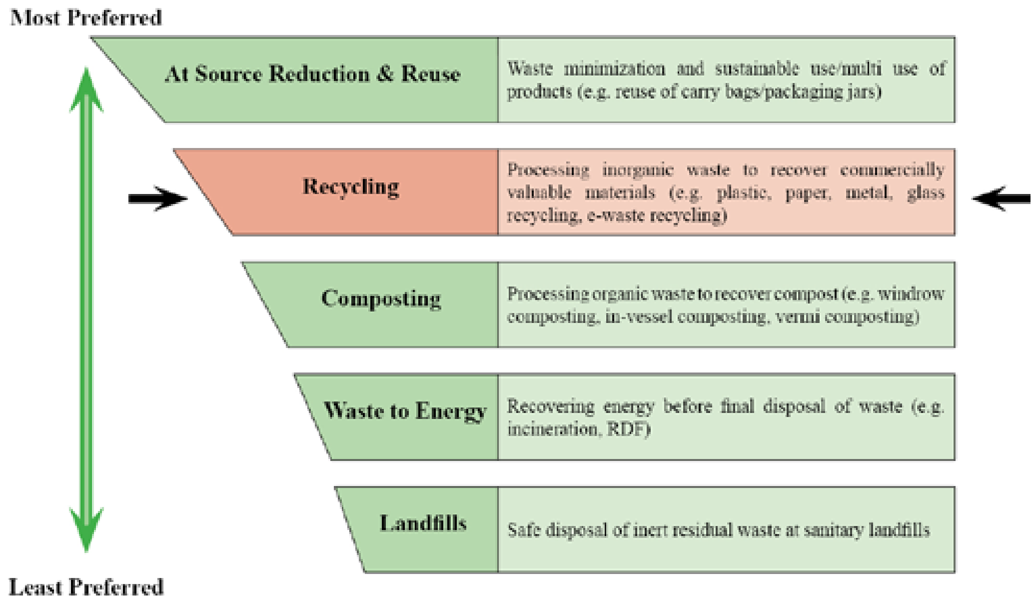


Figure 3.2: Recycling in ISWM hierarchy

3.1.2 Assessment Of Recyclables- Characterization And Quantification

According to the Central Pollution Control Board (CPCB, Govt. of India), urban India generates about 48 million metric tonnes of solid waste per year with a per capita waste generation rate ranging between 0.2 to 0.6 kg per day (2011-2012)[1].

As per data received from CPCB, it is estimated that urban India generated 1, 27,486 metric tonnes of municipal solid waste per day in 2011-12. Of this waste 40-60% is organic and 10-20% is recyclables. This indicates a clear waste minimization potential of 12,750 metric tonne – 25,500 metric tonne per day through recycling and recovery. Figure 3.3 is indicative of the typical waste fractions in municipal solid waste generated in India:

This India wide assessment underlines the importance of recycling. However, this information is not adequate when designing material recycling strategies for a specific municipality.

Recyclables mainly consist of paper, plastic, metal, and glass— and can be retrieved from the waste stream for further recycling. Table 3.1 gives an overview of typical recycling material and their recycling potential.

[1] CAG Environment Reports on Waste Management

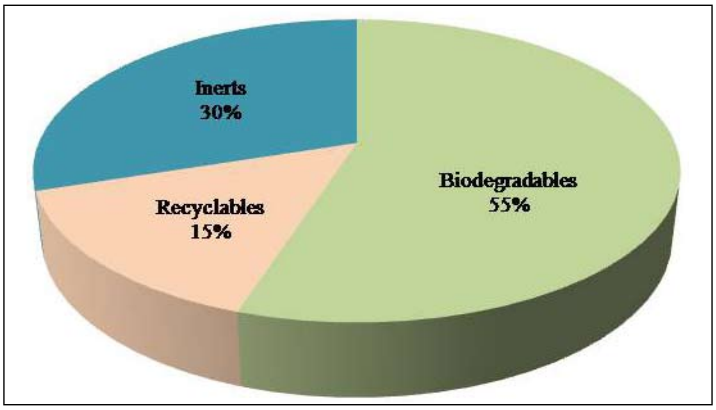


Figure 3.3: Municipal Solid Waste Characterization in India[2]

Every strategy for recycling (as also for other steps of MSWM) should be based on a thorough waste analysis / characterization in the respective city. Only based on this composition and quantification of MSW, a detailed estimation of the potentials for recycling for the different materials is possible. Methods for waste characterization are described in chapter 1 of Part II of this Manual.

Table 3.1: Important Recycling Material: Recycling Potential & Special Conditions[2]

Material	Recycling Potential	Special Conditions
Aluminium	• High Market Value • Easily recycled by shredding and melting • Can be recycled indefinitely because it does not deteriorate through reprocessing • Requires significantly less energy than producing aluminium ore	• Separate collection is important
Batteries	• Recovers valuable metals • Protects environment from heavy metals such as lead, cadmium and mercury	• Large variation in type and size of batteries • Only some types allow adequate material recovery.
Concrete and Demolition Waste (for specific information please refer to section 3.6 of Part II)	• Demolition waste can be sorted, crushed and reused for production of pavement material, flooring tiles, road construction, landscaping and other purposes. • Due to the amounts of demolition waste, its recycling allows significant reduction of otherwise required disposal capacities.	• Standards for recycled products are yet to be stipulated

2 'Improving Solid Waste Management in India,' D. Zhu, et al., (2008).Available at: http://www.tn.gov.in/cma/swm_in_india.pdf

Material	Recycling Potential	Special Conditions
Glass	• Moderate market value • Sorted into colours and melted • Saves energy compared with processing raw material • Can be recycled indefinitely because it does not deteriorate by reprocessing	• Broken glass can contaminate and eliminate opportunities for recycling of other materials such as paper.
Paper and cardboard	• Easily recycled • Paper or cardboard from recycled paper requires less energy during production and helps protect forests	• Recycling potential is reduced with each recycling cycle through deterioration of fibres.
Polyethylene terephthalate (PET)	• PET can be recycled if segregated from other waste	• Quality of recycled product decreases with every processing cycle • Recycled products have specific designated uses and cannot be used for all purposes
Other Plastics (for specific information please refer to section 7.4 of Part II)	• Other plastics, such as polyethylene or polyvinyl chloride, can be recycled but have less value in the market than PET; the value depends on recycling and manufacturing options in the vicinity.	• Clean segregated plastics, are subjected to mechanical recycling into the same plastic type. • Where recycling is not possible due to mixed plastics, these are then co-processed for energy recovery or used as aggregates in road material
Electronic Waste	• Electronic wastes contain high- value metals • Electronic items can be dismantled and components reused or recycled	• Metals are often covered with polyvinyl chloride or resins, which are often smelted or burned, causing toxic emissions, if recycling is not carried out under controlled conditions. • Disaggregation of electronic waste for recycling can be costly.

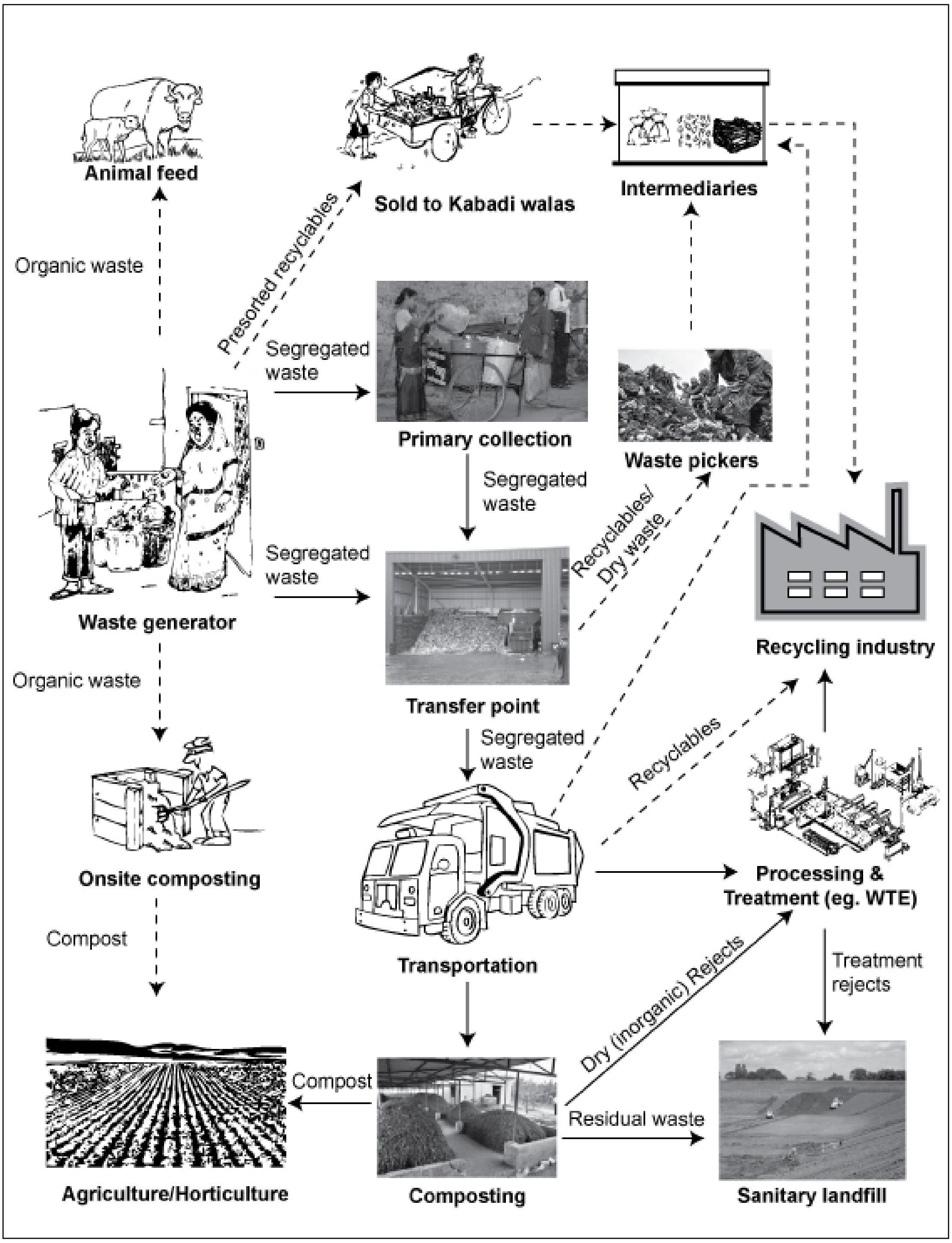
Material	Recycling Potential	Special Conditions
Metals (steel, copper, nickel, zinc, silver etc.)	Scrap metal has a high market value (especially steel, copper and silver) Can be recycled indefinitely because it does not deteriorate through reprocessing	High value metals (such as copper and silver) are incorporated in electronic devices, but extraction can cause severe environmental impacts, if uncontrolled.

3.1.3 Stages Of Material Recovery

Material recovery starts at the primary level, by households which segregate recyclables like newspapers, cardboard, plastics, bottles etc. from waste, to sell such material to local recyclers/ scrap dealers / haulers or kabadi system. What is not sold to the kabadi system, is discarded and becomes part of the municipal solid waste. Rag pickers pick-up parts of this waste and sell them to earn their living. Well segregated recyclables can directly be transferred to a processing site or to the recyclable market depending on local conditions.

The dry fraction of the segregated waste may be further segregated locally or at the transfer station or at the processing plant:

- The dry fraction of the waste can be segregated at the ward level, where waste from one or more wards is collected and segregated. Different recyclables are sent either directly to locally available recycling facilities or are sold to wholesale dealers. The residual waste, depending on the composition is sent for processing or disposal (Compost/RDF/landfilling). Where decentralized compost facilities are available, the wet fraction of the waste is processed locally.
- Dry waste fraction may also be transported to the waste transfer station, where it is further segregated. Municipal corporations can also appoint informal waste pickers for manual sorting of waste at the transfer station. Segregation at the transfer station is through manual and/ or mechanized segregation.
  - Where the dry waste fraction reaches the processing site (Compost/RDF) directly, manual/mechanical pre-sorting should be carried out to recover recyclable material. This also ensures good quality output.
  - In case regional processing/disposal facilities exist, transfer of recyclables to the regional facility should be avoided. In such cases the dry waste fraction should be sorted out either at the ward level or transfer station level. Where this is not possible, appropriate sorting facilities should be available at the regional facility. Figure 3.4 illustrates the different stages of material recovery along the solid waste



management chain.

Figure 3.4: Stages of Material Recovery in Municipal

[3] Adapted from: 'Improving Solid Waste Management in India,' D. Zhu, et al., (2008). Available at: http://w02/05/14ww.tn.gov.in/cma/swm_in_india.pdf

Solid Waste Management Chain[3]

3.1.4 Material Recovery Facility[4]

A Material Recovery Facility (MRF) accepts mixtures of waste fractions (e.g. selected materials collected in the dry waste bin – see specifications in section 2.3 of Part II of this manual) for the purpose of separating and diverting recyclable materials and transferring the remaining waste for disposal.

Configuration of a MRF depends upon factors such as types and quantities of material to be processed, quality and quantity of incoming waste, processing rates and desired quality of end products.

The configuration of an MRF processing line is critical to the overall quality of the segregated material. It depends upon numerous factors including the types and quantities of materials to be processed, quality and quantity of incoming waste, desired processing rates, and required specifications for the end products. While no two MRFs are identical, they generally employ common design principles and sequencing in the configuration of equipment and labour.

Types of MRF: Depending on the scale of the operations employed and the level of mechanization in the facility, MRFs may be classified as manual or mechanized facilities. Manual MRFs are usually small scale units, typically owned, managed and operated by the informal sector and largely employ manual sorting practices. Material is segregated based on the types of wastes (paper, plastic, metal, glass etc.) and gradation of material within each waste type (paper: news print, office paper, packaging paper, printed books etc.). Segregated material is then sold on to intermediaries, who supply material in bulk to the recycling industry.

Configuration of the MRF processing line will vary depending upon how material is received:

- **Mixed stream:** Unsegregated waste if received at the processing facility, may be segregated manually or mechanically to separate recyclable material from compostable and inert waste (Figure 3.5). Compostable matter and recyclable materials may then be processed separately and residual inert wastes should be sent to the landfill
- **Source separated:** Incoming recyclables are sorted at the point of collection. Some processing might be needed for further sorting of material, such as steel cans from aluminium cans and sorting of glass by colour; paper by quality etc. but the primary purpose of the facility is to remove contaminants and prepare the material for marketing, often by baling, flattening or crushing.

[4] Materials Recovery Facility Technology Review, 2009. Available at: http://www.dep.state.fl.us/waste/quick_topics/publications/shw/recycling/InnovativeGrants/IGYear9/finalreport/Pinellas_IG8-06_Technology_Review.pdf

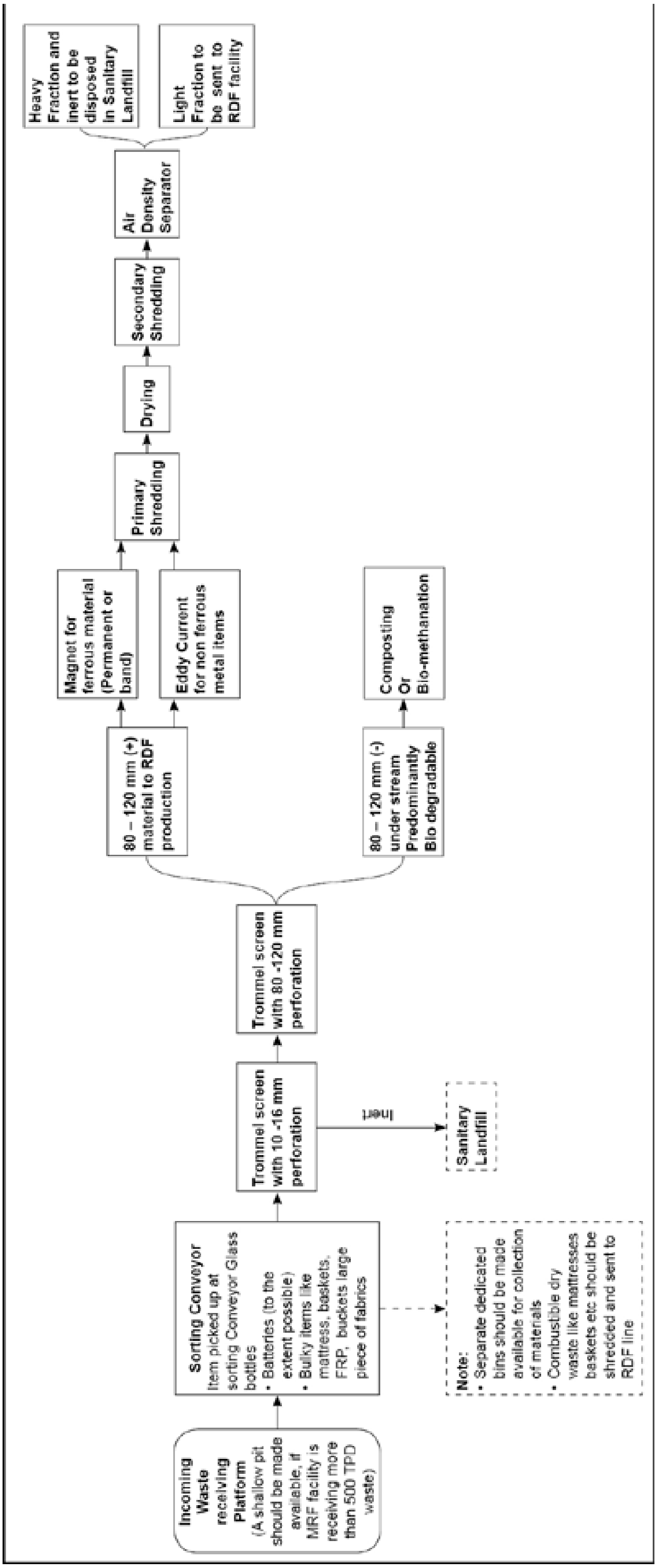


Figure 3.5: Indicative MRF & Pre-Sorting Facility for Mixed Waste

- **Dry waste stream:** Dry segregated material is received in a mixed form consisting of a combination of fibres (paper, card board, mixed paper, magazines etc.) and co-mingled containers (Plastic, glass, metal etc.), among other material. The first stage of processing typically utilizes manual labour or equipment that separate material into various streams (fiber, paper, plastic, containers etc.). These recyclables are also sorted by using automated machines when quantities to be handled are large. Below is a flowchart (figure 3.6) depicting the indicative MRF and pre-sorting facility dedicated to dry waste.

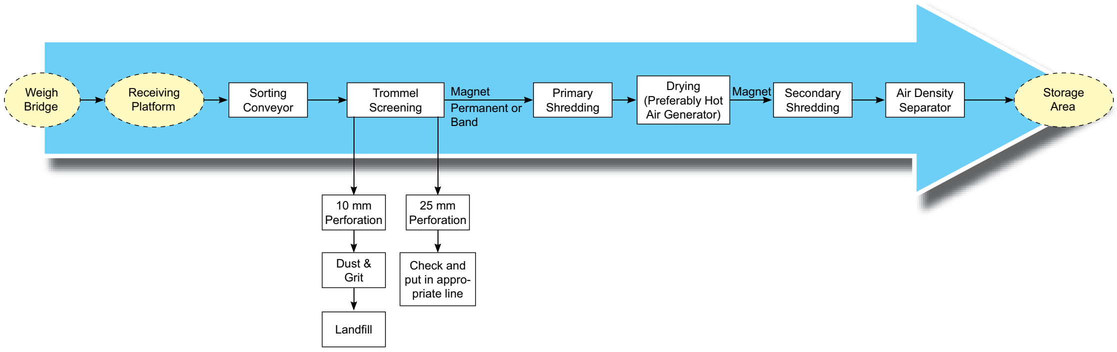


Figure 3.6: Indicative MRF & Pre-sorting Facility Dedicated to Dry Waste

If the ULB intends to compost biodegradable/wet waste, the wet waste that is segregated either at the source or at the mixed waste receiving MRF facility should be further pre-processed before being placed in windrows or sent for biomethanation. The pre-processing is carried out at the composting facility. Figure 3.7 outlines the pre-processing and processing at a windrow composting facility.

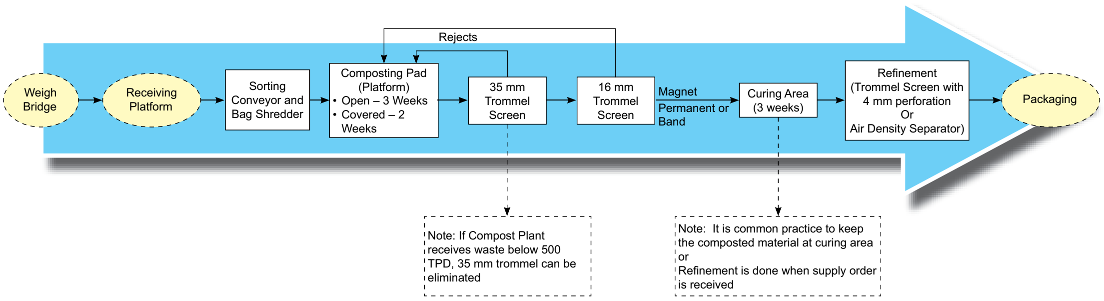


Figure 3.7: Indicative MRF & Pre-sorting Facility Dedicated to Wet Waste

3.1.4.1 MRF Unit Processes

MRF units employ varying combinations of manual and mechanical processes, based on the type of facility, easy availability of equipment, labour availability and associated cost implications. MRF units employing manual labour for sorting operations have relatively lower costs, but may also operate at lower efficiencies compared to mechanical sensor based sorting facilities.

A MRF unit, depending on the level of complexity, will consist of a combination of unit processes as shown in figure 3.8, in varying degrees of mechanization:

- **Pre-Sorting:** Bulky and contaminated wastes hamper further sorting/processing in the facility; mechanical or manual pre-sorting is essential to separate out these wastes. Manual sorting results in higher labour costs and lower processing rates. Bulky waste is removed by manual sorters as the waste passes along a conveyor belt, which carries the pre-sorted waste to the mechanized sorting unit of the facility.
- **Mechanical Sorting:** Mechanical processes based on principles of electro-magnetics, fluid mechanics, pneumatics etc. are used to segregate the different waste streams in the pre-sorted waste. Mechanical processes require specialized equipment for segregation of co-mingled municipal waste. Mechanical sorting typically employs the following processes:
    - **Screening:** Screening segregates waste into two or more size distributions. Two types of screens are used in MRF centres; 1) Disc screens 2) Trommels.
    - **Ferrous Metal separation:** In the second stage, electromagnets are used for separating heavy ferrous metals from mixed waste.
    - **Air Classification:** The residual waste stream is passed through an air stream with sufficient velocity to separate light materials from heavy material, specifically for separating out light weight plastics and paper from the mixed stream. Three types of air classifiers may be employed i.e. 1) horizontal air classifier 2) vibrating incline air classifier 3) incline air classifier. Heavy or bulky plastics are sorted out either in the pre-processing line (manually) or in the "detect and route" systems, employed at later stages of material recovery.
    - **Non-ferrous metal separation:** The non-ferrous metal separator segregates zinc, aluminium, copper, lead, nickel and other precious metal from commingled waste. An eddy current separator removes non-ferrous items from the comingled waste based on their electrical conductivity.
    - **Detect and Route system:** This system separates out various grades of paper, plastics and glass, which are not sorted out in the air classifier. This system works in two stages. The first stage employs programmed optical sensors to determine the nature of different materials. In the second stage, based on information received from the sensor, sorted material is routed to appropriate bins by directional air jets.

– **Size reduction:** Sorted materials after segregation are usually too large for further use or processing, they should be reduced to smaller sizes.

– **Baling:** Sorted and sized material is baled for further processing/use.

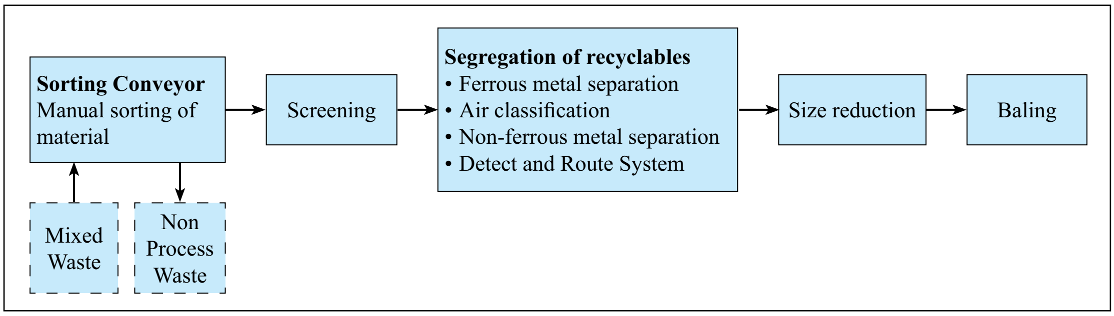


Figure 3.8: Indicative Unit Process in a Material Recovery Facility Receiving Mixed Wastes

Table 3.2 lists specific types of equipment employed at a MRF in a waste processing centre.

Table 3.2: Different Processes/Stages and Equipment Employed in a MRF

Process/Stages	Equipment
Pre- sorting material handling equipment	• Belt conveyor • Screw conveyor • Apron conveyor • Bucket elevator • Drag conveyor • Pneumatic conveyor • Vibrating conveyor • Debagger
Ferrous metal separation	• Magnetic Separator and Screening
Screening	• Disc Screening • Trommels
Air classification	• Horizontal air classifier • Vibrating inclined air classifier • Inclined air classifier
Non-ferrous metal separation	• Rotating disk separator • Eddy current separator

Process/Stages	Equipment
Size reduction	• Can densifier • Can flattener • Glass crusher • Plastic granulator • Plastic perforator • Baler
Pollution control	• Dust Collection System • Noise Suppression Devices • Odour Control System • Heating, Ventilating, & Air Conditioning (HVAC)
Other fixed equipment	• Fixed storage bin • Live-bottom storage bin • Floor scale for pallet or bin loads • Truck scale • Belt scale

A MRF facility is also equipped with suitable environmental pollution control and monitoring equipment. At a minimum a waste recycling facility should consist of the following equipment:

- Dust Collection System
- Noise Suppression Devices
- Odour Control System
- Heating, Ventilating& Air Conditioning (HVAC)

Recyclables separated from mixed waste usually have the lowest quality and might be contaminated with residual waste. In India, the segregation of recyclables from the mixed waste stream is often practiced, not through formal systems, but by the informal sector (rag pickers). Options for optimizing this system through better inclusion of informal workers are explained in section 2.2.7 in Part II of this manual.

3.1.5 Need For Establishing Market Linkages & Extended Producer Responsibility

Any recycling programme depends on two crucial factors:

(i) community awareness and willingness to co-operate;

(ii) access to markets for segregated materials with acceptable and reliable conditions.

The extent of recycling depends on the size of the market for recycled products

Market development for recyclables involves an assessment of the supply as well as the demand:

- The supply of recyclable materials should meet the requirements of recycling industries, both in terms of quality and quantity.

Products made from recyclable materials should meet market requirements as well. Unless a community has an established market for materials it collects, it may end up temporarily storing some materials and later landfilling some or all of them. It is necessary for decision makers to assess and establish market linkages prior to bringing recycling programmes into operation.

Local governments should encourage businesses to adopt and promote recycling initiatives. e.g. take back of large size mineral water containers

Market establishment for recyclables might take place with or without intervention of the ULB, the latter in the framework of Extended Producer Responsibility (EPR; See 2.1.3.1 of Part II of manual).

Various voluntary industrial initiatives have started recently where industries have set up their own collection and recycling systems. Mineral water suppliers voluntarily take back mineral water cans and refund the customer for the returned bottles. Breweries buy back beer bottles from kabadi system. There are also examples of different breweries using a similar bottle design, to facilitate reuse of these bottles, which are collected by the informal system.

EPR initiatives also benefit industries through saved production costs. Manufacturers and suppliers are ideal partners for municipal public private partnerships (PPPs) for development of drop-off sites and take- back facilities. Companies manufacturing consumer durables (e.g. Nokia, LG and Samsung) are in the process of establishing drop-off points for used electronics and components at various points of sale in the larger Indian cities. Such initiatives may be strengthened through appropriate municipal guidelines and bye-laws.

3.1.6 Informal Sector Involvement In Recycling

Informal sector contributes significantly to improving resource efficiency, thereby enhancing environmental and climate protection

In India, recyclable material is either purchased by the kabadi system from source of waste generation or picked up by rag pickers. Municipal authorities can promote recycling by educating the citizens and training them in segregating waste at source into dry and wet categories and in handing over segregated wastes to waste collectors. Recyclable material is sold to the recycling industry through a chain of intermediaries. Waste collected by the kabadi system is sorted and sold to intermediaries who further clean, sort and store the waste. Rag pickers pick up discarded recyclable materials from primary and secondary collection points including dump sites/ landfills, and sell such material to the appropriate recycling industry. It has been estimated that the informal sector alone recovers as much as 56% of recyclable material[5].

The informal recycling sector:

- supplements the formal system
- manages all types of waste through the informal network
- provides employment to a large number of people
- operates competitively and with high levels of efficiency
- establishes linkages with the formal economy at some point in the recycling chain
- offsets carbon emissions by making recycling possible and thus reducing the extraction and use of virgin raw materials.

However, there are a number of potential points of conflict between formal MSWM services and informal recycling activities that need to be recognised and addressed while attempting integration of the two systems. The current practice of material recovery and recycling often causes additional littering in streets, specifically when rag pickers rummage in the waste bags and bins. This problem frequently leads to a ban on rag pickers in residential areas, although residential areas are the best places to retrieve recyclable waste. Harassment of rag pickers forces them to collect recyclables from landfill sites, a practice that leads to even higher health threats and environmental pollution. The presence of rag pickers/scavengers at transfer stations and landfill sites can interfere with vehicle movement, which is dangerous, increases vehicle turnaround times and reduces efficiency. The informal sector of rag pickers works under unacceptable working conditions and many of them are exposed to health issues. In most cases, rag pickers are

[5] Dr. Prasad Modak, Environmental Management Centre, LLP, Promoting Recycling in Municipal Solid Waste Management through Sustainable Business Models, Project Preparation Support for Livable Cities in Asia, 2012

women and children from low-income groups, the most vulnerable groups in the Indian society. They are often exploited by middle men/waste merchants because of their low social status. It is estimated that a rag picker usually earns Rs 45 to Rs 80 a day while children earn just Rs 10 to Rs 15 a day. Child labour engaged in this work is a matter of great concern.

As long as the door to door collection system is not operationalized and segregated waste is not collected from the door step, rag pickers would continue to earn their living from rag picking at the cost of their health and well-being. The solution lies in organizing and training rag pickers to enable access to upgraded livelihoods; for e.g. upgrading rag pickers to at source waste collectors through RWAs, CBOs, NGOs or the private sector and thereby improving their quality of life.

Involvement of child labour, littering on streets, exploitation of informal waste sector by middle men are some of the issues that need immediate attention from local governments

These welfare activities can be undertaken through social development programmes in collaboration with local NGOs which provide schools and health-care facilities etc., to rag pickers. Children under a certain age should be kept away from these activities. Provision of a valid identity card to rag pickers through local NGOs or community based organizations, and creation of health schemes, access to medical facilities and regular medical checks can help in improving the lives of rag pickers. The ULB should identify a specific agency to conduct this activity periodically, at least once every two years. This would help identify waste pickers and facilitate their easy integration into formal waste management systems.

Refer to Section 1.3.4.8 of Part II of this manual for further details on informal sector integration into conventional solid waste management services.

3.1.7 Recycling Of Plastics

It is estimated that approximately 4,000 to 5,000 metric tonnes per day of plastic waste is generated in India which is roughly 4 to 5 percent by weight of MSW. The major problems in plastic waste management are collection, segregation and disposal. At present, plastic waste collection is done through the informal sectors such as the kabadi system and rag pickers[6].

Refer to Section 7.4.4 of Part II of this manual for details regarding recycling of plastics.

[6] CPCB, 2010. Available at:http://cpcbenvis.nic.in/newsletter/URBAN%20WASTE%20PROFILE_LV.pdf

3.1.8 Recycling Paper and Board

Recycling of 1 plastic bottle would save enough energy to power a 60W bulb for 3 hours

Relevance of paper and cardboard in the waste stream

The growth in the paper industry has mirrored the growth in Gross Domestic Product (GDP) of the country; an annual average growth of 6-7 % has been observed over the last few years. Globally, India is the fastest growing market for paper. Economic projections even assume that growth in paper consumption would exceed GDP growth, with an annual growth close to 9%. Consequently, the import of pulp & paper products is likely to show a growing trend. These figures demonstrate the high relevance of paper and cardboard as a fraction of the MSW – even increasing over time[7].

In India the collection of waste paper is mainly performed by the informal sector, i.e., by door to door collectors/ kabadi system and rag pickers. As much as 95% of the collection of waste paper in the country is carried out by the informal sector[8]. The value chain comprises direct collection from various source points and small shops, where primary sorting of the waste into different categories should take place; zonal segregation centres owned by wholesalers, where the waste material gets collected from small shops and baled, and finally dispatch to end users, which are usually paper mills.

'Waste Out of Wealth' in South India

ITC Paperboards and Speciality Paper Division launched the waste paper collection programme called Waste Out of Wealth (WOW) in 2011 in select areas in Hyderabad, Bangalore and Coimbatore and are expanding it to more areas in South India including Chennai. In Chennai, it has tied up with 30-40 IT companies including Infosys, IBM, and Wipro which would sell their waste paper to ITC for recycling. It also plans to tie up with Residential Welfare Associations (RWAs), NGOs and local bodies to expand the waste paper collection programme[9].

Paper recyclers are developing new technologies for handling, identifying and separating paper grades for recycling. One such technology allows segregation of paper fibers during the recycling process according to fiber length, coarseness, and stiffness through a sequential centrifuging and screening process.

---

7 Indian Paper Manufacturers Association

8 Effective Recycling of Waste Paper for Production of Good Quality Newsprint. Available at http://www.ipptaonline.org/July-Sept,%202013/2013_Issue_3_IPPTA_Article_02.pdf

9 CPCB, 2010; Available at:http://cpcbenvis.nic.in/newsletter/URBAN%20WASTE%20PROFILE_LV.pdf)

Making of Handmade Paper

The Indian handmade paper industry produces a variety of paper and paper products mainly by using waste paper collected from various sources such as schools and colleges and also other materials such as cotton rags, tailor cuttings, hosiery cuttings. Other agro based fibres available in the North Eastern region like jute, sabai grass, ramie, banana, straw, angelie grass, elephant grass etc. are also used to blend with the primary fibres for mottling effects and to manufacture special varieties of thin paper.

The basic steps of recycled handmade paper making process are discussed below:

A. Chopping & Dusting

Rag-chopper

The paper raw material and waste cotton rags are sorted manually to remove unwanted materials like plastics, iron and dust etc., that could contaminate pulp. Once the material is sorted, it is put through a rag chopper that cuts the rags into small uniform sized pieces. The wastepaper is directly sent to the beater after being dipped in the water for 3 to 4 hours. 2 to 3 people could be engaged in this phase depending upon the amount of raw material.

B. Beating

Hollander beater

The chopped rags are converted into a fine pulp in a Hollander Beater. Pulping of the raw materials is done using non-polluting chemicals such as lime, soda ash, caustic soda, oxalates, oxygen, and peroxides. It is not necessary to use harmful chemicals like alkali sulphide and sulphite, chlorine and chlorine compounds for the delignification processes. Rosin soap and alum are added to give the paper the desired physical properties and the required consistency. When making coloured or textured papers, colour dyes, straw, hemp, grass etc. are added in this phase. The resulting pulp is now ready for sheet formation.

C. Sheet Formation

There are two methods of sheet formation which are being used in India:


Univat being used for sheet formation

i. Lifting: Lifting is a modern method done with the help of Univat. Lifting employs the use of a steel water tank fitted with an apparatus to lift the mould. The mould is clamped between two wooden frames in a water tank. A measured quantity of the pulp, depending on the thickness of the paper required, is poured evenly into the mould. This mould is then shaken side to side horizontally and raised mechanically to drain excess water. A sheet of pulp is formed over the mould which is taken out after unclamping the frame.

ii. Dipping: Dipping is a traditional method where the pulp is transferred from the beater into a masonry trough or vat. Depending on the thickness of the paper required, the pulp is diluted by mixing it with water. The mould made of a wooden frame with a wire mesh or a bamboo stick mat is dipped by hand into the pulp. The frame is then shaken side to side and lifted out of the vat. A sheet of pulp is formed over the mould. Out of the two processes, lifting is favoured more as dipping requires constructing masonry trough/ vat.

D. Pressing & Drying

A manual/ hydraulic press is used for squeezing out the excess water from the sheets. This compresses the pulp adding strength to the fiber.

E. Calendaring

The calendaring machine is fitted with two chilled cylinders rotating in opposite direction to give a smooth finish to the sheets of paper passed through them. Calendaring also tends to enhance the gloss of the paper.

F. Sheet Cutting

At this phase, the calendered sheet still has a deckle edge. The sheets are cut to standard size of 22''x 30" or to desired sizes as required by the customers.

G. Paper Products

While it is possible to manufacture several handmade recycled paper products, there is a consistent market demand for select products such as note books and diaries made of recycled paper, stationary material, lamp shades, invitation card material and office paper.

Paper products

The municipal authorities should promote recycling of paper to save cutting of trees and natural resources. This will also provide employment to skilled and unskilled labour and will also correspondingly reduce waste management costs to the municipal authority.

3.1.9 Recycling Of Garden Waste/Yard Waste

Yard waste consists of grass, leaves, tree,s and brush trimmings. Composting of yard waste reduces the amount of yard waste entering the solid waste stream.

For details on composting please refer to section 3.2 of Part II of this manual.

3.1.10 Reuse Of Sand & Inert

Street sweeping normally comprises of street dust and tree leaves, besides domestic and commercial waste indiscriminately disposed in the streets. This waste contains a significant amount of sand, inert and debris, as well as some amount of biodegradable wastes depending on the extent of door to door collection systems introduced in the city / town. Once door to door collection becomes effective, street sweeping would be free from organic matter and will be by and large inert in character.

Street sweepings should therefore be transported separately to waste disposal facility without mixing with domestic or other commercial establishment waste, to ensure efficient waste processing.

3.1.11 Construction & Demolition Waste

Construction and Demolition Wastes (C & D waste) generally constitute upto 10-20 percent of all solid waste[10].

The report of the Supreme Court's expert committee (Supreme Court 1999) and the MSW (M&H) Rules 2000 recommend that ULBs shall facilitate the collection of construction and demolition waste generated in a city. Ward level debris banks should be created. Containers could be provided at such locations, and a small collection charge could be levied for receiving such waste and transporting it for disposal. Rates may be prescribed for such collection by the local body, and contracts could be given for managing such sites. Help-lines for lifting C&D waste should be created to ensure prompt clearance of such wastes.

Local bodies must make serious efforts to utilize C&D waste and should motivate the private sector to set up processing plants. There are several plants of various capacities in India to make bricks, paver blocks, aggregates etc. out of such waste material. Profitable use of C&D waste will minimize the cost of managing such waste and requirement for valuable landfill space, besides giving employment opportunities to unemployed youth. It will also save natural resources and reduces the use of native soil.

Chapter 2 of Part II gives details on the process for C&D waste collection and transportation. The potentials and appropriate processes for recycling C&D waste are discussed in detail in section 3.6 of Part II of this manual.

3.1.12 E-Waste

Recycled aluminium from soda cans requires only 5 to 8 percent of the energy required to produce primary aluminium, which results in a 95% reduction of GHG emissions as compared to primary production.

E-waste or Waste of Electrical and Electronic Equipment (WEEE) comprises of surplus, obsolete, broken, electrical or electronic devices. Its quantum is increasing year by year and disposal of e-waste is becoming a global environmental and public health issue.

According to a study[11] about 380,000 tons of e-waste is generated annually in India which is expected to increase manifold. The study also reveals that only about 6 percent of the e-waste is recycled, of which 95 percent is operated through the informal sector. Recyclers, while mainly interested in precious metals (such as copper, silver, and platinum) are also interested in the glass, plastic, and batteries within these devices. Currently applied

10 Ghosh,G., Ghosh,S.&Aich, A., (n.d), "Rebuilding C& D Waste Recycling Efforts in India", Waste Management World. Available at:http://www.waste-management-world.com/articles/print/volume-12/issue-5/features/rebuilding-c-d-waste-recycling-efforts-in-india.html

11 Study by MAIT and GIZ in 2007

processes for recycling WEEE pose serious threats to the health of workers and the environment. It will be a challenge to reorganize the recycling of waste electrical and electronic equipment in order to establish recycling methods that protect both workers and the environment. One option would be the introduction of the extended producer responsibility (EPR) concept, where the producer of an electrical or electronic device guarantees product redemption after use through recycling and/or disposing it in an environmentally friendly manner.

Refer to section 7.7 of Part II of this manual for more detail.

3.1.13 GHG Mitigation Potential From Recycling & Reuse

Waste handling and disposal generates greenhouse gases both directly and indirectly. The most efficient way to reduce greenhouse gas emissions in waste management is to reduce waste generation at source (see section 2.1 of Part II of this manual) followed by material recycling to decrease both the direct and indirect greenhouse gas emissions. Direct emissions are decreased when waste is not disposed off at landfills nor treated in any other way (e.g., combustion). Indirect emissions can be cut down by decreasing the energy consumption both in acquiring and producing raw materials and also in manufacturing the product itself. It is possible to substitute virgin material with recovered material. In most cases the replacement of virgin materials by recycled materials decreases the use of net energy and thus the greenhouse gas emissions originating from energy usage decrease. Greenhouse gas emissions can also be reduced by avoiding the use of materials, which produce emissions directly in the production phase. On the other hand recycling can produce greenhouse gas emissions if transportation operations increase or waste recycling processes generate emissions.

3.2 Composting

3.2.1 MSW (M&H) Rules 2000: Guidance On Composting

Rules The MSW Rules, 2000 specify that "Municipal authorities shall adopt suitable technology or combination of such technologies to make use of wastes so as to minimize burden on landfill. The biodegradable wastes shall be processed by composting, vermicomposting, anaerobic digestion or any other appropriate biological processing for stabilization of wastes. It shall be ensured that compost or any other end product shall comply with standards as specified in Schedule IV".

Composting is the third preferred choice in the ISWM Hierarchy; it ensures that waste is processed appropriately to facilitate material recovery

3.2.2 Composting In The ISWM Framework

The Integrated Solid Waste Management (ISWM) hierarchy indicates reduction of waste as the most preferred option for managing waste, followed by recycle of waste. The third preferred choice in the ISWM strategy, viz., adoption of resource recovery strategies and composting, ensures that waste is processed appropriately to facilitate further use of the material, as indicated in figure 3.9. Composting is a controlled process of biologically "digesting" the municipal solid waste, so it may be recycled for other purposes – plant nutrient, stabilization of soil in remediation process or soil amendment for recovery of poor soils.

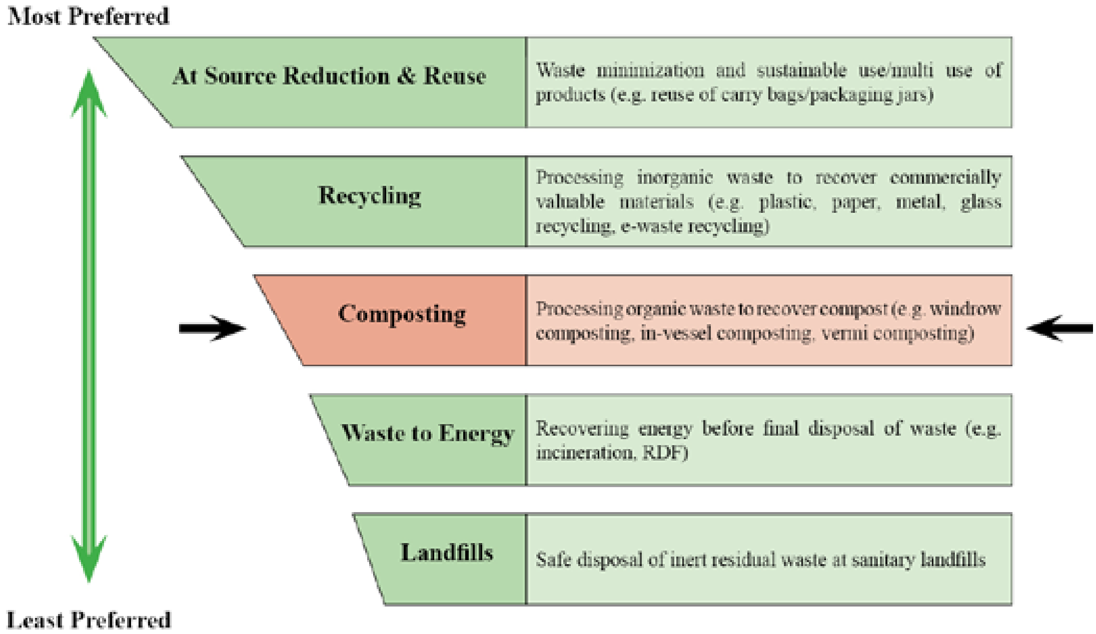


Figure 3.9: Composting in the ISWM Hierarchy

Organic waste contributes to environmental pollution in more ways than one. Composting and other biological stabilization processes mitigate the impact of uncontrolled decomposition of organic municipal solid waste and should be adopted by urban areas. Composting is an environmentally beneficial waste recycling mechanism and not a waste disposal mechanism.

Composting is a biological process in which microorganisms convert organic matter into compost

3.2.3 What Is Composting?

Municipal Solid Waste primarily consists of organic, inorganic and inert fractions. Under natural conditions, the organic fraction of waste continually decomposes, accompanied by a strong foul odour and production of gases, predominantly methane or carbon dioxide depending upon the aerobicity of the decomposing mass. Vector infestation during the natural decomposition process is a common phenomenon.

Composting is a process of controlled decomposition of the organic waste, typically in aerobic conditions, resulting in the production of stable humus like product, compost.

Considering the typical composition of wastes and the climate conditions, composting is highly relevant in India and should be considered in all MSWM concepts. Composting of the segregated wet fraction of waste (see chapter2 of Part II of this manual) is preferred. Mixed waste composting, with effective and appropriate pre-treatment of feedstock may be considered an interim solution; in such cases stringent monitoring of the compost quality is essential.

3.2.4 Benefits Of Composting

- The real economic benefits of compost use include improved soil quality, enhanced water retention capacity of soil, increased biological activity, micro-nutrient content and improved pest resistance in crops.
- Composting minimizes/avoids GHG emissions from anaerobic decomposition of organic waste (such as in a large unturned heap).
- Composting increases the design life of other waste management facilities
- Stringent design requirements and associated costs for catering to management of leachates from organic waste decomposition may be reduced in those landfills that do not receive organic waste (so far not in MSW Rules).
- Compost is particularly useful as organic manure as it contains macro plant nutrients (Nitrogen, Phosphorous and Potassium) as well as micro nutrients. When used in conjunction with chemical fertilizers optimum results are obtained.
- The use of compost reduces the dependency on chemical fertilizers (availability as well as quantity) for agricultural operations. When used as a soil amendment, compost reduces the need for water, fertilizers, and pesticides. Compost acts as a soil conditioner, therefore supporting the long term fertility of soil.
- Compost may be used to revitalize vegetation habitats and add life to marginal, impoverished soils
- Compost may also be used as a bio matrix in remediation of chemical contaminants and as a remediation soil in contaminated sites as compost helps in binding heavy metals and other contaminants, reducing leachability and bio-absorption.

Compost, because of its high organic matter content, is used as a valuable soil amendment thereby reducing dependence on chemical fertilizers

An analysis of market demand for compost and its potential end-use determines the design, capacity and hence the financial viability of compost plants.

3.2.5 Need For Market Identification & Analysis

Co-marketing of compost with chemical fertilizers by the fertilizer companies and their agents as a "Basket Approach" is recommended

The financial viability of compost plants is primarily dependent on the marketability of the compost. For the low carbon soil (soil organic carbon) prevalent in India, there is huge requirement of good quality compost for agriculture. Yet the demand for compost is very low. An analysis of the available markets and potential demand for compost is essential to decide the required size of the compost plant. An assessment of end user requirements of compost quality, as defined by the final use, is essential to arrive at the final design of the compost plant, especially the finishing stages.

Market development for compost and proper quality monitoring is a crucial issue. The following strategies can be applied for market development:

Successful market for compost depends on three major factors:
- Producing consistent quality and quantity of compost
- Identification of end use of compost
- Identification of potential users

- The pricing mechanism for sale of compost should be assessed. Each State Government should fix a minimum retail price for the sale of compost which meets FCO 2009 standards, to ensure economic viability of these plants.
- All state and local government departments should be encouraged to promote the use of compost in parks, gardens, nurseries and urban forestry projects.
- Value addition to compost may be done before marketing, to enrich its nutrient value. The compost may be enriched by addition of 10 kg. of rock phosphate per tonne of compost to upgrade the phosphate content upto a minimum of 0.8% P_2O_5.
- Co-marketing of compost from city garbage with chemical fertilizers in the ratio of 3 to 4 bags: 6 to 7 bags is suggested by the Inter Ministerial Task Force on Integrated Plant Nutrient Management, vetted by the Supreme Court of India in 2006[12]. Chemical fertilizer companies are encouraged to ensure the sale of 1 bags of organic compost for every 2 bags of inorganic fertilizer sold by them.
- Farmers should be made aware of the befits of compost and should be encouraged to substitute inorganic fertilizers with organic compost, as appropriate.

Pre-sorting and segregation of municipal solid waste is a pre-requisite for maintaining the quality of the compost produced

Both physical properties of the finished compost and the desired chemical characteristics are to be considered. Decisions on pricing the compost are based on the size and location of markets for the produced compost. The distance to which the finished product may be transported will have a strong bearing on the price of compost.

An assessment of competing compost suppliers is also essential, especially in cases where it is estimated that the compost will need to be marketed beyond the vicinity of the plant.

12 Inter-Ministerial Task Force on Integrated Plant Nutrient management, 2005

Analysis for Marketing Compost

- How much compost will your plant produce?
- Where will the compost be used and for what?
- Do you realize the importance of consistent quality control for building and maintaining the brand image of your compost?
- Does your plant have the necessary process flow and equipment to produce compost which is compliant with the relevant rules (such as, FCO 2009)?
- Who are your potential customers? Consider the number of compost plants and quantity of compost produced in the State, while assessing the size of the potential compost market.
- What is the typical quality of compost required by the different categories of consumers?
- How much are your consumers willing to pay for the compost?
- Identify competing products for identified consumer uses and their prices
- Identify compost transportation requirements and costs
- Develop a marketing strategy
- Re-consider at the size of the proposed compost plant, reflecting the size of the potential compost market.

3.2.5.1 Constraints Faced By The Composting Sector In India

Composting of municipal solid waste started in the late 70's when about a dozen mechanical compost plants were set up across the country. The concerned urban local body (ULB) were the owner and operator of the compost plant. These facilities were replica of plants from the industrial countries without the necessary adaptation exercise and consequently heavily mechanized and faced maintenance problems. These were capital intensive. An evaluation of the mechanical compost plants was carried out by NEERI (National Environmental Engineering Research Institute) during 1980-82. Since the input garbage was mixed and the design was not adequate for removal of all the contraries, quality of the final product was poor, leading to lukewarm response from the market and poor unviable price.

The scenario changed in the early 90's with the entry of private sector – equipment fabricators, plant operators etc. Mechanization was reduced by almost eliminating the pre-processing stages (somewhat like the mechanical compost plant of the Municipal Corporation of Delhi, established in 1985). The machinery / equipment manufacturers introduced equipment at the post-screening stages such as, trommels with finer screen, air density separator (de-stoner) etc. to improve the quality by better removal of small sized contraries, such as, pieces of glass and plastics, grit and coarse sand etc. Bio-inoculum was sprayed over the windrows for suppressing bad odour.

In the initial years, there were reports of good price of compost, leading to reported commercial viability. In later years, the euphoria was replaced by the realization that the good price belonged to the niche market of plantations and some cash crops and with more and more plants in operation, the bulk of the compost had to be sold to farmers, who could not afford a high price.

The compost sector at present faces the following constraints:

i. Introduction of increasingly stringent compost quality standards (MSW 2000 followed by FCO series).

ii. Majority of the collection of MSW is in the form of mixed waste.

iii. Making quality compliant compost from mixed waste requires a number of equipment for refinement and quality control and higher production cost but the yield is reduced as the quality standards are higher (10-15%).

iv. All compost sold for application to food crops is mandated to be FCO compliant.

v. Percentage of process rejects increase proportionally (30-40%) unless the processing facility produces compost as well as RDF.

vi. Lack of knowledge and practical experience amongst the various stakeholders responsible for planning, execution, O&M and marketing leads to inadequately designed plants, inefficient equipment, improper operation and shortcuts from equipment design to operational protocol.

vii. After the product is ready (called 'finished compost'), cost is incurred for bagging, transport, marketing (commission of the chemical fertilizer company, dealers etc.). The landed cost to the farmer is normally almost twice the price received by the compost plant operator.

viii. At present the landed cost to the farmer is about Rs. 4000-5000 per ton of finished compost (distance being the main variant). This price is too high for the average farmer.

ix. The long term benefits of soil conditioning properties of compost are not adequately appreciated by the farmers and other stakeholders.

3.2.6 The Composting Process – Phases And Critical Parameters

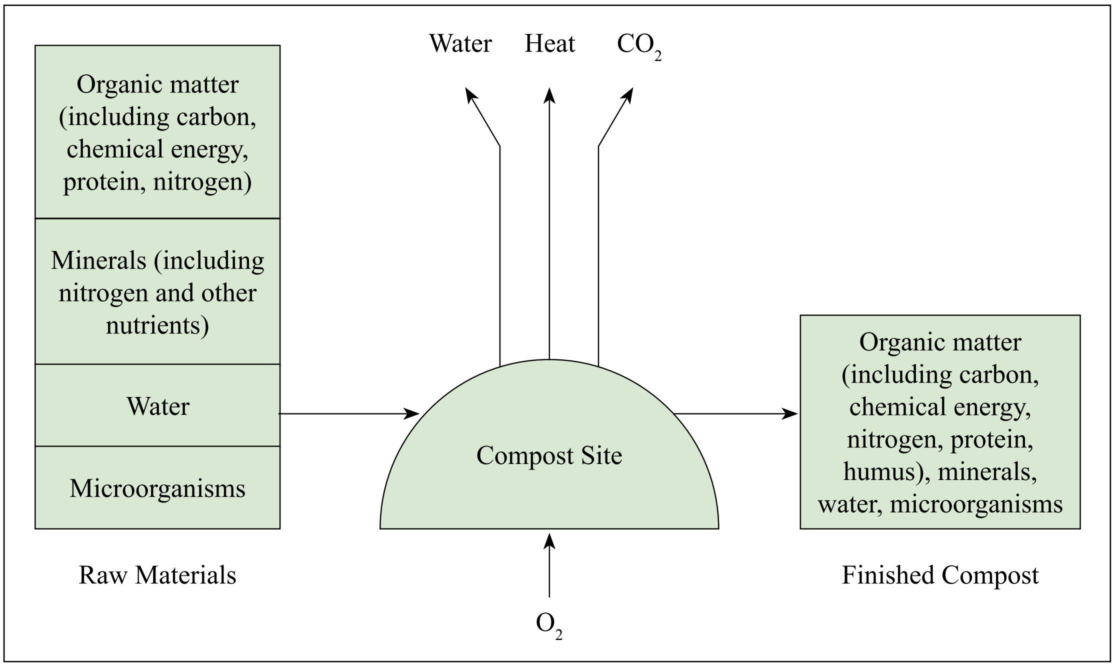


Figure 3.10: Process of Aerobic Composting[13]

The two distinct biological process stages observed during composting are:
- Thermophilic Stage
- Mesophilic Stage

During aerobic composting, micro-organisms oxidize organic compounds to Carbon-dioxide, Nitrite and Nitrate. Carbon from organic compounds is used as a source of energy while nitrogen is recycled. Due to chemical reactions producing heat, temperature of the mass rises.

Several biological, chemical and physical processes contribute to the success of the aerobic composting (Figure 3.10). Understanding these processes is necessary for making informed decisions when developing and operating a composting program.

Thermophilic Stage:
Moisture: 55-60%
Temperature: 35°C- 55°C
Air Voids: 20-30%
Microorganisms: thermotolerant fungi, thermophilic bacteria, actinomycetes
Lasts for few days

3.2.6.1 Biological Processes

The process of aerobic composting passes through two distinct stages of high significance

- Thermophilic stage (Sanitization)
- Mesophilic stage (Decomposition)

13 Rynk, et al., On Farm Composting Handbook, 1992 (NRAES-54)

Different organisms are known to play a predominant role in breaking down different constituents of municipal solid waste. The majority of microorganisms responsible for composting are already present in municipal solid waste. A succession of microbial growth and activity among the bacteria, fungi, actinomycetes, yeasts etc., takes place during the process, whereby the environment created by one community encourages the activity of a successor group. Different types of microorganisms are therefore active at different times & locations within the windrow depending upon the availability of substrate, oxygen supply and moisture content of the organic matter.

(i) Thermophilic Stage (Sanitization)

- This is the first phase of composting wherein microorganisms decompose the easily degradable organic substances producing heat as a result of intense metabolic activity. In the majority of cases with moisture content between 55-60% and air voids between 20-30% in the windrow, a temperature rise from 35°C to 55-60°C is achieved within 2-3 days.
- Typically thermo tolerant fungi, thermophilic bacteria and actinomycetes are the predominantly active micro-organisms at this stage.

Mesophilic Stage:
- Temperature: moderate
- Stabilization of compost material

(ii) Mesophilic Stage

- In the second stage, due to reduction in available nutrients and readily available carbon, the microbial activity reduces causing a decline in the temperature of the heap. There is a shift in the type of active microbial species in the compost heaps.
- The composted material becomes dark brown during this stage due to humus synthesis and starts to stabilize.

Curing:
- Maturation Stage
- Lasts for 3-4 weeks
- Microbial species population increases drastically

Curing Stage

- Curing of compost is done after the material from the windrow is screened. The screened material is then allowed to mature in the curing stage. This is a very important phase in the composting process. Microbial species degrading complex polymers such as cellulose, lignin and hemicelluloses increase drastically during this phase.
- Bacteria represent 80% of this population. Free living N-fixing, de-nitrifiers, sulphate reducers and sulphur oxidizers are important constituents of the total microbial population.

3.2.6.2 Chemical Parameters

(i) Moisture: Moisture is a critical factor in establishing stable conditions conducive for composting. Moisture tends to occupy the free air space between the decomposing particles. Hence, when the moisture content is very high, anaerobic conditions set in.

(ii) Aeration: The composting process requires adequate supply of oxygen for bio-degradation by micro-organisms. Under aerobic conditions decomposition rate is 10-20 times faster than under limited oxygen supply or anaerobic conditions.

High Oxygen levels in air voids are maintained within waste piles/ windrows through turning & mixing at regular intervals. In static piles, anaerobic conditions may be created due to a utilization of available oxygen by micro-organisms and production of CO2 during decomposition of the waste. This could result in a build-up of anaerobic microorganisms, resulting in foul smell.

Compost pile should have enough void space to allow free movement of air as aerobic conditions fasten the composting process by 10-20 times and also reduce foul smell generation

(iii) Carbon/Nitrogen (C/N) Ratio

- MSW in India has an initial C/N ratio of around 30:1, ideal for decomposition. The organisms involved in stabilization of organic matter utilize about 30 parts of carbon for each part of nitrogen. C/N ratio below 25:1 results in production of foul smell and a higher C/N ratio will result in impeding the decomposition process.
- Whenever the C/N ratio is less than the optimum, carbon source such as straw, sawdust, paper are added.
- Higher C/N ratios may be reduced by adding biodegradable material having high nitrogen content, such as, non-edible oil cakes, green biomass etc. It is not preferable to add slaughter house waste to MSW waste piles, as they require specific closed / in-vessel systems.

C/N ratio of 30:1 is ideal for decomposition. C/N ratio below 25:1 results in foul smell while higher C/N ratio impedes decomposition process

3.2.6.3 Physical Processes

(i) Temperature: Under properly controlled conditions temperatures are known to rise beyond 70°C in aerobic composting. This increased temperature results in increased rate of biological activity and hence results in faster stabilization of the material. However, if the temperature rise is very high, due to inactivation of the organisms & enzymes, the rate of activity may decrease.

High temperature also helps in destruction of some common pathogens and parasites. Ambient air temperatures have little effect on the composting process, provided the mass

Temperature plays a critical role in composting by increasing rate of biological activity resulting in faster stabilization of the material being composted can retain the heat generated by the microorganisms under aerobic condition. If the process is so controlled that the temperature is kept at 55°C or above for at least 3 days, destruction of pathogens and parasites can be ensured.

(ii) Particle Size: The optimum particle size should have enough surface area for rapid microbial activity, but also enough void space to allow air to circulate for microbial respiration. The feedstock composition can be manipulated to create the desired mix of particle size and void space.

3.2.7 MSW Feedstock For Composting

MSW feedstock for composting should essentially include the segregated wet fraction of waste. Vegetable market waste and yard waste, being rich in organic content, are a preferred feedstock

The segregated wet fraction of municipal solid waste (comprising mainly biodegradable waste) is the preferred feedstock for compost plants. Vegetable market waste and yard waste being rich in organic content, are considered preferred feedstock for compost plants.

However, where door to door segregation of dry and wet fractions is not practiced, and segregation of this mixed waste is not carried out before it reaches the processing plant, it is possible that mixed municipal solid waste reaches the plant. In such instances, pre-sorting and segregation of the organic fraction from the mixed fraction is a critical step in ensuring adequate quality of the processed compost. Presence of contaminants hampers the activity of the microbes and reduces the final quality of compost; it is essential to keep street sweepings and drain cleaning material out of the feedstock, which is a major source of contaminants. This can be done through organizational arrangements in the ULB. Street sweepers should not mix their waste with MSW collected from households and establishments.

Tipping cum storage area: Unregulated storage of waste should be avoided. MSW feedstock should be delivered at a well-defined area within the plant. This area is essential for overall smooth functioning and regulated flow of MSW feedstock into the processing area. The tipping area should be adequately sized shed (sides open) to receive predetermined quantities of waste daily. Garland drains leading to a leachate collection tank, connected to the leachate treatment system are essential at the tipping floor. Bulky items like bed mattress, tyres, large pieces of fabric (e.g., sarees) and thin plastic film, large toys, pieces of asbestos, FRP, branch of tree etc. have to be pulled out before the waste moves on to the pre-sorting section.

In large plants receiving above 300 TPD MSW, some designers prefer to provide a shallow pit to increase the volumetric capacity within the same footprint. However, in warm countries, pits may cause odour problem, if it is not emptied regularly, leachate is not pumped out every day and the pit thoroughly cleaned occasionally.

Storage area should be large enough to handle daily and weekly variations in waste quantity and should be provided with sheds to cater to wet weather conditions

Under certain conditions buffer storage may be required, such as:

a. High floating population – places of tourist, religious importance

b. Festive occasions, large gatherings like rallies / meetings etc.

c. In cities, where collection and transportation is not uniform on a daily basis, clearing of a backlog etc.

However, such buffers should be planned very carefully mainly because holding raw waste for more than a day attracts vectors, causes odour nuisance and leachate. Therefore such buffer areas should be planned only if it is essential due to the above conditions and should not normally be more than one day. Instead it would be more convenient to build additional capacity in pre-sorting line and compost pad area. The compost pad and the curing area for semi-finished compost are the most convenient buffer areas.

3.2.8 Pre-Processing Of Mixed MSW

Segregation and/or pre-processing are essential for composting

Typically, mixed MSW received at the compost plant consists of 40%-50% non-biodegradable material. Pre-processing of mixed MSW is crucial for preparing FCO-compliant compost. In case source segregated waste or dedicated waste from fruit and vegetable market is received, pre-sorting can accordingly be minimal. In the latter case the capital and O&M cost are less and the yield of compost is higher than in the case of mixed waste. Pre-processing serves the following purposes:

Pre-processing has a high economic value as it recovers recyclables, reduces contaminants, lowers processing costs and also ensures quality of compost

a. Separation of the mixed material into different streams, which are suitable for specific products – biodegradable for composting, combustible dry material for RDF, separation of recyclable material on sorting belt (glass, metal etc.)

b. To reduce cross-contamination of the materials which go on to make different products.

The pre-processing section is designed on the basis of average composition of the incoming waste, quantity, space available for pre-sorting and whether only composting is targeted or a combination of compost and RDF is targeted. Figure 3.11 below illustrates the various steps involved in pre-processing of mixed municipal solid waste.

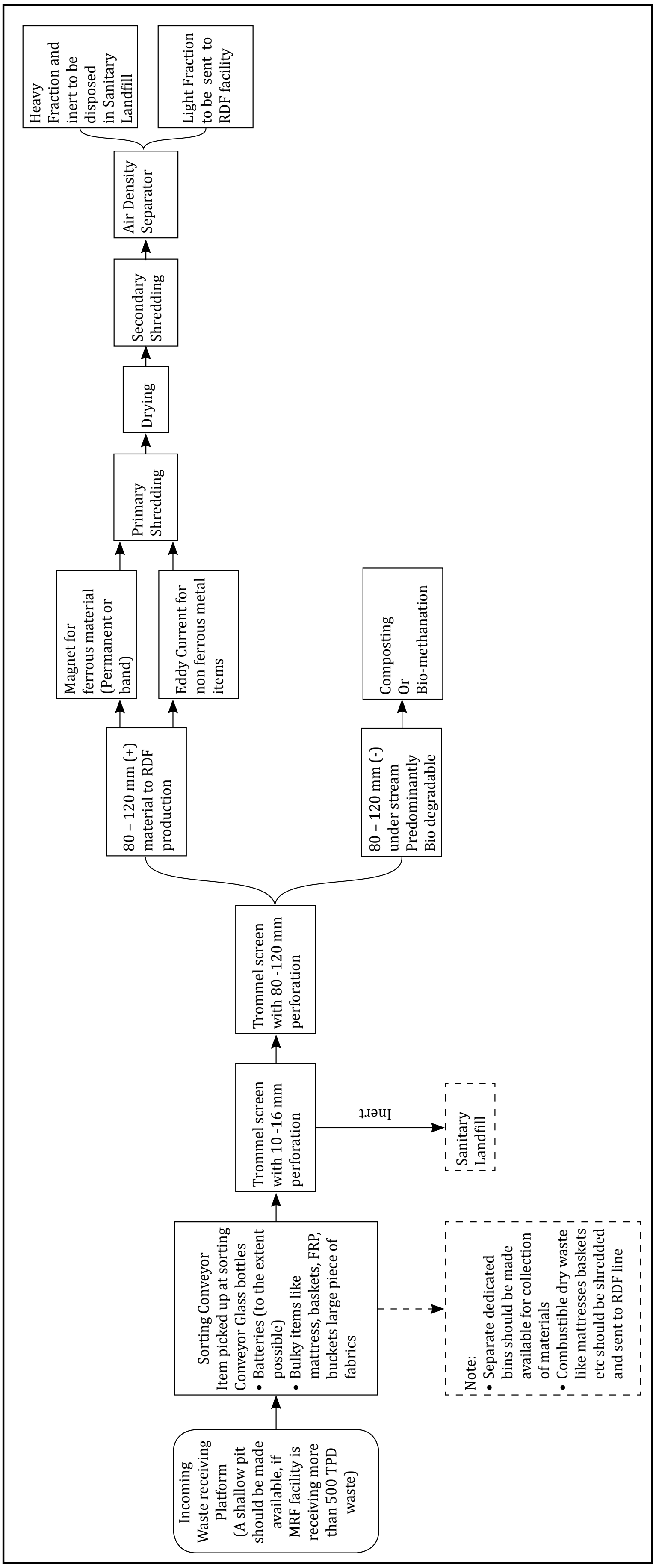


Figure 3.11: Pre-processing of Raw Municipal Solid Waste

Sorting: The level of sorting feedstock depends on several factors including the source of feedstock, the end use of the product and the operations and technology involved. Sorting in a well-designed compost cum RDF plant consist of hand sorting on a sorting belt followed by mechanical sorting in one or more trommel(s), which is a sophisticated rotating sieve described in the next paragraph. Mixed waste is fed on to a slow moving (5metres/minute) conveyor belt. Items not suitable for the trommel, such as glass bottle, metal container, any hazardous material like containers of paint etc. are taken out by hand and put in appropriate bins. The workers should be provided with hand gloves to avoid injury. The thickness of the moving waste pile on the conveyor belt should be less than 15cms (for better manual sorting) and the removed material is stored in segregated vats/ large containers. This is usually recyclable material or material with high calorific value, which can be further processed to recover the energy content. Metals are then removed from the waste by either a suspended magnet system or a magnetic pulley.

Sorting results in recover of recyclable material with high calorific value

Remaining mixed waste is subjected to mechanical separating devices such as a segregating trommel, where material passing through the screen (80-100 mm) is utilized for compost production. An additional trommel of 200 mm screen may be required as an add-on for plants over 500 TPD, which is placed before the trommel with 80-100 mm apertures.

The purpose of a trommel is to segregate materials on the basis of size through cascading action. For effective segregation it is necessary that the material undergoes sufficient number of turns inside the trommel and at the same time gets sufficient fall depth for good cascading action. Therefore, the length and the diameter of the trommel are very important. Normally for MSW, a trommel with a length of 10m and a diameter of 2.5 m and above would be desirable. At the same time there should be no axle passing through the trommel in the middle, the drive for the trommel has to be external.

Table 3.3 outlines mechanical separation technologies that are currently used in MSW composting.

Table 3.3: Pre-processing: Sorting of Mixed MSW Feedstock[14]

Technology	Materials Targeted
Screening	Plastics, paper, cardboard, metal
Magnetic Separation	Ferrous metal
Eddy Current Separation	Non-ferrous metals
Ballistic Separation	Plastic, paper, glass, gravel

14 USEPA, Composting of Yard Trimmings and Municipal Solid Waste

Details of these processes are briefly discussed below:

Pre-processing Technologies:
- Screens: control the size of feedstock
- Magnetic Separation: removes ferrous metals
- Eddy-Current machines: Separates aluminium and other non-ferrous metals
- Air Classifiers: removes heavier fractions like glass & ceramics

Screens: Screens are used to control the size of feedstock. They separate small dense materials such as food scrap, glass and plastics from the bulky light fraction of the feedstock. Trommel screens are commonly used for initial material processing at MSW facilities.

Magnet based Separators: Magnetic separators create magnetic fields that help in removing ferrous metals from the feedstock as it travels along conveyors. The efficiency of magnetic separators depends primarily on the quantity of materials processed and the speed at which they pass through the magnetic field.

Eddy-current Machines: Eddy-current machines separate aluminium and other non-ferrous metals from MSW. These machines generate a high energy electromagnetic field that induces an electrical charge in non-ferrous metals and forces these materials to be repelled from non-charged fractions of the feedstock material. The feedstock should be conveyed to eddy-current machines after magnetic separation to minimize contamination by metals. Eddy-current machines are not usually used in India, since metals are not usually found in waste.

Air Classifiers: Air classifiers separate feedstock material based on density differences, i.e., the heavier fractions (metals, glass, ceramics etc.) are removed from the lighter materials. The heart of an air classification system is an air column or throat into which the materials stream is fed at a specified rate. A large blower sucks air up through the throat, carrying light materials such as paper and plastic or fine dry compost, which then enter a cyclone separator where they lose velocity and drop out of the air stream. Heavy materials fall directly out of the throat/ column.

Ballistic or Inertial Separation: This technology separates constituents based upon density and elasticity differences. This can be applied for segregating materials on compost stream or RDF stream. However, it is more suitable for RDF stream for separating grit and other heavy inert material.

Compost feedstock is dropped on a rotating drum or spinning cone and the resulting trajectories of glass, metal and stones which depend on density and elasticity bounce the material away from the compost feedstock at different lengths.

Additional Inoculum: Inoculum (bacterial culture) is also added to the feedstock to improve efficacy of the process.

Indicative Equipment Required For Pre-Processing

- **Loader:** Tractor mounted front-end loaders or pay loaders are used to deliver the raw feedstock to conveyors. These vehicles have a shovel- like attachment at the front of the machine which can be raised by a hydraulic mechanism to lift feedstock materials and release materials onto the conveyors or into piles.
- **Conveyors:** Conveyors are mechanical systems with belts that slowly pass over rotating wheels. Conveyor belts are used in the sorting/ separation phase of composting to facilitate manual removal of non-compostable material. The width of the conveyor belt should be narrow enough for workers to reach its center.
- **Screens:** Screens are primarily used for separating large sized materials from the feedstock. Different screens that are used are:
  - **Trommel Screens:** Long, cylindrical screens that are placed at an angle to facilitate material movement through the perforated screen. Material smaller than the grate fall through and material with larger diameters than the grate pass through the trommel. As the trommel screens rotate, a brush is passed over the top of the screen to remove lodged material and prevent clogging of the screen.
  - **Rotary Screens:** Feedstock is loaded onto spinning, perforated discs in this system. Oversized materials are scattered from the screen because of the spinning action. Undersized materials fall through the perforations in the discs.
- **Magnetic Recovery Systems:** With these systems, a magnetic field removes ferrous metals from the rest of the feedstock material. The following types of magnetic separators are commonly used:
  - **Overhead Belt Magnets:** Cylindrical magnets are installed over a conveyor belt which carries feedstock and separates out ferrous materials.
  - **Drum Magnets:** Drum magnets are placed over a conveyor belt; ferrous metals in the feedstock that pass under the rotating drum are attracted to the magnet and stick to the drum.

The issue of adding inoculum is of great practical importance because of its cost implication. However, inoculum enhances composting process and also helps in suppressing foul odour

3.2.9 Composting Technologies

Technologies for composting can be classified into the following general categories:

- Windrow Composting
- Aerated Static Pile Composting
- In-Vessel Composting
- Decentralized Composting
- Vermicomposting

3.2.9.1 Windrow Composting

Windrow composting process consists of placing the pre-sorted feed stock in long narrow piles called windrows that are turned on a regular basis for boosting passive aeration. The turning operation mixes the composting materials and enhances passive aeration. Figure 3.12 gives a brief overview of the windrow composting process.

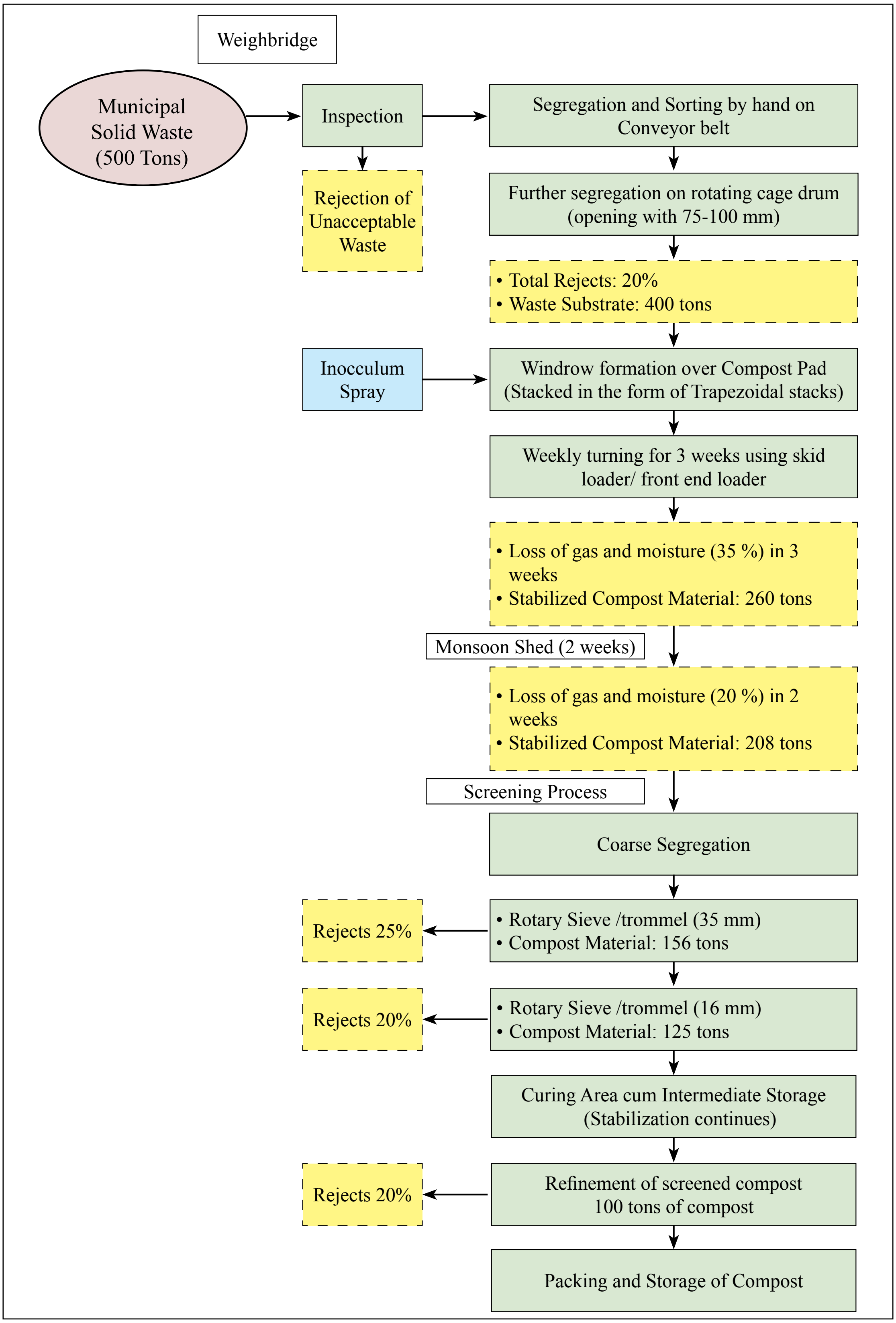


Figure 3.12: Process Flowchart and Mass-Balance for Aerobic Windrow Composting of 500 TPD[15]

15 Mazumdar, N., 2007, Composting Municipal Solid Waste: the Indian Scenario

3.2.9.2 Unit Operations In Windrow Composting

Compost pad should be impervious, have a drainage system to collect leachate for treatment and an appropriate gradient to route the leachate to the collection point

Compost pad (platform): The pre-processed MSW (refer section 3.2.8 above) is transferred onto the compost pad into windrows. The compost pad is an area where the windrows are stacked. The compost pad must be stable, durable and impervious. So it is constructed with an appropriately designed combination of RCC and PCC. The compost pad shall have a slope of about 1% to drain the excess water (storm water or leachate) from the windrows into a leachate collection tank. The leachate tank is placed in the lowest corner of the compost pad area. This leachate should be reused for recirculation of nutrients and for maintaining the moisture content of windrows.

Following factors have to be considered in the location and design of the composting pad:

Windrow composting is the most economical and widely accepted composting process

1. The base has to provide a barrier to prevent the percolation of leachate and/or nutrients to the sub-soil and groundwater.
2. The surface has to facilitate equipment movement even during wet weather conditions.
3. The surface area has to accommodate waste for 5 weeks, with sufficient room for equipment to manoeuvre and an area to establish a static pile for curing compost.

The height to base width ratio of the windrow depends basically on the angle of repose of the material. Windrows are typically trapezoidal in cross section.

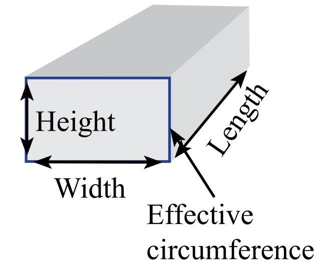
The space between windrows should be sufficient for movement of the windrow turning machine to be employed in the plant. Normally it is 1-3 meters. Figure 3.13 below illustrates calculation of windrows sizes.

In general, as the average windrow shape is between an oval and trapezoid a factor of 0.66 is assumed to estimate windrow volumes, therefore the equation for volume of the windrow is:

Volume = Height X Width X Length X 0.66

Size, shape and spacing of windrows depend on turning practices:

- Bucket loaders: high windrows
- Turning machines: low and wide windrows
- Manual labour: small scale windrows

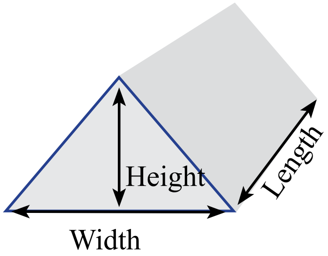


Rectangle

Volume = Height x Width x Length

Effective circumference= 2x height + width

Mass = Volume x Bulk Density

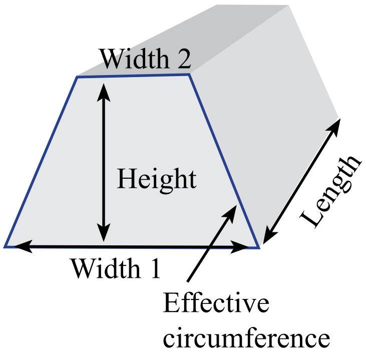


Triangle

Volume = Height x Width x Length x 0.5

Effective circumference= $2\text{x}\sqrt{\text{height}^2 + (\text{width}/2)^2}$

Mass = Volume x Bulk Density



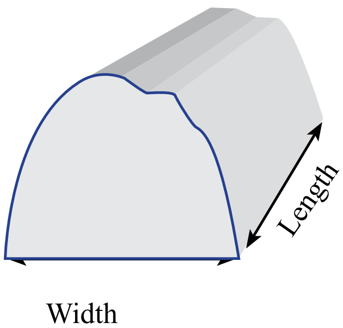
Trapezoid

Volume= Height x (Width1+Width2) x Length x 0.5 [*1]

Effective circumference =

$2 \text{ x } (\sqrt{((\text{width2}-\text{width1})/2))^2 + \text{height}^2}\ ) + \text{width2}$

Mass = Volume x Bulk Density



Oval

Approximations:

Volume = Height x Width x Length x 0.75 [*1]

Effective circumference= $2.3 \text{ x}\sqrt{\text{height}^2 + (\text{width}/2)^2}$

Mass = Volume x Bulk Density

Figure 3.13: Windrow Sizing Calculation[16]

[16] Compost Facility Operator Manual; Available at:http://www.transformcompostsystems.com/pdfs/Transform%20Compost%20Operator%20Manual%20teaser.pdf)

Windrow Formation: The size, shape, and spacing of windrows depend on the equipment used for turning. For example, bucket loaders are used to build high windrows whereas turning machines create low and wide windrows. Manual labour is also used for windrows of a smaller scale where additional equipment costs and use of machinery is not feasible.

Windrow dimensions should allow conservation of heat generated during composting process while also maintaining diffusion of air to the deeper portions of the windrow

Windrow Turning: Windrows are turned frequently to maintain aerobic conditions inside the pile. Windrow turning is a mechanized operation. Generally, pay loaders (wheel or tracked) or tractors with hydraulic attachments are used to scoop the material from one windrow to make a new pile in an adjacent location on the compost pad, while placing and mixing the material. Other equipment such as front end loaders/ windrows re-shifters may also be used for turning windrows. Windrow turning ensures that outer layers of piles are moved to inner layers. This process is repeated once every week for 5 weeks, high temperatures within the windrow (55 to 65°C) sanitize the material. During the rainy season where the interstitial spaces are filled with water, more frequent turning is necessary (interval of 3-4 days).

Regular turning of the windrows helps oxygenate the pile; breaks up particles to increase surface area; improves the porosity to prevent settling and compaction; and allows trapped heat, water vapour, and gases to escape. In general, the more frequently a pile is tuned, the more quickly the composting process is completed. However, repeated turnings in quick succession have two disadvantages – formation of heated pile in the core area is hampered (necessary for killing pathogens) and additional costs resulting from equipment and associated energy use. A balance is therefore to be achieved between number of turnings and cost of production.

Windrows should be turned frequently, once a week over 5 weeks, to maintain aeration, porosity and enhance degradation

A turning schedule should be established based on the rate of decomposition, moisture content, porosity of the material, and the desired composting time (often a function of land availability). Normally once a week turning is done but more frequent during rainy season (once in 3-4 days).

In general, each windrow should be allowed to stay on the compost pad for 35 days and at the end of the 35th day the compost is ready for use. Each windrow should have a flag board depicting the age of the waste. Fresh incoming waste is always depicted by "Age 1". The numbering on the windrow changes from Age 1 to Age 2 on the second day; Age 2 should be changed to Age 3 on the third day and so on. Each windrow may be turned manually or mechanically. This turning process has to be done every 7th day. Hence, only those windrows having a flag board showing Age 7, 14, 21 and 28 should be turned.

Figure 3.14 illustrates an indicative arrangement of windrows. Incoming waste on day

1 is placed in the pile A1. Waste that comes in on day 2 is placed in pile A2, incoming waste on day 3 is placed in pile A3 and so on. On the 7th day after receiving the first batch of waste A1, the pile/windrow is turned/mixed and the pile is moved to location B1. On the 14th day pile B1 is turned/mixed and moved to C1 and so on. Pile D1 will therefore be moved to E1 on the 28th day. On the 35th day the compost pile from E1 should be screened for further refinement. Each of the piles/windrows A2 to A7 are managed in a similar manner. Waste that is received on day 8 is placed in the initial location of pile A1, since this pile would already move to B1 on the 7th day and this location would be free to receive a new pile/windrow.

Frequency of turning depends upon:
- moisture content,
- porosity of material,
- rate of microbial activity, and
- desired composting time

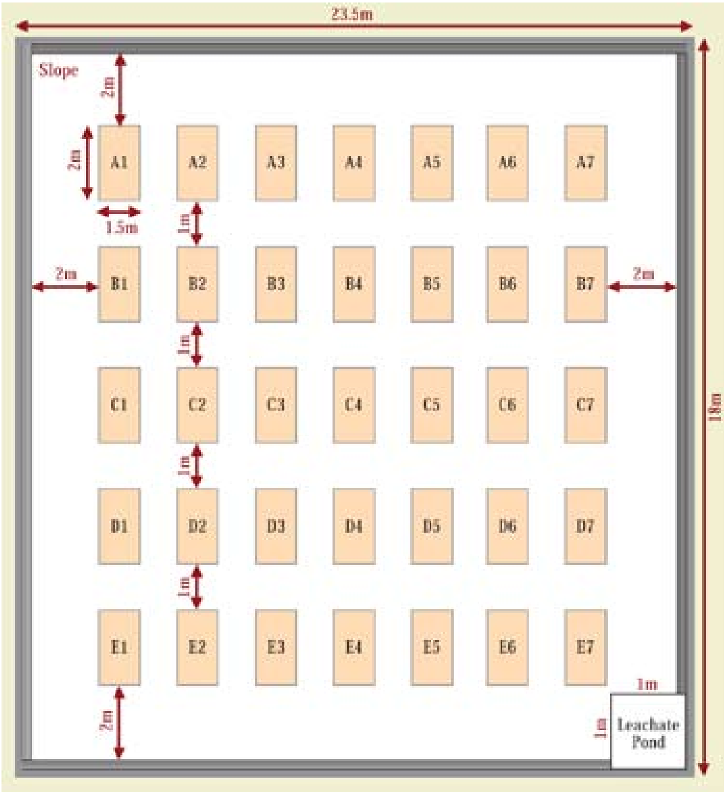


Figure 3.14: Arrangement and Turning of Windrows[17]

Fresh water or leachate stored in the leachate tank should be sprinkled during the turning process to maintain the moisture content of the waste. Figure 3.15 depicts a quick and simple method to test moisture content.

[17] GIZ, Decentralized Windrow Composting

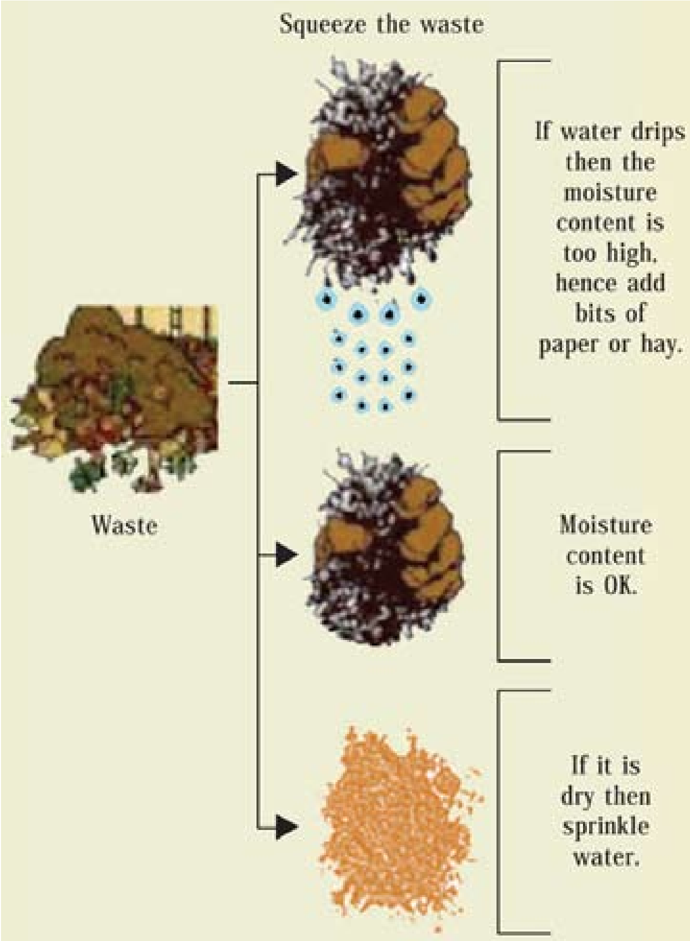


Figure 3.15: Squeeze test to estimate moisture content[17]

Temperature should also be monitored and maintained within 55-60°C.This is important because low/ high moisture and variation in temperature can slow down the composting process.

On the 35th day, the compost is successively sieved through two stage screening system of 35mm followed by 16mm. Screened material coming out of this section is uniform in texture but contains semi-solid organic compost, which requires further stabilization. The rejects from the 35 mm screen are sent to the RDF and the 35mm – material is sent to the 16 mm screen. The rejects from the 16mm (16mm+) screen are to be put back on the windrow as protective covering from bird menace, vermin and for odour control, as illustrated in figure 3.12.

Curing of screened material for at least 3 weeks in a covered area ensures complete maturation of compost

Curing: Screened material coming out of the coarse segregation section requires further maturation and moisture control for producing a product that is beneficial for plants and soil. The degree of maturity is determined through either oxygen uptake or carbon dioxide production rate.

Maturity may also be determined through a simple test, wherein the material is placed in a plastic bag and moistened to 60% water content, the mouth of the bag is then closed. The plastic bag containing the moist material is allowed to sit for 24 to 48 hours at room temperature (30° to 35° C). If foul smells/odours are released when the bag is opened at the end of 24 to 48 hours, it indicates that the material is not fully matured and needs to undergo further decomposition.

The cured material does not release odours because of carbon stabilization during aerobic decomposition of bio-degradable materials in the windrow. Microbial activity continues during the curing phase also, but at a lower rate compared to the main composting phase.

Nevertheless, during curing also, the supply of adequate oxygen is ensured through passive movement of air through the pile and moisture content is maintained within 25 to 30%. The curing piles are placed either in a storage area or covered area for a minimum duration of 2 weeks. In general, the area needed for the curing process is one quarter of the size needed for the windrow/composting process. The completely cured well composted material does not release foul odour and is ready for final screening and for the preparation of the finished product for marketing.

Mature and high quality compost should have C/N ratio around 20:1. Compost with either higher or lower C/N ratio is not beneficial to the soil

Compost Refinement: At the end of composting phase, the material usually contains 30 to 35% moisture. The composting is normally taken to be complete when the active decomposition stage is over and the C/N ratio is around 20:1.

The refinement section also consists of a feeder conveyer and a trommel with 4mm perforations. The screened product which is less than 4mm is passed through ADS (air density separator or de-stoner) to remove sand and grit. Then the compost can be put in bags and stored for sale. The remaining material greater than 4 mm in size should be put on top of the fresh incoming waste heap, to speed up the process of composting and for absorbing excess leachate. The residue material from the ADS is inert laced with fine organic material. This should be kept out of the composting stream. This material can be used for landscaping.

Final compost product should be less than 4 mm in size. Remaining material should be put on the incoming waste heap to hasten the composting process

The finished product is dark brown with an earthy smell, fragile and rich in organic matter content and nutrients.

Value added product can be produced depending upon the market demand, by enriching with beneficial micro-organisms and nutrient sources such as rock phosphate, pyrite etc. The product is bagged and dispatched for marketing, to be used on farmer’s fields.

Based on the desired end use, the compost should comply with specifications of the Fertilizer Control Order 2009 and MSW Rules.

Incoming Waste at Compost Yard

Rain Shed

Primary Screening

Bagging Machine

Figure 3.16: Unit operations in windrow composting

Leachate produced should be collected and used for moistening the waste heap.

Leachate Management: Leachate generation during composting varies with seasons. The compost pad surface should be designed with a proper gradient and surface drainage system such that the entire leachate from the windrows is directed through drainage pipes to a collection tank. This leachate could be utilized for moistening the waste placed in the windrows, as may be required. In case leachate production is higher than consumption, especially during rainy seasons, the leachate tank should be provided with treatment facilities for treating the leachate before disposal. Normally, the leachate tank is provided with a surface aerator for reducing the BOD content. Treated leachate could be subsequently used for irrigation and as a fertiliser.

For detailed design of aerobic windrow composting plants from 50 – 500 TPD MSW input capacity, please refer to the report of the 'Inter-Ministerial Task Force on Integrated Plant Nutrient Management using City Compost', Government of India, 2005.

Typical Equipment Required For Windrow Composting

- **Loader:** Tractor mounted front-end loaders or pay loaders are used to deliver the pre-processed feedstock to form windrows. Loaders are multi-functional and can be used for a number of other purposes such as site maintenance, piling the cured compost and loading the finished compost product into trucks or trailers for sale in the market.
- **Windrow Turner:** Loaders can be used to turn the compost windrows; however specialized compost windrow turners are much faster and do a better job of mixing the entire windrow. If space is limited at a compost facility site, a loader is a preferred option to make windrows higher and wider. (Windrow size need not be limited to suit the specialized compost turners). There are numerous turners available dependent upon the desired windrow height and width, production capacity and desired means of operation, i.e. self-propelled, loader mounted or pull-type, and PTO (power take-off) driven. Typically windrows can vary from 6 to 10 feet in height and 6 to 10 feet wide at the base.
- **Screener:** A trommel screen is desired at the end of the curing process to screen the finished compost for a suitable particle size. This will remove any larger undesirable items called (overs) and will fluff up the finished product to ensure a suitable compost quality.
- **Bagging:** Bulk supply of compost is usually through 50 kg bags.

3.2.9.3 Key Performance Indicators For Windrow Compost Production

Figure 3.12 depicts a process flow chart for a 500 TPD plant, indicating a 20% process efficiency. While 20% efficiency is possible under good operational conditions, the typical efficiency of a windrow compost plant receiving segregated organic solid waste is around 18-20%, i.e. for an input feedstock of 100 tons of segregated waste per day, it should be able to produce 18 - 20 tons of compost for use. Where mixed waste is received as input feedstock (not preferred), compost yield of 10 - 15% is to be achieved.

An indicative SOP for windrow composting is given in Annexure 5.

---

[18] Operation Manual for the Establishment of a Commercial Composting Facility, Prepared by Brent Hansen Environmental in co-operation with the City of Brandon, USA; Available at: http://www.composting.ca/files/op_manual.pdf

3.2.9.4 Aerated Static Pile Composting

Aerated static pile technology requires mechanical aeration of composting piles

Aerated static pile composting is a technology that requires the composting mixture (of pre-processed material) to be placed in piles that are mechanically aerated. The piles are placed over a network of pipes connected to a blower, which supplies the air for composting. Air can be supplied under positive or negative pressure. When the composting process is nearly complete, the piles are broken up for the first time since their construction. The compost is then taken through a series of post-processing steps.

As compost piles are not turned frequently, feedstock should be mixed with bulking agents like straw/ wood chips to ensure air circulation

Unlike aerobic windrow composting, the aerated static pile has direct control over aeration. This is the strength of this system, which can be used to reduce the fermentation time and also save precious fuel (diesel) used by the turning equipment.

MSW Feedstock: Municipal solid waste collected from various areas reaches the plant site at a variable rate depending upon the distance from collection point. As the MSW pile does not receive periodic turnings, the selection and initial mixing of raw materials is critical to avoid poor air distribution and uneven composting. It should be ensured that the feedstock is mixed with a stiff bulking agent such as straw or wood chips. Other possible bulking agents and amendments for static pile composting could include recycled compost, peat moss, crop residues, bark, leaves.

Pre-processing is pre-requisite as it ensures porosity in the raw materials and hence facilitates efficient air circulation in the pile

Pre-processing: Aerated static piles can produce excellent compost provided two basic operating conditions are met:

- The raw material has adequate porosity
- The air flow system is efficient and provides air flows uniformly during the active compost period

Pre-processing of raw MSW for composting in aerated static pile involves:

- Separation and removal of oversize, non-compostable inert materials
- Size reduction through chipping, grinding or shredding
- Blending with wood chips and other bulking agents to allow proper air distribution

Pre-processing involves:
- Segregation
- Size reduction
- Blending with bulking agents like straw etc.

Detailed pre-processing requirements have been discussed in detail in section 3.2.8 of Part II of this manual.

Process: The blended material is placed in stationary or static piles. The piles are constructed above an air source such as, perforated plastic pipes, aeration cones or a perforated floor and aeration is accomplished either by forcing or drawing air through the compost pile. It is very important that the pile should be placed after the floors are first covered with a layer of decay-resisting bulking agents such as wood chips or rejects from the 16 mm trommel.

The size of the pile depends on the material to be composted, air flow capabilities and the type of handling equipment. The initial height of the piles should be about 1.5 m to 2.45 m high, depending on: material porosity, weather conditions, and the reach of the equipment used to build the pile. Extra height is advantageous in lower temperatures as it helps retain heat.

Size of pile depends on:
- Incoming waste feed
- Blower capabilities
- Types of handling equipment

It may be necessary to top off the pile with 15 cm of finished compost or bulking agent to provide insulation. This layer protects the surface of the pile from drying, insulates it from heat loss, discourages flies, and filters ammonia and potential odours generated within the pile.

Controlled mechanical aeration enables construction of large piles, thus reducing the demand for land

The air supply blower either forces air into the pile or draws air out of it. Forcing air into the pile generates a positive pressure system, while drawing air out of the pile creates negative pressure. The blowers are controlled by a timer or a temperature feedback system similar to a home thermostat. Air circulation in the compost piles provides the needed oxygen for the composting microbes and also prevents excessive heat build-up in the pile. Removing excess heat and water vapour cools the pile to maintain optimum temperatures for microbial activity. A controlled air supply enables construction of large piles, which decreases the need for land.

It is suggested to cover the top of the pile with finished compost or bulking agent to ensure insulation, destruction of pathogens and suppression of odours

Blowers used for aeration serve not only to provide oxygen, but also to provide cooling. Blowers can be run continuously or at intervals. When operated at intervals, the blowers are activated either at set time intervals or based on compost temperature. Temperature-set blowers are turned off when the compost cools below a particular temperature. Blower aeration with temperature control allows for greater process control than windrow turning.

In well designed and operated aerated static pile composting system, odour is much less than the aerobic windrow composting system. Even then odours from the exhaust air could be controlled by filters. The suction method of aeration allows better odour control than positive pressure aeration, particularly if the air is directed through an odour filter. An odour filter is essentially a pile of finished compost that has an affinity for odour causing molecules. The disadvantage of using suction is that not as much air can be pulled through the pile as can be pushed through using positive pressure. Figure 3.17 below illustrates composting in an aerated static pile.

A top layer of matured compost could also act as an odour filter

Height of pile helps in retaining heat and should be ideally at least 1.5 m to 2.5 m

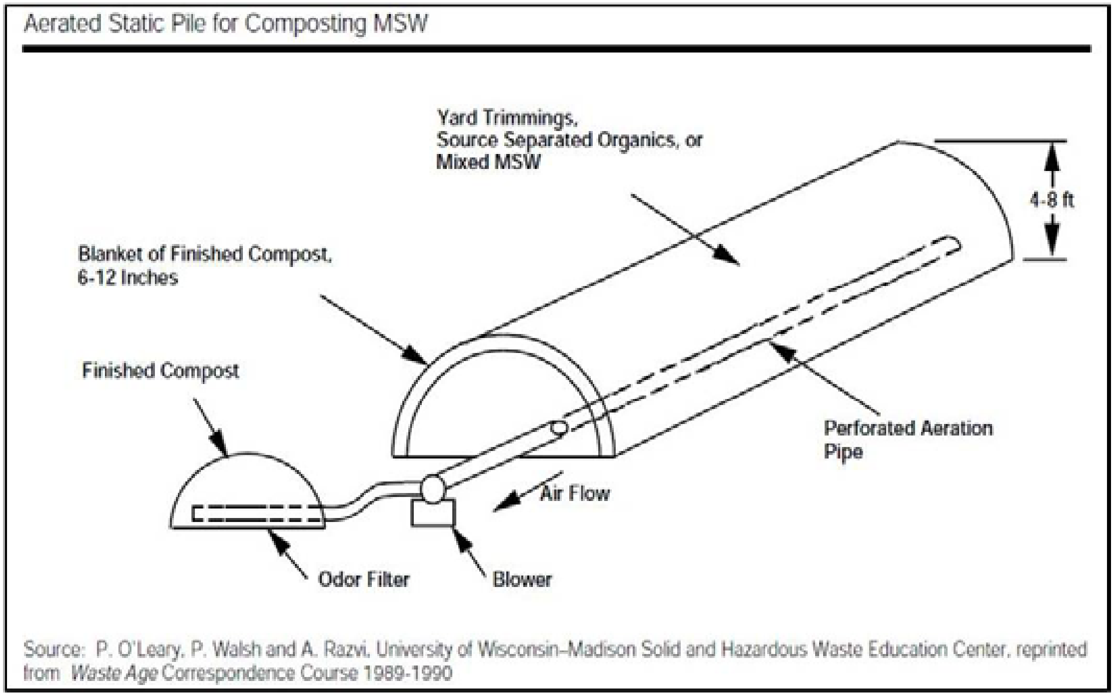


Figure 3.17: Aerated Static Pile[19]

Aerated Static Pile technology usually takes 6-12 weeks for producing mature compost

The temperatures in the inner portions of a pile are usually adequate to destroy a significant number of pathogens and weed seeds present. The surface of piles, however, may not reach the desired temperatures for destruction of pathogens because piles are not turned in the aerated static pile technology. This problem can be overcome by placing a layer of finished compost 6 to 12 inches thick over the compost pile.

Post processing of compost involves separation of wood chips from the finished products through use of a trommel screen

Producing compost using this technology usually takes 6 to 12 weeks depending on pre-processing of feedstock, air movement and temperature control.

Post processing: The compost produced needs to undergo post processing as it is mixed with bulking agents like wood chips. A trommel screen is used to separate the wood chips from the finished product, which is fine- grained and uniform compost. The size of the compost particles depend upon the usage and the quality should comply with the specifications of Fertilizer Control Order 2009 and Municipal Solid Waste Rules, 2000[20].

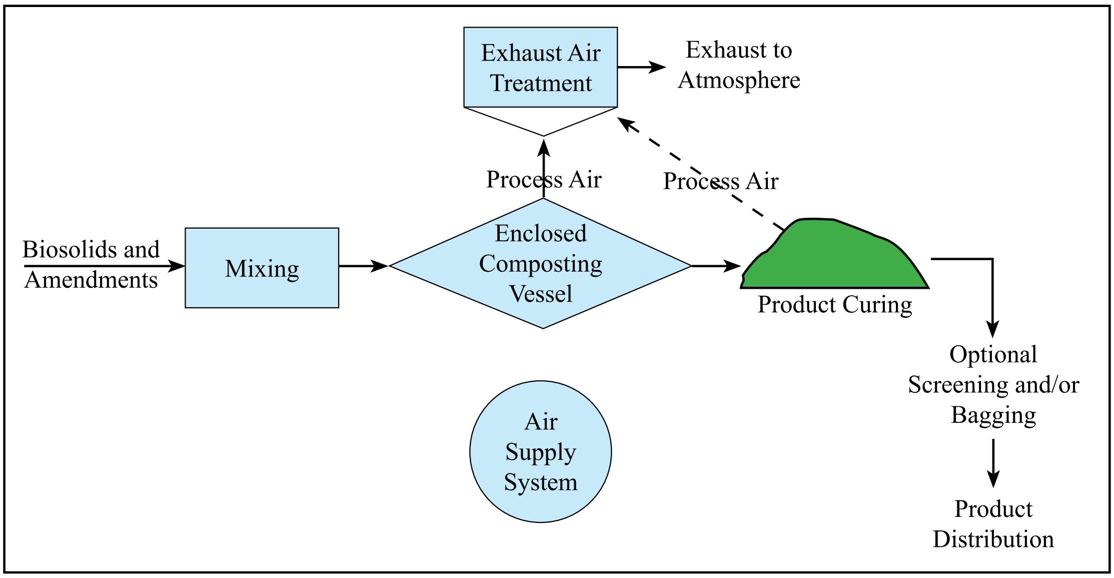
[19] Decision Maker's Guide to Solid Waste Management- Vol I, Available at: http://www.epa.gov/osw/nonhaz/municipal/dmg2/chapter7.pdf)

[20] Environmental Engineering National Engineering Handbook; Available at:http://www.uvm.edu/~99kchene/Resources/NRCS_CompostingGuide.pdf)

3.2.9.5 In Vessel Composting

In-vessel composting systems enclose the feedstock in a chamber or vessel that provides adequate mixing, aeration, and moisture. There are several types of in-vessel systems available; drums, silos, digester bins and tunnels. These vessels can be single- or multi-compartment units. In some cases the vessel rotates, in others the vessel is stationary and a mixing/ agitating mechanism moves the material around. Most in-vessel systems are continuous-feed systems, although some operate in a batch mode. The figure 3.18 below is a depiction of the in-vessel composting process.

Composting takes place in single or multi-compartment vessels that provide mixing, aeration and moisture to waste feed



Source: Modified from U.S. EPA, 1989

Figure 3.18: Composting process in In Vessel Composting[21]

In Vessel composting is recommended especially for kitchen and canteen food waste

MSW Feedstock: The ideal feedstock for in-vessel composting will be organic municipal solid waste co-mingled with food waste, which is highly biodegradable. In fact, in-vessel composting is recommended especially for kitchen and canteen food waste and even slaughterhouse wastes.

Pre-processing: In-vessel systems vary in their requirements for pre-processing materials: some require minimal pre-processing (e.g. food waste), while others require extensive pre-processing (mixed waste). All in-vessel systems require further curing after the material has been discharged from the vessel.

Types of In-vessel reactors:
- Vertical plug flow and Horizontal plug flow: feedstock is loaded on a periodic basis
- Agitated Bin: feedstock is loaded and agitated continuously

[21] Bio-solids Technology Fact Sheet- In Vessel Composting of Biosolids; Available at:http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_invessel.pdf)

Process: In-vessel composting is accomplished inside an enclosed container or vessel. Mechanical systems are designed to minimize odour and process time by controlling environmental conditions such as airflow, temperature, and oxygen concentration.

There are several types of in-vessel composting reactors: vertical plug-flow, horizontal plug-flow and agitated bed.

In vertical plug- flow systems, the feedstock is introduced into the top of the reactor vessel and compost is discharged out at the bottom by a horizontally rotating screw auger. Air is introduced in these systems either from the bottom and travels up through the composting mass where it is collected for treatment or through lances hanging from the top of the reactor.

In horizontal plug-flow systems, the compost feedstock and bulking agent mixture is loaded into one end of the reactor. A steel ram pushes the mixture through the reactor. Air is introduced and exhausted through slots in the floor of the reactor. Compost is discharged from the end of the reactor opposite the ram.

The agitated bed reactors are typically open topped; the feedstock is loaded from above. The composting mass is periodically agitated using a mechanical device and air is introduced through the floors of the reactors. The vessel is emptied when the feedstock processing is complete.

The detention time in the vessel varies from 1 to 2 weeks. A 4 to 12 week curing period after the active composting period is required. Carried out in the absence of oxygen, the anaerobic stabilization process or conversion of the organic material in MSW occurs in three steps. The first step involves the enzyme-mediated transformation (hydrolysis) of higher molecular mass compounds into compounds which act as substrates for release of energy. The second step involves the bacterial conversion of compounds resulting from the first step into identifiable lower-molecular mass intermediate compounds. The third step involves the bacterial conversion of intermediate compounds into simpler end products, principally methane and carbon dioxide.

Since composting takes place in an enclosed vessel, all environmental conditions can be controlled to enhance composting. Minimal odour and leachate generation are observed

Curing: After the composting stages the composted material is taken through a maturation stage in the form of standard windrows on an open pad that are turned once a week for 1-2 weeks.

A major advantage of in-vessel systems is that all environmental conditions can be carefully controlled to allow rapid composting. The material to be composted is frequently turned and mixed to homogenize the compost and promote rapid oxygen transfer. Retention times range from less than one week to as long as four weeks. The vessels are usually placed in a building. These systems, if properly operated, produce minimal odours with little or no leachate. In addition the air supply can be precisely controlled. Some units are equipped with oxygen sensors, and air is preferentially supplied to the oxygen deficient portion of the vessel. In-vessel systems enable exhaust gases from the vessel to be captured for odour control and treatment[22].

3.2.9.6 Decentralized Composting

Transportation of municipal solid waste through cities is a big issue. Decentralized composting is one of the options to reduce the burden of transportation of MSW on the ULB.

Composting of source-separated organic household waste of very small quantities to upto 20 tonnes/ day. Colony level and ward level composting should be promoted.

Decentralized composting is the composting of source separated organic waste in limited quantities from households, apartments, neighbourhoods, markets, gardens or from the entire ward. The decentralized composting approach reduces transportation costs, makes use of low-cost technologies based mainly on manual labour.

Decentralized composting facilities generally handle from very small waste quantities upto 20 tons/ day depending on the size of the community and volume of compostable waste materials in the waste stream.

MSW Feedstock: The feedstock for decentralized composting should include kitchen waste like food, fruit and vegetable leftovers (rich in nitrogen content), yard waste like leaves, twigs, straw and paper (rich in carbon content) .

Decentralized composting can be practiced in either box or bin depending upon the quantity of waste feed and cost implications

Pre-processing: The waste that reaches the decentralized composting facility should be segregated at source. Manual sorting at the facility also helps in removing recyclables and non- biodegradable waste present, if any.

Processing: Decentralized Composting can be practiced using box or bin composting. Box composting is typically carried out at the community scale, whereas bin composting may be practiced at individual household level as well.

[22] Technology Fact Sheet- In Vessel Composting; Available at: http://tech-action.org/Factsheets/ref15x07.pdf)

3.2.9.6.1 Bin Composting

Depending on the quantum of input material, the size of the bin may be decided. A series of bins may be used to accommodate all incoming waste, as shown in figure 3.19. The bottom of the bin should be covered with a thick layer (~15cm) of coarse material, such as twigs, broken pieces of stone or mulch, if available. Over this drainage layer, the feed stock is to be placed in layers. The feed stock should ideally contain a mix of garden/yard waste, kitchen waste, dried leaves and paper. Water may be sprinkled to keep the heap moist. Care should be taken not to add excess water; the heap should not be wet. Excessively wet conditions can be prevented by placing more dried waste like dried leaves, twigs and paper. Finished compost may be sprinkled on top to provide the required inoculum and to contain odour. This waste should be turned regularly to hasten the composting process. High temperatures are produced upon turning once every five to ten days. This also helps to kill larvae, weed seeds and provides a conducive environment for decomposer organisms. The composting process may take between 45 days – 6 months, depending on the feedstock and turning conditions.

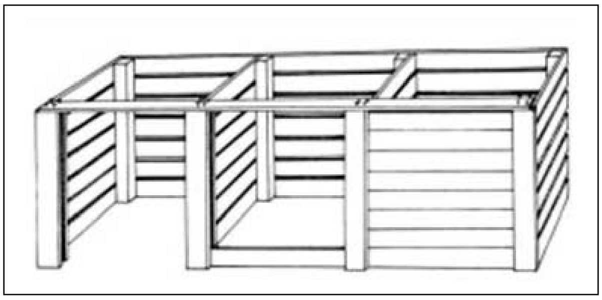


Figure 3.19: Bin Composting[23]

3.2.9.6.2 Box Composting

Box composting is practiced at the local community level and can cater to wastes upto 3-5 tonnes. The total space requirements for box are lower than for the windrow technology. The slab on which the boxes are built should be sealed and sloped towards one side. Leachate collection channels should be constructed, leading the leachate away from the boxes, towards a central collection point. To improve oxygen supply to the pile within the boxes, the box wall contains gaps between the bricks. The base of the box should be perforated and resistant to corrosion, to ensure aeration and drainage of excessive water from the pile. The base should be equipped with small PVC pipes or a coated metal grid to facilitate aeration and drainage of excessive water from the pile. Perforated PVC pipes

[23] Composting Methods, British Columbia; Available at: http://www.al.gov.bc.ca/resmgmt/publist/300Series/382500-5.pdf)

placed vertically inside the box provide additional oxygen exchange within the compost material.

Indicative cross sections for a 3 ton compost box with shed, a composting box and drainage and aeration for box composting are given in figures 3.20, 3.21 and 3.22.

The sorted organic waste is loosely spread in layers of 20 cm into the box, around the vertical aeration pipes. If one box is not sufficient, the remaining waste has to be spread in a second box. Assuming an input load of 3 tons of organic waste per day, two boxes are filled within 5 to 6 days. The boxes receive one layer of waste per day. Every time a layer is added it is loosely mixed with the previous layer using a fork or shovel. When the box is full the waste is left for 40 days to go through a thermophilic composting process similar to the windrow system.

Temperature and moisture are frequently monitored. If the material is too dry water is to be sprayed over the compost and the material is levelled again. Since the waste is thoroughly mixed with coarse material like straw, aeration takes place passively and there is no need to turn the waste. After 40 days one side of the box is opened and the fresh compost is removed from the box and stored in a pile for further maturation.

Curing: After about 40 days, the material in the piles has a soil like colour and the pile temperature has fallen below 50°C. This indicates that the process has entered the curing or maturing phase. Other micro-organisms and small insects like caterpillars and bugs re-colonize the still immature compost. Slowly, they further break down the more complex organic materials like cellulose. An additional three weeks are necessary to ensure that the compost is mature and suitable for direct application to plants.

Screening: The mature compost has a rather coarse texture. The particle size of the compost strongly depends on the size and the composition of the input material. Further screening is required to produce finer compost. A flat frame sieve or a rotating drum sieve is used for screening. Each size and type of sieve with its particular mesh size is suited for a particular throughput and application. Selection of screen sizes is dependent on the desired final compost characteristics.

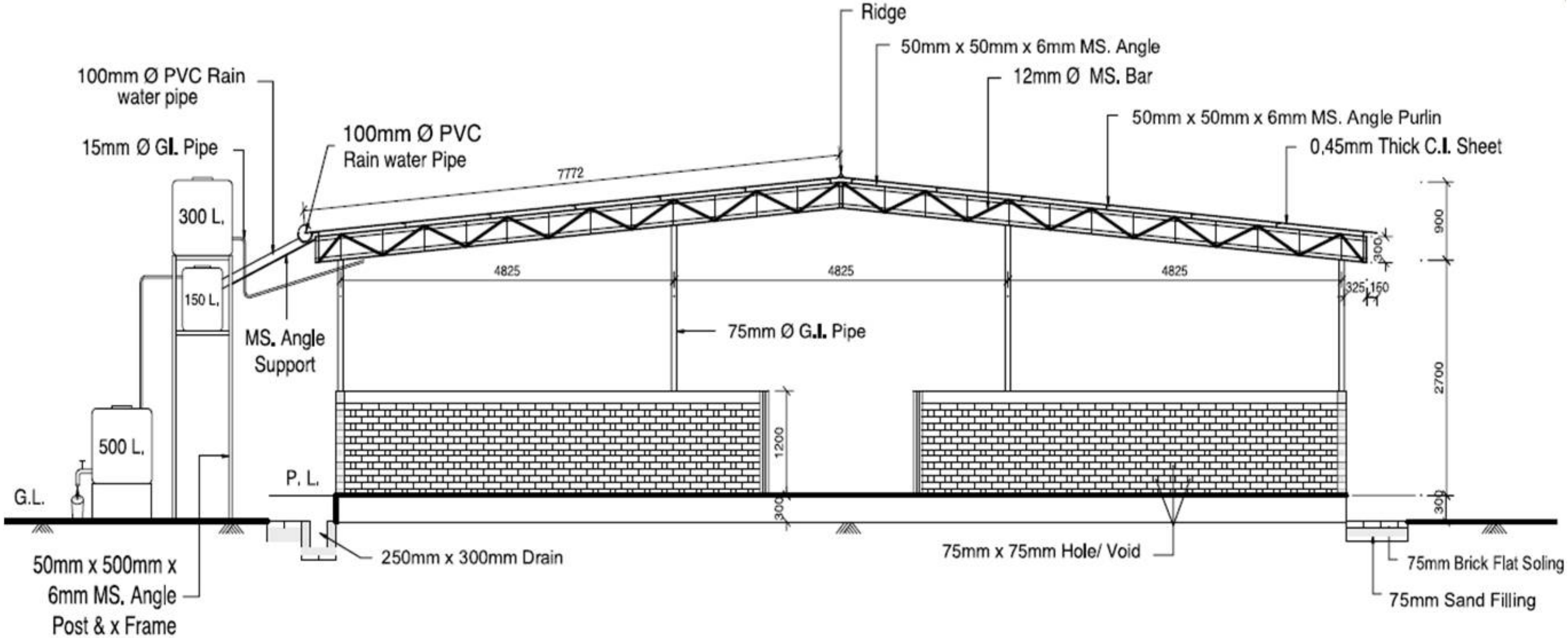


Figure 3.20: Cross section of typical 3 ton composting box[24]

[24] Decentralised composting for cities of low and middle income countries – a user's manual; Available at:http://www.unescap.org/esd/suds/swm/workshop/2010/dhaka/Resources/02-SWM-InteractManual/source/task6.htmlhttp://www.ircwash.org/resources/decentralised-composting-cities-low-and-middle-income-countries-users-manual

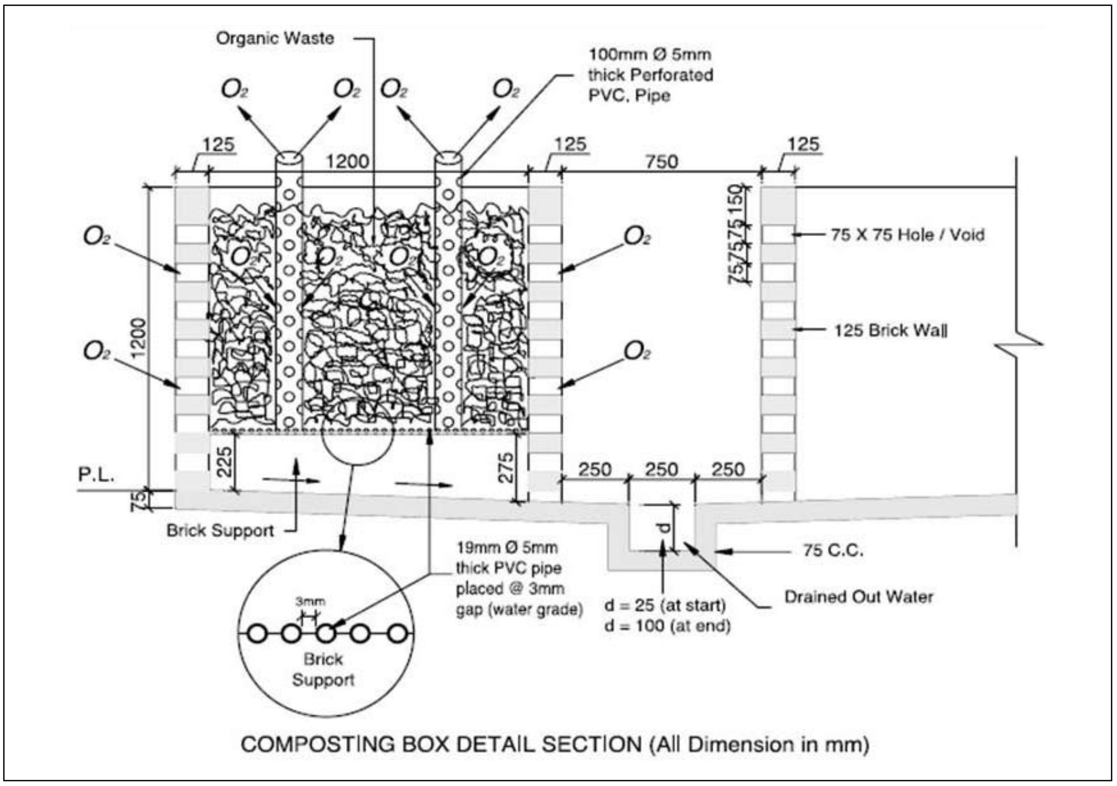


Figure 3.21: Typical Cross Section of Composting Box[25]

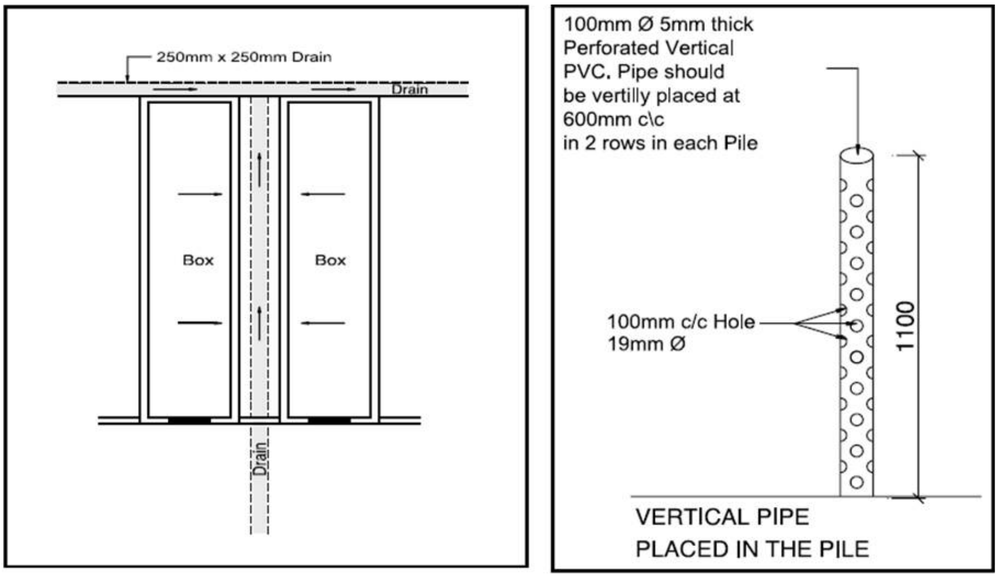


Figure 3.22: Cross section of drainage channels and vertical pipes[26]

---

[25] Decentralised composting for cities of low and middle income countries – a user's manual; Available at:http://www.unescap.org/esd/suds/swm/workshop/2010/dhaka/Resources/02-SWM-InteractManual/source/task6.htmlhttp://www.ircwash.org/resources/decentralised-composting-cities-low-and-middle-income-countries-users-manual

[26] Decentralised composting for cities of low and middle income countries – a user's manual; Available at: http://www.unescap.org/esd/suds/swm/workshop/2010/dhaka/Resources/02-SWM-InteractManual/source/task6.htmlhttp://www.ircwash.org/resources/decentralised-composting-cities-low-and-middle-income-countries-users-manual

In New Moti Bagh Colony in New Delhi, a decentralized composting and RDF facility has been established. The facility receives 3 tonnes of organic waste per day.

Bio Mechanical Composting Technology for Processing Waste 0.4 to 3 tons/ day

A typical batch aerobic digester shreds, cuts and homogenizes segregated organic waste. The segregated organic waste along with coarse wastes such as garden pruning, bones etc., are shredded in shredding machine prior to feeding into the digester. The organic waste is homogenized with appropriate bio-culture and organic absorbent media. The process involves aerobic digestion of organic waste in the machine chamber while homogenizing and again while curing raw compost in crates stacked in a rack. The leachate is controlled during homogenization process in the digester. The treated waste accelerates the composting cycle. Temperature achieved during the process ensures control of pathogens. Raw compost, having uniform colour and soil structured coarse material, free of bad odour is formed.

The raw compost is placed into a compost curing system where temperature and moisture is controlled using a fogging system or other moisture control means. The raw compost is bio-converted into matured compost in about 10 days of curing period. Curing the output in crates produces good quality organic manure within 10 days. The end product is recommended to be used for urban agriculture, terrace gardens, parks and for urban forests.

The batch aerobic digester system requires a three phase power supply for running the shredder and the aerobic digestion chamber. Periodic maintenance of the machine is essential for continuous operations.

Critical operating factors influencing the performance of a batch aerobic digestion chamber include presence of adequate moisture and absorbent media to ensure sufficient structural space within the material to facilitate continuous aerobic conditions. Temperature and moisture control are critical factors to be monitored continuously.

Section 1.4.4.7 of part II of this manual contains case studies of successful decentralized solid waste management initiatives.

3.2.9.7 Vermi Composting

Vermi-compost is the castings of earthworms. Vermicomposting is the process of composting the biodegradable fraction of municipal solid waste with the help of earth worms, resulting in the production of vermicompost which can be used in agricultural fields as a soil conditioner and nutrient supply.

Vermi-composting is the process of using earthworms and micro-organisms to turn kitchen waste into black and nutrient-rich humus

Vermicomposting is typically suited for managing smaller waste quantities. It is an ideal technology for towns which generate upto 50 tonnes of mixed municipal solid waste per day. The worm species that are commonly considered are Pheretimasp., Eiseniasp. & Perionyx excavates sp. These worms are known to survive in the moisture range of 20-80% and the temperature range of 20-40°C.

Commonly used earthworms:
- *Pheretima elongata*
- *Pheretima asiatica*
- *Eisenia foetida*
- *Perionyx excavatus*
- *Eisenia eugeniae*

MSW Feedstock: Kitchen waste is the preferred feed stock for vermicomposting, however wastes like meat waste, greasy and oily food and dairy products tend to foul the bed and cause bad odours as they take significant time to decompose. The ideal feedstock for vermicomposting is vegetable market waste, kitchen and garden waste, cow dung and agricultural waste.

Process: A vermicompost pit of any convenient dimension can be constructed in the backyard or garden or in a field. It may be a single pit, two pits or brick tank of any size with proper water outlets. The most convenient pit or chamber of easily manageable size is 2m x 1m x 0.75 m. The size of the pits and chambers could be determined based on the quantity of feedstock. The 'four tank' or 'four chamber' method of pit construction facilitates easy and continuous movement of earthworms from one chamber, with fully composted matter, to the one with the pre-processed waste in the chambers.

Vermi-composting takes place at 20-30°C which is the most favourable temperature for ensuring survival of earthworms

A Vermibed is prepared at the base of the compost pit. The vermibed is a layer of good moist loamy soil mixed with composted cattle manure placed at the bottom, about 15 to 20 cm thick above a thin layer of 5 cm of broken bricks and coarse sand. Around 150 earthworms may be introduced into the compost pit of about 2m x 1m x 0.75m, with a vermibed which is 15 to 20 cm thick. Pre-processed waste should be laid in vermibeds in layers of 6 inches each, along with uniform spraying cow dung slurry in the ratio of 1:1. Since the worms are known to be adversely affected by high concentrations of heavy metals such as Cadmium (Cd), Chromium (Cr), Lead (Pb) and Zinc (Zn), pre-processing of the waste as well as favourable environmental conditions are necessary for vermicomposting.

The waste has to be turned using rakes and sprinkled with water simultaneously, without changing the position of waste in a particular vermi-composting bed for the entire period of 3 days. This process is carried out to bring down the vermi-compost temperature of pre-processed waste from 55-60°C to 20-30°C which is the favourable temperature for vermicomposting process. Moist porous jute bags should be placed above the waste in the beds in order to maintain the moisture contents of the beds as well as to protect the worms from exposure to sunlight.

Water should be sprinkled as required, in order to maintain the moisture content in a range of 30-40% and temperature in the range of 20-30°C. Monitoring the moisture content and temperature should be carried out on a regular basis. Care should be taken with respect to the following point:

Worm casting or vermicast should be stored in sacks for at least a month to ensure complete maturation before being applied to soil

- Extreme wet and dry conditions will harm the worms therefore utmost care should be taken to control the temperature of the compost beds
- Extreme temperature should be controlled by sprinkling water or putting a wet gunny bag over the compost during summer season.

Each vermibed should be monitored every day for the development of worm castings (vermicast, black gold) at the surface. The earthworm cast which is present on the top is scooped off and collected every day, which is the final product of vermicomposting.

As the pit progressively gets emptied, the last 150 mm layer which retains the worms is retrieved and used for next load of waste to be treated. Fresh waste is introduced over the 150 mm residue and the process continues.

Since earthworms are very sensitive towards heavy metals, it is very important to ensure that waste feed is not contaminated

The vermicast is slightly moistened and then stored in sacks in the shade. It is stored for up to one month before being applied to the soil.

Commonly encountered problems, as well as possible causes and solutions are tabulated below in Table 3.4

Table 3.4: Vermicomposting- Problems, Possible Causes and Solutions

S.No.	Problems	Possible Causes	Solutions
1.	Foul Odour	Overfeeding	Remove the excess food, remove meat/dairy products if any
		Not enough air circulation/ Anaerobic conditions	Fluff bedding
		Bed too wet	Add bedding to absorb moisture
		Anaerobic conditions	Add bedding to absorb moisture
2.	Flies	Waste exposed	Bury the waste completely
			Place bin outside in colder weather

S.No.	Problems	Possible Causes	Solutions
3.	Ant Infestation		Immerse the base/feet of the vermibed in liquid
			A barrier of chalk or petroleum jelly may repel the ants
			If bedding seems dry, add water
4.	Mite Infestation		Avoid adding foods with high moisture content
5.	Worms are dying or crawling away	Bed too wet	Do not water till it reaches appropriate moisture
		Bed too dry	Sprinkle water till it turns moist
		Excess temperature, not enough air, not enough food	Sprinkle water till it turns moist and temperature drops, Add waste appropriately
		Bed packed tightly	Turn bed and make it fluffy

3.2.10 Summary: Criteria For Selection Of Composting Technologies

The choice of composting technology depends on a number of criteria which include quantity of waste to be processed, land requirement, climatic conditions, stability, energy requirements, financial implications, monitoring requirements and aesthetic issues. Table 3.5 gives a brief overview of different composting technologies.

Table 3.5: Summary of Different Composting Technologies[27]

Parameters	Windrow	Aerated Static Pile	In-Vessel	Vermicomposting
General	Simple Technology	Effective for farm and municipal use	Large- scale systems for commercial applications	Suitable for quantities less than 50 TPD generation of mixed MSW
Amount of waste treated	1 ton-500 tons per module	1 ton-500 tons per module	1 ton-300 tons per module	1 ton- 50 tons
Land Requirement	8 ha - 500 TPD	5 ha - 500 TPD (Less land required given faster rates and effective pile volumes)	4 ha - 500 TPD (Very limited land due to rapid rates and continuous operations)	2 ha: 50 TPD

[27] Developed by ICLEI South Asia

Parameters	Windrow	Aerated Static Pile	In-Vessel	Vermicomposting
Time	8 weeks	5 weeks	3 weeks (3-5 days in vessel; 3 weeks to mature)	8 weeks
Ambient Temperature	Not temperature sensitive	Not temperature sensitive	Not temperature sensitive	Temperature sensitive (30-40°C ideal range; 35-37°C specific to particular earthworm sp.)
Energy Input	Moderate	Moderate (2-3 hours aeration)	High	Low
Financial Implications	Moderate	Costly	Very Costly	Moderate. Purchase of exotic earthworms suitable for MSW composting are expensive
Odour/ Aesthetic Issues	Odour is an issue if turning is inadequate.	Moderate. Odour can occur but controls can be used such as pile insulation and filters on air system	Minimum. Odour can occur due to equipment failure or system design failure	None

3.2.11 Monitoring Of Compost Plants

Routine testing and monitoring is an essential part of any composting operation. Monitoring the composting process provides information necessary to maintain a high-quality operation. At least the following parameters should be monitored:

- Compost windrow temperature
- Oxygen concentrations in the compost mass
- Moisture content
- Maturity of the compost
- pH
- Soluble salts
- Ammonia

- Organic and volatile materials content
- Heavy metals

Compost quality should be monitored by the operator of the compost facility, per batch of compost being sold to the market. If the facility does not have sufficient laboratory capacity to perform all the tests, MoEF accredited laboratories should be contracted to perform these tests on a regular basis. Compost that does not meet specified standard should be put to uses other than for application to food crops. Compost contaminated with heavy metals, beyond the specified standards, should not be used for land application and should be landfilled.

Compost should meet standards set by FCO, 2009 and its amendments before being used as soil conditioner.

A standard operating procedure for windrow composting is given in Annexure 2.

3.2.11.1 Quality Parameters For Compost Production

The quality of the compost should meet the standards set by Fertilizer Control Order, 2009 and Municipal Solid Waste Rules 2000. The compost which is to be used as fertilizer for food crops should abide by the FCO Rules which are more stringent, while compost used as a soil conditioner and for other purposes should at least meet the requirements of MSW Rules, 2000. Phosphatic fertilizer is in short supply in the country; the use of Phosphate Rich Organic Manure (PROM) can reduce the use of phosphatic fertilizers to some extent, PROM is formed by the mixing of rock phosphate with MSW derived compost. The FCO 2013 specified quality standards for PROM, while retaining the standards specified in FCO 2009 for organic compost. Table 3.6 is a comparison of compost quality standards as specified by the FCO Rules 2009, 2013 and MSW (M&H) Rules 2000.

Standards for PROM are included in the FCO Rule, 2013

Prevention of cross contamination of organic material with inerts and street sweeping coupled with appropriate pre-sorting and segregation of raw material for composting will to a large extent ensure that heavy metal contamination is minimized in the finished compost.

Table 3.6: Compost Quality Standards as per MSW Rules, FCO 2009 and FCO 2013 (PROM)

Parameters	Organic Compost		Phosphate Rich Organic Manure
	MSW Rules 2000	FCO 2009	FCO (PROM) 2013
Arsenic (mg/Kg)	10.00	10.00	10.00

Parameters	Organic Compost		Phosphate Rich Organic Manure
	MSW Rules 2000	FCO 2009	FCO (PROM) 2013
Cadmium (mg/Kg)	5.00	5.00	5.00
Chromium (mg/Kg)	50.00	50.00	50.00
Copper (mg/Kg)	300.00	300.00	300.00
Lead (mg/Kg)	100.00	100.00	100.00
Mercury (mg/Kg)	0.15	0.15	0.15
Nickel (mg/Kg)	50.00	50.00	50.00
Zinc (mg/Kg)	1000.00	1000.00	1000.00
C/N ratio	20-40	<20	less than 20:1
pH	5.5-8.5	6.5 - 7.5	(1:5 solution) maximum 6.7
Moisture, per cent by weight, maximum		15.0-25.0	25.0
Bulk density (g/cm^3)		<1.0	Less than 1.6
Total Organic Carbon, per cent by weight, minimum		12.0	7.9
Total Nitrogen (as N), per cent by weight, minimum		0.8	0.4
Total Phosphate (as P_2O_5), percent by weight, minimum		0.4	10.4
Total Potassium (as K_2O), percent by weight, minimum		0.4	–
Colour		Dark brown to black	–
Odour		Absence of foul Odour	–
Particle size		Minimum 90% material should pass through 4.0 mm IS sieve	Minimum 90% material should pass through 4.0 mm IS sieve
Conductivity (as dsm-1), not more than		4.0	8.2

3.2.12 Integration Of The Informal Sector

The informal sector i.e., rag pickers contribute to maintaining the quality of feedstock coming to the compost plant by removing the plastics, glass, metal and paper. Integrating rag pickers into organized or formal waste management programs can improve the quality of their working conditions and the local environment. Rag pickers could be trained and employed in the pre-processing facility at the compost plant. Refer to sections 3.1.6 and 1.4.4.8 of part II of this manual for further details on integrating the rag pickers into formal systems.

Composting plants can provide livelihood opportunities to the informal sector.

3.2.13 Human Resource Requirement

Compost plant operators shall ensure that all personnel assigned to the operation shall be trained in subjects pertinent to operations and maintenance, physical contaminants and hazardous materials recognition and screening, with emphasis on odour impact management and emergency procedures. A record of such training shall be maintained on the site.

Training and capacity building of all staff employed in waste management plants is essential.

The level and nature of staffing and training should be adequate for environmentally responsible and safe management of the composting facility. Staffing levels should be high enough to ensure that the facility can comply at all times with provisions of the MSW Rules and other applicable guidance/consent.

Staff training should be effective enough to ensure that:

- All operators of the plant and its equipment are skilled at undertaking all the tasks required of them.
- All personnel who inspect incoming waste are skilled at identifying unacceptable waste and can record data accurately.
- Laboratory staff is well informed of sampling practices and requisite analysis of laboratory results. They should be conversant with the impacts of different parameters, to be able to suggest process modifications based on an analysis of the results. Constant communication with plant operating staff on related matters is crucial.
- Compost quality should be regularly checked through MoEF accredited laboratories, at least once a month or as per direction of the State Pollution Control Board. In case the quality is not meeting standards, it is important to reject the entire batch for use as fertilizer for food produce.

Staffing requirements will vary as a function of the size of the facility, the type of waste input, and the diversity and complexity of site operations.

Indicative staff requirement for a 300 TPD windrow composting plant is given in table3.7:

Table 3.7: Indicative Staff Requirement for a 300 TPD Compost Plant (Windrow)[28]

S.No.	Grade	Qualification	Experience	Number
1.	General Manager	B.E	2-3 years	1
2.	Shift In-charge	Diploma	1-2 years	2
3.	Mechanic	ITI	3 years	2
4.	Plant Operator	H.SC	1-2 years	3
5.	Chemist	B.Sc.	1 year	1
6.	Accounts Officer	B.Com	3 years	1
7.	Skilled Worker	-	2-3 years	4
8.	Semi-skilled Workers	-	-	6
9.	Unskilled Worker	-	-	12
10.	Drivers	-	3-4 years	20
11.	Contractual Labour	-	-	24

3.2.14 Greenhouse Gas Emission Avoidance Through Composting

Municipal solid waste contains large fractions of organic waste which is a potential source of methane and other Greenhouse Gas (GHG) emissions. Methane is a highly polluting GHG with a global warming potential 21 times that of carbon dioxide. Composting, an aerobic process, transforms a range of organic substrates into stable humus like material through microbial decomposition. In the process, methane emissions to the atmosphere are avoided, which would otherwise result from anaerobic decay of waste in a waste disposal site e.g. open waste disposal site or landfills.

Composting is acknowledged by the United Nations Framework Convention on Climate Change (UNFCCC) as one of the emission reduction methodologies in waste management. However, the potential for realizing finance through sale of carbon credits is rather limited in the current global climate regime.

3.3 Waste To Energy

It is assumed that at least 65 to 80% of energy content of waste can be recovered as heat energy through waste to energy technologies

Waste to Energy (W to E) refers to the process of generating energy in the form of heat or electricity from municipal solid waste.

3.3.1 W To E In The ISWM Hierarchy

The ISWM hierarchy indicates that recovery of energy from waste (refer to figure 3.23) is

[28] Inter-Ministerial Task Force on Integrated Plant Nutrient Management Using City Compost, 2005

preferable only after considering the potential for recovery of material. Valuable energy is sought to be recovered after ensuring that all possible reduce, recycle and recover mechanisms have been adopted.

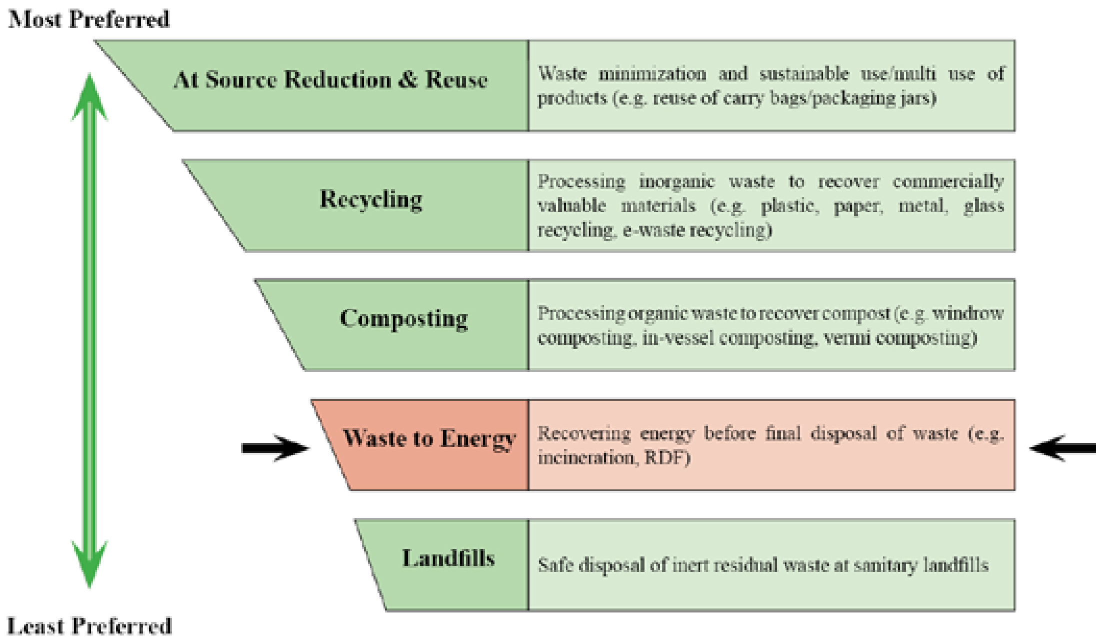


Figure 3.23: W to E in the ISWM Hierarchy

Proven Waste to Energy technologies include incineration of municipal solid waste with recovery of energy, either as heat or converted to electricity and production of high calorific value Refuse Derived Fuel (RDF) from municipal solid waste, which is fast gaining acceptance. However, stringent norms specifying quality standards and conditions for its utilization are awaited from the MoEF. There are various new technologies under discussion such as pyrolysis and gasification, which are not yet proven under Indian conditions. The level of experiences and their reliability is far beneath the well-proven waste incineration.

Combustion technologies in India have to cope with the comparably high moisture and inert content, as is common in Indian waste. However, door step segregation of waste, segregated management of inert wastes and pre-treatment to separate the high calorific fraction (Refuse Derived Fuel; see section 3.4 of Part II of this manual), would enable efficient W to E technologies.

Application of technologies like pyrolysis and gasification to treat municipal solid waste is at a very nascent stage in the country, with one or two experimental plants in the process of being stet-up. Nevertheless, section 3.5 of Part II of this manual provides a brief overview on these technologies.

Incineration of municipal solid waste (along with energy recovery) can reduce the volume of waste to be landfilled by 90%

Waste to Energy plants are an expensive option for managing municipal solid waste, requiring skilled manpower and adoption of high-level technologies. They also have the potential to cause significant environmental impacts through emissions and fly ashes, if plants are not operated efficiently and appropriate emission control mechanisms are not adopted.

3.3.2 Incineration

Incineration is a waste treatment process that involves combustion of waste at very high temperatures, in the presence of oxygen and results in the production of ash, flue gas and heat. Incineration is feasible for unprocessed or minimum processed refuse besides for the segregated fraction of the high calorific waste.

Since recovering energy value in waste prior to final disposal is considered preferable to direct landfilling, hence waste to energy option lies above landfilling in ISWM hierarchy

The potential for energy generation depends on the composition, density, moisture content and presence of inert in the waste. In practice, about 65 to 80 % of the energy content of the organic matter can be recovered as heat energy, which can be utilized either for direct thermal applications, or for producing power via steam turbine generators.

Besides the potential for energy use, incineration of municipal waste helps to reduce landfill volumes. Incineration is an option especially where other better options of processing of waste are not feasible and land for landfilling and other waste processing methods is scarce.

3.3.2.1 Key Criteria For MSW Incineration

The success of waste incineration projects depends entirely on incoming waste feed characteristics and quantity

MSW incineration projects are appropriate only if the following overall criteria are fulfilled:

- A mature and well-functioning waste management system has been in place for a number of years.
- Incineration is especially relevant for the dry bin content in a 2-bin system (see chapter 2 of Part II of this manual). For unsegregated waste, pre-treatment is necessary.
- The lower calorific value (LCV) of waste must be at least 1450 kcal/kg (6MJ/kg) throughout all seasons. The annual average LCV must not be less than 1700 kcal/kg (7 MJ/ kg) .

[29] Decision Maker's Guide to Municipal Solid Waste Incineration, The World Bank, 1999

- The furnace must be designed in line with best available technologies to ensure stable and continuous operation and complete burn out of the waste and flue gases.
- The supply of combustible waste should be stable and amount to at least 500 tonnes/ day.
- Produced electricity and/ or stream can be sold at a sustainable basis (e.g. feeding into the general grid at adequate tariffs).
- It is possible to absorb the increased treatment cost through management charges, tipping fees.
- Skilled staff can be recruited and maintained.
- Since the capital investment is very high, the planning framework of the community should be stable enough to allow a planning horizon of 25 years or more.
- Pre-feasibility study for the technology led to positive conclusions for the respective community.
- Strict monitoring systems are proposed and monitored.

To ensure financial viability of incineration plants, the supply of waste feed should be at least 500 TPD of segregated waste with a LCV not less than 150 kcal/kg of waste

3.3.2.2 Key Considerations For Incineration Of MSW

Incineration of municipal solid waste should meet with the following criteria:

- Minimum gas phase combustion temperature of 850 °C and a minimum residence time of the flue-gases, above this temperature, of two seconds after the last incineration air supply.
- Optimum oxygen content (~lower than 6%) should be maintained in order to minimize corrosion and ensure complete combustion. The carbon monoxide content of the flue-gas is a key indicator of the quality of combustion.
- Fly ash acts as a catalyst for de-novo synthesis (at 200-450°C) of dioxins and furans.In order to reduce formation of dioxins and furans, it is imperative that maximum fly ash is removed before gases cool down to 200-450°C.
- The flue gases produced in the boilers should be treated by an elaborate flue gas treatment system.

Operational Incineration Plants in India (As of 2013)

Currently implementation of 5 Waste-to-Energy plants is underway.All 5 plants receive grants from the Ministry of New & Renewable Energy (MNRE) under their programme on energy recovery from municipal waste. Waste-to-Energy plants are intended to comply with international emission standards. Details of the 5 plants supported by MNRE are given below:

Delhi: Timarpur-Okhla Waste Management Co Pvt Ltd: an initiative of M/s Jindal ITF Ecopolis. The incineration plant was commissioned in January 2012 and is foreseen to process 1,300 tons per day (TPD). The connected pre-processing plant will produce 450 TPD of Refuse Derived Fuel (RDF) to be fed into the Incineration Plan. Expected energy generation will be 16 MW. Performance data are not yet in the public domain.

Delhi, Ghazipur: Of the 2,000 TPD of waste received at the landfill daily, the facility will process/incinerate 1,300 TPD to generate 433 TPD of RDF and 12 MW power. The project is under construction. The PPP operator is M/s ILFS.

Bangalore: An 8 MW power plant is in the process of being set up in Bangalore. This initiative is carried out under a PPP framework between M/s Srinivasa Gayithri Resources Recovery Ltd and Bruhat Bangalore MahanagarPalike (BBMP). The plant is not yet operational.

Pune: A 10 MW gasification plant is being set up in Pune with funds from MNRE. The plant will need 700 TPD of waste for production of 10 MW of electricity. The plant is still being constructed.

Hyderabad: 11 MW power plant, which will utilize 1,000 TPD of MSW, is being installed in the Nalagonda district. The plant will produce RDF for in-house incineration and power generation. The plant is currently under construction.

[30] Waste incineration for urban India: Valuable contribution to sustainable MSWM or inappropriate high-tech solution affecting livelihoods and public health, Dr. Regina Dube*, VaishaliNandan and Shweta Dua, GIZ, New Delhi

3.3.2.3 OVERVIEW OF THE INCINERATION PROCESS

The following general description of an incineration plant includes the crucial processing steps and aspects:

- Siting of an Incineration Plant
- Waste reception and handling (storage, on site pre-treatment facilities)
- Combustion and steam generation system
- Flue gas cleaning system
- Energy generation system (steam turbine and generator in case the unit is equipped for waste to energy recovery)
- Residual hauling and disposal system
- Monitoring and controlling incineration conditions

In designing each of these process steps, the type(s) of waste that are treated in a concrete installation has to be reflected.

3.3.2.4 SITING OF INCINERATION PLANT

The siting of incineration plants should consider all the following: proximity to waste generation point, traffic and transport, air quality, noise impact, proximity to energy distribution networks, utilities and landfills

The location of a municipal solid waste incineration plant should always be determined with respect to both economic and environmental issues. Some of the key criteria for siting an incineration facility include:

- A controlled and well-operated landfill must be available for disposing residues (bed and fly ash).
- MSW incineration plants should be located in land-zones dedicated to medium or heavy industry
- MSW incineration plants should be at least 300 to 500 meters from residential zones
- In case of steam production, the plants should be located near suitable energy consumers

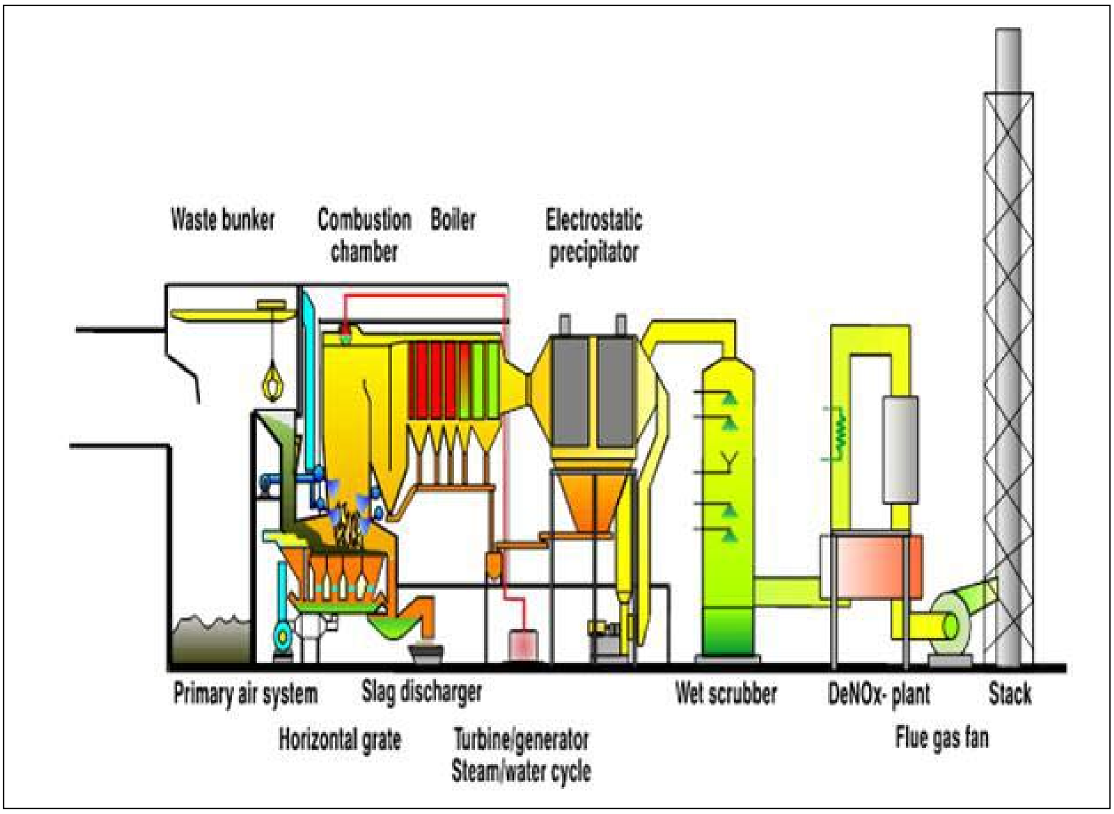


Figure 3.24: Typical Mass Burn Incinerator[31]

Waste reception and storage area should be designed in such a way as to allow for daily and weekly variations in the waste quantities and for mixing of waste to achieve balanced heat value, size, composition etc. Removal of inerts and C&D waste is essential to ensure combustion efficiency

3.3.2.5 Waste Reception And Handling:

Figure 3.24 provides an overview of the design of an incineration plant. The incoming waste reception area is usually a waterproof concrete bed which receives waste from vehicles usually after visual control and weighing. Enclosure of the delivery area can be one of the effective means of avoiding odour, noise and emission problems from the waste.

The waste is piled and mixed in the bunker using cranes equipped with grapples. The mixing of wastes helps to achieve a balanced heat value, size, structure, composition etc. of the material dumped into the incinerator filling hoppers. The bunker must have a storage capacity for at least 3-5 days depending on the plant's operational capacity. The storage area will also depend on local factors and the specific nature of the waste.

Waste Feeder: The key objective behind the waste feeder system is to supply exactly the right amount of fuel to the grate that is necessary to achieve minimum negative pressure and desired temperature for stable combustion and energy generation. The feed rate must

[31] Gleis, M. (2010). Experiences with other Thermal Treatment Processes-Reliability of new technologies. Federal Environment Agency. Available at: http://www.admas.vutbr.cz/files /wtert-prezentace/Gleis_-Experience_with_other_thermal_treatment_processes.pdf.

be constantly and continuously adapted to the transport capacity of the grate in order to obtain a uniformly distributed layer of fuel on the grate and thus achieve uniform energy generation. Consistent feeding also ensures minimal environmental pollution, especially as it fosters complete combustion.

Waste feeder system should be designed for constant feed rate to ensure complete combustion resulting in minimal environmental pollution

The waste is discharged from the storage bunker into the feeding chute by an overhead crane, and then fed into the grate system by a hydraulic ramp or other conveying systems. The grate moves the waste through the various zones of the combustion chamber in a tumbling motion. The filling hopper is used as a continuous waste supplier. It is filled in batches by the overhead crane. As the filling hopper surface is exposed to great stress, materials with high friction resistance are selected (e.g. boiler plates or wear-resistant cast iron). The material must survive occasional hopper fires unscathed. The waste hopper may sometimes be fed by a conveyor. In that case, the overhead crane discharges waste into an intermediate hopper that feeds the conveyor.

It is recommended to divide the total plant capacity into two or more identical incineration lines, thus improving the plant's flexibility and availability—for example, when one line is closed for maintenance. This is required since the plant needs to be shut down for mandatory maintenance and inspection of boilers for a minimum of 4-6 weeks.

3.3.2.6 Combustion And Steam Generation System

Combustion takes place above the grate in the incineration chamber. As a whole, the incineration chamber typically consists of a grate situated at the bottom, cooled and non-cooled walls on the furnace sides, and a ceiling or boiler surface heater at the top. As municipal solid waste generally has a high volatile content, the volatile gases are driven off and only a small part of the actual incineration takes place on or near the grate.

Typical incineration chamber consists of:
- Grate at the bottom
- Cooled and non-cooled walls
- Ceiling/ boiler surface heater at the top

The design of the incineration chamber depends on:

- Form and size of the incineration grate
- Vortexing and homogeneity of flue-gas flow
- Residence time for the flue-gases in the hot furnace
- Partial cooling of flue-gases

The detailed design of a combustion chamber is usually linked to the grate type. Its precise design demands certain compromises as the process requirements change with the fuel characteristics.

Grate incinerators are best suited for MSW which is mixed, non -homogenous and has low calorific value

Types of Combustion Systems

Municipal solid waste is usually incinerated in a grate incinerator. Uniform combustion of waste is dependent on the grate design.

3.3.2.6.1 Grate Incinerators

The incineration grate accomplishes the following functions:

- transport of materials to be incinerated through the furnace
- stoking and loosening of the materials to be incinerated
- positioning of the main incineration zone in the incineration chamber, possibly in combination with furnace performance control measures.

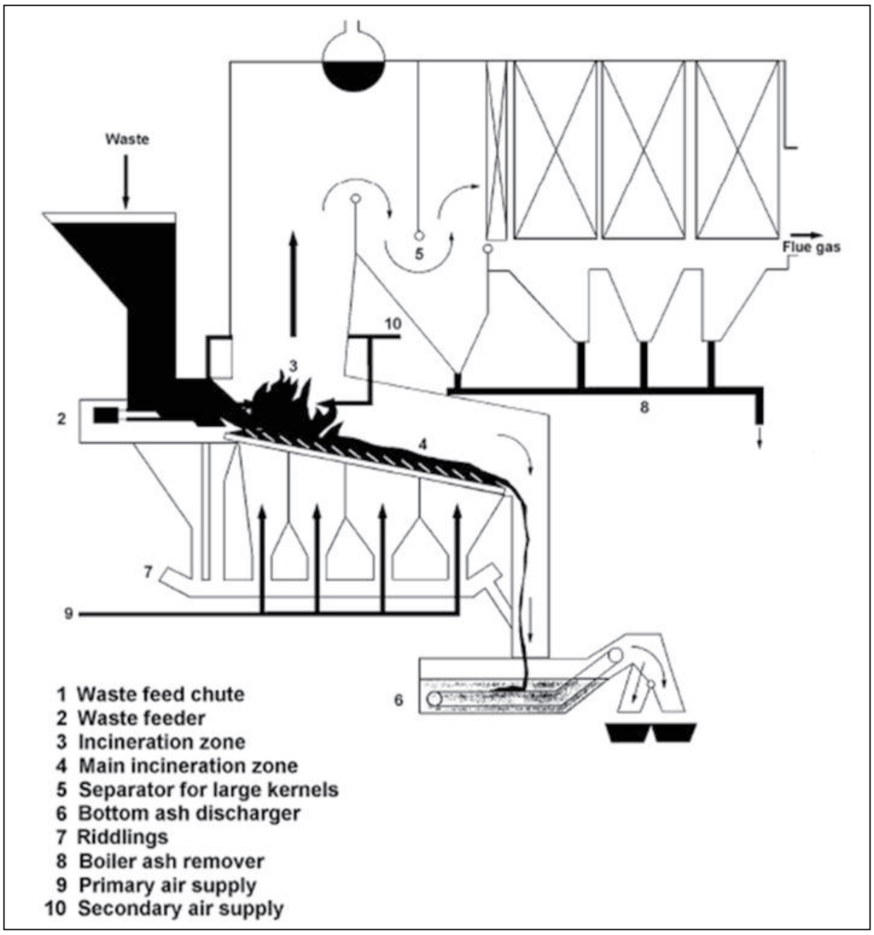


Figure 3.25: Grate Furnace & Heat Recovery Stages of A Municipal Waste Incineration Plant[32]

[32] European Union, (2006) "Reference Document on the Best Available Techniques for Waste Incineration". Available at: http://eippcb.jrc.ec.europa.eu/reference/wi.html European Union, (2006) "Reference Document on the Best Available Techniques for Waste Incineration". Available at: http://eippcb.jrc.ec.europa.eu/reference/wi.html

Grate incinerators (figure 3.25) are widely applied for the incineration of mixed municipal wastes and can be used for untreated, non-homogenous and low calorific municipal waste. An overhead crane feeds waste into the hopper, where it is transported via the chute to the grate in the furnace. On the grate, the waste is dried and then burned at high temperature with supply of air. The ash including non-combustiblefractions of waste leaves the grate as slag/bottom ash through the ash chute.

Grate incinerators are of two types:

- Moving Grate Furnace System: waste enters from one end while ash is discharged at other
- Fixed Grates: series of steps with drying stage and initial combustion phase, complete combustion and final carbon burn-out

Advantages of grate incinerators

- No need for prior sorting or shredding
- Technology is widely tested and meets the standards of technical performance
- Accommodate large variations in waste composition and calorific value
- Allows for an overall thermal efficiency of up to 85%

Disadvantages:

- Capital and maintenance costs are relatively high

Different grate systems can be distinguished by the way the waste is conveyed through the different zones in the combustion chamber. The type of grate systems determines the efficacy of primary air feeding, conveying velocity and raking, as well as mixing of the waste.

Reciprocating grates

Many modern MSWM incinerator facilities use reciprocating grates. The quality of burnout achieved is generally good. Reciprocating grates consist of sections that span the width of the furnace but are stacked above each other. Alternate grate sections slide back and forth, while the adjacent sections remain fixed. Waste tumbles off the fixed portion and is agitated and mixed as it moves along the grate.

There are essentially two main reciprocating grate variations:

1. **Reverse reciprocating grate:** The grate bars oscillate back and forth in the reverse direction to the flow of the waste. The grate is sloped from the feed end to the ash discharge end and is comprised of fixed and moving grate steps.
2. **Push forward grate:** The grate bars form a series of many steps that oscillate horizontally and push the waste in the direction of the ash discharge.

Other grate types that have been in use include rocking grates, travelling grates, roller grates and cooled grates.

Other types of incinerators include the fluidized bed incinerator and rotary kiln incinerator, which are not widely used for mixed MSW incineration. Rotary kiln incinerators are typically used for incineration of hazardous waste.

Timarpur Okhla Municipal Solid Waste Management project in Delhi uses a reciprocating forward moving grate incinerator for combustion of mixed solid waste.

3.3.2.7 Incinerator Chamber & Boiler

Combustion takes place above the grate in the incineration chamber. The incineration chamber typically consists of a grate situated at the bottom, cooled andnon-cooled walls on the furnace sides, and a ceiling or boiler surface heater at the top. As municipal waste generally has a high volatile content, the volatile gases are driven off and only a small part of the actual incineration takes place on or near the grate.

The following requirements influence the design of the incineration chamber:

- form and size of the incineration grate - the size of the grate determines the size of the cross-section of the incineration chamber
- vortexing and homogeneity of flue-gas flow - complete mixing of the flue-gases is essential for good flue-gas incineration
- sufficient residence time for the flue-gases in the hot furnace - sufficient reaction time at high temperatures must be assured for complete incineration
- partial cooling of flue-gases - in order to avoid fusion of hot fly ash at the boiler, the flue gas temperature must not exceed an upper limit at the incineration chamber exit.

In general, three different designs can be distinguished. The nomenclature comes from the flow direction of the flue-gases in relation to the waste flow: unidirectional current; counter-current and medium current/centre flow furnace. The centre flow furnace is most ideal for mixed MSW which is highly variable in quality. A good mixture of all partial flue-gas currents must be considered through mixture-promoting contours and/or secondary air injections.

3.3.2.8 Incinerator Air Feeding

Injection of air into the incinerator is required for:

- provision of oxidant

- cooling
- avoidance of slag formation in the furnace
- mixing of flue-gas

Air is added at various places in the combustion chamber, depending on the location it is described as primary and secondary air. Tertiary air and re-circulated flue-gases may also be used.

Primary air is generally taken from the waste bunker. This lowers the air pressure in the bunker hall and eliminates most odour emissions from the bunker area. Primary air is blown by fans into the areas below the grate, where its distribution can be closely controlled using multiple wind boxes, and distribution valves. Primary air is forced through the grate layer into the MSW bed. It cools the grate bar and carries oxygen into the incineration bed.

Secondary air is blown into the incineration chamber at high speeds via, for example, injection lances or from internal structures. This is carried out to secure complete incineration and is responsible for the intensive mixing of flue-gases, and prevention of the free passage of unburnt gas streams.

3.3.2.9 Flue Gas Recirculation

Flue gas recirculation is an integral part of the furnace design. After passing through the dust filter, part of the flue gas (20 to 30%) is retained and recirculated through an insulated duct to the furnace. The recirculated flue gas is injected through separate nozzles in the furnace. Among its primary advantages, flue gas recirculation:

- leads to a higher thermal efficiency, as the excess air and the oxygen content can be significantly reduced (efficiency can increase about 1to 3 percent)
- reduces NOx content by 20 to 40 percent
- reduces dioxin and furan generation
- stabilizes and improves the flow and turbulence conditions- particularly at partial load

Flue gas recirculation has its operational, economic and environmental advantages.

Residual wastes from incinerators like slag could be used as road construction material while fly ash from flue gas cleaning should be disposed of in hazardous landfill.

3.3.2.10 Residual Haulage And Disposal System

During the incineration process, most of the waste is combusted and converted to gases such as carbon dioxide, water vapour and toxic gases which are cleaned through a complex

Residual wastes from incinerators like slag could be used as road construction material while fly ash from flue gas cleaning should be disposed of in hazardous landfill.

flue gas treatment system. However, part of the waste is incombustible and is removed from the incineration furnace as slag, a solid residue. The amount of slag generated depends on the composition of the waste and amounts to 20 to 25 percent by weight of the waste combusted.

The flue gas cleaning process also produce residues, either directly (fly ash) or by the subsequent treatment of the spent scrubbing liquids, depending on the flue gas cleaning method applied. Fly ash from filter systems is highly contaminated and hence, care must be taken to separately collect bottom ash and fly ash separately. Bottom ash can be treated for further use.

The slag from a well-operated waste incinerator will be well burnt out, with only a minor content of organic material. Besides, the heavy metals in the slag which are normally leachable will to some extent become vitrified and thus insoluble.

Fly ash should be transported in 'silos' and disposed in hazardous landfill

Bottom ash may be treated either on-site or off-site by a dry system or wet system suitably combined with or without ageing. Dry bottom ash treatment installations combine the techniques of ferrous metals separation, size reduction and screening, non-ferrous metals separation and ageing of the treated bottom ash, usually for a period of 6 to 20 weeks. The product is a dry aggregate which can be used as a secondary construction material.

Wet bottom ash treatment system in the ash quench tank allows the production of a material for recycling with minimal leachability of metals. The economy of the bottom ash treatment depends on the market price of the produced fractions. Revenue can be generated by the sale of non-ferrous and ferrous metals fractions.

The fly ash generated in the boilers and air pollution control equipment is highly contaminated and must be disposed off appropriately. Since, the salt and heavy metal content is very high in the ash, it cannot be used for construction purposes. Fly ash may be stabilized in concrete and then disposed in a well-operated hazardous landfill.

3.3.2.11 Consumption Of Raw Materials And Energy By Incineration Plants

Waste incineration plants (process dependent) may consume:

- electricity, for process plant operation

- heat, for specific process needs
- fuels, support fuels (e.g. gas, light oils, coal, char)
- water, for flue-gas treatment, cooling and boiler operation
- flue-gas treatment reagents, e.g. caustic soda, lime, sodium bicarbonate, sodium sulphite, hydrogen peroxide, activated carbon, ammonia, and urea
- water treatment reagents, e.g. acids, alkalis, tri-mercapto tri-azine, sodium sulphite, etc.
- high pressure air, for compressors.

MSW incineration should be considered only after implementing suitable material recycling and recovery systems

3.3.2.12 Environmental Considerations

Municipal solid waste incineration produces a range of volatile and gaseous emissions, which, if untreated released to the atmosphere, can compromise environment quality. Fly ash and dust carry toxic contaminants. Ash leachate might contaminate soil and water.

The actual range of emissions depends upon the specific characteristics of the waste stream and engineering design of the plant such as combustion temperature, combustion chamber design and ancillary emission abatement technologies. Proper planning to minimize environmental damage, as well as public education and involvement, are essential to successful incineration programs.

State of the art incinerator technology and flue gas treatment system coupled with strict monitoring would ensure environmentally safe incinerator facilities.

3.3.2.13 Emission Reduction In Incinerators

Incineration of MSW generates large volumes of flue gases which carry ash, heavy metals and wide range of organic and inorganic compounds. Major air emissions from MSW incinerators include HCl, HF, SO_2, NOx, CO, VOC and heavy metals etc. which are hazardous to human health and environment. Dioxins and Furans are especially potent and need to be controlled through appropriate operating conditions and flue gas treatment technology.

Primary control measures include initiatives that actually retard the formation of pollutants, especially NOx and dioxins. It includes:

- Efficient combustion process
  - With long flue gas retention duration at high temperature

MSW incinerators pose environmental risks through potential emission of contaminants and ash leachate that could contaminate soil and water.

- Appropriate oxygen content
- Intensive mixing
- Recirculation of flue gas

- Precipitation of ashes in the boiler
- Short flue gas retention time at intermediate temperature

Secondary measures include installation of air pollution control equipment which comprise of bag house filters, dry, acid gas removal systems, catalytic reduction systems etc. Table 3.8 briefly describes available emission control technologies for different constituents of flue gas.

Table 3.8: Air Emission Control Technologies[33]

Flue Gas Constituents	Technology Description
Total dust	Effective maintenance of dust control systems is very important. Controlling dust levels generally reduces metal emissions too. Flue Gas Treatment (FGT): Pre-dust control before the Flue Gas Treatment : Bag filters, Electrostatic Precipitators, Cyclones and multi-cyclones Additional flue gas polishing system: Bag filters, wet-ESP, electro dynamic venture scrubbers, agglo-filtering modules, ionizing wet scrubber.
Hydrogen Chloride (HCl)/ Hydrogen Fluoride (HF)/ Sulphur dioxide (SO_2)	Waste control: Blending and mixing can reduce fluctuations in raw gas concentrations that can lead to elevated short-term emissions. FGT: Wet flue gas treatment systems generally have the highest absorption capacity and deliver the lowest emission levels for these substances, but are generally more expensive and difficult to maintain

[33] European Union, (2006) "Reference Document on the Best Available Techniques for Waste Incineration". Available at: http://eippcb.jrc.ec.europa.eu/reference/wi.html

Flue Gas Constituents	Technology Description
Nitrogen monoxide (NO) and Nitrogen dioxide (NO_2), expressed as Nitrogen dioxide for installations using SCR	Waste and combustion control techniques coupled with Selective Catalytic Reduction (SCR) generally result in operation within acceptable emission ranges. The use of SCR imposes an additional energy demand and costs. In general at larger installations the use of SCR results in less significant additional cost per tonne of waste treated. Waste with high nitrogen content may result in increased raw gas NOx concentrations
Nitrogen monoxide (NO) and Nitrogen dioxide (NO_2), expressed as Nitrogen dioxide for installations not using SCR	Waste and combustion control techniques with Selective Non-catalytic Reduction (SNCR) generally result in operation within acceptable emission ranges.
Gaseous and vaporous organic substances, expressed as TOC/Carbon monoxide (CO)	Techniques that improve combustion conditions reduce emissions of these substances. CO levels may be higher during start-up and shut-down, and with new boilers that have not yet established their normal operational fouling level.
Mercury and its compounds (as Hg)	Adsorption using carbon based reagents is generally required to achieve these emission levels with many wastes- as metallic Hg is more difficult to control than ionic Hg. The precise abatement performance and technique required will depend on the levels and distribution of Hg in the waste. Some waste streams have very highly variable Hg concentrations; waste pre-treatment may be required in such cases to prevent peak overloading of flue gas circulation system capacity.
Total Cadmium and Thallium	Dust and other metal control methods are more effective at controlling these substances
Other Metals	Techniques that control dust levels generally also control these metals
PCDD (Polychlorinated dibenzodioxins)/Dioxins and PCDF (Polychlorinated dibenzofurans)/Furans (ng TEQ/NM3)	Combustion techniques destroy PCDD/F in the waste. Specific design and temperature controls reduce de-novo synthesis. FGT: Static activated Carbon filters or Activated carbon is injected into the gas flow. The carbon is filtered from the gas flow using bag filters. The activated carbon shows a highabsorption efficiency for mercury as well as for PCDD/F. Catalytic bag filters are also used to reduce concentrations of PCDD/PCDF
Ammonia	Effective control of NOx abatement systems, including reagent dosing contributes to reducing NH3 emissions.

Flue Gas Constituents	Technology Description
Benz(a)pyrene/ PCBs/PAHSs	Techniques that control PCDD/F also control Benz(a) pyrene, PCBs and PAHs
Nitrous oxide (N_2O)	Effective oxidative combustion and control of NOx abatement systems contribute to reducing N_2O emissions.

3.3.2.14 MONITORING REQUIREMENTS

The MSW (M&H) Rules, 2000 provides operating and emission standards for incineration.

A. Operating Standards

(1) The combustion efficiency (CE) shall be at least 99.00%

B. Emission Standards

Table 3.9: Emission standards for incineration

Parameters	Concentration mg/Nm^3 at (12% CO, correction)
Particulate Matter	150
Nitrogen Oxides	450
HCl	50
Minimum stack height shall be 30 meters above ground.	
Volatile organic compounds in ash shall not be more than	0.01 %

However, the MSW (M&H) Rules are not in line with the international air emission standards for municipal solid waste based incineration plants which are more stringent.

Germany:

Stringent norms were set in 1990 for regulating emissions from incineration plants. The 17th Ordinance of the Air pollution Control Act in Germany (amended May 2013) sets the following norms for air emissions from incineration plants.

Table 3.10: German standards for air emissions from incineration plants - I

Parameter	Unit	Average per day	Half hour limit	Mean value per year
Dust	mg/m^3	5 (10)*	20	-
TOC	mg/m^3	10	20	-
HCl	mg/m^3	10	60	-
HF	mg/m^3	1	4	-
SO_2	mg/m^3	50	200	-
NOx	mg/m^3	150 (200)*	400	100
Hg	mg/m^3	0.03	0.05	0.01
CO	mg/m^3	50	100	-
Ammonia	mg/m^3	10	15	-
Minimum temperature of 850 C for at least 2 sec, O_2 content 11% ( )* Values for plants with firing thermal capacity <50 MW				

Table 3.11: German standards for air emissions from incineration plants - II

Mean values over sampling period per group	Unit	value
Cd, Tl	mg/m^3	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni,V, Sn	mg/m^3	0.5
As, Benzo(a)pyrene, Cd, Co, Cr	mg/m^3	0.05
Dioxine/Furanes	ng/m^3	0.1
Mean value per year of NOx	mg/m^3	100

European Union: Consolidated Emission norms from EU-Directive on the incineration of wastes (2000/76/EC) and its subsequent amendments[34]

Table 3.12: Emission Norms for Incineration of MSW as per EU Directive

(a) Daily average values	
Total dust	10 mg/m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	10 mg/m^3
Hydrogen chloride (HCl)	10 mg/m^3

[34] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000L0076:20081211:EN:PDF

Hydrogen fluoride (HF)		1 mg/m^3
Sulphur dioxide (SO_2)		50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide for existing incineration plants with a nominal capacity of 6 tonnes per hour or new incineration plants		200 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide (NO_2) expressed as nitrogen dioxide for existing incineration plants with a nominal capacity of 6 tonnes per hour or less		400 mg/m3
(*) Until 1 January 2007 and without prejudice to relevant (Community) legislation the emission limit value for NOx does not apply to plants only incinerating hazardous waste.		
Exemptions for NOx may be authorised by the component authority for existing incineration plants		
* with a nominal capacity of 6 tonnes per hour, provided that the permit foresees the daily average values do not exceed 500 mg/m^3 and this until 1 January 2008,		
* with a nominal capacity of >6 tonnes per hour but equal or less than 16 tonnes per hour, provided the permit foresees the daily average values do not exceed 400 mg/m^3 and this until 1 January 2010.		
* with a nominal capacity of >16 tonnes per hour but <25 tonnes per hour and which do not produce water discharges, provided that the permit foresees the daily average values do not exceed 400 mg/m^3 and this until 1 January 2008.		
Until 1 January 2008, exemptions for dust may be authorised by the competent authority for existing incinerating plants, provided that the permit foresees the daily average values do not exceed 20 $mg/m^{3.}$		
(b) Half-hourly average values		
	(100%) A	(97 %) B
Total dust	30 mg/m^3	10 mg/m^3
Gaseous and vaporous organic substances, expressed as total organic carbon	20 mg/m^3	10 mg/m^3
Hydrogen chloride (HCl)	60 mg/m^3	10 mg/m^3
Hydrogen fluoride (HF)	4 mg/m^3	2 mg/m^3
Sulphur dioxide (SO_2)	200 mg/m^3	50 mg/m^3
Nitrogen monoxide (NO) and nitrogen dioxide(NO_2), expressed as nitrogen dioxide for existing incineration plants with a nominal capacity exceeding 6 tonnes per hour or new incineration plants	400 mg/m^3 (*)	200 mg/m^3 (*)
(*) Until 1 January 2007 and without prejudice to relevant Community legislation the emission limit value for NOx, does not apply to plants only incinerating hazardous waste.		
Until 1st January 2010, exemptions for NOx may be authorised by the competent authority for existing incineration plants with a nominal capacity between 6 and 16 tonnes per hour, provided the half-hourly average value does not exceed 600 mg/m^3 for column A or 400 mg/m^3 for column B.		
(c) All average values over the sample period of a minimum of 30 minutes and a maximum of 8 hours		

Cadmium and its compounds, expressed as cadmium (Cd)	total 0.05 mg/m^3	total 0,1 mg/m^3 (*)
Thallium and its compounds, expressed as thallium (TI)		
Mercury and its compounds, expressed as mercury (Hg)	0.05 mg/m^3	0,1 mg/m^3
Antimony and its compounds, expressed as antimony (Sb)	0.05 mg/m^3	total 1 mg/m^3 (*)
Arsenic and its compounds, expressed as arsenic (As)		
Lead and its compounds, expressed as lead (Pb)		
Chromium and its compounds, expressed as chromium (Cr)		
Cobalt and its compounds, expressed as cobalt (Co)		
Copper and its compounds, expressed as copper (Cu)		
Manganese and its compounds, expressed as manganese (Mn)		
Nickel and its compounds, expressed as nickel (Ni)		
Vanadium and its compounds, expressed as vanadium (V)		
(*) Until 1 January 2007 average values for existing plants for which the permit to operate has been granted before 31 December 1996, and which incinerate hazardous waste only.		
These average values cover also gaseous and the vapour forms of the relevant heavy metal emissions as well as their compounds.		
(d) Average values shall be measured over a sample period of a minimum of 6 hours and a maximum of 8 hours. The emission limit value refers to the total concentration of dioxins and furans calculated using the concept of toxic equivalence.		
Dioxins and furans		
(e) The following emission limit value of carbon monoxide (CO) concentrations shall not be exceeded in the combustion gases (excluding the start-up and shut-down phase):		
50 milligrams/m^3 of combustion gas determined as daily average value;		
150 milligrams/m^3 of combustion gas of at least 95 % of all measurement determined as 10-minutes average values or 100 mg/m^3 of combustion gas of all measurements determined as half-hourly average values taken in any 24-hours period.		
Exemptions may be authorized by the competent authority for incineration plants using fluidized bed technology, provided that the permit foresees an emission limit value for carbon monoxide (CO) of not more than 100 mg/m^3 as an hourly average value.		

3.3.3 Biomethanation

Production of biogas under controlled condition is often termed as biomethanation, also known as Anaerobic Digestion (AD)

Biomethanation is the anaerobic digestion of biodegradable organic waste in an enclosed space under controlled conditions of temperature, moisture, pH, etc. It is a human engineered decomposing system wherein - depending on the waste characteristics - the waste mass undergoes decomposition thereby generating biogas comprising mainly of methane and carbon dioxide. Biomethanation could be considered as one of the most technically viable options for the Indian municipal solid waste due to the presence of high organic and moisture content.

3.3.3.1 Merits Of Biomethanation Process

- Energy generation
- Reduction in land requirement for MSW disposal
- Reduction of environmental impacts from landfilling by avoiding contamination of land and water sources from leachate
- Biomethanation of biodegradable organic material would ultimately result in stabilized sludge which can be used as a soil conditioner.

3.3.3.2 Applicability Of Biomethanation

Following are the necessary key criteria for successful biomethanation of MSW:

- Biomethanation plants require a consistent source of degradable organic matter mostly free from inert material.
- There has to be a sustainable demand for the generated biogas in the vicinity of the plant at appropriate economic conditions.

There should be a market potential for the manure produced during the process. Biomethanation is desirable when wet organic waste is available – e.g. cooked food. Odour problems are also solved by adopting biomethanation. If the proposed waste processing site is in close proximity to residential areas, biomethanation is a preferred treatment option, especially considering odour issues. Slaughter house waste is eminently suitable for biomethanation.

- Decentralized systems: 1-5 TPD
- The biomethanation technology for large scale systems is flexible and can be designed for different substrates, sizes and climatic conditions.
- The adopted business model defines the success of implementation of the technology. Proper maintenance is a critical factor for ensuring the success of the plant – implementation of a well-defined Standard Operating Procedure (SOP) is required for ensuring optimum plant performance.

3.3.3.3 General Process Involved In Biomethanation

Generally the overall process can be divided into four stages:

- Pre-treatment
- Waste digestion
- Gas recovery and usage
- Residue treatment

MSW feed to the digester should be segregated to remove inorganic material and avoid contamination. Shredding of segregated waste ensures homogenized feed

Pre-treatment: Most digestion systems require pre-treatment of waste to obtain homogeneous feedstock. The pre-processing involves separation of non-digestible materials either through segregation at source (e.g. 2-bin system; see section 2.2 of Part II of this manual) or through mechanical sorting; the former leads to less contaminated sludge compost. This segregation ensures the removal of undesirable or recyclable materials such as glass, metals, stones etc. The waste is shredded before it is fed into the digester.

Biomethanation provides an example of an efficient technology where residue from waste treatment is also used e.g. bio-solids used as compost

Waste Digestion: Inside the digester, the feed is diluted to achieve desired solids content and remains in the digester for a designated retention time. For dilution, a varying range of water sources can be used such as clean water, sewage sludge, or re-circulated liquid from the digester effluent. A heat exchanger is usually required to maintain temperature in the digesting vessel.

Gas Recovery: The biogas obtained is scrubbed to ensure pipeline quality gas. Biogas may also be further used for generating electricity.

Residue Treatment: In case of residue treatment, the effluent from the digester is dewatered and the liquid recycled for use in the dilution of incoming feed. The bio solids are dewatered to 50-55% Total Solids (TS) with a screw press, filter press or other types of dewatering systems and aerobically cured to obtain a compost product.

3.3.3.4 Important Operating Parameters For Biomethanation

Some of the important operating parameters of the digester should be controlled to enhance the microbial activity and increase the anaerobic degradation efficiency of the system. These parameters include:

- **Temperature**: Temperature affects bacterial growth and hence amount of biogas produced. Treatment of waste in anaerobic reactors is normally carried out within

Important Operating parameters controlling biomethanation
- Temperature
- Ph
- Moisture
- Toxicity
- C/N Ratio
- Organic Loading Rate
- Retention Period

two ranges: around 25-40 °C known as mesophilic range and higher than 45 °C known as thermophilic range.

At higher temperatures:

- the rate of digestion is faster, and thus shorter retention times are required
- smaller reactor volumes are required for treating the same amount of waste
- higher rate and efficiency of particulate matter hydrolysis
- more efficient destruction of pathogens

Organic loading rate for a plant of particular size determines the amount substrate to be added for optimum biogas production

- **pH**: The anaerobic digestion process is limited to a relatively narrow pH interval from approximately 6.0 to 8.5 pH.
- **Moisture:** The moisture content of waste should not be less than 15% as it can prevent decomposition of waste.
- **Toxicity**: A number of compounds are toxic to anaerobic microorganisms. Methanogens are commonly considered to be the most sensitive to toxicity.
- **C/N Ratio**: Optimum C/N ratio in anaerobic digesters isbetween 20–30. A high C/N ratio is an indication of rapid consumption of nitrogen by methanogens and results in lower gas production. On the other hand, a lower C/N ratio causes ammonia accumulation and pH values exceeding 8.5, which is toxic to methanogenic bacteria. Optimum C/N ratios of the digester materials can be achieved by mixing materials of high and low C/N ratios, such as organic solid waste (high in Carbon) and sewage or animal manure (high in Nitrogen).

Anaerobic digestion process can be:
- Single Stage: all three stages of anaerobic process occur in one reactor
- Multi Stage: Acetogenesis and Methanogenesis are separated

- **Organic Loading Rate:** Organic loading rate is the frequency and speed at which the substrate is added to the digester. For each plant of a particular size, there is an optimal rate at which the substrate should be loaded. Beyond this optimal rate, further increases in the feeding rate will not lead to a higher rate of gas production. Agitation or consistent stirring of the contents in the digester also plays an important role in determining the amount of biogas produced.
- **Retention time**: The required retention time for completion of the reactions varies with differing technologies, process temperature, and waste composition. The retention time for wastes treated in a mesophilic digester range from 10 to 40 days. Lower retention times are required in digesters operated in the thermophilc range. A high solids reactor operating in the thermophilic range has a retention time of 14 days.

3.3.3.5 Types Of Anaerobic Digestion (AD) System

AD processes can be categorized on the basis of number of reactors used, into single-stage and multi-stage. In single-stage processes, the three stages of the anaerobic process occur in one reactor and are separated in time. Single stage low solids processes are attractive because of their simplicity. The predominantly used reactor is the continuously stirred tank reactor (CSTR), where the digestate is continuously stirred and completely mixed. Feed is introduced in the reactor at a rate proportional to the rate of effluent removed. Generally the retention time is 14-28 days depending on the kind of feed and operating temperature.

Scum formed at the top and layer of heavier fractions at the bottom should be removed on a routine basis which might lead to reduced biogas yield

One of the technical issues with the digester is formation of a layer of heavier fractions at the bottom of the reactor and floating scum at the top, which indicate non-homogeneity in the reacting mass. This requires periodic removal of the floating scum and of the heavy fractions, thus incurring lower biogas yield. Another flaw is the short circuiting, i.e. fraction of the feed passes through the reactor at a shorter retention time than the average retention of the total feed which lowers biogas yield.

The Nisarguna Technology developed by the Babha Atomic Research Centre (BARC)

The organic solid waste, mainly kitchen waste, obtained through proper segregation is ideal feed stock for biomethanation plants. The waste slurry undergoes both anaerobic and aerobic degradation and release methane gas in the process, while the undigested material settles down and can be used as manure since it Is rich in plant nutrients. It must be noted that this technology is suitable both at the community level and at the ward level. Government establishments, housing colonies, big hotels etc. can set up such plants and process their kitchen wastes in the an environment friendly manner.

The success of the Nisargruna technology depends mainly on the proper segregation of the kitchen waste. This technology, while being low cost, has several other advantages which are inherently built into its processes. It would generate employment as well, and isself-sustainable as it generates fertilizers and biogas as outputs. Though its initial cost maybe relatively higher than conventional gobar gas plants, the BARC model is more reliable andenduring due to modifications made in its design to prevent choking. It is also more versatile in its capacity to tolerate varied biodegradable feed stock.

Examples of single stage anaerobic digester include: DRANCO (thermophilic), Kompogas and Valorga (mesophilic)

Some of the examples of patented single stage systems are DRANCO, Kompogas and Valorga processes.

The DRANCO (Dry Anaerobic Composting) process is a dry thermophilic process for treatment of the organic fraction of MSW. This process requires high total solids content in the reactor in order to have optimal performance. After the waste is pre-treated and screened it is mixed with recirculating material from the reactor. Three quarters of the reactor content is recycled. Mixing of the waste with this large amount of digested material ensures inoculation of the incoming material. The reactor is a downward plug-flow type reactor where no significant mixing takes place.

The Valorga process is a mesophilic process where the pre-treated waste is mixed with recycled process water. After mixing with process water, the influent is pumped into the reactor. The reactor is fully mixed reactor type where mixing takes place by pneumatic stirring i.e. the produced biogas is compressed and sent through the contents of the reactor.

The Kompogas process works similar as Valorga, except the movement takes place in plug flow in a horizontally disposed cylindrical reactor. Mixing is accomplished by the use of an agitator.

The multi-stage processes make use of two or more reactors that separate acetogenesis and methanogenesis stages in space, thus providing flexibility to optimize each of these reactions.

Batch reactors are not very efficient and hence not popular for treatment of organic fraction of MSW. Upflow Anaerobic Sludge Blanket (UASB) and Upflow Anaerobic Filter Process (UAFP) are typically used for treatment of high strength industrial/municipal waste waters.

CASE STUDY

"Adoption of The Nisarguna Biogas Technology- an Approach towards Decentralized Waste Management operated by Waste Pickers"

Location: Mumbai

Year of start: 1998

Main Players: Municipal Corporation of Greater Mumbai (MCGM), Stree Mukti Sanghatana, Bhabha Atomic Research Centre, Waste pickers cooperatives , Institutions, Navi Mumbai Municipal Corporation (NMMC)

Approach: Mumbai, the capital city of Maharashtra has witnessed rapid urbanization, economic growth and rising standards of living which has led to an increase in the quantity of waste generated. This increase in waste generation, coupled with inefficient and inadequate solid waste management and disposal systems, results in significant environmental impacts. The problems are multi-fold and cover issues that relate to the socio-political, economic and environmental sustainability. Several initiatives have been taken to address these issues like adoption of technology, new management approaches, imposition of regulation etc. However all these initiatives remained largely unsatisfactory. In order to address ever-increasing problems related to waste management, the Advanced Locality Management (ALM) Scheme was started in 1997 by Municipal Corporation of Greater Mumbai (MCGM) with the main objective of mobilizing citizens in a participatory approach for setting up a MSWM system in an environmental friendly manner. Local NGOs along with the MCGM have taken up new initiatives through the ALM Scheme to improve on existing practices, striking the appropriate partnership between, MCGM and NGO-Stree Mukti Sangathana (SMS).

Stree Mukti Sanghtana (SMS) is a woman's liberation organization established in 1975. SMS has directed its efforts towards the upliftment of women, primarily by creating awareness in the society about women's issues with the help of songs and Theatre,, starting family counselling centres, day care centers (crèche), adolescent sensitisation program, publication of books etc.. It was seen that 85% of the waste pickers population comprised of women. For upliftment of this sector the Parisar Vikas Programme (PVP) was one of the initiatives started by the Stree Mukti Sanghatana (SMS) in 1998. SMS has imparted training on segregation, handling of waste, composting and maintaining -operationalizing the bio gas plant through interactive sessions with the women waste-pickers, who are commonly addressed as "Parisar Bhaginis" (Neighbourhood Sisters).

Institutional approach:

- SMS facilitated the formation of a federation of self-help groups and cooperatives of several women waste pickers and supported them in formalizing contracts with the municipality, individual apartments, institutions and with public and private sector companies.
- Waste pickers were trained on the principles of zero waste, segregation, pre-sorting, waste handling from multi-family dwellings and in operating composting and biogas plants.

- Teams of waste pickers were formed for the collection and segregation of waste and for opearting the biogas units.
- Institutionalization and adoption of an innovative, locally viable technology for generation of biogas at 8 sites. Each site is managed by 1 supervisor, assited by a team of 4 parisa bhaginis. Workers were trained in the operation and maintenance of biogas plants which were based on the Nisarguna technology
- Development of a new training centre focussing on biogas generation from MSW, composting and rainwater harvesting at Kopar khairane, Navi Mumbai. A garbage gallery was also set up at this location.
- Development of a new training manual for composting and biogas plant maintenance.

Technological approach:

- Using the Nisarguna technology developed by BARC to generate biogas and manure. The technology has basically three stages of operation:
- Mixing stage- proper segregation of the waste before entering the plant as some material may detrimentally affect the efficiency of the plant. On-site sorting is a pre-requisite for the process. Waste is mixed with an equal amount of hot water to breakdown fibres converting it into a homogeneous slurry.
- Pre-treatment stage- slurry is kept in an aerobic digester converting it into organic acids (acetic acid, butyric acid).
- Anaerobic digestion stage-acidic slurry is transferred to the anaerobic tank, to generate methane. Prior digestion helps in improving the purity of methane gas upto 85%.
- Slurry is then sent to filter beds to recover high quality manure. Water is recycled in the plant again resulting in zero effluent system.
- Plant is simple to operate and is designed to be used by non- skilled workers.
- Providing training for operation and maintenance on site to the workers/ bhaginis.

Outcome:

- O&M training is give on-site to workers/bhaginis. 300 groups, with 10 Parisar

Bhaginis each, have been established. 200 groups are part of micro-credit enterprise. A federation of these groups has been registered as an independent organisation called 'Parisar Bhagini Vikas Sangha (PBVS) along with 6 working cooperatives.

- 100% segregation of waste at the plant to produce biogas.
- Improved recycling efficiency through market exploration and tie ups with recycling units by SMS.
- Income/ revenue generation from the sale of recyclables(Rs.100-150 per day) apart from the service fee for collecting, sorting and managing biogas plant.
- Less space required by the technology; only 50 m^2 required for a plant processing 100 kg per day.
- Utilization of the end product as cooking gas fuel for both domestic and/or industrial purpose.

Success factors:

- Strategic partnership between SMS, BARC, MCGCM, waste pickers cooperative and residents to take forward the decentralized waste management system
- On behalf of cooperatives SMS negotiates, markets, authorizes and manages contracts with the apartments and institutions.
- The approach is modular and adaptable to the demands of customer and has simple components.

Overall sustainability:

The overall model comprises of collection, segregation and on-site processing. The adopted technology is modular and replicable. The system is well- suited to the needs of the customer. This easily implementable and integrated decentralized system has allowed Parisar Vikas to bid for a variety of contracts. The model is a self- sustaining model and has successfully demonstrated the viability of decentralized waste management as income is generated from the sale of recyclables and at many sites a service fee for collection and managing the biogas plants is charged. The initiative has helped to mainstream the marginalized population of waste pickers giving them a recognized role in the formal waste management system.

3.4 Refuse Derived Fuel

3.4.1 What Is Refuse Derived Fuel

Refuse Derived Fuel (RDF) refers to the high calorific, non-recyclable fraction of processed municipal solid waste which is used as a fuel for either steam/ electricity generation or as alternate fuel in industrial furnaces/boilers (co-processing/co-incineration of waste in cement and steel industry and for power generation). The composition of RDF is a mixture that has higher concentrations of combustible materials than those present in the parent mixed MSW.

3.4.2 Legal Framework For RDF Production & Utilization[35]

Currently, the MSW Management & Handling Rules 2000 is the only available legal guidance for MSW incineration. There are no binding legal definitions which specify the composition of RDF, conditions of use or environmental monitoring requirements for RDF incineration[36]

The current legal situation can be summarized as follows:

- RDF projects work within the framework of MSW Rules 2000.
- RDF based power projects come under the purview of the Electricity Act 2003.
- RDF facilities are also governed by the Environment Protection Act. These facilities also have to obtain the Consent for Establishment and Consent for Operation licenses from the State Pollution Control Boards.
- Emission standards are specified by the State Pollution Control Board in accordance with the National Ambient Air Quality Standards 2009.
- All industrial units utilizing RDF as fuel also have to adhere to applicable laws, which are Air, Water and Environment Protection Acts. Stack emissions have to be monitored once in a year and submitted to the State Pollution Control Board[37].

[35] GIZ, Status Paper on Utilization of Refuse Derived Fuel (RDF) in India
[36] As on date of the publication of this manual
[37] As per guidance in MSW Management & Handling Rules, 2000

- Cement kilns using RDF also come under the purview of all the above acts.

In Europe, there is a separate directive for RDF. The Annex IIB of EU Directive 75/442/EEC as amended, defines RDF as "waste which is used principally as a fuel or other means to generate energy". This directive specifies the norms and standards for production, utilization and monitoring mechanisms to regulate RDF.

3.4.3 RDF In ISWM Framework

Integrated Solid Waste Management (ISWM) based on the 3R approach (reduce, reuse, and recycle) (see Chapter 1 of Part II) is aimed at optimizing the management of solid waste as explained in section 1.1 of Part II of this manual. While according to the 'ISWM Hierarchy' (see figure 3.26) source reduction, reuse and recycling are the most sustainable solid waste management options, recovery of energy from MSW is the next desirable waste management strategy.

Production & combustion of RDF for energy recovery is not only an economically viable option for MSW management, but also greatly reduces the requirement for landfill space. The techno-economic feasibility of producing high calorific value RDF from mixed MSW has to be seen in the context of the framework conditions of a particular ULB. Refer to Part II of this manual, for further guidance on selection of appropriate technologies.

RDF typically consists of high calorific fractions of MSW like paper, textile, jute etc.

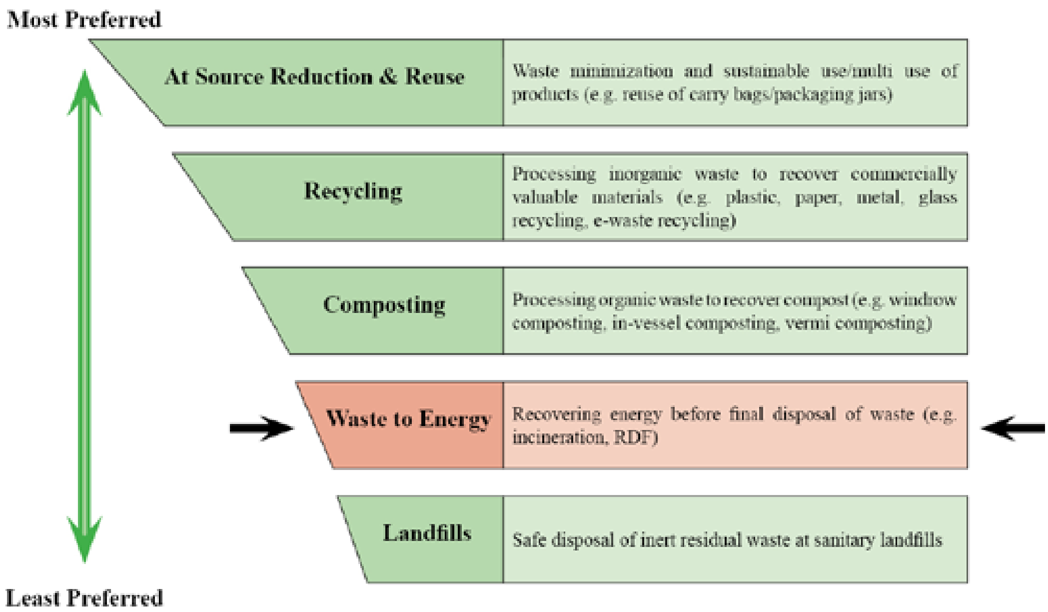


Figure 3.26: RDF in ISWM Hierarchy

RDF quantity and composition is determined by the nature of the waste and extent of material recovery/ recycling processes implemented by the city

3.4.4 General Composition Of RDF In India

RDF typically consists of dry fraction of MSW including paper, textile, rags, leather, rubber, non-recyclable plastic, jute, multi-layer packaging, and other compound packaging, cellophane, thermocol, melamine, coconut shells and other high calorific fractions of MSW. However from the ISWM hierarchy perspective, the city should give priority to separately recycle relevant components (e.g., paper, plastics, jute, metal, glass, multi-layer packaging used for liquid food items etc.). The composition and resultant energy content of RDF varies according to the origin of waste material and the sorting/separation/processing processes being adopted in the processing facility.

Typical desired ranges of these parameters observed in various studies are indicated in table 3.13. Values given herein are specific to the considered waste mix and are only indicative in nature. Required quality of RDF is determined by the end use of the fuel.

Table 3.13: Indicative Net Calorific Value of RDF vs. Coal

Indian Coal	**3345 - 4700 kcal[38]**
Mixed plastic	6000 kcal
Segregated MSW ((plastic, cloth, jute, paper, multi layered polythene, multi-layer packaging, cylofoam, thermocol, melamine, coconut shells)	1800 – 2000 kcal

The suitability of RDF for use as a fuel is dependent on certain critical parameters of the constituent waste.

- calorific value,
- water content,
- ash content,
- sulphur, and
- chlorine content.

The quality of RDF depends upon the characteristics of incoming waste feed. Segregation of waste into combustibles and non-combustibles is a pre-requisite

The required specific composition and characteristics of RDF for co-processing will be determined by the kind of furnace, temperatures achieved in the furnace and the associated flue gas management systems.

[38] Attempts to do so are underway, however not proven yet in India as on date of publication of this manual

3.4.5 RDF Potential from MSW

RDF quantity and composition is determined by the nature of the waste and extent of material recovery/recycling processes implemented by the city. The quantity of RDF that can be produced per tonne of MSW varies depending on the type of collection, pre-processing and composition of waste source.

3.4.6 Utilization Of Refuse Derived Fuel

RDF may be utilized in the following manner:

- co-processing in cement kilns;
- co-combustion in coal fired power plants[38];
- on-site/off site in an appropriately designed waste incinerator for thermal recovery or power generation

3.4.7 RDF Production Process

The RDF production line (see figure 3.27) consists of several unit operations in series in order to separate unwanted components and condition the combustible matter to obtain waste with required RDF characteristics. In general, segregation and processing may comprise:

- Sorting or mechanical separation (In case of effectively source segregated feed material, this process may not be required)
- Size reduction (shredding, chipping and milling)
- Drying (where required)
- Separation
- Screening
- Air density separation (for removing fine inert material)
- Blending
- Packaging and
- Storage

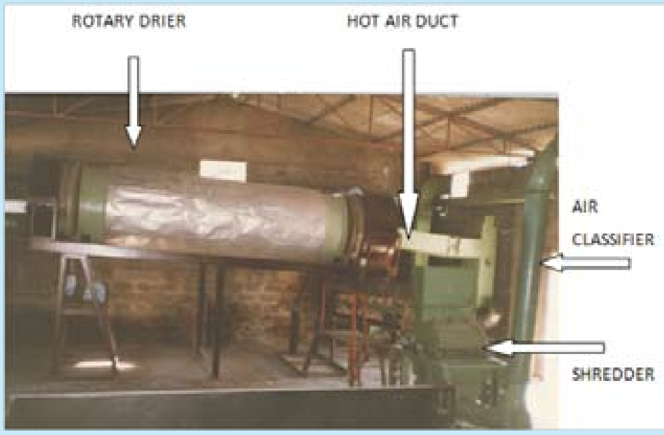
[38] Attempts to do so are underway, however not proven yet in India as on date of publication of this manual

Historical Evolution of RDF Pilot Plants

Bangalore, 1998

Pelletisation: In the early days of RDF production pelletisation of RDF was favoured. The current trend is to use RDF fluff (shredded un-consolidated RDF).

RDF Pellets: Light combustibles were ground to 10-15mm particle size. The binder and/or additives were mixed with ground garbage in a mixer/conditioner before pelletising. The pellets coming out of the pelletiser were cooled and stored in the pellet storage yard for dispatch.



The types and configurations of unit operations selected depend on the types of secondary materials that will be recovered and on the desired quality of the recovered fuel fraction. The end use of the RDF determines the necessary characteristics of RDF (size, moisture, ash content, calorific value, chloride, heavy metals etc.).

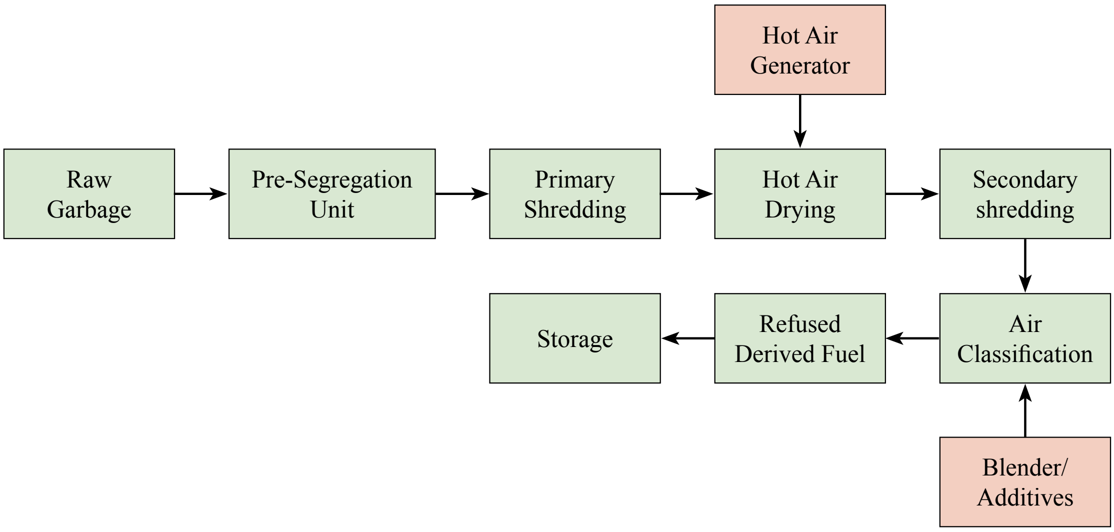


Figure 3.27: RDF Production Line (Pelletization)[39]

3.4.8 Potential Use Of RDF In Industry

The relative uniformity of properties and higher quality of RDF as compared to mixed MSW has led in the past to a preference for RDF in some applications. Co-processing of RDF in cement/steel/power plants is a preferred option. RDF can also serve as a feedstock for different thermal systems, e.g. MSW incineration, pyrolysis and gasification. In keeping with the present state og technology, RDF is fired in the moving grate furnace or in an appropriate boiler equipped with a grate system.

3.4.8.1 Co-Processing In Cement Kilns

Refuse Derived Fuel (RDF) can be used in cement plants as a substitute for fossil fuels. Depending on the characteristics of the RDF and the plant design, this RDF can be fed into the kiln or the pre-calciner. It needs to be noted that certain constituents of the RDF, such as chlorine, need to be controlled in order to avoid adverse impacts on the production processes and end product quality.

The suitability of RDF for use in a cement kiln as a fuel is contingent upon the material having the appropriate consistency, heat value and composition as per the requirements of the specific cement plant.

[39] Information collected by ICLEI SA

Long residence time, high temperature and turbulence in cement kilns ensures minimal production of dioxins and furans

3.4.8.1.1 Technical Specification Of Boilers

Boiler design dictates the final shape and size of RDF. Most boilers designed to burn RDF use spreader stokers and fire fluff RDF in a semi-suspension mode.

It is proven that RDF Co-processing in cement kilns has several advantages. The cement kiln process has wide ranging temperature zones with different residence times which provide opportunities to fine tune waste management systems appropriately. Different wastes can be co-processed at different points within the kiln system depending on their physical and chemical characteristics. The temperature in the cement kiln process varies from about 850°C to 1800°C. Excess level of Oxygen and counter flow operation with flue gases moving in a direction opposite to the materials lends a high degree of turbulence to the process. The presence of an alkaline reducing environment (lime) and the pre-heating of the raw materials by a pre-heater tower (>100 m tall) acts as an ideal scrubber for hot flue gases before they are emitted into the atmosphere. The long residence time, temperature and turbulence in cement kilns provides an extremely high destruction removal efficiency (DRE) for all waste types (>99.9999%). Co-processing leaves no residue as the incombustible, inorganic content of the waste materials are incorporated in the clinker matrix.

Siting of RDF plant plays an important role in ensuring viability of RDF usage in cement plants. Ideally, distance between RDF and cement plants should be within 200 km radius

Desirable RDF Characteristics for Co-processing in Cement Kilns[40]

- Moisture, preferably < 25%
- Size, 2D < 70 mm, 3D < 35 mm subject to process limitation of specific cement plant
- Chlorine, preferably < 0.7% however depends on particular raw mix & fuel mix
- Calorific Value, preferably > 2,800 kcal/kg
- Sulphur, < 2% however depends on particular raw mix & fuel mix
- Free of restricted items(PVC, Explosives, Batteries, Aerosol containers, Bio medical waste)

Advantages of Co-processing RDF in Cement Kilns

- High kiln temperature (1800oC at main burner and 1000oC at pre-calciner), which ensures destruction of organic pollutants.

[40] Cement Manufacturer, India

- Long residence time (5-6 sec. at 1800oC and 2-6 sec. at > 800oC) yields complete combustion
- Self-cleaning process of acid gas by lime
- Ash is incorporated into the clinker matrix

Limitations of Co-processing RDF in Cement Kilns

- More often than not, cement industry enterprises are reluctant to use RDF because of lack of established practice and requirements of retro-fitting of the existing feeder mechanisms to make them amenable to using RDF as fuel.
- Non-availability of regular supply of adequate quantity and quality of RDF
- Economics of producing and marketing RDF are largely contingent upon the distance to which the finished RDF needs to be hauled by the ULB. It has been found that economic viability of the RDF system can be ensured by supplying appropriate quality of RDF to cement plants within a 200 km radius from the RDF production plant.

In order to overcome some of these shortcomings, the RDF processing facility may produce crude RDF. This RDF from multiple locations can be transported to the cement plant by either party. Further refinement of the RDF may be accomplished at the cement plant, through installation of secondary shredders, hot air generators and ADS, based on specific requirements.

Benefits of RDF Based Plants Vs. Mass Burn Plants

- Pres-sorting and segregation of MSW ensures that RDF comprises of only desired waste fractions resulting in a homogeneous product. Hence, RDF is a buffer against fluctuating quality of incoming waste.
- All boilers (incinerators), including those using RDF as fuel, require an annual shut down for 4-6 weeks for mandatory maintenance. During such times the produced RDF may be sent for co-processing in cement plants/power plants. However in mass burn plants, during periods of shut down, the mixed waste will need to be diverted.

Co-processing of segregated plastic waste- An initiative of Jabalpur Municipal Corporation and ACC-Holcim

Location: Jabalpur, ACC-Kymore Cement Works.

Main Players: Jabalpur Municipal Corporation, ACC-Kymore Cement Works, Central Pollution Control Board, Madhya Pradesh Pollution Control Board, Rag pickers

Year of start: 2008

Approach: A Committee was constituted by Delhi High Court under the Chairmanship of Justice R. C. Chopra to study the issue of environmental hazards including health hazards arising out of the use of plastic bags and its waste generation. One of the recommendations submitted by the Committee was that plastic waste could be used as an additional fuel in the cement kilns. The matter was further discussed in the 54th Conference of Member Secretaries and Chairman of SPCBs.

These discussions in the apex conference prompted Madhya Pradesh Pollution Control Board to identify rotary cement kilns for co-processing of non-recyclable plastic waste and tie- up with Municipal Corporations. Kymore Cement Works of ACC Limited[41] pioneered the initiative and the trial of co-processing the segregated plastic waste was conducted successfully. The approach that was adopted is detailed below:

1. Planning and formulation of the strategy for the disposal of plastic waste by identification of different stakeholders and linkages in the process
2. Assessment of plastic waste generation in the Municipal Corporation. .
3. Coordination with cement industries by MPPCB for conducting trial runs for co-processing of plastic waste.
4. Establishment of the system managed solely by ragpickers, sub-vendors and kabadi walas.
5. Ensuring the transportation of plastic waste to the cement plant.
6. Development of an appropriate storage and handling facility at ACC Kymore.
7. Regular skill development and awareness programmes for the ragpickers.

41 ACC Limited is 77 year old cement company in India. It is now a group company of Holcim, Switzerland. Holcim is a large global cement company which is a pioneering cement company providing cement kiln co-processing solutions globally for management of wastes.

Outcome

1. Out of 340 tons of MSW generated in Jabalpur Municipal limits, plastic and other combustible fractions constitute 5% of waste (approximately 15-20 tons of waste per day), which is sent to the cement plant
2. Introduction of door to door waste collection service from households by JMC in 6-7 colonies as a pilot service wherein ragpickers collect the waste.
3. Self-help groups of over 200 ragpickers were formed for collection and segregation of waste
4. Jabalpur Municipal Corporation initiated a process of issuing identification numbers followed by issuing identification cards to the waste collectors/ ragpickers in order to formally integrate them within the system
5. Segregation and transportation of all non- recyclable fractions of plastic waste to cement plants like double coated plastic, torn paper, jute, tetrapak, thermocol, cylofoam, waste tyres etc.
6. Till 2013 ACC-Kymore Cement Works has successfully co-processed 1622 T of segregated waste from MSW and the initiative is being replicated in other locations as well.

Success Factor

1. Proactive role of Central Pollution Control Board, Madhya Pradesh Pollution Control Board and Jabalpur Municipal Corporation
2. Regular capacity building of workers
3. Readiness of the cement plants to modify the equipment accordingly to the feedstock in order to co-process the municipal solid waste including plastic waste within the premises.

Overall sustainability

To demonstrate the Co-processing methodology, ACC had conducted a trail run of co-processing plastic waste at its Kymore Cement plant, with support from CPCB and MPCB. The results of the trial run demonstrated that there are no negative influences of the plastic waste on stack emissions or on product quality. The presence of high temperature and long residence time in the kiln ensures complete destruction, thus making co-processing in cement kiln a safer and sustainable way of managing segregated plastic waste from MSW. The pilot was replicated in Bhopal, Indore within M.P. and then has gradually spread in many states, where ever the State Pollution Control Board and/ cement industry took an active role in the subject, like Tamil Nadu, Orissa etc.

Considering the importance and benefits of the co-processing technology and based on the experience of various successful trial runs conducted for hazardous and non-hazardous waste, across the country, CPCB formulated the 'Guidelines for Co-processing of Hazardous waste in Cement/ Steel/Power plants'. In these guidelines CPCB has included plastic as a non-hazardous fraction that can be co-processed.

However, co-processing of plastic fraction as a substitute to coal is still in its nascent stage and the business model is yet to be fully developed.

Environmental Standards for emissions from RDF combustion are to be set by the SPCB/CPCB.

3.4.9 Monitoring Requirements For Facilities Utilizing RDF

The MSW (M&H) Rules 2014 is the only legal document describing guidelines for incineration of MSW. They only stipulate standards for flue gas after incineration. Binding documents for definition of permissible input materials or the utilization of RDF do not exist.

For comparison German standards from 17.BImSCHV (Regulation on Reduction of Emissions for Mass Burn) are presented in table 3.14.

RDF from mixed municipal solid waste should be combusted in facilities with an appropriate and full emission control system, designed to meet applicable norms.

Table 3.14: Standards for Air Emissions for Incinerators

Parameters	Units	Average per day		
		EU Directive 2011	German 2013	MSW (M&H) Rules 2014
Particulate Matter	mg/m^3	30	5 (10*)	150
Total Organic Carbon	mg/m^3		10	
CO	mg/m^3		50	
HCL	mg/m^3	10	10	50
HF	mg/m^3	1	1	
SO_2	mg/m^3	50	50	100
NO_x	mg/m^3	500/800	150 (200)*	450
Cd + TI	mg/m^3	0,05	0.05	
Hg	mg/m^3	0.05	0.03	
Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V	mg/m^3	0.5	0.5	
TOC	mg/m^3	10		
Dioxins & Furans	ng/m^3	0.1ng TEQ	0.1ng TEQ	

Parameters	Units	Average per day		
		EU Directive 2011	German 2013	MSW (M&H) Rules 2014
Minimum Temperature			850°	
Retention Time			>2 sec	
Reference value- flue gas oxygen content			11% by volume	
Reference value- flue gas oxygen content for waste pyrolysis/ gasification/waste oil			3% by volume	

*for plants generating <50 MW per day

3.4.10 GHG Mitigation Potential From RDF Utilization

Waste management practices can influence greenhouse gas (GHG) emissions by affecting energy consumption, methane generation, carbon sequestration, and non-energy-related manufacturing emissions.

There are a number of climate related advantages of converting MSW into fuel for power generation. These include reducing the methane emission from landfills that would have been generated from anaerobic degradation of the organic components. The production and subsequent utilization of the RDF as fuel for energy recovery processes is a better option than mass burn. Uncontrolled combustion of materials such as plastic waste increase the atmospheric concentration of GHGs. RDF also reduces the consumption of depleting resources such as fossil fuels.

3.5 Technologies Under Development

Prevalent municipal solid waste treatment and processing technologies are based on long-lasting experiences in many countries. With respect to the applicability of upcoming technologies in India, some of these technologies are being tested with support by the Government of India. The results of these tests should be awaited.

Till these technologies are well established commercially, these should be regarded as experimental technologies and should be handled either as an R&D project or through specially designed concession agreements. Five years' successful commercial operation of new technologies may be regarded as a safe bet.

Recent technologies that are presently at their nascent stage:

- Pyrolysis
- Plasma Pyrolysis Vitrification
- Gasification
- Bioreactor Landfill

Caution on Adopting Alternative Technologies for MSW Processing

- Established technologies for defined and clean substances don't work automatically for heterogeneous wastes.
- Alternative technologies have to demonstrate:
  - Compliance with stringent emission standards
  - Reliable continuous operation
  - Verification of a complete analysis of inputs/outputs
  - Reliable proof of costs (investment, operation, maintenance) and revenues (if any)
- Decisions to rely on alternative technologies need backup by other possibilities to dispose off the wastes – in case of the new technology system will fail.
- If an immediate solution for managing MSW is needed urgently – proven technologies are recommended.

This chapter details out a few selected technologies, namely pyrolysis, gasification and bioreactor landfills.

3.5.1 Pyrolysis

Pyrolysis involves an irreversible chemical change brought about by the action of heat in an atmosphere devoid of oxygen. Synonymous terms are thermal decomposition, destructive distillation and carbonisation. Pyrolysis, unlike incineration is an endothermic reaction and heat must be applied to the waste to distil volatile components. Process of converting plastic to fuels through pyrolysis is possible, but yet to be proven to be a commercially viable venture.

Pyrolysis is carried out at temperature between 500 and 1000°C and produces three component streams.

i) **Gas:** A mixture of combustible gases such as hydrogen, carbon monoxide, methane, carbon dioxide and some hydrocarbons.

ii) **Liquid:** Consisting of tar, pitch, light oil and low boiling organic chemicals like acetic acid, acetone, methanol, etc.

iii) Char: Consisting of elemental carbon along with the inert materials in the waste feed.

The char, liquids and gas are useful because of their high calorific value. Part of the heat obtained by combustion of either char or gas is often used as process heat for the endothermic pyrolysis reaction. It has been observed that even after supplying the heat necessary for pyrolysis, certain amount of excess heat still remains which can be commercially exploited.

Though a number of laboratory & pilot investigations have been made, only a few have led to full scale plants.

3.5.1.1 Feed Stock For Pyrolysis

Many plastics, particularly the poly-olefins, which have high calorific values and simple chemical constitutions of primarily carbon and hydrogen, are usually used as a feedstock in pyrolysis process. More recently, pyrolysis plants are being tested to degrade carbon-rich organic materials such as municipal solid waste. Pyrolysis is also used for biomass.

Ideal feedstock for pyrolysis should have high calorific value with very less moisture content and should be homogenous in nature.

Pre-processing of Municipal Solid Waste: Where mixed municipal solid waste is received at the processing site, sorting and pre-treatment of the waste is an essential step to ensure removal of metals, ceramics and other recyclable material. The remaining feed stock is shredded and the moisture content is reduced. Size reduction is also an essential step in pre-treatment, to ensure appropriate size of the feedstock in relation to the feed equipment of the furnace. Maximum efficiency is achieved when the feedstock quality is homogenous.

3.5.1.2 MSW Pyrolysis Process

Sorted and pre-treated feed stock is supplied to pyrolysis reactor, (Rotary kilns, rotary hearth furnaces, and fluidized bed furnaces are commonly used as MSW pyrolysis reactors) where partial combustion of material occurs at temperatures as high as 500-800oC.

Syngas has a net calorific value of 2800-4800 kcal/Nm3 (10-20 MJ/Nm3) and can be further refined and combusted to generate electricity

As a result of combustion of organic matter in an oxygen deficient environment various products such as char (ash), pyrolysis oil and syngas are produced. Production of these by products is dependent on the organic component of MSW, temperature, pressure and time of retention in the reactor. Char (solid residue) is a combination of non-combustible materials and carbon. Figure 3.28 gives an overview of the pyrolysis process.

The syngas is a mixture of gases (combustible constituents include carbon monoxide, hydrogen, methane and a broad range of other volatile organic compounds). Syngas is further refined to remove particulates, hydrocarbons, and soluble matter, and is then combusted to generate electricity. The syngas typically has a net calorific value (NCV) of between 2800-4800 kcal/Nm^3(10 and 20MJ/Nm^3). If required, the condensable fraction can be collected by cooling the syngas, potentially for use as a liquid fuel (oils, waxes and tars).

One key issue for use of syngas in energy recovery is the problem related to tarring. The deposition of tars can cause blockages and other operational challenges and has been associated with plant failures and inefficiencies at a number of pilot and commercial scale facilities. Tarring issues may be overcome by higher temperature secondary processing.

In order to recover the energy content of syn gas, it should be further processed in the following ways:

1) Syngas can be burned in a boiler to generate steam which may be used for power generation or industrial heating.
2) Syngas can be used as a fuel in a dedicated gas engine.
3) Syngas, after reforming, may be suitable for use in a gas turbine
4) Syngas can also be used as a chemical feedstock.

Plasma pyrolysis vitrification is a modified pyrolysis technology which employs application of high voltage to decompose inorganic matter in waste stream

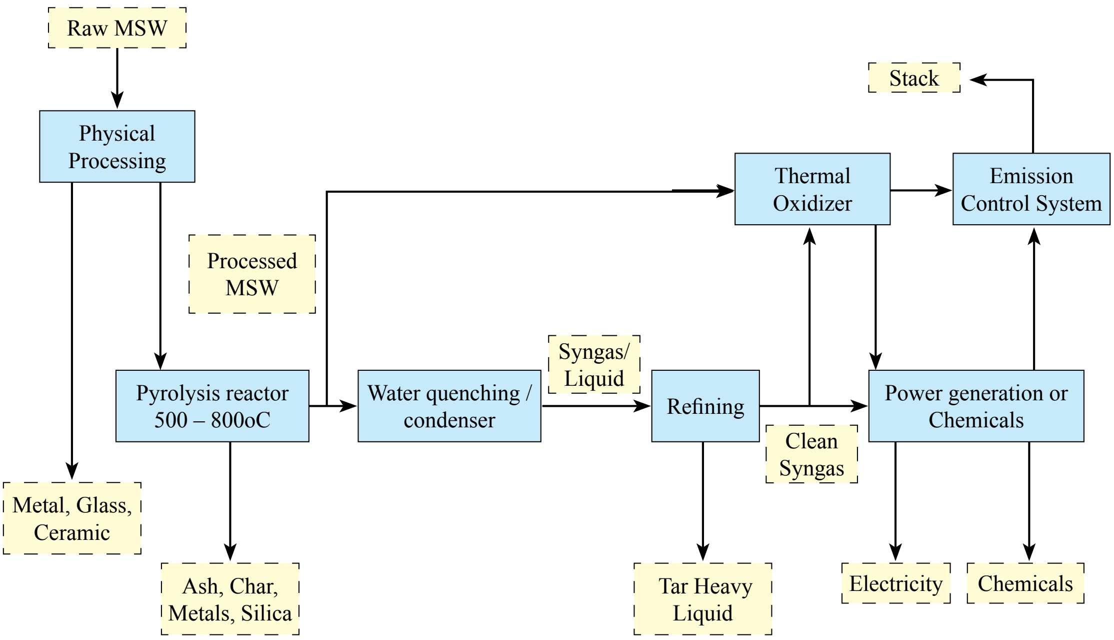


Figure 3.28: MSW Pyrolysis Process

3.5.1.3 Plasma Pyrolysis Vitrification

This is a modified pyrolysis technology aiming at energy/resources recovery from organic wastes. The system uses a Plasma Reactor which generates, by application of high voltage between two electrodes, an extremely high temperature (between 5,000-14,000°C). This hot plasma zone dissociates the molecules in any organic material into the individual elemental atoms while all the inorganic materials are simultaneously melted into a molten lava. This process is still far from any proven practical and sustainable application in MSWM.

3.5.2 Gasification

Gasification is a partial combustion of organic or fossil based carbonaceous materials, plastics etc. into carbon monoxide, hydrogen, carbon dioxide and methane. This is achieved at high temperatures (650°C and above), with a controlled amount of air/oxygen and/or steam. The process is largely exothermic but some heat may be required to initialise and sustain the gasification process. The main product is syngas, which contains carbon monoxide, hydrogen and methane. Typically, the gas generated from gasification will have a net calorific value of 4 - 10 MJ/Nm^3.The other main product produced by gasification is a solid residue of non-combustible materials (ash) which contains a relatively low level of carbon.

Gasification is a process of converting carbonaceous material in MSW into CO2 and syngas (CO, H2 and CH4)at high temperatures in the presence of controlled air/oxygen and/or steam

3.5.2.1 Gasification Of Municipal Solid Waste

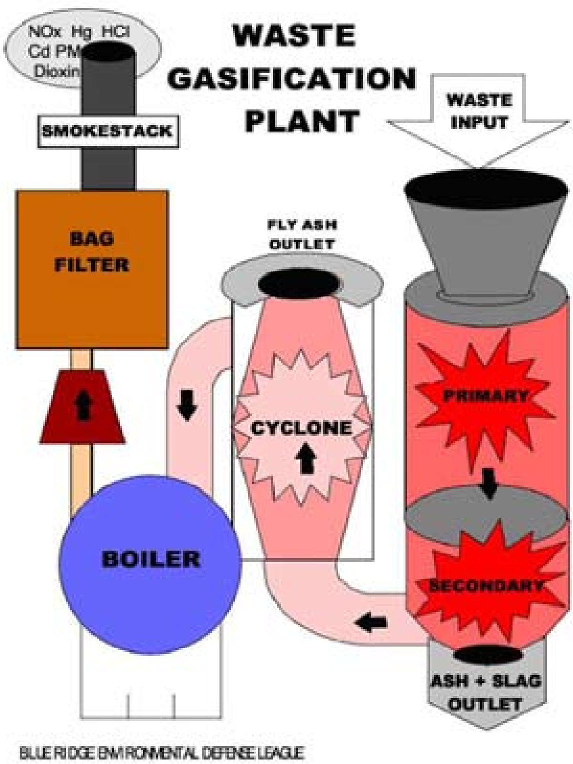
Feedstock Preparation: MSW should be pre-processed before it can be used as feedstock for the gasification process. The pre-processing comprises of manual and mechanical sorting, grinding, blending with other materials, drying and pelletization. The purpose of pre-processing is to produce a feed material with consistent physical characteristics and chemical properties. Carbonaceous material of municipal waste stream is most important feed stock for gasification process.

Gasification takes place in two chambers:
- Primary Chamber: operated below stochiometric air requirement
- Second Chamber: Under excess air conditions

Gasification of MSW in the waste gasification plant as shown in figure 3.29 is accomplished in two chambers: the primary is operated at below the stoichiometric air requirement and the second operated under excess air conditions. The waste is fed into the primary chamber and semi-pyrolysed, releasing moisture and volatile components. The heat is provided by the controlled combustion of fixed carbon within the waste. The syngas that is driven off contains a high calorific value and can act as a feedstock for the secondary chamber. Importantly, combustion air is then added to the syngas making it highly combustible and prone to self-ignition. The secondary chamber is equipped with a conventional burner to maintain operating temperature at all times. The combined gases are combusted in the secondary chamber.

Two main reactors used for gasification are: Fixed bed & Fluidized bed. Technology selection depends upon available fuel quality, capacity and gas quality

Figure 3.29: Waste gasification plant[42]



Fixed bed gasifiers are relatively easier to design and operate and more useful for small and medium scale power and thermal energy uses.

3.5.2.2 Types Of Gasifiers For MSW Treatment

Gasification technology is selected on the basis of available fuel quality, capacity range, and gas quality conditions. The main reactors used for gasification of MSW are fixed beds and fluidized beds. Larger capacity gasifiers are preferable for treatment of MSW because they allow for variable fuel feed, uniform process temperatures due to highly turbulent flow through the bed, good interaction between gases and solids, and high levels of carbon conversion.

Fixed bed gasifiers are of two types:
- Updraft: highly efficient, wet waste with 50% moisture can be gasified
- Downdraft: not preferred for MSW treatment

1) Fixed Beds

Fixed bed gasifiers typically have a grate to support the feed material and maintain a stationary reaction zone. They are relatively easy to design and operate, and are therefore useful for small and medium scale power and thermal energy uses. The two primary types of fixed bed gasifiers are updraft and downdraft.

42 Waste Gasification, 2009

In an updraft gasifier, the fuel is also fed at the top of the gasifier but the airflow is in the upward direction. As the fuel flows downward through the vessel it dries, pyrolyses, gasifies and combusts. The main use of updraft gasifiers has been with direct use of the gas in a closely coupled boiler or furnace. Because the gas leaves this gasifier at relatively low temperatures, the process has a high thermal efficiency and, as a result, wet MSW containing 50% moisture can be gasified without any pre-drying of the waste.

In a downdraft gasifier, air is introduced into a downward flowing packed bed or solid fuel stream and gas is drawn off at the bottom. The air/oxygen and fuel enter the reaction zone from the top, decomposing the combustion gases and burning most of the tars. Downdraft gasifiers are not ideal for waste treatment because they typically require a low ash fuel such as wood, to avoid clogging.

2) Fluidized Beds

Fluidized beds are an attractive proposition for the gasification of MSW. In a fluidized bed boiler, a stream of gas (typically air or steam) is passed upward through a bed of solid fuel and material (such as coarse sand or limestone). The gas acts as the fluidizing medium and also provides the oxidant for combustion and tar cracking. Waste is introduced either on top of the bed through a feed chute or into the bed through an auger. Fluidized-beds have the advantage of extremely good mixing and high heat transfer, resulting in very uniform bed conditions and efficient reactions. Fluidized bed technology is more suitable for generators with capacities greater than 10 MW because it can be used with different fuels, requires relatively compact combustion chambers and allows for good operational control. The two main types of fluidized beds for power generation are bubbling and circulating fluidized beds.

Fluidized bed are preferred for gasification of MSW as it can be used with multiple fuels, offers relatively compact combustion chambers and good operational control

In a Bubbling Fluidized Bed (BFB), the gas velocity must be high enough so that the solid particles, comprising the bed material, are lifted, thus expanding the bed and causing it to bubble like a liquid. A bubbling fluidized bed reactor typically has a cylindrical or rectangular chamber designed so that contact between the gas and solids facilitates drying and size reduction (attrition). As waste is introduced into the bed, most of the organics vaporize pyrolytically and are partially combusted in the bed. Typical desired operating temperatures range from 900° to 1000 °C.

Two types of fluidized bed are:
- Bubbling fluidized bed
- Circulating fluidized bed

A circulating fluidized bed (CFB) is differentiated from a bubbling fluid bed in that there is no distinct separation between the dense solids zone and the dilute solids zone. The capacity to process different feedstock with varying compositions and moisture contents is a major advantage in such systems.

Table 3.15 shows the thermal capacity ranges for typical gasifier designs.

Table 3.15: Thermal Capacity of Different Gasifier Design[42]

Gasifier Design	Fuel Capacity
Down draft	1kW - 1MW
Updraft	1.1 MW – 12 MW
Bubbling Fluidized bed	1 MW – 50 MW
Circulating Fluidized bed	10 MW – 200 MW

3.5.2.3 Emerging Trends in gasification

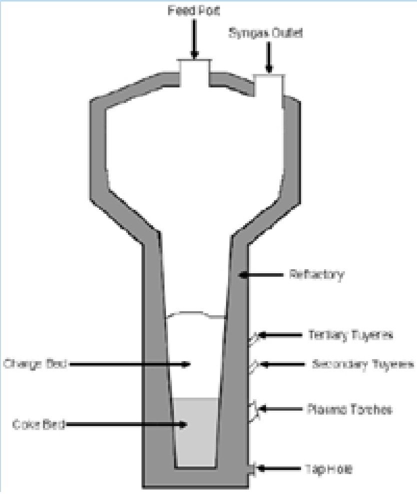
a) Gasification with pure oxygen or hydrogen

Gasification with pure oxygen or pure hydrogen (or hydrogasification) may provide better alternatives to direct air or indirectly heated gasification systems. Pure oxygen could be used to generate higher temperatures, and thus promote thermal catalytic destruction of organics within the fuel gas. Hydrogasification is an attractive proposition because it effectively cracks tars within the primary gasifying vessel. It also promotes the formation of a methane rich gas that can be piped to utilities without any modifications to existing pipelines or gas turbines, and can be reformed into hydrogen or methanol for use with fuel cells.

b) Plasma Gasification

Plasma gasification or plasma discharge uses extremely high temperatures in an oxygen-starved environment to completely decompose input waste material into very simple molecules in a process similar to pyrolysis. The heat source is a plasma discharge torch, a device that produces a very high temperature plasma gas. Plasma gasification has two variants, depending on whether the plasma torch is within the main waste conversion reactor or external to it. It is carried out under oxygen-starved conditions and the main products are vitrified slag, syngas and molten metal. Vitrified slag may be used as an aggregate in construction; the syngas may be used in energy recovery systems or as a chemical feedstock; and the molten metal may have a commercial value depending on quality and market availability.

Technical and Commercial Challenges of Plasma Gasification Technology for Municipal Solid Waste – A Case of the Eco-Valley Facility in Japan



Schematic Plasma Gasification Reactor used in the Eco valley plant

The first waste-to-energy facilities in the world to utilize Plasma Gasification technology on a commercial basis is the Eco-Valley facility in Japan. The facility processes up to 220 tonnes-per day of MSW or up to 165 tonnes per day of a 50/50 mixture of MSW and Auto Shredder Residue (ASR). The Eco-Valley facility faced several operational issues during the initial 7 years, which were resolved in later years. Due to poor commercial performance the plant is now closed. Being a first of its kind facility, Eco-Valley had to overcome several operational challenges during and after commissioning, which impacted its continued operation:

(1) The internal diameter of the bottom of the gasifier was initially too large. Cold spots formed which rendered the gasifier inoperable

(2) The refractory that was initially specified for the gasifier did not achieve an acceptable lifespan.

(3) Fine particulate that is entrained in the syngas that exits the gasifier attacked the refractory in the afterburner and accumulated on the walls of the afterburner.

The plant produces electricity through steam (rankine cycle). The process employed includes:

(1) Waste Pit: MSW and ASR are deposited in the waste pit. An overhead crane grabs waste and drops it into a shredder to reduce the size of the feedstock to 2.5 inches. The shredded material is returned to the waste pit where it is mixed with ASR, which arrives in shredded form.

(2) Gasifier: Waste material is conveyed to the gasifier and enters at the top of the vessel. Organic material in the waste is converted into synthesis gas (i.e. syngas) which consists primarily of CO, H_2, and CH_4 combustible gases as well as CO_2 and N_2 non-combustible gases. The syngas exits at the top of the gasifier. Inorganic materials are melted and exit the gasifier from the bottom of the gasifier as a molten slag, forming vitreous granules as the slag is water quenched.

(3) The syngas travels to the after burner, a refractory lined cylindrical vessel, in which it is immediately combusted.

(4) The hot gas leaves the afterburner and travels to the heat recovery steam boiler where it is cooled to produce steam.

(5) The steam is used to drive a steam turbine generator.

(6) The flue gas exits the heat recovery steam boiler and is cleaned in a bag house system before being vented to the atmosphere.

It is to be noted that such systems are not only very expensive but require a high level of understanding of the nature of the feed stock, may require feed stock other than MSW for commercial viability and require experienced and advanced technical capacity to ensure smooth and continuous operation. As such, this and similar technologies are not yet proven in the Indian context.

c) Thermal Depolymerization

Such processes use high-energy microwaves in a nitrogen atmosphere to decompose waste material. The waste absorbs microwave energy increasing the internal energy of the organic material to a level where chemical decomposition occurs on a molecular level. The nitrogen blanket forms an inert, oxygen free environment to prevent combustion. Temperatures in the chamber range from 150 to 3500°C. At these temperatures, metal, ceramics and glass are not chemically affected.

3.5.2.4 Integrated Gasification With Power Generating Equipment[42]

MSW gasification can be integrated with power turbines, steam cycle and other power generating equipment to provide thermal energy. Combination of MSW gasification with power turbines and fuel cells increases overall efficiency of the system.

1) Integrated Gasification combined cycle (IGCC): Based on the concept of integrating MSW gasification with gas turbines and Steam cycle.

2) Fuel Cell: Integrating MSW gasifier with fuel cells. Tubular Solid oxide fuel cells have been found to be most effective for these applications.

3.5.2.5 Challenges Of Operating Gasification Plants

Gasification takes place in low oxygen environment that limits the emission of pollutants. It also generates fuel gas that can be further used in a number of ways, as suggested in the section on pyrolysis (refer to section 3.5.1).

During gasification, tars, heavy metals, halogens and alkaline compounds are released within the product gas and can cause environmental and operational problems. Tars are high molecular weight organic gases that ruin reforming catalysts, sulphur removal systems, ceramic filters and increase the occurrence of slagging in boilers and on other metal and refractory surfaces. Alkalis can increase agglomeration in fluidized beds that are used in some gasification systems and can also ruin gas turbines during combustion. Heavy metals are toxic and accumulate in the atmosphere if released into the environment. Halogens are corrosive and cause acid rain if emitted to the environment. **The key to achieving cost efficient, clean energy recovery from municipal solid waste gasification will be overcoming problems associated with the release and formation of these contaminants. Focused research activities are needed to accomplish these goals.**

3.5.2.6 Challenges Of Utilising Pyrolysis & Gasification In The Indian Context

- High calorific value waste, which may otherwise be processed in more sustainable processes, is required as feedstock. Organics can be processed to compost in a much more cost effective and environmentally safe process as against using them as feedstock for these processes.
- Pyrolysis and gasification processes require specific feed stock quality, which has a direct impact on the efficiency and commercial viability of the product. Pre-treatment of waste is a must, specific size and consistency of solid waste is to be achieved before MSW can be used as feed.

3.5.3 Bioreactor Landfill

A Bio Reactor Landfill (BRL) is a municipal solid waste landfill that uses enhanced biochemical processes to transform and stabilize the decomposable organic waste within a short period of time of approximately 5 to 10 years as compared to longer time periods of 30 to 100 years taken by conventional landfills, also referred to as “dry-tomb” landfills. The bioreactor landfill significantly increases the extent of organic decomposition,

Bioreactor landfill stabilizes and decomposes organic waste within 5-10 years through enhanced biochemical processes like addition of leachate, sewage sludge and nutrient supplementation

Three types of bioreactor landfills:
- Aerobic bioreactor
- Anaerobic bioreactor and
- Hybrid bioreactor

conversion rates and process effectiveness. Aerobic, anaerobic and semi-aerobic BRLs have been developed.

However, in the Indian context the following issues have to be considered:

- As per the MSW (M&H) Rule, biodegradable material should not be disposed in a landfill; therefore any bio-reactor landfill with such small percentage of organics may not be very efficient.
- While a BRL may be regarded as a huge bio-methanation facility (with the potential for gas recovery due to enhanced degradation of MSW), it does not have the advantage of a bio-methanation facility, in that it is logistically impossible to evacuate it at the end of the design life. Therefore the BRL would remain as a stabilized landfill, albeit in a shorter time frame. Based on the above logic, a BRL does not appear to be a practical solution in the Indian context.

The bioreactor landfill provides control and process optimization, primarily through the addition of leachate or other liquid amendments like sewage sludge, temperature control and nutrient supplementation. The bioreactor landfill operation may also involve addition of air. Based on waste biodegradation mechanisms, different kinds of bioreactor landfills are operated viz., aerobic bioreactor, anaerobic bioreactor and aerobic-anaerobic (hybrid) bioreactors.

Bioreactor landfills have not achieved application beyond research and test plants. Key problems are ambitious operations, challenging technology optimization and high costs. However, the only commercial size (500 TPD) project being attempted currently in India is in Kanjurmarg, Mumbai.

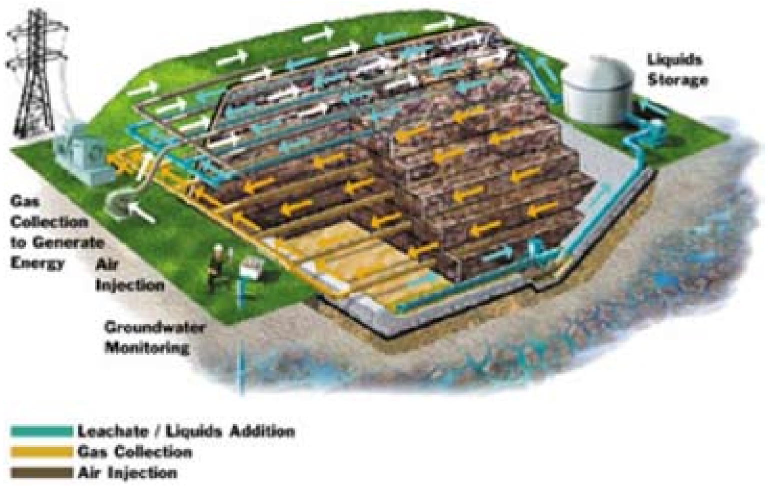
Aerobic Bioreactor: Leachate is re-injected back into waste mass in a controlled manner to optimize oxygen and moisture content

Aerobic bioreactor: An aerobic bioreactor as shown in figure 3.30 collects leachate from the bottom of the waste and is typically stored. From storage, leachate is re-injected back into the waste mass (possible with other liquids) in a controlled manner. The goal is to optimize oxygen and moisture content of the waste. Aerobic biological decay produces carbon dioxide and small components of ammonia.

Anaerobic Bioreactor: Leachate is re-injected back into waste mass to optimize moisture content while biological activity occurs in the absence of oxygen. Methane and carbon dioxide generated is captured

Figure 3.30: Aerobic Bioreactor[43]

Anaerobic Bioreactor: An anaerobic bioreactor, as shown in figure 3.31 collects leachate from the waste for reinjection with additional liquids. The goal is to optimize the moisture content of the waste mass while biological activity occurs in the absence of oxygen (anaerobically). This biological activity produces methane and carbon dioxide that is captured to minimize greenhouse gas emission and for energy recovery.



Hybrid Bioreactor: A sequential aerobic and anaerobic operation takes place to rapidly degrade waste

Figure 3.31: Hybrid Bioreactor[43]

Hybrid/Semi-aerobic/Facultative Bioreactor: A hybrid bioreactor (see figure 3.32) utilizes techniques of both aerobic and anaerobic processes. A sequential aerobic-

43 Bioreactor Landfills: A Viable Technology, Edward W Repa, NSWMA Research Bulletin 03-02, October 2003

anaerobic operation is used to rapidly degrade and stabilize the waste. Leachate is collected from the landfill and recirculated with other liquids back into the waste mass. The injection of air into the waste is sequenced based on internal parameters, primarily waste mass temperature. Methane and carbon dioxide produced are captured to minimize greenhouse gas emissions and for energy projects.

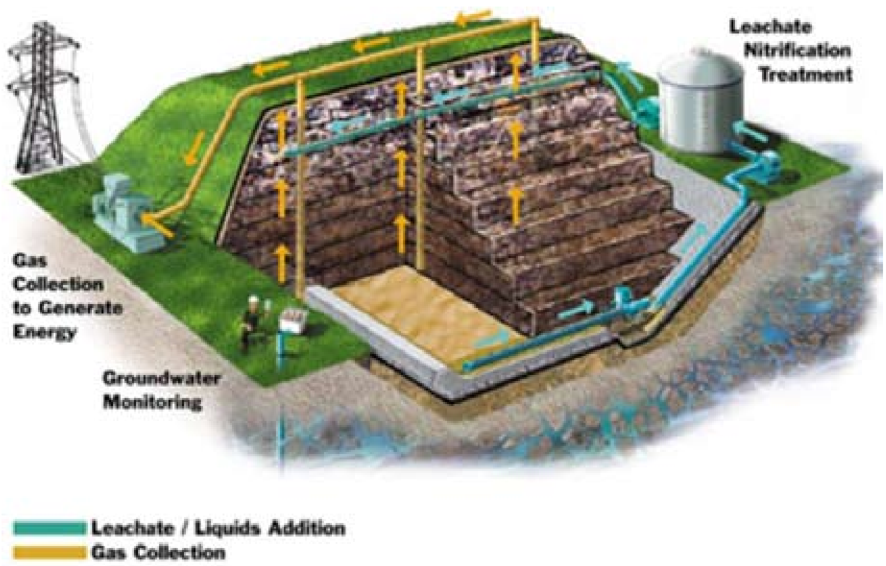


Figure 3.32: Hybrid Bioreactor[43]

Table 3.16: Bioreactor Landfill Configuration

Type	Description	Process
Aerobic	In an aerobic bioreactor, biodegradation occurs in the presence of air which contains oxygen	Air is injected into the waste mass using vertical or horizontal wells to promote aerobic bacteria to accelerate waste decomposition. The degradation of waste occurs under conditions similar to compost operations with the by-products of carbon dioxide and water.
Anaerobic	In an anaerobic bioreactor, biodegradation occurs in the absence of air and oxygen.	In the absence of air, methanogenic bacteria are promoted to accelerate waste degradation. The by-products are methane that can be used as an alternative energy source and Carbon dioxide.
Hybrid (Aerobic-Anaerobic)	In a hybrid bioreactor landfill, the waste is first degraded under aerobic conditions followed by anaerobic conditions.	Aerobic conditions usually occur in the newly placed waste in the upper sections of the landfill, while anaerobic conditions occur in the lower sections. Because anaerobic conditions exist in the older sections of the landfill, methane production still occurs.

3.5.3.1 Essential Components Of Bioreactor Landfill

- A liner system at the base and sides of the Sanitary Landfill which prevents migration of leachate or gas to the surrounding soil.
- A leachate recirculation system
- A higher efficiency gas collection and control facility (optional for small Sanitary Landfills) which can capture larger amount of gas within a shorter time frame
- A high efficiency capping system at the top of the bioreactor which helps in surface drainage, prevents infiltrating water and supports surface vegetation.
- A possible system for storing and pumping leachate up
- An environmental monitoring system which periodically collects and analyses air, surface water, soil-gas and ground water samples around the Sanitary Landfill site.
- A closure and post-closure plan which lists the steps that must be taken to close and secure a Sanitary Landfill site once the filling operation has been completed and the activities for long-term monitoring, operation and maintenance of the completed Sanitary Landfill

Refer to figure 3.33 for a cross-sectional view of a bioreactor landfill cell

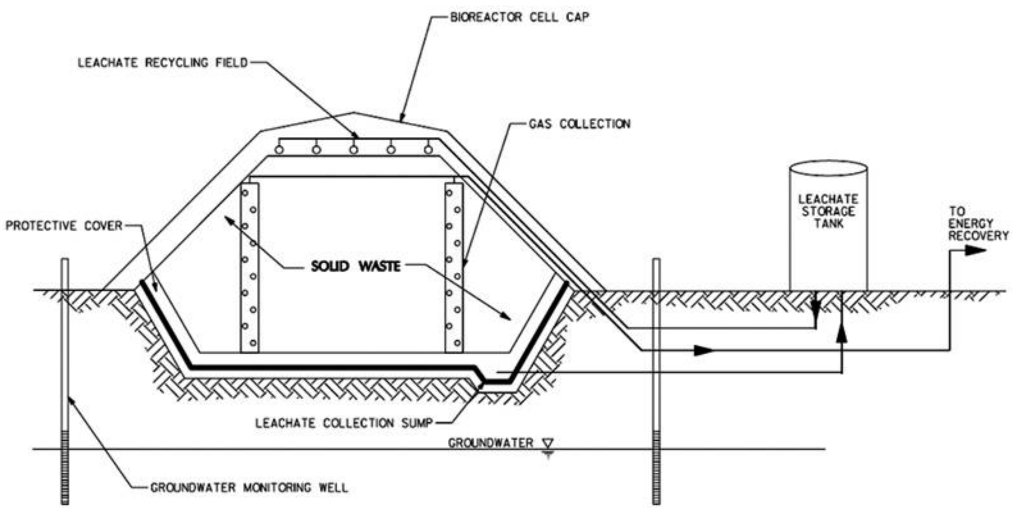


Figure 3.33: Cross Section of a Bioreactor Landfill Cell[44]

[44] Updated Research Report on Bioreactor Landfills, Landfill Leachate Recirculation andLandfills with Methane Recovery, Forth & Van Dyke & Associates Inc. for Ramsey/Washington County Resource Recovery Project, 2004

3.5.3.2 IMPLEMENTATION AND OPERATION OF BIOREACTOR LANDFILL:

The designing, operation and maintenance of bioreactor landfill are discussed in brief below:

1) Site Selection
2) Design of Bioreactor Landfill
3) Operation
4) Closure and post closure

3.5.3.3 SITE SELECTION

Many factors must be considered when evaluating a site for potential development into a bioreactor landfill. Some of these factors include public opinion, health, and safety, local geology, hauling distance, sufficient drainage, zoning, and land use requirements and economics. With these factors in mind, a site is selected based on its ability to:

- Conform with the local Solid Waste Management Plan;
- Conform with land use planning;
- Address community stakeholder concerns;
- Be accessible to haulage vehicles in all weather conditions;
- Provide adequate safeguards against potential surface and groundwater contamination;
- Provide adequate setback and buffer areas;
- Obtain large amounts of suitable soil for use as cover (daily, intermediate and final) material;
- Provide protection so that environmentally sensitive areas are not impacted during the landfill's operations;
- Be economically viable for the community it serves based on long-term solid waste generation projections; and
- Provide a potential beneficial end-use (i.e. recreational purposes such as a park or golf course) following landfill closure.
- Siting restrictions due to geographical location of the site: Bioreactor landfills should not be sited in or near a floodplain, wetlands, unstable soils, fault areas, seismic impact zones, airports, and other constraints. If any one or more of these factors are present

at the selected site, additional performance standards may be imposed on the design of the landfill, which will increase costs.

3.5.3.4 DESIGN OF BIOREACTOR LANDFILL

The design of bioreactor landfill is almost similar to the conventional landfill but with some differences which are described below:

1) Liquid Addition

Leachate/Moisture Recirculation: The most important aspect of a bioreactor is recirculation of leachate. Leachate recirculation enhances microbial activity. This also results in mitigating odour issues. The efficiency of leachate distribution varies with the method of application. These methods differ in leachate recirculation capacity, volume reduction and compatibility with active and closed phases of landfill operation.

Different methods of leachate recirculation:
- Spray application
- Vertical wells
- Surface ponds
- Surface trenches

Given below are already experimented methods of leachate recirculation.

- Spray application: Trucks mounted with a tanker are used to spray liquid on the waste
- Vertical wells: Vertical systems usually consist of large diameter wells drilled into the waste. Liquid is injected into the wells and is allowed to percolate into the waste.
- Surface ponds: Excavations are made at the landfill surface into the waste layer. Leachate is pumped into the open excavation and allowed to drain by gravity.
- Surface trenches: A series of long narrow trenches are dug at the landfill surface. Leachate is pumped into the open excavation and allowed to drain by gravity.

Leachate recirculation is not enough to fulfil water requirement, so bioreactor landfill requires other liquids such as storm water, waste water and waste treatment plant sludge to supplement leachate. Typically, 10 to 25 gallons per bank cubic yard (gal/bcy) of waste is preferred (including gallons of bio-solids). A minimum of 5 gal/bcy is required.

Bioreactor landfill requires huge amount of water for its operation. Generally, 10-25 gal/bcy of waste is required

Table 3.17: Bioreactor Process and Applicable Liquid Addition Methods

Waste Stabilization Process	Technology
Anaerobic Bio-stabilization	Vertical Wells Spray Application Surface Ponds Surface Trenches
Anaerobic Bio-stabilization with leachate Nitrification	Vertical Wells
Aerobic Bio-stabilization	Vertical Wells Horizontal Trenches
Aerobic/Anaerobic (Hybrid)	Horizontal Wells Semi- Aerobic Vacuum Induced Horizontal Wells

2) Landfill Gas recovery: Since bioreactor landfills generate more gas than a conventional landfill in short time.

3) Soil Cover: The bioreactor soil cover requires special attention. The cover should be designed to have sufficient slope and permeability to allow percolation and drain the leachate to the side, where it can be properly collected and drained.

3.5.3.5 Operation And Maintenance Of Bioreactor Landfill

Bioreactors fall into two major categories: "As built" bioreactors that are constructed during the fill sequence, and "retrofit" bioreactors that are retrofitted into an existing cell at or are near final grade.

3.5.3.6 Waste Filling And Compaction

Compaction of waste and application of cover material should provide for adequate permeability to facilitate distribution of liquids, thereby enhancing the biodegradation processes. Waste filling procedures should homogenize the waste to the maximum extent practicable to help achieve uniform field capacity throughout the landfill.

3.5.3.7 Key Monitoring Parameters

There are four key bioreactor operating parameters that are to be monitored to assess the progress of aerobic biodegradation in the waste. These are odour, landfill gas composition, pH, and waste temperature. Additional parameters may need to be monitored to satisfy air quality requirements.

1) Odour: A sweet smell of butyric acid in organic waste indicates composting process, when it disappears, the aerobic stage is over or waste is too dry and need to moisten with water.
2) Gas composition: The aerobic phase of gas production is characterized by production of methane and should be continually monitored.
3) pH: pH should be acidic during methanogenesis, which is crucial for biodegradation. The pH must be maintained neutral after completion of degradation.

Waste temperature: Within 15 days of aeration in warm weather, the aerated lift should be at approximately 60°C unless it is unusually wet or dry. Temperatures at or above 75° C are a cause for concern.

> While the commercial application of this process needs to be strengthened based on experiences in Mumbai and through further R&D in India, further use of this technology is currently restricted.

3.6 Construction And Demolition Waste

3.6.1 MSW Rules' Requirements On Construction And Demolition Wastes (C&D)

Rules: Schedule (II), Clause.1 (vi) of MSW (Management & Handling) Rules, 2000 and 9.1 (B) of Draft MSW Rules, 2013

"Horticultural and construction or demolition wastes or debris shall be separately collected and disposed of following proper norms."

Construction and Demolition waste means any waste generated during construction, demolition or re-modelling of any civil structure, such as buildings, bridges, flyovers, roads, drainage and laying of services etc. or associated activities for infrastructure provision such as, site preparation by way of digging, levelling, laying of pipelines, cables etc. Construction and demolition waste includes, but not limited to concrete, bricks, tiles, stone, soil, rubble, plaster, drywall/gypsum board, wood, plumbing fixtures, non-hazardous insulating material, plastics, wall paper, glass, metals (such as steel, aluminium), asphalt etc.;

However, C&D waste does not include any hazardous waste as defined under 'Hazardous Waste (Management & Handling) Rules, 1989'.

C&D waste does not include any waste which may have any chance of getting contaminated with nuclear waste or exposed to nuclear radiation. Special care shall be taken before demolition of any nuclear establishment.

Material generated from de-silting activity is also excluded from C&D waste category as it contains decomposed organic material and may also contain heavy metals and other toxic materials. However, de-silted materials from natural drains and storm water drains, not contaminated with organic material may be accepted as C&D waste.

Construction waste can constitute about 5% and demolition waste about 95% of C& D waste and both together constitute 10 to 20% of all municipal solid waste generated in the country[45] (excluding large projects). Natural calamities like earthquakes, landslides etc. also result in generation of large quantities of C&D waste.

Composition of C&D Waste

Construction waste is generated during building construction and renovation and results from surplus material, damaged or broken material, processing waste (saw dust, metal spoils), dismantled shuttering, and used tools. Demolition waste can result from demolition of built structures for renovation or complete removal or renewal or can result from natural events. This category of waste is complex due to the different types of building materials being used but in general may comprise the following materials:

Major Components: Cement concrete, Bricks, Cement plaster, Steel (from RCC, door/window frames, roofing support, railings of staircase etc.), rubble, stone (marble, granite, sand stone), timber/wood (especially demolition of old buildings)

Minor Components: Conduits (iron, plastic), Pipes (GI, iron, plastic), Electrical fixtures (copper/aluminium wiring, wooden baton, bakellite/plastic switches, wire insulation), Panels (wooden, laminated), glazed tiles, glass panes etc.

[45] Ghosh,G., Ghosh,S.&Aich, A., (n.d), "Rebuilding C& D Waste Recycling Efforts in India", Waste Management World. Available at:http://www.waste-management-world.com/articles/print/volume-12/issue-5/features/rebuilding-c-d-waste-recycling-efforts-in-india.html

These wastes are heavy, due to high density, often bulky and occupy considerable storage space. C&D wastes stored outside construction sites, along road sides, are a cause of both traffic congestion and mishaps. These wastes are quite often given away for filling in low lying areas /plots to private agencies or disposed of at open spaces or on the road side illegally. Waste from small generators quite often finds its way into the nearest municipal bin/vat/waste storage depots, making the municipal waste heavy and degrading its quality for further treatment like composting or energy recovery. C&D waste is also often dumped in surface drains obstructing the flow of waste water and leading to urban flooding.

3.6.2 Reuse And Recycling Potential

Many components of the C&D material have a high potential of reuse and recycling, as detailed in Table 3.18, provided they are properly segregated. Construction material such as aggregate, bricks, paving blocks etc. can also be made out of this waste at a minimal cost.

Use of C&D Waste for Road Works & Construction

- Experiments by Central Road Research Institute (CRRI) have shown that it is possible to use C&D waste for road and embankment construction, such as, embankment and sub-grade, sub-base, stabilized base course, rigid pavement etc.
- Central Public Works Department (CPWD) has a formal system in place for determining salvage value (salvage content) of C&D waste
- In the recent (2014-15) budget proposal of the Government of the National Capital Territory (Delhi), exemption of VAT has been proposed for tiles and kerbstones made from 'malba' (C&D waste)[46]

Table 3.18: C&D wastes and their Reuse Potential[47]

Material	Process	End Use
Plain Concrete (DW)	Crushed and sorted	Aggregate
Fresh Concrete (CW)	Washed to remove cement and recover aggregate	Aggregate

[46] Construction, demolition debris chokes Delhi. Available at: http://www.hindustantimes.com/india-news/newdelhi/construction-demolition-debris-chokes-delhi/article1-1035318.aspx

[47] Holcim & GIZ, (2007)."Reuse and Recycling of Construction and Demolition Waste"

Material	Process	End Use
Reinforced Concrete	Crushed, sorted and steel bars removed Steel recycled	Crushed concrete reused as aggregate New reinforcement steel
Clay bricks and roof tiles	Cleaned Crushed and sorted Pulverised	Reused for masonry Aggregate Mixed with lime to produce mortar
Calcium silicate bricks	Cleaned Crushed Pulverised	Reused for masonry Aggregate Recycled into new calcium silicate bricks
Natural stone masonry	Cleaned Crushed	Reused for masonry Aggregate
Natural stone slabs	Cleaned Crushed	Flooring, cladding Aggregate
Ceramic Tiles	Cleaned Crushed	Flooring, cladding Aggregate
Asphalt Paving	Crushed and cold mixed Crushed and hot mixed	Road construction
Mixed Demolition Waste (ABC i.e. asphalt, bricks, concrete)	Crushed	Fill material
Steel	Cleaned Recycled	Reused steel components New steel components
Aluminium	Cleaned Recycled	Aluminium recycling streams
Timber beams, doors etc.	Cleaned	Reused as beams, doors etc. (if free of hazardous preservatives).
Timber boards	Cleaned	Reused as shuttering and other products Feedback for engineered woods
Plastics	Recycled	Plastic recycling streams
Gypsum plasterboard	Cleaned Crushed Recycled	Reuse as boards Soil conditioner New Gypsum products
Glass	Cleaned Crushed Recycled	Glass recycling streams

3.6.3 Storage, Collection, Transportation And Disposal Of C&D Waste – Role Of ULB

3.6.3.1 Role Of Ulb In C&D Waste Management

ULBs should make arrangements for placement of appropriate containers (skips or other containers) and their removal at regular intervals or when they are filled either through own resources or by appointing private operators. The collected waste should be transported to appropriate site(s) for further processing and disposal either through ULB owned resources or by appointing private operators. ULBs should monitor and record generation of construction and demolition waste within its jurisdiction.

Smaller ULBs should designate specific locations in each zone for separate collection of small and large quantities of C&D wastes. Small quantities of C&D wastes should be periodically transported to bulk storage areas.

In consultation with Expert Institutions, the urban local bodies (ULBs) shall plan for appropriate management of C&D waste generated including processing facility and further plan to use the recycled products in the best possible manner. The Expert Institutions can also suggest ways to introduce 'de-construction' activity from the construction planning stage and provide assistance in this matter.

Municipal authorities should make bye-laws as well as special arrangements for storage, transportation, processing and disposal of C& D waste.

Small municipalities under 1 Lakh population should make simple arrangements as under:

- Notify locations, preferably in each zone (North, South, East, West) and centre of the city, where waste generators having small quantities of C&D waste under 1 MT load should be allowed to deposit their waste. Construct an enclosure at each notified location for storage of small quantities of waste or place tractor trolley at each such location for storage of C&D waste.
- Arrange for transportation of C&D waste deposited at collection centres through covered tractor trolleys / trucks to the area designated for bulk storage.
- Citizens should avail the provided facility at designated locations and refrain from disposal of C&D wastes at any other location or in MSW bins.
- Plan for reuse and recycling of such waste with private sector participation or the C&D waste could be used for land reclamation by filling in low lying areas. C&D waste can also be used to fill in areas where stagnant water is repeatedly observed in order to prevent mosquito breeding.

In cities above 1 Lakh population, the municipality should make elaborate arrangements as under:

- Notify suitable locations in different parts of the city where waste generators having small quantities of C&D waste under 1MT load can deposit their waste conveniently.
- Create a system of renting skips/ containers for storage of C&D waste at source departmentally or through an authorized private operator, where the generation of such waste is greater than 1 MT.
- Prescribed rates for collection and transportation of C&D waste to be published/ notified.
- Citizens to avail the facility and refrain from disposal of small quantities of C&D waste anywhere else.
- Arrange for transportation of C&D waste through skip lifting system departmentally or through designated contractor.
- Plan for reuse and recycling of such waste with private sector participation. The rejects from these plants (soft fines) are used for filling in low lying areas.
- While depositing waste in the bins, care should be taken by the small generators to see that waste material is not dumped outside the bin / skip. These bins /skips should be periodically inspected by the municipal authority to ensure that they are cleared before they over flow Littering should be strictly prohibited. Particularly C&D waste should never be allowed to be deposited in open/covered drains.
- Large generators who are provided with open skips or tractor trolleys on rent by the local body or its authorized private operators, should inform the municipal authority or concerned agency when the containers are likely to be full in order to replace the filled skip / trolley with an empty one and transport the waste at a designated site. In case of very large generators responsible for demolition, renovation, construction of infrastructure projects like bridges, fly-over, roads, large commercial / housing complex or demolition of unauthorized structures by municipality etc., the area should be screened and cordoned off and the material should be stacked systematically without obstructing traffic or causing any hindrance to the neighbourhood .Different waste components may be segregated and stored separately. Segregated materials should be loaded into tipper lorries/ tractors with the help of front end loaders or back hoes and transported to designated sites for further processing or other use. Private sector may be encouraged to facilitate reuse and recycling of C&D waste.
- The ULB should fix and notify charges for door step collection and transportation of C& D waste, based on the volume generated.

- Placement of Skips on Public Roads: Normally for bulk generators dedicated hook loader bins / skips may be provided at a cost wherever required and should be kept within the construction sites. The ULB should notify byelaws with regard to management of C&D waste and safety requirements of such containers on public roads.

3.6.3.2 Collection And Transportation

In large cities above 1 Lakh population, skip and hook loader containers are suitable for collection of construction and demolition waste. The skip containers or large roll-on roll-off bins should be standardized with proven design, amenable to automatic lifting, and unloading by a skip and hook loader vehicles respectively. Tipper trucks in conjunction with front-end loaders (manual labour in case of small quantity of scattered waste) can be used for handling such waste in bulk and for clearing backlogs. **(Please refer to chapter 2 of part II for more detail).**

Where C&D processing & recycling facilities exist, bulk generators could be directed to deposit their waste directly at such processing facility and small quantities of C&D waste deposited at designated sites should be transported to such facilities, as described above. Inert waste components from these facilities should be disposed of in designated sites as notified by the ULB. Adequate steps should be taken to reduce dust and noise during handling.

3.6.3.3 Processing Of C&D Waste

The reuse and recycling of construction and demolition wastes usually requires pre-processing and sorting. Toxic / hazardous components such as construction chemicals, paints, wood preservatives etc. have to be separated to avoid dangerous impacts on human health and environment.

C&D waste should be sorted within the site using personal protection equipment (PPE) to segregate hazardous material and material that may be reused. C&D waste at the first place should be sorted to separate reusable material such as left over unused bricks , grit, sand, wood etc. from the construction sites as well as usable bricks, wooden doors, windows etc. collected from demolition sites and rest may be processed to produce construction material such as aggregate, bricks, pavers blocks , tiles etc. The complexity of the process is dependent on the intended final products. The existing plants for processing C&D waste can handle a very small quantity to large quantity at an affordable price. Municipal authorities should set up appropriate processing facilities individually or collectively preferably through private sector participation.

C&D processing plants often generate hazardous wastes such as paint containers, construction chemicals, wood preservatives, asbestos etc. These wastes should be stored separately and sent to a nearby hazardous waste treatment, storage and disposal facility. In absence of such facility, such waste as may be disposed as advised by the State Pollution Control Board/Committee.

Experiences of first pilot project of Construction and Demolition waste Management in Delhi

In 2009 the Municipal Corporation of Delhi (MCD), and IL&FS Environmental Infrastructure and Services Ltd (IEISL) took a pioneering initiative of setting up a pilot project to process 500 tons per day (TPD) of C&D Waste in Burari, Jahangirpuri, Delhi, which is a first of its kind plant in the country, on Public Private Partnership model. A Concession Agreement for a period of 10 years had been signed and 7 acres of land provided by MCD for setting up the processing unit.

The project is based on an integrated approach covering collection and transportation of C&D waste from designated points and processing of C&D waste. C&D waste is collected from designated points by using JCBs; transportation to the processing site is through vehicles fitted with GPS.

Process flow

- Incoming waste is subjected to weighment at the site
- Segregation of undesirable items like rags, plastics, metal, Fiber Reinforced Plastic (FRP) sheets etc. through mechanical and manual means.
- Remaining waste is segregated into 3 parts:
  - Whole bricks (it’s kept for internal use and sale)
  - Large concrete
  - Mixed C&D waste
- Depending upon the waste inflow and its quality, the waste is processed

Process Technology

- Collected C&D waste is first screened through the grizzly to remove loose soil and muck.
- Over- sized screened materials are collected in the hand sorting section where bricks and concrete are separated.
- Segregated bigger size concrete boulders as well as mixed concrete are broken.

Crushing is done by jaw / impact (horizontal or vertical shaft) / cone crusher, depending upon the material, size of operation and targeted end use.

- Large scale screening of the crushed material is done by heavy-duty trommels (rotary screen) with suitably sized inter-changeable screens. For medium scale material, multi layered vibro-screens have been used. Vibro-screens (with suitably sized inter-changeable screens) may also be used for finer aggregates.
- Crushed waste is then processed through the use of a sequence of machinery consisting of the Grizzly, Vibro Screens, Evo Wash, Thickener etc., which are capable of segregating sand from mixed C&D waste.
- The wet processing technology helps in retrieving fine particles less than 5mm particles as well as controlling the dust and noise.

Final Products

The processed waste is being used for two purposes – making of road sub-base and making of pavement blocks and pre-cast products like kerb stones, paver blocks and square tiles. The loose soil and sand is sold in the market and the by-products are also used in construction of bus shelters in the city.

In order to test the application of the recovered product from the plant, the roads within the plant have been constructed with recycled material as well as the access road to the plant (approx. length 150 m) was made with the C&D waste recycled product. Granular sub-base (GSB) was used in the construction of the roads inside as well as outside the plant.

MCD has provided extensive cooperation to make this pilot implementable and successful.

3.6.4 Siting and Managing C&D Recycling Plants

3.6.4.1 IDENTIFICATION OF APPROPRIATE LAND FOR C&D PROCESSING FACILITIES

C&D waste processing/ recycling facilities should be located atleast 500m away from the boundary of residential areas, preferably in industrial zones or adjacent to landfill sites

The Town and Country Planning Department / Urban Development Department of the State or other Competent Authority should identify suitable site(s) for setting up processing facilities for construction and demolition waste according to the parameters necessary for such projects. The identified land should be incorporated in the approved land use plan so that there is no disturbance to the processing facility on a long term basis. 'No Development' zone should be notified around the site to safeguard the facility.

3.6.4.2 Siting Criteria

Construction & Demolition (C&D) waste recycling/processing facilities need to consider constraints such as maintaining a safe distance of at least 500 meters from residential areas, preventing / minimizing noise pollution, traffic, and transportation costs.

C&D recycling plants should ideally be installed in an industrial area/zone or adjacent to an existing or future landfill site. While industrial areas may object to the visual impacts and dust pollution from these facilities, a landfill site would be the most appropriate location for installation of such facilities. Municipal authorities and operators of C&D recycling facilities should conduct an environmental impact assessment and take adequate mitigation measures ensuring protection of health and environment before installation of C&D waste processing facilities. Municipal authorities should share the EIA report with the State Pollution Control Board/ Committee.

Table 3.19 provides a summary of environmental issues which need to be addressed during installation and operation of C&D plants.

Table 3.19: Potential issues with sitting and managing a C&D recycling Facility[48]

Activity	Potential Issue	Impacts
Site Clearing	Dust and Noise Loss of Biodiversity	Health Air pollution Ambience/visual impact Flora and fauna habitat
Site operations or contouring that permits water to pond on-site.	Odour	Health Ambience/visual impact
Uncontrolled or poorly managed site run-off	Surface water run-off resulting in transportation of sediments – erosion	Water pollution Soil erosion
Transporting materials to or from site or stockpiling of wastes or recycled products on site. Crushing, grinding or screening operations	Dust Noise	Health Air pollution Ambience

48 Source: Environment Guideline for C&D waste recycling Facilities, Department of Environment and Conservation, The Government of Western Australia

Activity	Potential Issue	Impacts
Asbestos contamination in waste loads	Asbestos pieces pass through crushing operations Asbestos from stockpiled material remains in soil	Health Air pollution Land contamination
Sorting of C&D wastes	Hazardous waste components of C&D waste	Health Air pollution Land contamination
Litter	Litter that is a result of operations or during transport to/from site	Littering, choking of drains

3.6.4.3 Benefits of Processing C&D Waste

- C&D waste can be put to a profitable use, saving huge natural resources, especially given the scarcity of sand and stone for construction.
- Prevents public nuisance and traffic congestion issues, due to indiscriminate dumping of C&D waste.
- Saves valuable space at landfill sites.
- Reduces cost of bulk transportation if recycled close to source of generation

In-situ Recycling of C&D Waste at Redevelopment Site by National Buildings Construction Corporation (NBCC): A New Example for India

An old government colony of about 2500 dwelling units is being redeveloped at East Kidwai Nagar in New Delhi. The huge quantity of C&D waste generated at the site is being recycled at a facility set up within the site. The process involves crushing of the C&D waste material in a crusher housed underground followed by further grinding in an over-ground milling machine. The fine material is mixed with a patented catalyst in a pan mixer and the mixture is passed through a brick making machine. The green bricks are sun dried / cured in the sun for 4 weeks. The bricks are of standard size and would be used in the buildings coming up at the site. This in-situ recycling of C&D waste has avoided the need of transportation of C&D waste and hence resulted in substantial saving in transport cost as well minimizing environmental degradation. The initiative will also save precious scarce land resource which is also increasingly getting difficult to procure.

Chapter 4:

Technical Aspects: Municipal Sanitary Landfills

4. Technical Aspects: Municipal Sanitary Landfills

4.1 MSW Rules 2000 On Landfills

Rules Schedule- II. Clause 6: Disposal of Municipal Solid Waste

"Landfilling shall be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing. Landfilling shall also be carried out for residues of waste processing facilities as well as pre-processing rejects from waste processing facilities. Landfilling of mixed waste shall be avoided unless the same is found unsuitable for waste processing. Under unavoidable circumstances or till installation of alternate facilities, landfilling shall be done following proper norms. Landfill sites shall meet the specifications as given in Schedule III."

Schedule- III. Specifications of Landfill Site

Site Selection

1. In areas falling under the jurisdiction of Development Authorities it shall be the responsibility of such Development Authorities to identify the landfill sites and hand over the sites to the concerned municipal authority for development, operation and maintenance. Elsewhere, this responsibility shall lie with the concerned municipal authority.
2. Selection of landfill sites shall be based on examination of environmental issues. The Department of Urban Development of the State or the Union territory shall co-ordinate with the concerned organizations for obtaining the necessary approvals and clearances.
3. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan.
4. The landfill site shall be selected to make use of nearby wastes processing facilities. Otherwise, wastes processing facilities shall be planned as an integral part of the landfill site.
5. The existing landfill sites which continue to be used for more than five years, shall be improved in accordance of the specifications given in this Schedule.
6. Biomedical wastes shall be disposed off in accordance with the Bio-medical Wastes (Management and Handling) Rules, 1998 and hazardous wastes shall be managed in accordance with the Hazardous Wastes (Management and Handling) Rules, 1989, as

amended from time to time.

7. The landfill site shall be large enough to last for 20-25 years.
8. The landfill site shall be away from habitation clusters, forest areas, water bodies, monuments, National parks, wetlands and places of important cultural, historical or religious interest.
9. A buffer zone of no-development shall be maintained around landfill site and shall be incorporated in the Town Planning Departments land-use plans.
10. Landfill site shall be away from airport including airbase. Necessary approval of airport or airbase authorities prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 20 km of an airport or airbase.

Facilities at the Site

11. Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.
12. The landfill site shall be well protected to prevent entry of unauthorized persons and stray animals.
13. Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site.
14. The landfill site shall have a waste inspection facility to monitor wastes brought in for landfill, office facilities for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments.
15. Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided.
16. Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided.
17. Safety provisions including health inspections of workers at landfill site shall be periodically made.

Specifications for land filling

18. Wastes subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the wastes. In high rainfall areas where heavy compactors cannot be used alternative measures shall be adopted.

19. Wastes shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up as per Schedule I.(Schedule I of the MSW Rule)

20. Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage berms shall be constructed to divert run-off away from the active cell of the landfill.

21. After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications, namely :--

    a. The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1 x 10-7 cm/sec.

    b. On top of the barrier soil layer there shall be a drainage layer of 15 cm.

    c. On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

Pollution Prevention

22. In order to prevent pollution problems from landfill operations, the following provisions shall be made, namely:-

    a. Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;

    b. Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfills receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geomembrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1 x 10-7 cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;

    c. Provisions for management of leachate collection and treatment shall be made. The treated leachates shall meet the standards specified in Schedule- IV;

    d. Prevention of run-off from landfill area entering any stream, river, lake or pond.

Water Quality Monitoring

23. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 metres of the periphery of the landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

24. Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely:

S. No.	Parameters	IS 10500: 2012 Desirable Limit (mg/l except for pH)
1.	Arsenic	0.05
2.	Cadmium	0.01
3.	Chromium	0.05
4.	Copper	0.05
5.	Cyanide	0.05
6.	Lead	0.05
7.	Mercury	0.001
8.	Nickel	-
9.	Nitrate as NO_3	45.0
10.	pH	6.5-8.5
11.	Iron	0.3
12.	Total hardness (as $CaCO_3$)	300.0
13.	Chlorides	250
14.	Dissolved Solids	500
15.	Phenolic Compounds as (C_6H_5OH)	0.001
16.	Zinc	5.0
17.	Sulphate (as SO_4)	200

Ambient Air Quality Monitoring

23. Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.

24. The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

25. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill

gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utilization or flaring is not possible.

26. Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the following specified standards, namely :

S. No.	Parameters	Acceptable Levels
1.	Sulphur dioxide	120 $\mu g/m^3$
2.	Suspended Particulate Matter	500 $\mu g/m^3$
3.	Methane	Not to exceed 25 per cent of the lower explosive limit (equivalent to 650 mg/m^3)
4.	Ammonia daily coverage (Sample duration 24 hr.)	0.4 mg/m^3
5.	Carbon monoxide	1 hour average: 2 mg/m^3 8 hour average: 1 mg/m^3

29 The ambient air quality monitoring shall be carried out by the concerned authority as per the following schedule, namely:

a. Six times in a year for cities having population of more than fifty lakhs;

b. Four times in a year for cities having population between ten and fifty lakhs;

c. Two times in a year for town or cities having population between one and ten lakhs.

Plantation at Landfill Site

30. A vegetative cover shall be provided over the completed site in accordance with the and following specifications, namely:-

a. Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;

b. The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilised;

c. Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;

d. Plantation to be made in sufficient density to minimize soil erosion.

Closure of Landfill Site and Post-care

31. The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely :-
    a. Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;
    b. Monitoring leachate collection system in accordance with the requirement;
    c. Monitoring of ground water in accordance with requirements and maintaining ground water quality;
    d. Maintaining and operating the landfill gas collection system to meet the standards.
32. Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis complies with the specified standards.

Special provisions for Hilly Areas

33. Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid wastes by the municipal authority with the approval of the concerned State Board or the Committee. The municipal authority shall set up processing facilities for utilization of biodegradable organic wastes. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. Because of constraints in finding adequate land in hilly areas, wastes not suitable for road-laying or filling up shall be disposed of in specially designed landfills.

4.2 Key Features Of Municipal Sanitary Landfills

The term Sanitary Landfill is used herein to describe a unit operation for final disposal of 'Municipal Solid Waste' on land, designed and constructed with the objective of minimizing impact to the environment and according to the Municipal-Solid Waste (Management and Handling) Rules.

4.3 Environmental Impacts And Its Minimization

In line with the MSW Rules 2000 as documented in section 4.1, sanitary landfills minimise the harmful impact of solid waste on the environment through the use of the following mechanisms:

a) Reduction of groundwater contamination through leachate collection and treatment

b) Control of surface water contamination through runoff

c) Reduction of air contamination due to gases, litter, dust, bad odour

d) Control of other problems due to rodents, pests, fire, bird menace, slope failure, erosion etc.

4.4 Types Of Municipal Solid Waste To Be Accepted At Landfills

Waste categories suitable for sanitary landfills:

i. Waste that is by its nature or through pre-treatment non-biodegradable and inert;

ii. Comingled waste (mixed waste) not found suitable for waste processing;

iii. Pre-processing and post-processing rejects from waste processing sites;

iv. Non-hazardous waste not being processed or recycled.

Sanitary landfilling is not adequate for the following waste streams in the municipal solid waste:

a. Bio-waste/garden waste;

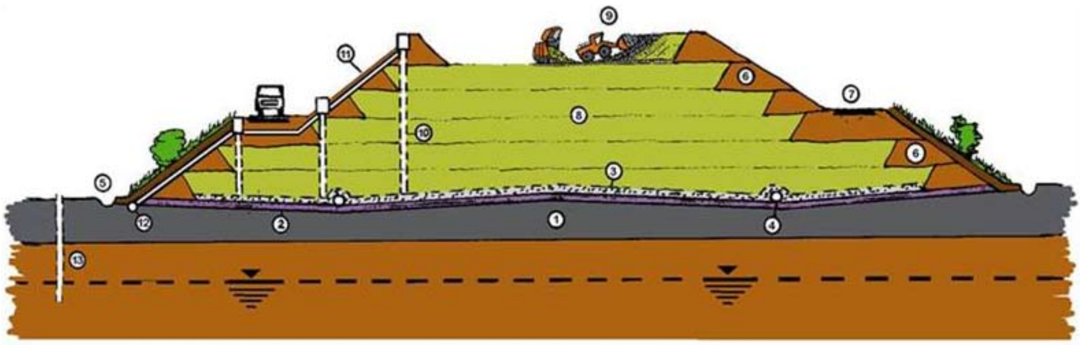
b. Dry recyclables

c. Hazardous wastes

Hazardous wastes have to be disposed off in special facilities designed for the respective types of waste, e.g. special Treatment Storage & Disposal Facilities (TSDF). Municipal solid waste having limited contamination of hazardous materials (such as aerosols, household chemicals, used batteries, contaminated containers (paint etc.) can be disposed in a sanitary landfill with adequate liner systems (see requirements in MSW Rules 2000). However, in line with guidance in this manual, such wastes should be segregated at source and managed appropriately; minimizing their disposal in sanitary landfills.

Construction & Demolition Waste should be landfilled in a separate landfill /cell so that it could be mined in the future, if required

Landfilling of construction and demolition waste, where processing options are not available, will be done in a separate landfill/cell where the waste can be stored and mined for future use in earthwork or road projects. Construction and demolition waste can be used as a daily cover and / or for road construction at the MSW Sanitary Landfill.



1. Geological barrier
2. Impermeable base liner
3. Drainage layer
4. Leachate collection system
5. Storm-water drain ditch
6. Bordering dams
7. Circulation roads
8. Landfill body
9. Filling and compacting in layers
10. Gas venting system
11. Protective cover system
12. Gas collectors
13. Groundwater control
14. Re-planting

Figure 4.1: Section of Typical Sanitary Landfill

Figure 4.1 illustrates the essential components of a MSW Sanitary Landfill which include:

- A liner system at the base and sides of the Sanitary Landfill which prevents migration of leachate or gas to the surrounding soil.
- A leachate collection and control facility which collects and extracts leachate from within and from the base of the Sanitary Landfill and then treats the leachate.
- A gas collection and control facility (optional for small sanitary landfills) which collects and extracts gas from within and from the top of the Sanitary Landfill and then treats it or uses it for energy recovery.
- A final cover system at the top of the Sanitary Landfill which enhances surface drainage, prevents infiltrating water and supports surface vegetation.
- A surface water drainage system which collects and removes all surface runoff from the Sanitary Landfill site.
- An environmental monitoring system which periodically collects and analyses air, surface water, soil-gas and ground water samples around the Sanitary Landfill site.
- A closure and post-closure plan which lists the steps that must be taken to close and secure a Sanitary Landfill site once the filling operation has been completed and the activities for long-term monitoring, operation and maintenance of the completed Sanitary Landfill.

4.5 Planning &Design Of A Landfill

Steps to design, implementation and operation of a Sanitary Landfill are:

1. Site Selection
2. Design of Sanitary Landfill
3. Implementation of Sanitary Landfill
4. Operation of Sanitary Landfill
5. Closure and post closure measures

4.5.1 Site Selection

Selection of a Sanitary Landfill site shall be governed by the strategy identified in the State Solid Waste Management Strategy/Policy and the MSWM Plan of the ULB. Decisions on constructing local landfills vis-à-vis utilizing regional landfills, are based on these strategy/planning documents.

Municipal engineers and planners face severe constraints and localized public reaction while selecting a site for landfill

Site selection usually comprises of the following steps, which are described in the following section :

i. Location criteria: Reference to the identifying location criteria published by the MSW Rules and national and state level guidelines. Central Pollution Control Board published guidelines on site selection criteria for landfills; attached to this manual as Annexure 4.

ii. Identification of potential search areas in consultation with the Town Planning Department

iii. Development of a list of potential sites

iv. Data collection for potential sites, based on guidance given below (section 4.5.1.4)

v. Field visit for local verification and identification of potential sites

vi. Selection of a few best-ranked sites;

vii. Preliminary environmental impact investigation and

viii. Final site selection

4.5.1.1 Location Criteria

The MSW Rules 2000/2014 provide criteria for the location of a sanitary landfill (see chapter 4.1). It should be verified if further criteria specified by a regional regulatory agency (e.g. Pollution Control Board). "Guidelines for the Selection of Site for Landfilling" from the Central Pollution Control Board (2002) (Annexure 4) should also be consulted, which includes guidance for developing a site sensitivity index for potential sites. .

In the absence of specific regulatory requirements, the following criteria, as tabulated below in Table 4.1, are suggested.

Table 4.1: Criteria for Identifying Suitable Land for Sanitary Landfill Sites

S.No	Place	Minimum Siting Distance
1	Habitation	500 m
2	Rivers, lakes, water bodies	200 m
3	Non meandering water (canal, drainage etc.)	30 m
4	Highway or railway line	300 m from centre line
5	Coastal regulation zoning	Sanitary Landfill site not permitted
6	Earthquake Zone	500 m from fault line fracture
7	Flood prone area (100 year flood plain)	Sanitary Landfill site not permitted
8	Water table	Over 2m. below bottom of landfill base liner
9	Airport	20 km

Construction of sanitary landfiils for municipal waste within restricted zones should be avoided at all costs.

4.5.1.2 Search Area

Search areas help in identifying potential sites for sanitary landfill by delineating waste generating unit as a centre

To identify the potential sites for a Sanitary Landfill a 'search area' has to be delineated. The search area is usually governed by the economics of waste transportation (Section 2.2.13 of Part II). Typically search areas are delineated on a map using a 'search radius' of 10 to 15km, keeping the waste generating unit as the centre.

Alternatively, the search area may be identified by adopting a range of 5 km all around the built-up city boundary. One should start with a small search area and enlarge it, if needed. It is imperative that the Town Planning Department and concerned authorities be consulted when demarcating the search area.

4.5.1.3 Development Of A List Of Potential Sites

After demarcating the search area, as well as after studying the various restrictions listed in the locational criteria, areas having potential for site development should be identified (White Mapping). A roadmap may be used to show the potential sites that satisfy the locational criteria.

Potential sites for sanitary landfill development should also confirm to the long-term land use goals

In areas where land is scarce, degraded sites such as abandoned quarry sites or old waste dump sites can be considered. Special design measures are required for such sites.

The values in table 4.2 can be used as rough guidance figures for the estimation of the required area for a Sanitary Landfill including the related infrastructure.

Table 4.2: Rough Guidance for Sanitary Landfill Sizes

Waste quantity (Tonnes)	Required site area (ha)
< 1.0 Million	15-20
1.0 Million - 2.0 Million	20-30
2.0 Million – 3.0 Million	30-40
> 3.0 Million	> 40

4.5.1.4 Data Collection for Potential Sites

In order to identify the potential for suitable landfill sites in the search area, a map screening will be conducted, applying more detailed selection criteria and data than in the previous step. The objective is to exclude unsuitable areas according to in-depth criteria application. The maps and other available sources of information as tabulated in table 4.3 might support this secondary selection process:

Table 4.3: Data Collection and Sources

S. No.	Data	Information	Sources
1	Topographic Maps	The topography of the area indicates low and high areas, natural surface water drainage pattern, streams, and rivers. Furthermore roads, railways and locations of airports	Survey of India
2	Soil Maps	These maps, primarily meant for agricultural use, will show the types of soil near the surface.	Indian Agricultural Research Institute

Map screening helps in generating plans showing both the areas which should be excluded from consideration and also areas which can be considered but requires further investigation

S. No.	Data	Information	Sources
3	Land Use Plans	These plans are useful in delineating areas with definite zoning restrictions. There may be restrictions on the use of agricultural land or on the use of forest land for Sanitary Landfill purposes.	Town Planning Authority/ Municipality.
4	Water Use Plans	The plans indicating the following items: ● private and public drinking water wells. ● drinking water supply line(s), ● wells located on surface water bodies, and open wells. ● Protection areas for drinking water	
5	Flood Plain Maps	These maps are used to delineate areas that are within a 100 year flood plain.	Irrigation Department
6	Geologic Maps	These maps will indicate geologic features and bedrock levels. They may be used to identify predominantly sandy or clayey areas.	Geologic Survey of India
7	Aerial Photographs/ Satellite Imagery/ Google maps	Surface features such as small lakes, intermittent stream beds, and current land use, which may not have been identified in earlier map searches, can be easily identified using aerial photographs.	
8	Ground Water Maps	These maps indicate the depth to ground water below the land surface as well as regional ground water flow patterns.	Ground Water Boards or Minor Irrigation Tubewell Corporations.
9	Rainfall Data	Precipitation data is used for designing the amount of possible leachate in cities	Indian Meteorological Department
10	Wind Map	Wind rose indicates the predominant wind direction, based on which landfill footprint has to be located	Indian Meteorological Department
11	Seismic Data	The seismic activity of a region has to be considered in the design of Sanitary Landfills – landfills should not be located in type II seismic areas	Geological Survey of India (GSI) or National Geophysical Research Institute (NGRI)
12	Road Maps	Accessibility of the potential site	

Also, authorities and other relevant stakeholders may be asked to provide further relevant information, if not already done during the analysis of the present situation. The map screening has the effect of excluding large zones within the project region for further consideration and at the same time focus on zones that are promising (e. g. away from settlements and hydro-geological favourable etc.). All areas that fall under exclusion criteria will be indicated in a constraint map.

The result of the map screening will be a plan (or plans) showing exclusionary (negative) areas as well as areas where further investigation (positive zones) is meaningful. The map-screening will give a clear sight on the potential and the constraints concerning land-fill-sites in the project area.

4.5.1.5 Field Visit For Local Verification & Identification Of Potential Sites

A site reconnaissance will be conducted by a site visit as a part of the preliminary data collection and map screening. All features observed in various maps will be confirmed.

The possible sites should be evaluated concerning the topographical conditions and the ability for landfill site such as:

(a) Sufficient size of land;

(b) Flat area with low inclination;

(c) Connection to highways; conditions of the access roads;

(d) Flooding during monsoons;

(e) Land use and soil type;

(f) Depth to Ground Water Table (as observed in open wells or bore wells)

(g) Information concerning the sub-ground from clay, stone or sand pits;

(h) Crossing of electrical lines

(i) Actual settlement patterns (eventual new or informal settlements)

4.5.1.6 Selection Of Best Ranked Sites

For the selection of a few best ranked sites, the Ranking System based on Site Sensitivity Index developed by Central Pollution Control Board in 2003 is recommended (Annexure 4).

4.5.1.7 Preliminary Environmental Impact Investigation

On the basis of the ranking scores received by various sites, two or three preferred sites may be chosen for a preliminary environmental impact investigation.

The impact of the Sanitary Landfill will be assessed and potentially quantified according to the national rules and the local conditions.

The Preliminary Environmental Investigation should conclude in a rough comparison of assessed alternative sites amongst themselves as well as with the null alternative (i.e. if the project was not carried out) and suitability of the sites summarised.

4.5.1.8 Final Site Selection

Transportation costs of waste being brought to landfill from source plays a critical role while selecting site for landfill

The final selection of the site from amongst the best-ranked alternatives should be done by comparing:

(a) the environmental impact;

(b) social acceptance

(c) land availability

(d) transportation costs and

(e) sanitary landfilling costs (site specific costs are to be considered)

Transportation costs may be compared on the basis of average hauling distance from the centre of the waste generating.

In general the material costs for liner system, leachate collection system, daily covers and final cover system and all facilities are similar for all sites, considering normal site conditions[1]. The main differences include:

- Distance of the access road to regional road system
- Sub-ground conditions for earth works to prepare the base of filling area
- Distance to waste generators and waste processing facilities

A Sanitary Landfill site with low environmental impact, high social acceptance and low costs is the most desirable. If conflicting results appear for (a), (b), (c), (d) and (e), environmental impact minimisation should normally be given top priority.

[1] This shall change in areas of high water table, in hilly areas and other peculiar issues

4.5.2 Site Investigation And Site Characterization

In-depth information on site parameters beyond those of the site selection process is necessary for the adequate design of the sanitary landfill at the selected site. A proper site investigation programme comprises:

- subsoil investigation, ground water/hydrogeological investigation,
- hydrological investigation,
- topographical investigation,
- environmental investigation,
- traffic investigation

4.5.3 Sanitary Landfill Design

4.5.3.1 Design Life

The 'life' of a Sanitary Landfill will comprise of an 'active' period and a 'closure and post-closure' period. The 'active' period may typically range from 20 to 25 years depending on the availability of land area. The 'closure and post-closure' period for which a Sanitary Landfill will be monitored and maintained will be 25 years and more after the 'active period' is completed.

Life of a Sanitary Landfill comprises of:
- Active Period: 20-25 years
- Closure and Post-Closure Period: 25 years more after active period

4.5.3.2 Specific Waste Volume; Sanitary Landfill Capacity And Area

A rough 'capacity needs assessment' was already conducted as the first step of the site selection process. An in-depth capacity calculation will be a first step in the design process, taking into account the SWMP and computed waste amounts for the 'active' period of the Sanitary Landfill.

Landfill volume estimates are necessary for planning and determining the dimensions of new landfill

Based on the SWMP the volume of waste to be placed in a Sanitary Landfill should be roughly calculated under the following assumptions:

- One tonne of waste is equivalent to one m^3 of Sanitary Landfill volume. (In reality the specific weight of waste in a Sanitary Landfill is 0.8 t/m^3 during the first years and will increase after settlement over the time to 1.2 t/m^3).
- Covering of waste will use about 10% more volume

Density of waste material in landfill will depend upon refuse compaction, moisture content and the degree of compaction.

The total Sanitary Landfill area (for details see next section) would be larger than the area

Amount of soil necessary for daily and final cover must be added to the refuse volume amount in order to obtain final landfill space projection.

required for the filling area to accommodate all infrastructure and support facilities as well as to allow the formation of a green belt around the Sanitary Landfill.

From an economical point of view a small base area with a high Sanitary Landfill is preferable, because it reduces considerably the cost for the sealing systems, leachate collection system and operational roads. The generation of leachate and the related costs will also decrease.

From a technical point of view it is important to guarantee the runoff of rainwater. Therefore minimum inclinations have to be maintained at the slopes. Every footprint of the disposal area of a landfill will have to maintain a certain minimum height to meet these inclination requirements. The height of the sanitary landfill is also constrained by the overburden pressure on the soil. capacity of the soil, it should be within acceptable limits.

From an environmental point of view a sanitary landfills with considerable heights can interfere with the landscape and cause visual disturbance. However, restricting the height would result in larger landfill footprints, requiring larger tracts of land. The larger the base of the landfill, higher is the risk of leachate contamination of groundwater.

4.5.3.3 Sanitary Landfill Layout

As explained above, a Sanitary Landfill site will comprise of the area in which the waste will be filled as well as additional area for support facilities. Within the area to be filled, usually only a part is under active disposal in a specific phase of operation. Figure 4.2 depicts a typical layout of a sanitary landfill.

The following facilities must be located in the layout:

- access roads;
- equipment shelters;
- weighing scales;
- office space;
- location of waste inspection and transfer station (if used);
- temporary waste storage and/or disposal sites for special wastes;
- areas to be used for waste processing (e.g. shredding);
- demarcation of the Sanitary Landfill areas and areas for stockpiling cover material and liner material;

- drainage facilities;
- location of Sanitary Landfill gas management facilities;
- location of leachate treatment facilities;
- location of monitoring wells;
- tyre cleaning unit.

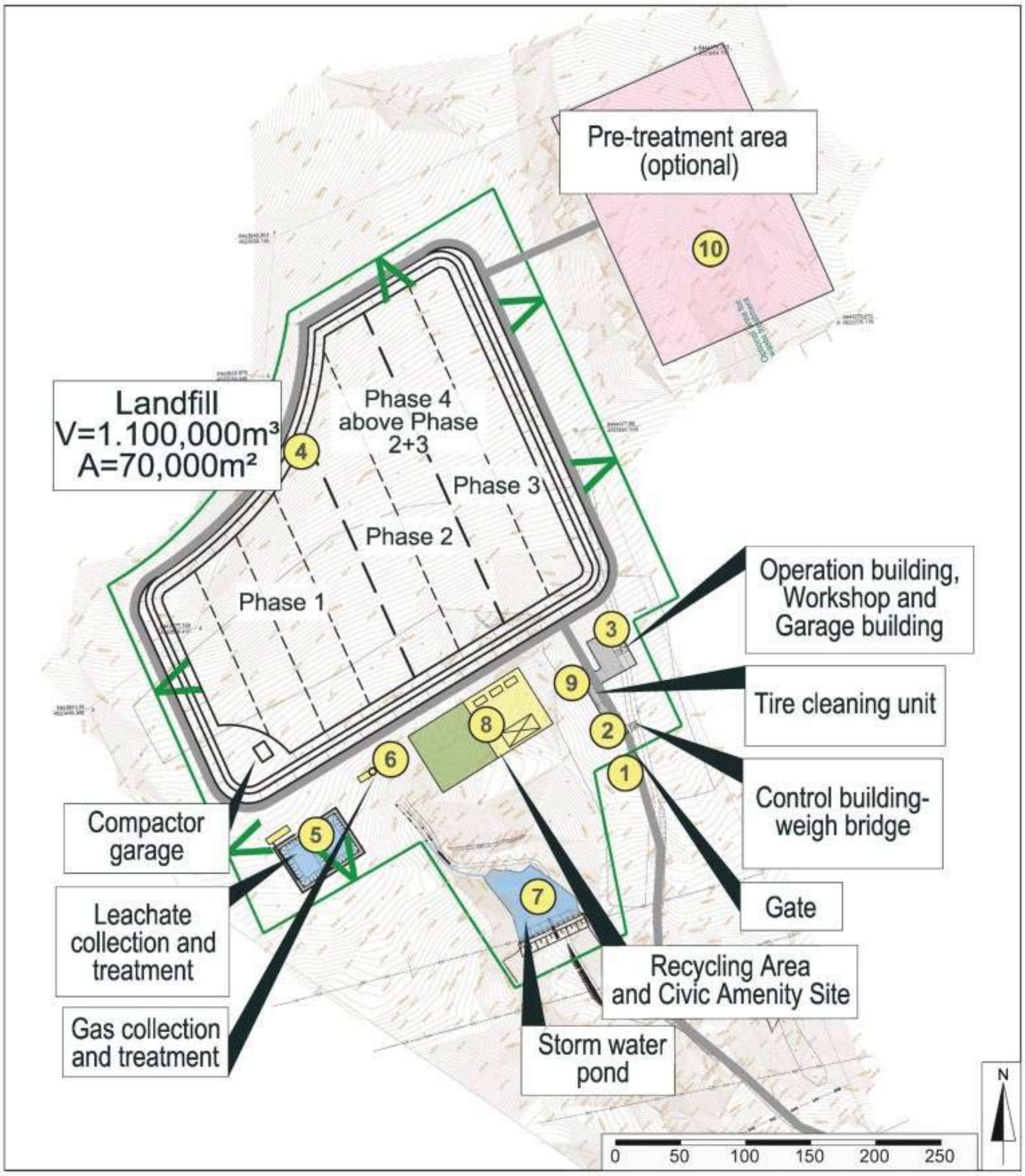


Figure 4.2: Typical Sanitary Landfill Layout with Facilities

For each Sanitary Landfill site a layout has to be designed incorporating all the above mentioned facilities. The layout will be governed by the shape of the Sanitary Landfill area.

4.5.3.4 Technical Design Requirements

The technical design specifications of sanitary landfill focus towards efficient leachate management

The design of the Sanitary Landfill focuses on optimized leachate management, as leachate generation is a main source of potential environmental pollution. It is important to minimize leachate generation and to avoid leachate being retained for a long time in the landfill body.

A landfill can be both above ground or partially below ground, based on the local hydro-geological situation and the availability of land. Where abandoned quarries are to be used as potential sanitary landfill sites, the landfill could be a below ground landfill, depending on the site situations.

Landfill constructed above ground faces minimal environmental impacts as leachate could be easily drained and collected for further treatment

Above ground landfills have the advantage that leachate can flow by gravity according to the natural surface slope; leachate is collected in the main leachate pipe (header pipe) which is laid to extend beyond the footprint of the landfill. Leachate is pumped only from outside the footprint of the landfill.

At locations where water table is not close to the ground surface, landfill base can be at a level below the ground level, by excavation, to accommodate more waste per unit area of land.

However, below ground landfills are to be engineered and constructed appropriately to address the following issues:

- Additional costs for excavation
- Leachate cannot flow by gravity and has to be pumped; continuous pumping of the leachate during and beyond the active life of the landfill is required.
- Environmental risks caused by non-functional pumps;
- Potential for retention of leachate in the waste body;
- No possibility of pipe cleansing and controlling;
- Pumping cost for the leachate during the lifetime and the aftercare phase of the landfill.

Sanitary Landfills in Hilly Regions

In hilly regions it is usually not possible to find flat ground for Sanitary Landfills. Slope Sanitary Landfills and Valley Sanitary Landfills have to be adopted to the topographical conditions. In a slope Sanitary Landfill, waste is placed along the sides of existing hill slope. Control of inflowing water from hillside slopes is a critical factor in design of such Sanitary Landfills.

The design of these landfills needs additional site investigations and calculations. Furthermore, the sealing system has to be adapted to the regional conditions. If adequate quantity of clay or fine soil is not available and the soil has permeability in excess of 10E-7 cm/sec, use of additional layers of geosynthetics, geocomposites or geo-synthetic clay liners can be considered along with the locally available low permeability soil. The requirement of 90cm clay (of best available quality locally) should be complied with and the overall equivalence of such design of soil and additional layers will be checked and certified by geotechnical experts. Where required soils amended with bentonite may be used to meet design specifications.

Sanitary Landfills in Marshy Regions

Sanitary Landfills should not be constructed in marshy areas. Under such circumstances the local authority should access a regional landfill facility outside the marshy area.

4.5.3.5 Base Sealing System

The shape of the site should be adapted to the existing conditions with a minimum of fills and cuts. However the mass which will be replaced by the sealing system has to be excavated.

Excavated soil could be used as a potential base sealing system and can also be compacted to be used as overlying clay liner

For construction of the landfill geometry, the planned landfill embankments and retaining dikes soil material is required which can be taken from the excavation part for the base sealing system. The remaining excavated soil should be stored for covering of waste during landfill operation.

The natural soil should be levelled and compacted to achieve 90% maximum dry density as obtained from Proctor tests, which is sufficient to compact the overlying clay liner.

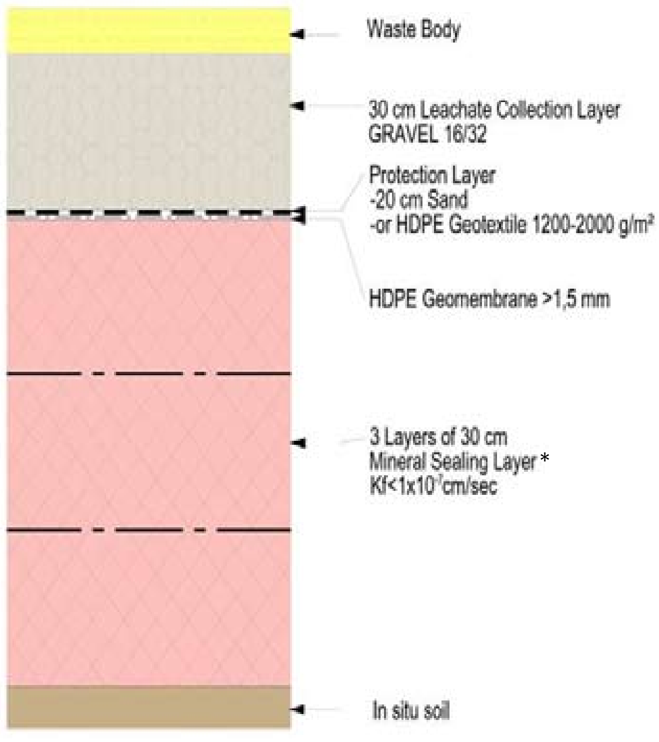
The base area has to have a sufficient slope to guarantee draining of leachate and stormwater. Minimum inclinations are indicated in the following table 4.4.

Table 4.4: Minimum slopes inside the sanitary landfill

Area	Minimum Inclination
Base sealing	3 % for leachate pipes, roof profile
Main leachate pipe	1.0 %
Secondary leachate pipe	3.0 %
Final slopes	Not less than 1:4 and not greater than 1:20

The composition of the base sealing system has to be in compliance with MSW Rules 2000. It should consist of:

- Mineral sealing liner as illustrated in the figure 4.3 comprises of three layers of clay or equivalent amended soil, at least 30 cm thickness each. In case adequate clay is not found in the vicinity, amended soil mixed with Bentonite can be used. The permeability of the mineral sealing must be less than kf ≤ 1 x 10-7 cm/s.
- In hilly regions the mineral part of the sealing system can be reinforced by a geosynthetic clay liner (see box below), if clay or natural soil for Bentonite mixture is not available in sufficient quantity at an acceptable transportation distance.



*Mineral sealing layer: compacted clay/amended soil

Figure 4.3: Base Liner

Use of Geo-synthetic Clay Liner (GCL) for Municipal Solid Waste Landfill

GCL is engineered to provide an impermeable barrier and could replace the usage of a mineral layer (clay) in the landfill base and cover. It consists of Bentonite clay bonded to a layer or layers of geo synthetics.

Bentonite (sodium montmorillonite) is volcanic clay and is used in a number of applications including geosynthetic clay liners. In India, Calcium bentonite is commonly used, which has attributes similar to sodium bentonite.

GCL is typically bentonite sandwiched between geotextiles: This is ideal for most liner and sloping applications. The GCL may be further reinforced by an additional layer of HDPE liner.

- HDPE geomembrane with a standardized thickness of 2 mm. Only HDPE geomembranes should be used, which comply with the requirements of American Society for Testing and Materials (ASTM) or corresponding applicable standards.
- A protection layer (of silty soil) 20 cm to 30 cm thick or alternatively a protection layer (geo-textile) with a weight of 2,000 g/m^2 or 1,200 g/m^2; depending on the landfill height.
- A leachate drainage layer 30cm thick made of filter gravel, ensuring a permeability greater than10-2cm/sec

4.5.3.6 Landfill Phasing

The excavation of the base of the landfill should be phased in accordance with a pre-determined phasing plan. In order to minimize damage to the landfill base layers and ensure their continued integrity over the lifetime of the landfill and also to minimize potential for infiltration of rain water, the excavation of the base is done in "phases". The extent of each phase is designed such that the proposed waste fill volume (based on extent of base and waste fill contours) should be large enough for a period of atleast two-three years. The base of the entire landfill would be excavated within the first few phases and subsequent waste placement would only be over already placed waste, until final waste fill contours are reached. Please see figure 4.4 for further details.

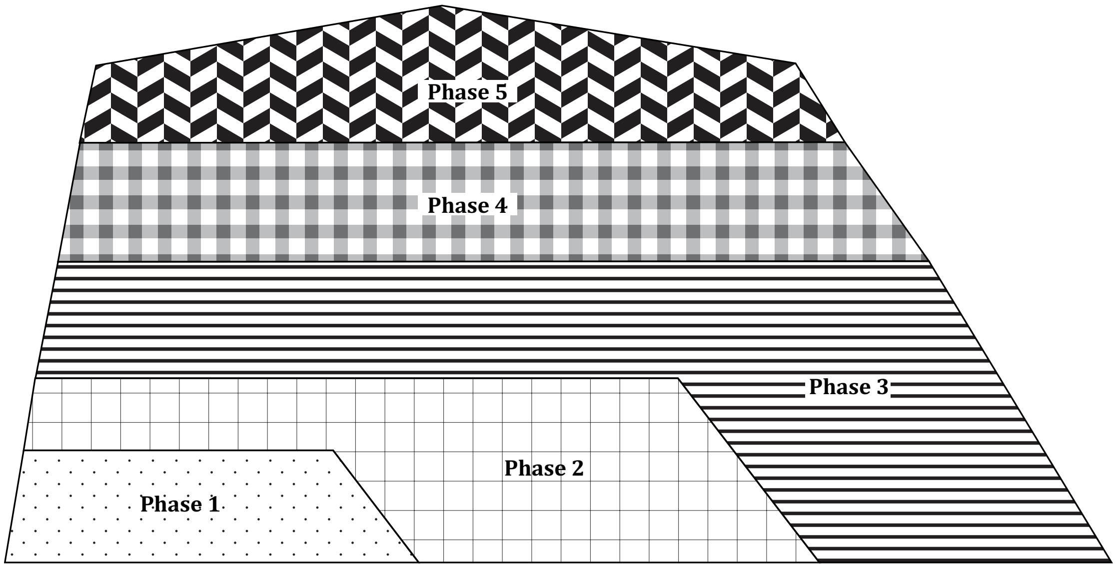


Figure 4.4: Indicative Longitudinal Section Profile of Landfill Phasing

It should be noted that the phases of the landfill which include the edge of the landfill have certain specific construction needs.

1. Integrating the base clay liner with the clay barrier layer in the top cover.
2. Preparation of a granular blanket layer, which is an extension to the drainage layer of the Leachate Collection System (LCS) system along the side slopes of the base. This granular blanket layer is required to prevent the entry of any rainfall runoff into the waste layers from the periphery of the landfill.
3. Tucking in the geotextile and HDPE liner into the trench located along the periphery of the landfill, till the top cover is built, in order to maintain stability and integrity of the liner as illustrated in figure 4.5. Once the top cover is placed, the HDPE liner will remain in the trench, but the geotextile will be turned in and taken below the gravel layer of the gas venting layer.

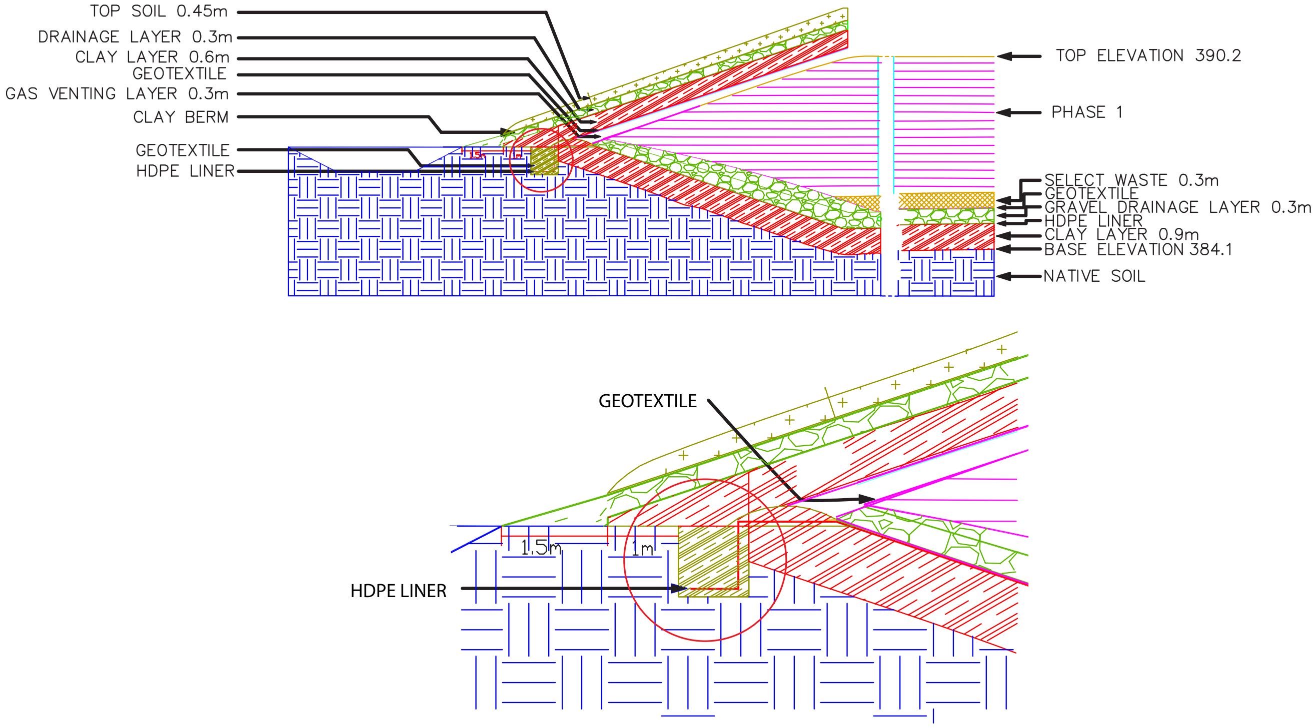


Figure 4.5: Liner placement at edges of the landfill

At the end of each phase, until the edge of the fill is reached, the HDPE and the geotextile of the liner are tucked into a trench, a temporary ramp – road into the landfill is prepared beyond the trench and a clay berm is constructed beyond this road to prevent runoff entering into the sub-cell.

The first layers of waste above the liner layers are always made up of select waste (30 cm). Select waste is defined as waste which has no sharp objects and hard debris in it and has a size range not exceeding 2 cm. The side slopes of the base have an extra layer of granular soil to prevent infiltration of any water into the waste. This layer acts as a granular drainage blanket and drains any water into the Leachate Collection layer.

Once the top fill contours are reached during any phase, part of the top cover layers is also laid.

4.5.3.7 Leachate Management

One of the most important objectives of a successful landfill management system is to avoid leachate generation as far as possible and to efficiently drain the leachate contained in the waste body and from other contaminated areas. As per the Rules, organic and hazardous wastes should be diverted away from the landfill.

Leachate generation amount should be estimated based on run-off coefficient and other data for efficient planning of leachate treatment system

4.5.3.7.1. Leachate Generation

The principal sources of leachate include:

- Moisture content of waste entering the landfill
- Infiltration from direct precipitation on the waste surface
- Sealed areas of landfill which are only partially covered with waste
- Surface water flow onto the active face of the landfill

To minimize the generation of leachate the system should be designed in a way that only filled areas and currently operated areas are connected to the leachate collection system. The other sections should be connected to stormwater ditches by using a storm water bypass system. Therefore the sealed landfill area should be divided into strips of several filling sections.

4.5.3.7.2. Leachate Collection

The base sealing system of the landfill should have a roof profile with a slope to the side embankment. The leachate from the waste body will be collected in the drainage layer system and in the secondary drain pipes made of HDPE and will be directed to the main leachate pipes outside the waste body. The leachate collection system (LCS) consists of three main components: a drainage layer, a series of collection pipes and a non-woven geotextile separator layer as illustrated in figure 4.6. The LCS layer is also to be laid along with the base, according to the phasing plan.

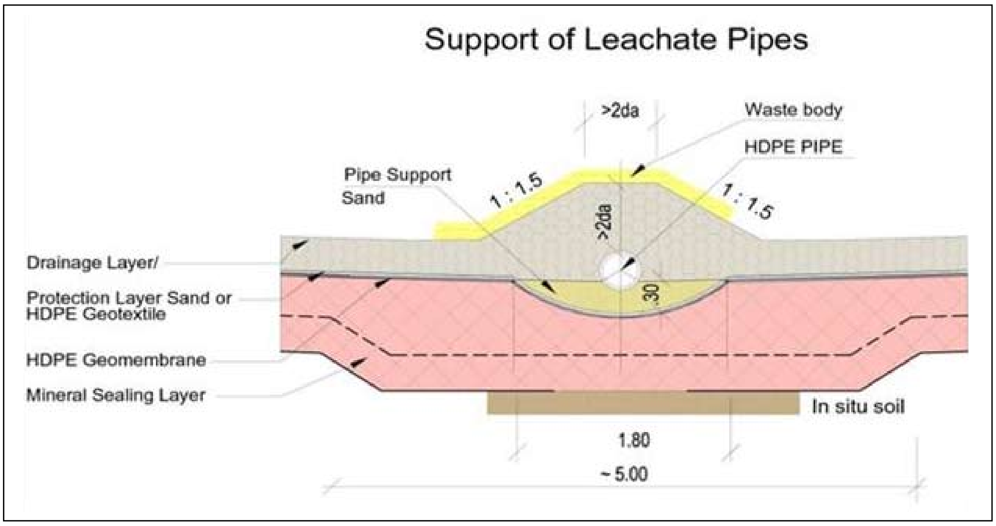


Figure 4.6: Support of Leachate Pipes

The leachate collection system and its components are to be laid over the HDPE geomembrane.

Gravel Drainage Layer: The LCS layer consists of a 30 cm thick gravel drainage layer of 25-50 mm sized rounded gravel. The slope of the gravel drainage layer follows the minimum slopes required for the leachate collection system and slopes towards the collection point.

LCS Pipes: Drain pipes are made of HDPE and slotted or holed on 2/3 of the circumference of the pipe. The diameter should be minimum 200 mm for secondary and 250mm for main leachate pipes. The mentioned diameters should not undercut to allow controlling by remote camera systems. The wall thickness of pipes has to be calculated under the consideration of the overburden stress due to filling height of waste.

Perforated HDPE pipes are embedded in this gravel layer. The networks of HDPE pipes collect the leachate and are connected to a LCS sump(s). Leachate from the sump(s) is to be pumped to the proposed leachate treatment plan for disposal.

The specified distance between the secondary drain pipes should be around 40 m.

At the end of the secondary leachate collection pipes, access windows for inspection and cleansing of pipes should be installed. The HDPE pipes are connected by welding.

Geotextile Layer: Further protection from clogging in the LCS will be provided by a non-woven geotextile installed above the entire stone drainage blanket. The geotextiles on top of the stone act as a separator layer between the drainage blanket and the solid waste and also provides additional filtering capacity to help maintain the high permeability of the underlying drainage layer. The geotextile covers the base and side slopes of the base and is tucked into a trench running along the periphery of the landfill limit. Once the top cover is laid, it is turned into the top cover and placed below the stone layer of the gas collection layer of the top cover.

At no time should vehicles be allowed to pass over the geotextile without a buffer layer in between.

The entire process of construction and arrangement of leachate collection system is illustrated through figure 4.7-4.10

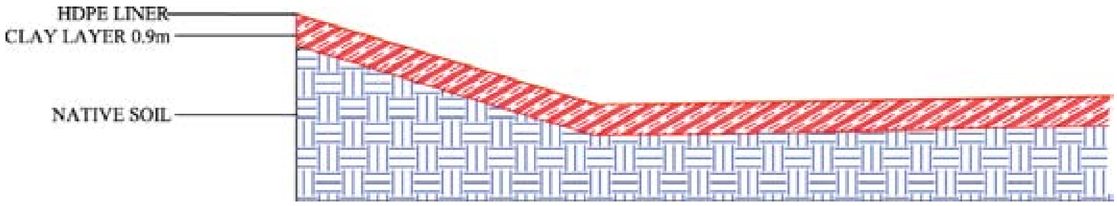


Figure 4.7: Placement of the HDPE Liner over the Clay liner

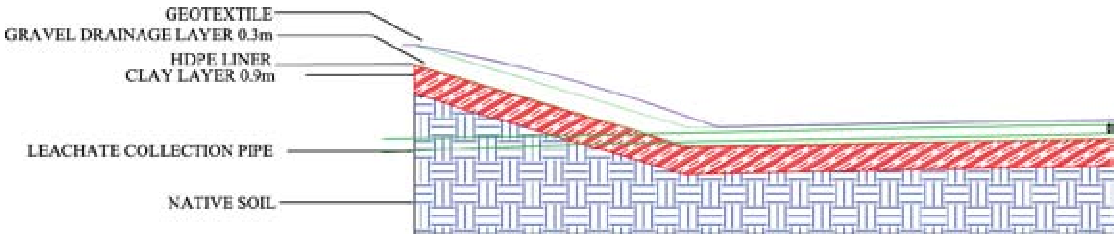


Figure 4.8: Placement of the Gravel Drainage Layer and Geotextile over the Clay liner

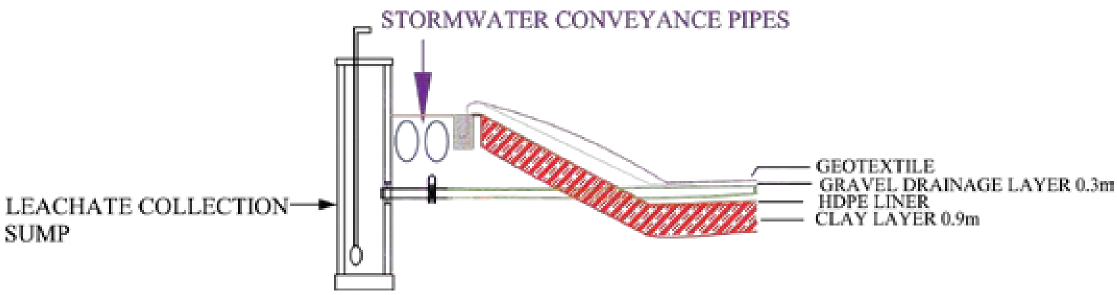


Figure 4.9: : Leachate Collection Pipes are to be connected to a sump, through the liner (in case of below ground landfills)

The primary criterion for design of the leachate collection system is that all leachate be collected and removed from the landfill at a rate sufficient to prevent a hydraulic head greater than 12 in from occurring at any point over the lining system. The system is designed to remove the accumulation of storm water resulting from a 25-year, 24-hour storm, within 72 hours. Other design criteria include the following:

- Bottom of the leak detection layer and the leachate collection layer is sloped at a minimum 2%.
- Granular drainage layer is 1 ft. thick with hydraulic conductivity >1 x 10-2cm/s.
- The system must be designed to minimize clogging.
- The system is located above seasonally high water table.
- System must be designed to handle the runoff from a 25-year, 24-hour storm.

4.5.3.7.3. Leachate Pond

The leachate pond is a basin to retain and pre-treat leachate within a period of several days. The pond allows sedimentation and biological stabilisation. Organic pollutants in the leachate are removed by micro-organisms and by sedimentation processes. At the bottom of the pond a mixture of mud and water will be settled, that will be pumped to the landfill when the pond is cleaned.

Leachate ponds help in sedimentation and biological stabilization of leachate

The leachate pond should have two basins to achieve an optimal leachate management (please refer to figure 4.10). Division of the leachate pond into two individual ponds will make it possible to clean the ponds and their associated pipes. One basin might be cleaned or repaired while the other stays operational. The pond will be a necessary base for all further treatment methods.

Leachate could be either:

- discharged to waste water treatment system for co-treatment ,
- recirculated through the landfill,
- treated using biological or physico-chemical treatment
- evaporated

Figure 4.10: Sealed Leachate Pond with Two Basins

4.5.3.7.4. Leachate Treatment

The type of treatment facilities to be used depends upon the leachate characteristics. Typically, treatment may be required to reduce the concentration of the following prior to discharge: degradable and non-degradable organic materials, specific hazardous constituents, ammonia and nitrate ions, sulphides, odorous compounds, and suspended solids.

The appropriate leachate treatment scheme would significantly depend on the organic content of the disposed waste. As per the MSW (M&H) Rule, biodegradables should not be disposed off in landfills. However, either due to absence of processing facilities or even the organic content in rejects from processing facilities, landfills are not devoid of biodegradable material. The concentrations would however vary from landfill to landfill.

A leachate treatment facility should be designed by an experienced landfill engineer in cooperation with a waste water treatment specialist.

Laboratory tests (TCLP) should be conducted to ascertain the quality and constituents of leachate.

Based on the chemical characteristics of the leachate, treatment processes may include biological processes (such as activated sludge, aeration, nitrification/denitrification), chemical processes (such as oxidation, neutralisation) and physical processes (such as air stripping, activated adsorption, ultra filtration etc.), based on leachate characteristics.

In many countries co-treatment of leachate with sewage is practiced successfully. However, depending on the age of the waste, the chemical composition of the leachate varies and would result in significant loads of different constituents at different times on the sewage treatment plant (STP). The BOD and nitrogen load are critical and should be considered before assessing whether an existing STP can handle incoming leachate.

Evaporation of Leachate:

One of the simple techniques used to manage leachate is to spray it in lined leachate ponds and allow the leachate to evaporate. Additionally, the leachate can be irrigated on the slopes of the pond to intensify the evaporation rate as shown in figure 4.11.

Figure 4.11: Irrigation of Leachate on the Slopes of the Pond

Such ponds have to be covered with geo-membranes during high rainfall periods. The leachate is exposed during the dry and hot months to allow evaporation. Odour control has to be exercised at such ponds.

The treated leachate may be discharged to surface water bodies, after ascertaining the quality as per the norms for discharge to inland water systems, specified by the MSW (M&H) Rules, 2000.

4.5.3.8 WASTE PLACEMENT

A 30 cm thick layer of select waste will be placed on the geotextile as and when the laying is completed. It is preferable that this select layer of waste be left without compaction. In order to dump subsequent layers of waste, soil should be pushed gently by a light dozer to make a path. Dumping of soil directly on the membrane should be avoided as much as possible. One or two main routes with 60-90 cm of soil should be created for use by heavier equipment for the purposes of soil moving. Damage to the membrane due to traffic can be severe and undetectable and hence should be avoided at all times. The first lift of waste should be spread and compacted with light vehicles. It is preferable not to compact the first foot of waste. No bulky items should be dumped in the first lift.

4.5.3.9 INFRASTRUCTURE OF SANITARY LANDFILL

4.5.3.9.1. Road Construction

A sanitary landfill should provide basic infrastructure and resources like roads, water supply, energy etc.

Access Road

The access road to a Sanitary Landfill should be constructed in accordance with the following design parameters:

- Widths of roadways with two lines: 6.5 m
- 20 cm stabilised sub-foundation layer, antifreeze layer if located in frost prone areas,

Roads within the site

Roads within the site should have:

- Widths of roadways: 3.0 m
- Structure: Foundation layer made of broken material or demolition waste, 40-50 cm

4.5.3.9.2. Equipment / resources

The Sanitary landfill should be supplied with:

- Water Supply
- Energy
- Communication
- Sewage System

- External Lighting
- Fire Fighting (external)

4.5.3.9.3. Waste Inspection Area /Emergency Area

The incoming waste has to be controlled within the entrance area. This area will also be used for parking during bad weather conditions while waste disposal on the landfill site is not possible.

4.5.3.9.4. Security and Fencing

Site should be peripherally fenced to ensure children, scavengers and cattle outside the boundary

Site security is among the most important considerations in landfills. The site should be secured to implement a good standard of service. In order to achieve this, the site has to be peripherally fenced and access to the landfill limited to one entrance gate, which will be blocked when the site is unattended. The fence will also keep children, unwanted / unorganized scavengers, cattle and animals out the site. It will also protect litter to be blown out of the landfill site.

4.5.3.9.5. Tyre Cleaning Unit

The tyre cleaning unit consists of concrete and a removable horizontal steel grit. The water of the tire cleaning unit will be discharged by a mobile pump to the leachate collection system. The mud will be excavated by a loader and disposed of at the landfill.

4.5.3.9.6. Sanitary Landfill Buildings

Sanitary landfill buildings will comprise of separate facilities for men and women, with adequate provision of toilets and shower rooms

Weighbridge and Control Building

The control building should be located next to the main entrance gate of the landfill and has electronic installations inside for control of the weighbridge. The area of the control building is around 25 m^2. The weighbridge should be situated adjacent to the Control Building. Administration Building

The Administration Building should include Manager's Office; Offices for Manager's Assistants, Meeting Room, Cafeteria, Kitchen, Secretary, Toilets& showers, Dressing Room, Rest Room, Storage.

Garage and Workshop

The garage is needed to shelter and to repair all mechanical equipment to be used in the landfill (except landfill compactor and bulldozer). The workshop or repair-centre in the garage will be a completely independent unit equipped to repair equipment and vehicles. Except for the costly or composite parts, the depots of the garage shall carry spare parts of vehicles, compactors and other equipment, according to the service contract signed by the suppliers of the equipment and the municipality.

Compactor Shed

The Compactor Shed should be located beside the disposal area. This building serves as a protection for the landfill compactor and bulldozer from bad weather conditions while they are not in operation.

4.5.4 Construction Of A Sanitary Landfill

Figure 4.12: Sanitary Landfill under Construction

4.5.4.1 Supervision Of Construction Works

The construction of Sanitary Landfill (please refer to figure 4.12) should be supervised by an Independent Engineer on behalf of the Municipality or of the employer. The main tasks are:

- Acceptance of the Drawings and the Final Design
- Quality assurance of all operations related to the landfill and their compliance with the MSW (M&H) Rules, 2000/2014;
- Time scheduling, steering and co-ordination of the construction sites;
- Acceptance of the construction work and supply.

4.5.4.2 Quality Assurance

Test Field: In order to ensure the sanctity of the liner system after sealing operations, a test field may be established, which is to be included as a part of the standard operating procedure for designing the landfill. The costs for establishing the test field (please refer to figure 4.13) should be included in the overall project costs.

Figure 4.13: Construction of Test Field

The test field has to be constructed outside of the sealing areas and have to be retained and protected for the entire duration of construction to prove the sanctity of the liner. Within a test field, the suitability of all materials for sealing must be proved under actual conditions of the site. The results of these tests should be considered as the basis for the detailed design.

Construction of the test field should start on the surface with 3 layers of clay. A trial pit shall be installed in the test field for visual check of the quality of the compressed layers.

Three samples of each test field (investigation area) must be examined for the following (laboratory tests):

- Truck drive tests
- Determination of density
- Determination of deformation module
- Proctor density
- Water permeability
- Water content

All tests and examinations required for each layer should be carried out by an independent engineer.

These results must be evaluated and documented including the following conclusions with regard to the design of the mineral sealing system:

- Compacting methods;
- Compacting equipment;
- Number of compacting passes of roller;
- Operation speed of compacting equipment;
- Thickness of compacted layers and those which are not compacted.

The test fields must be at least 20 m in length, the minimum width must be 2 machine widths plus the required ramps 1:10 and the embankments 1:5 as well as the distance of acceleration and deceleration with driving tracks as wide as the equipment, which are arranged alongside.

The test fields are to be built in the bottom and embankment area of the landfill. They show therefore the same slopes as the fields built later. After the mineral sealing material has been tested, the application of the other sealing compounds, protection layer and drainage layer will be tested in the test field accordingly (please refer to figure 4.14). This has to be done for the base sealing as well as for the surface sealing.

Figure 4.14: Test Field with all Sealing Components

Mineral Sealing layer

For the sealing material as well as for the construction, the requirements are as follows:

- Selection of the grain size distribution of the mineral material must prevent micro substances from getting discharged (suffusion stability /dispersion stability) as well as increasing the crack resistance.
- Soil containing coarse gravel and stones, wood, roots and other impurities shall not be applied. The digging locations provided for supply of the mineral material shall be examined thoroughly,
- When the sealing material is introduced, it must be homogenous and show homogeneous water content.
- The water content (w) must be higher than the Optimum Moisture Content (OMC) determined from Standard Proctor Test. Mineral sealing layers shall not be constructed under bad weather conditions (rainfall).
- The top of the landfill surface bearing and of each completed layer of the mineral sealing system must be dewatered sufficiently. The required layer thickness, which shall not be exceeded by more than 10 %, will be determined on the test field. Special attention shall be paid to tight intermeshing (compound) of the layers built one on the other.
- If required, the mineral sealing material must be homogenised and crushed by means of a milling cutter.

- Compression with the sheepsfoot roller is of special importance thanks to its kneading and packing effect.
- The top layer surface of the sealing system shall be flat and without driving tracks.
- After completion of each compacted layer, an acceptance test shall be carried out before start of introducing the next layer or the placement work of the geo-textiles.

HDPE Geo-membrane

For constructing the layer the following items have to be considered:

- The constructing and placing of the liner has to be supervised
- A suitable firm has to place the plastic liner
- Material requirements / tests
- Thickness of HDPE geomembrane(refer to figure 4.15) must not be less than 1.5 mm
- Proof of stamp-pushing-force /plunger puncture has to be ensured
- A manufacturer certificate, including product name and specifications, is needed.
- Static proof has to be ensured as well
- Proof of stability and resistance to sliding during building and final state.

A storage area must be prepared on site according to manufacturer.

For placing the plastic layer, among other things, the following issues have to be regarded:

- Welding of the HDPE liner is only carried out if the temperature is > 5 °C.
- On the surface of the HDPE liner, no water is allowed.
- The regulations of the manufacturer have to be regarded (width of the overlapping, welding, etc.).
- The placed plastic liner has to be fixed (e. g. sandbags).
- It is forbidden to drive on the welded plastic liner with any equipment (only with the necessary equipment for welding).
- Every welding seam (refer to figure 4.16) has to be proofed (stability, density, thickness).

Figure 4.15: Welding of HDPE Geomembrane

Figure 4.16: Proof of welding seams

Geotextile

For protection of the HDPE liner a geo-textile must be applied when building the base sealing system.

For the surface sealing system the geo-textiles are applied on the equalising and drainage layer.

The prescribed overlapping widths must be adhered to each other. The geo-textile must be laid in longitudinal roll direction with the inclination of the embankment. It is not allowed to drive on the webs laid, and equipment or machines shall not be placed on the layers under any circumstances.

The web position must be secured by appropriate measures (i.e. sand bags) to prevent them from getting lifted.

Material requirements / tests:

- Weight of geo-textile: 2,000 g/m^2 and/or 1200 g/m^2 (above HDPE liner)
- 1,200 g/m^2 (surface sealing)
- 150 g/m^2 (surface sealing)
- Proof of stability and resistance to sliding during building and final state.

4.5.4.3 DRAINAGE LAYER

For the base sealing system the drainage layer is built on the protection layer. The drainage layer must comply with the following requirements:

- The chemical/physical and mechanical stability of the material selected for the drainage layer must ensure that there is no negative effect on the drainage efficiency from the chemical and physical leachate characteristics and the mechanical load of the landfill body.
- For the drainage layer, washed material shall be used, and rounded grains shall be preferred.
- Grain-size distribution of the material to be used for the drainage layer, with permeability greater than 10^{-2} cm/sec.

4.5.4.4 Leachate Collection System

The leachate collection system at the base of the landfill consists of the following, from top to bottom

- Non-woven geotextile
- 300 mm thick granular leachate collection layer, with granular diameter ranges from 25 mm to 50mm, overlying a geosynthetic clay liner and a 900 mm layer of compacted clay layer. The landfill base will be covered with the solid waste in thin layers of about 1.5 to 2.5 m, placed over the non-woven geotextile. The granular leachate collection layer must be designed such that the calculated hydraulic head of leachate above the composite liner is less than 0.3 m.
- Leachate collection pipes: The function of the HDPE leachate collection pipes is to convey the leachate collected by the granular leachate collection layer to the leachate sump, where the leachate can drain freely and be removed by pumping before the level of leachate in the sump reaches the invert of the pipe.

Leachate collection pipes must have adequate flow capacity to convey the leachate and adequate structural resistance to withstand the applied loads. In addition, since collection pipes are usually perforated to permit flow of leachate into the pipes, the size of the perforations must be large enough to accept the flow of leachate into the pipe without the buildup of head, and small enough to prevent gravel from entering the pipe. Figure 4.17 depicts proper welding practices to be followed while welding HDPE pipes. Figure 4.18 depicts the proper placement of holes in the leachate pipes.

The leachate collection pipe and the granular material must be able to withstand the applied loads due to the overlying materials and equipment used at the facility throughout the entire design period. Three pipe failure mechanisms must be considered when designing a buried plastic pipe to be structurally stable under loads. These mechanisms are

- Wall crushing;
- Wall buckling; and
- Excessive ring deflection.

The following issues have to be considered while laying and attaching the HDPE pipes:

- Permission for HDPE welding submitted by the construction firm;
- Welding records for each welding seam made;
- Pipes to be covered with filter gravel after each working day;
- Visual check of position and slopes ;
- Check of the inside walls of the pipes and the welding seams with a movable video camera;
- Pressure tests of the solid wall pipes of the leachate collector;
- Daily visual acceptance before covering, complete acceptance after submission of all build-in test results.

Figure 4.17: Welding of Leachate Pipes

Figure 4.18: Proper Holed Leachate Pipes

4.5.4.4 Slope Stability Aspects And Seismic Aspects

The stability of a landfill should be checked for the following cases:

- stability of excavated or filled slopes;
- stability of liner system along excavated or filled slopes;
- stability of temporary waste slopes constructed to their full height (usually at the end of a phase);
- stability of slopes of above -ground portion of completed landfills;

- stability of cover systems in above -ground landfills.

The stability analysis should be conducted using the following soil mechanics methods depending upon the shape of the failure surface:

- failure surface parallel to slope;
- wedge method of analysis;
- method of slices for circular failure surface and
- special methods for stability of anchored geo-membranes along slopes.

4.5.5 Sanitary Landfill Operation

4.5.5.1 General Requirements

4.5.5.1.1. Operation Manual

Before the operation of a Sanitary Landfill can be undertaken it is important to develop the operating rules and methodologies, which will be documented in an Operation Manual.

This manual should serve as a guidance document for the Municipality, for a private landfill operator and the personnel working at the Sanitary Landfill sites to aid them in controlled landfill operations.

This operation manual should also be part of any operation contract for private operators of the landfill site.

The Operation Manual should comprise the following main aspects:

- Controlling and recording of landfilled waste
- Guide to use the remaining capacity in an optimized way with the support of filling plans and strategies,
- Guide to undertake all operational duties required at the landfill site,
- Basic health and safety measures,
- Maintenance of landfill facilities and landfill equipment if available.

4.5.5.1.2. Employee Assignments and Responsibilities

The composition and number of the landfill staff have to be designed according to the size and the requirements of the Sanitary Landfill. Table 4.5 suggests the following staff and chart for the operation landfill site.

Table 4.5: Provisional Staffing Table

Department	Functions
Management	Landfill Manager
Administration	Controller Weighbridge operator Night watchmen
Operation	Foreman Machine drivers (Wheel loader, dozer) Spotter Unskilled worker
Total	**Landfill staff**

4.5.5.1.3. Staff Responsibilities and Qualifications

The list in table 4.6 indicates the major assignments and responsibilities of the various employees who work at the landfill. However, the table does not necessarily includes all duties that may be required to safely and successfully operate the Sanitary Landfill. The list should be mandatory for private as well as municipal operators.

Table 4.6: Staff Qualification

Functions	Responsibilities	Education / Experiences
Landfill manager	Responsible for the Waste filling Compliance with operation manual and filling plans Responsible for daily (short-term) personnel planning Responsible for supervision of the controller (weighbridge operator) Responsible for customers' contacts Adherence of safety rules	Civil engineering technician Training in safety matters Training in environmental issues Knowledge of environmental legislation.

Functions	Responsibilities	Education / Experiences
Weighbridge operator (Controller)	Controls and recorded the incoming waste Operates the weighbridge Directs the vehicles to the disposal area Visual monitoring of delivered waste other than municipal waste	Administration competencies, Training in environmental issues Knowledge of environmental legislation.
Night Watchman	Responsible for site security especially during night time	Training in safety matters
Foreman	Responsible for the waste filling procedure Responsible for the daily personal and equipment planning Responsible for the control of the compaction of the landfill Responsible for the cell construction Responsible for road construction and control of the condition of the roads	Trained foreman with long-time experience in construction works; Training in safety matters
Spotter	Responsible for the traffic regulation on the filling area and for organization of waste disposal Checking of unloaded waste	Special training in filling procedure Training in distinction of different waste and of acceptable or unacceptable waste Basic training in safety.
Bulldozer; etc drivers	Responsible for the filling and the compaction of waste in the landfill. Responsible for waste unloading organization together with the Spotters. Daily Inspection and maintenance checks of machinery. Cleaning machines	Vehicles drivers licence Special training on compactor and bulldozer Basic training in safety.

4.5.5.1.4. Hours of Opening and Operation

The days and hours of opening of the landfill site for public deliverers should be determined by the Municipality and the operator of the Sanitary landfill. The opening hours should be published on a sign board and in the in the related news papers/ websites.

4.5.5.1.5. Site Notice Board

A notice board has to be installed at the entrance to the site, which should specify the following:

- The name and contact information for the sanitary Landfill site, including the telephone number;
- Opening days and times;
- Opening time, site rules and regulations – such as "No Smoking", "Wear Safety Clothes"etc.

4.5.5.1.6. Site Security

The Security has to ensure that the site is safe and secure at all times. The security staff will provide after hours security patrol around the entire landfill site. The security staff will be responsible for operating and maintaining the following:

- Landfill entrance security
- Safeguarding the on-site vehicles and equipment
- Reporting any security related incidents immediately to the landfill manager
- Completing the daily site security check list for the entire facility

4.5.5.1.7. Waste Reception and Control of Incoming Waste

All deliveries from collection vehicles of the Municipality and from private service providers by checking the (registered) license plate number, the respective labelling on the vehicles or the respective license.

Corresponding lists with the license plate numbers have to be compiled beforehand by the landfill supervisor, in order to help the weighbridge operator to identify the vehicles.

Waste deliveries from licensed commercial and industrial deliverers and private deliverers within the Municipality are to be identified by checking the identity card of the driver as well as the license plate number.

In case the presented documents do not fulfil the requirements of the waste permission, the deliverer has to be rejected. A rejection has to be documented in the operation diary.

A visual inspection has to be carried out in case of a questionable origin or unclear waste type. The visual inspection of waste deliveries can be carried out by examination of:

- Appearance
- Consistency and composition
- Colour
- Smell

In case that the visual inspection indicates the non-compliance with the MSW (M&H) Rules, 2000/2014, the consignment has to be rejected. This process has to be documented in the operation diary.

4.5.5.1.8. Execution of the Weighing Process

The following data has to be recorded:

- License plate number
- Name of the corporation (in case of regional facilities)
- Ward from which waste is collected
- Name of the weighbridge operator
- Gross & net weight of the vehicle
- Date & time of entrance

The deliverer has to follow the orders and instructions of the staff.

4.5.5.1.9. Waste Assignment

The spotters have to inform the deliverer at which location of the landfill the waste has to be unloaded. The following unloading areas should be available:

- Waste disposal area on the landfill
- Temporary storage areas for building materials, demolition waste, earth excavation (cover material).

The weighbridge operator will provide information regarding the temporary roads to be used. This has to be supported by corresponding traffic signs and by additional staff (Spotters) which duly direct the vehicles.

Driving on the loose landfilling area is not allowed without instruction by the staff.

4.5.5.1.10. Preparing of Filling Plans

A final structural plan of the waste body of the landfill site should be designed. Based on this plan different filling sections can be developed in order to ensure that:

- Staff could efficiently undertake all operational duties required in the landfill site.
- The filling follows the designed waste body to avoid secondary transfer of waste.

4.5.5.1.11. Filling And Compaction Procedure Of Waste

- The daily filling area should be determined every morning. It should be wide enough to prevent a backlog of vehicles. For safety reasons, the width of the landfilling face should not be reduced to less than 15 m.
- A high degree of waste compaction extends the life time of the landfill, reduces the need for cover material, reduces litter problems, and results in other beneficial effects such as minimized long-term land requirements.
- To maximize compaction, and to provide an optimal weight distribution of the bulldozer, the waste should be spread up a 1:3 slope in 50 cm layers. Figure4.19 illustrates the filling and compaction method to be employed.
- Good compaction is achieved by operating the landfill compactor (as shown in figure 4.20) up and down the filling area between 3 and 5 times on the waste layers.

Soil and other inert material should be used as a 10 cm thick daily cover on top of waste

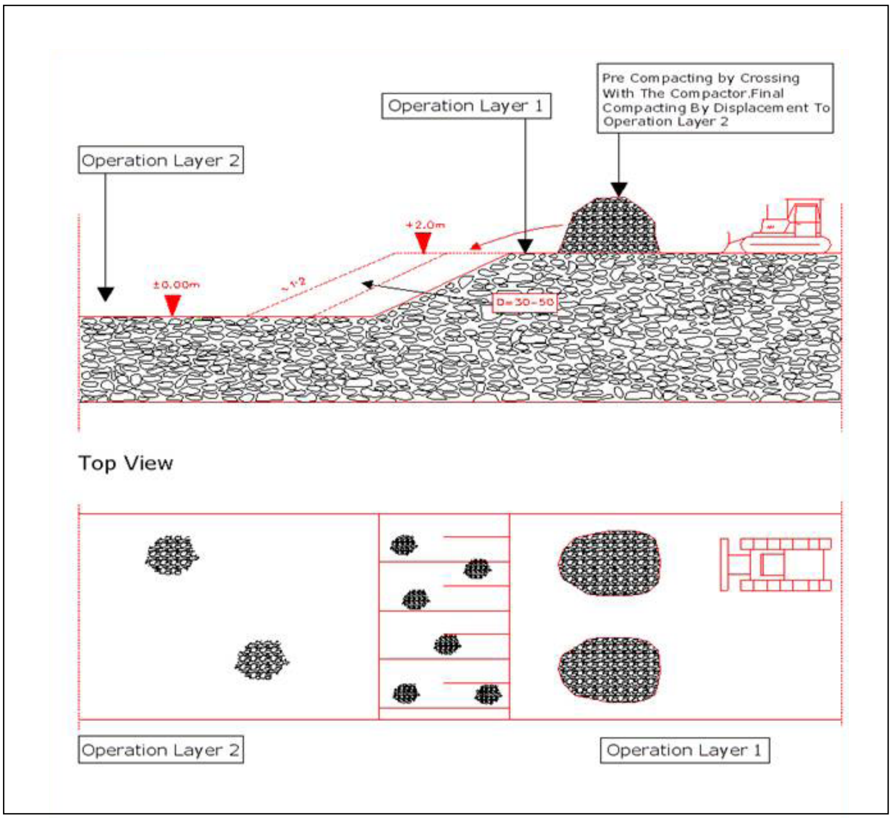


Figure 4.19: Filling and Compaction Method

Figure 4.20: Landfill Compactor

As an alternative to an intermediate soil cover, plastic/ tarpaulin sheets can be used

4.5.5.2 Covering Of Waste

Cover material includes imported cover such as soil or other inert material as well as material such as fine portion of C&D waste, street sweepings and dry drain cleaning silt.

The cover soil should be pushed by a bulldozer or wheel loader up the slope and spread out as evenly as possible. The daily cover should be at least 10 cm thick.

When constructing a body in an open area, the side slopes require soil cover also.

4.5.5.2.1. Intermediate Cover

In addition the top and side surfaces of a completed structure of waste that is not intended to be covered within 180 days by another waste layer may be exposed to weather and truck traffic. These surfaces should be covered with a layer of at least 30 cm of compacted soil, street sweepings, dry drain silt or compacted fine C&D waste. Surface water drainage should be built to minimise the volume of water entering the site.

The intermediate cover material should be removed as far as possible prior to applying waste over it. Soil removal and/or scarifying intermediate cover soil are essential to ensure controlled liquid conductivity between sections.

4.5.5.2.2. Temporary Surface Cover

When the waste body has reached the final planned grade, a temporary cover of compacted soil or compacted fine C&D waste should be placed. This cover is necessary to allow light traffic movement without exposing any waste. The temporary cover will also help keep the rain from seeping into the waste.

4.5.5.2.3. Covering during the Monsoon

Depending on the climatic conditions the filling areas which are not used should be covered during the monsoon period.

The recommended intermediate cover is 45 cm of soil or alternatively a waterproof cover material. The soil shall be tilled, and compacted in at least two lifts, graded to promote runoff and limit infiltration, and either mulched or seeded to prevent erosion.

Prior to the area being used for disposal again the intermediate cover shall be removed before any further landfilling can occur.

4.5.5.2.4. Final Cover (Surface Sealing System)

To minimize infiltration of stormwater in the landfill body and to allow stormwater runoff, a surface sealing system has to be installed after the final completion of each landfill part. The main purposes of the final cover system are:

- To control the amount of stormwater filtration into the waste to reduce leachate quantities;
- To prevent erosion;
- To minimise the migration of greenhouse gases into the atmosphere;
- To protect the base sealing (impermeable) layer;
- To minimise other emissions causing negative impacts on the environment.

The following layers are part of the surface sealing as illustrated in figure 4.21:

- Gas drainage layer: a 30cm thick granular gas drainage layer formed by crushed gravel or crushed demolition waste to facilitate gas collection;
- Mineral clay layer: The mineral material (60 cm) shall be clay or amended soil and should satisfy permeability requirements of k= 10-7 cm/s. If the available soil has marginally higher permeability, additional layers of 1.5mm HDPE orgeocomposites or geosynthetic clay liners (GCL) can be installed over 50cm thick soil layer. The overall equivalence of such design of soil+ additional layers will be checked and certified by geotechnical experts. 1.5mm HDPE liner, covered with a 20 cm protection layer or geotextile.
- Water drainage layer: A 30 cm thick water drainage layer formedbycrushed gravel. Alternative: drainage mat (Secudrain) which however increases the costs;
- Vegetative soil layer: The top layer should be of vegetative soil of 100 cm thickness

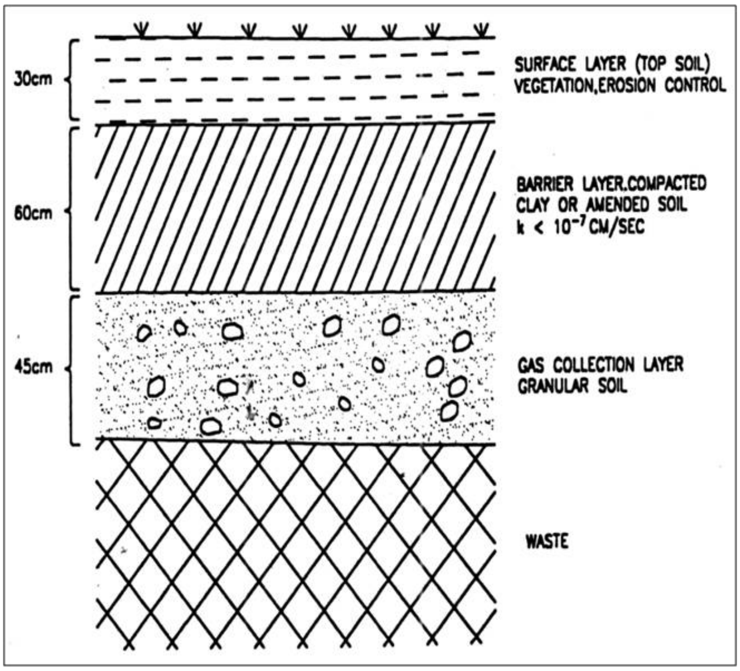


Figure 4.21: Surface Liner System

4.5.5.3 Sanitary Landfill Roads

4.5.5.3.1. Road Construction

An important part of the landfill operation activities is to enable vehicles to reach the landfilling area, which is progressing every day, and to cover the waste once it is landfilled. Therefore, continuous road construction is required.

4.5.5.3.2. Main and Temporary Roads

Access to the different filling sections and the top layers of the landfill site is possible by constructing main access roads. These roads, with a maximum slope of 10 %, should have a hard surface, and be protected with a lateral ditch to drain the surface water flowing from the temporary capping surface. These main access roads should be wide enough (7-8 m) for two ways vehicle traffic. Chained equipment should not be allowed to travel on the main access road as this is likely to cause damage.

The temporary side roads lead from the main access roads to the disposal face and therefore will have a short life. Placement of these roads has to be conducted based on the instructions of the operation manager. These roads are typically made of waste demolition material which has been delivered for disposal at the site. On the top 20 – 30 cm of gravel or other industrial waste type can be used.

4.5.5.3.3. Road Maintenance

Filling of Potholes: Potholes should be filled with materials compatible with the roadbed.

Filling of Areas Where Settlement Occurs: When roads are built on filling areas, settlement of the waste body may cause cracks in a road or cause the slope of a road to change. Cracks should be filled with material that is compatible with the roadbed.

Maintenance of Road-beside Ditches: All ditches should be kept free of obstructions and debris. Inspections of all drainage ditches and structures should be made at least once each week after rain events, or more frequently as required. Any debris should be removed from ditches.

4.5.5.4 Storm Water Management

All surface water ditches, culverts, drainage channels and settling ponds (storm water ponds) should be designed by a hydrologist using hydro-meteorological data.

4.5.5.4.1. Surface Water Collection

Surface water management is required to ensure that rainwater run-off does not drain into the waste from surrounding areas and that there is no water logging/ponding on covers of landfills.

These objectives should be achieved by the following:

- Rainwater running off slopes above and outside the landfill area should be intercepted and channelled to water courses without entering the operational area of the site. This diversion channel may require a low permeability lining to prevent leakage into the landfill.
- Rainfall on areas within the landfill site but on final covers of completed landfill segments should be diverted in drainage channels from active tipping areas, and directed through a settling pond to remove suspended silt, prior to discharge.
- Any drainage channels or drains constructed on the restored landfill surface should be able to accommodate settlement of the waste body, resist erosion and cope with localised storm conditions.
- The final cover should be provided a slope of 3 to 5% for proper surface water drainage.. Figure 4.22 illustrates surface drainage system in a landfill

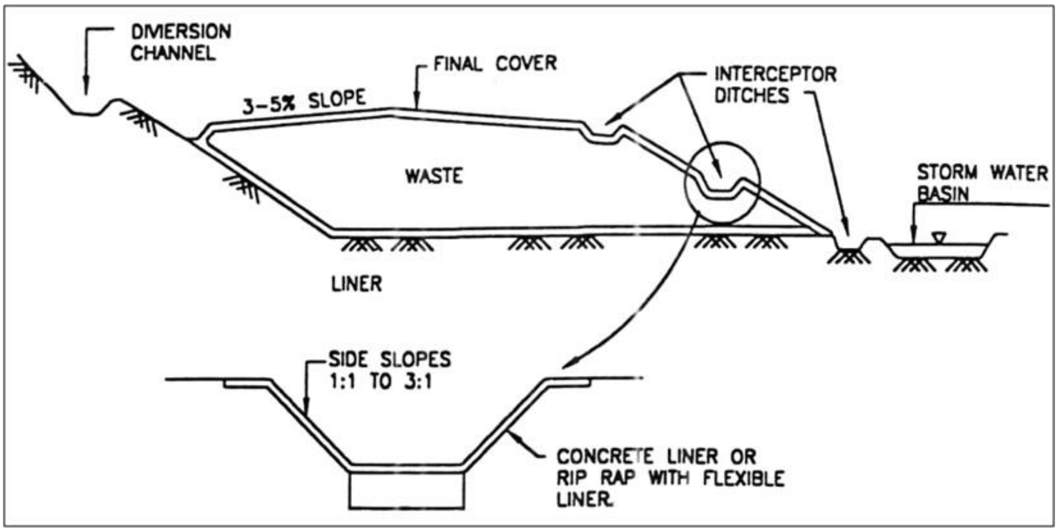


Figure 4.22: Surface water drainage system in completed landfill

4.5.5.4.2. Storm Water Retention Pond

The storm water retention pond should be designed according to the local conditions. It should protect the downstream situated villages against flooding. The construction should be designed as a ground basin with a regular discharge to the receiving water course. However, the retained waters can be used for irrigation purposes during dry climate conditions.

4.5.5.4.3. Maintenance of the Storm Water System

The landfill staffs have to inspect the drains on a periodic basis. The regular inspection should be undertaken weekly.

However, after heavy rainfall the storm water system has to be inspected and relieved from mud and sand.

It can be assumed that the pipes and ditches are full of papers and plastic bags after heavy storm occurrences. Therefore a cleansing in regular intervals is mandatory.

The storm water pond has also to be cleared of papers and plastics.

4.5.5.5 Landfill Gas Management

A large part of mixed waste (50-70%) consists of biodegradable parts which will produce methane gas. With a view to reduce environmental impacts as well as GHG emissions it is mandatory to install a degassing system for the Sanitary Landfill.

The gas management strategies should follow one of the following options:

- Controlled passive venting
- Controlled active collection and treatment/reuse

4.5.5.5.1. Controlled passive venting

For all sanitary landfills controlled passive degassing systems in the form of gas windows covered by suitable passive gas vents is recommended. Figure 4.23 illustrates placement of passive vents in a landfill.

The gas windows are to be installed in the frame of the final covering. The gas windows are openings in the cover system which may be filled with compost to avoid the generation of bad odours. The size should be not less than 1 m x 1 m and the distance between two gas windows should be about 20 m.

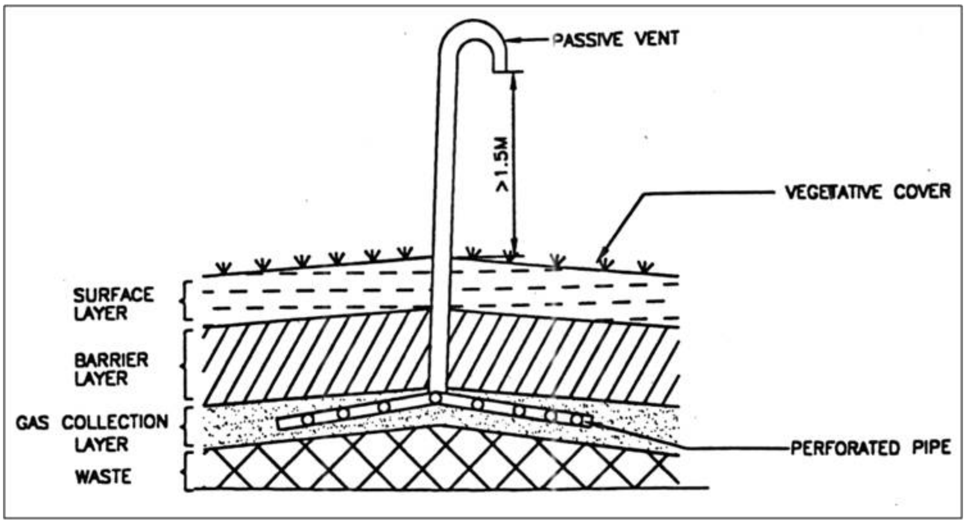


Figure 4.23: Placement of passive vent

4.5.5.5.2. Controlled active collection and treatment/reuse

In order to reduce GHG emissions, especially methane with its very high warming potential, future landfills should always install active gas collection systems. The active degassing system should contain the following elements as illustrated in figure 4.24:

- Gas collection wells: each well covering a collection area of around 2,000 m^2
- Gas transporting pipes: From each gas well HDPE gas transporting pipes will be installed on the waste during the filling procedure and connected via the main collection pipe to the compressor station and the flare
- Compressor station and gas use or flare system: The gas can be fed into a blower station and a flare, which burns the methane to CO_2 and water. This reduces the warming potential slightly since CO_2 has a lower warming potential then methane. Much better in terms of climate change mitigation and resource efficiency is the use of the gas to produce electric power through a generator.
- After a landfill lifetime of three to five years sufficient gas will be available, so that the installation of a gas generator could be profitable

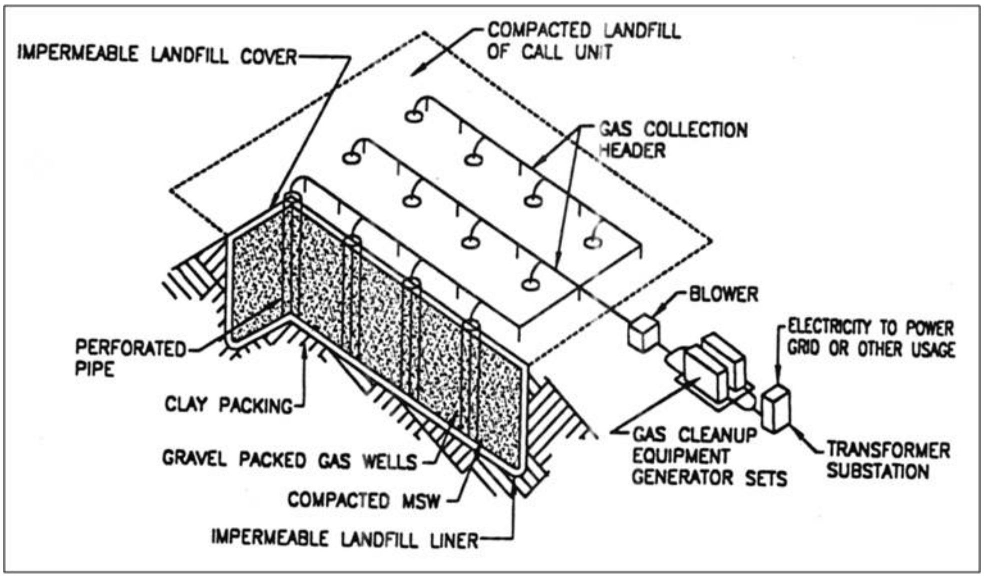


Figure 4.24: Gas recovery through wells-active

Controlled collection and treatment/use should be adopted only based on a feasibility study by experts in this area.

4.5.5.6 LANDFILL EQUIPMENT

4.5.5.6.1. Required Equipment

For controlled landfill operations the following equipment (table 4.7) is required at a Sanitary Landfill.

Table 4.7: Equipment Required on a Sanitary Landfill

Equipment	Functions
Landfill Compactor	For spreading and compaction of waste
Dozer	For spreading of waste , covering of waste maintenance of roads
Backhoes and front end loaders	Excavation and maintenance of ditches Loading of cover material
Tractor trailers; water tank	Internal movement Transportation of soil; Transportation of water

Equipment	Functions
Truck with tipper	Soil transportation
Pick up	Staff transportation

The numbers of equipment required depend on the amount of landfilled waste and size of the landfill and should be designed specifically for each sanitary landfill.

4.5.5.6.2. Maintenance of mobile equipment

Regular mobile equipment inspections and operating records are critical for an effective preventive maintenance. To ensure maximum operating efficiency, inspections need to be thorough and accurately recorded by all operating personnel.

4.5.5.7 Housekeeping On The Sanitary Landfill

Housekeeping should be conducted in such a manner that it protects the public and surrounding environment from risks and nuisance emanating from landfill operations. A well-controlled landfill operation will enhance public perception and acceptance of the landfill site.

The following general measures should be considered:

- **Vector and vermin control:** The landfill site might attract vectors and vermin because of the presence of organic waste. To avoid or reduce vector and vermin, the filling area should be minimised and the waste should be covered at regular intervals.
- **Litter control:** Offsite litter should picked up on a regular basis.
- **Noise control:** Noise in the landfill site arises from landfill operations and waste vehicles entering and leaving the site. During the operation of the landfill, faulty equipment having faulty or worn-out exhaust systems can cause high noise levels.
- **Dust control:** Dust within and around a landfill site can be a source of annoyance, harm and physical discomfort to site staff and neighbourhood. The combination of vehicle movements and winds on temporary and un-surfaced roads can create dust. Therefore all precautions have to be taken to avoid dust generation.
- **Odour Control:** The landfill will be operated in a manner that will minimise the odour from waste or associated items. Operational procedures include placing suitable cover material over the waste in a timely manner.

4.5.5.8 Health and safety

4.5.5.8.1. General Introduction

The landfill management (Municipality or Private Operator) shall be responsible for all aspects of site safety, and for ensuring public safety at the site and in areas adjoining the site.

The safety officer of the Municipality or of the Private Operator should be responsible also for the landfill staff. He should support the landfill management in the following tasks:

- Planning, operation, maintenance and inspection of installations with regard to health and safety
- Organisation and realisation of training and instructions of landfill staff with regard to occupational health and safety
- Assessment and evaluation of accidents
- Internal reporting on safety aspects

4.5.5.8.2. General Safety Measures

General safety measures have to be applied during the operation of the landfill, regardless of the nature of ongoing activity or location in the landfill. Given below are a list of priority measures, which should be elaborated based on site specific conditions:

- Maximum traffic speed should be 20 km/h.
- Every person working on the landfill should have a yearly medical examination.
- No one should be allowed to operate at the landfill without a mobile communication system (either radio or mobile telephone).
- Smoking should be prohibited except in designated smoking areas.
- Ingestion of food is restricted outside designated areas.
- General hygienic requirements while working on the landfill have to be applied.

4.5.5.8.3. Person Related Safety Measures

Workmen have to be equipped with the following personal protection equipment:

- Safety boots (always to be used while working outside the buildings);

- Reflective vests (always to be used by all staff working outside the buildings),
- Safety helmets (to be used in case of risk of injuries to the head e.g. during construction, loading or unloading activities, while operating machinery etc.);
- Gloves (to be used in case of risk of injuries to the hands e.g. during loading/unloading or maintenance activities).
- Ear protectors (to be used while working in noisy areas);
- Disposable dust mask (to be used e.g. in case of exposure to dust)

The landfill management has to strictly enforce the use of personal protection equipment.

4.5.5.8.4. First Aid

In order to provide first aid the landfill worker has to be trained as first aiders. Considering the specific conditions at a sanitary landfill, it is strongly recommended that First Aid training needs to be given to staff working in the landfill on a regular basis.

All vehicles working or entering the landfill have to be equipped with a first aid kit.

4.5.5.8.5. Personnel Accidents

In case of accidents involving injuries, the following procedure has to be applied:

- Immediate stop of work
- Inform first aid
- Inform management
- Call medical services (Ambulance emergency number:..........:has to filled in and maintained by the responsible landfill operator))

4.5.5.9 Fire Prevention And Protection

4.5.5.9.1. General Requirements

The following descriptions provide a general overview of fire prevention and protection as well as the procedures in case of fire or similar occurrences.

In any case the actual fire -fighting operation is under the responsibility of the fire brigade of the ULB.

To prevent fire incidents the following rules have to be applied:

- Banning Smoking in all areas of the sanitary landfill
- Handling material on fire as well as setting fire to materials on the landfill are strictly forbidden
- Waste that has been unloaded in the filling area has to be examined visually for potential fire sources (glowing ash or glowing burning remains). If fire sources are located, these have to be neutralized with cover material immediately.
- All mobile equipment/vehicles should be furnished with a fire extinguisher

4.5.5.9.2. Fire Control

In case of fire the following basic rules of conduct have to be complied with:

- Every fire has to be reported immediately
- The preservation and the protection of lives and health have priority before the fire fighting. Endangered persons have to be alerted and saved from the range of dangers.
- Rescue of people has priority over fire fighting
- Alarm signals have to be paid attention to.

4.5.5.9.3. Environmental Monitoring

The environmental monitoring of landfills should be performed as per MSW Rules' requirements as mentioned in the section 4.1 of this chapter. In addition to the parameters mentioned in the Rules, hydrogeology and surface water quality at the landfill site should be assessed and monitored as discussed below:

Hydrogeological assessment of landfills

An assessment of the hydrogeologic settings of a landfilling site is necessary to ensure that the site is conducive for the proposed design of the landfill, which should be in line with the specifications of the MSW (M&H) Rules, 2000. Such an assessment should also be used to develop effective ground water and leachate monitoring plans.

The hydrogeologic assessment should include the following:

- Obtaining samples to characterize soil or bedrock conditions
- Mapping ground water depth and pressure within the site
- Assessing baseline ground water quality

The identification of unsuitable soils that would not support the overburden of the proposed fill height is possible through such an analysis. An analysis of the ground water flow and pressure should result in the determination of groundwater flow paths and inform leachate control mechanisms and contingency plans for failure of the leachate liner. Future monitoring of ground water quality should be against a reference of baseline conditions.

Within the site, the location of the boreholes should be along the groundwater flow path, both hydraulically upgrade and downgrade to the footprint of the landfill, atleast 5 meters away from the footprint of the landfill. In addition, ground water monitoring as per specifications in the MSW (M&H) Rules is mandated. The design of the landfill should consider this hydrogeological information to prevent failure of containment.

The objectives of a hydrogeological assessment are to: determine the physical, hydraulic and chemical properties of the surface material (and bedrock where appropriate); define groundwater flow characteristics and potential contaminant migration pathways; determine the structural integrity of the sub-grade to support the landfill including its construction) and any overlying facilities; determine the availability and suitability of the soil for cover and liner uses; establish a groundwater monitoring network; and determine the feasibility of the contingency plans for contaminant control.

The hydrogeological investigation report for a site should include:

(i) Ground surface contour plan showing surface watercourses and surface waterbodies

(ii) a contour plan of the water table, showing expected directions of groundwater movement;

(iii) piezometric contour plans for each aquifer, showing expected directions of groundwater movement;

(iv) a description of any aquifers and their interconnection, with generalized estimates of groundwater flow; the potential flow paths and contaminant attenuation capabilities in the event leachate leaves the waste fill area in planned or unplanned quantities.

(iv) a description of the background quality of the groundwater, and the existing and potential uses of the groundwater;

(v) site plans and cross sections of the hydrogeologic conditions;

(vi) the identification of any unstable soils or unstable bedrock;

(vii) a water balance analysis considering precipitation, surface water drainage, infiltration, groundwater flow, exfiltration and evapotranspiration

Surface Water Assessment:

An assessment of the surface water conditions on the proposed landfill site and in the vicinity of the site (500 m.) is required to ensure a stable landfill that is not impacted by or impacts surface water.

Surface water assessment should include:

- a description of the watershed in which the site is located and the surface water features in the vicinity of the site (flood plains, natural watercourses and water bodies, municipal drains, drainage paths and boundaries.)
- a detailed investigation and description of the surface water conditions on the site and any surface water features receiving a direct discharge from the landfilling site,
- The baseline flow and quality of surface water that receives discharges from the landfill site, whether in the form of runoff from the site or in the form of treated leachate on and in the vicinity of a landfilling site, should be assessed.

Based on the above assessment, the suitability of the site for landfilling should be established.

The design of the site should include a plan for controlling runoff from the site and to prevent erosion and sedimentation downstream due to on-site activities. A surface water monitoring plan should be established to be able to identify surface water quality impacts, both on-site and off-site. Contingency plans should be prepared to control surface water impacts resulting from the production of leachate in a quantity greater than expected or with a quality worse than expected.

The surface water assessment report should include:

- A general description of the surface water features of the area (watershed) in which the site is located.
- A detailed surface water investigation to assess water quality, quantity and habitat conditions of the surface water (benthic community inventory) features identified on the site, any surface water features flowing through the site, and any surface water features that are to receive a surface water discharge from the site.

a. An interpretation of the results of the detailed surface water investigation including:

   (i) plans showing all existing surface water features;

   (ii) a description of current surface water quality, and the existing and proposed surface water uses

b. A site drainage plan showing the drainage of surface water at the site before the site is established, during operation of the site, and following site closure.

c. Plans, specifications and descriptions of the design features, control facilities and operational procedures to isolate, contain, convey, control and/or treat the surface water on and off site prior to its discharge to the receiving watercourse(s). The plans, specifications and descriptions should consider both clean surface water sources (off-site and on-site flows separated from landfill operations through control mechanisms like berms and ditches) and potentially contaminated storm water (on-site flows originating from landfill areas)

d. The design and location of any surface water control facilities, such as berms, swales, ditches, control ponds or other facilities for the control of the quality and quantity of surface water from the site. The design should be sufficient to convey peak flow volumes from a 25 hour design storm. However external storm water conveyance mechanisms should be able to transport peak flows from a 100 year design storm.

4.5.6 Closure & Post Closure Plan

Determination of the end-use of a landfill site is an essential part of the plan for landfill closure and post-closure maintenance. A closure and post-closure plan for landfills involves the following components:

- Plan for vegetative stabilization of the final landfill cover.

- Plan for management of surface water run-off with an effective drainage system.
- Plan for periodical inspection and maintenance of landfill cover (settlements) and facilities.
- Plan for quantity and quality of leachate monitoring in the landfill
- Plan for quantity and quality of landfill gas monitoring
- Plan for ground water quality (up gradient and down gradient)
- Plan for Surface water quality at the periphery of landfill and at receiving water bodies

The regulatory limits for various parameters of quality and the monitoring frequency will have to be agreed and/or stipulated by the regulatory authorities.

The post-closure care of landfill site shall be conducted for at least fifteen years in line with the MSW(M&H)Rules as mentioned above. The authority/concessionaire who operated the sanitary landfill shall be responsible for post closure activities and monitoring.

4.5.7 Plantation At Landfill Site:

Please refer to section 4..1of this chapter.

Chapter 5:

MSWM Plan Implementation

5. MSWM Plan Implementation

The chief executive of the local body i.e. Municipal Commissioner / Secretary / Executive officer, is responsible for implementing the MSWM Plan, which is to be developed in line with guidance given in Chapter 1 of Part II of this manual. The chief executive should operationalize the plan through the Solid Waste Management Department or Cell of the ULB.

The chief executive of the ULB is responsible for the successful implementation of the MSWM Plan

The implementation of the MSWM Plan is guided by the short term MSWM plan for a specific period, which is made in line with the goals of the long term plan.

The short term MSWM plan addresses a five year implementation period, with a mid-term review once every 2-3 years. Figure 5.1 indicates the various components of a short term MSWM plan. An indicative list of actions to be undertaken to develop short-term MSWM plan is given in table 5.1 below.

Table 5.1: Actions for preparation of short term MSWM Plan

Action	Implementing Agency
Identification of specific actions to be undertaken to ensure planned SWM service provision.	Urban Local Body
Preparation of DPRs for specific projects (e.g. processing & disposal facilities) and action plans for service provision	Urban Local Body/ Private Implementing agency (as the case may be)
Identification of institutional mechanisms to support provision, monitoring and reporting on specific solid waste management services	Urban Local Body
Implementing programmes for building relevant capacities (service provision, monitoring, reporting) within staff of the solid waste management cell	Urban Local Body

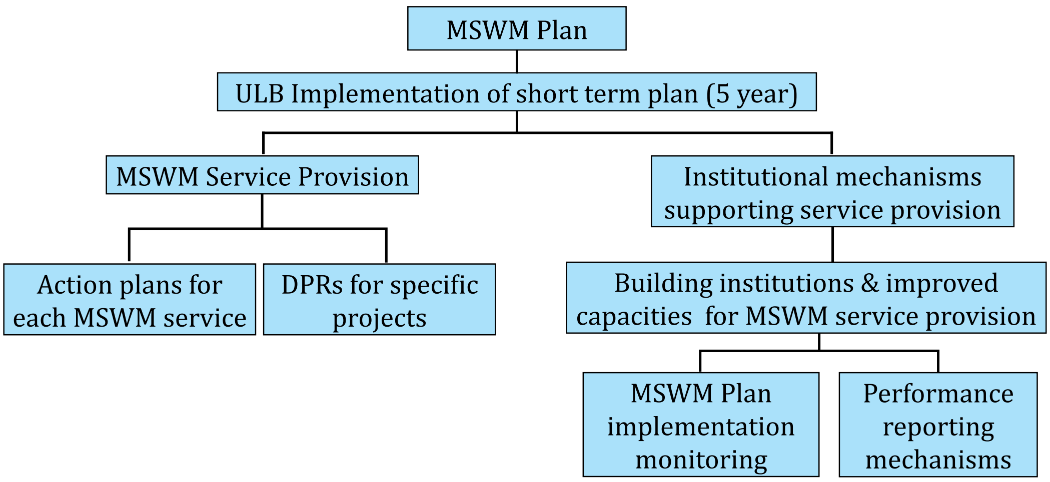


Figure 5.1: Components of MSWM Plan

Obtaining statutory and environmental clearances is a pre-requisite for establishing any MSWM Facility.

The subsequent sections of this chapter address specific issues that would facilitate the implementation of the short term MSWM Plan.

5.1 Obtaining Statutory Clearances For MSWM Facilities

Municipal solid waste management processing/treatment and disposal facilities require legal/statutory clearances and approvals for their establishment, depending on the type of facility to be created. Municipal Solid Waste (M&H) Rules 2000/2014 and the Environmental Impact Assessment (EIA) Notification, 2006 (MoEF) provide guidance on the statutory requirements for establishing storage/processing/treatment/disposal facilities:

Rules

- Municipal authority or any Municipal Solid Waste service provider shall seek authorization from the State Pollution Control Board/Committee for setting up waste handling, processing and disposal facilities. The MSW (M&H) Rules 2000/2013 provide that "The municipal authority or an operator of a facility shall make an application in **Form-I**, for grant of authorization for setting up waste processing and disposal facilities including landfills from the State Pollution Control Board or the Committee in order to comply with the implementation programme laid down in **Schedule I**" of the MSW (M&H) Rules, 2000.
- As per schedule I of the EIA Notification, 2006, the municipal solid waste handling, storage, treatment, and disposal activities fall under the items of 7 (d) and 7 (i) of the Schedule I and require clearance from the State Level Environment Impact Assessment Authority (SEIAA).

An indicative list of clearances and approvals to be obtained are given in the box below:

An Indicative list of statutory clearances/applicable Acts and non-statutory approvals required by all MSWM Processing/Treatment/ Disposal Facilities

Statutory Clearances

- Environmental Clearances [The Water (Prevention and Control of Pollution) Act, 1974; The Water (Prevention and Control of Pollution) Cess Act,1977; The Air (Prevention and Control of Pollution) Act, 1981; The Environmental (Protection) Act, 1986, and Rules; The EIA Rules, 2006]

- Clearance from the State Pollution Control Board
- Clearance from Airport Authority
- FCO Clearance for compost based plants
- Land use from Revenue Authority
- State Electricity Authority Clearance for Providing Grid Connectivity
- The Public Liability Insurance Act, 1991 and Rules, 1991
- The Industries (Development and Regulation) Act, 1951
- The Factories Act, 1948
- The Motor Vehicles Act, 1938, amended in 1988 and Rules, 1989
- The Petroleum Act, 1934
- The Indian Explosives Act, 1908
- The Energy Conservation Act, 2001

Non-statutory Approvals

- Proof of Possession of Site
- Bank Loan Sanction Letter and Agreement
- Bank Appraisal Note
- Water Supply Agreement
- Power Purchase Agreement
- MSW Supply Agreement with Municipal Authority

5.1.1 Environmental Impact Assessment (EIA) Requirements For SWM Facilities

EIA Notification 2006, of the Ministry of Environment & Forests, GoI has divided all infrastructure projects or activities into two categories i.e. Category A and Category based on the spatial extent and potential impacts on human health, natural and manmade resources. Category B projects are further divided into B1 and B2 based on requirement of conducting and submitting an EIA report and conducting a public consultation (decided by the State Expert Appraisal Committee (SEAC) at the project screening stage). Category B1 projects are required to submit an EIA report to the SEAC prior to establishing the facility and consent has to be obtained from the SEAC[1]. B2 category projects do not require an EIA clearance. For categorization of projects into B1 or B2, the MoEF shall issue guidelines from time to time.

Infrastructure projects are divided into 2 categories i.e. A & B based on their spatial extent and potential impacts on human health and environment

All Common Municipal Waste Management Facilities (CMWMF) are considered Category B projects. However, it is important to note that such facilities are considered under

CMWMF are usually considered Category B projects, unless they fall, partially or fully within 10 km from the stipulated eco-sensitive areas or other critical areas

[1] For details please refer to EIA Notification 2006, MoEF, GoI

Category A, if the project site is located wholly or partially within 10 km from the boundary of following:

Projects involving capping of existing dumpsites/ capture of landfill gas for power generation are designated as Category B projects

- Wildlife protection areas (Under Wildlife Protection Act 1972)
- CPCB identified critical polluted areas
- Eco-sensitive areas as notified under section 3 of the Environment (Protection) Act, 1986
- Inter – State boundary (However, this will not be applicable, if states or UTs concerned have allowed their land for setting up a solid waste management project)
- International boundary

All MSW projects that deal with capping of existing dumpsites (including capture of landfill gases for power generation) fall under Category B, as defined by the EIA Notification.

The draft EIA notification issued in January, 2009 (as an amendment to EIA Notification, 2006) suggests categorization of the following thermal power plants based on non-hazardous municipal solid waste as fuel:

Power plants upto 15 MW, based on non-hazardous MSW are exempted from EIA requirements.

- Category A: Greater than or equal to 20 MW
- Category B: Less than 20 MW and greater than 15 MW

Power plants upto 15 MW, based on non-hazardous municipal waste and using auxiliary fuel such as coal/lignite/petroleum products upto 15% are exempted from EIA requirements.

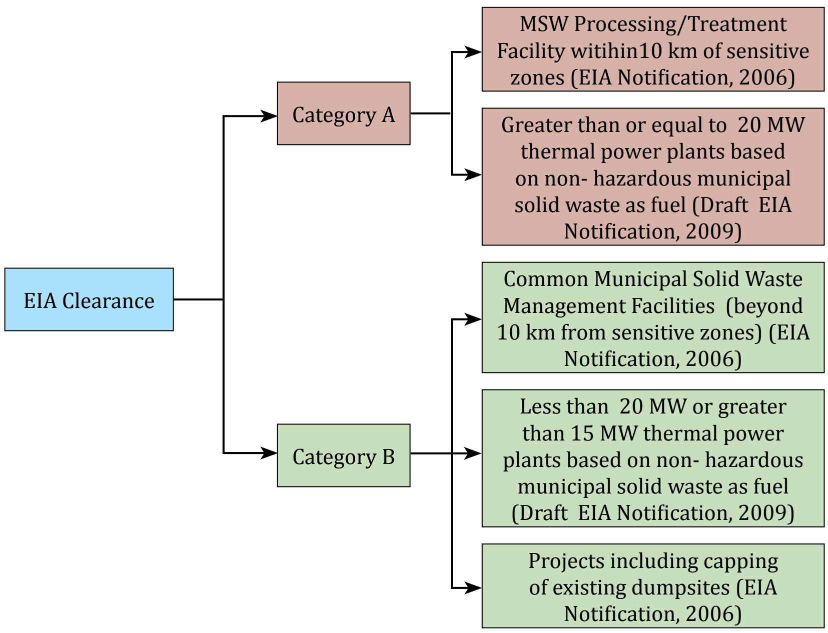


Figure 5.2: EIA Clearance Requirements for MSWM Projects

5.1.1.1 Roles And Responsibilities Of Stakeholders Involved in EIA

The environmental clearance process involves many stakeholders i.e. Central Government, State Government, State Level Environment Impact Assessment Authority (SEIAA), Expert Appraisal Committee (EAC), State Level Expert Appraisal Committee (SEAC), State Pollution Control Board (SPCB) etc.

The roles and responsibilities of SEIAA and SEAC involved in EIA are briefly discussed below:

- State Level Environmental Impact Assessment Authority (SEIAA) is constituted by the MoEF and takes a final decision regarding acceptance/rejection of environmental clearance for all Category 'B' projects. SEIAA shall receive application from the project proponent, communicates SEAC's views for finalizing the ToR, upload the EIA report on website in cases of Category 'B' projects and takes a final decision regarding the project clearance.
- Expert Appraisal Committee (EAC)/State Level Expert Appraisal Committee (SEAC) is a multi-disciplinary independent committee at the Centre and State/UT level which reviews each developmental activity and offer its recommendations for consideration of the Central Government and SEIAA respectively. EAC/SEAC reviews Form 1 of the EIA Notification 2006 and its attachments, undertakes site visits if necessary, to finalize the Terms of Reference (ToR) and reviews updated EIA-EMP reports.

5.1.1.2 Procedure For EIA Clearance

All MSW project proponents (ULBs/Private contractors) should follow the steps laid out in the EIA notification, 2006 and its amendments as shown in figure 5.2.

The entire environment clearance process consists of five stages as mentioned below, (however all these stages might not be required in some cases):

1) Screening
2) Scoping
3) Environmental Impact Assessment
4) Public Consultation
5) Appraisal

Screening is a process of ascertaining whether the project is categorized as a category (A) or category (B) project and further for distinguishing category (B1) from category (B2) projects.

Stages at which SEAC is consulted:
- Screening
- Scoping
- Appraisal and Clearance

Scoping: Potential environmental and health related impacts of the proposed facility are assessed during this phase of the EIA clearance. Results of the scoping exercise shall also be used to:

- Identify alternative project designs/sites to be assessed;
- Obtain local knowledge of site and surroundings; and
- Prepare a plan for public/community involvement.

The scoping will further support preparation of the Terms of Reference (ToR) for the EIA. The SEAC determines the ToR to ensure that all relevant environmental concerns will be addressed in the Environmental Impact Assessment (EIA) Report.

Stages at which SEIAA is consulted:
- Screening
- Scoping
- EIA Report & Public Hearing
- Appraisal and Clearance

The Expert Appraisal Committee (EAC)/SEAC is the final consenting authority, with powers to stipulate further improvements, where required. The EAC/SEAC scrutinises all the application and documents submitted during the EIA clearance process and decides on whether the project is to be granted a clearance and if so, the conditions for the clearance are also specified. Where the proposed project is deemed to impact the environment, without scope for due remedies, environmental clearance may be denied by the EAC/SEAC.

Environmental Impact Assessment (EIA): This is a detailed multistage process to identify and quantify specific impacts of the proposed project on the environment/eco-system.

Figure 5.3 illustrates the sequence of steps to be followed for conducting an EIA study for obtaining the EIA clearance.

Public Consultation is an important step in the EIA approval process. Concerns of local affected people and others who have a plausible stake in the environmental impacts of the project or activity are solicited, to be further addressed in the Environmental Management Plan of the project.

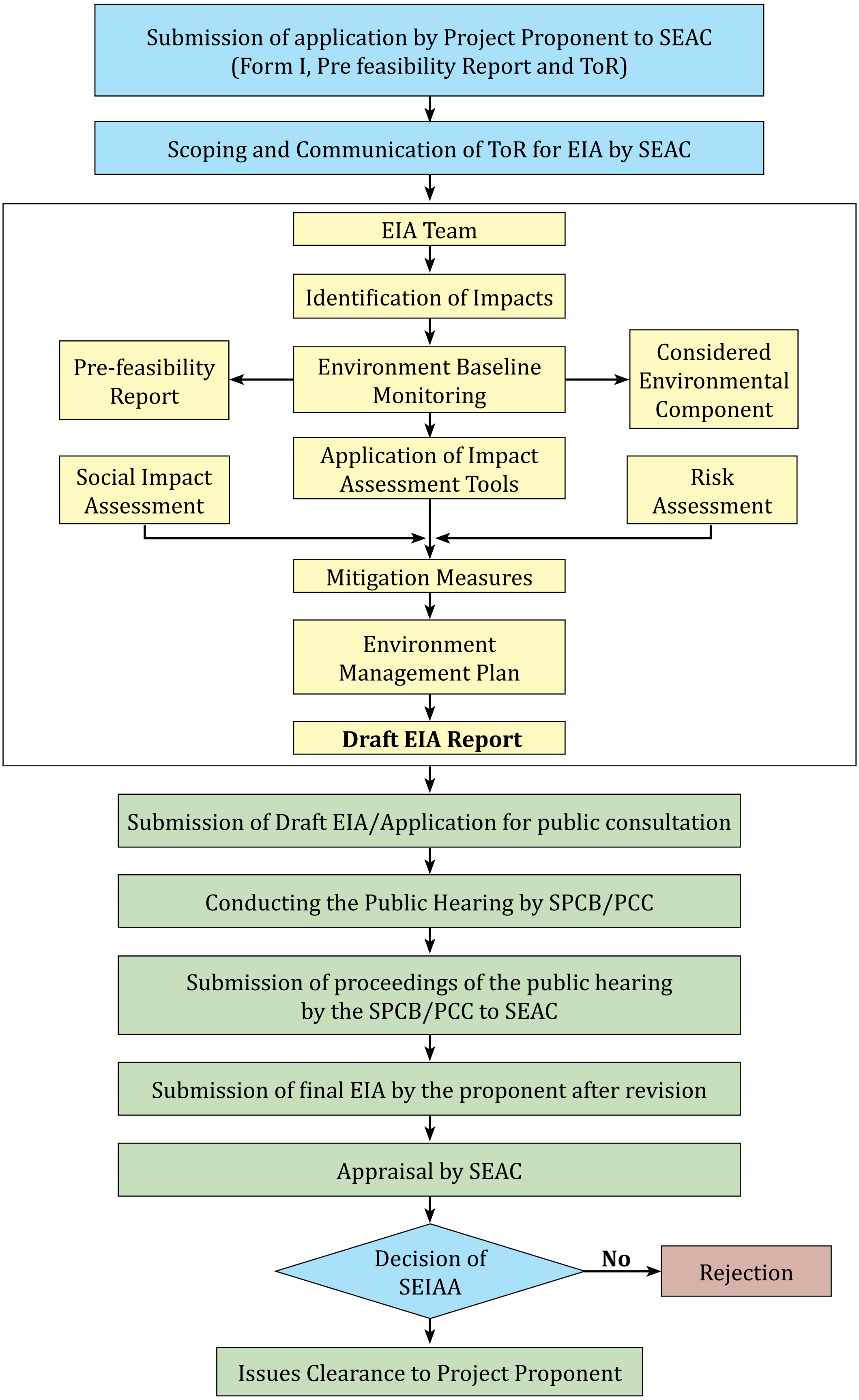


Figure 5.3: Steps for Conducting an Environment Impact Assessment[2]

[2] Adapted from Technical EIA Guidance Manual for Common Municipal Solid Waste Management Facility by ILFS, 2010

The scope of the Environment Baseline Monitoring is defined by the ToR approved by the SEAC. The impacts of the proposed facility are superimposed over the baseline scenario to assess the actual impacts on the receptors. Identification of appropriate mitigation measures is a key output of the EIA process. Mitigation of environmental impacts is central in achieving an environmentally sound design.

Figure 5.4 indicates a hierarchy of options to mitigate environmental impacts.

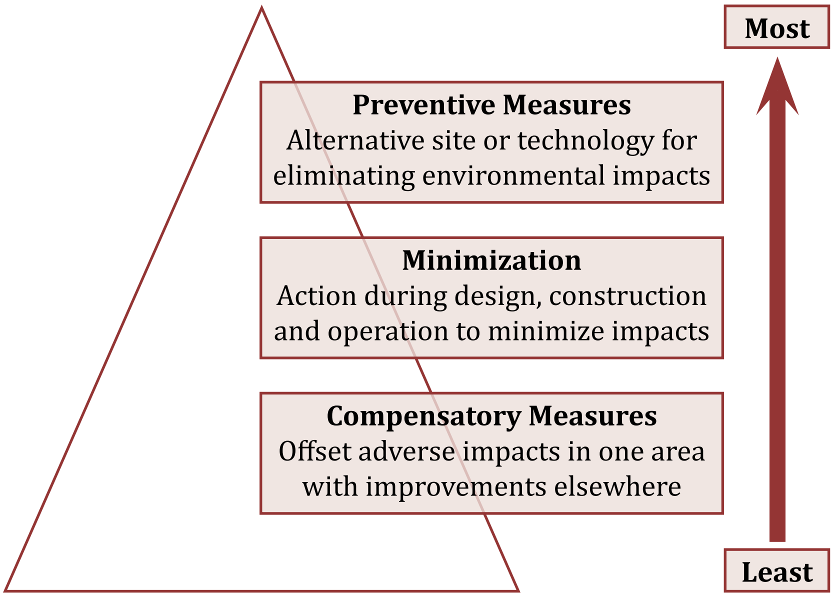


Figure 5.4: Hierarchy of Environmental Impact Mitigation Options

Identified environmental impacts and proposed mitigation measures constitute the Environment Management plan (EMP). The final EIA report addresses environment baseline conditions, potential impacts and sets of mitigation measures for the proposed project.

5.2 Operationalizing The Financial Plan

Identifying and mobilizing financial sources is central to the MSWM plan implementation

10 to 50 % of the municipal budget is spent on solid waste management, depending on the functions to be performed by the local body and its income sources. A financial operating plan gives details of estimated costs and expected revenue sources for all activities indicated in the MSWM plan. Full cost accounting principles outlined in section 1.4.4.5.1 of Part-II shall be applied while costing individual actions. Section 1.4.4.5.3 of Part II describes various sources of funding that could be availed by the ULBs.

The ULB should mobilize financial resources identified in the financial operating plan to ensure timely implementation of the plan and delivery of services. Public Private Partnerships (PPPs) and Private Sector Participation (PSP) should be carefully monitored to ensure timely execution of contracted services and avoid costs over run. ULBs should take necessary precautions to ensure disbursal of funds in time for implementation.

Identifying and mobilizing financial sources is central to the MSWM plan implementation

Double entry accrual based accounting shall be followed by the ULB for recording revenues and expenses, in accordance with norms established in the National Municipal Accounting Manual. Solid waste management is assigned a specific function code (41) under the function-group: Sanitation & Solid Waste Management (40). As per the manual, while recording revenues and expenditure, major revenue and expense heads from the Chart of Accounts shall be indicated along with the function code/budgeting centre code.

5.3 Considerations For Contracting A Municipal Solid Waste Management Service

Following essential aspects may be considered by the ULB while deciding to contract out municipal solid waste management services:

Private sector participation is beneficial especially in newly developed areas and underserved areas, where the ULB has not been providing services through its own labour force.

- The ULB should identify services that can be effectively provided by the existing staff and available financial resources.
- Subsequently, services which would need to be outsourced due to limited in-house technical know-how, capability and financial resources should be identified.
- Benefits and potential issues with outsourcing services which the ULB cannot provide (as identified above) should be fully evaluated and understood. Justification for the need to contract out identified services should be prepared.
- Commercial/economical feasibility of the services to be contracted out should be ascertained and appropriate contract models and their benefits are to be assessed for each of the services to be contracted out.
- Where contract labour is hired, the ULB should ensure compliance with the provisions of the "Contract Labour Abolition & Regulation Act 1970"
- Sharing of all possible risks: technical, operational and financial between ULB and the operator should be detailed
- Where acquisition of land/ rehabilitation of the community is involved, the ULB should

stand-in for the contractor in addressing such aspects.

- Contracts should specify the range of technology/ies that can be adopted after the ULB undertakes a thorough assessment of available technologies for specific services.
- In ULBs with population over 1 lakh, at least 2 contractors may be considered for every service that is out-sourced. However, this is not relevant for processing & treatment facilities in small and medium town.
- For cities with more than 1 million population, ULBs should prepare a Feasibility Report for the services/projects to be contracted. Depending upon the feasibility report, the ULB should prepare a Detailed Project Report (DPR) including the detailed engineering report for minimizing risks associated with the project. Cities with less than 1 million population may directly prepare a detailed project report to minimize costs associated with the feasibility study, provided the project can be appropriately defined. The ToR for the contracted services should be based on the developed DPR.
- On ascertaining the benefit of outsourcing services, the ULB shall prepare a Terms of Reference for the contracted service, which shall include at least the following:
  - Detailed description of scope of work
  - Specific outcomes / outputs of the services and performance standards for the contracted service
  - Specified duration of the contracted service and time lines for execution of projects/provision of services
  - Minimum qualification and experience of the bidder required for plan of work and methodology
  - Minimum manpower and equipment required for delivering the services
  - Envisaged Monitoring and Evaluation requirements
  - Management structure and reporting
  - Tender evaluation procedure
  - Payment mechanism
  - Adequate social and environmental safeguards to ensure equitable service provision
  - Confidentiality clause
  - Service level guarantee mechanisms

Pre-requisites for Contracting

- Cost benefit analysis of the existing solid waste management system
- Identification of services to be outsourced
- Characterization and physico-chemical analysis of municipal waste should precede tendering of any waste processing/treatment/disposal facility
- Detailed project development is the key to successful implementation: Detailed project definition & Key Performance Indicators have to be established.
- Land requirement for 25-30 years for proposed facilities shall be assessed and identified
- Complete ownership of all projects by the ULB (not just ownership of property, but active commitment and monitoring) is crucial

Contract Models for MSWM Services:
- Service Contract
- Management Contract
- Design-Built-Operate (DBO)
- Build-Own-Operate (BOO)
- Build-Own-Operate and Transfer (BOOT)
- Build-Operate-Transfer (BOT)
- Lease
- Concession

An overview of different kind of contracts specific to different solid waste management services and their characteristics are given in section 1.4.4.6 of Part II of the manual. .

5.3.1 Contracting Arrangements For MSW Service Provision

Not all contracting models are suitable for each of the solid waste management operations. Municipal Authorities may adopt one or more of the following contracting models:

- Service Contract (door to door collection and transportation of waste)
- Management Contract (door to door collection, C&D waste collection, secondary storage and transportation of waste)
- Build and Transfer (Transfer station, Sanitary Landfill (SLF))
- Build, Operate and Transfer (Biomethanation, Composting, SLF)
- Build, Own, Operate (Composting, Refuse Derived Fuel (RDF), Incineration)
- Design, Build, Own, Operate and Transfer (DBOOT) Contract (Large compost plants, RDF plants, Incineration and SLF)
- Design, Build, Finance, Operate and Transfer (DBFOT) Contract (Large compost plants, RDF plants, Incineration and SLF)

ULBs may decide to bundle certain services while contracting out solid waste management operations, in order to build accountability and efficiency in the system. Table 5.2 indicates a typical mix of services that are bundled and indicates most relevant contracting models for outsourcing these services:

Table 5.2: Typical Services Bundled for Contracting

S. No	Type of Project	Description of Project	Advantages	Risks	Unit of Measurement
1	MSW- Model 1- Integrated solid waste management	Consists of 1. Collection 2. Transportation 3. Processing 4. Sanitary Landfill	1. Increases accountability of one single party 2. Minimizes hassles among different contractors 3. With a single party responsible for all activities, there is no scope for issues regarding operational or process deficiencies in executing any of the services, poor performance cannot be blamed on upstream deficiencies or issues of quantity and quality of waste. 4. It is easier, more efficient and less time consuming for the ULB to deal with a single party for managing all MSWM services.	1. This creates a monopoly of the contractor and increases the scope for defaults and further negotiations, given that the entire solid waste service chain is in the hands of a single contractor. 2. The entire city service may get disrupted if the contractor fails to perform, or in case of any other unforeseen circumstances 3. If the principal contractor off-loads certain services to associates, risks (cost &monitoring) might increase substantially. 3. Delay in execution of one service will result in overall system delays 4. There is scope for the contractor to recover full fees though he may not perform certain functions on a day to day basis.	1. Quantity of waste collected and transported on a daily basis. 2. Tonnes of waste received at the processing plant 3. Tonnes of waste landfilled Using only a single monitoring measure as the basis to pay the contractor could be risky and against the interest of the local body.

S. No	Type of Project	Description of Project	Advantages	Risks	Unit of Measurement
2	MSW - Model 2	This model consists of two packages Package 1: (Collection and Transportation) and Package 2: (Processing and Disposal (P&D))	1. ULBs can hire suitable agencies that have experience and expertise in distinct areas of SWM services. 2. ULB could also retain package 1 within its own scope and outsource only P & D to specialized agencies. 3. Alternately package 1 can be divided among multiple players (on an area basis), leading to a better control on the MSW collection and transportation; the ULB can then fall back on any of the operators to manage the waste if any one agency fails to perform.	Adequate care should be taken to ensure that the collection and transportation of segregated wastes should be regular and in sync with the requirements of the processing facility	1. Package 1 – Tonnes of waste collected and transported 2. Package 2- i. Tonnes of waste processed per processing plant ii. Tonnes of waste disposed at disposal facilities
3	MSW- Model 3	This model consists of three packages Package 1: (Collection & Transportation), Package 2: (Processing facility) Package 3: (Sanitary Landfill)	1. ULBs can select agencies having expertise in relevant MSWM service areas at a very competitive rate. 2. Scope for competition between multiple service providers. 3. Does not create a monopoly of a single service provider 4. Enables the ULB to replace a non-performing contractor, without disrupting all other SWM services	Same as above	Package 1 –Tonnes of waste collected and transported Package 2- Tonnes of waste Processed per processing plant Package 3-Tonnes of waste disposed at disposal facilities

S. No	Type of Project	Description of Project	Advantages	Risks	Unit of Measurement
4	MSW- Model 4 Decentralized project	Each process is considered as individual projects Package1: Collection Package 2: Transportation Package 3: Processing Package 4: Sanitary Landfill	1. ULB can select agencies having expertise in relevant SWM service areas at a very competitive rate. 2. Scope for competition between multiple service providers. 3. Does not create a monopoly of a single service provider 4. Enables the ULB to replace a non-performing contractor, without disrupting all other SWM services 5. Each service can be operated by specific specialists 6. Scope to ensure provision of cost effective services due to competition and higher scope for replacing non performing contractors.	1. The risk of lack of synchronization between waste collection and transportation agencies can disrupt overall service provision. 2. This in turn can adversely affect the processing and disposal services.	Package 1 –Persons employed or Tonnes of waste collected Package 2-Tonnes of waste transported Package 3- Tonnes of waste processed per processing plant and tonnes of product produced (if any) Package 4-Tonnes of waste disposed at disposal facilities

5.4 Tendering, Contract Management And Supervision

Standardize pre-qualification criteria to support only those firms having adequate resources and expertise

ULBs may enter into contracts with private service providers for provision of specified solid waste management services such as collection, transportation, treatment, processing & disposal of waste. Please refer to Section 1.4.4.6 of Part –II of the manual for more details. Private Service providers have to be held accountable for maintaining required standards of services, as well as its effectiveness and efficiency.

Adequate care should be taken while preparing tender documents to ensure that only those firms with requisite qualifications and experience are considered. Following aspects may specially be kept in view:

Selection of bidders should be based on both technical & financial criteria

- The tender should clearly specify the technical and financial capability required to perform the task proposed to be outsourced. The qualification criteria should be standardized. It should provide equal opportunity to all those who have a capability to undertake the task. It should not restrict competition between big players and at the same time should not allow incompetent or inexperienced / unqualified parties to get into the fray. The eligibility criteria should be limited to what is required to perform the obligation; this shall enhance healthy competition and create a pool of entrepreneurs to provide SWM services.

Multiple contracts for MSWM Services should be encouraged to ensure duplicate competencies, which can be relied on during times of failure of contractual obligations by any one of the contractors

- Selection of bidders should be on the basis of both technical and financial bids. This could be done in several ways such as:
  - the ULB may prescribe minimum qualifying standards for technical bids; financial bids of only those bidders who meet the minimum qualifying standard may be opened unless otherwise justified.
  - ULB may give higher weightage to qualifications and experience in cases where higher skills are necessary.
- Awarding single contract covering all aspects of SWM in the city may be avoided as it can create unmanageable situation if the contractor ceases to operate. Multiple contracts are desirable so that if one contractor fails, other can take over till other arrangements are made. However, it may not be feasible in case of processing and landfilling.
- Develop transparent and stringent monitoring and evaluation system to ensure that contractors perform their obligations.
- Long term contracts should provide for a periodic revision of tariffs based on predetermined parameters and create a mechanism to implement it to ensure sustainability of the contract .

- Ensure timely payments for contracted services.
- ULBs need to ensure adequate in-house capabilities for appropriate contract monitoring.

The ULB could itself provide door to door collection and transportation of wastes in a few wards in the city, in order to maintain in-house capacity for providing critical services in times of crisis. (e.g. dispute in contract provisions, when the service provider does not discharge his obligations, etc.). Contingency plans should be prepared by the ULB for appropriate storage of waste, to tide over situations of non-performance of the processing/treatment/disposal facilities.

5.4.1 Engaging With A PPP Partner

A transparent procurement process should be adopted for the selection of PPP partner preferably through a Transaction Advisor after having got prepared a detailed project report by following the standard procedure as indicated below:

Depending upon the project structure and time/cost considerations, ULBs can adopt a single stage process or a two stage process for contracting

- Preparation of EoI, RFP Document and Concessionaire Agreement
- Obtain Approval from concerned Authority.
- Issue of Notice for Pre-qualification / EoI
- Short-listing of Firms
- Issue of RFP Document to the Shortlisted Firms
- Conduct Pre-bid Meeting
- Receiving Technical & Financial bids in separate packets in Response to the RFP and opening of technical bids.
- Evaluation of the Technical Bid Document received
- Opening of financial bids of the bidders found to be eligible for opening of financial bids (minimum three bids would be desirable).
- Evaluation of financial bids
- Selection of most preferred bidder
- Negotiation and Signing of Agreement
- Award of Contract

5.4.2 Tendering Process For PPP Projects

The Municipal Authority has an option of adopting a single stage selection process or a two stage selection process for awarding contracts to the private sector.

5.4.2.1 Single Stage Process

In a single stage bidding process, technical and financial bids are submitted simultaneously in response to a request for proposal. The selection of the preferred bidder is envisaged through an evaluation of a three-part proposal received from interested bidders covering:

PART I : RESPONSE TO QUALIFICATION REQUIREMENT

PART II : TECHNICAL OFFER

PART III : FINANCIAL OFFER

Contents of a typical RFQ include:
- Introduction
- Instruction to Applicants
- Fraud & Corrupt Prcatices
- Pre-bid Conference
- Miscellaneous

- Opening and evaluation of Part I – Response to Qualification: Pre-Qualification will be based on the documents received from bidders in response to the qualifying criteria laid down by ULB. The technical and financial Offers of Bidders, who do not qualify at this step, will be returned unopened.
- Opening and evaluation of Part II - Technical offers: Technical offersin the proposals from bidders who qualified at the end of first stage will be opened and evaluated against pre-determined criteria. Financial offers of bidders, who do not qualify at this step will not be opened and shall be returned.
- Opening and evaluation of Part III - Financial offers: Financial offers from proposals of those bidders whose technical offers have been qualified shall be opened and scrutinized. Only those financial offers which are in accordance with criteria laid down in RFP document shall be evaluated.

Indicative Schedule for Bidding- Single Stage Process

- Sale of Bid/RFP document to short-listed applicants: Zero date
- Submission of query by the perspective applicants: +15 days
- Pre bid meeting: +20 days
- Authority response to queries: +30 days

- Bid Submission Due Date: +60 days
- Opening of Technical Bids: +60 days
- Acceptance of Technical Evaluation Report by Tender Committee:+80 days
- Financial Bid opening:+90 days
- Letter of Intent (LoI): +within 30 days of Bid opening date
- Issue of Letter of Award to Bidder: +30 days of issue of LoI
- Signing of the Contract: +within 30 days of award of LoI

Note: + "x" days means time duration from the zero date i.e. date of publication of RFP

5.4.2.2 Two Stage Process

The two stage selection process is characterised by an initial pre-qualification stage, followed by a request for proposal stage, which is applicable only to pre-qualified bidders.

Request for Qualification (RFQ) contains useful information required by bidders for formulating their application for qualification

Stage 1: Qualification Stage: The Request for Qualification ('RFQ') specifies the minimum qualifications required for participation in the tender. Suitability of interested parties / consortia will be assessed by the tenderer in accordance with the provisions of the RFQ. At the end of this stage, the Authority will shortlist suitable pre-qualified applicants who are then eligible for participation in the second stage of the bidding process (the "Bid Stage").

Stage 2: Letter of Invitation: After the bidders have been shortlisted under the 'Request for Qualification (RFQ)' for the aforesaid project, ULB should invite the bidders to procure the 'Request for Proposal' document, with the objective of submitting a technical and financial proposal.

Indicative Schedule for Bidding- Two Stage Process

Stage 1: Pre-Qualification Stage

- Sale of RFQ documents: Zero date
- Submission of query by the perspective applicants: +15 days

- Pre bid meeting: +20 days
- Authority response to queries: +30 days
- Bid Submission Due Date: +60 days
- Opening of Technical Qualification Bids: +60 days
- Acceptance of Technical Qualification Evaluation Report by Tender Committee:+80 days

Stage 2: Bid Stage

- Sale of RFP document to short listed applicants: +90 days
- Submission of query by the perspective applicants: +105 days
- Pre-bid meeting: +110 days
- Authority response to queries: +130 days
- Bid submission due date: +150 days
- Opening of bids: +150 days
- Letter of Intent (LoI): within 30 days of Bid opening date
- Signing of the Contract: + 30 days of award of LoI

Note: + "x" days means time duration from the zero date i.e. date of publication of RFP

5.4.3 Request For Proposal (RFP) From ULBS

Request for Proposal (RFP) provides information to the bidders that is useful for preparing their financial offers

The Request for Proposal (RFP) is a document that ULBs prepare to elicit bids from potential vendors. The quality of an RFP is very important to successful project management because it clearly delineates the deliverables that will be required. This RFP includes statements, which reflect various assumptions and assessments arrived at by the Authority in relation to the Project. Such assumptions, assessments and statements do not purpose to contain all the information that each bidder may require.

The Request for Proposal (RFP) should be organized in three volumes as given below:

- VOLUME I: Instruction to Bidders (ITB)
- VOLUME II: Minimum Mandatory Technical and Performance Specifications/Project Information Memorandum (PIM)
- VOLUME III: Concession Agreement

5.4.3.1 VOLUME I: INSTRUCTION TO BIDDERS (ITB)

The instruction to bidders specifies procedures to be followed by bidders in preparation and submission of their proposals and provides information on submission, opening, evaluation of proposals & on award of concession.

Indicative contents of the Instruction to Bidders section of the RFP:

- General conditions
  - General responsibilities of bidding
  - Fraud and corrupt practices
- Contents and Submission of Proposal
  - Cost of Proposal
  - Language and Currency
  - Number of proposal
  - Eligibility and Pre-qualification
  - Bid Security
    - ✓ Performance Guarantee
  - Guidelines for Submission of Proposal: The Bidder shall submit the Proposal in accordance with the guidelines prescribed in the RFP and ensure that the Proposal is complete in all aspects. The Authority reserves the right to reject Proposals that do not conform to the guidelines prescribed.
    - ✓ The Proposal shall be submitted in three parts, viz.,

      Part I: Response to Pre- Qualification requirements

      Part II: Technical Offer and

      Part III: Financial Offer
  - Proposal due date and validity period
  - Late submission of proposal
  - Modifications/substitution/withdrawal of proposal
  - Verification of information and site visit
  - Right to accept or reject any or all bids

- Eligibility and Pre-Qualification
  - Technical capacity as per eligibility criteria
  - Financial capability
  - Change in ownership
  - Lock in periods
- Evaluation of bids
  - Confidentiality and Non- discriminatory process to be defined
  - Clarifications
  - Evaluation: Part I- Response to pre-qualification requirements
  - Evaluation: Part II- Technical offer
  - Evaluation: Part III- Financial offer
  - Notification and issue of letter of intent
  - Conditions precedent for issue of letter of award
  - Authority's right to accept or reject proposal

5.4.3.2 Volume II: Minimum Mandatory Technical And Performance Specifications/Project Information Memorandum (PIM)

- Brief description of the project
  - Scope of work
- General technical design requirements and standards
- Specific design requirements and standards for each facility
- Operation and performance requirements
- Existing infrastructure

5.4.3.3 Volume III: Draft Concession Agreement

The Draft Concession Agreement specifies various details pertaining to the project in its various articles. Formats for information to be provided by the bidder are specified in the various schedules of the concession agreement.

A list of articles to be included in the concession agreement is given below:

- ARTICLE I: General Terms
  - Definitions
  - Interpretations
- ARTICLE II: Concession
  - Grant of Concession
  - Rights Associated With the Grant of Concession
  - Concession Period
  - Extension of Concession
  - Acceptance of Concession
  - Conditions Precedent for Waste Processing and Landfill (WPLF)
  - Non-compliance with Conditions Precedent
- ARTICLE III: Project Site
  - Applicable Permits
  - Lease of Land
  - Handover of Project Site
  - Rights, Title and Use of Project Site
  - Peaceful Possession
- ARTICLE IV: Monitoring of the Project Facility
  - Composition of Committee
  - Specific Obligations of the Committee
  - Frequency and expenses related to meetings
  - Role of the Committee
  - Right to appoint an external consultant
- ARTICLE V: Concessionaire's Obligations
  - Performance Bank Guarantee
  - General Obligations
  - Arrangement for Finances
  - Operation and Maintenance
  - Insurance

  - Clearances, Permits, etc
  - Specific Obligations
  - Miscellaneous Obligations
  - No Breach of Obligations
- ARTICLE VI: Municipal Body's Obligations
  - Specific Obligations
  - General Obligations
- ARTICLE VII: Payments to the Developer
  - Payments Terms
  - Payment mechanism
- ARTICLE VIII: Force Majeure
  - Force Majeure Events
  - Duties of Parties during Force Majeure Events
  - Costs during the Force Majeure Events
  - Termination due to Force Majeure Events
- ARTICLE IX: Events of Default
  - Events of Default
  - Termination due to Events of Default
  - Rights of Municipal Body upon Termination
  - Rights of Parties
- ARTICLE X: Transfer of Project Facility
  - Ownership of Project Facility
  - Contractor's obligations
  - Municipal Body's obligations
- ARTICLE XII: Dispute Resolution
  - Amicable resolution
  - Arbitration Proceedings
  - Performance during dispute

- ARTICLE XI: Representation and Warranties
  - Contractor's Representations and Warranties
  - Municipal Body's Representations and Warranties
  - Obligation to notify change
- ARTICLE XIII: Miscellaneous
  - Sub-Contract
  - Labour (Interests and rights of labors be laid out clearly)
  - Interest and Right of Set off
  - Governing Law and Jurisdiction
  - Waiver
  - Survival
  - Amendments
  - Notices
  - Severability
  - Language
  - No Partnerships
  - Exclusion of Implied Warranties, etc
  - Counterparts

The various Schedules to be included in the concession agreement shall include:

- Schedule I: Details of Project Sites
- Schedule II: Construction requirement for waste processing facilities
- Schedule III: Fees (format)
- Schedule IV: Land license agreement (format)
- Schedule V: Authorization
- Schedule VI: Scope of work of monitoring authority
- Schedule VII: Format for performance bank guarantee
- Schedule VIII: Technical scheme for MSWM facility
- Schedule IX: Operation & maintenance for MSWM facility

- Schedule X: Approach and methodology for construction of MSWM facility
- Schedule XI: Service level condition and penalties

5.4.4 Suggested Contents Of Proposals From Bidders

The proposal shall include the following contents in the formats prescribed by the municipal authority:

Response to Pre-Qualification requirement

- Bid Security (as defined)
- Fees for RFP (as defined)
- Form I: Covering Letter for Proposal Submission
- Form II: Details of Bidder / Bidding Consortium
- Form III: Power of Attorney of Authorized Signatory of Bidder
- Form IV: Memorandum of Association (in case of Proposal submitted by a Consortium)
- Form V: Power of Attorney of Lead Member (for Consortium Proposal)
- Form VI: Format for Board Resolution of Bidder/Bidding Consortium Members
- Form VII: Format for Non-criminality
- Form VIII: Format for Anti-Collusion certificate
- Form IX: Details and Proof of Technical Capacity
- Form X: Details and Proof of Financial Capacity
- Form XI: Litigation History
- Certificate/s from a practising Chartered Accountant in India certifying Net worth as per Clause 3 (a) supra, along with the documents (if any) as required under relevant Clauses. For the purpose of this tender, the term Net Worth means the shareholders equity plus reserves and surplus
- Copy of Memorandum and Articles of Association or Registration Document

Technical Offer

- Form XI A: Formats for technical proposal
- Form XI B: Technical plan for project facilities

- Form XII: Details of Expert Team with curriculum vitae

Financial Offer

- Form XIII: Assumed project cost break-up Sheet
- Form XIV: Detailed break-up of operating costs & revenues

National Guidance for Contracting PPP Projects

- Toolkit for PPP Frameworks in MSWM developed by the Department of Economic Affairs, Ministry of Finance and Ministry of Urban Development (MoUD) with the support of the GOI -ADB PPP Initiative. Available at: http://www.urbanindia.nic.in/programme/uwss/pp_partnership.htm
- MoUD, (2012). "Toolkit for Solid Waste Management, JnNURM". Available at: http://jnnurm.nic.in/wp-content/uploads/2012/11/SWM-toolkit.pdf
- PPP Toolkit for Improving PPP Decision-Making Processes (2011). Ministry of Finance, GoI. Available at: http://toolkit.pppinindia.com/solid-waste-management/module1-intro.php?links=intro1

5.4.5 Cost Escalation

Cost of service provision may increase as a result of an increase in the general costs or an increase in specific cost components of a contract, such as fuel or wages, which form the major cost component of any MSWM contract.

MSWM contracts are sensitive to fluctuations in the cost of labour and fuel; contracts should build in mechanisms to enhance the cost of the contract when there is an escalation of these prices; contracts may otherwise fail due to increased costs to the contractor

5.4.5.1 Annual Escalation In General Costs

In order to enable stable service provision even in the face of annually escalating general costs, the concessionaire may be allowed an annual increase in the contract value. The following guidance may be used to calculate the allowed increase.

2 % increase in the base rate 'X' may be given annually to cover the general increase in costs. The increase may be calculated as per the examples given here under:

After 1 year X plus 2% of X

After 2 years X plus 4% of X

After 3 years X plus 6% of X

After10 years X plus 20% of X

After 14 years X plus 28% of X

Where 'X' is the "base rate" accepted at the time of award of contract as against rate per metric tons quoted by the Selected Bidder.

5.4.5.2 Increase In Price On Account Of Increase In Diesel/Manpower Costs

Besides the general costs, the concessionaire shall be given an increase or decrease in the diesel component as well as minimum wages component as and when the rates are increased or decreased.

For the purpose of calculations, the cost component of diesel may be taken as 25% of base rate "X" and the cost component of minimum wages of workmen may be taken as 45% of base rate "X". Any increase in price of diesel or minimum wages will be compensated by giving a proportionate increase in the aforesaid percentage component of diesel and minimum wages.

In a situation where for any reason the price of diesel or alternate fuel in use for the vehicle and equipment utilized for providing SWM services reduces, the tendering authority could suomoto order review of the diesel/fuel price & minimum wages and reduce the increase in the base rate already given subject to the condition that the final Base Rate 'X' shall not be reduced below the original rate accepted/granted by the tenderer. This cost difference shall be calculated as per formula given below:

Calculating increase in price on account of increase in diesel cost component

$$E(Rs) = A \times B \left\{ \frac{C}{D} - 1 \right\}$$

New Rate payable on account of price increase = A± E

Where;

A = base rate at the time of signing the Concession Agreement

B = % of diesel component in 'base rate' fixed at the time of signing the Concession

Agreement i.e. 25%

C = Actual rate of diesel at the time of price increase

D = Rate of diesel at the time of award of Concession or previous revision whichever is later

E = Increase/decrease in diesel component

Example:

A = Base rate on the date of signing of the Concession Agreement = 800

B = % of diesel part in the base rate = 25%

C = Rate of diesel at the time of price increase = 60.00

D = Rate of diesel at the time of grant of Concession = 55.00

= 800 x 0.25 x (1.09 -1)

= 800 x 0.25 x 0.09

= 800 x 0.0227

= 18.16

Therefore, the base rate to be further increased after review of diesel component cost

= Rs. 18.16

Calculating increase in price on account of increase in Minimum Wages

$$E(Rs) = A \times B \left\{\frac{C}{D} - 1\right\}$$

Minimum Wage increase adjustment shall be as per formula given below:

Change in Minimum Wage component

Where;

A = Base rate at the time of signing of the Concession Agreement

B = Percentage of Minimum Wage component in ‘base rate’ fixed at the time of signing of the Concession Agreement i.e. 45 %

C = minimum wages as increased now by Govt.

D= Minimum wages at the time of award of the Concession or previous review

E= Increase/decrease in Minimum Wage component

Example:

A=Base rate on the date of signing of the Concession Agreement	= 800
B= % age minimum wage component in the base rate	= 45%
C= Minimum wage of unskilled labor now increased	= 180.00
D= Minimum wage at the time of grant of the Concession	= 160.00

$$E(Rs) = A \times B \left\{ \frac{C}{D} - 1 \right\}$$

Change in Minimum wage component

= 800 x 0.45x 0.125

= 800 *0.45*0.125

=45

The base rate to be increased after review of minimum wage component

will be = Rs. 45/-

Therefore, further increase in the base rate at the time of review will be Rs. 18.16 as Diesel component + Rs. 45/- as minimum wage component =Rs. 63.16

The Base Rate of 800 /- will now is 863.16 from the date of such increase.

5.4.6 Evaluation & Selection

An evaluation team, appointed by the municipal authority will scrutinize the tender documents. The team will assess the applications for completeness and eligibility of the tendering bidders as per conditions mentioned in the ToR. This process from publication of the EoI to the selection of the final contractor usually takes about 6 months.

The evaluation committee shall shortlist all eligible bidders. Final selection may be based on specific selection criteria specified in the ToR. The following criteria may be considered:

1) Relevant qualification &experience of the bidder

2) Expertise of the bidding team
3) Financial capability of the bidder
4) Approach and methodology suggested
5) Reliability of the bidder (based on previous conduct)
6) Proposed pricing structures and cost to the ULB
7) Environmental and social safeguards provided / ensured
8) Assumption of risk liability and proposed mitigation measures

Negotiation: The ULB may enter into further negotiations with the highest ranked bidder. The contracting and service agreement should be finalized based on the agreements subsequent to the negotiation process.

Enabling Conditions for Successful PSP/PPP Contracts

- A transparent bidding process
- Timely handover of facilities free from encumbrances (physical and legal)
- Clearances /approvals/ decision making process need to be expeditious – delays in approval/ clearances have serious consequences
- A sustainable project structure and revenue model with appropriate risk allocation
- Price sensitivity of the financial proposal shall be established, specifically with respect to capital/ subsidies/ sale of products - this is a robust indicator of the financial viability of proposed projects, even when there is a change in the assumed circumstances.
- Political and stakeholder involvement and acceptance; these are crucial pre-requisites for successful PSPs/PPPs
- Cost recovery/revenue mechanisms shall be based on a real-world assessment
- Transparent subsidies & credit enhancement help expedite financial closure
- Clear performance based indicators
- Appropriate incentives

5.4.7 Contract Monitoring

A contract monitoring cell should be established within the SWM Department to monitor performance/ clauses as specified in the contract

Contract models detailed above and in step 4 of the planning process[3] are only as effective as their implementation. In this context, monitoring plays an important role in ensuring delivery of services which meet required specifications.

Based on specifications of the contract, the ULB should develop checklists, milestones and inspection schedules. A specific Monitoring Cell should be established within the SWM department, with a clear definition of roles and responsibilities. Table 5.3 gives an indication of specific activities that should be performed by the contractor and the ULB to ensure successful implementation of the project.

Table 5.3: Contract Monitoring – Activities/Clauses

Sl. No	Activities/ Clauses	Specific Actions	Primary responsibility	Monitored by
1	Applicable permits other than land clearances	1. List applicable permits under various laws and rules, respective authorities, validity of permits, fees payable, persons responsible to obtain the permits 2. Obtain necessary permits	Contractor	ULB
2	Appointment of project in-charge / engineer/ Independent engineer	1. Select / identify a suitable person from within the department or appoint a qualified person responsible for monitoring project implementation	ULB	ULB
3	Performance Bank Guarantee (PBG)	1. PBG to be furnished by contractor	Contractor	ULB
4	Project Design	1. Project design drawings, Equipment specifications, Spares list, Electrical drawings and operating plan, to be approved by the project engineer/ in-charge. 2. Standard Operating Plans to be prepared for all activities 3. All project design documents to be approved and signed by ULB officer in-charge	Contractor	ULB

[3] section 1.4.4.6 of Part II of this manual

Sl. No	Activities/ Clauses	Specific Actions	Primary responsibility	Monitored by
5	Insurance	1. Obtain valid insurance, covering risks, timely renewal of validity is to be ensured	Contractor	Contractor
6	Environmental Compliance	1. Carry out regular environmental social, health, and safety audits, safety and first aid trainings, ensure use of PPEs,	Contractor	ULB
7	General Obligations	1. Valid Public Liability Insurance and renewal; 2. Employee State Insurance (ESI) & Employees' Provident Fund (PF) payments 3. List of persons responsible for these actions to be maintained by the contractor and submitted to the ULB.	Contractor	Contractor
8.	Specific Obligations	1. Declaration and enforcement of a No Development Zone by ULB, Ensuring that Biomedical/ Hazardous/ Construction and Demolition waste are not brought to the MSW processing facility. 2. Timely notice on events of defaults / force majeure. 3. ULBs to make timely payments	ULB	ULB

Sl. No	Activities/ Clauses	Specific Actions	Primary responsibility	Monitored by
9.	Maintenance of records	1. Daily record of human resources, equipment deployed, incoming vehicle details (vehicle number and driver), Net weight of incoming/ outgoing waste, timing of entry/ exit of vehicles, 2. Maintenance of separate registers for waste delivered at processing facilities and disposal site, outgoing processed products and outgoing rejects from the processing plants with triplicate gate pass, signed off by ULB representative, who is to be stationed at every treatment/processing facility	Contractor	ULB
10	Operations & Maintenance	1. Approved SOP, recommended spares list and minimum inventory, regular audit of these stocks 2. Maintenance of equipment.	Contractor	ULB
11	Service levels	1. Verify and certify achieved service levels 2. Identify defaults 3. Assess compliance 4. Issue notices & follow up on previous notices/assurances given etc.	ULB	ULB

Chapter 6:

Management Aspects: Monitoring MSWM Service Provision

6. Management Aspects: Monitoring MSWM Service Provision

6.1 Monitoring MSWM Service Provision

Institutionalizing appropriate quality assurance systems is essential to ensure a continuous and efficient municipal solid waste management system. The performance of all components of solid waste management systems, from collection to processing and disposal, should be maintained on a daily basis. Provision of citizen centric services shall also be monitored through a feed-back mechanism which shall primarily focus on concerns of the community regarding door step collection, primary storage and transportation of waste.

MIS is a computerized system which stores and retrieves from a database of information; this data can be analyzed for identifying problem areas and improving service delivery efficiency.

6.1.1 Management Information System

A comprehensive monitoring and evaluation system should be adopted for assessing progress towards meeting the targets in the MSWM Plan and for monitoring successful implementation of the plan. The monitoring system adopted should:

- collect data regularly, and
- analyze collected information, take/propose corrective measures, and support the planning & implementation process.

Collection and analysis of data related to solid waste management is required to assess the existing situation and propose adequate measures to improve service delivery. A Management Information System (MIS) can retrieve relevant information which can then be used by decision makers.

MIS assists in monitoring the efficiency of SWM systems. It increases transparency and accountability of officials in the solid waste management system. It helps in establishing a strong and reliable information data base necessary to facilitate planning, mid-course corrections and decision making. Geographic Information Systems (GIS) and visual capture of information using cameras are now being integrated with the MIS to provide spatial and visual validation for provision of services.

Communication technologies such as Radio Frequency Identification (RFID), Global Positioning System (GPS) and General Packet Radio System (GPRS) are now integrated with Geographic Information Systems (GIS) for monitoring the solid waste management system. These can be suitably adopted by cities to improve the efficiency of service. Computer application of mentioned tools need some prior data/information to provide correct information to decision makers. Figure 6.1 illustrates prior data requirement for computer application of MIS-GIS-GPS system.

Advanced communication tools enable reliable and efficient services:
- GIS
- GPS
- GPRS
- RFID

Integrated Technologies

Management Information System (MIS)

It is a typical computer based system used to manage information about the operation, which is important for decision making. A MIS (Management Information System) can manage large amount of spatial and attribute data such as type of waste, vehicles etc. It provides concise, correct and timely information to decision makers.

Radio Frequency Identification (RFID)

RFID tags are designed to enable data capture by electronic readers, which then transmit this information via a wireless network to the MIS. These tags are pre-loaded with information related to the physical location to which they are attached. Auto-ID technologies have been used to reduce the amount of time and labor needed to input data manually and to improve data accuracy. Predominantly, RFID tags are used to identify secondary collection bins and help monitor their pick-up and evacuation at the treatment/processing/disposal site.

Global Position System (GPS)

GPS is a satellite-based navigation system which records geographical/physical locations on the earth. The satellites periodically emit radio signals to GPS receivers, based on the identification and reflection of these signals, GPS are used to calculate distance and to compute two-dimensional or three-dimensional position. GPS is used for tracking the position of trucks and bin locations.

General Packet Radio System (GPRS) Technology

GPRS is a wireless data network system which achieves real-time sending and receiving of data. The GPRS technology helps transfer data from remote devices to centralized data integration and management systems.

Geographic Information System (GIS)

GIS integrates software and hardware for collecting, managing and analyzing spatial and attribute data in a computer-based system. It helps to analyze spatial and related attribute data to identify patterns, trends and relationships. GIS systems help in planning waste transportation routes and locations for waste collection bins. Linked with RFID and GPRS systems, GIS provides real time, data on vehicle, collection of waste, bin pick up and transportation to treatment/disposal systems.

Use of integrated technologies such as MIS, GPS and GIS has resulted in the development of integrated and comprehensive solutions for SWM. Beneficial uses of these systems include:

- Data aggregation and process monitoring is managed electronically, avoiding day to day human intervention, thereby increasing reliability and transparency of information.
- Movement of vehicles may be monitored on real time basis by using a surveillance system based on GPS/GIS communication technologies, thereby reducing non-compliance and enhancing efficiency.
- Status of evacuation of bins on a daily basis can be monitored, facilitating increase in service efficiency.

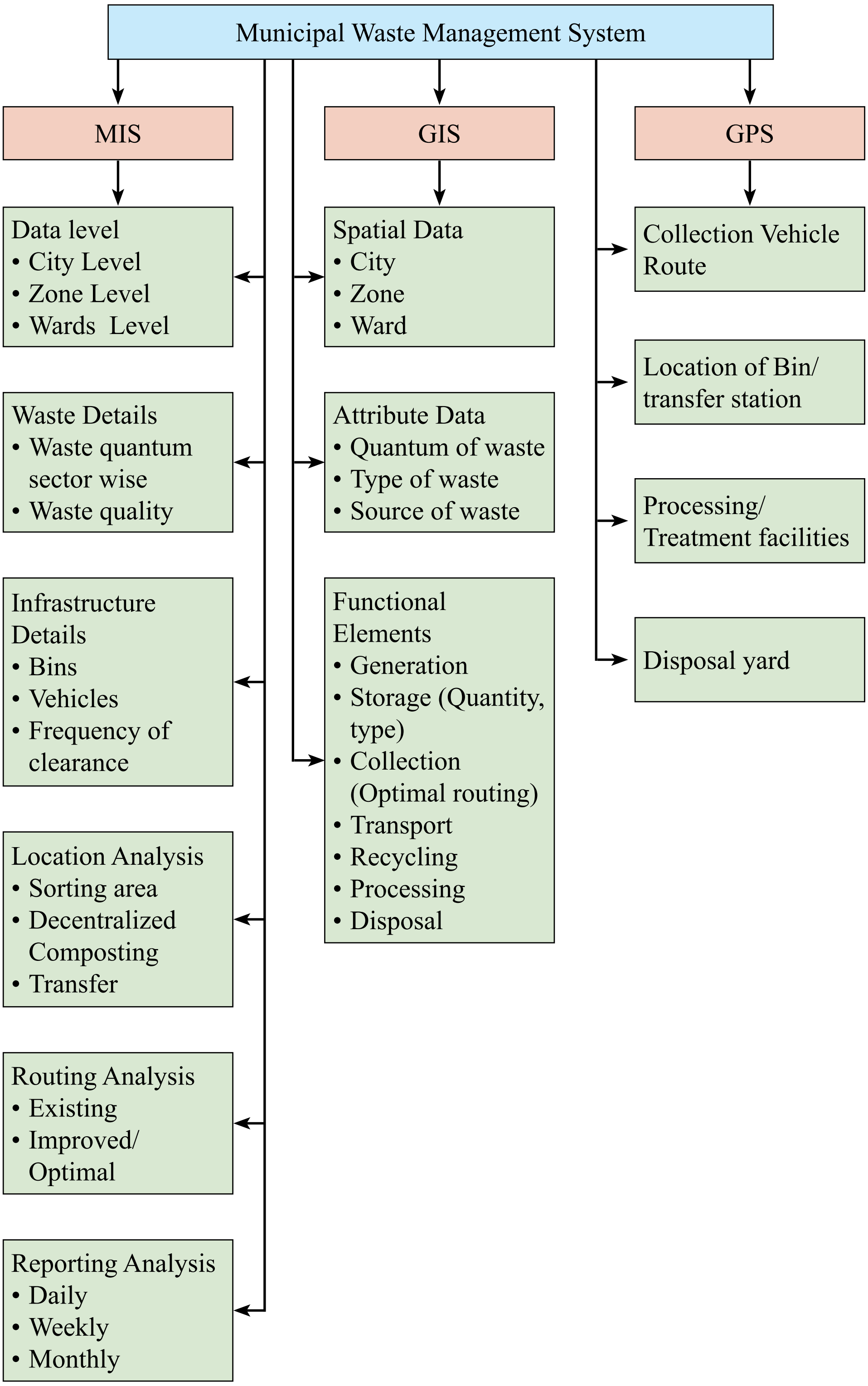


Figure 6.1: Minimum Data Requirement for MIS-GIS-GPS Systems

Integrated Technologies (MIS, GIS, GPS, RFID) for Monitoring Solid Waste Management

Real time monitoring of status of bin clearance, estimation of amount of waste in and around bins, surveillance of movement of vehicles, optimization of routes and reallocation of bins according to the estimated waste, are possible through integration of several technologies, hence providing transparency in civic administration. Figure 6.2 indicates integration of various technologies for solid wastes monitoring and management.

Each container is equipped with an RFID label having a unique identification code. Low frequency passive tags are proposed because they offer long term low cost solutions and are operational in extreme conditions resistant to environmental hazards. Geo-coding of containers is done manually through field visits and by noting the locations using a GPS receiver. When the container gets loaded onto the truck, the reader reads the serial number of the tag on the container. At the same time, the GPS receiver on the truck calculates its location using satellite data. The serial number of the tag, location, date and time are transmitted real time via the GSM network to the communication gateway of the control server. The same is repeated when the truck reaches its destination. After data processing, information is transferred to the GIS terminal. Real time information can be shared with clients via a web based solution.

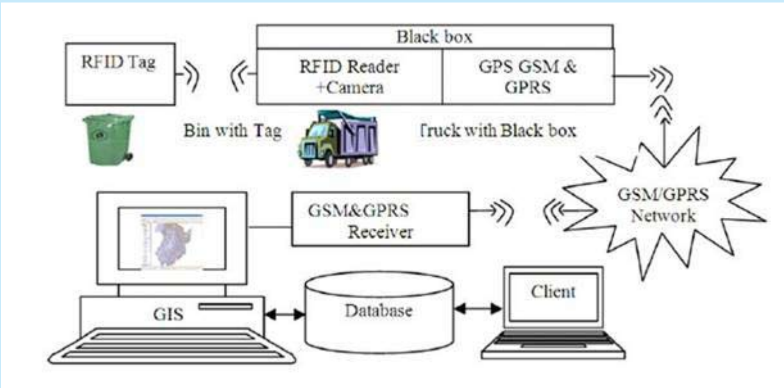


Figure 6.2: Solid Waste Monitoring and Management System[1]

[1] Hannan, M. A. et al., 2011, "Solid Waste Truck Monitoring and Management using RFID, GIS AND GSM", Journal of Applied Sciences Research, 7(12).

Pimpri-Chinchwad Municipal Corporation (PCMC) has initiated the task of monitoring its SWM services through the use of Information and Communication Technologies (ICT)

By deploying GPS based real time vehicle tracking system, PCMC is able to:

- Monitor the actual movement and real time position of the vehicle
- Monitor the movement of collection vehicles
- Improve service delivery mechanism and achieve better information management
- Ensure citizens' participation in governance mechanism for overall improvements in collection efficiency
- Reduce unwanted trips/detours/stoppages thereby enhancing the productivity/ utilization of the fleet
- Generate MIS report on daily basis to take informed decision.
- PCMC published the "Bin Pick up Status" on their website to inform citizens and encourage them to monitor bin pick-up status in their localities.

This endeavor resulted in improving PCMC's accountability and also offered a reliable tool to facilitate data provision under the Right to Information Act, where such information is sought.

Effective monitoring of collection and transportation of municipal waste through GPS (Global Positioning System)

Year of start: 2011

Main players: Nashik Municipal Corporation (NMC) - Health Department and Computer Department.

Approach: Door to door collection of waste in the city was established through Ghantagadis (designated waste collection vehicles) in 1998. With the start of the JnNURM project, the Nashik Municipal Corporation received central funds for strengthening the existing system resulting in the procurement of 124 Ghantagadis and GPS systems under the project. GPS machines were fitted on each vehicle in order to improve the collection and transportation efficiency of the vehicles. An agency was appointed by NMC for installation of the GPS system (machines and software) and its operation and maintenance. A Cell (centralized monitoring unit) was formed at the NMC office to manage and supervise the overall system - like monitoring and tracking of vehicle movement on a regular basis, for tracking of complaints and inefficiencies and for the generation of daily and weekly reports. The redressal of complaints which were generated was done with the support of the sanitary inspectors at ward level.

Outcome:

- Installations of GPS systems on all 124 Ghantagadis owned by NMC and centralized monitoring unit created at NMC headquarter.
- Skill development and capacity building of the ground staff and contractors engaged in collection of solid waste was undertaken when the system was introduced.
- Ensuring that the time delay and average stoppage time (4-5minutes) for each vehicle was tracked.
- Effective and timely redressal of complaints generated through the GPS monitoring system by the ward level sanitary staff.
- Generation of daily, weekly reports by vehicles to ensure adherence to the timing and collection of the waste at the respective collection points.
- Information transparency and data availability on the public domain for citizens and public representatives with respect to the routing and timings of the vehicles increased confidence in the system.

Success Factor:

- Proactive role of NMC to streamline and monitor the collection and transportation system.
- Capacity building of the NMC staff, contractors, vehicle drivers and workers prior to the installation of the system.
- Collection of waste at a given stipulated time by the contractors.
- The real time report generation through GPS helped in resolution of disputes between citizen's, officials and contractor thereby creating a transparency between the consumers and service providers.
- Regular monitoring of the reports by the Commissioner and the Health officer resulted in the improvement in the collection and transportation efficiency.

Overall Sustainability:

By appointing an operator for regular Operation and Maintenance of the GPS system, NMC has insured that the GPS machines and the monitoring system is functional and the initial teething troubles faced by NMC of dysfunctional/ destruction of GPS machines installed in the Ghantagadis, was overcome. The pro-activeness of the Commissioner and the Health Department of NMC towards transparency in the management of the MSW in the city ensuring the sustenance of the system.

(Source: Nashik Municipal Corporation, 2014)

6.1.2 Data Collection & Analysis For Monitoring

The head of the solid waste management department should be responsible for monitoring and evaluation. A dedicated Monitoring & Evaluation team should be constituted with distinct roles and responsibilities. Field level staff should be inducted and reporting schedules should be fixed.

Reports generated should capture critical information about MSWM of planning area. Reports should be effectively used for decision making, identifying gaps and corrective measures beneficial for decision makers. Standard formats should be developed for producing reports on daily, monthly, quarterly or annual basis, as per requirement. Where possible, an MIS system should be developed to facilitate the collection and reporting of this information. This information should also be used for mid-term review of the MSWM Plan and for defining goals of future planning periods. Hence, there is considerable overlap between data required for monitoring MSWM service provision and data required to establish a baseline for MSWM service provision.

Table 6.1 highlights key information that must be periodically collected and analyzed by urban local bodies to operate and monitor SWM systems.

The table also includes a visual indication SLB to identify data elements which are used directly in the computation of Service Level benchmarks (SLBs) for solid waste management service provision. SLB indicators are stipulated by the Ministry of Urban Development, GoI.

Table 6.1: Management Information System (MIS)

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
GENERAL CITY INFORMATION			
• Area of the city • Population of the city SLB • Decadal growth of population • Number of wards, their area and population • Total quantity of waste generated annually	At least once in 3 years	City Level	Baseline information to be used for further analysis
AMOUNT OF WASTE COLLECTED			
• Total amount of waste collected from the city	Daily	Weigh bridge	Assess collection efficiency
• Average number of carcasses removed each day	Daily	Processing/ Disposal facility	Assess requirement for management of carcasses along with slaughter house wastes
• Amount of waste collected from different sources: SLB - Household, shops, and establishments - Vegetable and food market SLB - Meat, Fish and Slaughter houses - Construction and Demolition Waste - Hospitals - Industrial Waste Enterprises	Monthly	Ward/zone and city level from weigh bridge	Assess requirement/capacity of waste management facilities needed by the ULB

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
STORAGE DEPOTS			
Number of sites designated for waste storage	Monthly	Ward Level	Data to be used to assess sufficiency of secondary collection points/storage depots
Type and size of containers / storage depots in each ward	Monthly	Ward Level	
Quantity of waste deposited at storage depots on a daily basis	Monthly	Ward Level	
Number of unauthorized waste dumping points in each ward	Monthly	Ward Level	
DOOR TO DOOR COLLECTION OF WASTE			
Number of houses with door to door waste collection	Semi-annually (Six monthly)	Ward Level	Assess efficiency of door to door Collection
Total number of vehicles, tricycles and human resources allotted for door to door collection of waste	Daily	Ward level	Assess sufficiency of infrastructure for primary collection of waste
Number of vehicles, tricycles and human resources actually reporting for duty	Daily	Ward Level	Assess utilisation rates of existing infrastructure
Short fall in human resources	Daily	Ward Level	Assess sufficiency of existing manpower
Areas left unattended	Daily	Ward Level	Assess efficiency of door to door service provision and identify problem areas
Arrangements made or proposed to be made for clearing the backlog of pending work	Daily	Ward Level	Ensuring daily management of service provision

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
STREET SWEEPING			
Number of sanitation workers on duty for street sweeping vis a vis on roll	Daily	Ward Level	Ensuring efficiency and daily management of street sweeping service provision
Number of sanitary workers absent	Daily	Ward Level	
Arrangements made or proposed to be made for clearing the backlog	Daily	Ward Level	
SILT REMOVAL/ DRAINAGE CLEANING			
Number of sanitation workers on roll for silt removal in the ward	Daily	Ward Level	Ensuring efficiency and daily management of street sweeping service provision
Number of persons found absent or on leave	Daily	Ward Level	
Arrangements made or proposed to be made for clearing the backlog of pending work	Daily	Ward level	
CONSTRUCTION & DEMOLITION WASTE (C&D)			
Number of C & D sites in the city	Monthly	Ward Level	Assess the demand for C&D waste management in the ULB and identify illegal/ non-notified dumping sites to prevent such dumping
Number of unauthorized disposal sites for C& D waste in the city	Monthly	Ward Level	
Quantity of C&D waste lying unattended (based on truck-loads)	bi-weekly	Ward level	

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
TRANSPORTATION OF WASTE			
Number and type of vehicles and equipment allotted	Daily	Ward Level/city level	Assess the sufficiency and efficacy of: 1. Secondary waste collection and transportation 2. Amount of waste collected and transported versus waste generated 3. Vehicle maintenance system
Number and type of vehicles and equipment that actually reported for duty	Daily	Ward Level/city level	
Number of trips made to the processing site / disposal site by each vehicle in one shift	Daily	Ward Level/city level	
Number of vehicles used in first, second and third shift	Daily	Ward Level/city level	
Total quantity of waste transported SLB	Daily	Ward Level/city level	
Number of vehicles that did not make adequate trips	Daily	Ward Level/city level	
Number of vehicles that transport waste but were not totally full	Daily	Ward Level/city level	
Number of bins cleared during the day	Daily	Ward Le/city level	
Number and locations of bins left un-cleared	Daily	Ward Level/city level	
Breakdown reported during the day and action taken	Daily	Ward Level/city level	
Arrangements made or proposed for clearing the backlog	Daily	Ward Level/city level	

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
WORKSHOP FOR VEHICLES & EQUIPMENT			
Total number of vehicles/equipment on the road	Weekly	City Level	1. Assess the road worthiness of vehicles based on number of breakdowns 2. Assess operational issues with equipment 2. Sufficiency of workshop facilities 3. Efficiency and time taken to repair vehicles/equipment vis-à-vis proposed tentative time
Number of vehicles/ type of equipment under repair	Weekly	City Level	
Nature and duration of breakdown	Weekly	City Level	
Time taken to repair	Weekly	City Level	
Alternate arrangements made	Weekly	City Level	
PROCESSING SITE			
Number of waste processing sites in the city	Annually	City Level	Assess the sufficiency of existing facilities to process/dispose collected waste
Distance of the Processing Plants from the City	Annually	City Level	
Area/Capacity of the sites/facilities	Annually	City Level	
Total operating hours of the processing plant	Weekly	Plant Level	1. Assess capacity and efficiency of processing plant. 2. Assess process efficiency 3. Identify potentially hazardous situations w.r.t. type of incoming waste or waste handling/ process mechanisms
Amount of waste received at the plant SLB	Daily	Plant Level	
Amount of end products (compost. RDF) produced at the plant	Weekly	Plant Level	
Amount of end products sold	Weekly	Plant Level	
Amount of end product in the stock	Weekly	Plant Level	
Quantity of reject material	Weekly	Plant level	
Number of staff employed (Sex disaggregated data and the level of work allotted)	Monthly	Plant Level	
Any irregularities noticed			

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
WASTE DISPOSAL SITE			
Number of disposal sites in the city	Annually	City Level	1. Assess sufficiency of existing waste disposal sites 2. Assess quantity of waste disposed vis a vis amount of rejects from processing facilities/ inerts to be disposed 3. Identify remaining life of the landfill
Distance of the disposal site from the city	Annually	City Level	
Area of this site	Annually	City Level	
Quantity of waste disposed each day SLB	Daily		
Expected life of each landfill site	Annually	City Level	
FINANCIAL ASPECTS			
Operating Cost	Annually	Municipal	1. Assess cost of waste management services in the ULB 2. Assess collection efficiency of waste management charges 3. Assess which of the waste management services are financially viable
Cost of collection per ton per day SLB	Quarterly (once in three months)	Municipal	
Cost of transport per ton per day SLB	Quarterly (once in three months)	Municipal	
Cost of disposal per ton per day SLB	Quarterly (once in three months)	Municipal	
Cost recovery made for a variety of services SLB	Quarterly (once in three months)	Municipal	
No. of defaults for which penalties are collected	Quarterly (once in three months)	Municipal	Assess efficiency of penalizing defaulters, as a deterrent to future non-compliance
Allocation of revenue and capital budget	Quarterly (once in three months)	Municipal	Assess that the budget addresses all priority services

Data Required	Minimum Frequency of Measurement	Point of Data Collection	Data Use & Potential Analysis
COMPLAINTS REDRESSAL			
Number of complaints received SLB	Daily	City Level	1.Assess and identify repeated problem areas 2. Assess efficacy of complaint redressal
Types of complaints received SLB	Daily	City Level	
Time taken for issues to be resolved and appropriates actions taken SLB	Daily	City Level	
LEGAL MATTERS			
Number of cases filed in the courts each month for violation of provision of Rules/applicable laws	Monthly	City Level	Assess and ensure legal compliance
Corrective measures taken	Monthly	City Level	

6.1.3 Monitoring Achievement Of SLBS

Eight SLB indicators are defined by the MoUD to assess MSWM service provision in a ULB

Assessment of SLBs is based on an analysis of information collected to monitor MSWM system on a regular basis, as discussed in the previous section. State Governments use SLBs to monitor long term progress of SWM service provision in ULBs. Release of funds from the State Finance Commission is partially contingent on achievement of pre-defined goals of SLBs. Indicators stipulated by the Ministry of Urban Development (MoUD), GoI, for benchmarking solid waste management service provision are:

1. Household level coverage of SWM services through door-to-door collection of waste
2. Collection efficiency
3. Extent of segregation of waste
4. Extent of recovery of waste collected
5. Extent of scientific disposal of waste at landfill sites
6. Efficiency in redressal of customer complaints
7. Extent of cost recovery for the ULB in SWM services
8. Efficiency in collection of SWM charges

A framework for monitoring and reporting on these indicators is given in Table: 6.2. Detailed guidance on data requirements and calculation methods may be found in the Service Level Benchmarking Handbook, Volumes I and II, notified by the Ministry of Urban Development.

Table 6.2: Monitoring achievement of Service Level Benchmarks for SWM service provision[2]

Performance indicators	Unit	Definition	Minimum frequency of performance measurement and reporting	Smallest geographical area for measurement
Household level coverage of SWM services through door-to-door collection of waste	%	Door step collection in percentage from households and other establishments	The monitoring of performance: monthly Reporting and Evaluation: quarterly	Ward level

[2] Adapted: MoUD, 2008, "Handbook of Service Level Benchmarking", New Delhi

Performance indicators	Unit	Definition	Minimum frequency of performance measurement and reporting	Smallest geographical area for measurement
Collection efficiency	%	Collection efficiency is defined as percentage of waste collected by the municipal authority or authorized private waste collector excluding waste recycled by the households or informal rag pickers	The monitoring of performance: daily Reporting and Evaluation: monthly	Ward level
Extent of segregation of waste	%	Percentage of households and other establishments that segregate their garbage into wet and dry waste at the source.	Monitoring of performance: daily Reporting and Evaluation: monthly	Ward level
Extent of recovery of waste collected	%	Percentage of municipal waste recovered or processed by the ULBs, households and informal sector	Monitoring of performance: daily Reporting and Evaluation: monthly	Ward level
Extent of scientific disposal of waste at landfill sites	%	Percentage of waste disposed at the landfill, which is designed, operated and maintained as per set standards	Monitoring of performance: daily Reporting and Evaluation: monthly	ULB level
Efficiency in redressal of customer complaints	%	Percentage of complaints related to municipal waste management redressed within a given time period	Monitoring of performance: daily Reporting and Evaluation: monthly	Zone or city level

Performance indicators	Unit	Definition	Minimum frequency of performance measurement and reporting	Smallest geographical area for measurement
Extent of cost recovery for the ULB in SWM services	%	This indicator denotes the extent to which the ULB is able to recover all operating expenses relating to SWM services from operating revenues of sources related exclusively to SWM.	Monitoring of performance: quarterly Reporting and Evaluation: annually	ULB level
Efficiency in collection of SWM charges	%	It is defined as current year revenues collected, expressed as a percentage of the total operating revenues, for the corresponding time period.	Monitoring of performance: quarterly Reporting and Evaluation: annually	ULB level

6.1.4 Operation &Maintenance Plan For MSWM Services

Irrespective of whether the provision of services is by private contractor or ULB, operation & maintenance plan has to be adhered to. The Operation & Maintenance (O&M) plan should be drafted by the authority responsible for procurement and management of equipment/facilities: either the ULB or the private operator. O&M plans developed by private operators should be ratified by the solid waste management department. The O&M Plan should include preventive maintenance schedules and responsibilities and also guidance for break-down maintenance. It should be the responsibility of the supervisor and operator to regularly maintain and update the O&M Plan. It should also indicate procedures for recording, reporting, analysis and further action.

Preventive Operation & Maintenance (O&M) of equipment, vehicles and facilities ensures the long term sustainability of solid waste management service provision. All contracts to private sector players, irrespective of the mode of contracting, should include a provision for operation & maintenance of all vehicles, equipment and installations during the period of contract. The term of the contract should be co-terminus with the expected life of the vehicles and equipment particularly where the contractor is expected to invest in the procurement of vehicle and equipment.

Operations & Maintenance for MSWM Services

- Operation & Maintenance for MSWM ensures timely availability of required spares (including high wear & tear components, critical components with long lead times for procurement), thereby reducing down-times.
- Preventive O&M provides financial planners with necessary budget information
- Preventive maintenance of equipment and fleet required for different activities (such as primary collection, secondary collection and transportation, transfer station, processing site and landfill) ensures their continuous utility at full capacity through their design life.

Key Components of an Operation & Management Plan:

- O & M plan should address critical components subject to high wear & tear, avoiding potential cost implications of break-down maintenance
- The O&M Plan shall be prepared at the time of procurement by the authority and schedule of preventive maintenance should be determined and strictly observed.
- O&M records shall be maintained for all equipment. An analysis of this information will indicate critical issues of frequent breakdowns and components undergoing regular wear and tear. Supervisors could use this information to identify incorrect operating practices leading to frequent break downs. This analysis may also lead to the identification of equipment which is ill-suited to perform the requisite tasks.
- The O&M Plan should include contact information of concerned staff responsible for maintenance of specific equipment
- Management personnel should periodically review this information to refine maintenance plans for individual vehicles and to identify improvements to the overall maintenance program.
- The effectiveness of the O&M plan is evident from observed plant/machinery down times, as well as from vehicle fleet available in working condition.

Good operating principles for waste processing, treatment and disposal facilities

Standard Operating Procedures (SOP) and manuals for all technical process and procedures should be made available

- Adequate and appropriate human resource available for operating the SWM facility with due consideration to minimum qualifications of key employees, supervisor and operators.
- Hands-on training of staff
- Regular inspection of facility by superior staff and ensuring timely corrective measures
- Mechanism for reporting unacceptable/ prohibited activities in sites
- Mechanism for reporting accidents and mishaps, with recorded investigative processes, follow-up action; including analysis of mishaps periodically to identify danger areas/weaknesses in the process system/equipment
- Scheduled Environment Monitoring as per MSW (M&H) Rules 2000 and other applicable norms

6.1.5 Preventive Maintenance

Preventive maintenance helps in identifying mechanical problems at an early stage and hence saves expenditure and minimizes downtime

Preventive maintenance is an essential part of the operation of collection equipment and transportation vehicles to ensure maximum life of the equipment and fleet life is at its maximum capacity most of the time. However, there is a need to make a clear distinction between preventive maintenance – which is carried out at a defined and disciplined schedule – and crisis (or breakdown) maintenance which is only carried out when a fault develops.

Good preventive maintenance starts with the selection and specification of appropriate vehicles and equipment. Vehicles should be well suited to pre-defined requirements, localized conditions and should be procured after ascertaining ease of availability of spare parts. Cost of spares should be considered while making purchase decisions. Local availability of spare parts is often associated with reliability. Preventive maintenance schedule must be notified well in advance to all concerned and should be strictly enforced.

6.1.5.1 Benefits Of Preventive Maintenance

An important aspect of a planned preventive maintenance programme is that it helps to take corrective measures well in advance, anticipate faults and prevent a major break down which could endanger the safety of the personnel and entail huge cost implications. A preventive maintenance programme gives advance notice of any requirement for spare parts, ensuring that equipment/vehicles are not out of service while the parts are being obtained in due course of time.

Preventive maintenance programme is tends to change the institutional culture of a municipal administration. Breakdowns are no longer seen as a regular matter.

A planned preventive maintenance programme will not only keep existing equipment operating at its maximum efficiency but will also provide requisite information to financial planners, enabling them to include accurate forecasts of required expenditures for repairs , maintenance and replacement of vehicles and equipment. Preventive maintenance programmes change the institutional culture of the municipal administration; breakdowns are no longer seen as a regular matter.

Accountability & Responsibility for Preventive Maintenance

Preventive maintenance imposes responsibility and accountability at various levels, such as drivers, store in-charges, mechanics and the workshop manager, for breakdowns and delays in repairs after a breakdown. Delays in procuring spares may also be due to lack of funds for purchasing essential parts, for which the financial controller/officer may be accountable.

Example of a Preventive Maintenance Schedule for Vehicles

- Daily checks by drivers
- Weekly servicing checks by a junior mechanic will highlight issues which a driver may not be able to identify and/or indicate if the daily checks are not effective
- Monthly service check by a senior mechanic shall reveal any inadequacies in the weekly checks
- The six monthly checks identify issues which have not been identified/addressed by the monthly checks

Preventive maintenance instills a sense of ownership and accountability within all tiers of administration

The success of a preventive maintenance programme is indicated by fleet and equipment availability on any day. The success can also be indicated by calculating the number of vehicles (perhaps of a particular type) that are ready for service on any particular day, divided by the total number of vehicles in the current fleet. The numbers could indicate the condition of the vehicles and whether the maintenance programme is improving or weakening. Availability levels can be used to show the number of standby vehicles that are needed (for each type of vehicle) and which types of vehicle are more reliable.

Management personnel should periodically review this information to refine maintenance plans for particular vehicles and to identify improvements to the overall maintenance program.

Similar systems should be in place for monitoring the downtimes and availability of other equipment and machinery used for all SWM activities. MSW processing, treatment and disposal facilities should be encouraged to maintain relevant records to ensure minimum down time of machinery.

6.1.6 Record Keeping

Based on the monitoring requirements specified in tables 6.1 and 6.2 , ULBs should maintain reports for all monitored elements. The Head of the SWM department should review all reports along with the M & E team and issue relevant guidance. Monitoring and reporting proves to be beneficial only when the generated data is effectively analyzed for improving performance.

Appropriate training and strengthening of capacities of existing staff is required to ensure accurate collection and reporting of monitored data. Capacity building is required for all levels of staff; external support from experts may be sought to streamline and integrate M&E of all functions.

6.1.7 Complaint Redressal System

A complaint redressal system creates a platform for citizens to voice their concerns and grievances regarding provision of solid waste management services and also helps in promoting efficiency and transparency at the ULB level. The ULB, through an analysis of the complaints/grievances it receives, is able to identify lacunae and bridge major gaps in service delivery. The time taken for resolution of grievances and the action taken are also monitored and recorded through this system. Typically ULBs have a common complaint redressal system for all municipal services.

A complaint redressal system is effectively supported through the introduction of a citizen charter. Citizen's Charter is a written, voluntary declaration with a basic objective to empower the citizens to get public service delivery by the municipality in a given time frame.

The Citizen's Charter includes:

- information on municipal services and expected outcomes
- defines municipal service delivery standards
- indicates response time for rendering services or redressing grievances
- information dissemination process on the complaint redressal process
- contact details of officers responsible for provision of the various municipal services

The Citizen's Charter should be prepared by the ULB and officially adopted by the Municipal Council/Committee and widely publicized. Urban Development/Local Government departments in the State Government may prepare a model/draft citizen's charter to be adopted by all ULBs in the state to be used while preparing city specific citizens charters for their own city and must be vetted by the citizens.

6.1.7.1 Elements Of A Complaint Redressal System

Typical elements of a complaint redressal system include:

1. A centralized computerized complaint management system which is networked to all the zonal/ward level complaint centers.
2. A grievance redressal officer from the solid waste management department / cell at senior level should be responsible for recording and monitoring the nature of complaints being received and also for taking necessary actions.
3. Multiple channels or a combination of different channels may be adopted for receiving complaints from citizens like phone calls to a centralized customer service number, 'SMS' messages to notified mobile numbers, walk-in complaint registration, online-complaint registration through the internet. Complaint registration through the postal service may be considered, if relevant, based on the demography and size of the ULB.
4. Complaint registration & recording system should:
   - Assign a unique ID to each generated complaint

- Record contact details of the complainant
- Record details of the physical location (zone/ward/area) relevant to the complaint
- Assign the complaint to the concerned official in the solid waste management department / cell
- Record the stipulated time within which the complaint shall be redressed
- Provide an acknowledgement receipt to the complainant with all the above details, in case the complaint is registered manually/ online. Telephone based complainants should be provided a complaint reference number with an SMS of registration.

5. Field officers, after resolving the complaint, should take resolution certificate from the complainant and subsequently inform the complaint cell.The complaint shall thereafter be treated as resolved.
6. Complaint resolution & feedback: The designated official for complaint resolution in the SWM department / cell shall be made aware of received complaints on a day to day basis. Feedback could be taken through telephone, online, SMS.
7. Complaints which are not resolved in stipulated time shall be deemed "pending" and appropriate reasons may be recorded against the complaint and the designated officer should be informed. Also, the complainant should be informed of the reasons for the delay immediately.
8. Reporting & Complaint Analysis: A daily status report of complaint redressal should be prepared by the responsible officer and submitted to the officer in-charge for further directives. The complaint management system should generate periodic area wise reports on number of complaints received, nature of complaints, time taken for resolution etc. The report should highlight the critical issues namely frequently received similar complaints, frequently delayed responses, repetition of complaints, if any and time for resolution of complaints etc. The weekly analysis of all complaints received should be reported to the Chief Executive Officer/Commissioner for information.

6.1.8 Environmental Monitoring As Per MSW (M&H) Rules, 2000

MSW (M&H) Rules, 2000 stipulates regular monitoring of soil, water and air around the municipal waste processing and treatment facility. Schedule II, III and IV of Rules stipulate environmental norms for treatment/ processing/ disposal facilities. Operators of MSW treatment, processing and disposal facilities are responsible for regular monitoring of these parameters. This data, as stipulated in the schedules given below, should be reported to the SPCB by the ULB on an annual basis, as part of the annual reporting of ULBs. The SWM service monitoring framework of the ULB should capture this information on a regular basis.

The State Pollution Control Board monitor the compliance of standards for ground water, ambient air, leachate and compost quality including incineration standards as specified under Schedules II, III and IV.

6.1.8.1 RULES SCHEDULE- III. SPECIFICATIONS FOR LANDFILL SITES AS PER MSW (M& H) RULES, 2000

Provision for preventing pollution from landfill operations

Clause 22. In order to prevent pollution problems from landfill operations, the following provisions shall be made, namely:-

a. Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;

b. Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geo-membrane, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1×10^{-7} cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;

c. Provisions for management of leachates collection and treatment shall be made. The treated leachates shall meet the standards specified in Schedule- IV;

d. Prevention of run-off from landfill area entering any stream, river, lake or pond.

Water Quality Monitoring

Clause 23. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 metres of the periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

Clause 24. Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The specifications mentioned in table 6.3, for drinking water quality shall apply for monitoring purpose.

Table 6.3: Specifications for drinking water quality for monitoring purpose

S.N	Parameters	IS 10500: 1991 Desirable limit (mg/l except for pH)
1	Arsenic	0.05
2	Cadmium 0.01	0.01
3	Chromium	0.05
4	Copper	0.05
5	Cyanide	0.05
6	Lead	0.05
8	Mercury	0.001
9	Nickel	-
10	Nitrate as NO_3	45.0
11	pH	6.5 -8.5
12	Iron	0.3
13	Total hardness (as $CaCO_3$)	300.0
14	Chlorides	250
15	Dissolved solids	500
16	Phenolic compounds (as C_6H_5OH)	0.001
17	Zinc	5.0
18	Sulphate (as SO_4)	200

Ambient Air Quality Monitoring

Clause 25. Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.

Clause 26. The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

Clause 27. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utilization or flaring is not possible.

Clause 28. Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the standards specified in table 6.4.

Table 6.4: Specifications for monitoring air quality at the landfill site

S.N	Parameters	Acceptable levels
1	Sulphur dioxide	120 µg/m3 (24 hours)
2	Suspended Particulate Matter	500 µg/m3(24 hours)
3	Methane	Not to exceed 25 per cent of the lower explosive limit (equivalent to 650 mg/m3)
4	Ammonia daily average	
5	(Sample duration 24 hrs)	0.4 mg/m3 (400 µg/m3)
6	Carbon monoxide	1 hour average : 2 mg/m3 8 hour average : 1 mg/m3

Clause 29. The ambient air quality monitoring shall be carried out by the concerned authority as per the following schedule, namely:-

(a) Six times in a year for cities having population of more than fifty lakhs.

(b) Four times in a year for cities having population between ten and fifty lakhs.

(c) Two times in a year for town or cities having population between one and ten lakhs.

Plantation at Landfill Site

Clause 30. A vegetative cover shall be provided over the completed site in accordance with the and following specifications, namely:-

(a) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;

(b) The plants grown be such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilized;

(c) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;

(d) Plantation to be made in sufficient density to minimize soil erosion

Closure of Landfill Site and Post-care

Clause 31. The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely :-

(a) Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(b) Monitoring leachate collection system in accordance with the requirement;

c) Monitoring of ground water in accordance with requirements and maintaining ground water quality;

(d) Maintaining and operating the landfill gas collection system to meet the standards.

Clause 32. Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis complies with the specified standards

Special provisions for hilly areas

Clause 33. Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid wastes by the municipal authority with the approval of the concerned State Board or the Committee. The municipal authority shall set up processing facilities for utilization of biodegradable organic wastes. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. Because of constraints in finding adequate land in hilly areas, wastes not suitable for road-laying or filling up shall be disposed of in specially designed landfills.

6.1.8.2 Schedule IV. Standards for Composting, Treated Leachates and Incineration

The waste processing or disposal facilities shall include composting, incineration, pelletization, energy recovery or any other facility based on state-of-the-art technology duly approved by the Central Pollution Control Board.

3. In order to prevent pollution problems from compost plant and other processing facilities, the following shall be complied with, namely:-
   i. The incoming wastes at site shall be maintained prior to further processing. To the extent possible, the waste storage area should be covered. If, such storage is

done in an open area, it shall be provided with impermeable base with facility for collection of leachate and surface water run-off into lined drains leading to a leachate treatment and disposal facility;

ii. Necessary precautions shall be taken to minimize nuisance of odour, flies, rodents, bird menace and fire hazard;

iii. In case of breakdown or maintenance of plant, waste intake shall be stopped and arrangements be worked out for diversion of wastes to the landfill site;

iv. Pre-process and post-process rejects shall be removed from the processing facility on regular basis and shall not be allowed to pile at the site. Recyclables shall be routed through appropriate vendors. The non-recyclables shall be sent for well-designed landfill site (s).

v. In case of compost plant, the windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay, 50 cm thick, having permeability coefficient less than 10^{-7} cm/sec. The base shall be provided with 1 to 2 per cent slope and circled by lined drains for collection of leachate or surface run-off;

vi. Ambient air quality monitoring shall be regularly carried out particularly for checking odour nuisance at down-wind direction on the boundary of processing plant.

In order to ensure safe application of compost, the specifications given in table 6.5 for compost quality, shall be met.

Table 6.5: Specifications for compost quality

S.No	Parameters	Concentration not to exceed * (mg/kg dry basis , except pH value and C/N ratio)
1	Arsenic	10.00
2	Cadmium	5.00
3	Chromium	50.00
4	Copper	300.00
5	Lead	100.00
6	Mercury	0.15
7	Nickel	50.00
8	Zinc	1000.00
9	C/N ratio	20-40
10	PH	5.5-8.5

* Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.

6.1.8.2.1. Standards for disposal of treated leachate

Table 6.6 indicates prescribed standards for disposal of treated leachate to inland surface waters, public sewers and for disposal on land.

Table 6.6: Standards for treated leachates

S.No	Parameters	Standard Mode of Disposal		
		Inland Surface Water	Public Sewer	Land Disposal
1	Suspended solids, mg/l, max	100	600	200
2	Dissolved solids (inorganic) mg/l, max.	2100	2100	2100
3	pH Value	5.5 to 9.0	5.5 to 9.9	5.5 to 9.9
4	Ammonical nitrogen (as N), mg/l, max.	50	50	-
5	Total Kjeldahl nitrogen (as N), mg/l, max.	100	-	-
6	Biochemical oxygen demand (3 days at 27° C), max.(mg/l)	30	350	100
7	Chemical oxygen demand, mg/l, max.	250	-	-
8	Arsenic (as As), mg/l, max	0.2	0.2	0.2
9	Mercury (as Hg), mg/l, max	0.001	0.01	-
10	Lead (as Pb), mg/l, max	0.1	1.0	-
11	Cadmium (as Cd), mg/l, max	2.0	1.0	-
12	Total Chromium (as Cr), mg/l, max	2.0	2.0	-
13	Copper (as Cu), mg/l, max.	3.0	3.0	-
14	Zinc (as Zn), mg/l, max.	5.0	1.5	-
15	Nickel (as Ni), mg/l, max	3.0	3.0	-
16	Cyanide (as CN), mg/l, max.	0.2 2.0 0.2	2.0	0.2
17	Chloride (as Cl), mg/l, max	1000	1000	600
18	Fluoride (as F), mg/l, max	2.0	1.5	-
19	Phenolic compounds (as C_6H_5OH) mg/l, max.	1.0	5.0	-

Note : While discharging treated leachates into inland surface waters, quantity of leachates being discharged and the quantity of dilution water available in the receiving water body shall be given due consideration.

6.1.8.2.2. Emission Standards for Incinerators

Incinerators shall meet the following operating and emission standards, namely:-

A. Operating Standards

The combustion efficiency (CE) shall be at least 99.00%

B. Emission Standards as per table 6.7

Table 6.7: Emission standards for Incinerators

Parameters	**Concentration mg/Nm^3 at (12% CO_2, correction)**
Particulate Matter	150
Nitrogen Oxides	450
HCl	50
Minimum stack height shall be 30 meters above ground.	
Volatile organic compounds in ash shall not be more than	0.01 %

However, standards for incineration prescribed by the MSW Rules are currently under revision by the Ministry of Environment &Forests (MoEF) and are likely to be amended soon.

Since the standards for incineration as per current MSW Rules are not in line with international practice, ULBs are advised to do the following, before deciding to adopt and implement any incineration technology:

- Consult CPCB/SPCB on applicability of proposed incineration technology
- Accept only those technologies which ensure that emissions are in line with relevant international standards. (Refer to chapter 3.3.2.14 for international emission standards for MSW incineration plants)
- As monitoring of highly toxic dioxins and furans is still not easily possible in India, ensure that the operator at a minimum:
  - Maintains a combustion temperature of 850°C in the combustion chamber for a minimum of 2 seconds.
  - Dust emisisons from the stack are lower than 10 mg/m^3 at all times
  - SPM is monitored through a continuous process
- Any RDF produced in a municipal waste management plant should be used for co-incineration only in processes which are equipped with suitable air pollution abatement technology. Emission standards are to be prescribed by CPCB or relevant SPCB. In India, the only proven sustainable use of RDF is for co-processing in cement plants.

6.1.9 Reporting Requirements

As stated in Clause 9 of the MSW (M&H) Rules 2000, the municipal authority is required to provide an annual report on key parameters of the MSWM operations (waste quantities/ qualities, facilities, transportation, needs for improvements, contracting) in a standard format (form – II, annexed to the MSW (M&H) Rules, 2000) to:

a. the Secretary-in-Charge of the Department of Urban Development of the concerned State or as the case may be of the Union territory, in case of a metropolitan city; or

b. the District Magistrate or the Deputy Commissioner concerned in case of all other towns and cities, with a copy to the State Board or the Committee on or before the 30th day of June every year.

Accident Reporting: Clause. 9 of the said rule indicates that "when an accident occurs at any municipal solid wastes collection, segregation, storage, processing, treatment and disposal facility or landfill site or during the transportation of such wastes, the municipal authority shall forthwith report the accident in Form-V to the Secretary in-charge of the Urban Development Department in metropolitan cities, and to District Collector or Deputy Commissioner in all other cases.

Additional reporting requirements, as indicated in 1.4.1.5.1 of Part II could be adopted by the state governments/ULBs, as they deem fit.

Chapter 7:

Management of Special Waste Streams

7. Management Of Special Waste Streams

7.1 Introduction To Special Waste

Special Waste includes any solid waste or a combination of solid wastes that because of its quantity, concentration and physical / chemical characteristics or biological properties, requires special handling and disposal to protect human health, as well as the environment and/or to exploit its potential for recycling.

In line with this definition, the following wastes are defined as Special Wastes:

Special wastes: Wastes that requires special handling and disposal due to their physical/ chemical characteristics

1. Plastics waste
2. Biomedical waste
3. Slaughterhouse waste
4. Electric and electronic waste (e-waste)
5. Waste Tyres
6. Battery Waste

Ideally, special wastes should not enter the municipal solid waste streams, but these wastes are also generated at the household and commercial level and, due to lack of segregation at source or imperfect collection systems, they frequently end up in the mixed MSW stream.

7.2 Existing Rules For Management Of Special Waste

Rules: The various rules notified for environmentally sound management of different special wastes are discussed briefly in table 7.1. A copy of all the Rules of the Ministry of Environment & Forests, which govern the management of such wastes, is included in Annexure 6 to 11 of this manual.

Table 7.1: Existing Rules for Treatment of Special waste

Laws and Regulations	Major Contents	Type of Waste
The Plastic Waste (Management and Handling) Rules, 2011[1] and Guidelines for Recycling of Plastics (Indian Standard IS 14534), 1998[2]	The manufacture, stocking, distribution, sale and use of plastic carry bags and sachets is regulated by this Rule. Requirements for management of plastic wastes are also specified in this Rule. Norms for labelling plastic bags and recycled plastic products; Recycling, recovery or disposal of plastic waste is to be carried out as per the Rules and standards notified by the central government;	Plastic wastes
The Bio-medical Waste (Management and Handling) Rules, 1998[3]	According to these rules the 'occupier' (a person who has control over the concerned institution / premises) of an institution generating bio-medical waste is responsible for ensuring that such waste is handled without any adverse effect to human health and the environment. The Rules govern the categorization, on-site and off-site storage, transport, treatment and disposal of Bio- medical wastes.	Bio-medical wastes
The e-waste (Management and Handling) Rules, 2011[4]	These Rules are based on the principles of Extended Producer Responsibility (EPR) wherein the producer engaged in the manufacture, sale, purchase of electric and electronic equipment is responsible for the end of life management of the electrical and electronic products listed in schedule 1 of the Rules. Procedures for handling e-waste as applicable to all stakeholders such as collection centres, dismantlers and recyclers of e-waste are provided. Stipulations for reducing the hazardous substances in electrical and electronic equipment are also prescribed. Procedures and formats for registration of facilities for recycling e-waste are specified.	Electrical and electronic wastes (e-waste)

1 Plastic Waste (Management and Handling) Rules, 2011. Available at: http://moef.nic.in/downloads/public-information/DOC070211-005.pdf

2 Guidance for Recycling of Plastics,1998. Available at: http://www.moef.nic.in/legis/hsm/plastic.html

3 Bio-medical Waste (Management and Handling) Rules, 1998. Available at: http://envfor.nic.in/legis/hsm/biomed.html

4 E Waste (Management and Handling) Rules, 2011. Available at: http://moef.nic.in/downloads/rules-and-regulations/1035e_eng.pdf

Laws and Regulations	Major Contents	Type of Waste
Battery (Management and Handling) Rules, 2001[5]	These Rules are for regulating the recycling of lead acid batteries after use. The Rules specify responsibilities of manufacturers, importers, assemblers, dealers and re-conditioners of lead acid batteries, which are a source of electrical energy and contain lead metal. Requirements for registration of recyclers are prescribed under the Rules. It also provides a control on the imports of substances by OEMs (original equipment manufacturers) and other equipment manufacturers.	Lead Acid Batteries
Hazardous Wastes (Management and Handling) Rules, 1998 and its Amendments[6]	These Rules are applicable to hazardous wastes specified in the Schedule of the Rules and specify the obligations of the occupier generating the hazardous waste, the process for grant of authorization for handling such wastes from the State Pollution Control Board (SPCB) or Pollution Control Committees (PCC). Requirements for packaging, labelling and transport of hazardous wastes are also mentioned in the Rules. The process for suspension/cancellation of licences to generators and restrictions on the import of these wastes are also specified. The responsibility of the State Government to inventorize all hazardous waste generators and the requirements for record keeping and reporting by the operator and the SPCB/PCC are mentioned.	Waste streams from process generating hazardous wastes as mentioned in the Schedule I of the Amendment Rules 2000

Note: Hazardous Waste is not commonly found in municipal waste streams and hence its management is not described in detail in this manual.

5 Battery (Management and Handling) Rules, 2001. Available at: http://www.moef.nic.in/legis/hsm/leadbat.html

6 Hazardous Wastes (Management and Handling) Rules, 1989. Available at: http://envfor.nic.in/legis/hsm/hsm1.html and Hazardous Wastes (Management and Handling) Amendment Rules, 2000 Available at: http://envfor.nic.in/legis/hsm/hwamdr.html

7.3 Special Waste Management – Guidance From The Integrated Solid Waste Management (ISWM) Framework

ISWM Framework Guidance: Waste streams that cannot be minimized should be reused/ recycled, focusing on resource recovery as a priority option.

The ISWM hierarchy (refer to section 1.1 of part II of this manual) indicates that the next preferred waste management method to waste minimization/reduction, is reuse and recycling. Waste that cannot be reduced/minimized should be reused (resource recovery) and recycled. Some special wastes like plastics waste, electric and electronic waste (e-waste) can be reused and/or recycled; on the other hand slaughter house waste and bio-medical waste should not be recycled and should be appropriately treated and disposed to prevent hazardous impacts of undesirable dumping of these wastes.

Recycling of special waste provides economic as well as environmental benefits and reduces reliance on virgin materials.

7.4 Plastic Waste

The disposal of plastic waste is legislated under the Plastic Waste (Management& Handling) Rules, 2011. These rules specify the responsibilities of Municipal Authorities for managing plastic waste. However, most of discarded plastics find their way into the municipal waste streams.

7.4.1 Excerpts From The Plastic Waste (Management& Handling) Rules, 2011, Relevant To Municipal Authorities

Rules

a) The municipal authority shall be responsible for setting up, operationalization and coordination of the plastic waste management system and for performing the associated functions. The municipal authorities are requested:
   i. To ensure safe collection, storage, segregation, transportation, processing and disposal of plastic waste.
   ii. To ensure that no damage is caused to the environment during this process.
   iii. To ensure setting up of collection centres for plastic waste involving manufacturers.
   iv. To ensure its channelization to recyclers.
   v. To create awareness amongst all stakeholders about their responsibilities.
   vi. To engage agencies or groups working in waste management including waste pickers.

vii. To ensure that open burning of plastic waste is not permitted.

b) For setting up plastic waste collection centres, the municipal authority may ask manufactures, either collectively or individually in line with the principle of Extended Producer's Responsibility (EPR) to provide the required finance to establish such collection centre

c) The concerned Municipal Authority shall ensure that the residues generated from recycling processes are disposed of in compliance with Schedule II (Management of Municipal Solid Wastes) and Schedule III (Specifications for Landfill Sites) of the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Environment (Protection) Act, 1986, as amended from time to time;

d) The municipal authority shall incorporate the said Rules in the municipal bye-laws of all the Urban Local Bodies

e) The Municipal Authority shall encourage the use of plastic waste by adopting suitable technology such as in road construction, co-incineration, etc. The municipal authority or the operator intending to use such technology shall ensure compliance with the prescribed standards including pollution norms prescribed by the competent authority in this regard.

7.4.2 Composition Of Plastics

Plastics comprise of polymers which are distinct for each product. The most common are Polyethylene Terephthalate (PET), High Density Polyethylene (HDPE) and Low Density Polyethylene (LDPE) as classified by Bureau of Indian Standards (BIS) and others in the box below. The Society of the Plastics Industry (SPI) has established the SPI resin identification coding system as a set of symbols placed on plastics to identify the polymer type. The code is used internationally. Its primary purpose is to allow efficient separation of different polymer types for recycling. Separation of different types of plastics is a must as the conditions for recycling each resin are different. The recycling process will be compromised by an incompatible mix of different resins.

Classification of Plastics – Bureau of Indian Standards

Bureau of Indian Standards classifies plastic into seven types

Symbol	Short Name	Scientific Name	Use In
1	PET	Polyethylene Terephthalate	Water bottles, PET bottles etc.
2	HDPE	High Density Polyethylene	Milk/detergent bags, Carry bags, Container etc.
3	PVC	Polyvinyl Chloride	Cables, Pipes, Floorings etc.
4	LDPE	Low Density Polyethylene	Carry bags, Films
5	PP	Polypropylene	Medicine bottles, Cereal liners, Packaging films etc.
6	PS	Polystyrene	Foam packaging, Tea cups, Ice cream cups, etc.
7	O	Others	Thermoset plastics, Multilayer & Laminated Plastics, PUF, Bakelite, Polycarbonate, Melamine, Nylone etc.

- Recyclable Plastics (Thermoplastics): Poly Ethylene (PET), High Density Poly Ethylene (HDPE), Low Density Poly Ethylene (LDPE), Polypropylene (PP), Poly Vinyl Chloride (PVC), Poly Styrene (PS), etc.
- Non-Recyclable Plastics (Thermoset & others): Multilayer & Laminated Plastics, Poly Urethane Foam (PUF), Bakelite, Polycarbonate, Melamine, Nylon etc.

Extensive use of plastic leads to the generation of huge quantities of plastic wastes that may account for 1-10% (by volume) of the total municipal solid wastes. India produces approximately 8 million tonnes of plastic products every year (2008)[7]. These are used in, but not limited to films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products, and building materials. But sooner or later all plastic products will end up as waste since virgin plastic material can be recycled 2-3 times only and the plastic material deteriorates due to thermal pressure after each recycling. Plastics are also highly resistant to bio-degradation.

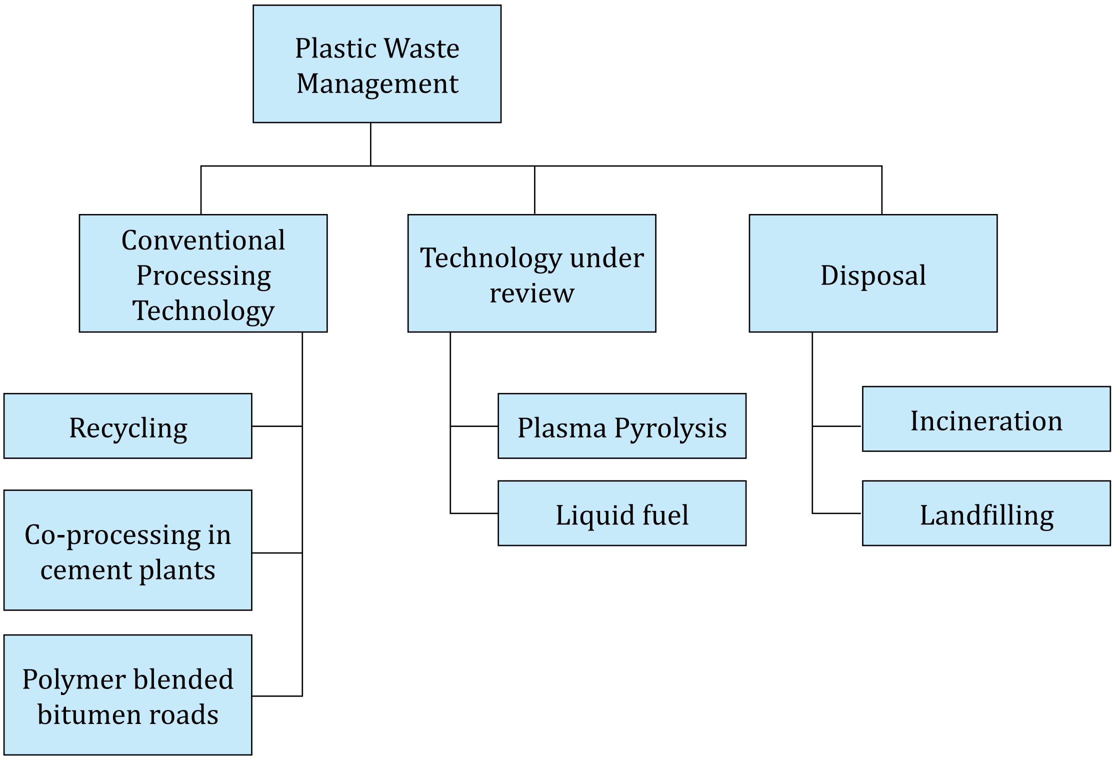
[7] CPCB, 2011-12. "Annual Report: Implementation of Plastic Waste Management"

7.4.3 PLASTIC WASTE MANAGEMENT

Following the ISWM hierarchy, reuse and recycling of plastic waste are the preferred methods for managing plastic wastes after avoidance. However, plastics cannot be recycled indefinitely; each recycling cycle reduces the strength and utility of the plastic. Energy recovery from plastics shall be considered when recycling is no longer possible. Plastic waste is accepted as fuel in cement kilns; residence times and temperatures are adequate to pre-empt the production of dioxins and furans. Incineration of plastic wastes for energy recovery may also be considered under strictly controlled and monitored conditions (For further details please refer to section 3.3.2 of part II of this manual). Reusing plastic waste to form polymer blended bitumen roads is an accepted method for final disposal of plastics in India. Landfilling of plastics should be avoided.

Plastic wastes virtually choke the urban drainage system, causing urban flooding in many instances. Immediate action on appropriate management (focusing on minimization) and disposal of these wastes is required.

Plasma pyrolysis and production of liquid fuel from plastic waste are technologies being tested; however commercial viability of such technologies is yet to be proven. The flowchart given in figure 7.1 depicts options for plastic waste management, in order of their preference. Conventional technologies are more reliable than technologies still under development.



Plastic recycling processes which produce end products with a higher order of reuse (e.g. reuse as a virgin material substitute) coupled with a longer product life should be preferred.

Figure 7.1: Options for Plastic Waste Management[8]

[8] Central Pollution Control Board. Available at: http://www.cpcb.nic.in/wast/plasticwast/Plastic_waste-1.pdf

7.4.4 Recycling Of Plastic Wastes

To a large extent, plastics are recyclable. Recycled polymers exhibit lower properties and performance than virgin polymers, and are useful only for lower value applications. Recycling of plastics without prior separation by resin produces a material with mechanical properties similar to timber. Hence, it is often used as a replacement for timber in certain applications. A higher quality of recycled plastics is achieved when separation by resin is carried out prior to the remoulding step.

7.4.4.1 Steps Involved In The Recycling Process

Collection: Plastic waste should be collected from the door step from all municipal solid waste generators along with other reusable and recyclable non-biodegradable wastes and should be sorted out at intermediate sorting facilities or at the municipal solid waste processing facility.

Recycling processes should seek to minimize pollution during the recycling process and maximize process efficiency while also maximizing energy efficiency of the process.

Segregation: As far as possible, plastic waste should be segregated from rest of the recyclable waste based on different types of plastic, requiring different recycling processes.

Processing: After collection and segregation, post-consumer waste (used plastic waste) should be given away to recycling industry at a pre-negotiated price by the municipality and in cases where the municipal authority has already given contract to a private operator to process municipal solid waste, plastic waste may be allowed to be processed or sold to recycling industry by the operator following good industrial practices.

7.4.5 Sustainable Disposal Of Plastic Waste

At a stage where further recycling is not possible, at the end of life of such a product/material, the plastic material/product should be disposed of by suitable methods. Safe disposal of plastics is possible through various technologies such as co-processing of plastic waste in cement kilns and utilization of plastic waste in road construction.

7.4.6 Co-Processing And Co-Incineration Of Plastic Waste As Alternative Fuel And Raw Material (AFR) In Cement Kilns

Co-processing refers to the use of waste materials in industry process such as cement and power stations or any other large combustion plants. Co-processing indicates substitution of primary fuel and raw material by waste. Waste material such as plastic waste used for co-processing are referred to as alternative fuels and raw material (AFR). Co-incineration refers to utilization of waste material for energy recovery.

Co-processing of plastic waste offers advantages for cement industry as well as for local authorities responsible for waste management. Cement producers save on fossil fuel and raw material consumption, also resulting in the adoption of eco-efficient production methods, where, substituting fossil fuel and virgin raw material by AFR further reduces overall CO_2 emissions of the process (assuming that the waste material being used would instead have been burned or disposed without energy recovery). Power plants and Steel plants save on fossil fuel as the material would be used for energy recovery. So far its application has been successful in the cement industry and municipal authorities are also benefitted since co-processing of plastic wastes is an efficient and environmentally safe method to manage a sizeable quantum of non-recyclable plastic waste found in municipal solid waste.

The Central Pollution Control Board has prescribed guidelines on co-processing of hazardous and non-hazardous waste plastic waste. The defined protocol is summarized below in table 7.2.

Table 7.2: CPCB guidance on Protocol for co-processing of Plastic Waste[9]

Sr. No.	Item	Description	Action to be taken by
1	Collection of plastic waste	Concerned Municipal Authority should create a system for collection of plastics waste from Dustbins/Dhalaos through Public Private Partnership (PPP mode on any other feasible method.	Municipal Corporation, Nagar Nigam, Nagar Parishad & Cantonment Boards
2	Segregation & Pre-processing of plastic waste	Collected plastics can be reprocessed/sorted into recyclable and non-recyclable fractions. The Non-recyclable plastic wastes will be transported to nearest cement kilns and power plant for co-processing by concerned Municipal Authority in consultation with concerned State Pollution Control Board (SPCB)/ Pollution Control Committee (PCC).	Municipal Corporations, Nagar Nigams, Nagar Parishads & Cantonment Boards

9 Available at: http://www.cpcb.nic.in/divisionsofheadoffice/pcp/management_plasticwaste.pdf

Sr. No.	Item	Description	Action to be taken by
3	Identification of cement factory	Mapping of cement kilns and power plant for accepting co-processing of plastic waste in the same State or neighbouring State. An agreement shall be signed between Municipal Corporations and Cement kilns.	State Pollution Control Boards & Pollution Control committees &Municipal Authorities/Bodies
4	Modification for feeding plastic waste (PW) in cement kilns/ power plants	Cement Industry/power plant to set-up storage facility, shredder, conveyor-belt, one hopper, one winch-machine and one double-flap damper.	Concerned Cement Industries/ power plant
5	Setting-up of laboratory for plastics waste analysis	Cement industry/power plant shall set-up a minimum lab facility to analyze plastics waste before sending for co-processing. The instrumentation includes Thermo-Gravimetric Analyzer, Bomb- Calorimeter and C, H, N & S Analyzer.	Concerned Cement Industries/ power plant
6	Monitoring of emission by cement industry/ SPCBs	Cement Industry/power plant shall monitor the stack emission in respect of routine parameters and Hazardous Air Pollutants (HAPs)	Concerned Cement Industry, Power Plant and SPCBs/PCCs
7	Forwarding Progress Report to CPCB	Forwarding quarterly progress report of Co-processing of plastic waste to CPCB.	SPCBs/PCCs and Cement Industries/ Power Plant

7.4.7 Other Plastic Waste Disposal Options

7.4.7.1 Use Of Waste Plastic In Construction Of Bituminous Roads[10]

The use of plastic waste in bitumen roads (figure 7.2) has been found to have several advantages including decreasing the susceptibility of the road to infiltration. There are also no observed deleterious impacts on the strength or properties of the road

[10] CPCB (2013). Plastic Waste Management. Available at: http://www.cpcb.nic.in/wast/plasticwast/Plastic_waste-1.pdf

Process Description:

- Waste plastic bags collected from roads, garbage trucks, dump sites and compost plants, rag-pickers, waste-buyers and households can be used in this process. Here plastic waste is sorted as per thickness and type of plastic. Polyethylene with a thickness greater than 60 micron is sent for recycling; PE below 60 microns is to be used in this process. Plastic waste should be cleaned by de-dusting or washing if required.
- Collected Plastic is cut and sized into fine pieces as far as possible.
- Lower micron plastic mixes easily with bitumen at higher temperatures (160°C-70°C). Bitumen is heated up to its melting temperature, around 160°C-170°C. Sized plastic pieces are added slowly to the hot bitumen at a temperature around 160°C-170°C.The mixture is stirred for about 20-30 minutes at a constant temperature of 160°C-170°C. Polymer-bitumen mixtures of different compositions are prepared and tested for their application in road construction.

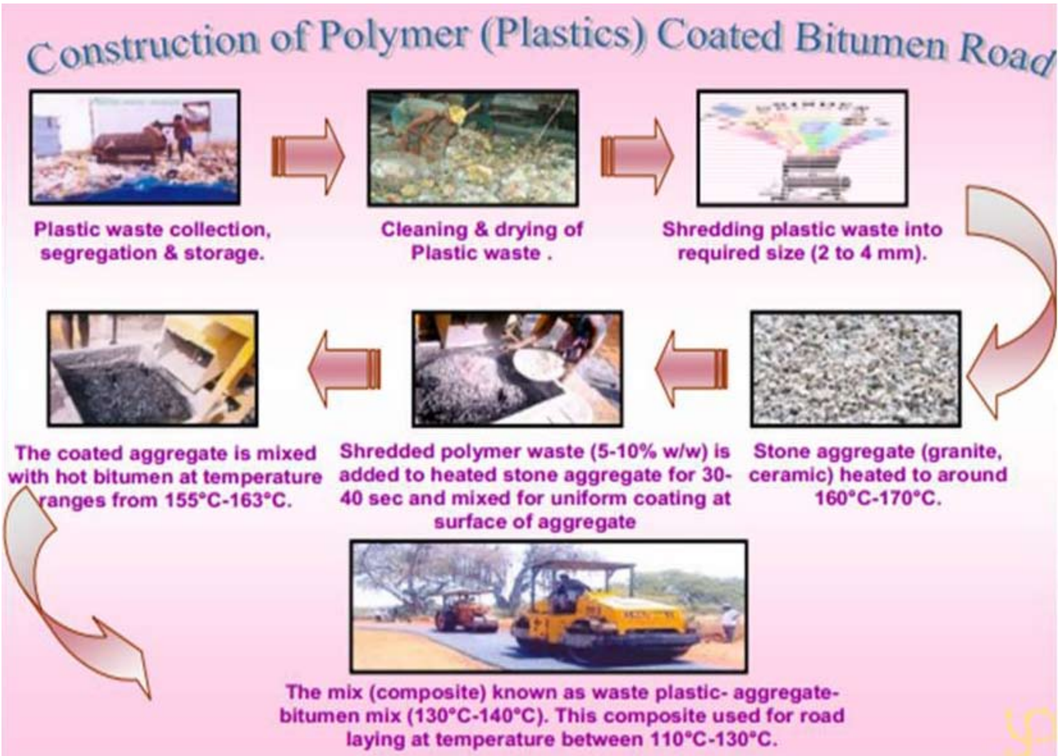


Figure 7.2: Use of Plastic Waste in Construction of Bituminous Road

7.4.7.2 Conversion Of Plastic Waste Into Liquid Fuel

A research-cum-demonstration plant at Nagpur, Maharashtra converts waste plastics into liquid fuel. The process adopted is based on random de-polymerization of waste plastics into liquid fuel in presence of a catalyst. The entire process is undertaken in closed reactor vessels followed by condensation, if required. Waste plastics while heating upto 2700°C to 3000 °C convert into liquid-vapour state, which is collected in condensation chambers in the form of liquid fuel while the tarry liquid waste is topped-down from the heating reactor vessel. Organic gas is generated, which is vented due to lack of storage facility. However, the gas can be used in dual fuel diesel-generator set for generation of electricity. This technology is at an experimental stage and may be considered only after it is well established as technically, financially and environmentally viable option of plastic waste processing and/ or disposal.

Plastic to liquid fuel: Initiative at New Moti Bagh, New Delhi

Under a 'zero waste' project at the GPRA Complex of the Ministry of Urban Development at New Moti Bag, a small facility to convert plastic waste into liquid fuel has been installed. The facility handles 50 kg of plastic waste per batch. The plastic waste, collected from the staff quarters, is segregated and put through a pyrolytic conversion at about 400°C in the presence of a catalyst. The large polymeric molecules break down into smaller fractions leading to yield of liquid fuel (in the range of light diesel oil / furnace oil), gaseous fuel and char, all of which can be used for different purposes. The Light Diesel Oil (LDO) / furnace oil is of key interest for commercial purposes. However, its environmental implications in terms of emissions etc., needs to be further established in due course of its operation.

7.4.7.3 Incineration Of Plastic Waste

ULBs should not experiment with non-proven technologies

In cases where material recovery is not feasible, incineration with energy recovery is an accepted technology internationally for plastic waste disposal, with provision for adequate pollution abatement safeguards. Inappropriate operating conditions can cause the release of several harmful gases including dioxins and furans from chlorinated and brominated plastic waste. However, it is to be noted that achieving the requisite temperatures and retention times in incinerators, coupled with an appropriate flue gas scrubbing/treatment system will ensure the safety of such technologies. For incineration technology, please refer to section 3.3.2 of part II of this manual.

7.5 Bio-Medical Waste

'Bio-medical waste' means any waste, solid and/or liquid waste, including its container and any intermediate product, which is generated during the diagnosis, treatment or immunisation of human beings or animals, in bio-medical research or in the production or testing of bio-medical products. This waste stream is infectious or potentially infectious and presents a hazard to the public health and the environment.

Municipal solid wastes generated by hospitals and other health care establishments should be collected by the ULB, after ensuring that such waste streams are not contaminated with bio-medical wastes.

Waste from kitchen, store, residential facilities and gardens or health care establishments can enter the municipal waste stream.

7.5.1 MSW Rules' 2000/2014 Requirements On Bio Medical Waste

Rules Schedule II. Clause.1.of the aforesaid rules mandates that

"Bio-medical wastes and industrial wastes shall not be mixed with municipal solid wastes and such wastes shall follow the rules separately specified for the purpose"

However, according to MSW (M&H) Rules, 2000 and draft MSW Rules 2013, MSW however includes treated bio-medical waste.

Rules Schedule III. Clause 6: Site Selection

"Biomedical wastes shall be disposed off in accordance with the Bio-medical Wastes (Management and Handling) Rules, 1998 and hazardous wastes shall be managed in accordance with the Hazardous Wastes (Management and Handling) Rules, 1989, as amended from time to time."

Bio-medical Wastes (Management and Handling) Rules, 1998 Requirements:

Biomedical waste storage, collection, transportation, treatment and disposal are governed by the Bio-medical Wastes (Management and Handling) Rules, 1998.

These Rules stipulate the following role for local authorities:

Rules Schedule VI: List of Authorities & the Corresponding Duties

"The Municipal Corporations, Municipal Boards or Urban Local Bodies, as the case may be, shall be responsible for providing suitable common disposal/incineration sites for the biomedical wastes generated in the area under their jurisdiction and in areas outside the jurisdiction of any municipal body, it shall be the responsibility of the occupier generating bio-medical waste/operator of a bio-medical waste treatment facility to arrange for suitable sites individually or in association, so as to comply with the provisions of these rules".

7.5.2 Collection & Segregation Of Waste Inside The Health Care Establishments

Due to its infectious and hazardous characteristics, bio-medical waste should be segregated from other municipal wastes at source and handled appropriately at collection and storage points in the health care establishments. Health care establishments such as hospitals, nursing homes, pathological laboratories etc., generate biomedical wastes as well as municipal solid wastes in each of their varied departments. These wastes should be segregated at the point of generation and stored in the colour coded containers separately following the provisions of Bio- medical waste (M&H) Rules, 1998. The biomedical wastes should be sent for further treatment and disposal as per Bio-medical Waste (Management and Handling Rules, 1998) and other solid wastes should be handled in accordance with the MSW (Management & Handling) Rules, 2000/2014 respectively. This is essential to ensure that the municipal solid waste generated from health care establishments is not contaminated, and does not pose any problem of health and environment to the municipal waste handlers, processing plants and users of end products of MSW processing facilities. Treated biomedical wastes which are subjected to disinfection or autoclaving are considered to be devoid of any biological or microbiological organisms and thereby could be disposed of as municipal solid waste considering various options as per the MSW (Management & Handling) Rules, 2000.

7.6 Slaughter house Waste

Slaughter house wastes are to be managed by the ULBs, in accordance with the provisions of the MSW (M&H) Rules, 2000

Slaughter house waste is predominantly disposed in dump sites or processed along with other organic waste in compost plants. Scientific processing and disposal of slaughter house waste is essential to recover useful fractions and for safe disposal of residual pathogenic biological wastes.

7.6.1 Requirements Of MSW (M&H) Rules, 2000

Rules Schedule II. Clause: 1

“Wastes from slaughter houses, meat and fish markets, fruits and vegetable markets, which are biodegradable in nature, shall be managed to make use of such wastes;”

Slaughterhouses are primary establishments which process animals for food consumption. Processes undertaken in a slaughter house include slaughtering, dressing, cutting and inspection of meats, refrigeration, curing and manufacturing of by-products.

Based on scale of operations, slaughter houses have been classified into three categories namely: large, medium and small (please refer to table 7.3).

Large slaughter houses are mostly in cities and are typically located in high density areas. They generate substantial quantity of solid wastes, which have to be processed in an environmentally acceptable manner.

Waste materials produced in these establishments are of three types: solid, liquid and gas. Solid waste is generated from manure, intestinal contents, hair, horns, hooves, gallbladders, trimmings, internal organs, condemned carcasses or body parts, carton and plastics. Solid wastes from slaughterhouses are varied depending on the kind and scale of operations. Liquid wastes of slaughterhouses come from urine, blood and wastewater from the slaughter processes. Odors and emissions also emanate as a result of processing operations.

Table 7.3: Classification of slaughter houses[11]

Category	Slaughtering Capacity (Tonnes of live weight killed per day)
Large	Above 70
Medium	15-70
Small	Below 15

These waste materials pose a hazard to the environment if not managed properly. High concentration of animal blood and fat, dirt and other pollutants in abattoir effluent, renders it very toxic to receiving waters.

11 Central Pollution Control Board, 2004

Usually the quantity of wastes per animal is large in small scale operations, where the recovery of offals is ineffective. Its main products are fresh meat in the form of whole, half or quarter carcasses or in smaller meat cuts. By-product processing is usually absent. In a modern complex slaughterhouse, there is extensive processing of by-products. In such plants at least three additional operations; rendering, paunch and viscera handling; blood processing; and hide and hair processing are conducted. By these operations maximum recovery of edible and inedible materials from the offals is achieved and this results in lower production of wastes per animal.

7.6.2 Processing Slaughter House Waste

Waste from Small slaughter houses: Type I & Type II wastes: Composting

The solid waste of slaughter houses can be broadly classified into two categories i.e. vegetative matter (type I) such as rumen, stomach and intestine contents, dung, agriculture residues, etc., and animal matter (type II) like inedible offals, tissues, meat trimmings, waste and condemned meat, bones etc. These waste streams can be segregated and treated separately.

Wastes from large & medium slaughter houses: Type I wastes: Bio-methanation/ composting; Type II wastes: Rendering

The best practicable methods currently available for processing and disposal of different wastes from slaughter houses are detailed in table 7.4.

Table 7.4: Methods for Processing, Utilization and Disposal of Solid Wastes from Slaughterhouse (SH)[12]

Waste	Constituents of Wastes	SH Category	Method(s)
Type I	Vegetable matter such as rumen, stomach and intestinal contents, dung, agriculture residues etc.	Large	Biomethanation
		Medium	Biomethanation/ Composting
		Small	Biomethanation/ Composting
Type II	Animal matter such as inedible offals, tissues, meat trimmings, waste and condemned meat, bones etc.	Large	Rendering
		Medium	Rendering/ Composting with Type I waste
		Small	Composting with type I waste

Composting: Composting is an aerobic biological decomposition of organic material, resulting in a stable humus-like product. This is a common practice of waste stabilization but requires proper understanding of the method of composting.

Both type I and type II slaughter house wastes can be stabilized through composting. The compost stack is prepared by adding alternate layers of type I waste and type II waste, to

12 Central Pollution Control Board, 2004

build a 4 to 5 feet high heap. The heap should be laid directly on the ground. It is advisable to put a layer of about 6-inch of coarse material, such as maize or millet stalks, banana stumps, straw, grass, small twigs etc. underneath in order to achieve proper ventilation.

Large sized matter (organs such as kidneys and lungs or other similar wastes) in type II wastes should be minced to 2 – 3 inch pieces before composting. For better results it is advised to mix these pieces with earth and evenly spread out in the centre of the heap where the temperature is high.

The ruminal and intestinal contents provide sufficient moisture for initiating and sustaining bacterial activity. As such, under normal circumstances, no additional water is required.

For details refer to section 3.2 of part II of this manual.

For large and medium slaughter houses, bio-methanation of type-I waste and rendering for type-II waste is suggested. Bio-methanation requires less space, which is advantageous for the slaughter houses with land constraints. Composting of type I waste may also be considered.

In the case of small slaughter houses, sophisticated and capital intensive technologies are unviable due to low volume of wastes and non-availability of other infrastructure facilities. For small slaughter houses, a financially and technically viable approach would be to compost both type I and type II wastes.

Biomethanation: Slaughter house waste is anaerobically stabilized in the bio-methanation process. The success of the process, especially the effective removal of BOD, has led to the acceptance of biogas plants for processing slaughter house wastes.

High Rate Biomethanation: The essential elements of a high rate biomethanation process are complete mixing to achieve a uniform temperature with more or less uniform feeding of the substrate. Pre-thickening or dilution of the digester contents are optional features of a high rate digestion system. The benefits of high rate biomethanation are reduced digester volume requirements and increased process stability. Wastes consisting of rumen and paunch contents, dung, agriculture residue, fat and blood may be processed in the high rate biomethanation plant.

Rendering: Rendering plants are a viable option for the recovery of fats and bone and meat meal. This is a useful method for the recovery of by-products from slaughter house waste.

All animal matter such as inedible offal, tissues, meat trimmings, waste and condemned meat, bones etc. can be processed in a rendering system, since the main constituents of animal matter are fat, water and solids. Rendering is effected by heating; heat ruptures the connective tissue of individual fat and muscle cells so that raw fat and other material bound within is released. Wet and dry rendering plants may be adopted. Wet rendering plants yield animal fat and bone meal. The dry rendering process enables 20% higher yield than wet rendering[13].

Fat recovered during rendering is used for industrial purposes, for making soap and greases. Fat recovered from flesh of healthy parts can also be used for edible purposes. Meat meal or bone meal is utilized for the manufacture of stock feed and fertilizers. Sludge bio-solids from dry rendering plants should be appropriately treated and disposed.

Incineration is also an option for treatment of slaughter house waste.

Clean technology and modernization for slaughter house waste treatment: Initiative of Municipal Corporation of Delhi at Ghazipur

Location: Ghazipur, New Delhi

Year of start: 2009

Main Players: Erstwhile Municipal Corporation Delhi (MCD), East Delhi Municipal Corporation (EDMC), HAARSLVE Industry, Al Anna Pvt Ltd.

Approach: The oldest slaughter house in Idgah, Delhi posed a major public health and environmental hazard due to indiscriminate disposal of waste, inadequate water supply and discharge of effluents in open drains. Concern raised by local Residents / NGOs and MCD prompted the Supreme Court, in 2004, to direct the MCD to relocate the Idgah slaughter house to a modernized slaughter house at Ghazipur. This led to the establishment of a modernized facility spread across 30 acres of land having slaughter house, livestock markets, rendering plant, ETP, roads etc. and to ensure wastewater

[13] CPCB. Available at:https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CC8QFjAB&url=http%3A%2F%2Fcpcbenvis.nic.in%2Fnewsletter%2Fslaughterhouse%2FSlaughterHouse.doc&ei=vUlRU_DGEMKprAe9_YCIDQ&usg=AFQjCNHBDaEJmk4yqZNLCOd63oKQJ3Glpw&sig2=1oXmfiOxPlT9wam7mBux5Q&bvm=bv.65058239,d.bmk

discharge and processing of waste as per the standards prescribed by Central Pollution Control Board (CPCB). The slaughter house plant has been established as a turnkey project. The funding for the project was from NCRPB (Rs. 60.00 Crore loan), MoUD (Rs. 20+20 Crore grant+ loan), GNCTD (Rs. 70.00 Crore loan), and Ministry of food processing (Rs. 4.00 Crore grant). The operation and maintenance of the plant has been handed over to the private operator named FRIGO RI FICO ALLANA Ltd on annual royalty in 2009 for 10 years. The approach that was adopted for installation and operationalization of the slaughter house plant is detailed below:

Institutional:

- Head of Department (HoD) of Veterinary department of erstwhile MCD and now EDMC, and project in-charge of the private operator work closely and coordinate on daily basis for smooth execution and functioning of the plant.
- Adequate health and safety measures (uniforms, gumboots, gloves, masks) as well intensive trainings on regular basis were provided to the workers to maintain cleanliness and hygiene during the operation.
- Intensive trainings and capacity building on regular basis for the workers to operate the rendering plant.

Managerial:

- The plant operates in three shifts. The morning and evening shifts are reserved for general traders and the middle shift is reserved for the operator of the facility.
- Introduction of token system for the general traders in order to maintain transparency and discipline during peak shifts.

Stakeholder Consultations:

- Intensive meetings of MCD officials with the slaughter house association for convincing them about the necessity and urgency of the relocation.

Outcomes:

- Livestock market at Ghazipur is about 3-4 times larger than Idgah facility thereby reducing the chances of insanitation and overcrowding. An ETP of 1,750 KLD capacity to treat the liquid waste and a rendering plant of 20 tonnes capacity including ETP of 250 KLD capacity has been established.
- Three separate lairages with adequate water, shed and fodder facilities have been constructed to allow proper rest to the animals before slaughtering, facilitating proper examination of each animal by the veterinary department.

- The entire process in the slaughter house is carried out under hygienic conditions and effluents discharged are treated and disposed in a safe manner.
- Utilization of the by-products obtained after the rendering process like tie ups with MBM & Tallo up for industrial use.
- Slaughtering of 5,500 animals per day and treatment of 60 tonnes paunch of waste in the plant. 1500 buffaloes and 4500 (sheep & goats).
- Carcasses are taken back by the shop keeper to their shop for retail distribution.
- Gradual acceptance of the general shopkeepers, traders for centralized and modern slaughter house facility as it provided them better market price owing to the quality of the final slaughtered product.

Success Factor:

- Intensive training was provided to the workers to handle the waste scientifically
- Modern and sophisticated technology is used for slaughtering

Overall Sustainability:

The total cost of the plant was Rs. 183 crores. The cost comprises of the construction and installation of the plant as well as the procurement of machinery for the rendering plant. The operational agreement is such that the concessionaire has to pay erstwhile MCD and now EDMC Rs. 1.5 crore quarterly as a royalty for the plant. In order to sustain and for optimal running of the plant, the concessionaire in consultation with erstwhile MCD has introduced the user charges from the general traders @ Rs 45 for sheep and goats and Rs 300 for buffaloes. The concessionaire has been given the liberty to run one shift for their own export purpose. Apart from this the by-product (bone meal, oils) obtained from the rendering plant act as a value added material for the concessionaire.

7.7 Electric and Electronic Waste

Electronic waste or E-waste means any waste from electrical or electronic equipment, whole or in parts, or rejects from their manufacturing and repair processes, which are intended to be discarded.

7.7.1 E- Waste Management & Handling Rules

E-waste is regulated under the E-Waste (M&H) Rules 2011. These rules are based largely on the principle of Extended Producer Responsibility (EPR)[14], which assigns the producer with the responsibility of 'end-of-life' management of the electrical and electronic equipment. The objective of the Rules is to put in place an effective mechanism to regulate the generation, collection, storage, transportation, environmentally sound recycling, treatment and disposal of the e-waste. It is mandatory that e-wastes be managed in accordance with provisions under these Rules.

7.7.2 Current Status Of E-Waste Generation And Its Management

Today electronic waste is one of the fastest growing waste streams in the country with a growth rate of 10% per annum. An increase in the use of electrical and electronic products and their high rate of obsolescence leads to generation of huge amounts of electric and electronic waste (e-waste). As per Central Pollution Control Board's (CPCB) preliminary estimates, e-waste generation in India was estimated to be 0.8 million tonnes by 2012[15].

Current e-waste management practices in India are beset with numerous shortfalls, such as the difficulty in inventorization of generated e-waste, unhealthy conditions of informal recycling, inadequate capacities, lack of awareness amongst generators and ULBs.

7.7.3 E- Waste Categories

E-waste is classified into two categories under the Schedule I of E-waste (Management and Handling) Rules 2011 according to their characteristics. The different categories of waste as per the rule are tabulated below in table 7.5.

[14] Defined and detailed in section 2.1.3 of Part II of the manual

[15] CPCB (2011). Available at http://cpcb.nic.in/upload/Latest/Latest_71_ImplementationOfE-WasteRules.pdf

Table 7.5: Categories of electronic wastes as per E Waste (Management and Handling) Rules, 2011[16]

Waste Category	Waste Stream	Type of E-waste
Category I	Information technology and telecommunication equipment	Centralized data processing, mainframes, minicomputers, personal computers (CPU with input and output devices), Laptop, Notebook, notepad etc. Printers including cartridges, Copying equipment Electrical & electronic typewriters, Pocket and desk calculators, other products and equipment for collection, storage, processing, presentation or communication of information by electronics means, User terminals & systems, facsimile, telex, telephones (cellular, cordless, pay phones) answering machines.
Category II	Consumer electrical and Electronics	Television sets (including LCD & LED), refrigerators, washing machines, air-conditioners etc.

The following three e-waste streams are not covered under the Schedule I of the E-waste (M&H) Rules 2011

- Tube lights and CFL and other lighting equipment
- Batteries used in electrical and electronic equipment, such as Ni-Cd, Li-ion, Mercury etc.
- Dry cell batteries

It is very likely that these components are found in the MSW, despite their inherent recycling potential, since no vendor pays for them. Local authorities (like Ahmedabad Municipal Corporation) may collect these wastes separately either as part of the special waste stream or mixed with dry waste, where special waste is not collected separately and dispose them appropriately in a separate designated portion of sanitary land fill. Please refer to section 2.2.2.2.5 of part 2 of this manual for further details.

As per E-Waste Management Rules 2011, the ULB should channelize E-waste found mixed with municipal solid waste, to appropriate E-waste recyclers.

16 E-waste (Management & Handling) Rules, 2011

Rules According to Schedule III of the Rules, the responsibilities of Urban Local Bodies are:

- To ensure that E-waste if found to be mixed with MSW is properly segregated, collected and is channelized to either authorized collection centre or dismantler or recycler.
- To ensure that E-waste pertaining to orphan products is collected and channelized to either authorized collection centre or dismantler or recycler.

Municipal authorities must therefore give basic education to their staff to identify e- waste and measures to be taken when they find such waste mixed with municipal waste.

7.8 Waste Tyres

The management of used tyres is a challenge for even the most modern MSWM systems, for reasons related to the tyres' physical properties and their shape. Tyres are composed primarily of complex natural and synthetic rubber compounds, both of which have substantial heating value, and various other materials.

7.8.1 Storage of Used Tyres

Stockpiles of used tyres can create substantial land use problems, harm the environment, and serve as breeding grounds for insects and other small animals that harbour pathogens detrimental to human health. Stockpiles can self-ignite and cause fires that are very difficult to control, resulting in negative human health and environmental impacts.

7.8.2 Reuse of Used Tyres

Some of the more common reuse practices include:

- Reuse through retreading for extended service;
- Used tyres are utilised for building retaining walls for narrow hill roads, for controling erosion along drainage channels, as barriers in coastal areas, as crash barriers, earth filling in civil engineering works etc. They are also used during landfill construction for weighing down the liner material.
- Cuttings from used tyres are used in shoe soles, gaskets, continuous conveyor belts etc. They may also be used for low-grade products such as automobile floor mats, rubber wheel hand carts and barrows

7.8.3 Processing Of Used Tyres

The typical product yield from scrap tyres is tabulated in table 7.6 :

Table 7.6: Typical product yield from scrap tyres[17]

Product Yield From	Truck Tyres	Equipment Manufacturer (EM) Tyres	Car Tyres
Crumb Rubber	70%	78%	70%
Steel	27%	15%	15%
Fiber and Scrap	3%	7%	15%

The recovery of rubber from used tyres can be very energy-intensive, and such processing may generate hazardous substances and many other types of process residues. Processing of tyre materials should be conducted under controlled conditions, as it generates dust and buffing, which may be carcinogenic to workers and surroundings.

Co-processing of tyres a fuel in cement plants is a preferred, environmentally safe method for disposing waste tyres in urban areas which are in proximity to cement factories.

7.8.4 Co-Processing Of Waste Tyres

Co-processing of tyres as fuel in cement plants is approved as an environmentally safe and efficient method to dispose of used tyres. Co-processing with tyres is also known to improve the combustion characteristics of high ash coal.

The CPCB Guidelines on co-processing in cement/power/steel industry[18] indicate specific requirements for the feeding of materials for co-processing, suitability of substances for co-processing, operating conditions for co-processing plants, air pollution control requirements and emission standards.

7.9 Lead Battery Waste

Once the lead acid battery is no longer capable of being recharged or cannot retain its charge, it is a waste useful and is to be disposed. At the end of its life the battery is classified as a hazardous waste and should be handled as prescribed in the Batteries (Management & Handling) Rules, 2001 in order to prevent damage to human health and to the environment.

[17] Reschner, K., Scrap Tire Recycling, Available at:http://entire-engineering.de/Scrap_Tire_Recycling.pdf

[18] http://www.cpcb.nic.in/upload/Latest/Latest_51_Guidelines%20on%20Co%E2%80%90processing%20in%20CementPowerSteel%20pg15.pdf

7.9.1 The Batteries (Management & Handling) Rules, 2001

The Batteries (Management & Handling) Rules, 2001 govern the management of lead acid batteries, which are a source of electrical energy and contain lead metal. Used lead acid batteries are not considered municipal solid waste and shall not be mixed with it and disposed.

These Rules apply to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof.

Rules Clause7: Responsibilities of dealer:

"It shall be the responsibility of dealer to:

(i) ensure that the used batteries are collected back as per the Schedule against new batteries sold;

(ii) ensure safe transportation of collected batteries to the designated collection centres or to the registered recyclers ; and

(iii) ensure that no damage is caused to the environment during storage and transportation of used batteries."

Rules Clause 10: Responsibilities of consumer or bulk consumer:

"It shall be the responsibility of the consumer to ensure that the used batteries are not disposed of in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler, re-conditioner or at the designated collection centers.

It shall be the responsibility of the bulk consumer to:

(i) ensure that the used batteries are not disposed of in any manner other than by depositing with the dealer/ manufacturer/ registered/ recycler/ importer/ reconditioned or at the designated collection centers"

Rules Clause 11: Responsibilities of auctioneer:

"The auctioneer shall ensure that used batteries are auctioned to the registered recyclers only.

Municipal authorities should acquaint their SWM staff with the above provisions. When disposed lead acid batteries are found mixed with MSW, ULB staff should be trained to report the identified defaulters to the concerned authority for taking appropriate action.

Abbreviations

ABBREVIATIONS

ABC	Asphalt, Brick and Concrete
ABS	Area Based System
AD	Anaerobic Digestion
ADB	Asian Development Bank
ADDA	Asansol Durgapur Development Authority
ADS	Air Density Separator
AFR	Alternative Fuels and Raw material
AIILSG	All India Institute of Local Self Government
ALM	Advanced Locality Management
APITC	Andhra Pradesh Industrial & Technical Consultancy Organization
APPCB	Andhra Pradesh Pollution Control Board
ASR	Auto Shredder Residue
ASTM	American Society for Testing and Materials
BARC	Bhabha Atomic Research Centre
BBMP	Bruhat Bangalore MahanagaraPalike
BFB	Bubbling Fluidized Bed
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
BOO	Build-Own-Operate
BOOT	Build-Own-Operate and Transfer
BOT	Build-Operate-Transfer
BRL	Bio Reactor Landfill
C&D	Construction & Demolition
CA	Concession Agreement
CAA	Constitutional Amendment Act
CBOs	Community Based Organizations
CCF	Clean City Foundation

CDP	City Development Plan
CE	Combustion Efficiency
CFB	Circulating Fluidized Bed
CFL	Compact Florescent Lamp
CIPET	Central Institute of Plastics Engineering and Technology
CMA	Commissionerate of Municipal Administration
CMWMF	Common Municipal Waste Management Facilities
CoC	Corporation of Cochin
CoP	Corporation of Panaji
CPCB	Central Pollution Control Board
CPHEEO	Central Public Health and Environmental Engineering Organization
CPWD	Central Public Works Department
CREDAI	Confederation of Real Estate Developers’ Associations of India
CRRI	Central Road Research Institute
CSP	CitySanitation Plan
CSTR	Continuously Stirred Tank Reactor
DBO	Design-Build-Operate
DBOOT	Design-Build-Own-Operate and Transfer
DEA	Department of Economic Affairs
DMA	Directorate of Municipal Administration
DMC	Durgapur Municipal Corporation
DPR	Detailed Project Report
DRANCO	Dry Anaerobic Composting
DRE	Destruction Removal Efficiency
DWCC	Dry Waste Collection Centres
EAC	Expert Appraisal Committee
EDMC	East Delhi Municipal Corporation
EIA	Environment Impact Assessment

EoI	Expression of Interest
EPF	Employment Provident Fund
EPR	Extended Producer Responsibility
EPTRI	Environment Protection Training and Research Institute
ESI	Employees' State Insurance
ESP	Electrostatic Precipitator
ETP	Effluent Treatment Plant
FAQ	Frequently Asked Question
FCA	Full Cost Accounting
FCO	Fertilizer Control Order
FGT	Flue Gas Treatment
FRP	Fiber Reinforced Plastic
GCL	Geo Synthetic Clay Liner
GDP	Gross Domestic Product
GHG	Green House Gas
GI	Galvanized Iron
GIS	Geographic Information System
GNCTD	Government of National Capital Territory of Delhi
GoI	Government of India
GPRS	General Packet Radio Identification
GPS	Global Positioning System
GSB	Granular Sub Base
GSI	Geological Survey of India
HAPs	Hazardous Air Pollutants
HDPE	High-Density Polyethylene
HoD	Head of Department
HUDCO	Housing and Urban Development Corporation
HVAC	Heating, Ventilation & Air Conditioning

IARI	Indian Agricultural Research Institute
ICT	Information and Communication Technology
IDBI	Industrial Development Bank of India
IDFC	Infrastructure Development Finance Company
IEC	Information, Education and Communication
IEISL	IL&FS Environmental Infrastructure and Services Limited
IFCI	Industrial Finance Corporation of India
IGCC	Integrated Gasification Combined Cycle
IL&FS	Infrastructure Leasing and Financial Services
ILO	International Labour Organization
IMD	Indian Meteorological Department
IPNM	Integrated Plant Nutrient Management
IREDA	Indian Renewable Energy Development Agency
IS	Indian Standards
ISWM	Integrated Solid Waste Management
ITB	Instruction to Bidders
JBIC	Japan Bank for International Cooperation
JnNURM	Jawaharlal Nehru National Urban Renewal Mission
KfW	Kreditanstalt für Wiederaufbau
KKPKP	Kagad Kach Patra Kashtakari Panchayat
KKPNSPS	Kagad Kach Patra Sahkari Patra Sansthan
KLD	Kilo Litre per Day
KMC	Kolkata Municipal Corporation
LCD	Liquid Crystal Display
LCS	Leachate Collection System
LCV	Low Calorific Value
LDO	Light Diesel Oil
LDPE	Low-density polyethylene

LED	Light Emitting Diode
LEL	Lower Explosive Limit
LIC	Life Insurance Corporation
LoI	Letter of Intent
M&E	Monitoring & Evaluation
MCD	Municipal Corporation of Delhi
MCGM	Municipal Corporation of Greater Mumbai
MIS	Management Information System
MML	Model Municipal Law
MMRDA	Maharashtra Metropolitan Regional Development Authority
MNRE	Ministry of New and Renewable Energy
MoA	Ministry of Food and Agriculture
MoEF	Ministry of Environment and Forests
MoUD	Ministry of Urban Development
MPPCB	Madhya Pradesh Pollution Control Board
MRF	Material Recovery Facility
MSW (M&H)	Municipal Solid Waste (Management and Handling)
MSWM	Municipal Solid Waste Management
MSWMP	Municipal Solid Waste Management Plan
NABARD	National Bank for Agriculture and Rural Development
NAPCC	National Action Plan on Climate Change
NBCC	National Buildings Construction Corporation
NCC	National Cadet Corps
NCRPB	National Capital Region Planning Board
NCV	Net Calorific Value
NEERI	National Environmental Engineering Research Institute
NGO	Non- Government Organization
NGRI	National Geophysical Research Institute

NMC	Nashik Municipal Corporation
NMMC	Navi Mumbai Municipal Corporation
NMSH	National Mission on Sustainable Habitat
NPK	Nitrogen, Phosphorus and Potassium
NUSP	National Urban Sanitation Policy
OEM	Original Equipment Manufacturer
OMC	Optimum Oxygen Content
PAHs	Polychlorinated Aromatic Hydrocarbons
PBG	Performance Bank Guarantee
PBVS	Parisar Bhagini Vikas Sangha
PCBs	Polychlorinated biphenyl
PCC	Pollution Control Committee
PCDD	Polychlorinated dibenzodioxins
PCDF	Polychlorinated dibenzofurans
PCMC	Pimpri Chinchwad Municipal Corporation
PET	Polyethylene terephthalate
PFDF	Pooled Finance Development Fund
PIM	Project Information Memorandum
POP	Persistent Organic Pollutants
PP	Polypropylene
PPE	Personal Protection Equipment
PPP	Public Private Partnership
PROM	Phosphate Rich Organic Manure
PS	Polystyrene
PSP	Private Sector Participation
PTO	Power Take-Off
PUF	Polyurethane Foam
PVC	Polyvinyl chloride

PVP	Parisar Vikas Programme
RCC	Reinforced Cement Concrete
RDF	Refuse Derived Fuel
RFID	Radio Frequency Identification
RFP	Request for Proposal
RFQ	Request for Qualification
RPM	Respirable Particulate Matter
RWA	Resident Welfare Association
SCR	Selective Catalytic Reduction
SEAC	State Expert Appraisal Committee
SEHB	Shimla Environment Heritage Conservation and Beautification Society
SEIAA	State Environment Impact Assessment Authority
SHGs	Self Help Groups
SI	Sanitary Inspector
SLB	Service Level Benchmark
SLF	Sanitary Landfill Facility
SMS	Stree Mukti Sanghathana
SNCR	Selective Non-catalytic Reduction
SO	Sanitary Officer
SOP	Standard Operating Procedure
SPCB	State Pollution Control Board
SPFE	State Pooled Finance Entities
SPI	Society of the Plastics Industry
SSI	Sanitary Sub-Inspector
SSS	State Sanitation Strategy
STP	Sewage Treatment Plant
SWaCH	Solid Waste Collection & Handling
TCLP	Toxicity Characteristic Leaching Procedure

ToR	Terms of Reference
TPD	Tonnes per day
TSDF	Treatment, Storage & Disposal Facility
UAFP	Up-flow Anaerobic Filter Process
UASB	Up-flow Anaerobic Sludge Blanket
UDD	Urban Development Department
UIDSSMT	Urban Infrastructure Development Scheme for Small & Medium Towns
UIG	Urban Infrastructure and Governance
ULB	Urban Local Body
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
VAT	Value Added Tax
WEEE	Waste of Electrical and Electronic Equipment
WMC	Warangal Municipal Corporation
WOW	Waste Out of Wealth
WPLF	Waste Processing and Landfill

Glossary

Glossary

Acid gas	A gas produced in the combustion process. It contains acid components such as sulfides and chlorides.
Act	The Environment (Protection) Act, 1986 (29 of 1986).
Active gas collection	A technique that forcibly removes gas from a landfill by attaching a vacuum or pump to a network of pipelines in the landfill or surrounding soils to remove the gases.
Aerated	A system / material, where free oxygen has been made available either with a mechanical device or natural draught of air.
Aerated static pile	The process of exposing bulk material, like compost, to air. Forced aeration refers to the use of blowers in compost piles.
Aeration	The process of exposing bulk material, like compost, to air. Forced aeration refers to the use of blowers in compost piles.
Aerobic	A system / material where free oxygen is available so that aerobic reactions can proceed.
Aerobic composting	A method of composting organic wastes using bacteria that needs oxygen (aerobic bacteria). This requires that the waste be exposed to air, either via turning or by forcing air through perforated pipes that pass through the material.
Aerobic decomposition	A type of decomposition that requires oxygen.
Agricultural waste	Waste material generated from agricultural activity or agroindustry residues, e.g., straw, husk, tree pruning etc.
Air classifier	A device used to separate materials at a facility such as a MRF. Air in the form of a wind is used to blow lighter materials off and away from the heavier materials.
Air Density Separator (ADS)	A device to separate sand, grit and other heavy particles from compost, by using floatation from a fluid bed condition. Compost is sucked up and heavy particles fall behind.
Anaerobic decomposition	A type of decomposition that does not use oxygen. Anaerobic decomposition creates odor problems.
Anaerobic digestion	A controlled process involving microbial decomposition of organic matter in absence of oxygen.
Animal house	A place where animals are reared/kept for the purpose of experimenting or texting.

Aquifer	A geological formation, group of formations, or portion of a formation capable of yielding significant quantities of groundwater to wells or springs.
Area fill	A method of landfilling that compacts the refuse in cells and then uses soil cover to separate and cover the cells. This is typically done in layers and in separate phases.
Ash	The non-combustible, solid by-product of incineration or other combustion process.
Ash quench water	Water that is used to cool the bottom ash when it is removed from an incinerator.
Ash residues	The left-over material from a combustion process. They may take the form of fly ash or bottom ash.
Assembler	A person who manufactures lead acid batteries by assembling various components.
Attenuation	A process of converting and destroying a chemical compound as it passes through layers of soil or rock.
Auction	Bulk sale of used lead acid batteries or component (s) thereof by invitation of tenders or auction, contract or negotiation by individual(s), companies or Government Departments.
Auctioneer	A person(s) who auctions used lead acid batteries or components, thereof.
Authorization	Permission granted by the prescribed authority for the generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of bio-medical waste in accordance with these rules and guidelines issued by the central pollution control board, ministry of Environment and Forests, ministry of Health and Family Welfare, Government of India.
Authorized person	An occupier or operator authorized by the prescribed authority to generate, collect, receive, store, transport, treat, dispose or handle bio-medical waste in accordance with these rules and guidelines issued by the central pollution control board, ministry of Environment and Forests, ministry of Health and Family Welfare, Government of India.
Autoclaving	Sterilization via a pressurized, high-temperature steam process.
Avoided cost	The amount of money saved when another less costly option that yields the same result is selected or used.

Bag house	A combustion plant emission control device that consists of an array of fabric filters through which flue gases pass in an incinerator flue. Particles are trapped and thus prevented from passing into the atmosphere.
Bailing	A machine used to compress recyclables into bundles to reduce volume. Balers are often used on newspaper, plastics, and corrugated cardboard.
Baler	A machine used to compress recyclables into bundles to reduce volume. Balers are often used on newspaper, plastics, and corrugated cardboard.
Basel convention	An international agreement on the control of trans-boundary movements of hazardous wastes and their disposal, drawn up in March 1989 in Basel, Switzerland, with over 100 countries as signatories.
Battery	Lead acid battery which is a source of electrical energy and contains lead metal.
Bentonite	A type of soil that swells greatly in the presence of water. Because bentonite impedes the flow of water, it is used for liners, covers, and various other landfill applications.
Berm	An elongated pile of soil used to control and direct the flow of surface water runoff. Berms may also be used to block out noise and screen operations from public view.
Bio-accumulation	The retaining and accumulation over time of certain chemical compounds in organic matter such as the tissues of plants and animals used as food source.
Bio-degradable substances	A substance that can be degraded by micro-organisms.
Biologicals	Any preparation made from organisms and micro-organisms or product of metabolism and biochemical reactions intended for the use in diagnosis, immunization, or the treatment of human beings or animals, or in research activities pertaining thereto.
Bio-medical waste	Any waste, which is generated during the diagnosis, immunization, or the treatment of human beings or animals, or in research activities pertaining thereto or in the production or testing of biologicals including categories mentioned in Schedule I of these rules.

Bio-medical waste treatment and disposal facility	Any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment and or disposal is carried out and includes common treatment facilities.
Biomethanation	A process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas.
BMW	Also known as Medical or Clinical Waste and normally refers to waste products produced from healthcare premises such as hospitals, dispensaries etc. It is also known as Health Care Waste; however in this report it is referred to as Bio-Medical Waste.
Bottle bill	A law requiring deposits on beverage containers.
Bottom ash	Generally, a toxic residue of incineration that accumulates on the grate of the furnace and is relatively coarse and non-combustible.
British Thermal Unit (BTU)	A unit of measure for the amount of energy a given material contains (e.g., energy released as heat during combustion is measured in BTU's.) Technically, one BTU is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.
Broker	The remaining noncombustible material collected on grates or in other locations during the combustion process.
Buffer zone	A zone of no-development which shall be maintained around landfills, processing and disposal facilities of municipal solid waste.
Bulking agent	A material used to add volume to another material to make the second material more porous, which increases air flow. For example, municipal solid waste may act as a bulking agent when mixed with water treatment sludge.
Bulky waste	Large wastes (such as appliances, furniture, trees and branches, etc.) that cannot be handled by normal MSW processing methods.
Buy back centre	A facility to which individuals bring recyclables in exchange for payment.
Canyon fill	A method of landfilling that is similar to area filling but is used primarily in mountainous terrain. Canyon fill landfills are typically much deeper than other types of landfills.

Capacity building	Refers to activities that strengthen an organization or an individual and helps fulfil its mission better. Capacity building is often regarded as the assistance provided to the entities which have a need to develop certain skills or competence, or for general upgrading of performance ability. These activities include, among others, strategic planning, technology upgrades, operational improvements, and board development.
Cell	The basic unit by which a landfill is developed. It is the general area where incoming waste is tipped, spread, compacted, and covered.
Central pollution control board	The Central Pollution Control Board constituted under sub-section (1) of Section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974).
Cleaner production	Processes designed to reduce the wastes generated by production.
Co-disposal	The disposal of different types of waste together in one area of a landfill or dump. For instance, sewage sludge may be disposed of with regular solid wastes.
Cogeneration	Production of both electricity and steam from one facility, from the same fuel source.
Collection	Lifting and removal of municipal solid waste from collection points or any other location.
Collection centre	A centre established, independently or jointly or a registered society, or a designated agency, or a company or an association to collect e-waste.
Combustibles	Inflammable materials in the waste stream, including paper, plastics, wood, food and garden wastes.
Combustion	In MSWM, the burning of materials in an incinerator.
Commercial waste	Waste materials originating in wholesale, retail, institutional, or service establishments, such as office buildings, stores, markets, theatres, hotels and warehouse.
Commingled	Mixed recyclables that are collected together after having been separated from mixed MSW.
Commodities	Means articles, including but not limited to, vegetable, fruits, pharmaceuticals, food grains and the like.
Communal collection	A system wherein individuals bring their waste directly to a central point for collection.

Communication	A task of getting specific information or ideas across the people not as learners but as a target audience.
Compaction station	A type of transfer station in which waste is compacted as an intermediate step before sending it to a disposal site.
Compactor vehicle	A collection vehicle using high-power mechanical or hydraulic equipment to reduce the volume of solid waste.
Components	Means lead bearing components of a lead acid battery.
Composite liner	A liner system for a landfill consisting of an engineered soil layer and a synthetic sheet of material.
Compost	The material resulting from composting. Also called humus, it is a soil conditioner.
Compost pad / platform	Hard impermeable surface, preferably concrete, on which composting is done.
Compostable plastics	The plastics that undergoes degradation by biological processes during composting to yield co2, water, inorganic compounds and biomass at the rate consistent with the unknown.
Composting	A controlled process involving microbial decomposition of organic matter.
Construction and demolition waste	The waste arising from building materials debris and rubble resulting from construction,. re-modelling, repair and demolition operation.
Consumer	Any person using electrical and electronic equipments excluding the bulk consumers.
Controlled dump	A planned landfill that incorporates, to some extent, some of the features of a sanitary landfill: siting with respect to hydro-geological suitability, grading, compaction in some cases, leachate control, partial gas management, regular (not usually daily) cover, access control, basic recordkeeping, and controlled scavenging.
Convertor	A company that creates a more usable material from a raw product.
Conveying line	A conveyor belt assembly that is used in a facility such as a MRF or IPC, to move materials from the tipping floor/pit to other areas of the facility.

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.
Corrugated paper	Paper or cardboard having either a series of wrinkles or folds, or alternating ridges and grooves.
Cover material	Material, either natural soil or geosynthetic material, used in a landfill to impede water infiltration, landfill gas emissions, and bird and rodent congregation. It is also used to control odors and make the site more visually attractive. Landfills have three forms of cover: daily cover, intermediate cover, and final cover.
Cullet	Clean, usually color-sorted, crushed glass used to make new glass products.
Curbside collection	Programs in which recyclable materials are collected at the curb, often from special containers, and then taken to various processing facilities.
Curing	Allowing partially composted materials to reside in a pile for a specified period of time as part of the maturing process in composting.
Daily cell	In landfills, a portion of refuse that has been compacted and then surrounded with cover material. Daily cover is placed over the landfilled materials at the end of each day to complete the cell.
Daily cover material	Material, usually soil that is used in a landfill to cover the refuse after it has been compacted at the end of each day. The cover is placed mainly to ward off animals and for odor control.
Dealer	A person who sells and receives lead acid batteries or components thereof to and from the consumers or other dealers or retailers on behalf of the manufacturers, importers, assemblers and reconditioners or otherwise.
Decide-announce-defend strategy	In the decision-making process, a strategy in which decisions are made and announced without input from other affected parties. After announcing their decisions, policy makers defend them. This strategy does not allow for public participation in the decision-making process.

Designated collection centre	A collection centre established, individually or jointly by one or more manufacturers or importers, assemblers and re-conditioners in pursuance of their responsibilities under rule- 4 of these rules.
Detention basin	An excavated area of land that is used to collect surface water runoff for the purpose of creating a constant outflow from the basin.
Detinning	Recovering tin from "tin" cans by a chemical process that makes the remaining steel more easily recycled.
Dismantler	Any person, or registered society, or designated agency, or a company or an organisation engaged with dismantling the used electrical and electronic equipments into their components.
Disposal	The disposal of municipal solid waste in terms of the specified measures to prevent contamination of ground-water, surface water, ambient air quality and source of bird attraction; means any operation which does not lead to recovery, recycling or reuse and includes physio-chemical or biological treatment , incineration and deposition in landfills.
Diversion rate	The proportion of waste material diverted for recycling, composting, or reuse and away from landfilling.
Double composite liner	A landfill liner system that uses synthetic and natural soil liners to prevent groundwater contamination. Two liners of each type are used, and each liner has several layers.
Double-liner system	A system in which two liners are used in a landfill to protect against groundwater contamination. The liners may by either synthetic or natural, and may be composed of several layers each.
Drop-off centre	An area or facility for receiving compostables or recyclables that are dropped off by waste generators.
Drop-off collection	A method of collecting recyclable or compostable materials in which the materials are taken by individuals to collection sites, where they deposit the materials into designated containers.
E waste	Means electrical and electronic equipments, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded.
Electrical and electronic equipments	Means equipments which are dependent on electrical currents or electro-magnetic fields to be fully functional.

Electrostatic precipitator	Device for removing particulate matter from an incinerator facility's air emissions. It works by causing the particles to become electrostatically charged and then attracting them to an oppositely charged plate, where they are precipitated out of the flue gasses.
Emissions	Gases released into the atmosphere.
End use market	A company that purchases recycled materials for use as feedstock in manufacturing new products.
Energy recovery	The process of extracting useful energy from waste, typically from the heat produced by incineration or via methane gas from landfills.
Enterprise fund	A fund for a specific purpose that is self-supporting from the revenue it generates.
Environmental Impact Assessment (EIA)	An evaluation designed to identify and predict the impact of an action or a project on the environment, human health and well-being. It can include risk assessment as a component, along with economic and land use assessment.
Environmental Risk Assessment (ERA)	An evaluation of the interactions between agents, humans, and ecological resources. It comprises of human health risk assessment and ecological risk assessment, typically evaluating the probabilities and magnitude of harm that could come from environmental contaminants.
Environmental technologies	Means any technology approved by the Central Government from time to time.
Environmentally sound management of e-waste	Means taking all steps required to ensure that e-waste are managed in a manner which shall protect health and environment, against any adverse effects, which may result from hazardous substances contained in such wastes.
Environmentally sound management of hazardous waste	Means taking all steps required to ensure that the hazardous waste are managed in a manner which shall protect health and the environment against the adverse effects which may result from such waste.
Extended Producer Responsibility (EPR)	Means responsibility of any producer of electrical and electronic equipments, for their products beyond manufacturing until environmentally sound management of their end-of-life products.
E-waste	A waste type consisting of any broken or unwanted electrical or electronic appliance. It is a point of concern, considering that many components of such equipment are considered toxic, and are not biodegradable.

Export	With its grammatical variations and cognatic expressions, means taking out of India to a place outside India.
Exporter	Means any person under the jurisdiction of the exporting country who exports hazardous waste including the country, which exports hazardous waste.
Facility	Means any location wherein the process incidental to the collection, reception, segregation, storage, dismantling, treatment and disposal of e-waste are carried out.
Ferrous metals	Metals derived from iron. They can be removed from commingled materials using large magnets at separation facilities.
Flaring	the burning of landfill gas/methane captured and emitted from collection pipes at a landfill.
Flood plain	A region of land around a body of water, usually a river or stream, that is flooded on a regular basis, usually annually.
Flue gas	All gasses and products of combustion that leave a furnace by way of a flue or duct.
Fluidized-bed incinerator	A type of incinerator in which the stoker grate is replaced by a bed of limestone or sand that can withstand high temperatures. The heating of the bed and the high air velocities used, causes the bed to bubble, which gives rise to the term “fluidized”.
Fly ash	A highly toxic particulate matter captured from the flue gas of an incinerator by the air pollution control system.
Food stuff	Means ready to eat food products, fast foods, processed or cooked food in liquid, powder, solid or semi-solid form
Form	A form appended to these rules.
Garbage	Also called refuse in everyday usage. Although not common, some MSWM manuals use garbage to mean “food wastes”.
Gas control and recovery system	A series of vertical wells or horizontal trenches containing permeable materials and perforated piping. The systems are designed to collect landfill gases for treatment or for use as an energy source.
Gas monitoring probe	Probes placed in the soil surrounding a landfill above the groundwater table. The probes are used to determine if landfill gases are migrating away from the landfill.
Gate volume	The amount of waste, measured by volume, that enters a landfill.

Generation rate	The amount of waste that is produced over a given amount of time. For example, a district may have a generation rate of 100 tons per day.
Generator of waste	Persons or establishments generating municipal solid waste.
Geographic information system (GIS)	A system, usually computerized, that includes locations of all geographical characteristics of an area of land. Items may include elevation, houses, public utilities, or the location of bodies of water, aquifers, and flood plains.
Geonet	A synthetic liner component that facilitates drainage. A geonet is analogous to the sand component in natural liner.
Geotextile	A synthetic component that is used as a filter to prevent the passing of fine-grained material such as silt or clay. A geotextile may be placed on top of a drainage layer to prevent the layer from becoming clogged with fine material.
Glassphalt	A mixture of asphalt that includes a small amount of finely crushed glass as an admixture.
Goals	Specific, discrete aims that define accomplishment of the vision and mission.
Grain size distribution	A method of categorizing soils in which soil particles are separated according to size. A well-graded soil has a uniform grain size distribution while a poorly graded soil has a non-uniform grain size distribution.
Groundwater	Water beneath the earth's surface that fills underground pockets (known as aquifers), supplying wells and springs.
Groundwater monitoring well	A well placed at an appropriate location and depth for taking water samples to determine groundwater quality in the area surrounding a landfill or other site.
Hammermill	A type of crusher or shredder used to break materials up into smaller pieces.
Hazardous Waste (HW)	A waste that poses substantial or potential threats to public health or the environment generally exhibiting one or more of these characteristics: ignitable, oxidizing, corrosive, eco-toxic, radioactive, etc. Such wastes arising from industries are called as Industrial Hazardous Waste.
Heat value	Heat generated per unit weight or volume of combustible material completely burned.
Heavy metals	Metals of high atomic weight and density that are toxic to living organisms, such as mercury, lead, and cadmium.

Help (hydrologic evaluation of landfill performance) model	A specialized computer program that performs the water balance equation and aids in modeling by predicting leachate generation. By selecting different covers and liners, an optimum combination can be achieved.
Historical E-waste	E-waste generated from electrical and electronic equipments as specified in Schedule I, which was available on the date from which these rules come into force.
Household hazardous waste	Products used in residences that are toxic to living organisms and/or the environment, such as paints and some cleaning compounds.
Humus	The end product of composting. Also called compost.
Hydraulic conductivity	A measurement of how fast a liquid can pass through the pores of a solid. Typically, the liquid is water and the solid is a soil of some type.
Importer	A person who imports new lead acid batteries or components containing lead thereof for the purpose of sale.
In vessel composting	A method in which compost is continuously and mechanically mixed and aerated in large, contained area.
Incineration	The process of combusting solid waste under controlled, approximately stoichiometric conditions to reduce its weight and volume, and often to produce energy. In combustion chemistry, the condition whereupon the quantity of oxygen provided to the combustion process is exactly that needed to completely oxidise all carbon in the fuel to carbon dioxide.
Industrial waste	Materials discarded from industrial operations or derived from manufacturing processes.
Infiltration layer	A low hydraulic conductivity layer in a landfill, usually a component in the cover that is placed to minimize liquid infiltration to the waste layer.
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.
Inoculants	Microbial concoction or natural material containing microbes, e.g., stabilized sewage sludge, cattle manure, and commercially available proprietary material to boost composting, e.g., EM solution.
Inorganic waste	Waste composed of material other than plant or animal matter, such as sand, dust, glass, and many synthetics.

Institutional waste	Waste materials originating in schools, hospitals, prisons, research institutions, and other public buildings.
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 & consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.
Intermediate Processing Center (IPC)	Usually refers to the type of materials recovery facility (MRF) that processes residentially collected mixed recyclables into new products available for markets; often used interchangeably with MRF.
In-vessel composting	Composting in an enclosed vessel or drum with a controlled internal environment, mechanical mixing, and aeration.
Itinerant waste buyer	A person who moves around the streets buying (or bartering for) reusable and recyclable materials.
Kerbside collection	Collection of compostables, recyclables, or trash at the edge of a sidewalk in front of a residence or a shop.
Key Performance Indicators (KPI's)	Parameters that provide a meaningful, concise, overall picture of an organization's performance or that of the project/programme, used to report progress that is chosen to reflect the critical success factors of a program or plan. The KPI's reflect long-term considerations.
Knuckleboom crane	A crane with a bending or pivot point in the boom, which enables it to reach over a longer horizontal distance.
Landfill gases	Gases arising from the decomposition of organic wastes; principally methane, carbon dioxide, and hydrogen sulphide. Such gases may cause explosions at landfills.
Landfill mining	A process of removing reusable resources from old landfills for recycling.
Landfilling	The disposal of residual municipal solid waste on land in a facility designed with protective ·measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odour, fire hazard, bird menace, pests or rodents, greenhouse gas emissions, slope instability and erosion.
Lateral pipe	A pipe used to connect wells or trenches in a landfill.

Leachate	The liquid generated from municipal solid waste that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it.
Leachate collection system	Network of pipes or geotextiles/geonets placed at low areas of the landfill liner to collect leachate from a landfill for storage and treatment. Flow of leachate along the liner is facilitated by the use of a soil drainage blanket or geonet.
Leachate pond	A pond or tank constructed at a landfill to receive the leachate from the area. Usually the pond is designed to provide some treatment of the leachate, by allowing settlement of solids or by aeration to promote biological processes.
Lift	The completed layer of compacted waste in a cell at a landfill.
Liner	a protective layer, made of soil and/or synthetic materials, installed along the bottom and sides of a landfill to prevent or reduce the flow of leachate into the environment.
Macrorouting (Route balancing)	Creating collection routes by dividing a collection area into smaller areas representing one day of work for one crew.
Magnetic band	Magnets fixed on a moving belt or band which moves close to a surface (e.g., a belt conveyor) and continuously picks up ferrous material and sheds them systematically into a hopper or another conveyor belt.
Magnetic separation	A system to remove ferrous metals from other materials in a mixed municipal waste stream. Magnets are used to collect the ferrous metals.
Manual landfill	A landfill in which most operations are carried out without the use of mechanized equipment.
Manufacturer	In relation to any factory manufacturing lead acid batteries or components thereof means a person or Chief Executive Officer (CEO) of the company who has control over the affairs of the factory or the premises for sale and collection of lead acid batteries or components thereof.
Market waste	Primarily organic waste, such as leaves, skins, and unsold food, discarded at or near food markets.
Mass burn incinerator	A type of incinerator in which solid waste is burned without prior sorting or processing.
Material recovery facility (MRF)	A facility where municipal solid waste can be segregated, baled and temporarily stored.

Mechanical separation	A system to remove ferrous metals from other materials in a mixed municipal waste stream. Magnets are used to collect ferrous metals.
Methane	An odourless, colourless, flammable, explosive gas, CH4, produced by anaerobically decomposing MSW at landfills.
Microrouting	Takes the smaller areas created in macrorouting and defines specific route paths for collection crews to follow.
Modular incinerator	Small, self contained incinerators designed to handle small quantities of solid waste. Modules may be combined as needed, to match the plant capacity with the quantity of waste to be processed.
Moisture content	The fraction or percentage of a substance or soil that is water.
Municipal Solid Waste (MSW)	Includes the commercial and residential waste generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous waste, e-waste and including treated bio-medical waste.
Municipal Solid Waste Management (MSWM)	The collection, segregation, storage, transportation, processing and disposal of municipal solid waste, including reduction, re-use, recovery, recycling in a scientific and hygienic manner.
Mulch	Ground up or mixed yard trimmings placed around plants to prevent evaporation of moisture and freezing of roots and to nourish the soil.
Multi layered plastic	Means any material having the combination of more than one layer of packaging material such as paper, paper board, polymeric materials, metalised layers or aluminium foils either in the form of laminate or co-extruded structure.
Municipal (project) revenue bond	A method of financing in which bonds are given on the basis of the worthiness, technological feasibility, and projected revenue of a project.
Municipal authority	The Municipal Corporation, Municipality, Nagar Palika, Nagar Nigam, Nagar Panchyat, Municipal Council including notified area committee (NAC) or any other local body constituted under the Acts for time being in .force and, where ihe management and handling of municipal solid waste is entrusted to such agency.

Occupier	A person having the administrative control over the institution and the premises generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health care facility, and clinical establishments by whatever name it may be called.
Operator of a common bio-medical waste treatment facility	A person who owns, or controls or operates, for the collection, reception, transport, storage, treatment, disposal or any other form of handling bio-medical wastes.
Operator of facility	A person who operates a facility for processing and disposal of municipal solid waste which also includes any other agency appointed by the municipal authority for the management of processing and disposal facility.
Open dump	An unplanned “landfill” that incorporates few, if any, of the characteristics of a controlled landfill. There is typically no leachate control, no access control, no cover, no management, and many scavengers.
Organic compost	Compost made from raw materials, which may include materials of biological origin (plant, animal) such as food waste, horticultural waste, fruit / vegetable / meat / fish market waste, chemically unprocessed minerals etc. (such as, rock phosphate).
Organic material (Organic waste)	Materials containing carbon. The organic fraction of MSW includes paper, wood, food scraps, plastics, and yard trimmings.
Original equipment manufacturer	Manufacturer of equipment or product using lead acid batteries as a component.
Orphaned products	Non branded or assembled electrical and electronic equipment as specified in the Schedule I, or those products by a company, which has closed its operations or has stopped product support.
Overlay maps	A series of individual maps, each of which shows specific data. The maps are placed on top of one another to form a composite map showing all the data.
Particulate matter (pm)	Tiny pieces of matter resulting from the combustion process. PM can have harmful health effects when breathed. Pollution control at combustion facilities is designed to limit particulate emissions.
Passive venting	A venting technique using the natural pressure created in landfills to expel gases and control gas migration.

Pathogens	Disease-causing agents, especially microorganisms such as bacteria, viruses, and fungi.
Pelletization	A process whereby pellets are prepared which are small cubes or cylindrical pieces made out of solid waste and includes the fuel pellets which are referred as refuse derived fuel.
Percolate	To ooze or trickle through a permeable substance. Groundwater may percolate into the bottom of an unlined landfill.
Permanent magnet	Larger piece of magnet, hung close to a conveyor, so that it picks up nails and other pieces of ferrous material. The 'catch' is removed from time to time.
Permeability	A measure of how well a liquid moves through the pores of a solid. Expressed as a number applied to landfills in terms of how quickly water moves through soil; it is typically expressed as centimeters per second.
Permeable	Having pores or openings that permit liquids or gasses to pass through.
Phase diagram	A diagram (or a series of diagrams) used to show chronological order in a project. The diagram should show key transition points and contain enough detail to move smoothly from phase to phase.
Phasing	A system of running a project in more than one step (phase). Each phase is generally independent of the others, which offers more flexibility in management and operation.
Plastic	Material which contains as an essential ingredient a high polymer and which at some stage of its processing into its finished products can be shaped by flow.
Plastic waste	Any plastic product such as carry bags, pouches or multi-layered packages which have been discarded after use or after their intended life is over.
Platform/pit noncompaction station	A type of transfer station that has a waste storage capacity of several days or more. While the waste is in temporary storage, recyclable materials may be removed.
Post-closure care	A procedure of maintaining the environmental controls and appearance of a landfill after it has ceased to accept waste.

Post-consumer recycling	The reuse of materials generated from residential and commercial waste, excluding recycling of material from industrial processes that has not reached the consumer, such as glass broken in the manufacturing process.
Precycling	The decision-making process consumers use to judge a purchase based on its waste implications. Criteria include whether a product is reusable, durable, and repairable; made from renewable or non-renewable resources; over-packaged; or in a reusable container.
Primary leachate	When waste enters a landfill, it contains some amount of liquid, which leaches out of the refuse as primary leachate.
Processing	The process by which municipal solid waste is transformed into new or recycled products.
Producer	Means any person who, irrespective of the selling technique used, 1. Manufacturers and offers to sell electrical and electronic equipment under his own brand; or 2. Offers to sell under his own brand, assembled electrical and electronic equipment produced by other manufacturers or suppliers; or 3. Offers to sell imported electrical and electronic equipment.
Reconditioner	A person involved in repairing of lead acid batteries for selling the same in the market.
Recycler	An occupier who processes used lead acid batteries or components thereof for recovering lead.
Recycling	The process of transforming segregated solid waste for producing new products.
Refractory	A material that can withstand dramatic heat variations. Used in conventional combustion chambers in incinerators.
Refuse Derived Fuel (RDF)	Fuel in the form of pellets or fluff produced by shredding and dehydrating combustible components of municipal solid waste.
Registered recycler	A recycler registered with the Ministry of Environment and Forests or an agency designated by it for reprocessing used lead acid batteries or components thereof.

Registration	The process of authentication of the facility run by an operator (NGO, CBO, private company), which would ensure standard operating procedure and produce material in compliance with applicable quality standards. This would be done in a time bound manner – initially for one year, to be renewed on yearly basis subject to appropriate inspection of the premises and sampling of the compost produced for quality check. Valid registration would be a pre-condition for consideration of any assistance from the Government or the Local Body.
Residue	The materials remaining after processing, incineration, composting, or recycling. Residues are usually disposed of in landfills.
Resource recovery	A term describing the extraction and use of materials and energy from the waste stream. The term is sometimes used synonymously with energy recovery.
Retention basin	An area designed to retain precipitation runoff and prevent erosion and pollution.
Reuse	The use of a product more than once in its same form for the same purpose; e.g., a soft drink bottle is reused when it is returned to the bottling company for refilling.
Roll-off container	A large waste container that fits onto a tractor trailer that can be dropped off and picked up hydraulically.
Rotary screen	A round screen which moves either on its axis or preferably moved from outside, so that the material inside goes through 'cascading' action. The feeding side is kept slightly higher than the discharge side.
Salvaging	At landfills or material recovery facilities, salvaging is the controlled separation of recyclable and reusable materials. Controlled means that the separation is monitored by operators.
Sampling by inspectors	Inspection of the composting premises would be carried out by authorized persons 'Inspectors', who would check the premises for compliance requirements and take samples of the product (compost) in the presence of authorized representative of the compost plant. The event would be documented in the presence of both sides and the samples sealed before being sent to authorised laboratories.

Scavenging	At a landfill or material recovery facility, scavenging is the uncontrolled separation of recyclable and reusable materials. Uncontrolled means that the operator does not monitor the removal of materials, and in many cases prohibits it. Material scavenging of recyclables may also occur at the curb or at drop-off centers.
Schedule	means a Schedule appended to these rules.
Scrap	Discarded or rejected industrial waste material often suitable for recycling.
Scrubber	Common anti-pollution device that uses a liquid or slurry spray to remove acid gases and particulates from municipal waste combustion facility flue gases.
Secondary leachate	When water percolates through a landfill, the waterbecomes contaminated and becomes leachate. This leachate is known as secondary leachate.
Secondary material	A material that is used in place of a primary or raw material in manufacturing a product.
Sedimentation basin	An excavated area of land that is used to allow solid particles in water to settle out. The rate of sedimentation is dependent on the depth of the basin and the size and weight of the particles.
Segregation	To separate the municipal solid waste into the groups of organic, inorganic ,recyclables, industrial hazardous waste and e-waste.
Settlement	As refuse decomposes and/or becomes compacted by the weight of overlaying layers, landfills experience a volume decrease and compaction of individual layers of waste in the landfill. Settlement refers to this volume decrease and compaction of layers.
Shredder	A mechanical device used to break waste materials into smaller pieces by tearing and impact action. Shredding solid waste is done to minimize its volume or make it more readily combustible.
Sludge	A semi-liquid residue remaining from the treatment of municipal and industrial water and wastewater.
Soil boring	A sample of earth representing underground conditions for the surrounding area. They are used to gather information about and model subsurface characteristics, which are important when designing landfills.

Source reduction	The design, manufacture, acquisition, and reuse of materials so as to minimize the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption, use, and waste generation. (See also, "waste reduction.").
Source separation	The segregation of specific materials at the point of generation for separate collection. Residential generators source separate recyclables as part of curbside recycling programs.
SPCB or PCC	The State Pollution Control Board or the Pollution Control Committee, as the case may be, constituted under subsection (1) of Section 4 of the Water (Prevention and Control of Pollution) Act, 1974.
Special waste	Refers to items that require special or separate handling, such as household hazardous wastes, bulky wastes, tires, and used oil.
Stacking	Arranging raw material in piles or heaps.
State board	The concerned State Pollution Control Board or the Pollution Control Committee as the case may be.
Static pile	A composting pile which is not turned for aeration. Instead, air is passed through the windrows by using perforated pipes and air blowers.
Storage	The temporary containment of municipal solid waste in a manner so as to prevent littering, attraction to vectors, stray animals and excessive foul odour.
Synthetic liner	A type of liner consisting of a plastic membrane, instead of soil. Synthetic liners are less permeable, thinner, and more flexible than soil liners.
Test pit	Part of an investigative procedure in which a backhoe or similar piece of equipment excavates a deep trench in the earth in order to allow subsurface investigation.
Thermophilic microorganisms	Heat-loving microorganisms that thrive in and generate temperatures above 105 degrees Fahrenheit.
Tipping fee	A fee charged for the unloading and or dumping of material at a landfill, transfer station, recycling centre, or waste-to-energy facility.

Tipping floor/pit	Unloading area for vehicles that are delivering municipal solid waste to a transfer station or municipal waste combustion facility.
Transfer station	A permanent facility where waste materials are taken from smaller collection vehicles and placed in larger vehicles for transport, including truck trailers, railroad cars, or barges. Recycling and some processing may also take place at transfer stations.
Transportation	Conveyance of municipal solid waste from place to place hygienically through specially designed transport system so as to prevent the foul odour, littering, unsightly conditions and accessibility to vectors;
Treated BMW	The wastes generated in hospitals and health care institutions which have been prescribed as treated under the Bio-medical Waste (Management and Handling) Rule1998, as amended time to time means the method, technique or process, designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its potential to cause harm;
Treatment	The method, technique or process, designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its 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.
Turning	The material in a pile or windrow is moved in a manner that the material in the core area comes out on the surface so that the whole windrow gets exposed to air by turn.
Used batteries	Used, damaged and old lead acid batteries or components thereof.
Vadose water	Water which occurs between the ground, surface and the water table that is the unsaturated zone.
Vector	An organism or insect which often carries diseases or parasites from one animal or plant to another, e.g., fly, mosquito etc.
Vermicast	The excrement from earthworms, which is also called vermicompost.
Vermicompost	Cast / excrement of earth worms.

Vermicomposting	It is a process of using earthworms for conversion of bio-degradable waste into compost. Earth worms are employed to ingest the organic waste as their food and excrete the vermi-compost as their 'cast'. The necessary digestion / stabilization take place in the gut of the worms. In this case, the earth worms manage the different set of microbes within their bodies. Vermi-composting is normally carried out with source-segregated organic waste.
Vibro-screen	A screening arrangement, in which flat screens vibrate in a horizontal plane; less expensive than trommel but less efficient.
Virgin plastic	Plastic material which has not been subjected to use earlier and has also not been blended with scrap or waste.
Volatilization	A process in which gases are produced and escape into the atmosphere. In landfills, methane volatilization is of concern.
Volume-based fees	A fee paid to dispose of material at a facility such as a landfill, based on the volume of the material being disposed of.
Waste exchange	A computer and catalog network that redirects waste materials back into the manufacturing or reuse process by matching companies generating specific wastes with companies that use those wastes as manufacturing inputs.
Waste management boundary	The boundary around the area occupied by the waste in a landfill, measured in terms of area.
Waste pickers	The individuals or groups of individuals engaged in the collection of municipal solid waste.
Waste reduction	Waste reduction is a broad term encompassing all waste management methods—source reduction, recycling, composting—that result in reduction of waste going to a combustion facility or landfill.
Waste stream	A term describing the total flow of solid waste from homes, businesses, institutions and manufacturing plants that must be recycled, burned, or disposed of in landfills; or any segment thereof, such as the "residential waste stream" or the "recyclable waste stream."
Waste-to-Energy system (WTE)	A method of converting MSW into a usable form of energy, usually though combustion.

Water balance	An equation that is used to model and predict the amounts of water that will go to various destinations. Typical destinations include evaporation, infiltration, and run-off. The sum of the amounts to the destinations must be equal to the source of the water (usually precipitation).
Water table	The level below the earth's surface at which the ground becomes saturated with water. Landfills and composting facilities are designed with respect to the water table in order to minimize potential contamination.
Waterwall incinerator	Waste combustion facility using lined steel tubes filled with circulating water to cool the combustion chamber. Heat from the combustion gases is transferred to the water. The resultant steam is sold or used to generate electricity.
Wet scrubber	Anti-pollution device in which a lime slurry (dry lime mixed with water) is injected into the flue gas stream to remove acid gases and particulates.
Wet/dry collection systems	A collection system that allows wet organic materials to be separated by generators from dry wastes. Wet organic materials are suitable for composting, while dry materials are non-organics that may include recyclables.
Windrow	Long trapezoidal heaps or piles. Long composting heaps are referred to as 'windrow'. The base is wider and the top is narrower.

Bibliography

BIBLIOGRAPHY

All India Institute of Local Self Government (2012). *Reference Material on Municipal Solid Waste Management for Urban Local Bodies – Collection, Transfer and Transportation of Waste Components.* Part I. Mumbai: India.

All India Institute of Local Self Government (2012). *Reference Material on Municipal Solid Waste Management for Urban Local Bodies – Processing Options.* Part II. Mumbai: India.

Anthena Infonomics (2012). *Public Private Partnership in Municipal Solid Waste Management- Potential and Strategies*. India. Available at:< https:// www.google.co.in /url?sa= t&rct= j&q=& esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCoQFjAA&url=https%3A%2F%2Fwww.gov.uk%2Fgovernment%2Fuploads%2Fsystem%2Fuploads%2Fattachment_data%2Ffile%2F186990%2FReportPPPMunicipalSolidWasteManagement270812.pdf&ei=QldpU5jxD4ycugSOiYD4BQ&usg=AFQjCNGSh5BmFJJgHpZYzTWihC03558IAQ&sig2=xBKoXJf_jZD4Duqn_Ps3xA&bvm=bv.66111022,d.c2E>. [Accessed: 12th June, 2013]

Brent Hansen Environmental (2004). *Operational Manual for Establishment of a Commercial Composting Facility.* Available at: <http://www.composting.ca/files/op_manual.pdf>. [Accessed: 11th July, 2013]

Bureau of Indian Standards (1998). *Indian Standard- Guidelines for Recycling of Plastics.* New Delhi: Government of India. Available at: < https:// law.resource .org/pub/in/ bis/S11/is.14534 .1998.pdf >. [Accessed: 1st August, 2013]

Central Pollution Control Board (2013). *An Overview on Plastic Waste Management.* New Delhi. Available at: <http://www.cpcb.nic.in/divisionsofheadoffice/pcp/ managementplasticwast e .pdf>. [Accessed: 20th May, 2013]

Central Pollution Control Board (2012). *Status Report on Municipal Solid Waste Management.* New Delhi. Available at: < http://www.cpcb. nic.in/divisionsofheadoffice/pcp/MSW_ Report.pdf >. [Accessed: 19th July, 2013]

Central Pollution Control Board (2011-12). Annual Report. Available at: <http://cpcb.nic.in/upload/AnnualReports/AnnualReport_43_AR_2011-12_English.pdf>. [Accessed: 20th August, 2013]

Central Pollution Control Board (2011) *Implementation of E-Waste Rules, 2011.* New Delhi. Available at: < http://www.cpcb.nic. in/upload/Latest/Latest _71_Implementation OfE-WasteRules.pdf >. [Accessed: 11th April, 2013]

Central Pollution Control Board (2010). *Guidelines on Co – processing in Cement/Power/Steel Industry.* New Delhi. Available at: <http://www.cpcb.nic.in/ divi-

sionsofheadoffice/ hwmd/ Latest 51Latest 51_GUIDELINES-ON_CO-Process-inginCement.pdf>. [Accessed: 12th May, 2013]

Central Pollution Control Board (2010). *Urban Waste Profile.* ENVIS Centre for Control of Pollution. New Delhi. Available at: < http://cpcbenvis.nic.in /newsletter /URBAN% 20WASTE %20PROFILE_LV.pdf >. [Accessed: 10th August, 2013]

Central Pollution Control Board (n.d.) *Sanitation in Slaughter House*. Pollution Control Implementation Division – III. New Delhi. Available at: < http://www.cpcb.nic.in /divisions of headoffice/pci3/pciiiidivslaughter.pdf >. [Accessed: 14th May, 2013]

Central Pollution Control Board (n.d.). Plastic Waste Management. Available at: <http://www.cpcb.nic.in/wast/plasticwast/Plastic_waste-1.pdf>. [Accessed: 20th August, 2013]

Central Pollution Control Board (n.d.). Slaughterhouse Waste Management. Available at: <https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0CC8QFjAB&url=http%3A%2F%2Fcpcbenvis.nic.in%2Fnewsletter%2Fslaughterhouse%2FSlaughterHouse.doc&ei=vUlRU_DGEMKprAe9_YCIDQ&usg=AFQjCNHBDaEJmk4yqZNLCOd63oKQJ3Glpw&sig2=1oXmfiOxPlT9wam7mBux5Q&bvm=bv.65058239,d.bmk>. [Accessed: 20th August, 2013]

Chikarmane, P. (2012). *Integrating Waste Pickers into Municipal Solid Waste Management in Pune.* WIEGO. Pune: India. Available at: <http://www.inclusivecities.org/wp-content/uploads/2012/10/Chikarmane_WIEGO_PB8.pdf>. [Accessed: 20th September, 2013]

Cointreau-Levine, S., & Coad, A. (2000). *Guidance Pack: Private Sector Participation in Municipal Solid Waste Management*. Swiss Centre for Development Cooperation in Technology and Management. St. Gallen; Switzerland. Available at: <http://rru.worldbank.org/Docu-ments/Toolkits/waste_fulltoolkit.pdf>. [Accessed: 12th August, 2013]

Cointreau-Levine, S. (1994). *Private Sector Participation in Municipal Solid Waste Services in Developing Countries (Vol. 1)*. Urban Management Programme Discussion Paper 13, The World Bank; Washington, DC. Available at: < http://www-wds.worldbank .org/external/ default /WDSContentServer/WDSP/IB/1994/04/01/0000092653970128111924/Ren-dered /PDF /multi_page.pdf >. [Accessed: 12th August, 2013]

Cointreau- Levine, S. (n.d.). *Transfer Station Design Concepts for Developing Countries.* Available at: <http://siteresources.worldbank.org/INTUSWM/Resources/463617-1202332338898 /transferdesignoptions.pdf>. [Accessed: 17th September, 2013]

Commissionerate of Municipal Administration (2008). *Ready Reckoner on Municipal Solid Waste Management for Urban Local Bodies.* Chennai: Government of Tamil Nadu. Available at: <http://cma.tn.gov.in/cma/en-in/Downloads/Ready%20Reckoner%20on%20Municipal% 20Solid% 20Waste%20Management%20for%20ULBs.pdf>. [Accessed: 11th July, 2013]

DEFRA (2007). *Introductory Guide to Options for the Diversion of Biodegradable Municipal Waste from Landfill. United Kingdom.* Available at: <http://archive.defra.gov.uk/environment /waste/residual/newtech/documents/introductory-guide-2007.pdf>. [Accessed: 22nd August, 2013]

Department of Environment and Conservation (2004). *Composting and Related Organic Processing Facility.* Government of Australia. Sydney. Available at: <http://www.environment.nsw.gov.au/resources/waste/envguidlns/composting_guidelines.pdf>.[Accessed: 9th August, 2013]

Department of Solid Waste Operations (2009). *Material Recovery Facility Technology Review.* St Petersburg: Pinellas County. Available at:< http://www.dep.state.fl.us/ waste/quick_topics /publications/shw/recycling/InnovativeGrants/IGYear9/finalreport/Pinellas_IG8-06_ Technology_Review.pdf>. [Accessed: 4th September, 2013]

Dhokhikah, Y. & Trihadiningrum, Y. (2012). *Solid Waste Management in Asian Developing Countries: Challenges and Opportunities. Journal of Applied Environmental and Biological Sciences, 2(7): 329-335.* Available at: <http://fpd-bd.com/wp-content/uploads/2013/05/J.-Appl.-Environ.-Biol.-Sci.-27329-335-2012.pdf>. [Accessed: 17th August, 2013]

Dube, R., Nandan, V. & Dua, S. (n.d.) *Waste Incineration for urban India: Valuable contribution to Sustainable MSWM or Inappropriate high – tech solution affecting livelihood and public health*? New Delhi: GIZ.

Eawag/Sandec- Waste Concern (2006). *Decentralized Composting for Cities of Low – Middle income countries.* Dhaka: Bangladesh Available at: <http://www.unescap.org/ esd/suds/swm/ workshop /2010/ dhaka/Resources/02-SWM-InteractManual/source/pdf/Manual.pdf>. [Accessed: 10th November, 2013]

Environmental Resources Management (2000). Strategic Planning Guide for Municipal Solid Waste Management. The World Bank, SCD and DFID, Waste-Aware, London. Available at: http://www.worldbank.org/urban/solid_wm/erm/start_up.pdf. [Accessed: 5th July, 2013]

European Commission (2006). *Reference Document on the Best Available Techniques for Waste Incineration*. Integrated Pollution Prevention and Control. Available at: <http://ec.europa.eu/environment/ippc/brefs/wi_bref_0806.pdf>. [Accessed: 20th August, 2013]

Gendebien A. et al. (2003*). Refuse Derived Fuel, Current Practice and Perspectives*. European Commission. Available at: <http://ec.europa.eu/environment/waste/studies/pdf/rdf.pdf>. [Accessed: 30th July, 2013]

GHK (2006). *A study to examine the benefits of the End of Life Vehicles Directive and the costs and benefits of a revision of the 2015 targets for recycling, re-use and recovery under the ELV Directive.* Birmingham; United kingdom. Available at: <http://ec.europa.eu/environment /waste/pdf / study/final_report.pdf>. [Accessed: 10th October, 2013]

Ghosh, S., Ghosh, S. & Aich, A. (2011), *Rebuilding C& D Waste Recycling Efforts in India.* Waste Management World. Available at: < http://www.waste-management-world.com /articles /print/volume-12/issue-5/features/rebuilding-c-d-waste-recycling-efforts-in-india.html >. [Accessed: 16th July, 2013]

GIZ (2011). *Recovering Resource, Creating Opportunities- Integrating the Informal Sector into Solid Waste Management.* Eschborn: Germany. Available at:< http://www.giz .de/de/downloads /giz2011-en-recycling-partnerships-informal-sector-final-report.pdf >. [Accessed: 12th August, 2013]

GIZ-TERI (2011). *Environmental Fiscal Reforms in India: Where and How?* The Energy and Resources Institute. New Delhi.

Gleis, M. (2010). Experiences with other Thermal Treatment Processes-Reliability of new technologies. Federal Environment Agency. Available at: http://www.admas.vutbr.cz/files /wtert-prezentace/Gleis_-Experience_with_other_thermal_treatment_processes.pdf. [Accessed: 20th September, 2013]

Gokaldas, V. (2012). *Waste Picker-Run Biogas Plants as a Decentralized Solution.* In: On the Road to Zero Waste-Successes and Lessons From Around the World. GAIA: Mumbai. Available at: <http://www.no-burn.org/downloads/ZW%20Mumbai.pdf>. [Accessed: 15th, November 2013]

Government of Kerala (2013). *Suchitwa Mission.* Available at: < http://www. sanitation. kerala. gov .in >. [Accessed: 13th November, 2013]

Hannan, M. A. et al. (2011). *Solid Waste Truck Monitoring and Management using RFID, GIS and GSM.* Journal of Applied Sciences Research, 7(12): 1961-1964. Available at: <http://www.aensiweb.com/jasr/jasr/2011/1961-1964.pdf> . [Accessed: 21st September, 2013]

Holcim-GTZ (2007). *Reuse and Recycling of Construction and Demolition waste.* Available at: <http://www.coprocem.org/documents/Holcim-GTZ%20-%20CDW%20Study%20--% 20 Revised%20Oct%202007.pdf>. [Accessed: 18th April 2013]

ICRA Management Consulting Service Limited (2011). *Toolkit for Public Private Partnership frameworks in Municipal Solid Waste, Volume I- Overview and*

Process [Online]. Government of India. Available at: <http://www.urbanindia.nic.in/programme/uwss/SWM_PPP_Tookit-Volume-I.pdf>. [Accessed: 12th October, 2013]

ICRA Management Consulting Service Limited (2011). *Toolkit for Public Private Partnership frameworks in Municipal Solid Waste, Volume II- Case Study of PPP projects.* GoI-ADB. Available at: <http://www.urbanindia.nic.in/programme/uwss/SWM_PPP_Tookit-Volume-II.pdf>. [Accessed: 14th October, 2013]

ICRA Management Consulting Service Limited (2011). *Toolkit for Public Private Partnership frameworks in Municipal Solid Waste, Volume III- Model PPP Templates and Documentation.* GoI-ADB. Available at: < http:// www.u rbanindia.nic.in /programme/uwss /SWM PP P Tookit-Volume-III.pdf >. [Accessed: 14th October, 2013]

ICRA Management Consulting Service Limited (2011). *Toolkit for Public Private Partnership frameworks in Municipal Solid Waste, Volume IV- Baseline Status of MSWM in Selected Satellite Towns.* GOI-ADB. Available at: <http://www.urbanindia.nic.in/programme/uwss/FinalSWM PPP_Tookit-Volume-IV.pdf>. [Accessed: 20th October, 2013]

IL&FS Environment (2010). *Technical EIA Guidance Manual for Common Municipal Solid Waste Management Facility.* [Online]. Ministry of Environment & Forests: New Delhi. Available at: <http://environmentclearance.nic.in/writereaddata/Form-1A/Home Links/TGM%20 Comman %20Municipal%20Sold%20Waste%20Management_160910_NK.pdf>. [Accessed: 20th November, 2013]

Interstate Technology & Regulatory Council (2005). *Characterization, Design, Construction, and Monitoring of Bioreactor Landfills. ALT-3.* Washington, D.C: USA. Available at: < https://www. google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&ved=0CC4QFjAA&url=http%3A%2F%2Fwww.itrcweb.org%2FGuidance%2FGetDocument%3FdocumentID%3D3&ei=mCouUrCdNsHZrQeIxoGwDw&usg=AFQjCNEl7gw0gqSWgW-zu9DUylMZj2 L0TQ&sig2=bc9utY6oxLa3JxeF3i1Vgw >. [Accessed: 3rd August, 2013]

Jacobsen, H. & Kristoffersen, M. (2002). *Case Studies on waste minimization practices in Europe.* European Environment Agency. Copenhagen; Denmark. Available at: < http://www. environmental-expert.com/Files/0/articles/2783/waste_min.pdf > . [Accessed: 21st August, 2013]

Kisliakova, A. (2005). *Decentralised Composting as an Approach towards a Sustainable Biowaste Management in Austria and Slovakia.* Austrian Society for Environment and Technology. Austria. Available at: <http://www.oegut.at/downloads/pdf/compask_finalreport.pdf>. [Accessed:13th June, 2013]

Kuehl, R., Marti, M. & Schilling, J. (2008). *Resource for Implementing Street Sweeping Best Practices.* Local Road Research Board. Minnesota: US. Available at: < [04:04:18 AM] Ritu Thakur: http://www .lrrb. org / media/ reports/2008RIC06.pdf >. [Accessed: 20th, April 2013]

Mazumdar, N.B. (2007). *Composting Municipal Solid Waste: The Indian Scenario.* International Journal of Environmental Technology and Management, 7(3/4): 326-350.

Ministry of Agriculture, Food and Fisheries (1996). *Composting Fact Sheet Series. Abbotsford*; British Columbia. Available at:< http://www.al.gov.bc.ca/resmgmt/publist/300Series/382500-5.pdf>. [Accessed: 4th August, 2013]

Ministry of Environment and Forests (2011). E Waste *(Management and Handling) Rules, 2011*. *Gazette of India, S.O. 1125 (E).* Government of India; New Delhi

Ministry of Environment and Forests (2011). Plastic Waste *(Management and Handling) Rules, 2011*. Government of India; New Delhi

Ministry of Environment and Forests (2009). Plastics (Manufacture, Usage and Waste Management) Rules 2009. *Gazette of India, S.O. 2400(E).* Government of India. New Delhi. Available at: <http://moef.nic.in/downloads/public-information/DOC070211-005.pdf>. [Accessed: 16th April, 2013]

Ministry of Environment and Forests (2008). *Guidelines for Environmentally Sound Management of E- Waste.* New Delhi: CPCB. Available at: < http://www.cpcb. nic.in/upload /New Items /New Item_109_Latest_19_E_Waste_GuideLines.pdf >. [Accessed: 14th May, 2013]

Ministry of Environment and Forest (2006). *EIA Notification- 2006*. Gazette of India, Extraordinary, Part-II, and Section 3, Sub – section (ii). Government of India : New Delhi.

Ministry of Environment & Forests (2000). *Municipal Solid Waste Management (Management & Handling) Rules, 2000*. Gazette of India, S.O. 783 (E). Government of India. New Delhi

Ministry of Environment and Forests (1998). *Bio-medical Waste (Management and Handling) Rules, 1998.* Government of India; New Delhi

Ministry of Environment and Forests (1989). Batteries (Management and Handling) Rules, 2001. Gazette of India, S.O. 432 (E). Government of India; New Delhi. Available at: <http://www.moef.nic.in/legis/hsm/leadbat.html>. [Assessed: 12th August, 2013]

Ministry of Environment and Forests (1989). Hazardous Waste (Management and Handling) Rules, 1989. Gazette of India, S.O. 594 (E). Government of

India; New Delhi. Available at: <http://envfor.nic.in/legis/hsm/hsm1.html>. [Assessed: 12th August, 2013]

Ministry of Finance (2011). *Draft National Public Private Partnership Policy.* Department of Economic Affairs; Government of India. New Delhi. Available at:< http://www.iritm.indianrailw ays.gov.in/uploads/files/1365143740928-6%20draftnational ppppolicy.pdf >. [Accessed: 20th November, 2013]

Ministry of Urban Development (2012). *Toolkit for Solid Waste Management: Jawaharlal Nehru National Urban Renewal Mission.* Government of India. New Delhi. Available at: < http://jnnurm .nic.in/wp-content/uploads/2012/11/SWM-toolkit.pdf > . [Accessed: 12th May, 2013]

Ministry of Urban Development (2011). *Municipal Solid Waste Management on a Regional Basis-Guidance Note.* Government of India. New Delhi. Available at:< http://www.wsp.or g/sites/ wsp.org/files/publications/WSP-Municipal-Solid-Waste-Management-India.pdf >. [Accessed: 22nd October, 2013]

Ministry of Urban Development (2008). *Handbook on Service Level Benchmarking.* Government of India. New Delhi. Available at:< http://www. urbanindia.nic.in/ programme /uwss /slb /handbook.pdf >. {Accessed: 11th September, 2013]

Ministry of Urban Development (2005) Inter Ministerial Task Force on Integrated Plant Nutrient Management. Government of India; New Delhi.

Ministry of Urban Development (2005). Report of the Technology Advisory Group on Solid Waste Management. Government of India; New Delhi.

Ministry of Urban Development. (2005). *Inter – Ministerial Task Force on Integrated Plant Nutrient Management Using City Compost.* Government of India. New Delhi

Ministry of Urban Development (2000). *Manual on Municipal Solid Waste Management.* Central Public Health & Environment Engineering Organization: Government of India. New Delhi

Mohanram, N.S. (2012, July 20th). *Environmentally Friendly and Viable Recycling Infrastructure in India- Opening Remarks.* [PowerPoint Presentation]. Presented at: SIAM Recycling International Seminar. Available at: <http://www.siamonline.in/International-Seminar-on-Environmentally-Friendly-and-Viable-ELV-Infrastructure-July-20-2012-NewDelhi-India/1-Welcome/Welcome-N-S-Mohanram-TVS-Motor-India.pdf>. [Accessed: 20th September, 2013]

Nagavallemma, K.P., et al. (2006). *Vermicomposting: Recycling Wastes into Valuable Organic Fertilizer.* SAT eJournal, 2(1); 1-16. Available at: <http://www.icrisat.org/journal/agroecosyste m/v2i1/v2i1vermi.pdf>. [Accessed: 10th

August, 2013]

Nithikul, J. (2007). *Potential of Refuse Derived Fuel Production from Bangkok Municipal Solid Waste.* Chulalongkorn University. Bangkok.

North Carolina Department of Environment, Health and Natural Resources (1997). *Analysis of the Full Costs of Solid Waste Management for North Carolina Local Governments.* Division of Pollution Prevention and Environmental Assistance; Raleigh, North Carolina. Available at: <http://infohouse.p2ric.org/ref/01/00369.pdf> [Accessed: 10th October, 2013]

Paradigm Environmental Strategies Private Limited- GIZ (2011). *Strategy for Improved Collection and Transportation of SWM in Tirupati City with additional resource.* Tirupati Municipal Corporation: India.

Patil, R.K., Garnaik, B., Khond, M. P. & Nawale, L. G. (2010). *Environment Pollution Reduction in Cement Industry for Co Combustion of Waste Tyre and Coal as a Fuel.* International Journal of Modern Engineering Research*, 2(6);* 4652-4656.

Paul, J. & Geesing, D. (n.d.) *Composting Facility Operator Manual*. Available at: <http://www.transformcompostsystems.com/learn-compost-operator-manual.php>. [Accessed: 17th August, 2013]

Rahman, M.H. & Sadre Gazhi, S. (2011) *Waste Concern: A Decentralized Community based Composting through Public Private Community Partnership.* UNDP: Bangladesh. Available at: <http://growinginclusivemarkets.com/media/cases/Bangladesh_WasteConcern_2011.pdf>. [Accessed: 20th August, 2013]

Repa, E.W. (2003). *Bioreactor Landfill: A Viable Technology*. National Solid Waste Management Association. Washington, DC: USA.

Rodrigues, S. (2013). *Panjim's Initiatives in Solid Waste Management.* Available at: <http://iipnetwork.org/Rodriguez_Towards-Green-Trash>. [Accessed: 17 September 2013]

Ryan, M. (2010). *Environmental Standards for Municipal Solid Waste Compost Facilities.* Department of Environment and Conservation, Government of Newfoundland and Labrador. Available at: <>. [Accessed: 15th May, 2013]

Rynk, R. et al. (1992). *On-Farm Composting HandBook*. Northeast Regional Agricultural Engineering Service. New York: USA. Available at: <http://watershedbmps.com/wp-content/uploads/2012/03/01744_FarmCompost.pdf>. [Accessed: 17th August, 2013]

Schlegelmilc, K., Meyer, E. & Ludewig, D. (2010). *Economic Instruments in the Waste Management Sector – Experience from OECD and Latin American Countries*. GIZ. Berlin: Germany. Available at: <http://www.giz.de/de/downloads/gtz2010-en-foes-economic-instruments-waste-management.pdf>. [Accessed: 11th October, 2013]

Sikka, P. (n.d.) *Energy from MSW RDF Pelletization- A Pilot Indian Plant.* Department of Science & Technology. Government of India: New Delhi. Available at: <http://www.environmental-expert.com/Files/0/articles/2080/2080.pdf>. [Accessed: 3rd July, 2013]

Statistical Data Analysis. (n.d.). Available at: < http://www.st-edmunds .cam.ac.uk /~kw 10004 /j/phd/chapter4.pdf >. [Accessed: 19th October, 2013]

Staudinger, J. & Keoleian, G. A. (2001). *Management of End-of-Life Vehicles (ELVs) in the US.* The Center for Sustainable Systems. Ann Arbor: Michingan. Available at: < http://css.snre.umich .edu/publication/management-end-life-vehicles-elvs-us >. [Accessed: 12th, September, 2013]

The Asian Foundation (2008). *Solid Waste Planning and Disposal – Service Delivery Training Module.* Sri Lanka Available at: <http://asiafoundation.org/resources/pdfs /08Solid Waste PlanningandDisposal.pdf>. [Accessed: 11th October 2013].

The World Bank (1999). *Decision Makers' Guide to Municipal Solid Waste Incineration.* Washington, DC: USA. *Available at:*<http://web.mit.edu/urbanupgrading/urbanenvironment /resources/references/pdfs/DecisionMakers.pdf>. [Accessed: 20th July, 2013]

Trezek, G.J et al. (1979). *Predication of the Impact of Screening on refuse- derived fuel quality.* Electric Power Research Institute; California. Available at:<>. [Accessed: 12th July, 2013]

UNEP (2009). *Developing Integrated Solid Waste Management Plan Training Manual– Volume 1: Waste Characterization and Quantification with Projection for Future, Training Manual.* Japan. Available at: <http://www.unep.or.jp/ietc/Publications/spc/ISWMPlan_Vol1.pdf>. [Accessed: 30th May, 2013]

UNEP (2009). *Developing Integrated Solid Waste Management Plan Training Manual – Volume 2: Assessment of Current Waste Management System and Gaps therein.* Japan. Available at: <http://www.unep.or.jp/ietc/Publications/spc/ISWMPlan_Vol2.pdf>. [Accessed: 30th May, 2013]

UNEP (2009). *Developing Integrated Solid Waste Management Plan Training Manual – Volume 3: Targets and Issues of Concern.* Japan. Available at:*< http://www. unep.or.jp/ietc /Publication s/ sp c/ISWMPlan_Vol3.pdf >.* [Accessed: 30th May, 2013]

UNEP (2009). *Development Integrated Solid Waste Management Plan Training Manual – Volume 4: ISWM Plan.* Japan. Available at:< http://www.unep .or.jp/ietc/Publications /spc/ISWM Plan _Vol4.pdf >. [Accessed: 30th May, 2013]

UNEP (2007). *E- waste Management Manual- Volume-II*. Available at:< http://www. unep.org /i etc/Portals/136/Publications/Waste%20Management/EWasteManual_Vol2.pdf >. [Accessed: 5th July, 2013]

UNEP (n.d.) *Sound Practices Composting.* Available at: < http://www.unep. or.jp/ietc/estdir/p ub/msw/sp/sp4/SP4_2.asp. >. [Accessed: 6th March, 2013]

UN ESCAP (2012). Operational Manual on Composting for Integrated Resource Recovery Centre. Available at: <http://waste2resource.org/wp-content/uploads/2014/02/Operational-Manual-on-Composting-for-IRRC_April-2012.pdf>. [Accessed: 12th December, 2013]

UN-HABITAT (2011). *Collection of Municipal Solid Waste- Key Issues for Decision-makers in Developing Countries.* Nairobi: Kenya. Available at: <http://waste.ccac-knowledge.net/sites /default/files/CCAC_images/documents/Un%20HABITAT%20-%20guidelines%20-%20Collect tion%20of%20MSW%20Key%20Issues%20for%20Decision%20Makers%20in%20Developin oping%20Countries.pdf>. [Accessed: 20th July, 2013]

US EPA (2000). *Bio- solids Technology Fact Sheet- In vessel composting of Bio solid.* Washington, DC: US. Available at:< http://water.epa.gov/scitech/wastetech/upload/ 2002_06_28mtb invessel.pdf>. [Accessed: 10 August 2013]

US EPA (1997). *Full Cost Accounting for Municipal Solid Waste Management: A Handbook.* Washington, DC: USA. Available at: <http://www.epa.gov/waste/conserve/tools/fca/docs/fca-hanb.pdf >. [Accessed: 10th October, 2013]

US EPA (1995). *Decision Maker's Guide to Solid Waste Management.* Available at: <http://www.epa.gov/osw/nonhaz/municipal/dmg2/>. [Accessed: 10th July, 2013]

US EPA (1994). *Composting of Yard Trimmings and Municipal Solid Waste.* New York: USA. Available at: < http://yosemite1.epa.gov /ee/epa/ria.nsf/vwAN/cytmsw.pdf/$file/cytmsw.pdf >. [Accessed: 10th June, 2013]

Urban Development Department (n.d.). *Policy on Integrated Solid Waste Management- Karnataka.* Available at: <http://www.uddkar.gov.in/SolidWasteManagement>. [Accessed: 10th October, 2013]

USDA (2000). Environment *Engineering National Engineering Hand Book.* Washington, DC: USA. Available at: <http://www.uvm.edu/~99kchene/Resources/NRCS_CompostingGuide.pdf>. [Accessed: 13th July, 2013]

Warith, M., Li, X & Jin, H. (2005). *Bioreactor Landfills: State of the Art Review*. Emirates Journal for Engineering Research, 10(1):1-14. Available at:< http://www.engg. uaeu.ac.ae/ejer/issues/ v10/pdf_iss1_10/p1_Warith.pdf >. [Accessed: 9th April, 2013]

Waste Minimization. (n.d.) Available at: **: <** http://www .dlist.org/sites/default / files /doclib /Module%206%20Initial%20Draft%20Waste%20Minimisation.pdf >.[Accessed: 21st March, 2013]

Water and Sanitation Program (2007). *Implementing Integrated Solid Waste Management Systems in India- Moving Towards the Regional Approach.* Available at: < http://www. wsp.org /sites/wsp.org/files/ publications/519200880608_SWM_dec_07.pdf >. [Accessed: 30th November, 2013].

Welsh, N., Schans, M. & Dethrasavong, C. (2005). *Monitoring and Evaluation System Manual.* Mekong Biodiversity Conservation and Sustainable Use Programme. Available at:< http://www .mekongwetlands.org/assets/programme/Systems/M&E%20manual.pdf >. [Accessed: 2nd September, 2013].

White, L. (2002). *Extended Producer Responsibility: Container Deposit Legislation Report.* Zero Waste New Zealand Trust; Auckland. Available at:< [04:15:28 AM] Ritu Thakur: http://www .zerowaste.co.nz /assets/ Reports/Beverage-containers.pdf >.[Accessed: 17th May, 2013]

Zafar, S. (n.d.) *Gasification of Municipal Solid Waste*. Available at:< http://www. altenergymag. com/emagazine.php?issue_number=09.06.01&article=zafar> [Accessed: 17th July, 2013]

Zhu, D. et.al. (2008). *Improving Solid Waste Management in India- A Sourcebook for Policy Makers and Practitioners.* The World Bank: Washington, DC. Available at:<http: //www. tn.gov.in /cma/ swm_in_india.pdf>. [Accessed: 24th July, 2013].

Annexures

List of Annexures

Annexure #	Title	Part II Chapter#
1	Formulation of Andhra Pradesh Integrated Municipal Solid Waste Management Strategy 2014.	Chapter 1
2	Notification to Create SWM and Health Wings to Implement MSWM Rules 2000 in All ULBs of Andhra Pradesh	Chapter 1
3	International Case Studies on Waste Minimization	Chapter 2
4	A Standard Operating Procedure for Windrow Composting	Chapter 3
5	Guidelines for The Selection of Site for Landfilling	Chapter 4
6	Municipal Solid Waste (Management and Handling) Rules 2000 and Draft Municipal Solid Waste (Management and Handling) Rules 2014	Chapter 7
7	The Plastic Waste (Management and Handling) Rules 2011	Chapter 7
8	The Bio- Medical Waste (Management and Handling) Rules 1998, Amended on 2003 and The Bio-Medical Waste (Management and Handling) Rules 2011	Chapter 7
9	The E- Waste (Management and Handling) Rules 2011.	Chapter 7
10	The Batteries (Management and Handling) Rules 2001, Amended on 2010.	Chapter 7
11	The Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008, Amended on 2009.	Chapter 7

Annexure 1

Formulation of Andhra Pradesh Integrated Municipal Solid Waste Management Strategy 2014

GOVERNMENT OF ANDHRA PRADESH

ABSTRACT

MA&UD Department – Municipal Solid Waste Management – Formulation of Andhra Pradesh Integrated Municipal Solid Waste Management Strategy 2014 approved - Orders – Issued.

MUNICIPAL ADMINISTRATION & URBAN DEVELOPMENT (H1) DEPARTMENT

G.O.Ms.No.64. **Dated: 13.02.2014.**

Read the following:-

From the Commissioner & Director of Municipal Administration Lr.Roc.No.26062/2013/H1, Dt. 03-02-2014.

****

ORDER:-

Solid Waste Management is one of the top priorities of the Government of Andhra Pradesh. For effective implementation of the Municipal solid Waste Management Rules, 2000 in all the Urban Local Bodies, it is felt that there is every need to formulate appropriate Solid Waste Management Strategy to guide the ULBs for effective handling Solid Waste. Accordingly, the Commissioner & Director of Municipal Administration has been instructed to formulate a draft strategy and submit the same to the Government.

2. Accordingly, after consultation with the relevant experts, the Commissioner & Director of Municipal Administration has submitted a draft Strategy on **Andhra Pradesh Integrated Municipal Solid Waste Management, 2014** for approval.

3. Government, after careful examination of the Andhra Pradesh Integrated Municipal Solid Waste Management Strategy 2014, hereby approve the same to enable Urban Local Bodies in the State to implement Municipal Solid Waste Rules, 2000 in letter and spirit by achieving the vision " and to equip the ULBs with efficient, environmentally friendly and sustainable waste management system with complete safe collection, transportation, treatment and disposal facilities and achieve the service benchmarks".

4. The approved strategy is herewith enclosed to this order as annexure. Further, Managing Director, Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC) Hyderabad is designated as the nodal agency for providing necessary financial services for effective implementation of the Strategy.

5. The Commissioner & Director of Municipal Administration is requested to take further necessary action in the matter.

(BY ORDER AND IN THE NAME OF THE GOVERNOR OF ANDHRA PRADESH)

Dr. S.K. JOSHI,
PRINCIPAL SECRETARY TO GOVERNMENT (UD)

To
The Commissioner & Director of Municipal Administration. Hyderabad,
Managing Director, Andhra Pradesh Urban Finance & Infrastructure Development Corporation (APUFIDC), Hyderabad
Copy to:
Director General & Special Chief Secretary to Government Environment Protection Training and Research Institute, 91/4, Gachibowli, Hyderabad
PS to Principal Secretary (MA) to Government MA&UD Department
The OSD to M(MA&UD)
SC/SF

//FORWARDED ::BY:: ORDER//

SECTION OFFICER

….2

ANNEXURE TO G.O.MS.No.64, MA &UD(H1) Dept., Dated: 13.02.2014.

1. Background

Municipalities have overall responsibility for Municipal Solid waste Management. However most of them are unable provide proper system to tackle the current situation. Magnitude and density of urban population in India is increasing rapidly and consequently the Municipal agencies spend about 5-25% of their budget on MSWM. Despite of such heavy expenditure, the present level of service in many urban areas is so low that there is a threat to the public health in particular and the environmental quality in general.

Collection and transportation activities constitute approximately 80–95% of the total budget of MSWM. Hence, it forms a key component in determining the economics of the entire MSWM system. On the contrary, disposal and treatment of waste is an underinvested area and open dumping, uncontrolled and poorly managed landfills are a common feature across most Indian cities and towns. The results pose a serious threat to the underground water reserves and surface water bodies through run –offs.

The challenges of municipal solid waste management range from insufficient capital expenditure, non-affordability to meet the O&M, lack of technical know-how, lack of public awareness, non-availability of land and fighting the opposition from the neighborhoods where the MSW facility is located

Managing the problem of solid waste in a more integrated and comprehensive manner, makes it imperative for the state government to set forth a strategy to address the different aspects of sanitation management related tackling solid waste in a systematic, coordinated and time-bound manner

Though the MSW Rules 2000 make the ULBs responsible for management of wastes, ULBs have to partner with private waste management companies, NGOs and RWAs for various segments of the MSW value chain due to various capacity constraints. In order to implement and comply with the MSW Rules 2000 and overcome capacity constraints at the local level, some states have come up with centralized waste management systems at the city level or regional level either on Non PPP or PPP approach. Centralized waste management systems at the city level are being practiced in Guwahati, Hyderabad and Chennai, among others. Regional level MSW management facilities have come up in Tamil Nadu and Gujarat

The need of the hour is to devise an efficient solid waste management system where in decision-makers and waste management planners can deal with the increase in complexity, and uncertainty. The Municipal Solid Waste (Management and Handling) Rules, 2000 (the 'MSW Rules'), issued by the Ministry of Environment and Forests, Government of India, under the Environment (Protection) Act, 1986, prescribe the manner in which the Authorities have to undertake collection, segregation, storage, transportation, processing and disposal of the municipal solid waste (the 'MSW') generated within their jurisdiction under their respective governing legislation.

In this context, there is need to revisit, develop, and implement appropriate strategy framework to guide the urban local bodies for effectively handling MSW in order to comply with the MSW (Management & Handling) Rules 2000 notified by the Ministry of Environment & Forest, Govt of India and related regulations. The framework will guide and support the urban local bodies in the state for managing the solid waste scientifically and cost effectively.

.....4

2. Municipal Solid Waste Management Scenario in India

The urban growth in India is faster than the average for the country and far higher for urban areas over rural. The proportion of population residing in urban areas has increased from 27.8 % in 2001 to 31.80 % in 2011 and likely to reach 50% by 2030. The number of towns has increased from 5,161 in 2001 to 7,935 in 2011. The rapid growth in urban areas has not been backed adequately with provisioning of basic sanitation infrastructure and thus leaving many Indian cities deficient in services as water supply, sewerage, storm water drainage, and solid waste management.

It is estimated that Urban India generates about 1.5 Lakhs Tonnes per day. The per capita waste generation in major cities ranges from 0.20 Kg to 0.6 Kg. Generally the collection efficiency ranges between 70 to 90% in major metro cities whereas in several smaller cities the collection efficiency is below 50%. The collection and disposal of municipal solid waste is one of the pressing problems of city life, which has assumed great importance in the recent past. Treatment of waste and scientific disposal of urban waste is not only absolutely necessary for the preservation and improvement of public health but it has an immense potential for resource recovery.

The composition of MSW at generation sources and collection points in India is observed to mainly consist of a large organic fraction (40–60%), ash and fine earth (30–40%), paper (3–6%) and plastic, glass and metals (each less than 1%). It is also estimated that the Urban Local Bodies spend about Rs.500 to Rs.1500 per tonne on solid waste for collection, transportation, treatment and disposal. About 60-70% of this amount is spent on street sweeping of waste collection, 20 to 30% on transportation and less than 5% on final disposal of waste, which shows that hardly any attention is given to scientific and safe disposal of waste. Landfill sites have not yet been identified by many municipalities and in several municipalities, the landfill sites have been exhausted and the respective local bodies do not have resources to acquire new land. Due to lack of disposal sites, even the collection efficiency gets affected.

Very few Urban Local Bodies in the country have prepared long term plans for effective Solid Waste Management in their respective cities. For obtaining a long term economic solution, planning of the system on long-term sustainable basis is very essential

As per the World Bank Statistics, incorporated by the High Powered Expert Committee in its Report on Indian Infrastructure and Services, the following is the report card on Solid Waste Management in Indian Cities:

- Primary collection – 38 per cent
- Segregation of recyclables – 33 per cent
- Street sweeping – 72 per cent
- Transportation – 52 per cent
- Processing – 9 per cent
- Disposal – 1 per cent

The Energy and Resources Institute (TERI) has estimated that by 2047, waste generation in Indian cities will increase five-fold to touch 260 million tonne per year (Asnani 2006). A study by the World Bank (2006) puts India's annual generation of municipal solid waste to be somewhat lower, i.e., in the range of 35 to 45 million tonne, amounting to about 100,000 to 120,000 metric tonne every day. It is also estimated that the annual increase in overall quantity of solid waste in India's cities will be at a rate of 5 % per annum.

The fact that a large part (over 60%) of India's waste is biodegradable, provides an opportunity for composting. While lifestyle changes, especially in the larger cities, are leading to increased use of packaging material, and per capita waste generation is increasing at about 1.3% per annum, the biodegradable component is still expected to be much higher than in industrialized countries.

....5

Even with **current levels** of highly inadequate service, solid waste management accounts for 25-50 % of a ULB's expenditure (World Bank2006), but cities recover less than 50 per cent of the O&M cost, according to a study by the Ministry of Urban Development, Government of India (2010b). The distribution of the expenditure is heavily loaded in favour of collection and transportation, and little attention is paid to processing and scientific disposal of the waste.

3. Current Status of SWM in ULBs of Andhra Pradesh

Urban Population in Andhra Pradesh is growing at 33.49% compared to the Country's 31.16%, in 2011. As per 2011 Census, total Population of Andhra Pradesh, which is 8.46 Crore, 2.8 Crore live in Cities and Towns. The overall decadal growth rate of Urban population in the State is 36.26 percent as compared to the 14.93 in 2001 and as against India's 31.80 percent as per the 2011 census. The total census town have increased from 210(2001) to 353(2011) with more than eight (8) districts have witnessed a growth of more than 50 % in its urban population. The urban population in Andhra Pradesh is projected to increase to 45.5 million or 4.55 Crores by the year 2030 constituting 46 percent of total population. Including GHMC, there are about 182 ULBs comprising of 19 Corporations, 113 Municipalities (of all grades), 50 Nagar panchayaths. The Class-1 towns in state have increased from 39 (2001) to 46 (2011).

The ULBs in the Andhra Pradesh state on an average generates about 9754 MT of wastes per day and in terms of the per capita of waste generation in the ULBs ranges from 0.2-0.4 kg/per day. The quantities of waste are growing 5% annually with the increasing per capita generation and change in living standards especially in the class-1 cities. Therefore, there is need to enhance waste management and handling capacity. ULBs in state spend around Rs. 500 - 1500 per tonne/day being paid from Municipal budget. Of which, 60-70% on collection alone, 20-30% on transportation, Less than 10% or less on Processing and Disposal activities. Low investments with majority of the ULBs lack proper treatment and disposal facility. The NUSP rating of the class-1 cities in state in 2009 indicates have poorly rated the cities and have recommended for immediate need for improvement in sanitation situation.

Government of Andhra Pradesh has taken a proactive interest in encouraging ULBs in the state to comply with the MSW rules 2000 and has spent entire allocation of 374 Crores under the 12th Finance Commission grants for development of the solid waste infrastructure and services. The mission mode program was conceptionalized and implemented with the support and involvement of the community based organizations. Despite of the efforts, the success has been limited to primary collection and transportation but a great deal is still to be achieved to comply with the MSW Rules in totality especially in relation to the treatment and disposal of waste.

Andhra Pradesh is one of the fore-runner in initiating 'Regional Cluster Based approach' for the MSW based Integrated Waste to Energy plants on PPP basis by grouping the then 124 ULBs into 19 clusters in the year 2004., however, the results have not delivered performance as anticipated. Presently, only one WTE plant is running its operations and the quantity of waste that has been actually processed in the plant is not monitored. The main reasons were over estimation of revenues, lack of viable business models and the inability to raise the required funds by the WTE plant developer and may not be attributed to the very concept of 'Regional MSW Facility. In addition to this, independent WTE plants stared of in Vijayawada and Hyderabad have closed their operations due to the technical reasons.

Apart from this, a very few smaller ULBs in the state have attempted the composting, vermin- composting plants for processing of organic waste in smaller scale through involvement of NGOs and CBO's have seen some degree of success but the same have failed due to lack of sustained interest. The key issues associated with composting are lack of segregation, marketing and quality of the compost. Moreover, till now no city across all class of cities in the state has set up

....6

the scientific landfill expect the cities OF Hyderabad, Vishakapatanam & Vijayawada where the developed the landfill under JNNURM are under process.

4. Approaches for Solid Waste Management

4.1. Decentralized vs. Centralized approach

MSW Management project can be centralized or decentralized waste management system depending upon the profile of the locality in terms of composition of waste, availability of land for processing waste, market linkages, health risks and extent of in formalization of the waste management system.

Centralized PPP models are suitable for urban areas where significant economies of scale are possible and the composition of waste allows for greater extraction of value from the waste through technological solutions. Health hazards due to inefficient waste disposal and non-availability of land in close proximity of localities are other two important factors to be considered while choosing a centralized waste management system. Centralized waste management systems at the city level are being practiced in Guwahati, Hyderabad and Chennai, among others. Regional level MSW management facilities have come up in Tamil Nadu and Gujarat.

The decentralized method of managing a city's waste involves management of municipal waste by various small waste management centers within the locality. This allows PPPs at the unit level where micro-entrepreneurs can work with the ULBs to produce compost or other value added products from the waste and the ULBs either on its own or through a bigger private partner manages the collection of refuse and maintenance of landfill sites. .

Decentralized process of collection and processing of wastes, avoids the carting of wastes too far off dumping sites. It reduces the expenditure of imported diesel, consequent traffic congestions, air pollution and road maintenance costs. It also reduces the contamination of ground water through the seepage of leachate. Cities like Namakkal and Trivandrum, among others, have engaged SHGs and NGOs for (decentralized) management of waste.

4.2. Management of Multiple Solid Waste streams

Municipal Solid Waste consists of Household Waste, Construction and Demolition Debris, Horticulture, and Waste from Streets. Municipal Solid Waste to be segregated into groups of bio –degrables , recyclables and hazardous waste. Bio-degradables like organic waste from kitchen, market and abattoir to be converted into rich organic manure or energy. Plastics, papers, glass; metals are to be recycled into new products. The construction & demolition waste to be used as landfill cover. "Segregation" shall remain to be centric approach solution. These further creates an opportunity to order the sequence of collection and processing of waste – for instance - vegetable market waste which is high on organic content can be collected and processed on a daily basis and on a decentralized model with the facilities being set up at the markets itself or at centralized processing unit. In case of recyclables or dry wastes, segregation by sorting them further into plastics, paper, metal, glass, and fuel (coco nut shells) and rubber. Bio-medical, hazardous and e -Waste to be managed by concerned authorities as per the existing legislations. The road sweepings, construction and demolition and the horticulture debris are to be collected separately and processed with. The non-recyclable waste components and inert would finally to be dispose off into scientifically designed sanitary landfills.

.....7

4.3. Hierarchy of Waste Management – 5Rs (Reduce, Reuse, Recycle, Recover and Remove)

The framework proposes to have a multipronged approach that includes the 5Rs principle Reduce, Reuse, Recycle, Recover and Remove.

The first choice of measures in waste management, is avoidance and waste reduction. This step aims for goods to be designed in a manner that minimises their waste components. Also, the reduction of the quantity and toxicity of waste generated during the production process is important

Re-using an article removes it from the waste stream for use in a similar or different purpose without changing its form or properties. The recycling of waste, which involves separating articles from the waste stream and processing them as products or raw materials. This approach seeks to recycle a product when it reaches the end of its life span.

Recycling is process of transforming materials into secondary resources for manufacturing new products. Promotion of waste recycling sector and providing that with an institutional support can and motivating all the stakeholders to segregate at source of generation

Recovery involves reclaiming particular components or materials, or using the waste as a fuel. Material recovery involves a variety of mechanical or biological processes that remove a variety of materials from the waste stream.

Remove refers to residuals management or the management of materials which remain after the previous 4Rs have been applied.The last step of the waste management whern the quantity of waste cannot be reduced during production, the purpose of implementing the waste management hierarchy is to use waste as a resource and divert these potential resources from dumpsites / landfill.

5. Vision:

The Municipal and Urban Development Department, Government of Andhra Pradesh, have initiated several Institutional reforms, like establishment of AP Solid Waste Management Board under the Chairmanship of Honorable Chief Minister, State Level Official Committee and Expert Committee to address the issues relating to Solid Waste Management in ULBs of Andhra Pradesh. The entire 12th Finance Commission Grants of around 375 Crores were earmarked to Solid Waste Management which is unique in the Country has been effectively utilized in strengthening the SWM infrastructure and service delivery. 'Cheta Pai Kotha Samaram' – 'New War on Waste' was program based initiative launched on state wide scale has successful in creating participatory based innovative approaches. Under the 13th Finance Commission Utilization of grants, Integrated SWM has been included as one of the admissible components for utilization of grants by ULBs for improvement of Urban Services.

The Department has regularly conducted workshops, seminars and meetings involving Municipal Functionaries, other related Departments, Civic Societies, and institutions partnering in technical matters such as GIZ, ASCI based on which, the following vision has been formulated:

"to equip the AP cities with efficient, environmentally friendly and sustainable waste management system with complete safe collection, transportation, treatment & disposal facilities and achieve the service benchmarks "

....8

5.1. Goals and Service outcomes

The overall goal is to ensure 100% compliance to the MSW (Management and Handling) Rules 2000 and related legislations w.r.t to municipal solid waste in all the cities and towns through multi stakeholder partnership approach. The specific goals are:

- 100% Door to Door collection and Source Segregation
- Efficient collection and safe transportation of wastes generated in the cities
- 100% treatment and scientific disposal facility & cost recovery
- Better awareness among the urban population and community mobilization participation
- Capacity Enhancement and Optimization of the human resources in SWM
- Strengthen the existing bye-laws for better regulation and user charges
- Encourage PPP in developing integrated treatment and treatment on Regional approach

6. Key Issues of Solid Waste Management

- ULBs lack resources, systems and capacity for development of treatment and disposal of solid waste
- Lack of substantial capital and O&M expenses without corresponding and matching revenues
- Lack of support in financial, technical and project development at state level to ULBs in identifying right technologies, processes, structuring projects and implementation. The role of the technical and advisory agencies like the APPCB, NREDCAP APTDC and PPP cell, APIA has been limited.
- Lack of awareness about the importance of good SWM practices especially about waste segregation
- Lack of policy framework in operationalizing PPP in MSWM and contract competence
- Not in my backyard (NIMBY) phenomenon, land acquisition is major issue in SWM projects and is a major cause of delay; especially in processing & landfill facilities
- Lack of technical expertise and institutional arrangements
- Inadequate equipment and inappropriate technology choices
- Lack of willingness to charge user fees provisions in Municipal Acts for levy of user charges
- Lack of Capacity in ULBs with reference to the processing technologies and scientific landfills even after a decade.

6.1. Guiding Principles of the SWM Strategy

- Defining the roles and responsibilities of various stakeholders and putting in place an operating framework

....9

- ❖ Greater emphasis on civic engagement by involving NGOs, women community groups, Ward Committees/Sabhas, Area Sabhas, etc., in awareness generation
- ❖ Establishing Institutional mechanism at State Level for planning, technical, financial and implementation support
- ❖ Promoting PPP investments for developing treatment and final disposal facilities on Regional level on Cluster based approach

7. Strategic Interventions

The proposed Strategy employs the six main elements

1. Door to Door Collection of Waste generated
2. Waste minimization and promotion of recycling of waste
3. Engaging stakeholders in implementation
4. Processing, Treatment and Disposal of Waste
5. Strengthening the capacities of the ULBs
6. State Level Institutional arrangements & Program support

7. 1. Door to Door Collection and Transportation of Waste generated

1. Organizing door-to-door collection of waste to be the irreversible strategic approach to prevent residents from dumping their garbage out. The waste collected from door-to-door should be source segregated and collected separately in wet and dry waste from all sources. Community level large and unsightly garbage bins to be withdrawn from streets and ' Litter Bins' to be limited to busy commercial areas and public places.

2. ULBs to encourage decentralized, community-managed primary collection system preferably managed by CBOs such as residents' associations, and welfare societies and Slum Level Federations that will be financially assisted and equipped for the purpose.

3. Route mapping of door to door collection activities on City Wide Scale for improved coverage. Primary vehicles to be used to collect and transport waste from lanes and by- lanes to the main roads synchronizing with bulk transportation vehicles.
4. The waste should be transported in a segregated form (wet and dry) by vehicles, at the primary collection and secondary/ bulk collection systems.

5. Waste to be handled mechanically across the MSW value chain with minimum human contact with waste. Modernize fleet management services with covered transportation system to be adopted for transportation of the waste.

7.2. Waste minimization and promotion of recycling of waste

1. Municipal Solid waste to be managed in accordance with the 5R Principle(Reduce, Reuse, Recycle, Recover and Remove) with special emphasis on waste prevention approaches.

2. Promotion of biodegradable and recyclable substitutes for non-biodegradable materials like plastics and develop systems for their recycle, reuse, through promotion of relevant technologies, and use of incentive based instrument, and developing and implementation of measures for reduce and remove of non-biodegradables through participatory approaches.

....10

3. Municipal Solid Waste to be segregated at source into groups of organic, inorganic, recyclables and hazardous waste. MSWM constituents like metal, plastics, glass and paper wastes are to be segregated and recycled. Each ULB to identify land to establish Dry Waste Sorting facilities (Material Recovery Facilities) wherever possible through social entrepreneurs, common interest groups of informal sector like rag pickers associations and cooperatives in lines with Swach, Pune, CBOs like Women Self Help Groups(SHGs),Slum Level Federations(SLFs), Apartment Societies, Resident Welfare Associations (RWA) and NGOs to be involved.

4. Encourage individual households/ apartment complexes for setting 'source composting options' like vermin composting/ composting at households level, portable new age small scale bio gas units for kitchen waste, and Small scale decentralized units for treating of organic waste fraction to the places like community level, large hotels, marriage halls, hostels, organized colonies and slums having strong RWAs and SLFs respectively.

5. ULBs to set up community-based composting yards on suitable road-side locations, institutional campuses and public parks for horticulture waste or leaf litter and encourage interested sweeper groups, apartment societies, resident welfare associations or CBOs to maintain them and use the proceeds from the sale of manure produced by them.

6. Phasing out and upgrading old open dumps in the ULBs and reclamation of the dumpsites through recovery of the decomposed matter through 'Bio- mining' and capping of the non-bio degradables in scientific manner as per the MSW (Management& Handling)Rules 2000 .

7. Landfill sites to be used sparingly and only as a last resort in waste management hierarchy and shall not exceed 20% of the total municipal solid waste generated. Organic material and recyclables to be recovered fully prior to land filling of only inerts.

7.3. Engaging stakeholders in implementation

1. Encourage sound contracting practice begins with setting operational goals, defining performance or service benchmark standards and specifications and producing a document that communicates these to private, semi-private, NGO, CBO or other economic actors who would like to participate as service providers.

2. Awareness among stakeholders on SWM is important and continuous process. There need to intensify extension activities so as to continuously motivate and educate the stakeholders through effective IEC programs. ULBs to raise the awareness of city stakeholders through regular meetings with (households, establishments, industries, elected representatives municipal functionaries, media, etc) since improved sanitation can ensure improved public health and environmental outcomes only if considerable changes in behavior and practice take place across the spectrum of the society.

3. ULBs to adapt mechanism for enforcement, supervision and monitoring the Pin Point System for optimum utilization of manpower resources through social audit mechanisms. The Pin Point System implementation shall involve the Resident Welfare Associations, Community Based Organization and other stakeholders in the process of monitoring of SWM services for improved accountability.

4. ULBs may formulate strategy to organize and strengthen CSOs (Civil Society Organizations-RWAs) in Non Slum Areas for effective democratic and participatory functioning devising methodologies on the lines of CBOs like SHGs/SLF/TLF in the Slum Areas to ensure Community participation and ownership of Solid Waste Management on sustainable mode.

....11

5. ULBs to disseminate relevant information on waste quantities and characteristics; waste treatment, recovery and disposal; the costs of providing the waste management services; the sources of funding used to finance the services in public domain. Publication of reports on Annual report of the Service Levels.
6. ULBs to constitute City Sanitation Task Force involving the stakeholders in Planning, Implementation and Monitoring of the City Sanitation Plans.

7.4. Processing, Treatment and Disposal of Waste:

1. ULBs to adopt a mix of multiple of options of centralized (city & regional level) and decentralized options for treatment and scientific disposal.

2. Waste treatment and disposal may need to be organized on a unified basis across the metropolitan areas as a whole, landfills and other waste management facilities to be regionally shared, clubbing of multiple municipalities and creation of clusters, accompanied by regional cooperation and fair cost-sharing arrangements.

3. Decentralized processing units at community level and city level in case of municipalities considering the quantities of waste generated, economics of clustering them into regional facilities.

4. Development of State level MSWM project for operationalizing and scaling up the strategy covering either the PPP and Non PPP approaches or combination of both in all the ULBs in the state. The Collection, Transportation components to be implemented on Non PPP approach as ULBs have the required experience and expertise whereas PPP approach may be confined to for setting up of transfer stations, Processing and Landfill projects. In case of outgrowths, expanded areas, and agglomerations the Integrated SWM PPP based approach for the entire MSWM value chain operations may be adopted with highest level of transparency.

5. Treatment of segregated waste to be done through appropriate technologies based on the feasibility, characteristics and quantities of waste. The technology options could be Composting, Biomethanation, Waste to Energy, RDF, Co-Processing of dry segregated rejects in cement/ power plants, which also includes utilization of construction and demolition debris and any other options as endorsed by the Central Pollution Control Board.
6. Treatment and Scientific disposal is net cost based and recovery of O&M cost is technology dependent. Tipping / Processing Fee is the mechanism to compensate the in PPP projects developed for treatment and disposal.

7.5. Strengthening the capacities of the ULBs

1. State Government to guide ULBs to draft model byelaws and legislations to facilitate levying user charges, penalties for violators and explore revenue options like revenues from sale of waste and by products, CDMs, SWM Cess, Landfill tax or Processing fee etc., to achieve financial sustainability.
2. Set out operational guidelines for the procurement of equipment and services based on the size of the town and population. Emphasis to mechanization for segregated collection, segregated transportation, processing, treatment and scientific disposal to reduce the manual and multiple handling of garbage.

.....12

3. Provide incentives and market linkages for the byproducts like compost and other recyclables. Ex. Creation of market avenues through involvement of the Department of Agriculture, Horticulture, Forests and Fertilizer companies as well as other agencies in the farm sector to ensure effective marketing of the compost as well as its by-products.

4. MSWM plan as part of the City Sanitation Plan and City Development Plan to cover the baseline data assessment, current practices, gaps in terms of manpower and infrastructure, existing facilities of treatment & disposal, current revenue and expenditure.

5. In compliance to the State Sanitation Strategy and National Urban Sanitation Policy (NUSP) all the ULBs in the State to prepare the City Sanitation Plan for addressing the issues short, medium and long terms actions in addressing the issues.

6. Data on quantities of waste generated is inconsistent in the ULBs. All the Class-1 cities in the state shall establish weigh bridge facilities for quantifying the solid waste generated in the city on daily basis prior to its treatment and disposal.

7. Formulate and implement state and ULB level capacity building programs on SWM topics based on contract management & monitoring, environmental compliance and complaint redressal& monitoring systems including attitude and behavior change and creation of platforms for field based interactive learning and exposure visits.

8. Formulate and implement state and ULB level for capacity building programs to the field staff, supervisory staff, contract employees, officers, civil society organizations, Community Based Organizations, on SWM topics based on the responsibilities including attitude and behavior change and creation of platforms for field based interactive learning and exposure visits.

9. ULBs to provide adequate protection and health care facilities to its workers. The local body, as a policy, should provide adequate protective clothing and health check up from time to time to the staff to ensure that their health is not adversely affected on account of their handling of solid waste. Free medical services and insurance to be made available to those whose health is affected on account of handling solid waste

10. Strengthen the institutional capacities of the ULBs as per the size of the ULB. The ULBs to have dedicated technical staff within the SWM department (Environmental Engineer) who should be responsible for the SWM activities within the city.

7.6. State Level Institutional Arrangements & Program support

1. Recognize and establish Regional MSW Project approach in case of smaller ULBs, Metropolitan Level Approach for integrated treatment and disposal of MSW and reorganize the existing clusters more comprehensively.

2. State to designate a nodal agency as company or state-level utility (which may be called the '**State MSW Management Company Limited/Utility'—the 'Company/Utility**') for the purposes of identifying and enabling the development of **Regional MSW Projects** within the state. Each such project should be of 300 TPD of MSW or more.

.....13

3. Setting up a Technical Cell with experts to extend support to the ULBs. The Technical cell would support in identifying sites for processing, treatment and landfill facilities (both individual and regional), PPP models, technologies, structuring and financing of projects including implementation and monitoring of the Mechanical Composting, Waste to Energy and Bio- Methanization, Co-Processing in cement/ power Projects.

4. State Level Sanitation Committee set up to review the progress of MSW management in ULBs across the state on regular basis and provide necessary advice in upscaling.

5. State to appoint an empowered committee for speedy and justified recommendations under "Andhra Pradesh Land Management Act 2013" for allotment of Government land for treatment and disposal of waste free of cost or on nominal lease rental basis for setting up treatment plants and sanitary landfill sites in land use plans keeping in mind requirements for the next 33 years and fast tracking the process under the provision of the Act.

6. Encourage ULBs to perform better in all aspects of planning, coordination, and implementation, the state government to institute an annual awards scheme to the best performing towns to create a competitive spirit among cities in AP.

Dr. S.K. JOSHI,
PRINCIPAL SECRETARY TO GOVERNMENT (UD)

SECTION OFFICER.

Annexure 2

Notification to Create SWM and Health Wings to Implement MSWM Rules 2000 in All ULBs of Andhra Pradesh

GOVERNMENT OF ANDHRA PRADESH
MUNICIPAL ADMINISTRATION & URBAN DEVELOPMENT DEPARTMENT

O/o Commissioner & Director of
Municipal Administration,
A.P., Hyderabad.

CIRCULAR

Roc.No.10414/2013/H1 **Dated:03-06-2013**

Sub: MA&UD – Implementation of MSWM Rules, 2000 in all ULBs – Creation of SWM and Health Wing In ULBs for more focused and effective implementation – Certain Instructions issued – Reg.

Ref:- 1) Municipal Solid Waste Management Rules 2000.
2) G.O.Ms.No.659 MA&UD (UBS) Dept., dated:17-11-2009 (Manual of Role and Responsibilities of various functionaries in ULBs in A.P)
3) G.O.Ms.No.151 Finance (SMPC-I) Dept., dt.18.07.2011.
4) G.O.Ms.No.125 Finance (SMPC-I) Dept., Dt.27.05.2013.

All the Municipal Commissioners (except the Commissioner, GHMC, Hyderabad) and all the Regional Director-cum-Appellate Commissioners of Municipal Administration in the State are aware that the Municipal Solid Waste Management is the top most priority item for the State for protecting Public Health and environment. Several initiatives have been taken in this regard both at the Departmental and the filed level for ensuring effective implementation of MSWM Rules 2000 in may of the Urban Local Bodies.

2. In the reference first cited, the Government have issued rules under the Municipal Solid Waste (Management and handling) Rules 2000, While following the said rules, considerable progress has been achieved in certain key SWM indicators. All the SWM activities need to be in a way ring fenced, within the Urban Local Body, to lend more focus on SWM activities and evolve a programmatic and targeted approach towards achieving and sustaining 100% compliance with MSWM Rules, 2000. One such issue, which has been identified for firming up and streamlining towards this direction with a target is clearly demarcating the Health and SWM Functionaries and their responsibilities in a clear cut manner at the ULBs. The ULB should define the role under the new solid waste and Resource Management wing and fix accountabilities accordingly.

3. In the reference 3rd cited Government have sanctioned the posts of Environment Engineers in different categories as follows:

a)	Executive Engineer Cadre	-	04
b)	Deputy Executive Engineer Cadre	-	28
c)	Assistant Engineer / Assistant Executive Engineer	-	89
	Total :		121

In the G.O. 4th cited Government have sanctioned (37) numbers of Environment Engineers in the cadre of Assistant Engineer / Assistant Executive Engineer (Grade-III).

4. Accordingly, the Engineer-in-Chief (PH) Hyderabad have posted 20 Environment Engineers in the cadre of Deputy Executive Engineer in 20 ULB's, in his proceedings number 111,222,666,333,444/CSZ/2013, dt.04.04.2013. Action is being taken to fill up all other sanctioned posts of Environment Engineers in ULBs by the ENC (PH) in due course

5. In the reference second cited (copy enclosed), the Government have issued orders in respect of the Manual of Role and Responsibilities of various Functionaries in ULBs in Andhra Pradesh. As per the said orders, *"the Public Health wing can be divided into (i) Health and (ii) Solid Waste and Resource Management (SMW). While MHO takes care of Health activities, Environmental Engineers will takes care of ISWM chain by action them wherever this post is sanctioned. In the absence of Environmental Engineer, both the activities will be looked after by MHO" (Para 6-4 of page no.35 of the Manual) of Role and Responsibilities of various functionaries in ULBs in A.P.,*

6. Therefore, all the Municipal Commissioners of Urban Local Bodies in the state are hereby instructed to follow the above manual scrupulously and form clearly Health and Solid Waste Management (SWM) Wings in their respective ULBs duly entrusting responsibilities to health wing as shown hereunder, and report back by 20.06.2013.

Sl. No.	Health Wing	Sl. No.	SWM Wing.
1	Registration of Birth & Death	1	Sweeping & Cleaning of roads & drains
2	Urban Health Centres	2	Source Segregation of waste
3	Municipal dispensaries	3	Mandatory Door to Door collection of Waste
4	Vector Control activities	4	Bulk / Commercial waste collection
5	Vaccination activities	5	Ward-wise route mapping & Manpower Allocation
6	Mass Drug Administration	6	Primary & Secondary Transportation
7	Family Planning	7	Wet & Dry Resource and improvement Processing centre.
8	Dog, Monkey, Pig menace etc.,	8	Market Tie-ups for sale of Compost, Dry Recyclables and non recyclables.
9	Fairs & Festivals	9	Establishment of Green belt in Compost yard
10	Heath Awareness in Slum areas	10	Reclamation of old Dump-sites
11	VIP Visits	11	Vehicles & Tools maintenance (Preventive & Breakdown)
12	He / She has to ensure that appropriate action is taken for prevention and control of communicable diseases namely G.E. cases, JE. Cases and Malaria	12	Setting up of material recovery facilities and any other Establishment of all infrastructure related to SWM
13	To inspect markets, hotels, restaurants, boarding and lodging houses, cafes and bars and	13	Establishment of Bio-methanization, Waste to Energy units.

	licensable places, factories, cinema theatres educational institutions, hostels and cattle yards, and ensure that the said establishments comply with P.H. regulations and sanitary requirements.		
14.	Intensive and regular awareness building.	14	Intensive and regular awareness building.
15	He / She has to ensure proper implementation of AP (Andhra Pradesh) Public Health Act.	15	Penality measures for violation of rules and littering vigilance squared / officer.
16	He / She has to ensure proper implementation of Prevention of Food Adulteration Act,	16	To inspect frequently slum areas and hutting ground, all backward areas and places where night soil and garbage are deposited to ensure their proper cleaning and maintenance of proper sanitation
17	He / She has to ensure proper implementation of Registration of Births and Deaths Act.,	17	Infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid wastes (MSW)
18	To implement Registration of Marriages Act.,	18	Apply for grant of authorization for setting up of waste processing and disposal facilities including landfills from the state board or committee.
19	To inspect places where dangerous & offensive trades are carried on to ensure that public health regulations and sanitary requirements are complied with	19	Notify the waste collection and segregation schedule to the generators of these wastes, to help them comply.
20	To inspect all dispensaries, maternity centers under the control of the municipality to ensure that they function properly.	20	Organize awareness programmes with citizens to promote re-use recycling of segregated materials and community participation in waste segregation.
21	To inspect all slaughter houses regularly to ensure that they are functioning satisfactorily.	21	Write an annual report and submit to higher authorities.
22	To cause statutory action to be taken against offences affecting public health.	22	To ensure prompt supply of uniforms, footwear, soaps and coconut oil to public health workers.
23	To cause such action to be taken as may be necessary for control of stray animals and elimination of dogs affected by rabies etc.,	23	Inspection of community toilets and ensure proper maintenance
24	To take such steps as are necessary about education and propaganda in respect of public health matters.	24	Any other duties entrusted by EE/SE/CE/ Commissioner
25	To plan and monitor the execution of anit-larval, anti-adult (mosquito) measures to control malaria.		

26	To issue trade licenses in consultation with Town Planning section with reference to land use / permitted use of building		
27	To take action on unauthorized trades		
28	To ensure implementation of Citizen Charter pertaining to Health wing.		
29	All other responsibilities as per relevant Acts and the Rules issued there under.		
30	Any other duties entrusted by the CMO / Commissioner		
31	Closer of toilets connections into the Drains.		

7. Further, all the Municipal Commissioners of Urban Local Bodies in the State are instructed to take immediate action for formation of Health Wing and SWM Wing in their ULB and the allocation of workers and supervisory staff to both the wings as per the need. All the RDMA's and M.Cs are instructed that no further outsourcing of SWM and Health Wing activities shall be taken up on account demarcation of work between Health and SWM wings.

8. All the RDMAs in the state hereby instructed to follow up on the above instructions issued and ensure that they are implemented by all the ULBs under their jurisdiction. They are also instructed to complete this exercise of formation of Health Wing and SWM wing separately as required under orders of Government, issued vide G.O.Ms.No.659 MA&UD (UBS) Dept., dt.17.11.2009 by 15.06.2013 positively and furnish a consolidated report by 20.06.2013.

Encl : As above.

Sd/- Dr.B.Janardhan Reddy
COMMISSIONER & DIRECTOR.

To,
All the Municipal Commissioner of ULBs in the State (except GHMC) (through the RDMAs concerned).
All the Regional Director-cum-Appellate Commissioners in the State.
All Special Officers.
Copy submitted to the Principal Secretary (UD) to Government, MA&UD Department, AP, Hyderabad for favour of information.
Copy submitted to the Principal Secretary (MA) to Government, MA&UD Department, AP., Hyderabad for favour of information.
Copy to the ENC (PH) with a request to fill remaining posts.
Copy to the Director of Health.
Copy to All District Collectors in the State.

for Commissioner & Director

Annexure 3

International Case Studies on Waste Minimization

International Case Studies on Waste Minimization

1) The Malmesbury Landfill Contract, South Africa

The Malmesbury landfill operation is outsourced to a private operator. What makes it different from other contracts though is that this service agreement is NOT based on the permission to operate for a certain amount of years but that the duration of the contract is in fact directly linked to the remaining airspace. As long as there is still airspace on this landfill the private operator is allowed to run it.

Interestingly when the agreement was made initially Council expected the landfill to last not much more than 5 years. To date the contractor has run this landfill for more than 11 years in total and is still running. Apart from higher compacting rate and deeper excavation he started a Material Recovery Facility onsite incoming rubbish is sorted through. Despite the fact that the waste received is a total mix of wet waste and the potential recyclables, 28% of the waste is recovered.

2) The Yellow Bag Household Recycling Project (City of Cape Town)

The Yellow Bag household waste recovery and recycling programme was implemented in August 2002 in the Marina Da Gama area in more than a thousand pilot households predominantly high to medium-high income) and is still continuing to date. A first of its kind, this post consumer waste recovery model is constantly being monitored and modified to optimize the recovery rates of recyclables while reducing the operational costs of the project. It is a pilot project that seeks to explore practical ways and develop strategies aimed at waste reduction to landfill. At the time of the implementation of the pilot programme in 2002 Cape Town faced a situation of generating annually about 1.6 million tons with a remaining landfill lifespan of about 8 years left. At the date of writing, local waste volumes generated have ballooned to nearly 2.2 million tons annually with only about 6 years of landfill airspace left.

The basic operational principle that has remained unchanged throughout the last two years of running the Yellow Bag project has been the post consumer separation of recyclables (all valuable packaging waste materials including paper, cardboard, glass, plastics, tins etc) from normal rubbish and placing it in a yellow bag provided to the participating households free of charge. Since its inception the project has undergone various characteristic phases of operational and management changes. This was done by the City in order to explore various technical and logistical options related to the collection, transport and utilisation of Yellow Bag waste materials in order to optimize the household waste separation process and make it financially more viable for a possible further rollout to other areas.

3) In-House Source Reduction, Wisconsin, USA

Dunn County, Wisconsin (pop. 35,909) set a goal to reduce the quantity of waste generated by government offices by 15% over a one-year period, and to reduce county-wide waste generation by 5%. The county met all of its goals, thanks to the success of offices like the County Health Care Center which reduced its waste generation by 18% and saved thousands of dollars in the process.

4) Economic Incentive or Policy Ordinance, New York, USA

Tompkins County, New York (pop. 94,000) instituted a "trash tag," or "pay-as-youth row" program that requires residents to purchase a tag for each container of garbage set out. The program creates an economic incentive for residents to reducetheir household waste, and adopts alternatives such as recycling and backyard composting. Soon after the program was implemented, the county noted an increase in residential recycling, and some Tompkins County municipalities reported up to 50% less trash set out at the curb.[1]

5) Education Programs for Residents, San Francisco, USA

The San Francisco, California Bay Area (pop. 6.5 million) conducted the Shop Smart: Save Resources and Prevent Waste campaign, a unique public-private partnership ,with 103 cities and counties working with 225 supermarkets to educate shoppers about the importance of waste prevention and buying products made with recycled content. Exit polls showed that 43% of shoppers remembered one or more elements from the campaign, with almost 30% saying it affected their buying habits.

6) Materials Exchange/Reuse Operations, New York, USA

New York City, New York (pop. 7 million) is home to Materials for the Arts, a program of the city's Department of Sanitation and Department of Cultural Affairs. The program's goal is to divert usable office equipment and supplies, furniture, construction materials, industrial by-products, paint, fabric and more from the landfill. The material is used by more than 1,300 cultural organizations, community, health and social services with art programs.

7) A PPP around Waste Minimisation in Hong Kong

The Wastewi$e Scheme encourages the private sector to initiate waste reduction activities. A working group comprising representatives from various industries, schools, hospitals, Government departments and the EPD *(Environment Protection Department)* has been formed to assist members and encourage more companies to join the scheme. About 430 organisations have applied to join the scheme and are receiving free assessments of their waste generation and waste reduction efforts. These assessments are carried out twice a year at each organisation by an EPD-appointed Advisor.

Participants who have made exceptional progress in reducing their waste are awarded Wastewi$e logos. So far 41 organisations have received the logos. The recipients collectively avoided the consumption of about 120 tonnes of paper and recycled 28,000 tonnes of paper, 400 tonnes of aluminium cans (most of this was on Housing Authority housing estates) and 1,000 tonnes of other metal scraps. They also purchased 160 tonnes of recycled paper and 900 refilled toner cartridges.

Universities and Tertiary Institutes

Waste recovery and recycling programmes have been set up at all 33 of Hong Kong's universities and tertiary institutes, under programmes organised with the support of the Environmental Protection Department (EPD) and the Environmental Campaign Committee (ECC). These

[1] It is important to support such initiatives through municipal bye-laws

programmes are fully backed by the presidents or vice-chancellors of the institutions. The programmes were the initiatives of working groups that were set up by the EPD in recent years and include members from all universities and tertiary institutes. The EPD and ECC have also jointly organised Waste Recycling Schemes and outreach programmes for working group members. The members are: the eight universities, Hong Kong Institute of Education, Hong Kong Academy for Performing Arts, Shue Yan College, Chu Hai College, the 17 Institutes of Vocational Education, and four training centres from the Construction Industry Training Authority.

Hotels, Hostels and Recreation Clubs

Hotels can produce large amounts of waste and the EPD and Hong Kong Hotels Association have been working together since 1997 to reduce this problem. The initiatives include tangible waste recovery programmes and awareness-raising efforts.

Some 43 hotels have joined a plastic bottle recovery programme, resulting in the collection of five to seven tonnes of plastic bottles per month. A programme to collect textiles for recycling has resulted in one tonne of textiles being recovered per collection.

Forty-two hotels have joined the Wastewi$e Scheme, which encourages the private sector to undertake their own waste reduction initiatives. Six of them have been awarded the Wastewi$e logo. Additionally, the EPD has provided technical advice and run workshops for Hong Kong Hotels Association members, who have also received a CD-ROM on environmental management in hotels which was produced by the Hong Kong Polytechnic University in 2000.

On a smaller scale is the problem of waste from hostels and recreation clubs. A working group was set up in 2000 with 10 hostels, including the YMCA and Salvation Army, and the EPD has provided technical advice on waste reduction and recovery programmes. All 10 hostels have set up such programmes. Similar advice has been offered to recreational clubs and most major clubs now have waste recovery programmes in place.

Supermarkets and Convenience Stores

Plastic bags are the main waste concern from supermarkets and convenience stores. A number of initiatives have been introduced to reduce this problem and the problem of waste in general from these outlets. A working group was set up in 1999 which includes members from the EPD, major shopping outlets and supermarkets and active NGOs. There is general agreement that plastic bag use should be reduced. A campaign in 1999-2000 collected some 500,000 signatures in support of using fewer plastic bags. More than 1,200 shops participated in the plastic bag reduction programme organised for the retail trade and supermarkets in 2001.

A number of initiatives have been introduced to reduce plastic bag use, such as promoting re-usable bags; encouraging shop staff to hand out fewer plastic bags and customers to request fewer bags; holding waste reduction workshops for front-line staff; producing a training manual for staff; airing public education programmes and organising a competition to design a re-usable shopping bag. The Conservancy Association was appointed to organise a series of 'No Plastic Bag, Please' campaigns aimed at newspaper vendors and supermarkets and convenience stores.

The most recent initiative is the Plastic Bags (Domestic) Recovery Trial organised by the EPD. As part of the Community Cleaning Programme organised by one of the leading supermarket chains, 7-Eleven, recycle bins for plastic bags has been placed in 90 7-Eleven stores from September 2002. Well come has also nominated 24 superstores to participate in the recovery trial starting from November 2002. The EPD will assist in the collection logistics, outlet arrangements and the provision of publicity support and related materials.

Hospitals

Hospitals are being encouraged to promote waste reduction and recovery and to join the Wastewi$e Scheme. Technical advice has been provided by the EPD and workshops and seminars have been organised for managerial and front-line staff in public and private hospitals.

Waste separation bins are in place in all 44 public hospitals and major private hospitals. As of September 2002, 38 public hospitals and the Hospital Authority Headquarters had applied to join the Wastewi$e Scheme.

Recycling Trade

A waste reduction task force was set up in March 2000 with members from the recycling industries. The task force discusses measures that can help the trade and aims to secure long-term land and berths for the trade and help develop markets for recovered materials. A focus of concern is a major export outlet for locally recovered materials, the Kwun Tong Public Cargo Working Area, which is affected by the South East Kowloon.

Annexure 4

A Standard Operating Procedure for Windrow Composting

Standard Operating Procedure for Windrow Composting

1. Troubleshooting

Understanding the basic concepts and limitations of the composting process will help operators run a successful operation. Frequent monitoring of the heaps is important, as the heap characteristics are clues to the composting process. Heap characteristics can be used to identify problems within the process.

Symptoms such as high or low temperature, odor, leachate discharge and others, are indications of problems. Commonly encountered problems, as well as possible causes and solutions, are included in the trouble shooting guide as follows:

Table 1: Solid Waste Composting Facility Troubleshooting Guide

Problem	**Cause**	**Recommendation**
Foul odor	Anaerobic conditions: Heaps too large	Reduce windrow size, no wider than 6-9 m, no taller than 2.5 m.
	Heaps too wet or excess organic	Turn or mix windrow; maybe add dry matter.
	Temperature too high	Turn windrow.
	Material compaction	Turn windrow or reduce windrow size.
Standing water/ ponds on surface of windrow	Ruts and holes	Regrade or reconstruct; use careful equipment operation.
	Inadequate slope	Regrade at recommended slope design.
	Improper construction	Align windrows to run down slope, not across.
Inadequate composting rate • with low windrow temp. • with high windrow temp.	Insufficient moisture	Add more water initially, or add water while turning.
	Uneven distribution of air, moisture or nutrients	Consider size reduction methods; turn heap, adding water if necessary.
	Windrow too small (heat loss)	Construct heaps to min. of 2.5 m tall or higher for cold

		seasons.
	Lack of nitrogen	Mix in a nitrogen source.
	Windrow too large or dense (anaerobic conditions)	Make heaps smaller; turn to loosen compacted materials.
Fires / dry heaps	Temperature too high	Make heaps smaller; turn to loosen compacted material.
	Not enough water	Add water and turn heaps.
	Stray sparks / embers	Keep potential fire sources away from heaps.
Surface water pollution	Leachate discharge	Configure windrows perpendicular to slope to eliminate surface water accumulation; treat leachate before it leaves the site by approved methods (such as conveying to catch basin or pass through filter area); practice storm water management methods to divert surface water away from compost or curing heaps.
Dust	Turning operations	Avoid turning dry heaps on windy days; use standard dust control methods; locate facility away from residential areas and downwind from sensitive areas.

2. DO´S/DON'T´S

DO's

- Implement and maintain SOP faithfully
- Monitor yard operation diligently
- Survey the raw material catchment's area periodically
- Select MSW rich in organic matter
- Keep a regular watch on the quality of MSW
- Always use fresh slurry
- Always follow safe measures
- Prepare working area for ragpickers
- Keep dump yard area neat and clean
- Develop & maintain good rapport with Municipal Corporation at all levels
- Keep records for all observations in prescribed formats.
- Collect leachate from windrows via drains and collection tank and use with garden mix
- Develop and maintain greenbelt and garden
- Dispose process rejects scientifically
- Harness maximum resource recovery
- Apply correct dosage inoculum
- Turn the windrows as per schedule.
- Reject out rightly, hospital/industrial/hazardous waste
- Always mask slaughter house/fish/chicken waste with regular garbage

DONT´S

- Do not create conditions for pathogens to develop
- Do not allow pigs, cows, dogs and birds in dump yard.
- Do not allow rag pickers within operation area of equipment
- Do not allow that windrows get compacted too much
- Do not Work in dump yard without mask, handgloves, gumboot and cap
- Do not touch electric fittings with wet hand
- Do not allow smoking in the dump-yard
- Do not use saline/hard water for spraying
- Do not spray excess water on the heap
- Do not keep dead animal / slaughter house /fish/chicken waste in open
- Do not accept industrial / hospital / hazardous waste with garbage.
- Do not allow leachate to flow uncontrolled out of windrows.
- Do not litter plastics within the premises.
- Do not let lechate contaminate soil, ground water and surface water.

3. Windrow Management

Reception of Waste at Entrance Area/Weighbridge

1. The weight of the loaded vehicles should note (Weight W1).
2. The dry waste is unloaded at designated area and the weight is recorded (W2).
3. The wet waste is unloaded at the reception area for wet waste (W3).
4. The waste is inspected for conforming and non-conforming waste and the following actions taken
    a. Wet domestic biodegradable waste.
       - Accepted and sent to windrow platform

    b. Pure vegetable, food waste from market, hotels and slaughter house.
       - Accepted and sent to Biomethanisation Plant

    c. Construction Debris
       - Accepted and disposed in Sanitary landfill.

    d. Biomedical, industrial sludge
       - Rejected- Informed to NMC, PCB – waste to be sent back to generators for proper elimination
5. The details of weighment shall be recorded in the format given in table: 1

Table: 1 Format for recording waste receipts

Material Weigh Slip					
Ticket Number					

Vehicle Number					
Vehicle Identification No.					
Ward / Zone No		**Time :**	**Gross Weight**		**Kg**
Driver Name /No		**Time :**	**Tare Weight**		**Kg**
Material Code		**Time :**	**Net Weight**		**Kg**

6. One copy of the weigh slip should be handed over to the driver. The original stays in the plant.
7. The wet waste shall be placed only in the first row using loader/ Excavator.
8. Deposit in the area designated for the weekday. Example: Waste received on Sundays would be placed on the area designated for Sundays.
9. The heaps have to be set up as loose heaps to allow infiltration of air. Moisture has to be added if simple squeezing test show that the humidity is too low.
10. Simultaneously, shift windrow heap of the corresponding weekdays by one row.
11. When constructing the windrow, care should be taken not to drive on or compact the material.
12. Record temperatures at every 20 m of the windrow heap using a long probe thermometer.
13. Turn the heap
    - When temperature are below 35°C or above 60°C
    - When moisture content is above 60%
    - When foul smell emanates from heap
14. The characteristics of the windrows shall be recorded by the yard supervisor of the plant responsible for the composting process according to the format given in table 2.

Table 2. FORMAT – Daily Report of Heap Characteristics – to be maintained by Yard Supervisor

Date	Heap No	Temp.	Moisture Content	Oxygen Level	pH	Odor	Texture	1st Turn	2nd Turn	3nd Turn

15. Spray water in case moisture content is below 40%
16. When the temperature has reduced to the ambient, and after elapse of 3-4 weeks, the windrow is dismantled and the fermented material is shifted to the presorting section of the screening process.

4. **Operation and Maintenance of Screening Plant.**

    1. The fermented material from the 3-4 week windrow is shifted to the pre-screening section and then post sorting section
    2. The following section describes operation and maintenance of Pre – screen and Post-screening equipments. This operation procedure is applicable to all screens – 200 mm, 100 mm, 75 mm, 16 mm and 4 mm.
        - Check Hydraulic levels of all power packs.
        - Check coolant levels. Top up with coolant as appropriate
        - Check for visible oil leaks. Tighten hoses or replace if needed.
        - Check for electrical safety. Tighten connections or rectify as appropriate.
        - The feeding should be stopped half an hour before the shutting down the plant.
        - Wait until all moving equipment in the trommel, process and reject conveyors are empty of material.
        - The operator should clean all the conveyors and trommels using hand rakes and hard brushes
        - Remove the waste/ rags which are still stuck to the machine.
        - Oil the chain links, grease the nipples as advised in the daily maintenance chart.
    3. Emergency
        - In case of any abnormal sound, temperature rise, choking of conveyor, the operator has to press the emergency stop
        - The plant may be restarted after the cause is investigated and addressed
        - The shift In charge has to sign off the release document

Annexure 5

Guidelines for The Selection of Site for Landfilling

HAZARDOUS WASTE MANAGEMENT
SERIES: HAZWAMS/23/2002-03

GUIDELINES FOR THE SELECTION OF SITE FOR LANDFILLING

cpcb

CENTRAL POLLUTION CONTROL BOARD
MINISTRY OF ENVIRONMENT & FORESTS
e-mail : cpcb@alpha.nic.in Website : www.cpcb.delhi.nic.in

February 2003

GUIDELINES FOR THE SELECTION OF SITE FOR LANDFILLING

CENTRAL POLLUTION CONTROL BOARD
(Ministry of Environment & Forests, Govt. of India)
Parivesh Bhawan, East Arjun Nagar
Delhi – 110 032
e-mail : cpcb@alpha.nic.in Website : http://cpcb.delhi.nic.in/

CPCB 200 Copies, 2003

Published By : Dr. B. Sengupta, Member Secretary, Central Pollution Control Board, Delhi - 32
Printing Supervision & Layout : P.K. Mahendru, P.K. Biswas and Satish Kumar
Composing & Laser Typesetting : Mohd. Javed
Printed at : NISCAIR Press, National Institute of Science Communication And Information Resources, (CSIR), Dr. K. S. Krishnan Marg, New Delhi

दिलीप विश्वास
अध्यक्ष

DILIP BISWAS
Chairman

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
(भारत सरकार का संगठन)
पर्यावरण और वन मंत्रालय

Central Pollution Control Board
(A Govt. of India Organisation)
Ministry of Environment & Forests
Phones : 2204948

FOREWORD

Solid Waste Management is one of the essential services to be provided by municipality to the community. This is an important activity which needs to be planned and executed in an appropriate manner to maintain clean environment.

In keeping with the guidelines formulated by the Committee appointed by the Honorable Supreme Court of India on "Solid Waste Management in Class I Cities in India" and regulations promulgated by the Ministry of Environment & Forests, Govt. of India a study was undertaken through NEERI to assess the problem of disposal of solid waste by landfilling and develop guidelines for selection of sites for developing sanitary landfilling.

We hope, the guidelines will be useful to the Municipal authorities, concerned organisations, academic institutions, researchers and others in planning solid waste management in the country.

(Dilip Biswas)

'**Parivesh Bhawan**', C.B.D.-cum-Office Complex, East Arjun Nagar, Delhi-110 032
Grams : "CLEENVIRON" Fax : (011) 2217078, 2204948, 2221995
e-mail : cpcb@alpha.nic.in, cpcb@sansad.nic.in, Website : http://envfor.nic.in/cpcb

TEAM WORK

Central Pollution Control Board

Dr.B.Sengupta	Member Secretary
Dr.A.B.Akolkar	Additional Director
Dr.D.C.Sharma	Senior Environmental Engineer, Zonal Office, Bangalore
Sh.A.K.Vidyarthi	Assistant Environmental Engineer

National Environmental Engineering Research Institute

Dr.A.V.Shekdar	Deputy Director & Head , Solid Waste Management Division
Sh.S.A.Gaikward	Assistant Director
Dr.R.V.Bhoyar	Assistant Director

CONTENTS

1.0 INTRODUCTION

In India, recently solid waste management systems are assuming larger dimensions in keeping with the Municipal Solid Wastes (Management & Handling) Rules, 2000. Many of the municipalities are taking appropriate actions to improve various component systems like collection of solid waste from generation areas, its transportation to processing and disposal site(s), utilising the recycling potential of Municipal Solid Waste (MSW) and ultimately disposing of by landfilling.

In view of this, under the sponsorship of Central Pollution Control Board (CPCB), NEERI has carried out the extensive studies to assess the pathways of pollution for various environmental media. Further, a site selection criteria has been developed in the form of guidelines to suit Indian condition in keeping with the findings of the other studies.

Guidelines have been developed through extensive literature search, and review of earlier studies carried out by NEERI. The developed criteria encompass environmental conditions, hydrogeological conditions, accessibility, ecological and societal effects, etc.

The guidelines have been divided into two Sections. Section - A deals with technical screening procedure based upon economic, engineering and environmental suitability and public approval/acceptance and presents the site scrutinising procedures. Section - B presents the validation of guidelines in real life situation for Bangalore city.

These guidelines are indicative and are only meant for guidance. Government agencies like municipalities, corporations, etc. and implementation authorities would be required to conform to the requirement of the legislation.

2.0 SALIENT FEATURES OF THE GUIDELINES FOR SELECTION OF SITES FOR LANDFILLS

1. The Guidelines are designed to provide a framework for the development of policy and procedure to protect health of community and environmental quality arising out of disposal of municipal solid waste.

2. The guidelines are for setting up of sanitary landfills for the disposal of municipal solid waste.

3. The guidelines delineate step-by-step procedure for screening potential sites and its selection through ranking of feasible site alternatives.

4. Ranking of site is based on objective evaluation of accessibility, receptor, environmental, socio-economic, waste management practice, climatological and geological related attributes based on scaling - weighing technique which involves importance and sensitivity of the attributes.

5. The guidelines indicate possible information sources, delineate the techniques for collection of samples and their analysis for site characterisation.

6. The guidelines provide details related to methodology, provide proforma and illustrate with a case study.

7. The guidelines discuss their application to municipal solid waste management as a whole, and to restore the environmental quality arising from waste disposal.

8. Bibliographic references are provided for the benefit of the users for obtaining specific detail from the these sources.

3.0 SCOPE AND APPLICABILITY

The guidelines are to provide policy and procedure to protect community, environment and ecosystem and to assist the appropriate agency in the siting of new facilities for disposal of municipal solid waste on techno-enviro-economic compatibility in suitable locations. Further, these are oriented primarily to the setting of independent disposal facilities, located away from the sources of waste generation.

4.0 SITING OF A FACILITY FOR DISPOSAL OF MUNICIPAL SOLID WASTE

The main purpose of the siting process is to make the best use of the land resources available. The siting for disposal of solid waste and disposal facilities requires the synthesis of two distinct selection procedures, viz. a technical screening process based upon economic, engineering and environmental suitability, and public approval process. A general listing of various factors to be considered for siting is presented in **Table 1**. The relative importance of these factors depends on the site consideration as well as the chosen method of disposal.

Table 1 Factors in Siting of Municipal Solid Waste Disposal Facility

- Accessibility to the site
  - Distance from the highway
  - Distance from the origin of waste

- Receptor related
  - Proximity of human habitation/locality
  - Drinking water sources
  - Land use designation
  - Agriculture value
  - Public utility facility
  - Historical/Archeological monuments
  - Public accessibility

- Environmental related
  - Hydrogeological investigation
  - Distance to nearest surface water
  - Air quality
  - Soil quality
  - Water quality
  - Safety

- Socio-economic
  - Job opportunity
  - Vision
  - Health

- Waste management practices related
  - Waste quantity/day
  - Life of site

The goals of siting facility are to:

- Minimise health risk
- Minimise adverse environmental impact
- Minimise costs of the development, construction, operation and closure
- Maximise public acceptability of the project

To achieve these goals specific objectives may be defined for siting in terms of physical, environmental, economic and cultural factors. No single site can, however, satisfy all the selection objectives, hence, trade off between various factors should be considered.

5.0 SITE SELECTION METHODOLOGY

The site selection process should be carried out in a progressive step-by-step procedure involving the evaluation of alternatives. Various steps to identify site for disposal of solid waste are shown in flowchart (**Figure 1**).

5.1 Definition of Waste Management Problem

The first step in the facilities development process is to define the nature and size of the waste problem to be managed by the proposed facility. This task is undertaken through surveys of waste generation, handling and management practices and options available and/or adopted. An outline of engineering, planning and environmental issues to be considered in the later phases is also to be prepared.

5.2 Selection of Candidate Sites

This phase is very crucial in the siting process and can be carried out through a multi-level screening process.

Level I - Constraint Mapping : Constraint mapping eliminates environmentally unsuitable sites and narrows down the number of sites for further consideration. Certain features termed as "exclusionary factors" identified for constraint mapping are given in **Figure 1**.

Level II - Potential Site Selection : The level II factors include landuse and infrastructure facilities. Land use includes target land area required, land ownership and its current use. Infrastructural facility includes major highway access, sites of existing/former waste disposal facilities and land designated for industrial use. These provide the basis for highlighting promising sites within the candidate areas remaining after level I analysis.

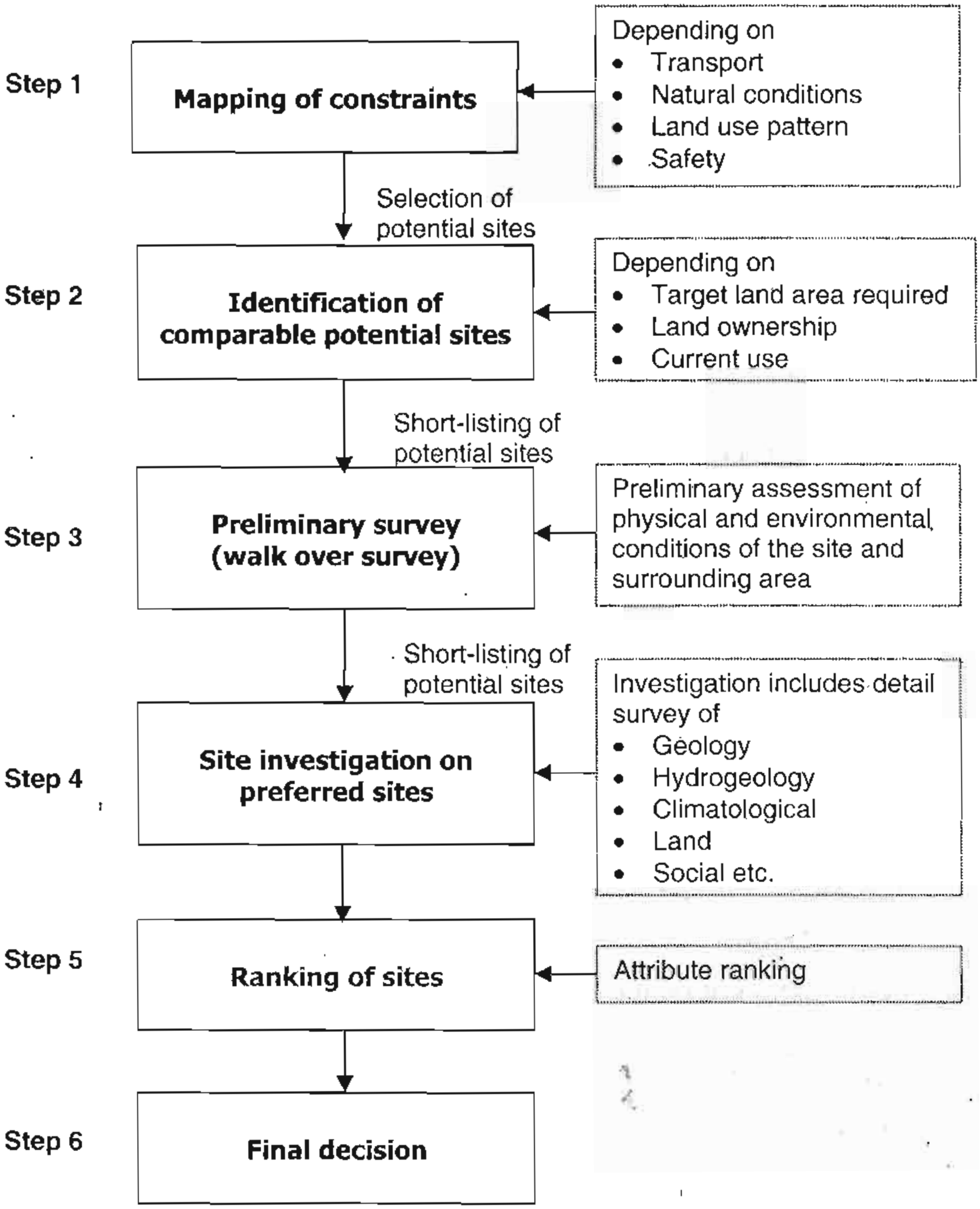


Figure 1 : Site Selection Criteria

Level III - Preliminary Survey : The sites selected in level II are further scrutinised to eliminate areas which fail to meet additional socio-economic and environmental concerns at the site and surrounding areas. The objectives of the walkover survey (preliminary survey) is to identify sufficient constraint to reduce the number of possible sites. This may be carried out by surveying the areas and collecting data regarding :

- Existing zones of development
- Agricultural land preserves
- Areas of mineral development
- Freshwater wetlands
- Visual corridors of scenic rivers
- Riverine and dam-related flood hazard areas

5.3 Ranking of Site Alternatives

The next stage of site selection involves comparison of candidate sites based on evaluation of each site for more detailed environmental impacts. The methodology for ranking of site alternatives comprises following steps:

- Select attributes for evaluation of site alternatives
- Apportion a total score of 1000 between the assessment attributes based on their importance through ranked pairwise comparison technique
- Develop Site Sensitivity Index (SSIs) using Delphi Technique
- Estimate score for each attribute for various candidate site alternatives using SSIs
- Add the scores for individual site alternatives, to rank the alternatives based on total score

5.4 Confirmation of Public Acceptability of the Site

For ensuring public acceptability of the site, target audience which include community leaders, municipal authorities, environmental groups, government departments, transporters, educational institutions, local social services, planners and site-specific groups should be addressed.

In keeping with the current life style and various problems of solid waste management, the community should be made aware and motivated for participation. The field staff should also educate the public that the risks associated with well designed municipal solid waste management systems are considerably less than its absence and that the risks associated with the facility would be no greater, and probably less, than those associated with any other industry.

5.5 Regulatory Approval

The site should be in accordance with the specification prescribed in the schedule III of the Municipal Solid Wastes (Management and Handling) Rules, 2000 and require approval from regulatory agencies for all facilities related to disposal of municipal solid waste.

Section A

6.0 SELECTION OF CANDIDATE SITES FOR DETAILED INVESTIGATION

The algorithmic procedure to be followed for the selection of candidate sites for sanitary landfills is as described below :

6.1 Step I - Mapping of Constraints

With increasing population the city boundaries are also increasing. The first step for site selection is mapping of constraints. The most stringent criteria for site selection at the initial stage may result in lesser possibility of getting the sites selected for landfilling. Several of these negative aspects may conveniently be recorded on a suitably scaled map of the municipality and its surroundings. Such mapping will reveal areas in which landfill sites might be located.

Constraint mapping eliminates environmentally unsuitable sites and narrows down the number of sites for further consideration. Certain features termed as "exclusionary factors" such as restricted areas for play ground, gardens etc., are identified using map of appropriate scale. These factors will eliminate unsuitable sites from further analysis.

The factors to'be considered while selection are as below :

1) **Transport consideration**

Should be as near as possible from a suitable main road
Must be within the economical travel distance from origin of waste

2) **Natural conditions**

- Should not be flood plains or other areas liable to flooding
- Extreme morphology (steep or over steep, liable to land slips)

3) **Land use pattern**

- Designated ground water recharge, sole source aquifer or surface water catchment areas for water supply schemes should be avoided

- Incompatible future land use designations on or adjacent to the site, particularly hard (built) development or mineral extraction should be avoided
- Should not be within a military exclusion zone

4) **Safety of selected site**

- Must not be within 20 km of an airport runway in the direction of approach and take-off
- Area of former military activity where buried ordnance may be present and hence needs to be avoided
- Must not be within a safe buffer distance (say 100 m) from an existing or planned quarry, which will undertake blasting with explosives
- Areas known to contain collapsing soils need not to be considered

6.2 Step II – Identification of Comparable Potential Sites

This step includes factors like land use and infrastructure facilities (major highway access site of existing/former waste disposal facilities and land designated for industrial use), land area required; which provides the basis for highlighting promising site within the candidate areas remaining after step I analysis.

Depending on the restrictions imposed by the constraint mapping exercise, the municipality should aim to draw up a list of maximum number of possible sites. These may include positive features such as:

- Easy access to a road system
- Proximity to the urban area
- Ease in land acquisition
- Beneficial after-use

The area required for landfilling can be computed by following methods :

The required site area will depend upon

- The total quantity of waste to be disposed at the site over its life time
- The volume that this waste (and any cover material) will occupy in the site

- How this volume can be accommodated in the site (% of site covered, depth, and/or height of landfilled waste)

Area of the site should be inclusive of :

- Buffer between adjacent properties at the site boundary and the filling area
- Access road
- Soil stockpile area outside the fill surface
- On-site structure and equipment-storage area

Typically, the usable fill area ranges from 50 to 80% of sites gross area

6.3 Step III – Preliminary Survey (Walk over survey)

The sites selected in step II are further scrutinised to eliminate areas which fail to meet additional socio-economic and environmental concerns at the site and surrounding area by walk over survey.

While the first two steps may not require first hand knowledge of the possible sites further elimination of sites will require a formal inspection of each site. A number of features, both favourable and unfavourable, may be identified by a walkover survey.

The preliminary survey may some times require confirmation by other authorities. The objective of the walkover surveys is to identify sufficient constraints to reduce the number of possible sites. This may be done by surveying the area and collecting data regarding :

- Existing zones of development
- Areas of mineral deposition
- Freshwater and wetland
- Natural vegetation
- Exposed geology

The data required from preliminary survey includes:

- Is the site presently well drained?
- Are there established watercourses within or adjacent to the site
- Is there evidence of ephemeral streams, springs or sinkholes?
- From knowledge of the geology of the area does the morphology of the site suggest significant or minimum depths of soft material?
- Is there any evidence of geological features on or near the site?

- Are there any features, which will significantly limit the useful area of the site for landfilling?
- Does the nearby well have high water table?
- Where are the nearest inhabited dwellings?

6.4 Step IV – Site Investigation on Preferred Sites

Fourth step is site investigation, includes detail survey of hydrogeology, water, climatology, soil etc. of the sites which are scrutinised from step III. Subsurface exploration and a topographic survey should be carried out at the preferred site. These site investigations will be critical to the success of the siting and design of the landfill.

From the results of the site investigation program, the estimates of cost and capacity of the preferred site(s) may be firmed up and clearly preferred site identified.

7.0 RANKING OF SITES

The next stage of site selection involves comparison of candidate sites based on evaluation of each site for more detailed impacts. After scrutinising the sites through step I to III (**5.2 Selection of Candidate Sites**), the number of sites may be reduced, and are ranked according to their environmental, social and community impacts.

7.1 Site Scrutinisation

After conducting siting phase for identifying comparable sites, final firm selection for one site is arrived through site scrutinising procedure. The procedure involves selection of attributes, attribute weightage and ranking.

Site Scrutinising Procedure

The methodology for ranking of site alternatives comprises following steps:

- Select attributes for evaluation of site alternatives
- Apportion of total score of 1000 between the assessment attributes based on their importance through pairwise comparison technique
- Develop Site Sensitivity Index using Delphi Technique
- Estimate weightage for each attribute for various candidate site alternatives using Site Sensitivity Index
- Add the scores for individual site alternatives to rank the alternatives based on total score

The procedure for ranking is described below :

7.2 Selection through Ranking of Sites

Selection of Attributes

A set of 32 attributes has been considered for ranking of disposal site alternatives (**Table 2**). These attributes are decided on the basis of the literature review pertaining to site selection, experts from waste management including NEERI's expertise and are also decided taking in view the factors contributing the pollution pathways. Each of the attribute is considered, keeping in view the environmental impacts, cost for the site, accessibility, volume of the site, etc. These attributes are then grouped according to the category so that those can be assigned with the weightage.

Attribute Weightage

The selected attributes are grouped into 7 categories, consequently, a numerical value called weightage has been assigned to each category, in accordance with the relative magnitude of impact it assesses using a pairwise comparison technique. Based on Delphi, weightage is assigned to each category. A total of 1000 points are assigned among the 7 categories. The weightage to each attribute is assigned following the same procedure of pairwise comparison within the category. Total points pertaining to a particular category are assigned to the attributes belonging to that category. The weightages for individual attribute and the categories are listed in **Table 3**.

7.3 Site Sensitivity Index

Site sensitivity index is scale indicating degree of sensitivity of individual attribute. Accordingly for each of the attribute a four-level sensitivity scale has been considered. This scale ranges from "0" (indicating no or very less potential hazard) to "1" (indicating a highest potential hazard). The sensitivity levels are listed in **Table 2**.

Estimation of Weightage (Score)

Based on the actual measurements and the opinion of the experts, the corresponding site sensitive index will be given for each attribute. The value of the sensitivity index will be multiplied by the corresponding weightages of the attributes. This will result in weightage (score) for each of the attribute. The worksheet for the procedure is presented in **Table 3**.

Table 2

Development of Site Sensitivity Index

Sr. No.	Attribute	0.0-0.25	0.25-0.5	0.5-0.75	0.75-1.0
			Accessibility Related		
1.	Type of road	National highway	State highway	Local road	No road
2.	Distance from collection area	< 10 km	10-20 km	20-25 km	> 25 km
			Receptor Related		
3.	Population within 500 meters	0 to 100	100 to 250	250 to 1000	> 1000
4.	Distance to nearest drinking water source	> 5000 m	2500 to 5000 m	1000 to 2500 m	< 1000 m
5.	Use of site by nearby residents	Not used	Occasional	Moderate	Regular
6.	Distance to nearest building	> 3000 m	1500 to 3000 m	500 to 1500 m	< 500 m
7.	Land use/Zoning	Completely remote (zoning not applicable)	Agricultural	Commercial or industrial	Residential
8.	Decrease in property value with respect to distance	> 5000 m	2500 to 5000 m	1000 to 2500 m	< 1000 m
9.	Public utility facility within 2 kms	Commercial and industrial area	National heritage	Hospital	Air port
10.	Public acceptability	Fully accepted	Acceptance with suggestions	Acceptance with major changes	Non acceptance
			Environmental Related		
11.	Critical environment	Not a critical environment	Pristine natural areas	Wetlands, flood plains, and preserved areas	Major habitat of endangered or threatened species
12.	Distance to nearest surface water	> 8000 m	1500 to 8000 m	500 to 1500 m	< 500 m

Contd...

Table 2 Contd...

Sr. No.	Attribute	0.0-0.25	0.25-0.5	0.5-0.75	0.75-1.0
13.	Depth to ground water	> 30 m	15 to 30 m	5 to 15 m	< 5 m
14.	Contamination	Air, water or food contamination	Biota-contamination	Soil contamination only	No contamination
15.	Water quality	Highly polluted	Polluted	Potable	Confirming to standard
16.	Air quality	Highly polluted	Polluted	Confirming to industrial standards	Confirming to residential standards
17.	Soil quality	Highly contaminated	Contaminated	Average	No contamination
			Socio-economic Related		
18.	Health	No problem	Moderate	High	Severe
19.	Job opportunities	High	Moderate	Low	Very low
20.	Odour	No odour	Moderate odour	High odour	Intensive foul odour
21.	Vision	Site not seen	Site partly seen (25%)	Site partly seen (75%)	Site fully seen
			Waste Management Practice Related		
22.	Waste quantity/day	< 250 tonnes	250 to 1000 tonnes	1000 to 2000 tonnes	> 2000 tonnes
23.	Life of site	> 20 years	10-20 years	2-10 years	< 2 years
			Climatological Related		
24.	Precipitation effectiveness index*	< 31	31 to 63	63 to 127	> 127
25.	Climatic features contributing to Air pollution	No problem	Moderate	High	Severe

Contd...

* Precipitation effectiveness index is the ratio of annual precipitation to annual evaporation.

Table 2 Contd...

Sr. No.	Attribute	0.0-0.25	0.25-0.5	0.5-0.75	0.75-1.0
Geological Related					
26.	Soil permeability	> 1 X 10^{-7} cm/sec.	1 X 10^{-5} to 1 x 10^{-7} cm/sec.	1 X 10^{-3} to 1 x 10^{-5} cm/sec.	< 1 X 10^{-3} cm/sec.
27.	Depth to bedrock	> 20 m	10 to 20 m	3 to 10 m	< 3 m
28.	Susceptibility to erosion and run-off	Not susceptible	Potential	Moderate	Severe
29.	Physical characteristics of rock	Massive	Weathered		Highly weathered
30.	Depth of soil layer	> 5 m	2-5 m	1-2 m	< 1 m
31.	Slope pattern	< 1%	1-2%	2-5%	> 10%
32.	Seismicity	Zone I	Zone II	Zone III	Zone IV & V

Table 3

Worksheet for Ranking of Disposal Sites

Name of site :

Location :

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Accessibility Related				
Type of road			25	
Distance from collection point			35	
Total			60	
Receptor related				
Population within 500 meters			50	
Distance to nearest drinking water source			55	
Use of site by nearby residents			25	
Distance to nearest building			15	
Land use/Zoning			35	
Decrease in property value with respect to distance			15	
Public utility facility within 2 kms			25	
Public acceptability			30	
Total			250	

Contd...

Table 3 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Environmental Related				
Critical environments			45	
Distance to nearest surface water			55	
Depth to ground water			65	
Contamination			35	
Water quality			40	
Air quality			35	
Soil quality			30	
Total			**305**	
Socio-economic Related				
Health			40	
Job opportunities			20	
Odour			30	
Vision			20	
Total			**110**	
Waste Management Practice Related				
Waste quantity/day			45	
Life of site			40	
Total			85	

Contd...

Table 3 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Climatological Related				
Precipitation effectiveness index			25	
Climatic features contributing to Air pollution			15	
Total			40	
Geological Related				
Soil permeability			35	
Depth to bedrock			20	
Susceptibility to erosion & run-off			15	
Physical characteristics of rock			15	
Depth of soil layer			30	
Slope pattern			15	
Seismicity			20	
Total			150	
Grand Total			1000	

7.4 Aggregating the Score for Selection

The scores for each attributes and then for all the categories of an individual site will be added to calculate the total score for the site. The same procedure has to be repeated for all of the alternative sites. The results will be interpreted on the basis of the total score. The total scores of all the alternative sites will be compared and will be ranked on the basis of less sensitivity. The site with the least score will be less sensitive, i.e. there will not be significant impact on the environmental quality due to the disposal site and hence will be the most acceptable. The site suitability accordingly will decrease with increase in the total score. Therefore, the site with less score will be selected for disposal. As far as the environmental related attributes are concerned, the contaminated land, polluted water, air and soil quality is preferred option for landfilling site.

A broad score is developed to identify which site is acceptable. The generalised scores are given below :

Total score	Site Description
< 300	Less sensitive to the impacts (preferable)
300 to 750	Moderate
> 750	Highly sensitive to the impacts (undesirable)

The criteria developed are applied to a case study for evaluation and validation purposes.

Section B

8.0 A CASE STUDY

The guidelines developed for selection of sites for developing sanitary landfilling are validated for the city of Bangalore. Bangalore Mahanagar Palike (BMP) proposed four sites, viz. Kannahalli, Seegehalli, Medhiagrahara and Gedanahalli.

8.1 Existing Solid Waste Management System in Bangalore

The prevailing system for solid waste management is presented in **Figure 2**. In order to select the site, it is necessary to know the quantity and composition of solid waste that would be disposed of in the landfill. Accordingly, per capita waste quantity is computed on the basis of field investigations keeping with the population rise at the rate of 4.25% per year and also the per capita rise of 0.383% per year. The waste quantity that would be generated, processed and finally disposed of in the landfills for every year till 2010 is computed and presented in **Table 4**.

On an average the waste contains biodegradable fraction in the range of 30-35%. The average plastic content is 9.18%. The moisture content of solid waste for residential and commercial area was 38% and 42.52% respectively. Part of the solid waste is processed by composting managed by 4 private entrepreneurs where approximately 100-300 metric tonnes of waste per day are utilised.

8.2 Landfill Site Selection

Keeping with the site selection procedure described in Part A, the site evaluation was carried out to select the best site for disposal amongst the available sites.

Medhiagrahara site measures approximately 27 acres. As this site is within the radius of 20 km from the proposed airbase at Devanhalli, cannot be considered for landfilling. This is in accordance with Government of India regulations on Municipal Solid Waste (Management and Handling) Rules, 2000 [The Gazette of India: Extraordinary part II-sec 3(ii): No landfill site should be within 20 kms radius from the airbase]. Hence this site was rejected and no investigations were carried out on the site.

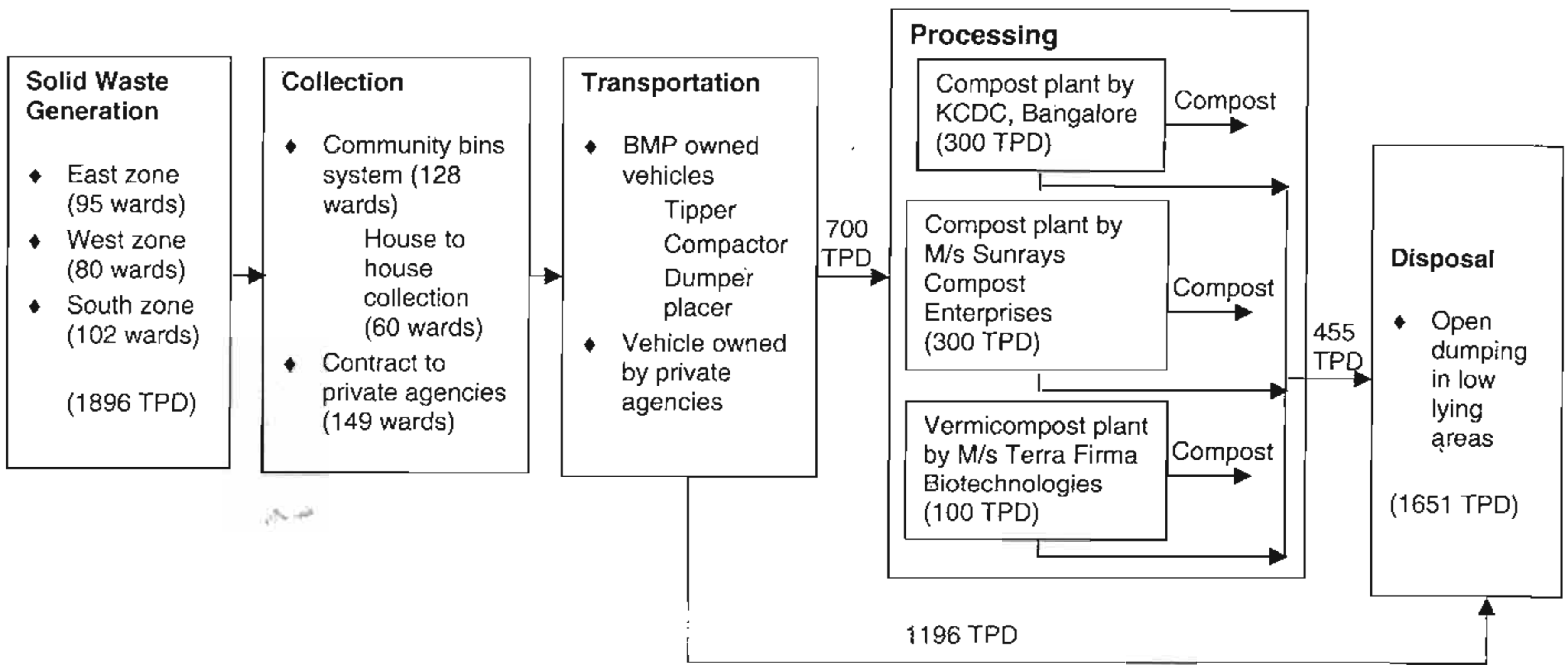


Figure 2 : Existing Solid Waste Management System in Bangalore City

Table 4

Estimates for Landfill Area required for the Period 2000-2010

Year	Population (lakhs)	MSW * (kg/capita/day)	MSW (MT/day)	Total biodegradable matter ** (MT/day)	Qty. of MSW for composting (MT/day)	Net qty. for disposal (MT/day)	Net qty. for disposal (MT/yr)	Qty. for disposal (Cumulative) (MT)	Landfill area (Cumulative) (hectares)	Land area, including cover mater (hectares)
2000	44.79	0.3831	1715.90	600.57	700	1015.90	370804	370804	12.36	14.83
2001	46.40	0.4088	1896.84	663.89	700	1196.84	436846	807650	26.92	32.31
2002	48.07	0.4362	2096.86	733.90	700	1396.86	509853	1317503	43.92	52.70
2003	49.80	0.4654	2317.97	811.29	1300 ***	1017.97	371558	1689061	56.30	67.56
2004	51.60	0.4966	2562.39	896.84	1300	1262.39	460773	2149834	71.66	85.99
2005	53.46	0.5299	2832.59	991.41	1300	1532.59	559396	2709231	90.31	108.37
2006	55.38	0.5654	3131.29	1095.95	1300	1831.29	668419	3377650	112.59	135.11
2007	27.38	0.6033	3461.47	1211.52	1300	2161.47	788938	4166588	138.89	166.66
2008	59.45	0.6437	3826.48	1339.27	1300	2526.48	922165	5088753	169.63	203.55
2009	61.59	0.6868	4229.98	1480.49	1300	2929.98	1069441	6158195	205.27	246.33
2010	63.81	0.7328	4676.02	1636.61	1300	3376.02	1232248	7390442	246.35	295.62

* Total biodegradable matter as per analysis 35%

** Waste generation rate increases @ 6.7% per annum equivalent to rate of increase of GDP (Source: www.asiaweek.com/asiaweek/features/asiacities/ac1999/data/bangalore.html)

*** A 600 TPD compost plat would be installed in 2003

The second proposed site Gedannahally measures approximately 50 acres. This site is also rejected as it is submerged in water. The remaining two sites viz. Kannahalli and Seegehalli are evaluated for their consideration as candidate landfill sites.

8.3 Attribute Evaluation for Kannahalli and Seegehalli Sites

It is always desirable to evaluate various attributes separately for each of the site under consideration. However, in the present case, as both of these sites are very close to each other their attributes are evaluated jointly for both the sides. Furthermore, an attempt has been made to differentiate between the sites wherever possible.

Accessibility Related Attributes

Both of these sites lie on the west side of the city at a distance of approximately 2.5 km from state high-way and are at a distance of approximately 22 km from the city and 9 km from corporation limit. Nearest locality is Kannahalli colony with approximately 100 residents at a distance of approximately 500 m from these sites.

Receptor Related Attributes

Kannahalli site is in the proximity of two villages, one at a distance of 1.5 km towards the east of the site (population of approximately 2000 people) and the other village (approximate population of 1500) at a distance of 2 km. Seegehalli site have three villages around it at a distance of 2-3 km with population of 200, 500 and 12000 residents.

These sites do not form a part of any specific zone of the city, except for unauthorised cultivation. Since the residential localities are developing along the highway the potential for moderate decrease in property value exist.

Environmental Related Attributes

The general elevation of the area is 828 m (Kannahalli) and 870 m (Seegehalli) above mean sea level. Kannahalli site represents a typical topographic valley which divides the area almost at the central part along northwest-southwest direction (Exhibit 1). Physiographically, the Seegehalli site is located on a mound sloping in all directions (Exhibit 2). These sites can be treated neither as a wetland nor as a flood zone. The proposed sites are barren land with very few bushes and no big trees.

Exhibit 1 : Proposed Kannahalli Landfill Site

Exhibit 2 : Proposed Seegehalli Landfill Site

Bore well is the main water source in the villages surrounding the site. There is a lake at a distance of 2.5 kms from the site. The minimum and maximum depth of water from ground level is 8 m and 29 m respectively. Baseline data for chemical analysis of the water samples from the surrounding water sources, groundwater and surface water, indicates that the hardness exceeds the permissible limit and concentration of heavy metals are within the permissible limit (IS : 10500:1991). Baseline data from soil analysis indicates that the soil is sandy soil with clay percent ranging in between 30 to 35%, silt percent ranging between 15 to 20%, whereas remaining is sand.

Socio-economic Related Attributes

As these sites are close to small colony, the residents will be affected by odour, noise, aesthetics, etc. due to landfilling operations. However, as human habitation in surrounding villages is mostly at a distance of approximately 2-3 km from the proposed site, the public vision would not be affected due to landfilling operation.

Waste Management Practice Related Attributes

Waste quantity generated per day is 1896 MT for the year 2001. The three composting plants accepts 700 TPD of which 455 TPD are rejected so totally 1651 tonnes are required to be disposed by landfilling. The area of the proposed site (Kannahalli) is approximately 29 acres. In keeping with the topography and the contour survey, the volume of the site is computed with the following the assumptions :

- The depth of landfilling as 8 m
- The density of waste as 1000 kg/m^3
- Volume consumed by soil cover as 20% of total volume

Accordingly, the total volume available for disposal of waste 751124 m^3. If the entire quantity of solid waste generated in Bangalore is landfilled at this site, the site will serve for approximately 21 months.

The area of Seegehalli site is approximately 7 acres. In keeping with the topography of the site and in absence of detailed contour survey, the volume of the site is computed with the following assumptions :

- The depth of landfilling as 3 m
- The density of waste as 1000 kg/cum

- Volume consumed by soil cover as 20% of total volume

Accordingly, the total volume of the site is 67990 m^3. If the whole waste that is generated in the city is landfilled, the site will serve for approximately 60 days.

Climatological Related Attributes

About 1200 mm per year rainfall is recorded for both the sites. The maximum temperature is in the range of 30 to 35°C. The mean wind speed is 5.4 kmph which does not pose any problem of air pollution.

Geological Related Attributes

These sites are mainly underlined by granites and gneisses. The depth to bedrock (overall thickness of soil) for weathered and semi-weathered formation varies from 5-40 m.

The soil permeability varies between $1x10^{-4}$ to $1x10^{-5}$ cm/sec. As per the seismic zoning map of India (www.mapsofindia.com), the stretch falls in the seismic zone - I.

8.4 Site Score Calculations

On the basis of the data, site sensitive index are calculated which are then multiplied by the weightages of each attribute. The total score for each category is then obtained by adding the score of each attribute. The sites scores calculation for Kannahalli site are depicted in **Table 5** whereas for Seegehalli site in **Table 6**.

8.5 Ranking of Sites

The total score for both the sites are calculated on the basis of the ranking methodology (**Table 7**). The site with less score indicates that the site is less sensitive to impact. Hence the site with less score will be ranked first.

As both the proposed sites are very close to each other, not much difference is expected for these sites. As far as the environmental related attributes (contaminated land, polluted water, air and soil quality) are concerned, Kannahalli site is the preferred option for landfill site.

Table 5

Worksheet for Ranking of Disposal Sites

Name of site : Kannahalli

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Accessibility Related				
Type of road	State highway	0.35	25	8.75
Distance from collection point	25 km	0.75	35	26.25
Total			**60**	**35**
Receptor related				
Population within 500 meters	100	0.25	50	12.5
Distance to nearest drinking water source	200m	1	55	55
Use of site by nearby residents	Not used	0	25	0
Distance to nearest building	100	1	15	15
Land use/Zoning	Completely remote	0	35	0
Decrease in property value with respect to distance	No decrease in property value	0	15	0
Public utility facility within 2 km	No public utility	0	25	0

Contd...

Table 5 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Public acceptability	No complains	0.15	30	4.5
Total			**250**	**87**
		Environmental Related		
Critical environments	Not a critical environment	0.15	45	6.75
Distance to nearest surface water	1.5 km	0.5	55	27.5
Depth to ground water	5 m	0.75	65	48.75
Contamination	No contamination	1.0	35	35
Water quality	Potable	0.75	40	30
Air quality	Confirming to residential standards	1.0	35	35
Soil quality	Average	0.75	30	22.50
Total			**305**	**205.50**
		Socio-economic Related		
Health	Moderate	0.25	40	10
Job opportunities	Low	0.5	20	10
Odour	Moderate	0.35	30	10.5
Vision	Site partly seen (25%)	0.3	20	6
Total			**110**	**36.5**
		Waste Management Practice Related		
Waste quantity/day	1197 t/d	0.6	45	27
Life of site	21 months	0.8	40	32
Total			**85**	**59**

Contd...

Table 5 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Climatological Related				
Precipitation effectiveness index	31 to 63	0.5	25	12.5
Climatic features contributing to Air pollution	No problem	0	15	0
Total			**40**	**12.5**
Geological Related				
Soil permeability	$1x10^{-4}$ to $1x10^{-5}$	0.5	35	17.5
Depth to bedrock	10-40 m	0.3	20	6
Susceptibility to erosion & run-off	Not susceptible	0	15	0
Physical characteristics of rock	Weathered	0.3	15	4.5
Depth of soil layer	0.3-3 m	0.75	30	22.5
Slope pattern	2%	0.25	15	3.75
Seismicity	Zone I	0	20	0
Total			**150**	**54.25**
Grand Total			**1000**	**489.75**

Table 6

Worksheet for Ranking of Disposal Sites

Name of site : Seegehalli

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Accessibility Related				
Type of road	State highway	0.35	25	8.75
Distance from collection point	24	0.6	35	21
Total			**60**	**29.75**
Receptor related				
Population within 500 meters	100	0.25	50	12.5
Distance to nearest drinking water source	500m	0.8	55	44
Use of site by nearby residents	Not used	0	25	0
Distance to nearest building	500	0.75	15	11.25
Land use/Zoning	Completely remote	0	35	0
Decrease in property value	Moderate	0.25	15	3.75
Public utility facility within 2 km	No public utility	0	25	0

Contd...

Table 6 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Public acceptability	No complains	0.15	30	4.5
Total			**250**	**76**
		Environmental Related		
Critical environments	Not a critical environment	0.15	45	6.75
Distance to nearest surface water	3 km	0.3	55	16.5
Depth to ground water	20 m	0.25	65	16.25
Contamination	No contamination	1.0	35	35
Water quality	Potable	0.75	40	30
Air quality	Confirming to residential standards	1.0	35	35
Soil quality	Average	0.75	30	22.5
Total			**305**	**162**
		Socio-economic Related		
Health	No problem	0.15	40	6
Job opportunities	Low	0.5	20	10
Odour	Moderate	0.35	30	10.5
Vision	Site not seen	0	20	0
Total			**110**	**26.5**
		Waste Management Practice Related		
Waste quantity/day	1197 t/d	0.6	45	27
Site area that can serve	2 months	1	40	40
Total			**85**	**67**

Contd...

Table 6 Contd...

Attribute	Attribute measurement	Sensitivity index	Weightage	Attribute score
Climatological Related				
Precipitation effectiveness index	31 to 63	0.5	25	12.5
Climatic features contributing to Air pollution	No problem	0	15	0
Total			**40**	**12.5**
Geological Related				
Soil permeability	$1x10^{-4}$ to $1x10^{-5}$	0.5	35	17.5
Depth of bedrock	9-27 m	0.6	20	12
Susceptibility to erosion & run-off	moderate	0.75	15	11.25
Physical characteristics of rock	Weathered	0.75	15	11.25
Depth of soil layer	0.9-5 m	0.75	30	22.5
Slope pattern	> 10 %	1	15	15
Seismicity	Zone I	0	20	0
Total			**150**	**89.5**
Grand Total			**1000**	**463.25**

Table 7

Ranking of Sites

Attribute category	Maximum weightage	Kannahalli site	Seegehalli site
Receptor related	250	87	76
Environment related	305	205.5	162
Accessibility related	60	35	29.75
Socio-economic related	110	36.5	26.5
Waste management practice related	85	59	67
Climatological related	40	12.5	12.5
Geological related	150	54.25	89.5
Total score	**1000**	**489.75**	**463.25**
Rank		**II**	**I**

BIBLIOGRAPHY

Aakeson, M. and Nilsson, P. *"International Conference on Solid Waste Technology and Management"*, Widener University, Chester (USA), Vol.1.

Ahel, M.; Nikac, N.; Cosovic, B.; Pronic, E. and Soakup, V. (1998). *"The impact of contamination from a MSW landfill on underlying soil"*, Water Sci. & Tech., Vol.37, No.8, pp.203-210.

Assmuth, T.W. and Strandberg, T. (1993). *"Ground water contamination in finnish landfill"*, Water, Air and Soil Pollution, Vol.69, No.1/2, pp.179-199.

Baldwin, T.D.; Stinson, J. and Ham, R.K. (1998). *"Decomposition of specific material buried within sanitary landfills"*, J. Env. Engg., Vol.124, No.12, pp.1193-1202.

Black, C.A. (1979). *"Methods of Soil Analysis Part I & II"*, American Society of Agronomy, Inc., USA

Brunnel, R.D.; Hubbard, S.J., Keller, D.J. and Newton, J.L. (1971). *"Closing Open Dumps – Report"*, Env. Protection Agency SWM Office.

Burton and Craik, W. (1998). *"Ammonia and nitrogen fluxes in landfill sites : applicability to sustainable landfilling"*, Waste Manag. Res., Vol.16, No.1, pp.41-53.

Cheung, K.C.; Chu, L.M. and Wong, M.H. (1993). *"Toxic effect of landfill leachate on microalgae"*, Water, Air and Soil Pollution, Vol.69, No.3/4, pp.337-349.

Ettala, M.; Rahkune, P.; Rassi, E. and Mangs, J. (1996). *"Landfill fires in finland"*, Waste. Manag. Res., Vol.14, No.4, pp.377-384.

Fatta, D.; Voscos, C.; Haralambous, A.J.and Loizidou, M. (1997). *"A study on groundwater quality in the surrounding of a landfill"*, J. Env. Sci. Health : A, Vol.32, No.8, pp.2275-2287.

Giroult, E.; Christen, J. and Brown, A. (1996). *"Public health aspects of municipal solid waste management"*, International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management – UNEP International Environmental Technology Centre.

Huren An; Englehardt, J.; Fleming, L. and Bean J. (1999). *"Occupational health and safety amongst municipal solid waste workers in florida"*, Waste. Manag. Res., Vol.17, pp.369-377.

Jones, H.K. and Elgy, J. (1994). *"Remote sensing to assess landfill gas migration"*, Waste Manag. Res., Vol.12, No.4, pp.327-338.

Kinman (1987). *"Sanitary landfill disposal of urban solid waste"*, Workshop on SWM, New Delhi, 16th & 17th January.

Kjeldsen, P.; Grundtvig, A; Winther, P. and Anderson, J.S. (1998). *"Characterization of an old municipal landfill (Grindsted, Denmark) as a ground pollution source : landfill history and leachate composition"* , Waste Manag. Res., Vol.16, No.1, pp.3-13.

Kjeldsen, P.; Grundtvig, A; Winther, P. and Anderson, J.S. (1998). *"Characterization of an old municipal landfill (Grindsted, Denmark) as a ground pollution source : landfill hydrology and leachate migration"*, Waste Manag. Res., Vol.16, No.1, pp.14-22.

Kjeldsen, P. and Fischer, E. (1995). *"Landfill gas migration – field investigations at skellingsted landfill, Denmark"*, Waste Manag. Res., Vol.13, No.5, pp.467-484.

LaGrega, M.D.; Buckingham, P.L. and Evans, J.C. , Environmental Resource Management Group – Hazardous Waste Management.

Lin, H.Y.; Kao, J.J. and Chang, L. (1998), *"A vector-based spatial model for landfill siting"*, J. Hazardous Material, Vol.58, pp.3-14.

Mac Donold, A. (1991). *"Landfill gas recovery"*, Biocycle, Vol.32, No.8, p.40.

MoEF (1991). *"Guidelines for Management and Handling of Hazardous Wastes"*, New Delhi

Morelli, J. and Spencer, R. (1991). *"Mining landfills for recyclables"*, Biocycle, vol.32, No.2, pp.34-37.

NEERI Report (1994). *"Solid Waste Management in Greater Bombay"*.

NEERI Report (1996). *"Solid Waste Management in MCD Area"*.

NEERI Report (2000). *"Rapid Environmental Impact Assessment of Proposed Rail Car Depot at Khyber Pass, Delhi"*.

Nikac, N.; Cosovic, B.; Ahel, M.; Andresis, S. and Toncic, Z. (1998). *"Assessment of groundwater contamination in the vicinity of municipal solid waste landfill"*, Water Sci. Tech., Vol.37, No.3, pp.37-44.

Noble, G. (1992). *"Siting Landfills and Other LULUs"*, Technomic.

Petts, J. and Edulijee, G. (1994). *"Environmental Impact Assessment for Waste Treatment and Disposal Facilities"*, John Wiley and Sons.

Rushbrook, P. and Pugh, Michael (1999) *"Solid Waste Landfill in Middle and Lower Income Countries"*, A Technical guide to Planning Design and Operation.

Schrab, G.E.; Brown, K.W. and Donnelly, K.C. (1993). *"Acute and genetic toxicity of municipal landfill leachate"*, Water, Air & Soil Pollution, Vol.69, No.1/2, pp.99-112.

Standard Methods for the Examination of Water & Wastewater (1998). 20th Ed.

Tchobanoglous, G.; Theisen, H. and Vigil, S.A. (1993). *"Integrated solid waste management - Engineering principles and management issues"*, McGraw-Hill International.

USEPA, Part 258 (1999). *"Criteria for Municipal Solid Waste Landfills"*, 40 CRF Ch. 1 (7-1-99 Edition).

Wall, D.K. and Zeiss, C. (1995). *"Municipal landfill biodegradation and settlement"*, J. Env. Engg., Vol.121, No.3, p.214.

West, M.E.; Brown, K.W. and Thomas, J.C. (1998). *"Methane production of raw and composted solid waste in simulated landfill cells"*, Waste Manag. Res., Vol.16, No.5, pp.430-436.

Annexure 6

Municipal Solid Waste (Management and Handling) Rules 2000 and Draft Municipal Solid Waste (Management and Handling) Rules 2014

प्ररूप-6

दुर्घटना का प्रतिवेदन

1.	दुर्घटना की तारीख और समय	
2.	दुर्घटना के लिए कारक घटनाओं का अनुक्रम	
3.	दुर्घटना में सम्मिलित अपविष्ट	
4.	दुर्घटना का मानव स्वास्थ्य और पर्यावरण पर होने वाले असर का निर्धारण	
5.	आपातकाल में की गई कार्यवाही	
6.	दुर्घटना के असर को कम करने के लिए किए गए उपाय	
7.	दुर्घटना को पुनःघटित होने से रोकने के लिए उपाय	
	तारीखः..........................	हस्ताक्षर..........................
	स्थानः..........................	पदनाम..........................

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 2nd July, 2013

S.O. 1978(E).—The following draft of certain rules, which the Central Government proposes to issue in exercise of the powers conferred by Section 3, Section 6 and Section 25 of the Environment (Protection) Act, 1986 (29 of 1986) and in supersession of the Municipal Solid Wastes (Management and Handling) Rules, 2000 except as respects things done or omitted to be done before such supersession, it is hereby published for the information of public likely to be affected thereby; and the notice is hereby given that the said draft notification shall be taken into consideration on or after the expiry of a period of sixty days from the date on which copies of this notification as published in the Gazette of India are made available to public;

Objections or suggestions on the proposals contained in the draft notification, if any, may be addressed, within the period so specified, to the Secretary, Ministry of Environment and Forests, Paryavaran Bhawan, CGO Complex, Lodi Road, New Delhi-110 003 or electronically at e-mail address: secy-moef@nic.in;

The objections and suggestions which may be received from any person with respect to the said draft rules before the expiry of the period so specified shall be considered by the Central Government.

Draft Rules

1. Short title and commencement.--

(1) These rules may be called Municipal Solid Waste (Management and Handling) Rules, 2013;

(2) They shall come into force on the date of their final publication in the Official Gazette.

2. Application - These rules shall apply to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid waste.

3. Definitions - In these rules, unless the context otherwise requires,--

(i) **"anaerobic digestion"** means a controlled process involving microbial decomposition of organic matter in absence of oxygen;

(ii) **"authorization"** means the consent given by the State Pollution Control Board or Committee as the case may be, to the "operator of a facility" or "municipal authority", "panchayat" or any other agency as applicable ;

(iii) **"biodegradable substance"** means a substance that can be degraded by micro-organisms;

(iv) **"biomethanation"** means a process which entails enzymatic decomposition of the organic matter by microbial action to produce methane rich biogas;

(v) "**buffer zone**" mean a zone of no-development which shall be maintained around landfills, processing and disposal facilities of municipal solid waste;

(vi) **"Central Pollution Control Board (CPCB)"** means the Central Pollution Control Board constituted under sub-section (1) of Section **3** of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);

(vii) **"collection"** means lifting and removal of municipal solid waste from collection points or any other location;

(viii) **"composting"** means a controlled process involving microbial decomposition of organic matter;

(ix) **"construction and demolition waste"** means the waste arising from building materials debris and rubble resulting from construction, re-modelling, repair and demolition operation;

(x) **"disposal"** means the final disposal of municipal solid waste in terms of the specified measures to prevent contamination of ground-water, surface water, ambient air quality and source of bird attraction ;

(xi) **"form"** means a form appended to these rules;

(xii) **"generator of waste"** means persons or establishments generating municipal solid waste;

(xiii) **"landfilling"** means the disposal of residual municipal solid waste on land in a facility designed with protective measures against pollution of ground water, surface water and air fugitive dust, wind-blown litter, bad odour, fire hazard, bird menace, pests or rodents, greenhouse gas emissions, slope instability and erosion;

(xiv) **"leachate"** means the liquid generated from municipal solid waste that seeps through solid waste or other medium and has extracts of dissolved or suspended material from it;

(xv) **"materials recovery facility (MRF)"** means a facility where municipal solid waste can be segregated, baled and temporarily stored;

(xvi) **"municipal authority" means the** Municipal Corporation, Municipality, Nagar Palika, Nagar Nigam, Nagar Panchyat, Municipal Council including notified area committee (NAC) or any other local body constituted under the Acts for time being in force and, where the management and handling of municipal solid waste is entrusted to such agency;

(xvii) **"municipal solid waste"** includes the commercial and residential waste generated in a municipal or notified areas in either solid or semi-solid form excluding industrial hazardous waste, e-waste and including treated bio-medical waste;

(xviii) **"municipal solid waste management"** means the collection, segregation, storage, transportation, processing and disposal of municipal solid waste, including reduction, re-use, recovery, recycling in a scientific and hygienic manner;

(xix) **"operator of a facility"** means a person who operates a facility for processing and disposal of municipal solid waste which also includes any other agency appointed by the municipal authority for the management of processing and disposal facility;

(xx) **"pelletisation"** means a process whereby pellets are prepared which are small cubes or cylindrical pieces made out of solid waste and includes the fuel pellets which are referred as refuse derived fuel ;

(xxi) **"Prescribed Authority"** means the Authority to undertake and ensure periodical implementation of the provisions of the these rule mentioned in rule 4;

(xxii) **"processing"** means the process by which municipal solid waste is transformed into new or recycled products;

(xxiii) **"recycling"** means the process of transforming segregated solid waste for producing new products;

(xxiv) **"refuse derived fuel (RDF)"** is fuel in the form of pellets or fluff produced by shredding and dehydrating combustible components of municipal solid waste;

(xxv) **"Schedule"** means a Schedule appended to these rules;

(xxvi) **"segregation"** means to separate the municipal solid waste into the groups of organic, inorganic, recyclables, industrial hazardous waste and e-waste;

(xxvii) **"State Pollution Control Board or Pollution Control Committee"** means the State Pollution Control Board or the Pollution Control Committee, as the case may be, constituted under sub-section (1) of Section 4 of the Water (Prevention and Control of Pollution) Act,1974;

(xxviii) **"storage"** means the temporary containment of municipal solid waste in a manner so as to prevent littering, attraction to vectors, stray animals and excessive foul odour;

(xxix) **"transportation "** means conveyance of municipal solid waste from place to place hygienically through specially designed transport system so as to prevent the foul odour, littering, unsightly conditions and accessibility to vectors;

(xxx) **"Treated bio-medical wastes"** means the wastes generated in hospitals and health care institutions which have been prescribed as treated under the Bio-medical Waste (Management and Handling) Rule1998, as amended time to time;

(xxxi) **"treatment"** means the method, technique or process, designed to modify physical, chemical or biological characteristics or composition of any waste so as to reduce its potential to cause harm;

(xxxii) **"vermicomposting"** is a process of using earthworms for conversion of bio-degradable waste into compost;

(xxxiii) **"waste pickers"** mean the individuals or groups of individuals engaged in the collection of municipal solid waste.

4. Prescribed Authority -

(1) The Prescribed Authorities are mentioned in column (2) of the table below:

Table 1:

List of Authorities and corresponding duties

S. No. (1)	Prescribed Authority (2)	Corresponding Duties (3)
1.	The Ministry of Environment and Forests, Government of India	To undertake periodic review of these rules.
2.	The Ministry of Urban Development, Government of India	Coordinate and review of implementation of these rules.
3.	The Secretary–in-charge, Urban Development Department, State Government	To ensure implementation of provisions of these rules by the urban local bodies and municipal authorities and to prepare a State Level Municipal solid waste policy or strategy.
4.	The Central Pollution Control Board	(i) To maintain Co-ordination with State Pollution Control Boards and Pollution Control Committees for review and enforcement of standards and guidelines; (ii) to prepare a consolidated annual review report on implementation of these rules.
5.	The Municipal Authority	(i) Collection, segregation, transportation and infrastructural development for the disposal of municipal solid waste; (ii) to seek authorization for setting up waste processing and disposal facility including landfills and to ensure compliance with specified standards; (iii) to seek environmental clearance for setting up municipal solid waste processing and disposal facility including landfills as per the Environment Impact Assessment notification dated 14th September, 2006 notified vide S.O. 1533 as amended time to time; (iv) to prepare and submit annual report to the Urban Development Department, concerned State Government and to the concerned State Pollution Control Board or Committee, as the case may be.
6.	The State Pollution Control Board or Pollution Control Committee	(i) Authorization, monitoring of parameters stipulated in the authorization or consents under the rules for the municipal solid waste processing and disposal facility including landfills; (ii) to prepare and submit annual report to the Central Pollution Control Board.

(2) The Prescribed Authorities referred under column (2) of the Table shall exercise the corresponding duties mentioned under column (3).

5. Responsibility of Municipal Authority -

(1) Every municipal authority shall be responsible for the implementation of the provisions of these rules and for the necessary infrastructure development for collection, storage, segregation, transportation, processing and disposal of municipal solid waste directly or by engaging agencies or groups working in waste management including waste pickers.

(2) The municipal authority or an operator of a facility shall make an application for grant of environmental clearance from the State Level Environment Impact Assessment Authority for setting up municipal solid waste processing and disposal facility including landfills as per the Environment Impact Assessment notification 2006 as amended time to time. The sites for landfills, processing and disposal facilities of municipal solid waste shall be incorporated in the Town Planning Department's land-use plans. The buffer zones shall be specified by the State Level Environment Impact Assessment Authority, on a case to case basis.

(3) The municipal authority or an operator of a facility shall obtain the authorization or consent for setting up waste processing and disposal facility including landfills from the State Pollution Control Board or the Pollution Control Committee, as the case may be.

(4) The municipal authority or an operator of a facility shall make an application in the form of Form-I, for grant of authorization for setting up waste processing and disposal facility including landfills from the State Pollution Control Board or the Pollution Control Committee, as the case may be.

(5) The municipal authority or an operator of a facility shall obtain the consents for the establishment and operations of the municipal solid waste processing, recycling, treatment under the provisions of the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981 from the State Pollution Control Board or the Pollution Control Committee.

(6) The municipal authority may determine the service fee for collection and transportation of municipal solid waste.

(7) The municipal authority or an operator of a facility shall comply with these rules as per the Schedules.

(8) The municipal authority shall prepare a municipal solid waste management plan as per policy or strategy of the concerned State Government or Union Territory.

(9) The municipal authority or an operator of a facility shall be responsible to design, set up and operate the facility as per the technical guidelines issued by the Central Pollution Control Board from time to time and shall obtain the approval for the design and lay out from the concerned State Pollution Control Board or Pollution Control Committee of the Union Territories.

(10)The municipal authority or an operator of a facility shall provide personal protection equipment namely hand gloves, high boots made of tough leather, goggles and masks to all workers for handling municipal solid waste.

(11)In case of existing engineered facilities that are in operation and have not obtained the requisite environmental clearances, consents and authorization, it shall be obtained within a period of one year from the issue of this notification.

6. Responsibility of the State Pollution Control Board or the Pollution Control Committees -

(1) The State Pollution Control Board or the Pollution Control Committee, as the case may be, shall monitor the progress of implementation of Action Plan and the compliance of the standards regarding ground water, ambient air, leachate quality and the compost quality including incineration standards or any other such condition as specified under the Schedules I and II.

(2) (i)For grant of authorization, the Municipal Authority or the operator of facility shall make an application in the form of Form I to the State Pollution Control Board or the Pollution Control Committee, as the case may be.

(ii)The State Pollution Control Board or the Pollution Control Committee, as the case may be, after the receipt of the application, from the Municipal Authority or the operator facility, shall examine the proposal.

(iii)While examining the proposal the State Pollution Control Board or the Pollution Control Committee, as the case may be, shall take into consideration the views of other agencies like the State Urban Development Department, the Town and Country Planning Department, Airport or Airbase Authority, the Ground Water Board or any such other agencies.

(3) The State Pollution Control Board or the Pollution Control Committee shall issue the authorization in form of Form-III to the municipal authority or an operator of a facility within a period of sixty

2921 GI/13-7

days stipulating compliance criteria and standards as specified in Schedule I and II including other conditions, as may be necessary.

(4) The authorization shall be valid for a specified period depending upon the type of waste processing or disposal facility; and after the validity is over, renewal of authorization shall be required.

(5) The State Pollution Control Board or the Pollution Control Committee, as the case may be, shall monitor the compliance of the conditions stipulated in the authorization and the standards specified in Schedules I, and II annexed to these rules as and when required.

7. Responsibility of the Central Pollution Control Board-

(1) The Central Pollution Control Board shall co-ordinate with the State Pollution Control Boards and the Pollution Control Committees with particular reference to implementation and review of standards and guidelines and compilation of monitoring data.

(2) The Central Pollution Control Board shall publish requisite guidelines for processing/treatment and disposal of municipal solid waste from time to time.

(3) The Central Pollution Control Board shall review the use of any new technology for processing, recycling and treatment of municipal solid waste and may prescribe standards in this regard.

8. Responsibilities of the State or Union Territory -

The State Level Urban Development Department shall prepare a Municipal Solid Waste Management Strategy for the State or the Union Territory and the strategy shall be consistent with the State Sanitation Strategy under the National Urban Sanitation Policy (NUSP) of the Ministry of Urban Development.

9. Management of municipal solid waste –

1. The waste collection, segregation, storage, transportation, and the processing and the disposal facilities to be set up by the municipal authority on their own or through an agency or an operator of a facility, shall fulfil the following specifications and standards namely:

(a) the safe collection and segregation of municipal solid waste into biodegradable and non-biodegradable components;

(b) the horticultural and construction or demolition or debris or dairy waste shall be separately collected and disposed of in accordance with the Bye laws and not to be mixed with municipal solid waste;

(c) the municipal authority shall identify storage spaces such as materials recovery facility, as appropriate, for segregation of municipal solid waste and the storage facilities to be set up by municipal authorities shall be so designed that the municipal solid waste stored are not exposed to open atmosphere and shall be user-friendly;

(d) the storage facilities or 'bins' shall have 'easy to operate' design for handling and transportation of municipal solid waste. Bins for storage of bio-degradable waste shall be painted green, those for storage of recyclable waste shall be painted white and those for storage of other waste shall be painted black;

(e) manual handling of municipal solid waste shall be prohibited: provided that in case unavoidable due to constraints, manual handling shall be carried out under proper precaution with due care for safety of workers;

(f) the landfill site may provide an appropriate facility for removing any recyclable material;

(g) the Land filling of mixed waste shall be avoided unless it is found unsuitable for waste processing;

(h) the landfill shall only be permitted for non-usable, non-recyclable, non-biodegradable, non-reactive inert waste and other waste such as residues of waste processing facilities as well as pre-processing rejects from waste processing facilities and the like nature provided that effort shall be done by the municipal authority or operators to utilize inert waste for making bricks, pavement blocks, construction blocks, non-recyclable plastics and other incinerable waste for co-incineration in cement kilns or any high temperature furnaces or manufacture of door panels, and the like nature so that the burden on landfill is reduced and the landfill sites shall meet the specifications as given in Schedule –I;

(i) to ensure that compost or any other end product shall comply with standards as specified in Schedule-II and also ensure that no damage is caused to the environment during this process;

(j) to create awareness among all stakeholders about their responsibilities;

(k) to ensure that the generator of municipal solid waste avoids littering, delivers the municipal solid waste to authorised agency or waste pickers as notified by the Municipal Authority and open burning of municipal solid waste is not permitted;

(l) the bio-medical waste, industrial hazardous waste and e-waste shall not be mixed with municipal solid waste and such waste shall follow the rules separately specified for the purpose.

2. The municipal authority shall incorporate the said rules in the Municipal bye laws of all the Urban Local Bodies;

3. The municipal authority shall encourage the use of municipal solid waste by adopting suitable technology which may include; composting, vermicomposting, anaerobic digestion with or without energy recovery, co-incineration, or combination of such technologies as appropriate, to make use of municipal solid waste so as to minimize burden on landfill.

4. The municipal authority or the operator, as the case may be, intending to use any other new technology may approach the State Pollution Control Board to get the standards laid down and seek authorization so as to ensure the compliance with the specified standards including pollution control norms prescribed by the competent authority in this regard.

5. The State Pollution Control Board or Pollution Control Committee, as the case may be, may approach Central Pollution Control Board for getting specified standards

6. The existing dumpsites which are not engineered landfill sites shall be closed down and capped as per the provisions of the rules.

7.. The new sites for solid waste disposal facility shall be in accordance with the provisions of the proposed rules.

8. The transition time for closing of such existing facilities and operation of new facilities shall be decided by the municipal authority in consultation with the State Urban Development Department.

10. State Level Advisory Body –

(1) The Government of every State or Union Territory shall constitute a State Level Advisory Board.

(2) The Body shall be constituted by Urban Development department of the concerned State Government or Union Territory.

(3) The constitution of the State Level Advisory Body shall be as given below:

(a) Secretary, Department of Urban Development – Chairperson, ex-officio

(b) one representative from each State Government, the Department of Environment – Member, ex-officio

(c) one representative from the Central Pollution Control Board or Central Pollution Control Board Zonal Office- Member, ex-officio

(d) one representative from the State Pollution Control Board or Pollution Control Committee – Member, ex-officio

(e) three representatives from the Urban Local Bodies - Member

(f) three representatives from the Non-Governmental Organisation or Civil Society working in the field of environment or waste management - Member

(4) The State Level Advisory Body shall meet at least once in a year to review all the matters related to implementation of Municipal Solid Waste (Management and Handling) Rules, 2013.

(5) The copies of the review report shall be forwarded to all the 'Prescribed Authorities' under these rules for necessary action.

(6) The Body shall also advise the Government of State or Union Territory, as the case may be, and also the Prescribed Authorities on the matters related to implementation of these rules.

(7) The State Level Advisory Body may co-opt experts, as necessary.

11. Annual Report-

(1) The municipal authority shall furnish its annual report in the form of Form-II to the Secretary-in-charge of the Department of Urban Development of the concerned State or Union Territory in

case of metropolitan city and the State Pollution Control Board or the Committee on or before the 30th day of June every year.

(2) The Operator of facility shall submit the annual report to the municipal authority as per Form-III.

(3) The annual report shall include the progress on action taken to comply with these rules and as per conditions stipulated by the State Pollution Control Board or Committee, as the case may be.

(4) Each State Pollution Control Board or Pollution Control Committee as the case may be, shall prepare and submit the annual report to the Central Pollution Control Board on the implementation of these rules by the 30th day of September of each year in the form of Form-IV;

(5) The Central Pollution Control Board shall prepare a consolidated annual review report on the use and management of municipal solid waste and forward the same to the Ministry of Urban Development and Ministry of Environment and Forests, Government of India along with its recommendations before the 30th day of December each year.

(6) The Ministry of Urban Development, Government of India shall make annual review for implementation of said rules with relevant stakeholders.

12. Accident Reporting. -- When an accident occurs at any municipal solid waste collection, segregation, storage, processing, treatment and disposal facility or landfill site or during the transportation of such waste, the municipal authority or an operator of facility shall forthwith report of the accident in the form of Form-V to the Secretary in-charge of the Urban Development Department and District Collector and the instructions issued by the said authorities shall be followed.

[F.No.18-3/2004 (Vol. II) -HSMD]

AJAY TYAGI, Jt. Secy.

SCHEDULE I

Specifications for Landfill Sites

A. Criteria for Site Selection.-

1. In areas falling under the jurisdiction of 'Development Authorities' it shall be the responsibility of such Development Authorities to identify the landfill sites and hand over the sites to the concerned municipal authority for development, operation and maintenance. Elsewhere, this responsibility shall lie with the concerned municipal authority.
2. Selection of landfill sites shall take into consideration the relevant environmental issue.
3. The landfill site shall be planned and designed with proper documentation of a phased construction plan as well as a closure plan. In case a new landfill facility is created adjoining an existing landfill site, the closure plan of existing landfill should form a part of the proposal of such new landfill.
4. The landfill sites shall be selected to make use of nearby wastes processing facility. Otherwise, wastes processing facility shall be planned as an integral part of the landfill site.
5. Landfill sites shall be set up as per the guidance notes formulated by the Ministry of Urban Development, Governmentof India.
6. The existing landfill sites which are in use for more than five years, shall be improved in accordance of the specifications given in this Schedule.
7. The landfill site shall be large enough to last for at least 20-25 years.
8. The landfill site shall be away from habitation clusters, forest areas, water bodies monuments, National Parks, Wetlands and places of important cultural, historical or religious interest and the distance to be maintained, as prescribed by the State Environment Impact Assessment Authority (SEIAA) on a case to case basis.
9. A buffer zone of no development shall be maintained around landfill sites and sites for processing and disposal of municipal solid waste. The sites for landfill, and processing and disposal of municipal solid waste shall be incorporated in the Town Planning Department's land-use plans. The buffer zone shall be prescribed by the State Environment Impact Assessment Authority (SEIAA), on a case to case basis. The site, as approved by the State Environment Impact Assessment Authority shall be notified by the concerned Local Government.
10. Landfill site shall be away from airport including airbase. Necessary approval of airport or airbase authorities prior to the setting up of the landfill site shall be obtained in cases where the site is to be located within 20 km of an airport or airbase.
11. Biomedical waste shall be disposed of in accordance with the Bio-medical Waste (Management and Handling) Rules, 1998, as amended. The hazardous waste shall be managed in accordance with the Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules, 2008, as

amended, from time to time. The E-waste shall be managed in accordance with the e-Waste (Management and Handling) Rules, 2011.

B. Criteria for Development of Facilities at the Site.-

1. Landfill site shall be fenced or hedged and provided with proper gate to monitor incoming vehicles or other modes of transportation.
2. The landfill site shall be well protected to prevent entry of unauthorized persons and stray animals.
3. Approach and other internal roads for free movement of vehicles and other machinery shall exist at the landfill site.
4. The landfill site shall have waste inspection facility to monitor waste brought in for landfill, office facility for record keeping and shelter for keeping equipment and machinery including pollution monitoring equipments.
5. Provisions like weigh bridge to measure quantity of waste brought at landfill site, fire protection equipments and other facilities as may be required shall be provided.
6. Utilities such as drinking water (preferably bathing facilities for workers) and lighting arrangements for easy landfill operations when carried out in night hours shall be provided.
7. Safety provisions including health inspections of workers at landfill site shall be periodically made.

C. Criteria for specifications for land filling operations and closure on completion of landfill.-

1. Waste subjected to land filling shall be compacted in thin layers using landfill compactors to achieve high density of the waste. In high rainfall areas where heavy compactors cannot be used alternative measures shall be adopted.
2. Waste shall be covered immediately or at the end of each working day with minimum 10 cm of soil, inert debris or construction material till such time waste processing facilities for composting or recycling or energy recovery are set up as per Schedule II.
3. Prior to the commencement of monsoon season, an intermediate cover of 40-65 cm thickness of soil shall be placed on the landfill with proper compaction and grading to prevent infiltration during monsoon. Proper drainage shall be constructed to divert run-off away from the active cell of the landfill.
4. After completion of landfill, a final cover shall be designed to minimize infiltration and erosion. The final cover shall meet the following specifications, namely :--
   (i) The final cover shall have a barrier soil layer comprising of 60 cms of clay or amended soil with permeability coefficient less that 1×10^{-7} cm/sec.
   (ii) On top of the barrier soil layer there shall be a drainage layer of 15 cm.
   (iii) On top of the drainage layer there shall be a vegetative layer of 45 cm to support natural plant growth and to minimize erosion.

D. Criteria for Pollution prevention.-

In order to prevent pollution problems from landfill operations, the following provisions shall be made, namely:-

1. Diversion of storm water drains to minimize leachate generation and prevent pollution of surface water and also for avoiding flooding and creation of marshy conditions;
2. Construction of a non-permeable lining system at the base and walls of waste disposal area. For landfill receiving residues of waste processing facilities or mixed waste or waste having contamination of hazardous materials (such as aerosols, bleaches, polishes, batteries, waste oils, paint products and pesticides) minimum liner specifications shall be a composite barrier having 1.5 mm high density polyethylene (HDPE) geo-membrane / geo-synthetic liners, or equivalent, overlying 90 cm of soil (clay or amended soil) having permeability coefficient not greater than 1×10^{-7} cm/sec. The highest level of water table shall be at least two meter below the base of clay or amended soil barrier layer;
3. Provisions for management of leachates collection and treatment shall be made. The treated leachates shall meet the standards specified in Schedule- II;
4. Prevention of run-off from landfill area entering any stream, river, lake or pond.

E. Criteria for Water Quality Monitoring.-

1. Before establishing any landfill site, baseline data of ground water quality in the area shall be collected and kept in record for future reference. The ground water quality within 50 metres of the

periphery of landfill site shall be periodically monitored to ensure that the ground water is not contaminated beyond acceptable limit as decided by the Ground Water Board or the State Board or the Committee. Such monitoring shall be carried out to cover different seasons in a year that is, summer, monsoon and post-monsoon period.

2. Usage of groundwater in and around landfill sites for any purpose (including drinking and irrigation) is to be considered after ensuring its quality. The following specifications for drinking water quality shall apply for monitoring purpose, namely :-

S. No.	Parameters	IS 10500:1991, Edition 2.2(2003-09) Desirable limit (mg/l except for pH)
(1)	Arsenic	0.01
(2)	Cadmium	0.01
(3)	Chromium(as Cr^{6+})	0.05
(4)	Copper	0.05
(5)	Cyanide	0.05
(6)	Lead	0.05
(7)	Mercury	0.001
(8)	Nickel	-
(9)	Nitrate as NO_3	45.0
(10)	pH	6.5-8.5
(11)	Iron	0.3
(12)	Total hardness (as $CaCO_3$)	300.0
(13)	Chlorides	250
(14)	Dissolved solids	500
(15)	Phenolic compounds (as C_6H_5OH)	0.001
(16)	Zinc	5.0
(17)	Sulphate (as SO_4)	200

F. Criteria for Ambient Air Quality Monitoring

1. Installation of landfill gas control system including gas collection system shall be made at landfill site to minimize odour generation, prevent off-site migration of gases and to protect vegetation planted on the rehabilitated landfill surface.

2. The concentration of methane gas generated at landfill site shall not exceed 25 per cent of the lower explosive limit (LEL).

3. The landfill gas from the collection facility at a landfill site shall be utilized for either direct thermal applications or power generation, as per viability. Otherwise, landfill gas shall be burnt (flared) and shall not be allowed to directly escape to the atmosphere or for illegal tapping. Passive venting shall be allowed if its utilization or flaring is not possible.

4. Ambient air quality at the landfill site and at the vicinity shall be monitored to meet the following specified standards, namely :-

S. No.	Parameters	**Acceptable levels**
(i)	Sulphur dioxide	50 µg/m^3(Annual*) 80 µg/m^3 (24 hours**)
(ii)	Nitrogen Dioxide	40 µg/m^3(Annual*) 80 µg/m^3(24 hours**)

(iii)	Particulate Matter(size less than 10μ) or PM_{10}	60 μg/m^3(Annual*) 100 μg/m^3(24 hours**)
(iv)	Particulate Matter(size less than 2.5 μ) or $PM_{2.5}$	40 μg/m^3(Annual*) 60 μg/m^3(24 hours**)
(v)	Carbon monoxide	1 hour ** : 04 mg/m^3 8 hours** : 02 mg/m^3
(vi)	Ammonia (NH_3) μg/m^3	100 μg/m^3(Annual*) 400 μg/m^3(24 hours**)
(vii)	Benzo(a) Pyrene(BaP)- particulate phase only, ng/m^3	01 ng/m^3 (Annual*)

Notes:

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

(ii) ** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year, 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

5. The ambient air quality monitoring shall be carried out by the concerned authority as per the following schedule, namely:-

(a) Six times in a year for cities having population of more than fifty lakhs;

(b) Four times in a year for cities having population between ten and fifty lakhs;

(c) Two times in a year for town or cities having population between one and ten lakhs.

G. Criteria for Plantation at Landfill Site

1. A vegetative cover shall be provided over the completed site in accordance with the and following specifications, namely:-

(a) Selection of locally adopted non-edible perennial plants that are resistant to drought and extreme temperatures shall be allowed to grow;

(b) The plants grown are such that their roots do not penetrate more than 30 cms. This condition shall apply till the landfill is stabilised;

(c) Selected plants shall have ability to thrive on low-nutrient soil with minimum nutrient addition;

(d) Plantation to be made in sufficient density to minimize soil erosion.

H. Criteria for Post-care of Landfill Site

1. The post-closure care of landfill site shall be conducted for at least fifteen years and long term monitoring or care plan shall consist of the following, namely :-

(a) Maintaining the integrity and effectiveness of final cover, making repairs and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(b) Monitoring leachate collection system in accordance with the requirement;

(c) Monitoring of ground water in accordance with requirements and maintaining ground water quality;

(d) Maintaining and operating the landfill gas collection system to meet the standards.

2. Use of closed landfill sites after fifteen years of post-closure monitoring can be considered for human settlement or otherwise only after ensuring that gaseous and leachate analysis complies with the specified standards.

I. Criteria for Special provisions for hilly areas

Cities and towns located on hills shall have location-specific methods evolved for final disposal of solid waste by the municipal authority with the approval of the concerned State Board or the Committee. The municipal authority shall set up processing facilities for utilization of biodegradable organic waste. The inert and non-biodegradable waste shall be used for building roads or filling-up of appropriate areas on hills. Because of constraints in finding adequate land in hilly areas, waste not suitable for road-laying or filling up shall be disposed of in specially designed landfills.

SCHEDULE II

A. Standards for Composting

1. The waste processing or disposal facilities shall include composting, controlled bioremediation, incineration, pelletisation, energy recovery or any other facility using suitable technology.
2. In case of engagement of private agency by the municipal authority, a specific agreement between the municipal authority and the private agency shall be made particularly, for supply of solid waste and other relevant terms and conditions.
3. In order to prevent pollution problems from compost plant and other processing facilities, the following shall be complied with, namely :-
   (i) The incoming waste at site shall be maintained prior to further processing. To the extent possible, the waste storage area should be covered. If, such storage is done in an open area, it shall be provided with impermeable base with facility for collection of leachate and surface water run-off into lined drains leading to a leachate treatment and disposal facility;
   (ii) Necessary precautions shall be taken to minimize nuisance of odour, flies, rodents, bird menace and fire hazard;
   (iii) In case of breakdown or maintenance of plant, waste intake shall be stopped and arrangements be worked out for diversion of waste to the temporary processing site or temporary landfill sites which will be again reprocessed when plant is in order;
   (iv) Pre-process and post-process rejects shall be removed from the processing facility on regular basis and shall not be allowed to pile at the site. Recyclables shall be routed through appropriate vendors. The non-recyclables shall be sent for well-designed landfill site(s).
   (v) In case of compost plant, the windrow area shall be provided with impermeable base. Such a base shall be made of concrete or compacted clay, 50 cm thick, having permeability coefficient less than 10^{-7} cm/sec. The base shall be provided with 1 to 2 per cent slope and circled by lined drains for collection of leachate or surface run-off;
   (vi) Ambient air quality monitoring shall be regularly carried out particularly for checking odor nuisance at down-wind direction on the boundary of processing plant.
   (vii) Leachate shall be re-circulated in compost plant for moisture maintenance.

4. In order to ensure safe application of compost, the following specifications for compost quality shall be met, namely:-

Parameters	**Concentration not to exceed * (mg/kg dry basis, except pH value and C/N ratio)**
Arsenic	10.00
Cadmium	5.00
Chromium	50.00
Copper	300.00
Lead	100.00
Mercury	0.15
Nickel	50.00
Zinc	1000.00
C/N ratio	20-40
PH	5.5-8.5

* Compost (final product) exceeding the above stated concentration limits shall not be used for food crops. However, it may be utilized for purposes other than growing food crops.

B. Standards for Treated Leachates

The disposal of treated leachates shall follow the following standards, namely:-

S. No.	Parameter	Standards (Mode of Disposal)		
		Inland surface water	Public sewers	Land disposal
1.	Suspended solids, mg/l, max	100	600	200
2.	Dissolved solids (inorganic) mg/l, max.	2100	2100	2100
3.	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4.	Ammonical nitrogen (as N), mg/l, max.	50	50	-
5.	Total Kjeldahl nitrogen (as N), mg/l, max.	100	-	-
6.	Biochemical oxygen demand (3 days at 27^0 C) max.(mg/l)	30	350	100
7.	Chemical oxygen demand, mg/l, max.	250	-	-
8.	Arsenic (as As), mg/l, max	0.2	0.2	0.2
9.	Mercury (as Hg), mg/l, max	0.01	0.01	-
10.	Lead (as Pb), mg/l, max	0.1	1.0	-
11.	Cadmium (as Cd), mg/l, max	2.0	1.0	-
12.	Total Chromium (as Cr), mg/l, max.	2.0	2.0	-
13.	Copper (as Cu), mg/l, max.	3.0	3.0	-
14.	Zinc (as Zn), mg/l, max.	5.0	15	-
15.	Nickel (as Ni), mg/l, max	3.0	3.0	-
16.	Cyanide (as CN), mg/l, max.	0.2	2.0	0.2
17.	Chloride (as Cl), mg/l, max.	1000	1000	600
18.	Fluoride (as F), mg/l, max	2.0	1.5	-
19.	Phenolic compounds (as C_6H_5OH) mg/l, max.	1.0	5.0	-

Note : While discharging treated leachates into inland surface waters, quantity of leachates being discharged and the quantity of dilution water available in the receiving water body shall be given due consideration.

C. Incineration:

The incinerators shall meet the following operating and emission standards, namely:-

Operating Standards

(1) The combustion efficiency (CE) shall be at least 99.00%.

(2) The combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO_2}{\%CO_2 + \%CO} \times 100$$

Emission Standards

Parameters	Concentration mg/Nm^3 at (12% CO_2 correction)
(1) Particulate matter	150
(2) Nitrogen Oxides	450
(3) HCl	50

(4) Minimum stack height shall be 30 meters above ground.

(5) Volatile organic compounds in ash shall not be more than 0.01%.

2921 GI/13-9

Note:

1. Suitably designed pollution control devices shall be installed or retrofitted with the incinerator to achieve the above emission limits, if necessary.
2. Waste to be incinerated shall not be chemically treated with any chlorinated disinfectants.
3. Chlorinated plastics shall not be incinerated.
4. Toxic metals in incineration ash shall be limited within the regulatory quantities as specified in the Hazardous Waste (Management, Handling and Trans boundary Movement) Rules, 2008, as amended from time to time.
5. Only low sulphur fuel like l.d.o., l.s.h.s or Diesel shall be used as fuel in the incinerator.

D. Waste to Energy.-

The State Pollution Control Board or Committee, on examination of the proposal on case-to-case basis, shall prescribe such standards for maintenance of ambient air quality around such facilities. The standards and other specifications shall be in consonance with the emission standards prescribed for incineration and for disposal of treated leachates.

The State Pollution Control Board or Pollution Control Committee shall examine the proposal submitted by Municipal Authority or an operator on behalf of these authorities and if it includes the technology other than mentioned in these rules shall be approved by the State Pollution Control Board or Committee. However, if the State Pollution Control Board or Committee so desire, may forward to Central Pollution Control Board for technical advice.

FORM – I

APPLICATION FOR OBTAINING AUTHORIZATION FOR PROCESSING/RECYCLING/TREATMENT AND DISPOSAL OF MUNICIPAL SOLID WASTE

To,

The Member Secretary,

..............State Pollution Control Board/Pollution Control Committee

of........

Sir,

I/We hereby apply for authorization under the Municipal Solid Waste (Management and Handling) Rules, 2012 for processing, recycling, treatment and disposal of municipal solid waste

1.	Name of the municipal authority/agency appointed by them/ operator of facility	
2.	Correspondence address Telephone No. Fax No. e-mail:	
3.	Nodal Officer & designation(Officer authorised by the municipal authority or agency responsible for operation of processing/ treatment or disposal facility)	
4.	Authorization required for setting up and operation of the facility (Please tick mark)	(a) waste processing ☐ (b) recycling ☐ (c) treatment ☐ (d) disposal ☐ (e) landfill ☐
5.	Attach copies of the Documents	(i) Site clearance (local authority) (ii) Proof of Environmental Clearance (iii) Consent for establishment (iv) Consent to operate (v) Agreement between municipal authority and operating agency

		(vi) Investment on the project and expected return
6.	**Processing/recycling/treatment of municipal solid waste** (i) Total Quantity of waste to be processed per day (a) Quantity of waste recycled per day (b) Quantity of waste treated per day (c) Quantity of waste disposed per day into landfill (ii)Utilization programme for waste processed (Product utilization) (iii)Methodology for disposal (attach details) (a) Quantity of leachate (b) Treatment technology for leachate (iv)Measures to be taken for prevention and control of environmental pollution (v)Measures to be taken for safety of workers working in the plant (vi)Details on municipal solid waste processing/recycling/ treatment/disposal facility (to be attached)	
7.	**Disposal of municipal solid waste** (i) Number of sites identified (ii) Quantity of waste to be disposed per day (iii) Nature and composition of waste (iv) Details of methodology or criteria followed for site selection (attach) (v) Details of existing site under operation (vi) Methodology and operational details of landfilling (vii) Measures taken to check environmental pollution	
8	A detailed Action Plan for implementation may be attached	

Date:

Place:

Signature:

Designation

Form- II

FORMAT FOR ISSUE OF AUTHORISATION

File No.: ________________

Dated:____________________

Authorization No ______________

To

Ref: Your application number ____________________dt. ____________

The ________________State Pollution Control Board/Pollution Control Committee after examining the proposal hereby authorises________________having their administrative office at ________________________________to set up and operate waste processing/recycling/ treatment/disposal facility at_______________________________

1. The authorization is hereby granted to operate the facility for processing, recycling, treatment and disposal of municipal solid waste.
2. The authorization is subject to the terms and conditions stated below and such conditions as may be otherwise specified in these rules and the standards laid down in Schedules II, IV and V annexed to these rules.
3. The ________________State Pollution Control Board/Pollution Control Committees of the UT may, at any time, revoke any of the conditions applicable under the authorization and shall communicate the same in writing.
4. Any violation of the provision of the Municipal Solid Waste (Management and Handling) Rules, 2012 will attract the penal provision of the Environment (Protection) Act, 1986 (29 of 1986).

(Member Secretary)

State Pollution Control Board/Pollution Control Committee of the UT

(Signature and designation)

Date :

Place :

Form - III

FORMAT OF ANNUAL REPORT TO BE SUBMITTED BY THE MUNICIPAL AUTHORITY

1	Name of the City/Town	
2	Population	
3	Municipal Body Name & Address Telephone No. Fax No. E-mail:	
4	Name of in-charge dealing with municipal solid waste	
5	Total Quantity of solid waste	
	(i) Quantity of waste generated per day	
	(ii) Quantity of waste collected per day	
	(iii) Quantity of waste processed	
	(iv) Quantity of waste disposed by landfilling	
6.	Waste Collection	Attach property map of city with location of all households/ commercial/ institutional/ other establishments marked on it
	(i) Area covered for collection of waste	
	(i) No. of houses covered	Total number in each category
	(ii) No. of commercial establishments including hotels covered	Provide number with details
	(iii) No. of educational institutions/ offices/ other	Provide number with details

		institutes generating municipal waste covered, as defined in Chapter I, point 3(xviii) of the Rules.	
	(iv)	whether door-to door collection of municipal solid waste is practiced	Yes/No
	(v)	whether waste is collected in segregated form at household, commercial and institutional level	Yes/ No (if yes, provide details)
7.	Waste Storage and facilities		
	(i)	No. of Bins (green, white, black), size, shape, type	Existing Proposed
	(ii)	RCC Bins (Capacity)	Existing Proposed
	(iii)	Containers (Capacity)	Existing Proposed
	(iv)	Dumper Location – Placers	Existing Proposed
	(v)	Trolleys and dhalao (Capacity)	Existing Proposed
	(vi)	Others, please specify	
		(a) Zone wise distribution of all Bins (colored and RCC , containers, dumper placers, dhalao points)	Attach property map of city with distribution of bins, dumper placers, containers, dhalaos marked on it
		(b) Whether all bins/collection spots are attended for daily lifting of garbage	Yes/No
		(c) Whether all bins/ collection spots have facility for segregated storage	Yes/ No (if yes, add details)
		(d) Whether lifting of garbage from dustbins is manual or mechanical	Manual/Loaders/Others specify
		(e) If mechanical - using (Please tick mark)	front-end loaders/ Top loaders
		(f) Whether garbage is lifted and transported to treatment plant in segregated form	Yes/ No (if yes, specify)
8.	Waste Transportation		
	(i)	Truck	Existing Proposed
	(ii)	Truck-Tipper	Existing Proposed
	(iii)	Tractor-Trailer	Existing Proposed
	(iv)	Refuse Collector	Existing Proposed
	(v)	Dumper Placers	Existing Proposed
	(vi)	Animal cart	Existing Proposed
	(vii)	Tricycle	Existing Proposed
	(viii)	Others	Existing Proposed
9.	Waste Treatment Technologies		
	(i)	Composting	Qty. raw material processed Qty. final product produced Qty. sold
	(ii)	vermicomposting	Qty. raw material processed Qty. final product produced Qty. sold
	(iii)	Refuse Derived Fuel	Qty. raw material processed Qty. final product produced Qty. sold

	(iv) Co-processing	Qty. raw material processed
	(v) Energy recovery	Qty. raw material processed Qty. final energy produced Qty. material landfilled
	(vi) Waste incineration	Qty. raw material processed Qty. final product produced Qty. material landfilled
	(vii) Others	Qty.
10	Details on the landfill facilities	
	(i) No. of landfill sites used	
	(ii) Area used	
	(a). Area is fenced	Yes / No
	(b). Lighting facility on site	Yes / No
	(c). Weigh bridge facility available	Yes / No (if yes attach data sheet)
	(d). Equipment used (specify)	Bulldozer, Compacters etc. available
	(e). Manpower available on site	Yes/No (if yes, attach details)
	(f). Covering is done on daily basis	Yes/No
	(g). Adequate covering material is available	Yes/No
	(h). Provisions for gas venting provided	Yes/No (if yes, attach technical data sheet)
	(i). Provision for leachate collection	Yes/No (if yes, attach technical data sheet)
11	Whether an Action Plan has been prepared for improving solid waste management practices in the city	Yes/No (if Yes attach Action Plan details)
12	What provisions are available and how these are implemented to check unhygienic operations of? (i) Dairy related activities : (ii) Slaughter houses and unauthorised slaughtering : (iii) Malba (construction debris) lifting : (iv) Encroachment in Parks, Footpaths etc.	Attach details on Proposals, Steps taken,
13	Details of Post Closure Plan	Attach Plan
14	How many slums are identified and whether these are provided with Solid Waste Management facilities :	Yes/ No (if Yes, attach details)

Signature of Municipal Commissioner

Dated:

Place:

Form - IV

FORMAT OF ANNUAL REPORT TO BE SUBMITTED BY THE OPERATOR OF FACILITY TO THE MUNICIPAL AUTHORITY

1	**Name of the City/Town**	
3	**Operator** Name and Address Telephone No.	

	Fax No. E-mail:	
4	**Name of in-charge dealing with MSW**	
5	**Total Quantity of solid waste**	
	(i) Quantity of waste generated per day	
	(ii) Quantity of waste collected per day	
	(iii) Quantity of waste processed	
	(iv) Quantity of waste disposed by landfilling	
6.	**Waste Collection**	Attach property map of city with location of all households/ commercial/ institutional/ other establishments marked on it
	(i) Area covered for collection of waste	
	(ii) No. of houses covered	Total number in each category
	(iii) No. of commercial establishments including hotels covered	Provide number with details
	(iv) No. of educational institutions/ offices/ other institutes generating municipal waste covered, as defined in Chapter I, point 3(xviii) of the Rules.	Provide number with details
	(v) whether door-to door collection of municipal waste is practiced	Yes/No
	if yes - whether done by	municipality/ Private Agency /Non-Governmental Organizations
	(vi) whether waste is collected in segregated form at household, commercial and institutional level	Yes/ No (if yes, add details)
7.	**Waste Storage and facilities**	
	(i) No. of Bins (green, white, black), size, shape, type	Existing Proposed
	(ii) RCC Bins (Capacity)	Existing Proposed
	(iii) Containers (Capacity)	Existing Proposed
	(iv) Dumper Location – Placers	Existing Proposed
	(v) Trolleys and dhalao (Capacity)	Existing Proposed
	(a) Others, please specify	
	(b) Zone wise distribution of all Bins (colored and RCC , containers, dumper placers, dhalao points)	Attach property map of city with distribution of bins, dumper placers, containers, dhalaos marked on it
	(c) Whether all bins/collection spots are attended for daily lifting of garbage	Yes/No
	(d) Whether all bins/ collection spots have facility for segregated storage	Yes/ No (if yes, add details)
	(e) Whether lifting of garbage from dustbins is manual or mechanical	Manual/Loaders/Others specify
	(f) If mechanical - using (Please tick mark)	front-end loaders/ Top loaders
	(g) Whether garbage is lifted and transported to treatment plant in segregated form	Yes/ No (if yes, specify)
8.	**Waste Transportation**	
	(i) Truck	Existing Proposed

	(ii) Truck-Tipper	Existing Proposed
	(iii) Tractor-Trailer	Existing Proposed
	(iv) Refuse Collector	Existing Proposed
	(v) Dumper Placers	Existing Proposed
	(vi) Animal cart	Existing Proposed
	(vii) Tricycle	Existing Proposed
	(viii) Others	Existing Proposed
9.	**Waste Treatment Technologies**	
	(i) Composting	Qty. raw material processed Qty. final product produced Qty. Sold
	(ii) vermicomposting	Qty. raw material processed Qty. final product produced Qty. Sold
	(iii) Refuse Derived Fuel	Qty. raw material processed Qty. final product produced Qty. Sold
	(iv) Co-processing	Qty. raw material processed
	(v) Energy recovery	Qty. raw material processed Qty. final energy produced Qty. material landfilled
	(vi) Waste incineration	Qty. raw material processed Qty. final product produced Qty. material landfilled
	(vii) Others	Qty.
10	**Details on the landfill facilities**	
	(i) No. of landfill sites used	
	(ii) Area used	
	(a) Area is fenced	Yes / No
	(b) Lighting facility on site	Yes / No
	(c) Weigh bridge facility available	Yes / No (if yes attach data sheet)
	(d) Equipment used (specify)	Bulldozer, Compacters etc available
	(e) Manpower available on site	Yes/No (if yes, attach details)
	(f) Covering is done on daily basis	Yes/No
	(g) Adequate covering material is available	Yes/No
	(h) Provisions for gas venting provided	Yes/No (if yes, attach technical data sheet)
	(i) Provision for leachate collection	Yes/No (if yes, attach technical data sheet)
14	**Details of Post Closure Plan**	Attach Plan

Signature of Operator

Dated :

Place:

Form - V

Format of Annual Review Report to be submitted by the State Pollution Control Board/Committees to the Central Pollution Control Board

To,

The Chairman,
Central Pollution Control Board,
'Parivesh Bhawan',
East Arjun Nagar,
DELHI- 110 032

1.	Name of the State/Union territory	:	
2.	Name & address of the State Pollution Control	:	
3.	Number of municipal authorities responsible for management of municipal solid waste in the State/Union territory under these rules	:	
4.	No. of authorization application Received	:	
5.	A Summary Statement on progress made by municipal authority in respect of municipal solid waste management	:	Please attach as Annexure-I
6.	A Summary Statement on progress made by municipal authorities in respect of waste collection, segregation, transportation and disposal	:	Please attach as Annexure-II
7.	A summary statement on progress made by municipal authorities in respect of implementation of Schedule II	:	Please attach as Annexure-III

Date: .... Place:	Chairman or the Member Secretary State Pollution Control Board/ Pollution Control Committee

Form - VI

Accident Reporting

1.	Date and time of accident	:	
2.	Sequence of events leading to accident	:	
3.	The waste involved in accident	:	
4.	Assessment of the effects of the accidents on human health and the environment	:	
5.	Emergency measures taken	:	
6.	Steps taken to alleviate the effects of accidents	:	
7.	Steps taken to prevent the recurrence of such an accident	:	

Date:	Signature:...........................
Place:	Designation: ....

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

Annexure 7

The Plastic Waste (Management and Handling) Rules 2011

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 4th February, 2011

S.O. 249(E).— Whereas the draft rules, namely, the Plastics (Manufacture, Usage and Waste Management) Rules, 2009 were published by the Government of India in the Ministry of Environment and Forests vide number S.O. 2400(E), dated the 17th September, 2009 in the Gazette of India, Extraordinary of the same date inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of a period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS copies of the said Gazette were made available to the public on the 17th day of September, 2009;

AND WHEREAS the objections and suggestions received within the said period from the public in respect of the said draft rules have been duly considered by the Central Government.

NOW, THEREFORE, in exercise of the powers conferred by sections 3, 6, and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Recycled Plastics Manufacture and Usage Rules, 1999, except as respects things done or omitted to be done before such supersession, the Central Government hereby makes the following Rules, namely:-

1. Short title and commencement .-

(1) These rules may be called the Plastic Waste (Management and Handling) Rules, 2011.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. Application.-

The provisions of rules 5 and 8 shall not apply to the manufacture of carry bags exclusively for export purposes, by export oriented manufacturing units, against an order for export received by the owner or occupier of the concerned manufacturing unit. This exemption does not apply to any surplus or rejects, left over and the like.

3. Definitions.- In these rules, unless the context otherwise requires .-

(a) **"Act"** means the Environment (Protection) Act, 1986 (29 of 1986);

(b) **"Carry bags"** mean all plastic bags used to carry commodities, including self carrying features;

(c) **"Commodities"** mean articles; including but not limited to vegetables, fruits, pharmaceuticals, food grains and the like;

(d) **"Compostable plastics"** mean plastic that undergoes degradation by biological processes during composting to yield CO_2, water, inorganic compounds and biomass at a rate consistent with other known compostable materials and does not leave visible, distinguishable or toxic residue;

(e) **"Consent"** means the consent to establish and operate from the concerned State Pollution Control Board or Pollution Control Committee granted under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974), and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981);

(f) **"Disintegration"** means the physical breakdown of a material into very small fragments;

(g) **"Extended producer's responsibility (EPR)"** means the responsibility of a producer or manufacturer of plastic carry bags and multilayered plastic pouches or packages for the environmentally sound management of the product until the end of its life. This responsibility also applies to all manufactures using such packaging;

(h) **"Food-stuffs"** mean ready to eat food products, fast food, processed or cooked food in liquid, powder, solid or semi-solid form;

(i) **"Manufacturer"** means any producer who manufactures plastic carry bags, multilayered packaging, pouches and the like or uses such materials in packaging of a product;

(j) **"Municipal authority"** means Municipal Corporation, Municipality, Nagar Palika, Nagar Nigam, Nagar Panchayat, Municipal Council including notified area committee (NAC) or any other local body constituted under the relevant statutes and, where the management and handling of municipal solid waste is entrusted to such agency;

(k) **"Multilayered plastics"** mean any material having a combination of more than one layer of packaging material such as paper, paper board, polymeric materials, metalised layers or aluminium foil, either in the form of a laminate or co-extruded structure;

(l) **"Plastic"** means material which contains as an essential ingredient a high polymer and which at some stage in its processing into finished products can be shaped by flow;

(m) **"Plastic waste"** means any plastic product such as carry bags, pouches or multilayered packaging, which have been discarded after use or after their intended life is over;

(n) **"Registration"** means registration of units manufacturing or recycling carry bags made of virgin or recycled plastics with the concerned State Pollution Control Board or Pollution Control Committee, as the case may be;

(o) **"Virgin plastic"** means plastic material which has not been subjected to use earlier and has also not been blended with scrap or waste;

(p) **"Waste management"** means the scientific reduction, re-use, recovery, recycling, composting or disposal of plastic waste;

(q) **"Waste pickers"** mean individuals or groups of individuals engaged in the collection of plastic waste.

4. Prescribed Authority.-

The prescribed Authority means the Authority-

(a) for enforcement of the provisions of these rules related to authorization, manufacture, recycling and disposal shall be State Pollution Control Board and Pollution Control Committee in respect of Union territory;

(b) for enforcement of the provisions of these rules relating to the use, collection, segregation, transportation and disposal of post consumer plastic waste shall be the concerned municipal authority.

5. **Conditions.**- During the course of manufacture, stocking, distribution, sale and use of carry bags and sachets, the following conditions shall be fulfilled, namely:-

(a) carry bags shall either be white or made using only those pigments and colourants which are in conformity with Indian Standard : IS 9833:1981 titled as List of pigments and colourants for use in plastics in contact with foodstuffs, pharmaceuticals and drinking water, as amended from time to time;

(b) no person shall use carry bags made of recycled plastics or compostable plastics for storing, carrying, dispensing or packaging food stuffs;

(c) no person shall manufacture, stock, distribute or sell any carry bag made of virgin or recycled or compostable plastic, which is less than 40 microns in thickness;

(d) sachets using plastic material shall not be used for storing, packing or selling gutkha, tobacco and pan masala;

(e) recycled carry bags shall conform to the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

(f) carry bags made from compostable plastics shall conform to the Indian Standard: IS/ISO 17088:2008 titled as Specifications for Compostable Plastics, as amended from time to time.

6. **Plastic Waste Management.**-

The plastic waste management shall be as under:-

(a) recycling, recovery or disposal of plastic waste shall be carried out as per the rules, regulations and standards stipulated by the Central Government from time to time;

(b) recycling of plastics shall be carried out in accordance with the Indian Standard : IS 14534:1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;

(c) the municipal authority shall be responsible for setting up, operationalisation and co-ordination of the waste management system and for performing the associated functions, namely:- (i) to ensure safe collection, storage, segregation, transportation, processing and disposal of plastic waste; (ii) to ensure that no damage is caused to the environment during this process; (iii) to ensure setting up of collection centres for plastic waste involving manufacturers; (iv) to ensure its channelisation to recyclers; (v) to create awareness among all stakeholders about their responsibilities; (vi) to engage agencies or groups working in waste management including waste pickers, and (vii) to ensure that open burning of plastic waste is not permitted;

(d) for setting up plastic waste collection centres, the municipal authority may ask the manufacturers, either collectively or individually in line with the principle of Extended Producer's Responsibility (EPR) to provide the required finance to establish such collection centre;

(e) recyclers shall ensure that recycling facilities are in accordance with the Indian Standard: IS 14534:1998 titled as Guidelines for Recycling of Plastics and in compliance with the rules under the Environment (Protection) Act, 1986, as amended from time to time;

(f) the concerned municipal authority shall ensure that the residues generated from recycling processes are disposed of in compliance with Schedule II (Management of Municipal Solid Wastes) and Schedule III (Specifications for Landfill Sites) of the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Environment (Protection) Act, 1986, as amended from time to time;

(g) the municipal authority shall incorporate the said rules in the Municipal bye laws of all the Urban Local Bodies;

(h) the municipal authority shall encourage the use of plastic waste by adopting suitable technology such as in road construction, co-incineration etc. The municipal authority or the operator intending to use such technology shall ensure the compliance with the prescribed standards including pollution norms prescribed by the competent authority in this regard.

7. **Protocols for Compostable Plastic Materials.** - Determination of the degree of degradability and degree of disintegration of plastic material shall be as per the protocols of the Indian Standards listed in the Annexure to these rules.

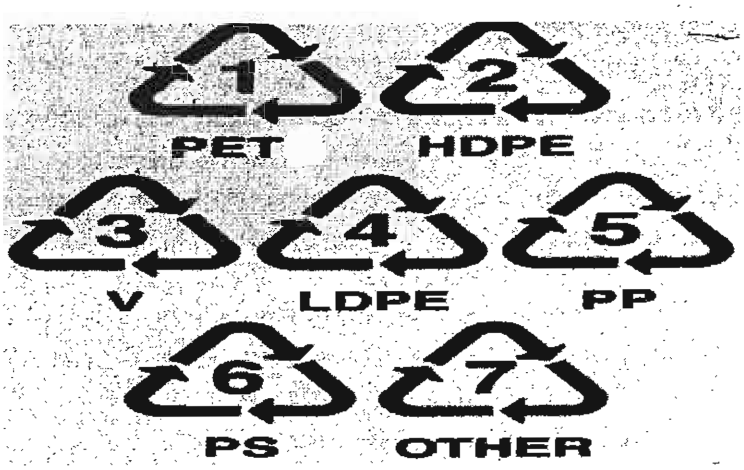
8. Marking or Labelling.-

(a) each plastic carry bag and multilayered packaging shall have the following information printed in English or in local language, namely:-

(i) name, registration number of the manufacturer and thickness in case of carry bag;

(ii) name and registration number of the manufacturer in case of multilayered packaging.

(b) each recycled carry bag shall bear a label or a mark "recycled" as shown below and shall conform to the Indian Standard: IS 14534: 1998 titled as Guidelines for Recycling of Plastics, as amended from time to time;



NOTE: PET-Polyethylene terephthalate, HDPE-High density polyethylene, V-Vinyl (PVC), LDPE- Low density polyethylene, PP-Polypropylene, PS-Polystyrene and Other means all other resins and multi-materials like ABS (Acrylonitrile butadiene styrene), PPO (Polyphenylene oxide), PC (Polycarbonate), PBT (Polybutylene terephalate) etc.

(c) each carry bag made from compostable plastics shall bear a label "compostable" and shall conform to the Indian Standard : IS/ISO 17088:2008 titled as Specifications for Compostable Plastics;

(d) retailers shall ensure that plastic carry bags and multilayered packaging sold by them are properly labelled, as per stipulations under these rules.

9. Registration of Manufacturers and Recyclers.-

(a) any person manufacturing or proposing to manufacture carry bags and multilayered plastics shall apply to the State Pollution Control Board (SPCB) or Pollution Control Committee (PCC) of the Union territory concerned for the grant of registration or for the renewal of registration for the manufacturing unit using Form 1 appended to these rules;

(b) any person recycling or proposing to recycle carry bags or multilayered plastics or any plastic waste shall apply to the SPCB or PCC for grant of registration or renewal of registration for the recycling unit using Form 2 appended to these rules;

(c) no person shall manufacture carry bags or recycle plastic bags or multilayered plastics unless without obtaining the registration certificate from the SPCB or PCC, as the case may be, prior to the commencement of production;

(d) the SPCB and PCC shall not issue or renew a registration for manufacturing or recycling units unless the unit possesses a valid consent under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and certificate of registration issued by the District Industries Centre or any other government agency authorised in this regard;

(e) every State Pollution Control Board or Pollution Control Committee shall take a decision on the grant of registration within ninety days of receipt of an application that is complete in all respects;

(f) the registration granted under this rule shall be valid for a period of three years, unless revoked, suspended or cancelled; and registration shall not be revoked, suspended or cancelled without providing the manufacturer an opportunity for a hearing;

(g) every application for renewal of registration shall be made at least ninety days before the expiry of the validity of the registration certificate.

10. Explicit pricing of carry bags.-

No carry bags shall be made available free of cost by retailers to consumers. The concerned municipal authority may by notification determine the minimum price for carry bags depending upon their quality and size which covers their material and waste management costs in order to encourage their re-use so as to minimize plastic waste generation.

11. State Level Advisory Body.-

(1) There shall be a State Level Advisory Body to monitor the implementation of these Rules.

(2) The State Level Advisory Body shall consist of the following persons, namely:-

(a) the Secretary, Department of Urban Development	- Chairman
(b) one expert from State Department of Environment	- Member
(c) one expert from State Pollution Control Board or Pollution Control Committee	- Member
(d) one expert from Urban Local Body	- Member
(e) one expert from Non-Governmental Organisation	- Member
(f) one expert from the field of Industry	- Member and
(g) one expert from the field of academic institution	- Member

(3) The State Level Advisory Body shall meet at least once in a year and may invite experts, if it considers necessary.

12. Annual Reports.-

(1) each State Pollution Control Board or Pollution Control Committee shall prepare and submit the annual report to the Central Pollution Control Board on the implementation of these rules by the 30th day of September of each year;

(2) the Central Pollution Control Board shall prepare a consolidated annual report on the use and management of plastic waste and forward it to the central government along with its recommendations before the 30th day of December each year.

[F. No. 17-2/2001-HSMD]

RAJIV GAUBA, Jt. Secy.

ANNEXURE

[See rule 7]

1.	IS/ISO 14851: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by measuring the oxygen demand in a closed Respirometer
2.	IS/ISO 14852: 1999 Determination of the ultimate aerobic biodegradability of plastic materials in an aqueous medium-Method by analysis of evolved carbon dioxide
3.	IS/ISO 14853: 2005 Plastics- Determination of the ultimate anaerobic biodegradation of plastic materials in an aqueous system-Method by measurement of biogas production
4.	IS/ISO 14855-1: 2005 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-1 General method)
5.	IS/ISO 14855-2: 2007 Determination of the ultimate aerobic biodegradability of plastic materials under controlled composting conditions-Method by analysis of evolved carbon dioxide (Part-2: Gravimetric measurement of carbon dioxide evolved in a laboratory- scale test)
6.	IS/ISO 15985: 2004 Plastics- Determination of the ultimate anaerobic biodegradation and disintegration under high-solids anaerobic digestion conditions- Methods by analysis of released biogas
7.	IS/ISO 16929: 2002 Plastics- Determination of degree of disintegration of plastic materials under defined composting conditions in a pilot - scale test
8.	IS/ISO 17556: 2003 Plastics- Determination of ultimate aerobic biodegradability in soil by measuring the oxygen demand in a Respirometer or the amount of carbon dioxide evolved
9.	IS/ISO 20200:2004 Plastics- Determination of degree of disintegration of plastic materials under simulated composting conditions in a laboratory - scale test

FORM - I

[See rules 9]

APPLICATION FOR REGISTRATION OF A UNIT FOR THE MANUFACTURE OF PLASTIC CARRY BAGS AND MULTILAYERED PLASTICS

From: ....

....

.................................(Name and full address of the occupier)

To

The Member Secretary,

.... Pollution Control Board/Pollution Control Committee

....

....

Sir,

I/We hereby apply for registration under rule 9 of the Plastic Waste (Management and Handling) Rules, 2011

PART – A GENERAL		
1.(a)	Name and location of the unit	
(b)	Address of the unit	
(c)	Registration required for manufacturing of: (i) Carry bags: (ii) Multilayered plastics	
(d)	Manufacturing capacity	
(e)	In case of renewal, previous registration number and date of registration	
2.	Is the unit registered with the DIC/DCSSI of the State Government/Union territory? If yes, attach a copy.	
3.(a)	Total capital invested on the project	
(b)	Year of commencement of production	
4. (a)	List and quantum of products and by-products	
(b)	List and quantum of raw materials used	
5.	Furnish a flow diagram of manufacturing process showing input and output in terms of products and waste generated including for captive power generation and water.	

6.	Minimum sizes and thickness of carry bags to be manufactured	
7.	Status of compliance with these rules	
PART – B PERTAINING TO LIQUID EFFLUENT AND GASEOUS EMISSIONS		
8.	(a) Does the unit have a valid consent under the Water (Prevention and control of Pollution) Act, 1974 (6 of 1974)? If yes, attach a copy	
	(b) Does the unit have a valid consent under the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981)? If yes, attach a copy	
PART – C PERTAINING TO WASTE		
9.	Solid Wastes: (a) Total quantum of waste generated (b) Mode of storage within the plant (c) Provision made for disposal of wastes	

Name and Signature

Designation

Date :

Place :

FORM - 2

[see rule 9]

APPLICATION FORM FOR REGISTRATION OF FACILITIES POSSESSING ENVIRONMENTALLY SOUND MANAGEMENT PRACTICES FOR RECYCLING PLASTIC WASTE

1.	Name and Address of the unit	
2.	Contact person with designation, Tel./Fax /email	
3.	Date Commissioned	

<table>
<tr><td>4.</td><td>No. of workers (including contract labour)</td><td colspan="3"></td></tr>
<tr><td>5.</td><td>Consents Validity</td><td colspan="3">a. Water (Prevention & Control of Pollution) Act, 1974;
Valid up to ________________

b. Air (Prevention & Control of Pollution) Act, 1981;
Valid up to____ ____________</td></tr>
<tr><td>6.</td><td>Authorization validity</td><td colspan="3"></td></tr>
<tr><td>7.</td><td>Manufacturing Process</td><td colspan="3">Please attach a flow diagram of the manufacturing process flow diagram for each product.</td></tr>
<tr><td>8.</td><td>Products and installed capacity of production (MTA)</td><td colspan="2">Products</td><td>Installed capacity</td></tr>
<tr><td>9.</td><td>Products manufactured during the last three years (as applicable)</td><td>Year</td><td>Product</td><td>Quantity</td></tr>
<tr><td>10.</td><td>Raw material consumed during the last three years (as applicable)</td><td>Year</td><td>Product</td><td>Quantity</td></tr>
<tr><td>11.</td><td>Water consumption</td><td colspan="3">Industrial ____________m³/day
Domestic____________m³ / day</td></tr>
<tr><td></td><td colspan="4">Date until which water cess has been paid (if applicable)</td></tr>
<tr><td></td><td>Waste water generation as per consent ______________m³/day</td><td colspan="3">Actual waste water generated (average of last 3 months)
Industrial ___________m³ /day
Domestic ___________m³ /day</td></tr>
<tr><td></td><td>Waste water treatment (provide flow diagram of the treatment scheme)</td><td colspan="3">Industrial
Domestic</td></tr>
<tr><td></td><td>Waste water discharge</td><td colspan="3">Quantity ____________m³/day
Location ___________________
Analysis of treated waste water for pH, BOD, COD, SS, O&G, any other parameter stipulated by SPCB/PCC (attach details)</td></tr>
<tr><td>12.</td><td>Air Pollution Control</td><td colspan="3"></td></tr>
<tr><td></td><td>a. Provide a flow diagram for emission control system(s) installed for each processing unit, utilities etc.</td><td colspan="3"></td></tr>
</table>

	b. Details for facilities provided for control of fugitive emissions due to material handling, process, utilities etc.				
	c. Fuel consumption	Fuel	Qty per day/month		
		(i)			
		(ii)			
	d. Stack emission monitoring	Stack attached to	Emission (SPM, SO_2, NOx , etc.) mg/Nm3		
		(i)			
		(ii)			
	e. Ambient air quality	Location Results $\mu g/m^3$	Parameters SPM, SO_2, NOx, etc.) $\mu g/m^3$		
		(i)			
		(ii)			
13.	Waste Management:	S No	Type	Category	Qty.
	a. Waste generation in processing plastic-waste	(i)			
		(ii)			
		(iii)			
	b. Waste Collection and transportation (attach details)				
	c. Waste Disposal details	S No	Type	Category	Qty
		(i)			
		(ii)			
	d. Provide details of the disposal facility, whether the facility is authorized by SPCB/SPCC				
	e. Please attach analysis report of characterization of waste generated (including leachate test if applicable)				
14.	Details of plastic waste proposed to be acquired through sale, auction, contract or import, as the case may be, for use as raw material	(i) Name (ii) Quantity required /year			
15.	Occupational safety and health aspects	Please provide details of facilities			
16.	Remarks:				
	Whether the unit has adequate pollution control systems / equipment to meet the standards of emission / effluent.	If Yes, please furnish details			

	Whether unit is in compliance with conditions laid down in the said rules.	Yes/No
	Whether conditions exist or are likely to exist of the material being handled / processed posing adverse immediate or delayed impacts on the environment.	Yes/No
	Whether conditions exist (or are likely to exist) of the material being handled / processed by any means capable of yielding another material (e.g. leachate) which may possess eco-toxicity.	Yes/No
17.	Any other relevant information	
18.	List of enclosures as per rule	

Name and Signature

Designation

Date :

Place :

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

Annexure 8

The Bio-Medical Waste (Management and Handling) Rules 1998, Amended 2003 and The Bio-Medical Waste (Management and Handling) Rules 2011

3. उपचार सुविधा के विस्तृत ब्यौरे

आफ-साइट सुविधा के मामले में

(i) प्रचालक व्यक्ति का नाम

(ii) सुविधा का नाम और पता

टेलीफोन सं. टेलेक्स सं. फैक्स सं.

4. उपचारित अपशिष्ट की श्रेणी वार मात्रा

5. उपचार की पद्धति ब्यौरों सहित

6. अन्य कोई सूचना :

7. प्रमाणित किया जाता है कि उपर्युक्त रिपोर्ट ——————————————— से प्रारम्भ होने वाली अवधि के लिए है।

हस्ताक्षर————————

पदनाम————————

तारीख ——————

स्थान ——————

प्रारूप 3

(नियम 12 देखिए)

दुर्घटना की रिपोर्ट

1. दुर्घटना की तारीख और समय

2. उन दुर्घटनाओं का क्रम जिनसे दुर्घटना हुई :

3. दुर्घटना में अंतर्वलित जैव चिकित्सीय अपशिष्ट :

4. मानव स्वास्थ्य और पर्यावरण पर दुर्घटना के प्रभावों का मूल्यांकन

5. किए गए आपातकालीन उपाय :

6. दुर्घटनाओं के प्रभावों के निराकरण के लिए उठाए गए कदम।

7. ऐसी दुर्घटना के पुन: घटित होने को रोकने के लिए उठाए गए कदम।

हस्ताक्षर————————

पदनाम————————

तारीख ——————

स्थान ——————

[फा. सं. 23/2/96/एच एस एम डी]

विजय शर्मा, संयुक्त सचिव

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, 20th July, 1998

S.O. 630 (E).—Whereas a notification in exercise of the powers conferred by Seetions 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) was published in the Gazette vide S.O. 746 (E) dated 16 October, 1997 inviting objections from the public within 60 days from the date of the publication of the said notification on the Bio-Medical Waste (Management and Handling) Rules, 1998 and whereas all objections received were duly considered:

Now, therefore, in exercise of the powers conferred by section 6, 8 and 25 of the Environment (Protection) Act, 1986 the Central Government hereby notifies the rules for the management and handling of bio-medical waste.

1. SHORT TITLE AND COMMENCEMENT :

(1) These rules may be called the Bio-Medical Waste (Management and Handling) Rules, 1998.

(2) They shall come into force on the date of their publication in the official Gazette.

2. **APPLICATION :**

These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio-medical waste in any form.

3. **DEFINITIONS :** In these rules unless the context otherwise requires :—

(1) "Act" means the Environment (Protection) Act, 1986 (29 of 1986);

(2) "Animal House" means a place where animals are reared/kept for experiments or testing purposes;

(3) "Authorisation" means permission granted by the prescribed authority for the generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of bio-medical waste in accordance with these rules and any guidelines issued by the Central Government.

(4) "Authorised person" means an occupier or operator authorised by the prescribed authority to generate, collect, receive, store, transport, treat, dispose and/or handle bio-medical waste in accordance with these rules and any guidelines issued by the Central Government;

(5) "Bio-medical waste" means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals, and including categories mentioned in Schedule I;

(6) "Biologicals" means any preparation made from organisms or micro-organisms or product of metabolism and biochemical reactions intended for use in the diagnosis, immunisation or the treatment of human beings or animals or in research activities pertaining thereto;

(7) "Bio-medical waste treatment facility" means any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment or disposal is carried out;

(8) "Occupier" in relation to any institution generating bio-medical waste, which includes a hospital, nursing home, clinic dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called, means a person who has control over that institution and/or its premises;

(9) "Operator of a bio-medical waste facility" means a person who owns or controls or operates a facility for the collection, reception, storage, transport, treatment, disposal or any other form of handling of bio-medical waste;

(10) "Schedule" means schedule appended to these rules;

4. **DUTY OF OCCUPIER:**

It shall be the duty of every occupier of an institution generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.

5. **TREATMENT AND DISPOSAL**

(1) Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V.

(2) Every occupier, where required, shall set up in accordance with the time-schedule in Schedule VI, requisite bio-medical waste treatment facilities like incinerator, autoclave, microwave system for the treatment of waste, or, ensure requisite treatment of waste at a common waste treatment facility or any other waste treatment facility.

6. **SEGREGATION, PACKAGING, TRANSPORTATION AND STORAGE**

(1) Bio-medical waste shall not be mixed with other wastes.

(2) Bio-medical waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II prior to its storage, transportation, treatment and disposal. The containers shall be labeled according to Schedule III.

(3) If a container is transported from the premises where bio-medical waste is generated to any waste treatment facility outside the premises, the container shall, apart from the label prescribed in Schedule III, also carry information prescribed in Schedule IV.

(4) Notwithstanding anything contained in the Motor Vehicles Act, 1988, or rules thereunder, untreated bio-medical waste shall be transported only in such vehicle as may be authorised for the purpose by the competent authority as specified by the government.

(5) No untreated bio-medical waste shall be kept stored beyond a period of 48 hours :

Provided that if for any reason it becomes necessary to store the waste beyond such period, the authorised person must take permission of the prescribed authority and take measures to ensure that the waste does not adversely affect human health and the environment.

6)

7. PRESCRIBED AUTHORITY

(1) The Government of every State and Union Territory shall establish a prescribed authority with such members as may be specified for granting authorisation and implementing these rules. If the prescribed authority comprises of more than one member, a chairperson for the authority shall be designated.

(2) The prescribed authority for the State or Union Territory shall be appointed within one month of the coming into force of these rules.

(3) The prescribed authority shall function under the supervision and control of the respective Government of the State or Union Territory.

(4) The prescribed authority shall on receipt of Form I make such enquiry as it deems fit and if it is satisfied that the applicant possesses the necessary capacity to handle bio-medical waste in accordance with these rules, grant or renew an authorisation as the case may be.

(5) An authorisation shall be granted for a period of three years, including an initial trial period of one year from the date of issue. Thereafter, an application shall be made by the occupier/operator for renewal. All such subsequent authorisation shall be for a period of three years. A provisional authorisation will be granted for the trial period, to enable the occupier/operator to demonstrate the capacity of the facility.

(6) The prescribed authority may after giving reasonable opportunity of being heard to the applicant and for reasons thereof to be recorded in writing, refuse to grant or renew authorisation.

(7) Every application for authorisation shall be disposed of by the prescribed authority within ninety days from the date of receipt of the application.

(8) The prescribed authority may cancel or suspend an authorisation, if for reasons, to be recorded in writing, the occupier/operator has failed to comply with any provision of the Act or these rules :

Provided that no authorisation shall be cancelled or suspended without giving a reasonable opportunity to the occupier/operator of being heard.

8. AUTHORISATION

(1) Every occupier of an institution generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner, except such occupier of clinics, dispensaries, pathological laboratories, blood banks providing treatment/service to less than 1000 (one thousand) patients per month, shall make an application in Form I to the prescribed authority for grant of authorisation.

(2) Every operator of a bio-medical waste facility shall make an application in Form I to the prescribed authority for grant of authorisation.

(3) Every application in Form I for grant of authorisation shall be accompanied by a fee as may be prescribed by the Government of the State or Union Territory.

9. ADVISORY COMMITTEE

(1) The Government of every State/Union Territory shall constitute an advisory committee. The committee will include experts in the field of medical and health, animal husbandry and veterinary sciences, environmental management, municipal administration, and any other related department or organisation including non-governmental organisations. The State Pollution Control Board/Pollution Control Committee shall be represented. As and when required, the committee shall advise the Government of the State/Union Territory and the prescribed authority about matters related to the implementation of these rules.

(2) in amendment notification.

10. ANNUAL REPORT

Every occupier/operator shall submit an annual report to the prescribed authority in Form II by 31 January every year, to include information about the categories and quantities of bio-medical wastes handled during the preceding year. The prescribed authority shall send this information in a compiled form to the Central Pollution Control Board by 31 March every year.

11. MAINTENANCE OF RECORDS

(1) Every authorised person shall maintain records related to the generation, collection, reception, storage, transporation, treatment, disposal and/or any form of handling of bio-medical waste in accordance with these rules and any guidelines issued.

(2) All records shall be subject to inspection and verification by the prescribed authority at any time.

12. ACCIDENT REPORTING

When any accident occurs at any institution or facility or any other site where bio-medical waste is handled or during transportation of such waste, the authorised person shall report the accident in Form III to the prescribed authority forthwith.

13. APPEAL

Any person aggrieved by an order made by the prescribed authority under these rules may, within thirty days from the date on which the order is communicated to him, prefer an appeal to such authority as the Government of State/Union Territory may think fit to constitute :

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

SCHEDULE I

(See Rule 5)

CATEGORIES OF BIO-MEDICAL WASTE

Option	Waste Category	Treatment & Disposal
Category No. 1	Human Anatomical Waste (human tissues, organs, body parts)	incineration@/deep burial*
Category No. 2	Animal Waste (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals colleges, discharge from hospitals, animal houses)	incineration@/deep burial*
Category No 3	Microbiology & Biotechnology Waste (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biologicals, toxins, dishes and devices used for transfer of cultures)	local autoclaving/micro-waving/incineration@
Category No 4	Waste sharps (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	disinfection (chemical treatment@@/auto claving/micro-waving and mutilation/shredding##
Category No 5	Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)	incineration@/destruction and drugs disposal in secured landfills
Category No 6	Solid Waste (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	incineration@ autoclaving/microwaving
Category No. 7	Solid Waste (wastes generated from disposable items other than the waste shaprs such as tubings, catheters, intravenous sets etc).	disinfection by chemical treatment@@ autoclaving/ microwaving and mutilation/ shredding##
Category No. 8	Liquid Waste (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities)	disinfection by chemical treatment@@ and discharge into drains.
Category No. 9	Incineration Ash (ash from incineration of any bio-medical waste)	disposal in municipal landfill
Category No. 10	Chemical Waste (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	chemical treatment@@ and discharge into drains for liquids and secured landfill for solids

@@ Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.

\## Multilation/shredding must be such so as to prevent unauthorised reuse.

@ There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.

* Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

SCHEDULE II

(see Rule 6)

COLOUR CODING AND TYPE OF CONTAINER FOR DISPOSAL OF BIO-MEDICAL WASTES

Colour Conding	Type of Container	Waste Category	Treatment options as per Schedule I
Yellow	Plastic bag	Cat. 1, Cat. 2, and Cat. 3, Cat. 6.	Incineration/deep burial
Red	Disinfected container/plastic bag	Cat. 3, Cat. 6, Cat.7.	Autoclaving/Microwaving/ Chemical Treatment
Blue/White translucent	Plastic bag/puncture proof container	Cat. 4, Cat. 7.	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
Black	Plastic bag	Cat. 5 and Cat. 9 and Cat. 10. (solid)	Disposal in secured landfill

Notes:

1. Colour coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.
2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.
3. Categories 8 and 10 (liquid) do not require containers/bags.
4. Category 3 if disinfected locally need not be put in containers/bags.

SCHEDULE III

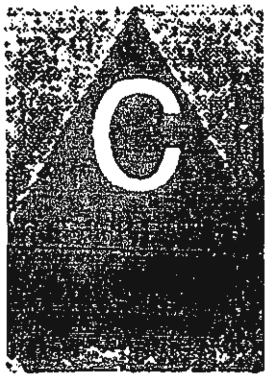
(see Rule 6)

LABEL FOR BIO-MEDICAL WASTE CONTAINERS/BAGS

BIOHAZARD SYMBOL

BIOHAZARD

CYTOTOXIC HAZARD SYMBOL



CYTOTOXIC

HANDLE WITH CARE

Note :

Lable shall be non-washable and prominently visible.

SCHEDULE IV

(see Rule 6)

LABEL FOR TRANSPORT OF BIO-MEDICAL WASTE CONTAINERS/BAGS

Day .... Month ....

Year ....

Waste category No. .... Date of generation. ....

Waste class

Waste description

Sender's Name & Address	Receiver's Name & Address
Phone No.	Phone No. ....
Telex No.	Telex No. ....
Fax No.	Fax No. ....
Contact Person	**Contact Person ....**

In case of emergency please contact :

Name & Address :—

Phone No.

Note :

Label shall be non-washable and prominently visible.

SCHEDULE V

(see Rule 5 and Schedule I)

STANDARDS FOR TREATMENT AND DISPOSAL OF BIO-MEDICAL WASTES

STANDARDS FOR INCINERATORS :

All incinerators shall meet the following operating and emission standards :

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The Combustion efficiency is computed as follows :

$$C.E. = \frac{\%CO2}{\%\ CO2 + \%\ CO} \times 100$$

3. The temperature of the primary chamber shall be 800 ± 50 deg. C°.
4. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50C°, with minimum 3% Oxygen in the stack gas.

B. Emission Standards

Parameters	Concentration mg/Nm3 at (12% CO2 correction)
(1) Particulate matter	150
(2) Nitrogen Oxides	450
(3) HCl	50

(4) Minimum stack height shall be 30 metres above ground

(5) Volatile organic compounds in ash shall not be more than 0.01%

Note :

- Suitably designed pollution control devices should be installed/retrofitted with the incinerator to achieve the above emission limits, if necessary.
- Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Chlorinated plastics shall not be incinerated.
- Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling Rules,) 1989.
- Only low sulphur fuel like L.D.O./L.S.H.S./Diesel shall be used as fuel in the incinerator.

STANDARDS FOR WASTE AUTOCLAVING :

The autoclave should be dedicated for the purposes of disinfecting and treating bio-medical waste,

(I) When operating a gravity flow autoclave, medical waste shall be subjected to :

(i) a temperature of not less than 121 C° and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or

(ii) a temperature of not less than 135 C° and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or

(iii) a temperature of not less than 149 C° and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.

(II) When operating a vacuum autoclave, medical waste shall be subjected to a minimum of one pre-vacuum pulse to purge the autoclave of all air. The waste shall be subjected to the following:

(i) a temperature of not less than 121 C° and pressure of 15 psi per an autoclave residence time of not less than 45 minutes; or

(ii) a temperature of not less than 135 C° and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes;

(III) Medical waste shall not be considered properly treated unless the time, temperature and pressure indicators indicate that the required time, tempeture and pressure were reached during the autoclave process. If for any reasons, time temperature or pressure indicator indicates that the required temperature, pressure or residence time was not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.

(IV) **Recording of operational parameters**

Each autoclave shall have graphic or computer recording devices which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.

(V) **Validation test**

Spore testing :

The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Biological indicator for autoclave shall be Bacillus stearothermophilus spores using vials or spore strips, with at least $1x10^4$ spores per millilitre. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure, a temperature less than 121 C° or a pressure less than 15 psi.

(VI) **Routine Test**

A chemical indicator strip/tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different location to ensure that the inner content of the package has been adequately autoclaved.

ANDARDS FOR LIQUID WASTE :

The effluent generated from the hospital should conform to the following limits :

PARAMETERS	PERMISSIBLE LIMITS
pH	6.5-9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/l
BOD	30 mg/l
COD	250 mg/l
Bio-assay test	90% survival of fish after 96 hours in 100% effluent.

these limits are applicable to those hospitals which are either connected with sewers without terminal sewage treatment plant or not connected to public sewers. For discharge into public sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 shall be applicable.

ANDARDS OF MICROWAVING:

Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.

The microwave system shall comply with the efficacy test/routine tests and a performance guarantee may be provided by the supplier before operation of the unit.

The microwave should completely and consistently kill the bacteria and other pathogenic organisms that is ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be Bacillus Subtilis spores using vials or spore strips with at least 1×10^4 spores per milliliter.

ANDARDS FOR DEEP BURIAL

A pit or trench should be dug about 2 meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron/wire meshes may be used.

On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

Burial must be performed under close and dedicated supervision.

The deep burial site should be relatively impermeable and no shallow well should be close to the site.

The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.

The location of the deep burial site will be authorised by the prescribed authority.

The institution shall maintain a record of all pits for deep burial.

SCHEDULE VI

(see Rule 5)

SCHEDULE FOR WASTE TREATMENT FACILITIES LIKE INCINERATOR/ AUTOCLAVE/MICROWAVE SYSTEM

A.	Hospitals and nursing homes in towns with population of 30 lakhs and above	by 31st December, 1999 or earlier
B.	Hospitals and nursing homes in towns with population of below 30 lakhs,	
	(a) with 500 beds and above	by 31st December, 1999 or earlier
	(b) with 200 beds and above but less than 500 beds	by 31st December, 2000 or earlier
	(c) with 50 beds and above but less than 200 beds	by 31st December, 2001 or earlier
	(d) with less than 50 beds	by 31st December, 2002 or earlier
C.	All other institutions generating bio-medical waste not included in A and B above	by 31st December, 2002 or earlier

FORM I

(see rule 8)

APPLICATION FOR AUTHORISATION

(To be submitted in duplicate.)

To

The Prescribed Authority
(Name of the State Govt/UT Administration)
Address.

1. Particulars of Applicant

(i) Name of the Applicant
(In block letters & in full)

(ii) Name of the Institution:
Address:
Tele No., Fax No. Telex No.

2. Activity for which authorisation is sought:
   - (i) Generation
   - (ii) Collection
   - (iii) Reception
   - (iv) Storage
   - (v) Transportation
   - (vi) Treatment
   - (vii) Disposal
   - (viii) Any other form of handling

3. Please state whether applying for resh authorisation or for renewal:
(In case of renewal previous authorisation-number and date)

4.
   - (i) Address of the institution handling bio-medical wastes:
   - (ii) Address of the place of the treatment facility:
   - (iii) Address of the place of disposal of the waste:

5. (i) Mode of transportation (in any) of bio-medical waste:
   (ii) Mode(s) of treatment:

6. Brief description of method of treatment and disposal (attach details):

7. (i) Category (see Schedule I) of waste to be handled
   (ii) Quantity of waste (category-wise) to be handled per month

8. Declaration

I do hereby declare that the statements made and information given above are true to the best of my knowledge and belief and that I have not concealed any information.

I do also hereby undertake to provide any further information sought by the prescribed authority in relation to these rules and to fulfill any conditions stipulated by the prescribed authority.

Date : Signature of the applicant

Place : Designation of the applicant

FORM II

(see rule 10)

ANNUAL REPORT

(To be submitted to the prescribed authority by 31 January every year).

1. Particulars of the applicant:
   (i) Name of the authorised person (occupier/operator):
   (ii) Name of the institution:
   Address
   Tel. No
   Telex No.
   Fax No.
2. Categories of waste generated and quantity on a monthly average basis:
3. Brief details of the treatment facility:
   In case of off-site facility:
   (i) Name of the operator
   (ii) Name and address of the facility:
   Tel. No., Telex No., Fax No.
4. Category-wise quantity of waste treated:
5. Mode of treatment with details:
6. Any other information:
7. Certified that the above report is for the period from ....
   ....

Date .... Signature ....

Place .... Designation ....

FORM III

(see Rule 12)

ACCIDENT REPORTING

1. Date and time of accident :
2. Sequence of events leading to accident :
3. The waste involved in accident :
4. Assessment of the effects of the accidents on human health and the environment :
5. Emergency measures taken :
6. Steps taken to alleviate the effects of accidents :
7. Steps taken to prevent the recurrence of such an accident :

Date : ....
Place : ....

Signature : ....
Designation : ....

[F.No. 23-2/96-HSMD)
VIJAI SHARMA, Jt. Secy.

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054 — 1998.

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 6th March, 2000

S. O. 201(E).—In exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) , the Central Government hereby makes the following rules further to amend the Bio-Medical Waste (Management and Handling) Rules, 1998, namely:-

1. (1) These rules may be called the Bio-Medical Waste (Management and Handling) (Amendment) Rules, 2000.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Bio-Medical Waste (Management and Handling) Rules, 1998, for Schedule VI, the following Schedule VI shall be substituted, namely:-

"**Schedule VI**

(see rule 5)

SCHEDULE FOR WASTE MANAGEMENT FACILITIES LIKE INCINERATOR/AUTOCLAVE/MICROWAVE SYSTEM

A. Hospitals and nursing homes in towns with population of 30 lakhs and above	By 30th June, 2000 or earlier
B. Hospitals and nursing homes in towns with population of below 30 lakhs- (a)with 500 beds and above	By 30th June, 2000 or earlier
(b)with 200 beds and above but less than 500 beds	By 31st December, 2000 or earlier
(c)with 50 beds and above but less than 200 beds	By 31st December, 2001 or earlier
(d) with less than 50 beds	By 31st December, 2002 or earlier
C. All other institutions generating bio-medical waste not included in A and B above.	By 31st December, 2002 or earlier"

[F. No.29-1/2000-HSMD]

V. RAJAGOPALAN, Jt. Secy.

Note :—The principal rules were published in the Gazette of India vide number S. O. 630(E) dated 20th July, 1998.

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.—2000

3. प्राधिकृत व्यक्ति, विहित प्राधिकारी की पूर्व अनुमति प्राप्त किए बिना जीव-चिकित्सा अपशिष्टों को भाटक पर, उधार में, विक्रय, अन्तरण या परिवहन नहीं करेगा।

4. किसी प्राधिकृत व्यक्ति द्वारा आवेदन-पत्र में उल्लिखित कार्मिक, उपस्कर या कार्य करने की स्थितियों में किसी अप्राधिकृत परिवर्तन को उसके प्राधिकार का भंग माना जाएगा।

5. यह प्राधिकृत व्यक्ति का कर्तव्य होगा कि वह ऐसी सुविधा को बन्द करने के लिए विहित प्राधिकारी की पूर्व अनुमति ले।

प्ररुप-V

(नियम 13 देखें)

जिला स्तर पर विहित प्राधिकारी द्वारा या विहित प्राधिकारी के रूप में कार्य कर रहे प्रदूषण नियंत्रण बोर्ड के क्षेत्रीय कार्यालय द्वारा या राज्य/ संघ राज्य क्षेत्र स्तर के प्राधिकारी द्वारा पारित आदेश के विरुद्ध अपील दायर करने के लिए आवेदन पत्र।

1. अपील के लिए आवदेन करने वाले व्यक्ति का नाम और पता:

2. उस प्राधिकरण की संख्या, आदेश की तारीख और पता, जिसने वह आदेश पारित किया है, जिसके विरुद्ध अपील की जानी है (आदेश की प्रमाणित प्रति संलग्न करें)

3. अपील करने का आधार

4. पैरा 2 में दिए गए आदेश, जिसके विरुद्ध अपील दायर की गई है, के अलावा संलग्नकों की सूची।

हस्ताक्षर

नाम और पता ————————

तारीख :

[फा. सं. 23 (2)/96-एच एस एम डी]

वी. राजगोपालन, संयुक्त सचिव

टिप्पणी:—मूल नियम का का. आ. सं. 630(अ) तारीख 20-7-1998 द्वारा प्रकाशित किया गया था तथा पश्चात्वर्ती संशोधन का.आ.सं. 201(अ) तारीख 6-3-2000 द्वारा प्रकाशित किया गया था।

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 2nd June, 2000

S.O. 545(E).—In exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Bio-Medical Waste (Management and Handling) Rules, 1998, namely:—

1 (1) These rules may be called the Bio-Medical Waste (Management and Handling) (Second Amendment) Rules, 2000.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Bio-Medical Waste (Management and Handling) Rules, 1998 (hereinafter referred to as the said rules), in rule 3, --

(i) in clause (7), after the words "carried out", the words "and includes common treatment facilities," shall be added;

(ii) after clause (7), the following clause shall be inserted, namely :-
'(7a)"Form" means Form appended to these rules;'.

3. In the said rules, in rule 6, after sub-rule (5), the following sub-rule shall be inserted, namely :-

"(6) The Municipal body of the area shall continue to pick up and transport segregated non bio-medical solid waste generated in hospitals and nursing homes, as well as duly treated bio-medical wastes for disposal at municipal dump site."

4. In the said rules, in rule 7, for sub-rule (1), the following sub-rule shall be substituted, namely:--

"(1) The prescribed authority for enforcement of the provisions of these rules shall be the State Pollution Control Boards in respect of States and the Pollution Control Committees in respect of the Union territories and all pending cases with a prescribed authority appointed earlier shall stand transferred to the concerned State Pollution Control Board, or as the case may be, the Pollution Control Committees."

5. In the said rules, in rule 8. after sub-rule (3), the following sub-rule shall be inserted, namely : -

"(4) The authorization to operate a facility shall be issued in Form IV, subject to conditions laid therein and such other condition, as the prescribed authority, may consider it necessary."

6. In the said rules, in rule 9, the words "The State Pollution Control Board/Pollution Control Committees shall be represented" shall be omitted.

7. In the said rules, in rule 13, after the words "prefer an appeal", the words and letter "in form V" shall be inserted.

8. In the said rules, after rule 13, the following rule shall be inserted, namely:-

Common disposal/incineration sites .—14. Without prejudice to rule 5 of these rules, the Municipal Corporations, Municipal Boards or Urban Local Bodies, as the case may be, shall be responsible for providing suitable common disposal/incineration sites for the biomedical wastes generated in the area under their jurisdiction and in areas outside the jurisdiction of any municipal body, it shall be the responsibility of the occupier generating bio-medical waste/operator of a bio-medical waste treatment facility to arrange for suitable sites individually or in association, so as to comply with the provisions of these rules".

9. In the said rules, in Schedule I, --

(i) in the sub-heading, for the word "option", the words "Waste Category No." shall be substituted;

(ii) in the sub-heading, after the words, "Waste Category" the word "Type" shall be added;

(iii) in the sub-heading, for the words "Treatment and Disposal", the following shall be substituted, namely :-
"Treatment and Disposal Option+"

\+ Options given above are based on available technologies. Occupier/operator wishing to use other State-of-the-art technologies shall approach the Central Pollution Control Board to get the standards laid down to enable the prescribed authority to consider grant of authorisation";

(iv) against Category No. 6, in the second column, for the word "Solid" the word "Soiled" shall be substituted;

(v) against Category No. 7, in second column, for the word "shaprs". the word "sharps" shall be substituted.

10. In the said rules, in FORM I, for the heading, the following heading shall be substituted namely :-
"Application for Authorisation/Renewal of Authorisation"

11. In the said rules, after Form III and the entries relating thereto, the following FORMS shall be added, namely :-
"FORMS IV & V"
(attached)

"FORM IV

[see rule 8(4)]

(Authorisation for operating a facility for collection, reception, treatment, storage, transport and disposal of biomedical wastes.)

1. File number of authorisation and date of issue...

2. ....of ....
is hereby granted an authorisation to operate a facility for collection , reception, storage, transport and disposal of biomedical waste on the premises situated at ....
.....
....

3. This authorisation shall be in force for a period of .... Years from the date of issue.

1583 |GI|2000 - 2

4. This authorisation is subject to the conditions stated below and to such other conditions as may be specified in the rules for the time being in force under the Environment (Protection) Act, 1986.

Signature ....

Date........... Designation

....

Terms and conditions of authorisation*

1. The authorisation shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made thereunder.
2. The authorisation or its renewal shall be produced for inspection at the request of an officer authorised by the prescribed authority.
3. The person authorised shall not rent, lend, sell, transfer or otherwise transport the biomedical wastes without obtaining prior permission of the prescribed authority.
4. Any unauthorised change in personnel, equipment or working conditions as mentioned in the application by the person authorised shall constitute a breach of his authorisation.
5. It is the duty of the authorised person to take prior permission of the prescribed authority to close down the facility.

---

* Additional terms and conditions may be stipulated by the prescribed authority.

FORM V

[see rule 13]

Application for filing appeal against order passed by the prescribed authority at district level or regional office of the Pollution Control Board acting as prescribed authority or the State/Union Territory level authority.

1. Name and address of the person applying for appeal :
2. Number, date of order and address of the authority which passed the order. against which appeal is being made (certified copy of order to be attached)
3. Ground on which the appeal is being made
4. List of enclosures other than the order referred in para 2 against which appeal is being filed.

Signature____________

Date : Name & Address____________ "

[F. No.23(2)/96-HSMD]

V. RAJAGOPALAN, Jt. Secy.

Note:—The Principal rules were published in the Gazette of India vide number S.O. 630(E) dated 20-7-98, and subsequently amended vide S.O. 201(E) dated 6-3-2000.

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 17th September, 2003.

S.O. 1069(E).- In exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Bio-Medical Waste (Management and Handling) Rules, 1998, namely:-

1. (1) These rules may be called the Bio-Medical Waste (Management and Handling) (Amendment) Rules, 2003.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In rule 7 of the Bio-Medical Waste (Management and Handling) Rules, 1998 (hereinafter referred to as the said rules),-

   (a) in sub-rule (1), for the opening words "The prescribed authority for enforcement",the words "Save as otherwise provide, the prescribed authority for enforcement" shall be substituted;

   (b) after sub-rule (1), the following sub-rule shall be inserted, namely:-

   "(1A). The prescribed authority for enforcement of the provisions of these rules in respect of all health care establishments including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, Animal houses, pathological laboratories and blood banks of the Armed Forces under the Ministry of Defence shall be the Director General, Armed Forces Medical Services.".

3. In the said rules , existing rule 9 shall be re-numbered as sub-rule (1) thereof , and after sub-rule (1) as so re-numbered, the following sub-rule shall be inserted , namely:-

" (2) Notwithstanding anything contained in sub-rule (1) , the Ministry of Defence shall constitute in that Ministry, an Advisory Committee consisting of the following in respect of all health care establishments including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories and blood banks of the Armed Forces under the Ministry of Defence , to advise the Director General, Armed Forces Medical Services and the Ministry of Defence in matters relating to implementation of these rules, namely:-

(1) Additional Director General of Armed Forces Medical Services …….. Chairman

(2) A representative of the Ministry of Defence not below the rank of Deputy Secretary, to be nominated by that Ministry …….. Member

(3) A representative of the Ministry of Environment and Forests not below the rank of Deputy Secretary To be nominated by that Ministry. …….. Member

(4) A representative of the Indian Society of Hospitals Waste Management, Pune …….. Member"

4. In the said rules, after rule 9, the following rule shall be inserted, namely:-

"**9A. Monitoring of implementation of the rules in Armed Forces Health Care Establishments.-**

(1) The Central Pollution Control Board shall monitor the implementation of these rules in respect of all the Armed Forces health care establishments under the Ministry of Defence.

(2) After giving prior notice to the Director General Armed Forces Medical Services, the Central Pollution Control Board along with one or more representatives of the Advisory Committee constituted under sub-rule (2) of rule 9 may, if it considers it necessary, inspect any Armed Forces health are establishments."

5. In the said rules, existing rule 13 shall be re-numbered as sub-rule (1) thereof; and-

(a) in sub-rule (1), as so re-numbered, for the opening portion, for the words " Any person" , the words, brackets and figure " Save as otherwise provided in sub-rule (2), any person " shall be substituted ;

(b) after sub-rule (1) as so re-numbered, the following sub-rule shall be inserted, namely:-

"(2) Any person aggrieved by an order of the Director General, Armed Forces Medical Services under these rules may, within thirty days from the date on which the order is communicated to him prefer an appeal to the Central Government in the Ministry of Environment and Forests.".

[F. No.23-2/96-HSMD]
Dr. V. RAJAGOPAL, Jt. Secy.

Note: The Principle rules were published in the Gazette of India vide tification number S.O. 630 (E) dated 20.7.98 and subsequently amended *vide*- (1) S.O.201 (E) dated 6.3.2000; and (2) S.O.545 (E) dated 2.6.2000.

Any person desirous of making any objection or suggestion with respect to the said draft rules may forward the same within the period so specified to the Joint Secretary (Hazardous Substances Management Division), Ministry of Environment and Forests, Paryavaran Bhavan, Central Government Offices (CGO) Complex, Lodhi Road, New Delhi – 110003.

1. **Short title and commencement.-**

(1) These rules may be called the Bio-Medical Waste (Management and Handling) Rules, 2011.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. **Application.-**

(1) These rules shall apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio-medical waste in any form and shall not apply to.-

(a) radioactive wastes as covered under the provisions of the Atomic Energy Act, 1962 and the rules made there under;

(b) hazardous chemicals covered under the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 made under the Environment (Protection) Act, 1986, (hereinafter referred to as the Act);

(c) wastes covered under the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Act;

(d) the lead acid batteries covered under the Batteries (Management and Handling) Rules, 2001 made under the Act; and

(e) hazardous wastes covered under the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 made under the Act.

3. **Definitions.-** In these rules, unless the context otherwise requires.-

(1) "Act" means the Environment (Protection) Act, 1986 (29 of 1986);

(2) "Animal House" means a place where animals are reared/kept for the purpose of experiments or testing;

(3) "Authorisation" means permission granted by the prescribed authority for the generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of bio-medical waste in accordance with these rules and guidelines issued by the Central Pollution Control Board, Ministry of Environment and Forests, Ministry of Health and Family Welfare, Government of India.

(4) "Authorised Person" means an occupier or operator authorised by the prescribed authority to generate, collect, receive, store, transport, treat, dispose and/or handle bio-medical waste in

5.	वर्ष ....के मास................. के लिए जीव चिकित्सा अपशिष्ट न भेजने वाली सदस्य स्वास्थ्य देख-रेख सुविधा (एचसीएफ) या स्वास्थ्य देख-रेख प्रतिष्ठान (एचसीई) की सूची	:	

प्रमाणित किया जाता है कि उपर्युक्त रिपोर्ट इस समान जीव चिकित्सा अपशिष्ट उपचार और व्ययन सुविधा के पास उपलब्ध अभिलेख पर आधारित है ।

तारीख :
स्थान:

संस्था के प्रमुख का नाम और हस्ताक्षर

****

[फा. सं. 3-1/2000-एचएसएमडी]

राजीव गौबा, संयुक्त सचिव

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 24th August, 2011

S.O. 1955(E).—Whereas by notification of the Government of India in the Ministry of Environment and Forests Bio-Medical Waste (Management and Handling) Rules, 1998, *vide*, S.O. 630 (E), dated the 20th July, 1998 as amended from time to time provided a regulatory frame work for management of bio-medical waste generated in the country.

AND WHEREAS, the Central Government considers it necessary in the public interest and to address environmental and health concerns, to review the rules published earlier, to enable the prescribed authorities to implement the rules more effectively, thereby, reducing the bio-medical waste generation and also for its proper treatment and disposal and to ensure environmentally sound management of these wastes.

DRAFT RULES

AND WHEREAS, the following draft of certain rules, which the Central Government proposes to make in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Bio-Medical Waste (Management and Handling) Rules, 1998, is hereby published for information of the public likely to be affected thereby; and notice is hereby given that the said draft rules will be taken into consideration by the Central Government after expiry of a period of sixty days from the date of publication of this notification in the Official Gazette;

The objections or suggestions which may be received from any person and institution in respect of the said draft rules before the period specified will be taken into consideration by the Central Government;

accordance with these rules and any guidelines issued by the Central Pollution Control Board, Ministry of Environment and Forests, Ministry of Health and Family Welfare, Government of India;

(5) "Bio-medical waste" means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals, including categories mentioned in Schedule I of these rules;

(6) "Biologicals" means any preparation made from organisms or micro-organisms or product of metabolism and biochemical reactions intended for use in the diagnosis, immunisation or the treatment of human beings or animals or in research activities pertaining thereto;

(7) "Bio-Medical Waste Treatment and Disposal Facility" means any facility wherein treatment, disposal of bio-medical waste or processes incidental to such treatment and or disposal is carried out and includes common treatment facilities;

(8) "Occupier" means a person having administrative control over the institution and the premises generating bio-medical waste, which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank, health care facility and clinical establishment by whatever name it may be called;

(9) "Operator of a common bio-medical waste treatment facility" means a person who owns or controls or operates a common facility for the collection, reception, storage, transport, treatment, disposal or any other form of handling of bio-medical waste;

(10) "Schedule" means Schedule appended to these rules;

(11) "Form" means Form appended to these rules;

4. **Duties of the Occupier.-**

It shall be the duty of every Occupier:

(1) To take all steps to ensure that bio medical waste is handled without any adverse effect to human health and the environment in accordance with these rules.

(2) To provide training for all its health care workers and others involved in handling of bio medical waste.

(3) To immunize all its health care workers and others involved in handling of bio-medical waste for protection against diseases that are likely to be transmitted by handling of bio-medical waste.

(4) To ensure segregation of bio medical waste at the point of generation in accordance with these rules.

(5) To ensure occupational safety of all its health care workers and others involved in handling of bio- medical waste by providing appropriate and adequate personal protective equipments.

(6) To conduct health check up annually for all its health care workers and others involved in handling of bio- medical waste and maintain the records for the same.

(7) To install necessary equipments and regular supply of materials required for proper in house handling of bio medical waste.

(8) To maintain and update everyday the bio medical waste management register according to quantity, various categories and the final mode of disposal of bio-medical waste as specified in schedule-I.

(9) To develop a system of reporting of unintended accidents like sharp injuries, mercury spills, fire hazards which are likely to occur during handling of bio-medical waste and the remedial action taken. Such records shall be maintained and reported in Form III to the prescribed authority along with the annual report and should indicate even the nil report.

(10) To inform the prescribed authority immediately in case the Operator of a facility does not collect the bio medical waste within the intended time or as per the agreed schedule.

(11) To establish a bio-medical waste management cell or unit in unit if the facility has more than 30 beds, in order to review and monitor the activities related to bio-medical waste management. Such unit or cell shall meet once in six months and the record of the minutes of such meetings shall be submitted along with the annual report to the prescribed authority.

5. **Duties of the operator of a common bio-medical waste treatment facility.-**

It shall be the duty of every Operator.-

(1) To take all necessary steps to ensure that the bio-medical waste collected from the Occupier is transported, handled, stored, treated and disposed of without any adverse effect to the human health and the environment in accordance with these rules.

(2) To ensure timely collection of bio-medical waste from the health care facility as prescribed under these rules.

(3) To inform the prescribed authority immediately regarding the Health Care Establishments (HCEs) or Health Care Facilities (HCFs), which are not handing over the segregated bio-medical waste in accordance with these rules as prescribed in Form-VI.

(4) To provide training for all its workers involved in handling of bio medical waste.

(5) To undertake appropriate pre-placement medical examination and also periodic medical examination and immunize all its workers involved in handling of bio-medical waste for protection against diseases that are likely to be transmitted while handling bio-medical waste and maintain the records for the same.

(6) To ensure occupational safety of all its workers involved in handling of bio-medical waste by providing appropriate and adequate personal protective equipments.

(7) To develop a system of reporting of unintended accidents like sharp injuries, mercury spills, fire hazards which are likely to occur during handling of bio-medical waste and the remedial action taken. Such records shall be maintained and reported in Form-III to the prescribed authority along with the annual report and also update even the nil reporting.

(8) To maintain a log book for each of its treatment equipment according to weight of batch; categories of waste treated; time, date and duration of treatment cycle and total hours of operation

6. Responsibilities of authorities.-

The Authority specified in column 2 of the Schedule-VI shall perform the duties as specified in column 3 of the said Schedule as per the provisions of these Rules.

7. Treatment and disposal.-

(1) Bio-medical waste shall be treated and disposed of in accordance with Schedule I, and in compliance with the standards prescribed in Schedule V.

(2) Any person including an occupier or operator of a common bio medical waste treatment facility intends to promote new technologies for treatment of bio medical waste other than those listed in Schedule I shall approach the Central Government or the Central Pollution Control Board for prior approval of the suitability of the new technology and laying down the standards or operating parameters. On approval, the standards for new technology shall be notified by the Ministry of Environment and Forests and the Schedules I and V shall stand modified accordingly.

(3) Every occupier shall either set up his own requisite biomedical waste treatment equipments like autoclave or microwave, shredder for treatment of bio-medical waste generated in his premises as a part of on-site treatment, prior to commencement of its operation or ensure requisite treatment of bio-medical waste through an authorised common bio medical waste treatment facility or any other authorised waste treatment facility:

Provided further the prescribed authority may authorize the occupier having five hundred or more bed capacity to install an incinerator, depending on the recipient environment and the location warranting such a course of action.

(4) Every Operator of a common bio medical waste treatment facility shall set up requisite biomedical waste treatment equipments like incinerator, autoclave or microwave, shredder and effluent treatment plant as a part of treatment, prior to commencement of its operation.

(5) Use of chlorinated plastic bags for handling of bio-medical waste shall be prohibited and the occupier or operator of a common bio-medical waste treatment facility shall not dispose of such plastics by incineration.

(6) The occupier or operator of a common bio-medical waste treatment facility shall dispose of the recyclable bio-medical wastes such as plastics and glass through authorized recyclers having consents from the respective State Pollution Control Board or Pollution Control Committee of Union Territory after ensuring treatment by autoclaving or microwaving followed by mutilation/shredding, whichever is applicable. The occupier shall maintain a record of such recyclable wastes auctioned or sold and the same shall be submitted to the prescribed authority.

(7) In the event of breakage of mercury containing medical instruments, necessary precautions shall be taken by the occupier to segregate such waste to the extent possible and also for its proper collection, storage and disposal as per the guideline issued by the Central Government and Central Pollution Control Board in order to avoid or minimize mercury releases into the environment. In case the mercury content in the bio-medical waste exceeds the limit specified under the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, the same needs to be disposed of in accordance with these Rules.

8. Segregation, packaging, transportation and storage.-

(1) Untreated Bio-medical waste shall not be mixed with other wastes.

(2) Bio-medical waste shall be segregated into containers or bags at the point of generation in accordance with Schedule II prior to its storage, transportation, treatment and disposal.

(3) The containers shall be labeled according to Schedule III.

(4) The transporter shall transport the bio-medical waste from the premises of an occupier to any off-site bio-medical waste treatment facility only with the label as prescribed in Schedule III along with the necessary information prescribed in Schedule IV.

(5) Notwithstanding anything contained in the Motor Vehicles Act, 1988, or rules made there under, untreated bio-medical waste shall be transported only in such vehicle as may be authorised for the purpose by the competent authority as specified by the Government.

(6) No untreated bio-medical waste of categories 1, 2, 3 and 6 shall be kept stored beyond a period of forty eight hours:

Provided that in case for any reason it becomes necessary to store such waste beyond such a period, the authorised person shall take prior permission of the prescribed authority and take measures to ensure that the waste does not adversely affect human health and the environment.

(7) The Municipal body of the area shall continue to pickup and transport segregated non bio-medical solid waste generated in hospitals and nursing homes as well as duly treated bio-medical wastes for disposal at municipal dump site.

9. **Prescribed authority.-**

(1) The prescribed authority for enforcement of the provisions of these Rules shall be the State Pollution Control Boards in respect of States and Pollution Control Committees in respect of Union Territories.

(2) The prescribed authority for enforcement of the provisions of these Rules in respect of all health care establishments including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories and blood banks of the Armed Forces under the Ministry of Defence shall be the Director General, Armed Forces Medical Services. The prescribed authority in this respect shall function under the supervision and control of the Ministry of Defence.

(3) The prescribed authority shall function under the supervision and control of the respective Government of the State or Union Territory administration.

(4) The prescribed authorities shall comply with the responsibilities as stipulated at serial number 6 of Schedule VI of these rules.

10. **Procedure for authorisation.-**

(1) Every occupier or operator of common bio-medical waste treatment facility involved in generating or collecting or receiving or storing or transporting or disposing and/or handling bio-medical waste, irrespective of the quantum of bio-medical waste generation shall make an application in Form I to the prescribed authority for grant of authorisation.

(2) The prescribed authority shall on receipt of Form I make such enquiry as it deems fit and if it is satisfied that the applicant possesses the necessary capacity to handle bio-medical waste in accordance with these rules, may grant or renew an authorisation, as the case may be.

(3) A provisional authorisation in Form IV shall be granted for trial run for a period of one year, to enable the occupier/operator of common bio medical waste treatment facility to demonstrate the adequacy of the waste management system. On satisfactory performance

during the trial period, the authorisation shall be renewed for a further period of five years and may also be renewed for a period of five years, if it is considered necessary.

(4) The prescribed authority may after giving reasonable opportunity of being heard to the applicant and for the reasons thereof to be recorded in writing, refuse to grant or renew authorisation.

(5) Every application for authorisation shall be disposed of by the prescribed authority within a period of ninety days from the date of receipt of duly completed application along with such necessary documents, failing which it shall be deemed that the authorisation is duly granted under these rules.

(6) The prescribed authority may cancel or suspend an authorisation, if for reasons, to be recorded in writing, the occupier or operator has failed to comply with any provision of the Act or these rules:

Provided that no authorisation shall be cancelled or suspended without giving a reasonable opportunity to the occupier or operator of being heard.

(7) Every occupier or operator shall intimate the prescribed authority about any change or variation in the activity relating to bio medical waste generation, handling, treatment and disposal for which authorisation was earlier granted and shall submit a fresh application in Form-I for modification of the conditions of authorisation.

11. **Advisory Committee.-**

(1) The Government of every State or Union Territory shall constitute an Advisory Committee under the Chairmanship of State health Secretary. The committee shall include representatives from the State departments of health, environment, urban development, animal husbandry and veterinary sciences, State Pollution Control Board or Pollution Control Committee, local bodies or urban or municipal corporation, representatives from Indian Medical Association, common bio medical waste treatment facility and non-governmental organisation. The advisory committee shall meet once in six months and review all the matter related to implementation of Bio-Medical Waste (Management and Handling) Rules.

(2) Notwithstanding anything contained in the above sub-rule (1), the Ministry of Defence shall constitute in that Ministry, an Advisory Committee consisting of the following, in respect of all health care facilities of the Armed Forces under the Ministry of Defence, to advise the Director General, Armed Forces Medical Services and the Ministry of Defence in matters relating to implementation of these rules, namely:-

(i) Additional Director General of Armed Forces Medical Services ... Chairman

(ii)	A representative of the Ministry of Defence (not below the rank of Deputy Secretary, to be nominated by that Ministry)	... Member
(iii)	A representative of the Ministry of Environment and Forests (not below the rank of Deputy Secretary, to be nominated by that Ministry)	... Member
(iv)	A representative of the Ministry of Health and Family Welfare (not below the rank of Deputy Secretary, to be nominated by that Ministry)	.. Member
(v)	A representative of the Armed Forces Medical College/ Command Hospital (To be nominated by DGAFMS)	... Member

Ministry of Defense may co opt representatives from the other governmental and non-governmental organizations having expertise in the field of bio-medical waste management.

The advisory committee shall meet once in six months and review all the matter related to implementation of Bio-Medical Waste (Management and Handling) Rules in the Armed Forces Health Care Facilities.

(4) Monitoring of implementation of the rules in Armed Forces health care facilities:-

(a) The Central Pollution Control Board shall monitor the implementation of these rules in respect of all the Armed Forces health care establishments under the Ministry of Defence;

(b) After giving prior notice to the Director General Armed Forces Medical Services, the Central Pollution Control Board along with one or more representatives of the Advisory Committee constituted under sub-rule (3) of rule 11 may, if it considers it necessary, inspect any Armed Forces health care establishments.

(5) The Government of every State or Union Territory shall constitute District Level Monitoring Committee in the districts under the chairmanship of District Medical Officer or his nominee to monitor the compliance of Bio- Medical Waste Rules in the health care facilities generating bio-medical waste and in the Common Bio-Medical Waste Treatment and Disposal Facilities where the bio-medical waste is treated and the District Level Monitoring Committee shall submit its report once in six months to the State Advisory Committee and a copy shall also be forwarded to Central Pollution Control Board or Ministry of Environment and Forests and the State Pollution Control Board or Pollution Control Committee concerned for taking further necessary action. The District Level Monitoring Committee shall comprise of Chief Medical Officer or District Health Officer, representatives from State Pollution Control Board or Pollution Control Committee, Public Health Engineering Department, Local bodies or Municipal Corporation, Indian Medical

Association, Common bio-medical waste treatment facility and registered non-governmental organisations working in the field of bio-medical waste management, headed by the District Medical Officer or his nominee. The committee may co-opt other members and experts, if necessary.

12. **Annual report.-**

(1) Every occupier or operator of common bio medical waste treatment facility shall submit an annual report to the prescribed authority in prescribed Form II or II A respectively by the 31^{st} day of January of every year, to include information about the categories and quantities of bio-medical wastes handled during the preceding year.

(2) The prescribed authority shall send this information in a compiled form to the Central Pollution Control Board by the 31^{st} day of March of every year.

(3) The Central Pollution Control Board shall send this information in a compiled form to the Ministry of Environment and Forests by 30^{th} June of every year.

13. **Maintenance of records.-**

(1) Every authorised person shall maintain records related to the generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of bio-medical waste in accordance with these rules and any guidelines issued.

(2) All records shall be subject to inspection and verification by the prescribed authority at any time.

14. **Accident reporting.-**

When any accident occurs at any institution or facility or any other site where bio-medical waste is handled or during transportation of such waste, the authorised person shall report the accident in Form III to the prescribed authority forthwith.

15. **Appeal.-**

(1) Any person aggrieved by an order made by the prescribed authority under these rules may, within thirty days from the date on which the order is communicated to him, prefer an appeal in Form V to the Secretary (Environment) of State government or Union Territory administration:

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

(2) Any person aggrieved by an order of the Director General Armed Forces Medical Services under these rules may, within thirty days from the date on which the order is communicated to him, prefer an appeal in Form V to the central government in the Ministry of Environment and Forests:

Provided that the authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

16. Common disposal or incineration sites.-

Without prejudice to rule 5 of these rules, the Municipal Corporation, Municipal or Local Bodies, as the case may be, shall be responsible for providing suitable common disposal or incineration sites for the biomedical wastes generated in the area under their jurisdiction.

17. Liability of the occupier, operator of a facility.-

(1) The occupier or operator of a common bio- medical waste treatment facility shall be liable for all the damages caused to the environment or the public due to improper handling of bio-medical wastes or disposal of bio- medical wastes.

(2) The occupier or operator of common bio medical waste treatment facility shall be liable for action under sections 5 and 15 of the Environment (Protection) Act, 1986.

SCHEDULE I
(See rule 4 and 7)

CATEGORIES OF BIO-MEDICAL WASTE

Category	Waste Category (Type)	Treatment and Disposal Option
Category No. I	**Human Anatomical Waste** (human tissues, organs, body parts)	Incineration @@
Category No. 2	**Animal Waste** (animal tissues, organs, body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals/colleges, discharge from hospitals, animal houses)	Incineration @@
Category No 3	**Microbiology & Biotechnology Waste and other laboratory waste** (wastes from clinical samples, pathology, bio-chemistry, haematology, blood bank, laboratory	Disinfection at source by chemical treatment@ or by Autoclaving /microwaving followed by mutilation /shredding## and after treatment final disposal in secured landfill or

	cultures, stocks or specimens of micro- organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)	disposal of recyclable wastes (plastics or glass) through registered or authorized recyclers.
Category No.4	**Waste sharps** (needles, glass syringes or syringes with fixed needles, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	Disinfection by chemical treatment@ or Destruction by needle and tip cutters, autoclaving or microwaving followed by mutilation or shredding##, whichever is applicable and final disposal though authorized CBWTF or disposal in secured landfill or designated concrete waste sharp pit.
Category No.5	**Discarded Medicines and Cytotoxic drugs** (wastes comprising of outdated, contaminated and discarded medicines)	Disposal in secured land fill or Incineration @@
Category No.6	**Soiled Waste** (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, linen, beddings, other material contaminated with blood)	Incineration @@
Category No.7	**Infectious Solid Waste** (Wastes generated from disposable items other than the waste sharps such as tubings, hand gloves, saline bottles with IV tubes, catheters, glass, intravenous sets etc).	Disinfection by chemical treatment @ or Autoclaving or Microwaving followed by mutilation or shredding ## and after treatment final disposal through registered or authorized recyclers
Category No. 8	**Chemical Waste** (Chemicals used in production of biologicals, chemicals used in disinfection, as insecticides etc.)	Chemical treatment @ and discharge into drains meeting the norms notified under these rules and solids disposal in secured landfill

Notes:

@ *Chemical treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.*

Mutilation/shredding must be such that so as to prevent unauthorized reuse.

@@ *There will be no chemical pretreatment before incineration. Chlorinated plastics/bags shall not be incinerated.*

Disposal of bio-medical waste by deep burial shall be prohibited in Towns and Cities. Disposal by deep burial is permitted only in rural areas where there is no access to common bio-medical waste treatment facility, with prior approval from the prescribed authority. The deep burial facility shall be located as per provisions and guidelines issued by Central Pollution Control Board from time to time.

Liquid waste generated from laboratory, washing, cleaning, house keeping and disinfecting activities shall be treated so as to meet the discharge standards stipulated under these rules.

Incineration ash (ash from incineration of any bio-medical waste) shall be disposed through secured landfill, if toxic or hazardous constituents are present beyond the prescribed limits as given in Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008.

SCHEDULE –II
(See rule 8)

COLOUR CODING AND TYPE OF CONTAINER FOR DISPOSAL OF BIO-MEDICAL WASTES

Colour coding	Type of container to be used	Waste Category Number	Treatment options as per schedule I
Yellow	Non-chlorinated plastic bags	Category 1, 2, 5, 6	Incineration
Red	Non-chlorinated plastic bags /puncture proof container for sharps	Category 3, 4,7 (4 - Waste sharps) (In the earlier Rules, Soiled wastes are for Red colour)	As per Schedule I (rule 7)
Blue	Non-chlorinated plastic bags container	Category 8 (chemical wastes)	As per Schedule I (rule 7)
Black	Non-chlorinated plastic bags	Municipal Waste	Disposal in Municipal dump sites

Notes:

1. *Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.*

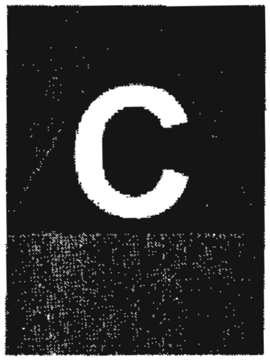
2. *Category 3 if disinfected locally need not be put in containers/ non-chlorinated plastic bags.*

3. *The municipal waste such as office waste (like paper waste), kitchen waste, food waste and other non infectious waste shall be stored in black coloured containers/bags and shall be disposed of in accordance with Municipal Solid Waste (Management and Handling) Rules 2000.*

SCHEDULE III
(See Rule 8)

LABEL FOR BIO-MEDICAL WASTE CONTAINERS/BAGS

CYTOTOXIC HAZARD SYMBOL



HANDLE WITH CARE

Note: Label shall be non-washable and prominently visible.

SCHEDULE IV
(See rule 8)

LABEL FOR TRANSPORT OF BIO-MEDICAL WASTE CONTAINERS OR BAGS

Day .... Month ....
Year ....
Date of generation ....

Waste category No ....
Waste quantity............

Sender's Name and Address	Receiver's Name and Address
Phone No	Phone No ....
Telex No	Telex No ....
Fax No	Fax No ....
Contact Person	Contact Person ....

In case of emergency please contact .

Name and Address :
Phone No.

Note :
Label shall be non-washable and prominently visible.

SCHEDULE V
(See rule 7 and schedule 1)

STANDARDS FOR TREATMENT AND DISPOSAL OF BIO-MEDICAL WASTES

1. STANDARDS FOR INCINERATORS.-

All incinerators shall meet the following operating and emission standards

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.

2. The Combustion efficiency is computed as follows:

$$C.E. = \frac{\%CO_2}{\%CO_2 + \%\ CO} \times 100$$

3. The temperature of the primary chamber shall be 800 ± 50 deg. C°.

4. The secondary chamber gas residence time shall be at least one second at 1050 ± 50 C°, with minimum 3% Oxygen in the stack gas.

B. Emission Standards

Parameters	Concentration mg/Nm^3 at (12% CO_2 correction)
(1) Particulate matter	150
(2) Nitrogen Oxides	450
(3) HCI	50
(4) Minimum stack height shall be 30 metres above ground	
(5) Volatile organic compounds in ash shall not be more than 0.01%	

Note:

(a) Suitably designed pollution control devices should be installed or retrofitted with the incinerator to achieve the above emission limits, if necessary.
(b) Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
(c) Chlorinated plastics shall not be incinerated.
(d) Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling and Transboundary Movement) Rules, 2008.

(e) Only low sulphur fuel like Light Diesel Oil or Low Sulphur Heavy Stock or iesel shall be used as fuel in the incinerator.

(f) The Occupier or operator of a common bio-medical waste treatment facility shall monitor the stack gaseous emission (under optimum capacity of the incinerator) once in three months through a laboratory approved under the Environment (Protection) Act, 1986 and record of such analysis results shall be maintained and submitted to the prescribed authority.

2. **STANDARDS FOR WASTE AUTOCLAVING.-**

The autoclave should be dedicated for the purposes of disinfecting and treating bio-medical waste.

(1) When operating a gravity flow autoclave, medical waste shall be subjected to:

(i) a temperature of not less than 121° C and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or

(ii) a temperature of not less than 135° C and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or

(iii) a temperature of not less than 149° C and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.

(2) When operating a vacuum autoclave, medical waste shall be subjected to a minimum of one pre-vacuum pulse to purge the autoclave of all air. The waste shall be subjected to the following:

(i) a temperature of not less than 121° C and pressure of 15 psi per an autoclave residence time of not less than 45 minutes; or

(ii) a temperature of not less than 135° C and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes;

(3) Medical waste shall not be considered as properly treated unless the time, temperature and pressure indicators indicate that the required time, temperature and pressure were reached during the autoclave process. If for any reasons, time temperature or pressure indicator indicates that the required temperature, pressure or residence time was not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.

(4) Recording of operational parameters:

Each autoclave shall have graphic or computer recording devices which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.

(5) Validation test

Spore testing:

The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave unit. Biological indicator for autoclave shall be Bacillus stearothermophilus spores using vials or spore Strips; with at least $1X10^4$ spores per milli litre. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure, a temperature less than 121° C or a pressure less than 15 psi. The occupier or operator of a common bio medical waste treatment facility shall conduct this test at least once in three months and records in this regard shall be maintained.

(6) Routine Test

A chemical indicator strip or tape that changes colour when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the inner content of the package has been adequately autoclaved. The occupier or operator of a common bio medical waste treatment facility shall conduct this test during autoclaving of each batch and records in this regard shall be maintained.

3. STANDARDS FOR LIQUID WASTE.-

The effluent generated or treated from the premises of occupier or operator of a common bio medical waste treatment facility, before discharge should conform to the following limits.

PARAMETERS	PERMISSIBLE LIMITS
pH	6.5-9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/l
BOD	30 mg/l
COD	250 mg/l
Bio-assay test	90% survival of fish after 96 hours in 100% effluent.

4. STANDARDS OF MICROWAVING.-

(1) Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.

(2) The microwave system shall comply with the efficacy test or routine tests and a performance guarantee may be provided by the supplier before operation of the limit.

(3) The microwave should completely and consistently kill the bacteria and other pathogenic organisms that are ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be Bacillus Subtilis spores using vials or spore strips with at least 1 x 101 spores per milliliter.

5. STANDARDS FOR DEEP BURIAL.-

(1) A pit or trench should be dug about 2 meters deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.

(2) It must be ensured that animals do not have any access to burial sites. Covers of galvanised iron or wire meshes may be used.

(3) On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

(4) Burial must be performed under close and dedicated supervision.

(5) The deep burial site should be relatively impermeable and no shallow well should be close to the site.

(6) The pits should be distant from habitation, and located so as to ensure that no contamination occurs to surface water or ground water. The area should not be prone to flooding or erosion.

(7) The location of the deep burial site shall be authorised by the prescribed authority.

(8) The institution shall maintain a record of all pits used for deep burial.

(9) The ground water table level should be a minimum of six meters below the lower level of deep burial pit.

Schedule VI
[See rule 6]

List of Authorities and the Corresponding Duties

Sl. No.	Authority	Corresponding Duties
1	Ministry of Environment and Forests, Government of India	(i) Policies concerning Bio-medical waste Management in the Country including notification of Rules and amendments to the Rules as and when required. (i) Financial assistance for training and awareness programmes on bio-medical Waste Management related activities for the State Pollution Control Boards or Pollution Control Committees. (ii) Financial assistance for setting up of common bio-medical waste treatment and disposal facilities.
2	Central or State Ministry of Health and Family Welfare, Central or State Ministry of Veterinary and Animal Husbandry	(i) Grant of license for Health Care Facilities or Nursing Homes or Veterinary Establishments subject to obtaining of authorization from the prescribed authority. (ii) Refusal or Cancellation of license for Health Care Facilities or Nursing Homes or Veterinary Establishments for violations of conditions of authorisation or provisions under these Rules. (iii) Publication of National Inventory of Health Care Facilities with regard to bio-medical waste generation, treatment and disposal. (iv) Assessment with reference to risks to environment and health due to bio-medical waste. (v) Constitution of Advisory Committees at National or State level for overall review and promotion of clean technologies for bio-medical waste management. (vi) Organizing or Sponsoring of trainings for the regulatory authorities on bio-medical waste management related activities. (vii) Sponsoring of mass awareness campaigns in electronic media and print media.
3	Ministry of Defence	(i) Grant and renewal of authorisation to Armed Forces Health Care Establishments or

		Common Bio-Medical Waste Treatment and Disposal Facilities (Rule 8). (ii) Conduct training courses for authorities dealing with management of bio-medical wastes in Armed Forces Health Care Establishments or Treatment Facilities in association with State Pollution Control Boards or Pollution Control Committees or Central Pollution Control Board or Ministry of Environment and Forest. (iii) Review of management of bio-medical waste generation in the Armed Forces Health Care Facilities through its Advisory Committee (Rule 9) (iv) Publication of inventory on bio-medical waste generation from Armed Forces Health Care Establishments and submission of the annual report to Central Pollution Control Board within the stipulated time period (Rule 10).
4.	Central Pollution Control Board	(i) Co-ordination of activities of State Pollution Control Boards or Pollution Control Committees. (ii) Conduct training courses for authorities dealing with management of bio-medical waste. (iii) Approval of new technologies for treatment and disposal of bio-medical waste (Rule 5); (iv) Prescribe specifications for treatment and disposal of bio-medical wastes (Rule 5). (v) Random inspection or monitoring of Common Bio-Medical Waste Treatment and Disposal Facilities. (vi) Submission of compiled annual report information to Ministry of Environment and Forets. (vii) Inspection and monitoring of Health Care Facilities operated by the Director General, Armed Forces Health Care Services (Rule 9) (viii) Undertake or support research or operational research regarding bio-medical waste.
5.	State Government or Union Territory Government or Administration	(i) Allocation of adequate funds to Government Health Care Facilities for bio-medical waste management. (ii) Procurement and allocation of treatment

		equipments for bio-medical waste management in Government Health Care Facilities. (iii) Advise State Pollution Control Boards or Pollution Control Committees on implementation of these Rules. (iv) Implementation of recommendations of the Advisory Committee.
6.	State Pollution Control Boards or Pollution Control Committees	(i) Inventorisation of Health Care Facilities and bio-medical waste generation and submission of annual report to Central Pollution Control Board within the stipulated time period. (ii) Grant and renewal or refusal cancellation or suspension of authorization under these Rules (Rule 7, 8 and 10). (iii) Monitoring of compliance of various provisions and conditions of authorization. (iv) Action against Health Care Facilities or Common Bio-Medical Waste Treatment and Disposal Facilities for violation of these Rules (Rule 15). (v) Organizing training programmes to staff of Health Care Facilities or Common Bio-Medical Waste Treatment and Disposal Facilities and State Pollution Control Boards or Pollution Control Committees staff on segregation, collection, storage, transportation, treatment and disposal of bio-medical wastes. (vi) Undertake or support research or operational research regarding bio-medical waste management. (vii) Any other function under these Rules assigned by Ministry of Environment and Forests or Central Pollution Control Board from time to time. (viii) Implementation of recommendations of the Advisory Committee.
7	Local Bodies such as Gram Panchayat, Municipalities or Corporations.	(i) Provide or allocate suitable land for development of Common Bio-medical Waste Treatment and Disposal Facility for safe treatment and disposal of bio-medical waste in their respective jurisdictions. (ii) Any other function stipulated under these Rules

FORM - I
(See rule 9 and 10)

APPLICATION FOR AUTHORISATION OR RENEWAL OF AUTHORISATION
(To be submitted in duplicate.)

To

The Prescribed Authority
(Name of the State or UT Administration)
Address.

1. Particulars of Applicant
   (i) Name of the Applicant
   (In block letters & in full)
   (ii) Name of the Institution:
   (iii) Address:
   (iv) Tele No., Fax No. Telex No.
   (v) Email
2. Activity for which authorisation is sought:
   (i) Generation
   (ii) Collection
   (iii) Reception
   (iv) Storage
   (v) Transportation
   (vi) Treatment
   (vii) Disposal
   (viii) Any other form of handling
3. Please state whether applying for fresh authorisation or for renewal:
(In case of renewal previous authorisation-number and date)

4. (i) Address of the institution handling bio-medical wastes:

   (ii) Address of the place of the treatment facility:

   (iii) Address of the place of disposal of the waste(s):

5. (i) Mode of transportation (in any) of bio-medical waste:

   (ii) Mode(s) of treatment:

6. Brief description of method of treatment and disposal (attach details):

7. (i) Category (see Schedule 1) of waste to be handled

(ii) Quantity of waste (category-wise) to be handled per month

8. Declaration

I do hereby declare that the statements made and information given above are true to the best of my knowledge and belief and that I have not concealed any information.

I do also hereby undertake to provide any further information sought by the prescribed authority in relation to these rules and to fulfill any conditions stipulated by the prescribed authority.

Date : Signature of the Applicant

Place : Designation of the Applicant

Form - II
(See rule 12)
ANNUAL REPORT

(To be submitted to the prescribed authority by 31st January every year for the period from January to December of the preceding year, by the Health Care Facility or Health Care Establishment i.e., Occupier)

Sl. No.	Particulars		
1 .	Particulars of the Occupier	:	
	(i) Name of the authorised person (occupier)	:	
	(ii) Name of the institution	:	
	(iii) Address	:	
	(iv)Tel. No, Fax. No	:	
	(v) E-mail ID	:	
	(vi) Ownership of the Health Care Facility	:	(State Government or Private or Semi Govt. or any other)
	(vii). Status of Authorization under the Bio-Medical Waste (Management and Handling) Rules	:	Authorization No.: ………………………………… ……………………….valid up to ……….
	(viii). Status of Consents under Water Act and Air Act	:	Valid up to:
2.	Type of Health Care Facility	:	
	(i) Bedded Hospital	:	No. of Beds:…..
	(ii). Non-bedded hospital	:	Clinic/Blood Bank or Laboratory or Veterinary Hospital or any other

3.	Categories of Bio-medical waste generated (please indicate category numbers as per Bio-Medical Waste (Management and Handling) Rules)	:	
4.	Quantity of waste generated in Kg or Tones per annum (on monthly average basis)	:	Yellow Category : Red Category : Blue Category :
5	Additional Details :		
	(i) Brief details of the on-site storage facility	:	Size : Capacity : Provision of on-site storage : (cold storage or any other provision)
	(ii). Brief details of th on-site treatment facilities	:	Incineration (Yes/No) Autoclaving (Yes/No) Microwaving (Yes/No) Shredding (Yes/No) Needle destroyer and Cutter : (Yes/No) Needle destroyer : .....Nos Needle Cutter : .....Nos. Liquid Waste Effluent Treatment Plant (Yes /No)
	(iii) Installed capacity of on-site treatment facility	:	Incineration: .....Kg/hr Autoclaving:.........Kg/batch Microwaving:.........Kg/batch Shredding: ....kg/batch Liquid Waste Effluent Treatment Plant: ....in KL
	(iv) Actual quantity of wastes treated in kg or Tons per annum (on monthly average basis) at on-site waste treatment facility	:	Incineration:............. Autoclaving :............ Microwaving:............ Shredding :.............. Liquid Waste Treatment : ....in KL
	(v) Actual quantity of recyclable wastes sold to recyclers after treatment in kg or Tons per annum (on monthly average basis)	:	Red Category (like plastic, glass etc.)
	(vi) Actual quantity of wastes disposed through common facility operator in Kg or Tons per annum (on monthly average basis)	:	Yellow category: Red Category : Blue Category:

	(a) Name of the Common Bio-Medical Waste Treatment Facility Operator through which wastes are disposed of	:	
	(b) Name and address of the Treatment facility with Telephone, Fax and E-mail ID	:	
	(vii). Mode of transportation of wastes to the Common Treatment Facility	:	
6.	Any other relevant information	:	(pl. attach schematic diagram of liquid waste effluent treatment plant, Air Pollution Control Devices attached with the Incinerator)
7.	Certified that the above report is for the period from		

Name and Signature of the Head of the Institution

Date:
Place

Form –II A
(See rule 12)
ANNUAL REPORT

(To be submitted to the prescribed authority by 31st January every year for the period from January to December of the preceding year, by the Operator of a Common Bio-Medical Waste Treatment and Disposal Facility)

Sl. No.	Particulars		
1	Particulars of the Operator of the Facility	:	
	(i) Name of the authorized person (operator of the facility)	:	
	(ii) Name of the Common Bio-Medical Waste Treatment and Disposal Facility	:	
	(iii) Address of the Facility	:	
	(iv)Tel. No. Fax. No	:	
	(v) E-mail ID	:	
	(vi) Ownership of the Common Bio-Medical Waste Treatment and Disposal Facility	:	(State Government or Private or Semi Govt. or any other)
	(vii).Authorization under Bio-Medical Waste (Management and Handling) Rules	:	Authorization No.: ....Validity up to..........
	(viii). Status of Consents under Water Act and Air Act	:	Valid up to:

2.	Bio-medical waste Categories		
	(i). Waste categories received from the member Health Care Facilities or Health Care Establishments (pl. indicate category numbers as per Bio-Medical Waste (Management and Handling) Rules)	:	
	(ii). Waste Categories generated (pl. indicate category number as per Bio-Medical Waste (Management and Handling) Rules)	:	
3.	Quantity of Waste Received in Kg or Tons per annum	:	Yellow category:
		:	Red Category:
		:	Blue Category:
4.	No. of vehicles used for collection and transportation of bio-medical waste	:	
5. Additional Details			
	(i) Brief details of the treatment units in the Common treatment facility	:	Waste Storage Room (Yes/No)
			Incineration (Yes/No)
			Autoclaving (Yes/No)
			Microwaving (Yes/No)
			Shredding (Yes/No)
			Liquid waste effluent treatment plant (Yes/No)
			Vehicle Washing Facility (Yes/No)
			DG Set provision (Yes/No)
	(ii) Installed Capacity of the treatment units of the Biomedical Waste Treatment and Disposal Facility	:	Storage and the provision of storage:
			Incineration : kg/hr
			Autoclaving :................ Kg/batch
			Microwaving:............... Kg/batch
			Shredding: ......kg/batch
			ETP for liquid waste: KL
	(iii)Category-wise quantity of bio-medical waste treated in kg or tons per annum (on monthly average basis)	:	Yellow category:
			Red Category:
			Blue Category:
	(iv) Actual quantity of recyclable wastes sold to recyclers after treatment in kg or tons per annum (on monthly average basis)	:	Red Category: (indicate item-wise details and the quantity)
	(v) Quantity of waste generated during the treatment of wastes in Kg or Tons per annum (on monthly average basis)	:	Incineration ash:
			Effluent Treatment Plant Sludge :
	(vi) Actual quantity of wastes disposed in secured landfill in Kg or Tons per annum (on monthly average basis)	:	Incineration ash:
			Effluent Treatment Plant Sludge :
	(a) Name and location of the secured landfill where disposable wastes are disposed of	:	

	(vii) Mode of transportation of bio-medical wastes from Occupier to the common treatment facility	:	
6.	Any other relevant information	:	(pl. attach map of the Biomedical Waste Treatment and Disposal Facility indicating locations of various units, flow diagram of liquid waste effluent treatment plant, schematic diagram of incinerator with Air Pollution Control Devices)
7.	Certified that the above report is for the period from		

Name and Signature of the Head of the Institution

Date:
Place

FORM - III
(See rule 14)
ACCIDENT REPORTING

1. Date and time of accident :

2. Sequence of events leading to accident :

3. The waste involved in accident :

4. Assessment of the effects of the accidents on human health and the environment:

5. Emergency measures taken :

6. Steps taken to alleviate the effects of accidents :

7. Steps taken to prevent the recurrence of such an accident :

Date : .... Signature ....
Place: .... Designation ....

FORM - IV
(See rule 10)

(Authorization for operating a facility for collection, reception, treatment, storage, transport and disposal of biomedical wastes.)

1. File number of authorisation and date of issue...

2. ....of .... is hereby granted an authorization to operate a facility for collection, reception, treatment storage, transport and disposal of biomedical waste on the premises situated at ....

3. This authorisation shall be in force for a period of .... Years from the date of issue.

4. This authorisation is subject to the conditions stated below and to such other conditions as may be specified in the rules for the time being in force under the Environment (Protection) Act, 1986.

Date .... Signature..........................
.... Designation ....

Terms and conditions of authorisation *

1. The authorisation shall comply with the provisions of the Environment (Protection) Act, 1986 and the rules made there under.
2. The authorization or its renewal shall be produced for inspection at the request of an officer authorised by the prescribed authority.
3. The person authorized shall not rent, lend, sell, transfer or otherwise transport the biomedical wastes without obtaining prior permission of the prescribed authority.
4. Any unauthorised change in personnel, equipment or working conditions as mentioned in the application by the person authorised shall constitute a breach of his authorisation.
5. It is the duty of the authorised person to take prior permission of the prescribed authority to close down the facility.

---

* Additional terms and conditions may be stipulated by the prescribed authority.

FORM -V
(See rule 15)

Application for filing appeal against order passed by the prescribed authority at district level or regional office of the Pollution Control Board acting as prescribed authority or the State or Union Territory level authority.

1. Name and address of the person applying for appeal :

2. Number, date of order and address of the authority which passed the order, against which appeal is being made (certified copy of order to be attached)

3. Ground on which the appeal is being made.

4. List of enclosures other than the order referred in para 2 against which appeal is being filed.

Signature ……………………..

Date : Name and Address……………………..

Form –VI
(see rule 5 (3))

Report of the Operator of the Common Bio-medical Waste Treatment and Disposal Facility on the Health Care Facility or Health Care Establishment not handing over Bio-Medical Wastes for the dates _____ the month of ________ , the Year of _______.

(To be informed immediately to the prescribed authority and also to be submitted to the prescribed authority by first week of every month for the previous month, by the Operator of the Common Bio-Medical Waste Treatment Facility)

Sl. No.	Particulars				
1.	Particulars of the Operator of the facility	:			
	(i) Name of the authorized person (occupier/operator)	:			
	(ii) Name of the Common Bio-medical Waste Treatment and Disposal Facility	:			
	(iii) Address	:			
	(iv)Tel. No, Fax. No	:			
	(v) E-mail ID	:			
2.	Total number of Health Care Facility or Health Care Establishment taken membership		Government	Private	Semi-Government

3.	Total Average Quantity of Bio-medical Waste Generated from the member Health Care Facility (HCF) or Health Care Establishment (HCE) in a day/month (based on authorization issued by State Pollution Control Boards /Pollution Control Committees)	:	........................In Kgs/Tons Type of HCF or HCE or Category of bio-medical waste | Govt. in kgs | Private in kgs | Semi - Government In kgs Yellow | | | Red | | | Blue | | |
4.	Bio-medical waste received during the month for the period in kg or tons per month	: : :	Yellow category: Red category: Blue Category
5.	List of member Health Care Facility (HCF) or Health Care Establishment (HCE) not sent bio-medical waste for the month of ....of the.................... year	:	

Certified that the above report is based on the records available with this Common Bio-medical Waste Treatment and Disposal Facility

Date :
Place:

Name and signature
of the Head of the Institution

******

[F. No. 3-1/2000-HSMD]
RAJIV GAUBA, Jt. Secy.

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

Annexure 9

The E-Waste (Management and Handling) Rules 2011

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 12th May, 2011

S.O. 1035(E).—Whereas, the draft rules, namely the e-waste (Management and Handling) Rules, 2010 were published by the Government of India in the Ministry of Environment and Forests vide number S.O.1125 (E), dated 14th May, 2010 in the Gazette of India, Extraordinary Part II, Section 3, Sub-section (ii) dated 14th May, 2010 inviting objections and suggestions from all persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS the copies of the said Gazette were made available to the public on the 14th day of May, 2010;

AND WHEREAS the objections and suggestions received within the said period from the public in respect of the said draft rules have been duly considered by the Central Government;

NOW, THEREFORE, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules, namely:-

CHAPTER I

PRELIMINARY

1. **Short title and commencement.** –

(1) These rules may be called the e-waste (Management and Handling) Rules, 2011.
(2) They shall come into effect from 1st May, 2012.

2. **Application.** – These rules shall apply to every producer, consumer or bulk consumer involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as specified in Schedule-I, collection centre, dismantler and recycler of e-waste and shall not apply to-

(a) batteries as covered under the Batteries (Management and Handling) Rules, 2001 made under the Act;
(b) Micro and small enterprises as defined in the Micro, Small and Medium Enterprises Development Act, 2006 (27 of 2006); and
(c) radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and rules made there under.

3. **Definitions.** – (1) In these rules, unless the context otherwise requires, -

(a) 'Act' means the Environment (Protection) Act, 1986 (29 of 1986);
(b) 'authorisation' means permission for handling, collection, reception, storage, transportation, dismantling, recycling, treatment and disposal of e-waste granted under sub-rule (3) of rule 9;
(c) 'bulk consumer' means bulk users of electrical and electronic equipment such as Central Government or State Government Departments, public sector undertakings, banks, educational institutions, multinational organizations, international agencies and private companies that are registered under the Factories Act, 1948 and Companies Act, 1956;
(d) 'central pollution control board' means the Central Pollution Control Board constituted under sub-section (1) of section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);
(e) 'collection centre' means a centre established, individually or jointly or a registered society or a designated agency or a company or an association to collect e-waste;
(f) 'consumer' means any person using electrical and electronic equipment excluding the bulk consumers;
(g) 'dismantler' means any person or registered society or a designated agency or a company or an association engaged in dismantling of used electrical and electronic equipment into their components;
(h) 'disposal' means any operation which does not lead to recycling, recovery or reuse and includes physico-chemical or biological treatment, incineration and deposition in secured landfill;
(i) 'environmentally sound management of e-waste' means taking all steps required to ensure that e-waste are managed in a manner which shall protect health and environment against any adverse effects, which may result from hazardous substance contained in such wastes;
(j) 'electrical and electronic equipment' means equipment which is dependent on electric currents or electro-magnetic fields to be fully functional;
(k) 'e-waste' means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded;
(l) 'extended producer responsibility' means responsibility of any producer of electrical or electronic equipment, for their products beyond manufacturing until environmentally sound management of their end-of-life products.
(m) 'facility' means any location wherein the process incidental to the collection, reception, storage, segregation, refurbishing, dismantling, recycling, treatment and disposal of e-waste are carried out;
(n) 'Form' means form appended to these rules;

(o) 'historical e-waste' means e-waste generated from electrical and electronic equipment as specified in Schedule I, which was available on the date from which these rules come into force;

(p) 'orphaned products' means non branded or assembled electrical and electronic equipment as specified in Schedule I or those produced by a company, which has closed its operations or has stopped product support;

(q) 'producer' means any person who, irrespective of the selling technique used;

   (i) manufactures and offers to sell electrical and electronic equipment under his own brand; or

   (ii) offers to sell under his own brand, assembled electrical and electronic equipment produced by other manufacturers or suppliers; or

   (iii) offers to sell imported electrical and electronic equipment;

(r) 'recycler' - means any person who is engaged in recycling or reprocessing of used electrical and electronic equipment or assemblies or their component;

(s) 'Schedule' means the Schedule appended to these rules;

(t) 'State Government in relation to a Union territory' means, the Administrator thereof appointed under article 239 of the Constitution;

(u) 'state pollution control board'- means the concerned State Pollution Control Board or the Pollution Control Committee of the Union Territories constituted under sub-section (1) of section 4 of the Water (Prevention and Control of Pollution) Act, 1974;

(v) 'transporter' means a person engaged in the off-site transportation of e-waste by air, rail, road or water

(2) Words and expressions used in these rules and not defined but defined in the m Act shall have the meanings respectively assigned to them in that Act.

CHAPTER II

RESPONSIBILITIES

4. **Responsibilities of the producer.** —The producer of electrical and electronic equipment listed in Schedule I shall be responsible for,-

(1) collection of e-waste generated during the manufacture of electrical and electronic equipment and channelizing it for recycling or disposal;

(2) collection of e-waste generated from the 'end of life' of their products in line with the principle of 'Extended Producer Responsibility' and to ensure that such e-wastes are channelized to registered dismantler or recycler. Producer shall, as necessary, ensure collection and channelization by authorizing collection agencies;

(3) setting up collection centers or take back systems either individually or collectively;

(4) financing and organizing a system to meet the costs involved in the environmentally sound management of e-waste generated from the 'end of life' of its own products and historical waste available on the date from which these rules come into force. The financing arrangement of such a system shall be transparent. The producer may choose to establish such a system either individually or by joining a collective scheme;

(5) providing contact details such as address, telephone numbers/helpline number of authorized collection centers to consumer(s) or bulk consumer(s) so as to facilitate return of used electrical and electronic equipment;

(6) creating awareness through publications, advertisements, posters, or by any other means of communication and information booklets accompanying the equipment, with regard to-

(i) information on hazardous constituents as specified in sub-rule 1 of rule 13 in electrical and electronic equipment;

(ii) information on hazards of improper handling, accidental breakage, damage and/or improper recycling of e-waste;

(iii) instructions for handling the equipment after its use, along with the Do's and Don'ts;

(Iv) affixing a visible, legible and indelible symbol given below on the products or information booklets to prevent e-waste from being dropped in garbage bins containing waste destined for disposal;

(7) obtaining an authorization from the concerned State Pollution Control Board or Pollution Control Committee in accordance with the procedure under rule 9;

(8) maintaining records in Form 2 of the e-waste handled and make such records available for scrutiny by the State Pollution Control Board or the Committee concerned.

(9) filing annual returns in Form 3, to the State Pollution Control Board or Pollution Control Committee concerned, on or before the 30th day of June following the financial year to which that return relates.

5. **Responsibilities of collection centers** –Collection centre shall-

(1) obtain an authorization in accordance with the procedure under rule 9 from the State Pollution Control Board or Pollution Control Committee concerned as the case may be and provide details such as address, telephone numbers/helpline number, e-mail, etc. of such collection centre to the general public;

(2) ensure that the e-waste collected by them is stored in a secured manner till it is sent to registered dismantler(s) or recycler(s) as the case may be;

(3) ensure that no damage is caused to the environment during storage and transportation of e-waste;

(4) file annual returns in Form 3, to the State Pollution Control Board or Pollution Control Committee concerned on or before the 30th day of June following the financial year to which that return relates; and
(5) maintain records of the e-waste handled in Form 2 and make such records available for scrutiny by the State Pollution Control Board or the Pollution Control Committee concerned.

6. **Responsibilities of consumer or bulk consumer.** –
(1) Consumers or Bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is channelised to authorized collection center(s) or registered dismantler(s) or recycler(s) or is returned to the pick-up or take back services provided by the producers; and
(2) bulk consumers shall maintain records of e-waste generated by them in Form 2 and make such records available for scrutiny by the State Pollution Control or the Pollution Control Committee concerned.

7. **Responsibilities of dismantler** – Every dismantler shall-
(1) obtain authorization and registration from the State Pollution Control Board in accordance with the procedure under the rules 9 and 11;
(2) ensure that no damage is caused to the environment during storage and transportation of e-waste;
(3) ensure that the dismantling processes do not have any adverse effect on the health and the environment;
(4) ensure that the facility and dismantling processes are in accordance with the standards or guidelines published by the Central Pollution Control Board from time to time;
(5) ensure that dismantled e-waste are segregated and sent to the registered recycling facilities for recovery of materials;
(6) ensure that non-recyclable/non- recoverable components are sent to authorized treatment storage and disposal facilities;
(7) file a return in Form 3, to the State Pollution Control Board or the Pollution Control Committee concerned as the case may be, on or before 30th June following the financial year to which that return relates;
(8) not process any e-waste for recovery or refining of materials, unless he is registered with State Pollution Control Board as a recycler for refining and recovery of materials.

8. **Responsibilities of recycler**– Every recycler shall-
(1) obtain authorization and registration from State Pollution Control Board in accordance with the procedure under the rules 9 and 11;
(2) ensure that the facility and recycling processes are in accordance with the standards laid down in the guidelines published by the Central Pollution Control Board from time to time;
(3) make available all records to the Central or State Pollution Control Board or Pollution Control Committee of Union territories for inspection;
(4) ensure that residue generated thereof is disposed of in a hazardous waste treatment storage disposal facility;
(5) file annual returns in Form 3, to the State Pollution Control Board or Pollution Control Committee concerned as the case may be, on or before 30th June following the financial year to which that returns relate.

CHAPTER III

PROCEDURE FOR SEEKING AUTHORIZATION AND REGISTRATION FOR HANDLING E-WASTES

9. **Procedure for grant of authorization.–**

(1) Every producer of electrical and electronic equipment listed in Schedule I, collection centre, dismantler and recycler of e-waste shall obtain an authorization from the State Pollution Control Board or Pollution Control Committee of Union territories concerned as the case may be.

(2) Every producer of electrical and electronic equipment listed in Schedule I, collection centre, dismantler and recycler of e-waste shall make an application, within a period of three months starting from the date of commencement of these rules in Form 1 to the State Pollution Control Board or the Pollution Control Committee for grant of authorization:

Provided that any person authorized under the provisions of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, prior to the date of coming into force of these rules shall not be required to make an application for authorization till the period of expiry of such authorization:

Provided further that a recycler of e-waste who has not been authorized under the provisions of the Hazardous Waste (Management, Handling and Transboundary Movements) Rules, 2008, shall require auhtorization following the procedure mentioned in sub-rule (1) above.

(3) On receipt of the application complete in all respects for the authorization, the State Pollution Control Board or Pollution Control Committee of Union territories may, after such enquiry as it considers necessary and on being satisfied that the applicant possesses appropriate facilities, technical capabilities and equipment to handle e-waste safely, grant within a period of ninety days an authorization in Form-1(a) to the applicant to carry out safe operations in the authorized place only, which shall be valid for a period of five years.

(4) The State Pollution Control Board or Pollution Control Committee of the Union territories after giving reasonable opportunity of being heard to the applicant shall refuse to grant any authorization.

(5) Every person authorized under these rules shall maintain the record of e-waste handled by them in Form-2 and prepare and submit to the State Pollution Control Board or Pollution Control Committee, an annual return containing the details specified in Form 3 on or before 30th day of June following the financial year to which that return relates.

(6) An application for the renewal of an authorization shall be made in Form-1 before sixty days of its expiry and the State Pollution Control Board or Pollution Control Committee may renew the authorization after examining each case on merit and subject to the condition that there is no report of violation of the provisions of the Act or the rules made there under or the conditions specified in the authorization.

(7) Every producer of electrical and electronic equipment listed in Schedule I, collection centre, dismantler and recycler of e-waste shall take all steps, wherever required, to comply with the conditions specified in the authorization.

(8) The State Pollution Control Board in case of a respective State or the Pollution Control Committee in case of Union territories shall maintain a register containing particulars of the conditions imposed under these rules for environmentally sound management of e-waste, and it shall be open for inspection during office hours to any person interested or affected or a person authorized by him on his behalf.

10. **Power to suspend or cancel an authorization.-**

(1) The State Pollution Control Board or Pollution Control Committee of the Union territories may, if in its opinion, the holders of the authorization has failed to comply with any of the conditions of the authorization or with any provisions of the Act or these rules and after giving a reasonable opportunity of being heard and after recording reasons thereof in writing cancel or suspend the authorization issued under these rules for such period as it considers necessary in the public interest.

(2) Upon suspension or cancellation of the authorization, the State Pollution Control Board or Pollution Control Committee of the Union territories may give directions to the persons whose authorization has been suspended or cancelled for the safe storage of the e-waste and such person shall comply with such directions.

PROCEDURE FOR REGISTRATION WITH STATE POLLUTION CONTROL BOARD

11. **Procedure for grant of registration. –**

(1) Every dismantler or recycler of e-waste shall make an application, within a period of three months starting from the date of commencement of these rules, in Form-4 in triplicate to the State Pollution Control Board accompanied with a copy of the following documents for the grant or renewal of registration:-

(i) consent to establish granted by the State Pollution Control Board under Water (Prevention and Control of Pollution) Act, 1974, (25 of 1974) and Air (Prevention and Control of Pollution) Act, 1981(21 of 1981);

(ii) certificate of registration issued by the District Industries Centre or any other government agency authorized in this regard;

(iii) proof of installed capacity of plant and machinery issued by the District Industries Centre or any other government agency authorized in this behalf;

(iv) in case of renewal, a certificate of compliance of effluent and emission standards, treatment and disposal of hazardous wastes as applicable from the State Pollution Control Board or Committee of the Union territories or any other agency designated for this purpose:

Provided that any person registered under the provisions of the Hazardous Wastes (Management, Handling and Transboundary Movements) Rules, 2008, prior to the date of coming into force of these rules shall not be required to make an application for registration till the period of expiry of such registration:

Provided further that a recycler of e-waste who has not been registered under the provisions of the Hazardous Waste (management, Handling and Transboundary Movements) Rules, 2008, shall require registration following the procedure mentioned in sub-rule (1) of rule 11.

(2) The State Pollution Control Board, on being satisfied that the application is complete in all respects and that the applicant is utilizing environmentally sound technologies and possess adequate technical capabilities, requisite facilities and equipment to recycle and process e-waste, may grant registration to such applicants stipulating therein necessary conditions as deemed necessary for carrying out safe operations in the authorized place only.

(3) The State Pollution Control Board shall dispose of the application for registration within a period of ninety days from the date of the receipt of such application complete in all respects.

(4) The registration granted under these rules shall be valid initially for a period of two years and thereafter for a period of maximum five years on subsequent renewals from the date of its issue, unless the operation is discontinued by the unit or the registration suspended or cancelled by the State Pollution Control Board.

(5) The State Pollution Control Board may after giving reasonable opportunity of being heard to the applicant, by order, refuse to grant or renew.

(6) The State Pollution Control Board shall monitor the compliance of conditions stipulated for granting registration.

(7) The State Pollution Control Board may cancel or suspend a registration granted under these rules, if it has reasons to believe that the registered recycler has failed to comply with any of the conditions of registration, or with any provisions of the Act or rules made there under, after giving an opportunity to the recycler to be heard and after recording the reasons there for.

(8) An application for the renewal of registration shall be made in Form-4 before sixty days of its expiry and the State Pollution Control Board or Pollution Control Committee may renew the registration after examining each case on merit and subject to the condition that there is no report of violation of the provisions of the Act or the rules made there under or the conditions specified in the registration.

(9) The dismantler or recycler shall maintain records of the e-waste purchased and processed and shall file annual returns of its activities of previous year in Form 3 to the State Pollution Control Board or Pollution Control Committee on or before 30th day of June of every year.

(10) The Central Government and the Central Pollution Control Board may issue guidelines for standards of performance for recycling processes from time to time.

CHAPTER IV

12. **Procedure for storage of e-waste,-** Every producer, collection centre, dismantler or recyclers may store the e-waste for a period not exceeding one hundred and eighty days and shall maintain a record of collection, sale, transfer, storage and segregation of wastes and make these records available for inspection:

Provided that the State Pollution Control Board may extend the said period up to one year in the following cases, namely:

(i). Collection centers in the States, which do not have any registered dismantling or recycling facility; or Dismantlers in the States, which do not have any registered recycling facility;

(ii). the waste which needs to be specifically stored for development of a process for its recycling or reuse.

CHAPTER V

REDUCTION IN THE USE OF HAZARDOUS SUBSTANCES IN THE MANUFACTURE OF ELECTRICAL AND ELECTRONIC EQUIPMENT

13. **Reduction in the use of hazardous materials in the manufacture of electrical and electronic equipment.–**

(1) Every producer of electrical and electronic equipment listed in schedule I shall ensure that, new electrical and electronic equipment does not contain Lead, Mercury, Cadmium, Hexavalent Chromium, polybrominated biphenyls or polybrominated diphenyl ethers:

Provided that a maximum concentration value of 0.1% by weight in homogenous materials for lead, mercury, hexavalent chromium, polybrominated biphenyls and polybrominated diphenyl ethers and of 0.01% by weight in homogenous materials for cadmium shall be permitted.

(2) The applications listed in Schedule-II shall be exempted from provisions of sub-rule (1) of rule 13.

(3) The sub-rule(1) of rule 13 shall not apply to components of electrical and electronic equipment manufactured or placed in the market six years before the date of commencement of these rules.

(4) In the event of such reduction in the hazardous materials used in the electrical and electronic equipment, the detailed information on the constituents of the equipment shall be provided in the product information booklet.

(5) Imports or placement in the market for new electrical and electronic equipment shall be permitted only for those which are compliant to provisions of sub-rule (1) of rule 13.

(6) Manufacture and supply of electrical and electronic equipment used for defense and other similar strategic applications shall be excluded from provisions of sub-rule (1) of rule 13.

(7) Such reduction in use of hazardous substances in manufactured or imported electrical and electronic equipment shall be achieved within a period of two years from the date of commencement of these rules.

CHAPTER VI

MISCELLANEOUS

14. **Duties of Authorities.** - subject to other provisions of these rules, the authorities shall perform duties as specified in Schedule-III.

15. **Annual Report.-**

(1) The State Boards and the Committees shall prepare and submit to the Central Pollution Control Board an annual report with regard to the implementation of these rules by the 30th September every year in Form 5.
(2) The Central Pollution Control Board shall prepare the consolidated annual review report on management of e-waste and forward it to the Central Government along with its recommendations before the 30th December every year.

16. **Transportation of e-waste.** –

(1) In case of transportation of e-waste for final disposal to a facility in a State other than the State where the waste is generated/collected, the transporter shall obtain 'No Objection Certificate' from the State Pollution Control Board concerned and shall intimate the State Pollution Control Board of the State(s) of transit.
(2) In case of transportation of e-waste for dismantling or for recycling in a State other than the State where the waste is generated or collected, the transporter shall give prior intimation to the State Pollution Control Boards concerned and the State Pollution Control Boards of the State(s) of transit.

17. **Accident reporting and follow-up.-** where an accident occurs at the facility processing e-waste or during transportation of e-waste, the producer, transporter, dismantler, or recycler, as the case may be, shall report immediately to the State Pollution Control Boards or Committees of Union territories about the accident.

18. The collection, storage, transportation, segregation, refurbishment, dismantling, recycling and disposal of e-waste shall be in accordance with the procedures prescribed in the guidelines published by the Central Pollution Control Boards from time to time.

SCHEDULE I

(see rules 2 (1), 3(j) and (k))

Categories of electrical and electronic equipment covered under the rules

Sr. No.	Categories of electrical and electronic equipment
i.	**Information technology and telecommunication equipment :** Centralised data processing: Mainframes, Minicomputers Personal computing: Personal Computers (Central Processing Unit with input and output devices) Laptop Computers(Central Processing Unit with input and output devices) Notebook Computers Notepad Computers Printers including cartridges Copying equipment Electrical and electronic typewriters User terminals and systems Facsimile Telex Telephones Pay telephones Cordless telephones Cellular telephones Answering systems
ii.	**Consumer electrical and electronics:** Television sets (including sets based on (Liquid Crystal Display and Light Emitting Diode technology), Refrigerator, Washing Machine, Air-conditioners excluding centralised air conditioning plants

SCHEDULE II

[See rule 13(2)]

Applications, which are exempted from the requirements of sub-rule (1) of rule 13 (applicable to categories of electrical and electronic equipment as listed in Schedule I)

	Exemption
1	Mercury in single capped (compact) fluorescent lamps not exceeding (per burner):
1(a)	For general lighting purposes < 30 W:5 mg
1(b)	For general lighting purposes ≥ 30 W and < 50 W:5 mg
1(c)	For general lighting purposes ≥ 50 W and < 150 W:5 mg
1(d)	For general lighting purposes ≥ 150 W:15 mg
1(e)	For general lighting purposes with circular or square structural shape and tube diameter ≤ 17 mm: 7mg
1(f)	For special purposes: 5 mg
2(a)	Mercury in double-capped linear fluorescent lamps for general lighting purposes

	not exceeding (per lamp):
2(a)(1)	Tri-band phosphor with normal lifetime and a tube diameter > 9 mm (e.g. T2): 4 mg
2(a)(2)	Tri-band phosphor with normal lifetime and a tube diameter ≥ 9 mm and ≥ 17 mm (e.g. T5): 3 mg
2(a)(3)	Tri-band phosphor with normal lifetime and a tube diameter > 17 mm and ≤ 28 mm (e.g. T8): 3.5 mg
2(a)(4)	Tri-band phosphor with normal lifetime and a tube diameter > 28 mm (e.g. T12): 5 mg
2(a)(5)	Tri-band phosphor with long lifetime (≥ 25000 h): 8 mg
2(b)	Mercury in other fluorescent lamps not exceeding (per lamp):
2(b)(1)	Linear halophosphalte lamps with tube > 28 mm (e.g T 10 and T12): 10 mg
2(b)(2)	Non- linear halophosphate lamps (all diameters): 15 mg
2(b)(3)	Non- linear tri-band phosphor lamps with tube diameter > 17 mm (e.g. T9):15 mg
2(b)(4)	Lamps for other general lighting and special purposes (e.g. induction lamps): 15mg
3	Mercury in cold cathode fluorescent lamps and external electrode fluorescent lamps (CCFL and EEFL) for special purposes not exceeding (per lamp):
3(a)	Short length (≤ 500 mm): 3.5mg
3(b)	Medium length (> 500 mm and ≤ 1500 mm): 5mg
3(c)	Long length (> 1500 mm): 13mg
4(a)	Mercury in other low pressure discharge lamps (per lamp)
4(b)	Mercury in High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner) in lamps with improved colour rendering index Ra>60:
4(b)-I	P ≤ 155 W: 30mg
4(b)-II	155 W < P ≤ 405 W: 40mg
4(b)-III	P > 405 W: 40mg
4(c)	Mercury in other High Pressure Sodium (vapour) lamps for general lighting purposes not exceeding (per burner):
4(c)-I	P ≤ 155 W: 25mg
4(c)- II	155 W <P≤ 405 W: 30mg
4(c)-III	P> 405 W: 40mg
4(d)	Mercury in High Pressure Mercury (vapour) lamps (HPMV)
4(e)	Mercury in metal halide lamps (MH)
4(f)	Mercury in other discharge lamps for special purposes not specifically mentioned in this Schedule
5(a)	Lead in glass of cathode ray tubes
5(b)	Lead in glass of fluorescent tubes not exceeding 0.2 % by weight
6(a)	Lead as an alloying element in steel for machining purposes and in galvanized steel containing up to 0.35% lead by weight
6(b)	Lead as an alloying element in aluminum containing up to 0.4%lead by weight
6(c)	Copper alloy containing up to 4% lead by weight
7 (a)	Lead in high melting temperature type solders (i.e. lead-based alloys containing 85% by weight or more lead)
7(b)	Lead in solders for servers, storage and storage array systems, network infrastructure equipment for switching, signaling, transmission, and network management for telecommunications
7(c)- I	Electrical and electronic components containing lead in a glass or ceramic other than dielectric ceramic in capacitors, e.g. piezoelectronic devices, or in a glass or ceramic matrix compound.
7(c)-II	Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC or higher

7(c)-III	Lead in dielectric ceramic in capacitors for a rated voltage of 125 V AC or 250 V DC
8(a)	Cadmium and its compounds in one shot pellet type thermal cut-offs.
8(b)	Cadmium and its compounds in electrical contacts
9	Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution
9(b)	Lead in bearing shells and bushes for refrigerant-containing compressors for heating, ventilation, air conditioning and refrigeration (HVACR) application.
11(a)	Lead used in C-press complaining pin connector systems
11(b)	Lead used in other than C-press complaint pin connector systems
12	Lead as a coating material for the thermal conduction module C-ring
13(a)	Lead in while glasses used for optical applications
13(b)	Cadmium and lead in filter glasses and glasses used for reflectance standards.
14	Lead in solders consisting of more than two elements for the connection between the pins and the package of microprocessors with a lead content of more than 80% and less than 85% by weight
15	Lead in solders to complete a viable electrical connection between semiconductor die and carrier within integrated circuit flip chip packages.
16	Lead in linear incandescent lamps with silicate coated tubes
17	Lead halide as radiant agent in high intensity discharge (HID) lamps used for professional reprography applications.
18(a)	Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps when used as specialty lamps for diazoprinting reprography, lithography, insect traps, photochemical and curing processes containing phosphors such as SMS ((Sr, Ba)2MgSi2O7:Pb)
18(b)	Lead as activator in the fluorescent powder (1 % lead by weight or less) of discharge lamps when used as sun tanning lamps containing phosphors such as BSP (BaSi2O5:Pb)
19	Lead with PbBiSn-Hg and PbInSn-Hg in specific compositions as main amalgam and with PbSn-Hg as auxiliary amalgam in very compact energy saving lamps (ESL)
20	Lead oxide in glass used for bonding front and rear substrates of flat fluorescent lamps used for Liquid Crystal Displays (LCDs)
21	Lead and cadmium in printing inks for the application of enamels on glasses, such as borosilicate and soda lime glasses
23	Lead in finishes of fine pitch components other than connectors with a pitch of 0.65 mm and less
24	Lead in solders for the soldering to machined through hole discoidal an planar array ceramic multilayer capacitors
25	Lead oxide in surface conduction electron emitter displays (SED) used in structural elements, notably in the seal frit and frit ring.
26	Lead oxide in the glass envelope of black light blue lamps
27	Lead alloys as solder for transducers used in high- powered (designated to operate for several hours at acoustic power levels of 125 dB SPL and above) loudspeakers
29	Lead bound in crystal glass
30	Cadmium alloys as electrical/mechanical solder joints to electrical conductors located directly on the voice coil in transducers used in high-powered loudspeakers with sound pressure levels of 100 dB (A) and more
31	Lead in soldering materials in mercury free flat fluorescent lamps(which e.g. are used for liquid crystal displays, design or industrial lighting)
32	Lead oxide in seal frit used for making window assemblies for Argon and Krypton laser tubes

33	Lead in solders for the soldering of thin copper wires of 100 μm diameter and less in power transformers
34	Lead in cermet-based trimmer potentiometer elements
36	Mercury used as a cathode sputtering inhibitor in DC plasma displays with a content up to 30 mg per display
37	Lead in the plating layer of high voltage diodes on the basis of a zinc borate glass body
38	Cadmium and cadmium oxide in thick film pastes used on aluminum bonded beryllium oxide
39	Cadmium in colour converting II-VI LEDs (< 10 μg Cd per mm^2 of light-emitting area) for use in solid state illumination or display systems.

SCHEDULE III

[See rule 14)]

LIST OF AUTHORITIES AND CORREPONDING DUTIES

Sl No	AUTHORITY	CORRESPONDING DUTIES
1.	Central Pollution Control Board, Delhi	(i) Coordination with State Pollution Control Boards/ Committees of Union territories (ii) Preparation of Guidelines for Environmentally Sound Management of e-waste (iii) Conduct assessment of e-waste generation and processing (iv) Recommend standards and specifications for processing and recycling e-waste (v) Documentation, compilation of data on e-waste and uploading on websites of Central Pollution Control Board (vi) Conducting training & awareness programmes (vii) Submit Annual Report to the Ministry (viii) Any other function delegated by the Ministry under these rules (ix) Enforcement of provisions regarding reduction in use of hazardous substances in manufacture of electrical and electronic equipment (x) Initiatives for IT industry for reducing hazardous substances, (xi) Set targets for compliance to the reduction in use of hazardous substance in manufacture of electrical and electronic equipment (xii) Incentives and certification for green design/products
2.	State Pollution Control Boards/ Committees of Union territories	(i) Inventorization of e-waste. (ii) Grant & renewal of Authorization (iii) Registration of recyclers of e-waste (iv) Monitoring compliance of authorization and registration conditions (v) Maintain information on the conditions imposed for authorization etc. (vi) Implementation of programmes to encourage environmentally sound recycling (vii) Action against violations of these rules (viii) Any other function delegated by the Ministry under these rules

3.	Urban Local Bodies (Municipal Committee/Council/ Corporation)	(i) To ensure that e-waste if found to be mixed with Municipal Solid Waste is properly segregated, collected and is channelized to either authorized collection centre or dismantler or recycler. (ii) To ensure that e-waste pertaining to orphan products is collected and channelized to either authorized collection centre or dismantler or recycler.

FORM – 1

[*See rule 9(2)*]

APPLICATION FOR OBTAINING AUTHORIZATION FOR GENERATION/ COLLECTION/ STORAGE/DISMANTLING/RECYCLING/ OF E-WASTE*

From: ....

....

To

The Member Secretary,

.... Pollution Control Board or.................. Pollution Control Committee

....

....

Sir,

I / We hereby apply for authorization/renewal of authorization under rule 11(2) and 11(6) of the E-wastes (Management and Handling) Rules, 2011 for collection/ storage/ transport/treatment/disposal of e-wastes.

For Office Use Only

Code No. :

Whether the unit is situated in a critically polluted area as identified by Ministry of Environment and Forests (yes/no);

To be filled in by Applicant

Part – A: General

1. (a) Name and full address, telephone nos. e-mail and other contact details of the unit :
   (b) Authorization required for (Please tick mark appropriate activity/ies*)
      (i) Generation* ☐
      (ii) Collection* ☐
      (iii) Dismantling* ☐
      (iv) Recycling* ☐
   (c) In case of renewal of authorization previous authorization no. and date
2. (a) Whether the unit is generating or processing e-waste as defined in the E-wastes (Management and Handling) Rules, 2011

      (i) generating* ☐
      (ii) processing* ☐

*strike off whichever is not applicable

3. (a) Total capital invested on the project :
   (b) Year of commencement of production:
   (c) Date of grant of the Consent to Establish:
   (d) Date of grant of the Consent to Operate:

Part – B: e-waste

4. E-waste details:

(a)	Type of e-wastes generated as defined under the e-wastes (Management and Handling) Rules, 2011:	
(b)	Total Quantity e-waste handled generated/collected/dismantled/recycled :	
(c)	Mode of storage within the plant :	
(d)	Method of treatment and disposal :	
(e)	Installed capacity of the plant :	

Part – C : Dismantling and Recycling Facility

5. Detailed proposal of the facility (to be attached) to include:
   (i) Location of site (provide map).
   (ii) Details of processing technology
   (i) Type and Quantity of waste to be processed per day
   (iv) Site clearance (from local authority, if any)
   (v) Utilization of the e-waste processed
   (vi) Method of disposal of residues (details to be given)
   (vii) Quantity of waste to be processed or disposed per day
   (viii) Details of categories of e-waste to be dismantled/processed
   (ix) Methodology and operational details
   (x) Measures to be taken for prevention and control of environmental pollution including treatment of leachates
   (xii) Investment on Project and expected returns
   (xiii) Measures to be taken for safety of workers working in the plant

Place : ________ Signature ____________

(Name________________)

Date : __________

Designation : __________

FORM 1(a)

[*See rule 9(3)*]

FORM FOR GRANTING AUTHORIZATION FOR GENERATION/COLLECTION/ /STORAGE/DISMANTLING/ RECYCLING/ OF E-WASTE*

1. (a) Authorization and (b) date of issue ....

2. ....of..................................is hereby granted an authorization for generation, collection, storage, dismantling and recycling of e-waste on the premises situated at...

3. The authorization granted for generation, collection, storage, dismantling, and recycling of e-wastes.

4. The authorization shall be in force for a period from ....to ....

5. The authorization is subject to the conditions stated below and such conditions as may be specified in the rules for the time being in force under the Environment (Protection) Act, 1986.

Signature-------------------------
Designation -------------------- Date: ---------------------

Terms and conditions of authorization

1. The authorization shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.
2. The authorization or its renewal shall be produced for inspection at the request of an officer authorized by the State Pollution Control Board or Committee of Union territories.
3. The person authorized shall not rent, lend, sell, transfer or otherwise transport the e-wastes without obtaining prior permission of the State Pollution Control Board or Committee of Union territories.
4. Any unauthorized change in personnel, equipment as working conditions as mentioned in the application by the person authorized shall constitute a breach of his authorization.
5. It is the duty of the authorized person to take prior permission of the State Pollution Control Board or Committee of Union territories to close down the operations.
6. An application for the renewal of an authorization shall be made as laid down in sub-rule (6) of rule 9.

1699 GI/2011—7A

FORM – 2

[See rules 4(8), 5(5) and 9(5)]

FORM FOR MAINTAINING RECORDS OF E-WASTE HANDLED/ GENERATED

Quantity in Metric Tonnes (MT) or Kilograms (Kg) per year

1.	Name & Address: Producer /Collection Centre/Dismantler/ Recycler/ Bulk consumer *		
2.	Date of Issue of Authorization* Registration *		
3.	Validity of Authorization* /Registration*		
4.	Types & Quantity of e-waste handled/ generated	Category	Quantity
		Item Description	
5.	Types & Quantity of e-waste stored	Category	Quantity
		Item Description	
6.	Types & Quantity of e-waste sent to authorized collection centre/ registered dismantler or recycler	Category	Quantity
		Item Description	
7.	Types & Quantity of e-waste transported*	Category	Quantity
		Quantity	
	Name, address and contact details of the destination		
8.	Types & Quantity of e-waste refurbished*	Category	Quantity
		Item Description	
	Name, address and contact details of the destination of refurbished materials		
9.	Types & Quantity of e-waste dismantled*	Category	Quantity
		Item Description	
	Name, address and contact details of the destination		
10.	Types & Quantity of e-waste recycled*	Category	Quantity
	Types & Quantity of materials recovered	Item Description	
		Quantity	
	Name, address and contact details of the destination		
11.	Types & Quantity of waste treated & disposed	Category	Quantity
		Item Description	

* Strike off whichever is not applicable

FORM – 3

[See rules 4(9), 5(4), 6(2), 7(7), 8(5) and 9(5)]

FORM FOR FILING ANNUAL RETURNS

[To be submitted by producer/collection centre/dismantler/recycler by 30th June following to the financial year to which that return relates].

Quantity in Metric Tonnes (MT) or Kilograms (Kg) per year

1	Name and address of the producer/ collection centre/ dismantler/ recycler		
2	Name of the authorized person and complete address with telephone and fax numbers and e-mail address		
3	Total quantity e-waste sold/purchased/ sent for processing during the year for each category of electrical and electronic equipment listed in the Schedule I (Attach list)		
	Details of the above	TYPE	QUANTITY
3(A)*	**DISMANTLERS**: Quantity of e-waste in MT purchased & processed and sent to (category wise):		
3(B)*	**RECYCLERS**: Quantity of e-waste in MT purchased/processed (category wise):		
4	Name and full address of the destination with respect to 3 (A-B) above		
5	Type and quantity of materials segregated/ recovered from e-waste of different categories as applicable to 3(A) &3(B)	Type	Quantity

Note: The applicant shall provide details of funds received (if any) from producers and its utility with an audited certificate

✓ enclose the list of recyclers to whom e-waste have been sent for recycling.

*strike off whichever is not applicable

Place______________
Date______________

Signature of the authorized person

FORM - 4

[see rule 11(1)]

APPLICATION FORM FOR REGISTRATION OF FACILITIES POSSESSING ENVIRONMENTALLY SOUND MANAGEMENT PRACTICE FOR RECYCLING E-WASTE

(To be submitted in triplicate)

1.	Name and Address of the unit			
2.	Contact person with designation, Tel./Fax			
3.	Date of Commissioning			
4.	No. of workers (including contract labour)			
5.	Consents Validity	a. Water (Prevention & Control of Pollution) Act, 1974; Valid up to ________________ b. Air (Prevention & Control of Pollution) Act, 1981; Valid up to ________________		
6.	Authorization validity	E-wastes (Management and Handling) Rules, 2011; Valid up to ____________		
7.	Manufacturing Process	Please attach manufacturing process flow diagram for each product(s)		
8.	Products and Installed capacity of production in (MTA)	Products	Installed capacity (MTA)	
9.	Products manufactured during the last three years (as applicable)	Year	Product	Quantity
10.	Raw material consumption during the last three years (as applicable)	Year	Product	Quantity
11.	Water consumption	Industrial ____________ m3/day Domestic ____________ m3 / day		
	Water Cess paid up to (if applicable)			
	Waste water generation as per consent ____________ m3/day	Actual (avg., of last 3 months) Industrial ____________ m3 /day Domestic ____________ m3 /day		
	Waste water treatment (provide flow diagram of the treatment scheme)	Industrial Domestic		
	Waste water discharge	Quantity ____________ m3/day Location ________________ Analysis of treated waste water for pH, BOD,COD, SS, O&G, any other		

		parameter stipulated by SPCB/SPCC (attach details)			
12.	Air Pollution Control				
	a. Provide flow diagram for emission control system(s) installed for each process unit, utilities etc.				
	b. Details for facilities provided for control of fugitive emission due to material handling, process, utilities etc				
	c. Fuel consumption	Fuel	Qty per day/month		
		(i)			
		(ii)			
	d. Stack emission monitoring	Stack attached to	Emission (SPM, SO_2, NOx , Pb etc.) mg/Nm^3		
		(i)			
		(ii)			
	e. Ambient air quality	Location Results ug/m3	Parameters SPM, SO_2, NOx, Pb etc.) $\mu g/m^3$		
		(i)			
		(II)			
13.	Waste Management:				
	a. Waste generation in processing e-waste	S No	Type	Category	Qty
	b. Waste Collection and transportation (attach details)				
	c. Provide details of disposal of residue.	S No	Type	Category	Qty
	d. Name of Treatment Storage and Disposal Facility utilized for				
	e. Please attach analysis report of characterization of hazardous waste generated (including leachate test if applicable)				
14.	Details of e-waste proposed to be procured through sale, contract or import, as the case may be, for use as raw material	(i) Name (ii) Quantity required /year (iii) Basel Convention Number			
15.	Occupational safety and health aspects	Please provide details of facilities			

16.	Remarks:	
	Whether industry has provided adequate pollution control system / equipment to meet the standards of emission / effluent.	Yes/No If Yes, please furnish details
	Whether industry is in compliance with conditions laid down in the Authorization	Yes / No
17.	Any Other Information of relevance: i) ii)	

I hereby declare that the above statements /information are true and correct to the best of my knowledge and belief.

Signature

Date:__________ Name:__________

Place:__________ Designation:__________

Form - 5

[see rule 15 (1)]

FORM FOR ANNUAL REPORT TO BE SUBMITTED BY THE STATE POLLUTION CONTROL BOARD/COMMITTEES TO THE CENTRAL POLLUTION CONTROL BOARD

To,

The Chairman,
Central Pollution Control Board,
(Ministry of Environment And Forests)
Government Of India,
'Parivesh Bhawan', East Arjun Nagar,
Delhi- 110 0032

1. Name of the State/Union territory :
2. Name & address of the State Pollution Control Board / Committee :
3. Number of authorised Producers, Collection Centres, registered Dismantler and Recyclers for management of e-waste in the State or Union territory under these rules :
4. Categories of waste collected along with their quantities on a monthly average basis: : Please attach as Annexure-I

5.	A Summary Statement on Category wise and product wise quantity of e-waste collected	:	Please attach as Annexure-II
6.	Mode of treatment with details	:	Please attach as Annexure-III
7.	Brief details of collection, dismantling and recycling facilities	:	Please attach as Annexure-IV
8.	Any other information	:	

9. Certified that the above report is for the period from ....

Date: ____________________

Place : ____________________

Chairman or the Member Secretary
State Pollution Control Board/
Pollution Control Committee

[F. No. 23-71/2009-HSMD]

RAJIV GAUBA, Jt. Secy.

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

Annexure 10

The Batteries (Management and Handling) Rules 2001, Amended on 2010

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 16th May, 2001

Amended by notification S.O.1002(E), dated 4th May, 2010)

S.O. 432(E).- Whereas a notification of the Government of India in the Ministry of Environment and Forests was published in the Gazette of India, Extraordinary, Part II-section 3, sub-section (ii) vide No. S.O. 491(E), dated 24th May, 2000 and corrigendum published in the Gazette of India Extraordinary Part-II section 3, sub-section (ii) vide No. S.O. 593(E), dated 23rd June, 2000 under powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), inviting objections from persons likely to be affected, within a period of sixty days from the date of publication of the said notification with regard to the Government's intention to notify the Battery (Management and Handling) Rules, 2000.

And, whereas all objections received have been duly considered by the Central Government;

Now, therefore, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby notifies the Batteries (Management and Handling) Rules, 2001.

1. SHORT TITLE AND COMMENCEMENT. –

(1) These rules may be called the **Batteries (Management and Handling) Rules, 2001.**

(2) They shall come into force on the date of their publication in the Official Gazette.

2. APPLICATION. –

These rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer, and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof.

3. DEFINITIONS.- In these rules, unless the context otherwise requires, -

(a) **'Act'** means the Environment (Protection) Act, 1986 (29 of 1986);

(b) **'assembler'** - means a person who manufactures lead acid batteries by assembling various components;

(c) **'auction'** - means bulk sale of used lead acid batteries or component (s) thereof by invitation of tenders or auction, contract or negotiation by individual(s), companies or Government Departments;

(d) **'auctioneer'-** means a person(s) who auctions used lead acid batteries or components, thereof;

(e) **'battery'-** means lead acid battery which is a source of electrical energy and contains lead metal;

[1][(f) **'bulk consumer'** - means a consumer such as the Departments of Central Government like Railways, Defence, Telecom, Posts and Telegraph, the Departments of State Government, the Undertakings, Boards and other agencies or companies who purchase hundred or more than hundred batteries per annum.]

(g) **'components'** means lead bearing components of a lead acid battery;

(h) **'consumer'**- means a person using lead acid batteries excluding bulk consumers;

(i) **'dealer'-** means a person who sells and receives lead acid batteries or components thereof to and from the consumers or other dealers or retailers on behalf of the manufacturers, importers, assemblers and reconditioners or otherwise;

(j) **'designated collection centre'**- means a collection centre established, individually or jointly by one or more manufacturers or importers, assemblers and re-conditioners in pursuance of their responsibilities under rule- 4 of these rules.

(k) **'importer'** -means a person who imports new lead acid batteries or components containing lead thereof for the purpose of sale;

[1] Substituted by the S.O.1002(E), dated 4.5.2010.

(l) **'manufacturer'-** in relation to any factory manufacturing lead acid batteries or components thereof means a person or Chief Executive Officer (CEO) of the company who has control over the affairs of the factory or the premises for sale and collection of lead acid batteries or components thereof,

(m) **'original equipment manufacturer'** - means manufacturer of equipment or product using lead acid batteries as a component;

(n) **'reconditioner'** -means a person involved in repairing of lead acid batteries for selling the same in the market;

(o) **'recycler'**-means an occupier who processes used lead acid batteries or components thereof for recovering lead;

(p) **'registered recycler'-** means a recycler registered with the Ministry of Environment and Forests or an agency designated by it for reprocessing used lead acid batteries or components thereof;

(q) **'State Board'**- means the concerned State Pollution Control Board or the Pollution Control Committee as the case may be;

(r) **'used batteries'** - means used, damaged and old lead acid batteries or components thereof; and

(s) the words not defined in these rules will have the same meaning as defined in the Environment (Protection) Act, 1986 and the rules framed thereunder.

4. RESPONSIBILITIES OF MANUFACTURER, IMPORTER, ASSEMBLER AND RE-CONDITIONER.-

It shall be the responsibility of a manufacturer, importer, assembler and re-conditioner to

(i) ensure that the used batteries are collected back as per the Schedule against new batteries sold excluding those sold to original equipment manufacturer and bulk consumer(s);

(ii) ensure that used batteries collected back are of similar type and specifications as that of the new batteries sold;

(iii) file a half-yearly return of their sales and buy-back to the State Board in Form- I latest by 30th June and 31st December of every year.

(iv) set up collection centres either individually or jointly at various places for collection of used batteries from consumers or dealers;

(v) ensure that used batteries collected are sent only to the registered recyclers,

(vi) ensure that necessary arrangements are made with dealers for safe transportation from collection centres to the premises of registered recyclers ;

(vii) ensure that no damage to the environment occurs during transportation;

(viii) create public awareness through advertisements, publications, posters or by other means with regard to the following:

(a) hazards of lead;
(b) responsibility of consumers to return their used batteries only to the dealers or deliver at designated collection centres; and
(c) addresses of dealers and designated collection centres.

(ix) use the international recycling sign on the Batteries;

(x) buy recycled lead only from registered recyclers; and

(xi) bring to the notice of the State Board or the Ministry of Environment and Forests any violation by the dealers.

[2][(xii) ensure that the new batteries shall be sold only to the registered dealers.]

Note: The assemblers and reconditioners are excluded from the purview of responsibilities as specified in sub-clauses (iv), (vii), (ix) and (xii).

[2] Inserted by the S.O.1002(E), dated 4.5.2010.

5. REGISTRATION OF IMPORTERS. –

[3][(i) the importers shall get registered as per Form I with the Central Pollution Control Board for a period of five years and a provision of cancellation for failure in collection of the required number of used batteries as per the said rules, non-submission of timely half yearly returns to the State Pollution Control Boards with a copy to the Central Pollution Control Board, renewal of the registration shall be as per the compliance status:
Provided that the registration granted to the importer shall not be cancelled unless he has been given a reasonable opportunity of hearing;

(ii) an appeal shall lie against any order of suspension or cancellation or refusal of registration passed by the Member-Secretary of the Central Pollution Control Board or any other officer designated by the Central Pollution Control Board;

(iii) the appeal shall be in writing and shall be accompanied with a copy of the order appealed against and shall be made within period of thirty days from the date of passing of the order.]

6. CUSTOMS CLEARANCE OF IMPORTS OF NEW LEAD ACID BATTERIES. –

Customs clearance of imports shall be contingent upon

(i) valid registration with the Reserve Bank of India (with Importer's Code Number);

(ii) one time registration with the Ministry of Environment and Forests or an agency designated by it in Form-II;

(iii) undertaking in Form-III; and

(iv) a copy of the latest half-yearly return in Form-IV.

7. RESPONSIBILITIES OF DEALER.–

It shall be the responsibility of a dealer to –

(i) ensure that the used batteries are collected back as per the Schedule against new batteries sold;

(ii) give appropriate discount for every used battery returned by the consumer;

(iii) ensure that used batteries collected back are of similar type and specifications as that of the new batteries sold;

(iv) file half-yearly returns of the sale of new batteries and buy-back of old batteries to the manufacturer in Form V by 31st May and 30th November of every year;

(v) ensure safe transportation of collected batteries to the designated collection centres or to the registered recyclers; and

(vi) ensure that no damage is caused to the environment during storage and transportation of used batteries.

[4][(vii) (a) registration with State Pollution Control Board for five years and a provision of cancellation for failure in collection of the required number of used batteries as per the said rules, non-submission of timely half yearly returns to the State Pollution Control Boards, renewal of the registration shall be as per the compliance status, to submit details as per Form IV, registration would be considered as deemed registered if not objected to within thirty days;

(b) an appeal shall lie against any order of suspension or cancellation or refusal of registration passed by the Member-Secretary of the State Pollution Control Board or any other officer designated by the State Pollution Control Board;

(c) the appeal shall be in writing and shall be accompanied with a copy of the order appealed against and shall be made within period of thirty days from the date of passing of the order.]

[3] Substituted by the S.O.1002(E), dated 4.5.2010.
[4] Inserted by the S.O.1002(E), dated 4.5.2010.

8. RESPONSIBILITIES OF RECYCLER. –

Each recycler shall -

(i) apply for registration to the Ministry of Environment and Forests or an agency designated by it if not applied already, by submitting information in Form VI;

(ii) ensure strict compliance of the terms and conditions of registration, however, those already registered with the Ministry of Environment and Forests or an agency designated by it for reprocessing used batteries would be bound by the terms and conditions of such registration;

(iii) submit annual returns as per Form VII to the State Board;

[5][(iv) make available all records relating to receipt of used batteries, sources, quantities and metal yield to be submitted to the State Pollution Control Board for inspection.]

(v) Mark 'Recycled' on lead recovered by reprocessing; and

(vi) Create public awareness through advertisements, publications, posters or others with regard to the following-
- (a) hazards of lead; and
- (b) obligation of consumers to return used batteries only to the registered dealers or deliver at the designated collection centres.

9. PROCEDURE FOR REGISTRATION/RENEWAL OF REGISTRATION OF RECYCLERS. –

(1) Every recycler of used lead acid batteries shall make an application in Form VI along with the following documents to the Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it for grant of registration or renewal;

- (a) a copy of the valid consents under Water (Prevention and Control of Pollution) Act, 1974, as amended and Air (Prevention and Control of Pollution) Act, 1981, as amended;
- (b) a copy of the valid authorization under Hazardous Wastes (Management and Handling) Rules, 1989 as amended;
- (c) a copy of valid certificate of registration with District Industries Centre; and
- (d) a copy of the proof of installed capacity issued by either State Pollution Control Board/District Industries Centre.

(2) The Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it shall ensure that the recyclers possess appropriate facilities, technical capabilities, and equipment to recycle used batteries and dispose of hazardous waste generated;

(3) The Joint Secretary , Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it shall take decision on application for registration within [6][90] days of receipt of application form with complete details;

(4) The registration granted under this rule shall be in force for a period of two years from the date of issue or from the date of renewal unless suspended or cancelled earlier;

(5) An application for the renewal of registration shall be made in Form VI atleast six months before its expiry. The Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it shall renew the registration of the recycler granted under sub rule(4) of this rule, after examining each case on merit;

(6) The Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it may, after giving reasonable opportunity to the applicant of being heard, refuse to grant registration;

(7) The Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it may cancel or suspend a registration issued under these rules, if in his/her opinion, the registered recycler has failed to comply with any of the conditions of registration, or with any provisions of the Act or rules made thereunder after giving him an opportunity to explain and after recording the reasons therefor;

[5] Substituted by the S.O.1002(E), dated 4.5.2010.

[6] Substituted by the S.O.1002(E), dated 4.5.2010.

(8) It shall be the responsibility of the State Boards to monitor the compliance of conditions prescribed while according registration, and

(9) An appeal shall lie against any order of suspension or cancellation or refusal of registration passed by the Joint Secretary to the Ministry of Environment and Forests or any officer designated by the Ministry or agency designated by it. The appeal shall be in writing and shall be accompanied with a copy of the order appealed against and shall be presented within 30 days of passing of the order.

10. RESPONSIBILITIES OF CONSUMER OR BULK CONSUMER.-

(1) It shall be the responsibility of the consumer to ensure that used batteries are not disposed of in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler, re-conditioner or at the designated collection centres.

(2) It shall be the responsibility of the bulk consumer to –

(i) ensure that used batteries are not disposed of in any manner other than by depositing with the dealer/manufacturer/registered recycler/importer/ re-conditioner or at the designated collection centers,- and

(ii) file half-yearly return in Form VIII to the State Board .

(3) Bulk consumers or their user units may auction used batteries to registered recyclers only.

11. RESPONSIBILITIES OF AUCTIONEER.-

The auctioneer shall -

(i) ensure that used batteries are auctioned to the registered recyclers only-,

(ii) file half-yearly returns of their auctions to the State Boards in Form-IX; and

(iii) maintain a record of such auctions and make these records available to the State Board for inspection.

12. PRESCRIBED AUTHORITY.–

The prescribed authority for ensuring compliance of the provisions of these rules shall be the State Board. And, it shall file an annual compliance status report to the Central Pollution Control Board by 30th April of every year.

13. DUTIES OF CENTRAL POLLUTION CONTROL BOARD.-

The Central Pollution Control Board shall compile and publish the data received every year from the State Boards. It shall review the compliance of the rules periodically to improve the collection and recycling of used lead batteries and apprise the Ministry of Environment and Forests, Government of India.

14. COMPUTERISATION OF RECORDS AND RETURNS.–

Ministry of Environment and Forests or an agency designated by it shall develop a system for computerized tracking of-

(i) distribution and sale of batteries;

(ii) collection, auction, transport and re-processing of used batteries;

(iii) sale of re-processed lead by registered recyclers; and

(iv) sale of lead from all domestic producers or importers.

SCHEDULE

[See rule 4(i) and 7(i)]

Sl. No.	**Year**	**Number of used batteries to be collected back**
(i)	During first year of implementation of rules	50% of new batteries sold
(ii)	During second year of implementation of rules	75% of new batteries sold
(iii)	After second year of implementation of rules	90% of new batteries sold

FORM – I

[See rule 4(iii)]

FORM FOR FILING RETUNS OF SALE OF NEW BATTERIES AND COLLECTION OF USED BATTERIES

[To be submitted by [7][manufacturer/importer/bulk consumer] by 30th June (for the period October-March) and 31st December (for the period April-September) every year]

[8][1.	Name and Address of the manufacturer /importer/bulk consumer]	
2.	Name of the authorised person and complete address with telephone and fax numbers	
3.	Total number of new batteries sold [9][importers or consumers] during the period October-March/April-September in respect of the following categories Category (i) Automative (a) Four Wheeler (b) Two Wheeler (ii) Industrial (a) UPS (b) Motive power (c) Stand-by (iii) Others (inverters, etc.) Number of batteries sold to (i) dealers (ii) bulk consumers (iii) OEM (iv) Any other party for replacement should be indicated separately	(i) No. of Batteries (ii) Approximate weight (in Metric Tones)
4.	Name and full address of the designated collection centres	
5.	Total number of used batteries of different categories as at Sl. No.3 collected and sent to the registered recyclers*	

* enclose the list of recyclers to who batteries have been sent for recycling.

Place _________________

Date __________________

Signature of the authorised person

FORM – II

[See rule 5 & 6(ii)]

FORM FOR REGISTRATION OF IMPORTER OF NEW LEAD ACID BATTERIES / PRIMARY LEAD

[To be submitted in triplicate to the Ministry of Environment and Forests]

1.	Name and Address of the importer	
2.	Import / Export Licence No.	
3.	Name of person / owner / occupier as the case may be	

Date _________________

Place_________________

Signature of the Importer

7 Substituted by the S.O.1002(E), dated 4.5.2010.
8 Substituted by the S.O.1002(E), dated 4.5.2010.
9 Inserted by the S.O.1002(E), dated 4.5.2010.

FORM – III

[see rule 6(iii)]

(to be submitted by importer of new lead acid batteries)

UNDERTAKING

To

The Member Secretary
State Pollution Control Board

1. I________________________ of M/s ____________________ hereby submit that I am in the process of importing ______________________ (MT) of new lead acid batteries.

2. I undertake that I shall collect back the used batteries as per the schedule prescribed by the Government from time to time in lieu of the new batteries imported and sold, and shall send these only to the registered recyclers. I further undertake that I shall submit half-yearly returns as per item (iii) of rule 6 to the State Board and abide by their directions, if any

Date :
Place : Signature of the Importer

Copy to : The concerned Customs Authority

[10]**[FORM – IV**

[See Rules 4 and 7 (vii)]

FORM FOR REGISTRATION OF DEALERS

[To be submitted by dealers to the State Pollution Control Boards/Pollution Control Committees]

1.	Name and address of the dealers with telephone and fax numbers	
2.	TIN / VAT number*	

* IF APPLICABLE (AS PER CURRENT STATE SALE TAX RULES, MANDATORY TIN/VAT NUMBER IS REQUIRED ONLY IF THE ANNUAL TURNOVER OF THE DEALER IS MORE THAN THE PRESCRIBED VALUE)

Signature of the authorised person

Place_________________
Date__________________

Note:- The principal rules were published in the Gazette of India, Extraordinary *vide* notification number S.O.432(E), dated the 16th May, 2001.

[10] Substituted by the S.O.1002(E), dated 4.5.2010.

FORM – V

[See rule 7(iv)]

FORM FOR FILING RETUNS OF SALE OF NEW BATTERIES AND COLLECTION OF OLD BATTERIES

[To be submitted by dealers to the manufacturers by 31st May (for sale during October-March) and 30th November (for sale during April-September) every year]

1.	Name and address of the dealer	
2.	Name of the authorised person and complete address with telephone and fax numbers	
3.	Number of new batteries sold during the period October-March/April-September in respect of the following categories; Category (i) Automative (a) Four Wheeler (b) Two Wheeler (ii) Industrial (a) UPS (b) Motive power (c) Stand-by (iii) Others Number of batteries sold (i) As replacement of used Batteries (ii) to bulk consumers (iii) to OEM (iv) to any other party	(i) No. of Batteries (ii) Approximate weight (in Metric Tones)
4.	Total number of used batteries of different categories as at Sl. No.3 collected and sent to registered recyclers */designated collection centres / manufacturers	

* enclose the list of recyclers to who batteries have been sent for recycling.

Place_________________

Date__________________ Signature of the authorised person

FORM – VI

[see rule 8(i), 9(1) & 9(5)]

FORM FOR APPLICATION FOR REGISTRATION OF FACILITIES POSSESSING ENVIRNMENTALLY SOUND MANAGEMENT PRACTIVE FOR RECYCLING OF USED LEAD ACID BATTERIES

(To be submitted in triplicate)

1.	Name and Address of the unit			
2.	Contact person with designation, Tel./Fax			
3.	Date of Commissioning			
4.	No. of Workers (including contract labourers)			
5.	Consent Validity	a) Under Air Act, 1981; Valid up to – b) Under Water Act, 1974; Valid up to -		
6.	Validity of Authorisation under rule 5 of the Hazardous Wastes (Management and Handling) Rules, 1989	Valid up to -		
7.	Installed capacity of production in (MTA)			
8.	Products manufactured Name : (a) (b) (c)	Year –1	Year-2	Year-3
9.	Raw material consumed (Tones/year) Name : (a) (b) (c)	Year –1	Year-2	Year-3
10.	Manufacturing Process	Please attach manufacturing process flow diagram for each product(s)		
11.	Water consumption	Industrial - m^3/day Domestic - m^3/day		
12.	Water Cess paid up to			
13.	Waste water generation a) as per consent m^3/day b) actual m^3 /day (average of last three months)	Industrial - Domestic -		
14.	Waste water treatment (please provide flow diagram of the treatment scheme)	Industrial - Domestic -		
15.	Waste water discharge	Quantity m^3/day Location- <u>Analysis of treated waste water –</u> PH_2, BOD,COD, SS, O&G, Any other (indicate the corresponding standards applicable)		
16.	Air Pollution Control a. Please provide flow diagram for emission control system(s) installed for each process unit, utilities etc. b. Details for facilities provided for control of fugitive emission due to material handling, process, utilities etc. c. Fuel consumption d. Stack emission monitoring results vis-à-vis the standards applicable e. Ambient air quality	S.No. Name of Fuel Quantity / day S.No Stack attached to Emission g/Nm^3 S.No Location Results ug/m^3		
17.	Hazardous Waste Management a) Waste generation b) Details of collection, treatment c) Disposal (including point of final discharge) (i) Please provide details of the disposal facility (ii) Whether facilities provided are in compliance of the conditions issued by the SPCB in Authorization (iii) Please attach analysis report of characterization of hazardous waste generated (including leachate test if applicable)	S.No Name of Process Quantity / y Waste category		

18.	Details of waste proposed to be taken in auction or import, as the case may be, for use as raw material	1. Name - 2. Quantity required /- 3. Position in List A/List as per Basel Convention (BC) – 4. Nature as per Annexure III of BC
19.	Occupational safety and health aspects	Please provide details of facilities provided.
20.	Remarks (i) Whether industry has provided adequate pollution control system / equipment to meet the standards of emission / effluent. (ii) Whether industry is in compliance with conditions laid down in the Hazardous Waste Authorization (iii) Whether Hazardous Waste collection and Treatment, Storage and Disposal Facility (TSDF) are operating satisfactorily. (iv) Whether conditions exist or likely to exists of the material being handled / processed of posing immediate or delayed adverse impacts on the environment. (v) Whether conditions exist or is likely to exist of the material being handled / processed by any means capable of yielding another material e.g., leachate which may possess eco-toxicity.	Yes/No If Yes, please furnish details Yes / No Yes / No Yes / No Yes / No
21.	(i) Cost of the unit (ii) Cost of pollution control equipment including environmental safeguard measures a) Capital : b) Recurring :	
22	Any Other Information : i) ii) iii)	

I hereby declare that the above statements/informations are true and correct to the best of my knowledge and belief.

Date :
Place: Signature Name Designation

FORM – VII

[see rule 8(iii)]

FORM FOR FILING RETURNS BY RECYCLERS OF USED BATTERIES

[To be submitted by recyclers by 30th June and 31st December of every year]

1.	Name and address of the recycler	
2.	Name of the Authorised person and full address with telephone and fax number	
3.	Installed annual capacity to recycle used battery scrap (in MTA)	
4.	Total quantity of used battery scrap purchased from/sent for processing during the period from October – March / April-September	(i) Quantity of used batteries sent by/purchased from the manufacturers (ii) Quantity of used batteries purchased from the dealers (iii) Quantity of used batteries purchased from auctioneers (iv) Quantity of used batteries obtained from any other source -
5.	Quantity of lead recovered from the used battery scrap (in MTA)	
6.	Quantity of recycled lead sent back to	(i) the manufacturer of batteries (ii) other agencies * -

* enclose list of other agencies.

Place ____________ Signature of the authorised person
Date ____________

FORM – VIII

[see rule 10 (2)(ii)]

FORM FOR FILING RETURNS FOR BULK CONSUMER OF BATTERIES

[To be submitted by the bulk consumer to the State Board by 30th June (for the period October-March) and 31st December (for the period April-September) every year]

1.	Name and address of the bulk consumer	
2.	Name of the Authorised person and full address with telephone and fax number	
3.	Number of new batteries of different categories purchased from the manufacturer/importer/dealer or any other agency during October-March and April-September Category (i) Automative (a) Four wheelers (b) Two wheelers (ii) Industrial (a) UPS (b) Motive power (c) Stand-by (iii) Others	(i) No. of Batteries (ii) Approximate weight (in Metric Tonnes)
4.	Number or used batteries of categories mentioned in Sl. No. 3 and Tonnage of scrap sent to manufacturer/dealer /importer/registered recycler/or any other agency to whom the used batteries scrap was sent*.	

* Enclose list of manufacture/dealer/importer/registered recyclers/or any other agency to whom the used batteries scrap was sent.

Place ____________ Signature of the authorised person
Date _____________

FORM – IX

[see rule 11 (ii)]

FORM FOR FILING RETURNS BY AUCTIONEER OF USED BATTERIES

[To be submitted by the auctioneer to State Board by 30th June and 31st December of every year]

1.	Name and address of the auctioneer	
2.	Name of the Authorised person and full address with telephone and fax number	
3.	Number of used batteries and total Tonnage (of MT) available during the period from October-March and April-September	
4.	Sources of the used battery scrap	
5.	Number of used batteries and total Tonnage (of MT) auctioned during the period from October-March and April-September	
6.	Number of used batteries and total Tonnage of (MT) sent to the registered recyclers *	

* enclose a list.

Place _______________
Date _______________ Signature of the authorized Person

Annexure 11

The Hazardous Waste (Management, Handling and Transboundary Movement) Rules 2008, Amended on 2009

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 24th September, 2008

S. O. 2265(E).—Whereas the draft rules, namely, the Hazardous Material (Management, Handling and Transboundary Movement) Rules 2007 was published by the Government of India in the Ministry of Environment and Forest vide number S.O.1676(E),dated 28th September,2007 in the Gazette of India, Extraordinary of the same date inviting objection and suggestions from all persons likely to be affected thereby, before the expiry of the period of sixty days from the date on which copies of the Gazette containing the said notification were made available to the public;

AND WHEREAS copies of the said Gazette were made available to the public on the 28th day of September,2007;

AND WHEREAS the objections and suggestions received within the said period from the public in respect of the said draft rules have been duly considered by the Central Government;

NOW, THEREFORE, in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Hazardous Wastes (Management and Handling) Rules, 1989, excepts in respect of things done or omitted to be done before such supersession, the Central Government hereby makes the following rules, namely:-

CHAPTER – I
PRELIMINARY

1. Short title and commencement: - (1) These rules may be called the Hazardous Wastes(Management, Handling and Transboundary Movement) Rules, 2008.

(2) They shall come into force on the date of their publication in the official Gazette.

2. Application: - These rules shall apply to the handling of hazardous wastes as specified in Schedules and shall not apply to -

(a) waste-water and exhaust gases as covered under the provisions of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and the rules made thereunder;

(b) wastes arising out of the operation from ships beyond five kilometres of the relevant baseline as covered under the provisions of the Merchant Shipping Act, 1958 (44 of 1958) and the rules made thereunder;

(c) radio-active wastes as covered under the provisions of the Atomic Energy Act, 1962 (33 of 1962) and the rules made thereunder;

(d) bio-medical wastes covered under the Bio-Medical Wastes (Management and Handling) Rules, 1998 made under the Act; and

(e) wastes covered under the Municipal Solid Wastes (Management and Handling) Rules, 2000 made under the Act;

3. Definitions: - (1) In these rules, unless the context otherwise requires, -

(a) "Act" means the Environment (Protection) Act, 1986 (29 of 1986);

(b)"authorisation" means permission for generation, handling, collection, reception, treatment, transport, storage, recycling, reprocessing, recovery, reuse and disposal of hazardous wastes granted under sub-rule (4) of rule 5;

(c) "Basel Convention" is the United Nations Environment Programme Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal;

(d) "Central Pollution Control Board" means the Central Pollution Control Board constituted under sub-section (1) of section 3 of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974);

(e) "disposal" means any operation which does not lead to recycling, recovery or reuse and includes physico chemical, biological treatment, incineration and disposal in secured landfill;

(f) "export" with its grammatical variations and cognate expressions, means taking out of India to a place outside India;

(g) "exporter" means any person under the jurisdiction of the exporting country who exports hazardous waste including the country, which exports hazardous waste;

(h) "environmentally sound management of hazardous wastes" means taking all steps required to ensure that the hazardous wastes are managed in a manner which shall protect health and the environment against the adverse effects which may result from such waste;

(i) "environmentally sound technologies" means any technology approved by the Central Government from time to time;

(j) "facility" means any establishment wherein the processes incidental to the handling, collection, reception, treatment, storage, recycling, recovery, reuse and disposal of hazardous wastes are carried out;

(k) "Form" means a form appended to these rules;

(l) "hazardous waste" means any waste which by reason of any of its physical, chemical, reactive, toxic, flammable, explosive or corrosive characteristics causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances, and shall include –

(i) waste specified under column (3) of Schedule-I,

(ii) wastes having constituents specified in Schedule-II if their concentration is equal to or more than the limit indicated in the said Schedule, and

(iii) wastes specified in Part A or Part B of the Schedule-III in respect of import or export of such wastes in accordance with rules 12,13 and 14 or the wastes other than those specified in Part A or Part B if they possess any of the hazardous characteristics specified in Part C of that Schedule;

(m) "hazardous waste site" means a place of collection, reception, treatment, storage of hazardous wastes and its disposal to the environment which is approved by the competent authority;

(n) "import" with its grammatical variations and cognate expressions, means bringing into India from a place outside India;

(o) "importer" means an occupier or any person who imports hazardous waste;

(p) "manifest" means transporting document prepared and signed by the occupier or his representative authorized in accordance with the provisions of these rules.

(q) "occupier" in relation to any factory or premises, means a person who has, control over the affairs of the factory or the premises and includes in relation to any hazardous waste the person in possession of the hazardous waste;

(r) "operator of disposal facility" means a person who owns or operates a facility for collection, reception, treatment, storage or disposal of hazardous wastes;

(s) "recycler or reprocessor or actual user " means an occupier who procures and processes hazardous waste for recycling or recovery or re-use;

(t) "recycling" means reclamation and reprocessing of hazardous waste in an environmentally sound manner for the original purpose or for other purposes;

(u) "reuse" means use of hazardous waste for the purpose of its original use or other use;

(v) "recovery" means any operation in the recycling activity wherein specific materials are recovered;

(w) "Schedule" means a Schedule appended to these rules;

(x) "State Government" in relation to a Union territory means, the Administrator thereof appointed under article 239 of the Constitution;

(y) "State Pollution Control Board means the State Pollution Control Board or the Pollution Control Committee constituted under sub-section (1) of section 4 of the Water(Prevention and Control of Pollution) Act, 1974 (6 of 1974);

(z) "storage" means storing any hazardous waste for a temporary period, at the end of which such waste is processed or disposed of;

(za) "transboundary movement" means any movement of hazardous wastes from an area under the jurisdiction of one country to or through an area under the jurisdiction of another country or to or through an area not under the jurisdiction of any country, provided at least two countries are involved in the movement;

(zb) "transport" means off-site movement of hazardous wastes by air, rail, road or water;

(zc) "transporter" means a person engaged in the off-site transportation of hazardous waste by air, rail, road or water;

(zd) "treatment" means a method, technique or process, designed to modify the physical, chemical or biological characteristics or composition of any hazardous waste so as to reduce its potential to cause harm;

(ze) "used oil" means any oil -

(a) derived from crude oil or mixtures containing synthetic oil including used engine oil, gear oil, hydraulic oil, turbine oil, compressor oil, industrial gear oil, heat transfer oil, transformer oil, spent oil and their tank bottom sludges; and
(b) suitable for reprocessing, if it meets the specification laid down in Part-A of Schedule -V but does not include waste oil;

(zf) "waste oil" means any oil which includes spills of crude oil, emulsions, tank bottom sludge and slop oil generated from petroleum refineries, installations or ships and can be used as fuel in furnaces for energy recovery, if it meets the specifications laid down in Part – B of Schedule-5 either as such or after reprocessing.

Words and expressions used in these rules and not defined but defined in the Act shall have the meanings respectively assigned to them in the Act.

CHAPTER II
PROCEDURE FOR HANDLING HAZARDOUS WASTES

4. **Responsibilities of the occupier for handling of hazardous wastes.–**

(1) The occupier shall be responsible for safe and environmentally sound handling of hazardous wastes generated in his establishment.

(2) The hazardous wastes generated in the establishment of an occupier shall be sent or sold to a recycler or re-processor or re-user registered or authorized under these rules or shall be disposed of in an authorized disposal facility.

(3) The hazardous wastes transported from an occupier's establishment to a recycler for recycling or reuse or reprocessing or to an authorized facility for disposal shall be transported in accordance with the provisions of these rules.

(4) The occupier or any other person acting on his behalf who intends to get his hazardous wastes treated and disposed of by the operator of a Treatment, Storage and Disposal Facility shall give to the operator of a facility, such information as may be determined by the State Pollution Control Board.

(5) The occupier shall take all adequate steps while handling hazardous wastes to:

(i) contain contaminants and prevent accidents and limit their consequences on human beings and the environment; and

(ii) provide persons working on the site with the training, equipment and the information necessary to ensure their safety.

5. **Grant of authorization for handling hazardous wastes.**

(1) Every person who is engaged in generation, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of the hazardous waste shall require to obtain an authorization from the State Pollution Control Board.

(2) The hazardous waste shall be collected, treated, re-cycled, re-processed, stored or disposed of only in such facilities as may be authorized by the State Pollution Control Board for the purpose.

(3) Every person engaged in generation, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like of the hazardous waste or occupier of the facility shall make an application in **Form 1** to the State Pollution Control Board for authorization within a period of sixty days from the date of commencement of these rules:

Provided that any person authorized under the provisions of the Hazardous Waste (Management and Handling) Rules , 1989, prior to the date of coming into force of these rules, shall not require to make an application for authorization till the period of expiry of such authorization.

(4) On receipt of the application complete in all respects for the authorization, the State Pollution Control Board may, after such inquiry as it considers necessary and on being satisfied that the applicant possesses appropriate facilities, technical capabilities and equipment to handle hazardous waste safely, grant within a period of one hundred and twenty days an authorization in **Form 2** to the applicant which shall be valid for a period of five years and shall be subject to such conditions as may be laid down therein.

(5) The State Pollution Control Board may after giving reasonable opportunity of being heard to the applicant refuse to grant any authorization.

(6) Every person authorized under these rules shall maintain the record of hazardous wastes handled by him in **Form 3** and prepare and submit to the State Pollution Control Board, an annual return containing the details specified in **Form 4** on or before the 30th day of June following to the financial year to which that return relates.

(7) An application for the renewal of an authorization shall be made in **Form 1**, before its expiry and the State Pollution Control Board may renew the authorization after examining each case on merit subject to the condition that there has been no report of violation of the provisions of the Act or the rules made thereunder or conditions specified in the authorization.

(8)The occupier or operator of the facility shall take all the steps, wherever required, for reduction and prevention of the waste generated or for recycling or reuse and comply the conditions specified in the authorization.

(9) The State Pollution Control Board shall maintain a register containing particulars of the conditions imposed under these rules for management of hazardous waste, and it shall be open for inspection during office hours to any person interested or affected or a person authorized by him on his behalf.

6. Power to suspend or cancel an authorization.

(1) The State Pollution Control Board, may, if in its opinion the holder of the authorization has failed to comply with any of the conditions of the authorization or with any provisions of the Act or these rules and after giving him a reasonable opportunity of being heard and after recording reasons thereof in writing cancel or suspend the authorization issued under rule – 4 for such period as it considers necessary in the public interest.

(2) Upon suspension or cancellation of the authorization the State Pollution Control Board may give directions to the person whose authorization has been suspended or cancelled for the safe storage of the hazardous wastes, and such person shall comply with such directions.

7. Storage of Hazardous Waste.

(1) The occupiers, recyclers, re-processors, re-users, and operators of facilities may store the hazardous wastes for a period not exceeding ninety days and shall maintain a record of sale, transfer, storage, recycling and reprocessing of such wastes and make these records available for inspection:

Provided that the State Pollution Control Board may extend the said period in following cases, namely:-

(i) small generators up to ten tones per annum;

(ii) recyclers, re-processors and facility operators up to six months of their annual capacity;

(iii) generators who do not have access to any Treatment, Storage, Disposal Facility in the concerned State; or

(iv) the waste which needs to be specifically stored for development of a process for its recycling, reuse.

CHAPTER – III

PROCEDURE FOR RECYCLING , REPROCESSING OR REUSE OF HAZARDOUS WASTES

8. Procedure for grant of registration :

(1) Every person desirous of recycling or reprocessing the hazardous waste specified in Schedule –IV may make an application in **Form 5** accompanied with a copy each of the following documents for the grant or renewal of the registration:-

(a) consent to establish granted by the State Pollution Control Board under the Water (Prevention and Control of Pollution) Act, 1974 (25 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981(21 of 1981);

(b) certificate of registration issued by the District Industries Centre or any other government agency authorised in this regard;

(c) proof of installed capacity of plant and machinery issued by the District Industries Centre or any other government agency authorised in this behalf; and

(d) in case of renewal, certificate of compliance of effluent, emission standards and treatment and disposal of hazardous wastes, as applicable, from the State Pollution Control Board or the Concerned Zonal Office of Central Pollution Control Board.

(2) The Central Pollution Control Board, on being satisfied that the applicant is utilizing environmentally sound technologies and possesses adequate technical capabilities, requisite facilities, and equipment to recycle, reprocess or reuse hazardous wastes, may grant registration to such applicants stipulating therein necessary conditions for carrying out safe operations in the authorized place only.

(3) The Central Pollution Control Board shall dispose of the application for registration within a period of one hundred twenty days from the date of the receipt of such application complete in all respects.

(4) The registration, issued under sub-rule (2) shall be valid for a period of five years from the date of its issue, unless the operation is discontinued by the unit or the registration is suspended or cancelled by the Central Pollution Control Board.

(5) The Central Pollution Control Board may cancel or suspend the registration granted under these rules, if it has reasons to believe that the recycler or re-processor has failed to comply with any of the conditions of the registration, or with any provision of the Act or rules made thereunder.

(6) The Central Pollution Control Board may after giving a reasonable opportunity of being heard to the ap icant, by order, refuse to grant or renew the registration.

(7) The recycler or re-processor shall maintain records of hazardous wastes purchased and processed and shall file an annual return of its activities of previous year in Form 6 to the State Pollution Control Board, on or before the 30th day of June of every year.

9. Conditions for sale or transfer of Hazardous Wastes for recycling.-

The occupier generating the hazardous wastes specified in Schedule-IV may sell it only to the recycler having a valid registration from the Central Pollution Control Board for recycling or recovery.

10. Standards for recycling.-

The Central Government and Central Pollution Control Board may issue the guidelines for standards of performance for recycling processes from time to time.

11. Utilization of hazardous wastes.-

The utilisation of hazardous wastes as a supplementary resource or for energy recovery, or after processing shall be carried out by the units only after obtaining approval from the Central Pollution Control Board.

CHAPTER IV
IMPORT AND EXPORT OF HAZARDOUS WASTES

12. Import and export (transboundary movement) of hazardous wastes.-

The Ministry of Environment and Forests shall be the nodal Ministry to deal with the trans-boundary movement of the hazardous wastes and to grant permission for transit of the hazardous wastes through any part of India.

13. Import and export of hazardous wastes. –

(1) No import of the hazardous wastes from any country to India for disposal shall be permitted.

(2) The import of Hazardous Waste from any country shall be permitted only for the recycling or recovery or reuse.

(3) The export of hazardous wastes from India may be allowed to an actual user of the wastes or operator of a disposal facility with the Prior Informed Consent of the importing country to ensure environmentally sound management of the hazardous waste in question.

(4) No import or export of the hazardous wastes specified in Schedule –VI shall be permitted.

14. Import or export of Hazardous Waste for recycling, recovery and reuses.-

(1) The import and export of the hazardous wastes specified in Schedule – III, shall be regulated in accordance with the conditions laid down in the said schedule;

(2) Subject to the provisions contained in sub-rule (1), -

(i) the import or export of the Hazardous wastes specified in Part A of Schedule – III shall require Prior Informed Consent of the country from where it is imported or exported to, and shall require the license from the Directorate General of Foreign Trade and the prior written permission of the Central Government;

(ii) the import of the hazardous wastes specified in Part B of Schedule III shall not require Prior Informed Consent of the country from where it is imported;.

(iii) the import and export of the hazardous wastes not specified in Part A and Part B of Schedule III but having the hazardous characteristics outlined in Part C of the said Schedule shall require the prior written permission of the Central Government, before it is imported into or exported from India, as the case may be.

15. Procedure for export of Hazardous Wastes from India.–

(1) Any person intending to export hazardous wastes specified in Schedule-III shall apply in **Form 7** and **Form 8** along with full cover insurance policy for consignment to the Central Government for the proposed transboundary movement of the hazardous wastes together with the Prior Informed Consent in writing from the importing country.

(2) On receipt of such application, the Central Government may give a 'No Objection Certificate' for the proposed export within a period of sixty days from the date of submission of the application and may impose conditions as it may consider necessary.

(3) The Central Government, shall forward a copy of the 'No Objection Certificate' granted under sub-rule (2), to the Central Pollution Control Board, the concerned State Pollution Control Board and the concerned Port and Customs authorities for ensuring compliance of the conditions, if any, of the export and to take appropriate steps for the safe handling of the waste shipment.

(4) The exporter shall ensure that no consignment is shipped before the 'No Objection Certificate' is received from the importing country.

(5) The exporter shall also ensure that the shipment is accompanied with the Movement Document in **Form 9.**

(6) The exporter shall inform the Ministry of Environment and Forest upon completion of the trans-boundary movement.

(7) The exporter of the hazardous wastes shall maintain the records of the hazardous wastes exported by him in **Form 10** and the record so maintained shall be available for inspection..

16. **Procedure for import of Hazardous Waste –**

(1) A person intending to import or transit for trans-boundary movement of hazardous wastes specified in Schedule-III shall apply in **Form 7** and **Form 8** to the Central Government of the proposed import wherever applicable, together with the Prior Informed Consent, which ever applicable and shall send a copy of the application, simultaneously, to the concerned State Pollution Control Board to enable them to send their comments and observations, if any, to the Ministry of Environment and Forests within a period of thirty days.

(2) On receipt of the application in complete, the Ministry of Environment and Forests shall examine the application considering the comments and observations, if any, received from the State Pollution Control Boards, and may grant the permission for import within a period of sixty days subject to the condition that the importer has -

(i) the environmentally sound recycling, recovery or reuse facilities;
(ii) adequate facilities and arrangement for treatment and disposal of wastes generated; and
(iii) a valid registration from the Central Pollution Control Board and a proof of being an actual user, if required under these rules.

(3) The Ministry of Environment and Forests shall forward a copy of the permission granted under sub-rule (2) to the Central Pollution Control Board, the concerned State Pollution Control Board and the concerned Port and Customs authorities for ensuring compliance of the conditions of imports and safe handling of the hazardous waste.

(4) The Ministry of Environment and Forests shall communicate the permission to the importer.

(5) The Port and Customs authorities shall ensure that shipment is accompanied by the Movement Document in **Form 9** and the test report of analysis of the hazardous waste consignment in question, from a laboratory accredited by the exporting country.

(6) The Customs authority shall collect three randomly drawn samples of the consignment (prior to clearing the consignment as per the provisions laid down under the Customs Act, 1962) for analysis and retain the report for a period of two years, in order to ensure that in the event of any dispute, as to whether the consignment conforms or not to the declaration made in the application and Movement Document.

(7) The importer of the hazardous waste shall maintain records of the hazardous waste imported by him in **Form 10** and the record so maintained shall be available for inspection.

(8) The importer shall also inform the concerned State Pollution Control Board and the Central Pollution Control Board, the date and time of the arrival of the consignment of the hazardous waste ten days in advance.

17. **Illegal Traffic.–**

(1) The export and import of hazardous wastes from and into India shall be deemed illegal if-

(i) it is without permission of the Central Government in accordance with these rules, or

(ii) the permission has been obtained through falsification, mis-representation or fraud; or

(iii) it does not conform to the shipping details provided in the movement documents; or

(iv) it results in deliberate disposal (i.e., dumping) of hazardous wastes in contravention of the Basel Convention and of general principles of International or National Law.

(2). In case of illegal import of the hazardous wastes, the importer shall re-export the waste in question at his cost within a period of ninety days from the date of its arrival into India and its implementation will be ensured by the concerned State Pollution Control Board.

CHAPTER – V

TREATMENT, STORAGE AND DISPOSAL FACILITY FOR HAZARDOUS WASTES

18. **Treatment, Storage and Disposal Facility for hazardous wastes.-**

(1) The State Government, occupier, operator of a facility or any association of occupiers shall individually or jointly or severally be responsible for, and identify sites for establishing the facility for treatment, storage and disposal of the hazardous wastes in the State.

(2) The operator of common facility or occupier of a captive facility, shall design and set up the Treatment, Storage and Disposal Facility as per technical guidelines issued by the Central Pollution Control Board in this regard from time to time and shall obtain approval from the State Pollution Control Board for design and layout in this regard from time to time.

(3) The State Pollution Control Board shall monitor the setting up and operation of the Treatment, Storage and Disposal Facilities regularly.

(4) The operator of the Treatment, Storage and Disposal Facility shall be responsible for safe and environmentally sound operation of the Treatment, the Storage and Disposal Facility and its closure and post closure phase, as per guidelines issued by the Central Pollution Control Board from time to time.

(5) The operator of the Treatment, Storage and Disposal Facility shall maintain records of hazardous wastes handled by him in **Form 10.**

CHAPTER – VI

PACKAGING, LABELLING, AND TRANSPORT OF HAZARDOUS WASTE .

19. Packaging and labeling.-

(1) The occupier or operator of the Treatment, Storage and Disposal Facility or recycler shall ensure that the hazardous waste are packaged and labeled, based on the composition in a manner suitable for safe handling, storage and transport as per the guidelines issued by the Central Pollution Control Board from time to time.

(2) The labeling and packaging shall be easily visible and be able to withstand physical conditions and climatic factors.

20. Transportation of Hazardous waste.-

(1) The transport of the hazardous wastes shall be in accordance with the provisions of these rules and the rules made by the Central Government under the Motor Vehicles Act, 1988 and other guidelines issued from time to time in this regard.

(2) The occupier shall provide the transporter with the relevant information in **Form 11,** regarding the hazardous nature of the wastes and measures to be taken in case of an emergency and shall mark the hazardous wastes containers as per **Form 12.**

(3) In case of transport of hazardous wastes for final disposal to a facility for treatment, storage and disposal existing in a State other than the State where the hazardous waste is generated, the occupier shall obtain 'No Objection Certificate' from the State Pollution Control Board of both the States.

(4) In case of transportation of hazardous wastes through a State other than the State of origin or destination, the occupier shall intimate the concerned State Pollution Control Boards before he hands over the hazardous wastes to the transporter.

21. Manifest system (Movement Document to be used within the country only).-

(1) The occupier shall prepare six copies of the manifest in **Form 13** comprising of colour code indicated below and all six copies shall be signed by the transporter:

Copy number with colour code (1)	Purpose (2)
Copy 1 (White)	To be forwarded by the occupier to the State Pollution Control Board or Committee.
Copy 2 (Yellow)	To be carried by the occupier after taking signature on it form the transporter and the rest of the four copies to be carried by the transporter.
Copy 3 (pink)	To be retained by the operator of the facility after signature.
Copy 4 (orange)	To be returned to the transporter by the operator of facility/recycler after accepting waste.
Copy5(green)	To be returned by the operator of the facility to State Pollution Control Board/Committee after treatment and disposal of wastes.
Copy6(blue)	To be returned by the operator of the facility to the occupier after treatment and disposal of hazardous materials/wastes.

(2) The occupier shall forward copy 1 (white) to the State Pollution Control Board, and in case the hazardous wastes is likely to be transported through any transit State, the occupier shall prepare an additional copy each for intimation to such State and forward the same to the concerned State Pollution Control Board before he hands over the hazardous wastes to the transporter.

(3) No transporter shall accept hazardous wastes from an occupier for transport unless it is accompanied by copies 3 to 6 of the manifest.

(4) The transporter shall submit copies 3 to 6 of the manifest duly signed with date to the operator of the facility along with the waste consignment.

(5) Operator of the facility upon completion of treatment and disposal operations of the hazardous wastes shall forward copy 5 (green) to the State Pollution Control Board and copy 6 (blue) to the occupier and the copy 3 (pink) shall be retained by the operator of the facility.

CHAPTER VII
MISCELLANIOUS

22. Records and returns.-

(1) The occupier generating hazardous wastes and operator of the facility for disposal of hazardous waste shall maintain records of such operations in **Form 3.**

(2) The occupier and operator of a facility shall send annual returns to the State Pollution Control Board in **Form 4.**

(3) The State Pollution Control Board shall prepare an inventory of the hazardous wastes within its jurisdiction and compile other related information like recycling of the hazardous wastes and treatment and disposal of the hazardous wastes based on the returns filed by respective occupier and operator of the facility .

23. Responsibility of Authorities.-The Authority specified in column 2 of the Schedule VII shall perform the duties as specified in column 3 of the Schedule subject to the provisions of these rules.

24. Accident reporting and follow-up.- Where an accident occurs at the facility or on a hazardous waste site or during transportation of the hazardous waste, the occupier or operator of the facility or the transporter, as the case may be, shall report immediately to the State Pollution Control Board about the accident in **Form14.**

25. Liability of occupier, transporter, operator of a facility and importer.-

(1) The occupier, importer, transporter and operator of the facility shall be liable for all damages caused to the environment or third party due to improper handling of the hazardous wastes or disposal of the hazardous wastes.

(2) The occupier and the operator of the facility shall be liable to pay financial penalties as levied for any violation of the provisions under these rules by the State Pollution Control Board with the prior approval of the Central Pollution Control Board.

26. Appeal. –

(1) Any person aggrieved by an order of suspension or cancellation or refusal of authorization or its renewal passed by the State Pollution Control Board, may, within a period of thirty days from the date on which the order is communicated to him, prefer an appeal in **Form 15** to the Appellate Authority comprising of the Environment Secretary of the State.

(2) Any person aggrieved by an order of suspension or cancellation or refusal of registration or its renewal passed by the Central Pollution Control Board, may, within a period of thirty days from the date on which the order is communicated to him, prefer an appeal in **Form 15** to the Appellate Authority comprising of the Secretary, to the Government of India in the Ministry of Environment and Forests.

(3) The Appellate Authority may entertain the appeal after the expiry of the said period of thirty days if it is satisfied that the appellant was prevented by sufficient cause from filing the appeal in time.

(4) Every appeal filed under this rule shall be disposed of within a period of sixty days from the date of its filing.

Schedule 1

[See rules 3 (l)]

List of processes generating hazardous wastes

S.No.	Processes	Hazardous Waste *
1.	Petrochemical processes and pyrolytic operations	1.1 Furnace/reactor residue and debris 1.2 Tarry residues 1.3 Oily sludge emulsion 1.4 Organic residues 1.5 Residues from alkali wash of fuels 1.6 Still bottoms from distillation process 1.7 Spent catalyst and molecular sieves 1.8 Slop oil from wastewater
2.	Drilling operation for oil and gas production	2.1 Drill cuttings containing oil 2.2 Sludge containing oil 2.3 Drilling mud and other drilling wastes

3.	Cleaning, emptying and maintenance of petroleum oil storage tanks including ships	3.1 Oil-containing cargo residue, washing water and sludge 3.2 Chemical-containing cargo residue and sludge 3.3 Sludge and filters contaminated with oil 3.4 Ballast water containing oil from ships.
4.	Petroleum refining/re-processing of used oil/recycling of waste oil	4.1 Oily sludge/emulsion 4.2 Spent catalyst 4.3 Slop oil 4.4 Organic residues from process 4.5 Spent clay containing oil
5.	Industrial operations using mineral/synthetic oil as lubricant in hydraulic systems or other applications	5.1 Used/spent oil 5.2 Wastes/residues containing oil
6.	Secondary production and/or industrial use of zinc	6.1 Sludge and filter press cake arising out of production of Zinc Sulphate and other Zinc Compounds. 6.2 Zinc fines/dust/ash/skimmings (dispersible form) 6.3 Other residues from processing of zinc ash/skimmings 6.4 Flue gas dust and other particulates
7.	Primary production of zinc/lead/copper and other non-ferrous metals except aluminium	7.1 Flue gas dust from roasting 7.2 Process residues 7.3 Arsenic-bearing sludge 7.4 Non ferrous metal bearing sludge and residue. 7.5 Sludge from scrubbers
8.	Secondary production of copper	8.1 Spent electrolytic solutions 8.2 Sludges and filter cakes 8.3 Flue gas dust and other particulates
9.	Secondary production of lead	9.1 Lead bearing residues 9.2 Lead ash/particulate from flue gas
10.	Production and/or industrial use of cadmium and arsenic and their compounds	10.1 Residues containing cadmium and arsenic

11.	Production of primary and secondary aluminium	11.1. Sludges from off-gas treatment 11.2. Cathode residues including pot lining wastes 11.3. Tar containing wastes 11.4. Flue gas dust and other particulates 11.5. Wastes from treatment of salt slags and black drosses
12.	Metal surface treatment, such as etching, staining, polishing, galvanising, cleaning, degreasing, plating, etc.	12.1 Acid residues 12.2 Alkali residues 12.3 Spent bath/sludge containing sulphide, cyanide and toxic metals 12.4 Sludge from bath containing organic solvents 12.5 Phosphate sludge 12.6 Sludge from staining bath 12.7 Copper etching residues 12.8 Plating metal sludge
13.	Production of iron and steel including other ferrous alloys (electric furnaces; steel rolling and finishing mills; Coke oven and by product plant)	13.1 Sludge from acid recovery unit 13.2 Benzol acid sludge 13.3 Decanter tank tar sludge 13.4 Tar storage tank residue
14.	Hardening of steel	14.1 Cyanide-, nitrate-, or nitrite-containing sludge 14.2 Spent hardening salt
15.	Production of asbestos or asbestos-containing materials	15.1 Asbestos-containing residues 15.2 Discarded asbestos 15.3 Dust/particulates from exhaust gas treatment.
16.	Production of caustic soda and chlorine	16.1 Mercury bearing sludge 16.2 Residue/sludges and filter cakes 16.3 Brine sludge containing mercury
17.	Production of mineral acids	17.1 Residues, dusts or filter cakes 17.2 Spent catalyst
18.	Production of nitrogenous and complex fertilizers	18.1 Spent catalyst 18.2 Spent carbon 18.3 Sludge/residue containing arsenic 18.4 Chromium sludge from water cooling tower
19.	Production of phenol	19.1 Residue/sludge containing phenol

20.	Production and/or industrial use of solvents	20.1 Contaminated aromatic, aliphatic or napthenic solvents may or may not be fit for reuse. 20.2 Spent solvents 20.3 Distillation residues
21.	Production and/or industrial use of paints, pigments, lacquers, varnishes, plastics and inks	21.1 Process wastes, residues & sludges 21.2 Fillers residues
22.	Production of plastic raw materials	22.1 Residues of additives used in plastics manufacture like dyestuffs, stabilizers, flame retardants, etc. 22.2 Residues and waste of platicisers 22.3 Residues from vinylchloride monomer production 22.4 Residues from acrylonitrile production 22.5 Non-polymerised residues
23.	Production and/or industrial use of glues, cements, adhesive and resins	23.1 Wastes/residues (not made with vegetable or animal materials)
24.	Production of canvas and textiles	24.1 Chemical residues
25.	Industrial production and formulation of wood preservatives	25.1 Chemical residues 25.2 Residues from wood alkali bath
26.	Production or industrial use of synthetic dyes, dye-intermediates and pigments	26.1 Process waste sludge/residues containing acid or other toxic metals or organic complexes 26.2 Dust from air filtration system
27.	Production of organo-silicone compounds	27.1 process residues
28.	Production/formulation of drugs/ pharmaceuticals & health care product	28.1. Process Residues and wastes 28.2 Spent catalyst / spent carbon 28.3 Off specification products 28.4 Date-expired, discarded and off-specification drugs/ medicines 28.5. Spent organic solvents
29.	Production, and formulation of pesticides including stock-piles	29.1 Process wastes/residues 29.2 Chemical sludge containing residue pesticides 29.3 Date-expired and off-specification pesticides

30.	Leather tanneries	30.1 Chromium bearing residues and sludges
31.	Electronic Industry	31.1 Process residues and wastes 31.2 Spent etching chemicals and solvents
32.	Pulp & Paper Industry	32.1 Spent chemicals 32.2 Corrosive wastes arising from use of strong acid and bases 32.3 Process sludge containing adsorbable organic halides [AOx]
33.	Disposal of barrels / containers used for handling of hazardous wastes / chemicals	33.1 Chemical-containing residue arising from decontamination. 33.2 Sludge from treatment of waste water arising out of cleaning / disposal of barrels / containers 33.3 Discarded containers / barrels / liners contaminated with hazardous wastes/chemicals
34.	Purification and treatment of exhaust air, water & waste water from the processes in this schedule and common industrial effluent treatment plants (CETP's)	34.1 Flue gas cleaning residue 34.2 Spent ion exchange resin containing toxic metals 34.3 Chemical sludge from waste water treatment 34.4 Oil and grease skimming residues 34.5 Chromium sludge from cooling water
35.	Purification process for organic compounds/solvents	35.1 Filters and filter material which have organic liquids in them, e.g. mineral oil, synthetic oil and organic chlorine compounds 35.2 Spent catalyst 35.3 Spent carbon
36.	Hazardous waste treatment processes, e.g. incineration, distillation, separation and concentration techniques	36.1 Sludge from wet scrubbers 36.2 Ash from incineration of hazardous waste, flue gas cleaning residues 36.3 Spent acid from batteries 36.4 Distillation residues from contaminated organic solvents

* **The inclusion of wastes contained in this Schedule does not preclude the use of Schedule 2 to demonstrate that the waste is not hazardous. In case of dispute, the matter would be referred to the Technical Review Committee constituted by MoEF.**

Note: *The high volume low effect wastes such as fly ash, phosphogypsum, red mud, slags from pyrometallurgical operations, mine tailings and ore beneficiation rejects are excluded from the category of hazardous wastes. Separate guidelines on the management of these wastes shall be issued by CPCB.*

Schedule II
[*See* rule 3(l)]

List of Waste Constituents with Concentration Limits*

<u>Class A</u>
Concentration limit: □ 50 mg/kg

A1 Antimony and antimony compounds
A2 Arsenic and arsenic compounds
A3 Berylliun and beryllium compounds
A4 Cadmium and cadmium compounds
A5 Chromium (VI) compounds
A6 Mercury and mercury compounds
A7 Selenium and selenium compounds
A8 Tellurium and tellurium compounds
A9 Thallium and thallium compounds
A10 Inorganic cyanide compounds
A11 Metal carbonyls
A12 Napthalene
A13 Anthracene
A14 Phenanthrene
A15 Chrysene, benzo (a) anthracene, fluoranthene, benzo (a) pyrene, benzo (K) fluoranthene, indeno (1, 2, 3-cd) pyrene and benzo (ghi) perylene
A16 halogenated compounds of aromatic rings, e.g. polychlorinated biphenyls, polychloroterphenyls and their derivatives
A17 Halogenated aromatic compounds
A18 Benzene
A19 Organo-chlorine pesticides
A20 Organo-tin Compounds

<u>Class B</u>
Concentration limit: □ 5, 000 mg/kg

B1 Chromium (III) compounds
B2 Cobalt compounds
B3 Copper compounds
B4 Lead and lead compounds
B5 Molybdenum compounds
B6 Nickel compounds
B7 Inorganic Tin compounds
B8 Vanadium compounds
B9 Tungsten compounds
B10 Silver compounds
B11 Halogenated aliphatic compounds
B12 Organo phosphorus compounds

B13 Organic peroxides
B14 Organic nitro-and nitroso-compounds
B15 Organic azo-and azooxy compounds
B16 Nitriles
B17 Amines
B18 (Iso-and thio-) cyanates
B19 Phenol and phenolic compounds
B20 Mercaptans
B21 Asbestos
B22 Halogen-silanes
B23 Hydrazine (s)
B24 Flourine
B25 Chlorine
B26 Bromine
B27 White and red phosphorus
B28 Ferro-silicate and alloys
B29 Manganese-silicate
B30 Halogen-containing compounds which produce acidic vapours on contact with humid air or water, e.g. silicon tetrachloride, aluminium chloride, titanium tetrachloride

Class C

Concentration limit; □ 20, 000 mg/kg

C1 Ammonia and ammonium compounds
C2 Inorganic peroxides
C3 Barium compounds except barium sulphate
C4 Fluorine compounds
C5 Phosphate compounds except phosphates of aluminium, calcium and iron
C6 Bromates, (hypo-bromites)
C7 Chlorates, (hypo-chlorites) ,
C8 Aromatic compounds other than those listed under A12 to A18
C9 Organic silicone compounds
C10 Organic sulphur compounds
C11 Iodates
C12 Nitrates, nitrites
C13 Sulphides
C14 Zinc compounds
C15 Salts of per-acids
C16 Acid amides
C17 Acid anhydrides

Class D

Concentration limit: □ 50, 000 mg/kg

D1 Total Sulphur
D2 Inorganic acids

D3 Metal hydrogen sulphates

D4 Oxides and hydroxides except those of hydrogen, carbon, silicon, iron, aluminum, titanium, manganese, magnesium, calcium

D5 Total hydrocarbons other than those listed under A12 to A18

D6 Organic oxygen compounds

D7 Organic nitrogen compounds expressed as nitrogen

D8 Nitrides

D9 Hydrides

Class E

Regardless of concentration limit, Classified as hazardous wastes if the waste exhibits any of the following Characteristics.

E1 Flammable
Flammable wastes with flash point 65.6°c or below.

E2 Explosive
Wastes which may explode under the effect of flame, heat or photochemical conditions. Any other waste of explosive materials included in the Indian Explosive Act.

E3 Corrosive
Wastes which may be corrosive, by chemical action, will cause severe damage when in contact with living tissue.

E4 Toxic
Wastes containing or contaminated with established toxic and or eco- toxic constituents.

E5 Carcinogenicity, Mutagenecity and Endocrine disruptivity
Wastes contaminated or containing established carcinogens, mutagens and endocrine disruptors.

---

*Waste constituents and their concentration limits given in this list are based on erstwhile BAGA (the Netherlands Environment Protection Agency) List of Hazardous Substances. In order to decide whether specific wastes listed above is hazardous or not, following points be taken into consideration:

(i) If a component of the waste appears in one of the five risk classes listed above (A,B,C,D or E) and the concentration of the component is equal to or more than the limit for the relevant risks class, the material is then classified as hazardous waste.

(ii) If a chemical compound containing a hazardous constituent is present in the waste, the concentration limit does not apply to the compound, but only to the hazardous constituent itself.

(iii) If multiple hazardous constituents from the same class are present in the waste, the concentrations are added together.

(iv) If multiple hazardous constituents from different classes are present in the waste, the lowest concentration limit corresponding to the constituent(s) applies.

(v) For determining the concentration of the hazardous constituents in the waste "Toxicity Characteristics Leaching Procedure (TCLP) as per ASTM-D5233-92 should be adopted.

Schedule III

[*See* rules 3(l),14(1),14(2) (i) ,(iii) and 15(1)]

PART A

Part A: List of Hazardous Wastes Applicable for Import with Prior Informed Consent [Annexure VIII of the Basel Convention*]

Basel No.	Description of Hazardous Wastes
AI	**Metal and Metal bearing wastes**
A1010	Metal wastes and waste consisting of alloys of any of the following
	- Antimony
	- Cadmium
	- Tellurium - Lead
A1020	Waste having as constituents or contaminants, excluding metal wastes in massive form as listed in B1020, any of the following:
	- Cadmium, cadmium compounds.
	- Antimony, antimony compounds.
	- Tellurium, tellurium compounds.
	- Lead, lead compounds.
A1040	Wastes having metal carbonyls as constituents
A1050	Galvanic sludges
A1060	Wastes Liquors from the pickling of metals.
A1070	Leaching residues from zinc processing, dusts and sludges such as jarosite, hematite etc.,
A1080	Waste Zinc residues not included on list B containing lead and cadmium in concentrations sufficient to exhibit hazard characteristics indicated in Part C of Schedule - 3
A1090	Ashes from the incineration of insulated copper wire
A1100	Dusts and residues from gas cleaning systems of copper smelters.
A1110	Spent electrolytic solutions from copper electrorefining and electrowinning operations
A1120	Waste sludges, excluding anode slimes, from electrolytic purification systems in copper electrorefining and electrowinning operations.
A1130	Spent etching solutions containing dissolved copper.
A1150	Precious metal ash from incineration of printed circuit boards not included in list' B'
A1160	Waste Lead acid batteries whole or crushed.
A1170	Unsorted waste batteries excluding mixtures of List B batteries.
A1180	Waste Electrical and electronic assembles or scrap containing, components such

	as accumulators and other batteries included on list A, mercury-switches, activated glass cullets from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Schedule 2 constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they exhibit hazard characteristics indicated in part C of this Schedule (refer B1110)
A2	**Wastes containing principally inorganic constituents, which may contain metals and organic materials**
A2010	Activated Glass cullets from cathode ray tubes and other activated glasses
A2030	Waste catalysts but excluding such wastes specified on List B of Schedule 3
A3	**Wastes containing principally organic constituents which may contain metals and inorganic materials**
A3010	Waste from the production or processing of petroleum coke and bitumen
A3020	Waste mineral oils unfit for their originally intended use
A3050	Wastes from production, formulation and use of resins, latex, plasticisers, glues/adhesives excluding such wastes specified in List B (B4020)
A3070	Waste phenol, phenol compounds including chlorophenol in the form of liquids or sludges
A3080	Waste ethers not including those specified in List B
A3120	Fluff: light fraction from shredding
A3130	Waste organic phosphorus compounds
A3140	Waste non-halogenated organic solvents but excluding such wastes specified on List B
A3160	Waste halogenated or unhalogenated non-aqueous distillation residues arising from organic solvent recovery operations
A3170	Waste arising from the production of aliphatic halogenated hydrocarbons (such as chloromethanes, dichloroethane, vinylchloride, vinylidene chloride, allyl chloride and epichlorhydrin)
A4	**Wastes which may contain either inorganic or organic constituents**
A4010	Wastes from the production and preparation and use of pharmaceutical products but excluding such wastes specified on List B
A4040	Wastes from the manufacture formulation and use of wood preserving chemicals
A4070	Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers, varnish excluding those specified in List B (B4010)
A4080	Wastes of an explosive nature excluding such wastes specified on List B
A4090	Waste acidic or basic solutions excluding those specified in List B (B2120)
A4100	Wastes from industrial pollution control devices for cleaning of industrial off-gases excluding such wastes specified on List B
A4120	Wastes that contain, consist of or are contaminated with peroxides.
A4130	Waste packages and containers containing any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein.
A4140	Waste consisting of or containing off specification or out-dated chemicals containing any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein.
A4150	Waste chemical substances arising from research and development or teaching activities which are not identified and/or are new and whose effects on human health and/or the environment are not known
A4160	Spent activated carbon not included on List B (B2060)

*This List is based on Annex.VIII of the Basel Convention on Transboundary Movement of Hazardous Wastes and comprises of wastes characterized as hazardous under Article 1, paragraph 1(a) of the Convention. Inclusion of wastes on this list does not preclude the use of hazard characteristics given in Annex.VIII of the Basel Convention (Part C of this Schedule) to demonstrate that the wastes are not hazardous. **Certain waste categories listed in the Schedule - 3 (Part–A) have been prohibited for import. Hazardous wastes in the Schedule – 3 (Part –A) are restricted and cannot be allowed to be imported without permission from Ministry of Environment & Forests and DGFT license.**

PART B

List of Hazardous Wastes applicable for Import and Export not Requiring Prior Informed Consent

[Annex IX of the Basel Convention*]

Basel No.	Description of Wastes
B1	**Metal and metal-bearing wastes**
B1010	Metal and metal-alloy wastes in metallic, non-dispersible form:
	- Precious metals (gold, silver, platinum)**
	- Iron and steel scrap**
	- Nickel scrap**
	- Aluminum scrap**
	- Zinc scrap**
	- Tin scrap**
	- Tungsten scrap**
	- Molybdenum scrap**
	- Tantalum scrap**
	- Cobalt scrap**
	- Bismuth scrap**
	- Titanium scrap**
	- Zirconium scrap**
	- Manganese scrap **
	- Germanium scrap**
	- Vanadium scrap **
	- Hafnium scrap**
	- Indium scrap**
	- Niobium scrap**
	- Rhenium scrap**
	- Gallium scrap**
	- Magnesium scrap**
	- Copper scrap**
	- Thorium scrap
	- Rare earths scrap
	- Chromium scrap**
B1020	Clean, uncontaminated metal scrap, including alloys, in bulk finished form (sheet, plates, beams, rods, etc.) , of:
	- Antimony scrap****
	- Cadmium scrap
	- Lead scrap (excluding lead acid batteries)
	- Tellurium scrap****

B1030	Refractory metals containing residues****
B1031	Molybdenum, tungsten, titanium, tantalum, niobium and rhenium metal and metal alloy wastes in metallic dispersible form (metal powder), excluding such wastes as specified in list A under entry A1050, Galvanic sludges****
B1040	Scrap assemblies from electrical power generation not contaminated with lubricating oil, PCB or PCT to an extent to render them hazardous**
B1050	Mixed non-ferrous metal, heavy fraction scrap, not containing any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein**
B1060	Waste selenium and tellurium in metallic elemental form including powder****
B1070	Waste of copper and copper alloys in dispersible form, unless they contain any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein***
B1080	Zinc ash and residues including zinc alloys residues in dispersible form unless they contain any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein***
B1090	Waste batteries conforming to a standard battery specification, excluding those made with lead, cadmium or mercury.****
B1100	Metal bearing wastes arising from melting, smelting and refining of metals:
	- Hard Zinc Spelter**
	- Zinc-containing drosses: ** ~ Galvanizing slab zinc top dross (>90% Zn) ~ Galvanizing slab zinc bottom dross (>92% Zn) ~ Zinc die casting dross (>85% Zn) ~ Hot dip galvanizers slab zinc dross (batch) (>92% Zn ~ Zinc skimmings (>90%Zn)
	-Slags from copper processing for further processing or refining containing arsenic, lead or cadmium***
	- Slags from precious metals processing for further refining**
	- Wastes of refractory linings, including crucibles, originating from copper smelting
	- Aluminum skimmings (or skims) excluding salt slag**
	-Tantalum-bearing tin slags with less than 0.5% tin****
B1110	Electrical and electronic assemblies
	- Electronic assemblies consisting only of metals or alloys****

	- Waste electrical and electronic assemblies scrap (including printed circuit boards) not containing components such as accumulators and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or not contaminated with constituents such as cadmium, mercury, lead, polychlorinated biphenyl) or from which these have been removed, to an extent that they do not possess any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein ****
	- Electrical and electronic assemblies (including printed circuit boards, electronic components and wires) destined for direct reuse and not for recycling or final disposal.
B1120	Spent catalysts excluding liquids used as catalysts, containing any of: Transition metals, excluding waste catalysts (spent catalysts, liquid used catalysts or other catalysts) on list A: Scandium Titanium Vanadium Chromium Manganese Iron Cobalt Nickel Copper Zinc Yttrium Zirconium Niobium Molybdenum Hafnium Tantalum Tungsten Rhenium Lanthanaides (rare earth metals): Lanthanum Cerium Praseodymium Neody Samarium Europium Gadolinium Terbium Dysprosium Holmium Erbium Thulium Ytterbium Lutetium
B1130	Cleaned spent precious metal bearing catalysts
B1140	Precious metal bearing residues in solid form which contain traces of inorganic cyanides
B1150	Precious metals and alloy wastes (gold , silver, the platinum group) in a dispersible form
B1160	Precious-metal ash from the incineration of printed circuit boards (note the related entry on list A A1150)
B1170	Precious metal ash from the incineration of photographic film

B1180	Waste photographic film containing silver halides and metallic silver
B1190	Waste photographic paper containing silver halides and metallic silver
B1200	Granulated slag arising from the manufacture of iron and steel
B1210	Slag arising from the manufacture of iron and steel including slag as a source of Titanium dioxide and Vanadium
B1220	Slag from zinc production, chemically stabilized, having a high iron content (above 20%) and processed according to industrial specifications mainly for construction
B1230	Mill scaling arising from manufacture of iron and steel**
B1240	Copper Oxide mill-scale***
B2	**Wastes containing principally inorganic constituents, which may contain metals and organic materials**
B2010	Wastes from mining operations in non-dispersible form:
	- Natural graphite waste
	- Slate wastes
	- Mica wastes
	- Leucite, nepheline and nepheline syenite waste
	- Feldspar waste
	- Fluorspar waste
	- Silica wastes in solid from excluding those used in foundry operations
B2020	Glass wastes in non-dispersible from: - Glass Cullets and other wastes and scrap of glass except activated glass cullets from cathode ray tubes and other activated glasses
B2030	Ceramic wastes in non-dispersible form:
	Cermet wastes and scrap (metal ceramic composites) - Ceramic based fibres
B2040	Other wastes containing principally inorganic constituents:
	- Partially refined calcium sulphate produced from flue gas desulphurisation (FGD) - Waste gypsum wallboard or plasterboard arising from the demolition of buildings - Sulphur in solid form

	- Limestone from production of calcium cyanamide (pH<9) - Sodium, potassium, calcium chlorides - Carborundum (silicon carbide) - Broken concrete - Lithium tantalum & Lillium-niobium containing glass scraps
B2060	Spent activated carbon resulting from the treatment of potable water and processes of the food industry and vitamin production (note the related entry on list A A4160)
B2070	Calcium fluoride sludge
B2080	Waste gypsum arising from chemical industry processes unless it contains any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein
B2090	Waste anode butts from steel or aluminium production made of petroleum coke or bitumen and cleaned to normal industry specifications (excluding anode butts from chlor alkali electrolyses and from other metallurgical industry)
B2100	Waste hydrates of aluminum and waste alumina and residues from alumina production, arising from gas cleaning, flocculation or filtration process
B2110	Bauxite residue ("red mud") (pH moderated to less than 11.5)
B2120	Waste acidic or basic solutions with a pH greater than 2 and less than 11.5, which are not corrosive or otherwise hazardous (note the related entry on list A A4090)
B3	**Wastes containing principally organic constituents, which may contain metals and inorganic materials**
B3010	Solid plastic waste The following plastic or mixed plastic waste, provided they are not mixed with other wastes and are prepared to a specification: - Scrap plastic of non-halogenated polymers and copolymers, including but not limited to the following:
	Ethylene
	Styrene
	Polypropylene
	polyethylene terephthalate
	Acrylonitrile
	Butadiene
	Polyacetals
	Polyamides

	polybutylene tere-phthalate
	Polycarbonates
	Polyethers
	polyphenylene sulphides
	acrylic polymers
	alkanes C10-C13 (plasticiser)
	polyurethane (not containing CFC's)
	Polysiloxanes
	polymethyl methacrylate
	polyvinyl alcohol
	polyvinyl butyral
	Polyvinyl acetate
	- Cured waste resins or condensation products including the following:
	urea formaldehyde resins
	phenol formaldehyde resins
	melamine formaldehyde resins
	epoxy resins
	alkyd resins
	polyamides
	- The following fluorinated polymer wastes (excluding post-consumer wastes):
	Perfluoroethylene/ propylene
	Perfluoroalkoxy alkane
	Metafluoroalkoxy alkane
	polyvinylfluoride
	polyvinylidenefluoride
B3020	Paper, paperboard and paper product wastes**** The following materials, provided they are not mixed with hazardous wastes: Waste and scrap of paper or paperboard of: • unbleached paper or paperboard or of corrugated paper or paperboard • other paper or paperboard, made mainly of bleached chemical pulp, not coloured in the mass • paper or paperboard made mainly of mechanical pulp (for example, newspapers, journals and similar printed matter) • other, including but no t limited to 1) laminated paperboard 2) unsorted scrap.
B3130	Waste polymer ethers and waste non-hazardous monomer ethers incapable of forming peroxides
B3140	Waste pneumatic tyres, excluding those which do not lead to resource recovery, recycling, reclamation or direct reuse

B4	**Wastes which may contain either inorganic or organic constituents**
B4010	Wastes consisting mainly of water-based/latex paints, inks and hardened varnishes not containing organic solvents, heavy metals or biocides to an extent to render them hazardous (note the related entry on list A A4070)
B4020	Wastes from production, formulation and use of resins, latex, plasticizers, glues/adhesives, not listed on list A, free of solvents and other contaminants to an extent that they do not exhibit Part C of Schedule 3 characteristics
B4030	Used single-use cameras, with batteries not included on list A

* This List is based on Annex. IX of the Basel Convention on Transboundary Movement of Hazardous Wastes and comprises of wastes not characterized as hazardous under Article – I of the Basel Convention.

** Import permitted in the country without any license or restriction.

*** Import permitted in the country for recycling/reprocessing by units registered with MoEF/CPCB and having DGFT license .

**** Import permitted in the country by the actual users with MoEF permission and DGFT license.

All other wastes listed in this Schedule -3 (Par – B) having no ' Star/s'(...) can only be imported in to the country with the permission of MoEF.*

Note:

(1) Copper dross containing copper greater than 65% and lead and cadmium equal to or less than 1.25% and 0.1% respectively; spent cleaned metal catalyst containing copper; and Copper reverts, cake and residues containing lead and cadmium equal to or less than 1.25% and 0.1% respectively are allowed for import without DGFT licence to units (actual users) registered with MoEF upto an annual quantity limit indicated in the Registration letter. Copper reverts, cake and residues containing lead and cadmium greater than 1.25% and 0.1% respectively are under restricted category for which import is permitted only against DGFT licence for the purpose of processing or reuse by units registered with MoEF (actual users).

(2) Zinc ash/skimmings in dispersible form containing zinc more than 65% and lead and cadmium equal to or less than 1.25% and 0.1% respectively and spent cleaned metal catalyst containing zinc are allowed for import without DGFT licence to units registered with MoEF (actual users) upto an annual quantity limit indicated in Registration Letter. Zinc ash and skimmings containing less than 65% zinc and lead and cadmium equal to or more than 1.25% and 0.1% respectively and hard zinc spelter and brass dross containing lead greater than 1.25% are under restricted category for which import is permitted against DGFT licence and only for purpose of processing or reuse by units registered with MoEF (actual users).

PART C
List of Hazardous Characteristics

Code	Characteristic
H 1	**Explosive**
	An explosive substance or waste is a solid or liquid substance or waste (or mixture of substances or wastes) which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such speed as to cause damage to the surroundings (UN Class 1; III)
H 3	**Flammable Liquids**
	The word "flammable" has the same meaning as "inflammable". Flammable liquids are liquids, or mixtures of liquids, or liquids containing solids in solution or suspension (for example, paints, varnishes, lacquers, etc. but not including substances or wastes otherwise classified on account of their dangerous characteristics) which give off a flammable vapour at temperatures of not more than 60.5°C, closed-cup test, or not more than 65.5°C, open-cup test. (Since the results of open-cup tests and of closed-cup tests are not strictly comparable and even individual results by the same test are often variable, regulations varying from the above figures to make allowance for such differences would be within the spirit of this definition).
H 4.1	**Flammable Solids**
	Solids, or waste solids, other than those classed as explosives, which under conditions encountered in transport are readily combustible, or may cause or contribute to fire through friction.
H 4.2.	**Substances or wastes liable to spontaneous combustion**
	Substances or wastes which are liable to spontaneous heating under normal conditions encountered in transport, or to heating up on contact with air, and being then liable to catch fire.
H 4.3	**Substances or wastes which, in contact with water emit flammable gases**
	Substances or wastes which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.

H 5.1 **Oxidizing**

Substances or wastes which, while in themselves not necessarily combustible, may, generally by yielding oxygen cause, or contribute to, the combustion of other materials.

H 5.2 **Organic Peroxides**

Organic substances or wastes which contain the bivalent-O-O- structure are thermally unstable substances which may undergo exothermic self-accelerating decomposition.

H 6.1 **Poisons (Acute)**

Substances or wastes liable either to cause death or serious injury or to harm health if swallowed or inhaled or by skin contact.

H 6.2 **Infectious substances**

Substances or wastes containing viable micro organisms or their toxins which are known or suspected to cause disease in animals or humans.

H 8 **Corrosives**

Substances or wastes which, by chemical action, will cause severe damage when in contact with living tissue, or, in the case of leakage, will materially damage, or even destroy, other goods or the means of transport; they may also cause other hazards.

H 10 **Liberation of toxic gases in contact with air or water**
Substances or wastes which, by interaction with air or water, are liable to give off toxic gases in dangerous quantities.

H 11 **Toxic (Delayed or chronic)**

Substances or wastes which, if they are inhaled or ingested or if they penetrate the skin, may involve delayed or chronic effects, including carcinogenicity).

H 12 **Ecotoxic**

Substances or wastes which if released present or may present immediate or delayed adverse impacts to the environment by means of bioaccumulation and/or toxic effects upon biotic systems.

H 13 **Capable** by any means, after disposal, of yielding another material, e.g., Leachate, which possesses any of the characteristics listed above.

Schedule IV
[(See rules), 8 (1)and 9]

List of Hazardous Wastes requiring Registration for Recycling/Reprocessing

Sl. No.	Wastes
1	Brass Dross
2	Copper Dross
3	Copper Oxide mill scale
4	Copper reverts, cake and residue
5	Waste Copper and copper alloys in dispersible form.
6	Slags from copper processing for further processing or refining
7	Insulated Copper Wire Scrap/copper with PVC sheathing including ISRI-code material namely "Druid"
8	Jelly filled copper cables
9	Spent cleared metal catalyst containing copper
10	Spent catalyst containing nickel, cadmium, zinc, copper, arsenic, vanadium and cobalt
11	Zinc Dross-Hot dip Galvanizers SLAB
12	Zinc Dross-Bottom Dross
13	Zinc ash/skimmings arising from galvanizing and die casting operations
14	Zinc ash/skimming/other zinc bearing wastes arising from smelting and refining
15	Zinc ash and residues including zinc alloy residues in dispersible form
16	Spent cleared metal catalyst containing zinc
17	Lead acid battery plates and other lead scrap/ashes/residues not covered under Batteries (Management and Handling)Rules, 2001. [*Battery scrap, namely: Lead battery plates covered by ISRI, Code word "Rails" Battery lugs covered by ISRI, Code word "Rakes". Scrap drained/dry while intact, lead batteries covered by ISRI, Code word "Rains".
18	Components of waste electrical and electronic assembles comprising accumulators and other batteries included on list A, mercury-switches, activated glass cullets from cathode-ray tubes and other activated glass and PCB-capacitors, or any other component contaminated with Schedule 2 constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they exhibit hazard characteristics indicated in part C of this Schedule.
19	Paint and ink Sludge/residues
20	Used Oil and Waste Oil - As per specifications prescribed from time to time .

Schedule V

[See rule 3 (ze)and (zf)]

PART A

Specifications of used oil suitable for reprocessing / recycling

S. No.	Parameter	Maximum permissible Limits
(1)	(2)	(3)
1.	Polychlorinated biphenyls (PCBs)	<2 ppm *
2.	Lead	100 ppm
3.	Arsenic	5 ppm
4.	Cadmium+Chromium+Nickel	500 ppm
5	Polyaromatic hydrocarbons (PAH)	6%

PART B

Specifications of fuel derived from Waste Oil

S. No.	Parameter	Maximum permissible Limits
(1)	(2)	(3)
1.	Sediment	0.25 %
2.	Lead	100 ppm
3.	Arsenic	5 ppm
4.	Cadmium+Chromium+Nickel	500 ppm
5.	Polyaromatic hydrocarbons (PAH)	6%
6.	Total halogens	4000 ppm
7.	Polychlorinated biphenyls (PCBs)	<2 ppm *
8.	Sulfur	4.5 %
9.	Water Content	1 %

The detection limit is 2 ppm by Gas Liquid Chromatography (GLC) using Electron Capture detector (ECD)

Schedule VI
[See rule 13(4)]

Hazardous Wastes Prohibited for Import and Export

S.No.	Basel No	Description of Hazardous Wastes
1.	A1010	Mercury bearing wastes
2.	A1030	Waste having Mercury; Mercury Compounds as constituents or contaminants
3.	A1010	Beryllium bearing wastes
4.	A1020	Waste having Beryllium; Beryllium Compounds as constituents or contaminants
5.	A1010	Arsenic bearing wastes
6.	A1030	Waste having Arsenic: Arsenic compounds as constituents or contaminants
7.	A1010	Selenium bearing wastes
8.	A1020	Waste having Selenium; Selenium Compounds as constituents or contaminants
9.	A1010	Thallium bearing wastes
10.	A1030	Waste having Thallium; Thallium Compounds as constituents or contaminants
11.	A1040	Hexavalent Chromium Compounds bearing wastes
12.	A1140	Wastes Cupric Chloride and Copper Cyanide Catalysts bearing wastes
13	A1190	Waste metal cables coated or insulated with plastics containing or contaminated with coal tar, PCB", lead, cadmium, other organohalogen compounds or other constituents as mentioned in schedule 2 to the extent of concentration limits specified therein.
14.	A2020	Waste inorganic fluorine compounds in the form of liquids or sludge but excluding calcium fluoride sludge
15.	A2040	Waste gypsum arising from chemical industry processes if it contains any of the constituents mentioned in Schedule 2 to the extent of concentration limits specified therein
16.	A2050	Waste Asbestos (Dust and Fibres)
17.	A3030	Wastes that consist of or are contaminated with leaded anti-knock compound sludge or leaded petrol (gasoline) sludges.
18.	A3040	Waste Thermal (heat transfer) fluids
19.	A3060	Waste Nitrocellulose
20.	A3090	Waste Leather dust, ash, sludges or flours when containing hexavalent chromium compounds or biocides

21.	A3100	Waste paring and other wastes of leather or of composition leather not suitable for the manufacture of leather articles, containing hexavalent chromium compounds and biocides
22.	A3110	Fellmongery wastes containing hexavalent chromium compounds or biocides or infectious substances
23.	A3150	Halogenated organic solvents
24.	A3180	Waste, Substances and articles containing, consisting of or contaminated with polychlorinated biphenyles (PCB) and/or polychlorinated terphenyls, (PCT) and/or polychlorinated naphthalenes (PCN) and/or polybrominated biphyenyles (PBB) or any other polybrominated analogues of these compounds
25.	A3190	Waste tarry residues (excluding asphalt cements) arising from refining, distillation and pyrolitic treatment of organic materials)
26.	A4020	Clinical and related wastes; that is wastes arising from medical, nursing, dental, veterinary, or similar practices and wastes generated in hospital or other facilities during the investigation or treatment of patients, or research projects.
27.	A4030	Waste from the production, formulation and use of biocides and phyto-pharmaceuticals, including waste pesticides and hebicides which are off-specification, out-dated, and/or unfit for their originally intended use.
28.	A4050	Waste that contain,, consist of, or are contaminated with any of the following; Inorganic cyanides, excepting precious metal bearing residues in solid form containing traces of inorganic cyanides. Organic cyanides
29.	A4060	Waste oil/water, hydrocarbons/water mixtures, emulsions
30.	A4110	Wastes that contain, consist of or are contaminated with any of the following : • Any congenor of polychlorinated dibenzofuran • Any congenor of polychlorinated dibenzo-dioxin.

Schedule VII
[See rule 23]

List of Authorities and Corresponding Duties

S.No.	Authority	Corresponding Duties
1.	Ministry of Environment and Forests under the Environment (Protection) Act, 1986	i. Identification of hazardous wastes ii. Permission to exporters of hazardous wastes iii. Permission to importers of hazardous wastes iv. Permission for transit of hazardous wastes through India v. Sponsoring of training and Awareness programme on Hazardous Waste Management related activities.
2.	Central Pollution Control Board constituted under the Water (Prevention and Control of Pollution) Act, 1974	i. Co-ordination of activities of State Pollution control Boards/ Committees ii. Conduct training courses for authorities dealing with management of hazardous wastes iii. Recommend standards and specifications for treatment and disposal of wastes and leachates Recommend procedures for characterization of hazardous wastes. iv. Sector specific documentation to identify waste for inclusion in Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008. v. Prepare guidelines to prevent/reduce/ minimize the generation and handling of hazardous wastes vi. Registration and renewal of registration of Recyclers/Re-processors vii. Any other function under Rules delegated by the Ministry of Environment & Forests.
3.	State Government/Union Territory Government/Administration	i. Identification of site(s) for common Hazardous Waste Treatment Storage and Disposal Facility (TSDF) ii. Assess EIA reports and convey the decision of approval of site or otherwise iii. Acquire the site or inform operator of

		facility or occupier or association of occupiers to acquire the site iv. Notification of sites v. Publish periodically an inventory of all disposal sites in the State/Union Territory
4.	State Pollution Control Boards or Pollution Control Committees constituted under the Water (Prevention and Control of Pollution) Act, 1974	i. Inventorisation of hazardous wastes ii. Grant and renewal of authorization iii. Monitoring of compliance of various provisions and conditions of authorization including conditions of permission for issued by MoEF exports and imports iv. Examining the applications for imports submitted by the importers and forwarding the same to Ministry of Environment and Forests v. Implementation of programmes to prevent/reduce/minimize the generation of hazardous wastes vi. Action against violations of Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 vii. Any other function under these Rules assigned by MoEF from time to time.
5.	Directorate General of Foreign Trade constituted under the Foreign Trade (Development and Regulation) Act, 1992	i. Grant of licence for import of hazardous wastes ii. Refusal of licence for hazardous wastes prohibited for imports and export
6.	Port Authority under Indian Ports Act, 1908 (15 of 1908) and Customs Authority under the Customs Act, 1962 (52 of 1962)	i. Verify the documents ii. Inform the Ministry of Environment and Forests of any illegal traffic iii. Analyse wastes permitted for imports and exports iv. Train officials on the provisions of the (Management, Handling and Transboundary Movement) Rules, 2008 and in the analysis of hazardous wastes v. Take action against exporter/importer for violations under the Indian Ports Act, 1908/Customs Act, 1962

FORM 1

[See rules 5(3) and (7)]

APPLICATION FOR OBTAINING AUTHORISTION FOR COLLECTION/RECEPTION/TREATMENT/TRANSPORT/STORAGE /DISPSOAL OF HAZARDOUS WASTE*

From: ....
....

To
The Member Secretary,
.... Pollution Control Board/......................Pollution Control Committee,
....

Sir,

I / We hereby apply for authorisation/renewal of authorisation under sub-rule (3) of Rule 5 of the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 for collection/reception/treatment/ transport/storage/disposal of hazardous wastes.

For Office Use Only

5. Code No. :

6. Whether the unit is situated in a critically polluted area as identified by Ministry of Environment and Forests;

To be filled in by Applicant

Part A: General

3. (a) Name and address of the unit and location of activity :

(b) Authorisation required for (Please tick mark appropriate activity / activities :
- (i) collection
- (ii) reception
- (iii) treatment
- (iv) transport
- (v) storage
- (vi) disposal

(c) In case of renewal of authorisation previous authorisation number and date

* delete whichever is not applicable

4. (a) Whether the unit is generating hazardous waste as defined in these Rules:
(b) If so the type and quantity of wastes (in Tonnes/KL) :

5. (a) Total capital invested on the project (in Rupees) :
(b) Year of commencement of production :
(c) Whether the industry works general/ 2 shifts/ round the clock :

6. (a) List and quantum of products and by-products (in Tonnes/KL) :
(b) List and quantum of raw material used (in Tonnes/KL) :

7. Furnish a flow diagram of manufacturing process showing input and output in terms of products, waste generated including for captive power generation and demineralised water.

Part B: Hazardous Waste

8. Hazardous Wastes:
   (a) Type of hazardous wastes generated as defined under these Rules :
   (b) Quantum of hazardous waste generated :
   (c) Sources and waste characteristics : (Also indicate wastes amenable to recycling, re-processing and reuse)
   (d) Mode of storage within the plant, method of disposal and capacity: (provide details).

9. Hazardous Wastes generated as per these Rules from storage of hazardous chemicals as defined under the Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989

Part C: Treatment, Storage and Disposal Facility

10. Detailed proposal of the facility (to be attached) to include :
   (i) Location of site (provide map) :
   (ii) Name of waste processing technology :
   (iii) Details of processing technology :
   (iv) Type and Quantity of waste to be processed per day :
   (v) Site clearance (from local authority, if any) :
   (vi) Utilization programme for waste processed (Product Utilization) :
   (vii) Method of disposal (details in brief be given) :
   (viii) Quantity of waste to be disposed per day :
   (ix) Nature and composition of waste :
   (x) Methodology and operational details of land filling/ incineration :
   (xi) Measures to be taken for prevention and control of environmental pollution including treatment of leachate :
   (xii) Investment on Project and expected returns :
   (xiii) Measures to be taken for safety of workers working in the plant :

Place : **Signature : ....**
Date : **Designation : ....**

FORM 2
[See rule 5(4)]

FORM FOR GRANT/RENEWAL OF AUTHORISATION BY SPCB/PCC FOR OCCUPIERS, REPROCESSORS, REUSERS AND OPERATORS OF FACILITIES FOR COLLECTION, RECEPTION, TREATMENT, STORAGE, TRANSPORT, AND DISPOSAL OF HAZARDOUS WASTE

1. Number of authorisation and date of issue :

2. ……………………of……………………………is hereby granted an authorisation to operate a facility for collection, reception, treatment, storage, transport and disposal of hazardous waste on the premises situated at………………………………………………

3. The authorisation granted to operate a facility for generation, collection, reception, treatment, storage, transport and disposal of hazardous wastes.

4. The authorisation shall be in force for a period of ………………………………………

5 The authorisation is subject to the conditions stated below and the such conditions as may be specified in the rules for the time being in force under the Environment (Protection) Act, 1986.

Date :

Signature of Issuing Authority
Designation and Seal

Terms and conditions of authorisation

1. The authorisation shall comply with the provisions of the Environment (Protection) Act, 1986, and the rules made there under.

2. The authorisation or its renewal shall be produced for inspection at the request of an officer authorised by the SPCB/PCC.

3. The person authorised shall not rent, lend, sell, transfer or otherwise transport the hazardous wastes without obtaining prior permission of the SPCB/PCC.

4. Any unauthorized change in personnel, equipment as working conditions as mentioned in the application by the person authorised shall constitute a breach of his authorisation.

5. It is the duty of the authorised person to take prior permission of the SPCB/PCC to close down the facility.

6. An application for the renewal of an authorisation shall be made as laid down under these Rules.

7. Any other conditions for compliance as per the Guidelines issued by the MoEF or CPCB.

FORM 3
[See rule 5 (6), and 22 (1)]

FORMAT FOR MAINTAINING RECORDS OF HAZARDOUS WASTES BY THE OCCUPIER OR OPERATOR OF A FACILITY

1. Name and address of the occupier or operator of a facility :

2. Date of issuance of authorisation and its reference number :

3. Description of hazardous waste :

Physical form with description	Chemical form	Total volume (m^3) and weight (in kg.)

4. Description of storage and treatment of hazardous waste :

Date	Method of storage of hazardous wastes	Date	Method of treatment of hazardous wastes

5. Details of transportation of hazardous waste

Name and address of the consignee of package	Mode of packing of the waste for transportation	Mode of transportation to site of disposal	Date of transportation

6. Details of disposal of hazardous waste :

Date of disposal	Concentration of hazardous constituents in the final waste form	Site Of disposal (identify the location on the relevant layout drawing for reference)	Method of disposal	Persons involved in disposal

7. Data on environmental surveillance :

Date of measu-rement	Analysis of ground water			Analysis of soil samples			Analysis of air samples		Analysis of any other samples (give details)
	Locatin of sampling	Depth of sampling	Data	Location of sampling	Depth of sampling	Data	Location of sampling	Data	

8. Details of hazardous waste sold/auctioned to the recyclers or reprocessors or re-users:

9. Details of hazardous waste reused or recycled :

Date	Total Quantity of Hazardous Wastes generated	Details of hazardous waste minimization activity	Materials received	Final Quantity of waste generated	Net reduction in waste generation quantity and percentage

Date: **Name and signature of the Head of facility**

Place:

FORM 4

[See rules 5(6) and 22 (2)]

FORM FOR FILING ANNUAL RETURNS BY THE OCCUPIER OR OPERATOR OF FACILITY

[To be submitted by occupier/operator of disposal facility to State Pollution Control Board/ Pollution Control Committee by 30th June of every year for the preceding period April to March]

1.	Name and address of the generator/ operator of facility	:				
2.	Name of the authorised person and full address with telephone and fax number	:				
3.	Description of hazardous waste	:	Physical form with description		Chemical form	
4.	Quantity of hazardous wastes (in MTA)	:	**Type of hazardous waste**		**Quantity (in Tonnes /KL)**	
			(a)			
			(b)			
			(c)			
			....		....	
5.	Description of Storage	:				
6.	Description of Treatment	:				
7.	Details of transportation	:	Name & address of consignee	Mode of packing	Mode of transportation	Date of transportation
8.	Details of disposal of hazardous waste	:	Name & address of consignee	Mode of packing	Mode of transportation	Date of transportation
9.	Quantity of useful materials sent back to the manufacturers* and others#	:	Name and type of **material sent back to**		**Quantity in Tonnes/KL**	
			Manufacturers*			
			Others#			

* *delete whichever is not applicable*

\# *enclose list of other agencies.*

Signature :

Designation :

Date : ....

Place : ....

FORM 5

[See rule 8(1)]

FORM OF APPLICATION FOR GRANT/RENEWAL OF REGISTRATION OF INDUSTRIAL UNITS POSSESSING ENVIRONMENTALLY SOUND MANAGEMENT FACILITIES FOR REPROCESSING/RECYCLING

(To be submitted to the Central Pollution Control Board in triplicate by the Reprocessor/Recycler)

1	Name and Address of the unit :			
2.	Name of the occupier or owner of the unit with designation, Tel / Fax:			
3	Date of commissioning of the unit :			
4.	No. of workers (including contract labourers) :			
5	Consent Validity	a) Water (Prevention & Control of Pollution) Act, 1974 valid up to......................... b) Air (Prevention & Control of Pollution) Act, 1981 valid up to.........................		
6.	Product Manufactured during the last three years (Tonnes / Year)	**Year**	**Name of the Product**	**Quantity in Metric Tonnes or KL**
			a)	
			b)	
			c)	
7.	Raw material consumption during last three years (Tonnes/ year)	**Year**	**Name of the Raw Material consumed**	**Quantity in Metric Tonnes or KL**
			a)	
			b)	
			c)	
8.	Manufacturing Process	Please attach manufacturing process flow diagram for each product (s)		
9.	Water Consumption	Industrial ....m^3/ day Domestic...............................m^3/day		
10	Water Cess paid up to (date)	....		
11	Waste water generation as per consent...........m^3/day	Industrial/Domestic Actual.........m^3/day (avg. of last 3 months)		
12	Waste water treatment (provide flow diagram of the treatment scheme)	Industrial Domestic		

13	Waste water discharge	Quantity.................................. m^3/day Location.. Analysis of treated waste water for parameters such as pH, BOD, COD, SS, O&G and any other as stipulated by the SPCB/PCC (attach details)
14.	Air Pollution Control	
	a. Flow diagram for emission control system (s) installed for each process unit, utilities etc.	
	b. Details of facilities provided control of fugitive emission due to material handling, process, utilities etc.	
	c. Fuel consumption	**Name of fuel** / **Quantity per Day/Month :** a) b)
	d. Stack emission monitoring results	**Stack attached to:** / **Emissions (for SPM, SO_2, NO_x and Metals (like Pb etc.) in particulates in mg/Nm^3**
	e. Ambient air quality	**Ambient air quality location:** / **Parameters (SPM, SO_2, NO_x, Pb, any other) in µg/ m^3**
15.	Hazardous waste management :	
	a. Waste generation :	**S. No.** / **Name** / **Category** / **Quantity (last 3 years)**
	b. Details on collection , treatment and transport :	
	c. Disposal	
	(i) Please attach Details of the disposal facilities	
	(ii) Please attach analysis report of characterisation of hazardous waste generated (including leachate test if applicable)	
16.	Details of hazardous wastes proposed to be acquired through sale/negotiation/ contract or import as the case may be for use as raw material.	1. Name 2. Quantity required per year 3. Waste listing & No. in Annex VIII (List A)/ Annex IX (List B) of Basel Convention (BC) 4. Hazard Characteristic as per Annex III of BC

17	Occupational safety and Health aspects	Please provide details of facilities provided
18	Remarks	
	(i) whether industry has provided adequate pollution control system/ equipment to meet the standards of emission/effluent.	Yes / No
	(ii) whether HW collection and Treatment , Storage and Disposal Facility (TSDF) are operating satisfactorily.	Yes / No
	(iii)Whether conditions exists or likely to exists of the hazardous waste being handled /processed of posing immediate or delayed adverse impacts on the Environment.	Yes / No
	(iv) Whether conditions exists or is likely to exists of the wastes being handled / processed by any means capable of yielding another material eg , leachate which may possess eco-toxicity.	Yes / No
19	Any other Information i) ii) iii)	
20	List of enclosures as per rule	

Signature :
Designation :

Date:............
Place:............

FORM 6

[see rules 8 (7)]

FORM FOR FILING ANNUAL RETURNS AND RECORDS ON RECYCLABLE HAZARDOUS WASTES BY THE RECYCLERS

[To be submitted by recyclers to State Pollution Control Board/Pollution Control Committee by 30th June of every year for the preceding period April to March]

1.	Name and address of the recycler :			
2.	Name of the authorized person and full address with telephone and fax number :			
3.	Installed annual capacity to recycle or dispose the hazardous waste (in MTA) :			
4.	Quantity hazardous waste (in MTA) purchased/sold	Type of wastes	Source of purchase/sold	Quantity (in MTA)
5.	Quantity of hazardous wastes processed :	Type of wastes processed	Quantity (in MTA)	
6.	Quantity and type of material recovered (in MTA)	Type of material recovered	Quantity (in MTA)	
7.	Quantity of useful materials sent back to the generators/ manufacturers* and others#	Name and type of material sent back to	Quantity in Tonnes/KL	
		Manufacturers*		
		Others#		
8.	Quantity of hazardous waste generated (in MTA) and its disposal methods.	Type of wastes	Quantity (in MTA)	Method of Dispsoal

* delete whichever is not applicable

\# enclose list of other agencies

Signature :

Place : ....

Designation :

Date : ....

FORM 7

[See rule 15 (1) and 16 (1)]

APPLICATION FOR IMPORT OR EXPORT OF HAZARDOUS WASTE FOR REPROCESSING/RECYCLING/REUSE

From

....

....

TO BE MAILED BY IMPORTER

To

The Member Secretary,
..................State Pollution Control Board/...........Pollution Control Committee
....

Sir,

I/we apply for permission for import of recyclable hazardous wastes.

FOR OFFICE USE ONLY

1. Code No. :

2. Whether the unit is situated in a critically polluted area as identified by the Ministry of Environment and Forests : If yes provide details.

TO BE FILLED IN BY APPLICANT

1. Name and Address of the Exporter with telephone number :
2. Details of hazardous waste to be exported/imported for recycling/reprocessing/reuse:

S.No.	Particulars of hazardous wastes	Six digit Code No.*	Constituent (s) expected	Quantity MT/KL	Any special handling requirement?

* *(Here enter as reference nomenclature, the equivalent six digit code no. from European Waste Catalogue EWC, issued pursuant to the Article 1 (a) of Council Directive 75/442/EEC on waste or its equivalent as the case may be).*

3. The hazardous waste permitted shall be fully insured for transit as well as for any accidental occurrence and its cleanup operation.

4. The exported wastes shall be taken back, if it creates a genuine environmental hazard or shall take all such measures to treat and dispose in an environmentally benign manner upto the satisfaction of concerned SPCB/PCC. All such costs involved in such operation shall be borne by Exporter and/or Importer

5. Name and Address of the importer with telephone number :

6. Whether authorization obtained : (Enclose the copy).

7. Whether you have received such imported hazardous waste in the past and if yes give details.

S.No	Description of hazardous wastes	Country of Export	Year	Quantity in tones

8. Whether the importer has :

   (a) Adequate facility to handle imported hazardous waste details). :(If yes furnish

   (b) Adequate facility to handle the hazardous wastes generated by the use of such imported hazardous wastes :(Provide details)

9. Break-up of the imported wastes :

   a. The total quantity applied for :....... Tonnes

   b. Out of (a) above, how much quantity after initial in-situ purification, will be available as raw material :...... Tonnes

   c. Out of (b) above, how much quantity will be converted into the useful product or co-product :...... Tonnes

10. Means of Transport (Road, Rail, inland waterway, sea, air) including country of export, transit and import, also point of entry and exit where these have been designated.

11. Information on special handling requirements including emergency provision in case of accident : **(Attach details)**

12. Undertaking :

I hereby solemnly undertake that

(i) The full consignment shall be cleared in one lot by arranging authorised transporter under my supervision with due prior intimation to the SPCB/PCC, District Collector and Police Station and the imported waste shall be admitted in an enclosure especially provided in the premises.

(ii) The waste permitted shall be fully insured for transit as well as for any accidental occurrence and its clean-up operation.

(iii) The record of consumption and fate of the imported waste shall be monitored and report sent to the SPCB/PCC every fortnight.

(iv) At every step of consumption of 25, 50, 75 and 100% of the imported waste, the situation in the store shall be shown to the SPCB/PCC at our cost.

(v) The hazardous waste which gets generated in our premises by the use of imported hazardous wastes in the form of raw material shall be treated and disposed of and only as per conditions of authorisation.

(vi) I agree to bear the cost of export and mitigation of damages if any.

(vii) I am aware that there are significant penalties for submitting a false certificate/ undertaking/ disobedience of the rules and lawful orders including the possibility of fine and imprisonment.

Signature of the Applicant

Date................ Designation

Place...............

Form 8

[See rules 15 (1) and 16 (1)]

APPLICATION FOR TRANSBOUNDARY MOVEMENT OF HAZARDOUS WASTE

S. No.	Description	Details to be furnished by the Exporter/Importer
1.	Exporter (Name & Address) :	
	Contact person :	
	Tel/fax :	
	Reason for export :	
2.	Importer/Recycler (Name & Address) :	
	Contact person :	
	Tel/fax :	
3.	Application concerning (1) :	
	Applicants reference number :	
	A. Single / Multiple movement : B. Recovery/Reprocessing Operation : C. Pre-authorized recovery/reprocessing facility (1) :	
4.	Total intended number of shipments :	
5.	Estimated quantity (3) in Kg/Liters :	
6.	Intended date(s) or period of time for shipment(s) :	
7.	Intended carrier(s) (name, address) (2) :	
	Contact person: Tel/fax. :	
8.	Waste generator (s) (Name, address) (2) :	
	Contact Person Tel/fax :	
	Site of generation & Process :	
9.	Method(s) of recycling (4) :	
	R Code :	
	Technology employed :	
10.	Means of transport (4) :	
11.	Packaging type(s) (4) :	
12.	(i) Designation and complete chemical composition of waste *(attach details)* :	

	(ii) Special handling requirements :	
13.	Physical characteristics [4] :	
14.	Waste identification code :	
	Basel No :	
	OECD No. :	
	UN No. :	
	ITC (HS) :	
	Customs Code (H.S.) :	
	Other (specify) :	
15	OECD classification [1] *(attach details)*	
	(a) amber/red/other :	
	(b) Number :	
16.	Y- Number [4] :	
17.	H-Number [4] :	
18.	(a) UN identification Number :	
	(b) UN shipping name :	
	(c) UN class [4] :	
	(d) Other :	
19.	Concerned states, code number of competent authorities, and specific points of entry and exit :	
	State of export :	
	States of transit :	
	State of import :	
20.	Customs offices of entry and/or departure **Entry:** | **Departure :**	
21.	Exporter's / Generator's declaration: I certify that the information is complete and correct to my best knowledge. I also certify that Legally-enforceable written contractual obligations have been entered into and that any applicable insurance or other financial guarantees are or shall be in force covering the transboundary movement. **Name:** **Signature:** **Date:**	
22.	Number of annexes attached	

FOR USE BY COMPETENT AUTHORITIES		
23.	To be completed by competent authority of Import :	
	Notification Received on :	
	Transit (Basel) :	
	a) Acknowledgement sent on :	
	b) Name of Competent authority, Stamp and/or signature	
24	Consent to the movement provided by the competent authority of (Country) :	
	a) Consent given on :	
	b) Consent expires on :	
	c) Specific condition :	(Yes/No) (Please attach)
	d)Name of Competent authority, Stamp and/or signature :	

FOR USE BY CUSTOMS OFFICES

25	COUNTRY OF EXPORT/DISPATCH OR CUSTOMS OFFICE OF EIXIT			
	The waste described overleaf has left the country on :			
	Stamp :			
	Signature :			
26.	COUNTRY OF IMPORT/DESTINATION :			
	The waste described overleaf has entered the country on :			
	Stamp :			
	Signature :			
27.	STAMPS OF CUSTOMS OFFICES OF TRANSIT COUNTRIES	**Name of Country**	**Entry**	**Departure**

Notes: (1) Enter X in appropriate box ; (2) Attach list if more than one ; (3) Attach detailed list of multiple shipment ; (4) See following codes

List of abbreviations used in the Movement Document

RECOVERY OPERATIONS (S.No. 9)	
R 1	Use as a fuel (other than in direct incineration) or other means to generate energy
R 2	Solvent reclamation/regeneration
R 3	Recycling/reclamation of organic substances which are not used as solvents
R 4	Recycling/reclamation of metals and metal compounds
R 5	Recycling/reclamation of other inorganic materials
R 6	Regeneration of acids or bases
R 7	Recovery of components used for pollution abatement
R 8	Recovery of components from catalyst
R 9	Used oil re-refining or other reuses of previously used oil
R 10	Land treatment resulting in benefit to agriculture or ecological improvement
R 11	Uses of residual materials obtained from any of the operations numbered R 1 to 10
R 12	Exchange of wastes for submission to any of the operations numbered R 1 to R 11
R 13	Accumulation of material intended for any operation numbered R 1 to R 12

MEANS OF TRANSPORT (S.No.10)	PACKAGING TYPES (S.No.11)	H NUMBER (S.No.17) AND UN CLASS (S.No. 18)		
		UN Class	H Number	Designation
R= Road	1. Drum	1	H 1	Explosive
T= Train/Rail	2. Wooden barrel	3	H 3	Inflammable liquids
S=Sea	3. Jerrican	4.1	H 4.1	Inflammable solids
A= Air	4. Box	4.2	H 4.2	Constituents or wastes liable to spontaneous combustion
W=Inland Waterways	5. Bag	4.3	H 4.3	Constituents or wastes which, in contact with Water emit inflammable gases
	6.Composite packaging	5.1	H 5.1	Oxidizing
	7.Pressure receptacle	5.2	H 5.2	Organic peroxides
	8. Bulk	6.1	H 6.1	Poisonous (acute)
	9.Other (specify)	6.2	H 6.2	Infectious wastes
		8	H 8	Corrosives
		9	H 10	Liberation of toxic gases in contact with air or water
		9	H 11	Toxic (delayed or chronic)
		9	H 12	Ecotoxic
		9	H 13	Capable, by any means, after disposal of yielding another material e.g. leachate, which Possesses any of the characteristics listed above

PHYSICAL CHARACTERISTICS (Sl. No. 13)	
	1. Powdery/powder
	2. Solid
	3. Viscous/paste
	4. Sludge
	5. Liquid
	6. Gaseous
	7.Other (specify)

FORM 9

[See rules 15 (5) and 16 (5)]

TRANSBOUNDARY MOVEMENT - MOVEMENT DOCUMENT

S. No	Description	Details to be furnished by the Exporter/Importer
1.	(i) Exporter (Name & Address) :	
	Contact person :	
	Tel./Fax :	
	(ii) Waste Generator (name and address) (1) :	
	Contact person with Tel./Fax :	
	Site of generation :	
2	Importer/recycler (name & address) :	
	Contact person with Tel./Fax :	
3.	Corresponding to applicant Ref. No. :	
	Movement subject to single/multiple.	
4.	Serial number of shipment :	
5.	(a) 1st Carrier (Name. address) : Registration number : Tel/fax Identity of Means of Transport (3) : Date of Transfer : Signature of Carrier's representative :	
	(b) 2nd Carrier (name, address) : Registration number : Tel/fax : Identity of Means of Transport (3) : Date of Transfer : Signature of Carrier's representative :	
	(c) Last Carrier (name, address) (4) : Registration number : Tel/fax : Identity of Means of Transport (3) : Date of Transfer : Signature of Carrier's representative :	
6.	Disposer (name, address) :	

	Contact person :	
	Actual site of disposal	
	Tel/fax :	
7.	Method(s) of recovery :	
	R code :	
	Technology employed* *(Attach details if necessary).	
8.	Designation and chemical composition of the waste :	
9.	Physical characteristics (3).	
10.	Actual quantity Kg/litre	
11.	Waste identification code :	
	Basel No :	
	OECD No. :	
	UN No. :	
	ITC (HS) :	
	Customs Code (H.S.) :	
	Other (specify) :	
12.	OECD Classification (2) (a)amber/red/other[attach details] (b) number	
13.	Packaging Type(3) :	
	Number :	
14.	UN Classification :	
	UN shipping name :	
	UN identification No. :	
	UN Class (3) :	
	H Number (3) :	
	Y Number :	
15.	Special handling requirements :	
16.	Actual date of shipment :	
17.	Exporter's declaration: I certify that the information in Sl No.1 of 16 above is complete and correct to my best knowledge. I also certify that legally-enforceable written contractual obligations have been entered into, that any applicable insurance or other financial guarantees are in force covering the transboundary movement and that all necessary authorizations have been received from the competent authorities of the States concerned. Date: Signature: Name:	

TO BE COMPLETED BY IMPORTER/RECYCLER		
18.	Shipment received by Importer/Recycler	
	Quantity received .... Kg/litres Date: Name: Signature	
19.	Shipment received at recycler :	
	Quantity received at recycler: Kg/litres	
	Quantity received and accepted: Kg/litres Date: Name: Signature	
20.	Approximate date of recycling :	
21	Method of recycling :	
22.	I certify that the Recycling of the wastes described above will be completed as per HW (M, H and TM) Rules **Signature:** **Date:**	
23.	SPECIFIC CONDITIONS ON CONSENTING TO THE MOVEMENT :	*(attach details)*

Notes:- (1) Attach list, if more than one; (2) Enter X in appropriate box; (3) See codes on the reverse (x) Immediately contact Competent Authority; (4) If more than three carriers, attach information as required in Sl.No. 5.

List of abbreviations used in the Movement Document

RECOVERY OPERATIONS (S.No. 7)	
R 1	Use as a fuel (other than in direct incineration) or other means to generate energy
R 2	Solvent reclamation/regeneration
R 3	Recycling/reclamation of organic substances which are not used as solvents
R 4	Recycling/reclamation of metals and metal compounds
R 5	Recycling/reclamation of other inorganic materials
R 6	Regeneration of acids or bases
R 7	Recovery of components used for pollution abatement
R 8	Recovery of components from catalysts
R 9	Used oil re-refining or other reuses of previously used oil
R 10	Land treatment resulting in benefit to agriculture or ecological improvement
R 11	Uses of residual materials obtained from any of the operations numbered R 1 to 10
R 12	Exchange of wastes for submission to any of the operations numbered R 1 to R 11
R 13	Accumulation of material intended for any operation numbered R 1 to R 12

MEANS OF TRANSPORT (S.No,5)	PACKAGING TYPES (S.No.13)
R= Road	1. Drum
T= Train/Rail	2. Wooden barrel
S=Sea	3. Jerrican
A= Air	4. Box
W=Inland Waterways	5. Bag
	6.Composite packaging
	7.Pressure receptacle
	8. Bulk
	9. Other (specify)

H NUMBER (S.No.14) AND UN CLASS (S.No. 14)

UN Class	H Number	Designation
1	H 1	Explosive
3	H 3	Inflammable liquids
4.1	H 4.1	Inflammable solids
4.2	H 4.2	Constituents or wastes liable to spontaneous combustion
4.3	H 4.3	Constituents or wastes which, in contact with Water emit inflammable gases
5.1	H 5.1	Oxidizing
5.2	H 5.2	Organic peroxides
6.1	H 6.1	Poisonous (acute)
6.2	H 6.2	Infectious wastes
8	H 8	Corrosives
9	H 10	Liberation of toxic gases in contact with air or water
9	H 11	Toxic (delayed or chronic)
9	H 12	Ecotoxic
9	H 13	Capable, by any means, after disposal *of* yielding another material e.g. leachate, which Possesses any *of* the characteristics listed above

PHYSICAL CHARACTERISTICS (Sl. No. 09)	
	1. Powdery/powder
	2. Solid
	3. Viscous/paste
	4. Sludge
	5. Liquid
	6. Gaseous
	7.Other (specify)

Y Number (S.No.13) refer to categories of waste listed in Annexure I and II of the Basel Convention as well as more detailed information can be found in an instruction manual available from the Secretariat of the Basel Convention

FORM 10

[See rule 15 (7) and 16 (7)]

FORMAT FOR MAINTAINING RECORDS OF HAZARDOUS WASTE IMPORTED AND EXPORTED

1. Name and address of the importer/exporter :
2. Date and reference number of issuance of permission to import/export hazardous wastes :
3. Description of hazardous waste :

S.No	Dates of import/export and relevant consignment numbers	Origin /destination of waste	Total volume and weight (in kilograms)	Physical form	Chemical form	Test report

4. Description of storage, treatment and reuse of hazardous waste :

S.No	Dates of import/export and relevant consignment numbers	Total volume and weight (in kilograms)	Test report	Method of Storage	Method of treatment and reuse (give details)

FORM 11

[See rule 20 (2)]

TRANSPORT EMERGENCY (TREM) CARD

[To be carried by the transporter during transportation of hazardous wastes, provided by the Occupier or Operator of a Facility]

1. Characteristics of hazardous wastes :

S. No.	Type of Waste	Physical Properties/	Chemical Constituents	Exposure Hazards	First Aid Requirements

2. Procedure to be followed in case of fire :
3. Procedure to be followed in case of spillage/accident/explosion :
4. For expert services, please contact :
   i) Name & Address :
   ii) Telephone No. :

(Name and Signature of Occupier/authorized representative)

FORM 12
[See rule 20(2)]

MARKING OF HAZARDOUS WASTE CONTAINER

HAZARDOUS WASTE *

Handle with Care

Waste Category No	Compatible Group ....
Total Quantity	Date of Storage
Contents and State of the Waste :	
Sender's Name & Address	Receiver's Name & Address
Phone	Phone ....
E-mail.....	E-mail .....
Tel. & Fax No	Tel.& Fax No ....
Contact Person	Contact Person ....
In case of emergency please contact	

Note :

1. *Background colour of lab l fluorescent yellow.*
2. *The words 'HAZARDOUS WASTES' & 'HANDLE WITH CARE' to be prominent and written in red in Hindi, English and in Vernacular Language*
3. *Label should be of non-washable material.*

** delete which ever is not applicable*

FORM 13

[See rule 21 (1)]

HAZARDOUS WASTE MANIFEST

1.	Occupier's Name & Mailing Address (including Phone No.) :	
2.	Occupier's Registration No. :	
3.	Manifest Document No. :	
4.	Transporter's Name & Address :(including Phone No.)	
5.	Type of Vehicle :	(Truck/Tanker/Special Vehicle)
6.	Transporter's Registration No. :	
7.	Vehicle Registration No. :	
8.	Designated Facility Name &Site Address :	
9.	Facility's Registration No. :	
10.	Facility's Phone :	
11.	Waste Description :	
12.	Total Quantity :	..................................m^3 or MT
13.	Consistency :	(Solid/Semi-Solid/Sludge /Oily /Tarry /Slurry)
14.	Transport Description of Wastes :	
15.	Containers :	Number / Type
16.	Total Quantity :	................................m^3 or MT
17.	Unit Wt/Vol. :	.... m^3 or MT
18.	Waste Category Number :	
19.	Special Handling Instructions & Additional Information :	
20.	OCCUPIER'S CERTIFICATE :	I hereby declare that the contents of the consignment are fully and accurately described above by proper shipping name and are categorised, packed, marked, and labeled, and are in all respects in proper condition for transport by road according to applicable national government regulations.
	Typed Name & Stamp : Signature :	Month Day Year
21.	Transporter Acknowledgement of Receipt of Wastes	
	Typed Name & Stamp : Signature :	Month Day Year
22.	Discrepancy Note Space	
23.	Facility Owner or Operator's Certification of Receipt of Hazardous Waste	
	Typed Name & Stamp : Signature :	Month Day Year

FORM 14

(See rule 24)

FORMAT OF ACCIDENT REPORT

[To be submitted by the occupier or operator of a facility and the transporter to the SPCB/PCC]

1. The date and time of the accident :
2. Sequence of events leading to accident :
3. The hazardous waste involvement in accident :
4. The date for assessing the effects of the accident on health or the environment :
5. The emergency measures taken :
6. The steps taken to alleviate the effects of accidents :
7. The steps taken to prevent the recurrence of such an accident :

[Place: **Signature:**

Date: **Designation]**

FORM 15

[see rule 26 (1) and (2)]

APPLICATION FOR FILING APPEAL AGAINST THE ORDER PASSED BY CPCB/SPCB/PCC OF THE UNION TERRITORY

1.	Name and address of the person making the appeal	:
2.	Number, date of order and address of the authority to which passed the order, against which appeal is being made	: (certified copy of the order be attached).
3.	Ground on which the appeal is being made	:
4.	Relief sought for	:
5.	List of enclosures other than the order referred in para 2 against which the appeal is being filed.	:

Signature....................................

Date: **Name and address ....**

[F. No.23-17/2006-HSMD]

R. K. VAISH, Jt. Secy.

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित

PUBLISHED BY AUTHORITY

सं. 1137] नई दिल्ली, मंगलवार, जुलाई 21, 2009/आषाढ़ 30, 1931

No. 1137] NEW DELHI, TUESDAY, JULY 21, 2009/ASADHA 30, 1931

पर्यावरण और वन मंत्रालय

अधिसूचना

नई दिल्ली, 21 जुलाई, 2009

का.आ. 1799(अ).—केन्द्रीय सरकार पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6, धारा 8 और धारा 25 द्वारा प्रदत्त शक्तियों का उपयोग करते हुए परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापारीय संचलन) नियम, 2008 का संशोधन करने के लिए निम्नलिखित नियम बनाती है ।

1. (1) इन नियमों का संक्षिप्त नाम परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापारीय संचलन) संशोधन नियम, 2009 है ।

(2) ये राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे ।

2. परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापारीय संचलन) नियम, 2008 (जिसे इसमें इसके पश्चात् उक्त नियम कहा गया है) के नियम 16 में प्राधिकृत

(क) उप नियम (5) में निम्नलिखित रखा जाएगा, अर्थात् :—

"परन्तु कि अनुसूची 3 के भाग ख में यथाविनिर्दिष्ट बेसल संख्या बी 1010, बी 1040, बी 1050, बी 1100, बी 1230 और बी 3020 में आने वाले परिसंकटमय अपशिष्टों के आयात की दशा में पत्तन या सीमा-शुल्क प्राधिकारी यह सुनिश्चित करेंगे कि लदाई के साथ प्रारूप 9 में संचलन दस्तावेज और निर्यातक देश द्वारा प्रमाणित निरीक्षण अभिकरण द्वारा जारी लदाई पूर्व निरीक्षण प्रमाण पत्र है । ";

(ख) उप नियम (6) के पश्चात् निम्नलिखित उप नियम अन्तःस्थापित किया जाएगा, अर्थात् :—

"(6क) उप नियम (6) में अन्तर्विष्ट कोई बात अनुसूची 3 के भाग ख में यथा विनिर्दिष्ट बेसल संख्या बी 1010, बी 1040, बी 1050, बी 1100, बी 1230 और बी 3020 के अंतर्गत आने वाले परिसंकटमय अपशिष्टों को लागू नहीं होगी ;

परन्तु सीमा शुल्क प्राधिकारी, किसी समय, यदि वह आवश्यक समझे, पारेषण की निकासी से पूर्व पारेषण का यादृच्छिक निरीक्षण कर सकेगा । "

3. उक्त नियमों के नियम 18 के उपनियम (5) में "प्रारूप 10" शब्द और अंक के स्थान पर "प्रारूप 3" शब्द और अंक रखे जाएंगे ।

4. उक्त नियम की अनुसूची 3 में ;

(i) भाग ख में, बेसल संख्या ख 3020 के सामने स्तंभ (2) के नीचे की प्रविष्टियों में "पेपर, पेपर बोर्ड और पेपर उत्पाद अपशिष्ट****" शब्दों और चिह्नों के स्थान पर निम्नलिखित शब्द और चिह्न रखे जाएंगे, अर्थात् :

"पेपर, पेपर बोर्ड और पेपर उत्पाद अपशिष्ट**"

(ii) भाग ख से संबंधित प्रविष्टियों के पश्चात् और टिप्पण से पूर्व चिह्नों और शब्दों " ** बिना किसी अनुज्ञप्ति या निर्बंधन के देश में आयात की अनुमति है," के स्थान पर निम्नलिखित चिह्न और शब्द रखे जाएंगे, अर्थात् :—

" ** वास्तविक उपभोक्ताओं द्वारा देश में बिना किसी अनुज्ञप्ति या निर्बंधन के आयात की अनुमति है ।"

5. उक्त नियमों में फार्म 3 में दिए गए शब्दों, अंकों, कोष्ठकों "नियम 5(6) और 22 (1) देखें" के स्थान पर "नियम 5(6), 18 (5) और 22(1) देखें, शब्दों, अंकों और कोष्ठकों को रखा जाएगा ।"

6. उक्त नियम में प्रारूप 9 और उससे संबंधित प्रविष्टियों के स्थान पर निम्नलिखित प्रारूप और प्रविष्टियां रखी जाएंगी, अर्थात् :—

"प्रारूप 9

[नियम 15(5) नियम 16(5), नियम 16(6) देखें]

सीमापार संचलन-संचलन दस्तावेज

क्र. सं.	विवरण	निर्यातक/आयातक द्वारा दिए जाने वाले ब्यौरे
(1)	(2)	(3)
1.	(i) निर्यातकर्ता (नाम और पता)	:
	सम्पर्क व्यक्ति	:
	टेनी/फैक्स	:
	(ii) अपशिष्ट उत्पादक/** प्रवर्ग का निर्यातकर्ता (नाम और पता)	:
	सम्पर्क व्यक्ति टेली/फैक्स सहित	:
	(iii) उत्पादन का स्थल	:
2.	आयातकर्ता/पुन: चक्रणकर्ता (नाम और पता)	:
	सम्पर्क व्यक्ति टेली/फैक्स सहित	:
	एक/अधिक संचलन के अध्यधीन	:
3.	आवेदक संदर्भ संख्या के अनुरूप, यदि कोई हो	:
4.	पोत लदाई का बिल (प्रति संलग्न करें)	
5.	अपशिष्ट का अभिधान और रासायनिक संयोजन	:
6.	भौतिक लक्षण (3)	:
7.	वास्तविक मात्रा कि. ग्रा./ली.	:
8.	अपशिष्ट पहचान कोड	:
	बेसल संख्या	:
	ओ ई सी डी संख्या	:
	यू एन संख्या	:
	आई टी सी (एच एस)	:
	सीमा-शुल्क कोड (एच एस)	:
	अन्य (विशिष्ट विवरण दें)	:
9.	ओ ई सी डी वर्गीकरण (2) (क) अम्बर/लाल/अन्य (ब्यौरा संलग्न करें) (ख) संख्या	
10.	पैकिंग टाईप (3)	:
	संख्या	:
11.	यू एन वर्गीकरण	:
	यू एन पोत परिवहन का नाम	:

(1)	(2)	(3)
	यू एन पहचान संख्या	:
	यू एन वर्ग (3)	:
	एच संख्या (3)	:
	वाई संख्या	:
12.	विशेष हथालन अपेक्षाएं	:
13.	**परिसंकटमय अपशिष्ट के लिए निर्यातकर्ता की घोषणा :**	
	मैं प्रमाणित करता हूँ कि ऊपर क्र. सं. 1 से 12 में दी गई जानकारी मेरे सर्वोत्तम ज्ञान के अनुसार पूर्ण और सही है । मैं यह भी प्रमाणित करता हूँ कि विधिक रुप से प्रवर्तनीय लिखित संविदाजन्य बाध्यताओं की बाबत करार कर लिया गया है और सीमा पारीय संचलन विनियमों/नियम भी प्रवृत्त हैं ।	
	तारीख :	
	नाम : ....**हस्ताक्षर :**	
	अपशिष्ट पेपर के लिए निर्यातकर्ता की घोषणा :	
	मैं प्रमाणित करता हूँ कि ऊपर क्र. सं. 1 से 12 में दी गई जानकारी मेरे सर्वोत्तम ज्ञान के अनुसार पूर्ण और सही है । मैं यह भी प्रमाणित करता हूँ कि विधिक रुप से प्रवर्तनीय लिखित संविदाजन्य बाध्यताओं की बाबत करार कर लिया गया है । मैं यह भी प्रमाणित करता हूँ कि इस पारेषण में कोई परिसंकटमय अपशिष्ट, नगर अपशिष्ट अथवा जैव-चिकित्सीय अपशिष्ट नहीं हैं ।	
	तारीख :	
	नाम : .... **हस्ताक्षर :**	

आयातकर्ता/पुनःचक्रणकर्ता द्वारा भरा जाए

मद सं. 7

14.	आयातकर्ता/पुनःचक्रणकर्ता द्वारा प्राप्त पोत लदाई	
	प्राप्त मात्रा ....कि. ग्रा./ली.	
	तारीख :....................................	
	नाम :...हस्ताक्षर :....................................	:
15.	वसूली की रीति	
	आर कोड, यदि लागू हो	
	प्रयुक्त प्रौद्योगिकी (यदि आवश्यक हो तो ब्यौरे संलग्न करें)	:
16.	मैं प्रमाणित करता हूँ कि ऊपर निर्दिष्ट पारेषण में एच डब्ल्यू (एम, एच और टी एम) नियमों के अनुसार उसके उनके अंतगर्त आने वाला घोषित माल के अतिरिक्त किसी भी माल का आयात नहीं किया जाएगा और न ही पुनःचक्रित किया जाएगा ।	
	हस्ताक्षर:....................................	
	तारीख :....................................	
17.	संचलन पर सहमति की विशिष्ट शर्तें, यदि लागू हो	: (विवरण संलग्न करें)

टिप्पण :—(1) यदि एक से अधिक हों तो सूची संलग्न करें ; (2) समुचित बॉक्स में X चिह्नांकित करें ; (3) कोड पिछले (X)पर देखें सक्षम प्राधिकारी से तुरंत संपर्क करें ; (4) यदि वाहक तीन से अधिक हैं तो क्र. सं. 5 में यथा अपेक्षित जानकारी संलग्न करें ।

संचलन दस्तावेज में प्रयुक्त संक्षेपाक्षरों की सूची

प्रत्युद्धरण संक्रियाएं (क्र. सं. 7)

आर 1 ईंधन (प्रत्यक्ष भस्मीकरण से भिन्न) या ऊर्जा उत्पादन के अन्य साधनों के रूप में प्रयोग ।

आर 2 विलायक का उद्धरण/पुररुत्पादन ।

आर 3 ऐसे कार्बनिक पदार्थों का पुनरावर्तन/उद्धरण, जो विलायक के रूप में प्रयुक्त नहीं हुए हैं ।

आर 4 धातुओं और धातु सम्मिश्रणों का पुनरावर्तन/उद्धरण ।

आर 5 अन्य अकार्बनिक पदार्थों का पुनरावर्तन/उद्धरण ।

आर 6 अम्ल और समावारों का पुनरुत्पादन ।

आर 7 प्रदूषण उपशमन के लिए प्रयुक्त संघटकों का प्रत्युद्धरण ।

आर 8 उत्प्रेरकों से संघटकों का प्रत्युद्धरण ।

आर 9 प्रयुक्त तेल का पुन: परिशोधन या पहले प्रयुक्त तेल के अन्य पुनरुपयोग ।

आर 10 भूमि -अभिक्रिया जिसके परिणामस्वरूप कृषि या परिस्थितिकीय अभिवृद्धि का फायदा ।

आर 11 सं. आर 1 से 10 तक की किसी भी संक्रिया से प्राप्त अवशिष्ट पदार्थों का प्रयोग ।

आर 12 सं. आर 1 से आर 11 तक की किसी भी संक्रिया के उपस्थापन के लिए अपशिष्ट पदार्थों का आदान-प्रदान ।

आर 13 सं. आर 1 से आर 12 तक की किसी भी संक्रिया के लिए आशतित पदार्थ का संचलन ।

परिवहन के साधन (क्र. सं. 5)	पैकेजिंग की किस्म (क्र. सं. 13)	एच. सं. (क्र. सं. 14) और यू एन वर्ग (क्र. सं. 14)		
		यू एन वर्ग	एच वर्ग	पद
(1)	(2)		(3)	
आर=सड़क	1. ड्रम			
टी=ट्रेन/रेल	2. लकड़ी का पीपा			
एस=समुद्र	3. जैरीकेन	1	एच 1	विस्फोटक
ए=वायु	4. डिब्बा	3	एच 3	ज्वलनशील तरल
डब्यू =अंतर्देशीय जलमार्ग	5. बैग	4.1	एच 4.1	ज्वलनशील ठोस
		4.2	एच 4.2	ऐसे पदार्थ या अपशिष्ट जो स्वत: दहन के भागी हैं ।
	6. विविधक पैकेजिंग			
	7. दाब पात्र			
	8. प्रपंज			
	9. अन्य (विनिर्दिष्ट करें)	4.3	एच 4.3	ऐसे पदार्थ या अपशिष्ट जो जल के संपर्क में जाने पर ज्वलनशील गैसें उत्सर्जित करते हैं ।
		5.1	एच 5.1	आक्सीकरण
		5.2	एच 5.2	कार्बनिक पैराआक्साइडस्
		6.1	एच 6.1	विषैले (तीक्ष्ण)
		6.2	एच 6.2	संक्रामक पदार्थ
		8	एच 8	संक्षारक
		9	एच 10	हवा या जल के संपर्क में विषैले गैसों का मोचन
		9	एच 11	विषैले (विलंबित या दीर्घकालिक)
		9	एच 12	इकोटोक्सिन
		9	एच 13	अन्य सामग्री उदाहरणार्थ लीचेट,जो ऊपर सूचीबद्ध किसी भी लक्षण को रखता है, की प्राप्ति के लिए व्ययन के पश्चात् किसी भी अन्य साधन

(1)	(2)	(3)
		द्वारा समर्थ ।
भौतिक गुण (क्र. सं. 13)		1. चूर्णमय/चूर्ण 2. ठोस 3. श्यान/पेस्ट 4. पंक 5. तरल 6. गैसीय 7. अन्य (विनिर्दिष्ट करें)

वाई संख्या (क्र. सं. 13) बेसल कन्वेंशन के उपाबंध I और II में सूचीबद्ध अपशिष्ट के वर्गों को निर्दिष्ट करें, साथ ही ब्यौरेवार जानकारी बेसल कन्वेंशन के सचिवालय से उपलब्ध अनुदेश निदेशिका में मिल सकती है ।"

7. उक्त नियमों के प्रारूप 10 के "नियम 15(7) और नियम 16(7) देखें" शब्दों, कोष्ठकों और अंकों के स्थान पर नियम 15(5) देखें" शब्द, कोष्ठक और अंक रखे जाएंगे ।

[सं. 23-17/2006-एचएसएमडी]

राजीव गौबा, संयुक्त सचिव

टिप्पण :—मूल नियम भारत के राजपत्र असाधारण में अधिसूचना संख्यांक का. आ. 2265(अ) तारीख 24 सितम्बर, 2008 द्वारा प्रकाशित किए गए थे ।

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 21st July, 2009

S.O. (E). 1799.—In exercise of powers conferred by Sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules to amend the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, namely :—

1. (1) These rules may be called the Hazardous Wastes (Management, Handling and Transboundary Movement) Amendment Rules, 2009.

(2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 (hereinafter referred to as the said rules), in rule 16,—

(a) in sub-rule (5), the following shall be inserted, namely :

"Provided that the Port or Customs authorities shall, in case of import of hazardous wastes covered under Basel numbers B1010, B1040, B1050, B1100, B1230 and B 3020 as specified in Part B of the Schedule III, ensure that shipment is accompanied by the Movement Document in Form 9 and preshipment inspection certificate issued by the inspection agency certified by the exporting country.";

(b) after sub-rule (6), the following sub-rule shall be inserted, namely :

"(6A) Nothing contained in sub-rule (6) shall apply to the hazardous wastes covered under the Basel numbers B1010, B1040, B1050, B1100, B1230 and B 3020 as specified in Part B of the Schedule III:

Provided that the Customs authority may, at any time if it considers necessary, make random inspection of the consignment prior to clearing the consignment.".

3. In the said rules, in rule 18, in sub-rule (5), for the word and figure "Form 10", the word and figure "Form 3" shall be substituted.

4. In the said rule, in Schedule III,—

(i) in Part B, against Basel number B3020, in the entries under column (2), for the words and signs "Paper, paperboard and paper products wastes ****", the following words and signs shall be substituted, namely :—
"Paper, paperboard and paper product wastes **";

(ii) after the entries relating to Part B and before the Note, for the signs and words

"** Import permitted in the country without any license or restriction" the following signs and words shall be substituted, namely :—

"**: Import permitted in the country by the actual users without any license or restriction."

5. In the said rules, in Form 3. For the words, figures and brackets "See rules 5(6) and 22(1)", the words, figures and brackets" See rules 5(6), 18(5) and 22 (1)" shall be substituted.

6 .In the said rule, for the Form 9 and the entries relating thereto, the following Form and entries shall be substituted, namely :—

"FORM - 9

[See rules 15 (5), 16 (5), 16 (6)]

TRANSBOUNDARY MOVEMENT-MOVEMENT DOCUMENT

S. No.		Description		Details to be furnished by the Exporter/Importer
1.	(i)	Exporter (Name and Address) Contact person Tel/Fax	:	
	(ii)	Waste Generator /Exporter for ** category (name and address) :	:	
		Contact person with Tel./Fax	:	
	(iii)	Site of generation (excluded for**category)	:	
2.		Importer/recycler (name and address) Contact person with TeL/Fax Movement subject to single/multiple	:	
3.		Corresponding to applicant Ref. No. if any	:	
4.		Bill of lading (attach copy)	:	
5.		Designation and chemical composition of the waste	:	
6.		Physical characteristics (3)	:	
7.		Actual quantity kg/litre	:	
8.		Waste identification code Basel No OECD No. UN No. ITC (HS) Customs Code (H.S.) Other (specify)		
9.		OECD Classification (2) (a) amber/red/other [attach details] (b) number		
10.		Packaging Type (3) Number		
11.		UN Classification UN Shipping name UN Identification No. UN Class (3) H Number (3) Y Number		
12.		Special handling requirements		
13.		**Exporter's declaration for hazardous waste:** I certify that the information in Sl. No. 1 of 12 above		

S. No.	Description	Details to be furnished by the Exporter/Importer
	is complete and correct to my best knowledge. I also certify that legally-enforceable written contractual obligations have been entered into and are in force covering the transboundary movement regulations/Rules. Date:............... Signature:................ Name:............................... **Exporter's declaration for waste paper:** I certify that the information in Sl. No. 1 of 12 above is correct to the best of my knowledge. I also certify that legally-enforceable written contractual obligations have been entered into. I also certify that the consignment does not have any Hazardous waste, Municipal waste or Biomedical waste. Date: Signature: Name:	

TO BE COMPLETED BY IMPORTER/RECYCLER
Item No. 7

14.	Shipment received by Importer/Recycler Quantity received..................... Kg/litres Date: Name: Signature	
15.	Methods of Recovery R Code if applicable Technology employed (Attached details if necessary)	
16.	I certify that nothing other than declare goods covered as per HW (M, H and TM) Rules is intended to be imported in the above referred consignment and will be recycled. Signature : Date:	
17.	SPECIFIC CONDITIONS ON CONSENTING TO THE MOVEMENT if applicable.	(attach details)

Notes :—(1) Attach list, if more than one; (2) Enter X in appropriate box; (3) See codes on the reverse (x) Immediately contact Competent Authority; (4) If more than three carriers, attach information as required in Sl. No. 5.

List of abbreviations used in the Movement Document

Recovery Operations (S. NO. 7)

R 1 Use as a fuel (other than in direct incineration) or other means to generate energy
R 2 Solvent reclamation/regeneration
R 3 Recycling/reclamation of organic substances which are not used as solvents
R 4 Recycling/reclamation of metals and metal compounds
R 5 Recycling/reclamation of other inorganic materials
R 6 Regeneration of acids or bases
R 7 Recovery of components used for pollution abatement
R 8 Recovery of components from catalysts
R 9 Used oil re-refining or other reuses of previously used oil
R 10 Land treatment resulting in benefit to agriculture or ecological improvement
R 11 Uses of residual materials obtained from any of the operations numbered R 1 to R 10
R 12 Exchange of wastes for submission to any of the operations numbered R 1 to R 11
R 13 Accumulation of material intended for any operation numbered R 1 to R 12

MEANS OF TRANSPORT (Sl. No. 5)	PACKAGING TYPES (Sl. No. 13)	H NUMBER (S.No.14) AND UN CLASS (Sl. No. 14)		
1	2	3		
R = Road	1. Drum	UN Class	H Number	Designation
T= Train/Rail	2. Wooden barrel			
S=Sea	3. Jerrican	1	H 1	Explosive
A = Air	4. Box	3	H 3	Inflammable liquids
W=Inland Waterways	5. Bag	4.1	H 4.1	Inflammable solids
	6. Composite packaging	4.2	H 4.2	Constituents or wastes liable to spontaneous combustion
	7. Pressure receptacle 8. Bulk 9. Other (specify)	4.3	H 4.3	Constituents or wastes which, in contact with Water emit inflammable gases
		5.1	H 5.1	Oxidizing
		5.2	H 5.2	Organic peroxides
		6.1	H 6.1	Poisonous (acute)
		6.2	H 6.2	Infectious wastes
		8	H 8	Corrosives
		9	H 10	Liberation of toxic gases in contact with air or water
		9	H 11	Toxic (delayed or chronic)
		9	H 12	Ecotoxic
		9	H 13	Capable, by any means, after disposal of yielding another material e.g.leachate, which possesses any of the characteristics listed above

PHYSICAL CHARACTERISTICS (Sl. No. 09)

1. Powdery/powder
2. Solid
3. Viscous/paste
4. Sludge
5. Liquid
6. Gaseous
7. Other (specify)

Y Number (S.No.13) refer to categories of waste listed in Annexure I and II of the Basel Convention as well as more detailed information can be found in an instruction manual available from the Secretariat of the Basel Convention".

7. In the said rules, in Form 10, for the words, brackets and figures "See rules 15 (5) and 16 (5)", the words, brackets and figures "See rule 15(5)" shall be substituted.

[No. 23-17/2006-HSMD]

RAJIV GAUBA, Jt. Secy.

Note :—The principle rules were published in the Gazette of India, Extraordinary, *vide* notification number S.O. 2265(E), dated the 24th September, 2008.

Printed by the Manager, Govt. of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (ii)
PART II—Section 3—Sub-section (ii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 1532] नई दिल्ली, बुधवार, सितम्बर 23, 2009/आश्विन 1, 1931
No. 1532] NEW DELHI, WEDNESDAY, SEPTEMBER 23, 2009/ASVINA 1, 1931

पर्यावरण और वन मंत्रालय

अधिसूचना

नई दिल्ली, 23 सितम्बर, 2009

का.आ. 2447(अ).— केन्द्रीय सरकार पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 6 धारा 8 और धारा 25 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापार संचलन) नियम, 2008 का और संशोधन करने के लिए निम्नलिखित नियम बनाती है :-

1. (1) इन नियमों का संक्षिप्त नाम परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापार संचलन) दूसरा संशोधन नियम, 2009 है ।
   (2) ये राजपत्र में प्रकाशन की तारीख को प्रवृत्त होंगे ।

2. परिसंकटमय अपशिष्ट (प्रबंधन, हथालन और सीमापार संचलन) नियम, 2008 (जिन्हें इसमें इसके पश्चात उक्त नियम कहा गया है) के नियम 16 के उप नियम 5 के परन्तुक में "निर्यातक देश द्वारा प्रमाणित निरीक्षण अभिकरण" शब्दों के पश्चात् "या विदेश व्यापार महानिदेशक द्वारा अनुमोदित निरीक्षण और प्रमाणन अभिकरण" शब्द जोड़े जाएंगे ।

3. उक्त नियमों की अनुसूची 3 के भाग ख में की प्रविष्टियों के पश्चात् और टिप्पण से पूर्व "** वास्तविक उपभोक्ताओं द्वारा देश में बिना किसी अनुज्ञप्ति या निर्बन्धन के आयात की अनुमति है ।" शब्दों के स्थान पर, "** वास्तविक उपभोक्ताओं द्वारा बिना किसी अनुज्ञप्ति या निबंधन के या रजिस्ट्रीकृत आयातकर्ता द्वारा देश में आयात की अनुमति है, जो ऐसे आयात के उनकी मात्राओं सहित ब्यौरे और वास्तविक उपभोक्ताओं की विशिष्टियां त्रैमासिक आधार पर राज्य प्रदूषण नियंत्रण बोर्ड को देगा ।" शब्द रखे जाएंगे।

[फा. सं. 23-27/2006-एचएसएमडी]

राजीव गौबा, संयुक्त सचिव

टिप्पणी : मूल नियम भारत के राजपत्र, असाधारण में अधिसूचना सं. का.आ. 2265(अ.) तारीख 24 सितंबर, 2008 द्वारा प्रकाशित किए गए थे और संख्यक का.आ.1799 (अ) तारीख 21 जुलाई, 2009 द्वारा उनका पश्चातवर्ती संशोधन किया गया ।

MINISTRY OF ENVIRONMENT AND FORESTS

NOTIFICATION

New Delhi, the 23rd September, 2009

S.O. 2447(E).— In exercise of the powers conferred by sections 6,8, and 25 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby makes the following rules further to amend the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, namely:-

1. (1) These rules may be called the Hazardous Wastes (Management, Handling and Transboundary Movement) Second Amendment Rules, 2009.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 (hereinafter referred to as the said rules), in rule 16, in sub-rule (5), in the proviso, after the words "the exporting country", the words " or the inspection and certification agency approved by the Director General of Foreign Trade" shall be inserted.

3. In Schedule III to the said rules, in Part B, after the entries and before the Note, after the words "without any license or restriction", the words "or by importer registered with the State Pollution Control Board on behalf of the actual user who shall furnish the details of such import and particulars of the actual users along with quantities to the concerned State Pollution Control Board on a quarterly basis" shall be inserted.

[F. No. 23-27/2006-HSMD]

RAJIV GAUBA, Jt. Secy.

Note : The principal rules were published in the Gazette of India, Extraordinary vide notification number S.O. 2265 (E), dated the 24th September, 2008 and subsequently amended vide number S.O. 1799 (E), dated the 21st July, 2009.

Printed by the Manager, Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

सत्यमेव जयते

GOVERNMENT OF INDIA

MINISTRY OF URBAN DEVELOPMENT

Nirman Bhawan, New Delhi 110 011, India

http://moud.gov.in

http://cpheeo.nic.in

D.O.No. Q-15014/2/2009-CPHEEO Dated 7th July, 2014

Dear

The Ministry of Urban Development (MoUD) along with its technical wing Central Public Health and Environment Engineering Organisation (CPHEEO) in collaboration with Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ) has revised the existing Manual on Municipal Solid Waste Management (MSWM) under the ongoing "Indo German Bilateral Cooperation – Indo German Environment Partnership (IGEP)".

The revision of the Manual is carried out with the relevant inputs from the Expert Committee, Working Group Members and Special Invitees. In this regard, an Expert Committee was constituted with members drawing from various Ministries/Departments/State Govts/ULBs/International organizations and experts having experience in Municipal Solid Waste Management.

The revised Manual reflects recent technological, managerial and policy level developments in order to support decision makers, technical staff and various other stakeholders involved in the proper management and implementation of all MSWM related activities at the ground level. The Manual has incorporated the relevant inputs from the Expert Committee members, GIZ experiences and those under JnNURM.

In order to take comments from various stakeholders on the revised Manual, the Ministry is organizing a two day National Stakeholders Workshop on 24-25th July, 2014 at Vigyan Bhawan, New Delhi. The draft revised Manual has been uploaded on the MoUD website (http://moud.gov.in) and a copy of the same is enclosed for reference along with a brief note on salient features of revised Manual. Advance comments can also be forwarded to the Ministry in the format attached.

It is requested that urgent steps may please be taken to nominate one or two experts from your Ministries/Departments/State Govts./ULBs/International organizations and the details of whom may be forwarded to Ministry (Dr. Ramakant, AA(PHE), email dr.kantrama@gmail.com and tel: 011-23062305) with a copy to GIZ (Mr. Ramesh Nair, Consultant – GIZ, e-mail rameshpknair@gmail.com and telephone 011-49495353) to contact the expert at short notice so as to ensure their presence in the workshop of revision of MSWM Manual. Draft Agenda for the meeting is enclosed. One official having good experience in Storm Water Management in the city may also be deputed to have fruitful discussion on the subject during workshop.

Yours Sincerely,

(Neeraj Mandloi)

सत्यमेव जयते

Comments on the Draft Municipal Solid Waste Management Manual (2014)

Central Public Health Environmental Engineering Office

Ministry of Urban Development, Government of India

Name of Commenter:

Designation & Organization of Commenter

Contact details: E-mail:

Phone #:

Address:

Date of Commenting:

(For each comment please indicate the following)

Part of the Manual: **Part I** ☐ **Part II** ☐

Section:

Sub-section:

Comment:

(For each comment please indicate the following)

Part of the Manual: **Part I** ☐ **Part II** ☐

Section:

Sub-section:

Comment:

(For each comment please indicate the following)

Part of the Manual: **Part I** ☐ **Part II** ☐

Section:

Sub-section:

Comment: